NP4007

Investigation of innovative sustainable low carbon product from waste glass for built environment

Research Question

A batch of broken glasses (i.e. tempered glass, borosilicate glass, float glass etc.) have different melting point and properties which tend to cause recycling problem if they are mixed together. What are the recycling option to tackle this issue?

How to create an innovative sustainable low carbon product from waste glasses with minimal energy consumption?

What are the steps needed to create the product, namely polymeric glass composite (PGC)?

Is the product produced in this study comparable to the standard dimension stone product available in the market?

Objective

The objective of this study is to create a polymeric glass composite (PGC) panel that can serve as kitchen countertop, bathroom vanities, tiles for wall and floor.

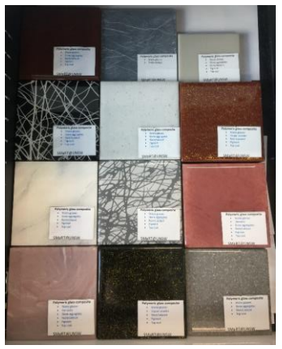

Figure 1. Polymeric glass composite (PGC) produced in this study

Methodology

The production process of the PGC are shown in the schematic diagram below:

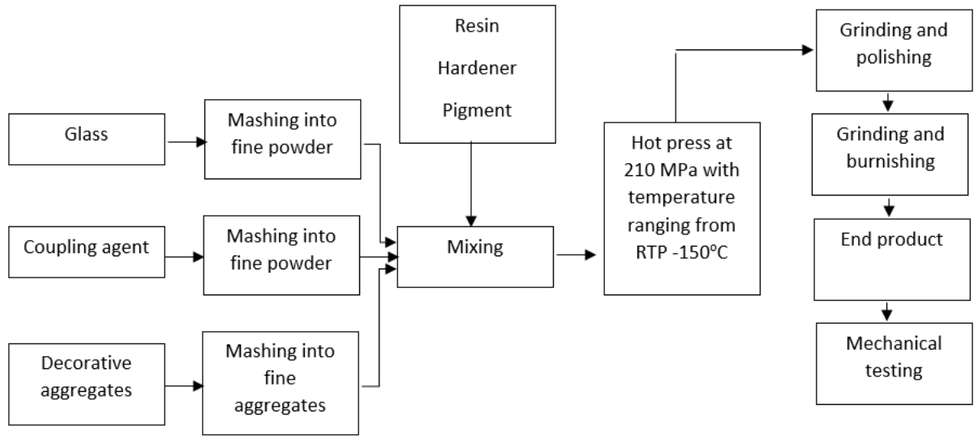

Figure 2. Schematic of the experimental procedure of PGC

Results

The mechanical properties of the PGC are listed below (labelled in yellow) and compared to that of standard dimension stone sold commercially.

Physical property	Types of dimension stone				
	Natural stone countertop		Polymeric glass composite (PGC)	PGC with fibre reinforcement	Engineering stone countertop
	Granite	Marble			TruQuartz
Bulk specific gravity (kg/m^3)	2560	2800	2113	2087	2410
Water absorption -max (%)	0.40	0.20	0.06	0.063	0.02
Flexural strength (dry condition)-min(MPa)	8.3	6.9	26.3	36.1	32.5
Compressive strength (dry condition)-min(MPa)	131	52	101	101	188.4
Abrasion resistance-min(Ha)	25	10	N/A	N/A	N/A
Mohs Hardness	5.5-6	3-4	5.5-6	5.5-6	6.5

The density, along with the flexural strength play a vital role in deciding the dimension of the product produced, especially in table/countertop production where beam system is applied. Beams are structures that span open spaces and are internally self-supporting. Higher flexural strength and moderate density thus are required. In terms of flexural strength, PGC without fibre reinforcement can resist bending 3 times better than natural stone but is slightly inferior compared to engineering stone. If required, the flexural strength of the PGC can be improved by adding a sheet of fibre glass mash. The combination of low density and high flexural strength in PGC and engineering stone allow the countertop slab to be produced thinly with longer span. In contrast, for marble and granite, the slab tend to be produced thicker with shorter span due to its low flexural strength and relatively high density.

Water absorption are closely related to porosity and stain. The water absorption in PGC is only 0.06 %, much lower compared to that of granite and marble with water absorption of 0.6 and 0.4% respectively. Compressive strength measures how easy a material fracture under compressive load and is usually used by company to compare one stone with another. PGC has compression strength of around 100 MPa. Although the compression value is not as high as granite and engineering stone, the value is reasonably good. Just for comparison, high performance concrete has compressive stress in range of 75-80 MPa.

Conclusion

This study has successfully manufactured a high quality artificial construction slabs from waste glass powder filler with high flexural and compression strength as well as low water absorption and moderate density.

Contact

Name: Heriyanto

Email: Heriyanto@unsw.edu.au

Supervisor: Prof.Veena Sahajwalla, Farshid Pahlevani

Organisation: SMaRT centre, UNSW