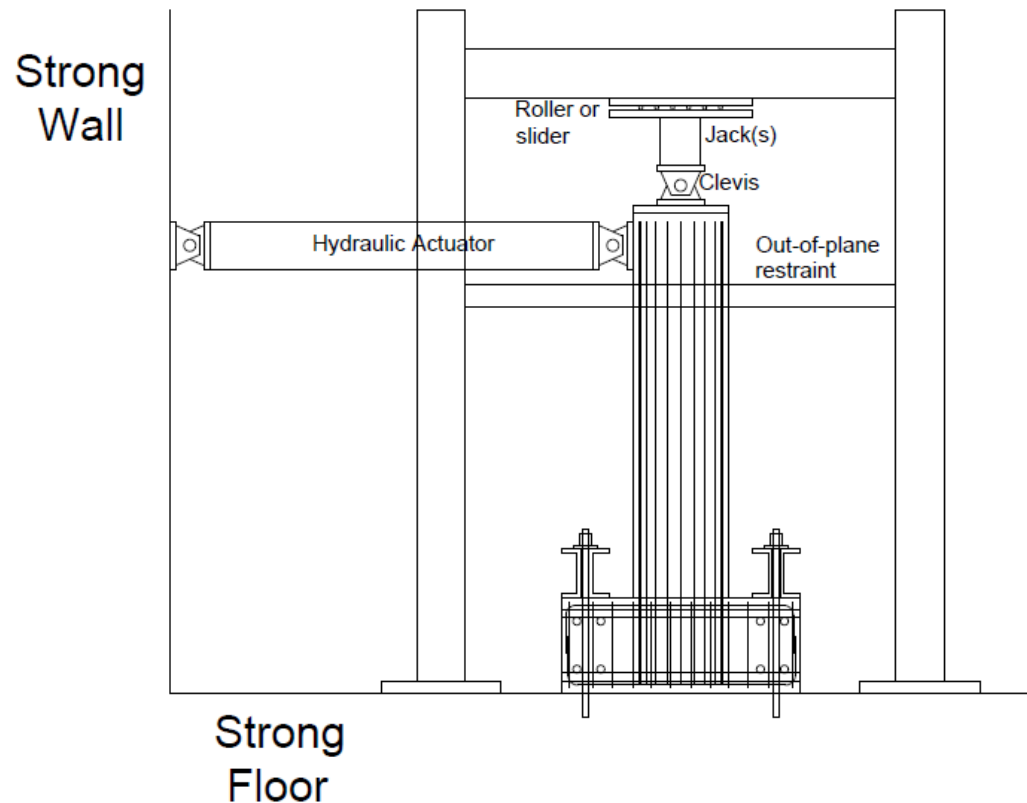


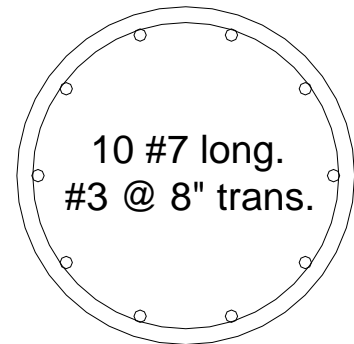
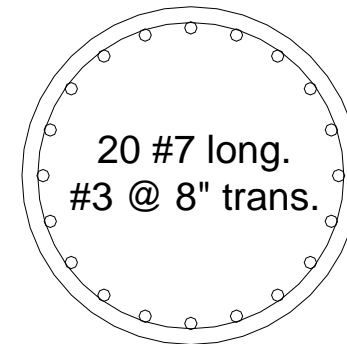
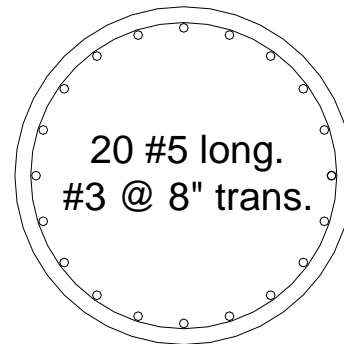
Fiber Reinforced Polymer (FRP) Seismic Retrofit of Reinforced Concrete Bridge Columns Vulnerable to Long-Duration Subduction Zone Earthquakes

P.I.s: Christopher Motter and Adam Phillips, Washington State University

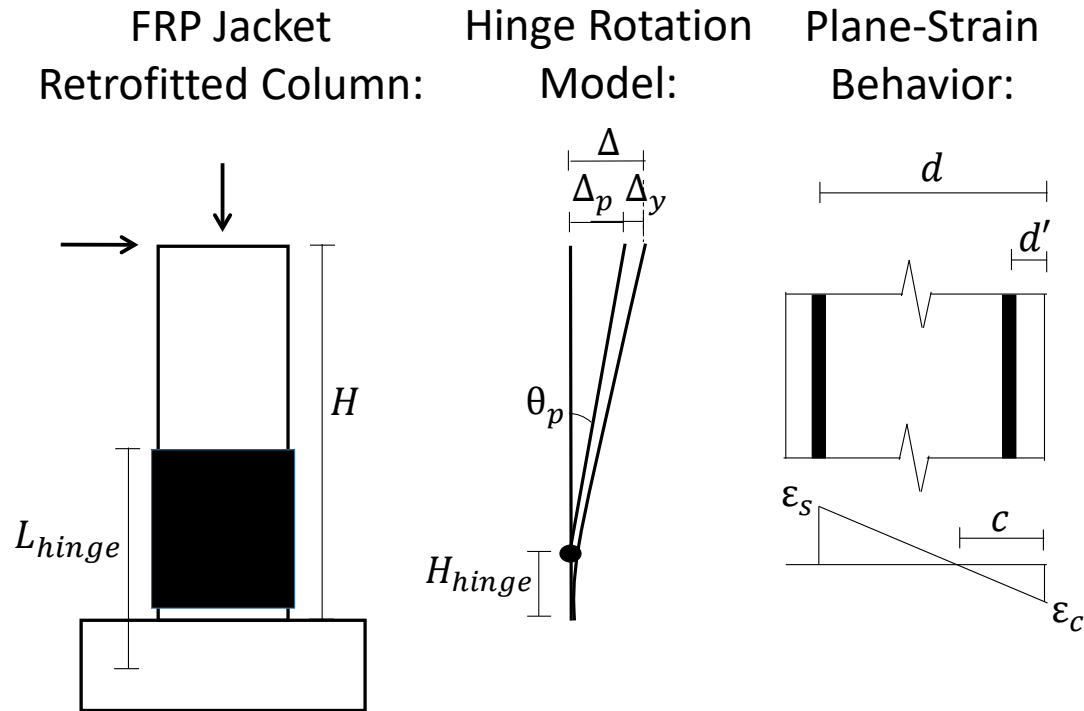
Testing of FRP-jacketed reinforced concrete columns under long-duration earthquake demands:



Column Name	Column Shape	Jacket Type	long. bar size	# long. bars	As/Ag	P/(Agf'c)	H/D	Loading Protocol
C(FRP)-4.0-#7(1.3)-0.05	Circular	FRP	#7	10	0.0133	0.05	4.0	Cyclic
C(FRP)-4.0-#5(1.4)-0.05	Circular	FRP	#5	20	0.0137	0.05	4.0	Cyclic
C(FRP)-4.0-#7(2.7)-0.05	Circular	FRP	#7	20	0.0265	0.05	4.0	Cyclic
C(FRP)-4.0-#7(1.3)-0.15	Circular	FRP	#7	10	0.0133	0.15	4.0	Cyclic
C(FRP)-6.0-#7(1.3)-0.05	Circular	FRP	#7	10	0.0133	0.05	6.0	Cyclic
C(FRP)-4.0-#7(1.3)-0.05-EQ	Circular	FRP	#7	10	0.0133	0.05	4.0	EQ



Deformation Capacity Model:



$$\theta_p = \frac{(\Delta - \Delta_y)}{(H - H_{hinge})} = \frac{\Delta_p}{(H - H_{hinge})}$$

$$\epsilon_s - \epsilon_y = \phi_p(d - c) = \frac{\theta_p}{L_p}(d - c)$$

$$\epsilon'_s - \epsilon_y = \phi_p(c - d') = \frac{\theta_p}{L_p}(c - d')$$

Project Overview:

- Testing of six FRP-jacketed columns under long-duration earthquake demands
 - For direct comparison on jacketing method, tests match another set of six steel-jacketed columns being tested through a separate study
 - Column parameters selected to reasonably span the range in Northwest U.S. bridge stock
 - Address gaps from previous tests
- Deformation capacity model
 - Plastic hinge model, with test data used to assess and refine existing recommendations for plastic hinge length
 - Includes slip-extension of reinforcement from footing
 - Plastic hinge demand converted to strain history based on plane-strain moment-curvature with confined concrete
 - Strain history input into existing fatigue models to determine when rebar fractures
 - Strain at failure, due to rebar fatigue or concrete crushing, used to determine deformation capacity based on plane-strain and plastic hinge model