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STUDY OF BOND STRENGTH ON HIGH PERFORMANCE CONCRETE

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Abstract:

The behaviour of reinforced concrete structures is influenced by the interaction between the concrete and reinforcement. The bond between steel and concrete is very important and essential so that they can act together without any slip in a loaded structure. Hence bond has been, and still is a topic of fundamental and applied research. Here a Study on the effect of steel and recron 3S fibre on the bond strength and bond stress- slip response of deformed steel bars embedded in fibre reinforced concrete was carried out both experimentally and analytically. Experimental study was carried out by doing pullout tests using Universal Testing Machine (UTM) on cubes of size 150x150x150mm. A total of 24 pullout specimens were cast and tested. The variables considered were, the volume fraction of hooked steel fibres, the volume fraction of recron 3S fibres and the diameter of reinforcement bars. The analytical study was carried out using ANSYS software by modeling a cubical specimen similar to experimental work. It was seen that steel fibres showed higher bond strength than recron 3S fibres and that of control specimen. The results obtained from analytical tests showed the same trend as that of experimental ones.

Keywords: Bond stress, deformed bars, fibre reinforced concrete, pullout tests, steel fibres, recron 3S fibres.

1. INTRODUCTION

The behaviour of reinforced concrete (RC) structures depends up on the type of bond developed between the steel reinforcement and the surrounding concrete. The utility of reinforced concrete as a structural material is derived from the combination of concrete that is strong and relatively durable in compression with reinforcing steel that is strong and ductile in tension. Maintaining composite action requires transfer of load between the concrete and steel. This load transfer is referred to as bond and is idealized as a continuous stress field that develops in the vicinity of the steel-concrete interface. Bond stress is the tangential shear or friction developed between the reinforcement and the surrounding concrete that transfers the force onto the reinforcement. To ensure the integrity of various constituent or composite action of concrete and steel reinforcement, sufficient bond should be developed by the surrounding concrete with the reinforcement. Proper bond between the steel reinforcement and the surrounding concrete is also crucial for the overall strength and serviceability of RC members. The failure of RC structures may be due primarily to the deterioration of the bond. Hence it is necessary to study the bond characteristics.

2. LITERATURE REVIEW

High Strength Reinforcing Steel reported that the pullout specimen with the smaller bar size has greater bond strength than the specimen with the larger diameter bar and it also showed that the bond strength and the initial stiffness increased as the amount of concrete surrounding the reinforcing bar increased. The bond strength of fly ash based geopolymer concrete and OPC concrete with reinforcing steel was evaluated by Prabir Kumar Sarker [3].The varying parameters were compressive strength , concrete cover, bar diameter. He found that geopolymer concrete has higher bond strength than OPC concrete and bond strength increased with the increase in concrete cover and the concrete compressive strength. Dr Ala'a & Wjdan Dhaif [4] studied the behaviour of bond between concrete and plain steel reinforcement both experimentally and analytically (using ANSYS).He found that there is good agreement between the finite element solution and the experimental results and that bond strength increases by decreasing the diameter of steel bar embedded in concrete cylinder specimens of the same compressive strength. Appa Rao and Kadhiravan [5] studied the influence of specimen geometry, bar diameter, strength of concrete, lateral confinement and embedment length on the bond properties of concrete by nonlinear finite element analysis. All the studies mainly investigated the influence of bar diameter, embedment length, surface type of reinforcing bars, concrete type, curing age of concrete, concrete compressive strength, different confining conditions etc on bond strength. Study involving comparison of analytical and experimental works is limited. The studies generally concluded that the bond strength increased with, decrease in bar diameter,increase in concrete cover, increase in compressive strength,decrease in water cement ratio.

3. PROPOSED SYSTEM

This experimental programme was carried out to evaluate the bond stress - slip behaviour and pullout strength of reinforced bars embedded in fibre reinforced concrete. A total number of 24 pullout specimens were cast (two specimen each for twelve different types). The details of specimens and variables are given in Table 1. The main variables considered were: (i) Volume fraction of crimped steel fibres (Vfs) viz; 0.5% and 0.1% , (ii) Volume fraction of polyester fibres (Vfp) viz; 0.1%,0.2% and 0.3%, (iii) diameter of reinforcing steel bars(ϕ) viz;16mm and 20mm. It was noted from literature review that, the volume content of steel fibres alone can vary up to 2%[7] and the optimum volume fraction of recron 3S fibres is in the range of 0.2 - 0.3%[8]. Based on the review the volume fraction of both the fibres was fixed. Two specimens were cast for each parameter and the average of the two was taken for analysis. In this experimental study concrete of M25 grade is used and for that mix design is done based on IS 10262:2009[9].The details of mix proportions are given in Table 4. Required quantities of cement, fine aggregates and coarse aggregates were first mixed thoroughly in a drum type mixer for a period of 2 minutes. During the mixing operation 80% of water was added first and mixed thoroughly and the remaining 20% water, mixed with superplasticizer was added later . The steel and polyester fibres were dispersed by hand to the mixture to achieve The pullout specimens were prepared as per IS 516-1959 (reaffirmed 2004) [10]. The specimen consists of concrete cubes 150x150x150mm with a single reinforcing bar (16mm or 20mm dia) 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. The end of the reinforcing bars on which the tip of LVDT was fixed during the test was ground to a reasonably smooth surface normal to the axes of the bars. The specimens were also reinforced with a helix of 6mm diameter plain mild steel bar at a pitch of 25mm to prevent splitting failure. Moulds for casting were prepared using plywood. De moulding was carried out after 24 hours and then the specimens were immediately placed into curing tank for 28 days of curing. Significant improvement in bond stress was seen in the case of 16 and 20mm bars when the steel fibre volume fraction was increased from 0.5% to 1%. In the case of 16mm bar, there was an increase of 27.2% compared to control specimen for 0.5% steel fibre ,whereas a significant improvement of 47.6% was seen compared to CS when steel fibre volume was increased to 1%. Similarly in the case of 20mm bars there was an increase of 18.26% and 37.39% compared to CS for 0.5% and 1% steel fibre respectively. For specimens with same bar diameters improvement in bond stress was observed when the fibre volume fraction was increased from 0.1% to 0.3% in case of recron fibres. For 16mm bar when the fibre fraction was 0.1%, 0.2% and 0.3% the bond stress increased 5.6%, 11.2%, 14.4 % respectively. In the case of 20mm bar when the fibre fraction was 0.1% the bond stress showed an increase of 3.04%, whereas for 0.2% and 0.3% of fibre fraction the bond stress showed an increase of 6.96% and 12.61% respectively compared with control specimen.

4. ANALYSIS

The value of bond stress at a slip of 0.025mm and 0.25mm which is the requirement as per IS 2770 Part (1):1967 (reaffirmed 2002) and the ultimate load and ultimate bond stress of all the specimens which failed due to pullout of reinforcement bars

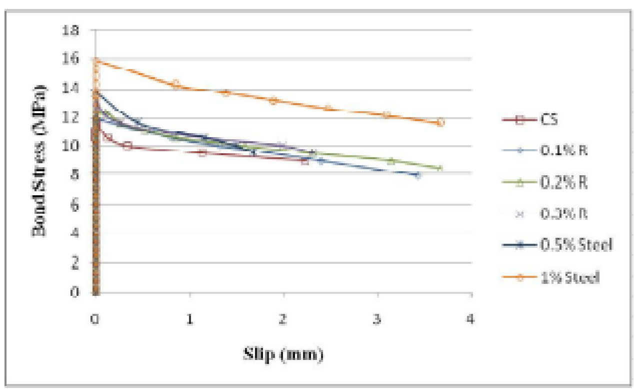
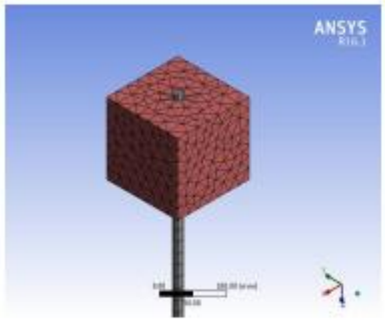


Fig.1.Analysis

For all the specimens very little slip was noted till the specimens reached the ultimate load. Only at the time of failure of specimen there was considerable slip. Hence for the sake of comparison of bond stress as per IS 2770 slip at 0.025mm and slip at 0.25mm was noted. The results from table show that the bond stress for polyester fibre reinforced concrete (PFRC) was more than the control specimen and that for steel fibre reinforced concrete was more than PFRC for both 16 and 20mm bars. This extend of increase was more pronounced in the case of 16mm bars where it increased by 47.6 % for 1% steel fibres. However the extend of increase was small ie 37.39 % for 20mm bars. The increase in bond stress values due to the increase in fibre content may be due to the fact that the increase in volume fraction of fibres increases the confinement and bridging effects in the matrix which will improve the bond stress values.



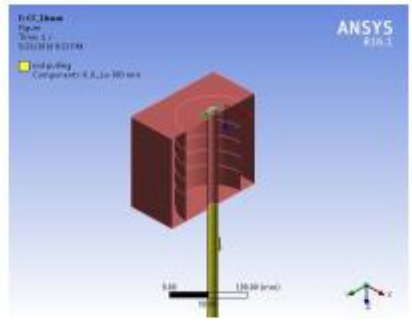


Fig.2.Model

It can be noted from Table 5 that, for a given embedded length and mix the bond stress for smaller diameter bars is more than that of larger diameter bars. This may be because of the larger concrete cover to bar diameter ratio available in the case of small diameter bars which may contribute more to the bond resistance of the bar. When the cover to the reinforcement is increased, then crack initiation load increases and subsequently bond strength improves. The bond stress for 20mm bar is about 8-36% lesser than that of 16mm bar when the different mixes are considered.

CONCLUSION

The graph for 16 mm and 20mm bar specimens shows that the value of bond stress for each type of specimen from experimental work is more than that of analytical work. This is acceptable, as the bond strength from analytical work which is predicted one, is less than experimental result, the analysis done by FEA is on the safer side. Thus it can be used for predicting the bond strength of various specimens by changing the parameters.

REFERENCES

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

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

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

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

[5] Appa Rao, G., Kadhiravan, D., "Non linear FE modelling of anchorage bond in reinforced concrete". International Journal of Research in Engineering and Technology, Vol.2, Issue.9, 377-384, 2013.

[6] Ganesan, N. , Indira, P.V., Sabeena, M.V., "Bond stress slip response of bars embedded in hybrid fibre reinforced high performance concrete". Construction and Building Materials, 50 , 108-115, 2014.

[7] Ahmed, K., Mahmood, A., EL Rajy, A.., Goraya, R.A., "Effect of cover on bond behaviour of fibre reinforced high strength concrete" International Journal Of Scientific & Engineering Research, Volume 5, Issue 1, pp 578-583, 2014.

[8] Abhinandh, G., Tisny, D.B., "Flexural Behaviour of Hybrid Fibre Reinforced Concrete Beam". International Journal of Scientific & Engineering Research, Volume 5, Issue 7, July-2014.