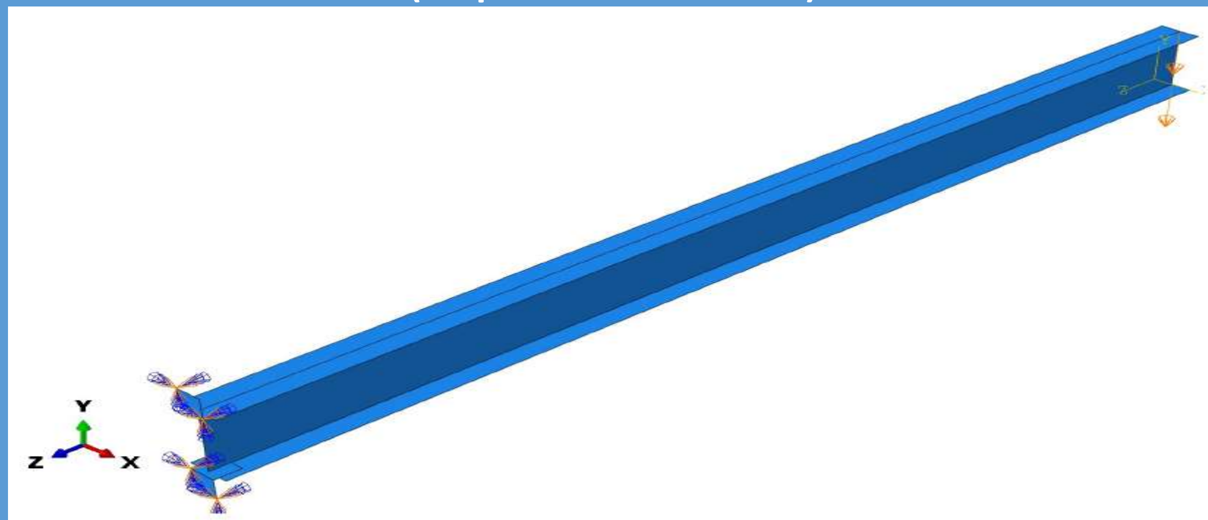
>> IN THE NAME OF GOD <<

Pushover Analysis of Steel Section Cantilever Beam with Semi-rigid Connection in MATLAB and ABAQUS (Displacement Control)



MATLAB Program is Verified by S ABAQUS v.2017

MATLAB program is written by Salar Delavar Ghashghaei - Date of Publication: 06/June/2017

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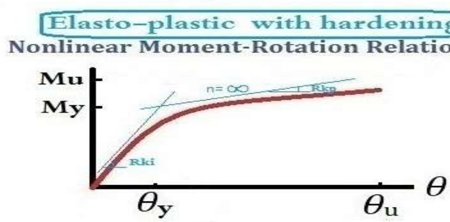
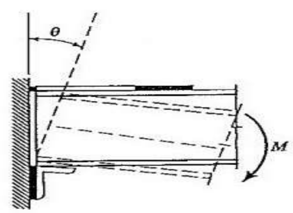
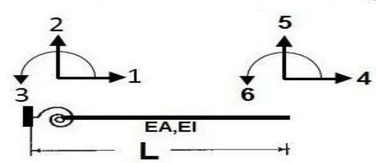




$$M(\theta) = \frac{(R_{ki}-R_{kp})\theta}{\left(1+\left(\left|\frac{R_{ki}\theta}{M_y}\right|\right)^n\right)^{\frac{1}{n}}} + R_{kp}\theta \quad \therefore\ R_{ki} = \frac{M_y}{\theta_y} \quad \therefore\ R_{kp} = \frac{M_u-M_y}{\theta_u-\theta_y}$$

Nonlinear stiffness-Rotation Relation

$$K(\theta) = \frac{(R_{ki}-R_{kp})}{\left(1+\left(\left|\frac{R_{ki}\theta}{M_y}\right|\right)^n\right)^{\frac{1}{n}}} + R_{kp}$$



Define Parameters:

```
% Define Parameters in unit: mm,kN
L=3000;% [mm] length of Beam
P3=0; % [kN.mm]
P4=0; % [kN]
P5=0; % [kN] Incremental Loading [DOF (5)]
P6=0; % [kN.mm]
D5=1;% [mm] Initial Displacement  [DOF (5)] Incremental Displacement
D5max=250; % [mm] Maximum displacement [DOF (5)]
%% Section Properties - IPE 220
tf=9.2;% [mm] I section thickness on flange
bf=110;% [mm] I section width on flange
tw=5.9;% [mm] I section thickness of Web
hw=201.6;% [mm] Height of web
%% Steel Properties
fy =0.3723;% [kN/mm^2] Yield strength of steel
fu =0.5114;% [kN/mm^2] Ultimate strength of steel
Es =200;% [kN/mm^2] Modulus of elasticity of steel
ey=fy/Es;% Yield strain of steel
eu=.14;% Ultimate strain of steel
d=2*tf+hw;
Ie=((tw*hw^3)/12)+((bf*tf^3)/12)+2*((bf*tf)*(0.5*(d-tf))^2);
EI= Es*Ie; % [kN.mm^2]
EA = Es*(2*(tf*bf)+(tw*hw)); % [kN]
%% Connection Behavior
ty=.001; % Yield rotation
My=2*70*7*fy*d; % [kN.mm] Yield moment
tu=.6; % Ultimate rotation
Mu=2*70*7*fu*d;  % [kN.mm] Ultimate moment
n = 9; % Moment-rotation shape parameter
lanX=1;lanY=0;
DU=50; % [mm] Ultimate displacement
m = 4000; % number of calculation
itermax = 5000;% maximum number of iterations
tolerance = 1e-12; % specified tolerance for convergence
% Element stiffness first-order coefficient
A=4*EI/L;B=6*EI/L^2;C=2*EI/L;D=12*EI/L^3;G=EA/L;
```

Analysis Report:

(+)Increment 1 : It is converged in 4 iteration
(+)Increment 2 : It is converged in 4 iteration
(+)Increment 3 : It is converged in 5 iteration

(+)Increment 4 : It is converged in 5 iteration
(+)Increment 5 : It is converged in 5 iteration
(+)Increment 6 : It is converged in 6 iteration
(+)Increment 7 : It is converged in 6 iteration
(+)Increment 8 : It is converged in 6 iteration
(+)Increment 9 : It is converged in 7 iteration
(+)Increment 10 : It is converged in 7 iteration
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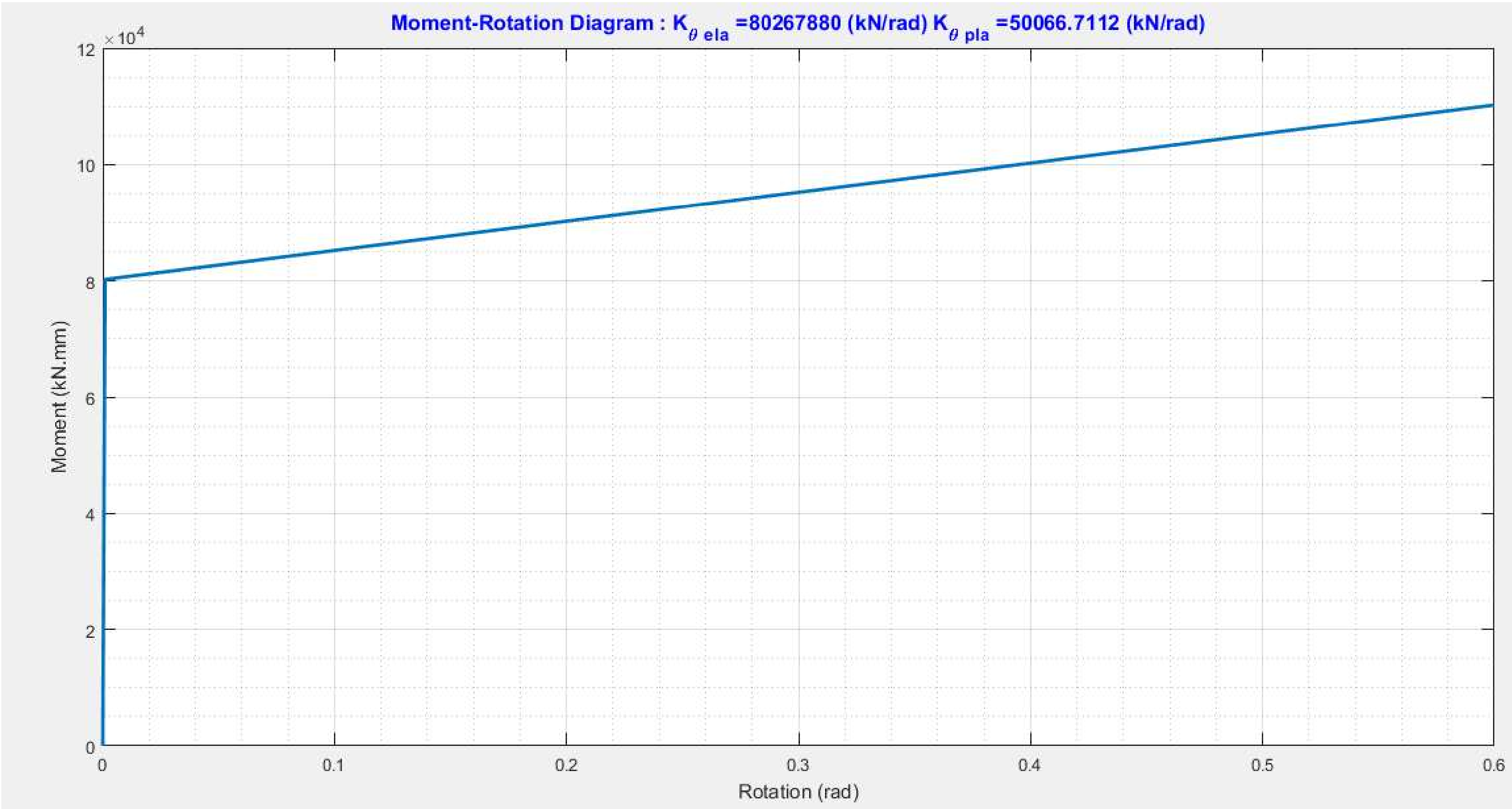
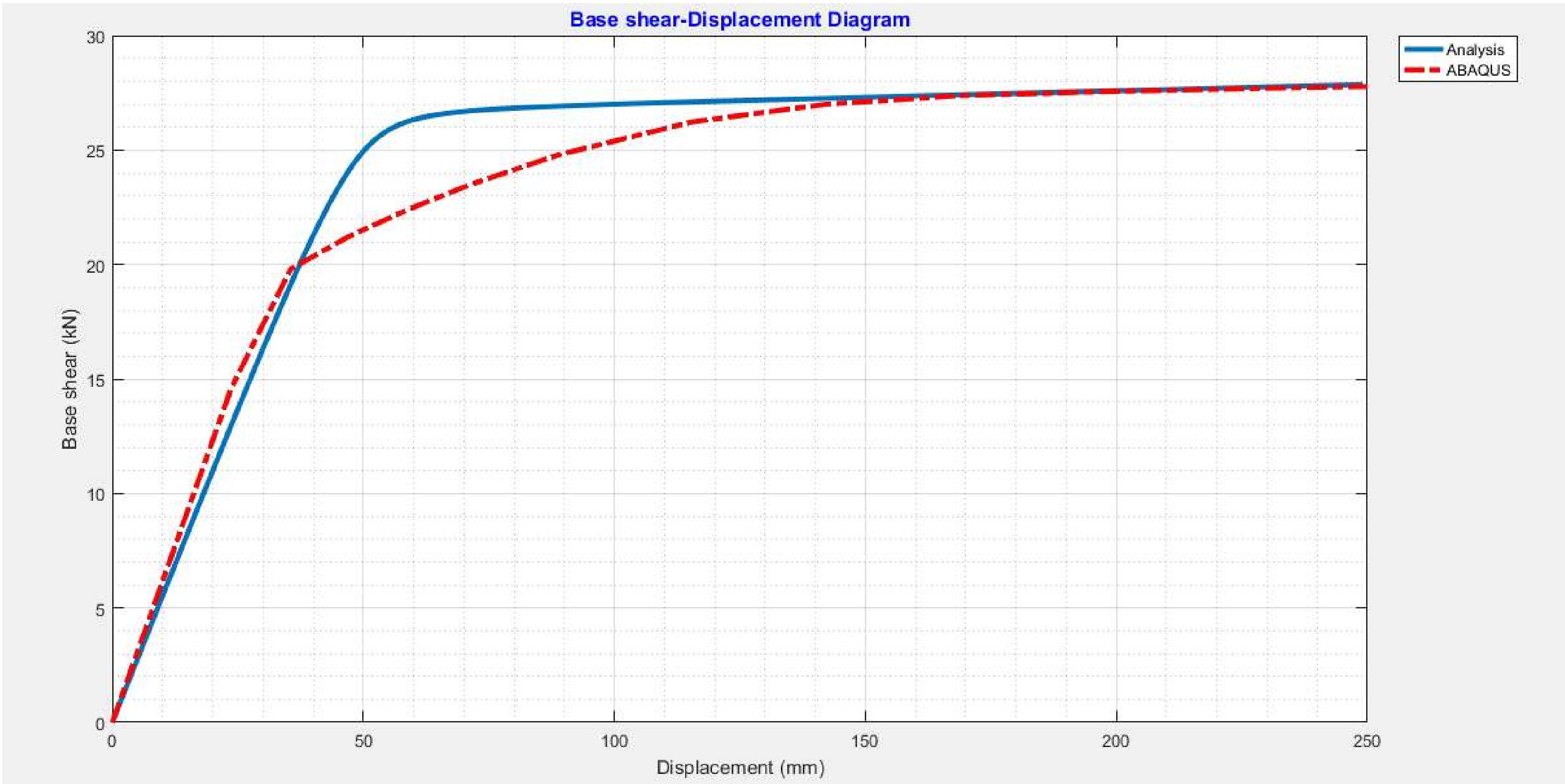
.
(+)Increment 240 : It is converged in 13 iteration
(+)Increment 241 : It is converged in 13 iteration
(+)Increment 242 : It is converged in 13 iteration
(+)Increment 243 : It is converged in 13 iteration
(+)Increment 244 : It is converged in 13 iteration
(+)Increment 245 : It is converged in 13 iteration
(+)Increment 246 : It is converged in 13 iteration
(+)Increment 247 : It is converged in 13 iteration
(+)Increment 248 : It is converged in 13 iteration
(+)Increment 249 : It is converged in 13 iteration
(+)Increment 250 : It is converged in 13 iteration
Displacement reached to Ultimate Displacement

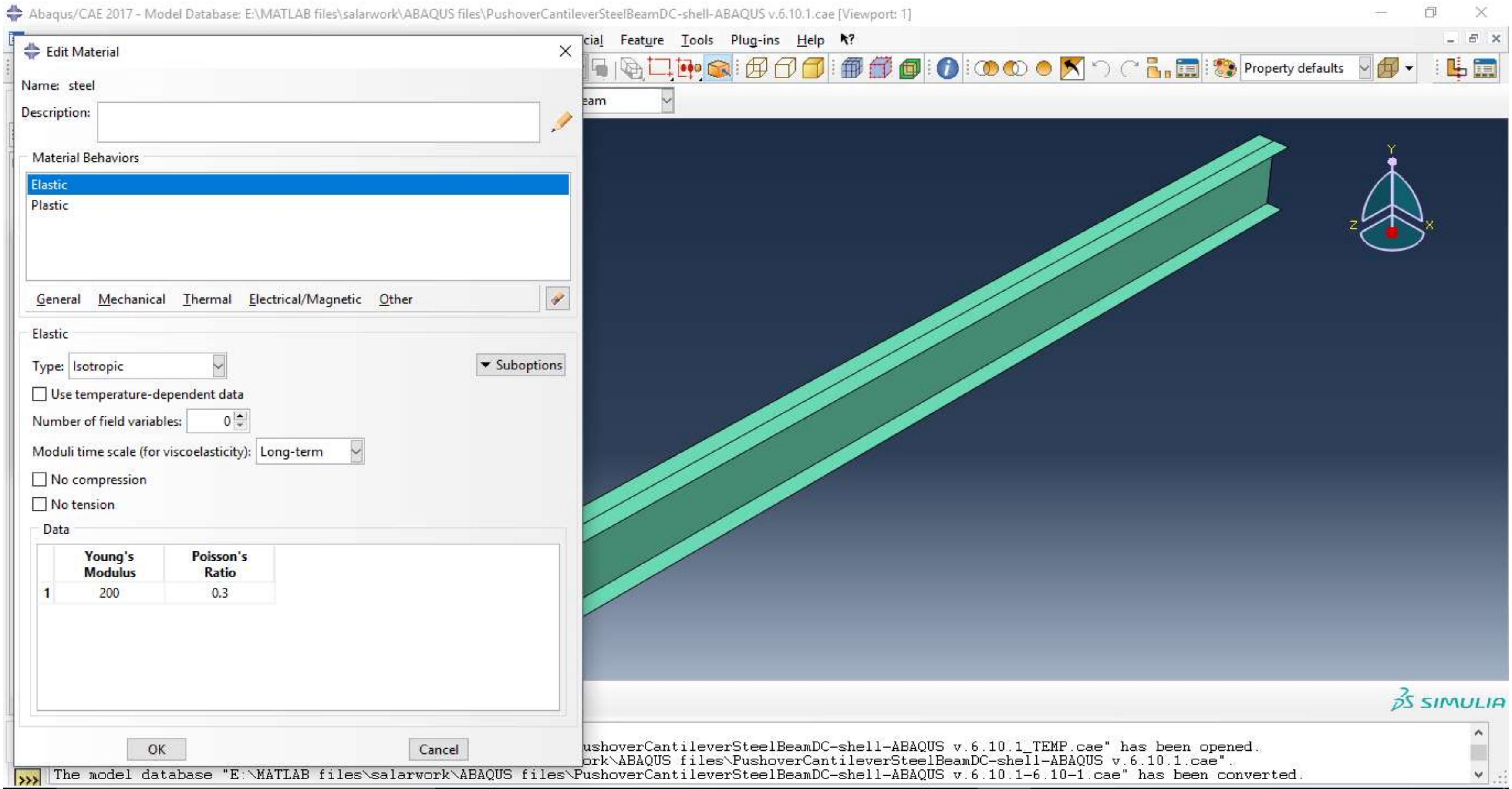
Plot :



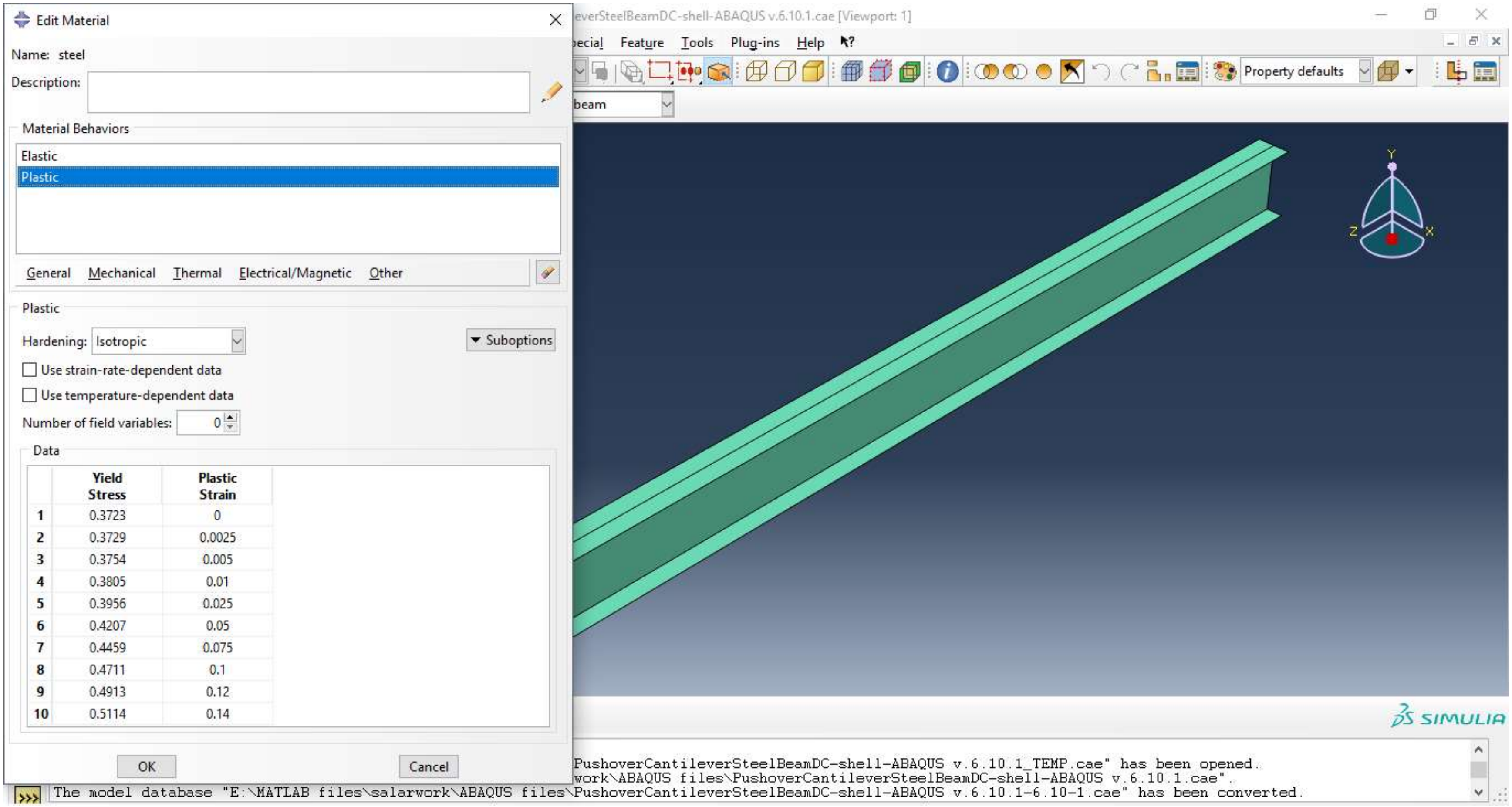
Figure(1) Moment-Rotation behavior of semi-rigid connection in MATLAB



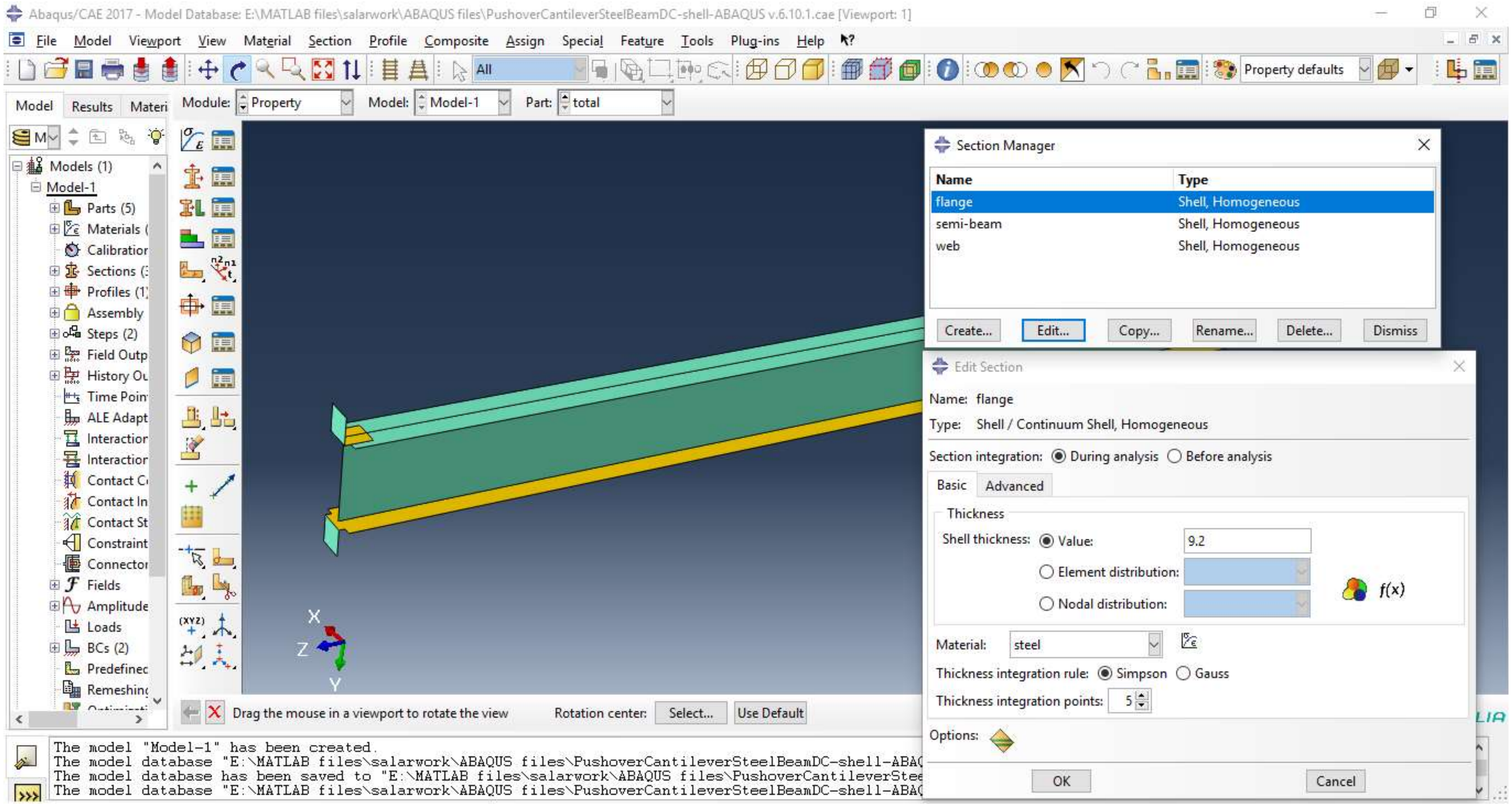
Figure(2) Base shear-Displacement result in MATLAB and ABAQUS



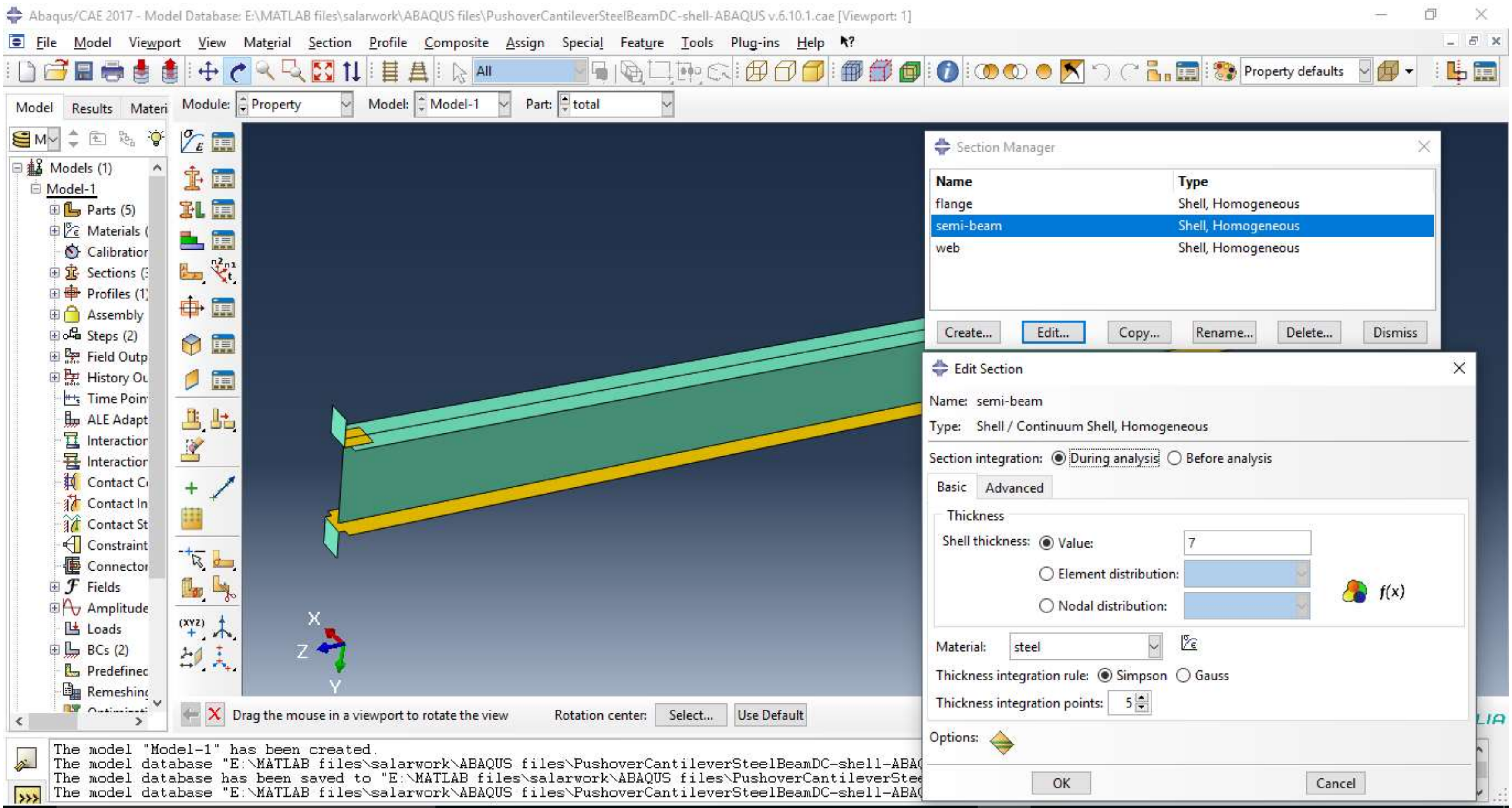
Figure(3) Elastic material properties in ABAQUS



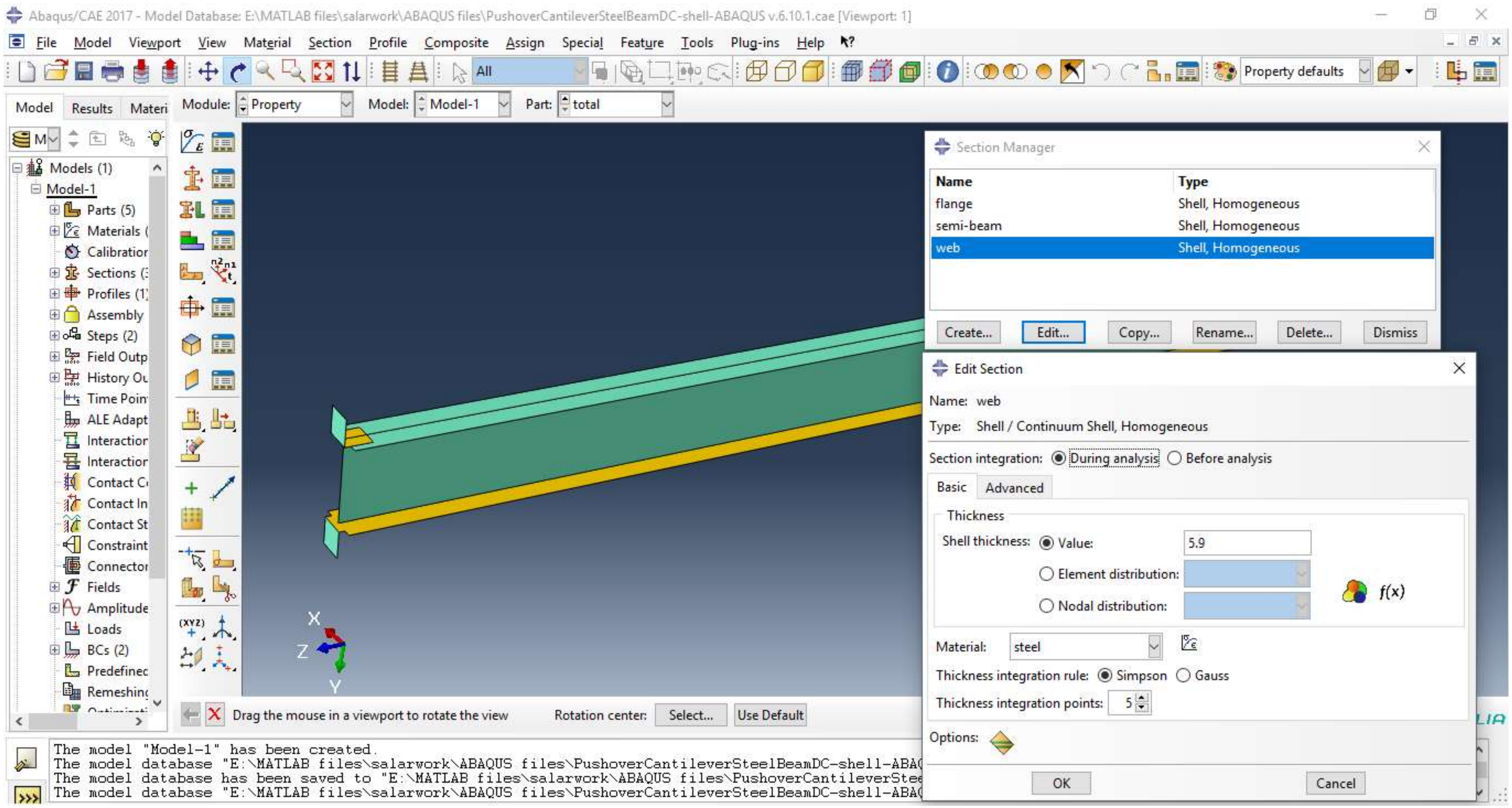
Figure(4) Plastic material properties in ABAQUS



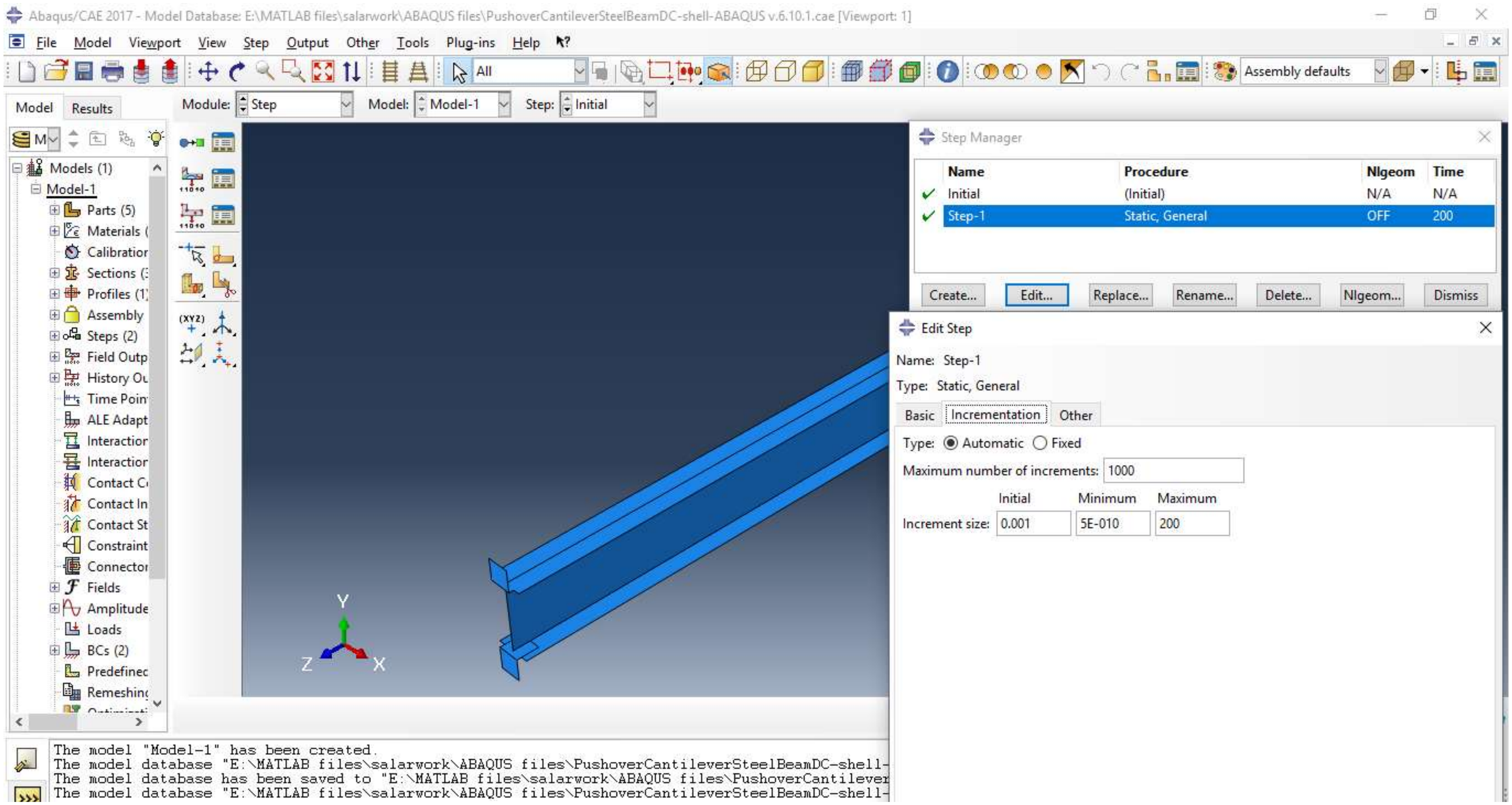
Figure(5) Definition of flange thickness in ABAQUS



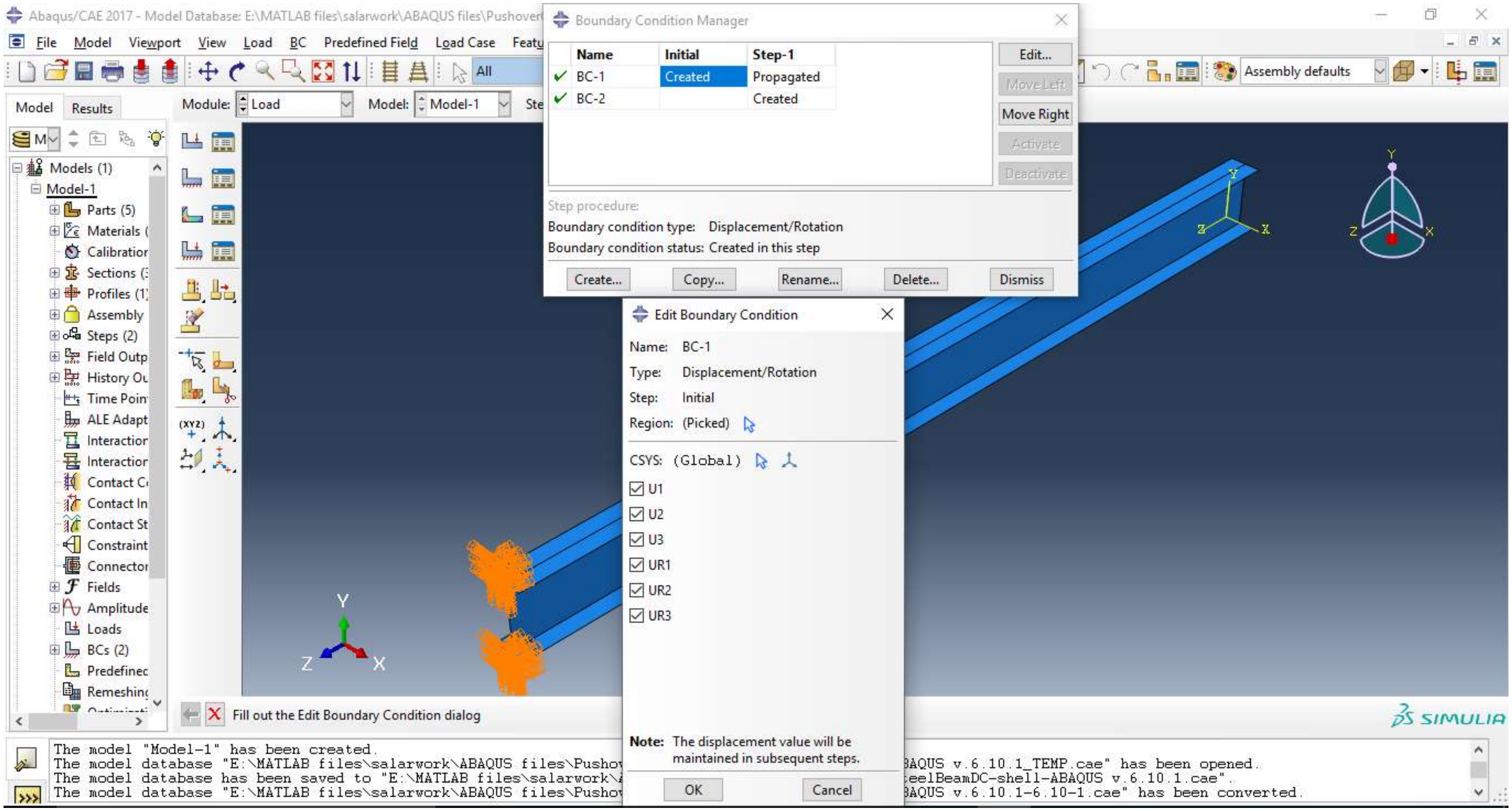
Figure(6) Definition of semi-rigid connection thickness in ABAQUS



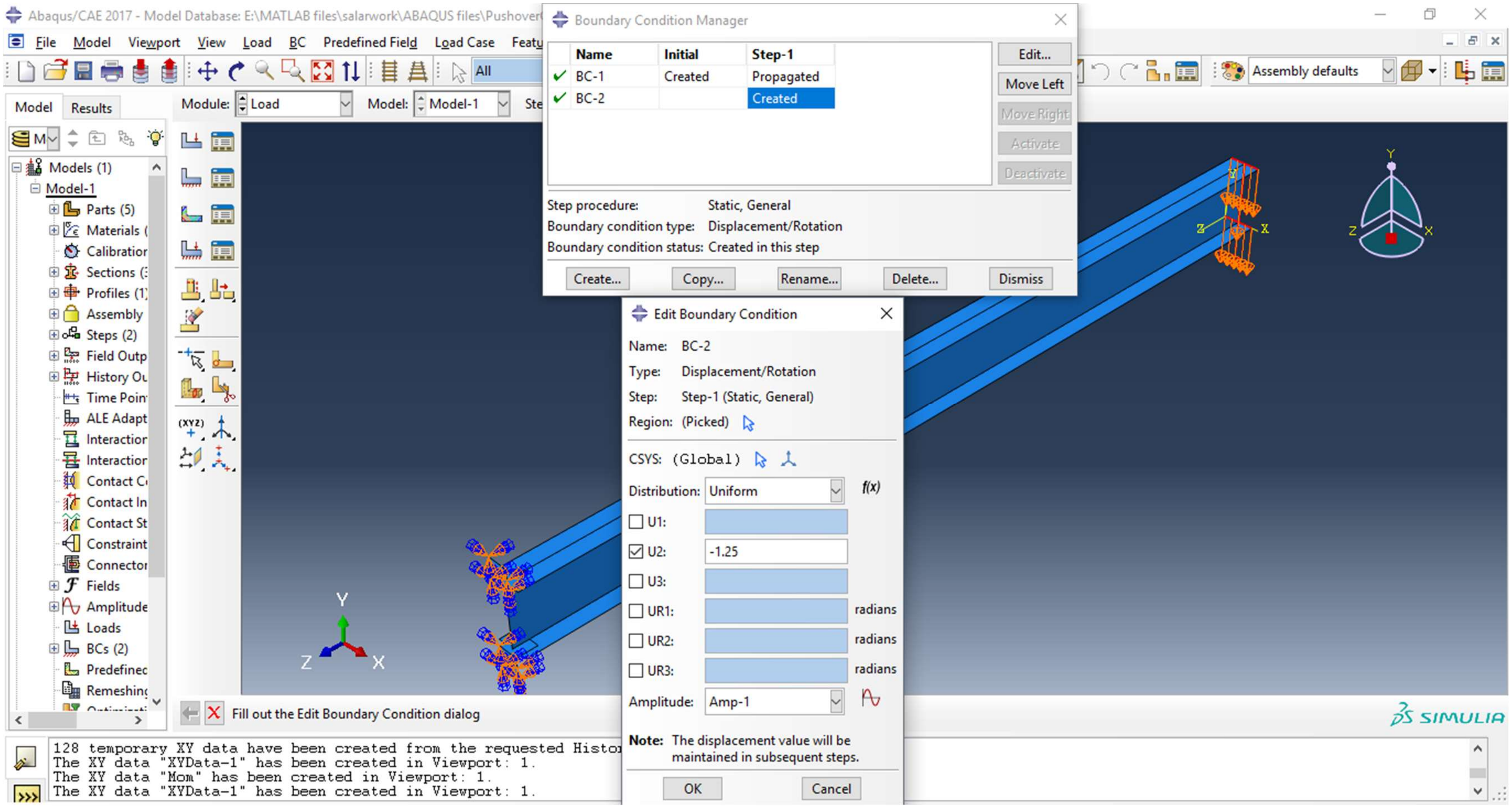
Figure(7) Definition of web thickness in ABAQUS



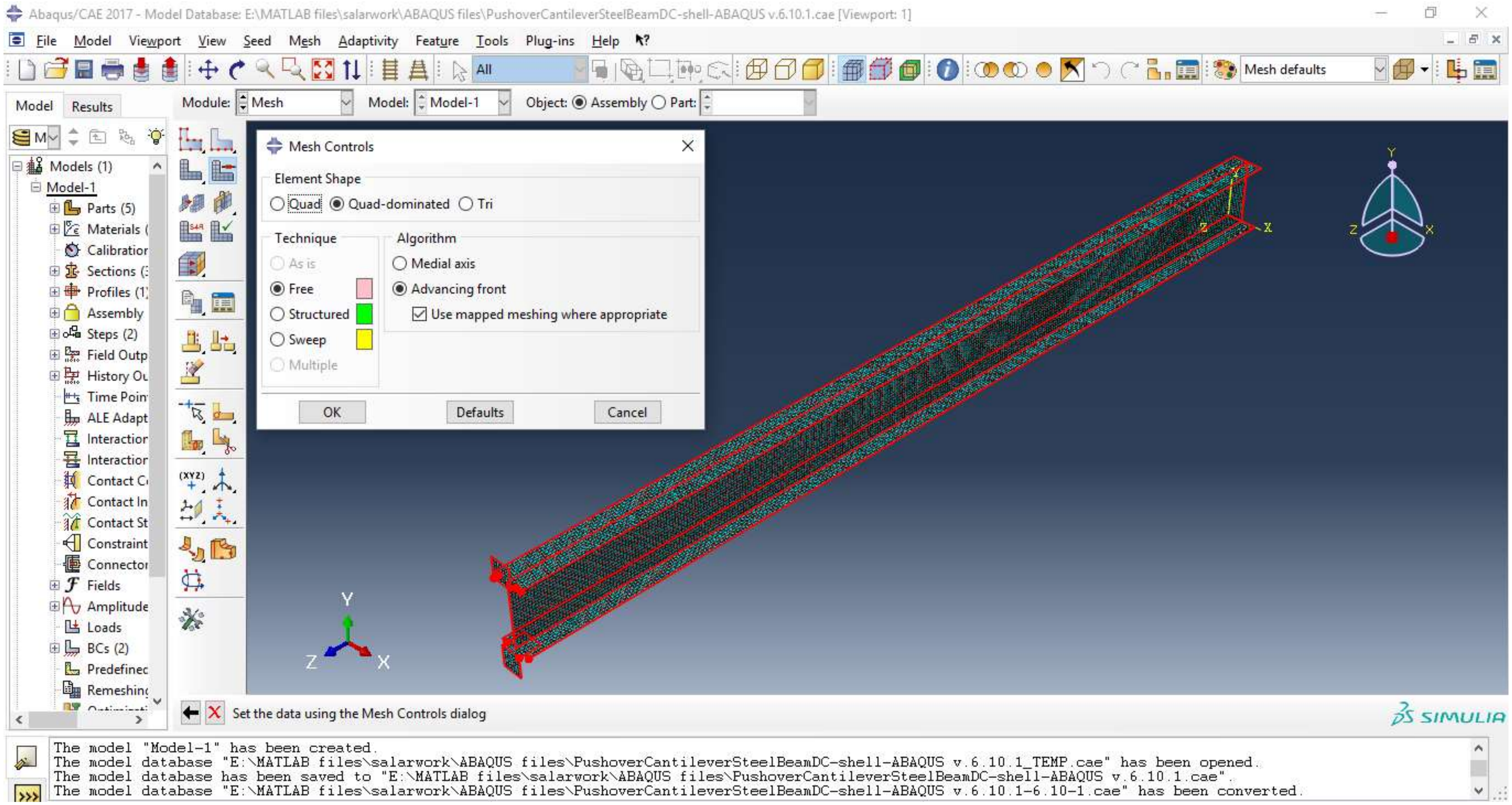
Figure(8) Definition of static analysis in ABAQUS



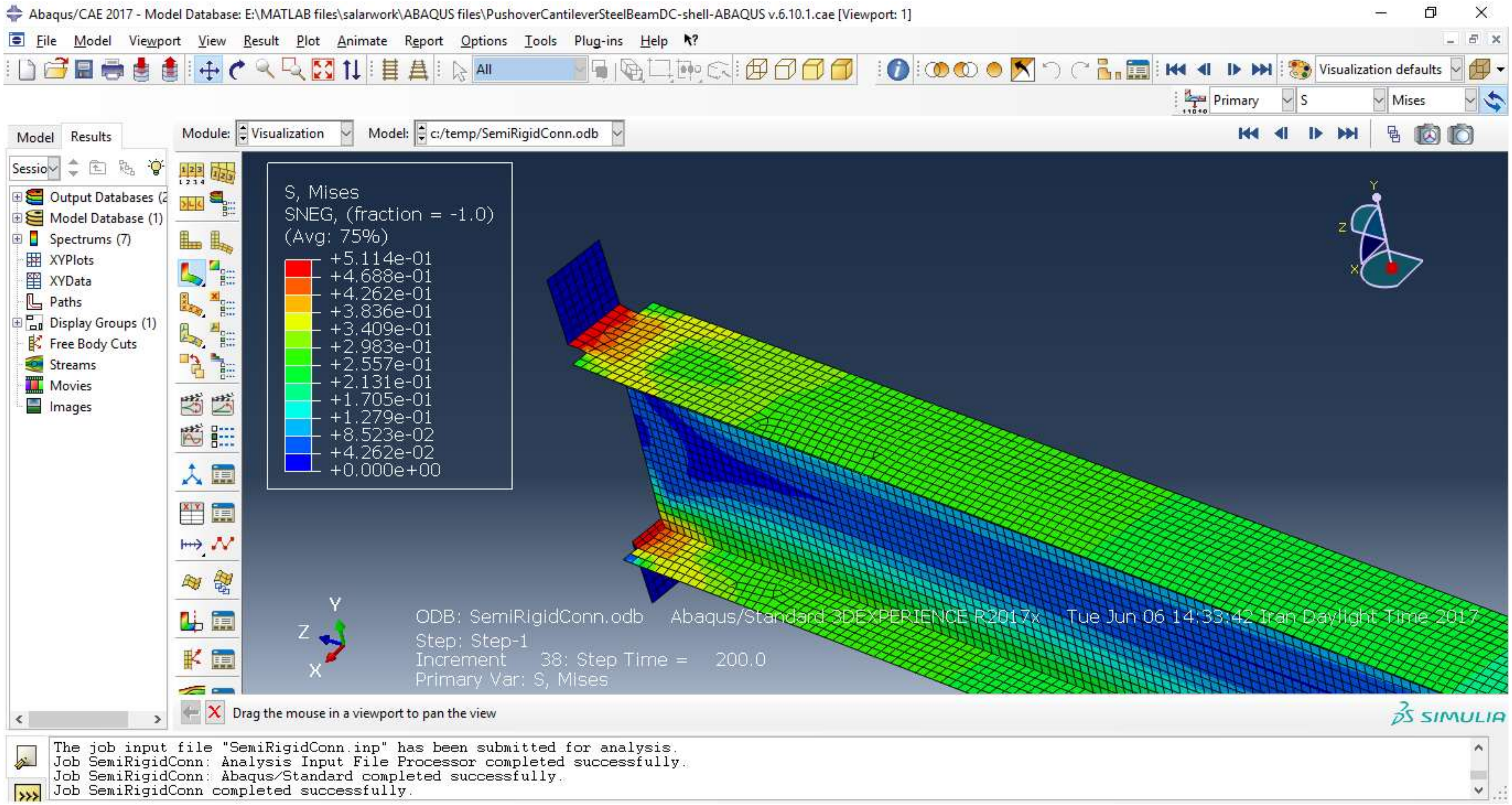
Figure(9) Definition of boundary condition in ABAQUS



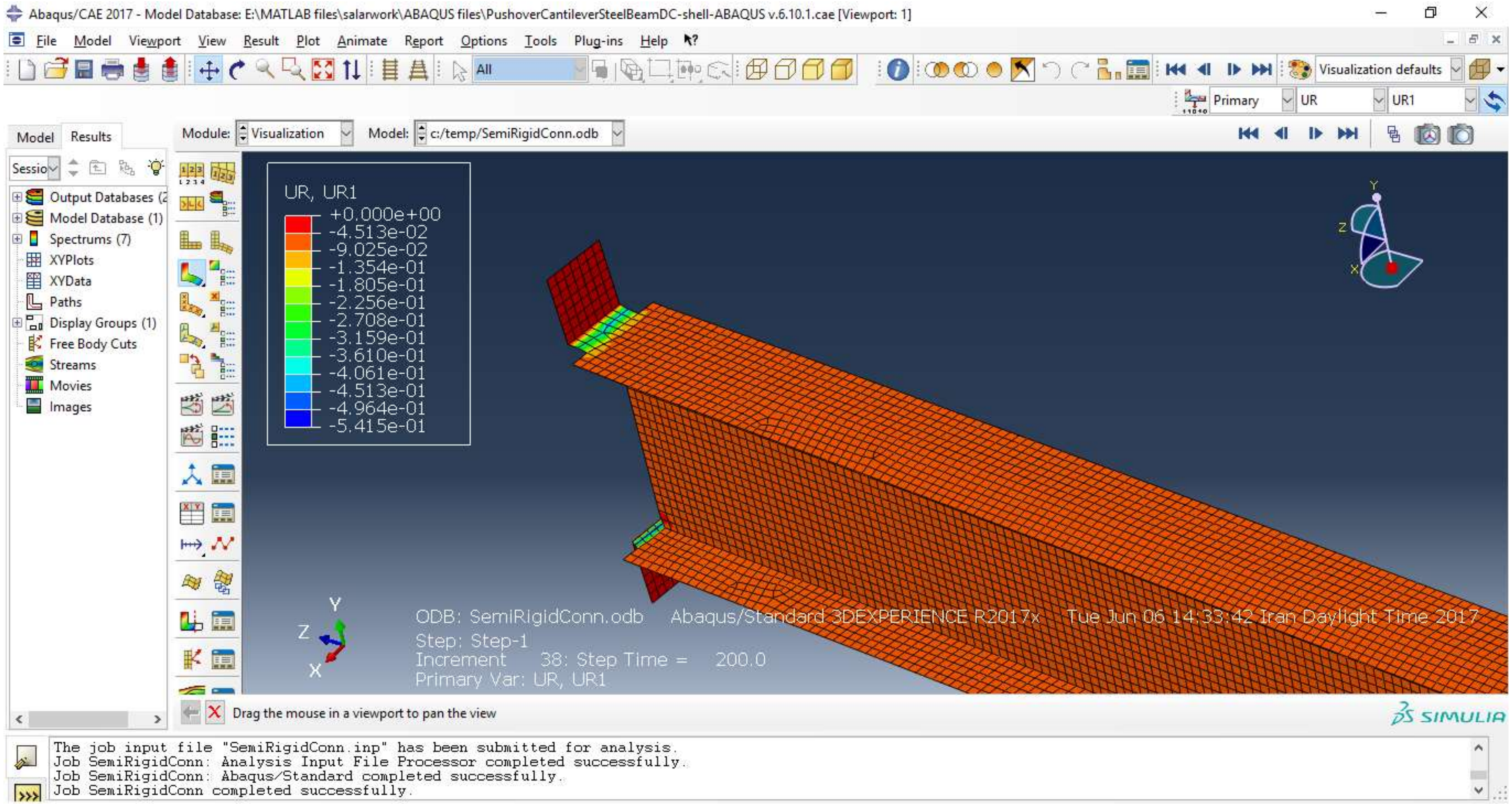
Figure(10) Definition of boundary condition incremental displacement in ABAQUS



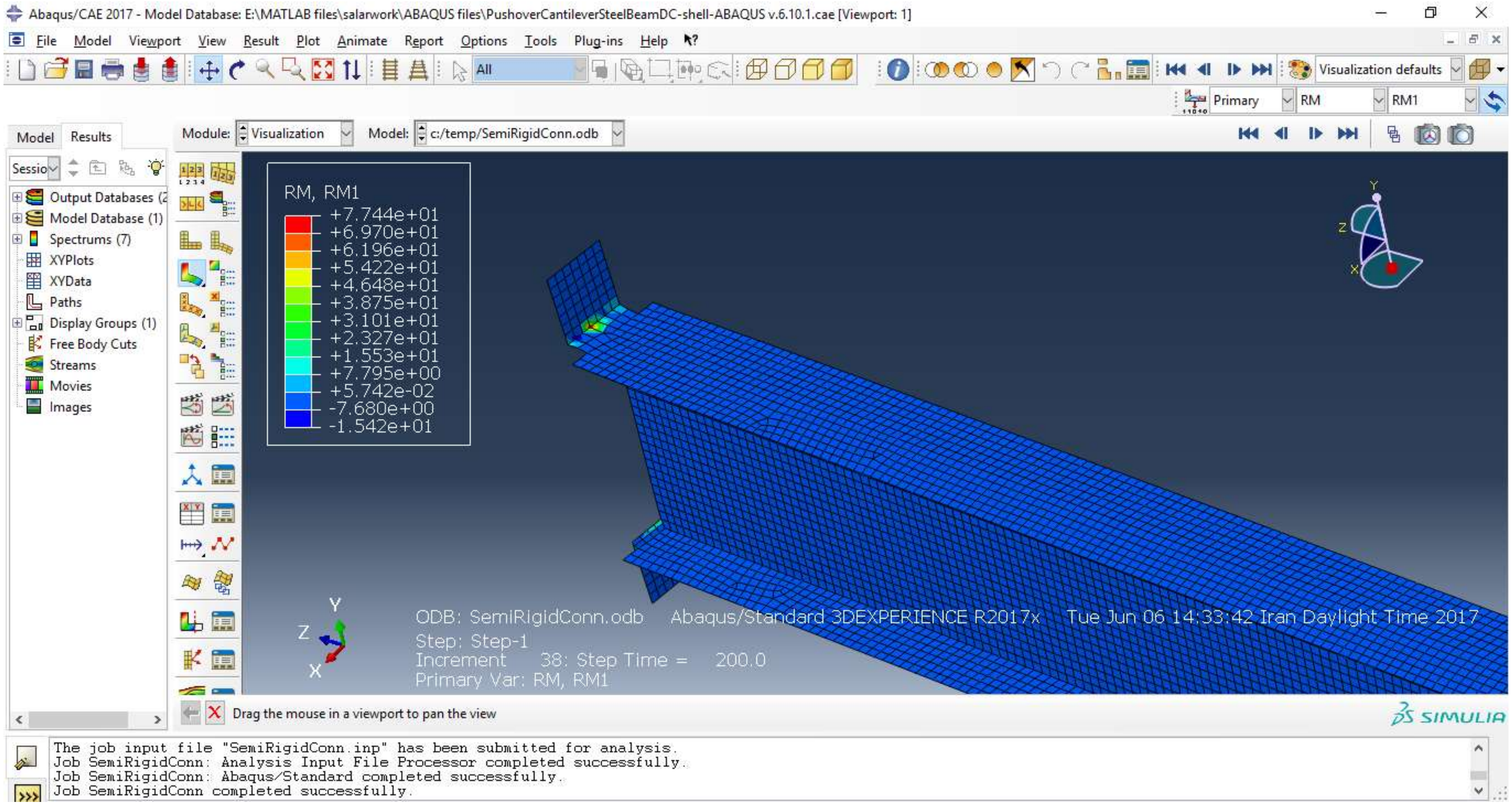
Figure(11) Definition of mesh in ABAQUS



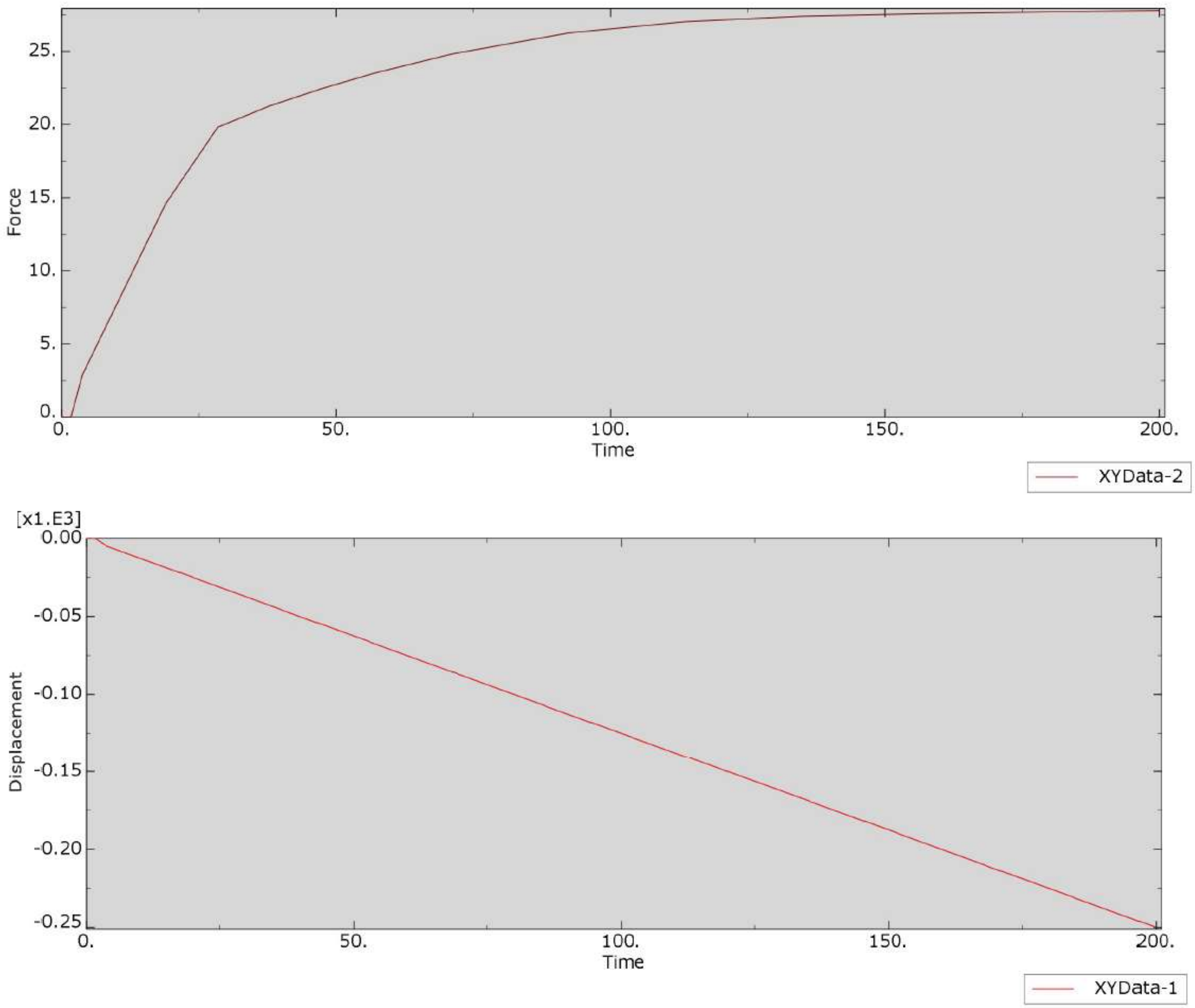
Figure(12) Von-Mises of connection in ABAQUS



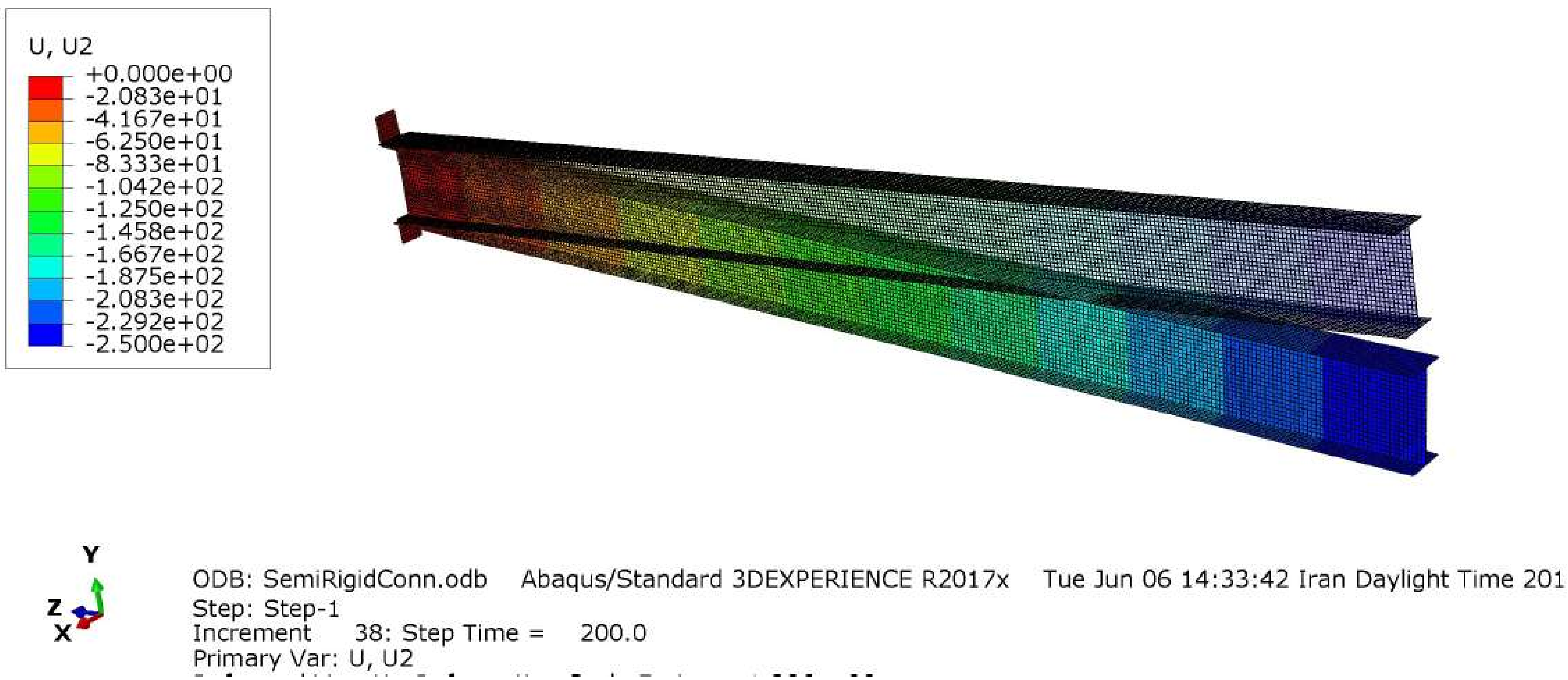
Figure(13) Rotation of connection in ABAQUS



Figure(14) Moment of connection in ABAQUS



Figure(15) Base shear - Displacement result in ABAQUS



Figure(16) Displacement result in ABAQUS