



# Design, installation and management of remote pedestrian structures in Tasmania



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- Walking tracks and structures managed by PWS
- Development of engineering program: 1990's – present
- Prioritisation based on risk
- Problems with older infrastructure
- Improving the standard of infrastructure
- Photographic record and case study
- Conclusions



PWS manages 2.9 million hectares of land, or 43% of the state by area. This includes about 2,715km of walking tracks.

Track Class (AS 2156)	Length (km)
1	11
2	53
3	375
4	1,060
5, 6 and routes	1,216
<b>Total</b>	<b>2,715</b>



- 500 pedestrian bridges
- 150 viewing platforms
- Numerous elevated walkways & safety barriers





# Development of PWS engineering program - 1990's to present:

- Prior to 1995: engineering services relating to design and inspection of structures were ad hoc. Structures often built with little or no engineering input.
- 1995: collapse of a viewing platform at Cave Creek (NZ) resulted in the tragic deaths of 13 students and one park ranger, with four seriously injured.
- At PWS, critical “risk of closure” program was initiated, with all “elevated” pedestrian structures being deemed potentially unsafe, unless certified by an engineer.



1995 – 2005: PWS engaged engineering consultants to inspect and certify hundreds of walking track structures.

- During this period, many structures were replaced, strengthened or closed due to safety issues.
- A number of identified structures that had the potential for catastrophic collapse, with possible consequences on a similar scale to those experienced at Cave Creek.



Typically low standard infrastructure dating from the 1980's,  
predominantly treated pine



Example of a structure that was closed during the first round of engineer inspections, post 1995





## 2005 – Present: prioritisation based on risk

If not managed strategically:

- The cost of engineering services can become unsustainable.
- Available resources may not be directed to where most needed.

A prioritised approach is required that provides acceptable inspection and maintenance regimes for different classes of asset, based on risk. This approach is supported by the Tasmania Civil Liability Act 2002.



## PWS risk score card

The score card sums points to give a risk score for each asset. Points are applied for:

- Fall height (measured to AS 2156)
- Structural complexity
- Materials
- Environment
- Risk of damage
- Age of the structure (as a percentage of design life)



CONSEQUENCE - SEVERITY OF HARM / LOSS Pick highest applicable row			RISK OF INCIDENT SCORE (Part A Total)			
Injury	Financial Impact	Social Impact	0 to 19	20 to 29	30 to 39	>40
None	Neglegible	Neglegible	<input type="checkbox"/> AIP 1	<input type="checkbox"/> AIP 1	<input type="checkbox"/> AIP 2	<input type="checkbox"/> AIP 3
First aid treatment	Economic loss <\$1k	Inconvenience to <10 persons p.a.	<input type="checkbox"/> AIP 1	<input type="checkbox"/> AIP 2	<input type="checkbox"/> AIP 2	<input type="checkbox"/> AIP 3
Casualty treatment	Economic loss \$1k - \$10k	Inconvenience to 10-100 person p.a.	<input type="checkbox"/> AIP 1	<input type="checkbox"/> AIP 2	<input type="checkbox"/> AIP 3	<input type="checkbox"/> AIP 4
Serious injury (e.g. permanent disability)	Economic loss \$10k - \$100k	Inconvenience to >100persons p.a.	<input type="checkbox"/> AIP 1	<input type="checkbox"/> AIP 2	<input type="checkbox"/> AIP 3	<input type="checkbox"/> AIP 4
Fatality	Economic loss \$100k - \$500k	Significant loss of amenity for >100 persons or community	➡	<input type="checkbox"/> AIP 3	<input type="checkbox"/> AIP 3	<input type="checkbox"/> AIP 4
Multiple fatalities	Economic loss >\$500k	Major loss of amenity for >100 persons or community	➡	➡	<input type="checkbox"/> AIP 4	<input type="checkbox"/> AIP 4



	Program Name	Inspection Schedule
Low Risk	AIP 1	<ul style="list-style-type: none"><li>Asset Inspector: 6 monthly, 12 monthly or 36 monthly (depending on remoteness of site)</li><li>Engineer: Not applicable</li></ul>
	AIP 2	<ul style="list-style-type: none"><li>Asset Inspector: 6 monthly, 12 monthly or 24 monthly (depending on remoteness of site)</li><li>Engineer: If requested by an Asset Inspector</li></ul>
High Risk	AIP 3	<ul style="list-style-type: none"><li>Asset Inspector: 6 monthly</li><li>Engineer: Every 5 years</li></ul>
	AIP 4	<ul style="list-style-type: none"><li>Asset Inspector: 6 monthly</li><li>Engineer: Every 3 years</li></ul>

- Using the scorecard and the (above) hierarchical inspection programs has streamlined the inspection effort and maximises the use of available resources.
- Focus on assets presenting the highest risk to the public.



## Problems with older infrastructure

- Limited life of timber and galvanized fasteners (mostly treated pine structures), often only 20 – 30 years service.
- Corrosion and other problems with steel structures, often leading to limited service life (e.g. 20 – 30 years).
- May be non-compliant with current codes and standards.
- Unrealistic maintenance requirements.
- Vulnerable to flood, snow, ice and fire damage (often inappropriate design).

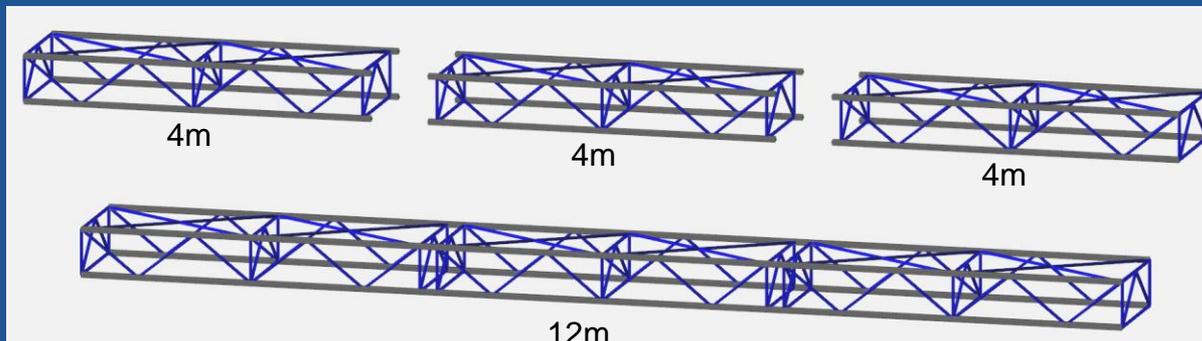
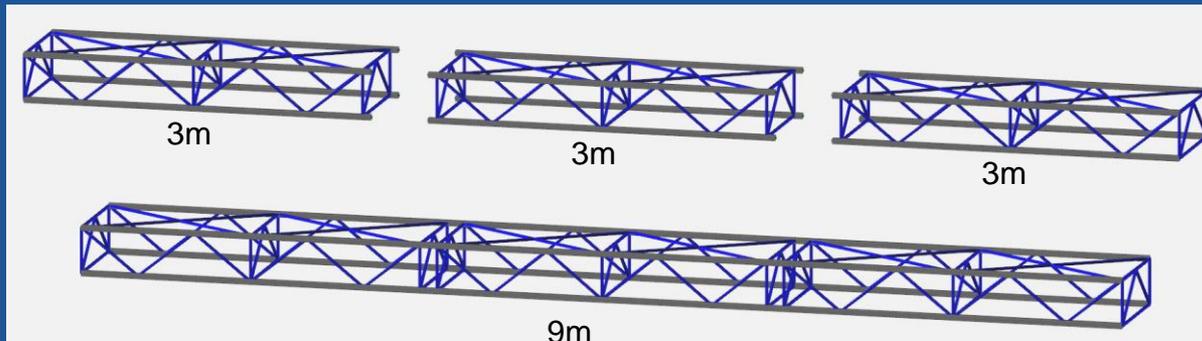


## Improving the standard of infrastructure

- Partially or fully prefabricated structures (fast installation)
- Typically long single spans for bridges
- Timber, steel or FRP beams for spans <9m
- Galvanized steel trusses for spans 9 -12m
- Light weight walk-through trusses for spans 12 – 24m
- FRP materials, particularly for decking
- Minimal maintenance requirements



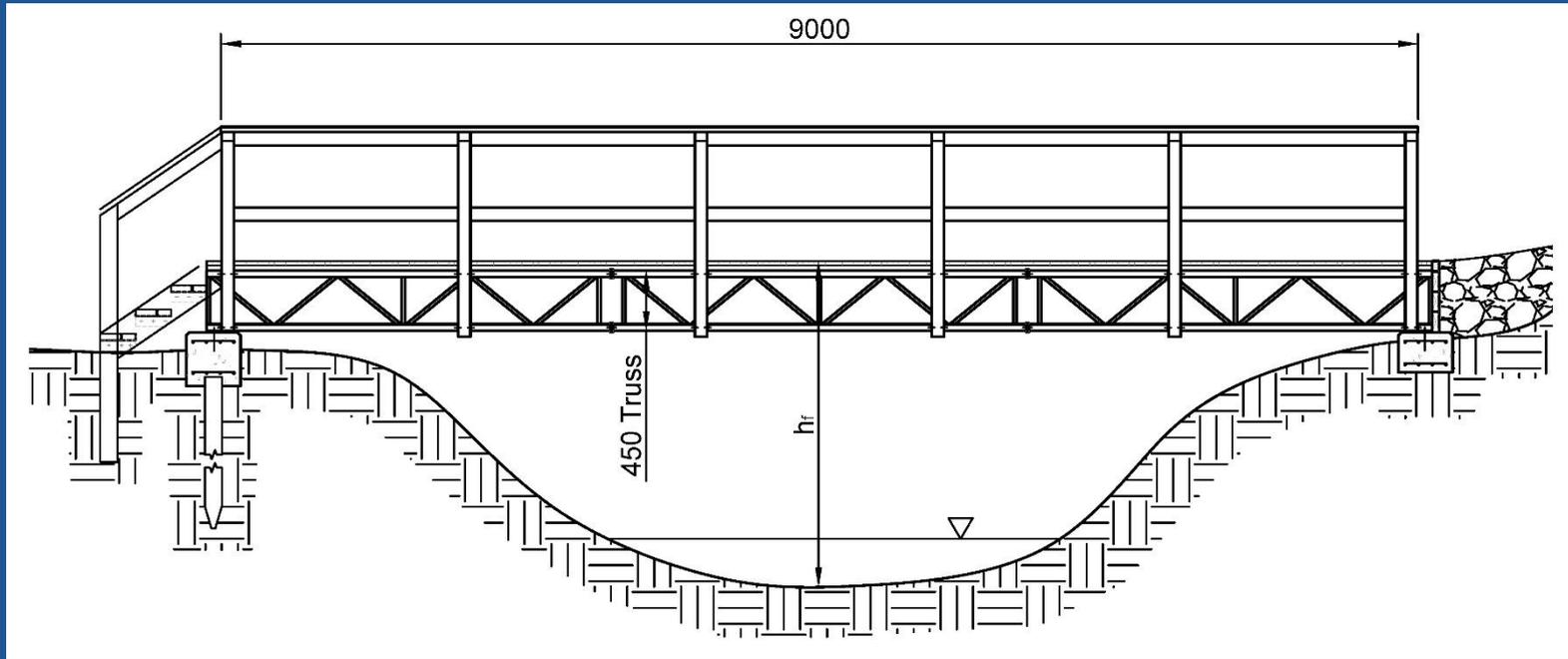
# Example: modular bridge (under-truss type)



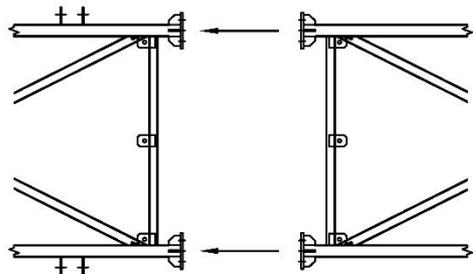


## Features:

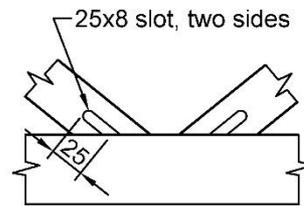
- Fully vented SHS truss for safe hot-dip galvanizing
- Modules can be transported on a small truck/ute or even a power barrow and can be lifted manually
- Single module mass 100kg (9m) or 185kg (12m)
- Heli lift mass (truss with deck): 525kg (9m) or 850kg (12m), suitable for B2/B3 “Squirrel” helicopter
- Modules bolt together, either prior to heli lift, or on site
- Safety barriers (if required) are fitted after installation



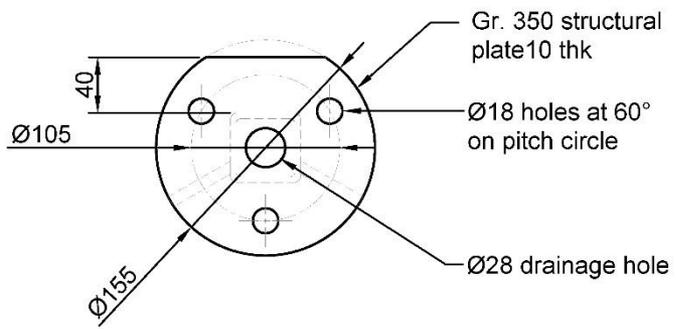
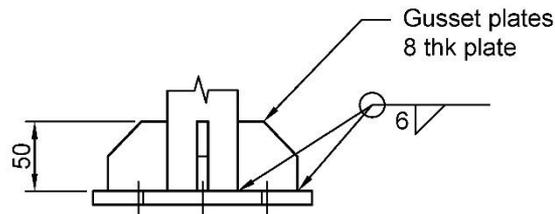
Example: 9m modular bridge



MODULE CONNECTION  
PLAN



VENTING



CONNECTION PLATE DETAIL

Material:  
 A..... 50x4 SHS Grade C350LO to AS 1163  
 B..... 35x3 SHS Grade C350LO to AS 1163  
 Bolts: M16-50 Grade 8.8/S galv. to AS/NZS 1252.  
 Total no. 24.

Finish:  
 Hot-dip galvanize to AS 4680, 390 g/sq.m

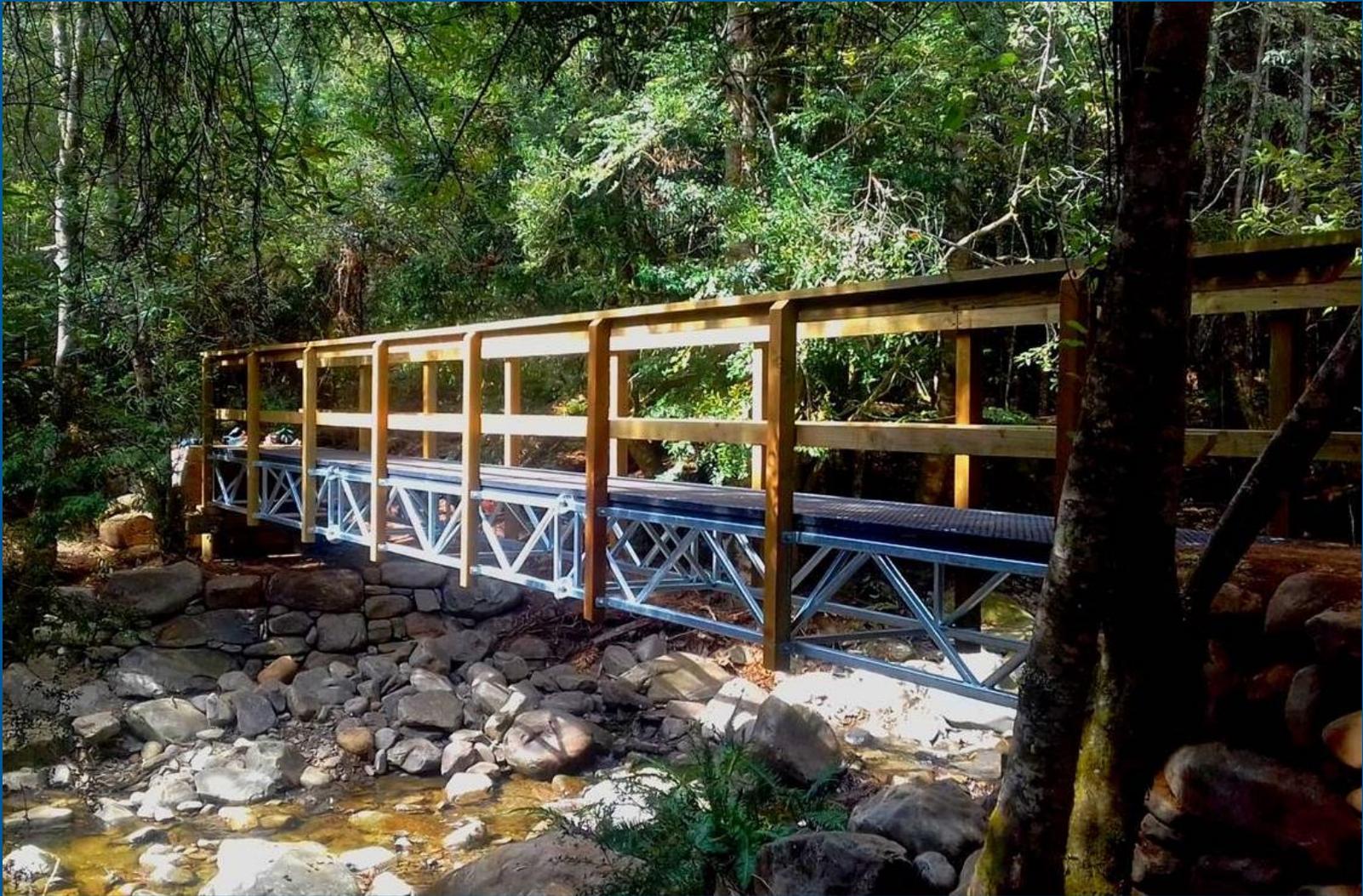


# Photographic record – Quinns Creek Bridge 12m modular truss





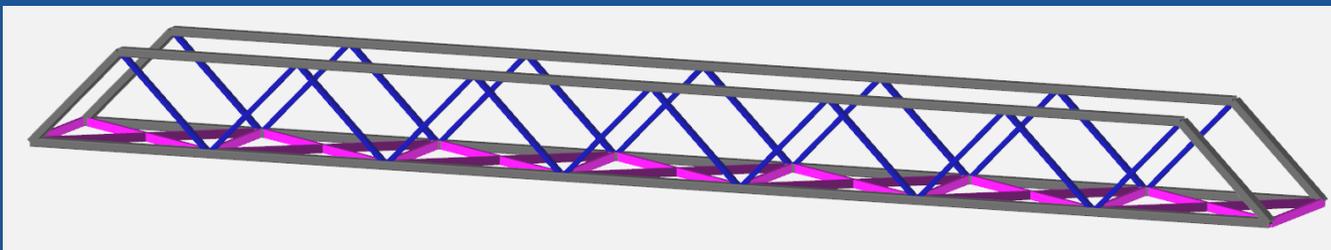




Quinns Creek Bridge: modular truss, span 12m.  
Total installation cost (including helicopter) approximately \$25,000.



## Walk-through truss bridge



- Efficient for longer spans, up to 24m length practical.
- Truss depth 1.0 – 1.4m desirable so the truss becomes part of the safety barrier system (but does not obstruct views).
- Welded marine-grade aluminium (6061-T6, 6063-T6 etc.) is light weight and suited to coastal and remote locations. It also performs well at low temperatures.



- Design to AS 1664.1 (limit state), analysis with Space Gass
- The top chord buckling mode and FoS determined using S.G.
- Tension in lower chords, particularly at butt welds, checked using welded alloy properties – often critical
- The structures are relatively stiff (Span/600)
- Resonant frequencies checked using S.G.
- AS 5100.2-2017, frequencies >5 Hz do not need to be investigated further (was 3.5Hz in the 2004 code)
- Thermal expansion/contraction is significantly higher for aluminium compared to steel



- Several 24m spans have been installed by crane at coastal sites accessible by vehicles
- To date, longest span installed by helicopter is 19m (very remote location on the South Coast Track)



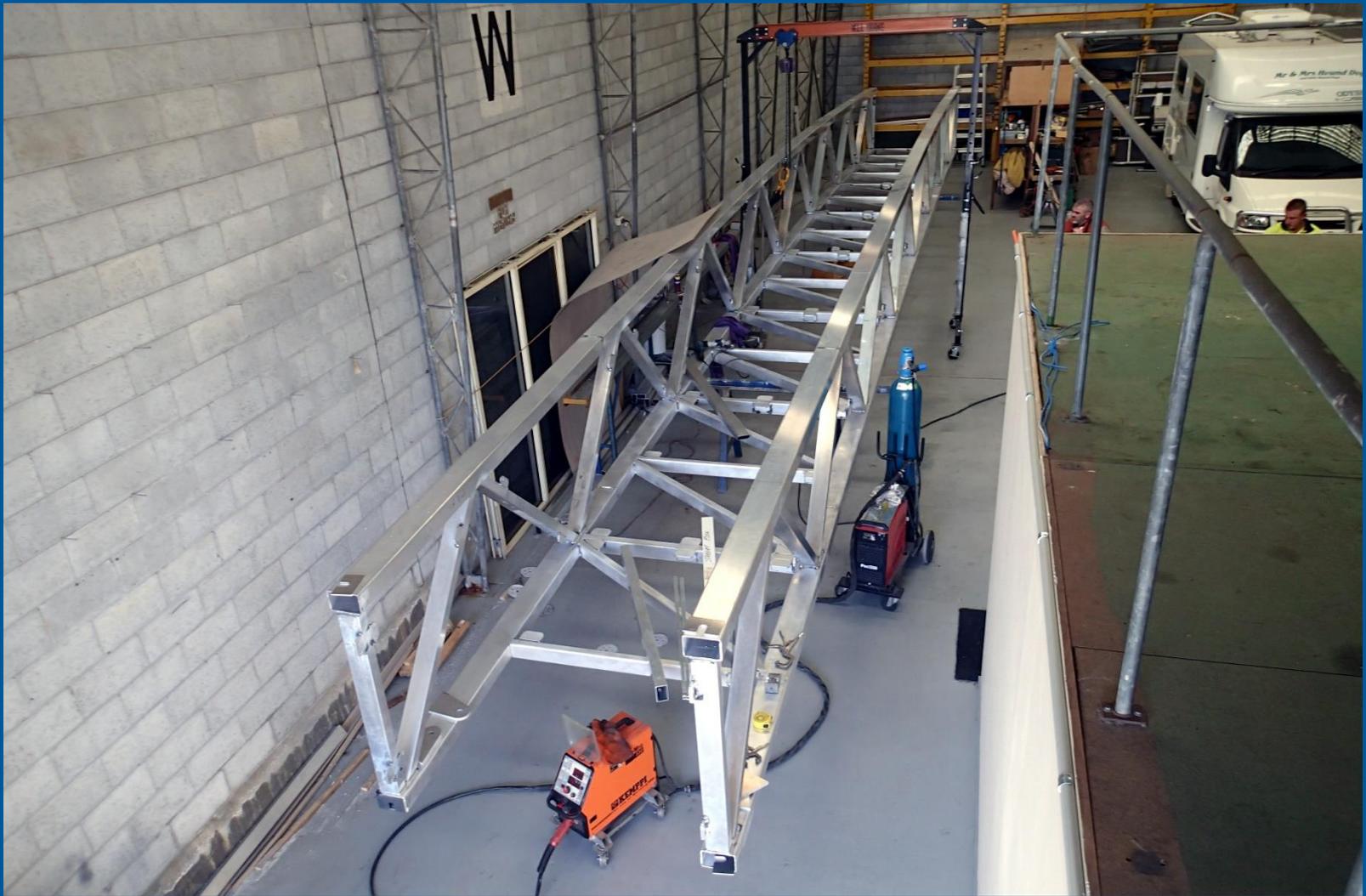
# Case study: Enchanted Bridge, Cradle Mountain



Previous structure (18m length with 2 intermediate piers)



Extensive freeze/thaw splitting, combined with other deficiencies, resulted in a recommendation to replace the structure after only 20 years in service.



Aluminium walk-through truss under fabrication, length 18m, mass 850kg



Heli lift from local base (AS350 B3 “Squirrel” helicopter)



The truss is lowered to tree top level, where ground crew can reach guide ropes.

Ground crew (both sides of river) use guide ropes to help manoeuvre structure through tree canopy. Radio communications are maintained with pilot throughout.



The structure is positioned on the existing abutments (with adapter brackets)



Decking and barriers are installed (timber recycled from the previous structure)



The project was completed for about \$80,000 (including helicopter).



First snowfall of the season



## Conclusion

- In the past 20 years there has been a dramatic improvement in the standard of design, inspection and management of walking track infrastructure in Tasmania, largely driven by the adoption of professional engineering services.
- As well as being of general interest to civil/structural engineers, it is hoped that this paper will demonstrate the significant value offered to land management authorities by professional engineers.