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Mt. Hotham Skiers Bridge

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Summary At Mt. Hotham in Victoria, a skiers bridge has been completed which now provides a continuous downhill path for skiers from the summit to Swindlers Creek Valley. High strength polymer geogrids were incorporated within the precast concrete abutments to reinforce the backfill material. The concrete panels were cast off site with the facing consisting of a series of randomly spaced graduated sized rock, and hand painted with muted tones of orange, red and brown. The panels were transported to site and erected in April 1995, in time for the 1995 ski season.

1. INTRODUCTION

The ski slopes in North East Victoria have long been a popular destination for Victorians and tourists alike. Abundant snow that falls between June and September provides a recreational playground for both novice and experienced snow skiers.

The Mt. Hotham ski resort is situated at Hotham Heights about 370 kilometres northeast of Melbourne. Hotham Heights is the highest alpine village in Australia, (at 1,740 metres), and consequently has on average 1500 millimetres of snow falling per year. The resort also receives competition for tourists from the nearby Falls Creek resort and the Mt. Buller Village (the nearest snowfield resort from Melbourne).

As a consequence, the Alpine Resort Commission in 1994 decided to commit funding to capital works to improve the resort and stay ahead of their competition. These works involve constructing two new ski lifts, a realignment of the Alpine Road, and a forty metre wide skier's bridge. The bridge provides a track over the Alpine Road creating a run for skiers from the top of the summit to the bottom of Swindlers Creek Valley.

2. DESIGN

The Alpine Resorts Commission called on the services of VicRoads (Bridge Division) to design the skiers bridge. The proposal called for a 40 metre wide bridge consisting of a corrugated steel arch supported at its end by a series of precast concrete panels reinforced with geogrids. The properties of these geogrids are shown in Table 1. The panels vary in height from 3.6 to 10.8 metres and have a nominal width of 2.5 metres, as shown in Figure 1.

The design loading on the corrugated steel arch and precast concrete end walls include normal earth pressures, an allowance of one metre of snow over the top of the steel arch, along with a 4 kPa pedestrian (skiers) load. An additional allowance for a 12 tonne emergency vehicle (used during summer conditions) was catered for.

The panels actually tilt up towards the summit and have all been hand painted with muted tones of orange, red and brown. A series of randomly spaced rocks are fixed into the face of the panels to enhance the aesthetics and keep with the environmental theme, as shown in Figure 2.

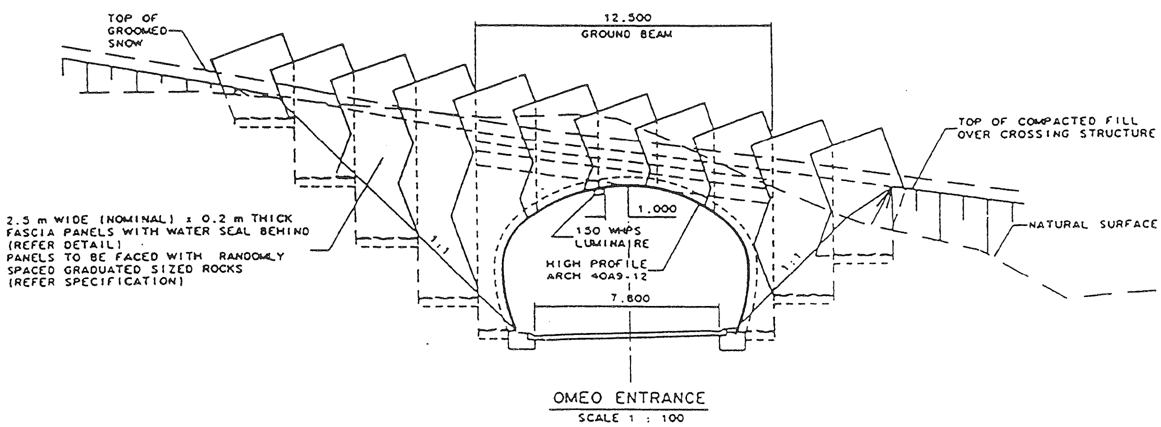

Figure 1. Elevation of precast panels.

Table 1. Geogrid properties.

Geogrid Type	Quality Control Strength (kN/m)	Creep Limited Strength (kN/m) × 10°C	Polymer	Weight (kg/m²)	Roll Dimensions (m)
S55RE	55	23	H.D.P.E.	0.4	50 × 1.3
S80RE	80	33	H.D.P.E.	0.6	50 × 1.3
SR110	110	45	H.D.P.E.	1.1	30 × 1.0

* Determined by the application of standard extrapolation techniques to creep data obtained in accordance with BS 6906 Part 5 for a strain not exceeding 10% in 120 years.

3. CONSTRUCTION

3.1 Works Program

The works were subject to a strict time frame to ensure construction was complete and the bridge ready for use by June 1995. Work on the site began in December 1994 with the realignment of approximately 340 metres of the Alpine Road. The pavement immediately under the bridge consists of a 200mm thick concrete slab. Incorporated in the slab is a heating device to ensure that any snow that blows into the tunnel melts almost immediately, and doesn't cause any access problems. The steel arched structure was immediately erected over the concrete pavement. The arch is approximately 42 metres long, has a width of 8 metres at road level, and a height clearance of 6.5 metres.

Once erected, the placement of permeable filling could commence. Against the steel arch, a layer of crushed aggregate, one metre thick, was placed to act as a permeable drainage layer. This would help dissipate any pore water pressure from within the fill material.

Filling around the steel arch and the reinforced filling required within the geogrid layers was listed in the Specification as: "a mixture of hard, durable clean sand and gravel or crushed rock, free from clay balls and perishable matter". It had to comply with the requirements given in Table 2.

All ring beams were then boxed and cast insitu. The base of each precast concrete panel would be "slotted" into these ring beams which would assist in holding them in place. A series of these ringbeams were constructed along the same line up the embankment, perpendicular to the centreline of the steel arch.

3.2 Pre-Cast Concrete Panels

3.2.1 Construction

In all there were twenty one precast panels to be constructed off site prior to their erection. All panels were cast flat, and required small "tailings" of geogrid to be fixed to the internal steel reinforcement, as shown in Figure 3). These "tailings" were then wrapped in plastic for protection. Graduated size rocks were dowelled into the face of each panel as per the architectural detail in the Specification. These rocks were sourced from

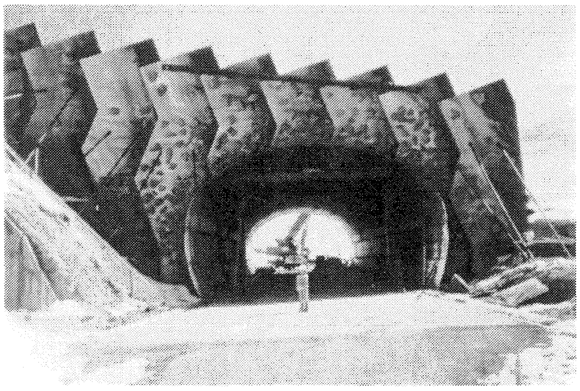

Figure 2. Omeo abutment panels erected.

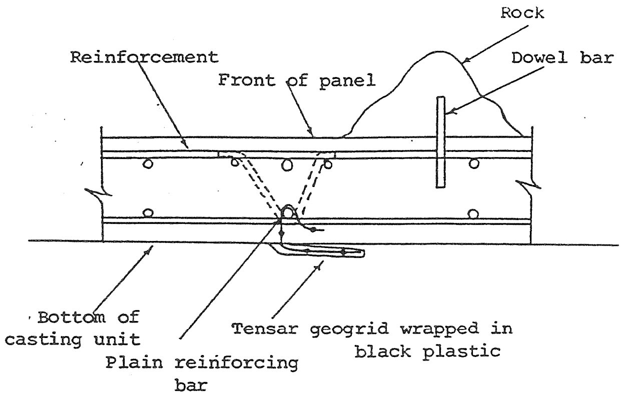

Figure 3. Cross section of panel being poured.

Table 2. Backfill specification.

LIMITS OF GRADING TEST VALUE (%) PASSING SIEVE SIZE AS (mm)				
53.0 mm	**37.5 mm**	**19.0 mm**	**4.75 mm**	**0.075 mm**
	100 %	0 - 15 %	0 - 2 %	

Glenrowan and transported to Swan Reach for use. The original design called for these rocks to be pushed into the face of the panel whilst it was curing. This was seen as inadequate as the freeze and thaw cycle on the mountain may cause the rock to break free of the panel.

Due to the unusual skewed shape of each panel, computer analysis had to be carried out to locate each panels' centre of gravity. This would ensure that the panels would not break when being loaded onto the trucks, and also during the unloading and erection procedures. Most of the panels had at least two lifting points to ensure against breakage. Once these procedures had been carried out, the panel was cast and allowed to cure.

3.2.2 Erection

On arrival at the worksite, the panels were unloaded using a mobile crane, as shown in Figure 4. The unloading procedure was slow and tedious to ensure the safety of the panels. Before lifting, the upper end of the props were fastened to the panel, as shown in Figure 5. Panels were lifted and guided into place using ropes. The panel base was guided into the ring beam and then propped using standard building props, as shown in Figure 4.

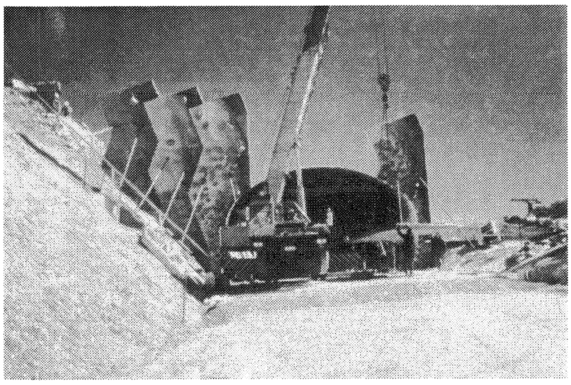

Figure 4. Panel being unloaded on site.

The three internal panels over the top of the arch required a different fixing method. The design called for these panels to be fixed to a concrete ground beam using a 20mm diameter galvernised rod, as shoen in Figure 6. This was placed behind the panel within the compacted fill. These panels were temporarily held by a steel I beam placed in front of the panels. This was later removed after construction was complete. The erection procedure continued till all twenty one panels were in place.

3.2.3 Backfilling

Once the erection procedure was complete, attention was given to the backfilling procedure. The design called for the panels to be reinforced with geogrids. The geogrid length from the back of the concrete panel ranged from 3000 to 6000 mm, with vertical spacings at either 400 or 600mm, as shown in Figure 7.

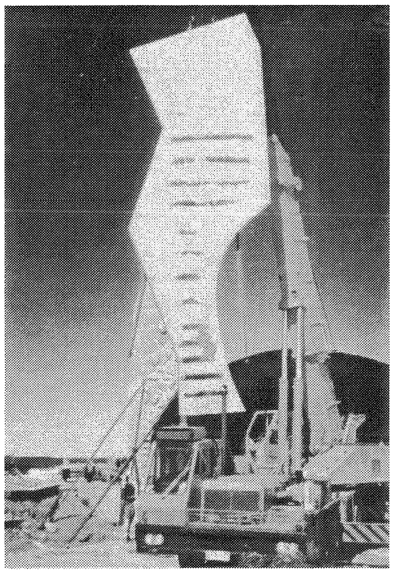

Figure 5. Rear view of panel.

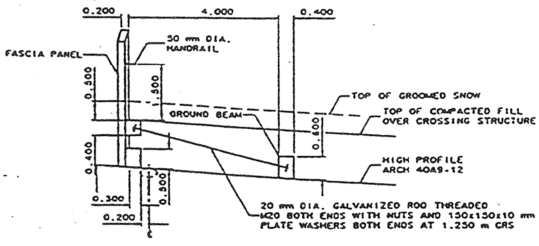

Figure 6. Ground beam anchor detail.

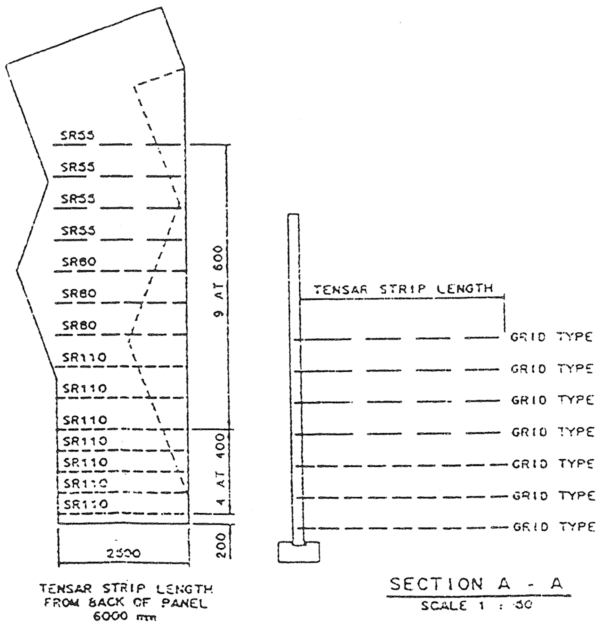

Figure 7. Elevation views of reinforced panel.

On site these geogrid lengths were connected to the "tailings" protruding out of the back of each panel, as shown in Figure 5. The connection detail consists of a plastic bodkin which is weaved alternatively between each grid aperture to provide a positive connection. Prior to this connection taking place, the black plastic protecting the tailings had to be removed. In some cases it also involved removing small amounts of concrete that had cured over the plastic. This was removed simply with a hammer and chisel.

As the compacted fill layer reached the level of the geogrid, it was rolled out and lightly tensioned. Backfill material was then placed onto the geogrid and compacted by plant. Compaction lifts were limited to 150mm to ensure specification compaction rates were met.

3.3 Miscellaneous Works

After the panels had been propped and backfilled, minor concrete and drainage works were carried out to complete the job. With the onset of winter and snow approaching quickly, there was an urgency to finalise the project.

4. CONCLUSION

A geogrid reinforced precast concrete panel skiers' bridge has provided an opportunity for skiers at Mt. Hotham to ski continuously from near the summit to Swindlers Valley below. From an engineering point of view it proved to be a challenging project for both the designers and the contractor.

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3. Harold Stadelmann - Stadelmann Enterprises

6. REFERENCES

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