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Properties of Concrete Containing Wollastonite

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***Abstract*— Wollastonite is a naturally occurring mineral known as calcium metasilicate (CaSio3). It contains silica which reacts with water to form calcium-silicate-hydrate (CSH). CSH is also responsible for imparting strength to cemented material when Portland cement hydrates. In this study wollastonite was used to replace cement in concrete mix up to 30 %. There were 9 concrete mixes prepared with different wollastonite percentages which are 0%, 5%, 10%, 12.5%, 15%, 17.5%, 20%, 25%, 30% by weight of cement. Water cement ratio used was 0.44. It was observed that there was a rise in compressive strength at 10%, 12.5%, 15% wollastonite replacement as compared to control mix. Highest rise was observed at 15% wollastonite replacement.**

Keywords: - Wollastonite, Tilting Mixer, RHA (Rice Husk Ash), Compressive Strength, Silica.

I. INTRODUCTION

Concrete is a material composed mainly of water, aggregate and cement .Often additives and reinforcement are added to achieve desirable physical strength. Concrete is highly used construction material strong, durable and efficient binding material and most vital ingredient of concrete is Cement, So far India is second largest manufacturer of cement across the globe. Despite being giant producers we are facing serious Environmental issues. The cement industry is mass producers of Carbon dioxides. To deal with environmental issues we need to find alternate sources. And from many general studies we can conclude that addition of minerals admixtures to concrete gives more durable concrete which is more resistance to environmental agencies responsible for concrete degradation. Wollastonite is naturally occurring mineral formed due to interaction of limestone with silica in hot magmas (Paul 1977) .It is chemically calcium-metasilicate (Ramchandra et al 1981) wollastonite was found to possess reinforcing quality and resistance to chemical attack even in high temperature (USGS minerals book 2009) .It is white mineral highly modulus. India produced 120000 tons of wollastonite in year 2010 which accounts 22% of total world production. It is abundantly available in Rajasthan Pali Sirohi Dist Udaipur and also found in Tamil Nadu, Uttarakhand and Andhra Pardesh. it is being used for reduction of shrinkage cracks ceramic tiles and refractory improvement in tensile strength of plastics.

Study available so far about wollastonite indicates that it is potential mineral responsible for properties enhancement. The objective of the present work is to facilitate the utilization of wollastonite as a new material in concrete with partial replacement of OPC. And this is done by determining the optimum level of replacement based on compressive strength.

II. BACKGROUND LITERATURE

According to previous study of Aditya Rana, Pawan Kalla and Sarabjeet Singh. With addition of wollastonite in concrete mixes compressive strength dropped marginally at water binder 0.45 and 0.50 but noticeable strength was witnessed at 0.45 water binder ratio. Low Beaudoin in their study observed that additional of wollastonite to cement matrix improve both flexural and ductility of hydrated cement and cement silica fume matrices it was found that 2 to 15 percent volumetric additional of wollastonite results in strong and tough matrices results in strong and tough matrices. These properties were found best in base matrix at 11.5 percent wollastonite content and 5.2 percent silica fume by volume. As per Mathur et al Incorporation 10% wollastonite as a substitute cement and sand improves compressive strength by 28-35 % at 28 days and 56 days respectively. It was observed that additional of wollastonite reduced water absorption drying shrinkage and abrasion loss of concrete improvement in durability against alternate freezing and thawing and sulphate attack was also observed. A

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previous study by Ransinchung and Brind Kumar has shown that the mortar containing wollastonite and microsilica attains higher compressive strength than the conventional mortar. Test results than the conventional mortar test results of this work indicated that the mortar containing 82.5% cement 10% wollastonite and 7.5% micro silica as binding material attended the highest compressive strength of 63 MPa the mortar which contained 77.5% cement ,15% wollastonite and 7.5% micro silica also achieved 2.8% higher compressive strength than conventional mortar.

III. EXPERIMENT

For the experiment Ordinary Portland Cement (OPC) of grade 43 confirming IS 12269 was used. Wollastonite was procured locally. Aggregates used in this study were procured locally and natural potable water was used. All the experiment was performed in the Concrete Lab of Priyadarshini College of Engineering, Nagpur.
Suitability of materials like wollastonite, OPC, aggregates was examined first. The test performed on these materials are shown in the table below:

S.N	Test	Relevant Codes
1.	Fineness test of wollastonite	IS 4031 Part 1-1996
2.	Sieve analysis	IS 383-1970
3.	Specific gravity	IS 2386 Part 3 – 1963
4.	Water absorption	IS 2386 Part 3 – 1963
5.	Free moisture content	IS 2386 Part 3 – 1963

Concrete mixes were prepared using water binder ratio as 0.44. Concrete mixes were prepared for 9 percentages of wollastonite i.e., 0%, 5%, 10%, 12.5%, 15%, 17.5%, 20%, 25%, 30% each percent having 9 cubes of size "150 x 150 x 150 mm". The properties of concrete mixes prepared replacing cement were compared with the control mix concrete. Cubes were casted for 3 days, 7days and 28 days.
Ratio used for preparing the control mix was:-
1:1.52:1.05:1.58 = cement: sand: 10mm aggregate: 20mm aggregate.
All materials of mix design were brought at room temperature 27°C before preparing mixes. Cement samples were thoroughly dry mixed with hand before their use to ensure proper blending and uniformity in the material. Aggregates were separated in fine and coarse fractions and were recombined for each concrete batch to obtain the desired grading. IS 4.75mm was used to sieve the sand, IS 10mm was used for separating 10mm aggregates and IS 20mm sieve was used to separate 20mm aggregate. The quantity of cement, sand, aggregate, wollastonite was determined by weight and water was measured in litres. Drum tilting mixer was used to prepare the concrete. The materials were first dry mixed for few minutes then water was added and the mix was done by setting the drum to desired angles. Slump test was performed for every mixes prepared. Slump between 90mm – 100mm was selected for casting. Cube moulds were oiled before filling the mix to avoid adhesion with concrete. Specimens were compacted to produce full compaction of the concrete with neither segregation nor excessive slurry flow. The moulds were filled in three layers and each layer was compacted by vibrations. After compaction of the top layer, the surface was levelled with the help of trowel. Total 9 mixes were prepared and 9 cubes for each mix were prepared i.e., 63 cubes. Test specimens were then stored in moist air for 24 hrs before de-moulding. After de-moulding the cubes were marked with markers and kept in curing tanks until their time of testing. Average of three test values were taken to calculate the compressive strength.

IV. RESULT ANALYSIS

Effect of wollastonite on properties of concrete like compressive strength was investigated at 3 days, 7 days and 28 days. With the increase in wollastonite content, workability was found to be decrease slightly as compared to control mix. Results of compressive strength of wollastonite added concrete at 3 days, 7 days and 28 days respectively are shown in figure. Incorporation of wollastonite in concrete mixes resulted into slight rise in compressive strength at 10%, 12.5%, 15% wollastonite replacement compared to control mix. There was slight decrease in compressive strength at 5 % replacement but at 10 % and 12.5%& 15% replacement there was rise in compressive strength. Maximum strength observed was 39.56N/ for the control mix prepared without any wollastonite replacement. Minimum strength observed was 34.5 N/

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for 25% wollastonite replacement.

MIX	COMPRESSIVE STRNGTH N/mm^2		
	3 days	7 days	28 days
CM / 0%	19.56	27.7	36.74
5%	23.11	28.03	36.67
10%	19.05	26.95	37.11
12.5%	18.22	25.03	38.96
15%	18.05	25.89	39.56
17.5%	17.93	26.67	36.3
20%	17.56	25.75	35.85
25%	18.2	25.33	34.5
30%	18.3	25.64	35.1

Table 1:- Compressive Strength of cube for 3, 7 &28 days

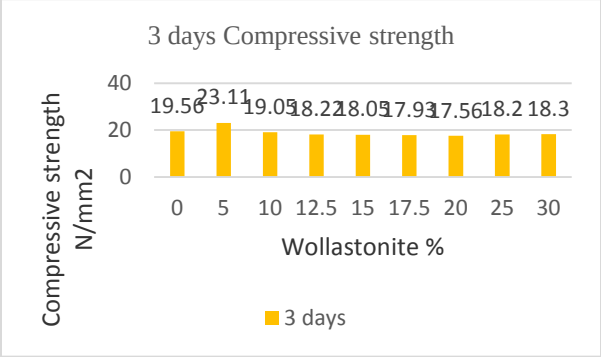

Fig 1:- 3 days Compressive Strength

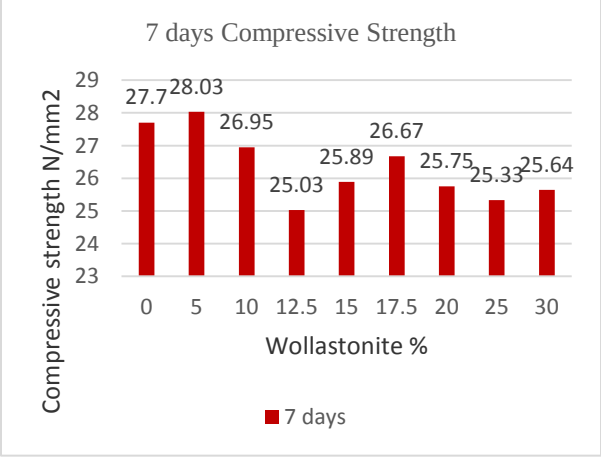

Fig 2:- 7 days Compressive Strength

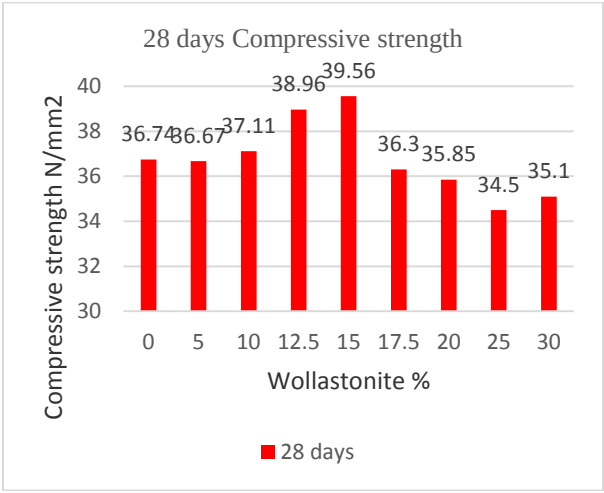

Fig 3:- 28 days Compressive Strength

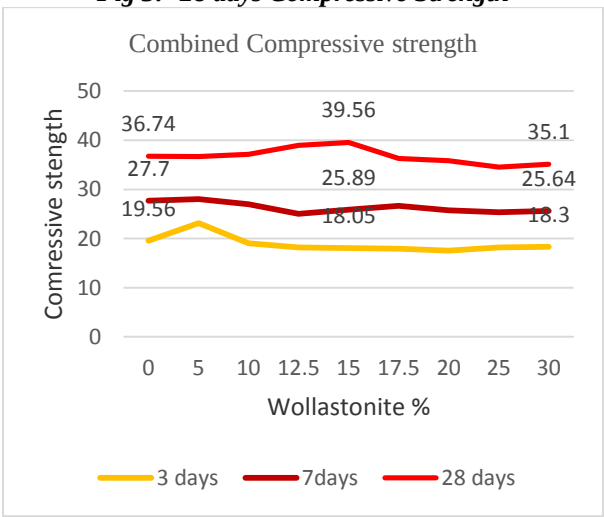

Fig 4:- Combined Compressive Strength

V. CONCLUSION

- There was slight decrease in compressive strength at 5 % replacement but at 10%, 12.5% & 15% replacement there was rise in compressive strength.
- Optimum percentage of replacing cement with wollastonite selected is 15%.
- The presence of silica in wollastonite is responsible for imparting strength in concrete.
- It is advantageous to use wollastonite in replacement of cement as it reduces pollution

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which occurs while making cement.

REFERENCES

Journal Papers:

1. Mechanical and durability properties of concrete containing wollastonite by A. Rana, P. Kalla, S. Singh.
2. Investigation on pastes and mortars of OPC admixed with wollastonite and microsilica by G.D. Ransinchung and Brind Kumar.
3. Experimental investigation of micro-reinforced, alkali activated GGBS with wollastonite by A. Waldron and B. Varela.
4. Effect of wollastonite micro fibre addition in mortar and concrete mixes by S.K Sharma, G.D. Ransinchung, Praveen Kumar.
5. Laboratory study use of wollastonite micro-fibre for abrasion resistance of pavement quality concrete by G.D. Ransinchung, P.N Kumar.
6. Influence of wollastonite on mechanical properties of concrete by Goel P, Mathur.

Websites

7. www.concretehelper.com/Concrete-Facts.php, visited on 5/9/2015.
8. www.cmaindia.org, visited on 5/9/2015.

IS CODES:

9. IS 456: plain and reinforced concrete – code of practice 2000.
10. IS 1237: specification for cement concrete flooring tiles, 1980.
11. IS 4031 Part 1-1996 for fineness test of cement and wollastonite.
12. IS 383-1970 for sieve analysis of aggregates.
13. IS 2386 Part 3 – 1963 for different test on aggregates.