

# DESIGNING BETTER DECKS

A photograph of a wooden deck with a diagonal railing, overlooking a lush green garden with various plants and trees. The deck is made of dark brown wood planks, and the railing is made of light-colored metal. The background is filled with dense green foliage, including trees and bushes.

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For Timber Queensland

## DESIGNING BETTER DECKS

Timber decks and boardwalks includes discussion on the sub framing:

- Timber bearers
- Timber joists
- Timber posts (or steel?)
- Fixings
- Finishes
- Decking material itself

Why me?

- Have always been interested in the use of Australian timbers, especially hardwood and I am still learning even at 68 years old. I am still a “Practicing” Architect is the term Engineers like to use
- Have designed many timber residences and commercial buildings, and also hardwood outdoor and indoor furniture



Custom timber chair design



Custom outdoor timber seating

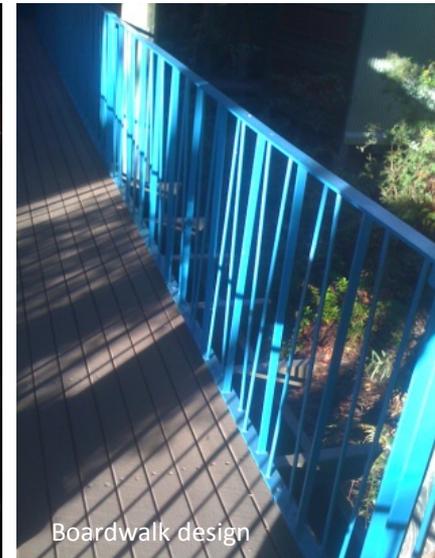
Have designed many verandah, decks and boardwalks and seen personally how if timber is not specified, designed and used correctly that serious failures can occur



Residential deck design



Commercial deck design



Boardwalk design

DECK FAILURE EXAMPLES



Joist rot under Satinay decking



Rotted decking



Rotted decking

## DECK FAILURES

At least two collapsed decks in recent years have led to serious injury and fatalities.



Archicentre's statistics show that approximately 6% of Australian homes have a timber balcony or deck and that about 2% of these were potentially fatal. This figure indicates that there could be as many as 8,000 of these dangerous balconies or decks throughout Australia.

- I have been involved with TRADAC and now TIMBER QUEENSLAND for many years
  
- I have been involved with Ted Stubbersfield from *Outdoor Structures Australia* and *Infrastruxion* and shared much information and knowledge over the years
  
- I accepted this talk today because I like Timber Queensland and I too am very concerned about the future of many existing and proposed deck and boardwalk designs that have been and are still being constructed in regard to:
  - Selection of timber species, strengths, sizes and durability
  - Poor design and detailing of decking and boardwalks – especially the substructure or framing
  - Poor selection of fixings
  - Poor selection of treatment and finishes to timber decking and boardwalks

### 3. The Problems

Ignorance /misunderstanding of timber as a material, when to use kiln dried, seasoned or green unseasoned timber, how to design and detail with timber, how to fix it, how to finish / preserve it

- Possibly to do with not having actually worked / observed / studied / good timber construction practices firsthand
- Been influenced by Home handyman style TV shows that oversimplify how to build timber decking, stairs, pergola or fencing (i.e. encouraging timber posts to be embedded in ground or with bag mix concrete)

- Decks laid on ground or very close to it with poor ventilation therefore, moisture and condensation build up and there is no room to inspect for possible termites etc.



On-ground decking example

- Poor fixing decisions (i.e. use of T nail nailing guns for decking)
- Thinly galvanised, light gauge fixing plates, joist hangers and not at least heavy hot dip galvanised fixings or preferably stainless steel
- New plastic and composite decking with its own problems
- The advent of using LVL joists and bearers in inappropriate external situations

All these issues can lead to dangerous situations caused by:

- Rot and decay organisms
- Termite attack
- Slip and trip hazards
- Splinter hazards for hands or bare feet

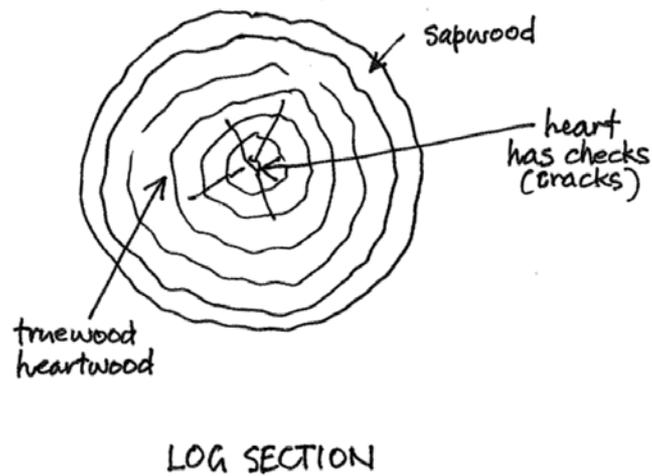
#### 4. Some solutions

- We need better understanding of timber as a material and choice of timber species for decks, verandahs and boardwalks
  
- We need to keep learning:
  - From Timber Queensland
  - Ted Stubbersfield has many important publications and can offer consulting advice after a life time in the timber industry

- Accepting that timber is not a manufactured product and is cellulose and porous and contains sap when it is cut green
- Can be used green as natural unseasoned sawn hardwood and it will shrink and tannins can leach out of the timber
- Can be kiln dried to a specified moisture content to reduce shrinkage and be more stable
- Can be dressed smooth or left rough sawn
- Various species have different strengths and durability
- All timber is affected by moisture i.e. rain, immersion, moist atmosphere and the sun
- Timber performs differently depending on how it is milled from the log
- Understand the different performance and quality from different cuts, i.e. expectations of shrinkage, cupping, face defects etc.

- We need to understand timber and design to take account of the qualities of timber as a material
- Have a clear idea of the design life you are aiming for. Timber life prediction software says 85 years is possible if everything is correct and maintenance is carried out (5 – 10 years is not acceptable)
- Understand timber species – Royal Species Class 1 timbers are ideal for external substructure and decking. For example:
  - Ironbark
  - Spotted Gum
  - Tallowood
  - Satinay
  - Turpentine

- Know whether the timber is suitable for above ground or in ground use
- Provenance is important
  - the source of the timber
  - ideally, we would want to use timber from Australia and from a sustainable source
- Ideally use timber that is free of heart for posts, bearers and joists. AS 2082 does allow heart content but warns about suitability for application
- Use Australian timber
  - from the wild
  - from forest farming plantations



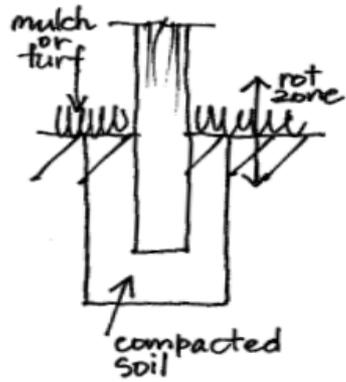
- Don't use imported hardwood from questionable sources that may be non – sustainable –kwila,merbau with questionable certification
- Design of decks and boardwalks that are durable and safer starts with the subframing/ support structure, i.e. posts, bearers and joists
- Do it properly – do it once.That is being truly sustainable

(i) Posts

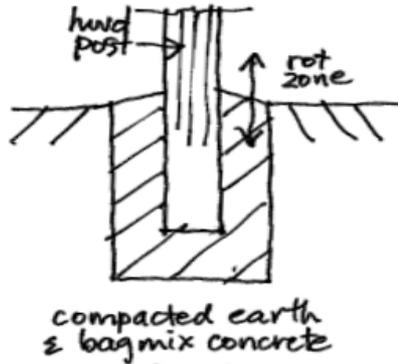
There is always the urge for Clients to want a cheap deck or boardwalk and it starts with “Let’s just use timber posts embedded in the ground or concrete”

We only need to look at hardwood timber fences with posts rotted off to know this won’t work

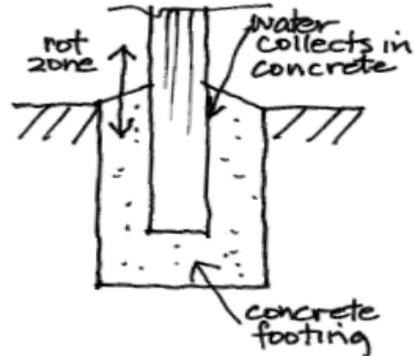




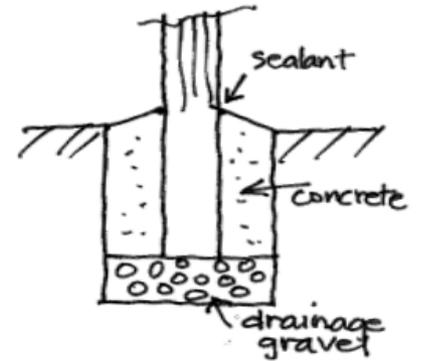
(irrigation & fertiliser accelerate decay)



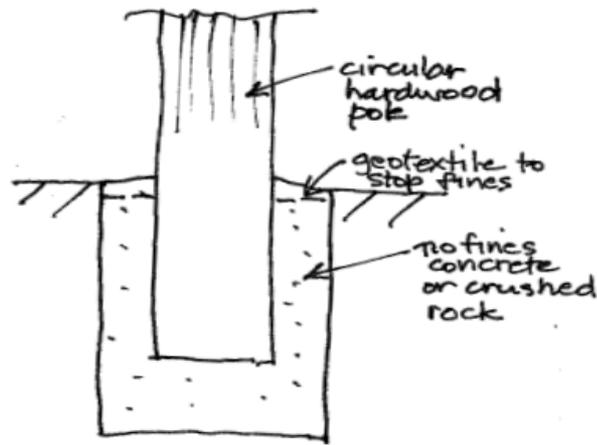
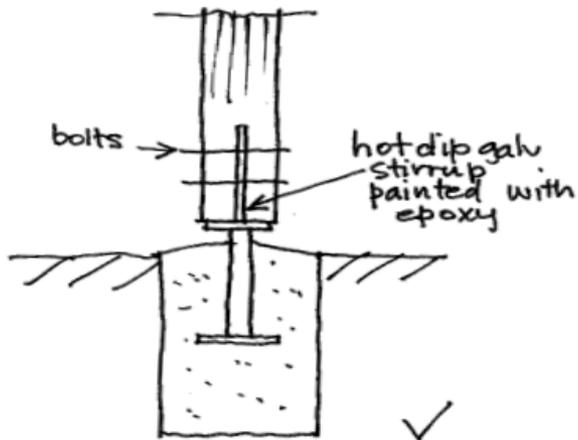
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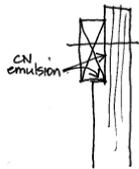
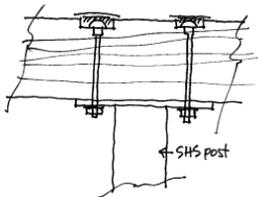
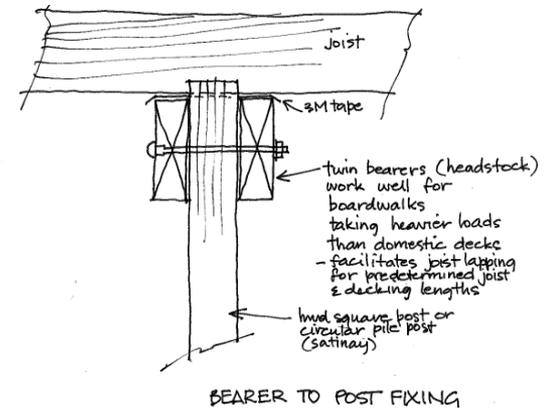
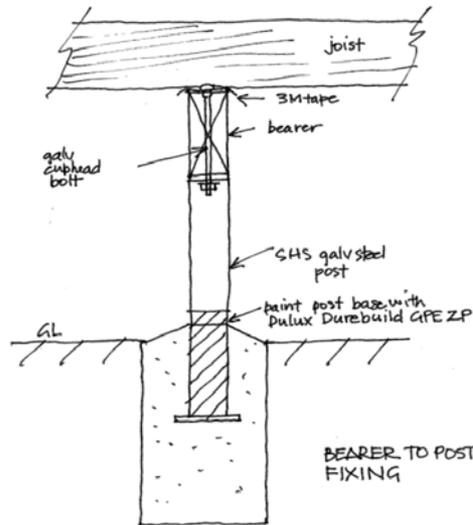
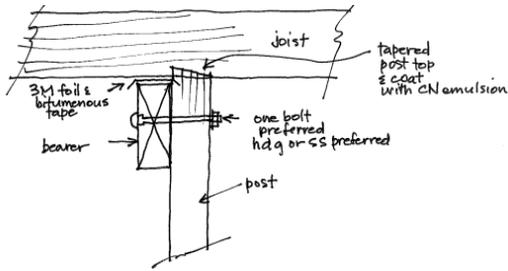
better but not much



Soil Engineers should advise on footings

(ii) Bearers

The size of the bearers and the fixing of the bearer to the posts is important to the durability of the substructure



Bearer to Post Connections

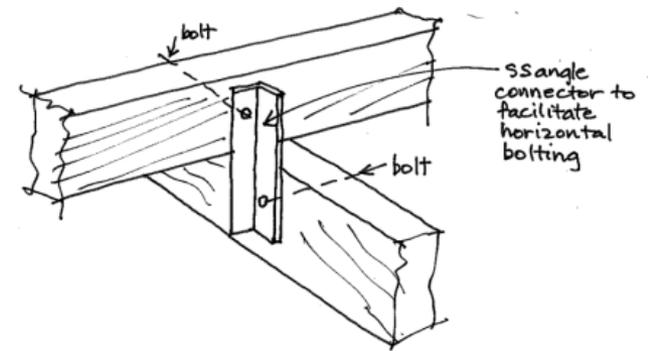
- A Structural Engineer will need to certify the structure and check sizing but it is up to us to get the detailing right
- For external structures 75mm thick minimum is preferred for bearers for good bolting practices
- Bolt end clearances in bearers are important to prevent splitting
- One bolt to post compared to two bolts means less risk of splitting with shrinkage
- Bolting to side of post rather than “let in” to the post for less end grain rot risk in the timber post
- Place with “wind” up when sighting along bearer
- Try for horizontal versus vertical bolting wherever possible
- Don’t check top of bearer if vertical bolting and bolt is too short – unless covered with 3M tape or bitumen filler in checks

### (iii) Joists

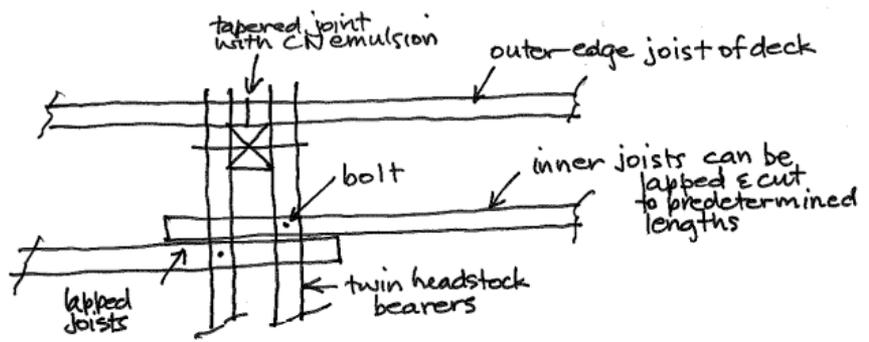
- Often specified as 50mm thick or even 38mm which causes problems with splitting when fixing decking with nails but especially if screw fixing is used
- Preferably use 75mm thick hardwood joists for external, exposed to weather decks and boardwalks
- No deck board fixings in straight lines – can cause splitting even in 50mm wide joists



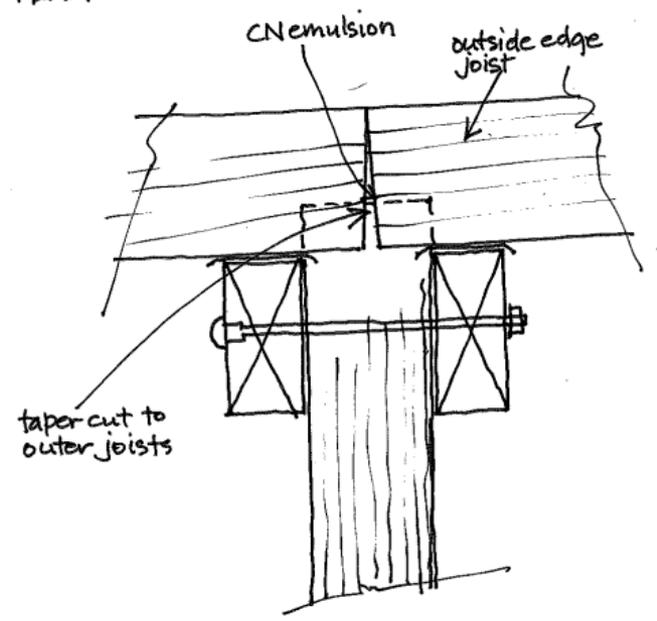
- 100 x 50 F11 hardwood joists may not be as good as 100 x 75 F14 hardwood – but strength grading is not the only criterion to select joists and sub framing. Even F17 may not perform as well unless species and specification of the timber is correct
- Fixing joists to bearers was traditionally by nailing (spikes) in domestic decks and often now by Trip L grips (Pryda). If nailing, predrilling is essential



- Ideally fixings and multi-grips should be stainless steel but certainly hot dip galvanised
- In heavier decks and boardwalks stainless steel angles with horizontal bolting is preferable. Remember to elongate holes in angle to allow for timber shrinkage
- Place joists with “wind” up when sighting along joist
- Designing the deck or boardwalk for predetermined lengths of joists saves timber but importantly allows predictable fixing locations when installing decking.
- Spend the time to set out posts, bearers and joists to allow predetermined lengths to be used
- Lapping of joists other than edge joists allows predetermined lengths of joists
- Decking can be in preset lengths and this is very achievable if using double joists



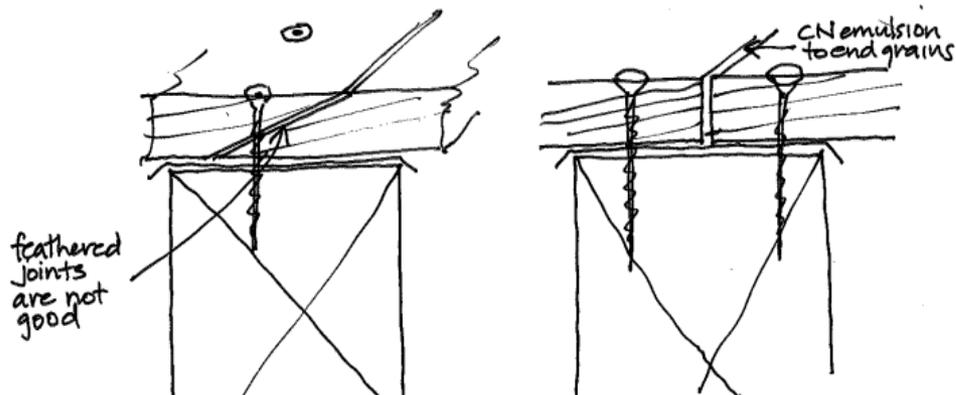
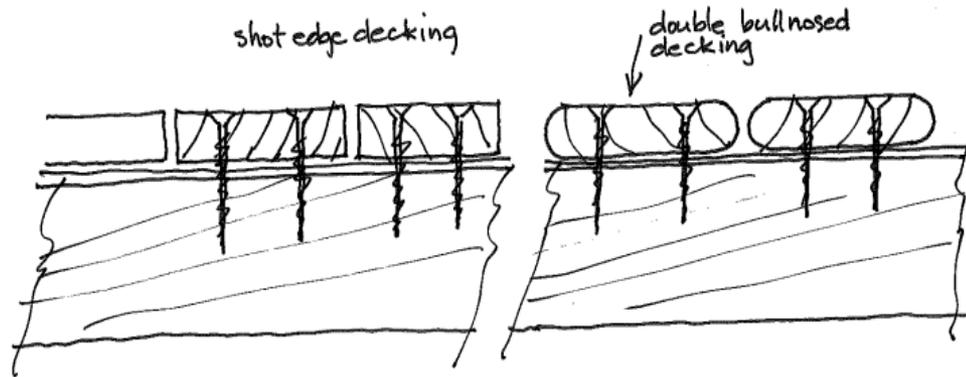
PLAN



ELEVATION

(iv) Decking

- Hardwood boards for domestic decks can be 88 x 19 shot edge or preferably double bull nosed (not suitable for domestic vehicle parking)



- Ideally decking should be specified for Royal Species – Ironbark, Spotted Gum, Tallowood and Satinay rather than strength F11, F14, F17
- Ideally nominate boards to have a clearface -i.e. no longitudinal or radial shelling, knots, surface gum veins, etc.

#### EXAMPLES OF TIMBER FACE IMPERFECTIONS



- Shot edge and bull nosed decking are dressed boards so can be slippery when wet. Preferably use thicker boards, say 25 or 35 with a natural sawn face and arrissededges (R12slip rating). Can rough sand over rough sawn if needed:
  - takes oil finish better
  - less risk of slip
  - can take vehicles
  - joists can be further apart
  - end joints of boards should not be feather jointed – but do allow a slight end gap and treat end joints with CN emulsion

- Thicker decking for commercial boardwalks, decks etc especially if vehicle movement or parking is likely

- Sizes

- 120 x 35            i.e. 3.4: 1

- 145 x 45                    i.e. 3.2:1

are stable sizes – 4:1 is maximum but less than 3.5:1 is ideal

(145 x 35 boards did cup in practice i.e. 4.1:1 was not good enough)

- Size and profile of deck boards can be important

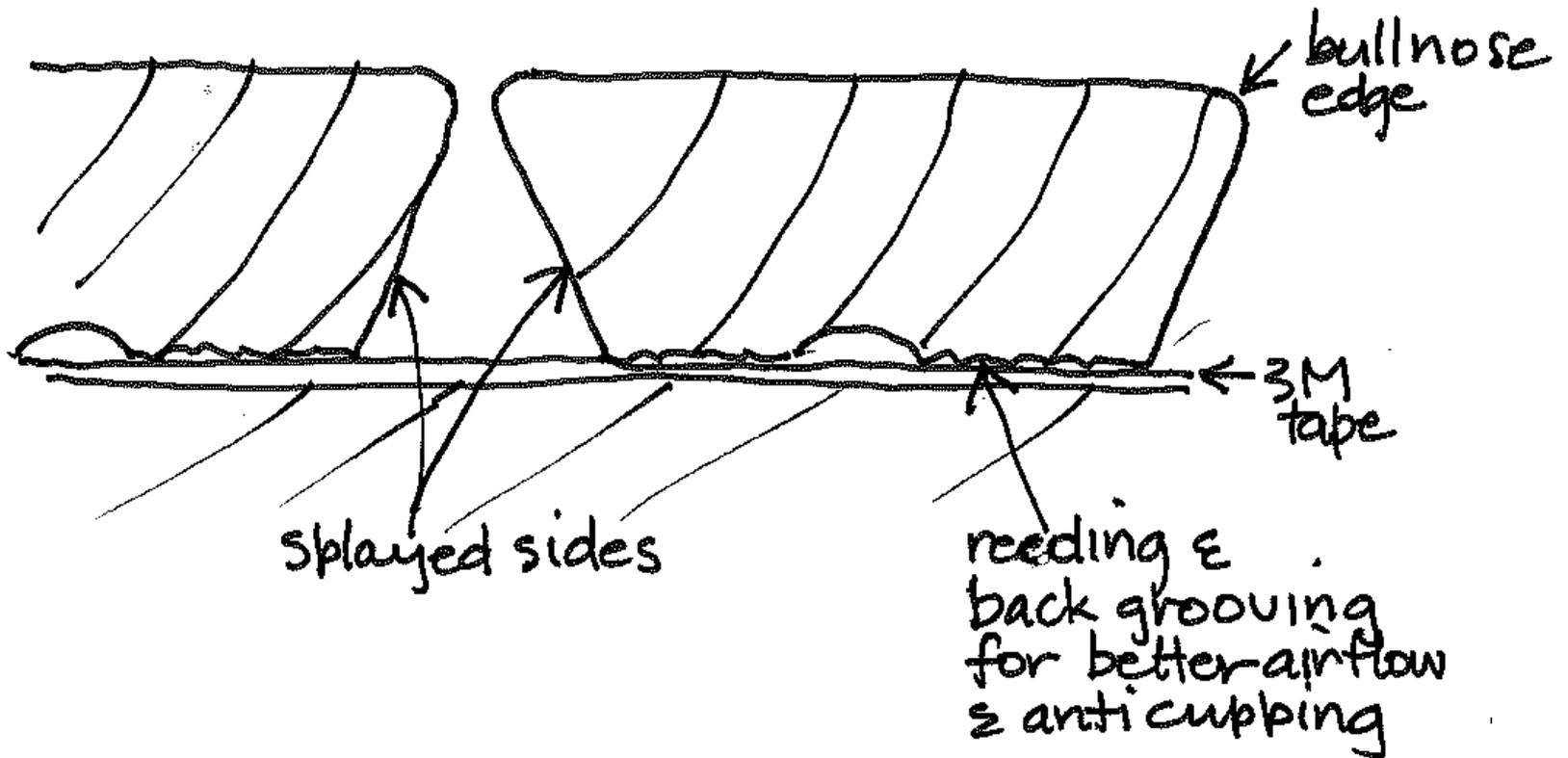
- To prevent cupping

- To allow water, dirt, leaves to drop through more easily

- To allow ventilation

- Never lay any reeded board face up

- it will rot quickly



DECKWOOD DECKING SECTION  
evolved to achieve durable decking  
- Patent OSA

## (v)Fixings

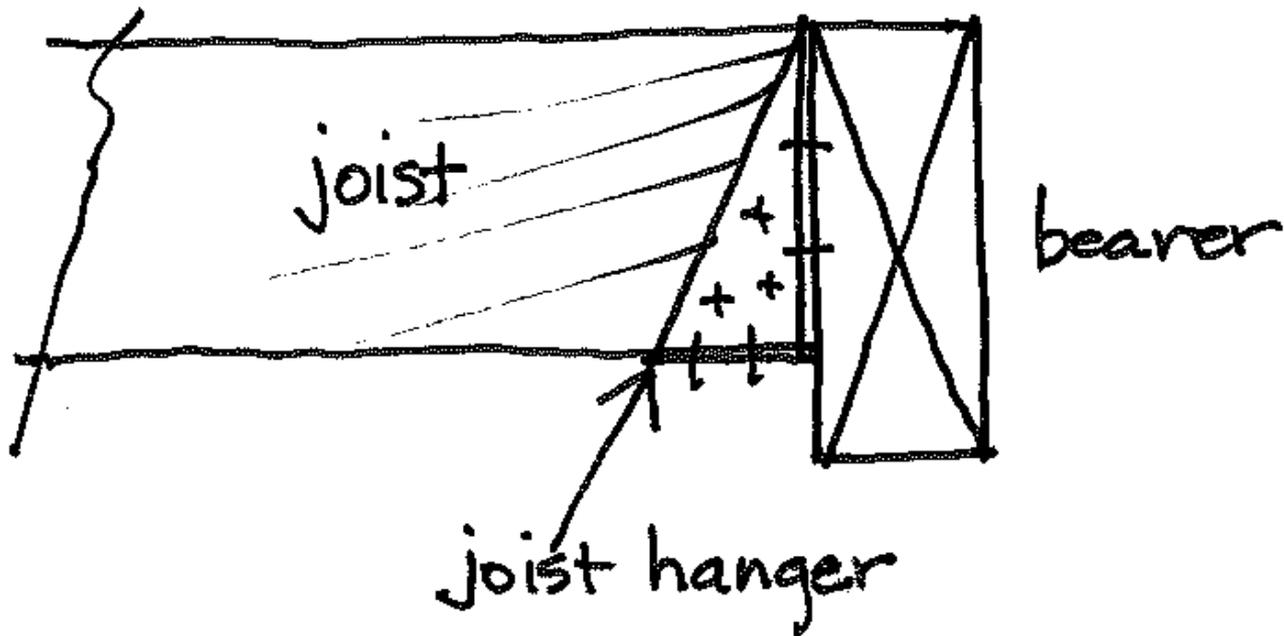
### 1. Substructure fixings

#### Bolts

- Minimum hot dip galvanised but serious rusting especially in CCA treated hardwood and pine has been observed.
- Minimum need to dip hot dip galvanised bolts in Dulux “Durebuild” GPE ZP and drill oversize holes.
- Some have tried grease or plastic sleeves to prevent corrosive attack on bolts
- Ideally use Type 304 or 316 stainless steel bolts or stainless steel threaded rod and large stainless steel washers and stainless steel nuts. (304 is fine, it just tea stains and is cheaper)

Trip L Grips, Multigrips, angles must be minimum TYPE 304 stainless steel. Simply galvanised especially with cut edges will corrode. Especially true if within 8-10kms of saltwater.

Joist hangers in galvanised finish are a “scary” proposition long term especially if water or salt air can get at them- must be stainless steel on decks in all cases.



## 2. Deck Board Fixings

### Nails

- Traditionally domestic deck boards were fixed with galvanised bullet head nails punched flush
  - Failure – Boards ride up and down on them and projecting nails are dangerous
- I don't even want to talk about T head gun nailed decking – too dangerous
- Then came dome headed Stainless Steel twist nails to stop the rising up of nail heads – better but a recent deck with these nails cupped badly due to timber species problems. You can't easily re-sand a deck with domehead nails. Total replacement is required

- The preference should be for countersunk head stainless steel batten screws of correct diameter and length for the job.

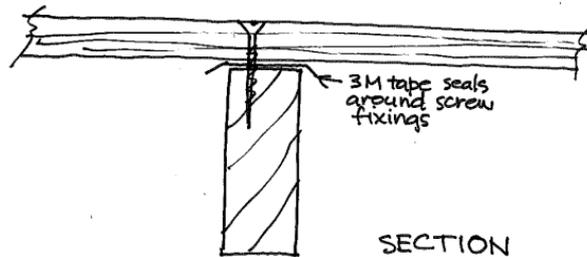
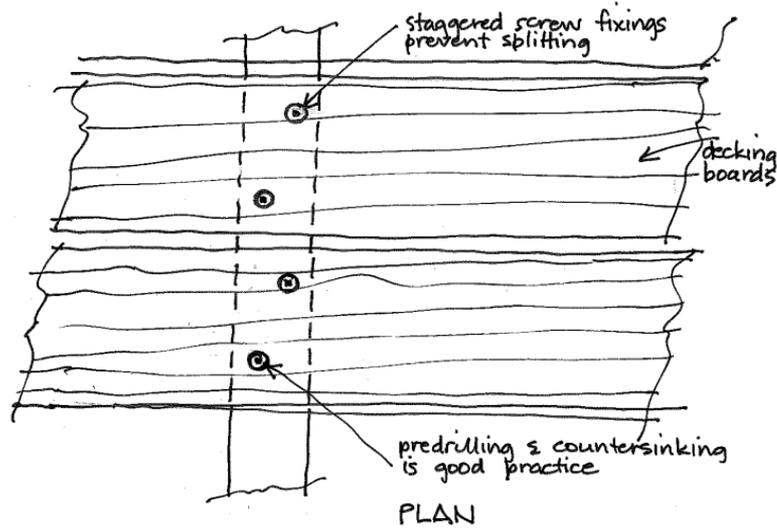
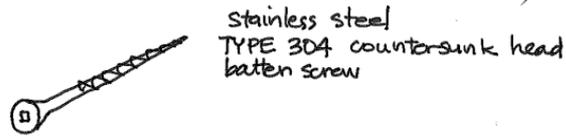
(6.3mm  $\emptyset$  (14 gauge) Type 304 countersunk head batten screws are commonly used for quality decks now)

- Ideally keep screws 4 diameters from edge of boards – always pre drill and countersink – especially in hardwoods

- Always stagger fixings to prevent joists splitting

- Don't over countersink

- Always use 3M tape(aluminium and bitumen tape) on top of joist to prevent water entry to top of joist



- Malthoid – a bitumen / sand coated material has been tried combined with CN emulsion and also a PVC extruded joist capping has been used
- Neither are as successful in my opinion as water can run down the fixing and wet below the Malthoid or PVC and start decay in the joist



### 3. Spacing of decking boards

- Relates to shrinkage and safety in use
- In an early project I was talked into butting shot edge boarding on a deck so they would shrink and make a gap as they shrank. Every time it rained the boards closed up and water lay on the deck
- When using kiln dried 88 x 19 dressed decking specify 4-6mm gaps if shot edge and slightly less if bullnosed boards are used
- If thicker green (unseasoned) deck boards are used understand timber shrinkage of the species specified to calculate the finished gap between boards
  - Ironbark}
  - Spotted Gum} 6% shrinkage
  - Satinay}
- Compared to Blackbutt (not recommended) up to 12% shrinkage  
i.e. F14 Hardwood Above Ground Durability Class 1 or 2 is used 12% shrinkage can be expected

- If high heeled shoes (foot traffic) is expected on the deck or boardwalk be careful with gap width i.e. after shrinkage a gap less than say 4.2mm would be OK
- Usually upto 7mm gap is OK
- Codes allow up to 12-13mm gaps but with shrinkage these gaps can open up to 24mm or more and trap bicycle tyres and wheelchair tyres – be careful



- Durability of timber decks & boardwalks is affected especially by moisture (rain, condensation) and sun exposure
- Aim to design timber decking so it dries out quickly and doesn't have moisture traps
- Never hose decks and boardwalks – use a leaf blower if you must
- Also design so decks do not hold leaf litter or dirt - All of the above foster fungi, dry and wet rot etc.
- Contact of timber with the ground is not acceptable for durability of deck

### (vi) Finishing

- If moisture is the enemy and sun also then how you finish the deck is important
- What product you use and whether you are prepared to maintain it – will affect the life of the deck
- Enormous range of deck finishing products and I have tried most of them

- Kingfisher Bay Resort and Village opened in 1991 and we used a lot of 'Intergrain' which eventually became owned by 'Dulux' and Barry McTague then went on to invent 'Woodmans' timber finishes

- Other brands include:

- Cabots

- Wattyl

- Sikken's

- Penetrol

- Ted Stubbersfield recommends "Tanacoat" which I have found to be very good – a water repellent and UV blocker for domestic decks and CN oil for commercial boardwalks. Penetrating oils rather than surface coatings or paints that crack at fixings and board ends and let moisture in and not out

- Oils are obvious (when water stops beading it's time to recoat and it is a relatively easy process because it can be mopped on)



Example of water beading on a deck coated with 'Tanacoat' oil

- A question of whether to oil / paint the boards on all faces usually causes debate
- My preference is to paint all faces For better durability
- My preference also is to add some tint to the oil, for a good timber look but don't go too dark since heat build up in full sun will affect the timber. Pale coloured stains are Timber Queensland's and Ted Stubbersfield's recommendation

(vii) Weathering of timber prior to finishing is another debate

- Some finishing products require 8 weeks- 3months of weathering
- How is this feasible in domestic construction especially if you want to paint the boards on all faces? It is almost impossible to achieve this recommendation, especially on small lot projects (some finishing manufacturers are addressing this problem and have preparations to overcome this)
- Weathering of Kwila and Merbau imported timber is important as these boards have even more tannin than Australian hardwoods. Spotted Gum seems to produce the least tanin staining
- Kiln drying is an energy consuming process that doesn't need to be used in all cases so unseasoned green timber can be designed for, especially if using thicker decking such as 25 or 35mm – just design for shrinkage

(viii) Other issues

- The use of laminated bearers and LVL's in external decking is not something I would recommend but we can discuss this later



- HS treated pine is an option for economy and ease of handling and working – another subject for later
- The use of synthetic (composite) timber decking such as “Modwood”, “Futurewood” etc. is something I have been exploring and I have written an article on it that has been published – refer “Deck and Boardwalk Design Essentials” by Edgar Stubbersfield





Composite decking at a Resort south of Broome

- I do have strong opinions about synthetics and other timber substitutes and I am happy to talk about it later also:

- Bamboo flooring

- Aluminium decking

- Recycled timber for decking and substructures

- Bollards, balustrades and handrail design are another subject worth discussing as failures in these designs can be as dangerous as hardwood decking failures

APPENDIX

## REAL TIMBER DECKING OR SYNTHETIC TIMBER DECKING

The verandahs, decks and steps on the Australian home have traditionally been constructed with shot edge or bull nosed boarding on hardwoods of durability Class 1 for the structural members and decking, especially in roofed verandah situations and durability of the verandahs has been excellent as evidenced in the traditional Queensland home. Some of the timbers used were Ironbark, Satinay, Turpentine, Tallowood to name a few.

In recent times hardwood has become harder to source and more expensive. Hardwood species of less durability and possibly younger trees are now being used. Often decks and boardwalks are fully exposed to the weather i.e. not roofed. Construction methods and materials are not always appropriate for the situation and verandah and deck failures (in full or part) due to rot are not uncommon. Also quality of workmanship has deteriorated in some circumstances.

With issues of sustainability rightly being pursued by architects, designers and builders in recent times, the option of using one of the many synthetic timber decking products is more frequently being exercised.

Investigation of some of these synthetic timber products has led to a questioning of the sense in using these products.

Some observations on these products include:

- Sagging between joists
- Cracking at fixings
- Very hot to walk or lie on especially dark brown colours
- Fading
- Can be permanently scratched by dragging furniture or other heavy items across it without lifting
- “tracking” wear in heavy use zones
- Questionable for use with commercial loadings i.e. bridges & boardwalks
- What do you do with offcuts? Landfill? Burn them? Recycle them?
- What will long term durability be like? How will it fail in the long term? Go brittle, erode or soften?

There are numerous brands of synthetic timber being offered to the market and they vary in composition i.e. some are ground up hardwood particles mixed in with plastics. Others mention rice husks and recycled milk bottles and babies nappies being used as components.

The manufacturers offer various colours and even imitation wood grain texture and all of them push that synthetic wood is a sustainable alternative to real timber decking.

It is interesting also that prefinished bamboo tongue and groove flooring is being promoted as a sustainable option to hardwood tongue and groove flooring. In regard to this bamboo product, one would need to be sure the laminated bamboo pieces in their resin (plastic) embedment have come from renewable bamboo groves and that the user understands exactly what the resin and prefinished components are and can justify shipping container loads of this flooring travelling around the globe if local hardwood can do the job. The other question is also what do you do with the offcuts? Landfill, burn them? They cannot breakdown and return naturally to the soil as will all the offcuts, sanding, waste, etc, of the natural hardwood tongue and groove flooring and decking. This latter objection is also applicable to the synthetic timber decking.

In discussions on the use of real wood versus synthetic wood we should state that all real wood used in construction ideally would be certified by the Forest Stewardship Council or its Australian equivalent – not always possible however at this time.

It is worth listing some of the for and against of real wood versus synthetic wood.

## **REAL WOOD**

### **FOR**

- Real beauty with a natural warmth
- Pleasant odour
- Aesthetically pleasing appearance
- Some pressure treated softwood decking can be quite inexpensive and is usually readily available (CCA pressure treatment has been discontinued in favour of arsenic-free alternatives)
- Not unreasonably hot to walk on barefoot
- Hardwood offcuts can be safely disposed of in landfill to rot or be consumed by termites
- Hardwood can be safely burnt

### **AGAINST**

- Some hardwoods can be quite expensive
- Unmaintained wood can split, crack and will fade to a grey colour
- Availability and price depends on source and region
- Certification of source needs to be documented
- Pressure treated softwoods dent and damage easily. They can warp or bend and contain chemical preservatives that may leach out
- Pressure treated offcuts should not be burnt or put in landfill

## **SYNTHETIC WOOD, COMPOSITE WOOD, PLASTIC WOOD**

### **FOR**

- Less expensive than real wood?
- Weather resistant
- Some are stain resistant
- Some are light weight
- Won't splinter or rot
- Said to be low maintenance i.e. no staining or re-oiling required
- Some have integral colour
- Claimed to be eco, sustainable due to recycled component materials
- Claimed to be easily cleaned with hose or mop

### **AGAINST**

- Some look obviously fake or cheap i.e. texture and/or colour doesn't really resemble wood
- Some are slippery when wet
- Some are not resistant to mould or mildew especially in the shade
- Some will show signs of age and wear/decay/fade
- Some tend to sag and bend more than real wood
- Dark colours are very hot to walk on barefoot
- Some will require more substructure than real wood decking
- How do you dispose of off cuts? Burn? Regrind? Toxic? Landfill?

## **ALUMINIUM DECKING**

### **FOR**

- Tough and strong
- Slip resistant if surface textured finish used
- Anodised colour or clear anodised does not fade
- Will not stain
- Can be totally maintenance-free if properly specified and installation is appropriate
- Stays cool under barefoot
- Won't rot, split, splinter or warp
- Fireproof
- Off cuts recyclable to new aluminium products
- Does not try to resemble wood decking unless painted with fake wood grain

### **AGAINST**

- Most expensive decking material
- Can be slippery when wet if texture unidirectional
- The correct aluminium alloy for decking and fixings must be used or corrosion can occur

An architect would choose to use real hardwood for decks ,verandah sand boardwalks rather than synthetic imitation wood and accepts that the design and detailing of the installation, the selection of the correct timber species and strength characteristics all need to be properly assessed and a maintenance regime established so that the long term performance is not compromised.

The matter of using synthetic timber as a look alike for real timber decking raises the question of whether these manufacturers might be better to produce a decking product that has its own identity and look, just as aluminium decking has done and has found a place as decking for fire lookout towers or elevated rainforest walks or coastal verandahs, etc.

The decision to use synthetic timber for decking ,in lieu of real timber is perhaps based on ready availability, less maintenance and hype at the moment more than price.