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Effect of its Mechanical Properties on Concrete Mix were sand is Partially Replaced with Industrial Ash

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Abstract: — In this present era, the use of alternative material and utilization of several types of waste is a very common topic. Now a day's using an alternative material and recycled waste material for the manufacturing of new product and this area is rapid growing day by day and with recent and innovative techniques. Reuse and recycled the waste material can be beneficial for the environment point and also it enhances the efficiency and durability is some aspect. In the field of concrete, various technological changes occur every day. Construction industry also encourages such technological changes and try to utilize the alternate product in place of conventional material. The conventional material are now very limited in quantity which can be depleted day by day and also due to its excess use can create various types of environment effects in the nature. This problem has bought the option of use of alternative sand. In the present study and laboratory test an attempt has made to use fly ash (which is a by-product coming from thermal power plants) as alternative raw material for our project and which is removed in some percentage of sand. The properties of these alternative sands are determined with the help of mechanical investigation such as slump test, compaction factor test and compressive strength test and compared with Natural sand. These sands can be used in place of natural sand. The use of these alternative sand is cost effective and eco- friendly.

Keywords: Recycled waste, natural sand, fly-ash, cost effective, eco-friendly.

I. INTRODUCTION

A. General

The most vital construction material which is widely used is cement, sand and aggregate. Sand is basically used in the place of fine aggregate in mortar and concrete It also an important ingredient while designing the mix. Due to which the usage of silica sand in the construction industry is very high because of its multiple use in various process of construction. Therefore the consumption of silica sand or natural sand in the construction is rapidly day by day to meet the current demand.[1] Some of the rapidly growing developing countries like India, the

demand and the consumption of the natural sand is very high due to which the shortage of good quality of sand arises. [2]Increased demand create rapid quarrying of natural sand which creates various types of imbalance in the river beds, aquatic life cycle and also disturb the agriculture by decreasing the water table in the nearby areas. In each component of structure the most used material is concrete[3] It is mixture of binding material and aggregates (Fine and coarse) which hardens day by day until the hydrations process completes [4]The cement reacts chemically with water and other ingredients to forms various compounds and also hardens the mortar and concrete. Concrete is a type of material which is good in compression and week in tension. [5]Usage of industrial scarp such as fly ash, ggbs, etc. are helpful for environment because utilization of theses waste cam save our environment and also enhances some physical properties also. Hence we are finding an alternative of fine aggregate in these tranch which can be utilized in the manufacturing of concrete and mortar [6]Across the globe various researcher and scientist were find various alternate materials in place of natural sand either partially or fully with materials such as manufactured sand, stone dust, silica dust, foundry sand, sieved silt coming out from reservoir[7].

B. Objectives of the work

- To develop the concrete mix with less amount of conventional sand.
- To investigate the effect of strength properties on the concrete mix.
- To have a detailed study of material used, causes and effect for the use of alternative sand in concrete.
- To decrease the amount of various types of factories trash in our environment to make it sustainable
- To make economical and eco-friendly mix with the help of industrial waste.

II. MATERIAL & MIX DESIGN

A. Cement

Cement is one of the binding materials which is generally used in construction work. It is a powdery substance and a output found by pulverizing clinker created by calcinating various raw material such as Lime (CaO), Silica (SiO2), Alumina (Al2O3) and Iron Oxide (Fe203). If it is mixed with water and silica sand to get mortar and when water, fine and coarse aggregate is binded together to form concrete.

TABLE I. **PHYSICAL PROPERTIES OF CEMENT**

Cement Grade	43 Grade
Initial setting duration	32 Minutes
Final setting duration	650 minutes
Standard Consistency	31.69 %
Specific Gravity	3.134

B. Fine Aggregate

Fine aggregate are finer dimension material used in construction as a filler. Fine aggregate are the particle whose dimension ranges varies between 0.075mm to 4.75mm.

Fine aggregates are obtained from river bed and it provides bulk, certain amount of strength and other properties of construction material.

TABLE II. **PHYSICAL PROPERTIES OF FINE AGGREGATE**

Description	**Fine aggregate**
Specific gravity	2.56
Water absorption	1.54%
Fineness modulus	3.104 (zone II)
Surface moisture	-
Bulk density	1447 kg/m3

C. Coarse Aggregate

Coarse aggregate are large dimension aggregate used in different varieties of construction works. Coarse aggregate are larger in dimension and size range between 4.75 mm to 80 mm. Aggregate are used in various layers of road while construction. Aggregate used is of good quality and cubic angular in shape; which provides good interlocking bond.

TABLE III. **PHYSICAL PROPERTIES OF COARSE AGGREGATE**

Properties	**Value**
Fineness modulus	3.22
Specific gravity	2.62
Size	Retain on 4.75 mm sieve
Water absorption ratio	0.9%

D. Fly Ash

Fly ash is basically becomes from air borne, and moves or transported up to a radius of 10 to 20 km. It can mixed with water or other surfaces. Flu ash is lightly finer than cement. Fly ash is a trash product of coal (fuel) combustion. [8]Fly ash is a variety of factory trash coming out from electricity generation power plant. It is a type of non-biodegradable waste which is harmful for human as well as environment. The fly ash are classified into two types according to their ingredients present in it. The fly ash can be used in various form sin our construction industry. In our work, fly ash is partially replaced from sand. Its properties are shown in below table.

TABLE IV. **PHYSICAL PROPERTIES OF FLY ASH**

Characteristics	**Values**
Specific gravity	2.0
Fineness	280
Bulk density	1150 Kg/m3
Colour	Light Grey

E. Mix Design – The mix design of the concrete mix is done according to the IS Code: 10262:2019.

TABLE V. **MATERIAL USED IN OUR WORK AND ITS QUANTITIES**

MATERIALS	QUANTITIES		
	Sample A	**Sample B**	**Sample C**
Cement	11.2 kg	11.2 kg	11.2 kg
Sand	12.47 kg	11.23 kg	9.98 kg
Fly ash	0 kg	1.24 kg	2.49 kg
Aggregate	22.06 kg	22.06 kg	22.06 kg
Water	5.6 lit.	5.6 lit.	5.6 lit.

III. MANUFACTURING PROCESS OF MIX & TESTING

A. Mixing

Mixing is a process of homogenous blend of all the ingredients in a required quantity. Mixing can be done by hand or machine but nowadays, machine mixing is generally used due to its various advantages. Firstly mix the ingredients (cement, sand, coarse aggregate, fine aggregate, fly ash) in dry state. Then water is added in required quantity with all the ingredients to form a uniform mix. The mix should be uniform in colour.

Figure 1 Mixing the Concrete Ingredients

Figure 2 Different Types of Moulds

B. Casting

After mixing the concrete can be casted on different types of mould according to their mechanical investigation. Firstly, the mould should be properly lubricated by oil or grease. Then, the mix can be put on the mould by three equal layers and every layer should be tamped by tamping rod in at least twenty five blows. Excess mix must be removed from the top and surface of the mould must be uniform. The mould should be placed in room temperature for twenty four hours for process of drying.

C. Curing

Curing is a process of providing moisture to the mix so that the strength property of concrete can be increased by the process of hydration. Curing is a method which enhances the abrasion property and also reduces cracks on structure. After removal of samples from mould. The samples were placed in curing tank for different curing duration according to their experimental investigation. The curing tank must be filled with proper quantity of water so that the sample should be fully immersed in the tank.

Figure 3. Curing Tank

D. Testing of Materials

The ingredients must be tested in different state of concrete. The testing of concrete are as given below.

- Workability

1. Slump cone test
2. Compaction factor test

- Compressive strength test
- Split tensile strength test

E. Slump cone test

Slump cone test basically identifies the consistency of fresh state concrete. Slump cone test measures the workability of test.[9] It is one of the test which is commonly used in every construction site. This test is generally gives a basic knowledge about the consistency of mix. In this test, the concrete mix is properly placed in the testing mould in three equal layers and each layers must be properly compacted with the help of tamping rod for at least twenty five blows. After filling of last layer the excess concrete on the top of the mould can be removed by horizontal movement of tamping rod. [10]Then the slump cone can be removed vertically by very gentle hand and reduction in height of the slump can be measured by desired process.

F. *Compaction Factor Test*

It is a test which is also used to determine the consistency of concrete mix. In this test two hoppers are attached in a vertical frame with a base plate having a cylindrical container. Firstly the mix is prepared in a proper proportion. The mix is firstly placed on the top hopper. Then, the base plate of the top hopper would be open, the concrete should be fall on second hopper. Similarly the concrete falls on the cylinder also which is placed just below the second hopper. Then the concrete in the cylinder is measured and denoted as W1 then the sample is removed from the cylinder and the cylinder is thoroughly washed. Again the concrete mix which is newly prepared with same proportion can be filled in cylinder with three equal layers and each layer must be properly compacted. The weight of the concrete is measured in cylinder and denoted as W2. The below formula shows the equation:

Compaction Factor = W1/W2

G. Compressive Strength Test

To investigate the compression strength test of concrete under desired loading conditions. In this test, Sample mould is firstly taken out from curing and remove the excess water and keep it for some time in room temperature. After that the arrangement of the equipment is properly assembled. [11]Now put the sample in such a way that the load must be applied opposite section of the cube cast. Always put the sample in the centre of the machine. Then, move the rotating portion by manual process until it touches the top surface of sample. Lastly, load is applied on the surface of the sample until fracture. Record the values of load against fracture to determine the compressive strength.

H. Split Tensile Strength Test

It is a test which is also used to determine strength of the concrete. In this test firstly prepare a sample in a cylindrical form. Grease the inside surface of mould and filled with mix layer by layer. Compact each layer 35 blows at tamping rod. [12] After someday remove the sample from it and immerse in water. Then, before testing remove the excess water present on it. Now place the sample on the testing machine and apply the load on sample until fails. After that record the maximum load at which the sample breaks or fails.

IV. RESULTS AND DISCUSSIONS

A. Slump Cone Test

In this test, the slump value of sample C shows the maximum slump value with respect of the rest of the sample A and B respectively. The test result is shown in below table:

TABLE VI. **SLUMP TEST DATA**

No. of Samples	Concrete grade	Slump (mm)
MIX 1	M25	80 mm
MIX 2	M25	70 mm
MIX 3	M25	90 mm

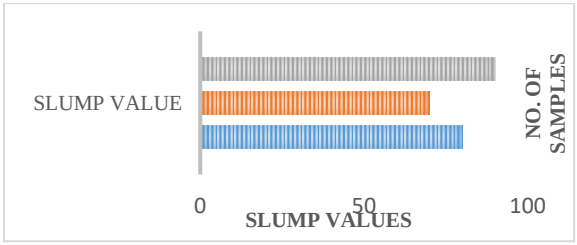

Figure 4. Graphical Representation of Slump Value for Different Types of Samples

B. Compaction Factor Test

TABLE VII. **TEST DATA OF COMPACTION FACTOR TEST**

No. of Samples	Compaction factor value
MIX 1	0.85
MIX 2	0.80
MIX 3	0.92

The higher amount of Fly ash in the mix shows good workability when compared with the rest of the two samples. The presence of fly ash enhances the homogeneity when compared with sand.

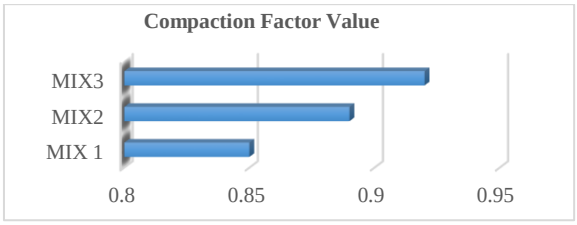

Figure 5. Graphical Representation of Compaction Factor Test for Different Mixes

C. Compressive Strength Test

TABLE VIII. **TEST DATA OF COMPRESSIVE STRENGTH**

No. of Samples	Compressive strength test at various ages		
	7 days	14 days	28 days
MIX 1	65.70%	69.31%	87.55%
MIX 2	55.05%	66.98%	78.84%
MIX 3	62.5%	67.50%	83.05%

The compressive strength of mix 1 shows higher compressive strength compared with rest of the mixes i.e. 2 and 3 respectively. Presence of fly ash decreases the compressive strength of mixes.

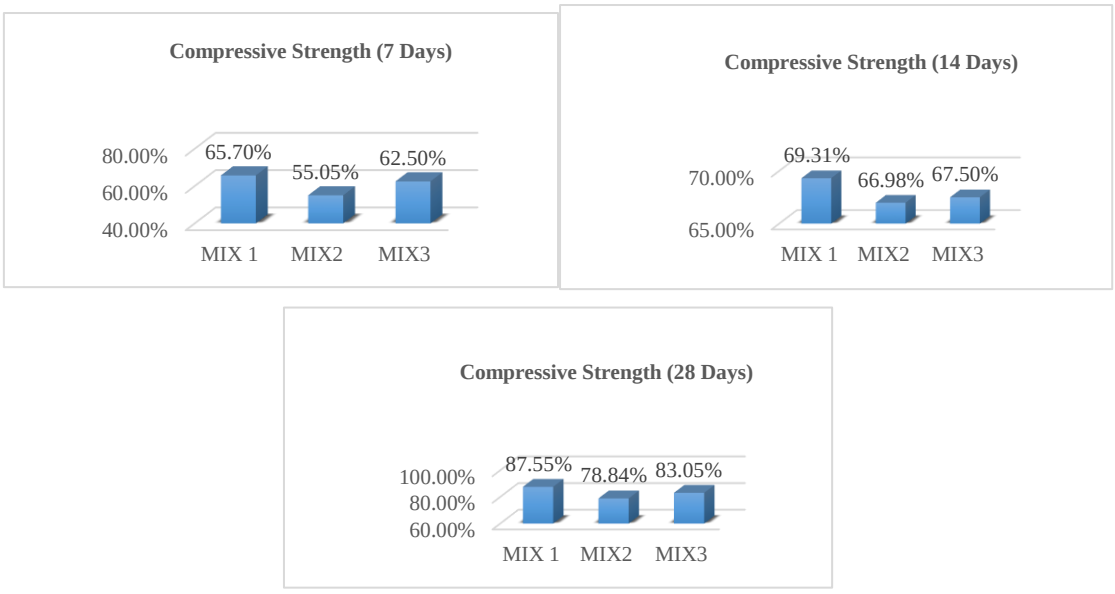

Figure 6. Graphical Representation of Compressive Strength in Different Curing Durations

D. Split Tensile Strength Test

TABLE IX. **SPLIT TENSILE STRENGTH TEST DATA**

No. of Samples	Tensile strength test (N/mm2)		
	7 days	14 days	28 days
MIX 1	2.3	2.35	3.4
MIX 2	2.1	2.39	3.12
MIX 3	2.09	2.34	3.05

The tensile strength investigated on cylindrical mould shows that the conventional concrete exhibits higher result than other mixes. The different curing periods also shows the same outcome.

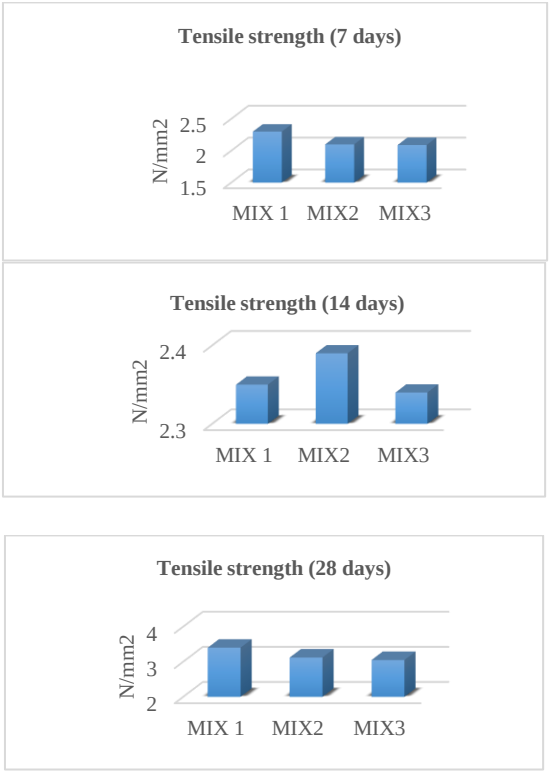

Figure 7. **Graphical** Representation of Tensile Strength in Different Curing Durations

V. CONCLUSIONS

In this research work, there are following outcomes which is mention below:

- The workability of mixes having fly ash shows better result than normal mix.
- The compressive strength of fly ash mixes shows descent result when compared with conventional mixes.
- The tensile strength of conventional mix shows higher result than rest of other mixes.
- The concrete formed is cost effective and eco-friendly.
- The utilization of industrial waste in place of conventional material leads to less usage of natural sand.

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