Analytical Model of Beam – Column Exterior Joints

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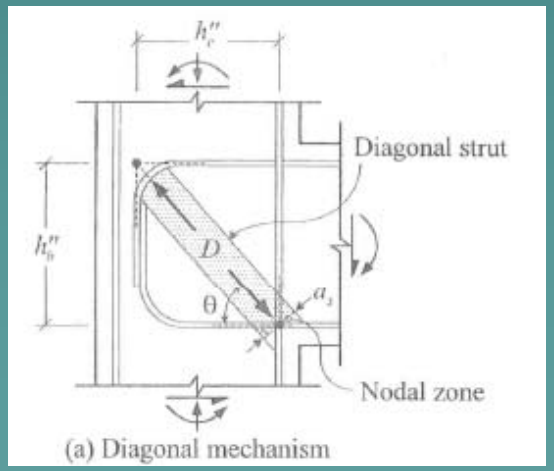
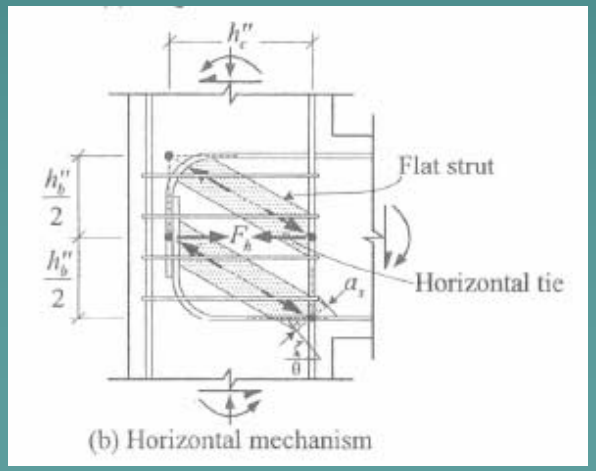
Agenda

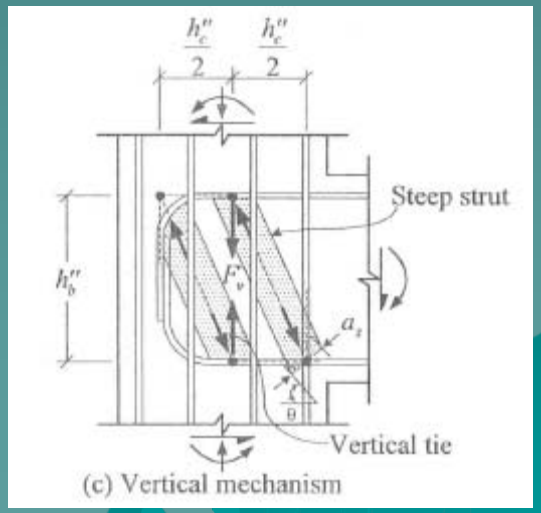
- Previous Models
- Objectives
- Proposed Model

Previous Models

- Hwang & Lee (1999)
- Based on the strut & tie concept. It was called “Softened strut and tie model”.
- The model was found to reproduce 63 test results form the literature with reasonable accuracy.

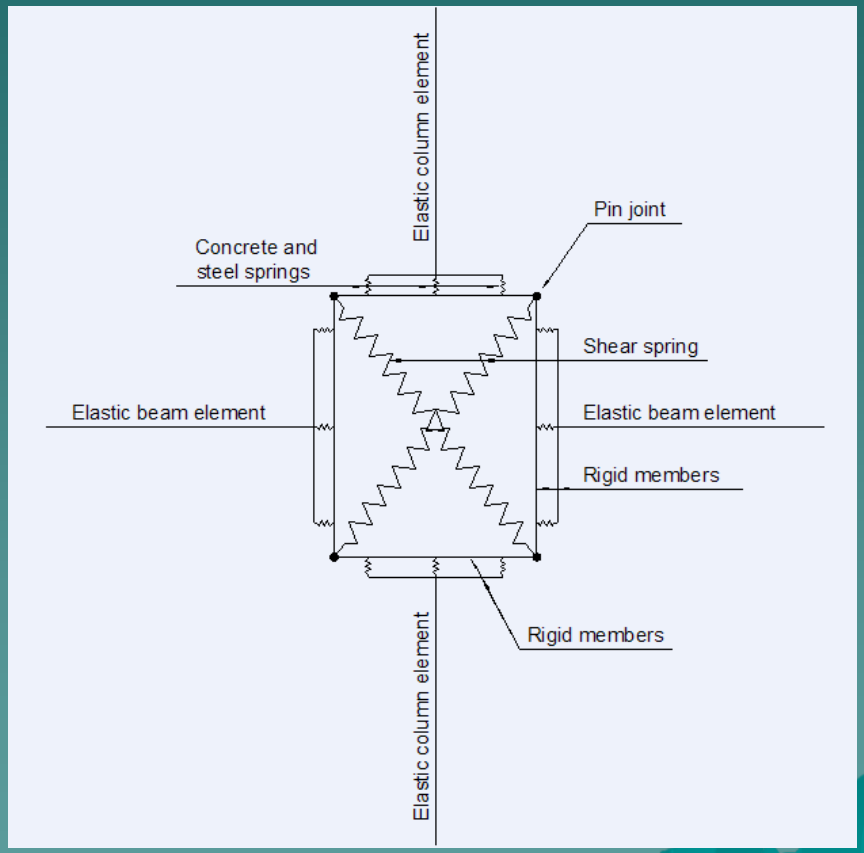






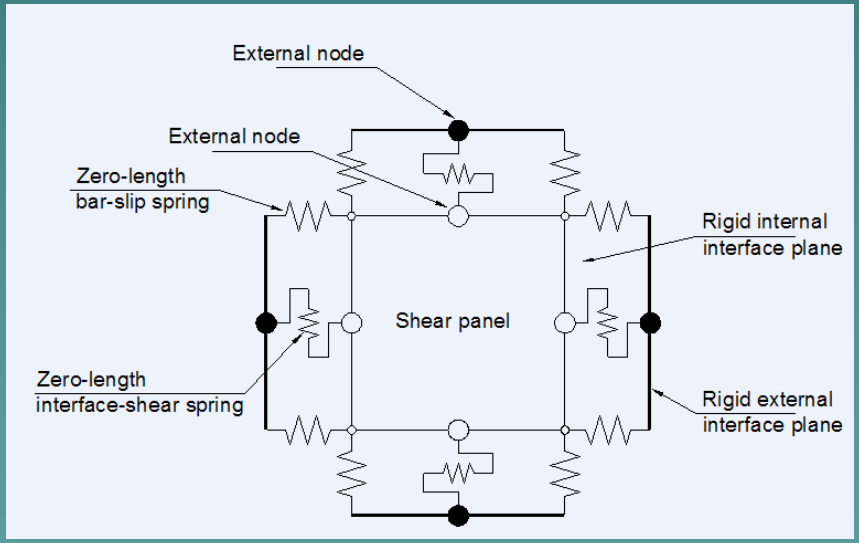
Previous Models

- Youssef and Ghobarah (2000) modeled the RC beam-column joint using a number of steel, concrete and shear springs connected by rigid members.
- The model, includes strength deterioration and softening parameters based on the bond slip in the steel springs, cumulative concrete crushing and shear failure.
- The model was tested using experimental results and shown suficiently accuracy in predicting the behavior of the specimens up to the failure load.



Previous Models

- Lowes and Altoontash (2003) developed a model to represent the response of RC beam joints under reversed cyclic loading.



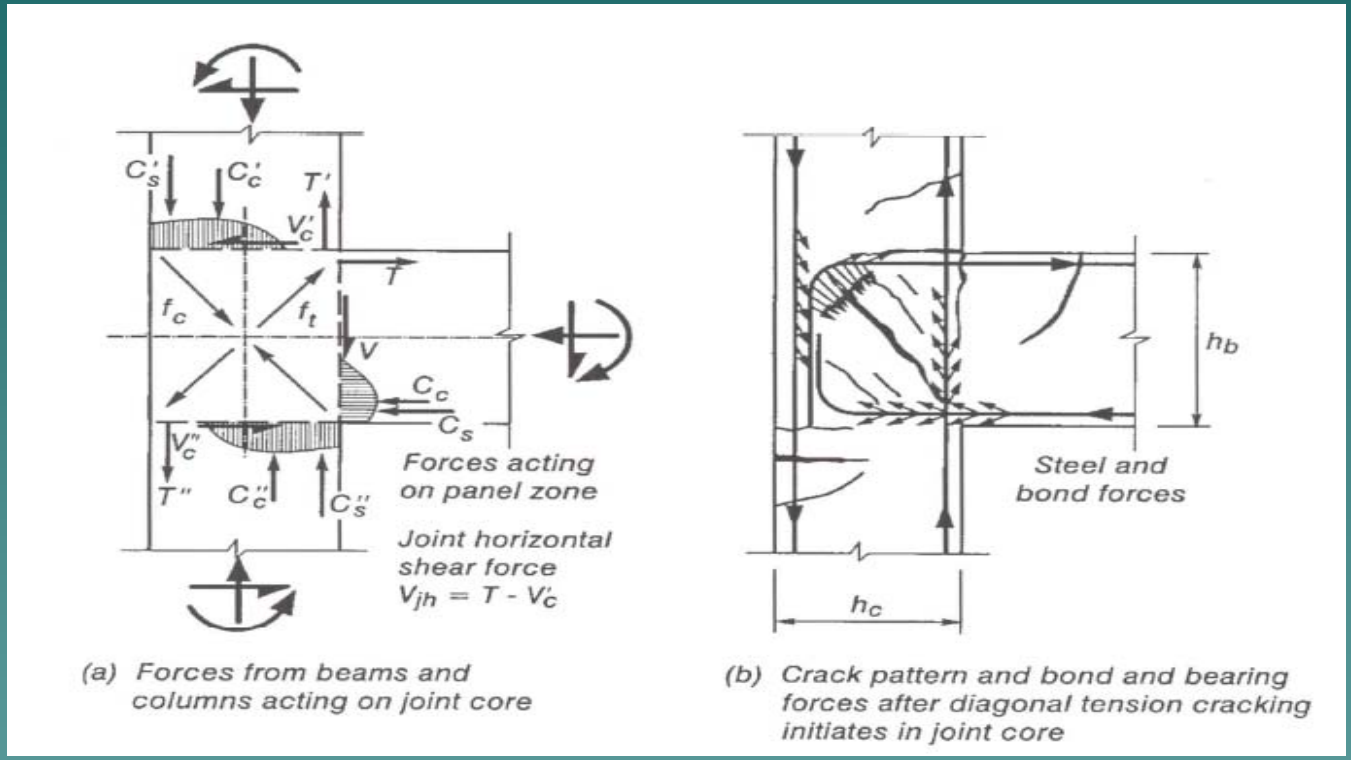
Previous Models

- The model, consisting on 4 internal nodal translations and 13 one-dimensional component, simulate the inelastic response of typical beam-column joints in 2D nonlinear analysis. A shear panel was used to simulated the inelastic response of the joint core. The model was compared with experimental data obtained from previous research, and the results shows that the model being proposed represents well the fundamental characteristics of response for joints subjected to moderate shear demands.

Objectives

- Develop a simplified model of RC exterior joints.
- Incorporate into a non linear analysis program.
- Make it suitable for 3D corner joints.

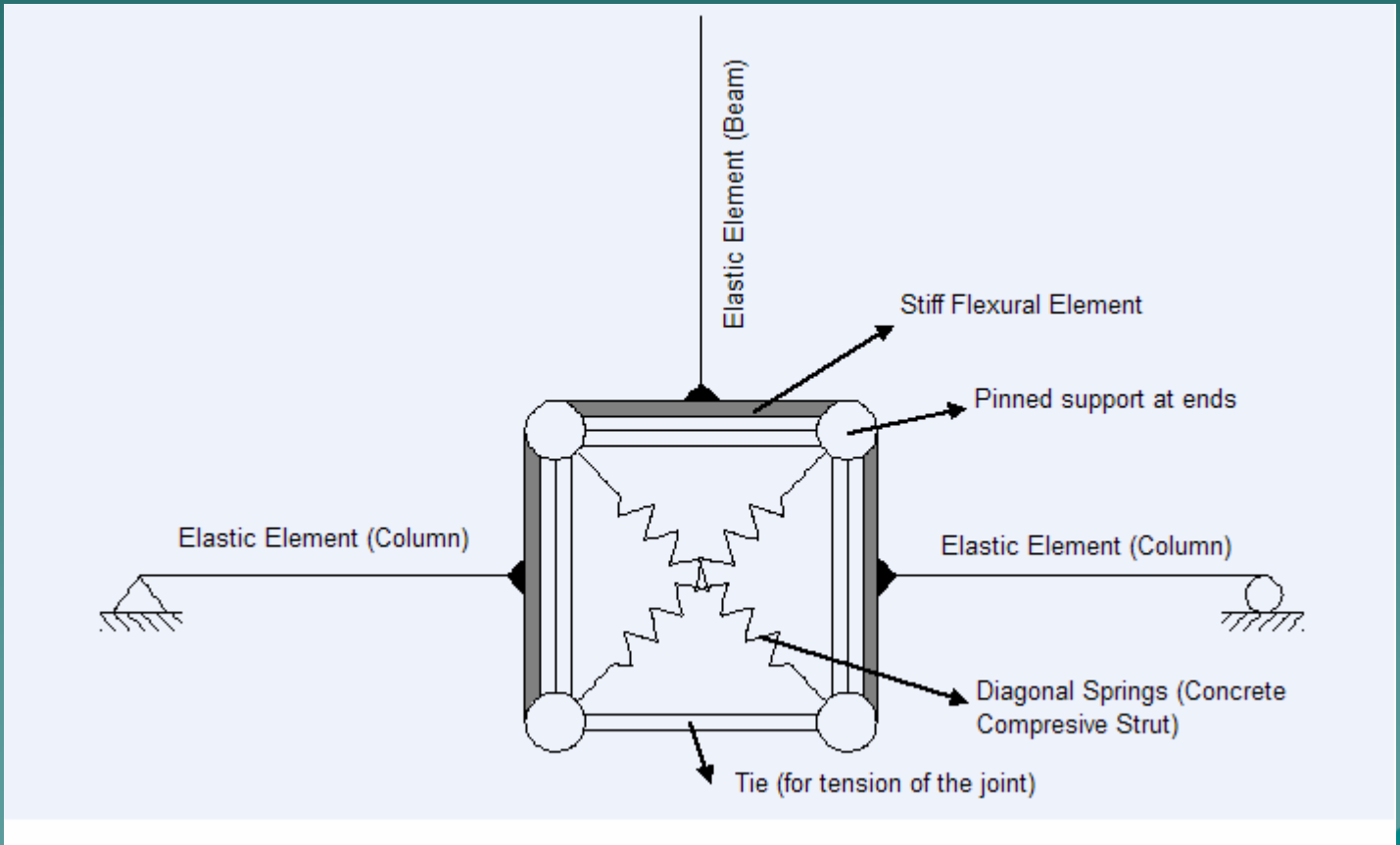
Proposed Model



(a) Forces from beams and columns acting on joint core

(b) Crack pattern and bond and bearing forces after diagonal tension cracking initiates in joint core

Proposed Model



Proposed Model

- The model represent a exterior joint without stirrups into the joint.
- Two diagonal springs represents the behavior of the concrete in shear.
- Surrounding ties, represent the behavior of the longitudinal bars.
- It’s basically a modification of the model proposed by Youssef and Ghobarah (2000)

Proposed Model (Cont.)

The properties of the elements are defined initially based on experimental data obtained from the PhD Thesis of Wong (2005), who tested seventeen large scale exterior column joints, with non ductile details.

Ho Fai Wong (2005), “Shear Strength and Seismic Performance of Non-Seismically Designed Reinforced Concrete Beam-Column Joints”, Phd dissertation thesis, Department of Civil Engineering, The Hong Kong University of Science and Technology.

Proposed Model (Cont.)

Table 3.3 Concrete properties for all specimens

Specimen	Cube Strength, f_{cu} (MPa)	Cylinder Strength, f_c' (MPa)	Modulus of Elasticity, E_c, (GPa)
BS-L	38.6	30.9	24.3

Table 3.1 Details of test specimens – BS series

Specimen	Axial load Level ($A_g f_c'$)	Beam - Column Joint Details			Beam Details	
		Vertical reinforcement	Horizontal reinforcement	Anchorage of beam reinforcement	Depth (mm)	Transverse reinforcement
BS-L	0.15	-	-	Both top and bottom bars bent into the joint	450	T10@250

Table 3.4 Reinforcement properties

Bar Diameter (mm)	**Yield Strength (MPa)**	**Modulus of Elasticity, E_s, (GPa)**
25	520	201
20	520	201
16	520	201
12	520	201
10	500	202

Proposed Model (Cont.)

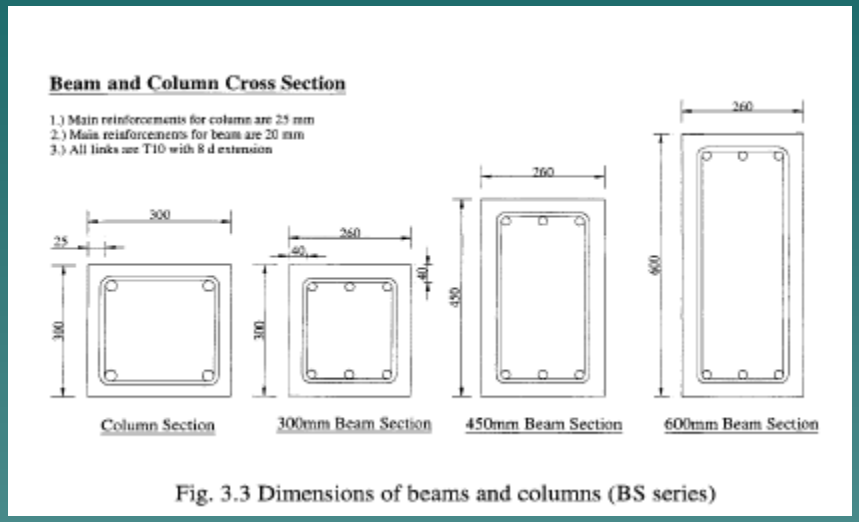
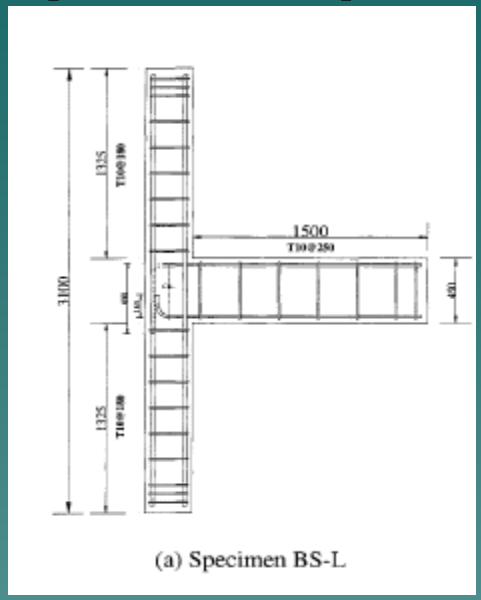
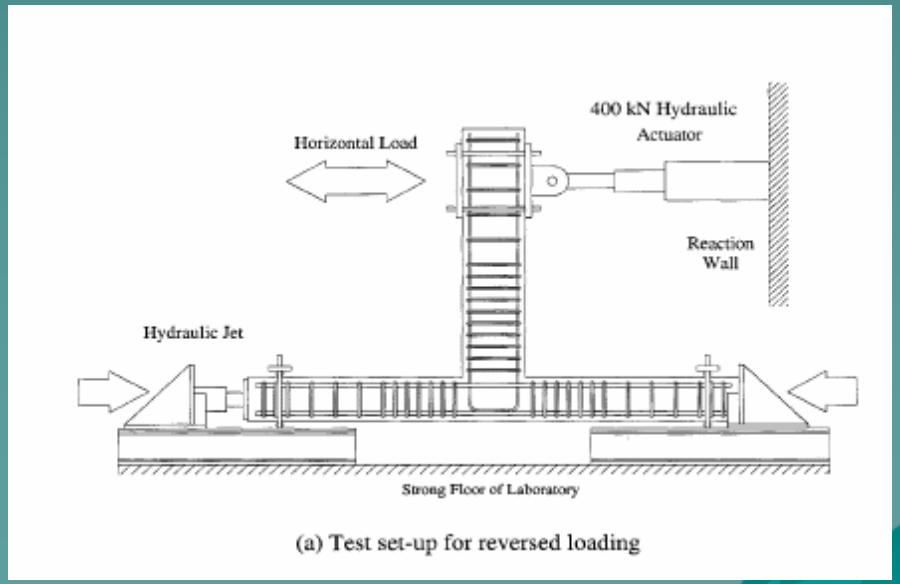


Fig. 3.3 Dimensions of beams and columns (BS series)

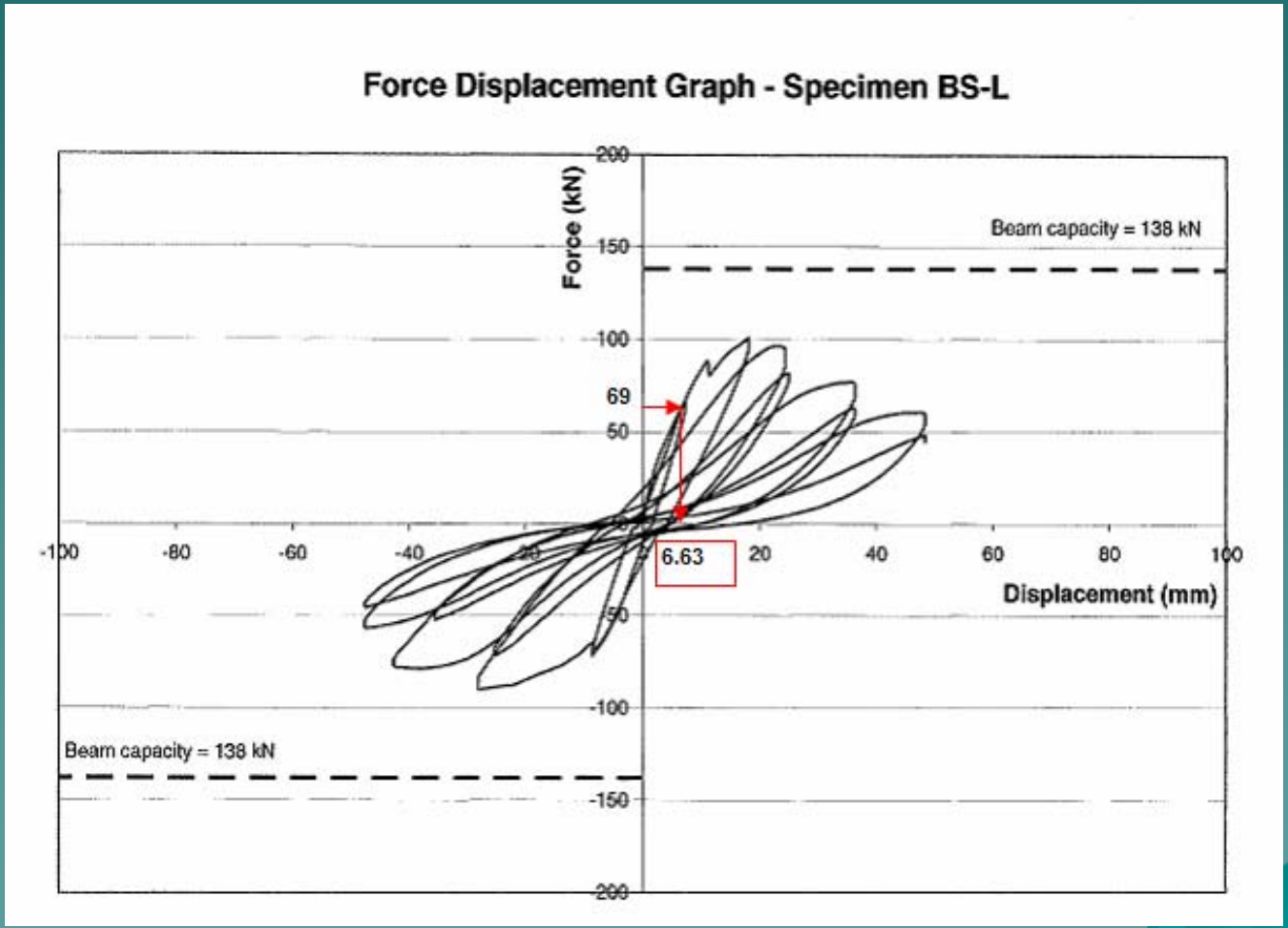


(a) Specimen BS-L



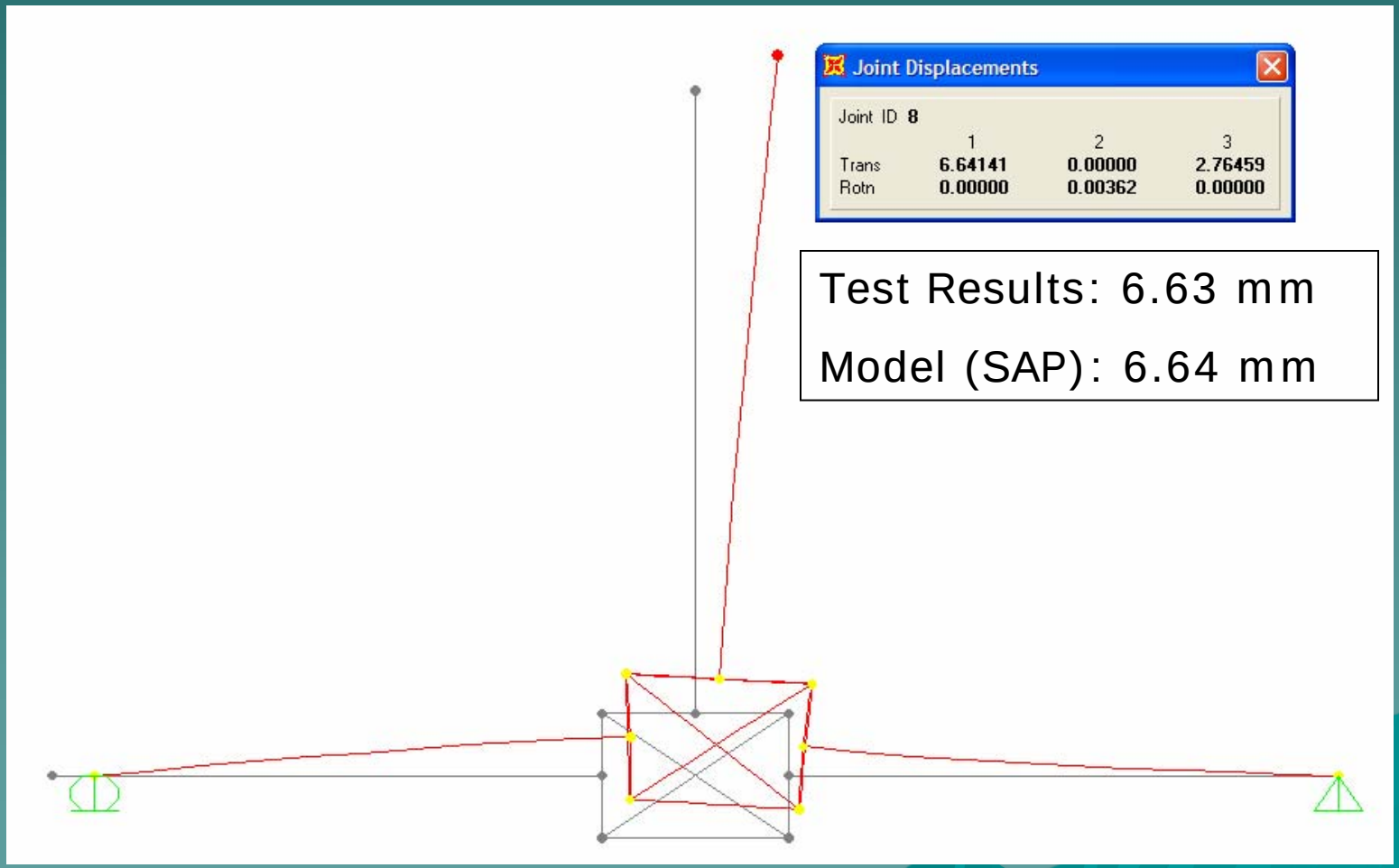
(a) Test set-up for reversed loading

Proposed Model (Cont.)



Proposed Model (Cont.)

Elastic Stage



Proposed Model (Cont.)

- Next steps:
  - Model Strength
  - Model Envelope
  - Hysteretic Behavior.