OpenSees: Modelling I

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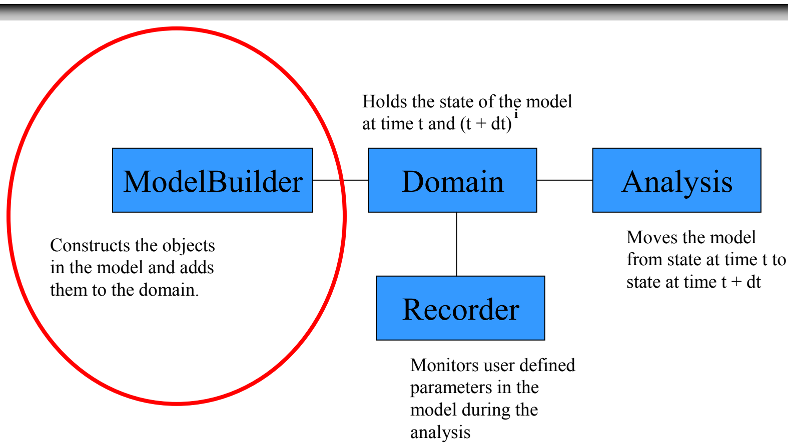
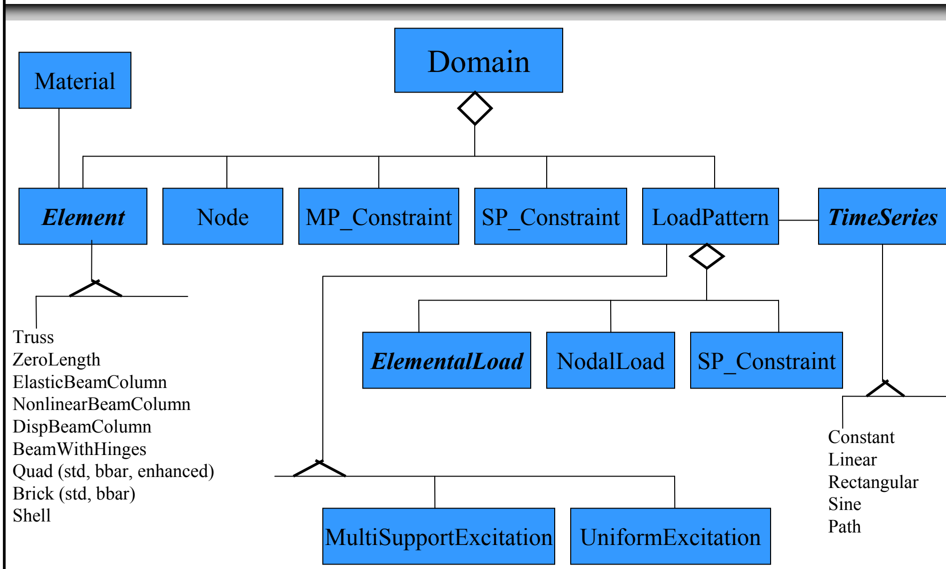
Main Abstractions in OpenSees



Today we focus on model generation with the OpenSees interpreter, i.e. We will create elements/nodes/etc. and add them to the Domain/Model

Domain – only a container



* It is the model builder which constructs these objects.

model command:

*Adds the modelling commands to the interpreter.

- BasicBuilder

$\boxed{\textit{model BasicBuilder –ndm ndm? <-ndf ndf?>}}$

This command now adds the following commands to the interpreter:

node	mass	block2D
element	fix	block3D
pattern	fixX	patch
fix	fixY	layer
equalDOF	fixZ	fiber
pattern	uniaxialMaterial	
load	nDMaterial	
eleLoad	section	
sp	geomTransf	

node command:

*Adds nodes to the domain.

node $nodeTag (ndm $coords) <-mass (ndf $massValues)>

Did you forget to add mass when defining the node?

1. *mass $nodeTag (ndf $massValues)*

2. *wipe*

and start again!

sp constraints:

- to specify movement at individual nodal dof's **Uc_i = value**

•Homogeneous Constraints **$Uc_i = 0$**

Use flags to specify constraint at each dof at a node:

1 – fixed, 0 – free

fix nodeTag? (ndf constraintFlags?)

fixX xCoordinate? (ndf constraintFlags?) <-tol $tol>

fixY xCoordinate? (ndf constraintFlags?) <-tol $tol>

fixZ xCoordinate? (ndf constraintFlags?) <-tol $tol>

•Non-Homogeneous Constraints **Uc_i = value**

sp nodeTag? dofTag? dofValue?

mp constraints:

- to specify how a node moves relative to another node

$$\mathbf{U_c = C_{rc}\, U_r}$$

equalDOF nodeTagR? nodeTagC? dof1? dof2? …

$$[\mathbf{I}]\ [\mathbf{U_{r_i}}] = [\mathbf{U_{c_i}}]$$

rigidDiaphragm perpDirn? nodeTagR? nodeTagC1? nodeTagC2? …

$$\begin{bmatrix} 1 & 0 & -d2 \\ 0 & 1 & d1 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} U_1 \\ U_2 \\ U_{\theta 3} \end{bmatrix} = \begin{bmatrix} U_1 \\ U_2 \\ U_{\theta 3} \end{bmatrix}$$

rigidLink type? nodeTagR? nodeTagC?

valid types:

•rod – for translational dof

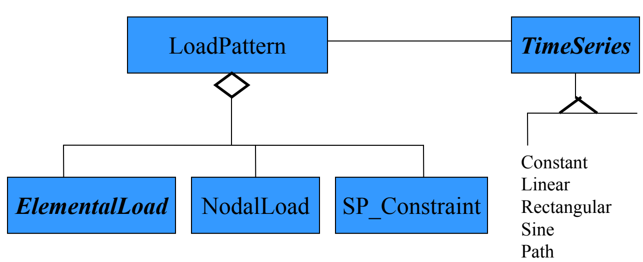
$$\begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} U_d \\ U_\theta \end{bmatrix} = \begin{bmatrix} U_d \\ U_\theta \end{bmatrix}$$

•beam – for all dof

$$\begin{bmatrix} 1 & d \\ 0 & 1 \end{bmatrix} \begin{bmatrix} U_d \\ U_\theta \end{bmatrix} = \begin{bmatrix} U_d \\ U_\theta \end{bmatrix}$$

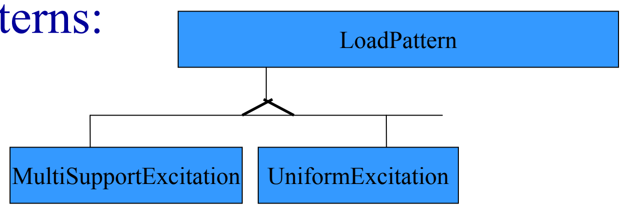
loads & load patterns:

* to add loads to the domain



pattern Plain $tag (TimeSeriesType arguments) {
load $nodeTag (ndf $loadValues)
sp $nodeTag dof? value?
eleLoad type? …
….
}

more patterns:



- Uniform Excitation – specfy ground acceleration

pattern UniformExcitation $tag $dir -accel (TimeSeriesType arguments)

- Multi-Support Excitation – specify nodal response at supports

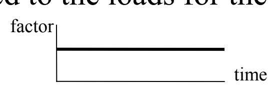
pattern MultipleSupport $tag {
groundMotion (groundMotion-command arguments)
imposedMotion $nodeTag $dirn $gMotionTag
…
}

groundMotion $gMotionTag Plain <-accel (accelSeriesType accelArgs)> <-vel (velSeriesType velArgs)> <-disp (dispSeriesType dispArgs)> <-int (IntegratorType intArgs)>

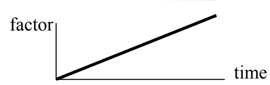
time series:

- specifies the load factor applied to the loads for the domain time

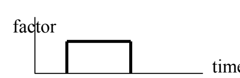
Constant <-factor $cFactor>



Linear <-factor $cFactor>



Rectangular $tStart $tFinish <-factor $cFactor>



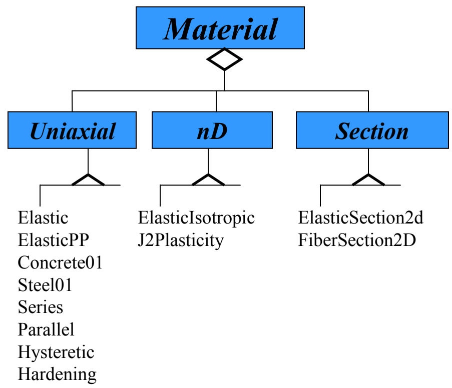
Sine $tStart $tFinish $period <-shift $shift> <-factor $cFactor>

Series -dt $dt -filePath $fileName <-factor $cFactor>

Series -fileTime $fileName1 -filePath $fileName2 <-factor $cFactor>

material commands:

- Adds the materials to the model builder.
- Each element makes copies of it's own materials



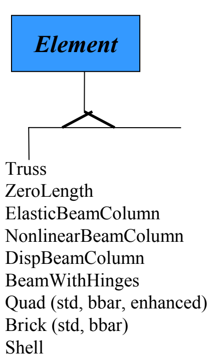
uniaxialMaterial $type ($args)

nDMaterial $type ($args)

section $type ($args)

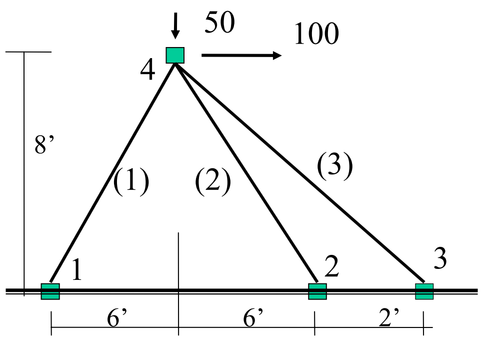
element commands:

- Adds the elements to the model.



element $type ($args)

Example 1: Simple Truss



	E	A
1	3000	10
2	3000	5
3	3000	5

OpenSees