EXPERIMENTAL INVESTIGATION ON REHABILITATION OF BEAM-COLUMN KNEE JOINT USING GFRP SHEETS

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Sequence of Presentation

- **Introduction**
- **Experimental Programme**
- **Test Results and Discussions**
- **Conclusions**

Introduction

Many reinforced concrete (RC) framed structures located in zones of high seismicity in India are constructed without considering the seismic codal provisions.

Introduction Contd..

Inadequately designed structures represents seismic risk to occupants and this explains a strong social need to retrofit and rehabilitate existing buildings.

Performance of RC moment resisting frame depends on

- Beams
- Columns
- Beam-column joints

Inadequate transverse reinforcement cause shear failure

- Enhanced by Retrofitting
- Increases strength and stiffness

Materials (Fiber Reinforced Polymer (FRP))

- Excellent corrosion resistance
- Fatigue resistance
- Specific strength
- Specific stiffness
- On site flexibility
- Electric & Magnetically inert
- Frequencies of vibration remains unchanged
- Ductility

Review of literature

- Geng *et al.* (1998)
- Parvin and Granata (2000)
- Shahawy *et al*. (2000)
- Mosallam *et al.* (2000)
- Ghobarah and Said (2001)
- Granata and Parvin (2001)
- Gustavo *et al.* (2001)

Review of literature Contd..

- Arya *et al*. (2002)
- Antonopoulos and Triantafillou (2002)
- Prota *et al.* (2002)
- Li *et al.* (2002)
- El-Amoury and Ghobarah (2002)

Objective of present investigation

To study the behaviour of RC beam-column knee joints rehabilitated by using glass fiber fabrics.

Experimental Programme

- Specimen : L-shaped knee joint

  beam : 250x200 mm

  2x16 mm bottom & 3x16 mm at top

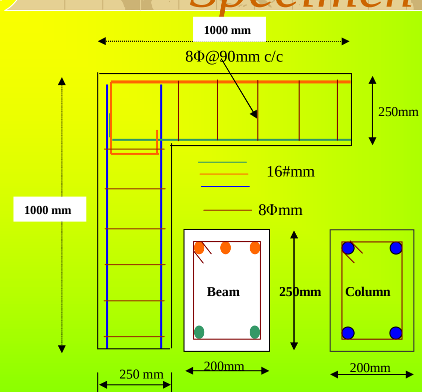
  column: 250x250 mm

  HYSD 4x16 mm Φ

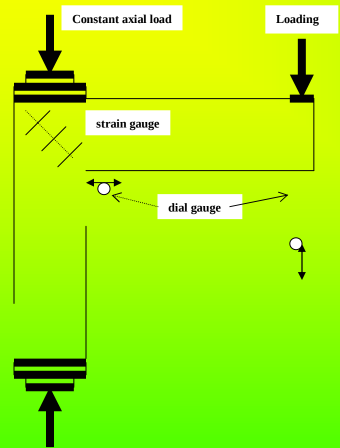
  No lateral reinforcement in the joint

  Concrete mix M30 proportion 1:1.137:2.25 with w/c ratio: 0.468.

Specimen



Experimental Set-up



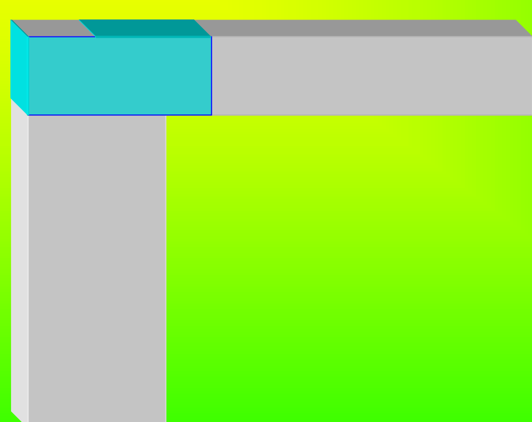
Details of rehabilitation scheme

Sl. No.	Specimen designation	Description of specimen	Purpose of confinement
1	B1	Fully failed specimen (Control specimen)	
2	B2 BC2	Partially failed specimen Partially failed B2 strengthen with 2 layers of chopped strand mat	Rehabilitation
3	B3 BB3	Partially failed specimen Partially failed B3 strengthen with 2 layers of Bi-directional woven mat	Rehabilitation

Properties of GFRP mat

Sl. No	Type of GFRP mat	No of layers	Thickness of mat (mm)	Tensile stress in MPa
1	Bidirectional woven mats	2	2	119.85
2	Chopped strand mats	2	1.48	88.35

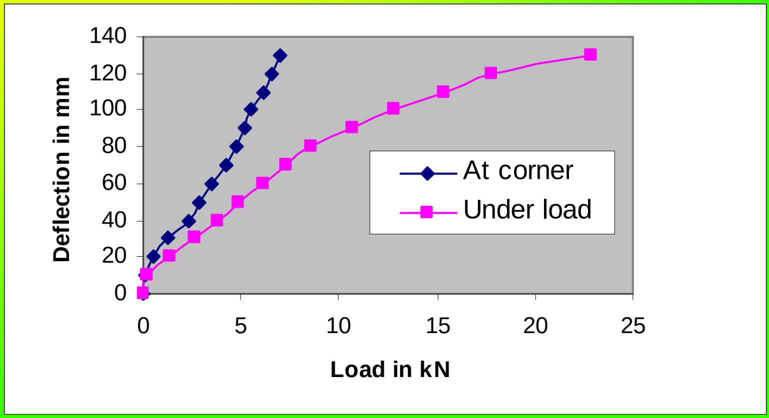
Application pattern of GFRP mats



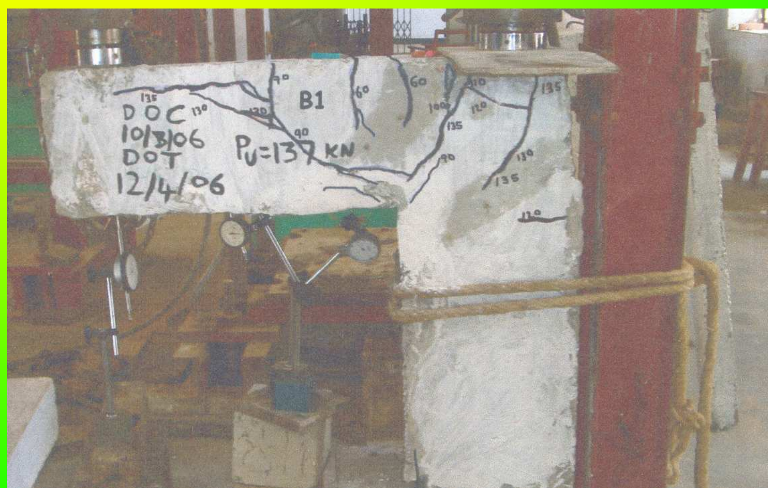
Measurements

- 500kN jack was placed on the column to apply a constant vertical load of 300kN. 250kN jack was placed at the tip of the beam and load was gradually increased until the ultimate load was reached and the specimen failed. This arrangement created a closing moment at the joint.
- Beam tip displacements by dial gauge
- Column lateral displacements

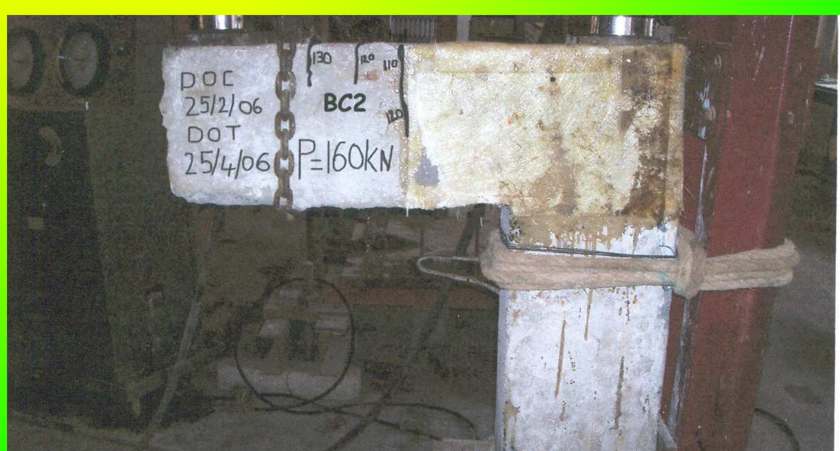
Variation of deflection with load for specimen B_1 at corner and under load



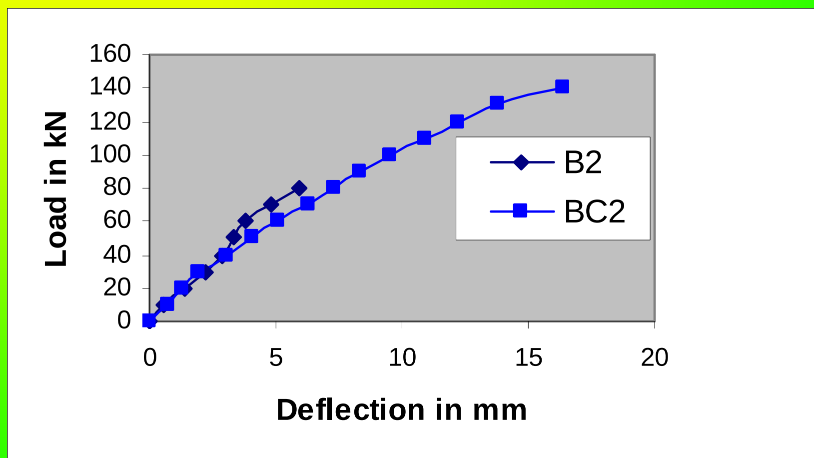
Test details of specimen B1



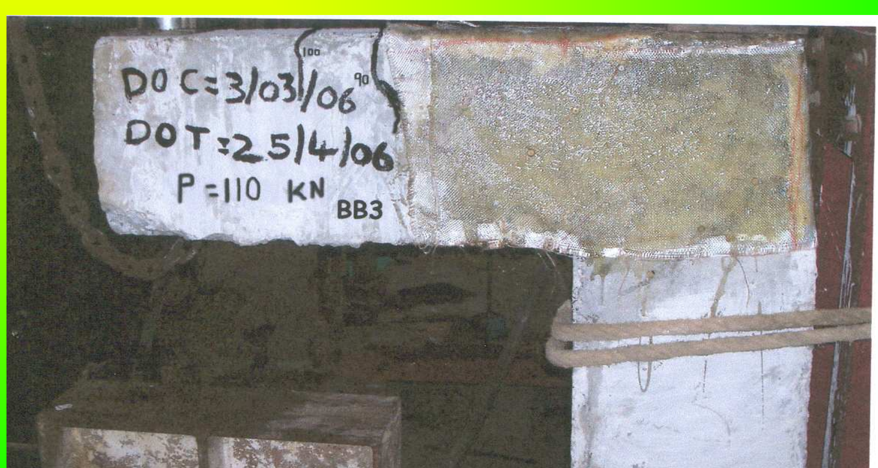
Test details of specimen BC2



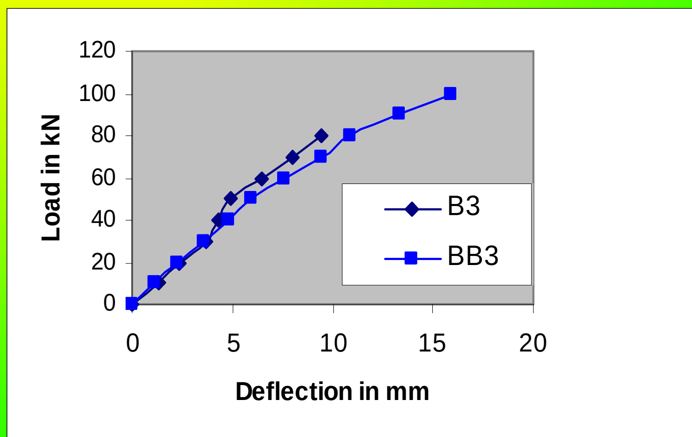
Variation of deflection with load for specimen B_2 and BC_2



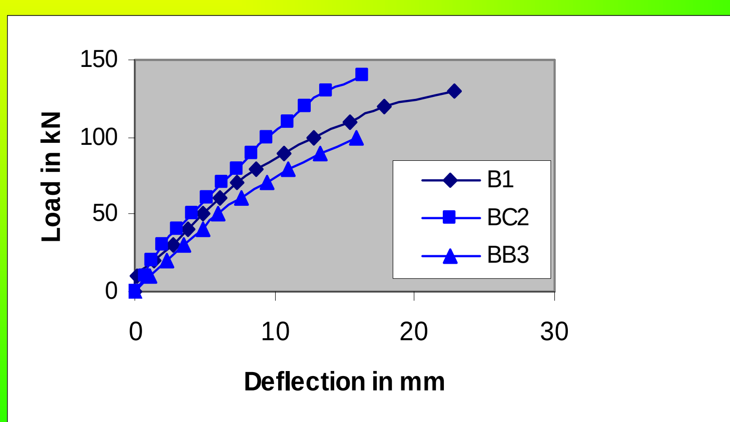
Test details of Specimen BB3



Variation of deflection with load for specimen B3 and BB3



Variation of deflection (beam-tip) with load for specimen B1 , BC2 and BB Comparison b/w B2 and B33



Conclusion

1. GFRP sheets confine the joint hence the joint shear failure was avoided and instead a ductile flexural hinging in the beam occurred.
2. Chopped strand mat is more effective in resisting the shear stress developed in the beam-column joints owing to randomly oriented chopped fiber reinforcements.
3. Specimen rehabbed with the chopped strand mat shows stiffer behaviour than the bi-directional woven roving mat.

Conclusions Contd..

4. Deflections of GFRP reinforced specimens were less than non-reinforced specimen which indicates distinct trend in increasing stiffness due to presence of FRP mats.
5. Local strains in the joints were reduced due to presence of GFRP mats.
6. The existence of FRP successfully delayed the initiation of cracks in the concrete
7. Results clearly indicates an increase in the load carrying capacity of FRP reinforced specimens

Finally

FRP based strengthening strategy is an attractive and better option to restore the joints. In addition of being lighter, having better aesthetic appearance compared with other methods and is easier to implement. GFRP reinforced joints make the joint more ductile, as this property is extremely desirable for seismic rehabilitation of structures.

Thank You