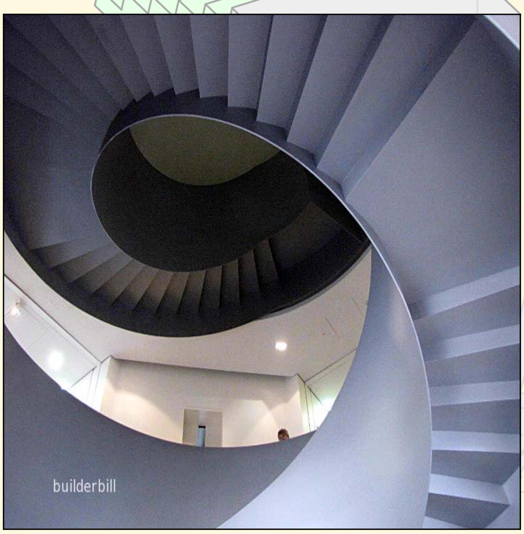
Bill Bradley


# Stair Design




**Regulations**

**Safety**

**Comfort**

**Handrails**

**Balustrades**

**Landings**

# Stair Design

Bill Bradley

November 2010

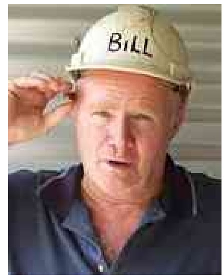
**Disclaimer**

This book is presented for information only. The material here is given as an overview and as advice on good practice only.

In my working lifetime we have gone from almost no regulations at all, to many layers of local, state or territory and national legislations each with different sets of rules.

Regulations change and there is no way that I can give specific advice for any particular jurisdiction. **It is up to you to check with your local authorities regarding specific details.** Always comply with your local requirements!

## About The Author




Bill has been fully involved in the construction and home building industry for over fifty years. He gained his qualifications as a Carpenter and Joiner from "The City & Guilds of London Institutes" in the UK before moving to Australia and forming his own construction company. Bill has taught many apprentices and young tradesmen over the years. While no longer actively building, in retirement he continues to share his wealth of practical knowledge by way of his popular website and these E-Books.

### Other titles

- Asbestos Guide, A Practical Guide.
- Solve Your Building Maths With a Ten Dollar Calculator

# Contents

# List of Figures

# List of Tables

# Chapter 1

# Introduction.

This book is about the design aspects of stairs in general. About the things that all stairs, no matter what materials they are made of have in common. The regulations that cover the construction of stairs do not make any differentiation between steel stairs or concrete stairs for example, and in this book neither will I.

In later books I will be going into detail of how to build Timber or Wooden Stairs, Concrete Stairs, Handrails and Balustrades , Steel Stairs and possibly Deck Stairs .

Your local regulations may well allow variations from what I suggest here.

- They may well allow you to use narrower stair flights, higher step rises, and lower headroom.
- They will use terms like maximum or minimum which will give you some choice in the design.
- That does not mean that you have to take advantage of them.
- As long as you stay within the bounds of your local regulations , I would advise you to always err on the side of **comfort, amenity and safety.**

By doing that, apart from the obvious benefits to the users of more comfort and safety, you will be building stairs that may still comply the next time that more stringent regulation changes occur.

To the best of my knowledge there has never been an easing of stair regulations They always seem to get tougher.

Imagine a time in the future when the property is being sold. If you have used rules that have since been discontinued then the property may well be seen by prospective purchasers as “dated” and less attractive compared to others on the market.

In this book you will find that I tend generalise a lot and it may seem to be inconvenient to you if you come from North America or the UK and you are used to reading books that are specific to your area. At the last count I get visitors from 192 different countries. I have to generalise, but also the specific details that other published books give may already be out of date.

Good design however is universal, the details change and so do fashions, but a comfortable and safe stair will always be that, no matter where or when it was built.


Img 1.0.1: An old stair circa 1670.

- This old stair predates modern building regulations by centuries. I think that it would quite easily pass them today, except that the handrails may be a touch too low. It is still being used on a regular basis.
- So in effect the old builder of this stair used good common sense and did not choose any extreme factors in his design.
- Thus making it able to still be used safely (in our modern highly regulated age), some 340 years after it was first built.

The craftsmen that built the stair above would have been members of one of the medieval London's craft or trade guilds and they would have jealously guarded their knowledge.

When I gained my papers as a journeyman carpenter and joiner in 1962 the feeling of the tradesmen and even the paperwork[1] was a direct link

[1] "City and Guilds of London Institutes"

to those earlier times. It was common for tradesmen that taught me to use the expression "tell em nowt"[2] with reference giving away trade tips and secrets.

**I don't believe in that old close minded secrecy.**

We are living in the middle of exiting times with the explosion of information distribution by electronic means.

I sincerely hope that I will be able to pass on to you something of value in the following pages.

I will try to give a good mix of practical and theoretical information and at the same time steer a course through the rules and regulations applying to stair design in this book and to stair construction later.

**Note on dimensions.**

I am fairly happy using imperial measurements as they are what I used when I was young, But now we are using metric here in Australia and personally I prefer it for it's simplicity. To make it easy for us all I will write sizes in two ways.

I will give the metric sizes first in millimetres only. So if you see 3152 I mean 3.152 Metres. I will not bother writing mm after each size.

As we are not talking about large measurements here when I refer to the imperial sizes, generally I will stick to inches only. $75\frac{1}{2}$" being the way I will write 6ft $3\frac{1}{2}$". I will round off to the nearest $\frac{1}{8}$" normally, but if you want to get some fraction more accurately then I have a conversion table here 12 in the appendix.

I will use decimal inches in some calculated tables, (generated by spreadsheets) and I will be rounding off to say 0.1 decimal place which I feel is good enough as we are only talking about design here.

**Note!** The red links, Table of contents, lists figures, footnotes and cross references, if you follow one of the links, to get back to where you just came from do "Alt plus the left arrow key".

If you want to quickly zoom in on a graphic to read the text just do "Ctrl plus the + key" and then use "Ctrl plus the - key" to zoom out again.

[2] Lancashire dialect "tell them nothing"

# Chapter 2

# The Range of Stairs

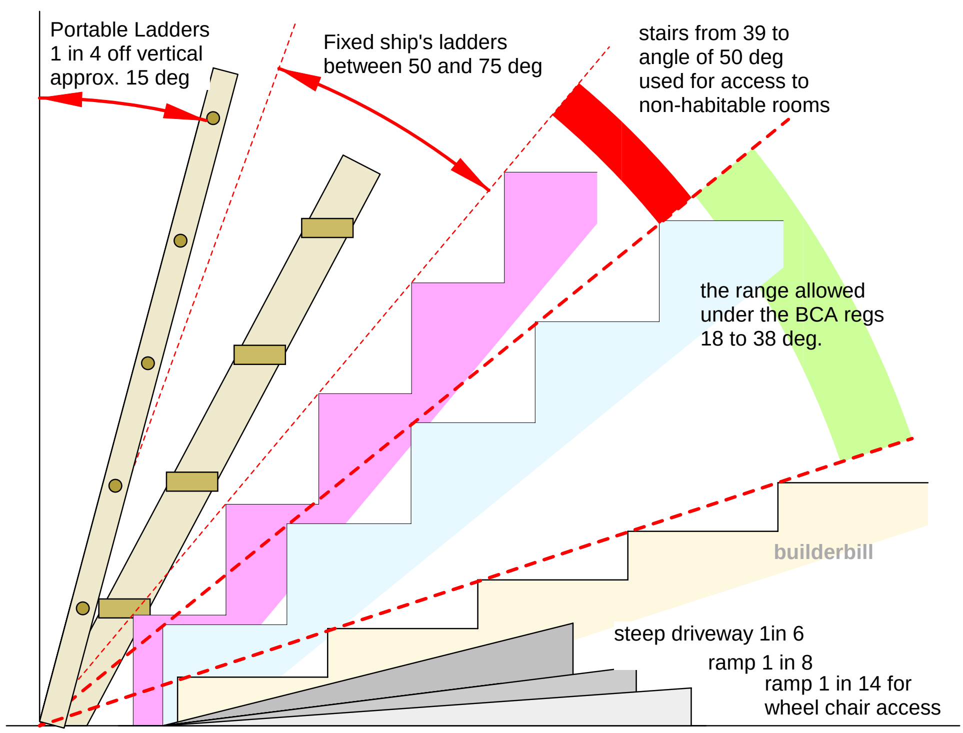



Table 2.1: The Range of Stair Angles

Note! If you have trouble reading the text on any of these images just hit CTRL and the "+" key once or twice. CTRL and the "−" key will reset back to normal.

There is a huge range of stair types available and also for each of the types there are differences in the slope and the construction methods. This chapter will introduce some of them to you before we get into the details.


Img 2.0.1: A vertical access ladder
Typically these access ladder have a cage around them and many times they have facility for connecting body harness lines for extra safety.


Img 2.0.2: A fixed ladder stair, circa around 1820

This may not conform to the general idea of a loft stair, which may be a recessed or pull-down extensible ladder that drops down into an upstairs corridor, but this is one all the same.

The stair here is one that is steeper than will be accepted as a normal main traffic stair. However under certain conditions a stair like this may be acceptable. They are often used for access to non-habitable rooms. That is stairs that are not used a lot. Loft stairs and basement storage areas come to mind.

This particular stair being old has no handrails. A similar modern stair would have a handrail to each side.

These stairs are easy and safe to ascend and similarly they are easy enough to get down if one always remembers to face inwards and come down in the same fashion that one does on a ladder. The danger occurs when people go down facing forwards.

The sailing community knows all the well the number of accidents caused by a slip on a companionway stair at this angle. A slip when facing inward may only result in a minor tumble but a slip facing forwards has resulted in many serious back injuries.


Img 2.0.3: Stairs over the critical angle

The stone stair flight here would definitely not fit in well with a modern stairway. However from a design point of view the ancient builders had a greatly different set of priorities than we have today. We can only guess at their objectives but they certainly constructed a series of buildings that create a feeling of grandeur and awe above all else.

- I include it here as an example of a staircase that exceeds what is known as the **critical angle.**
- This refers to the angle of a stair, above which a stair is deemed to be unsafe. It is said to be around 50 deg.

Following on from the comments on the previous page:-

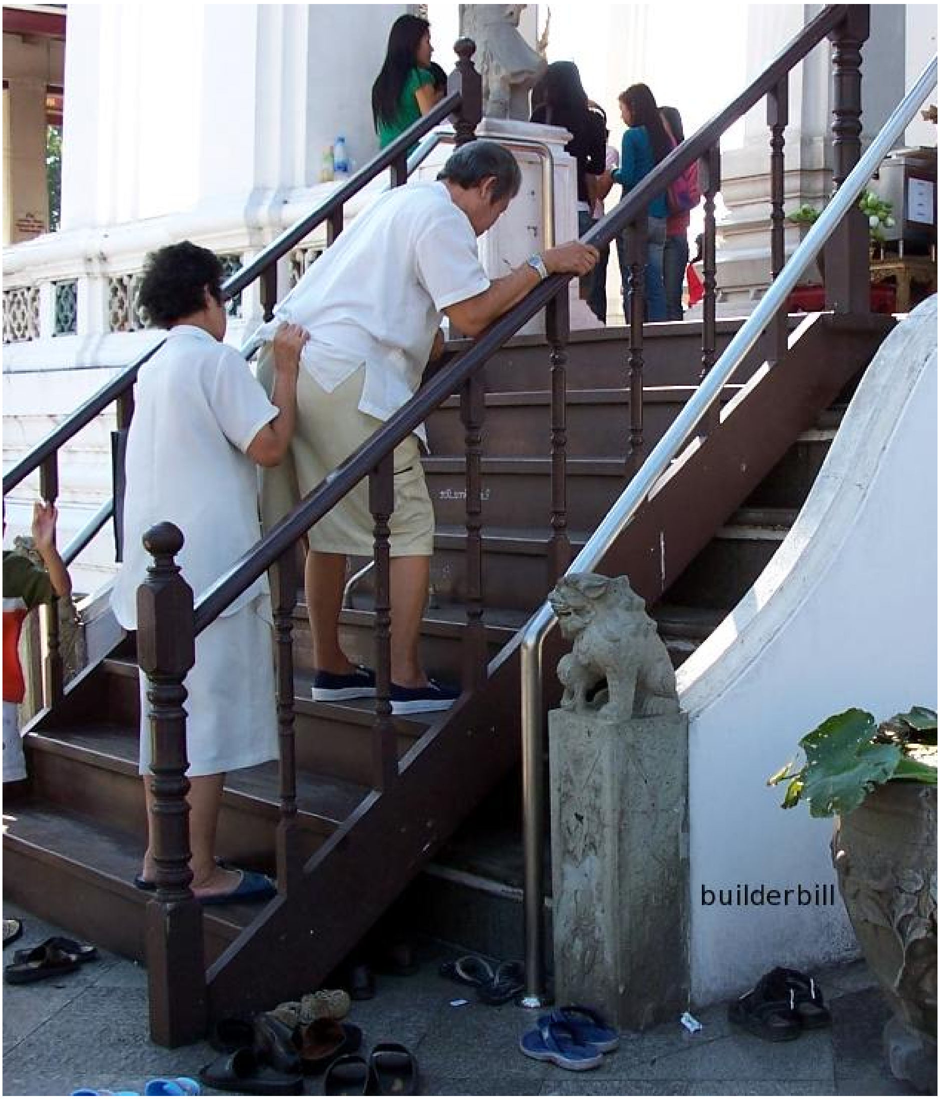
- The girl at the lower left is obviously not comfortable. The guy just above her seems confident enough even though half of his foot overhangs the tread, he is in effect walking on his heels.
- Walking up a stair like this is rarely a problem, it is the coming down that can be awkward. My strategy is to twist slightly to one side and walk down partly sideways so that I am able to step down onto the balls of my feet .
- The recent addition of the concrete blocks that to try to make the stair safer is a classic example of bad stairs being produced more from ignorance rather than any attempt at cutting costs.

**A good stair has all of it's nosings in a straight line.**
I'd be willing to bet that when the flight in the previous photo was built some eight hundred years ago that it was perfect in that respect, and yet the modern builders through ignorance have managed to get those new steps all over the place. They have in fact made the original stair probably worse.

- A stair that has all of it's steps (and so it's slope) consistent or regular, even though it may be too steep is manageable.
- We get used to it. So we take it for granted that as we walk down the stair the next step will be the same as the last.
- The danger lies when there are odd ones that are different. They break the rhythm and can easily cause a tumble.
- In img.2.0.3 it is easy to see that those new blocks are not in a straight line.

A little bit more time and the use of a string line or a straight edge or two would have made all the difference. **At no extra cost**

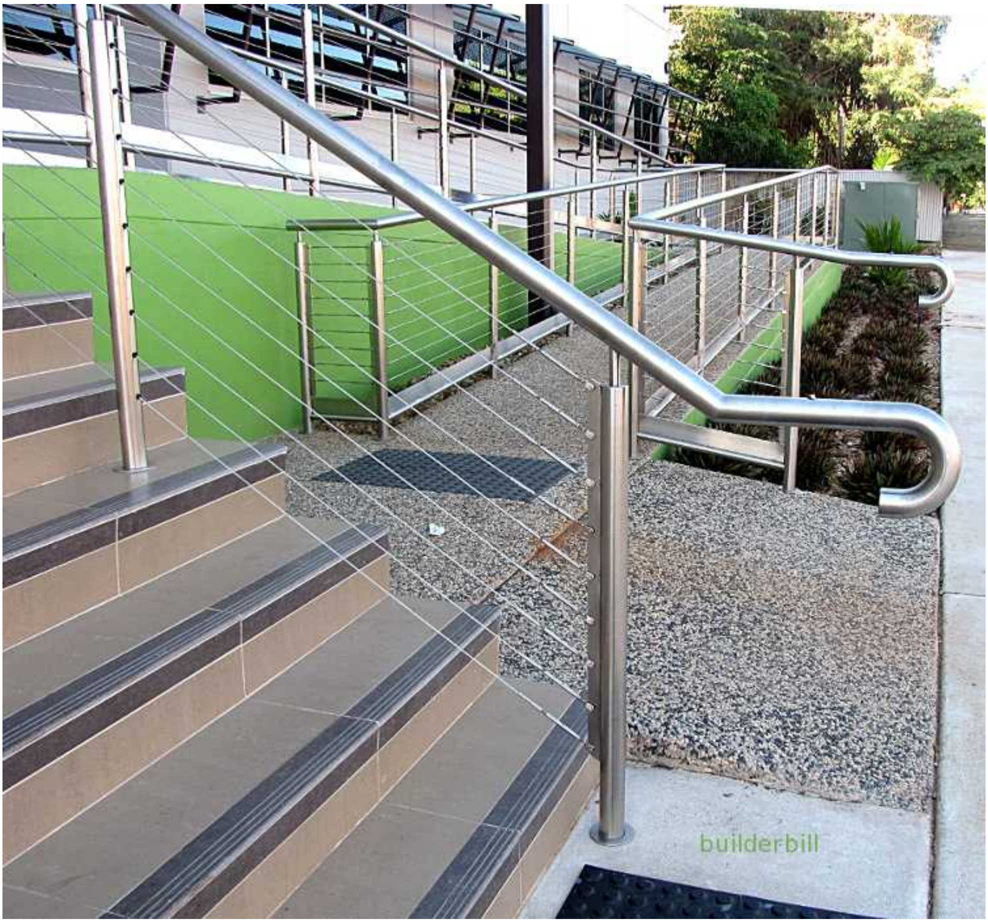



Img 2.0.4: A new addition to old steps

This photo of two old people is another illustration of stairs that are too steep.

- The original stone stairs were too steep so a new flight has been made to make the stairs more comfortable and safe.
- The newer timber stairs have a reasonable and quite acceptable angle for most of us but this image is an excellent reminder that stairs in public places have to use lower angles than normal to cater for the elderly.

Note the now redundant low stainless steel pipe handrails that show the slope angle of the original stairs.




Img 2.0.5: Public stair and wheelchair access ramps.
The photo here shows a modern external concrete stair and ramp that shows many of the features to be detailed later.

- It falls within the acceptable slope range,
- Gripable handrails with safety extensions/terminations,
- Closely spaced wire infills to the balustrades,
- Well defined nosings,
- The ramp has a pitch suitable for disabled access,
- Both use tactile pads to help the vision impaired.


Img 2.0.6: Old Spiral Staircase

Modern day spiral stairs are far different than this horror. The modern ones may appear sleek and shiny in a catalogue and they always appear in trendy design magazines, but the modern spirals and this one all have their main characteristics in common.

- A spiral stair takes up less room than any other stair. That is the one and only advantage of them. sure they can be made to look stunning and real attention getters, but so can other more comfortable stairs.
- They all are, quite simply hard work to use. They are not comfortable and they always have the potential for accidents.
- I know that the one here is old and worn, and it has no handrails but they are minor details compared to the previous points. Can you imagine carrying a breakfast tray up one of these?
- The original stone-masons provided non-slip tread surfaces and over the years this has worn down to show very graphically where people tend to walk when on a spiral. More on that later in the spiral stair section.


Img 2.0.7: An All Steel Helical Stair from Underneath

The stair above is still a spiral stair, though today larger stairs like this are usually described as helical.

- The previous stair was supported at the centre and at the walls.
- Household spiral stairs are quite stable when simply supported by just a central column usually called a newel post.
- This particular stair is supported by the stair string/balustrade combination.
- The whole of the construction is out of what appears to be 12mm or $\frac{1}{2}$" steel plate which must have been formed with some fairly technical rolling equipment.

Img 2.0.8: A Cantilever Stone Stair Circa 1670

This old stone stair manages to do something that modern concrete stairs can't do without a steel reinforced slab under them that usually makes the stair 150 or 6" thicker that what you see here.

- Most stairs have fairly obvious means of support, they have stringers at the sides, beams or carriages underneath.
- This type of stair is sometimes known as a cantilever stair. It is not a true cantilever but the name still sticks. It seems to be floating with not a lot of support.
- Modern designers and architects using modern materials and design software are now re-discovering and re-inventing these old stair forms that seem to float without too much means of support.


Img 2.0.9: Temporary stair tower

Increasingly the use of ladders in scaffold work is getting less on larger jobs. Ladders are getting replaced by the use of modular stairs.

- They are great and logical way to provide access to the different levels of scaffolding.
- All scaffold manufacturers now have these modules.

Note that scaffolding itself is a highly regulated field. Look at the close spacing of the ledgers and transoms to the section that contains the stair tower.

Img 2.0.10: Creative use of found materials

This is the end of this introduction and I hope that by the time you have finished the rest of this book then you will no longer be considering designs like this little beauty **:-)**

# Chapter 3

# Glossary Of Terms

| | General Terms |
|---|---|
| **CAD** | Computer Aided Design (or drafting) . Various software programs that aid in the drawing and design of curves, shapes, text and other information in two-dimensional (2D) space similar to traditional hand drafting; or the development of curves, surfaces, and solids in three-dimensional (3D) objects. |
| **CAM** | Computer Aided Manufacture. The use of computer software to control machine tools and other machine processes. |
| **CNC** | Computer Numerical Control is a method of using computer software to control the action of machine tools. |
| **Elevation** | A drawing looking at an object from the side. |
| **NTS** | Not To Scale. An abbreviation to tell the user that the drawing or particular detail of it is not drawn to any particular scale.<br>I include NTS when change the scale of on aspect in relation to the others.<br>For example I draw treads and risers to a certain scale but to get more information in a smaller space I may half the handrail heights to fit it in easier. In this case I label it as NTS |
| **Plan** | A drawing looking at an object from the top. |

**Scale** In a drawing this is the ratio between size of what is drawn and the real size of the object. So I may draw a 300mm wide stair tread 30mm on the drawing and label the drawing 1:10
All the drawings here are done to one scale or another on my CAD program but I do not show the particular scale because screens can be zoomed in and out and the figures are meaningless.

**Section** A drawing looking at an object as though an imaginary slice has been taken though it.

---

**Stair Terms**

---

**Balanced steps** A series of winders that are arranged to have the same width close to the inside of the turn as the adjacent flier treads.

**Baluster** A small post used to support a handrail and to infill the section below it.

**Balustrade** A complete railing system which may consist of vertical members and rails and any infill panels wire etc to stop people and objects falling off stairs landings and balconies etc.

**Bracketed strings** Strings that use a small decorative bracket that is fixed under the tread overhang to a cut string. It is mitred to the riser rather than the string being mitred.

**Bulkhead** In stair construction, a sloping ceiling that follows the pitch of a stair.

**Bullnose Step** A bottom or lower step of a flight of stairs with a quarter circular end.

**Bullnose** A quarter circular moulding applied to the front top and bottom edges of a tread.
A similar rolled curve to a steel plate tread.

**Closed or Housed String** A string with the inner face housed to receive the ends of the treads and risers.

**Cantilever** A part of a structural member that overhangs it's support.

**Cantilever step** A step that is supported at one end only.

**Cantilever stair** 1.) A whole stair that appears to be supported at one side only. It is also supported at the top and bottom. 2.) A stair supported by cantilever beams.

**Carriage** A support beam under a stair flight.

**Contrast edging** Making the edge of treads or the riser/nosing joint area of a contrasting colour and or texture so that it is easily seen.

**Commode Step** A round end step where the radius of the semicircular end is double or sometimes more than a standard round end step. Often supporting another normal radius round end step.

**Companion way** Companion ladder. Steps or staircases used on-board ships or boats. Usually over the critical angle.

**Continuous Handrail** A handrail with continuous in smooth curves from the bottom of the stair to the top. It does not stop and start at newel posts but flies over vertical supports.

**Critical angle** The angle at which a stair is said to be no longer comfortable or safe. Said to be anything over 50° .

**Curtail Step** The starting step of a flight of stairs that quite often is a feature step wider than the rest. In shape it has one or both ends in the shape of a scroll or spiral. For this reason sometimes called a Scroll Step.

**Cut and Mitred Strings** The outside strings are cut with a mitre to the vertical joint with the riser. The tread has a bead the same size as the nosing returned on the end of the tread.

**Cut Stringer Stairs** Stair stringers that are cut to the shape of the treads and the rises in a saw-tooth effect.

**Dog Leg Stair** A half space landing that is just wider than the combined width of the two flights that meet it.

**Elliptical stair** A type of geometrical stair being elliptical in plan.

**Flight** A continuous series of steps with no intermediate landings.

**Flier** A standard tread in a straight stair.

**Geometrical stair** A stair based on various geometrical curves in plan. Mostly based on arcs of circles with the centre of the arc being some distance away from the stair.

**Go, Going,(G)** The amount of horizontal distance covered in one step.

**Handrail Goose-neck** A curved section of a handrail that rises up and terminates at a newel post.

**Half turn stair** A stair that takes a 180° turn.

**Half turn landing** A landing at which two flights turn 180° .

**Handrail Scroll** A spiral type ending to a stair handrail. In most cases they transform from the sloping section to the horizontal plane. Also called a Handrail Volute in the US.

**Handrail Wreath** The section of a handrail that changes direction. Usually in a smooth curve.

**Handrails** A safety rail or railing at a convenient height to be grasped by the hand . Used on stairs-landings-platforms-elevated ramps etc.

**Head height Headroom** The clear vertical distance above the nosing line that must be provided over all stairs.

**Kite Winder** The central winder in a quarter turn of winding steps. Named for it's shape.

**Landings** Horizontal spaces or or platforms at the ends of stairs. Or as breaks between flights of stairs. Used for convenience to turn corners. Used to limit the distance that someone could fall.

**Landing Nosing** The strip usually moulded to the same pattern as the tread nosings to provide a neat finish to the edge of the floorboards and to maintain regular toe space.

**Loft stair** A stair leading typically to a roof space loft or non-habitable room. Stairs used infrequently. Typically allowed to be steeper than main stairs.

**Main stairs** Stairs that lead to the main habitable rooms or main traffic areas of a building. Stairs used frequently. Subject to strict regulations.

**Margin Template** A rebated piece of material used to keep the pitch-board the required distance from the edge of the string when setting out stairs.

**Newel Cap** An ornamented feature to the top of a newel post.

**Newel Drop** An ornamented bottom of a newel-post seen below the soffit.

**Newel Posts** Posts that carry the handrails in a flight of stairs.

**Nosing** 1.) The part of the tread that overhangs the riser.
2.) The often rounded last edge of a tread.

**Nosing line** A straight line that should connect all the nosings in a straight flight.
It is the line from which head height and the height of handrails is measured.

**Non slip, Anti Slip Nosing** Proprietary fittings for fixing to tread edges to prevent slipping.

**Open Riser Stair** A stair that has no physical riser members. It has gaps between the treads.

**Pitch** The slope or angle of a stair.

**Pitch Board** A template for marking out stairs. When workshop made they are out of ply. Some adjustable metal ones available.

**Pitch line** The theoretical line used in stair calculation and setting out that disregards material thicknesses and nosing overhang.

**Plate tread** A metal tread made out of steel plate folded or otherwise fabricated. Usually with chequer-plate pattern for non-slip. Mostly industrial use.

**Plate landing** Landing fabricated out of steel with the top surface normally out of chequer-plate steel.

**Quarter turn stair** A stair with a right angle turn in it. Either by a landing or a set of winders.

**Quarter turn landing** A landing in between two flights that are set at right-angles. Also called a quarter space landing.

**Ramp** An inclined surface that may be used instead of a stair or steps.

**Rise (R)** The amount of vertical separation in each step.

**Riser** The solid vertical part of a step.

**Round End Step** A bottom or lower step of a flight of stairs wider than the standard steps that has one or both ends in the shape of a semicircle.

**Routered Stringers** Full depth stringers that are routered or housed to hold the treads and risers

**Safety nosing** Same as non-slip nosing.

**Slab or Waist** The structural part of a concrete stair that holds the reinforcing steel.

**Slope Relationship** The relationship between the rise and the go of a stair. When used as 2RxG and set within various limits e.g. max 700 to min 550 then it is used to define comfortable and safe stairs.

**Spiral Newel** The central load bearing post in a spiral stair. Also simply called a Newel.

**Spiral Stairs** A circular staircase. The treads consisting of winders only. It takes the form of a helix and is quite often called a helical stair.

**Spandrel** A triangular section of wall or paneling used to enclose the area under a flight of stairs.

**Staircase, Stair, Stairway** A flight of stairs or series of flights used as a means of getting between floors or levels. Includes all supports and handrails and safety features.

**Stairwell** A vertical shaft through the floors of a building which contains the staircases.

**Stairwell Hole** 1.) The void in a floor prepared to receive a stair. 2.) The space between the two outer strings of a half-turn stair.

**Spiral stair Circular stair** A stair having wedge shaped treads winding around a central column or newel.

**Step** the distance a person moves in one step forwards and upwards. In stair construction a step has two components. The vertical distance of travel known as the rise (R) and the horizontal distance of travel known as the go (G).

**Story Rod** A staff or rod of wood used for taking the height between two floors and dividing it into equal rises to mark out the positions of steps and landings.

**Stanchion** A vertical support to a railing or balustrade

**Strings, Stringers** The sloping members of a flight of stairs that support the treads. They can also be categorised as:- **Bracketed. Close. Cut. Curved. Outside. Wall. Wreathed.**

**Threshold Landing** A landing adjacent to a door where there is then a flight of stairs.

**Timber** A UK and Australian term for wood or lumber.

**Toe Space** The amount by which a tread overhangs a riser. Usually 25 to 30 or 1” to $1\frac{1}{4}$”.

**Total Rise** The total rise from floor to floor. The amount that a stair or staircase or a person walking up a stair travels in a vertical direction.

**Stair Tower** 1.) A free standing building containing mostly a stair. 2.) An attached stair or stair enclosure that projects beyond the buildings roof

**Tapered Treads** A stair tread that is narrower at one end than the other. Used in spiral and Helical stairs.

**Threshold Landing** A landing adjacent to an external door where there is then a flight of stairs.

**Tread** The solid horizontal part of a step.

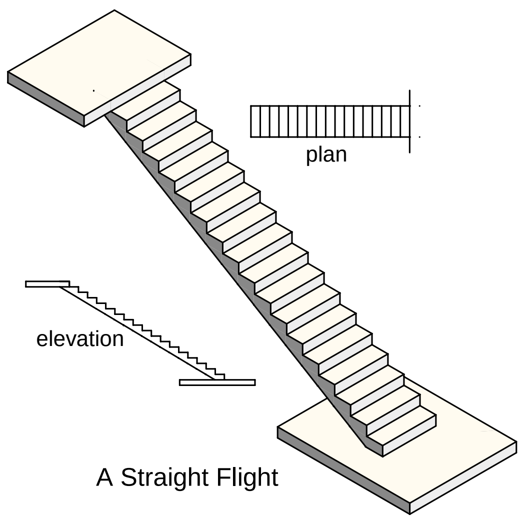
**Winder** Treads in an otherwise straight flight that are made tapered to change the direction of the stair.

**Wreath Wreathe** A curved section of a handrail.

**Wreathed String** A curved section of a string. **Wreath piece** A curved piece that forms a curved junction of two strings.

# Chapter 4

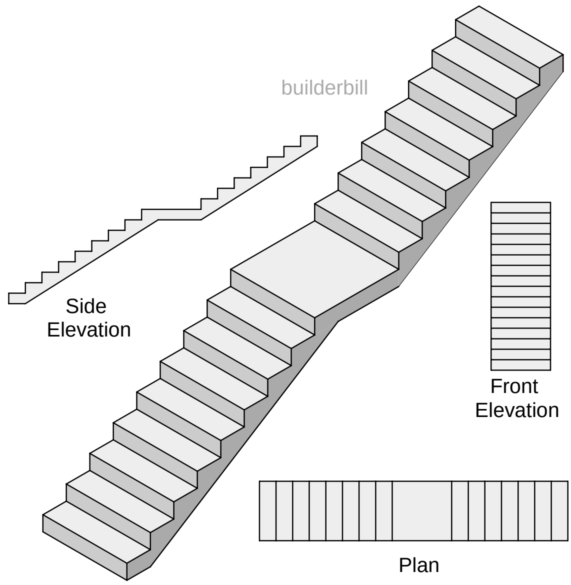
# Basic Stair Forms




Img 4.0.1: A single flight stair.

A single straight flight of stairs is the easiest to build and probably the most economical use of materials. It is restricted to having no more than 18 rises and no less than 2 rises.

- In house construction it is quite often fixed to one wall and sometimes has the spandrel space under it panelled or walled in to provide storage space.
- Other times it may be fixed between two walls.
- While the flight itself is compact in terms of space used, as with all stairs the top and bottom landing areas should be allowed for when choosing the stair layout.



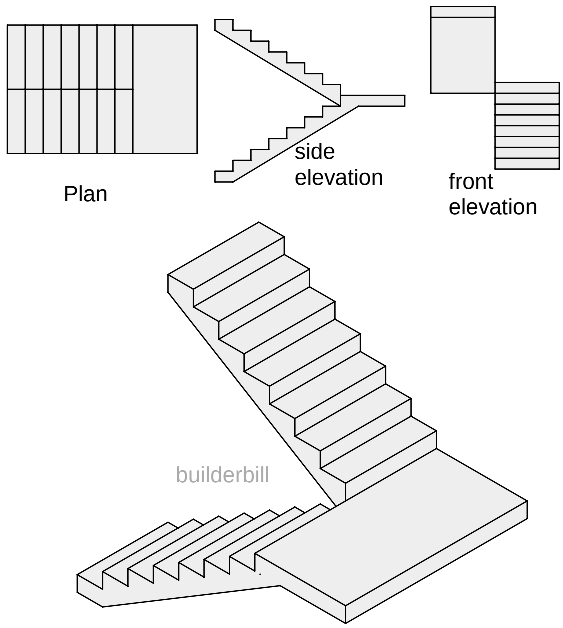

Img 4.0.2: A straight flight with a landing

There is a limit to the amount of steps allowed in one flight. Here in Australia. it is 18. In the UK I believe it is 16. The reason has nothing to do with the structural side of things, but it has to do with comfort and safety.

1. It limits the distance that someone may fall.

2. It gives old and sick people somewhere to rest and recover.

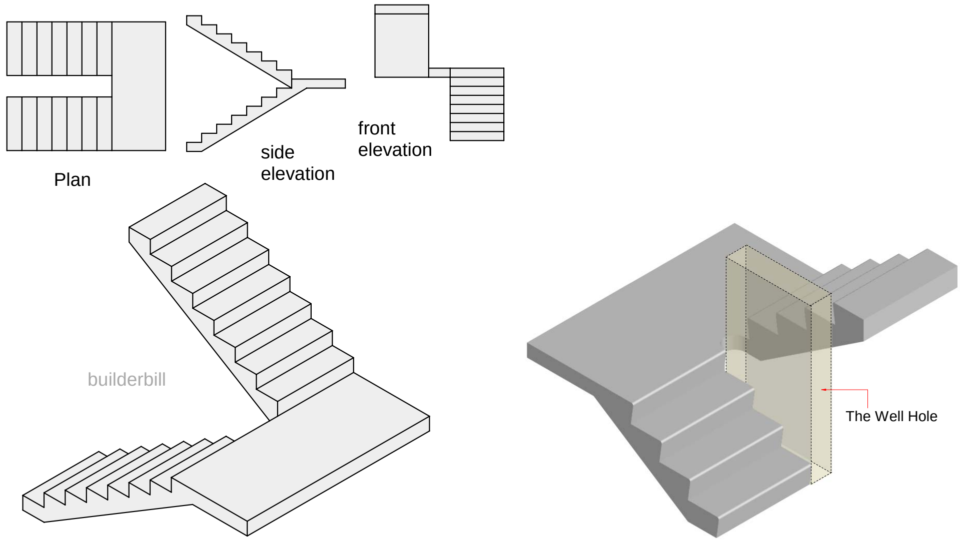
This type of stair is seldom used in houses because of space restraints, but it is seen outdoors in public spaces and also in large public buildings.




Img 4.0.3: Half turn landing

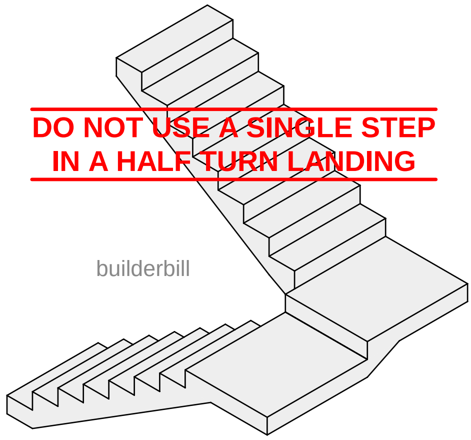
This stair while taking up more space than a single flight is quite often the easiest one to negotiate and it is a good choice when room is available.

- Also known as a dog-leg stair or a half space landing.
- It is more direct in many cases.
- Normally the stair well is just a simple large rectangular hole that helps to add light and open feeling.
- However when space is at a premium on the floor above the the well hole closely follows the stair stopping only at the minimum head height as will be explained later.
- Looking at the plan, the one above has no gap between the two outer strings.
- This is the most compact arrangement of this form but it does have the disadvantage that because there is no center well hole then the handrails have to be fixed to the top of the treads.
- The handrails can't be side fixed which is often done in the case of concrete stairs.




Img 4.0.4: Half turn landing

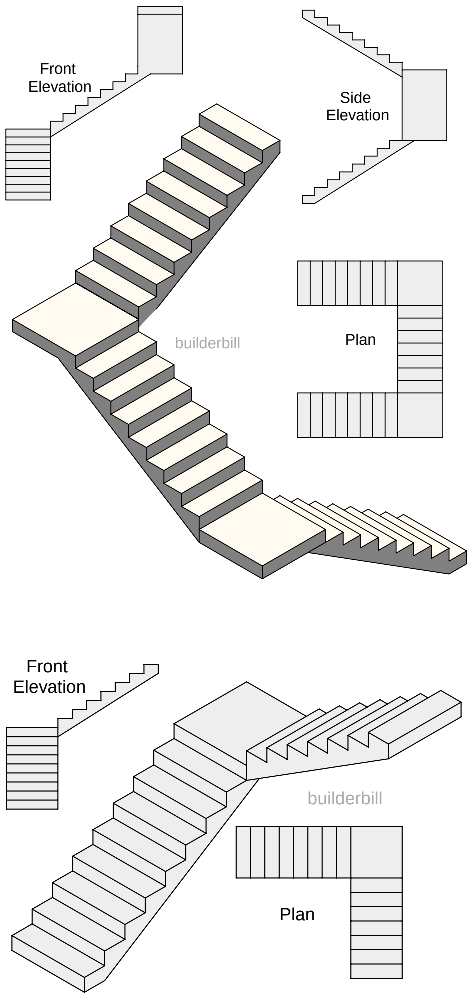
- This stair takes up slightly more space than the previous one, but it provides the benefits of options with the rails and there would be some improvement in the amenity.
- Often though the space is considerably more than shown here and it works to good effect.
- A stair with a well hole allows for larger items of furniture to be lifted higher than the handrail or leaned sideways over the rail by two people.
- These stairs are often used with wider flights and good sized well holes in public and semi-public buildings.




Img 4.0.5: Step in landing

In the case of a half turn landing, never use a single step in the middle. Single steps are known to be a major cause of accidents.

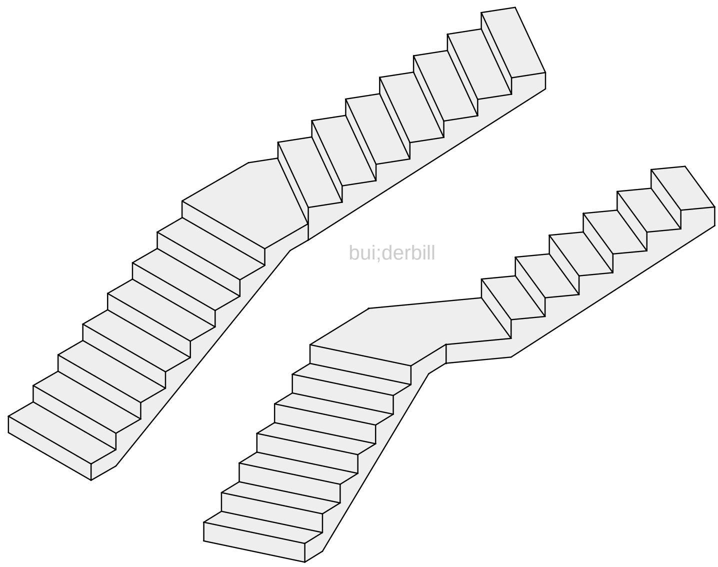
- This is a dangerous attempt to try to squeeze in an extra step.
- Far better, try adding the extra step to the bottom or top of the stair.
- Adjust the layout to give at least three risers in the middle. Then of course you are looking at quarter turn landings.




Img 4.0.6: Quarter turn landings

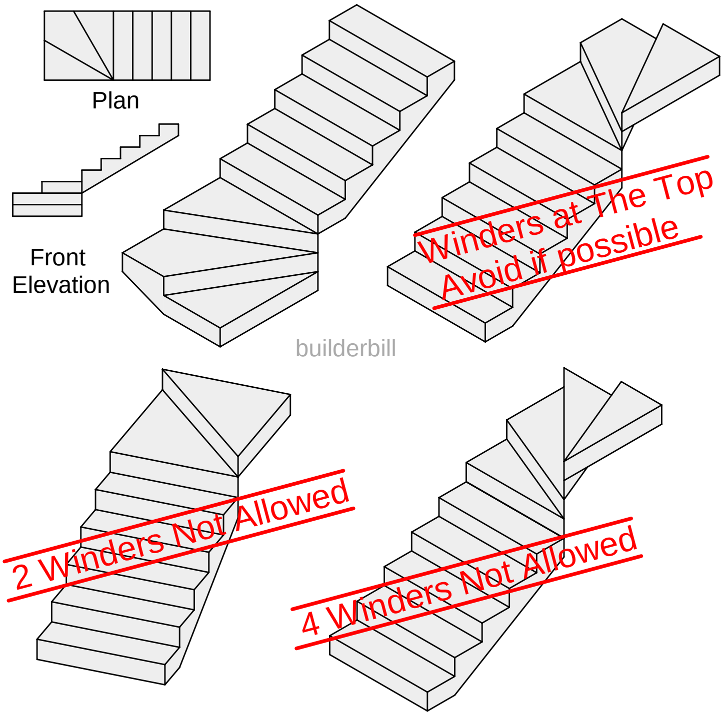
The quarter turn changes the direction of the stair by 90°.

- The landings here are square but they can be longer on either side or on each side making them "L" shaped. This is a technique that simplifies handrail problems. See the later chapter on the relationship between landings and handrails.
- Never make a quarter landing less than square.
- They are often used in pairs with three separate flights.
- Bear in mind that each of the flights must have at least 2 risers according to the regulations, but that should be treated as the bare minimum. Try for more if possible.




Img 4.0.7: Angled landings

- Landings can also set the stair direction to other angles greater than 90°.
- The pair above are set at 30° and 45°.
- All landings are subject to building regulations. We will go into them in detail later. At this stage just remember that what you are looking at in these sketches are landings and not just extra wide treads.

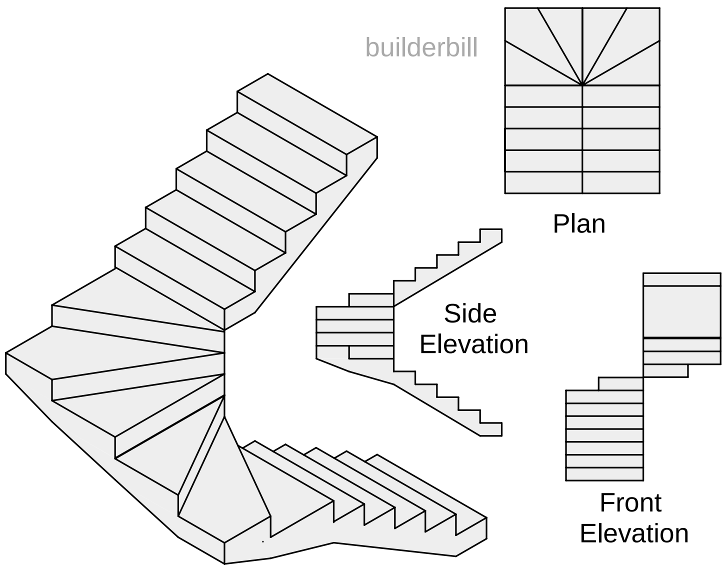



Img 4.0.8: Winders

**Winders are not recommended (at least by the author, see below).**

- Winders are a way of changing the direction of a stair.
- Unlike landings they are considered part of a stair flight and as such they have to comply with the rule below.
- **A landing is always to be preferred**. In cases where there are no alternatives then winders can be used, but my advice is to always use them when everything else has been considered first.
- Winders in conjunction with a straight flight like here must be used in the correct configuration, which is **three steps only** each tread is tapered at 30°.
- Don't confuse them with a spiral stair and start applying spiral regulations to them. It is all about trying to maintain a consistent slope angle.

Note! The only times that I have built winders I have always put them at the bottom of the stair, as shown in the drawing. A trip at the bottom is a lot less of a potential danger than a trip at the top.




Img 4.0.9: Two sets of winders

Here are two sets of winders that could be said to replace a half turn landing. Used only when room is very limited. They do in fact have five more risers than the landing, so they gain height in a small space, but at the cost of a very uncomfortable stair.

About 4:30 am one morning I was leaving a small hotel on the delta in Vietnam. The stairs were unlit and they were the same layout as the sketch above. Except that for some reason the rise on the winders was about two inches higher than the rest of the steps. That was the critically dangerous aspect of that stair.

Even though I had used the stairs a few times and knew this I still managed to take a dive head down, around that corner. I came out of it remarkably unscathed with just a patch of skin off one elbow.

When I got to my destination a few hours later I went into the local pharmacy and bought some antiseptic. The lady saw me looking at the label and she proudly stated in a cheery tone, "made in Vietnam"!

I looked her in the eye, pointed to my battered elbow and trying to appear stern said "made in Vietnam... also"!

These are the main layouts. Many more are possible and when we get to large buildings and public places then they are endless.

# Chapter 5

# The All Important Regulations

Previous generations of stair designers used various combinations of *"rules of thumb"*. [1]

**Rise x Go in inches = 72" to 75"** Wood Frame House Construction By L. O. Anderson.

**Twice the rise plus the go in inches = 24" to 25"** (devised in 1672 by Francois Blondel). Audel Complete Building Construction By Mark Richard Miller, Rex Miller, Eugene Leger.

**Rise plus go in inches = 17" or 18"** Audel Complete Building Construction By Mark Richard Miller, Rex Miller, Eugene Leger.

**Rise x Go in inches = 70" to 75"** Audel Complete Building Construction By Mark Richard Miller, Rex Miller, Eugene Leger.

**Rise x Go in inches = 66" approximately** Stairs and handrails By J.F. Dowsett and J.C. Stevens.

[1] Rules of thumb, goes back to the days of windmills and waterwheels for grinding flour. When setting the distance between the millstones the miller would feel the flour between his thumb and forefinger.

**All of the above rules and the many others besides can produce perfectly good and comfortable stairs.**

R x G = 66 is the one that I learned as an apprentice.

- This and all the other similar *rules of thumb* have one main fault. They do not cater for the extreme cases, they are not idiot proof.
- A rise of 3” times a go of 22” totals 66”. So will that make a good stair? No way, it’s got a pitch that is more like a ramp than a stair.
- **So the old rules may have worked, but they all require the application of something extra. That extra came in the form of instruction from experienced stair designers and stair builders.**

The new regulations simplify the choices to be made. Heed them well! Even a most beautiful and amazing stair will be useless if it does not get approved or worse still, causes a serious accident.

## 5.1 A Modern Approach

Prior to 1996 here in Australia we had a situation with each state having it’s own regulations and many times shires and local councils set their own rules.

In 1996 the BCA came in force giving a country-wide set of regulations. The BCA was formulated over a few years taking into consideration the changes and draft recommendations from a number of other countries that were also changing their systems. (Mainly the UK, Sweden, Holland and New Zealand.)

Wherever you live in the world this change will have been happening also. What we are concerned about here is the effect of these changes on stair design.

Using university studies of people moving on various configurations of stairs researchers found that changes in the proportions of steps, the width of the flights and the size and positions of landings could drastically change the comfort level and safety of stairs.

## Regulated Material

Use as a guide only, your regulations may differ.

Boxes like this denote the use of material that I have based on the Building Code of Australia which is what I have used since it came into force in 1998.

- I use it here only as a guide for people who are not as yet covered by building regs or just to give others an idea of what I personally recommend.
- I think it does a good job, but at the time of writing I have seen a draft proposal to change the maximum and minimum allowed riser and tread rises in next years edition. So things may already have changed slightly by the time you read this.
- Most of the regulations around the world are very similar, and so they should be as their intentions are the same, To provide safe and comfortable stairs while at the same time allowing people to move freely on foot between different levels.
- On the next page you will see a sketch that shows that with an open tread stair, a ball of 125 or 5" dia. should not be able to pass between the treads.
- Now that is correct as far as I am concerned, but beware of that figure if you don't live in Australia. I have seen other regulations that use a figure of 100 or 4". And yet others that just don't specify a minimum gap!
- So on pages like this I am showing you the type of things that are subject to regulation and that you should be aware of.

Don't take the figures quoted in pages like this as anything other than guidelines. Your own regulations should take precedence. There is a lot of stuff floating about on the web, but the best thing to do is to get onto your own regulatory body's website and make sure that you get the latest up-to-date information. Nothing else is good enough.

## Regulated Material

Use as a guide only, your regulations may differ.

Stairs serving habitable rooms, including external stairs must comply with the following:-

- For the purposes of the regulations, landings are not considered to be part of a flight and so they are not used when calculating slope relationships.
- Landings are used to limit the amount of distance that a person may fall.
- To limit that distance the maximum number of risers allowed in any flight is 18.
- The minimum number of risers in a flight is 2.
- The nominal dimensions of the Rise and Go in any Stair (complete between floors) should consistent.
- The only exception is when winders are used instead of quarter and half landings, and those winders should also have the same Rise as the rest of the flight.
- A flight of stairs should have no more than three winders in place of each quarter landing or no more than 6 in place of each half landing.
- Treads should be of solid construction if the stairway is over 10 m. (37 ft.) high or if the stair connects more than three storeys . (This means no mesh or perforated sections over this height).
- Treads should have a slip resistant finish or they should have non-slip strips fixed near the nosing.
- In the case of open riser stairs then a ball of 125 (5") diameter should no be allowed to pass between the treads.
- The width of single occupancy unit stairs is not regulated (as far as I know). In the past I have built stairs with a clear opening width of 900 or 36" but I consider this to be a bare minimum. The figure for public and semi-public stairs is 1000 or 40" minimum and I do suggest using that.

For stairs serving **only** non-habitable rooms. Using steeper than normal stairs, the Australian Standard AS 1657 used. So when ordering this type of manufactured stair make sure that it has compliance to your own particular standards.

## 5.2 The Slope Angle, Go, Rise and Slope Relationship

The old rules that just stated R + G = $X$, or R x G = $Y$, while being good guides were obviously open to less than perfect results if they were followed blindly. Some stairs could be made with far too high a rise or others with too narrow a tread making for uncomfortable and unsafe stairs.

Modern stair regulations **limit the ranges of the Rise and Go.**

As we have seen in the photos in the introduction and in fig 2 we know that the **Slope Angle** or pitch has a critical effect on the comfort of a stair. It is intimately tied into the Go (G) and the Rise (R).

We have always been able to build stairs without actually knowing any of the angles involved. The old rules of thumb never mentioned any angles, just the various combinations of the Rise and Go. We used to simply draw the steps out either to scale or full size and then go ahead and build.

Modern stair regulations keep things simple. No angles mentioned and no complicated tables or lists.

- The regulations have to be easily understood and applied in the design stage, the workshop and on the job.
- A building inspector can't be expected to carry a protractor or calculator around with him to see if a stair complies and falls between two angular measurements.
- A carpenter on the job does not want to look up a complicated table of allowed combinations of Rise and Go.

We know that the old rules of thumb only provide part of the answer so the modern regulators came up with the ingenious Slope Relationship. Along with limiting the Rise and Go it is all we need to build safe and comfortable stairs.

- No angular measures involved and no lists.
- The simple and easily used Rise, Go and Slope Relationship do it all.

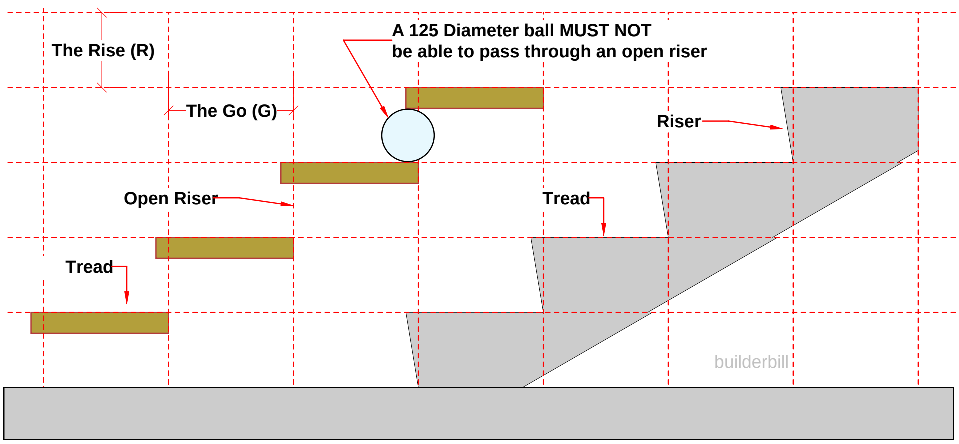
# Regulated Material

Use as a guide only, your regulations may differ.

## The Rise and Go dimensions

**Requirements for STRAIGHT stairs** | **Slope Relationship**

| **Rise {R}** | MM | Inches | **Go (G)** | MM | Inches | **2R+G** | MM | Inches |
|---|---|---|---|---|---|---|---|---|
| MAX. | **190** | **7.5** | MAX. | **355** | **14** | MAX. | **700** | **27.6** |
| MIN. | **115** | **4.5** | MIN. | **240** | **9.5** | MIN. | **550** | **21.6** |




**ALL STAIRS are set out on a grid of horizontal and vertical lines.**
**The vertical lines are EQUALLY spaced at the Go (G) or Going of the flight.**
**The horizontal lines are EQUALLY spaced at the RISE (R) of the flight**

Table 5.1: The R and G Straight Stairs

- This is probably the most important table in this book.
- In any one flight of straight stairs all the Go (G) values are equal and all the Rise (R) values are equal.
- The rise and go have to be within the figures given.
- The slope relationship is twice the rise plus the go 2R+G.
- The Rise is a dimension. A riser is an object. (That you can kick with your toe.)
- The Go or Going is a dimension. A tread is an object. (That you can stand on.)

Note! The table above is used for straight stairs only. Spiral stairs are different. See 5.3.

**The slope relationship makes it very easy to find a comfortable and a safe stair.**

- It is a simple ratio between the rise and the go, or the angle of the stair without mentioning angles or degrees.
- It is a way of determining the slope of a stair that you can do mentally.
- Multiply the the rise by 2 and add the go and if the answer does not fall between the limits then you are in trouble, discard that combination and try again. No need for calculating any angles. A very simple use of arithmetic rather than having to use algebra.
- Further, if you have a slope relationship value that is close to the maximum allowed then you know that you are looking at a steep stair, or if it is near the minimum then it has a low slope. You know this without any drawing or calculating of angles.

But, **and this is important** the simple to use slope relationship not only gets you between the correct angles for a stair, it also stops us from using some of the values for the rise and go that are known to be a bit extreme.

# Regulated Material

Use as a guide only, your regulations may differ.

Example: Using the narrowest allowed tread of 240
The R values allowed are between 155 and 190
The slope angle falls between 33 and 38 degrees

| | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | 20 | | 19 | | 19 | | 18 | |
| | | | | | | | | | | | | | | 21 | | R | G | R | G | R | G | R | G |
| | | | | | | | | | | | | 23 | | R | G | 115 | 320 | 115 | 330 | 115 | 340 | 115 | 355 |
| | | | | | | | | | | 24 | | R | G | 120 | 310 | 120 | 320 | 120 | 330 | 120 | 340 | 120 | 355 |
| | | | | | | | | 26 | | R | G | 125 | 300 | 125 | 310 | 125 | 320 | 125 | 330 | 125 | 340 | 125 | 355 |
| | | | | | | 27 | | R | G | 130 | 290 | 130 | 300 | 130 | 310 | 130 | 320 | 130 | 330 | 130 | 340 | 130 | 355 |
| | | | | 29 | | R | G | 135 | 280 | 135 | 290 | 135 | 300 | 135 | 310 | 135 | 320 | 135 | 330 | 135 | 340 | 135 | 355 |
| | | 31 | | R | G | 140 | 270 | 140 | 280 | 140 | 290 | 140 | 300 | 140 | 310 | 140 | 320 | 140 | 330 | 140 | 340 | 140 | 355 |
| 33 | | R | G | 145 | 260 | 145 | 270 | 145 | 280 | 145 | 290 | 145 | 300 | 145 | 310 | 145 | 320 | 145 | 330 | 145 | 340 | 145 | 355 |
| R | G | 150 | 250 | 150 | 260 | 150 | 270 | 150 | 280 | 150 | 290 | 150 | 300 | 150 | 310 | 150 | 320 | 150 | 330 | 150 | 340 | 150 | 355 |
| 155 | 240 | 155 | 250 | 155 | 260 | 155 | 270 | 155 | 280 | 155 | 290 | 155 | 300 | 155 | 310 | 155 | 320 | 155 | 330 | 155 | 340 | 155 | 355 |
| 160 | 240 | 160 | 250 | 160 | 260 | 160 | 270 | 160 | 280 | 160 | 290 | 160 | 300 | 160 | 310 | 160 | 320 | 160 | 330 | 160 | 340 | 160 | 355 |
| 165 | 240 | 165 | 250 | 165 | 260 | 165 | 270 | 165 | 280 | 165 | 290 | 165 | 300 | 165 | 310 | 165 | 320 | 165 | 330 | 165 | 340 | 165 | 355 |
| 170 | 240 | 170 | 250 | 170 | 260 | 170 | 270 | 170 | 280 | 170 | 290 | 170 | 300 | 170 | 310 | 170 | 320 | 170 | 330 | 170 | 340 | 170 | 355 |
| 175 | 240 | 175 | 250 | 175 | 260 | 175 | 270 | 175 | 280 | 175 | 290 | 175 | 300 | 175 | 310 | 175 | 320 | 175 | 330 | 175 | 340 | 172 | 355 |
| 180 | 240 | 180 | 250 | 180 | 260 | 180 | 270 | 180 | 280 | 180 | 290 | 180 | 300 | 180 | 310 | 180 | 320 | 180 | 330 | 180 | 340 | 26 | |
| 185 | 240 | 185 | 250 | 185 | 260 | 185 | 270 | 185 | 280 | 185 | 290 | 185 | 300 | 185 | 310 | 185 | 320 | 185 | 330 | 28 | | | |
| 190 | 240 | 190 | 250 | 190 | 260 | 190 | 270 | 190 | 280 | 190 | 290 | 190 | 300 | 190 | 310 | 190 | 320 | 29 | | | | | |
| 38 | | 37 | | 36 | | 35 | | 34 | | 33 | | 32 | | 32 | | 31 | | | | | | | |

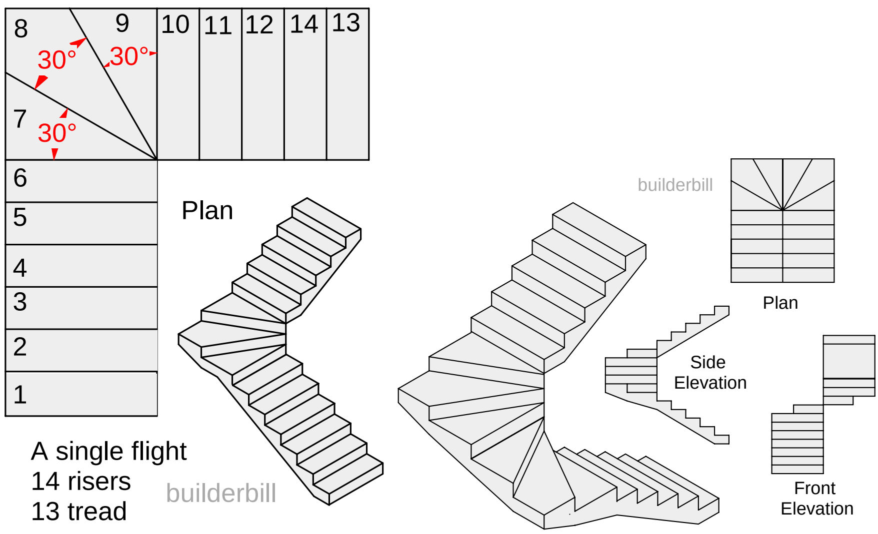
Table 5.2: R, G and Slope Values (straight stairs)

This table shows the effect of using the slope relationship. It can clearly be seen that some values have been cropped. They are the ones where the 2R+G rule have been outside the parameters of 700 to 550 or 27.6" to 21.6".

- At the table column ends are the slope angles produced for the first and the last combinations of Rise and Go
- The table shows that the angle of stairs allowed, ranges from 18° to 38° as shown in fig. 2 but it is interesting in that no Go value can cover the whole range of angles and only a few values for Rise.
- There is no real need to refer to this table again. It is here to show you the simple workings of the slope relationship and why it is so important.
- For that reason I have not transposed it to inches neither have I given the values for spiral stairs.
- Always refer to the small table 5.2 when deciding your rise and go for any particular stair and then do the simple 2R+G and check that you are within the allowed range.

## 5.3 Single Flights With Winders

**Regulated Material** Use as a guide only, your regulations may differ.




Img 5.3.1: Winders in single flights.

- Winders are allowed in the layouts as shown. They must have the same Rise as the flight that they form part of.
- They can be at the top or bottom of the straight flight.
- As long as the attached straight flight complies then the winders will comply provided that they have the same consistent rise as the rest of the flight and that they taper evenly at 30°.

## 5.4 Spiral Stairs, Tapered Treads

Look at the old stone spiral 2.0.6 in the second chapter. It is clear from the wear pattern that the people that have used the stair mostly stepped towards the outside edge.

Img 5.4.1: A spiral stair around a central column.

This Victorian era cast iron spiral would not pass the requirements for a modern stair although once again it is still functioning normally. It does quite well to illustrate the type of stair that winds tightly around a central column that also supports it.

- The handrails are a touch too low and modern baluster spacings state that a ball of 125 dia. should not be able to pass between them.
- The same 125 dia. ball should not be able to pass between the treads.
- This method of construction using an inner pipe support with mass produced tread units slipping over it is still used today using modern materials and designs, for the simple reason that it is a brilliant and timeless design concept.

## Regulated Material

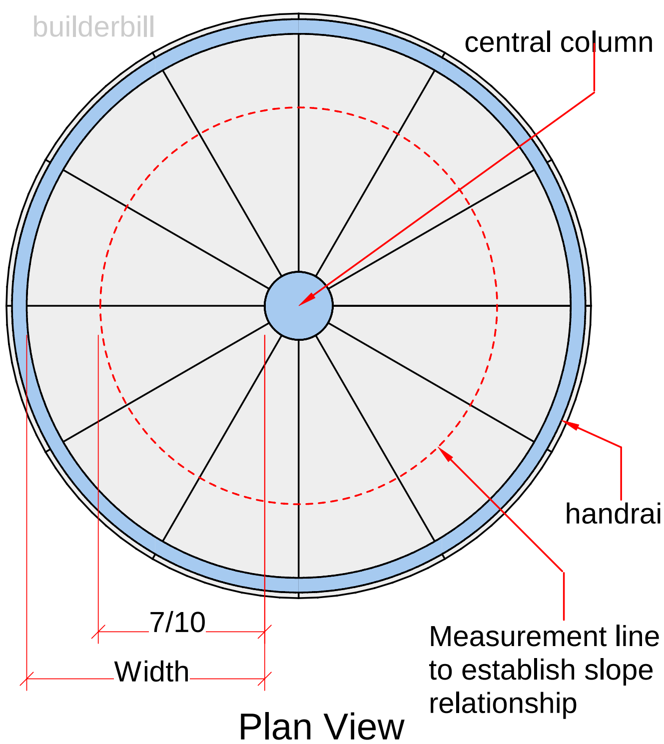
Use as a guide only, your regulations may differ.

**Spiral stairs - G, R and Slope Relationship.**

**Requirements for Spiral stairs** — **Slope Relationship**

| **Rise {R}** | MM | Inches | **Go (G)** | MM | Inches | **2R+G** | MM | Inches |
|---|---|---|---|---|---|---|---|---|
| MAX. | **220** | **8.6** | MAX. | **370** | **14.5** | MAX. | **680** | **26.8** |
| MIN. | **140** | **5.5** | MIN. | **210** | **8.3** | MIN. | **590** | **23.2** |

Table 5.3: Spiral slope relationship




Because the treads on a spiral stair do not have a consistent width like the ones on a straight flight then the regulations have to state where along that taper we have to take our go (G) values from.

- Note the change in Go and Rise values from straight flights.
- This type of stair that has a very narrow width at the centre. It rotates tightly around a small centre column.
- The place to take the G values is $\frac{7}{10}$. of the clear, unobstructed width of the stair.

## 5.5 Tapered Treads.


Img 5.5.1: Helical stair, tapered treads

These types of stairs form a separate class than the small spiral above. As you can see the narrow part of the tread at the inside of the curve is a reasonable width. Once again there is a wide variety of options here for a designer, from quite tight radii to so large that it is hardly noticeable. So the regulations take this into consideration by giving the options below.

This particular stair is showing it's age and has just had some rust spots cleaned up and primed with zinc chromate primer, but unlike the previous photo it does comply with modern regulations.

- The handrails are possibly a touch higher than the minimum requirement.
- The balustrade wires are closely spaced and the upturns at the back of the checker plate treads make sure that the gap there is also a lot less than 125 or 5".
- The stringers are channel sections rolled to the different curves.

## Regulated Material

Use as a guide only, your regulations may differ.

**Helical stairs - G, R and Slope Relationship.**

**Requirements for Spiral stairs** — **Slope Relationship**

| **Rise {R}** | MM | Inches | **Go (G)** | MM | Inches | **2R+G** | MM | Inches |
|---|---|---|---|---|---|---|---|---|
| MAX. | **220** | **8.6** | MAX. | **370** | **14.5** | MAX. | **680** | **26.8** |
| MIN. | **140** | **5.5** | MIN. | **210** | **8.3** | MIN. | **590** | **23.2** |

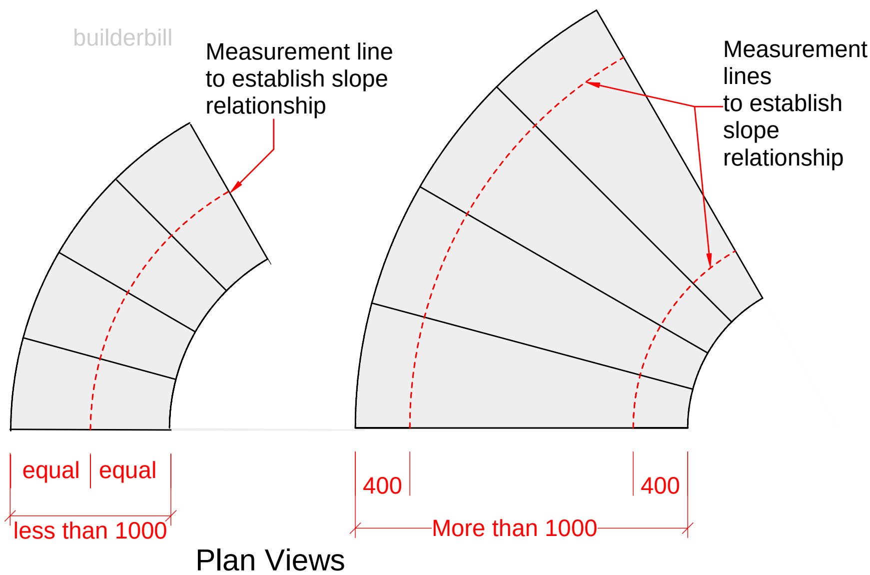



Table 5.4: The G value for tapered treads

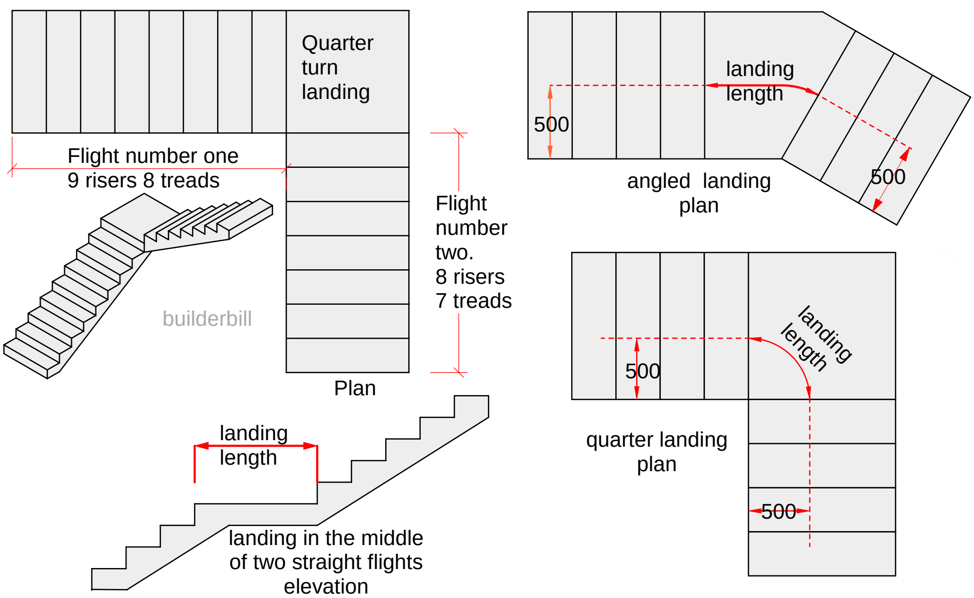
The stair in these instances wind around a centre point that is away from the stair itself usually leaving an open well space. there is no central support column.

- **Note the change in Go and Rise values from straight flights in the top table**.
- For stairs that are less than 1000 or 39" in width. Measure the Go value at the centre of the width.
- For stairs that are over 1000 or 39" in width. Measured the Go values at two places. 400 or 16" in from either end.

## 5.6 Landings

Regulated Material Use as a guide only, your regulations may differ.

**Landing - Length Measurements.**




Img 5.6.1: Landings

**A landing must be at least 750 or $29\frac{1}{2}$" long.**

- Where the landing involves a change in direction then the measurement is taken at a point 500 or 19.68" from the inside edge of the landing. It is measured around the curve. For example the 90° landing gives a length of 785 or 39.9". The curved segment of the 30° turn landing above would add 262 or 18.3" to the straight section.

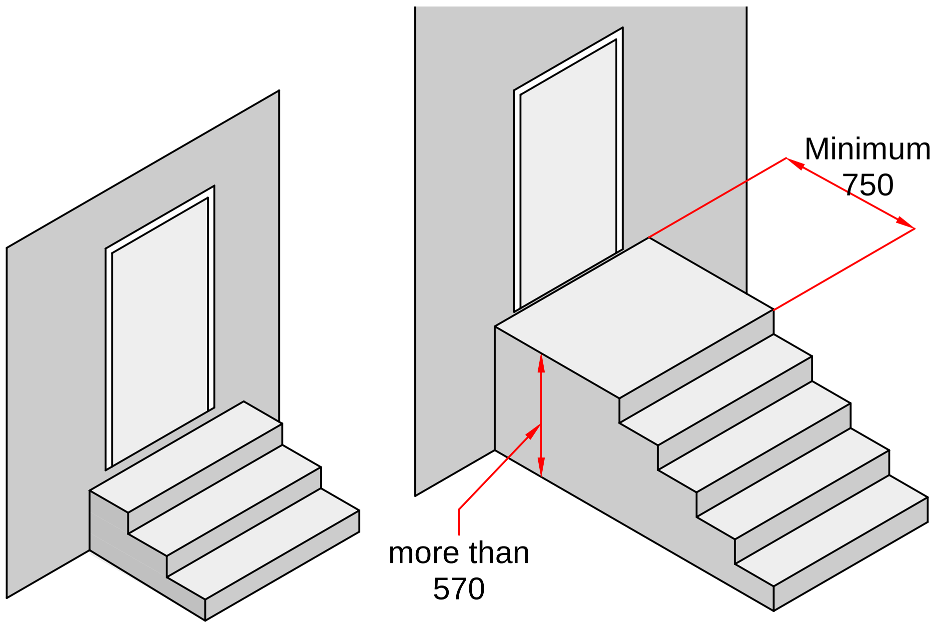
- A landing must not have a slope greater than 1:50. So in a minimum length landing of 750 (29.5") then a fall of no more than 15mm ($\frac{5}{8}$") is allowed.

- A rule of thumb or stair building convention is that landing length is never less than the width of the stair and personally I have never built a stair that was less than 900, 36" wide and so my landings were at least that. Mostly I used 1200, 48" long.

## Regulated Material

Use as a guide only, your regulations may differ.

**Landings - At door thresholds.**




Img 5.6.2: Threshold of doors

**Landings must be provided where the sill of a door opening or threshold opens onto a stair that is greater than 3 risers or 570 (22.4”) high.**
If the door opens out towards any stair then a landing should be provided not less than the swing of the door. (I use a 1200, 48”, landing in these cases.)

## Regulated Material

Use as a guide only, your regulations may differ.

**Landings -** Long Stairways.

Img 5.6.3: Long Stairs

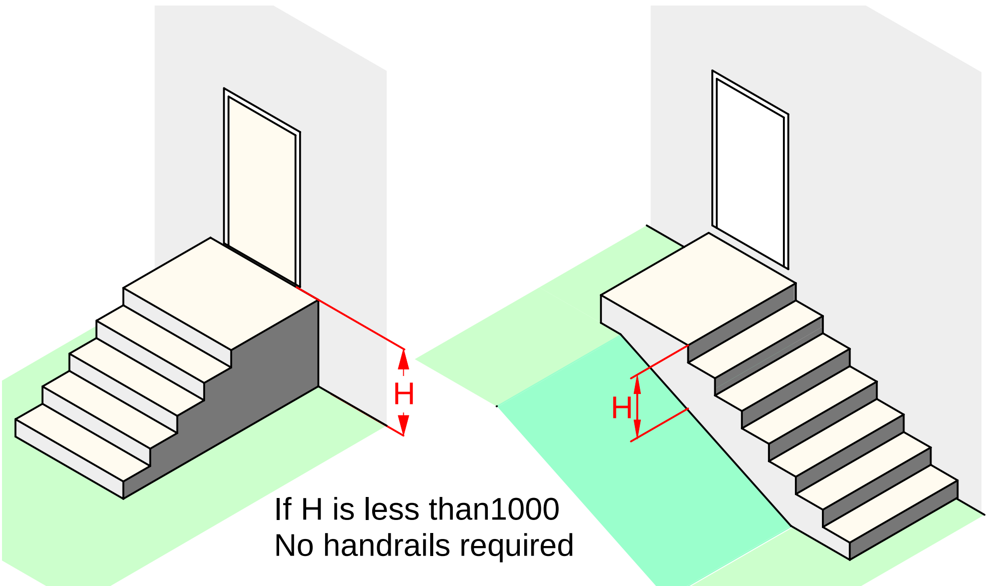
In public places and in residential situations the length of single flights are governed. Over a certain number of risers the stair must be have a landing.

- In Australia the length of a single flight of stairs is limited to 18 risers for public and private stairs. In the UK it is less.
- Large public stairs tend to reduce this amount considerably.

## 5.7 Handrails and Balustrades

Regulated Material — Use as a guide only, your regulations may differ.

Handrails Not Required




Img 5.7.1: No requirement for handrail or balustrade

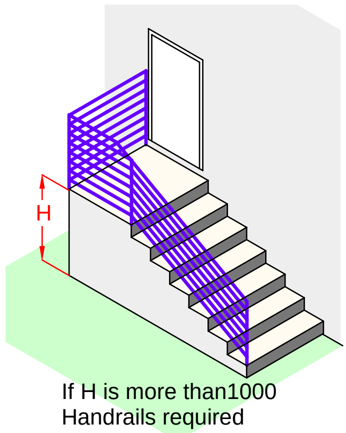
The examples in the sketches show external stairs and I have drawn the ground level or the lower surface in green. The same rule applies to indoor stairs.

Handrails and balustrades are not required if the height is less than 1000, or 40” on single household units but they may be needed in public and semi-public areas.

## Regulated Material

Use as a guide only, your regulations may differ.

### Handrails Are Required




Img 5.7.2: Handrails Required

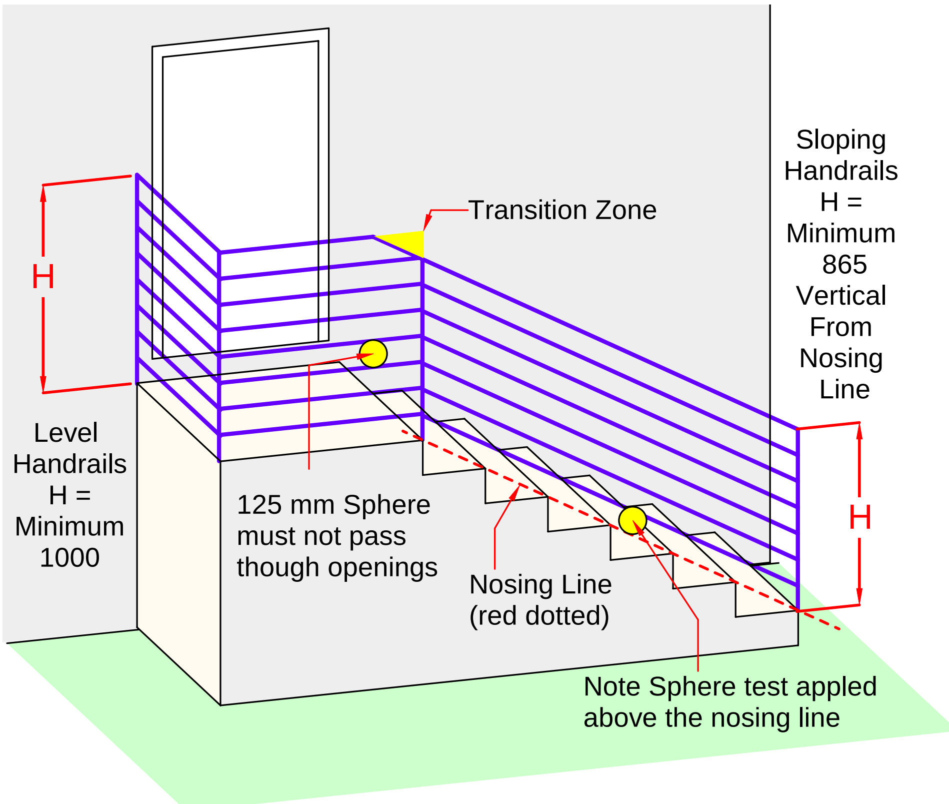
A continuous balustrade or other barrier must be provided along the side to any **roof** accessible by the public, any **stairway** or **ramp**, any **floor**, **corridor**, **hallway**, **balcony**, **deck**, **verandah**, **mezzanine**, **access bridge** or the like and along the side of a **path of access** to a building, if -

1. It is not bounded by a wall
2. It's level above the surface beneath **is more than -**
   (a) **4 metres** where it is possible for a person to fall through an open-able window, or -
   (b) **1 metre in any other case**. (H in the above sketch)

## Regulated Material

Use as a guide only, your regulations may differ.

### Handrail Specifics




Img 5.7.3: Handrail details

1. The **Height of the balustrade or other barrier must be -**
   (a) For a stair or ramp, a height of **at least 865, 34",** higher than the nosing line of the treads or the floor of the ramp.
   (b) The height must be not less than -
      i. **1 metre, 39"**, above the floor of any access path, balcony, landing or the like.
      ii. **865, 34",** on the section of a landing that is a continuation of the sloping stair rail. (This is the area known as the transition zone).
   (c) Openings in balustrades should not allow the passage of **a sphere of 125, 5", diameter** to pass through. This is applied to the area above the nosing line. (This is a slight back down for the regulations as there used to be no clear definition of this and we used to drop the bottom rails to touch the nosing line etc on open strings.)

## Regulated Material

Use as a guide only, your regulations may differ.

### Handrail Specifics

1. A landing or other barrier must be designed to take the loading forces in accordance with AS 1170.1 or AS/NZS 1170.1. (This is a quite complex set of loadings that is used by structural engineers. I have never had to refer to this as all building projects have to be certified structurally by an engineer, and the handrail and balustrade strength is covered in the engineering certification.)

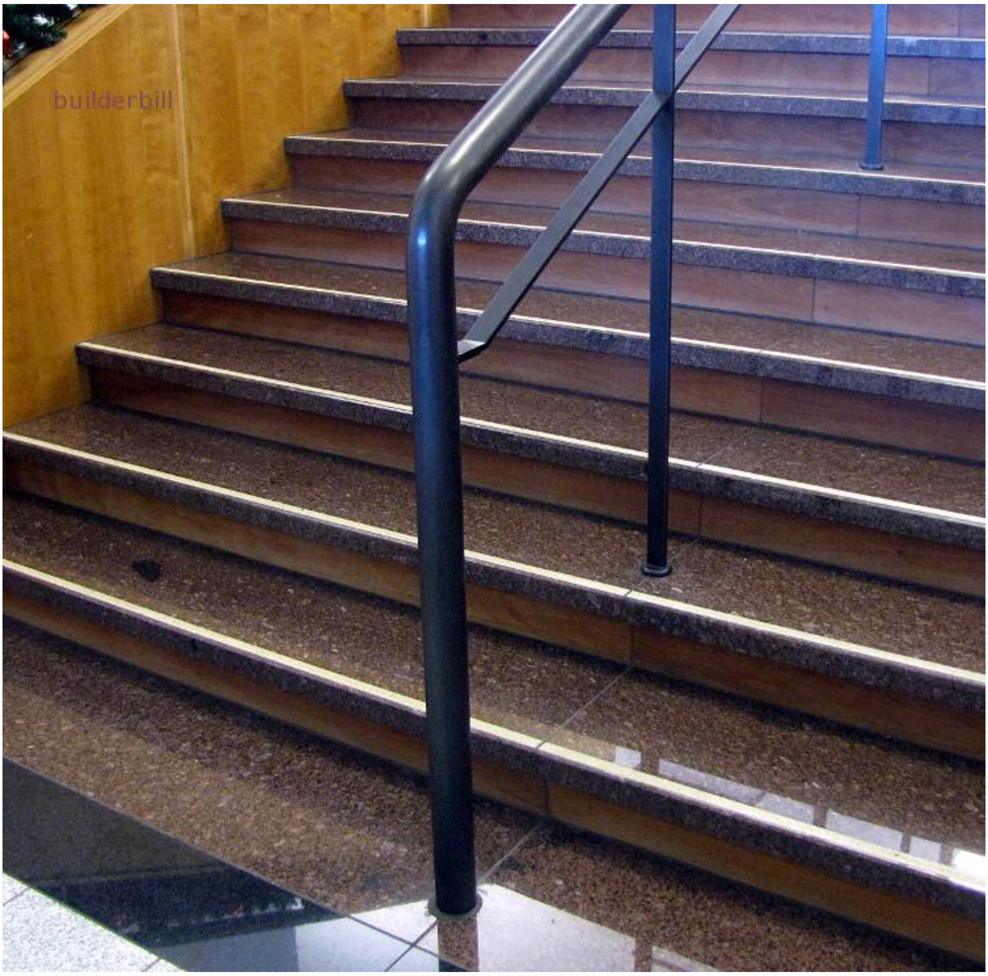
2. For Floors more than 4 metres 13.2ft. above the surface beneath, any horizontal elements in balustrades and other barriers, between 150, 6”, and 760, 30”, must not facilitate climbing. (Virtually this means that apart from the top and bottom rails just use vertical members, glass or mesh that children can’t climb.)

3. Then follows a long an detailed section on the use of and the strength and tensioning of wire for infilling balustrades which is outside the scope of this book.

## Regulated Material

Use as a guide only, your regulations may differ.

### Handrails To Wider Stairs

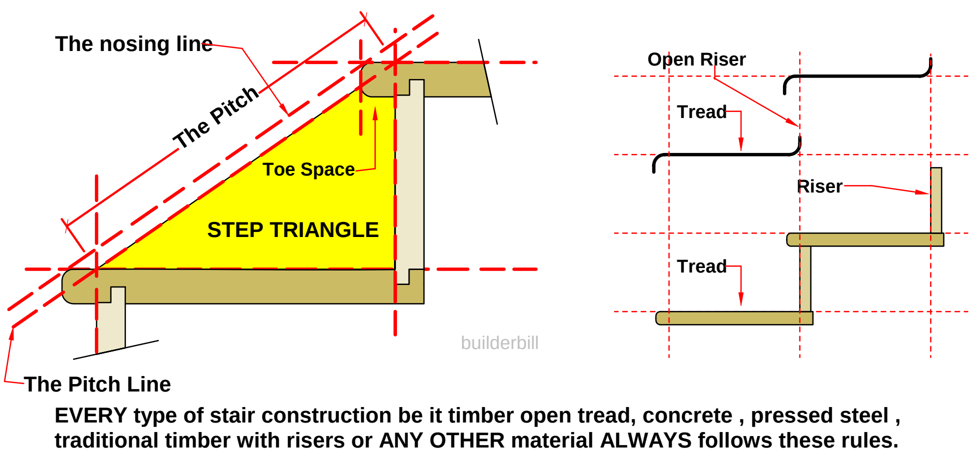



Img 5.7.5: Rails to Wide Stairs

1. Handrails should be located at least to one side of a flight or ramp
2. located along each side of a flight or ramp if the total width is 2M.or greater and
3. have intermediate handrails that are not more than 2M. apart
4. in certain classes of buildings (primary schools) have one handrail fixed at a height of not less than 865 and a second handrail fixed between 665 and 750.

# Chapter 6

# The Mechanics of The Design




Img 6.0.1: The step triangle

- Above are shown a couple of more stair construction details. They are included to drive home the point that no matter what type of construction method is used, the same basic set-out lines apply.
- The step triangle is formed from the lines of the Rise and the Go. It describes the angle of the stair and it is used much during stair construction.
- **The pitch line** is a theoretical line used in setting out. It defines the angle of the stair.
- **The nosing line** is the line produced by the finished treads. They may or may not have toe space, but they are usually rounded to some degree . It is the line that head height and handrails are measured from.

**Most important!** In any stair or staircase consisting of multiple flights and landings the G and R values should all be the same for that staircase. (A staircase or stair spans between two floors.) Some sources say that they can change with each flight but this is bad practice. Keep them all the same in each stair. Be safe!

- A stair starts and finishes with a Rise. There is always one more Rise than the number of Goes. One more riser than the number of treads
- Build stairs so that each flight has -
  - not more than 18 steps or -
  - less than 2 steps.
- If you have more than 18 then you must use a landing to break up the steps. This is to limit the amount that a person may fall and at the same time to give the elderly or physically impaired a place to rest.
- Keep risers and treads consistent in size within a tolerance of ±3 mm or $\frac{1}{8}$"

## 6.1 Nosings and Treads

The previous drawing 6.0.1 clearly shows that the overhang of the treads that makes the toe space is not part of the stair calculations. It is easy to see that the tread in many cases is greater than the Go.

**I have never built a stair without toe space.** Usually it is 25 to 30mm or 1" to $1\frac{1}{4}$". Toe space makes a comfortable stair but it should not be too large. It is to be preferred but it is not mandatory. Many concrete stairs that are ceramic tiled like in the photo here 2.0.5 do not use toe space. I guess that if you have a good tread width then toe space is less important than if the tread is narrower.

1. Make steps visually prominent, provide CONTRAST EDGING so that their presence is obvious.

2. Provide slightly rounded nosings for visibility and injury reduction (use a radius of 10-15 or 0.4” to 0.6”).

3. The rounded edge of a nosing helps to show the edge of the step, it causes either highlights or shadows that define the edge.

4. In certain light conditions the light can be reflected from the bull-nose make the nosing line easy to see.

5. The underside of the nosing should also be rounded slightly to avoid the possibility of the back of a shoe catching on the tread underneath.

6. On public and semi public stairs contrasting nosing colours are mandatory. Sometimes on every step and sometimes just on the top and bottom ones.

7. The top surfaces of the tread material should be durable and of a non-slip character.

8. Avoid tread materials and coverings with visually distracting patterns.

9. Treads in general should be level. But, outside stairs should not allow any pooling of water on the treads that may induce the growth of mildew or mould.

   (a) So on concrete external stairs it is common to use a fall to the tread to easily shed water.

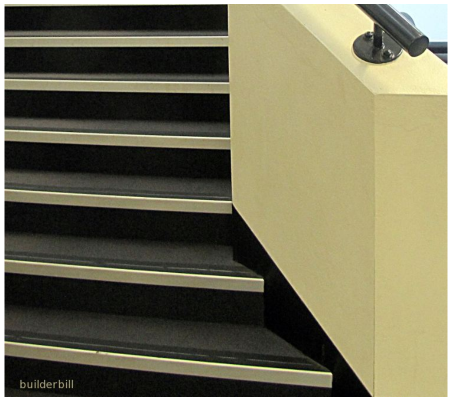
10. Where metal or other non skid materials are fixed to stairs they should be set flush with the surface of the tread.


Img 6.1.1: Concrete Nosings

In the photo above, taken on a bright day the nosings were almost impossible to see because there was only a small pencil round to them. They are about 30mm in front of the carborundum non slip inserts.


Img 6.1.1: A ceramic bullnose tread

The fact that the surface is curved means that for angles of view from horizontal to vertically down there is always a highlighted edge to be reflected back at the viewer. Note! This is a public stair and the black strips are glued on carborundum grit for their non-slip properties.



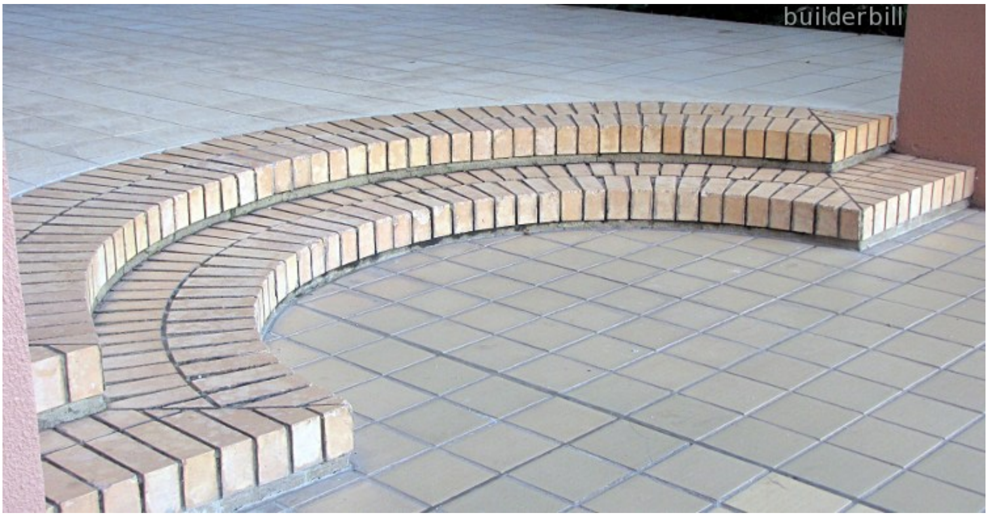

Img 6.1.2: Carpeted treads with metal nosings


Img 6.1.2: Tactile pads

A two step rise in a public area. The designer has tried to make these visible. The first one has a decent bullnose and also grooves. A pity he did not do the same with the top one.

Note the small handrail sections that are not required by the regulations but they do indicate the presence of steps from a distance.

The tactile pads are mandatory for public areas.




Img 6.1.3: Two steps in public area

Other methods of making a two step rise in a public area more visible.

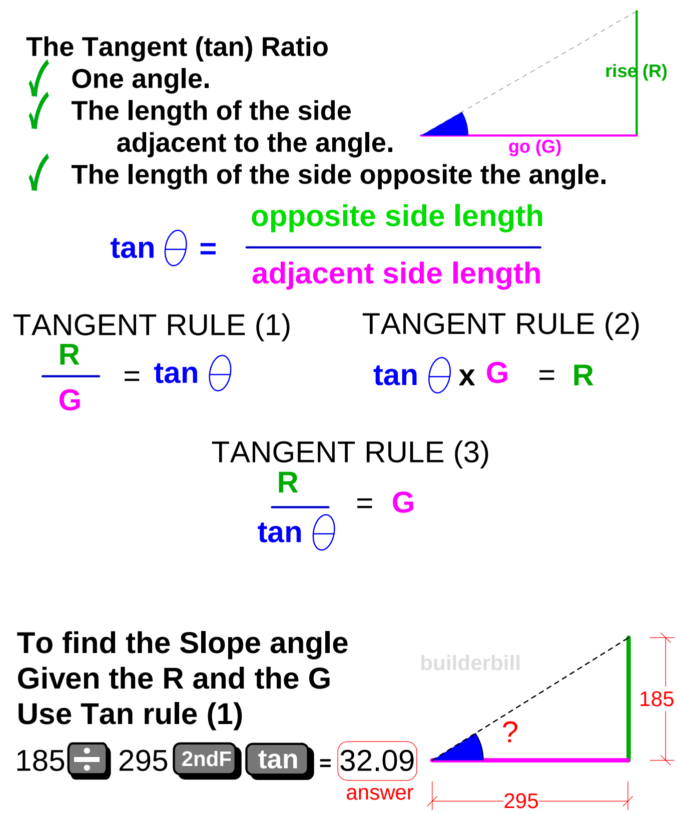
- The designer here as used a contrast colour, material and texture. All excellent.
- The shape is the main difference though. From any angle, top, side or bottom these steps would be hard to miss.

## 6.2 The Slope Angle

Build a stairway so that the **slope ranges between 18 to 38 degrees** with the lower end of the scale for elderly and disabled people. This is done by adjusting step Rise and Go dimensions.

A single step in a stair consists of the horizontal distance Go and the vertical distance Rise. These two dimensions can be used to form a right angled triangle that can be called the Stair or Step Triangle, and the angle that is formed at the base of the step triangle is called the Slope Angle and also sometimes called the Pitch of the stair.

This basic triangle shows that the Slope Angle is a function of the Rise and the Go. If either R or G changes it affects the angle.




Img 6.2.1: Step Triangle-Ratios

The sketch here shows a way of calculating the Slope Angle using trigonometry and a ten dollar calculator. A few keystrokes and it can be found easily.

Likewise using the tangent rule (3) as I call it, if you have decided on your slope angle and you have calculated your Rise then the correct Go can be found.

Using trigonometry like this is a bit of overkill at the design stage and it is not needed.

It can be extremely useful though when setting out stairs and when doing the actual stair-building.

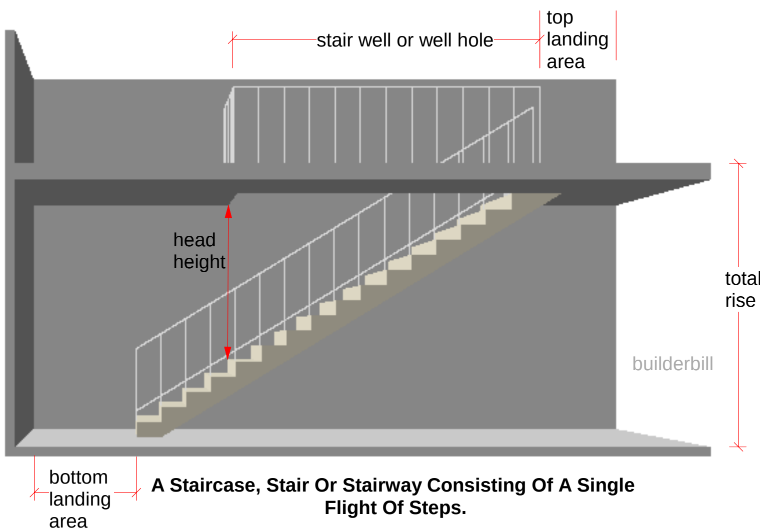
## 6.3 Head Height and Well Holes


Img 6.3.1: A generous sized stairwell

The hole in the floor that serves a stair is known as the well hole or simply the stairwell.

- The term Stairwell is particularly used in multi-storey buildings where an area is set aside for stairs that lead to all floors.
- The stairwell area is often associated with the lift well (elevator hoist-way) area also as in the photo above.
- Stairwells have a reputation for being dark and dismal places. They should not be. They should be well lit and ventilated to make them something more than just an place for stairs. Note the ambient light and wide open windows in the photo above.

It makes good sense from a structural and construction point of view to group stairs one above the other, but there are good safety reasons to do this also. In the event of an emergency then it is good to know that the exit from any particular floor is in the same place.




Img 6.3.2: Head height

In this straight flight the stair well hole simply follows the width of the stair until the head height is reached. This is the minimum. It can of course be made larger for a feeling of more light and space if the upper floor layout permits.
The width of the well hole should be the width of the stair plus an amount extra for clearance of the hand grip on the handrail. This extra amount depends on the layout of the handrails.

Provide adequate head height for anyone walking up a stair. Almost always it is measured vertically from the nosing line.

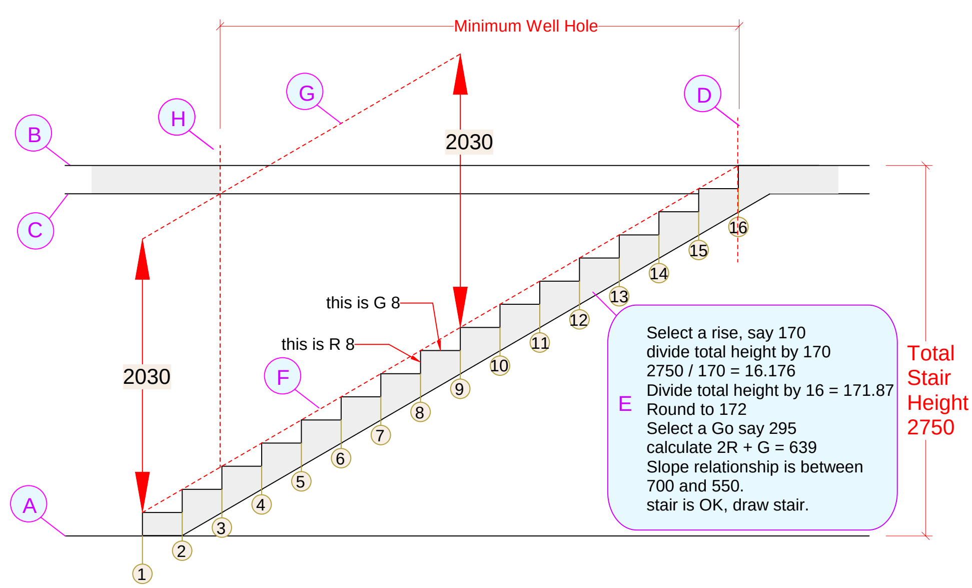
**Head clearance should be a minimum of 2000**.

- I have never used a finished head height of less than 2030 or 6ft 8". (Around normal door height). The consequences of getting it wrong are unthinkable. Always in any of these measurements allow that bit extra.
  - In relation to this I am talking as a builder. The designer may well state the mandatory minimum but a builder has to allow for varied conditions on the site that could include unknown floor and tread finishes or clients changing the finishes. Once a well hole is built it is expensive to change.
- 2000 over a stairway can be unsettlingly low for tall people who have no trouble negotiating a door at the same height.

- Always think of moving furniture and ambiance. Minimum ceiling heights are claustrophobic. Try to give more space.
- 2100 or better still 2200 gives a far better head height. Once again think of moving furniture up the stairs.

If you have trouble finding a rule that states what your own regulations require in the way of head height over stairs, try looking in the section that covers ceiling heights in general. (That's where our's is tucked away, nowhere near the stair section.)

The design of the stair always starts from a drawing of the stair in elevation, or side on. More correctly it is known as a section, because it is as though a slice has been taken through the building and the portion blocking our view removed. It is possible to do it from a plan but using a sectional elevation is by far the safest way.




Img 6.3.3: Drawing out a stair

In this sketch the well hole follows closely the shape of the stair until the minimum head height is reached.

Refer to fig 6.3.3

1. Draw the finished bottom floor level (A) and the finished top floor level (B).

   (a) These must include the final thicknesses of the respective floors. For instance you may have a cement topping and ceramic tiles to allow for at the bottom and vinyl or carpet at the top.

2. Draw the exact upper floor thickness. (C).

   (a) This may require drawing a new section at a larger scale showing the floor joists, floorboards, the ceiling lining and any fascia to the well hole edge etc.

3. Determine the start point of the first landing. (D).

   (a) Depending on the construction method you may well have to draw a detail for the stair to top landing connection to get the exact position of the landing edge.

4. Draw the stair (E) This is the time when the previous topics in the regulations chapter take on meaning. This is where you can run through various "what if" choices and see the effects of wider treads or higher rises etc. Always check the Slope Relationship.

   (a) This is explained on the sketch, but I will go through the simple system once more just to explain further.
   (b) Select a popular riser size, I have chosen 170, $6\frac{3}{4}$" in this instance.
   (c) I divide the total stair rise by my preferred rise of 170 to come up with a figure of 16 and a bit. So I decide that 16 rises will be OK.
   (d) I now divide the total rise by 16. I am using my pocket calculator here and it gives me a figure of 171.675. I round this off to the nearest mm and call the rise 172. (171.675 x 16 = 2750 of course, and 172 x16 = 2752, which is a 2mm error. Quite acceptable at the design stage.
   (e) Choosing the Go depends on quite a few factors. Firstly available space if renovating an older building. In my experience it boils down to the material that the treads will be made out of.

i. If it is going to be poured concrete then you can make them any legal width.

ii. Precast concrete steps that I have used have been 300 and 320.

iii. If it is timber then it depends again on what is available. The very last stair that I built was steel with laminated bamboo treads at 1000 x 295 x 40 thick. (This was an open riser stair so we got full use of the width.) Other timber manufacturers make step treads in very similar sizes so it would be silly at the design stage to select a tread size that is outside the range available unless there is a compelling reason to do so.

5. **Number the risers.** Do this also to any future plans and layouts while you are still designing. It is a great help when including landings. It avoids a lot of confusion.

6. Draw the nosing line (F)

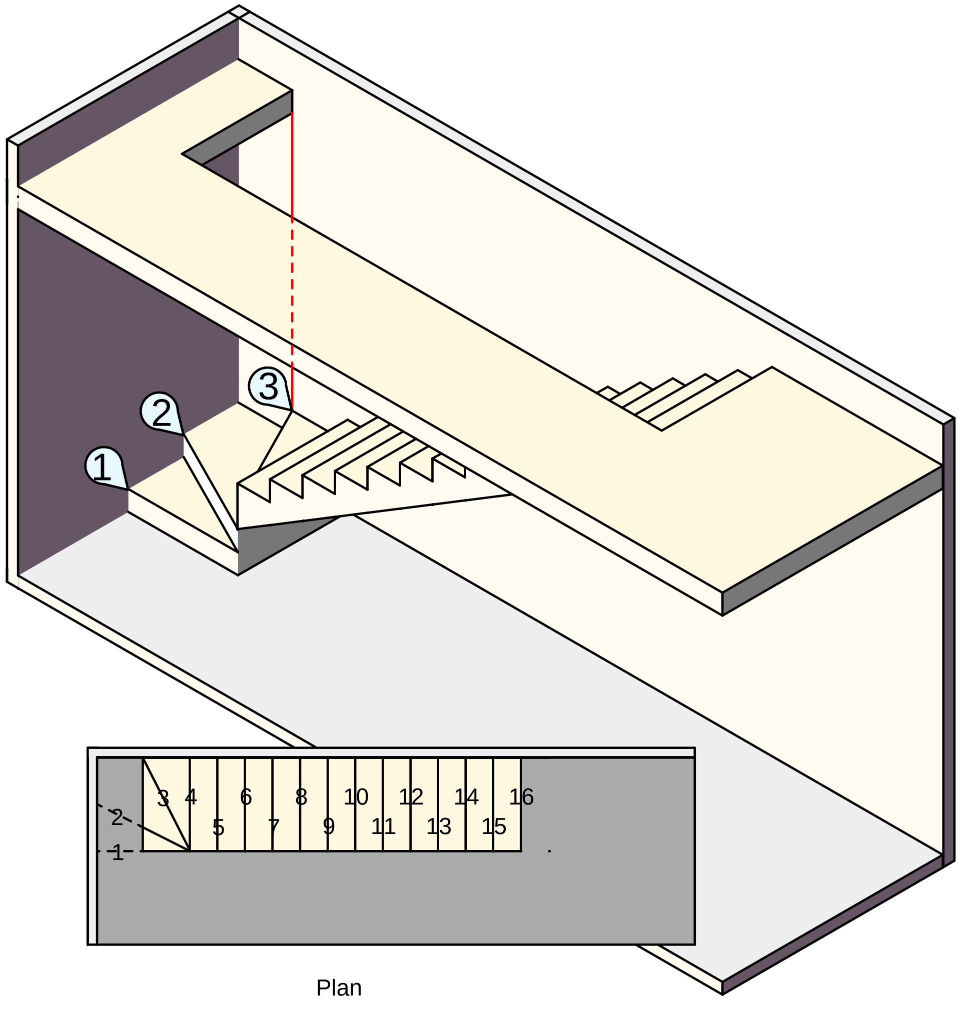
7. Draw a line parallel to the nosing line offset vertically by the clearance height. (2030) (G)

8. Where the line (G) intersects line (C) (the underside of the upper floor) this is the minimum well hole length. Project this line to the stair.

   (a) In the stair drawn above the position of the well hole line in relation to the stair is over tread 2 about 3mm away from riser 3. Note this position for future reference.

What you have just drawn is a generic straight flight. It may be just the thing that you had planned, or it can be used as the first step in the on going design process.

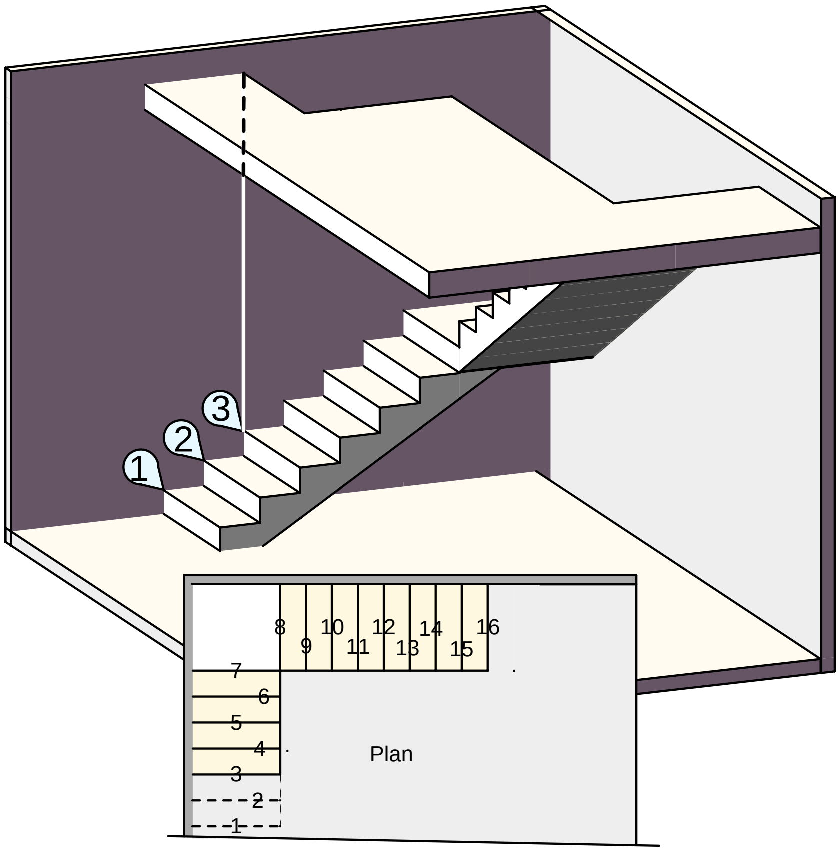



Img 6.3.4: A stair with winders

If you go back to the last drawing 6.3.3 you will see that the well hole was directly above the number three riser.

- If all the previous details like the overall floor height, floor thickness and the number of Rises and width of the Go all remain the same then the minimum head height will still be over riser 3.
- So for this flight that contains winders then the edge of the well hole will still be drawn vertically above riser 3.

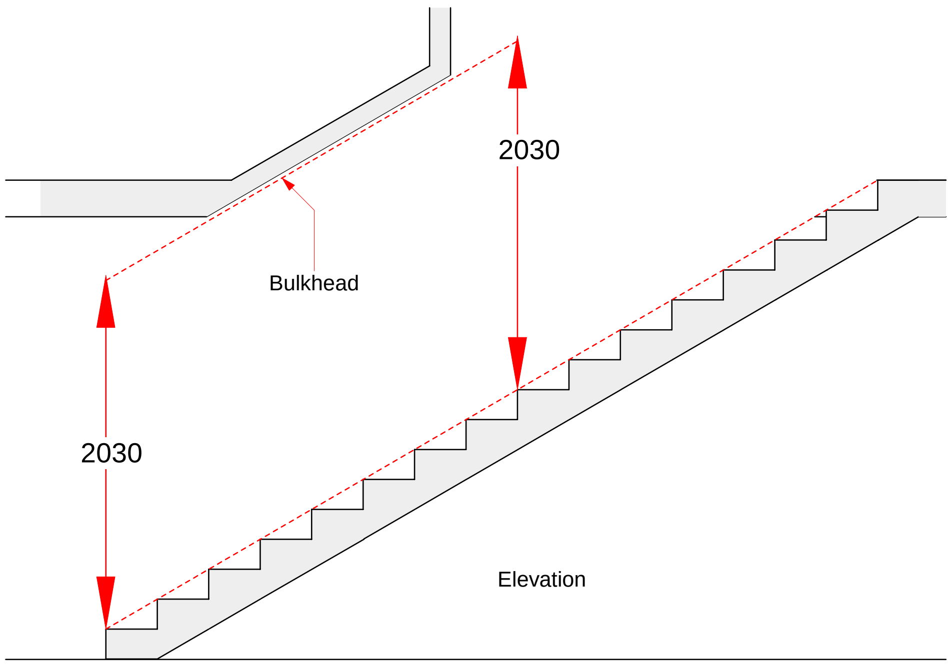
Note that in this instance I used the widest part of the winder no.3 as the projection point. If I had used the narrowest point then you can see that it is also shares the same position with riser 4. That would make the head height too small by one rise. Be careful with winders.




Img 6.3.5: A quarter landing well hole.

In this example I have drawn a quarter landing and once again shown the minimum well hole needed.

- I chose to put the landing at riser 7 position.
- This means that what we may call tread 7 is now made wider and changes to a landing. The original riser set out has not changed and the top surfaces of the treads and the landings are all just as before in the previous examples.
- I could play about with the landing position and make it higher or lower, and so change the lengths of the flights, but a vertical line above riser 3 still would define the edge of the well hole, all else being the same.
- Likewise I could change the landing to a half turn or I could add another quarter landing. The layout would change but the edge of the minimum size well hole will always be over riser 3 if all else remains the same.




Img 6.3.6: A Bulkhead over a stair

When room space is at a premium over the stairs then it is often possible to build a sloping ceiling or bulkhead above the stair.

- The slope of the bulkhead is the same as the slope or pitch of the stair and it is found by drawing a parallel line to the nosing line offset vertically by the head height distance.
- Usually the room above the bulkhead has the sloping section boxed in so that material can be stored on it. Often they are very small bedrooms or the like and they are often referred to as “box rooms”.
- Other options to cover up the framework of the sloping section is to build them into a cupboard or wardrobe.

Note! Any structural support beams must be incorporated inside the ceiling line. The head height must not be compromised.

# Chapter 7

# Handrails and Balustrades

**Handrails** are the rails that one holds with the hand. They should have one paramount feature! That is to be **easily and comfortably grasped**. They are there to provide safety and support, particularly at the beginning and end of a stair and also where a stair changes direction. If someone needs help or assistance negotiating a stair they should be there, at a **convenient height** and be **graspable.**

**Balustrades** are the whole structure. The posts, the rails and the infill panels. They should be strong.

1. Consideration of the handrail/balustrade combinations should be taken at the very start of the design process. All to often the they are left until later and sometimes to the detriment of good design. It is not a thing to be done on the fly when the pressure is on for making the stairs safe for workers .

2. In public and semi-public stairs handrails should end in safety terminals to diminish the risk of clothes or bags etc being snagged by them and throwing a person off balance.

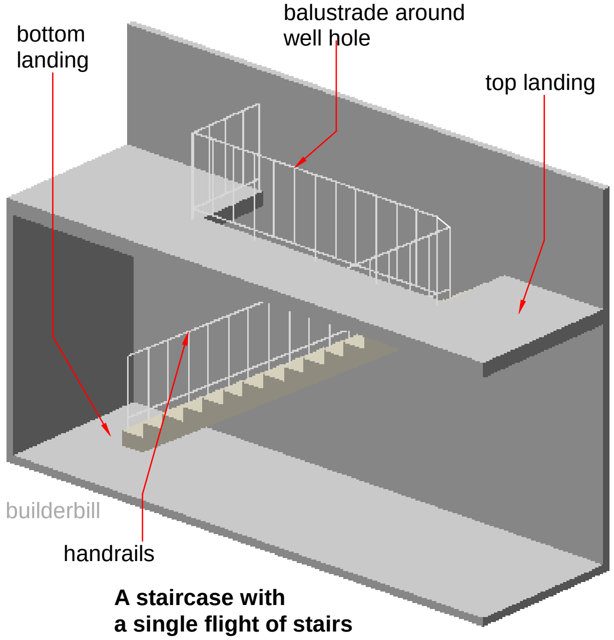
3. During construction well holes should have temporary balustrades around them.

One theme that recurs many times is that modern stair designers are quick to take advantages of technology spin offs from other industries.

We see glass balustrades that would have been impossibly expensive a few years ago now quite commonplace because of the advances in glass-making that were driven by demand for windows etc.

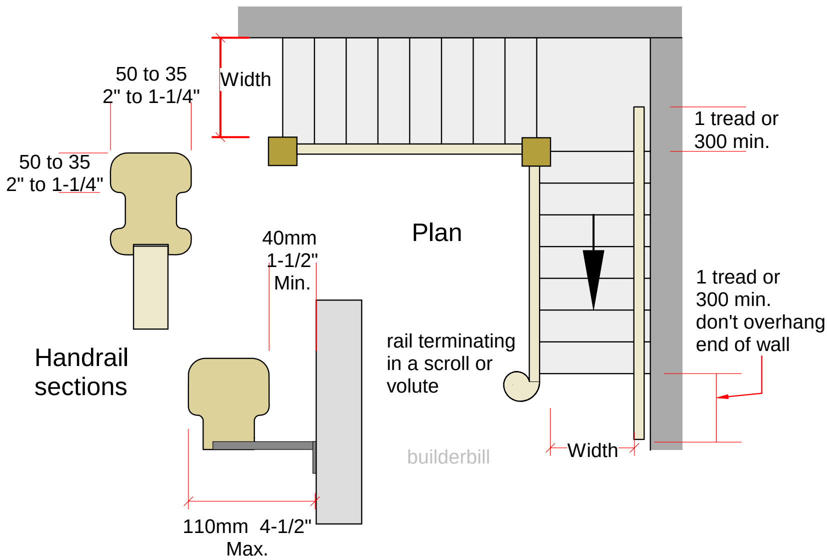
We have good cost savings now in stainless steel pipes, fittings and wires that are spin-offs from the marine industry.

There are many other new materials that are giving a lot more choices to anyone who is prepared to search them out.




Img 7.0.1: Handrails / Balustrades

Balustrades are required at the open sides of stairs and edges of well holes. Wall rails are not mandatory but recommended in residential construction against walls.




Img 7.0.1: Newel posts, stair width, rail dimensions

Not over stress a point but the rails should be graspable. They should be rounded and the fingers and thumb should gain a firm grasp.

The width of a stair generally is taken as being the width of the clear unobstructed space. In a residential stair the **absolute minimum** width should be 750 or 30".

- It does not include any space taken up by the handrails or newel posts.
- This normally includes any fixed wall handrails.
- So as a rough guide a 1200 wide stair overall could quite easily finish up with only 1050 usable space.
- A handrail scroll at the bottom of a stair can act as a safety terminal.
- Ideal handrail sections are oval or rounds.
- Ideal materials are metal. As much as I love to see an old piece of timber craftsmanship I can still see the beauty in a nicely tig welded stainless steel rail.
- It seems to me from the research that I have done and looking at many handrails and balustrades, that the current state of the art modern rails are as good and as strong as any ever built.
- However I see that traditional style timber rails are no longer being built with the same care and attention that they used to be.
- I have seen many timber handrails simply screwed to newel posts and balusters just stitch nailed to the rails and the strings.
- Timber being a natural material expands and contracts and as such the joints used in it should allow for that movement. In my opinion screws alone do not do that.
- Surely if the budget or time does not allow for a proper job using timber, then a change to modern, cheaper and stronger materials has got to be considered at the design stage.
- Do not design something that will not be satisfactory for it's full expected lifetime.


Img 7.0.2: Wall Rail

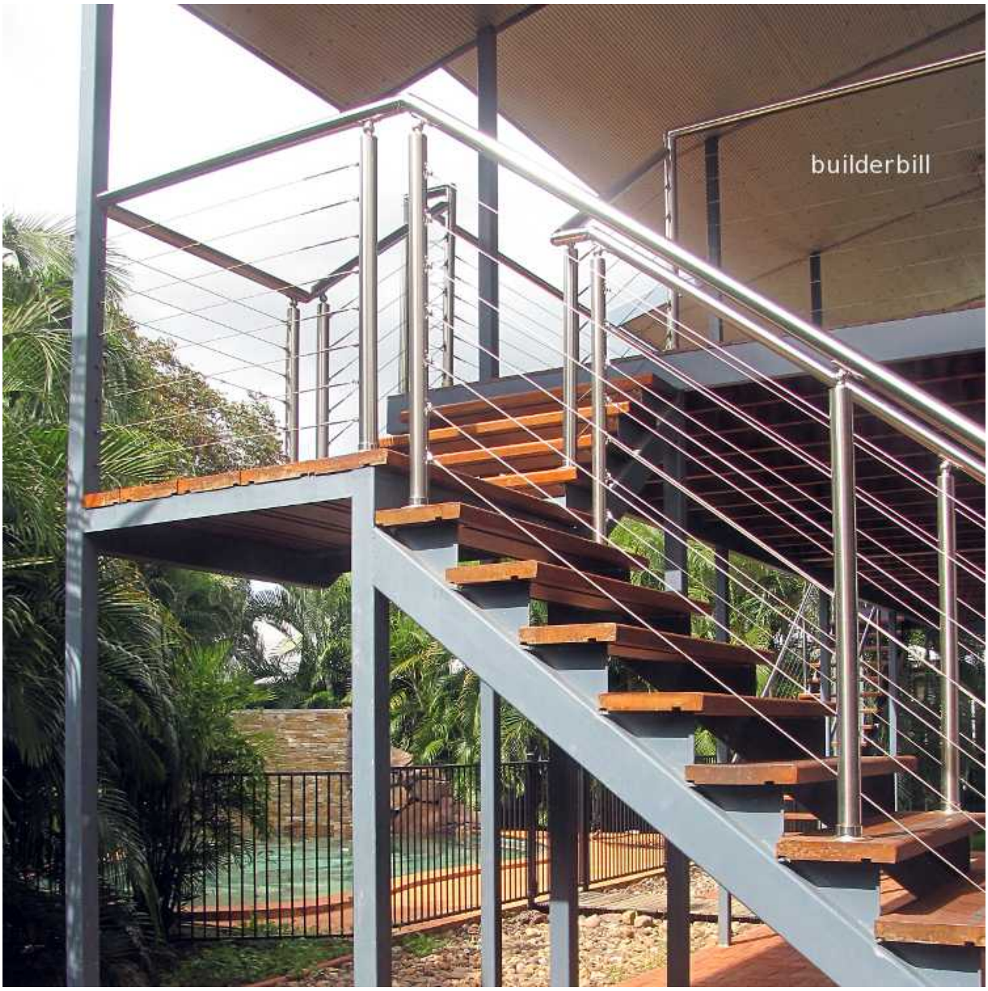
**Wall Rails** Sometimes called grab rails are rails fixed to a side wall. They do not need anything under them as the wall acts as the balustrade.

- Once again usually left until the design process is complete and then they are often added as an afterthought.
- This of course is not the best way to do it as looking at the details in the previous sketch it can be seen that up to 110mm can be taken off the allowed width of the stair.
- Most regulations do not insist on wall rails for domestic buildings. When they are used they are usually straight lengths and only rarely do they curve around corners.
- With commercial building is is a different matter and wall rails are usually required.


Img 7.0.3: Stainless Steel system.

While not looking as neat and tidy as a fully welded system. This propriety set up would obviously have a market with the DIY fraternity.

- The pipes are standard cut to length and then various end fittings are pop riveted to them.
- The slope is adjustable with ball or knuckle joints.
- The infill uses SS wire fittings that may have originally been a spin off from the marine industry, but I am sure that balustrading is a market on it's own now. There are many approaches to this and our BCA has a large section on the varying thicknesses and tensioning of the wire.




Img 7.0.4: Steel frame timber treads.

This is a wider shot of the previous photo. The external stair leads to a high level deck overlooking a backyard swimming pool.

- Stainless steel looks good, is easy to clean and is maintenance free.
- On the downside it is more expensive than other materials.
- The RHS (rectangular hollow section) steel framework for these stairs is also a good alternative for external stairs. Strong and very cost effective. Also fairly low maintenance.

I am not too keen on this stair. The timber boards to the landing (and the deck above) have no overhang and so no drip edge. They will be staining the edge of the steel in no time and water is being encouraged to settle in that all important interface between timber and steel. This will promote rust in the steel and rot in the timber. **Always provide drip edges, 25 to 30mm.** It costs nothing to do it right.


Img 7.0.5: SS rail and post.

A better designed and constructed system than the previous one but at the same time more expensive in labour.

- To comply with the continuous requirements (see the next section) and the easy grasp-ability then a scribed joint between the pipes is not used.
- The post section has an end cap to it with a vertical section of flat bar that makes the joint with the rail.
- The post further has a flat bar welded to it which performs the function of a stiffener and the holes provide a good anchor point for the turnbuckles. (Do not underestimate the tensile force applied by these wire system balustrades. Stiff supports are essential).
- There are a few varieties of turnbuckles with these being very slim with end fitting that is similar to half a shackle and one end that has it's own swage for fixing to the wire.
- A far better and neater system than the pop-riveted saddles and shackles and thimbles seen in cheaper systems.

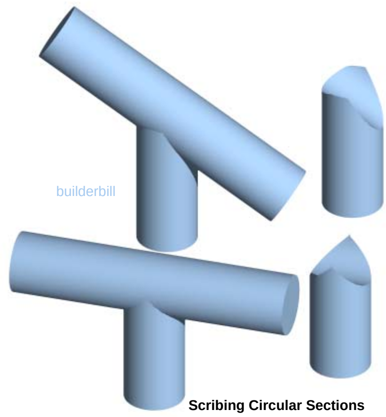
**Turnbuckles** are the method of tensioning the wire. The outer sections have right and left handed threads respectively and on turning the centre section then the wire is made tighter or looser.

**Shackles** are methods of connecting the components together.

**Swages** are hollow fittings that the wire is fitted into and then pressure is applied to to crimp them firmly to the wire.

**Thimbles** are teardrop shaped metal fittings that the wire is wrapped around to form an eye in the wire.




Img 7.0.6: Scribed pipes

This sketch is to just clarify what I mean by the term scribing the pipes. It is done with handrails quite a lot, mainly with older galvanised steel or black pipes in industrial of cheaper commercial projects, but it is rarely done with the thinner walled SS sections with their finely finished joints.


Brass Pipe Rails

An intermediate rail on a wide stair using standard 50mm 2" brass pipe sections. The joints are scribed and silver-soldered as in normal plumbing work.
Once again the hand-railing using readily available and cheap fittings from another industry.


Safety terminals to rails to a ramp.

An easier but less aesthetic way of joining pipes is shown here. The pipes are cut square and then simply belted with a hammer on each side to partly flatten them. A quick and cost effective way of making strong and durable rails using standard 50mm 2" dia galvanised steel pipes.


Img 7.0.7: Steel Pipe Rails

- The larger bends in this shot are made with a simple hydraulic pipe bender (hand or machine) and the tighter bends are fabricated out of two standard pipe elbow fittings.
- Standard pipe elbows come in short and long radius versions. Once again the hand-railing using readily available and cheap fittings from another industry.


Img 7.0.8: Cast Iron Balusters

Solid cast iron balusters ending in a volute or scroll. The bottom step here is known as a commode step and the next up is a simple round end step.


Img 7.0.9: Moulded Perspex Balustrade

A proprietary powder-coated aluminium pipe system that can use glass and perspex balustrade infills.

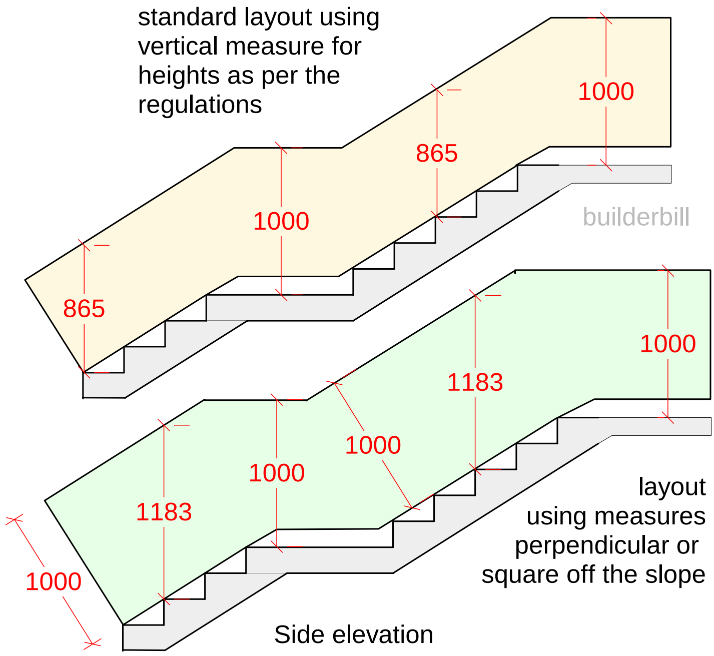
- The use of proprietary fittings to grip glass or in this case perspex are often used in high end work to give an effect of airiness and light to the stair.
- In this instance the perspex has been used to good effect for it's relatively cheap and easy to bend properties.
- A closer look reveals that the handrail extrusion uses the same groove and rubber beading system used in mass produced aluminium window sections.


Img 7.0.10: Side fixed balustrades

This type of balustrade fixing is an exception to the previous rule about the stair width.

- Most concrete stairs have no stringers to take up tread space because the strength of the stair is in the thickness of the slab below it.
- If the balustrades are mounted on the external faces then what you build is what you get, full width steps. When done well this is an excellent method. There is always plenty of room for the anchor bolts. Not too much worry about edge distances.
- These balustrades are made out of powder-coated aluminium box section with an perforated mesh infill to allow some movement of air.

Note! If the steelwork was bolted down to the top of the tread surface then the structural engineer would require that the fixings were a certain minimum distance from the edge of the concrete. If using 12mm bolts then it could be 80 to 110 minimum. A lot of space taken off the stair width. That is why a lot of concrete stairs are done either like this or use cast in-situ inserts to fix the rails.

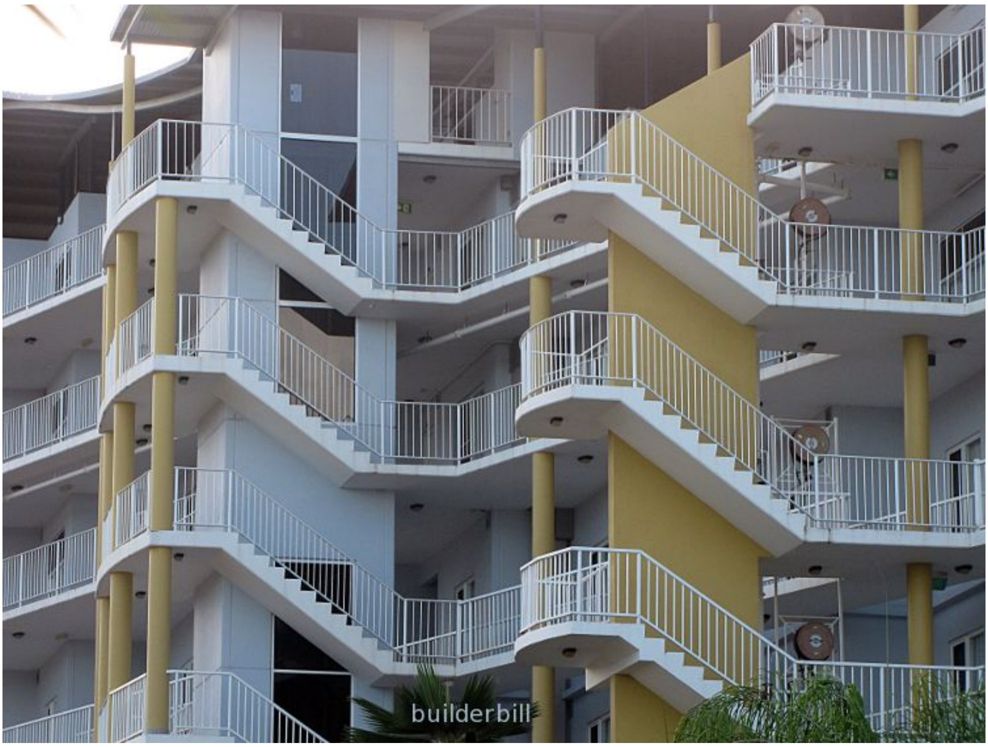



Img 7.0.11: Measuring the slope height.

The balustrade system in the previous page 7.0.10 also illustrates a point from another previous page
*"consideration of the handrail - balustrade combinations should be taken at the very start of the design process."*
This is one of a four stairs that I did on the job in this photo 11.2.1 .
The owner organised these handrails and balustrades himself after the concrete stairs were built because he wanted something different but he couldn't decide soon enough exactly what.

- While I am not too keen on the supports being square off the pitch myself, I have done another one like this so I was well aware of the basic geometry involved.
- I am not too sure whether the guy that supplied the handrail did though. I tend to think that he did; but he still did it this way to use standard panel widths of the aluminium mesh panels which were quite expensive.
- What I am sure of though is that he did not tell the owner that the stair handrails would be some 300mm higher than necessary doing it this way. (Still and all, the owner got something different.)

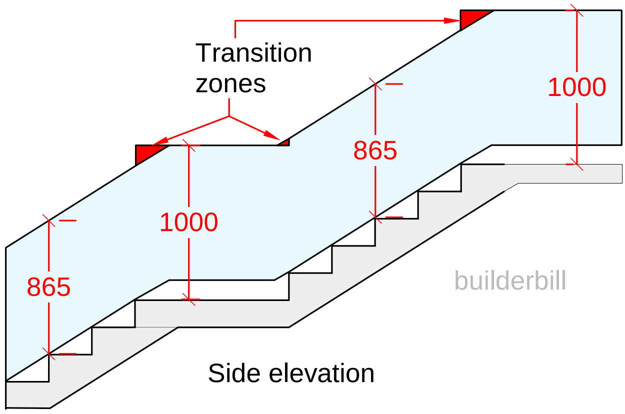
## 7.1 Continuous Handrailing




Img 7.1.1: Concrete Stairs and Steel Balustrades

The stairs and landings in this photo are protected by all steel balustrades and they use what is known as the continuous handrail system which is gaining popularity not only in commercial work but in private homes as well because of the safety feature of this method of building handrails.

- **A person should be able to grip the handrail at the bottom of a stair and walk all the way up it, around any landings without ever having to let go of the rail.**




Img 7.1.2: Transition Zones

Not too long ago it was necessary to make the little rises in the balustrades where the height changes from being around 870 on the slope to around 1000 on the level areas.


Img 7.1.2: A Gooseneck

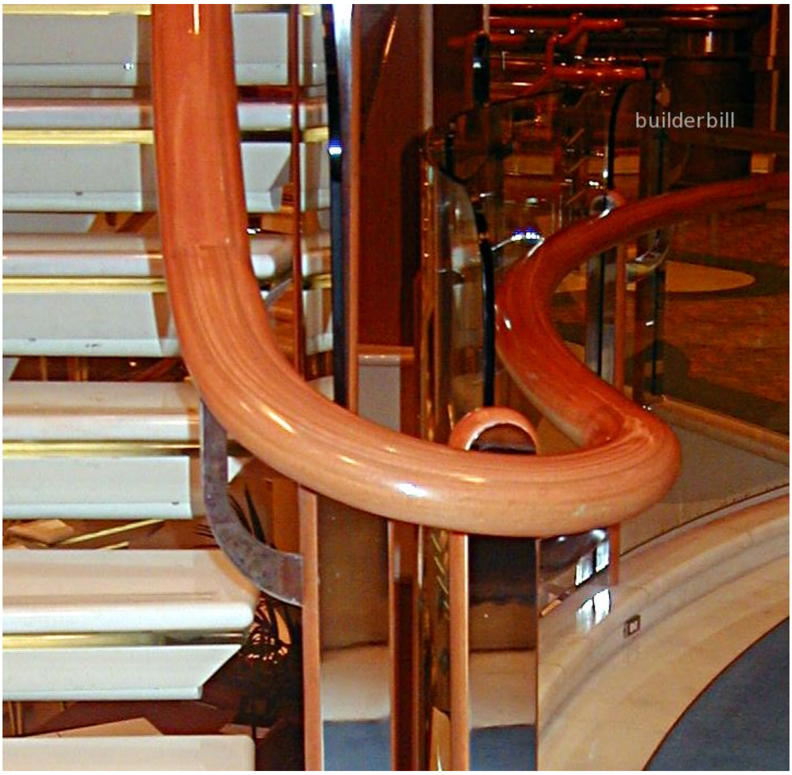
A common device to lift the rail to the higher landing level, goosenecks can be very ornamental.


Img 7.1.3: Newel extensions

When newel posts where part and parcel of the strength of stairs and balustrades they often used to project higher than the handrails. The reason for this was to give added strength to the mortise and tenon joints between the rails and the newels because full width tenons could be used. (They often projected under the landings too for the same reason.) This practical reason soon took on an aspect of decoration and it is common to see really ornately carved newels.
Beautiful as these old stairs are, showing off the craftsmanship of their builders, these features are no longer desirable in modern stair building.

- These old handrails would be too wide for the modern grip specifications.
- The gooseneck riser to the landing height is no longer required as we are allowed to modify the landing heights by removing the transition zone. 5.7.3
- The square corners to the newel posts on the previous photo and the newel extensions here are simply not easy for the hand to slide around. The grip has to be broken.

Incidentally, the old Chinese stair above could quite easily have used a continuous handrail, because the landing section's height has been made low to suit the sloping rails. This is common with old stairs.




Img 7.1.4: A Modern Continuous Handrail

What you see here is a handrail wreath. Once the high point in stair joinery these continuous flowing curves are now being made more and more by computerised machinery.

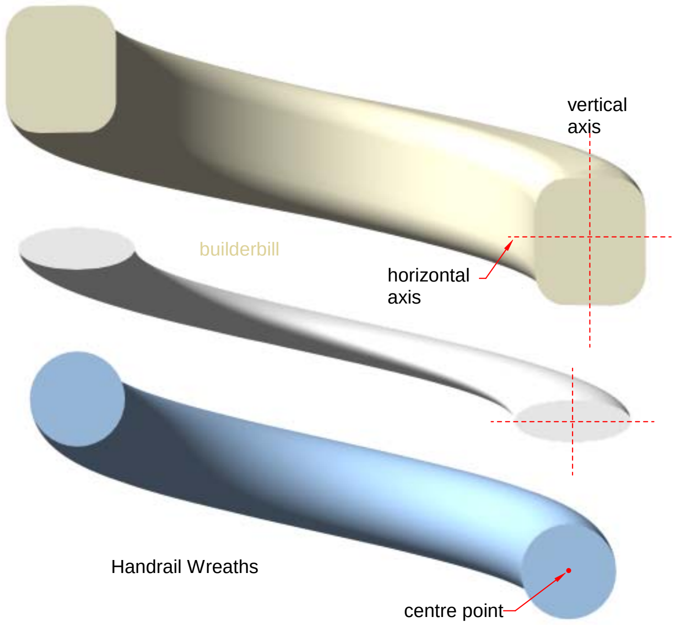
- The skill involved is no less than the old methods, but it is now in the hands of the machinery builders and software developers. And a good job they do too. Anything that can be built in the way of staircases can have modern handrails made for them.
- The old craftsmen knew how to do timber handrail wreaths like these, but what has made these modern ones viable in this day and age is the cost effectiveness of machine rather than hand work.
- The rail above would have been made on a 5 axis computer driven machine with numerous cutting heads. It would have a modern dowel and bolting system at the joints and use quite probably an epoxy resin or other hi-tech glue.


Img 7.1.5: Circular Rails

You may have picked up by now that at least where I live we use a lot of circular handrails. The reason is very simple. Ease of manufacture and the low relative cost of materials .

- Circular rails are cheaper than anything else. They are made out of many materials that are mass produced for other industries so that cost savings in scale occurs.
- For continuous railing they are particularly appropriate as the standard elbows and bends follow the complicated curves sometimes needed very easily.
- The reason for this is that a circle is a unique geometrical shape. It has one centre point or axis. Ovals and rectangular based shapes have a horizontal axis and a vertical axis.
- The joint above uses a mass produced elbow and the lower rail has had a bend applied to it with what could have been a very simple and cheap pipe bender.
- These joints are very neatly done with not a lot of effort, using an inner sleeve and gas welding with silver solder.




Img 7.1.6: Handrail Wreathes

Three handrail wreathes that are based on a rounded rectangle, an ellipse or oval and a circle.

1. The top one could possibly be a steel RHS (rectangular hollow section) and the middle one could be out of extruded aluminium.

2. You will rarely see sections like that though because it is extremely hard to do.

3. To bend shapes like these in metal needs complex machinery. Both the horizontal axis and a vertical axis have to be controlled precisely to stay true.

4. To make the circular one in metal is simple, two standard elbows joined together or non-standard purpose made 90° bends do the same.

5. To use basic stock item shapes in timber is fairly cost effective but one is restricted to what the individual manufacturer has to offer.

6. To make custom shapes in timber needs complex machinery, OR a lot of time, knowledge and skill that is in short supply these days. (I will be going into making timber handrails in a later book on timber stair construction).

# Chapter 8

# Landing-Handrail Relationships

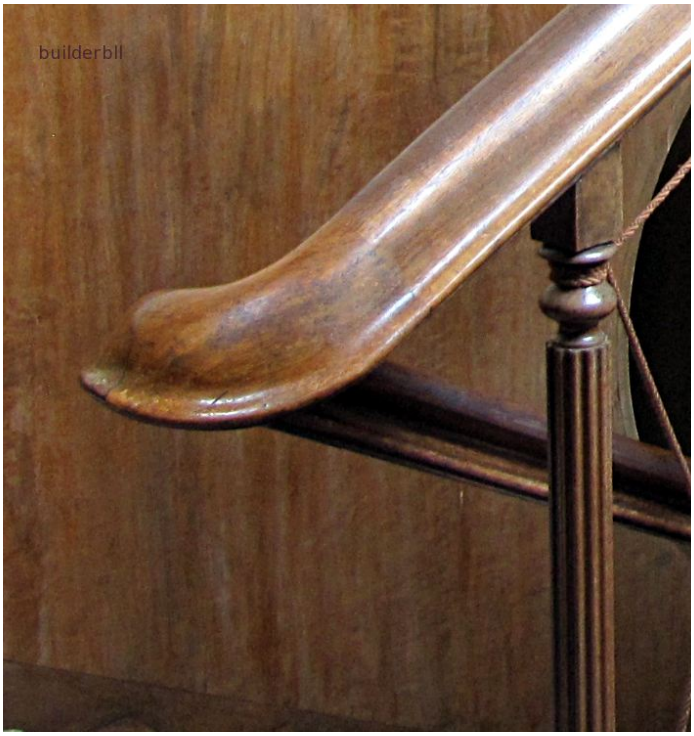
In section 7.1 I discussed the benefits of continuous hand-railing. It is easy to say, but how to achieve this.

By far the best way is to know the different relationships between various landing layouts and the handrails. Finding the sweet spots that not only make for a comfortable stair, but they make the handrail makers job so much easier.

Some basic rules.

- Try to avoid vertical rails.
- The section of the handrail that goes over the level or horizontal landing must also be horizontal.
- You cannot have a sloping rail to a level landing except -
    - If he well gap is quite small so the the radii of the rail wreathes join each other in a smooth curve. It is customary to keep these radii all the same for any one stair. In other words don't make the radius bigger just to suit one landing. Put in a straight section.
    - If it is the short section known as the transition zone. 5.7.3

## 8.1 Half Turn Landings

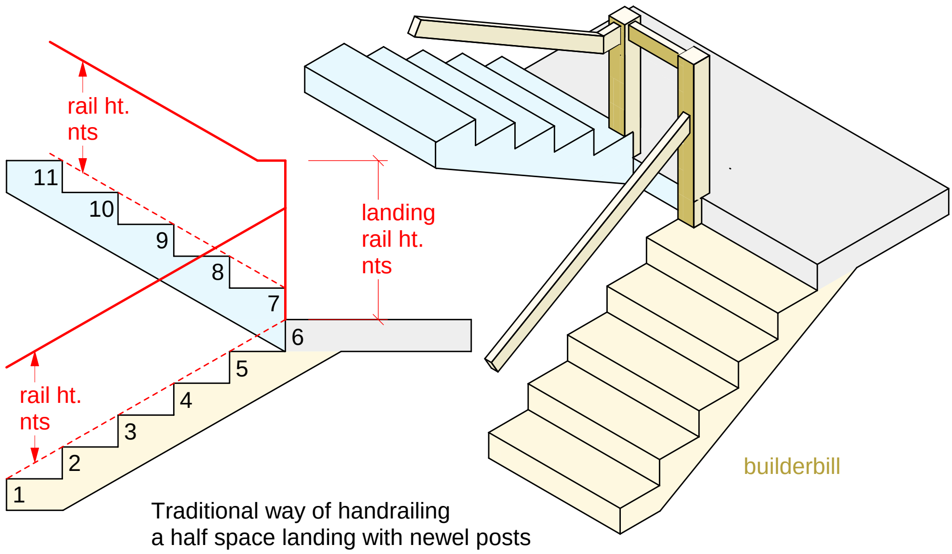



Img 8.1.1: A timber wreath

Any handrail wreath to a half turn stair like this one, is almost always made out of two pieces of timber. The centre joint is always vertical.

- This is the traditional way of making a 180° turn and it is still valid today in residential work.
- If we wanted to insert a level section in between the two wreaths then clearly the level section would then be too low. Modern regulations say that the height of handrails on landings should be a minimum of 1000, or just over 39".

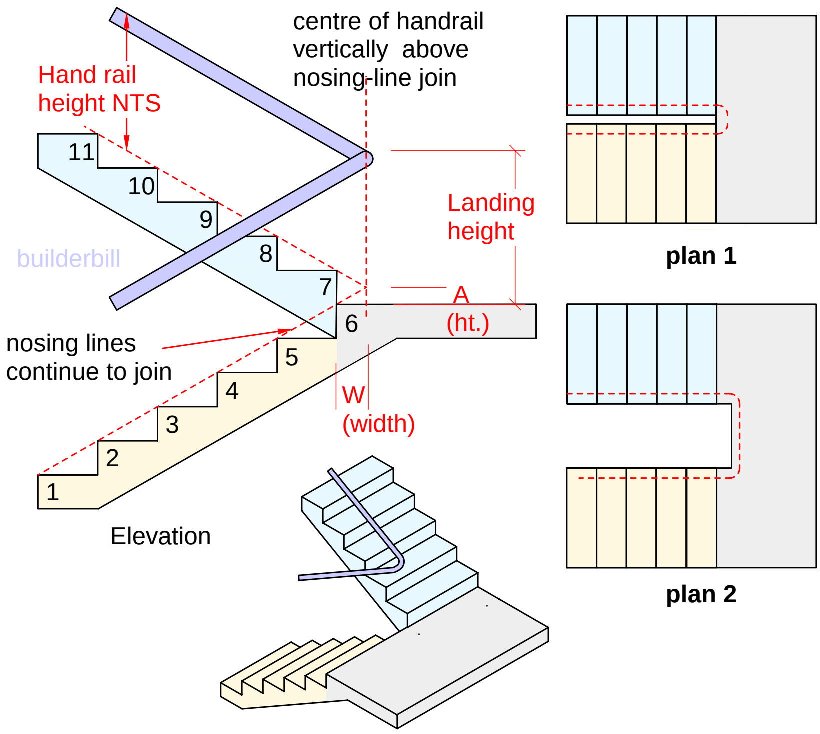
So we have to consider this difference of heights in our rails on the slope and on the levels and to find a way of making the two work together, or as I like to think of it, finding the sweet spot.




Img 8.1.2: A Traditional Half Space Landing With Newel Posts

- As before, any of the detail design work starts with the drawing of the sectional elevations of the stairs.
- This has to be done and then you have to consider what the effect of your landing layout will have on the handrails.
- The sketch above shows that when the nosing lines reach **the edge of the landing** there is a **difference of height of one Rise.**
- The rails are offset vertically parallel to the nosing lines so this step occurs at the rails also.
- As you can see a straightforward rectangular landing done like this does not lend itself to smooth transitions. It creates that vertical section which has to be addressed in some way. As seen previously the old answer was to make a gooseneck. 7.1.2
- This is still done with many residential timber stairs but it should not be used in public and semi-public stairs. There are other ways.

Note the use of numbering on the risers, always a good idea while playing around with the options.




Img 8.1.3: Dog leg landing

The landing in plan1 is similar to what the one in the wreath photo is 8.1.1 and plan2 shows a stair with a well gap that has had a section cut out of it. In effect the plan2 landing is just as though it has two half of the Go distances added to it. The elevation is the same for both plans.

1. The two nosing lines have been extended to meet each other. The two ends of them (over the landing) are at the same point in this side elevation and they will be level in an elevation drawn at right angles to it.

2. The handrails when drawn vertically above and parallel to the nosing lines will also have level ends. This is what we are aiming for.

3. The meeting point of the nosing lines encroaches into the clear space of the landing by the distance "W" which in this case is half of a Go. (I drew the R and G as 170 and 300). It also raises the height by half a Rise.

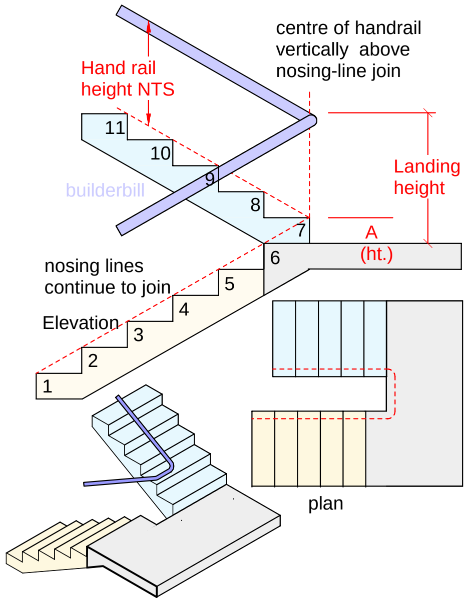
**Rule 1.** Doing it this way we **lose some of the width of the landing**, in this case 150mm.

**Rule 2.** Doing it this way **we gain some height for the landing rail,** in this case 170/2=135. 865 + 135 = 1000.


Img 8.1.4: SS Rails

Here we see a rail that is laid out more or less like the sketch on the previous page. In this case it is a wall but if it was a well hole the same geometry will apply.

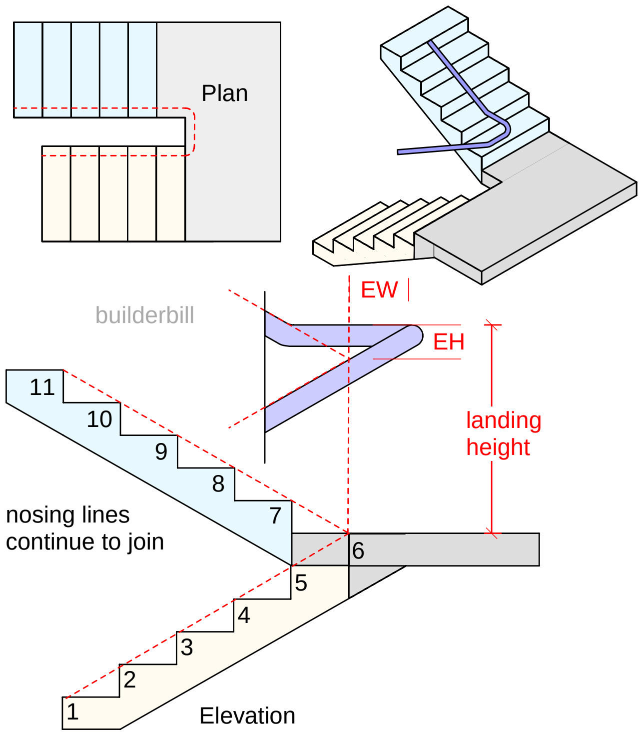



Img 8.1.5: "L" shaped landing

Another variation on a similar theme, this time instead of adding half a step to each side of the landing one full step width has been added pushing the lower flight sideways.


Img 8.1.5: An "L" shaped landing edge

On public stairs many times there is more emphasis on making the turn stand out to be more visible rather than saving space.




Img 8.1.6: "L" shaped 2

Working with a similar L shape but with the extra space added this time to displace the upper flight then we have to add an extra level section to get back to the correct height for the upper sloping rail.

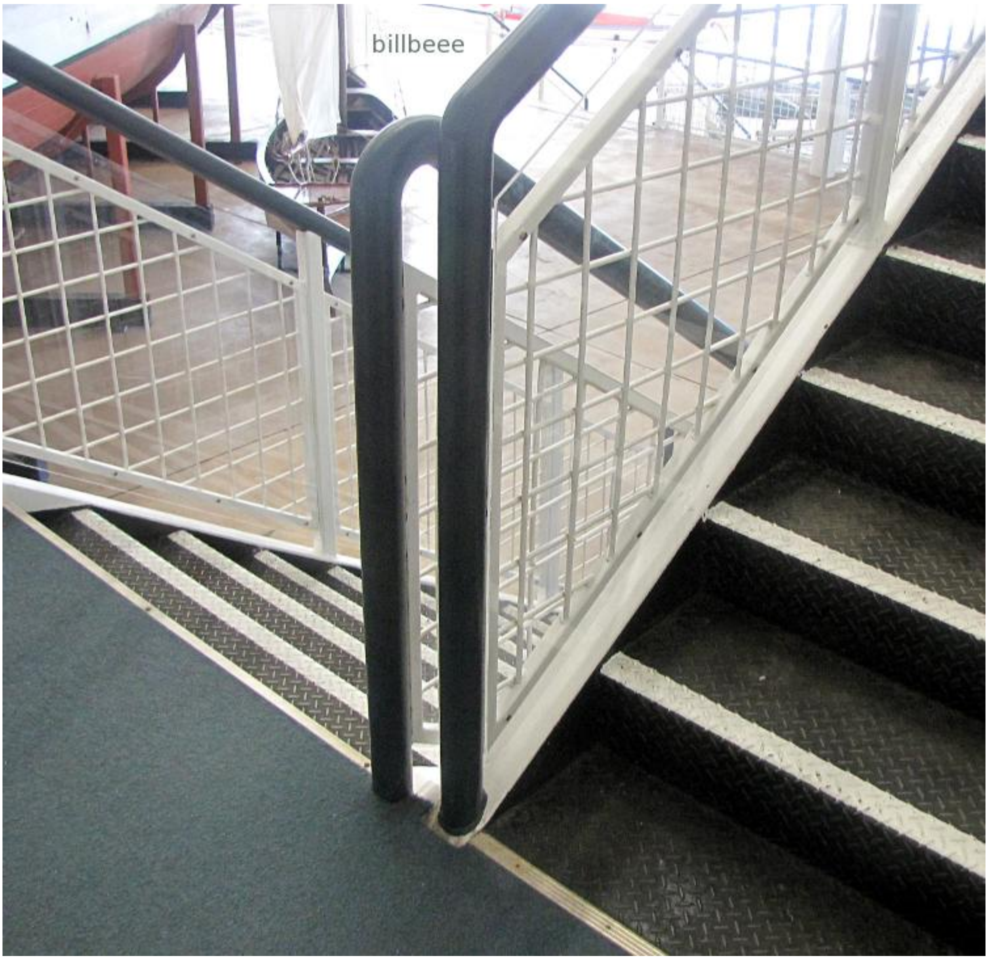
- The sketch shows an exaggerated detail of the rail join at the landing height.
- The level section is the landing height, say 1000.
- EH is the extra height needed above the junction of the two nosing lines. If we are using 865 above the nosing height then an extra height of 135 is needed.
- EW is the extra width that the rail needs, or the amount by which the clear landing width has been reduced.
- The line where the nosing lines meet, occurs in this and the previous instance when one flight is displaced by one Go width. In a previous example it occurred when two flights were moved by half a Go which made the total displacement one Go.
- Similarly you could use $\frac{3}{4}$ and $\frac{1}{4}$ Go displacements, there are no hard and fast rules.


Img 8.1.7: "L" shaped 3

This is a landing similar to the one in the last sketch. The upper flight has been displaced sideways about one tread width.

- The amount of extra space needed to do layouts like this, that give the full landing height around the well depends on the actual heights that you are aiming for.
- It is often better to raise one or the other a small amount to suit the stair pitch that you are building.

This is a really well detailed stair. The glass panels to the centre sections of the balustrades are fitted neatly and they are only apparent by the reflections that the cause.
The outer rails sit directly above the balustrade, while the inner ones are offset inwards 80mm or so.



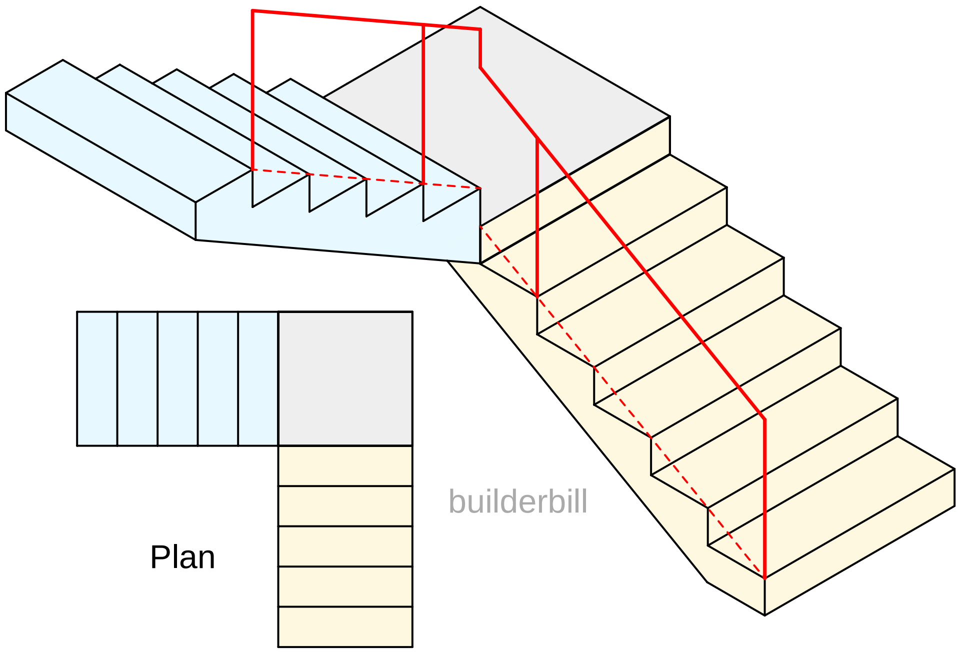

Img 8.1.8: All Steel “L” shaped

Another variation on the same theme. This time the rails do not join around the bend but because there is no well gap then the 125 max. gap rule is not broken.

- The steel treads have a chequer-plate pattern with the nosing having a white painted strip.
- Everything about this stair is utilitarian, no extra has been spent on decorative elements.
- I quite like the use of “weld-mesh” for the infill panels, but if you look closely you may be able to see that perspex sheeting has been screwed to the faces of them. Maybe some inspector knocked the mesh back because of it’s location in a public building.

Not recommended for a domestic living room but in the right place an excellent use of materials that are readily available and relatively inexpensive.

## 8.2 Quarter Turn Landings



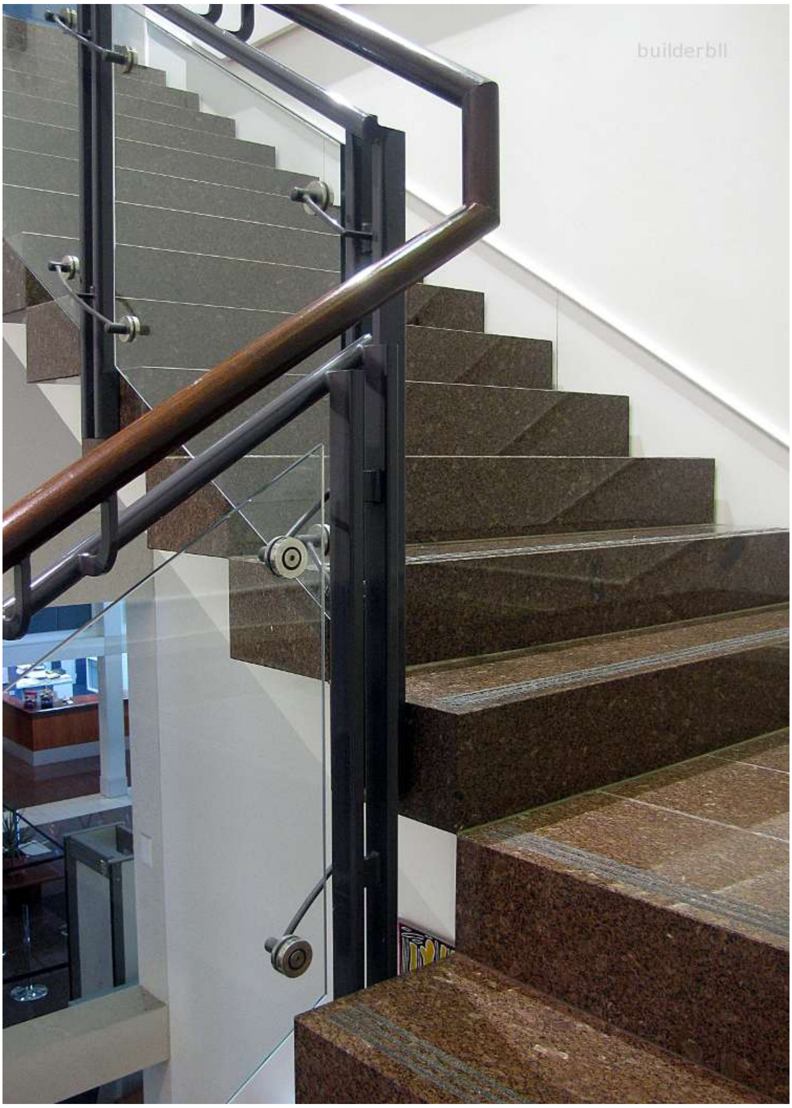

Img 8.2.1: Standard Quarter Turn Landing

Here is a standard quarter-turn and after drawing in the nosing lines as before, it is easy to see that no matter if they are extended they will never meet at the one spot.

1. With this layout One of them will always pass under the other!

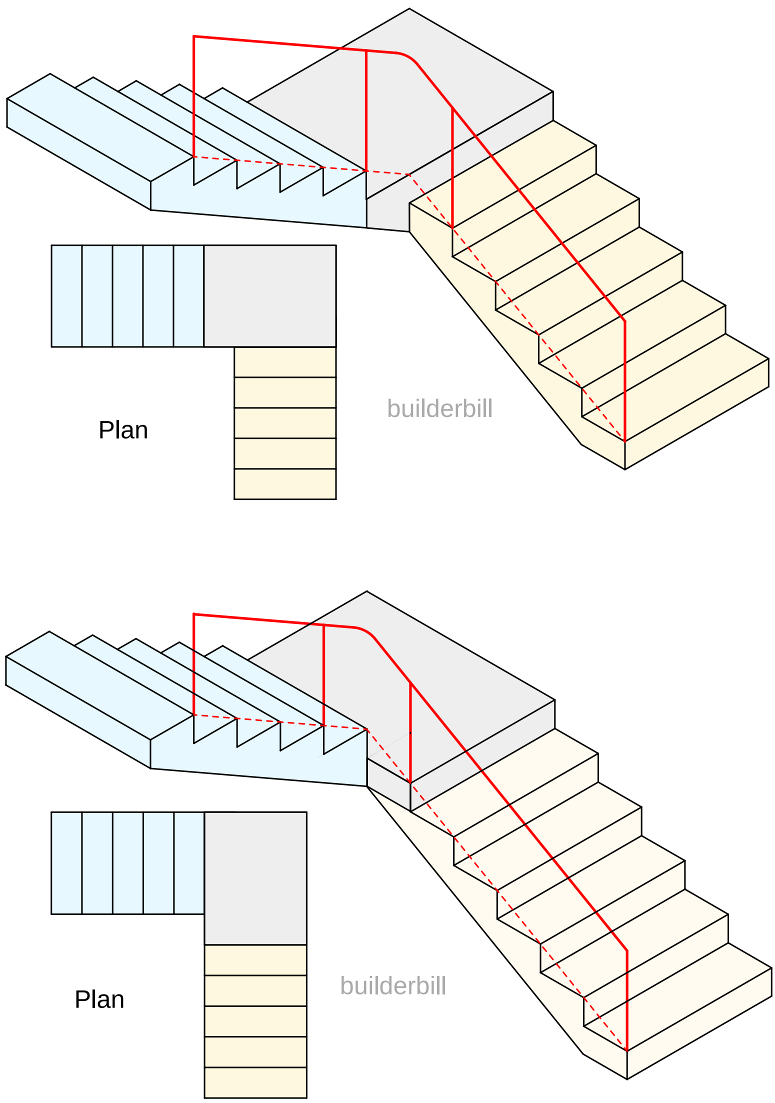
2. So with this layout there will always be a vertical section at the point where they cross in plan view.

Once again we are looking for what I call the sweet spot that will allow the use of a simple bend to merge the two rails into one continuous rail.




Img 8.2.2: Quarter Turn Landing

A practical example of what is drawn on the previous page.
This is another stair that is really well detailed with slabs of polished granite for the treads.
No it is not a cantilever stair, although it looks like one from this angle.
There is in fact a large concrete beam or carriage underneath supporting the treads.
The toughened glass balustrade infill panels are fixed differently this time and as in a previous example the handrail is offset towards the inside of the stair.

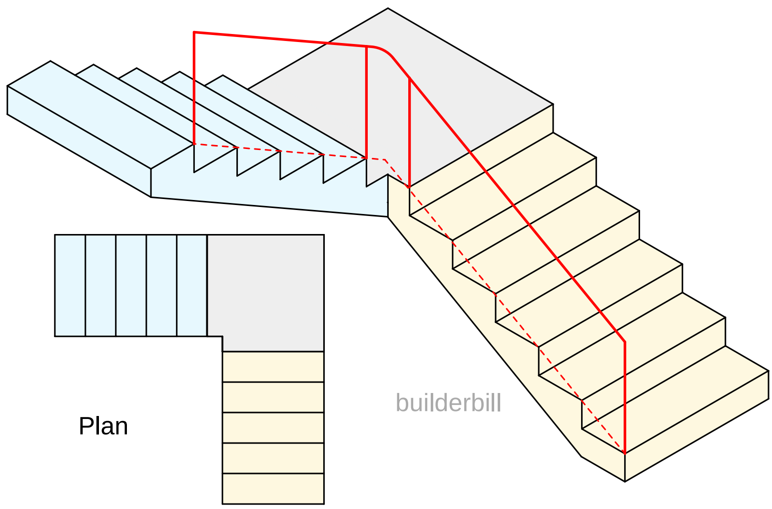



Img 8.2.3: Quarter Turn 1.

The two sketches above follow on what what we have seen previously with the half turn landings.

- They have one or the other flights displaced sideways by one Go distance.
- Nothing new at all, the same treatment when the stair turns 90° or 180° .

Once again it shows that there are different ways to achieve the same result and that it is always worth while playing about at the design stage to find just the right combination of the different parameters.




Img 8.2.4: Quarter Turn 2.

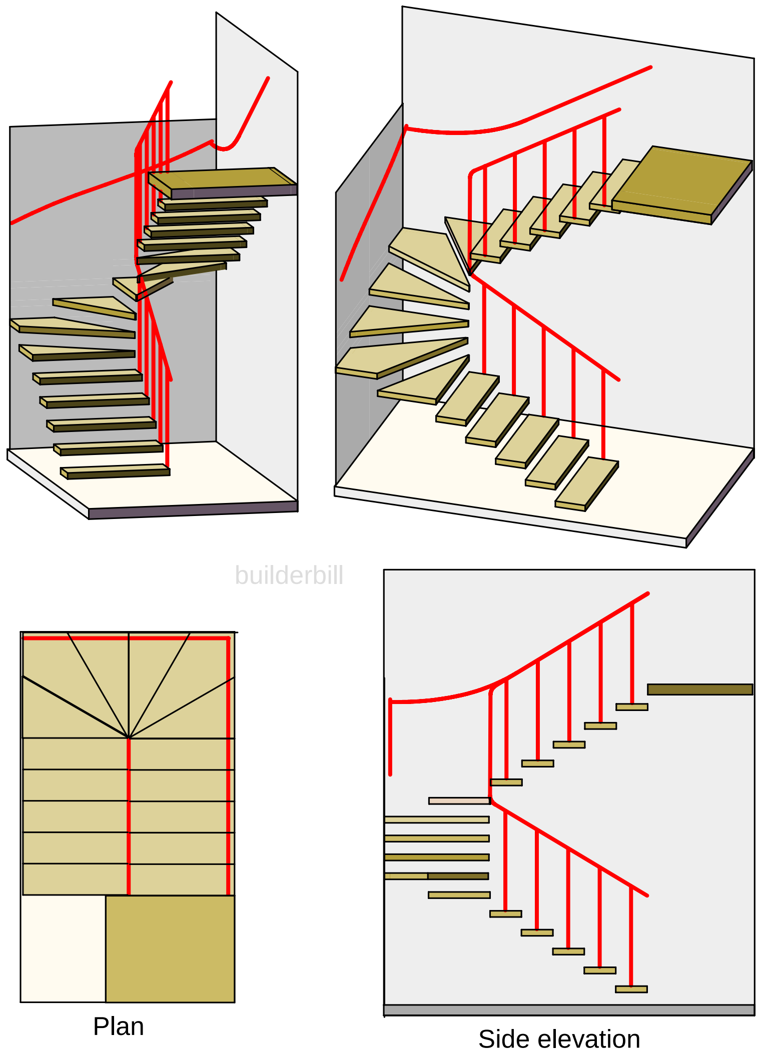
- A quarter turn landing with each flight displaced sideways by half of the Go distance to find the sweet spot.
- Depending on the construction method the internal corner of this type of landing always looks good when it is curved.
- It does not cost extra with concrete stairs but with timber stairs the extra work may be worth it as they do look great with the wreathed strings.

This is always a good option if there is the room. The combination of a landing that is half a Go wider each way and the rounded wreath to the rails makes for a comfortable and good looking stair.

Img 8.2.5: A Wreathed String

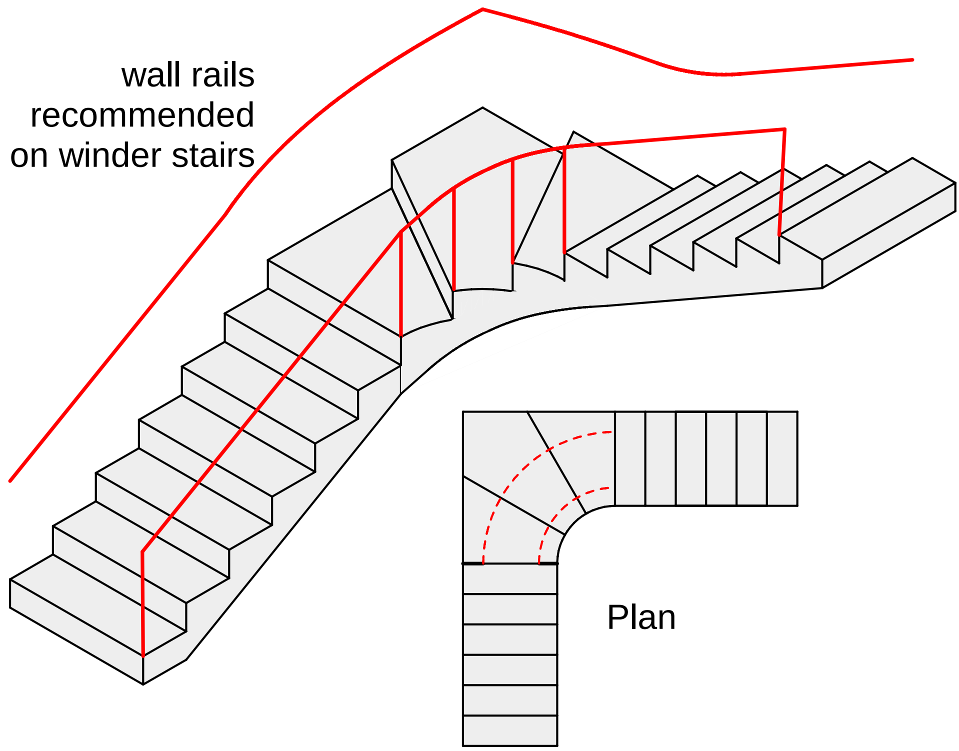
## 8.3 Handrails and winders




Img 8.3.1: Winder Half Turn

Above is a stair with a half turn of winders.

- As this stair is laid out there is no option but to use a vertical section of rail.
- Once again I have drawn it with smooth transition curves so that there should be no need in theory for someone to have to let go of the rail.
- Most people walk towards the outer edge of winders and so it is good practise to provide wall rails.




Img 8.3.2: Balanced winders

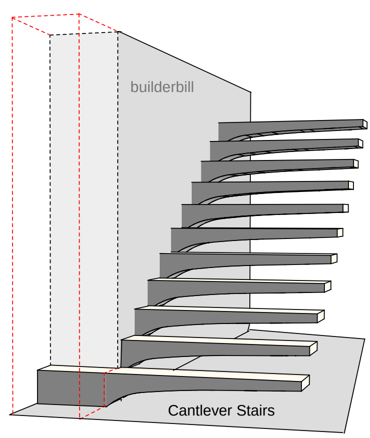
This is an excellent way to fit in a set of far more comfortable winders.

- The way that it is drawn here is just about as wide an arc as possible. Unless the point of the exercise is to make a feature out of the curve in the stairs.
- From a practical point of view the curve here that takes up as much space as two ordinary treads, so by using winders like this only one extra rise is gained in the stair.
- For this reason, more often than not a shorter radius is used.

Note that I have drawn in a couple of dotted arcs on the plan. They are used to get the slope relationship value if the stair is wider than 1000 or 39". 5.5

# Chapter 9

# Cantilever and Lightweight Stairs




Img 9.0.1: Cantilevered Steps

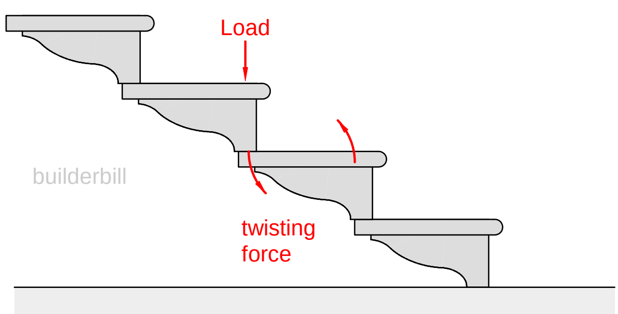
These individual steps are each cantilevered out from the wall that they are built into. To my knowledge steps like this just don't get built like this any more. There are better ways to do it.
I saw a photograph recently of a stair built exactly like this out of rough masonry slabs up the side of a rubble wall. The location was near Machu Picchu in Peru. The embedment in the wall may have been almost as long as the tread section sticking out and the the weight of the masonry above has held the steps in place for hundreds of years.
I have seen modern laminated timber treads that look similar to the sketched ones and they would have had a beam built into the wall that would accept hidden anchor bolts from the treads.


Img 9.0.2: Concrete Cantilever

Reinforced concrete stairs and landings supported by concrete beams. Flights of stairs like this are an excellent choice when the rest of the building contains a lot of other concrete work. This is part of the same building shown here 7.1.1 and looking at that photo you can see that the architect has used the versatility of concrete to provide some variety and change to the stairs and landings.


Img 9.0.3: Open Stair

Now for something completely different. A so called cantilever stair. This stair is of similar construction to the one in this photo 2.0.8. As I said before they are not true cantilevers, but the term “floating stair” would more correctly describe them.




Img 9.0.3: Stone Steps

- Stairs like the one above do not cantilever or hang. They are often only embedded in the wall 125 or 5”.
- If the embedment was the only thing supporting them then they would fall.

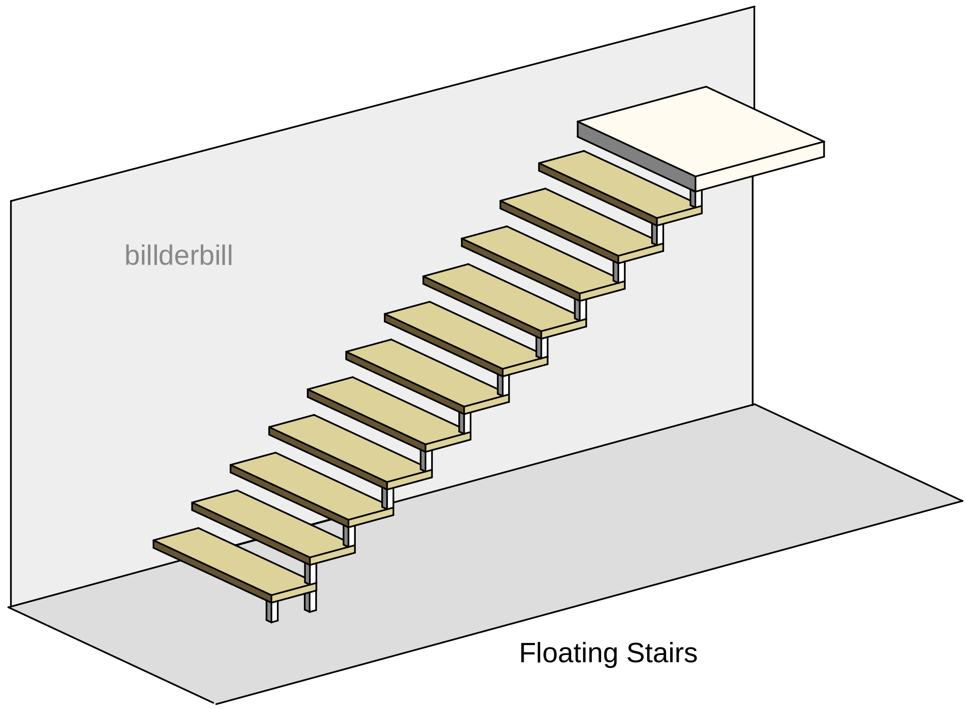
- They do not get any real support from the handrails.
- The riser section of each tread bears on the back of the tread below it and so on down to the floor.
- Stepping on a tread passes the load to the step below and so on down to the floor.
- The treads when under a spot load as shown in the sketch want to twist or rotate but they cannot do this as the embedment in the wall resists it. So the load is transmitted to the next step down and so on to the floor.

Think about it this way, imagine matchboxes under three corners of a book. It will balance OK but it will not hold any weight on it without tipping.

Now imagine something gripping the short end to stop it twisting.

It is this resistance to the twisting force rather than the depth of embedment is what holds these stairs up.

5.4.1




Img 9.0.4: Modern Floating Stair

Here is a sketch of a modern version of the old stone stair on the previous page. This type of stair and it's many offshoots are just about always internal.

- Many of the modern stair like this have solid risers but when they don't they all have some sort of connection at the ends of the treads as detailed. It often takes the form of a cylinder or RHS with a bolt though both treads.
- Tying the back outer edge of a tread to the front of the one above has been a technique to stiffen open spiral steps for ages. 5.4.1
- From reading the previous page you will understand that this is essential.
- Also essential is a really stiff fixing to the wall which will resist the twisting forces to the treads.
- Each manufacturer seems to develop their own proprietary fittings for these stairs and there are many variations on the same theme.

Modern designers are taking full advantage of a variety of new materials that make for some stunning stair designs. A quick scan of a few of the architectural design magazines will reveal a wide variety.

1. Different tread materials from classic polished timber, various metals, plastics and even glass. All of them in many finishes.

2. Many of these open stairs also get support from rods and wires hanging from the well hole framework.

3. The hangers often are part of the rail and balustrade systems.

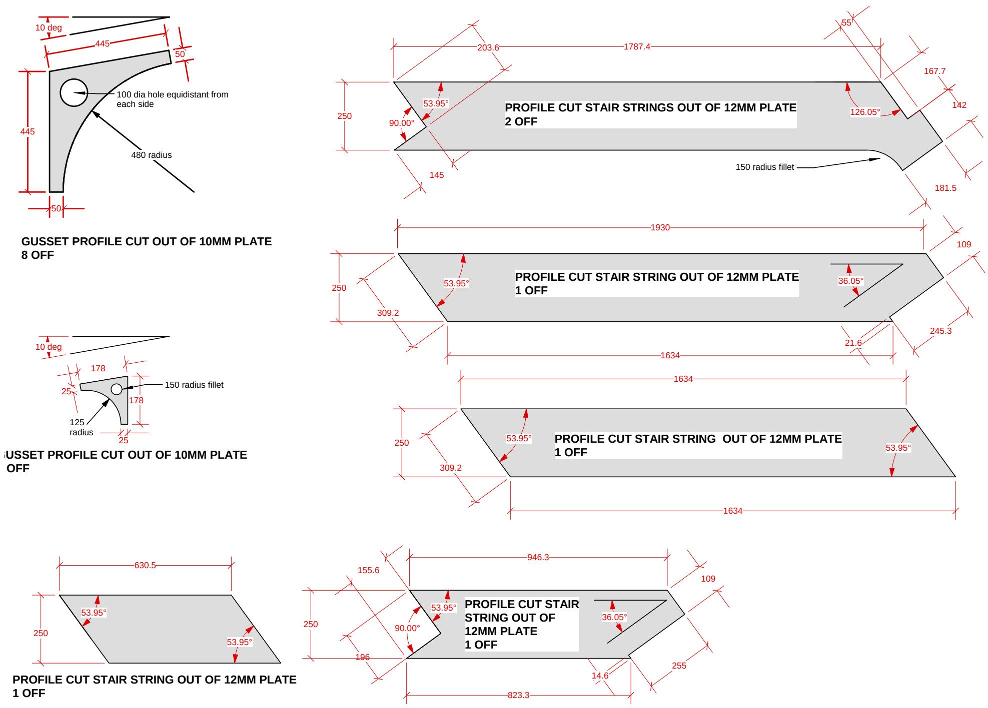
4. Custom built floor to floor glass panels that also support the steps and rails, and form the balustrades are also being seen in high end work.

All these and a lot more are being built with the idea of making the stairs appear to be floating in space and to minimise the bulky look of traditional stairs.

# Chapter 10

# CAD - CAM




Img 10.0.1:    Detail Cutting List

A drawing given to a steel supplier to cut to size some plate stringers for a steel stair. The cut shapes were delivered to the fabrication shop where tread cleats were added. Later we fixed the stair by on-site welding and bolted on timber treads.

I gave the supplier the drawing in the format he requested (all decent CAD programs export to many formats) and they loaded the information into their plate cutting machine.

## 10.1 CAD Design and Drafting

**CAD** stands for Computer Aided Design, but it could just as easily be Computer Aided Drafting. It is essential for anyone who needs to produce fast and accurate drawings.

**CAM** Computer Aided Manufacture.

The drawing on the previous page is an example of both. It was done on a home computer and given to a steel supplier who plugged the details into a computer program that directed the cutting head on a steel plate cutting machine.

- Why did I go to that trouble? Well in actual fact it was little trouble at all as most of the work was already done. I had designed the building and the stairs in my CAD program and the drawings had to be an acceptable standard to submit to the authorities for building approval.
- So right away we get to a real benefit of CAD. **Draw it once and use it or modify it many times**.
  - The main original house drawing went to the structural engineer then after modifying to his details, to the building approval authority and when it was approved it was used on site to build the house .
  - I often printed off odd pages with just the particular details that I needed at any one time with things like extra heights and diagonal distances to assist in fabricating items like the steel stair.
- The benefits in adapting my working drawing to use as I did in the sketch above are also many.
  - I received and paid for exactly the the right amount of material for this one off job. No offcuts of plate left lying about.
  - The accuracy of the cutting was excellent, no further work cleaning up the edges on the pates was needed saving us time and money.

- So the second real benefit of CAD, **accuracy** also helped me in this small project.
  - It was done faster and cheaper than we could do it manually and it left us free to do other things.

Without a doubt learning how to use a fully featured CAD program is a challenge and for small one off jobs I do not recommend it. However if you are starting out a career in the construction industry in general, or stair design or stair building in particular, then I urge you to get your hands on a decent program and learn how to use it.

I am not going to go into details of the various CAD systems available because in truth I only know the one that I use. (VectorWorks). I have been using it since the mid 1980's and I still do not use most of it's capabilities. I doubt that anyone does use everything as it has so many specialised sub-sets.

These programs are far to detailed to go into here. All I will say is have a play about with a few of the free ones first and get a feel for them.

To design and build stairs you do not need to have 3D capacity, it is sufficient to just have 2D but consider this -

- My philosophy has always been to get a good full featured program that I can sort of grow into, rather than starting off with something basic that I may grow out of.
- That way I continue the learning process instead of having to stop and then start again.
- Cost in my early days was a large factor, and the only good programs were commercial and expensive. I do think things are changing in this respect though. ( Ain't that an understatement!)
- The only reason that I use VectorWorks still is that I have invested a lot of time in learning it and I just don't want to start again.
- The web itself runs on free software, I am writing this book on free software (Lyx), my photo editor is free (gimp), and my operating system is also free (Linux). So it may be worth while looking at some of the GNU (free) programs before you dive into expensive stuff.

- More important than just cost, consider the ease of use, the clarity of the documentation, the feature set and the availability of free help such as large and active news groups and forums.
- Of course if you are going to use a CAD program while working for others or exchanging files with others then you may have to go for one of the industry standards.

Right at present you may not want to do much apart from a few 2D sketches to check various layouts. But who knows how your opinions may change once you get more knowledge of the program.

For instance, let's say that I could wave a magic wand and make myself 20 years younger (I wish :-). Just suppose I wanted to set up a small business designing or building stairs.

- Without a doubt I would go to my CAD program to make drawing stairs easier, I don't want to draw them out by hand every time, even with the many time saving features of my CAD program.
- The beauty of computers in general is the way that they can handle routine and boring tasks. So I need speed up the basic drawing process.
- Many CAD programs have their own scripting or macro languages. This means that I could write a script in maybe half a day or so that will draw a complete set of stairs in plan and the various elevations, once I had input various parameters to an options dialog box. The parameters could be -
  - Total rise, available horizontal space, preferred tread size, preferred slope angle at the steep end of the scale or at the low end. I can use sliders and radio buttons and all the trimmings that exist in the main application.
  - I would obviously in my script include the exact figures to make the drawing fully compatible with my own particular regulations and if those regulations change it is an easy job to change these details (variables).
- Now ain't that marvellous, using an easy to use and understand scripting language I can draw a stair at the push of a button.

- But there's more! I could now customise the script for my particular type of stair. If I was building the stairs I could input my commonly used sections. Be they timber or steel. I could have half a dozen adaptations of the same script for different types of stairs or construction materials or just one large script with the options built in.

- Now here is where it gets interesting, the CAD program has a database function that allows me to name the objects that I draw, so when the drawing is complete it is easy to tell it to spew out a list of materials.

- It could be a very specific list such as a cutting list with diagrams for a worker to print out and use as an aid to build the stairs. It could be made machine readable by certain computer driven machinery.

- The data base can contain a list of costs so that cost estimates can be done almost instantly.

So with a fully featured CAD program the sky is the limit. A designer can have multiple layout versions of stair produced very quickly for clients to have a look at or a builder can take his laptop with him to a job and give an accurate estimate there and then.

The end user does not have to do his own scripting because there are guys out there that just love messing about with code (instead of getting full of sawdust or weld spatter). All you need is to be able to use the system to draw out the details of what you need that you can give to a programmer ask him to do the scripting.

In my opinion there is absolutely no need to buy expensive turnkey software systems to do what we are talking about here. At least not for small start ups.

## 10.2 CAM - CNC Manufacture.

**CAM** Computer Aided Manufacture.

**CNC** Computer Numerical Controlled

Apart from making the basic drawing and then getting someone else do the machine work as I mentioned in the previous section I have no special knowledge of this subject. There is a fair bit out there on the net, and you can have a look at these two links to get an idea of what is possible in the field of carving timber handrail wreathes on CNC router type machines.

google video

utube video

At the same time the manufacturers of steel bending an forming machines are not lagging behind and innovations in the technology are fairly frequent.

A couple of posts that I have seen on newsgroups seem to indicate that this type of technology is hugely expensive. I tend to disagree with that type of blanket statement.

Things like this depend on the volume of work that can be done by these machines. If the work is there then so is the cash and in many cases buying machinery is not a case of “can I afford to buy it ?”, but more a case of “can I afford not to buy it?” and give the work to the competition.

Remember the old saying, a tool or a machine does not cost money, it makes money. I have had some pretty expensive machines in my time but every one of them made many times more money than they cost.

Another aspect is the tendency for technology when it is new to be extremely expensive but for it to get less costly as it matures and other manufacturers enter the market.

With a bit of luck the small manufacturing shops will soon be able to take advantage of the huge amateur and semi-professional interest in CNC machining and programming. There is a lot of information out there.

# Chapter 11

# Safety, Amenity and Utility

A good approach to safety is essential. The old saying, ***"if a job's worth doing, then do it well"*** is never truer than here. Don't cut corners with safety!

The aim of any good stair design should be to provide a way to move on foot between the levels in a building in a safe manner. It is the most important part of the process. Closely associated with safety are the concepts of comfort and amenability.

For the most part if the regulations are followed, and you take heed of my remarks about not being too mean with the widths and head heights and you choose a not too extreme pitch then the stairs will be well on the way to being safe and comfortable. Here are a few reminders and comments and then some details that I have not touched on yet.

- Install stairs only where they are necessary. As far as safety goes, ramps are a far safer option .
- Avoid less than three steps if at all possible. The usual definition of a stair is more than two rises.
  - These short stairs and particularly single steps are known to cause the greatest number of accidents. People seem to be careless with these one or two steps.
  - If you have to use one or two steps try your best to make them visible. Good lighting, contrast edging to the nosings and even short handrails to indicate the position of a step.

  - Do not place a single step in the middle of what would otherwise be a half turn landing.

An old mate of mine when renovating his house created a single step down inside his laundry area. It was only about 120 high in the middle of a ceramic tiled room.
It was legal, being about a metre from the doorway.
As is normal with small discrepancies, the residents of the house had no problems with it. Almost always in cases like this it is strangers to the house that come to grief.
Just about every first-time visitor had some sort of stumble on it.
He did his own tiling to that floor and it would have cost him a trivial amount extra to use a contrasting nosing tile to that step.

---

One day when I was strolling through London's V&A Museum looking at the roof/ceiling details above me (as I do).
I took a dive to the floor.
I had completely missed seeing the two steps that I had plunged down.
The hall was fairly dimly lit, I think to preserve the exhibits and I guess to give an ambiance, but at that time from my angle of approach the steps were almost invisible.
There were no visual or tactile indicators to show the two steps.

- Stairs must have **good lighting** and have light switches top and bottom.

  - Give consideration to the position of the light fittings with regard to changing the light bulbs. Many existing ones require precarious positioning of ladders to get to them, as a result stairs can be left unlit for long periods before bulb replacement.

- Try to make the stairs and landings wider than the minimum that the rules state. Think in terms of being able to take furniture comfortably up the stairs.

- Avoid winding, curved and spiral stairs if at all possible. Otherwise follow the recommendations.

- Avoid open riser stairs. Otherwise follow the recommendations for the minimum gaps between stair parts and balustrades.

- For public, semi-public and domestic stairs that vision impaired people may be using, tactile ground surface indicators should be provided to warn people that they are approaching a stairway. The treads should have clearly defined nosings or at the least the top and bottom treads should have them.

- Flights wider than 2000 or 72". should have central handrails separating them into sections no wider than 2000.

- Child safety gates to the top of a flight of stairs may not be mandatory but if you intend to include a gate then do it to the same standard that is required for swimming pool gates with self closing and child proof lock/open and make it the same height as the landing balustrades.

  – All to often these are seen and made just as a very temporary device and so they are not very good at what they do. I've seen them tied with string, and being so fiddly to open and close they inevitably get left open.

- Doors should not open directly onto stairs. Landings should be provided.

## 11.1 Other Stair Safety Points

There are many possibilities for compromising safety. It has to be considered early on in the overall design process. Below are a few lapses of good practice that I have actually seen.

- **Fire Safety.** The strict rules that apply to fire safety, number of exits and distance of travel etc. usually only come into effect in public and semi-public buildings. However good placement of stairs or even extra stairs with regard to fire safety are common sense for private residences also.

- A particular design of house where I live had both sets of stairs close to one end. When a kitchen fire started in one of these houses the bedrooms were cut off. The result was a needless death. Thee hundred or so houses had to be retro-fitted with fire escape ladders from the main bedroom.

- **Head Height.**
    - An external stair and hopper windows, to a small block of apartments that I worked on were placed in such a way that when windows were opened in the room above a few workmen were injured hitting their foreheads into the windows. (The developer who was a barber by trade fixed this minor error by screwing the windows shut. **:-)**
    - When planning awnings over windows make sure that they will not interfere with the stair headroom.
    - I have had to cut back a wide and shady section of overhanging eaves to a high set deck roof. The architect did not consider the stair head room at the design stage. It left a really ugly look to what was otherwise a great tropical design.

- **Too narrow well hole.** From time to time I have come across stairs that use half turn landings that have their outer strings and handrails too close together. In some cases it was possible when going up the stair to catch or trap one's hand between the handrail and the bottom of the next flight's string.
    - There should be a minimum 40mm or $1\frac{1}{2}$" clearance between the two to stop this happening.


Img 11.1.1: A badly positioned half turn landing

The term head height when referring to stairs refers to distance above the stairs that a person walking up the stairs needs. The photos here however show another side of the story. These shots were taken in an open courtyard of a small local theatre company. Often used for socialising.

- The not so creative architect/designer has made the steel framed landing at less than head height and not provided any barrier to stop people walking into it. This obviously happened a few times. (Presumably quite often during an evening's *"socialising"*.)
- Not to worry though, the creative users have padded the steelwork with rubber pipe lagging. **:-)**

The use or a metal rail would stop this happening but a few pot plants or planter boxes would solve the problem in a more sympathetic manner.

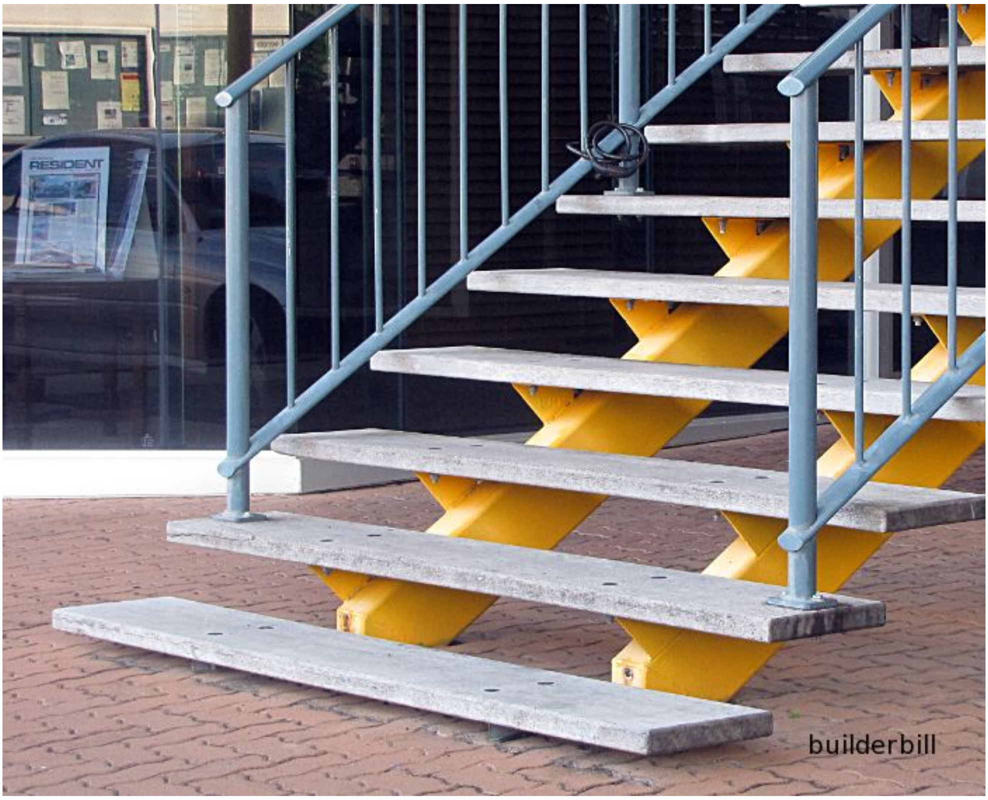

Img 11.1.2: Fire Escape Stair

This exterior stair to a small budget hotel is most likely designated as a fire escape stair. So the designer presumably did not have to comply with the rule against horizontal members in balustrades 4M. or more above the ground and quite possibly he also did not have to comply with the reg that states that treads should be solid (not mesh) to over 10M. high.

However it is fairly obvious that this is a stair that is used from time to time and not for fire evacuations. (It overhangs a main street that has at least a dozen night clubs in the near vicinity so my guess is that these landings are used for “socialising”).

Maybe the designer should have considered the possibility that fire escape doors being what they are (able to be opened from the inside), can and would opened and the various landings would be used as verandahs or smoking areas. If he had considered that he may then have complied with the vertical only handrail rule over 4000.

That way he would not be reminded every time that he walks past the joint of his inadequate balustrade design. 12mm mild steel bars supported at about 2000.




Img 11.1.3: Uneven Steps

This is a blatant case of a complete disregard of any regulations, rules or good practise. I saw this stair when it was new, just like this, so it can not be said that the paving was added at a later time to different levels than the original; which is the normal excuse for this sort of thing.
This almost certainly came about because the proprietary hand-railing system is manufactured at a fixed angle. Somebody went for the cheap fix.
All rises in a stair must be equal.
There is nothing wrong with using fixed rise stairs, just make sure in cases like this to make a landing at the bottom.

- The owner of this stair to avoid any possible injury claims should take off the bottom tread and build a small concrete or paved landing 750 minimum length so that the odd step height is seen to be different from the stair.

- As this is in a public place it should have safety edging and the handrails should extend to it.

We accept the fact that floor levels may change with new building work or that when wider stairs meet a sloping pavement then the riser height will vary along the length. So we **must make it obvious that the bottom step is different from the rest.**

You might be excused for thinking that I am an accident prone old fart, after reading a couple of my anecdotes here, but hey, I've survived 50 years of on-site construction work with nothing serious happening to me or any of my guys.. I am really proud of my safety record and I think that a safety mind-set is a good thing to cultivate.

- Many times in my working life when I have been faced with tricky decisions I have run through a short mental exercise.
- What is the **best** that could happen if make a particular decision?
  - This is nearly always tied in with saving money.
- What is the **worst** that could happen if make a particular decision?
  - This ranges from losing money by having to repeat work if the work is faulted by an inspector to possible accidents that do not bear thinking about.

When thinking about it like this and weighing the pros and cons the answer is always obvious. My advice is to never compromise on safety and sleep well at night!

## 11.2 Amenity

This is a term that we use when we are thinking of how pleasant or agreeable an aspect of a building may be. The word amenity is making it's way into various building codes over the last few years and rightly so. We are no longer allowed to build the airless and dark "dog boxes" that we used to do.

On the following page I advocate making a stairwell generally larger. But I do realise that doing this may have a significant effect on heating or cooling costs.

So, as with most design work there may have to be compromises made. The trick is to at least know the options and then be in a position make an informed decision.


Img 11.2.1: Stairwell windows

This apartment sits right on the sea front overlooking a tropical beach.

- I had to fight long and hard to get the owners to allow me to use part of the main living area and main bedroom above it to allow the use of windows in the stair wells pointing towards the front.
  - The other options were to have windows looking sideways at adjacent properties or no windows at all.
- They lost some floor space but they gained tremendously in amenity for the middle and rear sections of the apartments.
- Everyone using the stairs when we were building the apartments admired the million dollar view. It had a magnetic influence.
- It also opened up and gave light to the areas at the rear.
- When the hopper windows are open, seasonal onshore sea breezes ventilate the rear facing areas at a hot time of year.

**Never underestimate the convenience of windows in stairwells.**

As mentioned before all stairs should be well lit with light switches top and bottom. With regard particularly to private homes one of my hates are stair wells that have no source of natural light and ventilation. I have gone to a great deal of trouble many times to alter the design of stairwells to allow for windows. I appreciate that this may not be as critical in multi-storey work where minor stair wells are designed purely as fire escapes, but every effort should be made to give main stairways good windows.

Ventilation, cross ventilation and air flow may be more applicable to the normal rooms of a home, but window openings in areas set aside for stairs work wonders for the amenity and ambiance of a stairway.

Again I realise that your mileage may vary, particularly if you live in a cold climate.

There are mandatory aspects to the size of stairways, but for the most part they do allow for stairs to be built fairly narrow. In some cases they could or should be made wider. I've already mentioned getting furniture up the stairs but in addition to this; extra space which does not cost much in the scale of things, can make a huge difference in the feeling of spaciousness and amenity to one of the least considered but very important areas of a building.


Img 11.2.2: Stairwell Amenity

I love the country and I love the people, but Vietnam must have the worst stairs on the planet.

- This little beauty was photographed in a place that I stayed in Saigon. My modest room was on the top floor, the sixth. No lift/elevator in the building. The stair had one dim light on each of the floors.
- The individual flights between floors were arbitrarily laid out, some with landing and some with extra steps. Not too many of the flights could be said to be perfect.
- All in all a miserable and a hard stair to negotiate.
- It had one saving grace, the designer added the generous 2'6" wide stair well hole which in itself did not add much to the amenity of the stair.
- But the enterprising owner had a small electric winch installed, centred above the well that was used to hoist up the guest's back-packs.

So in a stair devoid of any amenity to speak of, it had one thing going for it. At least in the opinion of this geriatric backpacker :-)

**Shelter from the weather** could well be a consideration for external stairs. Where I live we normally use 900mm or 3ft overhanging eaves which if extended a short amount more could well give a lot more shelter from sun and rain.

External stairs in general are quite popular in warm and temperate climates because they are fairly cheap to build and save on valuable interior space.

- Where I live in the tropics we are mainly concerned with shade from the sun and rain. The advantages are fairly obvious if the stair is a main entry stair and no covered one is available.
- I have no experience with boxing in external stairs with a sloping roof and side walls. I have seen a few examples of this and to my eyes they look terrible, but again your mileage may vary and if your are thinking in terms of protecting an external stair from cold rain and snow, then I'd have to say go for it.


Img 11.2.3: A shaded stair tower

An old set of apartments, flats or units as we call them. Built about 30 years ago they would come under my category of “dog boxes”.

- A few years ago developers were allowed to split the titles (strata title) and sell units like these to individual owners. They had to make them comply to modern standards like higher handrail heights etc.
- Before the roof was put there, can you imagine the heat build-up from all that steel and concrete? It would gently waft into those living rooms.
- Imagine someone struggling up those steps with shopping bags or children and the steel handrails that had been in direct sun for hours were far too hot to touch!

I do like the way that the renovated stairs have been roofed though. A fair way of solving the problem.

**Travel Distance.** I once had a government contract to build quite a few high set verandah/decks to the rear of a particular style of high level house. The plan called for a rectangular roofed deck area and we had to re-use the existing steel framed stairs which were a straight flight of about 16 steps.

- I asked the architect before we started why he had not used a more direct layout for the stairs. He replied that it was easier and a lot cheaper to re-use the existing one.
- I suggested that it would not cost all that much extra. The stairs were out of steel we could easily cut them making two flights out of the one and the extra cost was modest for a half turn landing.
- The end result was that for a small amount of extra cost, some thirty families **over the last twenty odd years** have been saved the trouble of walking an extra distance of 8M. (25 ft) every time they carried shopping from the car to the kitchen or carried washing to and fro from the downstairs laundry.
- As an added feature, at the expense of losing about 3 sq.M. from the deck floor they have had the convenience of using those stairs shielded from the weather by the deck roof.

I know that in many cases there is only a certain amount of space available, particularly in renovation work, but at the same time, don't be too keen to go for the obvious answer. Give time to exploring different layouts. Mistakes in the design stage last a long time. Also, as shown above, using cost alone as a basis of design decisions can also be short sighted.

**Multi-storey.** Stairs between different storeys often have varying overall floor heights. If possible I personally try to keep the Go values the same throughout the job and try to get the Rises as close as possible to each other.

# Chapter 12

# Appendix

## Metric to Imperial Conversion Table

| Inch-Fractions | | | | decimal inches | mm | Inch-Fractions | | | | decimal inches | mm |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1/64 | 0.02 | 0.4 | | | | 33/64 | 0.52 | 13.1 |
| | | 1/32 | | 0.03 | 0.79 | | | 17/32 | | 0.53 | 13.49 |
| | | | 3/64 | 0.05 | 1.19 | | | | 35/64 | 0.55 | 13.89 |
| | 1/16 | | | 0.06 | 1.59 | | 9/16 | | | 0.56 | 14.29 |
| | | | 5/64 | 0.08 | 1.98 | | | | 37/64 | 0.58 | 14.68 |
| | | 3/32 | | 0.09 | 2.38 | | | 19/32 | | 0.59 | 15.08 |
| | | | 7/64 | 0.11 | 2.78 | | | | 39/64 | 0.61 | 15.48 |
| **1/8** | | | | **0.13** | **3.18** | 5/8 | | | | **0.63** | **15.88** |
| | | | 9/64 | 0.14 | 3.57 | | | | 41/64 | 0.64 | 16.27 |
| | | 5/32 | | 0.16 | 3.97 | | | 21/32 | | 0.66 | 16.67 |
| | | | 11/64 | 0.17 | 4.37 | | 11/16 | | 43/64 | 0.67 | 17.07 |
| | 3/16 | | | 0.19 | 4.76 | | | | | 0.69 | 17.46 |
| | | | 13/64 | 0.2 | 5.16 | | | | 45/64 | 0.7 | 17.86 |
| | | 7/32 | | 0.22 | 5.56 | | | 23/32 | | 0.72 | 18.26 |
| | | | 15/64 | 0.23 | 5.95 | | | | 47/64 | 0.73 | 18.65 |
| ½ | | | | **0.25** | **6.35** | ¾ | | | | **0.75** | **19.05** |
| | | | 17/64 | 0.27 | 6.75 | | | | 49/64 | 0.77 | 19.45 |
| | | 9/32 | | 0.28 | 7.14 | | | 25/32 | | 0.78 | 19.84 |
| | | | 19/64 | 0.3 | 7.54 | | | | 51/64 | 0.8 | 20.24 |
| | 5/16 | | | 0.31 | 7.94 | | 13/16 | | | 0.81 | 20.64 |
| | | | 21/64 | 0.33 | 8.33 | | | | 53/64 | 0.83 | 21.03 |
| | | 11/32 | | 0.34 | 8.73 | | | 27/32 | | 0.84 | 21.43 |
| | | | 23/64 | 0.36 | 9.13 | | | | 55/64 | 0.86 | 21.83 |
| 3/8 | | | | **0.38** | **9.53** | 7/8 | | | | **0.88** | **22.23** |
| | | | 25/64 | 0.39 | 9.92 | | | | 57/64 | 0.89 | 22.62 |
| | | 13/32 | | 0.41 | 10.32 | | | 29/32 | | 0.91 | 23.02 |
| | | | 27/64 | 0.42 | 10.72 | | | | 59/64 | 0.92 | 23.42 |
| | 7/16 | | | 0.44 | 11.11 | | 15/16 | | | 0.94 | 23.81 |
| | | | 29/64 | 0.45 | 11.51 | | | | 61/64 | 0.95 | 24.21 |
| | | 15/32 | | 0.47 | 11.91 | | | 31/32 | | 0.97 | 24.61 |
| | | | 31/64 | 0.48 | 12.3 | | | | 63/64 | 0.98 | 25 |
| ½ | | | | **0.5** | **12.7** | | | | | **1** | **25.4** |

Table 12.1: Fractional Inches to Millimetres

## Photo Details

All the photographs in this book were taken by and are the copyright the author except as noted below.

All the drawing sketches and tables in this book have been made by and are the copyright the author.

If would would like to use any of them please contact me and more than likely I will give you full resolution images without the logo.

Fig.2.0.9: 2.0.8 A Cantilever Stone Stair Circa 1670. Thanks to Wikipedia and User:Mcginnly.

Fig. 2.0.11: 2.0.10 Creative use of found materials. This is an image that I had sent to me by a reader, but I have seen it in other places as well. It would seem that it is now well and truly in the public domain.

Fig 5.6.3: 5.6.3 Long Stairs Thanks to the website Morguefile and user: Hotblack.

Fig. 8.3.3: 8.2.5 A Wreathed String Thanks to Morguefile and user Mensatic.