EXPERIMENTAL STUDY ON PARTIAL REPLACEMENT OF FINE AGGREGATE WITH SAW DUST FOR M30 GRADE CONCRETE

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Abstract: - The study was aimed at the replacement effects on the addition of Saw dust as a partial replacement of Fine Aggregates respectively. Saw dust here acts as a fiber in the concrete. The experiment is carried out by finding the slump value, compressive strength, split tensile strength and flexural strength. Natural Fine Aggregates are replaced by Saw dust in 10%, 20%, and 30% by weight in the concrete. Sawdust shares similar properties as Natural Fine Aggregates and good split tensile to the concrete. The results are compared with the control mix of design mix M30. The specimens are tested after 7 days, 14 days, and 28 days of curing .The replacement of fine aggregate with Saw dust in concrete that makes the structure more light in weight. The workability, strength and durability test are studied. The most important properties of concrete are the compressive strength also increasing. The Saw dust in corporation caused decreases in unit weights and compressive strength values of mortars with a parallel increase in water absorption values at all ages. The replacement of fine aggregates with Saw dust gives the properties and the benefits in the actual production of concrete. Conservation of natural resources and presentation of environment is the essence of any development. The application of saw dust mix for residential building structural member such as column, beam, slab and foundation and plastering are also elicited. The study brings out the fact that it also more economical than the typical cement concrete. The findings of this research call for the safe use and disposal of saw dust. Light weight concrete is a very versatile material for construction, which offers a range of technical, economic and environmental enhancing and preserving advantages and is destined to become a dominant material for construction in the new millennium. With the increasing high building construction, the construction weight becomes important and this problem can be solved using light weight concrete.

Keyword: - Compressive strength, split tensile strength, Flexural strength, Workability, Saw Dust, Fine aggregate, coarse aggregate, water.

INTRODUCTION: - Concrete is the highly used construction material in the world. The demand for it goes up tremendously day by day. If there will be the replacement of fine aggregates (sand) with Saw dust then there will be the less emissions of carbon dioxide in environment. We are using the industrial waste material to produce a better quality of concrete. The environmental problem can be solving by the replacement of industrial wastes and by product. The replacement of fine aggregates (sand) with the help of waste materials (Saw dust) can be beneficial for the structure, and our environment. Sawdust is the waste product obtained from sawmills, having the size similar to that of Natural Fine Aggregates and also shows a superior adhesion when mixing in concrete, hence it can be used as a partial replacement of Natural Fine Aggregate. This option also addresses the issue of excessive usage of sand which was further leading to raising serious threats concerning the environment, especially the river habitats.

The rising growth of population and economy in India is leading to industrialization. The urbanization is leading to various kinds of researches in the engineering fields over recent years. While some of these alternatives push forward the efficiency rate, some of them ease the demand of the traditional raw materials. For instance, in frame structures, walls act as screen to maintain a room's privacy. These walls support self-weight, and for that masonry component of low density and low strength materials can be used, which can help in reducing the dead load of the structure effective. Since most of the concrete mixture is expended in the walls, a component of the mixture can be considered to be substituted in a manner that it did not compromise the performance of the mixture. Large increasing amount in the population of the world requires larger establishment of the settlement. Thus new techniques and materials should be developed to construct new buildings. Besides large number of the settlement security of those building against natural disaster is the durability of the construction and also thermal conductivity. The use of saw dust in concrete production is doubtful because of its easy to decompose characteristics.

However, there have been so many studies are conducted to test the properties and abilities of this saw dust for use concrete production. The results of the study have shown that saw dust has unique properties and is competitive with other building materials.

1.1 GENERAL:

Concrete is the highly used construction material in the world. The demand for it goes up tremendously day by day. If there will be the replacement of fine aggregates (sand) with Saw dust then there will be the less emissions of carbon dioxide in environment. We are using the industrial waste material to produce a better quality of concrete. The environmental problem can be solving by the replacement of industrial wastes and by product. The replacement of fine aggregates (sand) with the help of waste materials (Saw dust) can be beneficial for the structure, and our environment.

1.2 SAW DUST:

The saw wood dust used in this study was collected from the sawmill factories located near VIDISHA. In order to prepared the material, first step is the collected saw wood dust were let dry in room temperature for a few days in order to remove excessive moisture. This is because the saw wood dusts collected from the saw mill are damp due to surrounding humidity at the saw mill factories and seasonal changes. Second, the saw wood dusts are sieve. The bigger sizes wood and unwanted impurities are removed and only wood dust passing sieve size 2.36mm are taken to be use in this study. Sawdust is the main component of particleboard. Saw dusts are easily available for furniture industries.

1.3 PROPERTIES OF SAW DUST:

Table1. Physical properties of saw dust

SL.NO	PARTICULARS	TEST RESULTS
1	Specific Gravity	2.62
2	Fineness Modulus	2.11
3	Water Absorption	1.7%

1.4 CHEMICAL PROPERTIES OF SAW DUST

Table 2. Chemical properties of saw dust

SL.NO	PARTICULARS	TEST RESULTS (%MASS)
1	CaO	10.1
2	SiO2	64.7
3	Al2O3	4.8
4	Fe2O3	3.16
5	MgO	6.12
6	Na2O	0.08
7	SO2	0.41

1.4 OBJECTIVE OF THE STUDT:

The objectives of the present study are given below:-

1. The main aim of this experiment is utilization of waste materials (Saw dust) as a fine Aggregates which are mixed (addition & partial replacement) with PPC and coarse aggregate to investigate the effect of these waste materials on various parameters of concrete grade M30.
2. To mix saw dust sample with sand in 10%, 20%, 30% and record the detail observations to check efficient percentage of the saw dust that can be replaced by sand in the construction work.
3. To find out the compressive strength, tensile strength and flexural strength test at different percentages of mixing saw dust (10%, 20%, 30%) in the concrete preparation of 7, 14 and 28 Days using cubic moulds, cylinders and beam have to check the optimum percentage of sawdust.

1.5 BENEFIT'S OF SAW DUST:

- Saw dust concrete Reduce pollution.
- To solve the problem of natural resources depletion.
- Sawdust concrete is made of green, ecologically pure stuff.
- Sawdust Concrete controls interior humidity level.
- Sawdust Concrete is frost proof.
- Sawdust Concrete is light weight.

2. LITERATURE SURVEY:-

Mageswari 2009 has carried the experiment by replacing natural fine aggregate with SDA (5%,10%, 15%, 20%, 25% and30%). This paper consists of fineness modulus, specific gravity, moisture content, water absorption, Bulk density, %voids, % porosity (loose and compact) state for sand and SDA. In this paper he had found compressive strength test, tensile strength test, flexural strength test of concrete sample for 28, 45, 60, 90, 180 days. The fineness modulus, specific gravity, moisture content, uncompacted bulk density and compacted bulk density of Sawdust ash were found. Along with that it was concluded that water requirement increases as the SDA content increases. The compressive strength of cubes and cylinders of the concrete for all mix increases with age of curing and decreases as the SDA content increases. The Tensile strength of cubes and cylinders of the concrete for all mix increases with age of curing and decreases as the SDA content increases. The Flexural strength of the beam of the concrete for all mix increases with age of curing and decreases as the SDA content increases. Workability of the concrete decreased as the percentages of SDA replacement increased. So there is a possibility that 10% of SDA can be used in the field purpose.

F.A.Olutoge et.al. 2010 has investigated the use of saw dust and palm kernel shells (PKS) as replacement of fine and coarse aggregates in reinforced concrete slabs. Reinforced concrete slabs measuring 800 x 300 x75mm were cast. Sawdust and PKS were used to replace both fine and coarse aggregates from 0% to 100% in steps of 25%. Flexural strengths were evaluated at 7, 14 and 28 days and compressive strengths were evaluated at 28 days. Increase in percentage of sawdust or palm kernel shells in concrete slabs led to a corresponding reduction in both flexural and compressive strength values. It is seen that at a low replacement value of 25% sawdust and PKS can produce lightweight reinforced concrete slabs which could be used where low stress is required at reduced cost. A weight reduction of 14.5% and 17.9% was achieved for sawdust and PKS replacement slabs respectively. It is also seen that the reduction in cost up to 7.43% can be achieved for every cubic meter of slab production with use of sawdust or palm kernel shell.

Abdullahi et.al. 2013 checked the compressive strength of concrete and analyse its effect on the construction cost. They casted (150x150x150)mm cube & evaluated the compressive strength of concrete at 7,14,21and 28 days by replacing fine aggregate from 0% to 50% (in percentage gap of 10). Based on the investigation following conclusions were made i.e. Saw dust as an air- entraining agent has no appreciable positive effect on the compressive strength of concrete. Variation in the compressive strength results is traceable to the fact that it is difficult to obtain sawdust which is not a mixture of several species. A possibility exists for the partial replacement of sand with sawdust in the production of Lightweight concrete. As a result of this experiment it was observed that as the percentage sawdust content increased in the mix the compressive strength decreased. The low values of the compressive strength of the concrete used in this investigation could be attributed to the fact that sawdust contains some substances which are injurious to the cement.

Oyedepo et.al.2014 carried out the test for investigation of properties of concrete using saw- dust as partial replacement for sand. The concrete mix ratio of 1:2:4 was prepared using water/cement of 0.65 with 0%, 25%, 50%, 75% and 100% sawdust as partial replacement for fine sand. The coefficient of uniformity and coefficient of curvature of the sand are used in this study. The result of the analysis carried out shows that the workability of concrete with partial replacement of sand with sawdust reduces at constant water-cement ratio; while the use of sawdust in concrete at high percentage of sawdust replacement of sand affected the strength of the concrete as there was a decrease in the strength value, and the density requirement of 1480 to 1840 kg/m3 was not meet. However, use of sawdust as partial replacement of sand at 25% by weight gives the same strength requirement when saw- dust was not used. Thus, the use of sawdust as partial replacement of sand between 0 to 25% will contributes to reduction in sawdust waste generated in the society without adversely affecting concrete strength.

Obilade et.al.2014 conducted experiments to check the validity of using sawdust ash as partial replacement for cement in concrete. The experiments were run with partial replacement of cement with Saw dust ash (SDA) in 0%, 5%, 10%, 15%, 20%, 25%, and 30%. The bulk densities of the concrete cubes were recorded at interval of 7, 14 and 28 days for the same SDA percentages mentioned earlier the trend shows decrease in the densities with increasing percentages. From the investigation carried out, the optimum addition of SDA as partial replacement for cement ranges up to 15%. The compressive strength of the concrete, however, took a dip when percentage SDA replacement increased. From the study it was further recommended that the use of local recycled materials like SDA as pozzolana should be encouraged more in this sector to enhance material usage efficiency and reduce the usage of sand or silica as a fine aggregate in concrete mixtures.

Anandaraj.S.L 2014 has experimented on concrete in partially replacement of fine aggregate with saw dust added by 10, 20 & 30percentage of weight of the fine aggregates to compare with conventional concrete. Compressive Strength test, Split tensile Strength test, Flexural Strength test of saw-dust was tested for 7-28 days. Addition of 30% of saw dust in concrete mix gives nearly 6.2% increases in tensile strength compared with conventional concrete and 13% increase in compressive strength and 8.12% increases in flexural strength compared with conventional concrete. The result concluded the saw dust increases 30% of characteristic strength of concrete. Addition of mini % saw dust itself increases the compressive strength in higher manner. From the above paper we can conclude that the sawdust of 30% can be used easily in the field purpose to get the proper strength.

Ambiga et.al 2015 has studied on strength of concrete by partial replacement of sand with sawdust. In this paper compressive strength of solid concrete cubes were tested by partial replacement of sand with a varying proportion (10%, 20%, and 30%) of sawdust. The project work confirms that the presence of tannin in sawdust acts as retarder, adversely affecting cube strength. Though, as the percentage sawdust content increases in the mix, the compressive strength decreases. But, for the cubes manufactured with 10% replacement level however, the sawdust replacement did not appear to have a significant effect on the compressive strength of the concrete cubes. The water /cement ratio increases as the percentage of saw dust increases. At 10% sawdust replacement, there is about 10% reduction in weight and 3% reduction in production cost. It could, therefore, be concluded that to achieve a better result in the use of saw dust for concrete cubes production, the percentage re- placement of sand should not be more than 10%.

Thomas Joseph Odero 2015 Has carried the experiment by replacing 5%, 10% and 25% by volume of sand with sawdust. In this paper different properties of sawdust and sand (moisture content, specific gravity, fineness modulus, grading of aggregate)was tested along with compressive tensile and flexural strength test of SC and OC of 7& 28 days. As lowering the value of sawdust in the concrete mixture giving higher strength in 28 days but by increasing sawdust content the 7 days strength get on increasing. Results showed that the compressive strength decreased with higher sawdust content with replacements beyond 10% resulting in a considerable strength decrease. From the above paper we have a clear ideation that saw-dust can be used in field purpose having 10% of saw-dust of total fine aggregate volume.

Nahak et.al 2015 executed compressive strength test, tensile strength test, flexural strength test for the study on strength of concrete due to partial replacement of cement with saw-dust and steel fibre. The compressive strength test was done for 3, 7,28,56 days for normal and SDA concrete and FRSDA concrete tests were done on 3,7,28 days. The split tensile test for the concrete cylinders were done for 3, 7,28,56 days for normal, SDA, FRSDA concrete. Flexural strength test were done for 28 days for normal, SDA, FRSDA concrete. The workability of concrete decreases significantly with the increase of SDA content in concrete mixes. It was also seen that at 20% SDA + 1% SF the compressive strength increases & again it is decreased at 20% SDA + 1.5% SF.

Chandana 2015 Has on Strength of Concrete by Partial replacement of Fine Aggregate with Sawdust and Robosand. In this paper different physical properties of robosand river sand sawdust were tested. The compressive strength, tensile strength of the concrete using 25%(5% sawdust+20% robosand),50%(10% sawdust+ 40% robo sand), 75%(15% saw- dust+60% robosand),100%(20% sawdust+ 80% robosand) replacement of fine aggregate. Along with in this paper the cost analysis has also done. The cube compressive strength at 7 days results in 70% of the characteristic compressive strength at 28days acquired. The compressive strength obtained for the replacement of fine aggregate by 50% totally with sawdust 10% and robosand 40% was proved to be the optimum mix to get M20 grade of Concrete. There are possibilities to increase the strength by adding admixtures. The thermal and fire resistance properties are to be tested for the performance of sawdust under such conditions.

Akshay sawant 2018 has used Partial replacement of sand with saw dust in concrete. In this experimental study, the test was conducted for M25 mix. They cast specified number of cubes, cylinder and beams by replacing fine aggregate with sawdust by 5%, 10%, 15%, 20%, 25% & 30% and to compare their property with standard mix (M25).Based on the investigation on sawdust, following conclusions were made i.e. in 28 days compressive strength and splitting tensile strength of the concrete is not increased to large extent but it almost matches with the compressive and splitting tensile strength of nominal mix concrete. The compressive strength obtained for the replacement of fine aggregate with 25% sawdust was proved to be the optimum mix to get M25 grade of concrete. But the flexural strength gradually increases as sawdust content increases. The fibre content in sawdust is very high and is responsible for the increase of strength. Weight of the sawdust concrete was reduced as compared with normal concrete and also become more economical. As a result of this experiment it was observed that the concrete containing sawdust get compacted more efficiently than the normal concrete.

3. MATERIALS ARE USED:-

3.1 Coarse Aggregate- Aggregates are the very important constituents in concrete.The concrete, decrease shrinkage and effect economy. Crushed granite of 10mm & 20mm size were used as a coarse aggregate.

3.2 Fine Aggregate- It is defined by size it should be finer than gravel and coarser than silt. Sand is a non- renewable resource and sand suitable for making concrete is in high demand. Fine aggregate which satisfied the required characteristics for experimental work and confirms to zone as per the specification of code IS: 383-1970.

3.3 Cement- Portland Pozzolana Cement used in this project brand name mycem Cement .

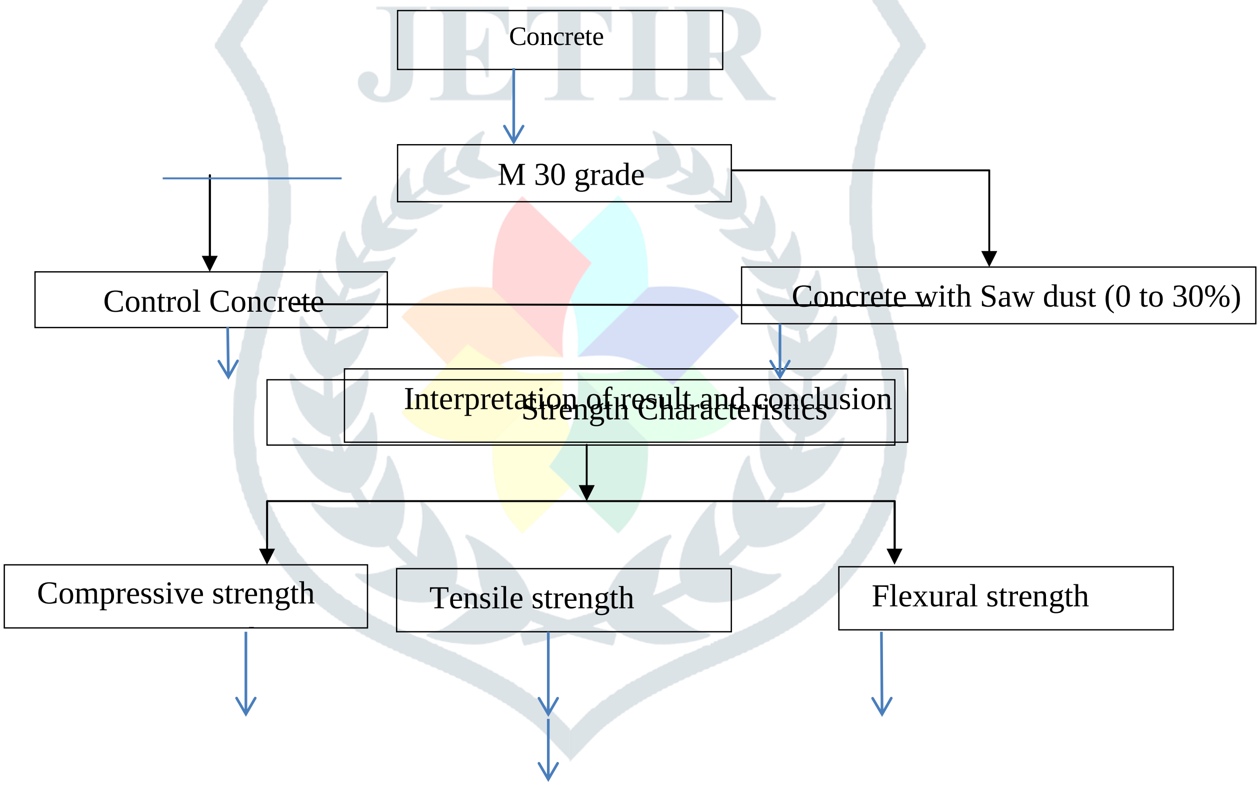
3.4Saw Dust- The saw dust consisted of chippings from various hardwoods. It was sun dried and kept in water proof bags. The saw dust was tested for density, moisture content and fineness modulus in laboratory.

3.5 Water- Distilled water was used for this study. The water was clean from impurities. The pH value of water should not be less than 6 according to test results.

Fig.1Shows Material's Aggregate, sand, cement and Saw Dust

4. METHODLOGY

The methodology of the work is shown by flow chart:-



5. MIX DESIGN

1. Concrete Mix Design Stipulation

(a) Grade designation = M 30

(b) maxi. size of aggregate = 20 mm

(c) Shape of CA - Angular

(d) Degree of workability required at a site =75 mm (slump)

(e) Degree of quality control available at the site - As per IS: 456

(f) Type of exposure condition (as defined in IS: 456) = mild

(g) Type of Cement: PPC (mycem Cement)

(h) Bulk density of cement =1450kg/m3

(i) Chemical admixture = not used

2. Test data for material are used

(a) Specific gravity of cement = 2.85

(b) Specific gravity of FA = 2.64

(c) Specific gravity of CA = 2.8

(d) Free surface moisture- Coarse aggregate = 1% Fine aggregate=2%

(e) Fine aggregate conforming to Zone II of IS – 383

5.1 Procedure for Concrete Mix Design of M30 Grade of Concrete
Step1 - Target Strength for mix proportioning :

Ft = fck + KS
= 30 + 1.65 x 5.0
= 38.25 N/mm2
where,
ft = Target strength of concrete in MPa
fck = Characteristic strength of concrete in MPa.
S = standard deviation in N/mm2 = 5 (as per table -1 of IS 10262- 2009) K = statistical coefficient = 1.65 (as per IS 456-2000)

Step 2 - Selection of water cement ratio:
From Table 5 of IS 456
Maximum Water-Cement ratio for mild condition = 0.45 Based on experience, adopt water-cement ratio as 0.42.
0.42 < 0.45, hence OK.

Step 3 - Selection of Water Content:
From Table 2 of IS 10262- 2009.
Maxi. Water content = 186 kg/m3 (for Nominal maximum size of aggregate - 20 mm) To achive slump value 75mm slump 191.5kg/m3 water is necessary
If slump value is more than 25mm water is increased by 30%. Calculated Water content = 186+ (3/100) x 186 = 191.5 kg /m3
There is no chemical admixture are used so, no changes in water content.

Step 4 - Selection of Cement Content
Water-cement ratio = 0.42
Adopted water content = 191.5 kg /m3 Cement content = 191.5/0.42 = 456 kg/m3 From Table 5 of IS 456.
Mini. Cement Content for mild exposure condition = 300 kg/m3 456 kg/m3 > 320 kg/m3, hence OK.
In the present shows against mild condition and for the case of reinforced concrete the mini. cement content is 300 kg/m3 which is less than 456 kg/m3.
Hence, Cement content adopted = 456 kg/m.3

Step 5 - Proportion of volume of coarse aggregate and fine aggregate
From Table 3 of IS 10262- 2009
For maxi. size of aggregate = 20 mm, Zone of fine aggregate = Zone II
And For w/c ratio = 0.5 as per IS 456 table10.28 is 0.62 0.01 (at the rate for every change in water cement ratio) to decrease the fine aggregate content. Therefore, corrected volume fraction of coarse aggregate for the w/c ratio of 0.45,p=0.606. The volume of fine aggregate,
1-p = 1-0.606 = 0.394

Step 6 - Calculation of the mix ingredients:-

a) Vol. of Concrete= 1 m3

b) Vol. of Cement = (Mass of Cement / Specific gravity of cement) * (1/1000)

= (456/2.85) x (1/1000) = 0.16 m3

c) Vol. of Water = (Mass of Water / Specific gravity of water) * (1/1000)

= (191.5/1) x (1/1000) = 0.192 m3

d) Vol. of chemical admixture = Nil.

e) Vol. of total Aggregates = a - (b + c) = 1 - (0.160 + 0.192) = 0.648 m3

f) Mass of Coarse Aggregate = vol. of total aggregate*vol.of C.A* Sp.Gravity of C.A*1000

= 0.648 x 0.606 x 2.8 x 1000 = 1099.5 kg/m3

g) Mass of Fine Aggregates = vol.of total aggregate*vol. of F.A* Sp.Gravity of F.A*1000

= 0.648 x 0.394 x 2.64 x 1000 = 674 kg/m3

Step – 7 Quantity of material's-

Cement = 456 kg/m3

Water = 191.5 kg/m3

Fine aggregates = 674 kg/m3 Coarse aggregate = 1099.5 kg/m3 Water cement ratio = 0.42

Concrete Mix Proportions for Trial Mix 1- 1:1.48:2.41

This value is checked for durability requirement from IS: 456.

Concrete Mix proportions for M 30 Grade-

Concrete mixtures were prepared with different proportions of fine aggregate and saw dust. The proportions (by weight) of F.A and S.D added to concrete mixtures were as follows:-

0% (control mix), 10%, 20% and 30%.The mix proportion chosen for this study is M30 grade with cement ratio of 0.42-0.45.

Final quantities of material after correction adjustment is suitable shown in table-

Table 5.1 Shows Material for different percentages of mixes

S.NO.	FA%	SD%	Cement(Kg/m3)	FA(Kg/m3)	CA(Kg/m3)	SD(Kg/m3)	Water(Kg/m3)
1	100	0	456	674	1099.5	0	191.5
2	90	10	456	606.6	1099.5	67.4	191.5
3	80	20	456	539.2	1099.5	134.8	191.5
4	70	30	456	202.2	1099.5	471.8	191.5

6. EXPERIMENTAL TECHNIQUES:-
The sawdust concrete test using cube's, cylinder's and beam's of various mixes are tested for Compressive, Splitting Tensile and Flexure strength at 7, 14,and 28 days of age's in the laboratory.

The following are the tests which were conducted in the project:

Strength Tests:

- Compressive strength test by cube
- Split tensile strength test by cylinder
- Flexural strength test by beam

In the present study according to IS standards the following dimensioned specimens were casted

- 150mm x 150mm x 150mm of cubes
- 150mm x 300mm of cylinders and
- 150mm x 150mm x 700mm of beams.

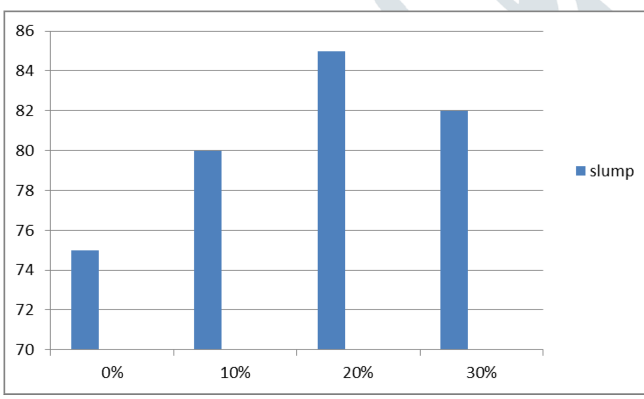
Achieving the objective of the work, the following procedural steps are followed:

1. Batching
2. Mixing
3. Casting of cube, cylinder and beam
4. Compaction
5. Curing
6. Testing

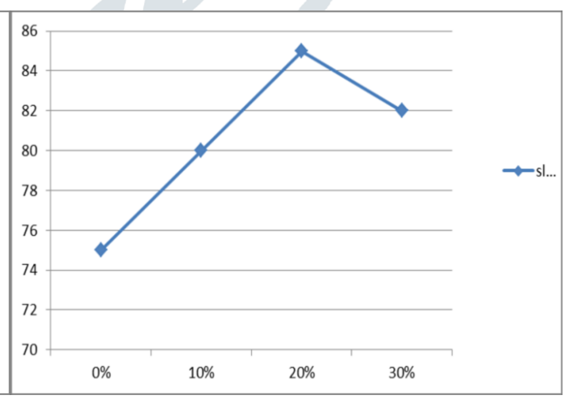
7. RESULTS & DISCUSSION:-
7.1 WORKABILITY-

Table 7.1 Slump value of sawdust mixed concrete at various

Sand Replacement by Saw Dust in %	Slump Value (mm)
0	75
10	80
20	85
30	82



bar chart showing slump test values



Line chart showing slump test values

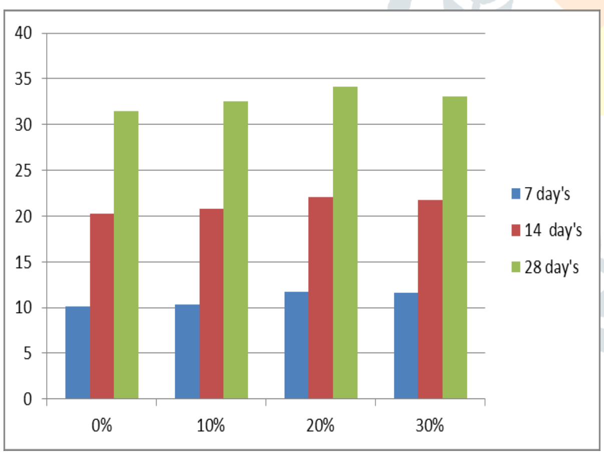
7.2 COMPRESSIVE STRENGTH:-
The compressive strength is calculated using the formula.
Compressive Strength=P/A in N/mm2
Where,
P= compression force in N
A=Area in mm2

Fig.7.1compression strength test cube specimen

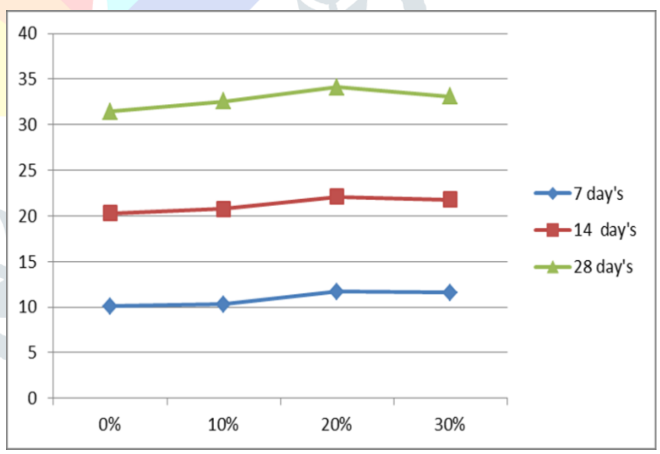
Fig.7.2 cube specimen after loading

Table 7.2 Compressive strength of Normal and saw dust mixed with fine aggregate concrete
Compressive Strength Values in MPa (N/mm2)

Saw Dust in %	Avg. Compressive Strength @ 7 days (N/mm2)	Avg. Compressive Strength @ 14 days (N/mm2)	Avg. Compressive Strength @ 28 days (N/mm2)
0	10.11	20.3	31.44
10	10.33	20.78	32.55
20	11.67	22.11	34.12
30	11.61	21.78	33.10



Bar chart showing compressive strength test values



Line chart showing compressive strength test values

7.3. SPLIT TENSILE STRENGTH:-

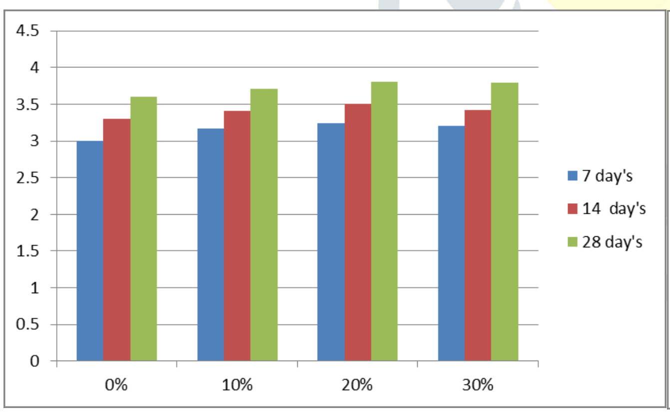
$$[\ \sigma = 0.637\ P/DL]$$

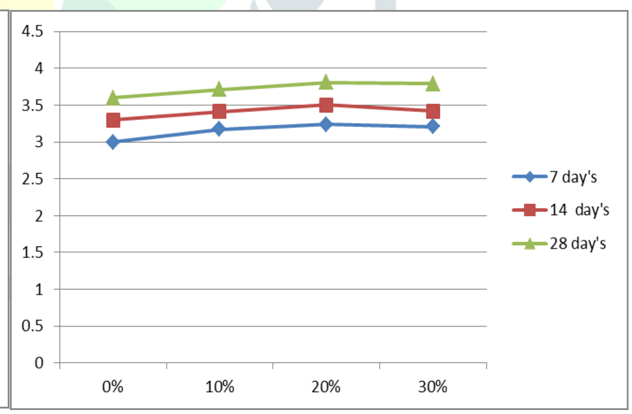
Where,
P= Tensile force in N
D= Dia.of cylinder
L= Length of cylinder

Fig.7.3 Testing of cylinder specimen Fig.7.4 breacking of cylinder after loading

Table 7.3 Split Tensile strength of Normal and saw dust mixed fine aggregate concrete

Saw Dust in %	Avg. Tensile Strength @ 7 days (N/mm2)	Avg. Tensile Strength @ 14 days (N/mm2)	Avg. Tensile Strength @ 28 days (N/mm2)
0	3.0	3.3	3.6
10	3.17	3.41	3.71
20	3.24	3.5	3.81
30	3.21	3.42	3.79





Bar chart showing Tensile strength values Line chart showing Tensile strength values

7.4. FLEXURAL STRENGTH:-

Maximum load applied on the specimen is noted at the point of failure of the specimen and flexural strength is calculated.

$$\Sigma = 3FL/2BD2$$

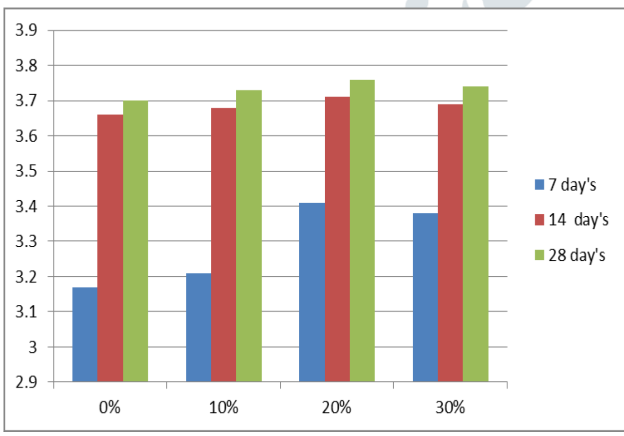
Where,
F= axial load
B= width of beam
D= depth of beam
L= length of beam

Fig.7.5 Shows Testing of Beam Specimen

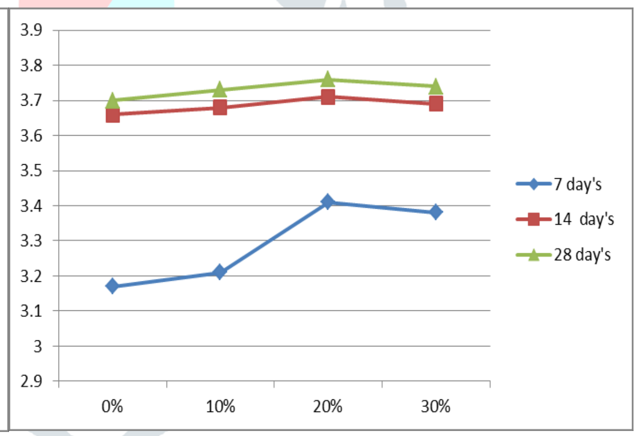
Fig.7.6 Shows Beam Specimen after loading

Table 7.4 Flexural strength of Normal and saw dust mixed fine aggregate concrete

Saw Dust in %	Avg. Flexural Strength @ 7 days (N/mm2)	Avg. Flexural Strength @ 14 days (N/mm2)	Avg. Flexural Strength @ 28 days (N/mm2)
0	3.17	3.66	3.70
10	3.21	3.68	3.73
20	3.41	3.71	3.76
30	3.38	3.69	3.74



Bar chart showing Tensile strength values



Line chart showing Tensile strength values

8. CONCLUSION:-

Based on the current experimental investigations the following conclusions were made-

1. The saw dust mixed fine aggregate with 10%, 20% and 30%, shows mostly the same properties as that of normal fine aggregate and therefore it is understood as a well graded aggregate based on Cu and Cc values and also sieve size analysis curve.
2. The suitability of using coarse aggregate and fine aggregate in the concrete mixture was confirmed with their physical properties test.
3. Based on the chemical observations of the saw dust it was found that saw dust can be used as partial replacement of fine aggregate 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 increasing the saw dust percentage replacement the workability, compressive strength, split tensile strength and flexural strength of the concrete decreases after 20% possibly due to higher moisture holding capacity of saw dust as mentioned in different literatures also.
5. Based on the above discussions it was decided to consider 20% of partial replacement as an optimum value.

9. FUTURE WORK:-

The following future studies can be recommended.

1. Saw dust collected from different saw-mills.it can also be used following the same procedure for the better understanding of its behavior in concrete preparation.
2. There are so many possibilities to increase the strength by adding admixtures.
3. Tests are to be carried out with different admixtures which give optimum results.
4. Thermal and fire resistance properties are to be tested for the performance of saw dust under such conditions.
5. Acid resistance tests and water absorption tests are to be carried out as the saw dust is weak in reacting with these liquids.
6. Further research work is required these saw dust as a partial replacement of fine aggregate in concrete to confirm the strength variation and thermal property**.**

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