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UTILIZATION OF WASTE PLASTIC IN CONCRETE

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Abstract: *India industrial activities related to huge amounts of solid, non-biodegradable waste, waste low density polyethylene (L.D.P.E) plastic being among the well-known. Also high density polythene (H.D.P.E) is added to increase rigidity and durability of the sample concrete. So in this study, the scraped LDPE and HDPE food boxes, plastic begs etc were transformed into fine particles and used as a sand in concrete. These wastes were utilized to alter 5% of fine aggregates in concrete mixture. In this experimental investigation compressive strength and tensile strength of prepared sample is were tested for concrete specimens. Here results shows that compressive strength of concrete sample has small reduction by addition of plastic waste, whereas increment in tensile strength is observed in samples with plastic waste . The survey says only 25% of the waste plastic is recycle and the rest ends up in the landfills, ocean etc. polluting the environment to and adverse extent. Improper disposal of plastic leads to release of hazardous chemicals gases affects human health causing impaired immunity, infertility and may cause asthma. The main motive of this proposed study is to reduce environmental pollution by recycling the waste low & high density polythene waste. In this study these wastes are recycled and used as total replacement for cement concrete blocks. There will be no economic problems as waste plastic is used. Compressive strength, Tensile strength and water absorption and environmental factors has been found out for the results to avoid the effect bon environment. The results of the paper shows that LDPE and HDPE plastic can be recycled which helps to reduce the environmental pollution and carries socioeconomic factors. As the result of this study shows less strength when compared to concrete paver blocks, it can be used light weight structure, where low loads are applied. This study can also be helpful for jobless to start a manufacturing unit.*

Keywords: *Concrete addictive, design mix, plastic waste, HDPE, environmental factors, pollution.*

1. Introduction

With the increase in industrialization and urbanization plastic has placed its footprint in all aspects of life. Plastic being used in electrical appliances, household materials, for packaging, as insulators, automobiles, electronic appliances, furniture and also building appliances like piping and plumbing equipment, as a result plastic has become an unavoidable thing in this world. But only 25% of the waste plastic is recycled and the rest of 75% ends up in the landfills, oceans etc polluting the environment to an adverse extent. Improper disposal of plastic leads to release of hazardous chemical gases affects human health causing impaired immunity, infertility and may cause asthma. Plastic also harms birds and animal habitat. Hence these materials must be rightly disposed of or economically recycled. Some of these waste materials may be used in construction activities. The usage of industrial leftover materials for construction reduces the consumption of natural resources, and formulates an economical disposal method for the waste material as well (Aliyu usman 2018). Plastics can be

majorly classified into two different types based on their density namely high density polyethylene and low density polyethylene. Both HDPE and LDPE can be shredded to dust and granular form and added to replace fine aggregate of concrete.

LDPE AND HDPE

Polyethylene is one of the most widely used thermoplastics in the world and can be found in everything from grocery bags to children's toys to shampoo bottles. It can be categorized into several subcategories based on its molecular structure, each of which demonstrates unique characteristics that make it suitable for use in particular applications. The most common types of polyethylene are

Low density polyethylene (LDPE). This clear or translucent plastic exhibits flexibility, chemical resistance, and waterproofing capabilities. It is used in the manufacture of a wide range of products, including grocery bags, plastic wrap and film, flexible packaging material, and injection molded parts. LDPE is used to make many thin, flexible products like plastic bags for dry-cleaning, newspapers, bread, frozen foods.

Fig 1 LDPE plastic bags

High density polyethylene (HDPE)

HDPE offers greater rigidity and durability than LDPE. It is available in translucent to opaque variation and displays excellent chemical resistance. Products made from HDPE include rigid packaging containers, toys, outdoor furniture and structures, kitchen equipment, and plumbing pipes. HDPE is known for its high strength-todensity ratio The density of HDPE can range from 930 to 970 kg/m. Although the density of HDPE is only marginally higher than that of low-density polyethylene HDPE has little branching, giving it stronger intermolecular forces and tensile strength than LDPE.

2. Literature Review

Ibrahim Almeshal et al. (2020), the study aimed to investigate the effects of utilising poly-ethylene terephthalate (PET) as a partial substitute for sand in concrete. The effects of this material on the physical and mechanical properties of concrete were examined. Result concluded the approach reduces the self-weight of concrete in structures and helps conserve natural resources such as sand. Although the mechanical properties of concrete decreased by increasing the replacement ratio of PET and plastic had a negative effect on the fire resistance of concrete, plastic particles can be encapsulated from other materials and produce environmentally safe concrete. **Ibrahim Almeshal et al. (2020),**the study aimed to investigate the effects of utilising poly-ethylene terephthalate (PET) as a partial substitute for sand in concrete. The effects of this material on the physical and mechanical properties of concrete were examined. Result concluded the approach reduces the self-weight of concrete in structures and helps conserve natural resources such as sand. Although the mechanical properties of concrete decreased by increasing the replacement ratio of PET and plastic had a negative effect on the fire resistance of concrete, plastic particles can be encapsulated from other materials and produce environmentally safe concrete.

3. Objectives of the study

This project is to formulate a procedure to use conventional concrete materials with recycled waste plastic dust. The main objectives of this experimental study are:

- To investigate whether recycled waste plastic dust can be used in concrete.
- To test the hardened properties of concrete with the waste plastic dust.
- To find which kind of plastic (low density polyethylene, high density polyethylene) is efficient. To test the 7,14,21,28 days of strength of 5% replaced waste plastic dust as fine aggregate replacement. If plastic can be used as a fine aggregate replacement, determining whether high density polyethylene (HDPE) or low density polyethylene (LDPE) is efficient.

The objectives of this study are itemized as follows:

i. Highlight the various classifications of lightweight aggregate (LWA) and other aggregates found in literature.
ii. Highlight the various classifications of concrete.
iii. Classify the pulverized LDPE into the appropriate classification.
iv. Evaluate the use of pulverized LDPE plastic wastes in concrete as an alternative solid waste management option viz a viz results obtained for normal compressive strength (CS).

4. Materials used in the study

Cement

Ordinary Portland Cement (53 Grade) confirming to IS: 269-1976 was used throughout the investigation. Different tests were performed on the cement to ensure that it confirms to the requirements of the IS specifications. The physical properties of the cement were determined as per IS: 4031-1968 and are presented in Table: 1

Table 1 Physical properties of Cement

Physical Properties of 53 Grade Cement	
Characteristics	**Values**
Standard Consistency	53
Fineness of cement as retained on 90 micron sieve	3%
Initial Setting Time	30 mins
Specific Gravity	3.15
7 days compressive strength	37 Mpa

Coarse Aggregate

Locally available coarse aggregate having the maximum size of 20 mm down size and confirming to Table 2 of IS 383 are used in the present work. The specific gravity of coarse aggregate is found to be 2.64. The water absorption test on coarse aggregate is found to be 0.4%.

Fine Aggregate

The sand used for the experimental program is locally available river sand and passing through 4.75mm sieve as per IS 383 provision. The specific gravity of fine aggregate is found to be 2.62. The water absorption test on fine aggregate is found to be 1.0%

Waste plastic dust

In this study waste plastic dust has been used as a partial replacement of fine aggregate which is in the form of HDPE crushed and LDPE granules having fineness modulus of 2.3. Recycled HDPE and LDPE. Specific gravity 0.76, 4.75mm sieve, angular shape, density of LDPE 903 kg/m^3.density of HDPE 970 kg/m^3.

fig 2: Waste plastic dust

5. Methodology

In this experimental work, the concrete mix having characteristic compressive strength of 21N/MM^2 has been tested with varying percentage of HDPE and LDPE ranging from 0% to 5% The tensile and compressive strength of plastic concrete were investigated. The methodology followed in the current research is given as flow chart in figure 3.

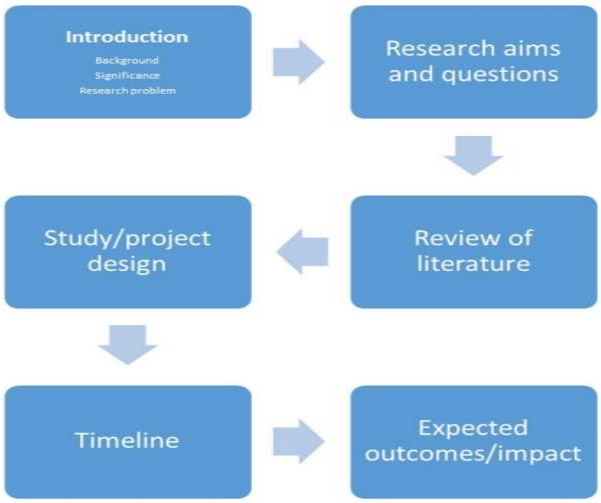

Fig 3 Research methodology

Compressive strength:

Compressive strength or compression strength is the capacity of a material or structure to withstand loads tending to reduce size, as opposed to Tensile strength which withstands loads tending to elongate. In other words, compressive strength resists being pushed together, whereas tensile strength resists tension (being pulled apart). In the study of strength of materials, tensile strength, compressive strength, and shear strength can be analyzed independently. Some materials fracture at their compressive strength limit; others deform irreversibly, so a given amount of deformation may be considered as the limit for compressive load. Compressive strength is a key value for design of structures. Compressive strength is often measured on a universal testing machine. Measurements of compressive strength are affected by the specific test method and conditions of measurement. Compressive strengths are usually reported in relation to a specific technical standard.

CALCULATION OF COMPRESSIVE STRENGTH

Three cubes (150 X 150 150mm) with 0%, 5% HDPE and 5% LDPE as fine aggregate of each mix were casted to check the compressive strength on 7th, 14th, 21st, and 28th day. The compressive strength on 28th day for conventional mix (0% plastic and 100% sand was 20N/mm2). For 5% replacement of HDPE the compressive strength was 19.5N/mm2. And for 5% LDPE the compressive strength was 19.69N/mm2. Compressive strength of 5% replaced HDPE and LDPE concrete showed a decrease in strength. When comparing LDPE and HDPE, the LDPE contributed to more strength. The reduction in the compressive strength may be due to the improper bonding of plastic granules. This is due to the lack of adhesion between plastic and cement. After curing the cubes for 28 days period, they were uncovered in readiness for compression test. The cube were then placed with the cast faces in contact with the platens of the testing machine that is the position of the cube when testing should be at right angle to that of casting. The load was then gradually applied until failure occurred, that is the cube crashed. It is seen from the Tables that the compressive strength is increased by 26% of 10% replacement. It is well established that addition of glass waste fibres contributes up to 10% replacement and do not contribute much to improvements in the compressive strength beyond 15% replacement of concrete. The results of the present study also indicate the same.

6. Results

Table 1 Compressive strength test result

Compressive strength of concrete (N/mm2)				
% Replacement	**7 th**	**14th**	**21st**	**28th**
0%	15. 6	17.32	19.76	21
5%HDPE	13.11	15.22	18.56	19.56
5%LDPE	13.23	15.66	18.76	19.89

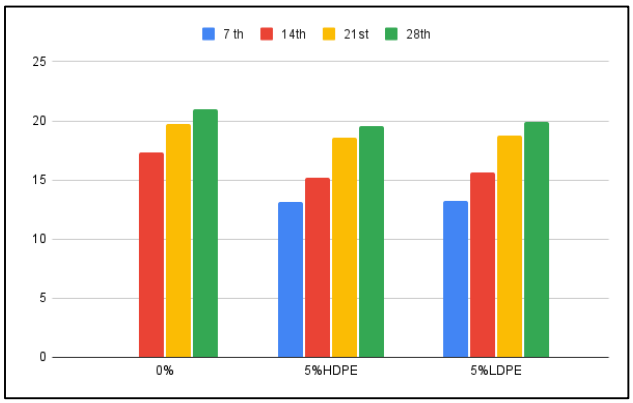

Fig 4 Comparison of Compressive Strength of Concrete for Different curing periods

Tensile strength

The tensile strength is on the basis of thread connection strength and includes yield strength, rupture strength, and slippage strength. Once the casing has been run in the well, it is no longer taken out; thus the tensile strength of the casing is calculated on the basis of the ultimate tensile strength of the material. However, tubing needs to be run in and pulled out many times; thus the tensile strength of tubing is calculated on the basis of the yield strength of the material, that is, only tubing thread yield strength is considered when the tensile strength of tubing is calculated. When trapezoidal thread is adopted, only the tensile strength of external thread or collar is considered. The weaker one between them is listed in the strength table.

Factors Affecting Tensile Strength Concrete

- Quality of Raw Materials – Cement, Sand & Aggregate.
- Water Cement ratio
- Coarse to fine aggregate ratio
- Aggregate cement ratio
- Age of concrete
- Compaction of concrete
- Temperature
- Relative humidity
- Curing

Table 2 : Split tensile strength test result

% Replacement	Tensile strength (28th day) Mpa
0%	3.15
5% HDPE	3.31
5% LDPE	3.19

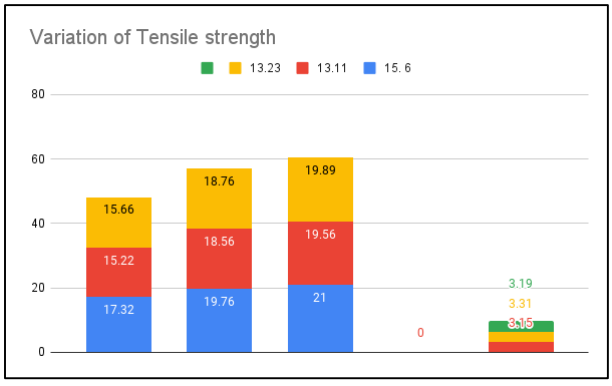

Fig 5 Results of Split tensile Strength test

7. Conclusion and Future Scope

i. It is determined that there is reduction in the compressive strength of plastic concrete. But LDPE showed higher results than HDPE which is almost equal to the conventional concrete.
ii. The overall cost of the mix is reduced and also serves as a purpose to utilize the waste plastic that decreases the land pollution.
iii. The tensile strength of the concrete increases with addition of plastic granules. HDPE & LDPE works as an fiber to increase the tensile strength of concrete .
iv. Finally the research reveals that, the plastic concrete does not increase the compressive strength, hence it cannot be used for load bearing structures, it can be for pavements, lightweight concrete structures, partition walls etc.

The e-waste can be disposed of effectively. Makes the concrete light weight and therefore reduces the weight of the structure. Allows it robust so that seismic loads can comfortably carry. The burden on natural capital is rising It reduces the risk of damaging e-waste materials.

Future Scope

In this study addition of plastic waste is limited to 5% whereas in future hiugher percentage can be added and investigation can be proceed. In this study no fiber is added as an admixture whereas in future any admixture can be introduced to improve its physical and mechanical properties.

In this study only plastic waste is introduced whereas in future electronic wastes like chip boards, mother boards can also be introduced.

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