CASE STUDY

New York State Pollution Prevention Institute

NYSP2I Conducts Feasibility Study on Electric Arc Furnace Slag for Nucor Steel Auburn, Inc.

Challenge
Nucor Steel Auburn, Inc. wanted a third party to evaluate the feasibility of using Electric Arc Furnace (EAF) slag in concrete applications.

Solution
NYSP2I partnered with the Center for Advanced Materials Processing (CAMP) at Clarkson University to conduct a feasibility study on using EAF slag as coarse aggregate replacement in concrete.

Results
The results of the evaluation suggest that EAF slag conforming to the gradation requirements of AASHTO M43 #67 could replace up to 40% of the volume of limestone coarse aggregate in concrete, however optimum slag replacement level should be selected based on the reduction in material stiffness that can be tolerated by application.

Nucor Steel Auburn, Inc.

Nucor Steel Auburn, Inc. (Nucor) in Auburn, NY, is an electric arc furnace (EAF) based steel recycling and manufacturing facility that produces rebar and other steel bar products. Part of the steel making process creates EAF slag. Nucor produces approximately 60,000 tons of slag annually. TMS International, Nucor's on-site mill services provider, currently processes the EAF slag into various grades suitable for applications like road base, backfill, driveways, and parking lots.

Challenge

TMS International has over a decade of sampling data showing that Nucor slag is non-expansive and can be used for concrete or asphalt applications in addition to its current uses. Nucor wanted a third party to evaluate if EAF slag could be a suitable coarse aggregate replacement in concrete.

Solutions

The New York State Pollution Prevention Institute (NYSP2I) partnered with the Center for Advanced Materials Processing (CAMP) at Clarkson University (Clarkson) to conduct a feasibility study on using EAF slag conforming to the gradation requirements of AASHTO M43 #67 (slag studied) as course aggregate replacement in concrete in accordance with ASTM standards. The study had three components: 1) measuring the physical properties of equivalently graded limestone and EAF slag; 2) measuring the fresh properties, mechanical properties, and volume stability of concrete with 0, 10, 20, 30, and 40% replacement of limestone with slag; and 3) synthesizing these results to recommend an optimum aggregate replacement level.

Results

The results of the feasibility study of the EAF slag studied show that:

- The EAF slag was 10-20% denser and 200% more absorptive than the limestone coarse aggregate.
- Replacement of limestone coarse aggregate with up to 40% EAF slag by volume did not significantly alter the workability or setting time of fresh concrete.
- No significant trend exists between concrete compressive strength and aggregate replacement level for ages between three and 90 days.
- Replacement of limestone coarse aggregate with up to 40% EAF slag by volume decreased the modulus of elasticity (MOE) of concrete by 10-66%.

Expansion tests did not reliably identify deleterious expansion of the EAF slag, EAF slag and limestone aggregate blends, or concrete containing the same.

The results suggest that the EAF slag studied could replace up to 40% of the volume of limestone coarse aggregate in concrete. However, concrete with slag aggregates had lower MOE as compared to concrete with only limestone aggregates, suggesting that it is more flexible than normal. This feature could be beneficial for low stress applications like pavements but would be detrimental for structural applications. Therefore, reduction in MOE should be the main consideration in optimizing aggregate replacement level. The MOE should also be measured as part of the concrete mixture design process to give potential users an accurate estimate of the expected reduction, and a qualified design professional should perform an engineering review of potential applications to confirm that this reduction in MOE is acceptable.

Partners

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