MS-ESSI for Professional Practice, Core Functionality

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May 2018

Outline

Motivation, General

Improve seismic modeling and simulation for infrastructure objects, focus on nuclear installations

Quality control of the modeling and simulation tool

Quality assurance for the modeling and simulation tool

Hierarchy of modeling capabilities,

- Linear elastic models, elastic constants, viscous damping
- Nonlinear models, core functionality, does not require much material data however, sensitivity study is advised
- High sophistication nonlinear models, require material data

Motivation, Practice

Usable models for professional practice

Core functionality needed for nonlinear modeling in professional practice

Use of prescribed (low?, high?) fidelity numerical models to analyze seismic behavior of soil structure systems

Investigate sensitivity of response to model sophistication

Investigate sensitivity or response to model parameters

Outline

Structure

- Truss
- Beam
- Shell
- Super-Element

Soil

- Linear elastic
- G/G_{max}
- Super-Element

Contact

- Bonded
- Frictional
- Gap open, close

Loads

- Static loads, self weight, etc.
- Dynamic loads, earthquake, 1C or 3$\times$1C
  - deconvolution from surface
  - convolution from depth, rock
- Aftershock, restart option, can stack simulations, and branch into loading cases

Outline

Simulation Options

- Explicit simulation without equilibrium check or enforcement
- Implicit simulation with equilibrium check and enforcement
  - relative and/or absolute tolerances for force or displacement increment
  - constitutive and global FEM level iterations
- Newmark for time advancement

Outline

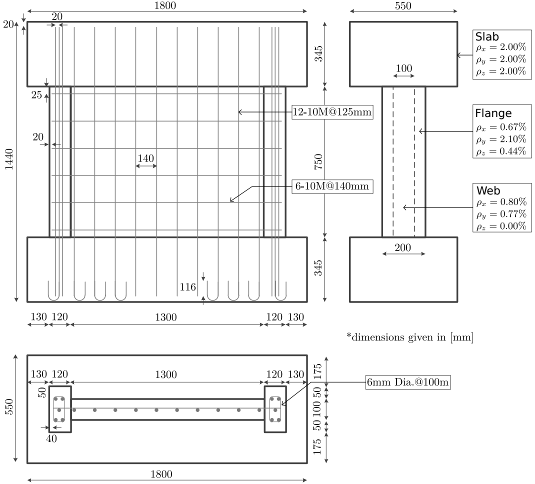
Outline

Model Dimensions and Rebar Plan

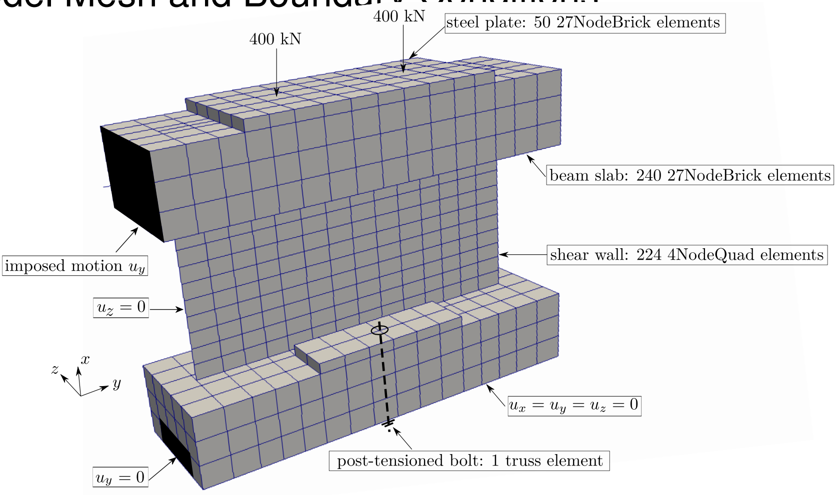
Heavily reinforced top and bottom slabs

Heavily(?) reinforced left and right flanges

Lightly reinforced web with unconfined concrete



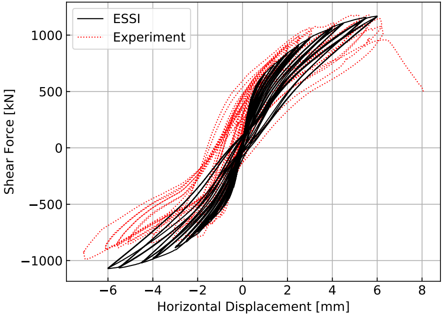
Model Mesh and Boundary Conditions



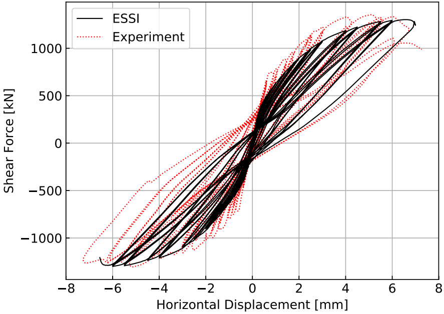
Outline

Force–Displacement Response

- Good match between ESSI simulation and experimental results.
- ASR concrete has a (slightly) higher shear strength.



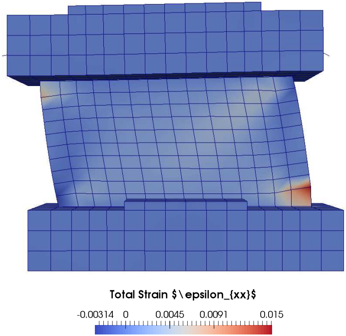
(a) Regular concrete



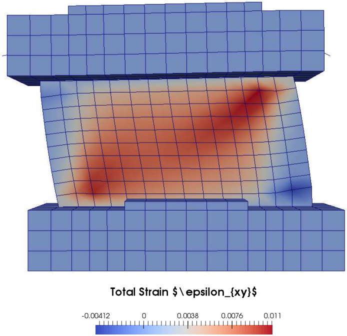
(b) ASR Concrete

Strain Distribution at u_y = 6 mm

- Large tensile and shear strains, small compressive strains
- Large shear strain in a 45° shear zone
- Large tensile/shear strain at bottom corners



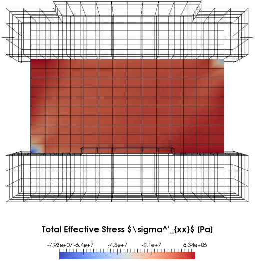
(a) Horizontal normal strain ϵ_{xx}



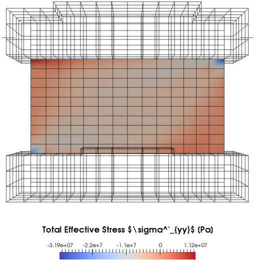
(b) Shear strain ϵ_{xy}

Stress Distribution at $u_y = 6$ mm

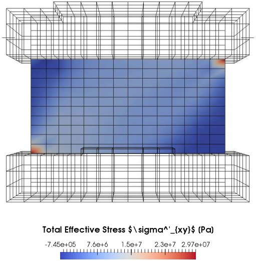
- Stress pattern is consistent with strain plots
- Large tensile, compressive, and shear stresses
- Large stresses at bottom corners and 45° shear zone



(a) Horizontal normal stress σ_{xx}



(b) Vertical normal stress σ_{yy}

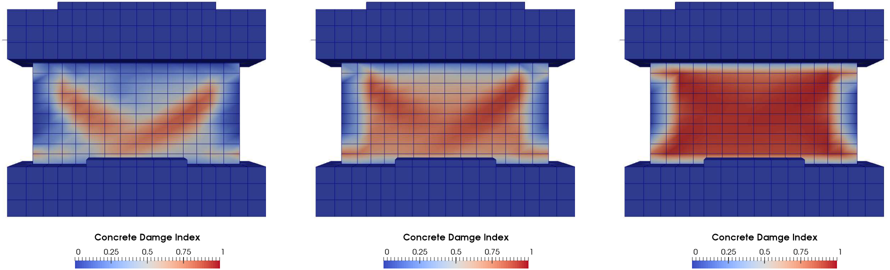


(c) Shear stress σ_{xy}

Outline

Evolution of Concrete Damage

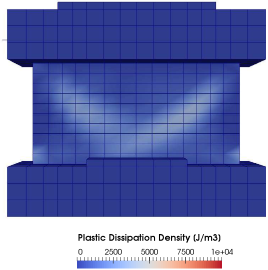
- Significant tensile damage, no compressive damage
- Two 45° tensile/shear damage zones
- Tensile damage zone along the bottom



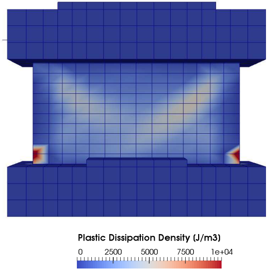
(a) At u_y = 1.4 mm (b) At u_y = 1.8 mm (c) At u_y = 3.0 mm

Evolution of Plastic Dissipation

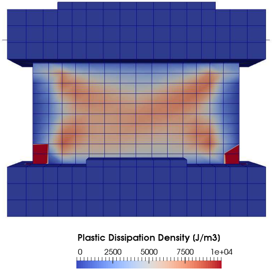
- Large energy dissipation in the damage zones
- Plastic dissipation can increase even after completely damage
- X–shaped zones in the wall and at the corners of flanges



(a) At u_y = 1.4 mm

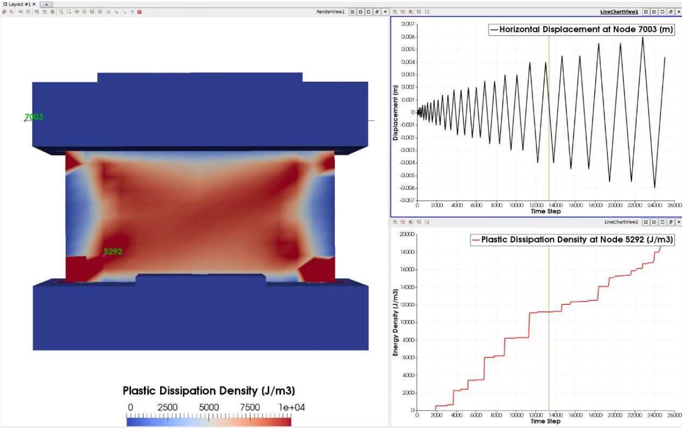


(b) At u_y = 1.8 mm



(c) At u_y = 3.0 mm

Evolution of Plastic Dissipation



(MP4)

Outline

Summary

Practical tool set for practicing engineers

Examples that support practical toolset

Development of Just in Time courses and refreshers

Development of online courses, once a day, few days a week for few hours

ESSI Consultants:
`http://essi-consultants.com/`