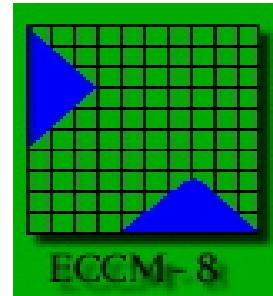




Safety Philosophy for FRP RC Structures



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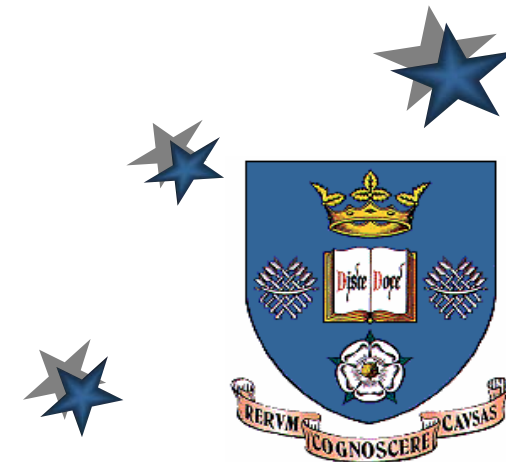




Outline



- ◆ **Design Guidelines**
- ◆ **Development of Safety Philosophy**
- ◆ **Discussion**
- ◆ **Future Work**

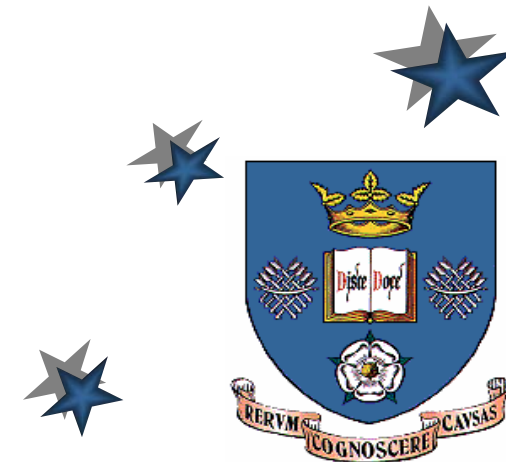




Current Design Guidelines



- ◆ **Needed to Facilitate Use of FRP Reinforcement**
- ◆ **Current Design Guidelines:**
 - **Japanese**
 - **Canadian**
 - **American**
 - **European**





European Design Guidelines



- ◆ **CEB TG 3.10 & ConFibreCrete Network**
- ◆ **EUROCRETE Project**
 - **Modifications to Existing Codes of Practice**
 - **Non Identifiable Safety Philosophy**





Proposed Safety Philosophy



◆ **Quantify all Possible Failure Modes**

e.g. Flexure, Shear, Bond ...

◆ **Establish Hierarchy of Failure Modes**

e.g. Bond prior to Flexure ?



Proposed Safety Philosophy



Use of Partial Safety Factors:

- ◆ Achieve Desired Failure Mode Hierarchy
- ◆ Each Failure Mode to Have a Target Reliability Level
- ◆ Fulfil a Uniform Structural-System Reliability Strategy



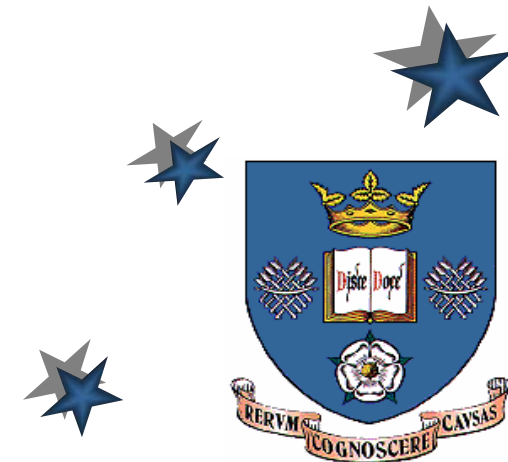


Hierarchy of Failure Modes

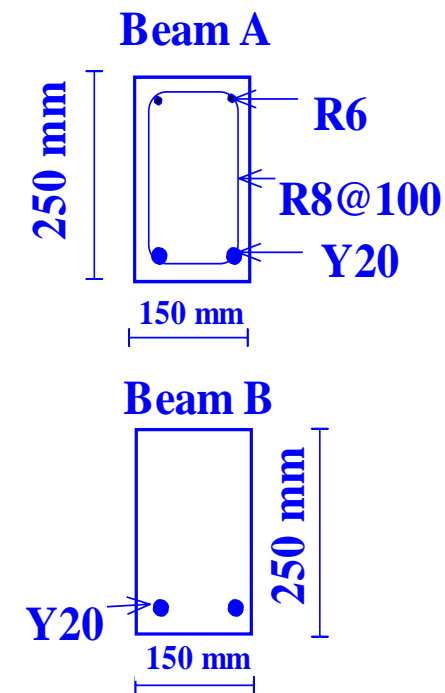
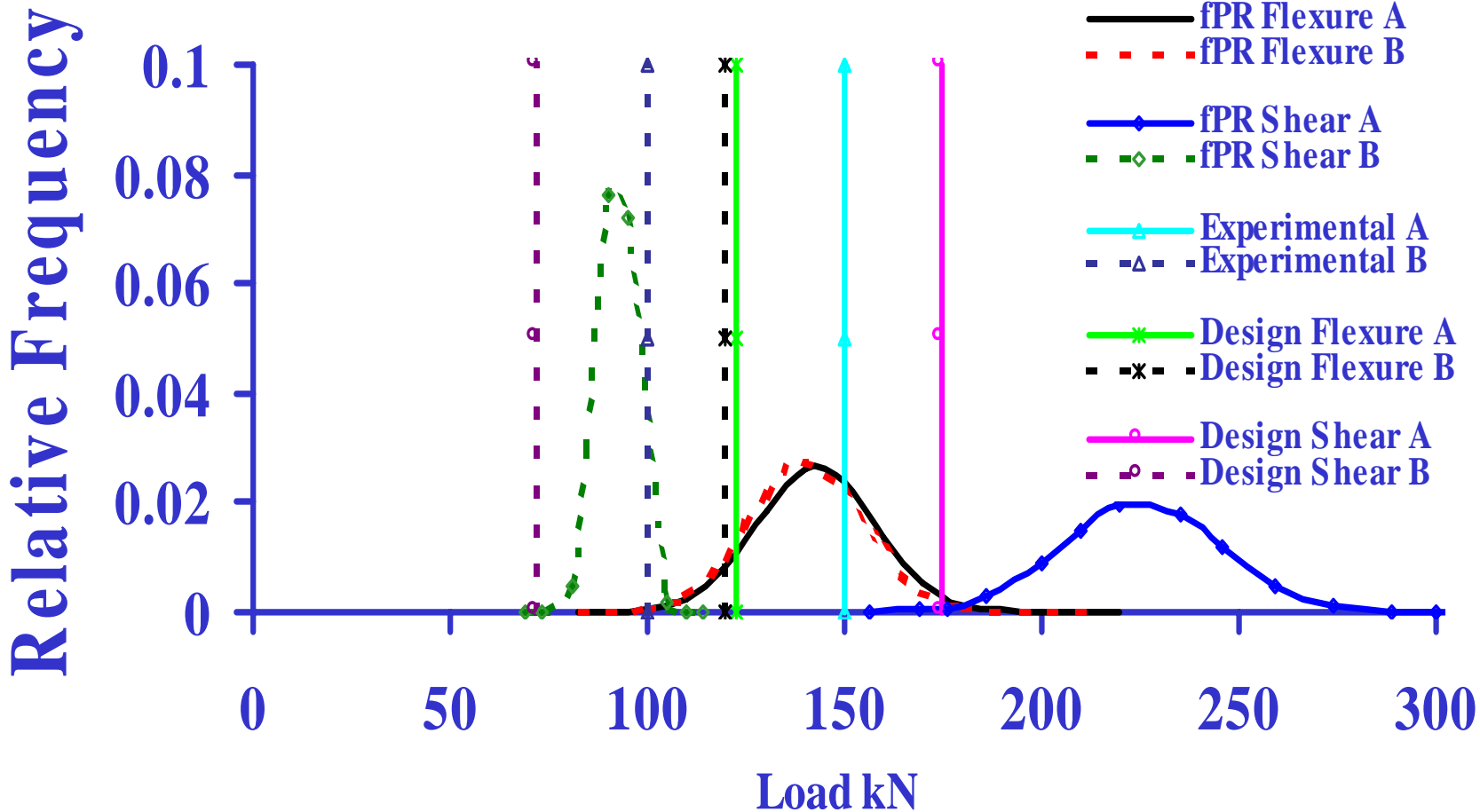


Examination of Steel and FRP RC Elements:

- ◆ **Use of Reliability Theory
Monte Carlo (Simulation) Method**
- ◆ **Flexure and Shear Failure Modes**



Failure Modes for a Steel RC Beam



Failure Probabilities Steel RC Beams

	Beam A				Beam B
Failure Mode	$f_{y_k}=460$ $\gamma_{mrein}=1.05$	$f_{y_k}=460$ $\gamma_{mrein}=1.15$	$f_{y_k}=490$ $\gamma_{mrein}=1.05$	$f_{y_k}=490$ $\gamma_{mrein}=1.15$	$f_{y_k}=460$ $\gamma_{mrein}=1.05$
f_{PR} Flexure	2.3E-02	4.1E-03	6.7E-03	9.4E-04	(2.68E-02)
f_{PR} Shear	3.8E-03	7.6E-04	3.9E-03	6.8E-04	5.1E-04

Beam A	$f_{y_k}=460$ $\gamma_{mrein}=1.05$	$f_{y_k}=460$ $\gamma_{mrein}=1.15$	$f_{y_k}=490$ $\gamma_{mrein}=1.05$	$f_{y_k}=490$ $\gamma_{mrein}=1.15$
Failure Mode				
Shear prior to Flexure	2.2E-04	2.3E-04	7.8E-04	7.2E-04

Discussion

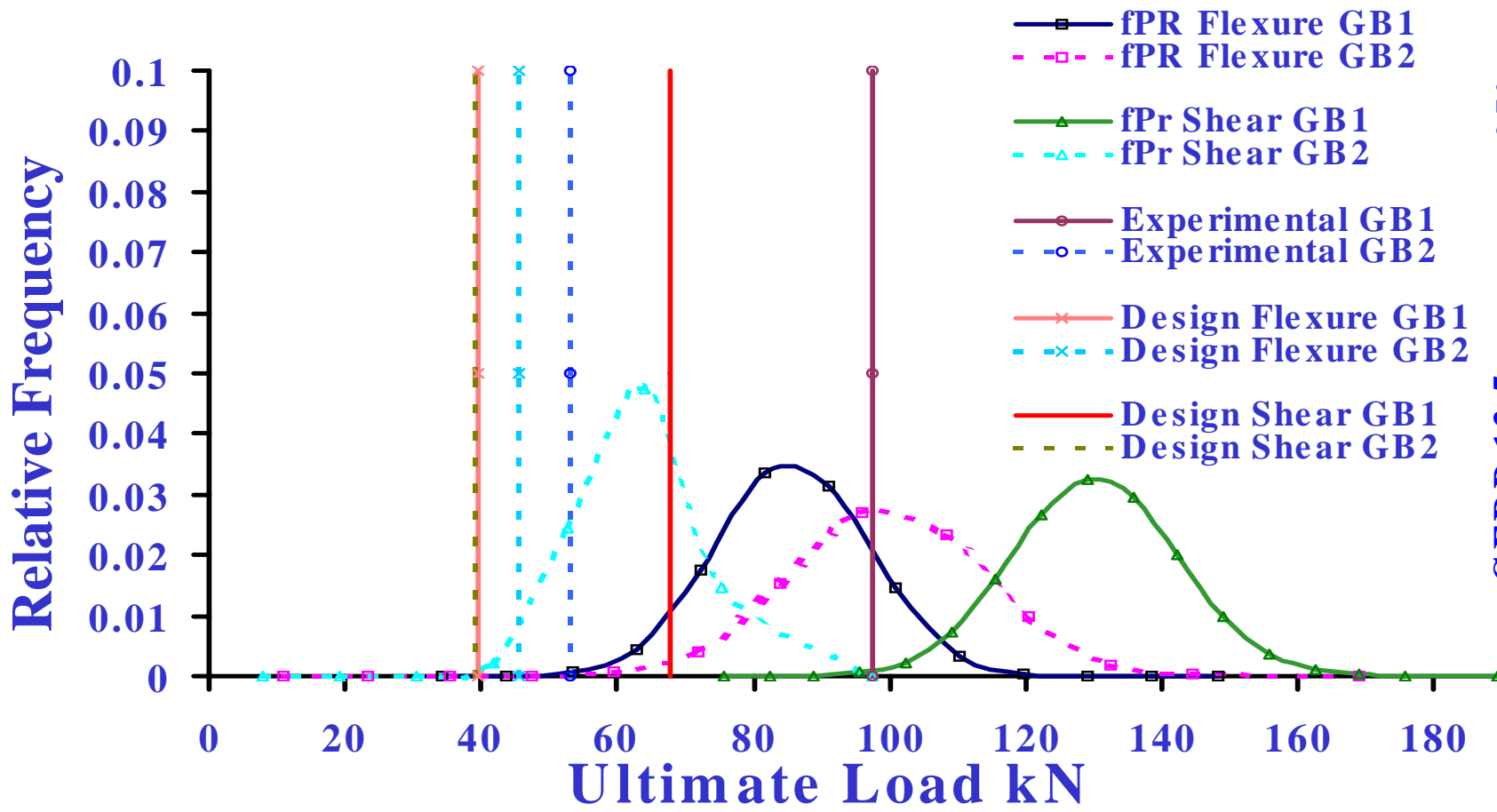
Steel RC Beams



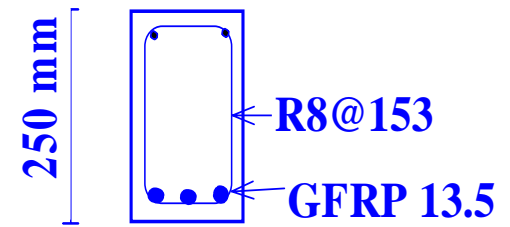
- ◆ Predictive Models in Agreement with Experimental Results
- ◆ Safety of Flexural Design is Mainly Dependent on Steel Characteristics
- ◆ Low Probability of Shear Failure



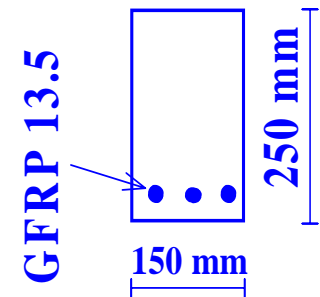
Failure Modes for a GFRP RC Beam



Beam GB1



Beam GB2



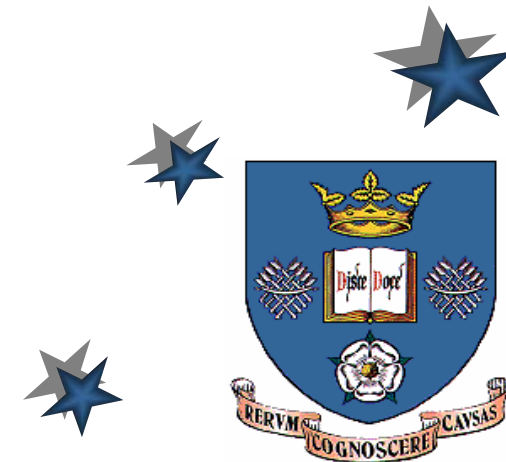


Discussion

GFRP RC Beams



- ◆ **Shear Model Not in Agreement with Experimental Values**
- ◆ **Low Failure Probability for Shear Failure**





Future Work



- ◆ **Improve Predictive Models, Especially for Shear**
- ◆ **Derive Partial Safety Factors for FRP RC Structures**

