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Strengthening of Nano Concrete Beam with GFRP Wrapping

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Abstract : India is a fastest developing country, due to the increase in the growth of industry, the production of goods has been increased and at the same time the waste products coming out of these industries has considerably increased. From the study it was noted that disposal of these waste material has been a major problem and has created many environmental issues. One of such material is fly ash a product from thermal power plant. In this project, flyash is made to nano size with the help of ball grinding mill. Nano fly ash is used as a replacement of cement.Ordinary Portland cement is replaced with 0%, 10%, 20%, 30%, 40% and 50% by nano fly ash M20 grade of concrete is used for the study. FRP application is a very effective way to repair and strengthen the structures that have become structurally weak over their life span. Hence the flexural behaviour of Nano concrete beams strengthened using GFRP sheets are carried out in this study. The difference in the flexural behaviour of wrapped nano concrete beams and unwrapped nano concrete beams are investigated. It was found that 30 % replacement of cement with nanoflyash gave an optimum value for both wrapped and unwrapped specimen.

Key words : nanoflyash, flexural strength, GFRP sheet, wrapping.

1.0 Introduction

A concrete structure is a permanent structure with a roof and walls standing more or less permanently in one place.The structures are of varying quality and function, but they are all ageing and deteriorating over time. Cracks can occur due to chemical reactions in construction materials, changes in temperature and climate, foundation movements and settling of buildings. There are many ways for repairing of cracks like injection, stitching, grouting, additional reinforcement, gravity filling. Fiber wrapping is one of the latest strengthening technology for reinforced concrete and masonry structural members. It is possible to increase the strength of structural members even after they have been severely damaged due to loading conditions. It is used for flexural strengthening, shear strengthening of structural members and ensure minimum disturbance to the structural members as compared to other conventional methods.FRP composite materials are comprised of high strength continuous fibers, such as glass, carbon, or steel wires, embedded in a polymer matrix. Fibre Reinforced Polymer (FRP) can be applied to strengthen the beams, columns, and slabs of buildings. The most common FRP systems for concrete strengthening applications are carbon fiber based (CFRP) and glass fibre based (GFRP).In this experimental investigation, GFRP is used because it has less weight, overall thickness is less and is economical compared to other FRPs. This paper presents the results of an experimental investigation carried out on normal nano concrete beams strengthened by glass fibre reinforced polymer sheets.

2.0 Literature Review

Vineeth Sharma and Yudhiv Yadav (2015)[1] made a review of application of GFRP to strengthen the RCC beam. The result obtained shows that the flexural strength of beam can be increased in range of 40% 125%

bending GFRP sheet on tension fare of RCC beam. R.Elanchizhiyan and C.Hema (2016)[2] investigated the flexural behaviour of RCC beams strengthened by GFRP sheets. The result showed that there is an increase in the ultimate bond carrying capacity. Rita Irmawati and hino Shinichi (2015)[3]experimental investigation the bending behaviour on the strengthened concrete beams for flexural loadings. Deepakkumar and Govind Ravish (2015)[4] made a study about use GFRP for strengthening of RCC beam. It was found that GFRP can be used for repair and reconstruction of damaged or deteriorating structures, due to its high tensile strength, excellent corrosion resistance and good non-magnetization properties.M.Vinod Kumar and M.Muthukannan (2014)[5] published a paper about the use of FRP composite in the strengthening and retrofitting of RC structures. Results obtained show that it enhances flexural strength, shear capacity and also improves over-all damage. Michael F.Petrou and Kent A.Harries (2001)[6] examines the effects of GFRP composite rehabilitation system on the fatigue performance of RCC beams. The result indicated that the fatigue life of RCC beams can be extended through the externally bonded GFRP sheets.Prof.R.Sterlin Fernald Sam and M.S.Sruthi (2016)[7] made an experimental investigation on the shear behaviour of RC beams strengthened using continuous GFRP sheets. The observed results indicate the external confinement using GFRP enhances the mechanical properties of RCC specimens.UgoIanniruberto and Mauro Imbimbo[8] carried out an experimental investigation on RCC strengthened in shear by GFRP .The results showed the effectiveness of the GFRP sheet to enhance the shear capacity of the beam. Pudale and Nair Veena (2014)[9] investigated the flexural behaviour of RCC beam wrapped with GFRP sheets. The result obtained from investigation wrapping enhances the strength, flexural retrofitting also increases the shear strength of concrete. Kaushal Parikh and C.D Modhera (2012)[10] analysed the application of GFRP sheet on few beams. Result were indicated that number and arrangement as well as preload level have more influence on the stiffness, toughness and ductility of the strengthened beam. Hamid saadatmanesh and Mohammed R Ehsani (1991)[11] studied about the static strength of RCC beams by gluing GFRP sheets. It was found that flexural strength of RC beams can be significantly incresed by gluing GFRP plates to the tension plate. Pappula Ravi kumar and E. Balakoteswar Rao (2015)[12] tested the RC Beam with and without GFRP sheat both experimentally and analytically. And as a result he found that GFRP sheets bonding is a capable method for improving the flexural behaviour as well as serviceability of damaged concrete beams. Sachul Mohammed and S.Natarajan[13] investigated experimentally the static strength of RCC beams strengthened by gluing GFRP sheets with epoxy. The result indicated the strengthening using GFRP sheets with epoxy increases the load carrying capacity and also greatly enhances the deflection of the beam.Mostoofinejad, S.B Talaeitaba (2014)[14] made a paper evaluating the rehabilitation convenience of a damaged RC beam under combined shear torsion capacity by using FRP rolled strips. Results indicated that rehabilitating and strengthening the beam not only retrieve the initial shear torsion capacity, but also increase the ultimate capacity upto 60%.A.Debaiky and Marwa.H.Bondok[15] made a research to investigate rehabilitation of corrosion damaged RC beams with CFRP and GFRP amounts on flexural behaviour of the beams. The results showed that FRP laminates successfully confined the corrosion cracking and spalling due to expansion of corrosion products.T. Mariselvam and N.Sakthiwaran (2015)[16] paper presents the seismic behaviour of beam column joint using GFRP wraps. Result obtained shows that specimen wrapped by GFRP carries more load carrying capacity than the unwrapped specimen. YEN Tsong LIN Yiching and WUJongaHevei (2004)[17] made a study regarding the strengthening of RCC beam using (PGFRP). Obtained result indicated that strengthening beams with GFRP sheets or PGFRP sheets give them the capacity to withstand larger ultimate loads than beams without fibersheets.S.Raja Subramanian (2016)[18] discussed about the review of repair and rehabilitation of heritage buildings. The major deflects are reported and discussed and a suitable and economical solution is identified. NorIzzahbintiMokhtar and Yusof Ahmed (2013)[19] made a review focusing in flexural strengthening techniques applied for concrete by experimental & analytical programs. The review hoped to be good reference & guidelines for all engineer in field of composites material especially in FRP to change the application of FRP for rehabilitation of existing structure. In this paper GFRP wrappers are used to strengthen concrete beam with nano-flyash.

3.0 Experimental Program

In this paper, the flexural behaviour of nano concrete beam without wrapping and wrapping with GFRP sheets is studied. The size of beam is 500x100x100mm without reinforcement. M20 grade of concrete is used. Beams were casted with the replacement of cement by nanoflyashin the proportion of0%, 10%, 20%, 30%, 40% and 50%respectively. Flyash is the waste material from thermal power plant. Flyash has comparatively high silica content and has pozzolonic properties. As per IS10262:2009, mix ratio for M20 grade of concrete of 1:1.5:3 was adopted. Preliminary test were conducted to find the quality of the material used. 53 grade ordinary Portland cement, conforming to IS12269:1987 was used. The specific gravity of cement was found to be 3.15.

Natural river sand conforming to zone 3 as per IS383:1970is used. The specific gravity of sand is 2.72 and the specific gravity of coarse aggregate is 2.96. Gravel was used as coarse aggregate. Portable water used for concreting and curing. Totally, 18 beams were casted. After 28 days of curing, beams were tested for flexural strength according to IS516 (1959), the flexural strength test has been conducted. The test was conducted using Digital Universal Testing Machine of capacity 100T.The dimensions of each specimen has to measured before testing. Clear cover of about 50mm has to be left at the both the ends of the beam. The remaining measures of 400mm is taken as the span(L) of the beam. The beam is tested under two point loading .Universal Testing Machine of capacity 100T.The dimensions of each specimen has to measured before testing. Clear cover of about 50mm has to be left at the both the ends of the beam. The remaining measures of 400mm is taken as the span(L) of the beam. The beam is tested under two point loading .The load shall be applied to the uppermost surface of the specimen, along two lines spaced 13.3 cm apart. The load shall be applied with increasing continuously at a rate such that the extreme fibre stress increases at approximately 7 kg/sq, that is, at a rate of loading of 180 kg/min for the 100mm specimens.

Fig.1. Casting of Beam

Fig.2. Testing Of Beam

Fig.3. Tested Beam

The load is increased until the specimen fails, and the maximum load applied to the specimen during the test is recorded. The appearance of the fractured faces of concrete and any unusual features in the type of failure is noted. Based on the distance between the support and the nearest crack, The flexural strength of the specimen is determined by $f_b = pl/bd^2$where $f_b$is the modulus of rupture, b is the width of the specimen in mm, d is the depth of the specimen in mm, l is the length in cm of the span on which the specimen was supported and p is the maximum load taken by the specimen in kg.After the beam is tested till failure the surface of the specimen is cleaned and the GFRP sheet in the form of woven sheet will be wrapped with epoxy resin as a binder. After wrapping, the wrapped specimen is tested in the same rate of loading till failure.

Fig.4.GLASS FIBRE SHEET

Fig.5.Gfrp Wrapped Beam

Fig.6.Testing of GFRP Wrapped Beam

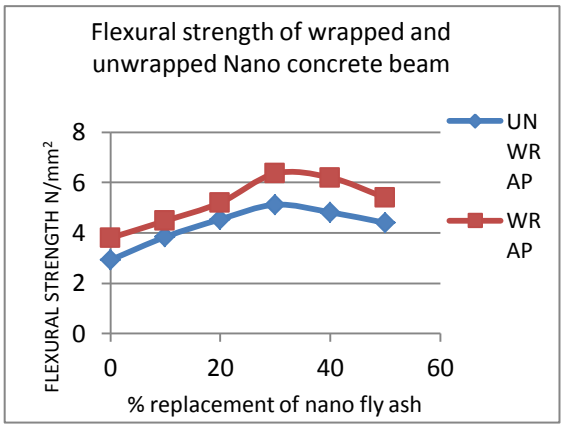
4.0 Results and Discussion

The following table shows the flexural strength of unwrapped and wrapped beam.

Table 1: Flexural Strength of Unwrapped And Wrapped Beam After 28 Days Of Curing

SAMPLE	% OF NANO FLYASH	UNWRAPPED FLEXURAL	WRAPPED STRENGTH
BEAM 1	0%	2.92	3.8
BEAM 2	10%	3.84	4.48
BEAM3	20%	4.54	5.2
BEAM 4	30%	5.12	6.36
BEAM 5	40%	4.82	6.2
BEAM 6	50%	4.4	5.4

The following graph shows the flexural strength of the wrapped and unwrapped specimens



Graph 1: Flexural strength of wrapped and unwrapped Nano concrete beam

5.0 Conclusion:

A set of 18 beams were casted and were tested for its flexural strength with and without wrapping of GFRP sheets. As a result, it was observed that there is an increase in the flexural behaviour of wrapped beam when compared to unwrapped beam. The observed results indicate that the external confinement using Glass Fibre Reinforced Polymer (GFRP) enhances the load carrying capacity of the beam, flexural strength of the concrete. And considerable strength was obtained for GFRP wrapped nano concrete beam rather than normal nanoconcrete beam. The optimum flexural strength was obtained at 30% replacement of cement by nanoflyash both for both wrapped and unwrapped.

6.0 Reference:

1. Vineeth Sharma, YudhvirYadav., "A Review Of Application Of GFRP In Shear And Flexure To Strengthen The Reinforced Concrete Beam", International Journal of scientific research and management (IJSRM) ,volume 4 issue 5 May 2016 Page 4109
2. R. Elanchezhiyan, K.Thiyagu, C.Hema., "An Experimental Investigation on Strengthening of Reinforced Concrete Beam Using Glass Fiber Reinforced Polymer Composites", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 5, Issue 1, January 2016
3. Rudy Djamaluddin, Mufti Amir Sultan, Rita Irmawati, and Hino Shinich., " Bond Characteristics of GFRP Sheet on Strengthened Concrete Beams due to Flexural Loading", IACSIT International Journal of Engineering and Technology, Vol. 7, No. 2, April 2015
4. Deepak Kumar, Govind Ravish., "Use Of GFRP (Glass Fiber Reinforced Polymer) for Strengthening of Reinforced Concrete Beam", SSRG International Journal of Civil Engineering (SSRG-IJCE) – EFES April 2015, Page 58
5. Mr.M.Vinodkumar, Dr.M.Muthukannan., "Review on GFRP / GFRP Composites used for Strengthening of Reinforced Concrete Beams", IJREAT International Journal of Research in Engineering & Advanced Technology, Volume 2, Issue 2, Apr-May, 2014
6. Prof. R. Sterlin Fernald Sam, Sruthi M.S., "Behaviour of R.C Beam and Glass Fiber Reinforced Polymer Composite Beam for Shear Strength",International Journal of Engineering Research & Science (IJOER), [Vol-2, Issue-5 May- 2016]
7. MauraImbimbo, UgoIanniruberto., "Experimental analysis on the shear behaviour of RC beams strengthened with GFRP sheets".
8. Fatigue behaviour of RC beam wrapped with GFRP sheet", IJRET: International Journal of Research in Engineering and Technology, Volume: 03 Special Issue: 03 | May-2014
9. Kaushal Parikh, C.D.Modhera., "Application of GFRP on preloaded retrofitted beam for enhancement in flexural strength", International journal of civil and structural engineering", Volume 2, No 4, 2012
10. Mostofinejad Professor, S. B. Talaeitaba ., "Strengthening and Rehabilitation of RC Beams with FRP Overlays under Combined Shear and Torsion", Electronic Journal of Structural Engineering 14 – 2014
11. Hamidsaadatmanesh and Mohammed R Ehsani., "RC beams strengthened with GFRP plates experimental study", Journal of Structural Engineering(United States), volume 117 issue number 11,published 1991

12. T.Mariselvam , N.Sakthieswaran., " Experimental Investigation on GFRP Wrapped R.C Beam Column Joint", International Journal of Engineering Research (IJOER) [Vol-1, Issue-1, April.- 2015]
13. Pappula Ravi Kumar, E.BalakoteswarRao., "Flexural Behaviour of RC Beam Retrofitted With GFRP", International Journal & Magazine of Engineering, Technology, Management and Research, Volume No: 2 (2015), Issue No: 9 (September),Page 279
14. A.S.Debaiky, Hala.M.R.Abusafa , Marwa H. Bondok., "Experimental study on the rehabilitation of corroded reinforced concrete beams using fiber reinforced polymer",
15. S. Raja Subramaniam., "A Review on Repair and Rehabilitation of Heritage Buildings, International Research Journal of Engineering and Technology (IRJET), Volume: 03 Issue: 04 Page 1330(Apr-2016)
16. HUANG Yue-lin† , WU Jong-hwei, YEN Tsong, HUNG Chien-hsing, LIN Yiching., " Strengthening reinforced concrete beams using prestressed glass fiber-reinforced polymer-Part I: Experimental study", Huang et al. / J Zhejiang University SCI 2005 6A(3):166-174,Aug. 12, 2004

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