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SUSTAINABLE CONSTRUCTION MATERIALS BASED ON RECYCLED ASBESTOS CEMENT WASTES

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ABSTRACT

Asbestos-containing waste is one of the main problems of the last decade. The management and disposal of these waste products are in fact of great importance to prevent damage to the environment and to human health. This study presents a characterization of asbestos cement wastes, after having been reduced to powder by a high energy milling (HEM) process of 4 hours. The very fine powders acquired at all processing occasions are described to check the mineralogical and morphological transformation of the asbestos stages. A SEM examination together with thermal and mechanical tests are performed to test the effectiveness of the recycling process. The consequences of thermal examinations demonstrate that the endothermic impacts related to the neo-shaped restricting stages significantly increment with relieving time. Moreover, the innovative efficacy of the reusing procedure is assessed by getting ready and testing water powered lime and processed powder-based mortars. The entire test set gives great outcomes as far as the hydration energy and mechanical properties of the building materials examined. Estimations of responded lime around 40% and estimations of compressive quality in the scope of 2.17 and 2.29 MPa, are estimated.

Keywords: Recycled asbestos cement wastes, high energy milling.

INTRODUCTION

A lot of asbestos-bond has been created and utilized in Italy in the previous decade, in truth a lot of this material is as yet present in the nation (Bianchi et al., 2002, Chapman, 2000). The materials that contain asbestos are delegated risky waste by the Italian orders of 2003 and 2005 and for their transfer and reusing are vital primer medicines in controlled landfills (EU report., 2000 and 2001) as per the rules issued by the announcement of the Ministry of Italian environment n. 248/2004. Among the treatments utilized are adjustment and inertization procedures to lessen the dangers related with waste containing asbestos (ACW) (Gualtieri and Tartaglia, 2000, Leonelli

et al., 2006, Gualtieri et al., 2008, Chan et al., 2000) and specifically high energy milling (HEM) which takes into consideration the mineralogical and morphological change of asbestos stages (Plescia et al., 2003) making it shapeless/amorphus as showed from the consequences of spectrophotometric and diffractometric investigations. In this procedure, energy impacts are produced between the crushing methods (rings, rollers, hammers with balls, and so forth.) and the powders containing asbestos, along these lines causing distortion, crack and nearby welding of particles. This mechanical procedure can obliterate the gem cross section and causes a critical increment in the explicit surface (Palaniandy and Jamil, 2009, Billik and Caplovicova, 2009). The asbestos powders are reasonable/suitable for different structural designing applications, in certainty the powders containing indistinct aluminosilicate are utilized as pozzolanic expansion to create concrete and mortar. This investigation dissects the HEM treatment completed on ACW and the consequent reusing of without asbestos powders. The viability of the powders is tried by utilizing them in various cover blends containing business lime and 30%, 40% and half of processed material. Moreover, such materials can be also employed in a mortar or concrete matrix in order to realize sustainable composite materials [Colangelo et. al 2017a, Fraternali et al.2015, Messina et al., 2015, Colangelo et. al 2015, Amendola et al.,2015, Messina et al., 2017, Colangelo et. al 2016, Roviello et al., 2017, Colangelo et. al 2017b].

EXPERIMENTALS

The examined ACW were first milled and then the morphology were investigated through the differential thermal investigation (DTA) and the Scanning Electron Microscope (SEM).

Different milled powder/calcium hydroxide weight ratios (50/50, 60/40, 70/30) were used to prepare the mortar samples and are indicated in the paper with the letters A,B,C depending on the ratio employed.

Furthermore, a reference mortar labelled as RM was manufacturing using 60% of pozzolana (NP) and 40% of lime was likewise. The pozzolana employed in the mixture was supplied by the company Italiana Zeoliti S.r.l. (Modena, Italy).

Table 1**:** Chemical composition of asbestos containing powders, wt.%.

Oxides	SiO2	Al2 O3	Fe2 O3	CaO	Na2 O	K2 O	MgO	MnO	SO3	Loss of ignition
Without treatment	18.76	4.75	1.46	23.98	0.57	1.62	2.63	0.5	20.56	29.11
MP30	18.64	4.83	1.45	23.59	0.6	1.59	2.59	0.53	19.67	28.72
MP120	18.95	4.91	1.47	24	0.61	1.61	2.64	0.54	20	29.21
MP240	18.6	4.82	1.45	23.55	0.6	1.58	2.59	0.53	19.63	28.67

Following the EN 196-1 standard, standardized characteristic sand with maximum feature size of 4 mm was used. The proportions of the manufactured mortars has

been illustrated in Table 3. Three prismatic specimens of every sort of mortar with two sides of 4 cm and the other one of 16 cm were cast and then subjected to curing for 90 days at 20°C with 100% RH. Finally mechanical tests were run, as indicated by UNI EN 196-1 standard (UNI report, 2005) with a Controls 50-C5600.

Table 2: Composition of examined mortars.

Milled powders	Mixtures		
	Milled powder/calcium hydroxide weight ratio		
	60/40	50/50	70/30
MP30	B30	A30	C30
MP120	B120	A120	C120
MP240	B240	`A240	C240

Table 3: Mixture proportion of prepared mortars

	RM	50 M	60 M	70 M
Lime	120	150	120	90
MP120	–	150	180	210
Sand	1200	1200	1200	1200
NP	180	–		
H2O	150	150	150	150

Table 4: Percentage by weight of bonded water and reacted lime for A,B,C systems

Systems			A1	B1	C1	A2	B2	C2	A3	B3
Chemically bonded water (wt.%)	Hydration time (days)	7	3.1	8	11.7	8.1	3.1	8.1	4.1	9.1
		14	6.2	7.2	12.1	7	3.2	9.3	9.3	11.5
		28	11.5	7	13.6	4.8	4.6	10.7	12.3	16.4
		56	11.8	9.7	22.6	3.5	7.1	14.8	18.7	24.4
Reacted lime (wt.%)	Hydration time (days)	7	5.8	18.5	24.1	14.5	13.4	26.4	18.7	18.9
		14	11.5	23.8	28	16.7	136	31.3	30.1	31.3
		28	20.8	27.1	29.1	27.7	15.3	39.3	36.7	38.4
		56	21.7	30.2	35.3	29.1	18.8	41.3	41.5	42.1

RESULTS AND DISCUSSION

The outcomes of nitrogen-BET examination demonstrate that the specific surface

region does not expand relatively to processing time: the values obtained are 16.18 m2/g, 23.95 m2/g and 18.92 m2/g, after 30, 120 and 240 min of processing, individually. After a process of 120 min, a 48% expansion is watched contrasted with the powder processed for 30 min. The specific surface region at that point falls pointedly in the accompanying 120 min of treatment (240 min altogether). The damage of asbestos fibres because of the contact with processing bodies at first delivers littler particles and it results in a specific surface territory increment. In this way, these micrometric particles will in general cluster because of electrostatic fascination and Vander Waals forces, so that the specific surface area definitely diminishes (Colangelo, et al., 2017, Colangelo, et al., 2015, Colangelo, et al., 2016, Colangelo and Cioffi, 2017, Messina et al., 2015, Messina et al., 2017). From a financial perspective, the venture cost of a modern ball processing plant can be gotten from that of comparable plants utilized in other ecological employments. This expense is requests of greatness not exactly of thermal or compound based inertization frameworks (Saito, 1998, Saito,1999 (a), Saito,1999 (b) Saito,1999 (c)).

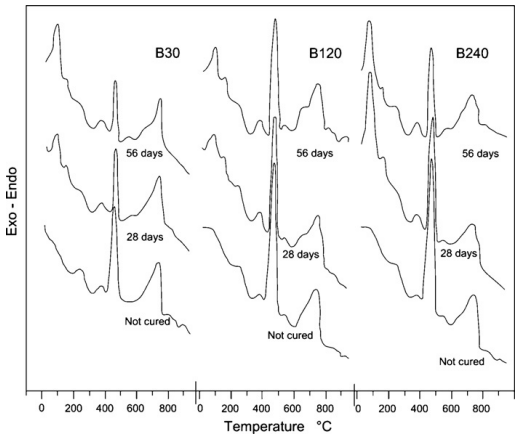

Fig.1. DTA thermograms performed on the B mixtures analysed.

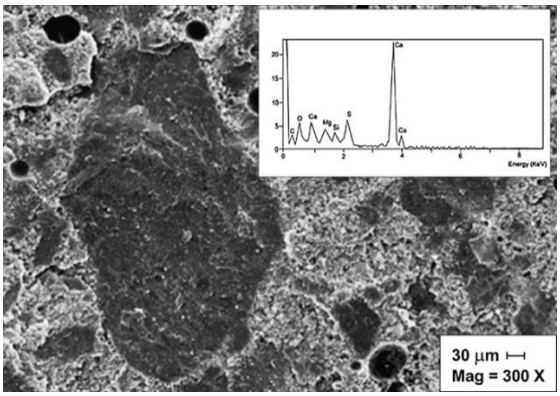

Fig. 2. SEM and EDS analysis of B240 after 28day of curing using a magnification of 300X.

Fig. 1 illustrates the thermograms in respect to the B30, B120 and B240 frameworks (reported in Table 2). The follows regard the not cured and the samples cured for 28 and 56 days. It is conceivable to see that the endothermic peak visible at about 80– 100 ◦C and 200–240 ◦C identified with the drying out of neo-shaped stages, for example, calcium silicate hydrates and calciumaluminate hydrates, increment with relieving time [27,28]. In the meantime the endothermic peak at 450 ◦C, reliant on drying out of Ca(OH)2 reactant, diminishes [29,30]. The endothermic crest resulting in the range temperature 120–140◦C, because of the dehydration of the neo-framed ettringite, is less clear since it covers with the calcium silicate hydrated thermal impact. The nearness of ettringite is more obvious in the B120 and B240 frameworks where a shoulder is available at about 120– 140 ◦C. The endothermic impacts that result in the range 600–800◦C are because of the decarboxylation of CaCO3 and are nearly the equivalent notwithstanding when the processing time of milled materials and the relieving time of blends increment. This proof confirms the selectivity of HEM treatment as uncovered

by the XRD examination. Other distinguished endothermic pinnacles are expected to the unreacted blend as they are now present before relieving. The aftereffects of SEM examination did on the B240 framework following 28-days restoring are appeared in Figs. 2– 4. In Fig. 2, regions with extremely different porosity are available and EDS investigation done on denser regions shows that these parts are chiefly made out of calcium carbonate. Figs. 3 and 4 illustrates micrographs with a greater magnification where the presence of flaky C– S– H gems (Fig. 3) and needle-like ettringite precious stones (Fig. 4) are appeared. In Fig. 3 the consequences of EDS investigation are likewise announced. The range confirms the run of the mill C– S– H substance organization of the flaky zone. In Table 4 the weight rates of synthetically reinforced water and responded lime estimated on frameworks A, B and C (see Table 1) are accounted for. The qualities are with respect to 7, 14, 28 and 56 days restoring time. This is because of the ceaseless change in the typology of the neo-shaped hydration items. The measure of synthetically fortified water in the different types of the principle hydrated stages, for example, C– S– H; C– A– H and ettringite, and their hydration energy shift considerably.

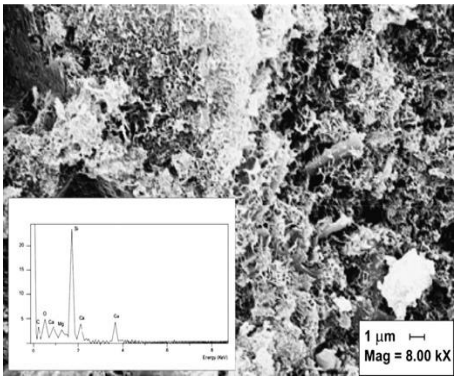

Fig. 3. SEM micrograph and EDS analysis of the B240 system after 28-day curing at 8000× magnification.

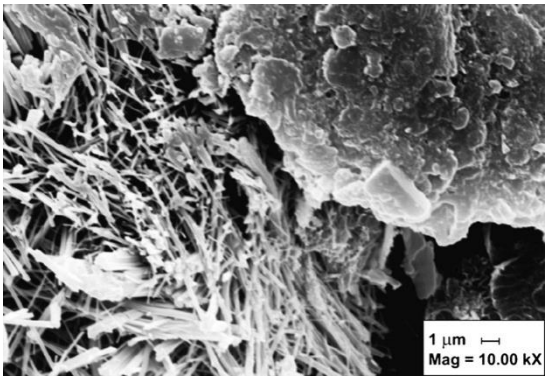

Fig. 4. SEM micrograph of the B240 system after 28-day curing at 10,000× magnification.

The stoichiometry of these compounds changes over the curing time, deciding a non-consistent variety in the measure of non-evaporable water with time. On account of responded lime assurance, it very well may be seen that the related sums increment for every one of the frameworks when the restoring time increments. Specifically, the qualities quickly increment up to 14 days of relieving, at that point relatively consistent qualities are come to following 28 days of the hydration time. These wonders can be clarified on the off chance that we consider the simple high specific surface region of the powders, which quickens the hydration dynamic amid the first few days of hydration. Estimations of responded lime around 40% confirm that HEM powders can give hydration responses that include significant measures of lime. This is exceptionally valuable for the arrangement of new stages with a decent water driven conduct.

CONCLUSIONS

This examination prompts the end that powders realized making use of the high energy handling of asbestos-solid/concrete waste are sans asbestos and can be successfully reused in the field of building materials. Specifically, it will in general be drawn that:
Two extensive stretches of high energy processing is satisfactory to ensure amorphization of waste. As a matter of fact, the common chrysotile X-shaft diffraction, spectroscopy infrared gatherings and fibrous organize thoroughly vanish after the high energy milling treatment. This finding is of remarkable interest considering the plain high energy aggregate required for the mineralogical change of asbestos waste by techniques for an impressively progressively costly thermal treatment.
The hydration strategies of the lime-inactive prepared powders mixtures are greatly perplexing. The synchronous advancement of calcium silicate and aluminate hydrates and ettringite can be controlled by strategies for differential thermal examinations and checking electron microscopy treatments. The mechanical properties of the water fueled mortars organized with the above mixes are better than those made with lime-pozzolana. These results show the extraordinary pozzolanic activity of the used without asbestos powders and confirm the probability of being reused as a mineral extension in the manufacture of building materials.

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