TECHINIQUES and MATERIALS – a new column

- Andy Spate and Deborah Carden

Some members may recall that I recently posted some ideas for a 'materials and methods column' to appear regularly in our Journal. I received a number of (largely) enthusiastic responses. Deb Carden was particularly interested and offered her help.

There were a number of papers presented at the (very successful) New Zealand conference that addressed the sorts of things I was canvassing – the need for us to exchange ideas and information on what we do in the development of show and adventure caves.

Two in particular stood out for me – those of Dan Cove on the how and why of the redevelopment of Lucas Cave at Jenolan and Jonathon Woods and Michael Kidd's fascinating paper on the use of optic fibre lighting at Kelly Hill. Ernie Holland and I used to fantasize about a solar-powered cave – i.e. the light of sun directly delivered via optic fibre – the concept is getting closer! Claire Baker, Steve Reilly, John Ash and Peter Chandler also presented informative papers on the nuts and bolts of cave development.

Conference attendees ***(=DELEGATES!!)*** will recall me talking about the suitability of various meshes on boardwalks to reduce slipping. This is of direct relevance to many of us – specifically in the case of my asking to try and help Brian Clark at Mulu, and potentially the management at Niah Caves (also in Sarawak), with the slipperyness of the many kilometres of their boardwalks. We need to swap ideas about costs, ease of installation, environmental implications, durability in terms of foot traffic and environmental breakdown, maintainability and so on.

We also had a sort of workshop on the idea one evening at Westport. I am not sure where we got to that evening. But I believe that the sorts of things it would be useful to talk about are:

- what materials we use?
- why we used them?
- what were the advantages and disadvantages of them?
- what problems we encountered using them?
- what environmental considerations were there?
- the sources of materials?
- what were the comparative costs involved in using this material rather than others?

So in the great traditions of your Editor, Deb and I will be volunteering people to write about such things for this new column. However we would greatly appreciate 'non-volunteered' submissions – even if it's just a few words. For example, someone may have found a new source of 32 volt bulbs or noted that the agency for some plastic tread mesh has changed hands. Or that aluminium alloy grade xyz does not do what the salesman said it would. Do the copper swages on the stainless steel wires work? Practical things for practical people!

The first 'volunteer' is Pete Chandler giving us some ideas about what went into the (re)development of his *Te Ana o te Atua* – the Cave of the Spirit, at Waitomo. Not only has Peter provided great detail – but he has been brave enough to show you his budget… Thanks Peter. Contributions from the rest of you do not have to be this long – and I would like to know names and addresses of material suppliers.

DESIGN AND ENGINEERING OF PATHWAYS FOR THE PASSAGE OF TOURISTS

- *Te Ana o te Atua*- the Cave of the Spirit, Waitomo, NZ

- Peter Chandler

Introduction

The background for the recent development was presented at the recent conference. This article will deal with the 'nuts and bolts'

This abandoned stream cave, with its infill of volcanic ash sediments and limited rockfall, has a change in height of only five to six metres, 4.5 of this just inside the cave entrance.

Damage to the cave over nearly 160 years of human visitation, has been mainly limited to the sediment-covered floors, some broken stalactites and 1895-1945 pencilled graffiti signatures.

Choice of route into the cave

In this relatively simple cave, generally between two and eight metres wide, there was not a huge amount of choice! The following principles were adopted:

- Use existing routes if they were suitable;
- Maximise distance away from walls;
- Maintain gentle gradients;
- Avoid low stalactites;
- Avoid speleothems on the floor;
- Only going as far as relevant to the visitor experience;
- Choosing assembly points relevant to the proposed experience (in and out); and
- Joining these points with aesthetically pleasing curves

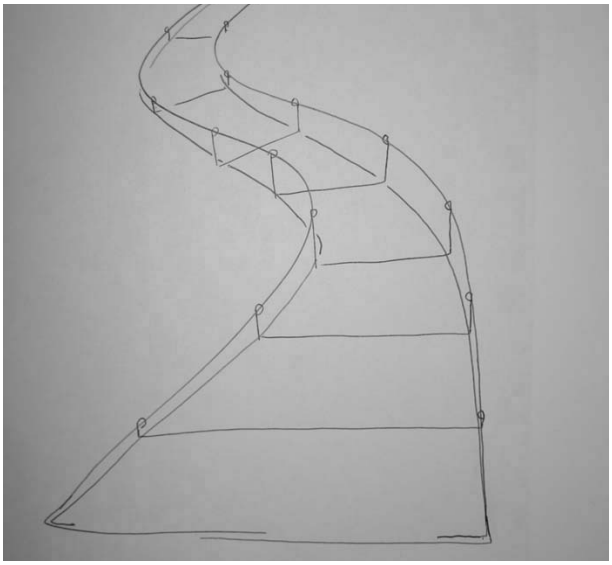
Above – before. Below – after.

Choice of materials

Concrete

- Cost effective with ease of access to site, acceptable because of degraded nature of cave floor, minimal increase in floor height through low sections.

Laying Concrete in the cave



16 M X 0.9 M S.S. Framework 6 and 10 mm. 3.0 mm lengths welded together. Other joins are (hot) bent loops and plastic cable ties.

Replas (recyled plastic) planking

- Grey colour similar colour to concrete
- Suited to raised/ramped sections rather than say suspended concrete sections.

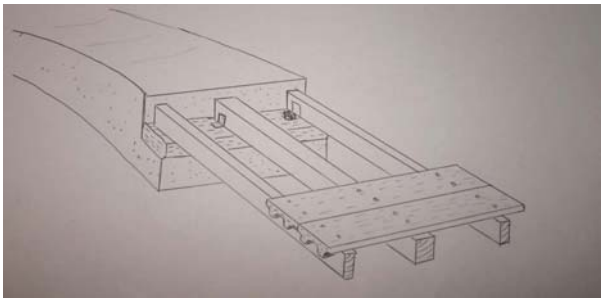
Stainless steel

- Used extensively to minimise amount of galavanised steel both for reinforcing in concrete and for fixtures and fittings(felt that 304 Grade was acceptable here, some items only available in 316 Grade)

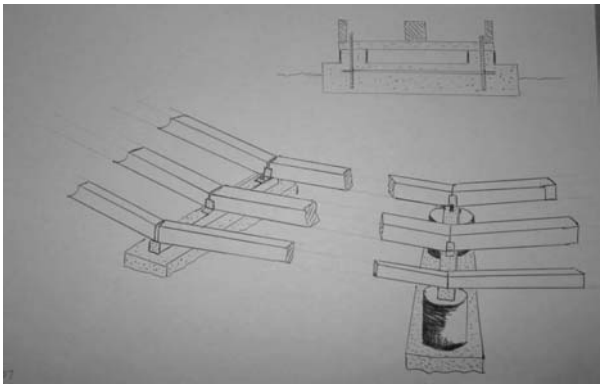
Treated timber

- Stringers to support Replas planking on ramped sections (estimate 10+ year life, with planned replacement at or before this time.
- Mitigated by using dried, sealed(painted) timber, using grease to seal any drill holes or screw threads

Painted, sealed stringers being assembled. Four bolts can be used to attach handrail post if required. Note detail on replacement stringer



General Pathway section. Concrete raised with timber Stringers. Replas 175X75 Bearer, Stainless Fittings Replas 195X50 Jetty Planking – Grey with timber grain surface.

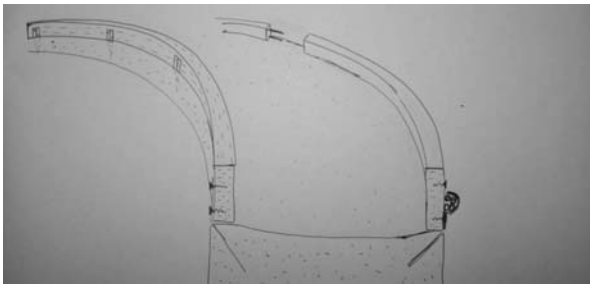


Stringers joined on low concrete pad / Elevated on 200 mm pillars / Cross section of latter.

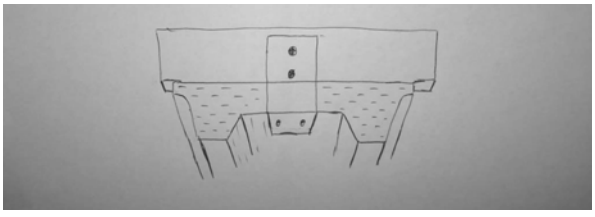
Choice of materials - secondary structures

Kerbing/Edging

- Replas 70 x 20 mm grey. Used on entire walkway except 18 metres in cave entrance.



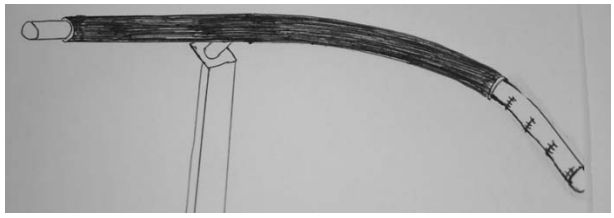
View of Replas Kerbing detail, cables attached on RHS, 6mm S.S rod sockets (back), attached to concreted in fixtures each 750mm



View of 150X60X4 S.S. Bracket attaching Replas Kerb to Replas decking

Lighting

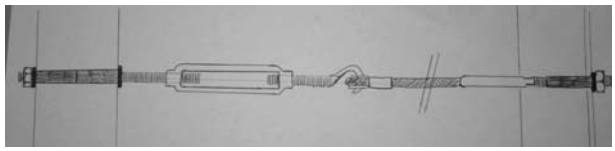
- Stainless steel 12v halogen lamp holders, 240v cables in black alkethene trunking through concrete sections.



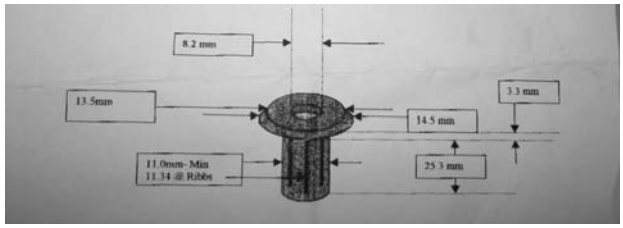
Handrail detail showing cut, bent and welded S.S., under ¾" / 20 mm black LDPE waterpipe, with 10 mm fixing bolts and sleeves.

Handrails

- Stainless steel enclosed inside black LDPE waterpipe, guide rails only, not significant fall hazard - deemed acceptable in small supervised groups.



Left to Right - 8mm threaded rod through 2X Grommets in 50X50 S.S. Post, S. S. Turnbuckle, Reverse Thread Hook-Thimble-Copper Talurit (Swage), Swage Stud (80T press)-1XGrommet through 50X50 S.S.Angle.



Black plastic grommets dimensions

Comments on techniques employed

Starting project in winter

- The main difficulty here was underestimating how impassable the 400 metre valley access to the cave would get. After rain in April 2004 it was clear that the soil would not dry out until summer. As a project that used our own 'Spellbound' staff, it made sense to use staff in low season, though with delays, most work was done in spring.

Starting from outside

- Only working on sections accessible, and using the new path for access minimised the mess and extra work.

Quantity estimates

- With imported goods such as Replas planking this was critical to getting the path finished.

Almost finished bridge structure

Refinement of the design as we go

- The handrails have evolved, to a design we are very happy with, as most were not required. This will require changing one nine metre handrail (but not the uprights) completed in December to March.
- With some extra crystal ball gazing, some handrail post attachment sockets could have been incorporated into the concrete paths.

Budget

- This was open ended, though we were confident we could keep the price per metre down and have a result that followed best practices.

Completion date

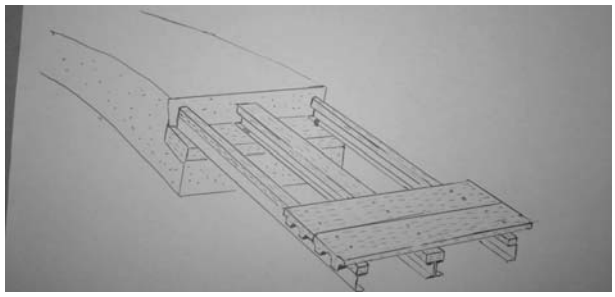
- Originally planned to be 1 October. Mainly completed by 1 December, opened with a brochure on 26 December 2004, (still finishing off the fine details – non-essential handrails)this winter.

Concreting

- All concrete sections are dished to contain drip and wash-water directed to sediment traps- these do not contain all wash down water, little washing down is required.
- Stainless steel bottom plate fixing anchors were spaced every 0.75 metres to attach kerbing.
- The first 18 metres has an exposed aggregate finish, originally more was planned for, but not done, because of:
    - extra time needed to finish concrete in a challenging environment
    - work required to contain wash-water
    - brushed finish is a similar shade to grey Replas.
- Concrete was placed in 20-metre manageable sections of pathway, using conveyor matting and short scaffolding type planks to access far end of each section by wheelbarrow.
- Access along each side was minimised, on polypropylene carpet mats and thereafter passage only on path. Partly cured paths were protected by this carpet. Regular washing of it minimised the mud that inevitably made its presence known.

Finishing off

- Timber stringers (3.0 metre maximum) can be replaced three at a time, section by section, by having one lay-on-top walkway section that could keep tours operational. Stainless steel channel sections, with a 50 mm thick Replas block on top to receive screws holding the decking down. If timber stringers are used as patterns, no underground stainless fabrication would be required.



4 of 100X75 4mm S.S. with 50X50,50X100
Replas fixed on top, to receive decking screws

COSTS FOR DEVELOPMENT OF *TE ANA O TE ATUA*
- 250 METRES OF PATH — August - December 2004

	Invoices	**Wages**		**Total**	Per Metre	
Cave pathways	32769.20	52112.00		84881.20	$339.52	Per Metre
Kerbing- edging	5313.00	2884.00		8197.00	$32.79	Per Metre (2 sides)
Lighting	10699.00	5092.00		15791.00	$63.16	Per Metre
Handrails	3000.00	407.00	not completed	3407.00		
				$ 112,276.20		

Does not include cost of track to cave or equipment/ tools .

Note -Does not include administration and transport expenses

Wages do include holiday pay and ACC Levies

Some materials are left over

Does not include finishing off work of handrails and lights and ongoing maintenance and restoration.

Concrete-16 cubic metres ready mixed, 21 cubic metres mixed outside cave.

All wheel-barrowed in.

Approximately 5 metres of path per cubic metre of concrete - including footings

Approximately 0.15 cubic metre of concrete for each footing on raised sections.