International Journal of Research Publication and Reviews, Vol 4, no 12, pp 3325-3330 December 2023

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Investigation of the Light Weight Aggregate Concrete and to Compare this with the Structural behaviour of Natural Aggregate Normal Concrete.

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ABSTRACT—

The main aim of using burnt bricks and PET bottles is to reduce the environmental impact that it creates if, not been decomposed properly. The impact can surely be reduced to a large extend if it can be used in the regular construction works, with long life. Another effect of using these waste materials can be seen while the estimating the cost of structure. Due to the waste products these materials are easily and cheaply available and if used properly it can reduce the construction cost by some handsome amount. In this present investigation concrete specimens are casted and tested for 28 days strength and are compared with the strength of the plain cement concrete at 28 days. This project also includes the scope and application of the light weight concrete. Present investigation includes the advantages of light weight eco-friendly concrete over the conventional cement concrete. In the present investigation represents the result on the flexural and the compressive strength of the light weight eco-friendly concrete over the period of 28 days. The various percentage of PET bottles and the burnt bricks are been assumed and the structural member is casted. It is proposed to compare with each other and with plain cement concrete as base. Thus the feasibility of using PET bottles and burnt brick to prepare light weight eco-friendly concrete is studied..

Key word: - Light weight, Eco friendly concrete, PET bottles, burnt brick, Flexural strength and Compressive strength.

I. Introduction

The problem of disposing and managing solid waste materials in all countries has become one of the major environmental, economical, and social issues. A complete waste management system including source reduction, reuse, recycling, land-filling, and incineration needs to be implemented to control the increasing waste disposal problems.

The purpose of this investigation is to evaluate the possibility of using granulated plastic waste materials to partially substitute for the fine aggregate (sand) in concrete composites and burnt bricks as coarse aggregates. The polyethylene (PET) bottle which can easily be obtained from the environment with almost no cost is shredded and added into ordinary concrete to examine the strength behaviour of various specimens.

The burnt bricks are collected and are manually crushed and are added to the concrete to examine the strength and behaviour of concrete.

The plastic waste is found to have no water absorption (based on literature) and hence corrosion control analysis can be done.

The products which are aimed in this project really have a commercial value since there is a need for alternate materials for construction.

The using up of the garbage from the environment for the use of construction purpose will not only reduce the impact on the environment created by these garbage, but will also lead to the new form of construction.

II. Literature review

Olukanni et al. (2021) An analysis of plastic waste in civil engineering as a sustainable resource Plastic wastes can persist in the ecosystem for many years since they are not biodegradable. It may age as a result of chemical, biological, and physical processes that have the potential to destroy habitats and degrade the environment necessary for life. A thorough investigation of a workable substitute for the care, processing, and disposal of used plastic containers has been prompted by the severe environmental issue caused by the careless disposal of plastic waste containers. Because of this, scientists have discovered uses other than its recovery. The trash can be recycled, repurposed, or reprocessed to replace building materials as a substantial amount of aggregates and cement are needed for construction. Its application can also be applied to bricks, plastic reinforcement, bitumen modification, soil stabilisation, geosynthetic materials, and natural aggregates, all of which help to limit the amount of natural aggregates that can be extracted for use in the building sector. The review includes the gathering of pertinent data from published sources regarding plastics, including their many forms, waste products associated with them, and applications in the building sector. It also looks at the problems with plastic garbage and how it may be used sustainably as building material. It might be possible to manage plastic trash, clean up, and enhance our natural environment by altering the way plastics are made. According to this analysis, there is a chance for the building industry to employ plastic trash as a creative substitute.

Hilal and Nahla (2021) Enhancement of environmentally friendly self-compacting concrete production by extensive waste material recycling. The rising expense of landfills and the scarcity of naturally occurring big aggregates are factors that influence the desire to use waste resources to make mortar and concrete. Recycling plastic garbage and broken ceramic debris lowers the cost of using natural aggregates while also saving landfill space. Second, a significant quantity of trash is produced by tea, which is the second most consumed beverage worldwide. This article thus adds plastic garbage, tea waste, and broken ceramics in an attempt to establish the proper properties of self-compacting concrete (SCC). While the amount of crushed ceramic and tea waste remained constant, the fresh and hardened properties of the SCC were examined to study the addition of waste plastic. The findings showed that the addition of plastic waste resulted in a decrease in SFD, L-Box, segregation, and fresh density; the maximum values obtained for PP5 and RP5 were 765 mm, 0.94, 19, and 2382 kg/m3, respectively. On the other hand, T500 and V- funnel flow gradually increased as the amount of waste plastic increased; the maximum values obtained for RP25 and PP+RP25 were 3.44 and 16, respectively. Additionally, as waste plastic content increased, compressive and flexural strengths fell. At 28 days, the maximum values for PP5 and PP+RP5 were 55 MPa and 6.5 MPa, respectively. The outcomes demonstrated that plastic trash, tea waste, and crushed ceramics could all be used in SCC.

Hanis, Gani and Uvarajan (2021) recycling plastic trash for use as gravel in building supplies. Due to the massive amounts of plastic garbage generated every day and the lack of an efficient method for disposal, there is an accumulation of plastic trash in the environment. garbage management and public awareness campaigns have increased the need to find alternatives to the current disposal methods. Utilising waste or recycling plastic has been seen as a great way to minimise environmental effects and cut down on the copious amounts of plastic waste that are produced. This article discusses the use of various plastic waste kinds as aggregate in construction materials by reviewing 163 prior studies conducted between 2012 and 2021. This study assesses the usage of plastic as aggregate in terms of the building materials' mechanical, physical, and durability qualities as well as cost and environmental considerations. It was discovered that the inclusion of plastic as aggregates changed the mechanical and durability qualities of the created materials, but the materials still meet the requirements for construction materials. In addition, a basic SWOT analysis was carried out to illustrate the benefits and drawbacks of using plastic trash.

Karthik and Mangala (2021) Analyse the behaviour of concrete mixtures by substituting waste plastic for coarse aggregates.In place of natural coarse particles in M20 mix concrete, this study suggests using waste plastics, namely high density polyethylene (HDPE), low density polyethylene (LDPE), and polypropylene ethylene (PPE). Examining specimens made by substituting recycled waste plastic coarse aggregates (RPCA) produced through a semi- mechanized process with a conventional mix, the study examined the plastic aggregates' behaviour at high temperatures as well as their workability, compressive strength, flexural strength, and split tensile strength. Using HDPE, LDPE, and PPE plastic wastes, three distinct sets of plastic aggregates were created. It was shown that the workability of concrete mixtures decreased as the percentage of plastic waste aggregates increased. Because of the weak Interfacial Transition Zone (ITZ) between the plastic aggregates and paste, the compressive and flexural strengths were lowered. Because of its aggregate characteristic, the inclusion of waste plastic aggregates boosted the tensile strength. Concrete specimens exposed to higher temperatures exhibited favourable behaviour in terms of strength measures. It is possible to replace 10%–20% of RPCA without compromising durability and strength standards.

Ijaz and Ansari (2022) lightweight concrete from the standpoint of environmentally friendly recycling of waste materials. Effective alternatives to traditional waste management programmes are needed since they present a number of environmental, social, and economic issues. In addition to requiring enhanced qualities of concrete with low density, the manufacture of concrete requires a significant quantity of natural resources, which has an adverse effect on the environment. As a result, the concept of lightweight concrete, or LWC, has become more well- known. LWC offers a plethora of opportunities for the practical use of waste byproducts from its diverse industries, making it a viable option for sustainable waste management. Numerous waste byproducts have been extensively studied for their potential applications in LWC as aggregate, cementing agent, admixture, and combinations thereof. This study examines the present state of research on the utilisation of waste byproducts from different sectors in LWC, as well as any gaps, difficulties, and solutions. Waste byproducts can be used in LWC for a variety of purposes, including material, admixture, or both. The acceptability of using any waste material in LWC can be determined based on these regulating variables. The study dimensions that require more focus, despite the great number of conducted studies, include characterisation of more waste material for use in LWC, assessment and mitigation of harmful impacts of waste byproducts in LWC, durability, and life cycle assessment of waste-based LWC. The purpose of this study is to assist related scholars and practitioners in the building, waste management, and sustainable development domains.

Paul and Jahidul (2022) A comparative analysis of concrete using waste plastic polypropylene and polyethylene terephthalate in place of certain coarse aggregate. Over the past 60 years, there has been a tremendous increase in the production of plastic worldwide, with 10% of that plastic ending up as solid trash. If suitable recovery techniques are not used, this plastic represents a threat to the environment. Another method of recycling this waste plastic is to mix it with concrete. Two of the most often used plastics that are rarely recovered and recycled are polypropylene (PP) and polyethylene terephthalate (PET). Consequently, 10%, 20%, and 30% by volume of coarse aggregate are replaced with PP and PET in the current study. Three different water-to-cement ratios (0.42, 0.48, and 0.57) are compared for these concretes. Comparable

characteristics include density, workability, compressive, and tensile strengths. Compared to brick aggregate concrete, concrete containing PP aggregate has demonstrated up to 39% stronger compressive strength and 9% lower density. Conversely, compared to the reference concrete, concrete containing PET aggregate showed a 53% decrease in compressive strength. It also exhibits decreased density and better workability. Relationships between the splitting tensile and compressive strengths of concrete are described using equations, together with the impact of the proportion of plastic aggregate.

According to a cost estimate, using waste plastic in concrete has a higher cost than using standard brick aggregate concrete. However, up to 10%, PP may considering the gain in compressive strength.

Lamba and Kaur (2022) Scientists and researchers are searching for creative and sustainable ways to reuse or recycle plastic garbage in order to lessen its detrimental effects on the environment, as a result of the exponential increase in plastic production and the ensuing spike in plastic waste. Among the industries where waste plastic is showing promise are construction material, household items, clothes, fabric, and fuel conversion. Of these, the construction material that has been altered to include plastic trash has attracted the most interest. There are two benefits to modifying building materials with plastic trash. By decreasing the quantity of plastic trash that ends up in litter or landfills, as well as the amount of mined materials used in building, it helps to mitigate the damaging effects of the construction industry on the environment. This essay provides an overview of the advancements made in the field of using plastic waste as a building material. A thorough analysis has been conducted on the use of plastic waste as a binder, aggregate, fine aggregate, modifier, or replacement for cement and sand in the production of bricks, tiles, concrete, and roadways. Additionally, a lot of discussion has been had regarding the impact of adding plastic trash on durability, water absorption, strength qualities, etc. The research works that were taken into consideration for this evaluation were divided into groups according to whether or not they addressed the usage of plastic waste in concrete for building roads or in bricks and tiles..

III. METHODOLOGY

Specific gravity of cement = 3.15

Specific gravity :-

(a) Coarse aggregate = 2.766

(b) Fine Aggregate = 2.513

(c) Burnt brick = 2.17

Water absorption :-

(d) Coarse aggregate = 0.60%

(e) Fine Aggregate = 2.75%

(f) Burnt brick = 4.4%

Moisture Content :-

(g) Coarse aggregate = 0.148%

(h) Fine Aggregate = 1.297%

(i) Burnt brick = Nil

Grading of aggregate:-

(j) Fine aggregates = Zone I

DESIGN

Target Mean Strength Of Concrete :-

$F_{ck} = f_{ck}$ +t.s

Where, F_{ck} = characteristics compressive strength at 28 days t= statistical constant

s = standard deviation F_{ck} = 20+ (1.65 x 4)

F_{ck} = 26.6 MPa

Selection Of W/C Ratio :-

(a) As required for target mean strength= 0.50

(b) As required for 'Mild' Exposure = 0.55

Hence , **Assume W/C ratio = 0.50** for design

Determination Of Water & Sand Content :-

For W/C = 0.6

Compaction factor = 0.8

Maximum size of aggregate = 20 mm

a) Water content =186 kg/cum

b) Sand as percentage of total aggregate by absolute volume = 35%

Table 1. Adjustment required in Preparation

Sr. No.	Change in condition	Adjustment (in%) required in	
		Water content	Sand content
i)	Fine aggregates conforming to Zone I	0	+1.5
ii)	For increase in CF (0.9-0.8) i.e. 0.10	+3	0
iii)	For decrease in W/C ratio by 0.10 (0.60-0.50)	0	-2
iv)	For rounded aggregates	NA	NA
Total Adjustments		+3	-0.5

Thus ,

Net water content = 191.6 Kg/m^3 Net sand percentage = 34.5%

Determination of Cement Content:-

W/C ratio = 0.5

Water content = 191.6 Kg/ m^3 Thus, cement content = 383 Kg/ m^3

This cement content is adequate for 'mild' exposure condition i.e. greater than minimum cement content of 300 Kg.

Determination Oof Coarse and Fine Aggregate Content:-

Entrapped Air = 2%

V = [W+ C/Sc + 1.Fa/P.Sfa] x 1/1000

V = [W+ C/Sc + 1.Ca/(1-P).Sca] x 1/1000

Where,

V = absolute volume of concrete

= [Gross volume (1m^3) – the volume of entrapped air] Sc = Specific gravity of cement

M = Mass of water per cubic meter of concrete , kg C = mass of cement per cubic meter of concrete, kg

P = ratio of fine aggregate to total aggregate by absolute volume

Fa , Ca = Total masses of fine and coarse aggregate , per cubic meter of concrete , respectively , kg , and

Sfa, Sca = Specific gravities of saturated surface dry fine and coarse aggregates , Respectively

Thus,

0.98 cum = [191.6 +383/3.15 +{1/0.345}*{Fa/2.513}]/1000]

&

0.98 cum = [191.6 +383/3.15 +{1/0.65}*{Ca/2.76}]/1000]

Hence, Fa = 577.46 Kg/cum

Ca = 1170 Kg/cum

Table 2. Final Mix Proportions Of M-20 Grade of Concrete

Water	**Cement**	**FA**	**CA**
191.6	383 Kg	577.46 Kg	1170 Kg
0.50	1	1.507	3.05

ESTIMATION OF QUANTITIES

Required cubes & beams specimen:-

- Size of cube :- 150mmx150mmx150mm
- Size of beam:- 700mmx150mmx150mm

Table 3. Required cubes & beams specimen

Type	NO. of Cubes	NO. Of Beams
Normal	3	3
4% PET bottles + 25% Burnt Brick(BB) (below neutral axis of beams)	3	3
4% PET bottles + 50% Burnt Brick(BB)(below neutral axis of beams)	3	3
4% PET bottles + 75% Burnt Brick(BB) (below neutral axis of beams)	3	3

Grade of concrete M20 (1:1.5:3) Density of concrete: - 2400 kg/m^3

Volume of 1 cube: - 150mmx150mmx150mm = 3.375 x 10^{-3} m^3

Hence,

Weight of concrete = 3.375 x 10^{-3} m^3 x 2400 kg/m^3

= 8.1 kg.

Let weight of Cement = x kg Hence ,

x+1.5x+3x = 8.1

x= 1.472 kg

Table 4. Quantities required for 3 cubes

Type	Cement (Kg)	Sand (Kg)	Coarse Aggregate (Kg)	Pet Bottles (Kg)	Burnt Brick (Kg)
Normal	4.416	6.624	13.25	-	-
4% PET bottles + 25% Burnt Brick(BB)	4.416	6.359	9.937	0.264	3.31
4% PET bottles + 50% Burnt Brick(BB)	4.416	6.359	6.625	0.264	6.625
4% PET bottles + 75% Burnt Brick(BB)	4.416	6.359	3.31	0.264	9.937
TOTAL	17.664	25.70	33.122	0.792	19.872

IV. Conclusion

Based on the above study following conclusions can be made:

For Beams

- On The Basis Of Load Carrying Capacity:-
- Normal Beams:-When tested for flexure all three specimens failed in bending.
- With 25% Replacement:- The beam with 25% replacement shows 16.1% decrease in the average load w.r.t. the normal beam.
- With 50% Replacement:- The beam with 50% replacement shows 34.2% decrease in the average load w.r.t. the normal beam.
- With 75% Replacement:- The beam with 75% replacement shows 54.4% decrease in the average load w.r.t. the normal beam. Hence, it is not advisable to use beam with 75% replacement .

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