EFFECT ON PROPERTIES OF CONCRETE BY PARTIAL REPLACEMENT OF CEMENT WITH BRICK POWDER AND COARSE AGGREGATE WITH SCRAP RUBBER

Submitted in partial fulfillment of the requirements
of the degree of

MASTER OF TECHNOLOGY
in
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by

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DECLARATION

I, Tufail Ahmad Malik (11617747), hereby declare that this thesis report entitled **"Effect on Properties of Concrete by Partial Replacement of Cement with Brick Powder and Coarse Aggregate with Scrap Rubber"** submitted in the partial fulfillment of the requirements for the award of degree of Master of Civil Engineering, in the School of Civil Engineering, Lovely Professional University, Phagwara, is my own work. This matter embodied in this report has not been submitted in part or full to any other university or institute for the award of any degree.

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CERTIFICATE

Certified that this project report entitled " **Effect on Properties of Concrete by Partial Replacement of Cement with Brick Powder and Coarse Aggregate with Scrap Rubber**" 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

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ABSTRACT

Concrete is the most trusted and widely used building material in today's world. Concrete is made by mixing coarse aggregates, fine aggregates, binding material (cement) and water in a definite proportion. To meet the strength characteristics and other properties of concrete for special purposes, efforts have been made to improve some special properties by adding pozzolanic materials. Some of the materials have been effectively utilized which improve fresh properties like workability, consistency, settlement and bleeding, plastic shrinkage etc. and various hardened properties such as strength, durability, porosity and density, thermal and acoustic insulation, impact resistance etc. of concrete. Due to the increasing demand of natural resources as a construction material, these materials have become very costly which increases the overall cost of the project. In order to sustain the building materials for coming generations and reduce the cost of materials we need to replace the building materials by some other materials**.** Efforts are being made to use the waste materials in concrete, which are hazardous to environment, easily available and reduce the overall cost of project. Ground brick powder has been potentially used as a partial replacement of cement and scrap rubber pieces as a partial replacement of coarse aggregates. The use of these waste materials in concrete not only decreases the waste from the environment but also decreases the overall cost of the structures, without affecting the properties of concrete. Brick powder can be potentially replace cement by some percentage without affecting the properties of concrete, however improving its permeability properties and reduces its heat of hydration in the initial stages. Therefore it can be used in mass concreting projects reducing the crack formation in initial stages. However the partial replacement of coarse aggregates by scrap rubber reduces the compressive strength of concrete at higher percentages of replacement. But use of scrap rubber reduces the weight of structures as the density of rubber is less as compared to the density of natural coarse aggregates

CHAPTER 1 INTRODUCTION

1.1 General

Today's world's leading towards advancement, eager for more comfort has led to innovations and revolutions in each and every field of life. But on the other hand it has put some negative impacts on environment, as natural resources get depleted. As concrete is most commonly used building material across the world and consumes most of the natural resources in the form of coarse and fine aggregates. After studying all these research papers we concluded that if we can use some materials other than basic ingredients of concrete which do not have negative impacts, rather have positive effects on various fresh and hardened properties of concrete, partial replacement of these ingredients of concrete with waste material will largely impact environment and will lead to pollution free and soothing environment. This waste creates air pollution and land pollution by dumping and also causes water pollution so by using this material in concrete we can save our atmosphere and land. Our ultimate goal is to produce economical and eco-friendly concrete which will possess strength and other desired properties which one achieves by basic concrete ingredients. By using locally available waste like brick powder as partial replacement, it may prove more economical than traditional concrete and dumping of such waste produced by brick industries is also solved. Also construction cost is very high by using conventional materials due to unavailability of natural materials. We have the only option of partially replacing its ingredients by locally available waste materials. Over 3.3 billion tons of cement was consumed globally in 2010 based on survey of world coal association and also cement production emits CO2 in to the atmosphere which is harmful to the nature. Also for producing 1 kg of cement we require 372 Kilo joules of energy while we require only 19 kilo joules of energy to produce 1 kg of brick powder (surkhi). If we can partially replace the cement with the material with desirable properties then we can save natural material, reduce emission of CO2 in to the atmosphere and save the energy for the coming generations. The industrial waste dumping to the nearest site which spoils the land and atmosphere as well as it also affects aesthetics of urban environment so use of this waste material in concrete is economical as well as environment friendly way to disposal of waste.

This Use of brick powder or surkhi has been used as pozzolana in India for many years. This material is used as a partial replacement of cement to produce mortar or concrete, which results in improved concrete properties which include reduction of permeability and resistance to sulphate attack and alkali-aggregate reaction. It has been used in Europe since ancient times, where powdered brick was mixed with hydrated lime to produce mortars. There are many examples across Europe of Roman buildings bearing the fact that these mortars have been used since long time in past and hence, the fact that these materials are durable is

proved. So potential use for ground brick powder is possible, not only for repair of important historic buildings where compatibility of materials is important, but this can also be used for the production of durable and impermeable concrete or mortars. The pozzolanicity of brick powder depends upon the burning or calcining temperature of clay. The most reactive state of clay is when the burning temperature results in loss of hydroxyl and a collapsed and distorted clay structure, the burning temperature to produce this active state is usually in the range of 600-900°C. The various materials used in this study are:-

1.2 Brick powder

About 1-5% of waste bricks are generally produced in all brick companies, which add to quantity of waste materials considerably. This varies from 50,000 tons for a large scale company to 100 tons for a small scale company. Recycling of these waste bricks is one of the most challenging problems worldwide with the extraordinary growth of the world population. The waste from these companies is crushed and sold as low grade aggregate at prices varying between Rupees 129 to 430 Rupees per ton. Although this is a much lower cost than cement (4300 Rupees per ton) however there will be added cost of crushing if this is to be used as cement replacement.

It is the waste material produced from brick kilns which is of no use adds to the waste to environment, which is to be landfilled. The landfilling of this material degrades the quality of soil and also contaminates the ground water of that area. It is finely ground bricks, orange in color and Sp. gravity 2.52. Particle size of brick powder is about 20 to 60 microns. Calcination temperature of bricks ranges from 900 to 1000 degree Celsius. The SiO_2 content in brick powder is about 54.8% and Al_2O_3 content is about 19.1%.

Figure 1 Brick powder

1.3 Scrap rubber

Due to the fact that rubber non-biodegradable material it has become a serious problem for researchers to degrade it. Due to the problems faced by landfilling of scrap rubber it has degraded the quality of soil. For this problem it has been used as a fuel for cement klins, which produce huge amount of carbon dioxide. The carbon dioxide produced degrades the quality of atmosphere. The huge quantities of scrap rubber are produced from used automobile tyres. This waste is increasing day by day and adding more waste to environment. Rubber is a non-biodegradable material, which cannot be degraded by the available treatment

techniques. Scrap rubber is used as fuel in various cement klins or other types of klins, but its use as a fuel cause serious atmospheric pollution. The particle size which is to be used is varying from 15mm to 30mm. The Sp. Gravity of the scrap rubber is 1.79.

Figure 2 Rubber piece

CHAPTER 2 SCOPE OF THE STUDY

The concrete made by the partial replacement of cement by Brick powder and coarse aggregates by scrap rubber can be effectively used in future.

1. This can be used for mass concreting works, as the heat of hydration produced at initial stages will be less and hence that will reduce the initial cracking of concrete.
2. It can be used in lightweight structures (in higher earthquake zones), as the weight of scrap rubber is lower than natural coarse aggregates.
3. This can be used in submarine structures as it will be more sulphate resistant, as permeability is decreased by using brick powder.
4. It can be used in the zones near to railways, as rubber is more elastic and reduces the vibrations.
5. It can be used in the structures where sound absorption is necessary, as rubber concrete possess good sound absorption properties.
6. The study can be the basis for researchers to make effective use of waste materials without any harmful effect, and further research may be done regarding this.

CHAPTER 3 OBJECTIVE OF STUDY

The objective of this study is:-

- To make an economical and lightweight concrete that satisfies all the strength requirements and effectively reduces the waste from environment.

Giulia Baronio et al. (1996) [1] Investigated the pozzolanic activity of some bricks and clays. The firing temperatures are usually higher than 900 degree Celsius for the production of bricks. There is the specific temperature required for every type of clay to produce better material. The calcination processes were very poor in ancient times. The temperatures in the burning ovens in which the bricks are made is uncontrolled and varying according to the position of the bricks. It is now possible to provide uniform and controlled atmosphere for the manufacture of bricks. Ancient mortars were durable for centuries, which are clearly demonstrated by the condition of ancient buildings. The author states that brick powder can be used in mortar, provided that the bricks possess pozzolanic character. Modern bricks are fired at high temperature and are made of materials which do not contain or have a low content of clays, are seldom pozzolanic. When bricks are made up of clayey material, upon calcination these produce a pozzolanic material. The temperature and duration of temperature treatment to bricks is a function of the minerals contained in the clay and must be chosen very carefully.

M. Kamal Uddin (2004) [2] Studied the use of brick dust in concrete as mineral admixture and partial replacement of cement and studied the effect on various properties of concrete. These results of the study show that compressive strengths of specimen prepared with brick dust as a mineral admixture are comparable to those of the control specimen. The author states that the cement concrete specimen in which replacement of cement by brick powder is between 20 to 30 percent, gives almost the same or slightly higher compressive strengths compared to control specimen under normal curing for 45 and 90 days. Concrete prepared with 20% cement replaced by brick dust as a mineral admixture also shows good resistance to chemical attack, specially the sulphate attack. They also show better pore refinement after long period. Chemical composition and lime reactivity strength of brick dusts have been found to be within the range given for good pozzolanic material.

Md. Mohsin Khan et al. (2017) [3] studied the various properties of concrete by partially replacing cement by brick powder and marble dust. The results and findings of the study show the strength and workability of concrete increased considerably by replacing the cement by marble dust and brick powder. The M25 mix was prepared for this study and cubes were cast, results were calculated. The results showed that when marble dust was replaced between 5-7.5%, increase in compressive strength was noticed. But compressive strength was reduced if the replacement of marble dust is increased beyond 10%. The results shown by brick powder were more promising as compared to the marble dust. However brick powder as an admixture shows significant increase in 28 days compressive strength of concrete. It was also concluded from that the waste

material i.e. marble dust and brick powder can be used effectively as construction material. The use of such waste materials which possess pozzolanic activity and are easily available in construction industry reduces the cost, pollution and disposal problems of such waste material.

S.K. Malhotra et al. (1999) [4] investigated the effect on addition of flyash and burnt clay on certain engineering properties of cement composites. The study revealed that the use of suitable pozzolanic material such as brick powder may be advantageous and ultimately improves the overall properties of the mortars. It has been proved in the study that there exists specific relationship between the strength and pozzolanicity of the material. The presence of lime which has good pozolanic property, results in the improvement of early age properties such as workability. This also helps in improving the hardened properties. Therefore with the addition of pozzolanic materials, modified cement composites are likely to be more economical and satisfying strength parameters. It was also investigated in the study that by using pozzolanic materials in concrete it shows good early age properties and also better strength at later ages.

M. O'Farrell et al. (2006) [5] studied the compressive strength and the corrosion effect using brick powder in concrete which were subjected to different treatments. The durability of concrete was also studied. The samples were prepared at the percentage replacements of 10%, 20% and 30% of cement by brick powder. Then the compressive strength of the concrete was obtained at 90 days. Also the resistance to sodium sulphate was studied The compressive strengths of the mortars were monitored up to 90 days and the resistance to sodium sulphate solution and synthetic seawater was monitored up to 300 days. The specimens were also monitored for weight changes. The results indicated that the compressive strength increases till 20% replacement of cement with brick powder. Further, increase in percentage of brick powder reduces the compressive strength.

M. M. Reda Taha at al. (2008) [6] Investigated the mechanical and fracture properties of rubber concrete. Chipped rubber has been used as partial replacements of 20%, 50%, 75% and 100% of coarse aggregates. It was concluded that using chipped rubber as partial replacement of coarse aggregates reduces the unit weight of concrete and decreases the workability of fresh concrete. It was also concluded that the compressive strength decreases at higher percentage replacements. Moreover, the impact resistance enhances while using chipped rubber in concrete.

El-Gammal et al. (2010) [7] Studied the effect of rubber on different properties in concrete. In this experimental study, chipped rubber and crumb rubber was used. Four mixtures were cast, one control mixture and three rubbercrete mixtures. In first mixture, 100% replacement of coarse aggregates with chipped rubber was employed. While, in the other two rubbercrete samples, fine aggregate was replaced by 100% and 50% with rubber by weight. It is concluded that average densities and compressive strength

significantly reduced, when aggregates are replaced with tyre rubber in the concrete mixes. However, a large amount of energy was absorbed under compressive loading.

Nell N. Eldin et al. (2014) [8] studied strength and toughness properties of concrete with different amounts of replacements of coarse aggregates with rubber-tire particles having several sizes. The concrete made with partial replacement of aggregates with scrap rubber pieces, exhibit lower compressive and splitting-tensile strength than normal concrete. However, the concrete did not show the brittle failure, but show ductile, plastic failure. The concrete also absorbed a large amount of plastic energy under compressive and tensile loads. It was concluded from the study that loss of compressive strength up to 85% and 50% decrease in tensile strength was observed, depending on the percentage replacement of rubber. No increase in 7 days and 28 days strength was also observed, decrease in compressive strength depends on increased percentage replacements.

N. I. Fattuhi et al. (1996) [9] various tests were conducted on various cement and concrete mixes to determine the density and compressive strengths. Tests for impact resistance, fire resistance etc. was also carried out in this study. Due to the lesser adhesion of cement with rubber the compressive strength decreases. While the lesser unit weight of rubber as compared to natural aggregates decreases the density of concrete. The reductions in compressive strength and density depends on the amount of rubber added was concluded from the study. 20% and 70% decrease in density and compressive strength respectively was observed, when compared to ordinary concrete. Results showed that the various properties depend upon the size of rubber particles replaced, lower the size of scrap rubber particles lower will be decrease in compressive strength.

Eshmaiel Ganjian et al. (2008) [10] studied the effects on various properties of concrete by the utilization of scrap rubber pieces as replacement of coarse aggregates. Performance of concrete was studied with 5%, 7.5% and 10% replacement with discarded tyre rubber as aggregate. The results showed that up to 5% replacement, no major changes on concrete characteristics were observed. However further increase in replacement ratios the decrease in strength properties were observed. The compressive strength, tensile strength, flexural strength and modulus of elasticity were observed. It was found that 7 days and 28 days compressive strengths were similar when the percentage replacement up to 5%.

4.1 Impact on various properties of concrete

4.1.1 Workability

Paulo B. Cachim (2008) generated many concrete series as shown

Table 1 Amount of materials used in different concrete series

Materials	Concrete series name				
	NN45	**NA45**	**NB45**	**AA45**	**BB45**
Cement(kg/m^3)	400	400	400	400	400
Water(kg/m^3)	180	180	180	180	180
Sand(kg/m^3)	713	713	713	713	713
w/c ratio	0.55	0.55	0.55	0.55	0.55
Brick powder (kg/m^3)		138		278	

The workability was studied for these mixes and the results were plotted in the graph

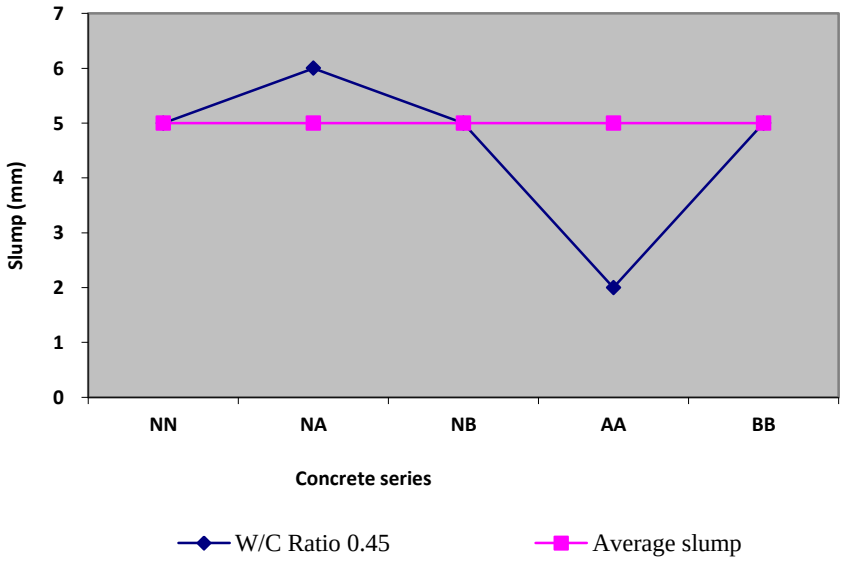

Figure 3 Slump of different concrete series casted

Md. Mohsin Khan Workability tests show that the workability increases as the amount of brick powder and marble dust is increased. The effect of brick powder and marble dust on slump is given in table below.

Table 2 Slump of concrete at different replacement %ages

S.no.	Concrete	w/c ratio	Slump(mm)
1	Ordinary	0.45	20
2	5% brick powder	0.45	25
3	10% brick powder	0.45	25

Ali R. Khaloo (2008) The slump of the concrete was obtained in accordance with American Code. The results are shown in figure below.

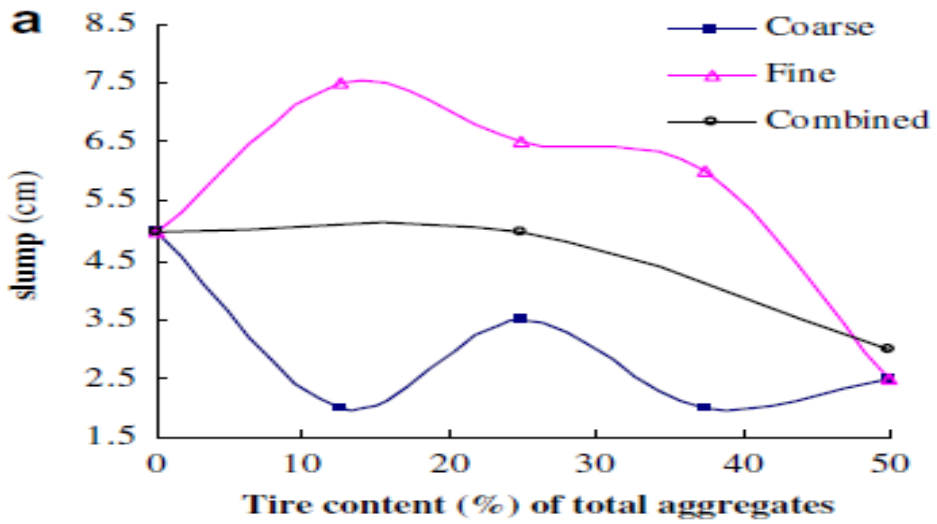

Figure 4 Slump VS %age replacement by rubber

4.1.2 Compressive strength

M. Kamal Uddin (2004) studied the outcome on compressive strength of concrete by replacement of cement by brick powder. 100mm cubes were casted at a ratio of 1:2:4. The replacement of cement was 0, 20 and 30 percent by weight of total cementing material and results were calculated and results are presented in graph below. It is clear from the graph that the strength is optimal at 10% replacement.

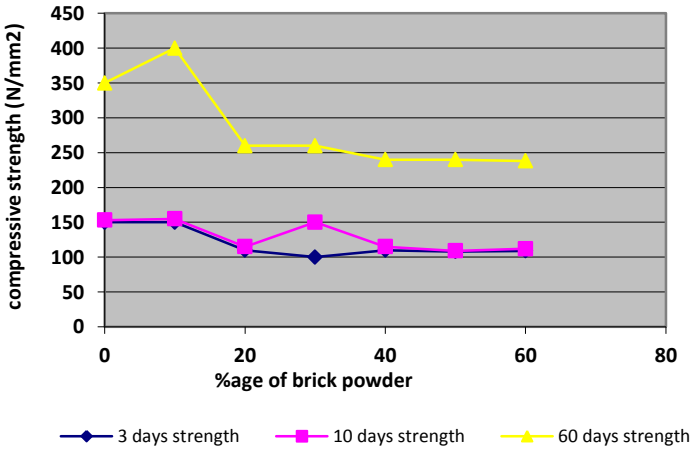

Figure 5 percentage replacement of BP VS compressive strength

Md. Mohsin Khan (2017) The compression tests were done and compression strength of sample cubes was measured the results are plotted in bar chart below.

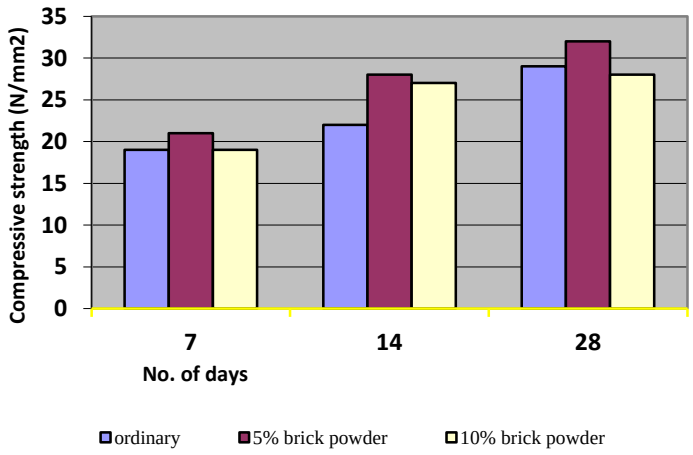

Figure 6 7, 14 & 28 days compressive strength

From these results It can be concluded that using 5% brick powder tends to increase the strength of concrete, 10% of brick powder also increases the strength but less than that of 5% brick powder in 7 days, 14 days and 28 days.

M. O'Farrell (2006) The compressive strength results which were obtained are as follows.

Table 3 compressive strength of ground brick mortars

Compressive strength 0f ground brick mortars (N/mm^2)			
Mix	**7 days**	**28 days**	**90 days**
Control	52.2	65.3	67.0
10% ground brick	43.8	61.2	47.1
20% ground brick	39.4	55.4	66.2
30% ground brick	31.3	45.2	55.7

Paulo B. Cachim (2008) generated many concrete series and tested them for compressive strength and found these results.

Table 4 compressive strength of various concrete series

Concrete Series	**Fc (MPa)**			
	7 days	14 days	28 days	90 days
NN45	29.0	32.2	36.2	40.1
AA45	20.0	26.1	27.6	32.3
NA45	26.9	29.0	32.1	40.0
BB45	25.4	29.0	32.3	36.0

Concrete Series	Fc (MPa)			
NB45	26.1	31.5	38.5	44.8

El-Gammal (2010) the effect of replacing coarse aggregate with rubber is shown below

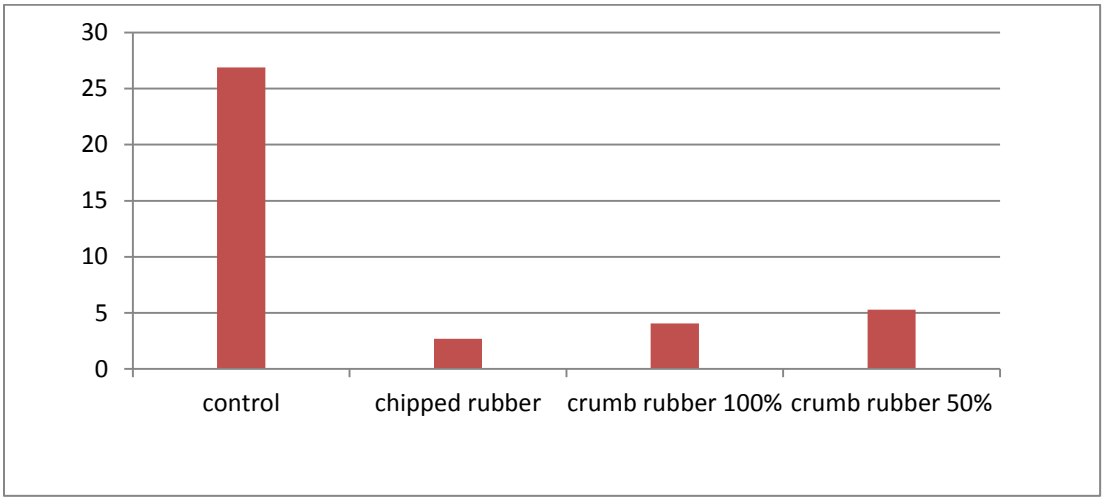

Figure 7 compressive strength VS type of rubber replaced

Eshmaiel Ganjian (2008) the results for compressive strength obtained by the study are shown in bar chart. The results show that there is no decrease in compressive strength when the percentage with scrap rubber is low. When the percentage replacement is increased the compressive strength gets decreased.

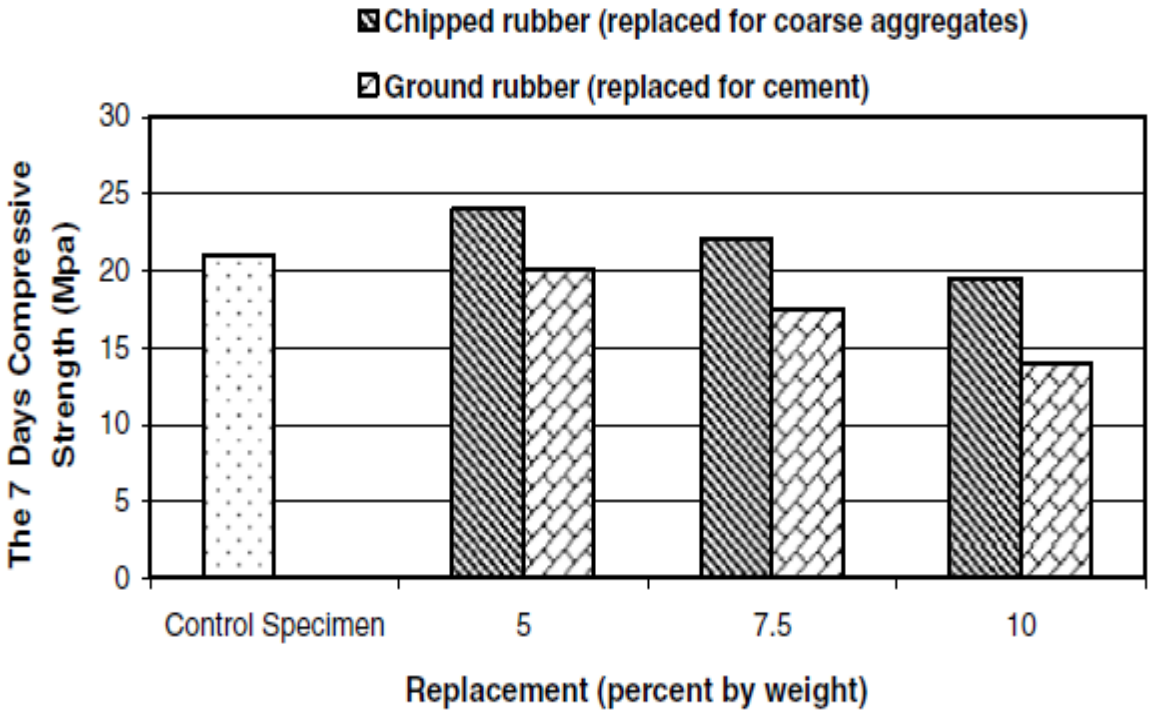

Figure 8 compressive strength VS replacement by weight

CHAPTER 5 EQUIPMENT, MATERIALS, AND EXPERIMENTAL SETUP

5.1 Equipment

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

a) IS Sieves: - To perform the gradation, sieve analysis according to IS 383 of coarse and fine aggregate.

b) Pycnometer: - To determine the specific gravity 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 that will be used for further testing of the specimens are as follows: -

a) Compression Testing Machine: - To determine the compressive strength of concrete cubes.

b) Universal Testing Machine: - To determine the split tensile strength and flexural strength of concrete.

5.2 Materials

The materials that will be used to perform the testing materials are: -

a) Cement

b) Brick powder

c) Natural Sand

d) Scrap rubber

e) Coarse Aggregates

CHAPTER 6 RESEARCH METHODOLOGY

Methodology and investigational work includes the tests required to determine the quality of materials for concrete making, concrete mix design, specimen preparation and different methods for the concrete testing.

Research methodology includes: -

A. After thorough and intense reviewing of literature, a null hypothesis "Effect on Properties of Concrete by Partial Replacement of Cement with Brick Powder and Coarse Aggregate with Scrap Rubber".

B. More literature regarding the hypothesis was studied. Constituent materials to be used were tested to obtain the different properties.

C. A design mix has been prepared in accordance with IS 10262:2009 and IS 456:2000.

6.1 Design Mix

Based on the properties of aggregates, the design mix for M25 concrete mix as per IS 10262:2009 is calculated as: -

1. Target Mean Strength

$f_{ck}' = f_{ck} + 1.65s$

Where standard deviation s = 4 [IS 10262:2009]

Therefore,
$f_{ck}' = 31.6$ N/mm^2

2. Water Cement Ratio

As per IS 456:2000, the minimum w/c ratio required for the complete hydration of cement is 0.34. However, for concrete to be workable, we prefer w/c ratio of 0.45 to 0.5.

Hence we assume w/c ratio as 0.5

3. Water Content

As per IS 456:2000, for aggregate size of 20mm, the water content is 186 kg/m^3

4. Cement Content

Water cement ratio = 0.5

Water content per m^3 of concrete = 186 kg

Cement content = 186/0.5 = 372 kg / m^3

Calculation of Sand & Coarse Aggregate

Volume of concrete = 1 m^3

$$\text{Volume of Aggregate} = \frac{\text{Aggregate Content}}{\text{Specific Gravity of the aggregate} \times 1000}$$

Volume of cement = 372/ (3.0975 × 1000) = 0.120 m^3

Volume of water = 186 / (1 × 1000) = 0.1440 m^3

5. Fine and Coarse Aggregate Content

$$\text{Total Volume of other mateials except coarse agg.} = \text{Volume of Cement} + \text{Volume of Water}$$

Total volume of other materials except coarse aggregate = 0.120 +0.1440 = 0.264 m^3

Coarse and fine aggregate Volume = 1 – 0.264 = 0.736 m^3

Fine Aggregate Volume = 0.736 × 0.33 = 0.2429 m^3 (Assuming 33% by volume of total aggregate)

Coarse Aggregate Volume = 0.736 – 0.2429 = 0.4931 m^3

Fine Aggregate Weight = 0.2429 × 2.65 × 1000 = 643.68 kg/ m^3

Coarse Aggregate Weight = 0.4931 × 2.57 × 1000 = 1267.26 kg/ m^3

Therefore

Cement : Fine Aggregate : Coarse Aggregate = 372 : 643.68 : 1267.26

Cement :Fine Aggregate : **Coarse Aggregate = 1 : 1.73 : 3.41**

D. Required number of Indian Standard size cubes, cylinders and beams were fixed (as per IS codes to calculate the mean of the properties of concrete).

Table 5Percentage Replacement and Number of Specimens

% age replacement	No of cubes for compressive strength		Number of beams for flexural strength		Number of cylinders for split tensile strength	
	7 Days	28 Days	7 Days	28 Days	7 Days	28 Days
0 %	3	3	3	3	3	3
5% SR + 10% BP	3	3	3	3	3	3
5% SR + 15% BP	3	3	3	3	3	3
5% SR + 20% BP	3	3	3	3	3	3
5% SR + 25% BP	3	3	3	3	3	3
5% SR + 30% BP	3	3	3	3	3	3
Total	36 cubes		36 beams		36 cylinders	

E. After that casting is to be done with adequate quality control.

F. Finally testing of the specimens and results are to be summarized.

CHAPTER 7 EXPECTED OUTCOMES

After studying the literature about the study, the following outcomes are to be expected:-

1. An economical lightweight concrete that exhibits the required strength properties.
2. Effective disposal of harmful waste materials from the environment.

CHAPTER 8 PROPOSED WORK PLAN WITH TIMELINES

The research work will be done in four phases.

Phase 1: - Reviewing the literature

Phase 2: - Testing of concrete ingredients and setting up the concrete mix design as per grade of concrete.

Phase 3: - Casting of the specimens.

Phase 4: - Final Testing of the specimens and final report writing.

The phases along with the timelines are listed below:

9.1 Material Testing

Several tests has been conducted to find out the different properties of fine and coarse aggregates like sieve analysis, specific gravity, water absorption, impact value, LOS Angeles Abrasion value etc. The test results are discussed below

9.1.1 Testing of Cement

The cement grades available in the market are 33, 43 and 53. The cement grade that has been used for material testing is grade 43. The various tests on cement has been done confirming IS 4031-1988 and IS 12269-1987. The test results on Ordinary Portland Cement are tabulated below:

Table 6 Properties of Ordinary Portland Cement

S. No.	Property	Test Results
1	Consistency	28%
2	Sp. Gravity	3.217
3	Initial Setting Time	33 minutes
4	Final Setting Time	285 minutes
5	Fineness of Cement	3.15%

9.1.2 Testing of Fine Aggregate

A mixture of natural sand and robo sand will be used as a fine aggregate. Several tests has been conducted according to IS 2386 and IS 383 in order to find out the different properties of fine aggregates. The test results are tabulated as:-

9.1.2.1 Sieve Analysis of Natural Sand

A total of 1000gm of natural sand has been taken to carry out the sieve analysis through a set of IS Sieves and accordingly zone of sand and fineness modulus has been obtained.

Table 7 Sieve Analysis of Natural Sand

IS Sieve No.	Weight Retained (gm)	% age of weight retained	Cumulative % age retained
4.75 mm	5	0.5	0.5
2.36 mm	10	1.0	1.5
1.18 mm	130	13.0	14.5
600 µ	215	21.5	36
425 µ	15	1.5	37.5
300 µ	515	51.5	89
150 µ	75	7.5	96.5
75 µ	20	2.0	98.5
Pan	15	1.5	100
Total	1000 gm	100%	Cumulative % age Retained = 474%

Test Results: -

The fine aggregate (natural sand) is confirming Zone-II according to IS 383.

$$\text{Finess Modulus} = \frac{\text{Commulative \% age retained}}{100} = \frac{474}{100} = 4.74$$

Therefore, the fineness modulus of natural sand is 4.74

9.1.2.3 Specific gravity of Natural Sand

The specific gravity of the natural sand has been determined by the pycnometer method. The results are showed that the specific gravity of natural sand is 2.65.

9.1.2.4 Water Absorption of Natural sand

By the experiments, the water absorption of natural sand is 2.26%.

9.1.3 Testing of Coarse Aggregate

Locally available coarse aggregate has been taken and different properties like sieve analysis, specific gravity etc. has been investigated.

9.1.3.1 Sieve Analysis of Coarse Aggregate

Coarse aggregate of 10 kg has been taken to carry out the sieve analysis. The grading or particle size distribution of coarse aggregate shown close to average size of 40mm as per IS383-1970 are

Table 8 Coarse Aggregate Sieve Analysis

IS Sieve No.	Weight Retained (kg)	% age 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%

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REFRENCES

[1] Giulia Baronio and Luigia Bindat, "Study of the pozzolanicity of some bricks and clays", Construction and Building Materials, Vol. 11, pp. 4146, 1997.

[2] Paulo B. Cachim, "Mechanical properties of brick aggregate concrete" Construction and Building Materials, 23, 2009.

[3] M. Kamal Uddin, "Use of brick dust in concrete as mineral Admixture and partial replacement of cement", Journal of Civil Engineering (IEB), 32(1) (2004) 69-78.

[4] Md. Mohsin Khan, "Innovative Use of Brick Powder and Marble Dust as A Mineral Admixture in Concrete", International Journal of Civil Engineering and Technology (IJCIET), Volume 8, Issue 1, January 2017, pp. 987–990.

[5] S.K. Malhotra, N.G. Dave "," Investigations into the effect of addition of flyash and burnt clay pozzolana on certain engineering properties of cement composites" Cement & Concrete Composites, 21 (1999) 285-291.

[6] M. O.Farrell , B.B. Sabir, S. Wild, "Strength and chemical resistance of mortars containing brick manufacturing clays subjected to different treatments", Cement & Concrete Composites, 28 (2006) 790–799.

[7] S. Wild, "Observations on the use of ground waste clay brick as a cement replacement material", Building Research & Information, Vol. 24, Number 1 1996

[8] El-Gammal, A., A. K. Abdel-Gawad, Y. El-Sherbini, and A. Shalaby, "Compressive Strength of Concrete Utilizing Waste Tire Rubber", Journal of Emerging Trends in Engineering and Applied Science,(2010) pp 96-99

[9] M. M. Reda Taha, M.ASCE, A. S. El-Dieb, M. A. Abd El-Wahab, and M. E. Abdel-Hameed, "Mechanical, Fracture, and Microstructural Investigations of Rubber Concrete", journal of materials in civil engineering , october 2008, pp 640-649.

[10] Nell N. Eldin and Ahmed B. Senouci,, "rubber-tire particles as concrete aggregate", ASCE, 05 (2014)

[11] N. I. Fattuhi* and L. A. Clark, "Cement-based materials containing shredded scrap truck tyre rubber", Construction and Building Materials, Vol. 10, No. 4, pp. 229-236, 1996.

[12] Eshmaiel Ganjian, Morteza Khorami and Ali Akbar Maghsoudi, "Scrap-tyre-rubber replacement for aggregate and filler in concrete", Construction and Building Materials, 23 (2009) pp- 1828 to 1836.