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Effect of Adding Industrial Wastes on the Mechanical Properties of Gypsum

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Abstract: ***In this research an attempt has been made to study the effect of adding P.V.C (by weight) on gypsum properties (compressive strength, modules of rapture). The research plan consists of using eight different percentage of waste material (P.V.C) (0, 1, 2, 3, 4, 5, 6 and 7)% (by weight as addition) and (water/gypsum) ratio equal to 32 % . The results of this study show that the local waste material PVC can be used with construction materials such as gypsum safely and the PVC enhancing the mechanical properties (compressive strength and modulus of rupture) when it used the optimum ratio 3% .***

Keywords: waste material, gypsum, compressive strength, P.V.C

1. Introduction

Polyvinyl chloride (PVC) is one of the most prevalent thermoplastics in the consumption of polymers worldwide, and is now one of the largest polymers that can be recycled by volume in developed and developing countries, as it is practically suitable for all recycling methods and is therefore given Great interest in research and technology. [1]

At present, PVC can be processed in a wide range of short-lived products, such as PVC, and other materials such as packaging materials used in foodstuffs, detergents, textiles and medical devices, as well as long-life products such as pipes, window frames, cable insulation, floor coverings and roof covers, etc. [2]

In recent years, plastics' recycling has been a topic of growing interest, due to the large amount of waste generated and the lack of space available at landfill sites. This problem is particularly important for high-consumption plastics, such as PVC. [1, 2]

The study of recycled PVC is the focus of many papers [3–9], although its recycling is mainly related to problems such as waste separation and toxic gas emissions. [3]

In this study, attention turns to the reprocessing behavior of these substances. If the incorporation of recycled PVC into the stream of raw materials in larger quantities, then it is important to fully understand the effects they have on the processing behavior. [4]

2. Local juss (gypsum)

The word "juss" is derives from the Assyrians word "jasso". Local juss in iraq is a materials produced from calcined gypsums by the "Koor method" Gypsums rocks pieced are placed on opening in the koor domes and the heated source is at the base of the domes. Heating continue for (24) hours. The final products the juss is a mechanicals mixture of anhydrites, bassanite and unburnt gypsum.

Gypsum (Local juss) used as a main matrix in this project was calcium sulfate hemihydrate gypsum (CaSO4.½H2O), which was obtained from local market in Baghdad. [5]

3. Research Significance

The environmental damage caused by the industrial waste, the preservation of depletion of natural resources, the need to generate and develop the methodological information and the urgent need to get rid of these wastes and recycling is one of the main reasons for this research, in addition to studying the effects of these wastes on the properties of the materials involved in construction works and its combined behavior.

4. Source of recycled wastes

The sources of these waste materials are the industrial processes, which were collected from the Factories for the production doors , windows and some of the home furniture, where these Factories are widespread in the capital Baghdad, and then been cleaned and sieved to get rid of foreign objects and undesirable materials in the production of concrete.

5. Experimental Work

5.1 Materials

5.1.1 Gypsum

Materials that are come from the calcination of gypsum (CaSO4.2H2O) and having the synthetic structure of hemihydrate (CaSO4.1/2H2O) are classified "Gypsum Products". Despite that they have the same compositions; they are distinctive in their mechanical properties. Gypsum (Local juss) used as the main matrix in this research was calcium sulfate hemihydrate gypsum (CaSO4.½H2O).[7]

5.1.2 P.V.C (waste materials)

PVC (waste materials) used in this study as shown in plate (1)

Plate 1: locally waste PVC used in this study

6. Water

Ordinary tap water was used for all gypsum mixes in this research.

7. Gypsum Mixes

Eight mixes of gypsum have been studied in this research, these mixes have eight different percentage ratios of waste material (P.V.C) (0, 1, 2, 3, 4, 5, 6 and 7) % (by weight) and (water/gypsum) ratio equal to 32 %.

8. Mixing Procedure

All mixes were made by weighted quantities (gypsum, P.V.C., and water). In the beginning, P.V.C was added to the gypsum and dry- mixed, and then the specified quantity of the water was added to the mix and re-mixes handily, and then poured into the mold. The mold has been vibrated benefiting from the vibration. After specimens are hardened, the cubic (50×50×50) mm specimens were taken off from the mold.

9. Testing program

In this research, the 50 mm cubic specimens were tested the compressive strength, and (50*50*150) specimens mm for modulus of rupture tests according to Iraqi Standard Specification IQS 27-1985, [6] for eight mixes.

10. Results and Discussion

10.1 Compressive Strength

Figure 1, 2 and Table (1) shows the results of the compressive strength of the gypsum specimens with respect to P.V.C content (as addition ratio). These results reveal clearly that the compressive strength slightly increases (0.85%, 2.5%, and 8.25 %) with the increasing of P.V.C content ratios (1 %, 2 %, and 3 %) respectively.

When the P.V.C content ratios increasing (4%, 5%, 6% and 7%) the compressive strength decreasing (2.89%, 9.23%, 10.43%, and 14.27%) respectively.

Table 1: Effect of PVC content on compressive strength

Mix No.	Mix 1	Mix2	Mix 3	Mix 4	Mix 5	Mix 6	Mix 7	Mix 8
P.V.C content % by weight	0	1	2	3	4	5	6	7
Compressive strength (MPa)	7.57	7.63	7.76	8.19	7.35	6.87	6.78	6.49
(W/G) ratio %	32							

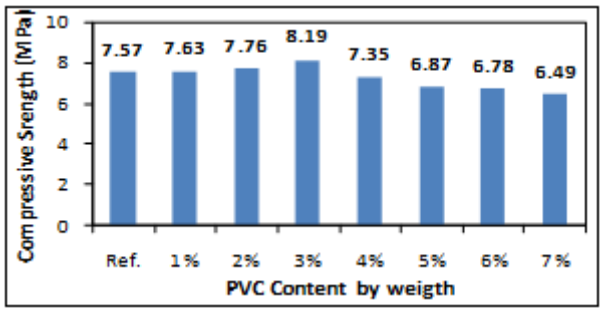

Figure 1: Effect of waste PVC as addition ratio on compressive strength

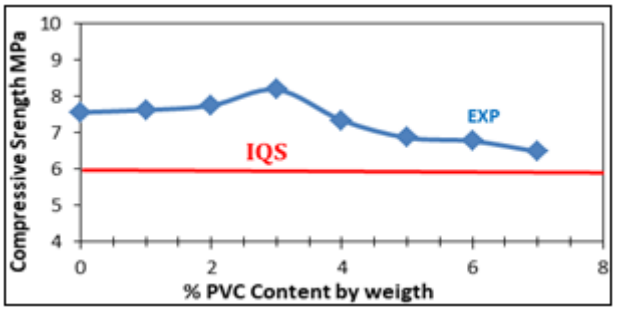

Figure 2: A comparison between IQS and waste PVC used in study on compressive strength

This increase in compressive strength can be illustrated by the fact that the PVC granules worked as a fine aggregate work, since the hardness of these granules is greater than the hardness of the local juss granules used in this research and the bond between plaster and granules reached a peak when the percentage of addition was 3% With the increase in the percentage of PVC particles, the bond between the two materials decreases and consequently the compressive strength decreases.

10.2 Modulus of rupture

It is obvious from Table 2 and Figures 3, 4 that the addition of PVC content (1 %, 2 %, and 3 %) the modulus of rupture increasing about (1.84 %, 4.51 % and 7.0 %) respectively. After that when the PVC content is increasing (4%, 5%, 6%, and 7%) the modulus of rupture decreasing by about (1.76%, 6.64%, 7.66% and 10.29%) respectively.

Table 2: Effect of PVC content on Modulus of Rupture

Mix No.	Mix 1	Mix 2	Mix 3	Mix 4	Mix 5	Mix 6	Mix 7	Mix 8
P.V.C content % by weight	0	1	2	3	4	5	6	7
Modulus of Rupture (MPa)	4.77	4.86	4.99	5.11	4.69	4.46	4.41	4.28
(W/G) ratio %	32							

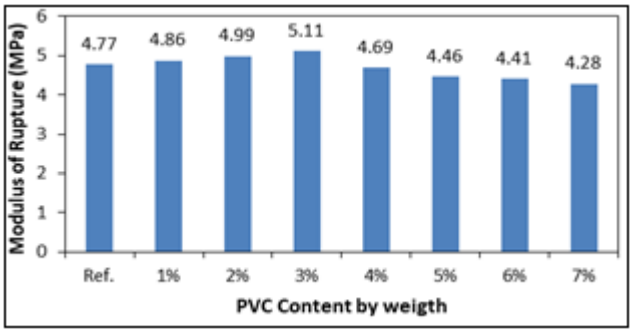

Figure 3: Effect of waste PVC as addition ratio on Modulus of Rupture

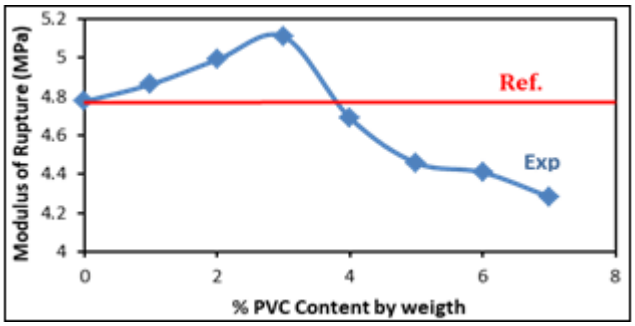

Figure 4: Comparison between ref. sample and PVC samples used in study on Modulus of Rupture

11. Conclusions

The results of this study show that the local waste of PVC can be used with construction materials such as gypsum safely and the PVC enhancing the mechanical properties (compressive strength and modulus of rupture) when it used with 1%, 2% and 3% content by weight of gypsum as shown previously, and the optimum ratio is 3% (as addition ratio).

So the goal of this study is satisfied and the authors suggested using this method to release the environment from the waste materials (PVC) with minimum energy and emissions of CO2.

12. Acknowledgements

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