STRENGTH ANALYSIS ON CONCRETE WITH M-SAND AS A PARTIAL REPLACEMENT OF FINE AGGREGATE

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ABSTRACT

In general concrete is a combination of cement, fine and course aggregate. These days, natural river sand is difficult to acquire and extraction of sand from river has represented an awesome threat to environment. In addition, government has connected limitation on extraction of sand from riverbed. Subsequently, insufficiency of natural river sand and increase in demand contemplate research seek towards alternate fine aggregate. This seek turns the research intention towards effective utilization of Manufactured sand (M-sand) for commercial purpose. This research incorporates effectiveness of M-sand by investigation compressive stress, split tensile stress and durability of concrete with various mix.

Key words: Manufactured sand, Concrete, Durability, Natural River Sand, Compressive stress and Split Tensile stress.


1. INTRODUCTION

In current world, the world is observer of extremely difficult civil work in developments and frameworks. In civil work concrete is the most valuable material [1]. The cement concrete is the biggest manufactured item by human society and the fundamental ingredient for the construction business [2]. Expenditure of concrete production is now on the expansion because of the current subsidence in globe wealth. Conventional production equipments are getting to be plainly costly [3]. Ordinarily concrete is mix of cement, sand and aggregate. Fine aggregate is an important component of concrete, because properties of aggregate influence the durability and presentation of concrete. Natural river sand is the most ordinarily utilized fine aggregate [4]. Fine aggregate is a fundamental raw material for construction cement, and its attributes from workability to strength and durability can affect concrete properties [5]. Yet, river sand is
not a renewable normal source. In a few districts, river sand has been too much abused which
has imperiled the stability of riverbanks and makes ecological issues and the security of bridges.
Then again, from natural sources the river sand is costly because of over the top cost of
transportation. Looking for river sand choices has turned out to be critical. From literature [6,7]
it was recognized that the option materials for river sand incorporate manufactured sand, reused
aggregates, industrial by products (a few types of slag, bottom ash), and so forth. Between these
materials, manufactured sand is getting incredible consideration nowadays as a substitution for
river sand [8].

In any case, because of the expanded utilization of concrete in a wide range of construction
works, the demand of natural or river sand has been expanded. To gather this demand of
construction industry inordinate quarrying of sand from riverbeds is occurring causing the
exhaustion of sand assets [9]. Manufactured sand is the response for this issue particularly when
a few states have effectively restricted the utilization of river sand for construction [10].
Manufactured sand is delivered by squashing rock declarations to create a fine aggregate, which
is rougher surface texture than river sand particles and has generally additional angular [11].
Manufactured sand squashed from stone or rock, otherwise called machine-made sand or
crushed-stone sand, has been utilized as an alternate of natural sand in concrete [12].

In China, the utilization of manufactured sand (MS) has been expanding, since great
superiority ordinary sand is not monetarily accessible in numerous regions. In view of the
squashing procedure, MS contrasts from natural sands in its evaluating, texture, and particle
shape; and commonly has among 10% and 20% fines. In manufactured sand, these fines
generally are more expected smaller size fractions of compacted aggregate; the fines can be
mud or different injurious particles in natural sands [13]. Concrete is assigned as “high-strength
concrete” based on its compressive strength measured at a given age [14]. Concrete Mix design
methodology considers just the compressive strength of concrete. Even though compressive
strength is a measure of durability of concrete overall, however it is not generally obvious that
a strong concrete is a durable concrete. To predict the durability of concrete Penetration Test
and Water Permeability Test were conducted [15].

2. LITERATURE REVIEW

Hayla Miceli et al (2017) ‘Contaminant removal from manufactured fine aggregates by dry
rare-earth magnetic separation’ had suggested that manufactured fine aggregates had turned
into a reasonable contrasting option to natural sands in building and structure everywhere
throughout the earth, specifically somewhere a supportable resource of the afterward was not
accessible. Though composition normally makes no significant problems in their use as coarse
aggregates, the utilization of these stones in construction of MS be able to symbolize a test, for
the most part related to the nearness of calculable measures of contaminating minerals,
specifically micas, which can negatively affect together rheology and strength of concrete and
mortars. The effort exhibits the change in the attributes of three manufactured fine aggregates
throughout dry rare-earth attractive division. It exhibits that the mica/biotite substance has been
diminished altogether, foremost additionally to a huge change fit as a fiddle in the item.

sand’ had proposed test contemplates on compressive strength improvement of cement through manufactured sand
be completed. Impacts of stone powder substance on long-standing compressive strength of concrete among
various water-to-cement ratios be investigated. Experiments comes about demonstrated that while substance of
stone powder was under 13%, it fundamentally had affirmative connection with the long-standing compressive
strength of MSC. In light of experiments information, predict form of long-standing compressive strength of MSC
regarding curing age, density and cement’s compressive strength and water-to-cement ratio are planned.
P Daisy Angelin et al (2015) ‘Durability Studies on Concrete with Manufacturing Sand As A Partial Replacement of Fine Aggregate In HCL Solution’ had anticipated that manufactured sand was individual among such materials to supplant river sand which can be utilized as an option fine aggregate in mortars and concrete. An endeavor had been completed in the current analysis to talk about the properties of concrete for example, workability and compressive strength of concrete, which was set up by supplanting natural sand with artificial sand at various substitution levels (0%, 20%, 40%, 60%, 80% and 100%). The outcomes had anticipated that supplanting of natural sand with manufactured sand in order of 60% deliver cement of acceptable workability and compressive strength. Durability of the concrete was additionally tried through immersing the cubes in 5% hydrochloric acid solution.

M.Adams Joe et al (2013) ‘Experimental Investigation on the Effect of M-Sand in High Performance Concrete’ had proposed the natural river sand was the least expensive resource of sand. The silt and clay show in the sand decrease the strength of the concrete and holds dampness. A couple of choices have come up for the business to count on of which manufactured sand or M-sand, as it was called, was observed to be the more appropriate individual to supplant river sand. Utilization of MS can radically lessen the cost since, as river sand, it does not include contaminations and wastages was nil as it is create with present day innovation and machinery. The reason for this examination was tentatively explore the impact of MS in structural concrete by supplanting river sand and build up a high performance concrete. The examination done by utilizes few tests, which incorporate workability test, compressive test, tensile test, and flexural test.

3. EXPERIMENTAL INVESTIGATION

Material properties

3.1. Cement (OPC53)
Ordinary Portland cement of 53 grade, was utilized for the current exploratory examination. The use of high strength cements is important to create high performance concrete. The decision of brand and kind of cement is the most imperative to create a good quality of concrete. The kind of cement influenced the rate of hydration. It is additionally essential to guarantee similarity of the chemical and mineral admixtures with cement.

3.2. River sand
Over the decades, river sand extract from the rocks in various weather conditions and it is accessible on riverbanks. The quality of natural river sand segregated based on its texture, which decided the grade and application in construction. In quality sand, adequate silt contains is three percentages and in case of medium quality, sand silt will be around 5 to 20 percentages.

3.3. M-sand
Rapid growth in construction and depleting natural source of river sand seeks the vision towards alternate product so called Manufacture sand (M-sand). It is generate from hard granite rocks crushers availability and transportation make M-sand easy accessibility. Moisture is accessible just in water washed M Sand. Higher concrete strength contrasted with river sand utilized for concreting and it is harmless to environment.
3.4. Coarse aggregate
Aggregates are artificially inert material and it involves 70-80% space in concrete. 80mm size is the maximum. The maximum size outcome in reduction of drying shrinkage, reduction in water requirement, reduction of the cement content

3.5. Super plasticizer
Super plasticizer diminishes water up to 30% without decreasing workability. It is utilized for generation of flowing, self-leveling, self-compacti ng and creation of high strength and high performance concrete. By utilizing super plasticizer, strength of 120 MPa is acquired. Super plasticizers can create

- At a similar w/c ratio more workable concrete than plain ones
- For similar workability to allows low w/c ratio
- Increased strength with low w/c ratio and allows diminishment of cement content

3.6. Glass fiber
So far in past decades glass manufacture industries involves various experiments in utility of fiber, but it is being fact after finer machine tooling. Glass fibers have analogous mechanical properties to polymers and carbon fiber, when utilize in composite application it is having less brittleness and cost effective.

3.7. Mixing, casting and testing
Mix proportion - 1: 1.24: 1.89
Cement - 550 kg/m3
Fine aggregate - 684 kg/m3
Coarse aggregate - 1042 kg/m3
W/c - 0.32

3.8. Use of alternative materials by %
Flyash - 10 % by weight of cement
20 mm - 60 % by wt of coarse aggregate
12.5 mm - 40 % by wt of coarse aggregate
M – Sand - 0 %, 20%, 40%, 60%, 80%, 100% by weight of sand
Glass fiber - 0%, 0.2%, 0.4%, 0.6%, 0.8% by wt of cement
Glenium - 0.4% of cement

4. RESULTS AND DISCUSSION
This section illustrate the investigative result obtain while executing different test such as compressive stress, split tensile stress, durability test, permeability test, acid resistance test and thermal resistance test for different concrete mixture. The investigation detailed below.

4.1. Compressive stress analysis
This stress analysis incorporates 90 cubes having 150 mm X150 mm X150 mm specification from 30 different proportions tested for 7 and 28 days. Those investigative results detailed in below figure-1 and figure-2.
From the figure-1, it is quite evident that 7-day compressive stress test establishes 23\textsuperscript{th} composition having high compressive stress over other compositions. The proportion obtained from superior composition having OPC-495 Kg/m\textsuperscript{3}, Flyash-55 Kg/m\textsuperscript{3}, FA-136.8 Kg/m\textsuperscript{3}, CA (20mm)- 625 Kg/m\textsuperscript{3}, CA (12.5mm)- 417 Kg/m\textsuperscript{3}, M-sand- 547.2 Kg/m\textsuperscript{3}, Fiber- 2.2 Kg/m\textsuperscript{3}.

From the figure-2, it is quite evident that 28-day compressive strength test reveals 19\textsuperscript{th} composition having high compressive strength over other compositions. The proportion obtained from superior composition having OPC-495 Kg/m\textsuperscript{3}, Flyash-55 Kg/m\textsuperscript{3}, FA-273.6 Kg/m\textsuperscript{3}, CA (20mm)- 625 Kg/m\textsuperscript{3}, CA (12.5mm)- 417 Kg/m\textsuperscript{3}, M-sand- 410.4 Kg/m\textsuperscript{3}, Fiber- 3.3 Kg/m\textsuperscript{3}.
4.2. Split tensile stress analysis

The tensile stress of concrete is one of the fundamental and essential properties; splitting tensile stress test on concrete cylinder is a process to establish the tensile stress of concrete. This stress analysis includes 30 different proportions test for 7 and 28 days. Those investigative results detailed in below figure-3 and figure-4.

![Figure 3 Split tensile stress results for 7 days](image)

From the figure-3, it is quite evident that 7-day split tensile stress test establishes 18th composition having high split tensile stress over other compositions. The proportion obtain from superior composition having OPC-495 Kg/m$^3$, Flyash-55 Kg/m$^3$, FA-273.6 Kg/m$^3$, CA (20mm)- 625 Kg/m$^3$, CA (12.5mm)- 417 Kg/m$^3$, M-sand- 410.4 Kg/m$^3$, Fiber- 2.2 Kg/m$^3$.

![Figure 4 Split tensile stress results for 28 days](image)

From the figure-4, it is evident that 28-day split tensile stress test founds 18th composition having high split tensile stress over other compositions. The proportion attain from better composition having OPC-495 Kg/m$^3$, Flyash-55 Kg/m$^3$, FA-273.6 Kg/m$^3$, CA (20mm)- 625 Kg/m$^3$, CA (12.5mm)- 417 Kg/m$^3$, M-sand- 410.4 Kg/m$^3$, Fiber- 2.2 Kg/m$^3$. 

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4.3. Durability test
Durability test, with respect to different load condition and time the characteristic of system determined. This performance analysis will establish stability of transaction response times over the duration of the test.

4.4. Permeability test
This investigative establish the rate of flow of water via concrete, the rate of flow determined by forced recognized constant pressure via concrete specimen of identified dimensions. Result exemplifies the penetration depth; where, M1 and M2 have highest depth over other and M4 having lowest over other those detail exemplify below.

4.4. Acid resistance test
A specified dimension casted concrete stored in ambient temperature (27°C) for a entire day and let specimens for 28 days and dry it for a day. A volume of water about 2 ph value utilize to dilute five percentage of H₂SO₄ for acid attack, from that point forward, cubes absorbed in the aforementioned acid water over a period of 30 to 60 days.
Figure-6, establish acid resistance test result for both normal curing and thermal shock from M1 to M6 mix design. The result shows that the strength while after thermal shock reduce over normal curing, which is evident in all sort of mixture compositions.

4.5. Thermal resistance test

![Thermal resistance test](image)

Figure 7 Thermal resistance test

From the figure-7, it is evident that normal curing having high strength value over thermal shock in all sort of mixture. In the case of normal-1 and normal-2 curing, normal-2 curing establishes high strength value in over all contests testing on other hand, thermal shock-2 having high strength over thermal shock-1 testing.

6. CONCLUSIONS

The results evaluate in this experimentation listed below:

- The workability of concrete decreases while utilizing manufactured sand in Concrete as replacement of river sand.
- The Compressive stress in concrete increases 40.1% and 64% for respective 7 and 28 days.
- The split tensile stress in concrete increases 2.5% and 4.4% for respective 7 and 28 days.
- The percentage weight loss in Sea water of concrete with Manufacture sand is not as much as the concrete with river sand which demonstrates that the Durability of Concrete is improved by utilizing manufacture sand as replacement of river sand.
- The permeability test increase 4.5mm depth for M1 and M2 mix, which is superior over other mix.
- The acid resistance test and thermal resistance test evaluated for M1 to M6 mix.
- In addition, M-sand is cost and performance effective in replace of river sand.
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