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Application of Single Use Plastic for Concrete Making

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Abstract*: The production of plastic is increasing at a faster rate. It is very difficult to dispose this plastic waste as it creates environmental pollution. Plastic bottles usually take thousands of years to degrade and produce toxic fumes when incinerated. For solving this problem, construction industry can take a step to utilize this plastic waste as a substitute for aggregates. By replacing coarse aggregate as well as fine aggregate with waste plastic known as green innovation. As the years go by, waste plastic increases day by day, since most of the plastic used by human is non-bio-degradable. The idea behind this review is to identify research done by the researchers who uses recyclable material such as plastic obtained mostly from waste plastic that the people had generated around the world by utilisation of waste plastic in becoming of construction materials in order to overcome the environment problem that the society are facing. This paper aim to review the using of waste plastic to replace fine and coarse aggregate and stated the mechanical properties of the concrete. With different percentage replacement of aggregates will affect the different properties such as slump, compressive strength and ultimate strength of the concrete and compare with the control sample in order to find the suitable percentage of the waste plastic to replacement of aggregates for the concrete used. It was found that plastic as replacement for fine and coarse aggregate both have has lower compressive quality of the concrete, almost the same or lower slump test value for ordinary concrete and waste plastic concrete and lower density for the waste plastic concrete compare to the ordinary concrete.*

Keywords: *Low density polyethylene, Polyvinyl Chloride Waste, Silica Fumes.*

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I. INTRODUCTION:-

Concrete is the mostly used man made material used in construction industry and is the second after water as the most utilized thing on the Earth. In simple words it is defined as a mixture of four ingredients as coarse aggregates that form the largest proportion of the mix, fine aggregates such as sand that act as filler material in the voids, binding material such as lime or Portland cement that binds these material together and water that reacts with binding material. The mixing of these four materials gives us a paste that is called as matrix. At this stage it is called as fresh concrete or green concrete and get hardened like a stone, as the water reacts with binding material. This reaction is called as hydration of concrete. In fresh state concrete can be casted into any desired shape by placing it in forms. This property of concrete help in using the concrete in most efficient manner.

Plastic needs no introduction as it is the widely used material now a days on our Earth. Due to its properties like strength, durability and easy processing it can be used for many purposes. Studies shows 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 non-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. MATERIALS USED:-

1. Fine Aggregate: - Fine aggregate is first graded to decide the zone to which it belongs to. Generally, there are four categories of fine aggregate Zone-I, Zone-II, Zone-III & Zone-IV. In this work, sand of zone-II is chosen whose properties were given below. Generally, fine aggregate is passed through 4.75 mm sieve.

Properties :-

- Specific gravity **2.65**
- Water absorption **1.01**
- Fineness Modulus **2.699**

2. Coarse Aggregate Coarse aggregate is another fundamental raw material which gives strength, hardness and increases the volume of the concrete. Here, coarse aggregate of size 10mm & 20 mm and angular crushed shape is chosen.

Properties :-
Specific gravity **2.68**
Water absorption **0.8%**

3. Cement :- cement is one the major component in the manufacturing process of concrete. It has the property to stick to any other raw material added in the preparation process of concrete, especially when comes in contact with water and hence produces a good paste. Here, OPC 53 grade cement is used whose properties are shown below.

Properties :-
Specific gravity **3.15**
Normal consistency **30%**
Initial & Final setting time **30 min & 580 min**

4. Water:- Normal tap water is utilized in the present work in the preparation of concrete specimens.

5. Silica Fumes :- Silica fume, also known as micro silica is an amorphous (non-crystalline) polymorph of silicon dioxide. It is an ultrafine powder collected as a by-product of the silicon and ferrosilicon alloy production. It is extremely fine with particles size less than 1 micron and with an average diameter of about 0.1 microns, about 100 times smaller than average cement particles. The use of silica fume as a pozzolana has increased worldwide attention over the recent years because when properly used it as certain percent, it can enhance various properties of concrete both in the fresh as well as in hardened states like cohesiveness, strength, permeability and durability. Silica fume concrete may be appropriate in places where high abrasion resistance and low permeability are of utmost importance or where very high cohesive mixes are required to avoid segregation and bleeding.

6. Low density polyethylene (LDPE) :- Low-density polyethylene (LDPE) is a thermoplastic made from the monomer ethylene. It is Semi-rigid, translucent, very tough, weatherproof, good chemical resistance, low water absorption, easily processed by most methods, low cost.

Physical properties:-
Physical state **Solid**
Grain size **5-7mm**
Tensile Strength **0.20 - 0.40 N/mm²**
Notched Impact Strength **no break Kj/m²**
Thermal Coefficient of expansion **100 - 220 x 10-6**
Density **0.917 - 0.930 g/cm3**

7. Polyvinyl chloride (PVC):- Polyvinyl chloride, also known as vinyl or simply PVC, is the third-most produced plastic in the world. PVC is replacing traditional building materials such as wood, concrete and metals in many applications. Versatility, cost effectiveness and an excellent record of use mean it remains the most important polymer for the construction sector. Polyvinyl Chloride (PVC) that is a widely used thermoplastic polymer. Polyvinyl Chloride (PVC) finds application in diverse construction applications. We procure superior quality Polyvinyl Chloride (PVC) from reliable manufacturers across the country.


Silica Fumes


LDPE


PVC

III. EXPERIMENTAL PROCEDURE:-

3.1 Mix Design for M30 Grade of Concrete:-

Cement	**Sand**	**Aggregate**	**Water**	**Admixture**
(Kg)	(Kg)	(Kg)	(Litre)	(Litre)
50	102.5	153.5	22.5	0.255

For 1 Cub.M.

380	779	1166.6	171	1.938
1.28 Kg	2.62Kg	3.94Kg	0.6 Liter	6.54 ml

3.2 Mix Proportions:-

MIX 1 (M1)	Replace LDPE plastic with coarse aggregate by 5%, 10%, 15%
MIX 2 (M2)	Replace PVC plastic with fine aggregate by 5%, 10%, 15%
MIX 3 (M3)	Replace Silica Fumes with cement by 5%, 10%, 15%

3.3 Mixing, Casting & Curing:-

The Plastic Waste concrete is manufactured by as similar to the classical concrete. Initially the dry materials Cement, Aggregates & Sand are mixed. The liquid component of the mixture was then added to the dry materials and the mixing continued for further about 4 minutes to manufacture the fresh concrete. The fresh concrete was cast into the moulds immediately after mixing, in three layers for cube specimens. For compaction of the specimens, each layer was given 60 to 80 manual strokes using a rodding bar, and then vibrated for 12 to 15 seconds on a vibrating table. Before the fresh concrete was cast into the

MIXING

CASTING

CURING

moulds, the slump value of the fresh concrete was measured. The Plastic Waste concrete specimens should be wrapped during curing at elevated temperature in a dry environment to prevent excessive evaporation. Extensive trails revealed wrapping of concrete specimens by using vacuum bagging film is effective for temperature up to 100c for several days of curing. To tighten the film to the concrete moulds, a quick lock seal or a twist tie wire was utilized. The later was used in all further experimental work due to its simplicity and economics. Preliminary test also revealed that Plastic Waste -based concrete did not harden immediately at room temperature. When the room temperature was less than 30c, the Harding did not occur (rather than setting time used in the case of OPC concrete) for Plastic Waste -based Concrete.

IV. TESTING PROCEDURE:-

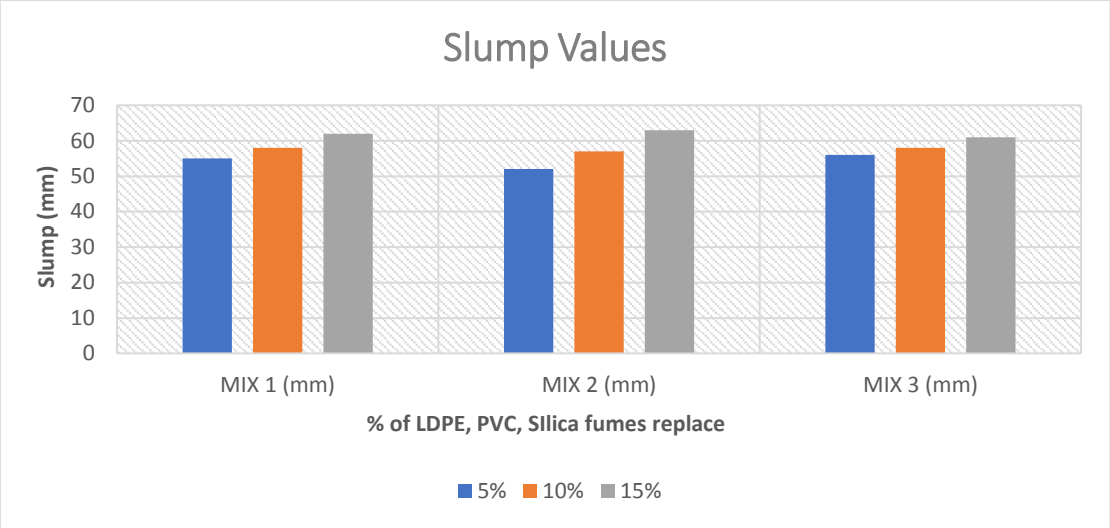
Test on Concrete:-

1. SLUMP TEST:-

Workability is a term associated with freshly prepared concrete. This can be defined as the ease with which concrete can mixed, placed, compacted and finished. Slump test is the most commonly used method of measuring 'workability' of concrete in a laboratory or at site of work. It is used conveniently as a control test and gives an indication of uniformity of concrete from batch to batch. Vertical settlement of a standard cone of freshly prepared concrete is called 'slump'.

Table 1. Slump test report for different mixes of concrete cubes

Plastic in %	MIX 1 (mm)	MIX 2 (mm)	MIX 3 (mm)
5%	55	52	56
10%	58	57	58
15%	62	63	61



2. COMPRESSIVE STRENGTH TEST:-

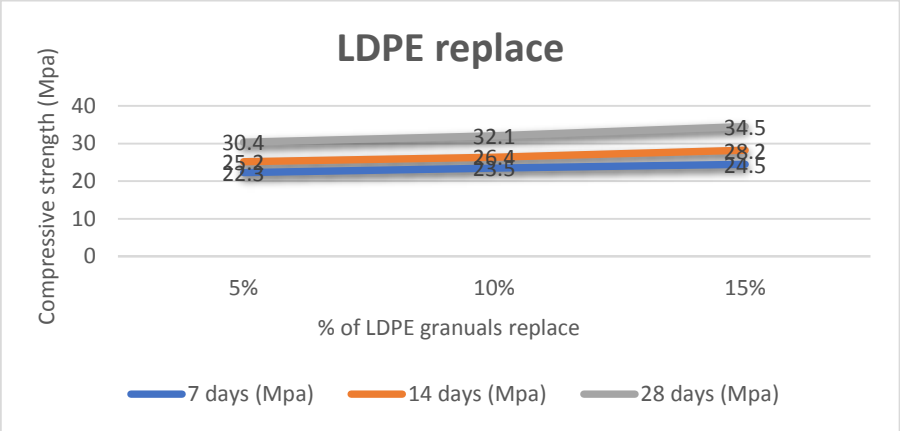
At the time of testing, each specimen must keep in compressive testing machine. The maximum load at the breakage of concrete block will be noted. From the noted values, the compressive strength may calculated by using below formula.

Compressive Strength = Load / Area

Size of the test specimen = 150mm x 150mm x 150mm

1. Partial replacement of Coarse aggregate with LDPE plastic (MIX 1) :-

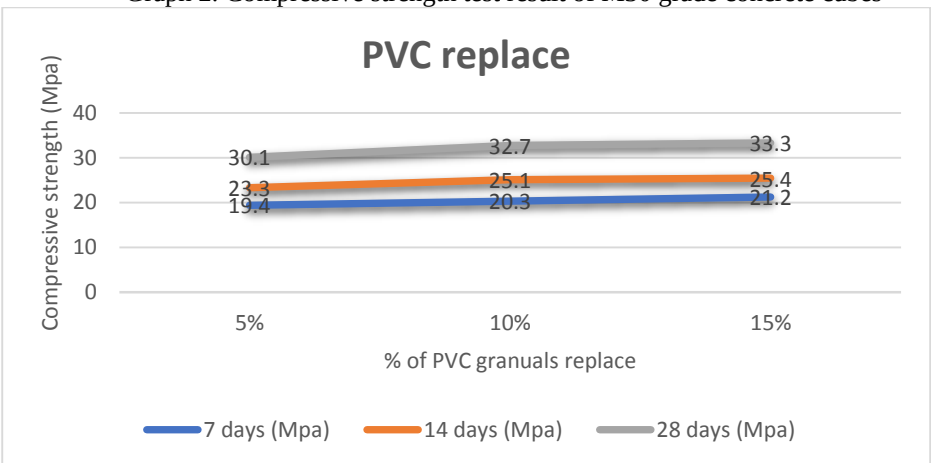
Graph 1**.** Compressive strength test result of M30 grade concrete cubes



As per the observation we found that as percentage of LDPE plastic increase strength of concrete also increases.

2. Partial replacement of Fine aggregate with PVC plastic (MIX 2) :-

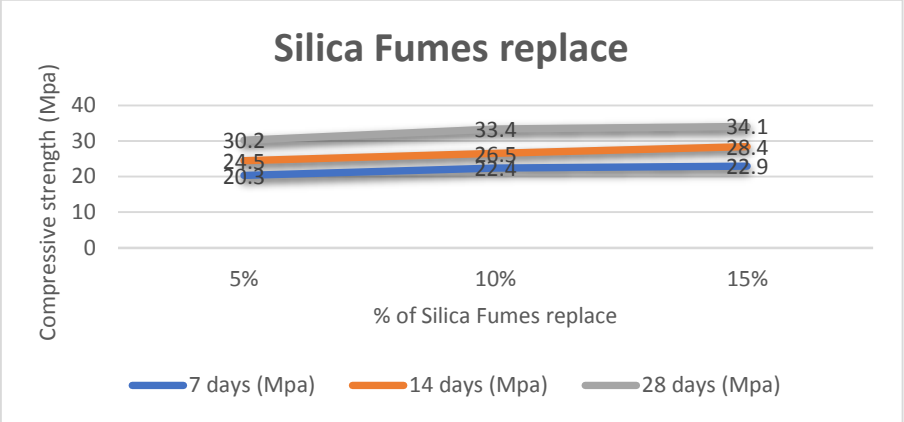
Graph 2. Compressive strength test result of M30 grade concrete cubes



By replacement of PVC plastic we found that as percentage plastic increase strength of concrete also increases.

3. Partial replacement of Cement with Silica Fumes (MIX 3) :-

Graph 3. Compressive strength test result of M30 grade concrete cubes



As per the observation we found that as percentage of Silica fumes increase strength of concrete also increases.

V. RESULTS:-

- From above graph results we can say that 5%, 10%, 15% replacement of LDPE plastic by Coarse aggregate increases strength of concrete also increases.
- As per 5%, 10%, 15% replacement of PVC plastic by Fine aggregate increases strength of concrete also increases.
- As per 5%, 10%, 15% replacement of Silica fumes by Cement increases strength of concrete also increases.

VI. CONCLUSION: -

- From the above study we can conclude that replacement by 5%, 10%, 15% of coarse aggregate, fine aggregate & cement by Low density polyethylene, Polyvinyl chloride & Silica fumes respectively can increase the strength of concrete.
- As we can achieve the natural require strength of concrete by replacing industrial waste can makes useful concrete for environment.
- Use of plastic recycled aggregate in construction industry it can slow the impact of waste on environment & also sustainable for environment.
- Replacement of silica fumes in concrete help in reduction of cost considerably.

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