FLOW AND MECHANICAL CHARACTERISTICS OF SELF COMPACTING CONCRETE BY PARTIAL REPLACEMENT WITH RECYCLED BRICK BATS

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ABSTRACT

Self-compacting concrete (SCC) is an innovative concrete that does not require vibration for placing and compaction. It is able to flow under its own weight, completely filling formwork and achieving full compaction, even in the presence of congested reinforcement. This experimental investigation study on the flow and mechanical characteristic of self-compacting concrete (SCC) obtained replacing coarse aggregate varying percentage of brick bats while other materials are kept unchanged. The variable considered in this study was by the weight of partial replacement of coarse aggregate by brick bats aggregate of 0%,10%,20%,30% and 40% in concrete for the self-compacting concrete This study is focused on the flow and mechanical characteristics of SCC by varying percentage of partial replacement of brick bats with coarse aggregate are determined. This investigation is an attempt to examine the influence of bricks bat coarse aggregate, GGBS and super plasticizer on the flow and mechanical characteristic of self-compacting concrete. In the study, the replacement of coarse aggregate with bricks bats resulted the flow and mechanical characteristic of SCC fresh properties of passing ability, filling ability, and segregation resistance of the concrete are within the given standard value ,the hardened concrete properties of Splitting tensile strength, Compressive strength, Flexural Strength tests and unit weight of concrete are become reduced in the study.

Keywords: *Brick bats, Compressive Strength, Flexural Strength, Self-Compacting Concrete and Splitting Tensile Strength.*

1 INTRODUCTION

1.1 GENERAL

Self-Compacting Concrete (SCC) is characterized as a high performance concrete which has the properties of passing ability, filling ability and resistance to segregation, and it is a kind of concrete that does not require any kind of compaction either manual or with vibration machine for compaction, placing and able to flow under its own weight, completely filling formwork and getting a high degree of compaction, even in the presence of heavy and congestion reinforcements is bound to become the most concrete will be cast in future both to comply with healthy and safety requirement for site operation and for economic reasons in order to save construction time and make a considerable cost saving in addition the high quality surface finish that is obtained from self-compacting concrete makes it an ideal material for as struck architectural finishes and complicated precast concrete units. In the present study, the use of brick bats as a replacement of coarse aggregate in the concrete production as an alternative a construction material for SCC. In this study, it has been made to design the mix proportion of SCC on the strength characteristics of M 30 mix produced using coarse aggregates with partial replacement of brick bat and to improve workability, reduce water content, passing and filling ability. Materials which is used for mix ratio were tested for their suitability has been made with the mixing proportion validation with appropriate standards. we study the flow and mechanical properties of SSC with partial replacement of coarse aggregate by brick bates

The purpose of this study is to examine the influence of brick bats as a coarse aggregate on the strength and durability properties and flow characteristic of SCC by partial replacement of using brick bats coarse aggregate. self-compacting concrete is highly engineered concrete with much higher fluidity without segregation and is capable of filling every corner of form work under its self-weight only .The study effect of flow characteristics of passing ability, filling ability and resistance to segregation and mechanical characteristics such as compressive, tensile, flexure and shear strength of selected grades of concretes after curing for different periods 7 ,14 and 28 days SCC mixes with partial replacement of brick bats and here an effort has been taken to compare the characteristic properties of SCC using coarse aggregates. Therefore, the study of self-compacting concrete has been done on concrete made with 12.5 mm coarse aggregate, M sand, fine aggregate, PPC, GGBS, Brick bats, Conplast SP 430 and w/c =0.38. are used in this project

1.2 NEED FOR THE STUDY

This study is conducted to investigate the effectiveness and performance of the flow and mechanical properties of concrete as a partial replacement of clay brick bats coarse aggregate as a coarse aggregate of concrete, the tests of the concrete was done on different methods such as Slump flow test, V-Funnel test, L-Box test and U -Box test of fresh concrete and compressive strength test, flexural strength test and split tensile strength of harden properties of concrete and tests were confirmed based on as per IS code and the conventional concrete was compared with control concrete also.

1.3 OBJECTIVES OF THE STUDY

- To compare the effects of different percentage of Bricks bat with coarse aggregate using as a constitute of SCC.
- To determining the most suitable self-compacting concrete (SCC) mixes proportion that can produce concrete of desirable strength.
- To examine the influence of partial replacement of using brick bats coarse aggregate on the flow and mechanical properties of SCC
- To investigate the performance of SCC with brick bats coarse aggregate as a partial replacement of concrete with conventional concrete
- To compare the performance of partial replacement of brick bat concrete with conventional concrete

1.4 SCOPE OF WORK

The scope of this study focuses

- The effect of clay brick bats aggregate on the flow characteristics of passing ability, filling ability and resistance to segregation.
- The effect of brick bats aggregate on the mechanical harden properties of compressive strengths, flexural strength and splitting tensile of the concrete.
- To produce cost effective partial replacement of clay brick bats as an alternative of construction material.
- To minimize the weight of dead load on the entire structure and alternative for conventional concrete.

2 LITERATURE REVIEW

In this literature review, I have found a good representative literature discussing, there are many international studies in the field of self-compacting concrete in construction industry. in this study 25 different literatures are reviewed with respect to flow and mechanical characteristic of compressive strength, flow-ability, passing ability and segregation resistance criteria. by studying the relevant literature, it will help me understand more fully how other factors play a big role in self-compacting concrete. the experimental work for the self-compacting concrete properties under the fresh and hardened state are discussed in the literature review on study has been done on concrete made with replacement of Coarse and fine aggregate, In this study will focus more on a brick bats as a coarse aggregate replacement in term of its flow characteristics and mechanical strength. Most of the information getting for the preparation of this literature review from the study through journal, articles, websites, newspaper and previous student's thesis as well. Among those related, some of literature reviews are mentioned below: -

Sivamalar C.et al (2018) studied on a wide applications construction material is increasing day by day and it causes the environment. A number of researches have been conducted on compacting concrete (SCC), but there are relatively very few studies on SCC with recycled aggregates. In this study, an experimental investigation has been conducted and hardened properties of SCC with the use of (RBA) as partial replacement to natural coarse aggregates trials on SCC were carried out with different mix proportions by varying the percentage of RBA and steel fibers (SF) along with suitable dosages of superplasticizer (SP) until an ideal mixture proportion was obtained. The effectiveness of the RBA and SF in SCC column has been evaluated by experimental investigation and discussed in this study. Therefor that From this investigation it concluded that RBA proportion of up to 30% can be satisfactorily adopted to produce SCC with required fresh and hardened state properties.

Javaid I. and Sameer M. (2018) have focused on the increase of energy absorption capacity and toughness to produce SCC material, from the investigation, brick dust is a waste product, which is obtained from different brick kilns and tile factories. There is numerous brick kiln which have grown over the decades in an unplanned way in different part of the country. Tons of waste products like brick dust or broken pieces or flakes of bricks (brickbat) come out from these kilns and factories. So far, such materials have been used just for filling low lying areas or are dumped as waste material.

Kshama S. and Akansha T.(2017) have presented an experimental investigation on Self-Compacting Concrete (SCC) was first practiced in Japan which was a very special type of concrete or High Performance Concrete that could flow and fill into every corner of form work, even if congested confinement is present and itself consolidates by the virtue of its own weight completely without any special requirement of mechanical compaction, tamping etc. Self-Compacting Concrete as the name says is nothing special but different from normal concrete, it is just employment of admixtures and different amount of composite materials that makes SCC acts as different as compared to normal one. It speeds up the construction, reduces the cost of labour needed, confirmed compaction, finished and wipes out the factors responsible for environmental pollution. The SCC is used for retrofitting, primarily in confinement where vibration is difficult to employ. SCC can be stated as a high-performance material which flows on its own without using compacting vibrators or tamping to attain desired compaction with the entire filling of formworks even when there occurs a problem by congestion between reinforcement bars. SCC can also be used in conditions where it is clumsy or not feasible to use mechanical compaction. Deformability (tendency to flow) of SCC allows it to fill the formwork without using mechanical vibration. He concludes that there is no such specification are given for mix design procedures of SCC, hence study mixes are casted on the basis of Indian Standards and suitable adjustments can be done as per the previous studies and guidelines by various concern agencies.

Lohani T.et al (2016) presented the research on the study of concrete mixes using brick dust and marble powder fulfilled the performance criteria for fresh and hardened SCC. Good hardened properties were achieved for the concretes with 25% marble powder which can be considered as the optimum content for high compressive strength. The hardened properties of the SCCs were improved at 28 days due to greater hydration of cement Brick dust and marble powder can be efficiently used to produce good quality self-compacting concrete with satisfactory slump and setting times.

Manimaran S.and Suresh R. (2015) investigated on the Self-compacting concrete with partial replacement of coarse aggregate using brick bat was prepared with 30%, 40% and 50% replacement. Also, self-compacting concrete reinforced with steel fibres and coarse aggregate partially replaced with brick bat were prepared with varying ratios with 20%, 25% and 30% steel fibre and 30%, 40% and 50% brick bat were prepared.

Sachin k. and Momin A. A. (2015) Conducted their study on “Experimental Study on Strength Properties of Concrete using Brick aggregates”. In this investigation an attempt was undertaken to produce 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 greenhouse 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 and it is 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. The results showed that it may be very well concluded that hard over burnt bricks may be taken as „artificial stone or metamorphic stone.

Manimaran S.and Suresh R. (2015) investigated on the Self-compacting concrete with partial replacement of coarse aggregate using brick bat was prepared with 30%, 40% and 50% replacement. Also, self-compacting concrete reinforced with steel fibres and coarse aggregate partially replaced with brick bat were prepared with varying ratios with 20%, 25% and 30% steel fibre and 30%, 40% and 50% brick bat were prepared.

3. METHODOLOGY

3.1 INTRODUCTION

To achieve the above objectives the following methodology is used summarized; the methods that have been used in the collection and analysis of data to answer the SCC mixes of varying strengths and performances were developed to meet the flow-ability, passing ability and segregation resistance criteria of fresh concrete and compressive strength test, flexural strength test and split tensile strength of harden properties of concrete as a partial replacement of clay brick bats coarse aggregate as a coarse aggregate of concrete mechanical properties of concrete. In this study, Physical Properties of material like Cement fine coarse and clay brick bat aggregate were tested for Specific gravity Fineness modulus, Consistency, and setting time. The methodology has been carried out using literature review, selection of material for SCC, data and sample collection, identification % of replacement of material properties mix design calculation, preparation of concrete, test on concrete, and analysis of lab result and based on the result found discussion and conclusion have been summarized considering with conventional and non-conventional concrete, Refer fig 3.1 chart flow of methodology below

3.2 MATERIALS USED FOR STUDY

For the preparation of SCC mix, PPC cement conforming as per IS 8112 (1989), brick bats of size 12.5mm, M sand, fine aggregate and coarse aggregates are confirmed as per IS 383:1982 and guidelines IS: 383-1970 respectively. Mix proportion are obtained for M30 mix as per modified NANSU method are given in Table

- Cement/PPC
- Fine aggregate /M-Sand
- Coarse aggregate/12.5mm
- Aggregate /Bricks bat 12.5mm
- Mineral admixture: GGBS (Ground-granulated blast-furnace slag.)
- Chemical Admixture: - Super Plasticizer /conplast SP430
- Water

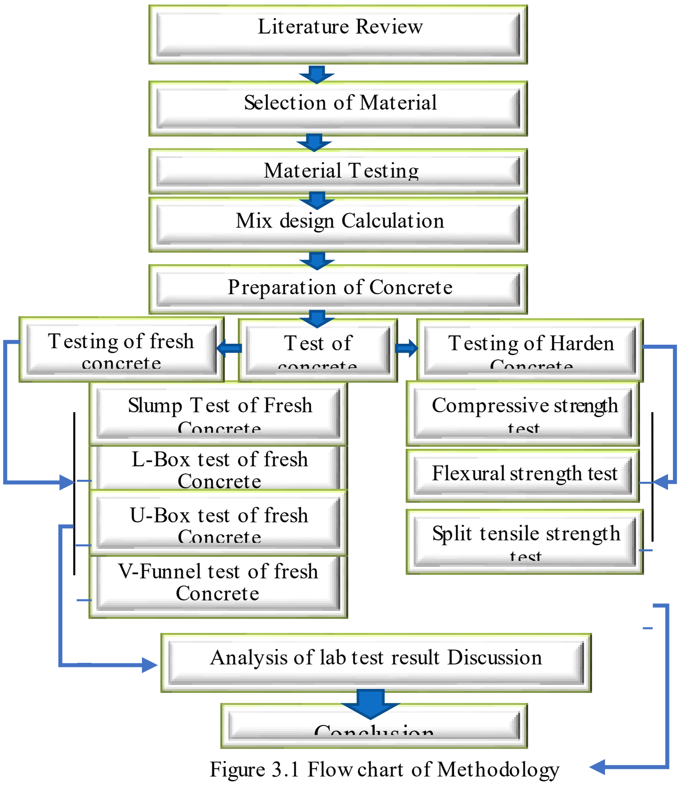

Figure 3.1 Flow chart of Methodology

3.2.1 Cement

PPC (Pozzolanic Portland Cement) is a variation of OPC which includes a mixture of a pozzolanic material which is known to increase the strength of concrete and reduce the amount of OPC used. Now a days PPC is used as a replacement to OPC. PPC requires more curing and has more setting time. Pozzolana materials namely fly ash, volcanic ash, are added to the OPC so that it becomes PPC. Pozzolana materials are added to the cement in the ratio of 15% to 35% by weight. Portland Pozzolana Cement is a kind of blended Cement which is produced by either inter grinding of OPC clinker along with gypsum and pozzolanic materials in certain proportions or grinding the OPC clinker, gypsum and Pozzolanic materials separately and thoroughly blending them in certain proportions. Refer Table 3.1,3.2 and 3.3

Table 3.1 Chemical composition of PPC cement

Compound	**PPC, %**
SiO_2	28-32
Al_2O_3	7.0-10.1
Fe_2O_3	4.9-6.0
CaO	41-43
MgO	1.0-2.0
SO_3	2.4-2.8
Loss on ignition	3.0-3.5

Table 3.2 Physical Properties of PPC Cement

S.No	*Description*	*Properties*	*Experimental result*	*Standard value*
1	*PPC (Pozzolanic Portland Cement)*	*Finenesss*	*3.75%*	*Max.10%*
2		*Consistency*	*29.5%*	*26 to 33%*
3		*Specific gravity*	*2.85*	*2.90*
4		*Initial setting time (min)*	*42min*	*Not <30min*
5		*Final setting time(min)*	*200min*	*Not>600min*

i. Fineness of cement

The Fineness modulus (FM) is an empirical figure obtained by adding the total percentage of the sample of an aggregate retained on each of a specified series of sieves, and dividing the sum by 100. Fine aggregates range from a FM of 2.00 to 4.00, and coarse aggregates smaller than 38.1 mm range from6.50to8.00 The tests were conducted as per IS:4031-PART 1-1996 by using 90µm sieve, balance capable of weighing 10g to the nearest 10mg, glass rod stoppered jar, pan and lid, the sample of cement to be tested were stirred and shacked for 2 minutes in a stoppered jar to disperse lumps. The resulting powder was stirred gently using a clean dry rod in order to distribute the fines throughout the cement. A pan was attached under the sieve to collect the cement passing the sieve.10 g of cement was weighted to the nearest 0.01 g and place it on the sieve and the lid Fit over the sieve. The sieve was sacked by swirling, planetary and linear movement until no more fine material passes through it. Finally, the Fineness modulus of cement becomes 3.75 %. The fineness of cement is measured by sieving it on standard sieve. The proportion of cement of which the grain sizes are larger than the specified mesh size is thus determined. A Standard reference material of known sieve residue shall be used for checking the sieve. Refer Table 3.3

Lab experiment on fineness test

W1= Weight of cement taken = 400gm

W2=Weight of cement retained in 90-micron sieve = 15gm

Calculation: %g. of cement retained = (W2/W1) *100

= (15/400) *100

= 3.75%

Table 3.3 Fineness test result Table

Type of test	Weight of cement, in gm(W1)	Weight of cement retained in 90-micron sieve, in gm (W2)	Percentage of cement retained, % (W2/W1) *100
Fineness test	400	15	(15/400) *100= 3.75%

ii. Consistency of cement test

Standard consistency of cement paste is defined as that consistency which permits the Vicat plunger to penetrate to a point 5 to 7 mm from the bottom of the Vicat mould in this test. it is expressed as amount of **water** as a percentage (by weight) of dry cement. apparatus. Vicat Apparatus Conforming to IS: 5513-1976.The setting of cement and hardening of concrete. Cement hardens when it comes into contact with water. This hardening is a process of crystallization. Crystals form (after a certain length of time which is known as the initial set time) and interlock with each other. Initial setting time duration is required to delay the process of hydration or hardening. Final setting time is the time when the paste completely loses its plasticity. It is the time taken for the cement paste or cement concrete to harden sufficiently and attain the shape of the mould in which it is cast (Is: 4031-Part 5-1988).Initial setting time is that time period between the time water is added to cement and time at which 1 mm square section needle fails to penetrate the cement paste, placed in the Vicat's mould 5 mm to 7 mm from the bottom of the mould.

Final setting time is the time when the paste completely loses its plasticity. It is the time taken for the cement paste or cement concrete to harden sufficiently and attain the shape of the mould in which it is cast. Final setting time is that time period between the time water is added to cement and the time at which 1 mm needle makes an impression on the paste in the

Sieve size	Weight of Fine Aggregate Retained in gm. Determination No.(gm) Trial 1	Trial 2	Trial 3	Avg.wt	%ge.Retained	Cumulative % retained	Cumulative % passing	Percentage passing by Weight, Grading Zone: Zone I	Zone II	Zone III	Zone IV
1000	0	0	0	0.0	0.00	0	100	100	100	100	100
4.75mm	25	20	20	21.7	2.17	2.17	97.83	90-100	90-100	90-100	95-100
2.36mm	150	165	160	158.3	15.83	18.00	82.00	60-95	75-100	85-100	95-100
1.18mm	300	305	360	321.7	32.17	50.17	49.83	30-70	55-90	75-100	90-100
600mic	195	180	175	183.3	18.33	68.50	31.50	15-34	35-59	60-79	80-100
300mic	175	160	165	166.7	16.67	85.17	14.83	5-20	8-30	12-40	15-50
150mic	100	105	75	93.3	9.33	94.50	5.50	0-10	0-10	0-10	0-15
90mic	35	35	30	33.3	3.33		2.17				
Pan	20	30	15	21.7	2.17	318.51	0.00				
total	1000	1000	1000	1000.0							

Table 3.4 Sieve Analysis of fine aggregate test result

mould but 5 mm attachment does not make any impression the normal consistency of a given sample of cement at a depth penetration of 6.5mm is 29.5 %. Refer Table 3.3 and Figure 3.2

3.2.2 Fine aggregate /M sand

Fine aggregates generally consist of natural sand or with most particles passing through a 3/8-inch sieve., Here M sand is used as a fine aggregate in this experiment. Manufactured sand (M-Sand) is a substitute of river sand for concrete construction. Manufactured sand is produced from hard granite by crushing. The sand is of cubical shape with grounded edges, washed and graded to as a construction material. The size of manufactured sand (M-Sand) is less than 4.75mm. BIS Code specifications for Manufactured Sand (M Sand) Bureau of Indian Standards

(BIS) Guidelines IS: 383-1970 for selection and testing of Fine aggregates. Refer Table 3.4 and 3.5

Table 3.5 Physical property of fine aggregate

s/no	Description	Properties	Experimental result	Standard value
1	Fine aggregate	Specific Gravity	2.68	2.6-2.8
2		Water Absorption	0.6	0.5-1%
3		Moisture Content	1.27	
4		Fineness modulus	2.23	2.00-4.00

Sieve Analysis of fine aggregate test result

Based on Table 3.5, Fine Aggregate sieve Analysis, Weight of Sample:1000gm, Confirmed As per IS 383:1982, grading zone is Zone I

- F.M of aggregate = (cumulative % retained) / 100 = (318.51/100) = 3.185
- F.M limits for zones I of M sand according to IS 383-1970 are 2.71-4.0

Lab experiment on Specific Gravity and Water absorption of fine aggregate

Weight of Sample taken (in gm) =1000

- Weight of Pycnometer +Sample + Water, (in gm) (A) =1515
- Weight of Pycnometer +Water, (in gm) (B) =1220
- Weight of Saturated and Surface Dry Aggregate, (in gm) **(C)** = 500
- Weight of Oven Dry Sample, ((in gm)(D) =497
- Specific Gravity=[D/(C-(A-B))]
  =[497/[500-(1515-1220)] =2.60
- Apparent Specific gravity=[D/(D-(A-B))] = 2.59
- Water absorption of fine Aggregate =[(C-D) /D]*100
  = [(500-497)/497]*100
  =.603=0.6%

3.2.3 Coarse aggregate

Coarse aggregate sizes are larger than 4.75 mm (5 British code), and the maximum size up to 40 mm is used for coarse aggregate in most structural applications, while for mass concreting purposes such as dams, sizes up to 150 mm may be used. In this experiment 12.5 mm size coarse aggregate was used as the coarse aggregate and confirmed with the Guidelines IS: 383-1970 for selection and testing of coarse aggregates. Refer Table 3.6 and 3.7.

Sieve Analysis of coarse aggregate test

Table 3.6 Coarse Aggregate test result

Table 3.7 Coarse aggregate sieve test result

Sieve size	Weight in gm.			Average wt.	Percent Retained	Cumulative % retained	% passing
	Trial 1	Trial 2	Trial 3				
40	0	0	0.0	0.0		0.00	0.00
25	0	0	0.0	0.0	0.0	0.00	100.00
20	0	0	0.0	0.0	0.0	0.00	100.00
16	20	15	20.0	20.0	2.0	2.00	98.00
12.5	80	70	81.7	81.7	8.2	10.17	89.83
10	855	870	855.0	855.0	85.5	95.67	4.33
pan	45	45	43.3	43.3	4.3	100.00	0.00
total	1000	1000	1000.0	1000.0		207.83	

Note:

As per IS 383-1970 percentage of passing for single sized aggregate nominal size by weight is 12.5mm

F.M of coarse aggregates = sum (cumulative % retained) / 100 = (707.83/100) = 7.078=7.1

Fineness modulus of 7.1 means, the average size of particle of given coarse aggregate sample is in between 2nd and 3rd sieves, that is between 12.5mm to 10 mm.

i. **Specific gravity of Coarse Aggregate**

The coarse aggregate specific gravity test is used to calculate the specific gravity of a coarse aggregate sample by determining the ratio of the weight of a given volume of aggregate to the weight of an equal volume of water. It is similar in nature to the fine aggregate specific gravity test.

Lab experiment on Specific gravity and Water absorption coarse aggregate

- Weight of sample (Coarse Aggregate) =1000gm
- A=Weight of empty pycnometer + Coarse Aggregate +Water =2115gm
- B=Weight of empty pycnometer +Water =1495gm
- C=Weight of Saturated and surface dry of Coarse Aggregate (in gm) = 980gm
- D=Weight of Oven dry Coarse Aggregate =970gm
- Specific gravity =D/[C-(A-B)] =970/[980-(2115-1495)]=970/360=2.694 =2.7
- Apparent Specific gravity= D/[D-(A-B)] =970/[970-(2115-1495)]=970/350 =2.771
- Water absorption of Coarse Aggregate

s/no	Description	Properties	Experimental result	Standard value
1	Coarse Aggregate	Specific Gravity	2.77	2.6-2.8
2		Water Absorption	1 %	0.5-1%
3		Moisture Content	1.0	
4		Fineness Modules	7.5	6.5-8.00

=[(C-D)/D]*100=[(980-970)/970]*100=1000/970 =1.0%

ii. **Water content /absorption**

Water content or moisture content is the quantity of water contained in a material, such as soil (called soil moisture), rock, ceramics, crops, or wood. Water content is used in a wide range of scientific and technical areas, and is expressed as a ratio, which can range from 0 (completely dry) to the value of the materials' porosity at saturation. It can be given on a volumetric or mass (gravimetric) basis. The water content of a given soil is defined as the ratio, expressed as a percentage, of the mass of the pore water to the mass of the solid material

3.2.4 Brick bats

Brick is made of clay or shale formed, dried and fired into a durable ceramic product. There are three ways to form the shape and size of a brick: extruded (stiff mud), moulded (soft mud) and dry-pressed. The majority of brick are made by the extrusion method. There are four different operations are involved in the process of manufacturing of bricks Preparation of clay, Moulding, Drying and Burning.Bulk density of brick bats aggregate is in the range of 1000kg/m³ to 1200kg/m³,the clay brick bat is collected locally and then prepared by crushing the clay bricks manually in to pieces at 12.5 mm as coarse aggregate required size with related selected coarse aggregate size of 12.5 mm. The test result is shown that the specific gravity of bricks bat equal to 1.476, water absorption 15.703% and Moisture Content 6.5% are found. Refer Figure 3.2

Lab experiment on Specific gravity and Water absorption of Brick bats

- Weight of sample(brickbat) =1000gm
- A=Weight of empty pycnometer +Bricks bat +Water (in gm) =1785gm
- B= Weight of empty pycnometer +Water (in gm) =1495gm
- C=Weight of Saturated and surface dry (in gm) = 700gm
- D=Weight of Oven dry bricks bat =605gm
- Specific gravity

=D/[C-(A-B)] =605/[700-(1785-1495)] =1.476

- Apparent Specific gravity
  = D/[D-(A-B)] =605/[605(1785-1495)] =1.921
- Water absorption
  = [(C-D) /D]*100 =[(700-605)/605]*100 =15.703%

Figure 3.2 Brick bats

3.2.5 GGBS

Ground-granulated blast-furnace slag (GGBS) is obtained by quenching molten iron slag from a blast furnace. Concrete made with GGBS cement sets more slowly than concrete made with ordinary Portland cement. Physical properties of GGBS, the specific gravity of GGBS is 2.85 and Fineness modulus 3.36. The physical and chemical properties of GGBS study based on IS: 12089 – 1987 Refer Table 3.8 and Figure 3.3

Advantages of GGBS

- Good workability which helps in better placing and compaction.
- Due to the less heat of hydration the temperature rise will be less avoiding the risk of thermal cracking in large volume of concrete.
- High resistance to chloride attack which reduces the risk of corrosion in concrete.
- High resistance to sulphide attack and also other chemicals.
- Increase the setting time, the setting time of concrete is mainly influenced by the temperature and water cement ratio. Using of GGBS in concrete generally increase the setting time slightly up to 30 minutes. This has an advantage that this concrete mix can be workable for a longer time and the risk of developing cold joints will be lesser. This property is helpful in construction in warm weather
- Improved consistency, It has similar or slightly improved consistency than Portland cement concrete. This makes the concrete very easy to place and compact
- Good sustainability, GGBS is one of the greenest construction materials.

Figure 3.3 GGBS powder

Lab experiment on Specific gravity of GGBS

- Wt. Of empty, clean specific gravity pycnometer (W1) =35gm
- Wt. Of empty, clean specific gravity pycnometer + GGBS, (W2) =50gm
- Wt. Of empty, clean specific gravity pycnometer GGBS +Kerosene, (W3) =85gm
- Wt. Of empty, clean sp. Gravity pycnometer +Kerosene, (W4) =75gm
- Wt. Of empty, clean sp. Gravity pycnometer +Water, (W5) =85gm
- **Sp. Gravity of GGBS**
  =(W2-W1)/(W2-W1) -(W3-W4) *Sp. Gr. Of Kerosene =2.85

produce a glassy, granular product that is then dried and ground into a fine powder. Concrete made with GGBS cement sets more slowly than concrete made with ordinary Portland cement, depending on the amount of GGBS in the cementitious material, but also continues to gain strength over a longer period in production conditions. This results in lower heat of hydration and lower temperature rises, and makes avoiding cold joints easier, but may also affect construction schedules where quick setting is required. GGBS is used as a direct replacement for Portland cement, on a one-to-one basis by weight. Replacement levels for GGBS vary from 30% to up to 85%. Typically, 40 to 50% is used in most instances. Physical properties of GGBS, the specific gravity of GGBS is 2.85 and Fineness modulus 3.36. The physical and chemical properties of GGBS study based on IS: 12089 – 1987 is given in table 2.8 refer Figure 2.4

Properties of GGBS

Table 3.8 Typical chemical composition of GGBS

Sr. No.	Constituents	Percent by Weight
1	Silica (SiO_2)	35.4
2	Alumina (Al_2O_3)	11.2
3	Iron Oxide (Fe_2O_3)	0.6
4	Calcium Oxide (CaO)	40.3
5	Magnesium Oxide (MgO)	6.8
6	Total Sulphur (SO_3)	2.7
	Alkalies	
	a) Sodium Oxide (Na_2O)	0.7
7	b) Potassium Oxide (K_2O)	0.2
8	P_2O_5	0.02
9	TiO_2	0.8
10	Mn_2O_3	0.8

Advantages of GGBS

- Good workability which helps in better placing and compaction.
- Due to the less heat of hydration the temperature rise will be less avoiding the risk of thermal cracking in large volume of concrete.
- High resistance to chloride attack which reduces the risk of corrosion in concrete.
- High resistance to sulphide attack and also other chemicals.
- Increase the setting time, the setting time of concrete is mainly influenced by the temperature and water cement ratio. Using of GGBS in concrete generally increase the setting time slightly up to 30 minutes. This has an advantage that this concrete mix can be workable for a longer time and the risk of developing cold joints will be lesser. This property is helpful in construction in warm weather
- Improved consistency, It has similar or slightly improved consistency than Portland cement concrete. This makes the concrete very easy to place and compact
- Good sustainability, GGBS is one of the greenest construction materials. Manufacturing of Ground Granulated Blast Furnace Slag utilizes all of the slag material and produces no significant waste. The production of GGBS requires less than a fifth the energy and produces less than a fifteenth of the carbon dioxide emissions. Further benefits of GGBS includes that the manufacturing does not requires use of any virgin materials.
- Improve the Strength of concrete, If 50% of GGBS is used in a concrete mix, it can develop almost same 28 day strength as ordinary Portland cement. At higher GGBS percentages the increased cementitious content may lead achieve equivalent 28-day strength much faster. GGBS concrete gains strength more steadily than equivalent concrete made with Portland cement.

Lab experiment on Specific gravity of GGBS

- Wt. Of empty, clean specific gravity pycnometer (W1) =35gm
- Wt. Of empty, clean specific gravity pycnometer + GGBS, (W2) =50gm
- Wt. Of empty, clean specific gravity pycnometer GGBS +Kerosene, (W3) =85gm
- Wt. Of empty, clean sp. Gravity pycnometer +Kerosene, (W4) =75gm
- Wt. Of empty, clean sp. Gravity pycnometer +Water, (W5) =85gm
- Sp. Gravity of GGBS
  =(W2-W1)/(W2-W1) -(W3-W4) *Sp. Gr. Of Kerosene =2.85

3.2.6 Admixture

Super plasticizer is a chemical compound and it can be added to concrete mixtures to improve workability of concrete, it producing homogeneous and cohesive concrete without segregation and bleeding without adding more water to form a uniform mix and it can acts as a lubricant among the materials and it was used in all the self-compacting concrete mixtures. High range water reducers result in substantial enhancement in workability at a given water cement ratio. For a constant workability reduction of water content up to 30% may be achieved by the use of superplasticizers. s can be used at the higher dosage than the conventional plasticizers in the range of 0.5 % to 3% by weight of cement. characteristics of concrete are highly influenced by the ratio (by weight) of water to cementitious materials (w/cm) used in the mixture. By reducing the amount of water, the cement paste will have higher density, which results in higher paste quality.

Conplast SP 430 is used in this project, and it is a product of FOSROC chemicals, (Manufactured at Bangalore, India) having a specific gravity of 1.22. Plasticizers are additives that increase the plasticity or fluidity of the material to which they are added as per IS: 9103-1999

Main uses of Superplasticizers

- To provide excellent acceleration of strength gain at early ages and major increases in strength at all ages by significantly reducing water demand in a concrete mix. Particularly suitable for precast concrete and other high early strength requirements.
- To significantly improve the workability of site mixed and precast concrete without increasing water demand.

- To provide improved durability by increasing ultimate strengths and reducing concrete permeability

Specification of Conplast SP 430

Specific Gravity: 1.20- 1.22 at 30 Degree C

Air entrainment: Approx. 1% additional air is entrained

Dosage Range : 0.5-2 litre / 100 kg cement

Appearance: Brown liquid

Freezing point approximately: 2 Degree C

Superplasticizer @ 1 % by mass of cement= (mass of admixture/Sp. Gravity of admixture) × (1/1000) 1% = (2.82/ 1.1) × (1/1000)

SP430 (Conplast SP430) dosage =1 % of cementitious material by Weight, Hence, SP 430 = 524.31*1 % of cementitious materials=5.243lit/m^3 .

3.2.7 Water

The water which is used in this investigation for making concrete, mixing and curing of concrete it should be clean and free from harmful impurities such as oil, alkali, acid, etc. For cement mixing and curing throughout this work conforming as per IS 456-2000.

3.3 Mix Design

Initially the concrete mix is designed for M3 0 grade using IS10262:2009. As self-compacting concrete requires high amount of fine content the fine aggregate content is increased and coarse aggregate content is reduced. Super plasticizer is used to reduce the water content, so that there won't be any adverse effect on strength of concrete. For the purpose of the experiment four types of concrete mixes will be made. In each mix coarse aggregate is replacing by bricks bat in the ratio of 0%, 10%, 20% 30% and 40% by volume. After the initial mix design, SCC of grade M3 0 was adopted. In this study, mix proportion are obtained for M3 0 mix as per modified NANSU method which satisfy the requirements of EFNARC guidelines. The trial mix design was prepared and tested for the fresh properties of SCC as per IS10262:2009 and EFNARC guidelines. Mix proportions for M3 0 Grade are listed below. Refer Table 3.9 and 3.10

3.4 Mix Proportion of Concrete

This study is carried out in the M3 0 mix proportioning varying percentage of partial replacement of clay brick bats with coarse aggregate of SCC to determine the flow and mechanical characteristics of SCC is designed as per guidelines according to the IS 10262- 2009 and in the study, five different mix ratio were designed with the proportion of 0%, 10%, 20%, 30% and 40% were used with 80% PPC , 20% of GGBS and clay brick bats as replacement of coarse aggregate.

Table 3.9 Replacement of materials in Mixes

Replacement of materials in Mixes	
Mix	**Alternate Substitution**
Mix 1 (0%)	80% PPC & 20% GGBS, B. bats at 0% for CA
Mix 2 (10%)	80% PPC & 20% GGBS, B. bats at 10% for CA
Mix 3 (20%)	80% PPC & 20% GGBS, B. bats at 20% for CA
Mix 4 (30%)	80%PPC & 20% GGBS, B. bats at 30% for CA
Mix 5 (40%)	80% PPC & 20% GGBS, B. bats at 40% for CA

Table 3.10 M30 SCC mix concrete are modified as per EFNARC

Description	Mix1	Mix 2	Mix 3	Mix 4	Mix 5
	0%	10%	20%	30%	40%
Cement, Kg/m^3	419.5	419.5	419.4	419.5	419.5
GGBS, kg/m3	104.9	104.9	104.9	104.9	104.9
F. aggregate,kg/m^3	895.9	895.9	895.9	895.9	895.9
C.aggregate, kg/m^3	703.9	633.6	563.2	492.8	422.4
Brick bats, Kg/m^3	0	70.4	140.8	211.2	281.6
Water/Cement ratio	0.38	0.38	0.38	0.38	0.38
Super Plasticizer	1%	1%	1%	1%	1%

4 EXPERIMENTAL TEST RESULT AND DISCUSSION

4.1 GENERAL

The experimental study comprised of two parts: In the fresh state, the tests are slump flow, V-funnel, L-box and U-box are all test methods used for the assessment of the fresh properties of SCC in this study. While compressive and flexural strengths and static modulus of elasticity are tests used for studying hardened properties. In this study, all testing is carried out as per following IS code. Testing of Fresh Concrete Properties like slump flow test-Funnel test, L-Box test and U -Box test , compressive strength (as per IS : 516 – 1959), split tensile strength (as per IS : 5816 – 1999), flexural strength (as per IS: 516 – 1959) .the fresh state, the tests are slump flow, V-funnel, L-box and U-box are all test methods used for the assessment of the fresh properties of SCC in this study. While compressive, tensile strength and flexural strengths are tests used for studying hardened properties the experimental study comprised of two parts:

i. Testing of flow characteristics of Fresh Concrete Properties
ii. Testing of mechanical properties of concrete

4.2 TESTS PERFORMED ON FLOW CHARACTERISTICS OF FRESH CONCRETE PROPERTIES

In this study, five different mix proportions of Mix1, Mix2, Mix3, Mix4, and Mix5 are tested and form these mixes, the flow characteristic of fresh concrete passing ability filling ability, workability and segregation resistance of the concrete were tested in this study using. four different test methods i.e. Slump flow test, L-Box test, U -Box, test and V-Funnel. Result and Acceptable range of fresh concrete tests are mentioned in table form below. Refer Table 4.1,4.2 and Figure

Table 4.1 Test Result for fresh concrete

S.No.	Mixture ID	% Replacement of brick bats	Slump flow Test (mm)	L-box blocking ratio (H2/H1)	U - box , H1-H2	V-funnel flow time (seconds)
1	Mix 1	0%	730	0.92	15	8.83
2	Mix 2	10%	722	0.87	12	10.63
3	Mix 3	20%	705	0.86	13	11.25
4	Mix 4	30%	685	0.83	7	11.98
5	Mix 5	40%	682	0.82	4	12
Acceptable range / Standard Values			650-800	0.8-1	0-30	8-13

Table 4.2 Acceptable range for fresh concrete test

S/No.	Method	Property	Unit	Acceptable range / Desired value	
				Min	Max
1	L-box	Passing ability	Ratio	0.8	1
2	U -box	Passing ability	Mm	0	30
3	V-funnel	Filling ability	Sec	8	13
4	Slump flowtest	Filling ability	Mm	650	800

4.2.1 *Slump Flow Test*

The slump flow test aims at investigating of filling ability is the characteristic of SCC to flow under its own weight and to completely fill the formwork and It measures two parameters: flow spread and flow time T50 (optional). The former indicates the free, unrestricted deformability and the latter indicates the rate of deformation within a defined flow distance. Slump Flow Test on Self Compacting Concrete (Mini slump cone), the slump flow is used to assess the horizontal flow of SCC in the absence of any kind of obstructions.

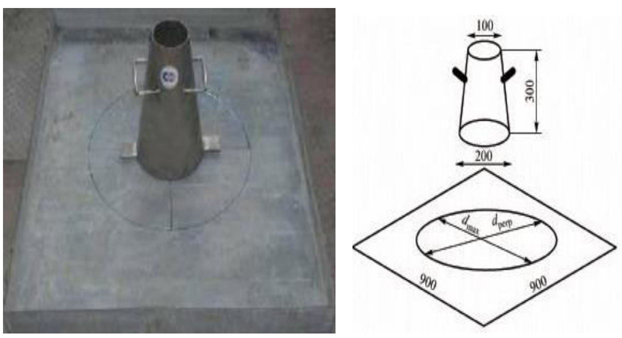

Figure 4.1 Slump flow test apparatus dimension

Note: The higher the slump flow (SF) value, the greater its ability to fill formwork under its own weight. A value of at least 650mm is required for SCC.

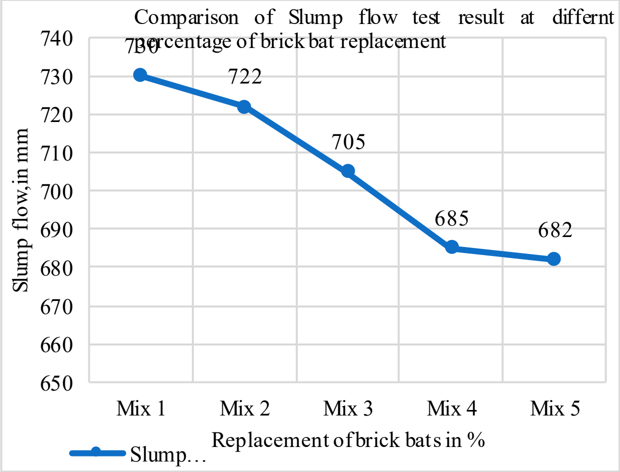

Figure 4.2 Slump flow test graph

4.2.2 *L-Box Test*

This method aims at investigating Passing ability is the characteristic of SCC to flow through and around obstacles such as reinforcement and narrow spaces without blocking and It measures the reached height of fresh SCC after passing through the specified gaps of steel bars and flowing within a defined flow distance. With this reached height, the passing or blocking behaviour of SCC can be estimated. L Shape Box is used for determining the passing ability rate of freshly SCC. The distance between 12 mm diameter bars can be set between 41±1 mm or 59±1 mm. The SCC sample is poured in to the L-Box apparatus, now the plate is removed to allow flow. The L-box ratio is calculated as H2/ H1. According to EFNARC, when the ratio of h2 to h1 is larger than 0.8, SCC has good passing ability. Refer table 4.1 and Figure 4.3 and 4.4

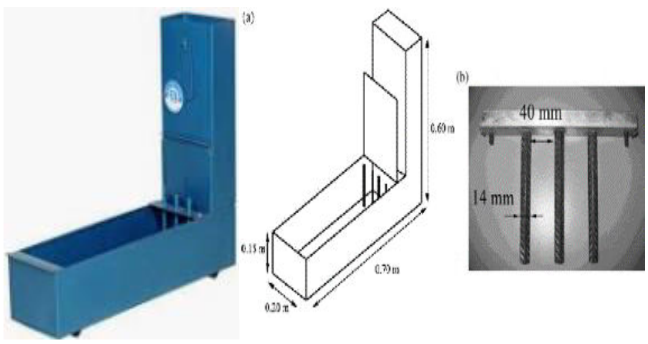

Figure 4.3 L-Box apparatus standard dimension

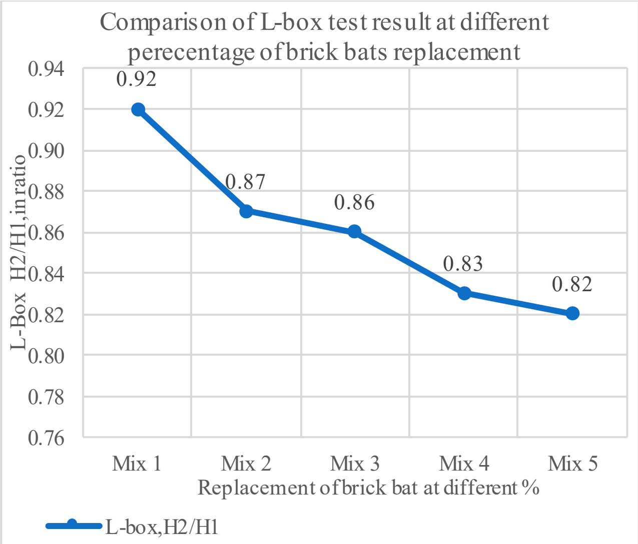

Figure 4.4 L-Box test Result graph

Note: If the concrete flows as freely as water, at rest it will be horizontal, so H2/H1=1. Therefore, the nearest this test value, the ‘blocking ratio’, is unity, the better the flow of concrete. calculated as H2/ H1. According to EFNARC, when the ratio of h2 to h1 is larger than 0.8

4.2.3 U-Box Test

The test is used to measure the Passing ability is the characteristic of SCC to flow through and around obstacles such as reinforcement and narrow spaces without blocking of self-compacting concrete. The apparatus consists of a vessel that is divided by a middle wall into two compartments; an opening with a sliding gate is fitted between the two sections. Reinforcing bar with nominal diameter of 134 mm are installed at the gate with centre to centre spacing of 50 mm. this create a clear spacing of 35 mm between bars. The left-hand section is filled with about 20 litres of concrete then the gate is lifted and the concrete flows upwards into the other section. The height of the concrete in both sections is measured. Refer table 4.1 and Figure 4.5 and 4.6

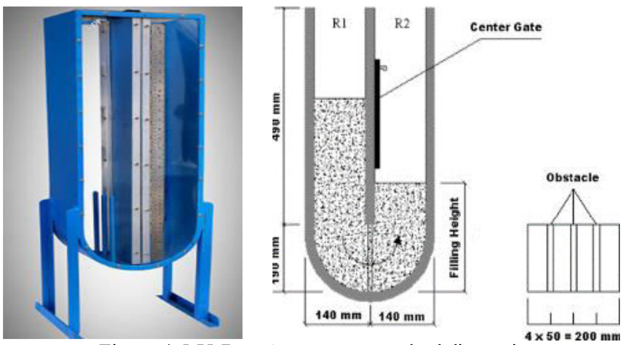

Figure 4.5 U-Box Apparatus standard dimension

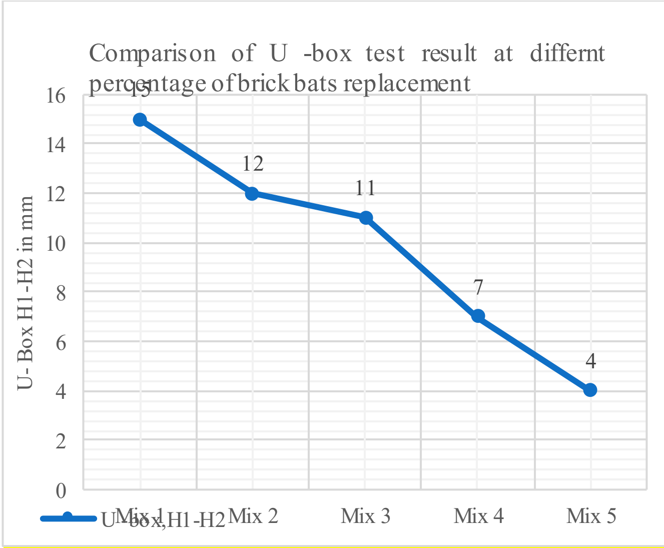

Figure 4.6 U-Box test Result graph

Note:

U Box test is used to measure the filing ability of SCC. If the concrete flows as freely as water, at rest it will be horizontal, so

H1-H2=0. Therefore, the nearest this test value, the ‘filling height’, is to zero, the better the flow and

passing ability of the concrete. filling height less than 30 cm is acceptable.

4.2.4 V-Funnel Test

The filling ability of the concrete is the characteristic of SCC to flow under its own weight and to completely fill the formwork, this properties were measured by the V-funnel flow time test method and it is the period a defined volume of SCC needs to pass a narrow opening and gives an indication of the filling ability of SCC provided that blocking and/or segregation do not take place; the flow time of the V-funnel test is to some degree related to the plastic viscosity Funnel apparatus is used to evaluate the flow time of freshly mixed self-compacting concrete and to find the Segregation Resistance of SCC. The test is not suitable when the maximum size of the aggregate exceeds 22.4 mm. Refer table 4.1 and Figure 4.7 and ,

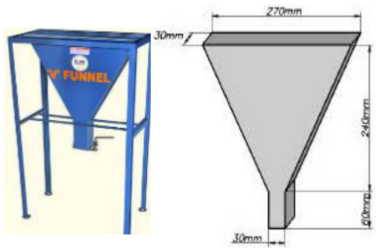

Figure 4.7 V-Funnel Apparatus standard dimension

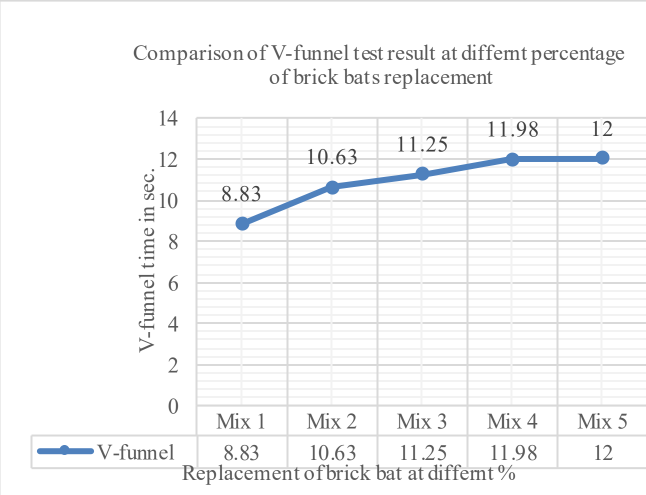

Figure 4.8 V-Funnel test result graph

Table 4.3 Compressive strength of concrete attainable % range of strength

Age of concrete in days	Strength per cent
1 day	16%
3 days	40%
7 days	65%
14 days	90%
28 days	99%

Test result for compressive strength of concrete

Table 4.4 Compressive Strength of concrete for Different Mixes at 7,14 &28 Days

Compressive Strength of concrete for Different Mixes at 7,14 &28 Days of Concrete, in N/mm2			
Mixture ID	7 Days	14Days	28Days
Mix 1	14.71	16.84	27.7
Mix 2	13.99	15.7	25.23
Mix 3	12.89	14.52	22.9
Mix 4	12.15	14.49	22.89
Mix 5	9.27	13.67	22.12

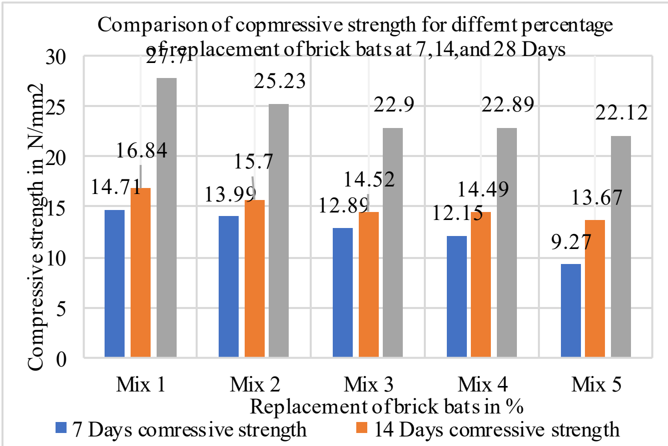

Figure 4.9 Compressive strength test result graph for 7,14 &28 Days

Figure 4.10 Compressive Test Machine (for compressive) test

4.3 TESTS PERFORMED ON MECHANICAL PROPERTIES OF HARDENED CONCRETE

In the present our investigation the hardened properties of SCC tests of compressive strength, split tensile strength and Flexural Strength tests were analysed: Compressive strength test, Split tensile test and Flexural Strength of prism test

4.3.1 Compressive Strength of Concrete

Compressive strength is the ability of material or structure to **carry** the loads on its surface without any crack or deflection. A material under compression tends to reduce the size, while in tension, size elongates. (as perIS:456-2000). compressive strength gained by concrete after 7,14 and 28 days of curing period the concrete gains 16 percent strength in one day, 40 percent in 3 days, 65% in 7 days, 90% in 14 days and 99% strength in28 days. Refer table4.3,4.4 ,4.5 and Figure 4.9,4.10,4.11

Strength Calculation

The total maximum load indicated by the testing machine was recorded, and the compressive strength was calculated accordingly as follows:

Compressive Strength of concrete = Maximum compressive load / Cross Sectional Area F=P/A

Note: Minimum three specimens should be tested at each selected age. If strength of any specimen varies by more than 15 percent of average strength, results of such specimen should be rejected. Average of three specimens gives the crushing strength of concrete. The strength requirements of concrete. As per IS 516, the individual variation in compressive load should not be more than plus minus 15% of the average value

S/No	Proportion	Strength after 7 days curing period, in N/mm2				Strength after 14 days curing period, in N/mm2				Strength after 28 days curing period, in N/mm2			
		1	2	3	Avg.	1	2	3	Avg	1	2	3	Avg
1	0%	15.56	14.09	14.49	14.71	14.58	12.36	23.60	16.84	30.98	23.56	28.58	27.70
2	10%	12.00	14.40	15.56	13.99	15.56	16.00	15.56	15.70	25.47	21.24	28.98	25.23
3	20%	11.82	12.89	13.96	12.89	13.82	18.00	11.73	14.52	17.73	20.53	30.44	22.90
4	30%	11.11	13.78	11.56	12.15	15.51	13.51	14.44	14.49	26.04	17.38	25.24	22.89
5	40%	8.62	9.20	10.00	9.27	15.16	11.64	14.22	13.67	29.42	18.18	18.76	22.12
4	30%	11.11	13.78	11.56	12.15	15.51	13.51	14.44	14.49	26.04	17.38	25.24	22.89

Figure 4.5 Compressive strength of concrete test

4.3.2 Flexural Strength of Concrete

Flexural Strength is the capacity of the concrete (usually beams) to resist deformation under bending moment. It is sometimes called bending strength. and it is one measure of the tensile strength of concrete, measure of an un-reinforced concrete beam or slab to resist failure in bending. and it is measured by loading 150 x 150 mm concrete beams with a span

length of at least three **times** the depth dimension of the prism (test specimen) is 100x100x500mm.the mould should be of metal, preferably steel or cast iron and the metal should be constructed with the longer dimension horizontal and in such a manner as to facilitate the removal of the moulded specimens without damage. The testing machine may be of any reliable type of sufficient capacity for the tests and capable of applying the load at the rate specified. The permissible errors should not be greater than ± 0.5% of the load applied where a high degree of accuracy is required and not greater than ± 1.5% of the load applied for commercial type of use. IS: 516-1959 Methods of tests for strength of concrete are used in this result. Refer table 4.6and Figure 4.12,4.13

Strength Calculation

The Flexural Strength or modulus of rupture (**f_b**) is given by

f_b = pl/bd^2 (when **a** > 20.0cm for 15.0cm specimen or > 13.0cm for 10cm specimen) or

f_b = 3pa/bd^2 (when **a** < 20.0cm but > 17.0 for 15.0cm specimen r < 13.3 cm but > 11.0cm for 10.0cm specimen.)

Where,

a = the distance between the line of fracture and the nearer support, measured on the centre line of the tensile side of the specimen

b = width of specimen (cm)
d = failure point depth (cm)
l = supported length (cm)
p = max. Load (kg)

Note: -flexural strength is about 12 % to 20% of compressive strength of concrete

Figure 4.11 Cube testing

Test result for Flexural strength of concrete

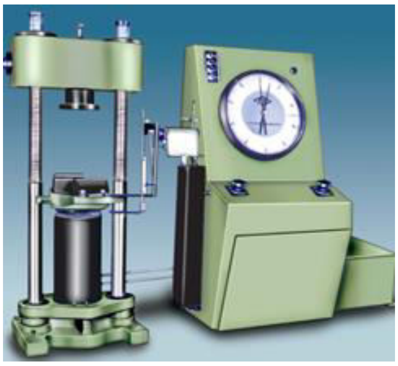

Figure 4.12 Universal Test M machine (for flexural test & tensile test)

Table 4.6 Test result for Flexural strength of concrete

Flexural strength result for different % of brick bats						
Mix Ratio	No.of prism casted		14 Days Flexural strength		28 Days Flexural Strength	
	For 14 days	For 28 days	in KN	in N/mm²	in KN	in N/mm²
Mix 1	3	3	11.1	4.32	15.8	5.94
Mix 2	3	3	10.8	4.28	14.2	5.10
Mix 3	3	3	10.7	4.00	12.7	4.95
Mix 4	3	3	10.5	3.92	11.4	4.31
Mix 5	3	3	9.7	3.50	10.1	3.95
total	**15**	**15**				

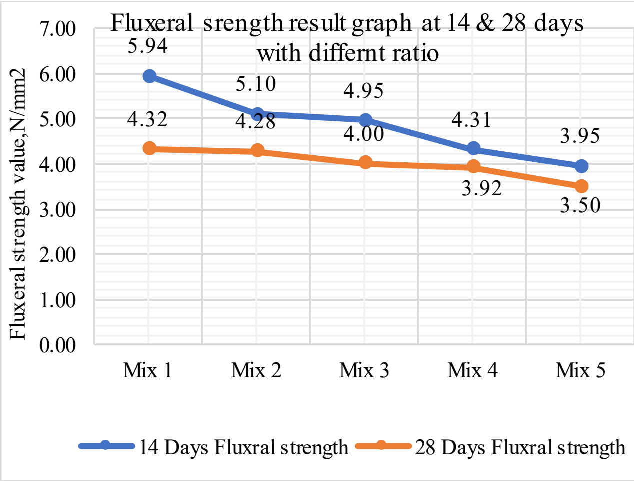

Figure 4.13 Flexural strength result graph

4.3.3 *Split* Tensile strength of concrete

This property for concrete relates to its tension strength and in this test, it is taken as cylindrical in shape. Tensile strength for concrete specimen is defined as the tensile stresses developed due to application of the compressive load at which the concrete specimen may crack. A measure of the ability of material to resist a force that tends to pull it apart. It is expressed as the minimum tensile stress (force per unit area) needed to split the material apart. Tensile strength for concrete specimen is defined as the tensile stresses developed due to application of the compressive load at which the concrete specimen may crack. The test is carried out by placing a cylindrical specimen horizontally between the loading specimen of a compression testing machine and the load is applied until failure of the cylinder, along the vertical diameter. The loading condition produces a high compressive stress immediately below the two generators to which the load is applied. But the larger portion corresponding to depth is subjected to a uniform tensile stress acting horizontally. The dimension of test specimen used was & 150x300 mm concrete cylinder. It is estimated that the compressive stress is acting for about 1/6 depth and the remaining 5/6 depth is subjected to tension. Refer table 4.11 and Figure 4.23,4.24

Write the expression for calculating the split tensile strength Tsp of the concrete.

Tsp=2P/πDL

Here, the term P is applied load on the concrete, D is cylindrical specimen diameter and L is cylindrical specimen length. Split tensile strength for concrete is given as below.

Tsp=0.7(fck)1/2

Here, the term fck refers to characteristic strength of concrete.

Table 4.7 Test result for Tensile strength of concrete

Tensile strength result for different % of brick bats						
Mix ratio	No.of cylinder casted		After 14 days curing time		After 28 days curing time	
	For14 days	For 14 days	Tensile strength in KN	Tensile strength in N/mm	Tensile strength in KN	Tensile strength in N/mm^2
Mix 1	3	3	64	2.03	136	4.32
Mix 2	3	3	59	1.88	108	3.44
Mix 3	3	3	58	1.74	98	3.12
Mix 4	3	3	47	1.58	80	2.56
Mix 5	3	3	45	1.43	67	2.12
Total	15	15				

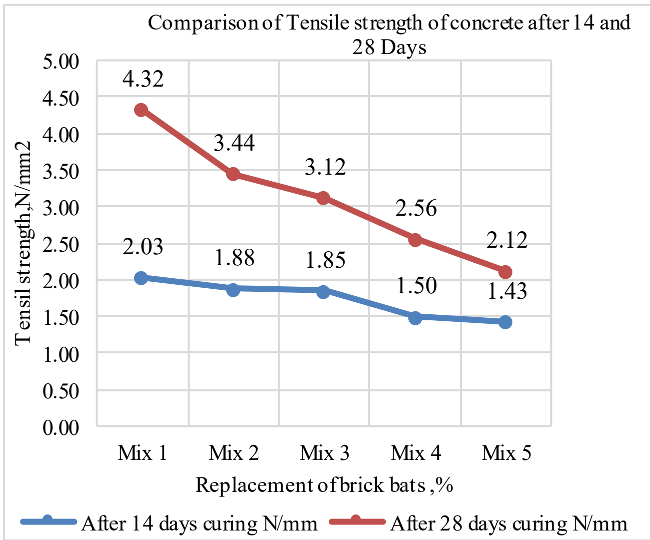

Figure 4.14 Tensile strength result graph

4.4 *DISCUSSION*

4.4.1 *Discussion based on fresh concrete properties Test Result*

- The slump flow test result shows that with the increasing replacement percentage of crushed bricks bat as a coarse aggregate from 0% to 40%, the horizontal free flow of concrete in the absence of obstructions have been steadily decreased from 730mm to 680 mm.
- L-Box test results are shown in the ratio L-box blocking (H2/H1) value similarly decreased from 0.92 to 0.82 (the test value is obtained with in the acceptable range / standard Values).

- The test value of U- box shows that the passing ability of the concrete H2-H1 with different percentage of bricks bat replacement are decreased from15 to 4,
- The readings of V- funnel flow time test results are increasing from 8.83 sec to 12 sec,

As we keep the replacement percentage of crushed bricks bats are Similarly increased. and the above fresh concrete property test results are found.

4.4.2 Discussion based on of harden /Mechanical Concrete Properties Test Result

The most important hardened concrete property is compressive strength, split Strength test, & Flexural Strength, give the comparative results of harden concrete strength.

- The Compressive strength of concrete test result shows that when the value of the replacement percentage of mix ratio of brick bats coarse aggregate increased from 0% to 40% the value of compressive strength of concrete has been decreased.
- The flexural strength and Tensile strength tests result value fb from 4.28 to 3.5 N/mm2 in 14- and 28-days age value compare to the standard conventional mix ratio of concrete.

It is clearly observed that with the increase in percentage mix ratio of brick bats coarse aggregate replacement value have been steadily decreasing at different age of in 14- and 28-days age value compare to the standard conventional mix ratio of concrete

5 CONCLUSION AND FUTURE WORK

5.1 CONCLUSION

Based on the experimental work, the following conclusions are drawn.

- Compressive strength of 20 MPa or N/mm2 and above is suited for structural use such as shaft, column, shear wall and slab, while concrete with the compressive strength less than 20 MPa or N/mm2 are only suited for non-structural role,
- The bulk density of brick bats aggregate is in the range of 1000kg/m³ to 1200kg/m³ that can be consider as a light weight, below 1850 kg/m3
- Brick bats aggregate is used for as a structural lightweight concrete and to produce precast building blocks.
- Brick bats can be used for lower weight, dead loads and for low bearing capacity of soil and non-load bearing structure like filling for floor and roof slabs, partition walls
- Brick bats may be taken and used as an artificial stone or metamorphic stone can be considered as light weight aggregates.

5.2 FUTURE WORK

From the result, we found that the concrete compressive strength up to 20% partial replacement of coarse aggregate with Brick bates has got the required standard for light weight concrete structures but still it needs further study can be done on durability, permeability and absorption tests

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