Recycling aggregate from concrete, properties and possibility for using in ready Mix Concrete

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ABSTRACT

Many requests for different types of concrete, in general are depends of the aggregates. One of the aim of this paper is to analyses the possibilities of using the recycling aggregate, from part of existing concrete such a raw materials and during the technological process for production of aggregate. Recycling of concrete is a relatively simple process. It involves breaking, removing, and crushing existing concrete into a material with a specified size and quality. In this paper the main target is to compare the properties of fresh concrete and the hardening concrete for the mix design with crashed aggregate and recycling aggregate from parts of concrete after the demolition process.

Nowadays large amount of demolished concrete are available on construction sites which are now posing a serious problem for transport in urban areas. Day by day this amount is larger and the reasons are that:

- Many old buildings, concrete sidewalks, bridges and other structures have exceeded their age limit use due to structural deterioration.
- Other possible structures for use are in ruin, because they are not serving the needs of today's society.
- Structures have become waste resulting from natural disasters like cyclones, earthquakes, floods etc.

As a result of greater demand for concrete, taking into account the fact that aggregate is the component with the largest participation in concrete. Decreasing the source of natural aggregate we should explore the use of recycled aggregate. Recycled aggregate has good quality especially in resistance to pressure when the content of brick is not more than 0.5%, it presents the potential for use in a wide range of applications, for the case when it meets the test and performance requirements. However the quality of the concrete which is made with recycled aggregate is lower compared to concrete which is made with natural aggregate. Nowadays, the application of recycled aggregate in construction areas is extensive. It's application is different from country to country, in the sense that each state sets the criteria for use depending on it's quality.

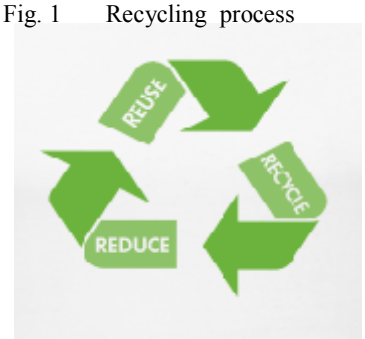
Based on the experience of use, recycled aggregate can be used for: production of concrete, in concrete roads, for production of concrete domes, as padding of the embankment, for construction of pipes, production of concrete blocks etc. Almost in all cases where natural aggregate is used.

Based on laboratory analysis Recycled aggregate compared with natural aggregate: absorbs more water, it has less density in many cases, it has lower specific weight, lower resistance to abrasion, it's more easily to destroy it, it contains more dust particles etc. Due to these results

to gain the desired workability of concrete obtained from the recycled aggregate is necessary to add a certain amount of water to saturate recycled aggregate before or during mixing with other ingredients of concrete, if not previously used any additional reducing the rate of water absorption. On the other hand it is very important to use the concrete with recycling aggregate for the concrete which offer very good properties in thermo insulation, such a very important request in efficiency of energy.

1. INTRODUCTION

Fig. 1 Recycling process



Recycling is the reprocessing of materials process. The recycling of waste helps our planet. By collecting them we can have a cleaner environment for us and our families, also their recycling protect natural resources assets so they can be never exhausted.

REUSE, REDUCE and RECYCLE are three main words that helps the nature and the environment where we live. Recycling can be possible thanks to our aid. It is important to know which materials are recyclable and how should you divide them, if we want to make a separate collection more effectively. Because we are the ones that need to make the difference on waste at first.

From Physic laws we know that matter known in nature does not disappear, it remains in nature, and therefore we should be aware for the recycling process and the use of the matter. Recycling as a process is very expensive it needs many investments, so it takes time for us to achieve development in this sector for our country.

2. RECYCLED AGGREGATE

Using recycled materials from construction operations during the demolition of the structures, shows the next application in the construction sector as an alternative to make the replacement of natural aggregates with recycle aggregates. To achieve this emphasis should be put to use waste and by-products of cement and the old buildings concrete so we can use it for new construction. Every construction activity requires some materials such as steel, concrete, glass, clay, wood etc. Concrete however remains the main material used in the construction industry.The use of recycled aggregate is especially promising because almost 75% of concrete is made of aggregate.

Fig. 2 Demolished Concrete

Large amount of broken concrete are available on construction sites which are now posing a serious problem of leaving their work in urban areas. Many researches and activities are developed around the world to test its feasibility, economic sustainability and cost effectiveness.

A study by Environmental Resources predicts that there will be increasing demand for large amounts of concrete in the future during construction and also we will have large amounts of destroyed concrete. We should use this relation between the demand for quantity and quantity of demolished concrete which we will have in the near future by treating it with recycling process. In the near future it will be a need to solve the problem of lack of natural aggregate because it's reserves will be depleted after this consumption of concrete which increases rapidly. Therefore we should considered apart from natural aggregate and start to use the recycled aggregate at least in some cases.

Classification of aggregate for use:

- Natural aggregate - in building aggregate produced from natural resources such as gravel and sand, and such products acquired in quarries and the river aggregates.
- Recycled aggregate - represents the aggregate resulting from the processing of materials previously used in a construction zone.
- Aggregate produced from by-products of industrial processes - from the title itself means that these are aggregates obtained by the thermal process, the blast furnace, slag, fly ash, etc.

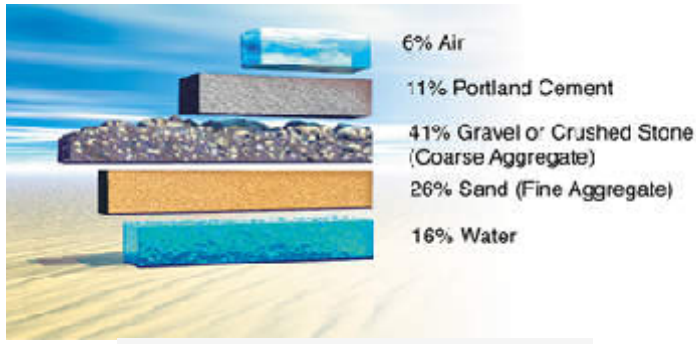


Fig. 3 Constituent components of concrete

When the broken concrete crumbles, a certain amount of mortar and cement concrete pastries from the original structure remains attached to the stone particles in the recycled aggregate. This mortar attached (that underpin Recycled aggregate) is the main reason for lower quality of recycled aggregate compared with natural aggregate.

Besides the initial investment in technology for recycling, costs for production of recycled aggregate are very small, with approximately about 40% less energy expenses for producing recycled aggregate in comparison with natural aggregate.

Fig. 4 The benefit process of recycled aggregate

To ascertain all that we said above we made a laboratory work. When we crushed the concrete material as it is shown in Fig.4 this accumulated amount of the ground material is brought into laboratory, where in we have done some lab tests:

2.1.Properties of ordinary and recycling aggregate

2.1.1.Moisture of aggregate-To determine the moisture of the recycled aggregate, we have got an amount of
4000gr of recycled aggregate, later we put this amount into the furnace at constant temperature 105 °C for three hours. After that it was weighed again and it showed the value of 3805 gr.

First mass :M_1=4000gr
After Furnace :M_0=3805gr
M1-M0 / M1 * 100 = 4.8%

We have got the result of 4.8% of moisture, but we have to mention that the samples fro m which we have got the recycled aggregate were exposed to external influences before the laboratory tests.

2.1.2.Physical properties of aggregates-The determination the bulk density of aggregate: first we weighed the recycled aggregate in regular circumstances also in the compressed state. The vessel has the standard volume of five liters.

The recycled aggregates mass in regular circumstances is:

$M1 = 7807$ gr . $\rho = 1561$ kg/m^3

The aggregates mass in compressed state is:

$M2 = 8675$ gr . $\rho = 1735$ kg/m3

Fig. 6 Determination of bulk density of Recycled aggregate

For comparing the bulk density between the recycling with the ordinary aggregate, we also examined the bulk density for ordinary aggregate , and the results are present with following figures.

$M_1 = 8330$ gr. $\rho = 1666$ kg / m^3

Natural aggregates mass in compressed state is:

$M_2 = 9456$ gr. $\rho = 1890$ kg/m^3

Determination of specific density: We have counted the specific mass by mixing 500 gr. of recycled aggregate with 500 ml. of water in the vessel which mix of water and aggregate after while shows 725 ml. of weighed.

$$\rho_s = 500 / (725 - 500) * 100 = 2200 \text{ kg/m}^3$$

Fig. 7 The process of determination of specific density

We have made a manually sifting of recycled aggregate and we have create a mix design for recycled and ordinary concrete .

Fig.8 . Manually stifting of recycled aggregate

Fig. 9 Visual differences between ordinary and recycled aggregate

Table 1.Comparing values between the ordinary and recycling aggregate

	Recycled aggregate	Natyral aggregate
Bulk density	ρ=1561kg/m3	ρ =1666kg/m3
Specific density	ρ_s =2200kg/m3	ρ_s =2650kg/m3
Color	Dark brown	Open color

After the main properties of aggregate we calculate the granulometry of recycled aggregate

Fig. 11 Process of sieving the recycling aggregate

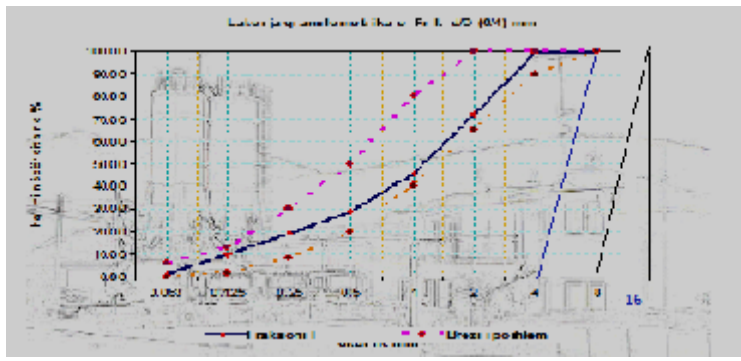


Fig.12 Granulometry of Recycled aggregate

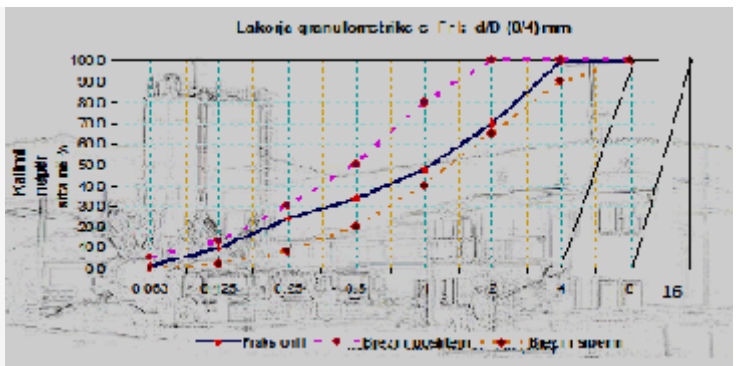


Fig.13 Granulometry of Ordinary aggregate

3. MIX DESIGN OF ORDINARY AND RECYCLING AGGREGATE

Quantity of components	Recycled aggregate	Natural aggregate
Aggregate	1415 kg	1840 kg
Cement	300 kg	300 kg
Water	253 lit.	200 lit
Percentage of fractions		
Fr 1. 50 %	707.5 kg	920 kg
Fr 2. 20 %	283.0 kg	368 kg
Fr 3. 30 %	424.5 kg	552 kg
Total quantity of aggregate	1415 kg	1840 kg

Fig. 14 Mix design for recycled and ordinary concrete

We mix an aggregate with cement and water and earn the concrete with ordinary aggregate and recycled aggregate with current mix design:

Fig. 15 Mixing of concrete

Fig . 16 Slump test (S-3 plastic concrete)

Table 2- Properties of fresh concrete

Properties of fresh concrete	Recycled conrete	Ordinary concrete
W/C ratio	0.833	0.666
Volume measure	2185 kg/m3	2398 kg/m3
Slump test	S3 (10cm)	S3(12cm)

Fig. 17 preparing the concrete samples

Fig. 18 Ready concrete samples

Fig. 19 Examination of natyral concrete

Fig. 20 Examination of recycled concrete

Table 3-Comparing the results between the ordinary and recycling concrete

No.	**Type of sample**	**First Date**	**Examination Date**	**Mass (g)**	**Dimensions (mm)**	**Area (cm^2)**	**Density (kg/m^3)**	**Force**	**Compr. strength (N/mm^2)**
1.	Ordinary concrete	**10.03.2012**	**17.03.2012**	**8040**	**150x150x150**	**225**	**2382**	**697.5**	**31.0**
2.	Ordinary concrete	**10.03.2012**	**24.03.2012**	**8042**	**150x150x150**	**225**	**2382.2**	**776.3**	**34.5**
3.	Recycled concrete	**10.03.2012**	**17.03.2012**	**7400**	**150x150x150**	**225**	**2189**	**507.2**	**22.5**
4.	Recycled concrete	**10.03.2012**	**24.03.2012**	**7404**	**150x150x150**	**225**	**2193**	**542.2**	**24.1**

CONCLUSIONS

Comparing the ordinary and recycling aggregate results with:

- **Increased of water absorption.**

The water absorption of concrete depends on the quantity of recycled aggregate. Water absorption depends on the porosity of cement matrix in the new concrete and porosity of cement matrix of the recycled concrete: if recycled aggregate is produced from low porosity waste concrete, water absorption of the new concrete depends on the achieved structure of the new cement matrix.

- **Decreased bulk density**.

Bulk density of fresh concrete is slightly decreased with increasing quantity of recycled aggregate.

- **Decreased specific density.**

The specific density of recycled aggregate is decreased than the natural aggregate. The reason is that it contains a lot of cement dust.

- **Increased abrasion loss.**

Wear resistance of the concrete depends on the amount of recycled aggregate. Concrete wear resistance decreases with increasing recycled aggregate content, due to the increased quantity of hardened cement paste, which wears easier than grains of natural aggregate.

- **Workability**

The way of preparing recycled aggregate for concrete mixtures influences the concrete workability: workability of concrete with natural and recycled aggregate is almost the same if water saturated surface dry recycled aggregate is used.

- **Shrinkage of concrete**

Shrinkage of concrete depends on the amount of recycled concrete aggregate. Concrete with more than 50% of recycled coarse aggregate has significantly more shrinkage compared to concrete with natural aggregate. Increased shrinkage is a result of the attached mortar and cement paste in the recycled aggregate grains.

- **Possible content of chemically harmful substances**

Depending on service conditions in building from which the demolition and crushing recycled aggregate is obtained.

- **Module of Elasticity**

The modulus of elasticity of concrete also decreases with increasing recycled aggregate content as a consequence of lower modulus of elasticity of recycled aggregate compared to natural aggregate.

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