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EXPERIMENTAL INVESTIGATION ON REHOLOGICAL AND MECHANICAL PROPERTIES OF SCC USING METAKAOLIN POWDER

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Abstract :
Self Compacting Concrete (SCC) is the new category of High Performance Concrete (HPC) characterized by its ability to spread and self consolidate in the form work exhibiting any significant separation of constituents. In this study, the benefits of & Metakaolin powder as partial replacement of Portland cement are established. Furthermore, MP are used directly without attempting any additional processing in the production of Self Compacting Concrete (SCC). The water binder ratio is maintained between 0.3 and 0.35 depending upon the mix. The fresh and hardened properties were examined. Workability of the fresh concrete is determined by using the slump-flow test. For all mix the constant replacement of by weight of cement. The remaining up to 15% is replaced by Metakaolin powder with different proportions. The Hardened Properties like compressive strength, splitting tensile strength, Flexural strength were evaluated at 7, 14 and 28 days. In addition to that the durability properties were examined by saturated water absorption and acid resistance test. Based on the above tests result the comparative percentage replacement of Metakaolin powder will be studied.

I. INTRODUCTION

Self-compacting concrete (SCC) was first developed in Japan (in the mid to late 1980s) as a means to create uniformity in the quality of concrete by controlling the ever present problem of insufficient compaction by a workforce that was losing skilled labour and by the increased complexity of designs and reinforcement details in modern structural members. Durability was the main concern and the purpose was to develop a concrete mix that would reduce or eliminate the need for vibration to achieve consolidation. Self-compacting concrete achieves this by its unique fresh state properties.In the plastic state, it flows under its own weight and maintain homogeneity while completely filling any formwork and passing around congested reinforcement. In the hardened state, it equals or excels standard concrete with respect to strength and durability.The use of SCC concrete has been increasing in the United States also during the last 5 years. Currently the technology is being primarily applied to the precast industry. Other segments being targeted are flatwork, columns and wall construction.The applications of SCC are many, limited only by the industry's knowledge of it, ability to produce it and acceptance of it. The usual self-compacting concretes have compressive strengths in the range of 60-100N/mm². However Ultra High Performance Self-Compacting Concrete (UHPSCC) with strength about 150 N/mm² have also been successfully developed .The durability of cement concrete is defined as its ability to resist weathering action, chemical attack, abrasion or any other process of deterioration. Durable concrete will remain its original form, quality and serviceability when exposed to its environment**.**

II.LITERATUREREVIEW

N. Ganesan, Bharati Raj. J and A.P. Shashikala(2012) Strength and durability characteristics of self compacting rubberised concretes with and without steel fibres for specimens of 30 to 50 Mpa. The water absorption test was carried out following IS 1237:1959 on 100 mm cube specimens and the water absorption of SCRC was 50% of that of conventional SCC. For determining the resistance to acid, the cubes were immersed in a 3% sulphuric acid (H2SO4) solution for 90-days.Results suggest that Self Compacting Rubberised Concrete may be a useful cementitious composite with better durability characteristics than conventional Self Compacting Concrete.

Md.SAFIUDDIN, et.all (2011) “Properties of freshly mixed self consolidating concrete incorporating rice husk ash has a supplementary cementing material**.** Entrained SCC mixture were produced based on the water binded ratio of 0.3 to 0.4%. RHA was used to substituting 0 to 30% of cement by weight. The fresh properties investigated were filled ability, passing ability, Segregation resistance air content and unit weight. The fresh properties were significantly influenced by the water binded ratio and RHA content of concrete. RHA also affected air entrainment and decreases the unit weight of concrete. RHA content greater than 15 to 20% than become highly viscous and excessive surface. The optimum RHA content was 10 to 15% based on the results of filling and passing ability, segregation resistance, unit weight and air content.

A.S.C BELAIDI, et.all,(2011), Effectives of natural pozzolana and marble power on the properties of SCC, construction and building. OPC was partially replaced by different percentages of pozzolana and marble power (10 to 40%). The compressive strength was determined on prisms at the ages of 7, 28, 56 and 90 days. The result indicates an improvement in the workability of SCC with the use of PZ and MP. Compressive strength of binary SCC decreased with the increase in natural pozzolana and the marble dust content, but strength at 28 days and 90 days indicate that even with 40% (natural PZ + MP), Suitable strength could be achieved. At a constant water power ratio and SP content the use of both PZ and MP by substitution to cement has no negative effects on the workability of SCC. The binary system, an improvement of workability was absorbed up to 15% of Pozzolana content**.** In ternary system, the use of MP content 5 to 30% enhances the properties of concrete. The maximum strength obtained 28 days was with 5% of pozzolana in binary system and with (5% of PZ and MP), in ternary system.

SALIM BARBHUIYA, et.all,(2011), Effects of fly ash and dolomite power on the properties of SCC. The utilization of an alternative material, Dolomite power instead of lime stone power, for the production of SCC**.** The mix containing fly ash and dolomite power in the ratio 3:1 was found to satisfy the requirement suggested by guide for making SCC. The dosage of super plasticizer was found to be the minimum in this mix. The density increased with the increase in the constant of dolomite power at the cost of fly ash.

MD NOR ATAN, et.all, (2011). The compressive and flexural strengths of SCC using Raw RHA Vol.6, No.6, PP 720- 732. The investigation of the compressive and flexural strengths of SCC incorporating RHA, individually and in combination with other types of mineral additives as partial cement replacement. The results show that 15% replacement of cement using raw RHA produced grade 40 concrete. It was also revealed that 30% and 45% cement replacements using raw RHA combined with limestone powder and RHA combined with limestone powder and silica fumes, produced comparable compressive strength to normal concrete and improved flexural strength. 15% replacement of OPC with RRHA, 30% replacement with two mineral additive components (LP/ RRHA) and 45% replacement with three mineral additive components (LP/ SF/RRHA) produce comparable compressive strength and flexural strength. The general, RRHA addition exhibits better performance in flexure as compared to its performance compression

Baboo Rai, et.all, (2011), Influence of marble powder/ granules in concrete mix IJCS volume-1, PP 827–833**.** Usage of marble powder/granules reduce the quantity of cement**.** Partial replacement of cement with marble powder / granules increase the workability and compressive strength of the concrete**.** The mean strength of all concrete mixes with marble granules was 5-10% higher than the conventional concrete confirming to IS 456-2000**.** The flexural strength of waste marble mix concrete increases with the increase of the (WMR) waste marble ratio in these mixtures.

Mucteba Uysal, et.all,(2011), Performance of SCC containing different mineral admixtures**,** construction and building mat vol.25, PP 4112—4120. Portland cement is replaced by FA, GBFS, LP, BP and MP. The influence of mineral admixtures on the workability, compressive strength, UPV, density and sulphate resistance for SCC. The sulphate resistance involved immersion of 10% , magnesium sulphate and 10% sodium sulphate solution for a period of 400 days. Replacing 25% of PC with FA resulted in strength of more than 105 mpa at 400 days. The best resistance to sodium and magnesium sulphate attacks was obtained from a combination of 40% GBFS with 60% PC. Among the mineral admixtures considered, the best performance has been obtained for FA series as workability properties.

S.N.Raman, et.all, (2011). High strength RHA concrete incorporating quarry dust as a partial substitute for sand construction and building material vol 25, pp-3123-3130. To evaluate the suitability of quarry dust as a partial substitute for sand in (HSC). Quarry dust used ranges from 10 to 40%,the slump and compressive strength is monitored upto 28 days. The quarry dust can be used as a viable replacement material to sand to produce high strength RHA concrete. There is a slight decline in compressive strength and other mechanical properties of the hardened concrete due to the inclusion of quarry dust can be compensated with the combined utilization of super plasticizer and mineral admixtures such as RHA.

VALERIA CORINAL DESI, et.all, (2010) Characterization of marble power for its use in mortal and concrete, construction and building**.** The marble power showed a very high Blaine fineness value of about 1500 m2per kg with 90% of particles finer that 50 meter and 50% under 7mue meter. The mixture where evaluated based upon cement or sand substitution by the marble power. Results obtained show that 10% substitution of sand by the marble power provided maximum compressive strength at about same workability. Due to its quite higher fineness, marble power provide to be effective in accuring very good cohesiveness of concrete, even in the presence of a super plasticizing at mixture with low water cement ratio.

RAFAT SIDDIQUE, et.all, (2010). Properties of self compacting concrete containing class F fly ash materials and design vol 32, PP 1501-1507. The mixes are prepared with class F fly ash percentage ranging from 15% to 35%. SCC mixes developed 28 days compressive strength between 30 and 35 mpa and splitting tensile strength between 1.5 and 2.4 Mpa. SCC mixes made with fly ash exhibited very low chloride permeability resistance at the age of 90 and 365 days. SCC mixes made with fly ash reduced the rapid chloride ion penetrability to the very low range at the age of 90 and 365 days.

SHAZIM ALLI MEMON, et.all (2009) , Production of low cost SCC using (RHA). The use of RHA to increase an amount of fines and hence achieve self compactibility in an economical way. The comparison of fresh properties of SCC containing various amount of RHA with that containing commercially available viscosity modifying at mixture. The comparison is done at different dosage of supper plasticizer keeping cement, water, coarse aggregate and fine aggregate content constant. The possibilities of developing low cost SCC using RHA are feasible. Low cost SCC can be made incorporating some percentage of RHA along with ingredients and super plasticizers. Utilization of RHA in SCC solves the problem of its disposal and makes environment free from pollution.

D.W.S HO, et.all, (2001) The use of quarry dust for SCC applications, cement and concrete Rea Vol1.32, PP. 505-511, 2002. Utilization of alternative materials, such as, quarry dust, for SSC applications. Due to its shape and particle size distribution, mixes with quarry dust required a higher dosage of super plasticizer to achieve similar flow properties. Compared to the use of limestone, the incorporation of granite fines required a higher dosage of super plasticizers for similar yield stresses. This is important to point out that as a waste material the properties of granite fines are expected to vary over time. The fineness of granite fines could promote durability problems, such as alkali-silica reactions.

III. METHODOLOGY:

The methodology for producing Self Compacting Concrete (SCC) By Partial Replacement of Cement by Metakaolin Powder

1. Material selection: The materials used in this study included cement, Viscosity modifying agent, natural coarse aggregate, and Metakaolin Powder . The proportions of each material were selected based on previous studies and laboratory tests.
2. Preparation of SCC: The concrete was crushed and cleaned to remove any contaminants, such as dirt or debris. The SCC was then proportioned and mixed with natural coarse aggregate to create the desired coarse aggregate blend.
3. Casting of specimens: The SCC was cast into molds to create specimens for testing. The specimens were cured for 28 days under controlled conditions.
4. Mechanical testing:The mechanical properties of the specimens were evaluated using compressive strength, splitting tensile strength, and flexural strength tests. The results of the tests were analyzed to determine the effect of SCC.
5. Economic and environmental analysis: The economic and environmental benefits of using SCC were analyzed by comparing the cost and carbon footprint of SCC with SCC+ MP. The results of the analysis were use to evaluate the feasablity of using SCC form an economical and environmental prespective.

Overall, the methodology used in this study involved a combination of laboratory testing, material selection, andeconomic and environmental analysis to evaluate the feasibility of using Metakaolin Powder as a partial replacement for Cement. The results of the study provide valuable insights into the potential benefits of using SCC and could in form future research and construction practices.

IV. RESULTSANDDISCUSSION

Introduction

The Normal Cement and Metakaolin Powder concrete are mixed at various proportions and are made into concrete blocks. These specimens are tested and the results of the respective proportions are compared and the better composition that is obtained are discussed.

Compressive strength test

Compressive strength of concrete is tested using Compression testing machine (CTM). Where the force is applied by the help of compression testing machine till the concrete block of dimension 150mm × 150mm × 150mm fails. Then the strength is found when the applied force is divided by cross sectional area of concrete block. Compressive strength of respective mixes are given in the table below.

MixType	7 Days	14 Days	28 Days
	Compression Strength(N/mm^2)	Compression Strength(N/mm^2)	Compression Strength(N/mm^2)
SCC	17.02	23.11	25.15
SCC + 5MP	30.08	32.41	33.11
SCC + 10MP	31.12	33.66	35.07
SCC + 15MP	33.13	37.74	38.87

Table4.1Compressivestrengthtestresults

Table 4.1 shows that the compressive strength of the specimen shows greater strength at 15% replacement ofSCC that is mix M3 and decreasing after. The conventional mix M1 shows results approximately similar toM3.

Table4.2 Split tensile strength test results

Mix Type	7 Days	14 Days	28 Days
	Split tensile Strength (N/mm^2)	Split tensile Strength(N/mm^2)	Split tensile Strength (N/mm^2)
SCC	1.27	1.44	1.65
SCC + 5MP	1.83	2.13	2.43
SCC + 10MP	1.83	2.05	2.40
SCC + 15MP	1.76	2.286	2.61

Table 4.2 shows that the tensile strength of the specimen undergoes an gradual decrease with increase in content of Recycled aggregate concrete. The conventional mix M0shows greater strength at the end of the test.

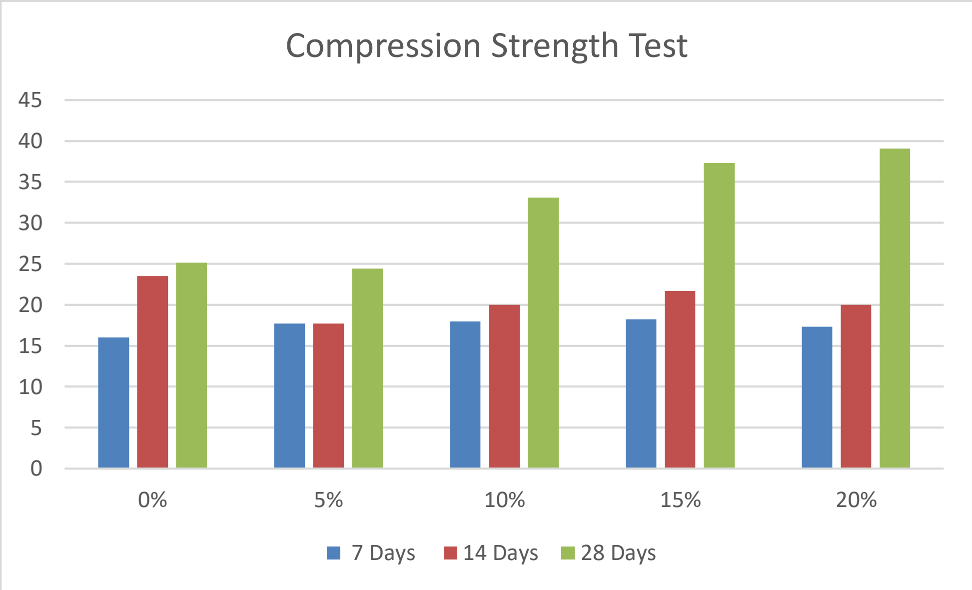

Fig 4.1GraphshowingCompressivestrengthofspecimen

Table4.1shows that the compressive strength of the specimen shows greater strength at 30% replacement of RAC that is mix M3 and decreasing after. The conventional mix M1 shows results approximately similar to M3.

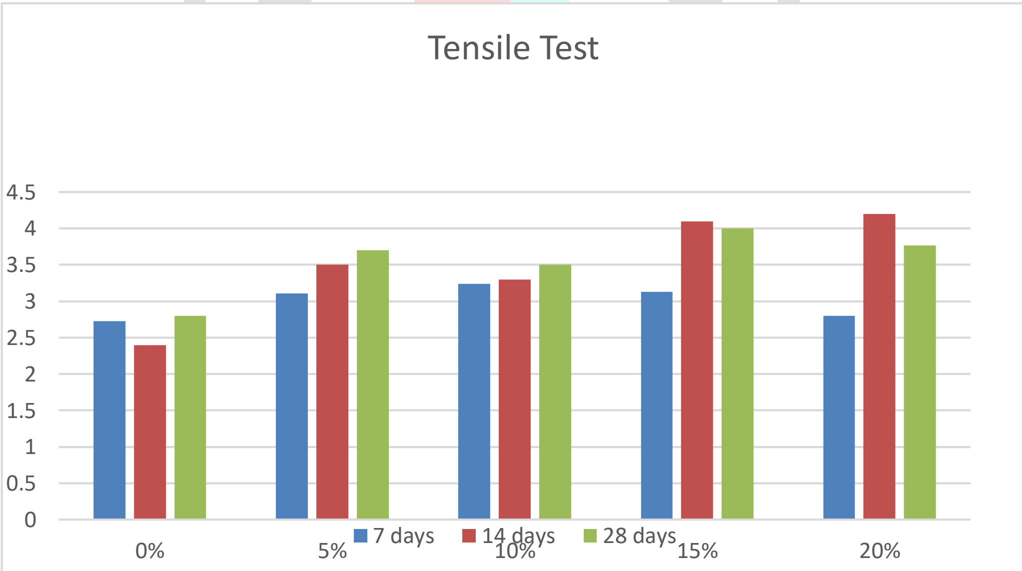

Fig 4.2Graph showing Split tensile strength of specimen

Table 4.2 shows that the tensile strength of the specimen undergoes an gradual decrease with increase in content of Recycled aggregate concrete.The conventional mix M0shows greater strength at the end of the test.

V. CONCLUSION:

The reason of this project is to design a suitable SCC mix and evaluate it by 4 tests which are slump flow, V-Funnel, L-Box, and then determine the strength of it by casting the concrete in cubes and then put it in the compression machine and measure the strength after 7,14, 28 -days curing.

The main conclusions of this project are:

· SCC helps in creating durable and reliable concrete structures requiring very little maintenance work. SCC is becoming so widely used that it will be soon seen as the "standard concrete" rather than as a "special concrete".

This project has studied the feasibility of using Metakaolin Powder in SCC. The mechanical and durability properties of various mixture proportions were studied and results were compared.

Test results show that SCC with equal replacement of Metakaolin Powder gives better performance than other mix proportions.

SCC with equal replacement of Metakaolin Powder increases Compressive Strength by 35%, Split Tensile Strength by 37% and Flexural Strength by 25%.

The results also show that SCC with equal replacement of Metakaolin Powder gives better acid resistance.

Substitution of Metakaolin Powder in cement also reduces cost.

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