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Development of Melbourne Docklands

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Summary Melbourne Docklands is a spectacular inner city waterfront development, which over the next decade will transform an underused area of docks to a mixture of residential, business, retail and sporting precincts. The Stadium Precinct will see the development of a world class sports stadium that will accommodate 52,000 seated spectators to view AFL football, rugby and soccer events. To assist the construction of the stadium, an engineered construction platform was required over the soft compressible fill, in order to allow piling rigs to traverse over the site to drive piles for the main stadium. The earthworks contractor used a series of Tensar biaxial geogrids, after suitable site trials, in order to ensure the required construction platform achieved its primary function. The paper details the background of the site trials, results and conclusions of the engineering techniques adopted.

1. INTRODUCTION

Melbourne Docklands is a spectacular inner city waterfront development next to the heart of Melbourne. Over the next decade the existing site, which consists of a semi-industrial, inaccessible and underused area of docks and storage yards, will be transformed into a friendly and livable environment. It will constitute Melbourne's biggest urban/architectural undertaking since the pegging of the city grid. It will transform urban settlement west of Melbourne between Spencer Street and Port Philip Bay and anchor the developments along the Yarra River bank, including the Melbourne Exhibition Centre, Crown Casino, Southbank and the proposed Federation Square.

The development of the site is being coordinated by the Docklands Authority, a division of the Victorian Government. The site consists of a total area of 220 hectares (of land and water) including seven kilometres of waterfront. It has high accessibility from the CBD, together with direct arterial links with greater Melbourne. The current construction of the Western Link, which includes the spectacular 350 metre long City Link bridge, will provide a western boundary to the precinct, as well as a direct freeway link to Tullamarine Airport.

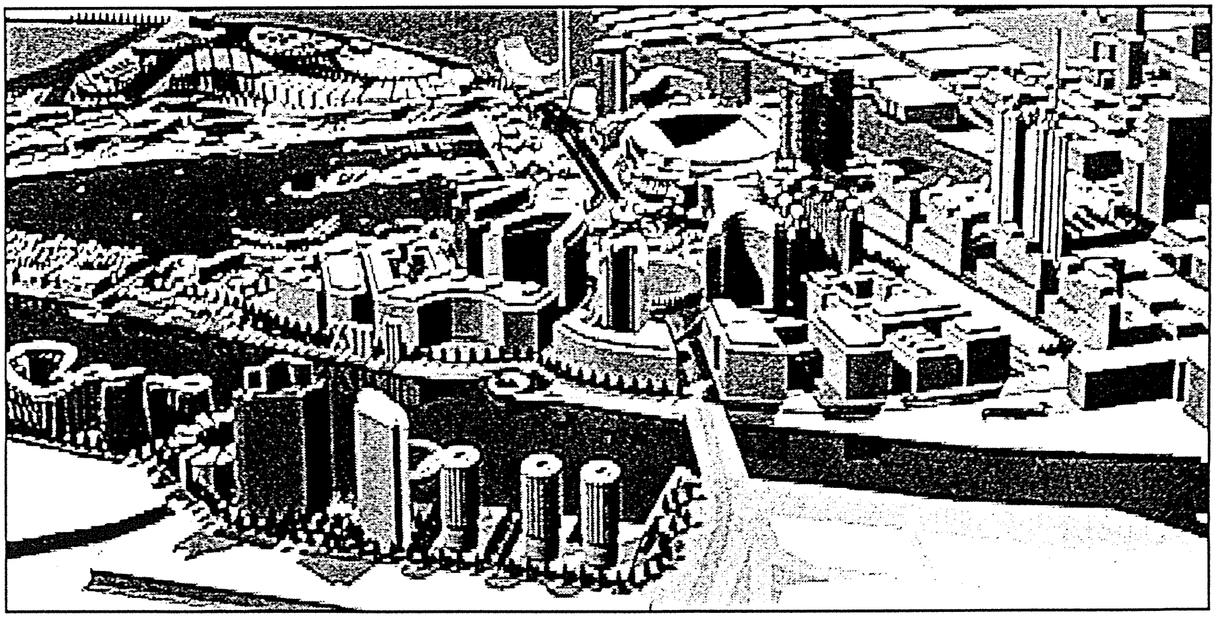

Figure 1. Docklands overview.

2. PRECINCTS

The docklands area has primarily been broken up into seven precincts. (see figure 2):

Business Park: location for corporate headquarters and new growth industries.

Victoria Harbour: set aside for hotels, shops, cafes and maritime developments. This precinct is likely to make the most of the waterfront.

Yarra Waters: could become Melbourne's prime waterfront residential address. Expected to take advantage of its northeast aspect as its situated on the south bank of the Yarra River.

Batmans Hill: to consist of a mix of residential, commercial and leisure areas.

Technology Park: dedicated to new technologies - information, multimedia and communications, technology, together with educational development.

West End: a unique area that could house offices, residential, retail and transport activities. This precinct forms the gateway between the CBD and the Melbourne Docklands.

Stadium Precinct: a world class sports stadium that will accommodate 52,000 seated spectators. It will feature a permanent roof over seating areas and a retractable roof over the playing arena. (See figure 3).

3. DOCKLANDS STADIUM

3.1 Announcement

On 1st September 1997 the winning bidder to build the high technology sports and entertainment stadium was announced. To be built at an estimated $400 million dollars, it will be built and operated by the Docklands Stadium Consortium.

It will be the first multipurpose stadium of its type ever built in Australia. It will have a retractable roof and adjustable seating layouts to provide spectators with optimum viewing for all sporting events. It is envisaged the stadium would be able to cater for Australian Rules football, soccer, rugby and other major sports and entertainment events.

3.2 Construction

Construction of the Docklands Stadium began on the 8th September 1997. Baulderstone Hornibrook, as one of the members of the consortium, are acting as project managers. The stadium will basically consist of a two level concrete structure founded on a series of concrete piles. The immediate two levels will act as a carpark for patrons, with the sports ground being constructed on the top concrete slab. The grandstands will then be built at ground level and surround the main playing arena.

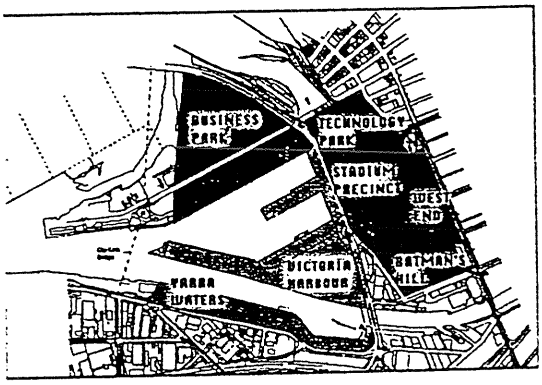

Figure 2. Docklands Precincts.

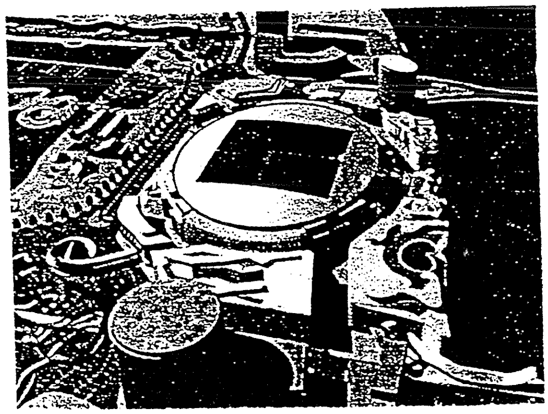

Figure 3. Sports Stadium.

3.2.1 Soil Conditions

Geological conditions vary across the Melbourne Dockland site. Over the stadium precinct, areas of imported fill are evident. The layer of fill has a typical depth of between one to three metres. Along the eastern edge of the precinct the fill overlies a ledge of basalt rock 4 - 10 metres below the surface. Elsewhere over the site, the fill overlies a layer of soft to firm silty clay which varies in depth from 10 to 30 metres. This silty clay is more commonly known as Coode Island silt and extends from the Melbourne CBD to the north of the Yarra River. The material was deposited 8,000 - 12,000 years ago when the area lay at the floor of a quiet river estuary.

Coode Island silt is highly compressible and has a record of variable settlement under load. The loads imposed by large structures can result in unacceptable amounts of settlement, unless appropriate countermeasures are taken. The stadium structure is to be founded on the basalt bedrock. This occurs at depths up to 12 metres.

Ground water levels across the site are largely controlled by the water levels in Moonee Ponds Creek, the Yarra River and Victoria Dock. Levels may be as much as 8-10 metres below ground level, and founded in either the fill layer or the underlying Coode Island silt.

3.2.2 Earthworks Trial

The contractor is responsible for letting out all works packages for the project. The earthworks package was let to the earthworks sub contractor. Their scope of work was to remove areas of low contaminant fill material and replace with appropriate structural fill. This construction platform would then be used by piling rigs to drive thousands of concrete piles into the fill, to allow construction of the main concrete structure.

Before any earthworks operations took place, it was evident that the structural fill being used to replace the contaminated fill on site, would not withstand the loading imposed by the piling rigs. This was due to the fact that the structural fill would be underlain by Coode Island silt, which typically exhibited a C.B.R value of 1-2%.

Two options were presented to the earthworks subcontractor in order to ensure the structural fill was adequately reinforced. These options are presented in Table 1 and Figures 4 and 5.

Pavement	Option 1	Option 2
Subgrade C.B.R	2%	1%
Axle load	100kN	100kN
Geogrid	SS30 biaxial 30kn/m	SS30 biaxial 30kN/m SS20 biaxial 20kN/m

Table 1: Reinforced pavement options.

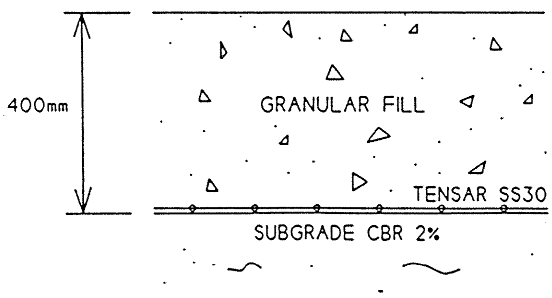

Figure 6. Reinforced pavement option 1.

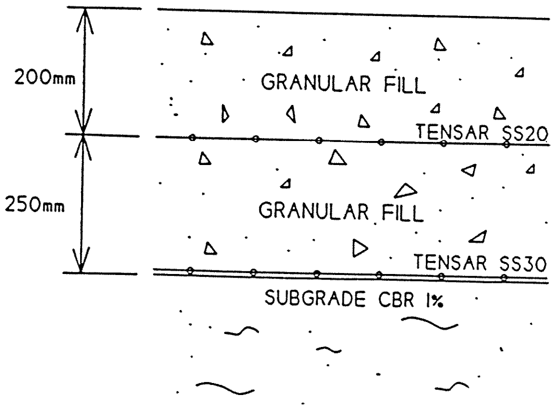

Figure 7. Reinforced pavement option 2.

Of the two reinforced pavement designs presented to the earthworks contractor the first, comprising one layer of Tensar SS30 was incorporated in a site trial. Options two was not considered and as a third option, the earthworks subcontractor decided to incorporate one layer of Tensar SS20 instead of the SS30 as depicted in option one. This option was not considered as structurally adequate as option one, and the SS20 was expected to fail prematurely. An area approximately 25 x 10 metres was set aside. Two 16 metre lengths of Tensar SS20 and SS30 were laid side by side (see Photo 1). The control section with no reinforcement was placed south of the Tensar grids for a distance of about 9 metres. A 600 mm layer of 20 mm minus structural fill was then placed over the entire area. This fill was deemed to be structurally suitable and it was also available onsite.

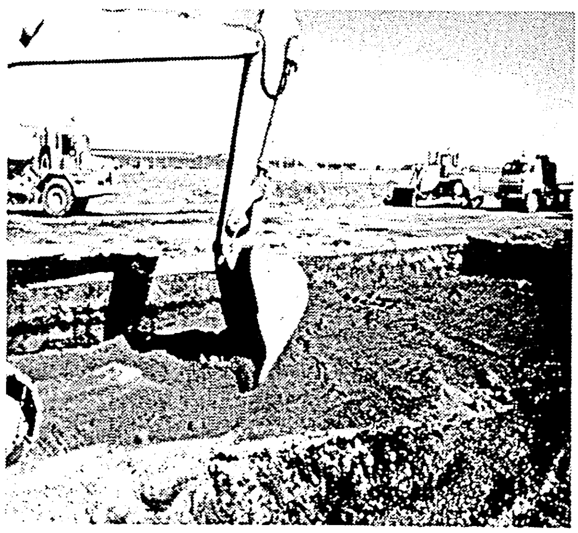

Photo 1: Laying of Tensar SS20 and SS30 under fill. Tensar SS20 placed in background and SS30 next to it. Control section is to the left (out of picture).

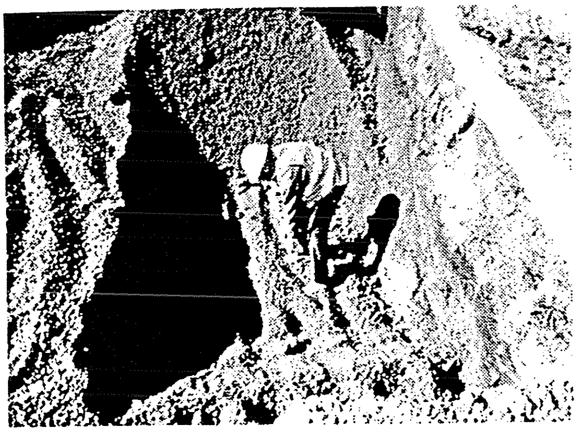

Photo 2: Location of SS30 prior to backfilling with 20mm minus fill.

Once the area was practically level, a 60 tonne excavator was used to compact the fill. The excavator made approximately 30 passes over the entire length of the trial site (Photo 3).

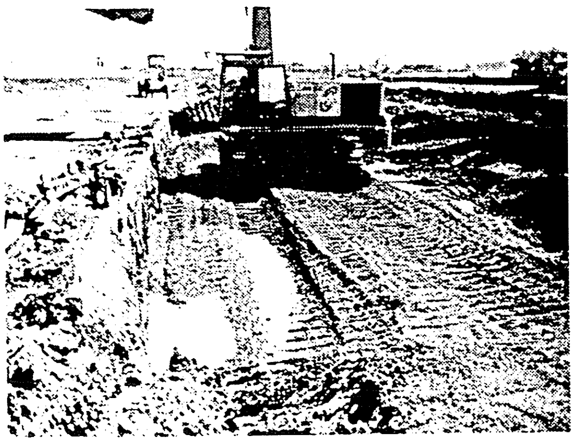

Photo 3: Compaction of the trial area. Note the deep rutting and pumping of groundwater.

Rutting was evident over the length of the trial site. An observation onsite was the movement of fill material when the excavator traversed from the reinforced to the unreinforced section. Continual pumping up of ground water was especially evident in the unreinforced section (Photo 3).

At this point it was decided to add 200mm of fill over the trial area and recompact. After another 30 passes the pumping of groundwater up into the fill layer was evident over the entire trial site. The excavator then exhumed part of the reinforced section to expose the Tensar grids (Photo 4).

This showed that a rupture failure had occurred with the Tensar SS20 geogrid (Photo 5). It was commented that this was probably due to the excessive number of passes from the 60 tonne excavator, and the low C.B.R value of the subgrade. There was evidently no damage to the Tensar SS30.

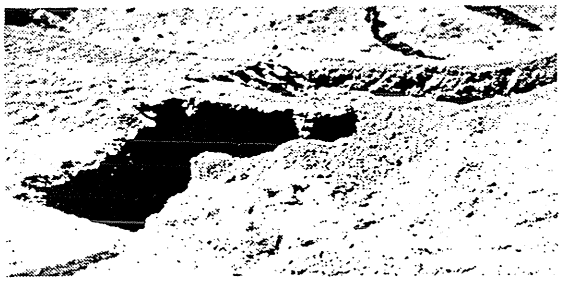

Photo 4: Exhumed Tensar SS20 (in foreground) and Tensar SS30 (in background).

Photo 5: Exhumed Tensar SS20 showing rupture failure.

The main conclusion drawn from the site trial was that a reinforced pavement was required, and a 'do nothing' option was unsatisfactory. The unreinforced section of the trial had failed prior to the placing of the 200mm layer of fill.

Consequently the earthworks contractor decided to adopt Option One : a layer of Tensar SS30 under 400mm of 20 mm minus structural fill material. Option two which incorporated two layers of geogrid (SS20 and SS30) was considered uneconomical.

3.2.3 Earthworks

First task onsite was to remove 100,000m^3 of low contaminant fill. A total of 90 trucks (truck and trailer) each with a capacity of 20m^3 were used to transport the fill at a rate of 12 trucks/hour. This resulted in almost 3000m^3 per day being transported offsite to a landfill.

Once the subgrade area had been prepared, a layer of Tensar SS30 geogrid was placed down and overlapped 300mm. Structural fill was then dumped and spread over the grid to a compacted depth of 400mm (Photo 6).

Photo 6: Tensar SS30 underlying structural fill.

4. CONCLUSION

Overall 70,000m² of Tensar SS30 was used to provide a reinforced platform for piling rigs over the Dockland site. The client was satisfied as the use of geosynthetics provided a solution which avoided digging out large amounts of Coode Island silt and replacing with imported rock. Overall the reinforced area was prepared and placed over a six week period.

5. ACKNOWLEDGEMENTS

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