Recycled Glass as Concrete Aggregate

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ABSTRACT

Concrete as a composite material, produced by mixing Portland cement along with the aggregate water and admixtures is the most widely used construction material. Using aggregate mostly of natural origin, the concrete industry causes high extraction of natural resources, especially rocks, sand and gravel. The continued exploitation of these natural, non-renewable resources, contributes to nature destruction. Due to that, current research activities are mainly focused on use of alternative materials, protecting the environment and promoting sustainable concrete industry. There is a growing interest in substituting natural aggregate materials with alternative materials such as blast furnace slag, granulated coal ash, as well as various solid wastes. One of the recycled solid wastes that are suitable to substitute aggregate of natural origin is glass.

The aim of this research is to analyze the applicability of recycled glass as a concrete aggregate. Laboratory experiments were performed to analyze the feasibility of utilizing recycled glass as a concrete aggregate in fine aggregates and fine glass powders. Four different mixtures have been made: the glass is used as partial (50%) or entire replacement (100%) of the fine aggregate (0-4mm) in concrete, with and without admixtures. Couples of samples were prepared for each recipe and properties of fresh concrete and hardened concrete were tested at 3, 7, and 28 days. The density, porosity, compressive strength and tensile strength, water absorption of the concrete with different percentage of glass aggregate have been tested.

Results from the laboratory experiments are indicating that the concrete containing waste glass has almost identical properties as the concrete produced with aggregate of natural origin. Concrete using waste glass can be commercially wide used for specific products such as paving stones, curbs, concrete masonry blocks, terrazzo tiles etc.

Using recycled glass as an aggregate contributes to great economical savings and huge ecological impact.

Keywords: concrete, waste glass, waste management, properties of concrete, sustainable development.

LABORATORY TESTING

Front glass from CRT monitors used as partial (50%) or entire replacement (100%) for the fine aggregate (0-4mm) in concrete.

Four recipes:

- normal concrete (0% glass),
- concrete containing 50% waste glass as fine aggregate,
- concrete containing 100% waste glass as fine aggregate, and
- concrete with admixtures (air entrainers and superplasticizers) containing 50% waste glass as fine aggregate.

The mixtures have water to cement ratio of 0,45.

Porosity, density and consistency of the fresh concrete measured for all recipes.

Samples stored in standardized laboratory conditions, and tested at 3, 7 and 28 days.

Glass and natural stone aggregate

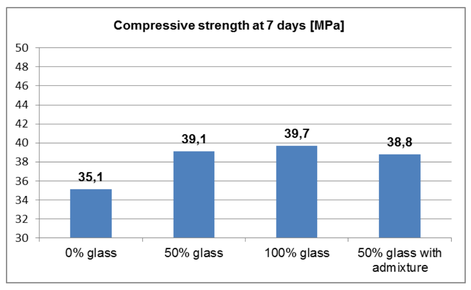
Preparing of concrete samples

RESULTS

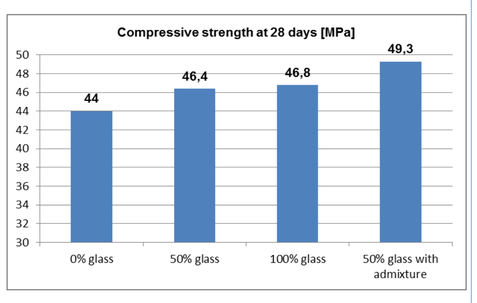
Compressive strength

The compressive strength tested in series of three cubes each, at 3, 7 and 28 days.

Press for testing compressive strength



Compressive strength at 7 days



Compressive strength at 28 days

Splitting tensile strength

Brazilian method – testing of specimen with splitting test

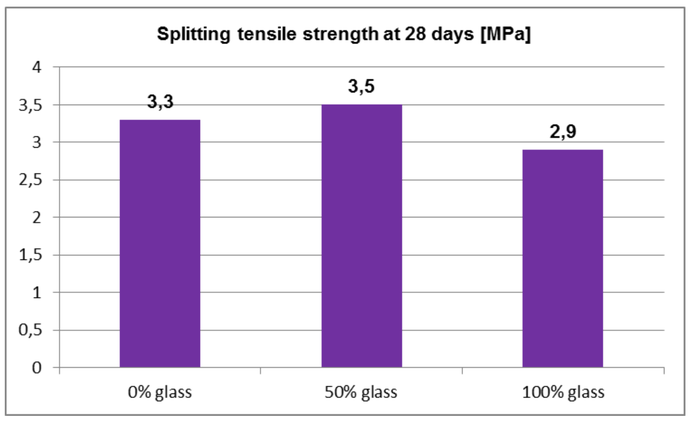


Diagram of splitting tensile strengths at 28 days

Flexural strength

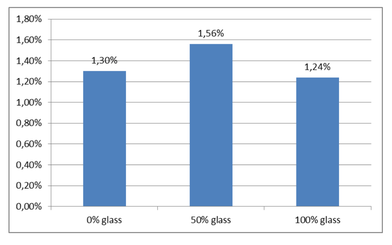
Used primarily in testing concrete for the construction of pavements and slabs.

Prisms tested to bending

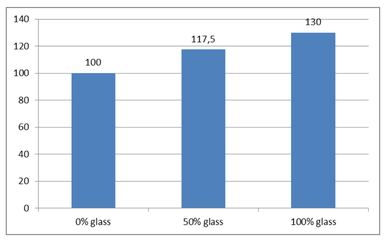
Tested specimens for flexural strength

Watertightness

Wet concrete cubes



Average values of water penetration in samples (mm)



Average values of water absorption, in percentages

CONCLUSIONS

Experimental laboratory study of concrete containing a partial or total replacement of the fine aggregate with glass has been conducted.

The compressive strength increases in concrete with used waste glass instead of gravel aggregate. Mixtures made with 50% replacement of the fine aggregate with waste glass and with 100% replacement showed improved compressive strengths (up to 12%) in comparison to the standard concrete.

Tensile strength due to splitting and bending showed concrete containing waste glass has almost identical properties as the standard concrete.

Percentage of water absorption for the concrete containing 100% glass is the lowest and it is 1.24%.

Waste materials as recycled glass can produce a concrete with same properties as the standard concrete and contribute to great economic and ecological savings.