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A Review Study of Strength Analysis of Concrete by Using Waste Plastic in Concrete

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Abstract- There is no doubt concrete is most useful thing in construction industry but it has a negative impact also, just like a coin has two faces. Raw materials used in manufacturing of concrete affect the environment in one or another negative way. Like manufacturing of cement produce carbon dioxide whereas the production of aggregates adds dust to the environment. Production of coarse aggregates also impact the geology of the area from they were extracted. A step taken in this direction is the use of waste products along with or in replacement of cement. Many of these materials are already in use, like silica fume, fly ash etc. In recent time use of such, Industrial wastes from polypropylene (PP) and polyethylene terephthalate (PET) were studied as alternative replacements of a part of the conventional aggregates of concrete. Plastic recycling was taking place on a significant scale in an India. As much as 60 % of both industrial and urban plastic waste is recycled which obtained from various sources. People in India have released plastic wastes on large scale have huge economic value, as a result of this, recycling of waste plastics plays a major role in providing employment.

Keywords: - Concrete, Plastic waste, strength, recycle waste, aggregates.

I. INTRODUCTION

The compressive strength of hardened concrete which is generally considered to be an index of its other properties, depends upon many factors, e.g. quality and quantity of cement, water and aggregates; batching and mixing; placing, compaction and curing. The cost of concrete is made up of the cost of materials, plant and labour. The variations in the cost of materials arise from the fact that the cement is several times costly than the aggregate, thus the aim is to produce as lean a mix as possible.

From technical point of view the rich mixes may lead to high shrinkage and cracking in the structural concrete, and to evolution of high heat of hydration in mass concrete which may cause cracking, the productive use of waste material represents a means of alleviating some of the problems of solid waste management. The reuse of wastes are important from different points of view. It helps to save and sustain natural resources that are not replenished, it decreases the pollution of the environment and it also helps to save and recycle energy production processes. Wastes and industrial by-products should be considered as potentially valuable resources merely awaiting appropriate treatment and application.

Plastic wastes are among these wastes, their disposal has harmful effects on the environment due to their long biodegradation period, and therefore one of the logical methods for reduction of their negative effects is the application of these materials in other industries. Concrete plays an important role in the beneficial use of these materials in construction.

Although some of these materials can be beneficially incorporated in concrete, both as part of the cementitious binder phase or as aggregates, it is important to realize that not all waste materials are suitable for such use. Concrete contains numerous flaws and micro cracks.

The rapid propagation of micro cracks under an applied load is considered responsible for the low tensile strength of concrete. It is reasonable to assume that the tensile strength as well as the flexural strength of concrete can be substantially increased by introducing closely spaced fibers. These fibers would arrest the propagation of micro cracks, thus delaying the onset of tensile cracks and increasing the tensile strength of the material. Plastic needs no introduction as it is the widely used material now days on our Earth. Due to its properties like strength, durability and easy processing it can be used for many purposes.

Studies show that plastic is nearly inert that is it get very less affected by the chemicals and have higher durability. Disposal of plastic waste is a huge problem as due to absence of organic compounds; it is no decomposable material and proves to be a threat to our environment as it has many health hazards. As decomposition of plastic is a serious problem as it takes very long time and adversely affection the environment in many ways. So, we can use it in construction, where we need life of structure to be improved and use of waste plastic after small processing can help us to reduce the waste in the environment which is new motto of civil engineering.

II. POLYMERS IN CONCRETE

Concrete is a versatile material with the ability to get cast in any form and shape. Nonetheless the properties of concrete can be changed by adding some special natural or artificial ingredients. Concrete has advantages including good compressive strength, durability, permeability, specific gravity and fire resistance.

However, it is weak in tension, brittle, low resistant to cracking, lower impact strength, heavy weight, etc, but some remedial measures can be taken to minimize these limiting properties of concrete. Research concerning the use of waste products to augment the properties of concrete has been going on for many years and in the recent decades, efforts have been made to use industry waste products such as foundry sand, glass cullet, polyethylene terephthalate, high density polyethylene (HDPE), un plasticized polyvinyl chloride (UPVC) plasticized polyvinyl chloride (PPVC), low density polyethylene (LDPE), polypropylene (PP), polystyrene (PS) expanded polystyrene (UPS).

1. Plastics:

The word “plastic” means substances which have plasticity, and accordingly, anything that is formed in a soft state and used in a solid state can be called a plastic. Therefore, the origin of plastic forming can be traced back to the processing methods of natural high polymers such as a lacquer, shellac, amber, horns, tusks, tortoiseshell, as well as inorganic substances such as clay, glass and metals. Because the natural high polymer materials are not uniform in quality and lack mass productivity in many cases, from early times it has been demanded in particular to process them easily and into better quality and to substitute artificial materials for natural high polymers. Celluloid, synthetic rubber, Ebonite, and rayon are these artificial materials. Presently, it is defined that the plastics are synthesized high polymers which have plasticity, and consequently substances made of these natural materials are precluded.

Plastics can be separated into two types. The first type is thermoplastic, which can be melted for recycling in the plastic industry. These plastics are polyethylene, polypropylene, polyamide, polyoxymethylene, polytetrafluorethylene, and polyethylene terephthalate. The second type is thermosetting plastic. This plastic cannot be melted by heating because the molecular chains are bonded firmly with meshed Crosslink. These plastic types are known as phenolic, melamine, unsaturated polyester, epoxy resin, silicone, and polyurethane.

At present, these plastic wastes are disposed by either burning or buying. However, these processes are costly. If the thermosetting plastic waste can be reused, the pollution that is caused by the burning process as well as the cost of these waste management processes can be reduced. To achieve this purpose, a study of these thermosetting plastics for application into construction materials has been conducted, particularly for the concrete wall in buildings. In Thailand, lightweight concrete is extensively used for the construction of interior and exterior walls of buildings for the case where the walls are not designed for lateral loads. This is due to the special characteristics of lightweight concrete (panyakapo, 2007).

2. Plastic Aggregates:

The quantity of plastics consumed annually all over the world has been growing phenomenally. Its exceptionally user-friendly characteristics/features, unique flexibility, coupled with immense cost-effectiveness and longevity are the main reasons for such astronomical growth.

Besides its wide use in packaging, automotive and industrial applications, plastics are also extensively used in medical delivery systems, artificial implants and other healthcare applications, water desalination and bacteria removal, preservation and distribution of food, housing appliances, communication and the electronics industry, etc. the uses of plastics and recycled plastics.

The types of recycled plastics are shown in tabular form in Table 1.

Table 1. Types of recycled plastics (Nabajyoti and Brito 2012).

S.No	Name of Plastic	Description	Range of product	Use of plastic made from Recycled Waste Plastic
1	Polyethylenetere phthalate	Clear tough plastic	Soft drink & mineral water bottles	Soft drink bottles; detergent bottles; clear packaging film; fleecy jackets; carpet fibers
2	High density polyethylene (HDPE)	Usually, white or colored. Very common plastic	Milk, cream, shampoo and cleaner bottles; milk crates; freezer bags.	Compost bins; Mobile garbage bins; agricultural pipes
3	Un plasticized polyvinyl chloride (UPVC) Plasticized polyvinyl chloride (PPVC)	Hard rigid plastic may be clear. Flexible clear elastic plastic	Clear cordial & juice bottles: plumbing fittings Garden hoses, shoe soles.	Detergent bottles; hoses; tiles; plumbing pipes & fittings.
4	Low density polyethylene (LDPE)	Soft, flexible plastic	Garbage bags, black plastic sheet; ice cream Container lids.	Film & bags for building and packaging.
5	Polypropylene (PP)	Hard but flexible plastic	Ice-cream containers, drinking straws potato crisp bags.	Compost bins; Kerbside recycling crates.
6	Polystyrene (PS) Expanded polystyrene (UPS)	Rigid, brittle plastic. May be	Yoghurt containers; plastic	Clothes pegs, coat hangers, video &

		clear or glassy.	cutlery. Hot drink cups; meat trays; packaging.	CD boxes.

III. LITERATURE REVIEW

Availability of raw material is very less due to higher use of concrete. Normal practice of concreting is batching of all raw materials, mixing (all raw materials), transporting, compaction at site, finishing and curing is followed by industry. In developed country like India use of concrete is higher quantity and availability of raw material is very less.

Total replacement of concrete is not possible due to no material plays the role of concrete in terms of strength, durability, and workability. We have to partial replace all the material to achieve desire properties of concrete in terms of workability, strength and durability. This paper includes survey of different waste material used in the concrete from this survey we can understand the effect of different waste materials on the properties of concrete.

Atul Uniyal et. al. (2019) studied about ceramic waste used in partial replacement in concrete with cement. This study was carried to obtain the results, test conducted on the tile powder modified cement concrete mix, in order to ascertain the influence of tile powder on the characteristic strength of concrete. The most optimal dosage for the partial alternative of cement by ceramic tile powder is 15 %.

The compressive strength of concrete decreases, when the addition of dosage is more than 15%. The results show if 20% replacement of cement by ceramic tile powder will affect the strength of concrete. Utilization of tile powder and its application for the sustainable development of the construction industry is the most efficient solution and also address the high value application of such waste. By using the replacement materials offers cost.

Azad Khajuria et. al. [2019] In this study, plastic coarse aggregates was used in place of natural coarse aggregates. Plastic aggregates were produced by little processing of waste plastic. Plastic is the biggest threat to the environment, and it is affecting the environment rapidly. Some recent studies show that it can be used construction industry due to some of its properties like inert behaviour, resistance to degradation etc. Also use of waste plastic can help in reducing plastic waste various experiments was performed to test the mechanical properties of the concrete with plastic coarse aggregates. Concrete was prepared using plastic coarse aggregates in varying proportions of 0, 2.5, 5, 7.5 and 10%. Plastic was added to concrete in replacement of coarse aggregates by proportion of 0, 2.5, 5, 7.5 and 10%. On the basis of the results from the present study. It was observed while experiment that the compressive strength of concrete initially increases at 2.5% PCA but further addition of PCA shows reduction in strength.

Jagadeesh Bommisetty et. al. (2019) the crushed waste ceramic tiles were used in concrete as a replacement for natural coarse aggregates with 0%, 5%, 10%, 15% 20% and 25% of substitution. After analyzing results, the optimum value of waste ceramic tile to be used within the concrete mix with a water/cement ratio of 0.5 was determined as about 20%. The findings revealed that using waste ceramic tile lead to enhancing the properties of concrete. The optimum compressive strength of concrete is obtained at 20% replacement and the value is 35.55 N/mm2 which is 10.09% more than that of conventional concrete. The optimum Flexural strength of concrete is obtained at 20% replacement and the value is 5.43 N/mm2which is 8.27% more than that of conventional concrete.

Jagdish D. kalapad et. al. (2019) This paper deals with experimental investigations to evaluate the optimum percentage of waste paper pulp to be used for making concrete. The M25 grades of concrete were used in this study. Three different replacement level of cement with waste paper pulp i.e. 5, 10, and 15% were used and PPC concrete of 0% cement replacement level was also made for comparison. Compressive test strength of concrete was tested at a curing age of 7 and 28 days.

Overall result reveals that use of paper pulp as partial replacement of cement can improve the strength of lower grade concrete up to 20% replacement level. Use of waste paper pulp as partial replacement of cement also markedly reduces the cost of construction which otherwise been dumped making environmental hazard.

Mohammad hosseini et. al. (2019) In this study, the strength and durability properties of a mortar comprising ceramic waste powder as supplementary cementing material and ceramic particles were investigated. Properties studied include workability, compressive and tensile strengths, chloride and sulfate resistance. The effect of waste ceramic was also assessed by using scanning electron microscopy and X-ray diffraction analysis.

It was observed that the utilization of waste ceramic in both forms of binder and fine aggregate significantly improved the compressive and splitting tensile strengths and higher resistance against chloride and sulfate attacks. The microstructure of the mortar was further enhanced by replacing ceramic waste powder and fine aggregates. It, therefore, caused in the higher crystalline formation and reduction in porosity and cracks in addition to eliminating the spalling behaviour of mortar specimens exposed to chloride and sulfate attacks. The pozzolanic effect of ceramic powder in mortar considerably increases the level of sulfate resistance. It was noted that ceramic mortar exhibited lower mass loss and compressive strength loss in comparison with the OPC mortar.

Amalu R.G et al. [2016] involved 86 experiments and 254 tests to determine the efficiency of reusing waste plastic in the production of concrete. Thirty kilograms of waste plastic of fabiform shapes was used as a partial replacement for sand by 0%, 10%, 15%, and 20% with 800 kg of concrete mixtures. All of the concrete mixtures were tested at room temperature. These tests include performing slump, fresh density, dry density, compressive strength, flexural strength, and toughness indices. Seventy cubes were molded for compressive strength and dry density tests, and 54 prisms were cast for flexural strength and toughness indices tests. Curing ages of 3, 7, 14, and 28 days for the concrete mixtures were applied in this work. The results proved the arrest of the propagation of micro cracks by introducing waste plastic of fabriform shapes to concrete mixtures. This study insures that reusing waste plastic as a sand-substitution aggregate in concrete gives a good approach to reduce the cost of materials and solve some of the solid waste problems posed by plastics.

M Mahesh et. al. [2016] investigated the possibility of using the waste polyethylene as partial replacement of fine or coarse aggregate in concrete. Concrete with 2%, 4%, 6% pulverized/non pulverized polyethylene material is prepared after doing the mix design. Various tests on cement like specific gravity, fineness, setting time, etc., tests on coarse and fine aggregates like sieve analysis, fineness modulus, specific gravity, etc. are performed.

Mix design using IS Code method is done and cubes and cylinders are cast for M25 grade concrete with and without plastics and tests on concrete like slump, cube tests and cylinder tests are performed to understand their behaviour and usefulness as replacement. The standard mechanical properties of concrete like compressive strength, split tensile strength are tested and compared with the results of standard specimen.

Manhal A Jibrael et. al. [2016] investigated the strength and behaviour of concrete contains waste plastic. Studied the strength of concrete by the addition of percentages recycled waste plastic (polyethylene). Almost 126 samples of concrete are prepared, the concrete Strength (compressive, splitting tensile and flexural strength) are investigated along a time interval of 7 to 28 days using 1%, 3% and 5% from fine aggregate recycled waste plastic (polyethylene). It is found that when waste plastic bottles increased from zero to 5% of the sand in the mix, the compressive, tensile and flexural strength of concrete decreased by the ratios of 12.81, 10.71, and increase by 4.1% respectively at 7 days age and also these concrete strengths decrease by the ratios 7.93, 28.6, and 23.6% at 28 days age.

Mansi jain et al. [2016] evaluated the impact on the mechanical functions of concrete by using of polypropylene (PP) particles in concrete. Poly propylene waste employed in a various type of construction applications in which disposal cup is one of them. Waste plastic disposal cup is a major reason of solid waste disposal and difficult to reuse and recycle and plastic if burnt releases many harmful gases, which are dangerous for human health, but if we use waste polypropylene particles in concrete then there is no need of recycle and can be used in huge amount without any harmful effect. It's also cumbersome to biodegradation. On the other side construction organization is in the use of cost effective, material for making high quality strength of concrete structure. PP particles are added at the concrete with 1%, 2%, 3% & 4% of fine aggregates and compared with control mix.

In this study experimental work was using M25 mix. Then analyze the difference between values of results with conventional concrete. Using of waste plastic particles protect natural resources and also reduce the dead load of a building as a result of its low unit weight.

Parvesh Kumar et al. [2015] investigate the change in mechanical properties of concrete with the addition of plastics in concrete. Along with the mechanical properties, a thermal characteristic of the resultant concrete is also studied. It is found that the use of plastic aggregates results in the formation of lightweight concrete.

The compressive, as well as tensile strength of concrete reduces with the introduction of plastics. The most important change brought about by the use of plastics is that the thermal conductivity of concrete is reduced by using plastics in concrete. Therefore, it can be said that recycled plastics can be used for thermal insulation of buildings.

P. S. Kothai et. al. (2014) This work relates the use of steel slag, a waste cheap material used as fine aggregates in M20 grade of concrete and recommends the approval of the material for use in concrete as a replacement material for fine aggregates. The partial substitution of natural aggregates with steel slag aggregates permits a gain of compressive, tensile and flexural strength and modulus of elasticity of concrete up to an optimum value of replacement. Slag is a by-product of metal smelting and hundreds of tons of it are produced every year all over the world in the process of refining metals and making alloys. Like other industrial byproducts, slag actually has many uses, and rarely goes to waste. It appears in concrete, aggregate road materials, as ballast, and is sometimes used as a component of phosphate fertilizer.

IV. CONCLUSION

Plastic bags, which are widely used for packaging, shipping vegetables, foods, and other products, lead to a severe environmental issue. Since plastic bags last in the world for up to 1000 years, the number of plastic bags collected rises year after year. The dumping of a large number of plastic bags can pollute the soil, water sources, and air. Plastic pollution has many uses in concrete.

The decreased slump values of waste plastic concrete mixes indicate that it can only be used in conditions requiring a low degree of workability. In structural engineering applications, such as precast bricks, partition wall frames, canal linings, and so on, such conditions abound.

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