REPLACEMENT OF FINE AGGREGATES BY WASTE GLASS AND COARSE AGGREGATES BY WASTE PLASTIC

A RESEARCH REPORT

Submitted by

WARIS AHMAD KAR

11611360

RC1611A29

In partial fulfillment for the award of the degree of

MASTERS OF TECHNOLOGY

IN

STRUCTURAL ENGINEERING

Under the guidance of

Mr. Ashfaq Malik

Assistant Professor

School of Civil Engineering LOVELY PROFESSIONAL UNIVERSITY
Phagwara–144411, Punjab (India)

DECLARATION

I hereby declare that the dissertation report titled "**REPLACEMENT OF FINE AGGREGATE BY WASTE GLASS AND COARSE AGGREGATE BY WASTE PLASTIC**" is an authentic record of my own research work carried out as a requirement for the preparation of M-Tech dissertation for the award of Masters of Technology Degree in Civil Engineering from Lovely Professional University, Phagwara, Punjab, under the guidance of Mr. Ashfaq Malik, during the period between February 2017 and May 2016. All the information furnished in this report is based upon my intensive work and is completely genuine to the best of my knowledge. And no part of the uncited work in this report has ever been published before in any journal or presented for the award of any degree or honour.

Date: 27-11-2017

Waris Ahmad Kar

11611360

CERTIFICATE

Certified that this project report entitled **"REPLACEMENT OF FINE AGGREGATES BY WASTE GLASS AND COARSE AGGREGATES BY WASTE PLASTIC"** submitted individually by student of School Of Civil Engineering, Lovely Professional University, Phagwara, carried out the work under my supervision for the Award of Degree. This report has not been submitted to any other university or institution for the award of any degree.

Signature of Supervisor

Mr. Ashfaq Malik
Assistant Professor

ACKNOWLEDGEMENTS

Firstly I would like to express my special thanks of gratitude to my respected guide Mr. Ashfaq Malik who with his intelligence and humbleness guided me at every step of my project "**Replacement of Fine Aggregates by Waste Glass and Coarse Aggregates by Waste Plastic**" I worked my fingers to the bone to complete this project. His patience, helpfulness, and friendly style are extraordinary and exceptional. He is extremely active, sincere and helpful to all the students whether they come under his supervision or not. Without his guidance this project work wouldn't have been possible.

I would also like to offer my sincere thanks to all those without whose guidance, help, and unlimited support this study could not have been completed. At last I would like to pay a heartily gratitude to my beloved family whose unconditional support has never let my head hang down, especially when we had to be far from each other for some years.

ABSTRACT

Solid waste management is one of the major environment concerns in the world. Replacement of aggregate in concrete at different percentages has been done in the past. There is possibility of partial replacement of fine aggregate and coarse aggregate by waste glass and waste plastic (HDPE) respectively. This will help in producing light weight concrete as well as will be effective in utilizing waste products. Different tests will be conducted to find out appropriate replacement percentage of waste glass and plastic to maintain the strength of concrete. As pozzolanic activity increase strength in concrete due to glass replacement and plastic helps in producing light weight concrete.

Keywords: concrete; waste glass; plastic; strength; light weight concrete

CONTENTS

LIST OF FIGURES

LIST OF TABLES

Chapter 1 Introduction

1.1 General

Concrete is a composite material made up of coarse aggregate bonded together by cement which hardens with time. Most concrete are Portland cement concrete or hydraulic cement concrete or asphalt concrete which is mostly used for road surfaces. The aggregate is mixed with cement and water that forms slurry and is easily moulded into different shapes. The water and cement react chemically with other materials that form a hard stone like material. Many materials have been tried to replace the conventional aggregates and cement in concrete. Depending upon the effect of replacements on fresh and hardened properties of concrete different optimum percentage of replacements has been achieved. Fine aggregate can be successively replaced by waste glass and coarse aggregate by waste plastic. And also utilising waste materials in concrete can lead to betterment of concrete properties and reduction of waste materials from environment.

1.2 Waste Glass

Waste glass can be obtained locally from shops or crushed bottles, broken glass ware etc. The glass has sufficient silica content and is amorphous in nature. The glass can be grounded to the size fine enough to reduce alkali silica reaction and to enhance pozzolanic reactions. The size of the glass is the important criteria to activate the pozzolanic activity.

1.3 Waste Plastic

There are different types of waste plastic that can be used in the concrete mix like low density polyethylene (LDPE), high density polyethylene (HDPE), polypropylene (PP), polystyrene (PS), polyethylene terephthalate (PET).Depending upon suitable percentage replacement of fine aggregate and coarse aggregate different properties of concrete show different behaviour. Since it isn’t possible to completely replace the aggregates by plastic so different replacements are done at different percentages to find out optimum percentage.

Solid waste management is one of the biggest problems faced by the world. We should find ways to recycle waste materials into some usable products. The concept of utilizing waste materials for building purposes has been done in the past. Different waste materials like fly ash, rice husk, silica fume etc has been successfully incorporated into construction use. Similarly we can use waste glass and waste plastic as partial replacement of fine aggregate and coarse aggregate respectively. Different percentage of these waste materials have been used in concrete and tested for their strength. Successful incorporation of these waste materials (glass and plastic) has provided alternate means of solid waste management. Glass and Plastic as waste materials is being produced in large quantities around the globe. Reusing of these waste materials has decreased the burden of dumping them in soil. Different tests have been carried out on concrete at different percentages by waste glass and plastic with good results. Utilization of these waste materials will decrease the cost of concrete as well as help in producing light weight concrete. There is need to recycle the glass to avoid environmental threats and by using waste glass in concrete makes it more valuable material.

Chapter 2 Scope of the Study

- The modified concrete can be used in light weight structures as it will decrease the dead weight of the structure.
- It can be used in pavement blocks in parking areas and the places where bearing capacity of soil is low.
- Short-creting in canals can be done with this concrete because of low permeability.

Chapter 3 Objective of the Study

The main objective of the research is:

- To develop a concrete mix that is economical and light in weight yet effectively satisfies all the structural requirements.

Chapter 4 Literature Review

The use of waste material represents a means of relief to some of the solid waste management. Various researchers have worked on the replacement of fine aggregate and coarse aggregate in concrete and to see the effect of replacement on different properties of concrete.

They have discussed about the effects on different properties of concrete. Here are some of the details of their outcomes which come from their papers in the shape of literature.

Yixin Shao et al. (1999) [1] in this research paper study was carried out to find the possibility of using waste glass as fine aggregate replacement. Different tests were conducted to check the possibility of replacement. Some of these tests include Lime glass test, Mortar bar test and compressive strength test. Lime glass test was done to check the pozzolanic activity due to presence of waste glass. Compressive strength test was conducted at 30% replacement of fine aggregate by WG and mortar bar test was used to study the effect on expansion. It was confirmed from the tests that WG having size lessthan 38 microns did possess some pozzolanic behaviour. The specimen passed the compressive strength test by surpassing 4.11 MPa. The strength activity index was 91, 84, 96, and 108% at 3,7,28 and 90 days respectively exceeding 75% at all stage. The reduction in expansion was more than 50% as confirmed by mortar bar test. It was confirmed than smaller sized particles have higher strength and lower expansion due to their interaction with the lime.

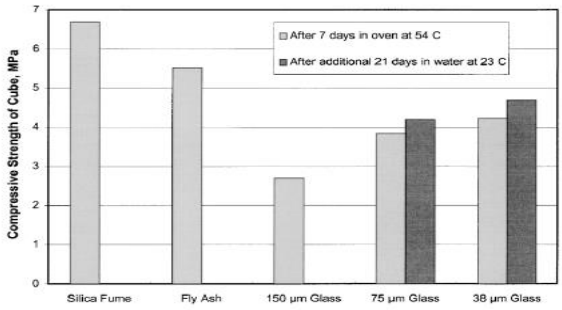

Fig 4.1 Compressive strength of additive mixtures

Mehmet Canbaz et al. (2003) [2] this research was done to study the effects of WG as coarse aggregate replacement. WG having size 4-16 mm was used in the experiment. The study was carried out on the fresh and hardened properties of concrete. It was found out from the test results that WG does not have much effect on workability and strength is slightly reduced due to replacement of coarse aggregate. ASR properties were also taken into consideration during the testing process. It also decreased the cost of concrete production because of usage of waste materials instead of natural coarse aggregates. WG replacement declined the slump, air content and fresh unit weight. However VeBe values were increased. These were the effects on fresh properties of concrete. On examining the hardened properties, the test results suggested that compressive strength, flexural and indirect tensile strength show a declining pattern with increase in WG. With 60% replacement of coarse aggregate by WG, the compressive strength values decreased by 49%. Due to high amount of silica (SiO2) alkali silica reaction can be the reason for decrease in strength.

Seung Bum Park et al (2004) [3] this work was aimed at finding out the possibility of using recycled glass as fine aggregate replacement. Test results showed that slump and compacting factors decrease due to angular size of waste glass and air content was also increased due presence of so many small sized particles in the waste glass. It was also found out that compressive strength, flexural strength, and split tensile strength decreases with increase in percentage of waste glass. As per the test results it was predicted that use of waste glass in the concrete is possible practically and percentage should be under 30 %. Increasing the percentage would decrease the strength drastically and concrete won't be of use. So the different replacements under 30% were tested and favourable results were found out.

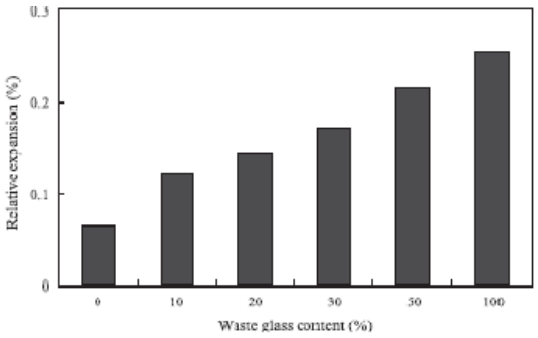

Fig 4.2 Expansion versus waste glass percentage

Zainab Z. Ismail et al. (2007) [4] the study was done on the use of plastic as sand replacement. Different replacements of 0%, 10%, 15% and 20% as fine aggregate were carried out. Different concrete mixtures were tested at room temperature and tests include slump, fresh density, dry density, compressive strength, flexural strength, and toughness indices and curing was done at 3, 7, 14 and 28 days. The results showed decrease in micro crack propagation due to inclusion of plastic. The results showed decrease in slump with increase in plastic ratio. The fresh and dry density showed a declining pattern and the reason was attributed towards lower density of plastic than sand. The compressive strength and flexural strength also decreased at each stage and this was due to decrease in adhesive strength between waste plastic and cement paste.

Rafat Siddique (2007) [5] in this paper, the research was carried out on the use of waste plastic as coarse aggregate replacement and effects on fresh and hardened properties of concrete after replacement. The different properties of concrete like bulk density, air content, workability, compressive strength, split tensile strength, modulus of elasticity, impact resistance, and permeability and abrasion resistance were examined in this research. From the tests, it was conducted that plastic aggregates can be used to replace the conventional coarse aggregates. Due to plastic aggregates, the bulk density of concrete is reduced due to light weight nature of plastic aggregates. Split tensile strength was found to decrease by 17% at 10% replacement by plastic aggregates. It showed a declining trend. Polypropylene had an adverse effect on the air content. The air content was increased due to presence of polypropylene in the plastic aggregates. The workability was also reduced. However due to presence of polypropylene fibres, impact resistance was significantly improved.

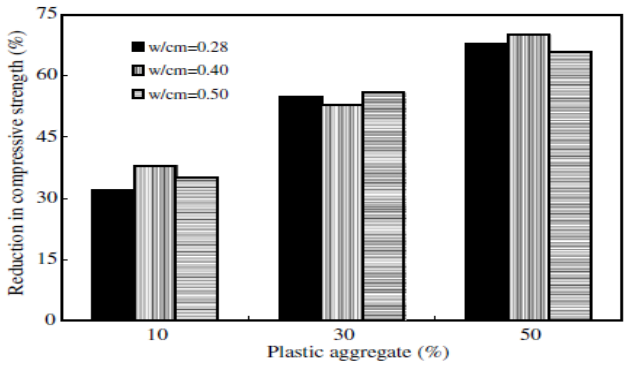

Fig 4.3 Percentage reduction in compressive strength versus plastic percentage

Zainab Z. Ismail et al. (2008) [6] Recycled waste glass was used as partial replacement of fine aggregate. The properties of concretes containing waste glass as fine aggregate were investigated in this study. The strength and ASR properties were investigated in terms of waste glass. The waste glass was used as partial replacement at 10%, 15%, and 20%. The result showed 80% pozzolanic activity after 28 days. The compressive and flexural strength was found out to be higher than normal concrete after 28 days. The tests verified that finely ground waste glass reduce expansion by 66%. The optimum percentage of waste glass was 20% based on the test results.

S.P. Gautam et al. (2012) [7] Ground waste glass was used as a fine aggregate replacement and no reaction was detected with fine particle size. This shows the viability of using it as fine aggregate replacement. The effect on workability and compressive strength was carried out in this research. After testing the samples it was found out there is 20% increase in strength after 28 days. There is little decrease in strength when replacement was done between 30 % to 40 % and optimum percentage was found out to be 10%.

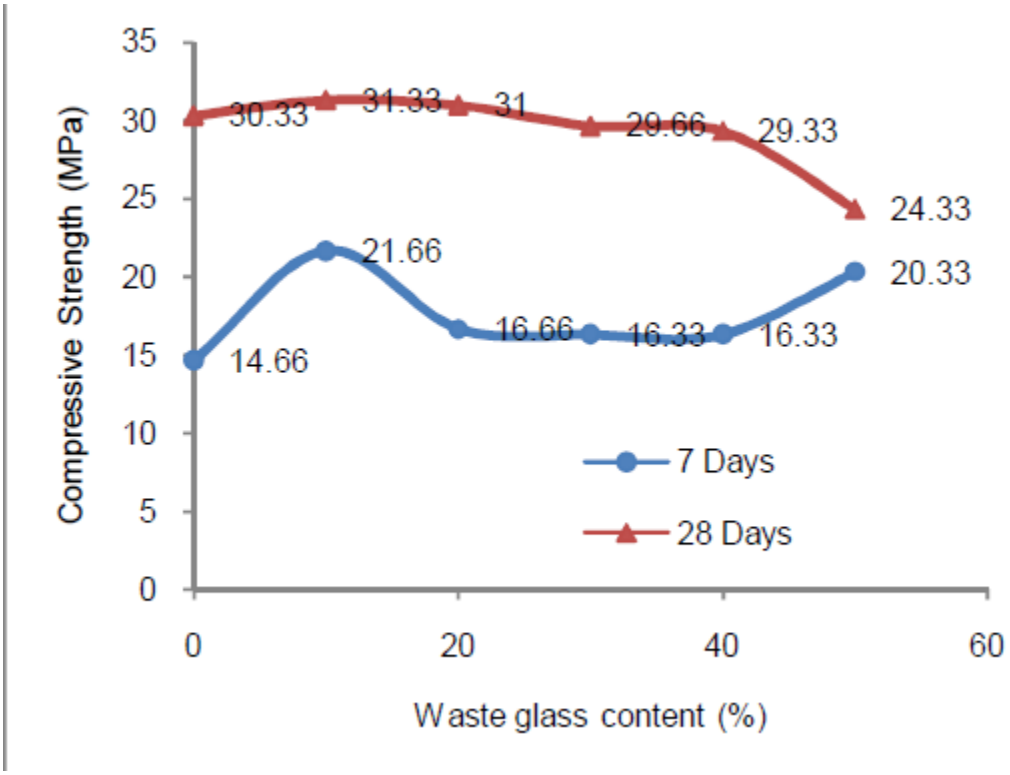

Fig 4.4 Variation of compressive strength of glass concrete

Praveen Mathew et al. (2013) [8] This research is based on use of recycled plastic as coarse aggregate in concrete. Different replacements were done and different tests were conducted and it was found out that max compressive strength is achieved at 20% replacement.

Particulars	Cylinder compressive strength in Mpa	Splitting tensile strength in Mpa	Modulus of elasticity in Mpa
NCA	11.8	2.45	16290
22% PCA	16.27	1.91	12686

Table 4.1 Structural properties of concrete

K.Madhangopal et al. (2014) [9] Influence of glass powder on the properties of concrete were studied in this research. Fine aggregate was replaced by glass powder at 10%, 20% and 30%.The cubes were tested for compressive strength at 3, 7 and 28 days.

Fig 4.5 Variation in compressive strength at 3, 7 28 days

The compressive strength of cubes for 10% is found to be 43.99 MPa, whereas for 20% it is found to be 54.32 MPa, and for 30% it is found to be 47.36 MPa. Hence it is obvious that at 10% and 20%, the compressive strength increases and decreases for 30%. So, incorporating 20% of waste glass powder to partially replace the fine aggregate in concrete yields ideal results.

S. Vanitha et al. (2014) [10], this paper deals with the use of plastic aggregates as coarse aggregate replacement. The percentage replacement was done at 0%, 2%, 4%, 6%, 8%, and 10% in M20 concrete. Based on the test results it was found out that plastic can be used as replacement of coarse aggregate and plastic concrete can be used in pavement construction successfully. The optimum percentage was found out to be 4% for paver blocks and 2% for solid blocks.

T.Subramani et al. (2015) [11] Experimental study of using plastic waste as coarse aggregate replacement was carried out. The percentage replacement which gave highest compressive strength was used to determine other properties of concrete like modulus of elasticity, split tensile strength and flexural strength. Maximum compressive strength was found at 20% replacement.

Tanveer Asif et al. (2016) [12], this research is intended at the use of waste plastic (HDPE) in concrete as a partial replacement of coarse aggregate to obtain light weight concrete. In this research, M20 grade of concrete was used for test analyses because M20 concrete is mostly used for construction work. The percentage of waste plastic used in concrete was 0%, 10%, 20%, and 30% to replace the coarse aggregate. Different cubes of concrete were casted and tested after 3, 7, 14, 28 days of curing for compressive strength test. The compressive strength of modified concrete was then matched with the conventional concrete to study the effects of replacement by HDPE. It was observed that compressive strength of 79.55%, 85.61%, 76.47% was achieved for 10%, 20%, and 30% respectively. The test results showed that HDPE as coarse aggregate replacement can be used in concrete up to 30%, if only compressive strength was taken in to consideration. It also resulted in production of light weight concrete due to low density of HDPE than natural coarse aggregates. However percentages more than 30% of HDPE were not acceptable as strength gets reduced below the threshold value.

Tanveer Asif et al. (2016) [13], the study was carried out on the compressive strength of concrete by replacing coarse aggregates by plastic granules (HDPE). M20 concrete was used and plastic replacements were done at 0%, 10%, 20%, 30%. The test results showed that maximum compressive strength was achieved at 20% replacement but was less than the normal concrete

mix. And also increasing the plastic percentage further decreases the compressive strength. It was observed that the compressive strength in comparison to normal concrete was 79.55%, 85.61%, 76.47% for mix of waste plastic of 10%, 20%, and 30% respectively.

Gaurav Verma et al. (2016) [14] Study was carried out on the effect of waste plastic as coarse aggregate replacement in concrete. It was concluded from the test results that strength decreases drastically when replacements above 20% were done.

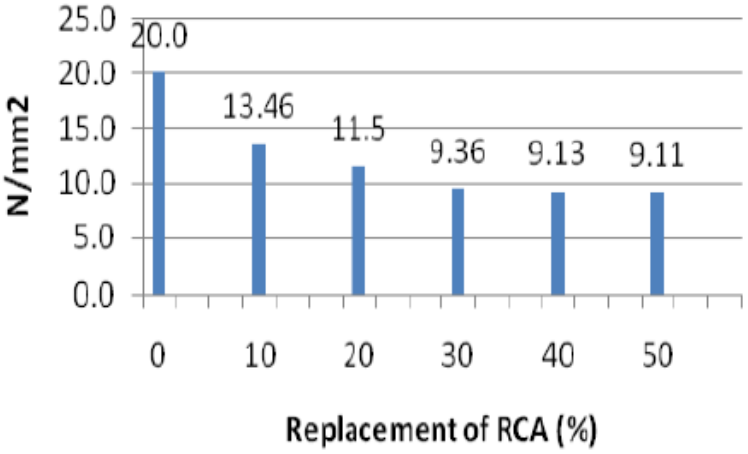

Fig 4.6 Compressive strength of concrete after 28 days

Dr. G.Vijayakumar et al. (2016) [15] this work examines the possibility of replacing cement by waste glass. Glass powder was partially replaced at 10%, 20%, 30% and 40% and tested were conducted on compressive, split tensile and flexural strength up to 60 days and compared with conventional concrete. From the results it was found that glass powder can be used replacement having particle size lessthan 75 microns. The results determine increase in strength and can be successfully replaced.

Replacements	0%	20%	30%	40%
Compressive	31.1 N/mm2	19.6% increase	25.3% increase	33.7% increase
Split tensile	2.27 N/mm2	NA	NA	4.4% increase
flexural	3.25 N/mm2	83.07% increase	99.07% increase	100% increase

Table 4.2 Effect on strength at different replacements

Chapter 5 Equipment, Materials, and Experimental setup

5.1 Equipment

The equipment that has been used till now for testing of materials are as follows:

a) IS Sieves: - To determine the gradation, sieve analysis according to IS383 of fine and coarse aggregate.
b) Pycnometer: - To determine the specific gravity values of aggregates as per IS 2386.
c) Impact Testing Machine: - To determine the impact value of coarse aggregates against impact loading.
d) LOS Angeles Abrasion Testing Machine: - To determine the LOS Angeles Abrasion value of coarse aggregate against wear and tear.

The equipment's that will be used for further testing of the specimens are as follows: -

a) Compression Testing Machine: - To determine the compressive strength of concrete.
b) Universal Testing Machine: - To determine the split tensile strength band flexural strength of concrete.

5.2 Materials

The materials that will be used for testing are: -

a) Cement
b) Natural Sand and Waste Glass
c) Coarse Aggregate and Waste Plastic

Chapter 6 Research Methodology

Waste glass, due to its pozzolanic activity leads to increase in compressive strength of concrete and due to low specific density of waste plastic; it helps in formation of light weight concrete. These both can be used in concrete as replacement of fine aggregate and coarse aggregate respectively to form high strength light weight concrete. Different tests will be conducted on concrete at regular intervals of time to find the effect of replacements which include compressive strength test, flexural test, Split tensile test etc. Different percentages replacements of waste glass and waste plastic will be carried out to find the optimum percentage of both the waste materials.

Percentage	No. of beams	No. of cylinder	No. of cubes
0%WG + 0%WP	3	3	3
10%WG + 0%WP	3	3	3
10%WG + 5%WP	3	3	3
10%WG + 15%WP	3	3	3
10%WG + 20%WP	3	3	3
10%WG + 25%WP	3	3	3

Table 6.1 Proportions of Materials

Keeping the waste glass percentage constant at 10% and replacing the waste glass percentage to find the optimum percentage. This will be followed by regular testing to find out the maximum strength of concrete.

6.1 Mix Design

Design steps of M25 mix design as per IS-10262-2009 are as follows

Strength Calculation:-

fck' = fck + 1.65s

Where fck' = Target compressive strength at 28 days in N/mm2

fck = Characteristic compressive strength at 28 days in N/mm2

s = Standard deviation

fck' = 25 + 1.65*4 = 31.6 N/mm2

Where s = 4 for M25 Concrete

Selection of water-cement ratio as per IS-456 Table-1

So select w/c ratio as 0.5.

Selection of water content

As maximum size of coarse aggregate is 20mm, so maximum water content will be 186 Kg.

Calculating cementious material content

Cement amount = Water amount/wc ratio

Cement quantity = 186/0.5 = 372 Kg

From IS 10262 minimum cement content for M25 is 300 Kg

Finding out volume proportions of coarse aggregate and fine aggregate

As per Table-3 IS-10262, coarse aggregates fall in zone 2 and size of coarse aggregate is 20mm

Hence coarse aggregate = 62% of total aggregate

Mix calculations

Volume of concrete = 1 m3

Volume of cement = 372/(3.15*1000) = 0.118 m3 where 3.15 is specific gravity of cement

Volume of water = 186/(1*1000) = 0.186 m3

Total volume except aggregates = 0118 + 0.186 = 0.304 m3

Therefore volume of aggregates = 1 – 0.304 = 0.696 m3

Volume of coarse aggregate = 0.696 * 0.62 = 0.4315 m3

Volume of fine aggregate 0.696 – 0.413 = 0.2645 m3

In terms of weight

Weight of coarse aggregate = 0.413*2.84*1000 = 1225.46 Kg/m3

Weight of fine aggregate = 0.2645*2.64*1000 = 698.28 Kg/m3

Therefore cement: fine aggregate: coarse aggregate

372: 698: 1225.46

1: 1.87: 3.29

Chapter 7 Expected Outcomes

After reviewing sufficient review papers, we concluded that replacement of fine aggregate and coarse aggregate can lead to following outcomes can be expected: -

- Light weight concrete will be produced due to low specific gravity of waste plastic.
- The compressive strength will be increased by replacement of fine aggregate by waste glass due to pozzolanic activities.

Chapter 8 Proposed Work Plan with Timelines

The work for the research started in Aug 17 and continued in different phases. Different work was done at each phase of the project.

Phase 1

Study of literature review: - It started in August 2017.

Phase 2

Testing of materials: - The timeline was November 2017.

Phase 3

Casting of specimen in January 2018

Phase 4

Testing of specimen in February 2018

Phase 5

Tabulation of results and preparation of Report by April 2018

Chapter 8 Results

Different tests were done separately on waste glass, natural sand, cement and coarse aggregate. The results of different tests are given below: -

8.1 Natural Sand

A) Sieve Analysis: -

IS Sieve No.	Weight Retained (gm)	% of weight Retained	Cumulative % Retained
4.75	5	0.5	0.5
2.36	15	1.5	2.0
1.18	125	12.5	14.5
600	210	21.0	35.5
425	20	2.0	37.5
300	520	52.0	89.5
150	70	7.0	96.5
75	15	1.5	98
pan	20	2.0	100
Total	1000 gm	100%	Cumulative % Retained = 474%

Table 8.1 Sieve Analysis of Natural Sand

B) Specific Gravity: - The specific gravity of natural sand has been determined by pycnometer method. The results showed that specific gravity of natural sand is 2.65.

C) Water Absorption: - By the experiments, the water absorption of natural sand is 2.26%.

8.2 Cement

Different grades of cement are available in the market which includes grade 33, 43 and 53. The grade 43 and 53 mainly corresponds to average compressive strength. The grade used for the test analysis is 43.The test results are below: -

S.No.	Property	Test Results
1	Consistency	29%
2	Specific Gravity	3.097
3	Initial Setting Time	34 minutes
4	Final Setting Time	610 minutes
5	Fineness of Cement	3.5%

Table 8.2 Properties of Ordinary Portland cement

8.3 Coarse Aggregate

A) Sieve Analysis: -

IS Sieve No.	Weight Retained (Kg)	% Retained	Cumulative % Retained
80 mm	0	0	0
40 mm	0	0	0
20 mm	2.7	27	27
10 mm	6.2	62	89
pan	1.1	11	100
Total	10 Kg	100 %	210%

Table 8.3 Sieve Analysis of Coarse Aggregate

8.4 Waste Glass

A) Specific Gravity: - Based on the test results, the specific gravity of waste glass is 2.18.

B) Water Absorption: - By doing experiments on waste glass, it was found out that water absorption of waster glass is 0.43%.

C) Sieve analysis: -

IS Sieve No.	Weight Retained (gm)	% of Weight Retained (gm)	Cumulative % Retained
4.75 mm	0	0	0
2.36 mm	20	2	2
1.18 mm	125	12.5	14.5
600 microns	195	19.5	34
425 microns	17	1.7	35.7
300 microns	530	53.0	88.7
150 microns	63	6.3	95
75 microns	25	2.5	97.5
pan	25	2.5	100
Total	1000 gm	100 %	467.4 %

Table 8.4 Sieve analysis of waste glass

Chapter 9 Summary and Conclusion

As, it has been found by experimental study that replacements by waste glass and waste plastic can lead to increased strength, light weight concrete and low cost of concrete. Based on the different tests that have been done on individual materials of concrete, the following conclusion can be made: -

- The physical analysis of waste glass aggregates gave the values of specific gravity and water absorption which qualify the waste glass as suitable replacement of fine aggregates.
- The testing results of sieve analysis of coarse aggregate and waste plastic makes it appropriate replacement of coarse aggregate.

Chapter 10 References

1. **Yixin Shao et al. (1999)** Department of Civil Engineering and Applied Mechanics, McGill University, Montreal, Quebec H3A 2K6, Canada.
2. **Mehmet Canbaz et al. (2003)** Civil Engineering Department, Osmangazi University, Eskisehir 26480, Turkey.
3. **Seung Bum Park et al (2004)** Department of Civil Engineering, Chungnam National University, 220 King Dong, Yuseong-Gu, Taejon 305-764, South Korea.
4. **Zainab Z. Ismail et al. (2007)** Department of Environmental Engineering, College of Engineering, University of Baghdad, Iraq
5. **Rafat Siddique (2007)** Thapar Institute of Engineering and Technology, Deemed University, Patiala – 147 004, India.
6. **Zainab Z. Ismail et al. (2008)** Department of Environmental Engineering, College of Engineering, University of Baghdad, Iraq
7. **S.P. Gautam et al. (2012)** Centre for Effective Design of Structures, Department of Civil Engineering, McMaster University, 1280 Main Street West, Hamilton, ON, Canada L8S 4L7
8. **Praveen Mathew et al. (2013)** Civil Engg. Dept., SHIATS (formerly AAI-DU), Allahabad-211007, UP, India
9. **K.Madhangopal et al. (2014)** Assistant Professor in Civil Engineering Department, RGMCET, Nandyal
10. **S. Vanitha et al. (2014)** Department of Civil Engineering, Sathyabama University, Chennai, Tamil Nadu,
11. **T.Subramani et al. (2015) 1**Professor & Dean, Department of Civil Engineering, VMKV Engg. College, Vinayaka Missions University, Salem, India
12. **Tanveer Asif et al. (2016)** Director, Professor & H.O.D Civil Engineering, Dept K.C.T.E.C, C/o Dr Meenaz Hospital H.NO. 5-408/40/1&2, Near KBN Medical College,Roza B, Kalaburgi. Karnataka India
13. **Tanveer Asif et al. (2016)** Director, Professor Head of Civil Engg Dept, KCT Engineering college, Gulbarga, Karnataka, India.

14. **Gaurav Verma et al. (2016)** Post Graduate Student, BBD University, Uttar Pradesh, India
15. **Dr. G.Vijayakumar et al. (2016)** Associate Professor, 3Professor, Civil Engg., Pondicherry Engineering College, Pondicherry India