Sustainable Concrete for Paths on Glenroy Level Crossing Project

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Introduction

North West Program Alliance (NWPA) has been developing and delivering Level Crossing Removal Projects since 2016. This Alliance is made up of John Holland, KBR, Level Crossing Removal Projects and MTM.

These projects have a significant amount of scope in rail and heavy civil construction. However, these projects are in community centres and often enable opportunities for enhancement to railway stations, landscaping, and carparks.

NWPA have recently successfully delivered the Bell to Moreland level crossing removal which includes four level crossing removals on the Upfield line in the suburb of Coburg: Moreland Road, Reynard Street, Munro Street and Bell Street. During the development phase, the scope was broadened to include a new footpath and cycle path for the significant length of this project. The opportunity to utilize sustainable concrete in these paths was realized by incorporating recycled macro synthetic fibre and eliminating the need to use steel reinforcement mesh. At the time eMesh fibres supplied by emesh (previously known as Fibrecon) had been used for paths in Victoria, however this was the first time it was used as part of Victorias 'Big Build' program, and the first time used as part of a Level Crossing Removal Program.

Following the successful use of eMesh for Bell to Moreland, NWPA were keen to incorporate it for subsequent projects. Based on lessons learned Glenroy Road LCRP implemented eMesh fibres with a concrete with high supplementary cementitious materials (SCMs). The development of this concrete mix (ECOPact by Holcim) to be suitable for incorporating eMesh met the requirements for use in a path application. The sustainability benefits from this were increased and form the basis for design of paths for NWPA projects moving forward.

Bell to Moreland Experience

The level crossing project at Bell to Moreland Level Crossing Removal included a shared path/cycle path of approximately 2.2km which runs through the linear park under the rail viaduct and for the extent of section of elevated rail.

Typically, NWPA would deliver a Shared path/Cycle Path in accordance with Councils standard drawings. This would consist of a 125mm thick concrete path and SL72 reinforcement.

During the design the requirement was waived on the basis the macro synthetic fibres would replace the reinforcement mesh in the design and would provide equal or better performance. In this case the dosage of eMesh macro synthetic fibres at 4kg/m^3 replaced the steel reinforcement. Photo 1 and 2 below shows a section of this cycle path and shared use path. In this case the dosage of eMesh macro synthetic fibres at 4kg/m^3 replaced the steel reinforcement. Photo 1 and 2 below shows a section of this cycle path and shared use path.

Photo 1: cycle path under Upfield Rail near Munro St; Photo 2: SUP alongside Coburg Station

The sections of footpath was thinner with 100mm concrete thickness. Similarly, the eMesh fibre dosage rate was 4kg/m^3 which alleviated the need for steel reinforcement. Photo 3 shows the section of pedestrian path

Photo 3: Pedestrian path under Upfield Rail near Reynard St

The total new length of paths being 3.83km over a 2.1km length of linear park. The path types are described in Table 1.

Section / Type	Start Rail Chainage	End Rail Chainage	Min. Width (m)	Horizontal Clearance (m)
Shared Path	8200	8300	Existing	Existing
Shared Path	8300	8490	3.0	1.0
Pedestrian Path	8490	8670	1.5	0.5
Cycle Path	8520	8670	2.5	1.0
Pedestrian Path	8670	10250	1.5	0.5
Cycle Path	8670	10250	3.0	1.0
Shared Path	10250	10400	3.0	1.0
Shared Path	10400	10650	Existing	Existing

Table 1: Bell to Moreland LCRP path summary.

Figure 1 is a snapshot from the design drawings and details the path construction.

PAVEMENT TYPE 1 - CONCRETE FOOTPATH		
PAVEMENT LAYER	LAYER THICKNESS (mm)	MATERIAL
A	100	25 MPa CONCRETE WITH MACRO SYNTHETIC EMESH FIBRES APPLIED AT 4 kg / m³ AT 100mm SLUMP
B	50	20mm CLASS 3 CRUSHED CONCRETE OR REMNANT HARDSTAND MATERIAL
TOTAL DEPTH	150	SUBGRADE MIN. CBR 5%

NOTE:
CONCRETE HAS A ROUGH BROOM FINISH

PAVEMENT TYPE 2 - SHARED USE PATH / CYCLE PATH		
PAVEMENT LAYER	LAYER THICKNESS (mm)	MATERIAL
A	125	25 MPa CONCRETE WITH MACRO SYNTHETIC EMESH FIBRES APPLIED AT 4 kg / m³ AT 100mm SLUMP
B	50	20mm CLASS 3 CRUSHED CONCRETE OR REMNANT HARDSTAND MATERIAL
TOTAL DEPTH	175	SUBGRADE MIN. CBR 5%

NOTE:
CONCRETE HAS A ROUGH BROOM FINISH

Figure 1: Bell to Moreland LCRP path composition.

The calculated benefits based on removing reinforcement was considerable. Based on the estimation from eMesh below, the total project saving was 89.5 tonnes of carbon equivalent (refer to Table 2).

BELL TO MORELAND EMESH PATH SUMMARY: (source: emesh 21/5/2021)					
		Slab Depth	mm	125	
		Area	m2	7020	
Impact Category	**Unit**	**Emission totals Emesh**	**Emission totals - steel reinforcement**	**Emesh savings**	**% saved**
Global Warming	kg CO2 - eq	8775.000	79037.647	70262.647	88.90
Ozone Depletion	kg CFC11 - eq	7.420E-07	2.320E-03	2.319E-03	99.97
Eutrophication	kg PO4 - eq	2.924	69.186	66.262	95.77
Land Use	Ha.years	3.460E-02	2.830E-01	2.484E-01	87.77
Water Use	M3 H2O	17.294	1324.390	1307.096	98.69
Fossil Fuels	kg oil eq	1868.116	15510.822	13642.706	87.96
Minerals	kg Fe eq	24.837	492.210	467.373	94.95
Total Saving		70262.647	kgs of carbon eq compared to steel mesh		
		88.90	% of carbon eq compared to steel mesh		
		Slab Depth	mm	100	
		Area	m2	1878	
Impact Category	**Unit**	**Emission totals Emesh**	**Emission totals - steel reinforcement**	**Emesh savings**	**% saved**
Global Warming	kg CO2 - eq	1878.000	21144.259	19266.259	91.12
Ozone Depletion	kg CFC11 - eq	1.590E-07	6.200E-04	6.198E-04	99.97
Eutrophication	kg PO4 - eq	0.626	18.509	17.883	96.62
Land Use	Ha.years	7.410E-03	7.560E-02	6.819E-02	90.20
Water Use	M3 H2O	3.701	354.303	350.602	98.96
Fossil Fuels	kg oil eq	399.809	4149.476	3749.667	90.36
Minerals	kg Fe eq	5.315	131.677	126.362	95.96
Total Saving		19266.259	kgs of carbon eq compared to steel mesh		
		91.12	% of carbon eq compared to steel mesh		

Table 2: Bell to Moreland LCRP Emesh Savings Summary

Sustainable Path Design for Glenroy

Following the first use of eMesh on Bell to Moreland, NWPA were keen to re-use the eMesh design for the next programmed project which was Glenroy LCRP. This project was different in form in that it includes a lowered section of rail track which passes underneath Glenroy Road Bridge. The total area of paths was 2,258m^3 with a majority of these located in the public realm between Glenroy Road and the station entrance, and other paths constructed as connections to existing access points. Figure 2 shows the shape and extent of paths using eMesh/ECOPact Zero.

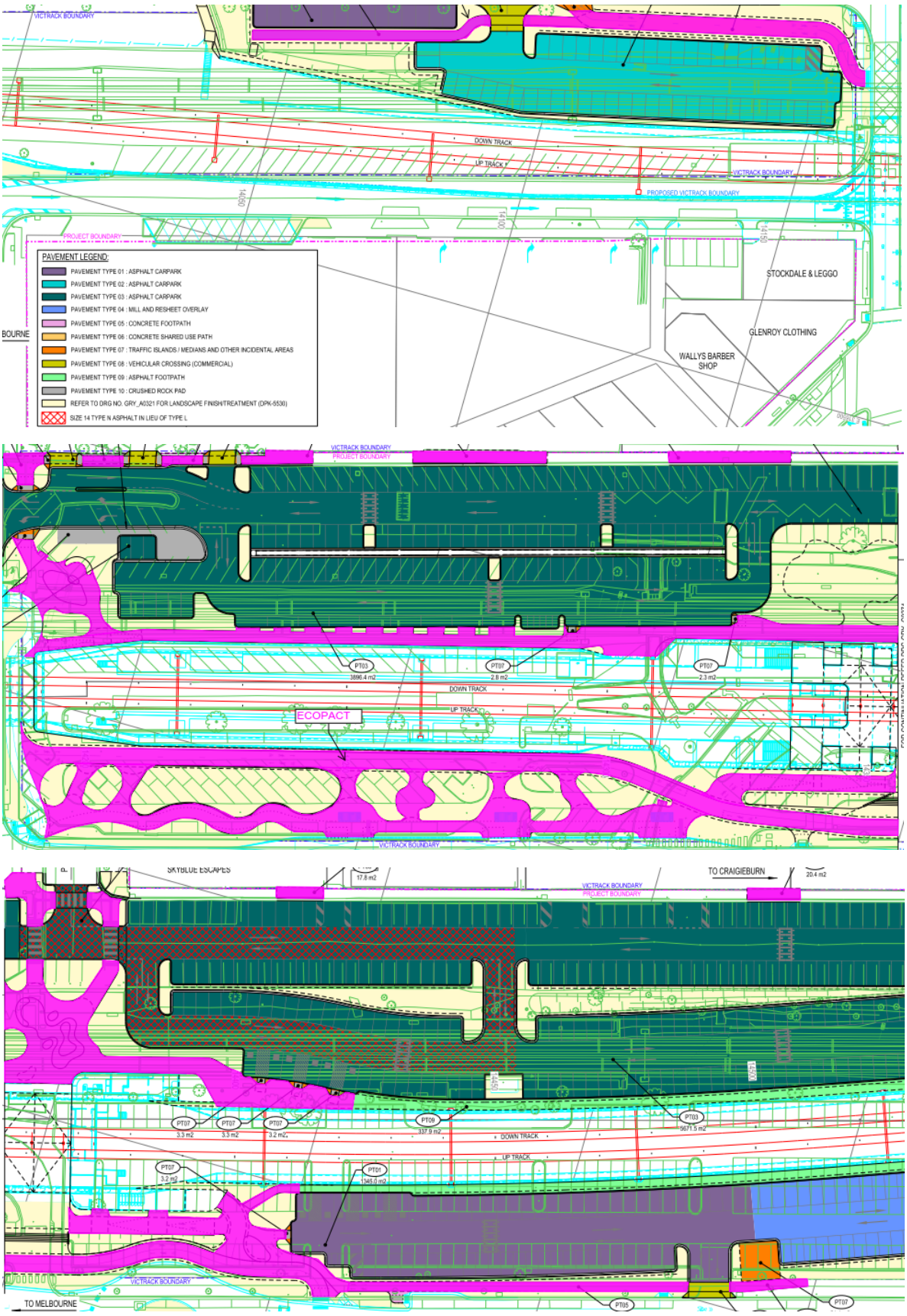

Figure 2: Plan Showing emesh/ECOPact paths at Glenroy LCRP

Similarly to Bell to Moreland, the concrete pedestrian path thickness was 100mm and shared use path was 125mm. Figure 3 is a snapshot from the design drawings and details the path construction.

PAVEMENT TYPE 05: CONCRETE FOOTPATH		
PAVEMENT LAYER	LAYER THICKNESS (mm)	MATERIAL
A	100	25 MPa CONCRETE WITH MACRO SYNTHETIC EMESH FIBRES APPLIED AT 4.0 kg / m³ AT 100mm SLUMP
B	75	20mm CLASS 3 CRUSHED CONCRETE
TOTAL DEPTH	175	SUBGRADE MIN. CBR 2%

NOTE: CONCRETE TO HAVE A ROUGH BROOM FINISH

PAVEMENT TYPE 06: CONCRETE SHARED USE PATH		
PAVEMENT LAYER	LAYER THICKNESS (mm)	MATERIAL
A	125	25 MPa CONCRETE WITH MACRO SYNTHETIC EMESH FIBRES APPLIED AT 4.0 kg / m³ AT 100mm SLUMP
B	75	20mm CLASS 3 CRUSHED CONCRETE
TOTAL DEPTH	200	SUBGRADE MIN. CBR 2%

NOTE: CONCRETE TO HAVE A ROUGH BROOM FINISH.

Figure 3: Glenroy LCRP path composition.

The extent of paths was reduced from that at Bell to Moreland LCRP, however the possibility to include a further sustainability initiative was identified. The concrete supplier Holcim has developed a sustainable concrete mix, ECOPact Zero which has benefits including a high percentage of up to 35% of supplementary cementitious material to replace the regular Portland cement in the concrete. This mix is compliant to VicRoads Specification 703, General Concrete Paving and successfully gained stakeholder approval from both MTM and Merri-bek City Council. This concrete was also able to accommodate the 4kg/m^3 of eMesh fibres.

With due care to construction, the impact of this high SCM contributed to a successful outcome for the project. The construction costs using this concrete was 7% higher than the standard footpath concrete with conventional mesh, however the offset carbon emissions saving more than accounts for this increase. Photos 4 to 5 show the construction of these paths.

Photo 4: Concrete after finishing; Photo 5: Broom finish applied during construction

The outcome can then be seen in Photos 6 and 7.

Photo 6: footpath alongside Hartington St

Photo 7: Shared Path alongside the Craigieburn Line Rail cutting

The increased saving from using ECOPact Zero on Glenroy LCRP saved 80.11 tonne of carbon. A proportional saving of carbon from the use of eMesh is approximately 22 tonne.

Conclusion

The use of macro synthetic fibres for both LCRPs has been successful and able to present savings in embodied energy used in steel reinforcement. The amount of carbon savings in both these projects due to the use of eMesh is over 110 tonnes. The eMesh product replacing steel reinforcement with dosage rate of 4kg/m^3 of concrete is significantly lighter, and being recycled, has additional sustainability benefits.

Following the use of eMesh for Bell to Moreland LCRP, the experience on Glenroy has demonstrated that paths of high quality can be constructed using concrete with high SCMs in ECOPact Zero, allowing further savings in carbon which would otherwise be embodied in cement. The carbon savings for this project by using ECOPact Zero is 80.11 tonnes. Across these two projects over 200 tonnes of carbon has been saved.

Future level crossing projects, and other infrastructure projects now have a precedence for a highly sustainable path design solution.

Acknowledgements

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