Experiment on Manufacture Sand With Different Grades

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Abstract- *The consumption of concrete by the construction industry is very high. Sand is essential material in concrete. Nearly 30% of sand is taken for the preparation of concrete. The fine aggregate is usually obtained from natural sources dredging of river beds or river banks. Because of deficiency of river sand the main alternative to this inconvenience is the utilization of produced sand or manufactured sand. The manufactured sand is obtained by crushing the rocks. The cost of manufactured is lower than river sand. The most advantage of manufactured sand is easily available and it has better results as compared to the river sand. In this investigation the river sand was replaced with Manufactured Sand by 50% and 100% mix. Self-curing of concrete is enhanced by polyethylene glycol which increases hydration and strength properties of concrete. It also shows the effect of Polyethylene glycol on compressive strength, split tensile strength, Flexural strength, stress-strain behavior, load deflection behavior of RCC beam and Impact strength by 0.3% percentage of PEG(1500) by weight of cement were studied for 50% and 100% replacement of Manufactured sand with different grades of concrete*

I. INTRODUCTION

GENERAL:

Proper curing of concrete structures is great significance to achieve performance and durability requirements. In normal curing this is achieved by external curing applied after mixing, placing and finishing. The curing period may depend on the properties required of the concrete, the purpose for which it is to be used, and the ambient conditions, i.e. the temperature and relative humidity of the surrounding atmosphere. Curing concrete means creating conditions such that water is not lost from the surface.

Self curing is a technique that can be used to provide additional moisture in concrete for more effective hydration of cement and reduced self-desiccation. Some specific water-soluble chemicals added during the mixing can reduce water evaporation from and within the set concrete, making it “self curing”. The self curing concrete has been done by using shrinkage reducing admixture. The self curing agents are polyethylene glycol, super absorbent polymers, and light weight aggregate. Here polyethylene glycol 1500 is one of the shrinkage reducing admixtures used in the concrete to make it as a self curing.

Manufactured sand is a substitute of river for construction purposes sand produced from hard granite stone by crushing. The crushed sand is of cubical shape with grounded edges, washed and graded to as a construction material. Here we are adopting manufacture sand by river sand is used to concrete mix in self curing concrete. Manufactured sand is an alternative for river sand. Due to fast growing construction industry, the demand for sand has increased tremendously, causing deficiency of suitable river sand in most part of the world. The sizes of M-sand can be controlled easily so that it meets the required grading for the given construction.

The Manufactured sand is easily available and has shown better results as compared to the natural sand. In this project the natural sand was replaced with Manufactured Sand by 50% and 100% proportion. Plain concrete needs for a minimum period of 28 days curing to attain good strength. The present study involves the use of polyethylene glycol 1500(PEG 1500) in concrete which helps in self-curing and helps in better hydration and hence strength. It also shows the effect of admixture (PEG 1500) on Compressive strength, split tensile strength, Flexuralstrength, Stress-strain behaviour, Load deflection behaviourof RCC beam and Impact strength by varying the percentage of PEG by weight of cement by 0.3%, were studied for 50% and 100% replacement of M-Sand with different grades of concrete. The quality of M-Sand is better than the river sand in all aspects and self-curing gives better results as compared to the standard moist curing.

SELF CURING CONCRETE:

Self curing refers to the process by which the hydration of cement occurs because of the availability of additional internal water that is not part of the mixing Water. Conventionally, curing concrete means creating conditions such that water is not lost from the surface i.e., curing is taken to happen ‘from the outside to inside’. In contrast, ‘self curing’ is allowing for curing ‘from the inside to outside’ through the internal reservoirs (in the form of saturated lightweight fine aggregates, superabsorbent polymers, polyethylene glycol) Created.

Need for self curing:

When the mineral admixtures react completely in a blended cement system, their demand for curing water (external or internal) can be much greater than that in a conventional ordinary Portland cement concrete. When this water is not readily available, due to depreciation of the capillary porosity, for example, significant autogenously deformation and (early-age) cracking may result. Due to the chemical shrinkage occurring during cement hydration, empty pores are created within the cement paste, leading to a reduction in its internal relative humidity and also to shrinkage which may cause early-age cracking. The empty pores created during self-desiccation induce shrinkage stresses and also influence the kinetics of cement hydration process, limiting the final degree of hydration. The strength achieved by self curing could be more than that possible under saturated curing conditions.

Currently, there are two major ways available for self curing of concrete. The first way uses saturated porous lightweight aggregate (LWA) in order to supply an internal source of water, which can replace the water consumed by chemical shrinkage during cement hydration. The second way uses polyethylene glycol (PEG) which reduces the evaporation of water from the surface of concrete and also helps in water retention.

Mechanism of self curing:

Continuous evaporation of moisture takes place from an exposed surface due to the difference in chemical potentials (free energy) between the vapor and liquid phases. The polymers added in the mix mainly form hydrogen bonds with water molecules and reduce the chemical potential of the molecules which in turn reduces the vapor pressure, thus reducing the rate of evaporation from the surface.

MANUFACTURED SAND CONCRETE:

Manufactured sand (M-Sand) is a substitute of river sand for concrete construction. Manufactured sand is produced from hard granite stone by crushing.

The crushed sand is of cubical shape with grounded edges, washed and graded to as a construction material. The size of manufactured sand (M-Sand) is less than 4.75mm.

Why Manufactured Sand is Used

Manufactured sand is an alternative for river sand. Due to fast growing construction industry, the demand for sand has increased tremendously, causing deficiency of suitable river sand in most part of the word.

Due to the depletion of good quality river sand for the use of construction, the use of manufactured sand has been increased. Another reason for use of M-Sand is its availability and transportation cost.

Since manufactured sand can be crushed from hard granite rocks, it can be readily available at the nearby place, reducing the cost of transportation from far-off river sand bed.

Thus, the cost of construction can be controlled by the use of manufactured sand as an alternative material for construction. The other advantage of using M-Sand is, it can be dust free, the sizes of m-sand can be controlled easily so that it meets the required grading for the given construction.

Advantages of Manufactured Sand (M-Sand)

- It is well graded in the required proportion.
- It does not contain organic and soluble compound that affects the setting time and properties of cement, thus the required strength of concrete can be maintained.
- It does not have the presence of impurities such as clay, dust and silt coatings, increase water requirement as in the case of river sand which impair bond between cement paste and aggregate. Thus, increased quality and durability of concrete.
- M-Sand is obtained from specific hard rock (granite) using the state-of-the-art International technology, thus the required property of sand is obtained.
- M-Sand is cubical in shape and is manufactured using technology like High Carbon steel hit rock and then ROCK ON ROCK process which is synonymous to that of natural process undergoing in river sand information.
- Modern and imported machines are used to produce M-Sand to ensure required grading zone for the sand.
- Construction defects during placement and post-concreting such as segregation, bleeding, honeycombing, voids and capillarity in concrete gets reduced by the use of M-Sand as it has optimum initial and final setting time as well as excellent fineness.
- As discussed above, since usage of M-Sand has increased durability, higher strength, reduction in segregation, permeability, increased workability, decreased post-concrete defects, it proves to be economical as a

construction material replacing river sand. It can also save transportation cost of river sand in many cases.

- sage of manufactured sand prevents dredging of river beds to get river sand which may lead to environmental disaster like ground water depletion, water scarcity, threat to the safety of bridges, dams etc. to make M-Sands eco-friendlier than river sand.

II. OBJECTIVE AND METHODOLOGY

OBJECTIVE:

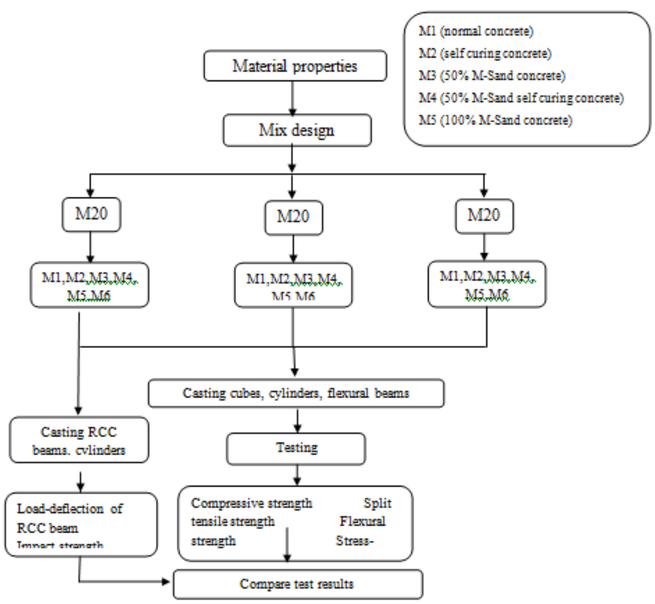
The main objective of the present study is to experimentally investigate conventional concrete and self curing concrete containing 50% and100% Manufactured sand.

- To study the strength characteristics of normal concrete replacing with manufactured sand.
- To study the strength characteristics of self curing concrete replacing with manufactured sand.

Selected parameters:

- Replacing 50% and 100% with manufactured sand.
- Different grades of concrete

METHODOLOGY



PROPERTIES OF MATERIALS:

The properties of each material in a concrete mix where studied at the early stage. Different tests were conducted for each material as specified by relevant IS codes.

GENERAL:

Cement used in the investigation was 53 grade ordinary Portland cement. The specific gravity of cement was 3.15. The initial setting time of cement is 30 minutes and final setting time is 600 minutes. The fine aggregate was conforming to zone-II according to IS: 383 (19). The fine aggregate used was taken from river and manufactured sand. Coarse aggregate used in this investigation passes through 20mm sieve and retained on 16mm sieve. Potable water was used in the experimental work for both mixing and curing composition specimens. PEG 1500 was used for the investigation of this experiment.

ORDINARY PORTLAND CEMENT (OPC):

Cement can be defined as the bonding material having cohesive & adhesive properties which makes it capable to unite the different construction materials and form the compacted assembly. Ordinary/Normal Portland cement is one of the most widely used type of Portland Cement.

COMPOSITION OF OPC:

The chief chemical components of ordinary Portland cement are:

- Calcium
- Silica
- Alumina
- Iron

Calcium is usually derived from limestone, marl or chalk while silica, alumina and iron come from the sands, clays & iron ores. Other raw materials may include shale, shells and industrial byproducts.

Basic composition OPC

Contents	Percentage
CaO	60-67
SiO2	17-25
Al2O3	3-8
Fe2O3	0.5-6.0
MgO	0.5-4.0
Alkalis	0.3-1.2
SO3	2.0-3.5

The chief compound which usually form in process of mixing:

- Tricalcium silicate ($3CaO.SiO_2$)
- Dicalcium silicate ($2CaO.SiO_2$)

- Tricalcium aluminates ($3CaO.Al_2O_3$)
- Tetracalciumalumino ferrite ($4CaO.Al2O_3.Fe2O_3$)

FINE AGGREGATE:

Fine aggregate means sand which is a mixture of small particles of grains and minerals which passes 9mm sieve and it is used for construction purposes like mixing in concrete and farming works e.t.c.

River sand:

Sand is primarily filler for the voids in concrete. Increasing the proportion of sand in the total mix increases cement demand because of the relatively very large surface area that needs to be coated by cement paste. The properties of fine aggregate is shown in below table below. Flat elongated and angular shaped sand such as products from crushed sand, also require more water to produce workable concrete. Hence, cement demand is increased to maintain the same W/C Ratio. Locally available river sand having bulk density 1860 kg/m3 was used. River sand is sieved to 4.75 mm and the passed out sand is used.

Specific gravity of fine aggregate:

- Take the pycnometer of about 900 ml capacity with a conical brass cap.
- Find the weight of clean pycnometer as W1.
- Take about one-third of dry sand, put it in pycnometer and find the weight as W2.
- Fill the pycnometer with water and mix thoroughly with glass rod. Dry the pycnometer outside and its weight is determined W3.
- Empty the pycnometer and fill it with water to whole of conical cap and find the weight as W4.

Specific gravity of fine aggregate $= \frac{W2-W1}{(W4-W1)-(W3-W2)}$

Properties of river sand

S. No.	Property	Value
1	Specific gravity	2.66
2	Water absorption	6.2%

Manufactured sand:

Manufactured sand or M-Sand, as it is popularly known is made by powdering hard granite rocks using heavy machinery. It's particles are cubical in shape and finely graded and hence provides greater durability and higher strength to concrete by overcoming deficiencies like segregation, bleeding, honey combing, voids and capillary. M-Sand has balanced physical and chemical properties that can withstand any aggressive environmental and climatic conditions as it has enhanced durability, greater strength and overall economy. Usage of M-Sand can overcome the defects occurring in concrete such as honey combing, segregation, voids, etc. The physical properties of sand provide greater strength to the concrete by reducing segregation, bleeding, honeycombing, voids and capillary. Thus required grade of sand for the given purpose helps the concrete more compact and dense, thus increasing the strength of concrete.

As discussed above, since usage of M-Sand has increased durability, higher strength, and reduction in segregation, permeability, increased workability, decreased post-concrete defects; it proves to be economical as a construction material replacing river sand. It can also save transportation cost of river sand in many cases. Usage of manufactured sand prevents dredging of river beds to get river sand which may lead to environmental disaster like ground water depletion, water scarcity, to make M-Sand more eco-friendly than river sand. The properties of M sand are shown in below table.

Properties of manufactured sand

S.No.	Property	Value
1	Specific gravity	2.70
2	Water absorption	6.7%

COARSE AGGREGATE:

Coarse aggregate used in this investigation, passes through 20mm sieve and retained on 16mm sieve. Well graded cubical or rounded aggregates are desirable. Aggregates should be uniform quality with respect to shape and grading. Specific gravity of coarse aggregate used here is 2.80.

Concrete is a composite material consists of filler and binding material where the filler materials are fine or coarse aggregate and binding materials are cement paste. At the earlier stage of coarse aggregate development, it was believed that aggregates where chemically inert and held together by cement. But modern technology proves that aggregates exhibits chemical bond at the interface of aggregate and paste. Aggregate is such important matter in concrete that maximum properties and workability of concrete are directly changed with the properties of aggregates. Density of concrete is determined by the aggregate density as well as soft with porous concrete produce weak concrete with lower wear resistance. That’s why the overall or mechanical properties of concrete depends on the certain properties of aggregate like source of aggregates, normal or light or heavy weight aggregate, size of aggregate, shape of aggregate, crushing type of aggregates, angularity index, surface texture, modulus of elasticity, bulkdensity, specific gravity, absorption and moisture content, bulking of aggregates, cleanliness, soundness of aggregates, thermal properties and grading of aggregates. Moreover, Interfacial Transition Zone (contact surface between aggregate and cement paste) plays an important role in strength and durability of concrete.

Coarse aggregate of specific gravity:

- Two kg of aggregate is weighed and placed in the wire basket and immersed in distill water at a temperature between 22^0-32^0c.
- To immediately after immersion, air is removed from the sample by lifting in bracket, and then they are kept in water for 24 hours
- The basket and aggregate are jolted and weighted in water at 22-32 ^{0}c.
- The basket and aggregate removed from the water and allowed to drain for few minutes, the aggregate is taken out and made surface dry.
- The empty basket is immersed, again in water, jolted25 times and weighted in water jolted 25times and weighed in water.
- The surface dry aggregate is weighted.
- The aggregate is then kept in an oven at a temperature of 100-110 degree centigrade for 24 hours it is then cooled in air tight container and weighted.

Specific gravity = c/ (b-a)

Where, a=weighted of aggregate saturated in water (gm) = (a1-a2)

b=weight of surface dry aggregate in gm
c= weight of oven dry aggregate
Properties of coarse aggregate

S. No.	Property	Value
1	Specific gravity	2.8

Coarse aggregate

WATER:

Water is one of the most important elements in construction but people still ignore quality aspect of this element. The water is required for preparation of mortar, mixing of cement concrete and for curing work etc. during construction work. The quality and quantity of water has much effect on the strength of mortar and cement concrete in construction work. The water used for mixing and curing should be clean and free from injurious quantities of alkalis, acid, oils, salt, sugar, organic materials, vegetable growth and other substances that may be deleterious to bricks, stone, concrete or steel. Potable water is generally considered satisfactory for mixing.

Potable water available in laboratory was used for casting all the specimens. The quality of water was found to satisfy the requirements of IS: 456-2000. Water molecule has a slight positive charge. On the other side of the molecule a negative charge exists. This molecular polarity causes water to be a powerful solvent and is responsible for its strong surface tension.

POLYETHYLENE GLYCOL:

Polyethylene glycol is a condensation polymer of ethylene oxide and water with the general formula $(CH2CH2O)_n$, where n is the average number of repeating oxy ethylene groups typically from 4 to 180. The abbreviation (PEG 1500) is termed in combination with a numeric suffix which indicates the average molecular weights PEG are prepared by polymerization of ethylene oxide and are commercially available over a wide range of molecular weights from 300 g/mol to 10,000,000 g/mol. One common feature of PEG appears to be the water-soluble nature. Polyethylene glycol is non-toxic, odorless, neutral, lubricating, non-volatile and non-irritating and is used in a variety of pharmaceuticals.

Polyethylene glycol

Properties of polyethylene glycol 1500:

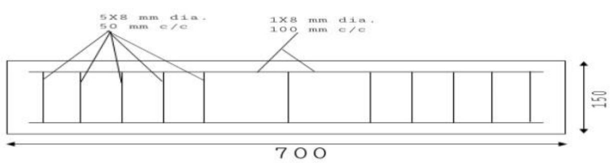
Physical state and appearance: solid (liquid above freezing point, solid below freezing point.)

Chemical properties:

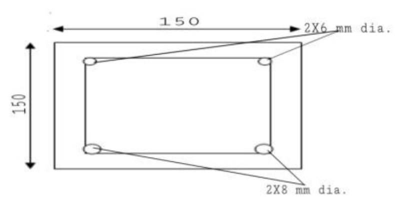
Polyethylene glycol 1500 is strongly hydrophilic. The patition coefficient of PEG1500 between hexane and water is 0.000015(log), indicating that when PEG 1500 is mixed with water and hexane, they are only parts of PEG 1500 in the hexane layer per 1 million parts of PEG 1500 in the water layer. PEG 1500 is soluble in water, acetone, alcohols, benzene, glycerin, glycols and aromatic hydrocarbons, and is slightly soluble in aliphatic hydrocarbons.

Reinforcement details:

The RCC beam has the dimensions of 150X150X700 mm. the reinforcement consists of 2 numbers 6mm diameter at top and 2 numbers of 10mm diameter bars at bottom with 8mm diameter of 5 stirrups spaced 50mm c/c at ends and at middle one stirrup 100mm c/c spacing. 25mm of cover provided at all sides.



longitudinal section of reinforcement



cross section of reinforcement

III. EXPERIMENTAL INVESTIGATION

MIX DESIGN

As per IS 10262:2002, the mix designs are calculated for different grades such as M20, M30 and M40.

DATA FOR M20

Grade designation = M20
size of aggregate = 20mm
Degree of workability = 0.9 compaction factor
Degree of quality control = good
Type of exposure = mild
Cement used = OPC 53 grade conforming to IS 12269
Fine Aggregate= confirming to zone II

Test data for materials

Specific gravity of
i) Cement = 3.15
ii) Coarse Aggregate= 2.80
iii) Fine aggregate = 2.66

1. Target mean strength for mix design:-

The target mean compressive strength at 28 days is given by
Fck = fck+ts
= 20+1.65*4 (t= 1.65 and s = 4) from is 10262:2009 = 26.6 N/mm²

2. Selection of water cement ratio

W/c ratio = 0.55 from IS 456:2000 table no: 5 of IS 456
Adopt water cement ratio as 0.53

3. Selection of water content

Maximum water content for 20mm aggregate = 186 litre (for 25 to 50 mm slump)
Estimated water content for 75 mm slump = $186+\frac{186\times3}{100}$
Calculation of cement content
Water cement ratio = 0.53
Cement content = $\frac{191.58}{0.53}$ = 361.47
From table 5 of IS 456, minimum cement content for severe exposure condition = 320
Proportion of volume of coarse aggregate and fine aggregate content
From table 3 of IS 10262 : 2009, volume of coarse aggregate corresponding to 20mm size of aggregate and fine aggregate (zone II) for water cement ratio of 0.50 = 0.62
Therefore, volume of coarse aggregate = 0.614
Volume of fine aggregate content = 0.385

Mix calculations

The mix calculation per unit volume of concrete shall be as follows

a) Volume of concrete = 1 m^3
b) Volume of cement $=\frac{mass of cement}{specific gravity of cement}\times\frac{1}{1000}=$ 0.1148

c) Volume of water $= \frac{mass\,of\,water}{specific\,gravity\,of\,water} \times \frac{1}{1000}$ = 0.191

d) Volume of all in aggregate = (a - (b + c))
= (1 – (0.114 + 0.191) = 0.3063

e) Mass of coarse aggregate = d $\times$ Volume of coarse aggregate $\times$ specific gravity of coarse aggregate $\times$ 1000 = 1193

f) Mass of fine aggregate = d $\times$ Volume of fine aggregate $\times$ specific gravity of fine aggregate $\times$ 1000 =711.12

Mix ratio = 1:1.96:3.30

DATA FOR M30

Grade designation = M30
size of aggregate = 20mm
Degree of workability = 0.9 compaction factor
Degree of quality control = good
Type of exposure = mild
Cement used = OPC 53 grade conforming to IS 12269
Fine Aggregate = confirming to zone II

Test data for materials

Specific gravity of
i) Cement = 3.15
ii) Coarse Aggregate= 2.80
iii) Fine aggregate = 2.66

1. Target mean strength for mix design: -

The target mean compressive strength at 28 days is given by,
Fck =fck+ts
= 30+1.65*5 (t= 1.65 and s = 5) from is 10262:2009= 38.25 N/mm²

2. Selection of water cement ratio

W/c ratio = 0.50 from IS 456:2000 table no: 5 of IS 456
Adopt water cement ratio as 0.46

3. Selection of water content

Maximum water content for 20mm aggregate = 186 litre (for 25 to 50 mm slump)
Estimated water content for 75 mm slump = 186+ $\frac{186\times3}{100}$

Calculation of cement content
Water cement ratio = 0.46
Cement content = $\frac{191.58}{0.46}$ = 416.47

From table 5 of IS 456, minimum cement content for severe exposure condition = 320

Proportion of volume of coarse aggregate and fine aggregate content

From table 3 of IS 10262 : 2009, volume of coarse aggregate corresponding to 20mm size of aggregate and fine aggregate (zone II) for water cement ratio of 0.50 = 0.62
Therefore, volume of coarse aggregate = 0.672
Volume of fine aggregate content = 0.372

Mix calculations

The mix calculation per unit volume of concrete shall be as follows

a) Volume of concrete = 1 m^3

b) Volume of cement $= \frac{mass\,of\,cement}{specific\,gravity\,of\,cement} \times \frac{1}{1000}$
= 0.132

c) Volume of water $= \frac{mass\,of\,water}{specific\,gravity\,of\,water} \times \frac{1}{1000}$
= 0.191

d) Volume of all in aggregate = (a - (b + c))
= (1 – (0.132+0.191) = 0.323

e) Mass of coarse aggregate = d $\times$ Volume of coarse aggregate $\times$ specific gravity of coarse aggregate $\times$ 1000 = 1187.52

f) Mass of fine aggregate = d $\times$ Volume of fine aggregate $\times$ specific gravity of fine aggregate $\times$ 1000 = 650.56

Mix ratio = 1:1.61:2.85

DATA FOR M40:

Grade designation = M40
size of aggregate = 20mm
Degree of workability = 0.9 compaction factor
Degree of quality control = good
Type of exposure = mild
Cement used = OPC 53 grade conforming to IS 12269
Fine Aggregate = confirming to zone II

Test data for materials

Specific gravity of
i) Cement = 3.15
ii) Coarse Aggregate= 2.80

iii) Fine aggregate = 2.66

1. Target mean strength for mix design:-

The target mean compressive strength at 28 days is given by,

Fck = fck+ts

= 40+1.65*5 (t= 1.65 and s = 5) from is 10262:2009= 48.25 N/mm²

2. Selection of water cement ratio

W/c ratio = 0.40 from IS 456:2000 table no: 5 of IS 456

Based on experience, adopt water cement ratio as 0.38

3. Selection of water content

Maximum water content for 20mm aggregate = 186 litre (for 25 to 50 mm slump)

Estimated water content for 75 mm slump = $186+\frac{186\times3}{100}$ = 191.58

Calculation of cement content

Water cement ratio = 0.53

Cement content = $\frac{191.58}{0.38}$ = 504.15

From table 5 of IS 456, minimum cement content for severe exposure condition = 340

Proportion of volume of coarse aggregate and fine aggregate content

From table 3 of IS 10262 : 2009, volume of coarse aggregate corresponding to 20mm size of aggregate and fine aggregate (zone II) for water cement ratio of 0.50 = 0.62

Therefore, volume of coarse aggregate = 0.641

Volume of fine aggregate content = 0.358

Mix calculations

The mix calculation per unit volume of concrete shall be as follows

a) Volume of concrete = 1 m^3

b) Volume of cement $=\frac{mass of cement}{specific gravity of cement}\times\frac{1}{1000}$ = 0.160

c) Volume of water $=\frac{mass of water}{specific gravity of water}\times\frac{1}{1000}$ = 0.191

d) Volume of all in aggregate = (a - (b + c))

= (1 – (0.160 +0. 191) = 0.351

e) Mass of coarse aggregate = d $\times$ Volume of coarse aggregate $\times$ specific gravity of coarse aggregate $\times$ 1000 = 1164.78

f) Mass of fine aggregate = d$\times$ Volume of fine aggregate $\times$ specific gravity of fine aggregate $\times$ 1000 = 618

Mix ratio = 1:1.22:2.31

MATERIAL CALCULATIONS:

Mix proportion of Normal Concrete (kg/m³)

Grade	Cement	Fine aggregate	Coarse aggregate	Water
M20	361.47	711.12	1193	191.58
M30	416.47	670.56	1187.52	191.58
M40	504.15	618	1164.78	191.58

Mix proportion of Self curing concrete (kg/m³)

Grade	Cement	Fine aggregate	Coarse aggregate	Water	PEG
M20	361.47	711.12	1193	191.58	1.08
M30	416.47	670.56	1187.52	191.58	1.24
M40	504.15	618	1164.78	191.58	1.51

Mix proportion of 50% M-sand concrete (kg /m³)

Grade	Cement	Fine aggregate		Coarse aggregate	WATER
		50% Normal sand	50% M sand		
M20	361.47	355.56	355.56	1193	191.58
M30	416.47	335.28	335.28	1187.52	191.58
M40	504.15	309	309	1164.78	191.58

Mix proportion of 50% M-Sand Self Curing Concrete (kg/m³)

Grade	Cement	Fine aggregate		Coarse aggregate	Water	PEG
		50% Normal Sand	50% M Sand			
M20	361.47	355.56	355.56	1193	191.58	1.08
M30	416.47	335.28	335.28	1187.52	191.58	1.24
M40	504.15	309	309	1164.78	191.58	1.51

Mix proportion of 100% M-Sand Concrete (kg /m³)

Grade	Cement	Fine aggregate (100% M-Sand)	Coarse aggregate	Water
M20	361.47	711.12	1193	191.58
M30	416.47	670.56	1187.52	191.58
M40	504.15	618	1164.78	191.58

Mix proportion of 100% M-Sand Self Curing Concrete (kg /m³)

Grade	Cement	Fine aggregate (100% M-Sand)	Coarse aggregate	Water	PEG
M20	361.47	711.12	1193	191.58	1.08
M30	416.47	670.56	1187.52	191.58	1.24
M40	504.15	618	1164.78	191.58	1.51

COMPRESSIVE STRENGTH TEST:

After 28 days of curing, three 150mm cubes of a concrete mixture were tested using a compression machine. These cubes were loaded on their sides during compression testing such that the load was exerted perpendicularly to the direction of casting. The average value of the three cubes was taken as the compressive strength.

Procedure:

- The cubes are placed in the compressive testing machine and the loads are applied gradually.
- The digital machine shows the amount of load applied on the display. Care should be taken that the load is applied at a uniform rate.
- The load reaches a maximum point and starts reducing thereafter. The maximum load is the ultimate load and that reading is to be noted.
- The maximum load is noted in kN and the compressive strength is calculated by using the formula.

$$\text{Compressive strength} = \frac{load}{area}$$

Cube specimen testing

SPLIT TENSILE TEST:

Procedure:

- The cylinders are placed in the compression testing machine horizontally
- Load is applied gradually.
- The load is increased at a uniform rate until the specimen fails and the maximum load applied to the specimen during the test is recorded.
- The tensile strength of the specimen is calculated using the below mentioned formula.

$$\text{Split tensile Strength} = \frac{2P}{\Pi \times d \times L}$$

Where,

P = Compressive load on the cylinder

L = length of the cylinder

d = diameter of the cylinder

Cylinder specimen testing

FLEXURAL STRENGTH TEST:

Procedure:

- The bearing surfaces of the supporting and loading rollers are wiped clean and any other loose sand or other material are removed from the surface of the specimen where they are to make contact with the rollers.
- The specimen is then placed in the machine such that the load is applied to the upper most surface as cast in the mould along two lines spaced 20 cm apart.
- The load is increased until the specimen fails and the maximum load applied to the specimen during the test is recorded.

The flexural strength (f_b)is calculated using the formula,

$$f_b = \frac{P \times l}{b \times d^2}$$

When a > 13.3 cm

$$f_b = \frac{3 \times p \times a}{b \times d^2}$$

When 11 < a < 13.3 cm

Flexural strength specimen testing

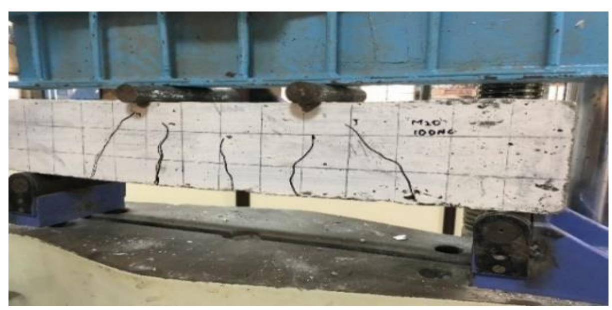
- **STRESS STRAIN BEHAVIOUR:**

The stress-strain can be determined by measuring the compressive strain when a sample is subjected to a compressive stress. After 28 days of curing, tests are carried on 150X300 mm cylinder. The cylinders are tested in Universal testing machine. Here peak load and strain at peak load was noted.

Cylinder specimen testing.

LOAD DEFLECTION BEHAVIOUR OF RCC BEAM:

The RCC beam has the dimensions of 150X150X700 mm. the reinforcement consists of 2 numbers 6mm diameter at top and 2 numbers of 10mm diameter bars at bottom with 8mm diameter of 5 stirrups spaced 50mm c/c at ends and at middle one stirrup 100mm c/c spacing. 25mm of cover provided at all sides. Here M20 grade is taken for the casting RCC beam. After 28 days of curing the RCC beam is tested by using the Universal testing machine. Two-point load was applied at the center. The load was applied until the peak load and load vs deflection was record.



RCC beam specimen testing

IMPACT STRENGTH TEST:

The cylindrical moulds of dimension 100 X 150mm for casting the specimens. From these cylindrical specimens, twelve discs of size 100 x 64mm were cut using a diamond cutter..The test consisted of repeated application of impact load in the form of blows, using a 44.5 N hammer falling from 457 mm height on the steel ball of 63.5 mm diameter, placed at the center of the top surface of disc. Number of blows (N1) and (N2) that caused the first visible crack and failure respectively was noted as first crack strength and the failure strength of the sample.. The impact energy was calculated for each concrete specimen using Equation (1):

$$\text{Impact energy } U = \left(\frac{n.m.v^2}{2}\right) \quad \text{.........(1)}$$

$$H = \left(\frac{g.t^2}{2}\right) \quad \text{......... (2)}$$

$$V = g.t \quad \text{......... (3)}$$

$$m = \frac{W}{g} \quad \text{......... (4)}$$

Where, H is the falling height of hammer, V is the velocity of the hammer at impact, W is the hammer weight, m is mass of the hammer, g is acceleration due to gravity, t is the time required for the hammer to fall from a height of 457 mm, n is the number of blows and m is the drop mass.

The number of blows required to cause the first visible crack (N1) and final failure (N2) of concrete specimens are indexed in Table-5.6 and the impact energy corresponding to number of blows. The impact energy of specimens during every blow can be calculated as follows. Substituting the corresponding values in Equation (2-4):

$$457 = \frac{9810t^2}{2}$$

t = 0.3052 s and V = 9810 x 0.3052 = 2994.01 mm/s

The impact energy delivered by hammer per blow can be obtained by substituting the values in Equation (1)

$$U = \frac{44.3X2994.01^2}{2X9810} = 20.345 \text{ KN mm}$$

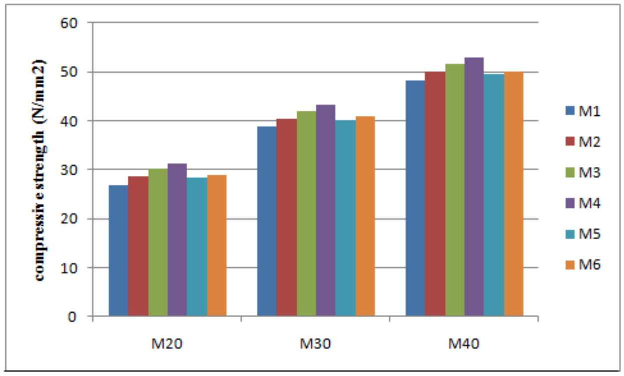
Impact strength specimen testing

IV. RESULTS AND DISCUSSION

COMPRESSIVE STRENGTH:

Compressive strength of concrete @ 28 days (N/mm2)

Concrete mix	M20	M30	M40
M1(Normal concrete)	27.11	39.02	48.53
M2 (0.3% PEG)	28.88	40.73	50.30
M3 (50% M-Sand)	30.48	42.30	51.82
M4 (50% M-Sand +0.3% PEG)	31.55	43.55	53.24
M5 (100% M-Sand)	28.61	40.44	49.86
M6 (100% M-Sand +0.3% PEG)	29.18	41.03	50.36



Compressive strength of concrete

From the above figure it concluded that replacement of normal sand withmanufactured sand gives good compressive strength. 50% replacement of M-sand gives higher strength compare to zero percent replacement M1 and 100% replacement (M5).

Self curing is achieving higher strength with normal sand compare to M-sand replacement.

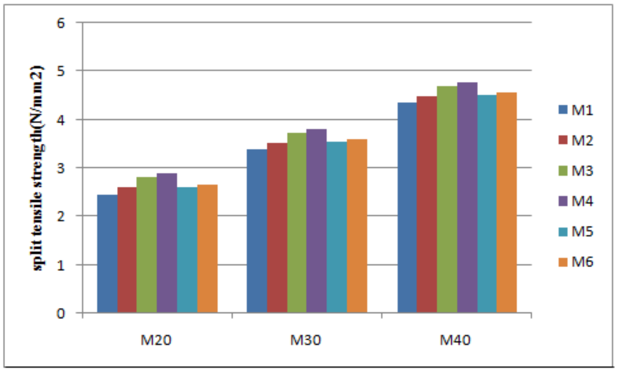
Reduction of strength takes place with the percentage of increase of manufactured sand.

50% M-sand self curing concrete shows higher compressive strength compare to other mix proportions.

SPLIT TENSILE STRENGTH:

Split tensile strength of concrete @ 28 days (N/mm2)

Concrete mix	M20	M30	M40
M1(Normal concrete)	2.45	3.39	4.35
M2 (0.3% PEG)	2.61	3.53	4.49
M3 (50% M-Sand)	2.82	3.72	4.69
M4 (50% M-Sand +0.3% PEG)	2.90	3.81	4.77
M5 (100% M-Sand)	2.61	3.56	4.52
M6 (100% M-Sand + 0.3% PEG)	2.66	3.60	4.56



Split tensile strength of concrete

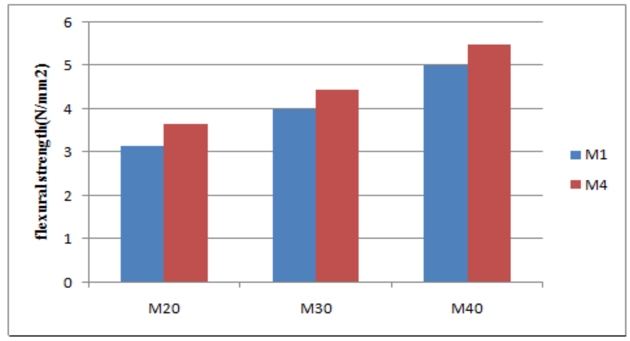
From the above figure it shows that replacement of normal sand with manufactured sand gives good split tensile strength.50% replacement of M-sand gives higher strength compare to zero percent replacement (M1) and 100% replacement (M5) of manufactured sand.

Self curing is achieve higher split tensile strength with normal sand compare to M-sand replacement. Reduction of strength takes place with the percentage of increase of manufactured sand.50% M-sand self-curing concrete shows higher split tensile strength compare to other mix proportions.

FLEXURAL STRENGTH:

Flexural strength of concrete @ 28 days (N/mm2)

Concrete mix	M20	M30	M40
M1(Normal concrete)	3.13	4.0	5.02
M4 (50% M-Sand +0.3% PEG)	3.64	4.43	5.49



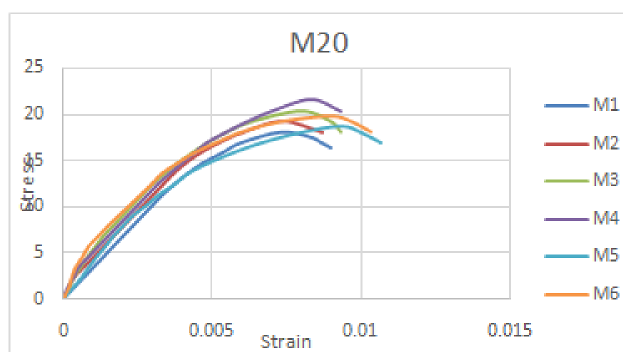
Flexural strength of concrete

From the above figure it shows that flexural strength of 50% manufactured self-curing concrete gives higher strength compare to normal concrete.

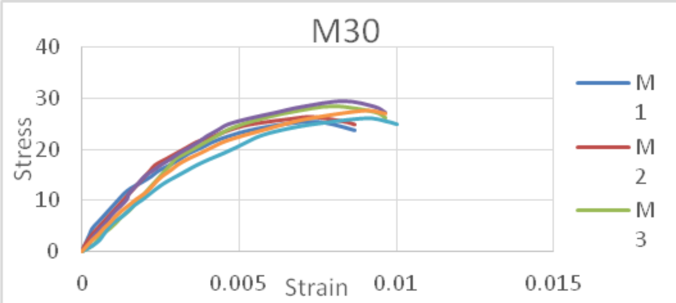
STRESS STRAIN BEHAVIOUR:

Stress strain behaviour of concrete @ 28 days (N/mm2)

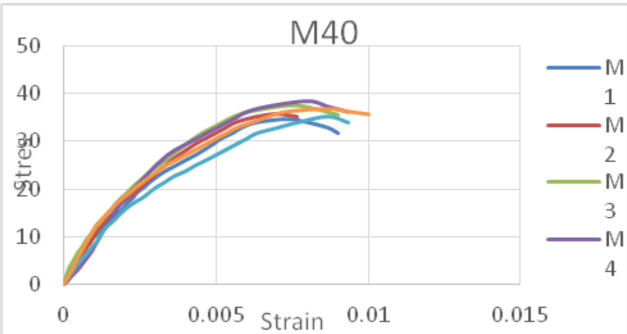
Concrete mix	M20		M30		M40	
	Stress	Strain	Stress	Strain	Stress	Strain
M1(Normal concrete)	18.11	0.0073	25.46	0.0073	34.63	0.0073
M2 (0.3% PEG)	19.33	0.0073	26.37	0.0073	35.65	0.007
M3 (50% M-Sand)	20.37	0.008	28.29	0.008	37.63	0.0076
M4 (50% M-Sand +0.3% PEG)	21.67	0.0083	29.42	0.0083	38.48	0.008
M5 (100% M-Sand)	18.78	0.0093	26.08	0.009	35.19	0.0086
M6 (100% M-Sand + 0.3% PEG)	19.80	0.0096	27.44	0.009	36.78	0.0086



Stress strain behaviour of M20 grade concrete(N/mm2)



Stress strain behaviour of M30 grade concrete(N/mm2)



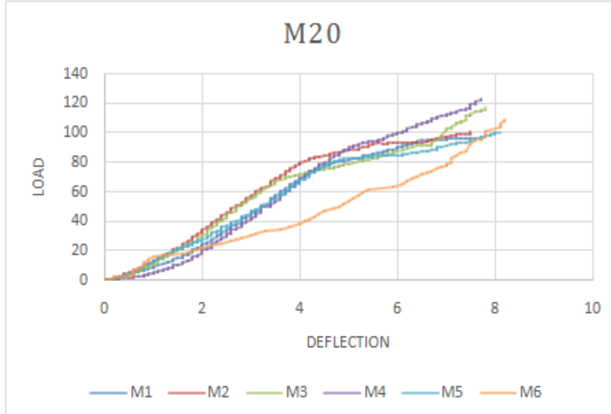
Stress strain behaviour of M40 grade concrete(N/mm2)

From the above figures it concluded that stress-strain behavior other mixis higher than normal mix. 50% replacement of M-sand gives higher strength compare to 0% replacement and 100% replacement. The M4 mix has well in stress. The strain was increasing with the increment of manufactured sand.

LOAD DEFLECTION BEHAVIOUR OF RCC BEAM:

Load deflectionbehaviour of RCC beam @ 28 days

Concrete mix	M20	
	Load(KN)	Deflection(mm)
M1(Normal concrete)	96.7	7.6
M2 (0.3% PEG)	101	7.5
M3 (50% M-Sand)	117.8	7.8
M4 (50% M-Sand +0.3% PEG)	123.3	7.7
M5 (100% M-Sand)	100.2	8.1
M6 (100% M-Sand + 0.3% PEG)	108	8.2



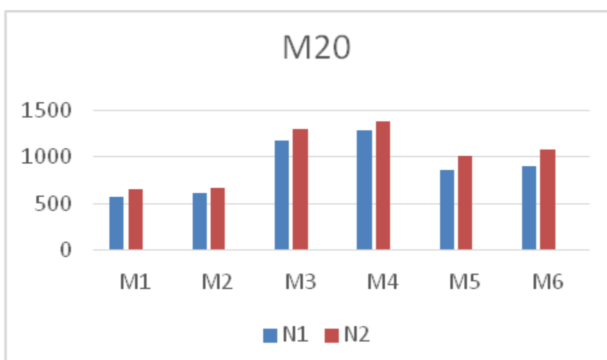
Load-deflection behavior of RCC beam

From the above figure it shows that load deflection behaviour of other mix are higher than normal mix. The M4 has well in Load capacity. The deflection was increasing with the increment of manufactured sand.

IMPACT STRENGTH:

Table 5.6 Impact strength of concrete @ 28 dayskN mm

Concrete mix	M20 N1/N2	
	hammer per blow	Impact energy
M1(Normal concrete)	28/32	569.66/651.04
M2 (0.3% PEG)	30/33	610.35/671.38
M3 (50% M-Sand)	58/64	1180.01/1302.08
M4 (50% M-Sand +0.3% PEG)	63/68	1281.75/1383.46
M5 (100% M-Sand)	42/50	854.49/1017.25
M6 (100% M-Sand + 0.3% PEG)	44/53	895.18/1078.28



Impact strength of concretekN mm

From the above figure it shows that addition M3 and M4 mix having high impact strength compare to other mix. When the replacement of M-Sand increases there is a increase in number of blows from visible crack (N1) to failure crack (N2).

V. SUMMARY AND CONCLUSIONS

Based on the results obtained in this study, the following conclusions can be drawn. The experimental investigation has been completed to analysis the residual compressive, split tensile, flexural strength, stress-strain behavior, load-deflection behavior of RCC beam with replacement of 50% and 100% manufactured sand and manufactured sand self curing concrete with 0.3% of polyethylene glycol (1500).

- It is observed that the strength of concrete is improved by 50% and 100% replacement of M-sand.
- The experimental results shows that the manufactured sand replaced concrete has higher strength at 50% replacement and additionally increment in the percentage of manufactured sand, decreased the strength of concrete.
- Comparing of test results we found that self-curing concrete attains higher strength at lower replacement of manufactured sand.
- Stress and Peak load for the 50% replacement of M-sandself curing concrete is high compare to the other mix. Increase in the replacement of manufactured sand was attaining higher strain and deflection.
- When the replacement of M-sand increases there is a increase in number of blows from visible crack (N1) to failure crack (N2).
- Hencethisresearchconcludedthat50%manufacturedsa nd self curingconcrete obtain high strength.
- The superior shape, proper gradation, and smooth surface texture of manufactured provide greaterstrength.

Scope for Future Work:

- To determine the Durability Properties in self curing concrete along with M-sand.
- To determine the shearbehaviour of concrete columns using self curingconcrete with replacement of M-sand.
- To study the fire performance of concrete with replacement of M-sand.

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