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Research paper



Effect on Strength Properties of Concrete Containing Seashell Powder as a Partial Substitution of Fine Aggregate and Silica Fume used as Admixture

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Abstract

Sand is the most normally utilized fine aggregate in construction industry for the generation of concrete. The present scenario is in such a way that the cost of sand reached new heights and the demand for sand is also exhaustive. The replacement of the sand has a lot of constraints. Seashells are composed of calcium carbonate or chitin can be suitable alternative. It is used as a replacement of fine aggregate by 2%, 4%, 6%, 8%, and 10% for M20 grade concrete. Further 15% and 20% replacements are made. Silica fume is a ultrafine powder gathered as a result of silicon and ferrosilicon compound generation and the principle field of use is as pozzolanic material. It is used as an admixture by 5% to 10% of weight of cement to improve the strength properties. Concrete cubes and cylinders with mentioned proportion and conventional concrete are casted. Mechanical properties are evaluated by conducting compressive strength and split tensile strength tests.

Keywords: *Seashell powder, Silica fume and fine aggregate replacement.*

1. Introduction

1.1. General

For the past several years, sand has been used as fine aggregate in the construction industries for the production of concrete. River sand is one of the conventional fine aggregate used in reinforced concrete structures. Unnecessary sand mining causes the corruption of waterways. Consumption of sand in the streambed and along beach front regions causes the deployment of waterways. Any volume of sand traded from ocean informal lodging territories is a misfortune to the framework in now-a-days. Today the cost and demand for river sand continues to increase. The search forvarious suitable alternative of fine aggregate on goes unending in the construction field. Some of the alternative materials like bottom ash, quarry dust, foundry sand were used and evaluated experimentally but cost and availability does not match with sand. Seashells are the hard protective layer which is an exoskeleton of sea animals. Most of the sea shells are marine mollusks consists of calcium carbonate or chitin. Seashells waste is a growing economic and environmental hazard. Most of the seashells are particularly interesting for recycling with concrete in construction industries. The chemical composition of these shells demonstrates strength properties that will help bind and strengthen concrete when added as aggregate. The chemical constituent is specifically focused on the calcium carbonate ($CaCO_3$) which makes up 90% to 95% of the shell. For this purpose the seashell sample collected were tested using XRFlaboratory. The dynamic modulus of elasticity of concrete decreases and compressive strength increases in concrete by increase in silica fume admixture [1]. Expansion of silica fume expands the compressive quality and modulus of flexibility and reduces the compressive ductility [2]. Workability and modulus of elasticity of cement diminished and compressive quality expanded when oyster shell is utilized as fine aggregate in concrete[3]. The compressive quality of controlled low quality materials was created higher when the seashells are utilized as 5% substitution of fine aggregate [4]. The dynamic and static modulus of elasticity and compressive quality was diminished marginally when seashells are utilized as halfway substitution of fine aggregate [5]. The compressive quality was decreased when ground seashell is utilized as substitution of cement and the elastic and flexural quality expanded [6].The compressive strength of concrete made using marsh calm seashells as a replacement of sand is higher and tensile strength was lower [7]. Silica fume which is the side-effect of silicon metal or ferrosilicon composites is exceptionally responsive pozzolon in view of fine particles, bigger surface territory and high SiO_2 content. It has the most beneficial uses in concrete. It consists of non- crystalline silicon dioxide (SiO_2).Usage of silica fume in concrete gives high compressive strength and it is capable of carrying high vertical loads in high rise structures. The concrete containing silica fume has high resistant for chloride penetration. The most common constituent of sand is silica (silicon dioxide SiO_2).As the sand is replaced by seashell powder and the main constituent of seashell powder is calcium carbonate, micro silica which is available in abundant in India were used as admixture.

2. Materials and Methodology

2.1. Materials

Cement

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OPC of 53 grade adjusting to IS 8112 ASTM C 150/TYPE 1 was utilized. The physical properties of cement are valuated tentatively. The specific gravity of concrete is 3.15 and consistency is 29%.

Sand
River sand conforming to zone III of IS 383-1970.The specific gravity of sand is 2.74 and fineness modulus is 2.65.

Coarse Aggregate
Characteristic surface dried squashed stone went through 20mm sieve and held in 12.5mm sieve were used. The specific gravity of coarse total is 2.73.

Seashell Powder
Seashells acquired from waterfront territories are smashed and powdered. Specific gravity of seashell powder is 2.27 and fineness modulus is 1.37. Refer TABLE 1 for chemical composition.

Silica fume
Micronized white colored powder which is a byproduct of ferrosilicon obtained from local manufacturing industry. The specific gravity of micro silica is 2.63.Refer TABLE 1 for chemical composition.



Fig. 1: Silica Fume



Fig. 2: Seashell Powder

Table 1: Compound Composition of Cement, Seashell Powder and Silica Fume

Chemical Composition	Seashell Powder	Silica Fume
CaO	85.85	0.001
SiO_2	5.00	99.89
Na_2O	2.38	0.003
Fe_2O_3	1.64	0.040
Al_2O_3	1.63	0.043
Cl	1.31	-
MgO	0.70	-
SO_3	0.65	-
SrO	0.30	-
TiO_2	0.21	-
K_2O	0.17	0.001
P_2O_5	0.08	-
PbO	0.07	-

2.2. Mix Design

Grade of concrete: Mix design was carried out for M20 grade of concrete conforming to IS 10262-2009.

Table 2: Mix Proportion of M20 grade concrete

Description	M20	
Cement (kg/m^3)	380	
Fine Aggregate (kg/m^3)	570	
Coarse Aggregate (kg/m^3)	1140	
Water	190	
Water cement ratio	0.5	
Mix ratio	1:1.5:3	

2.3. Methodology

The methodology of work involves obtaining materials and casting of cube and cylinder specimens. The cube specimens of size 100mm x 100mm x100mm were casted for the M20 grade conventional(with no substitution) according to the blend plan necessities. Seashell powder was used as the partial replacement for sand at 2%, 4%, 6%, 8%, and 10%. Three cubes (100mm x 100mm x 100mm) were casted for each proportion. The cylinders of size 100mm diameter and 200mm height were also casted for the conventional concrete and concrete containing seashell powder(2%, 4%, 6%, 8%, 10%) as a fractional substitution of fine aggregate. Three cylinders were casted for each proportion. Further 15% and 20% replacements of fine aggregate are also made for and cubes and cylinders and were casted. Silica fume is used as an admixture by 10% of weight of cement in all the specimens. Slump value is 50cm to 90cm.So it has medium workability. The casted samples were kept for curing in the water.

Table 3: Blend extents of materials for 1 m^3 of cement

Blend	Cement(kg)	Fine aggregate(kg)	Seashell Powder(kg)	Coarse aggregate(kg)	Silica Fume(kg)
CM	380	570	0	1140	38
SP1	380	558.6	11.4	1140	38
SP2	380	547.2	22.8	1140	38
SP3	380	535.8	34.2	1140	38
SP4	380	524.4	45.6	1140	38
SP5	380	513	57	1140	38
SP6	380	484.5	85.5	1140	38
SP7	380	456	114	1140	38

3. Test Procedure



Fig. 3: Compressive Strength Test



Fig. 4: Split tensile Strength Test

3.1. Compressive Strength Test

The compressive strength test is the widely recognized and fundamental test since the entire basic outline and the characteristic properties are related with the compressive strength of the concrete. The compressive strength testing machine were used for the testing 28 day strength as per IS 516:1959 specifications. This test was led under ordinary room temperature. The compressive strength test was tested for control concrete and concrete containing seashell powder as a fractional substitution of fine aggregate at different extents.

3.2. Split Tensile Strength Test

The split tensile strength test is one of the most common indirect tests which was carried out at 28 days for the cylindrical samples of size 100mm dia and 200mm height. This test was carried out for the conventional concrete cylindrical specimen and cylindrical specimens containing seashell powder as partial replacements of fine aggregate. These specimens were tested using the compression testing machine of 3000KN capacity as per IS516-1959.The readings were taken when the applied load increases gradually and the specimen splits.

4. Results and Discussion

4.1 Compressive Strength Test

The compressive quality of the cube samples for different blend extents were represented in graph beneath. For each mix proportions 3 nos. of concrete cubes were casted. The concrete cubes were in conventional curing for 28 days and tested. The average compressive strength was considered.

The compressive strength of the conventional concrete is 26.49MPa.The compressive strength of the concrete cube containing 2% replacement SP1 was found to be 28.52MPa. Similarly the concrete cubes containing 4% replacement SP2 and 6% replacement SP3 was found to be 31.73MPa and 33.33MParespectively. The compressive strength of the concrete cube containing 8% replacement SP4 was found to be more than the conventional strength and was 35.21MPa.The compressive strength of the concrete cube containing 10% replacement SP5 was the highest and was found to be 36.64MPa. The 28 days compressive strength of 15% and 20% replacement cubes were found to be 29.89MPa and 27.47MPa respectively. The compressive strength of SP5 was 1.38 times higher when compared with the conventional mix.

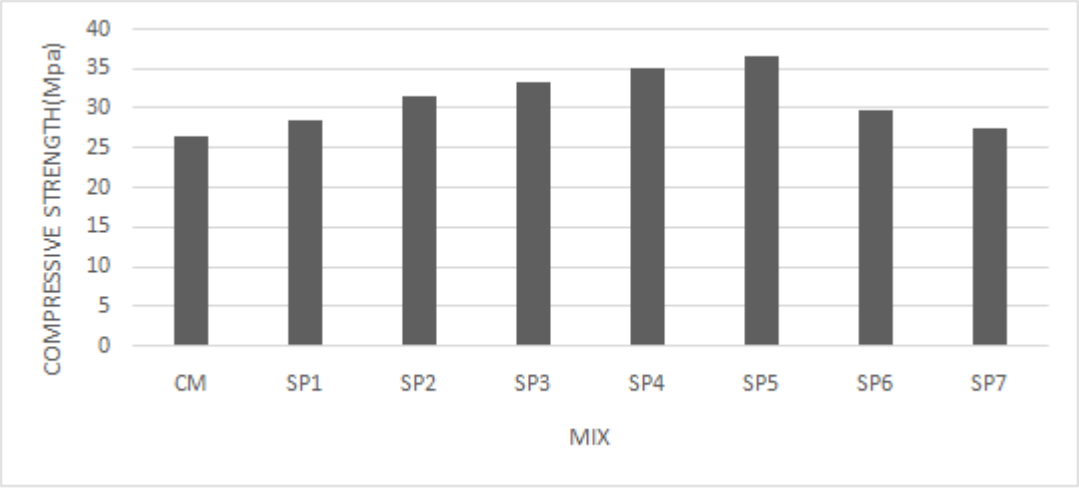

Fig. 5: Compressive strength

4.2 Split Tensile Test

The split tensile strength of the cylinder samples for different blend extents were represented in diagram beneath. For each mix proportions 3 nos. of concrete cylinders were casted.

The concrete cylinders were in conventional curing for 28 days and tested. The average split tensile strength was considered.

The split tensile strength of the conventional concrete is 2.77MPa.The split tensile strength of the concrete cylinder containing 2% replacement SP1 was found to be 2.9MPa. Similarly the concrete cylinders containing 4% replacement SP2 and 6% replacement SP3 was found to be 3.1MPa and 3.14MPa.The split tensile strength of the concrete cylinder containing 8% replacement SP4 was found to be more than the conventional strength and was 3.22MPa. The split tensile strength

of the concrete cylinder containing 10% replacement SP5 was the highest and was found to be 3.38MPa.
The 28 days split tensile strength of 15% and 20% replacement cylinders were found to be 2.96MPa and 2.84MPa respectively. The split tensile strength of the mix SP5 was 1.22 times higher when compared with the conventional mix.

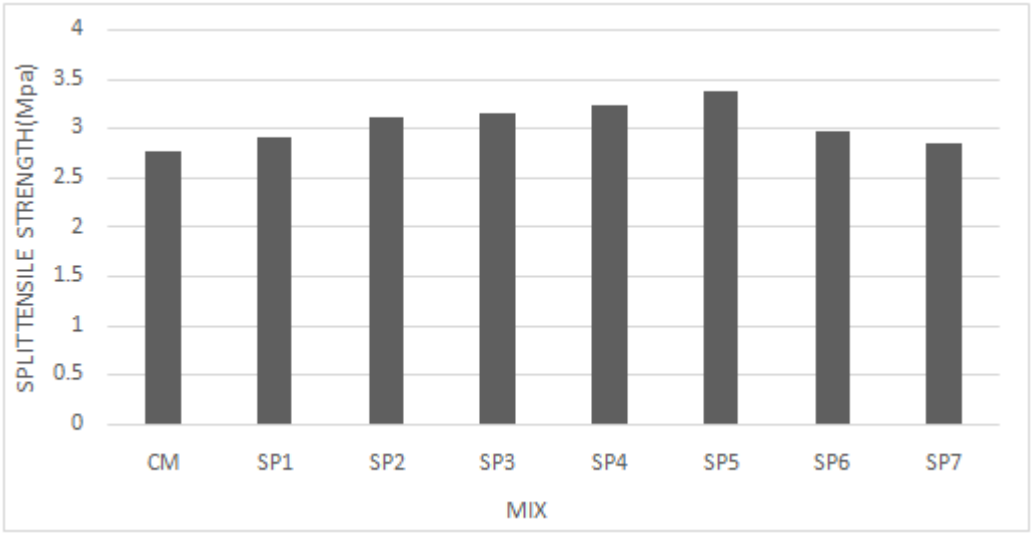

Fig. 6: Split tensile strength

5. Conclusions

From the above experimental test results of various proportions containing seashell powder as fine aggregate and silica fume as admixture, the following were observed.

- The compressive strength of the concrete with partial replaced seashell powder for fine aggregate and silica fume admixture was found to be more than conventional concrete cubes.
- The compressive strength of the concrete increases with increase in percentage of seashell powder up to 10%. The 10% (SP5) was the highest and thereafter it decreases marginally for 15% and 20% replacement.
- The split tensile strength of the concrete with partial replaced seashell powder for fine aggregate and silica fume admixture was found to be more than conventional concrete cubes.
- The split tensile strength of the concrete increases with increase in percentage of seashell powder up to 10%. The 10% (SP5) was the highest and thereafter it decreases marginally for 15% and 20% replacement.
- The compressive strength and split tensile strength properties were studied for the concrete containing seashell powder. Further Flexural strength properties can be tested and studied for optimum 10% replacement of fine aggregate with seashell powder and silica fume admixture.

References

[1] V.T. Giner, S. Ivorra, F.J. Baeza, E. Zornoza, B. Ferrer,"Silica fume admixture effect on the dynamic properties of concrete" Construction and Building Materials 25 (2011) 3272–3277.
[2] YunshengXu, D.D.L. Chung, "Cement of high specific heat and high thermal conductivity, obtained by using silane and silica fume as admixtures" Cement and Concrete Research 30 (2000) 1175–1178.
[3] Eun-Ik Yang, Seong-Tae Yi, Young-Moon Leem, "Effect of oyster shell substituted for fine aggregate on concrete characteristics: Part I. Fundamental properties"Cement and Concrete Research 35 (2005) 2175 – 2182.
[4] Wen-Ten Kuo, Her-Yung Wang, Chun-YaShu, De-Sin Su, "Engineering properties of controlled low-strength materials containing waste oyster shells" Construction and Building Materials 46 (2013) 128–133.
[5] Brahim Safi, Mohammed Saidi, AbdelhakimDaoui, Ahmed Bellal, Ali Mechekak, KamelToumi, "The use of seashells as a fine aggregate (by sand substitution) in self-compacting mortar (SCM)"Construction and Building Materials 78 (2015) 430–438.
[6] Monita Olivia, AnnisaArifanditaMifshella, LitaDarmayanti, "Mechanical properties of seashell concrete"Procedia Engineering 125 (2015) 760 – 764.
[7] Monita Olivia, RevinaOktaviani, Ismeddiyanto, "Properties of concrete containing ground waste cockle and calm seashells" Procedia Engineering 171(2017) 658 – 663.
[8] C.S. Poon, S.C. Kou, L. Lam, "Compressive strength, chloride diffusivity and pore structure of high performance metakaolin and silica fume concrete" Construction and Building Materials 20 (2006) 858–865.
[9] FuatKoksal, FatihAltun, IlhamiYigit, YusaSahin,"Combined effect of silica fume and steel fiber on the mechanical properties of high strength concretes" Construction and Building Materials 22 (2008) 1874–1880.