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Experimental Study on Mechanical Properties of Jute Fibre Reinforced Concrete with Partial Replacement of Cement by Wollastonic Powder

Mrs. Dhavane Shubhangi[1] and Prof. Dr. P. K. Kolase[2]
Student, ME Structural Engineering, Pravara Rural Engineering College, Loni[1]
Professor (HOD), Dept. of Civil Engineering, Pravara Rural Engineering College, Loni[2]

Abstract: *Concrete is a widely used construction material for various types of structure due to its structural stability and strength. The ordinary Portland cement is one of the main ingredients used for the production of concrete and has no alternative in the civil construction industry. Sustainable energy and cost saving can result when industrial by-products are used as a partial replacement of cement. Wollastonite increases the performance of products like polymers, plastics, paints and coatings, construction materials, friction devices, ceramic, etc. It also been employed for metallurgical applications. Wollastonite powder is used in numerous mixtures which can be replaced at from 0% to 18% through weight of cement in concrete and constant percentage of jute fiber. After curing period of 28 days, it is checked for its compressive strength, flexural strength test and durability test are taken. These are in comparison with a normal mixture which is 0% of wollastonite powder and constant percentage of jute fiber determine the best combination of replacing the material.*

Keywords: Wollastonite Powder, OPC, Concrete, Compressive Strength, Flexural Strength

I. INTRODUCTION

Concrete is a widely used construction material for various types of structure due to its structural stability and strength. The usage, behavior as well as the durability of concrete structure, built during the last first half of the century with ordinary Portland cement and plane round bar of mild steel, the ease of procuring the constituents material (whatever may be their qualities) of concrete and the knowledge that almost any combination of the constituents leads to a mass of concrete have bred contempt. Strength was stressed without a thought on durability of structure. As a consequence of the Liberty station, the durability of concrete and concrete structures is on southward journey; a journey that seems to have gained momentum on its path to self-destruction.[20] The ordinary Portland cement is one of the main ingredients used for the production of concrete and has no alternative

in the civil construction industry. Unfortunately production of cement involves emission of large amount of carbon dioxide gas into the atmosphere a major contributor for greenhouse effect and the global warming, hence it is inevitable either to search for another material or partly replace it by some other material. The search for any such material which can be used as an alternative or as a supplementary for cement should lead to global sustainable development and lowest possible environmental impact. Sustainable energy and cost saving can result when industrial by-products are used as a partial replacement of cement. Fly ash, ground granulated blast furnace slag, rice husk Ash, silica fume are some of the pozzolanic material which can be used in concrete as partial replacement of cement. A number of studies are going on in India as well as abroad to study the impact of use of these pozzolanic materials as cement replacement and the results are encouraging.[22]

Wollastonite is a mineral blessed with many unique characteristics. Till 1970, the primary use of Wollastonite was as a decorative stone. Since the past 4 decades, one of the uses has been as a replacement for asbestos in products like insulating board and panels, paint, plastics, roofing tiles, and in friction devices such as brakes and clutches. Wollastonite is one of the most versatile functional filler and reinforcement agents. Wollastonite increases the

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performance of products like polymers, plastics, paints and coatings, construction materials, friction devices, ceramic, etc. It also been employed for metallurgical applications.[19].

A. Wollastonite Powder

Wollastonite is an industrial mineral containing chemicals like calcium, silicon and oxygen. Molecular formula of Wollastonite is CaSiO3 and its approximate theoretical composition consists of 48.28% of CaO and 51.72% of SiO2. Natural Wollastonite may contain traces or minor amounts of various metal ions such as aluminum, iron, magnesium, potassium and sodium.[9].

Fig 1 Wollastonite Powder

B. Jute Fibre

Jute is a kind of bast fibre that belongs to family Tiliaceae. Most of the jute in the world is produced in countries like India, Pakistan, China, Bangladesh, and Brazil. Jute fibre has been widely used in the fields of textile, construction and automotive because of its fine texture, low thermal conductivity, and low cost. Like other natural fibres, cellulose, hemicellulose and lignin are the major components of jute fibres.

Fig 2 Jute Fibre

II. METHODOLOGY

1) Data Collection:

Collect relevant data from literature and previous studies regarding the use of wollastonite and its effects on concrete. Gather details on the material properties, including cement, wollastonite powder, aggregates, and fibers, as well as the mix design, curing methods, and test results used in prior research.

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2) Material Used:

• Cement: Ordinary Portland Cement (OPC) of standard grade (e.g., 53-grade cement) will be used as the base material.

• Wollastonite Powder: A naturally occurring mineral used as a partial replacement for cement. The wollastonite powder will be sourced locally.

• Coarse Aggregate: Crushed stone aggregates with a size range from 10 mm to 20 mm.

• Fine Aggregate: Natural river sand with a specific fineness modulus (e.g., 2.5-3.0).

• Jute Fibre: Natural fibers added to the concrete mix to enhance mechanical properties, used at constant proportion 1%.

• Water: Clean, potable water, free from impurities, to ensure proper hydration of cement and to maintain workability of the mix.

3) Mix Design:

• Grade of Concrete: The M30 grade concrete mix will be designed using IS 10262:2019.

• Replacement Proportions: Cement will be partially replaced with wollastonite powder at different percentages (e.g., 0%, 10%, 13%, 16%, and 18%).

• Jute Fibre Addition: Jute fibers will be added at constant proportions (e.g., 1%) to observe their effect on the mechanical properties of the concrete.

Water-Cement Ratio: The water-cement ratio will be adjusted according to the mix design guidelines to maintain adequate workability and strength development.

Table 1. Mix Proportion for casting Cube

Wollastonite Powder %	Cement (kg)	Wollastonite Powder (kg)	Jute Fiber %	Jute Fiber (K g)	Sand (kg)	Aggregtes (kg)
0%	2.27	0	0	0	3.91	5.74
10%	2.04	0.23	1%	0.22	3.91	5.74
13%	1.97	0.30	1%	0.22	3.91	5.74
16%	1.91	0.36	1%	0.22	3.91	5.74
18%	1.86	0.41	1%	0.22	3.91	5.74

Table 2. Mix Proportion for casting Beam

Wollastonite Powder %	Cement (Kg)	Wollastonite Powder (Kg)	Jute Fiber %	Jute Fiber (Kg)	Sand (K g)	Aggre gates (Kg)
0%	10.57	0	0	0	17.78	26.74
10%	9.51	1.06	1%	0.105	17.78	26.74
13%	9.20	1.37	1%	0.105	17.78	26.74
16%	8.88	1.69	1%	0.105	17.78	26.74
18%	8.67	1.90	1%	0.105	17.78	26.74

III. RESULTS OF ANALYSIS

A. Compressive Strength for Wollastonic Powder

Graph 1 Compressive Strength (Wollastonic powder) Above Results show that there is a marginal increase in Compressive strength in replacement of Wollastonic powder up to 16% at the age of 7, 14, 28 days and gets slightly decreased at the 18%.

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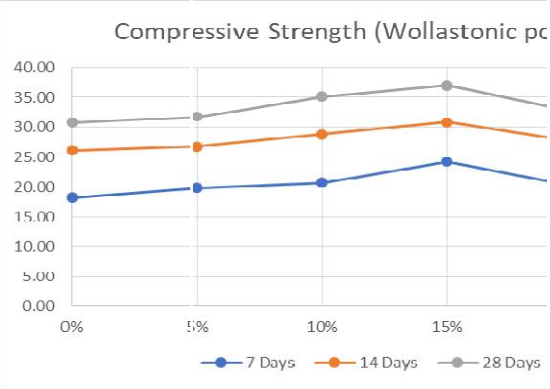
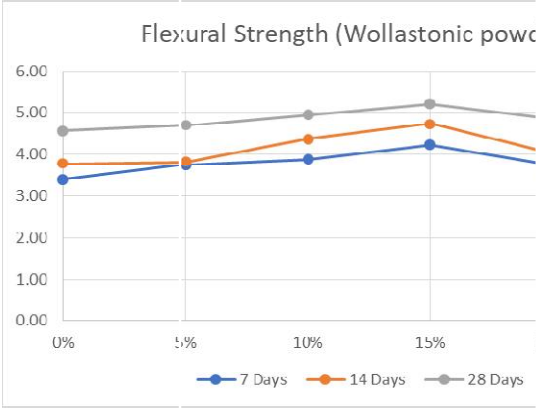
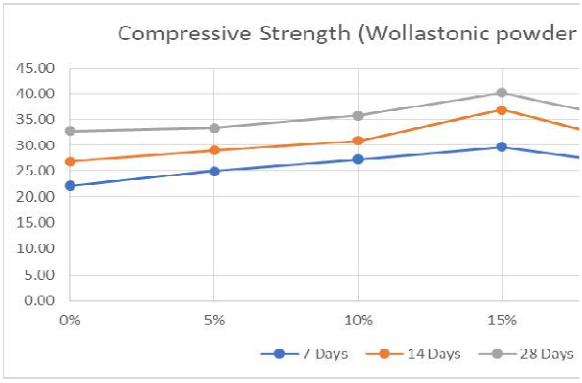


B. Flexural Strength for Wollastonic Powder



Graph 2 Flexural Strength (Wollastonic powder) Above Results show that there is a marginal increase in Flexural Strength in replacement of Wollastonic powder up to 16% at the age of 7, 14, 28 days and gets slightly decreased at the 18%.

C. Compressive Strength for Wollastonic powder + Jute fiber



Graph 3 Compressive Strength (Wollastonic powder + Jute fiber)

Above Results show that there is a marginal increase in Compressive strength in replacement of Wollastonic powder + Jute fiber up to 16% at the age of 7, 14, 28 days and gets slightly decreased at the 18%.

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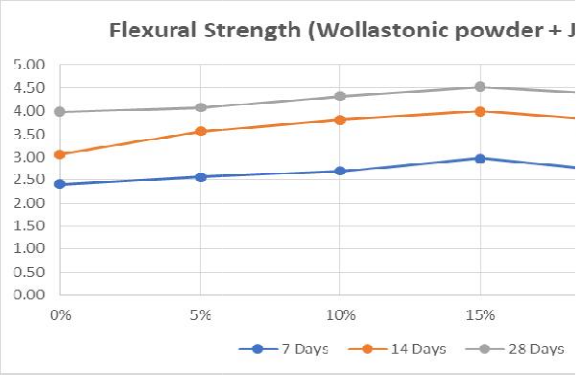
D. Flexural Strength for Wollastonic powder + Jute fiber



Graph 4 Flexural Strength (Wollastonic powder + Jute fiber)

VI. CONCLUSION

A detailed study has been carried out on the Compressive and tensile strength of concrete with varying the various percentage of Wollastonic powder and jute fiber. Experimental investigation was carried out to check suitability and veracity of the Plain concrete mix with Wollastonic powder for 10, 13, 16, 18% with cement and jute fiber for constant percentage on performance of concrete. Inclusion of Wollastonic powder for cement performs better up to 16%, and similarly, inclusion of Wollastonic powder with jute fiber also performs better up to 16%, adding both together gives excellent performance results of replacement. Hence the following conclusion is considered based on the results and observations are following.

• There is a marginal increase in Compressive strength in replacement of Wollastonic powder up to 16% at the age of 7, 14, 28 days and gets slightly decreased at the 18%.

• There is a marginal increase in Flexural Strength in replacement of Wollastonic powder up to 16% at the age of 7, 14, 28 days and gets slightly decreased at the 18%.

• There is a marginal increase in Compressive strength in replacement of Wollastonic powder + Jute fiber up to 16% at the age of 7, 14, 28 days and gets slightly decreased at the 18%.

• That there is a marginal increase in Flexural Strength in replacement of Wollastonic powder + Jute fiber up to 16% at the age of 7, 14, 28 days and gets slightly decreased at the 18%

REFERENCES

[1]. Suhad D. Salman et. al. "Effects of jute fibre content on the mechanical and dynamic mechanical properties of the composites in structural applications" Defence Technology (2020)

[2]. Akash Gupta et. al. "Study on mechanical properties of natural fiber (Jute)/synthetic fiber (Glass) reinforced polymer hybrid composite by representative volume element using finite element analysis: A numerical approach and validated by experiment" Hybrid Advances (2024)

[3]. Salihu Sarki Ubayi et. al. "A Review of the Impact of Jute Fiber Reinforcement on Mechanical Properties of Concrete" International Journal in Engineering Sciences (2024)

[4]. Mahfuza Farzana et. al. "Properties and application of jute fiber reinforced polymer-based composites" GSC Advanced Research and Reviews (2022)

[5]. Nishant A. Nair et. al. "Research initiatives on the influence of wollastonite in cement-based construction material- A review" Journal of Cleaner Production (2021)

[6]. Ishan Anand et. al. "A Review Paper On Properties Of Concrete With Jute Fibre Reinforced Concrete With Partial Replacement Of Cement With Metakaolin" International Journal of Mechanical Engineering (2022)

[7]. Supriya Xavier Lopes et. al. "Effect of Wollastonite as Partial Replacement of Cement on Mechanical and Durability Properties of Concrete" International Research Journal of Engineering and Technology (2020)

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[8]. P.Raghavendra et. al. "Effect Of Wollastonite And Ggbs As Partial Cement Replacement On The Properties Of Concrete" Journal of Emerging Technologies and Innovative Research (2023)

[9]. Kiran Kumar M S et. al. "Wollastonite Partial Replacement of Cement : An Experimental Research" International Journal of Engineering Research&Technology (2023)

[10]. Pothuru Sucharitha et. al. "Impact of Wollastonite and Glass Powder as Partial Cement Replacement on the Properties of Concrete" Journal For Research in Applied Science and Engineering Technology (2024)

[11]. Ziming He et. al. "Effect of wollastonite microfibers as cement replacement on the properties of cementitious composites: A review" Construction and Building Materials (2020)

[12]. Shanti Saroop Sundhan et. al. "To Investigate the Mechanical Properties of Concrete by Partial Replacement of Cement with Ceramic Tiles Waste Powder and Addition of Jute Fiber" Journal For Research in Applied Science and Engineering Technology (2022)

[13]. R. Haripraba et. al. "Strength and Reliability Performance of Wollastonite in Concrete as Part Replace of Cement with Metakaolin as Admixture" SSRG International Journal of Civil Engineering (2024)

[14]. Vikas Kumar et. al. "Study on Strength of Concrete by Partial Replacement of Cement to Wollastonite and make Concrete Economical" International Journal of Trend in Scientific Research and Development (2022)

[15]. Aman Sharma et. al. "Strength and Durability of Concrete Made with Wollastonite Mineral" International Journal of Research Publication and Reviews (2021)

[16]. Velamuri Sai Vikas et. al. "An Experimental Study on Mechanical Properties of Concrete by Partial Replacement of Cement with Graphene Oxide" Journal For Research in Applied Science and Engineering Technology (2024)

[17]. Jawad Ahmad et. al. "Performance of concrete reinforced with jute fibers (natural fibers): A review" Journal of Engineered Fibers and Fabrics (2022)

[18]. Anuj Garg et. al. "A Review Paper On Study Of Mechanical Properties Of Jute And Hemp Epoxy Polymer Composites" International Journal of Research and Analytical Reviews (2019)

[19]. Prof.R.Jagadeesh Kumar et. al. "Civil Engineering Application And Earlier Research On Wollastonite – A Review" Journal of Emerging Technologies and Innovative Research (2017)

[20]. Behzad Nematollahi et. al. "A review on ultra high performance 'ductile' concrete (UHPdC) technology" nternational Journal of Civil and Structural Engineering, (2012)