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A Study on Fresh and Hardened Properties of High Strength Concrete with Hybrid Fibres

Alanka Ravali¹, Ch. Kameswara Rao²

M.Tech Student, Dept. of Civil Engineering, Pydah College of Engineering, Visakhapatnam, India¹

Assistant Professor, Dept. of Civil Engineering, Pydah College of Engineering, Visakhapatnam, India²

ABSTRACT: Concrete is the most widely used construction material today. Increase in construction activities have led to an increase in demand for the various raw materials in concrete, especially river sand which is the conventionally used fine aggregate. Due to increase in mining process, the availability of this river sand is becoming scarce. This led to researches on alternate materials as ingredients of concrete that are in no way inferior to the conventional materials. Manufactured sand (M-Sand) was one of the alternate materials proposed. Though manufactured sand has many advantages, one of the major areas of concern is the fine material of size 150 micron and down removed during the manufacturing process and accumulated as a waste material.

The purpose of this research is to experimentally investigate the effect of M-sand in structural concrete by replacing river sand and develop a high strength concrete. It is proposed to determine and compare the differences in properties of concrete containing river sand and m-sand. It is also proposed to use different fibres and chemical admixtures to increase the strength and workability of concrete respectively. The investigations are to be carried out using several tests which include workability test, compressive test, tensile test, and durability test.

KEYWORDS: Manufactured sand, Natural Sand, chemical admixture, fibres, compressive strength, tensile strength, durability test.

INTRODUCTION

1.1 GENERAL

With the overall decrease in the accessibility of development sands alongside the natural weights to diminish extraction of sand from waterways, the utilization of made sand as a substitution is expanding. With the restriction on sand mining executed by various states, and with the expanding interest for stream sand for development works, numerous structural designers have communicated the need to quality concrete as solid meeting uncommon blends of execution and consistency prerequisites that can't advance utilization of made sand in the development business. According to reports, made sand is broadly utilized all around the globe and professionals of significant ventures the world over demand the obligatory utilization of fabricated sand on account of its steady degree and zero pollution. Solid blend plan of M40 review was finished by Indian Standard code Concrete 3D shape and round and hollow examples were tried for assessment of compressive, split rigidity a solidness test individually.

The solid shows superb quality with 100% substitution of normal sand, so it can be utilized as a part of concrete as practical contrasting option to regular sand. A Concrete include with different rates as of late, the wording "High quality Concrete" has been brought into the development business. The American Concrete Institute (ACI) characterizes high generally be accomplished routinely when utilizing customary constituents and typical blending, setting and curing rehearses. A critique to the definition expresses that a high quality cement is one in which certain attributes are created for a specific application and condition.

1.2 HIGH STRENGTH CONCRETE

As of late, the wording "High quality Concrete" has been brought into the development business. The American Concrete Institute (ACI) characterizes high quality concrete as solid meeting uncommon blends of execution and consistency prerequisites that can't generally be accomplished routinely when utilizing customary constituents and typical blending, setting and curing rehearses. A critique to the definition expresses that a high quality cement is one in which certain attributes are created for a specific application and condition.

Examples of characteristics that may be considered critical for an application are:

- Ease of placement
- Compaction without segregation
- Early age strength



- Long-term mechanical properties
- Permeability
- Density
- Heat of hydrati
- Toughness
- Volume stability
- Long life in severe environments

Since numerous qualities of high quality cement are interrelated, an adjustment in one for the most part brings about changes in at least one of alternate attributes.

A high-quality cement is dependably an elite cement. ACI characterizes a high-quality concrete as solid that has a predetermined compressive quality for outline of (40 MPa) or more noteworthy. All the more as of late, the edge rose to 50 to 60 Mpa. Different nations additionally determine a greatest compressive quality, though the ACI definition is open-finished.

Salient Features of HSC:

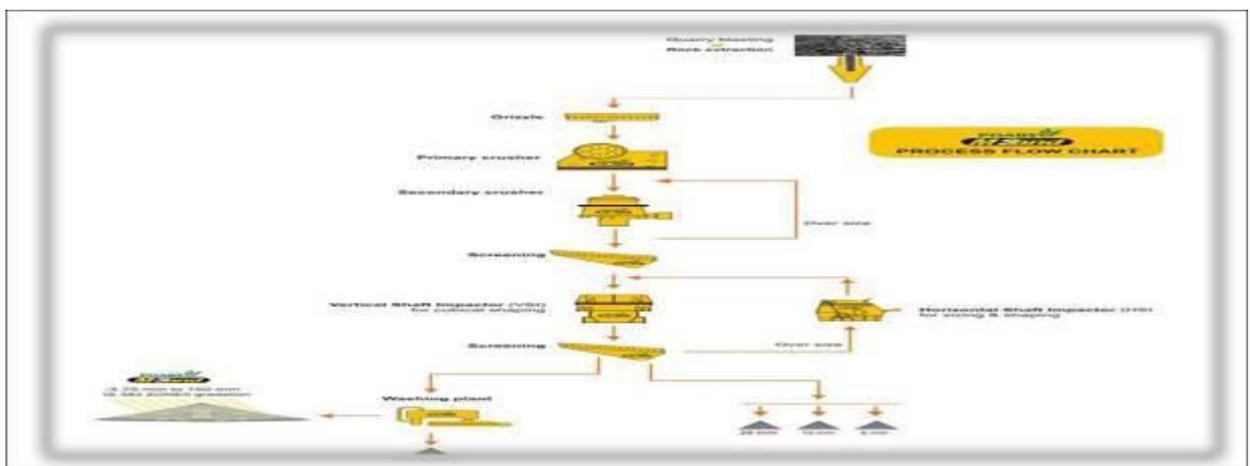
- To put the concrete into service at much earlier age, for example opening the Pavement at 3-days.
- To build high-rise buildings by reducing column sizes and increasing available space. To build the superstructure of long span bridges and to enhance the durability of bridge decks.
- To satisfy the specific needs of special applications, such as durability, modulus of elasticity and flexural strength. Some of these applications include dams, grandstand roofs, marine foundations, parking garages and heavy duty industrial floors.

1.2.2 Aggregates

Totals are the essential constituents in concrete. They offer body to the solid, lessen shrinkage and impact economy. A standout amongst the most vital elements for creating workable cement is great degree of totals. Great reviewing suggests that an example division of totals in required extent with the end goal that the specimen contains least voids. Tests of the very much reviewed total containing least voids require least glue to top off the voids in the totals. Least glue will mean less amount of bond and less water, which will additionally mean expanded economy, higher quality, bring down shrinkage and more prominent toughness. Total involves around 55% of the volume of mortar and about 85% volume of mass cement. Mortar contains of size of 4.75 mm and cement contains total up to a most extreme size of 150 mm.

Stretching out the evaluating of total to a bigger most extreme size brings down the water prerequisite of the blend, so that, for a predetermined workability and concrete substance, the water/bond proportion can be brought down with an ensuing increment in quality. Exploratory outcomes demonstrated that over the 38.1mm greatest size the pickup in quality because of the decreased water necessity is balanced by the inconvenient impacts of lower security range (with the goal that volume changes in the glue cause bigger worries at interfaces) and of discontinuities presented by the huge particles. In auxiliary cement of common extents, there is no preferred standpoint in utilizing total with a most extreme size more noteworthy than around 25 or 40mm when compressive quality is a foundation.

Fig: 1.1 Process of Manufactured sand





1.4.3 Natural Sand Vs Manufactured Sand

The sand from waterway because of characteristic procedure of whittling down has a tendency to have smoother surface and better shape. It likewise conveys dampness that is caught in the middle of the particles. These characters improve solid workability. Be that as it may, residue and dirt conveyed by stream sand can be unsafe to the solid. Another issue related with waterway sand is that of getting required evaluating with a fineness modulus of 2.4 to 3.1. It has been checked and found, at different areas crosswise over south India, that it has turned out to be progressively hard to get stream sand of reliable quality as far as reviewing prerequisites and restricted residue/dirt substance. It is on the grounds that we don't have any control over the common procedure.

However late investigations demonstrate that these fine particles might have the capacity to be used to build the compressive, ductile and flexural qualities of cement.

LITERATURE REVIEW

A thorough writing accessible in the field of High quality solid utilizing produced sand audit is attempted to comprehend the past endeavors, which incorporate the survey of course books, periodicals and scholastic diaries, workshop, gathering and research papers.

K.Srinivasa rao, (2013) An expansion in compressive quality and elasticity has been watched for both standard cement and fiber strengthened standard solid when presented to a temperature of 500C. In the scope of 50 to 800C the split elasticity of both standard cement and fiber strengthened standard cement is same.

Flexural quality of standard cement is equivalent to that of the fiber strengthened standard cement in scope of 500C-800C. Past 500C, both standard cement and fiber fortified standard cement are found to free compressive quality step by step. Fiber strengthened standard cement is found to display more compressive quality split elasticity and flexural quality than standard cement at all temperatures.

The distinction between compressive quality of fiber fortified standard concrete and standard cement differs in the scope of 6-10percentage. The contrast between split elasticity of fiber fortified standard concrete and standard cement fluctuates in the scope of 0-12 rate.

Priyanka. A, (2013) The impact of fractional substitution of common sand by made sand on the compressive Strength of concrete mortar of extent 1:2, 1:3 and 1:6 with water bond apportion as 0.5 and 0.55 are considered. Results are contrasted and reference blend of 0% substitution of common sand by made sand. The compressive quality of bond mortar with half substitution of Natural sand by made sand uncovers higher quality when contrasted with reference blend. Produced sand can possibly give other option to regular sand and aides in keeping up the earth and additionally sparing equalization. Non-accessibility of characteristic sand at sensible cost, powers to Search for elective material.

Fabricated sand qualifies itself as appropriate substitute for River sand at sensible cost. The fabricated sand found to have great degree and pleasant Finish which is inadequate in normal sand and this has been brought about great firm bond Mortar.

II.METHODOLOGY AND EXPERIMENTAL PROGRAMME

2.1 OBJECTIVE.

The main objectives of this project are as below:

- To develop high strength concrete by replacing natural sand into manufactured sand and additional fibers like Glass, Nylon.
- To examine the workability of manufactured sand and using chemical admixture in concrete.
- To investigate the performance of these concrete terms of its compressive strength, split tensile strength and durability test.

1.2 METHODOLOGY TO BE ADOPTED 1.2.1 Material Collection for Experimental Investigation.

The materials usually used in the concrete mix are cement, fine aggregate (M-Sand & River Sand), coarse aggregate, fibers & water. The materials used in this project for concrete mix are,



1.2.1.1 Cement:

Portland Pozzolana cement of 43 Grade conforming to IS 8112 -1989, and the specific gravity of cement was found to be 3.15. Many tests were conducted to cement some of them are consistency tests, setting tests, etc. The properties of cement are given in table 1.

Table: 1.1 Properties of Cement:

| SI.NO. | PROPERTY | VALUE |
|--------|----------------------|---------|
| 1 | Specific gravity | 3.15 |
| 2 | Initial setting time | 45 min |
| 3 | Final setting time | 385 min |
| 4 | Fineness modulus | 6% |

1.2.1.2 Fine aggregate

1. Manufactured Sand:

For total produces solid total are finished results while for solid makers, totals are crude materials to be utilized for solid generation. The nature of totals can be affected while crude materials, rock or shake may have attributes which can't be changed by the generation procedure. One critical factor is steady supply obviously, fine total. In such manner a course total created by pulverizing basaltic stone and stream sand is the real normal wellspring of fine total in our nation. However the extraordinary development action is bringing about developing lack and cost increment of the common sand in the nation furthermore the total and solid industry are by and by confronting a developing open mindfulness identified with natural dangers.

In this way, searching for a practical option for common sand is an absolute necessity. One option utilized as substitution is the utilization of M sand. Because of the figure deficiency in supply of normal sand and expanded development hones time will come when M sand will assume a critical part as a fixing in solid generation.

At the point when shake is pounded and estimated in quarry the principle point has by and large been to deliver course total and street development materials. M sand is characterized as a reason made pounded fine total delivered from appropriate source materials. Fabricated sand has been created by assortment of pounding types of gear including cone crushers, affect crushers, move crushers, street rollers and so on. The crude material for M sand generation is the parent mass of shake. It depends on the parent shake that the synthetic, mineral properties, surface, synthesis of sand would change.

Fine aggregate used in this research is M- sand.

2.2.1.5 Super plasticizer:

In order to improve the workability of high-performance concrete, super plasticizer in the form of Sulphonated Napthalene Polymers complies with . IS 9103:1999 and ASTM C 494 type F as a high range water reducing admixture (CONPLAST SP 430) was used. This had 40% active solids in solution. The specific gravity is 1.22. It is a brown liquid instantly dispensable in water. It was collected from **High tech- chemicals**, Salem, India.



Fig 3.3-Conplast SP- 430.

Table: 2.10 Properties of super plasticizer:

| SI. NO | PROPERTIES | VALUE |
|--------|---------------------------------|---------------------------------|
| 1 | Appearance | Brown liquid |
| 2 | Specific gravity | 1.220-1.225@30°C |
| 3 | Water soluble chloride | Nil |
| 4 | Alkali content | Less than 55g.Na ₂ O |
| 5 | Chloride content | 0.2% Max |
| 6 | Air entrainment □ To produce | Nil |
| 7 | Nitrate content | Nil |

Uses

- To produce pumpable concrete.
- To produce high strength, high grade concrete M30 & above by substantial reduction in water resulting in low permeability and high early strength
- To produce high workability concrete requiring little or no vibration during placing.

Advantages

- Improved workability - Easier, quicker placing and compaction.
 - Increased strength - Provides high early strength for precast concrete with the advantage of higher water reduction ability.
 - Improved quality - Denser, close textured concrete with reduced porosity and hence more durable.
 - Higher cohesion - Risk of segregation and bleeding minimized; thus aids pumping of concrete
- Chloride free - Safe in prestressed concrete and with sulphate resisting cements and marine aggregates.

2.2.1.6 Fibers. 1) Glass fibers:

Glass fibers are made of silicon oxide with addition of small amounts of other oxides. Glass fibers are characteristic for their high strength, good temperature and corrosion resistance, and low price. Alkali resistant E-glass fibers of 12mm length, 0.014mm nominal diameter, specific gravity of 1.9 and density of 2650 kg/m³ were used.

The glass fibers used in concrete suppressed the localization of micro cracks in to macro cracks hence tensile strength increase. It improves durability of concrete by increasing the strength of concrete. The aspect ratio of Glass Fibers is

857.1. The number of fibers per 1 kg is 212 million. It was collected from .

Nylon fibers



Glass fibers

Fig 2.4: Various fibers used in concrete

- > Control cracking
- > Increase flexibility
- > Reduction in water permeability
- > Reduction in rebound loss in concrete
- > Safe and easy to use

2.2.2 Mix design & Mix proportions:

In this study, control mix A was designed as per IS 10262:1986 to achieve a target compressive strength of 40 Mpa. River sand was used to 100% replace M-sand using Portland pozzolana cement (PPC). The various fibers of 0.5%, 1%, 1.5% and 2% by volume fraction of concrete were used. The casted cubes are test for 7, 28, days Compressive strength, Split tensile strength and Durability test.

Various fibers:

- > Glass fibers
- > Nylon fibers

2.2.2.1 Mix design:

A total no. of 10 mixes was cast using different percentages of various fibers by volume of concrete. The proportion of Cement, M-sand, Coarse Aggregate, and Fibers & Water was kept same for all mixes. Various parameters used in the research are given below:

- > Concrete mix ratio: 1:1.3:2.01
- > Water cement Ratio: 0.375
- > Fibre percentages by volume of concrete:
 - ❖ Glass fibers - 0.5%, 1% , 1.5%.&2%
 - ❖ Polypropylene – 0.5%, 1% , 1.5%.&2%
- > Super Plasticizer (CONPLAST SP 430) – 1%
- > Mix with 0% Fibers content was declared as control mix.

2.4 Workability Test

The properties of fresh concrete such as the unit weight, the initial slump and the slump after 30 minutes of the mixtures are presented in Table 3.15. It was observed that the workability of concrete decreased as the percentage of different fibres will be added. The optimum m- sand with percentage of fibres by Gf, Pp, is 0.5%,1.0%,1.5%,2.0% for strength related tests for M40 grade of concrete.

TABLE: 3.16 Workability Test Results

| M ₄₀ Mix id | % of fibres added | Slump (mm) |
|------------------------|--|------------|
| T | 0% | 41 |
| T1 | Glass fibres & Nylon 0.5% 0 fibre 0.1% | 39 |
| T2 | Glass fibres & Nylon 1% | 36 |
| T3 | Glass fibres & Nylon 1.5% | 35 |
| T4 | Glass fibres & Nylon 2% | 35 |

Chart no: 3.2 Slump value in glass and nylon fibre

2.5 CURING OF SPECIMENS

All naturally cast examples were left in the molds for 24 hours before being shaped. The shaped examples were cured in water and hydrochloric acid (HCL) and sodium hydroxide (NAOH) for 7, 28 days, were air dried and after that tried for its compressive quality, split elasticity and strength test according to Indian benchmarks.

2.6 TESTING OF SPECIMENS

2.6.1 Compressive strength of concrete:

Compressive quality of cement is the most helpful and critical property of cement. Numerous different properties of cement, for example, sturdiness, protection from shrinkage Young's modulus, impenetrability and so forth are subject to the compressive quality of cement. The reason for the pressure test is to decide the devastating quality of solidified cement and is directed on shape examples of 150x150x150mm size. Standard shape examples are threw and tried for compressive quality following 7 days and 28 days. For setting up the examples, the lasting steel molds size of 150mmx150mmx150mm were utilized.

Before blending the solid, the molds were kept prepared. The sides and the base of the shape were appropriately oiled for simple demoulding. In the wake of emptying concrete into the form, Table vibrator was utilized to smaller the solid and after that the best surface was given a smooth wrap up. In the wake of throwing, test examples were demoulded following 24 hours and were kept in the curing tanks until the season of test.

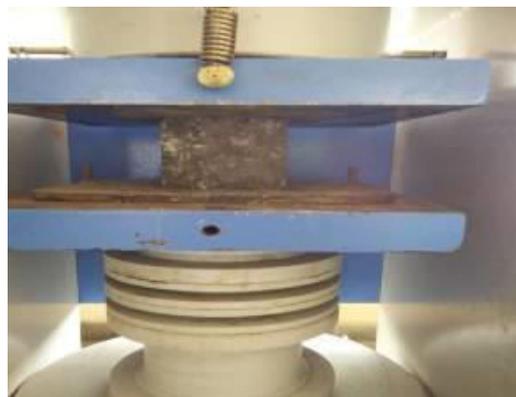


Fig: 3.6 Compressive Strength Test



Percentage Strength of Concrete at Various Ages. The strength of concrete increases with age. Table shows the strength of concrete at different ages in comparison with the strength at 28 days after casting.

| Age | Strength percentage |
|---------|---------------------|
| 1 day | 16% |
| 3 days | 40% |
| 7 days | 65% |
| 14 days | 90% |
| 28 days | 99% |

3.6.2 Split tensile strength.

This is test to determine the tensile strength of cylindrical specimens. splitting tensile strength tests were carry on cylinder specimens of size 100 mm diameter and 200 mm length at the age of 7, 28, 56 days curing, using compression testing machine. To avoid the direct load on the specimen the cylindrical specimens were kept below the specimens spilt and readings were noted. The splitting tensile strength has been calculated using the following formula:

$$F_1 = 2P/II.l.d$$

III. RESULT AND DISCUSSION

3.1 COMPRESSIVE STRENGTH TEST

Table: 4.1 Compressive Strength Test Results

| S.No | Cube ID | compressive STRENGTH (N/mm ²) (9SSSSSSSTRENGTHstrength N/mm ²) | |
|------|---------------------|---|---------|
| | | 7 days | 28 days |
| 1 | River&M-Sand(25+75) | 38.8 | 39.35 |
| 2 | Gf&Pp-0.5% | 45 | 50.23 |
| | Gf&Pp-1% | 48 | 53.23 |
| | Gf&Pp-1.5% | 50.10 | 55.34 |
| | Gf&Pp-2% | 50.25 | 55.78 |



4.2 SPLIT TENSILE STRENGTH.

Table: 4.2 Split Tensile Strength Test Results

| S.No | Cube ID | SPLIT TENSILE STRENGTH (N/mm ²) (N/mm ²) | |
|------|---------------------|--|---------|
| | | 2 | 2 |
| | | 7 days | 28 days |
| 1 | River&M-Sand(25+75) | 20.3 | 30.35 |
| 2 | Gf&Pp-0.5% | 37.6 | 42.23 |
| | Gf&Pp-1% | 40 | 47.23 |
| | Gf&Pp-1.5% | 42.03 | 49.77 |
| | Gf&Pp-2% | 48.25 | 52.62 |

4.3 DURABILITY TEST.

Table: 4.3 Durability Test Results

| S.No | Cube ID | INITIAL WEIGHT (kg) | FINAL WEIGHT(kg) | | ORIGINAL COMPRESSIVE STRENGTH (N/mm ²) | COMPRESSIVE STRENGTH (N/mm ²) | | COMPRESSIVE STRENGTH (N/mm ²) | |
|------|------------|---------------------|------------------|---------------------|--|---|---------|---|---------|
| | | | IN ACID | IN BASE | | IN ACID | IN BASE | IN ACID | IN BASE |
| | | | 1 | River&M-Sand(25+75) | | 2.6 | 2 | 2.29 | 39.35 |
| 2 | Gf&Pp 0.5% | 2.68 | 2.49 | 2.60 | 50.23 | 47.36 | 48.25 | 2.87 | 1.98 |
| 30 | Gf&Pp-1% | 2.72 | 2.49 | 2.61 | 53.23 | 50.05 | 52.93 | 3.18 | 0.3 |
| 4 | Gf&Pp-1.5% | 2.73 | 2.64 | 2.70 | 55.34 | 52.6 | 54.58 | 2.74 | 0.76 |
| 5 | Gf&Pp-2% | 2.79 | 2.65 | 2.3 8 | 55.78 | 53.03 | 53.87 | 2.75 | 1.91 |

This test was directed according to IS 516-1959. The 3D shapes of standard size 150mm x150mm, barrels measure 100mm dia x 200mm high were utilized to locate the compressive and elasticity of cement. Examples were put on the bearing surface of Compression Testing Machine (CTM) without unconventionality and a uniform rate of stacking was connected till the disappointment of the examples. The greatest load was noted and the compressive and rigidity was figured. To decide the normal compressive and elasticity, in the present work, 3-3-3 3D shapes and barrels of plain bond concrete with glass, polypropylene are tried under pressure testing machine

It is watched frame the outline 4.1 that the 3D square compressive quality expanded up to 1.5times contrast and River sand. It is watched frame the outline 4.2 that the split elasticity expanded up to 1.5times contrast and River sand.



IV. CONCLUSIONS

A Comprehensive report had been done on different diaries and books identified with the high quality cement with fabricated sand and different strands. Every one of the written works are considered in the field produce sand, diverse strands and concoction admixture. From the outcomes it is reasoned that the M-Sand can be utilized as a trade for fine total. It is discovered that 75% substitution of fine total by M-Sand give most extreme outcome in quality perspectives than the customary cement. The proper materials important for the readiness of examples for experimentations have been accomplished. The amount of examples and the tests to be led have been foreordained. The including level of 0.5%, 1%, 1.5%, 2% in glass, Polypropylene,

strands. The greatest quality achieves the level of 1.5%. The outcomes demonstrated that the substitution of 75% of fine total by M-Sand and strands initiated higher compressive quality and higher split elasticity.

The workability of cement was increment and also diminish the droop esteems on the grounds that the made sand was more water retention contrast with the stream sand. The expansion the workability in concrete including some level of admixture like Super Plasticizer. These additionally the workability increment least esteems. So substitute compound admixture utilized as a part of the fabricated sand and increment the droop esteems.

The compressive quality of the review M40 cements made with PPC. The outcomes demonstrate that the 7, 28 days compressive qualities ran from 39.88, 50.33, MPa, separately. The 75% supplanted stream sand in to made sand to meet the prerequisite of review M40 concrete.

The 7, 28 days part rigid qualities of the cements ran from 3.20, 4.34 and 5.86 MPa, individually. It gives the idea that the 75% supplanted stream sand in to made sand to meet the necessity of review M40 concrete.

. The both compressive and split elasticity went from 7, 28 days of (44.25,61.58 and 65.49) MPa and (3.89,5.60 and 7.78) Mpa separately.

The high quality solid utilizing fabricated sand with strands. The most extreme quality achieves the solid shape and chamber is 2% of strands by volume of cement. The cost likewise least for contrast with different strands.

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