Evaluation of Feasibility for Novel Modular Block Construction

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Abstract

Nowadays, a requirement of fast construction technology and modular construction is the future of the construction industry. In India, the population below the poverty line was 21.9% due to this total housing shortage of 24.71 million dwelling units for 67.4 million households, where 98% of this shortage was in the low income and economically weaker sections (EWS) segment. Further, a need for warehouses to store agricultural products and 40% of agriculture products get waste due to a lack of proper handling and storage infrastructure. As we all know, plastic is a big enemy of the environment. Further CO_2 production during the manufacturing of cement is a major challenge for the environment. The study stated that one tonne of cement produces 1.25tonnes of CO_2.After considering all these problems for reducing pollution and fast construction, we propose using gypsum and recycled plastic to produce ideal sized modular unit and check its strength and economy criteria.

Keywords: - *Modular construction, Agricultural products, Gypsum, Plastic, Steel curls, Coconut shell fibre*

INTRODUCTION

As per the 2011 census, the housing stock available in urban India stood at 78.48 million for 78.86 million urban households. Due to the continuousurbanization, the economically weaker sections are forced to live in the slums, continuously deteriorating their living standards. The study says that88% of this shortage pertains to houses for Economically Weaker Sections (EWS) and 11% for Lower-Income Groups (LIG). For Middle- and High-Income Groups (MIG and HIG), the estimated shortage is only 0.04 million.

Hence, the use of Speedy techniques for time and cost-effective construction projects by adopting Different alternate Construction building materials and fast construction methods is essential in India, given the tremendous housing shortage. The Use of Glass Fiber Reinforced Gypsum (GFRG) panels construction is considered as one of the best solutions to meet this challenge. This product was initially developed in Australia in 1990 and used for mass-scale building construction.

GFRG Panels are developed from the gypsum, which is an available lot like an industrial by-product waste. These low-weight panels are fire-resistant, thermally insulated, earthquake tested waterproof, termite resistant, and 100% recyclable. This is becoming the best eco-friendly or green building concept, which saves energy and protects the environment.

The Requirements of conventional materials used in major building components in the housing sector like clay, sand, stone, gravels, cement, brick, block, tiles, distemper, paint, timber, and steel is increasing every year, and that's why the cost of construction materials is growing incrementally. Also, due to the high transportation costs of these raw materials, demand, environmental restrictions, it is critical to find innovative substitutes for conventional building materials in the construction sector. The key challenges facing today's mass housing sector are the minimum use of these energy-intensive construction materials and the speedy delivery of housing units at affordable cost.

The presence of large quantities of plastic waste cause several environmental problems. Various researches have already been conducted to find out a safe and environmentally friendly solution for the disposal of plastic wastes. Recently, different types of plastic have been included in concrete mixtures because of their long service life and lower weight to reduce environmental problems.

In the lathe industries, the steel curls are produced when we give finishing of different machines parts, and after that, we dump that steel scraps of steel curls waste in the landfill and unfertile soil. Due to this dumping process of steel curls, the groundwater and ground soil builds an unhealthy environment. These steel scraps are waste products used by the advanced construction industry and the transportation and highway industry. In addition to getting sustainable progress and environmental compensation, lathe scrap as worn-recycle fibres with concrete can be used.

Coconut is growing in more than 93 Nations. Southeast Asia is regarded as the origin of coconut. India is the third-largest, having cultivation on an area of about 1.78 million hectares. The coconut industry, particularly in India, accounts for over a quarter of the world's total coconut oil output.

However, it is also the main contributor to the nation's pollution problem as solid waste in coconut shells, which involves an annual production of approximately 3.18 million tonnes. Coconut shell contains more than 60% of the domestic waste volume. Coconut Shell, which presents serious disposal problems for the local environment, is an abundantly available agricultural waste from the local coconut industrial sector. In developing countries where more agricultural and industrial wastes are discharged, these wastes can be used as potential material or replacement material in the construction industry. And due to that double advantage of the reduction in the cost of construction material and as a means of disposal of wastes. Using gypsum, coconut shell fibre, plastic, and steel curls, we are trying to manufacture an ideal size modular unit that is to be used for a partition wall in housing projects, which reduces the cost and time of the project.

AIM & OBJECTIVES

AIM

To prepare and evaluate modular units with optimum dimensions of unsegregated recycle plastic, gypsum, coconut shell fibre, and fiber or curls to achieve maximum workability and economy in construction.

OBJECTIVES

- To find ideal mix proportions for gypsum, recycled plastic and fibres/curls, and Coconut shell fiber.
- Optimum size and dimensions for easy handling and economy.
- Attaining satisfactory workability in real-life applications.
- Decide an ideal locking arrangement for modular blocks.
- Evaluation of strength and performance.
- Checking economic feasibility for the product.

LITERATURE REVIEW

The Phosphogypsum waste generated in India is about 12million tons/year from fertilizer industries. Also, 6.5 billion tons of discarded plastic and rubber wastes are produced every year globally, and due to that, the disposal of these wastes cause a great threat to the environment.

India's urban housing shortage was estimated at nearly 18.78 million households in 2012.

Also, there is a shortage of primary health centres, primary schools, and warehouses to store agriculture products and agriculture markets in villages. More than 40% of agricultural products get wasted due to a lack of proper handling and storage infrastructure. Due to all problems, modular construction is the best option for the rapid construction of all these units.

Modular construction is one of the most growing and high technology innovations in the construction industry. It is rapidly evolving as apowerful alternative to conventional on-site buildings. Modular construction is a type of construction in which a building is constructed using three-dimensional units assembled and produced in a manufacturing plant. Modular construction reduces project time, waste generated on-site, numbers of on-site activities, noise, traffic, etc., and gets done high quality and speedy construction.

Wu (2009) States in his research paper that, as a result, the structural behaviour of GFRG walls and the associated building system are more complex than that of conventional structural systems. The results of comprehensive experimental and theoretical investigations into the structural behaviour of GFRG walls offer a structural design methodology for GFRG walls and the associated building system.

In their research paper, Cherian etal. (2016) state that the GFRG building construction is found to be about 1/4 reduction in structural weight and construction cost, 3/4 savings in construction time, and 1/2 savings in total manpower required for construction of the building. Further, the use of conventional materials like cement, steel rebar, and sand are reduced.

Generalova et al. (2016) State that in the research paper for developing of modern modular construction system to provide the population with affordable, comfortable, and eco-friendly housing. Prospects and relevance of introducing modular prefabricated units into low-rise and multi-story and high-rise construction.

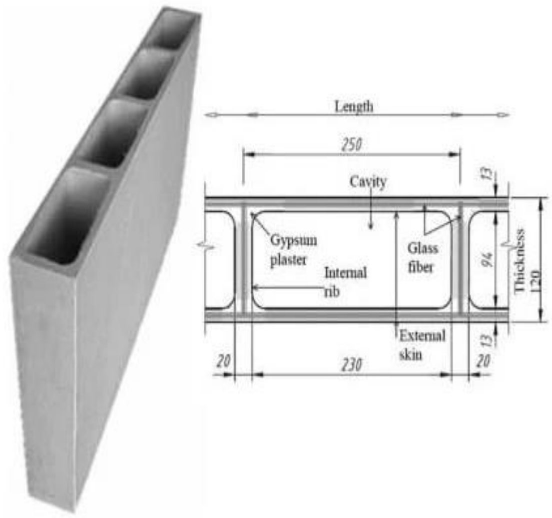
In his research paper, Grigore(2017) states the ideal properties of thermoplastic polymers such as corrosion resistance, low density or user-friendly design. The production of plastics has increased markedly over the last 60 years, becoming more used than aluminium or other metals. Also, recycling is one of the most important actions available to reduce these impacts and represents one of the most dynamic areas in the plastics industry.

Caggiano et al. (2017) State that in their research paper, the results of experimental research on "sustainable" cementitious composites are internally reinforced with industrial and recycled steel fibres, the latter being recovered from waste tires and employed in addition to the industrial steel ones.

Kaur et al. (2019) State that in their research paper, the use of coconut shells as coarse aggregates in concrete reduces the cost of materials. The use of coconut shells can also help the prevention of the environment as well as help economically. This paper aims to spread awareness about the utilization of coconut shells as a construction material in civil engineering.

Makul (2020) States that in his research paper that recycle concrete aggregate manufacturing set-ups can be used in the industrial-scale manufacture of recycled concrete and at significantly fewer prices. Also, overhead bin type and front-end loader type of plants can lower the gradual costs of recycled concrete aggregate.

Santana et al. (2020) State that in their research paper, Gypsum plaster waste is still faced with severe economic and environmental problems. Then, blocks were made with the recycled material. After its characterization, the material was evaluated for its mechanical performance when used in walls, regarding the tests of suspended vertical loads and hard and soft body impact, according to the given guidelines. It was noticed that the small walls get good resistive capacity.



CONCLUSION AND SUGGESTIONS

In India, modular construction faced many problems and failed due to the lack of skilled labour and advanced equipment. Also, GFRG or Rapid wall panel is more economical than conventional buildings.

Thus, GFRG panels can be effectively used in building walls, parapets, and compound walls. It provides a new method of building construction on a fast track. Using GFRG Panel construction, we can reduce manpower, cost, and time of construction.

Similarly, the use of traditional materials like cement, sand, aggregates reduce, and the use of waste material like gypsum, plastic, coconut shell, and steel curls increase. We all know all these waste materials are a big challenge for the environment. By using it as a construction material, we reduce the effect of those materials on the environment.

The current situation of our country is that there is a requirement of vast numbers of houses for EWS peoples and also currently the natural disasters increase day by day for that it can be a good choice for such type of sustainable construction for that we are trying to use gypsum, recycle plastic, waste steel curls and Coconut shell fiber for producing ideal sized modular unit, which will be easy to handle, ecofriendly and economical.

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