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Structural behaviour of the Light Weight Aggregate Concrete Using Granulated Plastic Waste Material and Burnt Bricks.

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ABSTRACT—

Concrete is a composite material composed of coarse granular material (the aggregate or filler) embedded in a hard matrix of material (the cement or binder) that fills the space among the aggregate particles and glues them together. Concrete is widely used for making architectural structures, foundations, brick/block walls, pavements, bridges/overpasses, highways, runways, parking structures, dams, pools/reservoirs, pipes, footings for gates, fences and poles and even boats. Concrete is used in large quantities almost everywhere mankind has a need for infrastructure. The amount of concrete used worldwide, ton for ton, is twice that of steel, wood, plastics, and aluminum combined. A Eco Friendly concrete is the one which not only minimizes the environmental impact but also retains the life of structure, with good durability characteristics and high strength. It has been found that the light weight eco-friendly concrete has good engineering properties with a reduced global warming potential resulting from the total replacement of ordinary Portland cement.

Present investigation includes studies of light weight eco-friendly concrete mixed design and its structural behavior. For this purpose special light weight aggregate like PET bottles and burnt bricks are tried. The PET bottles used is the indisposed bottles that is been thrown as the waste product. And the burnt bricks used is the brick which are been largely burnt and is kept at the touching zone of the furnace where the bricks are been burnt. These materials are easily and cheaply available.

Keywords— concrete, architectural structures, infrastructure, ordinary Portland, warming potential.

I. Introduction

In the present World of speedy and high rise construction, materials have played role in structural application. Using different materials have revolutionized traditional design concept and made possible an unparallel range of new exciting possibilities.

Numerous different structural systems are used today to meet performance or functional requirement in structures. Light weight structures are widely used in the high rise structures, with advantage of providing the similar strength. Light weight eco friendly concrete is the environment friendly with reduction in amount of its weight.

Lightweight aggregate concrete can be produced using a variety of light weight aggregates. Lightweight aggregates originate from either:

- Natural materials, like volcanic pumice.
- The thermal treatment of natural raw materials like clay, slate or shale etc.
- Manufacture from industrial by-products such as fly ash, i.e. Lytag.
- Industrial waste like PET bottles.

Eco friendly concrete is a concrete in which some part of the concrete is been replaced by some natural or the industrial waste , thus reducing the effect created by the cement and concrete in the environment .The lightweight eco friendly concrete is concrete in which we are replacing some percentage of concrete by PET bottles and the rest by the burnt bricks. This type of concrete can be used in the light weight carrying structure. The RCC structure when constructed is basically formed to take the compressive force. The concrete is weak in taking the tension force so the reinforcement is used in the structure , and the concrete in the tension part of the structure is just for the cover and support for the reinforcement.The aim of the investigation is to replace this concrete material (under tension part) and study the compression property of cubes and flexure property of beam. And a comparison is made with the conventional cubes & R.C.C. beam.The focus of this project is to study the compression and flexure property of concrete by replacing the coarse aggregates by burnt bricks and fine aggregates by crushed PET bottles.With the proposed changes in the material of concrete we can expect, the reduction in the self weight of concrete , thus effecting the load on the footings. Its use also reduces the effect created by the indisposed PET bottles. The reduction in the strength of the concrete is comparatively less & this concrete has less deformation as compared to the other concrete.

II. Literature review

Akçaözoğlu et al. (2010) This study examined the use of crushed, wasted Poly-ethylene Terephthalate (PET) bottle granules as a low-weight mortar aggregate. Two sets of mortar samples—one produced entirely of PET aggregates and the other with PET and sand aggregates combined—were used in the investigation. In order to save money and minimise the quantity of cement used, blast-furnace slag was also utilised as a mass replacement for cement at a replacement ratio of 50%. In the mixtures, the water-binder (w/b) and PET-binder (PET/b) ratios were 0.45 and 0.50, respectively. The shredded PET granules used in mortar mixture preparation ranged in size from 0 to 4 mm. Based on the results of the testing and laboratory study, mortars with only PET aggregate, mortars with PET and sand aggregate, and mortars modified with slag in place of cement can all be classified as structural lightweight concrete in terms of strength and unit weight. Thus, it was determined that there might be a chance to employ waste PET granules that have been shredded as aggregate in the creation of structurally lightweight concrete. Because of their low unit weight, shredded waste PET granules are used to reduce the unit weight of concrete, which lowers the death weight of a structural concrete element of a building. Since earthquake pressures are linearly dependent on a building's dead weight, knowledge of the building's death weight can help lower the building's seismic risk. Additionally, it was determined that using industrial wastes in concrete, such as PET granules and blast-furnace slag, has certain benefits, including lowering the need for natural resources, disposing of trash, preventing environmental contamination, and saving energy.

Apebo et al. (2013)

The purpose of the study was to investigate the potential use of burned brick waste as coarse aggregates in structural concrete. Brick bats, or broken over-burned bricks, were used exclusively as coarse aggregates in trial mixes. Concrete cubes were made and tested in order to determine their compressive strength. Based on the results, medium-light weight concrete with a density of 2000–2200 kg/m3 can be defined as concrete that contains brick bats as aggregates. Concrete with brick aggregates needs more water in proportion to obtain the same workability as concrete with regular gravel particles. In situations when natural aggregate is difficult to get and high concrete strength is not necessary, using shattered, burned bricks as coarse aggregate in structural concrete is advised.

A certain proportion of concrete was burned bricks in this study. The light weight carrying structure can be constructed using this kind of concrete. There are several advantages to this kind of concrete. First, it has the ability to significantly reduce carbon dioxide emissions. This lessens the concrete's self-weight, which affects the footings' load. Its use also lessens the impact that the discarded PET bottles have. The concrete's strength has decreased quite little. Effective reduction of the water cement ratio is also achieved. In comparison to the other concrete, this concrete has undergone less distortion.

Many studies on the characteristics of coarse aggregates and concrete built with them were carried out in order to investigate the impact of substituting crushed clay bricks for natural coarse aggregate on the properties of concretes. In this study, brick aggregate was substituted volumetrically for stone aggregate at levels of 0%, 25%, 50%, and 75%, with all other factors remaining constant. This suggests that the compressive strength of brick aggregate concrete can be increased by reducing its water-cement ratio. An investigation into the properties of higher strength concrete made with crushed brick as coarse aggregate found that higher strength concrete with brick aggregate is achievable, whose strength is much higher than the parent uncrushed brick. Masonry is a flexible . Numerous studies on the porosity, permeability, and absorption of bricks have been conducted. Additionally, experimental research has been

conducted to use crushed brick aggregate to produce concrete with a better strength. It's been discovered that reclaimed brick can serve as a coarse aggregate in concrete as well. It is discovered that overburned brick has a specific gravity of 1.71 and a water absorption of 6.502%, respectively.

Akinyele et al. (2020)Impact of PET waste on burned bricks' structural characteristics. Because of its resilience to environmental deterioration and chemical attack, polyethylene terephthalate (PET) is frequently used for product packaging. However, disposing of this nonbiodegradable material properly has proven to be a significant difficulty. In order to explore the potential of this material as an additive to clay in burnt bricks, this study mixed PET at 0, 5, 10, 15, and 20% with lateritic clay. Following a 48-hour burning of the bricks at roughly 900 °C in a kiln, the samples underwent mechanical, density, and water absorption testing. The findings showed that the brick samples from the 15% and 20% disintegrated at high temperatures, whereas the samples from the lower percentage samples had edge deformation. The modulus of rupture values for the0,5, and 10% samples are 13.20, 11.96, and 8.53 N/mm2, respectively, whereas the compressive strength results are 5.15, 2.30, and 0.85 N/mm2, respectively. The three samples' respective water absorption percentages were 10.29, 9.43, and 6.57%; all of these are within allowable bounds. This study found that, under regulated circumstances, less than 5% PET may be utilised in burnt bricks.

Jayaram et al. (2020) The proper disposal of plastic garbage was becoming increasingly problematic for both the environment and human health. Virgin plastic, a new type of material, can be created by recycling this waste plastic. This is also a useful by-product of coal-burning power plants and may be utilised to produce building materials like bricks and other materials. Bottom Ash is another such substance. In this experimental investigation, bricks are produced using a 1:6 ratio of virgin plastic to bottom ash. Here, manufactured sand, also known as crusher sand, was utilised in place of fine aggregate, and bottom ash was added at percentages of 5%, 10%, 15%, and 20%. Virgin plastic has been utilised in conjunction with bottom ash at a percentage of 2%, 4%, 6% and 8%. GGBS and Gypsum are used in place of cement at 50% and 5%, respectively, in order to save money and minimise the amount of cement required. Virgin plastic and bottom ash are separately varied to create various trial combinations. Properties thatare studied include compressive strength and water absorption. According to test results, the percentage of plastic is rising while water absorption is declining. The experiments with 5% Bottom Ash, or Trial 1, and with 5% BA, 2% Virgin plastic, or Trial 5, have produced superior results in terms of compressive strength.

Jahidul and Shahjalal (2021) Impact of polypropylene plastic on concrete characteristics when used in place of some stone and brick aggregate. In the concrete industry, the use of waste materials in concrete is becoming more and more common since it can lower associated costs and environmental effects. The goal of this study is to determine how concrete performs when burnt clay brick aggregate (BA) and natural stone aggregate (SA) are partially replaced with polypropylene (PP) plastic, which is made from waste plastic products. The percentages of PP aggregate (PPA) at 0%, 10%, 20%, and 30%, the water-to-cement ratio at 0.45 and 0.55, and the aggregate types (SA and BA) are the primary factors. The workability, hardened density, compressive, tensile, modulus of rupture, modulus of elasticity (MoE), ultrasonic pulse velocity (UPV), and cost analysis of the results are presented. Additionally, concrete qualities are predicted using empirical formulae; in particular, compressive strengths are predicted using UPV values. The slump value rose as the percentage of PPA grew, according to the results. The modulus of rupture, splitting tensile strengths, and compressive strength of concrete containing 10% PPA were all greater than those of the control concrete containing brick aggregate (BAC) and stone aggregate (SAC). The PPA content and aggregate kinds had an impact on the UPV results. As the proportion of PPA increased from 10 to 30, both the compressive strength and the UPV values declined. Moreover, SAC had greater compressive strength and UPV values compared to BAC. For concrete containing PPA, a strong association was seen between the UPV values and the compressive strength. In comparison to the control and other PPA concrete, concrete with a 10% PP content had the highest strength over cost ratio, according to the cost sensitivity analysis. For structural concrete, it is therefore advised to utilise up to 10% PPA in combination with either brick or stone aggregate. Last but not least, this research will create new prospects for making green concrete from non-biodegradable waste plastic materials.

III. METHODOLOGY

In present investigation used beam of size **150mm x 150mm x 700mm**

Therefore,

Effective depth (d) = 150-20-(10/2)

= 125mm

Here clear cover = 20mm Diameter of Steel bar = 10mm

As per IS-**456:2000**(clause 26.5.1.1)

Ast min =0.85 x bd

Fy =0.85 x 150 x 415

415

= 38.40 mm^2

Ast max = 0.04 x b x D

= 0.04 x 150 x 150

= 900mm^2

Where Ast = Area of steel in tension

For all four types of beams , keeping the cross sectional area and percentage of steel same . So that, can compare the results of all types of beams.

Normal Reinforced Beam Taking main reinforcement as 4#8 A_{st} = 4 x 50.26

= 201.06 mm^2

Percentage steel (p_t) = Ast x 100

bd

= 201.06 x 100

150 x 125

= 1.07%

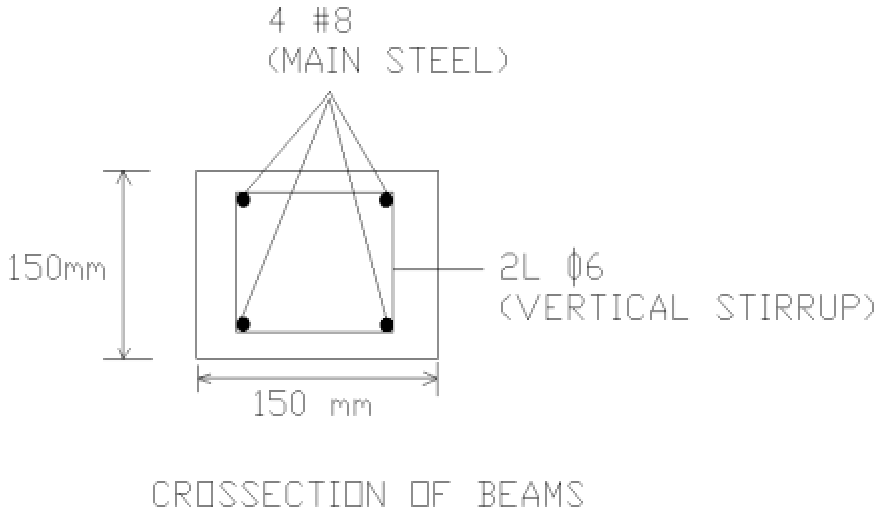

Figure 1. Cross section of beams used in present investigation

Stirrups

Design of Stirrups ,

Assume 2L #8mm steel bars for stirrups

Therefore, Provide Stirrups of size #8 @ 130 mm c/c.

Table 1. Mix Design for M20

Grade Destination	M20
Type of cement	OPC 53 grade confirming to IS-12269- 1987
Characteristics strength	20 N/mm^2
Maximum Aggregate Size	20mm
Workability	0.90
Exposure Condition	Normal
Type of Aggregate	Crushed Angular Aggregate
Maximum Water Cement Ratio(MORT&H 1700- 3A)	0.55
Adopted Water Cement ratio	0.5
Degree of quality control	Good
Type of exposure	Mild

IV. Conclusion

Based on the above study following conclusions can be made:

- As per the Design of M20 grade, compressive strength of cubes as:
- Normal cube =37.30 kN/mm2
- With 25 % replacement =32.50 kN/mm2
- With 50 % replacement =26.00 kN/mm2
- With 75 % replacement =20.90 k/Nmm2
- The reduction in strength is due to the replacement of fine and the coarse aggregates. And the most feasible is to use the one with the replacement of 50% of aggregates, not below it.

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