Study on Utilisation of Waste Foundry Sand in Concrete as a Fine Aggregate

NAGA ANKINEDU, P1, CH. BHAGAYA LAKSHMI2

1PG Scholar, Dept of Civil Engineering, DJR College of Engineering &Technology, AP, India, Email: ankineedu.ce@gmail.com.
2Associate Professor, Dept of Civil Engineering, DJR College of Engineering &Technology, AP, India, Email: lakshmi.chandhaluri@gmail.com.

Abstract: The administration of strong mechanical waste is of enormous worldwide concern these days. The larger part of businesses are not intrigued by the treatment and safe transfer of modern waste because of its high cost inclusions, bringing on natural and other environmental effects. The transfer of waste foundry sand is of prime significance because of the huge volume created from the foundries everywhere throughout the world. Additionally strong stone work squares which are generally utilized as a part of development designs are fundamentally subststandard compared to blazed dirt blocks. This likewise has a detriment that it can't be utilized for load bearing and seismic safe structures. This paper principally focuses on two arrangements: making of monetarily accessible strong brick work squares to high quality so it can be utilized as a part of load bearing structures and substitution of fine total in these pieces with waste foundry sand. Albeit many reviews have been figured utilizing waste foundry sand in cement, no such review has been accounted for so far with strong stone work pieces. Plan of squares were made after IS: 10262(2013) rules and testing of pieces were fulfilled utilizing IS: 2185(1979). It was surmised that around 20 to 30 percent of substitution of fine total to waste foundry sand gave great outcomes for all down to earth purposes. This review additionally plans to urge enterprises to begin business creation of solid items utilizing waste foundry sand.

Keywords: High Strength Solid Masonry Blocks, Waste Foundry Sand, Chemically Bonded Foundry Sand, Compressive Strength.

I. INTRODUCTION

Natural sand has been used widely in construction activities and is diminishing day by day. At present due to the unavailability of natural sand, manufactured sand produced from quarries are widely used for mass production of concrete. Very soon in the near future there will be a scarcity for manufactured sand also. Use of recycled products is the new trend in industry and researchers are keen to find a new material that fit for the right purpose. Here waste foundry sand can be effectively utilized as partial or full replacement of natural sand or manufactured sand. Waste foundry sand (WFS) is a by-product of the metal casting industries generated from the released moulds for casting after several reuses [1]. Foundry sand is basically high quality silica sand. Depending upon the type of binders used, waste foundry sand or used foundry sand can be classified into green sand and chemically bonded sand. In green sand the binder used is bentonite whereas in chemically bonded sand it is mainly of organic system [2]. Due to the chemicals present in the binders the disposal of waste foundry sand for land filling may cause adverse environmental and ecological impacts. Due to high treatment cost, foundry industries are not much interested to invest on the safe disposal of waste sand. As per present disposal practices, the waste foundry sand which is dumped on barren land cannot be recovered. So the waste foundry sand should be used for other beneficial applications to reduce its adverse effects. In this study the properties of high strength concrete masonry blocks with partial replacement of waste foundry sand to fine aggregates are examined. This alternate use is also advantageous in saving of natural resources like river sand, which is in threat of depletion. It can also save the natural rock deposits to some extent as nowadays manufactured sand are used in abundance instead of natural sand. The energy requirement for the waste foundry sand is also a minimum compared to the manufactured sand. By the efficient use of this waste foundry sand total construction cost can be reduced substantially.

II. RECENT INNOVATIONS USING WASTE FOUNDRY SAND IN CONSTRUCTION ACTIVITIES

At present waste foundry sand obtained from foundry industries are used in structural fills such as filling embankments, in road construction as filling material for sub bases etc. [3]. Latest innovations prove it can also be used in normal concrete as a replacement for fine aggregate for certain level of replacement [2, 4, 5]. A peripheral research has also been carried out by incorporating waste foundry sand on paving units [6]. Waste foundry sand in self compacting concrete was another milestone achieved in research field [7, 9]. High strength concrete was also set up using waste foundry sand [8]. All these experiments were made either on concrete, or its properties. But no such report has been
presented so far distinguishing the significance of using waste foundry sand in commercial products such as concrete masonry blocks.

III. RESEARCH SIGNIFICANCE

At present the commercially available blocks are of very inferior quality both in strength and durability. Main objective of this study was that if blocks of higher strength and durability can be obtained by the use of partial or full replacement of waste foundry sand total cost of the cost of construction of residential buildings can be reduced. Most of the individual residential buildings are made with single storey or twin storey access. Normally these buildings are made using burnt clay bricks or solid concrete blocks utilising its load bearing characteristics. Adopting lesser width concrete blocks enables more room space for the same plinth area and this will be cost effective according to the availability of high strength solid masonry blocks. Hence the main aim was to find out the feasibility of employing waste foundry sand as an ingredient in the manufacture of high strength concrete masonry blocks. Experimental investigations was carried out to investigate the effect of waste foundry sand (WFS) as partial or full replacement of fine aggregate for the manufacturing of solid concrete blocks. This will be achieved by comparing the parameters such as Block Density, Compressive Strength, Water Absorption, Drying Shrinkage and Moisture Movement with that of blocks made with controlled concrete, utilizing the normal ingredients.

IV. PHYSICAL COMPOSITION OF WASTE FOUNDRY SAND

Investigations were made on foundry sand procured from Local Foundry near Chavara, Kollam dist., Kerala, India. This type of sand has a peculiarity that it is of chemically bonded nature. Foundry sand obtained directly from foundry is shown in Fig 1. It has to be crushed to usable size before supplying it into concrete making. For laboratory applications it was crushed using manual means. In the case of commercial application aggregate crusher can be engaged. The physical properties of the foundry sand used in this investigation are listed in Table 1 respectively.

![Fig 1. a) Waste foundry sand directly taken from site b) Crushed used foundry sand.](image1)

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific gravity</td>
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<tr>
<td>Water absorption</td>
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<tr>
<td>Bulk density</td>
<td>1440 kg/m³</td>
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<td>Voids ratio</td>
<td>0.62</td>
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<tr>
<td>Porosity</td>
<td>38.27%</td>
</tr>
</tbody>
</table>

Table 1. Physical properties of waste foundry sand

A. Moulds Sizes and Specifications

Concrete masonry building units shall be made in sizes and shapes to fit different construction needs. The maximum variation in the length of the units shall not be more than $\pm 5$ mm and maximum variation in height and width of unit, not more than $\pm 3$ mm

Length 400, 500 or 600 mm
Height 200 or 100 mm
Width 50, 75, 100, 150, 200, 250 or 300 mm.

Hence as per the code provisions different sizes can be adopted for manufacturing of blocks. Here 200×100×100 mm size blocks were taken for the ease of making and testing. Depending on strength aspects and controlling the factors used in design half sizes of bricks were convenient. For the purpose of experiment five specially designed moulds were fabricated and casted specimens were shown in Fig 2.

![Fig 2. Special moulds with casted concrete blocks](image2)

V. MIXDESIGN PROCEDURE

As per IS: 2185 (Part 1) -1979 concrete mix used for blocks shall not be richer than one part by volume of cement to 6 parts by volume of combined aggregates before mixing. Therefore volume batching has been prescribed for the production of concrete for manufacturing concrete masonry blocks. But for comparative study volumetric batching will not give precise results. So the volumes of each ingredient are converted to corresponding weights as per IS 10262(2009) - Indian standard guidelines for mix proportioning [11]. Thus
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Among 20 numbers of blocks, for each percentage of replacement, 8 numbers were used for testing of compressive strength. The strength of the full-size units is considered as that which is calculated from the average measured strength of the segments. For the purpose of acceptance, age of testing the specimens shall be 28 days. Water absorption tests were conducted for three blocks by completely immersing in water at room temperature for 24 hours. Subsequent to saturation, all specimens are dried in a ventilated oven at 100 to 115°C for not less than 24 hours and until two successive weighing at intervals of 2 hours show an increment of loss not greater than 0.2 percent of the last previously determined mass of the specimen. Results are stipulated in Figure 5. Drying Shrinkage was found out using micrometer gauge by noting down wet measurement and dry measurement for three selected blocks. The difference between the ‘original wet measurement’ and the ‘dry measurement’ expressed as a percentage of the ‘dry length’ is calculated The specimens which have previously been used for the drying shrinkage test after the completion of that test, was immersed in water for 4 days, the temperature being maintained at 27 ± 2°C for at least 4 hours prior to the removal of the specimens and the wet length measured. The moisture movement was determined as the difference between the dry and wet lengths and expressed as a percentage of the dry length for each specimen

VII. DISCUSSION

From the tests, the obtained value of maximum strength was 20% replacement. Further addition decreased the strength. Water absorption limit as per the codes was 10% of volume. But it was found that the addition of waste foundry sand in concrete has induced some minor variations in water absorption. However in all the cases observed values were much less than the permissible value in the order of 12.4% of the maximum allowed value. Block density value decreased by the increase of waste foundry sand which may be due to the reduced value of specific gravity for waste foundry sand. Moisture movement limit as stipulated in code was 0.1%. For this parameter also addition of waste foundry sand from 0-100% was found to be within limits. Drying shrinkage also followed the conditions of codes given as maximum limit as 0.09%, which was also satisfied for all percentages of replacement. For 20% replacement moisture movement, drying shrinkage and water absorption value decreased and in the later increase of percentages it increased which shows optimum replacement gave good results in all tests as specified in codes.

VIII. CONCLUSION

From the test results obtained it is evident that ordinary concrete blocks can be made high strength and thereby it can be used in construction of shear walls, load bearing walls, infill walls etc. It can also be used in earth quake prone areas for higher lateral resistance. Incorporation of waste foundry sand increases the strength of blocks and optimum percentage of replacement was found between 20 to 30%. For 100% replacement efflorescence was noted which may be due to heavy salts present in waste foundry sand. Hence 100% replacement is not advisable as it may be harmful for connected R.C.C works like footings, columns, beams, slabs etc. The Indian Standard codes IS 2185(1979) [11] prescribes strength up to 5 N/mm² for concrete masonry blocks whereas burnt clay bricks are available in different grades starting from a strength of 3.5N/mm² to 35N/mm² as per IS 1077(1992) [12]. For special applications heavy duty burnt clay bricks are available in strengths of 40 N/mm² and 45 N/mm² as per IS 2180(1988) [13]. In the present scenario the code prescribed strengths for concrete masonry blocks are very insufficient to cater the loads especially in seismic regions. So the Indian standard code for the concrete blocks has to be revised accordingly to accommodate a wide range of strengths for different applications. Volumetric batching specified in the code has to be changed to weigh batching in line with the good construction practices as modern weigh batching equipments are available in affordable cost for the commercial production to ensure durability and consistent strength for the manufactured blocks.
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X. REFERENCES


Authors Profile:

P Naga Ankineedu received his B.Tech degree in Civil Engineering in the year 2013 and pursuing M.Tech degree in Civil Engineering from DJR College of Engineering & Technology.

Ch. Bhagya Lakshmi received her M.Tech degree and B.Tech degree in Civil Engineering. She is currently working as an Assoc Professor in DJR College of Engineering & Technology.