Use of municipal solid waste and Marble residue in the manufacturing of bricks and roofing tiles

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INTRODUCCIÓN

The substitution of ceramic clays for other wastes, in this case municipal solid waste (MSW) and marble residue rich in calcium carbonate, in the production of traditional ceramics could give rise into cost savings due to the utilization and recycling of wastes as a secondary raw material. Total Spanish municipal solid wastes (MSW) production exceeds 21 million tons per year, of which 28.1% and 6.2% are treated in compost and incineration plants, respectively (Tayibi et al., 2007). On the other hand, in Spanish natural stone industry, about 70% of the processing wastes are being disposed locally. The marble dust is usually dumped on the riverbeds and this possesses a major environmental concern. In recent years residues have been constructively applied to resources in recycling research, and related achievements are seen in engineering applications. Different authors have been investigating the incorporation of different types of residues in the manufacture of traditional ceramic materials in recent years (Hauser, 2000; Dondi et al., 1997 and Dondi et al., 2002). However, very little research has focused on ways to improve the properties of clay tile. Ceramic tiles bodies have been obtained by recycling municipal solid wastes (MSW) and marble residues. In order to evaluate the ceramic properties of the obtained material, water absorption capacity and bending strength have been determined

MATERIALS AND METHODS

A standard ceramic clay and a representative sample of municipal solid waste coming from two different plants were selected. On the other hand one representative sample of a residue rich in calcium carbonate (sludge) coming from different marble plants of the natural stone industry of Alicante province (Spain) was selected. Some experimental tests have been carried out with the ceramic clay, the MSW and marble residue. Such tests consist of the preparation of mixtures with the following MSW: 0 (control), 1, 2, 3, 4, 5 and 10 (wt. %) and 0 (control), 15, 20, 25, 30 and 35% of marble residue, respectively (Figure 1).

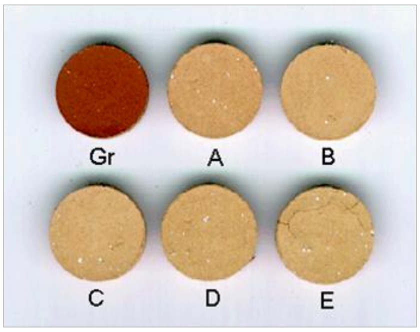

Figure 1. Aspect of the ceramic test bodies (discs of 20 mm diameter and 5mm thick) obtained with different percentages of added residue and firing cycles (Gr, reference sample).

The usual industry sector firing cycles were designed (0-500ºC: 2h; 500-650ºC: 2 h; 650-Tmax: 2 h; Tmax: 4h), and maximum temperatures (Tmax) of 975, 1000, 1025 and 1050 °C were reached. The water absorption capacity (%) has been determined in ceramic tile bodies following the ISO-10545-3 (AENOR). With the aim of determining the extent to which the residue introduction in the ceramic paste affects the mechanical properties of the product, the bending strength of both dried and heated samples has been carried out using INSTRON 1011 equipment using a 3-point loading method (Montero et al., 2009).

RESULTS

Figure 2 shows the results of the water absorption test. In this case, there is a clear tendency to increase as the quantity of sludge in the body increases.

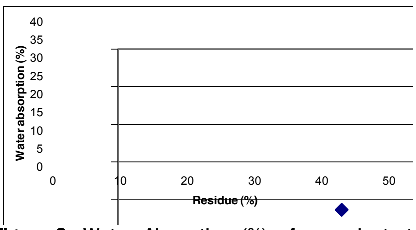

Figure 2. Water Absorption (%) of ceramic test bodies.

The results of the bending strength are shown in Table 1.

Residue %	*Green %*	*Sintered %*
0	*2.5*	*14.5*
16	*1.8*	*12.3*
22	*1.6*	*10.2*
28	*1.1*	*9.3*
34	*1.2*	*8.8*
40	*9.8*	*6.0*

Table 1. - Bending strength of the original green body and the sintered ceramic after thermal cycling

There is a decrease in this property when the addition of sludge increases. The addition of residue gives rise to a decrease in the bending strength in such a way that the selection of the adequate percentage of sludge to be added to the body must be controlled to the standards of specific construction materials.

palabras clave: Mármol, Residuos sólidos urbanos, Materias primas, Arcilla

key words: Marble, municipal solid waste, Raw materials, Clay

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CONCLUSIONS

The increase in water absorption with the increase in the residue percentage is evident. The addition of these residues gives rise to a decrease in the bending strength. The use of residues tested in the manufactory of bricks and roofing tiles affects the final properties of these products. However, by considering the physical and mechanical properties here determined the new ceramic tile bodies are close to the conventional market bricks and roofing tiles.

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