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Application of Construction Debris in Gypsum Blocks

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ABSTRACT

Processed demolition materials have gained widespread application in modern construction practices. This paper deals with the application of processed demolition material in the production of gypsum blocks. Specimens of gypsum blocks containing processed demolition materials have been tested. The results reveal that they fulfill the requirements of BS EN 12859 for non structural gypsum block elements.

INTRODUCTION

In the recent years the application of construction and demolition (CD) materials in new construction projects has gained much attention. Sustainable development addresses the efficient production of construction materials. A high amount of energy is consumed in the production of various building and construction materials, such as cement, gypsum, lime, concrete blocks, glass etc. Therefore their recycling and re-usage is beneficiary from the view point of lowering construction costs, preserving energy and natural resources, and reducing environmental impacts [Jakobsen et al 1988; Yoda et al 1988; Ikeda et al,1988].

One of the most prominent forms of CD materials is recycled aggregates. In developing countries, many buildings are constructed with masonry materials. Hence, in general, the demolition materials contain high amounts of brick rubble and hardened mortar, which limits their application in structural concretes. However these materials can be successfully used in non-structural construction members, such as gypsum blocks, partition walls, etc. This paper deals with the application of demolition materials in the production of gypsum blocks.

MATERIAL SPECIFICATIONS

A brief description of materials used in this study is presented in the followings:

-Aggregates

The aggregates used in this study were a mixture of various materials such as sand, organic soil, cement mortar, gypsum mortar etc. The aggregates were collected from the dumped debris at the Ab-Ali landfill site [Houshmand 2002; Personal communications with the Material refining agency, 2008]. Since the aggregates were fine grained and highly mixed, they were not

separated and there mixture was used in the research program. According to Iranian Standard **[**ISIRI 301] the aggregates used in gypsum blocks should fall in the limits presented in Figure 1. Also, in Figure 1, the particle size distributions for the median gradation of rubble sand, a natural aggregate used in control specimens, is provided.

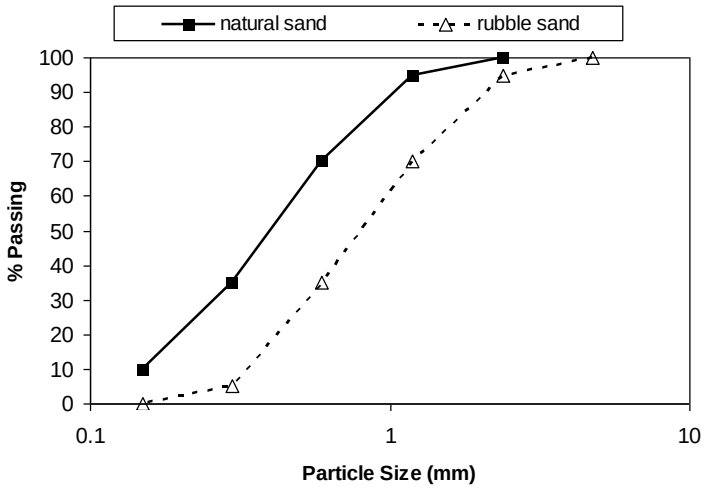

Figure 1. Gradation of sands

-Gypsum

The gypsum is produced in Tehran. The physio-mechanical and chemical properties of this gypsum are presented in Tables 1 and 2.

-Water

Tehran municipal tap water was used in the study.

Table 1. Physical and mechanical properties of gypsum

Specification	Value
Initial Setting Time (min)	28
Final Setting Time (max)	35
Density (gr/cm^3)	1.36
Compressive strength (MPa)	14.5
Flexural strength (MPa)	5.3

Table 2. Chemical characteristics of gypsum

Constitute	% in gypsum
Free Water	0
Adsorbed Water	5.65
SiO_2	2.72
CaO	37.24
SO_3	53.14
MgO	0.20
Cl^-	0.20
K_2O	0.55
Na_2O	0.34

MIX DESIGNS

Two mixtures were designed for both experimental specimens with rubble sand and control specimens with natural sand. These are:

Mix I (Control and Recycle): comprising equal portions of sand and gypsum with constant water.

Mix II (Control and Recycle): constituting two portions of sand and one portion of gypsum with constant water.

SPECIMEN PREPARATION AND STORAGE

Required proportions of graded rubble sand and gypsum are dry mixed, and then water is added. The mixture is placed in 650×500×100 mm prismatic molds. The resulted specimens have no holes and perforations. Specimens are detached from the molds after 24 hours and are kept in the laboratory temperature for 2 days. Curing is performed at the temperature of 45c for 4 days.

For the control specimens, i.e. specimens with natural sand and gypsum, the dimensions were identical to the experimental specimens with rubble sand.

Before the tests, specimens are stored in the temperature of 40±2 ºC to reach a constant weight (that is the difference in weight measurement after 24 hours is limited to 0.1%), and then they are kept in room temperature until the testing.

TEST RESULTS

Based on the methodology and specifications of **[**BS EN 12859], the required tests for gypsum blocks were performed on the specimens. In the following the results are presented:

-pH at the specimen surface

The value of pH at the specimens' surfaces is about 8, which satisfies the standard limit of 6.5 to 10.5 as presented in BS EN 12859.

-water adsorption

The water adsorption for the specimens is less than 5% as required by BS EN 12859. The water absorption is measured by comparing the specimens' weights before and after submerging in water.

-density

The dry density of specimens, reported in Table 3, reveals that the blocks are classified as high density gypsum blocks (i.e. 1.5gr/cm^3>density>1.1gr/cm^3 according to BS EN 12859).

-strength

The compressive, flexural and tensile strengths are measured according to BS EN 12859 and reported in Table 3.

Table 3. Results of testing program

Mix	Sand (%)	Gypsum (%)	Water (%)	Strength (MPa)			Density (gr/cm3)
				Compressive	Flexural	Tensile	
I Recycle	37.5	37.5	25	18.9	4.1	2.2	1.49
I Control	37.5	37.5	25	20.1	4.4	2.5	1.51
II Recycle	46	23	31	14.8	3.3	1.7	1.50
II Control	46	23	31	16.3	3.8	2.2	1.52

Note: The proportions of sand, gypsum and water in the mixes are defined as a fraction of the total specimen weight.

CONCLUSIONS

The study implies that gypsum blocks comprising processed demolition materials fulfill the requirement presented in BS EN 12859.

The tests results reveal that for Mix I the compressive, flexural and tensile strength have decreased by 6, 7 and 12% respectively in comparison to control samples. For Mix II the compressive, flexural and tensile strength have decreased by 9, 13 and 23% respectively in comparison to control samples. Hence increasing the amount of rubble processed sand leads to lower strengths.

Thus, it can be concluded that demolition materials can be useful in the production of gypsum blocks which owing to their strength reduction are applicable in non structural construction elements.

Of note, demolition materials are generally non-homogenous mixtures. Hence, the chemical reaction of different constitutes with gypsum should be considered. For example steel particles may be subjected to corrosion in the gypsum blocks.

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