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Effect on Compressive Strength of Concrete by the Use of Metakaolin, Laterite Sand and Quarry Dust

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ABSTRACT

When ordinary Portland cement is used in structures bearing huge loads, it requires more quantity of cement to achieve strength. This leads to increase in cross section of structure which increases dead load of structure. Hence in this paperpartial amount of cement is replaced by supplementary cementious material metakaolin to increase the strength of concrete. Also Portland cement production is one of the major reasons for CO2 emissions into atmosphere. It is due to the use of fossil fuels, including the fuels required to generate electricity during cement manufacturing process. Here metakaolin isused and increase in compressive strength of concrete is determined.Also due to recent development in construction industry there is an increase in the use of river sand which will lead to scarcity of river sand in future. The proposed topic gives an idea of properties of concrete for combination of laterite sand and quarry dust as complete (100%) replacement for conventional river sand as fine aggregates. Aim of this work is to increase the compressive strength of concrete and also to reduce the use of natural sand. This work will lead to reduction in use of cement which will ultimately reduce carbon dioxide emissions.

KEYWORDS: Portland cement, CO_2 emission, Cementitious material, Metakaolin, Compressive strength,Laterite soil, Quarry dust

INTRODUCTION

Portland cement production is one of the major reasons for CO_2 emissions into atmosphere. It is due to the use of fossil fuels, including the fuels required to generate electricity during cement manufacturing process. Supplementary cementitious materials are often used to reduce cement contents and improve the strength and enhance durability of hardened concrete. There are various types of supplementary cementious material as fly ash, silica fume, slag cement, metakaolin, rice husk ash etc. Out of these metakaolin is used to investigate the compressive strength of concrete. 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.

Recent development in construction industry is witnessing an increase in the use of river sand which leads to scarcity of river sand in future. A number of attempts have been made to replace the river sand with other materials which are waste in the environment and to utilize those materials which are disposed without being used.The proposed topic gives an idea of properties of concrete for combination of laterite sand and quarry dust as complete (100%) replacement for conventional river sand as fine aggregates. Quarry dust is the waste obtained during quarrying process and laterite is sedimentary rock obtained from weathering of basalt. Specific gravity of laterite sand is 2.63 and of quarry dust is around 2.6 to 2.65. Here 70% quarry dust is used and 30% laterite sand is used as a complete replacement to river sand. Also the cost of these 2 materials is low than natural sand. The use of laterite sand in combination with quarry dust can help to achieve this purpose and impact positively in reducing the cost of building materials. Many experiments were carried out on replacement of sand by laterite sand and quarry dust during recent years. Quarry dust has been identified as possible replacement for sharp sand in concrete works. Laterite sand can also be used for structural concrete.

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MIX DESIGN AND CASTING OF CONCRETE

Mix design forM30

Factors considered:

- Type of cement: OPC 53 grade (confirming to IS 12269-1987)
- Maximum size ofaggregate:20mm
- Workability:100mm-125mm
- Type of exposure:mild
- Sp gravity ofcement:3.15
- Sp gravity ofwater:1
- Sp gravity of coarseaggregate:2.67
- Sp gravity of fineaggregate:2.62
- Water absorption of coarseaggregate:0.10%
- Water absorption of fineaggregate:0.15%
- Method of placing: byhand
- Chemical admixture is superplasticizer confirming to IS9103
- Sp gravity of superplastisizer:1.145
- (from is 456 pg 20 table 5)Min cement content=300kg/m^3
- Min w/cratio=0.55
- Fine aggregate is of zone 2

Concrete proportions

Cement	:	Fine Aggregate	:	Course aggregate	: Water/Cement Ratio
350/350		:		700/350	: 1269/350
1	:	2	:	3.62	:0.4

Casting of Concrete

Concrete cubes are casted for

A) Conventional Concrete mix

B) MK 10:- A concrete mix with 10% metakaolin replacing cement

C) MK 15:- A concrete mix with 15% metakaolin replacing cement

D) MK 20:- A concrete mix with 20% metakaolin replacing cement

Each mix except conventional mix will have 30% laterite sand and 70% quarry dust. 3 cubes for 7 day strength and 3 for 28 day strength are casted for each of above mix.In this way each of the 4 mixes will have 6 cubes. In total 24 cubes each of size 150*150*150 are casted.

TESTING OF CONCRETE CUBES

Compressive strength of all cubes were tested. Average strength of 3 cubes of each mix was determined. 12 cubes (i.e. 3 cubes of each of the 4 mixes) were tested for 7 day strength and remaining 12 cubes were tested for 28 day strength.

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Table 1: Slump values

	Conventional (mm)	MK10 (mm)	MK15 (mm)	MK20 (mm)
Slump value	115	90	97	108

RESULTS

Following results are obtained for compressive strength of conventional, MK10, MK15, MK20 Concrete cubes.

Table 1: Compressive strength of Concrete cubes

Compressive strength	Conventional N/mm^2	MK10 N/mm^2	MK15 N/mm^2	MK20 N/mm^2
At 7DAYS	27.55	21.33	23.25	24.59
At 28DAYS	35.81	54.37	44.88	43.23

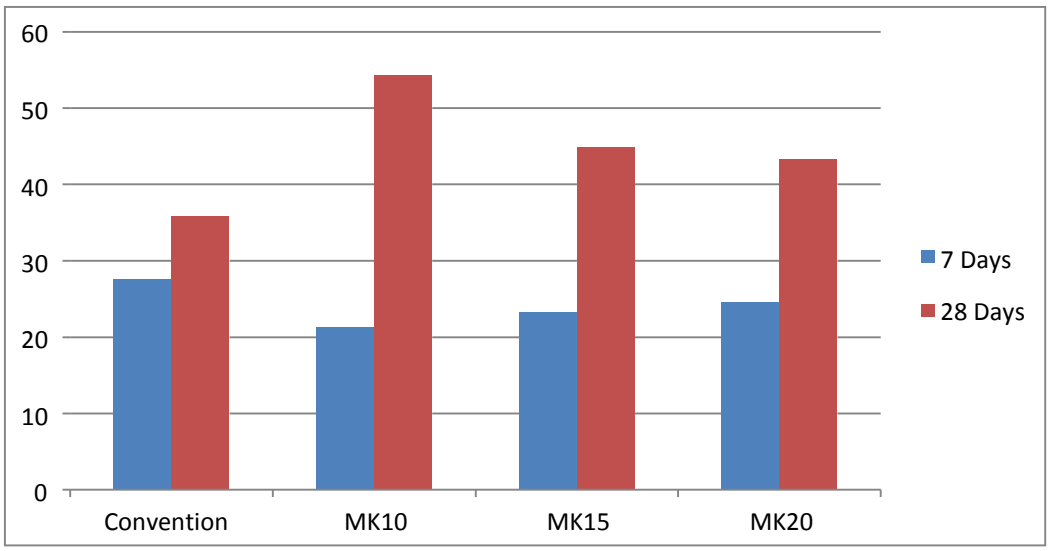

Fig.1 Chart of compressive strength of various mixes at 7 and 28 days

CONCLUSION

After performing the experiments and analyzing the results we can conclude the following things:

- The best compressive strength achieved after 28 days is by replacing cement with metakaolin of 10% of weight of cement and natural river sand by laterite sand (30%) and quarry dust (70%)
- Initially 7 day compressive strength was more for conventional concrete and less for metakaolin admixed concrete whereas final 28 days strength was minimum for conventional concrete and more for metakaolin

admixed concrete. This shows that metakaolin admixed concrete shows lower initial strength but has higher final strength

- Compressive strength was maximum for MK10 mix, decreased a bit for MK 15 mix and decreased even more for MK20 mix. This shows that as metakaolin percent increases after 10% replacement, compressive strength of concrete decreases. But final strength of these three mix was still more than conventional concrete mix
- Also from the rate analysis, concrete mix having 10% cement replaced by metakaolin and 100% natural sand replaced by 30% laterite sand and 70% quarry dust i.e. MK10 has the lowest cost of materials. This mix is more economical than conventional concrete mix and also gives highest compressive strength.

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