OpenSees Software Architecture

Frank McKenna

OpenSees Developers Workshop
Berkeley, CA
August 15, 2006

Sponsored by the National Science Foundation through the Pacific Earthquake Engineering Research Center and through NEESit
What is OpenSees?

The Open System for Earthquake Engineering Simulation is:

- A software *framework* for developing sequential, parallel and grid-enabled simulation applications in earthquake engineering using finite element methods.
- A communication mechanism within PEER and NEES, and beyond, for exchanging and building upon research accomplishments.
- As open-source software, it has the potential for being a community code for earthquake engineering.

http://opensees.berkeley.edu/phpBB2/index.cgi
Main Abstractions in OpenSees

ModelBuilder: Constructs the objects in the model and adds them to the domain.

Domain: Holds the state of the model at time t and (t + dt)

Recorder: Monitors user defined parameters in the model during the analysis.

Analysis: Moves the model from state at time t to state at time t + dt.
What is in a Domain?

An Aggregation

Domain

Element  Node  MP_Constraint  SP_Constraint  LoadPattern  TimeSeries

ElementalLoad  NodalLoad  SP_Constraint

Truss
ZeroLength
ElasticBeamColumn
NonlinearBeamColumn(force, displacement)
BeamWithHinges
Quad(std, bbar, enhanced, u-p)
Shell
Brick(std, bbar, 20node, u-p, u-p-U)
Joint

ExperimentalElement

Constant
Linear
Rectangular
Sine
Path
Some Other Classes associated with Elements:

- GeomTransformation
- Linear
- Pdelta
- Corotational

Element in Global System

Element in Basic System
And some more:

Material

Uniaxial
- Elastic
- ElasticPP
- Hardening
- Concrete
- Steel
- Hysteretic
- PY-TZ-QZ
- Parallel
- Series
- Gap
- FatigueMaterial

nD
- Elastic
- J2
- TemplateElasto-Plasto
- FluidSolidPorous
- PressureMultiYield(dependent, independent)

Section
- Elastic
- Fiber
Fiber Based Beam-Column Modeling
What is an Analysis

Analysis

Solver

StaticAnalysis
TransientAnalysis

CHandler
Numberer
AnalysisModel
SolnAlgorithm
Integrator
SystemOfEqn

Penalty
Lagrange Transformation
RCM
MinDegree

EquiSolnAlgo
Linear
NewtonRaphson
ModifiedNewton
Broyden
BFGS
KrylovNewton
NewtonLineSearch

StaticIntegrator
LoadControl
DispControl
ArcLength
MinUnbalDispNorm

TransientIntegrator
Newmark
HHT

BandGeneral
BandSPD
ProfileSPD
SparseGeneral
SparseSymmetric
Remembering Why We do Finite Element Analysis NCREE frame tested at the Taiwan facility

Centerline model and model with joint comparison