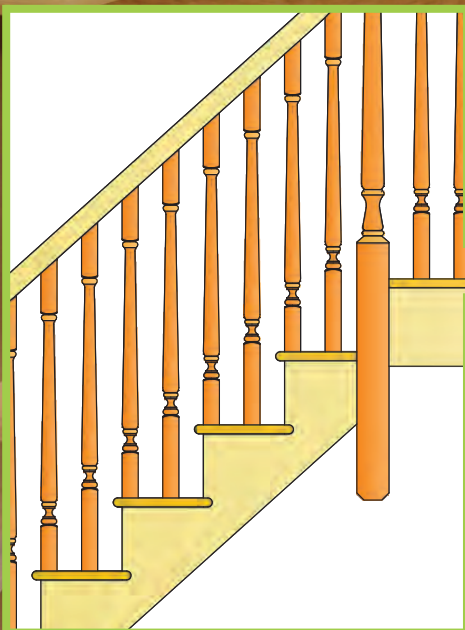




Simply Stairs

**The Definitive
Handbook for
Stair Builders**

Mark Milner

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Whittles Publishing

Published by
Whittles Publishing,
Dunbeath,
Caithness KW6 6EG,
Scotland, UK

www.whittlespublishing.com

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Reprinted with corrections 2016

978-184995-149-4

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Preface

At the age of 40, when six-metre-long planks of timber started to feel a little heavier, splinters in the hands more painful, and early morning starts more difficult, I switched from industry to education. It was then that I was introduced to the numerous high quality carpentry books available to help students of the trade in their studies – books still widely used today. Covering a broad range of woodwork activities, they enable readers to learn about the names of components, the relevant Building Regulations, and the methods of construction. As good as these books are, however, I have always felt that there are some subjects which warrant more than a single chapter's coverage. Stairs is one.

For trainees, apprentices, and others in education, stairs remain part of the criteria of wood occupation NVQs and have been awarded equal prominence in Construction Diplomas. In writing *Simply Stairs* though, my aim has been to create not only a book useful for the duration of a vocational course, but a manual whose detailed guidance can be referred to throughout a working life. It is intended for use by apprentices and students of carpentry and joinery, their lecturers, college libraries, those working in the trade, and anyone interested in woodwork. If you're studying carpentry and joinery at a further education college, the book will guide you step-by-step through the construction of your

very first straight-flight staircase, of which you will be immensely proud. If you're entering employment as a newly qualified tradesperson, you will be provided with the knowledge and confidence to take your place in the industry alongside experienced carpenters and joiners who might not always have the time to pass on to you the benefit of their experience. And if you already have some knowledge of stairs, having been in the trade for a period of time, this unique source of information should be welcomed as a provider of empowerment, enabling you to tackle more advanced stairs and take your career to the next level (no pun intended).

Special features include the 'Rise and Going calculator', a colourful, easy-to-read chart which aids stair calculations by eliminating the need for geometry and trigonometry. Detailed illustrations, together with a relaxed and informal writing style will reassure, increase confidence, and provide inspiration. My philosophy is one of methodical working, checking and double-checking, and avoiding pitfalls and the possibility of making mistakes, and has been gained during twenty-five years of stair building, both at home in the UK and in North America. You are invited and encouraged to share this philosophy, allowing you to reap the rewards of producing strong, well-designed stairs that fit beautifully in their intended location.

Mark Milner

Acknowledgements

So much help, support, and encouragement has been extended to me during the writing of this book and has come from family members, friends, colleagues, students, companies, and organisations. My sincere thanks to the following:

My wife Nicola and our two sons Christopher and Stuart.

My parents Phyllis and Roy.

My friend and colleague Stephen Parry.

My employer and colleagues at North Kent College, Lower Higham Road, Gravesend, Kent, DA12 2JJ. www.nwkcollege.ac.uk

My students Sam Bailey, Lee Barnet, Zach Chin-Yue, Tom Copus, Ricky Davis, Kieran Hall, Ashley Harrison, Nick Hughes, Stuart King, Charlie Longhurst, Tommy Penfold, Chris Richards, Grant Ross, Charlie Saunders, Frank Turtle, Brett West, and Georgie Worsdell.

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Foreword

I have worked with stairs for 35 years yet to my surprise I find I can remember that far back, to my school days, although I cannot recall as much as I would like. I have probably forgotten more than I can remember, but I can recall the words of my old maths teacher which are as fresh today as they were all those years ago:

You may not think so now but you will use maths every single day of your life so pay attention at the back ... that means you, Jones.

When Mark Milner asked if I would write a short foreword for this book it was very easy to say 'Yes'. Over the years I have worked on and seen literally thousands of stairs, from basic straight flight 12 treads, quarter-turns, and dog-legs to the more complex geometrical curved stairs. All have one simple thing in common – they take the user from one level to the next ... and all of them should do so safely.

For many years we have relied on American books which are great, but they do construct their stairs differently across the pond. There are well-respected books such as Ellis's *Modern Practical Stairbuilding & Handrailing* from the 1930s but I am now very excited that the UK market has at last got its own dedicated and, more importantly, up-to-date and truly modern book on one of my favourite subjects.

The very fact that you have purchased this book means you have at the very least a passing interest in stairs and/or balustrades. I can tell you that you are in safe hands. When Mark first contacted me it became clear from the very first email that I was talking to someone with a shared passion for stairs. Through each chapter of *Simply Stairs* you can feel safe in the knowledge that you are being led and taught by an

expert. Mark has many years experience in all things stairs from making, installing and repairing to teaching and photographing. Yes, that's right – every image from the very first chapter are real stairs, real situations not only constructed but also photographed by Mark.

If you are a student or DIY enthusiast then this book will introduce you to strings, risers and goings, winders and building regulations and how to measure, prepare and assemble stairs. For those of you with more experience of constructing straight flights and stairs with 90° and 180° turns, you will probably find something new – perhaps in the chapters covering circular or alternating tread stairs or the details about why mortise and tenon joints are a far safer bet than nails or screws for fixing a handrail to newels.

Whilst finally seeing this project in print is pleasing for me, I can only imagine how Mark must feel. Well done to you, Mark. Over the last 18 months I've enjoyed our chats, problem-solving and working out the best way of doing a task. You can now sit back and take a rest, get back to the day job comfortable in the knowledge that this book will become the bible on all things stairs for every student and expert.

Now it's time get down to the business in hand – all things stairs, treads, rise, go, pitch-line, handrails and spindles and much more. They can be simple or complex, plain or decorative but whatever the type and shape of stairs, they all share a common theme – they are a mathematical solution to getting safely from one level to the next. My old maths teacher was right ... pay attention at the back.

Kevin Jones, Technical Manager
ARCHWOOD LIMITED t/a Richard Burbidge

Glossary

alternating tread staircase: a steep staircase, used for access to a converted loft, which saves space by the use of alternately handed paddle-shaped treads.

angle of pitch: a flight's angle of inclination, measured between a horizontal plane and the pitch line.

angled glue blocks: triangular-shaped pieces of timber used to support the treads and risers where they meet.

Approved Documents: government-produced documents, approved by the Secretary of State, which give practical guidance on how the functional requirements contained in the Building Regulations can be complied with in England and Wales.

apron lining: boards which cover the joists and finish a trimmed opening in a floor.

balusters: narrow, vertical members of a balustrade system that provide support to the handrail and fill the gap between the underside of the handrail and the steps below. Also known as spindles.

balustrade: a safety barrier providing guarding for a staircase and consisting of handrail, balusters, and newel posts.

balustrade centre line: a notional line representing the centre of a balustrade system on an open staircase.

baseraill: an inclined or horizontal member into which stair or landing balusters are housed.

bending form: a structural skeleton, constructed much like a curved stud wall, around which the strings and handrail of a circular staircase are bent and laminated.

bullnose step: a starting step with a quarter-round at one or both ends, and a short straight section returning to the face of the bottom newel post.

carriage: an inclined member fixed beneath the steps and providing additional support at their centres or at their ends.

circular stair: a sweeping staircase turning around a central void.

closed string: see housed string.

continuous handrail: handrail which, by passing above newel posts, forms an uninterrupted length from the bottom to the top of a flight.

creeping: see spring-back.

curtail step: a rounded starting step which projects beyond the face of the string and corresponds to the rounded terminal – known as a 'volute' – of the handrail above.

cut and bracketed staircase: a stair with decorative brackets glued and screwed to its cut string and mitred to the riser ends.

cut and mitred string: an open string that has its vertical edges mitred to receive the mitred ends of the risers.

cut string: (usually) an outer string whose top edge is shaped and notched to support the ends of the steps.

dogleg staircase: a stair using an intermediate half landing to turn 180° on plan and resembling a dog's hind leg when viewed from the side.

double-mitred tread: a tread with mitred nosing returns at each end and forming part of a staircase with cut and mitred strings on both sides.

draw pins: short lengths of wooden dowel which, when passed through offset holes, draw the tenon shoulders of a string or handrail up tight to the face of the newel post.

drop newel: an upper newel post whose lower end is cut below the ceiling line.

D-step: a rounded starting step which projects beyond the outer string and bottom newel post

and returns back into the side of the newel. Also known as a D-end step or a round-end step.

easements: timber pieces used to widen a string which will house winding steps.

easing: the wide, curved part of a string which houses winding steps.

finial: an ornament providing a decorative finish at the top of a newel post.

general access stair: a stair intended for all users of a [non-domestic] building on a day-to-day basis, as a normal route between levels.

going: the horizontal distance measured from the tip of one nosing to the tip of the next, known, in North America, as 'run'.

guide bush: a circular flange, fixed to the base of a router, whose outer edge runs against a jig or straight edge to accurately guide the cut.

gooseneck: a handrail fitting consisting of, at its lower end, a curved upward easing and, at its upper end, a short horizontal section. Used with over-the-post railings to connect an inclined (rake) handrail to a horizontal balcony handrail.

half landing: intermediate platform at which a staircase turns 180° on plan.

handrail: the uppermost component of a stair balustrade system that can be grasped by the user for guidance, balance, and support.

headroom: minimum unobstructed vertical distance above a flight's pitch line.

helical stair: see circular stair.

housed string: a string whose upper and lower edges are parallel, and into which the steps are housed, glued, and wedged.

inner string: a string (usually housed) on the side of a staircase which abuts a wall.

jig: a device which acts as a guide for a tool, allowing cuts to be repeated safely and accurately.

kite winder: the centre winding step of a set of three which fits into the corner of an L-shaped flight.

laminated block: a solid block of timber, built up in glued layers, used to provide support to the tread and the riser at the rounded end of a curtail step or a D-step.

landing nosing: a narrow tread-like member, diminished in thickness at the rear, where the staircase meets the upper floor decking.

L-shaped stairs: a stair which uses either a quarter landing or winding steps to turn 90° on plan.

margin: the distance between a housed string's top edge and a notional line running parallel with its top edge and connecting the tips of the steps (without the nosings).

margin template: a short T-shaped piece of timber that maintains a uniform margin when marking the steps on the strings with a pitch board.

mitred nosing return: see nosing return

monkey's tail: see volute.

newel cap: a timber cap housed over the top of a newel post to provide a decorative finish.

newel post: a heavy, vertical member, into which the strings and handrail are (usually) tenoned.

nosing return: a nosing at the exposed end of a tread on an open, cut, or cut and mitred staircase.

nosing: the moulded front edge of a tread (or landing) which overhangs the face of the riser.

offset: the distance between the cutting edge of a router cutter and the outside edge of the router's guide bush.

open staircase: a stair with an open, cut, or cut and mitred outer string.

open-riser stair: a staircase where the spaces between each tread are only partially filled with riser downstands, upstands, or horizontal bars. Sometimes referred to as 'modern' or 'contemporary' stairs.

over-the-post railings: balustrade featuring a continuous handrail which passes above the newel posts.

partial riser: see riser downstand.

pitch board: a right-angled triangular piece of (usually) hardboard, cut to the size of the rise and going, and used, with a margin template, to mark out the steps on a pair of strings.

pitch line: a notional line that touches all the nosings at the centre of a flight.

post-to-post railings: balustrade featuring a handrail that runs and is fixed between newel posts.

preformed plywood bullnose riser: an off-the-shelf riser for a bullnose step, with a quarter-round at one end and a short straight section returning to the face of the newel post.

private stair: a stair intended to be used for only one dwelling.

quarter landing: intermediate platform at which a staircase (usually) turns 90° on plan.

quarter-turn staircase: see L-shaped stairs.

railings: see balustrade.

rake: inclined line of a stair string or handrail.

rise: the vertical distance from the top of one tread to the top of the next.

riser: the vertical part of a step that provides support to the tread.

riser downstand: a riser fixed beneath a tread which, by not extending all the way to the tread below, only partially fills the space between the two.

round-end step: see D-step or curtail step.

run: see going

skew nail: nailing, by necessity, at an angle through one component into another.

skew winder: the third of a set of three winding steps whose tread's rear edge is at 90° to the strings.

space-saving stairs: see alternating tread staircase.

spandrel: triangular infill beneath a string forming (usually) the face of an understairs cupboard.

spigot: a large dowel-like projection from the underside of a newel post, which fits into a hole drilled through the tread and into the laminated block of a round-end step.

spindles: see balusters

spring-back: an unpredictable and unwelcome expanding of a laminated and tensioned curved rail's radius.

square winder: the first of a set of three winding steps whose tread's nosing is at 90° to the strings.

stair gauges: a pair of small brass gauges which, when clamped to a steel roofing square, are used to mark out stair strings – an alternative to a pitch board and margin template.

stairwell: a trimmed hole in a floor through which a staircase passes.

starting step: the first step in a flight.

storey newel: an upper newel post providing support to a staircase by extending down to the floor below.

storey rod: a batten marked with lines representing the unit rise and total rise of a staircase and used to mark newel posts and circular strings.

string capping: an inclined baserail, grooved at its underside to sit over a closed outer string and, at its upper side, to house the balusters.

strings: the main inclined members which support the treads and risers – known in North America as 'stringers'.

stub newel: a short newel post on top of which a turned section is dowelled.

template: a pattern used as a guide for forming shaped components.

tosh nail: see skew nail

total going: horizontal distance from the tip of the first nosing to the tip of the last.

total rise: vertical distance finished floor level (FFL) to finish floor level.

trammel heads: steel points which, when clamped to a length of timber, are used to draw large circles.

tread: The horizontal part of a step which (usually) includes a nosing.

upward easing: a short upwardly curving handrail piece used to connect an entry fitting (e.g. a volute) to the main inclined (rake) handrail.

utility stair: a stair used for escape, access for maintenance, or purposes other than as the usual route for moving between levels on a day-to-day basis in properties other than single domestic dwellings.

volute: a decorative, spiral-shaped, entry component part of a stair handrail.

walk line: a notional line indicating the average path of users of a staircase.

wall string: a string (usually closed) which abuts a wall.

winder box: an L-shaped section of stairs consisting of winding steps, strings, and newel post.

winder: a step in which the going reduces from one side to the other. Used to change the direction of a flight.

1

Let's Talk Stairs!

What can I say about stairs? I've been building stairs for twenty-five years – walking up and down them even longer! My name is Mark Milner, and from early in my career in joinery, stairs have held a certain fascination for me, possibly because most other chippies I knew were wary of them. After all, a staircase is a major item of joinery – mistakes would be very costly. And with all those components, measurements, angles, and joints, there is plenty of room for mistakes, isn't there?

There are joinery companies that shy away from stairs, fearing they don't have the expertise to tackle such projects, while some other manufacturers subcontract the work to specialist stair builders. Those companies who do take them on often rely on one senior craftsman – a 'stair hand' – to undertake the work. And all too often, stairs sent to site are ill-fitting, leading to frustration for those fixing them.

I like the language of stairs. The amount of terminology and names involved in stair building is rivalled only by those in roofs. And I like stairs because they are three-dimensional. Doors and windows have a height and a width; they do have a third dimension too, of course, but that is merely the thickness of the timber used. Stairs are truly three-dimensional – and this will be appreciated when you build your first staircase.

If you understand stairs, you will command the respect of those you work with – including your boss! But what I like most is that stairs equals employability! Your ability to measure, set out, and build stairs will make you indispensable and increase your earnings potential.

Read this book, study it, and keep it as a reference manual. Trust me when I tell you that stairs are not

complicated at all. They're really quite simple, and soon you will be designing and building strong bespoke staircases which, when delivered to site, will go in, 'click'.

The language of stairs

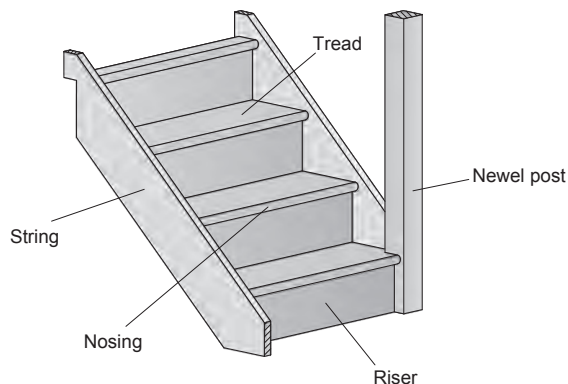


Figure 1.1 The five main components of a staircase.

Let's start by learning a little of the language of stairs. The five main components, illustrated in Figure 1.1, are:

Tread: The horizontal part of a step – the part you 'tread on' when using the stairs.

Riser: The vertical part of a step that provides support to the tread.

Nosing: The moulded front edge of a tread (or landing) which overhangs the face of the riser.

Strings: The inclined structural members – the sides of the stair which support the treads and risers.

Newel post: A heavy, vertical member, to which the handrail is connected and the string (usually) tenoned.

Setting out terms

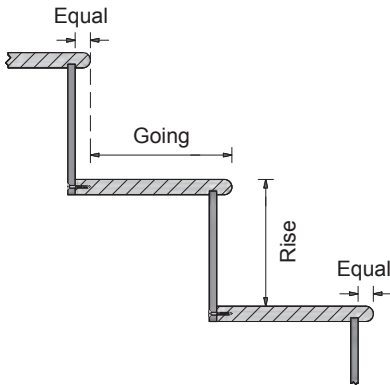


Figure 1.2 Individual rise and going.

Now that you know the names of the five main components – we'll look at more as they arise throughout the book (or you can refer to the glossary) – let's look at some setting out terms:

Rise: The vertical distance from the top of one tread to the top of the next (Figure 1.2).

Going: The horizontal distance from the tip of one nosing to the tip of the next, which, for the purposes of setting out a straight-flight staircase, is the same as the distance from the face of one riser to the face of the next (Figure 1.2).

The total rise is measured vertically from finished floor level (FFL) to finished floor level, and the total going is measured horizontally from the tip of the first nosing to the tip of the last or, in the case of a straight-flight staircase, from the face of the first riser to the face of the last (Figure 1.3).

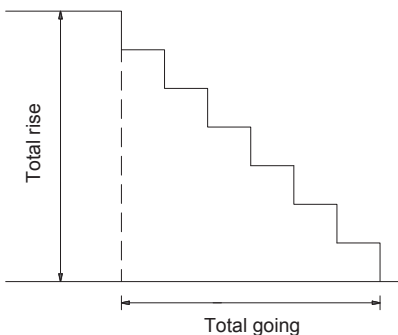


Figure 1.3 Total rise and total going.

So if the rise has two different meanings, and the going has two different meanings, how can we tell them apart? It's really not difficult at all; if someone refers to a staircase with a going of, say, 3m, we immediately know that this is the total going. If we are told that a staircase has a rise of, say, 200mm, clearly this is the individual, or unit rise.

Building Regulations

I can remember falling down the stairs as an eight-year-old – it hurt! To minimize the risk of accidents on stairs, their design and construction in England and Wales falls under the control of the Building Regulations, whose aim is to ensure the health and safety of people in and around buildings of all types. Similar regulations apply in Scotland and Northern Ireland, and, in North America, rules specifying the minimum standards for construction projects exist in the form of local building codes. It is important that you consult the regulations or codes applicable in your area before starting any project.

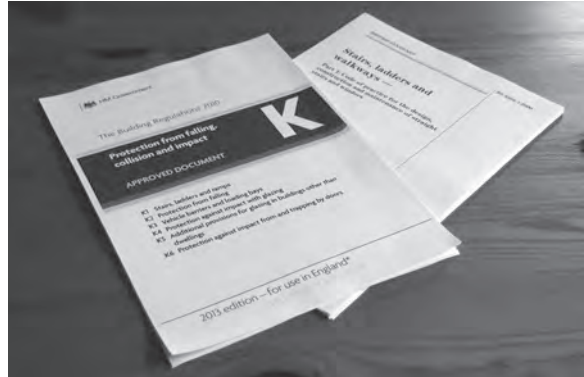


Figure 1.4 Approved Documents and British Standards give practical guidance on how to comply with the functional requirements of the Building Regulations 2010.

The Building Regulations, which are made under powers provided in the Building Act 1984, require that stairs should be safe but offer no advice or guidance as to how this can be achieved. Instead, the Regulations are supported by Approved Documents (Figure 1.4), which give practical guidance on how the functional

requirements contained in the Building Regulations can be complied with. Another method of demonstrating compliance is by observing the relevant British Standard, although it is important to bear in mind that, whichever instrument is chosen, the recommendations made should be observed fully – don't 'mix and match'.

NHBC (National House-Building Council) is the UK's largest provider of warranties and insurance for new homes, enjoying a market share of around 80%. Their stated aim is to raise the standards of new homes and to provide consumer protection for homebuyers by working with the house-building industry. Among its many services, NHBC publishes Technical Standards whose guidance its registered builders follow in order to sell homes with NHBC Buildmark cover. Funding for the NHBC is provided by the construction industry, leading some to question its claimed independence.

Stairs fall into one of three categories:

Private stair: a stair intended to be used for only one dwelling.

Utility stair: a stair used for escape, access for maintenance, or purposes other than as the usual route for moving between levels on a day-to-day basis.

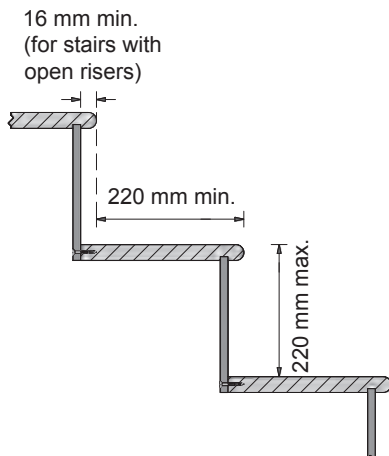


Figure 1.5 Maximum rise and minimum going of a private stair.

General access stair: a stair intended for all users of a building on a day-to-day basis, as a normal route between levels.

Provisions for the three categories vary, but it is in the first (private) where stairs are predominantly made from timber (materials such as steel and glass are typically used elsewhere). And with my living having been earned almost exclusively from private stairs, it is this category that will be the focus of Simply Stairs. So let's look at some of the recommendations that apply to a private stair as laid down in The Building Regulations 2010: Approved Document Part K: Protection from falling, collision and impact, 2013 edition:

The maximum permitted rise is 220 mm

The minimum permitted going is 220 mm (Figure 1.5).

220 mm is easy to remember because the same number applies to both the rise and the going – you just have to remember that one is a maximum and the other is a minimum.

The treads of a staircase with open risers must overlap each other by a minimum of 16 mm (Figure 1.5). (See chapter 9 for more information on open risers.) All nosings in a flight should be equal (Figure 1.2).

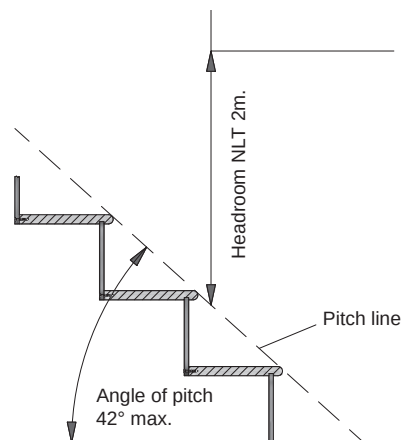


Figure 1.6 Maximum pitch (angle) of stairs and minimum headroom.

The pitch line is an imaginary line which touches all the nosings in a flight (Figure 1.6). The maximum permitted angle of pitch, measured from a horizontal plane (the floor) to the pitch line, is 42°. And headroom

is measured vertically from the pitch line and must be not less than 2 m.

As well as specifying maximum and minimum sizes for the rise and going, the Approved Document also stipulates the relationship between the two, in order to make walking up and down stairs as comfortable as possible. This relationship is expressed as a formula, which states that twice the rise plus the going should be not less than 550 mm or greater than 700 mm, and can be written:

$$2R + G = 550-700$$

(where R = rise and G = going).

For example, a staircase with a rise of 200 mm and a going of 225 mm would satisfy this requirement because the sum of twice the rise plus the going does fall between 550 mm and 700 mm:

$$2 \times 200 + 225 = 625 \text{ mm}$$

The going should be limited to a maximum of 300 mm and the rise to a minimum of 150 mm. Any rise

between the minimum and maximum (150–220 mm) can be used with any going between the minimum and maximum (220–300 mm), provided the angle of pitch does not exceed 42° and the relationship formula is satisfied.

At this stage, there is a question that I like to ask my students: from Approved Document K we know that a going of 220 mm suggests compliance with the Building Regulations, as does a rise of 220 mm, but put the two together and they contravene the Regulations – why?

Did you know the answer? It's all to do with the pitch: a staircase with a 220 mm going and a 220 mm rise would have a pitch of 45°, and as we know, the maximum permitted angle of pitch is 42°, meaning 220/220 is not acceptable.

No recommendations are made in Approved Document K concerning the minimum width of a staircase. Where a staircase forms part of a means of escape, however, reference should be made to Approved Document B: Fire safety. And where a staircase provides access for disabled people, Approved Document M: Access to and use of buildings, should be consulted. The width of a typical private staircase is around 860 mm, and the length, although not compulsory, should be limited to a maximum of 16 steps.

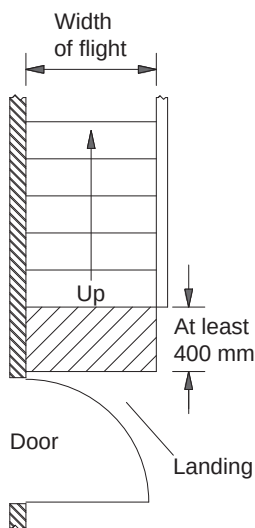


Figure 1.7 Bottom landing next to a door.

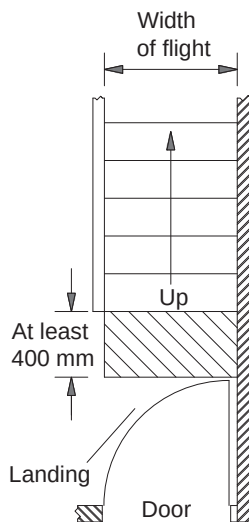


Figure 1.8 Bottom landing next to a door (alternative layout).

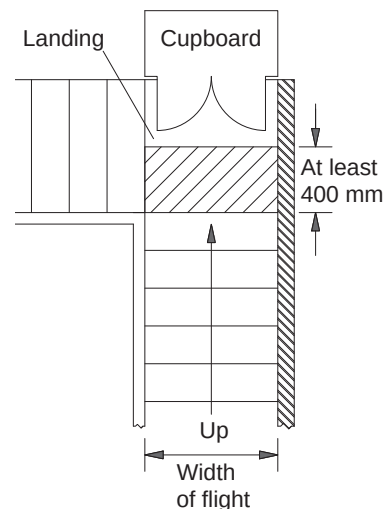


Figure 1.9 Cupboard onto a landing.

Landings, which may include part of the floor of a building, should have a width and length at least that of the narrowest width of the staircase and should be provided at the top and bottom of every flight. All landings should be kept clear of permanent obstructions and, where a door opens across the bottom landing, a clear space of 400mm across the width of the flight should be maintained (Figures 1.7 and 1.8). The only doors permitted to open over a landing at the top of a flight are those to cupboards and ducts which are kept shut or locked shut when under normal use, and which maintain 400mm of clear space across the width of the flight when open (Figure 1.9).

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Measuring up

All staircases start at the measuring up stage – a task I have known to cause more than a degree of apprehension even to some highly skilled and experienced tradespeople, unnerved by the prospect of measuring an opening for a staircase. But let me reassure you, like most other aspects of stairs, there's really nothing difficult about the measuring process.

But why should you need to worry about the measuring up at all? Surely the architect or the client will provide the measurements, won't they? Actually, they almost certainly won't. Instead it will be left to the individual or company building the stairs to take responsibility for their own measurements.

And the ability to measure up should not be confined strictly to bench joiners. I can think of a number of reasons why site carpenters would benefit greatly from this skill: it could provide the opportunity of being able to check that the joiner is measuring competently; where time is short, the carpenter could phone through the measurements to the joiner, rather than waiting for a site visit; and, in certain circumstances, the site carpenter might be called upon to build a staircase on site.

So where do you start? You will encounter two possible situations: (1) the required staircase will be a replacement for an existing staircase which has not yet been removed; (2) there will be an open stairwell – the latter being by far the more desirable situation. Why? Because it is effectively a blank canvas upon which to work. An existing staircase can hinder the measuring process; it is often 'in the way' when attempting to measure the total rise and going, and it provides the temptation of measuring the existing staircase, which may be (and often is) an ill-fitting staircase.

A typical straight-flight staircase will require only five measurements to be taken: the width plus the four measurements described below and illustrated in Figure 1.10.

1. The rise: the first and most important measurement needed is the vertical height from FFL to FFL – the total rise. Of course, the finished floor/s may not yet be in place, in which case you should check with the site manager in order to establish what the finished levels will be.

Position yourself on the upper-floor landing and allow your tape measure to drop to the floor below. Check that the end of the tape is sitting firmly on the floor below, and that you are holding it plumb. Carefully read and record the total rise. Bear in mind though, that a staircase is not vertical and you need to be sure that

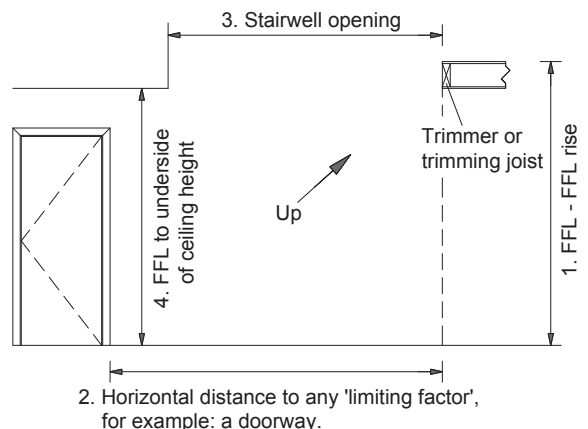


Figure 1.10 Required site measurements.

the lower floor is level. Any slope in the lower floor will affect the total rise.

2. The available horizontal distance: you need to measure horizontally from the face of the trimmer or trimming joist to what I would describe as 'any limiting factor'. This might be a doorway, a wall, or perhaps a radiator (although if necessary, a radiator can be moved). Use a laser level, a spirit level, or a plumb bob to plumb down from the joist to accurately take this measurement.
3. Length of stairwell opening: the opening formed in the upper floor is the stairwell. This length and the following measurement (4) – will enable you to work out whether or not there will be sufficient headroom.
4. Lower FFL to underside of ceiling: the purpose of this measurement is so that sufficient headroom can be provided when designing the stairs.
5. The width: arguably the easiest dimension to take provided there is clear access for fixing the new stairs. Measure the width of the trimmed opening in the upper floor and deduct 10mm for tolerance (5mm each side). If the staircase is to fit between two walls, measure tight between the two walls at the narrowest point and, again, deduct 10mm for tolerance. If there is not clear access, and the staircase will have to be turned between the two walls, then far more tolerance will be required. A tolerance of 75mm should enable the staircase to be turned into position; use a piece of plywood or MDF cut to the sizes shown in Figure 1.11 to check prior to manufacture.

If replacing an existing staircase where the string thickness is partly concealed by the plaster, measure from the inside of one string to the inside of the other string (Figure 1.12).

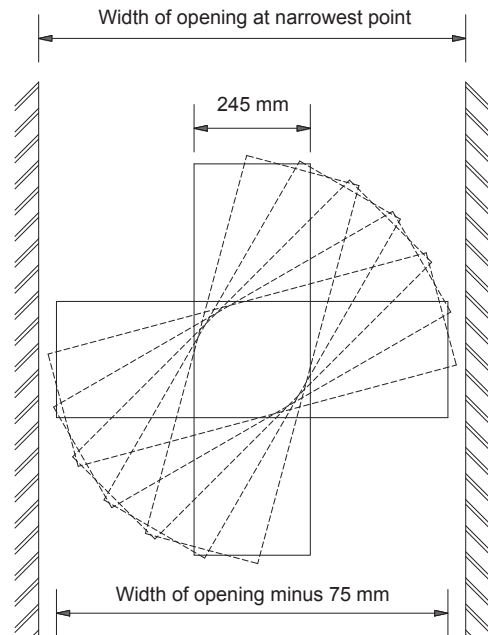


Figure 1.11 Allow sufficient tolerance when the staircase will need turning in its opening prior to fixing.

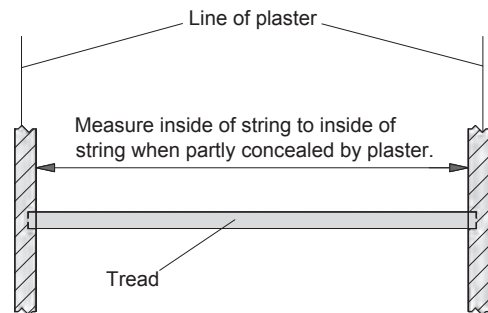


Figure 1.12 Staircase fixed between two plastered walls.

Armed with accurate site dimensions and familiar with the relevant provisions in Approved Document K, it's now time to return to the workshop where the process of designing the staircase can begin.

2

Staircase Calculations

The secret to building a staircase that will fit perfectly? It's all down to the calculations, because staircase design, as Kevin Jones points out in his foreword, can be thought of as merely a mathematical solution to the problem of how to provide safe access from one floor level to the next. So once you have accurately recorded the site measurements, you can set about designing a new staircase to fit the opening. Sounds daunting, doesn't it? Relax – it's simple! Just follow these four steps:

- Step 1: Work out the rise.
- Step 2: Determine a suitable going.
- Step 3: Check that the relationship between the dimensions of the rise and going satisfies the recommendation given in Approved Document K.
- Step 4: Check that there's sufficient headroom.

For example, let's assume that a new straight-flight staircase is required and that, in addition to the width,

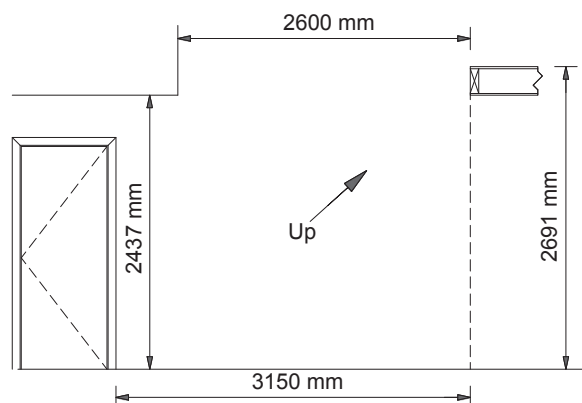


Figure 2.1 Example site measurements.

we've recorded the following site measurements, illustrated in Figure 2.1:

- Finished floor to finished floor rise: 2691 mm
- Finished floor to underside of ceiling height: 2437 mm
- Length of stairwell opening: 2600 mm
- Limit of horizontal distance at lower floor: 3150 mm

Step 1:

To work out the rise, divide the total floor to floor rise (2691 mm) by 220. Why 220? Because 220 mm is the maximum permitted rise.

$$2691 \div 220 = 12.2$$

Rarely will the answer to this calculation be a whole number. So the question is: should we round the number up to 13, should we round it down to 12, or should we leave it unchanged? Well, we certainly can't leave it unchanged, because this will give us 12 whole steps and 0.2 of a step. This would provide a trip hazard and be in contravention of the Building Regulations because the rise and going of each step should be consistent throughout a flight of steps.

From your school days you might remember learning a rule for rounding to the nearest whole number, which said that if the number to the right of the decimal point is 5 or above, round up to the next whole number; if the number to the right of the decimal point is 4 or less, round down. This rule does not apply here because to round down to 12 would give us a rise height greater than 220 mm:

$$2691 \div 12 = 224.25 \text{ mm} \quad \boxed{\times}$$

But, when we round up to 13...

$$2691 \div 13 = 207 \text{ mm} \quad \boxed{\checkmark}$$

The answer of 207 mm is below the permitted maximum of 220 mm.

So having performed two simple calculations we have learnt two things: firstly, how many risers (or steps) there will be (13), and secondly, how high each rise will be (207 mm). A quick double-check will confirm this:

$$13 \times 207 = 2691 \text{ mm} \quad \boxed{\checkmark}$$

Always perform this double-check – it takes seconds and could save you from an extremely costly mistake!

Step 2:

The next thing to do is determine a suitable going to use with our rise of 207 mm. There are three ways of doing this, and I will show you all three so that you can choose your preferred method.

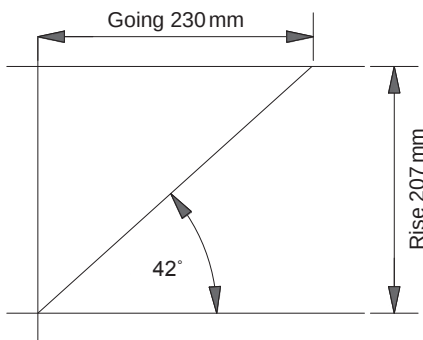


Figure 2.2 Using geometry to determine the going.

The first method involves a little geometry and is the most practical method. Referring to Figure 2.2, start by drawing two horizontal, parallel lines on a

sheet of paper; the distance between the lines should be equal to the rise.

Towards the left-hand side of the page draw a vertical line which cuts through, and is perpendicular to, the horizontal lines.

Now, using a protractor placed where your lines cross at the bottom left of the page, measure and mark an angle of 42°. Draw a straight line through your marked angle until it reaches the upper horizontal line.

The going can now be measured from the vertical line on the left to where your diagonal line touches the upper horizontal line.

Some points to note about this first method: personally, I don't like it. I find it time-consuming, and unless you're extremely careful with the measurements and lines, it is often inaccurate. That said, I do believe that it's a good idea to try this method at least once, as it will allow you to visualize the pitch and gain a sense of perspective concerning the size of each step. A 42° angle is used because it is the maximum permitted pitch, and with space in most homes being at a premium, it is the angle which produces a staircase that takes up the least amount of room while complying with Approved Document K's recommendation. The illustrated rise of 207 mm will fit on a piece of A4 paper in landscape orientation; any higher and you will either have to switch to A3 paper or reduce the size of your drawing to, say, a 1:2 scale. However, scaling your drawing will increase the risk of inaccuracy.

The second method is quick, easy, and totally accurate. And although it is my method of choice, I am about to mention a word that may put some people off: trigonometry. Now, before you abandon this method and move straight to the third, bear with me and remember: it is just a button on a calculator! Using a scientific calculator, divide the rise by the tangent of 42°. Sounds complicated? It's simple:

$$207 \div 42 \tan = 229.8967906$$

$$\text{Going} = 230 \text{ mm}$$

How long did that take, three or four seconds? Always remember to double-check though, by performing

Going
↓

mm	220	222	223	224	225	226	227	228	229	230	232
198	42°	<42°	<42°	<42°	<42°	<42°	<42°	41°	<41°	<41°	<41°
199	>42°	42°	<42°	<42°	<42°	<42°	<42°	41°	<41°	<41°	<41°
200	>42°	>42°	42°	<42°	<42°	<42°	<42°	<42°	41°	<41°	<41°
201	>42°	>42°	>42°	42°	<42°	<42°	<42°	<42°	<42°	<42°	41°
202	>42°	>42°	>42°	>42°	42°	<42°	<42°	<42°	<42°	<42°	<42°
203	>42°	>42°	>42°	>42°	>42°	42°	<42°	<42°	<42°	<42°	<42°
204	>42°	>42°	>42°	>42°	>42°	>42°	42°	<42°	<42°	<42°	<42°
205	>42°	>42°	>42°	>42°	>42°	>42°	>42°	42°	<42°	<42°	<42°
206	43°	>42°	>42°	>42°	>42°	>42°	>42°	>42°	42°	<42°	<42°
207	>43°	43°	>42°	>42°	>42°	>42°	>42°	>42°	>42°	42°	<42°
208	>43°	>43°	43°	>42°	>42°	>42°	>42°	>42°	>42°	>42°	42°
209	>43°	>43°	>43°	43°	>42°	>42°	>42°	>42°	>42°	>42°	>42°
210	>43°	>43°	>43°	>43°	>42°	>42°	>42°	>42°	>42°	>42°	>42°

Rise
→

Figure 2.4 Using the Rise and Going calculator

steep and therefore in contravention of the Building Regulations.

Using the Rise and Going calculator couldn't be easier. Simply look up the rise in the left-hand vertical column, which in our example is 207 mm (Figure 2.4). Follow the row across until you reach the bright green 42°. Then vertically at the top of that column you will find the going. A staircase with a rise of 207 mm and a going of 230 mm will have a pitch of 42°.

There are a few common questions which arise when using the Rise and Going calculator.

The rise of my staircase is 195 mm and the lowest rise shown on the calculator is 198 mm. What should I do? The answer is to use the minimum permitted going of 220 mm, which will result in a staircase with an angle of pitch slightly less than 42°.

215	>44°	>44°	44°	>43°	>43°	>43°	>43°	>43°	>43°
216	>44°	>44°	>44°	44°	>43°	>43°	>43°	>43°	>43°
217	>44°	>44°	>44°	>44°	44°	>43°	>43°	>43°	>43°
218	>44°	>44°	>44°	>44°	>44°	44°	>43°	>43°	>43°
219	>44°	>44°	>44°	>44°	>44°	>44°	44°	>43°	>43°
220	45°	>44°	>44°	>44°	>44°	>44°	>44°	44°	>43°
mm	220	222	223	224	225	226	227	228	229

Figure 2.5 A staircase with a rise of 218 mm and a going of 226 mm will exceed the maximum permitted angle of pitch by 2°.

Contravening the Building Regulations is a criminal offence, and action may be taken under Section 35 of the Building Act 1984, against any person who contravenes them. If convicted, that person is liable to be fined up to £5000 for each offence and may also have to pay a daily fine if the default continues after conviction. The daily fine is £50 for each offence at the time of writing. Section 36 of the Building Act allows a notice to be served requiring the owner to (a) pull down or remove any work contravening the regulations, or (b) bring the work into compliance with the regulations.

How else can the Rise and Going calculator be used? A price that is based on dimensions provided by a customer might be requested for a new staircase. You are told that the rise is 218 mm and that the going is 226 mm. Following a quick check of the Rise and Going calculator, you can inform the customer that the staircase has a pitch of 44° – something to be avoided if the building inspector is to be kept happy (Figure 2.5).

Step 3:

Checking the relationship between the dimensions of the rise and going is quick and easy. Remember the formula:

$$2R + G = 550-700$$

So, when we substitute the letters *R* and *G* in the formula for the rise and going that we have now worked out, we get the following sum:

$$2 \times 207 + 230 = 644 \text{ mm} \quad \checkmark$$

The result of 644 mm is between 550 mm and 700 mm, so the relationship in Approved Document K, between the dimensions of the rise and going, is satisfied.

Step 4:

The tricky bit – checking that there will be sufficient headroom. Let's start with what we know: the staircase

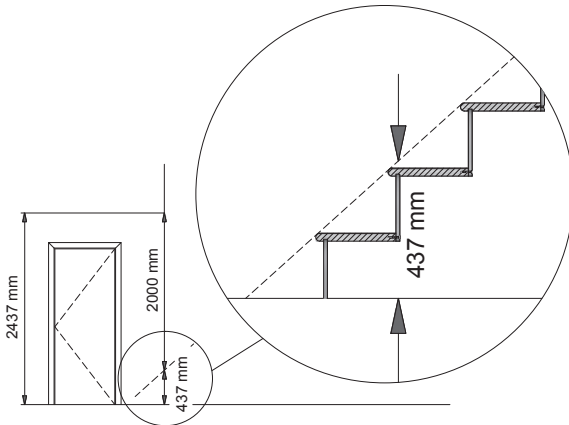


Figure 2.6 Checking headroom. The 437 mm is equal to slightly more than two risers.

can rise up to 437mm and still provide sufficient headroom. How do we know this? We know this because the minimum amount of headroom required is 2m or 2000mm. When we take 2000mm away from the floor to the underside of the ceiling height of 2437 mm we get (Figure 2.6):

$$2437 \text{ mm} - 2000 \text{ mm} = 437 \text{ mm}$$

The next thing we must ask ourselves is how many risers does 437mm represent? To find this we must divide 437mm by our rise of 207mm. The answer is just over two:

$$437 \div 207 = 2.1 \text{ risers}$$

As can be seen in Figure 2.6, at the point where the staircase rises to 437 mm, there is just over one tread (or going). This means that there are a further 11 treads (almost) between this point and the landing trimmer or trimming joist (Figure 2.7). If the combined horizontal length of these 11 treads, i.e. 11 goings, is less than the length of the stairwell opening (2600mm), then there will be sufficient headroom. If greater than 2600mm, the headroom height will be less than the required 2m.

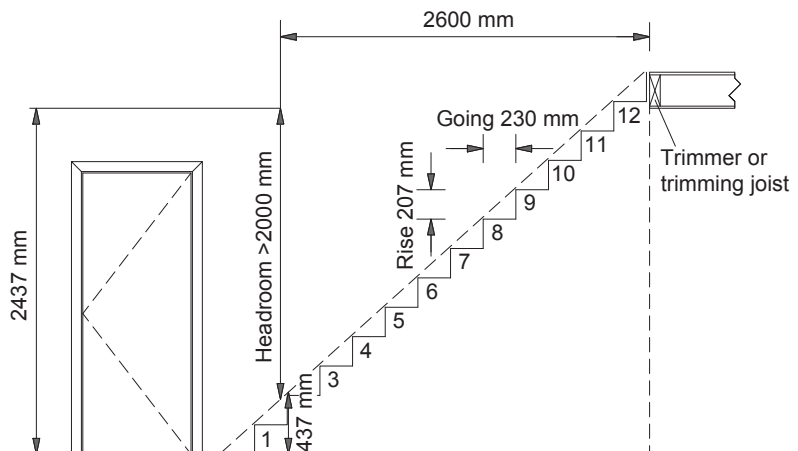
The going for our staircase is 230 mm, therefore:

$$11 \times 230 = 2530 \text{ mm}$$

The combined horizontal length of the remaining 11 steps is less than the stairwell length of 2600mm, meaning that the available headroom will be greater than the required 2m.

Ok, I admit it – working out the headroom is one part of *Simply Stairs* that is not very, er... simple! Figures 2.8 a and b should help. Imagine that the staircase is one giant triangle. If the answer to our calculation had come to more than 2600mm, the 'triangle' would effectively be further to the left, resulting in a headroom height of less than 2m (Figure 2.8a). But since the answer came to less than 2600mm, the triangle is further to the right

Figure 2.7 Having 11 goings (almost) between the point where the staircase rises to 437mm and the landing joist means that there will be sufficient headroom.



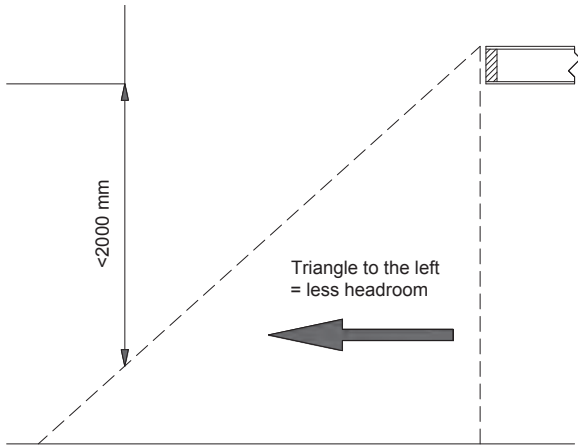


Figure 2.8a Insufficient headroom.

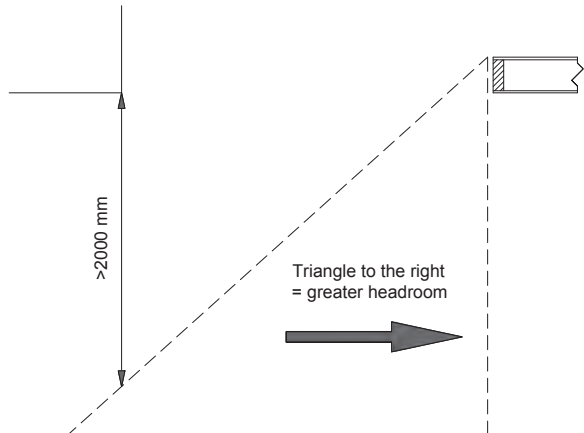


Figure 2.8b Sufficient headroom.

(Figure 2.8b), meaning the headroom height is greater than 2 m.

So, to sum up, in designing our example 13-rise staircase we have demonstrated compliance with the Building Regulations because:

The rise, at 207 mm, is less than the maximum of 220 mm.

The going, at 230 mm, is greater than the minimum of 220 mm.

The angle of pitch (as determined by the Rise and Going calculator) is 42°.

Twice the rise plus the going, at 644 mm, is between 550 mm and 700 mm.

Headroom is greater than 2 m.

3

Tools of the Trade

Although a staircase is a major item of joinery, it can be built with surprisingly few tools. I was once told by the owner of a stair manufacturing company that he decided to specialise in stairs, rather than windows and doors, because all he needed to get started was a router!

He was over-simplifying things slightly, but the stair builder's toolkit needn't be particularly large. This chapter will focus on the more specialised tools and equipment used in stair building – some of which you can make yourself. We'll start, though, with an essential:

Electric router: For routing stair strings, use a heavy-duty plunge router (1600 watts or above) with a $\frac{1}{2}$ " shank (Figure 3.1). Fine-depth adjustment is a useful feature.



Figure 3.1 Electric router with accessories, from left to right: 30 mm guide bush with inner plate, guide bush line up pin, 16 mm stair housing dovetail cutter, and 22 mm spanner.

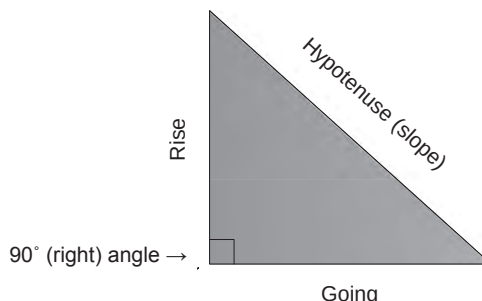


Figure 3.2 A pitch board is simply a piece of hardboard (or similar) cut to the shape of a right-angled triangle; it is useful for marking out the steps on a pair of strings.



Figure 3.3 A pitch board and margin template in use.

Pitch board: A triangular piece of (usually) hardboard, cut to the size of the rise and going, and used to mark out the steps on the strings (Figures 3.2 and 3.3). Note: the hypotenuse is the side opposite the right angle of a right-angled triangle, and is the sloping edge of a pitch board (Figures 3.2 and 3.9).

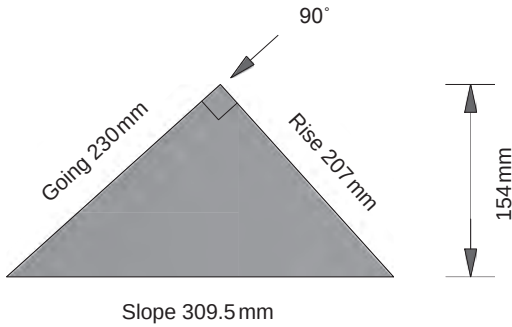


Figure 3.4 Pitch board dimensions (rounded to the nearest half millimetre) for our example staircase.

207 $\times$ 230 $\times$ = 95749 $\div$ 309.43
 Length of hypotenuse (or slope) 309.5 mm

Figure 3.5 Using Pythagoras' theorem to work out the length of the pitch board's sloping edge takes seconds with a calculator.

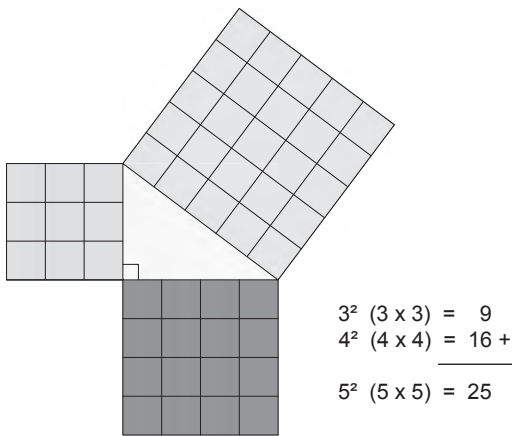


Figure 3.6 Three-four-five method is a practical application of Pythagoras' theorem.

Using the rise and going measurements that we calculated for our example staircase in chapter 2, the dimensions of an accurately cut pitch board will be as shown in Figure 3.4. Note: dimensions have been rounded to the nearest half millimetre.

Margin template: This is a T-shaped template approximately 350mm long, which maintains a uniform

Pythagoras' theorem

This is a scary sounding title for a very simple way of working out the length of the hypotenuse of a right-angled triangle, or, in our case, the length of the sloping edge of a pitch board. When the lengths of the two shorter sides are squared (multiplied by themselves), and then added together, the total is equal to the square of the hypotenuse (or slope). Figure 3.5 illustrates how quickly and easily this can be done on a calculator.

If you've worked on site, you will probably have heard the expression, 'three-four-five'. 3-4-5 is a practical application of Pythagoras' theorem, used to check, say, whether rooms are square, or whether an extension is being built square off an existing wall, etc. Figure 3.6 illustrates how it works.

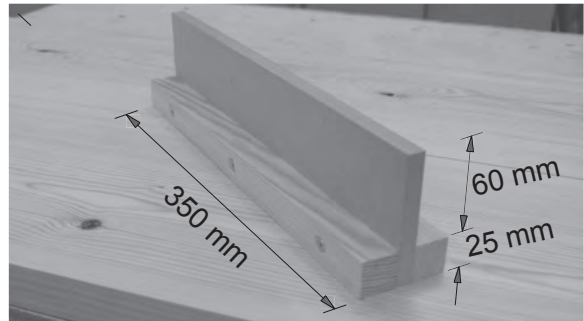


Figure 3.7 Use two pieces of softwood sandwiching a piece of 12mm MDF and make your margin template to the dimensions shown.



Figure 3.8 A pair of brass stair gauges clamped to a steel roofing square makes a good alternative to a pitch board and margin template.

margin when marking the steps on the strings with a pitch board (Figures 3.7 and 3.3).

Stair gauges: A pair of small brass gauges which, when clamped to a steel roofing square, can be used to mark out stair strings (Figure 3.8). These offer an alternative to the pitch board and margin template.

Dividers: When marking out the strings, it is essential that the spacings between each of the steps are identical (Figure 3.9). Dividers are useful in achieving this (Figure 3.10).

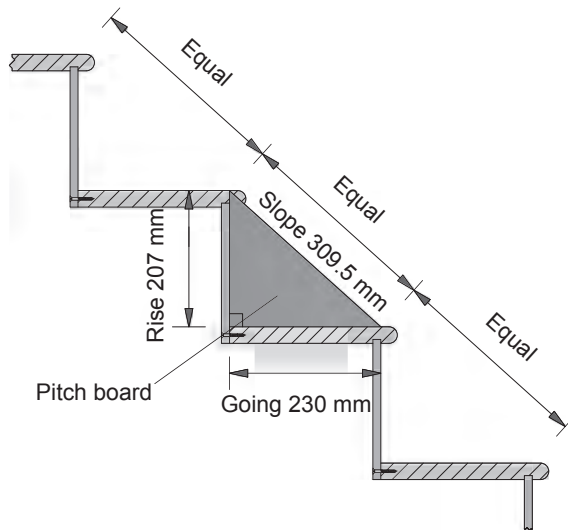


Figure 3.9 Equal spacings between steps are essential.



Figure 3.10 Dividers can be used to accurately space the markings for the steps on the strings.

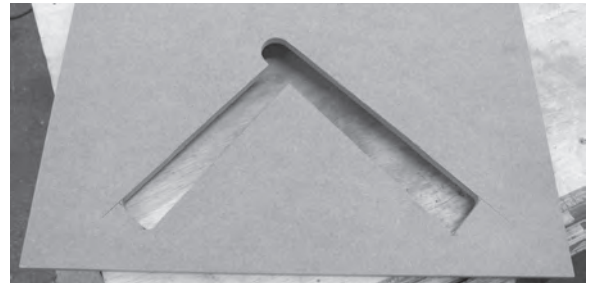


Figure 3.11 Use 12 mm MDF or plywood to make your router jig.

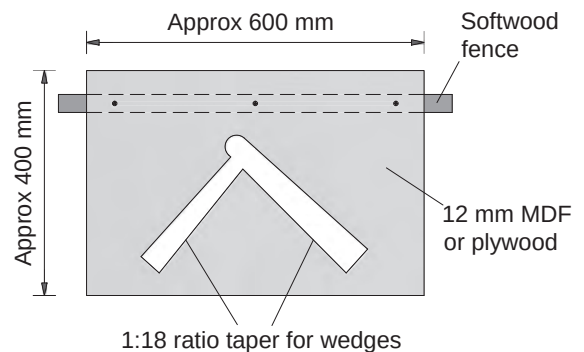


Figure 3.12 Router jig – typical dimensions.

Router jig: This is used when routing the housings in the strings for the treads and risers, and for the wedges which will firmly secure the treads and risers and help prevent the staircase from creaking when in use (Figures 3.11 and 3.12).



Figure 3.13 A proprietary router jig manufactured by Trend.

The proprietary router jig shown in Figure 3.13 is manufactured by Trend and is demonstrated during the manufacture of a straight-flight staircase in Chapter 4. If the number of staircases you intend building is not large enough to justify investing in Trend's product, a router jig can be made in the workshop from 12mm thick plywood or MDF (Figure 3.11).

Figure 3.14 (right) A 16 mm stair housing dovetail cutter.

Figure 3.15 (far right) A 12 mm straight fluted cutter.



A 12 mm straight fluted cutter (Figure 3.15) is commonly used to rout the strings of a staircase. I prefer a stair housing dovetail cutter (Figure 3.14) because the undercutting of the dovetail shape not only ensures good contact between tread and string, and riser and string, but also helps to keep the wedges tight within their housings during staircase assembly.

Whether or not a self-made router jig includes a nosing is optional. Some tradespeople prefer their router jig without a nosing, although it does mean that, after routing their strings, they then have to cut each nosing individually. I favour a router jig with a nosing, the making of which is described below.

Making a router jig

When making a router jig, the first thing we need to know about the router that we will be using is the 'cutter

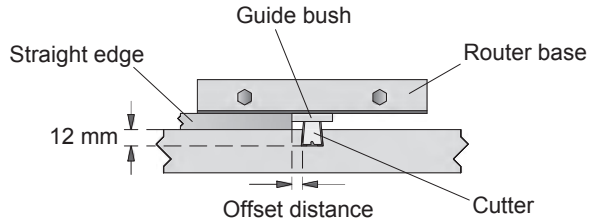


Figure 3.16 Determining the cutter offset distance.

offset distance'. This is the distance from the tip of the router cutter – which should be a 16 mm stair housing dovetail cutter (Figure 3.14) – to the outside edge of the guide bush, as illustrated in Figure 3.16.

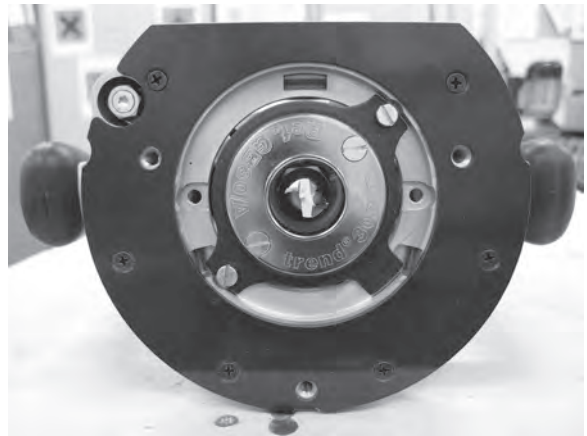


Figure 3.17 View of base of router fitted with a 16 mm stair housing dovetail cutter and a 30 mm guide bush.

The base of the router is shown in Figure 3.17. In the centre is the cutter, surrounded by the guide bush. The offset distance will vary according to the size of cutter and the size of guide bush you are using. You can measure the distance carefully with a steel rule, or a better method is shown in Figures 3.18a–c. Clamp a straight edge to a piece of scrap timber and rout a groove 12 mm deep. You can then measure easily and accurately from the straight edge to the groove that you have just cut.



Figure 3.18a, b, c Cutting a groove using an electric router and straight edge in order to determine the 'cutter offset distance'.

Marking out your router jig

Assuming a distance of 8 mm from the tip of your cutter to the outside edge of your router guide bush – in other words, an 8 mm cutter offset distance – proceed as follows:

Having selected a suitable piece of 12 mm thick MDF (or plywood) measuring approximately 600 mm by 400 mm, lay your pitch board centrally on top of the MDF with the longest edge (the slope) parallel with the long edge of the MDF (Figures 3.19 and 3.20).

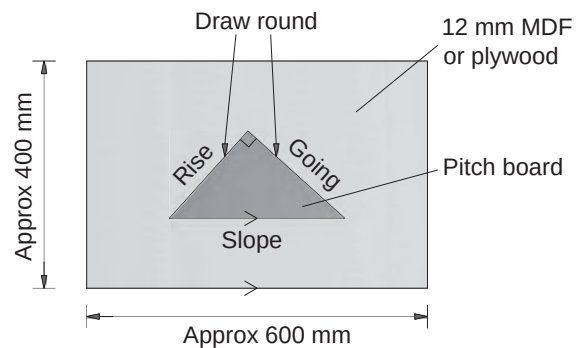


Figure 3.19 and Figure 3.20 Draw round the two shorter sides – the rise and the going – of the pitch board, after positioning centrally on the MDF.



Figure 3.21 Use a steel roofing square to extend the tread and riser lines.

Draw round the two shorter sides – the rise and the going – of the pitch board. Take the pitch board away and use a steel roofing square to extend your lines and, at the same time, check that your lines are at right angles to each other (Figure 3.21).

Next, we need to measure and mark the area of the MDF to be cut out. This area will be made up of the thickness of the tread or riser, the wedge (and the taper of the wedge), and the cutter offset distance. At this stage you should have your piece of MDF with two lines marked on it at right angles to each other. The longer of the two lines represents the tread, the shorter line the riser.

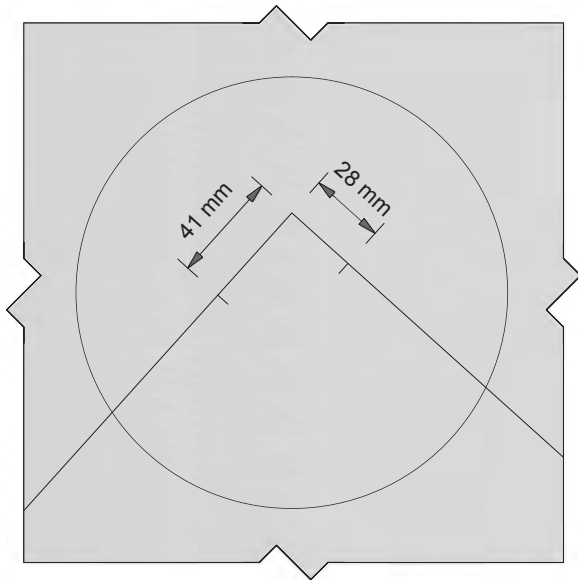


Figure 3.22 Preparing to mark tapered lines for wedges.

Starting at the point where the two lines meet, measure and mark distances of 41mm down the riser line and 28mm along the tread line (Figure 3.22). Here's how these two distances are arrived at:

Tread thickness:	25mm
Cutter offset:	8mm
Cutter offset:	8mm +
Total:	41mm

Riser thickness:	12mm
Cutter offset:	8mm
Cutter offset:	8mm +
Total:	28mm

Provision for wedges

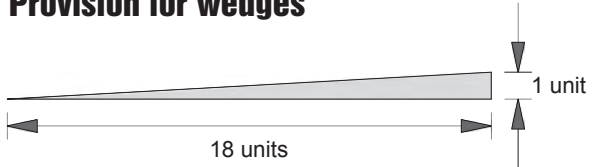


Figure 3.23 A 1:18 ratio for wedges.

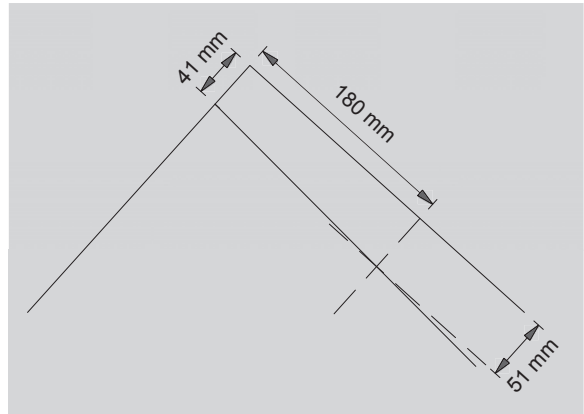


Figure 3.24 Tapered line for tread wedge.

Next mark the taper of the wedges. Wedges for stairs should taper at a ratio of 1:18 (around 3°) (Figure 3.23), and the easiest way to do this is to use multiples of 18 – so let's do just that. From the point where the tread and riser lines meet, measure and mark a distance of 18 cm, or 180mm (Figure 3.24).

Figure 3.23 will tell you that if you have a length of 180 mm, a height of 10 mm will be needed in order to achieve a ratio of 1:18. But here's the part that is often forgotten: you must remember to add the 41 mm that was marked at the meeting point of the tread and riser lines. So, over a distance of 180 mm, the new line will taper from 41 mm to 51 mm (Figure 3.24).

Repeat the process for the tapered line for the riser wedge, extend both tapered lines to within approximately 40mm of the bottom edge of your jig,

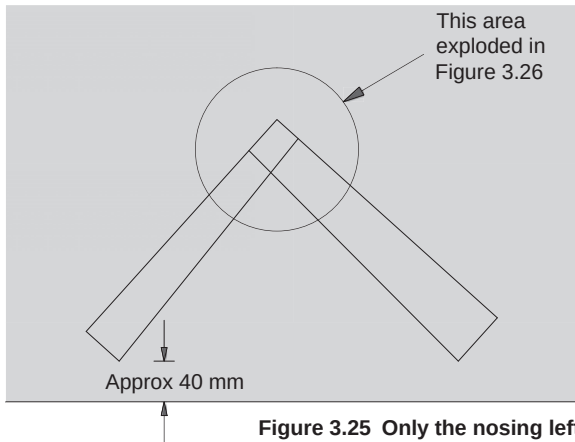


Figure 3.25 Only the nosing left to be marked on the router jig.

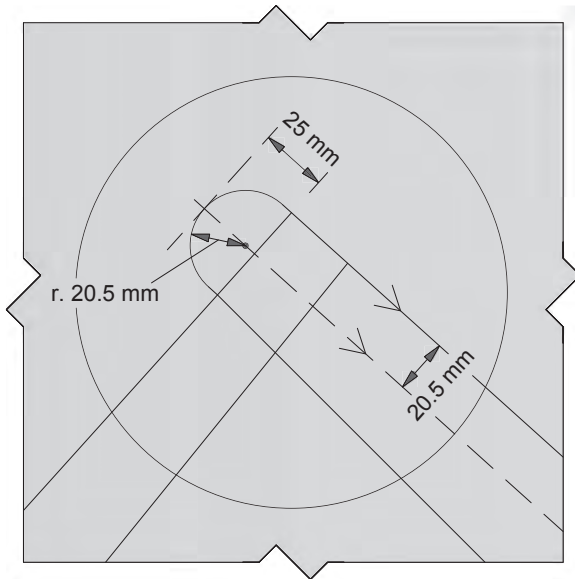


Figure 3.26 Marking a nosing on the router jig.

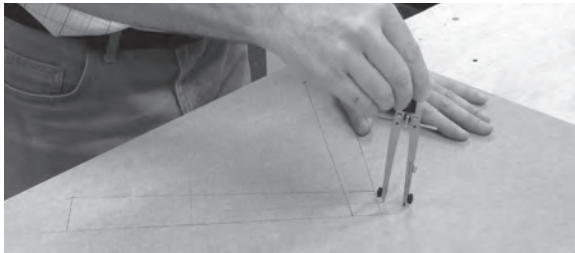


Figure 3.27 Mark the nosing on the router jig using a compass set to a radius of 20.5 mm.

and then square off from your tread and riser line so that your jig is now as illustrated in Figure 3.25.

Marking the nosing

The marking out of your router jig is almost complete; all that is left to mark is the nosing. The distance measured down the riser line from the tread line was 41 mm; start by measuring down half of that distance (20.5 mm) and draw a faint or broken line that runs parallel with the tread line (Figure 3.26). Next, measure and mark a distance of 25 mm from the riser line to the centre of what will be the front of the nosing and then, using a compass, draw a semicircle with a radius of 20.5 mm (Figures 3.26 and 3.27).

Cutting out your router jig

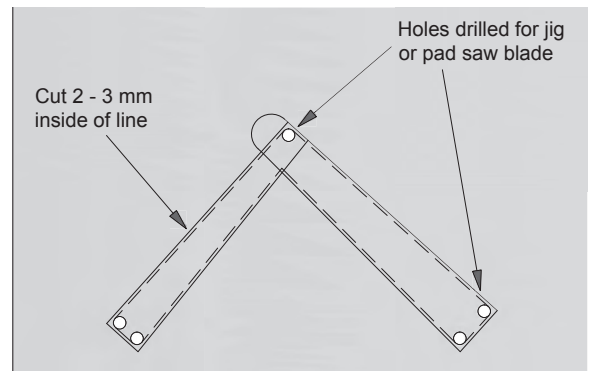


Figure 3.28 Drill and cut on the waste side of the marked lines.

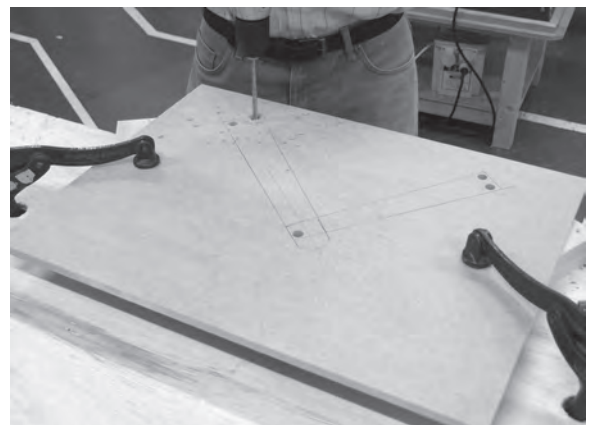


Figure 3.29 Use a 13 mm flat bit to drill holes, through which the blade of a jig saw will fit.

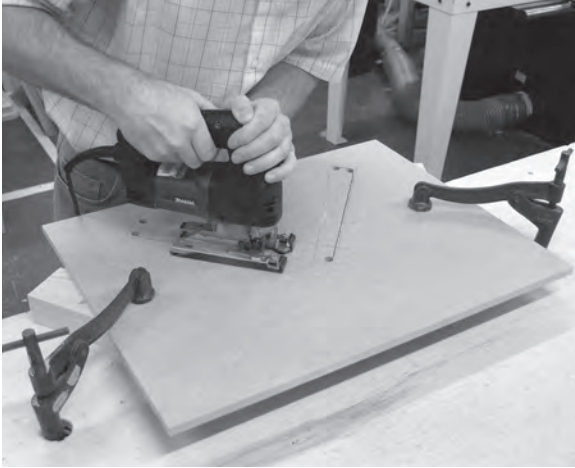


Figure 3.30 Cut on the waste side of your lines with a jig saw.

Your router jig is now ready to be cut out. Start by drilling holes into which the blade of a jig saw or pad saw will fit (Figures 3.28 and 3.29). And then using a jig saw or pad saw, cut 2 to 3mm on the waste side (inside) of your lines (Figures 3.28 and 3.30).



Figure 3.31 With a straight edge for guidance, rout neatly to your marked lines.

The cut doesn't have to be particularly neat because the final operation is to use a router and a straight edge to cut accurately to your lines (Figure 3.31).



Figure 3.32 Freehand routing of the nosing. Gradually skim the MDF as you work towards the marked line in a gentle circular motion. Tip: Leave the straight edge in place, it will ensure that your nosing finishes flush with the line of the tread.

Cutting out the circular nosing can be tackled in one of two ways: it can be bored out with a brace and bit – in which case the boring should be undertaken before cutting with a jig saw – or it can be routed freehand (Figure 3.32). Freehand routing may seem daunting if it is something you haven't attempted before, but with a little practice on a piece of scrap timber. I think you'll be pleasantly surprised: it is not as difficult as you might imagine.

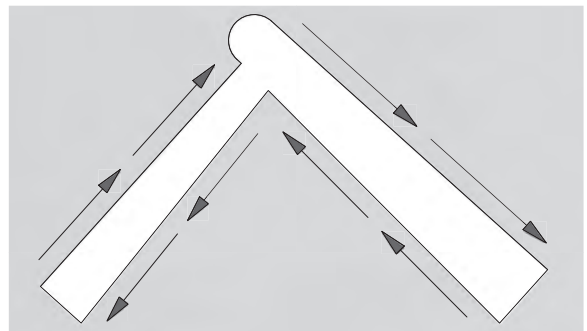


Figure 3.33 Direction of routing.

Here are some points to remember when finishing your router jig:

Rout in the direction of the arrows shown in Figure 3.33.

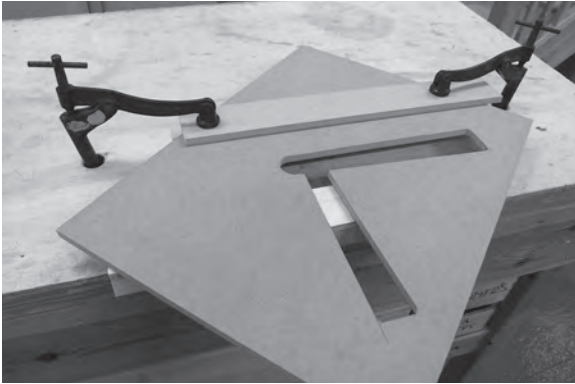


Figure 3.34 Secure work with two clamps.

Do not attempt to run your router off a straight edge secured by one clamp only – this will lead to ‘pivoting’. Always secure work with *two* clamps (Figure 3.34).

Figure 3.12 shows a softwood fence screwed to the jig; the time to fix this fence is after the strings have been marked.

Finish your jig neatly (Figure 3.11); any imperfections will be repeated time and again when using the jig to rout the strings – and this would be completely unacceptable to any customer.

Avoiding ‘rounding’

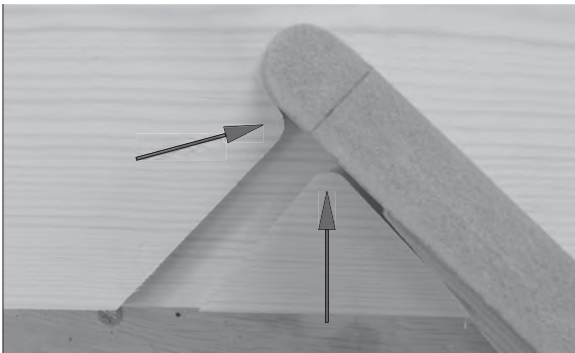


Figure 3.35 The result of using the jig without infill pieces.

Figure 3.11 shows the finished router jig. Before it can be used though, there are two very important things to remember. Firstly, as the router is pushed round the two external corners, visible in Figure 3.11,

rounding will occur (Figure 3.35). And secondly, the jig must be tested on a scrap piece of timber before it is used on a stair string.

The rounded area shown on the right in Figure 3.35 will be beneath the step of the finished staircase and is therefore of no concern. The rounded area on the left is where the riser meets the tread, and will be visible (and therefore unacceptable), unless a scotia moulding is to be fitted (Figure 10.44). To avoid rounding the visible part of the string, it is necessary to make two infill pieces; the first will fit in the nosing of the jig and the second in the riser/wedge area.

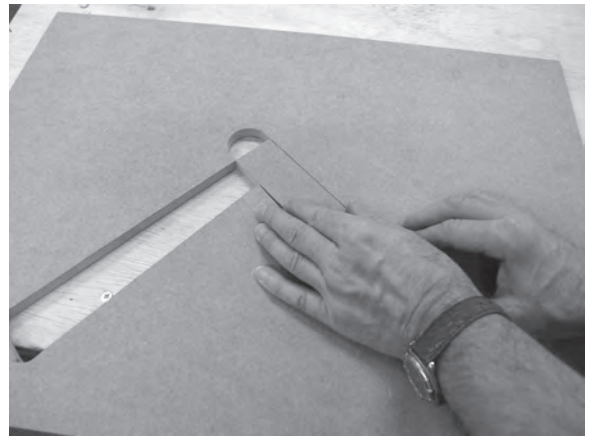


Figure 3.36a Prepare the nosing infill by using a short length of 12 mm MDF that is equal in width to the nosing aperture (41 mm).



Figure 3.36b Use a coping saw to cut roughly to the shape of the nosing



Figure 3.36c Neatly round the nosing, either by hand or mechanically.

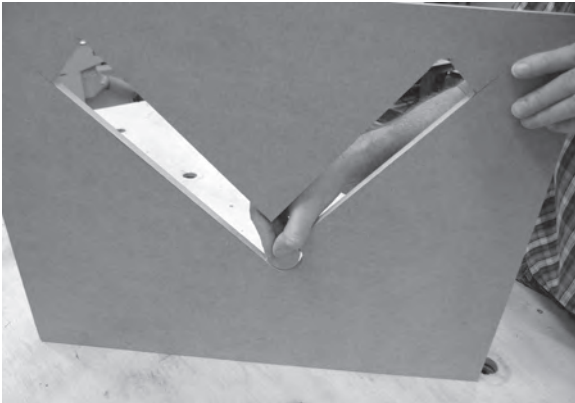


Figure 3.36d Cut to length then check the fit of the nosing infill.

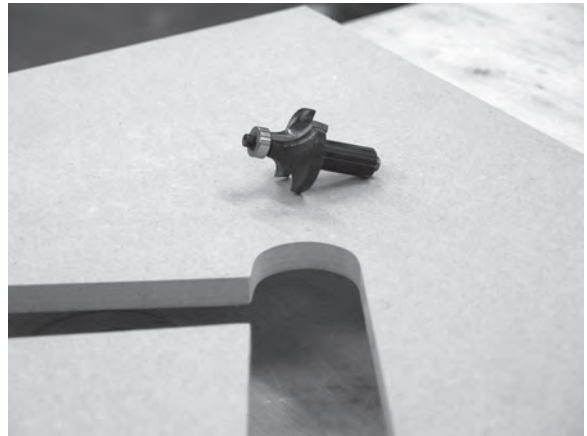


Figure 3.38 A bearing-guided round over cutter with a radius of 12.7 mm.

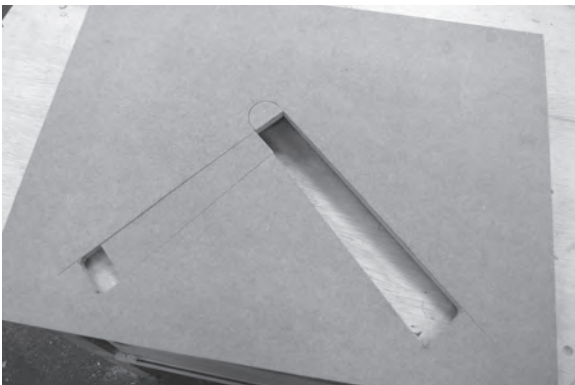


Figure 3.37 The router jig with both infills in place.

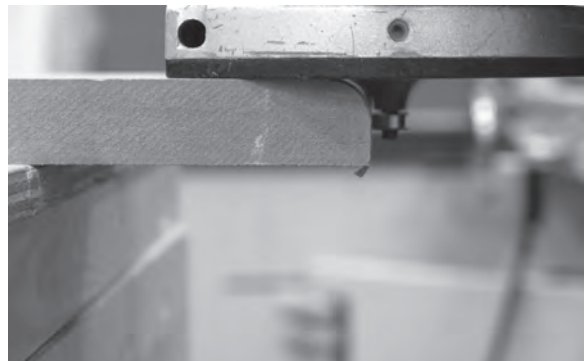


Figure 3.39 Apply a bull-nosed edge to a scrap piece of 25mm MDF for the purpose of checking the housing produced by the newly made router jig.

Now it's time to test the jig. To do this, we'll need something to test it with. Using a bearing-guided round over cutter with a radius of 12.7 mm (Figure 3.38), rout a nosing on the edge of a scrap piece of 25mm MDF (Figure 3.39). This small section of 'tread' can be used to test the housing produced by your new router jig.

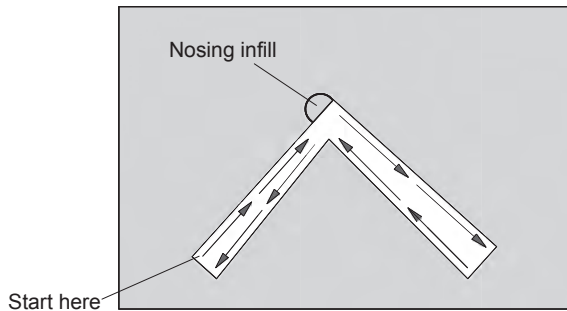


Figure 3.40 Direction of routing.

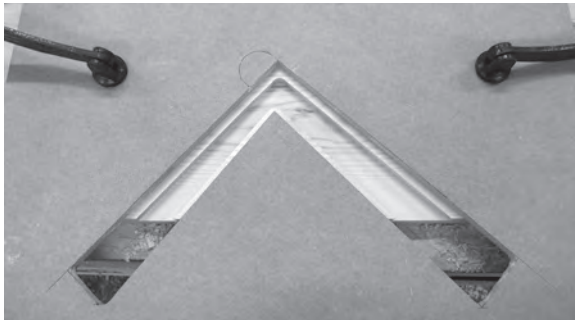


Figure 3.41 The first stage of testing the jig takes place with the nosing infill but without the riser infill.

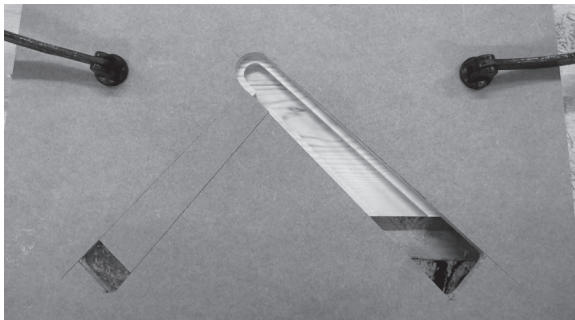


Figure 3.42 Swap the nosing infill for the riser infill and complete the test housing.

Clamp your jig to a scrap piece of timber, which doesn't need to be as wide as a stair string because it is only the nosing area of the jig we are testing. With the nosing infill inserted and the riser infill removed, start on the left and rout in the direction of arrows shown in Figure 3.40; the result is shown in Figure 3.41. Remove and set aside the nosing infill, insert the riser infill, and complete the routing of the nosing (Figure 3.42).

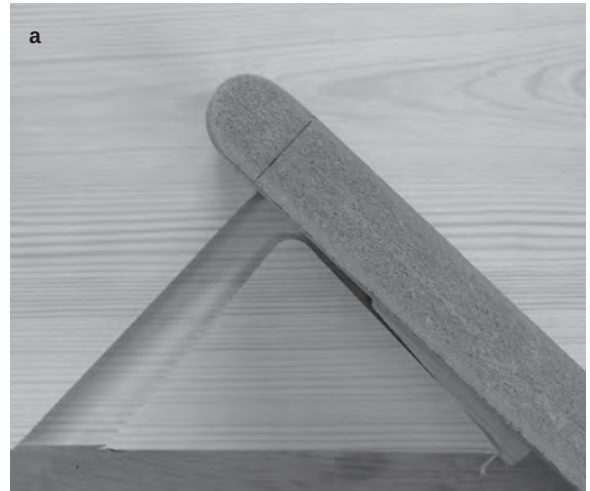


Figure 3.43a & b The tread nosing fits nicely, and the corner beneath the nosing is now square.

Use your small section of tread to test the fit of the nosing, which should be a snug fit with no gaps (Figure 3.43a). The housing beneath the nosing should be square at the point where the tread will meet the riser (Figure 3.43b).

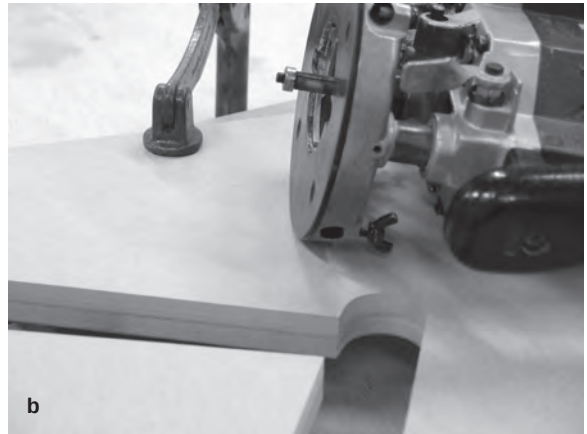


Figure 3.44a & b Further router jigs can now be produced quickly and easily by using the original jig and a bearing-guided trimmer.

Further router jigs can be produced quickly and easily by using the original jig and a bearing-guided trimmer (Figures 3.44a and b).

Now that we've made a router jig and assembled the tools and equipment that we need, let's build a staircase!

4

Straight-Flight Stairs



Figure 4.1 Historic properties of Rochester in Kent.



Figure 4.2 The cellar entrance is a hatch in the floor of the dining room.



Figure 4.3 A wooden ladder propped against a wall is not the safest way to access a cellar.

Welcome to historic Rochester in Kent – Charles Dickens country (Figure 4.1). My purpose in this former city is to visit an eighteenth century house, with a cellar thought to have been first excavated in medieval times! The owner's access to his cellar is through a hatch in the dining room floor (Figure 4.2), beneath which is a wooden ladder leading down to an extremely uneven cellar floor (Figure 4.3).

Fed up with this steep and unsafe means of access (particularly when carrying heavy items), the owner would like to enlarge the hatch and install a new straight-flight staircase. My task is to take measurements and assess the feasibility of the proposed project.

Immediately evident is the lack of headroom. Available floor space in the dining room above will not permit sufficient enlarging of the hatch to provide the required 2 m of headroom. However, this 250-year-old property – once a butcher's shop – has low ceilings throughout, and a head-banging 1.4 metres of headroom at the main, ground-to-first-floor, staircase. Furthermore, the new staircase, in replacing a propped-up ladder, will be – in the words of the local Building Control department – 'no worse' than existing; in fact, it will be a considerable improvement. And finally, as the work being planned does not involve a change of use, Approved Document K's recommendation of 2 m of headroom can, on this occasion, be overlooked.

Next, we need some clarification as to the category that the new staircase falls under. A utility staircase is defined in Approved Document K as 'a stair used for escape, access for maintenance, or purposes other than as the usual route for moving between levels on a day-to-day basis'. The last part of this definition,

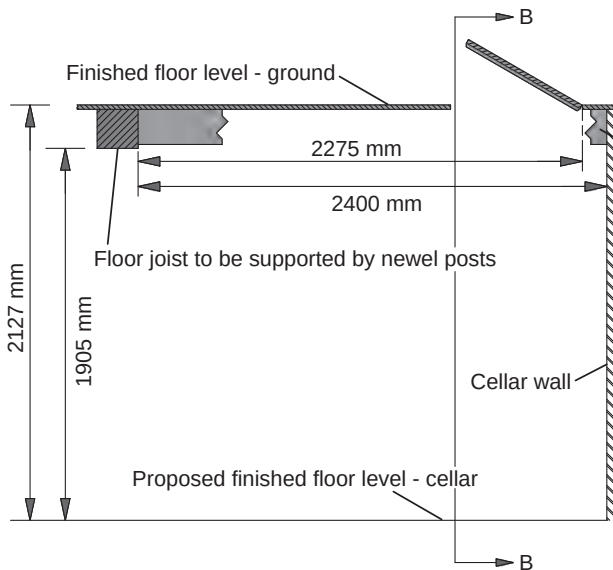
It's always a good idea to consult your local planning officer at an early stage in the project. Where it is not possible to observe all the recommendations made in Approved Document K, adherence should be as close as possible. While the lack of headroom above the cellar staircase will not be an issue, it is important that other recommendations – maximum rise, minimum going, angle of pitch, etc. – are adhered to wherever possible.

while seeming to apply to this cellar staircase, in fact applies to buildings other than private dwellings, such as schools and commercial premises. The proposed cellar staircase is 'intended to be used for only one dwelling', making it a 'private stair'.

The client explained his plans for the cellar floor, and between us we determined what would be the finished floor level. We decided that the foot of the new staircase should finish beneath a main ground floor joist, which could then be supported by a pair of newel posts. The following site dimensions are illustrated in Figure 4.4:

Finished floor to finished floor rise: 2127 mm

Finished floor to underside of floor joist: 1905 mm



SECTION A-A. LENGTH AND HEIGHT OF OPENING

Horizontal distance from cellar wall to floor joist:
2400 mm

Horizontal distance from hinged side of hatch to floor joist: 2275 mm

Width of opening: 725 mm

Using calculations to design the staircase

In chapter 2 we looked at calculations for straight-flight stairs – calculations which work well in most situations. This cellar staircase, though, is a good example of why flexibility sometimes has to be demonstrated when performing stair calculations.

First attempt

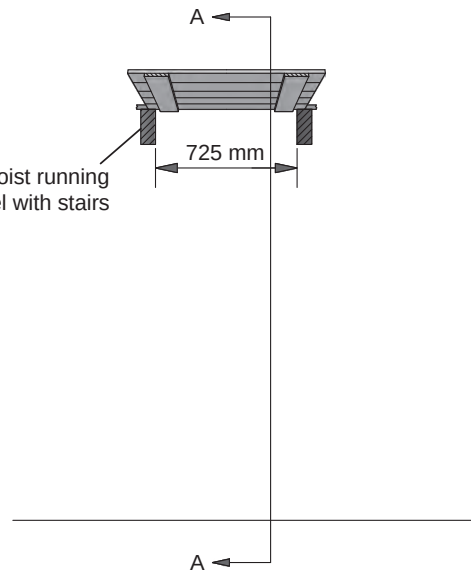
The starting point, as always, is to divide the total floor-to-floor rise by 220 (mm):

First calculation:

$$2127 \div 220 = 9.7 \text{ (round up to 10 steps)}$$

Second calculation:

$$2127 \div 10 = 212.7 \text{ mm.}$$



SECTION B-B. WIDTH OF OPENING

Figure 4.4 Dimensions recorded on site.

These two calculations have told us that we need ten steps, each with a height, or rise, of 212.7 mm.

Double check:

$$212.7 \times 10 = 2127 \text{ mm} \quad \checkmark$$

Next, use the Rise and Going calculator to determine a suitable going. Use the far left or far right vertical column to look up the rise, which, rounded to the nearest whole millimetre, is 213. Read across to the bright green 42°, and then vertically up or down to find the going, which is 237 mm.

Now that we have a rise and going, we can use the formula $2R + G = 550-700$ to check that the relationship between the two is correct:

$$2R + G = 550-700 = 2 \times 212.7 + 237 = 662.4 \text{ mm}$$

Except headroom, we have demonstrated compliance with the Building Regulations because:

The rise is less than 220 mm.

The going is greater than 220 mm.

The angle of pitch (as determined by the Rise and Going calculator) is 42°.

Twice the rise plus the going, at 662.4 mm, is between 550 mm and 700 mm.

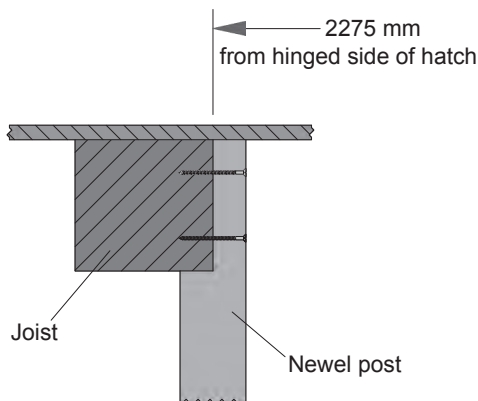


Figure 4.5 Tops of newel posts to be cut to form halving joints that will be screwed to, and will support, the joist above.

So, everything appears fine and we can proceed with the manufacture, can't we? Not just yet. There's one part of our plan that hasn't quite worked out. The client said that he wanted a pair of newel posts at the foot of the stairs that could be used to support the floor joist above. To achieve this, my plan is to cut halving joints at the tops of the newel posts so that they support and can be screwed through the sides into the joist (Figure 4.5). At the moment, this is not possible because the staircase that we have designed, with a total going of 2133 mm (9×237 mm), isn't sufficiently long, and lands on the cellar floor before it reaches the floor joist above.

Second attempt

To reach the floor joist, a total going of 2275 mm is needed (Figure 4.4), meaning that the individual going would have to be increased from 237 mm to 252.8 mm:

$$2275 \text{ mm} \div 9 = 252.8 \text{ mm}.$$

Check that the relationship between the dimensions of our rise and new going is still acceptable:

$$2R + G = 550-700 = 2 \times 212.7 + 252.8 = 678.2 \text{ mm}$$

It is. Although, at 678.2 mm, the result of the calculation is very close to the maximum of 700 mm, meaning that the steps, while acceptable, are on the large side. In instances like this, I like to try introducing an additional step to see if a more pleasing result can be achieved.

Third attempt

Our usual first calculation is to divide the total rise by 220, but since we already know that we want eleven risers, we can move straight to working out the height of each step:

$$2127 \div 11 = 193.4 \text{ mm}$$

Double check:

$$193.4 \times 11 = 2127.4 \text{ mm} \quad \checkmark$$

A staircase with eleven risers will have ten treads, so the individual going will be:

$$2275 \div 10 = 227.5 \text{ mm}$$

Check the relationship:

$$2R + G = 550 - 700 = 2 \times 193.4 + 227.5 = 614.3 \text{ mm}$$

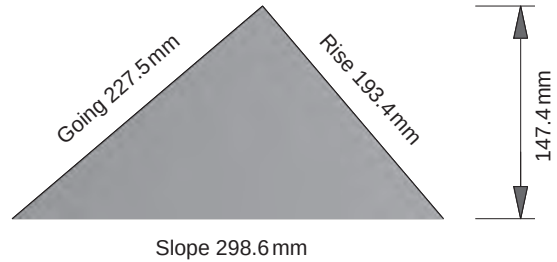


Figure 4.8 Dimensions of pitch board for cellar staircase.

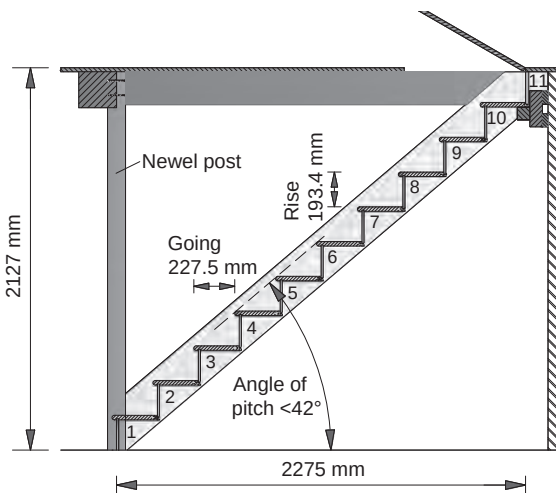
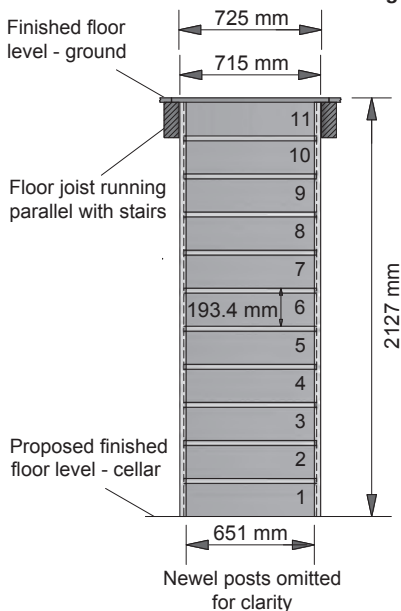


Figure 4.6 and Figure 4.7 The planned cellar staircase.



The figure of 614.3 mm is very close to the midpoint between 550 and 700 mm, and that tells us that eleven steps is a better choice than ten for this staircase (Figures 4.6 and 4.7).

When making any item of joinery it's a good idea to keep in mind the dimensions at all times. If expensive mistakes are to be avoided it is important that regular checks are made so that any error is spotted at the earliest opportunity. This is particularly true of stairs. When I'm building a staircase, I have the rise and going measurements constantly in mind (although this does get more difficult when there are several staircases in production at the same time). So, before we continue, a quick reminder of the size of the cellar staircase. It will have 11 steps, each with a rise of 193.4 mm and a going of 227.5 mm. A pitch board for this staircase is shown in Figure 4.8.

Cutting list and timber preparation

Having completed the necessary calculations and made a pitch board and margin template, the next step is to prepare a cutting list which, for a straight-flight staircase, is perfectly straightforward. If you're a student of carpentry and joinery, you will be required to draw a paper rod from which cutting list dimensions can be taken. A rod is useful because it provides an opportunity for the inexperienced joiner to foresee any problems that might arise, while also providing a document that can go into a portfolio of evidence or be photographed for an eportfolio. In industry though, a rod for a straight-flight staircase is not necessary since the string, when marked, will serve the same purpose.

When writing a cutting list, try to group members according to the material that they are to be cut from. Therefore, on this cutting list, the strings, newel posts, and treads will be together, because they are all to be made from European Redwood, while the risers will be left until last because they are to be cut from Far Eastern plywood. Ancillary components, such as wedges and glue blocks, are standard items and not usually included on a cutting list.

'Balustrade' is a term referring to all the components that make up the guarding of a staircase (chapter 11). Since this includes the handrail, the term 'handrail and balustrade' is incorrect and frowned upon by some. Nevertheless, it remains widely used throughout the joinery and stair-building industry, and I am perfectly comfortable using the term.

First of all, let's consider the materials that will be used for the cellar staircase. The client requested that, rather than MDF, the treads be made from European Redwood. The same timber will be used for the strings and newel posts, while the risers will be Far Eastern plywood. Handrail and balustrade are excluded from the cutting list, as the guarding of stairs is looked at in detail in chapter 11.

So let's look at the cutting list, and then we'll discuss how the sizes are determined, and also look at the preparation of the components.

Stairs which are to be carpeted are, these days, typically constructed using treads made from MDF (medium density fibreboard). The advantages of MDF over solid timber are: it's cheaper; it's easy to cut and work with; it's available in wide boards, which eliminates the need for gluing up, thereby reducing labour and saving time. The use of MDF for the risers should be avoided when the treads are MDF as this can lead to squeaking. Instead, use plywood for the risers. Strings and newel posts are always made from solid timber and, unless specified otherwise, that timber is usually European Redwood.

Cutting List

No.	Member	Length	Width	Thickness	Material
2	strings	3500	245	32	European Redwood
2	newel posts	2200	100	100	European Redwood
10	treads	700	259	25	European Redwood
9	risers	700	200	12	Far Eastern Plywood
1	riser	700	175	12	Far Eastern Plywood
1	riser	700	197	18	Far Eastern Plywood

All dimensions in millimetres.

Strings

Two are required, one of each hand, each measuring 3.5m long × 245mm wide × 32mm thick. How did we arrive at these dimensions?

Firstly, the length of 3.5m. Your pitch board will tell you everything you need to know about the size of each step (Figure 4.8). For most private staircases, the length

of one step – which is the slope of the pitch board – will be around 300mm. If you're familiar with imperial measurements you will know that 300mm is approximately equal to 1 foot. So our 11-rise cellar staircase will require a string length of 11 feet (3.35m) plus wastage, which for this staircase will be minimal as the bottom ends of each string will be tenoned into newel posts, and the top ends cut beneath the cellar hatch. A total length of 3.5m will be adequate for each string.

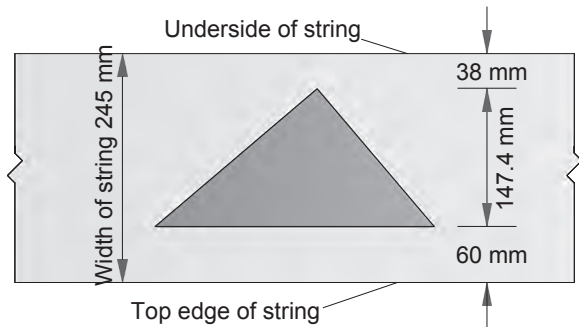


Figure 4.9 Determining width of string.

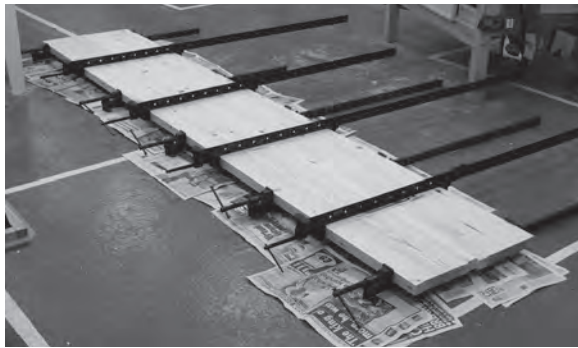


Figure 4.10 Glued-up strings should be left in T-bar clamps for 24 hours. Newspaper is used to protect the workshop floor and also to separate the steel of the clamps from the wet glue to prevent timber staining.

Secondly, the width of 245mm (Figure 4.9). The vertical height of the pitch board is 147.4 mm. The margin at the top of the string (where the tread nosings will be) should ideally be around 60mm, and will be achieved if your margin template is made to the

dimensions shown in Figure 3.7. And to accommodate the wedges on the underside of the strings, 32–38mm is desirable. So, $147.4\text{ mm} + 60\text{ mm} + 38\text{ mm} = 245.4\text{ mm}$, say 245mm. And unless you're using 250mm wide timber, rather than the more common 225mm, some gluing-up will be required to achieve this width (Figure 4.10).

Figure 4.9 may appear confusing because it shows the top edge of the string at the bottom, and the underside of the string at the top. This is because a string should always be marked off its top edge; and this is because it will be routed using a jig with a fence placed against the top edge.

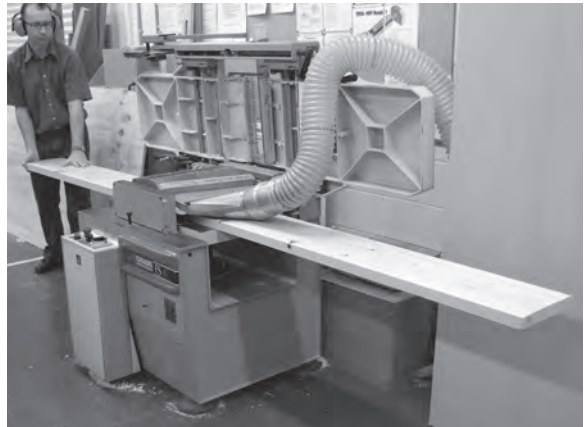


Figure 4.11 When dry, the strings are re-planed to their finished sizes.

And lastly, the thickness is 32mm (or $1\frac{1}{4}$ inches) which is the traditional finished thickness of stair strings and that specified in BS 585-1:1989. When preparing sawn timber, 6mm is normally allowed for planing (3mm over the planer, and 3mm through the thicknesser). So 32mm finished timber would usually come ex 38mm sawn timber. Long stair strings, however, can be better straightened if 50mm sawn timber is used (Figure 4.11).

Newel posts

The cellar staircase will have two newel posts, one on each side, at the foot of the stairs. The size of the newel posts will be 2.2m long $\times$ 100mm $\times$ 100mm. A length

of 2.2m is required so that the newel posts reach from the cellar floor to the underside of the floor above and support the dining room floor joist (Figure 4.6).

A finished sectional size of almost four inches square will require some gluing-up, and this can best be achieved by ripping 2.2m lengths of 225mm × 75mm and 225mm × 38mm European Redwood down the middle and then planing the pieces to produce suitable gluing surfaces.

Treads

Since the cellar staircase has 11 risers, it will have 10 treads, each measuring 700mm long × 259mm wide × 25mm thick.

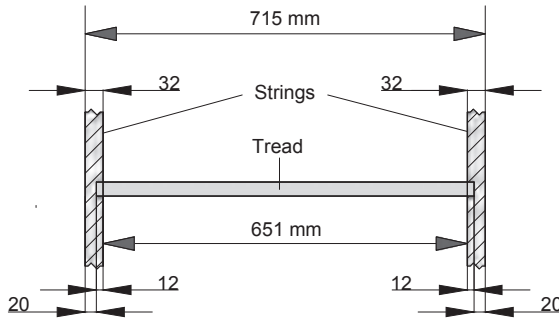


Figure 4.12 Determining the length of the treads and risers.

The overall width of the staircase, measured from the outside of one string to the outside of the other, is 715mm (Figure 4.12). From that we must deduct 64mm (the combined thickness of the two strings), and then add 24mm (12mm deep housings in each string).

A simpler way of determining the length of the treads would be to deduct 40mm (20mm each side) from the overall staircase width:

Length of treads: $715\text{ mm} - 40\text{ mm} = 675\text{ mm}$
(say, 700mm for the cutting list)

The tread thickness is a standard 25mm (or one inch), while the width of 259mm is achieved by adding the going to the nosing length, and then finally adding a

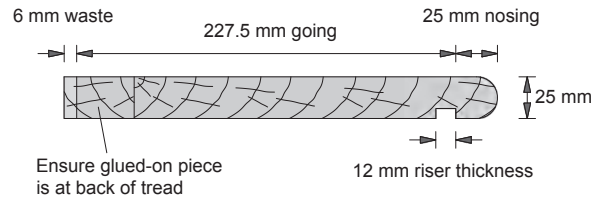


Figure 4.13 Width and thickness of tread. Note: glue joint is positioned at back of tread.

further 6mm for waste, which will be removed after the strings have been routed (Figure 4.13). The going for the cellar staircase is 227.5mm. Approved Document K states that all the nosings in a flight must overlap the tread below by the same amount. In North America, where I worked in stair-building during the early 1990s, longer nosings of 32mm are preferred, but here in the UK, 25mm is the norm. The waste portion at the back of the tread is vitally important, and this will be appreciated when the staircase is nearing completion – but more on that later.

Once again, gluing up will be required to achieve the required tread width of 259mm. Since the treads will be supported at their ends within the string housings, there is no need to use tongue and groove joints when widening the timber for the treads. Butt joints are perfectly acceptable, provided the glue joint is positioned at the back of each tread (Figure 4.13).

Risers

We need 11 Far Eastern plywood risers. However, instead of stating '11 risers', our cutting list calls for 9

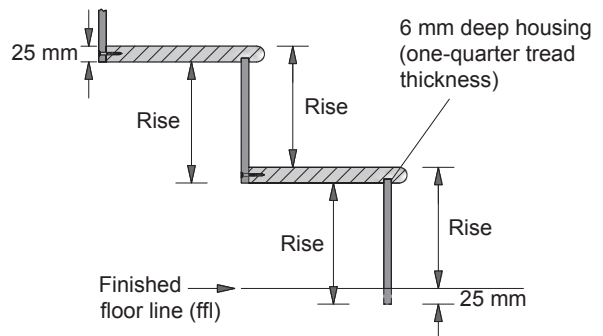


Figure 4.14 Determining the height of risers.

risers, 1 riser, and 1 riser. The 9 risers each measure 700mm long × 200mm wide × 12mm thick. The length of 700mm is the same as that of the treads; the thickness is a standard 12mm, although 9mm plywood could be used (BS 585-1:1989); the width of 200mm is achieved by adding the rise (193.4mm) to the depth of the housings in the underside of the treads (6mm).

The first of the two single risers is riser number 1. It also measures 700mm long and 12mm thick, but is only 175mm wide; Figure 4.14 explains why.

As we know, the rise is the distance between the top of one tread and the top of the next. As all the treads in a flight should be the same thickness (usually 25mm), it follows that the distance from the underside of one tread to the underside of the next is also equal to the rise. But unlike risers 2 to 10, riser number 1 does not extend beyond the tread below, because there is no tread below! Instead, it simply sits on the finished floor level and is therefore 25mm narrower than the other nine.

The second of the two single risers is riser number 11, and this one is a little unusual in that the width (or height) has been reduced so that it finishes at the underside of the dining room floor (Figure 4.15).

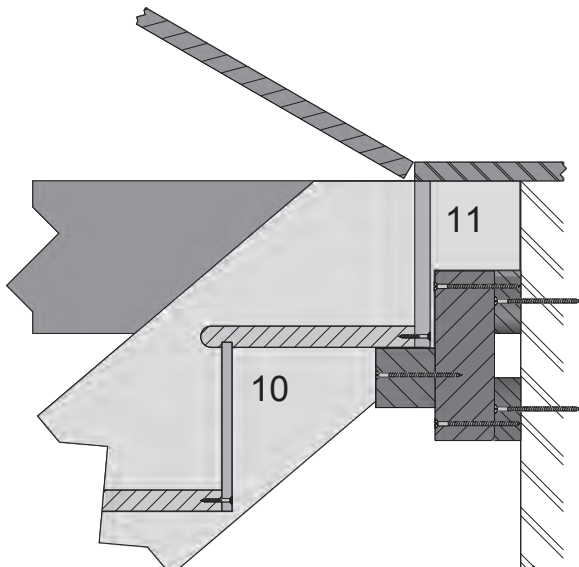


Figure 4.15 Softwood plates screwed to the cellar wall provide support and fixing points for the top of the staircase.

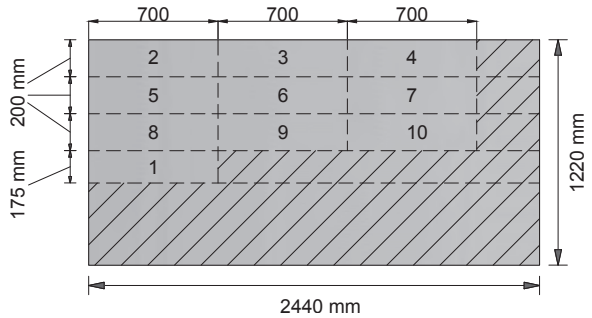


Figure 4.16 Cutting plan for risers from a sheet of 12mm thick plywood.

Whenever a circular saw is used to dimension timber-based sheet material, every cut results in waste due to the kerf of the saw blade. A typical rip saw blade is approximately 3mm thick; I usually allow 4mm for each saw cut, in case the blade wobbles a little in use. Here though, as is often the case, there is no need to worry about the saw cuts. The total width of four risers is 775mm (Figure 4.16). With a board width of 1220mm, the remaining 445mm is more than enough for the four saw cuts which will only account for around 16mm of plywood being lost to the dust extractor.

And in the absence of a landing (upper) newel post and landing nosing, and being the top riser, through which the staircase will be fixed, I have thickened it up to 18mm.

When working with board materials, I use sketches to illustrate exactly how each board will be cut as this not only ensures that waste is minimised, but also helps avoid the possibility of mistakes during cutting. Figure 4.16 shows that a little over half a sheet is required for the 12mm thick risers.

Marking out the strings

Following the heavy work of cutting the timber and the somewhat messy task of gluing up the components, we've now arrived at the operation I enjoy most – the marking out of a clean, freshly prepared pair of strings. It is important to remember that the person who marks out the strings might not necessarily be the person

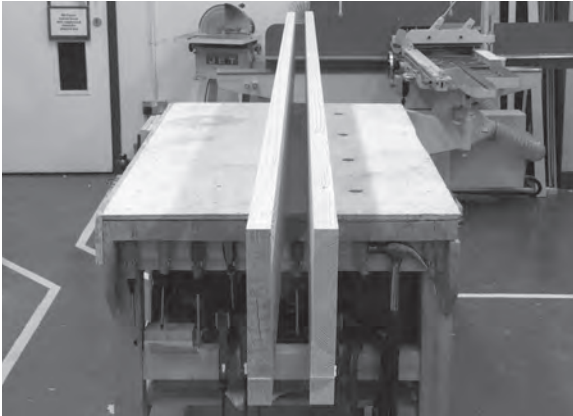


Figure 4.17 Strings that are not as straight as these, require careful marking if the effects are to be minimised.

who goes on to rout them, so all markings must be entirely accurate, clear, and professional if mistakes are to be avoided.

Start by examining the strings to decide which edge will be the top and which will be the bottom, and which side will be the inside and which will be the outside (Figure 4.17). If the strings are not straight, the curved edge, or camber, should be positioned upwards if further sag is to be avoided when under load. And if the sides are not straight, the curves should be positioned in opposite directions so that each string pulls the other straight.



Figure 4.18 Defects should be concealed beneath the steps wherever possible.

Defects in the sides should be positioned according to the string's use. An inner, or wall string, as the name suggests, goes against a wall, providing the ideal opportunity to forever hide any defects. Defects in the outer string should be positioned, if possible, on the lower half of the side to be routed. Careful marking will allow the defects to be concealed beneath the steps (Figure 4.18).

Before we put pencil (or pen) to timber, let's have a quick reminder of the results of our cellar staircase calculations:

Number of steps:	11
Rise:	193.4 mm
Going:	227.5 mm

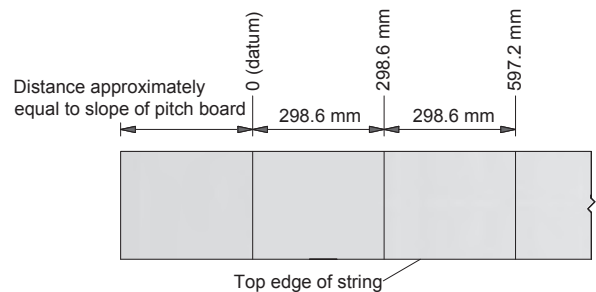


Figure 4.19 Setting out the steps on the strings from a datum point.

Select what will be the right-hand string and stand facing its upper edge. From the end on your left, measure and mark a distance approximately equal to the slope of the pitch board, say 300 mm (Figure 4.19). From that mark, which can be considered a datum, we now need to accurately measure and mark multiples of 298.6 mm (10 in total) along the length of the string. Dividers are a good option here (Figure 3.10), but I prefer another method.

Run your tape measure out along the length of the string as shown in Figure 4.20. Enter the length of the pitch board slope (298.6) into your calculator and then repeatedly add that figure, marking the string at each new total until you reach 2986 mm (Figure 4.21), as follows:

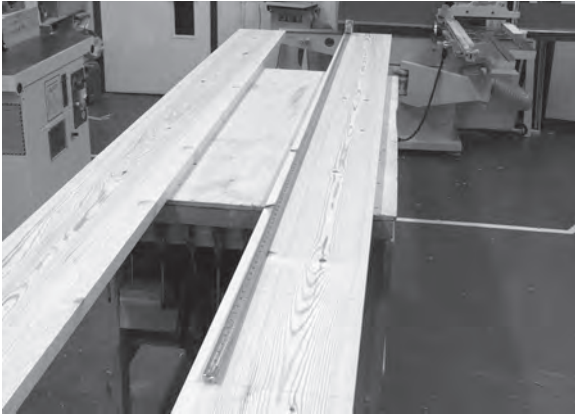


Figure 4.20 Maintain accuracy when marking the strings by ensuring that all dimensions originate from the same point – a datum point.



Figure 4.21 Using your calculator's memory reduces the risk of errors.

Some calculators allow further repetitions of the last operation by repeatedly pressing the '=' key. Otherwise, the risk of mistakes can be reduced by making use of your calculator's memory. And don't worry too much about having to mark '.2' of a millimetre or '.4' of a millimetre because, by working from a datum, and keeping your tape measure perfectly still, each subsequent mark will correct a previous inaccuracy.



Figure 4.22 Your pitch board can be used to speedily check the marks for accuracy.

Now square each mark across the width of the string and, before proceeding, double-check your markings quickly and easily by comparing each spacing with your pitch board (Figure 4.22).

0	(first mark on string and datum)
+ 298.6 =	298.6 (second mark on string)
+ 298.6 =	597.2 (third mark on string)
+ 298.6 =	895.8 (fourth mark on string)
+ 298.6 =	1194.4 (fifth mark on string)
+ 298.6 =	1493 (sixth mark on string)
+ 298.6 =	1791.6 (seventh mark on string)
+ 298.6 =	2090.2 (eighth mark on string)
+ 298.6 =	2388.8 (ninth mark on string)
+ 298.6 =	2687.4 (tenth mark on string)
+ 298.6 =	2986 (eleventh mark on string)

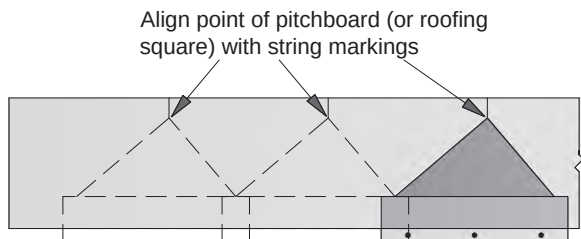


Figure 4.23 The point of the pitch board (or steel roofing square) is aligned with each string marking before drawing round.



Figure 4.24 Steps on strings being marked with stair gauges fixed to a steel roofing square.

Now it's time to mark the steps onto the string, which can be done with either a pitch board and margin template (Figure 3.3), or a steel roofing square with stair gauges (Figure 4.24). Align the point of the pitch board (or roofing square) with the marks on the strings (Figure 4.23) and draw round using a sharp 2H pencil (I tend to use a pen for better visibility when demonstrating to students).

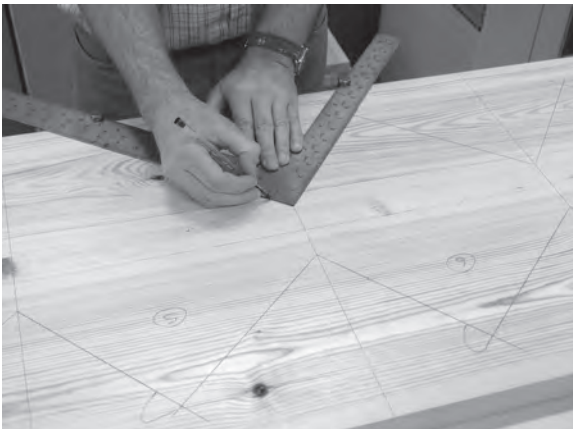


Figure 4.25 The roofing square is turned over to mark the opposite string.

When all of the steps have been marked, butt the two strings together (remembering that they must be a

handed pair) and square the original lines across onto the face of the second string. Now mark the steps onto the second string, ensuring it is the opposite hand by flipping the pitch board (or roofing square) over. This part is so important it is worth emphasising: if the first string was marked with the smooth side of the pitch board's hardboard facing upwards, the second string must be marked with the smooth side facing downwards; or, if the first string was marked with the stair gauge screws facing upwards, the second string must be marked with the screws facing downwards (compare Figures 4.24 and 4.25).



Figure 4.26 The steps are numbered and the nosing positions indicated.

When all of the steps have been marked, number them, and draw the nosings on (freehand) so as to avoid the risk of routing the strings upside down – yes, I have seen it done (Figure 4.26).

Lastly, the tenons that will join the strings and the newel posts should be marked. Figure 4.27 shows that the face of riser number 1 will sit centrally on the 100 mm newel posts. The tenon shoulder lines will therefore be 50 mm behind the face of riser number 1 (Figure 4.28).

Routing the strings

With the strings marked, it is now time to use a 16 mm stair housing dovetail cutter (Figure 3.14) to rout the 12 mm deep housings. And this gives us the opportunity

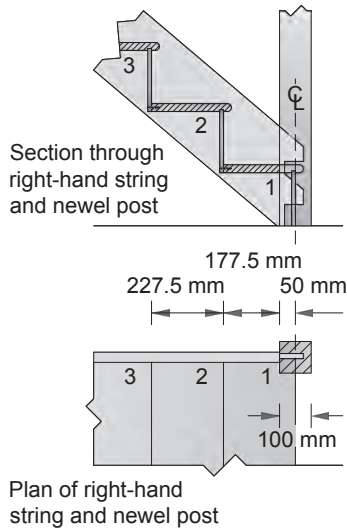


Figure 4.27 Face of riser number 1 to sit centrally on newel posts.



Figure 4.28 The tenon shoulder is marked 50 mm behind the line of riser number 1.

to compare the shop-made router jig, made in chapter 3, with the proprietary jig manufactured by Trend (Figure 3.13). Constructed from solid laminate, Trend's 'staircase housing jig' incorporates a number of features which give it the edge over shop-made jigs – for a price.

Setting up the router jig

Both jigs require spacer blocks in order to offset them the correct distance from the rise and going lines marked on the string – 8 mm in the case of the shop-made jig (based

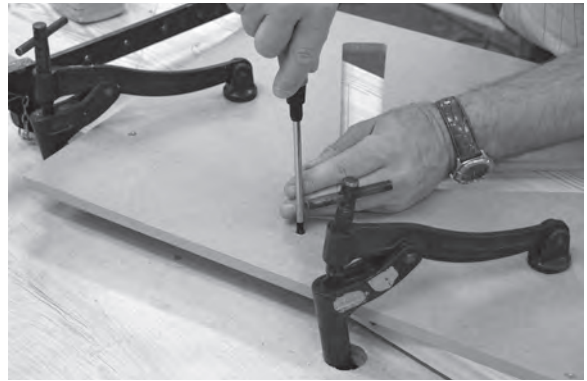


Figure 4.29 Clamp the shop-made router jig accurately in position, then screw through the face of the jig into a softwood fence below.



Figure 4.30 Trend's aluminium fence is secured by reversible barrel nuts, which permit quick switching of the jig from one string to the opposite string during use.



Figure 4.31 and Figure 4.32 (opposite) With either jig, use spacer blocks (the thickness of which should be equal to the cutter offset distance) to accurately align the jig with the string markings.



Figure 4.32

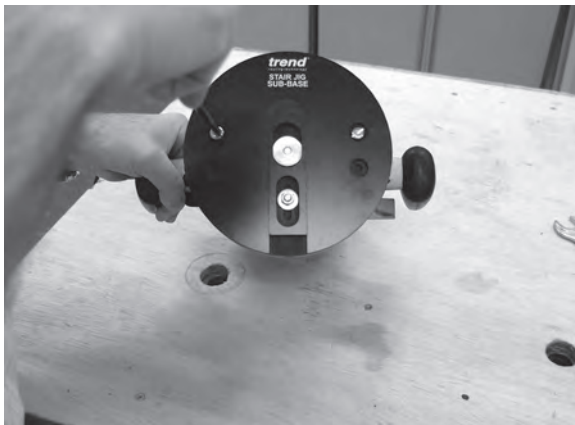


Figure 4.33 Trend's sub-base features an adjustable nosing piece and, provided treads are at least 25mm thick, also prevents 'rounding' on the string beneath each nosing.

on a 30mm guide bush), and 7.5mm for the Trend jig (Figures 4.31 and 4.32). Once clamped in position on the string, the shop-made jig requires a softwood fence, which is fixed in place by screwing through the face of the jig (Figure 4.29). Trend's aluminium fence is secured by reversible barrel nuts that permit quick switching of the jig from one string to the opposite string during use (Figure 4.30). And the size of the nosing on the shop-made jig is determined during manufacture and is not adjustable. Trend's jig features an adjustable nosing piece as part of a sub-base which is screwed to the base of the router (Figure 4.33).

Using the router jig

Unlike marking out, where you should stand facing the upper edge of the string, routing should take place facing the string's lower edge (Figure 4.34). And the single most important thing to remember is always rout from left to right; irrespective of which string you



Figure 4.34 Stand facing the string's lower edge and rout each step, working from left to right.



Figure 4.35 Trend's jig is secured during use by its built-in front clamp.



Figure 4.36 The clean, sharp corners, where the back of each tread meets the next riser, will be maintained, provided the steps are routed from left to right.

route first, start with the step farthest to your left and work towards the right (Figures 4.34 and 4.35). Failure to do this will result in the loss of the sharp corners of the string where the back of each tread meets the following riser, which should look as shown in Figure 4.36.

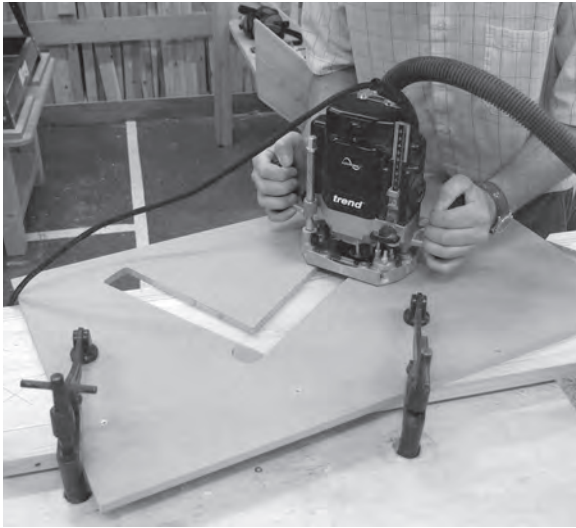


Figure 4.37 Two clamps are required to hold the shop-made jig in place during use. The first operation should take place with the nosing infill inserted.

The shop-made jig requires the use of two bench clamps to secure it to the string (Figure 4.37), while Trend's jig benefits from an easy-to-use built-in front clamp (Figure 4.35). Trend's sub-base (Figure 4.33) eliminates the need for infill pieces, essential with the shop-made jig if 'rounding' beneath the tread nosings is to be avoided (Figures 4.37 and 4.38).

Routing strings produces a lot of waste, and the build-up of dust within the jig housings needs clearing regularly if the sub-base (or guide bush) is to make good contact with the jig edge. This is particularly true of the nosing.



Figure 4.39 The routing is complete.

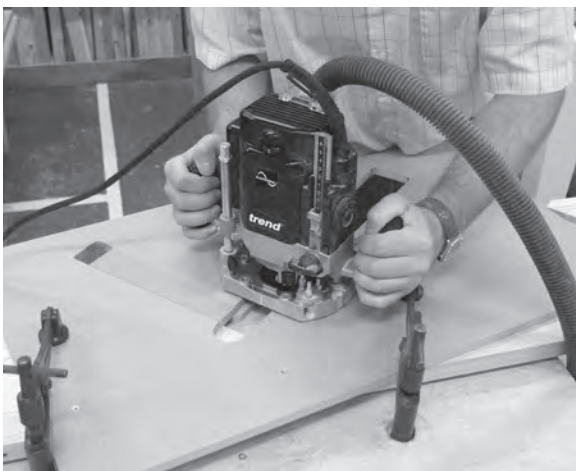


Figure 4.38 With the nosing infill removed and replaced by the riser infill, the routing of the step can be completed.

Work steadily down the length of the string, one step at a time, routing in the direction shown in Figure 3.40. When the string is complete, turn the jig over and transfer to the opposite string. At this stage, the fence of the shop-made jig will need unscrewing and re-aligning on the opposite side, an operation which can be performed more quickly on the Trend jig thanks to its reversible barrel nuts. The completed strings are shown in Figure 4.39.

Router jig verdict

So should you pay for a router jig or make one yourself? Certainly the Trend jig is a nice piece of kit – I enjoy using it. But you need to be building stairs in sufficient quantity to justify the investment. If not, you can make something quite similar for very little cost. The other

thing to bear in mind is that despite the hard-wearing nature of its solid laminate, the Trend jig, just like its shop-made counterpart, can be easily damaged if the router is lifted out and tilted while the cutter is still spinning.

String tenons

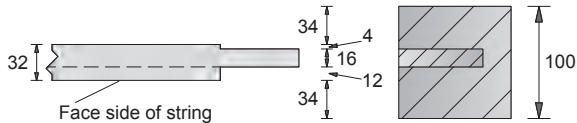


Figure 4.40 String tenon with two unequal shoulders.

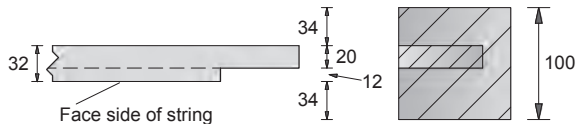


Figure 4.41 Bare-faced string tenon.

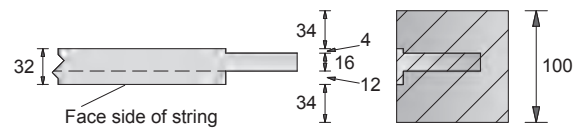


Figure 4.42 Shoulders housed into newel post.

The tenons at the ends of the strings, on which the newel posts will be fixed, should be cut with a 12mm straight fluted cutter (Figure 3.15), and they can have either two shoulders or one. Either way, the width of the shoulder on the face side will be 12mm (the same as the depth of the tread/riser housings). For this cellar staircase, I opted for a 16mm tenon with two (unequal) shoulders; an alternative would have been a 20mm bare-faced tenon (compare Figures 4.40 and 4.41). Or, for traditional work, the string shoulders can be housed into the newel posts (Figure 4.42).

With a single tenon routed at the lower end of each string (Figure 4.43), it is now time to remove any waste from the ends of the strings and to cut the tenons to form pairs of tenons with haunches. This is necessary because a string, owing to its width, is prone to cupping. Mark a line on the tenon which is 50mm from, and parallel to, the shoulder – the 50mm represents half the thickness of the newel post. Now divide that



Figure 4.43 The string tenons, shown before the second shoulder is cut and prior to haunching.

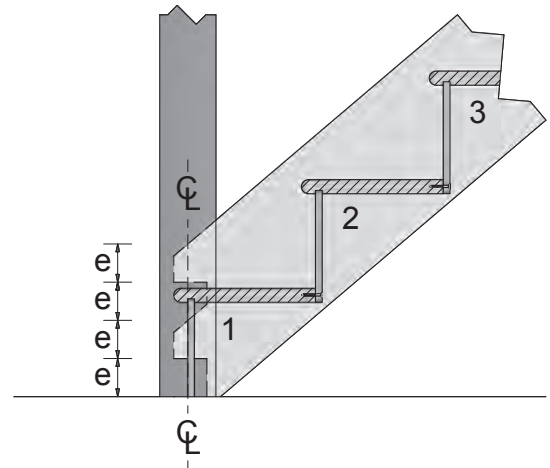


Figure 4.44 Tenon detail at bottom of stair strings into newel posts.



Figure 4.45 The string tenons, cut to form pairs and haunched.

line equally into four, and cut the tenons and haunches as shown in Figures 4.44 and 4.45. The haunch depth should be approximately equal to the tenon thickness, in this case, 16 mm.

Preparing the newel posts

The two glued-up newel posts can, when dry, be planed to their finished sectional dimensions of 100 mm by 100 mm, which will make them ready for marking, routing, and mortising – in that order.

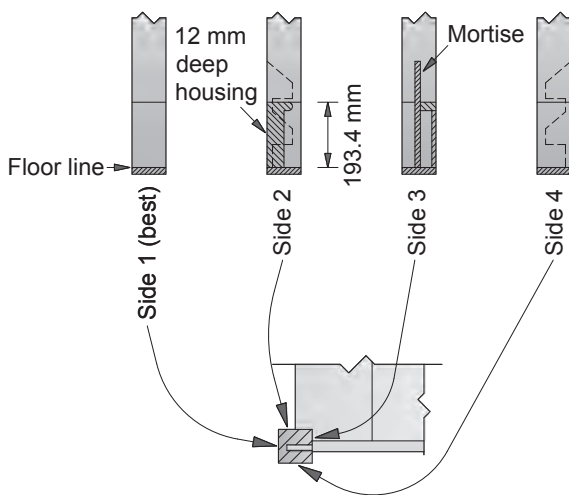


Figure 4.46 Marking out newel post.

Refer to Figure 4.46 and start by squaring a line, which will represent the floor line, around the right-hand newel post, say 20 mm, from one end. From that line, measure and mark a distance equal to the rise (193.4 mm), and again square the line around the newel post. The best side of the newel post (side 1) should face the front, so that it is the side you see when approaching the staircase. Side 2 should be marked to receive a housing 50 mm wide (half the thickness of the newel post) by 12 mm deep, together with a housing for the tread nosing. Side 3 should be marked to receive a mortise which, although off-centre to the newel post, is positioned so that the string will sit centrally on the newel post (Figures 4.46 and 4.40). A short housing, 25 mm wide × 12 mm deep (into which tread number 1 will be housed), links the housing on side 2 with the mortise on side 3 (Figure 4.47). The opposite, left-hand newel post is marked to form a handed pair.

The newel posts are now ready for routing, which can be done with the aid of a straight edge when routing across the grain (Figure 5.26), and the router's fence attachment when routing with the grain (Figure 5.25). The mortise is a combination of mortises, haunches, and slopes (Figure 4.46 sides 3 and 4).

Preparing the treads

When the glued-up treads have been removed from clamps, they should be planed (if necessary) to their



Figure 4.47 Sides 2 and 3 of the right-hand newel post.

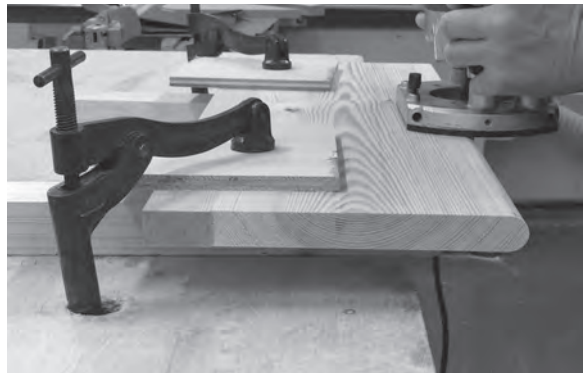


Figure 4.48 Each tread is secured, and a nosing routed on the front edge. The glued-on piece must be at the back of the tread.

finished thickness of 25mm (no need to worry about the length or width at this stage). Each tread essentially requires only two operations: a nosing on the front edge and a groove on the underside into which the riser will be housed. The nosings should be formed first.

Secure each tread in turn and, using a bearing-guided round over cutter with a radius of 12.7mm (Figure 3.38), rout nosings on the front edges of the treads (Figure 4.48). Remember, the front edge is on the wide part of the glued-up tread; the glued-on piece must be at the back of the tread (Figure 4.13).



Figure 4.49 With a tread pushed fully into a housing, the riser position can be marked on the underside.



Figure 4.50 The rear of the tread is marked to finish flush with the face of the following riser.

Once nosed, the treads can be pushed fully into the string housings. Take one tread and, ensuring that the nosing is fully up in the housing, carefully mark two riser lines, the first on the underside of the tread (Figure 4.49), and the second at the top rear of the tread (Figure 4.50) which is where we allowed an extra 6mm for waste when cutting the treads (Figure 4.13).

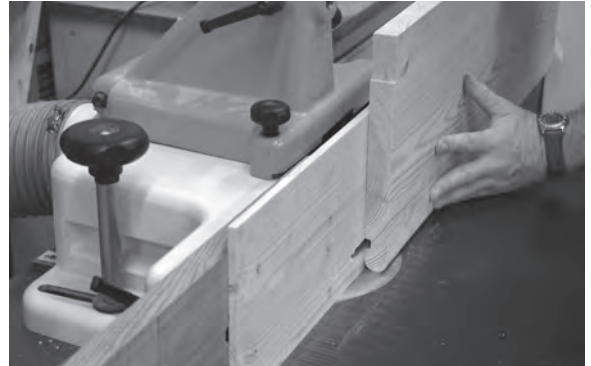


Figure 4.51 The depth of the groove in the underside of the tread, which will house the riser, should be one-quarter the tread thickness.

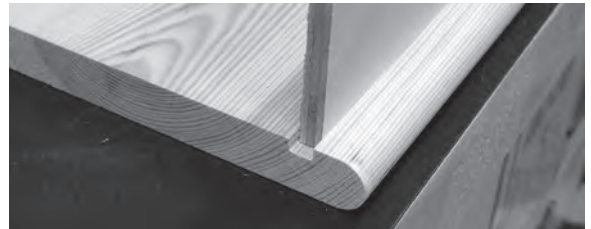


Figure 4.52 The riser is checked for fit.



Figure 4.53 The housing is checked against the string for correct alignment.

I used an adjustable grooving head on a spindle moulding machine to cut the 6 mm deep riser housings on the underside of the treads (Figure 4.51), although a router with 12 mm straight fluted cutter is an alternative method. Check the fit of the riser (Figure 4.52) and the correct positioning of the riser housing (Figure 4.53) before proceeding with the remaining treads.



Figure 4.54 Cut the treads to width slightly proud of the mark.

The treads can now be cut accurately to width, for which I used a circular rip saw (Figure 4.54) before skimming over a surface planer (Figure 4.55) to ensure good contact between the tread back and following riser. Again, test fit one tread before committing to the rest (Figure 4.56).



Figure 4.57 Ensure that the treads and risers are cut to the correct length by measuring the combined thickness of the strings, where there is a housing, and deducting this measurement from the overall width of the staircase.

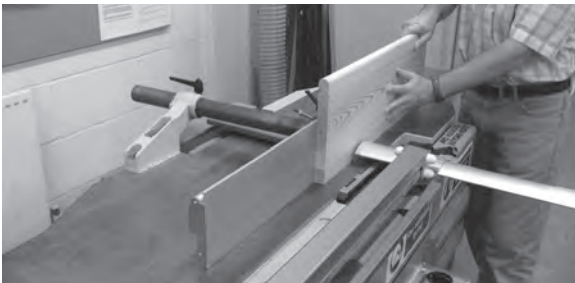


Figure 4.55 Skim the back of each tread over a surface planer to ensure good contact with the following riser.

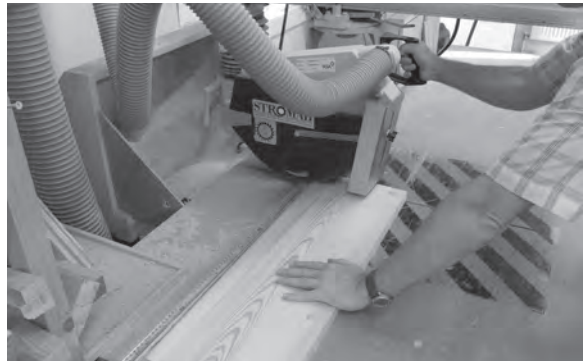


Figure 4.58 Using a radial arm saw to crosscut the treads and risers to length.



Figure 4.56 Check the fit of the first tread planed against the string before cutting and planing the remaining treads.



Figure 4.59 The finished tread.

The last operation is to cut the treads (and risers) to length (Figure 4.58). Tread and riser length is equal to the overall width of the staircase (715mm), minus the total thickness of both strings (64mm), plus the total depth of housings on each side (24mm):

$$715 - 64 + 24 = 675 \text{ mm}$$

As the correct overall width of the staircase is dependent on the accuracy of the tread and riser length, it is worthwhile making a simple check before cutting. Hold the two strings tightly together, back to back, and measure the total thickness where there is a housing (Figure 4.57). Now deduct this thickness from the overall staircase width:

$$715 - 40 = 675 \text{ mm}$$

Figure 4.59 shows the finished tread.

Tread and riser assembly

If desired, each tread and riser can be assembled as a step prior to building the staircase. Here, a cradle is used with folding wedges (Figure 4.60) to hold the tread and riser at right angles to each other. Glue blocks are applied before the step is carefully set aside to dry.

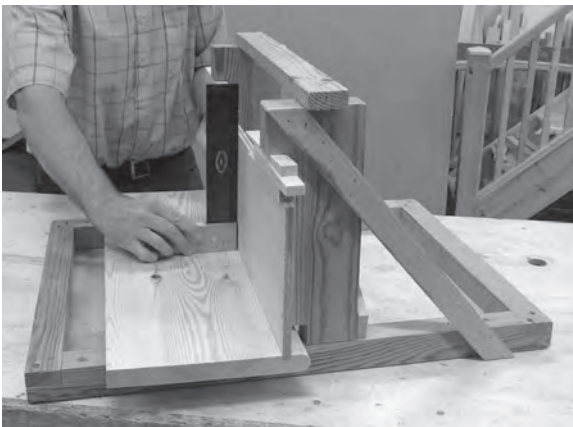


Figure 4.60 A cradle can be used to assemble each tread and riser squarely as a step.

Using a cradle, and pre-assembling the steps is something I rarely, if ever, do. In industry, where speed is essential, it is considered unnecessary since the steps can be assembled later, along with the staircase as a whole. Those in favour of using a cradle argue that pre-assembled steps help keep the staircase square during assembly.

Draw-bore preparation

The newel post is joined to the string by means of a mortise and tenon joint. Using a clamp to pull the joint up is impossible due to the oblique angle of the string. Instead, draw-boring is necessary.



Figure 4.61 An inexpensive flat bit can, if necessary, be ground narrower to ensure a snug fit for the 12mm wooden dowel.



Figure 4.62 Masking tape wrapped around the bit ensures correct depth of hole.

Start by drilling holes to suit 12mm wooden dowel through the newel post in positions that coincide with the centres of the tenons. To ensure a snug fit, an inexpensive flat wood bit can, if necessary, be ground down in width (Figure 4.61). Drilling right through the newel post will mean that the dowels will be visible both sides, while drilling three quarters of the way through will leave one side of the newel post free of any visible fixings; wrap a piece of tape round the bit to ensure correct depth of drilling (Figure 4.62).

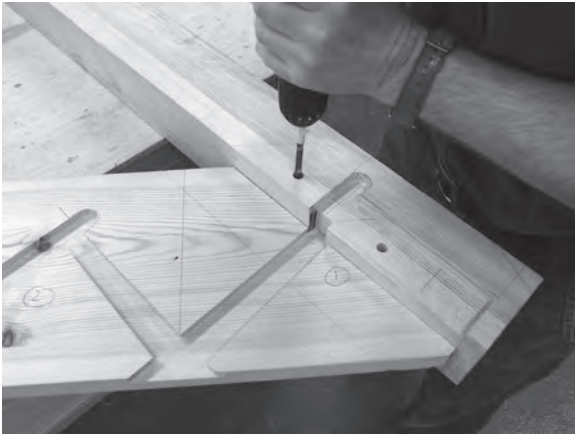


Figure 4.63 The point of the flat bit is used to mark the hole positions on the tenons, which should be offset from those of the newel post.



Figure 4.64 Drill holes through the tenons approximately 2–3mm closer to the shoulder.



Figure 4.65 The ends of the wooden dowels are tapered, so that the resulting ‘wedging’ action pulls the shoulder up tightly.

Reposition the newel post and use the point of the flat bit to mark on the tenons the positions of the holes (Figure 4.63). Remove the newel post and drill holes through the tenons approximately 2–3mm closer to the shoulder (Figure 4.64) so that the wooden dowel, when driven in, pulls the joint up tightly. Tapering the ends of the wooden dowels enables them to pass through the offset holes (Figure 4.65).

Ancillary components and final preparation before assembly

With the main members machined, we are almost ready to build the staircase. First though, some ancillary components must be prepared.

Wooden dowel

Wooden dowel, required for draw-boring the newel posts to the strings, is usually purchased off the shelf; making your own, however, is quick and simple.

Drill a 12mm diameter hole through a thick piece of metal plate (the metal plate shown in Figure 4.66 came from an old vice). Prepare some softwood pieces around 200mm long by 13mm × 13mm (the sectional dimension should be slightly greater than the diameter of the hole in the metal plate).

Plane the sharp corners from the timber and then hammer the now octagonal shaped softwood pieces through the hole in the metal plate (Figure 4.67). The

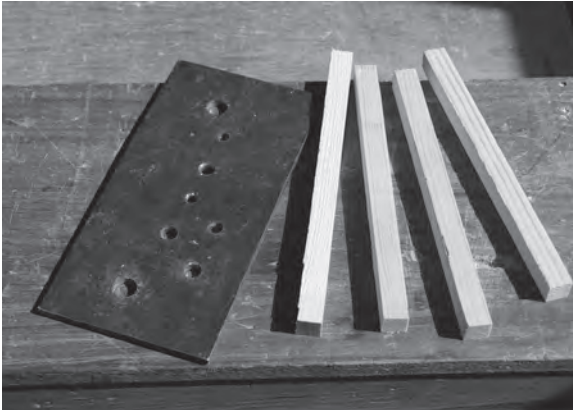


Figure 4.66 Wooden dowel can be made in the workshop if necessary.



Figure 4.67 Plane the sharp corners off and hammer the short timber pieces through the hole in the metal plate.

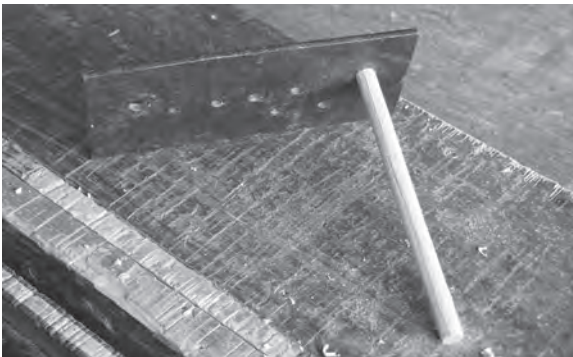


Figure 4.68 A reasonable dowel is produced.

resulting dowel, although a little rough, is perfectly suitable for draw-boring (Figure 4.68).

Wedges

As both sides of riser number 1 of our cellar staircase are housed within a newel post, it will not require wedges; neither will riser number 11, as this sits against a softwood plate fixed to the cellar wall (Figure 4.15). The remaining nine risers (numbers 2–10) will each require two wedges, as will each of the ten treads, making a total of 38 wedges needed.



Figure 4.69 With a single step inserted into a string housing, the required length of wedges can be measured.



Figure 4.70 Use a wedge jig to cut a trial pair of wedges.

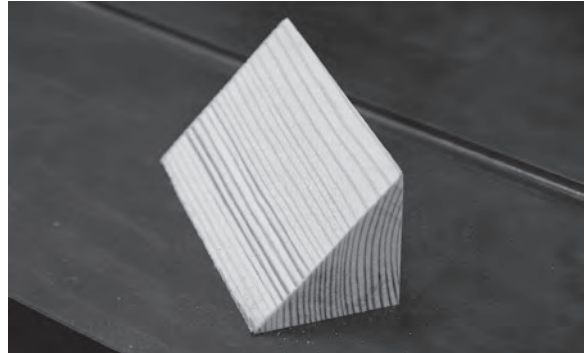


Figure 4.73 Glue blocks should be not less than 75 mm long with a sectional size of at least 38 mm × 38 mm.

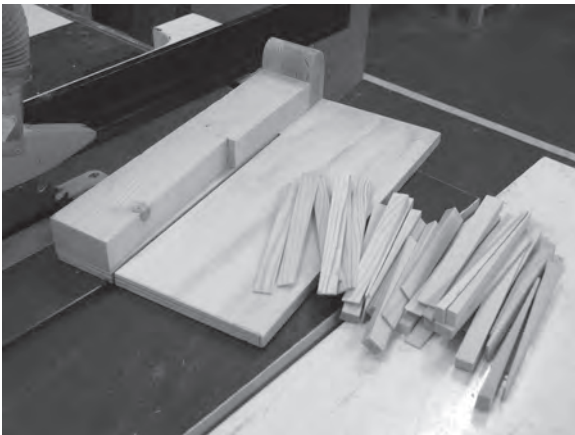


Figure 4.71 (top) and Figure 4.72 (above) Test the fit of the trial wedges before cutting the remaining wedges.

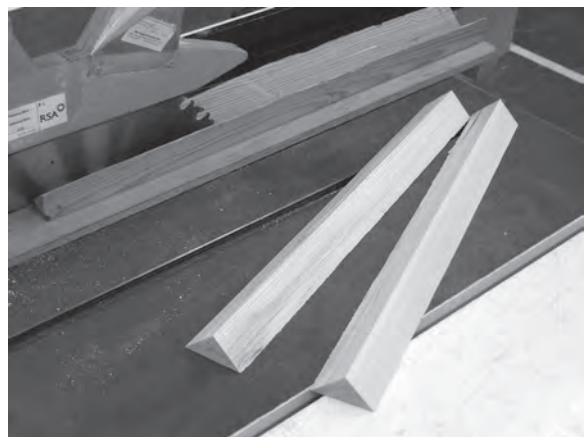


Figure 4.74 (top) and Figure 4.75 (above) A glue block jig is used to rip ex 50 mm × 50 mm PAR timber diagonally along its length, producing the triangular shape of the glue blocks.

Place a tread and riser into any one of the string's housings and measure the length of the required wedges (Figure 4.69). Prepare timber with a (suggested) sectional size of around 100 mm × 18 mm, and cut to length. Use a wedge jig to cut a couple of trial wedges (Figure 4.70), and test the fit of those wedges before proceeding further (Figure 4.71). If the trial wedges fit nicely, the remaining wedges can then be cut (Figure 4.72).

Angled glue blocks

Glue blocks (Figure 4.73) help keep the treads and risers at right angles to each other and provide support to the treads which, in turn, helps prevent creaking. Glue blocks should be not less than 75 mm long

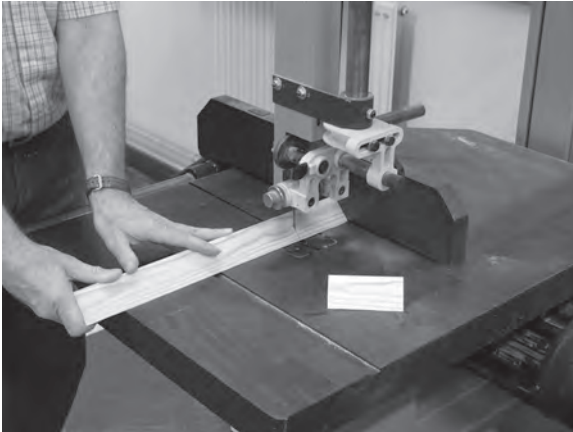


Figure 4.76 Cutting the glue blocks to length on a band saw ensures good contact with the tread and riser by keeping the two shorter sides free from breakout.



Figure 4.77 Fill any defects in the components prior to cleaning up.

with a sectional size of at least 38mm × 38mm. For staircases up to 900mm wide, two glue blocks per step are required, three glue blocks for staircases up to 990mm wide, and four glue blocks for staircases over 990mm. The ten steps of our cellar staircase, at only 715mm wide, will require a total of 20 glue blocks.

Prepare (plane) random lengths of ex 50mm × 50mm timber and use a glue block jig to rip them diagonally, producing the triangular shape of the glue blocks (Figures 4.74 and 4.75). I like to use a band saw to cut the glue blocks to length so that the two shorter sides, which make contact the tread and riser, are free from breakout (Figure 4.76).

Cleaning up

With the ancillary components prepared, all that remains is to clean up the stair parts prior to assembly. In Figure 4.77, I am using a good quality two-part wood filler to fill any defects in the strings before using a belt sander (in the absence of a drum sander) to clean them up (Figure 4.78). Fill and clean up the newel posts and treads, paying particular attention to the tread nosings.

Staircase assembly

Staircases are generally assembled in one of two ways: flat on a workbench or on edge on trestles – the latter being used for our cellar staircase. And in



Figure 4.78 A belt sander can be used to clean up the components, although a drum sander is a far speedier option.

order to avoid any access problems on site, the newel posts will be left loose, as will riser number 1 as that is housed into the newel posts. The sequence of work is as follows.

Figure 4.79: A 50mm thick board – one of a pair of boards that will sandwich the staircase in order to protect the strings from bruising when clamped and to distribute the loads imposed by the clamps – is placed on top of three evenly spaced trestles. The two outer trestles are positioned to suit the length of the



Figure 4.79 The first of a pair of 50mm thick protective boards is laid on top of three evenly spaced trestles.

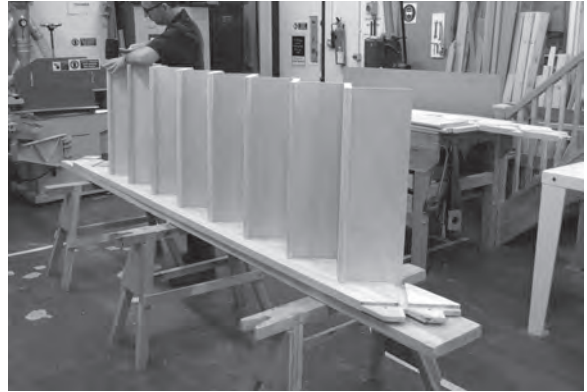


Figure 4.83 The opposite string is lifted into position.



Figure 4.80 The first of the two strings is laid on top of the board. Ensure that the housings are free of dust.



Figure 4.84 With the second protective board in position, clamping of the staircase can begin.



Figure 4.81 (above) and Figure 4.82 (top right) The treads and risers are inserted dry into their housings.

staircase while the third, centre trestle prevents the staircase sagging in the middle.

Figure 4.80: Next comes the first of the two strings, face up, the housings of which must be entirely free of dust if good adhesion is to be achieved when gluing and wedging the treads and risers.

Figures 4.81 and 4.82: Position the treads and risers, one by one, within the housings, working steadily along the length of the string. No glue is required at this stage.

Figure 4.83: With the help of a second person, lift the opposite string into place, carefully locating all of the treads and risers within their housings.

Figure 4.84: With the staircase now sandwiched by a pair of 50mm thick boards, clamping can begin. Evenly space T-bar clamps along both sides of the staircase (remembering to allow access for the wedges on the underside) and then tighten, without over-tightening.

Figures 4.85 and 4.86: Check the staircase for square, either by measuring the diagonals between fixed points on the underside, or with the use of a steel roofing square.

Figures 4.87 and 4.88: Glue and wedge the staircase. PVA glue is applied to the wedges and they are driven in, one by one. Wedge the risers first so that as each riser is pushed forward in its housing, so too is the tread nosing. In Figure 4.87 a piece of timber is being used to hold the wedge firmly in its housing while being hammered home. Keep a close eye on the other side of the staircase to make sure the treads and risers are going up nicely (Figure 4.88).



Figure 4.85 With the help of a second person, check the staircase for square by measuring a pair of diagonals.



Figure 4.86 A steel roofing square can also be used to check that the treads and risers are square to the strings.



Figure 4.87 Glue and wedge the staircase.



Figure 4.88 While gluing and wedging, ensure that the treads and risers are going up fully within their string housings.



Figure 4.89 Screw positions are marked using a template for a uniform appearance.



Figure 4.90 The lower part of each riser is screwed to the back of the tread with number 10 gauge screws, fixed at centres not exceeding 230 mm, and should penetrate the tread by at least 23 mm or 1.5 times the thickness of the riser, whichever is the greater.



Figure 4.91 Apply glue blocks at equidistant spacings (150 mm minimum) with PVA adhesive using rubbed joints.

Figures 4.89 and 4.90: Drill and countersink 6 mm diameter clearance holes for 5.0 × 40 mm wood screws (1½ inch 10s) through the lower parts of the risers into the backs of the treads, and fix at centres not exceeding 230 mm. Maintain uniform screw positions throughout the staircase for a neat finish (Figure 4.89).

Figure 4.91: Apply glue blocks at equidistant spacings (150 mm minimum) with PVA adhesive using 'rubbed' joints.

Treatment of bottom step

The front edge at both ends of tread number 1 is cut to form L-shapes, so that it sits within the housings of the

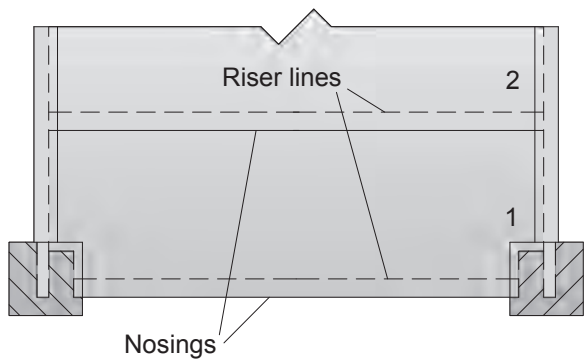


Figure 4.92 Plan detail of tread number 1 housed into newel posts.



Figure 4.93 Tread number 1, showing the L-shaped cut that will allow it to sit within the housings of the newel post.



Figure 4.94 The finished staircase with newel posts test-fitted before delivery to the customer.

newel posts (Figures 4.92 and 4.93). As it fits between the two newel posts, rather than the strings, riser number 1, along with the newel posts, is left loose for site fixing. To ensure speed of assembly on site, the fit of the newel posts should be tested before delivery (Figure 4.94).

Protection of stairs during and after delivery

Although the purpose of this straight-flight staircase is to provide better and safer access to a cellar, the fixing of stairs is usually a first-fix activity and, as such, leaves the stairs vulnerable to damage from other tradespeople as the building work progresses.



Figure 4.95 Cover the finished staircase with heavy-gauge polythene for protection during delivery and while on site.



Figure 4.96 The polythene is held down, and the treads protected, by hardboard false treads pinned to the stair treads.

An effective way of protecting the stairs is to cover them with heavy-gauge polythene (Figure 4.95) and then staple or pin hardboard (or similar) offcuts to the treads (Figure 4.96), which serve not only to hold the polythene in place but also act as 'false treads', protecting the real treads from the rigours of the ongoing building process.



Figure 4.97 The staircase and loose components are protected and ready for delivery.



Figure 4.98 The installation is complete, making access to this cellar safe and comfortable.

Figure 4.97 shows the finished staircase wrapped and ready for delivery and, in Figure 4.98, the completed staircase after installation (compare with Figure 4.3).

5

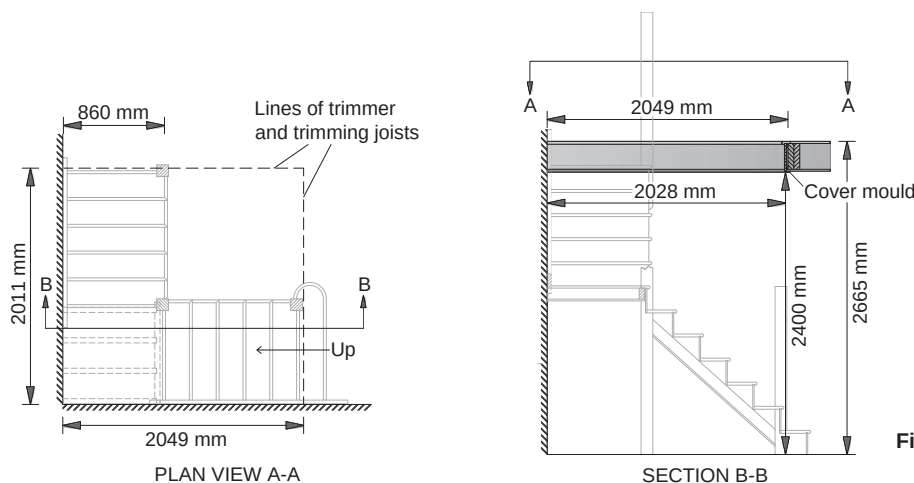
L-Shaped Stairs with Quarter Landing

Not all dwellings have sufficient room for a straight-flight staircase – a change of direction mid-flight is sometimes unavoidable. A quarter landing can provide a safe, convenient, and attractive means of turning 90°. And there are other benefits to a quarter-turn staircase: the change in direction interrupts the view from the lower to the upper floor, providing a measure of privacy for the occupants; the landing can be a welcome resting place for anyone experiencing difficulty using stairs; and, in the event of an accident on the upper half of the staircase, a quarter landing might break a person's fall.

Staircase dimensions

A quarter-turn staircase is, in fact, two short straight flights linked by an intermediate newel post and a landing which, for the purposes of calculations, can be thought of as another step. Detailed information and dimensions of this chapter's staircase are listed opposite and illustrated in Figure 5.1:

- Size of opening: FFL to FFL Rise: 2665 mm
Stairwell length: 2011 mm
Stairwell width: 2049 mm
- Headroom measurements: FFL to underside of ceiling cover mould: 2400 mm
Width, wall to ceiling cover mould: 2028 mm
- Width overall the strings: 860 mm
- A 90° right-hand turn (when walking up the stairs)
- Type of turn: quarter landing
- Number of treads before turn: six
- Number of newel posts: three 100 mm square newel posts on right-hand side of staircase
- Starting step: right-hand D-step



A D-step, also known as a D-end step, is a rounded starting step that projects beyond the outer string and bottom newel post and returns back into the side of the newel. Compare with curtain step, chapter 8.

Figure 5.1 Site dimensions with proposed staircase indicated.

- Strings: 32 mm thick European Redwood, closed on inner (wall) side, open on outside
- Treads: 25 mm European Redwood with mitred nosing returns on right-hand side
- Risers: 12 mm Far Eastern plywood

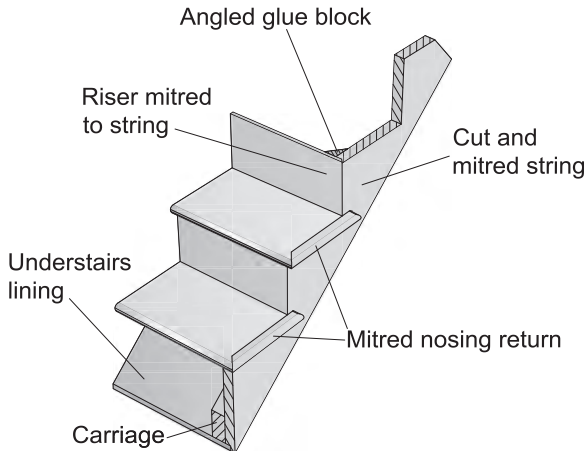


Figure 5.2 Typical construction of an open staircase with cut and mitred string.

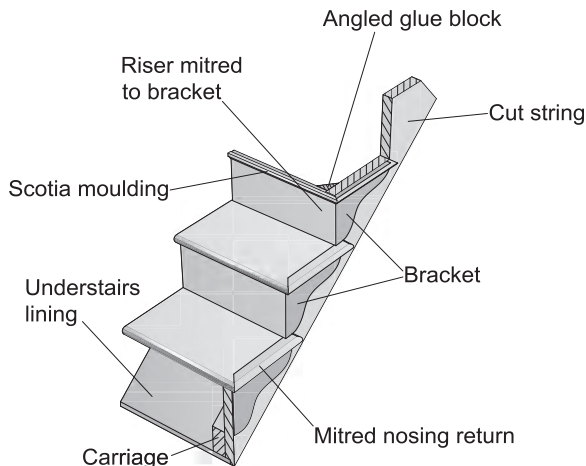


Figure 5.3 Cut and bracketed staircase.

The outside of the staircase which, in this case, is the right-hand side, is going to be 'open', and this is achieved with the use of 'cut and mitred' strings (Figure 5.2). Each of the two outside strings is cut,

Newel posts are generally identified according to their location on a staircase.

Commonly used in North America are terms such as 'starting newel', for a newel post set at the foot of a staircase, 'balcony landing newel', referring to one fixed at the top, and 'intermediate landing newel', indicating a placing in between. I tend to prefer 'top' (or 'upper'), 'intermediate', and 'bottom' newel post.

rather than housed, so that the shape of the steps can be seen when viewed from the side. And so that the unsightly edges of the plywood risers and end grain of the cut strings remain unseen, they meet with mitres. Sometimes, the risers run past the string and are mitred to decorative brackets glued and screwed to the outside of the string forming part of a 'cut and bracketed' staircase (Figure 5.3).

Staircase calculations

The amount of space available for a staircase can affect the size and type of treads, and whether any landings or changes in direction are required. What remains unaffected, always, is the requirement for the total rise to be divided into an equal number of steps. And that is why the starting point for any staircase is to divide the total floor-to-floor rise by 220 (mm):

First calculation:

$$2665 \div 220 = 12.1 \text{ (round up to 13 steps)}$$

Second calculation:

$$2665 \div 13 = 205 \text{ mm.}$$

These two calculations have told us that we need 13 steps (one of which is the quarter landing), each with a height, or rise, of 205 mm.

Double check:

$$205 \times 13 = 2665 \text{ mm} \checkmark$$

A pitch angle of 42° produces a staircase that takes up the least amount of space while complying with the

recommendation given in Approved Document K. So, referring to the Rise and Going calculator, use the far left or far right vertical column to look up the rise of 205 mm; read across to the bright green 42°, and then vertically up or down to find the going, which is 228 mm.

Next, check that twice the rise plus the going is between 550 mm and 700 mm by using the formula:

$$2R + G = 550 - 700 = 2 \times 205 + 228 = 638 \text{ mm}$$

It is, so the relationship between the rise and going suggests that the staircase will be comfortable to use.

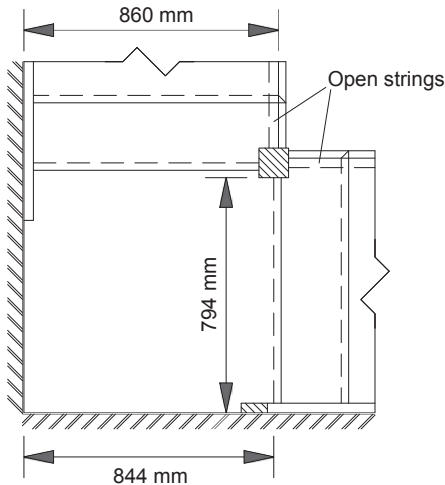


Figure 5.4 At 844 mm, the landing's width and length are greater than the smallest width of the flight (794 mm).

Approved Document K recommends that a staircase's landing should have a 'width and length at least as great as the smallest width of the flight'. The smallest width of the flight can be found by deducting half the thickness of the 32 mm-thick outside string and half the width of the 100 mm wide newel post from the staircase width:

$$860 - 16 - 50 = 794 \text{ mm (Figure 5.4)}$$

As the two risers immediately adjacent to the quarter landing will sit centrally on the faces of the intermediate newel post, the width and length of the landing will be:

$$794 + 50 = 844 \text{ mm (Figure 5.4)}$$

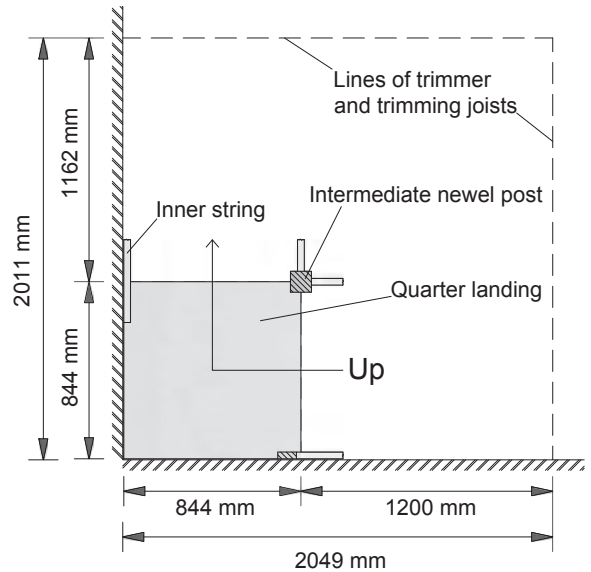


Figure 5.5 Horizontal distances available between quarter landing and trimmer and trimming joists.

Between the quarter landing and the landing joist at the top of the stairs we want to fit five steps. The total horizontal distance of five goings is:

$$228 \times 5 = 1140 \text{ mm}$$

Plus the thickness of the top riser:

$$1140 + 12 = 1152 \text{ mm}$$

The five steps will fit because Figure 5.5 shows that the total distance available is:

$$2011 - 844 - 5 = 1162 \text{ mm}$$

(The 5 mm allows for any minor irregularities in the wall against which the staircase is to be fixed).

Lastly, we must ensure that there will be at least 2 m of headroom. This means that the staircase cannot rise by more than 400 mm at the point where headroom will be measured:

$$2400 - 2000 = 400 \text{ mm}$$

The 400 mm represents almost two risers:

$$400 \div 205 = 1.95 \text{ risers}$$

So, at the point where the staircase rises to 400 mm, there is almost one full tread (or going). This means that there are a further five treads between this point and the quarter landing. If the combined horizontal length of these five treads, or five goings, is less than the horizontal distance between the point where headroom will be measured and the quarter landing (1200 mm) (Figure 5.5), then there will be sufficient headroom. If greater than 1200 mm, the headroom height will be less than the required 2 m.

The going for our staircase is 228 mm, therefore:

$$5 \times 228 = 1140 \text{ mm}$$

The combined horizontal length of the five goings is less than the available horizontal distance of 1200 mm, meaning that the headroom will be greater than the required 2 m.

By building a staircase to the dimensions calculated, we will have demonstrated compliance with the Building Regulations because:

- The rise is less than 220 mm.
- The going is greater than 220 mm.
- The angle of pitch (as determined by the Rise and Going calculator) is 42°.
- Twice the rise plus the going, at 638 mm, is between 550 mm and 700 mm.
- The landing length and width is greater than the smallest width of the flight.
- The headroom will be more than 2 m.

Cutting list

Using the stairwell dimensions and our stair calculations, we now have the information necessary to prepare an accurate cutting list for the staircase shown in Figure 5.6 (handrail and balustrade excluded).

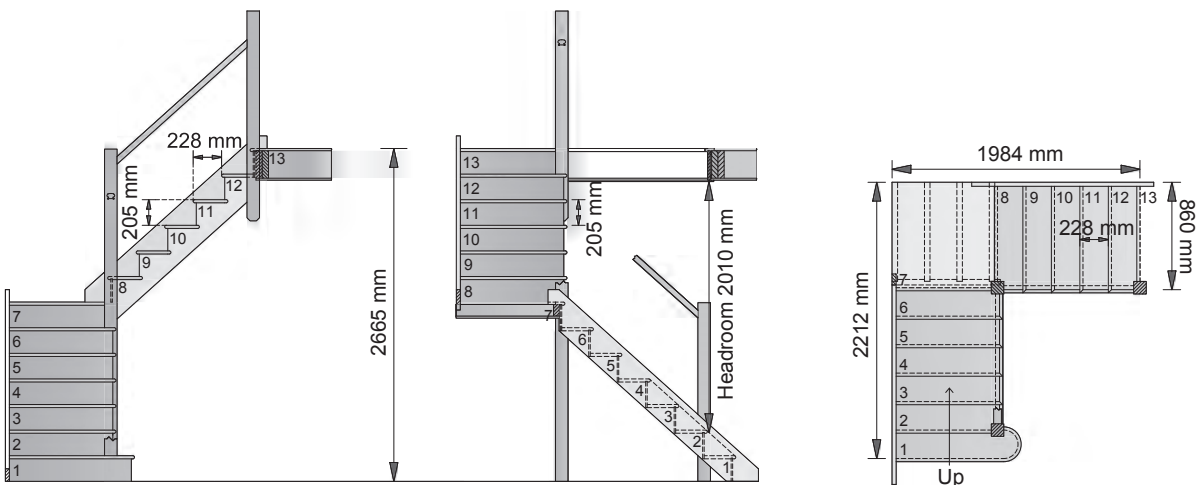


Figure 5.6 The planned quarter-turn staircase.

Cutting List

No.	Member	Length	Width	Thickness	Material
1	lower wall string	2500	245	32	European Redwood
1	upper wall string	2200	245	32	European Redwood
2	outer strings	1900	270	32	European Redwood
1	intermediate newel post	2700	100	100	European Redwood
1	top newel post	1750	100	100	European Redwood
1	bottom newel post	1500	100	100	European Redwood
1	starting tread	1060	284	25	European Redwood
10	treads	900	259	25	European Redwood
2	landing nosings	825	75	25	European Redwood
10	nosing returns	285	50	25	European Redwood
12	risers	880	211	12	Far Eastern plywood
1	riser (D-step)	1500	186	12	Far Eastern plywood

All dimensions in millimetres.

Gluing up

The three main components of our staircase – strings, newel posts, and treads – all require gluing up in order to achieve the finished dimensions called for on the cutting list. The use of 250 mm (10 inch) wide European Redwood would exclude the wall strings from this list, but I tend to use the more common 225 mm (9 inch) wide timber because it lends itself more favourably (and economically) to a broad range of joinery products – in other words, windows and doors.

There are a number of reasons why PVA (polyvinyl acetate) is the ideal adhesive for constructing internal staircases: it is readily available and relatively inexpensive; it comes ready-mixed and is non-hazardous; full strength is achieved in 24 hours and clean-up is in water. Once the correct adhesive has been selected, other factors key to successful gluing up include the preparation of clean, straight, and true surfaces for joining, and the even distribution of pressure provided by suitable clamps.



Figure 5.7 The strings (seen here), newel posts, and treads are glued up to achieve their finished dimensions.

So having completed the theory part of the job, the first practical task is to prepare the timber and glue up the strings (Figure 5.7), the newel posts, and the treads. In chapter 4, the treads of the straight-flight staircase,



Figure 5.8 Making each tread from three relatively narrow pieces will help to avoid cupping.

which were housed at both ends within closed strings, were glued and butt-jointed (Figures 4.13 and 4.59). To minimise the risk of cupping, the treads of our quarter-turn staircase, which are housed only at one end, are made up in three tongued and grooved sections (Figure 5.8).

Marking out the strings

Our quarter-turn staircase consists of two left-handed wall strings and two right-handed outer strings. Because the wall strings will be routed using a jig and fence placed against their top edges, marking, using either a roofing

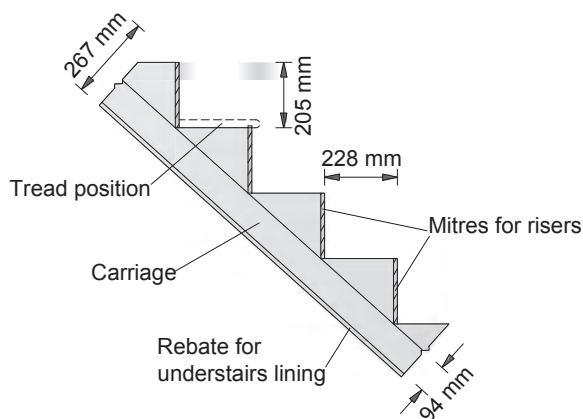


Figure 5.9 Inside face of cut and mitred string showing supporting carriage and rebate for understairs lining.

square and stair gauges (Figure 4.24) or pitch board and margin template (Figure 3.3), should also be from the strings' top edges (described in detail in chapter 4). The outer strings are to be cut and mitred (not routed) and are therefore marked from their lower edges.

At 270 mm, the depth of the outer strings is 25 mm greater than that of the wall strings. To achieve the open side of the staircase, triangular sections equal in size to the rise and going, will be cut from the outer strings forming the steps against which the treads and risers will be fixed. The weakened strings will be stiffened with 94 mm deep timber carriages screwed to the inside immediately beneath the steps (Figures 5.9 and 5.2). The lower edges of the outer strings will be rebated to house linings that will finish the underside of the staircase.

Once the steps have been marked, tenon shoulder lines are added at both ends of both outer strings. The newel posts will have standard sectional dimensions of 100 mm square. The lower shoulder lines will therefore be 50 mm behind the lines of risers number 2 and 8, and the upper shoulder lines will be 50 mm in front of the lines of risers number 7 and 13.

The marked strings are shown in Figures 5.10a and 5.11, and it will be noticed that the two wall strings are almost identical (the lower wall string has one more step), while the two outer strings are entirely identical with only their step numbers differing.

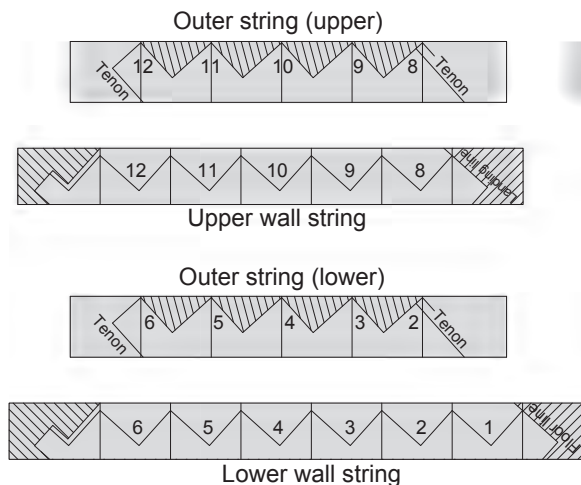


Figure 5.10a The marked strings.

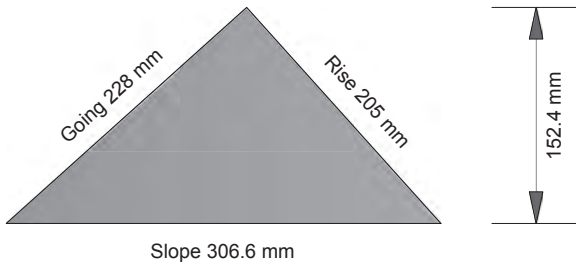


Figure 5.10b Dimensions of pitch board for quarter-turn staircase

With the strings marked, the next stage in their preparation is the routing of the wall strings. This fundamental of stair building operations, seen in Figure 5.12 using Trend's staircase housing jig, is described in detail in chapter 4. The two outer strings are prepared in an entirely different way.

Cutting and mitring the outer strings

Steps are cut from the two outer strings using a hand-held circular saw which can, if required, be guided by a straight edge (Figure 5.13). Work up the length of the first string cutting the riser lines first (Figure 5.14), and



Figure 5.11 A pair of marked strings: on the left, the lower flight's wall string, and on the right, its outer string with waste portions indicated.



Figure 5.13 Cutting the steps of the outer string using a hand-held circular saw guided by a straight edge.



Figure 5.12 Working from left to right, rout the wall string housings to a depth of 12 mm.



Figure 5.14 With the riser lines cut it's now time to start the tread lines.



Figure 5.15 Avoid weakening the string by finishing the cuts with a hand saw.

then back down the string with the tread lines. Removing the triangular waste pieces entirely using a circular saw blade would mean cutting into the lower part of the string and weakening it; far better to stop short and use a hand saw to finish the cuts (Figure 5.15).



Figure 5.16 (above) and Figure 5.17 (below) The first cut when mitring the outer string is parallel with the riser lines.

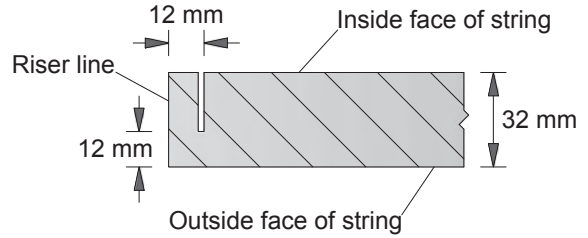
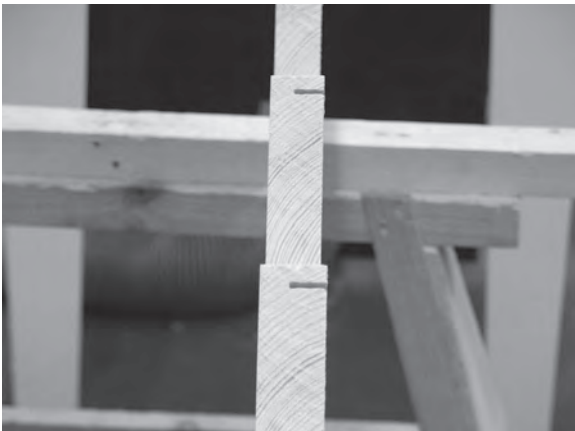


Figure 5.18 Preparing the open strings to receive mitred risers; the first of two cuts is square to the strings' inside faces and parallel to the riser lines.

Next, the outer strings are first rebated, and then mitred, to receive the risers. Adjust the circular saw's depth of cut so that it will leave a portion of timber equal to the risers' thickness, which, in this case, means cutting the 32mm thick strings to a depth of 20mm, leaving 12mm remaining (Figure 5.18). When set, work from the strings' inside faces and make repeated cuts parallel to, and 12mm behind, each riser line (Figures 5.17, and 5.18).

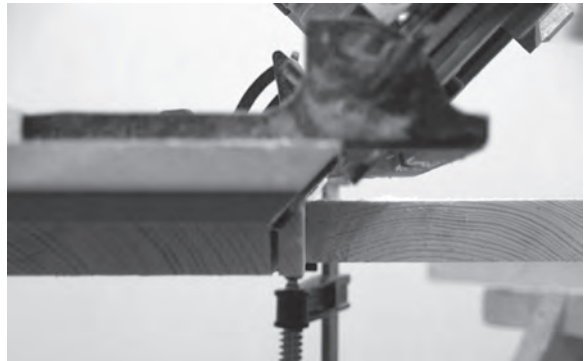


Figure 5.19 (above) and Figure 5.21 (below) The base of the hand-held circular saw is tilted to an angle of 45° and the mitres cut. Here I'm using an MDF fence for accuracy.



GOING

[illegible]

GOING

Rise and Going calculator. See pages 9 and 10



Brass stair gauges are clamped to a steel roofing square and butted against this string's upper edge. Steps are marked by aligning the square's point with the setting out lines, beneath which defects - including the knot next to my right hand - can be concealed. See page 35.



Stair strings are marked and routed as handed pairs. The haunched tenons in the foreground will ensure strong and secure joints between strings and newel posts at the foot of this staircase. See page 39.



The steps of this closed string are being routed using Trend's staircase housing jig and T11 heavy duty router with 16 mm stair housing dovetail cutter. The jig is clamped against the string's lower edge and the direction of routing is always from the operator's left to right. See page 37.



Draw-bore dowelling is the only way to pull the shoulder of a string's tenon up tight to a newel post. The holes in the softwood tenons are 2 – 3 mm closer to the shoulder than those in the newel post, and the ends of the dowel tapered to allow them to pass through the offset holes. See page 44.



The nosing of this tread is moulded in two operations using a router and bearing-guided round over cutter. The tread is raised on bearers, its front edge overhanging the bench, and secured beneath a pair of bench holdfasts; plywood offcuts protect the tread's surface. Importantly, the narrow glued-on piece is positioned at the tread's rear. See page 40.



The accuracy of the machining becomes apparent during wedging as the treads and risers are pushed up within their housings. Clean, gap-free lines are pleasing to the eye as the staircase nears completion. See page 49.



This right-hand string is lifted onto the steps and the treads and risers located within their housings.

The flight is being prepared for clamping, gluing, and wedging in an upright position while supported by three trestles. See page 48.



The assembled straight-flight staircase. Out of sight, beneath the flight, the steps have been glued and wedged, the risers screwed to the backs of the treads, and angled glue blocks applied. Next, the strings' upper edges will be cleaned and the sharp arrises removed. See page 50.



The cellar staircase viewed through the newly enlarged hatch in the dining room floor. The home owner is delighted with this new, comfortable, and safe means of accessing the cellar. See page 25.



A stair string should always be marked from its upper edge; in other words, upside down from the marker's point of view, evident here by the roughly drawn nosings, necessary so that all members of the stair building team know which way is up. See page 58.



Above: Ready for use: the newly installed cellar staircase with handrail and balustrade fixed and bottom newel posts supporting the floor joist above. See page 52.



Each riser is housed into the underside of a tread, their locations accurately determined by pushing a nosed tread fully up into its string housing and marking where it meets the riser housing. See page 41.

Right: Mitred nosing returns are used to hide unsightly end grain that would otherwise be visible on the treads of an open-string staircase. In preparation for cutting and mitring, the shape of the nosing return is drawn on the treads with the aid of a combination square. See page 63.





Mitred nosing returns, individually numbered, are fixed to their corresponding treads with glue and nails. This tread's number is about to be hidden by PVA adhesive ahead of offering up the nosing return. See page 66.



Beneath the assembled flight angled glue blocks support the treads and risers where they meet with the open string and where they meet with each other. See page 72.



During assembly of this open-string flight, the two treads have been glued and screwed to the cut and mitred string and all four risers glued and nailed.

The steps at the closed-string end have yet to be glued and wedged. See page 71.



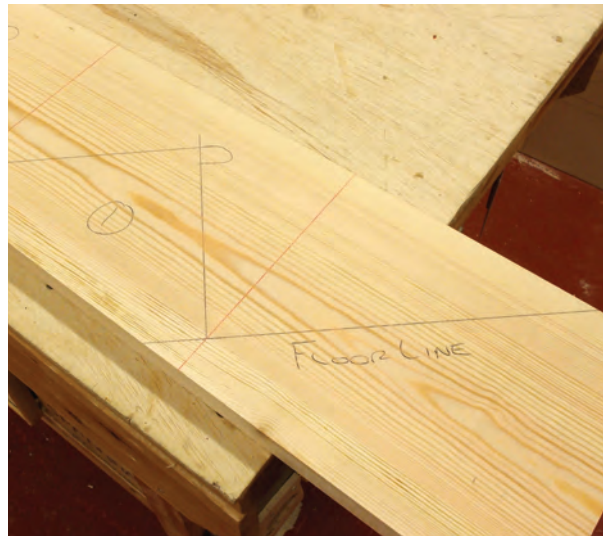
The outer corner of this quarter landing is supported by the intermediate newel post to which it is fixed. Routed into the newel post immediately above the landing is a housing for the landing nosing that links the lower flight and the landing decking. See page 74.



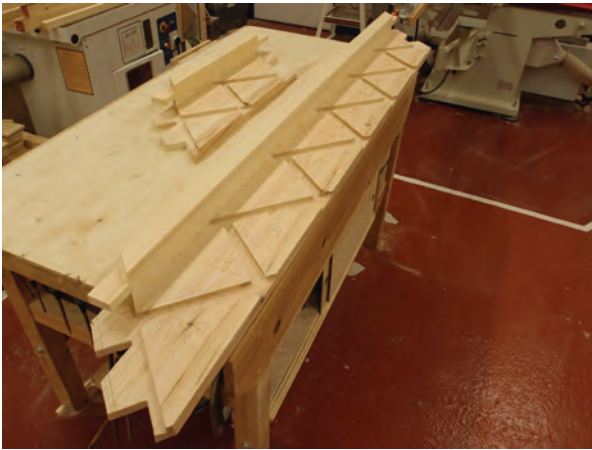
Above and below: Seen from alternative views are these two short straight flights meeting with a quarter landing. Each has a closed inner wall string supported by the landing, and an open outer string tenoned into the intermediate newel post. See page 77.



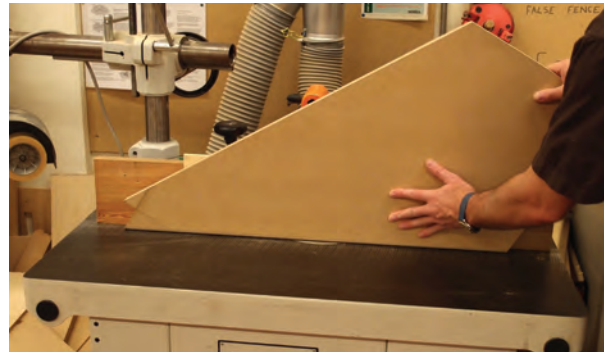
An L-shaped staircase with quarter landing, complete with handrail and balustrade and newel caps. See page 206.



The lower end of this marked right-hand wall string has nosings, step numbers, and floor line indicated. It is ready for routing. See page 88.



Four members of the staircase with Kite and winders, all of which have been tenoned at both ends for joining to newel posts. The lengths and shoulder angles of the two as-yet-unmoulded handrails match those of the strings below. See page 193.



This MDF kite winder is being held firmly against the spindle moulder's fence while its underside is grooved with an adjustable grooving head for housing a riser. See page 94.



Above: The tongue at the upper end of this return string is offered into the housing at the lower end of the wall string and, for the first time, the L-shape of the staircase becomes apparent. See pages 89 and 91.



Main flight assembly: with the strings inverted on evenly-spaced T-bar clamps, the treads are slotted one by one into their housings and will be followed by the risers. See page 98.

Right: The main flight, glued and wedged and still clamped. Sawn boards protect the strings from bruising and help distribute pressure from the T-bar clamps. The wide part of the wall string, which will carry winding steps, overhangs the end of the bench allowing the flight to lay flat. See page 98.





These wooden dowel draw pins have just been glued and driven through offset holes in the newel post and string tenon. With the string shoulder pulled up tight, the protruding dowels can be cut flush with the surface of the newel post. See page 99.



The narrow ends of these winding treads are housed into the intermediate newel post, the housings modified to receive the nosings made longer by the angles at which the treads meet the newel post. See page 106.



This bullnose starting step is notched round and housed into the bottom newel post. The face of the preformed riser sits centrally on the front face of the newel post. See page 100.



Looking down towards this staircase's winding steps; on the left, the concave easing of the wall string and, at the top, the convex easing of the return string. See page 106.

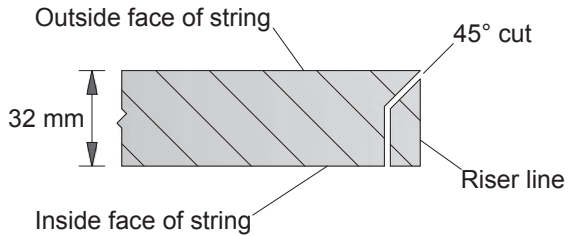


Figure 5.20 The second of the two cuts is a 45° mitre made from the strings' outside faces.



Figure 5.22 Finish the mitres with a sharp chisel.

Mitres are made by adjusting the circular saw's angle of cut to 45° and this time working from the strings' outside faces (Figures 5.19 and 5.20). Cut down each riser line, stopping at the intersecting tread line (Figure 5.21). The cuts can then be finished with a sharp chisel (Figure 5.22).



Figure 5.23 Rout the inside face of an outer cut string to produce 20 mm thick bare-faced tenons before trimming the waste to leave a tenon length equal to approximately two-thirds the newel post thickness

The only routing required on the outer strings is during the preparation of the tenons that will join the strings to the newel posts. For perfect tenon shoulders, run the router off a straight edge and, working from the strings' inside faces, rout to a depth of 12 mm, leaving 20 mm thick bare-faced tenons (Figure 5.23). The waste portions beyond the tenons can be trimmed quickly and easily on a band saw.

Preparing the newel posts

Once the three glued-up newel posts have been removed from clamps and re-planed to their finished sectional dimensions of 100 mm × 100 mm, marking of the housing and mortise positions can commence. The finished marking out is shown in Figures 5.24 a–c, and the notable difference between these newel posts and those which are joined to closed strings lies with the mortises – none of which extend above the tread housings that they meet (compare Figures 5.24a and 4.46).

The housings of the marked newel posts are routed to the usual depth of 12 mm. To ensure accuracy, use the router's fence attachment when routing with the grain (Figure 5.25) and a straight edge when routing across the grain (Figure 5.26). The newel posts are then mortised to receive the string tenons (Figure 5.27).

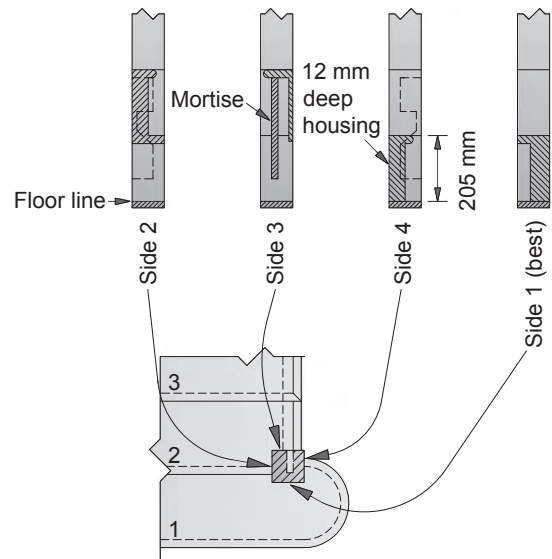


Figure 5.24a Marking out of the bottom newel post.

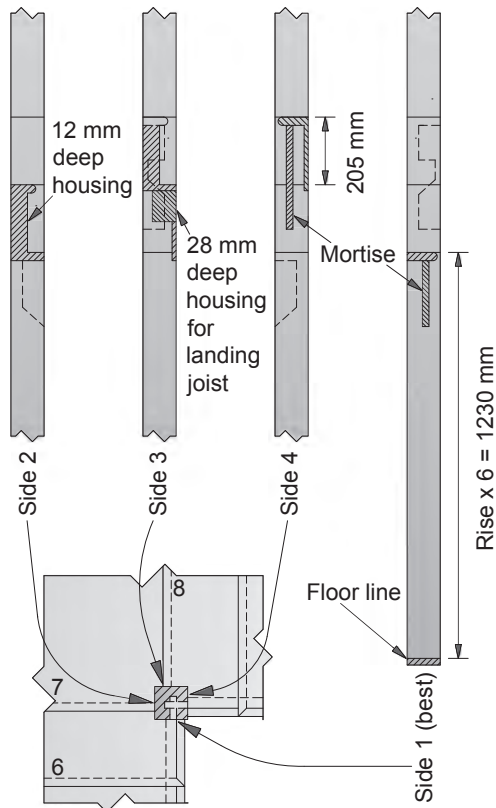


Figure 5.24b Marking out of the intermediate newel post.

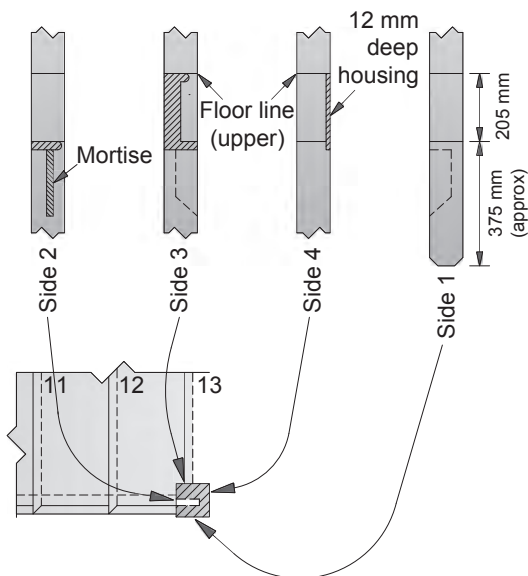


Figure 5.24c Marking out of the top newel post.

On an open-string staircase such as this, the position of a newel post is determined by the 'balustrade centre line' – a notional line upon which the centre of future balusters will sit. And the balusters of an open-string staircase should, ideally, be flush with the outer face of the string (Figure 8.75); so when using 32 mm balusters, for example, the balustrade centre line will be 16 mm in from the face of the string (Figure 11.7). As the baluster thickness and string thickness of this staircase are the same (32 mm), the balustrade centre line will coincide with the centre of the string, meaning that these three newel posts will be fixed centrally to the strings. See chapter 11 for more details.



Figure 5.25 Use the router's fence attachment when cutting parallel to the newel posts' long edges.



Figure 5.26 Use a straight edge when routing across the grain of the newel posts.



Figure 5.27 With the tread and riser housings routed, the newel posts are mortised for joining to the outer strings.



Figure 5.28 The shape of a nosing return is marked on the treads at the ends that meet with an outer (cut) string.

Providing mitred nosing returns to straight treads

In chapter 4 we saw that a nosing on the front edge and a riser housing on the underside are the only two operations required for the treads of a closed-string staircase, and that the nosings should be formed first. The treads of our open-string staircase, it will be seen, are quite different. And one difference is that, this time, the riser housings are applied ahead of the nosings. First though, we need to determine the exact position of the riser housings and width of the treads.

Having re-planed the glued-up and now over-length and over-width treads to their finished thickness of 25mm, a nosing of no more than say, 75mm long, can be routed on the wall-string end of one tread (in this case, the left-hand end). This short nosing will allow the tread to be pushed fully home in a string housing and permit the careful marking of the riser line beneath the tread and that of the following step (Figures 4.49 and 4.50). The treads can now be cut to width and their newly sawn back edges skimmed over a planer (Figures 4.54 and 4.55).

The unsightly end grain of the treads is concealed on the open side of the staircase by mitred nosing returns, cut using a band saw. Achieving a perfectly straight cut on a band saw is not easy – the blade tends to wobble in use, as might the hands of the operator. By fixing what will be the nosing return to the tread and



Figure 5.29 Arrange the marking and nailing of the nosing returns so that the treads extend away from the band saw's throat. Provide support to the treads during cutting.

cutting both items simultaneously, any imperfections in the cut will be identical, leading to a perfect fit.

Start by marking the shape of the nosing returns on what will be the open-string ends of the treads (Figure 5.28). In doing so, consideration must be given to the handing of the treads; the width of cut possible on any band saw is limited by its throat – the distance from its blade to the vertical section of its frame. And for that reason, we want to cut the left-hand end of each tread so that its length extends away from the band

saw's throat (Figure 5.29). The treads of our quarter-turn staircase are right-handed, and this means that the marking of the nosing returns must take place on the underside of the treads (left-handed treads would be marked on their upper side).



Figure 5.30 The marked treads and over-width nosing returns are nailed together.

The finished width of the nosing returns will be the same as that of the nosings on the front of the treads – a standard 25mm. Our cutting list, however, calls for a width of 50mm – the extra material permitting the temporary pinning of the nosing returns to their respective treads. Unwanted holes caused by the pins can be lost by fixing through the waste portion of tread beyond the markings (Figure 5.30). Work through the pile, marking the treads and pinning the nosing returns, and stacking them ready for band sawing.

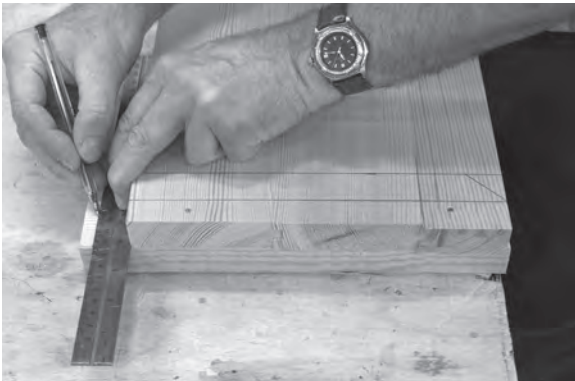


Figure 5.31 A nosing return's rear projection of 25mm is marked parallel to the tread's back edge.

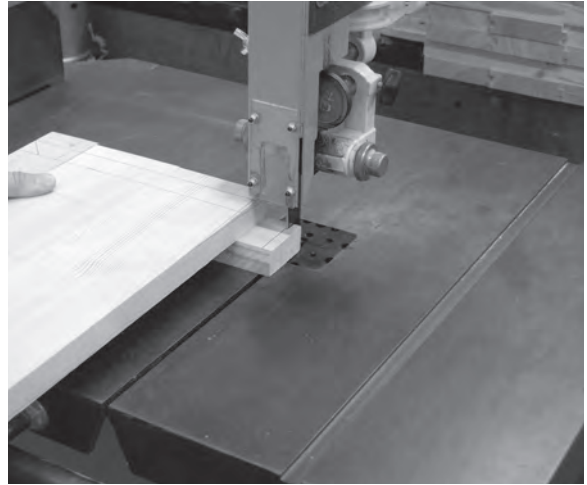


Figure 5.32 First cut: the rear edge of the nosing return.

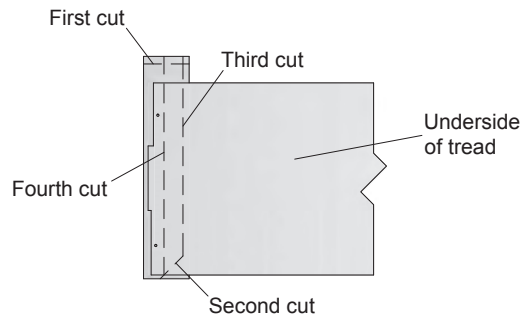


Figure 5.33 The sequence of four band saw cuts required to prepare the nosing returns.

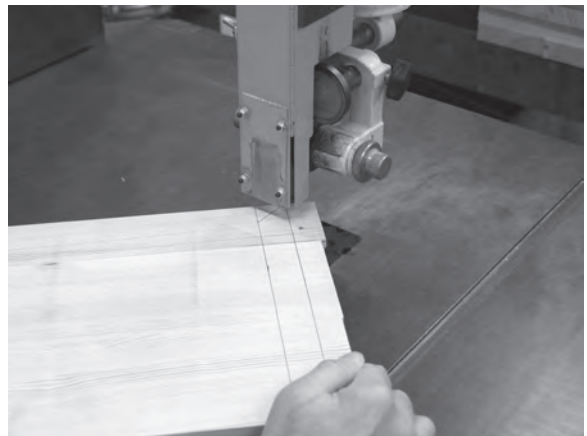


Figure 5.34 Second cut: the mitre at the front of the treads.

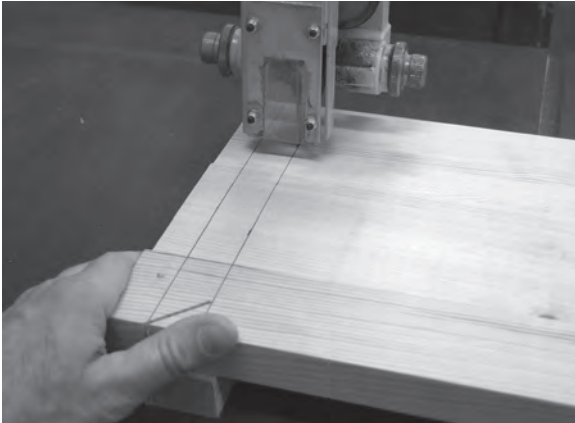


Figure 5.35 Third cut: the inside edge of the nosing return that will meet with the tread.

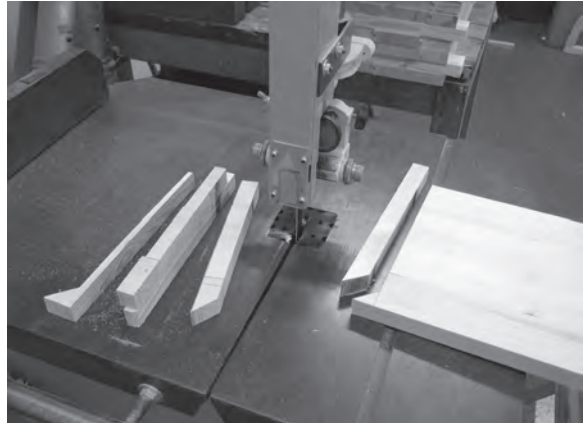


Figure 5.37 The short-grained tread offcuts are discarded, leaving just the nosing return.

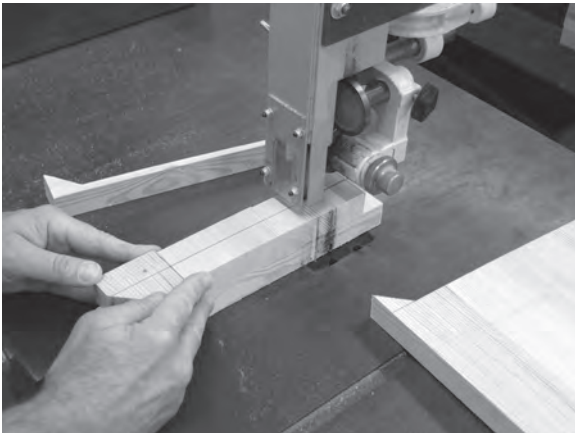


Figure 5.36 Fourth cut: the outside edge of the nosing return.



Figure 5.38 Number the treads and nosing returns for matching up later.

With the nosing returns fixed to their respective treads, one last mark is required: a line parallel to, and 25mm from, the back of each tread, representing the distance by which the nosing returns extend beyond the treads' rear edges (Figure 5.31). And it is this line that is cut first on the band saw (Figure 5.32). A total of four cuts are required and should be made in the sequence shown in Figure 5.33, the second of which is the 45° mitre at the front of the tread (Figure 5.34). The third cut is the line where the tread and nosing return will meet (Figure 5.35), and the final cut is the outside edge of the now separated nosing return (Figure 5.36).

The newly cut and mitred tread and nosing return are almost ready to be set aside while the rest of the treads are prepared (Figure 5.37). Before doing so, however, there is one other, extremely important task: the nature of band sawing means that no two treads and no two nosing returns will be exactly the same. Each nosing return will fit the tread it was fixed to during cutting and no other. Each set should therefore be marked so that they can be later matched up again (Figure 5.38).

The next step is to cut the 6mm deep riser housings on the underside of the treads (Figure 5.39); set up

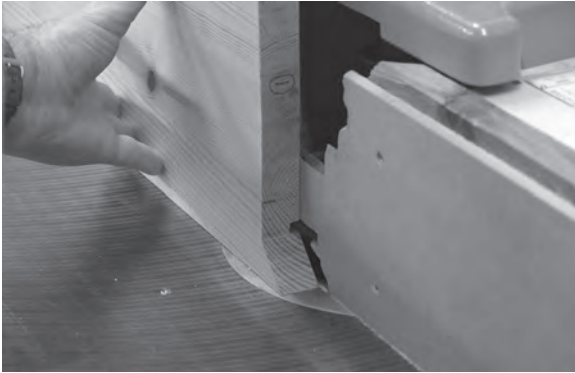


Figure 5.39 Cut the riser housing in the underside of the treads, before fixing the nosing returns.



Figure 5.42 Two carefully positioned nails sunk beneath the surface will secure the nosing return.



Figure 5.40 The treads and nosing returns are ready for fixing.



Figure 5.43 Set aside to dry while continuing with the rest of the treads and nosing returns.



Figure 5.41 Apply a generous amount of glue to a tread's mitred end, line up the corresponding nosing return, and bring the two components together.

using the tread prepared earlier with a short nosing which was marked with the groove's position. The treads and nosing returns are now ready for gluing and nailing (Figure 5.40).

Apply ample PVA adhesive and carefully align the numbered components (Figure 5.41). Secure with nails sunk beneath the surface, wipe off excess glue, and set aside to dry (Figures 5.42 and 5.43). Some thought should be given to the positioning of the nails, so that they don't impede future operations; as seen in Figures 5.24 a-c treads number 2, 6, 8, and 12 will require cutting where they meet with the newel posts, and balusters will later be fixed to all treads.



Figure 5.44 Nose the treads, taking care at the corners; here, timber offcuts butted at each end ensure a smooth and consistent cut with the router.

As well as the treads' long front edges, nosings are applied along the length of the returns and, if desired, the short end grain which returns to the string. Nosings are routed using a bearing-guided round over cutter with a radius of 12.7 mm (Figure 3.38); butting timber offcuts each side of the treads during routing will prevent the cutter 'dropping in' at the corners (Figure 5.44).

Trimming the treads to length means cutting one end only. In Figure 5.45, I have set up a stop, against

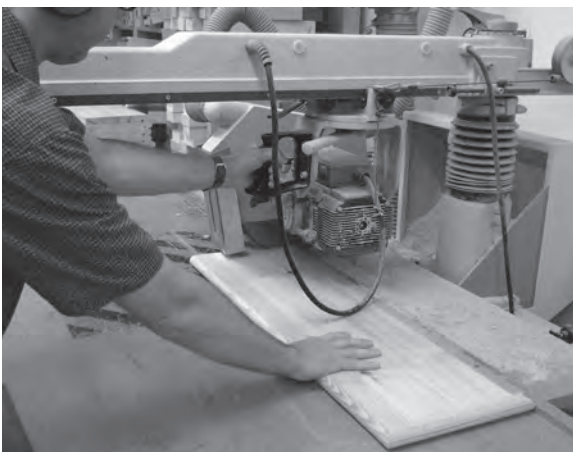


Figure 5.45 The inside edge of the nosing return is butted up to a stop and the tread is cut to length. Here, I am working left-handed so that breakout is kept to the underside of the tread.

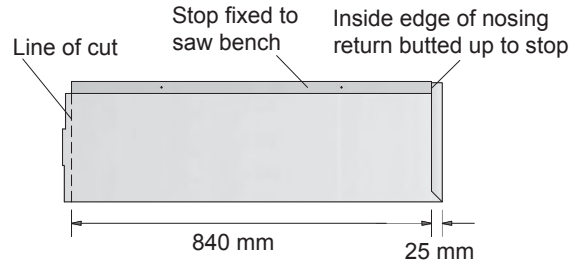


Figure 5.46 Work from the inside edge of the nosing return when trimming the treads to length.

which the inside edge of the nosing return (the part that projects from the tread's rear edge) is butted. At 840 mm, the length of the treads (excluding the nosing returns) is the difference between the staircase width overall the strings (860 mm) and the remaining thickness of the wall string where the steps have been routed (20 mm) (Figure 5.46).



Figure 5.47 The risers are mitred at one end.

The risers' overall length is also 840 mm and should be cut after the ends that meet with the cut strings on the open sides of the staircase have been mitred (Figure 5.47). It is important to check that the mitred ends are square to the risers' long edges.

Ancillary components and final preparation before assembly

During the making of chapter 4's straight-flight staircase, we saw that, just ahead of assembling a flight,

a number of final tasks are necessary: offset holes should be drilled in the newel posts and string tenons, and wooden dowel prepared for draw-boring; the main components – the strings, treads, and newel posts – need cleaning up; and wedges and angled glue blocks are required to support the underside of each step.

Our quarter-turn staircase is wedged only on the closed side, halving the number required. And at less than 900mm wide, the staircase requires two angled glue blocks per step at the point where the back of a riser meets the underside of a tread; a third glue block supports each riser where it meets with the cut string (Figure 5.2), and a fourth adds support to each tread on the open side of the staircase.

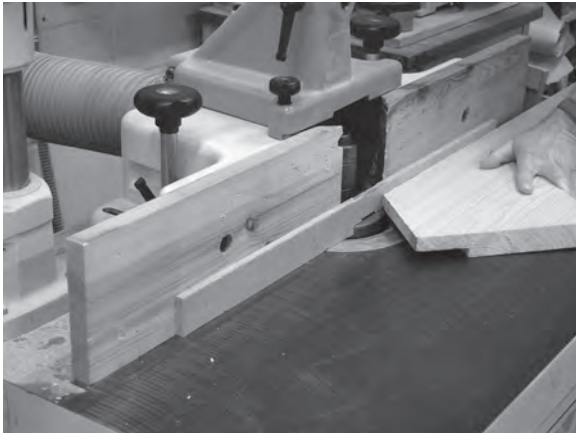


Figure 5.48 The two outer (cut) strings are rebated so that the underside of the stairs can be lined after fixing.

Prior to cleaning up, two additional tasks not seen on chapter 4's straight flight are the rebating of the outer strings' lower edges to house linings that will finish the underside of the staircase (Figure 5.48) and the drilling of holes in the treads so that they can be screwed and pelleted to the cut outer strings.

Staircase assembly

Like most aspects of our open-string staircase, the method of assembly requires a slightly different approach from that of a conventional flight, where pressure from clamps is applied to a pair of closed

strings, forcing them against the ends of the treads and risers. Here, open strings sit beneath the treads and meet each riser with a mitre; they cannot be clamped against their opposite, closed strings. The quarter landing has divided our staircase into two straight flights, each short enough to be supported by only two trestles without sagging in the middle. The assembly process begins with the (slightly longer) lower wall string laying face up on a protective board and supported by the trestles; the string's housings are cleared of dust, and work continues as follows.

Figure 5.49: The highest tread to be supported by the outer (cut) string is number 6. Complete with riser, step number 6 is located in its wall string housing and is followed by the step with the lowest riser to be supported by the cut string – number 3.

Figure 5.50: These first two steps are held in place by dry, loose-fitting wedges driven temporarily beneath each tread.

Figure 5.51: F-clamps – tight enough to hold the risers within their tread housings yet loose enough to avoid bruising the treads – add further support to the two steps. A steel roofing square is used to check that the steps are perpendicular to the string.

Figure 5.52: The two steps, standing securely, are ready to receive the outer (cut and mitred) string.



Figure 5.49 Commence assembly by locating two steps within their free-of-dust wall-string housings. The steps selected will be at opposite ends of the facing outer (cut and mitred) string.



Figure 5.50 Loosely and temporarily wedge the steps to hold them in place.



Figure 5.52 Only two steps are required at this stage; further treads and risers will be added once the outer string has been positioned.



Figure 5.51 The opposite ends of the steps are held together with F-clamps; before continuing, use a steel roofing square to check that the steps are perpendicular to the string.



Figure 5.53 Before lifting the outer string into place, spread PVA adhesive onto the string's corresponding steps.

Figure 5.53: Coat steps 3 and 6 of the cut string generously with PVA adhesive.

Figure 5.54: With the help of a second person the cut string is lifted into position and held in place with two more F-clamps.

Figure 5.55: Fix the treads to the cut string by screwing through the pre-prepared holes with 5.0 × 65mm screws (2½ inch 10s). The clamps holding the string and treads together can now be removed.



Figure 5.54 Use two further F-clamps to hold the outer string in place.



Figure 5.55 Screw through the treads into the outer string. Here a small clamp ensures good contact between the nosing return and string.

While the treads of a cut-string staircase are always secured with screws, methods used to conceal the fixings can vary. An alternative to pelleting, demonstrated in chapter 8, is to hide the screws directly beneath balusters by screwing through the holes into which baluster dowels will later be fixed.

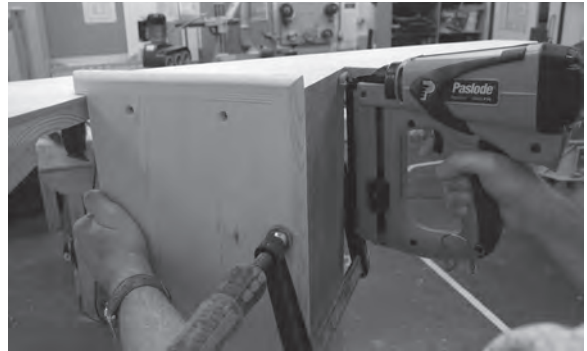


Figure 5.56 Nail the risers to the cut string.



Figure 5.57 Accurately prepared mitres will result in neat-fitting risers

Figure 5.56: Nail through the face of the mitred riser into the cut string.

Figure 5.57: The riser is held in place by three 40mm nails sunk beneath the surface, the lowest of which can be concealed behind the preceding tread.

Figure 5.58: With the two steps glued and fixed to the cut string all clamps can be removed.



Figure 5.58 All clamps are now removed.



Figure 5.59 Locate the remaining risers in their wall-string housings and glue and nail to the cut string.



Figure 5.60 Add the treads ensuring correct location between treads and strings and also treads and risers.

Figure 5.59: All steps between the two fixed ends can now be built – starting with the risers. Take each riser in turn and insert the square-cut end, without glue, into its closed-string housing, and then locate the mitred end, with glue, against the cut string. Nail the risers to the cut string.

Figure 5.60: Insert the treads which, again, are glued only at the cut-string end. As the treads are dropped into the closed-string housings the tops of the risers should locate in the housings beneath the treads.

Figure 5.61: All treads are now correctly located, and glued and screwed to the cut string, including tread number 2 which, like number 6, has a corner removed to receive the newel post. The staircase is now ready for wedging.

Figure 5.62: Clamping the flight ready for wedging is not easy; neither is it absolutely necessary – gravity will hold the treads and risers within their closed-string housings. However, if desired, the staircase can be pulled up by laying a protective board on top of the tread nosing returns and applying only mild pressure with clamps angled over the cut string.

Figure 5.63: Apply glue generously to the wedges and drive home, checking that the tread nosings are inserted fully into their housings.



Figure 5.61 The treads are fixed. Note the notching (for newel posts) at the back of the closest tread on the left and at the front of the farthest tread on the right.

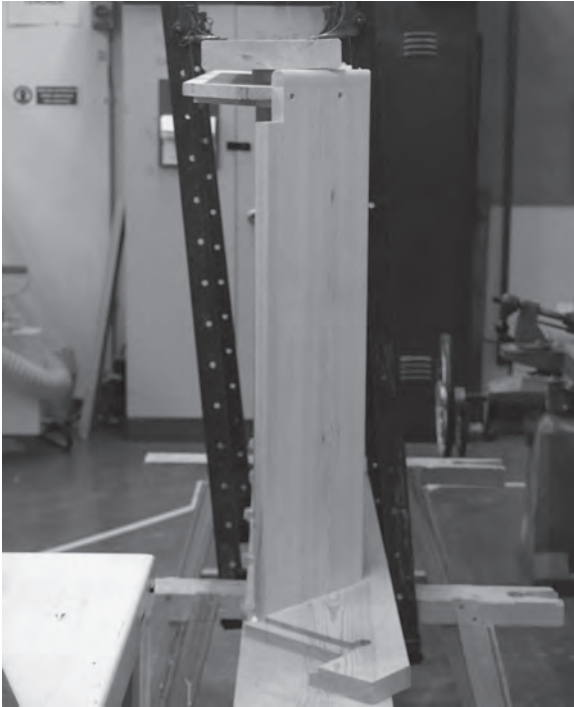


Figure 5.62 Apply only light pressure with clamps if required.



Figure 5.63 Glue and wedge all treads and risers to the wall string.

Figure 5.64: Screw through the lower parts of the risers into the backs of the treads using 5.0 × 40 mm wood screws (1½ inch 10s), fixing at centres not exceeding 230 mm.

Figure 5.65: Use PVA adhesive to fix glue blocks at equidistant spacings (two per step for flights below



Figure 5.64 Screw risers to backs of treads.



Figure 5.65 At the underside of the assembled flight, glue blocks support the steps where the treads meet the risers, and where the treads and risers meet the cut string.



Figure 5.66 Nail holes visible on the riser faces should be filled before cleaning up.

900mm wide) using 'rubbed' joints. A third glue block supports the riser where it meets the cut string, and a fourth supports each tread where it meets the cut string. Leave for 20 minutes while the glue dries, otherwise the glue blocks will require pinning.

Figure 5.66: Fill and clean up the nail holes and any imperfections.

Figure 5.67: At this stage the lower flight should be set aside so that work can continue on the upper flight, for to continue further would see handling, delivery, and (if required) storage impeded by the projecting bottom newel post.

Figure 5.68 and 5.69: After delivery, and ahead of installation, the bottom newel post is glued and draw-bored onto the outer string.



Figure 5.69 Glued dowels are used to pull the joint up nicely.



Figure 5.67 The assembled flight.



Figure 5.70 A D-step is an attractive starting step for a staircase (compare with curtain step, Figure 8.126).



Figure 5.68 The bottom newel post, protected by a scrap piece of timber, is tapped into place.

Figure 5.70: This is the pre-assembled D-step. The tread has a cut-out at the right-hand rear where it will be housed into the bottom newel post. Detailed information on the construction of this step can be found in chapter 10.

Figure 5.71: The solid block which makes up the semicircular end of the first riser is notched around the newel post. Held in place by an F-clamp, the D-step is glued to the newel post and secured by two 5.0×100 mm screws (4 inch 10s).

Figure 5.72: The D-step is glued and wedged to the closed wall string, completing the assembly of the lower flight and making it ready for installation. The upper flight is made ready for installation with the fixing



Figure 5.71 The D-step, viewed from the underside, meets with the bottom newel post which is glued and screwed to the step's solid block.



Figure 5.73 The outer corner of the quarter landing is supported by the intermediate newel post and, for speed, is often butted and screwed rather than 'let in', as seen here.



Figure 5.72 The outside of the lower flight, showing D-step, newel post, and cut string.

of the top newel post (which has been notched to sit over the landing joist), the landing nosing, and finally the top riser. Detailed guidance on the preparation of a landing nosing can be found in chapter 6.

Quarter landing

A quarter landing can be thought of as a small timber upper floor, usually supported by adjacent walls or, in some instances, a landing frame. A trimmer joist bears, at one end, on a return wall running parallel

with the lower flight of a quarter-turn staircase and, at the other end, on an intermediate newel post which extends down to the floor (Figure 5.73). Trimmed joists are fixed to the trimmer by means of joist hangers or, alternatively, traditional carpentry joints. A short span and close joist centres mean that the size of members can be kept to a reasonable depth.

Final installation

The installation of stairs should be a first-fix activity; in other words, it is a carpentry task best undertaken before plastering or dry lining. Plastering up to the string of a staircase provides a visually better finish than could be achieved by fixing to a finished wall (second-fixing), where gaps between the two would be hard to conceal. First-fixing means that part of the strings' thickness is hidden beneath the plastered surface, providing an opportunity to match that of the skirting board which will meet the strings after second-fixing.

Our quarter-turn staircase will be installed from the top down. Before the quarter landing is constructed, the upper flight, complete with top newel post, top riser, and landing nosing, is hooked over the upper-floor landing joist, levelled, and supported at its lower end with temporary props (Figure 5.74). Next, the outside string's tenon is coated with glue and the intermediate



Figure 5.74 The upper flight supported, at the top, by the landing joist and, at its lower end, by temporary props.



Figure 5.75 The upper flight's cut string meeting with the intermediate newel post.



Figure 5.76 When fully up, the intermediate newel post should be checked for plumb.



Figure 5.77 Fix the flight to the wall by screwing through the wall string.

newel post offered up (Figure 5.75). Before pushing the newel post fully up, install the handrail and then draw-bore dowel the two handrail tenons and string tenon.

Check the intermediate newel post for plumb (Figure 5.76). If satisfied, select the appropriate fastener for the background and fix the wall string to the wall by screwing through the triangular sections beneath, say, every other step (Figure 5.77). The flight can be further secured by screwing down through the landing nosing into the joist below, and nailing through the top riser (and shims) into the same joist. With the flight levelled and secured, the props can be removed.



Figure 5.78 With space limited, the quarter landing is often decked before the lower flight is offered up.



Figure 5.79 The lower flight's wall string is hooked over the quarter landing's trimmer joist, while the outer string is tenoned into the intermediate newel post (decking removed for clarity).



Figure 5.81 The lower flight's wall string is supported by the quarter landing.



Figure 5.80 The lower flight's cut string meeting with the intermediate newel post.



Figure 5.82 Install the handrails before pulling joints up tightly.



Figure 5.83 Insert the landing nosing within its housings.

return wall and through the top step (the landing nosing and top riser of the lower flight) into the quarter landing as described earlier. The bottom newel post is cut to floor level and can, if resting on a suspended timber floor, be skew nailed to the decking; better still (although rarely seen in practice) the newel post can be left long and bolted to a joist beneath the decking. The fixing of the foot of the staircase is strengthened by 'blocking' the bottom rear of the first riser to the floor either with suitable fixings (beware of underfloor heating) or suitable adhesive depending on the type of floor, which could be timber, concrete, or tiles.



Figure 5.84 A cut string provides an opportunity for clamping not possible on closed strings.



Figure 5.85 The quarter landing, with decking removed, showing timber shims between the trimmer joist and riser.

The quarter landing can now be constructed, the height of which is equal to step number 7 and indicated by the housings routed into the intermediate newel post. Once the landing has been levelled and securely fixed to both adjacent walls and the intermediate newel post (and decked, as space will be limited – Figure 5.78) the lower flight can be offered up (Figures 5.79, 5.80, and 5.81). Before pulling the string shoulder fully up, the lower handrail should be installed (Figure 5.82), as too should the flight's landing nosing and top riser (Figure 5.83). Pull the flight up, using a clamp if necessary (Figure 5.84). Dowel the outer string to the intermediate post and check that the flight is level and firmly seated at floor and landing levels. If it is, fix by screwing to the



Figure 5.86 Beneath the landing, access is available to screw the top riser to the preceding tread.

Figures 5.85 and 5.86 show how the lower flight meets with the quarter landing (the landing nosing and decking have been removed for clarity). Correctly sized timber packers, or shims, are placed between the top riser and trimmer joist, through which the riser can be nailed to the joist. Relatively small landing members permit access to the back of the top riser where it can be screwed to the preceding tread.



Figure 5.87 A split timber connector joining the upper flight's wall string to the quarter landing.

After the landing has been decked, riser number 8 – the first riser of the upper flight – can be installed; the upper flight's carriage will need to be temporarily removed so that access to the riser's housings can be gained. And lastly, a split timber connector secures the upper flight's wall string to the quarter landing (Figure 5.87), before the flights' undersides are lined with (usually) 12.5 mm plasterboard (Figures 5.2 and 12.28).

Figure 5.88 shows the finished staircase.



Figure 5.88 The finished staircase.

6

L-Shaped Stairs with Kite and Winders

We've seen how the introduction of a quarter landing can be used to change the direction of stairs as well as the other benefits it brings. Where available space is more restricted, a quarter landing can be replaced by what Approved Document K calls 'tapered treads' and what the joinery industry calls 'kites and winders'.

A tapered tread is described in the latest edition of Approved Document K (2010) as 'a step in which the going reduces from one side to the other', and in the previous edition (1998) as 'a step in which the nosing is not parallel to the nosing of the step or landing above it'.

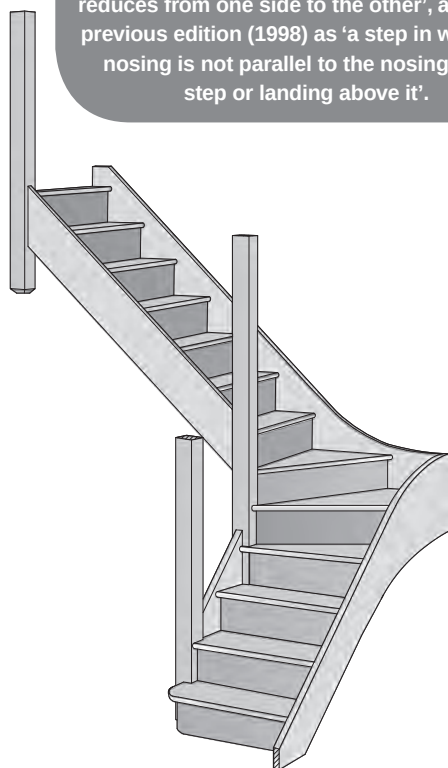


Figure 6.1 Three winding steps are typically used to make a 90° quarter-turn.

Where a staircase is required to turn 90°, as few as two or as many as four winding steps are sometimes used to make the quarter-turn (whether such arrangements satisfy the recommendations made in Approved Document K, however, is questionable). By far the most common arrangement is to have three winding steps for a 90° quarter-turn (Figure 6.1) and six for a 180° half-turn, the latter being not the easiest of stairs to climb and, in particular, to descend.

It is important to bear in mind that the introduction of winders to a staircase brings with it certain safety issues. The narrow ends of the winders – the side on which users often find themselves when grasping the handrail – provide insufficient room for a secure foothold. And the change in routine demanded while navigating the tapered steps disrupts the repetitive nature of stair climbing, resulting in a trip hazard. For these reasons, it is advisable (although not compulsory) to situate winders near the lower part of a staircase wherever possible.

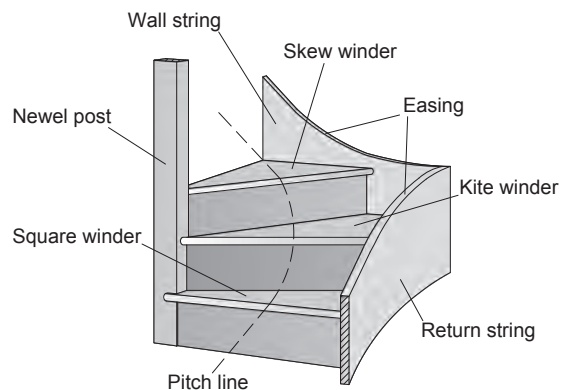


Figure 6.2 Winder box.

Building Regulations

All the usual recommendations apply: maximum rise and minimum going 220 mm; maximum angle of pitch 42°; minimum headroom 2 m, etc. (see chapter 1 for details). Headroom above the winders is measured vertically from the pitch line, which touches the nosings of each straight and tapered tread at the centre of the staircase (Figure 6.2). And it is at the centre of each winder where the relationship between the rise and going should be checked ($2R + G = 550\text{--}700\text{ mm}$).

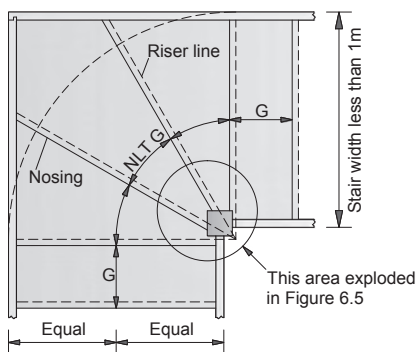


Figure 6.3 For stairs under 1 m wide, Approved Document K states that the going of the tapered treads should be measured at the centre and from a curved stair line, even when the treads are in a rectangular enclosure.

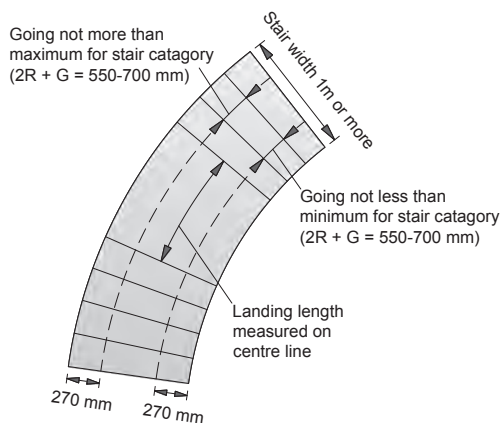


Figure 6.4 Staircases with a width of 1 m or greater are measured 270 mm from each side.

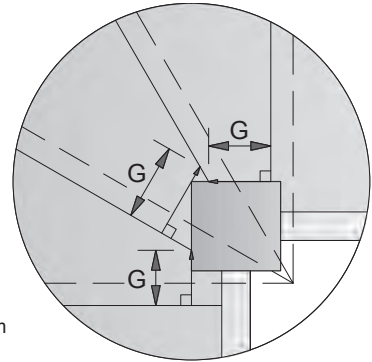


Figure 6.5 The going at the narrow ends of tapered treads should be not less than 50 mm.

Additional recommendations focus on the tapered treads (or winders) and are detailed below. First though, we must know how measurements are taken: staircases with a width narrower than 1 m are measured in the centre (Figure 6.3), while those with a width of 1 m or greater are measured 270 mm from each side (Figure 6.4).

The going at the narrow ends of tapered treads should be a minimum of 50 mm (Figure 6.5).

A uniform going should be maintained for staircases without straight treads and containing consecutive tapered treads only (Figure 6.4).

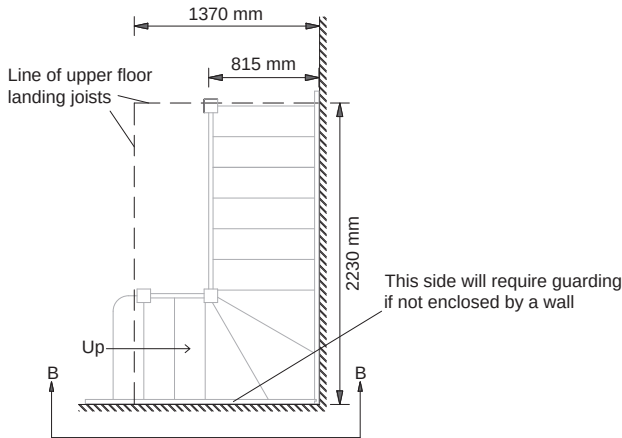
Where a staircase contains both straight and tapered treads, the going of the tapered treads (measured in the centre) should be not less than the going of the straight treads (Figure 6.3). The rise for both the straight and tapered steps should be the same throughout the flight.

The general provisions contained in paragraphs 1.2 and 1.3 of Approved Document K should be met (see Figure 1.4 and chapter 1 for details of how to access this document).

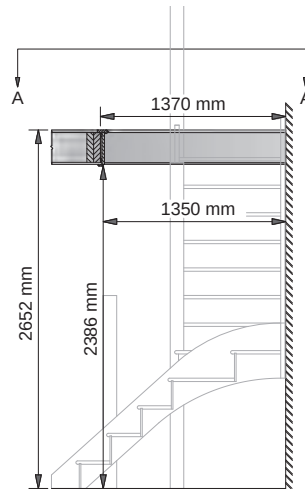
Staircase dimensions

Dimensions and design information on this chapter's staircase are detailed below and illustrated in Figures 6.1 and 6.6.

- Size of opening: FFL to FFL Rise: 2652 mm
Stairwell length: 2230 mm
Stairwell width: 1370 mm



PLAN VIEW A-A.



SECTION B-B. MEASUREMENTS FOR HEADROOM

Figure 6.6 Site dimensions with proposed staircase indicated.

- Headroom measurements: FFL to underside of ceiling cover mould: 2386 mm. Width, wall to ceiling cover mould: 1350 mm
- Width overall the strings: 815 mm
- A 90° left-hand turn (when walking up the stairs)
- Type of turn: three winding steps
- Number of treads before turn: three
- Number of newel posts: three 100 mm square newel posts on left-hand side of staircase
- Starting step: Bullnose on left-hand side
- Strings: 32 mm thick European Redwood
- Treads: 25 mm MDF
- Risers: 12 mm Far Eastern plywood

Second calculation: $2652 \div 13 = 204 \text{ mm}$.

These two calculations have told us that we need thirteen steps, each with a height, or rise, of 204 mm.

Double check: $204 \times 13 = 2652 \text{ mm}$ ✓

Next, we use the Rise and Going calculator to determine a suitable going. Use the far left or far right vertical column to look up the rise of 204 mm. Read across to the bright green 42°, and then vertically up or down to find the going, which is 227 mm.

Now check for a correct relationship between the rise and going by ensuring that twice the rise plus the going is between 550 mm and 700 mm:

$$2R + G = 550 - 700 = 2 \times 204 + 227 = 635 \text{ mm}$$

So far, our staircase meets the following requirements:

- The rise is less than 220 mm
- The going is greater than 220 mm
- The angle of pitch (as determined by the Rise and Going calculator) is 42°.

Staircase calculations

We'll start the way we always start, by dividing the total floor-to-floor rise by 220 (mm):

$$\text{First calculation: } 2652 \div 220 = 12.05 \\ (\text{round up to 13 steps})$$

- Twice the rise plus the going, at 635 mm, is between 550 mm and 700 mm

Setting out

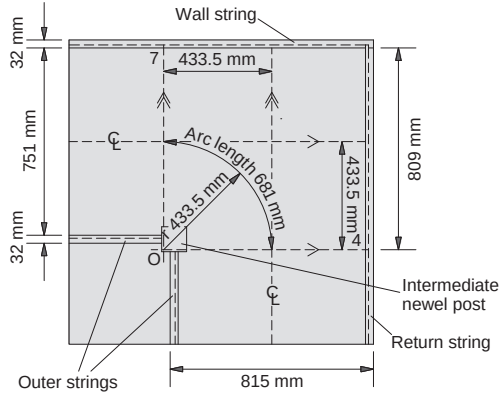


Figure 6.7 Setting out the winder box.

We saw in chapter 4 how the steps of a straight-flight staircase are marked directly onto the strings without the need for a rod. When setting out a staircase with kites and winders, a rod is essential and takes the form of a plan view of the winder box drawn full-size on a half-sheet of (usually) MDF (Figure 6.8).

Referring to Figure 6.7, the 32mm-thick strings should be drawn first. Start by selecting an original (uncut) corner of the MDF board – a corner that we can be confident is a 90° (right) angle. Draw lines that are 32 mm from, and parallel to, the two sides adjacent to the right angle (a combination square is useful for this); these are the wall and return strings. The width of the staircase (815mm) will determine the location of the outer strings.

Once the strings have been drawn it's a good idea to pause for a double-check: the distance from inside of string to inside of string should be:

$$815 - 32 - 32 = 751 \text{ mm}$$

Satisfied that the width between strings is 751 mm, we can continue as follows:

At the intersection of the two outer strings, draw a 100 mm × 100 mm (intermediate) newel post, ensuring that it is central to, and square to, both strings. Then

use feint or broken lines to mark the centres of the two straight sections of the staircase.

Next, the winders; to draw these accurately some geometry is useful, as follows:

Geometry

Our staircase will contain both straight and tapered treads and, as we've seen, Approved Document K recommends that the going of the tapered treads should not be less than that of the straight treads – in our case, 227 mm. Therefore, the total going for the three winders (measured in the centre) should be not less than:

$$227 \text{ mm} \times 3 = 681 \text{ mm}$$

The 681 mm represents the length of an arc that is the winder walk line between risers number 4 and 7. As we are turning 90°, the arc is one quarter of the circumference of a circle. Therefore, the total length of the circle's circumference is:

$$681 \text{ mm} \times 4 = 2724 \text{ mm}$$

A walk line, or walking line, is described in BS 5395-1:2010 as a 'notional line that indicates the average path of users of a stair'.

Now that we have a circumference we can calculate the radius of the circle by using the formula:

$$\begin{aligned} \text{Radius} &= C \div 2\pi \text{ where } C \text{ is the circumference of} \\ &\text{the circle and } \pi \text{ is pi, approximately } 3.142 \\ \text{Radius} &= 2724 \div (2 \times 3.142) = 2724 \div 6.284 = 433.5 \text{ mm} \end{aligned}$$

To find the centre of the circle, draw lines that are 433.5 mm from, and parallel to, the two centre lines of the staircase; the point at which they cross (O) marks the circle's centre and the geometric centre of the winders. Using trammel heads or a large compass, draw an arc with a radius of 433.5 mm between risers number 4 and 7.

Now we must divide our 90° turn into three equal parts to represent the three winders (Figure 6.8). There are a couple of methods that can be used to accurately measure an angle of 30° – for an item as large as a winding tread, a protractor is not one of them. The first method involves using dividers (seen in Figure 3.10) to divide the arc into three equal parts. Although this will involve trial and error, as we can expect the required distance to be slightly less than the going of 227 mm, the process should be straightforward.

Alternatively, if like me you prefer 100% accuracy to trial and error, try this second method: if we consider winding treads number 4 (the square winder) and 6 (the skew winder) right-angled triangles, we can use a scientific calculator to set out the 30° angles. Yes, more trigonometry, but don't be put off; we saw in chapter 2 how quickly, how easily, and how accurately trigonometry can be used to determine the going of a staircase while staying within the maximum 42° angle of pitch. Setting out our 30° winders is equally simple; just multiply the base length of the triangles (809 mm) by the tangent of 30°. And don't forget to double-check.

$$809 \times 30 \tan = 467.0763678$$

Answer: 467 mm

Double check:

$$467 \div 30 \tan = 808.8677271$$

Answer: 809 mm ✓

From the points where the lines of risers number 4 and 7 meet the insides of the return and wall strings respectively, measure and mark distances of 467 mm in the directions of the corner junction of the two strings. Lines drawn from O to these marks will give us our three winders less their nosings, as shown in Figure 6.8.

The 467 mm is an extremely important figure. Check that the wide sides of winding treads number 4 and 6 (where they meet with the return and wall strings respectively) are 467 mm, and write this figure on your

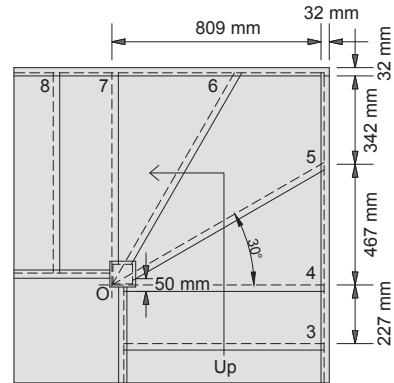


Figure 6.8 Setting out the winder box.

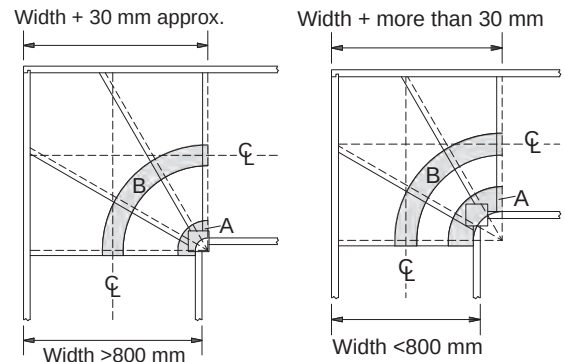


Figure 6.9 Indication of winder box sizes for staircases less than 1 m wide.

rod for later use when marking the strings. The two wide sides of the kite winder (tread number 5) should measure 342 mm (the difference between 809 mm and 467 mm). This too should be written on the rod.

Figure 6.9 highlights the two important areas to consider when setting out the winders of a staircase less than 1000 mm wide. Area A is the going at the narrow ends of the tapered treads which should measure not less than 50 mm, and area B is the tread centres where the going should be not less than that of the straight treads. As a general rule, and provided the going of the straight treads is not excessive, a staircase wider than 800 mm will require a winder box approximately 30 mm greater than its width, so the winder box of an 860 mm wide staircase will be around 890 mm. However, below 800 mm the difference between the width of the staircase and the size of the

winder box increases as the staircase width is reduced: a 680mm wide staircase, for example, will require a winder box of around 780mm.

Another way of looking at it is, for staircases greater than 800mm wide, get area A right and area B will take care of itself; below 800mm, get area B right and area A will take care of itself.

To complete the rod (Figure 6.8)...

- Draw the two straight treads (numbers 3 and 7) adjacent to the winders.
- Draw lines 25mm in front of, and parallel to, each of the riser lines to represent the nosings.
- Use broken lines to represent the 12mm deep housings in the strings and newel post.
- Show a tongued housing joint in the corner where the wall and return strings meet.
- Number the steps.
- Indicate the direction of 'up'.

A quick check of the horizontal distance from front to back (at the narrow end) of tread number 4 (less the nosing of tread number 5) shows that we have the required 50mm.

Within the stairwell length of 2230mm we want to fit the winder box, six straight steps, and the top riser:

Winder box:	841mm	
Six goings:	$227 \times 6 =$	1362mm
Top riser:	12mm	+
Total:	2215mm	

The difference between the stairwell length and the length of the staircase is:

$2230 - 2215 = 15\text{mm}$ (10mm between the top riser and landing joist and 5mm between the return wall string and return wall).

Lastly, we must ensure that there will be at least 2m of headroom. This means that the staircase cannot rise by more than 386mm at the point where headroom will be measured:

$$2386 - 2000 = 386\text{mm}$$

The 386mm represents nearly two risers:

$$386 \div 204 = 1.9\text{ risers}$$

So, at the point where the staircase rises to 386mm, there is nearly one full tread (or going). This means that between this point and the wall there are two full treads (or goings) and the winder box. If their combined length is less than the horizontal distance between the wall and the ceiling cover mould (1350mm), then there will be sufficient headroom. If greater, the headroom height will be less than the required 2m:

Two goings:	$227 \times 2 =$	454mm
Winder box:		841mm
Tolerance between wall and wall string:	5mm +	
Total:		1300mm

By building a staircase according to our calculations and setting out, we will be able to demonstrate compliance with the Building Regulations because:

- The rise is less than 220mm.
- The going is greater than 220mm.
- The angle of pitch (as determined by the Rise and Going calculator) is 42° .
- Twice the rise plus the going, at 635mm, is between 550mm and 700mm.
- The going of the tapered treads (measured in the centre) is not less than that of the straight treads.
- The going at the narrow ends of the tapered treads is 50mm or greater.
- The rise for both the straight and tapered steps is the same throughout the flight.
- The headroom will be more than 2m.

Use of scale drawings

Having completed our calculations and drawn a rod, the usual next task would be to write a cutting list. However, for this staircase, we need additional information – information not available on our rod.

To accommodate the wide ends of the tapered treads, the wall and return strings require widening in

that area; the strings will be built up with additional, shorter lengths of European Redwood called 'ease-ments'. The difficulty, because the information is not available on our MDF rod, is knowing the easement lengths and jointing positions. The preparation of scale line drawings will provide the answers.

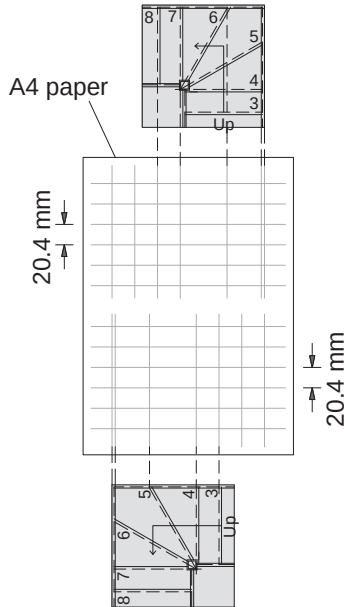


Figure 6.10 Draw faint horizontal and vertical lines to represent the rise and going to a scale of 1:10 on a sheet of A4 paper.

Using the convenient scale of 1:10 we can fit both the wall and return strings on a single sheet of A4 paper in portrait orientation. Using a scale rule or, as I prefer, a regular rule while dividing all measurements by ten, proceed as follows.

Figure 6.10: Draw two sets (one each for the wall string and return string) of faint parallel horizontal lines across the width of the sheet; the distance between each line should be 20.4mm (the rise of 204mm divided by ten). Then draw parallel vertical lines to represent the winding treads and, say, three straight treads, plus the adjacent string. The important measurements required for this task are taken from the MDF rod – a task made easier if the measurements were written on the rod during its preparation earlier.

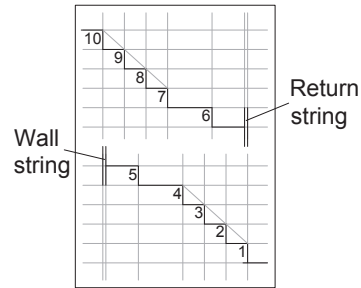


Figure 6.11 Using bold lines draw and number the steps.

Figure 6.10 shows how the vertical lines relate to our rod.

Figure 6.11: Add bold lines to the two grids to represent the treads and risers, number the steps, and draw faint lines that connect the tips of each straight step.

Figure 6.12: Now draw the strings in bold. The tops of the strings should be parallel to, and 6mm scale (60mm real-life measurement) above, the faint lines connecting the tips of the straight treads. The undersides of the strings should be parallel to the tops and give a string width of 24.4mm scale (244mm real-life measurement).

To draw in the wide parts of the two strings, measure and mark distances equal to the rise above and below the kite winder (tread number 5) where it meets the adjacent string. The string curvature, known as 'easing', can now be added to the drawing.

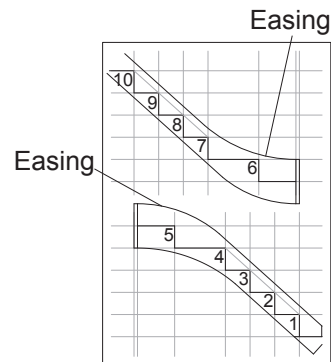


Figure 6.12 Add the strings including the wider curved (eased) sections which house the winding steps.

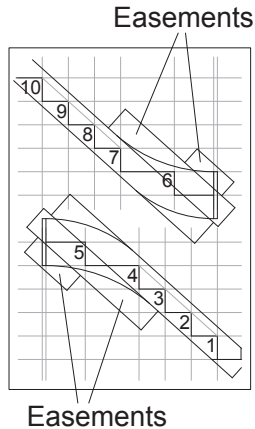


Figure 6.13 Add the necessary easements required to build up the strings to their required widths.

Figure 6.13: Lastly, draw the easements - the boards that will be required to build up the strings to their required widths.

Cutting list *(see following page)*

Using our scale drawings, MDF rod, and stair calculations, we now have all the information needed to prepare an accurate cutting list (handrail and balustrade excluded) for the staircase shown in Figure 6.14.

Pitch board and router jig

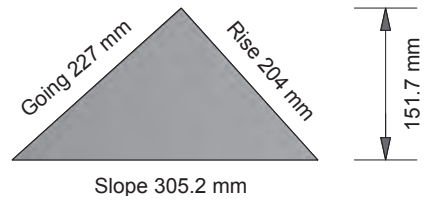


Figure 6.15 Pitch board dimensions.

You will by now know that my preferred method of marking the strings is to use a pair of stair gauges clamped to a steel roofing square. If you would rather make your own pitch board to use with a margin template, the dimensions will be as shown in Figure 6.15.

When tackling stairs of this type during my early days in the trade, I would use a regular router jig for the straight steps, and then switch to the time-consuming and somewhat awkward arrangement of using straight edges to rout the wider housings of the tapered treads. I quickly realised that a far better approach was to make a wide router jig that would accommodate both the straight steps and the winders. Figure 6.16 shows the wide router jig alongside a standard jig.

Preparation of wall and return strings

Our scale drawings illustrate how the strings and easements should be glued up in order to achieve

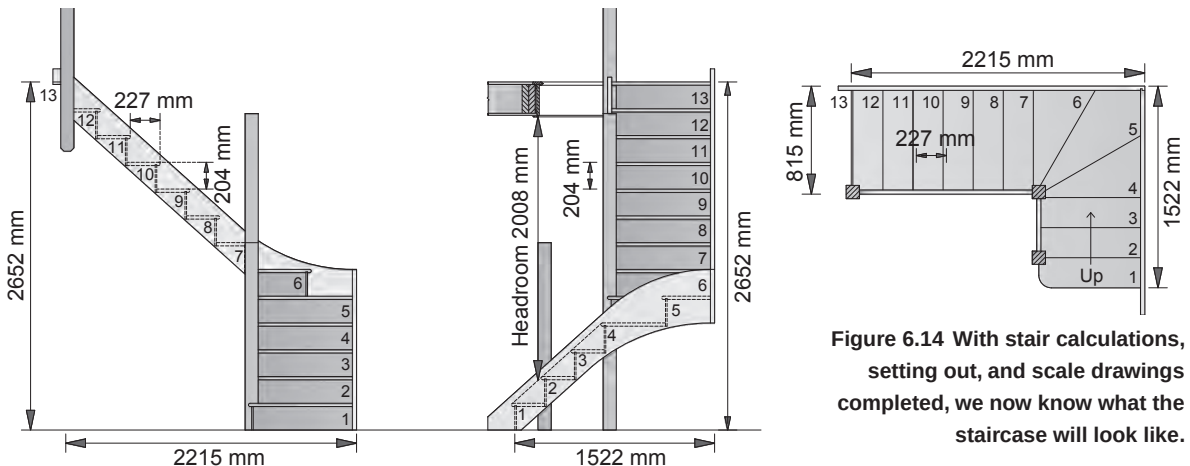


Figure 6.14 With stair calculations, setting out, and scale drawings completed, we now know what the staircase will look like.

Cutting List

No.	Member	Length	Width	Thickness	Material
1	wall string	3100	244	32	European Redwood
1	return string	2300	244	32	European Redwood
1	outer string	2100	244	32	European Redwood
1	outer string	900	244	32	European Redwood
2	easements	1400	220	32	European Redwood
2	easements	500	175	32	European Redwood
1	intermediate newel post	2500	100	100	European Redwood
1	top newel post	1700	100	100	European Redwood
1	bottom newel post	1500	100	100	European Redwood
1	kite winder	1200	525	25	Medium Density Fibreboard
1	panel (square and skew winders)	900	650	25	Medium Density Fibreboard
1	starting tread	850	258	25	Medium Density Fibreboard
8	treads	800	258	25	Medium Density Fibreboard
1	landing nosing	800	75	25	Medium Density Fibreboard
2	risers (winders)	900	210	12	Far Eastern plywood
10	risers (straight)	800	210	12	Far Eastern plywood
1	riser (bullnose)	1030	185	9	Far Eastern plywood

All dimensions in millimetres.

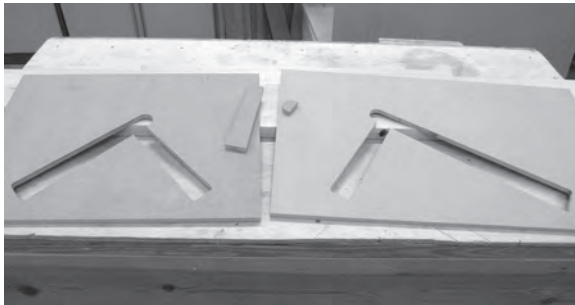


Figure 6.16 A wider-than-normal router jig (seen here alongside a standard jig) can be used when routing both straight and tapered steps.

the wide sections required to house the winding steps (Figures 6.10–6.13). When gluing multiple pieces of wood together, perfect alignment in the clamps and so avoiding even the smallest of steps between each

piece, is very difficult. Re-planing after gluing would solve this problem, except that the newly glued-up strings would now be too wide for most planer-thicknessers.

The solution is to glue up in two separate stages. Firstly (unless 250mm timber is being used), the straight sections of the strings are glued up to achieve the 244mm finished width (see cutting list), while in separate clamps, the easements are glued up (Figure 6.17). The resulting sections, when dry, can be re-planed to their finished thickness of 32mm, smoothing out any steps in the joints (Figure 6.18). Now, instead of trying to align up to four pieces in the clamps, we have just two (Figures 6.20 and 6.21). Before carrying out this second stage of the gluing process, however, some marking and routing of the strings are necessary.

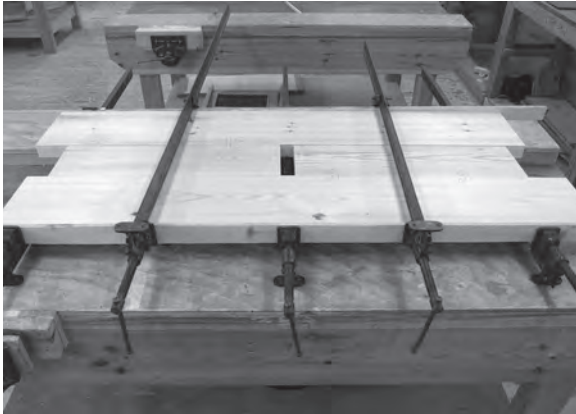


Figure 6.17 The over-thick easements for the wall and return strings are glued up separately from the strings.

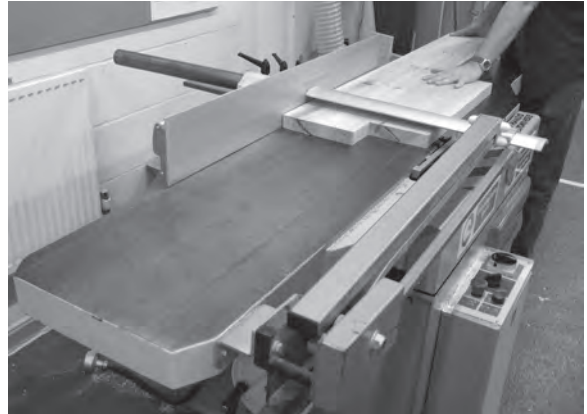


Figure 6.18 The glued-up easements, when dry, are re-planed to their finished thickness of 32 mm.

The marking and routing of the straight steps is much easier if done before the easements are added, as their presence would prevent the stair gauges or margin template, and the router jig's fence, from moving unhindered along the length of the string.

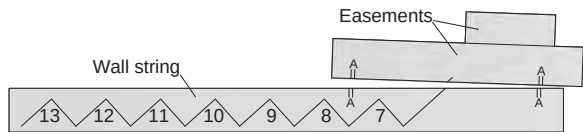


Figure 6.19 Using the scale drawings for guidance, mark the wall and return strings and indicate with letters the jointing position of the easements.

String marking and routing

The marking of the steps and newel post tenons on the two outer strings is a straightforward task using either stair gauges clamped to a steel roofing square or a pitch board and margin template (see chapter 4 for detailed procedure). One difference between this staircase and the straight flight described in chapter 4 lies with the string tenons, where this time I have opted for my preferred 20mm bare-faced tenons (Figure 4.41). The 20mm tenon thickness is a result of routing the shoulders on the face side of the strings to a depth equal to that of the tread and riser housings – 12mm.

Next, the straight sections of the wall and return strings should be marked. Once again, our scale drawings can be used to determine the starting point of the marking and the jointing positions of the easements. Indicate with letters where the two sections are to be jointed (Figure 6.19).

The easements can now be set aside while the housings for the straight steps are routed to the usual

depth of 12mm using a 16mm stair housing dovetail cutter (Figure 3.14). Only once all of the straight steps have been routed should the gluing up of the strings be completed (Figures 6.20 and 6.21).

When dry, the strings can be removed from their clamps and the glue lines sanded and cleaned. The lines of the winding steps are then marked using a steel roofing square, and dimensions taken from our MDF rod (Figures 6.22–6.24).

The string easings can be marked in one of three ways. A quick, yet crude, method is to flex a thin strip of timber to form a curve and draw round it (Figure 6.25); a more time-consuming, yet accurate, method is to draw the curves using a pair of trammel heads set to the desired radius (Figure 6.26); or a good compromise between speed and accuracy is to draw round a pre-prepared template cut to suit most staircases of this type (Figure 6.27).

The routing of the housings for the winding steps can now be carried out before the easings are cut on a



Figure 6.20 (above) and Figure 6.21 (below) With the routing of the straight step housings complete, the easements can now be glued to the wall and return strings.



Figure 6.22 (above), Figure 6.23 (below), and Figure 6.24 (bottom) After cleaning off the dried glue, the marking of the wall and return strings is completed by using a steel roofing square to add the winding steps and the tongued housing joint that will connect the two strings.



band saw and smoothed off using either a spokeshave or a compass plane (Figures 6.28–6.30).

The wall and return strings are jointed using a tongued housing joint stopped 25 mm from the top edge (Figure 6.31). When testing the fit of the joint, the two strings are correctly aligned when the tops of the housings for the kite winder (tread number 5) are flush (Figure 6.32).

Preparing the newel posts

Our staircase will have three newel posts, the longest of which – the intermediate newel post – will house the winding steps and provide a junction where the two straight sections of the flight will meet. The finished sectional size for all three newels will be 100 mm × 100 mm.



Figure 6.25 (above), Figure 6.26 (below), and Figure 6.27 (bottom) Use your preferred method for marking the string easings.

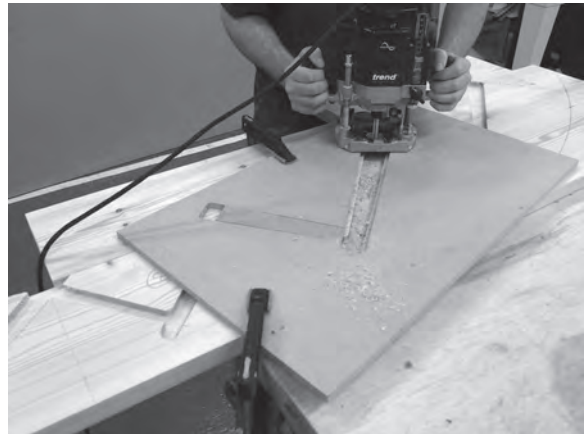


Figure 6.28 The housings for the winding steps together with the tongued housing joint are now cut, completing the routing of the wall and return strings.



Figure 6.29 A band saw is used to cut the easings of the return string.



Figure 6.30 Smooth off the easing of the top edge of the return string using a compass plane.

The marking out of the three newel posts is shown in Figures 6.33–6.35, the most complicated of which is, again, the intermediate newel. To help, Figure 6.34 should be compared with Figures 6.36–6.39, which show all four sides of the finished newel post. As indicated, the depth of the housings is 12 mm; the housing widths are taken from our MDF rod.

Figure 6.35 shows the marking out of the 'drop newel' at the top of the stairs. The newel post is finished at its lower end with a chamfered edge (Figure 6.40) and takes its name from its 'drop' below the ceiling line. In some instances, the top newel post might be required to extend all the way to the floor below to provide additional support for the staircase, in which case it is known as a 'storey newel'.

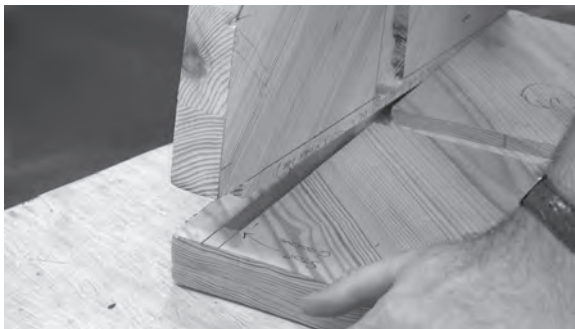


Figure 6.31 Test the fit of the tongued housing joint that will connect the wall and return strings.



Figure 6.32 A flush fit where the housings for tread number 5 (the kite winder) meet indicates correct alignment of the two strings.

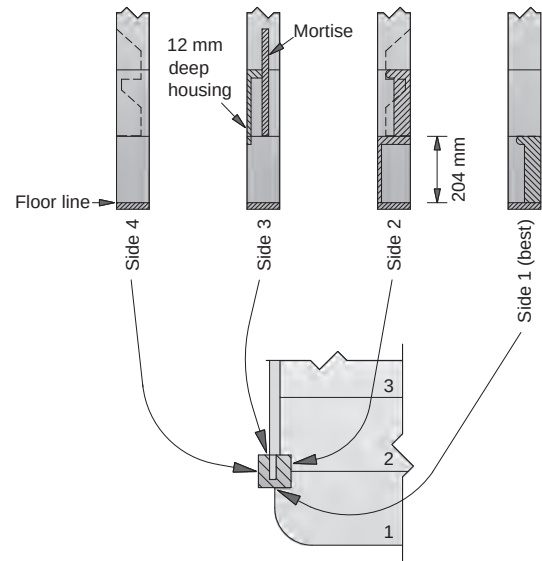


Figure 6.33 Marking out of the bottom newel post.

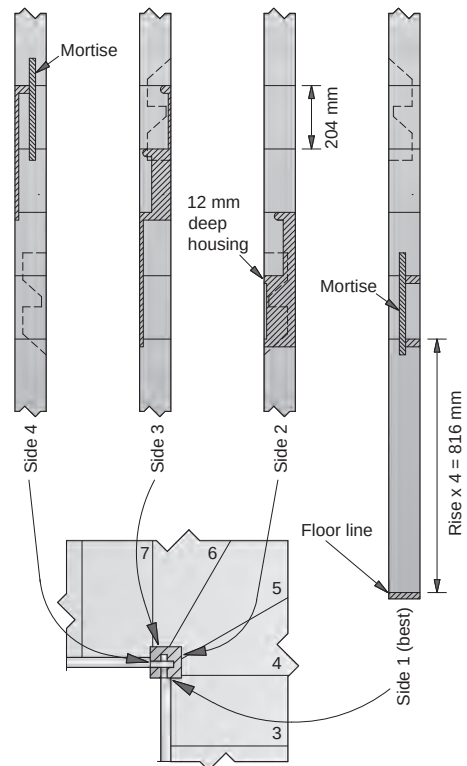


Figure 6.34 Marking out of the intermediate newel post.

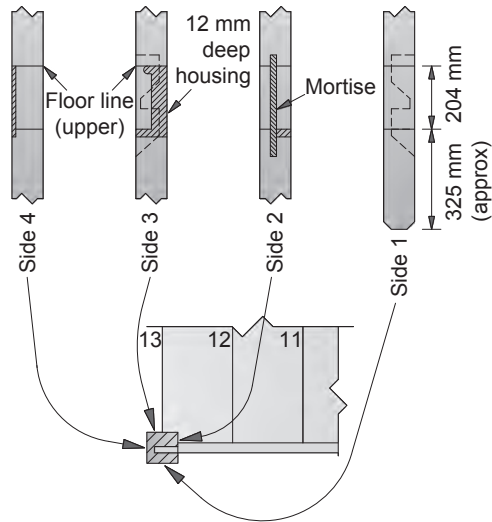


Figure 6.35 Marking out of the top newel post.

As a general rule, the side of the newel post faced when climbing the stairs should be the best of the four sides. That side of the top newel post, however, will be hidden, in the main, behind handrail and balustrade, so the decision on which direction to face its best side should be based upon the layout of the landing at the top of the stairs.

When marked, the housings of the newel posts are cut using a router guided by its fence attachment or a straight edge (Figures 5.25 and 5.26). And lastly, the newel posts are mortised to receive the string tenons (Figure 5.27).

Preparing the treads

The preparation of straight treads is described in detail in chapter 4, the only differences being that here no gluing or planing are required because these treads, unlike those described in chapter 4, are made from MDF. And with the construction of bullnose step number 1 demonstrated in chapter 10, the following describes only the winding, or tapered treads.

The kite winder (tread number 5) is shown on the cutting list as a stand-alone item, while treads number 4 (the square winder) and 6 (the skew winder) are

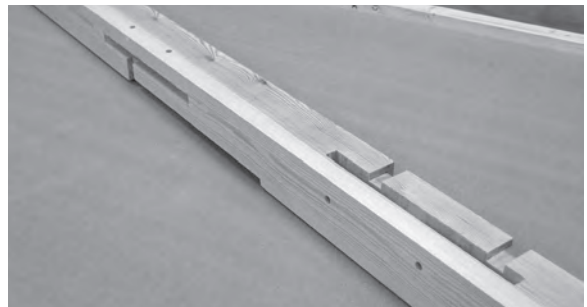
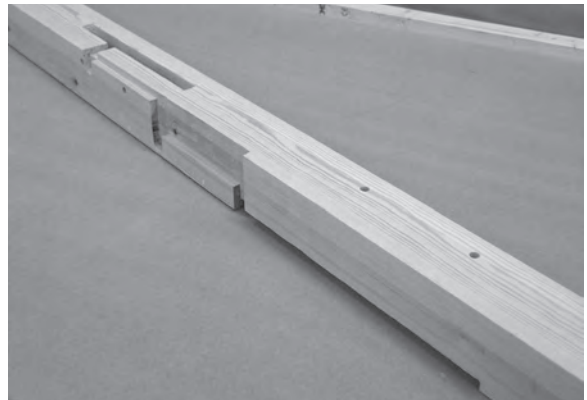
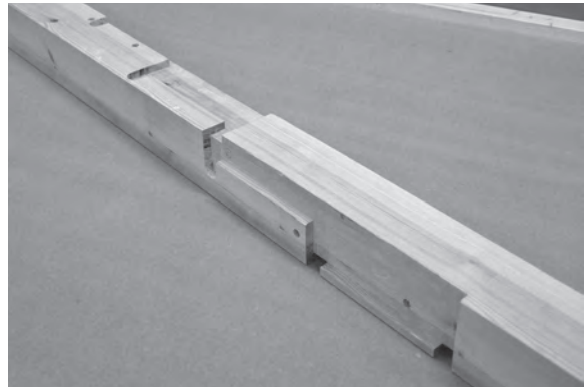
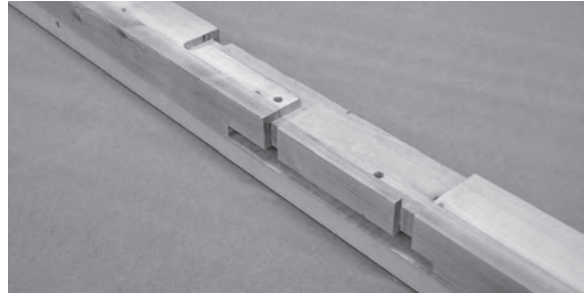


Figure 6.36 Figure 6.37, Figure 6.38, and Figure 6.39 (in sequence from the top) The four sides of the completed intermediate newel post.

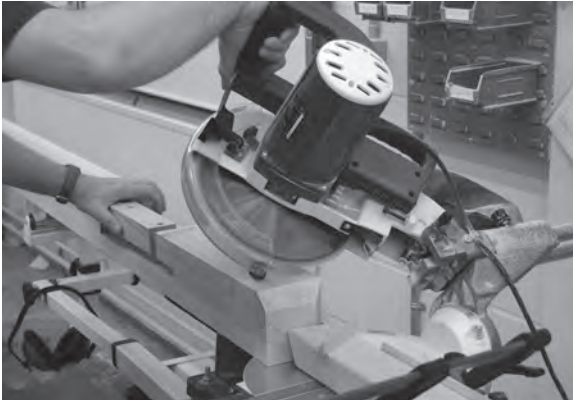


Figure 6.40 The top newel post doesn't extend all the way to the floor below, and is known as a 'drop newel'. Its lower end is finished with a chamfer using a chop saw set to a 45° angle. A clamped stop ensures correct alignment of the chamfer on all four sides.

both to be cut from a single item described as '1 panel' measuring 900mm long by 650mm wide. Figure 6.41 shows the panel being marked diagonally with the aid of a large shop-made 30° set square, after which the panel is cut to produce the two winders using either a band saw or, as illustrated in Figure 6.42, a circular rip saw.

Using a circular rip saw without the guidance of a fence is something only highly experienced users of the machine should undertake (Figure 6.42). When doing so, it is important that the item being cut is kept straight and true, as any wobble could result in kick-back.

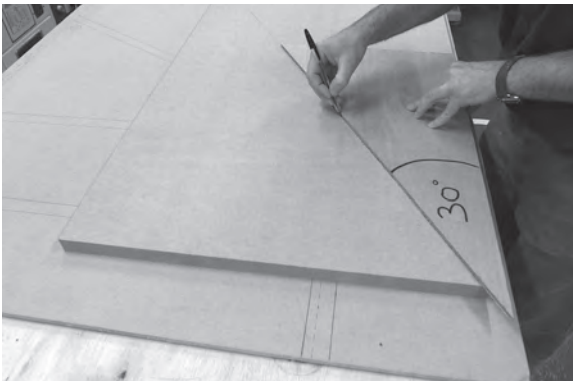


Figure 6.41 A large, shop-made, 30° set square is used to mark the angle of the winding treads.



Figure 6.43 The rough sawn rear edges of the winders are skimmed over a surface planer.



Figure 6.42 The MDF panel is cut diagonally to produce the square and skew winding treads.



Figure 6.44 Test the angle and size of the winders on the MDF rod.

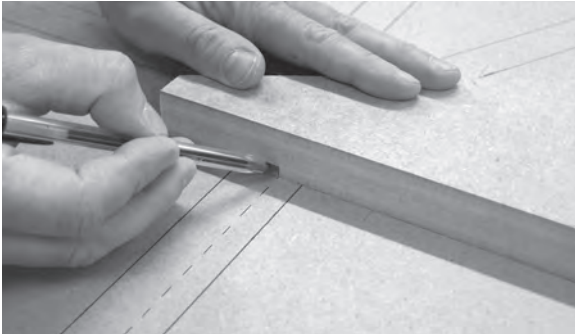


Figure 6.45 Mark the winders to length against the MDF rod.

After planing smooth the rough sawn back edges of the winders (Figure 6.43) they are laid, in turn, on the MDF rod for checking that the angle is correct and for marking to length (Figures 6.44 and 6.45). The winders are then cut to the marked lines and re-laid on the MDF rod to check for accuracy (Figures 6.46 and 6.47).

Always cut a winder's 30° angle before cutting it to length. The resulting wedge shape allows the tread to be slid across the MDF rod until it completely covers its own drawing. Small errors when cutting the angle can be easily corrected by re-planing the back of the winder – something not possible if the winder has already been cut to length.



Figure 6.46 Cut the narrow end of the square winder that will be housed partly in the intermediate newel post and partly in the outer string of the return flight.



Figure 6.48 The undersides of all treads (straight and tapered) are grooved to house the risers. The depth of groove should equal one-quarter of the tread thickness.

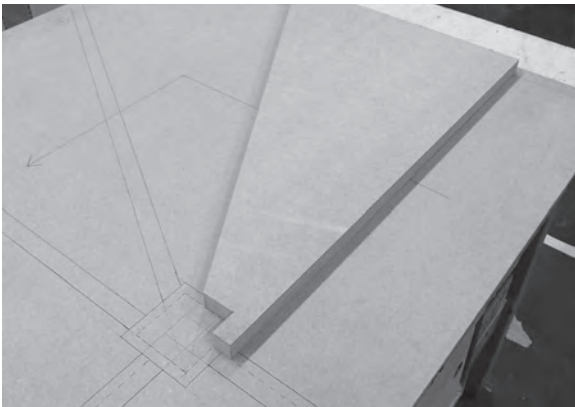


Figure 6.47 Final test for correct size of winders before the nosings are routed.

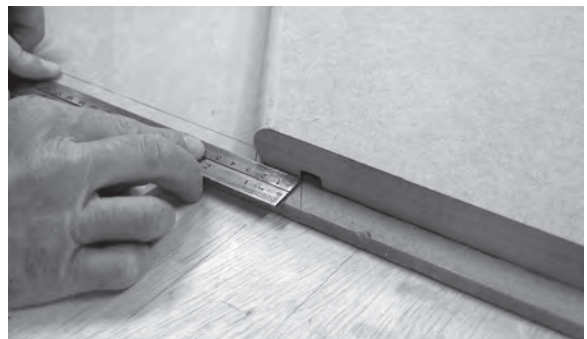


Figure 6.49 The MDF rod can be used to measure the nosing lengths of the winders.

The next task is to rout nosings on the front edges of all the treads (straight and tapered) using a bearing-guided round over cutter with a radius of 12.7mm (Figure 3.38), before grooving the undersides of the treads to a depth equal to one quarter the tread thickness (6.25mm) to house the risers (Figure 6.48). When setting up to machine the grooves, it is good practice to check, once again, that the winders sit perfectly on the MDF rod (Figure 6.49).

Fitting the winders

The nosings of the kite and skew winders meet with the return and wall strings respectively at one end and the intermediate newel post at the other. They meet at one of two angles: 120°, which is an obtuse angle, and 60°, which is an acute angle (Figure 6.50). Consequently the nosings of these two tapered treads will not fit their housings without some modification. Figure 6.51 shows the nosing at the wide end of the skew winder and illustrates the problem: the obtuse meeting angle between this end of the tread and the wall string prevents the nosing from going fully up in its housing.

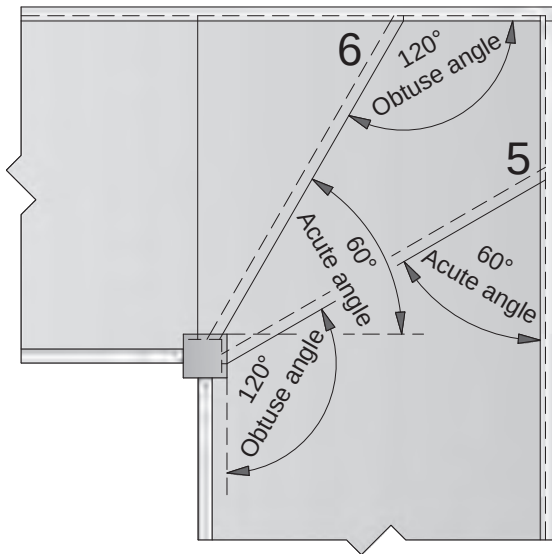


Figure 6.50 The angled fronts of tapered treads number 5 and 6 require modifications to their nosings and to the string and newel post housings.

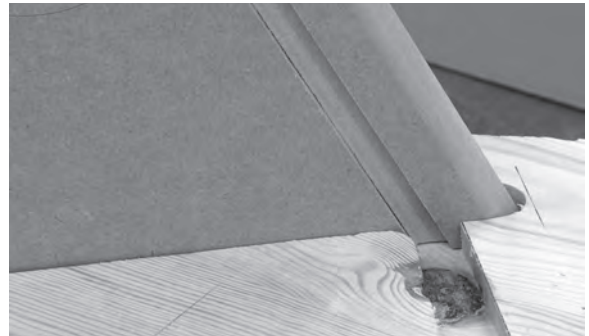


Figure 6.51 Immediately after machining, the kite and skew winders will not fit in their string housings without some modification. Shown here is the wide end of the skew winder; note the gap at the front of the nosing and the non-alignment of the tread's riser housing with that in the string (compare with Figure 6.56).

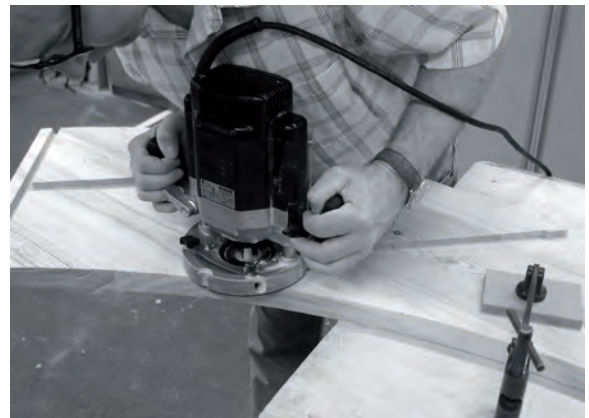


Figure 6.52 Lengthen the housings for the winders' nosings according to measurements taken from the rod.

Two operations are necessary. Firstly the nosing housings in both the strings and the newel post must be lengthened. These new lengths can be measured accurately off the MDF rod (Figure 6.49) and then transferred onto the strings and newel post for re-routing (Figure 6.52). Where the two ends meet with the newel post and return string at acute angles (the narrow end of skew winder number 6, and the wide end of kite winder number 5) no further action is necessary. But the two obtuse meeting points require a second operation.



Figure 6.53 Cut the skew winder's nosing back so that it enters the wall string at a 90° angle rather than an obtuse angle.

The parts of the nosings that will be concealed within the housings should be trimmed so that they meet with the wall string (in the case of skew winder number 6) and the intermediate newel post (in the case of kite winder number 5) at 90° (right) angles. Figure 6.53 shows the nosing at the wide end of the skew winder being cut back using a disc sander. The cut end of the soft MDF can then be rounded off quickly and easily (Figures 6.54 and 6.55).



Figure 6.56 The skew winder now fits nicely within its housing, the tread's nosing is fully up, and the riser housings are perfectly aligned (compare with Figure 6.51).



Figure 6.54 (above) and Figure 6.55 (below) Re-round the trimmed nosing so that it fits the string.



Figure 6.57 As with the straight treads, the back of each winding tread must finish flush with the riser housing of the following step.



Figure 6.58 The wide side of the skew winder is seen here sitting nicely within its housing in the wall string.

The task has been successfully completed when the tread nosing goes fully up in its housing while the front edge of the groove in the underside of the tread (which will later house the riser) meets the string's riser housing (Figure 6.56), and the back edge of the tread is flush with the riser housing of the following step (Figure 6.57). Figure 6.58 shows the wide end of skew winder number 6 fitted to its housing in the wall string.

Preparing the landing nosing

At just 75 mm deep, the landing nosing can be thought of as a small tread. It is prepared from the same material as the treads and should be nosed and grooved along with the other treads (Figure 6.59).

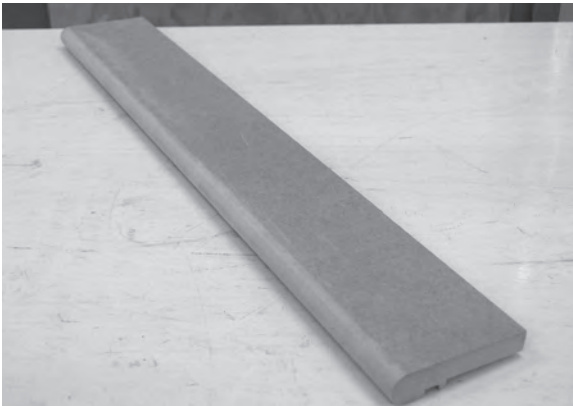


Figure 6.59 A landing nosing.



Figure 6.60 Mark the underside rear of the landing nosing before reducing its thickness to that of the upper floor decking.



Figure 6.61 The marked portion of the landing nosing is removed using a thin saw blade in a spindle moulder. Here, the guard has been removed for clarity.

The back half of the landing nosing is diminished in thickness to match that of the decking on the upper floor (Figures 6.60 and 6.61). The top riser is housed into the underside of the landing nosing and will sit against the upper floor's landing joist which, depending on the floor's layout, will be either a trimmer or a trimming joist.

Ancillary components and final preparation before assembly

Just ahead of staircase assembly, the strings and newel posts should be cleaned up. Only the nosings of the MDF treads require a light clean using, say, 180-

grit sandpaper. Drill offset holes in the newel posts and string tenons, and prepare wooden dowel for draw-boring. Cut sufficient numbers of angled glue blocks and wedges, remembering that longer wedges will be required to support the winding treads.

Staircase assembly

The two straight sections of the staircase – the main flight and the return flight – will be assembled on the workbench prior to delivery. But, to allow access on site, the intermediate and top newel posts will be left loose, as will the three winding steps and the landing nosing and top riser. Starting with the longer of the two straight sections – the main flight comprising steps 7 to 12 – the sequence of work is as follows:

Figure 6.62: Evenly space three T-bar clamps along the length of a workbench and screw down to prevent them from toppling over. Lay the wall and outer strings in the clamps, top down, with the wide part of the wall string overhanging the end of the bench. Ensure that the string housings are free of dust, and locate, one by one, firstly the treads and then the risers. With all of the treads and risers in place, position a pair of protective boards each side before clamping. Place a further three T-bar clamps above the staircase, remembering to allow access for the wedges.

Figure 6.63: With the staircase clamped and checked for square, wedging can begin. Apply a generous amount of PVA glue and wedge firstly the risers and then the treads. An additional wedge can be used to drive the wedges fully home without risk of damaging the strings.

Figure 6.64: After applying angled glue blocks to the underside of the steps and screwing the risers to the backs of the treads using 5.0 × 40mm chipboard screws (1½ inch 10s) at centres not exceeding 230 mm, the completed section of staircase is now ready to be set aside so that work can continue on the return flight.

Provided there is sufficient access on site, assembling the (much smaller) return flight in the workshop, complete with bottom newel post and bullnose step, will save a significant amount of work on site.

Following the sequence of work described above, glue up the flight, which at this stage will comprise only steps 2 and 3, and then continue as follows.

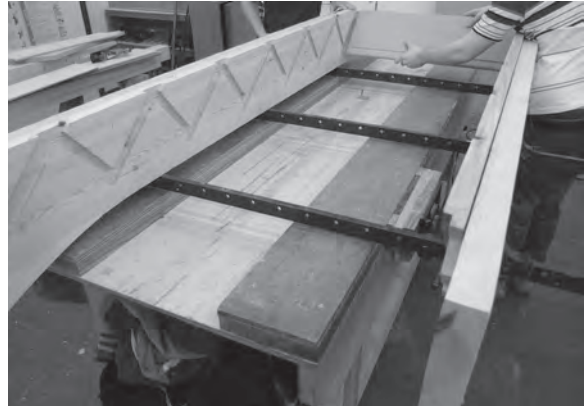


Figure 6.62 Assembling a staircase flat on a workbench is an alternative to constructing it on edge on trestles (demonstrated in chapter 4).



Figure 6.63 The clamped-up staircase is glued and wedged.

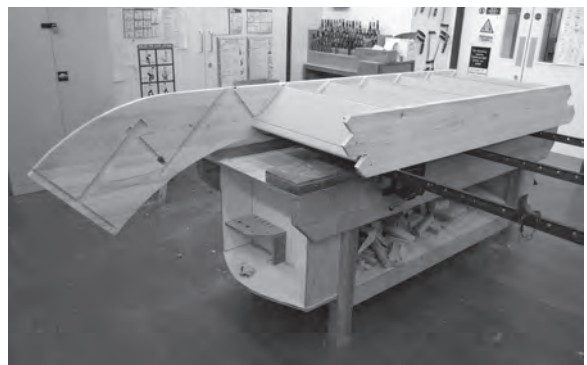


Figure 6.64 The assembled main flight is ready to be set aside so that work can commence on the return flight.



Figure 6.65 The return flight's outer string tenon is glued to receive the bottom newel post. Check that there is sufficient access on site before undertaking this task.

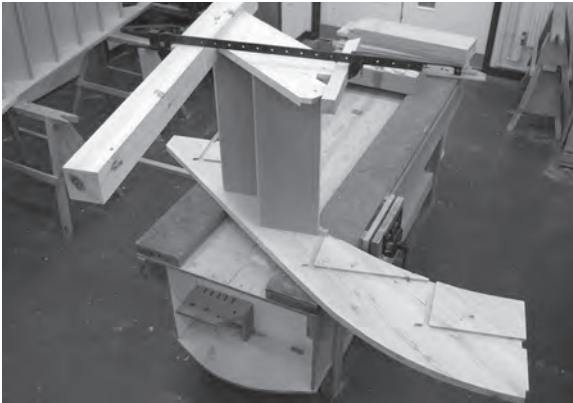


Figure 6.66 A string's tenon is pulled up into a newel post's mortise by draw-bore pinning, because the oblique angle of the string makes clamping impossible. Here, though, the very short length of the string has allowed pressure to be applied using a sash clamp.



Figure 6.67 Drive wooden dowel, tapered at the end and glued, into pre-prepared holes drilled through the newel post and string tenon.

Figure 6.65: Having prepared both the newel post and string tenon for draw-boring, coat the tenon with PVA glue.

Figure 6.66: On a section of staircase as small as this, the newel post can, if required, be pulled up using a clamp.

Figures 6.67, 6.68, and 6.69: Drive in the glued dowel and then cut flush with the newel post.



Figure 6.68 Cut the dowel flush with the newel post.



Figure 6.69 The outer string's shoulder has been pulled nicely up to the bottom newel post.

Figures 6.70, 6.71, and 6.72: The rear corner of tread number 1, which will be concealed within the newel post housing, will require easing. The bullnose

step can then be placed in the string housing before being offered into the newel post housing. Detailed guidance on the construction of this bullnose step can be found in chapter 10.

Figure 6.73: Insert riser number 2 and secure this and the bullnose step at the string with glue and wedges, and at the newel post with glue, screws, and angled glue blocks. Screw through riser number 2 into the back of bullnose tread number 1. A quick clean-up of the string easing, and this section of the staircase is complete.



Figure 6.72 The bullnose step dry-fitted into its housings.



Figure 6.70 Ease the rear corner of the bullnose tread to permit entry into the newel post housing.



Figure 6.73 Glue and screw angled blocks to the bottom newel post provide support for riser number 2 and the bullnose step.



Figure 6.71 Locate the bullnose step firstly in the housing of the inner return string and then into that of the bottom newel post.

Pre-fitting the winding steps before delivery

Most staircase manufacturers will claim that winding steps are always dry-fitted in the workshop prior to delivery; how many actually do so is questionable. I have worked at companies where the pre-fitting of winders was unthinkable – an unnecessary waste of time. And in truth, it didn't seem as though we were doing anything wrong, because with experience comes confidence: that the winders would fit was never in doubt. Nevertheless, the pre-fitting of winding steps is considered good practice and can be carried out as follows.

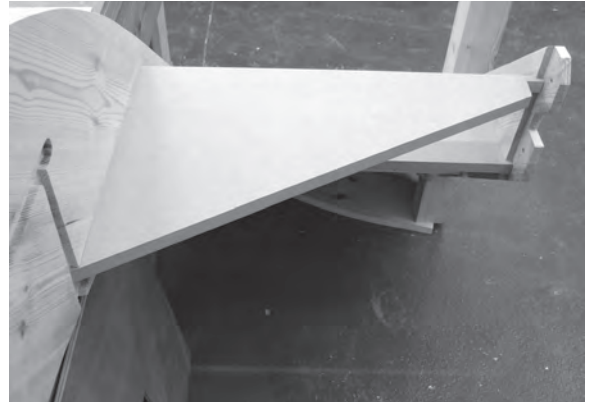


Figure 6.74 (above) and Figure 6.75 (below) The return flight is levelled and the intermediate newel post tested for fit.



Figure 6.78 With the intermediate newel post replaced, riser number 4 is pushed forward and then upwards into its housing in the underside of the square winder. A small notch cut in the bottom corner of the riser permits access.



Figure 6.76 (above) and Figure 6.77 (top right) The intermediate newel post is temporarily removed to allow access for tread number 4 – the square winder.

Figure 6.74 and 6.75: Level the staircase and test the fit of the intermediate newel post.

Figure 6.76 and 6.77: Remove and set aside the intermediate newel post. Square winder number 4 can now be installed.

Figure 6.78: Replace the intermediate newel post and fit riser number 4. The bottom corner of the riser is notched so that it can be pushed forward and then up into its housing in the underside of the tread.

Figure 6.79 and 6.80: Test the fit of riser number 5 which, for clarity, is shown here without the kite winder above it, by sliding it up into its housings. A wedge can



Figure 6.79 (above) and Figure 6.80 (below) Riser number 5 being lifted into its housings and held in place with a wedge. For clarity, the kite winder has been omitted.



Figure 6.81 The wide end of the kite winder meeting with the return string.



Figure 6.82 The narrow end of the kite winder meeting with the intermediate newel post.



Figure 6.83 The square and kite winders (numbers 4 and 5), together with their risers, are fitted as part of the return flight.

be used to secure it temporarily, before it is removed and set aside so that the kite winder can be fitted.

Figure 6.81, 6.82, and 6.83: Insert the kite winder, check for fit, and then reinstall the riser below it (number 5). The sixth step – the skew winder – is housed into the wall string which contains the steps of the longer straight section of the staircase.

On-site preparation prior to fixing

Once the staircase is in its intended location, the items delivered loose (so as not to restrict access) can be fixed, the first of which is the top newel post. After notching the newel to fit over the face of the landing joist (Figure 6.84) and with the staircase on its side – outer



Figure 6.84 The top newel post is notched to sit over the face of the landing joist.

string uppermost – apply PVA glue to the tenon and, using a rubber mallet, knock the newel post home (Figure 6.85). Pull the joint up by driving glued wooden dowel into pre-prepared holes in the newel post, offset from holes drilled through the string tenon (Figure 6.86).

The staircase's top step, comprising riser number 13 and the landing nosing, is now assembled and fixed in place. With no room for angled glue blocks (because the top step will sit against the upper floor's landing joist) a secure fixing to the main flight is essential. Glue the riser to the landing nosing (Figure 6.87) and insert the step into its housings. The step is fixed by screwing through the riser into the back of tread number 12 and screwing at an angle into the string on one side and the newel post on the other (Figure 6.88). The main flight is now ready to be lifted into place.



Figure 6.85 Timber bruising is avoided by using a rubber mallet to tap the newel post home.



Figure 6.87 The top riser (number 13) is glued to the underside of the landing nosing.



Figure 6.86 Draw-bore dowelling pulls the joint up tight.



Figure 6.88 The assembled top step is placed into its housings and screwed, on one side, into the wall string and, on the other, into the top newel post. The riser is screwed to the back of tread number 12.



Figure 6.89 The top newel post is hooked securely over the landing joist.



Figure 6.92 Check the flight for level.



Figure 6.90 The main flight in position and temporarily supported at its lower end with props.



Figure 6.91 Use a storey rod to confirm that tread number seven is at the correct height.

Final installation

Once the main flight has been hooked over and firmly located on the landing joist (Figure 6.89), it can be temporarily secured with props (Figure 6.90), and then checked for correct height and level (Figures 6.91 and 6.92). The presence of a return wall, against which the long wall string will abut, will prevent the flight from sliding forwards.

The next task is to glue and dowel the intermediate newel post to the tenon on the lower end of the main flight's outer string. The handrail for this section of flight should, at the same time, be fixed by means of mortise and tenon joints between the top and intermediate newel posts (Figure 6.93). With the string and handrail



Figure 6.93 The intermediate newel post is mortised to receive the main flight's outer string and handrail.



Figure 6.94 Check the intermediate newel post for plumb.



Figure 6.95 With the lower end of the main flight pulled clear of the wall, the strings are dry-fixed together, connecting the main and return flights.

shoulders fully up in their mortises the intermediate newel post can be checked for plumb (Figure 6.94).

The lower end of the main flight now needs to be pulled temporarily clear of the wall to provide access for connecting the shorter return flight (Figure 6.95). The return string is tongued into the stopped housing joint in the wall string and, at this stage, dry-fixed only with 5.5 x 75 mm wood screws (3 inch 12s). The outer string of the return flight is glued and tenoned into the intermediate newel post and handrail fixed between the bottom and intermediate newel posts (Figure 6.96).



Figure 6.97 Riser number 4 is installed.



Figure 6.96 The main and return flights are now joined. Only the first of the three tapered treads – the square winder, which must be positioned ahead of the intermediate newel post – is in place at this stage.



Figure 6.98 The wall and return strings are temporarily separated, providing access for locating kite winder number 5 and its return-string wedge.



Figure 6.99 With the kite winder and riser number 5 fixed in place, skew winder (number 6) is inserted into its housings.



Figure 6.101 All three winding steps are now complete, and so with the exception of balusters and newel caps, the staircase is complete.



Figure 6.100 With the skew winder and riser number 6 now fixed our last remaining gap is for the first straight riser of the main flight, riser number 7.

Just prior to the final fixing of the staircase the winding steps are installed, which, if pre-fitted in the workshop, is a straightforward task. Start at the bottom and work upwards. The lowest of the winding treads – square winder number four – is already in place because this has to be fitted ahead of the intermediate newel post (Figure 6.96). Continue by slotting riser number four into its housings in the return wall string

and intermediate newel post and up into the groove in the underside of the square winder (Figure 6.97). Next comes the kite winder (and its riser) and the reason why we haven't yet glued the wall and return strings together: the two will need to be temporarily separated to allow access for this large winding tread (Figure 6.98). Wedging beneath the kite winder in the corner of the staircase is not easy, so advantage should be taken of this brief separation of the two strings to drive in the first of the kite winder's two wedges, joining it to the return string. Re-fix the two strings, this time with glue as well as screws (Figure 6.95). Now the staircase can now be pushed back against the wall, re-checked for level, and fixed as described in chapter five, before inserting the skew winder (Figure 6.99), and finally risers number 6 and 7 immediately below and above the skew winder (Figure 6.100).

When all of the winding steps are in place they should be glued and wedged on the inner (wall) side of the staircase and screwed to the intermediate newel post on the outer side. Screw through the lower part of each riser into the back of each preceding tread at centres not exceeding 230 mm, and then apply angled glue blocks to the underside of each step at equidistant spacings of not less than 150 mm.

Figure 6.101 shows the finished staircase.

7

Dogleg Stairs with Half-Turn Landing

Much like the staircase with quarter landing seen in chapter 5, a dogleg staircase is simply two short, straight flights connected by an intermediate landing (and newel post), the difference being a quarter landing turns 90° while the half landing of a dogleg staircase turns 180°. The choice between the two would be determined by the space available and the arrangement of surrounding walls.

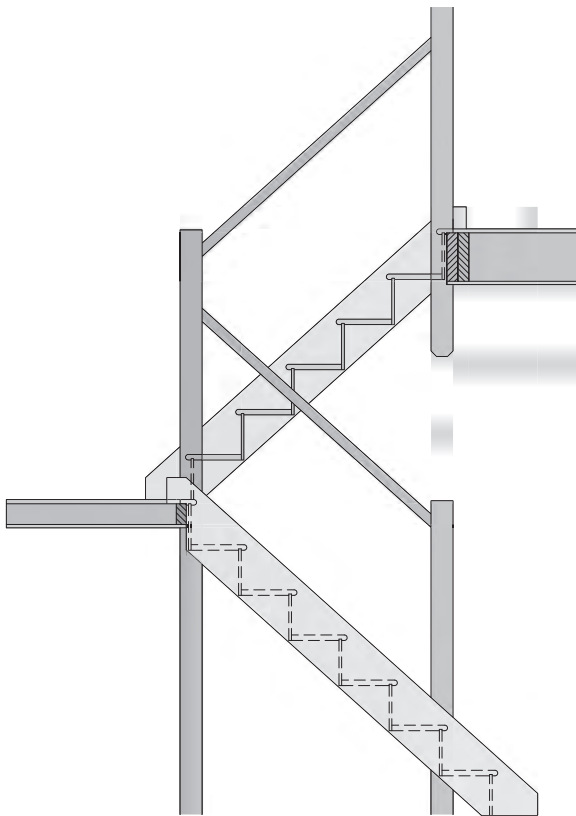


Figure 7.1 The reason for a dogleg staircase's name is clear when it is viewed from the side.

A dogleg staircase takes its name from its sectional resemblance to a dog's hind leg (Figure 7.1), and shares many of the benefits of a staircase with quarter landing: it can be considered where available space won't permit the installation of a straight-flight staircase; privacy is afforded to occupants because the view to the upper floor is inhibited by the layout of the staircase; the presence of the landing not only provides

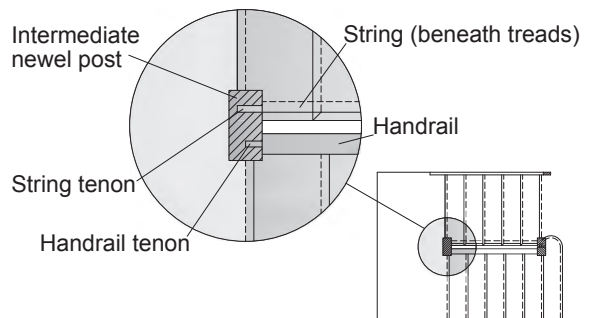


Figure 7.2 Plan view of the wide intermediate newel post.

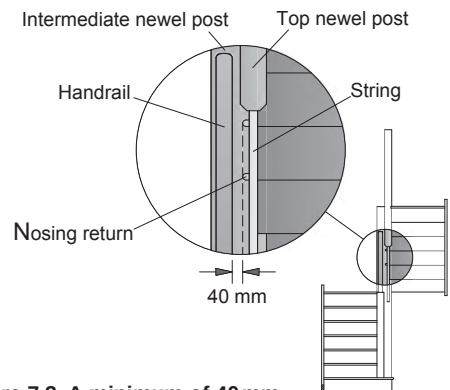


Figure 7.3 A minimum of 40 mm handrail finger room should be provided.

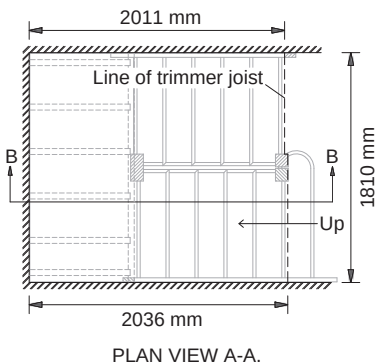
the opportunity of a rest for those who need it, but also reduces the likelihood of serious injury should an accident happen. And the visual appeal of the landing can be further enhanced with the addition of some wall-mounted pictures or, in the right location, a window.

There are two significant differences between a dogleg and a quarter landing staircase. The first is the intermediate newel post where, on a dogleg staircase, it is widened considerably to accommodate the tensions of the outer strings of both flights and those of the handrails of both flights (Figure 7.2). The second difference is, perhaps, even more important because it concerns the question of handrail finger room. There will be a point on the lower section of a dogleg staircase where the fingers of a person grasping the handrail will come very close to the outside of the opposite flight. It is generally recommended that a minimum clearance of 40 mm (1½") is provided to ensure comfortable use of the handrail (Figure 7.3).

Stairwell dimensions

The dogleg staircase that we will be building will have closed inner (wall) strings and open outer strings, and will be built to fit a stairwell with the following dimensions, as illustrated in Figure 7.4:

- Finished floor to finished floor rise: 2665 mm
- Length of stairwell opening: 2011 mm
- Width of stairwell opening: 1810 mm



- Finished floor to underside of ceiling height: 2412 mm
- Horizontal distance from middle wall to bevelled trimmer joist: 2036 mm

Staircase dimensions

As shown in Figure 7.5, our dogleg staircase will have 13 steps, each with a rise of 205 mm and a going of 228 mm; headroom will be a more than adequate 2023 mm. Please see chapter 5, and the calculations for the staircase with quarter landing, for detailed information on how these dimensions are worked out.

The overall width of the staircase will be 1800 mm which, at 10 mm less than the width of the stairwell opening, provides 5 mm tolerance each side. Clearly, this doesn't mean that the width overall the strings of each of the two straight sections will be 900 mm, because this would not allow for the handrail finger room discussed earlier. In order to achieve the required 40 mm of finger room, the clear distance between flights of a closed-string staircase should, dependent on handrail width, be around 55 mm. A further 25 mm should be added for an open-string staircase to allow for the nosing returns. Therefore, the width overall the strings of each of the two straight sections of the staircase will be 860 mm:

$$1800 - 80 = 1720 \text{ mm} \quad 1720 \div 2 = 860 \text{ mm}$$

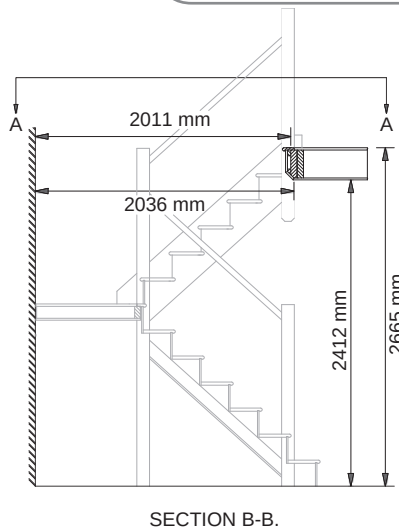


Figure 7.4 Site dimensions with proposed staircase indicated.

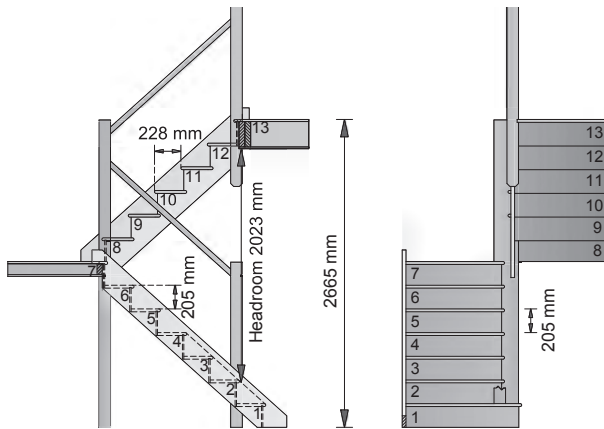
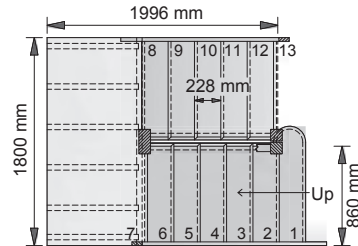


Figure 7.5 The planned dogleg staircase.



The cutting list for our dogleg staircase (excluding hand-rail and balustrade) is as follows.

Cutting list

No.	Member	Length	Width	Thickness	Material
1	lower wall string	2500	245	32	European Redwood
1	upper wall string	2200	245	32	European Redwood
2	outer strings	1900	270	32	European Redwood
1	intermediate newel post	2700	212	100	European Redwood
1	top newel post	1750	100	100	European Redwood
1	bottom newel post	1500	100	100	European Redwood
1	starting tread	1060	284	25	European Redwood
10	treads	900	259	25	European Redwood
2	landings nosings	825	75	25	European Redwood
10	nosing returns	285	50	25	European Redwood
12	risers	880	211	12	Far Eastern plywood
1	riser (D-step)	1500	186	12	Far Eastern plywood

All dimensions in millimetres.

Preparing the straight flights

The preparation of the two straight flights is explained in detail in chapter 5. Briefly though, once gluing up and re-planing has been carried out on the strings, treads, and newel posts, the first task is to mark the strings as handed pairs. Figure 7.6 shows, in the background, a marked wall string and, in the foreground, an outer string with the triangular waste portions being marked for removal. And in Figure 7.7 the marked strings are ready for routing and cutting.



Figure 7.6 The triangular waste portions of the outer strings are shaded to indicate their removal.

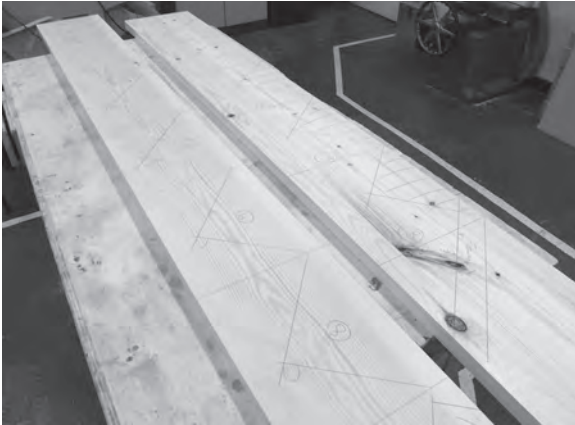


Figure 7.7 The marked strings of the upper flight.



Figure 7.8 With practice, a hand-held circular saw can be used to accurately cut an open string without the need for a straight edge.

The two outer strings are cut using a hand-held circular saw. A straight edge clamped to the string ensures accuracy (Figure 5.13), but with experience the straight edge can be dispensed with, speeding up the operation (Figure 7.8). In any case, care should be taken to avoid cutting beyond the intersecting lines so that the triangular waste pieces remain until being removed with a hand saw (Figure 5.15). Next, the outer strings' riser lines are mitred and then tenons are routed at each end so that the strings can be joined to the newel posts.

The treads will be housed within the wall strings on the left-hand side and fixed to the cut and mitred

strings on the right where, without the addition of mitred nosing returns, unsightly end grain would be in full view. The four cuts required to accurately cut and mitre nosing returns using a band saw (Figure 5.33) are described and demonstrated in chapter 5, while an alternative method is shown in chapter 10.

Preparing the newel posts

The newel post centres of an open-string staircase should align with the balustrade centre line and not necessarily the centres of the strings (see chapter 11); in this case, though, the strings and the future balusters are the same thickness (32 mm), meaning that the balustrade centre line and string centres are the same. The bottom and top newel posts will finish at 100 mm × 100 mm and can be seen marked out in Figures 5.24a and 5.24c. As the intermediate newel post provides support to both straight flights it should be wide enough to accommodate both outer strings and both handrails, and provide sufficient finger room. A finished width of 212 mm will meet these requirements; the depth will remain 100 mm.

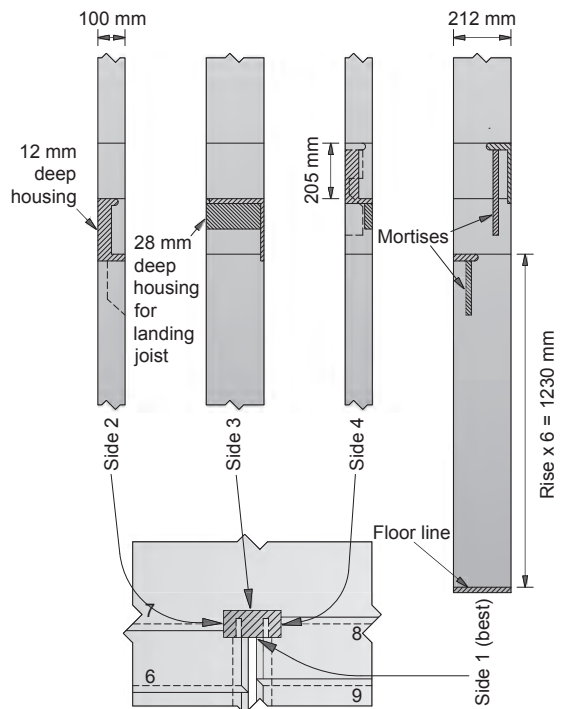


Figure 7.9 Marking out the intermediate newel post.

The intermediate newel post should be marked out and routed as shown in Figure 7.9. It will also require mortising to receive the outer strings and handrail tenons of both flights, but at 212mm wide not all mortising machines will accommodate the newel – I had to remove the machine's clamp and replace it with two F-clamps (Figure 7.10). The four sides of the finished intermediate newel post can be seen in Figures 7.11 to 7.14.



Figure 7.10 The wide intermediate newel post is held against the mortiser's fence with two F-clamps.

Staircase assembly

The assembly process for open-string stairs can be followed step by step in chapter 5 during the building of an L-shaped staircase with quarter landing. The following is a brief overview, with alternative techniques to those demonstrated in chapter 5 highlighted.

Preparations start with the laying of a protective board, of similar length to the wall string, on a pair



Figure 7.11, Figure 7.12, Figure 7.13, Figure 7.14 The four sides of the finished intermediate newel post.

of trestles. Face up on the protective board should be laid the free-of-dust wall string, but before that, and in a change from the method shown in chapter 5, the cut and mitred string can be prepared for fixing the treads. Any method used to fix treads to an open string will require a plan for concealing the screws. In chapter 5 the problem was solved by hiding the screw heads beneath timber pellets; in chapter 8 the screws are located in holes that will subsequently house the baluster dowels. Here we are going to pocket-screw through the open string into the underside of the treads.



Figure 7.17 F-clamps hold the steps perpendicular to the wall string.



Figure 7.15 Pocket-screwing from beneath the treads means that all fixings are hidden.

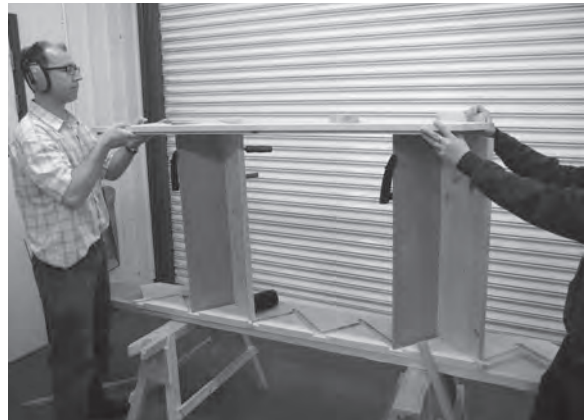


Figure 7.18 The outer (cut and mitred) string is lifted into position.



Figure 7.16 Two end steps are located within their wall-string housings and loose wedged.



Figure 7.19 The outer string is pocket-screwed into the underside of the treads.



Figure 7.20 The mitred ends of the risers are glued and nailed to the outer string.

Countersunk clearance holes (two per tread) are drilled through the inside of the cut and mitred string at a sufficiently low angle for the holes to emerge at the tread seating (Figure 7.15). The outer string can now be set aside while work continues with the locating of two tread and riser combinations, one at each end of the wall string, upon which the cut and mitred string can be laid (Figure 7.16). The treads and risers are loose-wedged and held perpendicular to the wall string with F-clamps (Figure 7.17). Glue is applied to the corresponding steps of the cut and mitred string and, with the help of a second person, it is lifted into place on the mitred ends of the two risers and held in place with two more F-clamps (Figure 7.18). The string is then pocket-screwed through the pre-prepared holes into the underside of the treads using 5 mm screws (size 10s) of an appropriate length (Figure 7.19), and the risers nailed to the string (Figure 7.20).

Pocket screwing from beneath the treads is an undeniably effective way of concealing the fixings; it does, though, come at a cost. A basic rule of screw-fixing is that for maximum strength the thinner of the two materials should be screwed to the thicker, and not vice versa. In screwing through the string's depth into the tread's thickness we have broken this rule, resulting in a weaker fixing than would otherwise have

been achieved by screwing through the tread into the string.

All clamps are now removed, and steps between the two fixed ends installed – risers first, followed by treads (Figure 7.21). The steps are glued and fixed to the cut and mitred string (Figure 7.22) and then all are glued and wedged to the wall string (Figure 7.23). The flight is finished by screwing through each riser into the preceding tread and by applying glue blocks beneath the steps (Figure 7.24). The first flight can now be set aside while work continues on the second.



Figure 7.21 The remaining risers and treads are installed.



Figure 7.22 Apply glue generously before fixing the treads and risers.



Figure 7.23 Glue and wedge the treads and risers to the wall string.



Figure 7.25 The half landing.



Figure 7.24 Apply glue blocks beneath the steps and where the treads and risers meet the outer string.



Figure 7.26 (above) and Figure 7.27 (below) The half landing's trimmer joist is screwed to the notched intermediate newel post.

Half landing

A half landing, sometimes referred to as a half-space landing, is made up of a trimmer joist which (usually) spans between two walls (Figure 7.25). Although longer than a quarter landing, the trimmer joist is supported mid-span by the intermediate newel post, allowing its depth to be kept to a reasonable size (Figures 7.26 and 7.27). Trimmed joists extend from the facing wall across the width of the landing and bear against the trimmer joist.

Final installation

Once in its intended location, the flights' final components – the bottom and top newel posts, the starting



D-step, and the landing nosing and top riser – can be fixed, making the staircase ready for installation.

Installation will take place, as is usually the case, from the top down, and ahead of the half landing's construction. The upper flight is hooked over the upper-floor landing joist, levelled, and supported at its lower end on temporary props (Figure 5.74). The wide intermediate newel post is then fixed by mortise and tenon to the outer (cut and mitred) string and to the handrail running between it and the top newel post. The flight is then checked for plumb by placing a spirit level against two sides of the intermediate newel post before being fixed permanently to the wall and to the upper-floor landing joist. At this stage the props can be removed and the half landing constructed.

In new-build construction it is not unusual for the site carpenters to install the half landing before fixing the staircase. During what is known in the trade as 'house-bashing' (owing to the speed at which the tradespeople, on price work, enter the building, carry out the work, and then move on to the next property), the fixing of the upper floor's trimmed joists is delayed

while the stairs are installed. The exclusion of the trimmed joists allows the trimmer joist, which spans between two steel I-beams, to be pushed back while the upper flight is positioned before being slid back firmly against the top newel post. The trimmed joists are then installed keeping everything in place.

Before the lower flight is positioned and while there is still good access, the half landing can be decked. The lower flight is then offered up against the half landing's trimmer joist, and its outer string tenon located in the corresponding mortise of the intermediate newel post. Before pushing the flight fully home, the landing nosing and top riser are located between the wall string and intermediate newel post and the handrail glued and positioned for permanent fixing. The flight can now be brought up firmly against the half landing, checked for level and proper seating, and then fixed as described earlier.

The view of the finished staircase in Figure 7.28 shows clearly why it is named 'dogleg'. And although not ready for use until balusters have been installed, our setting out has produced the necessary finger room (Figure 7.29).



Figure 7.29 (above) Adequate finger room ensures comfortable use of the handrail.

Figure 7.28 (left) The finished dogleg staircase in the workshop, with typical safety banner.

8

Circular Stairs

Demand for circular stairs in some parts of the world, notably the United States and Canada, is huge; less so in the UK, possibly because houses here – and, in particular, new houses – tend to be smaller. Not to be confused with a spiral staircase, which saves space by turning tightly around a central column, a sweeping circular staircase turns around a central void and can take up a lot of room, particularly above the stairs where a sizeable space is essential to provide adequate headroom. Sometimes called ‘curved’ or ‘helical’ stairs, a circular staircase can be a beautiful and elegant focal point for the home – its visual impact in an entrance hall immense, adding character and value to a property.

Building Regulations

Reference to helical stairs in Approved Document K is limited to directing the reader to the relevant British Standard, BS 5395-2:1984 Stairs, ladders and walkways – Part 2: Code of practice for the design of helical and spiral stairs, which provides guidance on the design, construction, and dimensions of such stairs. Approved Document K can, however, be used to satisfy the functional requirements of the Building Regulations because, in defining a tapered tread as ‘a step in which the going reduces from one side to the other’, the document’s specification is the same for both circular stairs and stairs containing kites and winders (chapter 6).

For the staircase that we will be building in this chapter, Approved Document K’s most important clause (1.27 on page 11) states, ‘If a stair consists of straight and tapered treads, ensure that the going of the tapered treads [measured in the centre] is not less than the going of the straight treads’ (Figure 6.3).

Staircase design and dimensions

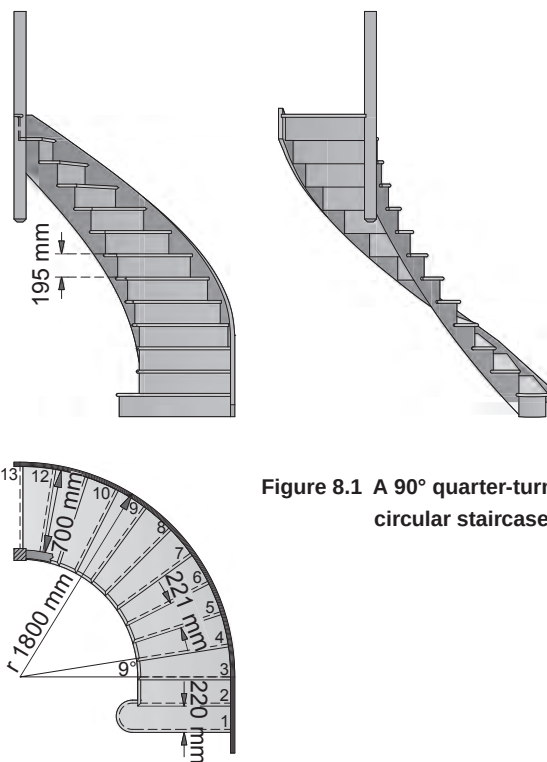


Figure 8.1 A 90° quarter-turn circular staircase.

The design of this chapter’s circular staircase is based upon a style often built for higher-end new homes in North America. The first two steps will be straight, starting with a left-hand curtail step, and leading to a series of tapered treads turning the stairs through a 90° quarter-turn (a half-turn circular staircase is known as a ‘one-eighty’). The staircase will be supported by a wall on the right-hand side; the wall string will be closed and the opposite string open, or ‘cut and mitred’. The

A curtail step, rather like the D-step seen in chapter 5, is a rounded starting step which projects beyond the face of the string. Where it differs from a D-step is in the rounding which, on a curtail step, corresponds to the rounded terminal – known as a 'volute' – of the handrail above. The projection of both step types is the widest part of the flight, an important consideration when incorporating either into a staircase design (see figure 10.1).

open side of the staircase will require guarding and a single newel post at the top of the flight reflects an alternative approach to that seen in previous chapters and is explained fully in chapter 11. The following dimensions are illustrated in Figure 8.1:

- Rise: 195 mm
- Going (of straight treads): 220 mm
- Going (of tapered treads): 221 mm
- Angle of tapered treads: 9°
- Turn of stairs: 90° left-hand
- Clear width: 700 mm
- Outside radius: 1800 mm

Clause 1.27 of Approved Document K is satisfied because the going of our tapered treads is not less than that of the two straight treads. 'Clear width' is defined by BS 5395-2 as, 'the unobstructed walking area throughout the stair's rise', which, on our staircase, is measured radially from the inside edge of the handrail to the inside edge of the wall string.

The 25 mm-thick treads and 100-mm square newel post will be made from European Redwood. The risers will be cut from 12 mm thick Far Eastern plywood, and the circular strings laminated from four layers of 8 mm thick flexible plywood (flexi ply) plus one layer of 3.6 mm facing plywood, making a total string thickness of 35.6 mm:

$$(4 \times 8) + 3.6 = 35.6 \text{ mm}$$

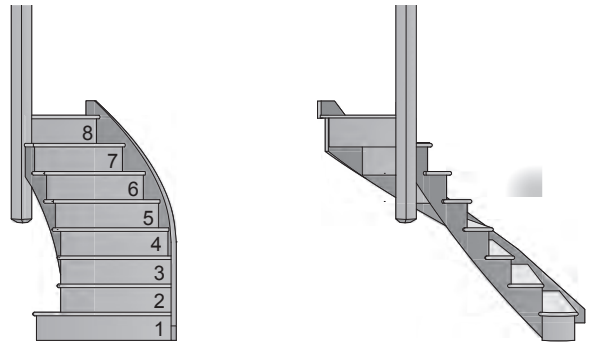
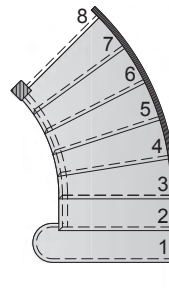


Figure 8.2 Eight-rise circular staircase turning through 45°.



Throughout this chapter, certain aspects of the design and construction of the circular staircase take account of the future guarding of the staircase, which is described and demonstrated in chapter 11.

Conscious of the cost of these materials and with workshop space limited, for demonstration purposes I will be reducing the staircase to eight steps turning through 45° as shown in Figure 8.2 (all other details remain unaltered).

Setting out

The footprint of our eight-rise circular staircase, with an outside radius of 1800 mm, will fit on a single sheet of plywood. And it is on a sheet of plywood that a full-size plan of the staircase is set out (Figures 8.3 and 8.4). Working on the right-hand side of the board (to allow room for the left-hand sweep), the starting point is to set out the first two straight treads with a going of 220 mm, and the overall width of the stairs, which



Figure 8.3 A full-size plan of the staircase can be set out on plywood, MDF, or chipboard.

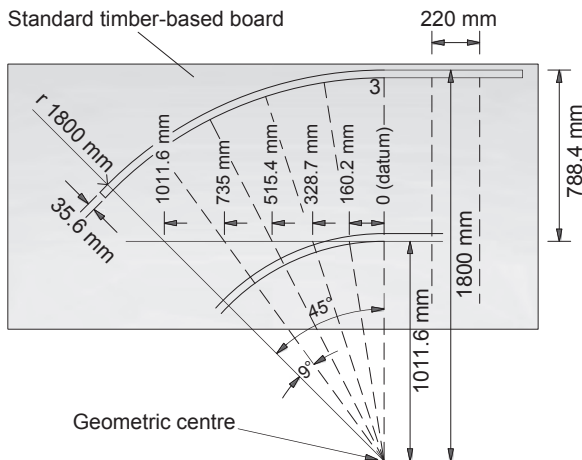


Figure 8.4 The five tapered treads radiate from the geometric centre of the stairs.

is a rather strange sounding 788.4mm, arrived at as follows:

- Clear width: 700 mm
- Handrail width $70 \text{ mm} \div 2$: 35 mm
- Cut string thickness $\div 2$: 17.8 mm
- Wall string thickness: 35.6 mm +
- Total: 788.4 mm

The inside radius is therefore:

$$1800 - 788.4 = 1011.6 \text{ mm}$$

The geometric centre of the staircase is on the line of riser number 3, 1800mm from the outside of the right-hand (wall) string, and 1011.6mm from the outside of the left-hand (open) string (Figure 8.4). The next five treads, each tapered at an angle of 9° , can be set out using trigonometry. Extend the (straight) line of the outside of the left-hand string and, using the point at which this line crosses the line of riser number 3 as a datum, measure and mark the following points, found by multiplying the inside radius (1011.6mm) by the tangent of 9° and then multiples of 9° :

	0 (datum at riser number 3)
$1011.6 \times 9 \tan =$	160.2 mm (second mark)
$1011.6 \times 18 \tan =$	328.7 mm (third mark)
$1011.6 \times 27 \tan =$	515.4 mm (fourth mark)
$1011.6 \times 36 \tan =$	735 mm (fifth mark)
$1011.6 \times 45 \tan =$	1011.6 mm (sixth mark)



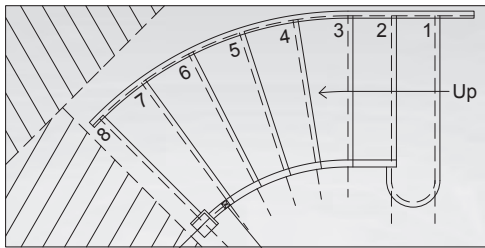
Figure 8.5 Having set out the tread positions, a straight edge, radiating from the geometric centre, is used to mark the riser lines.

Straight lines drawn from the geometric centre through the marked points will accurately set out the five tapered treads (Figure 8.5).

The two strings are straight until riser number 3, at which point the curve of the flight starts. Use trammel heads to draw four arcs – the first of which will have



Figure 8.6 Trammel heads clamped to a timber batten are perfect for setting out the circular strings.



Centre line of newel post and future 32 mm balusters (balustrade centre line)

Outside face of (future) baluster to be flush with outer face of string (see Figure 8.75)

Figure 8.7 The completed rod. Cutting the board to the marked lines and removing the waste area indicated will allow the rod to be positioned close to a wall.

a radius of 1800mm – to represent the two strings (Figure 8.6).

To complete the rod (Figure 8.7)...

Draw the 100mm × 100mm upper newel post, positioning it central to both the line of riser number 8 and future balusters (the balustrade centre line – see chapter 11) and also ensuring that it is true to the circle.

- Draw the left-hand curtain step at tread number 1.
- Draw lines 25mm in front of, and parallel to, each of the riser lines to represent the tread nosings.

- Use broken lines to represent the 12mm deep housings in the right-hand (wall) string and in the newel post.
- Number the steps.
- Indicate the direction of 'up'.

Our plywood rod will later be used as a base upon which the staircase will be built; trimming the board as indicated in Figure 8.7 will allow it to be fitted close to a wall and minimise the amount of floor space it takes up.

Circle geometry

The majority of dimensions needed to prepare a cutting list can be measured directly off the rod. Difficult to measure accurately, though, is the going at the wide side of each tapered tread and at the narrow side – information that will be essential not only to establish the number of sheets of flexi ply required but also later when marking up the strings.

Flexi ply, as the name suggests, is an extremely bendable sheet material used extensively in furniture making and shop fitting. It is available in a variety of sizes, including a standard 2440 × 1220mm, and thicknesses ranging from 3mm up to 16mm. There is also a very useful choice between long grain and cross grain (Figures 8.8 and 8.9).



Figure 8.8 Long grain flexi ply will be used for the shorter, open string.



Figure 8.9 Cross grain flexi ply will be used for the longer, wall string.

The two required goings of the tapered treads – one at the wide side where they meet with the right-hand (wall) string, and one at the narrow side where they meet with the left-hand (open) string – can, with care, be measured from the rod using a flexible steel rule. A more accurate and reliable method, though, is with the use of geometry:

The length of a circle's circumference can be found using the formula:

$$2\pi r \quad \text{where } r \text{ is the radius of the circle and } \pi \text{ is pi, approximately } 3.142$$

The radius of the circle at the wide side of the tapered treads is the difference between the staircase's outside radius and the wall string's thickness:

$$1800 - 35.6 = 1764.4 \text{ mm}$$

The circumference of the circle is therefore:

$$2\pi r = 2 \times 3.142 \times 1764.4 = 11087.5 \text{ mm}$$

The tapered treads' widest going can now be found by dividing the length of the circumference by the number of degrees in a circle, and then multiplying the answer by the treads' angle of taper:

$$11087.5 \div 360 \times 9 = 277.2 \text{ mm (Figure 8.10)}$$

The radius of the circle at the narrow side of the tapered treads is the sum of the staircase's inside radius and the open string's thickness:

$$1011.6 + 35.6 = 1047.2 \text{ mm}$$

The circumference of the circle is therefore:

$$2\pi r = 2 \times 3.142 \times 1047.2 = 6580.6 \text{ mm}$$

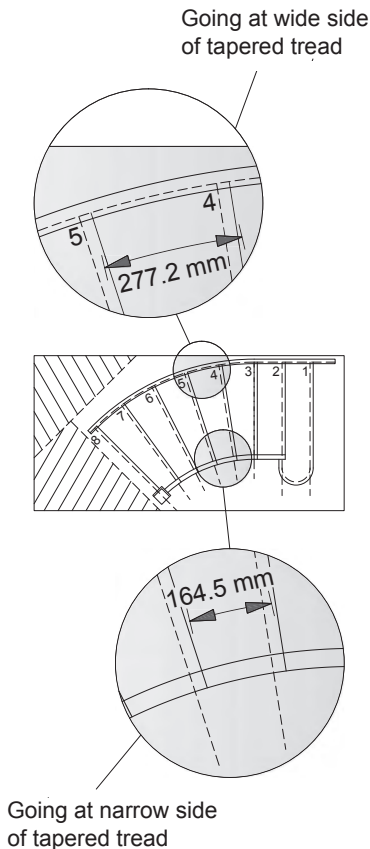


Figure 8.10 The goings at the wide sides and the narrow sides of the tapered treads.

And the going of the tapered treads at their narrow side is:

$$6580.6 \div 360 \times 9 = 164.5 \text{ mm (Figure 8.10)}$$

Developing the strings

Now that we know the depths of the tapered treads at their two opposite ends, the information can be used to develop the surfaces of the two strings in the form of scale drawings. Accurately produced scale drawings will allow us to better visualise the circular strings and also work out how many sheets of plywood will be required for their manufacture.

Two sheets of A4 paper are needed – one for each string. The left-hand (open) string will be drawn with the paper in portrait orientation and the right-hand (wall) string in landscape. And it is important to bear in mind that the views drawn will be of the inside surfaces of the two strings – the surfaces upon which the steps will later be marked. The scale used will be 1:10, convenient because, in the absence of a scale rule, measurements can very simply be divided by ten.

Figure 8.11a: Start by drawing faint parallel lines horizontally across each sheet of paper; the distance between each line should be 19.5mm (the rise of 195mm divided by ten). Next, using our going measurements calculated earlier, and remembering that the first two steps are straight, faint parallel lines are drawn vertically on the two sheets to represent the treads.

Figure 8.11b: Bold lines are added to the grids to represent the treads and risers, and the steps are numbered.

Figure 8.11c: Lastly the strings are drawn. The top of the wall string should be parallel to, and 6mm (60mm real-life measurement) above, imaginary lines connecting the tips of the treads (notice the slight change in direction at step number 3, where the straight section ends and the curved section begins – also visible in Figure 8.46). Allowing sufficient material for the change in direction and trimming up after laminating, the total string width should be around 36mm (360mm real-life measurement). And for the

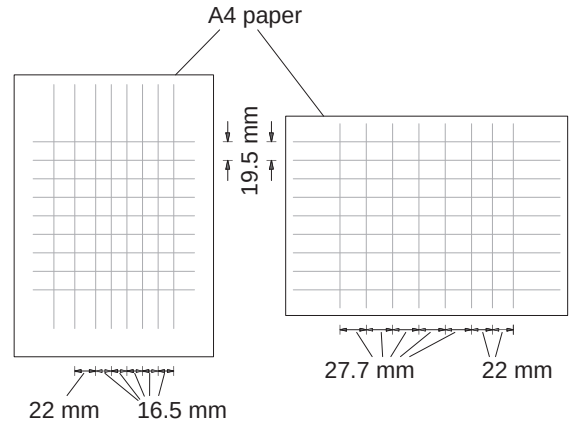


Figure 8.11a Faint grid lines representing the rise and going are drawn to a scale of 1:10 on A4 paper – the open string in portrait orientation on the left and the wall string in landscape on the right.

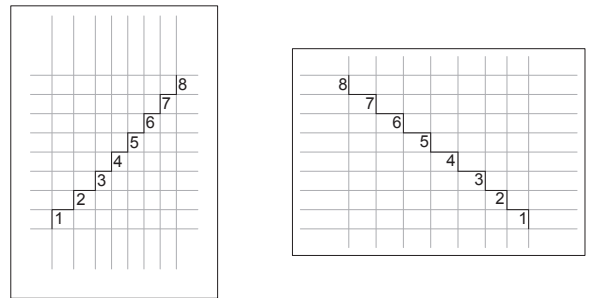


Figure 8.11b Numbered steps are indicated with bold lines.

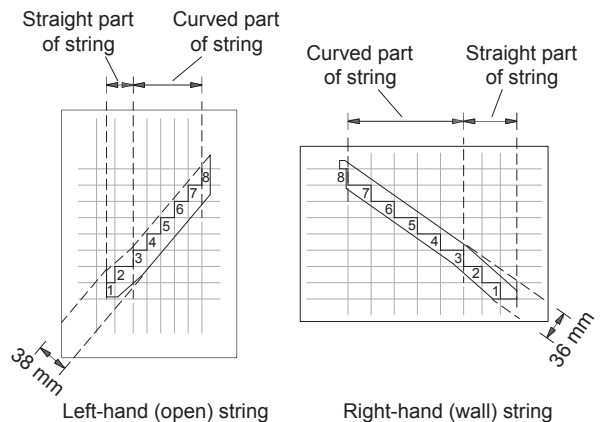


Figure 8.11c With the strings added to the drawings, the plywood requirements can now be determined.

open string, a similar change in direction, an allowance for trimming, plus a depth of around 150mm beneath each step adds up to a total string width of around 38mm (380mm real-life measurement).

Flexi ply requirements

A choice of long grain (column wrap) and cross grain (barrel wrap) flexi ply is available (Figures 8.8 and 8.9) and, as will be seen later (and as already indicated by our scale drawings), the left-hand (open) string will be best cut from long grain and the right-hand (wall) string from cross grain. Measuring from our scale drawings we can determine that the surface area of each string is:

- Right-hand (wall) string: $3.000\text{ m} \times 0.360\text{ m} = 1.080\text{ m}^2 \times 4\text{ layers} = 4.320\text{ m}^2$
- Left-hand (open) string: $2.440\text{ m} \times 0.380\text{ m} = 0.927\text{ m}^2 \times 4\text{ layers} = 3.708\text{ m}^2$

The surface area of a standard sheet of flexi ply is:

$$2.440\text{ m} \times 1.220\text{ m} = 2.977\text{ m}^2$$

Two sheets of long grain and two sheets of cross grain plywood will be sufficient for the two strings and includes an allowance for cutting and wastage.

Cutting list

The cutting list below is for our eight-rise circular staircase and, as usual, excludes handrail and balustrade.

Building a bending form

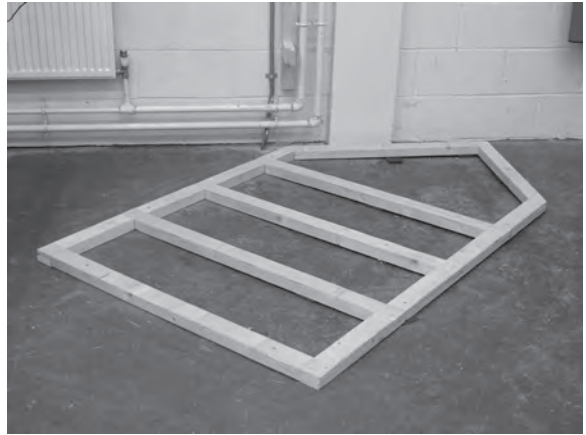


Figure 8.12 A timber frame is levelled and fixed to the concrete floor, forming a base for the bending form.

Cutting List

No.	Member	Length	Width	Thickness	Material
1	upper newel post	1850	100	100	European Redwood
3	panels (tapered treads)	850	520	25	European Redwood
1	starting tread	1000	275	25	European Redwood
1	second tread	800	250	25	European Redwood
3	nosing returns (cuts 6)	500	70	25	European Redwood
1	bullnose step	900	225	70	European Redwood
7	risers	800	201	12	Far Eastern plywood
1	riser (bullnose)	1300	176	12	Far Eastern plywood
1	string facing (open)	2440	380	3.6	long grain facing plywood
1	string facing (wall)	3000	360	3.6	long grain facing plywood
2	sheets for open string	2440	1220	8	long grain flexi ply
2	sheets for wall string	2440	1220	8	cross grain flexi ply

All dimensions in millimetres.



Figure 8.13 The plywood rod is screwed to the levelled frame, and wall studs are fixed plumb to the wall.

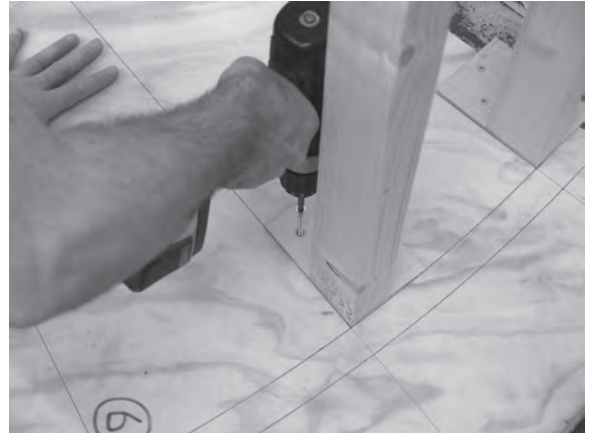


Figure 8.15 Each stud is fixed immediately behind a riser line and adjacent to the circular string.



Figure 8.14 Plywood fixing plates are glued and screwed to the undersides of the studs.



Figure 8.16 With the fixing of the studs, our work, which has so far been two-dimensional on a flat sheet of plywood, is now developing three-dimensionally.

A bending form is a structural skeleton constructed much like a curved stud wall, around which the strings will be bent and laminated. Our plywood rod will be used as a base for the structure and should be entirely level. The starting point, therefore, is to construct and fix a level framework to the floor (Figure 8.12), upon which the plywood rod will be laid and secured. Figure 8.13 shows a laser level being used to check that the wall studs are plumb.

The studs are fixed to the base using plywood plates which, having been glued and screwed to the underside of the studs (Figure 8.14), are then fixed to

the rod, one behind each riser line (Figures 8.15 and 8.16). Finally, the studs are plumbed and then braced for rigidity (Figure 8.17). In Figure 8.18 the tread heights are being marked on the studs using an accurately set out storey rod.

Marking out the wall string

Unlike the left-hand (open) string – which will be marked out while still fixed to the bending form – the right-hand (wall) string is marked out before laminating takes place. The inside surface of the wall string, upon



Figure 8.17 The studs must be perfectly plumb and stiffened with the use of bracing.



Figure 8.18 A storey rod is a straight length of timber marked with the tread heights and used here to transfer the heights onto the studs.



Figure 8.19 Plywood, which will form the faces of the strings, is ripped to width.

which the marking of the steps will be applied, is ripped to a width of 360mm from a sheet of 3.6mm-thick facing plywood (Figure 8.19). Our cutting list calls for a string length of 3000mm and, with a standard board length of 2440mm, jointing will be necessary.

Figure 8.20 shows the first of the two edges to be joined being cleaned, trued, and slightly undercut using a sanding block. The two edges are then butted tightly together and a very thin piece of plywood (say, 2mm thick) is glued to the rear of the string and then weighted for a few minutes while the glue goes off, providing support for the joint (Figures 8.21 and 8.22).



Figure 8.20 Use a sanding block to prepare the plywood for lengthening.



Figure 8.21 (above) and Figure 8.22 (below) The butt joint used to lengthen the facing plywood is supported by a thin, glued-on, plywood plate which is weighted while the glue dries.



Figure 8.23 Once the wall string has been fully laminated, the slight bulge caused by the lengthening joint will be unnoticeable.



Figure 8.24 The relatively large surface area of a wooden fence, when compared to the stair gauges' points of contact, makes it more suitable for marking the thin facing plywood.

A couple of things to mention about this joint: firstly, it is not particularly strong – but then it doesn't have to be, because the string has yet to be laminated with the four layers of flexi ply; secondly, the small bump beneath the surface of the string, caused by the 2mm plywood supporting the joint, will be virtually undetectable on the finished string (Figure 8.23).

If the marking of the string is to be carried out using a pitch board and margin template, two pitch boards will be required due to the change in going between the first two straight treads and the following five tapered treads. And that is one reason why I prefer to use an easily-adjusted steel roofing square, this time with a wooden fence rather than a pair of brass stair gauges (Figure 8.24).

Stand facing the top edge of the string (which at the moment is a thin strip of facing plywood) and mark the steps carefully as shown in Figure 8.25. It is good practice to arrange the steps so that the very tip of a step (in this case, number 7) falls where the plywood has been joined in its length, thereby minimising the part of the joint visible on the completed staircase (Figure 8.26).

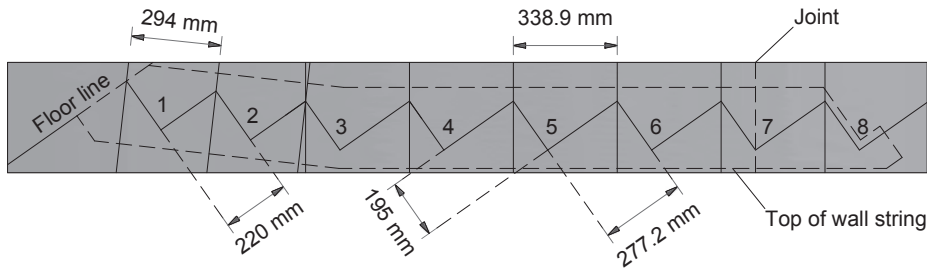


Figure 8.25 Careful positioning of the marked steps will minimise the visibility of the wall string's lengthening joint.

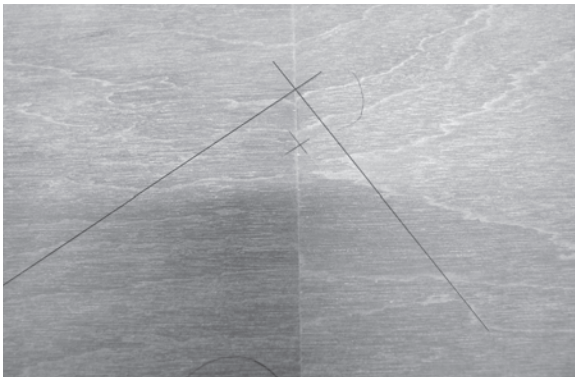


Figure 8.26 Joint lines should be as short as possible. Here, the majority of the line will be concealed beneath the step.



Figure 8.27 Plan to bend the flexi ply in the direction of its natural bow.

Marking and cutting the flexi ply

A seemingly obvious, yet none the less important fact to bear in mind is that flexi ply bends either along its length or across its width, depending on which orientation is chosen; it doesn't bend diagonally. When used for strings, therefore, flexi ply must be cut diagonally according to the stairs' angle of pitch, so that when bent around a form, its natural bend is entirely vertical.

If we were to lay a sheet of flexi ply on a workbench we would notice that it is not completely flat (Figure 8.27). We can take advantage of the board's tendency to bow one way or the other by ensuring that we work with the bow when bending it around the form. For the right-hand (wall) string we will use cross grain flexi ply and we will start with the first sheet laid on the bench with its natural bow upwards.

The first line marked on the flexi ply will be the angle at which we want to cut it – remember, the

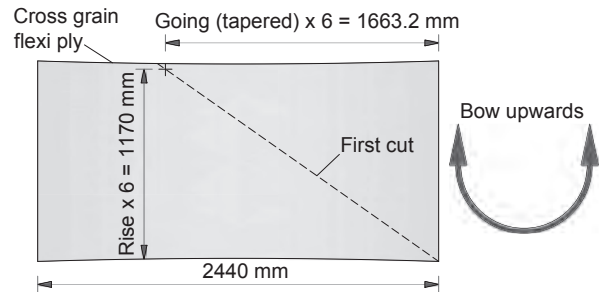


Figure 8.28 Setting out the cutting angle on a sheet of cross grain flexi ply for the wall string.

board's grain must be vertical when bent around the form. To find the correct angle, measure and mark a distance equal to the sum of six rises across the width of the board (Figure 8.28):

$$6 \times 195 = 1170 \text{ mm}$$

Then measure and mark a distance equal to the sum of six goings along the length of the board:

$$6 \times 277.2 = 1663.2 \text{ mm}$$

The going measurement that we are using is that of the tapered treads at their wide sides where they meet with the wall string. We can now use our marked facing plywood as a straight edge to draw repeated parallel lines on which we will cut using a hand-held circular saw (Figures 8.29, 8.30, and 8.31).

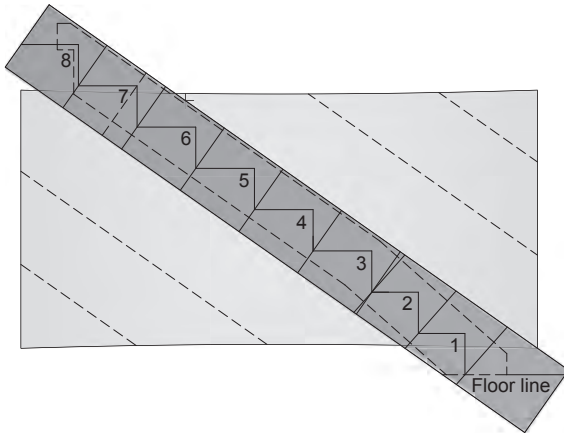


Figure 8.29 The flexi ply sections are marked to the correct width using the marked plywood that will be the face of the wall string.



Figure 8.30 The flexi ply is best marked using the facing plywood to draw a diagonal line equal to the stairs' angle of pitch followed by repeated parallel lines.



Figure 8.31 Use a hand-held circular saw to cut the flexi ply to width, taking care not to damage the work bench below.

Laminating the circular strings

Probably the most crucial part of the whole project, laminating the circular strings can be an awkward and messy task best undertaken using more than one pair of hands. However, before any gluing up is done, the first operation is to pin or staple the marked facing plywood to the studs of the bending form.

Cut the facing plywood at the marked floor line and then position carefully against the studs. Each marked riser line should coincide perfectly with the edge of the stud which is fixed vertically behind the line of the corresponding riser on the plywood rod (Figure 8.32).



Figure 8.32 Accurately aligned riser and tread lines indicate that the facing plywood is correctly positioned.



Figure 8.33 This close-up shows perfect alignment between the marked facing plywood and the stud at tread number 8.



Figure 8.35 PVA glue dries quickly, especially in warm weather – so work quickly!



Figure 8.34 A gentle, sweeping curve must be maintained as the facing plywood is bent round the form. Pinning close to the facing plywood's edges will mean less damage later during its removal from the studs.

And the facing plywood's horizontal tread lines should meet with the corresponding tread-height lines on the studs, marked earlier using a storey rod (Figure 8.33). Pin or staple the facing plywood to the studs ensuring that the fixings are close to the edge of the plywood (Figure 8.34). With the facing plywood forming a sweeping curve around the bending form we are ready to start laminating.



Figure 8.36 Lay down newspaper to catch the glue drips as the flexi ply is clamped in place.



Figure 8.37 During clamping, ease the flexi ply round the form to maintain the string's sweeping curve.

Once the gluing process has started, it is important to work speedily. So first arrange the lengths of flexi ply in the order that they are to be offered to the form. And then, taking one piece at a time, generously apply PVA adhesive (Figure 8.35) and clamp to the studs with the glued surface against the back of the facing plywood (Figure 8.36). Continue working swiftly throughout the string's length, ensuring that a gentle, sweeping curve is maintained as each section of flexi ply is applied (Figure 8.37).

Clearly, the lengths of the flexi ply are limited by the size of the sheet from which they are cut. To form an entire stair string, the flexi ply is lengthened by overlapping the sections as they are laminated to form 'finger joints' (Figure 8.38). Gaps between the layers are eliminated by clamping against timber blocks positioned between each stud (Figure 8.39). Similarly, lengths of timber are clamped at the bottom to maintain the straightness of the part of the string which will house step numbers 1 and 2 (Figure 8.40). The finished string should be left in clamps for 48 hours (Figure 8.41).

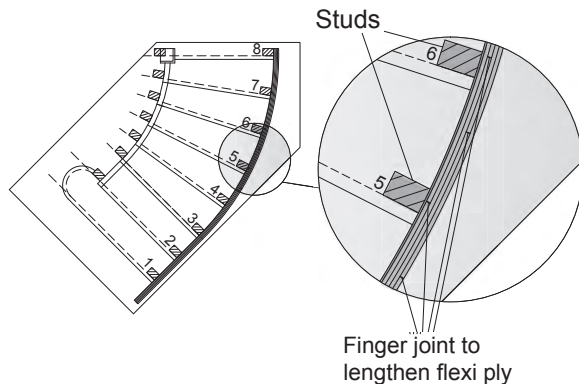


Figure 8.38 The string is lengthened with the use of finger joints, which should overlap by a distance approximately equal to the string's width.

As can be seen, it takes many, many clamps to make a circular staircase – up to 100 per string. It might therefore be necessary to wait until the first string can be removed from the bending form before starting the second. After removing the clamps, the string can be prized gently away from the studs



Figure 8.39 Clamping against wooden blocks between studs ensures that good contact is made between the layers, and that gaps are avoided.

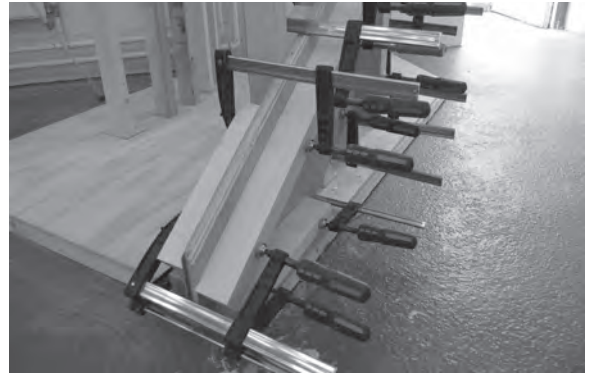


Figure 8.40 Short timber lengths are used to keep the lower part of the string straight while the glue dries.

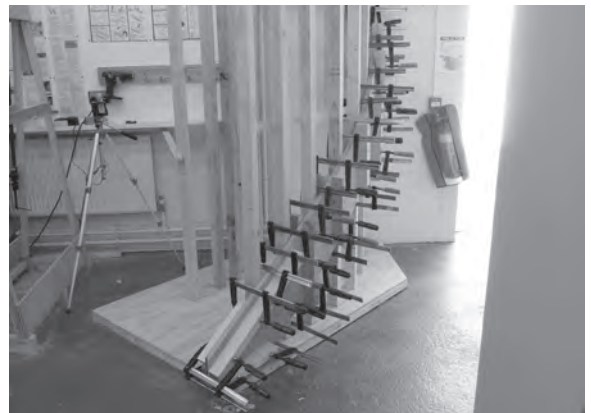


Figure 8.41 The fully clamped string should now be left to dry for at least 48 hours.



Figure 8.42 The wall string is carefully removed from the form.



Figure 8.44 Use a straight-edge to mark the waste part of the string.

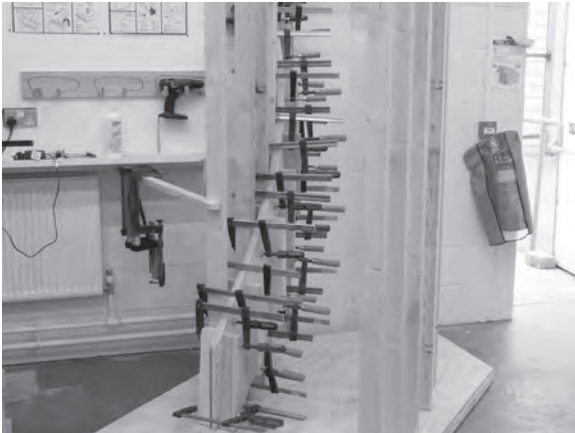


Figure 8.43 The shorter, yet more tightly radiused, left-hand string is glued and clamped.

(Figure 8.42). In doing this, some damage may occur to the edges of the string where it was fixed to the studs. Provided the pins or staples were placed close to the string's edges, the damaged areas will be removed when trimming the string prior to routing. With the supply of clamps replenished, the left-hand (open) string can be glued up (Figure 8.43).

Trimming and routing the wall string

Before the routing of the step housings can commence, the wall string must be trimmed accurately to width. Clamp the string securely to a pair of trestles, and

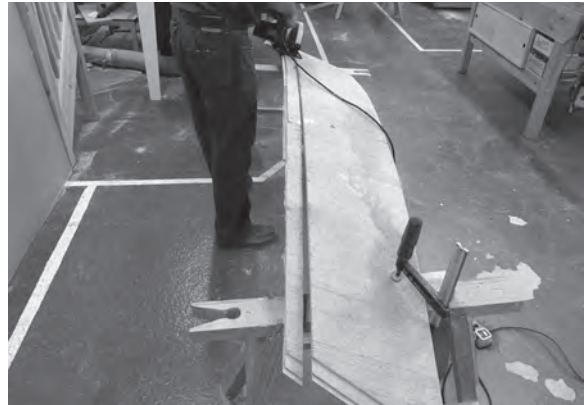


Figure 8.45 The waste is removed with a hand-held circular saw.

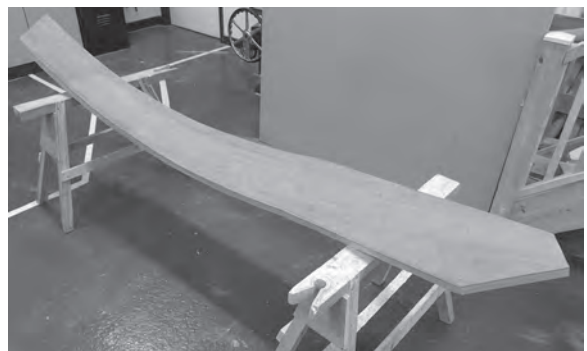


Figure 8.46 The steps of the neatly trimmed wall string are ready for routing. The noticeable change in direction at the string's top edge marks the point, at step number 3, where the straight section of the string meets with the curved section.

then use a straight, thin, flexible length of timber to mark where the string has to be cut (Figure 8.44). Trimming can then be done in one of two ways: either with a hand-held circular saw (Figure 8.45), or with a router running against a straight edge. For the latter, it might be necessary to pin the straight edge to the string, in which case the pins should be positioned beneath the marked triangles of the steps so that the resulting holes will be removed during the routing of the housings. Figure 8.46 shows the wall string marked, trimmed, and ready for routing.

The concave surface of the wall string will require the use of a flexible router jig; what better to use then, than an offcut of flexi ply (Figure 8.47). The flat bottom of the router could be adapted to suit the concave string with a shop-made convex-shaped base – beneficial if routing the tight radius of a spiral stair string, but for the relatively gentle curve of our circular staircase, not essential. However, as a safeguard against any slight variations in the housing depths, caused by the flat base of the router running against the concave surface of the string, we will be using a 12mm straight fluted cutter rather than a dovetail cutter (Figures 3.14 and 3.15). As usual, rout from left to right and use infill pieces to protect against rounding beneath the nosings where they will meet with the risers (Figures 8.47, 8.48, and 8.49).



Figure 8.47 A router jig, made from an offcut of flexi ply, is firmly secured to the concave surface of the wall string.

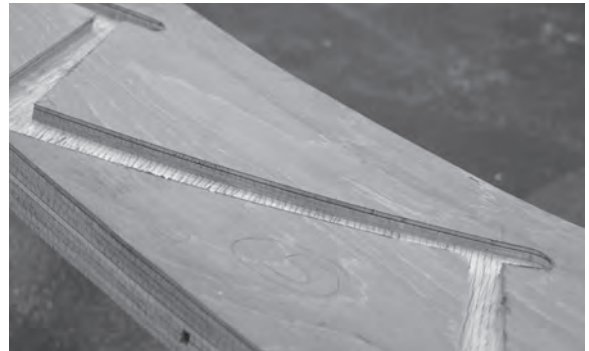


Figure 8.48 Routing in the correct direction (from left to right), and using nosing and riser infills, produces sharp and neatly cut edges.

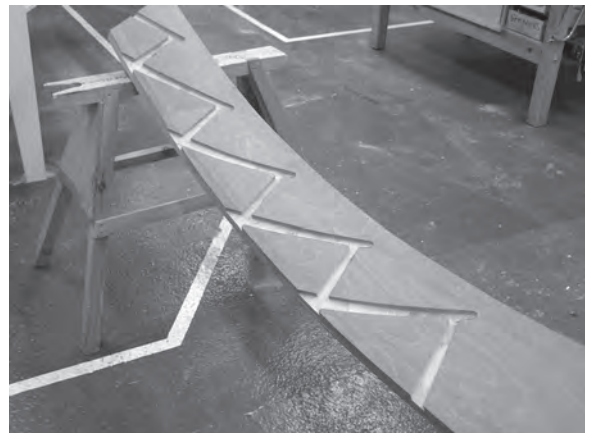


Figure 8.49 As work progresses towards the right-hand end of the string, the routing of the steps nears completion.

Marking out the open string

The marking out of the left-hand (open) string is carried out while it is still fixed to the form, and takes place on the inside (flexi ply) surface, not the outside (facing plywood) surface. Once the glue has dried and the clamps have been removed, the starting point is to mark the riser lines by plumbing up from the corresponding lines on the plywood rod. This can be done with a spirit level (Figures 8.50 and 8.51), or with a laser level (Figures 8.52 and 8.53). Check for accuracy by measuring between riser lines (Figure 8.54).



Figure 8.50 (above) and Figure 8.51 (below) Riser lines are transferred from the rod to the open string by plumbing up using a spirit level.



Figure 8.54 As the riser lines are marked on the string, the accuracy of the goings should be checked regularly.



Figure 8.52 (above) and Figure 8.53 (top right)
A laser level allows the accurate transfer of riser lines from the rod to the open string.

Next, the tread heights are marked on the string, using a storey rod (Figure 8.55). The important thing to remember here is that, being a cut string, the required marks represent the undersides, not the tops of the treads, and are therefore 25mm lower than the corresponding marks on the opposite (wall) string; this is most apparent at riser number 1, where the height from the floor to the underside of the starting tread is only 170mm (Figure 8.56). Marked on each riser line should be the underside-of-tread height and that of the preceding tread. Horizontal tread lines can then be marked by joining the upper mark on one riser with the lower mark on the next (Figure 8.57).

Lastly, using measurements taken from the rod, a tenon is marked at step number 7 (Figure 8.56).



Figure 8.55 Use a storey rod to mark heights representing the underside of each tread onto the open string.

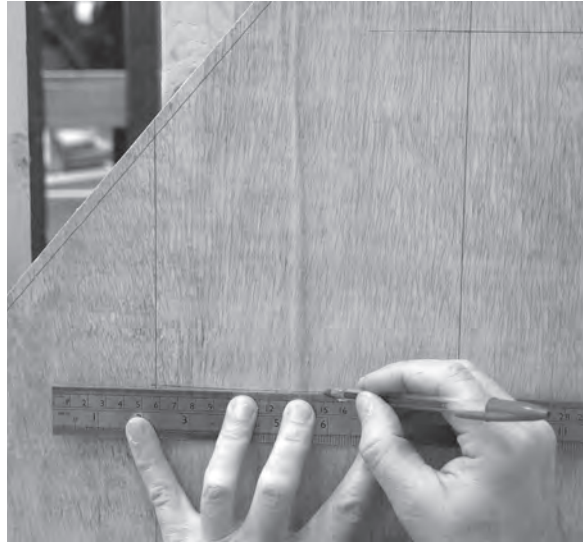


Figure 8.57 Join the underside-of-tread heights horizontally.

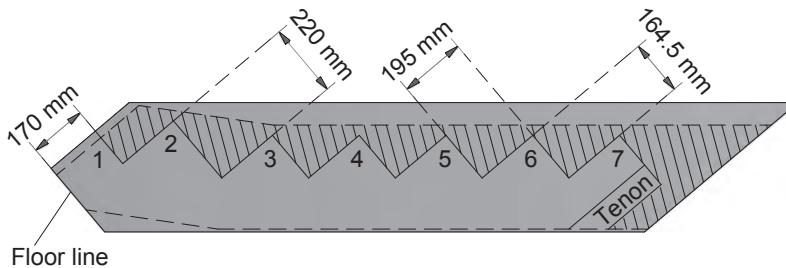


Figure 8.56 The marked open string, showing the tenon on the right and the 170 mm rise at step number 1, which will become the required 195 mm once the tread has been installed.

Veneering the strings' edges

The edges visible on the strings of the completed staircase will be the top of the right-hand (wall) string and the underside of the left-hand (open) string; these two edges, therefore, need veneering so that they match the strings' faces. Achieving a perfect match for the facing plywood's grain and colour might not be easy, but it is essential.

One solution is to use delaminated offcuts of the original facing plywood. I started by ripping down short lengths (say, 600 mm) to a width of around 90 mm ($3\frac{1}{2}$ inches), before carefully splitting the plywood's thickness in two on a band saw (Figure 8.58) and then removing what was left of the plywood's inner core with a belt sander.

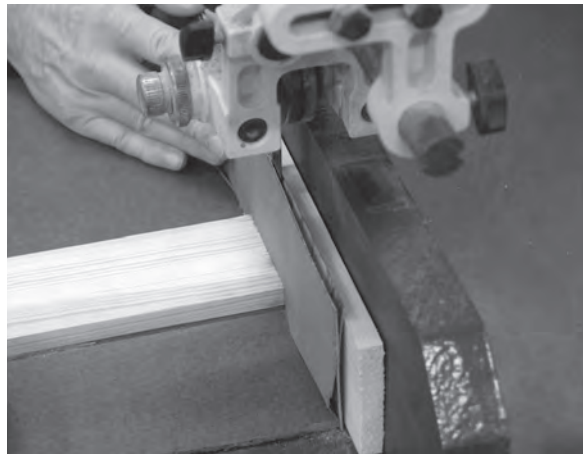


Figure 8.58 Delaminated offcuts of facing ply can be used to veneer the strings' exposed edges.



Figure 8.59 Prepare the string edges to be veneered with a belt sander.



Figure 8.62 Carefully lay the over-width veneer strips onto the string's edge.



Figure 8.63 A short piece of bathroom towel rail, or similar, is ideal for applying pressure to the glued veneer.

Figure 8.60 (above) and Figure 8.61 (below) Coat both surfaces with contact adhesive and wait 15 minutes until touch-dry.



Figure 8.64 Use a sanding block to cut and remove the excess veneer.

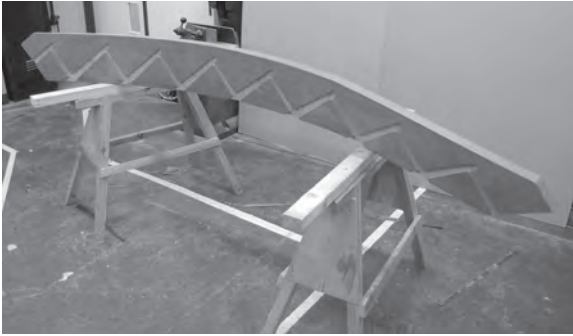


Figure 8.65 The wall string.

The surfaces to be veneered must be clean, dry, and free of dust and grease. If necessary, a belt sander can be used to remove the unevenness of an edge that has been cut by a hand-held circular saw (Figure 8.59). A thin, even layer of contact adhesive is applied both to the string's edge and the rear of the veneer strips (Figures 8.60 and 8.61). Around 15 minutes later, when the glue is touch-dry, the two surfaces are brought together causing instant grab (Figure 8.62), which means that there is just one chance to get it right. Apply pressure to the veneer, paying particular attention to the edges (Figure 8.63). The overlapping veneer can then be trimmed neatly using a sanding block (Figure 8.64), before the sharp arrises and excess adhesive are removed with 180-grit sandpaper leaving the completed string (Figure 8.65).

Cutting and mitring the open string

When the left-hand (open) string is removed from the bending form, it will have been marked out but its edges still rough and uneven. Trimming the string's top edge is not necessary since the steps have yet to be cut; the bottom edge, however, will require trimming, cleaning up, and veneering as described earlier.

The steps are cut using a hand-held circular saw with the string secured to a pair of trestles. I worked down the length of the string, cutting the riser lines first, followed by the tread lines (Figure 8.66). Stop the circular saw short of the intersecting lines, because to proceed further would weaken the string; instead, finish the cuts and remove the triangular waste pieces with a hand saw (Figure 8.67).



Figure 8.66 Clamp the open string securely to trestles and cut down the riser and tread lines with a hand-held circular saw, taking care to not cut beyond the intersecting lines.



Figure 8.67 Remove the triangular waste pieces with a hand saw so that the string is not weakened.



Figure 8.68 The first stage in mitring the string is to use a router to 'let in' the risers.

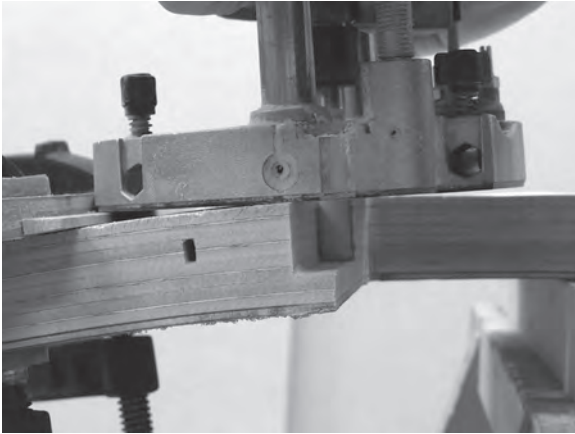
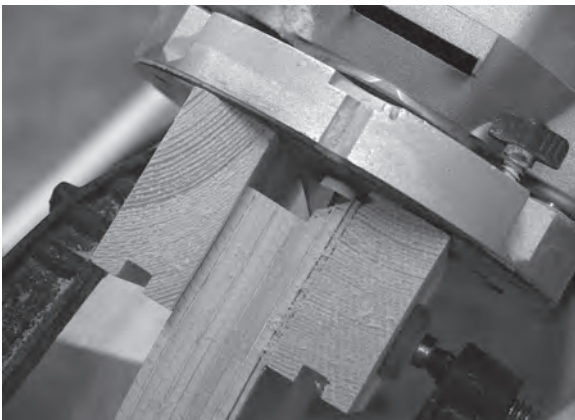


Figure 8.69 The thin MDF strip on the left keeps the centre of the router's base in contact with the string and prevents it from rocking.



Figure 8.70 (above) and Figure 8.71 (below) A bearing-guided chamfer cutter can be used to rout the majority of the waste when mitring the open string.

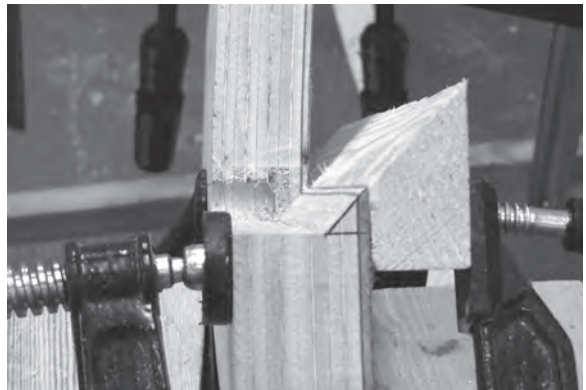


The next task is to rebate and mitre the string to receive the 12 mm thick risers. For chapter 5's quarter-turn staircase a hand-held circular saw was used for this task, but here I'm using a router running against a straight edge (Figure 8.68), and in order to achieve cuts that are radial to the string's curve, a thin MDF strip, approximately 3 mm thick, is used to keep the centre of the router's base in contact with the string (Figure 8.69), without which it would be difficult to prevent the router's flat base from rocking on the convex surface.

The softness of flexi ply makes chiselling the mitres a fairly simple task, but to speed up the job I used a router and bearing-guided chamfer cutter to remove the majority of the waste (Figure 8.70). A pair of timber blocks clamped each side of the string provided a stable and level surface upon which to run the router (Figure 8.71). The remainder of the waste can then be removed with a sharp chisel (Figure 8.72); a short length of bevelled



Figure 8.72 (above) and Figure 8.73 (below) Finish the mitres with a sharp chisel while protecting the face of the string with a short piece of bevelled timber.



timber clamped in place provides a guide for the chisel, while protecting the face of the string (Figure 8.73).

The open string is completed by using a router, guided by a straight edge, to cut the bare-faced tenon which will join the string to the newel post (Figure 8.56).

Preparing the newel post

Mark, rout, and mortise the upper newel post as indicated in Figure 8.74. When determining the mortise position it is important to bear in mind that the outside face of the balusters that will eventually provide guarding for the staircase should be flush with the outer face of the string (Figures 8.75 and 8.7). It is the balusters – or the balustrade centre line (see chapter 11) – and not neces-

sarily the string, that should be central to the newel post. Only when the two components are the same thickness will both be central to the newel post, and that is not the case here as the strings are 35.6 mm thick and the balusters will be 32 mm. Another consideration is that the bare-faced cheek of the open string's tenon will be curved and so care must be taken to achieve a good-fitting joint.

Providing mitred nosing returns to tapered treads

In chapter 5 we saw how the straight treads of an open staircase can be cut and mitred to receive nosing returns using a band saw; this method lends itself particularly well to the tapered treads of a circular staircase.

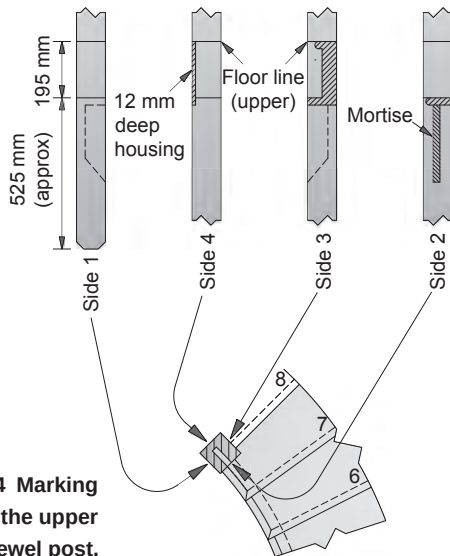


Figure 8.74 Marking out of the upper newel post.

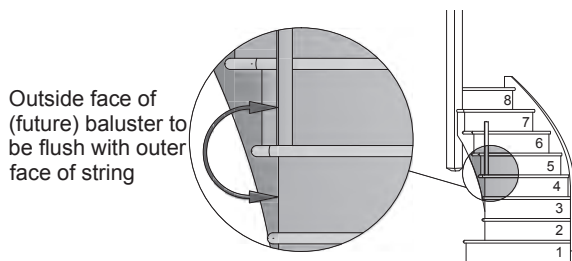


Figure 8.75 Mortise the newel post so that future balusters, rather than the string, will sit central to the newel post.



Figure 8.76 This thin plywood template is ideal for maintaining consistency when marking the treads; it comprises two parts: the main tread and the nosing return.



Figure 8.77 Use the main part of the template to mark the treads' angle of taper on each of the panels.

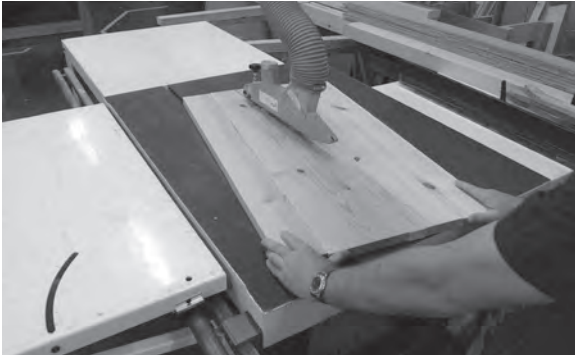


Figure 8.78 Cut the panels diagonally on the waste side of the lines.



Figure 8.80 (above) and Figure 8.81 (below) Realign the template and use both parts in turn to mark the nosing returns.



Figure 8.79 Plane smooth the treads' sawn back edges for a professional finish.



Accurate and consistent marking is best achieved using a two-piece template (Figure 8.76), which is first used to mark the treads' angle of taper on each of the three panels called for on the cutting list (Figure 8.77). The panels can then be cut to produce treads using either a band saw or, with experience, a circular rip saw (Figure 8.78). Whichever method is used, the sawn back edges of each tread should be skimmed over a surface planer to ensure good contact with the following riser (Figure 8.79).

Next, the shape of the nosing returns is marked on what will be the open-string ends of the treads using both parts of the template (Figures 8.80 and 8.81). Our treads are left-handed, and marking their upper sides will ensure that their lengths extend away from the band saw's throat (Figure 8.82).



Figure 8.82 Marking the upper side of these left-handed treads means that their length – which should be supported – will extend away from the band saw's throat during cutting.



Figure 8.83 Nail through the waste part of the tread into the over-width nosing return below.



Figure 8.84 Mark the nosing return's 25mm rear projection.

With the treads marked, the over-width nosing returns can be temporarily fixed beneath the markings by nailing through what will be the waste portion of each tread (Figure 8.83). The important thing here is to ensure that the nails will not obstruct the path of the band saw blade that will be used to cut the nosing returns. Once fixed, a 25mm wide steel rule placed against the tread's rear edge will permit the marking of a line parallel to the tread's taper (Figure 8.84).

The back of the nosing return is trimmed first so that it extends from the rear of the tread by a distance equal to that of the nosings: 25mm (Figure 8.85). The

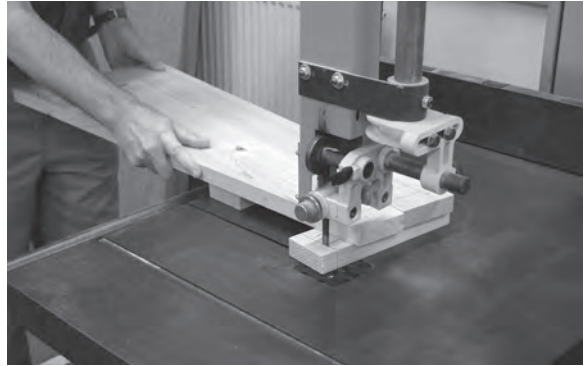


Figure 8.85 First cut: the rear edge of the nosing return.

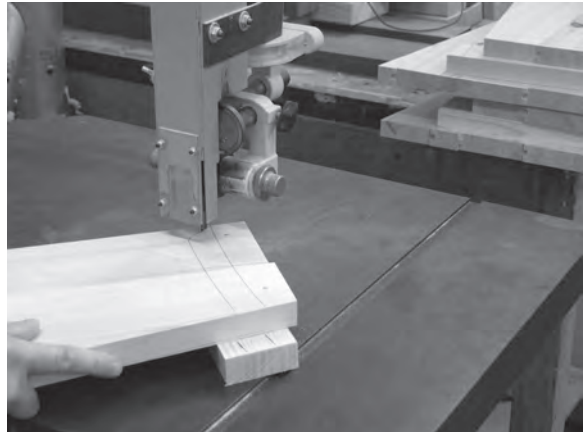


Figure 8.86 Second cut: the mitre at the front of the treads.



Figure 8.87 Third cut: the inside edge of the nosing return that will meet with the tread.



Figure 8.88 Fourth cut: the outside edge of the nosing return.

45° mitre at the front of the tread is next; take care to cut just on the waste side of the line (Figure 8.86). While making the third cut, on the line where the tread and nosing return will meet (Figure 8.87), support should be provided to the opposite end of the tread (Figure 8.82). The outside edge of the nosing return, now detached from the tread, is the last of the four cuts (Figure 8.88).

The waste pieces can now be set aside, leaving just the tread and nosing return (Figure 8.89), which should be marked as a matching set before continuing with the remaining treads (Figure 8.90).

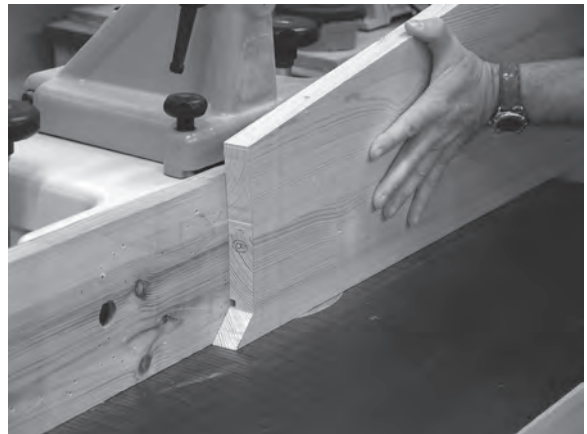


Figure 8.91 Ahead of fixing the nosing returns, form the riser housings by grooving the underside of the treads.

Figure 8.89 (above) and Figure 8.90 (below) Discard the offcuts and mark each tread and nosing return as a matching pair.



Figure 8.92 Use a belt sander to clean up the nosing returns' outside edges only.



Figure 8.93 Apply a generous amount of PVA glue to the tread's mitred end.



Figure 8.94 Line up the corresponding nosing return and bring the two components together.



Figure 8.95 Two carefully positioned nails sunk beneath the surface will secure the nosing return.

Before the newly cut nosing returns are fixed to their respective treads, two further operations are required: a 6 mm deep groove is cut into the underside of the treads to later house the risers (Figure 8.91); and a belt sander is used to clean up the outside edges of the nosing returns (Figure 8.92). The components can now be assembled ready for gluing and nailing.

PVA adhesive is applied generously to the tread's edge (Figure 8.93) before offering up the matching nosing return (Figure 8.94). The nosing return is then nailed to the tread (Figure 8.95), before the excess glue is wiped off and the tread set aside to dry.



Figure 8.96 (above) and Figure 8.97 (below) When nosing the treads, prevent the 'dropping in' of the router cutter at the corners by abutting offcuts each side of the tread.

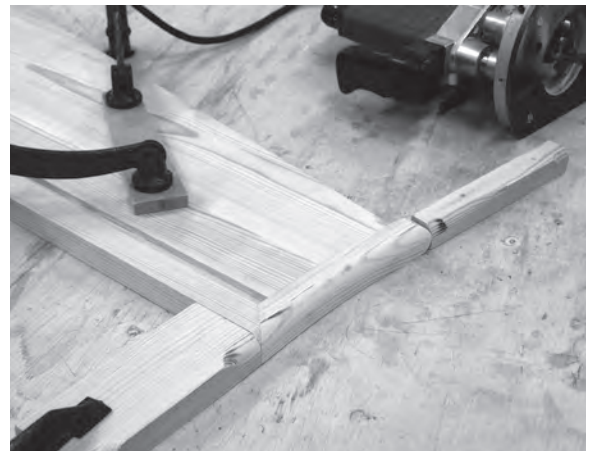




Figure 8.98 Use the template to mark the treads' length, and cut on the band saw.

The concave outer edges of the nosing returns are best routed using a bearing-guided round over cutter with a radius of 12.7 mm (Figure 3.38); butting timber offcuts each side of the treads during routing will prevent the cutter 'dropping in' at the corners (Figures 8.96 and 8.97). Lastly, the treads are cut to length by trimming round the convex line marked earlier using the template (Figure 8.98).

Final preparation before assembly

Screwing down through the treads into the cut string below provides the strongest fixing between the two components, but the problem is how to conceal the



Figure 8.99 Use the template to mark the screw positions which should coincide with future balusters.

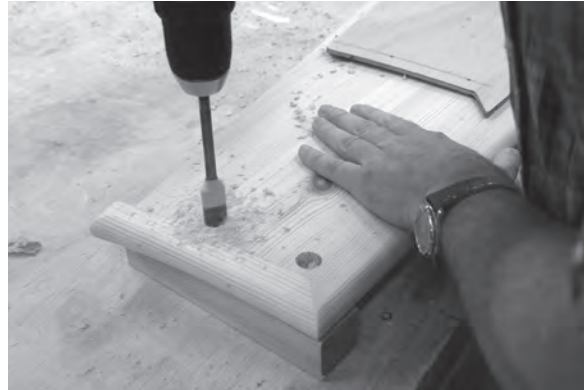


Figure 8.100 (above) and Figure 8.101 (below) The 18 mm diameter holes drilled to a depth of 18 mm will house future baluster dowels, and 6 mm diameter holes drilled through the remainder of the treads' thickness are screw clearance holes.



fixings. While pelleting is a good method, a better solution is to locate the screws directly beneath the balusters. A line representing the balustrade centre line is drawn on the tread template, and 2 mm holes drilled where the baluster dowels are to be located. The template can then be placed on top of each tread in turn and the hole centres marked using a bradawl (figure 8.99). Holes, 18 mm in diameter, are drilled to a depth of 18 mm followed by 6 mm clearance holes through the remaining tread thickness (8.100 and 8.101).

As well as gluing and wedging, the treads are fixed to the wall string by screwing through the string into the end grain of the treads. Positioning the screws correctly is made easy by first drilling 6 mm clearance holes through the string housings (Figure 8.102).



Figure 8.102 Screws for the treads are easily located by pre-drilling 6 mm clearance holes through the housings in the closed string.



Figure 8.104 Prepare for assembly directly above the plywood rod.



Figure 8.103 Clean up all components prior to assembly.

A sufficient number of wedges and angled glue blocks must be cut, and six of the eight plywood risers (numbers 2 - 7) require mitring one end, as indicated in Figure 5.47. And just ahead of assembly, all components should be cleaned up (Figure 8.103).

Staircase assembly

The preferred assembly method of most stair builders is to construct a circular staircase as if it were being built in situ. Having cleaned up and gathered together all components, a horizontal board, representing the landing joist, is fixed at the appropriate height directly

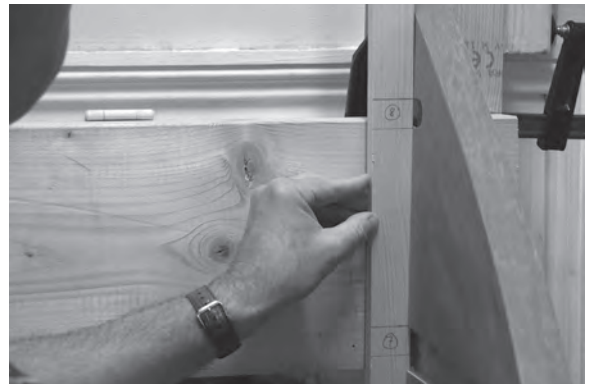


Figure 8.105 Position the wall string, clamp in place, and use a storey rod to confirm correct height.



Figure 8.106 and Figure 8.107 Align the bottom end of the string with the rod and secure by skew nailing.

above the levelled plywood rod, which should be considered the finished floor level (Figure 8.104). The building of our circular staircase can now commence.



Figure 8.107



Figure 8.109 Check for plumb with a spirit level.



Figure 8.108 Check the height with the storey rod and prop the mid-part of the string.

Figure 8.105: First, the closed wall string is hooked over the landing joist, clamped in place, and the string housings checked for correct height using a storey rod.

Figures 8.106 and 8.107: Aligned with the rod, the bottom end of the string is held in place by skew nailing through its back into the plywood.

Figure 8.108: Having secured the upper and lower ends of the string, the middle will tend to sag. This can be prevented by clamping a prop to the string.



Figure 8.110 Both strings are correctly positioned and secured in place.



Figure 8.111 Apply PVA adhesive to the mitred ends of the open string. Start at the top of the string and work downwards.



Figure 8.112 Fix the mitred end of the riser to the open string.



Figure 8.115 The notched rear of tread number 7, below which the open string's tenon is just visible.



Figure 8.113 The risers (all except numbers 1 and 8) are installed ahead of the treads, and the circular staircase begins to take shape.



Figure 8.114 Glue the open string's horizontal surface and install the first of the treads, again working from the top down.

Figure 8.109: A spirit level is used to check that the string is plumb and that the string's riser lines plumb up accurately from those on the rod below.

Figure 8.110: Use the plywood rod, spirit level, and storey rod to accurately position the open string and secure in place.

Figure 8.111: Starting at the top, the risers are fixed first. Apply PVA adhesive generously to the open string only (the steps will be glued at the closed string side later during wedging).

Figure 8.112: Position the mitred riser, and nail through its face into the open string.

Figure 8.113: Work steadily down the flight, gluing and nailing one riser at a time, until all except riser number 1 (which is part of the curtail step) and riser number 8 (which meets the upper newel post) are in place.

Figure 8.114: Back to the top of the flight where glue is applied to the horizontal surface of the open string ready for the first of the treads (number 7) to be installed.

Figure 8.115: The rear of tread number 7 is notched for housing within the upper newel post.

Figure 8.116: At the wall string side, push the tread firmly up into its housing and ensure that the nosing is fully forward, then screw through the pre-prepared holes in the string into the end grain of the tread using 5.0 × 80mm wood screws (3 inch 10s).

Figures 8.117 and 8.118: Through the pre-prepared holes at the opposite end of the tread, screw down into the open string below using 5.0 × 65mm chipboard screws (2½ inch 10s).



Figure 8.116 Screw through the pre-drilled holes in the wall string into the end grain of the tread.



Figure 8.119 Avoid damaging the treads' nosings and the wall string by carefully 'angling' the treads into their housings.



Figure 8.117 (above) and Figure 8.118 (below) At the open end, screw down through the tread's baluster dowel holes into the string below.



Figure 8.120 Glue and wedge the steps.



Figure 8.119: As seen here with tread number 2 (one of the two straight treads) each tread should be gently 'angled' into its wall string housing before being screwed at both ends.

Figure 8.120: Glue and wedge the risers, followed by the treads, bearing in mind that gravity will cause the glue to drip down onto the plywood rod below; not necessarily a bad thing – a former boss of mine used to say of the stairs being built by his company, "I like to see glue oozing out all over the place."

Figure 8.121: Screw through the risers into the backs of the treads using 5.0 × 40mm wood screws (1½ inch 10s), fixing at centres not exceeding 230mm.



Figure 8.121 Fix each riser to its preceding tread.



Figure 8.122 Support the steps with glue blocks which require pinning while the glue dries.



Figure 8.123 Once wedged, the wall string side of the staircase should be entirely gap-free.

Figure 8.122: Apply glue blocks to support the joints between the treads and risers at equidistant spacings (150mm minimum) and hold in place with pins while the glue dries. An additional glue block supports the mitred end of each riser where it meets the open string.

Figure 8.123: The wedged steps are now firmly up in their closed string housings and gap-free. In this view of step number 7 (yet to be wedged because access is obstructed by the landing joist), the join in the string's facing plywood can just be seen near the tread's nosing.



Figure 8.124 The open side of the staircase – also gap-free.



Figure 8.125 The staircase so far – looking good!

Figure 8.124: Accurately mitred risers, curved nosing returns, and a gently swept open string all combine for a highly attractive staircase.

Figure 8.125: Six of the eight steps in place and our circular staircase is nearing completion. Just curtail step number 1, top step number 8, and newel post to go.

Fitting the curtail step

The construction of the curtail step, shown in Figure 8.126, is explained in detail in chapter 10. The fixing of the step to the main flight, however, is described here and can be more clearly demonstrated with the tread set aside. The first task is to cut both the main front length of the plywood riser and the short return at the rear of the solid block accurately to length.



Figure 8.126 The curtail step (compare with D-step, Figure 5.70).



Figure 8.127 The rear of the curtail riser needs trimming carefully if it is to fit nicely against the open string.

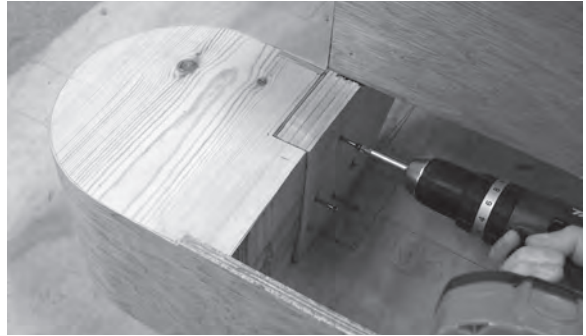


Figure 8.128 Glue and screw through the open string into the curtail step's solid block.



Figure 8.129 We are now ready to install tread number 1.



Figure 8.130 Glue and screw through the pre-drilled baluster dowel holes into the solid block below. The locations of these holes were marked using a volute template - see chapter 11.



Figure 8.131 Laying on its side, the staircase's twisted appearance is clear to see and we now have access to glue and wedge riser number 1 and tread number 7.



Figure 8.134 Finally, add the landing nosing and riser number 8.



Figure 8.132 With the staircase on its side, the newel post can be fitted to the open string.



Figure 8.133 Pull the newel post up tightly by draw-bore dowelling through offset holes.

Figure 8.127: The plywood riser at the rear of the solid block might require scribing to the open string if it doesn't go up as nicely as this.

Figure 8.128: The curtail step is fixed in place by gluing and screwing through the open string into the step's solid block.

Figure 8.129: The curtail step, minus its tread, is now in place, although not yet glued and wedged at the closed string side.

Figure 8.130: The tread is inserted into its closed string housing and, at the open side, glued and screwed to the solid block below, again making use of the baluster dowel holes to conceal the fixings.

Figure 8.131: The assembled staircase is brought down, and access for gluing and wedging riser number 1 and tread number 7 is gained. At this stage, the staircase can be prepared for delivery to a customer (see chapter 4 for guidance on protecting stairs during and after delivery).

Figure 8.132: Once in its intended location, the flight's upper newel post, landing nosing, and top riser can be fitted. Here, these components are dry-fitted only as they will later be removed so that the manufacture of a circular handrail and balustrade can be demonstrated in chapter 11.

Figure 8.133: Draw-bore dowelling pulls the joint up nicely.



Figure 8.134: Install the landing nosing and then riser number 8.

Figure 8.135: The staircase is now fully assembled.

Figure 8.135 Our circular staircase is complete.

9

Alternating Tread Stairs

Moving home is expensive, and those requiring larger living accommodation are looking increasingly towards extending their existing homes rather than relocating. And one of the most cost-effective ways of 'extending' a home is to convert a loft space into living accommodation.

Possibly the greatest challenge when planning a loft conversion is providing access to the new accommodation – a staircase takes up a lot of space, both in the converted loft and on the floor below. While a small spiral staircase might provide a compact as well as attractive solution, transporting a bed and other items of furniture up to the newly converted space would be extremely difficult. An alternating tread staircase is designed to be both space-saving and accommodating while complying with the Building Regulations.

Design

The size of a staircase's footprint is largely determined by its angle of pitch – the steeper a staircase, the less room it takes up. An alternating tread staircase saves space because it is designed to be very steep – often over 60° – and this is achieved with the use of specially designed treads. The staircase takes its name from its paddle-shaped treads, which are alternately handed and require those using the stairs to always lead with the correct foot (Figure 9.1). Part of each tread is cut away, leaving a wide side and a narrow side; steepness is achieved because the wide side of each tread entirely overlaps the narrow side of the tread below (Figure 9.2).

Steeper than a traditional staircase yet safer than a loft ladder, an alternating tread staircase can be the ideal solution where space is limited. However, while its main advantage over a ladder is that it allows the user

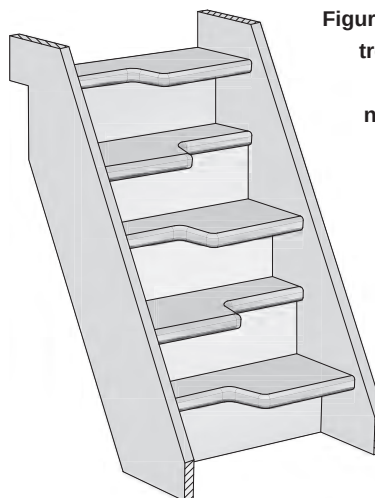


Figure 9.1 The staircase's treads are cut to leave a wide side and a narrow side, resulting in a paddle-shaped appearance.

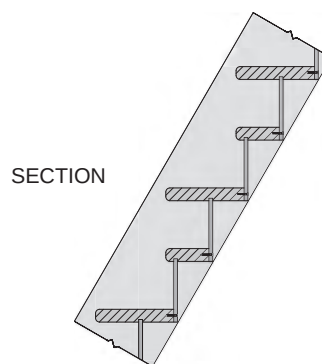
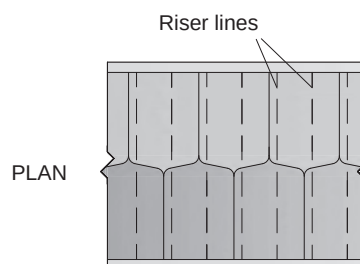


Figure 9.2 The narrow side of each tread is overlapped entirely by the wide side of the one above, permitting a very steep angle of pitch.





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to face forward while both ascending and descending the stairs, an alternating tread staircase might not be suitable for everyone. People who experience difficulty when climbing conventional stairs should, for their own safety, avoid a staircase of this type. But with repeated use comes familiarity, and those using the stairs will be provided with what Approved Document K describes as 'reasonable safety'.

If you're planning a loft conversion, it is strongly recommended that you discuss your proposal with your local authority's building control department. As well as a safely designed staircase, the structural strength of the new floor, escape from fire, sound insulation, and stability of the structure as a whole must all be considered before work commences. You will also need to know whether your planned project falls within The Party Wall etc. Act 1996.

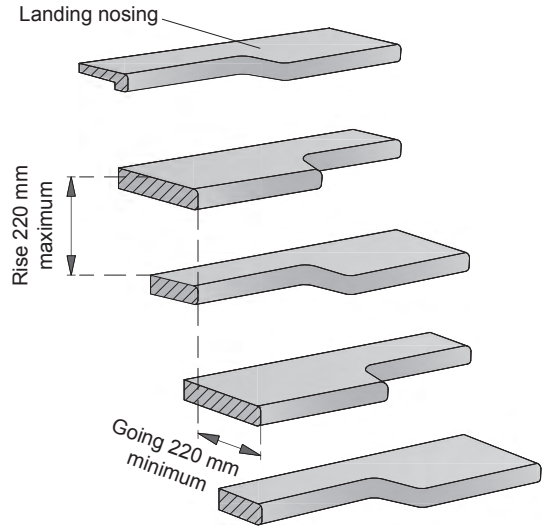


Figure 9.3 The 220 mm minimum going of an alternating tread staircase is measured between alternate nosings.

Building Regulations

At 220 mm, the maximum rise and minimum going for an alternating tread staircase is the same as that of a conventional private staircase. The difference, though, is that the going on the space-saver is measured between alternate nosings (Figure 9.3), meaning that the total horizontal length can be half that of an ordinary straight-flight staircase.

An alternating tread staircase should provide access to one habitable room only, plus an en suite bathroom if that forms part of the loft conversion and is not 'the only WC in the dwelling'. And it should only be installed where there is insufficient room for a conventional staircase. A handrail should be provided on both sides, and the treads should have slip-resistant surfaces, which can be provided with the use of anti-slip varnish, anti-slip paint, or suitable carpet.

Headroom should be a minimum of 2 m, although in recognition of the constraints faced when converting a loft space, this can be as low as 1.9 m at the centre of the clear width of the stairs, reducing to 1.8 m on one side (Figure 9.4).

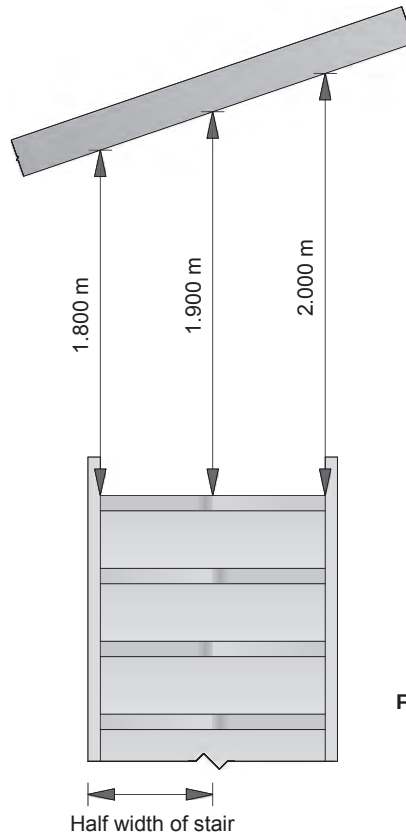


Figure 9.4 Limited headroom on a straight staircase running parallel with the eaves.

Stair dimensions

The alternating tread staircase that we will be building will have open risers (discussed later), and will be built to the following dimensions, as illustrated in Figure 9.5:

- Number of steps: 12
- Rise: 190 mm
- Going: 220 mm
- Angle of pitch: 60°
- Overall width: 650 mm

Note, in Figure 9.5, that the left- and right-hand strings are not mirror images of each other.

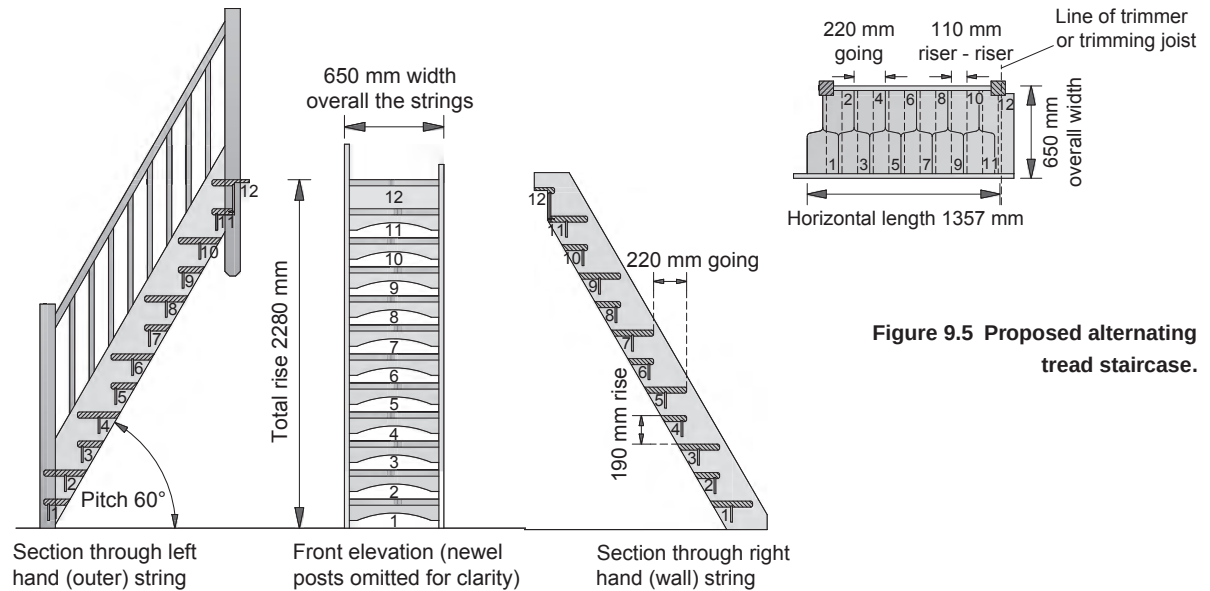


Figure 9.5 Proposed alternating tread staircase.

Cutting List

No.	Member	Length	Width	Thickness	Material
2	strings	3000	282	32	European Redwood
1	top newel post	1800	100	100	European Redwood
1	bottom newel post	1520	100	100	European Redwood
6	panels	660	480	45	European Redwood
1	riser	700	198	12	medium density fibreboard
11	risers	700	108	12	medium density fibreboard

All dimensions in millimetres.

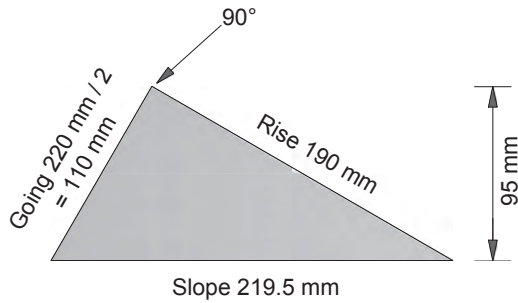


Figure 9.6 Pitch board dimensions.

Using an infill piece to convert the router jig from suiting the nosings on the wide side of the treads to suiting the nosings on the narrow side of the treads (Figure 9.7: D) is not recommended since the resulting points will be quickly and easily damaged. This 'nosing conversion' infill should not be confused with nosing and riser infills (Figure 9.7: A–C) which will be required in order to avoid 'rounding' beneath the tread nosings.

- A: Riser infill piece
- B: Nosing infill (wide)
- C: Nosing infill (narrow)
- D: Nosing conversion infill (not recommended)

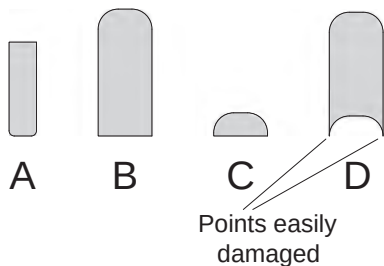


Figure 9.7 Infill pieces for use with the router jig.

housing to accommodate the wide sides of the treads. Conversely, a jig that would permit the routing of the wider housings would require an infill piece for the narrower housings (Figure 9.7: D).

The solution is a jig that will permit the routing of both the wide and narrow halves of the treads

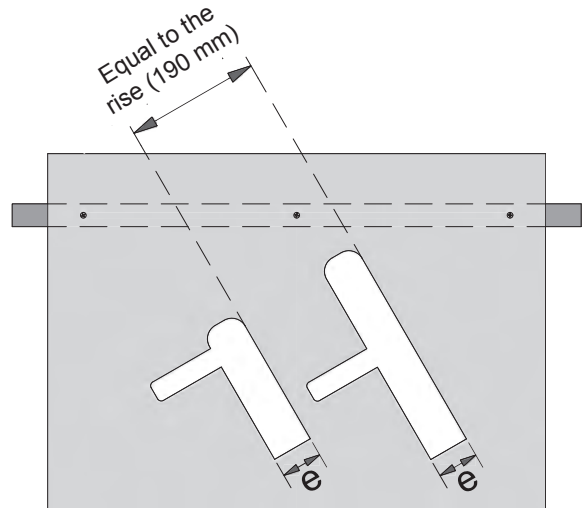


Figure 9.8 Router jig for an alternating tread staircase.



Figure 9.9 A carefully prepared router jig will permit the routing of both the wide and narrow sides of the alternate treads.

(Figures 9.8 and 9.9). Figure 9.8 shows the two critical measurements: firstly, the distance from the top of the narrow tread on the left to the top of the wide tread on the right, must be exactly equal to the rise which, for our staircase, is 190mm; and secondly, the width of each tread opening must be equal because not only will the two openings be used to rout consecutive treads, they will also be used to rout opposite ends of the same tread.

The riser openings do not meet with the tread below because our alternating tread staircase is to have open risers. And, because the underside of the staircase will be visible, the treads will be housed, glued, and screwed, but not wedged; therefore the tread (and riser) openings in the jig are not tapered on the underside to accommodate wedges.

String marking

The staircase's steep angle of pitch means that wide strings of 282 mm are required to accommodate the treads and risers, as illustrated in Figure 9.10; gluing up will be required to achieve this width. The finished thickness will be a standard 32 mm.

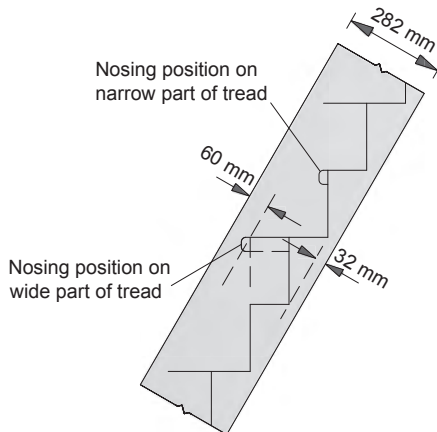


Figure 9.10 The flight's steep angle of pitch means that wide strings are required to house the treads.

My preferred method of marking strings is to use stair gauges with a steel roofing square (Figure 9.11). A pitch board and margin template can be used but the pitch board is small and the strings are wide, so to mark the steps correctly, the pitch board will have to be pushed further across the string using a 95 mm wide spacer resting against the margin template (Figure 9.12). The marking out of a pair of strings is described in detail in chapter 4, so the following is an overview.

Once the usual checks concerning the locations of bows and defects have been carried out, marking can commence with either string. Stand facing the string's



Figure 9.11 Marking the steps on the strings using a pair of stair gauges clamped to a steel roofing square.

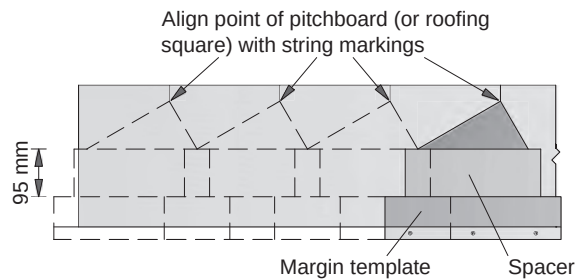


Figure 9.12 The small pitch board requires the additional use of a spacer when marking the wide strings.

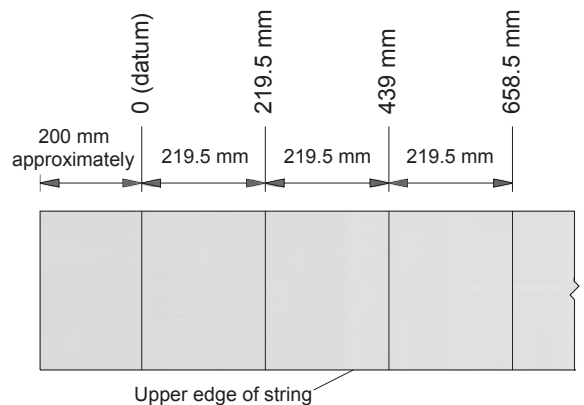


Figure 9.13 When marking the first string, establish a datum from which the steps should be marked.

upper edge and mark a datum approximately 200 mm from the end on your left (Figure 9.13). From the datum, measure and mark 12 multiples, each equal to the slope of the pitch board (219.5 mm). Square each mark across the width of the string, double-check the distances and, if satisfied, mark the steps. Mark the second string off the first so that you have a handed pair.

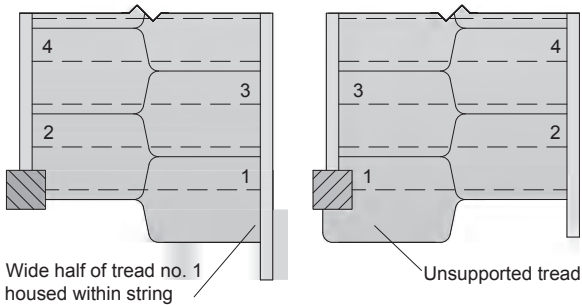


Figure 9.14 Ensure that the first tread is fully supported by housing its wide side within the wall string.

50 mm behind the line of riser number 1, and 50 mm in front of the line of riser number 12 respectively. The marked strings are shown in Figures 9.15 and 9.16.

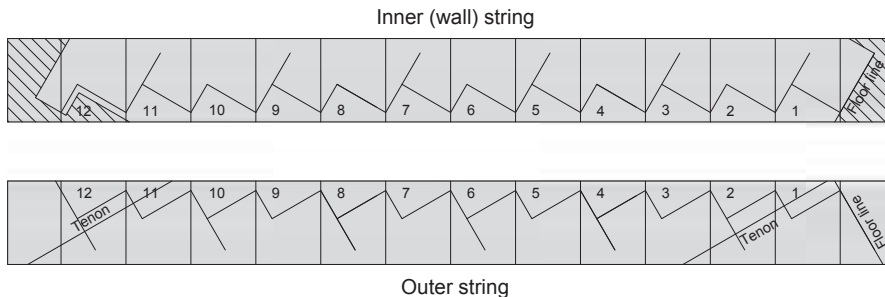
Routing the strings

Unlike the treads and risers of a conventional staircase, those of our alternating tread staircase with open



Figure 9.15 (left) The marked pair of strings.

Figure 9.16 (above) The strings are marked and ready for routing.



When all of the steps have been marked, the wider housings should be indicated by extending alternate tread lines (Figure 9.10). The first tread of the staircase being built here has the wide side on the right, which is helpful if the majority of people lead with their right foot. More importantly, though, the wider half of tread number 1 should be on the opposite side of the stairs to that of the bottom newel post, because, if not, a large amount of the tread will remain unsupported (Figure 9.14).

All that remains to be marked are the tenon shoulder lines on the outer string. The newel posts will have standard sectional dimensions of 100 mm square. The lower and upper shoulder lines will therefore be

risers will not be wedged. For that reason a 12 mm straight fluted cutter (Figure 3.15) will be used to rout the strings.

Align the router jig with any two steps on either string (ensuring that it is offset by the correct distance) and clamp in position (Figure 9.17). Screw a softwood fence to the jig so that the fence rests against the top edge of the string. We're now ready to start routing.

As usual, start on the left and work towards the right. With the router jig clamped in position, rout in the direction indicated in Figure 9.18. Start with the two nosing infills inserted, and rout along the line of the tread and then down the line of the riser. Remove the



Figure 9.17 Use spacer blocks to ensure that the router jig is offset by the correct distance.

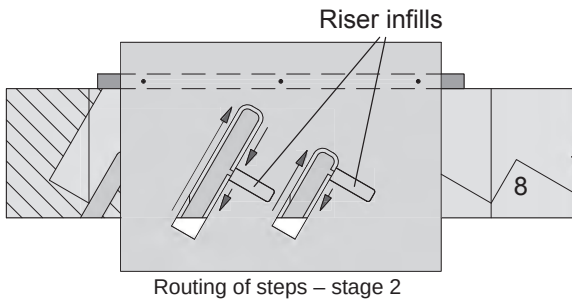
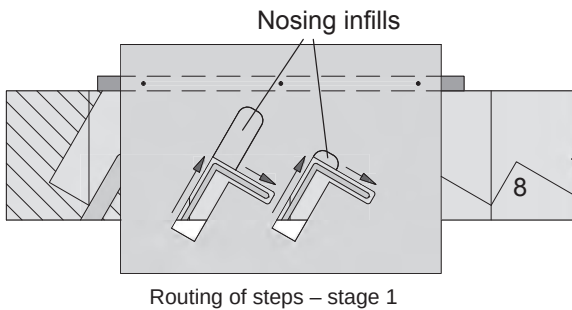


Figure 9.18 Working from left to right, rout the steps in two stages.

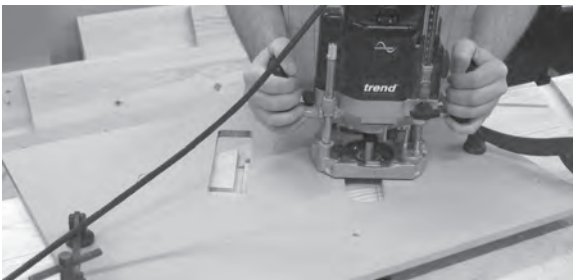


Figure 9.19 With the nosing infills removed and the riser infills inserted, the tread and riser housings for two consecutive steps can be completed.



Figure 9.20 The routing of the wall string is complete.

nosing infills and insert the riser infills to complete the housings (Figures 9.18 and 9.19). Work methodically down the string before turning the jig over, repositioning the fence on the opposite side of the jig, and continuing with the opposite string. The fully routed wall string is shown in Figure 9.20.

String tenons

When all of the housings for the treads and risers have been routed, the outer string tenons should be cut. This operation can almost be viewed as a continuation of the tread and riser housings in that the depth of cut from the face side of the string is the same (12 mm) and the same 12 mm straight fluted cutter is used.



Figure 9.21 (above) and **Figure 9.22** (following page) Cut the long-shouldered tenons at the ends of the outer string to form three haunched tenons.

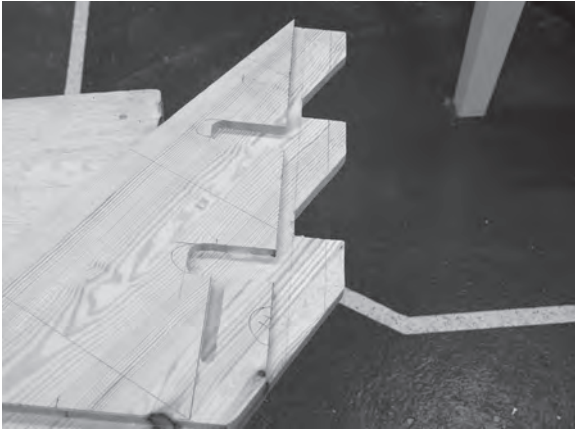


Figure 9.22

To prevent cupping, a string tenon is usually cut to form a pair of tenons with haunches. With this alternating tread staircase, the wide string combined with steep angle of pitch has resulted in very long shoulders. Consequently, rather than a pair, I opted for a trio of tenons at each end of the string (Figures 9.21 and 9.22).

Newel posts

The finished sectional size of the two newel posts is 100 mm × 100 mm. The marking out of the bottom newel post is shown in Figure 9.23 and should start, as always, with a line squared round the lower end to represent the finished floor level. Two further lines are squared round the newel post at 190 mm spacings to represent the tops of steps 1 and 2. 12 mm deep housings to receive riser number 1 and the fronts of treads number 1 and 2 are marked on side 4 of the newel post. And the tread housings continue round on side 3, where they meet with the mortise that will receive the string tenon.

Figure 9.24 shows the marking out of the top newel post. Known as a 'drop newel', the lower end of the post extends below the line of the ceiling where the end receives a chamfered finish (a top newel post which extends all the way to the floor below is known as a 'storey newel').

Preparing paddle-shaped treads

The wide part of each paddle-shaped tread overhangs the riser to an extent where it bears no support from

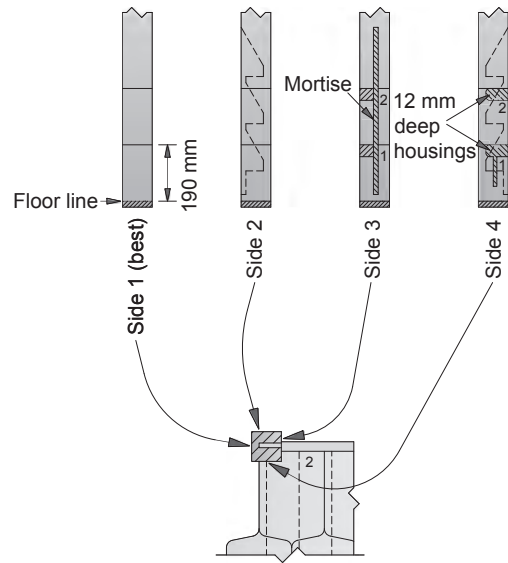


Figure 9.23 Marking out the bottom newel post.

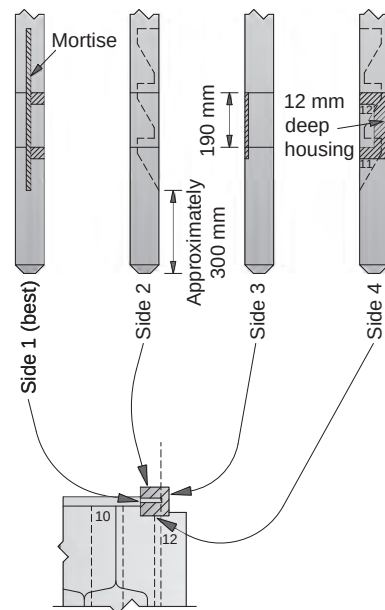


Figure 9.24 Marking out the top drop newel post.

the riser. For rigidity, therefore, the treads of an alternating tread staircase need thickening up, and this is especially true of an open-riser staircase. If MDF is to be used, the treads should be a minimum of 30 mm thick. In the case of our staircase, 12 treads (or, more

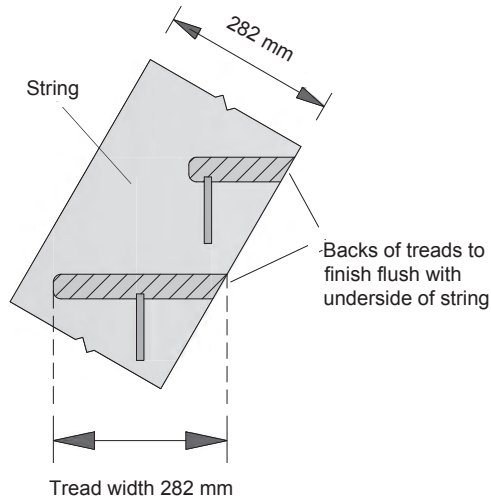


Figure 9.25 Extending the backs of the 282 mm wide treads to finish flush with the undersides of the strings provides a neat finish to a staircase with open risers.

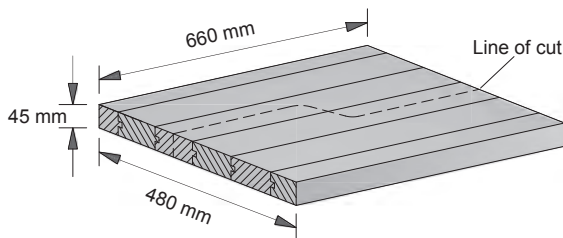


Figure 9.26 Two alternating treads will be cut from each panel.

accurately, 11 treads and one landing nosing) will be cut ex 50mm European Redwood, planed to 45mm, glued up, and then re-cut and re-thickened to finish at 40 mm thick. The backs of the treads will extend beyond the line of the face of each following riser to finish flush with the underside of the string, resulting in a total tread width of 282 mm which, coincidentally, is identical to that of the strings (Figure 9.25).

To minimise waste, the treads will be glued up in pairs so that the material that is removed to leave the narrow part of one tread forms the wide part of another (Figure 9.26), and this is why, on our cutting list, twelve 40 mm-thick treads are described as six 45 mm-thick 'panels'. Two treads will be cut from each of the 480 mm wide panels before re-thickening. The risk of cupping is avoided by gluing up boards no wider than 100 mm, using tongue and groove joints to form the panels (Figure 9.27). Timber should be carefully selected to avoid the risk of splitting along the grain where the paddle shape is to be cut.

Panels into treads

The treads are best cut from the panels using a narrow band saw (Figure 9.28). Before that, though, the panels require marking, and this is made easy with a template cut from 12 mm thick MDF (Figures 9.29 and 9.30), which should be over-length for subsequent use as a jig for truing the rough sawn edges produced by the band saw.



Figure 9.27 Twelve paddle-shaped treads will be cut from six tongued and grooved softwood panels.



Figure 9.28 A narrow band saw is used to cut the alternating treads from the panels. Cut on the waste side of the line so that the sawn edge can be cleaned up later.

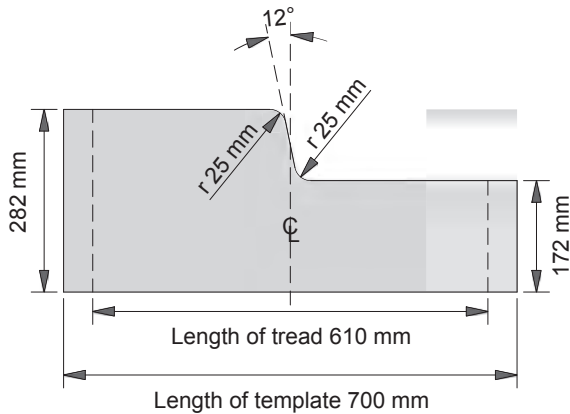


Figure 9.29 Tread template.



Figure 9.30 Use a template made from 12 mm MDF to mark the alternating treads.



Figure 9.31 The six panels are now twelve alternating treads, ready to be planed to their finished thickness of 40 mm.

Once all the treads have been cut out on the band saw (Figure 9.31) they will need re-thickening from their current 45 mm down to their finished 40 mm. Thickness just one tread to start with and then test the fit of that tread in the string housings before thickening the remaining treads. It is vitally important that the treads are a snug fit in the string housings and free from play, as there will be no wedges to take up any slack in loose-fitting treads.

Routing the tread nosings

The tread nosings will be formed using a bearing-guided round over cutter with a radius of 12.7 mm (Figure 3.38). However, the cutter's bearing will need to be provided with a true edge upon which to run. So before we can start the nosings, the treads' front edges will need skimming with a 12 mm straight fluted cutter in a router with a 30 mm guide bush which will run off a jig (Figure 9.34).

The MDF template that was used to mark the treads will require some modification before it can be used as a jig. This is because the offset router cutter would cause the radius of the two rounded corners (one internal and one external) at the front of each tread to change if the template were used unaltered. So, to ensure that our treads turn out as shown in Figure 9.29, the front edge of the template will need trimming back by a distance equal to the cutter offset. And marking where to trim will require a little geometry.

Referring to Figure 9.32, start by marking straight lines on the template which run parallel with the three straight lines of the template's front edge, and which are set back from the front edge by a distance equal to the cutter offset (see chapter 3 if a more detailed explanation of 'cutter offset' is required). Extend the

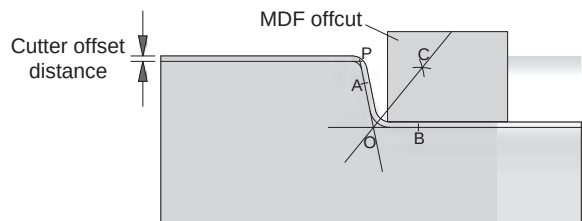


Figure 9.32 Converting the template for use as a jig.

lines so that they intersect at O and P. With O as centre, use a compass to draw arcs that cut the adjacent lines at A and B. Then, with A and B as centres, draw arcs to intersect at C on a scrap piece of MDF. A line drawn through O-C will be radial to the 25 mm rounded corner on the front edge of the tread. Now, adding 25 mm to the cutter offset distance will give us the radius of the offset line to which we must cut the template.

For clarity, Figure 9.32 shows only the geometry for the internal corner at O; that for the external corner at P can be seen being carried out in Figure 9.33 and is slightly easier in that the geometry can be marked out entirely on the template rather than having to abut a scrap piece of MDF.

The template, which is now a jig, is clamped to each tread in turn for routing which will 'plane' the front edges and also bring the treads to their finished width (Figures 9.34 and 9.35). The jig is then dispensed with as the nosings are formed with a round over cutter guided by a bearing (Figure 9.36).

The treads still need to be cut to length, grooved to accommodate the risers, angled at their rear edge, and cleaned up; but all this can wait until after the risers have been prepared.

Open risers

Wherever the new, additional, staircase is to be located, there is a likelihood of loss of natural light. This light loss can be minimised with the installation of an 'open-riser' staircase. Sometimes referred to as 'modern' or 'contemporary' stairs, an open-riser staircase can



Figure 9.33 Geometry is used to mark the template prior to trimming the front edge so that it can be used as a jig.



Figure 9.34 The treads' front edges are cleaned up with a 12 mm straight fluted cutter. Rout from left to right starting with the wide side of the tread.

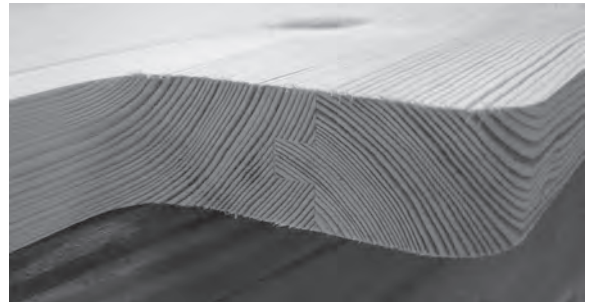


Figure 9.35 The front edge of the tread is now true and ready for nosing (compare with Figure 9.31). Neat, accurate, and well-proportioned joints ensure tread strength.



Figure 9.36 Cut the nosings with a bearing-guided round over cutter with a radius of 12.7 mm.

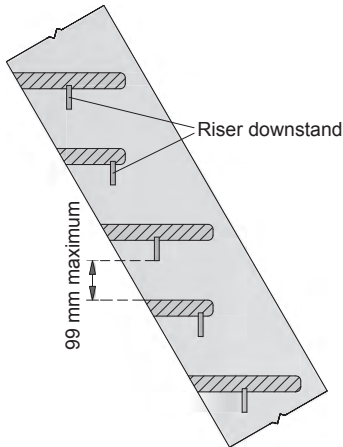


Figure 9.37 Riser downstands prevent the passage of a 100 mm sphere between the treads of an open riser staircase.

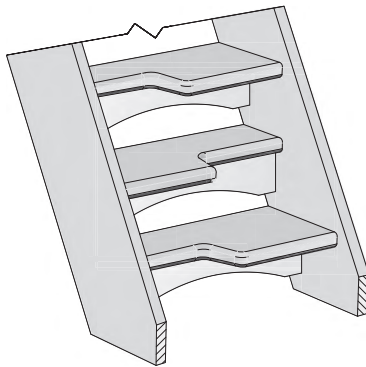


Figure 9.38 'Riser downstands' or 'partial risers' can be cut decoratively provided the '100 mm sphere' rule is observed.

make the room or hallway in which it is located seem more spacious and airy.

There was a time when 'open risers' meant no risers at all. While this is still possible, Approved Document K's requirement that the open risers should not allow the passage of a 100 mm diameter sphere has led to the introduction of horizontal bars in the spaces where there would normally be risers. This stipulation of the Approved Document can also be satisfied with the use of 'riser downstands', or 'partial risers' (Figure 9.37), which can, if desired, be cut decoratively (Figure 9.38). Treads of a staircase with open risers should overlap by a minimum of 16 mm (Figure 1.5).

For the risers – all-but-one of which are known as 'eyebrow' risers – 12 mm MDF will be used. The twelfth riser is full and closed so that the floor joist against which it rests is concealed (depending on the floor layout, this joist is either a trimming or a trimmer joist).

A 100 mm diameter sphere represents the head of a young child, and although Approved Document K's recommendation applies to stairs that are likely to be used by children under 5 years, observing it during the manufacture of all stairs is good practice. The 'baby's head theory' – as it has long been known – is often checked quickly with a building inspector's clenched fist.

Once the risers are dimensioned, trammel heads can be used to mark an arch on a pattern riser, which is then cut out on a band saw (remember to cut on the waste side of the line), and finally finished using a spokeshave or circular plane. The pattern riser (Figure 9.39) can then be used as a template to mark the remaining 10 risers, and as a jig to finish the circular underside of each riser on a spindle moulder (Figure 9.40), so that we have 11 identical eyebrow risers plus one closed riser.

It is important to note that Figure 9.39 shows the dimensions of a riser designed only for a staircase with a rise of 190 mm. It satisfies clause 1.9 on page 6 of Approved Document K because the space between the highest point of the arch and the top of the tread below, at 99 mm, will not permit the passing of a 100 mm sphere (Figure 9.41). And this is the critical measurement that must be maintained for any staircase, irrespective of the rise.

Finishing the treads and risers

The treads and risers can now be cut to their finished

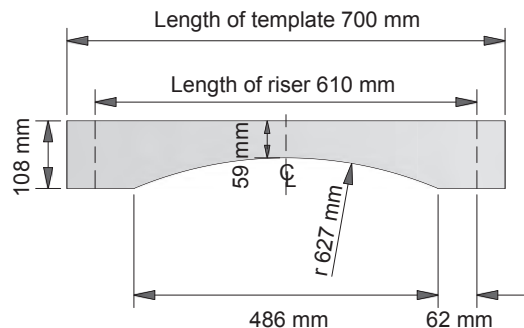


Figure 9.39 Pattern riser.



Figure 9.40 Using a spindle moulder with a ring fence, the arch of the pattern 'eyebrow' riser is reproduced time and again on the remaining 10 risers. Nailing near the ends of the jig to the over-length riser beneath will ensure that the resulting holes are lost when the risers are cut to their finished length.

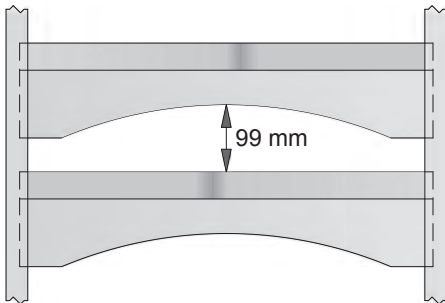


Figure 9.41 At 99 mm, the widest opening at the risers will not permit the passage of a 100 mm sphere.

length, which will be 610mm. The length is best determined by holding the two strings tightly together, back to back, and measuring the total thickness where there is a housing (Figure 4.57). Deduct this measurement from the overall staircase width:

$$650 - 40 = 610 \text{ mm}$$

I used a radial arm saw to crosscut the treads and risers to length. The design of the alternating treads and of the eyebrow risers means that dimensions should

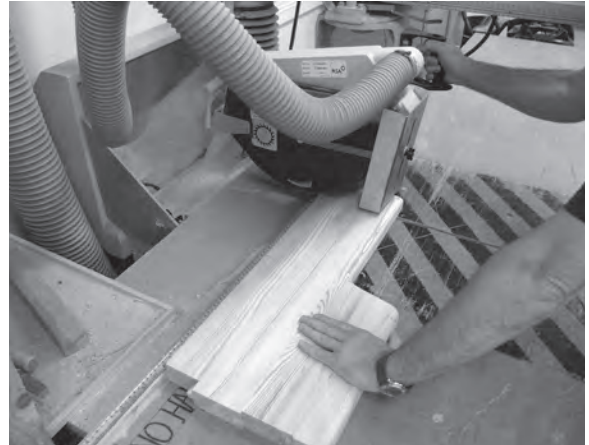


Figure 9.42 Measuring from the centre and trimming one end only is the first stage in cutting the treads and risers to length. Set up a stop to maintain accuracy when trimming the opposite ends.

radiate from the centre. Measure and mark centre lines on each of the treads and risers. Next, measure and mark on the crosscut table a distance from the blade of 305 mm (half the length of the treads and risers). Align the centre mark of the first tread with the mark on the crosscut table and trim one end only (Figure 9.42) before setting aside. Repeat with the remaining treads and risers (trimming one end only).

When all of the treads and risers have had one end trimmed, re-align the centre mark of the first tread with the mark on the crosscut table, ready to cut the opposite end. This time, though, set up a stop which will not only speed up the job but will also ensure that the finished lengths of all the treads and risers are identical.

Before proceeding, there is something extremely important that we must bear in mind: at this stage all 12 treads are identical, but now they must be handed so that we have six right-hand and six left-hand treads.

Take one tread and, in turn, insert firstly the wide side into a string housing, and then the narrow side into the corresponding housing on the opposite string. While doing so, ensure that the nosing is pushed fully home in the housing, and mark the position of the riser on the underside of the tread, and also where the tread meets



Figure 9.43 Push each tread fully into its housing, and mark the location of the riser housing and where the back of the tread meets with the underside of the string.



Figure 9.44 With a straight edge clamped to the underside of a tread, the routing of the riser housings can commence. Here a spacer block is used to accurately offset the straight edge by the correct distance.



Figure 9.45 Check the fit of a riser in the first housing routed before proceeding further.

the underside of the string (Figure 9.43). It's a good idea to repeat this for each of the remaining 11 treads, and number them so that each tread can be placed in the correct housing during staircase assembly.

With the riser positions marked on all 12 treads (remember, there should be six treads of each hand), we are now ready to rout 12mm wide by 8mm deep housings for the risers. Clamp a straight edge to the underside of the first tread, ensuring that it is offset by the correct distance. A spacer block whose width is equal to the cutter offset distance will not only save time when repositioning the straight edge on the remaining treads, but will also minimise the risk of error (Figure 9.44). After routing the first riser housing, test the fit of a riser before proceeding. Check that the riser protrudes from the underside of the tread by the correct amount which, in this case, is 100mm at the widest part (Figure 9.45).



Figure 9.46 (above), Figure 9.47 (below) and Figure 9.48 (opposite) With the blade tilted, the back of an alternating tread is angled on a circular rip saw. The sawn edge is then skimmed on a planer and the tread checked for fit. If satisfied, repeat the process for the remaining treads.

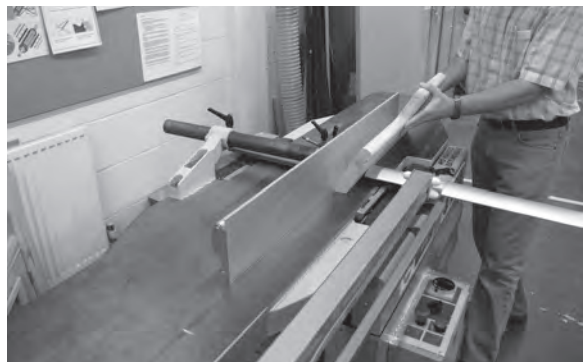




Figure 9.48

The angled cuts can now be made to the backs of the treads – I used a circular rip saw with the blade tilted (Figure 9.46). Cut on the waste side of the line and finish by skimming over a surface planer (Figure 9.47). As usual, test the fit of the first tread cut before proceeding with the rest (Figure 9.48). Before a tread and riser combination can be tested for fit, the rounded ends of the riser housings, seen in Figure 9.48, will need ‘squaring off’ with a mallet and 12 mm chisel.



Figure 9.49 Converting the top tread into a landing nosing. Having trenched the underside of the tread with a rebate block in a spindle moulder, the remaining waste is removed using a thin saw blade. Here, the guard has been removed for clarity.

The twelfth and top tread is now cut to form a landing nosing by having its back half diminished in thickness to match that of the decking on the upper floor (Figure 9.49). And lastly, the landing nosing at the top of the stairs, and treads number 1 and 2 at the bottom, are notched round their respective newel posts.

Ancillary components and final preparation before assembly

With the exception of cutting wedges (which are not required), all of the usual tasks should be undertaken in order to make the staircase ready for assembly. They are: drilling offset holes in the newel posts and string tenons for draw-bore dowelling; preparation of wooden dowel for draw-boring; cutting angled glue blocks to support the underside of each step; and cleaning up the strings, treads, and newel posts.

Screwing and pelleting

The staircase will be glued and, in the absence of wedges, screwed together. Screws heads in the inner string will not be visible after the staircase has been fixed against a wall, so can simply be countersunk. But those in the outer string will need concealing beneath softwood pellets. Use a pellet cutter to drill softwood pellets in a scrap piece of timber, preferably an offcut of the string itself (Figure 9.50). The pellets can be prized from the timber using a flat screwdriver or cut out on a band saw (Figure 9.51).



Figure 9.50 Cut pellets from a scrap piece of softwood.



Figure 9.51 A band saw enables rapid removal of pellets from the scrap piece of softwood.



Figure 9.52 Drill through the tread housings to ensure that the screw holes are correctly located.

Drill 6mm diameter clearance holes for 5.5 × 75mm wood screws (3 inch 12s) in the tread housings of the strings (Figure 9.52). Flip the strings over, and countersink the holes in the inner string and enlarge those in the outer string using a suitably sized flat bit or auger bit (usually 12mm) for the pellets.

Angled glue blocks

We have dispensed with unsightly wedges because the underside of the staircase will be seen. For the same reason non-standard glue blocks will be manufactured and installed. For a more 'presentable' appearance, their length will be equal to the internal width of the stairs and their edges chamfered (Figure 9.64).

Staircase assembly

Our alternating tread staircase will be assembled on edge on three evenly spaced trestles. Usually, to protect against clamp bruising and to evenly distribute the pressure from the clamps, a staircase is sandwiched between a pair of 50mm thick boards during assembly. Such an arrangement in this case, however, would prevent access to the screw holes in the strings. Instead, two narrow strips of timber (seen in Figure 9.60) will be used each side of the staircase which will leave the centre part of the strings accessible. So, having cleaned up all the components, positioned the trestles, and laid the inner (wall) string face up on two narrow strips of timber, the work will continue as follows.

Figure 9.53: Ensure that the tread and riser housings are free of dust, and apply PVA glue. Extra hands are helpful here, as it is important to work quickly before the glue goes off.

Figure 9.54: Locate the alternating treads in their housings, which should be pre-numbered to ensure a good fit.

Figure 9.55: Run a bead of glue into the riser housings and then tap the risers into position.

Figures 9.56 and 9.57: Coat the opposite ends of the treads and risers with PVA glue, before lifting the outer string into place, and carefully locating all of the treads and risers into their housings.

Figure 9.58: Protect the outer string with two narrow lengths of timber and then use T-bar clamps to pull the joints up nicely.



Figure 9.53 Apply PVA glue speedily to the dust-free housings of the wall string.



Figure 9.54 Tap the pre-numbered alternating treads into their housings.



Figure 9.57 Lift the outer string into place, carefully locating the treads and risers into their housings.

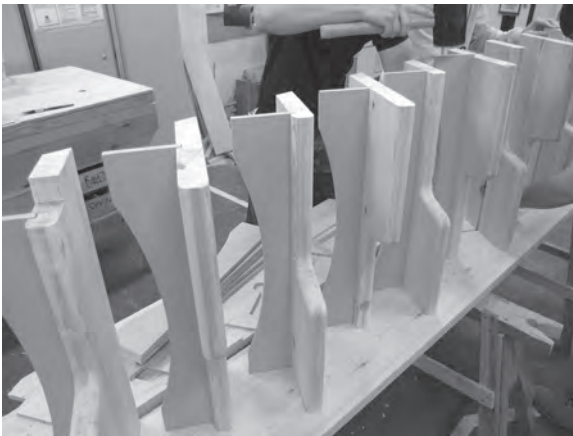


Figure 9.55 Glue and locate the open risers into their housings in the underside of the treads.



Figure 9.58 Apply pressure to the strings of the assembled staircase. Avoid clamp indentation by positioning narrow timber strips which also allow access to the strings' screw holes.



Figure 9.56 Apply PVA glue to the opposite ends of the treads and risers.

Figure 9.59: Check carefully that all the treads and risers are located correctly in their housings with the nosings fully up.

Figure 9.60: Using 5.5 × 75mm wood screws (3 inch 12s), screw through the outer string into the end grain of the treads. 'Dovetail' the screws slightly to better hold the treads. Lay the staircase down and screw through the inner string into the opposite ends of the treads.



Figure 9.59 Before screwing, check that the tread nosings are fully up in their housings.



Figure 9.62 Carefully cut the protruding pellets flush with the surface of the string.



Figure 9.60 'Dovetail' the screws for a better hold of the treads' end grain.

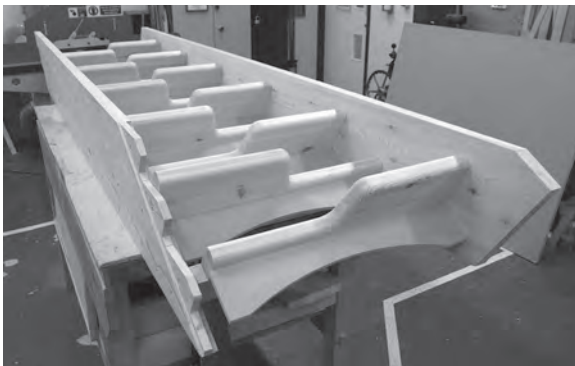


Figure 9.61 The clamps are removed from the assembled staircase.

Figure 9.61: The assembled staircase.

Figure 9.62: Apply a spot of glue and insert pellets into the holes in the outer string, then twist them so that the grain runs in the same direction as that of the string. The protruding pellets are 'flushed off' using a chisel and mallet.

Figure 9.63: Any steps where the tread backs meet the underside of the strings should be flushed off with a smoothing plane before sanding.

Figure 9.64: Glue and apply angled glue blocks to the underside of the steps, remembering that the underside will be visible, so it is important not to allow the glue to run.



Figure 9.63 Plane and sand the angled backs of the treads flush with the underside of the strings.



Figure 9.64 Apply full-width angled glue blocks to the underside of the steps.

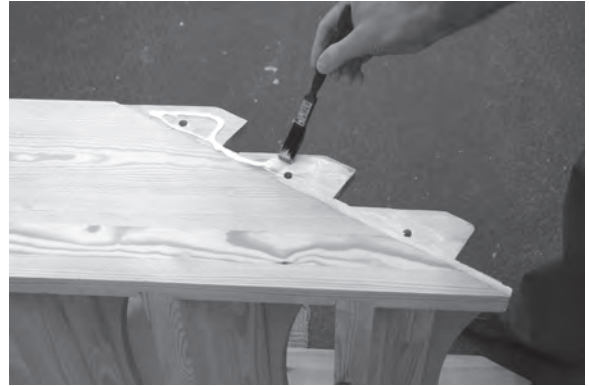


Figure 9.66 Coat the string tenon generously with PVA glue.

On-site preparation prior to fixing

Once the staircase is in its intended location, the newel posts can be glued and fixed permanently to the outer string. Lay the staircase on its side with the outer string uppermost (Figure 9.65). Coat the first tenon with PVA glue (Figure 9.66) and tap the newel post home. In Figure 9.67 the face of the newel post is protected from the blows of the mallet with a timber offcut. Insert wooden dowel into the pre-prepared offset holes to draw-bore the joint and pull the string shoulder up tight (Figure 9.68).



Figure 9.67 Tap the newel post home.

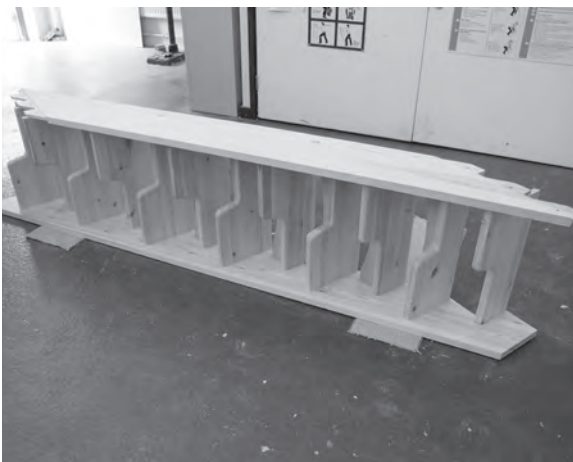


Figure 9.65 Lay the staircase on its side on carpet offcuts with the outer string uppermost ready to receive the newel posts.



Figure 9.68 Drive glued wooden dowel through the offset holes to pull the tenon shoulder up tight.

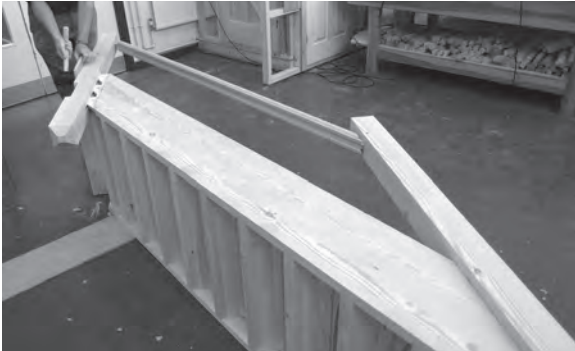


Figure 9.69 As the top newel post goes on, so too does the handrail between the two newel posts.



Figure 9.70 The staircase is ready for fixing.



Figure 9.71 The erected staircase. Note the full top riser hiding the landing joist.



Figure 9.72 The very steep angle of pitch is evident from this side profile.



Figure 9.73 This plan view of the staircase can be compared with Figure 9.5.

Time to fix the second newel post; at the same time, handrail is fixed between the two newel posts (Figure 9.69). Note that the top newel post has been

notched to sit over the face of the landing joist. Once the tenon shoulders at both ends of the string and both ends of the handrail have been pulled up tight by means of draw-boring (Figure 9.70) the staircase is ready to be lifted into place, hooked over the landing joist, and fixed.

Figures 9.71, 9.72, and 9.73 show the finished staircase. To comply with the guidance given in Approved Document K, a second handrail should be fixed to the wall on the right-hand side of the staircase, and the treads should be provided with slip-resistant surfaces.

10

Special Features

Whether replacing an existing staircase as part of a property refurbishment or working to an architect's design for a new-build house, certain individual design features will often be required. You will have noticed a variety of such features incorporated into the stairs built and described throughout this book; this chapter looks in detail at their design and construction.

Constructing a round-end step

A round-end step, such as the D-step seen in chapter 5's quarter-turn flight and the dogleg staircase in chapter 7, is defined by BS 5395-1:2000 as a 'step, at the

bottom of a stair, with a semicircular end that projects in front and to the side of the newel'. A similar definition is provided by the same publication for the starting step to chapter 8's circular staircase; a curtail step, it says, is a 'step, at the bottom of a stair, that projects beyond the string and is rounded to correspond to the rounded terminal or scroll of the handrail' (Figure 10.1).

The differences between the two types of starting step lie firstly in the amount of projection (the curtail step requiring a greater projection to correspond with the volute above), and secondly, where the steps project from – the newel post in the case of the D-step,



Figure 10.1 A curtail starting step corresponds to the handrail's volute, its projection forming the widest part of the flight. (Photo courtesy of Richard Burbidge Ltd)

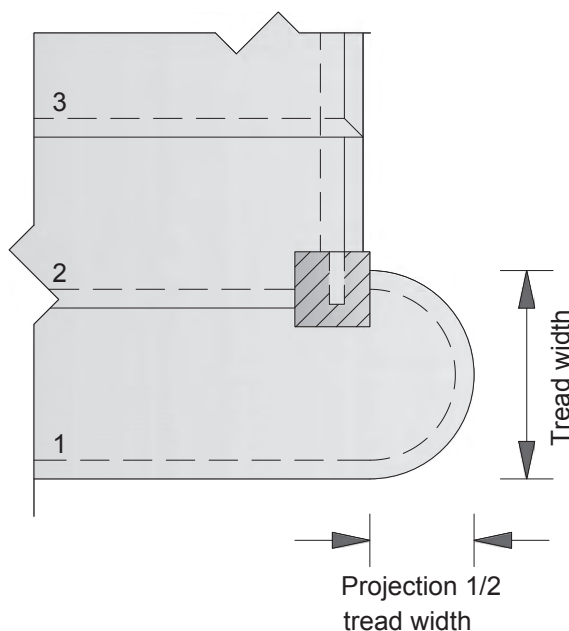


Figure 10.2 The semicircle of a round-end D-step projects from the newel post.

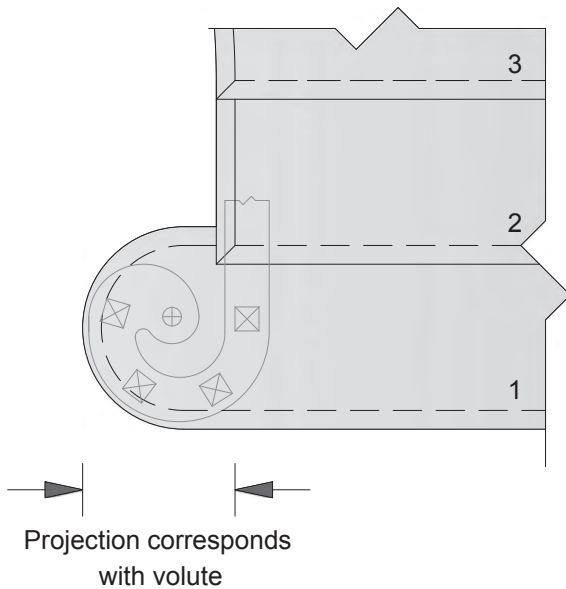


Figure 10.3 A curtail step corresponds to the handrail's spiral-shaped volute and projects from the string.

and for the curtail step, the string (Figures 10.2 and 10.3). Their methods of construction can be the same.

Step construction

The tread of a round-end starting step will be wider than all other treads in a flight by a distance equal to one nosing – usually 25 mm. Unlike the others, the starting tread, at its rounded end which returns to either the newel post or the string, is nosed at both the front and the back. And for the stability of a tread which is housed at one end only, its width is achieved by gluing up three tongued and grooved sections (Figure 5.8).

The step's riser is cut from a piece of 12 mm plywood of sufficient length for the staircase width plus the semicircular end, where the riser's thickness will be reduced, leaving only its face veneer and allowing it to be bent around a laminated block.

Laminated block

A laminated block supports both the tread at its round end and the riser, whose thickness is reduced, allowing it to be bent around the laminated block to form a semicircle. Much like plywood, whose strength and stability is achieved by laminating an odd number



Figure 10.4 (above) and Figure 10.5 (below) A block for the step's round end is built up in alternating layers of European Redwood.



Figure 10.6 Once the glue has dried, the laminated block can be thickened to its finished height.

of veneers with alternating directions of grain, the block is glued up in three layers with the grain of its two outer layers running in the same direction (Figures 10.4 and 10.5). The block seen here is sufficiently long for two round-end steps, and that length will, when the glue is dry, allow it to be passed safely through a thicknesser, reducing it to its finished height (Figure 10.6).

A compass is used to mark the block's round end (Figure 10.7), the diameter of which is equal to the stairs' going, minus twice the thickness of the plywood riser's face veneer. The diameter of a block suitable for a staircase with a going of 220mm, for example, will be:

$$220 (\text{going}) - 1.5 (\text{veneer}) - 1.5 (\text{veneer}) = 217 \text{ mm}$$

The block is cut out on a narrow band saw (Figure 10.8) and the offcut preserved for later use (Figure 10.9). Any irregularities in the block's rounding can be smoothed out with a belt sander (Figure 10.10).



Figure 10.7 The round end is marked onto the laminated block with a compass.

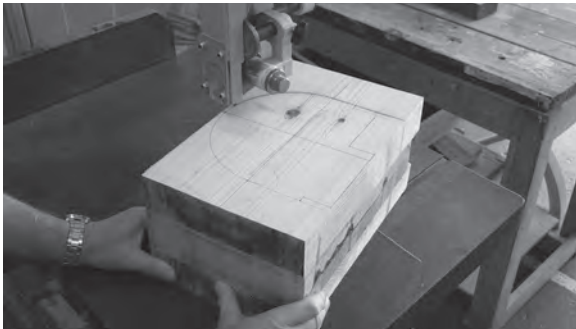


Figure 10.8 The block is cut to a semicircular shape on a narrow band saw.

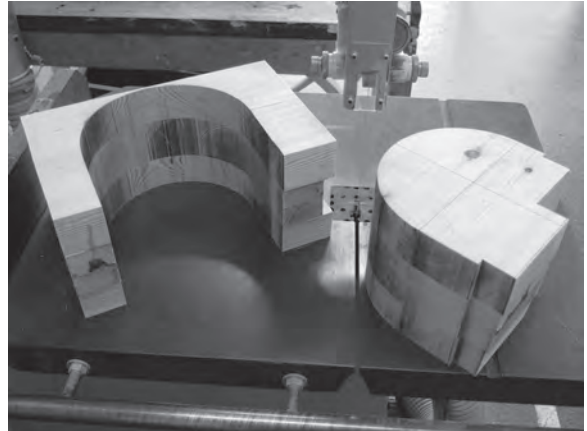


Figure 10.9 The offcut will be useful later when veneering the laminated block.



Figure 10.10 The block's semicircular surface is prepared for veneering with a belt sander.

Plywood riser

At the round end of the step, the plywood riser's thickness must be diminished so that it can be bent around the laminated block; the first task, therefore, is to work out the arc length of the block. The circumference length of a circle can be found using the formula:

$$\pi d \text{ where } d \text{ is the diameter of the circle and } \pi \text{ is pi, approximately } 3.142$$

The diameter of the laminated block is 217mm; its arc length is therefore:

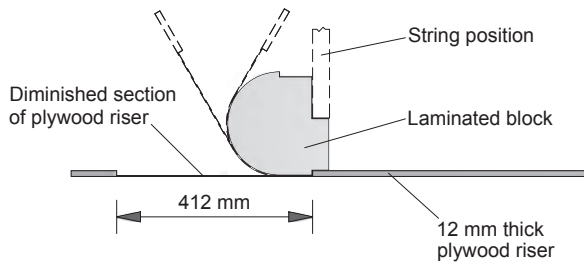


Figure 10.11 The length of the diminished section of the plywood riser should match that of the laminated block's arc.

$$3.142 \times 217 \div 2 = 340.9, \text{ say } 341 \text{ mm}$$

The total length of the diminished section of the plywood riser is:

$$341 \text{ mm} + 68 \text{ mm (flat section)} + 3 \text{ mm (tolerance)} = 412 \text{ mm (Figure 10.11).}$$

Once marked, the plywood's thickness is reduced by making repeated cuts with a radial arm saw raised 2 mm above the bench (Figure 10.12). The riser's inner surface is then belt-sanded, further diminishing its thickness and making it ready for gluing (Figure 10.13).

Gluing up

It is important to ensure that all items are free of dust before applying PVA adhesive generously to the riser's inner surface and to the laminated block (Figure 10.14). The riser is then wrapped carefully around the block, followed by the block's band-sawn offcut allowing pressure from clamps to be distributed evenly (Figures 10.15 and 10.16). The offcut is useful because the waste lost to the band saw provides clearance for the plywood's face veneer plus a sheet of newspaper to prevent the offcut sticking.

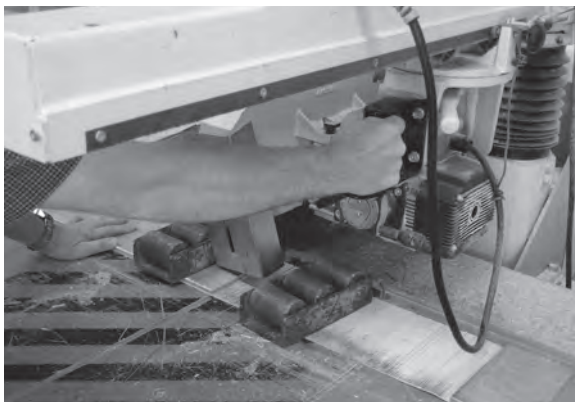


Figure 10.12 Weights keep the plywood riser firmly on the saw bench while its thickness is reduced using a radial arm saw.



Figure 10.13 The plywood riser's inner surface is belt sanded, making it thin enough and flexible enough to bend around the semicircular block.



Figure 10.14 PVA adhesive is applied to the carefully positioned plywood riser and block.



Figure 10.15 The diminished section of the plywood riser is wrapped around the semicircular block, leaving a short straight section which will return to the string.



Figure 10.16 The offcut, preserved after band sawing earlier, is now used to distribute pressure from clamps. Newspaper will prevent the outside of the plywood veneer from sticking to the timber offcut.



Figure 10.17 A D-step's smaller projection requires no straight return to the newel post.

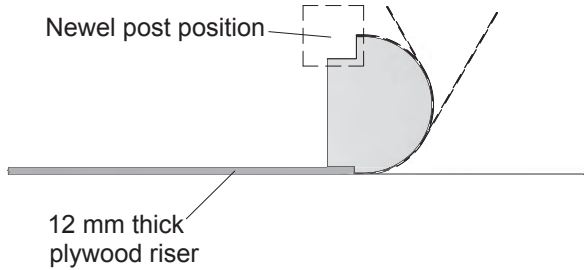


Figure 10.18 The absence of a straight return at the rear of the semicircular block can be seen clearly in this plan view of a D-step.

The difference in the amount of projection between the two types of starting step can be seen clearly during the gluing of the plywood riser. The curtail step's riser has a small length of full-thickness plywood next to the diminished area which allows a short straight section to return to the string, unlike the D-step where the return end of the semicircle ends at the newel post (compare Figures 10.11 and 10.15 with Figures 10.18 and 10.17).

Shaping the tread

The radius of the tread's round end is 25 mm greater than that of the riser below (assuming a 25 mm nosing). It can be marked with a compass and cut out on a band saw (Figure 10.19). The rough sawn semicircular end can then be smoothed off using a disc sander (Figures 10.20 and 10.21). The tread's nosing is applied using an electric router with a bearing-guided round over cutter with a radius of 12.7 mm (Figure 4.48). And the riser housing on the underside of the tread – which is routed on the straight section only and stopped just before the semicircle begins – is cut to a depth of 6 mm using a 12 mm diameter straight fluted cutter (Figure 10.22).

Final assembly

The tread and its nosing are cleaned up and all dust removed, making the step ready for final assembly (Figures 10.23 and 10.24). PVA adhesive is applied to the top of the laminated block and within the tread's riser housing before the two components are brought together (Figures 10.25 and 10.26). The fixing is made

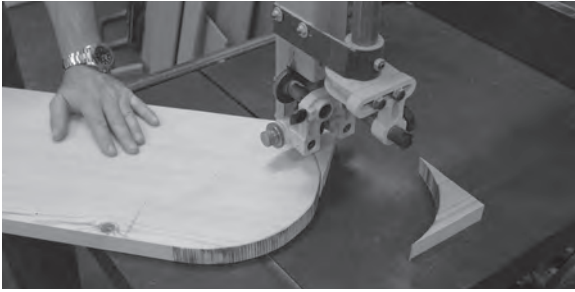


Figure 10.19 The marked starting tread is cut on a narrow band saw to produce its round end.

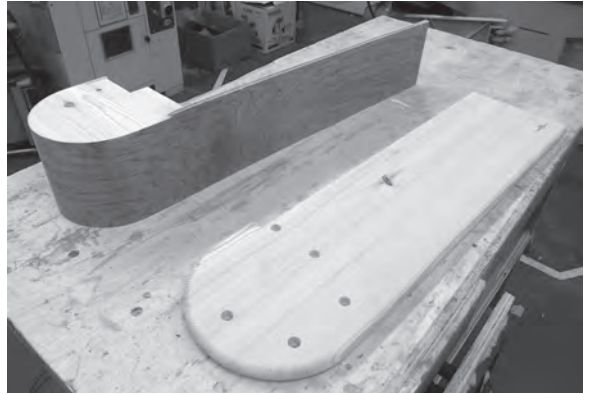


Figure 10.23 The curtail step (pre-drilled using a volute template – see chapter 11) is ready for final assembly.



Figure 10.20 (above) and Figure 10.21 (below) The tread's rough-sawn round end is cleaned up using a disc sander before the nosing is applied.

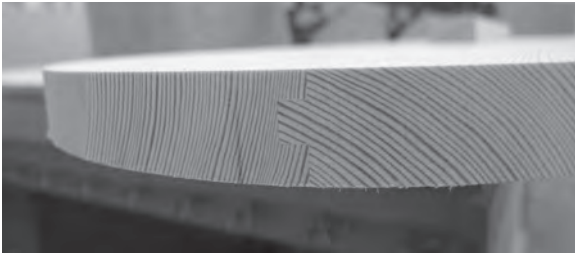


Figure 10.24 The D-step, with its notched rear for housing into the newel post, is ready for final assembly.



Figure 10.22 Running off a straight edge, the riser housing is routed into the underside of the tread; the round end is not grooved.



Figure 10.25 PVA adhesive is applied to the top of the laminated block and within the tread's riser housing.

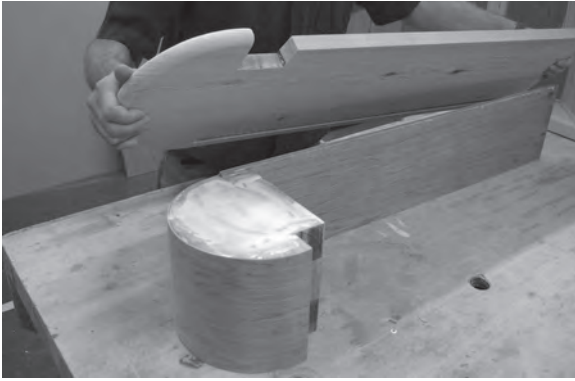


Figure 10.26 The two components are brought together.



Figure 10.29 The D-step viewed from the underside. Glue blocks provide additional support where tread and riser meet.



Figure 10.27 The curtail tread is screwed down into the laminated block through its pre-drilled holes.



Figure 10.28 The D-step's screws are concealed beneath wooden pellets. Note the notches in both the tread and laminated block's rear where the step will be housed into the newel post.

secure by screwing down through the tread's upper surface into the solid block below (Figure 10.27). The screw positions for the curtail step have already been determined using a volute template and will be concealed by the later installation of balusters (see chapter 11). Those for the D-step will need to be marked and drilled, and the screws concealed beneath timber pellets (Figure 10.28).

Additional support for the tread and riser is provided by glue blocks applied to the underside (Figure 10.29). The finished D-step is shown in Figure 5.70 and the curtail step in Figure 8.126; their installation is described in chapters 5 and 8 respectively.

Constructing a bullnose step

Another decorative feature often provided at the foot of a staircase is a bullnose starting step (Figure 10.30). Traditionally, such a step would be constructed by gluing together pieces of softwood (to achieve the step's height) which would then be shaped on a band saw to form a backing block, around which a thin veneer would be applied (Figures 10.31, 10.32, and 10.33). A preformed plywood bullnose riser provides a modern, cost-effective alternative (Figure 10.34).

Available in a choice of veneered finishes, the preformed riser's standard thickness is 9mm and



Figure 10.30 The quarter-round of a bullnose starting step provides an attractive feature at the foot of a staircase. (Photo courtesy of Richard Burbidge Ltd)

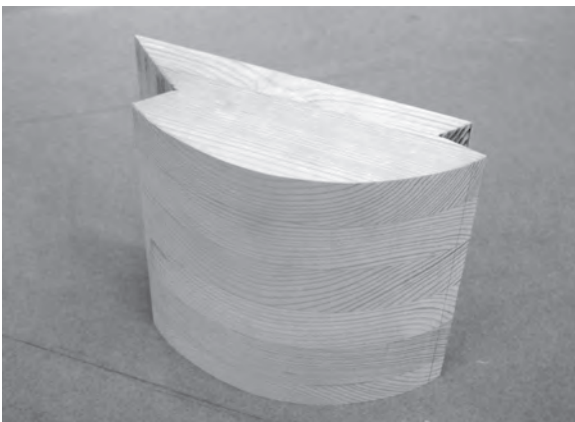


Figure 10.31 Much like a round-end step, a laminated block can be used to form the quarter round of a bullnose step.



Figure 10.32 Submerging the European Redwood riser in water for 24 hours makes the diminished thickness section pliable enough to bend round the laminated block.



Figure 10.33 The wet riser is clamped to the laminated block, where its shape is held while it dries sufficiently for gluing.

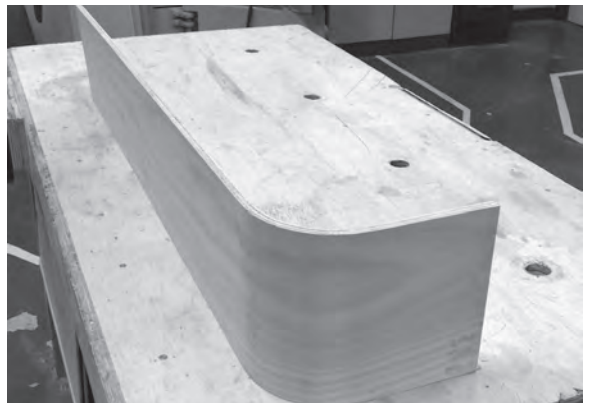


Figure 10.34 A preformed plywood bullnose riser.

its length and height can be cut to suit most private staircases; the external radius of the bullnose is typically 95mm.

With the starting tread cut, shaped, and nosed, the bullnose riser is laid on the inverted tread and offset by 25mm (the size of the tread's nosing). The tread is marked where the straight section of the riser ends and the bullnose begins (Figure 10.35). The underside of the tread is grooved to house the straight section of the riser only, while the preformed riser is notched to fit (Figure 10.36). The assembled step is supported by the application of glue blocks (Figure 10.37). Figure 10.38 shows the finished bullnose step.

Cut and mitred strings: methods of cutting

Cut and mitred strings are outside strings found on higher-end staircases; the additional work involved in cutting and mitring a string – and its treads and risers – as opposed to routing housings, leads to an increase in costs and hence a higher end price. However, the resulting staircase, with its steps visible when viewed from the side, is very attractive and highly desirable.

The quarter-turn and dogleg staircases, seen in chapters 5 and 7 respectively, were built with open outer strings that were cut and mitred using a hand-

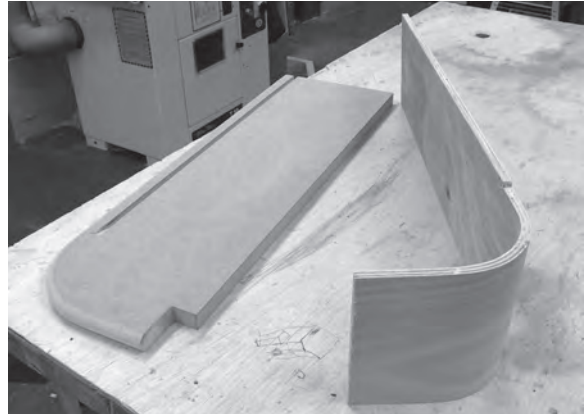


Figure 10.36 A stopped groove is cut into the underside of the tread, and the top of the preformed riser is notched to suit.

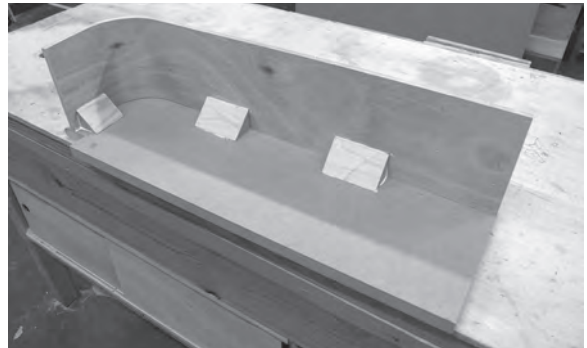


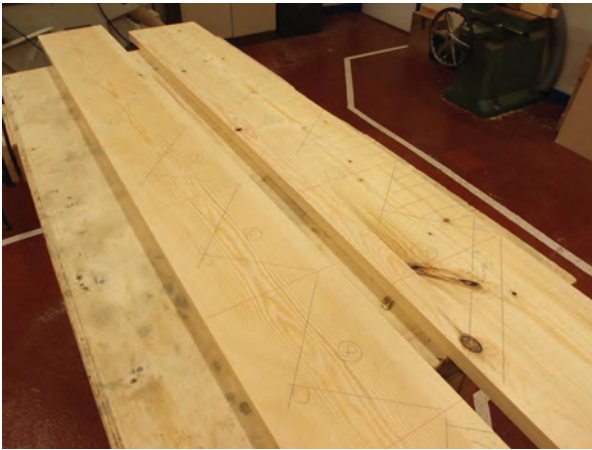
Figure 10.37 The joint between the riser and the tread is supported with angled glue blocks.



Figure 10.35 The underside of the bullnose tread is marked to house only the straight section of the riser.



Figure 10.38 The finished bullnose starting step. Note the L-shaped notch at the left-hand rear of the tread, prepared so that the step can be housed into the bottom newel post.



A marked pair of strings. On the left, the inner, closed wall string with nosings marked ready for routing. And on the right, the outer, open string with waste shaded ready for cutting and mitring. See page 110.



Much of the work in removing the triangular waste pieces from this open string is carried out with a hand-held circular saw. The cuts are stopped short of the intersecting riser and tread lines and finished with a hand saw so that the string is not unnecessarily weakened. See page 60.



This wide intermediate newel post is being mortised ready to receive the tenons of two outer strings. The machine's clamp has been removed to accommodate the newel post which, instead, is held secure with a pair of F-clamps. See page 111.

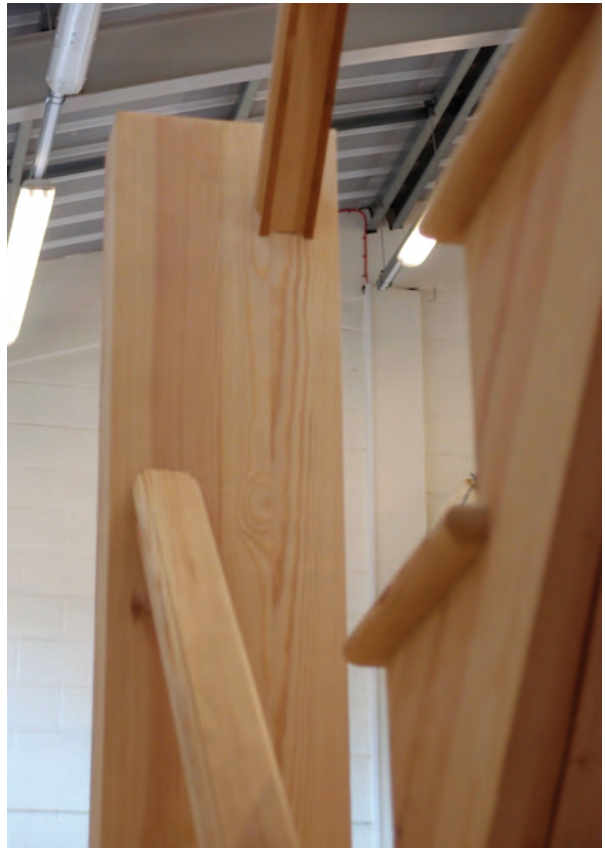


Above: In preparation for concealing the screws that will fix this round-end tread to the solid block below, holes for pellets are drilled with a 12 mm flat bit. The rear of the assembly has been notched for housing into the bottom newel post. See page 178.

Left: These two steps are the first and last to be carried by the cut and mitred outer string (seen top). Laying face up on the trestles is the closed inner wall string to which the treads have been temporarily dry-wedged while being glued and screwed to the open string. See page 112.



The wide intermediate newel post continues down to floor level and supports the half landing at its mid point. The mortises near the top of the newel post will accommodate the handrail tenons, and those further down the tenons of the two outer strings. See page 114.



Looking up from the foot of the dogleg staircase towards the intermediate newel post. Visible are the underside of the upper handrail and the upper side of the lower handrail, which has been set out to provide adequate finger room during use. See page 115.



The outer string tenon of the upper flight of this dogleg staircase is seen here being offered into the intermediate newel post's mortise. The tread, with its nosing return, has been notched round, and will be housed into the newel post. See page 115.



Looking down from the top of the dogleg staircase towards the half landing. The landing has been decked and the treads, with their mitred nosing returns, have been drilled to receive dowelled balusters. See page 205.



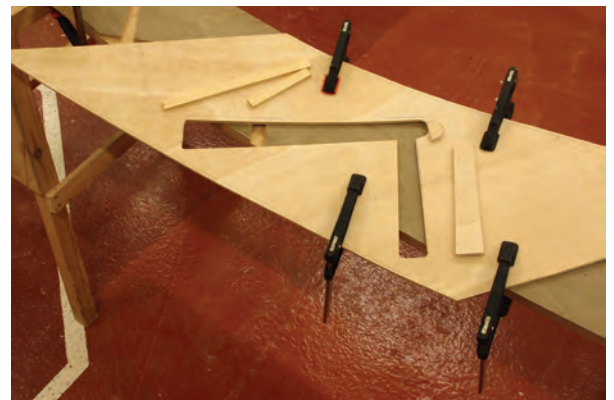
A dogleg staircase with half-turn landing, complete with handrail and balustrade and newel caps. See page 207.



Laminating a circular stair string round a bending form requires the availability of a clamp or two. The glued-up string must stay in clamps for 48 hours in order to retain its shape. See page 129.



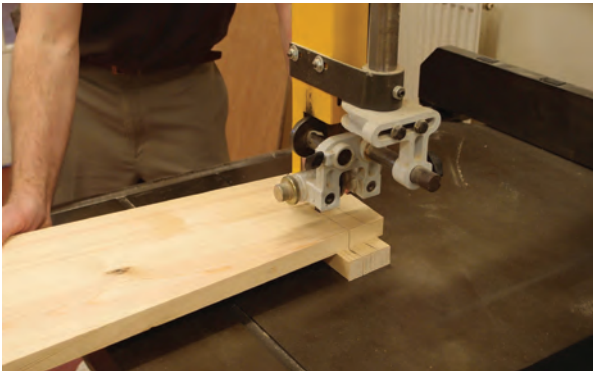
Above: Trammel heads clamped to a timber batten: perfect for setting out circular stair strings on a sheet of plywood. See page 119.



This shop-made router jig, complete with infill pieces and spacer blocks, has been constructed from an offcut of flexi ply – perfect for routing the concave surface of a circular string when clamped securely. See page 131.

Right: The first stage of the cutting and mitring of this circular open string is carried out with a hand-held circular saw. The string is secured to, and supported by, a pair of trestles. See page 135.





A band saw, with its thin, wobbly blade, might not seem the right choice for cutting and mitring treads and nosing returns; in fact, it is the perfect choice.

This tapered tread is nailed to its nosing return beneath, and both items are cut simultaneously, which will result in a perfect fit. See page 139.



Circular staircases are usually assembled as if being built in situ. With the strings levelled and secured above the plywood rod, assembly starts at the top of the flight with the gluing and nailing of mitred risers to the open string. See page 145.



This mitred nosing return is being offered to its corresponding tapered tread and will be secured with glue and nails. Both items have been numbered as a matching set. See page 141.



Above: Tapered treads are glued and screwed to the open string below. The holes, through which the screws are passing, will later house dowelled balusters which, in turn, will conceal the screw fixings. See page 146.



The 18 mm diameter holes being drilled into this tapered tread are centred on the balustrade centre line. Through the holes the tread will be screwed to the string, and into the holes will be housed dowelled balusters. See page 142.

Opposite page, top left: This fully assembled 8-rise circular staircase is complete with over-the-post handrail, balustrade, and volute. See page 230.

Opposite page, middle left: The routed strings of an alternating tread staircase, with wide and narrow housings for paddle-shaped treads. Although a handed pair, the two strings do not mirror each other. See page 157.

Opposite page, bottom left: These two paddle-shaped treads have just been cut roughly to shape using a band saw. So that waste is minimised, they were cut from a single board which had been glued up to achieve the required width. See page 159.



The rough-sawn front edge of this paddle-shaped tread requires planing before it can be nosed; it is 'planed' using a router fitted with a 12 mm straight fluted cutter. Guidance is provided by a 30 mm guide bush running off a jig. See page 161.



The paddle-shaped tread has a smooth planed front edge, making it ready for nosing and bringing it to its finished width. See page 161.



The newly assembled alternating tread staircase lying on the work bench. In the foreground, the right-hand rear corner of the top tread has been notched for housing into the upper newel post. This view shows the reason for the staircase's name. See page 168.



The steeply-pitched alternating tread staircase with open 'eyebrow' risers. Handrail was fitted ahead of installation; string capping and balusters will be fixed next. See page 170.



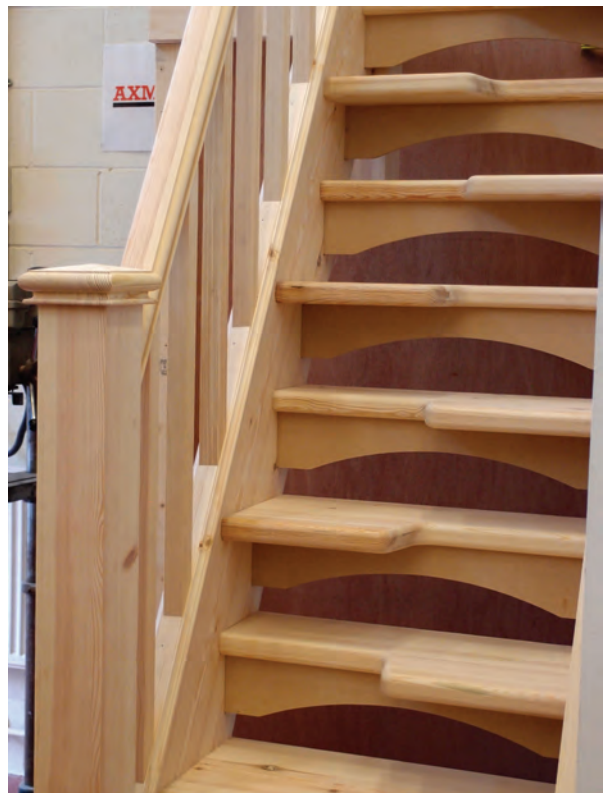
Underside of the alternating tread staircase, showing the chamfered finish to the drop newel post, full-width angled glue blocks, and non-wedged treads extending back to finish flush with the underside of the strings. See page 170.



This view of the foot of the alternating tread staircase shows the string capping fixed to the top of the outer string and the balusters and timber fillets cut to length and ready for fixing. See page 201.



Alternating tread staircase complete with handrail and balustrade and, providing the finishing touch, a newel cap. See page 201.



The gaps between balusters and spaces beneath eyebrow risers provide many openings in this alternating tread staircase. Careful setting out means that, in accordance with Approved Document K, none will permit the passing of a 100 mm sphere. See pages 162, 163 and 198.



These 18 mm diameter holes being drilled in this curtain tread will house dowelled balusters extending down from a Richard Burbidge volute above. The hole locations were set out using a trace template provided with the volute. See page 215.



Ridges, caused during routing, are evident in the concave edge of this circular handrail. They will be smoothed out using the wooden moulding plane which is fitted with a rounded fluting cutter. See page 214.



Rigidity of balustrade where there is a volute can be enhanced by fixing a curtain tread's last baluster to the next ascending riser (and string). Notches, cut in both the baluster and the tread nosing, allow the baluster to be butted firmly against the riser. See page 224.



This Richard Burbidge volute, viewed from the underside, shows how square tenons, rather than round dowels, securely hold the balusters at the correct angle as they rotate the volute and also prevent the balusters turning after installation. See page 226.



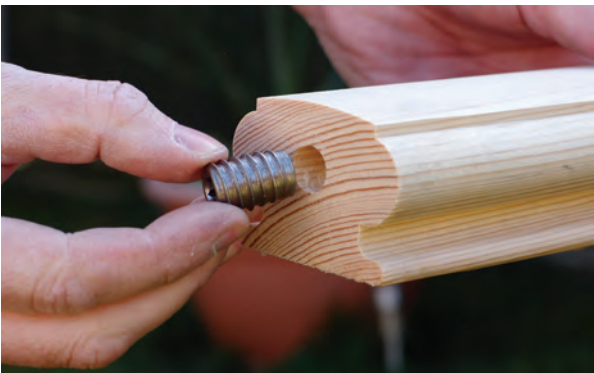
This plan view shows the staircase's circular shape and its handrail sweeping down to join the spiral-shaped volute. See page 229.



During the installation of a new horizontal balcony balustrade, a level handrail is achieved by first marking the top-of-handrail height on the existing newel post and then transferring that height to what will be the balustrade's opposite end. See pages 244 and 245.



Shrinkage of a newel post would cause handrail connected to it to appear short. Letting the shoulders of horizontal handrail into the newel post provides a gap-free and shrink-proof joint. See page 196.



Lifting this near-5-metre length of handrail onto the wall-mounted brackets is a two-person job. Once in position, the handrail is secured by screwing up through the brackets into the underside of the handrail. See page 254.



This refurbished and now creak-free staircase, dating from around 1930, benefits from a new short length of handrail and balustrade on its right-hand side, a new wall-mounted handrail on its left, and, at the top, a new horizontal balcony balustrade. See page 255.

Left: This insert (the first of a three-part handrail bolt) has a male thread and is about to be screwed into a pre-drilled hole in the end face of this handrail. The insert also has a female thread, into which will be screwed a connecting bolt allowing the handrail to be lengthened. See page 251.



Figure 10.39 This beautiful open-string staircase – one of several flights spanning two stories – was manufactured in American white oak by Totally Bespoke Joinery Limited in Rochester, Kent.
(Photo courtesy of Frank Turtle)

held circular saw, which can be either guided by a straight edge or used freehand. An alternative method was used during the construction of the oak staircase seen in Figure 10.39, which was manufactured by Totally Bespoke Joinery Ltd (TBJ) in Rochester, Kent.

The open strings of TBJ's staircase – one of a number of flights which spanned two storeys – were cut and mitred in two distinct operations, the first of which was the cutting of the tread lines. Once cut, the strings provide surfaces upon which the treads are seated. These surfaces, which are square to the face of the string, were cut using a hand-held circular saw guided by a straight edge, just like those for the quarter-turn staircase in chapter 5 (Figure 10.40).

Next, the riser lines; and here, rather than bring the saw to the string, the string was taken to the saw – a chop saw, angled to the marked riser lines and tilted to 45° (Figure 10.41). In both operations, care was taken to not cut beyond the intersecting lines which would have weakened the strings; instead, the triangular waste pieces were removed with a handsaw (Figure 10.42).



Figure 10.40 The tread lines are cut with a hand-held circular saw guided by a straight edge.



Figure 10.41 The mitred riser lines are cut using a chop saw. (Photo courtesy of Frank Turtle)

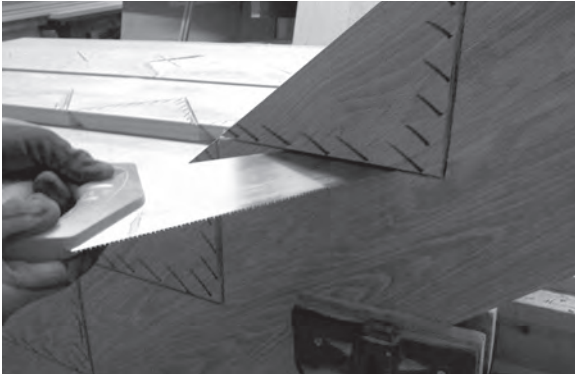


Figure 10.42 Finishing the cuts with a hand saw avoids unnecessarily weakening the string. (Photo courtesy of Frank Turtle)



Figure 10.43 Using a chop saw to mitre the strings' riser lines highlights the difference in thickness between the string and the riser, which backs against an angled glue block.

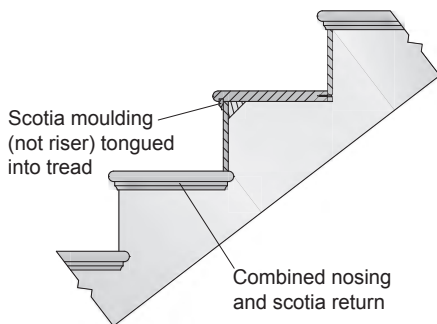


Figure 10.44 Section through the open side of TBJ's oak staircase.

The use of the chop saw is undoubtedly an effective and speedy way of mitring the riser lines. However, it does produce a different result to that seen in chapters 5 and 7, where a combined mitre and rebate produced a 'backing' for the risers. Backings for TBJ's solid oak risers were provided by angled glue blocks (compare Figures 10.43 and 5.22).

Tread preparation

TBJ's oak staircase has been finished with a decorative scotia moulding, fixed beneath the nosings of each step. The scotia (and not the risers) is housed into grooves routed into the underside of the treads. The moulding is returned, together with mitred nosings, along the treads' open ends; but here, each nosing and scotia return is a single component which, when fixed, matches the two separate components running across the face of each step (Figure 10.44).

Work on the combined nosing/scotia returns starts with the shaping of what will be the short end grain at the rear of the components. Using a spindle moulder to shape the end grain of a piece of oak just 25mm wide would only be possible with the aid of a jig. TBJ overcomes the problem by machining the end grain of wide boards prior to ripping them down into 25mm wide strips (Figures 10.45 and 10.46). With the end grain



Figure 10.45 (above) and **Figure 10.46** (opposite page, top left) The end grain of wide boards are spindle to produce combined nosing and scotia mouldings. (Both photos courtesy of Frank Turtle)

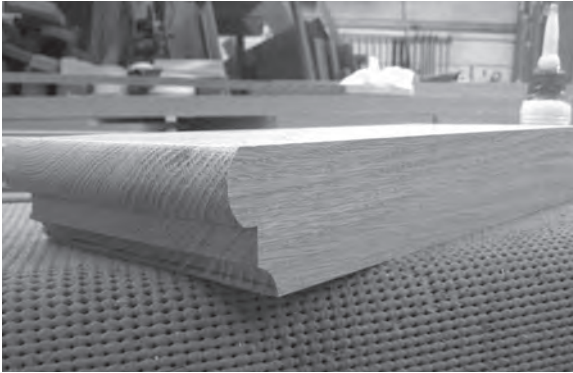


Figure 10.46

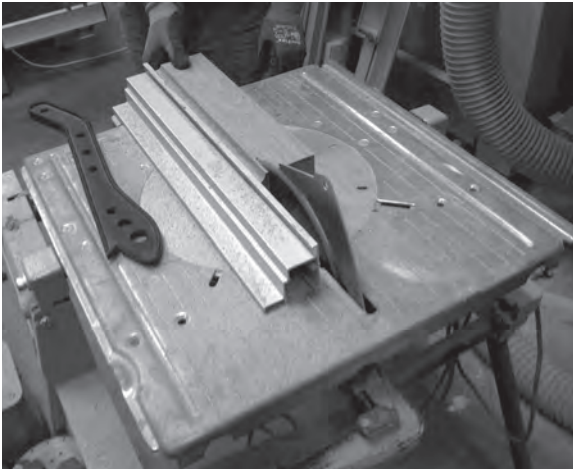


Figure 10.47 (above) and Figure 10.48 (below) The boards are then alternately moulded and then ripped to produce nosing/scotia returns. (Photos courtesy of Frank Turtle)

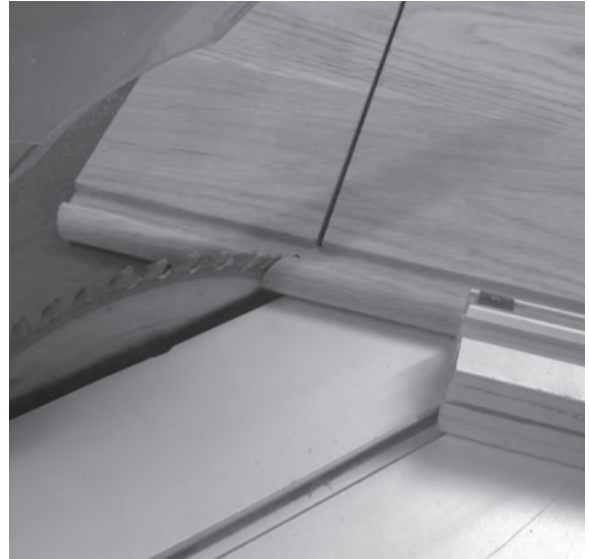
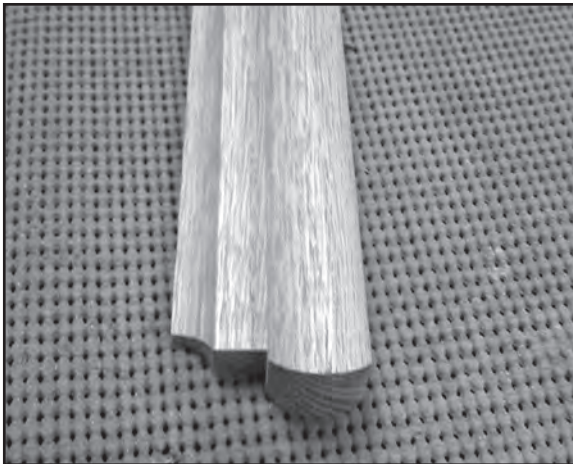


Figure 10.49 In two operations, a small dimension saw is used to crosscut and then mitre the treads' open ends. Guard lifted clear for clarity. (Photo courtesy of Frank Turtle)

shaped, the nosing/scotia returns are produced by repeatedly alternating between shaping the long grain and then ripping a return (Figures 10.47 and 10.48). The open ends of the treads are cut and mitred using a small dimension saw (Figure 10.49). (This operation is demonstrated and described in greater detail using a band saw in chapter 5.)

At the closed side of the stairs, the treads and risers are glued and wedged into housings routed into the wall strings – housings that include the scotia's profile (Figures 10.50 and 10.51). At the open side, the treads are glued and screwed to the cut string (Figure 10.52); the countersunk screws have been carefully positioned so that they will be covered by 45 mm balusters to be dowelled immediately adjacent to the screws. The combined nosing/scotia returns are glued and nailed to the tread ends (Figures 10.53 and 10.54).

Two views of the staircase during site fixing show, firstly in Figure 10.55, the underside, where a centre carriage has been provided to support the centre of the steps, and secondly, in Figure 10.56, sheet foam protecting the American white oak treads.



Figure 10.50 (above) and Figure 10.51 (below) Tread and riser housings routed into the wall strings include an allowance for the scotia mouldings.



Figure 10.52 The treads are fixed to the open strings with glue and countersunk screws, before the nosing/scotia mitred returns are attached.



Figure 10.53 The nosing/scotia returns are glued and nailed in place.



Figure 10.54 The combined nosing/scotia mitred return (a single item) intersects nicely with separate items, the tread and scotia moulding.

Open-to-closed strings

For some (and I largely share this view), a closed string should only be used where a staircase abuts a wall; where there is an exposed side to a flight there should be an open string. During my time in Canada, where I worked for one of North America's leading manufacturers of production and custom staircases, a closed outer string was almost unheard of. There are instances, however, where a wall, against which a staircase abuts, stops short of the foot of the staircase, resulting in a side which is partially open and partially closed and requiring a string which is partially open (cut and mitred) and partially closed (housed) (Figure 10.57).



Figure 10.55 This view of the flight's underside shows a centre carriage supporting the steps. (Photo courtesy of Frank Turtle)



Figure 10.56 The stairs are protected during installation with sheet foam covering the treads. (Photo courtesy of Frank Turtle)

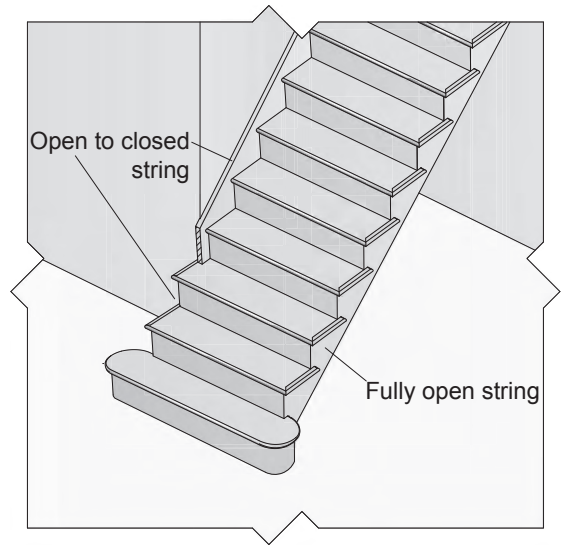


Figure 10.57 An open-to-closed string can be used where a wall, against which a staircase is fixed, doesn't extend all the way to the foot of the staircase.

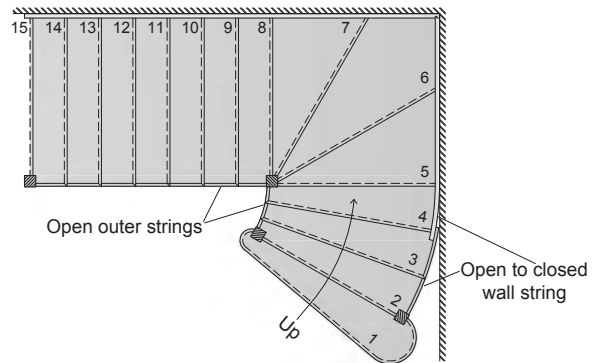


Figure 10.58 Plan view of the 'Ascot' staircase with its open-to-closed right-hand string.

Open-to-closed strings are often required on circular stairs, where the sweep of the flight takes the closed string away from the wall. Figure 10.58 shows the layout of a staircase built by Stephen Parry and me in 2001 (before we both moved from industry to education) for a client owning a beautiful house in Ascot in Berkshire. (Steve can be seen in chapter 11 demonstrating the manufacture of a circular handrail.) The 'Ascot' staircase, manufactured in American white oak,

Distance between start of closed section of string and face of next ascending riser to suit balustrade layout

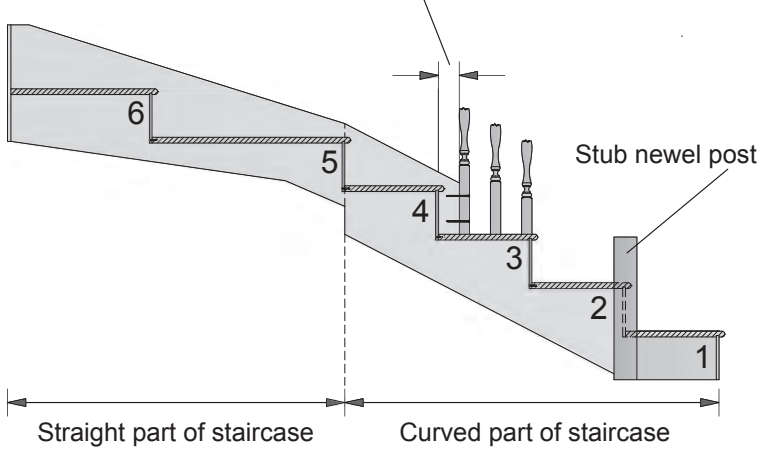


Figure 10.59 Vertical section through the open-to-closed right-hand string of the Ascot staircase.



Figure 10.60 Using information from the architect's drawings and a visit to site, 1:10 scale line drawings are produced prior to manufacture of the Ascot staircase.

starts on the ground floor with a short circular section, leading to three winders turning left 90°, and followed by seven straight treads up to the first floor.

The flight's circular section is open on both sides with double mitred treads and risers. The right-hand string sweeps round to meet with the return wall where the steps are then housed into the string, resulting in an open-to-closed right-hand string. The distance between the point where the open section of string ends and the closed section begins and the face of

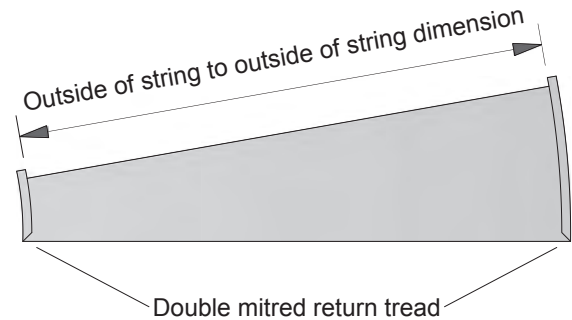


Figure 10.61 A staircase open on both sides requires double-mitred treads and risers.

the next ascending riser can be cut according to the client's preference. However, as a general guide, cutting the string so that it abuts the last baluster on the open part of the staircase provides an additional fixing point that strengthens the balustrade assembly (Figure 10.59).

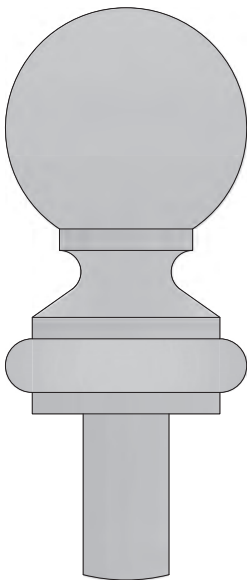
The cutting and mitring of nosing returns for circular treads is demonstrated in detail in chapter 8. Chapter 8's circular staircase is open on one side, but where a staircase is open on both sides, the treads require mitred nosing returns at each end (Figure 10.61). The completed circular section of the Ascot staircase, with its open-to-closed right-hand string, can be seen in Figures 10.62 and 10.63. Stub newel



Figure 10.62 (above) and Figure 10.63 (below) The circular section of the newly built Ascot staircase – still in the workshop – with its open-to-closed right-hand string.



Figure 10.64 A newel post-topping finial with connecting spigot.



posts are provided, upon which turned upper sections will later be fixed.

Newel capping

The tops of newel posts can be finished with decorative features such as finials (Figure 10.64) and newel caps. These items are available to purchase off the shelf from DIY stores and specialist suppliers of stair parts. A spherical finial is turned on a wood lathe, while the making of a newel cap is demonstrated below.

The 'pyramid' newel cap that we are going to make is 54 mm thick and will overhang the 100 mm square newel post by 20 mm all round, making the size of the newel cap 140 mm square (Figure 10.65). It will be moulded to match the stair handrail, and as the major work involved in producing the newel cap is the setting up of the woodworking machinery, it makes sense to run several out at the same time. Running out a number of newel caps also means that the timber can be planed up in a sufficiently long length to make using a planer-thicknesser safer than it would be planing a short length. So the first task is to prepare a piece of timber with a finished sectional size of 140 mm wide by 54 mm thick, the length of which will provide the required number of multiples of 140 mm.

A gap-free joint between the newel cap and post is achieved by housing the underside of the newel cap. The 10 mm deep housing can be trenched out on a mortising machine (Figure 10.66), its length and width

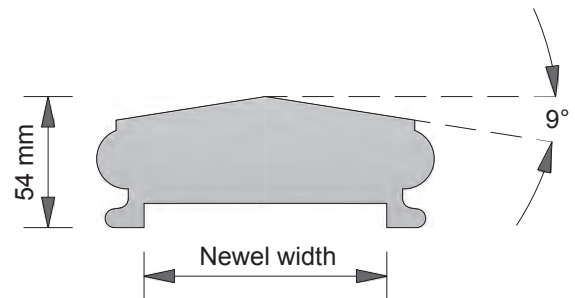


Figure 10.65 A pyramid newel cap, housed to suit the sectional size of the newel post.



Figure 10.66 A mortiser is used to trench out the underside of the newel cap to suit the size of the newel post.

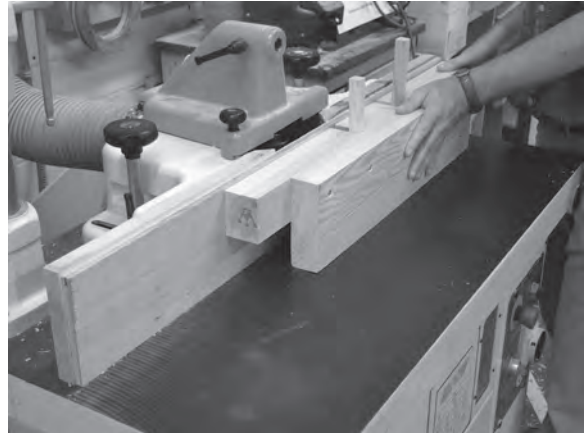


Figure 10.68 An item as short as a newel cap can only be spindled safely with the aid of a jig.

matching the sectional size of the newel post. It should be cut to ensure a snug fit but not so tight as to cause the short grain of the newel cap to break.

From a safety point of view, it would be nice if all machining operations could be carried out while the timber is in one long length. However, as mouldings must be applied to all four sides of the newel cap, there is no alternative but to machine each cap individually – running a piece of timber just 140mm long through a spindle moulder can only be done safely with the aid of a jig.



Figure 10.69 After cutting across the grain, two of the four passes required to form the pyramid are complete.

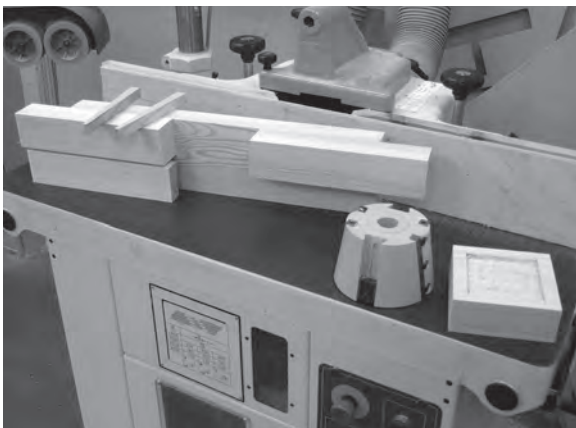


Figure 10.67 A 9° sill head will be used to form the pyramid on the newel cap's upper surface.



Figure 10.70 The completion of the pyramid is the end of the first spindle operation.

The jig shown in Figure 10.67 can be made quickly and easily from a piece of planed timber around 800mm long with a width to match that of the newel cap (140mm). Three smaller pieces of timber are screwed to the first, creating a void in the centre large enough to accommodate the newel cap, which will be secured with a pair of large wedges. The first operation is the cutting of the pyramid-shaped upper surface with a 9° sill head (Figure 10.67). For this operation the jig is used in an upright position (Figure 10.68), and breakout is avoided by wedging the newel cap tightly against the jig's lower rear plant-on piece and by applying mouldings across the grain first and with the grain second (Figure 10.69); care should be taken to prevent the sill head's spur cutters from scribing a line across the newel cap. With four passes through the spindle, the pyramid is complete (Figure 10.70).

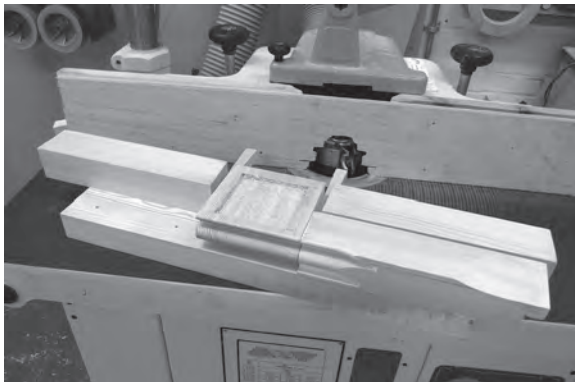


Figure 10.71 A handrail profile is applied to the sides of the newel cap.

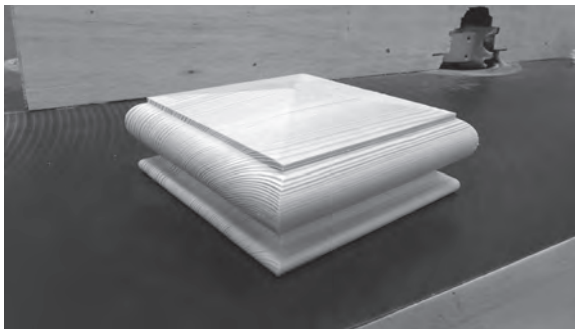


Figure 10.72 The finished newel cap.



Figure 10.73 A newel cap provides an attractive finish to the top of a newel post.



Figure 10.74 The newel cap is glued and nailed through pre-drilled holes in its sides into the newel post.

The second spindle operation is the cutting of the profile around the sides of the newel cap to match that of the stair handrail (the cutters used can be seen in Figure 11.9). This time, the jig is used flat, and what was its front end becomes its back and vice versa. Protection from breakout is once again provided by the same plant-on piece which has been unscrewed and re-fixed at the opposite side of the newel cap (Figure 10.71). The finished newel cap is shown in Figure 10.72. The newel cap is glued to the top of the newel post (Figure 10.73) and secured by pinning through the sides (Figure 10.74).

11

Railings

Throughout this book we have looked at a variety of staircase designs including straight, L-shaped, dogleg, circular, and alternating tread. What they all have in common is a requirement to guard users from the risk of falls by providing a safety barrier at open edges, at the top of which is a handrail that can be grasped comfortably. As well as the handrail, the barrier is made up, on traditional staircases, of narrow vertical members called balusters (or spindles), secured at their ends with either glue and dowels or grooves and timber fillets, or, as seen increasingly on modern or contemporary stairs, panels made from glass and steel. Collectively, the components that make up the barrier are known as balustrade, held rigid by newel posts placed at the top and bottom of the stairs and at intermediate heights if there is a change of direction.

Building Regulations

The single most important aspect of staircase design is safety, and nothing plays a more crucial role in staircase safety than strong, rigid, correctly installed balustrade.

Correct installation means complying fully with the guidance given in Approved Document K, which states that the sides of all private flights and landings with a drop of more than 600mm should be guarded. Handrail should be positioned so that its upper surface is between 900mm and 1100mm from the pitch line or floor (Figure 11.1), and it should be provided on both sides of a staircase that is 1000mm or wider. Where a staircase is likely to be used by children under the age of five, the guarding should be constructed so that it cannot easily be climbed, nor should a 100mm sphere be able to pass through any openings (Figure 11.2).

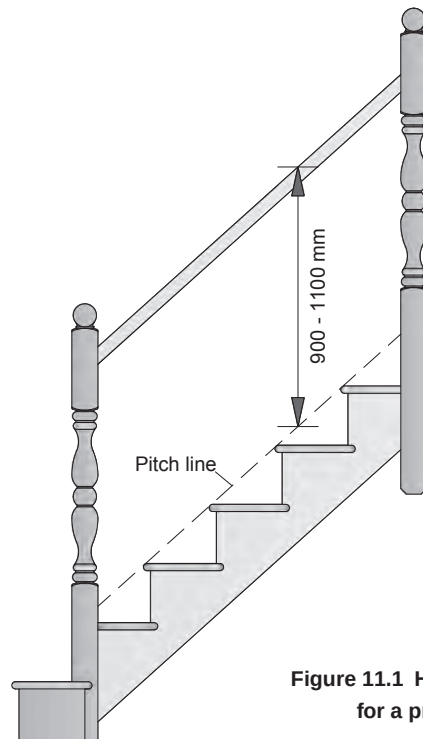


Figure 11.1 Handrail heights for a private staircase.

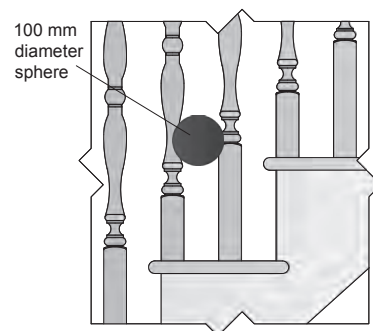


Figure 11.2 Openings between balusters should not allow the passing of a 100mm diameter sphere, or the head of a young child.

Balustrade types and designs

Handrail, which forms the uppermost component of any stair balustrade system, can either be fixed in straight sections between two newel posts or, by using specially shaped fittings, can pass above the newel posts forming a continuous run. The two systems are known as 'post-to-post' (Figure 11.3a) and 'over-the-post' (Figure 11.3b).

The simplicity of the post-to-post system makes it a far more common installation than its continuous counterpart. The straight handrail sections are fixed between newel posts using proprietary brackets or traditional mortise and tenon joints. A post-to-post balustrade can be quickly and easily constructed – even by relatively inexperienced stair builders. Over-the-post (continuous) handrail, on the other hand, with its easings, goosenecks, and volutes (Figures 11.3b and 11.4), is a trickier proposition, demonstrated later in this chapter.

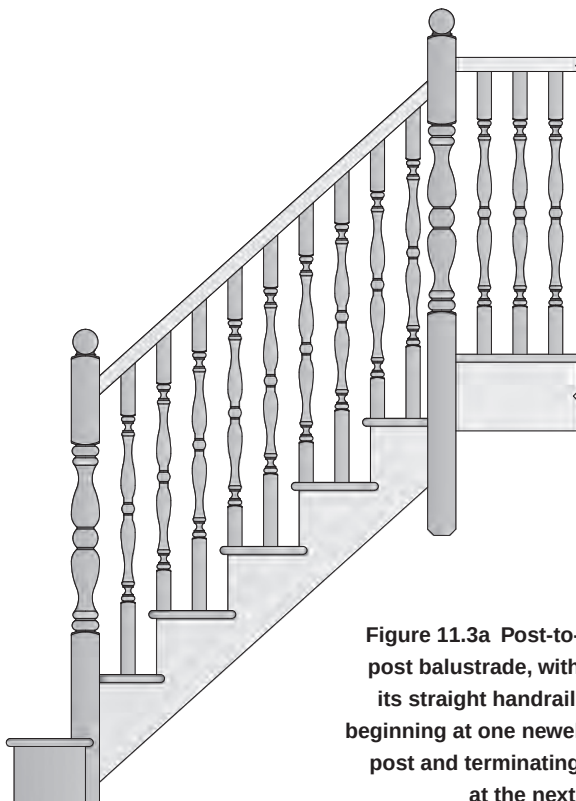


Figure 11.3a Post-to-post balustrade, with its straight handrail, beginning at one newel post and terminating at the next.

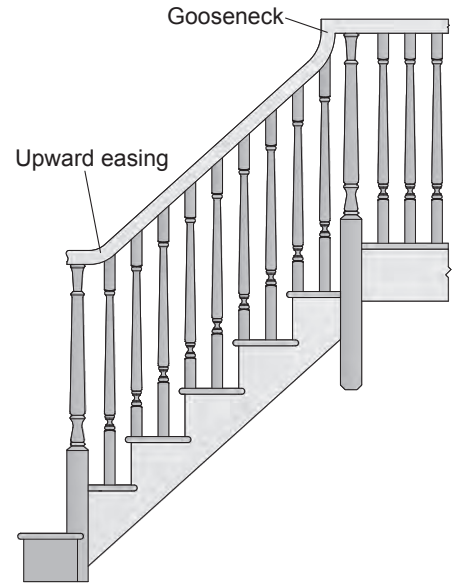


Figure 11.3b Over-the-post balustrade, with its specially shaped fittings forming a continuous handrail.

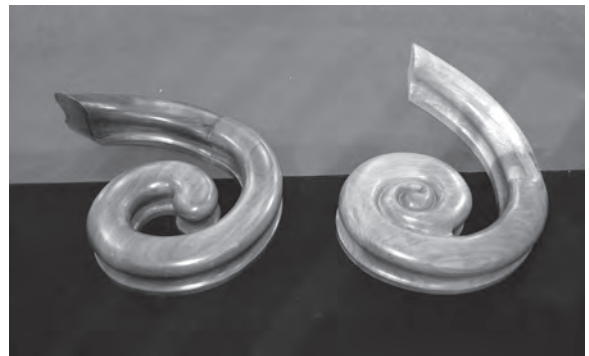


Figure 11.4 Volutes are decorative scroll-shaped entry sections of handrail.

Stair handrail is often supported by balusters which have been turned on a lathe; when used on an open (cut string) staircase, turned balusters can offer additional design options. The tops of the balusters can be either square or tapered (Figures 11.5 and 11.6), and they can be oriented to either the treads or the handrail. The more traditional tread-oriented balusters are cut so that their square sections at the bottom are all the same length, meaning that the line that marks

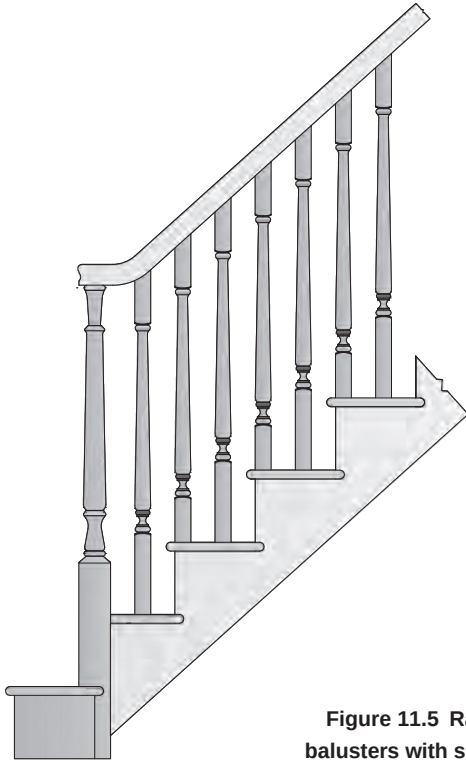


Figure 11.5 Rail-oriented balusters with square tops.

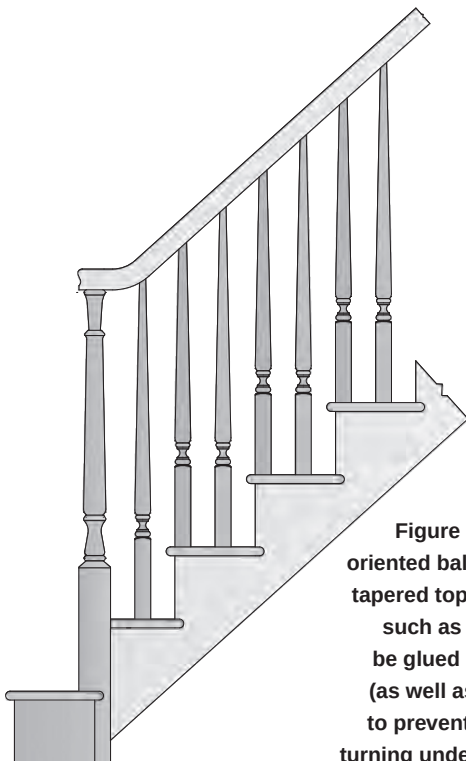


Figure 11.6 Tread-oriented balusters with tapered tops. Spindles such as these must be glued and pinned (as well as dowelled) to prevent them from turning under pressure.

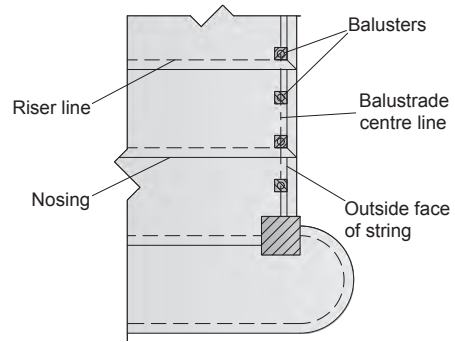


Figure 11.7 Balustrade centre line.

the top of the square section and the bottom of the turned section runs parallel with the surface of each tread (Figure 11.6). Rail-oriented balusters are cut and fixed so that each turned section is positioned to run parallel with the handrail (and pitch line) (Figure 11.5).

Balustrade centre line

The balustrade centre line is a notional line upon which the centre of each baluster sits (Figure 11.7); its location will determine the position of the newel posts and can alter depending upon the thickness of baluster being used. On an open-string staircase, the outer faces of the balusters should, ideally, be flush with the outer face of the string (Figure 8.75). When using 32mm balusters, for example, the balustrade centre line will be 16mm in from the face of the string. From this example it should be seen that the balustrade centre line will only coincide with the centre of the string if the two components are the same thickness. On a closed-string staircase using string capping (Figure 11.29) the balustrade centre line will always coincide with the centre of the string, whether or not the two components are the same thickness.

Newel posts

Newel posts provide structural support for the balustrade, their heavy section (up to 100mm square) and correct installation adding rigidity to the handrail and balusters. Identified by their location on a staircase, bottom, intermediate, and top newel posts are, in North America, respectively referred to as 'starting', 'intermediate landing', and 'balcony landing' newels.

A common method of installation is to join a newel post to a stair string by means of a haunched mortise and tenon joint. Where a newel post meets with a closed string, the joint is cut so that the string sits centrally on the face of the newel post and is glued and then pulled up tight with draw pins; the position of a newel post that meets with an open string is determined by the balustrade centre line (see previous page).

A tenoned string with notched tread can be seen in Figure 4.93, while the mortised and housed newel post to which it will be joined is shown in Figure 4.47. A tread and riser meeting with a newel post are housed in to a depth of 12 mm.

The marking, routing, and mortising of a range of newel posts are demonstrated throughout this book. Later in this chapter, we will look at an alternative installation method, involving the dowelling of a newel specifically designed for volutes into a solid block beneath a curtail step.

When fixing to a suspended timber floor, it is recommended that a newel post is left long so that it can extend through the decking and be bolted to a joist. In reality this rarely happens, with the newel post being cut at the floor line and then skew nailed to the decking.

Handrail

A balustrade's uppermost component is the handrail. Standard handrails that are both attractive and graspable are available to buy off the shelf; Figure 11.8 shows a selection made by Richard Burbidge, a leading UK manufacturer of stair parts.

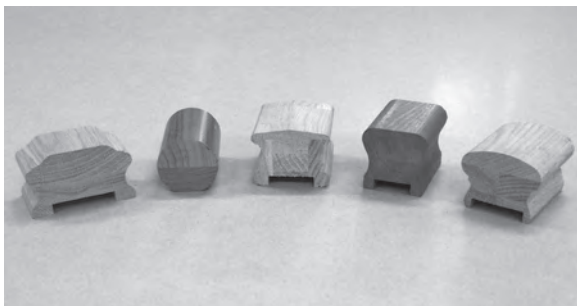


Figure 11.8 A wide selection of handrails is available to purchase 'off the shelf'. Those seen here are manufactured by Richard Burbidge.

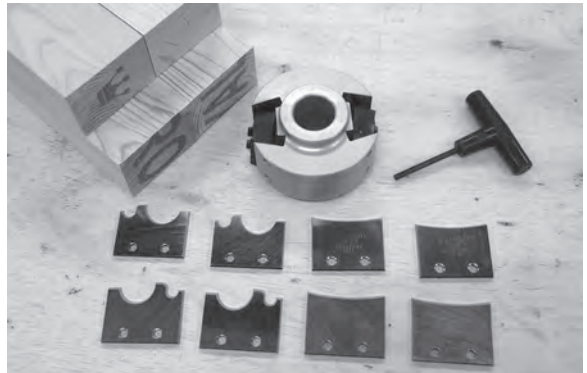


Figure 11.9 A spindle block with a set of handrail cutters and limiters made by Whitehill.

Making your own handrail is not difficult when using any of the dedicated cutters available for use with an electric router or spindle moulder. Figure 11.9 shows a set of spindle cutters made by Whitehill and consists of cutters and safety limiters for a classic handrail profile. Before shaping the prepared timber, though, the handrail length should be established.

Establishing the handrail length

With the exception of the handrail for chapter 8's circular staircase, which is to form part of an over-the-post balustrade system, all handrails featured in this book have been designed to run in straight lengths between newel posts (post-to-post). And with manufacture taking place ahead of staircase assembly, the handrail can be attached to the newel posts with traditional draw-bored mortise and tenon joints.

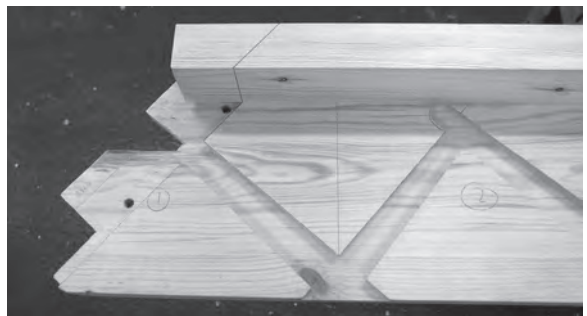


Figure 11.10 A handrail's length can be marked directly off the string above which it will be fixed.



Figure 11.11 (above) and Figure 11.12 (below) Tenons can be cut either by hand or, as seen here, on a tenoning machine.



Figure 11.13 An adjustable grooving head can be used to plough a groove into the underside of the handrail, into which the balusters will be housed.

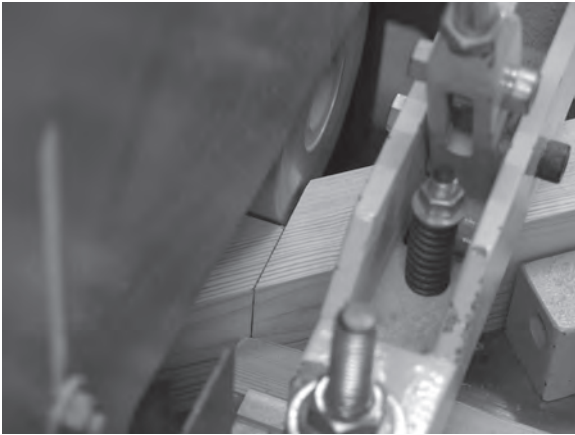


Figure 11.14 (above) and Figure 11.15 (below) The Whitehill cutters produce a classic handrail profile.

The unmoulded handrail is laid on the prepared string so that the two components' top edges are flush; tenon shoulder lines can then be marked onto both ends of the handrail (Figure 11.10). The tenons can be cut using either a hand saw or, if available, a tenoning machine (Figures 11.11 and 11.12). If applying the moulded shape with a router, leave the cutting of the tenon shoulders until after routing so that 'dropping in' is avoided.

Shaping the handrail

The underside of the handrail is grooved to a depth of 10mm and a width to match that of the balusters (Figure 11.13). The moulding is then applied in two



operations – the curved top first and the shaped sides second (Figures 11.14 and 11.15).

The handrail's curved top will continue on to the tenons (Figure 11.16) – not important at the upper end where the top of the tenon will be trimmed square to the newel post (Figure 11.18). For a neater joint at the handrail's lower end, however, the tenon should be cut back so that its top edge is flat, creating a very small third shoulder. And just like the strings, the handrail is pulled up to the face of the newel post by driving draw pins through offset holes (Figure 11.17).

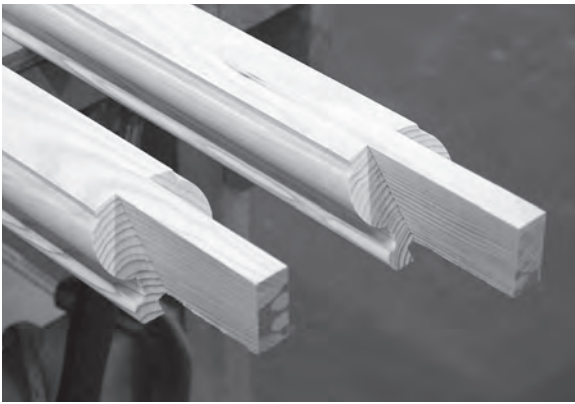


Figure 11.16 The curvature of the handrail's upper sides continues onto the tenons.

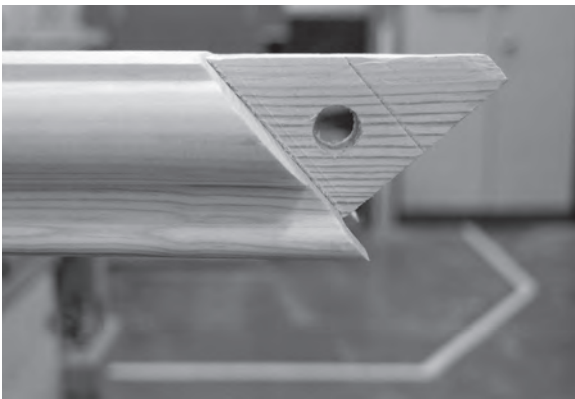


Figure 11.17 For a neat-fitting joint, the tenon's curved upper edge is squared off, creating a small third shoulder. And a hole through the handrail's tenon (its width reduced by the baluster groove) will allow the joint to be pulled up tightly using a draw pin

If making a handrail for an existing staircase, the use of mortise and tenon joints will require the newel posts to be forced apart during insertion, risking loosening the newels and making proprietary brackets a better choice. For a cut-string staircase, the length and angled cuts at each end of the handrail can be marked by laying the rail on the stairs so that it rests on each nosing. The rail can be held in place by gently clamping it to one or both newel posts while the angled cuts are marked. Cut one end and then reposition the rail to double-check for correct length; a little extra should be allowed if the newel posts are anything other than perfectly plumb. If the outside of the staircase has a closed string, the rail will need to be positioned entirely parallel to the string's top edge before marking and cutting.

Fixing handrail to newel posts

Handrail bolts are available for both inclined and horizontal handrails, providing a strong and convenient fixing between newel post and rail; and later, in chapter 12, the use of a proprietary bracket will be demonstrated. My preferred method of joining handrail to newel post, though, is the mortise and tenon joint. The centre of any newel post should align with the balustrade centre line, so it follows that the handrail should be fixed centrally to the face of a newel post. When marking the position of the mortise on the newel post, it is important to remember that the baluster groove ploughed on the underside of the handrail will lead to a reduction in the tenon width (Figure 11.17).

Glue and draw pins are very effective in securing the handrail's tenon within the newel post's mortise (Figure 11.18). And, traditionally, to add stability to the joint and eliminate the risk of future gaps caused by timber shrinkage of the newel post, the handrail's tenon shoulders were let into the newel post. This time-consuming and difficult practice is rarely seen these days – particularly on inclined handrails. For new horizontal balcony handrails, though, the procedure is quite straightforward.

The handrail is first pushed firmly up into the newel post and a sharp 2H pencil used to draw accurately round the profile (Figures 11.19 and 11.20). Working

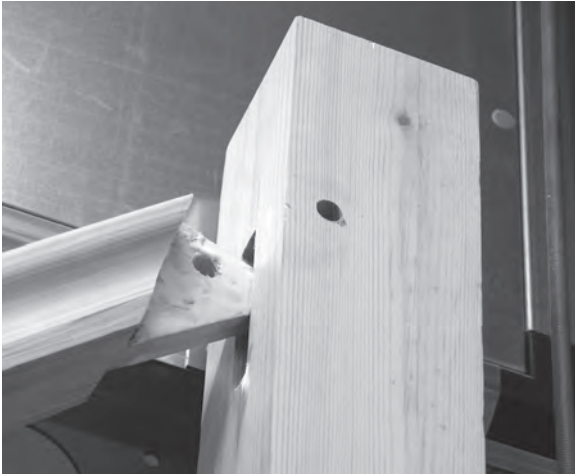


Figure 11.18 Draw-bore pinning is an effective way of pulling an angled handrail up tight and securing it within a mortise.



Figure 11.19 (above) and Figure 11.20 (below) Offer the horizontal handrail into the newel post's mortise and draw tightly around its profile with a sharp pencil, before removing and setting aside.



Figure 11.21 Rout out the majority of the waste to a depth of 6 mm, using the router freehand.



Figure 11.22 Remove all the remaining waste by using a sharp chisel to get into the corners that the router is unable to.



Figure 11.23 When the housing is complete, the handrail is offered back into its mortise.



Figure 11.24 The handrail's shoulders disappear into the housing, creating a joint which won't open up through shrinkage.

freehand, the majority of the waste is then removed to a depth of around 6mm by a router with a straight fluted cutter (Figure 11.21). The remainder of the waste is removed with a sharp chisel and, if required, a gouge (Figure 11.22), resulting in a gap-free joint that will stand the test of time (Figures 11.23 and 11.24).

Balusters

Balusters are narrow vertical members that provide support to the handrail and fill the gap between the underside of the handrail and the steps below. Also known as spindles, the vertical balusters make climbing the railings a far less tempting proposition for children than would railings running horizontally or parallel with the handrail ('ranch style', as it was called, was popular in the 1970s and doesn't meet modern-day regulations). And Approved Document K's reference to a 100mm diameter sphere means that the gaps between each baluster must be small enough to prevent a child's head passing through and becoming lodged between them (see sidebar, chapter 9, page 162); architects often specify a maximum gap between balusters of 99mm, although this would need to be less for turned balusters to allow for the narrowing at the turned sections.

Balusters are generally fixed using one of two methods: (1) at the top end, where a baluster meets with the handrail, it can either be housed into a groove ploughed in the underside of the handrail, with the

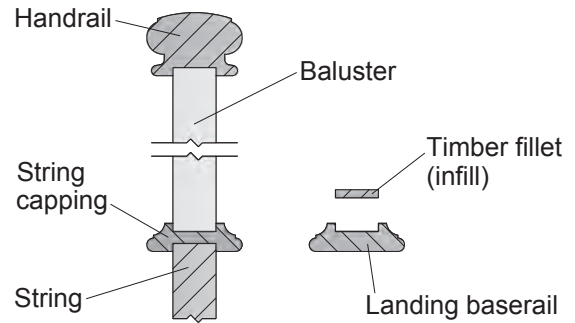


Figure 11.25a At their lower ends, balusters can be housed, on a closed-string staircase, within a string capping or, along a landing, within a baserail.

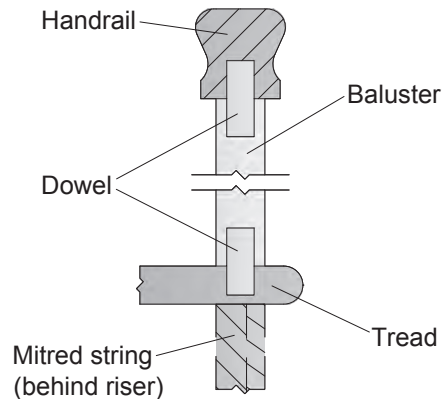


Figure 11.25b On an open-string staircase, balusters – which must be glued and pinned to prevent turning – are dowelled into the treads.

spaces between each baluster infilled with timber fillets (Figure 11.25a), or (2) it can be glued and dowelled into the underside of the handrail (Figure 11.25b); the lower ends of balusters, in the case of a closed-string staircase, are housed into string capping. Sometimes referred to as a baserail, a string capping is a length of timber grooved on both sides; the width of each groove matches, on the underside, the thickness of the string and, on the upper side, that of the balusters. Again, timber fillets are used to infill the spaces between each baluster. A similar arrangement can be used along a landing – the only difference being that a landing baserail requires grooving on its upper

side only (Figure 12.58). On an open-string staircase the lower ends of balusters are glued and dowelled into the treads (compare Figures 11.25a and 11.25b). It should be borne in mind that balusters dowelled at both ends will be at risk of turning – a risk best avoided by stub mortising and tenoning one end or by pinning the glued and dowelled joint, and allowing the glue to dry before use.

Constructing a post-to-post balustrade for a closed-string staircase

Straight handrail, elementary connections between components, and an established balustrade centre line make a post-to-post balustrade for a closed-string staircase the simplest of systems to construct.

Baluster calculations

The planning of a balustrade system of this type starts with some calculations to determine the number of balusters required and the equal spacing of the balusters. Our target spacing is 99 mm, because this is the maximum dimension that will not allow a 100 mm diameter sphere to pass through. Using chapter 9's alternating tread staircase as an example, together with 32 mm thick square balusters, proceed as follows:

Step 1: Establish the horizontal distance between newel posts which, in our example, is 1110 mm (Figure 11.26a).

Step 2: Add together one square baluster thickness and one (target) spacing:

$$32 + 99 = 131 \text{ mm}$$

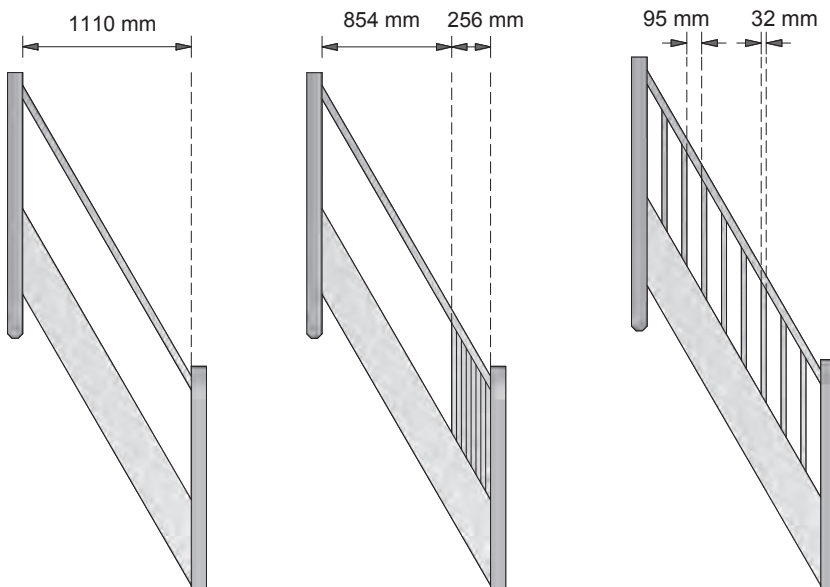
Step 3: To determine the number of balusters, find out how many times 131 mm goes into the total distance of 1110 mm:

$$1110 \div 131 = 8.47 \text{ (round down to 8 balusters)}$$

Step 4: Imagine all eight balusters pushed tightly up against one of the newel posts (Figure 11.26b) and find their combined thickness:

$$8 \times 32 = 256 \text{ mm}$$

Step 5: The remaining area next to the balusters is the total of all the spacings and can be found by



[Figures left to right]

Figure 11.26a Measuring the horizontal distance between newel posts is the first step in determining the number of balusters required.

Figure 11.26b The combined baluster thickness on the right and the total of all the spacings on the left.

Figure 11.26c Eight balusters spaced evenly up the stairs.

deducting the combined baluster thickness from the total horizontal distance:

$$1110 - 256 = 854 \text{ mm (Figure 11.26b).}$$

Step 6: As the number of spacings is always one more than the number of balusters, we know there will be nine spacings. So the next step is to divide 854 (mm) by nine:

$$854 \div 9 = 94.9 \text{ mm, say } 95 \text{ mm (Figure 11.26c).}$$

Double check:

Spacings: $95 \times 9 = 855 \text{ mm}$

Balusters: $32 \times 8 = 256 \text{ mm} +$

Total: 1111 mm (1 mm difference due to rounding).

So, for our alternating tread staircase, we have calculated that there will be eight square balusters, each 32 mm thick, and nine spacings, each with a horizontal distance between balusters of 95 mm (Figure 11.26c).

It is important to bear in mind that these balusters are square. Similar calculations performed for turned spindles would need to take the narrowing of such components into account if gaps nearer 125 mm are not to be inadvertently arrived at.

A quick calculation, often used by stair builders to determine the number of balusters for a 42° staircase, is to allow two balusters per (full) tread, and one for each tread that meets with a newel post. A standard 12-tread staircase with newel posts top and bottom would therefore require 22 balusters.

The balusters will be secured within grooves ploughed into the underside of the handrail and the top of a string capping, with timber fillets infilling the grooves between balusters and spacing them according to our calculations. The fillets will be angled to the

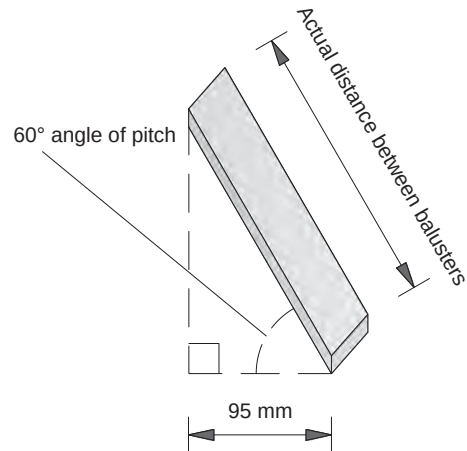


Figure 11.27 The distance between balusters when measured on the rake of the stairs is significantly longer than the horizontal distance.

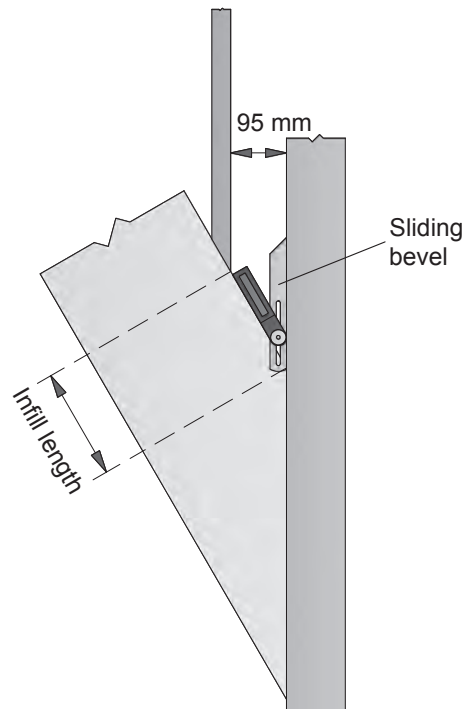


Figure 11.28 A sliding bevel can be used to transfer the angle of the cuts required for the balusters, the timber infill fillets, and the string capping to a chop saw.

rake of the stairs and, as such, will be considerably longer than the horizontal distance between each baluster. The flight's angle of pitch is 60° , so if we imagine a $60^\circ/30^\circ$ right-angled triangle, the horizontal baluster spacing of 95 mm will be adjacent to the 60° angle and the actual distance between balusters will be equal to the triangle's hypotenuse (Figure 11.27). We therefore have sufficient information to calculate this length using trigonometry and Pythagoras' theorem; however, a more practical method would be to position a cut baluster 95 mm from the bottom newel post and then measure the required fillet length (Figure 11.28). Figure 11.28 also shows how a sliding bevel can be used to obtain the angle of the cuts required for the balusters, the fillets, and the string capping; once measured, the angle can be transferred to a chop saw, using the set sliding bevel.



Figure 11.29 The string capping is tapped home, protected by a baluster resting within its groove.

Cutting list

Having determined the required components, a cutting list for the balustrade for chapter 9's alternating tread staircase can be written. Two handrails are shown on the cutting list in order to comply with Approved Document K's requirement that handrail should be provided on both sides of the flight.

Balustrade assembly

With the handrail already fixed during staircase assembly, the next component to be installed is the string capping, whose length should be identical to those of the string below and handrail above (shoulder to shoulder). Using a block of wood placed within the capping's upper groove (a baluster is ideal), the string capping is

gently tapped into place (Figure 11.29) and fixed to the string with 4.0×32 mm wood screws ($1\frac{1}{4}$ inch 8s) at centres not exceeding 230 mm.

Next, a baluster is cut at one end only to the angle obtained earlier using a sliding bevel. The cut end of the baluster is offered into the string capping and plumbed by holding the baluster against the bottom newel post or by using a spirit level. The baluster length can then be marked against the underside of the handrail, as shown in Figure 11.105. Before cutting, remember to add on for the depth of the groove in the underside of the handrail. The pattern baluster is then tested for fit at the top, middle, and bottom of the stairs before the remaining seven balusters and 18 timber infill fillets are cut to length.

Cutting List for Balustrade for Chapter 9's Alternating Tread Staircase

No.	Member	Length	Width	Thickness	Material
2	handrails	2500	70	45	European Redwood
1	string cap	2500	70	28	European Redwood
8	balusters	850	32	32	European Redwood
6	infill fillets (cuts 18)	650	32	10	European Redwood
2	newel caps	140	140	54	European Redwood

All dimensions in millimetres.

Fixing balusters on a closed-string staircase

The process of fixing the balusters starts at the bottom of the stairs with the gluing and pinning (with 25mm panel pins) of two timber fillets, one in the upper side of the string capping and the other in the underside of the handrail, against the bottom newel post. The first of the balusters is then offered, first into the string capping groove at the bottom, and then into the handrail groove at the top, before being skew-nailed with 38mm oval nails at both ends. The process is repeated as work continues up the stairs (Figure 11.30) until the final two fillets are fixed against the top newel post. The nailing and pinning of the balusters and fillets, all of which should be punched below the surface, could lead to timber splitting, making the pre-drilling of pilot holes a good idea.



Figure 11.30 Glue and skew-nail each baluster at both ends before inserting the next pair of infill fillets which should also be glued and nailed.



Figure 11.31 Newel caps provide an attractive finishing touch to the balustrade.



Figure 11.32 The completed alternating tread staircase with balustrade to its outside. (The fixing of wall-mounted handrail is demonstrated in chapter 12.)

The aesthetic appeal of the balustrade can be enhanced with the addition of newel caps (Figure 11.31), the manufacture of which is demonstrated in chapter 10. Figure 11.32 shows the completed stairs and railings.

Constructing a post-to-post balustrade for an open-string staircase

Constructing balustrade for an open-string staircase requires a slightly different approach to that of a flight with closed strings. If the string and newel posts have been joined using mortise and tenon joints, the balustrade centre line will, by this time, have been established. So the first difference concerns the spacing of the balusters which, depending on the size of the going, is usually arranged in one of two ways: two balusters per tread, typical of standard domestic installations, or three balusters per tread, found on shallower-pitched

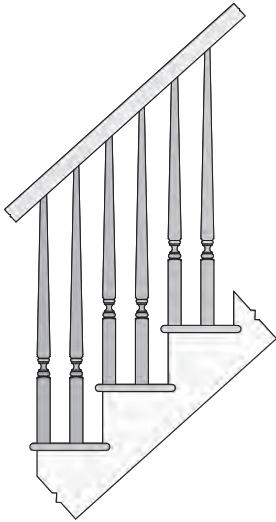


Figure 11.33a Two balusters per tread

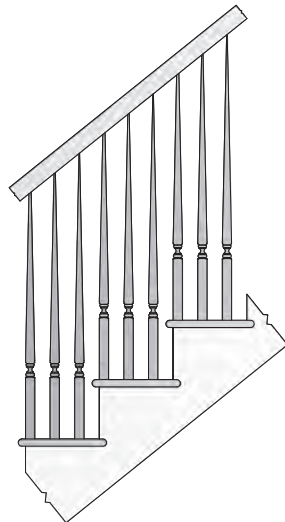


Figure 11.34a Three balusters per tread

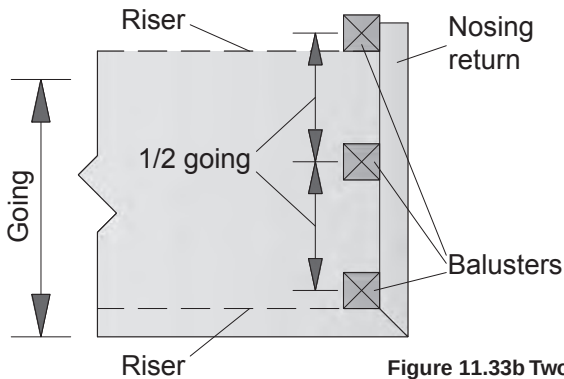


Figure 11.33b Two balusters per tread

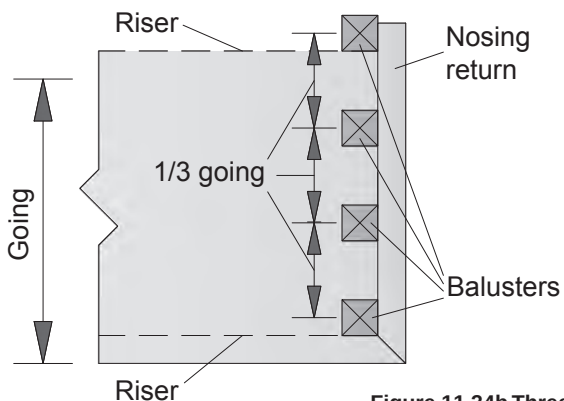


Figure 11.34b Three balusters per tread

staircases in larger properties (Figures 11.33a and b and Figures 11.34a and b).

In both installations the first baluster of each tread should be positioned so that its front face aligns with the face of the riser below, and its outside face with that of the string (Figure 8.75). Equal baluster spacing is, for a two balusters per tread installation, achieved by halving the going to obtain the centre of baluster to centre of baluster distance and, for a three balusters per tread installation, by dividing the going by three (Figures 11.33b and 11.34b).

Cutting list

Determining the cutting list requirements for the balustrade for an open-string staircase, such as the quarter-turn or dogleg described in chapters 5 and 7 respectively, requires little more than knowing the number of treads and the number of balusters per tread.

Marking baluster centres

Both the quarter-turn staircase in chapter 5 and chapter 7's dogleg stairs were built with open outer strings and will be used to demonstrate the construction of a two balusters per tread system. Work starts on the first full step after the bottom newel post with the marking of the centre of what will be the flight's second 32 mm baluster. A distance equal to half the baluster thickness (16 mm) from the face of, what is in this case, riser number 3 is marked on the tread and intersects with the balustrade centre line (Figure 11.35). The centre of tread number 3's second baluster will be a distance equal to half of the going from the first (in this case, 114 mm).

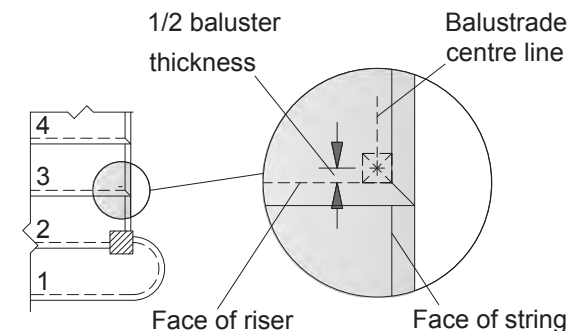


Figure 11.35 Positioning of the first baluster of each tread.

Cutting List for Balustrade for Chapter 5's Quarter-turn Staircase and for Chapter 7's Dogleg Staircase

No.	Member	Length	Width	Thickness	Material
2	handrails	1600	62	45	European Redwood
10	balusters	1000	32	32	European Redwood
8	balusters	900	32	32	European Redwood
5	infill fillets (cuts 20)	600	32	10	European Redwood
3	newel caps	140	140	54	European Redwood
For dogleg staircase (intermediate newel post) only:					
1	newel cap	252	140	54	European Redwood

All dimensions in millimetres.



Figure 11.36 Baluster locations can be marked quickly and accurately using a steel roofing square aligned with the balustrade centre line.

This process can be repeated quickly and easily throughout the remaining treads – and without risk of error – by setting up the marked positions on a steel roofing square. The balustrade centres are transferred onto masking tape stuck to the smaller of the roofing square's arms – its tongue. A third piece of masking tape on the square's blade (the larger of the two arms) is positioned so that when aligned with the mitred end of the next ascending riser, the inside edge of the tongue lays directly on the balustrade centre line (Figure 11.36).

The handrail here has been grooved to house the baluster tops; however, if using balusters that are to be



Figure 11.37 Plumbing up from the marked treads is necessary when dowelling balusters into the underside of the handrail.



Figure 11.38 Use a plumb bob to check that baluster locations marked on the handrail correspond with those marked on the treads.

dowelled into the underside of unploughed handrail, the centres marked on the treads must now be transferred by plumbing up with a spirit level and marking the side of the handrail (Figure 11.37). Those marks can then be squared across the underside of the handrail and the centres marked. The new marks can be checked for perfect alignment with those below by hanging a plumb bob at several locations up the stairs (Figure 11.38). Balusters dowelled at both ends will, it should be remembered, turn under pressure, which can be prevented by gluing and nailing the balusters or by tenoning one end to fit into a square mortise.

Drilling for dowels

The treads are now drilled at each baluster centre point to receive 18mm dowel (Figure 11.39). If the tread thickness is greater than 25mm, then the hole depth should be 25mm; if, as in this case, the tread thickness is a standard 25mm, then to avoid drilling right through the tread and reaching the string below, the hole depth can be 18mm. One end of each of the



Figure 11.39 The treads are drilled to receive 18mm dowel.

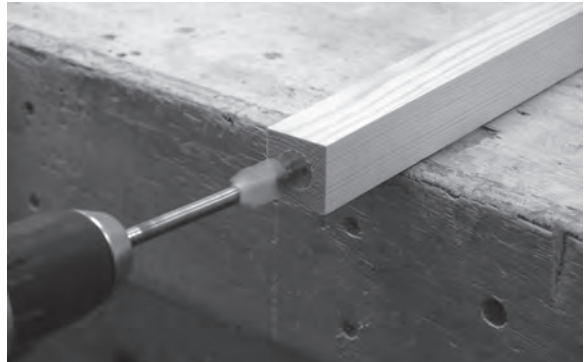


Figure 11.40 The balusters are drilled at one end only with an 18mm diameter bit wrapped with a piece of tape marking the hole depth of 25mm.

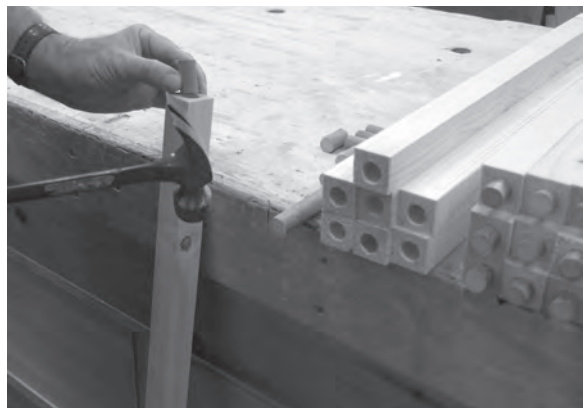


Figure 11.41 Short pieces of 18mm dowel are inserted into the drilled ends of the balusters, at this stage without glue.

balusters is then drilled to a depth of 25mm (Figure 11.40) and appropriate lengths of 18mm dowel are tapped, without glue, into the holes (Figure 11.41).

Marking baluster lengths

On a two balusters per tread system, the balusters towards the rear of each tread will be longer than those at the front. In theory, all rear balusters should be identical in length, as should all front balusters. The likelihood of this working out in practice can be gauged by checking the handrail for bowing using a long spirit level (Figure 11.42). The safest way to ensure perfect results, however, is to mark each baluster individually.

The dowelled end of the first baluster is located (without glue) in the tread and pushed home (Figure 11.43); the baluster is then plumbed and marked at the underside of the handrail, as shown in Figure 11.105, before being removed and cut to length on a chop saw while remembering to add on for the depth of the handrail groove.

Fixing balusters on an open-string staircase

PVA adhesive is poured in and around the edge of the dowel hole (Figure 11.44). The baluster is then pushed firstly into the tread hole and then into the handrail groove where it is secured with glue and two pins,



Figure 11.43 The first baluster is located, without glue, in the pre-drilled hole and plumbed; a line is then scribed against the underside of the handrail, to which the depth of the groove must be added.



Figure 11.42 Use a long spirit level to check the straightness of the handrail.



Figure 11.44 Glue is trickled in and around the tread's dowel hole ready to receive the baluster.



Figure 11.45 The front of the baluster should be square to the tread's edge – particularly important when dowelling into the underside of the handrail.



Figure 11.46 Lay the cut balusters in pairs on their respective treads ready for installation.



Figure 11.47 The completed quarter-turn staircase and balustrade.

as shown in Figure 11.124. The tops of the balusters are further secured with timber fillets glued and nailed between each one. If using taper-top balusters (at risk of turning if not stub tenoned into the treads), they should be checked for square before the glue dries and before pinning (Figure 11.45).

Each baluster can be individually marked, cut, and fixed as work proceeds up the stairs. Alternatively, all marking and cutting can be carried out prior to any baluster being fixed, in which case the cut balusters should be laid, in pairs, on the step to which they are to be fixed (Figure 11.46).

The completed quarter-turn staircase is shown in Figure 11.47 and the dogleg staircase in Figure 11.48.

Constructing an over-the-post balustrade for a circular staircase

In chapter 8 we built a circular staircase that has a closed side for fixing to a wall and an open side



Figure 11.48 The completed dogleg staircase and balustrade.

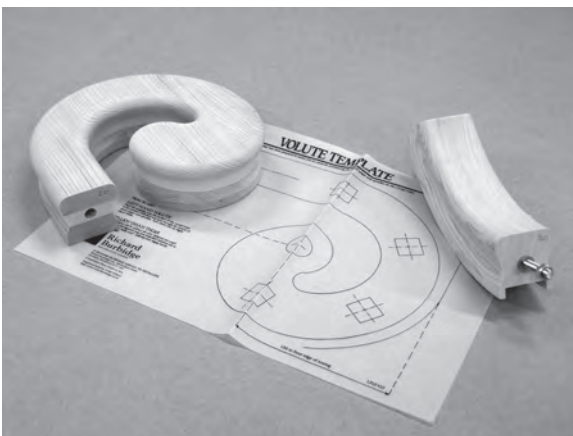


Figure 11.49 The two-part Richard Burbidge volute includes a template to aid installation.

that requires guarding. With balustrade construction generally considered the more exacting aspect of stair building, over-the-post systems more involved than post-to-post, and circular railings more formidable than straight, this staircase provides us with an ideal opportunity to combine all three elements for a particularly challenging project.

Design

Chapter 8's circular staircase has, at its lower end, a curtain starting step, best suited to over-the-post balustrade, and, at its top, an upper newel post designed for post-to-post handrail; the balustrade that we will be building will therefore be a combination of the two systems.

The flight's handrail will start at the foot of the stairs with a volute, an attractive, spiral-shaped component sometimes called a 'monkey's tail' or, when installed with the additional balusters that follow the curve of the volute, a 'bird cage'. The model shown in Figure 11.49 is manufactured by Richard Burbidge and comes in two parts: a scroll-shaped entry handrail and a ramp, or 'upward easing', which can be cut to suit the pitch of any staircase. A template, printed on transparent paper, allows the newel post and baluster locations to be transferred onto the curtain step below. The balustrade's rigidity is achieved with the use of a second Richard Burbidge item designed specifically for use with the volute: a turned volute newel post fitted, at its underside, with a large spigot for housing into the solid part of the curtain step (Figure 11.99).

A combination of straight and tapered steps, together with a cut string, results in a flight where spacing the balusters equally throughout is very difficult. By following a few basic principles, however, a satisfactory layout can still be achieved. The setting out of the baluster spacings, in this case, took place ahead of staircase assembly because the holes through which we screwed the treads to the cut string will also be used to house the baluster dowels which will, in turn, conceal the screw heads. The following explains my thinking when setting out the baluster locations.

Figure 11.50a: The balustrade centre line, established during staircase construction to suit 32 mm balusters, is 16 mm from the face of the string.

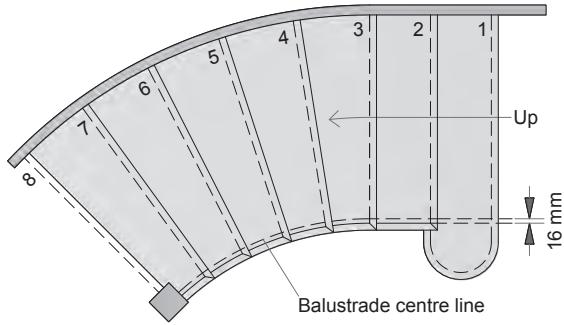


Figure 11.50a The balustrade centre line was determined during staircase construction.

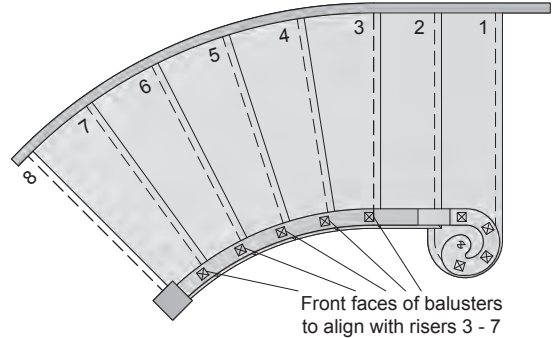


Figure 11.50c Balusters are located so that their front faces align with the faces of the risers of the five tapered steps.

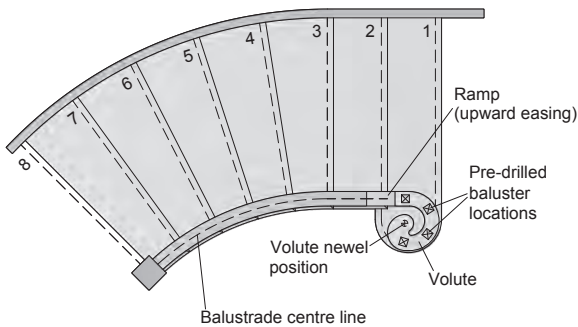


Figure 11.50b The volute newel location and those of the first four balusters are factory-drilled into the underside of the volute.

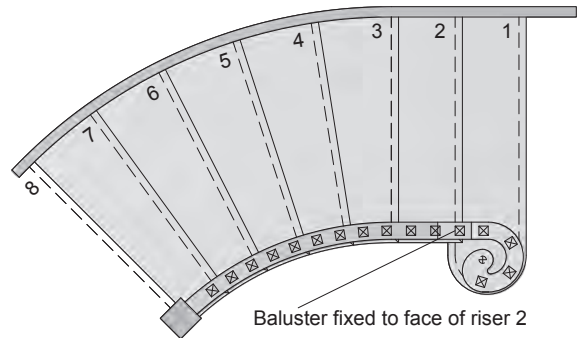


Figure 11.50d Fixing a baluster to the face of riser number 2 provides additional rigidity to the balustrade at the foot of the stairs.

Figure 11.50b: The locations of the first four balusters and bottom (volute) newel post are factory-drilled into the underside of the volute and transferred to the curtail step using the manufacturer-provided trace template. The circular handrail is centred above the balustrade centre line.

Figure 11.50c: The next five balusters to be set out are those at the front of each of the five tapered treads and are positioned so that their front faces align with each riser, and their outer faces with that of the cut string. At around 127 mm, the gap between each of these balusters exceeds Approved Document K's 100 mm sphere rule; the circular part of the staircase will therefore require two balusters per tread.

Figure 11.50d: While a volute is a highly desirable and attractive feature of any staircase with over-the-post balustrade, rigidity is often a problem. The balustrade's horizontal loading (strength) can be increased by positioning the curtail step's last baluster against the next ascending riser – riser number 2. Additional strength is achieved by screwing through the square of the baluster into the riser and into the cut string behind (Figure 11.115). A further two balusters spaced equally on tread number 2 will closely match the spacings of those on the tapered steps and of those beneath the volute. The one noticeable difference can be seen at tread number 7 between the top baluster and newel post, but at around 77 mm it is still well within the '100 mm sphere' rule.

Cutting List for Balustrade for Chapter 8's Circular Staircase

No.	Member	Length	Width	Thickness	Material
12	handrail	2000	59	5	European Redwood
5	balusters	1150	32	32	European Redwood
5	balusters	1100	32	32	European Redwood
8	balusters	1000	32	32	European Redwood
1	newel cap	140	140	54	European Redwood

All dimensions in millimetres.

Cutting list

Three baluster lengths are required, the longest five of which are beneath the volute, followed by a further five positioned at the rear of each tread, with the shortest six found at the tread fronts. And with the exception of balusters meeting the underside of the upward easing, which will be housed and fixed using flexible

infill pieces supplied with the volute, all other balusters will be dowelled top and bottom (and glued and pinned to prevent turning); no timber infill fillets, therefore, are required on our cutting list. The circular handrail will be formed from thin laminated strips.

Forming circular handrail

The bending form constructed for the manufacture of the circular staircase's left-hand (cut) string (see chapter 8) will now be used to bend and laminate the thin softwood strips that will form our circular handrail. The first step, therefore, is to prepare a piece of timber of sufficient length for the handrail and of sufficient width to rip down the required number of 5 mm thick strips (Figure 11.51).

The structural performance of a staircase balustrade system is set out in BS 6180:2011 Barriers in and about buildings – Code of practice. The minimum horizontal imposed loads that a balustrade must be able to resist are measured in kilonewtons (kN), kilonewtons per metre (kN/m) and kilonewtons per square metre (kN/m²). For a domestic installation these are: 0.36 kN/m horizontal uniformly distributed line load; 0.5 kN/m² uniformly distributed load applied to the infill; 0.25 kN point load applied to part of the infill.

A kilonewton is a measure of force and can perhaps be more easily understood by converting to pounds force:

$$1 \text{ kN} = 224.8089 \text{ lb}$$

Therefore $0.36 \text{ kN} = 80.93 \text{ lb}$ (rounded to 81 lb)

The British Standard's reference to 0.36 kN/m therefore means that each metre run of balustrade must be able to resist a force of 81 lb. And this begins to make more sense when we think of a typical two-metre run having to resist 162 lb, around 11½ stone, the weight of an average human.



Figure 11.51 European Redwood, planed to the handrail's finished thickness, is ripped down into 5 mm thick strips.



Figure 11.52 Cascamite adhesive is spread quickly and evenly on the timber strips ahead of bending and laminating



Figure 11.54 The circular handrail's upper surface must be kept square to the vertical studs of the bending form.



Figure 11.53 Following the pitch line of the circular staircase at its open side, the glued strips are clamped to the bending form.



Figure 11.55 Straightness at the foot of the staircase is maintained by clamping straight timber to the laminated handrail.

The timber strips are now laid out ready for gluing (Figure 11.52), while ensuring that the best strips will form the handrail's outer edges and any with defects, such as knots and shakes, are positioned nearer the middle where they will be mostly out of sight. The gluing of the strips and clamping of the handrail to the bending form must be carried out speedily, so the use of a second pair of hands here is helpful.

The glued and laminated handrail is now clamped to the bending form, aligning it with the marks representing the tread heights applied earlier during the preparation of the string (Figure 11.53). And it will become clear that because the handrail is rising as it curves, the result is a twisted length of timber (Figure 11.67). But it has to be the correct twist, and that means ensuring that the handrail's top surface is kept square to the vertical studs of the bending form throughout its length (Figure 11.54). Timber blocks, screwed to the studs beneath the handrail, can help achieve the correct twist, although I have relied upon the tread-height marks on the studs and upon pulling the handrail square using F-clamps. At the foot of the staircase the handrail straightens out above the flight's two straight steps; the shape of this short section of handrail can be maintained by sandwiching it between two straight pieces of timber while the glue dries (Figure 11.55).

After 48 hours, the handrail can be removed from the bending form (Figure 11.56). At this stage, the rail is a twisted and stressed length of timber that can, if an unsuitable adhesive was selected during lamination, be vulnerable to 'creeping' or 'spring-back'. This unpredictable and unwelcome expanding of the tensioned rail's radius can begin as soon as the clamps are removed. The solution is to laminate using a good quality powdered synthetic resin glue such as Cascamite.

The handrail for our eight-rise circular staircase is sufficiently short to not need lengthening. Handrail for a larger staircase can be made longer by overlapping the timber strips as they are laminated to form finger joints (Figure 8.38).

Cleaning up before routing

At this stage, we have a square-edged length of curved handrail and a Richard Burbidge volute with upward easing. The volute's profile is Richard Burbidge's



Figure 11.56 After 48 hours, the handrail can be removed from the clamps and bending form.

own, and the company offers handrail to match in a range of lengths. The problem for us, though, is that all stair parts offered by Richard Burbidge are off-the-shelf components that allow balustrade systems to be constructed quickly without the need for lead times; all of their handrails are straight. Our circular handrail is a 'made-to-measure' item and, as such, is not the market of Richard Burbidge. Our task, therefore, is to shape the circular handrail so that it matches the volute's profile – a task that will be demonstrated by my good friend and colleague, Stephen Parry.

Let me tell you a little about Steve: Steve and I have worked together for more than 17 years, during the 1990s at the same joinery manufacturing company and, more recently, at the same further education college, teaching our trade. Steve describes himself as, "the best joiner I have ever met" – a rather immodest claim, although few who have seen his work would disagree. Wherever he has worked, if there was a tricky job to be done, it would be Steve who was called upon to tackle it. And our circular handrail, it could be said, falls into this category.



Figure 11.57 Steve pauses to check for squareness while cleaning up the handrail's glued surfaces.

Steve starts by cleaning up the top and bottom surfaces of the handrail, removing excess dry glue and flushing off any steps in the timber strips, while maintaining squareness (Figure 11.57). A self-made cardboard gauge is used to check for consistency of width throughout the handrail's length (Figure 11.58).

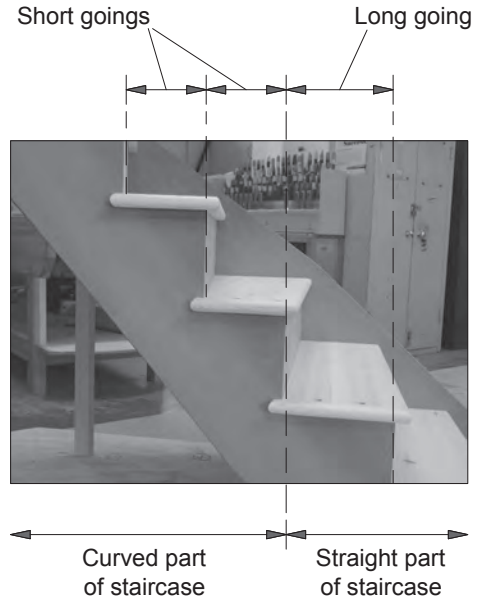


Figure 11.59 An inconsistent going requires a change of angle, or kink, in the handrail.

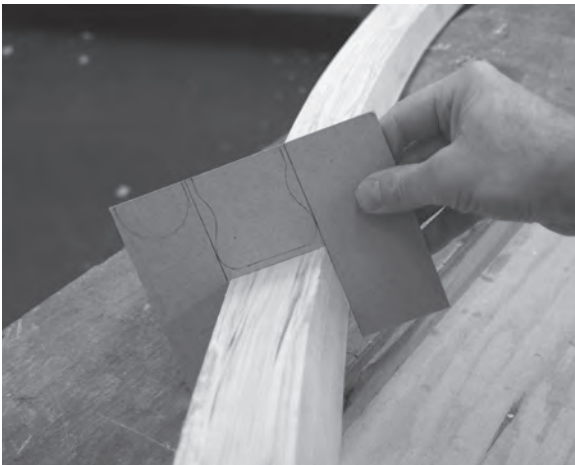


Figure 11.58 Uniformity of width is checked with a self-made cardboard template.



Figure 11.60 The change in going between the straight and tapered treads requires a kinked handrail, achieved by gluing a solid block to the rail's upper surface. The clamp at the front prevents the wedge-shaped block from sliding forwards on the wet glue.

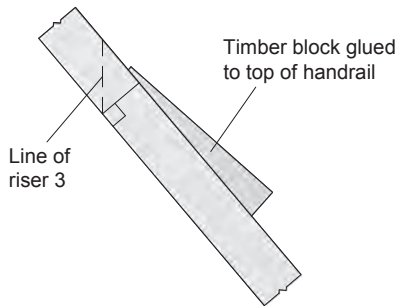


Figure 11.61 A kink is achieved by gluing a solid block to the handrail's upper surface.



Figure 11.62 A compass plane is used to blend the upper surfaces of the handrail and solid block.

Creating a kink in the handrail

If this handrail wasn't challenging enough, the staircase's mix of straight and tapered treads means that there is not a consistent going throughout the flight (Figure 11.59), and this, in turn, means that there is a change in the angle of pitch at the point where the straight part of the flight ends and the circular part begins. Achieving a change of angle, or kink, in the handrail is not possible during lamination and gluing up around the bending form. So, using the line of riser number 3 as a reference point (the precise location of the change from straight flight to curved), Steve glues a solid block to the handrail's upper surface (Figures 11.60 and 11.61).

With the glue dry and the clamps removed, Steve uses his compass plane to blend the upper surfaces of the two components before cutting the underside of the handrail so that it is parallel with the top (Figures 11.62 and 11.63).

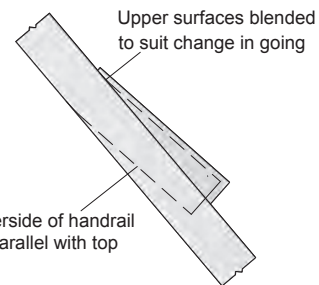


Figure 11.63 The handrail's change of angle can be shaped once the glue has dried.

Routing the circular handrail

Before progressing, Steve pauses to check the handrail against the staircase for which it is intended (Figure 11.64). The handrail's curve should match that of the staircase at the balustrade centre line, and its underside should touch each of the tread nosings when rested on the steps. Note the flight's upper newel post, landing nosing, and top riser, dry-fitted at the end of chapter 8 have now been removed.

Happy that the shape is correct, Steve sets about applying a profile to match that of the Richard Burbidge volute. The handrail's top corners are rounded off



Figure 11.64 Regular checks are essential. Here Steve checks that the curve of the handrail matches that of the staircase.



Figure 11.65 With the handrail secured, Steve begins the task of shaping the rail to match that of the Richard Burbidge volute.



Figure 11.66 A small palm router with curved fence reaches parts that a larger router cannot.

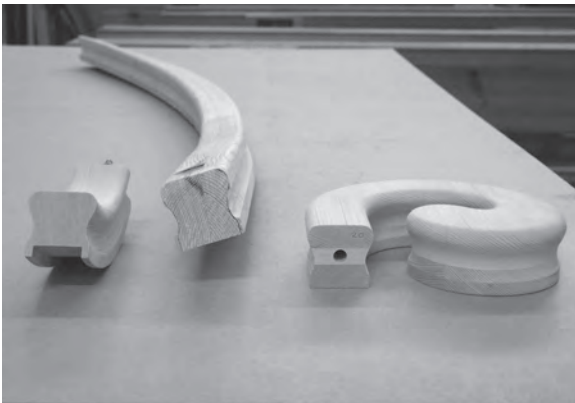


Figure 11.67 The similarity of the handrail's profile and that of the volute is now clear.

using an electric router and bearing-guided round over cutter with a radius of 12.7mm. The concave sides present more of a challenge. Using a variety of straight and fluting cutters of varying diameters, a series of 'reference points' are routed into the sides of the handrail – the router this time running off a fence held against the handrail's upper and lower surfaces (Figure 11.65). The small base of a palm router, together with a convex-shaped piece of MDF fixed to the fence, allows the cutter to reach into the concave side of the handrail where a larger router base would be pushed away (Figure 11.66). Not yet comfortable to grasp but beginning to take shape, the circular handrail's profile now resembles that of the Richard Burbidge volute and upward easing (Figure 11.67).

The flat surfaces and sharp corners of the developing handrail are rounded using a pair of wooden moulding planes with rounded fluting cutters. Steve uses his straight-based plane to smooth the hollow in the handrail's inner, or convex side, and his round-based model for the outer, or concave side (Figure 11.68).



Figure 11.68 A curved-based wooden moulding plane with rounded fluting cutter is used to smooth out the handrail's outer, or concave side.



Figure 11.69 The handrail's sides are diminished to match those of the volute using a compass plane.

The handrail's lower sides now just require diminishing, which Steve cuts with his compass plane whose flexible sole can be adjusted to suit both convex and concave surfaces (Figure 11.69). The cleaning up of the handrail will be left until after it has been attached to the upward easing and volute.

Using the volute template

The Richard Burbidge volute is supplied with a template printed on transparent paper that allows the easy transfer of baluster and newel post locations machined into the underside of the volute onto the curtail step below (Figure 11.49). It can be used either before or after staircase assembly.

Before assembly, the template is laid on the curtail tread and aligned with the balustrade centre line. The newel post and baluster centres are marked on the curtail tread by piercing the template with a bradawl (Figure 11.70). The template is removed and holes for the baluster dowels only are drilled at this time (drilling for the newel post should be left until after staircase assembly). The balusters require 18 mm diameter holes drilled to a depth of 18 mm followed by 6 mm clearance



Figure 11.70 After aligning the template accurately with the balustrade centre line, the newel and baluster locations are marked with a bradawl.



Figure 11.71 The 18 mm diameter dowel holes are drilled to a depth of 18 mm for the balusters only. A hole for the volute newel's spigot is drilled after staircase assembly.

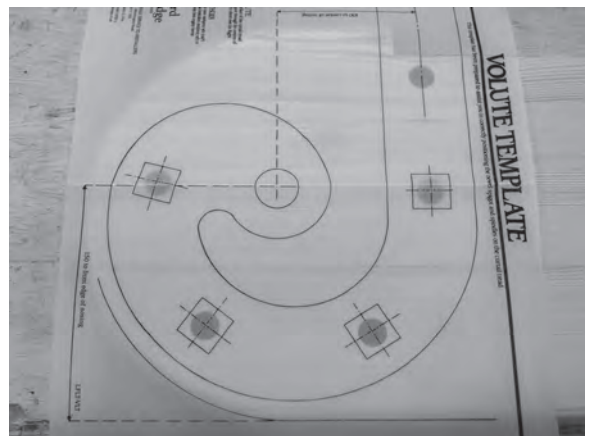


Figure 11.72 The newly drilled holes can be seen through the template's transparent paper.



Figure 11.73 The template can be used after staircase assembly by trimming its corner so that it fits around the second riser and string while still aligned with the balustrade centre line.



Figure 11.74 Working on a flat surface with the going side down, slide the pitch board up beneath the upward easing and then mark the point at which the slope side touches the fitting.

holes through the remaining tread thickness (Figure 11.71). Figure 11.72 shows the template laid back on the curtail tread after drilling; through the transparent paper the holes can be seen to align perfectly with the template. If used after staircase assembly, the template will require trimming to fit round the string and next ascending riser (Figure 11.73). As always, the most important consideration when positioning the template is aligning it with the balustrade centre line.

Marking and cutting the volute and upward easing

The volute and upward easing are joined together using one of two double-threaded rail bolts supplied with the fitting: one half of each bolt has a wood thread, the first of which is screwed into the end face of the upward easing, while the other half has an engineering thread which is located in a pre-drilled hole in the end face of the volute and secured with a nut and washer (seen in Figure 11.88). During marking and cutting, the two components should be dry-fixed only.

The curved upward easing is supplied over-length so that it can be cut to suit the pitch of any staircase. Marking is best carried out with the aid of a triangular pitch board cut to suit the going of the straight treads, and not that of the tapered treads, because the fitting will be located directly above the straight part of the staircase.



Figure 11.75 Turn the pitch board so that its rise side is down and scribe a line against the slope side starting at the tangent point already marked on the fitting.



Figure 11.76 Square the cut line across the fitting's upper surface.

The dry-assembled fitting is rested on a flat surface; the pitch board, with the going side down, is held so that its slope side touches the curved underside of the easing. This tangent point is marked on the easing (Figure 11.74). The pitch board is then flipped so that its rise side is down and its slope side aligns with the tangent mark; a line can then be marked across the side of the easing (Figure 11.75), and across its upper side with a squaring block (Figure 11.76).

The easing is cut using a chop saw, and accuracy here is essential. The fitting can either be cut while

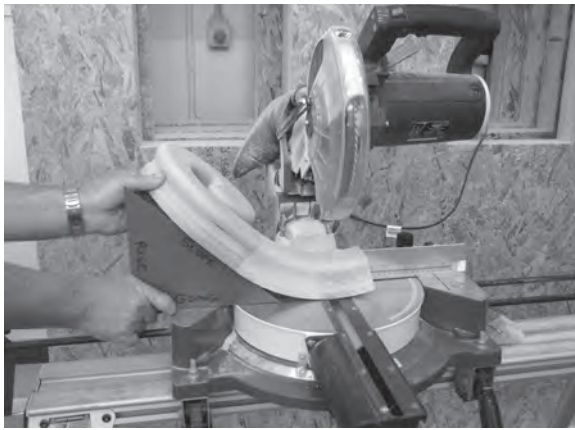


Figure 11.77 If cutting the fitting base down, support from a pitch block will be required to hold it at the correct angle.

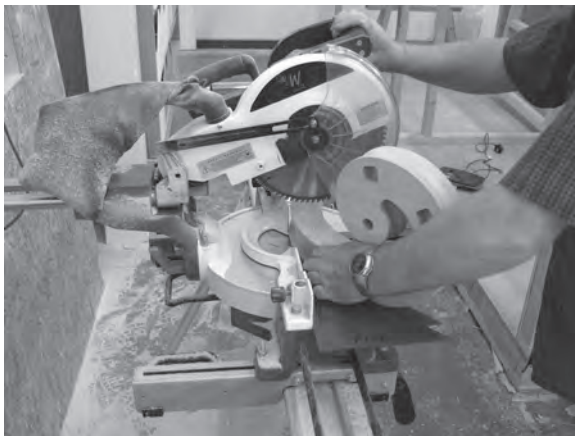


Figure 11.78 On its side, the upward easing can be held against the pitch board during cutting.

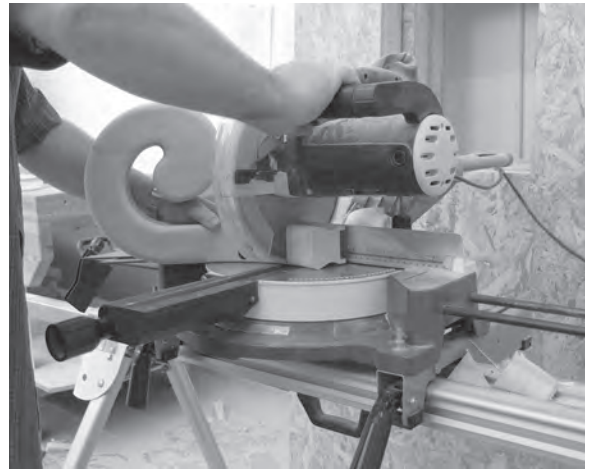


Figure 11.79 No turning back now!

resting on its underside, in which case it will require supporting with a pitch block, as indicated in Figure 11.77, or on its side using the pitch board as a guide (Figure 11.78). The latter is Steve's preferred method (Figure 11.79).

Marking, cutting, and assembling the handrail

The first of two cuts required to join the volute and upward easing assembly to the handrail is complete and Steve now prepares to mark the second. The volute template is used to position the fitting correctly above the curtail step while timber blocks are used to raise it to a height matching that of the handrail when resting against the tread nosings (Figure 11.80). The handrail cut line is marked against the cut end of the upward easing (Figure 11.81) and, rather than attempt to hold a long, heavy, and twisted piece of handrail against the fence of a chop saw, Steve opts to cut the rail with a tenon saw.

Holes for the second of the two rail bolts which will join the trimmed upward easing to the handrail are not factory drilled; included with the fitting is a template for use in marking the bolt hole positions on both components. Ensuring that the drill is held at 90° to the end face, a 6mm diameter hole is drilled into the end grain of the upward easing, into which the wood thread of the rail bolt is screwed (Figure 11.82). In the



Figure 11.80 With the volute raised on timber blocks directly above the template, Steve positions the handrail next to it.



Figure 11.81 The handrail is marked for cutting by scribing a line against the trimmed end face of the upward easing.



Figure 11.82 The rail bolt is screwed into the end grain of the upward easing, its position marked using a template provided with the volute.



Figure 11.83 A 9 mm hole in the handrail will receive the engineering-thread-half of the double-threaded rail bolt. When drilling for the rail bolts, it is essential that the drill is held at 90° to the surface.



Figure 11.84 An access hole in the underside of the handrail can either be drilled or, as seen here, mortised.



Figure 11.85 With the components dry-fixed together, Steve levels the volute and checks the handrail for correct alignment before gluing.

end face of the handrail, a 9mm hole is drilled which will accommodate the engineering-thread-half of the double-threaded rail bolt (Figure 11.83).

In the underside of the handrail an access hole is needed for the nut and washer which will pull the upward easing and handrail together. A 32mm diameter hole will suit the purpose, although an 18mm mortise hole, cut to a width of 32mm, will minimise the size of the access hole, be easier to patch later, and will still provide adequate lateral leverage for the spanner (Figure 11.84). The handrail and upward easing can now be dry-fixed together and the whole assembly repositioned, levelled, and checked for correct alignment (Figure 11.85).

Satisfied that the entire handrail assembly is correct, Steve loosens the nuts holding the three components together and squeezes glue into the joins (Figure 11.86). The nuts are re-tightened (Figures 11.87 and 11.88) and excess glue cleaned off. The access hole mortised earlier is patched (Figure 11.89) and later, when the glue has dried, the handrail cleaned up (Figure 11.90).



Figure 11.86 The nuts securing the assembly are loosened, and glue is squeezed into the joins.



Figure 11.87 (above) and Figure 11.88 (below) The fixings are re-tightened causing glue to ooze out. The excess glue should be cleaned off with a damp cloth while still wet.





Figure 11.89 The rail bolt access hole is patched.



Figure 11.90 Steve gives the newly assembled handrail and volute a light clean up with 180-grit sandpaper.

Joining the handrail to the upper newel post

As previously indicated, the guarding for our circular staircase will combine the over-the-post and post-to-post balustrade systems. The volute at the foot of the staircase will run above the volute newel post, while at the top of the flight the handrail will be tenoned into the upper newel post.



Figure 11.91 Mark a line on the upper tread where it meets with the top newel post.



Figure 11.92 The handrail can be laid on the tread nosings and balustrade centre line, and secured with a sash clamp.



Figure 11.93 (above) and Figure 11.94 (below) Plumbing up from the line marked on the upper tread to form the handrail shoulder line can be done with a spirit level or steel roofing square.



Figure 11.95 The tenon cheeks are cut with a handsaw.

To mark the handrail's tenon shoulder lines, the flight is temporarily lifted clear of the landing joist so that access to the cut string's upper tenon is gained. The upper newel post is then dry-fitted to the tenon (Figure 8.132), pushed up fully, and a pencil line marked on the upper tread where its rear edge is housed within the newel post (Figure 11.91). The newel post is removed, the flight re-levelled on the landing joist, and the handrail carefully positioned on the balustrade centre line, resting on the tread nosings, and held in place by gently clamping it to the string (Figure 11.92). The line marked on the upper tread can now be transferred to the handrail in one of two ways: by plumbing up with a spirit level (Figure 11.93), or by squaring up with a steel roofing square (Figure 11.94). The lines drawn on each side of the handrail are joined across its upper and lower surfaces, creating the required shoulder line. The tenon cheeks are marked square to the shoulder line and cut with a hand saw (Figure 11.95).

The first half of the joint is cut; to mark the second (the newel post's mortise) the handrail is repositioned on the balustrade centre line, held with clamps as previously described, and the volute checked for level across its length and width (Figure 11.96). The height from the top of the curtail tread to the underside of the levelled volute is measured (Figure 11.97) and this distance (202mm) deducted from the volute newel post's height of 1100mm:



Figure 11.96 Prepare for marking the top newel's mortise by repositioning the handrail and checking that the volute is level across its width (as seen here) and length.



Figure 11.97 Carefully measure the height from the top of the curtail tread to the underside of the levelled volute.

$$1100 - 202 = 898 \text{ mm (Figure 11.98).}$$

The 898mm is now added to the height from the top of the upper tread (tread number 7) to the top of the handrail tenon (249 mm):

$$249 + 898 = 1147 \text{ mm (Figure 11.98).}$$

The location of the upper newel post's mortise can now be determined by measuring and marking a distance of 1147mm from the top of the housing for tread number 7. The mortise is chopped out, the newel

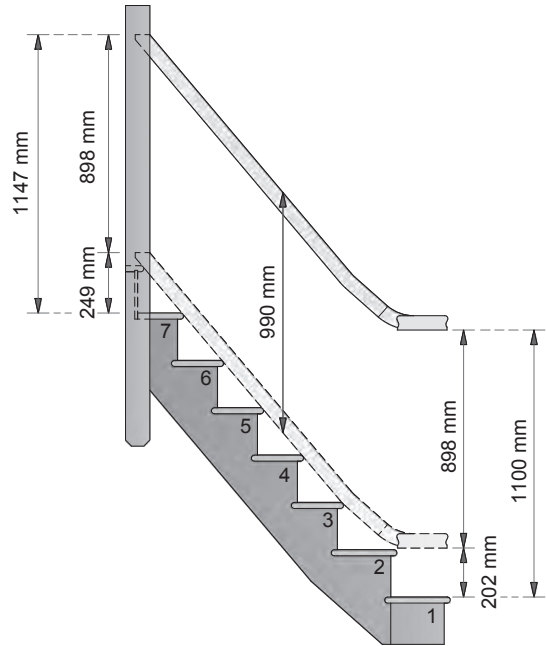


Figure 11.98 Measurements for determining the height of the top newel post's mortise that will receive the handrail's tenon.

post cleaned up and, along with the landing nosing and top riser, glued and fixed in place (see figures 8.133, 8.134, and 8.135).

It can be seen in Figure 11.98 that our handrail height is 990mm. The Richard Burbidge volute newel post is supplied with an adjustable sleeve allowing, if desired, the handrail's height to be adjusted downwards.

Joining the volute newel post and the last baluster to the curtail step

The Richard Burbidge volute newel post has, at its lower end, a large spigot which relies for its strength on being housed within a solid block beneath the curtail tread (Figure 11.99). A hole of a diameter to suit the manufacturer's instructions, and located according to the volute template is drilled through the curtail tread into the solid block below (Figure 11.100). As a general rule, the deeper the hole, the better, but very often this depth will be limited by the length of the drill bit. A minimum depth of 100 mm (around half a riser height) should be achievable (more if using a brace and bit).



Figure 11.99 The volute newel's spigot should be a minimum of 100 mm long.



Figure 11.100 The hole for the volute newel's spigot is drilled through the curtail tread into the solid block below at the location marked using the volute template.



Figure 11.101 With the handrail dry-fixed between the two newel posts the marking and cutting of the balusters can begin.

The handrail can now be dry-fixed between the two newel posts (Figure 11.101), which will allow the best results to be obtained by individually marking and cutting each baluster. And the first baluster to be marked and cut is the curtail step's last baluster – this is important because by fixing through the square of the baluster into riser number 2 and into the cut string behind, increased rigidity is provided to the whole assembly of balusters, volute newel, volute, and handrail at the foot of the staircase.

The positioning of the baluster against the face of the riser will require notches cut in both the baluster and the tread nosing. Having marked the nosing of tread number 2, Steve starts by cutting the notch's outer edges with a tenon saw (Figure 11.102). The remainder of the waste – the nosing's rounded front edge – is removed with a sharp chisel (Figure 11.103). The baluster is then notched and tested for fit (Figure 11.104). The cut-line at



Figure 11.102 Tread number 2 is notched to allow the curtail step's final baluster to be screwed through the face of the second riser and into the cut string behind.



Figure 11.103 The rounded part of the tread's nosing is chopped out with a sharp chisel.



Figure 11.105 The plumb baluster is marked against the underside of the handrail and then adjusted to suit the depth of the groove.



Figure 11.104 The housed baluster is tested for fit.

the top of the over-length baluster is marked by holding it plumb against the side of the handrail (Figure 11.105) and then adding the depth of the groove.

The upward easing is the only part of the handrail with its underside grooved; balusters throughout the rest of the handrail will be dowelled, and those beneath the volute tenoned. The next baluster – the first to be dowelled into the handrail – is cut to length and its bottom dowel inserted into the hole drilled in the tread. Steve then draws round the top of the baluster (Figure 11.106) before removing it, marking its centre on the underside of the handrail, and drilling an 18mm diameter hole to a depth of around 38mm (Figure 11.107).

It is important that the dowel holes drilled into the underside of the handrail are perfectly plumb, and it will be noticed in Figure 11.107 that Steve is plumbing his drill by eye. For those of us not quite as clever, there are a couple of techniques to aid accurate drilling. The first is a pitch block cut to the size of the rise and going and clamped to the handrail (Figure 11.108). An added benefit of the pitch block is that it can also act as a depth stop to prevent accidentally drilling right through the handrail. Alternatively, the handrail can be removed after marking, inverted, and the holes bored with a drill guided by a pitch board (Figure 11.109).



Figure 11.106 The location of the first dowel-top baluster is marked on the underside of the handrail.



Figure 11.108 A pitch block clamped to the handrail is a useful aid which ensures that holes are drilled plumb and to the correct depth.



Figure 11.107 An 18mm diameter hole is drilled to a depth of around 38mm, allowing dowel penetration of at least 25mm.



Figure 11.109 A pitch board can be used as a guide when drilling the inverted handrail on a work bench.

With the handrail temporarily lifted clear, Steve inserts the balusters that will follow the curve of the volute into the remaining holes drilled in the curtail tread (Figure 11.110). These balusters are identical in length to that of the volute newel post and, rather than



Figure 11.110 With the handrail lifted clear, the balusters that will follow the curve of the volute are inserted into the holes drilled in the curtail step.



Figure 11.112 The handrail is repositioned, and each baluster is individually marked and cut.



Figure 11.111 Mortise and tenon joints hold the balusters at the correct angle and prevent turning after installation.

dowels, have tenons at the top (Figure 11.111). Unlike dowels, tenons will not allow the balusters to turn after installation and will hold these square-edge balusters at the correct angle as they rotate the volute. The handrail is repositioned and Steve continues up the stairs marking, cutting, and numbering each baluster one by one (Figure 11.112).

Chamfering the balusters

Now that all of the balusters have been cut to length, they can be removed and stop-chamfered so that their moulded sections run parallel with the handrail; in other words, they will be rail-oriented balusters. The chamfers can be applied with a router, but I used a vari-angle cutterhead in a spindle moulder with a false fence nailed to the machine's fence for safety, accuracy, and a better finish (Figure 11.113).

Our balusters are 32mm square; the Richard Burbidge volute is suitable for use with 41 mm balusters and, by inserting the flexible rail converter included with the product into the upward easing's groove, 32mm balusters as well. Gluing the converter in place ahead of final installation makes the fixing of the balusters easier (Figure 11.114).

Final balustrade installation

All components are now cut and fitted, cleaned up, and ready for final installation, allowing gluing to be carried out speedily. The first component to be glued in place is the all-important last baluster on the curtail step. Glue



Figure 11.113 Stopped chamfers add an attractive finish to the balusters.



Figure 11.116 The baluster screw holes are pelleted and the volute newel's spigot glued and inserted into the curtail step.

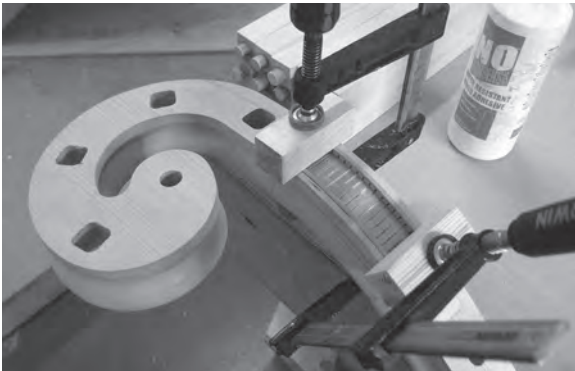


Figure 11.114 A flexible rail converter decreases the upward easing's groove from 41 mm to 32 mm. It should be glued and allowed to set prior to the fixing of the 32 mm balusters.



Figure 11.115 The notched baluster is glued and screwed through the face of the second riser into the cut string behind.



Figure 11.117 The first two components are glued in place while polythene protects the volute newel during installation.

is poured in and around the dowel hole in the curtail tread before the baluster, with glue spread onto its face that will meet with the second riser, is inserted. The baluster is screwed through its face into the riser and cut string behind (Figure 11.115). The balusters screw holes are pelleted and the turned volute newel, with its spigot coated thickly in glue, is inserted into its glue-filled hole (Figures 11.116 and 11.117).



Figure 11.118 Dowel at the top of the balusters should penetrate the underside of the handrail by a minimum of 25mm.



Figure 11.119 The trimmed and numbered balusters are glued into their respective dowel holes in the treads.



Figure 11.120 Glue is applied to the tops of the volute newel and all balusters ahead of handrail installation.



Figure 11.121 The installation and lowering of the handrail onto the tops of the balusters is a two-person job.

Working quickly to get the job done before the glue dries, short lengths of 18mm dowel are glued into holes drilled in the upper ends of the balusters (Figure 11.118). And, with the handrail set aside, the trimmed and numbered balusters are glued and dowelled into their corresponding tread holes (Figure 11.119). Glue is then applied to the dowelled and tenoned tops of the volute newel and balusters (Figure 11.120), before the handrail is re-installed by first locating its glued tenon into the upper newel's mortise (Figure 11.18) and then, with the help of a second person, lowering it

gently onto the balusters and volute newel and tapping it home with a rubber mallet (Figure 11.121).

The handrail is pulled up tight at its upper end by draw-bore pinning the tenon into the upper newel post and, at its lower end, by placing a protective board on top of the volute and clamping with only mild pressure between the board and the nosing of the curtail tread (Figure 11.122). The volute newel can then be secured by gluing and dowelling through the solid block beneath the curtail tread into the newel's spigot (Figure 11.123). Flexible timber fillets, included with the Richard Burbidge volute, infill the spaces between the balusters fixed beneath the upward easing. The installation is completed by nailing at an angle through the back of each baluster into the underside of the handrail (Figure 11.124).



Figure 11.123 Secure the volute newel by gluing and dowelling through the curtail step's solid block into the newel post's spigot.



Figure 11.122 With a protective board on top of the volute, the volute newel and balusters forming the 'bird cage' can be pulled up by clamping gently against the curtail tread's nosing.



Figure 11.124 As well as gluing and dowelling, each baluster is nailed through its upper rear portion into the handrail.



Figure 11.125 A cap on top of the top newel provides a finishing touch.



A light clean-up of the handrail , the fitting of a newel cap on top of the upper newel post (Figure 11.125), and our circular staircase is finished (Figure 11.126).

Figure 11.126 The completed circular staircase and balustrade.

12

Repairing Stairs

A newly built bespoke staircase can be an expensive item of joinery – before it's been installed. Installation in anything other than a new-build property will require the removal of the existing staircase which, in turn, might lead to the stripping of surrounding plaster, producing dust and rubble and much disruption for the occupants. Faced with such a prospect, a homeowner might choose the cheaper and far less invasive option of refurbishing an existing staircase.



Figure 12.1 This creaky old staircase was installed when the property was built in 1930.

Creaky and damaged steps, broken balusters, loose newel posts and handrail are all problems commonly found on older staircases. Curing these problems needn't be beyond the scope of an apprentice stair builder and can be an immensely satisfying project. The 16-rise staircase seen in Figure 12.1 dates from around 1930 and is quite possibly the creakiest I've ever walked on. It's in desperate need of refurbishment. And with new carpets on order, work must get under way immediately – starting with those creaks.

Creaks: the causes



Figure 12.2 The movement of this tread as the gap closes under the weight of a stair user results in loud and unwanted creaking.

Creaks are caused by two pieces of wood rubbing together, and the most common cause of staircase creaks is treads not sitting firmly on their risers. Usually, through shrinkage or the separation of parts through age, a gap develops between the underside of a tread

and the top of a riser (Figure 12.2). When stepped on, the tread creaks as it is forced downwards onto the riser, and then creaks again as it springs up after use. Loose wedges from a closed string staircase, missing screws, and broken glue blocks can all contribute to a creaky staircase. Whatever the cause, identification of problems is not difficult if the underside of the flight is accessible (perhaps via an under-stairs cupboard), and you have a helper who will use the stairs during inspection.

Curing a creaky staircase

A staircase with both its upper and undersides accessible provides the most opportunities for curing creaks. At the flight's upper side, a creaky tread can be forced downwards under the weight of a helper so that it settles onto its riser. Spring back is prevented by driving 65mm oval nails in 'dovetail' configurations through the tread into the riser below (Figure 12.3). The nails are then punched below the surface and the holes filled and sanded.



Figure 12.3 Under the weight of a helper, a settled tread can be held in place with nails 'dovetailed' into the riser.

A stronger fixing can be achieved with screws. A 12mm auger bit is used to drill holes to a depth of around 8mm (Figure 12.4), followed by 5mm clearance holes through the remainder of the tread's thickness. Pilot holes of 2.5mm diameter are drilled into the riser, and the tread is secured with 4.0 × 65mm wood screws (2½ inch 8s) (Figure 12.5). Finally the holes are glued and pelleted (Figure 12.6).



Figure 12.4 Prepare screw holes for pelleting with a 12mm auger bit.



Figure 12.5 Movement is eliminated by screwing the tread to the riser.



Figure 12.6 Use pellets to hide screws if the stairs are to remain uncarpeted.



Figure 12.7 (above) and Figure 12.8 (below) Replace all loose and missing wedges if the flight's underside is accessible.

Replacing wedges

Beneath a flight with housed strings it is likely that some wedges are loose or possibly missing altogether (Figure 12.7). If the underside of the flight is accessible, vacant wedge ways should be cleaned out and new wedges glued and driven home (Figure 12.8). As with new staircase assembly, risers should be wedged ahead of treads (where both are required) and both sides of the same step wedged before moving on to the next.



Separation of the string from the wall

Typical of the era, the strings of our 1930s staircase were nailed to the brickwork with cut clasp nails. The passage of time has seen too many of the nails work loose, further adding to the creaks and, on a staircase open on one side, could cause the closed string to separate from the wall and possibly sag. A sagging string should be propped up ready for fixing by bracing off the floor below in a similar way to that seen in Figure 12.14. The type of fixing used to secure the string to the wall will depend upon the background, but whether that background be timber or masonry, screws are always better than nails.

Fixing should take place through the triangular sections beneath every two or three steps. For the brick wall seen in Figure 12.9 I opted for 100mm long by 10mm diameter medium-duty frame fixings of the type made by Fischer or Rawlplug, consisting of a



Figure 12.9 A long masonry bit is used to drill a 10mm diameter hole in the brickwork behind the string. Pack any gaps between the string and the wall.



Figure 12.10 Tap the frame fixing until the sleeve is just within the string's countersunk hole.



Figure 12.11 The sleeve expands within the brickwork as the screw is tightened, securing the string to the wall.

nylon sleeve and screw. Countersunk holes, 10mm in diameter, are drilled through the timber string and into the wall; the total depth of the holes should be 10mm greater than the fixing length. Holes should be positioned near a brick's middle area and not near the edge, which could cause crumbling, and not between the brick courses (Figure 12.9). A frame fixing is inserted into the hole and tapped lightly until the sleeve is flush with the surface (Figure 12.10). The protruding screw is then tightened, expanding the sleeve within the brickwork (Figure 12.11). Gaps between the string and the wall, caused by irregularities in the wall surface, should be packed with timber shims prior to fixing.

Screwing risers to treads

Modern staircase construction includes screwing through the lower part of each riser into the back of the preceding tread (Figure 12.12). Older staircases are more likely to have been nailed, and many of those nails will have worked loose over the years. Screwing risers to treads is an important part of eliminating creaks, but is, of course, only possible where steps are exposed and accessible.



Figure 12.12 The lower portion of each riser should be screwed to the back of its preceding tread.



Figure 12.13 Screws should be positioned uniformly at centres not exceeding 230mm.

Screw length should be three times the riser thickness, so for typical 12mm thick risers 5.0 × 40mm wood screws (1½ inch 10s) would be required. Countersunk clearance holes, 6 mm in diameter, are drilled through the risers at centres not exceeding 230 mm; and 3mm diameter pilot holes drilled into the backs of the treads eliminate the risk of the timber splitting. Maintaining uniform screw positions will provide a neat finish where the steps remain exposed and is good practice throughout the whole of the flight (Figure 12.13). Tackling the flight's lower steps will mean adopting some awkward working positions.

At the top of the stairs it is likely that access to the last riser is prevented by a trimmer joist which, in turn, might be covered by the ceiling at its bottom edge and by the upper floor decking at its top edge. However, if the staircase overhaul is part of a general property refurbishment and the upper floor joists are exposed, a secure fixing can be obtained by screwing



Figure 12.14 A prop is used to push up a sagging tread ready for fixing.



Figure 12.15 The space between the top riser and trimmer joist is packed prior to screwing, and clearance holes are drilled through the trimmer joist.



Figure 12.16 Sufficiently long wood screws pass through the trimmer joist, packers, and top riser into the back of the top tread, providing a solid fixing at the top of the stairs.

through the trimmer joist and riser into the back of the top tread. If necessary, a sagging tread can be supported temporarily by bracing a prop from the floor below (Figure 12.14). Correctly sized timber packers, or shims, bridge the space between the riser and joist before clearance holes are drilled (Figure 12.15) and appropriate length screws are driven through the joist, packers, and riser, into the back of the tread (Figure 12.16).

Replacing angled glue blocks

Figure 12.13 shows the newly screwed risers and treads; it also reveals the poor state of the glue blocks, some of which do not meet with the treads above, others are damaged and broken, and a number are missing altogether. Broken or ill-fitting glue blocks can be easily removed with a short, sharp blow to the side with a hammer. A chisel is used to scrape away excess dry glue which, if left, would prevent the good adhesion of the replacement glue blocks (Figure 12.17). New glue blocks are then glued and pinned in place (Figure 12.18). On this particular staircase almost all of the glue blocks had to be renewed (Figure 12.19).

Finishing the underside of the stairs

With the treads fixed to the risers, the string to the wall, and wedges and glue blocks replaced, the staircase is now virtually creak-free, and preparations for lining its underside can begin. The lining, which will be 12.5mm thick plasterboard, skim coated and then painted, provides an opportunity to create a void in which unsightly electric cables (seen in Figure 12.19) running from the consumer unit and providing power to the upper floor can be run and concealed.

At more than 950mm, the staircase's width is too great for the plasterboard to span from string to string without an intermediate fixing point. A centre carriage would not only provide a fixing point, but would help provide clearance between the plasterboard lining and the underside of the steps, creating a void in which to channel the electric cables. And by providing support to the centre of the steps, it would help to further reduce creaks. The problem, though, is that for an unnotched centre carriage to provide adequate support it should be at least 100mm (4 inches) deep, which, for this staircase, would mean a reduction in much-needed headroom beneath the flight.

So without room for a deep, unnotched centre carriage but in need of a fixing point for the plasterboard lining, a channel for the electric cables, and support for the centre of the staircase, a compromise is needed. The solution is a carriage of sufficient depth to allow the electric cables to pass beneath the steps, with the addition of plywood cleats to provide support to the treads.



Figure 12.17 Dry glue is scraped off before applying the new glue blocks.



Figure 12.18 New glue blocks are held in place with pins while the glue dries.



Figure 12.19 Few of the old glue blocks remain. Note the electric cables hanging beneath the flight.



Figure 12.20 A narrow carriage is nailed temporarily to the steps, prior to marking.



Figure 12.21 Using a steel rule, the tread and riser lines are extended onto the carriage.

Planned timber, ex 50mm square, and of sufficient length to reach, ideally, from the trimmer joist at the top of the stairs to a corresponding joist or nogging at the bottom, is nailed temporarily to the underside of the steps (Figure 12.20). However, for this staircase, the frame of an understairs cupboard, fixed at right angles to the strings, prevents the use of a continuous centre carriage. The tread and riser lines are extended onto the carriage (Figure 12.21), which is then notched round the steps, leaving the underside level with battens that will be screwed to the underside of the strings (Figure 12.22).

The notched carriage is screwed through the risers into the backs of the treads (Figure 12.23), and triangular cleats, cut from 18mm plywood, are butted up against the undersides of the treads and are screwed to the sides of the carriage (Figure 12.24). Timber battens are



Figure 12.23 The carriage is screwed to the underside of the steps.



Figure 12.22 The notched carriage is offered into position in the centre of the flight.



Figure 12.24 The tread centres are supported by triangular plywood cleats screwed to the carriage.



Figure 12.25 (above) and Figure 12.26 (below) Timber battens fixed to the strings level the underside of the flight and provide clearance for the electric cables.



fixed to the strings' lower edges (Figure 12.25) and the underside of the flight checked for level (Figure 12.26).

Just ahead of lining and to better prevent unwanted noise from staircase users, mineral wool insulation is placed in the triangular voids beneath the steps (Figure 12.27). Care is taken to keep the insulation clear of the electric cables which might otherwise cause overheating. Plasterboard, 12.5mm thick, is then screwed to the underside of the stairs (Figure 12.28) and the room plastered (Figure 12.29). The remaining short length of exposed cables, seen in Figure 12.29 emerging from the underside of the staircase, passing beneath the trimmer joist, and disappearing again into the ceiling void, will be concealed entirely by cornice (Figure 12.30).



Figure 12.27 Mineral wool insulation is placed beneath the steps but kept clear of the electric cables which would otherwise be at risk of overheating.



Figure 12.28 The flight's underside is lined with 12.5mm plasterboard secured with drywall screws.

Replacing broken balusters

At the foot of our 1930s staircase is a short length of handrail running between a bottom newel post and a wall enclosing the flight's right-hand string. Beneath the handrail are two balusters, one of which is loose and the other split; both need replacing. At their tops, the balusters are housed into a groove in the underside of the handrail and held in place with timber fillets, while at the bottom they are simply glued and skew-nailed to the top of the string.



Figure 12.29 The room is plaster-skimmed, and the short section of electric cables still exposed (top right-hand corner) will soon be covered by cornice.



Figure 12.30 The newly decorated room beneath the now creak-free staircase.

The balusters are square-edged, so finding replacements won't be a problem; turned balusters, on the other hand, might be difficult to replace. Standard off-the-shelf profiles are available at most DIY stores and builders' merchants, while older and more unusual designs can be reproduced by a specialist wood turner who is provided with a sample to copy. If such a service is deemed too expensive, the only option might be to replace all of the balusters.

The handrail height of this old staircase doesn't meet modern regulations which state that a rail's upper surface should be between 900 mm and 1100 mm from the pitch line or floor (Figure 11.1), so while replacing the balusters I'm going to take the opportunity of installing a new, higher handrail with matching newel cap. The old balusters are easily removed by sawing through at an inclined angle and pulling the two parts away from their fixings (Figure 12.31). Here, the handrail too is being replaced, but if renewing a baluster only, its adjacent timber fillet would have to be chiselled out to provide access for the new baluster.



Figure 12.31 Broken or damaged balusters are removed by sawing through at an inclined angle and then pulling the two parts from their fixings.



Figure 12.32 Start removing waste from the newel post's new mortise by drilling with an 18mm flat bit.



Figure 12.33 All remaining waste is removed with a wood chisel.



Figure 12.34 Prepare for draw-bore pinning by drilling a 12mm diameter hole into the newel post's side and through the mortise.

The seemingly insecure method used to fasten the existing handrail to the newel post, by butting, gluing, and skew-nailing, has lasted many years. Nevertheless, the new handrail will be connected properly with a mortise and tenon joint. In its new higher position, an 18mm flat bit is used to take out the majority of the mortise's waste (Figure 12.32), after which the mortise is finished with a chisel (Figure 12.33). Next, a 12mm draw-pin hole is drilled through the side of the newel post, again using a flat bit (Figure 12.34). Breakout is avoided by allowing only the flat bit's point to emerge from the newel post's opposite side so that the hole can be drilled from both directions.

The handrail's tenon, including a 12mm diameter hole offset slightly from that in the newel post, is coated in PVA adhesive and inserted into the mortise (Figure 12.35). The joint is pulled up tightly by driving a draw pin – a length of 12mm dowel, tapered at one end – through the assembly (Figure 12.36). At its opposite end, the handrail is notched and glued and screwed to the wall, and finished with a small mitre (Figure 12.37). And just before installing the new balusters, the matching newel cap is glued and nailed to the top of the newel post (Figure 12.38).



Figure 12.35 The handrail's tenon, with its offset draw-pin hole, is coated with PVA adhesive and inserted into the mortise.

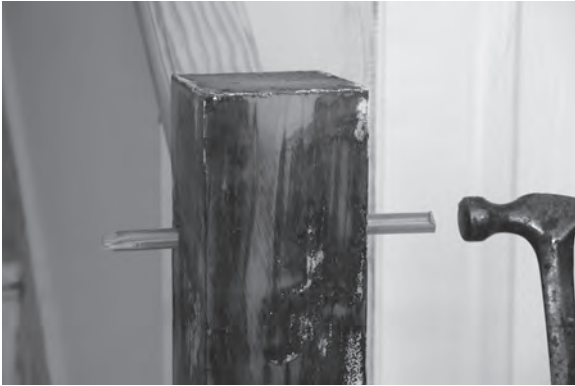


Figure 12.36 A short length of 12mm dowel, tapered at one end, is driven through the offset holes, pulling the handrail up tightly.



Figure 12.37 At its upper end, the short handrail is notched round and screwed to the wall.



Figure 12.38 A new newel cap is glued and nailed to the top of the newel post.



Figure 12.39 String capping, grooved on both its upper and undersides, is glued and screwed to the top of the string.



Figure 12.40 The new balusters will be housed into the string capping's upper groove and secured with glue and nails, and spaced with timber fillets also glued and nailed in place.

The existing balusters were joined at their lower ends with simple butt joints which were glued and skew-nailed directly to the string's top edge. The new balusters will be housed within the groove of a string cap, itself ploughed, glued, and screwed to the string (Figure 12.39). Once cut to length, the new balusters are glued and skew-nailed within the grooves of the string capping and handrail, with glued-and-nailed



Figure 12.41 The short balustrade run at the foot of the stairs is complete.

timber fillets infilling the vacant grooves between balusters (Figures 12.40 and 12.41).

Securing a loose newel post

The newel post at the top of the stairs (seen in Figure 12.45) has loosened over the years. Not an uncommon occurrence on an old staircase but one that needs addressing if it is to be made safe. The newel post is joined to the staircase's string using a traditional mortise and tenon joint and has been notched over a trimmer joist. Running alongside the flight on the upper floor is a trimming joist to which access can be gained by lifting a timber floorboard.

Two suitably sized holes are drilled through the joist and into the newel post, which is then secured with 120mm long by 10mm diameter coach screws (Figures 12.42, 12.43, and 12.44). The underside of the floor was, in this case, easily accessible; had it



Figure 12.42 (above), **Figure 12.43** (below), and **Figure 12.44** (bottom of page) The loose newel post is secured to the adjacent trimming joist with two coach screws.





Figure 12.45 Along the landing, a new horizontal balcony balustrade is required.

not been, screws could have been driven through the newel post and into the string's tenon just above the top tread and then concealed with timber pellets.

Installing a new balcony balustrade

At the upper floor, the old loose and insecure handrail and balusters running horizontally along the landing have been removed, clearing the way for a brand new balcony railing (Figure 12.45). It's a good idea, before starting work, to check existing components for level and plumb (Figures 12.46 and 12.47). Neither the upper floor nor upper newel post is perfect but, given the age of the property, they're not too far out.



Figure 12.46 (above) and Figure 12.47 (below) The floor and upper newel post are checked for level and plumb.

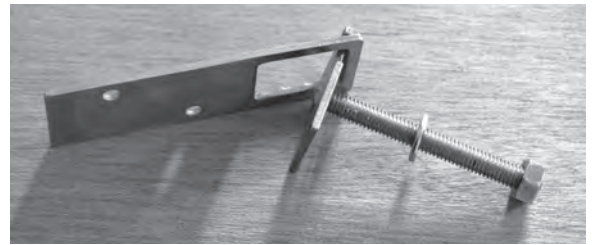


Figure 12.48 Handrail bracket manufactured by Richard Burbidge.



Figure 12.49 A string line is tied to the upper newel post and pulled parallel with the landing nosing.



Figure 12.49 (previous page) and Figure 12.50 The new balustrade must run parallel to the landing nosing, so a string line is used to accurately mark the location of the half newel on the facing wall.

The new balcony handrail will be joined, at one end, to the upper newel post by traditional mortise and tenon, and, at its opposite end, to a half newel post using a handrail bracket manufactured by Richard Burbidge (Figure 12.48). As a general guide, the distance between two balcony newel posts should not exceed 2.4 m (8 feet); this one, although a little longer, is being built to customer requirements. The half newel will be screwed to the facing wall, its location determined by running a string line from the upper newel post, pulling the string tight so that it is parallel with the landing nosing, and marking the position on the wall (Figures 12.49 and 12.50).

The threaded portion of the handrail bracket is passed through the half newel, let in to finish flush with the half newel's face (Figure 12.51), and secured from behind with a nut and washer (Figure 12.52). An offcut of the new handrail can now be held in position, its upper edge marked onto and squared round the half newel (Figure 12.53). The same offcut is used to mark the handrail height onto the upper newel post and the height transferred to the facing wall using a laser level (Figure 12.54). The over-length half newel is held against the wall in its position marked earlier using the string line and the amount to be trimmed from its lower end determined by measuring the difference in height between the line representing the top of the handrail and the line levelled from the upper newel post (Figure 12.55). Once



Figure 12.51 (above) and Figure 12.52 (below) The threaded portion of the Richard Burbidge handrail bracket is passed through the half newel and secured from behind with a nut and washer.





Figure 12.53 Rest an offcut of the new handrail on the bracket and mark its top on the half newel. The top-of-handrail height should also be marked on the upper newel post.



Figure 12.55 The amount to be trimmed from the lower end of the half newel is equal to the difference between the handrail height marked on the half newel and that marked on the wall.



Figure 12.54 The handrail height marked on the upper newel post is transferred to the facing wall with a laser level.



Figure 12.56 Plumb and screw the half newel to the wall using suitable fixings.

trimmed to length, the half newel is fixed to the wall using screws suitable for the wall construction, in this case wood screws into a timber stud (Figure 12.56).

Time to fit the new handrail. At one end, a tenon is glued and inserted into the upper newel post's mortise and pulled up tight with a draw pin. At the other end the handrail is glued and butt jointed to the half newel and secured by screwing up through the bracket into the ploughed groove (Figure 12.57). The handrail bracket will later be concealed by a timber fillet infilling the groove between the last baluster and half newel. Directly beneath the handrail and fixed to the landing nosing will be a baserail, grooved at its upper side to mirror that ploughed in the underside of the handrail, into which the balusters will be housed (Figures 12.58 and 12.59). The baserail is cut tight between the two newel posts, which it meets with butt joints only, and fixed with $4.0 \times 32\text{ mm}$ wood screws ($1\frac{1}{4}$ inch 8s) at centres not exceeding 230 mm.



Figure 12.57 The new handrail is glued and butted against the half newel and secured with screws to the handrail bracket.



Figure 12.58 The groove in the baserail's upper side will house the new balusters.



Figure 12.59 The baserail is fixed to the floor using $4.0 \times 32\text{ mm}$ wood screws ($1\frac{1}{4}$ inch 8s) at centres not exceeding 230 mm.



Figure 12.60 The new balusters are housed, glued, and skew-nailed top and bottom.



Figure 12.61 Timber fillets are glued and pinned into the grooves in the baserail and handrail between each baluster.



Figure 12.63 The newly installed balcony railing.



Figure 12.62 One and a half newel caps provide finishing touches to the new installation.

Now that we have a four-sided frame comprising a handrail at the top, a baserail at the bottom, and newel posts at each end, the cutting and fixing of the balusters can begin. Each baluster is marked and cut individually, and fixed by gluing and skew-nailing into the grooves top and bottom (Figure 12.60). The balusters are spaced and further secured by timber fillets glued and pinned between each one (Figure 12.61); remember: the spacings between balusters must not allow the passing of a 100 mm sphere (see Figure 11.2). A full newel cap and a half newel cap



Figure 12.64 The balcony railing now painted and carpets laid.

on the upper newel post and half newel respectively, provide finishing touches to the new balcony railing (Figure 12.62).

The completed balcony railing is shown, in Figure 12.63, immediately after installation and, in Figure 12.64, after painting and the laying of the carpet.

Wall-mounted handrail

At the foot of our 1930s staircase, on the right-hand side, a short run of balustrade provides guarding for the first three steps (Figure 12.41). Thereafter, guarding is not a concern because the flight is enclosed between two walls. Without a graspable handrail running the



Figure 12.65 A new continuous handrail will be fixed to this wall.



Figure 12.66 Wall-mounted handrail bracket manufactured by Richard Burbidge.

entire length of the flight, however, the safety of users cannot be assured; and the left-hand wall provides the ideal background for an uninterrupted length of railing (Figure 12.65).

At less than a metre wide (just), handrail is required on one side of the staircase only, and I shall be using wall-mounted handrail brackets manufactured by Richard Burbidge (Figure 12.66). The handrail brackets come with installation instructions, which advise fixing the brackets to the railing before offering the assembly up to the wall. While this method might work for shorter lengths of lighter-weight handrail, a near-five-metre run of ex 3 × 2 (75 × 50 mm) railing will require a different approach.



Figure 12.67 The pitch line is marked on the edge of a plumbed spirit level held against a tread nosing.



Figure 12.68 From the pitch line mark, the desired handrail height is also marked onto the edge of the spirit level.

Fixing wall-mounted handrail brackets to a wall

The first task is to determine the fixing height of the handrail brackets. Handrail should be fixed so that its upper surface is at least 900 mm above the flight's pitch line (Figure 11.1), which can be marked on the edge of a spirit level held plumb against the nosing of



Figure 12.69 $4\frac{1}{2}$ " (around 114 mm) should be deducted from the handrail height marked on the spirit level.

a tread (Figure 12.67). From that mark, the desired height of the handrail (which, in this case matches that of the short, right-hand handrail) is measured and marked on the spirit level (Figure 12.68). This second mark, it should be remembered, represents the upper surface of the handrail, not the fixing point of the brackets. So, from this mark we must deduct the thickness of the handrail (measured vertically with the railing parallel to the pitch line), and the distance from the top of a bracket to the centre of its fixing hole, both of which can be measured by flipping the handrail so that its upper surface rests against the tread nosings and holding (or temporarily screwing) a bracket to the underside of the rail (Figure 12.69).

The spirit level is now held plumb, firstly against a tread nosing near the foot of the stairs, and then against one at the top of the stairs, while the mark representing the brackets' fixing point is transferred to the wall (Figure 12.70). Through those two marks a chalk line can be snapped, leaving a continuous line representing the fixing height of the handrail brackets (Figure 12.71). The required number of handrail brackets can now be spaced evenly along the line at intervals of no more than a metre which, on a masonry wall such as this, is quite straightforward, but less so on a hollow wall, where an electronic stud locator will be needed in order to ensure that the brackets are fixed to solid timber. Holes to suit the wall construction are drilled (Figure 12.72), and the handrail brackets screwed into place (Figures 12.73 and 12.74).



Figure 12.70 The brackets' fixing height is marked from the spirit level to the wall at the top and bottom of the stairs.



Figure 12.71 A chalk line, parallel with the pitch line, is snapped against the wall.



Figure 12.72 Always beware hidden services when drilling into a wall.

Lengthening the handrail

The total length of the handrail required for this staircase is very nearly 5m – too long to comfortably plane straight, too long to easily transport from the workshop to site, and too long to steer through the entrance door to its final location. Too long also, to buy in one length off the shelf, where the longest available rails are 4.2m. My plan, therefore, is to make the handrail in two sections and join them on site using the handrail bolt seen in Figure 12.75. The handrail bolt comprises two inserts, each with a male thread, for screwing into the meeting ends of the two lengths of handrail, and a female thread, into which a connecting bolt is screwed.



Figure 12.73 The wall-mounted handrail brackets are screwed to the wall.



Figure 12.75 This three-part handrail bolt (two inserts and a threaded bolt) is designed for lengthening handrail.



Figure 12.74 Wall-mounted handrail brackets should be spaced at no more than 1 m apart.

The locations of the inserts can be accurately marked by using a template in the form of a thin offcut trimmed from one of the handrail lengths (Figures 12.76 and 12.77). In the centre of the template (handrail offcut) a 3mm hole is drilled, through which a bradawl is used to transfer the location onto, first, the end grain of one handrail length, and then, after turning the template 180°, onto the second (Figure 12.78). Next, a flat bit is used to drill 13mm diameter holes in the marked locations, into which the inserts can be screwed (Figure 12.79). The inserts are tightened with an 8mm hex bit (Figure 12.80), during which it is important that the inserts remain straight and true if correct alignment of the two component halves is to



Figure 12.76 (above) and Figure 12.77 (below) Trim a thin handrail offcut for use as a template for marking the insert locations.

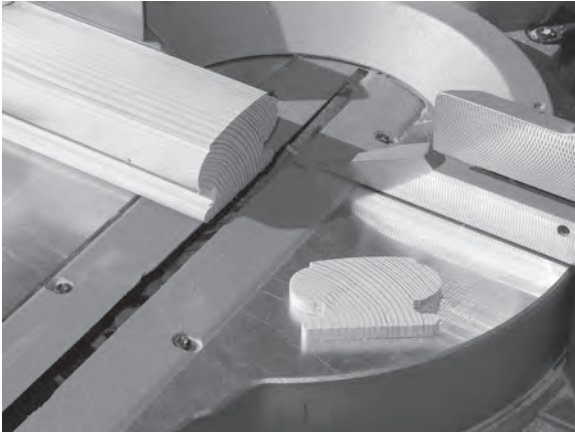


Figure 12.78 The template and a bradawl are used to mark the insert centres on the two handrail halves.



Figure 12.79 Holes, 13 mm in diameter, are drilled into the meeting ends of the handrail halves ready to receive the inserts.

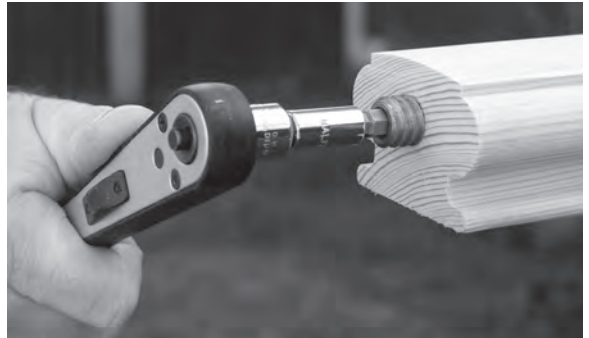


Figure 12.80 The first of the two inserts is tightened with an 8 mm hex bit, ensuring that it remains perpendicular to the end face of the handrail.



Figure 12.81 The two handrail halves are connected by a threaded bolt screwed into both inserts.



Figure 12.82 The handrail is marked to length at the top and bottom of the staircase.

screwing through one of the brackets, while the ends of the rails at the top and bottom of the stairs are marked (Figure 12.82). Mitred returns to the wall will provide a finish to the handrail ends and also reduce the risk of clothing getting caught, and should be cut sufficiently long to provide at least 40 mm (1½ inch) of finger room between the railing and the wall (Figure 12.83).

The handrail (still in two separate lengths) is mitred where marked – the offcut from one providing the mitred return for the other (Figure 12.84). Pilot holes are drilled through the mitred returns, which are then fixed by gluing and nailing (Figures 12.85 and 12.86). The handrail is carefully repositioned on the wall-mounted brackets and the mitred returns marked for scribing to the wall (Figure 12.87).



Figure 12.83 Allow 40 mm of finger room between the handrail and the wall.



Figure 12.84 Use a chop saw to mitre the ends of the handrail. The offcut from one end will become the mitred return for the other.

be achieved. With the two inserts driven fully home, the threaded bolt can now be screwed into either of the inserts ready to receive the other length of handrail (Figure 12.81).

With the meeting ends of the two handrail halves prepared (but not yet glued and screwed), they are now ready to be cut to length. The two halves are rested on top of the wall-mounted brackets and held in place, either with the help of a second person or by temporarily

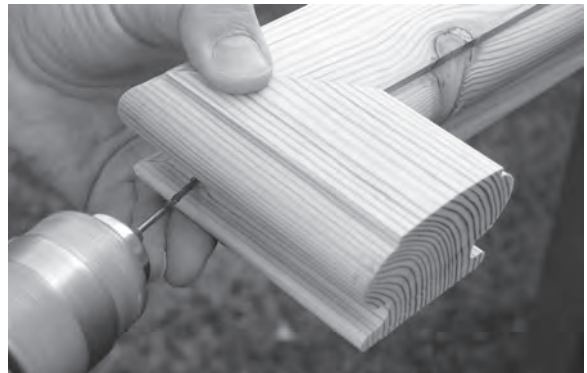


Figure 12.85 Prepare for nailing by drilling pilot holes through the mitred return.

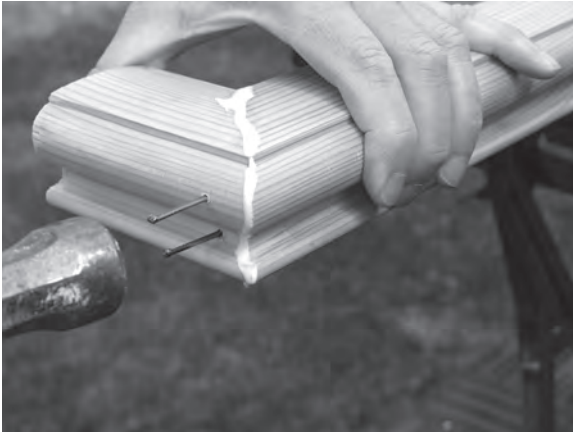


Figure 12.86 Glue and nail the mitred handrail returns.



Figure 12.87 Hold the handrail in place and, ensuring that it is entirely level, mark for scribing to the wall.

With the returns scribed and the handrail painted, it's time to glue and screw the two lengths together – and joining an item as long as this requires sufficient room (Figure 12.88). After locating the handrail bolt in the two lengths, glue is poured in before tightening the bolt (Figure 12.89). It's a good idea to have a 'dry run' before gluing the two lengths to ensure correct alignment once fully tightened. Adjustments can be made by removing the threaded bolt and screwing an insert by, say, half a turn. Once glued and fully tightened, excess glue is wiped from the joint (Figure 12.90), and



Figure 12.88 Make sure that access to the handrail's final location is possible before gluing and screwing the two halves together.



Figure 12.89 Generously coat the two meeting ends with PVA adhesive before tightening the handrail bolt.



Figure 12.90 Wipe excess glue from the tightened joint.



Figure 12.91 The handrail is lifted carefully into place.



Figure 12.93 The newly installed wall-mounted handrail.



Figure 12.92 Screw up through the brackets into the underside of the handrail. Note: there is no ploughed groove on the underside of wall-mounted handrail.



Figure 12.94 The two handrails, level and parallel.



Figure 12.95 The fully refurbished 1930s staircase.

any imperfections sanded and repainted. With the help of a second person, the new handrail is lifted into place (Figure 12.91) and secured by screwing up through the wall-mounted brackets into the underside of the handrail (Figures 12.92 and 12.93).

Two final photos...

Figure 12.94 shows the new wall-mounted handrail level and parallel with the short handrail on the right-hand side of the staircase, and, in Figure 12.95, the fully refurbished staircase (compare with Figure 12.1).

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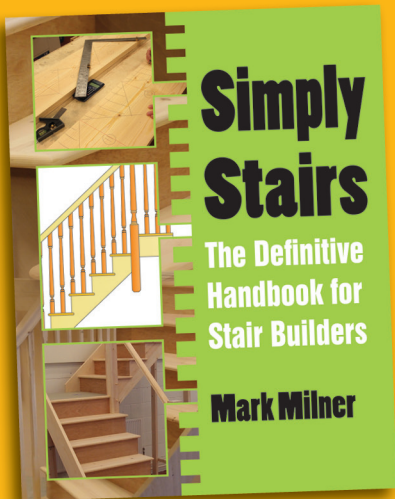
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