© 2017 IJSRST | Volume 3 | Issue 8 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X
Themed Section: Science and Technology

An Experimental Investigation on the Properties of Concrete with Replacement of Natural Sand with Robosand as Fine Aggregate

[1]Kadapa Naresh Kumar, [2]Syed Rizwan

[1]M.Tech Student ,Department of Civil Engineering, St.Mark Educational Institution Society Group of Institutions, Anantapur, Andra Pradesh, India
[2]Assistant Professor, Department of Civil Engineering, St.Mark Educational Institution Society Group of Institutions, Anantapur, Andra Pradesh, India

ABSTRACT

Concrete is the most widely used composite construction material. Fine aggregate plays a very important role for imparting better properties to concrete in its fresh and hardened state. Generally, river sand was used as fine aggregate for construction. Due to the continuous mining of sand from riverbed led to the depletion of river sand and it became a scarce material. Also, sand mining from river bed caused a lot of environmental issues. As a substitute to river sand, Robo sand has been used. In this present experimental study a comparative study has been carried out to check the usability of Robo sand in place of natural sand. This study involves determination of some major properties of concrete like compressive strength, split tensile strength, flexural tensile strength and durability in acidic medium made of both the sands. Based on proposed studies, quality of Robo sand is equivalent to natural sand in many respects, such as cleanliness, grading, strength, angularity, specific gravity. Conclusion have been arrived that Robo sand produced from VSI (vertical shaft impact or) is a suitable and viable substitute to river sand and could be effectively used in making concrete which provides adequate strength and durability for the concrete. In the design of concrete structures, concrete is taken into account by taking its compressive strength value. The compressive strength of the concrete made of Robo sand is observed to be very nearer to the strength of the concrete made of natural sand in the present investigation, there by 100% replacement is reasonable.

Keywords : Natural Sand, Robosand, VSI, Water Binder, Vastu Shastra

I. INTRODUCTION

This chapter contains the general information about Robo sand, its origin, need of manufactured in construction. It also includes the exact meaning of Robo sand, crushed dust, process of manufacturing by various machinery.

Natural sands are weathered and worn out particles of rocks and are of various grades or size depending on the accounting of wearing. The main natural and cheapest resource of sand is river. Dams are constructed on every river hence these resources are erasing very fast. Now a day's good sand is not readily available, it should be transported from long distance. Those resources are also exhausting very rapidly.

1.1. Robo sand :

"Robo sand is defined as a purpose made crushed fine aggregate produced from a suitable source material. Production generally involves Crushing, Screening and possibly Washing, separation into discrete fractions, recombining and blending. At the beginning Robo sand produced (by Jaw crusher, cone crusher, roll crusher, hammer mill) contains flaky and elongated particles. But now Robo sand produced from V.S.I (vertical shaft impact or) is a suitable and viable substitute to river sand and could be effectively used in making concrete which provides adequate strength and durability for the concrete.

Having cubical shape, it effectively provides good bonding in concrete. Grading of Robo sand can be controlled i.e required zone of sand can be obtained. Robo sand can be produced with zero fines. As it doesn't contain silt and clay, setting properties of

cement are not altered. For big projects where large quantity of aggregate is required, Plants are established near the site so that the cost of transportation can be reduced.

1.2. Need for Robo sand :

The Civil engineers, Architects, Builders, and Contractors agrees that the natural sand, which is available today, is deficient in many respect. It does not contain the fine particles, in proper proportion as required. Presence of other impurities such as coal, bones, shells, mica and silt etc makes it inferior for the use in cement concrete. The decay of these materials, due to weathering effect, shortens the life of the work. Now days, Government have put ban on dragging sand from river bed.

Due to dragging of the sand ,from river bed reduces the water head, so less percolation of rain water in ground, which result in lower ground water level. In some places it may be up to 600 ft deep. The roots of the tree may not be able to get water. The water flowing in the river may be covered with sand so it is less exposed to Sun. In the absence of sand, more water gets evaporated due to direct sunlight. The rain water flowing in the river contains more impurities. When it passes through sand bed it gets filtered. (In water supply schemes the water is filtered in sand bed only) If there is no sand in river-bed, water will not be filtered. Such water may be harmful for drinking purpose. Reduced water level in ground, may result in draught, even scarcity of drinking water, so Government have to supply water by tanker. Which is more expensive compared to the royalty collected for sand.

Vastu Shastra:

Now a day's Vastu Shastra is more popular, followed by so many persons for constructing a house. As per Vastu shastra the Building material must be free from traces of human body or animal body. The River sand contains bones of human beings and animals. The shells are also one kind of bone. It is not easy to take out all such things present in the river sand. The best solution for this is to use Robo sand of good quality.

Cost:

Enormous growth of infrastructure in the country resulting in increased use of river sand. Therefore, scarcity of sand effecting the cost of sand and hence cost of construction.

Considering all the above facts, need for Robo sand has increased drastically. Therefore, it is necessary to replace natural sand in concrete by an alternate material either partially or completely without compromising the quality of concrete.

1.3.Market name for Robo sand .

It is being called in the market with different names like Artificial sand(as it is artificially produced), Robo sand(as it produced first by the company named Robosilicon ,pvt, limited) ,crushed sand (as it is produced from crushing),Rock sand (as the origin is rock).

1.4 Manufacturing process:

Manufacturing process involves the following three steps:
1. Crushing by VSI crusher.
2. Screening.
3. Washing.

Crushing of stones in to aggregates by VSI, then fed to Rotopactor to crush aggregates into sand to required grain sizes (as fines). Screening is done to eliminate dust particles and Washing of sand eliminates very fine particles present within. The end product will satisfy all the requirements of IS:383 and can be used in Concrete & construction. The VSI Plants are available capacity up-to 400Ton Per Hour(TPH). Only, sand manufactured by VSI crusher/ Rotopactor(shown in the fig1,fig2) is cubical and angular in shape. Sand made by other types of machines is flaky, which is troublesome in working. The Jaw crushers are generally used for crushing stones in to metal/aggregates. Robo sand from jaw crusher, cone crusher, roll crusher often contain higher percentage of dust and have flaky particle.

II. REVIEW OF LITERAURE

2.1.General

Misra (1984) studied the effect of complete replacement of sand with crushed sand (fine sand passing through 75µ). The percentage of water required to produce mortar of same consistency is high for Robosand as compared to river sand of same grading and same mix proportions. Hudson (1999) reported that Concrete Manufactured with a high percentage of minus 75 micron material will yield a more cohesive mix than concrete made with typical natural sand. Giridhar (2000) have observed that the concrete prepared using crusher stone dust was found to be relatively less workable than those compared with river sand and for the concrete made with crusher dust, there is an increase of 6% strength split tension and an increase of 20% strength in flexural tensile tension at 28 days for M20 grade design mix. Rao et.al (2002) has found that as percentage of stone dust increases the workability decreases in each grade of concrete, to compensate the decrease in workability, some quantity of water and cement were added to get normal workability. The percentage of increase in water is in the range of 5% to7%.

Bhanuprabha,(2003) observed that the percentage of weight for M20, M25 and M30 grade Robo sand concrete increased in 5% H2S04 and 5% Na2S03 acid compared to plain concrete and found to be as−30.3%,−24.4%, −22.9%; and −5.3%, −2.2%,−1.25% respectively. The negative sign indicates less reduction in weight loss that means the concrete is slightly more durable to sulphuric acid attack and sulphate attack when compared to river sand. Dinesh Khare (2002) has reported that flexural tensile stress of the concrete increases as percentage of Robo sand increases.

2.2. Experimental studies conducted by different researchers along with their study.

- Bhikshma et.al(2009) conducted tests on 30 concrete cubes and 10 reinforced beams. They observed increase in compressive strengths by 6.89%, 10.76%, 17.24% and 20.24% for replacements of 25%,50%,75% and 100% of Robo sand .
- Having conducted different tests ULTRA TECH PVT LTD, arrived at increased in compressive strength values.
- According to the report given by Venu et.al from BITS PILANI, Hyderabad the flexural strength of high performance concrete increases with increase in silica fume and Robo sand.

III. METHODOLOGY OF EXPERIMENTAL WORK

3.1 General

An experimental study is conducted to find 7 and 28 day Compressive , Flexural, Split tensile tests along with 60 days acid ponding test in M_{30} grade concrete made of both Natural sand and Robo sand and the results were compared for drawing a conclusion.

Methodology and experimental work involves the tests required to ascertain the quality of materials for making concrete, designing the concrete mix, preparation of specimens and different standard methods for testing the concrete.

3.2. Tests on materials:

Cement:

Ordinary Portland cement of 53 grade available in local market is used in the investigation.The cement used has been tested for various properties as per IS:4031-1988 and found to be confirming to various specifications as per IS:12269-1987.The tests results on Ordinary Portland cement are shown in Table 1. Table-1: Physical properties of Ordinary Portland cement of 53 grade:

S	Property	Test
1	Normal consistency	30%
2	Specific gravity	3.047
3	Setting time Initial setting time Final setting time	35min 230min

4	Fineness of cement(IS	3.5%
5	Compressive strength(1:3 sand mortar cubes) 7 days 28 days	37Mpa

Fine aggregate:

The locally available natural sand and machine made Robo sand are used as fine aggregate. It should be free from clay, silt, organic impurities etc.,The sand is tested for various properties such as specific gravity ,bulk density etc. in accordance with IS:2386-1963. The grading or particle size distribution of fine aggregate shows that it is close to grading Zone –II or IS:383-1970 and details of sieve are shown in tables 3.1,3.2.

Table 2**:** Sieve analysis for fine aggregate

Table 3.1 Natural sand:Wt taken=1000gm

Sieve no:	Wt retained on each sieve	% of wt retaine	Cumulative % of wt retained	Cumulative % of passing
10 mm	0	0	0	100
4.75 mm	10	1	1	99
2.36 mm	10	1	2	98
1.18 mm	140	14	16	84
600 µ	215	21.5	37.5	62.5
300 µ	535	53.5	91	9
150 µ	70	7	98	2
75 µ	20	2	100	0
	Total 1000g			

This fine aggregate is confirming to Zone –II according to IS:383

Water:

Water used for mixing and curing shall be clean and free from injurious amount of oils, acids, alkalies, salts ,organic materials or other substances. They may be deleterious to concrete. Portable water is used for mixing as well as curing of concrete as prescribed in IS:456:2000.

3.3 Formulation of mix design procedure:

Target mean strength: The target mean strength(fck) is calculated as follows. Fck=fck+(txs) with usual BIS notations . When adequate data are not available to establish ‘s’ ,the fck value can be determined from the following table.

IS:10262-2009

Specified characteristic compressive strength,fck(Mpa)	Target mean compressive strength Fck(Mpa)
Less than 20.5 20.5-34.5	fck+6.9 fck+8.3 , fck+9.7

3.3.1Selection of Maximum size of coarse aggregate:

The maximum size of coarse aggregate is selected from the following table.

IS10262:2009

Required concrete strength(Mpa)	Maximum aggregate size (mm)
Less than 62 Greater than or equal to 62	20-25 10-12.5

3.3.2 Estimation of free water content:

The water content to obtain desired workability depends upon the amount of water, super plasticizers and its characteristics. However , the saturation point of super plasticizer is known and then the water dosage is given below. If the saturation point is not known, it is suggested that the water content of 145 lit /cu.m shall be taken to start with.

Determination of minimum water dosage: IS:10262-2009

3.3.3 Selection of water binder ratio:

The water binder (w/b) ratio for the target mean compressive strength is chosen from below graph, the w/b ratio verses compressive strength. The w/b is so chosen is checked against limiting w/b ratio for the requirement of durability

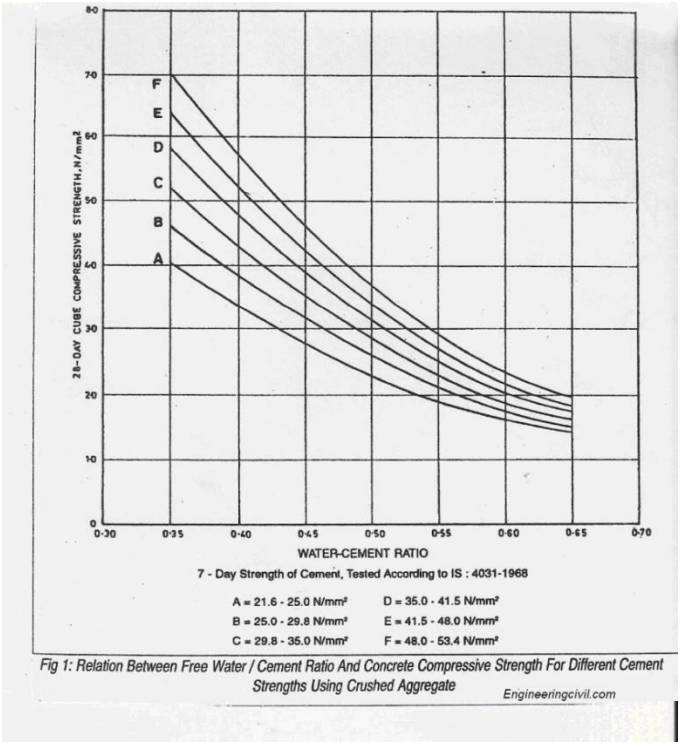


Fig 1: Relation Between Free Water / Cement Ratio And Concrete Compressive Strength For Different Cement Strengths Using Crushed Aggregate

3.3.4 Calculation of binder content:

The binder or cementations contents per cu.m of concrete is caluculated from the w/b ratio and quantity of water content per cu.m of concrete. Assuming the percentage of replacement of cement by silica fume content is obtained from the total binder contents. The remaining binder content is composed of cement. The cement content is so calculated and is checked against the minimum cement content for requirement of durability above values are adopted.

3.3.5 Estimation of fine aggregate contents:

The absolute volume of fine aggregate is obtained from the following equation .

$$V_{fa}=1000(V_w+M_c/S_c+M_{sf}/S_{sf}+M_{ca}/S_{ca}+M_{fa}/S_{fa}+V_{sol}+V_{ea})$$

Where

Vfa=Absolute volume of F.A in lit/cu.m of concrete.

Vw=Volume of water in lit/cu.m of concrete.

Mc= mass of cement kg/cu.m of concrete.

Sc=Specific gravity of cement

Msf,Mca=Total masses of Sf and CA in kg/cu.m of concrete.

Sca,Ssf=specific gravities of saturated surface dry coarse aggregate and silica fume respectively.

Vsol,Vea=Volume of solids in the super plastisizer and entrapped air lit/cu.m concrete respectively.

The fine aggretgate conctent per unit volume of concrete is obtained by multiplying the absolute volume of fine aggregate and the specific gravity of the finr aggregate .

3.4 PREPARATION OF THE SPECIMENS:

Design parameters :(for M30 grade concrete)

Parameters	Natural sand	Robo sand
Average size of aggregate	40 mm	40mm
Degree of Workability	Slump(100 mm)	Slump(100 mm)
Degree of quality ofcontrol	Good	Good
Type of exposure	Severe	Severe
Compressive strength of cement	53 N/mm2	53N/mm2
Selection of W/c ratio	0.45	0.4

3.4.1 Mixing:

Pan- mixing is adopted throughout the experimental work. First the materials cement, Fine aggregate, coarse aggregate, weighed accurately.pan mixer is used as a capacity of 1 cu.f t. The drum is made of steel plates with a number of blades put in inclined position in the drum. As the

drum rotates, the materials encountered resistance from the blades and these disturbing effects helps in good mixing of ingredients. The mixing is continued until there is a uniform distribution of materials and the mass uniform in color and consistency.

5-10% of total quantity of water required for mixing, sufficient to wet the drum thoroughly, shall be introduced before the other ingredients in order to prevent any chocking of cement on the blades or the sides of the mixer. After mixing the concrete is tested for workability using slump cone test.

3.4.2 Casting of specimens:

For casting the cubes, cylinder and beam specimens a standard cast iron metal moulds of size 150x150x150 mm cubes , 150 mm diameter and 300mm height cylinders and beams of size 150x150x700mm are used . The mould have been cleaned off dust particles and applied with mineral oil on all sides , before concrete is poured into the mould. Thoroughly mixed concrete is filled into the mould in three layers of equal height followed by vibration with needle vibrator. Excess concrete is removed with trovel and top surface is finished to smooth level.

3.4.3 Compaction of concrete:

Compaction of concrete is a process adopted for expelling the entrapped air from the concrete. In the process of placing and mixing of the concrete , air is likely to get entrapped in the concrete. If this air is not removed fully, the concrete looses strength considerably.

In order to achieve full compaction and maximum density with reasonable compacting efforts available at the site, it is necessary to use a mix with adequate workability. In the present investigation, the internal vibration is used for compacting the concrete.

Needle vibrator consists of a steel tube, which is inserted in fresh concrete. Theirs steel tube is connected to an electric mortar through a flexible tube. The size of poker is 40 mm diameter. The frequency of vibration is about 3000 rpm. Compaction of concrete by vibration makes the concrete better quality, higher strength with given cement content with less mixing water.

3.4.4 Curing of specimens:

Curing is the process of preventing the loss of moisture from the concrete while maintaining a satisfactory temperature regime. More elaborately, curing is defined as the process of maintaining satisfactory moisture content and a favorable temperature in concrete during the period immediately following placement, so that hydration of cement may continue until the desired properties are developed to sufficient degree to meet the requirement at service.

After casting, the moulded specimens are stored in the laboratory free from vibration, in moist air and room temperature for 24 hours from the time at addition of water to the dry ingredients. After this period, the specimens are removed from the moulds, immediately submerged in clean fresh water tank. The water in which specimens are submerged are renewed at every 7 days and maintained at a temperature of 27+_2 degree. The specimens are cured for 7 days and 28 days respectively.

Curing of Beams, Cubes and Cylinders.

3.5 Standard test procedures on concrete:

A.WORKBILITY BY SLUMP CONE TEST:
(According to IS: 1199 – 1959)

Unsupported concrete, when it is FRESH, will flow to the sides and a sinking in height will take place.

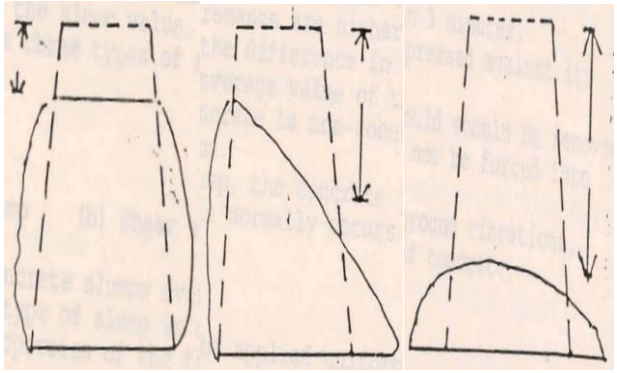
This vertical settlement is known as SLUMP. Slump is a measure indicating the consistency or workability of cement concrete. It gives an idea of water content needed for concrete to be used for different works. A concrete is said to be workable if it can be easily mixed and easily placed, compacted and finished. A workable concrete should not show any segregation or bleeding. Slump increases as water-cement ratio increases.

Slump test is the most commonly used method of measuring consistency of concrete which can be employed either in laboratory or in site of work. It is not a suitable method for very wet or very dry concrete. It does not measure all factors contributing to workability, nor it is always representative of the place-ability of concrete. However, it is used conveniently as a control test and gives an indication of the uniformity of concrete from batch to batch. Repeated batches of the same mix, brought to the same slump, will have the same water content and W/c ratio, provided the weights of aggregate, cement and admixtures are uniform and aggregate grading is within acceptable limits.

Apparatus consists of Slump cone, tray for mixing concrete, trowel, tamping *rod*, *steel* rule, measuring jar, weighing platform machine, spatula. The apparatus for conducting the slump test essentially consists of metallic mould in the form of a frustum of a cone having the dimensions as under:

Bottom diameter = 20cm Top diameter = 10 cm Height = 30 cm

The thickness of the metallic sheet for the mould should not be thinner than 1.6mm. For tamping the concrete, a steely tamping rod 16mm diameter; 0.6m long with bullet end is used.



True slump Shear slump Collapse slump

B.TESTING OF CUBES FOR COMPRESSIVE STRENGTH :

(According to IS: 516-1959)

In the design of concrete mixes, the compressive strength of concrete is generally the main target since it usually represents an overall picture of quality of concrete.The compressive strength is the maximum load per unit area sustained by a concrete before failure under compression. Since the strength development of concrete depends on both temperature .it can be said the strength is a function of summation of product of time and temperature this summation is called maturity of concrete.

The cube specimens cured as above are tested as per standard procedure after removal from the curing tank and allowed to a dry under shade. The cube specimens tested under microprocessor based compression testing machine of

2000KN capacity. The results are tabulated in table.

TESTNIG OF CUBES FOR DETERMINING COMPRESSIVE STRENGTH.

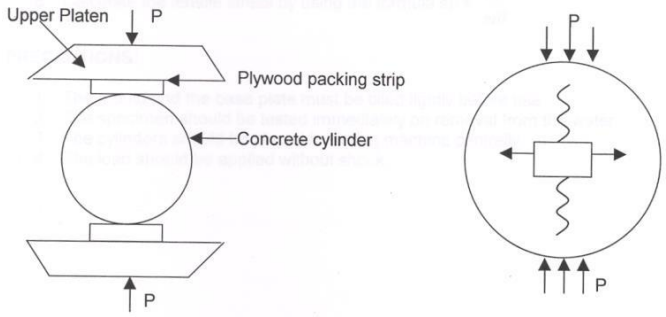
C. SPLITTING TENSILE STRENGTH :
(According to IS :516-1959)

Cylinder Splitting Tension Test: This is also sometimes referred as, “Brazilian Test”. This test was developed in Brazil in 1943. At about the same time this was also independently developed in Japan.

The test is carried out by placing a cylindrical specimen horizontally between the loading surfaces of a compression testing machine and the load is applied until failure of the cylinder, along the

vertical diameter. Figure 10.6 shows the test specimen and the stress pattern in the cylinder respectively.

When the load is applied along the generatrix, an element on the vertical diameter of the cylinder is subjected to a vertical compressive stress



D.DETERMINATION OF FLEXURAL STRENGTH :(According to IS:516-1959)

Direct measurement of tensile strength of concrete is difficult. Neither specimens nor testing apparatus have been designed which assure uniform distribution of the "pull" applied to the concrete. While a number of investigations involving the direct measurement of tensile strength have been made, beam tests are found to be dependable to measure flexural strength property of concrete.

The value of the modulus of rupture (extreme fibre stress in bending) depends on the dimension of the beam and manner of loading. The systems of loading used in finding out the flexural tension are central point loading and third point loading. In the central point loading, maximum fiber stress will come below the point of loading where the bending moment is maximum.In case of symmetrical two point loading, the critical crack may appear at any section, not strong enough to resist the stress within the middle third, where the bending moment is maximum. It can be expected that the two point loading will yield a lower value of the modulus of rupture than the centre point loading.

the modulus of rupture of beams of different sizes subjected to centre point and third point loading. I.S. 516-1959, specifies two point loading. The details of the specimen and procedure are described in the succeeding paragraphs.

The standard size of the specimens is 15 x 15 x 70 cm. Alternatively, if the largest nominal size of the aggregate does not exceed 20 mm, specimens 10 x 10 x50 cm may be used.

The mould should be of metal, preferably steel or cast iron and the metal should be of sufficient thickness to prevent spreading or warping. The mould should be constructed with the longer dimension horizontal and in such a manner as to facilitate the removal of the moulded specimens without damage.

The tamping bar should be a steel bar weighing 2 kg. 40 cm long and should have a ramming face 25 mm square.

The testing machine may be of any reliable type of sufficient capacity for the tests and capable of applying the load at the rate specified. The permissible errors should not be greater than 1.5 per cent of the applied load for commercial type of use. The bed of the testing machine should be provided with two steel rollers. 38 mm in diameter, on which the specimen is to be supported, and these rollers should be so mounted that the distance from centre to centre is 60 mm for 15 cm specimen or 40 cm for 10.0 cm specimens. The load is applied through two similar rollers mounted at the third points of the supporting span, that is spaced at 20 or 13.3 cm centre to centre. The load is divided equally between the two loading rollers, and all rollers are mounted in such a manner that the load is applied axially and without subjecting specimen to any torsional stresses or restrains.

E.DURABILITY OF CONCRETE :

The factors influencing durability include

1.Environment.
2. Cover to embedded steel.
3. The type and quality of constituent materials .
4. Cement content and w/c ratio of concrete.
5. Workmanship, to obtain full compaction and efficient curing.
6. Shape and size of member.

The degree of exposure anticipated for the concrete during its service life together with other relevant factors relating to mix composition, workmanship, design and detailing should be considered . All relevant requirements for durability of concrete as specified in IS456-2000.

In the present , investigation carried out to study the durability characteristics of concrete specimens of size150x150x150 mm subjected to acid attack.

Acid attack on concrete:

First of all , concrete containing Portland cement , being highly alkaline, is not resistant to attack by strong acids or compounds which may convert to acids .Chemical attack of concrete occurs by way of decomposition of the products of hydration and formation of new compound , which, if soluble , may be leached out and if not soluble, may be disruptive insitu. The attacking compounds must be in solution. The most vulnerable cement hydrate is $Ca(OH)_2$,but C-S-H can also be attacked calcareous aggregate are also vulnerable. Concrete can be attacked by liquids with Ph value below 6.5 but the attack is severe only at Ph below 5.5, If below4.5 , the attack is very severe.

Acids first react with free lime of concrete forming calcium salts and later on attack the hydro silicates and hydro aluminates forming. The corresponding calcium salts, whose solubility will govern the extent of deterioration caused to the concrete. In the present investigation , concrete specimens of size 150x150x150 mm are immersed in 5% H_2SO_4 solution. The deterioration of concrete specimens is presented in the form of % reduction in weight of concrete specimens.

POURING OF ACID TO MAINTAIN CONSTANT ACIDITY AT
REGULAAR INTERVAL OF 5 DAYS

IV. EXPERIMENTAL RESULTS AND DISCUSSIONS

4.1 Comparison of tests results of natural sand with artificial sand

4.1.1 Specific gravity:

The specific gravity value from the table indicates that the specific gravity of natural sand is more than that of artificial sand. Since the specific gravity of natural sand is more, corresponding weight of cubes of size 150x150x150 mm made from this sand is also more than weights of cubes made of robo sand .weights of cubes made of both sands can be observed in table .For the given volume of concrete quantity of manufactured sand required is more compared to requirement of natural sand.

Observed Specific gravities of fine and coarse aggregates:

S.no	Material	Specific gravity
1	Natural sand	2.66
2	Robo sand	2.55
3	Coarse aggregate	2.78

Bulking of fine aggregate:

% of water	Bulking of natural sand	Bulking of Robo sand
0	21.3	20.3
1	23.9	23.5
2	24.8	26.6
3	25.3	27.6
4	25.6	27.8
5	25.7	27.2
6	25.8	27

7	25	26.9
8	24	26.8

From the above table up to 4% the bulking is observed to be increased. The bulking values from the table shows that the bulking of artificial sand is more than natural sand. Thereby, Mix design by volume batching is difficult with artificial sand.

Concrete made of	Cube1 (KN)	Cube2 (KN)	Cube3 (KN)	Average (KN)
Natural sand				
At 7 days	930	1200	820	983
At 28 days	960	1200	1000	1053
Robo sand				
At 7days	850	900	920	890
At 28 days	900	1050	1300	1083

4.1.2 Workability by Slump cone method:

W/c ratio	Slump in mm for Robo sand	Slump in mm for natural sand
0.4	10	10
0.425	14	17
0.45	20	40
0.5	Collapsed	Collapsed

At low water/ cement ratios , the workability of concrete made of both sands is more or less same. But , as the w/c ratio increases, the natural sand was observed to be highly workable than artificial sand. So, where ever high workability is required, it is better to use natural sand (i.e congested reinforcement and pump able concrete). And where requirement workability is low, it is always advised to use Robo sand as it is economical. (i.e laying of concrete payments).

4.1.3 Compressive strength:

Compressive strength values of concrete made of both the sands.

At the beginning, i.e at 7 days the strength of the concrete made of Robo sand is less than that of natural sand. But as the days of curing increases , the strength of concrete cubes made of both sands are found more or less equal. As compressive strength is the main property of the concrete that is considered in design, we can replace natural sand with Robo sand completely in making concrete.

4.1.4 Flexural strength of concrete:

Concrete made of	Beam1 (kgf)	Beam2 (kgf)	Average (kgf)
Natural sand At 28 days	3700	3700	3700 kgf
Robo sand At 28 days	3400	2940	3170 kgf

4.1.5 Splitting tensile strength of concrete:

Concrete made of	**Cylinder 1** (KN)	**Cylinder 2** (KN)	**Average** (KN)
Natural sand At 28 days	230	230	230
Robo sand At28 days	164	188	176

The values of flexural and splitting tensile strengths of concrete made of natural sand were found to be slightly more than the values of concrete made of artificial sand .In any structural member, as

the tensile stresses are taken by steel to the greater extent, very low stresses are allowed to act on the concrete. So, artificial sand can be used in concrete.

V. FUTURE SCOPE OF WORK

5.0 Future scope of work:

- Replacing natural sand with different % of Robo sand so that clear variation of strength can be plotted as well as optimum amount can also be determined.
- Conducting investigation for M40, M50 and also for high strength concrete.
- Conducting chloride penetration test and water absorption tests on concrete to ensure adequate durability.
- Suitability of Robo sand must be ascertained for plastering.

VI. CONCLUSIONS

- 100% replacement is reasonable where there is low workability requirement.
- And where there is high workability requirement, partial replacement can be made keeping in view the strength and economy.
- Strength criteria can be fully ascertained with 100% replacement of natural sand with Robo sand.
- For big projects like highways, establishing a plant leads to economy as they require large amount of fine aggregate.
- River beds can be safeguarded by reducing the excavations for natural sand

VII. REFERENCES

[1]. Bhanuprabha(2003) , "studies on use of manufacuted sand as Fine Aggregate " M.Tech dissertion ,submitted to JNTU ,Hyderabad,India.

[2]. V.Bhikshma, K. Nittukar, and Venkatesham (2009), "Investigations on mechanical proper-ties of high strength silica fume concrete ".ASIAN JOURNAL OF CIVIL ENGG(building and .)Vol.10,no.3.pp.335-346

[3]. Dinesh Khare(2002), "Marvelous properties of Stone crusher dust: A Waste by product of tone Crushers" ,National conference on Advance of Construction material,Hamirpur(H.P), india

[4]. Giridhar ,V(2000)., "Strength characteristics of Concrete using crusher stone dust as fine aggregate" ,63rd annual general meeting Hyderabad "ROBO SAND FOR CONCRETE ," ICJ,AUGUST 1999.

[5]. Misra,V.H(1984)., "use of stone dust from crusher in cement and sand mortar" ICJ,August1984

[6]. Saeed Ahmed and Shahid Mahmood(2008), "Effects of crushed and natural sand on the pro-Perties of freshsand Hardend concrete,our world in concrete and structures

[7]. Srinivas Rao,P.Seshagiri Rao ,and sarvana, (2002), "Effect of crusher stone dust on some properties of concrete ",National conference on Advances in construction materails , Hamirpur, pp:196-201.