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EFFECT OF BOND STRENGTH WITH POLLUTED AND NON POLLUTED REBAR USING HYPO SLUDGE

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Abstract—To aid the resistances like mechanical, pure adhesive, frictional in ensuring bond between rebar and concrete, development length is provided for rebars.This paper examines the bond strength through Pull-out test of hypo sludge concrete with non-polluted, half-polluted, polluted rebars. This paper also helps to select the optimum dosage of hypo sludge in replacement of cement for preparing low cost concrete. In this paper compressive strength of concrete is determined with the different percentages (0% - 30%) hypo sludge in replacement of cement. And it is also observed from the study that at 20% hypo sludge replacement in cement gave the good compressive strength for the designed concrete. The bond strength between hypo sludge concrete and non-polluted/half-polluted/full-pollutedrebar are compared. At 20% replacement of hypo sludge in cement showing good results of bond strength between hypo sludge concrete and rebar.

Keywords—Bond strength, oil polluted, cement, Hypo Sludge ash.

I. INTRODUCTION

The transfer of axial force from reinforcing steel bar to the surrounding concrete produced from the development of tangential stress components along the contact surface. The stress acting parallel to the bar along the interface is called bond stress.(Pillai & Kirk 1938, Hadi 2008).For the reinforced concrete material, it is necessary to create suitable bond between steel bars and surrounding concrete. Bond ensures that there is no slip of the steel bars relative to the concrete and the means by which stress is transferred across the steel-concrete (Hadi 2008, Warner et al 1998). Bond resistance is made up of chemical adhesion, friction and mechanical interlock between the bar and surrounding concrete. To avoid the adhesion of the hardened concrete and the constructional forms, the oil is widely used nowadays in the site constructions. This practical method may influence on the bond between the concrete and steel bars due to the pollution of steel bars by the oil before concrete casting.The bond strength of the reinforcement steel with concrete was studied by many authors. Moetaz and EL-Hawary (1999) were studied bond strength properties of epoxy-coated steel reinforcement embedded in concrete with considering many pull-out tests. Studies conducted by Darwin [13] and ACI 408R [1] revealed that forces are transferred from concrete to reinforcement in three ways: (a) chemical adhesion between the concrete and the steel (b) friction between the bar surface and the concrete and (c) bearing of the ribs against the concrete. It was further noted by ACI 408R [1] that, whileload transfer through bearings depends on the geometry of the steel and the magnitude of the friction, the adhesionbetween steel and concrete depends on the properties of the concrete.Research have shown that contaminants such as oil, found on construction sites affect bond strength.

A. Hypo sludge ash

In the present scenario, 300 million tons of waste paper was produced per annum by agro-based industries in India. These materials serve as a huge problem in the disposal, leads to health hazards and aesthetic problems. Nowadays because of low accessibility of natural resources, the ordinary Portland cement has been used rapidly for construction of industries, residential buildings and other concrete based structures. Thus, resulted in the huge production of waste paper and utilization of this in concrete can reduces heat of hydration caused by cement. By using Hypo sludge as a partial replacement to cement we can decrease the amount of waste produced by the paper mills. The Hypo sludge is rich in magnesium and silica particles which would help to increase the strength of concrete. As Hypo sludge is a fresh arrival among cementitious materials and was originally produced as artificial pozzolana while producing paper, the waste products that has come out from various processes used in paper industry.

II. Experimental Investigation

A. *Cement*

The ordinary Portland cement which conforms to IS: 8112 – 1989 was used for making concrete.

TABLE I
Properties of Cement

S.No	properties	Test results
1	Fineness test	6%
2	Standard consistency	33%
3	Initial setting time	38 min
4	Specific gravity	3.12

B. *Fine Aggregate*

The sieve analysis for coarse aggregates was done as per IS 383-1970.

TABLE II
Properties of Fine Aggregate

S.No	properties	Test results
1	Specific gravity	2.29
2	Bulk density(g/cc)	1.52

C. *Coarse Aggregate*

Locally available coarse aggregate having the maximum size of 20mm is used in the present work.

TABLE III
Properties of Coarse Aggregate

S.No	properties	Test results	
		10mm	20mm
1	Specific gravity	2.3	2.78
2	Bulk density Kg/m^3	1.3	1.59

D. *Water*

The water which is used is free from oil, acids, vegetable matter, alkalis clay and portable drinking water.

E. *Hypo sludge*

Hypo sludge is a recent arrival waste produced material from the paper industry. The preliminary tests are to be conducted on hypo sludge are given below.

TABLE IV
Properties of Hypo sludge

S.No	properties	Test results
1	Specific gravity	2.13
2	Fineness test	8%

F. *Reinforcing bars*

Reinforcing bars used in the present experimental study is of 12mm diameter and of 750 mm long. It is provided as per IS: 2770 (part 1) -1967.

G. *Used engine oil*

Used engine oil applied as a coating on the embedded bar surface at varying coverage areas.

H. *Chemical composition of hypo sludge*

The chemical composition of hypo sludge.

TABLE V

Chemical Properties of Hypo sludge

Silicon Dioxide(SiO_2)	5.92%
Calcium Oxide (CaO)	46.88%
Magnesium Oxide(MgO)	4.875%
Sulphur Trioxide(SO_3)	0.26%
Aluminium Oxide(Al_2O_3)	1.79%
Ferric Oxide(Fe_2O_3)	0.705%
Loss on Ignition	38.75

I. *Preparation of specimens*

The research is carried out to study the properties of M25 grade concrete with replacement from 5% to 30% of hypo sludge by the weight of cement. The mix proportion was 1:1.625:3.217 with water cement ratio 0.5.The compressive strength, pull out test were carried out .The experimental program to casted 21 cubes of size 150x150x150 mm, 42 cylinders of size 150x300 mm. The development length of rebar was 300mm.

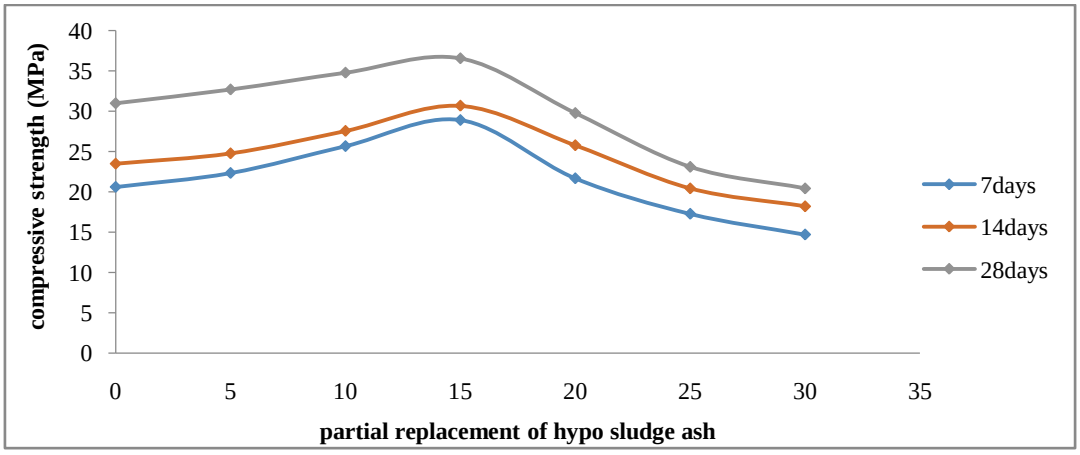
0%pollution: The embedded length of rebar0% polluted.
50%pollution: The embedded length of the rebar half of the surface area polluted (50%).
100%pollution: The embedded length of the rebar fully surface area polluted (100%).

III. RESULTS AND DISCUSSIONS

1. COMPRESSIVE STRENGTH:

In this test, to take the readings which place load reached the ultimate point. The test results are depends upon the many factors quality of material, surface moisture condition. These specimens are tested compressive testing machine otter 7, 14, 28, days curing.Fig.1.shows the variation of % of hypo sludge ash content Vs Compressive strength of concrete at 7, 14, and 28 days.

Fig.**1**.Variation of % of hypo sludge ash Vs Compressive strength of concrete at 7,14,28 days



2. *BOND STRENGTH*:

The cylinders were each inserted into a 500 KN capacity electronic tensile test machine and loaded until failure in the form of tensile splitting of the concrete or pull-out of the rebar. The failure load was then recorded. The load from the machine was distributed onto the test specimen by a steel plate at the rate of 2.5 KN/sec.

$$\tau bd = \frac{p}{\pi dl}$$

Where,

τbd=1.4MPa M25 grade concrete

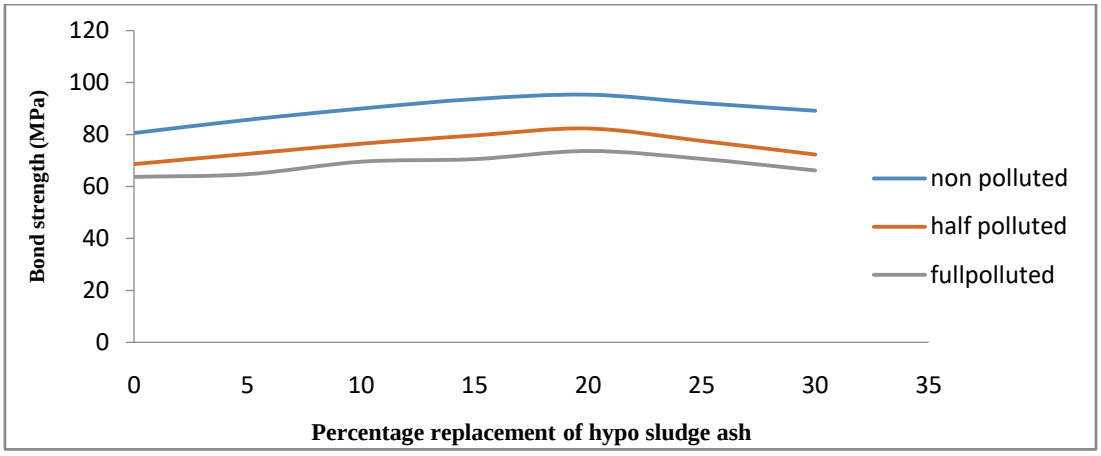
p=pull out load

d=dia of bar

L=development length

Development length$(Ld) = \frac{\emptyset \sigma s}{4 \tau bd}$

Fig.2. Comparison between 0%.50%, 100% polluted rebar for 28 days



IV. CONCLUSION

- From the above study we can conclude that the non-polluted gains high strength when compared to half-polluted and fully polluted. Due to the change in length of bar and its diameter there is a change in bond strength and is inversely proportional.
- The used engine oil for the concrete in steel negatively affects the bond strength through the protective layers between materials within the bond zone. The serviceability and ultimate strength of the reinforced concrete elements were also affected due to decrease in strength.
- By using hypo sludge, we can reduce the environmental impacts due to the utilization of wastes disposal from paper mills. When compared to conventional concrete, hypo sludge gains more strength.
- In this project, hypo sludge is used as a partial replacement in concrete with 0%,5%,10%,15%,20%,25% and 30%.From the above replacements, the strength of the concrete increases in pull out test at 20%.and 15% replacement of hypo sludge the compressive strength increases at 28 days.
- A better measure towards the sustainable environment can be undertaken by effective utilization of hypo sludge in concrete. The cost analysis indicates that with incorporation of hypo sludge decreases the cost of concrete. The material is economically feasible.

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