DISSERTATION –II REPORT

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AFFORDABLE LIGHT WEIGHT AGGREGATE CONCRETE IN WHICH SAWDUST AND BRICK BALLAST PARTIALLY REPLACES WITH FINE AGGREGATES AND COARSE AGGREGATES

Submitted in partial fulfilment the requirements

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In

CIVIL ENGINEERING

by

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DECLARATION

I, Mandeep Kumar (41400040), hereby declare that this Dissertation: II report entitled **"Affordable light weight aggregate concrete in which sawdust and brick ballast partially replaces with fine aggregates and coarse aggregates"** submitted in the partial fulfilment of the requirements for the award of degree of Master of Civil Engineering, in the School of Civil Engineering, Lovely Professional University, Phagwara, is my own work. This matter embodied in this report has not been submitted in part or full to any other university or institute for the award of any degree.

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Place: - Lovely Professional University

CERTIFICATE

Certified that this project report entitled "**Affordable light weight aggregate concrete in which sawdust and brick ballast partially replaces with fine aggregates and coarse aggregates**" submitted individually by student of School of Civil Engineering, Lovely Professional University, Phagwara , carried out the work under my supervision for the Award of Degree. This report has not been submitted to any other university or institution for the award of any degree.

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Thank You.

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ABSTRACT

Construction industry relies heavily on conventional material such as cement, sand and gravel for the production of concrete The river sand and gravels which are most commonly used as fine aggregates and coarse aggregates respectively in the production of concrete, poses the problem of acute shortage in many areas, whose continued use has started posing serious problem with respect to its availability, cost and environmental impact. Attempt is being made in this project to use the locally available waste materials to replace the river sand and gravels to produce light weight and low cost concrete. Sawdust and Brick ballast are easily affordable at low cost or free of cost, which are partially replaces with river sand and gravels respectively for making concrete. Sawdust can be defined as loose particles or wood chippings attained as by products from sawing of timber into standard useable sizes. Brick ballast is common in form of over burned bricks at the time of its manufacturing and also in the form of broken bricks during its transportation at the time of construction work. Natural sand and Gravels were partially replaced (4% SD 8% BB, 4% SD 16% BB, 4% SD 24% BB, 8% SD 8% BB, 8% SD 16% BB, 8% SD 24% BB, 12% SD 8% BB, 12% SD 16% BB and 12% SD 24% BB. by using M30 grade of concrete) with sawdust and broken brick ballast respectively. For this concrete cube of size 150mm X 150mm X 150mm were casted with various given these materials in different proportion and with constant water cement ratio of 0.42. Water reducing admixture is used to increase the workability. Slump test, Compacting factor test and compressive strength up to 28 days of age were compared with those of concrete made normal materials. The workability and compressive strength gradually decreases for the increasing the replacement percentages. The optimum mix found to produce M30 grade of concrete is 8% of sawdust and 16% of Brick ballast. The compressive strength found at this proportion is 28.94 N/sq. mm. The weight reduction achieved is 10.07%.

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CHAPTER 1

INTRODUCTION

1.1 General

As the time is passing, due to the development of infrastructure the construction industry is growing at a vast rate and in the last few decades we are seeing huge constructions in the world. With the rapid growth of infrastructure and population, various types of waste materials can be managed with the same speed of growth of infrastructure. This is not a problem in India only, but it is a global problem raising his head high very fast.

Concrete is a mixture of cement, fine aggregates, coarse aggregates and water. Normally river sand is used as fine aggregates and stones or gravels are used as coarse aggregates in the concrete. These materials are limited on the earth. The increase of demand of these materials, it causes shortage of materials due to less availability and increases the cost of the materials. The availability of natural sand and stones decreases day by day for making concrete due to using excessive and unusual non-scientific mining methods from the riverbeds and drop down the water level. To overcome these types of problems researcher found an alternate or substitute materials for aggregates. There are many types of waste materials are available in our environment, which can be replaced with aggregates in concrete for making concrete. Many types of waste light weight materials like sawdust, fly ash, Rice husk ash, cow dunk and over burnt bricks are easily available in our environment. If these materials are directly disposed in our environment then it causes many problems. So that these materials can be used as construction material for making concrete. The choice of these alternate or substitute materials depends upon many factors like easily availability, cost factor, physical and chemical composition of ingredients. If these materials are replaced with aggregates in concrete then they can considerably reduce the dumping and waste storage problems and simultaneously helps to preserve the sources of natural aggregates. Saw dust and brick ballast are the waste materials which can be replaced with fine aggregate and coarse aggregate respectively in concrete. These materials are light in weight, so that it is helpful to construct light weight structures. Structural light weight aggregate concrete is an important and versatile material in modern construction. It has many and varied applications including multi-storey building frame and floors, bridges, offshore oil platform and precast elements of all types.

From last few decades it can be seen that sawdust waste growing at a vast rate and increases year by year in our environment, households, mills and factories etc. Sawdust can be

defined as loose particles or wood chippings attained as by products from sawing of timber into standard useable sizes .Sawdust is mostly used in many areas as a fuel for domestic areas in which they occur. From new research it can be investigated that sawdust is often dumped as waste products and about 105 million tonnes of sawdust are generated annually in India alone. So that sawdust is the best alternative for fine aggregates. In this changing time, sawdust particles might be one of an infinite no. of solutions for low cost housing. The sawdust is light in weight as compare to river sand; its density is very less as compare to fine sand about 10 to 15 % of the unit weight of fine river sand. But there are many problems and obstacles for using sawdust in concrete as compared with normal concrete. The main problem is water absorption, use of sawdust in concrete reduce the workability of concrete and increase the water demand. This demand of water can be reduced by using water reducing admixtures. Sometimes sawdust concrete is also known as nailing concrete. The nailing concrete may be defined as concrete in which nails can be driven and in which they are firmly held. There are many other benefits of using sawdust concrete, if the concrete made from sawdust it controls interior humidity level, it has thermal and heat proofing properties and not subjected to fungi. It is an inert material so that not react with any ingredients of concrete and steel. Sawdust can be used in concrete in two forms, first is powder form and second is chips form. The powder form sawdust used in concrete for replacement of fine aggregates with some treatment. This is also known as dry sawdust. The chips form is used in concrete for replacement with cement, after burning of sawdust in the form of sawdust ash.

The sawdust partially replaces with fine aggregates and brick ballast can be partially replaces with coarse aggregates. Bricks are the common materials in construction industry. Bricks are important construction material used in the construction of buildings either in main walls, partition walls and some other construction purpose. During manufacturing of bricks in a kiln, high amount of over burnt bricks are produced which acts as a waste. These bricks can be recycled by using with replacement of another material in concrete. With the help recycling process we can reduce the loss of those materials which are potentially useful. The consumption of raw materials can be reducing which ultimately save time and energy. The brick which are near the fire in the kiln subjected to high heat more than 1000 degree centigrade ultimate shrink and loose its shape, colour becomes reddish and its appearance like reddish to blackish gradients stone. The major volume of ingredients in concrete is the aggregates, it attains 60- 80% of the total volume of concrete. So that the cost of the whole concrete is largely depends upon the aggregates used. Normally in concrete, crushed stones or gravels are used as coarse aggregates.

These are obtained naturally either from river bed or by crushing rocks mechanically up to the required size. The concrete is the composite material, so in this research studied on how concrete is behave when natural coarse aggregates partially replaced by over burnt bricks or by brick bats.

Many architects, engineers and contractor recognize the inherent economics and advantages offered by these materials, as evident by the many impressive lightweight concrete structure today throughout the world. Structural lightweight aggregate concrete solves weight and durability problems and exposed structures. Light weight concrete has strengths comparable to normal weight concrete, yet is typically 25% to 35%. Structural light weight concrete offers design flexibility and substantial cost savings by providing, less dead load, improved seismic structural response, longer spans, better fire rating, thinner sections, smaller size structural members, less reinforcing steel and lower foundation costs. The seismic forces are proportional to the mass of the structure, then in earthquake prone areas the light weight concrete may contribute to a safer and more economic design. In bridges and other precast construction, the light weight concrete helps to reduce costs of shipping and crane capacity, inclusive considering a higher cost of the aggregates. It is necessary to know that the lightweight concrete has different properties that must be considered during the design.

CHAPTER 2

LITERATURE REVIEW

2.1 General

The sawdust is the light weight waste by-products of wood or timber and it is easily available from the local carpentry shop. A lot of study has been done in the past and is being done at the present for a utilization of sawdust in construction industry.

Brick ballast is also a light weight, average strength material used as coarse aggregates for making light weight concrete in construction industry.

2.2 Review on previous work

M. Geethta Bhargava and J.D. Chaitanya Kumar (2015) have studied on the usage of many waste products such as sawdust, Fly ash, Rice Husk Ash, Recycled aggregates etc. as alternate materials in concrete, that can be utilised as a ingredients of concrete by partially or fully replaced with one or more materials that can be used other than the normal concrete. They cover many aspects about the using of waste materials in concrete as alternate aggregates and strength variations parameters with different materials at different proportion in mixture of concrete.

K. Ambiga and P. Meenakshi (2015) have studied on low cost waste construction material as saw dust in production of concrete cubes to investigate the best possible solutions. The present paper works on the comparison of weight and compressive strength of sawdust concrete with normal concrete. They casted the three specimen for curing period of 7 days and 28 days by partial replacement of sand with sawdust with a varying proportion of 10%, 20%, 30% . The compressive strength and weight of each block were checked and compared with devoid of sawdust. From data gathered at last, recommendation were given which will be beneficial to the construction industry and general popularity with respect of low cost and light weight concrete cubes.

Saurabh G. Sable and S. B. Walke (2015) researched on brick ballast in the form of over burned bricks at the time of manufacturing and also in the form broken bricks during its transportation at the time of construction work. It can be used as partial replacement for stone aggregate in concrete. This research should provide optimum % of replacement, use of 30% brick aggregate replaced for natural coarse aggregate was found feasible and economical. They

worked on the analysis of both fresh and hardened concrete with partial replacement of brick waste by studied from various tests like slump, compaction factor test, unit weight, compressive strength, tensile strength and flexural strength etc.

T. Subarmani and S. Kumaran (2015) researched on effect of replacement of coarse aggregates with over burnt brick ballast and concrete waste at proportion of 25%, 50% (M15, M25) in concrete mixture for building construction. They evaluate the different properties of concrete in fresh state as well in hardened stage like slump test, compaction factor test, unit weight and compressive strength of concrete and compared with normal concrete. From this research it was concluded that Concrete formed with over burnt brick ballast and concrete waste aggregate showed beneficial performance as compared with normal concrete obtained from local resources. It reduced the costs of concrete by reducing the aggregate cost and produces economical infrastructure system. It had been observed that the use of waste materials results in the formation of light weight concrete. They casted the concrete cubes and tested to study the compressive strength and also concluded that by reducing the water-cement ratio from 0.60 to 0.40, the compressive strength of crushed over burnt bricks – sand concrete and gravel – sand concrete increases by more than 30%.

P. Sri Chandana and Shaik Ahamed Mvouddin (2015) have studied on the effect of replacement of fine aggregates with sawdust and robosand in concrete mixture for building construction. Concrete is a composite material made from cement, fine aggregates, coarse aggregate, water and some admixtures. The present paper deals with the replacement of fine aggregate with sawdust and robosand and comparison replaced material concrete and traditional concrete. The present paper deals with to use the locally available material to replace the river sand to produced low weight concrete. They also used the crusher dust produced from granite crushers and waste by product from quarry is one of the alternative materials for river sand. The use of crusher dust can be called ROBO has been accepted as a building material. Sawdust and robosand in different proportion is used as fine aggregates in concrete and tested various properties like compressive strength and split tensile strength. For this research work, there were five mixes prepared for the investigation, with gradually replaced the percentage proportion from 0 – 100% with sand and robosand. The compressive strength and split tensile strength gradually decreases with increase in percentage replacement. The optimum mix found to produce M20 grade of concrete is 10 % of sawdust and 40% of robosand, totally 50% replacement of river

sand. The weight reduction achieved was 7% and cost reduction was 2% per cubic meter of concrete.

K. Gopinath et al. (2015) researched on the low cost construction material for concrete and mortar as sawdust and investigated on various concrete and mortar properties in plastic and hardened stage such as Slump test, compacting factor test, weight analysis, compressive strength and cost analysis. In present paper, the researchers introduced two reproductive form of sawdust such as Dry sawdust and Sawdust Ash. Dry sawdust was partially replaced for fine aggregates and sawdust ash was used for partially replacement for cement. They were casted 16 mortar cubes and 48 concrete cubes for curing period of 7 days and 28 days. For 1:5 mortar, Compressive strength of sawdust mortar cube after 7 days of curing achieve 92%, 77% and 50% of strength for 10%, 30% and 50% respectively and self weight decreases 5%, 10% and 17% for 10%, 30% and 50% respectively. For M20 grade of concrete, design mix ratio of 1:1.5:3, Compressive strength of Dry sawdust concrete after 28 days curing was achieved 80%, 75% and 47% of strength for 10%, 30% and 50% replacement of Dry sawdust for fine aggregate respectively.

Tomas.U.Ganiron Jr (2014) researched on Effect of replacement of fine aggregate with sawdust in concrete mixture for building construction. Concrete is a mixture of cement, fine aggregate, coarse aggregate, water and admixtures if required. The present paper deals with the replacement of fine aggregate with sawdust and comparison of sawdust concrete and normal traditional concrete. For research work, he casted the three specimens for curing period of 7 days, 14 days and 28 days, in that highest compressive strength is gained by 7 days sample which was not cured in that period and Strength of sawdust concrete decrease as the water cement ratio less than 0.45. The workability of concrete decreases continuously by increasing the sawdust content. The sawdust concrete showed 10% reduction in weight as compared with normal concrete which go about 40%. With the replacement of waste material in concrete, the workability and consistency parameter varied from normal concrete and the sawdust waste material is cheaper than the fine aggregates.

Dilip Kumar et al. (2014) researched on low cost construction material for concrete as sawdust and investigated on the effects of introducing the cost between sawdust concrete block and concrete block made with sand. There made concrete specimens by replacing the sand with 10%, 15% and 20% sawdust and there conclude that at the initial ages with the increase in the percentage replacement of sawdust, the compressive strength increases. While using sawdust

concrete, the weight of concrete will decreases and it can be used as Light weight concrete in civil engineering related structures.

Tariq Ali et al. (2014) researched on the use of Over Burnt brick ballast aggregate partially replaced with coarse aggregates in concrete at different proportions such as 5%, 10%, 15% and 20% (M5, M10, M15, M20). From this research evaluate the different properties of concrete made with over burnt brick ballast i.e. slump value, compaction factor value, unit weight, flexural strength and Los angles abrasion value as compared with normal concrete in the plastic stage as well in hardened concrete. From experimental investigation it was concluded that Concrete formed with over burnt brick ballast aggregate showed beneficial performance as compared with normal concrete. It reduced the cost of concrete by reducing the cost of aggregates and produces economical infrastructure system.

Mahmud Abubakar et al. (2013) researched on the use of sawdust as partial replacement for the fine aggregates in concrete production. Sawdust was used to replace fine aggregates from 0% to 50% in steps of 10%. Concrete cubes measuring 150 x 150 x 150 mm were casted and their compressive strengths evaluated at 7, 14, 21 and 28 days. From the results, the optimum sawdust content was obtained at 10% and its corresponding compressive strength at 28 days is 7.41 N/sq. mm which falls within the characteristics strength of plain concrete (7-10 N/sq. mm). This concrete cannot be used in structural applications.

Prof. R. Sathish Kumar (2012) has studied on the properties of concrete varied with the use of alternate construction material in concrete. He used cement, sand, rice husk ash, coarse aggregate, sawdust, brick bats, recycled aggregates as materials in concrete. The compressive strength of concrete made with sawdust was found to be nearly 10- 15% of normal concrete. The maximum average compressive strength of sawdust concrete after 7 days and 28 days is 20.26 Kg/sq. Cm and 43.22 Kg/sq. cm at proportion of 1:(1+0.5):3 and water –cement ratio of 0.75.

M. Mageswari and B. Vidivelli (2009) researched on the usage of waste sawdust ash, which are generated from rice mills replaced with fine aggregates in concrete and conserved the natural resources. The natural sand was partially replaced with sawdust ash at different proportion such as 5%, 10%, 15%, 20%, 25% and 30%. The present paper worked on different properties of concrete in its plastic and hardened stage like compressive strength, Tensile strength (cubes and cylinders) and flexural strength up to 180 days of age were compared with normal concrete. Apart from these properties they were also studied many other properties of sand and sawdust ash during research work such as Fineness modulus, specific gravity, moisture content, water

absorption, Bulk density, % voids and % porosity (loose and compact) . The optimum result for compressive strength of concrete made with sawdust concrete was found in between 10-20% of normal concrete.

CHAPTER 3

SCOPE OF THE STUDY

This experiment work planned in this investigation consisting of testing similar cubes by replacement of sand and coarse aggregates with sawdust and brick ballast. There are total ten mixes of different proportion of sawdust and brick ballast aggregate is used for experiment purpose.

The properties of the concrete can be determined in the plastic as well as in hardened stage. In the plastic stage of concrete, the workability of concrete is determined by slump cone test and compacting factor test with constant water cement ratio. There are three concrete cubes of every mix proportion are casted, poured in water for curing for 28 days and then tested for determination of compressive strength.

CHAPTER 4

OBJECTIVES OF THE STUDY

This project is on the utilization of sawdust and brick ballast partially replaces with sand and gravels at different proportion in concrete mix. The main aim of this project is to achieve the light weight and economical concrete. The work further deals with the comparative study of concrete makes with using sawdust and brick ballast at different proportion and normal aggregates concrete, in accordance to their structural member, cost, weight of structure as well as strength they provide. The specific researches in this project are:-

1) To investigates the variations in the compressive strength of concrete by replacing natural fine and coarse aggregates with sawdust and brick ballast aggregates respectively at different proportions. Compressive strength testing machine is used to check compressive strength of concrete.
2) To identify the optimum quantity of sawdust and brick ballast aggregates concrete.
3) To compare the weight reduction between the Nominal aggregate concrete and the concrete made with replacement of sawdust and brick ballast.
4) To compare the cost reduction between the nominal mix and optimum mix after replacement.

CHAPTER 5

EXPERIMENTAL SETUP

5.1 Introduction

The experiment investigation includes the casting of cube with sawdust and Brick ballast partially replaced with fine aggregate and coarse aggregate respectively and the tests were conducted to study the various physical properties such as slump test, compaction factor test, 14 days and 28 days compressive strength. A total of 30nos. of specimens were casted and tested in the laboratory to evaluate their compressive strength.

5.2 Materials and Methods

5.2.1 Materials:- The test specimens have been casted using cement, coarse sand, coarse aggregate(Gravels), sawdust, brick ballast, water and admixure, wherever applicable. The materials, in general, confirming to the specifications laid down in the relevant Indian Standard Codes of Practice, wherever applicable. The materials used for making concrete have the following characteristics.

Table-5.1: Test Analysis of Materials

	Description		**Cement**	**Admixture**	**20 mm agg.**	**10 mm agg.**	**Combined Sp. Gr. Of**	**FA**
A	Consistency		29.42%	-	-	-	-	-
B	Initial Setting		148 min	-	-	-	-	-
C	Final Setting		241.5 min	-	-	-	-	-
D	Comp. Strength (7		41.46 N/mm^2	-	-	-	-	-
	Comp. Strength (28		52.83 N/mm^2					
E	Specific Gravity		3.15	1.235	2.65	2.659	2.655	2.68

F	Water Absorption				0.64%	0.68%		1.59
G	Aggregate Impact				17.05			
H	Flakiness Index				12.30%			
I	Zone of Sand							II
J	Fineness Modulus of							2.846

1) Cement- Cement used in this study is Portland Pozzolona Cement (PPC), which is available under the commercial name "ACC Cement". The cement has uniform grey with light greenish shade colour and was free from any hard lumps. Portland Pozzolona Cement is confirming to IS: 1489 (Part 1) 1991. Different types of cement have different water requirements to produce workable paste. The choice of brand and type of cement is the most important to produce good quality of concrete.

2) Fine Aggregates

i) Coarse Sand- Aggregates are the important constituents in concrete. They give body to the concrete, reduce shrinkage and effect economy. Coarse sand consists of natural sand, crushed stone sand or crushed gravel stone dust. Clean and dry sand available locally will be used. Sand passing 4.75mm sieve and retained on 1.18mm sieve will be used for casting all the specimens.

ii) Sawdust: Sawdust is the tiny particles of wood that are formed from sawing of wood. The sawdust is partially replaces with sand in concrete with different proportions. Sawdust is obtained from the local mills, and it is mixture of soft and hard wood. It is light in weight, so that will reduce the overall density of concrete. When the density of concrete decreased, the self weight and overall dead load of the structure is reduced. Sawdust used for casting of cubes is sun dried.

Fig. 5.1: Saw Dust

3) Coarse Aggregates- Coarse aggregates are also very important constituents in concrete. They give body to concrete; reduce the shrinkage and effect in economy. The aggregates occupy 70-80% volume of concrete. The aggregates were tested as per the IS: 2386-1936 for crushing strength and Impact value. Coarse aggregates passing 20mm sieve and retained on 10 mm sieve will be used for casting of all specimens.

Fig. 5.2 Coarse Aggregate (Gravels)

i) Brick Ballast-These are the broken brick parts obtained from well burnt bricks. It is made free of dust before use. Brick ballast is partially replaces with gravels in concrete with different proportions. It is light in weight, so that will reduce the overall density of concrete. When the density of concrete decreased, the self weight and overall dead load of the structure is reduced. Sawdust used for casting of cubes is sun dried.

Fig. 5.3 Brick Ballast

4) Water- Potable water was used for casting and curing of specimens that is available in the college premises.

5) Admixture- Super plasticiser (ROFF 820 super Plast) based on high molecular weight polymers and sulphonated melamine formaldehyde has been used throughout the investigation. The nominal dose of the super plasticiser has been kept at 1.0% of the weight of cement.

5.3 Concrete mix

The proportion by weight of the ingredients constituting the concrete mix is 1:1.23:2.53 with a water-cement ratio of 0.42 by weight. Since the same mix is to be employed for both the concrete made with normal materials and the concrete made with partially replacement of sand and gravels with sawdust and brick ballast, the recommendations of ACI Committee 544 *(ACI 544.3R-93)* have been taken into account while deciding the mix proportions. The details of the concrete mixes along with the 7-days and 28-days compressive strength are tabulated in Table-3.1

Fig. 5.4 Compressive Strength Testing Machine

Table-5.2: Reference Concrete Mix Proportions

Mix No.	Proportion by weight C : F.A. : C.A	Water-Cement ratio by weight	7-days Compressive Strength (Mpa)	28-days Compressive Strength (Mpa)
1	1:1.23:2.53	0.42	30.73	44.00
2	1:1.23:2.53	0.42	30.03	43.53
3	1:1.23:2.53	0.42	30.16	43.20

5.4. CASTING AND CURING OF TEST SPECIMENS

The casting of the various specimens has been done under laboratory conditions using standard equipment. Each casting batch consists of in the form of at least three 150 mm cubes determining the concrete cube compressive strength. For each batch, quantities of cement, fine

aggregate, coarse aggregate and water have been kept ready in the required proportion. Sawdust and Brick ballast aggregates, wherever required to be added in the concrete mix, in terms of weight, have been also kept ready.

The same mix proportions have been used for the normal concrete and concrete made with different percentage proportion of sawdust and brick ballast aggregates. Initially the sand and cement have been mixed thoroughly to get a uniform mix in dry condition, indicated by the uniform colour of the mix, no concentration of either material being visible. Then, coarse aggregates have been added to this dry mix. About 60% of the total water has been then added slowly to get a uniform mix. After this, the remaining water along with the super-plasticizer thoroughly mixed in it has been added, and the mixing was continued for about one minute.

Table 5.3 Detail of Test Specimens

Sr.No.	Designation of Specimen	% Replacement of Sand with Sawdust	% Replacement of Gravels with Brick ballast
1	M0	-	-
2	M1	4	8
3	M2	4	16
4	M3	4	24
5	M4	8	8
6	M5	8	16
7	M6	8	24
8	M7	12	8
9	M8	12	16
10	M9	12	24

5.5 Tests on Properties of Concrete

5.5.1 Tests on Fresh concrete Properties

1) Workability- Workability is the fresh property of concrete. It is defined as the ease of mixing, transporting, placing and compaction. Slump test and Compaction factor test is used to

check the workability of concrete during this research work. With the addition of sawdust and brick ballast, slump value is decreases and compaction factor value is also decreased.

Slump Test

Apparatus Required- i) Slump Cone.

ii) Weighing Balance.

iii) Measuring Jar.

iv) Trowel.

v) Tamping Rod.

Fig. 5.5 Slump Cone Apparatus

Procedure

i) The slump cone placed on a water tight levelled platform and fresh concrete is placed in three layers.

ii) Each layer is tamped with 25 blows with rounded end tamping rod of steel of 16 mm diameter and 60 mm long.

iii) After filling the slump cone, the cone is gently and vertically raised, the concrete is allowed to settle under its own weight.

iv) The vertical distance from the original level to the new level after subsidence is measured. This is called slump and measured in mm.

v) The above procedure is repeated for various other water cement ratio.

While conducting the slump test, following types of slump is often comes:-

i) True Slump-In this cone the mixture subsides uniformly and cohesively. This type of slump in normally obtained in rich mixture and where the proportion of fine aggregate is high.

ii) Shear Slump- Here half of the cone shears off along the inclined plane while the other half is true slump. The shear slump is obtained in the first instance. The test should be repeated at least once.

iii) Collapse Slump-In this type of slump the concrete first collapses and spreads over larger areas. This phenomenon normally occurs in wet mixture.

Compacting Factor Test: - Compacting factor test or compaction factor test is the type of test used to determine the workability of concrete in its plastic stage. This test is normally used if the slump value is less than 25 mm. This test can be performed in laboratory only.

Fig. 5.6: Compacting factor apparatus

Compacting Factor value:- It is the ratio of weight of the partially compacted concrete to the weight of fully compacted concrete

5.5.2 TESTS ON HARDENED CONCRETE

Following test have been performed on the hardened concrete.

i) Compressive Strength of Concrete

Compressive strength tests have been conducted on concrete cubes of size 150 x 150 x 150 mm cast from each batch of concrete. To check the quality of concrete, these tests have been carried out in accordance with IS: 516- 1959 after 28 days. The bearing surfaces of the machine have been cleaned and the test specimen has been placed in the machine such that the load is applied to the faces other than the cast faces of the specimen. The maximum compressive load has been recorded at which the specimen failed to take any further increase in the load. The average of three samples has been taken as the representative value of the compressive strength for each batch of the concrete. The compressive stress has been calculated by dividing the maximum compressive load by the cross sectional area of the cube specimens.

Figure 5.7: Compressive Strength testing Machine

CHAPTER 6

EXPERIMENTAL RESULT AND DISCUSSION

6.1 General

The experimental programme consists of the tests on fresh concrete and hardened concrete. For this purpose concrete specimen of standard size and according to designed mix proportion were prepared. Then, the experiments are performed on them to check properties like slump value, compaction factor and compressive strength.

6.2 TESTS

6.2.1. Slump cone test: - Slump cone test is used to check the workability of concrete. A constant water cement ratio of 0.42 is used throughout the research work. Additional water reducing admixture is used to increase the workability of concrete.

The test was performed immediately after mixing Table 4.1 shows the slump values of concrete mix at defined replacement. Graphical representation of the slump test values illustrated in Figure. Facts revealed that the slump value decreases with increases in the quantity of sawdust and brick ballast aggregates. This decreasing pattern of slump directly affects the workability of concrete and ultimately reduces the workability of concrete with increase in the sawdust and brick ballast aggregates proportion.

The following results of slump values are obtained from experiment work on replacement of sand and gravels with sawdust and brick ballast:-

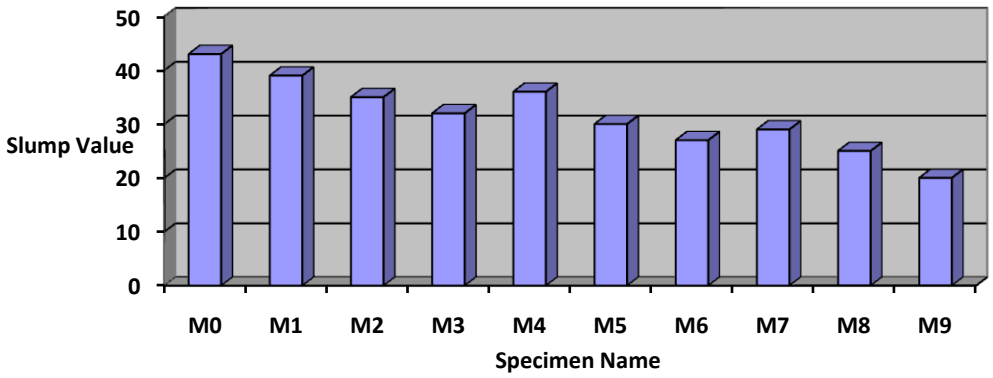
Fig. 6.1: Slump Cone Test Performance

Table 6.1: Observation Table on Slump values

Sr. No.	Designation of Specimen	Slump Value(mm)
1	M0	43
2	M1	39
3	M2	35
4	M3	32
5	M4	36
6	M5	30
7	M6	27
8	M7	29
9	M8	25

10	M9	20

Degree of Workability: - Low



Graph 6.1 Slump Value Vs Specimen Name

6.2.2. Compacting Factor Test: - The compacting factor test is used to check the workability of concrete. From this research work, it is investigated that with increase in the replacement proportion of sawdust and brick ballast in concrete, the compacting factor value is decreases. Means the workability of concrete is decreases with increases in replacement proportion of sawdust and brick ballast.

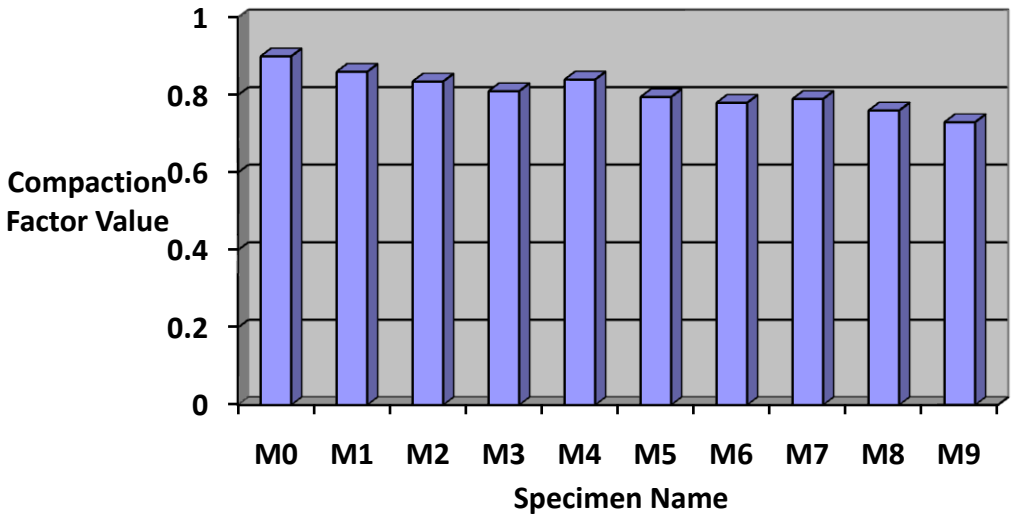
Table 4.2 shows the compaction factor values of the concrete mix at defined replacement. Graphical representation of the compaction factor value illustrated in Fig. 2. Trend clearly revealed that as the percentage of sawdust and brick ballast aggregates in the concrete increases, compaction factor values decreases ultimately lesson the workability of concrete.

Fig. 6.2: Compacting Factor Test Performance

Table 6.2: Observation Table of Compaction factor values

S.NO.	Designation of Specimen	Compaction Factor Value
1.	M0	0.90
2.	M1	0.86
3.	M2	0.835
4.	M3	0.81
5.	M4	0.84
6.	M5	0.795
7.	M6	0.78
8.	M7	0.79
9.	M8	0.76

10.	M9	0.73



Graph 6.2: Compaction Factor Vs Specimen Name

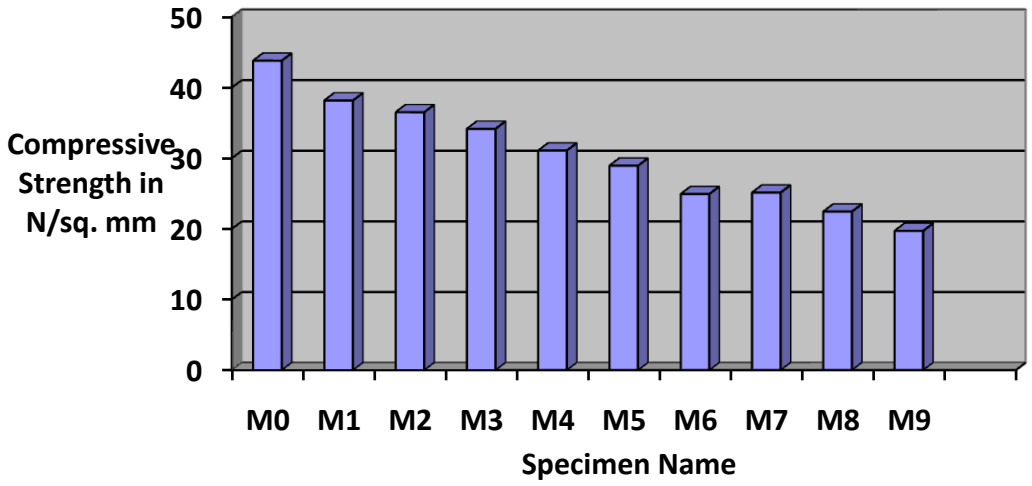
6.2.3) Compressive strength:- The compressive strength gradually decreases for the increasing replacement percentage of sawdust and brick ballast aggregates . This is a negative sign using it as structural concrete. For mix M0 (Normal Mix), the characteristics compressive strength after 28 days is 43.80 N/sq. mm for M 30 grade of concrete. It decreases continuously with increase in replacement proportion of sawdust and brick ballast aggregates.

Fig. 6.4: Cube Specimen

Table 6.3: Compressive strength of various Mix proportion at 28 days

S.NO.	Designation of Mix	Specimen Name	Compressive Strength of Specimen (After 28 days)		
			Load (KN)	Compressive Strength (N/sq. mm)	Mean Compressive Strength (N/sq. mm)
1.	M0	1	990	44.00	43.91
		2	998	44.53	
		3	972	43.20	
2.	M1	1	868	38.57	38.17
		2	858	38.13	
		3	851	37.82	
3.	M2	1	840	37.33	36.51
		2	800	35.55	
		3	825	36.66	
4.	M3	1	790	35.11	34.16
		2	748	33.24	
		3	768	34.13	
5.	M4	1	720	32.00	31.08
		2	680	30.22	
		3	698	31.02	
6.	M5	1	635	28.22	28.94

		2	672	29.86	
		3	647	28.75	
7.	M6	1	550	24.44	24.93
		2	570	25.33	
		3	563	25.02	
		3	551	24.48	
8.	M7	1.	598	26.57	25.13
		2	548	24.35	
		3	551	24.48	
9.	M8	1	490	21.77	22.44
		2	520	23.11	
		3	505	22.44	
10	M9	1	468	20.80	19.71
		2	455	20.22	
		3	408	18.13	



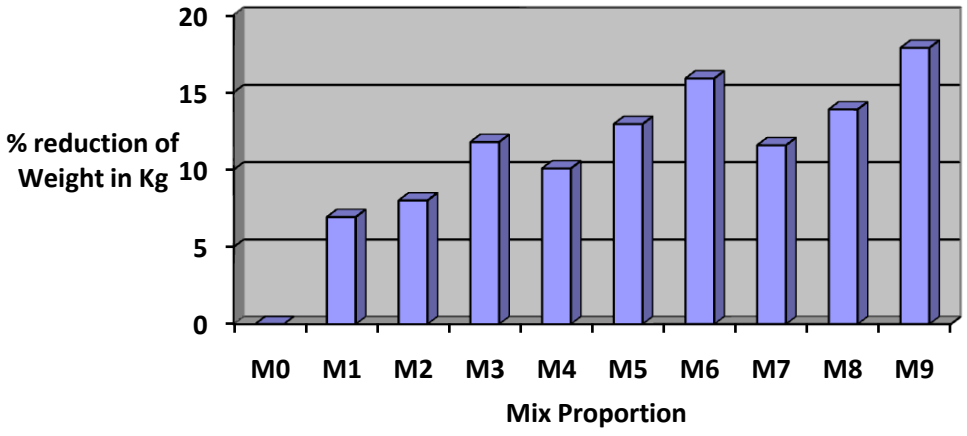
Graph 6.3: Compressive Strength Vs Specimen Name

6.2.4) Weight Reduction:- The weight of concrete cubes is recorded for calculating weight reduction properties of sawdust and brick ballast aggregates concrete. Table 4 shows the weight reduction obtained for various mixes in percentages. The graphical representation is shown in the Fig. It is evident from the graph that weight of the concrete cubes decreases with increase in the replacement proportion of sawdust and brick ballast aggregates. For M1 mix replacement of sand and coarse aggregates with sawdust and brick ballast a weight reduction is 6.93%. For M2 mix 8%, for M3 11.78%, for M4 10.07%, for M5 12.94%, for M6 15.89%, for M7 11.57%, for M8 13.89% and for M9 mix of concrete weight reduction of 17.87% is achieved.

From different concrete mix weight reduction of each mix is calculated and compared with the nominal concrete mix. The weight of the concrete cubes gradually decreases with increase in the % replacement. Reduction in weight results the overall self weight of the structure is reduces which ultimately reduces the structural design details and ultimately reduces the construction cost.

Table 6.4: Weight reduction of Concrete of Various mix proportions

Sr. No.	Mix designation	Weight of specimen (After 28 days in Kg)			Mean Value (Kg)	% Reduction in weight (%)
		I	II	III		
1.	M0	8.380	8.490	8.435	8.435	0
2.	M1	7.856	7.930	7.880	7.888	6.93
3.	M2	7.760	7.910	7.700	7.81	8
4.	M3	7.410	7.680	7.550	7.546	11.78
5.	M4	7.550	7.710	7.730	7.663	10.07
6.	M5	7.340	7.580	7.485	7.468	12.94
7.	M6	7.220	7.315	7.300	7.278	15.89
8.	M7	7.650	7.450	7.580	7.560	11.57
9.	M8	7.315	7.425	7.480	7.406	13.89
10.	M9	7.050	7.250	7.168	7.156	17.87



CHAPTER 7

CONCLUSIONS

The following conclusions have been found from the present work:-

1) The core objective of this research was to investigate the effects of sawdust and brick ballast aggregates on the properties of concrete. The investigation discovered decrease in workability, compressive strength, unit weight and cost per unit volume of concrete.

2) As the replacement proportion of sawdust and brick ballast increases in concrete then slump value of the mixes gradually decreases and workability is also decreases. At the optimum replacement proportion i.e. M5 (8 SD 16 BB), the slump value decreases from 43mm (For Nominal concrete) to 25 mm.

3) As the replacement proportion of sawdust and brick ballast increases in concrete then compacting factor value of the mixes gradually decreases and workability is also decreases. At the optimum replacement proportion i.e. M5 (8 SD 16 BB), the compacting factor value decreases from 0.90 (For Nominal concrete) to 0.78.

4) 28 days compressive strength of the concrete decreases gradually for the increasing replacement percentages. For the optimum mix M5 (8 SD 16 BB), the compressive strength of M 30 grade of concrete decreases from 43.80 N/sq. mm (For normal mix) to 28.94 N/sq. mm.

5) This sawdust and brick ballast concrete can be used in the production of non load bearing precast concrete units, Flooring and pavement concrete, hollow blocks and flooring tiles.

6) For the optimum mix the weight reduction up to 10.07%.

CHAPTER 8

SCOPE OF THE FUTURE WORK

After the through study following areas will be recommended:

1) It should be used in non structural members in the structures like PCC works and partition walls.
2) Evaluate Mechanical Properties by constant W/C ratio.
3) The fresh concrete properties are to be analysed and found out experimentally for the practical use of concrete.
4) The thermal and fire resistance properties are to be tested for the performance of sawdust under such conditions.
5) The acid resistance tests and water absorption tests are to be analysed to be carried out as the sawdust is weak in reacting with these liquids.

CHAPTER 9

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