

Experimental Investigation on Compressive Strength of M30 and M40 Grade of Concrete with Partial Replacement of Robo Sand by Natural Sand and Cement by Flyash

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ABSTRACT: Concrete is a mixture of cement, fine aggregate, coarse aggregate and water. Concrete plays a vital role in development of infrastructure i.e; buildings, industrial structures, bridges and highways etc. sand is basic material in concrete making that is required in large quantities But in the present scenario it is necessary to find the suitable substitute for sand, easy to produce and has all the required qualities for use in concrete. Manufactured sand is one among such materials to replace river sand, which can be used as an alternative fine aggregate in mortars and concretes.

KEYWORDS: Concrete, aggregate, bridges, ingredients, fly ash, specimens

I. INTRODUCTION

GENERAL

Now a day's the most commonly used structural material for all types of construction is concrete. Concrete owes its unique position as the structural material to the fact, that it is economically highly resistant to fire, wind, water, and earthquakes. In the recent times its use in construction has been increased considerably thus the cities and the towns are virtually becoming concrete jungles. The demand is likely to increase in the future to match the growing population, housing, transportation, and other amenities.

As modern engineering practices become more demanding, there is a corresponding need for special types of materials with novel properties. Scientists, engineers and technologies, are continuously on the lookout for the materials which can act as substitute for conventional materials are which posses such properties as wood enable new design and innovations resulting into economy, so that the structure can be built economically.

Fly ash is finely divided residue resulting from the combustion of the ground or pulverized bituminous coal or sub-bituminous coal. It is available in large quantities in the country as a waste product from a number of thermal power stations and industrial plants using pulverizes coal or lignite as fuel for the boilers. The effective use of flyash for complete replacement of cement as an admixture in cement motor and concrete as established in the country in the recent years.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 10, October 2016

FLY ASH



II. RELATED WORK

GENERAL

Extensive research works both at National and International level has been done on the use of various admixtures in mortars and concrete's with a common goal.

To combat the environmental hazards from the industrial wastes.

To modify the properties of traditional concrete to the desired level suitable to the specific circumstances.

To conserve the natural resources used in the production of construction materials.

To bring down the increasing cost economics of cement, building blocks and high strength concrete.

To combat the scarcity of traditional ordinary Portland cement and bricks.

Of late, to rehabilitate the existing structures which are deteriorated over a period of time etc.

In India, only government educational and research institutions and construction departments are responsible for research while in advanced countries, the most remarkable breakthrough have been achieved by the building material industries and their R & D laboratories. An accepted fact is that these encouraging results on the use of admixtures are not penetrating into the user community and the entire research work is getting flocked at their origination. With the result the very purpose of research work is questioned. Along with R & D units. The policy maker and consultants should take more interest in handling these issues directly keeping not only the techno economics in view but also national obligations.

REVIEW

- Lot of research has been done regarding the crusher dust as alternative materials for river sand. Misra (1984) studied the effect of complete replacement of sand by stone dust in the cement – sand mortar cubes.
- Ahmad et. al. investigated by replacing sand with crusher sand (fine sand i.e. passing through 75 μ).
- They found that the compressive strength of concrete having constant slump decreased linearly with increase in percentage of very fine sand.
- Sahu et al (2003) reported significant increase in compressive strength, modulus of rupture and split tensile strength when 40% of sand is replaced by quarry rock dust in concrete.
- They found that the compressive strength, flexural strength of concrete made of quarry rock dust is nearly 10% more than the conventional concrete.
- Study on prediction of compressive strength of concrete with fly ash as sand replacement material has been conducted by N.P.RAJAMANI, J.ANNIE PETER, P.S.AMBILY cement concrete compose .2006.10.001. in which a prediction equation has proposed which estimates the 28 days compressive strength of fly ash concrete and also be used to modify any basic cement concrete mix so that the concretes with and without sand replacement by fly ash have similar strength. The prediction equation also considers the different levels of replacement of sand. And fly ash concretes with FA at sand replacement levels of 20%, 40%, 60% were prepared. Actual FA quantity added was varied from 1.0 to 1.6 times the quantity of sand replaced to study the effect of higher quantity of fly ash in concrete. Compressive strength of these mixes was determined at 7 and 28 days. They reached their target mean strength and compared with proposed prediction equation.

International Journal of Innovative Research in Science, Engineering and Technology

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Vol. 5, Issue 10, October 2016

III. THEORITICAL ANALYSIS

A. CEMENT

Cement is a material that has cohesive and adhesive properties in the presence of water. Such cement is called hydraulic cements. These consist primarily of silicates and aluminates of lime obtained from limestone and clay. There are different types of cement, few of them are,

Ordinary Portland cement

Portland slag cement

Ordinary Portland cement (OPC) is the basic Portland cement and is best suited for use in general concrete construction. It is of three types, 33 grades, 43 grades, 53 grades. One of the important benefits is the faster rate of development of strength. Portland slag cement is obtained by mixing Portland cement clinker, gypsum and granulated blast furnace slag in suitable proportion and grinding the mixture to get a thorough and intimate mixture between the constituents. This type of cement can be used for all purposes just like OPC. It has lower heat of evolution and is more durable and can be used in mass concrete production.

B. AGGREGATES

Aggregate properties greatly influence the behavior of concrete, since they occupy about 80% of the total volume of concrete. The aggregates are classified as

Fine aggregate



Sand Manufacturing Factory near Bidadi

Coarse aggregate



Stone Crushing Machine



Grinding Mill



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Casting of concrete cubes



Slump Cone Test



Sieve analysis of sand



Compaction Factor Test



IV. EXPERIMENTAL SET UP

A. OBJECTIVE OF TESTING

It was proposed to investigate the behavior of robo sand as fine aggregate and fly ash in place of cement in concrete and it is compared with the regular mix.

4.1.1 Experimental Set Up

In the stage collection of materials and the data required for mix design are obtained by sieve analysis and specific gravity test. Sieve analysis is carried out from various FA and CA samples and the sample which suits the requirement is selected specific gravity tests are carried out for fine and coarse aggregate. The various materials used were tested as per Indian standard specifications.

Materials

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Raw materials required for the concreting operations of the present work are cement, fly ash, fine aggregate, robo sand, coarse aggregate and water.

B. CEMENT

Cement :(CHETTINAD cement of 43 Grade ordinary Portland cement was used)

4.2.1 Determination of Specific Gravity of Cement

Empty weight of bottle	=31Gms
W1+Water (W2)	=82Gms
W1+Kerosene (W3)	=71Gms
W1+Cement Sample 25 Gms+ Kerosene (W4)	=90Gms
Weight of cement (W5)	=25Gms
Specific gravity of kerosene = $\frac{W3-W1}{W2-W1}$	=0.784
Specific gravity OF CEMENT = $\frac{W5 (W3-W2)}{(W5+W3-W4) (W2-W1)}$	=3.267

Table 4.1 physical properties of ordinary Portland cement

S.NO.	PROPERTY	TEST RESUTS
1	Normal consistency	32.5%
2	Specific gravity	3.12
3	Initial setting time	185 minutes
	Final setting time	480 minutes
4	Soundness (Expansion) Lechatlier method	2 mm
5	Fineness of cement (Dry sieving method)	3%

C. FLY ASH

The requirement of IS 3812-1981 along with typical characteristics of ash from THERMAL PLANT AT E.THANDRAPADU in respect of chemical and physical characteristics are summarized below. The test of fly ash obtained THERMAL PLANT AT E.THANDRAPAD

Empty weight of bottle (w1)	=30 gms
W1+ water (w2)	=82 gms
W1+ kerosene (w3)	=72 gms
W1 + fly ash sample 25 gms +kerosene (w4)	=85.15 gms
Weight of fly ash (w5)	=25 gms
Specific gravity = $\frac{w5 (w3-w1)}{[(w5+w3-w4)(w2-w1)]}$	=1.70

D. FINE AGGREGATE

The size of the fine aggregate is below 4.75mm, natural sand or the fly ash used as the fine aggregate in concrete mix. Sand may be obtained from rivers, lakes but when used in concrete mix, it should be properly washed and tested to ascertain that total percentage of clay silt, silt and other organic matters does not exceed the specified limit. For the experimental investigation locally available river sand which is free from organic impurities is used.

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Specific gravity = 2.64

4.4.1 Determination of specific gravity of sand

Weight of pycnometer (w1)	=648 gms
Weight of pycnometer with sand (w2)	=1506 gms
Weight of pycnometer with sand and water (w3)	=2051 gms
Weight of pycnometer with water (w4)	=1516 gms
Specific gravity	$= \frac{(w2-w1)}{[(w4-w1)-(w3-w2)]}$
	= 2.64

4.4.2 Determination of specific gravity of Robo Sand

Weight of pycnometer (w1)	=648 gms
Weight of pycnometer with sand (w2)	=1467 gms
Weight of pycnometer with sand and water (w3)	=2003 gms
Weight of pycnometer with water (w4)	=1506 gms
Specific gravity = $\frac{(w2-w1)}{[(w4-w1)-(w3-w2)]}$	= 2.543.

V. MIX DESIGN OF CONCRETE

A. INTRODUCTION

The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required, strength, durability and workability as economically as possible, is termed the concrete mix design. The proportioning of ingredient of concrete is governed by the required performance of concrete in 2 states, namely the plastic and the hardened states. If the plastic concrete is not workable, it cannot be properly placed and compacted. The property of workability, therefore, becomes of vital importance.

The compressive strength of hardened concrete which is generally considered to be an index of its other properties, depends upon many factors, e.g., quality and quantity of cement, water and aggregates; batching and mixing; placing, compaction and curing. The cost of concrete is made up of the cost of materials, plant and labour. The variations in the cost of materials arise from the fact that the cement is several times costly than the aggregates, thus the aim is to produce as lean a mix is possible. From technical point of view the rich mixes may lead to high shrinkages and cracking in the structural concrete, and to evolution of high heat of hydration in mass concrete which may cause cracking.

The actual cost of concrete is related to the cost of materials required for producing a minimum mean strength called characteristic strength that is specified by the designer of the structure. This depends on the quality control measures, but there is no doubt that the quality controls add to the cost of concrete. The extent of quality control is often an economic comprise, and depends on the size and type of job. The cost of labour depends on the workability of mix, e.g., a concrete mix of inadequate workability may result in a high cost of labour to obtain a degree of compaction with available equipment.

B. REQUIREMENTS OF CONCRETE MIX DESIGN

The requirements which from the basis of selection and proportioning of mix ingredients are:

- The minimum compressive strength required from structural consideration.
- The adequate workability necessary for full compaction with the compacting equipment available.
- Maximum water-cement ratio and/or maximum cement content to give adequate durability for the particular sight conditions.
- Maximum cement content to avoid shrinkage cracking due to temperature cycle in mass concrete.

C. TYPES OF MIX

1. Nominal mixes

In the past the specifications for concrete prescribed the proportions of cement, fine and coarse aggregates. These mixes of fixed cement-aggregate ratio which ensures adequate strength are termed nominal mixes. These offer

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simplicity and under normal circumstances, have a margin of strength above that specified. However, due to variability of mix ingredients the nominal concrete for a given workability varies widely in strength.

2. Standard mixes

The nominal mixes of fixed cement-aggregate ratio (by volume) vary widely in strength and may result in under or over-rich mixes. For this reason, the minimum compressive strength has been included in many specifications. These mixes are termed standard mixes.

IS 456-2000 has designed the concrete mixes into a number of grades as M10, M15, M20, M25, M30, M35 and M40. In this designation the letter M refers to the mix and the number to the specified 28 days cube strength of mix in N/mm². The mixes of grades M30 and M40 correspond approximately to the mix proportions (1:1.25:2.75) and (1:1.65:92) respectively.

VI. RESULTS AND DISCUSSION

A.COMPRESSIVE STRENGTH VALUES FOR REPLACEMENT OF SAND BY ROBO SAND AND CEMENT BY FLYASH MIX DESIGN M30

6.1.1 Compressive strength Results3-days:

Table 6.1.1 : Compressive strength Results3-days:

S. No	Replacement of Natural sand and cement By Robo Sand + Fly ash (%) (M30)	Compressive Strength(MPA)
1	O	21.5
2	10%+10%	22.06
3	20%+20%	26.55
4	40%+30%	29.9
5	60%+40%	24.05

VII. CONCLUSION

A. THE COMPRESSIVE STRENGTH OF THE CONCRETE CUBES FOR MIX DESIGN M30:

- 40%+30% maximum compressive strength of 3 days is 29.9 mph
- 40%+30% maximum compressive strength of 7days is 41.73 mph
- 40%+30% maximum compressive strength of 28 days is 49.7 mph

B. THE COMPRESSIVE STRENGTH OF THE CONCRETE CUBES FOR MIX DESIGN M40:

- 40%+30% maximum compressive strength of 3 days is 31.92 mph
- 40%+30% maximum compressive strength of 7 days is 43.75 mph
- 40%+30% maximum compressive strength of 28 days is 51.74 mph.

VIII. SCOPE FOR FUTURE STUDY

- (i)There are possibilities to increase the strength by adding admixtures. Tests are to be carried out with different admixtures which give optimum results.
- (ii)The acid resistance tests and water absorption tests are to be carried out as the robo sand is weak in reacting with these liquids.

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International Journal of Innovative Research in Science, Engineering and Technology

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