BEHAVIOUR OF RED SLUDGE ON THE PROPERTIES OF HDPE FIBRE REINFORCED CONCRETE

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Abstract

HDPE fibres are having good tensile strength as well as impact strength and they are also chemically inert, so a trail is made to improve the properties of Concrete. The present work is done on HDPE fibre reinforced cement Concrete with 15% red sludge and with different percentages of HDPE fibre. The compressive strength test specimens were of dimensions 150 x 150 x 150mm. The split tensile strength test specimens were of dimensions 150mm diameter x 300mm length. The flexural strength test specimens were of dimensions 100 x 100 x 500mm and impact strength test specimens were of dimensions 250 x 250 x 30 mm these specimens were cast and tested after 28 days of curing as per IS specifications. Short and discrete small fibres can improve the engineering properties of concrete notably flexural strength. The impact strength of HDPE fibre reinforced concrete with red sludge increases as the percentage of fibres in it increases. The higher impact strength can be achieved with the addition of 2% of HDPE fibres and 15% red sludge (by weight cement) and the percentage increase in the impact strength for first crack and for final failure are 148% and 194% respectively. It can be concluded that the higher strength characteristics of HDPE fibre reinforced concrete with red sludge can be induced with 2% addition of fibres in it. Higher percentage addition of HDPE fibres reduces the workability characteristics of HDPE fibre reinforced concrete. It is observed that there is an average improvement of all the properties of concrete with a blend of red sludge and HDPE fibres.

Index Terms: *HDPE fibres, red sludge, workability, Discrete small fibres, Flexural strength, tensile strength, impact strength*

1.OBJECTIVE

The main objective of this experimental investigation is to find out the behaviour of addition of red sludge on the workability and strength characteristics of HDPE fibre reinforced concrete for various percentages of fibres.

1.1Materials used

- Cement: Ordinary Portland Cement-43 grade was used having a specific gravity of 3.15 and it satisfies the requirements of IS: 8112-1989 specifications.
- Fine aggregates: Locally available sand collected from the bed of river was used as fine aggregate. The sand used was having fineness modulus 2.96 and confirmed to grading zone-III as per IS: 383-1970 specification.
- Corse aggregates: The crushed stone aggregates were collected from the local quarry. The coarse aggregates used in the experimentation were 10mm and down size aggregates and tested as per IS: 383-1970 and 2386-1963 (I, II & III). The aggregates used were having fineness modulus of 1.9.
- Fibres: The HDPE fibres used in the experimentation were obtained by cutting

the HDPE buckets etc. The breadth of fibers was 5mm and thickness was 2mm. The volume fraction of HDPE fibres used in the experimentation were 0%, 0.5%, 1%, 1.5%, 2%, 2.5%, 3%, 3.5%, 4%, 4.5% and 5%

- Super Plasticizer: To impart the additional desired properties, a superplasticizer (conplast SP 430) was used. The dosage of super plasticizer adopted in the experimentation was 1% (by weight of cement).
- Red sludge: The red sludge used in experimentation was obtained from Indian Aluminum Company (INDAL) Belgaum. As the name itself suggests red sludge is rust red colour. Its pH value exceeds 11there by revealing its alkaline nature. The density of red sludge is between 0.026-0.032 gm/mm3. Chemical and physical properties of red sludge are given in table No.1

Table 1: Chemical and physical properties of red sludge

Chemical composition		**Physical properties**	
Fe_2O_3	40-50%	Color	Reddish brown
SiO_2	8-10%	Grain size distribution	Clayey
TiO_2	13-14%	Reaction to water	Becomes sticky exhibits increase in cohesion
Ammonia	17-22%	Specific graivity	3.08
CaO	3-4%	Moisture content	12.03%
Na_2O	4-5%	Percentage of finer	99%
		Bulk density	21.87 KN/m3
		pH value	10.58

* Data taken from the production centre

2.0 EXPERIMENTAL PROCEDURE

Concrete was prepared by a design mix proportion of 1: 1.435:2.46 with a W/C ration of 0.48 which correspond to M20 grade of concrete. The different volume fraction of HDPE fibres used in the experimentation were 0%, 0.5%, 1%, 1.5%, 2%, 2.5%, 3%, 3.5%, 4%, 4.5% and 5%. HDPE fibres having 2mm thickness, 30mm length and 5mm breadth were added. The red sludge was used 15% by weight of cement. The entire mix was homogeneously mixed with calculated quantity of water and plasticizer. The compressive strength test specimens were of dimensions 150 x 150 x 150mm. The split tensile strength test specimens were of dimensions 150mm diameter x 300mm length. The flexural strength test specimens were of dimensions 100 x 100 x 500mm and impact strength test specimens were of dimensions 250 x 250 x 30 mm these specimens were cast and tested after 28 days of curing as per IS specifications.

3.0 EXPERIMENTAL RESULTS

The following tables give the details of the experimental results.

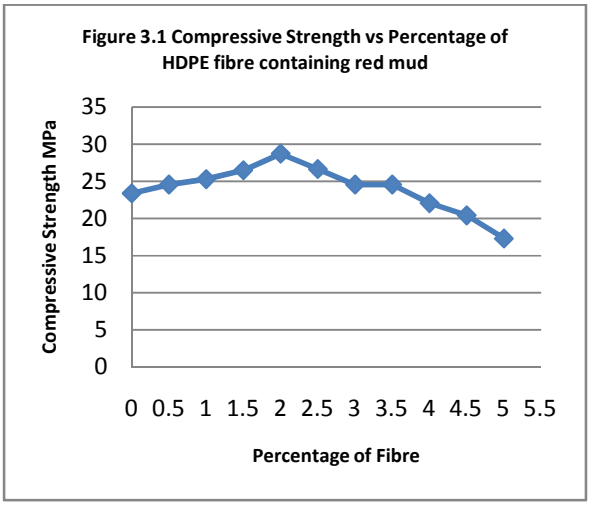
3.1 Compressive strength test results:

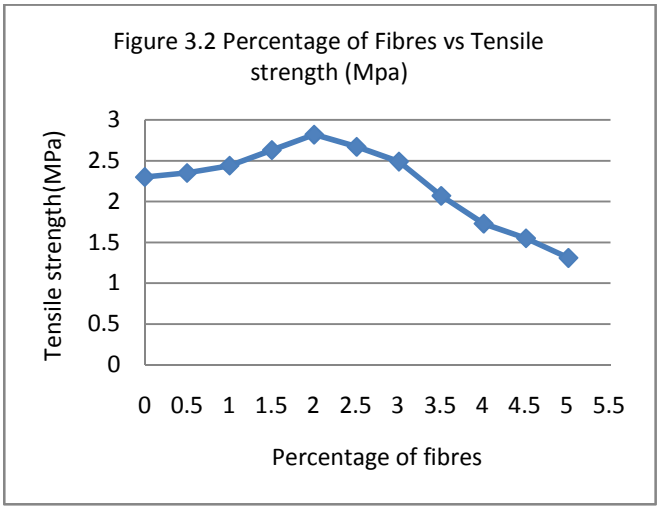
The following table No. 3.1 gives the compressive strength test results of HDPE fibre reinforced concrete with the addition of different volume fraction of HDPE fibres and 15% red sludge (by weight of cement)

Table 3.1: The compressive strength test results of HDPE fibre reinforced concrete containing red sludge

Percentage addition of fibres	**Average density (KN/m3)**	**Average compressive strength (MPa)**
0.0	26.26	23.41
0.5	25.71	24.57
1.0	25.55	25.32
1.5	25.22	26.51
2.0	24.84	28.73
2.5	24.68	26.66
3.0	24.59	24.58
3.5	24.24	24.58
4.0	24.19	22.07
4.5	24.04	20.44
5.0	23.74	17.31

The above results can be depicted in the form of graph as shown fig 3.1





3.2 Tensile strength test results:

The following table No 3.2 gives the average results of tensile strength of HDPE fibre reinforced concrete containing red sludge and different percentages of HDPE fibres.

Table 3.2 Average results of tensile strength of HDPE fibre reinforced concrete containing red sludge

Percentage addition of fibres	Tensile strength(MPa)
0 (Ref. mix)	2.31
0.5	2.34
1.0	2.43
1.5	2.63
2.0	2.82
2.5	2.67
3.0	2.49
3.5	2.08
4.0	1.74
4.5	1.54
5.0	1.31

The above results can be depicted in the form of graph as shown fig 3.2

3.3 Flexural strength test results:

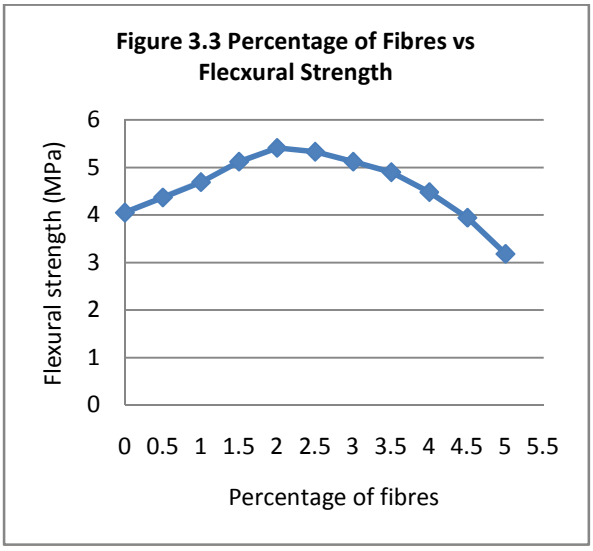
The following table No 3.3 gives the flexural strength test results of HDPE fibre reinforced concrete with the addition of different volume fraction of HDPE fibres and 15% red sludge (by weight of cement)

Average results of flexural strength: The following table No 3.3 gives the average results of tensile strength of HDPE fibre reinforced concrete containing red sludge and different percentage of HDPE fibres.

Table 3.3: Results of flexural strength of HDPE fibre reinforced concrete containing red sludge

Percentage addition of fibres	Flexural strength (MPa)
0 (Ref. mix)	4.04
0.5	4.36
1.0	4.69
1.5	5.13
2.0	5.42
2.5	5.33
3.0	5.12
3.5	4.90
4.0	4.45
4.5	3.94
5.0	3.19

The above results can be depicted in the form of graph as shown fig 3.3



3.4 Impact strength test results:

The following table No 3.4 gives the average results of impact strength of HDPE fibre reinforced concrete containing red sludge and different percentages of HDPE fibres.

Table 3.4: Average results of impact strength of HDPE fibre reinforced concrete containing red sludge

Percentage addition of Fibres	Impact strength required to cause (N-m)	
	First crack	Final failure
0(Ref. mix)	79.97	103.00
0.5	91.00	131.00
1.0	105.96	142.00
1.5	123.96	166.00
2.0	149.00	197.00
2.5	117.96	166.00
3.0	112.00	152.00
3.5	102.00	122.00
4.0	9500	117.00
4.5	88.00	102.00
5.0	73.99	93.00

The above results can be depicted in the form of graph as shown fig 3.4

3.5 workability test results: The following table No. 3.5 gives the average result of workability of HDPE fibre reinforced concrete with the addition of different volume fraction of HDPE fibre and 15% red sludge(by weight of cement).

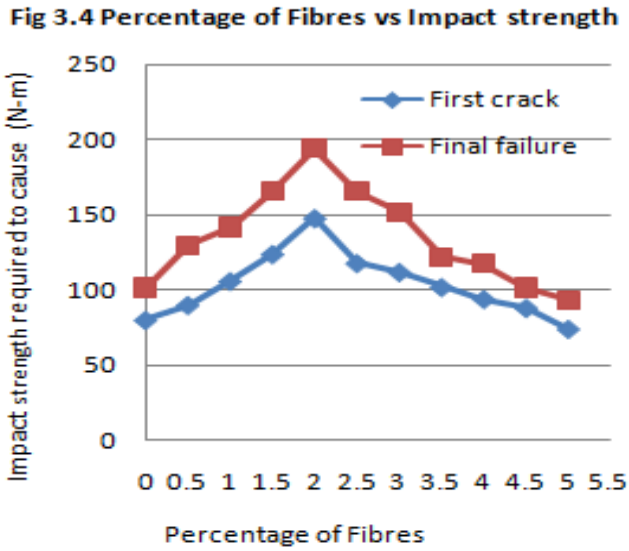


Table 3.5: The workability test result of HDPE fibre reinforced concrete containing red sludge.

Percentage addition of fibers	Workability through	
	Compaction factor	Vee-Bee degree(sec)
0.0	0.918	35
0.5	0.916	36
1.0	0.915	35
1.5	0.914	39
2.0	0.910	45
2.5	0.910	52
3.0	0.900	60
3.5	0.906	66
4.0	0.898	95
4.5	0.898	125
5.0	0.894	240

The above result can be depicted in the form of graph as shown in fig 3.5 and 3.6

Table 3.5: The workability test result of HDPE fibre reinforced concrete containing redmud.

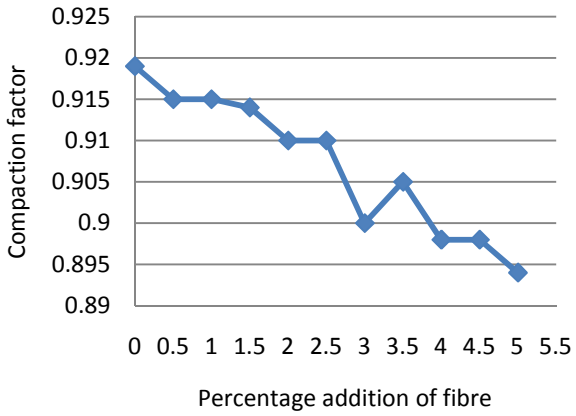
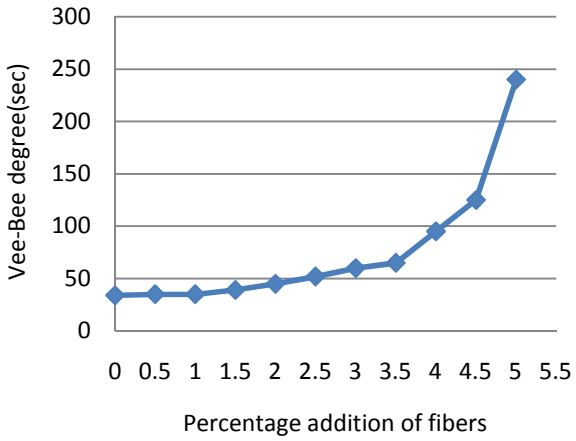


Table 3.6: The workability test result of HDPE fibre reinforced concrete containing redmud.



4.0 OBSERVATION AND DISCUSSIONS

Based on experimentation conducted the following conclusion can be drawn.

It has been observed that the compressive strength of HDPE fibre reinforced concrete with red sludge increases as the percentage of fibres in it increases up to 2%. The addition of fibres beyond 2% will decrease the compressive strength of HDPE fiber reinforced concrete i.e. the HDPE fibre reinforced concrete with red sludge shows maximum compressive strength when 2% fibres are used. Therefore the higher compressive strength can be achieved with the addition of 2% of HDPE fibres and 15% red sludge (by weight cement) and the percentage increase in the compressive strength is 28.73%.

It has been observed that the tensile strength of HDPE fibre reinforced concrete with red sludge increases as the percentage of fibres in it increases up to 2% The addition of fibres beyond 2% will decrease the tensile strength of HDPE fiber reinforced concrete i.e. the HDPE fibre reinforced concrete with red sludge shows maximum tensile strength when 2% fibres are used. Therefore, the higher tensile strength can be achieved with the addition of 2% of HDPE fibres and 15% red sludge (by weight cement) and the percentage increase in the tensile strength in 22.60%.

It has been observed that the flexural strength of HDPE fibre reinforced concrete with red sludge increases as the percentage of fibres in it increases up to 2%. The addition of fibres beyond 2% will decrease the flexural strength of HDPE fiber reinforced concrete i.e. the HDPE fibre reinforced concrete with red sludge shows maximum flexural strength when 2% fibres are used. Therefore, the higher flexural strength can be achieved with the addition of 2% of HDPE fibres and 15% red sludge (by weight cement) and the percentage increase in the flexural strength in 5.41%.

The impact strength of HDPE fibre reinforced concrete with red sludge increases as the percentage of fibres in it increases upto 2%. The addition of fibres beyond 2% will decrease the impact strength of HDPE fiber reinforced concrete i.e. the HDPE fibre reinforced concrete with red sludge shows maximum impact strength when 2% fibres are used. Therefore, the higher impact strength can be achieved with the addition of 2% of HDPE fibres and 15% red sludge (by weight cement) and the percentage increase in the impact strength for first crack and for final failure are 148% and 194% respectively.

This may be due to the fact that 2% addition of HDPE fibres may fit in and

interlock the aggregates there by by increasing the strength characteristics.

Thus it can be concluded that the higher strength characteristics of HDPE fibre reinforced concrete with red sludge can be obtained with 2% addition of fibres in it.

It has been observed that the workability of HDPE fiber reinforced concrete decreases as the percentage of fibres in it increases.

This is obviously because of less flow of concrete with more fibre content.

Thus it can be concluded that as the percentages of HDPE fibres increase the workability decreases.

5.0 CONCLUSION

(1) It can be concluded that the higher strength characteristics of HDPE fibre reinforced concrete with red sludge can be induced with 2% addition of fibres in it.

(2) Higher percentage addition of HDPE fibres reduce the workability characteristics of HDPE fibre reinforced concrete**.**

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REFERENCES

1. Balaguru P.N. and Shah S.P., “Fibre Reinforced Cement Composites”, 1992, Mc Graw-Hill lnc., New York, Unites State of America.
2. Balaguru, P. ”Fiber- Reinforced Rapid – Setting Concrete,” Concrete International, ACI, Detroit, Michigan, Vol.14, No.2, 1992.pp.64-67.
3. Balaguru, P and Ramakrishnan, V. “Freeze-Thaw Durability of Fiber Reinforced Concrete,” ACI journal, Vol.83, No.2, 1986.pp.374-382.
4. Bentur A and Mindess S., “Fibre Cementitious Composites”, 1990, Elsvier Science publishing Ltd., New York, Unites State of America
5. Broms, B.B. and Shah, S.P., ‘Discussion of Mechanics of Crack-Arrest in Concrete’ by Proc. ASCE, V.90, EM, 1992, I pp. 167-171
6. Brown.R, Shukla. A and Natrajan. K. R “Fiber Reinforcement of Concrete Structures, URITC Project No 536101, September 2002”

BIOGRAPHY

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