Development of Protocols for Determining Deleterious Material Content in Crushed Recycled Glass

Fiona Nutbeam, Advisors: Drs. Matthew Scarborough and Mandar Dewoolkar
Department of Civil and Environmental Engineering
University of Vermont

Introduction

Processed glass aggregate studied in this project is a fine crushed recycled glass with a high potential to replace sand borrow and other free-draining fill materials. In practice however, PGA is not widely used in our region because of a lack of clear guidance on deleterious material content determination.

Primary objectives are to research, develop, and evaluate processes to determine deleterious material content in PGA; evaluate the effectiveness of individual processes using lab-manufactured PGA (LM-PGA) samples with known deleterious content and type; and recommend a reliable protocol for practice by also examining PGA produced by recycling facilities (RF-PGA).

Figure 1. Glass crusher (left) and clean crushed glass (right) for producing LM-PGA

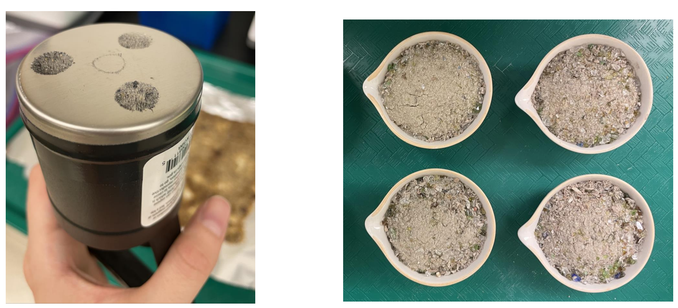

Figure 2. Metals magnet collected from clean glass (left) and RF-PGA post-furnace (right)

Methodology

A magnet process, furnace process, float process, and acid washing process were evaluated for determining deleterious material content, on LM-PGA with known amounts of plastics, paper, metals, and organics.

Two overall protocols were developed:

Protocol 1: Magnet + Furnace (for determining overall deleterious content)

Protocol 2: Magnet + Float (for determining upper limit on plastics content)

LM-PGA sample LMO: 98% glass + 2% deleterious organics (0.5% office paper + 0.5% newspaper + 0.5% sugar + 0.5% peanut butter)

LM-PGA sample LMP: 98% glass + 2% deleterious (0.4% office paper + 0.4% newspaper + 0.5% HDPE plastic + 0.5% PP plastic + 0.2% steel)

RF-PGA: Four samples – three from three different locations from a pile; one sample produced on a different date

6 samples of 100 g each tested for repeatability and statistics.

Results

LM-PGA	Protocol 1		Protocol 2	
	Magnet	Furnace	Magnet	Float
LMO	**0.01%**	**1.93%**	**0.02%**	**0.02%**
Ideal Measurement	0%	2%	0%	0%
LMP	**0.21%**	**1.92%**	**0.22%**	**1.22%**
Ideal Measurement	0.2%	1.8%	0.2%	1%
RF-PGA 1	0.07%	3.50%	0.07%	6.51%
RF-PGA 2	0.09%	2.41%	0.07%	3.99%
RF-PGA 3	0.07%	1.85%	*0.78%	0.94%
RF-PGA 4	0.01%	0.90%	0.07%	0.24%

*A nail was in the PGA.

Conclusions

LM-PGA:

- Protocol-1 was accurate
- Protocol-2 was fairly accurate

RF-PGA:

- The exact deleterious content was unknown
- Protocol-1 worked well
- Protocol-2 was not reliable

Additional findings:

- Added ceramics in LM-PGA did not impact any measurements in the processes investigated.
- Magnet process did a good job in picking steel, but it also picked a very small amount of impurities in glass.
- Acid washing process attempted to determine aluminum did not produce good results. However, presence of aluminum, if any, is less of a concern.

Future work:

- Additional work would be useful to determine plastics content accurately.
- Once the maximum allowable deleterious content is selected, geotechnical characterization of PGA with the allowable deleterious content would be examined.
- Economic analysis would help in catalyzing widespread use of PGA as sand borrow.

Acknowledgments

Funding for this project is provided by TIDC at the University of Maine under grant 69A3551847101 from the U.S. DOT's University Transportation Centers Program. Additional financial support is provided by CSWD. In-kind support by VTrans and VTANR is gratefully acknowledged. Special thanks to Drs. Greg Rowangould, Ehsan Ghazanfari, Rory Waterman, Emily Parkany and Ian Anderson, and Josh Tyler, Tanya Miller, Callie Ewald, August Arles, Nick Van Den Berg, James Surwilo, Josh Kelly, Aric Brown, Sarah Foy for advice and help.

References

VTrans *2018 Standard Specifications for Construction*.

VTrans 2021 "General Special Provisions Version GSP-1809."