Utilization of Processed Glass Aggregate in transportation projects as a substitute to sand borrow

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Motivation & Objective

- ❖ Glass recycling is beneficial for the environment, economy, and society.
- ❖ Processed Glass Aggregate (PGA) is a suitable replacement for sand in construction, as it has similar engineering and geotechnical properties.
- ❖ The use of PGA in construction helps reduce the demand for sand, which is an increasingly scarce resource, and it also decreases glass in waste streams.
- ❖ Currently there is no reliable method to determine deleterious material content in PGA, which is restricting widespread use of PGA in construction.
- ❖ Here, we focus on developing protocols to determine the overall deleterious materials in PGA and plastic content.

Methodology:

- ❖ **LM-PGA sample- LMPO** : 98% Glass + 2% deleterious materials (0.4% HDPE plastic, 0.4% PP plastic, 0.4% office paper, 0.4% newspaper, 0.4% peanut butter). (LM: lab manufactured)
- ❖ **RF-PGA:** Sample from Chittenden Solid Waste District (CSWD), Vermont recycling facility (VT). (RF: from a recycling facility)
- ❖ For each batch, six samples of 1200 grams each were tested.

Protocol 1: Determination of overall deleterious material content

Magnet Test → Furnace Test (550 °C) for 50 min, Mixing in 25 min

Figure 1: Metals collected from RF-PGA(Left), 550 deg furnace (Middle), and post furnace test LM-PGA(Right)

Protocol 2: Quantification of plastic content

Float Test → Visual Inspection & Sorting by Type and Color

Figure 2: RF-PGA float(Left), Blue fragment of plastics (Right)

Test Results:

Table 1: Protocol 1 and 2 results for LM-PGA

LM-PGA LMPO-SAMPLE	Protocol 1				Protocol 2			
	Magnet (%)		Furnace (%)		Float (%)		Plastic (%)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
	0.03	0.01	1.88	0.09	0.80	0.01	0.80	0.01
Target Measurements	0.00		2.00		0.80		0.80	

(All the plastics were retrieved after float test)

Table 2: Protocol 1 and 2 results for RF-PGA

RF-PGA		Protocol 1				Protocol 2							
		Magnet(%)		Furnace(%)		Float(%)		Plastic-like materials in float(%)		Plastic-like materials in leftover (%)		Ceramics in leftover (%)	
Sample	CSWD	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
		0.12	0.01	2.86	0.03	0.25	0.02	0.07	0.02	0.07	0.02	0.38	0.01
Target Measurements		Unknown		Unknown		Unknown		Unknown		Unknown		Unknown	

(5 batches of CSWD samples were analyzed and their average was recorded.)

Identification of plastics using FTIR

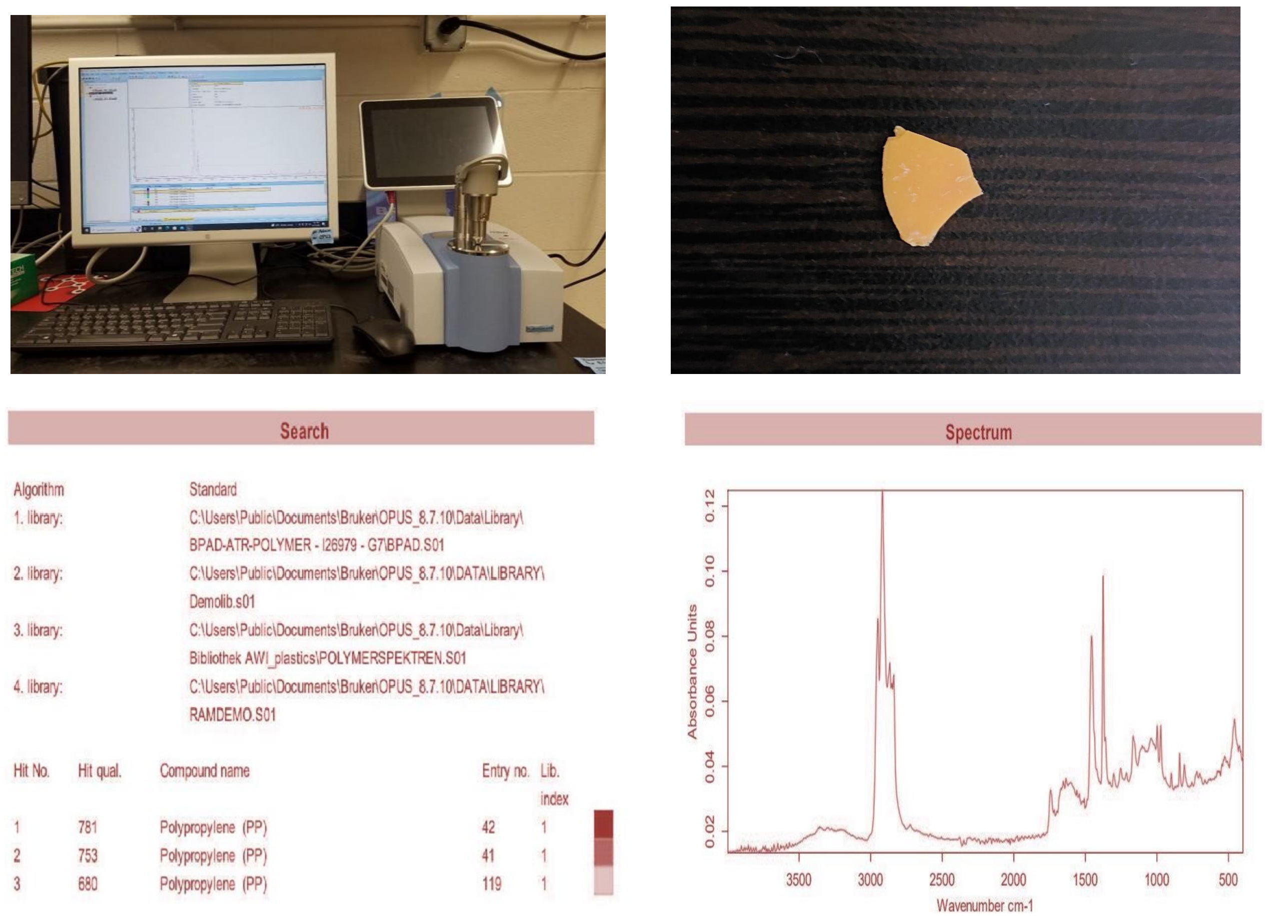

Figure 3: FTIR setup (top left), a piece of plastic collected from RF-PGA (top right) tested in FTIR, FTIR library result (bottom left), spectrum result (bottom right)

Table 3: Types of Plastic Identified in by FTIR in a single batch of RF-PGA

Types of Plastic			
Polypropelyn	Cellulose Acetat	Polystyrol/Polystyrene	Polyvinyl chloride- Hard
High desnity polyethylene	Ethylene Vinyl Acetate	Polyoxymethylene	Polyvinyl chloride- Flexible
Sheet Molding Compund	Low density polyethylene	High Impact Polystyrene	Polycarbonate
Polyurethane	Acrylnitiril Butadien Styrol	Hostalen GM 6255	Blend of PP+Ethylene/Polypropelyn
Poly Dimethylsiloxane	Copolymide	Styrol Acrylnitril	Polyamide 66
Polylactic Acid	Polyhyroxybutyrate	1-Decanol	Terpolymer

Conclusions & Planned Work

Conclusions:

- ❖ Protocols 1 and 2 are operationally reliable.
- ❖ Deleterious material contents in RF-PGA varied some among production dates and locations within stockpiles.
- ❖ The quantity of plastics discovered in the tested batches is minimal.

Upcoming work:

- ❖ Evaluate geotechnical properties of PGA to assess if PGA can replace sand borrow.
- ❖ Perform economic and environmental life cycle assessment analysis to hopefully catalyze widespread use of PGA.

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