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Civil and Environmental ENGINEERING

Engineering and Life CycleAssessment of Activated, Recycled Glass-based Concretes.

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Background

The main objective of this research is to investigate the use of chemical activation and physical treatments in enhancing the pozzolanic reactivity of the currently land-filled recycled glass powder, so it can be used as an efficient cement replacement in high performance and green concrete materials. The practice of recycling glass containers and window panes is growing in many states and municipalities in the nation. Unfortunately, a significant portion (~600,000 tons/yr) of the collected glass is not actually recycled into new glass; mainly due to the prohibitive shipping costs from glass collection points to remelting facilities. In addition, the majority of domestic container glass production is in clear and amber colors; which makes recycling of the imported green beverage containers challenging and costly. As a result, large quantities of the post-consumer glass are currently land-filled or stockpiled in hopes that future technologies would allow a profitable use of this materials.

Project Plan

Using recycled glass as a cement replacement will only achieve wide adoption if the system has favorable economics compared with traditional PC concrete and other PC replacements like fly ash. We intend to produce a first-tier comparative life cycle cost analysis of these three alternative concrete production pathways, including:

- Materials costs (cementitious material, chemical activators)
- Energy and GHG emissions costs
- Infrastructure costs (plant and machinery costs)
- Labor, profit and overhead
- Transportation costs

Many of these variables, particularly cost of materials and transporation costs, will vary depending on geographical distribution of producers of cement, fly ash, and recycled glass. One potential cost advantage of recycled glass is it is widely available wherever population centers are (especially compared to fly ash, which is co-located with coal power plants).

After modeling the individual processes necessary to produce recycled glass cementitious material, the information will be combined with life cycle information on other related processes in order to compare different pathways to recycled glass concrete and its competing products (fly ash concrete and traditional PC concrete). These results will then be compared on a functionally-equivalent basis for different types of concrete use (ie, similar strength concrete made from high glass content, from a similar amount of fly ash, or from traditional PC concrete)..

Creating these models will require overcoming several challenges in current life cycle modeling for concrete and glass. First, the material property limits for alternative cements will need to be obtained and translated into overall concrete mix designs. Second, as discussed above, the modeling of open loop recycling (ie, turning recycled glass or coal wastes into concrete) is a challenging and open question in LCA and thus several different types of end-of-life allocation will be reviewed and utilized to obtain uncertainty bounds on the life cycle impacts of recycled glass and fly ash. Finally, geographical distribution and transportation will likely play an important role in the LCA of recycled glass concrete as it does in life cycle cost.

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