
RECYCLED AGGREGATE CONCRETE

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ABSTRACT

Deposit of large quantity of buildings material resulting from demolition of structures or from natural or other catastrophies, represent a significant ecological problem. That is why the possibility of recycling waste building material seem often justified and sometimes even the best solution. The experimental results of two investigations were shown in this paper. The first investigation included concrete made by using recycled brick as aggregate. Determination of the influence of polymer admixture quantity on some modified concrete properties is shown in this paper. Experimental work included several types of concrete made with different cement content (250 or 350 kg/m³), and same consistency (slump about 5 cm), and with 0, 4, or 8 % admixture of polymer (dry material) by weight of cement. Recycled brick or combination of river sand and recycled brick were using as aggregates. The influence of polymer on concrete compressive and bending strength, modulus of elasticity, coefficient of thermal conductivity, resistance to frost, waterproofness, shrinkage and creeping, and stress - strain diagram were observed. The second investigation included concrete made by using recycled concrete as aggregate. The data concerning two types of concrete with essentially different structures: concrete with monolith (compact) structure and concrete with cavernous structure were shown. On the ground of the results obtained during experimental research, a general conclusion can be drawn that the application of recycled concrete as aggregate can lead to new composites with satisfactory physical-machanical properties.

Key words: buildings materials, recycling, recycled concrete, aggregate

1. INTRODUCTION

For environmental and other reasons the number of ready accessible disposal sites around major cities in the world have decreased in the recent years. Both disposal volume and maximum sizes of westes have been restricted. The distance between demolition sites and disposal areas have become large and transporatation costs higher. At the same time critical

shortages of good natural aggregate are developing in many urban areas, and distance between deposits of natural material and sites of new construction have grown larger, and transportation costs become correspondingly higher.

After demolition of concrete structure it is possible:

- Reuse of individual concrete members
- Crushing of concrete or mixing concrete to produce recycled concrete aggregate (RCA)
- Use of demolished material as fill, or final disposal.

Collapse of buildings due to elemental and other catastrophes or by tearing down of buildings which can not be economically renewed leads to waste building material which may be possible for use for production of aggregate for concrete. The production process comprises crushing, grinding, and separating crushed waste material into fractions and removal of undesired materials.

Fabrication of light-weight aggregate for concrete from industrial waste, helped transform waste material into raw material from which high quality aggregate is obtained.

Due to its chemical composition and physical properties, every waste material can not be used as raw material for production of light-weight aggregate (produced aggregate must be chemically inert and harmless in concrete). Every production of light-weight aggregate on the basis of industrial waste material is not economical. However, the produced aggregate must be competitive on the market regardless the type of process.

During industrial production of brick and tiles when the burning process is not adequately performed, waste can appear and it can successfully be used for production of concrete prefabricated elements with smaller sizes, mainly hollow blocks for building.

Recycled Aggregate Concrete - RAC is concrete produced by using recycled aggregates or combinations of recycled aggregates and other aggregates.

2. CONCRETE BASED ON RECYCLED BRICK

Concrete on the basis of crushed bricks aggregate has satisfactory compressive and tensile strength and thermal insulating properties but shows weaker resistance to water and frost action and has greater shrinkage by 20-60% than ordinary concrete.

Polymer modified concrete has improved properties when compared with non-modified concrete. This concrete has high tensile and flexural strength, good adhesion to various bases, high resistance to frost and chemical agents, better waterproofness.

On the basis of characteristics of PMC and concrete made on the basis of crushed bricks, it has been assumed that concrete, modified by polymer on the basis of recycled bricks, must be material which will preserve good properties of both types of concrete.

The concrete with various composition were designed by varying cement quantity, polymers, and use of natural and recycled sand. The influence of concrete composition on its bulk density, compressive and tensile strength, module of elasticity, shrinkage and creep, coefficient of heat conductivity, resistance to frost and waterproofness, were observed.

2.1. Component Materials and Concrete Mixtures

Concrete mixtures were made using pure Portland cement which, according to Yugoslav standards, is marked PC 45.

Crushed bricks were separated into fractions 0/4, 4/8, 8/16 and 16/32 mm.

Six kinds of concrete (A, B, C, D, E and F) were made using recycled bricks as aggregate. Other kinds of concrete (G, H, I, J, K and L) were made using combination of river sand and recycled bricks.

Concrete mixtures B, C, E, F, H, I, K and L were made using polymer "Polibet" (produce by "Prvi Maj", ^a~ak, Yugoslavia). It was latex BSR, with 47.4 % of dry materials in dispersion.

3. CONCRETE BASED ON RECYCLED CONCRETE

Experimental results of some basic properties of concrete based on recycled concrete, concrete made with aggregate produced by grinding of "old" - demolished concrete were shown. The data concerning two types of concrete with essentially different structures: concrete with monolith (compact) structure and concrete with cavernous structure were shown.

3.1. Component Materials and Concrete Mixtures

Concrete mixtures were made using cement according to Yugoslav standards is marked PC 30 dz 45 B.

The aggregate used in experimental research was produced by crashing and separation a demolished concrete. This concrete was made with ordinary river aggregate "Moravac" graded int fractions 0/4, 4/8, 8/16 and 16/32 mm, and it had compressive strength of 30 N/mm². In the research two fraction of aggregate made of demolished concrete were used: 4/8 and 8/16 mm.

Concrete with monolith structures was made using three fractions of aggregate. The first fraction was a natural sand, while the second and third fraction were recycled concrete aggregates. Concrete with cavernous structure was made using single-sized aggregate - fraction 8/16 mm.

4. CONCLUSIONS

4.1. Concrete based on recycled brick

Analyzing results of investigations it can be conclude that polymer modified concrete based on recycled bricks has approximately same value of compressive and bending strength, better waterproofness and frost resistance, smaller shrinkage strains, worse modulus of elasticity and slightly greater creep strains than concrete without polymer. The value of static modulus of concrete on the basis of recycled brick reaches up to one third of the value of static modulus of concrete made with natural aggregate.

Comparing concrete with and without river sand we can conclude that that concrete with river sand has: grater compressive and bending strength, greater modulus of elasticity, letter shrinkage, greater bulk density e.g. grater coefficient of thermal conductivity.

By modeling the structural characteristics of concrete, materials of various densities, mechanical and insulation properties can be provided.

Concrete based on recycled brick can be used for production of various solid and hollow construction blocks. Beside their function as thermal insulators, such blocks, with regard to

their mechanical characteristics, can have an important role in the bearing walls of buildings.

4.2. Concrete based on recycled concrete

If the decision is made to produce concrete with compact structure the conducted research shows that even higher strengths can be obtained than in the case of ordinary - aggregate based concrete. In this experimental work the designed concrete nominally reached class 50.

The concrete with cavernous structure can be described as constructive - insulate concrete and it can be without any about applied as a material for different partition elements (bulk density - 1730 kg/m³, compressive strength about 12 N/mm²).

5. REFERENCES

1. Janković, K. "Polymer modified concrete based on recycled brick", dissertation, Faculty of Civil Engineering, University of Belgrade, Yugoslavia, 1998. (in Serbian)
2. Muravljev, M., Jevtić, D. and Zakić, D. "Experimental research of certain properties of concrete based on recycled concrete", JDGK Symposium, Vrnjačka Banja, Yugoslavia, 2000., Vol. 2, pp. 271-276 (in Serbian)