JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

EXPERIMENTAL STUDY ON PARTIAL REPLACEMENT OF CEMENT WITH HYPOSLUDGE AND FLY ASH IN CONCRETE

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Abstract : The construction industry is a significant contributor to environmental degradation due to the extensive use of Portland cement, which emits substantial CO_2 during production. This study investigates the feasibility of partially replacing cement with hyposludge (a byproduct of the paper industry) and fly ash (a byproduct of coal combustion) in concrete mixes. Concrete specimens were prepared with varying percentages of hyposludge and fly ash, and their mechanical properties, including compressive strength and split tensile strength, were evaluated. The results indicate that a 20% replacement of cement with a combination of hyposludge and fly ash yields optimal strength characteristics, suggesting a sustainable alternative for cement in concrete production.

IndexTerms **- Concrete, Hyposludge, Fly Ash, Cement Replacement, Compressive Strength, Split Tensile Strength, Sustainable Construction.**

I. INTRODUCTION

The rapid urbanization and infrastructural development have led to an increased demand for concrete, consequently escalating the production of Portland cement. Cement manufacturing is energy-intensive and releases a significant amount of CO_2, contributing to global warming. To mitigate environmental impacts, researchers have explored alternative materials to partially replace cement in concrete. Hyposludge, a waste product from the paper industry, and fly ash, a byproduct of coal combustion in thermal power plants, have shown potential as supplementary cementitious materials. Utilizing these industrial byproducts not only addresses waste disposal issues but also reduces the environmental footprint of concrete production.

II. MATERIALS AND METHODS

Materials:

- **Cement:** Ordinary Portland Cement (OPC) 53 grade.
- **Fine Aggregate:** Natural river sand conforming to IS 383-1970.
- **Coarse Aggregate:** Crushed granite stones of 20 mm size.
- **Water:** Potable water free from impurities.
- **Hyposludge:** Collected from a local paper industry, dried, and sieved.
- **Fly Ash:** Class F fly ash from a thermal power plant.

Mix Proportions:
Concrete mixes were prepared with varying percentages of hyposludge and fly ash replacing cement by weight. Mix design was for M25 grade concrete with water-cement ratio of 0.45.

Table 1 : Mix Proportions

Mix ID	Cement (%)	Hyposludge (%)	Fly Ash (%)
M0	100	0	0
M1	90	5	5
M2	80	10	10
M3	70	15	15
M4	60	20	20

III. Results and Discussion

Table 2 : Compressive Strength

Mix ID	7 Days	28 Days	56 Days
M0	24.5	35.7	38.2
M1	25.8	37.6	40.1
M2	26.4	38.9	42.3
M3	24.9	36.5	39.0
M4	22.7	33.2	35.8

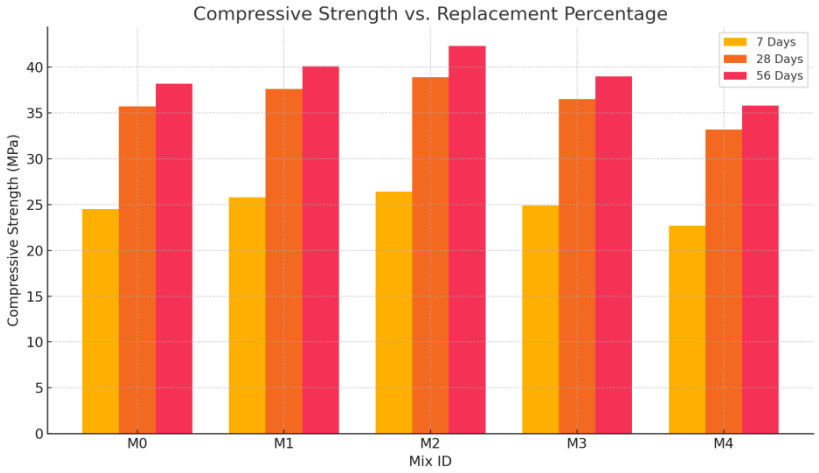
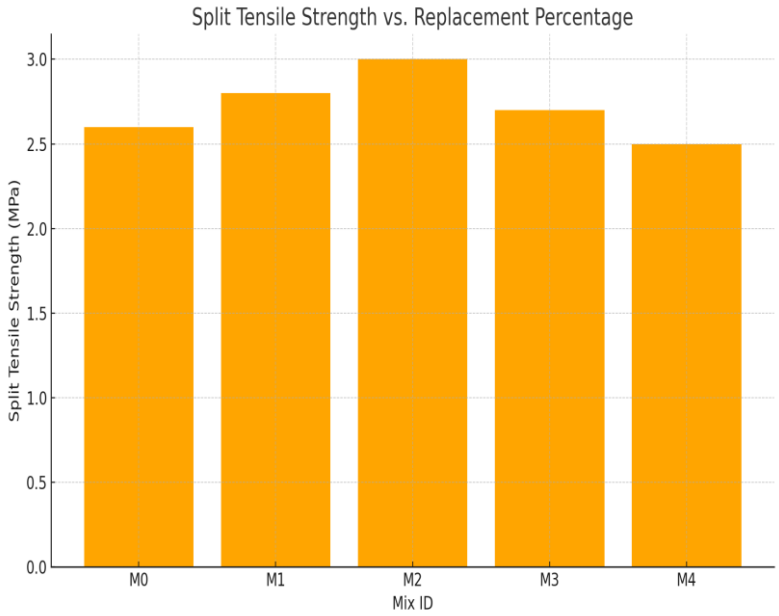


Table 3 : Split Tensile Strength

Mix ID	Split Tensile Strength (MPa)
M0	2.6
M1	2.8
M2	3.0
M3	2.7
M4	2.5



IV. DISCUSSION

The enhancement in strength properties up to 20% replacement can be attributed to the pozzolanic reactions of fly ash and the filler effect of hyposludge, which refine the pore structure and improve the interfacial transition zone in concrete. Beyond 20% replacement, the dilution effect becomes significant, reducing the available calcium hydroxide for pozzolanic reactions.

V. CONCLUSION

This study demonstrates that partial replacement of cement with hyposludge and fly ash up to 20% enhances the compressive and split tensile strengths of concrete. The optimal mix (M2) achieved a 9% increase in compressive strength and a 15% increase in split tensile strength at 28 days compared to the control mix.

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