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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 project, partial amount of cement will be 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. Supplementary cementious materials are often used to reduce cement contents. Here metakaolin will be used and increase in compressive strength of concrete will be determined.

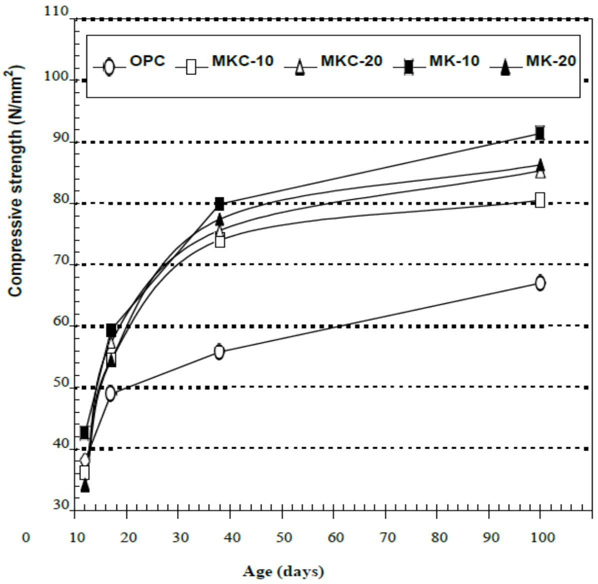
Keywords : Metakaolin, Laterite Sand, Quarry Dust, IPCC, MK10

I. INTRODUCTION

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. Supplementary cementious 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 mechanical properties of concrete by various experiments. Metakaolin is obtained by thermal activation of kaolin clay. This activation will cause a substantial loss of water in its constitution causing a rearrangement of its structure. To obtain an adequate thermal activation, the temperature range should be established between 600 to 750ºC. Chemical formula of Metakaolin is Al2O3·2SiO2·2H2O. Specific gravity of metakaolin varies from 2.4 to 2.6. It is in powder form and its colour is off white. Its specific surface area varies from 8 to 15 m2/gm while of cement is 0.3 to 0.5 m2/gm. More the specific area,finer the particle. 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. fear of pollution. With modern technology and innovation, transportation and communication have undergone a paradigm shift.

The most necessary requirements of an electric vehicle are reduced design effort, lower cost, less depreciation, and optimization of the volume and weight needed by the traction drive system.



II. Problem Statement

Ordinary Portland cement alone cannot give the adequate strength to structural members which require high strength. Use of cement in large quantities results in development of huge amount of heat of hydration. Also 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. CO2 is also emitted as a by-product of clinker production, an intermediate product in cement manufacture, in which calcium carbonate (CaCO3) is calcinated and converted to lime (CaO), the primary component of cement. According to IPCC (Intergovernmental Panel on Climate Change) 0.507 tons of CO2/ton of clinker production is released. Recent development in construction industry is witnessing an increase in the use of river sand which leads to scarcity of river sand in future. Hence to prevent this problem of scarcity of sand in future and to preserve natural sand, quarry dust and laterite sand is used. Removal of natural sand also leads to scouring and erosion of river beds.

III. Objectives

- ✓ To study the compressive strength of concrete with supplementary cementious material as metakaolin and fine aggregate as laterite sand and quarry dust.
- ✓ To reduce cost of concrete by replacing natural river sand by laterite sand & Quarry Dust.
- ✓ To increase compressive strength of concrete.
- ✓ To reduce the use of natural river sand so as to reduce its harmful environmental impact.
- ✓ To reduce environmental impact caused due to production and use of cement

IV. Scope of project work

Scope of our project is to increase the compressive strength of concrete and also to reduce the use of natural sand. This project will lead to reduction in use of cement which will ultimately reduce carbon dioxide emissions. Use of metakaolin enhances properties of concrete like resistance to chemical attack, reduce permeability, reduce shrinkage due to particle packing making the concrete denser. This concrete will also increase the durability of structure and reduce cross section of members. Reduction in use of natural river sand will reduce the scouring and erosion of river beds. It will overcome the problem of scarcity of natural river sand.

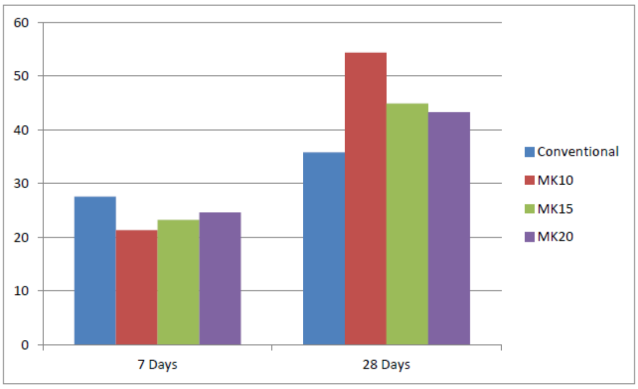
There is also scope of using this concrete as precast and prestressed concrete. This concrete can also be used in ferrocement and fiber reinforced concrete. This concrete also increases tensile and flexural strength.

V. RESULTS AND DISCUSSION

Compressive strength of cubes.

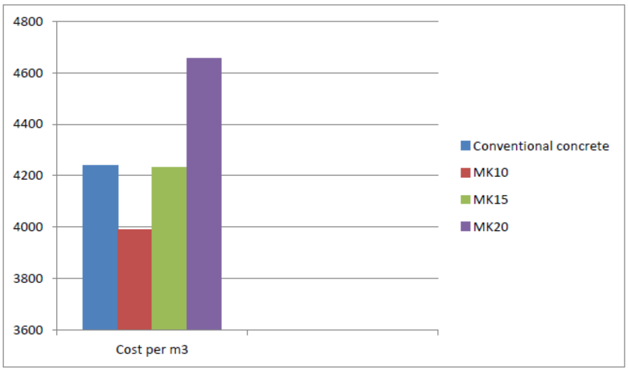
	Conventional N/mm^2	MK10 N/mm^2	MK15 N/mm^2	MK20 N/mm^2
Fcu at 7 DAYS	27.55	21.33	23.25	24.59
Fcu at 28 DAYS	35.81	54.37	44.88	43.23

Chart of comparison of compressive strength of various mixes at 7 and 28 days



Material costs per cub.m

	Conventional (Rs.)	MK10 (Rs.)	MK15 (Rs.)	MK20 (Rs.)
Cost/m^3	4240	3990	4320	4655



Comparison of cost of materials for various mixes per cub.m

VI. CONCLUSION

The best compressive strength achieved after 28 days is by replacing cement with metakaolin by 10% of its weight 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.

Moreover, cost of MK 15 concrete mix is nearly equal to conventional concrete mix and still yields higher strength than it.

MK 20 mix gives higher strength than conventional concrete mix but has higher cost than conventional concrete mix. Hence it is not preferable as strength more than MK20 mix can be achieved by MK10 and MK15 mix at a lower cost.

Hence, in terms of economy and in terms of compressive strength, MK 10 concrete mix shows the best results. Using this mix high strength can be achieved and a cost less than or nearly equal to cost of conventional concrete mix. From this we can conclude that 10% replacement of cement by metakaolin & 100% replacement of natural sand by 30% laterite sand & 70% quarry dust is best replacement.

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