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RESEARCHES ON THE REVALUATION OF THE USED SANDS FROM THE INDUSTRIAL WASTES IN THE COMPOSITION OF CONCRETE

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ABSTRACT. The heritage of the past, when there wasn't much focus on complying with norms of good practice on the environment, has now become very visible on the sites found in the areas of industrial deposits. According to the information available at national level, there are 169 deposits for industrial waste which are subject to the provision of Directive 1999/31/EC32, covering a surface of around 2765 ha.

In order to diminish the quantities of waste and the problems of their storage, it is recommended to review the technological processes and maximize the revaluation of the waste, as well as evacuating and storing it in a grouped manner, for the purpose of annihilating certain toxic effects.

Without minimizing the importance of risks related to industrial waste storing, we must point out that, sometimes, the decisions of prevention/reduction of environmental risks are contrary to those of economic nature, which focus, most of all, on controlling factors affecting the production from the point of view of quantity and quality.

The main directions with successful attempts of revaluation of industrial waste are: cement industry, asphalt industry and construction materials.

Key words: *industrial waste deposits, metallurgic waste, used sands, revaluation, concrete*

INTRODUCTION

Storing waste in an over-crowded world has become a very serious issue that is difficult to solve due to the large amount of waste generated by industrial processes, due to their diversity and toxicity, and major impact on the environment. Increasing the volume of industrial waste raises serious problems, by occupying important areas of land, as well as by affecting the health of people and animals (Micle, 2009).

Industrial waste represents one of the important problems within the environment protection policy, and efforts are being made in order to harmonize the national provisions, with those of the European Union (Directive 1999/31/EC). In Romania, the idea of reusing industrial waste in various domains is developed around the cement industry, constructions materials etc. (Guide GG 119, 1998).

Ferrous metallurgical factories in Romania, mostly being steel works factories, have been preserved after 1990 and very few of them were privatized.

In foundries, there are large amounts of waste from used sands, which must be stored, these implying large areas of land and having a negative impact on the environment (Guide GG 119, UK, 1998).

The used sands represent the material used for making forms and cores. This material is made from a base material (sand) and a material that makes the connection between the grains of the base material (binding agent) and other elements introduced in the mix, for the purpose of improving their properties (Soporan and Lehene, 2005).

The constantly increasing consumption of natural resources and their diminishment at global level represents a highly important problem (Dan and Pop, 2010).

Revaluation of industrial waste by reusing the in various domains, including that of construction materials, represents the object of various researches within national and international research institutes (Arad et al., 2000; Avram and Bob, 1980).

Since concrete is the most frequently used construction material, there have been experimental attempts to include the used sands as element in the process of producing concrete (Boda, 2013).

Component materials of the studied concrete are the usual ones, used for preparing concrete: aggregates, cement, additives, water, and additions for improving performances (Szilagyi, 2011; SR EN 206-1/2002)

EXPERIMENTAL METHODS

For the physical and chemical characteristics of the waste, samples have been taken from three different places on the site of the industrial waste deposit of Apahida-Cluj, presented in figure 1.

Fig. 1. *Location of the waste sampling sites*

For visual characteristics of the waste samples, we have prepared a 3000 g sample, of which we have separated seven parts of materials, resulting from the activities of metallurgic industry. From the point of view of the physical state, the separate waste is presented in figure 2.

Fig. 2. *Visual characteristics of waste from the representative sample site*

Following the visual and quantitative characterization of the waste samples (figure 3) we observed that approximately 57% of the used sand is of granular type and lumps, thus showing that this waste reaching the deposit, could be revaluated in various domains of activity, through a regeneration process.

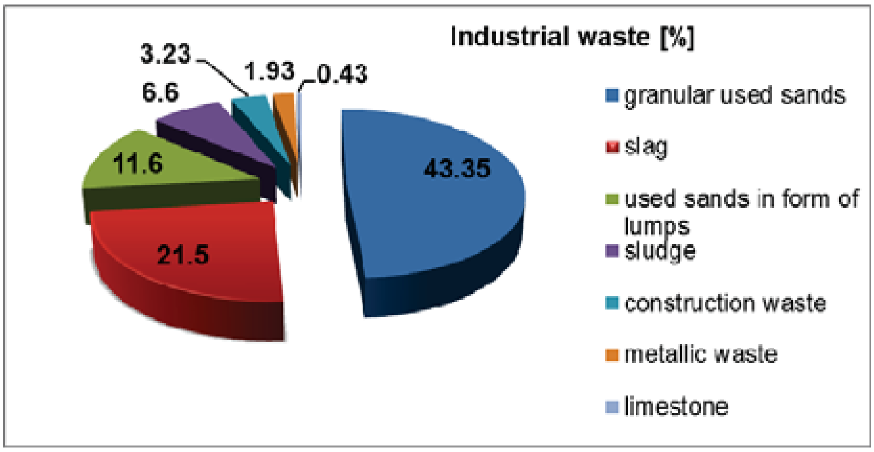

Fig. 3. *Graphical representation of industrial waste*

In order to analyze the used sand, it is extremely important to determine the size of its grains. The purpose of this analysis is to establish the destination where the used sand can be reused correctly.

The characteristics of the used sands, from the point of view of the granulometric composition, were determined by sifting it through a sieve with openings between 1.6 mm and 0.004 mm, according to the results shown in table 1 and figure 4.

Table 1. *Results of experiments*

Sieve no 10677-67	quantity remained on the sieves (g) % compared to the processed sample			characteristics
	Sampling place 1	Sampling place 2	Sampling place 3	
S 1,6	47	22	52	coarse sand (>0,2 mm);
S 0,8	14	10	12	
S 0,6	11	7	6	
S 0,44	21	21	12	
S 0,32	11	14	10	
S 0,20	7	13	8	fine sand (0,2 mm – 0,02 mm);
S 0,16	3	6	3	
S 0,15	2	6	4	
S 0,071	2	2	2	
S-0,063	-	2	-	
S-0,040	-	7	-	

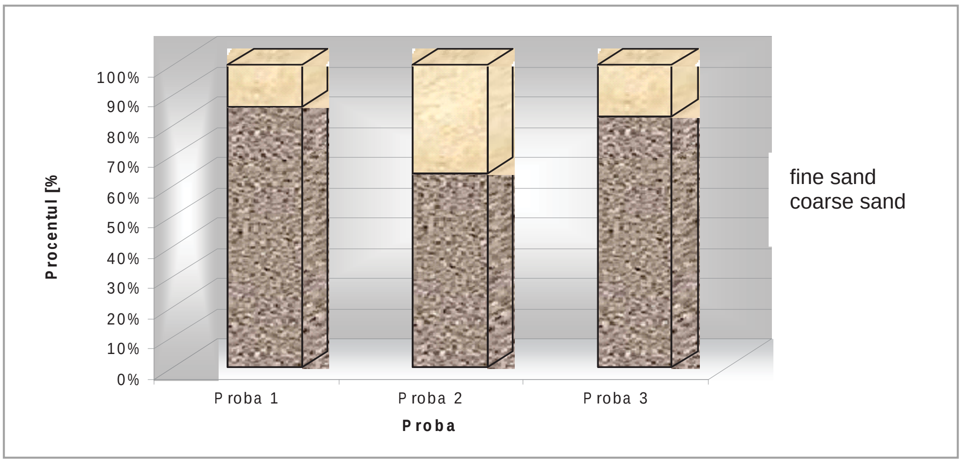

Fig. 4. *Graphical representation of granulometric fractions for the three samples*

After determining the granulometric fractions, we have made the granulation curves, presented in figures 5, 6 and 7.

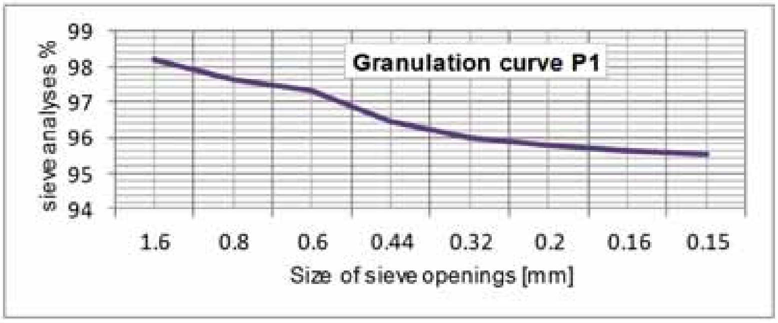

Fig. 5. *Granulation curve for the used sand taken from the sampling place 1*

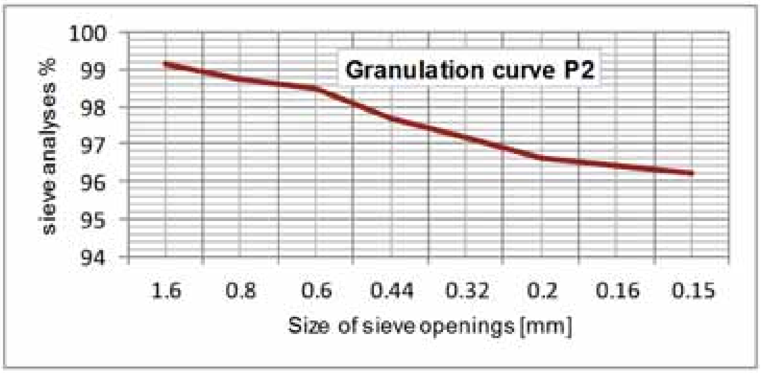

Fig. 6. *Granulation curve for the used sand taken from the sampling place 2*

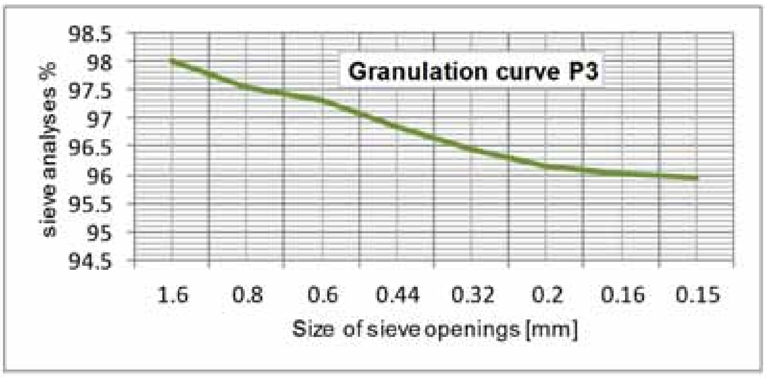

Fig. 7. *Granulation curve for the used sand taken from the sampling place 3*

RESULTS

Following the study performed regarding the possibilities of revaluing the used sands, there have been experimental researches with the purpose of bringing improvements, by adding used sands in the composition of concrete.

Experimental researches were performed by making three castings, for the revaluation of used sands in the composition of concrete. The representative images obtained are shown in figures 8, 9 and 10.

The strength of concrete is considered the most important of its features, offering an overall evaluation of the quality of concrete, thus, the results obtained for the concrete hardened in 7 days are presented in the charts of figures 11 and 12.

The strength was determined, based on the testing made on 150 mm cubes, according to SR EN 12390-1 (identical with the European Standard EN 13791:2007), made and preserved according to SR EN 12390-2, from the samples taken according to SR EN 12350-1 (identical with the European Standard EN 12350-1:1999).

Casting 1

To determine the compressive strength of the concrete control casting (figure 8), we performed three tests and we considered the average value, to establish the compressive strength class.

Fig. 8. *Image of the concrete control casting subject to compression (casting 1)*

Casting 2

The determination of compressive strength for the concrete containing additions of used sands obtained in casting 2, complying with the composition and proportions of the recipe established for the concrete control casting is presented in figure 9.

Fig. 9. *Images of concrete with used sand, subject to compression testing (casting 2)*

<u>Casting 3</u>

The concrete sample containing additions of used sand, in casting 3, was made by large quantity of water dosage of 3500 ml, which significantly influences the compressive strength of the concrete with addition of industrial waste, and is presented in figure 10.

Fig. 10. *Images of concrete with used sand subject to compression (casting 3)*

The results from determining the resistance to compression casting used sands compared with the control casting is shown in figures 11 and 12.

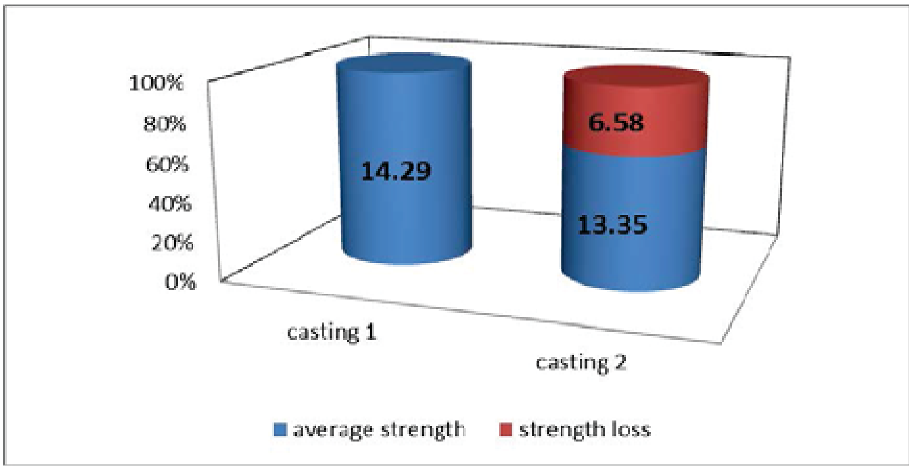

Fig. 11. *Comparison of compressive strength for the concrete control casting with the newly obtained one (casting 2)*

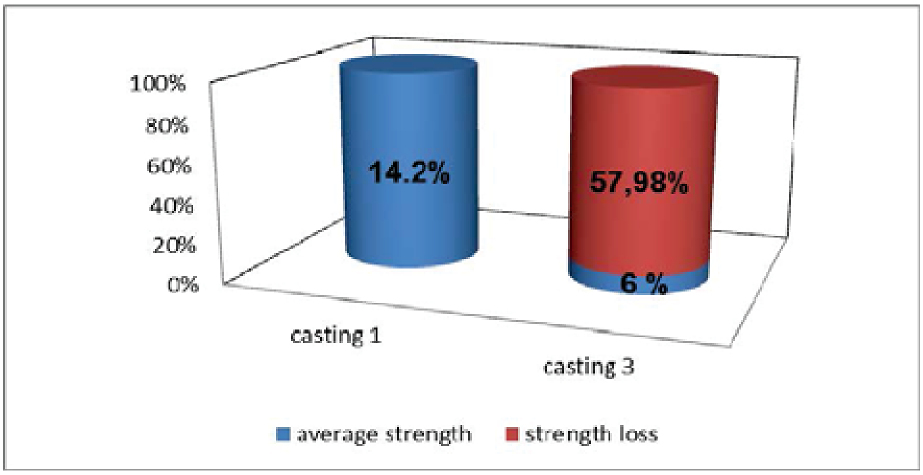

Fig. 12. *Comparison of compressive strength for the concrete control casting with the newly obtained one (casting 3)*

Making a comparison between the water/cement (W/C) proportion on the three cast concretes, and the compressive strength, we found that the strength decreases when we increase the quantity of water introduced in the process of casting and obtaining the concrete with addition of used sand (figure 13).

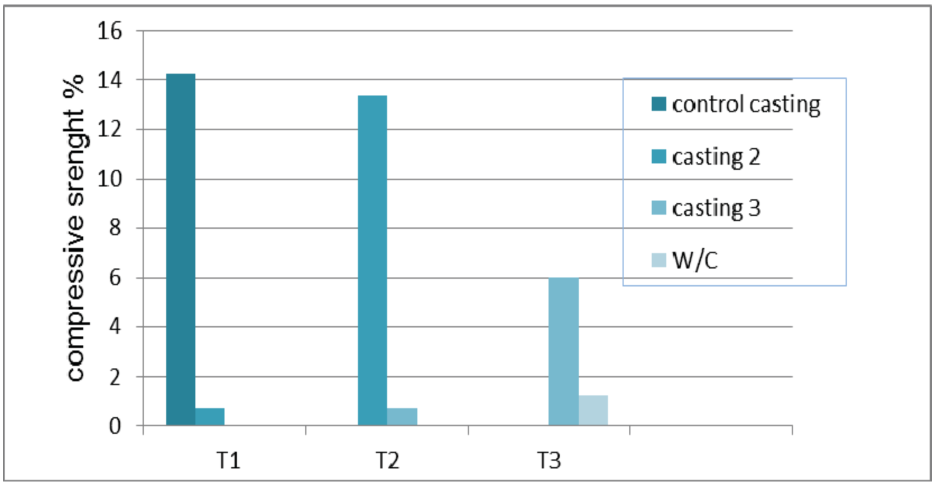

Fig. 13. *Influence of the water/cement proportion on the compressive strength*

CONCLUSIONS

- ❑ Comparing the compressive strength of the concrete with used sand from casting 2 with the compressive strength of the concrete control casting, it can be observed that their values are very close with an approximate loss of 6,5%.
- ❑ By comparing the compressive strength of the sample obtained in casting 3 to the compressive strength of the sample obtained in casting 1 (control casting), it can be observed that there is a great loss of strength.
- ❑ The supplementary water addition, different from the pre-established recipes, is intended to improve the workability of the concrete made and to extend the variety of domains for using the industrial waste.
- ❑ In order to obtain concrete having strengths comparable to those obtained for the concrete control casting, the following are recommended:
  - ➢ Only partial replacement of the gravel pit sand with foundry sand;
  - ➢ Using additives according to the dosage of the recipe of last generation type, superplasticizers, with strong effect of reducing water in the composition of concrete and increasing the workability of the material;
- ❑ This industrial waste, the used sand, can be revalued without high processing costs, being used in the composition of concrete, as part of the aggregate or completely replacing the aggregate.

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