STRENGHTENING OF RC BEAM COLUMN JOINT BY GEOSYNTHESIS

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Abstract:*The beam column joint is the crucial zone in a reinforced concrete moment resisting frame. It is subjected to large forces during severe ground shaking and its behaviour has a significant influence on the response of the structure. Hence, new techniques and sustainability material have to be adapted. Notable work has been done with Glass Fibre Reinforced Polymers (GFRP), Carbon Fibre Reinforced Polymers (CFRP) and Basalt Fibre Reinforced Polymer (BFRP) as a fibre reinforced polymers used as a retrofitting material. But less work has been done with geosynthetics material (Geotextiles. Geogrids, Geonets, Geomembranes). The main purpose of this research study is to evaluate the behaviour of RC beam-column joint specimens wrapped with Geogrid and Glass Geocomposite. In the process 8 beam-column joint specimens were casted and 4 of them tested for strength by wrapping it with Geogrid and the other 4 were tested for strength without wrapping it with Geogrid. Beams were casted to check the various properties of the geosynthetic materials in concrete. From the result, it has been observed that geogrid wrapped specimen and glass geocomposite wrapped specimen showed more deflection than control specimen and had higher load carrying capacity than the specimen withoutwrapping.*

Keywords: Beam-Column Joint, Geogrid, Glass Geocomposite, Wrapping

1.INTRODUCTION

Reinforced concrete structural system are quite frequently used in high rise building due to a number of infrastructure advantage they provide over other material.In reinforced concrete structures, failure in a beam often occurs at the beam-column joint making the joint one of the most critical sections of the Sudden change in geometry and complexity of stress distribution at joint are the reasons for their critical behavior. In early days, the design of joints in reinforced concrete structures was generally limited to satisfying anchorage requirements. In succeeding years, the behavior of joints was found to be dependent on a number of factors related with their geometry; amount and detailing of reinforcement, concrete strength and loading pattern. A heavy damage in a beam-column joint should beam voided during an earthquake because

- the gravity load is sustained by thejoint,
- a large ductility andenergydissipation is hardto achieve in thejoint,
- a joint is difficult to repair after an earthquake.

However, an excessive complication of reinforcement detailing should be equally avoided to insure good workmanship and construction. Therefore, joint shear failure and a significant beam bar slippage within a joint should be prevented up to an expected structural deformation**.**

2. LITERATURE REVIEW

Kazuhiro Kitayama, Shunsuke Otani and Hiroyuki Aoyama,2010 summarized earthquake resistant design criteria for reinforced concrete interior beam-column joints. The design criteria emphasize the protection of the joint to an acceptable deformation level of a frame structure during an intense earthquake. For the design against shear, shear resisting mechanism by truss and concrete compression strut, the role of joint lateral reinforcement, and the effect of transverse beams and slabs were studied experimentally. The requirement for beam bar bond was discussed on the basis of nonlinear earthquake response analysis.

Gregoria Kotsovou and Harris Mouzakis ,2012, proposed a method for the seismic design of external beam–column joints by considering the load transferred from the linear elements to the joint is predominantly resisted by a diagonal strut mechanism. The work presented is intended not only to verify the validity of the proposed method, but also to identify means for its implementation that will maximize its effectiveness. The effect of the above characteristics on structural behavior is established by testing full-size beam–column joint specimens under cyclic loading; the results obtained show that the proposed method produces design solutions that fully satisfy the code performance requirements and are found consistent with already published experimental information.

N. Subramanian and D.S. Prakash Rao,2012, discussed the behavior and design of two-, three- and four-member beam — column joints in framed structures are; obtuse and acute angle joints are included. Detailing of the joints based on experimental investigations is also explained. The specifications of American, New Zealand and Indian codes of practice are appraised. An equation for calculating the area of joint transverse reinforcement has been proposed for the Indian code, based on recentresearch.

S. S. Patil and S.S. Manekari,2013, studied various parameters for monotonically loaded exterior and corner reinforced concrete beam column joint. The corner as well as exterior beam-column joint is analyzed with varying stiffness of beam-column joint. The behavior of exterior and corner beam-column joint subjected to monotonic loading is different. Various graphs like load vs. displacement (deformations), Maximum stress, Stiffness variations i.e. joint ratios of beam-column joints areplotted**.**

3. PROCEDURE

Initially the question was the durability of the Geosynthetics fibers in the concrete since the reactionofcementinconcreteisachemicalreaction,butitwasprovedinseveralstudiesthatGeosynthetics are used in any type of environment, even in marine conditions and provedto be durable. Several types of Geosynthetics are resistant to acid attack, alkali reaction, etc which proves them to be viable alternative fibers that can be added in concrete. Figure 6 shows the way the Geosynthetics are added as fibers in the concrete as similar to the glass and polypropylene fibers added to theconcrete There are several ways to add the Geosynthetics fibers to concrete as listed below

1. Addition of Geosynthetics as small fibers in the freshconcrete
2. AdditionofGeosyntheticsassmallpiecesinsteadoffibersintheconcrete
3. Addition of large length of Geosynthetics in the direction perpendicular to the load application in the structuralmembers.
4. Combination of the above-mentionedmethods.

Figure 1 shows the image of the type of Geosynthetics used in the studies, the sample is cut into15cmX15cmpieceandaddedinthebeams column joint specimen. Beams and columnsare also cast with one layer and two layers of

Geosyntheticstochecktheviabilityofadditionof Geosynthetics. There are several types of Geosynthetics available in the market and the current study also aimstofindthebestsuitableGeosynthetics whichcanbeimpregnatedintheconcrete.Fewof them cannot be used in the concrete due to their brittle nature but they can be used as supporting reinforcement in several areas such as beam column joints or surrounding the columnsinsteadoftieupssincetheytakeloaduniaxially.Figure2showstheimageofatype of Geonet used in the studies with beam column jointspecimens.
TestspecimenswerecastwiththeM20concretemix design for arriving the quantity of the components of concrete. The water cement ratio is fixedas0.5forinitialstudies,furtherstudiesareproposedwithvaryingwatercementratioin highstrengthconcrete. Separatespecimensarecastfortestingon7 days,28daysstrengthas per code requirements and the test results are givenbelow.

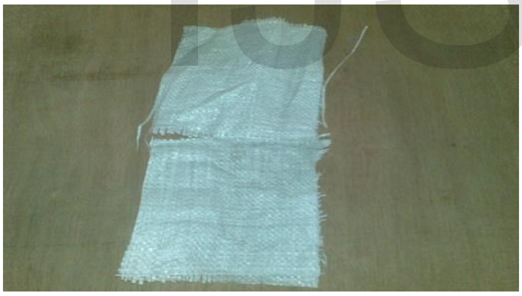

Figure 1: Image showing the Geocomposite material

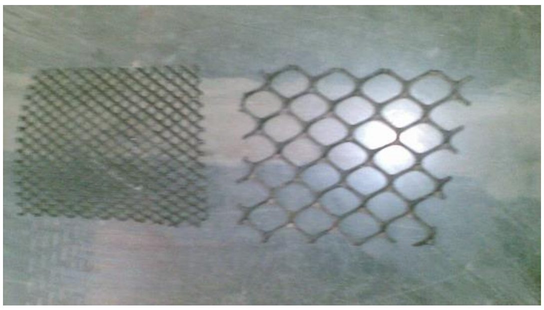

Figure 2: Image showing the geonet and geogrid

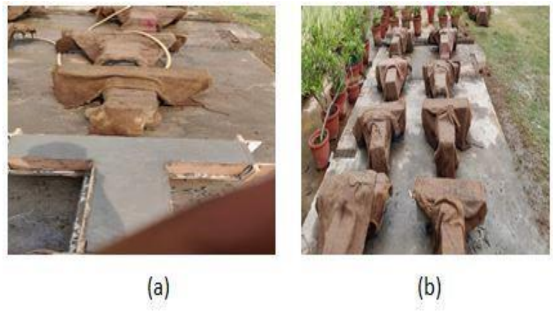

Figure 3: (a) Casted specimens, (b) Curing of specimens

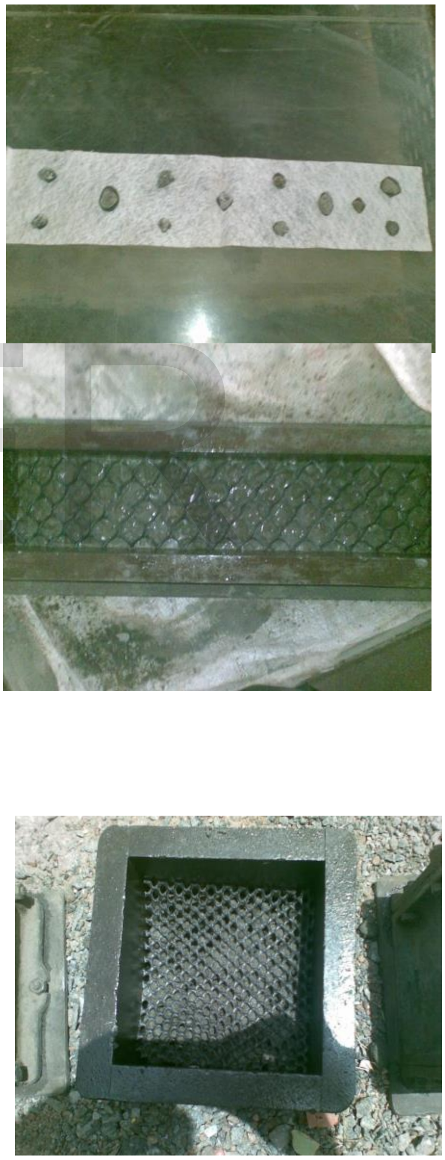

Figure 4: Image showing the Geosynthetic material added to beam and cube

3.1 TEST RESULTS

ANDDISCUSSION:

Several tests were conducted for testing the quality of the Geosynthetics used and the properties were found to be quite satisfactory for using it with the following test are conducted on aggregates they are listed below and table 1 shows the results obtained in various initial testsconducted

1. Specificgravity
2. Crushing test foraggregate
3. Abrasiontest
4. Soundnesstest
5. Finenesstest
6. Impact testaggregate.

The fine aggregate and coarse aggregate are gradedproperlybeforeusingitwiththe concrete and the results obtained in workability are found to be satisfactory. Moderate vibration was used using vibratory table for compacting the concrete in the moulds, it was found that bleeding occurs in the concrete added with Geosynthetics fibers to a large quantity. Initial studiesprovedthattheGeosyntheticsfibersmaynotallowtheconcretetomix properlyinthe layer it was spread, few small holes were made on the surface of the Geosynthetics to allow the bonding ofconcrete.

3.2 ViabilityStudies

TocheckthedurabilityofGeosyntheticsinconcretetwotypesoftestswereconducted

- Mortar cubes of size 70mm X 70 mm X 70 mm was prepared without and with Geosynthetic fibers in the direction perpendicular to the appliedload.
- Geosyntheticsfibers(varioustypes)areaddedwithcementpasteofgoodconsistency and cured for 30 days to check the durability offibers.

Thestudyresultsprovedthatitisfeasibletouse Geosyntheticswithconcreteandthecement reactionwhilesettingandheatofhydrationisnotaffectingthefibers.TheGeosyntheticsare removedfromthecementpastesetand studiedunderElectronmicroscopecomparedwiththe original fibers. It shows that small disorientation of fibers with non-polymer based Geosynthetics but polymer and plastic based Geosynthetics resist the action of cement and there are no notable changes fromoriginal.

3.3 StrengthStudies

TochecktheincreaseinstrengthbyadditionofGeosyntheticfiberscontrolspecimenswere cast with 1:2:4 ratio of required amount and tested, the initial tests conducted on the control specimens gave the confidence that the introduction of Geosynthetics may increase the strength. It is decided to study Flexure and compression strength initially, beam and cube specimens were casted as per IS 516 of required number with varying Geosynthetic proportion and type of Geosynthetic and tested. Figure 9 shows the Geosynthetics added in the beam specimen casted for flexuretesting.

All the test specimens were cured for required period of time in quality water without chloride content or any other harmful impurities.

Thestudieswereconductedinthecompressiontestingmachineandflexuretestingapparatus, theresultsfoundtobethereisanincreas eofnearly30%intheload carryingcapacityofthe beam and cube members after the addition of Geosynthetics. Further testing is going on to

Sl. No	TEST CONDUCTED	RESULTS
1	Specific gravity of fine aggregate	2.66
2	Specific gravity of coarse aggregate	2.78
3	Crushing value of Coarse aggregate	24%
4	Abrasion value of Coarse aggregate	25.5%
5	Aggregate Impact value of Coarse aggregate	28%
6	Fineness Test on fine aggregate	2.66
7	Test for Soundness of Coarse aggregate	14%
8	Mix design used	1:2:4
9	Slump Value of fresh concrete without fibers	160 mm
10	Slump Value of fresh concrete with fibers	110 mm
11	Flexure strength test on hardened concrete without Geosynthetics	0.86 N/mm^2
12	Flexure strength test on hardened concrete with Geosynthetics	1.2 N/mm^2
13	Compressive Strength in alternate orientation on hardened concrete without Geosynthetics	16 N/mm^2
14	Compressive Strength in alternate orientation on hardened concrete with Geosynthetics	17 N/mm^2

findthesplittingtensilestrengthwithvaryingproportionoffibersintheconcrete.

4 CONCLUSION

Theincreaseinstrengthbyadditionof Geosyntheticfiberscontrolspecimenswere cast with 1:2:4 ratio of required amount and tested, the initial tests conducted on the control specimens gave the confidence that the introduction of Geosynthetics may increase the strength.

It also does not crack as easily as regular cement anddoesnotchipwhenitiscut.Itisfoundfromthestudiesconductedthatthe Geosynthetics canbeusedasawholeintheconcreteoralsoasfibersintheconcreteforaddingstrengthand durability of concrete. Geosynthetics are available plenty in the market and the cost per Square meter is less than Rs.60 which makes it as an economical choice also. The strength and durability of concrete using Geosynthetic is to be studied further for arriving into any conclusion but initial studies proved the viability of using them in tandem with other constituents ofconcrete.

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