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A REVIEW PAPER ON STRUCTURAL STRENGTHENING OF RCC BEAM BY USING FRP SHEETS

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ABSTRACT

Strengthening the structural members of old buildings using advanced materials are a contemporary research in the field ofrepairs and rehabilitation. Many researchers used Glass Fiber Reinforced Polymer (GFRP) sheets for strengthening ReinforcedConcrete RC-beams we all dream of a house structurally safe and aesthetically beautiful but it is not so easy. Due to malpractice during construction or some unavoidable reasons different type of cracks starts to appear on various structural and non- structural parts of the building with the passage of time. The aim of this paper is to give a brief idea about the various researches done on the strengthening of the reinforced structure such as beam.

Keywords:CFRP,GFRP, Strengthening,Glass Fiber.

I.INTRODUCTION

Generally, structures are subjected to natural and man-made loads during their service life. When the magnitude of these loads exceed the capacity of the structures, they are possible to be damaged. Sometimes the strength of a structure is reduced because of the use of sub-standard materials in its construction or due to application the extra load because of change in functioning or due to seismic forces for which the structure had not been designed originally.

TheFRPsheetsarebeingusedforrepair,strengtheningandretrofittingofstructuralcomponents.Degradationofsteelreinforcementsduetocorrosion,crackingofconcreteduetoweathering,rapidlychangingtrack'sneeds(bothintermsofintensityandloadlevels)andrecentearthquake damages have necessitated the use of strengthening of basic structuralcomponentssuchasslabs,panels,walls,beamsandcolumns.

II.THEORY

Experience from past earthquakes and results of structural analysis indicate that a large proportion of the existing reinforcement concrete building in Gujarat (or anywhere) in vulnerable to damage or event collapse during a strong earthquake. These structures are possessing neither sufficient strength nor ductility to perform satisfactorily during future past, and not just which have been those damaged during earthquake. However, the redesigning of all damaged or non-damaged (conceptual error design) structure are very difficult. Replacement of damaged building or existing unsafe building by reconstruction is generally, avoided due to a number of reasons, the main ones among them is Higher cost of Repair and retrofitting. The retrofitting work carried out in various regions, although on a small scale, offers a number of lessons that could be valuable for the further development of retrofitting as well as for its promotion as the most attractive option for reducing vulnerability. [4] Glassfibers are of different types such as E-glass, S-2 Glass, AR-Glass, A-Glass, C-Glass, D-Glass and R-Glass depending on their properties and chemical composition of the deferent types of glass fibers, E-Glass is mostly used for reinforcement due to its high strength and electrical resistivity. Glass fibers have high strength and temperature resistance, but it is the low cost that makes GFRP the most popular FRP reinforcement in civil engineering applications. [5]

III.MATERIALS

High performance concrete and steel, and some of the other materials are also used to regain structural strength. Like Glass fiber wrap, Carbon fiber wrap and Carbon laminates.adhesive-compatible (epoxy) primer,saturate.

IV.SPECIMENS

The specimen consists of 100 mm wide, 100 mm deep and 1000 mm long plain concrete beams without any internal reinforcements. All the beams after casting were cured at normal temperature in a water bath for 28 days. The effective span of the beam was 940 mm.[5] The overall program included 16 small-scale reinforced concrete beams (100x150x1200mm), 9 `medium-scale beams (175x125x2000mm) and 20 larger-scale beams (152x254x3200) [1]. The cross section of beam was 100 x 120 mm and the total length of 600 mm.[2]

V.EXPERIMENTAL SETUP

The assembly consists of clamps made of steel channel sections, long threaded bolts with nuts and springs. The springs of 60 mm external diameter, 200 mm unloaded length and stiffness of 77 N/ mm were used. The loads were controlled by regularly monitoring the spring length while tightening the bolts. The beams were loaded to 20% of ultimate load as service loads[5].Chamber consist of a steel rack to support the specimens and mist nozzles that mix pressurized air and water to produce a mist. Accelerated corrosion was applied using a constant impressed current with an approximate density of 150 A/cm2. The current was passed through the main rebars, which act as the anode while the stainless steel bar in each specimen acts like the cathode. During accelerated corrosion, the specimens were subjected to wet-dry cycles to provide water and oxygen that are essential for the corrosion process. Specimens which have to strengthened prior to corrosion and repaired after being corroded using different schemes of Carbon or Glass fiber sheets The first scheme involved wrapping the specimen intermittently with U-shaped glass (GFRP) strips around the tension face and the sides. The second scheme consist of the flexural strengthening of the beam which is corrodedspecimen by externally bonding carbon (CFRP) sheet to the tension face of the specimen and then wrapping the specimen with U-shaped GFRP sheets [1]

The specimens were divided into two types, which are strengthened beams on all span (BFL) and strengthened beams on one-third span at the span center (BFH), respectively. Beam specimens for rupture test were also prepared to determine the material properties of concrete. The beam specimens were tested under simple supported beams subjected to two point load using a universal testing machine, once the concrete cracks, the tension stresses was resisted only by GFRP sheet.

Incaseoftheflexuralbeams,thebondingstressisaffectedbytensilestressoftheGFRPsheetattachedattheextremetensionsurface.[2]They found that beam strengthened with CFRP laminate require less number of layers than those strengthened with glass FRP laminate for the same load .[3]

VI.MACHINARY USED

Universal testing machine.

VII.PROCEDURE

Concrete surface was cleaned using sand paper. Primer (epoxy of low viscosity) was applied to fill up any pores and holes and level the concrete surface. When the primer had set fully, one coat of saturant (epoxy of high viscosity) was applied on the primer coat. Then the E-glass sheet was cut to required dimension using sharp scissors. . To load the beams, spring bracket-assembly was fabricated. . The beams were loaded to 20% of ultimate load as service loads. A steel tank of size 1.2 m wide, 1 m deep and 2.4 m length was fabricated to accommodate ten sets of loaded specimens at a time. The heating system was designed to maintain water at 60 ± 0.1 C. The loaded specimens were kept in water tank for 1, 3, 6 and 9 months durations. Specimens were wrappedfor 20, 30 and 40 mm wide E-glass sheets. The specimens were tested under universal testing machine (UTM) under four-point loading [5]. Specimens which have to strengthened prior to corrosion and repaired after being corroded using different schemes of Carbon or Glass fiber sheets The first scheme involved wrapping the specimen intermittently with U-shaped glass (GFRP) strips around the tension face and the sides. The second scheme consist of the flexural strengthening of the beam which is corroded specimen by externally bonding carbon (CFRP) sheet to the tension face of the specimen and then wrapping the specimen with U-shaped GFRP sheets. By examining the corroded un-repaired large-scale specimens, some typical cracking patterns were identified [1].The concrete beams were cured for 28 days before the application of the GFRP sheet. The cylinders and beam specimens for rupture test were also prepared to determine the material properties of concrete. Before the application of GFRP sheet, the bottom surfaces of the beams were smoothed by a disk sander. The epoxy resin is applied on the GFRP sheet which are placed on the table using a soft roller .The epoxy resin is applied on the treated surface of the beam using a soft roller before patching of the impregnated GFRP sheet to the treated surface.. The beam specimens were tested under simple supported beams subjected to two point load using a universal testing machine [2]. Based

Procedure of Glass Fiber Wrap: Grind the corner of the beam at 1 inch, which is covered by the glass fiber wrap. Grind the corner of the beam at 1 inch, which is covered by the glass fiber wrap. When the primer will be in sticky form then applied the saturate on the primer. The saturate will be in two parts, so mix properly and applied on the beam. Then, after the 5 minutes wrapped the glass fiber on the surface and press with the rollers.

The glass fiber will be take the 45 minutes for the bonding with the saturate. After the wrapped of glass fiber, applied the 1 layer of saturate on the glass fiber for proper bonding. Procedure of Carbon Laminates: Before bonding the laminates on the concrete, the surface were ground to remove all contamination and weak surface layers and to expose the aggregates. Surface preparation generally has a much greater influence on long term bond durability than it does on initial bond strength, so that a high standard of surface preparation is essential for promoting long term bond performance. Then the dust and debris were removed by air blast. The next step was applying an adhesive-compatible (epoxy) primer. The primer that comes in two components was mixed thoroughly with a drill equipped with an agitator until a smooth homogeneous mass was obtained. The epoxy adhesive is prepared as the same way as the primer, by mixing the two components. The mixture was then applied evenly with a trowel ensuring that on the rough surface all gaps are covered. The thickness of epoxy adhesive's was maintained constant at 2mmthroughout the length, for all of the beams. After uncoiling, the laminates to be installed were cut to the proper length. Surface preparation of the composite plates was accomplished by stripping off a clean, scrubbed, nylon peel-ply layer molded into one surface during composite fabrication. The laminates were placed in their final position by using light finger pressure. After checking the location and the alignment with the help of a rubber roller and a trowel the excess adhesive was removed.[4]

VIII.RESULT

Final failure took place due to debond of the sheets and the sheets remained intact. Only one crack developed under the load under the three-point loading and this crack was bridged by the composite sheet until debond took place. . All conditioned beams Sustain higher loads than the fresh beams. The increase is around 13.5% in nine months of conditioning in water tank maintain at 60 C. The beams conditioned outdoors (pre-cracked) for 12 months failed at a lesser load but deflected more than the fresh beams primarily due to debond. The decrease in failure load was 18.9% while the increase in deflection was large at 370%.[5] When the repaired specimens were exposed to further corrosion, the sealed cracks did not open, and there was hardly any other longitudinal cracking observed[ref.1].The average bonding stress on the specimen strengthened by one third at span center was 2.40MPa while bonding stress of the specimen strengthened on full length of span was 1.28 MPa . center was 2.40 MPa, while bonding stress of the specimen strengthened on full-length of span was 1.28 MPa.[2]From this research and from the result of this research project we can conclude that the CFRP wrapped at tension side gives better strength as compared to CFRP wrapped at two parallel sides but gives less strength as compared to CFRP wrapped at three sides. CFRP wrapped at three sides gives higher strength but as the CFRP composite is costly it increasing the cost of construction so from an economic point of consideration CFRP wrapped at tension side to the beam[3].Result of flexural strength of wrapped glass fiber beam is 2.7 times and wrapped carbon laminates beam is 4 times more than normal beam without wrapped. The compressive strength of wrapped glass fiber cylinder is 4.3 more than normal cylinder .By result of test, we conclude that the strength of beam with wrapping by glass fiber and carbon laminates are increase as compare to the normal beam[4].

IX.CONCLUSION

From this paper we are conclude that the strengthening of RCC beam done by various methods and it is very essential now a days. Also with the help of the carbon and glass fiber polymer the strengthening is done easily and economically.The result of this research project we can conclude that the CFRP wrapped at tension side gives better strength as compared to CFRP wrapped at two parallel sides but gives less strength as compared to CFRP wrapped at three sides. CFRP wrapped at three sides gives higher strength but as the CFRP composite is costly it increasing the cost of construction so from an economic point of consideration CFRP wrapped at tension side to the beam.[3].

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