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AN ALTERNATE FINE AGGREGATE AND ZEOLITE BLEND TO ASSESS COMPRESSION QUALITY OF CONCRETE

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ABSTRACT
The current exploratory examination centers around the impact of Quarry residues and normal zeolite on the compression quality of concrete. Sand is mostly supplanted with Quarry residue and cement by natural zeolite in M30 grade of concrete. The present experimentation uncovers that zeolite can supplant cement, and quarry residue can substitute fine sand in concrete to some degree. At half supplanting of fine sand with Quarry dust, increment in compressive strength was taken note. At the same time, 30% supplanting of cement with zeolite, showed better compression quality. The test outcomes were observed to be palatable with the individual and joined substitutions of Quarry residue and zeolite regarding compression nature of concrete.

KEY WORDS: Zeolite, Quarry dust, Compressive strength, Partial Replacement

I. INTRODUCTION

Concrete is a composite material that comprises of a coupling medium inside which are inserted the pieces of particles of aggregates. Aggregates are the granular materials like sand, rock, smashed stone or annihilation squander that is utilized with the solidifying medium to create either mortar or concrete. The coarse aggregates are the items coming about because of characteristic breaking down by weathering of rocks. Waterway sand is most generally used fine aggregate in concrete yet as a result of exceptional insufficiency in various locales; openness, cost and characteristic impact are of critical concern. To overcome this crisis, halfway supplanting of sand with quarry buildups can be a financial option. Stone residue satisfies the reason for the elective material as a substitute for sand at insignificant expense. Concrete shows higher compressive quality subsequent to supplanting fine total with quarry sand. Pressure driven or water resisting cements utilized in concrete comprise of Portland cement and its few alterations. The properties of concrete containing Portland cement create because of substance responses between the Portland bond mixes and water, on the grounds that the hydration responses are joined by changes in issue and vitality. Choice of appropriate materials and blend extents are essential strides in producing a concrete meeting the requirements of strength and durability in a structural member. Portland cement, the principal hydraulic binder employed in trendy concrete mixtures, could be a factory-made product that isn't solely energy-intensive (4 GJ/ton of cement) however conjointly to blame for giant emissions of carbon-di-oxide. The manufacture of one ton of Portland cement clinker releases on the common 1 ton carbon dioxide into the atmosphere. The worlds yearly cement production of four billion plenty of principally Portland cement is to blame for nearly seven per cent of total world carbon dioxide emissions [1]. Typical ingredient of general use concrete mixtures could be a cementing material composed of Portland cement and one or additional supplementary cementing materials/mineral admixtures like fly ash, ground granulated blast furnace slag, rice husk ash, silica fume, zeolite, alcoffine, metakaolin, pulverized lime stone or lime stone dust from quarries and raw or calcined pozzolan, coarse and fine aggregates, mixing water, and one or more chemical admixtures.
Mineral admixtures are often finely divided siliceous materials that are added to concrete in relatively large amounts, generally, in the range of 20 to 70 per cent by mass of the total cementitious material. Although natural pozzolanas in the raw state or after thermal activation are being used in some parts of the world, due to economic and environmental considerations many industrial by-products have become the primary source of mineral admixtures in concrete. With proper quality control, large amounts of many industrial by-products can be incorporated into concrete, either in the form of blended Portland cement or as mineral admixtures. Whenever a pozzolanic and /or cementitious by-product can be used as a partial replacement of Portland cement in concrete, it represents significant energy and cost savings.

II. EXPERIMENTAL PROGRAM

A. Materials

The materials used for the project work were in accordance with the required standards. Ordinary Portland cement (Type-I) cement is an excellent general cement and is used most widely. Portland cement is produced by pulverizing clinkers consisting of crystalline hydraulic calcium silicates, and a small amount of one or more forms of calcium sulfate and up to

5% limestone as an integral addition. OPC of 53 grade, coarse aggregates, waterway sand, natural zeolite and potable water were used for the preparation of concrete.

Natural mineral aggregates form the most important class of aggregate for making Portland cement concrete. Approximately three-quarters of the volume of concrete is occupied by aggregate, hence its quality is of considerable importance. Natural aggregates of 20 mm size, formed by the process of weathering, abrasion or by artificially crushing a large parent mass were used.

Natural zeolites are alumino-silicates of alkaline and alkaline earth cations such as potassium (K), calcium (Ca), and sodium (Na). They form the largest and most varied mineral group of the earth's crust. The main features of zeolites are an open structure and ability to accommodate water and cations within the structure and give them up without changing its structure significantly. Structurally they are considered hydrated aluminum tecto-silicates where aluminum is replacing silicon (Si) at the center of the structural tetrahedrons, with alkaline and alkaline earth cations forming open structures [3].

Zeolites can be considered a novel product in the construction industry due to the great number of advantages they offer, including ease of removal, wide availability of deposits, lack of complexity of their manufacturing process and a reduction of environmental pollution. Several research studies have evidenced the reduction of environmental pollution caused by the use of zeolites [6].

Specifically, zeolite application in cementitious materials such as mortar and concrete contributes to enhancing the mechanical properties of these materials as well to noticeable increase resistance chloride ion diffusion, their freeze-thaw resistance, and overall permeability [4]. It also increases their sulfate resistance, enabling them to be used in aggressive environments, such as special foundations or injection mortars.

Quarry residue, a waste material that causes disposal problem in quarries is made as a valuable resource by its successful utilization as fine aggregate and this will help to overcome the strain on the demand and supply of river sand [9]. Quarry residue is obtained during the crushing of large rock boulders into coarse aggregates. About 20-25% of the total material crushed in a crusher unit for extraction of aggregates is left as fine dust and is considered to be waste. These are sieved aggregates usually less than 5mm in size with a particle size distribution close to that of sand and are usually produced in large volumes. Quarry residue has been proposed as an alternative to natural river sand that gives additional benefit to concrete. It is known to cause an increase in the strength of concrete over that made with equal amount of natural sand. Utilization of quarry residue not only relieves pressure on river sand but also reduces the need for its dumping, as quarry residue is considered a waste product in the quarries [10].

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 water used for the mixing and curing of concrete should be free from injurious amounts of deleterious materials. The unwanted situations leading to the of concrete have been found to be a result of, among others, the mixing and curing water being of inappropriate quality. Potable water is generally considered satisfactory for mixing concrete.

B. Mix proportions and preparation of specimens

The procedure adopted for mix design was in compliance with the provisions of IS: 10262-2009 & IS: 456-2000. Firstly, the cement and aggregates were mixed together in the mixing pan. Water was then added and mixing was continued until a uniform and homogenous matrix was obtained. The mix for each sand replacement level of M30 grade concrete was cast in 150x150x150 mm standard cube moulds and compacted with a tamping rod in three layers. The specimens were de-molded after 24 hours and cured by immersion in water at a room temperature of 27°C for 7,14 & 28 days.

Five replacement levels of 0%, 25%, 50%, 75% and 100% quarry residues were used in the concrete mixes. The 50% is the optimum replacement percentage achieved by carrying out strength studies for 0%, 25%, 50%, 75% and 100% sand replacement levels. The respective 28-day strengths were 32.86, 34.17, 37.38, 31.12 and 27.88 N/mm^2. At 50% substitution level, maximal compression was noticed. Keeping up half ideal level of quarry sand, the cement content is supplanted with zeolite in the gradual dimensions of 10, 20, 30, 40 and 50%. The comparing 28-day compressive qualities were 37.54, 39.84, 41.21, 30.58, and 22.65 N/mm^2 respectively. At 30% superseding dimension of zeolite, maximal compression quality was watched. One percent super plasticizer (Fosroc-Conplast SP-430) has been incorporated into the blending water and cube samples were casted. The compressive qualities of 39.63, 40.78, 43.25, 32.69, and 24.41 N/mm^2 were shown at 28 days.

C. Test setup and method

On the day of testing, the specimens were taken out of the curing tanks and left in the open air for about 2 hours before testing. These specimens are tested by compression testing machine after 7, 14 or 28 days curing. The cube sample is placed in the crushing machine on its side so that the two faces in contact with the platens of the machine are faces which were in contact with the polished steel sides of the mould, they should, therefore, be perfectly plane and smooth. The steel platens of the crushing machine are brought together until they just touch the upper and lower surfaces of the specimen. The specimen should be central on the platens and the upper platen should be free to rotate so that any small differences in alignment between the upper and lower surfaces of the specimen may be accounted for. The load is then applied to the specimen at a constant rate to give an increase in stress on the specimen of 0.2 to 0.4 N/mm^2/sec. The maximum load attained during the test should be recorded. Load at the failure divided by area of specimen gives the compressive strength of concrete.

III. RESULTS AND DISCUSSION

The compression test results of M30 grade concrete cube specimens at 7, 14 and 28 days typical curing, with 0, 25, 50, 75 and 100% supplanting of fine sand with stone residue are introduced in table-1. A slow increment in compression quality was seen up to half substitution, and after that decrease in strength took note. Keeping up half substitution of stone residue and with the substitution of cement levels by zeolite at an incremental increase of 10%, the maximal compression was recorded at 30% overriding dimension. The option of stone residue diminished the workability of concrete and henceforth the super plasticizer (of 1%) was included, and minimal increments in compression were watched. Compression test results acquired were equivalent with the ordinary cement concrete.



Designation of mix	Compression [N/mm^2]		
	7 Days	14 Days	28 Days
S-0	20.39	25.89	32.86
S-25	21.51	26.62	34.17
S-50	23.42	28.03	37.38
S-75	19.67	22.34	31.12
S-100	17.72	20.91	27.88

Table 1: Compression test results of M30 grade concrete at 7, 14 & 28 days for various percentages of stone dust

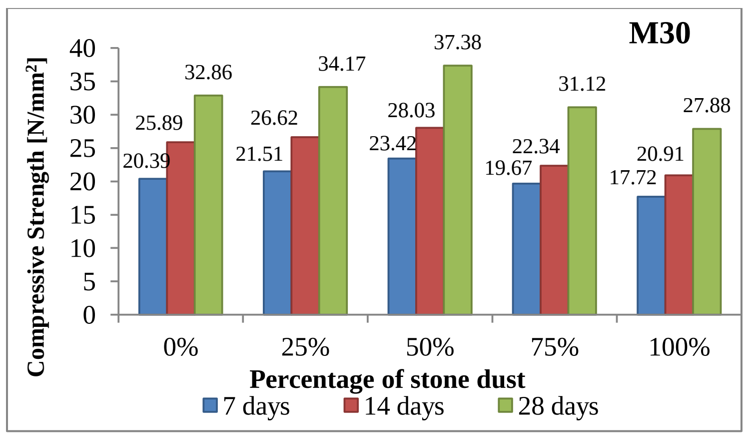

Fig-1: Variation of Compressive strength of M30 grade concrete at 7, 14 & 28 days for various dust percentages of stone dust

M30 mix	
S-0	0% stone dust
S-25	25% stone dust
S-50	50% stone dust
S-75	75% stone dust
S-100	100% stone dust

Designation of mix	Compression [N/mm^2]		
	7 Days	14 Days	28 Days
S-50	23.42	28.03	37.38
S50-Z10	24.10	28.88	37.54
S50-Z20	25.72	30.88	39.84
S50-Z30	26.84	31.92	41.21
S50-Z40	20.14	23.93	30.58
S50-Z50	15.25	17.65	22.65

Table 2: Compression test results of M30 grade concrete at 7, 14 & 28 days for various percentages of stone dust & zeolite

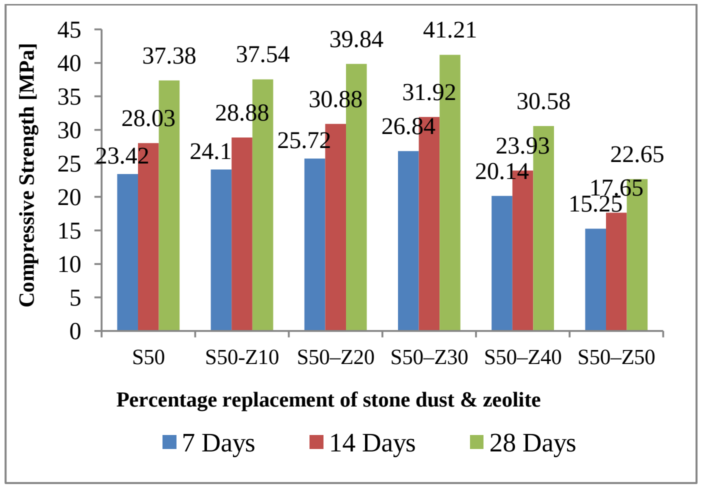

Fig-2: Variation of Compressive strength of M30 grade concrete at 7, 14 & 28 days for various percentages of stone dust & zeolite

M30 mix	
S50	50% stone dust
S50-Z10	50% stone dust & 10% zeolite
S50-Z20	50% stone dust & 20% zeolite
S50-Z30	50% stone dust & 30% zeolite
S50-Z40	50% stone dust & 40% zeolite
S50-Z50	50% stone dust & 50% zeolite

Designation of mix	Compressive Strength with 1% super plasticizer [N/mm^2]		
	7 Days	14 Days	28 Days
S-50	23.42	28.03	37.38
S50-Z10-P	23.78	29.72	39.63
S50-Z20-P	24.47	30.59	40.78
S50-Z30-P	25.95	32.44	43.25
S50-Z40-P	19.61	24.52	32.69
S50-Z50-P	14.65	18.31	24.41

Table 3: Compression test results of M30 grade concrete at 7, 14 & 28 days for various percentages of stone dust, zeolite & super plasticizer

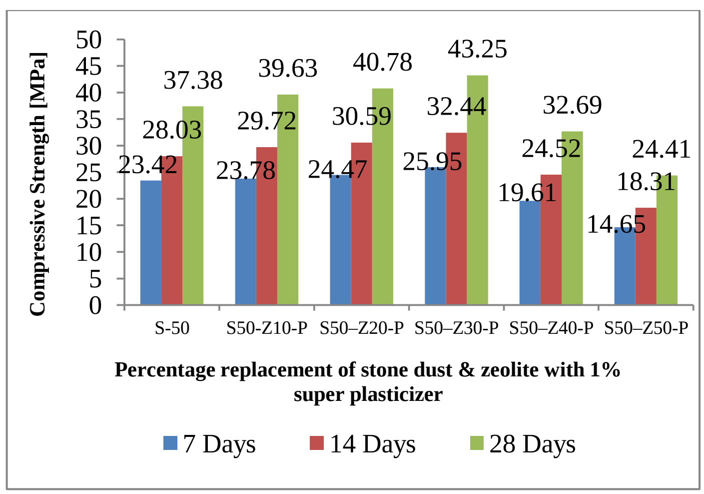

Fig-3: Variation of Compressive strength of M30grade concrete at 7, 14 & 28 days for various percentages of stone dust & zeolite

M30 mix	
S50	50% stone dust
S50-Z10-P	50% stone dust,10% zeolite & 1% super-plasticizer
S50-Z20-P	50% stone dust,20% zeolite & 1% super-plasticizer
S50-Z30-P	50% stone dust,30% zeolite & 1% super-plasticizer
S50-Z40-P	50% stone dust,40% zeolite & 1% super-plasticizer
S50-Z50-P	50% stone dust,50% zeolite & 1% super-plasticizer

IV.CONCLUSIONS

The idea of substitution of characteristic fine aggregate by quarry residue and cement by zeolite is featured in the present examination. It could improve the usage of created quarry dust, along these lines lessening the necessity of land fill zone and monitoring the hardly accessible characteristic sand manageable advancement.

From the trial think about, it is inferred that the quarry residue can be utilized as a substitution for fine content of aggregate. It is discovered that half substitution of sand by quarry dust gives most extreme outcome in quality contrasted with ordinary concrete and after that diminishes past half.

The expansion in the quality of concrete prepared with zeolite supplanting can be credited to the improved aggregate-matrix bond coming about because of the development of a less permeable change zone in the zeolite concrete. The best execution was accomplished by the concrete with a swap of 30% of zeolite for OPC. Strength outcomes got were comparable to the reference concrete. This level of substitution (30%) infers a lower utilization of cement, which means a solid commitment to the preservation of nature. The joining of common zeolites in cement will in general diminish the slump estimation of fresh concrete because of its cubical molecule shape and harsh surface. This can be compensated with the addition of super plasticizers. Absolutely zeolite is a situation neighborly material with great mechanical attributes.

A littler measure of Portland cement and the utilization of zeolite would thus be able to result in comparable properties as those of concretes with Portland cement as it were. From this point of view, zeolite can be viewed as a functioning admixture which after some time adds to the arrangement of micro-structure and to the improvement of required coming about properties of solidified concrete. Thus, finely processed normal zeolite seems, by all accounts, to be an appropriate crude material in the creation of concrete with which it is conceivable to substitute Portland cement.

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