Experimental study on sustainable concrete using brick aggregate as coarse aggregate replacement

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ABSTRACT

Concrete are widely use building material in the construction industry. In this study we used brick aggregates as waste product by partial replacement of coarse aggregate. Three mixes are prepared by 30%, 40% and 50% replacement of coarse aggregate. Total nine cube nine cylinders and nine beams are casted. The testing was carried out at 7 days, 14 day and 28 days. In the study we compared the compressive strength, split tensile strength and flexural strength of specimen by replacing the various percentages of brick bats as coarse aggregate. During the study it was found that the concrete by using 30% replacement of brick bats as coarse aggregate gives the nearly equal results as nominal mix (0% replacement of bricks bats). By using this material the dead load of structure are also reduced to some extent. Since we can use the concrete by 30% replacement of brick bats as coarse aggregate.

CHAPTER 1
INTRODUCTION

1.1 GENERAL

Lightweight concrete has extreme importance to the construction industry. Most of current concrete research focuses on high-performance concrete, by which is meant a cost-effective material that satisfies demanding performance requirements, including durability. Lightweight concrete can be defined as a type of concrete which includes an expanding agent in that it increases the volume of the mixture while giving additional qualities such as lessened the dead weight. It is lighter than the conventional concrete. The use of lightweight concrete has been widely spread across the world.

The other main specialties of lightweight concrete are its low density and thermal conductivity. So its advantages are that there is a reduction of dead load, faster building rates in construction and lower transport and handling costs.

One of the disadvantages of conventional concrete is the high self-weight of concrete. Density of normal concrete is in the order of 2200 to 2600 kg/m3. However, using Light Weight Aggregates (LWAs) in place of dense aggregates can also reduce the concrete weight. Use of Brick Bats is one such light weight aggregate, used in certain places where natural aggregates are not available or costly. Where ever brick bats aggregates are used the aggregates are made from slightly over burnt bricks. This will be hard. The waste brick bats such as over burnt bricks, normal burnt bricks are thrown away from the brick manufacturing units. These brick bats are obtained and used. Also recycled bricks obtained from the dismantled structures can be used in the concrete as an alternative replacement to coarse aggregate.

1.2 CLASSIFICATION OF LIGHT WEIGHT CONCRETE

Various types of light weight concrete can be classified by their method of production in to three groups
i) No-fines concrete: - By omitting the fine aggregate from the mix so that a large number of interstitial voids present; normal weight coarse aggregate is generally used. This concrete as no-fines concrete.
ii) Lightweight aggregate concrete: - By using porous lightweight aggregate of low apparent specific gravity instead of normal coarse aggregate. This type of concrete is known as lightweight aggregate concrete. Generally Pumice, Foamed slag, Expanded clays and Shales used as natural light weight aggregate and Brick bats, Expanded Perlites, Cinders ,Clinker and Breeze used as artificial light weight aggregate.
iii) Aerated/Foamed concrete: - Aerated concrete does not contain coarse aggregate, and can be regarded as an aerated mortar. Typically, aerated concrete is made by introducing air or other gas into a cement slurry and fine sand. Since the lightness of these aggregates derives from the air trapped in each individual particle, the more air that is trapped per particle unit, the lighter the weight and the better but conversely, lower the strength.

1.3 NECESSITY OF LIGHT WEIGHT CONCRETE

One of the most negative aspect of the conventional concrete is its high self-weight. Because of heavy self-weight of concrete makes it to some extent uneconomical structural material in some particular applications. Attempts have been made in the past to lower the self -weight of concrete and hence to increase its effectiveness as structural materials. Till now, studies on lightweight concrete with pumice aggregate have been scarce. However, considerable research work has been carried out on normal weight concrete. The development and use of lightweight concrete is important to the construction and maintenance of civil engineering structures. Light weight concrete is that concrete which by one means or the other has been made lighter than the conventional concrete. The DRAFT INTERNATIONAL MODEL CODE for concrete construction classifies light weight concrete as having densities between 1200 and 2000 Kg/m3. The most and great important quality of light weight concrete is its low density. There are many advantages of having low density. It helps in reduction of dead load, increases the improvement of building and lowers the haulage and handling costs. The use of light weight concrete has made it possible to proceed with the construction of tall structures on soils of low bearing capacities. In framed structures, if floors and walls are made of light weight concrete it will results in considerable economy. Another advantage of light weight concrete is its low thermal conductivity, and by which improves with decreasing density. Hence, in extreme climatic conditions and also in case of building with air-conditioning, the use of light weight concrete not only results in thermal comforts but also helps in declining the power consumption. Further, the use of light weight concrete results in opening an outlet for industrial wastes such as clinker, fly-ash, slag etc., which otherwise create problems of disposal. Keeping in view, the growing construction industry, it is almost necessary to resort to non-conventional and economic building materials, as the conservative materials are becoming more and more rare and costly.

1.4 AIM AND OBJECTIVES

To study the compressive strength, tensile strength , flexural strength of brick bats based light weight concrete.

1.4.1 Objectives of the study

The main objectives of the study of

1. To calculate the cost of manufacturing one cubic meter of light weight concrete.
2. To compare the cost variation of light weight concrete with normal concrete.
3. To compare the weight of light weight concrete and conventional concrete.
4. To understand the light weight concrete
5. To compare the strength of concrete with various percentage of brick bats used (30%, 40%, 50%).

CHAPTER NO. 2
LITERATURE REVIEW

2.1 INTRODUCTION

The research data presented in this paper are useful to understand the behavior of light weight concrete. The present study deals with the manufacture of light weight concrete and the influence of several parameters on the compressive strength flexural & split tensile. The purpose of the literature review is to get an overview of the behavior of concrete members in which the waste material is used in various percentages.

2.2 REVIEW OF PAPER

1. R. Veerakumar (2018) et. al1 Concrete is the most material being used in infrastructure development throughout the world. Fine aggregate is a prime material used for preparation of mortar and concrete and which plays a major role in mix design. Fine aggregates are weathered and worn out particles of rocks and are of various grades or sizes depending upon the amount of wearing. Now-a-days fine aggregate is not readily available, it is transported from a long distance. Those resources are also exhausting very rapidly. The non-availability or shortage of fine aggregate will affect the construction industry, hence there is a need to find the new alternative material to replace the fine aggregate, such that harm to environment is prevented. Many researchers are finding different materials to replace fine aggregate. This study aimed to investigate the suitability of using brick debris in concrete in place of fine aggregate. Brick debris originated from demolished masonry walls crushed in the laboratory and added in partial fine aggregate replacement. Four replacement levels, 5%, 10%, 15%, and 20%, were compared with the control. The tests on concrete showed that the mechanical properties (compressive strength test) of concrete containing brick debris were well comparable to those of the concrete without ground brick.

2. k divya teja (2017) et. al. 2 International research journal of engineering and technology “a study on mechanical properties of light weight concrete obtained by partial replacement of cement with fly ash, ground granulated blast furnace slag and coarse aggregate with brick bats”. The objective of this project is to study the effect of class F fly ash (FA) and Ground Granulated Blast Furnace Slag (GGBS) on the mechanical properties of Brick Bats at different replacement levels. In the present investigation it is

proposed to study the mechanical properties viz. Compressive strength at 3, 7, 28 and 90 days, Flexural strength at 7, 28 and 90 days, Rapid Chloride Permeability Test (RCPT) at 90 days and Scanning Electron Microscopy (SEM) and Energy Dispersive X-Ray Analysis (EDX) tests at 3 and 28 days for M 25 mix at ambient room temperature curing.

3. Nilesh Kumar(2017) et. al.2 Concrete is a composite material used for the ground that all considerate designing structure is developed with concrete in an efforts to find an alternative material in concrete much work has been focused to use brick aggregates in producing normal strength or even higher strength by far the most common course aggregates used in concrete is obtained from natural rock, but type of rock suitable for concrete making is not available locally and everywhere. However, there is hardly any literature producing previous concrete using bricks chips as course aggregates. The research was conducted to study the suitability crushed over burnt bricks as alternative course aggregates for concrete production. The concrete cube beams and cylinders of M-25, M30, and M-35 grade were thrown in this trail explore work and try to analyze different properties of concrete with crushed over burnt bricks as an alternative material. The physical properties like compressive strength, tensile strength, flexural strength and workability with alternative material was used with a dosage of 10%, 20% and 30% in concrete with the age of 7, 14, 28 and 50 days of curing. The general properties of fresh and hardened concrete were tried and the outcomes were dissected. Over Burnt bricks were casted and tested for compressive strength, tensile strength, flexural strength, and workability. The result shows that the aggregate that concrete derived from Over Burnt bricks aggregate attained lower strength than the regular concrete. More detailed and elaborated work is recommended with different mix ratio and a different proportion of Over Burnt aggregates for a better conclusion.

4. Kuldeepak dwivedi (2017) Concrete is a mixture of cement fine aggregate coarse aggregate and water. Concrete plays a vital role in the development of infrastructure Viz., building, industrial structures, bridges and highways etc. leading to utilization of large quantity of concrete. So the rapid increase in consideration activities has led to a dramatic increase in the price of conventional construction materials. Additionally various government agencies have put restrictions on sand and stone quarrying to conserve this diminishing natural resource. This has prompted many engineers to look for alternate materials that are cheaper while possessing similar characteristics. In this context an experimental study was carried out to find the suitability of the alternate materials such as over burnt brick chips and demolished concrete waste as a partial replacement of coarse aggregate because these materials are easily available at very low cost as compared to conventional coarse aggregates. The study was conducted to analyze the compressive and split tensile strength of concrete when conventional coarse aggregate was replaced with 10 to 50% of over burnt brick chips and 10 to 50% of demolished concrete waste separately. To increase the workability of concrete SUPER PLAST-HS plasticizer was used as an admixture. The plasticizer was used as 0.8 to 1% by weight of cement to achieve required workability. It is found that up to 25% replacements by over burnt chips and up to 35% replacement by demolished concrete waste the variation in properties of concrete is within permissible limit i.e. near the properties of M25 grade concrete. The study concludes that the over burnt brick chips can be used up to 25% and demolished concrete waste can be up to 35% effectively as an alternative to conventional coarse aggregate for m 25 grade of concrete. It has been seen that a replacement of coarse aggregate by over burnt brick up to 25% and by demolished concrete waste up to 35% shows a negligible variation in properties of concrete. The reduction in the cost of coarse aggregate by 10% in case of over burnt brick chips and in the case of demolished waste that is 25%.

5. Sardar Faisal Abbas (2016) et. al 3 Concrete is the most undisputable and indispensable material being used in infrastructure development throughout the world. The present investigation shows the performance of brick aggregates in concrete with a view of achieving the target compressive strengths specified in concrete mix design. It will also explore the performance of burnt brick aggregates in comparison with the natural granitic aggregates. The production of natural aggregates and building stones through quarry is an expensive process. Kiln burnt bricks when crushed to the required nominal sizes provide a rough and irregular
surface whichaids in bonding of cement paste and the aggregate. Therefore the bond strength of concrete is likely to beincreased when these aggregates are used. From all the results and experimental approaches it is concluded that concrete formed with over burnt brick aggregates showed considerably beneficial performance as compared to the concrete made up of natural aggregates obtained from local resources. It was observed that compressive strength of concrete was increased by 10% with brick aggregate and tensile strength was increased by 18%. This projectencourages the recovery of waste materials to be used in production of aggregates for concrete henceconserving the environment.

6. sachin kulkarni (2015) et. al. 1 Experimental study on strength properties of concrete using brick aggregates Concrete has captured almost entire construction industry and its ingredients such as cement, manufacture of cement and bricks consume large quantities of natural resources and fuel with C02 to the green house gases resulting in global warming. Therefore, under such critical scenario of shrinkage of natural aggregates resource and ever increasing pressure to reduce construction costs and further construction & dismantling of old structure producing heavy debris needing disposal has made it necessary to invert, discover & think of other alternatives for replacement of coarse aggregate. The present paper aims with the study of strength properties of concrete using brick aggregates. To use over-burnt bricks, normal burnt brick as replacement to conventional normal aggregate in different proportions. Brick aggregates can fully or partly replace the conventional coarse aggregate to produce M20 concrete. M20 grade concrete mix with different proportions i.e. [1:1.5:1, 1:1.5:2, 1:1.5:3] are carried out using over-burnt, normal burnt brick aggregates. Physical proportions of cement, fine aggregate & normal aggregate, normal burnt brick aggregates, over-burnt brick aggregates are carried out. Cube compressive strength test & split tensile test are carried out for 7 & 28 days. An attempt has been made using brick aggregate concrete to replace normal aggregate concrete. proportions. Brick aggregates can fully or partly replace the conventional coarse aggregate to produce concrete.

7. Mr.S.Manimaran(2015)et. al.1 This study presents the performance of Self compacting concrete (SCC). Ordinary Portland cement was replaced with fly ash(FA), and coarse aggregate(CA) was partially replaced with class I bricks (BB). In addition to this steel fibers (SF) were added in proper proportion. Suitable dosage of super plasticizers and viscosity modifying agents were also added for achieving increased workability and to maintain a low w/p ratio. By conducting fresh and hardened tests on the specimens an attempt has been made to study the workability, compressive strength, split tensile strength, flexural strength and shrinkage characteristics of SCC. Though the replacement of CA with BB showed a considerable decrease in the strength when compared to the control specimen (CA), the addition of steel fibers increased the same. But there was no major decrease in the split tensile strength and flexural strength. The addition of steel fibres had minimal influence on the workability of SCC. The test results reveal that the BB along with steel fibers could be effectively used in SCC which may be applied for

instances which require normal strength of the order of 20N/mm2.Also usage of BB in SCC can serve as an effective way of disposal of construction wastes from building construction and demolition.

8. n. S., agunwamba (2014) et. al. 3 The suitability of crushed over burnt bricks as coarse aggregates for concrete apebo, n. S., agunwamba, j. C., ezeokonkwo, j. C. Issn: 2319-5967 iso 9001:2008 certified international journal of engineering science and innovative technology (ijesit) volume 3, issue 1, january 2014. The research was conducted to study the suitability of crushed over burnt bricks as alternative coarse aggregates for concrete production. Tests were carried out to determine the physical properties of the crushed over burnt bricks aggregates. Values of 22.8%, 28.2% and 4.4% were obtained for aggregate crushing value, aggregate impact value and aggregate water absorption respectively. The concrete mixes were prepared using crushed over burnt bricks as coarse aggregates at water – cement ratios of 0.40, 0.50, 0.55 and 0.60. Cubes of concrete were prepared and tested to study the compressive strength. The results were compared with concrete made with river wash gravel as coarse aggregates which at present is the only coarse aggregate.

9. s. Keerthinarayana (2013) et. al1 Study on strength and durability of concrete by partial replacement of fine aggregate using crushed spent fire bricks Concrete is the most undisputable and indispensable material being used in infrastructure development throughout the world. Umpteen varieties of concretes (FAC, HVFAC, FRC, HPC, HSC, and others) were researched in several laboratories and brought to the field to suit the specific needs. Although natural fine aggregates (i.e., river sand) are so far and/or will be superior to any other material in making concrete, their availability is continuously being depleted due to the intentional overexploitation through out the Globe. Hence, partial or full replacement of fine aggregates by the other compatible materials like sintered fly ash, crushed rock dust, quarry dust, glass powder, recycled concrete dust, and others are being researched from past two decades, in view of conserving the ecological balance. In this direction, an experimental investigation of strength and durability was undertaken to use “Spent Fire Bricks” (SFB) (i.e. waste material from foundry bed and walls; and lining of chimney which is adopted in many industries) for partial replacement of fine aggregate in concrete.

10. mohammad abdur rashid (2012) et. al.3 Effect of replacing natural coarse aggregate by brick aggregate on the properties of concrete mohammad abdur rashid1, md. Abdus salam1, sukanta kumar shill1 and md. Kowsur hasan2 1dept. Of civil engineering, dhaka university of engineering & technology, gazipur, bangladesh 2abul bashar consultant, mirpur, dhaka, bangladesh vol. 1, issue 3, june 2012. This paper presents an experimental investigation on the properties of concrete obtained replacing stone aggregate (partly or fully) by crushed clay-brick. The target compressive strength of stone aggregate concrete was 24 MPa. Remaining concretes were made by replacing the stone aggregate (partly or fully) by equal volume of brick aggregate while everything else was kept unchanged. The only variable considered in this study was the volumetric replacement (0%, 25%, 50%, 75%, and 100%) of stone aggregate by brick aggregate. The use of brick aggregate as a replacement of stone aggregate resulted reductions in unit weight, compressive strength, and modulus of elasticity of concrete by about 14.5%, 33%, and 28% respectively. Different relations for determination of compressive strength, splitting tensile strength, and modulus of elasticity of mix-aggregate concrete have been tentatively proposed.

11. Abdus salam (2012) et.al.3 'effect of replacing natural coarse aggregate by brick aggregate on the properties of concrete'This paper presents an experimental investigation on the properties of concrete obtained replacing stone aggregate (partly or fully) by crushed clay-brick. The target compressive strength of stone aggregate concrete was 24 MPa. Remaining concretes were made by replacing the stone aggregate (partly or fully) by equal volume of brick aggregate while everything else was kept unchanged. The only variable considered in this study was the volumetric replacement (0%, 25%, 50%, 75%, and 100%) of stone aggregate by brick aggregate. The use of brick aggregate as a replacement of stone aggregate resulted reductions in unit weight, compressive strength, and modulus of elasticity of concrete by about 14.5%, 33%, and 28% respectively. Different relations for determination of compressive strength, splitting tensile strength, and modulus of elasticity of mix-aggregate concrete have been tentatively proposed.

12. engineering, k.l. University, vaddeswaram, guntur dist., india *e-mail: pskumarphd@gmail.com international journal of civil engineering research volume 1, number 1 (2010), pp. 65–7.

13. M. A. Rashida, t. Hossaina, and m. A. Islam, "properties of higher strength concrete made with crushed brick as coarse aggregate," journal of civil engineering (ieb), vol. 37, no. 1, pp. 43-52, 2009.

14. M. A. Rashid(2008) et. al2 higher strength concrete using crushed brick as coarse aggregate", indian concrete journal, vol. 82, no. 10, pp.18-23, 2008. This paper presents an experimental investigation on the properties of concrete obtained replacing stone aggregate (partly or fully) by crushed clay-brick. The target compressive strength of stone aggregate concrete was 24 MPa. Remaining concretes were made by replacing the stone aggregate (partly or fully) by equal volume of brick aggregate while everything else was kept unchanged. The only variable considered in this study was the volumetric replacement (0%, 25%, 50%, 75%, and 100%) of stone aggregate by brick aggregate. The use of brick aggregate as a replacement of stone aggregate resulted reductions in unit weight, compressive strength, and modulus of elasticity of concrete by about 14.5%, 33%, and 28% respectively.

15. M. K. Hasan, m. M. U. Khan, and m. S. Uddin, "properties of concretes obtained replacing stone chips by brick aggregates", b. Sc. Engineering thesis, department of civil engineering, dhaka university of engineering & technology (duet), gazipur, bangladesh, september 2007.

16. Farid DebiebaSaid Kenaib (2007) Recycling and reuse of building rubble present interesting possibilities for economy on waste disposal sites and conservation of nat-ural resources. This paper examines the possibility of using crushed brick as coarse and fine aggregate for a new concrete. Either naturalsand, coarse aggregates or both were partially replaced (25,50,75 and 100%) with crushed brick aggregates. Compressive and flexuralstrengths up to 90 days of age were compared with those of concrete made with natural aggregates. Porosity, water absorption, waterpermeability and shrinkage were also measured. The test results indicate that it is possible to manufacture concrete containing crushedbricks (coarse and fine) with characteristics similar to those of natural aggregates concrete provided that the percentage of recycled aggre-gates is limited to 25% and 50% for the coarse and fine aggregates, respectively 2007

17. Jafar bolouri bazaz (2006) et. al.2'performance of concrete produced with crushed bricks as the coarse & fine aggregate' the geological society of london, iaeg2006, pp. 616 - 622. This project explains about the replacement of fine aggregates by partially crushed spent fire bricks. Therefore varying percentage of fine aggregates by crushed spent fire bricks with varying percentage of 10%, 15%, 20% & 25% and optimum percentage of replacements is made and strength and workability parameters are studied. The workability of concrete gets decreased with the addition of the crushed spent bricks. From the test results, crushed spent fire bricks replaced for fine aggregates give a maximum strength at 20% when compared to conventional concrete. Then the optimum percentage of replacement of fine aggregates by crushed spent

fire bricks are used in combination as partial replacement in concrete and the optimum percentage of the combination is obtained(2006).

CHAPTER 3
MATERIALS AND METHODOLOGY

3. PROPERTIES OF MATERIALS

3.1 GENERAL

The main constituents of the light weight aggregate concrete are Cement, fine aggregate, coarse aggregate, water and Cinder are procured from various places. Fine aggregate and coarse aggregate are procured from local area. Local drinking water is used for mixing and curing. The properties of cement, fine aggregate, coarse aggregate, water. The experiments conducted on cement are fineness test, specific gravity, normal consistency, initial setting and final setting time. The experiments conducted on fine and coarse aggregates are sieve analysis, water absorption, specific gravity, crushing strength.

3.2 MATERIALS

The constituents of the concrete mix are cement, fine aggregate, coarse aggregate and brick bats. The details of each constituents are as follows:

3.2.1 Cement

In the present investigation, Ordinary Portland Cement (OPC) of 43 grade confirming to IS: 8112-1989 specifications were used. The properties of cement are shown in table 3.1.

Table: 3.1 Physical properties of 43 grade Ordinary Portland Cement

SR. No	Properties	Results
1.	Fineness	7%
2.	Specific gravity	3.15
3.	Normal Consistency	30.5%
4.	Setting time(min) a) Initial b) Final	 90 min 285 min

3.2.2 Fine Aggregate

The locally available natural sand is procured and is found to be conformed to grading zone-II of IS383-1970. Various tests have been carried out as per the procedure given in IS 383-1970 from them it is found that

Table: 3.2 Physical properties of Fine Aggregate

SR.No	Properties	Test Results
1.	Specific gravity	2.52
2.	Fineness	2.50 mm

3.	Bulk Density	1.71 kg/m^3
4.	Moisture Content	3.477%

3.2.3 Natural Coarse Aggregate

Machine crushed granite aggregate conforming to IS 383-1970 consisting 20mm and below maximum size of aggregates has been obtained from the local quarry. It has been tested for physical and mechanical properties such as Specific Gravity, Water Absorption and Sieve Analysis and the results are as follows:

Table: 3.3 Physical properties of Natural Coarse Aggregate

SR. NO	Properties	10 mm	20 mm
1.	Specific gravity	2.92	2.92
2.	Fineness	8.65	8.94
3.	Bulk Density	1438 kg/m^3	1543 kg/m^3
4.	Moisture Content	0.92%	0.95%

3.2.4 Brick Bats

Bricks are a versatile and durable building and construction material with good load bearing properties. Various researchers have been carried out in porosity, permeability and absorption of brick. The traditional clay bricks are manually produced by pressing clay with certain amount of sand in the wooden mould. Then the wet bricks are first dried in the sun and air and then transported to the brick kiln for subsequent burning process. The bricks are burnt up to temperature of 800-900C in the brick kiln. As brick bats are waste products that are easily available and it is hard to decompose these waste are so in this project we are going to use these brick bats which makes the use of these waste products.
Following material properties are carried in the given project.

3.2.5. Specific Gravity

Specific gravity of coarse aggregate is made use of in design calculation of concrete mixes. Average specific gravity of the coarse aggregate varies from 2.6 to 2.8.

3.2.6 Fineness Modulus

Sieving can be done either manually or mechanically. In the manual operation, the sieve is shaken by giving the movements in all the possible direction to give chance to all the particles for passing through the sieve. Operation should be continued till such time that almost no of particle is passing through the sieve. From the sieve analysis the particle size distribution in a sample of aggregate is found out in this connection a term is known as "Fineness Modulus."

3.2.7 Bulk Density

The bulk density of an aggregate gives valuable information regarding the shape and grading of the aggregate. For determining of bulk density the aggregate are filled in the container and then they are compacted in a standard manner. The weight of the aggregate gives the bulk density calculated in kg/m^3

3.2.8 Moisture Content

To determine the most accurately the quantity of water to be added to the mix, the moisture content of sand has to be considered. It is the ratio of mass of water in a sample to the mass of solid in sample it is expressed in %
Formula for calculating moisture content:

$$\text{Moisture Content} = (\text{Mass of water}/\ \text{Mass of solid}) \times 100$$

3.2.9 Water

As per recommendation of IS: 456 (2000) the water to be used for mixing &curing of concrete should be free from deleterious material. Potable water was used in the present study in all operations control over water quality.

3.3 PREPARATION OF SPECIMEN

The quantities of the constituents of the concrete were obtained from the Indian standard mix design procedure. The variation in strength of hardened concrete using over burnt brick chips and demolished concrete waste as a partial replacement of coarse aggregate is studied by casting cube and cylinders. The concrete was prepared in the laboratory using concrete mixer .The cement, fine aggregate and course aggregate were mixed in dry state and calculated of water is mixed to achieve required workability.

3.4 CASTING MIXING AND CURING

After the preliminary tests on the constituents of concrete confirmed the suitability of ingredients and the design mix was found to be satisfactory, the task of casting cube and cylinder was taken up. The available laboratory equipment's were utilized in the accomplishment of the experimental program. The guidelines in the IS 10262: (1982) [40], were strictly adhered to in the process of mixing concrete. Firstly, the coarse aggregate was washed a day before casting in order to make it silt free and was laid to dry. On the following day, the coarse aggregate was found to be satisfactorily moisture. This was necessary to prevent absorption of moisture by the aggregate from the water being added mix i.e. the design water cement ratio had to be carefully regulated.

3.5 MIX DESIGN

Mix design can be defined as the process of selecting suitable ingredients of concrete and determining their relative proportions with the object of producing concrete of certain minimum strength and durability as economically as possible.

3.5.1 Objects

The main objects of concrete mix design are:

1. To achieve the stipulated minimum strength and durability.
2. To make the concrete in the most economical manner.

3.5.2 Principal of Concrete mix design

Design of concrete mixes involves determination of the proportion of the given constituents, namely, cement, water, coarse and fine aggregates and admixture, if any, which would produce concrete possessing specified properties both in the fresh and hardened states with the maximum overall economy. Workability is specified as the important of concrete in the state; for hardened states compressive strength and durability are important. The mix design is, therefore, generally carried out for p particular compressive strength if concrete can be designed for flexural strength or, for that matter, for any other specific property for concrete. The proportioning of concrete mixes is accomplished by the use of certain relationships established from experimental data, which afford reasonably accurate guide to select the best combination of ingredients so to desirable the properties.

3.5.3 Mix Design for Conventional Concrete

Table no 3.4 mix design for Conventional Concrete

Grade of concrete	M 25
Cement	43 grade
Target strength	fck + 1.65
Cement content	416 kg/m^3
W/C ratio	0.405
Sand content	680.33 kg
C.A content	1020.49 kg

Water	Cement	Fine Aggregate	Coarse Aggregate
208	416	680.33	1020.49
0.5	1	1.635	2.453

3.5.4 Mix Design by using Brick Bats

Table No. 3.5 Mix Design (30% replacement of Coarse aggregate with brick bats)

30% Replacement	
Water	208 lit
Cement	416 kg
Fine Aggregate	680.33 kg
Coarse Aggregate	714.343 kg
Brick bats	306.147 kg

Table No. 3.6 Mix Design (40% replacement of Coarse aggregate with brick bats)

40% Replacement	
Water	208 lit
Cement	416 kg
Fine Aggregate	680.33 kg
Coarse Aggregate	612.294 kg
Brick bats	408.196 kg

Table No. 3.7 Mix Design (50% replacement of Coarse aggregate with brick bats)

50% Replacement	
Water	208 lit
Cement	416 kg
Fine Aggregate	680.33 kg
Coarse Aggregate	510.245 kg
Brick bats	510.245 kg

3.6 LABORATORY TEST

Following tests were carried out for given nominal mix and brick bats concrete mix.

3.6.1 Test on Workability

3.6.1.1 Slump cone test on workability

The test is carried out using a metallic mould in the shape of a conical frustum known as a slump cone that is open at the both ends and has attached handles. The tool typically has a top diameter of 10 cm and of 20 cm at the bottom with a height 30 cm. The mould is filled with concrete in the three layers of equal volume. Each layer is compacted with 25 strokes of a tamping rod. The slump cone mould is lifted vertically upward and the change in height of concrete is measured. Four types of slumps are commonly encountered, as shown in fig. The only type of slump is frequently referred as the true slump. A zero slump and a collapsed slump are both outside the range of workability that can be measured with the slump test. The slumped concrete takes a various shapes and according to the profile of slumped concrete, the slump is termed as true slump, shear slump or collapse slump. If shear or collapse slump is achieved, a fresh sample should be taken and the test repeated. A collapse slump is an indication that the mix is too wet.

1. True: In a true slump the concrete simply subsides, keeping more or less to shape.
2. Zero: Zero slump concrete is defined in the same document, as concrete of stiff or extremely dry consistency showing no measurable slump after removal of the slump cone.
3. Collapse: In a collapse slump the concrete collapses completely.
4. Shear: In a shear slump the top portion of the concrete shear off and slips sideways.

3.6.2 Non Destructive Test

Non Destructive Test is the process of inspecting, testing, or evaluating materials, components or assemblies for discontinuities, or differences in characteristics without destroying the serviceability of the part or system.

3.6.2.1 Types of Non Destructive Test.

1. Rebound Hammer Test.
2. Ultrasonic Pulse Velocity Test.

3.6.2.1 Rebound Hammer Test

A rebound hammer, also known as Swiss hammer or a rebound hammer, is a device to measure the elastic properties or strength of concrete or rock, mainly surface hardness and penetration resistance. The hammer measures the rebound of a spring loaded mass impacting against the surface of the sample. The test hammer will hit the concrete at a defined energy. Its rebound is dependent on the hardness of the concrete and is measured by the test equipment. The Schmidt hammer is an arbitrary scale ranging from 10 to 100. Hold the instrument firmly so that the plunger is perpendicular to the test surface. Gradually push the instrument toward the test surface until the hammer impacts. After hammer for the determination of compressive strength of hardened concrete. Button on the side of instrument to lock the plunger in its retracted position. Read the rebound number on the scale to the nearest whole number and record the rebound number.

This non destructive method is considered for the given study to check the quality of concrete.

Table No. 3.8 Rebound hammer range

Quality of concrete from rebound number	
Average Rebound	Quality of the concrete
>35	Excellent
30-35	Very Good
25-30	Good
20-25	Fair
15-20	Poor
<15	Very Poor

3.6.3 Destructive Test

In destructive testing tests are carried out to the specimen's failure, in order to understand a specimen's performance or material behavior under different loads.

Types of Destructive testing

1. Compressive strength test.
2. Flexural strength test.
3. Split tensile strength test.

3.6.3.1 Compressive strength test

Compressive strength of concrete cube test provides an idea about all the characteristics of concrete. By the single test one judge that whether concreting has been done properly or not. Concrete compressive strength for general construction varies from 15MPa to 30MPa and higher in commercial and industrial structures. Compressive strength of concrete depends on many factors such as water cement ratio, cement strength, quality of concrete material, quality control during production of concrete etc. The test for compressive strength is carried out either on cube or cylinder.

Formula for calculating Compressive Strength

$$\text{Compressive Strength} = \text{Load/Area}$$

3.6.3.2 Flexural Strength Test

Flexural strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam to resist failure in bending. The flexural strength can be determine by standard test method of third point of loading or center – point loading. In this study, three beams of size 100mm x 100mm x 500mm were used to find flexural strength. The system of loading used for finding the flexural strength is shown in figure 5.3. In case of three point loading, the critical crack may appear at any section, of the pure bending zone. In the given study center point load method have been used for to check the flexural strength of beam.

3.6.3.3 Split Tensile Strength Test

This test is conducted in a 2000 tones capacity of the compression testing machine by placing the cylindrical specimen of the concrete, so that its axis is horizontal between the plates of the testing machine. Experimental setup for Split Tensile Test is shown in fig 4.2 the load was applied uniformly at a constant rate until failure by splitting along the vertical diameter takes place. Load at which the specimen failed is recorded and the splitting tensile stress is obtained using the formula based on IS: 5816-1970.

CHAPTER 4
OBSERVATION

4.1 GENERAL

In this chapter results obtained from various test conducted that is workability, non-destructive test and destructive test are presented. The workability results by using slump cone test are shown in this chapter. The non destructive testing by using rebound hammer test, destructive testing of compressive strength test on cubes, split tensile test on cylinders and flexural strength on beams have been performed after 7, 14 & 28 day of curing & after 24 hours of air drying. Observations of non- destructive and destructive testing's are shown in this chapter.

4.2 LABORATORY TEST

4.2.1 Workability Test:

The slump test is most well-known and mostly used test method to characterize the workability of fresh concrete. This test is inexpensive test which measures consistency the test method is widely standardized for measuring the consistency throughout the world.

Table no - 4.1 Results of workability test

Mixes	Slump Value in mm	Average in mm
Nominal Mix	46	48
	48	
	50	
Mix 1	62	64
	61	
	65	
Mix 2	54	54
	53	
	55	
Mix 3	28	30
	31	
	30	

4.2.2 Non Destructive Test Results

4.2.2.1 Rebound Hammer Test observation

In this non-destructive test, six readings were taken at centre at each face of cube. And eight readings were taken for the beam. The readings for beam were taken 10 cm from the end. The highest and lowest reading were discarded. Average of the remaining rebound number were considered.

Table No. 4.2 Rebound Hammer Test observation for cube

28 Days	Cube No	Rebound number				Average Rebound number	Average	Remarks
	1	34	32	32	35	33.25		
Nominal	2	32	30	31	30	30.75	32.58	Very good
	3	35	32	34	34	33.75		
	1	30	29	32	33	31.00		
Mix1 (30%)	2	32	32	34	31	32.25	31.86	Very good
	3	34	34	30	31	32.25		
	1	31	30	30	29	30.00		
Mix 2	2	33	34	32	32	30.75	30	Good
	3	32	29	30	30	30.25		
	1	28	28	29	27	28.00		
Mix 3	2	25	29	27	28	27.25	27.25	Good
	3	29	27	25	25	26.50		

Table No. 4.3 Rebound Hammer Test observation for beam

28 Days	Beam No	Rebound number						Average Rebound number	Average	Remarks
Nominal	1	30	32	34	28	35	30	31.5		
	2	30	34	32	35	31	33	32.6	32.3	Very good
	3	35	34	34	30	31	33	32.8		
Mix1 (30%)	1	28	30	33	32	34	32	31.5		
	2	30	30	32	33	29	31	30.83	31.16	Very good
	3	29	32	33	29	33	34	31.16		
Mix 2	1	31	28	30	32	28	29	29.66		
	2	28	29	30	32	30	32	30.16	29.77	Good

	3	30	29	31	28	30	29	29.5		
Mix 3	1	24	28	29	30	24	22	26.16		
	2	22	28	24	29	28	24	25.66	26.05	Good
	3	24	28	30	29	25	22	26.33		

4.2.3 Destructive Test Result

4.2.3.1 Compressive strength Test observation:

In this test, compressive strength of concrete cube were determined by using compressive testing machine. Three specimen were tested and the reading were observed for 7 days, 14 days and 28 days. The average of three readings were considered.

Table no 4.4 Results of compressive strength for nominal mix

Nominal Mix	Cube No	Failure Load(N/mm2)	Compressive Strength (N/mm2)	Average	Remark
7 Days	1	356.85	15.86		
	2	360.9	16.04	17.24	
	3	446.17	19.83		
14 days	1	577.12	25.65		
	2	540.45	24.02	25.44	
	3	599.62	26.65		
28 days	1	622.12	27.65		
	2	630.45	28.02	28.10	
	3	644.62	28.65		

Table no 4.5 Results of compressive strength for mix 1 (30% replacement of Coarse aggregate with brick bats)

Mix 1 (30%)	Cube No	Failure Load(N/mm2)	Compressive Strength (N/mm2)	Average	Remark
7 Days	1	327.6	14.56		
	2	356.85	15.85	15.40	
	3	355.5	15.80		
14 days	1	514.35	22.86		
	2	453.82	20.17	21.33	
	3	472.05	20.98		
28 days	1	540.00	24.00		
	2	556.65	24.74	24.76	
	3	559.35	24.86		

Table no 4.6 Results of compressive strength for mix 2 (40% replacement of Coarse aggregate with brick bats)

Mix 2 (40%)	Cube No	Failure Load(N/mm2)	Compressive Strength (N/mm2)	Average	Remark
7 Days	1	289.55	12.87		
	2	279.67	12.43	12.77	
	3	293.17	13.02		
14 days	1	447.97	19.91		
	2	432	19.20	20.07	
	3	468	20.80		
28 days	1	454.5	20.20		
	2	414	18.40	20.19	
	3	491.85	21.86		

Table no 4.7Results of compressive strength for mix 3 (50% replacement of Coarse aggregate with brick bats)

Mix 3 (50%)	Cube No	Failure Load(N/mm2)	Compressive Strength (N/mm2)	Average	Remark
7 Days	1	270.9	12.04		
	2	272.25	12.10	12.23	
	3	266.85	11.86		
14 days	1	379.35	16.86		
	2	395.10	17.56	17.50	
	3	404.55	17.98		
28 days	1	404.10	17.96		
	2	405.00	18.00	18.06	
	3	409.5	18.20		

4.2.3.2 Split Tensile strength observation:

The tensile strength of concrete is one of the basic and important properties which greatly affect the extent and size of cracking in structure the results of split tensile strength test of cylinder are given below respectively as per the mixes following tables showing the results of 7 days and 14 days and 28 days as per nominal mix and three different mixes.

Table no 4.8 Results of Split tensile strength for Nominal mix.

Nominal Mix	Cylinder No	Failure Load(N/mm2)	Split Tensile Strength (N/mm2)	Average	Remark
7 Days	1	115	1.63		
	2	120	1.69	1.63	
	3	112	1.58		
14 days	1	149	2.1		

	2	155.6	2.2	2.18	
	3	160	2.26		
28 days	1	171	2.41		
	2	169	2.39	2.48	
	3	187	2.64		

Table no 4.9 Results of Split tensile strength for mix 1 (30% replacement of Coarse aggregate with brick bats)

Mix 1 (30%)	Cylinder No	Failure Load(N/mm2)	Split Tensile Strength (N/mm2)	Average	Remark
7 Days	1	101.9	1.44		
	2	99.3	1.4	1.45	
	3	109	1.53		
14 days	1	148	2.08		
	2	140	1.98	2.06	
	3	151	2.14		
28 days	1	139.95	1.98		
	2	152.68	2.16	2.10	
	3	152.68	2.16		

Table no 4.10 Results of Split tensile strength for mix 1 (40% replacement of Coarse aggregate with brick bats)

Mix 2 (40%)	Cylinder No	Failure Load(N/mm2)	Split Tensile Strength (N/mm2)	Average	Remark
7 Days	1	101.2	1.43		
	2	105.6	1.49	1.46	
	3	104	1.47		
14 days	1	110	1.55		
	2	115.9	1.63	1.61	
	3	117.2	1.65		
28 days	1	158.8	2.25		
	2	120.2	1.7	1.81	
	3	105.10	1.48		

Table no 4.11Results of Split tensile strength for mix 1 (50% replacement of Coarse aggregate with brick bats).

Mix 3 (50%)	Cylinder No	Failure Load(N/mm2)	Split Tensile Strength (N/mm2)	Average
7 Days	1	88.35	1.25	
	2	103.20	1.46	1.40
	3	106.00	1.50	
14 days	1	93.30	1.32	
	2	95.43	1.35	1.32

	3	91.89	1.30	
28 days	1	119.6	1.69	
	2	115.67	1.63	1.67
	3	120.67	1.7	

4.2.3.3 Flexural Strength Observation:

Flexural strength is one measure of the tensile strength of concrete. It is measure of the tensile strength of concrete .It is measure of an unreinforced concrete beam or slab to resist failure in bending. The results of flexural strength test of beam are given below respectively as per the mixes following tables showing the results of 7 days, 14 days, 28 days as per nominal mix and three other mix.

Table no 4.12 Results of flexural strength for Nominal mix

Nominal Mix	Beam No	Failure Load(N/mm2)	Flexural Strength (N/mm2)	Average Flexural Strength
7 Days	1	2.402	1.096	
	2	2.525	1.14	1.09
	3	2.346	1.06	
14 days	1	4.95	2.25	
	2	5.18	2.36	2.30
	3	5.05	2.30	
28 days	1	6.10	2.78	
	2	6.26	2.85	2.82
	3	6.21	2.83	

Table no 4.13 Results of Flexural strength for mix 1 (30% replacement of Coarse aggregate with brick bats)

Mix 1 (30%)	Beam No	Failure Load(N/mm2)	Flexural Strength (N/mm2)	Average Flexural Strength
7 Days	1	2.15	0.98	
	2	2.28	1.04	1.02
	3	2.32	1.06	
14 days	1	5.05	2.30	
	2	4.95	2.25	2.27
	3	5.01	2.28	
28 days	1	6.37	2.90	
	2	6.06	2.76	2.8
	3	5.80	2.64	

Table no 4.14 Results of Flexural strength for mix 2 (40% replacement of Coarse aggregate with brick bats)

Mix 2 (40%)	Beam No	Failure Load(N/mm2)	Flexural Strength (N/mm2)	Average Flexural Strength
7 Days	1	2.10	0.96	
	2	2.13	0.97	0.95
	3	2.06	0.94	
14 days	1	4.61	2.10	
	2	4.70	2.14	2.13
	3	4.74	2.16	
28 days	1	5.75	2.62	
	2	5.53	2.52	2.51
	3	5.27	2.40	

Table no 4.15 Results of Flexural strength for mix 3 (50% replacement of Coarse aggregate with brick bats)

Mix 3 (50%)	Beam No	Failure Load(N/mm2)	Flexural Strength (N/mm2)	Average Flexural Strength
7 Days	1	1.84	0.84	
	2	1.95	0.89	0.87
	3	1.91	0.87	
14 days	1	4.57	2.08	
	2	4.35	1.98	2.02
	3	4.39	2.00	
28 days	1	5.09	2.32	
	2	4.83	2.20	2.20
	3	4.61	2.10	

4.3 COST ANALYSIS FOR NOMINAL MIX AND LIGHTWEIGHT CONCRETE GENERAL

The basic purpose of any project is to obtain new material of environmental friendly product. At the same time, cost of product should also be kept in mind so that cost of mass production should not be exceeded. If the new material is not cost effective, it will not reach the common person. Mass production of lightweight elements at factory will be not only speed up the construction but also will be cheap. This chapter is targeted on studying the cost of production of one cubic meter of lightweight concrete based on the market rates of various constituents.

4.3.1 COST OF MATERIAL

The cost of all materials obtain from local suppliers and are used in this project are shown in following tables. Brick bats are waste material; which are use in mix. The cost of lightweight concrete for one cubic meter is analyzed based on the quantity of material required and is tabulated in the following tables.

Table no 4.16 Cost analysis for nominal mix

SR. NO.	MATERIALS	RATES(Rs./Kg)	NOMINAL MIX	
			QUANTITY (KG)	PRICE (Rs.)
1	CEMENT	6.4	416	2662.4
2	FINE AGGREGATE	0.45	680.33	306.1
3	COARSE AGGREGATE	0.65	1020.49	663.3
4	BRICK BATS	0	0	0
	TOTAL			3631.8

Table no 4.17 Cost analysis for mix-1 (30% replacement)

SR. NO.	MATERIALS	RATES(Rs./Kg)	MIX-1	
			QUANTITY (KG)	PRICE (Rs.)
1	CEMENT	6.4	416	2662.4
2	FINE AGGREGATE	0.45	680.33	306.1
3	COARSE AGGREGATE	0.65	714.343	464.3
4	BRICK BATS	0	306.147	0
	TOTAL			3432.8

Table no 4.18 Cost analysis for mix-2 (40% replacement)

SR. NO.	MATERIALS	RATES(Rs./Kg)	MIX-2	
			QUANTITY (KG)	PRICE (Rs.)
1	CEMENT	6.4	416	2662.4
2	FINE AGGREGATE	0.45	680.33	306.1
3	COARSE AGGREGATE	0.65	612.294	397.9
4	BRICK BATS	0	408.196	0
	TOTAL			3366.4

Table no 4.19 Cost analysis for mix-3 (50% replacement)

SR. NO.	MATERIALS	RATES(Rs./Kg)	MIX-3	
			QUANTITY (KG)	PRICE (Rs.)
1	CEMENT	6.4	416	2662.4
2	FINE AGGREGATE	0.45	680.33	306.1
3	COARSE AGGREGATE	0.65	510.245	331.6
4	BRICK BATS	0	510.245	0
	TOTAL			3300.1

CHAPTER 5
RESULT AND DISCUSSION

5.1 LABORATORY TEST RESULTS

5.1.1 slump cone test

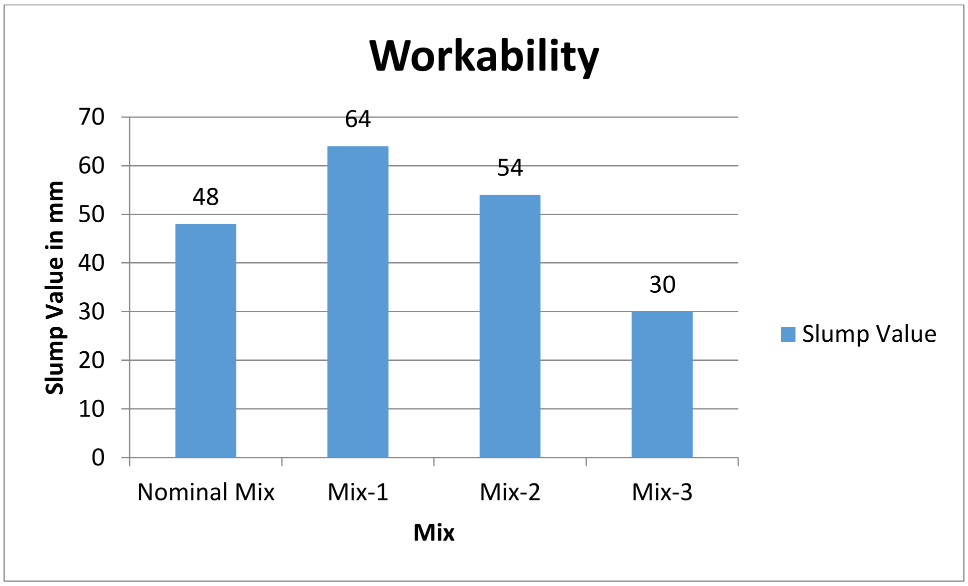


Fig. No.5.1 slump cone test results

Figure number 5.1 showing the results of slump cone test. For nominal mix as well as other mixes with varying percentage of brick bats as course aggregate from above study it found out to be the workability of mix 1 (30% replacement of course aggregate with brick bats) are good but as the brick bats increases the workability of concrete decreases. Mix 1 is more workable than other two mixes.

5.2 NON DESTRUCTIVE TEST RESULT

5.2.1 rebound hammer

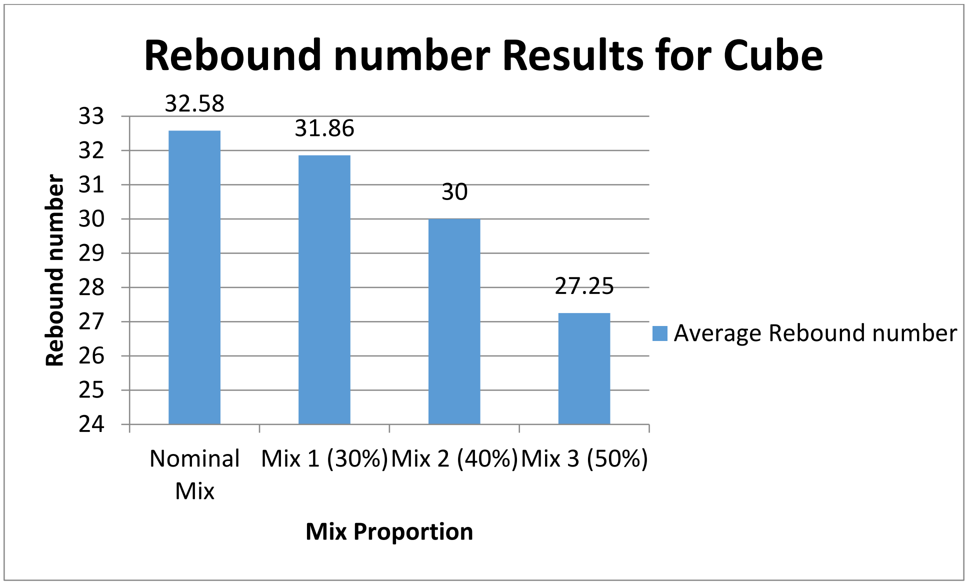


Fig. No.5.2 rebound hammer test result for cubes

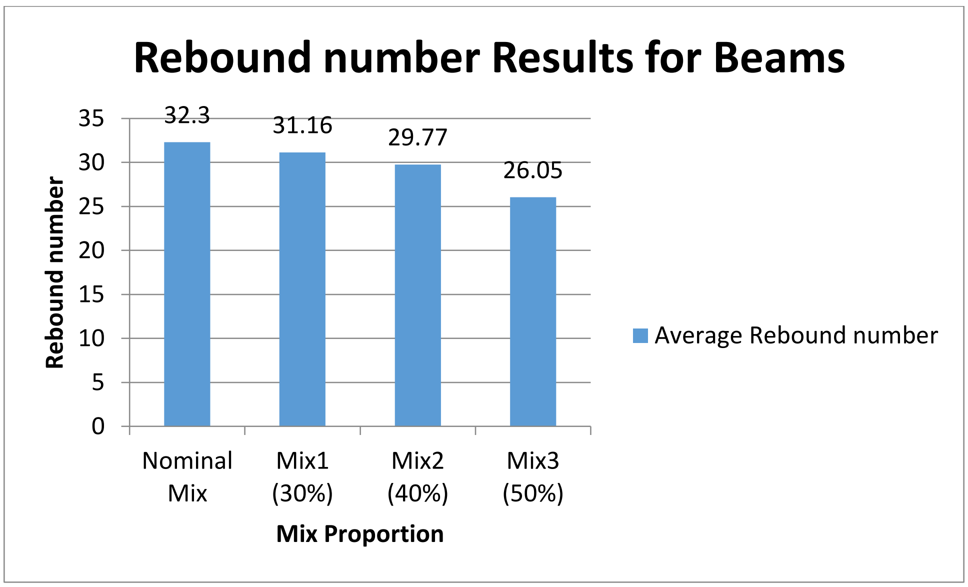


Fig. No.5.3 rebound hammer test result for beams

The above figure showing the average rebound hammer number at 28 days. For nominal mix, mix 1 (30% replacement of coarse aggregate with brick bats), mix 2 (40% replacement of coarse aggregate with brick bats), and mix 3 (50% replacement of coarse aggregate with brick bat. From this study it is concluded that quality of concrete found out very good. For some cases and good for some cases.

Average rebound number is found out greater for mix 1 and it is similar to the nominal mix. For mix 2 and mix 3 the average rebound number is less. Quantity of mix 1 concrete is good than mix 2 concrete and mix 3 concrete.

5.3 DESTRUCTIVE TEST RESULT

5.3.1 compressive test result

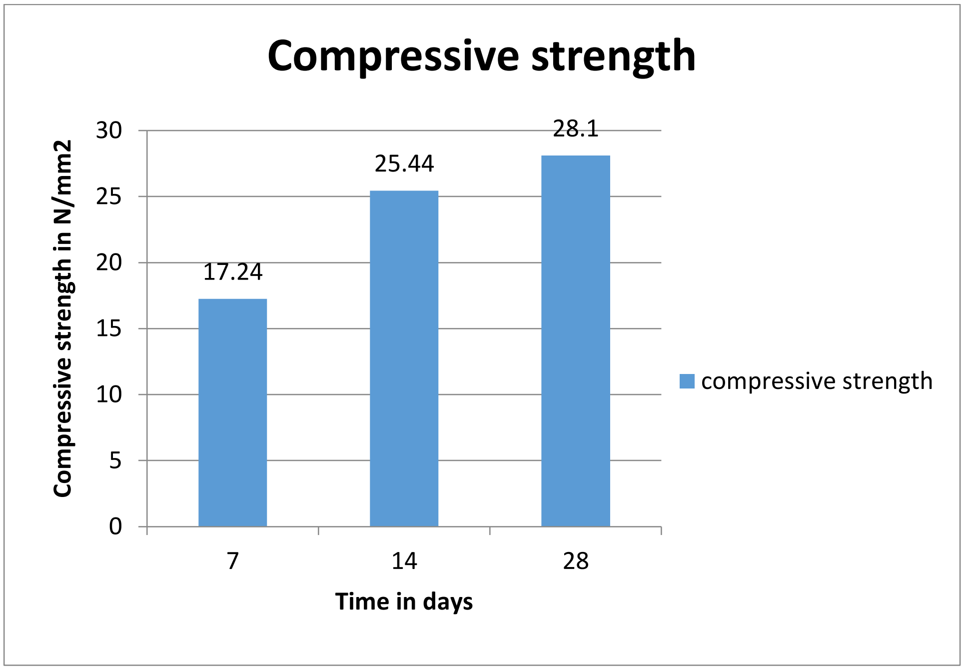


Fig. No.5.4 compressive test results for normal mix

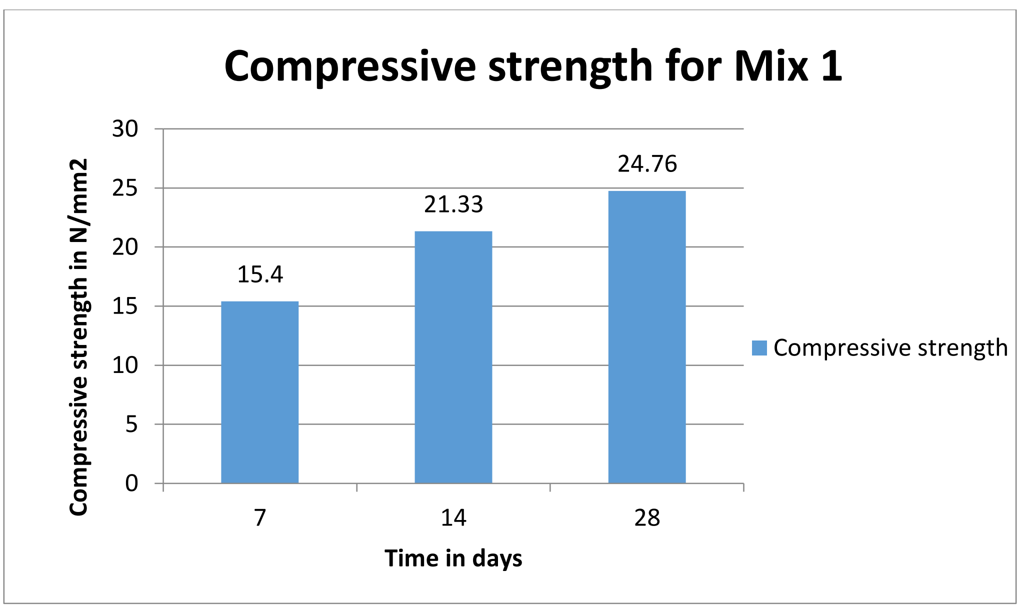


Fig.no. 5.5 Results of compressive strength for mix 1

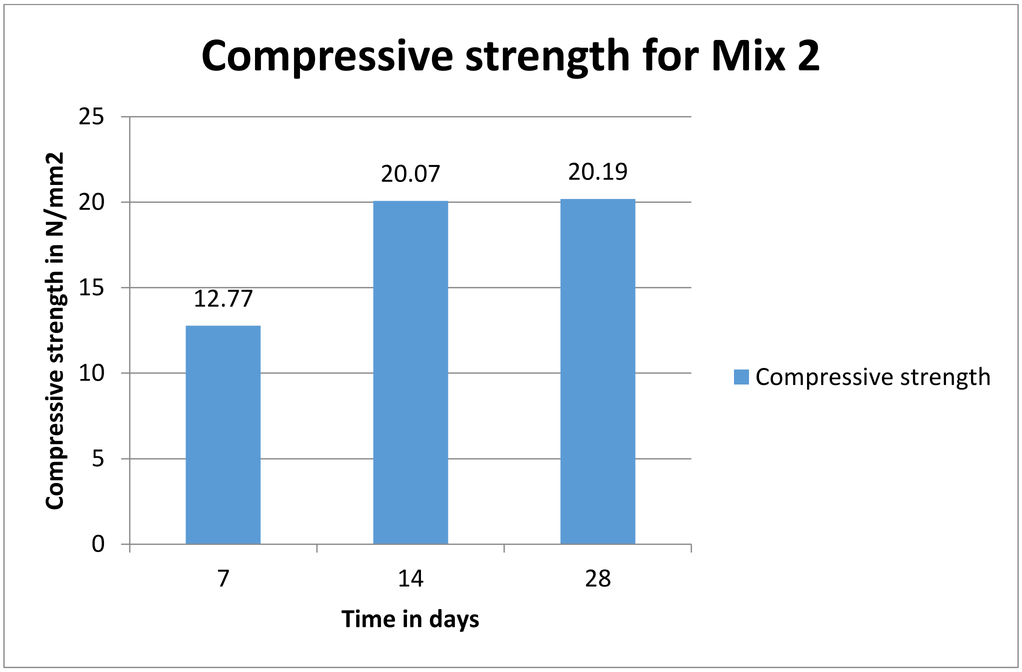


Fig.no. 5.6 Results of compressive strength for mix 2

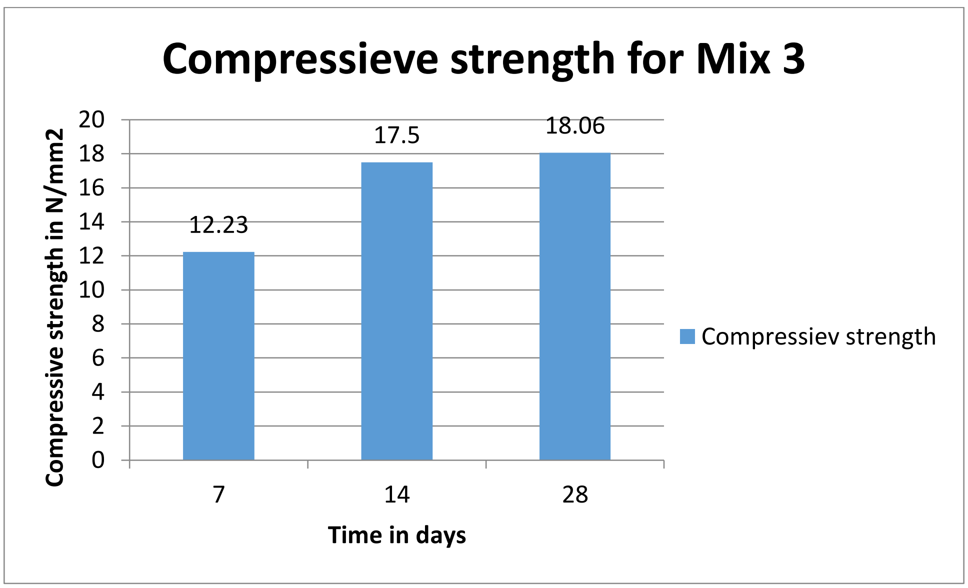


Fig.no. 5.7 Results of compressive strength for mix 3

Above all the figure depicts the compressive test results obtained. For nominal mix, mix 1 (30% replacement of coarse aggregate with brick bats), mix 2 (40% replacement of coarse aggregate with brick bats), and mix 3 (50% replacement of coarse aggregate with brick bat. The compressive strength of mix 1 is nearly equal to nominal mix and for mix 2 and mix 3 the compressive strength goes on decreasing.

5.3.2 split tensile test result

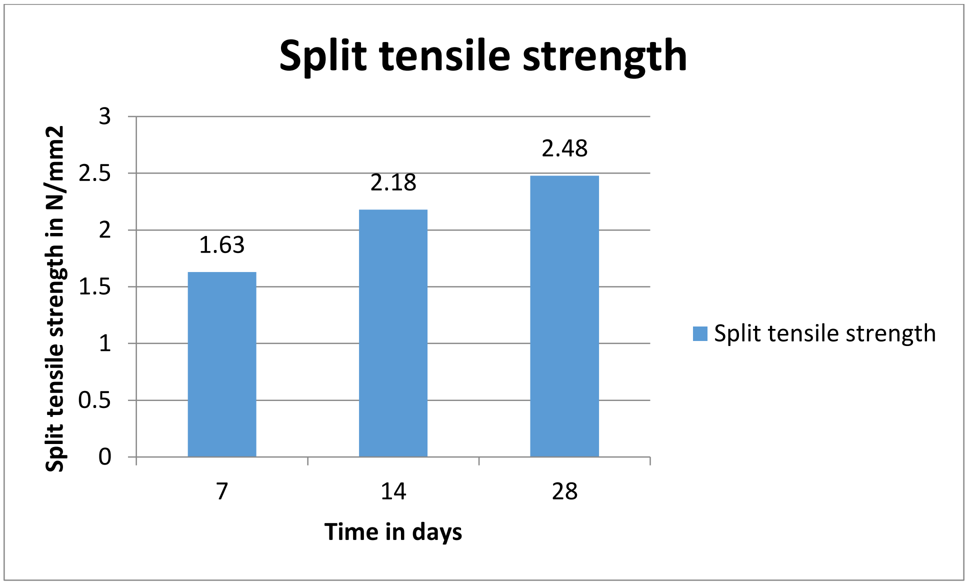


Fig. No.5.8 split tensile test result for normal mix

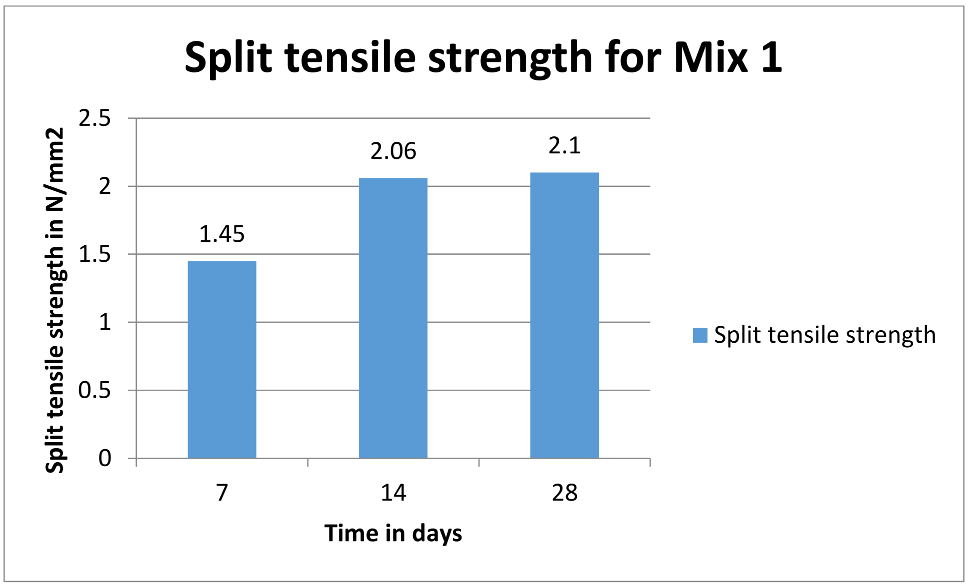


Fig. No.5.9 split tensile test result for mix 1

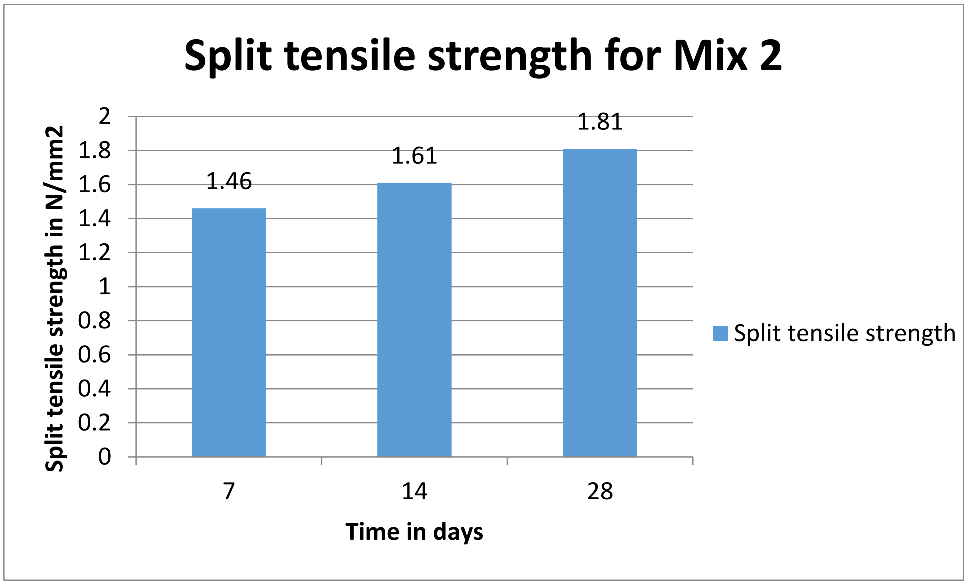


Fig. No.5.10 split tensile test result for mix 2

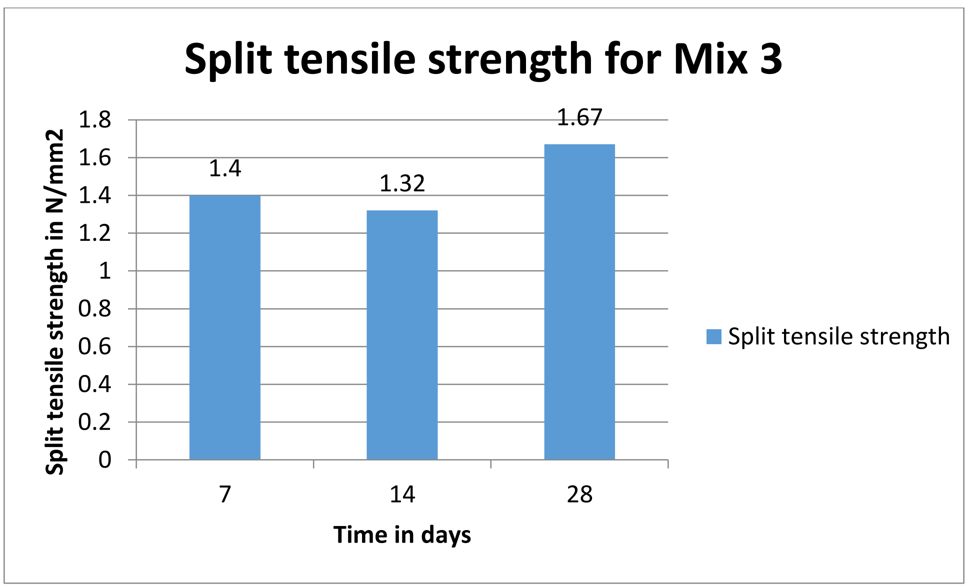


Fig. No.5.11 split tensile test result for mix 3

Above figure showing the split tensile strength results obtained for nominal mix and the other three times mixes with variation in the percentage of brick bats. The above results showed that the 30% replacement of coarse aggregate gives the better strength than40% and 50%replacement of coarse aggregate with brick bats. As the quantity of brick bats increases the tensile strength ultimately decreases.

5.3.3 flexural strength result

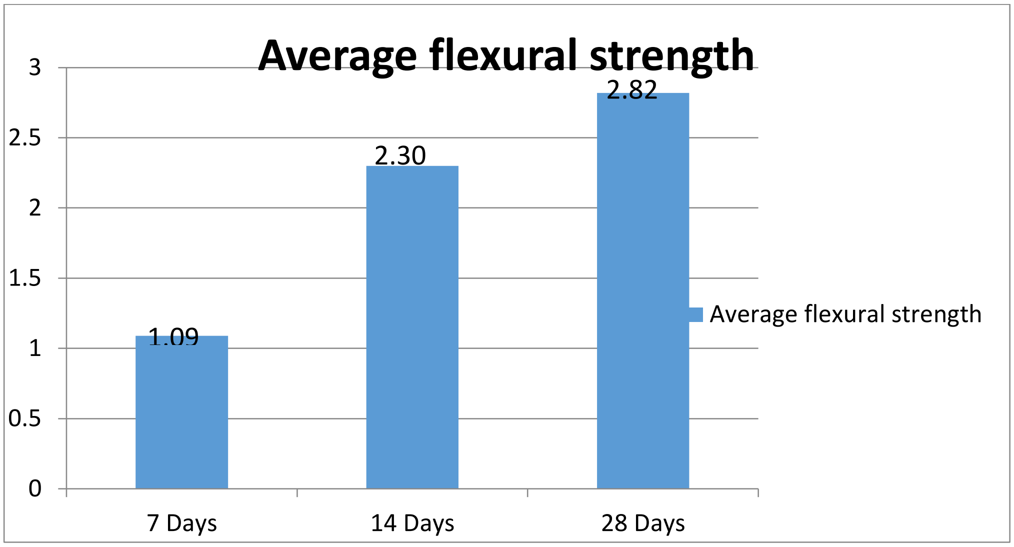


Fig. No. 5.12 flexural strength result for normal mix

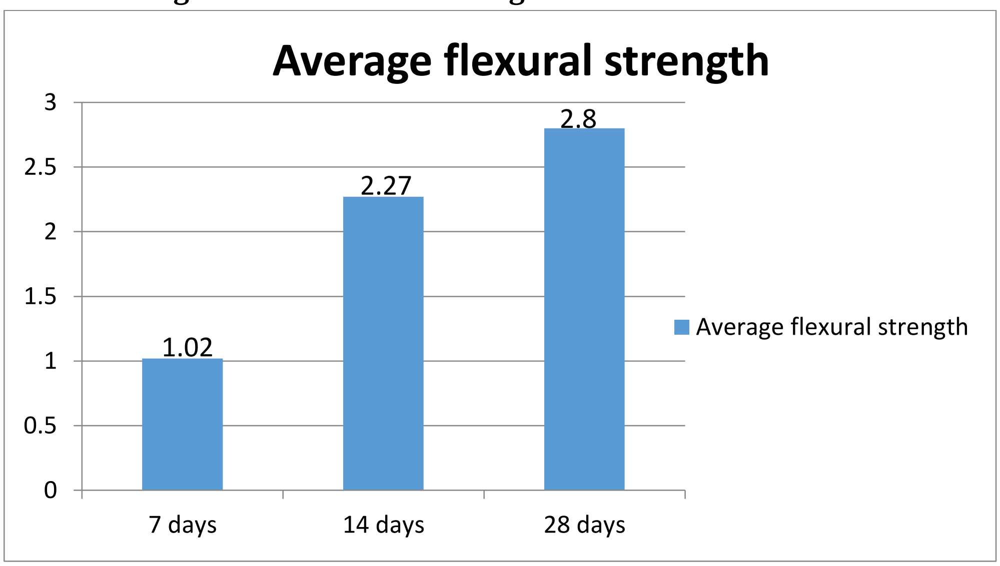


Fig. No. 5.13 flexural strength result for mix 1

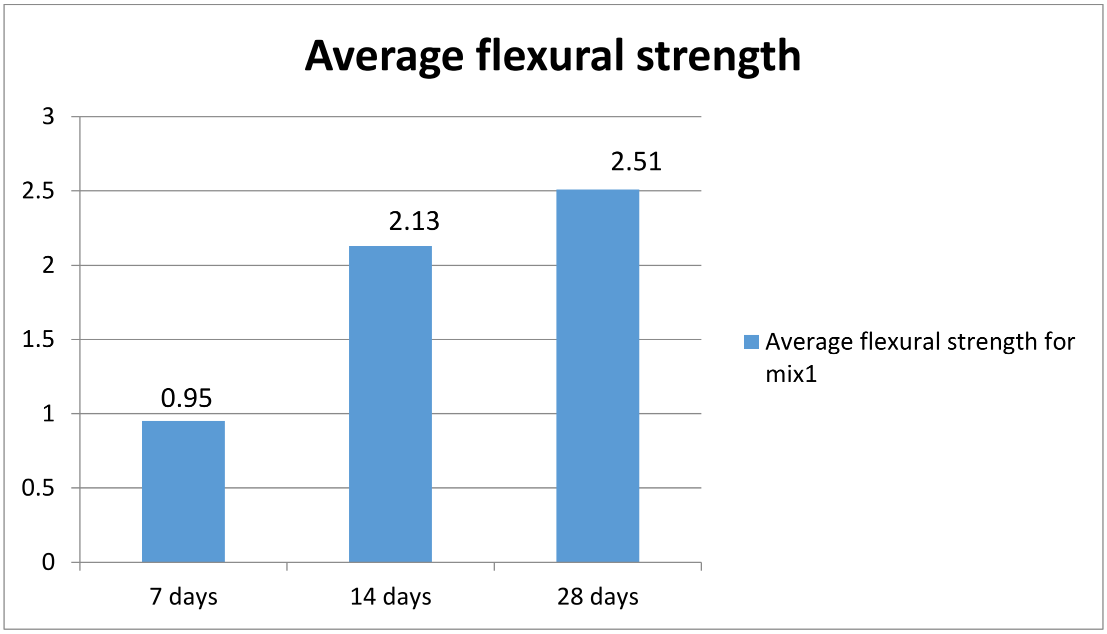
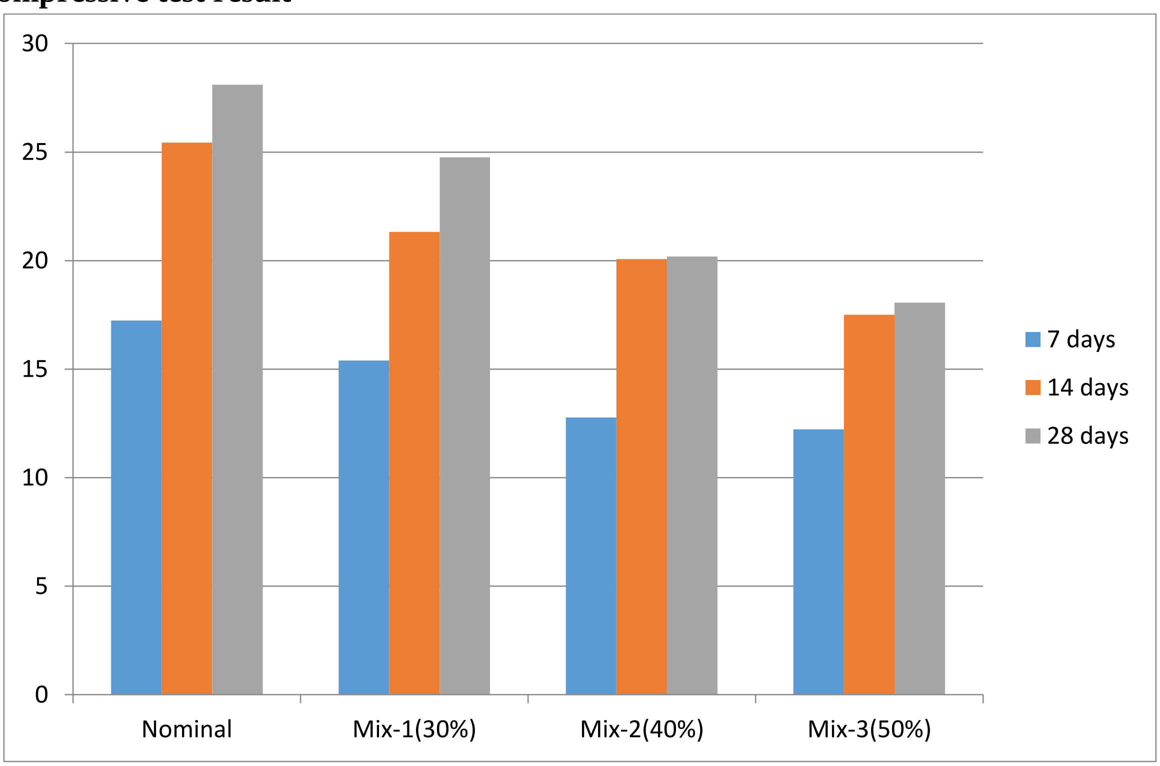


Fig. No. 5.14 flexural strength result for mix 2

Above figure showing the variation in the flexural strength for nominal mix and mix 1 (30% replacement of coarse aggregate with brick bats), mix 2 (40% replacement of coarse aggregate with brick bats), and mix 3 (50% replacement of coarse aggregate with brick bat. In the present study it observed that the flexural strength decreases as the brick bats increases. But the result for mix 1 is good than other two mixes. Therefore mix 1 can be used for the construction

5.4 comparative result

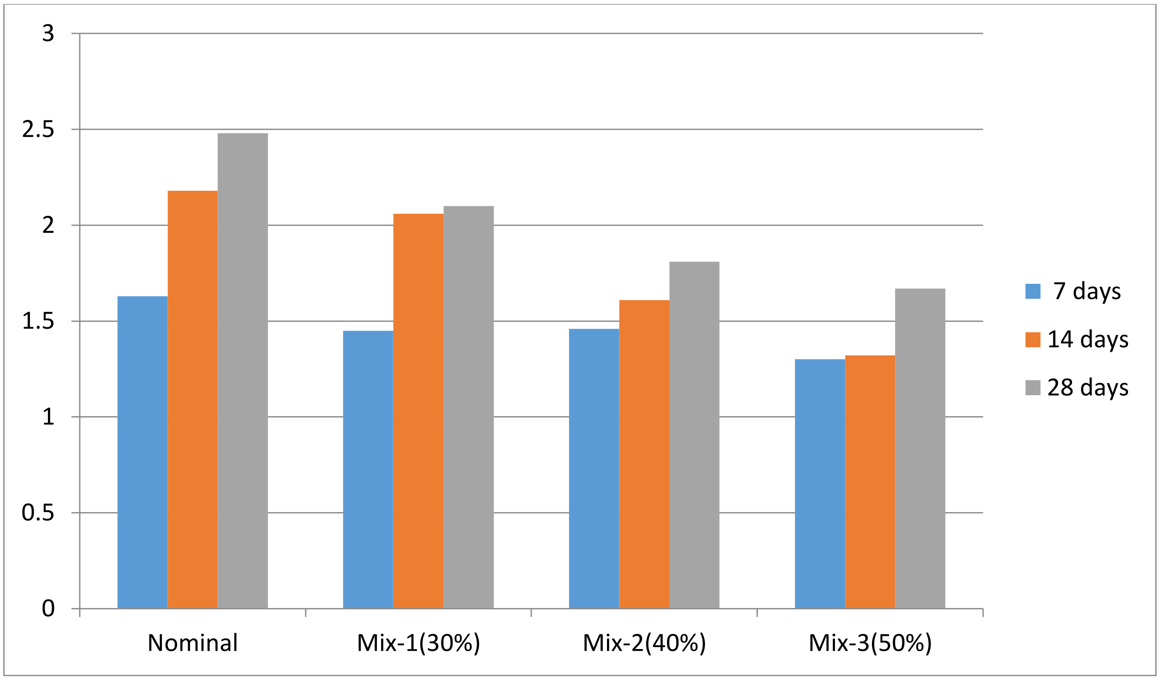
5.4.1 compressive test result



comparative results of compressive test

Above figure shows the comparative results of nominal mix and mix 1, mix 2, mix 3.
It is clearly reveal that as the percentage of brick bats increases the compressive strength decreases. For mix 1 the compressive strength was found to be good as compared to mix 2 and mix 3. Results for mix 2 and mix 3 are not inferior to nominal mix because of more quantity of brick bats.

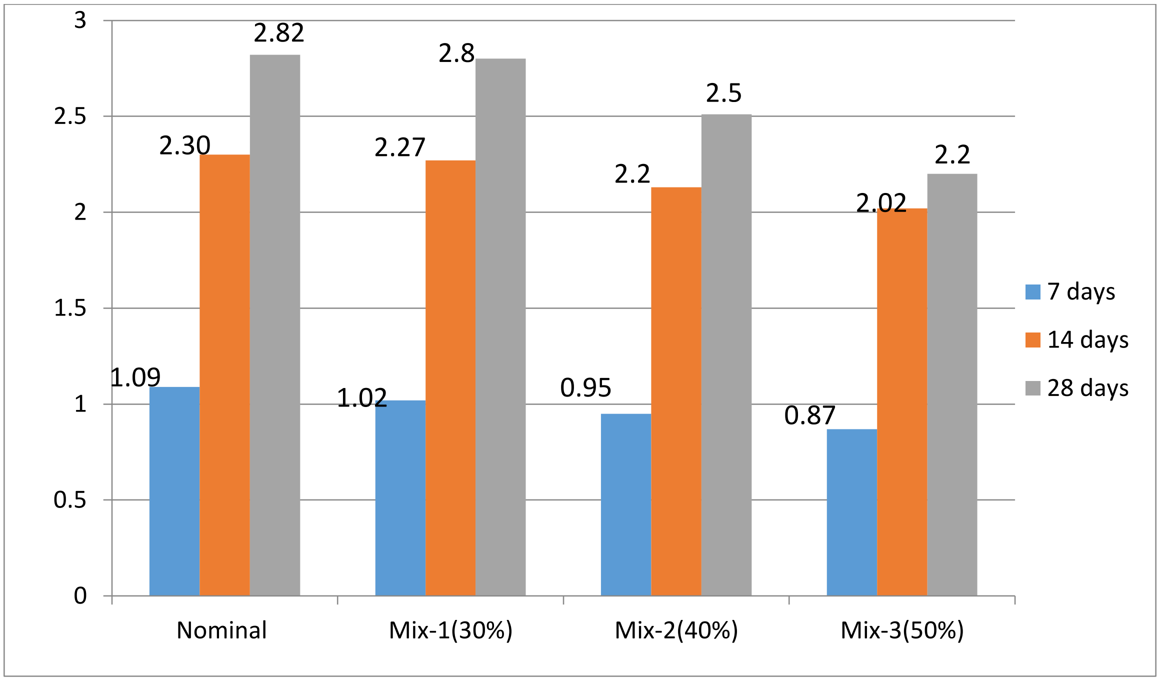
5.4.1 split tensile test result



comparative results of tensile test

Above figure shows the comparative split tensile test results of nominal mix and other three mixes. (mix 1, mix 2, and mix 3)
In the present study it was noted that the mix 1 (30% replacement of coarse aggregate with brick bats) gives the more strength as compared to mix 2 (40% replacement of coarse aggregate with brick bats) and mix 3 (50% replacement of coarse aggregate with brick bats). Therefore the mix 1 concrete can be used in construction industry.

5.4.1 flexural strength result



comparative results of flexural strength test

CHAPTER 6
CONCLUSION

The experiment results were analyzed on concrete and following conclusions are drawn :-

1. Considering the basic properties i. e. workability , as the burnt brick content in concrete goes on increasing the workability goes on decreasing.
2. Non-destructive test performed on the samples , the results for this ND Test for conventional concrete are very good and that for 30% replacement with brick bats are good and same for 40% and 50% are less than that of 30% sample.
3. Compressive strength for the conventional mix and that for 30% replacement is good and almost same as compared to 40% and 50% sample.
4. Considering the practical use of this project, 30% replacement concrete can be used in actual use on site as compared to 40% and 50% replacement concrete.
5. Brick waste is produced on large scale ,it is hard to decompose and demolish , so use of this waste contributes to reduction of waste.
6. As compared to conventional concrete this concrete is in light weight.

CHAPTER 07
FUTURE SCOPE

From the available literature and research papers on brick bats and its composition with concrete the experimental and research work has been done. The present work is carried out on replacement of coarse aggregate with the brick bats with various increase in percentage rate and whether it is feasible to use for the construction industry. Further understanding is required to produce economical and durable concrete using brick bats. Therefore this study will give an access to allowance of use of brick bats in conventional concrete to achieve strength, light weight and economical.

The following works are suggested for future research.

1) Achieving high strength to the concrete by replacing some amount of coarse aggregate with brick bats.
2) As removal of coarse aggregate makes the concrete light weight to some extent.
3) The structural behavior of reinforced concrete replaced using brick bats can be studied to establish the suitability for structural applications.
4) As brick bats is a waste produced from manufacturing units it can be reused to reduce amount of non-usable waste, i.e. brick bats.
5) Specimens of varying percentage should be used.

As the concrete thus formed is light weight can be used for making various equipment to be used in residential as well as commercial buildings.

CHAPTER 07

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