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INFLUENCE OF AGGREGATE TYPE ON THE CEMENT CONCRETE

M. RUJANU[1] M. BĂRBUȚĂ[1] L. DIACONU[1] D. PLIAN[1] D. BABOR[2] C. CADERE[1]

Abstract: *The studies regarding the influence of mix components on the mechanical characteristics of concrete had shown that crushed aggregates contributed to the increase of concrete strength. In this paper, a quantification of mechanical strength modifications which occurred by using crushed aggregates for concrete grade C25/30 is presented. Mechanical strengths are experimentally determined and compared with a control mix. The idea that the specific surface of crushed aggregates is bigger, in the case of maintaining the same quantity of water, resulted in a bigger adherence between the matrix and aggregates. Also is considered that the strength of aggregate is bigger when it is produced from basalt rock.*

Key words: *cement concrete, crushed aggregate, compressive strength*

1. Introduction

It is well-known that the aggregate used for concrete obtaining represents the basic component, having a ratio of about 75% [1].

The aggregate influences the concrete structure by: nature, aspect of granules surface, geometrical characteristics, granularity etc. The provenience nature of rocks can influence the concrete structure by the density of aggregate granules, especially its porosity, by the petrography nature, especially the chemical character of rock [2,3].

The aspect of granules surface is important for adherence, a rough surface assures a better adherence between matrix and aggregate and also, due to internal frictions, the consistency of the mix will increase, resulting a more compact structure, with a reduced pore volume. The granules shape of aggregates modifies the volume of voids and specific surface of the mix, thus influencing the compactness and the workability of the concrete. For lamellar or acicular shape of granules, the volume of voids and the specific surface will be bigger, with unfavorable consequences on the workability and, by retaining the mixing water, the lens of evaporated water are formed, followed by occurring *of "pores under aggregates"*. Another consequence of using acicular granules consists in forming of a stratification structure of the concrete, with negative influence on the final strength and durability of concrete [4,5].

According to actual norms [6] the appreciation of granules shape is realized by the ratio b/a and c/a and medium volume coefficient C_v, where a, b, c –are

[1] "Gheorghe Asachi" Technical University of Iasi, Faculty of Civil Engineering and Services,Romania.
[2] Corresponding author: e-mail: danbabor@yahoo.com

the sizes of granules and C_v is computed with relation (1):

$$C_v = \frac{V}{\pi / 6\Sigma a_i^3} \quad (i = 1......n) \qquad (1)$$

where:
V = aparent volume of granules of aggregat;
$\pi/6\Sigma a_i^3$ = volume of spheres circumscribed to granules, where a_i is maximum size (diameter) of each granule of aggregate.

The methodology for determining these characteristics supposes the use of certain sorts of aggregates, and the condition of their use is:

$b/a \geq 0.66$ $c/a \geq 0.33$ $C_v \geq 0.20$

The upper values can give informations about general shape of aggregate granules:

- **For values under the imposed limits**, aggregate presents a huge quantity of acicular or plate shape, shapes which are unfavorable for the concrete mix and that produces an increase of permeability and a decrease of mechanical characteristics.

- **For values over the imposed limits**, aggregate presents short prismatic shape, isometric, appropriate for concrete mixes, shapes which result in favorable effects on the compactness and porosity of the concrete structure and also ensure good mechanical strengths.

2. Experimental Program

In the experimental program the actual norms [6] were considered. These imposed some limits for composition factors (such as minimum cement dosage, maximum W/C ratio) and also recommended the type of cement that must be used in function of exposure class.

In the study were prepared 4 mixes of concrete, using river aggregates with maximum size of granule of 16 mm and also crushed aggregate for comparative analysis.

The cement type was CEM I-42,5R [7]. The W/C ratio was 0.48 (Table 1).

The concrete was poured into cube molds of 150x150x150mm and prism molds of 100 × 100 ×500mm and kept in water under laboratory conditions at 20^0C. The samples were prepared and kept according to European standards [7].

After 28 days the specimens were tested for compressive strength, on tree samples of each mix, according to European standards [8].

- **Experimental Results**

The cement type was CEM I-42,5R [7]. The W/C ratio was 0.48 (Table 1) and the results of experimental tests are given in Table 2.

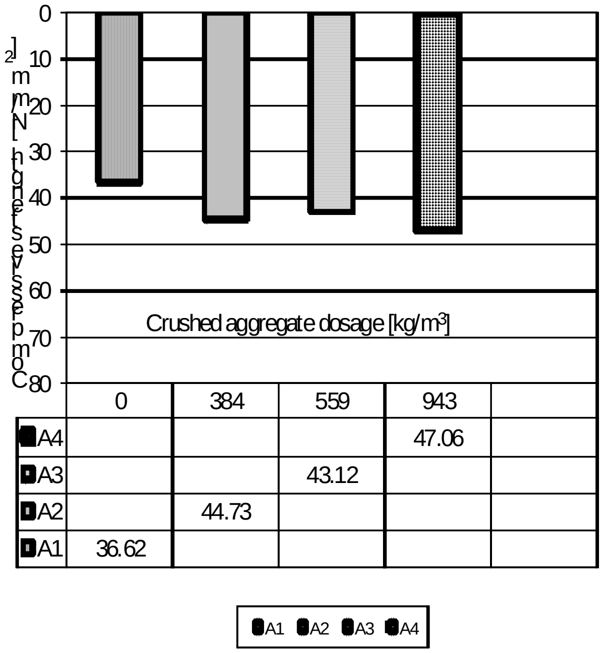

Fig. 1.*Corelation between crushed aggregate dosa and compressive strength*

Components Dosage Table 1.

Mix	Cement-C kg/m³	River Aggregate kg/m³			Crushed Aggregate kg/m³			Water (W) l/m³	W/C
		0-4	4-8	8-16	0-4	4-8	8-16		
A1	360	803	384	559	-	-	-	172	0.48
A2	360	803	-	559	-	384	-	172	0.48
A3	360	803	384	-	-	-	559	172	0.48
A4	360	803	-	-	-	384	559	172	0.48

Experimental results Table 2.

Mix	Ratio W/C	River aggregate dosage kg/m³	Crushed aggregate dosage kg/m³	Compressive strength N/mm²	Medium value of compressive strength N/mm²
A1	0.48	1746	-	36.60	36.62
				32,90	
				40.36	
A2	0.48	1187	384	45.67	44.73
				43.01	
				45,52	
A3	0.48	1562	559	45.67	43.12
				40.69	
				43.01	
A4	0,48	803	943	47.78	47.06
				47.83	
				45.57	

The results are presented in graph from Fig. 2.

3. Conclusions

The analyze of experimental values have shown:

• Mix **A2,** with crushed aggregate for sort 4-8mm in the place of river aggregates, presents a value of compressive strength higher than in the case of control mix (+22%), when the same characteristics of consistency, component dosages etc. were kept.

• Mix **A3**, with crushed aggregate for sort 8-16 mm in the place of river aggregates, presents a value of compressive strength higher than in the case of control mix (+17.7%), when the same characteristics of consistency, components dosages etc. were kept.

• Mix **A4**, with crushed aggregate for sort 4-8 and 8-16 mm in the place of river aggregates, presents a value of compressive strength higher than in the case of control mix (+28.5%), when the same characteristics of consistency, components dosages, etc were kept.

• From the point of view of economical efficiency and mechanical strength, the mix A4 is the best, but the other mixes A2 and A3 presented also an increase in compressive strength in comparison with the control mix. The use of crushed aggregates of high sort in concrete mix for concrete grade C25/30 results in the improvement of compressive strength (with 15-20%). The mechanical characteristics are also influenced by the other components (superplasticizer, type of cement, addition etc) and so in choosing the concrete mix all factor which are implied must be considered.

References

1. Neville, A., H., Concrete properties, Technical Publishing House, Bucureşti, 1980 (*in romanian*)
2. Rujanu, M., PhD Thesis, Faculty of Constructions and Architecture Iaşi, 1993
3. Moldovan, V., Tatu, D., Construction materials 9(2), 1979 (*in Romanian*)
4. Vermat, M., Romanian Journal of Materials, nr. 629, 1968
5. Marta, L., ş.a., Considerations on the waterproofing possibilities of the concrete, The 5th Geotechnical Conference, Cluj-Napoca, vol. III, pg. 39, 1984 (*in Romanian*)
6. Norm NE 012-1/2007 for concrete production and execution of concrete works, reinforced and prestressed concrete, Part 1, Published in Official Journal of Romania, Part I no. 374 from 16/05/2008
7. Romanian Standard Association, SR EN 197-1:2011, Cement- Part 1: Composition, specifications and conformity criteria for common cements, 2011
8. Romanian Standard Association, SR EN 12390-1:2002/ AC:2002, Testing hardened concrete. Part 1: Shape, sizes and other requirements for specimens and moulds, 2002
9. Romanian Standard Association, SR EN 12390-3:2009/ AC:2011, Testing hardened concrete. Part 3: Compressive strength of test specimens, 2011