

Timber & Boardwalk Maintenance and Construction

Scope

This guide is intended to give path managers and developers an insight into the minimum standards which should be applied to boardwalk and small timber bridge design. Readers are strongly advised to obtain professional advice regarding any walks and bridges they intend to construct as ground conditions and the average number of users are likely to affect the structure and foundation design.

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Users

The designs shown below are based on use by pedestrians, mobility vehicles and cycles. Golf carts and slow moving vehicles weighing up to 1.5 tonnes can also be accommodated.

Livestock

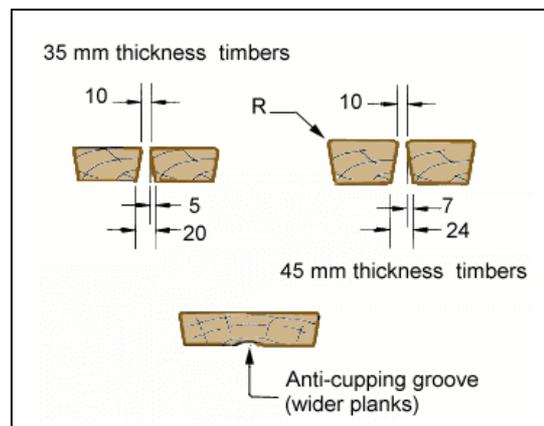
Widely spaced boards resemble stock grids and are not compatible with livestock. Livestock (horses included) loading can be considerable and would unduly govern decking design and should be excluded from these structures. Prohibition notices should be posted for the benefit of horse riders in areas where rider intrusion is a possibility.

Timber

Douglas fir and Slash pine would be overloaded 100%, hem-fir, meranti, and hoop pine would be even worse; most likely suffering visible damage if loading goes to 1.8 kN per 350 mm², which is a likely loading for wheelchair castor. These woods are not recommended for use as decking.

For wheeled transport decking needs to be at least 120 mm wide to reduce rumble during movement.

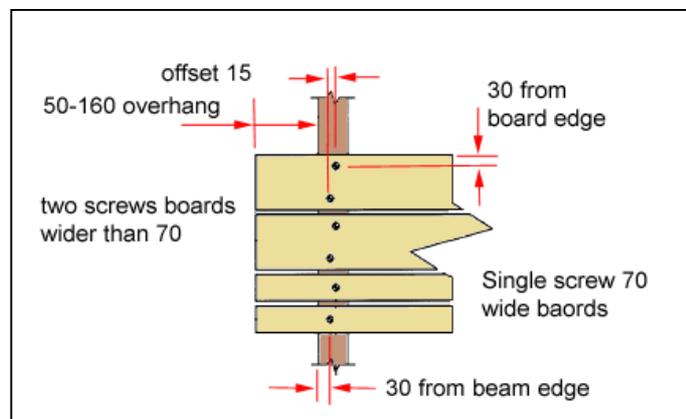
Planks need to be shaped to aid draining and air drying of the timber. Wider planks need an anti-cupping groove cut.



Fixing

Nails or screws can be used.

By using 14 gauge batten screws there is less chance of damaging the timbers. Stainless Steel screws are quite reasonably priced and should be considered. Although screws are often self tapping it is advisable to pre-drill and countersink. This reduces the chance of over tightening and breaking the screw.



If nails are used they should be at least No.10 and 100 mm long. It is advisable to pre-drill the holes to reduce damage and stressing the timbers.

Screws and nails should be staggered either side of the beam to reduce the chance of cracking along the nail line.

Layout & Design

Timber decked boardwalks should be designed to much the same standards as other pathways.

- 1800 mm width between rails/obstructions allows 200 people per hour and two wheelchairs to pass or a buggy and crutch users to pass (with difficulty) 2400 mm width is preferred. This width also suits people with companion dogs and tapping cane users. This is the preferred minimum width.
Seating/rest areas and look-out areas should be a regular feature of boardwalks. These should be large enough for the bench or perches and at least one powered wheelchair, scooter or companion dog. Seated people should have at least 800 mm space between the front edge of the seat and the edge of the walkway.
- 1200 mm wide paths (with passing places) can be used in restricted space or where people with disabilities or people with young children or babies are unlikely to be path users.
- 2000 mm wide clear decks are preferred for cyclists travelling in one direction, minimum width sections of 1500 mm can be used for short distances. Passing places should be provided every 30-40 metres 3000 mm wide and 5 metres long.
- 3000 mm wide decks are needed for cyclists moving in two directions, 2500 mm width can be used for short sections and in restricted space.
- 3200 mm wide decks can be used where there is low usage for mixed cycle and pedestrian paths, 2900 mm should be the absolute minimum for short distances in restricted space. Passing rest spaces should be provided as for pedestrian routes. Mixing children, older and disabled people with cycles is not desirable and should be avoided wherever possible.
- 2000 mm clear width in the minimum for one way golf carts, with 3500 mm the minimum for two way travel. These may be shared with cycles or pedestrians. On long runs a passing place 3500 mm wide 3500 mm long should be provided every 30-50 metres.
- 4100 to 5600 mm width should be the minimum for segregated pedestrian and cyclists.

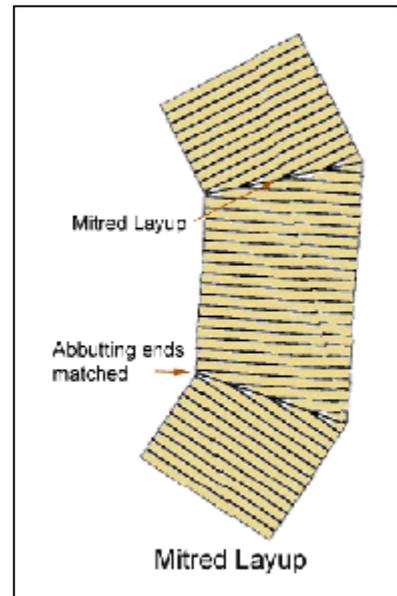
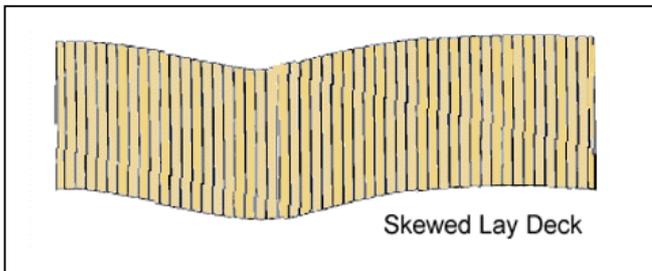
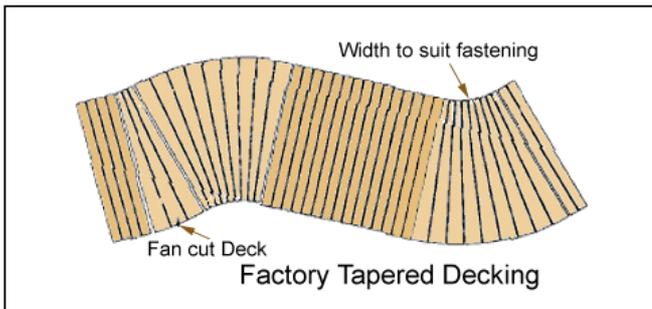
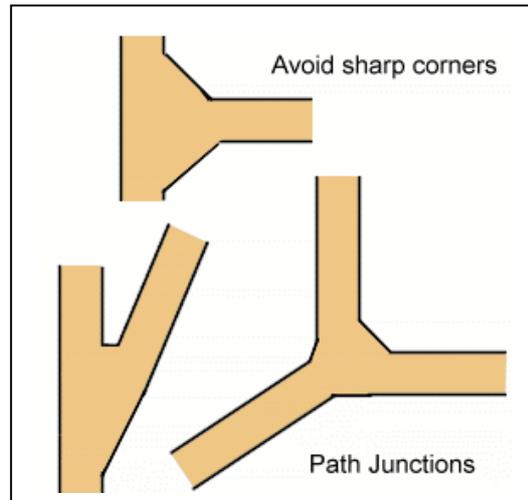
Head clearance should be 2100 mm for pedestrians and 2500 mm for cycle ways.

Junctions and curves

Where two or more paths intersect or join it is preferable to make the junction area wider than the paths this can be achieved by using an angle or taper at the corners to allow greater turning space. All junctions should be made on level sections of the path.

Curves for cycles should have a radius of 5 metres for 15 kph, travel or 8 metres for 20 kph.

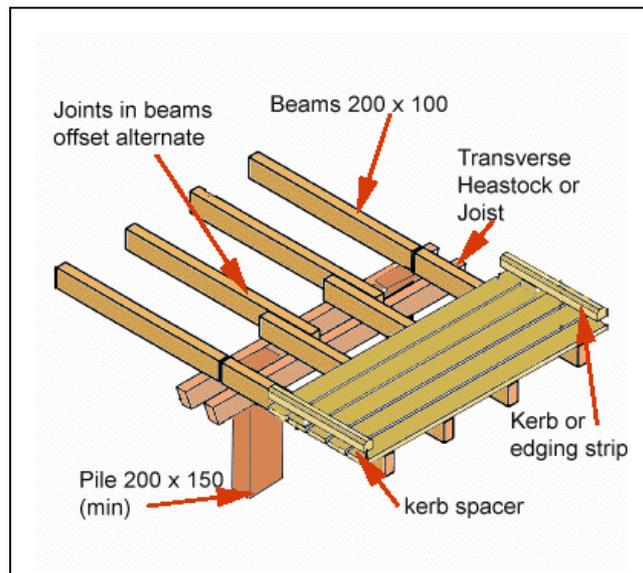
There are various ways of changing direction using timber decks.



Skewed and mitred decks are marginally easier for mobility vehicles and mobility aids.

Design Features

The structure should be built of timber pressure-treated with a preservative, such as Tanalith. Although more expensive than untreated timber, it will be much more durable. Two three different, but similar, approaches are illustrated in this section.



Bearer beams, and decking should be designed to carry a distributed load of no more than 5 kPa.

Piles, foundations and joists should be designed for a 4 kPa distributed load.

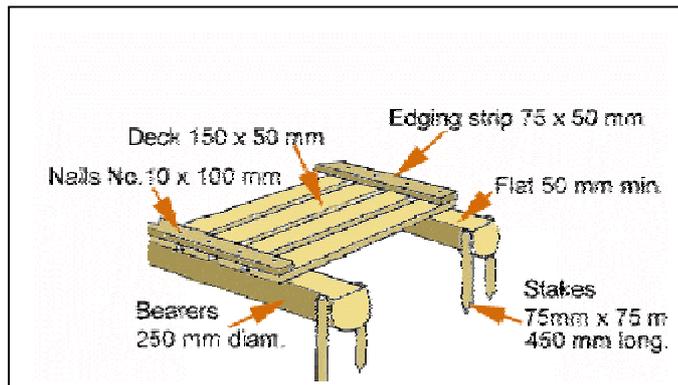
This allows a concentrated load of 4.5 kN, equivalent to a 1.5 tonne vehicle moving at low speed. Scooters and golf carts of up to 8 kN, can also use the boardwalk at low speeds. Equivalent to 500 kg vehicle plus two riders with 2.5 kN wheel load concentrated over 100 x 100 mm area.

A deck designed for the 4.5 kN load above also allows Typically Uniformly Distributed Dead Loads for the boardwalk superstructure range from 1.25 to 0.85 kPa depending on deck thickness, width, kerb and railing arrangements. The Concentrated Live Load of 4.5 kN governs the relative movement between decking planks.

Note; typical pedestrian and cycle loading in 1 kN/unit and a golf cart 2.5 kN.

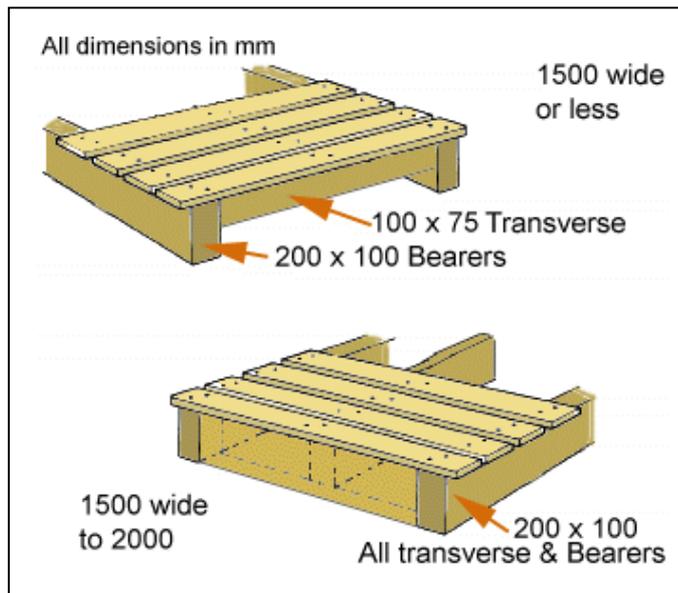
Provide low edging strips/kerbs or toe-rails, which delineate the edge, and provide some protection against vandals removing the decking.

These also add to the strength of the deck, 75 x 50 or 75 x 75 mm are suitable for pedestrians, and 150 x 150 mm for mobility vehicles and golf carts as the higher barrier helps stop vehicles leaving the deck. Care must be taken to ensure that these do not act as tripping hazards.



In most open locations, treated timber will not have algae growth and become slippery, provided water it is designed to shed water quickly.

In shaded locations, chicken wire or a tar and grit mixture may need to be applied to provide a non-slip surface. Care must be taken not to affect the vegetation beneath.



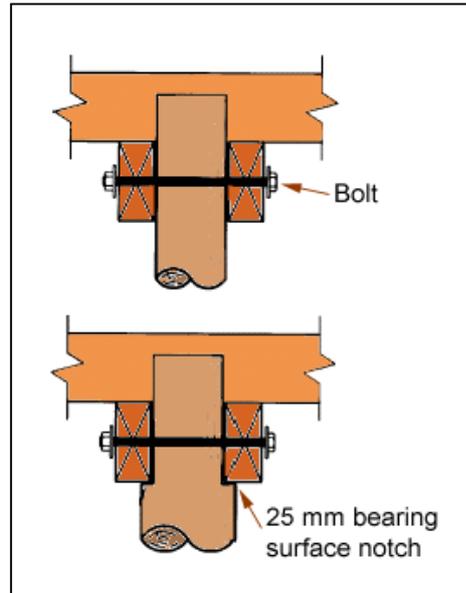
Bearers can be either prepared timber or 250 mm (or more) diameter tree trunk timbers.

Prepared timber bearer beams should be 200 x 100 mm.

Transverse supporting timbers should be used to increase the rigidity and structural strength of the deck units and to transfer the deck weight to the piles. For example these could be 100 x 75 mm on decks 1500 mm wide or less. On decks wider than 1500 mm transverse beams should be 200 x 100 mm.

These can be joined to the piles either by bolting or by bolt plus a bearing seat cut into the pile head. If bearing seats are used care must be taken to ensure they are cut correctly to support the full area of timber in contact. For most purposes bolt only is satisfactory but does limit the total loading capability. Bolts are M20 galvanised with galvanised washers.

Figures shown assume a twin transverse, headstock joist system is used.



Assuming 3000 mm pile centres

- 2 off joists 150 x 75 with a 150 pile and no bearer notch these would be suitable for normal and golf car decks up to 2000 wide.
- 2 off joists 150 x 75 with a 200 pile and a bearer notch these would be suitable for normal and golf car decks up to 2600 wide.
- 2 off joists 200 x 75 with a 200 pile and a bearer notch these would be suitable for normal decks 3500 wide, and golf cart decks up to 3200 mm wide.

See table for typical maximum length of deck units between pile or transverse joists.

Use	Beam size	
	150 x 75	200 x 75
Pedestrian/Cycle	3600	4900
Golf cart	2900	3900

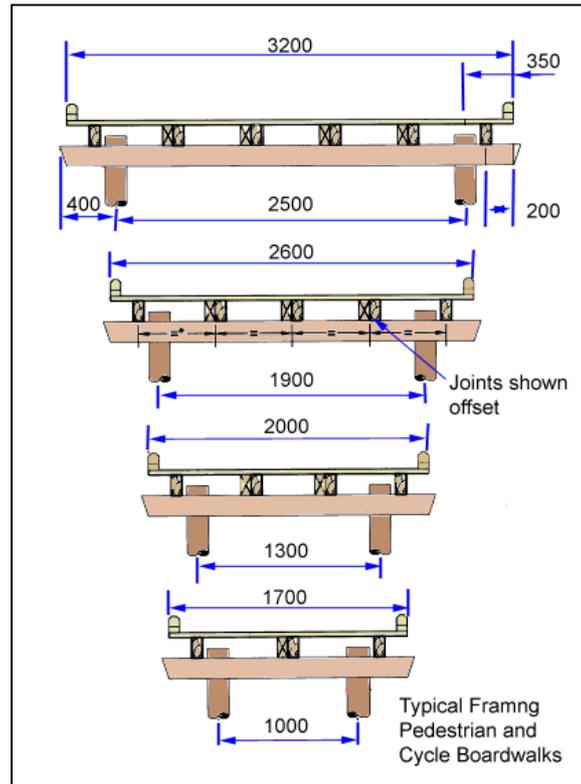
These apply to the typical deck span designs shown below and in the golf cart section.

Where the bearers are resting on the ground 75 x 75 mm stakes should be fitted every 2-3 meters to hold the deck in position.

Where the deck is raised above the surface support piles are needed. These should be 200 x 150 mm and penetrate the surface at least 450 mm. In soft soils and sand a 200 mm thick lean concrete footing should be used.

Deck planks should be 150 x 50 mm thick where loads require else see table below.

Gaps between planks should be no greater than 12 mm on routes intended for use by manual wheelchairs. Large gaps up to 19 mm can be used on 'hiking' paths where people using walking aids and mobility vehicles are less likely path users. Closer packed decks are smoother and less noisy with wheel traffic. Gaps should be at right angles to the travel direction.



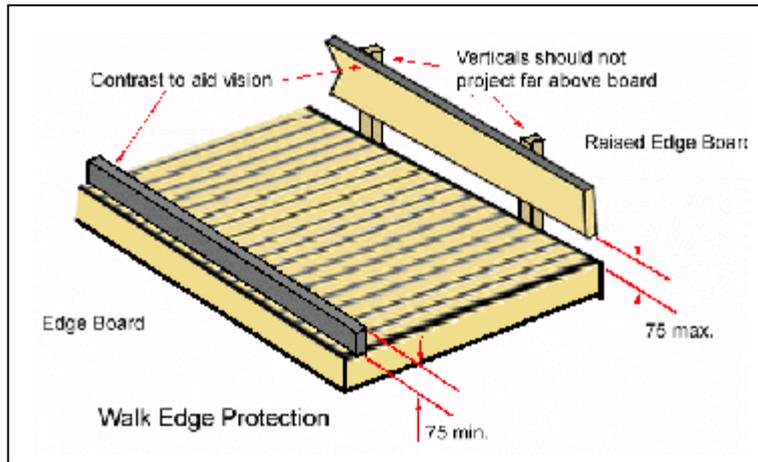
Deck Plank Size	Pedestrian Cyclist		Golf Cart
	Normal	Readed	Normal or Profile
35 x 70	500	450	N/A
35 x 95	650	580	N/A
35 x 120	660	590	590
35 x 145	660	600	630
45 x 70	830	690	N/A
45 x 95	960	890	N/A
45 x 120	980	900	770
45 x 145	990	910	820

At rest and turning points gaps should be no wider than 10 mm to prevent manual wheelchair wheels being caught.

Deck surfaces should have no more than 5 mm height variation.

Decks should be inspected regularly for damage and cracked or broken boards replaced as soon as possible.

In parks where there is seasonal use decks should be inspected and repaired before the start of the season. The annual check should look for rot and damage of the bearers, deck, tapping rail and edging strips. Stakes should be checked for any looseness.



Consider fitting a tapping rail or board to aid people who use tapping sticks. This should be at least 150 mm high along sections where there is a drop or where there are hand/guardrails fitted. A gap 75mm high (max) should be left below the board to assist drainage (tight fit decks) and allow sand and dust build up to be cleared.

Edging strips/kerbs and tapping rails should provide colour contrast to reduce the tripping hazard.

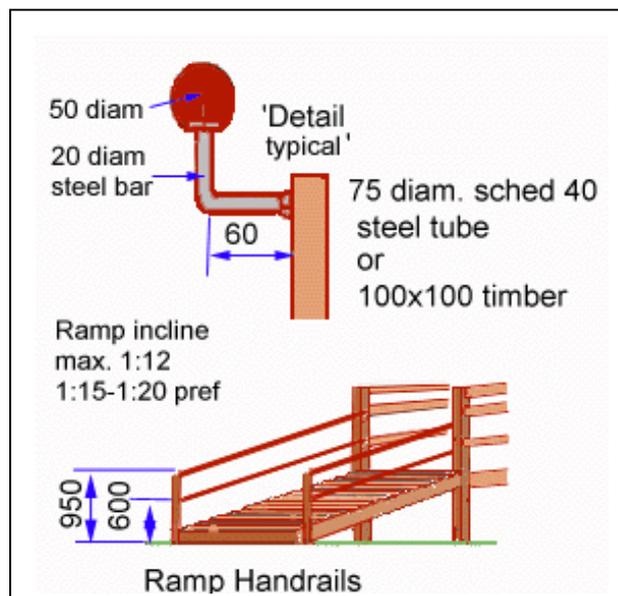
Hand & Guardrails

Handrails and guardrails made from timber need to be 75 x 75 or 100 x 100 for rigidity and strength. 75 x 75 should have posts at 2600 centres and 100 x 100 at 3200 centres. Use of wire mesh panels on higher drops and on sand dune walks should be considered.

Where paths are curved hand and guardrails may need to be made from galvanised pipe as timber rails are difficult to train along curved walks.

It is preferred for strength and aesthetic reasons that handrail posts are located at pile locations.

The cross section of each handrail should be such that the grip is between 40 mm and 50 mm in diameter. When designed specifically for children, a grip of 25 mm to 35 mm in diameter is more



suitable. In countryside locations, handrails will normally be constructed from timber (preferably hardwood) which, if well smoothed, will minimise the risk of splinters.

It is important to remember when hand and guardrails are used on elevated walks that the rails do not become a ladder for children and less responsible youth.

Handrail heights

Handrails are not required on long stretches of level walkway.

The 950 and 600 heights are required on all steps and ramps.

- On steps, stairs and ramps 900-950 mm adult, 780-800 mm wheelchair rider, 600 mm children.
- On platforms 950-1000 mm adult, 800-850 mm wheelchair, 600 mm children.

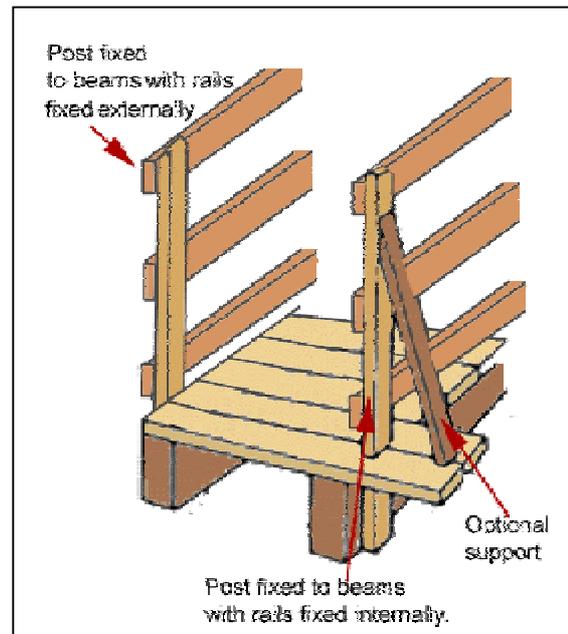
Guardrail heights

- Pedestrians 1100 mm min.
- Cyclists 1200 mm min.
- Road and rail bridge crossings 2500-3000 mm.

See also Fishing Points where special heights are permitted.

Guardrails should be provided for any drop over 600 mm or where there is water more than 900 mm deep, where people with disabilities and older people are likely users.

Guardrails should be designed to discourage climbing by children, wire mesh or vertical baluster on a 150 mm centres.



Preservation

In addition to treatments such as Copper Azole or CCA further protection will aid in extending the life of the deck. Wetting and drying, UV, frost all have an effect on the life of the timber.

All timbers should be treated with protective oil or emulsion during assembly.

Timber to timber surfaces and ends of grain should have a coat of CN (Copper Napthanate) emulsion.

Bolts heads should be painted with CN emulsion.

Decking coat with CN oil on all sides before laying- coat ends of grain with CN emulsion.

Coat sides and bottom of all beams and joists with CN oil. Coat the top surface of all joists with CN oil.

Coat all parts of the handrail and posts with a fungicide and water repellent then coat with an inter-grain D-W-D as per manufacture's instructions.

Staining

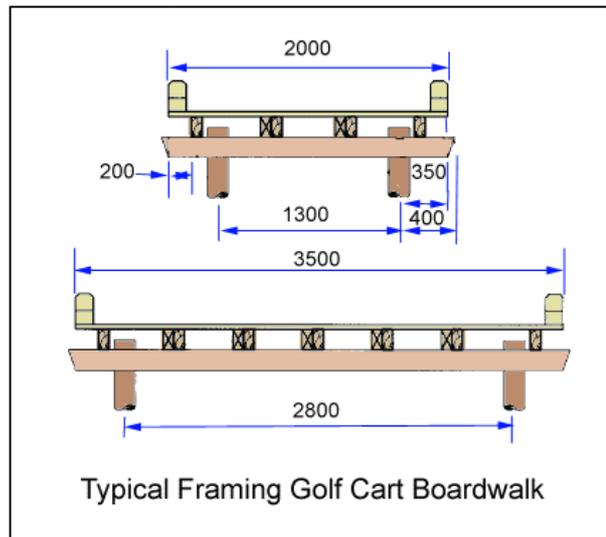
If water passes over unpainted hardwood it can produce a brown stain on the surfaces below. This is more likely to occur when the timber is freshly sawn but will continue to a lesser extent after it is seasoned or weathered. There are some cleaning agents that will remove the stain, but discolouring will reoccur unless water is excluded.

Flashings or roofing can be used to direct water away from any surfaces to be protected or an opaque paint system can be applied to all the hardwood surfaces including all housings and notching. This is not necessary for most boardwalks.

Golf cart decking

Decks for use with golf carts need additional support to carry the dynamic loads for more intense usage.

These two drawings illustrate the beam requirements using 100 x 200 mm beams to carry the weight and loading.



Surface & Slip

A non-slip surface can be provided by epoxy tar sprays, spread with fine grit to form a grip. The main weakness of this technique is that the tar may not form a secure and long lasting bond to the wood: this can be strengthened by applying the tar to new timber, before it has had time to weather. High summer direct sun temperatures may cause melting of the tar.

Grooving/roughening the decking boards prior to installation can improve grip.

Galvanised rabbit netting or plastic mesh can also be stapled to the boards to improve the level of grip for pedestrians and wheelchair users. However, care should be exercised in the use of this technique

in that, in time, holes often develop and, if these are not repaired, there is a serious risk of people being tripped or spiked by up standing broken wires. It can also make the boardwalk more dangerous in icy conditions. Care should be exercised in the use of anti-icing chemicals and they should be avoided on sites of sensitive wildlife or plants.

Foundations

Foundations for decks have to cope with a wide range of soils, water tables and conditions.

Design pier/pile loading of 35 kN is typical for a 2000 wide deck supported every 3000.

- Piled or bedlog foundations are used for soft ground and high water tables.
- Potted pile for stiff ground (cement encased)
- Drilled anchorages are used for rock.

Mud

Mud is common in estuaries and lake shores and will often require mats to be used to allow vehicles to work in the location. It typically has a bearing strength of 20 kPa or less.

Boardwalk decks in these areas need to be piled, usually timber as they are easily trimmed and spliced to length, have greater friction surfaces and lateral strength than steel, and do not rust. Mud is often very deep so that friction piles are used. These are piles which use the friction generated by their length to transfer the weight to the mud. Piles are typically 3 to 8 metres long, therefore machine pile driving is necessary.

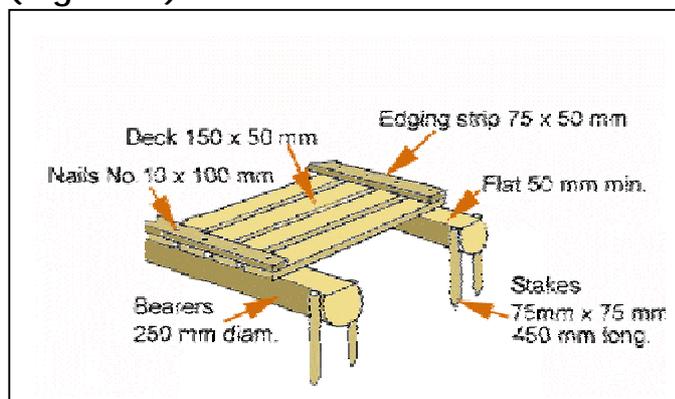
Where a firmer material underlies the mud the pile may be shorter and rest on the firm surface (e.g. rock)

Soft Ground

Ground which has a surface bearing capacity of 50 kPa or better found in marshes and freshwater swamps.

A bedlog system is useful, although care must be taken not to disturb the local hydraulic system by blocking water flows.

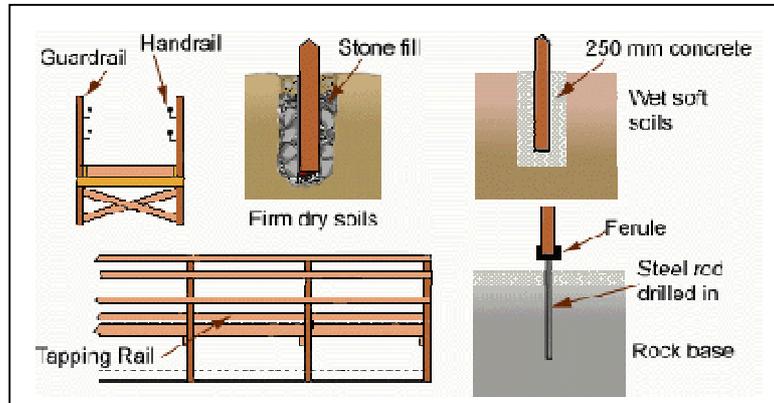
This can either be constructed in place or prefabricated and deck section brought in on a trolley.



Stiff Ground

Ground with a surface bearing capacity of 100 kPa or better and no significant water table. Potted piles can be used in these locations unless the water table is high when driven piles may be required.

For hardwood piles an auger can be used to extract the soil, and then the pile fitted and back filled with gravel.



For treated softwoods such as pine it is preferable to auger the pit then concrete the pile into position.

Sand

Piles are either driven or jetting is used.

Sand provides poor lateral support, but use of buried deadmen can be used to help distribute the load.

Water and wind can undermine and expose the piles if not long enough and cared for.

High water tables make sand unstable and tend to flow (quick sand).

Rock

Rock foundations are more expensive and can be a problem to install. Typically a 75 to 100 mm diameter hole 400 mm deep is drilled and a rod installed.

In softer rocks it may be possible to use a potted foundation 600 mm minimum.

Slopes

Care must be taken on slopes not to destroy the land stability by piling. Always check for subsidence. It is often preferable to install a normal path on sloped sections.

Marine

Treated pine piles with a fibre cement sheath is necessary to protect against marine organisms.

Fire

As with any timber structure a timber boardwalk is susceptible to fire. Preservatives will tend to increase the speed of fire spreading. There is a transparent paint which can be used to inhibit fire spread if applied to the underside and supporting structure, applied to the walkway surface it can make the deck slippery.

Good maintenance clearing- dried leaves and keeping grass under control all help reduce risk.

Where the walk is distant from water consideration to providing fire extinguishers at intervals should be given.

Where water is available a hand pulled manual water pumps could be kept.

Puncheon Walks

A variation on boardwalks is the puncheon design which provides planking which runs in the same direction as travel.

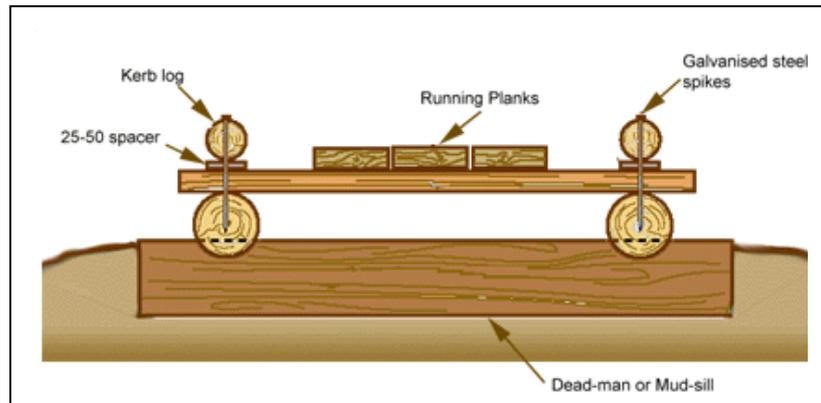
These are liked by some cyclists and joggers. However, they are hazardous to use as cycles and joggers fall off the timbers.

They are totally unsuitable for people with disabilities as they form a tripping hazard.

Wheelchairs and mobility vehicle

wheels become trapped; mobility aids cannot be used on these walks.

Their use is not recommended as they are a general safety hazard.

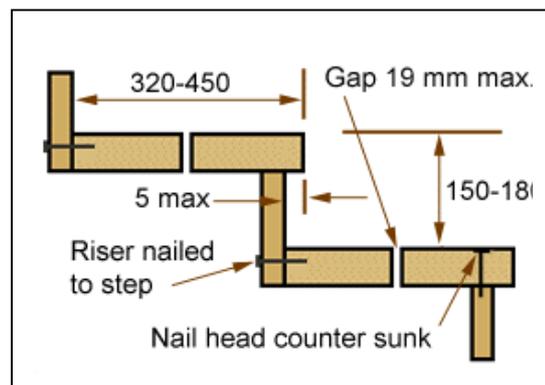


Timber steps

If timber steps are used they should have solid risers nailed to the treads. Open plan steps are not suitable for many people with mobility or visual impairments.

Nosing should not protrude more than 5 mm beyond the riser face.

A strong contrasting nosing can be used to strengthen the edge and reduce damage.



The risers are normally rebated into the side stringers.

Erecting

Nail the top of the stringers to the deck structure.

Temporarily pack with blocks of wood under the bottom tread until treads are level.

Dig a hole 250 x 250 x 250 under each stringer and fill with concrete. Place a galvanised wire or bracket into the wet concrete against the two stringers.

When the concrete has cured (2 days) place a piece of damp course membrane, melthoid or similar under the stringer and on top of the concrete pad. This prevents moisture from the concrete pad going to the timber. Remove temporary packers from under bottom tread and nail or staple the galvanised wire or bracket to the stringers.

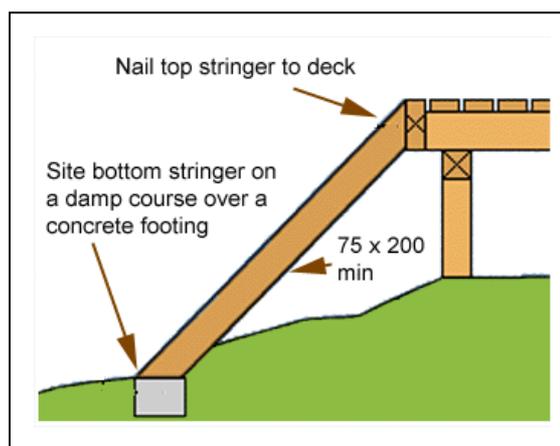
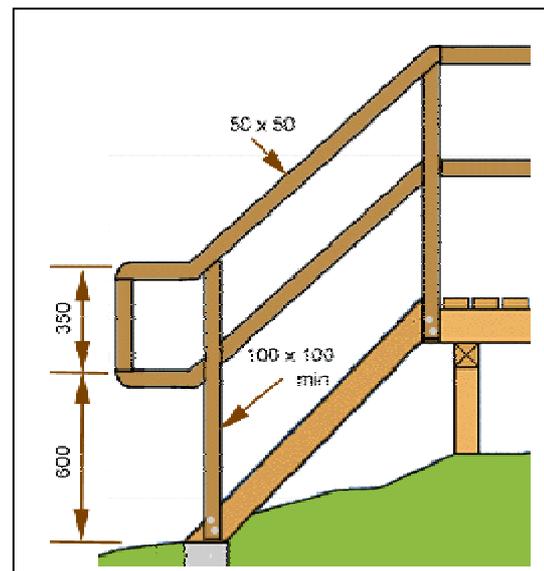
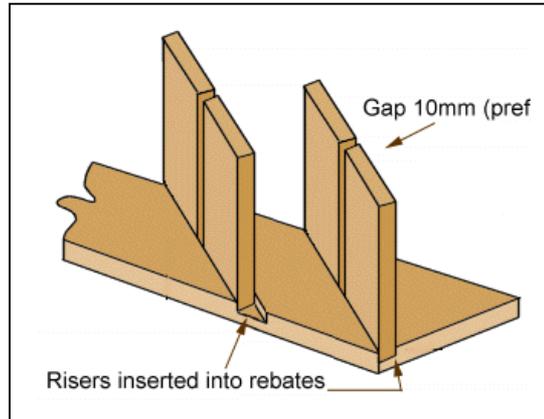
Handrails should be fitted to all steps. These can be screwed onto the stringers with stainless steel screws.

Timber steps need to be checked regularly for rot and algae which make the steps hazardous for everyone. Dry cracking caused by the sun or impact and load cracks can appear at any time weekly inspections should be made.

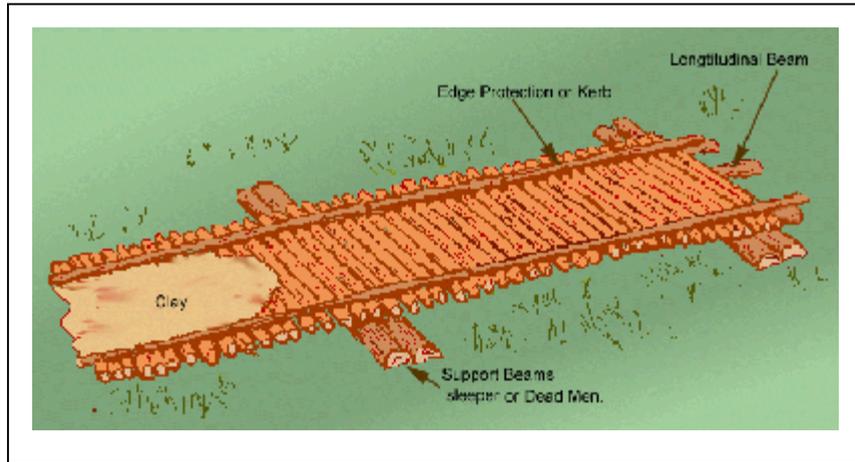
Damage timber should be replaced as soon as possible.

Corduroy Tracks & Paths

This should be considered for temporary spans across wetland terrain. It is useful for constriction purposes as it is fairly robust and resistant to sinking. Corduroy is material intensive and has a short life span which is maintenance intensive.



The route is constructed by laying two three 300 + mm logs (sometimes called 'sleepers' or 'dead men') at right angles to the path route every 3-6 metres, dependent on the soil strength.



Longitudinal beam logs (150+ mm pedestrian routes, 250 + mm vehicle routes) are laid above this to support the deck. Decks are made from whole or half logs spiked to the beams. An edge log (200 mm) is sometimes used to reinforce the structure. The structure should be buried to the at least 1/2 the dead man diameter. The logs are held together with galvanised spike 1.5 x the log diameter.

A layer of clay or stone dust is sometimes laid over the travel surface to improve the ride. Without this surface layer the path is not suitable for use by people with disabilities and many older people or cyclists.