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An Experimental Investigation of Modified Concrete Using Silica Fume and Stone Dust

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ABSTRACT: The demand of natural sand is quite high as there was an extensive use of concrete in the world of globalization era and this will lead to certain problems in construction field. Natural river sand is expensive due to excessive cost of transportation from natural sources. Also large-scale depletion of these sources creates environmental problems. As natural transportation and different imperatives make the accessibility and utilization of waterway sand less alluring, a substitute or replacement product for concrete industry should be found. Stream sand is most generally utilized fine total in the production of concrete represents the issue of intense deficiency in numerous zones. Whose proceeded with utilize has begun posturing difficult issues regarding its accessibility, cost and ecological effect. In such a circumstance the Stone clean can be a monetary contrasting option to the waterway sand. Stone Dust can be characterized as deposit, following or other non-volatile waste material after the extraction and handling of rocks to shape fine particles under 4.75mm. Normally, Stone Dust is utilized as a part of vast scale in the roadways as a surface completing material and furthermore utilized for assembling of empty squares and lightweight concrete pre-assembled Elements.

KEYWORDS: cement, silica fume stone dust, coarse aggregate, fine aggregate, water

I. INTRODUCTION

Portland cement concrete is the most widely manufactured material. Judging from the modern trends, the future of concrete looks brighter because for most purposes it offers suitable engineering properties at low cost combined with energy savings and ecological benefits. Concrete is the most generally utilized development material, usually made by blending cement, sand, pulverized stones and water. Its aggregate utilization is around twenty billions tones, which is proportionate to two tones for each living individual. People devour no material with the exception of water in such enormous amount. Concrete is a composite material that comprises basically of a coupling medium inside which are inserted particles of pieces of totals. In pressure driven cement concrete, the cover is framed from a blend of cement and water. Cement is a finely powdered material, which without anyone else is not a folio, creates restricting properties because of hydration. With the administration and different overall ecological associations proceeding to build weight on the cement and total businesses to decrease CO₂ emanations, and diminish the extraction of normally happening totals, new and imaginative arrangements are always being tried to give replacement materials which can be substituted for the essential totals. Silica fume is a side-effect of the produce of silicon and ferrosilicon amalgams from high immaculateness quartz and coal in a submerged-bend electric heater. The getting away vaporous SiO oxidized and condensates as to a great degree fine round particles of silica (SiO₂). Silica fume can have more than 90% of indistinct silica which is exceptionally receptive. The fineness of the particles accelerates the response with calcium hydroxide (created by the hydration of Portland cement). Silica fume has a distance across going in the vicinity of 0.03 and 0.3 μm, making it to a great degree fine and hence the particular surface is likewise high. This causes an expansion in water request, yet additionally makes the blends extremely steady. The high fineness additionally makes the particles get in the middle of the cement and therefore enhance pressing, yet this can't make up for the misfortune in workability. The expansion of silica fume is for the most part around 6.5 to 8% by mass. It must be noticed that silica fume is very

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costly. The term sand is normally utilized for fine totals coming about because of breaking down and assimilation procedure of sand stone. Fine total alludes to molecule measure littler than 4.75mm and bigger than 75microns. The overall utilization of sand as fine total in concrete production is high, and a few creating nations have experienced some strain in the supply of normal sand keeping in mind the end goal to meet the expanding needs of infrastructural improvement lately. A circumstance that is in charge of increment in the cost of sand, and the cost of concrete

II. LITERATURE REVIEW

A literature study was conducted to obtain general information about the different types of materials used and to investigate what type of research has been done on the topic so far. **PrachoomKhamput**^[13], contemplated the compressive quality of concrete utilizing quarry clean as fine total rather than sand. Proportion of cement: sand: shake is 1: 2: 4 (by weight) and at water-cement proportion (w/c) of 0.45. The admixture sort E is included for expanding the compressive quality. Without utilizing the admixture, it is discovered that the compressive qualities are 26.97, 25.506, 23.64 and 22.95 N/mm² for utilizing quarry clean at 70%, 90%, 100% (sifter investigation) and 100% (not strainer examination) separately. At the point when the admixture is included, the aftereffects of compressive qualities are 28.64, 28.154, 27.07 and N/mm² for 70%, 90%, 100% (strainer examination) and 100% (not sifter investigation) of quarry clean individually. The paper of **M.R.Chitlange, R.S.Bang, Dr.P.S.Pajgade**^[14], presents the feasibility of using made sand procured by beating basalt, over regular sand considering the specific ,environmental and business factors .For the inspiration driving experimentation solid mixes were expected for M20,M30 and M40 grades with 100% substitution of trademark sand by reenacted sand. The compressive, flexural and split malleable tests were coordinated to contemplate the nature of cement using fake sand and the results are differentiated and that of trademark sand concrete. The paper published by **S. N. Raman, M. F. M. Zain, H. B. Mahmud, and K. S. Tan**^[15], reports the exploratory examination attempted to research a few properties of quarry tidy and talks about the reasonableness of those properties to empower quarry clean to be utilized as incomplete trade material for sand in concrete. The properties of quarry tidy that were resolved are total pulverizing esteem, flakiness file, pH esteem, soundness, particular gravity, ingestion and fineness modulus. Plus, the 28th day compressive quality of solid examples, in which incomplete supplanting of stream sand with quarry clean were honed, is additionally announced for correlation purposes. **R. IlangoVana, N. Mahendrana and K. Nagamanib**^[16], contemplated the achievability of the use of Quarry Rock Dust as hundred percent substitutes for Natural Sand in concrete. Blend configuration has been created for three evaluations utilizing plan an approach IS, ACI, USBR, RN.No.4 and BRITISH for both regular cement and quarry tidy cement. Therefore, charnockite, and charnockitic gneiss and granitic gneiss shake quarries are sensible for supply of quarry clean to be used as a possibility for stream sand. **ChaturangaLakshaniKapugamage, ArunaLalAmarasiri, WiranjithPriyan Solomon Dias and DissanayakeMudiyanselageChandaniShyamaliDamayanthiBandara**^[18], said that The usage of fly blazing stays in concrete is charming an aftereffect of points of interest, for instance, accommodating exchange of a reaction, extended workability, diminishment of bond use, extended sulfate resistance, **S. N. Raman, M. F. M. Zain, H. B. Mahmud, K. S. Tan**^[19], reports the exploratory examination grasped to look into the effect of deficient supplanting of sand with quarry clean, and bond with fly ash on the solid compressive quality change. **M. ShahulHameed , A.S.S. Sekar and V.Saraswathi**^[20]were intended to focus chloride invasion examination of self compacting green cement (SCGC) made with current misuses i.e. marble overflow powder (MSP) from marble get ready, and quarry shake clean (CRD) from stone beating wands. MSP can be used as filler and reductions the total voids content in concrete. Along these lines, this adds to improve the nature of cement. A test examination has been done to contemplate the combined effect of development of MSP and CRD on the chloride penetration of SCGC. From the result it is watched that CRD with 15% MSP was more useful than conduit sand for amassing SCGC. The paper presented by **T. Felix kalaand P. Partheeban**^[21]looks at the likelihood of utilizing rock powder as substitution of sand and halfway supplanting of bond with fly cinder, silica smoke, slag and superplasticiser in concrete. The rate of stone powder included by weight was 0, 25, 50, 75 and 100 as a substitution of sand utilized as a part of cement and concrete was supplanted with 7.5% silica smolder, 10% fly fiery remains, 10% slag and 1%Nsuperplasticiser. **H. Katkhuda, B. Hanayneh and N. Shatarat**^[22], examined the disengaged impact of silica fume on pliable, compressive and flexure qualities on high quality lightweight concrete. in light of the fact that it relies upon the water– cementitious material (w/cm) proportion of the blend. In light of the outcomes, a connection between split-pliable, compressive and flexure

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qualities of silica fume concrete was produced utilizing measurable techniques. **Manasseh JOEL**^[23], In this postulation creator researched the reasonableness of Crushed rock fine (CGF) to supplant waterway sand in solid production for use in unbending asphalt. **Md. Safiuddin, 1 S.N. Raman and 3M.F.M. Zain**^[24] This paper surveys the use of Quarry Waste Fine Aggregate in Concrete Mixtures. Four distinct sorts of solid blend were arranged, and tried in new and solidified states. With the exception of control solid, quarry squander fine total was utilized as a part of all cements as a fractional substitution of common sand. The impacts of quarry squander fine total on a few crisp and solidified properties of the cements were explored. What's more, after conclusions are drawn: Quarry squander fine total upgraded the droop and droop stream of cement, as the water request was diminished because of decreased surface territory of fine totals. Quarry squander fine total did not influence the unit weight and air substance of crisp cement. Quarry squander fine total diminished the compressive quality of cement because of inadequate reviewing and unnecessary flakiness.

III. MATERIALS

The regular elements of concrete are cement, coarse and fine totals and water. By wise utilization of accessible materials for concrete making and their proportioning, concrete blends are delivered to have the coveted properties in the crisp and solidified states, as the circumstance requests. The sorts of materials utilized for the Concrete blend, and its attributes according to significant codes of training are shown. In this segment the physical and concoction properties of the concrete making materials which impact the properties and execution of concrete blends are talked about.

Characteristics of Materials Used in present study

The following are the details of the materials used for mix, properties of the materials and mix proportioning for the present investigation.

Cement: Cement is a finely ground material that has cohesive and adhesive properties in the presence of water, which provide a binding medium for the discrete ingredients. Such cements are called hydraulic cements. These consist primarily of silicates and aluminates of lime obtained from limestone and clay. Ordinary Portland cement of 53 grade is used in the study. The properties of 53 grade cement used in the study are given in the

Table Properties of cement

Sl.no	Properties	Obtained Values	As per IS12269-1987
1	Fineness(Blaine's air permeability test)	370m ² /kg	Shall not be less than 225 m ² /kg
2	Soundness (by Le Chatelier's)	1.00 mm	Not more than 10 mm
3	1. Initial SettingTime	85.00 min	Not less than 30 min
	2. Final SettingTime	355.00 min	Not more than 600 min
4	Compressive strength	55	Not less than 53 N/mm ²
5	Standard Consistency	30 %	
6	Specific Gravity	3.15	

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Water

Water is the most important and least expensive ingredient of concrete. A part of mixing water is utilized in the hydration of cement to form the binding matrix in which the inert aggregates are held in suspension until the matrix has hardened. The remaining water serves as a lubricant between the fine and coarse aggregates and makes the concrete workable.

Clean potable water available in the laboratory was used for mixing and curing of the concrete. The w/c ratio is the key factor that determines the strength of concrete.

Aggregates

The total is utilized essentially with the end goal of giving mass to the concrete, and constitutes 60 to 80 percent of completed product. To expand the thickness of the subsequent blend, the total is habitually utilized as a part of at least two sizes. The most imperative capacity of littler size particles (fine total) is to help with delivering workability and consistency in the blend. The fine total additionally helps the cement glue to hold the bigger particles (coarse total) in suspension. This activity advances versatility in the blend and keeps the conceivable isolation of glue and coarse total. The order of totals utilized as a part of concrete production is for the most part in light of their land beginning, measure, shape, unit weight, and so forth be that as it may, here just the characterization as per estimate is talked about as fine total and coarse total.

Fine aggregates : Sand: River sand was used as fine aggregate. Natural River sand conforming to specification IS: 383-1970.

Table 3.2: Physical Properties of FA (SAND)

Sl No	Property	Test Result
1	Specific gravity	2.66
2	Water absorption	0.6%

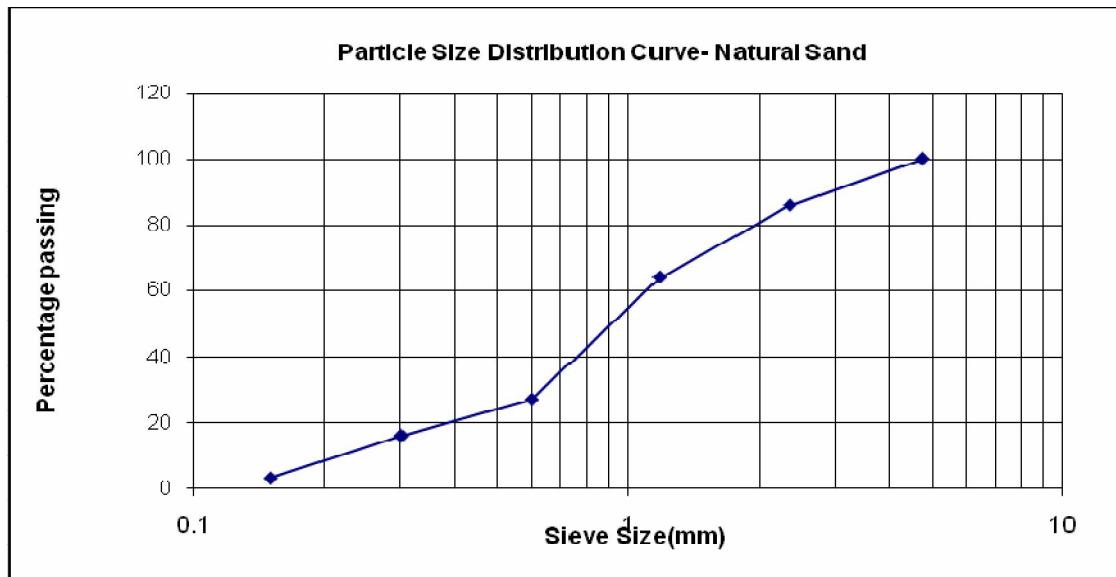
IS Sieve No	Natural Sand	Zone II
4.75 mm	100	90-100
2.36 mm	86	75-100
1.18 mm	64	55-90
600 micron	27	35-59
300 micron	6	8-30
150 micron	3	0-10

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Graph no: 1 Showing the sieve analysis of natural sand

Stone dust: Stone dust used in the laboratory investigations was procured from a local crushing plant. The specific gravity of stone dust was 2.63 and fineness modulus was 2.72. Table 3.3: Physical properties of FA (STONE DUST)

Sl No	Property	Test Result
1	Specific gravity	2.63
2	Water absorption	0.6 %
3	a) Dry rodded bulk density	1807 Kg/m ³
	b) Loose bulk density	1628 kg/m ³
4	Fineness modulus	2.72

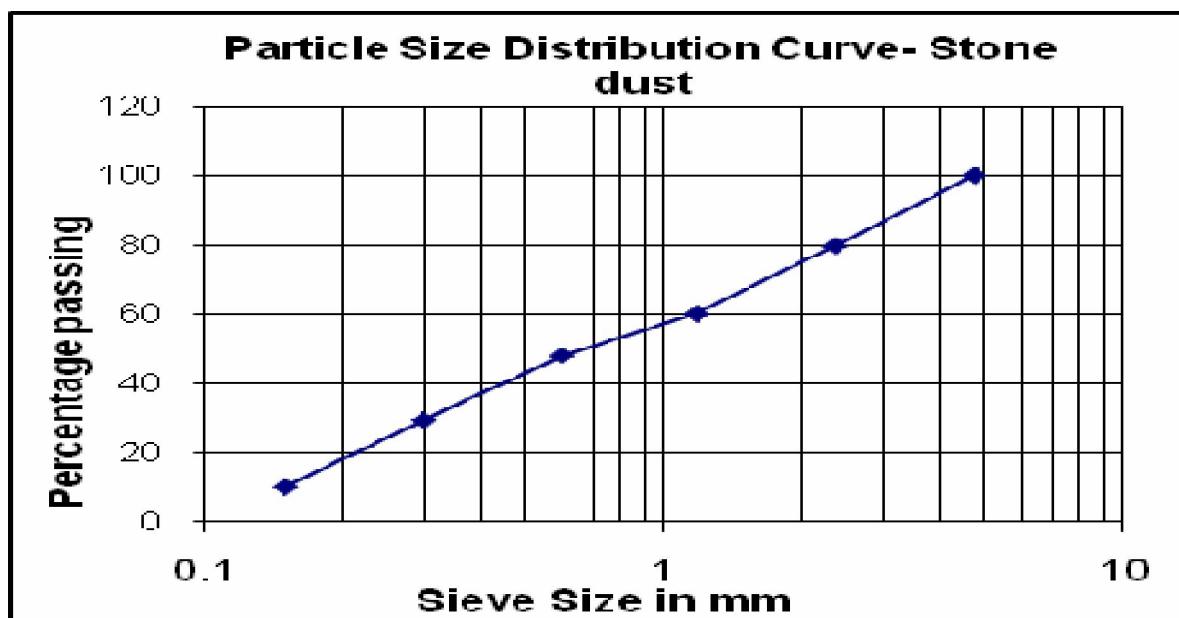
IS Sieve	Stone Dust	Zone II
4.75 mm	100	90-100
2.36 mm	79.9	75-100
1.18 mm	60.2	55-90
600 micron	48.3	35-59
300 micron	29.5	8-30
150 micron	10.5	0-10

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Graph no: 2 Showing the sieve analysis of Stone dust

Coarse Aggregates It is an aggregate such as crushed stone, crushed gravel most of which is retained on 4.75 mm IS sieve. Coarse aggregate (granite) from Bettadadasuru quarry site, Bengaluru of size 20mm passing, and 12.5mm conforming to specification IS 383:1970 and also to Testing requirements as per - IS 2386 Part I are used for the investigation (Fig 4.1).

Table 3.4: Physical Properties of CA (Max size 20mm)

Sl No	Property	Test Result
1	Specific gravity	2.66
2	Water absorption	0.4 %

Table 3.5: Sieve analysis details of CA (Max size 20mm)

IS Sieves	Cumulative Percent	
	Retained	Passing
20 mm	00	100.0
16 mm	9.00	91.0
12.5 mm	93.00	7.0
10.0 mm	99.20	0.8
4.75 mm	100.00	0.0

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REMARKS: Sample conforms to the requirements of single size aggregate as per IS:383- 1970

Table Physical Properties of CA (Max size 12.5mm)

Sl No	Property	Test Result
1	Specific gravity	2.66
2	Water absorption	0.4 %

Table Sieve analysis details of CA (Max size 12.5mm)

IS Sieves	Cumulative Percent	
	Retained	Passing
12.5 mm	2.60	100
10.0 mm	23.6	97.4
4.75 mm	100	0.0

REMARKS: Sample conforms to the requirements of graded aggregate as per IS:383-1970.

3.2.5 Silica fume:

Silica fume was collected from chronic India Pvt. Ltd, Navi Mumbai. The properties provided by the manufacturer are as is shownTable Physical properties of Silica Fume

Sl.no	Properties	Obtained values	ASTM-C-1240
1	Loss of Ignition(LOI)	2.8 %	Not more than 6%
2	Moisture	0.4 %	Not more than 3 %
3	Pozz Activity Index	131 %	Should be more than 105%
4	Specific Surface Area	22 m ² /gm	Should be more than 15 m ² /gm
5	Bulk Density	590	Range between 550 to 700
6	+ 45 Microns	0.3 %	Not more than 3 %

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V. CONCLUSION

From the above results, it can be concluded that silica fume and stone dust can be effectively used in concrete.

1. The inclusion of stone dust has desirable effect on concrete mechanical properties which is comparable to normal concrete.
2. The usage of silica fume in concrete as cement replacement materials will lessen the CO₂ being emitted during its manufacture and acts as an eco-friendly material reducing the Green house effect.
3. Incorporation of these materials in concrete helps in making it more economical.
4. The cost of stone dust is less compared to natural sand.
5. Thus, it can be concluded that the replacement of natural sand with Stone Dust, as full replacement in concrete is possible. However, it is advisable to carry out trial casting with Stone Dust proposed to be used, in order to arrive at the water content and mix proportion to suit the required workability levels and strength requirement.
6. Stone dust used as Fine Aggregate replacement enables the large utilisation of waste product.
7. The workability of fresh concrete can be increased by adding suitable admixtures.

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