USE OF WASTE MATERIAL IN CONCRETE BLOCKS

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ABSTRACT

Today with increasing size of infrastructure industry and with depletion of conventional resources, there is a growing need for use of alternative low cost and environment friendly building materials to cope with this demand. This work was conducted to investigate the performance of hollow concrete blocks containing discarded foundry sands and stone dust as a replacement of fine aggregate with a view to verify the suitability and potential use of stone dust, a waste product from aggregate crushing plants. Foundry sand, a by-product of metal casting industry, if not disposed properly causes environmental problems. The purpose for using stone dust is owing to the fact that now a days natural sand confirming to Indian Standards is becoming scarce and costlier due to its non-availability in time because of law of land, illegal dredging by sand mafia, non-accessibility to the river source during rainy season, non-confirming with IS 383-1970. Use of air entrained hollow blocks instead of solid ones also has advantages like thermal insulation, sound proofing, weight-reduction, resistance against frost action, cost-effectiveness.

Keywords: Foundry Sand, Stone Dust, Hollow Concrete Block

I. INTRODUCTION

The demand of good quality construction material is increasing at a rapid rate. These building materials are becoming costlier day by day due to scarcity of natural resources required for their manufacturing. Bricks are the conventional building material used for construction of partition walls and compound walls. With the recent introduction of new mining laws, the mining of clay and sand has been restricted in many areas particularly the northern region of India. This has led to acute shortage of raw material used for manufacturing good quality clay bricks. In the present scenario, due to restriction on clay mining, the availability of good quality bricks is decreasing and the cost is getting higher. On one hand the natural resources are depleted and on the other hand there are many compatible waste materials which can be used to replace some of these recourses. So, there is an urgent need to find alternative building materials by utilizing the available waste materials so to meet the increasing demand of material as well as to have more environment friendly and economic building materials. Few competitive waste materials that are being generated in bulk amount from different industries are foundry sand, fly ash and stone dust. Every year foundries generate between 9 and 13 million tons of foundry sand. This sand cannot be used for making the moulds. It is generally dumped in private or municipal landfills. Similarly the stone industry generates stones itself as a waste material in huge amounts.

Fly ash, a by-product from coal based thermal power plant (TPPs), is produced in bulk amount and the rate is

increasing day by day. Current generation is about 132 million tonnes (MT). Some of the problems associated with fly ash are large area of land required for disposal and toxicity associated with heavy metal leached to groundwater. Fly ash, being treated as waste and a source of air and water pollution till recent past, is in fact a resource material and has also proven its worth over a period of time.

These wastes are facing disposal problems and if not handled properly can damage the various environments. Hence quality construction material, depleting resources and waste materials require proper attention of researcher. Also, waste disposal is a major problem in India. Materials such as foundry sand, fly ash and stone dust are by-products from various industries which are generated in huge quantities. Currently, there is a lack of adequate infrastructure in India for proper processing and recycling of these waste materials. So, these materials are simply dumped into landfills without any treatment or processing. Therefore, there is an urgent need to properly utilize these waste materials and only construction industry can utilize the waste materials in bulk quantity. Hence in the present work foundry sand, stone dust and fly ash are mixed together in different proportion for the preparation of concrete blocks.

Kaur I. [1] used different percentage (up to 30%) of foundry sand to replace sand in concrete and observed increase in compressive 28 day strength and the modulus of elasticity. Aggarwal Y., Siddique R. [2] carried out studies that indicated the viability of using waste from the foundry industry and bottom ash from electro- static precipitators as recycled fine aggregates in the production of concrete for structural purposes. The mechanical behavior of the concrete with waste foundry sand and bottom ash showed strengths comparable to that of conventional concrete. They recommended that the maximum replacement could be taken as 50%. Mahzuzl et al. [3] carried out a study that focused on the relative performance of concrete by normal sand and crushed stone and concrete by stone powder and stone chip. From the laboratory study, it was concluded that stone powder was well appropriate for a medium graded concrete which provided a better performance in terms of strength and economy over normal sand. Salokhe E.P., Desai D.B [4] focused on application of foundry sand in manufacture of concrete. They observed that the addition of foundry waste sands gives low slump mainly due to the presence of very fine binders, and suggested to use high superplasticizer dosage in order to maintain a good workability. Maximum increase in strength was observed with 20% FWS (Foundry Waste Sand). The mechanical behavior of the concrete with waste foundry sand and bottom ash showed strengths comparable to that of conventional concrete. They recommended that the maximum replacement could be taken as 50%. Pathariya et al. [5] conducted a study on application of foundry sand for evolution of low-cost concrete. Based on the study several observations were made regarding the properties and behavior of concrete on partial replacement of fine aggregate by waste foundry sand. Compressive strength increased on increase in percentage of waste foundry sand as compare to traditional concrete.

II. MATERIALS

Ordinary Portland cement of 43 grade was used for all concrete mixes. Coarse aggregates of size 10 mm to 20 mm were used. The river bed sand passing through sieve no. 4.75 mm has been used in the study. Stone dust conformed to zone II as per IS: 383-1970. Conplast AEA was used as an air entraining admixture for making the block light weight.

III. METHODOLOGY

Temporary moulds were prepared with the help of battens and plywood for casting of hollow blocks. The cubes were casted and tested for compressive strength. Cylindrical mould of standard size was used for split tensile strength test.

Fig. 1: Mould for hollow block

Fig. 2: Split Tensile Test on cylindrical specimen

Initially, all the samples were casted based on the Mix 1:1.5:3 (1 Cement: 1.5 Fine aggregate: 3 Coarse aggregate) by weight with 20% replacement of fine aggregate (stone dust) by foundry sand. After conducting a number of trials, a stable block was obtained with same nominal mix of M20 and with 2.5% replacement of fine aggregate (stone dust) by foundry sand. Afterwards same 2.5% of foundry sand for mix 1:2:4, M15 grade concrete, and a stable block was obtained. Water cement ration of 0.5 was used for preparing the mix.

IV. RESULT AND DISCUSSION

Different properties of concrete mix prepared with the use of various proportions of stone dust and foundry sand were studied. The results were obtained for compressive strength and split tensile test and were checked with ordinary mix. Also, the stability of the block was checked for each trial mix.

Desired results were achieved with 100 % replacement of fine aggregate with stone dust. Initially block failed with 20%, 10%, 5%, 4% replacement of fine aggregate with foundry sand for the mix M20. Finally, desired results were achieved with M15 1:2:4 by weight at 2.5% of foundry sand.

The compressive strength and split tensile strength were checked for the samples. After the desired compressive strengths were achieved, a hollow block was casted to check the stability of the mix in a hollow concrete block. And the block was found to be stable. Split Tensile Strength was checked under compression testing machine and was found to be well within the desired limits.

Ultimate Load for split tensile strength was 330 kN and the strength of 4.67 N/mm^2 for cylinder of diameter 150 mm and length 300 mm.

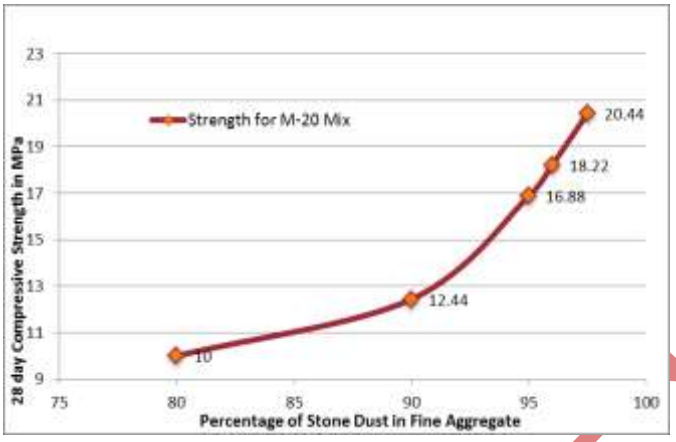

Fig. 3: Variation of compressive strength at different percentages of foundry sand

V. CONCLUSION

Following conclusions can be drawn from this study.

- Stable block is formed for 100 % replacement of fine aggregate (sand) by stone dust. The 28-day mean compressive strength of sample is 21.11 N/mm^2.
- Foundry sand is replaced at various percentages of fine aggregate. Stable block is formed by replacing fine aggregate (stone dust) by 2.5% foundry sand. The 28-day mean compressive strength for sample (M20 Grade) is 20.44 N/mm^2. And the 28-day mean compressive strength for sample (M15 Grade) is 15.56 N/mm^2. Compressive strength of burnt clay bricks have range of 3.5 N/mm^2 to 35 N/mm^2 as per IS 1077: 1992.
- Split tensile test for the final design mix is 4.67 N/mm^2, which is greater than the minimum desired limits.
- Air entrainment with 6% reduction in weight of block is achieved by adding 0.08 liters of admixture per 100 kg of cement, which may impose lesser load on foundation.
- The waste materials- foundry sand, fly ash, stone dust were successfully used to make hollow concrete block. Thus, reducing the impact on environment.

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