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STUDY ON INFLUENCE OF PLASTIC IN NO-FINE CONCRETE ON MECHANICAL AND DURABILITY PROPERTIES

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Abstract – in the present day's climate change and global warming are main threat due to human intervention and lots of industrial activities. In the context urbanization and industrialization are major reason for it. Our metropolitan cities and urban are covered with the buildings, industries roads which are major barriers for water infiltration. Due to which flooding of water during rainy reasons taking places, and also decreases in the ground water table due to lack of infiltration activities, lack of water supplies to the flora and fauna which leading to degradation of environment in the urban areas. In order to overcome all this adverse effects there is requirements of new technologies and methods of building the infrastructures which are eco friendly. In the regards no fine concrete is new technique which allows water to percolate through. No fine concrete is also known as pervious concrete which allows fluids to pass through it. Which helps in avoiding the flooding of water as well recharges ground water. The advantage of this concrete are of lower density, lower thermal conductivity, cost effective due to absence of fine aggregate and lower cement content. It is having better insulating property than the normal concrete due to presences of larger voids. In the present study various test like mechanical test such as compression test, split tensile strength and durability properties such as acid attack, alkali reaction test, chloride penetration and permeability tests were conducted. From the present study it has been observed that the no fine mix with waste plastic as an additive performed well in respect to compression, durability and permeability when compared to no fine mix without plastic.

I. INTRODUCTION

Demand for concrete is increasing day by day with its usage in construction. Alternatives for materials used in concrete are necessary to be found to meet the demand. Disposal of plastic waste has been a challenging issue with environmental aspect due to its very low biodegradability.

Annual consumption of plastic around the world has increased from 1950 to 2001 by 5 million tons to 100 million tons respectively. Plastic waste constitutes around 11% of total solid waste in which most of the waste is from solid plastics like bottles, plastic covers. These wastes are disposed by burying which has an environmental impact.

Many researches are carried out in using plastic shredding as partial replacement for both fine aggregates and coarse aggregates in concrete and its strength and mechanical behavior is tested.

Plastic can be defined as the substance that have plasticity and also which can be manufactured in soft state and will be used in solid state. Plastics can be classified into two types thermoplastics and thermosetting plastic. With meshed cross links molecular chains are bonded firmly in thermo setting plastic and they cannot be melted by heating. Plastic like polyurethane, silicone, unsaturated polyester comes under thermosetting plastic. Where as in thermoplastics they can be melted by heating and can be used in plastic industry by recycling. Plastics like polyamide, polyethylene, polypropylene comes under thermo plastic. At present these plastics are disposed by burying or burning process and the process is harmful for the environment. If thermoplastics are used in any applications by recycling process the environmental pollution can be controlled and the process becomes eco friendly.

Recycling of plastic is much needed at this time and its effective use becomes eco friendly. The use of plastic in concrete has advantages as the life of plastic is long and hence plastic can be removed and can safeguard the environment for the next few decades. Properties like chemical resistance, tensile strength, creep and shrinkage of concrete can be increased with the use of plastic waste as constituent of concrete.

Types of Plastics

- Low Density Polyethylene(LDPE)
- Unplasticised Polyvinyl Chloride(UPVC)
- High Density Polyethylene(HDPE)
- Polyethylene Terephthalate(PET)

- Polystyrene(PS)
- Polypropylene(PP)

Polyethylene or polythene is the most common type of plastic. Its primary usage is in packaging (geo membranes, plastic films, plastic bags). Major kinds of polyethylene is with chemical formula of $(C_2H_2)_n$. Polyethylene is usually be a mixture of similar type of polymers of ethylene and with various values of n.

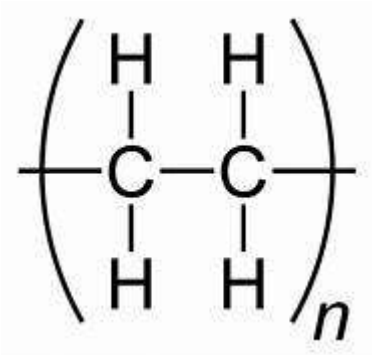

Fig. 1 Polyethylene

Properties of Polyethylene can be studied as thermal, mechanical and chemical properties.

- Thermal properties

  The usefulness of polyethylene is reduced by its low melting of 80°C. The melting point for commercial and common high and medium density polyethylene will be in the range of 120 to 180°C. The melting point of low density polyethylene is in range of 105 to 115°C.

- Mechanical properties

  Polyethylene is of high ductility and impact strength and of low friction but has low strength, hardness and rigidity. It feels waxy when touched. Polyethylene shows strong creep under the application of persistent force, and this can be eliminated with the addition of short fibres.
- Chemical Properties

The chemical behavior of polyethylene plastic is much similar to paraffin and this is due to high molecular weight, non-polar and saturated hydrocarbons. The molecules are not covalently linked. Polyethylene is partially crystalline because of its molecular structure. Density, chemical and mechanical stability increases with higher crystalline. Most LDPE, MDPE, HDPE grades have good chemical resistance, meaning they are not attacked by strong bases or strong acids, and show good resistance to gentle oxidant and reducing agents. Polyethylene (other than the cross-linked polyethylene) can be usually dissolved at elevated temperatures in aromatic hydrocarbons such as toluene or xylene. Water absorption of polyethylene is nil. The behavior of polyethylene when exposed to sunlight shows brittleness, and can be reduced with the usage of carbon black which acts as UV stabilizer. Polyethylene slowly burns with blue flame and gives odor of paraffin. Polyethylene cannot be imprinted or stuck together without pre-treatment. Polyethylene has been classified depending on its branching and density. Polyethylene is of different types and is listed below:

- High molecular weight polyethylene(HMWPE)
- Ultra low molecular weight polyethylene (ULMWPE)
- Ultra high molecular weight polyethylene(UHMWPE)
- High density cross linked polyethylene(HDXLPE)
- High density polyethylene(HDPE)
- Cross linked polyethylene(XLPE)
- Linear low density polyethylene(LLDPE)
- Very low density polyethylene(VLDPE)
- Medium density polyethylene(MDPE)
- Low density polyethylene(LDPE)

We choose LDPE for replacement because 500 billion plastic bags are used every year (nearly one million bag per minute). Many mammals like whales, sea turtles die every year because of consumption of discarded plastic bag as mistaken food. On land also many animals are dieing because of same issue.

Low density Polyethylene (LDPE) has a specific gravity in the range of 0.810-0.940. They have a high degree of long chain and short chain branching, meaning the chains will be not packing in the form of crystals structure as well. Hence less strong intermolecular forces will develop, meaning less dipole-induced-dipole attraction will develop. Therefore it shows higher ductility and tensile strength reduces. They are created by free radical polymerization. Due to high degree of branching with long chains LDPE has got desirable and unique flow properties.

Polyethylene accumulates in landfills due to non-biodegradable properties. Though there are different types of species of animals and bacteria that can be able to degrade polyethylene but the process becomes costly.

The presence of polyethylene in environment is harmful and disposal method available by burning is harmful for the environment. Hence the only option available is to use polyethylene as a part to form useful product

II. OBJECTIVE OF PRESENT STUDY

1. To understand the influence of plastic and GGBS in the concrete with no fines.
2. To examine the durability and mechanical properties of the no fine concrete with the addition of plastic.
3. To understand the percolation capacity of water in no fine concrete with plastic as additives
4. Comparing the results of no fine concrete mix with mineral admixture and plastic with no fine concrete mix without mineral admixture and plastic

III. MATERIAL USED

Table 1 Material Used

Cement	OPC-53 grade cement confirming IS:12269:1987' SG-3.11
Coarse aggregate	Coarse aggregates of 20mm down sized is used confirming IS:383:1970, SG-2.67
Plastic waste	Low density Polyethylene (LDPE) has a specific gravity in the range of 0.810-0.940.
Water	Clean and portable water has been used throughout the investigation for mixing concrete and for curing purpose.

IV. RESULTS AND DISCUSSION

a) Compressive Strength Value of Concrete Cube:

The compression strength is the measure of capacity of the material or structure to resist against deformation. In this dissertation the concrete cubes of sizes 150x150x150mm were casted in addition with mineral admixtures like GGBS and with and without plastic waste The water curing has been done and the specimens were tested on different ages as 7, 14 and 28 days. The compressive strength results were tabulated and graphs were drawn.

Table 2 Compression strength of concrete cubes with plastic waste mixes

Materials	7Days (MPa)	14Days(MPa)	28Days (MPa)
Without plastic waste	19.8	20.06	22.5
With plastic waste	20.1	23.7	24.1

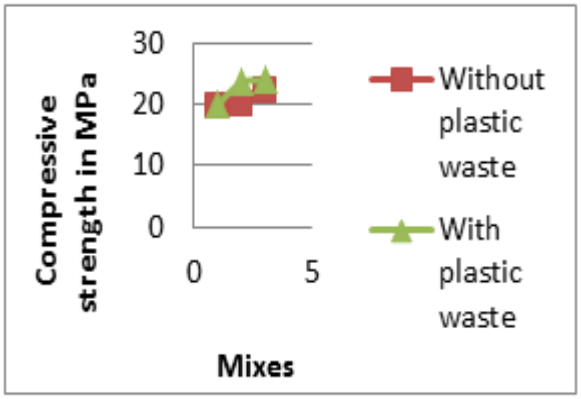

Figure 1 Compression strength of concrete cubes with plastic admixtures

From figure 1 it has been observed that at all the ages compressive strength of concrete with plastic mix was more when compared with without plastic mix. At 28th day with plastic was having compressive strength of 24.1MPa and without plastic of 22.5MPa which is about 7% more than the without plastic mix.

With respect to mechanical properties the concrete mix with plastic performs better than the concrete mix with without plastic.

b) Split tensile Strength Value of cylinder

The split tensile strength is the measured for cylinders with plastic and without plastic. In this dissertation the concrete cylinder of sizes 100mm in diameter and 200mm in length were casted in addition with mineral admixtures like GGBS and with and without plastic The water curing has been done and the specimens were tested on age of 28 days.

The split tensile strength results were tabulated and graphs were drawn

Table 3 Split tensile strength of cylinders

Materials	28Days (MPa)
Without plastic waste	1.91
With plastic waste	1.86

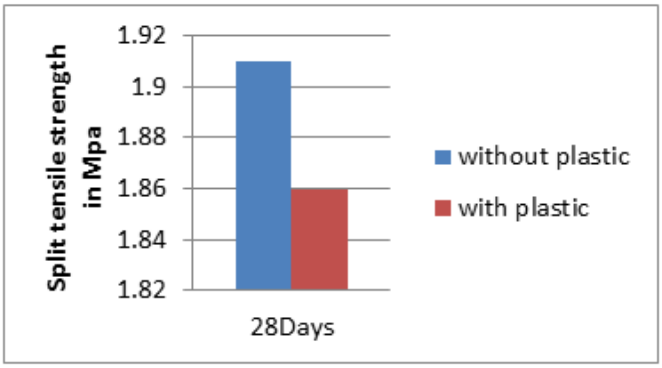

Figure 2 Split tensile strength of concrete cylinder with plastic admixtures

From figure 2 it has been observed that at the age of 28days split tensile strength of concrete with plastic mix was less when compared with without plastic mix. At 28th day with plastic was having split tensile strength of 1.86MPa and without plastic of 1.91MPa which is about 2.6% more than with plastic mix.

c) Chloride Penetration Test

The calorimetric chlorination test was carried out after 28 days curing in water and 28 days curing in 1N sodium chloride solution (NaCl). The concrete cube of size 150×150×150mm was casted without plastic and with plastic mix. And the specimens were dipped in NaCl solution and cured it for 28days. The test results were shown in table below

Table 4 Chloride Penetration depth of concrete cubes with mineral admixtures

Mixes	Chloride penetration depth 28 days, (mm)
Without plastic	11.31
With plastic	13.19

From the table 4 it has been observed that both the mixes showed reasonable performance against chloride attach. It is also been observed that out of two mixes, the mix with without plastic was more resistant to chloride attack than with plastic mix. It may be because of chemical composition, which resist to the attack of chloride on concrete mix.

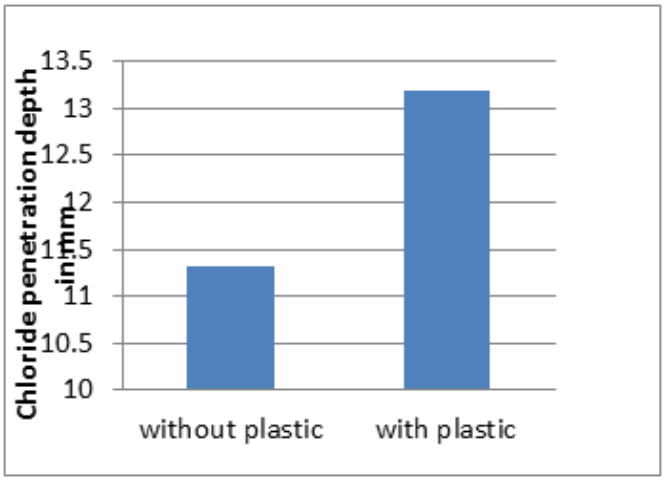

Figure 3 Chloride Penetration depth of concrete cubes with different mineral admixture

From the fig.3 the chloride penetration in concrete cubes were observed, which indicates that the depth of penetration of chlorine is more in plastic mix which is about 13.19mm when compared with without plastic mix which is about 11.31mm.

d) Acid attack Test

The concrete cubes with plastic and without plastic mix were tested for acid attack. The concrete cubes of size 150×150×150 mm were casted and cured for 28 days of water curing, then it was dipped in Sulphuric acid (H_2SO_4) solution for 28 days then it was checked for compressive strength. The average compressive strength of the degraded samples was evaluated at the end of every phase of exposure to the sulphuric acid solutions and compared with the initial 28 day compressive strength of normal water cured specimens of same mix

Table 5 Acid attack of concrete with different plastic waste mixes

Material	Compressive strength in water curing (MPa)	Compressive strength in acid solution (MPa)	% loss in compressive strength(MPa)
Without plastic	22.5	17.6	21.78
With plastic	24.1	19.5	19.08

From the table 5 it has been observed that both the mixes were reacted more with the H_2SO_4 solution, which deteriorated its surfaces, The condition of the specimens were severely damaged, and when these specimens are checked for compression strength there was drastic reduction in the compression strength. Nearly 19 to 20% losses in the compression strength were observed

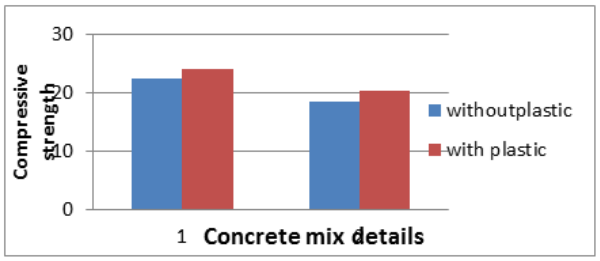

Figure 4 Percentage loss in compressive strength due acidity

From the fig.4 indicates mix with the plastic and 2 indicates mix without plastic, it has been observed that mix with plastic concrete reacted more with the acid solution when compared with the mix with without plastic concrete. The normal water cured without plastic concrete cube's 28 days compressive strength was 22.5MPa, where as acid solution cured same mix cube strength was 17.6MPa, there was 21.7% reduction in the compressive strength were observed. Where in The normal water cured with plastic concrete cube's 28 days compressive strength was 24.1MPa, where as acid solution cured same mix cube strength was 19.5MPa, there was 19.08% reduction in the compressive strength were observed.

d) Alkali Attack Test:

The concrete cubes with plastic and without plastic mix were tested for alkali attack. The concrete cubes of size 150×150×150 mm were casted and cured for 28 days of water curing, then it was dipped in Sodium hydroxide (NaOH) solution for 28 days then it was checked for compressive strength. The average compressive strength of the degraded samples was evaluated at the end of every phase of exposure to the Sodium hydroxide solutions and compared with the initial 28 day compressive strength of normal water cured specimens of same mixes.

Table 6 Alkali attack of concrete with different plastic waste mixes

Material	Compressive strength in water curing (MPa)	Compressive strength in acid solution (MPa)	% loss in compressive strength(MPa)
Without plastic	22.5	18.44	18.04
With plastic	24.1	20.35	15.33

From the table 4.5 it has been observed that both the mixes were reacted more with the NaOH solution, which deteriorated its surfaces, The condition of the specimens were moderately damaged, and when these specimens are checked for compression strength there was reduction in the compression strength. Nearly 15 to 20% losses in the compression strength were observed.

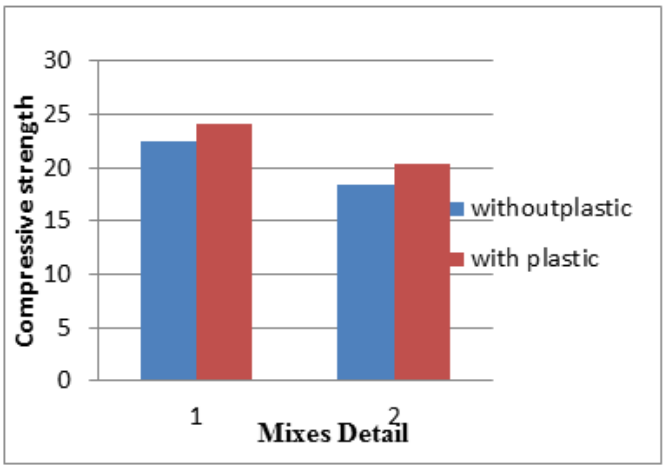

Figure 5 Percentage losses in compressive strength due to alkaline

From the fig.24 it has been observed that mix with plastic concrete reacted more with the alkaline solution when compared with the mix with without plastic concrete. The normal water cured without plastic concrete cube's 28 days compressive strength was 22.5MPa, where as acid solution cured same mix cube strength was18.44MPa,there was 18.04% reduction in the compressive strength were observed. Where in The normal water cured with plastic concrete cube's 28 days compressive strength was 24.1MPa, where as acid solution cured same mix cube strength was 20.35MPa, there was 15.33% reduction in the compressive strength were observed

e) Permeability Test:

The concrete cubes of size 150x150x150mm with plastic and without plastic mix were casted and cured for 28days. Then those specimens were tested for water permeability, The Co-efficient of permeability results were tabulated and graph were Drawn below

Table 7 Permeability Test

Mixes	Co-efficient of Permeability(k)
Without plastic	1.36×10^4
With plastic	1.195×10^4

From the table 7 it is observed that concrete with different mixes behaves differently. It has been observed that mix with plastic waste performed better when compared with mix without plastic waste. The mix without plastic waste has 1.36×10^4 at 28days and with plastic waste has

1.195×10^4 at 28days test. The mix with plastic performed well.

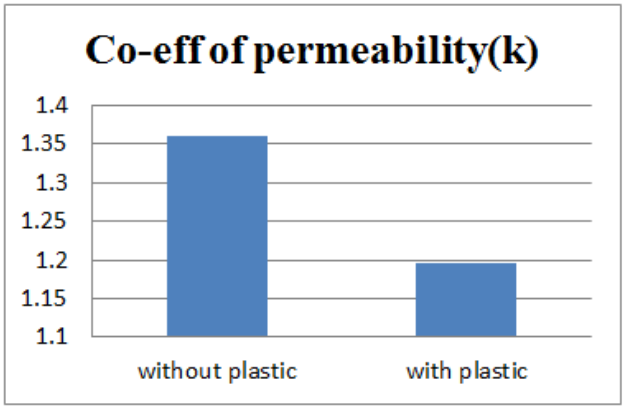

Figure 6 Co-eff of permeability for different mixes

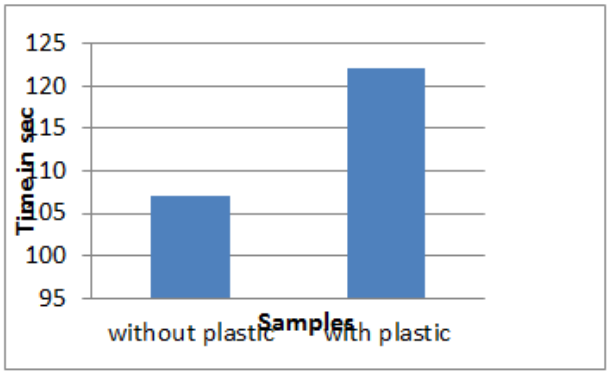

Figure 7 Time taken for collection of 1liter of water

From figure 6 it has been observed that at time taken in seconds to collect 1Liter of water for the concrete with plastic mix was more when compared with without plastic mix. A mix with plastic took 108 seconds to collect 1Liter of water and without plastic took 122 seconds to collect water .The mix with plastic took more time to collect 1Liter of water and it performs better. With respect to mechanical properties and durability properties the concrete mix with plastic performs better than the concrete mix with without plastic.

V. CONCLUSION

1. From the compressive strength test results it is been concluded that mix without plastic showed less compressive strength than the mix with plastic.

2. In split tensile strength test it can be concluded that mix without plastic show higher strength than mix with plastic

3. In durability test of chloride penetration test it can be concluded that the depth of penetration was lesser in without plastic mix than in with plastic mix.

4. In durability test of both acidity and alkalinity tests it can be concluded that the percentage losses in compressive strength was more in without plastic mix than in with plastic mix.

5. From the permeability test it can be concluded that the water percolation was less without plastic mix than the with plastic mix.

6. To achieve high strength pervious concrete without compromising on the permeability by replacing the coarse aggregates up to 5% with fine aggregates and 10% GGBS in pervious concrete. and to understand the percolation capacity of water in no fine concrete with plastic as additives

7. Ahmad K. Jassim "Recycling of Polyethylene Waste to Produce Plastic Cement" 14th Global Conference on Sustainable Manufacturing, GCSM 3-5 October 2016, Stellenbosch, South

REFERENCE

1. P. Suganthy, Dinesh Chandrasekar, Sathish Kumar. P. K " Utilization of Pulverized Plastic in Cement Concrete as Fine Aggregate" Volume:02 Issue:06 June-2013

2. Praveen Mathew, Shibi Varghese, Thomas Paul, Eldho Varghese, " Recycled Plastic as Coarse Aggregate for Structural Concrete" International Journal of Innovative Research in Science, Engineering and Technology vol. 2,Issue3,March 2013.

3. RaghatateAtul M. "Use of plastic in a concrete to improve its properties" International journal of Advance engineering Research and studies. http://www.technical journals online.com, 2012

4. Bhogayata, K. D. Shah, B. A. Vyas, Dr. N. K. Arora " Performance of concrete by using Non Recyclable plastic wastes as concrete constituent", International Journal of Engineering Research & Technology (IJERT) vol. 1 issue 4, june-2012.