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Study on Strength of Concrete by Partial Replacement of Cement to Wollestonite and make Concrete Economical

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ABSTRACT

Concrete is the vast used material in the world. The main ingredient of concrete is cement, fine and course aggregates and water. Cement is the main ingredient of concrete which binds it and provide strength to the concrete. For the high strength of concrete dependency on cement is high. To reduce the dependency on cement it is necessary to introduce some another material which can be replaced or partially replaced by cement. The high demand of cement also increases the pollution. From a study it can be calculated that manufacturing of cement produced more pollution than the trucks around the world. Near about 900KG carbon produced over 1000KG cement. It is necessary to control the pollution from the cement industries the only way to control the pollution from cement industries is to use some other material which have similar property to cement. These materials can be used by partial replacement of the cement in some percentage. In this study we are going to use material Wollastonite as partial replacement of cement. We are going to replace cement with wollastonite with percentage change of 6%, 12%, 18%, 24% respectively by weight. After replacing these materials with cement check the effect on compressive strength, split tensile strength, flexural strength (at 7 days, 14 days, 28 days).

KEYWORDS: *Cement, Fine aggregates, Course aggregates, Wollestonite, Workability, Compressive strength, Split tensile strength*

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INTROCUTION

Infrastructure decides the development of any country. In present time it is necessary for a developed country should have a good infrastructure. In developing country like India there is a huge scope in construction. Construction of many mega projects like different bridges, tunnels and different kind of structures including Cement concrete roads are in progress and planning for construct many such projects in future. Due to the structural strength and stability, concrete is widely used as construction material. Ordinary Portland cement is the most used binding material in the concrete. Unfortunately, production of cement produces huge amount of carbon di oxide gas which is highly responsible for global warming and greenhouse effect. Production of cement produces approximately 8% of carbon di oxide which is greater than the total carbon emission from the trucks in the world. We are going to minimize the use of cement by using wollastonite in place of cement in some different percentages. Wollastonite is in the powder form and can be mix in cement easily. The mineral is easily available in India. So the use of this mineral can decrease the carbon emissions from the cement industries. Here we discus about the wollestonite use as partial replacement of cement which increase the strength as well as reduce the dependency on cement.

Wollestonite: Wollestonite has itsname in the honour of minrologist W.H. Wollestone. The cemical name of wollestonite is Calcium metasilicate as it includes calcium oxygen and silicon. Chemical formula of wollestonite is CaSiO3. It forms when mixed limestone is subjected to high pressure and temperature at times in the occurrence of silica-bearing fluid as contact in metamorphic rock.

LITERATURE REVIEW

Dr. Sudhikumar G S (2021) - Concrete is durable and efficient binding material which is used for construction. India is second largest producer of cement. About 1.5 tons of raw materials is required for every single ton production of cement. In order to reduce the consumption of cement, supplementary cementitious materials are used in concrete production. Wollastonite is a naturally occurring mineral formed due to interaction of limestone with silica in hot magmas which imparts additive strength to concrete. In the present work, cement is partially replaced by wollastonite at various percentage in concrete. Graphene Oxide is an extraordinary Nano-material which is accessible in powder, sheets, flakes and oxide form. It is strong, elastic and light weight in nature and recently adopted in construction field. It is having great properties which are beneficiary in construction field. When graphene oxide is added to concrete composites, it increases the rate of hydration, bond strength to concrete structures and reduces permeability. In this project, optimum quantity of graphene oxide (0.2%) is used as an additive to study the strength properties of M25 grade concrete, cement is partially replaced by wollastonite at 0%, 5%, 10%, 15%, and 20% in concrete.

Supriya Xavier Lopes (2020) Concrete is durable and efficient binding material which is used for construction. India is second largest producer of cement. About 1.5 tons of raw material is required for every single ton production of cement. In order to reduce the consumption of cement, supplementary cementitious materials are used in concrete production. Wollastonite is one such naturally occurring mineral formed due to interaction of limestone with silica in hot magmas. In the present work, cement is partially replaced by Wollastonite at 0%, 110%, 12%, 14%, 16% and 18% in concrete. The effect of Wollastonite on strength properties of concrete for M30 grade mix is studied. IS 10262 (2019) is used to carry out the Mix Design. Slump and compaction factor are determined to measure workability. For various mixes of concrete, compression and flexural strengths are determined. Durability in terms of chloride and sulphate resistance is determined by immersing the cubes in HCl and MgSO4 solution for 28 days. The obtained results from various combinations of mixes are then compared with conventional concrete mix.

Kuldasheva A. (2020) An analysis the effect of using mineral Wollastonite fiber as a partial substitute of cement in Portland cement mortar mixes are reported. Three different mixes were prepared and tested, which Wollastonite fiber used as a reinforcing component with replacement levels of 5 and 10%. Investigated and test results showed that incorporation Wollastonite fiber into a cement composition increase flexural straight to 132% and compressive straight to 140%

Srushti zade (2019) In the present year of grace, the most extensively used material in the construction industry is for sure the concrete. One of the main constituent of concrete is cement. And this fact should be one of the main concerns that cement production causes emission of large amount of carbon dioxide gas into the atmosphere and so this exhale of gases further leads to the contribution in the greenhouse effect. So taking this unwell consequence into consideration we have come up with a choice. A choice to cement which is wollastonite. Wollastonite is naturally occurring mineral and is cheaper when compared to cement. So in this project particular we are studying the strength properties of concrete by adding wollastonite in it to some desirable percentage with simultaneously replacing the cement percentage by maintaining W/C ratio. This would further help in reducing cement production and thus the greenhouse effect at some extent.

Material Used

Cement - Cement is the binding material which used vast in present day for many kinds of projects. Different grades and kind of cement is used for different kind of projects. Grades like 33, 43 and 53. In our work we use of grade 53. There are some different kinds of cement we can use for different type of projects. Here we use OPC (ordinary Portland cement).

Fine Aggregates - Fine aggregates are the material which is passing from 4.75mm sieve. The fine aggregates used in this present study are collected from the local market.

Course Aggregates - Course aggregates are the material which is retained on 4.75mm sieve. The course aggregates in this study are collected from local market.

Wollestonite - Wollastonite is a mineral which contains silica and clay are predominant, almost in half ratio, 48.3% CaO and 51.7% SiO2. It also contain small amount of manganese (mn), iron (Fe) and magnesium (mg). Chemical formula for Wollastonite is “CaSiO3”. It forms due to the weathering action or can say from the metamorphism reaction on limestone. So wollastonite is a metamorphic rock. It is found in different colours like white, grey, pale green, pinkish, red, brown, yellow with high brightness. Wollastonite has its different crystal shapes. It is not found in circular shape

although it is found in needle like crystal structure. The length of wollastonite micro fiber is 0.4 – 0.6 mm and dia 25 – 150 µm. And less than 25 µm will be consider as powder and more than 150 µm will be consider as fibers. Because of its shape it can also be used as filler and can be replaced by sand also. From different researches it was proved that use of wollastonite as a replacement of cement or as filler in place of fine aggregates and sand improves the flexural strength, its compressive strength and ductility of the concrete. India is the second largest producer of wollastonite after China. It is profusely found in Pali (Rajasthan) Sirohi Distt. Udaipur and also found in Uttarakhand, Andhra Pardesh and Tamil Nadu. It has similar properties as cement. Also it has its binding properties. So it can be used as a replacement or partially replacement of cement with some ratio. It helps to reduce cracking and glaze effect. It can be used as an additive in paints and helps in improvement in the durability of the paint. It also use in plastic to increase its flexural strength. Wollastonite is used in friction products like breaks and clutches. One another use of wollastonite is, it use in the tile manufacturing industries.

Properties of Wollastonite

Specific gravity

The specific gravity of wollastonite is in-between range of 2.87 – 3.09.

Bulk density

There are two types of bulk densities one is in loose condition and the other one is in compacted or tapped condition:

Loose bulk density (g/cc) 0.20 to 1.23 and compacted or tapped bulk density (g/cc) 0.35 to 1.66.

Colour

Pure wollastonite has white in colour bug due to impurities or even small amount of impurities it may in colour cream, pinkish, red or brown. These colours will appear due to the presence of iron and the other colouring ions.

Melting point

Pure wollastonite has a melting point of 1540 ℃ but some amount of impurities present in the wollastonite so practically the value will be lower. The melting point will be 1380 ℃.

Mechanical properties

A. Diameter of wollastonitefiber 25 – 150 µm
B. Elastic modulus (GPa) 303 – 530
C. Young's modulus (109 psi) 44- 72
D. Tensile strength (MPa) 2700 – 4100

Acicular Structure

Wollastonite has a different structure such as acicular structure or needle-like structures which make it useful in different purposes.

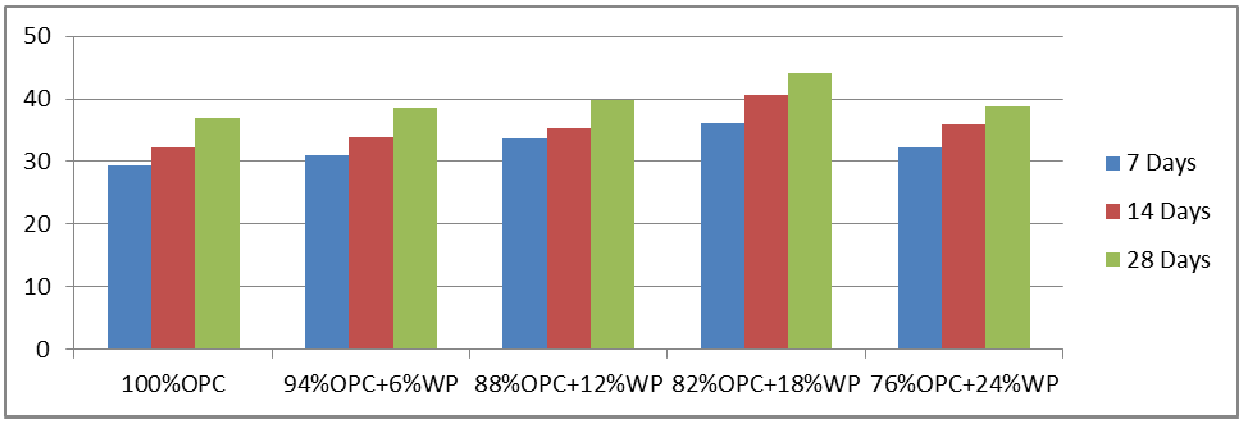
Scratch Resistance

The hardness of wollastonite is higher. Its hardness is 4.5

RESULT AND DISCUSSION

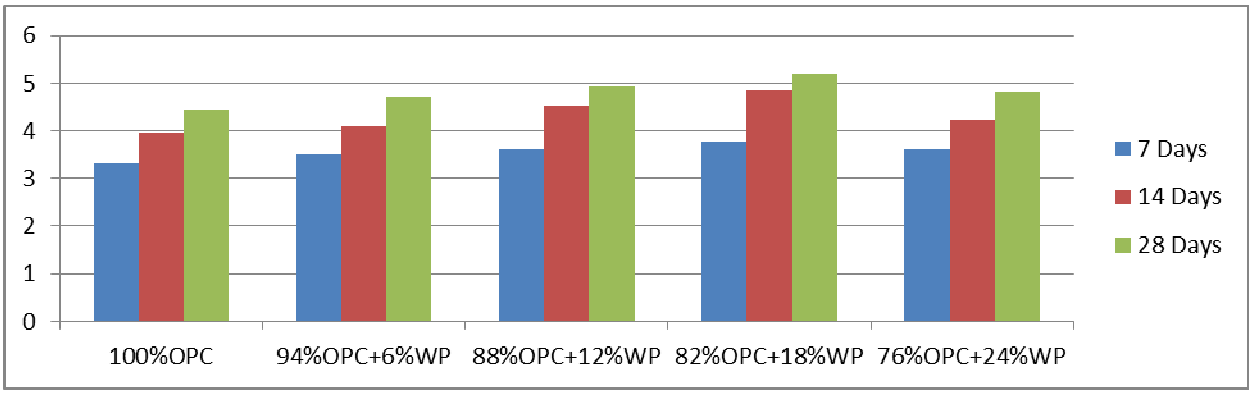
Compressive Strength:

Description	7 Days	14 Days	28 Days
100%OPC	29.35	32.2	37.02
94%OPC+6%WP	31.06	33.82	38.6
88%OPC+12%WP	33.65	35.29	39.86
82%OPC+18%WP	36.04	40.56	44.04
76%OPC+24%WP	32.21	35.92	38.79



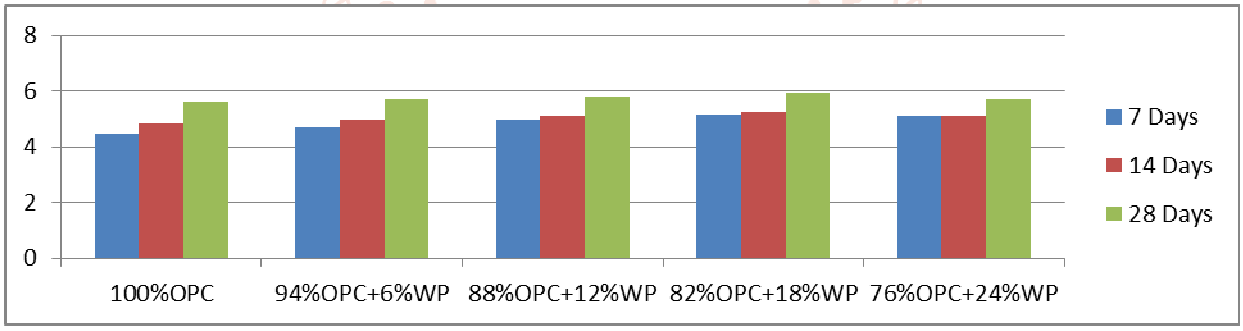
Split Tensile Strength:

Description	7 Days	14 Days	28 Days
100%OPC	3.32	3.97	4.45
94%OPC+6%WP	3.51	4.1	4.71
88%OPC+12%WP	3.62	4.53	4.94
82%OPC+18%WP	3.77	4.85	5.21
76%OPC+24%WP	3.6	4.24	4.83



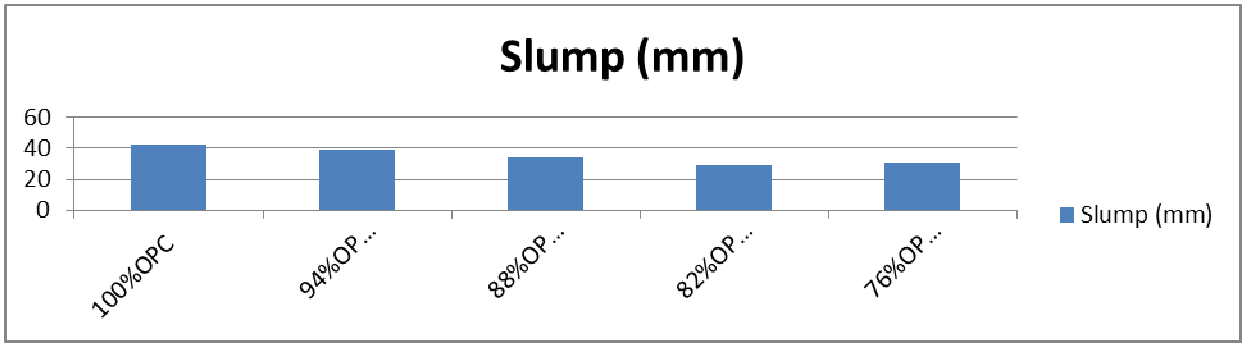
Flexural Strength

Description	7 Days	14 Days	28 Days
100%OPC	4.45	4.85	5.6
94%OPC+6%WP	4.7	4.98	5.73
88%OPC+12%WP	4.98	5.1	5.82
82%OPC+18%WP	5.15	5.26	5.95
76%OPC+24%WP	5.11	5.13	5.70



Workability

Description	Slump (mm)
100%OPC	42
94%OPC+6%WP	39
88%OPC+12%WP	34
82%OPC+18%WP	29
76%OPC+24%WP	31



CONCLUSION

- Addition of 18% wollestonite i.e. 82% cement and 18% wollestonite gives more compressive strength to concrete then 100% cement concrete.
- There is increase in split tensile strength by addition of 18% wollestonite as compare to concrete cement only.
- Maximum increase in flexural strength can also be seen at 18% usage of wollstonite in concrete.
- Reduction in bleeding can also be seen by addition of wollestonite to concrete.
- Workability of wollestonite mix concrete consciously decreases.

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