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Sustainable Concrete with Recycled Aggregate

Patricija Kara (*Riga Technical University, Institute of Materials and Structures*)

Keywords **– recycled aggregate concrete (RAC), fluorescent waste glass waste, coal/wood ash**

I. Introduction

Concretes produced with recycled aggregates are the subject of several papers recently published in the technical literature. Substitution of natural aggregates can be one of possibilities to take care of landfills and increase of CO_2 emissions into the atmosphere in Latvia [1]. Recycled aggregate is a valuable resource; value-added consumption of recycled aggregate, as replacement for virgin aggregate in concrete, can yield significant energy and environmental benefits. Concrete produced with coarse recycled aggregate differs from normal concrete produced with virgin aggregates in terms of some mechanical properties and durability characteristics. The employ of wastes coming from demolished concrete structures or from industrial production of precasted concrete members is a primary choice for obtaining recycled aggregates useful in producing new concrete products [2]. As the next step from studies [1] could be the usage of waste glass as cement partial substitution at level of 20-30% in concrete mixes with recycled aggregates. "Eco-friendly" way to produce concrete consists of fluorescent waste glass powder usage in addition or partial substitution of Portland cement which manufacture as energy-intensive and highly polluting process contributes about 5-8% to global CO_2 emissions and accounts for 3% of total (5% of industrial) energy consumption worldwide, production of each ton of cement results one ton of carbon dioxide (CO_2) [3] into the atmosphere.

In present study mechanical properties of concrete with optimized utilization of recycled aggregates and partial substitution of Portland cement with glass waste are determined.

II. Materials and Methods

An experimental study was carried out to investigate the effects on the mechanical properties determined of concrete with recycled aggregates obtained from crushed concrete specimens from previous studies which were stored as concrete waste. Crushed concrete specimens grains from coal/wood ash concrete, DRL – fluorescent waste glass concrete, DRLS - fluorescent waste glass suspension concrete were separated into fractions (4/8mm, 8/11.2mm, 11.2/16mm). Ordinary Portland cement CEM I 42.5N from "Kunda Nordic" (Estonia) was applied as binding agent. Cement conforms to standard EVS EN 197-1:2002 "Cement – Part 1: Composition, specifications and conformity criteria for common cements". Natural local aggregates (gravel, crushed stone and sand) have been used for mix preparation. A total of 8 different concrete mixes were prepared. Concrete mixes were made with natural aggregate substitution by 100% since from previous studies [1] the gain of compressive strength was the most effective and Portland cement substitution at level of 20% with fluorescent waste glass powder ground to Blaine specific surface 358 m^2/kg. All concrete mixes were made with capacity of 10.5 litres. The mixing procedure was following:

- Mixing of the dry ingredients for 120 s;
- Adding 70% of the total water for 60 s;
- Adding the rest of the water and mixing for 60 s.

As soon as the mixing finished, Abram slump test was carried out for each mix in accordance with LVS EN 12350-2:2009 "Testing fresh concrete – Part 2: Slump test". Specimens were cast in 150x150x150 mm steel moulds, which conform to standard LVS EN 12390-1:2009 "Testing hardened concrete – Part 1: Shape, dimensions and other requirements for specimens and moulds". The moulds were cleaned and lightly coated with form oil before the casting procedure. Concrete was compacted on a vibrating table. After that the specimens were covered with polyethylene pellicle and left to set for 24 hours. Then they were removed from moulds and cured in water (with temperature +20±2°C) for 28 days and then in curing chamber (with air temperature +20±2°C and relative humidity ≥95%) for other 56 days. Mechanical properties of cube specimens were determined at the age of 84 days.

III. Conclusions

In present study recycled aggregates from concrete specimens with known mix composition and Portland cement partial substitution have performed good mechanical strength results and higher permeability. The general application of fluorescent waste glass and bottom wood ash recycled aggregates and reduced cement volume could be solution for structural concrete element production in concern to reduce the amount of waste disposed and preserve natural resources, as also to reduce CO_2 into the atmosphere.

IV. Acknowledgement

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