MAV/Australian Research Council research grant application
Low carbon footpaths with recycled materials and geopolymer concrete

Chief Investigators
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Research Background
This project will be collaboration between the Swinburne University and the Municipal Association of Victoria. ***This project will involve a new concept for Low Carbon footpaths with recycled materials in the base in combination with geopolymer concrete for the surfacing. The proposed research will be the first of its kind in the world in attempting to construct footpaths from recycle materials with low carbon emissions. Footpaths and pavements consume very large amount of virgin construction materials, hence this pilot study, if successful, will have significant national benefit in paving the way for new type of footpaths with low carbon emissions.***

2 new recycled materials for footpath bases

Demolition waste materials are a growing part of the community waste. Currently in Victoria, 1.4 million tonnes of crushed brick and 250,000 tonnes of crushed glass are stockpiled annually and these stockpiles are growing. Swinburne University has been actively undertaking research in the use of various recycled demolition materials as pavement sub-base and in other geotechnical applications. A recently completed research project by Swinburne University with demolition materials investigated the laboratory testing of crushed glass and crushed brick in blends of up to 50% with traditional footpath sub-base materials comprising of crushed concrete and crushed rock. The completed project was able to find a way to use up to 30% crushed glass and 50% crushed brick in footpath sub-bases, without compromising the quality of footpaths. Other research projects by Swinburne enabled VicRoads to allow new and rehabilitated roads to be made up of up to 15 per cent crushed glass and crushed brick (a significant increase on the current standards that only allows 3 per cent).

Traditional footpath and bicycle path building materials are becoming scarce in some regions. The use of these materials is unsustainable in the longterm both from an environmental and cost perspective. Crushing of virgin quarry aggregates is an energy intensive process and has a significant carbon footprint. Research carried out by Flower and Sanjayan (2007) showed that aggregates manufacture in Victoria releases at the rate 0.05 tons of CO_2 per ton of aggregates crushed. Further, the available quarries in Victoria are limited and supply of aggregates is diminishing. Using recycled materials in sub-bases has a carbon footprint 65% less than equivalent virgin quarry aggregates.

This has led to this proposed project to further investigate ***2 new recycled materials in footpath bases*** to follow on from the previous project and in this case with ***recycled asphalt and slag in footpath bases.*** The development of a procedure for the evaluation of these reclaimed products in footpaths and bicycle paths as a base, and sub-base material would result in an increased level of confidence within local government councils as to their likely in-service performance and appropriate application.

Geopolymer Concrete

Production of 1 ton of Portland cement consumes 1½ tons of raw materials and is responsible for the release of about 1 ton of CO_2 into the atmosphere. Portland cement production releases 9 million tons of CO_2 in Australia per annum. Worldwide, carbon emissions from Portland cement production is the third largest contributor to the human carbon footprint (highest is the liquid and gas fuels followed by coal). Further, the production of Portland cement worldwide is increasing 3% annually.

Utilisation of unused industrial by-products such as fly-ash and recycled crushed glass, which otherwise are dumped in land fills and contribute to land pollution, to make concrete without the use of any Portland cement will not only reduce the cost of construction materials but also

reduce the carbon emissions arising from Portland cement manufacture. Coal fired power stations around the world produce enormous quantities of fly-ash residues every year. Currently, 14 million tons per annum of fly ash is produced in Australia, of which only 10% is used for cementitious applications (e.g. Portland cement/fly ash blended cements, road stabilisation, low strength fills, asphaltic fillers etc).

This project aims to investigate the manufacture of Portland cement free concretes using fly ash and recycled crushed glass as a 100% substitute for Portland cement. This concrete is named ***geopolymer concrete***, and Swinburne researchers have successfully produced this concrete in the laboratory. However, the field applications of geopolymer concrete needs to be carried out so that construction industry can gain confidence in using this novel concrete. The use of geopolymer concrete to construct "low carbon footpaths" will provide new benchmark for construction industry to adopt low carbon construction methods. The proposed project is to develop mix designs suitable for footpath construction complying with the relevant local government and VicRoads standards. The mix designs will be based on locally available aggregates and fly ash. The research will also trial recycle concretes as aggregates for the concretes to further reduce the carbon footprint of the footpath construction.

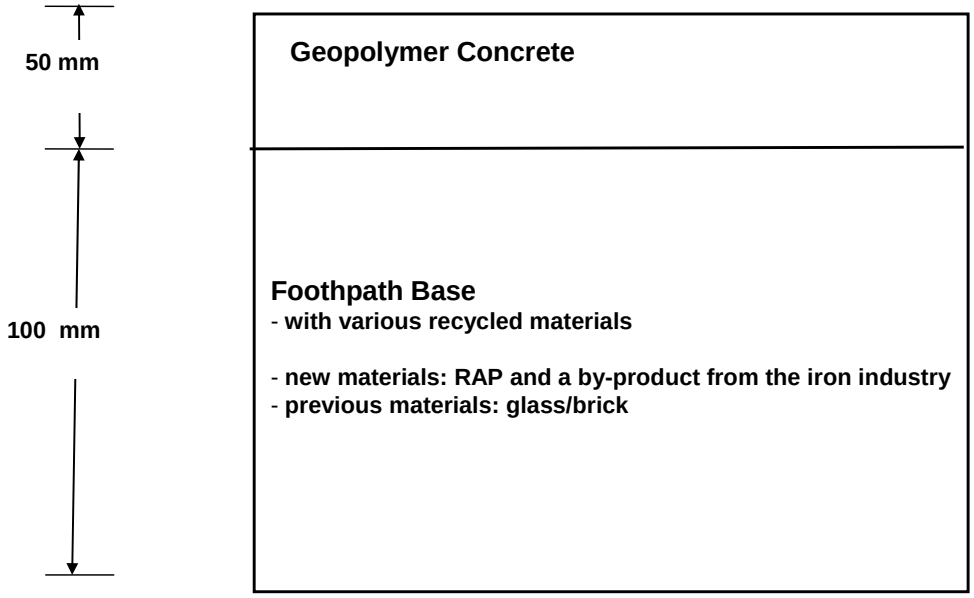

Figure 1. Schematic diagram of the low carbon footpath

Research Program

This research project will be undertaken in the following phases detailed below in a period of ***36 months***:

Phase 1: Laboratory testing or 2 new recycled aggregates: Recycled Asphalt Pavement (RAP) and slag for footpath bases. Laboratory testing of geopolymer concrete including concrete mix trials of geopolymer concrete using 100% fly-ash and crushed glass and tests to identify mixes that comply with the local government and VicRoads specifications of concrete for footpaths. (12 months)

Submission of a report at the completion of the laboratory testing (12 months)

Phase 2: Field testing and monitoring of up to 4 new Low Carbon footpaths

Submission of a report at the completion of the field testing and monitoring (24 months)

Research Objectives

The project objectives include:

- ***This project will investigate the usage of Recycled Asphalt Pavement, slag as well as previously tested recycled crushed brick and crushed glass in blends with crushed rock and crushed concrete in footpath base applications in combination with geopolymer concrete.***
- Swinburne undertaking geotechnical laboratory testing of footpath sub-base material with usage of up to 50% recycled asphalt and up to 50% slag in blends with crushed rock and crushed concrete. A report will be submitted at the completion of the laboratory testing. The report will contain all relevant supporting information to upgrade (where appropriate) current specifications or prepare a new specification for recycled asphalt and slag in footpaths and shared paths.
- Assist local government councils in the development of an accepted process for the evaluation of reclaimed materials in footpaths and bicycle paths.
- Provide improved knowledge in order to support the development and lead to improvements to the material specifications, construction standards and the geotechnical design of footpaths and bicycle paths based on the research results.
- Swinburne undertaking concrete laboratory testing of footpath concretes made of geopolymer manufactured from fly ash and recycled crushed glass and free of any conventional Portland cement.
- Demonstrate the feasibility of constructing footpaths with geopolymer concrete and recycled aggregates in the footpath bases by field tests and monitoring of up to 4 local government footpaths using the "low carbon" footpath design. Field testing and monitoring is required to trial the truck concrete mix of geopolymer concrete, compactability of the footpath bases with recycled materials as well as to identify any construction issues in the field with this novel concrete.
- Develop long-term strategic research alliances between academic institutions (SUT) and local Victorian government councils in order to apply advanced knowledge and technologies to the usage of reclaimed Construction and Demolition materials and geopolymer concrete.

Research Funding

It is proposed that the Swinburne/MAV partnership apply for an Australian Research Council (ARC) grant in Sept/October 2010

- 3 year project starting mid-2011
- Funding for laboratory testing, field testing and field monitoring of new footpaths.
- University staff time, lab facilities will be free for the project (except for direct costs).
- ***ARC will match cash funding from MAV/industry (1:2 leverage)***
- ***Cash funding of $30,000 x 3 years (total = $90,000) is sought from the MAV.***

Year	2012	2013	2014
MAV funding	**$30,000**	**$ 30,000**	**$30,000**
Australian Research Council (ARC) funding	$60,000	$60,000	$60,000

For further information or queries on this proposal, please contact:

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