THE USE OF WASTE BRICKS AND TILES AS A PRECURSOR FOR ALKALI ACTIVATED BINDERS

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Key Words: Alkali Activated Binders, Construction and Demolition Waste, Performance, Workability

Currently, the most common treatment of construction and demolition waste (CDW) in Europe, other than disposal, is backfilling with a very small amount being effectively reused. In an attempt to optimize the use of construction and demolition waste (CDW), potential recycling and reuse routes exist, with the most popular method being to use CDW as recycled aggregates. Another viable route, however, would be to use bricks and tiles (BT) waste, collected from CDW, as a precursor for alkali activated binders as they can make up a larger proportion of CDW[i]. The work was performed in the framework of RE[4], "Reuse and Recycling of CDW materials and structures in energy efficient prefabricated elements for building refurbishment and construction", a European project founded by the European Commission in the framework of H2020 Research and Innovation Program (call H2020-EEB-04, GA n. 723583 I project website: www.re4.eu)

Two sources of recycled waste have been collected from Northern and Southern Europe. They were ultimately sorted and were found to contain 14 % and 27 % by weight of bricks and tiles waste respectively. Upon separation, the BT waste from both sources were ground together to form a fine powder to be used as a precursor for alkali activation.

To assess the potential use of BT waste as a precursor, mortars were prepared to measure workability and strength evolution (measured on 50 mm cubes), fixing the sand to binder ratio at 2.75. The activating solution made use of both NaOH and Na_2SiO_3, varying the alkali dosage M+ (M+ = Na_2O/BT) and alkali modulus AM (AM = Na_2O/SiO_2). The original water/solids (w/s) ratio was fixed at 0.37 and was increased in increments up to 0.45 to assess its impact on strength and workability. Mortars, prepared replacing up to 80 % of BT waste with GGBS by weight, were also tested.

It was found that mortars, containing BT as the sole precursor, cured at room temperature did not set after one day. In order to accelerate reaction, subsequent mortars were cured at 70°C. Mortars prepared with a low alkali dosage (M+ ≤ 5.5%) reached low to moderate strengths after 28 days of curing; the strongest mixes reached strength values of 15 MPa. Increasing the M+ up to 7.5 % led to higher strength, up to 30 MPa. However, the strength plateaued, and even reduced marginally, at higher M+ values. Interestingly, varying the AM ratio had very limited effect on strength.

Partial substitution of BT with GGBS led to the possibility of room temperature curing. Strength also increased as the GGBS content increased. Mortars containing 20 % by weight of GGBS of precursor reached a modest strength value of 28 MPa, whereas mortars containing 80 % by weight reached an ultimate strength of 79 MPa.

The mortars were found to be workable, albeit very cohesive. When measured using the flow table test mortars prepared with a w/s = 0.37 spread to an average diameter of 14 mm. The value was near constant regardless of the AM value, ranging from 0.5 up to 1.5, for a fixed M+ = 7.5%. Only mortars prepared with NaOH as the sole activator (AM = ∞) showed a reduction in workability. Increasing the water content of the mortars led to more workable mortar. When the w/s was increased up to 0.45, the spread reached an ultimate diameter of 20 mm. The increase in w/s, from 0.37 up to 0.45, however, resulted in a 25 % drop in strength.

Work to date suggests the potential use of BT as an alkali active binder. However, more work is needed in order to understand the reaction mechanisms in an attempt to further optimize BT as a precursor for alkali activated binders, including microstructural analysis.

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[i] ROBAYO, F.A., MULFORD, A., MUNERA, J., MEJIA DE GUTIERREZ, R., Alternative Cements Based on Alkali-Activated Red Clay Brick Waste, Construction and Building Materials, 128, pp 163-169, 2016