

Heat Transfer and Fire Models in OpenSEES

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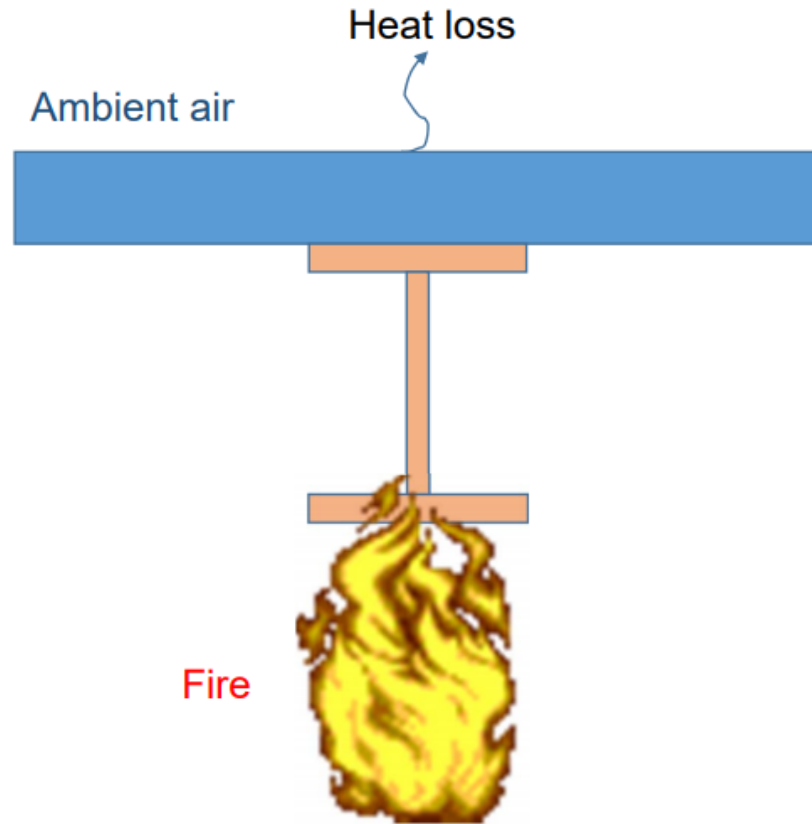


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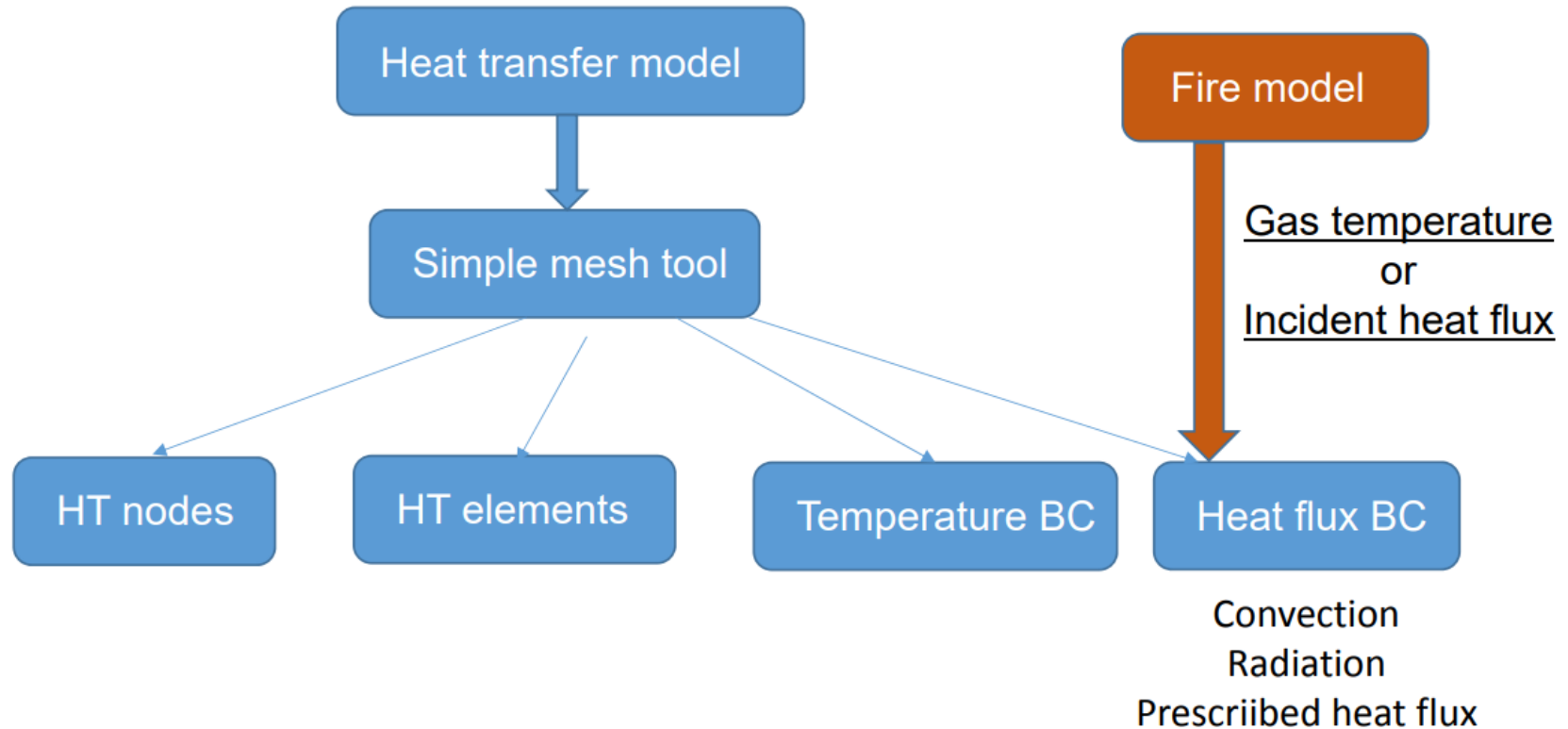
Heat transfer in OpenSEES

A typical heat transfer problem in structure



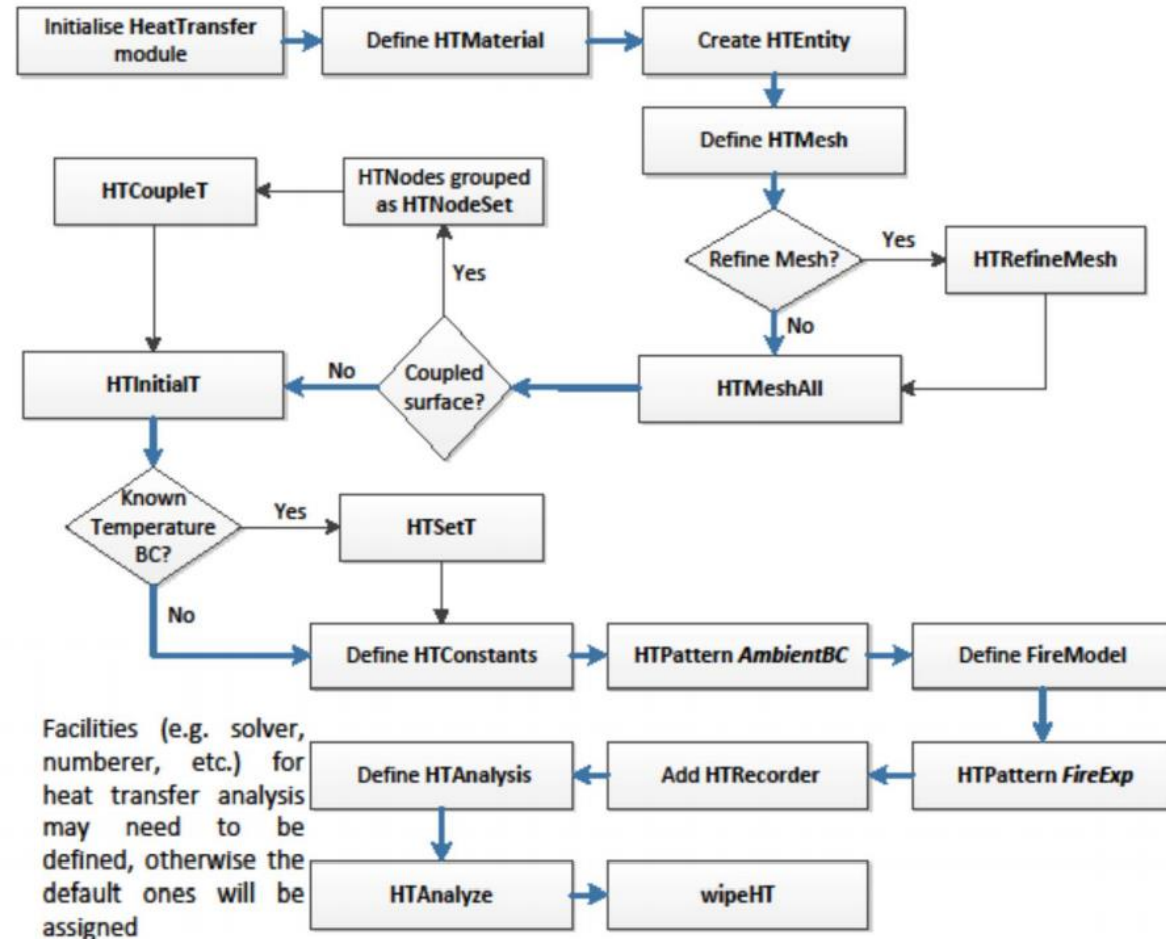
Heat transfer in OpenSEES

Development for Heat Transfer Analysis

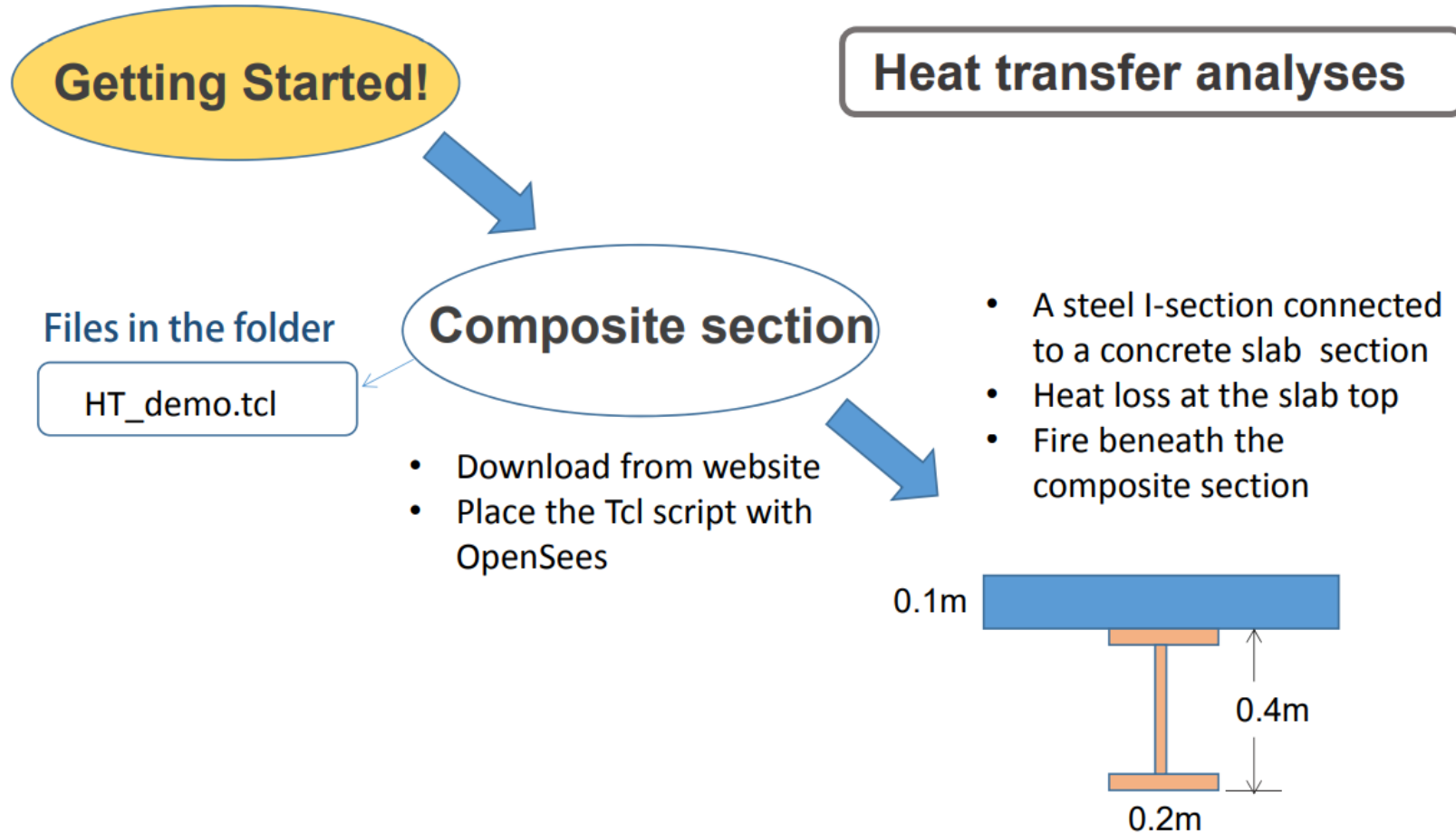


Heat transfer in OpenSEES

Heat transfer analysis flowchart



Heat transfer in OpenSEES



HT_demo.tcl

```
wipe;
```

Clear the domain

```
HeatTransfer 2D;
```

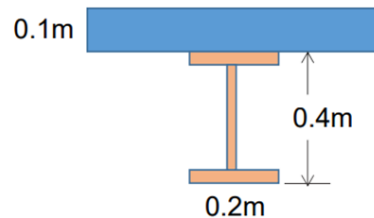
2D section analysis

```
HTMaterial CarbonSteelEC3 1;
```

Heat transfer material

```
HTMaterial ConcreteEC2 2;
```

```
HTMaterial $materialType $materialTag <$par_1...$par_n>
```



```
HTEntity Isection 1 0.0 0.2 0.2 0.40 0.02 0.02;
```

```
HTEntity Block 2 0.0 0.45 0.6 0.1;
```

HTEntity definition

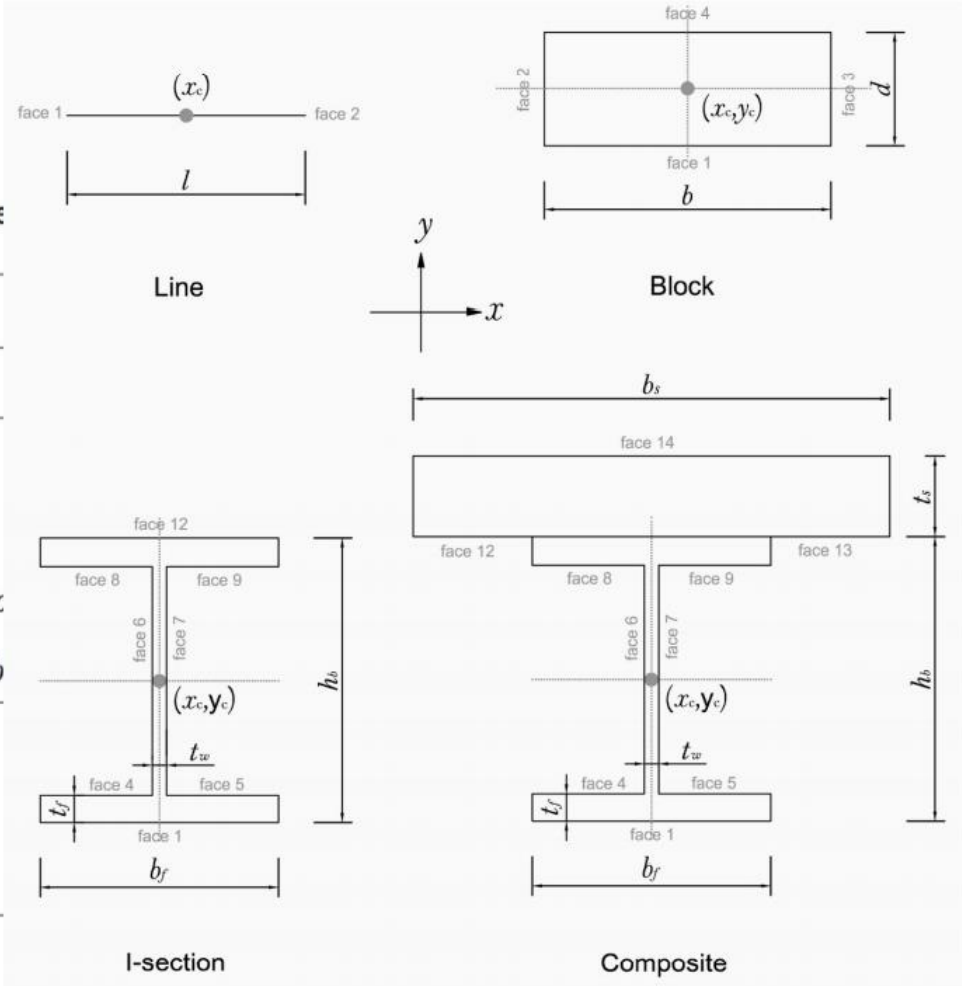
```
HTEntity $EntityType $EntityTag $centre_x $centre_y $dim_1  
<$dim_2..$dim_n>
```



HTEntity Definition

Table A.1: Commands for creating a heat transfer e

Type	HTEntity	Centroid	Dimension
1D	Line	x_c	l
	Block	x_c, y_c	b, d
2D	Isection	x_c, y_c	b_f, h_b, t_w, t_f
	IsectionPro	x_c, y_c	b_f, h_b, t_w, t_f, c_c
	Composite	x_c, y_c	b_f, h_b, t_w, t_f, b_s
	Brick	x_c, y_c	b, d
3D	Isection3D	x_c, y_c, z_c	b_f, h_b, t_w, t_f
	Composite3D	x_c, y_c, z_c	b_f, h_b, t_w, t_f



HT_demo.tcl

```
HTMesh 1 1 1 -phaseChange 0 -MeshCtrls 0.01 0.005 0.005 0.014
```

```
HTMesh 2 2 1 -phaseChange 1 -MeshCtrls 0.02 0.02
```

Mesh definition

```
HTRefineMesh -Entity 2 -SeedTag 1 4 -space 0.02 10 0.01 9 0.005 4 0.01 9 0.02 10;
```

```
HTMeshAll;
```

Do the mesh now

Refine mesh to match the interface nodes

```
SetInitialT 293.15;
```

Initialise temperature

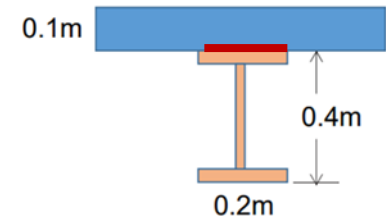
```
HTNodeSet 1 -Entity 1 -face 12;
```

HTNodeSet

```
HTNodeSet 2 -Entity 2 -face 1 -locx -0.1 0.1;
```

```
HTCoupleT -NodeSet 1 2;
```

Coupling nodal temperature



HT_demo.tcl

```
HTConstants 1 4.0 293.15 0.7 5.67e-8 0.7 ;
```

```
HTConstants 2 25.0 293.15 0.7 5.67e-8 0.7;
```

Heat transfer coefficients

```
HTPattern AmbientBC 1 {
```

```
    HeatFluxBC -HTEntity 2 -faceTag 4 -type ConvecAndRad -HTConstants 1;
```

```
}
```

Heat flux BC for the unexposed surface



HT_demo.tcl

```
FireModel standard 1;
```

Heat transfer coefficients

```
HTNodeSet 3 -Entity 2 -Locx -0.3 -0.1;
```

```
HTEleSet 1 -Entity 2 -NodeSet 3 -face 1;
```

```
HTNodeSet 4 -Entity 2 -Locx 0.1 0.3;
```

```
HTEleSet 2 -Entity 2 -NodeSet 4 -face 1;
```

Nodal selection
Element selection

```
HTPattern fire 2 model 1 {
```

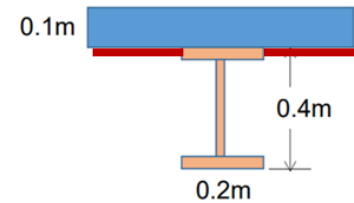
```
HeatFluxBC -HTEntity 1 -face 1 4 5 6 7 8 9 -type ConvecAndRad -HTConstants 2;
```

```
HeatFluxBC -HTEleSet 1 -face 1 -type ConvecAndRad -HTConstants 2;
```

```
HeatFluxBC -HTEleSet 2 -face 1 -type ConvecAndRad -HTConstants 2;
```

```
}
```

Heat flux BC for exposed
surfaces



HT_demo.tcl

```
HTNodeSet 5 -Entity 1 -face 6;  
HTNodeSet 6 -Entity 2 -Locx [expr 0] -Locy [expr -0.05] [expr 0.05];
```

#Recorder

```
HTRecorder -file temp0.out -NodeSet 5;  
HTRecorder -file temp1.out -NodeSet 6;
```

Heat transfer recorder

```
HTAnalysis HeatTransfer
```

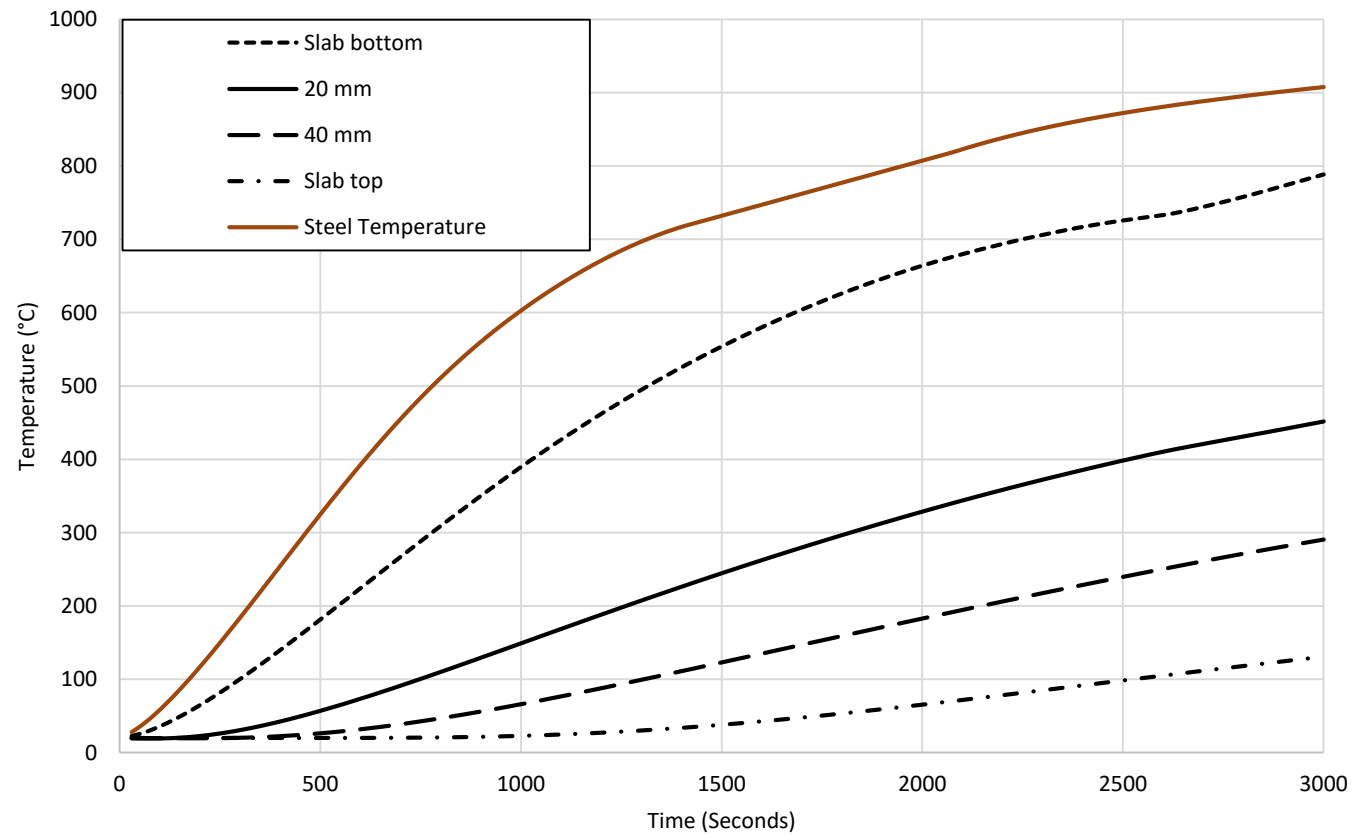
```
HTAnalyze 100 30;
```

```
wipeHT;
```

Heat transfer analysis control
(100 steps, 30s each step)



Temperature history



Fire Models in OpenSEES

- Standard Fire Model
- Hydrocarbon Fire Model
- Parametric Fire Model
- Travelling Fire Model
- Used Defined Fire Models



Thank You

