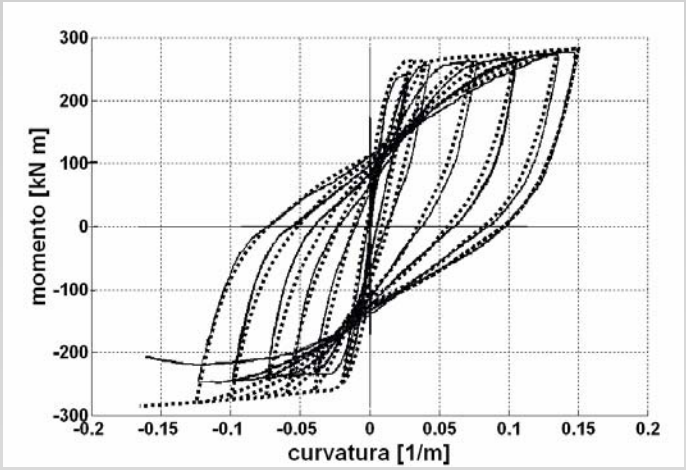
Materiali ed Approcci innovativi per il Progetto in Zona Sismica e la Mitigazione della Vulnerabilità delle Strutture

Columns Retrofitted by FRP subjected to Cyclic Action



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Advantages of reinforcement of r/c columns with FRP

1. Increasing resistance of r.c. columns
2. Increasing ductility for seismic applications

Effect of confinement with FRP on column's response under monotonic and cyclic loadings

1. Fiber model for r/c cross-section confined with FRP
   i. Hysteretic models for steel, concrete in compression (confined with FRP and unconfined), concrete in tension
   ii. Comparison with experimental results
   iii. ductility and dissipated energy by hysteresis loops of columns wrapped by FRP under cyclic loadings
2. Proposed model has been implemented in F.E. code in order to investigate the increasing stuctural ductility by FRP retrofitting.

MODEL FOR CONFINED CONCRETE UNDER MONOTONIC AXIAL LOAD (MANDER , 1988 - FOR CONCRETE CONFINED BY STEEL)

$$\sigma_c = \frac{f_{cc} \cdot x \cdot r}{r - 1 + x^r}$$

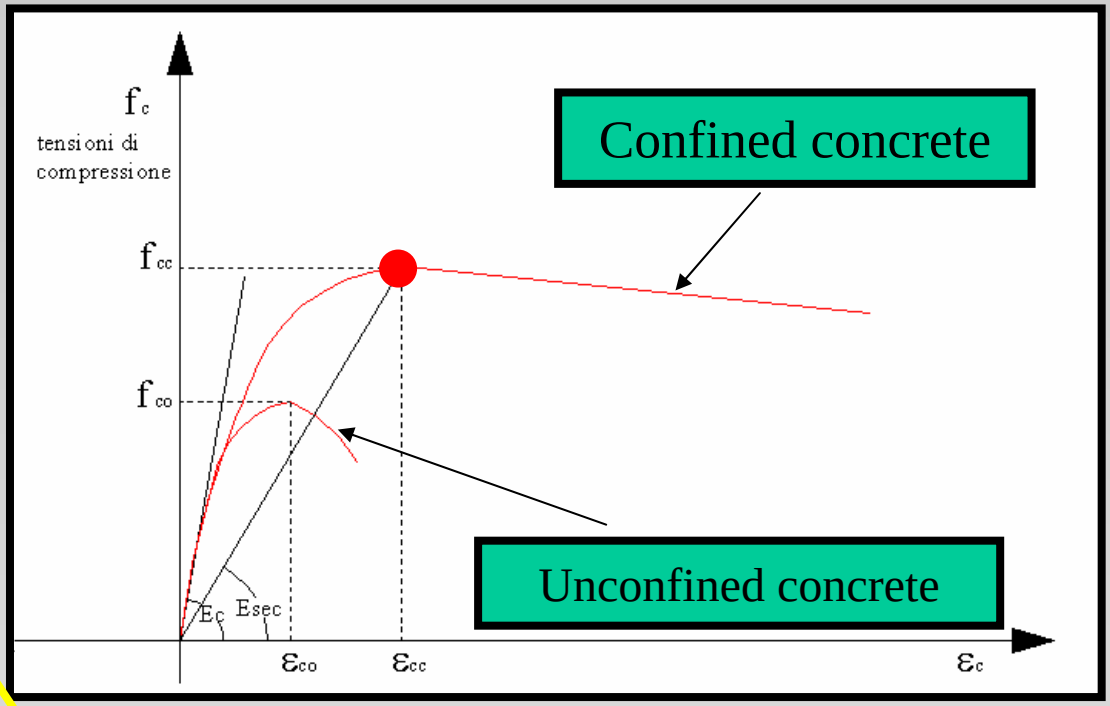
$$x = \frac{\varepsilon_c}{\varepsilon_{cc}}$$

$$f_{cc} = f_{co} \cdot \left(-1.254 + 2.254 \sqrt{1 + \frac{7.94 f_l}{f_{co}}} - 2 \frac{f_l}{f_{co}} \right)$$

$$\varepsilon_{cc} = \varepsilon_{co} \cdot \left[1 + 5 \cdot \left(\frac{f_{cc}}{f_{co}} - 1 \right) \right]$$

$$r = \frac{E_c}{E_c - E_{sec}}$$

$$E_{sec} = \frac{f_{cc}}{\varepsilon_{cc}}$$

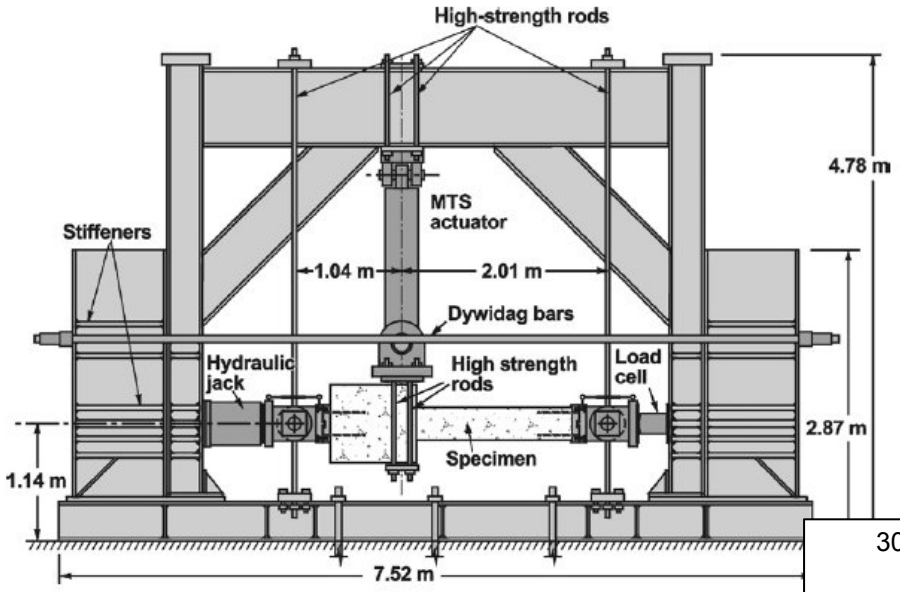


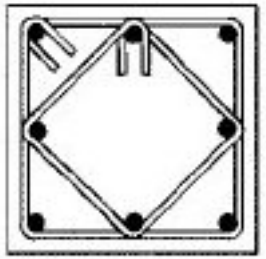
f_l = confinement pressure

STEEL: f_l is costant (corresponding to yielding of stirrups)

FRP: f_l depends on FRP elastic deformation (iterative procedure – Spoelstra, Monti (1999))

COMPARISON WITH EXPERIMENTAL RESULT : Square concrete Columns (Memon & Sheikh, 2005)





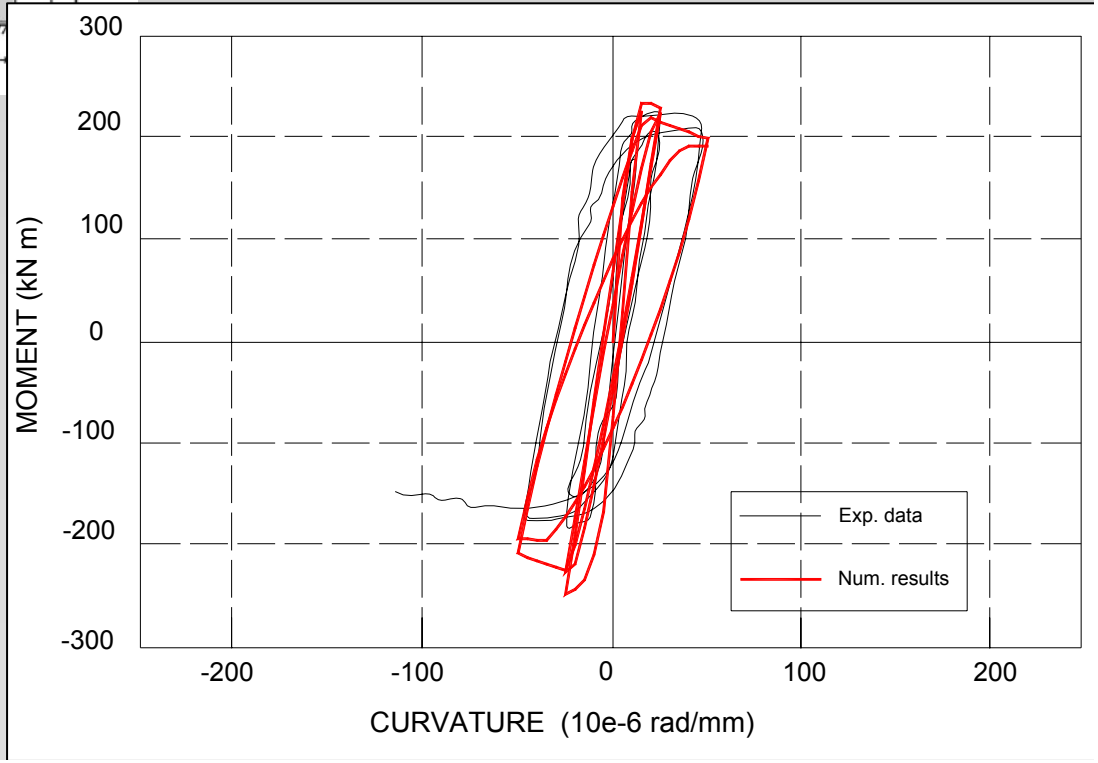
30 X 30 cm

8 ø 20

GFRP= 1.25 mm

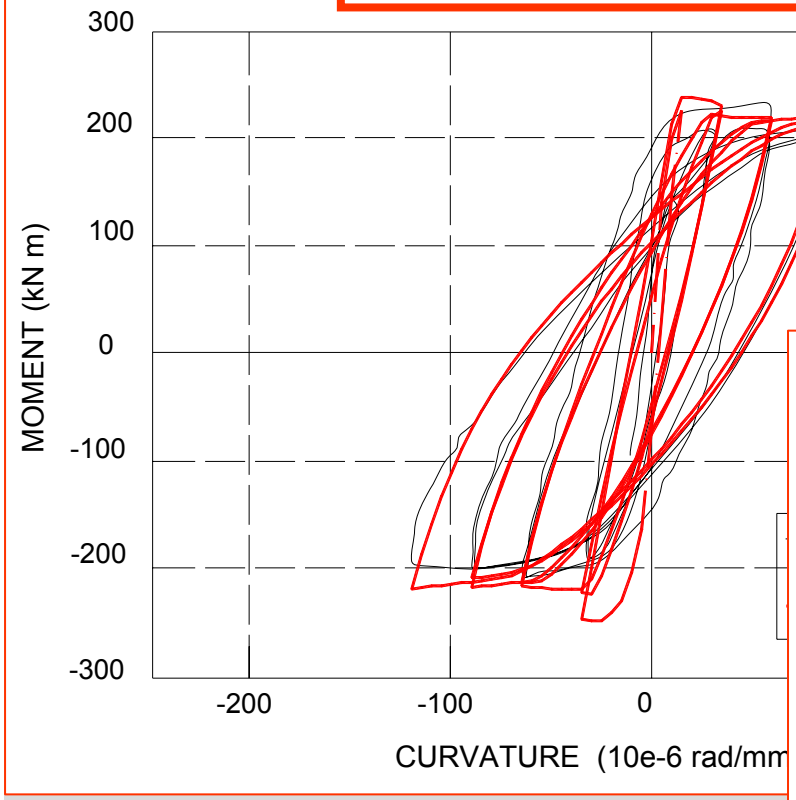
2 Layers GFRP

2 Layers GFRP

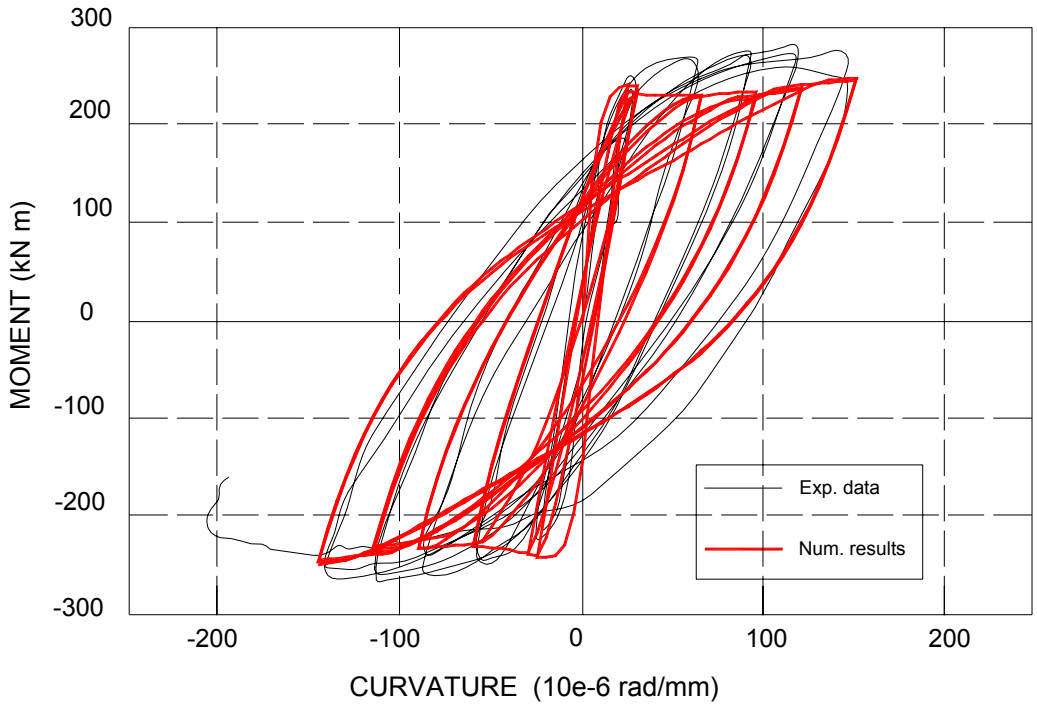


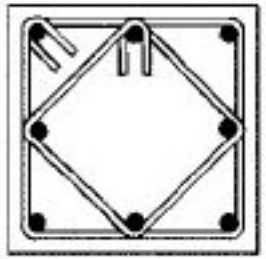
COMPARISON WITH EXPERIMENTAL RESULT : Square Concrete Columns (Memon & Sheikh, 2005)

4 Layers GFRP



6 Layers GFRP





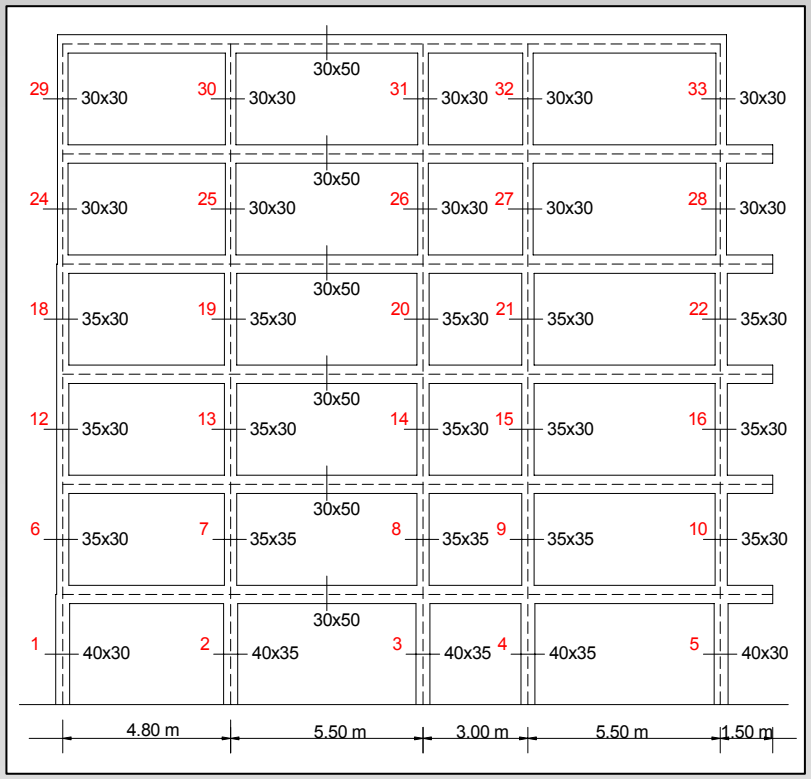
30 X 30 cm

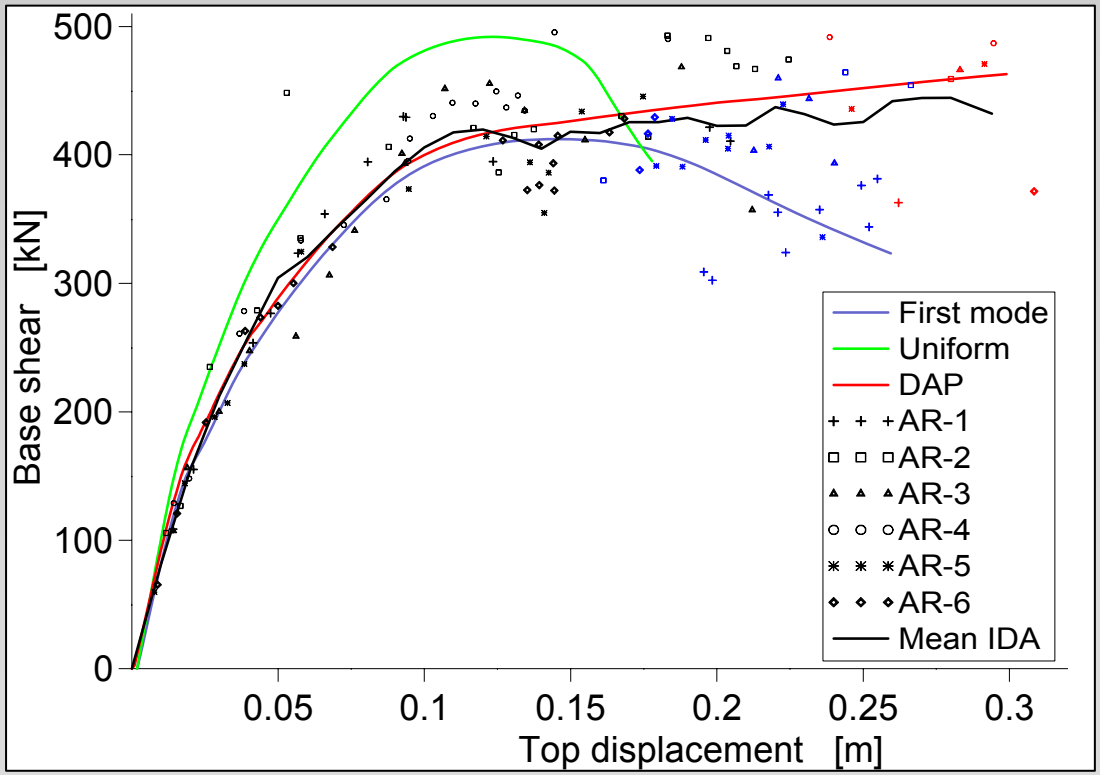
8 Φ 20

GFRP= 1.25 mm

FRP Confined Concrete Model has been implemented in F.E. code (SeismoStruct 4.0, Pinho & Antoniou 2007) in order to investigate the increasing stuctural ductility by FRP retrofitting

Incremental Dynamic Analyses and Pushover Analyses





Ferracuti B., Savoia M., Pinho R., Francia R., Antoniou S., Pushover Analysis of FRP-retrofitted Existing RC Frame Structures. FRPRCS-8. Greece 2007.