STUDY ON THE PERFORMANCE OF CONCRETE USING METAKAOLIN WITH NATURAL FIBRES

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Abstract

In recent years, there has been a growing interest in utilization of metakaoline in concrete as partial substitution is addition to cement due to its high pozzolanic activity. In the present work an attempt has been made to study the suitability of metakaolin as a mineral admixture and its effect on the properties concrete. Concrete mixes were made using Ordinary Portland Cement alone as Control and also replacing cement by 5%, 10%, 15%, 20%, 25% and 30% of metakaolin. In this experimental investigation, workability, strength and durability of concrete mix with partial replacement of cement by metakaolin and with and without coir fibres has been studied. The results obtained shows that at 15% replacement of OPC with metakaolin have higher compressive strength as compared to the other replacement levels. The workability of concrete has reduced due to the addition of coir fibres in the concrete. The durability of the coir fibre reinforced concrete was affected in the alkaline exposure.Hence the coir fibre has stability in metakaolin based concrete, in resistance the cracks even after exposure to the alkaline environment.

Keywords: *Metakaolin, Coir Fibre, Compressive Strength, Flexural Strength, Split Tensile Strength.*

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1. INTRODUCTION

Natural fibres from centuries, mankind has been used for various types of application including building materials. These fibres are light weight, high strength to weight ratio and corrosion resistance. The versatility of OPC attracted everyone in the construction industry and its application is steadily increasing when compared to other material used in these days. With the present level of OPC production, it is not possible to meet the dwelling needs of the country. The OPC can be substituted partially or fully by industrial waste materials to reduce cost with improved performance. The answer to the above question has been realized in the form of natural pozzolans, which have been The present project entitled 'Studies on Metakaolin based coir fibre reinforced incorporated cement and concrete' has taken up with the objectives listed below,

1. To study the performance of concrete containing different percentages of metakaolin and to identify the Proper replacement percentage.
2. To investigate the effect on the strength and durability of metakaolin based concrete by adding coir fibre. proved to be successful to replace OPC up to 30%.

2 MATERIALS AND METHODS

2.1 Materials

The materials used in this research work are ordinary Portland cement of 53 grade, river sand, coarse aggregate of 20mm nominal size, metakaolin, natural (coir) fibre.

2.2 Preparation of Specimens

Concrete mix proportions for M30 mix as per mix design is used for the preparation of specimens. Conventional specimens were casted. Concrete mix with partial replacement of cement by metakaolin including (0%, 0.5%, 1%, 1.5% and 2%) amount of coir fibres are also casted in parallel. The specimens were cured under tap water at room temperature and tested at the age of 7 and 28days.

Fig -1: (a) Metakaolin (b) Coir Fibre

3 TESTS ON CONCRETE

3.1 Compressive Strength Test

The casted specimens of size 150mm*150mm*150mm cubes were tested to determine the compressive strength at the age of 7 and 28days.

3.2 Tensile Strength Test

The casted specimens of size 150mm*300mm cylinders were tested to determine the tensile strength at the age of 28days.

3.3 Flexural Strength Test

The casted specimens of size 1m*0.15m*0.15m beams were tested to determine the flexural strength at the age of 28days.

4. RESULTS AND DISCUSSION

The various results obtained from the compressive strength tests, tensile strength tests and flexural strength tests were discussed and tabulated. The charts representing the test results were also provided. The table 1 indicates the results of the compressive strength of the conventional concrete cubes and concrete cubes with cement replaced by metakaolin. The table 2 indicates the results of the compressive strength of the Coir fibre reinforced concrete cubes with 0%, 0.5%, 1%, 1.5%, 2% of coir fibre respectively and cement partially replaced by metakaolin.

The table 3 indicates the results of the split tensile strength of of the Coir fibre reinforced concrete cylinders with 0%, 0.5%, 1%, 1.5%, 2% of coir fibre respectively and cement partially replaced by metakaolin. The table 4 indicates the results of the Flexural strength of Coir fibre reinforced concrete beams with 0%, 0.5%, 1%, 1.5%, 2% of coir fibre respectively and cement partially replaced by metakaolin.

Table -1: Compressive strength of concrete incorporating with Metakaolin

Mix code	Compressive strength (MPa)	
	7 days	28 days
Control	23.7	39.4
5Mk	27.6	42.7
10 Mk	31.4	46.1
15 Mk	34.8	49.4
20 Mk	33.1	48.4
25 Mk	32.1	47.3
30 Mk	30.4	45.1

Table -2: Compressive strength of coir fibre reinforced concrete

SI.No.	Fibre Length	Fibre Content %	Compressive strength (MPa)	
			7 days	28 days
1	20mm	0	34.8	49.4
2		0.5	43.9	58.6
3		1	42.4	55.9
4		1.5	37.8	51.9
5		2	31.9	44

Table -3: Split Tensile strength of coir fibre reinforced concrete

SI.No.	Fibre Length	Fibre Content %	Split Tensile strength (MPa) (28 days)
1	20mm	0	4.28
2		0.5	4.93
3		1	4.53
4		1.5	4.03
5		2	3.73

Table -4: Flexural Tensile strength of coir fibre reinforced concrete

SI.No.	Fibre Length	Fibre Content %	Flexural strength (MPa) (28 days)
1	20mm	0	5.44
2		0.5	6.4
3		1	5.88
4		1.5	5.20
5		2	4.95

Based on the experimental result, the following were discussed.

- It is found that the slump (or) workability decreases, as the percentage of metakaolin increases.
- From the result it show that the compressive strength increases with increase in the percentage of metakolin, up to 15%, beyond which the compressive strength decreases.
- The maximum compressive strength obtained is 20.2% higher than the reference concrete compressive strength.
- The best mix proportion was found at 15% replacement of metakaolin for further study i.e. for the coir fibre reinforced concrete.
- The percentage decrease in workability at 30% of replacement of OPC with metakaolin is 40% with respect to the reference concrete.It shows that the workability decreases with increase in fibre content.
- The compressive strength of coir fibre reinforced concrete has shown considerable increase relative to the reference concrete, upto 0.5% fibre content, beyond which the strength decreases.
- The compressive strength obtained at 0.5% fibre content is 58.6 N/mm^2 which is 18.62% higher than the reference concrete strength.
- The compressive strength at 1.5% fibre content is 51.9 N/mm^2, which is 5% higher than the reference concrete strength.
- Flexural strength of coir fibre reinforced concrete is also maximum, when the fibre content is 0.5%, when compared to the other fibre contents.
- The maximum flexural strength obtained at 0.5% fibre content is 6.4 N/mm^2, which is 17.64% higher than the reference concrete strength.

- Split tensile behaviour of coir fibre reinforced concrete is similar to that of compressive and flexural strength within the range of fibre content (i.e 0% to 2% at fibre length of 20mm) and fibre length considered.
- Split tensile strength of coir fibre reinforce concrete is also maximum, when the fibre content is 0.5%, when compared to other fibre contents.
- The maximum split tensile strength attained at 0.5% fibre content is 4.93 N/mm^2, which is 15.18% higher than the reference concrete strength.

5. CONCLUSION

From the discussion it is concluded that, the workability decreases, as the percentage of metakaolin increases. The maximum compressive strength obtained is 49.4N/mm^2 at 15% replacement of OPC with metakaolin, which is 20.2% higher than the reference strength. The best mix proportion was chosen at 15% replacement of metakaolin for further study i.e. for the coir fibres reinforce concrete. Compressive, flexural and split tensile strength of coir Fibre Reinforced Concrete are maximum at 0.5% fibre content with 20mm fibre length. The compressive strength obtained at 0.5% fibre content is 58.6 N/mm^2 which is 18.62% higher than the reference concrete strength. The maximum flexural strength obtained at 0.5% fibre content is 6.4 N/mm^2, which is 17.64% higher than the reference concrete strength. The maximum split tensile strength attained at 0.5% fibre content is 4.93 N/mm^2, which is 15.18% higher than the reference concrete strength. Fibres help in resisting the cracks in the concrete.

SCPOE OF FUTURE STUDIES

- It is necessary to characterize the natural fibres in the cementations composites, to ensure durability and develop fibre reinforced quality concrete.

- Natural fibres like coir fibres are to be established, so that concrete thickness can be reduced with high cracking resistance.

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