Method for using waste abrasive material from abrasive waterjet cutting

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Introduction

The abrasive used in the process is a hard sand material, alumina, silica, carbide or silicon nitride, composed of small particles (the equivalent diameter ranging from 0.08 mm to 0.1 mm). The most commonly used material is Garnet type abrasive. It is durable, rough and inexpensive, available with different types of granulation values such as 120, 80 or 50 Mesh. This abrasive used in industry is a product mainly imported from Australia or India.

After performing the abrasive water jet cutting operations, the resulting abrasive material has smaller granule sizes and usually is no longer used for further cutting operations. In this case this material becomes waste.

Waste abrasive quantities are stored in special designed places for this purpose, with the usual name of waste abrasive dump.

Currently, further use of this waste material does not take place, as there are no practical methods being developed for this purpose.

In this respect, it is proposed the solution of the use of dry waste abrasive in construction industries for use in mortars or similar mixtures.

The technical problem presented is preceded by an economic problem, that of using a material that has the quality of waste, in combination with other materials, in construction industries, so to capitalize this waste by methods that are characteristic of obtaining materials with adhesive function.

From a technical point of view, it's about how the mixing it's done between materials in the specific field, the proportions between the components of the mixture and the working temperature range, in order to achieve an adequate anchoring of the mixtures obtained in the working process.

The use of the waste abrasive material refers to a use method of abrasive resulting as waste in the abrasive waterjet process in cement-based mixtures in construction industries.

Method for re-using Garnet abrasive waste

The abrasive, in a dry state, having a certain grain size range and containing a large number of fine fractions, is mixed with a certain amount of water, sand and cement. The amount of waste abrasive is variable, establishing the optimum values based on tests, the rest of the components being quantitatively compliant with the provisions of the standards and regulations. These mixtures result in various mortars, which are subjected to specific tests, obtaining values that characterize the product obtained, conferring specific attributes for use in construction. The products obtained are used in mortar constructions or as cladding adhesives.

The method can be applied at an industrial level by identifying the location of the waste abrasive deposits, processing it to obtain mortars for using them in specific industrial activities.

The process of using the waste abrasive material according to this method has the following advantages:

- exploits a material that is currently considered waste after the abrasive water jet cutting process;
- performs an environment cleaning activity of the areas in which the waste abrasive material is currently stored;
- savings are achieved as the same amount of sand obtained at certain costs is not consumed to obtain mortars;
- the purchased abrasive material for abrasive waterjet cutting has certain physicochemical characteristics that are also valid for mortars and similar mixtures.

A description of this method will now be described, in connection with the tables 1, 2, 3 and 4 which represent:

- Table 1 grain sizes of abrasive wear;
- Table 2 mortar compositions;
- Table 3, values of the diameters of mortar forms according to SR EN 1015-3: 2005;
- Table 4, values of apparent densities and bending strength, according to SR EN 1015 10: 2002, respectively SR EN 1015-11: 2002.

The process relates to the methodology for obtaining waste abrasive materials mixtures resulting from abrasive waterjet cutting operations, based on Portland cements.

These mixtures of sand, cement, abrasive, and water lead to building mortars.

As far as the technology for obtaining these mortars is concerned, the main stages of the whole process are presented.

The waste abrasive, has a particle size distribution as shown in Table 1.

Table 1. Waste Abrasive Grain Size.

Sieve size [mm]	0.063	0.125	0.250	0.500
Waste abrasive material passes [%]	26.8	50.6	96.0	99.7

Table 2 shows the compositions useful in obtaining mortars. Composition 3 represents the control.

Table 2. Compositions.

Name	Composition no.		
	1	2	3
Cement/Sand	1/3	1/3	1/3
Waste abrasive [% of cement]	10	5	0
Water / Cement ratio [%]	0,535	0,535	0,535

The only variable shown in Table 2 is the amount of waste abrasive. The amount of water is constant. Sand is the one used for cement testing, according to SREN 196-1: 1995.

On the basis of the compositions shown in Table 2, the Spread Ability Testing is carried out according to SR EN 1015-3: 2005. By this method, the mortar-shaped conic sample is deformed by successive shocks and the measurement of two diameters perpendicular to the resulting circular shape is carried out.

The values obtained for this workability test are shown in Table 3.

Table 3. Diameters values at the workability test.

The name	Composition no.		
	1	2	3
Spreading [cm]	21.1	19.9	21.3
Anchoring start [min]	180	160	120

It can be seen that by the addition of waste abrasive material up to 10% (composition 1), the spread varies very little, although the amount of the waste abrasive was expected to decrease much when adding such a quantity. The very small variation in the spread with this added abrasive addition proves that it fits very well into the grain size of the sand, which it improves.

Regarding the influence of the abrasive material on the hardened mortars, there are two characteristics: apparent density and mechanical resistance to stretching and compression.

Apparent density was determined according to SREN 1015-10: 2002 by weighing the specimens in water and air. Table 4 shows the values obtained. It is noted that the density increases with the increase of the amount of waste abrasive. The density variation with the amount of waste abrasive demonstrates that the abrasive is well suited to the grain sizes of the sand, which it improves.

The obtained mechanical strength values for the tensile strength tests and the compression tests are shown in Table 4. Resistances were determined after SREN 1015-11: 2002 at the age of 7 days after casting.

Table 4. Apparent densities and bending and compression strength.

The name	Composition no.		
	1	2	3
Apparent density [kg/dm^3]	2.276	2.263	2.238
Bending resistance [N/mm^2]	3.8	3.6	3.5
Compression strength [N/mm]	19.8	17.6	15.8

Values are higher with the increase of the amount of waste abrasive up to 10%.

Increased resistances have two causes:

- increasing the density, respectively reducing the volume of air and increasing the compaction;
- there is a physical action of increasing the water absorption within the abrasive grains during the cutting operations, the initial granules being broken, thus capable of higher absorption resulting in a better bond with the cement paste from mortar.

Conclusions

The technology for obtaining and using mortars with waste abrasive in composition, allows the following conclusions to be drawn:

- In fresh state the addition of up to 10% of the cement mass does not change the workability in relation to the mortar mixture; so up to this percentage, no water addition is required for the same workability;
- The grouting time of the mortar increases with the increase in the amount of waste abrasive, which leads to the conclusion that the usage time of abrasive mortars is higher;
- This property is important in the adhesives industries, which defines and classifies them;
- In the reinforced state, the increase in the amount of waste abrasive results in a significant increase in apparent density and mechanical strength.
- From the above it is found that the waste abrasive influences the Portland cement mixtures. There were two variants with a percentage of 5 and 10 of cement, values established on the basis of experiments carried out in this regard.
- Fields of use of these blends are special mortars used as adhesives for fixing tile or ceramic tiles, gluing of expanded polystyrene sheets as thermal insulation elements, as wear floors of underfloor floors, prefabricated buildings with special properties strength and durability.

References

[1] SR EN 1015-3: 2005
[2] SR EN 1015 10: 2002
[3] SR EN 1015-11: 2002