Method for using waste abrasive material

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1. Introduction

Currently, different processes are used in industrial activities for cutting materials. One of these is the abrasive water jet cutting process or abrasive water jet.

The abrasive material used in the process is sand, alumina, silica, carbide or silicon nitride, composed of small particles (the equivalent diameter ranging from 0.08 mm to 0.1 mm). Of these types, Garnet is the most commonly used abrasive. It is durable, rough and inexpensive, sold with different types of granulation. Values that are marketed are 120, 80 and 50 Mesh units. This abrasive used in industry is a product mainly imported from Australia or India.

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

The quantities of used abrasive are stored in places intended for this purpose, with the usual name of abrasive waste dumps.

The use of this waste material is not being currently utilized and practical methods are not being developed for this purpose.

2. Method of capitalizing waste abrasive material

In this respect, a solution is proposed for the utilization of the dry waste abrasive in the construction industry by using it in the form of mortars [1].

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

From a technical point of view, it is about how to mix the materials in the specific field, the proportions between the components of the mixture and the working temperature range, in order to achieve good adhesion of the mixtures obtained in the working process.

The use of abrasive material refers to the use of abrasive waste resulting from abrasive water jet cutting in cement-based mixtures in the construction industry.

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

The method can be applied industrially by identifying the location of the used abrasive deposits, processing it for the production of mortars and using them in specific industrial activities.

3. Results and discussions

The use of waste abrasive according to the method has the following advantages:

- Exploitation of a material that is currently considered waste after applying the abrasive water jet cutting process;
- Performs a sanitation activity of the areas in which currently used abrasive material is deposited as waste;
- Savings are achieved as the same amount of sand obtained at certain costs is not consumed to obtain mortars;
- The abrasive material is purchased with certain physicochemical characteristics that are also valid for mortars, using waste abrasive material.

A description of the method is currently presented, in connection with Tables 1, 2, 3 and 4, which represents:

- Table 1, waste abrasive granulation;
- Table 2, compositions for mortars;
- Table 3, values of size diameters for 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 blends of waste abrasive material resulting from abrasive waterjet cutting operations on Portland cements.

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

With regard to the technology for obtaining these mortars, the main stages of the whole process are presented.

The waste abrasive in dry state has a granulation shown in Table 1.

Table 1. Waste abrasive granulation

Mesh 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 is a control.

Table 2 Compositions

No.	Name	Composition no.		
		1	2	3
1	Cement/Sand	1/3	1/3	1/3
2	Waste abrasive [% cement]	10	5	0
3	Water/cement ratio [%]	0.535	0.535	0.535

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

On the basis of the compositions shown in Table 2, the workability test is carried out by the spreading method according to SR EN 1015-3: 2005. By this method, a tortuous form of the mortar has been deformed by successive shocks and measurements of two diameters perpendicular to the resulting circular shape were done.

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

Table 3. Diameter values at the workability test

No.	Name	Composition no.		
		1	2	3
1	Spread [cm]	21.1	19.9	21.3
1	Adhesion start [min]	180	160	120

It can be seen that by the addition of abrasive material up to 10% (composition 1), the spread varies very little, although the use of fine abrasive was expected to sharply decrease the spread. The very small variation in the spread with this added abrasive addition proves that it fits very well in the grain size of the sand, which it improves.

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

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

The values obtained for mechanical strength at stretching and compressions are shown in Table 4. Resistances were determined in accordance to SR EN 1015-11: 2002 at the age of 7 days after casting.

Table 4. Apparent densities, bending and compression strength

No.	Name	Composition no.		
		1	2	3
1	Apparent density [kg/dm^3]	2.276	2.263	2.238
2	Bend resistance [N/mm^2]	3.8	3.6	3.5
3	Compression resistance [N/mm^2]	19.8	17.6	15.8

Values are up to 10% higher with increasing the amount of abrasive used.

Increased resistances have the following two causes:

- Increased density reduced air volume and increased compaction;
- There is a physical action of increasing the absorption of water inside the abrasive grains during the cutting operations, the initial granules being broken, thus capable of higher absorption resulting in a better bond to the cement paste within the mortar.

Conclusions

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

- Freshly adding waste abrasive up to 10% of cement mass does not change workability with mortar mixture, so up to this percentage, no water addition is required for the same workability.
- The adhesion time of the mortar increases with the increase in the amount of waste abrasive used, which leads to the conclusion that the work time of abrasive mortars is higher.
- In a hardened state, the increase in the amount of waste abrasive used results in a significant increase in apparent density and mechanical strength.

From the above presented it is observed that the waste abrasive used influences Portland cement mixtures. There were presented two variants with a percentage of 5 and 10 of cement, values established on the basis of experiments carried out in this respect.

Fields of use of these blends are special mortars used as adhesives for fixing tiles or ceramic tiles, gluing of expanded polystyrene sheets as thermal insulating elements, wear layer of floors, prefabricated concrete with special properties for strength and durability.

References

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