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DEVELOPMENT OF LIGHT WEIGHT CONCRETE BLOCKS USING WASTE POP AND GYPSUM BOARD

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Abstract

Buildings built of concrete reinforced have become more common over the past several decades due to the abundance of building materials, their low cost, and convenience of construction. Better design standards throughout the years have resulted in the production of more earthquake-resistant design constructions. The self-weight of reinforced structures is rather high. The live load that a reinforced concrete structure can take is relatively low in relation to the structure's dead weight. Replace heavy concrete with light concrete as a practical way to reduce the structure's dead mass and increase its load bearing capability. The main objective of the study was to compare the structural performance of grade M20 and M30 lightweight concrete to that of regular conventional concrete. Pop gypsum board was employed as a volumetric alternative for coarse material for producing light weight concrete examples for the inquiry. Casting of the light-weight concrete takes place in line with the requirements. A 150x150x150mm cube made from the best mix of light weight concrete was built in order to measure the compressive strength. From the investigation, it is evident that Plaster of Paris gypsum board replaced at 40% and 60% replacement levels offers the requisite strength to produce light-weight concrete blocks.

Keywords: Light weight concrete (LWC), Plaster of Paris (POP), Gypsum board, Recycled coarse aggregate (RCA), Compressive strength, Density, Light Weight Concrete Block.

1. INTRODUCTION

Recent years have seen significant environmental harm from numerous productive sectors, including the untreated release of waste materials into ecosystems. Environmental concerns have grown as a result of the accumulation of mismanaged trash, particularly in emerging nations. Recycling such wastes into building materials seems to be a workable solution to both the pollution the issue with the cost-effective design of structures. The employment of more sustainable building methods is essential given that the construction industry consumes a significant number of resources including materials, energy, and water. Studies of the behavior of heavy and light concrete in terms of compression strength, split tensile strength, and flexural strength are conducted through experiments. A form of sedimentary material called "Plaster of Paris" or gypsum powder, which settled as a result of the evaporation of ponds with trapped seawater. A form of plaster called plaster of Paris has applications in art, building, fireproofing, and even medicine. Moulds made of gypsum can also be made, and they will be highly reliable despite enduring extreme temperatures. We are all aware that pop cannot dissolve in water, yet we continue to disregard the dangers of water contamination and its adverse effects on our health. Therefore, in order to prevent contamination from waste pop, it must be diverted to a useful purpose. The examination of several papers for the recycling of pop and textile waste. We may utilize a material's qualities with composition. As a result, it will be simple and

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affordable. In the current investigation the POP gypsum board as aggregate entirely takes a material's position of the heavy weight aggregate and Experimental work is done. Waste POP gypsum board as light weight aggregates are used to replace the traditional granite aggregates.

Lightweight coarse materials used to manufacture lightweight concrete include slate, clay, and slate. The material's notably low density is a result of these components. In addition to using a light-weight coarse aggregate, however, lightweight fine aggregates may occasionally be utilized in lightweight concrete formulations in place of conventional aggregates. The density of the existing structural lightweight concrete varies between (1440 and 1840 kg/m^3). A normal weight of concrete has an average density of between 2240 and 2400 kg/m^3. For structural applications, concrete strength should be more than 17.0 MPa.In order to provide a porous structure, expanded shale, clay, or slate materials are often utilized as lightweight aggregates in structural lightweight concrete. Additionally, items like air-cooled blast furnace slag are used. Other non-structural LWC classes, which includes cellular concrete, have lower densities and are manufactured using various aggregates and have a greater percentage of air voids in the cement paste matrix.

To increase the reinforcing effect and reduce the expense of technological resources, the RCA was impregnated with a cement slurry that had a high water-to-cement ratio (W/C = 1.0). Then, utilizing the combined effects of the carbonation and cement slurry, the RCA was strengthened. Examined were this effect's effects on recycled aggregate concrete (RAC) strengthened by RCA strengthening. The findings show that carbonation of cement slurry has a synergistic impact that is noticeably stronger than slurry wrapping treatment alone on the enhancement of RCA. Furthermore, when the water-cement ratio is greater than 0.5, this effect reinforces RCA more significantly. The findings of the microscopic tests show an improvement in RCA morphology because the modification treatment improved the pore size distribution and corrected internal weak spots. The aggregate surface had the cement paste enclosed inside of it, which helped the RCA and new mortar adhere to one another.(Feng et al., 2023)

The use of high strength lightweight cement made with lightweight extended mud aggregate (LECA) in support cement footers utilizing the balanced two-point loads test. The substantial strength and steel bar support were two significant boundaries inspected during the pillar tests. The creator looked at flexural execution of the tried pillars (disappointment modes, load avoidance reaction, and extreme second limit) with those of the hypothetical investigation. The exploratory outcomes recommended that a definitive snapshot of bars made with LECA lightweight cement could be anticipated sufficiently utilizing the condition given by the ACI 318 construction regulation (Aslam et al., 2017)

This study examines the qualities of newly blended concrete and solidified substantial that have been blended in with locally open normal lightweight totals and mineral admixtures. The compressive strength and modulus of flexibility of the primary lightweight concrete were found to ascend by up to 57% and 14%, separately, in contrast with blends without silica rage, as per test results. Be that as it may, contrasted with blends without fly ash, amounting to 10% fly ash as a fractional concrete substitution by weight to similar combinations brought about an 18% decrease in compressive strength with no adjustment of modulus of versatility. In contrast with

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discrete blends, lightweight substantial combinations that contain 10% or more silica fume and 5% or more fly ash perform better concerning strength and solidness.(Shannag, 2011)

This exposition presents research on the utilization of lightweight totals in primary light weight concrete. The strength qualities of primary lightweight cement produced by subbing coarse total with mixed lightweight total such LECA and soot for M20 grade concrete were the subject of the examination. By volume of cement, ash and LECA were blended in various proportions, including 0:100, 10:90, 20:80, 30.70, 40.60, and 50:50. By casting 33 cubes with aspects of 150x150x150 mm and round and hollow molds with aspects of 150x300 mm, the qualities including compressive strength, split rigidity, and density. As indicated by the study LWC with 60% cinder and 40% LECA showed a compressive strength of a typical 28.89 N/mm^2 and a typical split tensile force of 1.67 N/mm^2. The compressive strength was expanded to 30.68 N/mm^2 when 20% GGBS was utilized instead of cement, matching the worth of standard weight concrete. Also, the accomplished density went from 1750 to 1850 kg/m^3, which is not exactly ordinary concrete weight. (Anil Kumar R, 2015)

The study was finished to decide if marble dust may be utilized as a fine total in lean mortar mixtures. Marble dust was squashed into fine total and utilized instead of waterway sand in sums going from 0% to 100 percent by volume. These discoveries prompted the end that marble squander, when fill in for 25% and half of the stream sand in lean mortar combinations, can be utilized securely in both threatening and non-forceful circumstances.(Khyaliya et al., 2017)

The author attempted to analyze the mechanical properties of the structural grade lightweight concrete M30 by partially substituting lightweight aggregate pumice stone for coarse aggregate and mineral admixture components like fly ash and silica fume. The test resulted in a general gain in strength and weight reduction along several courses. When lightweight aggregate was employed to replace natural coarse aggregates to the amount of 20%, the strength at compression was sufficient. The compressive strength of concrete decreased as pumice content. Concrete's flexural, split-tensile, and compressive strengths were all increased by mineral admixtures (Minapu et al., 2007)

The experimental work is separated into two parts. In the first phase, LECA was blended to produce light-weight concrete. Cinder in various ratios of 0:100, 10:90, 20:80, 30:70, 40:60, and 50:50 in place of traditional coarse aggregates. A total of 33 simple cubes measuring 150 mm x 150 mm x 150 mm, together with 4 regular concrete cubes, were created and tested for the experiment. Forty per cent LECA and sixty per cent cinder had the best compressive strength when combined. For M20 grade concrete, the strength was improved from 29.07 MPa to 31.68 MPa, and the density was 1816 kg/m3, through the addition of 20% GGBFS as a partial replacement for cement.(Kumar, 2016).

LECA accurate evaluations. It has been discovered that 60% Cinder and 40% LECA are the optimal extents for reaching the necessary compressive quality for the M20 and M30 evaluations of concrete separately. These specimens were also subjected to acid, sulphate, and chloride for 28, 56, 90, and 180 days in order to examine the durability performance. A fireproof test was also carried out. According to the research, lightweight aggregates should be

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able to replace coarse aggregates in concrete without sacrificing strength or durability.(Kumar, 2016)(Anil Kumar et al., 2019)

2. SCOPE OF THE WORK

Municipal solid trash also contains POP waste, which comprises pieces from false ceilings, plaster boards, plaster cornices, and plaster mouldings, among other things. Since Because POP cannot biodegrade and there is a need to reduce the amount of POP waste, the BBMP currently employs landfills to store POP waste. Finally, both the general public and the government ignore the harmful consequences of POP waste in water pollution and the dangers it poses to us. So, in order to prevent pollution caused by an excess of POP, we must transform the extra POP trash into something valuable and useful.

3. OBJECTIVES

The objectives of the investigation are given below.

1. To obtain the lightweight concrete of M20 and M30 grade by blending of POP gypsum board in place of conventional aggregates.
2. To compare the mechanical properties of LWC with normal conventional concrete of M20 and M30 grades.
3. To obtain the lightweight concrete Blocks for the optimum mix M20 and M30 grades.

4. METHODLOGY

The experimental attempt was done to produce LWC by combining light weight aggregates such POP gypsum board at various proportions and to create LWC Blocks by selecting an optimal ratio of light weight aggregates and regular aggregates.

Following are the materials required for the experimental work.

- Ordinary Portland cement of grade 53, in accordance with IS 8112-1989.
- Fine Aggregates that pass through a 4.75 mm IS filter and confirm to zone II.
- Coarse aggregates, such as locally available granites that have been passing through 20 mm IS sieve to be utilized.
- In experiment, light-weight aggregates- POP gypsum board has been used.
- Chemical admixture Fosroc Conplast SP430 DIS super plasticizing admixture for concrete.

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Table 1: MIX PROPORTIONS M20	
Cement	383 kg/m^3
Water	192 kg/m^3
Fine aggregate	683 kg/m^3
Coarse aggregate	1150 kg/m^3
w/cm	0.5

Table 2: MIX PROPORTIONS M30	
Cement	367 kg/m^3
Water	158 kg/m^3
Fine aggregate	681 kg/m^3
Coarse aggregate	1234 kg/m^3
Chemical admixture	1.44 kg/m3
w/cm	0.43

4.1 Characterization of Light Weight Aggregates

POP GYPSUM BOARD: Lightweight coarse aggregate is substituted as POP gypsum board. Gypsum POP (Plaster of Paris) sheets, often known as gypsum plaster walls or drywall, are frequently used in the construction industry for inner walls as well as roofing applications. A core of gypsum plaster is used in their construction, which is layered between layers of specialty paper or fiberglass. Collection of panel components is referred to as "gypsum board." These elements a flame-resistant gypsum center with front and center in reverse, and long edges canvassed in paper. The various sheets of gypsum utilized in development and building are alluded to as "gypsum board items". Despite the fact that the surface can be covered with a variety of materials, such as paper and fiberglass matting, gypsum serves as the foundation for all gypsum board products. POP Gypsum board waste from construction and demolition and household that was found in much amount and really easy to found. Fig 1 shows waste pop gypsum board dumped. Fig 2 shows the breaking of pop gypsum board as aggregate and coated with cement slurry.

Using standard tests, the outcomes were as follows:

Tests conducted on POP gypsum board were

Shape of Aggregates	Irregular
Bulk density in compacted state	350 kg/m3
Bulk density in loose state	275 kg/m3
Specific gravity	0.6
Water absorption	35%

Since the water absorption is more in gypsum board to reduce this gypsum board is coated with cement slurry so, the water absorption is reduced is by 15%.

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For the current test, lightweight aggregates such as POP gypsum board were chosen, and both their chemical and physical characteristics were evaluated. Design mix was determined using the ISI approach based on the attributes. These aggregates are combined in a predefined ratio ranging from zero percent to 100% to replace traditional coarse aggregates. Cubes were manufactured for each replacement specimen in the manner seen in FSSig 3. The components underwent conventional cure by being submerged in water for 28 days at room temperature. After compressive loadings were applied to the cured cube specimens, the relevant strength parameters were identified.

Fig 1: Waste POP gypsum Board dumped

Fig 2: Before & after coating of POP gypsum board

Fig 3: Mixing

Fig 3: Casted cubes

Fig 4: Demoulding of LWC block

Fig 5: Curing

Fig 6: Testing & failure of Specimens

Fig 7 : LWC Block

Fig 8: Testing of LWC block

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5. RESULTS

The light weight concrete is mixed to replace natural coarse aggregates by POP gypsum board coated with cement slurry in a predetermined ratio ranging from 0% to 100%. The average compressive strength of 150x150x150mm cubes is tabulated below.

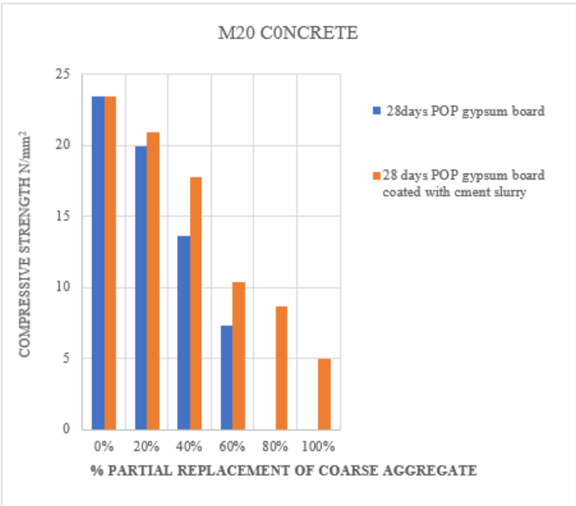
Table 3: Compressive strength of M20 grade concrete

Sl.no	Light weight aggregates %POP gypsum board	Density (Kg/m^3)	Average Compressive strength (Mpa) 7days	28days
1	0	2409	17.29	23.12
2	20	2124	15.41	20.77
3	40	1911	14.56	18.07
4	60	1869	8.86	10.49
5	80	1780	4.82	8.66
6	100	1650	3.12	4.95

Table 4: Compressive strength of M30 grade concrete

Sl.no	Light weight aggregates %POP gypsum board	Density (Kg/m^3)	Average Compressive strength (Mpa) 7days	28days
1	0	2409	24.472	32.52
2	20	2124	24.42	29.53
3	40	1911	18.44	22.22
4	60	1869	13.34	15.22
5	80	1780	7.62	12.22
6	100	1650	4.75	5.83

The comparison and analysis of experimental results were conducted using graphical representations.



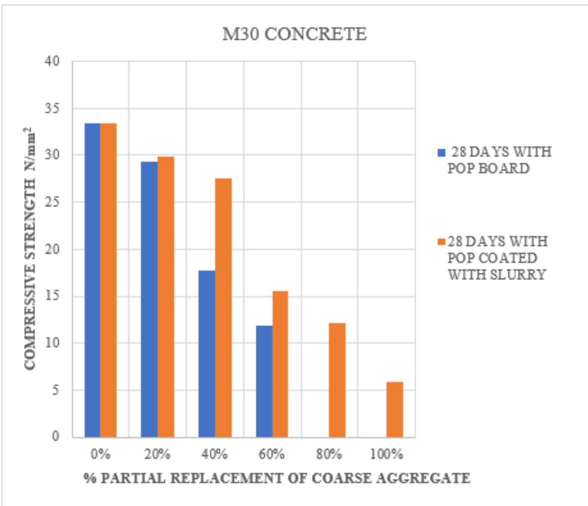


Fig 9: Comparing the percentage of aggregate proportion with the compressive strength

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6. DEVELOPMENT OF LIGHT WEIGHT CONCRETE BLOCKS.

Based on the results above for an optimum mixture of M20 and M30 grade lightweight concrete produced by replacing up to 40% and 60% of POP gypsum board coated with cement slurry, the mix was also designed to cast light weight concrete blocks and prisms in addition to cubes. The cubes are cast in order to evaluate their compressive strength for 28 days. Both the compressive and flexural strengths of the respective concrete mix were evaluated on light weight concrete blocks and prisms after they had been cast, cured, and measured. All light weight concrete blocks and prisms underwent a 28-day curing and testing process.

Table 5: Compressive strength of LWC Block of M20 grade

Sl.no	Light weight aggregates	Density (Kg/m^3)	Average Compressive strength (Mpa)
	%POP gypsum board		28 days
1	40	2091	13
2	60	1963	7.85

Table 6: Compressive strength of LWC Block of M30 grade

Sl.no	Light weight aggregates	Density (Kg/m^3)	Average Compressive strength (Mpa)
	%POP gypsum board		28 days
1	40	2091	10
2	60	1963	4.95

The compressive strenght of concrete block

Fig 10: Locally available concrete block

7. CONCLUSION

- The results of this small-scale experiment, which was carried out to compare the behavior of lightweight concrete, are as follows.
- The mix proportion for M20& M30 grade concrete was calculated with the help of IS 10262-2019.

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- POP gypsum board coated with cement slurry gives more strength than POP gypsum board without coated.
- Optimum replacement of POP Gypsum board by coarse aggregate of M20 & M30 grade concrete was found to be 40% & 60%; further increase in POP gypsum board can result in the reduction of strength.
- For 28 days, the maximum compressive strengths for M30 and M20 grade concrete are 27.56 MPa and 18.44 MPa, respectively. This is for a 40% replacement of POP gypsum board coated with cement slurry.
- For 28 days, the maximum compressive strengths for M30 and M20 grade concrete are 15.22 MPa and 10.55 MPa, respectively. This is for a 60% replacement of POP gypsum board coated with cement slurry.
- The Maximum compressive strength was achieved for Mix with 40% & 60% POP Gypsum board waste.
- LWC concrete blocks are cast with an optimal mix, and as a consequence, their compressive strength is almost two times higher than concrete blocks that are readily accessible locally.
- Maximum Flexural strengths for M20 and M30 grade concrete for 28 days are 3.147MPa and 3.47 MPa. This is for a 40% replacement of POP gypsum board coated with cement slurry.
- Maximum Flexural strengths for M20 and M30 grade concrete for 28 days are 2.51 MPa and 2.47 MPa. This is for a 60% replacement of POP gypsum board coated with cement slurry.
- The experiment shows that using Waste POP gypsum board can help in producing LIGHT WEIGHT CONCRETE BLOCKS.

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