Foundry Sand for Highway Applications

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ABSTRACT
Using waste foundry sands (WFS) in civil engineering applications is being investigated in this study. The WFS mixture contains silica sand, clay and combustible additives like sea coal, and water and leaching test results showed that WFS are not hazardous. The cemented samples prepared by adding up to 6% (by weight) of cement to WFS shows good physical properties.

1. Introduction

Waste foundry sand (WFS) is a byproduct of the casting industry that results from the molding and core making processes. Depending on the molding process the foundry sand mixture contains silica sand, clay and combustible additives like sea coal, and water. The annually generated foundry sand in Texas and U.S. are estimated to be 70,000 and 9,000,000 tons, respectively. The bulk of WFS is non-hazardous and is currently deposited in landfills. The scarcity of landfill space and increase in tipping fees have stimulated the pursuit of beneficial reuse. The civil engineering uses of WFS are in embankment fill, subgrade, flowable fill, concrete and etc.. The beneficial re-use of waste foundry sand has the potential to:

- o reduce consumption of finite natural resources;
- o reduce or eliminate the need to landfill wastes, thus preserving landfill capacity;
- o reduce or eliminate cost associated with waste disposal;
- o reduce raw material costs for industries that are able to utilize the 'wastes'.

2. Objective

The overall objective of this study is to investigate the potential engineering applications of used foundry sands. Specific objectives are (1) to evaluate the physical and chemical properties of foundry sand; (2) to evaluate the leaching property of foundry sand; (3) to investigate the role of foundry sand in cemented sand; (4) to develop a design chart for foundry sand.

3. Testing Program

Samples. Foundry sand samples from various casting industries in Texas were collected and stored in plastic containers. Foundry sands are characterized for being their physical and chemical properties such as particle size, pH, index properties, moisture content and total organic and inorganic.

Environmental evaluation. The environmental properties of foundry sands are evaluated by the EPA Method 1311 (Toxicity Characteristic Leaching Procedure, TCLP), and TNRCC Statistic Leaching Test Method, respectively.

Cemented sand. Foundry sand was used as fine aggregates in preparing specimens. The cement/sand and water/cement ratios are 5% and 200%, respectively. The samples are tested for unconfined compressive strength following the ASTM D2166 after 7- and 28-days curing. The electric resistance of cemented sand was also measured.

Analysis methods. The analysis of inorganic and organic are followed the EPA Method 6010B and 8260B, respectively. The instruments used are ion chromatography plasma (ICP) and gas chromatography (GC) with a FID detector, respectively. The unconfined compressive strength test is conducted by using an INSTRON (Model 1322) testing machine according to the ASTM C 109.

4. Results

TCLP and TNRCC Leaching Test. The major constituents detected in TCLP supernatant are Si and Ca. For those constituents regulated by the EPA are well below the regulation limits. It shows that WFS is not hazardous and can be recycle for further applications.
UCS Test. Cylindrical samples cured for 7- and 28-days were tested for UCS according to ASTM C 109. The UCS of foundry sand containing concrete samples was all above 250 psi. Increasing the cement content also increases the UCS accordingly. The average UCS values obtained with 4%, 5% and 6% cement samples were 100, 185, and 230 psi, respectively. The long term UCS is under investigation.

5. Conclusions

(1) Laboratory leaching tests shows that WFS is not hazardous and Ca and Si are the major constituents detected.
(2) The UCS of cemented sand samples obtained by adding up to 6% of cement (by weight) to WFS are greater than 250 psi. The long term properties are under investigation.

6. Acknowledgments

This study is funded by the Texas Department of Transportation, however, the contents do not necessarily reflect the views and policies of the funding agency.

7. Reference

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