International Journal of Research in Advent Technology (IJRAT) Special Issue "ICADMMES 2018"
E-ISSN: 2321-9637
Available online at www.ijrat.org

Shear Strength of Ternary Blended Fibre Reinforced Concrete Beams Using Crimped Fibres

P.Rakesh[1*], P.Thejaswini[2] and Dr. S.Lakshmi Shireen Banu[3]
*[1]Department of Civil Engg.,MREC,Kompally,Secunderabad District-500100, Telangana, India. [2]Department of Civil Engg. SCCE., Thimmapur, Karimnagar- 505527, Telangana, India. [3]Department of Civil Engg.,MREC,Kompally,Secunderabad District-500100, Telangana, India. *e-mail of corresponding author: padakantirakesh@gmail.com*

Abstract: An exact analysis of shear strength in reinforced beam is quite complex because of involving large number of parameters, some may not be known. Unlike flexural failure, shear failure are sudden and unexpected, sometimes violent and catastrophic. In the present investigation an attempt has been made to study the shear strength of ternary blended steel fibre reinforced concrete beams. The steel fibres used in the experiments are of crimped shape with aspect ratio of 80. The percentage of mix proportions of ternary blend yielding optimum results for M30 grade concrete were obtained. Tests were conducted on beams with varying percentage of crimped steel fibres (0%, 0.5%, 0.75%, 1%, and 1.25%). Shear strength of ternary blended fibre reinforced concrete beams is determined by testing beams of size 1400mm×100mm×150mm under two point loads in univers al testing machine at the age of 7 days and 28 days.
The results from the tests have shown that the increase in the percentage of steel crimped fibres increases the shear strength of ternary blended fibre reinforced concrete beams. The percentage increase in shear strength was maximum at 0.75% in The percentage increase in shear strength carrying capacity of ternary blended steel fibre reinforced concrete beams compared to ternary blended concrete was 18.98%. Inclusion of fibres beyond 0.75% has shown to decrease the shear strength of the beams which might be attributed to the lack of workability, difficulty in compaction and clumping of fibres.
Index Terms: Ternary blended concrete, Fibre reinforced concrete, steel crimped fibres, aspect ratio, workability, fly ash, Metakaolin, Shear strength, Shear failure.

INTRODUCTION:

Ternary blended concrete includes cement and two pozzolanic materials being added. The ternary blend of concrete using fly as has the advantage of producing better workability but late development of strength. Metakaolin provides an early strength but produces lesser workable mix. Combination of these two provides workable and early strength gain mix. Ternary blended mixtures give high strength, low permeability and corrosion resistance. Studies have shown that shear force is resisted by the combination of, uncracked concrete in compression region, aggregate interlocking and the shear acting across the longitudinal steel bars. The different types of fibre used are steel fibres, glass fibres, synthetic fibres, aramid fibres, nylon fibres, polyester fibres etc. When a fibre reinforced composite is loaded, the matrix will crack long before the fibres can be fractured. Once the matrix is cracked the composite continues to carry increasing tensile stress. As an SFRC beam is loaded, steel fibres bridges the cracks such that it provides the SFRC specimen with greater ultimate tensile strength and larger toughness and better energy absorption. As the steel fibres are distributed throughout the matrix of concrete, they are better capable of resisting the shear cracks. Based on the above mentioned facts, the need to carry out study of shear carrying capacity of ternary blended fibre reinforced concrete identified. Therefore in the present study shear strength of fibre reinforced concrete is carried out. The present paper focuses on the use of various fibres and admixtures in concrete and their influence on its properties

.

LITERATURE REVIEW:

Nagarakar P.K, TambeS and PazareD.G(1987) carried out the experimental investigation to study the mechanical properties of concrete. He showed that there is considerable increase in the compressive and tensile strength of concrete along with that workability was found to decrease with the addition of fibres and increase in aspect ratio.

Yoon-keun kwark, Mare O. Eberhard, Woo Suk Kim and Jubumn (2002) said that the increase in strength was particularly large for beams with smaller a/ds. The addition of steel fibres consistently decreased crack spacing and sizes, increased deformation capacity and changed the brittle nature to ductile.

Choi, kyoug-Kyu (2007) said that due to that material characteristic of steel fibres, the shear strength of fibre reinforced concrete (FRC) beam increase. The failure modes of the beam changed to be more ductile. Also the steel fibres can prevent excessive diagonal cracking and localization of the tensile crack damage. And also hesaid that steel fibres can increases the effective stiffness and decrease the deflection of the beam.

The work carried by the **Remigijus Salna, Gediminas Marciukaitis (2007)** shows that the plasticity, cracks propagation and load capacity of elements are greatly influenced by the steel fibre volume and shear shear span. Load capacity of tested beams, in variation of volume fraction at different a/h, is different. When a/h = 1 , load capacity grows from 1.62 to 1.89 times. At higher values of shear span ratio, the increase of load capacity is not so significant. When a/h = 1.5 and a/h= 2 the increase from 1.26 to 1.56 and 1.14 to 1.54 times, respectively, is observed.

The work carried by the **Neves and Fernandes (2005)** indicated that the addition of fibres to the concrete enhances its toughness and strain at peak stress, but can slightly reduce the young's modulus. An analytical model to predict the stress-strain relationship for steel fibre concrete in concrete in compression is also proposed. The model results are compared with experimental stress-strain curves.

Roland Bleszynski, Doug Hooton based his works he said that the combination of SF and blast-furnace slag offers increased resistance to ASR expansion and chloride ingress than the use of these materials alone. The results of laboratory scaling tests indicated that the concretes produced with blended cement had inferior performance compared with plain Portland cement concrete, especially at higher level of slag. Ternary blended concrete exhibits greater overall durability performance than an OPC concrete mixture and concrete with single SCM replacements.

Lysnsdale and khan (2002) given the conclusion that the ternary enabled negligible chloride transport at the early ages, both fly ash and silica fume contributing. At the low w/b with 10% silica fumes, 15-20% fly ash gave the lowest chloride transport of the tests.

Nassif and Suksawang (2005) made the conclusion that combing silica fumes and fly ash enhances the durability and mechanical properties of HPC.

EXPERIMENTAL INVESTIGATION:

Experimental investigation included 5 tasks. Task 1 consist of determining the physical and chemical properties of various material involved in the making of concrete mix such as cement, fine aggregate, coarse aggregate, fibres, fly ash, metakaolin. It is observed that the specific gravity of cement is 3.15, initial setting time of38min. For the fine and coarse aggregate fineness modulus are 2.49, 7.7 respectively and the specific gravity are 2.60, 2.59respectively. Super plasticizer used in concrete was 1% by weight of cement. The fibres used in the experiments were steel fibres of crimped shape with circular cross section with an aspect ratio of 80. The diameter and length of the fibres are 0.85mm, 30mm.Tensile strengths of fibres is about 550Mpa. Fly ash used in the experiment has the surface area of 230-600 m²/kg. The metakaolin used in the work has specific gravity 2.54. Task 2 determines the concrete mix proportions for the M30 grade of concrete using the code IS: 20262 with the help of properties of the materials which are determined in previous step. It is determined that mix proportions for the M30 grade concrete is 1:1.26:2.34. Task 3 involves the determination of optimum replacement of cement and metakaolin for good bonding. It is observed that M10F30 is the optimum grade of concrete provides good binding material. Task 4 involves the casting of 6 cubes of size 150×150×150 mm and 4 beams of size 100×150×1400mmfor each percentage of mix (0.5, 0.75, 1 and 1.25). The design of beam gives the reinforcement details as 6mm dia bars, 2 No's in compression zone. Curing has been carried out in portable water tank for the samples for 7days, and 28 days. The workability of concrete was checked by compaction factor test. Task 5 involves testing of casted cubes and beams. Cubes are tested under compressive testing machine to determine the compressive strength of concrete. Beams are tested under the two point load in the universal testing machine (UTM). The distance between the two point loads is 600mm. the shear span is 300mm. The beam experiences uniform shears in the shear span i.e. W/2.

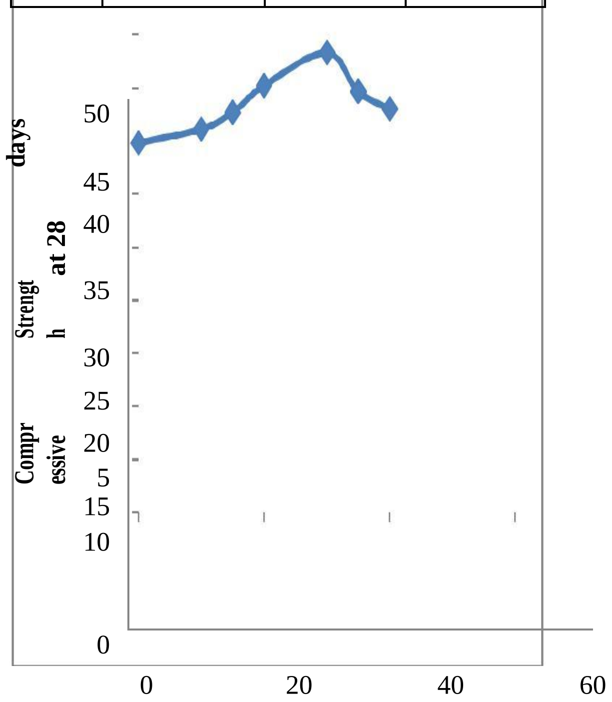
TEST RESULTS AND DISCUSSIONS:

Compressive strength of TBC:

For the determination of optimum replacement of cement by fly ash 14 concrete cubes are casted to determine concrete compressive strength at different times: at release 7 days, and 28 days. The content of fly ash as a replacement of cement for 10%, 20%, 30%, 35% and 40% are in the table given.

The graphical representation of 28 days strength of the mixes is shown in below. From this it is observed that the compressive strength of TBC was observed to be optimum of cement by fly ash.

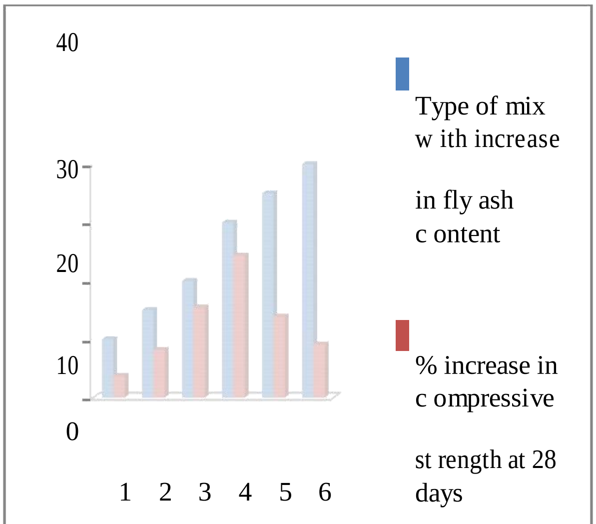
S.No.	Designation of Mix	7 days strength (MPa)	28 days strength (MPa)
1	M0F10	21.27	34.83
2	M10F10	23.27	36.13
3	M10F15	24.55	37.68
4	M10F20	26.11	40.21
5	M10F30	29.44	23.31
6	M10F35	24.24	39.67
7	M10F40	24.11	38.01



% of fly ash content

The below graph shows the percentage increase in the compressive strength for the replacement of cement by fly ash for 10%, 15%, 20%, 30%, 35%, and 40%. From this it is observed that the percentage increase in the compressive strength of TBC when 30% fly ash was replaced with cement was 24.34%.**Increse In Cube Compressive Strength of Ternary Blended C oncrete**

With Different Mix



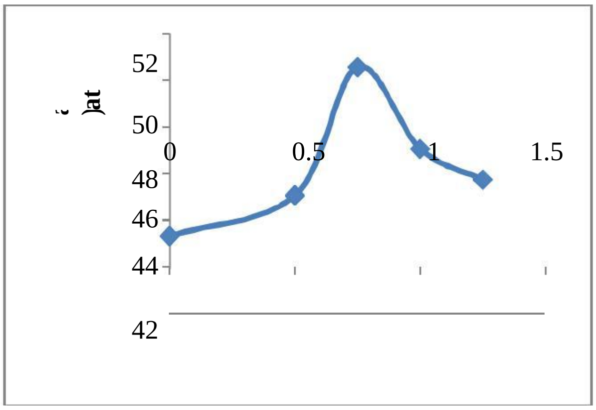
No. of mix and % increase in stren gth

Compressive Strength of TBSFRC:

Four cubes were casted for the fibre content 0.5%, 0.75%, 1% and 1.25% for the optimum mix of M10F30. The results obtained from the compressi on test of cubes of TBSFRC are shown in the table given below.

S.No.	Designation of Mix	7 days strength (MPa)	28 days strength (MPa)
1	M10F30S0	29.44	43.31
2	M10F30S0.5	31.28	45.06
3	M10F30S0.75	36.41	50.57
4	M10F30S1.0	30.57	47.06
5	M10F30S1.25	26.51	45.73

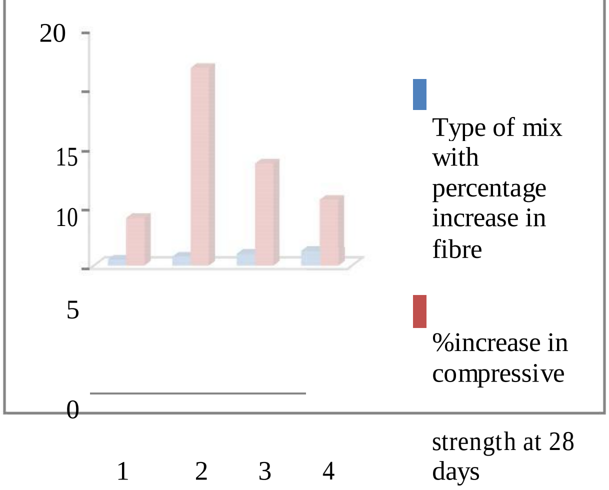
The graphical representation of th e compressive strengths of the cubes is shown in belo w. From this the compressive strength of TBSFRC was observed to be optimum when 0.75% fibres were used.



Percentage of fibres increas e

The following graph shows the percentage increase in the compressive strength of Ternary Blended SFRC with various mixes compared with T ernary blended concrete. From this it is observed that the percentage increase in the compressive strength of TBSFRC when 0.75% fibre was used was found to be optimum which is 16.76%.

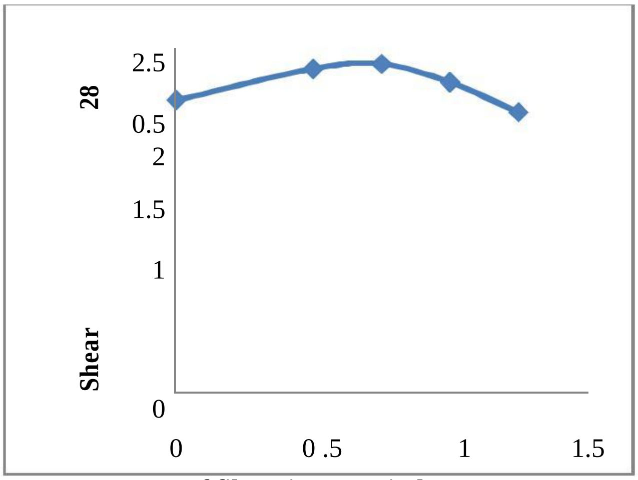
% Increase In The Cube Compressive Strength Of Terna ry Blended SFRC



No. of mix and incr ease in strength

Shear strength of Beam:

Four beams are tested under two point loading of TBSFRC to determine the shear strength of the beams. For the each percentage o f fibre content 0%, 0.5%, 0.75%, 1% and 1.25% one b eam is casted and tested to determine the shear strength . The shear strength of the beams at 28 days is tabulated below.



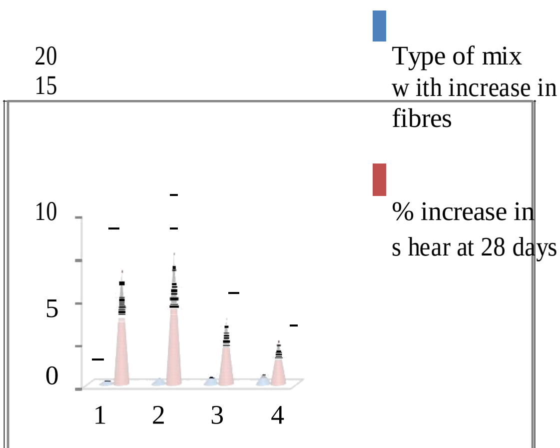
% of fibres increase in beams

The following graph shows the percentage increase in shear strength of ternary b lended FRC with various mixes compared with terna ry Blended concrete. From this it is observed that the percentage increase in the shear strength of TBSFRC when 0.75% fibres content was used was found to be optimum which is 15.38%.

Effect on workability of concrete:

Addition of metakaolin, fl y ash and steel into the concrete reduced the workab ility. The concrete mix was found to become strongly cohesive and stable compared to that of ordinary plain c oncrete. No bleeding was observed. Mix with metaka olin, fly ash and steel fibre tends to become harsh, stick y and stiff. By varying the dosage of super plasticizer workability is maintained i.e., maintaining the compact ion factor 0.8 to 0.9.

% **Increase in Shear Stren gth of Ternary blended FRC Be am**



No. of mix with %increase in shear strength

CONCLUSIONS:

- The Shear carrying capacity of the beams has improved with the presence of fibr es.
- There has been an increase in shear strength beams by 15.38% with the inclusion of 0.75% Crimped steel fibres.
- Compressive strength of concrete increases with the replacement of cement wi th the mineral additives fly ash and metakaolin. H owever beyond certain limit of their addition, the strength decreases. The maximum streng th is obtained when 10% Metakaolin and 30% fly ash by weight of cement is used as partial replacement of cement.
- Increase in the Compressive strength of ternary blended concrete at the above
  Said replacement is by 24.34% c ompared to the plain concrete.
- The addition of fibres in ternary blended concrete at the above said replacement is by 24.34% compared to the plain concrete.
- The addition of fibres in ternary blended concrete further enhances the compressive strength of concrete. There is a further increase in the compressive strength by 16.76% w ith the addition of fibres. The percentage of fibres for this being 0.75%.
- Addition of metakaolin and steel fibres into the concrete reduced the workability.
- The concrete mix was found to b ecome strongly cohesive and stable compared to that of ordinary plain concrete. No bleeding was observed. This may be due to the void filling action of the metakaolin and fly ash particle s. Which gives should be limited and should not be more than 0.75percent.

SCOPE FOR FURTHER STUDY:

- Work can also be carried out by v arying different length of fibre to improve Workabi lity.The shear carrying ca pacity of ternary blended
  fibre reinforcement concrete improves considerably. There is scope of further investigation on shear behaviour of beams with different types of fibre.
- Various other fibres like glass, polypropylene, nylon etc. can be us ed to enhance the shear capacity of beams
- Work can also be car ried out by varying other parameters like the spa n to depth ratio, graded of concrete, using of hybr id fibre.
- Behaviour of quarter na ry Blended fibre reinforced concrete in shear also be studied.

REFERENCES:

[1] D Manjula, K Raja sekhar, (2016), "Strength properties of FRC b y Using Ternary blended material.
[2] Cengiz Duran Atis a nd okan karhan, (2009), "Properties of steel fibre reinforced fly ah concrete", constructio n an d building material, volume 23, issue 1, pag es 392-399.
[3] C.J Lynsdale and M. L khan, (2002), "Strength, permeability and carbonation of High performance Concrete", Cement and Concrete Research, Volume 32, Issue 1, pa ges123-131.
[4] IS 456-2000, "coe o f practice for Plain and Reinforced Concrete", Bureau of Indian standards, New Delhi.
[5] IS 10262-1982, "Reco mmended Guidelines for Concrete Mix design", bureau of Indian standards, New Delhi.
[6] IS 383-1970, "Specific ation for coarse and fine aggregate from natural sources of Standards, New Delhi.
[7] IS12269-1987, "Specification for 53 grade ordinary Portland ce ment", Bureau of Indian Standards, New Delhi.
[8] Meda A., Minelli, F., Plizzari, G.A and Riva, P., (2005), "Shear Behaviour of steel Fibre Reinforced Concrete, Volume 36, Issue 9, pages 1727-1734.
[9] R.D neves and J.C.O . Fernandes de Almeida, (2005) "COMPRESS IVE BEHAVIOUR OF STEEL FIBRE REI NFORCED CONCRETE". Structural Concrete, vo lume 6, issue 1, pages 1-8, ISSN: 1464-4177, E-ISSN: 1751-7648.
[10] S.K. Madan, G.Rajes h Kumar and S.P. Singh, (2007), "Steel fibres as replacement of web reinforcement for RCC deep beams in shear", Asian journal of Civil Engineering (building and housing) VOL. 8, NO. 5, pages 479-489.
[11] M.S. Shetty, Concrete Technology.
[12] A.M. Neville, Propertie s of concrete.