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An Experimental Study on Bond Strength of Concrete with M-Sand

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Abstract

The present investigation aims to study the bond strength of concrete made with M-sand and natural river sand as fine aggregates. The bond strength of M20, M25, M30 grade concretes with manufactured sand (M-Sand) and river sand is analysed. The diameter of steel bars used in this investigation are 8 mm, 10 mm, 12 mm,16 mm, 20 mm and 25 mm. All the specimens were cured for 28 days and were subjected to pull out test in the UTM. The results show that the bond strength of M-Sand is superior when compared to river sand. It is also observed that the bond strength increases with the increase in diameter.

Keywords: *Bond strength. Manufactured sand, Pullout test.*

1. Introduction

Bond strength is an important parameter for reinforced concrete to function effectively. It can be defined as the measure of transfer of load between the reinforcement and surrounding concrete. Proper bond ensures that there is little or no slip occurring between the reinforcement and concrete leading to the transfer of stress between steel and concrete. In reinforced constructions, the bond between the concrete and reinforcement is a very important factor affecting the strength of the structure. When a reinforced concrete element is loaded, the load is initially transferred to concrete and then to the steel reinforcement, the transfer of force from concrete to steel and vice-versa will be effective only if there is proper bond between steel and concrete. The various factors affecting the concrete-reinforcement bond include the strength of concrete, yield strength of steel, diameter of steel reinforcement, surface geometry of reinforcement, depth at which reinforcement is embedded into concrete. This property is crucial, as it has a major effect on the structural performance of a member. While the bond characteristics of steel and normal concrete have been investigated extensively, data for concrete with manufactured sand is lacking.

Thus in this paper an attempt is made to study the the bond characteristic of concrete containing manufactured sand.

2. Materials

Cement

OPC 53 grade as per the requirements of IS 12269:1987 was used in the manufacture of concrete.

M-Sand

M-Sand is used as fine aggregates for this investigation. M-Sand confirming to the grading zone II as per IS 383:1970 is used.

River sand

The naturally available river sand confirming to zone II is used for this investigation.

Coarse Aggregates

Well graded granite coarse aggregates, free from dust and deleterious materials is used in this investigation. Gap graded aggregates i.e. passing through 20mm IS sieve and retained on 12.5 mm IS sieve is used.

Water

Potable water is used for mixing of concrete.

Steel reinforcement

High yield strength deformed steel bars of grade Fe415 and diameters of 8 mm, 10 mm, 12 mm, 16 mm, 20 mm and 25 mm are used in this investigation.

MIX DESIGN

M20 concrete with w/c ratio 0.5, M25 grade concrete with w/c ratio 0.45 , M30 with w/c ratio 0.45 is designed as per 10262-2009 for both the set of specimens. i.e., one set with river sand and the other set with 100 % M-Sand.

The design basically involves the determination of selection of water content, cement content, coarse aggregate content and fine aggregate content. The mix proportions obtained on the above procedure will be finalized with minor adjustments on the quantities of constituent materials

3. Methodology

In this experimental study 9 pull out specimens for each grade of concrete and each diameter of bar was prepared (total 162 specimens). 150 mm cube specimens with the steel rod in center was prepared. The specimens were cured in water for 28 days and was subjected to pull out test in UTM. The testing was performed as per the codal requirements of IS-2770(Part-1)-1967.

Bond stress is calculated as per the following:

$S = P_{max} / (\pi \times D \times L)$

Where, S = Bonding stress (MPa)

P_{max} = Maximum pull-out load (N)

D= Diameter of bar (mm)

L= Embedded length (mm)

π= Constant (3.142)

4. Results and Discussions

All the specimens were tested and the pull out load was recorded. The failure pattern was also observed. From the observations we can see that the specimens have failed in split mode .Specimens with 8 mm, 10 mm, 12 mm diameter steel has failed in steel rupture mode.

Table 4.1 Bond strength for M20 (M-Sand)

Sl No	Rebar Dia (mm)	Ultimate Bond stress (Mpa)
1	8	7.69
2	10	10.6
3	12	12.87
4	16	10.07
5	20	7.87
6	25	6.55

Table 4..2 Bond strength for f M20 grade((River sand)

Sl No	Rebar Dia (mm)	Ultimate Bond stress (Mpa)
1	8	7.69
2	10	10.6
3	12	12.11
4	16	7.16
5	20	5.44
6	25	3.57

Table 4.3 Bond strength for M25 (M-Sand)

Sl No	Rebar Dia (mm)	Ultimate Bond stress (Mpa)
1	8	8.08
2	10	10.6
3	12	11.77
4	16	10.54
5	20	7.9
6	25	8.07

Table 4..4 Bond strength for f M25 grade((River sand)

Sl No	Rebar Dia (mm)	Ultimate Bond stress (Mpa)
1	8	7.95
2	10	10.71
3	12	9.94
4	16	5.9
5	20	5.21
6	25	6.49

Table 4.5 Bond strength for f M30 grade((M-Sand)

Sl No	Rebar Dia (mm)	Ultimate Bond stress (Mpa)
1	8	8.08
2	10	10.6
3	12	11.77
4	16	10.54
5	20	7.9
6	25	8.07

Table 4.6. Bond strength for f M30 grade((River-Sand)

Sl No	Rebar Dia (mm)	Ultimate Bond stress (Mpa)
1	8	7.95
2	10	10.71
3	12	9.94
4	16	5.9
5	20	7.21
6	25	6.49

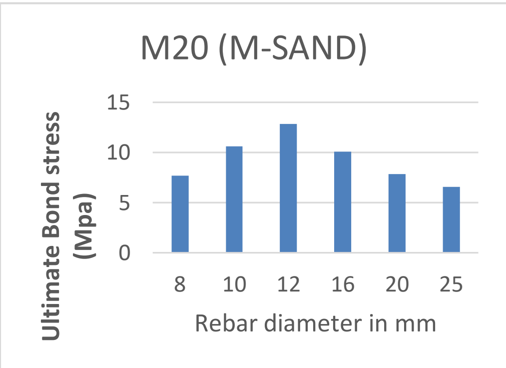

Fig 4.1. Bond strength for M20 (M-Sand)

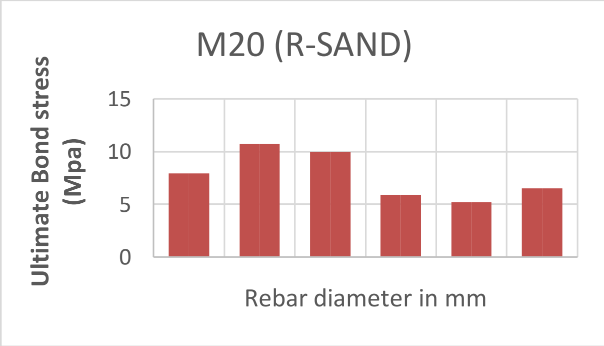

Fig 4.2. Bond strength for M20 (River-Sand)

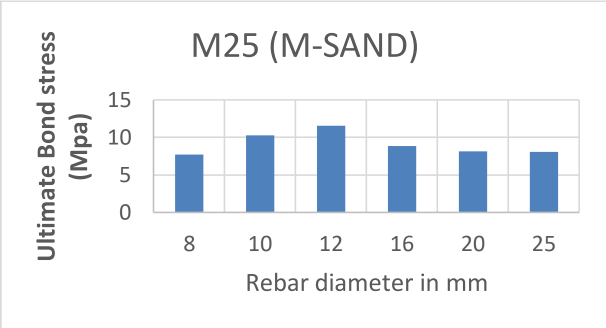

Fig 4.3. Bond strength for M25 (M-Sand)

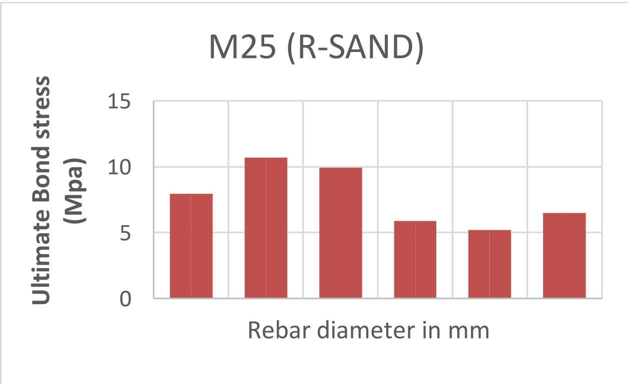

Fig 4.4. Bond strength for M25 (River-Sand)

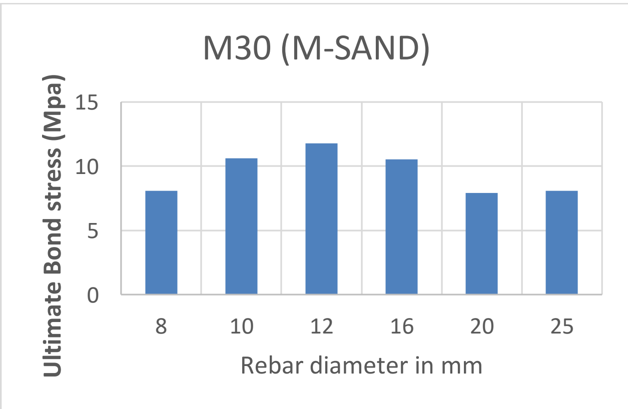

Fig 4.5. Bond strength for M30 (M-Sand)

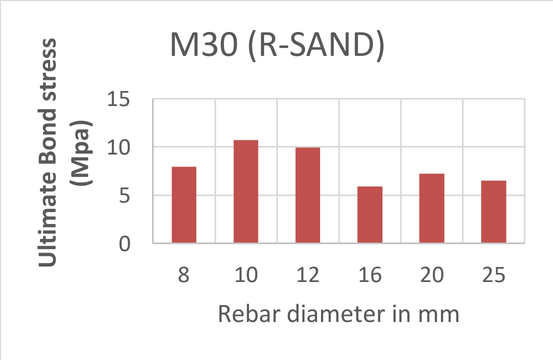

Fig 4.6. Bond strength for M25 (River-Sand)

5. Conclusions

The following conclusions are made in this investigation;

- From the results it is concluded that the bond strength of M-Sand is superior to river sand.
- It is also observed that as the diameter of the bar increases the bond strength decreases.
- The other observation is that the bars of diameter 8 mm, 10 mm usually failed by rupture of steel
- Based on the experimental results it is concluded that, M-Sand can be used to replace river sand safely regarding bond strength is concerned, also it is cost effective.

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