AN EXPERIMENTAL INVESTIGATION OF CONCRETE OF PARTIAL REPLACEMENT OF CEMENT BY USING METAKOLIN

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Abstract - Concrete is strength and tough material but it is porous material also which interacts with the surrounding environment. The durability of concrete depends largely on the movement of water and gas enters and moves through it. This project presents result of an experimental investigation carried out to evaluate effects of replacing cement by metakaolin which is an industrial waste by-product on concrete strength,.Metakaolin is a dehydroxylted aluminium silicate. The effect of replacement of metakaolin to the cement at varying percentage of 5 %, 10%,15%,20% for for mix design of M20 , M25, M30.The Investigation was carried out for the following test like compressive strength and split tensile strength.

Key Words: **(Metakolin,compressive strength,split tensile strength)…**

1. INTRODUCTION

Concrete as any solid made with the use of a cementing medium; the ingredients generally comprise sand, gravel, cement and water. Concrete is the most common material used in the construction industry. It is made primarily with aggregate, cement, and water. Concrete is made with several types of cement and also containing pozzolana, fly ash, blast-furnace slag, micro-silica, additives, recycled concrete aggregate, admixtures, polymers, fibres, and so on. Fresh concrete or plastic concrete is a freshly mixed material which can be easily moulded into any shape. The relative quantities of cement, aggregates and water mixed together, control the properties of concrete in the wet state as well as in the hardened state. Concrete is reasonably strong in compression and weak tension, whereas steel is good in tension and the combination of these materials makes an ideal and popular materials is known as reinforced cement concrete. Generally, steel rods used resist tensile forces but in some cases they are also used to resist a part of the compressive force either because of natural constraints in construction or because of secondary requirements. The compressive strength of concrete is one of the most important and useful properties of concrete.

1.1METAKAOLIN

Metakaolin is produced by ZIGMA INTERNATIONAL with latest Technology and under guidelines from various Concrete Associations in India. Metakaolin is highly reactive Super Pozzolan with high purity Amorphous Reactive Silica. Adding metakaolin in Concrete significantly enhances many performance characteristics of Concretes and related products.

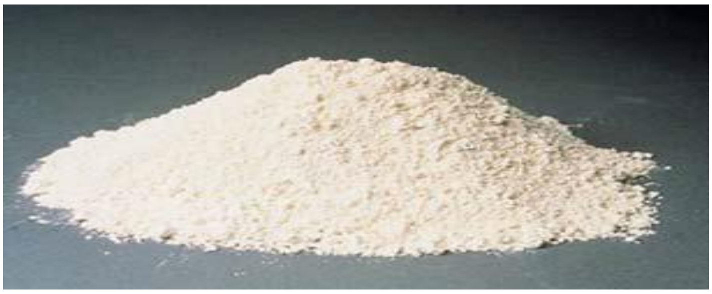


Fig1.2 METAKAOLIN

Metakaolin (MK) is produced from calcining kaolin clay at a specific temperature range (600-800oC) to make it reactive, with the general form Al2O3-SiO2. Literature confirm that partial replacement of cement by metakaolin improve concrete strength and durability as a result of the refinement of the pore structure. Beside the performance benefits of using metakaolin in concrete there are also ecological benefits, which make metakaolin concrete a more sustainable alternative to OPC concrete. The production of metakaolin does not release CO2 as that of OPC as a result of the de - carbonate of limestone and lower temperature are required to produce metakaolin, hence lower energy required.

Metakaolin is Superior Pozzolanic material and the best choice among a new generation of such materials due to highly reactive silica. The use of pozzolans become stable ingredients in the production of concretes of >50 Mpa or where service Environments, Exposure Conditions, or life cycle cost considerations dictate the use of High Performance Concrete (HPC).

2 MATERIAL INVESTIGATION

2.1 General

Selection of each ingredient like cement, aggregates and water of appropriate quality and quality is performed on cement concrete. Ordinary Portland cement is most commonly used. In the existing scenario there has been growing trend towards the use of supplementary materials for coarse aggregate because of their scarcity. This experimental study aimed to investigate the compressive strength of concrete with different percentage of rubber wastes are partially replacement for cement.

2.2 Cement

Lots of factor impacts on the strength of concrete, but strength of cement is the most important and direct factor. Ordinary Portland cement of 43 grade conforming to IS 8112- 1989 is used. Specific gravity of cement is 3.15.

2.3 Fine Aggregate

Natural river sand is used as fine aggregate. The properties of sand are determine by conducting tests as per IS: 2386(part-1). The results are shown in the table. The results obtained from sieve analysis are furnished.

Table 4.1 Physical property of fine aggregate

SI NO	PROPERTIES	VALUES
1	Specific gravity	2.67
2	Fineness modulus	2.9

2.4 Coarse Aggregate

Properties of the coarse aggregate affect the final strength of the hardened concrete and its resistance to disintegration, weathering and other destructive effects.20mm size of coarse aggregate is used. The properties of coarse aggregate are shown in table.

Table 4.2 Physical property of coarse aggregate

SI NO	PROPERTIES	VALUES
1	Specific gravity	2.74
2	Fineness modulus	7

2.5 Water

Mixing water quality is required in accordance with the quality standards of drinking water, use for PH>4clean water.

2.6 Metakaolin

Calcium hydroxide is one of the by-products of hydration reaction of cement. When cement is partially replaced with Metakaolin, it reacts with calcium hydroxide and results in extra C-S-H gel. C-S-H gel is the sole cause for strength development in cement and cement based concrete. The chemical reaction is given below

Cement + Water = C-S-H gel + Ca (OH)2
Ca (OH)2 + Metakaolin = C-S-H gel

Table 4.3 Physical property of Metakaolin

SI NO	PROPERTIES	VALUES
1	Specific gravity	2.50

3EXPERIMENTAL WORK

3.1 Compressive Strength

M20 & M25 & M30 Compressive Strength at 7th & 28th Days 100% replacement of Course Aggregate by using Recycled Course Aggregate. Increase strength of concrete added Metakaolin 5%, 10%, 15% and 20% replacement of cement.

Mix Design	% of Cement	% of Metakaolin	% of FineAggregate	% of Recycled Course Aggregate	Compressive Strength N/mm² for 7th day	Compressive Strength N/mm² for 28th day
M_{20}	100	0	100	100	16.16	25.91
	10	0	100	100	14.03	23.79
	95	5	100	100	14.65	24.50
	90	10	100	100	17.32	27.44
	85	15	100	100	20.24	31.17
	80	20	100	100	17.76	28.06

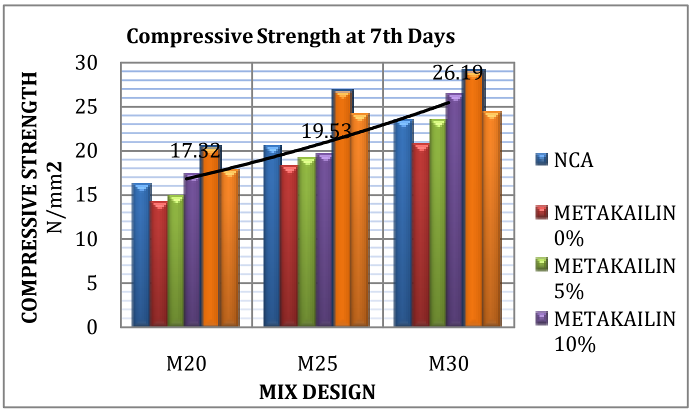
M_{20}- Compressive strength at 7th and 28 thdays

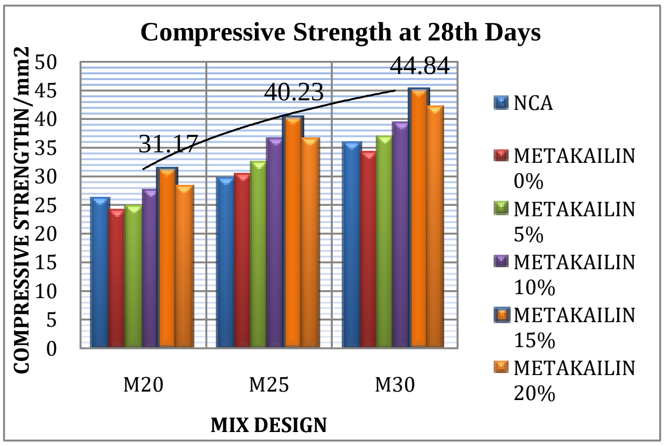
Mix Design	% of Cement	% of Metakaolin	% of Fine Aggregate	% of Recycled Course Aggregate	Compressive Strength N/mm² for 7th day	Compressive Strength N/mm² for 28th day
M_{20}	100	0	100	100	20.42	29.66
	10	0	100	100	18.02	30.10
	95	5	100	100	19.00	32.41
	90	10	100	100	19.53	36.14
	85	15	100	100	26.64	40.23
	80	20	100	100	23.98	36.41

M_{25}- Compressive strength at 7th and 28 th days

Mix Design	% of Cement	% of Metakaolin	% of Fine Aggregate	% of Recycled Course Aggregate	Compressive Strength N/mm² for 7th day	Compressive Strength N/mm² for 28th day
M_{20}	100	0	100	100	23.44	35.96
	10	0	100	100	20.60	33.92
	95	5	100	100	23.44	36.67
	90	10	100	100	26.19	39.16
	85	15	100	100	28.86	44.84
	80	20	100	100	24.24	42.18

M_{30}- Compressive strength at 7th and 28 th days





3.2. TENSILE STRENGTH

M20 & M25 & M30 Tensile Strength at 7th & 28th Days 100% replacement of Course Aggregate by using Recycled Course Aggregate. Increase strength of concrete added Metakaolin 5%, 10%, 15% and 20% replacement of cement.

Mix Design	% of Cement	% of Metakaolin	% of FineAggregate	% of Recycled Course Aggregate	Tensile Strength N/mm² for 7th day	Tensile Strength N/mm² for 28th day
M_{20}	100	0	100	100	1.01	2.10
	10	0	100	100	1.06	2.01
	95	5	100	100	1.12	2.07
	90	10	100	100	1.17	2.12
	85	15	100	100	1.23	2.24
	80	20	100	100	1.09	2.15

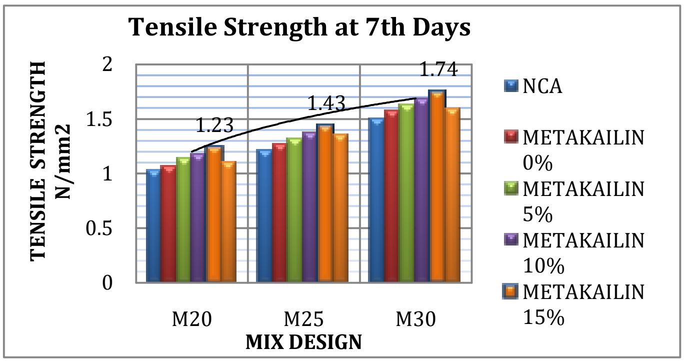
M_{20}- Tensile Strength at 7th and 28 th days

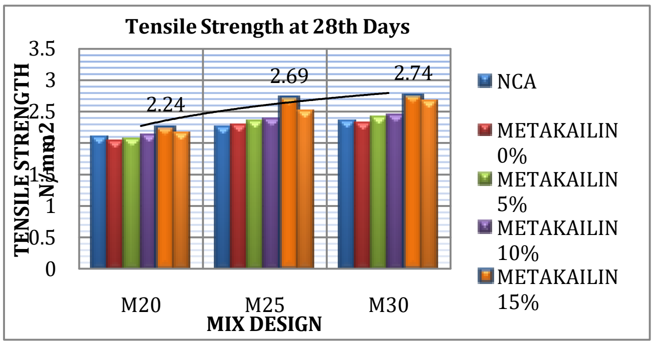
Mix Design	% of Cement	% of Metakaolin	% of FineAggregate	% of Recycled Course Aggregate	Tensile Strength N/mm² for 7th day	Tensile Strength N/mm² for 28th day
M_{20}	100	0	100	100	1.20	2.24
	10	0	100	100	1.26	2.29
	95	5	100	100	1.31	2.35
	90	10	100	100	1.37	2.38
	85	15	100	100	1.43	2.69
	80	20	100	100	1.34	2.49

M_{25}- Tensile Strength at 7^{th} and 28^{th} days

Mix Design	% of Cement	% of Metakaolin	% of FineAggregate	% of Recycled Course Aggregate	Tensile Strength N/mm² for 7th day	Tensile Strength N/mm² for 28th day
M_{20}	100	0	100	100	1.50	2.35
	10	0	100	100	1.56	2.32
	95	5	100	100	1.62	2.41
	90	10	100	100	1.68	2.43
	85	15	100	100	1.74	2.74
	80	20	100	100	1.59	2.66

M_{30}- Tensile Strength at 7^{th} and 28^{th} Days





4. CONCLUSIONS

The following conclusions can be made on the basis of this study. The concrete with 15% metakaolin cement replacement give the optimum compressive strength. The behaviour of the concrete with partial replacement of Portland cement by metakaolin is significantly superior to concrete that use only Portland composite cement as binder.

It was generally observed that the flexural behaviour of metakaolin concrete is comparable to that of ordinary Portland cement concretes and this investigation gives encouraging results for metakaolin to be used as cement replacement substitutes in the production of structural concrete.

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