INVESTIGATION OF STRENGTH CHARACTERISTICS ON CONCRETE SPECIMEN REPLACING SAND BY SAW DUST AS A AGGREGATE

[1]Yashraj Suman,[2] Kamini Laheriya
[1] M.tech Schlor, Civill Department, SSSUTMS University, M.P.India
[2] Assistant Professor, Civill Department, SSSUTMS University, M.P.India

ABSTRACT

With increase in industrial enterprise Associate in Industries exceedingly|in a very} developing country like Asian country value is an im-portant space of concern for the fashionable day construction. The recent study has shown North American nation that quantity of saw dirt waste created in our country is around 30000-33000 tons annually. This study focuses on the experimental investigation of victimization saw-dust as a partial replacement of sand within the properties of concrete combine. Saw dirt conjointly referred to as wood dirt could be a by-product or waste material of wood operating operations like saw-ing, milling, planing, routing, drilling and sanding. Natural sand was partly re-placed with saw dirt in (10%, 20%, 30%and 40%). The mixed fine mixture was pursued through sieve size analysis together with relative density take a look at. once this chemi-cal analysis of saw dirt by machine-controlled mass spectrometer was done. This freshly shaped blended fine mixture was employed in mortar and concrete to match with natural con-crete mixture. The compressive strength, durability and flexural strength up to twenty-eight days of concrete created with natural fine mixtures were (31.56mpa, 3.29mpa, 8.56mpa) that is less than the values of concrete victimisation 100% of replaced sand by saw-dust (35.23mpa, 3.7mpa, 8.87mpa). The take a look at results indicate that it's attainable to manufacture concrete containing wood with characteristics the same as those of natural concrete as long as the share of saw dirt replaced by sand ought to be with-in (10 to 20) per cent. on the far side that it violates the IS code demand because the strength of concrete lowers down with the rise of exchange you look after sand by saw-dust.

Keywords*: Saw dust, Compressive strength, Flexural strength ;*

INTRODUCTION

The rising growth of population and economy in Asian country is resulting in industrial enterprise. The urbanization is resulting in numerous sorts of researches within the engineering fields over recent years. the sphere that has been liable to higher and a lot of economical changes is without doubt, the development business.

With technological developments sky-rocketing, the standard ways area unit slowly replaced with higher alternatives. whereas a number of these alternatives thrust ahead the potency rate, a number of them ease the demand of the standard raw materials. for example, in frame structures, walls act as screen to keep up a room's privacy. These walls support self-weight, and for that masonry element of density and low strength materials are often used, which may facilitate in reducing the burden of the struc-ture effective. Since most of the concrete mixture is exhausted within the walls, a compo-nent of the mixture are often thought-about to be substituted in an exceedingly manner that it didn't compromise the performance of the mixture.

Sand is historically used as fine mixture within the concrete mixture. Saw dirt (or wood dirt in industrial terms) could be a by-product or waste created in work operating operations. These might embody sawing, milling, routing, drilling and sanding. It con-sists of fine wood particles and shows properties of wet holding that proper-ties are often

helped to use this wood concrete as a self-curing concrete. it's been tried that in an exceedingly concrete mixture it doesn't compromise the performance of the mix-ture and acts similar to the standard various. Saw dust, are often used as fine mixture work the antecedently used sand in an exceedingly concrete mixture. By being an efficient various for sand because the fine mixture, it accomplishes the 2 necessities of an alternate. As mentioned earlier, it doesn't compromise the performance of the concrete combine however rather makes the amount lighter compared to the sand combine concrete.

This option conjointly addresses the problem of excessive usage of sand that was any resulting in raising serious threats regarding the atmosphere, particularly the watercourse habitats.

ORGANISATION OF THE THESIS

This thesis provides the introduction about FRP composite materials, methods of fabrication of composites and its application in the construction of bridges. Different cross sectional profiles of FRP composite bridge deck panels available in the literature are reported. Overall review of literature on FRP composite bridge deck panels. The various aspects include characterization, preparation of GFRP members, structural performance under static, fatigue and dynamic loadings, fire resistance, durability, analytical studies etc

OBJECTIVES OF THE THESIS

The objectives of the present investigation are stated below

1. To hold out the literature review for comprehensive study on partial replacement of sand by saw dirt as fine aggregate in concrete mixture.
2. To mix saw dust sample with sand in 10%, 20%, 30% and 40% and record the detail observations to check efficient percentage of the saw-dust that can be replaced by sand in the construction field.
3. To find the particle size distribution by sieve analysis for getting an idea of the grada-tion of the proportionate mixture of sawdust.
4. To find the chemical composition of sawdust by automated spectrometer in order to find its suitability for the use in concrete mixture.
5. To find the specific gravity of the saw-dust mix in order to use it for mix-design of concrete.
6. To prepare the mix design of concrete in order to get the adequate proportions of the mix and also to find the workability of concrete by using slump test.
7. To find out the compressive strength test at different percentages of mixing saw dust (10%, 20%, 30% and 40%) in the concrete preparation at the end of 28 days using cu-bic moulds to check the optimum percentage sawdust that can be replaced in conven-tional concrete mix.

ORGANISATION OF THE REPORT

- The present work has been organised into six chapters. Following is a brief outline of the different chapters included in this report.
- In the first chapter the brief outline of the topic along with objectives of the study and work schedule plan is mentioned.
- In the second chapter, general overview of literatures from various journals and publi-cation are overviewed and discussed.
- The third chapter presents the general overviews of various raw materials used in this
- study.
- The fourth chapter presents the experimental program like mixing procedure, specifi-cation, detail of various tests and their procedure.

- The fifth chapter deals with the various results and discussions of the present work.
- Finally the scope of future work is mentioned.

LITERATURE REVIEW

Joy et al. [1] checked the twenty eight days compressive strength, flexural strength and cacophonous durability at numerous combine proportions. They forged such as variety of cubes, cylinder and beams by exchange fine mixture with wood by V-J Day, 20%, twenty fifth & half-hour and to match their property with customary combine (M25).Based on the investigation on wood, following conclu-sions were created i.e. in twenty eight days compressive strength and cacophonous durability of the concrete isn't exaggerated to giant extent however it nearly matches with the compressive and split-ting durability of nominal combine concrete. The compressive strength obtained for the re-placement of fine mixture with twenty fifth wood was proven to be the optimum combine to urge M25 grade of concrete. however the flexural strength step by step will increase as wood content will increase. The fibre content in wood is incredibly high and is answerable for the rise of strength. Weight of the wood concrete was reduced as compared with traditional concrete and conjointly be-come a lot of economical. As a results of this experiment it had been ascertained that the concrete con-taining wood get compacted a lot of with efficiency than the conventional concrete. Dry porous saw-dust might absorb adequate quantity of water that would be an efficient mean of internal cur-ing and absorb the surplus water within the combine and supply the water needed for the association of the cement.

Abdullahi et al. [2] checked the compressive strength of concrete and analyse its impact on the development value. They casted (150x150x150)mm cube & evaluated the compressive strength of concrete at seven,14,21and twenty eight days by exchange fine mixture from third to five hundredth (in proportion gap of 10). supported the investigation following conclusions were created i.e. Saw-dust as Associate in Nursing air-entraining agent has no considerable positive impact on the compressive strength of concrete. Variation within the compressive strength results is traceable to the actual fact that it's dif-ficult to get wood that isn't a combination of many species. a prospect exists for the partial replacement of sand with wood within the production of light-weight concrete. Opti-mum replacement of sand with wood has been found to be 100%. on the far side this limit, the concrete created didn't meet code necessities. As a results of this experiment it had been ob-served that because the proportion wood content exaggerated within the combine the compressive strength cut. The low values of the compressive strength of the concrete employed in this investiga-tion can be attributed to the actual fact that wood contains some substances that area unit injurious

Suji.D et al. [3] determined the optimum amount of watercourse sand to get replaced by Quarry dirt and saw dirt and to get most results and compared the characteristic strength of traditional concrete and concrete with Quarry dirt and Saw dirt. during this experimental study, the take a look at was conducted for M30 combine containing Quarry dirt starting from zero, 10%, 20%,30%,40% combined with Saw dirt starting from zero,5%,10%,15% &20% remaining proportion watercourse sand is employed. supported the experimental study following conclusions were created i.e.The com-pressive strength of quarry dirt and saw dirt up to half-hour and V-J Day severally is sort of simi-lar to it of management combine. Split durability of quarry dirt and saw dirt up to half-hour and V-J Day severally is sort of the same as that of management combine. Two-point loading take a look at result shows that the primary crack load is sort of same for each management combine and quarry dirt and saw dirt concrete. As a results of this experiment Quarry dirt and saw dirt content of half-hour and V-J Day by weight has shown the most effective results. therefore indicates the likelihood of victimisation quarry dirt and saw dirt as a partial replacement of fine mixture up to the present level. the burden are often reduced up to twenty.

Kumar et al. [4] meted out Associate in Nursing experimental study to match the value of sand used concrete block and saw dirt used concrete block and conjointly compared the reduction in weight of 2 blocks. during this experiment, they ready six take a look at specimens of management concrete & 100%, 15%, 2 hundredth fine mixture replaced by saw dirt by volume every. supported the study meted out on the strength behaviour of saw dirt the subsequent conclusions area unit drawn i.e.at the initial ages, with the rise within the proportion replacement of saw dirt, the strength further as compressive strength will increase. what is more with the employment of saw dirt, the burden of concrete reduces, therefore creating the concrete lighter which may be used as a light-weight weight construction material in several engineering science functions.

Tomas et al. [5] meted out the experiment study to analyse the impact of wood concrete mixture in terms of adhesion of aggregates, thermal insulation, workability and surface quali-ty. This study conjointly aims to see the factors moving the performance of wood in con-crete mixture in terms of humidness and temperature and style a wood concrete mixture as an alternate fine mixture. so as to contribute to the business and saving the environ-ment, to produce new data to the contractors and developers on a way to improve the development business ways and services by victimisation wood concrete mixture, and sustain good product performance this study was done. This experimental analysis tries to implicate that sawdust-cement-gravel combine has Associate in Nursing equal advantage than the quality mixture of cement-sand-gravel. each mixed in proportions of 1:2:4 of cement, a fine mixture, and a rough ag-gregate severally. 2 sets of sample with 3 sample of every were created for a complete of six specimens to be tested. the primary set of 3 samples consists of the sawdust-cement-gravel combine, the second set of the normal concrete combine. every set were mixed and moulded within the same approach and with constant volume proportions. once placement in moulds, each sets were left to cure for variety of days. The action samples can then be tested at a given amount of days such as underneath the National Structural Code of the Philippines or NSCP (7, 14, and twenty eight days). The seven day specimen wasn't cured, the fourteen day specimen was soaked, and also the twenty-eight day specimen was washed with a bit little bit of water each morning. Analysis showed a distinction in every specimen tested. Since the action of specimens were altered in an exceedingly thanks to be able to explore alternative aspects of the analysis. Experimentation and information analysis shows that the upper the saturation of water deposits within the wood particles throughout action tend to weaken the sample, creating it softer than it had been designed for, therefore explaining why the soaked and splashed sample appeared weak.

Jeson.P et al. [6] meted out the take a look at experimental study on properties of concrete by partial replacement of cement with silicon oxide powder and fine mixture with saw dirt ash. during this exper-iment natural sand was partly replaced (5%, 10%, and 15%) with SDA. Compressive strength and durability (cubes and cylinders) on seven, fourteen and twenty eight days elderly were com-pared with those of concrete created with natural fine mixture. supported the study meted out on the strength behaviour of saw dirt the subsequent conclusions area unit drawn i.e.in the project it's ascertained by five-hitter, 100% and V-J Day partial replacement of Fine mixture with wood Ash and twenty fifth partial replacement of Cement with silicon oxide Powder, the five hundred of Compressive Strength is over the traditional Concrete Target Strength. the opposite proportion combine encompasses a low Compressive and durability this might result to low bulk density of Saw dirt Ash. however literature says that Saw dirt Ash offer smart strength if replacement with fine mixture on concrete.

Oyedepo et al. [7] meted out the take a look at for investigation of properties of concrete victimisation saw-dust as partial replacement for sand. The concrete combine magnitude relation of 1:2:4. was ready victimisation wa-ter/cement of zero.65 with 0%, 25%, 50%, seventy fifth and 100% wood as partial replacement for fine sand. The constant of uniformity and constant of curvature of the sand area unit employed in this study. Concrete created victimisation wood as partial replacement of sand has influence on the properties of the concrete. The results of the analysis meted out shows that the workability of concrete with partial replacement of sand with wood reduces at constant water-cement ratio; whereas the employment of wood in concrete at high proportion of wood replacement of sand affected the strength of the concrete as there was a decrease within the strength price, and also the density demand of 1480 to 1840 kg/m3 wasn't meet. However, use of wood as partial replacement of sand at twenty five % by weight offers constant strength demand once saw-dust wasn't used. Thus, the employment of wood as partial replacement of sand between zero to twenty fifth can contributes to reduction in wood waste generated within the society while not adversely af-fecting concrete strength.

Osei et al. [8] has carried the experiment on the subject of the impact of exchange sand with wood on the properties of concrete. A concrete mixture of 1:2:4 was used as management whereas wood was accustomed replace twenty fifth, 50%, seventy fifth and 100% of sand by volume. during this study the consequences of the replacement of sand with wood on the strength and density were investigated. supported the results obtained, the subsequent conclusions area unit drawn i.e. the compressive strength and density of concrete reduced because the proportion replacement of sand by wood exaggerated.The impact of wood on the strength of concrete was a lot of pronounced than the impact on the density of concrete. wood concrete will probably be employed in things wherever compressive strength isn't a serious demand. A proportion replacement of a minimum of Bastille Day will probably be employed in manufacturing structural concrete. wood will probably replace Sixteen Personality Factor Questionnaire of sand within the production of structural light-weight concrete. Since wood is also ob-tained at just

about no value, the value of concrete will probably be reduced by exchange sand with wood in concrete. any studies ought to be conducted on the potential of wood as replacement of sand within the production of structural concrete.

Mageswari et al. [9] has carried the experiment by exchange natural sand with SDA (5%, 10%, 15%, 20%, twenty fifth and30%). This paper consists of fineness modulus, relative density, wet content, water absorption, Bulk density, %voids, nada consistency (loose and compact) state for sand and SDA. during this paper he had found compressive strength take a look at, durability take a look at , flexural strength take a look at of concrete sample for twenty eight,45, 60, 90, 180 days. The fineness modu-lus, relative density, wet content, uncompacted bulk density and compacted bulk density of wood ash were found. together with that it had been all over that water demand increas-es because the SDA content will increase. The compressive strength of cubes and cylinders of the con-crete for all combine will increase with age of action and reduces because the SDA content will increase. The durability of cubes and cylinders of the concrete for all combine will increase with age of action and reduces because the SDA content will increase. The Flexural strength of the beam of the concrete for all combine will increase with age of action and reduces because the SDA content will increase. SDA is out there in important quantities as a waste and may be used for creating concrete. this may go a protracted thanks to cut back the amount of waste in our surroundings. The optimum re-placement level in fine mixture with SDA is 100%. Workability of the concrete cut because the percentages of SDA replacement exaggerated. thus there's a prospect that 100% of SDA are often employed in the sphere purpose.

Thomas Joseph Odero et al. [10] has carried the experiment by exchange five-hitter, 100% and twenty fifth by volume of sand with wood. during this paper totally different properties of wood and sand (mois-ture content, relative density, fineness modulas, grading of aggregate)was take a look ated together with compressive tensile and flexural strength test of SC and OC of 7& twenty eight days. As lowering the worth of wood within the concrete mixture giving higher strength in twenty eight days however by increasing wood content the seven days strength get on increasing. Results showed that the compressive strength cut with higher wood content with replacements on the far side 100% leading to a substantial strength decrease. From the on top of paper we've a transparent intellection that saw-dust are often employed in field purpose having 100% of saw-dust of total fine mixture volume.

MATERIALS

CEMENT

Cement has totally different properties and characteristics that rely on their chemical com-positions. By dynamic in fineness of grinding, compound compositions cement have exhibit dif-ferent properties and totally different quite cement. the employment of additives, dynamic chemical com-position, and use of various raw materials have resulted within the availableness of the many varieties of cements. Cement employed in the experimental work is OPC (43 grade) orthodox to IS: 8112/1989. The physical properties & chemical properties of the cement obtained on con-ducting applicable tests and also the necessities as per IS: 8112/1989

AGGREGATES

Aggregates area unit the vital constituents in concrete. they furnish body to the concrete, cut back shrinkage and impact economy. the actual fact that the aggregates occupy 70-80 gift of volume of concrete, it's some impact on numerous characteristics and properties of concrete. Earlier, mixtures were thought-about as with chemicals inert material however currently it's been recog-nised that a number of the mixture area unit chemical active and conjointly bound aggregates ere exhibit bond at the interface of aggregate and paste.

COARSE AGGREGATE

Crushed granite of 10mm & 20mm size were used as coarse aggregate. The sieve analysis of aggregates confirms to the specifications of IS: 383-1970. The Physical Properties are given in the Table 3.3

Fig : Coarse aggregate sample

FINE AGGREGATE (SAND)

Fine aggregate which satisfied the required properties for experimental work and con-forms to zone as per the specification of IS: 383-1970. . The Physical Properties are given.

Fig : Fine aggregate sample

Fig : SAW DUST

Saw dust is produced by cutting or chopping the log & thin flat sheet of wood. Saw-dust is partially mixed with sand by 10%, 20%, 30%, and 40% and its different characteristics as a fine aggregate were tested as per specification of IS: 383-1970. The Chemical properties are given Clean potable water as obtained from Structural laboratory of School Civil Engineer-ing, KIIT was used for mixing and curing of concrete.

EXPERIMENTAL PROGRAM

PREPARATION OF FINE AGGREGATE SPECIMEN

Different mixture of wood and sand (10%, 20%, 30%, and 40%) obtained to conduct the sieve size analysis take a look at and relative density take a look at so as to grasp the atomic number 29, Cc price and to use the particular gravity price for combine style purpose Sieve size analyses of the mixed fine aggregate were done to find out the gradation of the fine aggregate with saw-dust mix. Fine aggregate means the aggregate which passes through 4.75mm sieve. To find the fineness modulus of fine aggregate mix we need sieve sizes of 4.75mm, 2.36mm, 1.18mm, 0.6mm, 0.3mm and 0.15mm. Fineness modulus of finer aggre-gate is lower than fineness modulus of coarse aggregate

Coefficient of Uniformity (C_u)

Coefficient of uniformity represents particle size range of distribution curve. It is defined as ratio D_{60} size of particle to the D_{10} size of particle.

TESTING OF HARDENED CONCRETE

Compressive Strength of concrete

The compressive strength of concrete that's final strength of concrete is outlined because the load to that causes failure of the specimen divided by the realm of the cross section in uniax-ial compression, underneath a given rate of loading. To avoid giant variation within the results of com-pression take a look at, an excellent care is taken throughout the casting of the take a look at specimens and loading as welt. it's but accomplished that in Associate in Nursing actual structure, the concrete at any purpose is in an exceedingly com-plex stress condition and not in uniaxial compression. but it's customary to conduct the take a look at in uniaxial compression solely. Concrete underneath triaxial state can give a lot of resistance and can fail solely once extended giant deformations, the employment of one hundred fifty metric linear unit cubes has been created as per code of practices IS 456. The advantage of choice of Section IS-516 1959 (24) cube, because the customary take a look at specimen is that tow plane and parallel surfaces will perpetually he found be-tween that the load will he applied. Compression testing machine is employed to check the con-crete cubes. The compressive strength is calculated victimisation the formula.

Flexural Strength of concrete

Modulus of rupture is defined as the normal tensile stress in concrete, when cracking occurs in flexure test (IS 516-1599). This tensile stress is the flexural strength of concrete and is cal-culated by the use of the formula, which assumes that the section is homogeneous.

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$$F = \frac{}{}$$

where, F_b= Modulus of rupture, N/mm^2

b = Measured width in mm.

d = Measured depth in mm.

l = Span length in mm

p = Maximum load in kN applied to the specimen.

The symmetrical two points loading creates a pure bending zone with constant bend-ing moment in the middle third span and thus the modulus of rupture obtained is not affected by shear, as in the case of single

concentrated load acting on the specimen. The concrete test specimen is a prism of cross section 100 mm × 100 mm and 500 mm long. It is loaded on a span of 400 mm.

RESULTS

This chapter deals with the presentation of test results obtained, and discussion on dry sieve size analysis along with specific gravity of the fine aggregate mixed with saw-dust mix.

PARTICLE SIZE DISTRIBUTION

This experiment is done to get the particle size distribution of the saw-dust mixed fine aggre-gate. The table shows the sieve size analysis report of the same.

Sieve Sizes (mm)	Sawdust (10%) +Sand (90%)	Sawdust (20%) +Sand (80%)	Sawdust (30%) +Sand (70%)	Sawdust (40%) +Sand (60%)
10	100	100	100	100
4.75	92.36	93.24	94.12	95.12
2.36	62.34	68.75	75.16	81.57
1.18	32.53	38.78	45.03	51.28
0.6	16.78	17.46	18.14	18.82
0.3	6.89	7.26	7.63	8.3
0.15	5.67	5.98	4.29	4.6
0.075	1.21	1.34	1.47	1.6

Table: Sieve size analysis of saw-dust mixed fine aggregate

SPECIFIC GRAVITY

Specific Gravity of the fine aggregate mixed with sawdust shows the result that can be used further in mix-design purpose.

Table : Specific gravity of saw-dust mixed fine aggregate

	Sawdust (10%) +Sand (90%)	Sawdust (20%) +Sand (80%)	Sawdust (30%) +Sand (70%)	Sawdust (40%) +Sand (60%)
Specific Gravity	1.40	1.53	1.67	1.89

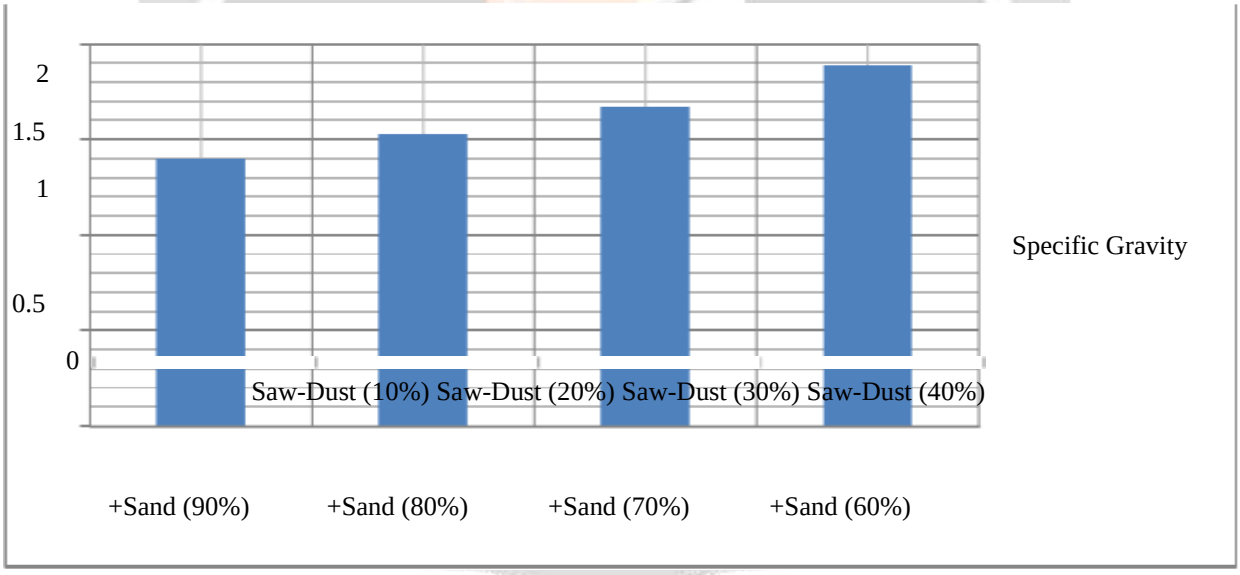

Fig : Bar-chart showing specific gravity of different % of saw dust mixed with sand

ANALYSIS OF SAWDUST

Table: Physical properties of Saw Dust

SL.NO	PARTICULARS	TEST RESULTS
1	Specific Gravity	1.2
2	Fineness Modulus	2.11
3	Water Absorption	1.8%

Table : Chemical properties of Sawdust

SL.NO	PARTICULARS	TEST RESULTS (%MASS)
1	CaO	10.2
2	SiO_2	64.8
3	Al_2O_3	4.9
4	Fe_2O_3	3.26
5	MgO	6.1
6	Na_2O	0.09

7	SO_2	0.43

ANALYSIS OF COARSE AGGREGATE

Table: Physical Properties of coarse aggregate

SL.NO	PARTICULARS	TEST RESULTS
1	Specific Gravity	2.7
2	Fineness Modulus	6.2
3	Water Absorption	0.4(%)

ANALYSIS OF FINE AGGREGATE

Table : Physical Properties of fine aggregate

SL.NO	PARTICULARS	TEST RESULTS
1	Specific gravity	2.65
2	Fineness Modulus	2.47
3	Water Absorption	0.85(%)

4	Free Surface Moisture	0.90(%)

COMPRESSIVE STRENGTH

Compressive strength or compression strength is the capacity of a material or structure to withstand loads tending to reduce size, as opposed to tensile strength, which withstands loads tending to elongate. In other words, compressive strength resists compression (being pushed together), whereas tensile strength resists tension (being pulled apart). In the study of strength of materials, tensile strength, compressive strength, and shear strength can be analyzed inde-pendently.

Table : Compressive strength of Normal and saw-dust mixed fine aggregate concrete

Compressive Strength Values (in MPa)	Grade of Concrete	No. of Days	Strength of Saw-dust (0%) +Sand (100%)	Strength of Sawdust (10%) +Sand (90%)	Strength of Saw-dust (20%) +Sand (80%)	Strength of Sawdust (30%) +Sand (70%)	Strength of Sawdust (40%) +Sand (60%)
	M-25	7	27.03	31.63	28.05	26.73	24.89
		28	31.56	35.23	32.07	30.28	29.68

CONCLUSION AND DISCUSSION

In the present study an effort has been made to experimentally understand the feasibility of using sawdust as partial replacement of sand in concrete and to analyze and compare the re-sults obtained with the properties of conventional concrete. Based on the current experi-mental investigations the following conclusions were made

1. The sawdust mixed fine aggregate (10%,20%,30% and 40%) shows mostly thesame properties as that of normal fine aggregate and therefore it is understood as a well graded aggregate based on C_u and C_c values and also sieve size analysis curve.
2. The suitability of using coarse and fine aggregate in the concrete mixture was con-firmed with their physical properties test.
3. Based on the chemical observations of the saw dust it was found that sawdust can be used as partial replacement of sand in making of concrete such that it will not cause any further leaching issues or does not react with any chemical composition of cement, fine aggregate, coarse aggregate.
4. It has been observed that upon increasing the saw dust percentage replacement the workability, compressive strength, split tensile strength and flexural strength of the concrete decreases after 10% possibly due to higher moisture holding capacity of sawdust as mentioned in different literatures also.

FUTURE WORK

1. The saw-dust concrete made by 10% replacement of sand can also be tested in acidic, basic and neutral solution to test the viability of the sawdust concrete in different weather conditions.

2. Sawdust from different saw-mills can also be used following the same procedure for the better understanding of its behavior in concrete preparation.

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