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BOND STRENGTH OF REBAR EMBEDDED IN GRAPHENE CONCRETE

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Abstract-In this experimental study, the graphene concrete on ordinary portland cement paste are investigated. The project presents the results of an investigation on strength properties of graphene concrete. The graphene is added to the cement as a partial replacement in four mix proportions (0%, 0.1%, 0.3% and 0.5%) to the concrete and tested for 7 and 28 days. The maximum strength attained at 0.5% of graphene. By the test results we observed that the addition of graphene content may enhance the strength properties of concrete.

Keywords- Steel Bars, Graphene Concrete, Lubricant Oil, Bond Strength

I. INTRODUCTION

Graphene a super-material, it has been incorporated into traditional concrete production to develop a composite material which is more than twice as strong. Its water resistance makes it suitable for construction in areas that are hard to reach for maintenance, while the strength of the composite will make buildings more resilient to future shocks and strains. The technique could be copied in incorporating nano materials into concrete construction in the future, which could pave the way to further innovations in the industry. For graphene the most important quality is feather-weight super-strength.

Fig.1 Graphene

OBJECTIVES OF GRAPHENE CONCRETE:

- To study the bond strength of graphene concrete, when the graphene content is partially replaced to the cement.
- To know at what percentage of graphene content will give an optimum bond strength value.
- To find, at what embedded lengths of reinforcement gives the higher bond strength.

II. MATERIALS USED AND THEIR PROPERTIES

A. Graphene

Preparation of graphene:

Preparation of graphene is not expensive because the process is very simple. It is basically similar to a kitchen blender, where you take 20 grams of graphite powder with addition of acetone plus water (70:30) and 40ml tea solution in a shear exfoliation container. Blend it for 30seconds, keep it over a night and filtered the solution with a filter paper, then the retained graphene particles are dried until it becomes powdered. Test the graphene powder with the multimeter, whether the electricity is passed over it.

Table-I Properties of Graphene

Tests	Results
Specific gravity	1.60

B. Lubricant Oil

Lubricant oil is coated for steel bars as oil polluted.

C. Cement

Ordinary-portland cement of 53-grade is used for casting. The physical properties of the cement as obtained from various testsare listed in table-2. All the tests are carried out inaccordance with procedure laid down in IS-1489(Part-1):1991.

Table-IIProperties of Cement

Tests	Results
Specific gravity	3.1
Fineness	7%
Standard consistency	31%
Initial setting time	140 minutes
Final setting time	230minutes

D. Coarse Aggregate

The locally available crushed stone of 20mm and 10mm size of aggregates were used for the experimental work. The properties of coarse aggregate are listed in table-3.

Table-III Properties of Coarse Aggregate

Tests	Results
Specific gravity	2.7
Fineness modulus	7.89
Void ratio	0.92
Bulk density	1.402gm/cm^3
% of voids	49.8%

E. Fine Aggregate

For preparation of concrete mix the Zone-II sand is used which is locally available. As per IS-383:1970 the various properties were done and the results were in the table-4.

Table-IV: Properties of Fine Aggregate.

Tests	Results
Specific gravity	2.4
Fineness modulus	3.2
Zone	II
Void ratio	0.57
Bulk density	1.6gr/cm^3
% of voids	39%

F. Water

The ordinary portable water is used for mixing concrete and for curing.

III. EXPERIMENTAL WORK

A. Size of the Specimen

The size of the cylinder is 150X300mm were casted and cured, tested for 7 and 28 days.

Fig.2: Casting of Cylinders.

Fig.3: Specimens are in a Curing Tank.

B. Reinforcement Details

The mild steel bars Fe500 of 12mm diameter are used.

C. Development Length of Rebar

Development length is the quantity of the rebar length that is actually required to be enclosed into the concrete to make the desired bond strength between two materials and further more to produce required stress in the steel at that area. The two (20 and 30cm) different embedded lengths are used to the specimens. Development length is calculated as,

$$L_d = \frac{\phi \sigma_s}{4 \tau_{bd}}$$

D. Calculation of Bond Stress

Bond strength is the measure of the effectiveness of the grip between concrete and steel. Bond stress is calculated as,

Bond Stress=P/ 3.14dl

E. Mix Design for M20 Grade of Concrete

Mix design for M20 grade of concrete as per IS 456:2000, the table-5 explains the design values.

Table-V: Mix Proportions

Materials	Cement	Fine Aggregate	Coarse Aggregate	Water
Quantity(Kg/m^3)	395	596	1150	198
Mix Proportions	1	1.5	2.9	0.5

Fig.4:Testing of Specimenson Pull-Out Testing Machine.

Fig.5: Splitting in Concrete for 20cm Embedded Length of Bar.

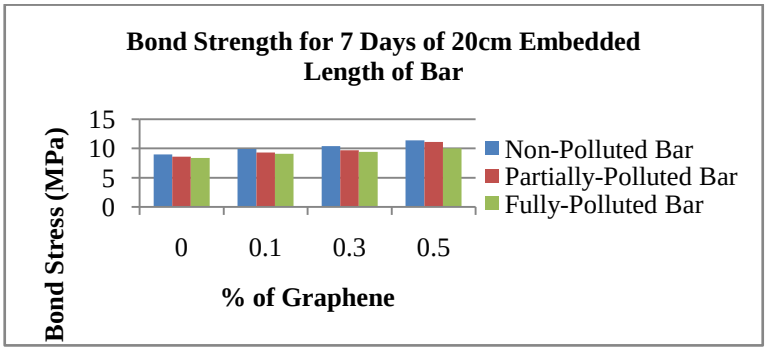
Fig.6: Failure in Steel Reinforcement for 30cm Embedded Length of Bar.

IV. RESULTS AND DISCUSSIONS

A. Pull-Out TestResults

Table-VI Bond Stress Results for 7 Days of 20cm Embedded Length of Bar.

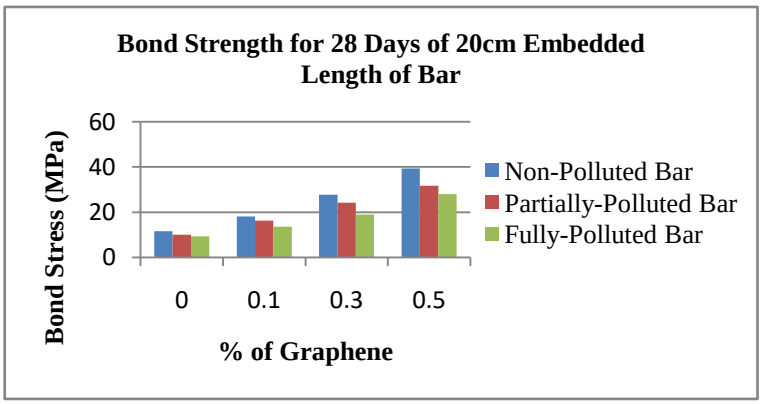
Sno	% of Graphene	Ultimate Load (KN)			Bond Stress (MPa)		
		NP	PP	FP	NP	PP	FP
1	0	66.3	65.2	58.6	9	8.6	8.4
2	0.1	69.9	63.9	64.2	9.9	9.3	9.1
3	0.3	72.7	70.9	70.4	10.4	9.7	9.4
4	0.5	82.7	80.1	78	11.4	11.1	10



Graph-1 Bond Strength for 7 Days of 20cm Embedded Length of Bar

Table-VII Bond Stress Results for 28 Days of 20cm Embedded Length of Bar.

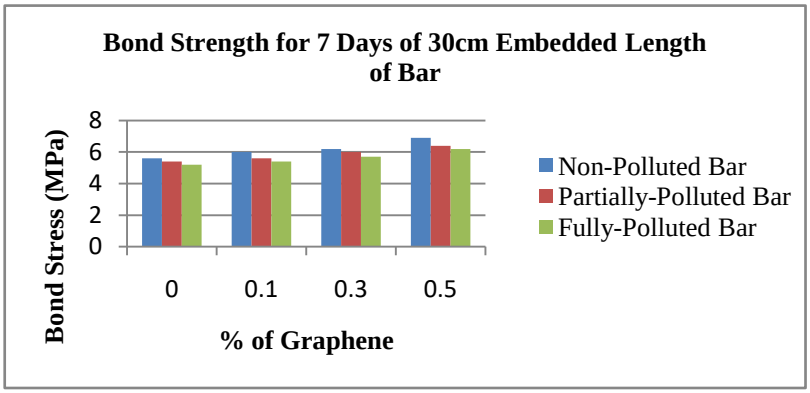
Sno	% of Graphene	Ultimate Load (KN)			Bond Stress (MPa)		
		NP	PP	FP	NP	PP	FP
1	0	75.6	72	70.2	11.6	10	9.4
2	0.1	105.1	89.7	86.1	18.1	16.3	13.6
3	0.3	124.3	97.4	93.7	27.8	24.2	18.9
4	0.5	148.5	121.6	106.4	39.4	31.7	28



Graph-II Bond Strength for 28 Days of 20cm Embedded Length of Bar

Table-VIII Bond Stress Results for 7 Days of 30cm Embedded Length of Bar.

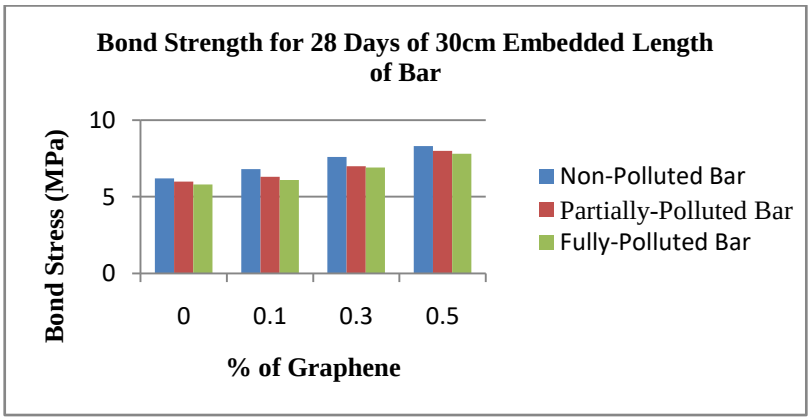
Sno	% of Graphene	Ultimate Load (KN)			Bond Stress (MPa)		
		NP	PP	FP	NP	PP	FP
1	0	63.5	61.8	59.6	5.6	5.4	5.2
2	0.1	67.9	63.5	61.3	6	5.6	5.4
3	0.3	71.4	68.7	64.8	6.2	6	5.7
4	0.5	78.6	73.5	71.2	6.9	6.4	6.2



Graph-III Bond Strength for 7 Days of 30cm Embedded Length of Bar

Table-IX: Bond Stress Results for 28 Days of 30cm Embedded Length of Bar.

Sno	% of Graphene	Ultimate Load (KN)			Bond Stress (MPa)		
		NP	PP	FP	NP	PP	FP
1	0	70.3	68.5	65.6	6.2	6	5.8
2	0.1	77	71.4	69.2	6.8	6.3	6.1
3	0.3	86.9	80	78.1	7.6	7	6.9
4	0.5	94.4	91.5	89	8.3	8	7.8



Graph-IV Bond Strength for 28 Days of 30cm Embedded Length of Bar

V. CONCLUSION

In this study the graphene plays a vital role, which improves the bond strength of a concrete. The different proportions of graphene content (0%, 0.1%, 0.3% and 0.5%) in ordinary-portland cement are used as partial replacement in the concrete. The test results exhibits the increase in strength for28 days of curing. When compared with conventional concrete the graphene concrete may increases the strength of the graphene concrete.

A. The bar of embedded length of 20cm specimens gives a greater bond strength compared to 30cm embedded of the bar specimens.

B. The embedded length of the bar inversely affects the deterioration of the bond strength due to the bar pollution.

C. As % of graphene content increases then thebond strength increases in the concrete.

D. The optimum strength attains at 0.5% of graphene content as a partial replacement of cement in the concrete, for 20cm embedded length of steel bar.

E. In 20cm embedded length of steel bar the specimen fails in concrete-reinforcement.

F. The steel reinforcementfailure (SRF) occurs in 30cm embedded length of a bar specimens.

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