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Mechanical Properties of Cement Paste with Glass Cullet

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Keywords **– glass cullet, fluorescent waste glass, concrete, mechanical properties.**

I. Introduction

Glass cullet is a solid waste material, which represents an environmental problem all over the world. Not all waste glass can be recycled into new glass because of impurities, prohibitive transportation costs or mixed colour waste streams and therefore it is stored in landfills. Governments and waste producers are as a result turning to new technologies to solve this problem. As it was mentioned by Meyer in 2001[1], crushed waste glass which is amorphous and with high silica content, with it subangular particle shape and a smooth, flat surface texture used as a form of construction material was rapidly becoming one of the most favoured options because of the large quantity consumed, relatively low quality requirements, widespread construction sites, and the potential benefits achievable. Nowadays, waste glass ground into small size particles up to nanoparticles[2] with modern technological means limited the potential risk of alkali-silica reaction in concrete and therefore increased potential application of it in the concrete. A size effect was observed by many researchers when partial cement in concrete was replaced with glass powder. Shayan[3] concluded that the use of ground waste glass as a high volume cement replacement in concrete seemed feasible if the particle size of the glass can be reduced sufficiently. It has been found that the pozzolanic reaction between the glass powder and cement paste enhances the properties of concrete. With different fineness the glass powder show different effects on the properties and pore structure of Portland cement hydrates. The finer the glass powder, the higher the strength of glass powder blended cement. The same trend has been demonstrated by Shayan and Xu[3]. In their study, a smaller glass particle size led to higher reactivity with lime, higher compressive strength in concrete and lower expansion.

II. Materials and Methods

An experimental study was carried out to investigate the effects on the mechanical properties of concrete with finely ground waste glass as Portland cement partial substitution at levels of 30%. Glass cullet (clear, amber, emerald green bottle glass), borosilicate DRL and lead LB fluorescent lamp glass chippings were ground within 60 minutes in laboratory planetary ball mill Retsch PM400 (with rotation speed 300 min-1) into powder with Blaine specific surface of 371m^2/kg, 481m^2/kg, 303m^2/kg, 458m^2/kg, 475m^2/kg accordingly. Ordinary Portland cement CEM I 42.5N from "Kunda Nordic" (Estonia) was applied as binding agent. Cement conformed to standard EVS EN 197-1:2002 "Cement – Part 1: Composition, specifications and conformity criteria for common cements". A total of 8 different cement paste mixes were prepared: Cem2 – reference mix, DRL60 – mix with DRL glass, LB60 – mix with LB glass, DRLs60 – DRL glass ground in water environment [2], DL60 – DRL(15%) and LB(15%) glass mix, C60 – mix with clear glass, A60 – mix with amber glass, E60 – mix with emerald green glass. Portland cement substitution was at level of 30% with waste glass powder in 6 mixes and waste glass suspension in 1 mix. Specimens were cast in 40x40x160 mm steel 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.

III. Results

The results for compressive strength are shown in Fig.1.

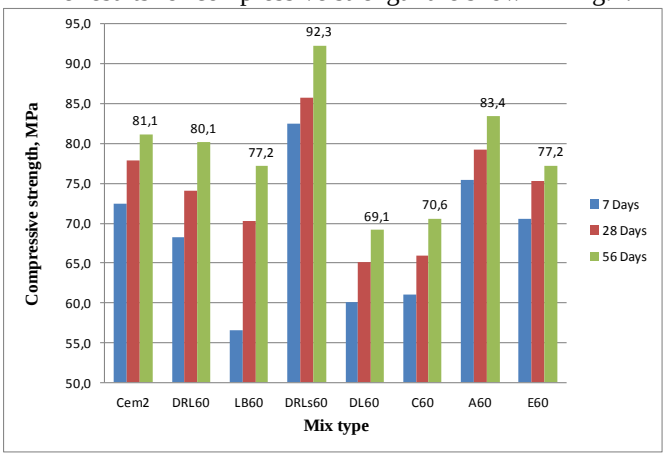

Fig.1. Influence of waste glass content and curing time on the concrete compressive strength

IV. Conclusions

In present study Portland substitution with ground DRL fluorescent waste glass suspension and amber glass cullet powder at level of 30% showed the best results at the age of 7days, what is very important for structural elements, with 82 and 75Mpa accordingly compressive strength values in comparison to reference mix.

V. Acknowledgement

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VI. References

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