Experimental Study on Partial Replacement of Fine Aggregate With Plastic

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Abstract- *As the plastic has become major environmental pollutant and has become major component of land fill, it has to be recycled and reused such that decrease in landfill, environmental pollution can takes place. Usage of recycled plastic waste helps to save and sustain natural resources that are not replenished, it provides additional support to prevent further environmental pollution and Concrete plays a significant role in the beneficial use of these materials in construction.So as concrete plays major role in construction field plastic can be used as aggregate in concrete such that usage of natural aggregates can be reduced which leads to compensate the scarcity of natural aggregates as well as reduction in plastic waste. Main aim of this study is to carry out an experimental study on partial replacement of fine aggregate with pulverized polypropylene plastic. Pulverized Polypropylene waste plastic is being used to replace sand at percentages of 10, 20, in concrete and the strength characteristics of this concrete will be compared with that of conventional concrete. All of the concrete mixtures were tested at room temperature. These tests include performing slump, compressive strength, flexural strength, and toughness indices. 18 cubes were molded for compressive strength, and 18 cylinders were cast for split tensile test, and 18 rectangular beams were cast for flexural test. Curing ages of 7, 14, and21 days for the concrete mixtures were applied in this work. The test results Final conclusion there is no much decrease in strength characteristics of concrete when 10% of fine aggregate is replaced with plastic. By using recycled waste plastic in concrete can reduce the land fill and environmental issues. This type of aggregate replacement is useful where aggregates are in crisis .By this we can conserve natural resources.*

I. INTRODUCTION

Concrete is one of the most important and frequently used materials in civil engineering, such as in high-low buildings, bridges, infrastructure and environmental protection facilities. Concrete is a composition of an aggregate and a binder substance. Generally the aggregate or aggregates make up about 60% to 70% of the total concrete volume. Constant and rapid increase in construction and demolition (C&D) waste generation and consumption of natural aggregate for concrete production became one of the biggest environmental problems in the construction industry. Over the last 30 years, worldwide production of plastic grew by more than 500%. Current annual global production is estimated at over 100 million tons and is expected to increase by 3% a year. About 80% of the plastic wastes are either left in stockpiles, as landfill material, or is illegally dumped. Most importantly, much of the non-decaying wastes will remain in the environment for hundreds, perhaps thousands of years. The non-decaying waste will not only cause a waste disposal crisis, but also contribute to significant environmental problems As the plastic has become major environmental pollutant and has become major component of land fill, it has to be recycled and reused such that decrease in landfill, environmental pollution can takes place. Usage of recycled plastic waste helps to save and sustain natural resources that are not replenished, it provides additional support to prevent further environmental pollution and Concrete plays a significant role in the beneficial use of these materials in construction. So as concrete plays major role in construction field plastic can be used as aggregate in concrete such that usage of natural aggregates can be reduced which leads to compensate the scarcity of natural aggregates as well as reduction in plastic waste.

Problem description

We know that plastic has become major environmental problem now a days. As the usage of plastic increases, problem in its degradation and disposal increases. This leads to huge land fill and pollution as plastic takes hundreds or thousands of years for degradation. The studies in using recycled plastic in various fields are being done. Among these studies, usage of plastic in concrete as reinforcement as well as aggregate got prominent place. Studies on various plastics such as HDPE (high density polyethylene), Poly terephthalate etc., as aggregates has been done. But in these studies it has been found that the decrease in compressive strength than conventional concrete has occurred. So in our study we used polypropylene as partial replacement of fine aggregate such as experimental study can be carried out on this concept

II. LITERATURE REVIEW

INTRODUCTION

Doing a careful and thorough literature review is essential when you write a thesis of research at any level. It is basic homework that is assumed to have been done vigilantly, and a given fact in all research papers. By providing one, usually offered in your introduction before you reach your thesis statement, you are telling your reader that you have not neglected the basics of research. It not only surveys what research has been done in the past on your topic, but it also appraises, encapsulates, compares and contrasts, and correlates various scholarly books, research articles, and other relevant sources that are directly related to your current research. Given the fundamental nature of providing one, your research paper will be not considered seriously if it is lacking one at the beginning of your paper. The literature review will help you compare and contrast what you are doing in the historical context of the research as well as how your research is different or original from what others have done, helping you rationalize why you need to do this particular research. Perhaps you are using a new or different research method which has not been available before, allowing you to collect the data more accurately or conduct an experiment that is more precise and exact thanks to many innovations of modern technology. Thus, it is essential in helping you shape and guide your research in the direction you may not have thought of by offering insights and different perspectives on the research topics

YoucefGhernouti et al:

The study present the partial replacement of fine aggregate in concrete by using plastic fine aggregate obtained from the crushing of waste plastic bags. Plastic bags waste was heated followed by cooling of liquid waste which was then cooled and crushed to obtained plastic sand having finesse modulus of 4.7. Fine aggregate in the mix proportion of concrete was replaced with plastic bag wastesandat10%, 20%, 30% and 40% whereas other concrete materials remain same for all four mixes. In fresh properties of concrete it was observed from the results of slump test that with increase of waste content workability of concrete increases which is favorable for concrete because plastic cannot absorb water therefore excessive water is available. Bulk density decreases with increase of plastic bags waste. In harden state, flexural and compressive strength was tested at 28 days and reductions in both strengths with increasing percentage of plastic bag wastes and in concrete mix. Plastic waste increases the volume of voids in concrete which on other hand reduce the compactness of concrete simultaneously speed of sound in concrete is also decreased. Strength reduction in concrete mix was prime concern; however they recommend 10 to 20% replacement of fine aggregate with plastic aggregate. Use of admixtures to address the strength reduction property of concrete with addition of plastic aggregate is not emphasized.

RaghatateAtul M:

The paper is based on experimental results of concrete sample casted with use of plastic bags pieces to study the compressive and split tensile strength. He used concrete mix by using Ordinary Portland Cement, Natural River sand as fine aggregate and crushed granite stones as coarse aggregate, portable water free from impurities and containing varying percentage of waste plastic bags (0%, 0.2%, 0.4%, 0.6% 0.8% and 1.0%),

Compressive strength of concrete specimen is affected by the addition of plastic bags and with increasing percentage of plastic bag pieces compressive strength goes on decreasing (20% decrease in compressive strength with 1% of addition of plastic bag pieces). On other hand increase in tensile strength of concrete was observed by adding up to0.8%of plastic bag pieces in the concrete mix afterward it start decreasing when adding more than 0.8% of plastic bags pieces. He concluded that utility of plastic bags pieces can be used for possible increase in split tensile strength. This is just a basic study on use of plastic bags in concrete. More emphasis was required by varying the shape and sizes of plastic bags to be use in concrete mixes.

R L Ramesh et al:

They have used waste plastic of low density poly ethylene as replacement to coarse aggregate to determine its viable application in construction industry and to study the behavior of fresh and harden concrete properties. Different concrete mix were prepared with varying proportions (0%, 20%, 30% & 40%) of recycle plastic aggregate obtained by heat treatment of plastic waste (160-200 centigrade) in plastic granular recycling machine. A concrete mix design with 1: 1.5:3 proportions was used having 0.5 water/cement ratio having varying proportion of plastic aggregate as replacement of crushed stone. Proper mixing was ensured and homogeneous mixture was prepared.A clear reduction in compressive strength was reported with increase in percentage of replacing plastic aggregate with crushed aggregate at 7, 14 and 28 days of casted cubes (80% strength achieved by replacing waste plastic up to30%). The research highlights the potential application of plastic aggregate in light weight aggregate. Their research was narrowed down to compressive strength of concrete with no emphasis given to flexural

properties of concrete.They suggest future research scope on plastic aggregate with regard to its split tensile strength to ascertain its tensile behavior and its durability aspects for beams and columns.

Conclusions on literature review

- The researchers have represented different forms of plastic waste which can be use in production of concrete. They proposed the replacement of various concrete ingredients with suitable plastic waste material. Their proposals were based on results obtained from experimentation of various casted concrete samples.
- Most of the researchers have restricted their work to analyze the specific concrete property which does not reflect the true behavior of concrete containing plastics. Concrete is a composite material in which all the properties have direct or indirect relation.
- The main focus of researchers was on the compressive strength of concrete containing plastics and very less attention was given to other properties of concrete.
- A plastic with low specific gravity have great potentials in light weight concrete but was not comprehensively covered by any of the researcher.
- The area of research on use of plastics in concrete has no information on binding property of plastic in the concrete mix.
- The effect on ductility of concrete containing plastics is another ignored area on behalf of all researchers.
- Based on above literature work we reached to a conclusion that Plastic waste can be successfully use in concrete. Reduction in density and compressive strength was reported by all researchers. The area of focus of all the researchers was limited to compressive strength and a wide gap is left for further research on other properties of concrete produce by using plastic wasted. Plastic waste material requires detail investigation on behavior of its various types in concrete.

III. EXPERIMENTAL WORK

IntroductionBeing one of the most versatile building materials, concrete is used in many forms of construction. Reinforced concrete was used to make building columns and decks in high rises. As the concrete is the major and dominant construction material various tests have to be conducted on constituents of concrete as well as the concrete mix. There are many tests which are conducted to check the quality of concrete. These tests are basically divided into two categories that are tests on fresh concrete and tests on hardened concrete. Various lab tests on fresh concrete are Slump test – workability , Compacting Factor, Vee- Bee test. There are two kinds of tests which are done on hardened the sample is not destroyed and this test is very useful in determining the strength of existing buildings or structures where as in destructive test a sample is made and then destroyed to find out the strength of concrete. Compression test is the example of destructive test.

Materials used: Concrete Concrete is one of the most important construction material and most widely used man made construction material. It is a mixture of cement, sand, pebbles or crushed rock and water, which when placed in skeleton of forms and allowed to cure, becomes hard like a stone. It is the most versatile building material and it is used in many forms of construction

Properties of cement concrete

- It has high compressive strength.
- It is free from corrosion and there is no appreciable effect of atmospheric agents on it.
- It hardens with age and the process of hardening continues for a long time after the concrete has attained sufficient strength.
- It is more economical than steel.
- It binds rapidly with steel.
- It forms a hard surface, capable of resisting abrasion. Under following conditions it has a tendency to shrink:
- There is initial shrinkage of cement concrete which is mainly due to loss of water through forms, absorption by surface of forms.
- Shrinkage of concrete occurs as it hardens. This tendency can be minimized by proper curing of concrete

CementCement is one of the oldest building materials in the world. It acts as adhesive binder that is used in concrete and mortar; it has the ability to harden even in water.53 grade ordinary port cement has been used.

AggregatesAggregates are used in concrete for very specific purposes. The use of coarse and fine aggregates in concrete provides significant economic benefits for the final cost of concrete in place. Aggregates typically make up about 60 to 75 percent of the volume of a concrete mixture, and as they are the least expensive of the materials used in concrete, the economic impact is measurable.

Fine aggregate Aggregate of size less than 4.75mm are called Fine aggregate. River sand is commonly used as Fine aggregate in mortars and concrete

Figure : 1 Fine aggregate

Coarse aggregate Aggregates of size more than 4.75mm are known as Coarse aggregate. If 85 to 100% of the aggregate passes through the specified size of the sieve, and 0 to 25% retain in the next lower sieve, then it is called single sized aggregate. If aggregate contains more than one single sized aggregate, then it is called Graded aggregate

Figure: 2 Coarse aggregate

PolypropylenePolypropylene (PP), also known as polyprotein, is a thermoplastic polymer used in a wide variety of applications including packaging and labeling, textiles (e.g., ropes, thermal underwear and carpets), stationery, plastic parts and reusable containers of various types, laboratory equipment, loudspeakers, automotive components, and polymer banknotes. An addition polymer made from the monomer propylene, it is rugged and unusually resistant to many chemical solvents, bases and acids.

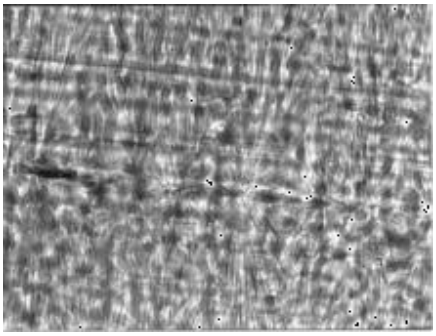

Figure: 3 Structural diagram of polypropylene

Chemical and physical properties Polypropylene is in many aspects similar to polyethylene, especially in solution behaviour and electrical properties. The additionally present methyl group improves mechanical properties and thermal resistance, while the chemical resistance decreases. The properties of polypropylene are depending on the molecular weight and molecular weight distribution, crystallinity, type and proportion of comonomer (if used) and the isotacticity

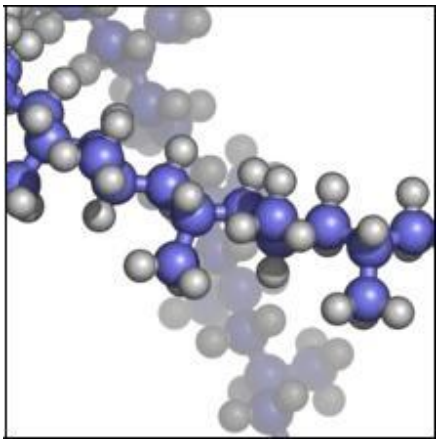

Figure:4 Micrograph of polypropylene

Mechanical properties The density of PP is between 0.895 and 0.92 g/cm³. Therefore, PP is the commodity plastic with the lowest density. With lower density, moldings parts with lower weight and more parts of a certain mass of plastic can be produced. Unlike polyethylene, crystalline and amorphous regions differ only slightly in their density. However, the density of polyethylene can significantly change with fillers. The Young's modulus of PP is between 1300 and 1800 N/mm².Polypropylene is normally tough and flexible, especially when copolymerized with ethylene. This allows polypropylene to be used as an engineering plastic, competing with materials such as acrylonitrile butadiene styrene (ABS). Polypropylene is reasonably economical. Polypropylene has good resistance to fatigue.

Chemical properties Polypropylene is at room temperature resistant to fats and almost all organic solvents, apart from

strong oxidants. Non-oxidizing acids and bases can be stored in containers made of PP. At elevated temperature, PP can be solved in of low polarity solvents (e.g. xylene, tetralin and decalin). Due to the tertiary carbon atom PP is chemically less resistant than PE (see Markovnikov rule). Most commercial polypropylene is isotactic and has an intermediate level of crystallinity between that of low-density polyethylene (LDPE) and high-density polyethylene (HDPE). Isotactic &Atactic polypropylene is soluble in P-xylene at 140 degree centigrade. Isotactic precipitates when the solution is cooled to 25 degree centigrade &atactic portion remains soluble in P-xylene. The melt flow rate (MFR) or melt flow index (MFI) is a measure of molecular weight of polypropylene. The measure helps to determine how easily the molten raw material will flow during processing. Polypropylene with higher MFR will fill the plastic mold more easily during the injection or blow-molding production process. As the melt flow increases, however, some physical properties, like impact strength, will decrease. There are three general types of polypropylene: homopolymer, random copolymer, and block copolymer. The comonomer is typically used with ethylene. Ethylene-propylene rubber or EPDM added to polypropylene homopolymer increases its low temperature impact strength. Randomly polymerized ethylene monomer added to polypropylene homopolymer decreases the polymer crystallinity, lowers the melting point and makes the polymer more transparent.

Tests conducted on materials

- **Tests conducted on cement**
- Standard consistency test
- Soundness test
- Initial setting time
- Specific gravity

Standard consistency test Standard consistency of a cement paste is defined as that consistency which will permit a vicat plunger having 10 mm diameter and 50 mm length to penetrate to a depth of 33-35 mm from top of the mould. Consistency of standard cement paste is done as per (IS: 4031-part4-1988) at normal room temperature and it was found to be p=29% of water by weight of dry cement.

Figure: 5 Vicat apparatus

Measuring Instruments

Name	Capacity / range / size	Accuracy / least count
Vicat apparatus	Should be made as per IS:5513	—
Measuring cylinder	100 ml	1 ml

Table: 1 standards for vicat apparatus

Soundness Soundness is the property of cement due to which it undergoes large change in volume after setting. This change in volume may cause crack and disintegration of concrete. This expansion in volume is due to the presence of uncombined lime in cement. To check the soundness of cement Le-Chatlier‘s apparatus is used which consists of cylindrical mould having a cut or split.

- Cement paste of normal consistency is prepared of 100 grams consisting of 0.78 times of water required for normal consistency.
- This paste is filled in the mould and got cured for 24 hours. After setting the mould is immersed in water

and boil for one hour, after boiling the increase in split distance is noted.

- The difference between two measurements before and after heating was found to be 3mm.
- The difference between two measurements before and after heating should not be greater than 10mm.

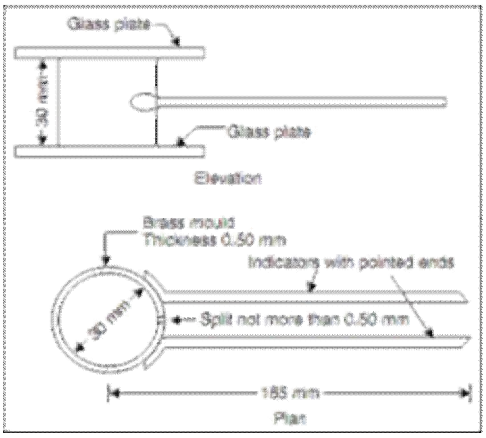

Figure: 6 Le-Chatlier's apparatus

Initial setting time It is the time at which cement starts setting. As per IS:4031-part 5-1988 the initial setting time of cement should not be less than 30 minutes, so that within that time concrete can be mixed, transported and placed at required place. Initial setting time test is carried out on vicat apparatus with cement of 400grams and water content of 0.85p (where p is the standard consistency value). Initial setting time was found to be 32 minutes as the needle penetrated up to 5mm measured from bottom.

Specific gravity of cement (As per IS: 4031-Part 11-1988) Specific gravity is defined as the ratio between the weight of a given volume of cement and weight of an equal volume of water.

Tests conducted on fine aggregate

- **Sieve analysis of sand**
- **Specific gravity of sand**

Specific gravity of sand The fine aggregate specific gravity test is used to calculate the specific gravity of a fine aggregate sample by determining the ratio of the weight of a given volume of aggregate to the weight of an equal volume of water.

Specific gravity use Aggregate specific gravity is used in a number of applications including super pave mix design, deleterious particle identification and separation, and material property change identification.

Tests conducted on coarse aggregate

- **Crushing value test**
- **Water absorption test**

Crushing value test Aggregates used in the construction, should be strong enough to resist crushing. If the aggregates are weak, the stability of the structure is likely to be adversely affected. The strength of coarse aggregates is assessed by aggregate crushing test. The aggregate crushing value provides a relative measure of resistance to crushing under gradually applied compressive load.

Lesser the aggregate crushing value stronger is the given sample of aggregates. Crushing value test has been done as per [IS: 2366(Part IV) -1963].

- The value is higher when more percentage of aggregates crush and break into smaller pieces which indicates the aggregates are of a lower quality.
- Aggregate crushing value < 45% for aggregates used for concrete for non wearing surfaces and <25% for wearing surfaces like runways and roadways.

Water absorption test This test helps to determine the water absorption of coarse aggregates as per IS: 2386 (Part III) – 1963. For this test a sample not less than 2000g should be used.

Tests conducted on pulverized plastic

- **Fineness test**

Fineness test on pulverized plastic Fineness test on pulverized plastic was done with the following IS sieves;4.75mm,2mm,1,600µ,450µ,300µ,150µ,75µ,<75µ with the help of sieve shaker apparatus by performing sieve analysis for 5 minutes

Figure: 7 Sieve analysis of pulverized plastic

Mix design of concrete Mixing of concrete is done to determine whether the concrete is workable or not i.e. the easy with which the concrete is mixed, applied, compacted and transported. The mix of concrete depends on the amount of fine aggregate coarse aggregate is added and water is mixed as well as other factors as size and shape of the aggregates the shapes of the aggregates; cement strength and the water/cement ratio. Too much water destroys the concrete and makes it sloppy while too less of water makes the concrete stiff and makes it hard to work with.

M20 grade concrete (1:1.5:3)

- **Cement of 53 grade.**
- **Fine aggregate.**
- **Coarse aggregate of size passing through 20mm and retained on 16mm sieve.**

Mix design

Characteristic strength of M20 (fck) = 20kn/m

(fck)'=fck+(1.65xSd)

=20+(1.65x4)

= 26.6kn/m

Where Sd is standard deviation and as per Is code it is equal to 4. Maximum water content for 20mm coarse aggregate is 186litres for a slump of 25 to 50. For a slump of 100mm water content is increased by 6%.

Therefore the water content

= 186+ [(6/100) x186]

= 197litres

The adopted watercement ratio (w/c)

= 0.5 Cement content = 197/0.5

= 394kg/m3

Minimum cement content for M20 in severe exposure to the environment is 320kg/m3.

Here 394>320(Hence safe)

As per code the volume of coarse aggregate per unit volume of all aggregate for 20mm in zone-1 is equal to 0.6

Therefore volume of fine aggregate required

= 1-0.6

= 0.4

Let volume of concrete= 1m3

Volume of cement

= [mass of cement/specific gravity of cement] x [1/1000]

= (394/3.15) x (1/1000)

= 0.125m3

Volume of water

= [mass of water/specific gravity of water] x [1/1000]

= (197/1) x (1/1000)

=0.197m^3

Volume of all aggregates (e)

= 1-[volume of cement + volume of water]

= 0.678m^3

Mass of coarse aggregate

= e x volume of coarse aggregate x specific gravity x1000

=0.678x 0.6x2.74x1000

=1114.63kg

Mass of fine aggregate

= e x volume of fine aggregate x specific gravity x1000

=0.678x0.4x2.6x1000

=705.12kg

Water content= 197litres

Mix proportion = 1:1.7:2.8

Materials required for one Cube

Cement for one cube = (0.15^3) x394

= 1.33kg

Sand for one cube = (0.15^3) x 705.12

= 2.38kg

Coarse aggregate for one cube = (0.15^3) x 1114.63

= 3.76kg

Specimen type	No: of specimens	Cement (Kg)	Sand (Kg)	Coarse aggregate (Kg)
Cube	1	1.33	2.38	3.76

Table: 2 Material contents

The material contents for concrete with partial replacement of sand with 10, 20%by weight with pulverized polypropylene are listed in the table given below:

Specimen type	No: of specimens	Cement	Sand+10%plastic	Sand+20%plastic	Coarse aggregate
Cube	1	1.33	2.142+0.238	1.904+0.476	3.76

Table:3 Material contents for concrete with plastic

Tests conducted on fresh concrete

- Slump cone test

The concrete slump test is an empirical test that measures workability of fresh concrete.

The test measures consistency of concrete in that specific batch. It is performed to check consistency of freshly made concrete. Consistency refers to the ease with. The test is popular due to the simplicity of apparatus used and simple procedure. Unfortunately, the simplicity of the test often allows a wide variability in the manner in which the test is performed.

The slump test is used to ensure uniformity for different batches of concrete under field conditions, and to ascertain the effects of plasticizers on their introduction. Slump cone test on concrete has been conducted as per IS:7320-1974 specification.

Figure: 8Slump cone test

Tests conducted on hardened concrete

- **Compression test**

When a specimen of material is loaded in such a way that the material compresses and shortens it is said to be in compression. The "strain" is the relative change in length under applied stress; compressive stress that shortens an object gives negative strain. Compression tends to amplify small sideways deflection into buckling.

Out of many test applied to the concrete, this is the utmost important which gives an idea about all the characteristics of concrete. By this single test one can judge that whether Concreting has been done properly or not.

Compressive strength is measured on materials, components, and structures. By definition, the ultimate compressive strength of a material is that value of uniaxial compressive stress reached when the material fails completely. The compressive strength is usually obtained experimentally by means of a compressive test. The apparatus used for this experiment is compressive testing machine.

A Stress–strain curve is plotted by the instrument and would look similar to the following:

Figure: 9 True Stress-Strain curve for a typical specimen

The compressive strength of the material would correspond to the stress at the red point shown on the curve. In a compression test, there is a linear region where the material follows Hooke's Law. Hence at this region **σ=EЄ**where this time E refers to the Young's Modulus for compression. In this region, the material deforms elastically and returns to its original length when the stress is removed.

This linear region terminates at what is known as the yield point. Above this point the material behaves plastically and will not return to its original length once the load is removed

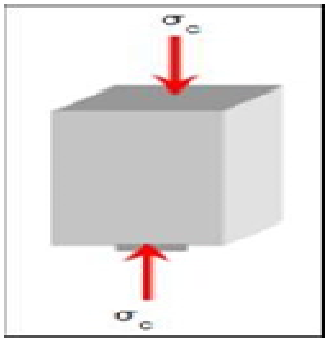

Figure:10 Action of compressive load

Compression test on cubes of conventional concrete and the concrete with partial replacement of sand with 10 and 20% pulverized plastic has been done

Figure: 11 Compression test

SummaryThe mix design for M20 grade concrete has been done with W/C ratio of 0.52mm and nominal size of coarse aggregate as 20mm is taken in to design considerations. Mix proportion was found to be 1:1.7:2.8. Different tests like slump tests, compaction factor test on fresh concrete have been done. Compression test, split tensile test, flexural test on hardened specimens have bee done.

IV. EXPERIMENTAL RESULTS

IntroductionAn experiment is a procedure carried out to verify, refute, or validate a hypothesis. Experiments provide insight into cause-and-effect by demonstrating what outcome occurs when a particular factor is manipulated. Experiments vary greatly in goal and scale, but always rely on repeatable procedure and logical analysis of the results. These results help in deciding the properties of the specimens and their usability and reliability

Test results of Cement

Standard consistency The standard consistency was found to be 29% of water by weight of dry cement.

SoundnessThe difference between two measurements before and after heating was found to be 3mm.

Initial setting time Initial setting time of the cement was found to be 32 minutes.

Specific gravity of cement

Weight of empty gravity bottle (W_1) = 30gm
Weight of empty gravity bottle + cement (W_2) = 46gm
Weight of empty gravity bottle + cement + kerosene (W_3) = 87gm
Weight of empty gravity bottle + Water (W_4) = 76gm
Specific gravity of cement
$= (W_2 - W_1)/ (W_2 - W_1)-(W3 - W_4)$
$= (46-30)/ (46-30)-(87-76)$
$=3.15$

The specific gravity of cement was found to be 3.15.
The results of experiments conducted on 53 grade ordinary Portland cement are listed in the table given below:

	Standard consistency	Soundness	Initial setting time	Specific gravity
IS code	IS:4031 part4-1988	----	IS:4031 part 5-1988	IS: 4031 Part 11-1988
Permissible limits	-----	Not >10mm	>30minutes	----
Result	29% of water by weight of dry cement.	3mm.	32 minutes	3.15

Table : 4 Test results of cement

Test results of sand

Sieve analysis, specific gravity test were conducted on fine aggregate. The results of sieve analysis and specific gravity are mentioned in tables given below:

Sieve analysis of sand

Sand of 1kg was used to perform sieve analysis. By using mechanical sieve shaker the test has been performed. The results are as follows

Sieve No:	Weight retained	% weight retained	Cumulative % retained	Cumulative % passed
4.75mm	24	2.4	2.4	97.6
2mm	25	2.5	4.9	95.1
1mm	102	10.2	15.1	84.9
600µ	328	32.8	47.9	52.1
300µ	519	51.9	99.8	0.2
150µ	1.8	0.18	99.98	0.02
			Total =270.8	

Table :5 Sieve analysis of sand

Fineness modulus	Specific gravity
270.8/100 =2.7	2.6

Table :6 Sieve analysis results of sand

Here from the sieve analysis it is found that fineness modulus of sand is 2.7

Specific gravity of sand

Weight of empty pycnometer(W_1) = 450gm
Weight of pycnometer bottle + sand (W_2) = 664gm
Weight of pycnometer + sand + water (W_3) = 1550mg
Weight of pycnometer + water (W_4) = 1280gm
Specific gravity of sand = (W_2 -W_1)/ (W_2 -W_1)-(W3 -W_4)

= (664-450)/ (664-450)-(1550-1280) = 2.6

Test results of coarse aggregate

- **Crushing value test**

Crushing value test on aggregate passing through 12mm and retained on 10mm IS sieves has been done. The test results are as follows:

S.No:	Details	Weight in kg
1	Total weight of aggregate sample filled in the cylindrical mould (w1)	3
2	Weight of aggregate retained on 2.36 mm sieve after the test(w3)	2.375
3	Weight of aggregate passing through 2.36mm sieve(w2)=(w1-w3)	0.625
4	Aggregate crushing value (w2/w1)x100	20.83

Table: 7 Crushing value test values

As crushing value is found to be 20.38 which is less than 40, the aggregate usable in concrete mix

Specific gravity of coarse aggregate

Weight of empty pycnometer(W_1) = 450gm
Weight of pycnometer bottle + coarse aggregate (W_2) = 781gm
Weight of pycnometer + coarse aggregate + water
(W_3) = 1490gm
Weight of pycnometer + water (W_4) = 1280gm

Specific gravity of Coarse aggregate
= (W_2 -W_1)/ (W_2 -W_1)-(W3 -W_4)
= (781-450)/ (781-450)-(1490-1280) = 2.7

Water absorption

Water absorption results are listed in table given below:

S.No:	Determination No:	Trial-I	Trial-II
1	Weight of saturated surface dried sample in kg	2.409	2.380
2	Weight of oven dried sample in kg	2.400	2.372
3	Water absorption	(0.005/2.400)x100 =0.208%	(0.005/2.372)x100 =0.210%

Average water absorption value=0.206%

Table:8 Water absorption test values

Note: Since water absorption values are < 4% the aggregate can be used in concrete

Tests results of pulverized plastic

- **Sieve analysis**

Sieve analysis is done on plastic material as it helps in finding the necessary in using sieved material or not. If the Coefficient of uniformity and Coefficient of gradation are > 6 and 1 respectively then the material is said to be well graded and the total material can be used, if not the material has to be sieved with the required IS sieve.

The sieve analysis values are listed in the table given below:

Sieve No:	Weight retained	%weight retained	Cumulative % retained	Cumulative % passed
4.75mm	3	0.3	0.3	97
2mm	370	37	37.3	62.7
1mm	197	19.7	57	43
600µ	218	21.8	78.8	21.2
450µ	80	8	86.8	13.2
300µ	73	7.3	94.1	5.9
150µ	48	4.8	98.9	1.1
75µ	9	0.9	99.8	0.2
<75µ	2	0.2	100	0
				Total =244.3

Table :9 Sieve analysis of plastic

Fineness modulus, **Coefficient of uniformity, Coefficient of gradation of the plastic material are listed below:**

Fineness modulus	Coefficient of uniformity	Coefficient of gradation
(244.3/100) =2.443	$C_u = D_{60}/D_{10}$ =1.7/0.37 =4.59	$C_g = (D_{30})^2/(D_{60} \times D_{10})$ =(0.79)²/(1.7x0.37) =1

Table : 10 sieve analysis results of plastic

Since the Coefficient of uniformity is found to be less than 6, the pulverized plastic is not a well graded one. So, the pulverized plastic is sieved on 2mm IS sieve and the material that got retained on 1mm sieve is taken.

Results of tests conducted on fresh concrete

- **Slump test**

Slump test on conventional concrete and concrete with partial replacement of sand with plastic at 10, 20% by

weight of sand and for all the concrete mixes true slump was found.

Results of tests conducted on hardened concrete

- **Compression test**

Compression test on cubes of dimensions 150x150x150mm has been done. Test on both conventional and concrete with partial replacement of sand with 10 and 20% of plastic by weight for 7, 14, 21 days has been done.

The compression test results of the specimens were listed in the table given below:

	Compressive strength for 7 days (N/mm^2)	Compressive strength for 14 days(N/mm^2)	Compressive strength for 21 days(N/mm^2)
Conventional concrete	25.33	27.8	29.3
Concrete with **10% plastic** replacement	25.77	27.22	28.8
Concrete with **20% plastic** replacement	24.4	24.88	27.11

Table: 11 Compression test values

The following graph gives the comparative results of compressive strengths

V. CONCLUSIONS

This project is an experimental study on partial replacement of sand with pulverized polypropylene in concrete. In this study we have prepared the conventional concrete and as well as concrete with partial replacement of sand with plastic at 10, 20% by weight of the sand. Coarse aggregate passing through 20mm IS sieve and retained on 16mm sieve is used. 53 grade ordinary Portland cement is used. Initial tests on cement, sand,coarse aggregate, pulverized plastic have been done. The mix design for M20 grade concrete has been done with W/C ratio of 0.52mm and nominal size of coarse aggregate as 20mm is taken in to design considerations. Mix proportion was found to be 1:1.7:2.8. Different tests like slump tests, compaction factor test on fresh concrete have been done. Compression test, split tensile test, flexural test on hardened specimens have been done. The test results of conventional concrete and concrete with partial replacement of sand with plastic at 10, 20% were compared

VI. CONCLUSIONS

As we know that plastic waste has become serious environmental problem an alternative way for use of this waste plastic has to be found. In this scenario usage of plastic in concrete has become best alternative for the reduction of plastic waste, as concrete has become main construction material.

VII. FUTURE SCOPE

Future studies can be carried out to increase the compressive and tensile strengths by adding some additives which does not effect the properties of this concrete mix (i.e., concrete with plastic replacementfor sand partially) as swell as the proper ties of plastic material. This may be done by adding some additives which can increase bonding between the materials.

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