UTILIZATION OF SOLID WASTES IN BUILDING MATERIALS

Rahul Kushwaha[1], Vaibhav Dubey[2]

[1]*M.tech, Department of Civil Engineering Rama University Kanpur UP*
[2]*Assistant Professor, Department of Civil Engineering Rama University Kanpur UP*

---***---

Abstract - Waste is a significant environmental issue and a hazard to the ecosystem. Reusing and discarding these resources are crucial. Reusing components and recycling garbage into raw materials for the manufacture of building materials are the two ways waste can be put to use in the construction sector. The paper covers my own research on the usage of foam glass and high-impact polystyrene as substrates derived from waste processing and the potential for their application as composition modifiers of fundamental building materials. Glass cullet is used to create glass foam. It provides a lot of benefits, including an improvement in workability and sound absorption. It is utilised as an incredibly light filler because of its low density and spherical form. High Impact Polystyrene, sometimes known as HIPS (short for High Impact Polystyrene), is a polystyrene modified with butadiene rubber. Rubber's mechanical and physical qualities are also altered as rubber content varies, for instance, by making HIPS more durable. On the examples of cellular concrete, cement, and sand-lime products, the essay gives a comprehensive evaluation of the literature on changes in the composition of classic construction materials. My personal study and a thorough examination of them are presented in the publication. The study's objective was to compare newly developed materials to their conventional equivalents in order to ascertain the effects of additions on various aspects of their physical, mechanical, and microstructural features. My own research's findings on compressive strength, water absorption, bulk density, and structural material construction have all been considered in the analysis. Tables and graphs are used to present the results.

Keywords: calcium silicate products; waste materials; recycling; glass foam; high impact polystyrene;

1. INTRODUCTION

Mortar, a compound made of a binder, fine-grained aggregate, and a liquid for mixing, has been used in building for a very long time

[1]. Mortars are a common building material because of their mechanized manufacture, advanced technology, and inexpensive cost of materials

[2]. Mortars are frequently used in their conventional form and when enhanced by admixtures and additions.

This substance has undergone numerous alterations, which are shown in research.

The study's goal is to ascertain the impact of particular recycled plastic additives on the mechanical and physical characteristics of modified cement mortars. Selected additives include high impact polystyrene retranslate (HIPS) and foamed glass grains because of their unique qualities.

2. MODIFICATION WITH HIGH IMPACT POLYSTYRENE AND FOAMED GLASS

All a byproduct is high impact polystyrene regranulate

1. It is polystyrene treated with butadiene rubber (Fig. 1a). The mechanical and physical characteristics of the material vary as rubber content does, and this includes an increase in the impact strength of HIPS regrind.
2. HIPS is utilised by numerous industries, including the food business (food packaging), the furniture industry (hospital furniture), and the toy industry.
3. Glass cullet is used to create foamed glass, also known as poraver (Fig. 1b). It can be used for a variety of things, such as a lightweight extender, to improve sound absorption, and its spherical shape makes it easier to work with
4. This additive is used to make lightweight building blocks, which offer good thermal and sound insulation because to their porous nature
5. Results of studies on sand-lime products that also included high-impact polystyrene are described in the literature
6. The compressive strength significantly increased as a result of this addition, reaching over 50 MPa. The adsorption of modified products is also less than that of regular silicate products. The initial studies of high impact polystyrene's impact on autoclaved aerated concrete are well documented
7. They demonstrate that the incorporation of regrind HIPS led to a minimal rise in the compressive strength of these products. In the literature, there are additional attempts to apply an additive in the form of foamed

glass granules to reduce the bulk density of the silicate blocks and enhance their thermal insulating qualities.

8. The compressive strength of changed materials has decreased, yet they still meet the standards

3. METHODOLOGY

A comprehensive 2-factorial design experiment has been used to carry out the orthogonal compositional plan type 3k (from k = 2) experiments. Samples that were rectangular in shape and measured 40x40x160 mm were created. Nine samples have been made in total, each with a different proportion of additives (ranging from 5% to 25% by weight relative to cement), as well as one sample without additives for comparison. There have been six parallel tests run for each interdependence. Samples were collected at a cement: sand ratio of 1:3 and a water/cement ratio height of 0.56. T0a00ble 1 gives a detailed breakdown of the samples' composition. A comprehensive 2-factorial design experiment has been used to carry out the orthogonal compositional plan type 3k (from k = 2) experiments. Samples that were rectangular in shape and measured 40x40x160 mm were created. Nine samples have been made in total, each with a different proportion of additives (ranging from 5% to 25% by weight relative to cement), as well as one sample without additives for comparison. There have been six parallel tests run for each interdependence. Samples were taken in the ratio of cement: sand of 1:3, water/cement ratio height is W/C = 0.56. Table 1 displays the samples' precise composition in detail. A comprehensive 2-factorial design experiment has been used to carry out the experiments, which have an orthogonal compositional plan type 3k (from k = 2). 40x40x160 mm-sized rectangular samples were created. In addition to a single series without additives for comparison, a series of 9 samples with various amounts of additives (ranging from 5% to 25% by weight relative to cement) have been created. Six parallel tests have been run for each interdependence. Samples were collected at a cement:sand ratio of 1:3 and a water/cement ratio height of 0.56. Table 1 displays the samples' precise composition in detail. A comprehensive 2-factorial design experiment has been used to carry out the orthogonal compositional plan type 3k (from k = 2) experiments. Samples that were rectangular in shape and measured 40x40x160 mm were created. Nine samples have been made in total, each with a different proportion of additives (ranging from 5% to 25% by weight relative to cement), as well as one sample without additives for comparison. There have been six parallel tests run for each interdependence. Samples were collected at a cement:sand ratio of 1:3 and a water/cement ratio height of 0.56. Table1 lists the samples' precise composition in detail.

Ingredients/Number	Cement [g]	HIPS [g]	Foamed glass [g]	Sand [g]	Water [g]
P1	450	22.5	22.5	1350	252
P2	450	22.5	67.5	1350	252
P3	450	22.5	112.5	1350	252
P4	450	67.5	22.5	1350	252
P5	450	67.5	67.5	1350	252
P6	450	67.5	112.5	1350	252
P7	450	112.5	22.5	1350	252
P8	450	112.5	67.5	1350	252
P9	450	112.5	112.5	1350	252
N	450	-	-	1350	252

Tab.1. The composition of samples.

Three-part forms were filled with properly prepared mortar, which was then compacted. The samples were left in a dark area for 24 hours, then they were dismantled and matured for an additional 28 days in a water bath. Thus, the material was given the proper care, and the bar did not lose the water required to hydrate the cement. Tests for the use of cement mortar as underlay flooring were conducted due to the characteristics of the used additives: cellular glass (excellent thermal and acoustic insulation), and high-impact polystyrene (high impact resistance). Numerous tests have been performed on the samples, including those for water absorption, flexural strength, compressive strength, and bulk density of fresh and hardened mortar.

4. PERFORMED TESTS AND OBTAINED RESULTS

1. The density of bulk

The findings of measuring the bulk density of the materials revealed that the bulk density decreases as the amount of additives increases. Additionally, foam glass granulate has a bigger impact on the decrease in density than HIPS, which is related to the different additive densities (Fig. 2).

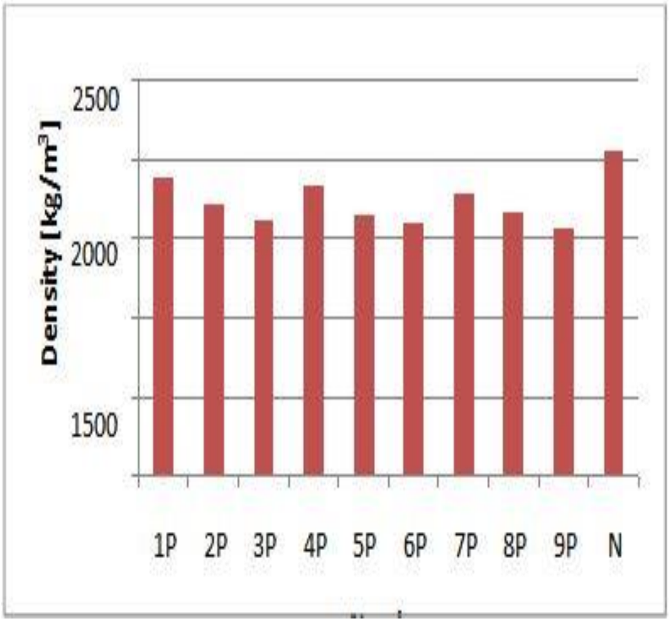

Fig. 1. The results of the density.

2. Absorbability

The bulk density has an inverse relationship with absorbability. Glass foam is a thin addition that fills the sample greatly, reduces weight, but increases porosity. When this supplement is used in sufficient quantities, cement paste cannot adequately wrap the particles, and a new mortar becomes rather "dry". Figure 3 demonstrates that as the amount of additional foam glass is raised, so is the water absorption.

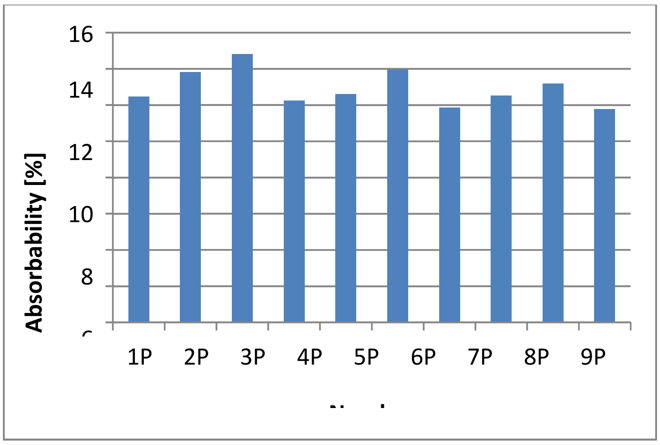

Fig. 2. The results of the water absorption.

3. Flexural and compressive strength

The compressive strength of hardened mortar grows in direct proportion to density rise (Fig. 4). The thermal insulation of materials, however, rises as bulk density decreases. When bending strength and compressive strength findings are analysed, it is clear that strength declines as the amount of foamed glass increases, whereas regrind HIPS increases compressive strength by up to 15%. This enables us to draw the conclusion that the researched features are positively impacted by high-impact polystyrene.

Conclusions about the impact of the additives on the characteristics of mortars have been made in light of the investigation. According to the STATISTICA 12.0 software-generated graph, samples with 90 g of high-impact polystyrene (19% of the weight of cement) can achieve the highest compressive strength. This mixture's sample reaches a strength of more than 40 MPa (Fig. 5). All samples exceeded the minimal values from PN - EN 13813 [11] despite variations in compressive strength (depending on the amount of additives applied). The minimum compressive strength is specified as being equivalent to 5 MPa class C5 in the aforementioned standard.

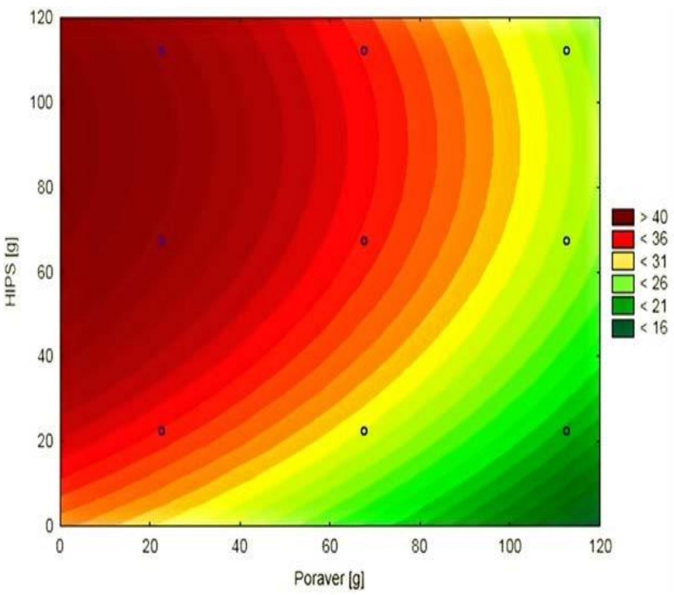

Fig. 3. The dependence of the compressive strength on the number of applied additives.

5. CONCLUSIONS

We may evaluate the impact of the additives on parameters including bulk density, flexural strength, compressive strength, and water absorption based on investigations of modified cement mortars. The following conclusions can be made based on the study of the research:

1. Depending on the kind and quantity of additives, additives in the form of plastic raw materials have a major impact on the characteristics of cement mortars.

2. While adding regrind HIPS increases compressive strength, the change in absorption is not significantly impacted.

3. While decreasing the compressive strength of the modified products, the addition of foamed glass aids in the absorption of the modified products.

4. Using plastic as a component in cement mortars causes the bulk density to decrease, which lowers the weight of the finished component.

5. One option for using this waste is to use foamed glass granulate and HIPS regrind.

REFERENCES

1. W. Kurdowski, Cement chemistry, PWN, Warszawa, 1991 (in Polish).
2. L. Lichoáai, A. Szalacha, Building materials and their laboratory tests, Wydawnictwo Politechniki Rzeszowski (in Polish).
3. K. Kijeński, A. K. BáĊdzki, R. Jeziórska, Recovery and recycling of polymeric materials, PWN, Warszawa 2011 (in Polish).
4. J. Pielichowski, A. Puszyński, Polymer chemistry, Wydawnictwo Naukowo-Techniczne TEZA, Kraków 2004 (in Polish).
5. M. Dziewońska, Macromolecular compounds - polymers, Wydawnictwo Akademii Ekonomicznej w Krakowie, Kraków, 1995 (in Polish).
6. M. Scheffler, P.Colombo, Eds., Cellular Ceramics: Structure, Manufacturing, Properties and Applications, WILEY – VCH Verlag GmbH & Co. KGaA, Weinheim, 2005 (in Polish).
7. R. Dachowski, A. Stepien, The impact of various additives on the microstructure of silicate products. Procedia Engineering 21 (2011) 1173- 1178 (in Polish).
8. M. Nowek, The use of selected regranulates in silicate masonry elements. The 9th International Conference “ENVIRONMENTAL ENGINEERING” 22–23 May 2014, Vilnius, Lithuania (2014), pp 1-6 (in Polish).
9. R. Dachowski, S. Kapaáa, The impact of high-impact polystyrene regrind on properties of autoclaved aerated concrete. Materiaáy Budowlane 12/2015, p. 18-20 (in Polish).
10. Jasńska, R. Dachowski, Foam glass granulate as an additive light weight silicate, Praca zbiorowa pod redakcją Joanny Bzówki pt.
11. Experimental and theoretical construction studies, monografia, Wydawnictwo Politechniki Śląskiej, Gliwice 2012 (in Polish).
12. PN - EN 13813: Subfloors and materials used to made them. Materials. The properties and requirements