A STUDY OF GREEN LIGHTWEIGHT CONCRETE USING POLYPROPYLENE (PP) AS A COARSE AGGREGATE

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December, 2015

A STUDY OF GREEN LIGHTWEIGHT CONCRETE USING POLYPROPYLENE (PP) AS A COARSE AGGREGATE

A Thesis Submitted in Partial Fulfillment of the Requirements for the Bachelor of Science in Civil Engineering.

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APPROVAL

This is to certify that the thesis submitted by Mohammad Abdur Raquib, Md. Nurul Haque Molla, Md. Mamun Hassan, Md. Ataur Rahman, Md. Nabi Hossen and Abu Sayed Ahmmadulla Farukee entitled as "A study of green lightweight concrete using polypropylene (PP) as a coarse aggregate" has been approved, in partial fulfillment of the requirements for the Bachelor of Science in Civil Engineering.

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DECLARATION

We hereby declare that the undergraduate research work reported in this thesis has been performed by us under the supervision of Abul Hasnat and this work has not been submitted elsewhere for any purpose (except for publication).

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OUR BELOVED PARENTS

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May almighty Allah give us the strength and courage to successfully complete our B.Sc. thesis.

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ABSTRACT

In the modern world it is to difficult for collection of suitable materials in construction and other renewable sources. Uses of plastic materials are largely used in family broadly, so their alarming waste is made us afraid. If these wastes are not reuse, the environment will be polluted. It is essential to focus this study to reuse the PP as partial replacement of coarse aggregate in concrete. For the safety durability and stability of the structure the PP will be used in the normal concrete. In lieu with this objective six cylinders are prepared with conventional concrete materials and eighteen cylinders are prepared with PP as a partial replacement 10%, 20% & 30% by volume of coarse aggregate to find out the best possible replacement ratio compared with regular (0%). Water cement ratio 0.48 is taken under consideration for achieving optimum workability to using PP as plastic coarse aggregate.

CHAPTER-1

Introduction

1.1 General

Light weight concrete (LWC) is a very important issue in this time. In concepts the most accepted the light weight concrete will be used instead of coarse aggregate (i.e. stone chips, bricks chips). LWC has many advantages in structural members which reduce the self weight of load bearing members (i.e. foundations, columns, beams).

Nowadays polypropylene (PP) is available everywhere in Bangladesh. Because a large number of PP are used and discarded daily which has pollution the environment. Specially reusing of plastic PP growing consciousness for the environmentalists. In this way PP can use in a concrete as a coarse aggregate which can be chooseable thing in the environment. In the construction works large numbers of brick chips required as coarse aggregates. Which is produced in the brick kilns its coil blast polishing in the environment by throwing carbon monoxide (CO), carbon dioxide (CO2) but PP omit gases.

So the study of PP will be used as a replacement of coarse and fine aggregate in concrete. The casting with the PP make a rough surface with aggregate & bindings materials for proper bonding and obtaining required compressive strength.

1.2 Literature Review

Phaiboon Panyakapo and Mallika Panyakapo (2007) This research presence utilization of thermosetting plastic as an admixture in the mixed proportion of light weight concrete. Experimental test for the variation of mix proportion were carried out to determine the suitable proportion to achieve the required properties of light weight concrete which are low dry density and acceptable compressive strength. Mix design proportion is plastic, sand, water cement ratio, aluminum powder and lignite fly ash. There experiment show that the plastic not only leads to a low dry density concrete and also a low strength. There mix design proportion is cement, sand, fly ash and plastic was 1.0:0.8:0.3:0.9. is an appropriate mix proportion. The result of compressive strength and dry density are 4.14 N/mm^2 and 1395 kg/m^3, respectively. This type of concrete meets most of the requirements for non load bearing light weight concrete according to ASTM C129 type II standard.

Choi et al (2004) This paper investigates of waste PET bottles lightweight aggregate for examine the effect of GBFS on WPLA. This test was conducted on compressive strength, splitting tensile strength, modulus of elasticity, slump and density of waste PET bottle. The compressive strength of 28 days with the replacement ratio 75% reduces about 33% compared and water cement ratio 45% .The density of WPLAC various from 1940 to 2260 kg/cum. In the water cement ratio 53 % the concrete workability improves 75% to 123%.

D.O. Oyejobi et al (2012) This paper gives on the effects of PKS sizes and percentage of light weight concrete. There are various kind of mix design proportion 1:1.5:3, 1.:2:4, 1:3:6, 1:4:8 were used for making cube & cylinders. It was cured for 7, 14 & 28 days before testing. The result of compressive strength of mix concrete 20.1 N/mm^2 with the proportion 1:1.5:3. Which is not less than British standard minimum strength of 15 N/mm^2.

T.R. Naik et al (1996) This research presence the post consumers uses waste HDPE plastic as a soft filler in concrete. Uses particles were three chemicals treatments (water, bleach, bleach+ NaOH) to improve their bonding with the cementitious matrix. The range of plastic particles 0% to 5% of total mixture by weight. After the chemical treatment the best performance was observed with alkaline bleach treatment (bleach+NaOH) with reference to compressive strength of concrete.

Meriaenrica Frigione (2010) In a similar research 5% of natural sand equal weight of pet aggregates which is manufactured from waste and unwashed pet bottle. As a result the WPET concrete display similar workability, characteristics, compressive strength and splitting tensile strength and higher ductility.

Bagherzadeh et al (2012) The polypropylene fibers in different proportion and fiber length improve the characteristics of LWC. There are two kinds of fiber length (6 mm and 12 mm) and there proportion in 0.15 % and 0.35% used in mixed design. This is compared to unreinforced LWC polypropylene (pp) reinforced LWC with the proportion 0.35% and 12 mm fiber length which flexural strength increased 35.1% and splitting tensile strength increase 27%.

Rahman et al (2012) This research presence three types of waste polymer that's are expanded polystyrene best packaging waste high density polyethylene and vehicle tire were used in the experiment. The experiment result show that the inclusion of waste polymer materials decreases compressive strength density porosity and water absorption properties. It can be used in non load bearing structure, floating structure, where light weight materials recommended.

Choi et al (2009) This paper presents as a fine aggregate use in light weight concrete which is manufactured from waste PET bottle. Result of the 1st phase showed that WPLA density is 1390 kg/m³, water absorption is 0%, bulk density is 844 kg/m³. Result of the 2nd phase showed that flow value increased when the compressive strength decreased proportionally to the addition of WPLA with elapsed time. In 3rd phase result showed that the slump of the WPLA concrete increased of the WPLA content increased regardless of W/C. The compressive strength decreased in the 28 days cured period 5%, 15% & 30% respectively increase of WPLA content 25%, 50% & 75%.

C. Albano et al (2009) The mechanical behavior of the concrete with recycle polyethylene therephtalate variation of water cement ratio and pet content and particle size. The thermal degradation of PET in the concrete in different temperature (200°, 400°, 600° C). As a result PET filled concrete when the particle size and volume ratio of PET increased.

Marzouk et al (2006) This paper describe and innovative use of consume plastic bottle as sand substitution aggregate in composite materials for building construction. Volume of sand 2% to 100% if substitute by the same volume of granulated plastic and various size of PET aggregates were used in the concrete composite. As a result the substituting sand below 50% of granulated PET which upper granular limit 5 mm that effects compressive strength and flexural strength of composite. A sand substitution aggregate used in cementitious concrete composite. These composite would appear and attractive low cost materials with consistent properties and they would help in resolving some of the solid waste problem in plastic production and in saving energy.

Alam et al (2013) This research gives us sustainable construction received much attention in many countries over the last few years. The countries most successful at recycling include Denmark the Netherlands and Japan. There recycling rates are 80, 75 and 65 respectively (Tam et al. 2005). This high recycling rates can be attribute to the quality of the new product using recycled C&D waste to reach a similar recycling rate in any country a comprehensive plan must exist and be exercise. The concrete produced by using this replacement aggregates will be greener and more sustainable materials.

Hyungu Jeong (2011) As interest in sustainable materials such as recycled aggregate concrete (RAC) rises, effort, it is important to understand the properties of RAC that relates to its use in construction. Processing variable indeed in this study are two stage mixing approach (TSMA) and control of RAC initial moisture contents. In case of shrinkage, some previous studies showed that RCA can absorb larger amount of water than natural aggregate because RCA has a higher porosity which leads concrete to increase shrinkage.

Sumaiya Binte Huda and M. Shahria Alam (2014) This study discusses the use of recycled coarse aggregate in concrete in a repeated fashion and investigates the fresh and hardened properties of this green concrete type. The results show that the repeated recycled concrete experienced slightly lower compressive strength than the control concrete. Its achieved their target strength at 56^{th} day except the 3^{rd} generation concrete.

Liang et al (2014) This paper discuss the one of the feasible alternative is to reuse construction and demolition waste as aggregates, all recycled aggregate. To make new concrete called recycle aggregate concrete (RAC). However the compressive strength of RAC is usually poor due primarily to the high water absorption capacity, high porosity and weaker bond of interfacial transition zone between recycled aggregate and new cement mortar. This paper presents the results of a comprehensive experimental study on RACs made of 100% recycled coarse aggregate.

1.3 Observation from the literature review

- Light weight concrete can be used in non load bearing floating structure where light weight materials recommended.
- The element of broken PP and HDPE as a replacement aggregates restrict the proper bonding between the aggregates and cementitious materials for the cause of smooth surface of plastic aggregates.
- For proper bonding chemical treatments or any others polymer is required.
- The partial replacement of plastic of fine aggregate does not reduce the density the concrete significantly.

1.4 Objectives

- The objective of this research are using PP aggregates instead of natural coarse aggregates in concrete for desire compressive strength.

1.5 Scope of work

To achieve the above mentioned objectives to research includes:-

- To get opportunity of plastic materials PP in concrete as a partial replacement of coarse aggregates.
- To achieve the objective with different PCA amounts using in concrete.
- To make relationship among the quantity of PCA, the water cement ratio and the compressive strength.

1.6 Organizing the thesis

In this chapter the overview of the research project is provided in order to have a clear theme of the entire thesis. All purposes of the research work is described at the same time. In the relevant literature review gives us previous clear concept and previous works which is done in the thesis. These thesis reviews have been under taken all over the world in the same field of materials engineering and structural or nonstructural application. In the letter parts of this thesis shown us advantage and disadvantage of using plastic materials in concrete. At last scope of the work mentioned the results which are obtained for our thesis purpose.

In the second chapter coarse aggregates, fine aggregates and binding materials are necessary for concrete mixture. Here describe gradations of the coarse aggregate and fine aggregate which are shown in charts and formats. In case of coarse aggregate and fine aggregate both the materials include plastic coarse aggregate (PCA) and the sieve analysis of the fine aggregate (Sand) is shown in tabular and graph format.

Following to the second chapter the third chapter methodologies obtained for the execution of the research project is described elaborately. In order to find out different properties of the materials and the concrete samples different methods were obtained. The specific gravity test and water absorption test are done to obtain the properties of the materials. To find out the workability of concrete samples of different combinations by the slump test. After the casting and curing procedures of the specified concrete are described. After 7 and 28 days of casting the compressive strength test are done in different combinations. At last the mix design of the concrete samples mentioning volume ratio of the materials used the amount of materials needed (by weight).

In the fourth chapter which consists of the test results and the discussions related to the obtained results. The parameter of the PCA concrete compared to the regular concrete samples are describe in a tabulated format including density, workability, compressive strength and failure pattern for the convenience of understanding. The compression among the properties and strength of the regular concrete, PCA concrete are shown in graphs and bar charts. These charts and graphs are provided to compare the results obtained from different tests of the concrete samples which include workability with water cement ratio, density with water cement ratio and the compressive strength of the concrete with water cement ratio.

Lastly the conclusions and the recommendations related to the research project are mentioned in the fifth chapter of this thesis.

CHAPTER 2

MATERIALS

2.1 General

In the concrete mixture various kinds of materials are used. The materials varying in properties and their function in the mixture. In the advance concrete technology along with conventional materials use of alternative materials and plasticizers are getting positive attention both in research and practical purposes. Different codes were followed for the specification of the materials. Brick chips were used as traditional coarse aggregates and we replaced some percentage of them with PP, Sylhet sand was used as fine aggregates and cement was used as binding materials.

2.2 Binding materials

We used seven rings cement (Portland cement) as binding materials for the chemical composition, physical properties and compressive strength. We followed quality test certificate of seven rings cement. Specific gravity of cement recorded 3.15, Initial setting time 133minutes and final setting time 328 minutes. These tests were done according to ASTM specification, which are ASTM C192, ASTM C187, ASTM C109 and ASTM C595.

Figure 2.1 Cement (binding materials)

Table 2.1 Properties of seven rings cement

Sl. no	Characteristics	Value
01.	Normal consistency	27. 00 %
02.	Specific gravity	3.15
03.	Initial setting time	133mins
04.	Final setting time	328mins

2.3 Coarse Aggregates

As a coarse aggregate we used PP (polypropylene) along with brick chips. PP is used to partially replace of brick chips as coarse aggregates.

2.3.1 Brick Aggregates

We collected bricks from local brick field. Then it's crushed at the maximum size of aggregates 19 mm and minimum sizes of aggregates are 4.75 mm. It washed to remove dust and dirt aggregates and were dried until the surface dry condition was obtained.
According to the ASTM C136, ASTM C127 standard to obtained it's physical properties. The results of various results are given below.

Table 2.2 Properties of brick (coarse aggregate).

Sl. No.	Characteristics	Value
01	Type	Crushed
02	Maximum size	19 mm
03	Minimum size	4.75 mm
04	Bulk specific gravity	1.97
05	Apparent specific gravity	2.28
06	Water absorption	14.57 %
07	Fineness modulus	6.93

Figure 2.2 Brick chips (coarse aggregate).

Table 2.3 Sieve analysis of brick chips (coarse aggregate).

Sl no	Sieve size (mm)	Mass Retained (gm)	% Retained	Cumulative % Retained	Cumulative % Passing
1	75	0	0	0	100
2	37.5	0	0	0	100
3	19	322	32.2	32.2	67.80
4	9.5	289	28.9	61.1	38.90
5	4.75	389	38.9	100	0
6	2.36	0	0	100	0
7	1.18	0	0	100	0
8	0.6	0	0	100	0
9	0.3	0	0	100	0
10	0.15	0	0	100	0
11	Pan	0	0		
			Total =	693.3	

Fineness modulus (FM) of brick chips = 693.3/100 = 6.93

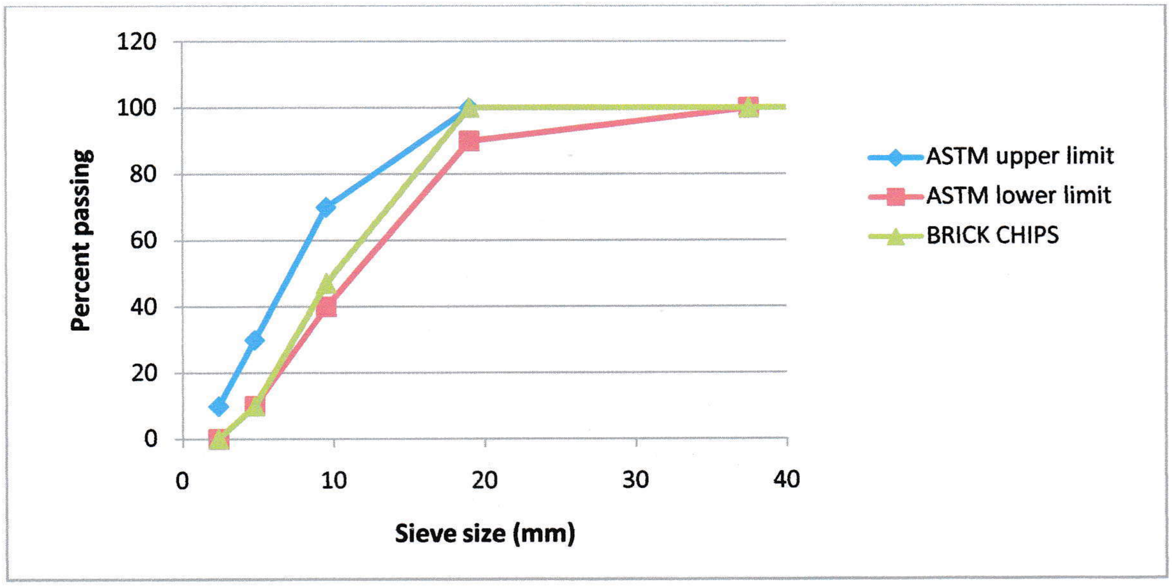


Figure 2.3 Fineness modulus of brick chips (coarse aggregate)

2.3.2 Plastic Aggregates

We used polypropylene (PP) as a part of coarse aggregate partially replaced of brick chips. PP is thermoplastic polymer. PP can be semi rigid to rigid. This PP is obtained as by product in melted condition while recycling of PP. Melted PP is collected and cooled to obtain PP mould when crashed, to use as coarse aggregate. This PP was sieved according to ASTM standard for coarse aggregate.

According to the ASTM C136, ASTM C127 standard to obtained it's physical properties. The properties are shown in below.

Table 2.4 Properties of plastic coarse aggregates (PP)

Sl. No.	Characteristics	Value
01	Type	Crushed
02	Maximum size	9.5 mm
03	Minimum size	2.36 mm
04	Bulk specific gravity	1.34
05	Apparent specific gravity	1.35
06	Water absorption	0.38 %
07	Fineness modulus	5.90

Figure 2.4 Polypropylene (Coarse Aggregate).

Table 2.5 Sieve analysis of plastic aggregate (PP)

Sl no	Sieve size (mm)	Mass Retained (gm)	% Retained	Cumulative % Retained	Cumulative % Passing
1	75	0	0	0	100
2	37.5	0	0	0	100
3	19	0	0	0	100
4	9.5	23	2.3	2.3	97.7
5	4.75	856	85.6	87.9	12.1
6	2.36	121	12.1	100	0
7	1.18	0	0	100	0
8	0.6	0	0	100	0
9	0.3	0	0	100	0
10	0.15	0	0	100	0
11	Pan	0	0		
			Total =	590.2	

Fineness modulus (FM) of PP = 590.2/100 = 5.90

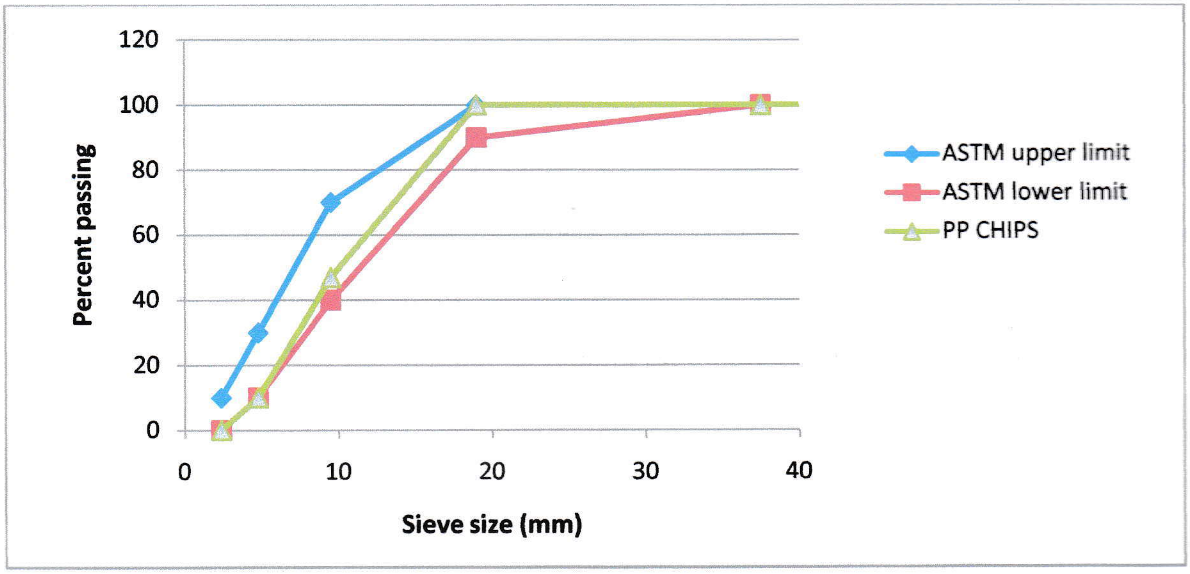


Figure 2.5 Fineness modulus of plastic coarse aggregate (PP)

2.4 Fine Aggregate

Sylhet sand was used as fine aggregate. It was collected from local supplier and it will be passed by 2.36 mm sieve. Foreign particles were removed from the sand. Various types of test are done like sieves analysis, moisture content, bulk specific gravity, apparent specific gravity etc.

According to the ASTM C136, ASTM C128 and ASTM C70-94 standard to obtain it's physical properties. The properties like type of sand, maximum and minimum size, specific gravity water absorption capacity and sieve analysis are shown in below.

Table 2.6 Properties of fine aggregate (Sand)

Sl. No.	Characteristics	Value
01	Type	Uncrushed (Natural)
02	Maximum size	2.36 mm
03	Minimum size	0.15 mm
04	Bulk specific gravity (oven dry)	2.15
05	Bulk specific gravity (SSD)	2.34
06	Apparent specific gravity	2.61
07	Water absorption	7.90 %
08	Fineness modulus	2.85

Figure 2.6 Sand (Fine aggregate)

Table 2.7 Sieve analysis of fine aggregate (sand)

Sl no	Sieve size (mm)	Mass Retained (gm)	% Retained	Cumulative % Retained	Cumulative % Passing
1.	75	-	-	-	-
2.	37.5	-	-	-	-
3.	19	-	-	-	-
4.	9.5	-	-	-	-
5.	4.75	-	-	-	-
6.	2.36	22	4.40	4.40	95.60
7.	1.18	116	23.20	27.6	72.40
8.	0.60	159	31.80	59.40	40.60
9.	0.30	175	35.00	94.40	5.60
10.	0.15	22	4.40	98.80	1.20
11.	Pan	6	1.20		
			Total =	284.60	

Fineness modulus (FM) of sand = 284.60/100 = 2.85

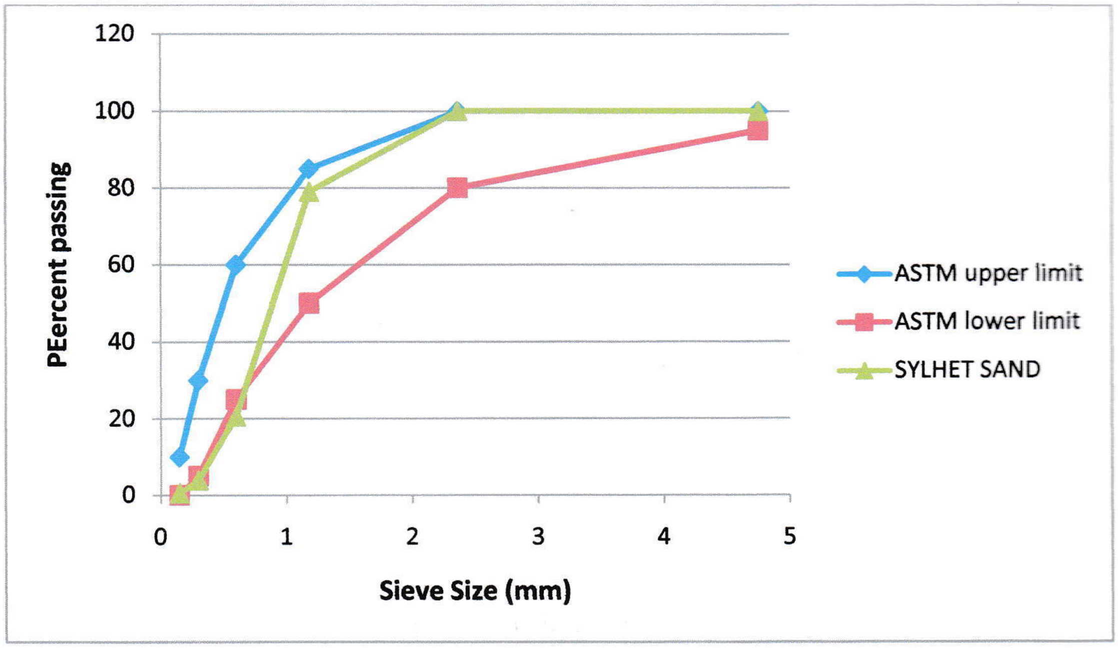


Figure 2.7 Fineness modulus of sand (Fine aggregate)

2.5 Conclusion

We collect different properties of materials which are used in our project. It has given in different data table.

CHAPTER 3

METHODOLOGY

3.1 Introduction

Some laboratory test of materials done to find out their characteristics before and after casting of cylinders that were tested to measure the compressive strength and failure pattern to reach the experimental goals, The following test were done as specific gravity test, slump test, water absorption test, density test, casting and curing and compressive strength test.

3.2 Specific Gravity

This test is used to determine the specific gravity of aggregates by Calculating the Ratio of the weight of a given volume of aggregate to the weight of an equal volume of water. The specific gravity measures aggregates weight under three different sample conditions:

1.Oven -dry (no water in sample)

2. Saturated surface -dry (SSD, water fills the aggregate pores)

3. Sub merged in water (under water)

The standard coarse aggregate specific gravity and absorption test is ASTM C127 and ASTM C128 specific gravity and absorption of coarse aggregate and fine aggregate respectively. Approximate test time is three days (from sample preparation two final dry weight determination).

Formula:

Bulk specific gravity (oven dry), Sd:

$$\frac{A}{B-C} \qquad (3.1)$$

Here,

A= Weight of oven dry test sample in air, g

B = Weight of saturated surface dry test sample in air, g

C = Weight of saturated test sample in water, g

Bulk specific gravity (saturated surface dry), Ss:

$$\frac{B}{B-C} \qquad (3.2)$$

Apprent specific gravity, Sa:

$$\frac{A}{A-C} \qquad (3.3)$$

Water Absorption

$$\frac{B-A}{A} \text{ X } 100\% \qquad (3.4)$$

3.2.1 Basic procedure for coarse aggregate

At first constant weight of the sieved materials is taken and dried at a temperature of 110°$\pm$ 5 in oven. After one hour of drying the weight of the sample is taken. A bucket containing the sample is drowned in water. The weight of drowned sample is taken. After that the sample is surface dried and weight is taken. By using formulas mentioned above the bulk specific gravity (oven dry) from equation 3.1, bulk specific gravity (saturated surface dried) from equation 3.2, apparent specific gravity from equation 3.3 and water absorption capacity from equation 3.4 are determined.

Figure 3.1 Measurement of brick chips

Figure 3.2 Measurement of PP

3.2.2 Basic Procedure for Fine Aggregate

The sieved sample of fine aggregates is thoroughly washed to remove finer particles and dust, drained and then placed in the wire basket and immersed in distilled water at a temperature between 22° and 32°C. The weight of the sample is taken first before placing it under water. After that the basket and sample are immersed under water for a period of 24+½ hrs. Then the basket and aggregates are removed from the water, allowed to drain for a few minutes, after which the aggregates are gently emptied from the basket one to one of the dry cloths and gently surface-dried with the cloth. After wards the samples are transferred to a second dry cloth when the first would remove no further moisture. The Aggregates are spread on the second cloth and exposed to the atmosphere away from direct sunlight till it appears to be completely surface- dry. The aggregates are then weighed. Lastly the aggregates are placed in an oven at a temperature of 100° to 110° C for 24 hrs. The samples are then removed from the oven cooled and weighed. From the aforementioned formulas the desired properties for fine aggregates are determined.

Figure 3.3Measurement of Sand

3.3 Mix Design

For one selected water- cement ratio the tests are carried out. Water cement ratio of 0.48 is used. The selected mix proportion is 1:1.5:3 (Cement: fine aggregate: coarse aggregate) by volume. The coarse aggregate is partially replaced by PP by volume 10%, 20% and 30%. There is also 6 sample concrete cylinders which contains only brick chips as coarse aggregate where PP is 0%. For compressive strength test three cylinders for 7 days and three cylinders for 28 days. Total six cylinders are casted for each designation or mixing criteria. Ten, Twenty and thirty percentage of coarse aggregates are used for one water cement ratio. That means total 24 (6×4) cylinders are casted in the project to determine compressive strength test. The coarse is partially replaced by volume. But the aggregates amount is determined in weight (kg) by the help of specific gravity of the aggregate. So the mix proportion 1:1.5:3 is maintained by the volume.

Table 3.1 Mix design for 1 cft concrete (by Volume)

Designation	W/C Ratio	Water (kg)	Cement (kg)	Fine aggregate (kg)	Coarse aggregate (kg)	Plastic Coarse aggregate (kg)
W48P0	0.48	3.167	6.597	7.791	12.499	0
W48P10	0.48	3.167	6.597	7.791	11.249	0.533
W48P20	0.48	3.167	6.597	7.791	9.999	1.065
W48P30	0.48	3.167	6.597	7.791	8.749	1.598

3.4 Slump test

The test is performed by using a mould known slump cone or Abrams cone. The cone is placed on a hard non absorbent surface. Then the cone is filled with fresh concrete in three layers, each time it is tempered (16 mm plain rod) 25 times. At the end of the third stage, concrete struck off flush to the top of the mould. The mould it's carefully lifted vertically upwards, so as not to disturb the concrete cone. The slumped concrete takes various shapes and according to the profile of slumped concrete, the slump is termed as true slump, shear slump or collapse slump.

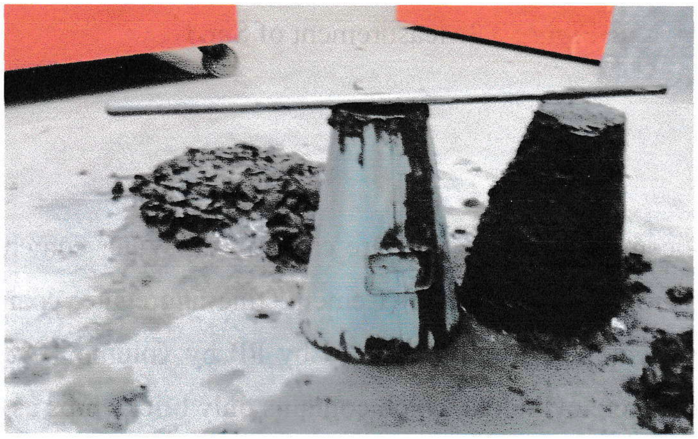


Figure 3.4 Slump test

3.5 Casting and curing

4"x8" cylinder moulds are used for casting fresh concrete. First all moulds are cleaned and oiled properly and grease is applied in the inner portion of the moulds and grease is applied in the inner portion moulds. Care is taken that there is no gaps in the mould so no possibility of leakage of slurry. The cement, water, coarse aggregate and fine aggregate are weighted first according to mix design. The concrete mixtures are prepared by automatic mixture machine. Then the moulds are filled up with concrete in two layers. In each layer 25 blows are given with the tempering rod. Then moulds are placed for 24 hours for compaction. After 24 hours the cylinders are taken out from the moulds by loosening the screws of the steel moulds and the samples are made ready for curing. Ponding method of the samples is selected as curing method for the concrete specimens. After 24 hours of casting, all the cylinders are designated by marker at the top of the cylinder and kept under water for 7 and 28 days at controlled temperature. Generally the compressive strength of concrete differs according to the edge (i.e. 7, 14, 21, and 28 days). For this project 7 and 28 days of curing are considered as standard. Curing is done for the increase in strength of the cylinders. This is done in a small pond and the temperature is controlled. Also fresh water is provided for better curing.

Figure 3.5 Casting of concrete cylinder

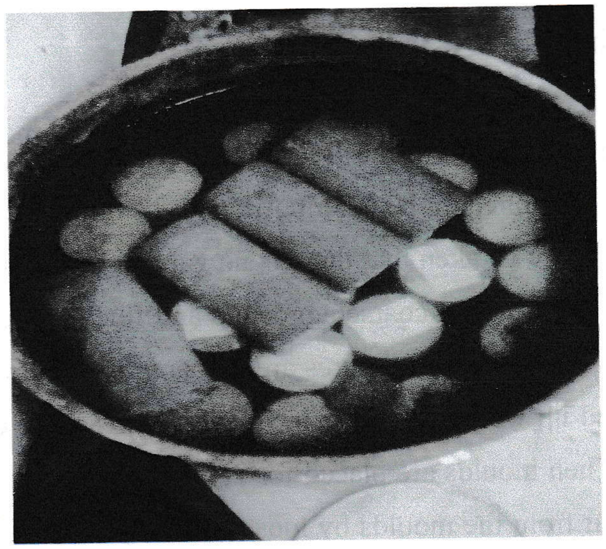


Figure 3.6 Curing of concrete cylinder

3.6 Density measurements

The density of concrete is measured from 4" × 8" concrete cylinder. The cylinders are taken from curing pond and outside water is cleaned by a piece of towel. The weights are taken afterwards. Then the weights are divided by the total volume of the cylinder to get the density of concrete.

Figure 3.7 Density measurement

3.7 Compressive strength test

After 7 and 28 days of curing compressive strength test is done. The cylinders are taken to the lab after finishing the curing and density measurement. The samples are entered into the Universal Testing Machine (UTM) to determine compressive strength after measuring its' diameter to determine its' contact surface area. In this project, for capping of concrete we use rubber capping. Its thickness is 2.5 in with a larger diameter of concrete cylinder and it is placed between the top lever and top surface of cylinder. Both the levers of UTM machine are kept in touch with the two surface of cylinder. After placing the samples in the machine, the loads are applied unless the cylinder reaches its ultimate limit of taking the compression loads. When ultimate load is obtained, there is a drop of load value in graph in the computer screen and ultimate load is obtained in KN unit. Which is then decided by the contact surface area to measure compressive strength. For each designation or mixing properties average of three cylinders compressive strengths are taken.

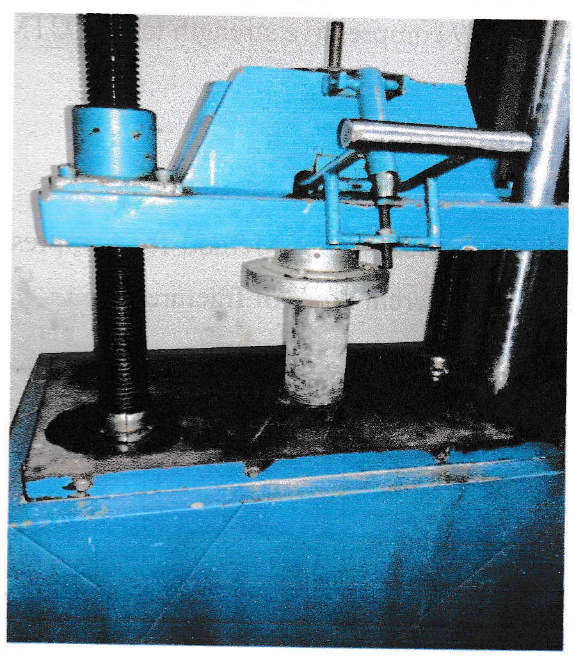
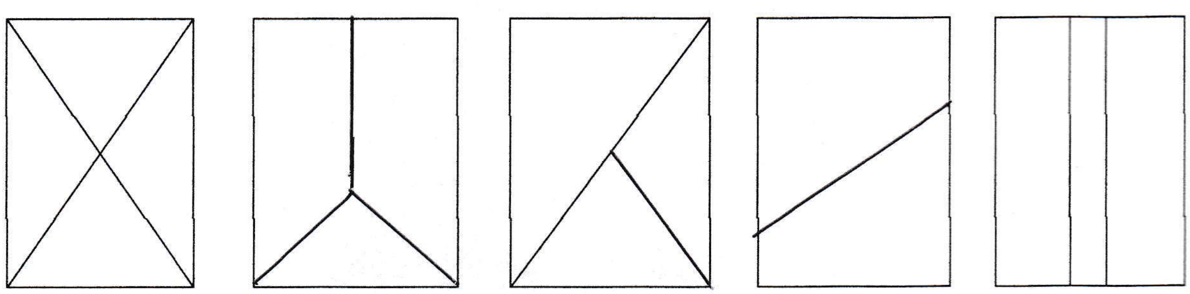


Figure 3.8 compressive strength test by UTM

Figure 3.9 compressive strength test by UTM

3.8 Failure pattern of concrete

According to ASTM C 39-03, Standard Test Method for compressive strength of cylinder concrete specimens" shows five different types of fractures:



Cone (a)	Cone and split (b)	Cone and shear (c)	shear (d)	Columnar (e)

The cone failure results when friction at the plates of the testing machine restrains lateral expansion of the concrete as the vertical compressive is applied (a). The cone and split is the combination of cone and splitting of the concrete specimen (b). The cone and shear results according to the combination of both cone and shear failure of a concrete specimen (c). The shear failure occurs in the concrete specimen and failure occurs in the week shearing zone (d). The columnar failure occurs vertical to the length of the specimens (e).

3.9 Conclusions

In this chapter the physical properties of the materials including specific gravity and water absorption are formulated and described elaborately. Also the properties of the concrete and the samples including slump value, compressive strength and density are discussed simultaneously.

CHAPTER 4

RESULT AND DISCUSSION

4.1 General

In this chapter we performed the results from the experimental work and adopted methodologies. We obtained data from the experiments which have been analyzed for suitable measure of polypropylene (PP) as an alternative light weight aggregate in load bearing structures. From the observation of the experiments several parameters of natural aggregate concrete PP coarse aggregate concrete in various proportions. The parameter includes density, workability, compressive strength and failure pattern which are shown in the Table 4.1 and 4.2.

Table 4.1 Summary of the test results for regular and PP concrete at 7 days

% of PCA	W/C ratio	Density (Kg/m³)	Av. Density (Kg/m³)	Slump (cm)	Compressive strength (Mpa)	Average of Compressive strength (Mpa)
0	0.48	2105	2099	2.54	15.61	15.43
		2102			15.96	
		2090			14.72	
10	0.48	1990	2003	3.81	12.40	11.78
		1995			11.78	
		2024			11.16	
20	0.48	2001	1991	4.45	13.64	14.88
		1995			16.12	
		1978			14.88	
30	0.48	1963	1945	5.08	14.26	14.47
		1904			14.26	
		1969			14.88	

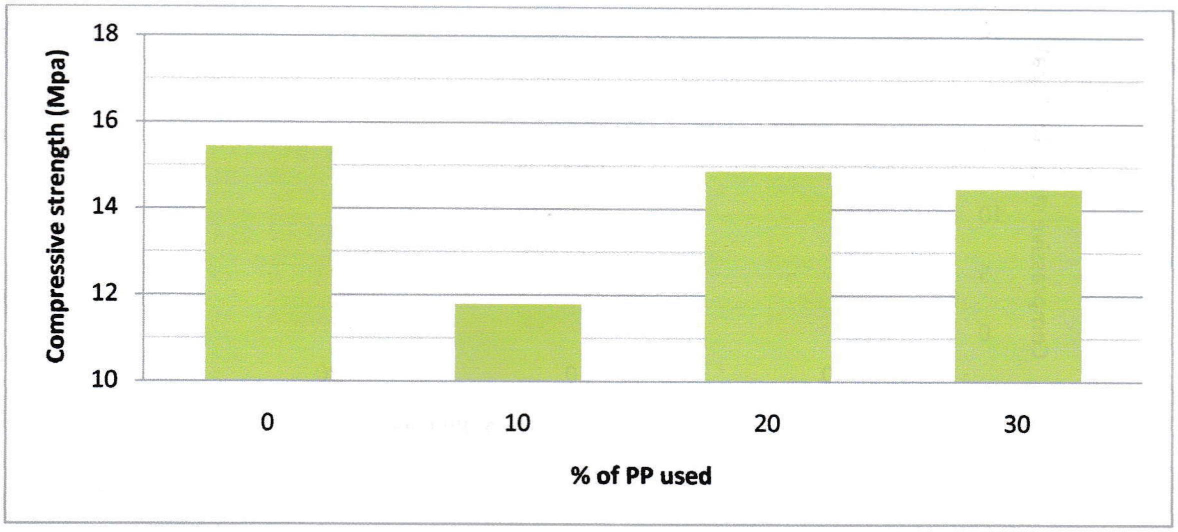


Figure 4.1 Compressive strength vs. percentage of regular and PP at 7 days

Table 4.2 Summary of the test results for regular and PP concrete at 28 days

% of PCA	W/C ratio	Density (Kg/m^3)	Av. Density (Kg/m^3)	Slump (cm)	Compressive strength (Mpa)	Average of Compressive strength (Mpa)
0	0.48	2108	2115	2.54	20.71	20.17
		2136			19.52	
		2102			20.29	
10	0.48	2047	2004	3.81	15.50	15.71
		1980			16.12	
		1985			15.50	
20	0.48	2018	1981	4.45	18.60	18.20
		1985			17.36	
		1940			18.60	
30	0.48	1985	1975	5.08	16.12	15.84
		1983			16.12	
		1956			15.50	

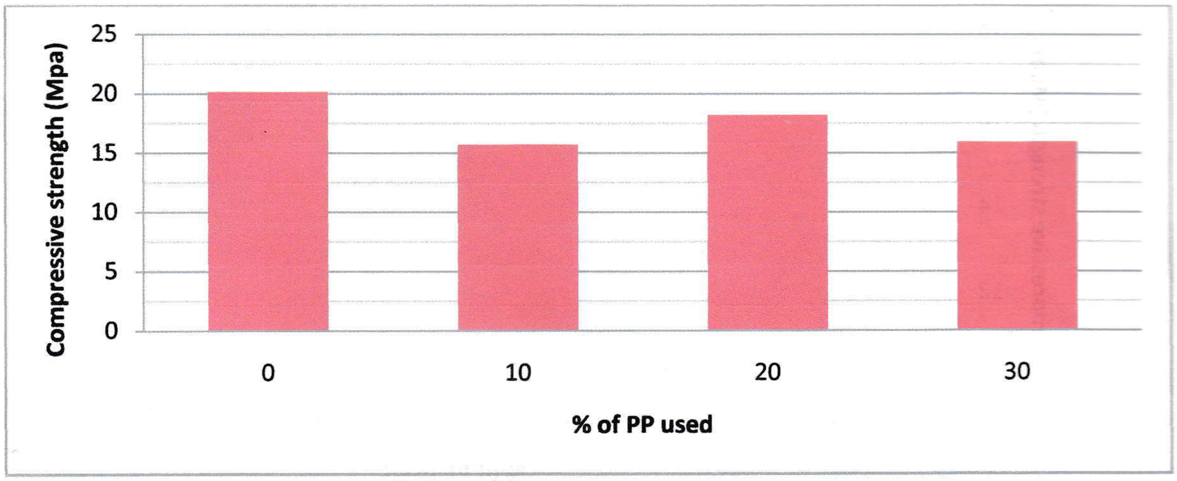


Figure 4.2 Compressive strength vs. percentage of regular and PP at 28 days

4.2 Workability

In concrete mixture workability is an important step. It is affected by water content in the mixture along with mix proportion and size, shape and grading of the aggregate. Concrete will be workable when it is easily laying and compacted homogeneously i.e. without segregation.

Table 4.3 Slump value for regular and PP concrete

Coarse PP (%)	Water-Cement ratio	Slump Value (cm)
0	0.48	2.54
10	0.48	3.81
20	0.48	4.45
30	0.48	5.08

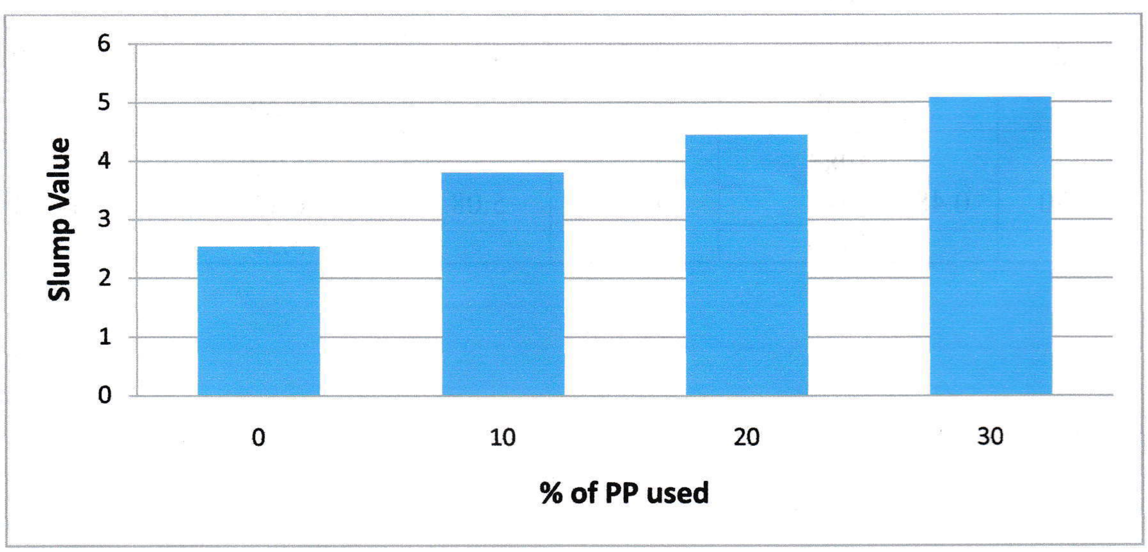


Figure 4.3 Slump value vs percentage of regular and PP

4.3 Density

The density of concrete is measure of its unit weight. The mixture of concrete is made by cement, fine and coarse aggregate and water. The density mostly depending on the amount of aggregate and density of the aggregate. The density of the samples was measured at dry condition of 7 & 28 days just before the strength test. Density values of all the cylinders for various conditions are given in Table 4.1 & 4.2. With increasing percentage of PP in concrete the density is gradually decreasing which is mostly due to the low unit weight of PP. The maximum reduction was observed for the replacement of coarse aggregate with 30 % of PP and the reduction of density was about 7.5%. For 10% replacement of coarse aggregate the density reduction is very less (2.3% for water-cement ratio 0.48). Density reduction is almost 6% for any 20% replacement (10% to 30% PP used)

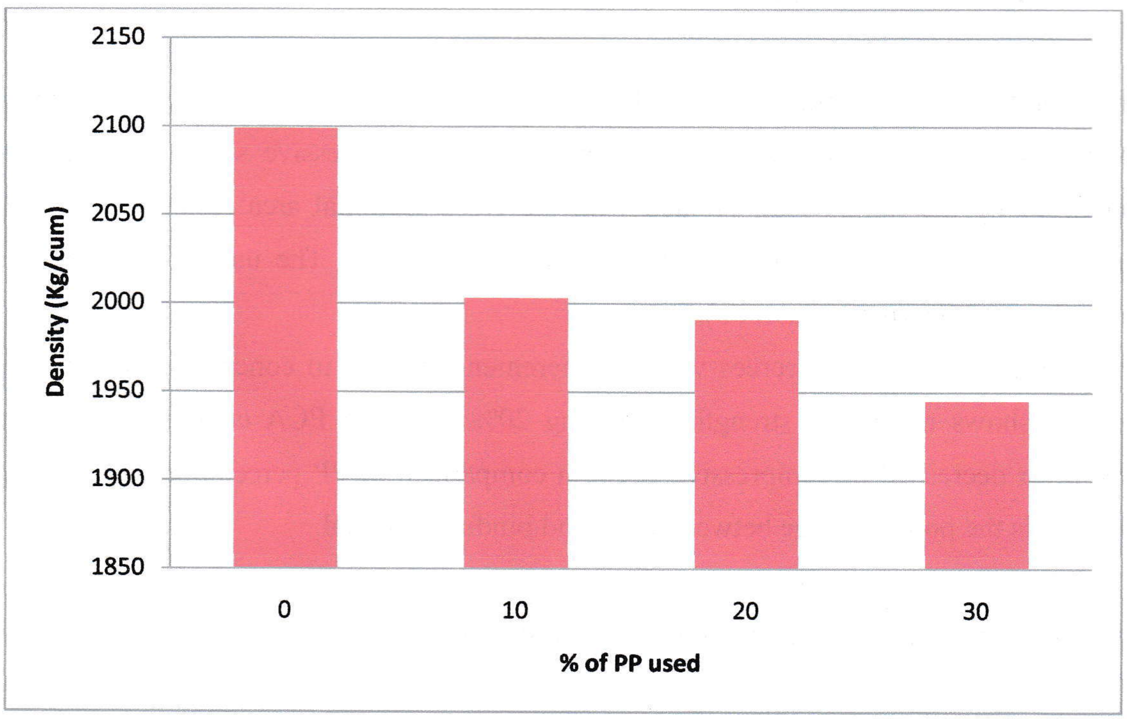


Figure 4.4 Density vs percentage of regular and PP at 7 days.

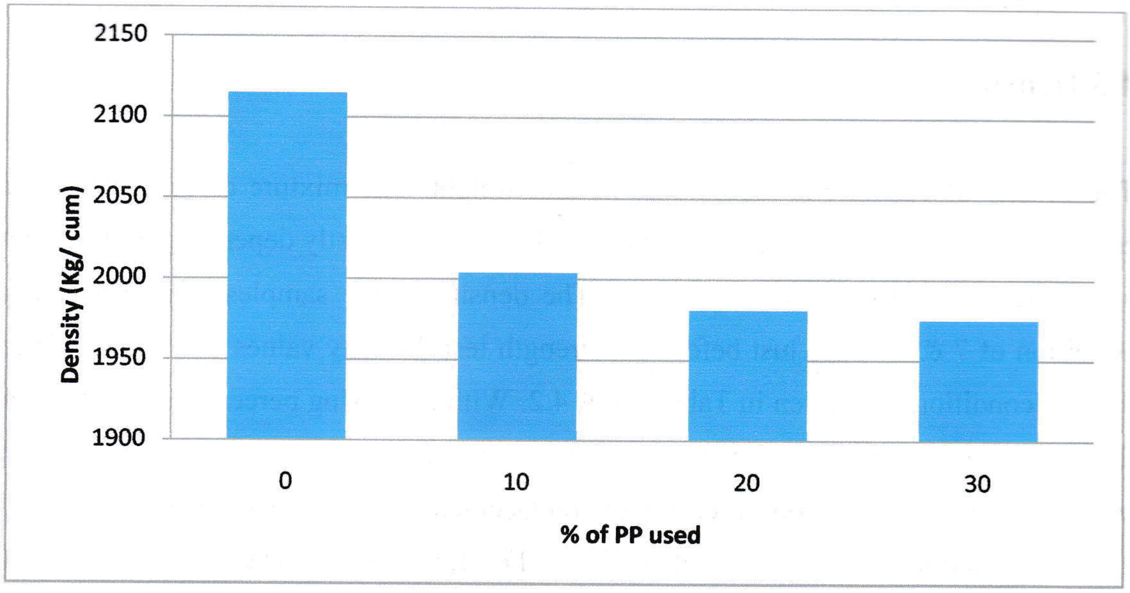


Figure 4.5 Density vs. percentage of regular and PP at 28 days.

4.4 Compressive Strength

The compressive strength measured by crushing cylindrical concrete specimen in compression testing machine (ASTM Standard). The compressive strength of concrete is calculated by the failure load divided with the cross sectional area resisting the load and reported after 7 days in table 4.1 and 28 days in table 4.2. The unit of the compressive strength is in Mpa (mega Pascal's).

The strength increase or decrees with the increment of PCA in concrete. The compressive strength shows maximum strength in mixing 20% of PP in PCA concrete. The probable reason for decreased of compressive strength comparison of PP percentage with the regular concrete is the poor bondage between PCA and binding material.

Table 4.4 Percentage reduction of compressive strength at 7 days

Percentage of PP	Compressive strength of 7 days	Percentage reduction in compressive strength (%)
0 %	15.43	-
10 %	11.78	23.7
20 %	14.88	3.6
30 %	14.47	6.2

Table 4.5 Percentage reduction of compressive strength at 28 days

Percentage of PP	Compressive strength of 28 days	Percentage reduction in compressive strength (%)
0 %	20.17	-
10 %	15.71	22.1
20 %	18.20	9.8
30 %	15.84	21.5

Figure 4.6 Failure by compressive strength

4.5 Conclusion

This chapter gives us different kind of test results as like as workability, density and compressive strength which is suitable for the building construction work and satisfied the BNBC (Bangladesh National Building Code) code. PCA concrete indicate that plastic can be used as an coarse aggregate for light weight concrete. Due to the limitation only two sets of each sample concrete cylinders are made and average is being taken for comparison. The result shows that PCA contained concrete is better suitable over natural concrete as a light weight concrete aggregate.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 General

This experiment replaced by plastic coarse aggregate PP in the instead of normal coarse aggregate. There are 03 (Three) different percentage of plastic coarse aggregate (PP) used in concrete mixture to find out an optimum replacement solution. The experimental results and various type of table are drawn and recommendations are made.

5.2 Summary and Conclusion

Different types of point from this experiment are given below:

1. Polypropylene (PP) as a plastic coarse aggregate (PCA) can be used partial replacement in normal concrete.
2. Because the lower specific gravity, PCA has helped reducing the unit weight of concrete which gives us advantage for creating light weight concrete structure.
3. The workability of concrete is improved by increasing of PP Percentage because the shape and surface condition of PP and suitable water cement ratio.

5.3 Recommendations

From this experiment we recommend that plastic coarse aggregate can be used light weight concrete. For the cause of specific gravity, density, workability and compressive strength which is suitable for low cost building structure. Therefore the further research can be increase the strength the light weight concrete by chemical and any other treatment of PP.

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