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Experimental Study on Bond Performance of Reinforced Bars Embedded in Fiber Reinforced Concrete with Optimum Replacement of Lime Sludge with Cement

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***Abstract*: Lime sludge, an inert material composed of calcium carbonate and Plastic which do not decompose easily and remain in the environment which causes environmental problem. But lime sludge has the properties similar to cement and plastics have the properties of tension and it can reduce permeability of concrete, due to this bleeding of water can be reduced. This project aimed at the study of bond stress by using this waste product. The conclusion was made after project was the bond stress was maximum at 2%. It also concludes that as the fiber percent increases the bond stress increases and it decreases with the decrease of percent of fiber. The maximum bond stress of concrete after replacing cement with lime sludge was found to be**
8.09 N/mm^2 and 12.26 N/mm^2 for 7 and 28 days respectively. The optimum workability of concrete was found to be at 2%.

Key words: Lime Sludge, Plastic Fiber, Bond Stress

1. INTRODUCTION:

For construction and infrastructure process, Concrete is the most important material as it gives strength to a structure. To increase the strength of concrete, now a day plastics or plastics fiber and lime sludge are used. Plastic fiber are used as admixture due to its easily availability, light weight and the property to reduce crack due to Plastic shrinkage and drying shrinkage. The plastic fiber can reduce permeability of concrete, due to this bleeding of water can be reduced. Lime sludge, an inert material composed of calcium carbonate, and is the result of softening hard water for distribution as drinking water. Lime sludge is used as replacement to the cement as it has same properties as cement. As this both products are waste material (plastics and lime sludge from BGPPL), so to used it in convenient way we used this material in our project.

2. OBJECTIVE:

1. To find out the percentage of admixture as plastic fiber which gives the optimum strength to concrete.
2. To compare the result of various percentage replacement with adding of plastic fiber.
3. To give the proportion which produce the low-cost concrete.
4. To search for new materials in which weak matrix is reinforced with strong and stiff fibers to produce a composite of superior properties and performances.
5. To study the bond stress and strength of concrete by adding fibers.

MATERIAL AND METHODOLOGY

1) Cement

Cement is a binder, a substance used for construction that sets, hardens, and adheres to other materials to bind them together. Cement is seldom used on its own, but rather to bind sand and gravel together. Cement (UltraTech) grade 53 (OPC) have been used for mix proportion for M25 Grade concrete.

2) Sand

Sand is a granular material composed of finely divided rock and mineral particles. It is defined by size, being finer than gravel and coarser than silt. Sand can also refer to a textual class of soil or soil type; i.e. a soil containing more than 85 percent sand sized particles by mass. Natural yellowish colored locally available sand at Chandrapur region is used for the study.

3) Aggregate

Aggregate are the most mined materials in the world. Aggregates are a component of composite material such as concrete and asphalt concrete; the aggregate serves as reinforcement to add strength to the overall composite material. Aggregate are used as base material under foundation, road, and railroads. 20mm and 10mm mix coarse aggregate available at Chandrapur region is used for study.

4) Lime Sludge

Lime sludge, an inert material composed of calcium carbonate, is the result of softening hard water for distribution as drinking water. Lime sludge is used as replacement to the cement as it has same properties as cement. Waste product of Ballarpur graphics paper product limited in Ballarpur area.

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5) Plastic fiber

Plastic fibers are usually use in concrete to control cracking due to plastic shrinkage and to drying shrinkage. They also reduce the permeability of concrete and thus reduce bleeding of water. Plastic do not decompose easily and remain as it is on land over a period of years. It has tensile property which can maintain good relation with steel in concrete.

6) Reinforcement bars

Rebar also known as reinforcement steel and reinforcing steel, is a steel bar or mesh of steel wires used in reinforced concrete and masonry structure to strengthen and hold the concrete in tension. Concrete is strong under compression, but has weak tensile strength. Rebars significantly increases the tensile strength of structure. 16 mm diameter of bars is used for pull out test.

TABLE-1: PROPORTION OF MATERIAL

Sr.No.	DESCRIPTION	DETAILS
1	Type of cement	OPC
2	Maximum nominal size of aggregate	20mm
3	Maximum nominal size of plastic fiber	3cm
4	Maximum nominal size of reinforcement bar	16mm
5	Maximum nominal height OF Reinforcement bar	450mm
6	Maximum lime sludge content	10% of vol. of cement
7	Maximum water cement ratio	0.5
8	Workability	94 mm

TABLE -2: TEST OF MATERIAL

SR.NO	MATERIAL	RESULT
1	Specific gravity	2.845
2	Sand specific gravity	2.83
3	Aggregate specific gravity	2.50
4	Lime sludge specific gravity	1.88

TABLE-3: MIX DESIGN

MATERIAL(Kg/m^3)	TRIAL 1
Cement	394
Sand	606.48
Aggregate	1048.35
Water	197
Plastic fiber	3.94
Lime sludge	39.4

BOND STRESS STUDY

The pullout specimens consist of concrete cubes 150x150x150mm with a single reinforcing bar (16mm) embedded vertically along the central axis in each specimen. The bar was projected down by about 10 mm from the bottom of the cube for measuring the slip of the reinforcement bar. Also, the bar was projected upwards by about 85 cm from the top face of the cube to provide an adequate length for gripping the specimen in the testing machine. Demolding was carried out after
24 hours and then the specimens were immediately placed into curing tank for 28 days of curing. The test was conducted using a universal testing machine of600kN capacity. While testing, the pullout specimen was mounted on the testing machine in such a manner that the bar is pulled axially from the specimen. As per IS 2770 the end of the bar at which the pull is applied shall be that which projects from the top face of the cube as cast. Load was applied to the reinforcing bars monotonically at a rate not greater than 22.5 kN/min. The loading was continued until the specimen failed. The recording of loads and deformations were carried out. The loads recorded were then converted to bond stress. Assuming a uniform bond stress distribution over the embedment length in concrete, the average bond stress between the reinforcing bar and the surrounding concrete τ b was calculated as,

$$\tau\, b = P/\pi\, db\, lb$$

where, τ b is the bond stress in (MPa), P is the applied load (N), db is the diameter of bar (mm) and lb is the embedded length of bar (mm).

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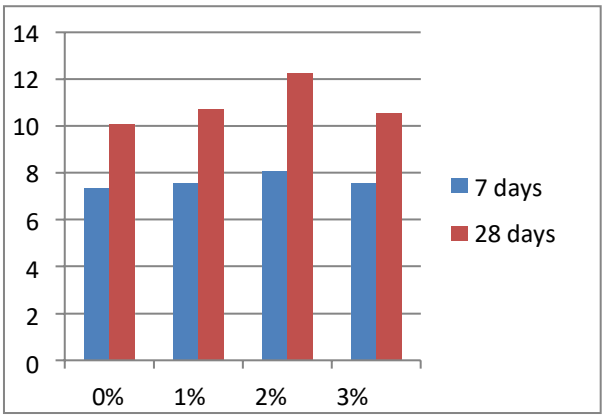
TABLE -4 BOND STRESS OF CONCRETE AFTER REPLACING CEMENT WITH LIME SLUDGE IN ADDITION OF FIBRE PERCENT (7 DAYS)

% of fiber	Sr.no.	Bond stress at o.o25 mm slip (MPa)	% increase or decrease in bond stress compared to CS	Bond stress at 0.25 mm slip (MPa)	% increase or decrease in bond stress compared to CS	Ultimate load (kN)	Ultimate bond stress (MPa)	Average stress	Failure mode
0%	1	6.54	----------	7.05	----------	54	7.16	7.36	Pull out
	2	6.87	----------	7.24	----------	57	7.56		Pull out
1%	1	6.40	-2.14	6.96	-1.27	55	7.29	7.55	Pull out
	2	7.02	2.18	7.32	1.10	59	7.82		Pull out
2%	1	6.84	4.58	7.46	5.82	60	7.96	8.09	Pull out
	2	7.23	5.24	8.12	12.15	62	8.22		Pull out
3%	1	5.89	-9.93	7.40	4.96	58	7.69	7.55	Pull out
	2	6.45	-6.11	7.32	1.10	56	7.42		Pull out

TABLE -5 BOND STRESS OF CONCRETE AFTER REPLACING CEMENT WITH LIME SLUDGE IN ADDITION OF FIBRE PERCENT (28 DAYS)

% of fiber	Sr.no.	Bond stress at o.o25 mm slip (MPa)	% increase or decrease in bond stress compared to CS	Bond stress at 0.25 mm slip (MPa)	% increase or decrease in bond stress compared to CS	Ultimate load (kN)	Ultimate bond stress (MPa)	Average stress	Failure mode
0%	1	7.89	----------	9.64	----------	74	9.81	10.07	Pullout
	2	7.97	----------	10.22	----------	78	10.34		Pull out
1%	1	8.12	2.92	10.42	8.09	80	10.61	10.74	Pull out
	2	8.20	2.37	10.67	4.40	82	10.87		Pull out
2%	1	9.23	16.98	12.46	29.25	96	12.73	12.26	Pull out
	2	9.18	15.18	11.54	12.91	89	11.80		Pull out
3%	1	9.34	18.37	10.24	6.22	79	10.48	10.54	Pull out
	2	8.90	11.66	10.32	0.97	80	10.61		Pull out

TABLE-6 GRAPH CONCLUSION



4. CONCLUSION

1) The maximum bond stress of concrete after replacing cement with lime sludge was found to be 8.09 N/mm^2 and 12.26 N/mm^2 for 7 and 28 days respectively.
2) The optimum workability of concrete was found to be at 2%.
3) The waste product form by BGPPL i.e. lime sludge can be used in concrete which can reduce soil pollution
4) The use of plastic fibers helps to reduce the bleeding and segregation of concrete.
5) The use of this waste can enable for low cost construction works.

5. FUTURE SCOPE

- This study aimed at studying the use of BGPPL waste i.e. lime sludge in concrete by analyzing bond stress and workability.
- Further analysis can also be done on the parameters of tensile strength and flexural strength.
- Further Study can also be done using other waste from paper mill industry in construction works.
- Further study can be conducted by using ANSYS software.

6. REFERENCES

[1] A new method for pull out test of reinforcing bars in plain and fiber reinforced concrete S. H. chu and A. K. H. kwan -Engineering Structures, Volume-164, (2018)
[2] Bond stress-slip relationship between Basalt Fiber-reinforced polymer bars and concrete using pull-out test Dejian Shen, Binod Ojha, Xiang Shi, Hui Zhang- JRPF 35(9), JAN 2016
[3] Experiment studies on Fiber reinforced concrete (FRC). E. Arunakhanthi, J.D. Chaitanya Kumar –I RCIET, Volume-7, Issue-5, SEP (2016)
[4] Augmentation of Mechanical and bond strength of shell concrete using quarry dust. K. Gunase Karan, S. Prakash Chandar, R. Annadurai & K. S. Satyanarayanan -EJECE, Volume-21, No-5,629-640, FEB (2016)
[5] Bond stress behavior concrete and steel rebar Via pull-out test: Experimental and Finite Element Analysis M. R. Kabir, Md.mashfiqual islam -CICM,14-15 DEC (2015)
[6] Bond stress behavior Between concrete and steel rebar: Critical investigation of pullout test Via finite element modelling Md. Rashedul Kabir, Md. Mashfiqul Islam -IJCSE, Volume 5, No.1,SEP (2014)

International Journal of Engineering Research & Technology (IJERT)
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[7] Investigation of Bond stress in pull out specimens with High Strength Concrete. Maria Teresia, Gomes Barbosa & Souza Sanchez Filho -Global Journal, Volume 13, Issue 3 Version 1.0, (2013)

[8] "Local bond stress–slip behaviour of reinforcing bars embedded in plain and fiber concrete." Harajli, M.H.., Hout, M., and Jalkh, W., ACI Materials Journal, V.92, No.4, 343-354, 1995.

[9] "Bond of High strength concrete with High strength reinforcing steel". Muhammad N.S. Hadi, The open civil engineering journal, 2,143-147, 2008.

[10] "Bond strength of reinforcing steel embedded in fly ash based geopolymer concrete". Prabir Kumar Sarkar, Materials and structures, 44, 1021-1030, 2011.

[11] , "Numerical prediction of bond-slip behaviour in simple pull-out concrete specimens". Dr. Ala'a Hussein Alwan Al-Zuhairi, Wjdan Dhaif Sahi Al-Fatlawi, Journal of Engineering, Vol.19, 1-12, 2013

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