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Original Research Article

# Utilization of recycle paper mill residue and rice husk ash in production of light weight bricks

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ABSTRACT

Resource recovery and utilization of industrial by-product materials for making construction material has gained significant attention across the world. In this research study, recycle paper mill residue (RPMR) and rice husk ash (RHA) are utilized to improve the properties of bricks. This research study evaluated the feasibility of utilizing RPMR and RHA for making construction bricks. A homogeneous mixture of RPMR–RHA–cement was prepared with varying amount of RHA (10–20% by weight) and RPMR (70–80% by weight) and tested in accordance with the IS codes. Characterization of RPMR and RHA was performed using XRF, TG-DTA, XRD and SEM techniques. The SEM monographs show that RPMR has a porous and fibrous structure. The TG-DTA characterization demonstrated that RPMR can withstand temperatures up to 280 °C. The results indicate that RPMR-bricks prepared from RPMR–RHA–cement combination are light weight and meet compressive strength requirements of IS 1077-1992. This novel construction material serves objectives of resource recovery through prudent solid waste management.



## 1. Introduction

Brick is one of the widely used construction materials in India. In the past, rudimentary brick making techniques used locally available natural materials such as clay. With industrial revolution, economic growth and overall increase in population, tremendous demand is exerted on natural resources for creating new infrastructure. The increasing demand for the construction materials especially bricks are exploiting natural resource to the large extent. With dwindling resources and emphasis on sustainability and resource recovery, novel approaches to utilize the waste material as a construction material has gained widespread attention of the scientific community, since the 1980s (http://www4.uwm.edu/cbu). Growing environmental awareness in the building industry has brought about the need to investigate ways to incorporate residuals and by-products materials in place of traditional construction material and preserve the environment while maintaining the material requirements stipulated in the standards [1].

Brick is one of the most accommodating masonry units as a building material in India due to its physical, chemical and mechanical properties. Utilization of residuals and by-products materials as a construction material could address two issues;

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it will not only lead to conservation of natural resources, but will herald better ways of managing residuals and by-product materials. As per the recent report of Indian Paper Manufacturers Association (IPMA), recycle paper mills (RPM) contributes nearly 30% of the total pulp and paper mill segment. With 85% average efficiency of RPM, around 5% (by weight) of total pulp and paper mill production is generated as RPMR annually. As a by-product, often times RPMR are landfilled without any resource recovery. Use of such recyclable materials as a raw material in the production of bricks has been an evolving process [2]. They have been successful in creating a brick-making material by mixing recycle paper mill waste and cement with varying proportions (up to 20% by weight) of cement. Their research shows that the bricks made by using recycle paper mill waste are light weight and increased acceptable compressive strength. Continuous efforts are made to incorporate industrial by-products as a raw material in the production of bricks. For example, Mucahit and Sedat [3] developed porous and light-weight bricks by using paper processing residues as an additive to a clay brick. They have been successful in creating a brick-making material by mixing brick-making raw materials with varying proportions (up to 30% by weight) of paper residues. Their research shows that the bricks made by using paper processing residues had

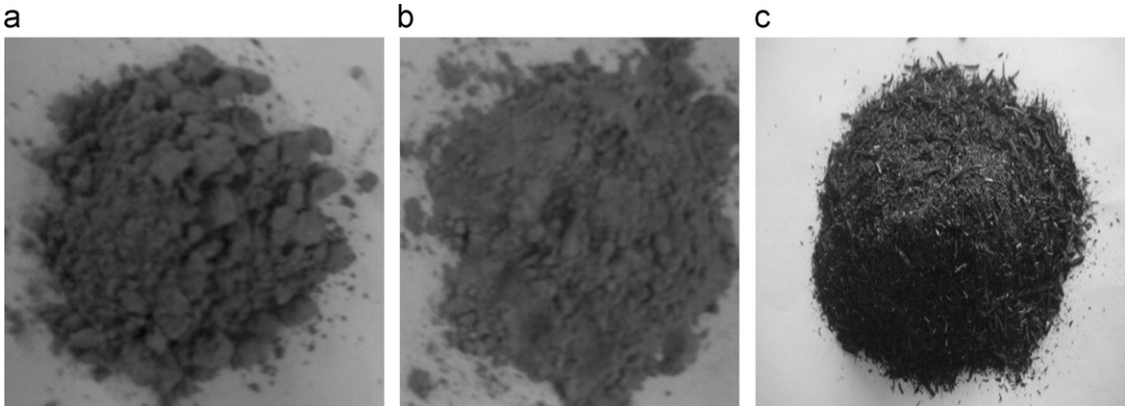


**Fig. 1 – (a) Dry RPMR, (b) OPC and (c) RHA.**

**Table 1 – Details of compositions.**

| Sr no. | Sample name | Wt of wet RPMR (g) | Wt of dry RPMR (g) | Wt of cement (g) | Wt of RHA (g) | % Consistency of RPMR Dry RPMR/(water+dry RPMR) |
|---|---|---|---|---|---|---|
| 1 | A | 3200 | 716.8 | 89.6 | 89.6 | 0.23 |
| 2 | B | 3200 | 672.0 | 89.6 | 134.4 | 0.22 |
| 3 | C | 3200 | 627.2 | 89.6 | 179.2 | 0.21 |

**Table 2 – Material balance.**

| Sample: no of samples | A:60 | B:60 | C:60 | % Average |
|---|---|---|---|---|
| Weight (wt) of wet RPMR, g | 3200 | 3200 | 3200 | |
| Wt of dry RPMR, g | 716.8 | 672 | 627.2 | |
| Wt of cement, g | 89.6 | 89.6 | 89.6 | |
| Wt of RHA, g | 89.6 | 134.4 | 179.2 | |
| Water, g | 2304 | 2304 | 2304 | |
| Wt of wet brick after P1, g | 2630 | 2725 | 2794 | |
| Amount of water removed during P1, g | 570 | 475 | 406 | $24\pm4^{*}$ |
| Amount of water removed by partial solar drying, g | 325 | 376 | 394 | $15\pm3^{*}$ |
| Wt of wet brick before P2, g | 2305 | 2349 | 2400 | |
| Wt of wet brick after P2, g | 2089 | 2142 | 2179 | |
| Amount of water removed during P2, g | 216 | 207 | 221 | $10\pm2^{*}$ |
| Wt of dry brick, g | 973 | 1006 | 989 | |
| Amount of water removed by partial solar drying, g | 1179 | 1136 | 1221 | $42\pm5^{*}$ |
| Wt of dry material, g | 896 | 896 | 896 | |
| Wt of water in brick, g | 77 | 110 | 93 | $8\pm2^{*}$ |
| Wt of water removed by pressing, g | 786 | 682 | 627 | $35\pm5^{*}$ |
| Wt of water removed by evaporation, g | 1504 | 1512 | 1615 | $57\pm5^{*}$ |