



5 - 8 DECEMBER 2022
DUBAI WORLD TRADE CENTRE

PRESENTATION TITLE

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CONCRETE TALKS BY ACI

06-12/2022

OVERVIEW ON ACI 440.2R: GUIDE FOR THE DESIGN
AND CONSTRUCTION OF EXTERNALLY BONDED
FRP SYSTEMS FOR STRENGTHENING CONCRETE
STRUCTURES



ACI 440.2R-17 Review of Chapters

Chapter 1—Introduction and Scope

Chapter 2—Notations and Definitions

Chapter 3—Background Information

Chapter 4—Constituent Materials and Properties

Chapter 5—Shipping, Storage, and Handling

Chapter 6—Installation

Chapter 7—Inspection, Evaluation, and Acceptance

Chapter 8—Maintenance and Repair

Chapter 9—General Design Considerations

Chapter 10—Flexural Strengthening

Chapter 11—Shear Strengthening

Chapter 12—Strengthening of Members Subjected to Axial Force or Combined Axial and Bending Forces

Chapter 13—Seismic Strengthening

Chapter 14—Fiber-Reinforced Polymer Reinforcement Details

Chapter 15—Drawings, Specifications, and Submittals

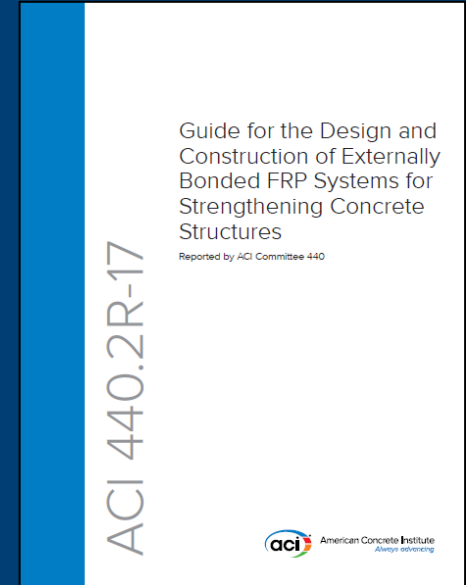
Chapter 16—Design Examples

Background information

Evaluation and Installation

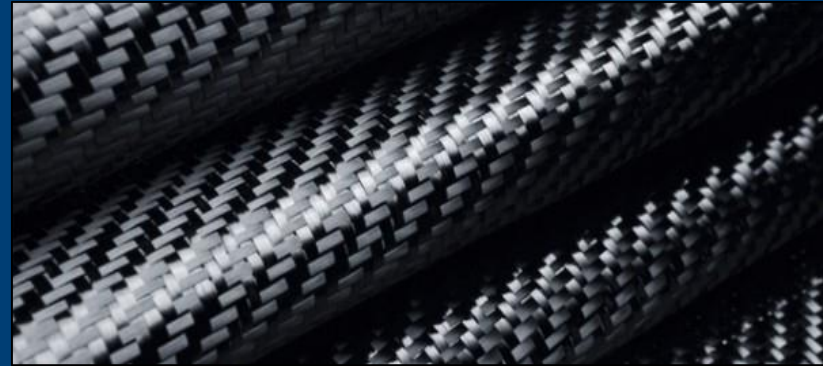
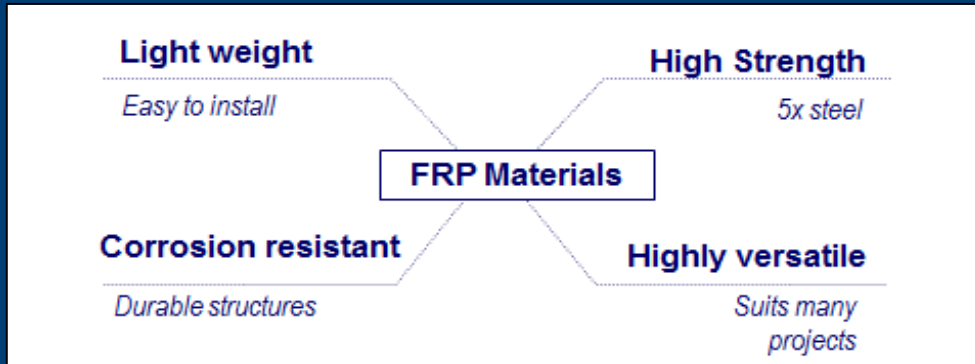
Design

Detailing and submittals



Chapter 1- Introduction and Scope

- The need to retrofit existing RC structures:
 - Resist higher design loads
 - Correct strength loss due to deterioration
 - Correct design or construction deficiencies
 - Increase ductility



Chapter 1- Introduction and Scope

- **Scope:**
- Provide guidance for the selection, design, proper detailing and installation of FRP systems for EBR concrete structures.
- **Applications and use:**
 - Conduct a thorough field investigation of the existing structure in accordance with ACI 437R, ACI 562, ACI 369R:
 - Existing dimensions
 - Location/size of the cracks
 - Location/ extent of corrosion
 - In place compressive strength of concrete

Chapter 3- Background Information

- Development and research into the use of FRP materials for retrofitting concrete structures started in the 1980s.

Commercially available FRP systems

Wet layup systems



Prepreg systems



Precured systems



Near-surface-mounted (NSM)

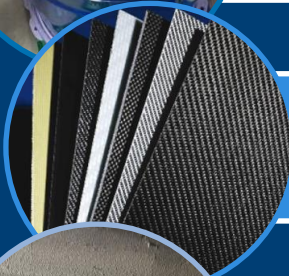


- **Constituent Materials:**



Resins

Primer, Putty fillers, Saturating resin, Adhesives



Fibers

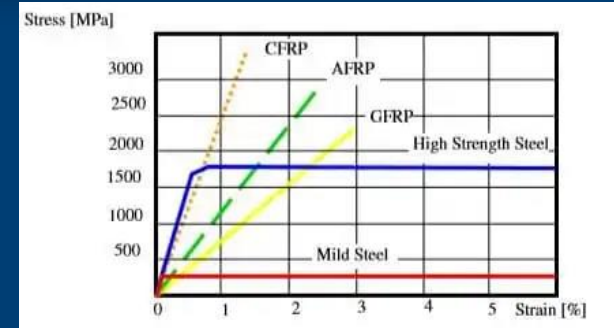
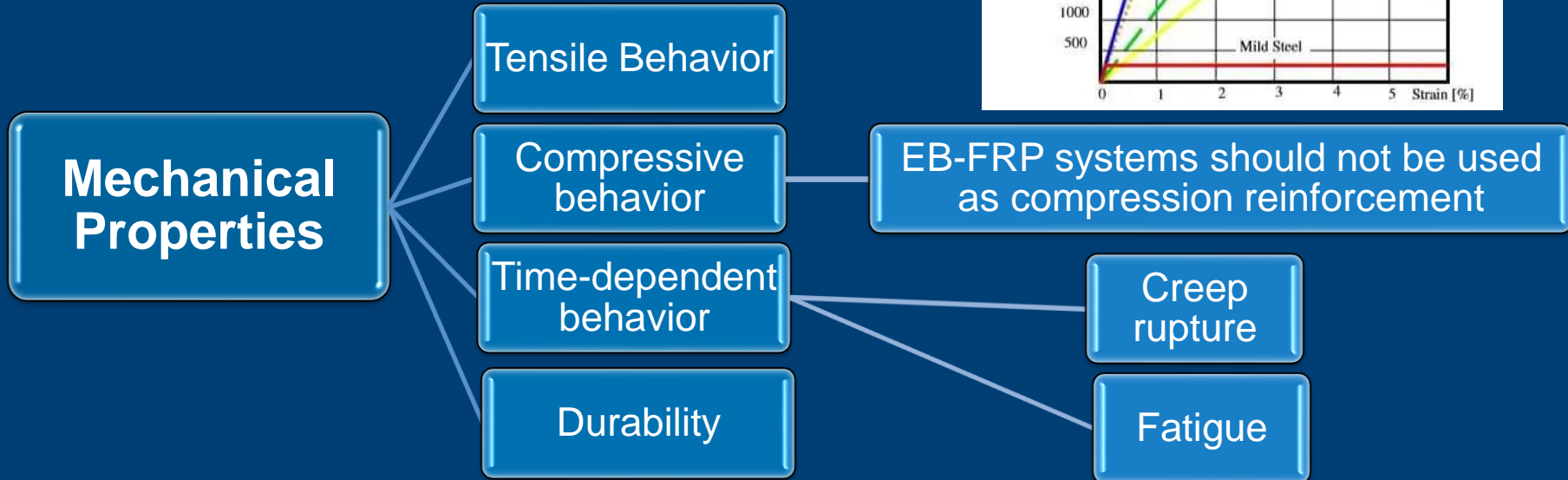
CFRP, GFRP, AFRP, BFRP



Protective coatings

Polymer coatings, Acrylic coatings, Cementitious systems

Chapter 4- Constituent Materials and Properties



Chapter 9- General Design Considerations

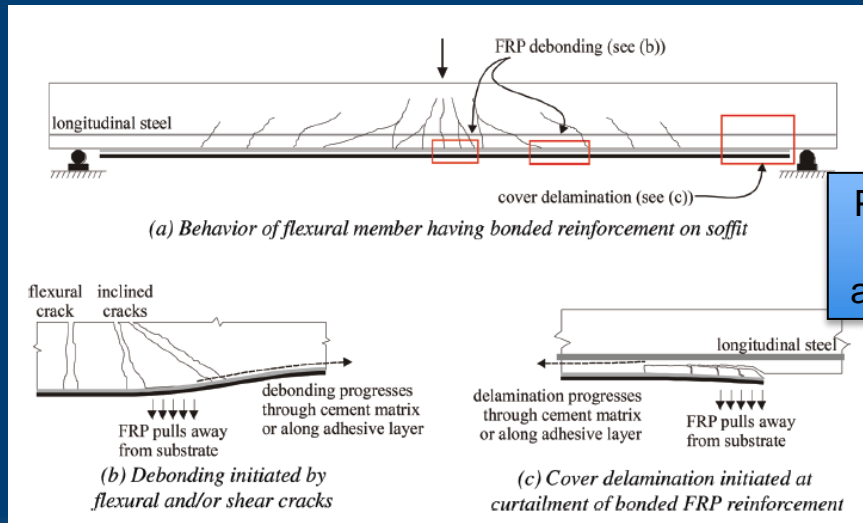
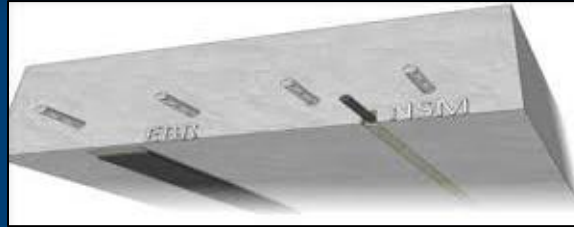
- **Design recommendations are based** on the traditional RC design principles.
- FRP strengthening systems are designed to resist **tensile forces** while maintaining strain compatibility between the FRP and the concrete substrate.
- Acceptable levels of safety for the occurrence of:
 - Serviceability limit states
 - Ultimate limit states

Chapter 9- General Design Considerations

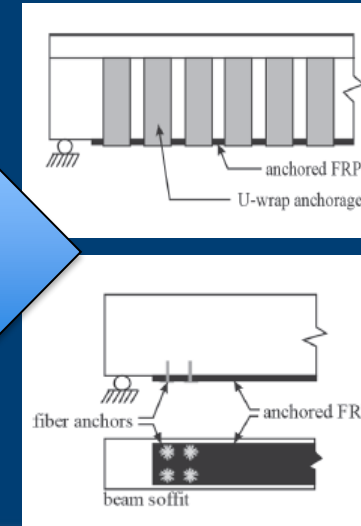
- Selection of FRP systems:
- Environmental considerations:
 - Alkalinity/acidity
 - Thermal expansion
 - Electrical conductivity
- Loading considerations
 - Impact tolerance
 - Creep rupture and fatigue
- Durability
- Protective-coating selection considerations.



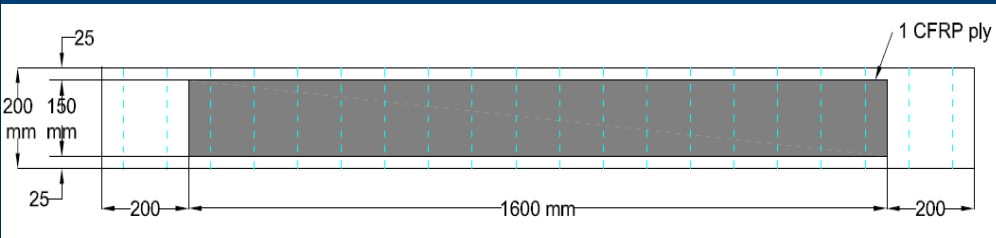
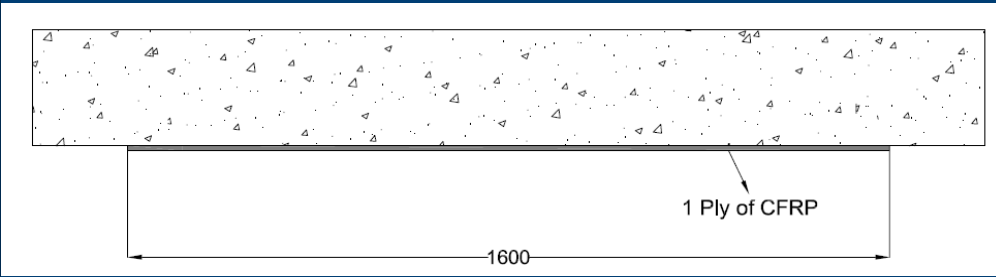
Chapter 10- Flexural Strengthening



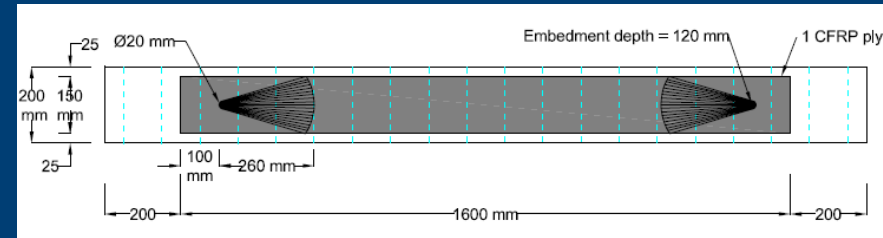
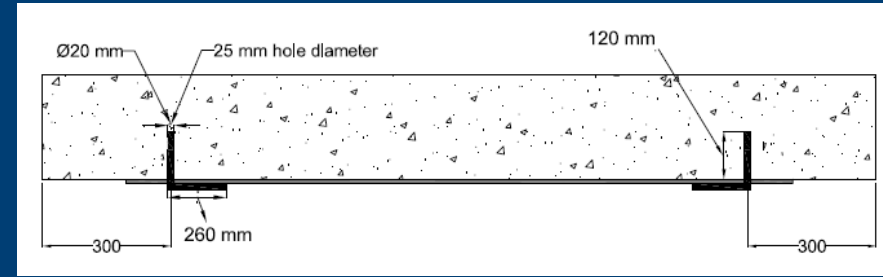
Prevented by anchorage



Flexural Strengthening

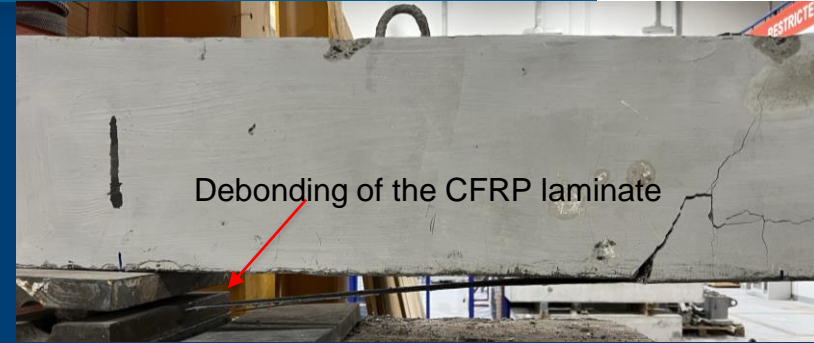
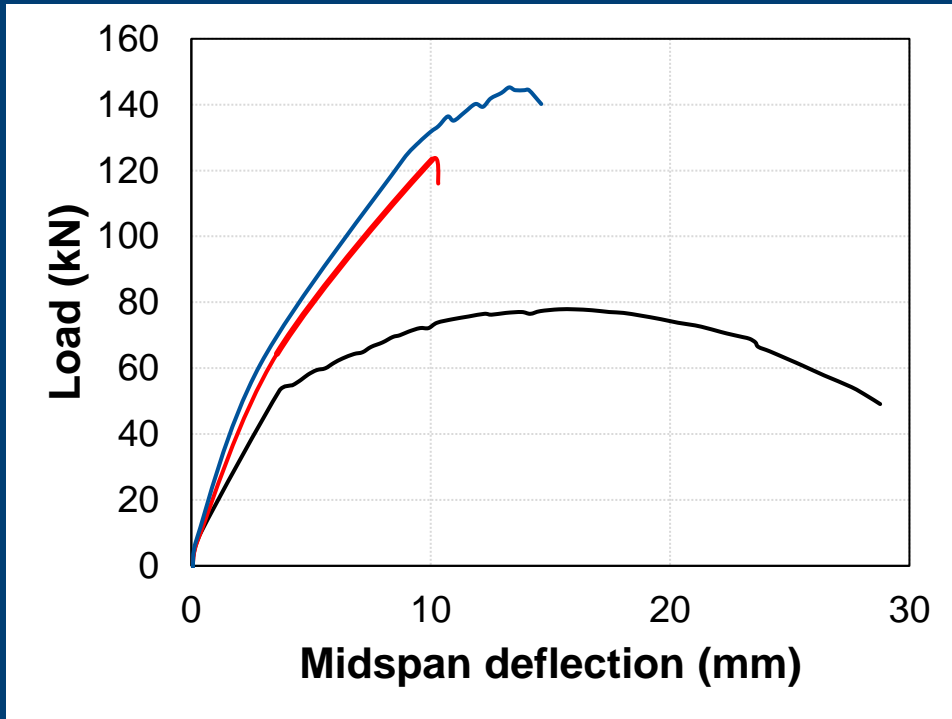


Specimen strengthened with one CFRP laminate

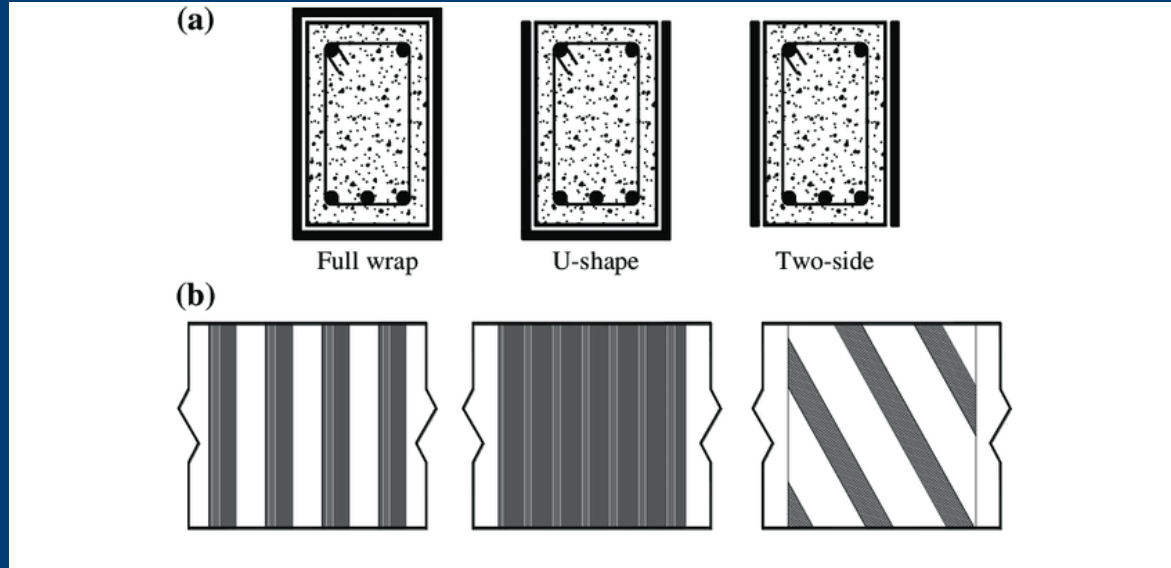


Specimen strengthened with one CFRP laminate and anchored with CFRP spike anchors

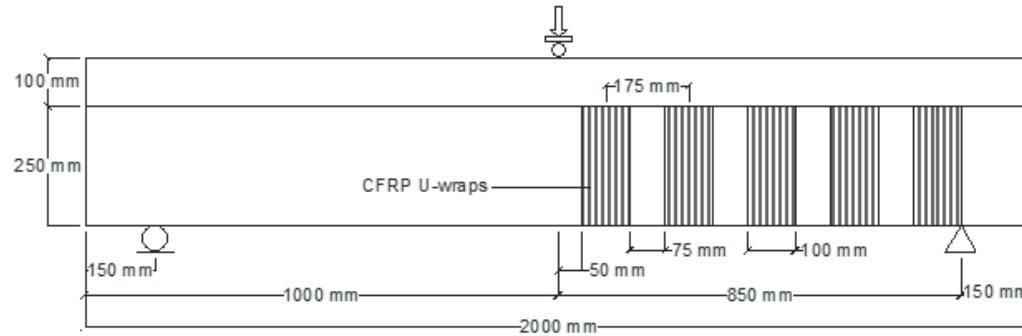
Chapter 10- Flexural Strengthening



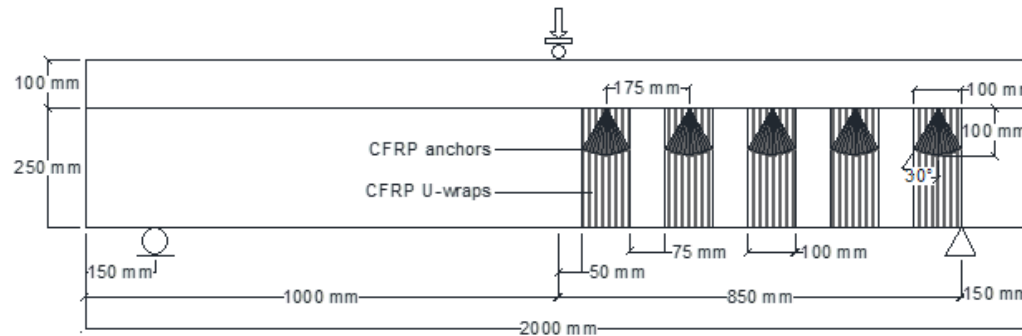
Chapter 11- Shear Strengthening



Shear Strengthening

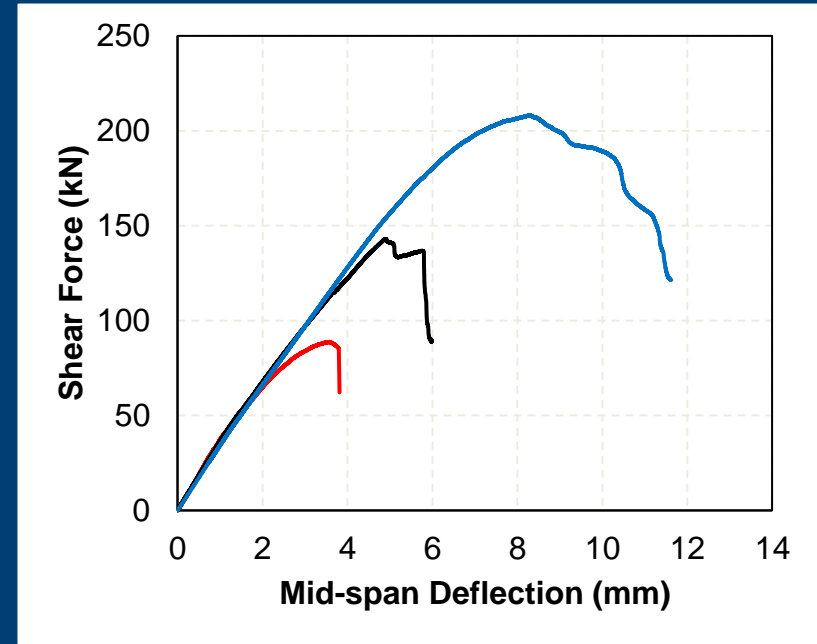


(a) Side view - Unanchored Specimen



(b) Side view - Anchored Specimen

Chapter 11- Shear Strengthening



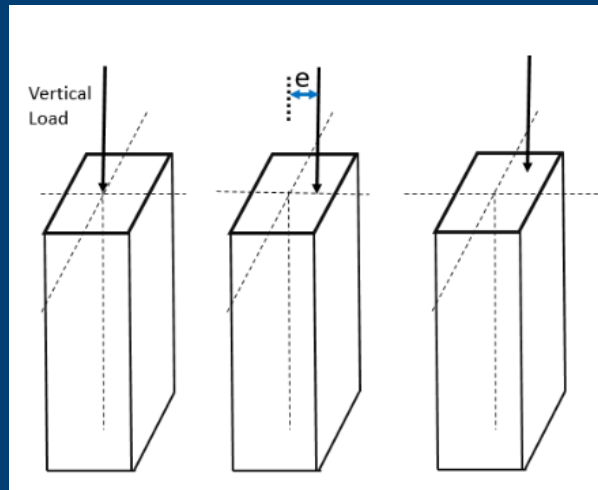
Chapter 12- Strengthening of Members Subjected to Axial Force or Combined Axial and Bending Forces



- Fibers are oriented transverse to the longitudinal axis of the member (circular and noncircular).

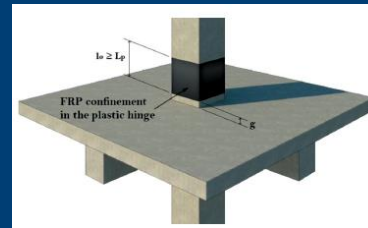
Chapter 12- Strengthening of Members Subjected to Axial Force or Combined Axial and Bending Forces

- Classification Based on Loading:
 - Pure axial compression
 - Combined axial compression and bending



Chapter 13- Seismic Strengthening

- Strengthening with FRP improves the overall seismic performance of the structure.
- Chapter 13 is subdivided into:
 - Confinement with FRP
 - Flexural strengthening
 - Shear strengthening
 - Beam-column joints
 - Strengthening of RC shear walls

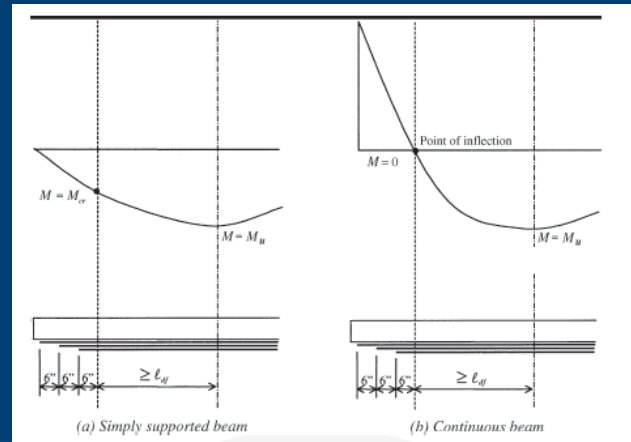
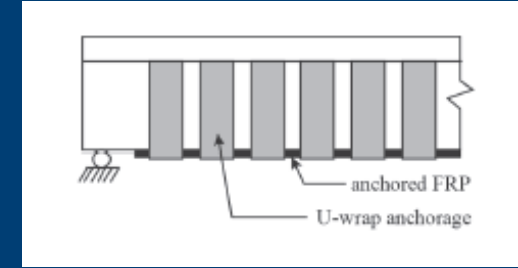


Chapter 13- Seismic Strengthening

- Advantages:
- Mitigates brittle mechanisms of failure:
 - shear failure of unconfined beam-column joints
 - shear failure of beams, columns, or both
 - lap splice failure
- Increases the flexural capacity of RC members
- Increases the global displacement and energy dissipation capacities of the structure.

Chapter 14- Fiber-Reinforced Polymer Reinforcement Details

- This chapter provides guidance for detailing EB-FRP reinforcement.
- Termination points, Laps and splices
- Design of U-wraps anchorage



Chapter 16- Design Examples

- Design examples for:
 - Calculation of tensile properties of FRP.
 - Flexural and shear strengthening of beams.
 - Strengthening columns to enhance axial and bending capacities
 - Seismic strengthening
 - Designing plastic hinge confinement
 - Shear strengthening
 - Flexural and shear seismic strengthening of shear walls

THANK YOU



Concrete



Facilities
Management



Geotechnical
& Engineering



HVAC R



Offsite
& Modular



Project
Management



Solar



Stone Design



Technology



Urban Design
& Landscape