STUDY ON COMPRESSIVE STRENGTH OF SELF COMPACTING CONCRETE USING VARIOUS PROPOTIONS OF STEATITE POWDER

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Abstract- Self compacting concrete is a high-performance concrete which is highly flowable or self-leveling cohesive concrete that can be easily placed in the tight reinforcement. It is also known as super workable concrete. In this experimental study the changes on compressive strength of self-compacting concrete produced by steatite powder were investigated. Self- compacting concrete achieves this by its unique fresh state properties. Steatite powder were used as a replacement for cement. Cement is replaced with steatite powder by 15%, 20%, 25%, and 30%, mass of cement. Ordinary Portland cement of 43 grade is used. The compressive strength properties will be compared with the conventional concrete for curing periods of 7 and 28 days. The grade of concrete used in this project is M30.

Keywords: steatite powder, concrete, compressive strength.

1. INTRODUCTION

Self-consolidating concrete or self-compacting concrete (commonly abbreviated to SCC) is a concrete mix which has a low yield stress, high deformability, good segregation resistance and moderate viscosity. In principle, a self - compacting or self - consolidating concrete must:

1 Have a fluidity that allows self - compaction without external energy.

2 Remain homogeneous in a form during and after the placing process.

3 Flow easily through reinforcement.

Self-compacting concrete (SCC) has little resistance to flow so that it can be placed and compacted under its own weight little or no vibration effort. SCC has viscosity such that segregation and bleeding do not occur. SCC was developed in japan in the late 1980s as solution to achieve durable concrete structures independent of the quality of construction work. SCC usage is also reported to lower the noise level on the construction site and diminish the effect on the environment. Consequently, the use of SCC as a construction material has gradually increased over the last few years. Gradually, is produced using new generation super plasticizers to reduce the water-binder ratio. In addition, supplementary cementations or inert materials such steatite powder are used to increase the viscosity, workability and reduce the cost of SCC.

Compared with conventional concrete of similar mechanical properties, the material cost of SCC is more due to the relatively high demand of Cementation materials and chemical admixtures including high - range water reducing admixtures (HRWRA) and viscosity enhancing admixtures (VEA). Typically, the content in Cementation materials can vary between 450 and 525 Kg/m 3 for SCC targeted for the filling of highly restricted areas and for repair applications.

The SCC essentially eliminates the need for vibration to consolidate the concrete. This results in an increase in productivity, a reduction in noise exposure and a finished product with few if any external blemishes such as “bug holes". However, after completion of proper proportioning, mixing, placing, curing and consolidation, hardened concrete becomes a strong, durable, and practically impermeable building material that requires no maintenance.

2. METHODS AND MATERIAL PROPERTIES

2.1 Methodology:

Mix design of M30 concrete was done with various proportions of steatite powder. The curing was done for 7, 14 and 28 days, after that the hardened tests of compressive, flexural and tensile were made on specimens for the strength test.

2.2 MATERIAL PROPERTIES

2.2.1 Steatite Powder

Steatite is the softest known mineral and listed as 1 on the Mohs hardness scale. The thermal properties of steatite are also good. Lowest apparent porosity is achieved when steatite particles are coarser,

and 40%of polymeric phase is employed. Addition of steatite powder increases the viscosity and mechanical properties of feed stock. The thermal properties of steatite are also good Indian steatite, mined in Rajasthan and Andhra Pradesh, is comparable with the best quality available in other Countries .The chemical properties of steatite powder are listed in Table 2.1.

Table 2.1 Chemical Properties of steatite

SI.NO	Chemical Element	Results (%)
1	Sio_2	44.73
2	Al_2O_3	3.70
3	Fe_2O_3	8.38
4	TiO_2	< 0.001
5	CaO	2.95
6	MgO	29.28
7	Na_2O_2	<0.001
8	K_2O	<0.001
9	MnO	0.13
10	P_2O_5	0.01

3. LITERATURE SURVEY

"Mechanical properties of self -compacting concrete containing silica fume and steatite powder (Padmanapam and N. Sakthieswaren., 2015)"[1], Self-Compacting Concrete which flows under its own weight and homogeneity while completely filling any formwork and passing around congested reinforcement. The experimentation is performed in M30 grade concrete, by nansu method for the volume fractions of Natural Steatite Powder were 0 to 15% by weight of cement content with 1.8% of conplast 430 as super plasticizer in SCC. Many different fresh concrete test methods slump flow, v-funnel and L-box have been developed in attempt to characterize the property of Self-Compacting concrete. The specimens of size 150mm x 150mm cube, 150mm diameter with 300mm height cylinder and 100mm x 100mm x 500mm beam are used. Then the specimen is to tested on 7th and 28th days. The compressive strength, Split Tensile Strength and Flexural Strength are being determined.

"Properties of green concrete containing quarry rock dust and marble sludge powder as fine aggregate. (M. Shahul Hameed and A. S. S. Sekar., 2009)" [2], Green concrete capable for sustainable development is characterized by application of industrial wastes to reduce consumption of natural resources and energy and pollution of the environment. Marble sludge powder can be used as filler and helps to reduce the total voids content in concrete. Natural sand in many parts of the country is not graded properly and has excessive silt on other hand quarry rock dust does not contain silt or organic impurities and can be produced to meet desired gradation and fineness as per requirement. Consequently, this contributes to improve the strength of concrete. Through reaction with the concrete admixture, Marble sludge powder and quarry rock dust improved pozzolanic reaction, micro-aggregate filling, and concrete durability. This paper presents the feasibility of the usage of quarry rock dust and marble sludge powder as hundred percent substitutes for natural sand in concrete. An attempt has been made to durability studies on green concrete compared with the natural sand concrete. It is found that the compressive, split tensile strength and durability studies of concrete made of quarry rock dust are nearly 14 % more than the conventional concrete. The concrete resistance to sulphate attack was enhanced greatly. Application of green concrete is an effective way to reduce environment pollution and improve durability of concrete under severe conditions.

"Behaviour of concrete partially replacement of cement by steatite and polypropylene fiber. (Dr. T. Bhagavathi pushpa and S. Rajesh Kumar., 2016)" [3], The interest in the use of fibers for the reinforcement of composites has increased during the last several years. Use of fibers show considerable improvement in tensile properties of concrete and also reduce shrinkage and cracks. In this study, the results of the Strength properties of concrete, setting time and pozzolanic activity of cement using polypropylene fiber and steatite have been presented. Steatite powder and polypropylene are used as a replacement for cement. Cement is replaced with steatite powder by 30%, 25%, 20%, and 15%, mass of cement and 0.5 % of polypropylene fiber by weight of concrete is constantly added for all mixes. Ordinary Portland cement of 53 grade is used. The strength properties will be compared with the conventional concrete for curing periods of 7, 14 and 28 days. The grade of concrete used in this project is M30.

"Mechanical properties of scc with steatite powder, silica fume and fiber (E. Murugesan ME (structural) and Dr. N. Sakthieswaren Ph.D., 2015)" [3], In this experimental study the changes of some

mechanical properties of self- compacting concrete specimen produced by steatite powder were investigated. Steatite powder can fix the matter by improving ductility and decreasing the total cost of SCC were investigate .Self compacting concrete achieves this by its unique fresh state properties. The main objective is to obtain Self Compacting Concrete which flows under its own weight and homogeneity while completely filling any formwork and passing around congested reinforcement. The Self Compacting Concrete produced by using natural steatite powder. In this experiments the volume fractions taken as 0 to 25% of NSP, 0 to 3% of coir by weight of cement content added.

"Self-compaction high performance green concrete for sustainable development (M. Shahul hameed and A. S. S. Sekar., 2010)" [4], Self-Compacting Concrete (SCC) as the name implies that the concrete requiring a very little or no vibration to fill the form homogeneously. SCC is defined by two primary properties: Ability to flow or deform under its own weight and the ability to remain homogeneous while doing so. A sustainable industrial growth will influence the cement and concrete industry in many respects as the construction industry has environmental impact due to high consumption of energy and other resources. One important issue is the use of environmental-friendly concrete ("green concrete") to enable worldwide infrastructure growth without affecting the environment [1]. The potential environmental benefit to society of being able to build with green concrete is huge. Suitable environmental cost of producing concrete into the current price by adjusting the price of environment resources to elevate concrete's price, which will be helpful for protection of the environment and will promote the advancement of concrete technology. The problems of sustainable development should be considered on the society-economy-technology level. Fresh properties and basic strength characteristics, such as compressive strength, splitting tensile strength, with crusher rock and marble slurry dusts are the main focuses in this research.

"Experimental Methods on Glass Fiber Reinforced Self compacting Concrete (Deepak Raj A, et al IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) ISSN: 2278-1684)" [5], The purpose of this study is to investigate the workability and mechanical properties of plain SCC and GFRSCC. The laboratory testing included slump flow test, L-Box test, sieve segregation resistance test, density test, ultrasonic pulse velocity test, compressive strength test, splitting tensile strength test, and flexural strength test. With reference to the obtained test result we conclude that the addition of glass fibers does not affect the filling ability, passing ability and segregation resistance of the SCC. The glass added is maximum 1% of glass fiber in all sizes.

"Effect of Polypropylene Fibers on Fresh and Hardened Properties of SCC at elevated temperatures (Arabic Nawwaf Saoud AL Qudi, et al., Australian Journal of Basic and Applied Science, 5(10): 378-384,2012)" [6], This research present the result from an experimental study on the optimum amount of Polypropylene (PP) to be used in SCC to prevent spalling when exposed to elevated temperatures. The compressive strength increased, when the polypropylene will be increased up to 10% at elevated temperatures.

"Development of Self Compacting Concrete, Goodier, Nov 2003 (L V A Seshasayi, et al ., 33rd Conference on OUR WORLD IN CONCRETE & STRUCTURES: 25-27 August 2008 Singapore)" [7], This paper outlines a history of SCC from its origins in Japanto the development of the material throughout Europe. Europe are discussed, together with a look at the future for the material in Europe and the rest the world. The history and development of SCC can be divided into two key stages; its initial development I japan in the late 1980s and its subsequent introduction into Europe. SCC was developed from the existing technology used for high workability and underwater concretes where additional cohesiveness is required. The main barrier to the increased use of SCC in the UK and Europe seems to be the lack of experience of process, and the lack of published guidance, codes and specifications.

"Rapid Chloride Permeability Test on Self-Compacting High Performance Green Concrete (M. Shahul Hameed, V.Saraswathi and A.S.S. Sekar.,2011)" [8], Self-compacting concrete (SCC) is one of the most significant advances in concrete technology in the last two decades. SCC was developed to ensure adequate compaction through self-consolidation and facilitate placement of concrete in structures with congested reinforcement and in restricted areas. Marble Sludge Powder (MSP) can be used as filler and helps to reduce the total voids content in concrete. Consequently, this contributes to improve the strength of concrete. An experimental investigation has been carried out to study the combined effect of addition of MSP and crusher rock dust (CRD) on the durability of self-compacting high performance green concrete SCHPGC. This paper aims to focus Chloride Permeability study of (SCHPGC) made with industrial wastes i.e. MSP and CRD from marble processing, and from stone crushing industries. Rapid Chloride Permeability test (RCPT) was conducted to measure thechloride permeability of SCHPGC and the results were compared with the normal concrete made up of river sand (NCRS).

4. EXPERIMENTAL PROGRAM

A. MATERIALS USED

i) Cement

Ordinary Portland cement of 43 grade confirming to IS: 8112-1989 was used for the present experimental investigation. Specific gravity-3.1, Consistency test-31%.

ii) Fine aggregate

Locally available sand passing through 2.36 mm sieve with specific gravity of 2.69 which falls under grading zone II were used for the entire investigation.

iii) Coarse aggregate

Coarse aggregates consist of aggregates larger than fine aggregates and their sizes vary from 10 to 12mm. These tend to improve quality and bond characteristics and generally results in a higher flexural strength of concrete. It also helps in reducing shrinkage. These aggregates occupy 70-80% of volume of the concrete. It is having specific gravity of 2.7 and it is subjected to the sieve analysis the maximum size of large is 150 mm.

iv) Steatite powder

Steatite is a type of metamorphic rock, largely composed of talc ore, rich in magnesium. It is composed of hydrated magnesium silicate: $MgSi_4O_{10}(OH)_2$. Steatite is the softest known mineral and listed as 1 on the Mohr's hardness scale.It is already used in paint industry, particularly in marine paints and protective coatings. This is used in ceramics due to its high resistivity, very low dielectric loss factor, and good mechanical strength. Addition of steatite powder increases the viscosity and mechanical properties of feed stock. The thermal properties of steatite are also good.

v) Super plasticizer

Super plasticizer is essential for the creation of SCC. The job of SP is to impart a high degree of flow ability and deformability, however the high dosages generally associate with SCC can lead to a high degree of segregation. Conplast SP 430 is utilized in this project, which is a product of FOSROC Company having a specific gravity of 1.222. Super plasticizer is a chemical compound used to increase the workability without adding more water i.e. spreads the given water in the concrete throughout the concrete mix resulting to form a uniform mix. SP improves better surface expose of aggregates to the cement gel.

5. DISCUSSION

Compressive strength is most important property of the hardened concrete. The concrete cubes were casted, cured and tested accordance with the IS standard and 7 & 28 days. Compressive strength result of concrete are listed in Table3.1. The highest compressive strength value is 40.8 Mpa which is obtained at 28 days by replacement of 15% of cement by steatite powder by weight of concrete when compared to the conventional mix. Fig 5.1 shows that the compressive strength of concrete
for various mixes.

Table 5.1Compressive Strength

Specimen	7 Days (N/mm2)	28 Days (N/mm2)
CONVENSIONAL	25.1	37.7
S.P (30%)	20.0	26.6
S.P (25%)	21.7	30.1
S.P (20%)	26.1	35.1
S.P (15%)	30.3	40.8

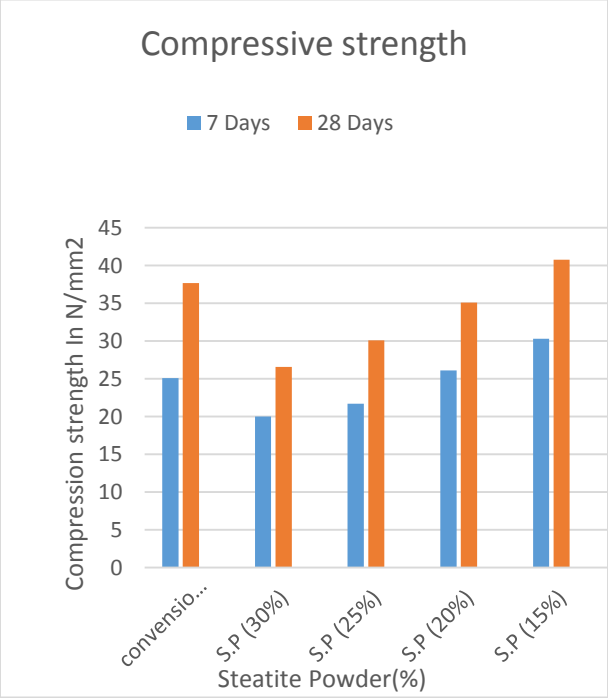

Fig: 4.1.Compressive Strength

From the result, the optimum strength is obtained at replacement of 15% of fine aggregate by steatite powder by weight of concrete. Maximum Compressive strength of cube is found to be 40.8 Mpa at 15% of cement by steatite powder by weight of concrete and it increased by 6.3% than the conventional concrete.

6. CONCLUSION

From the summary of this experimental work the following conclusions were arrived.

- Admixtures affected the workability of SCC Adversely.
- Gradual increase in the compressive strength for M 30 Grade of concrete at 7 and 28 days when 15% partial replacement of natural steatite powder with 1.5% of super plasticizer of SCC compared with conventional SCC.
- The simple method of mix design is greatly reducing the cement material usage and reduces the construction cost.
- The slump value, V-funnel, and L Box value for M30 grade concrete with varying proportions were found out. The values found are identical values.

6. REFERENCES

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