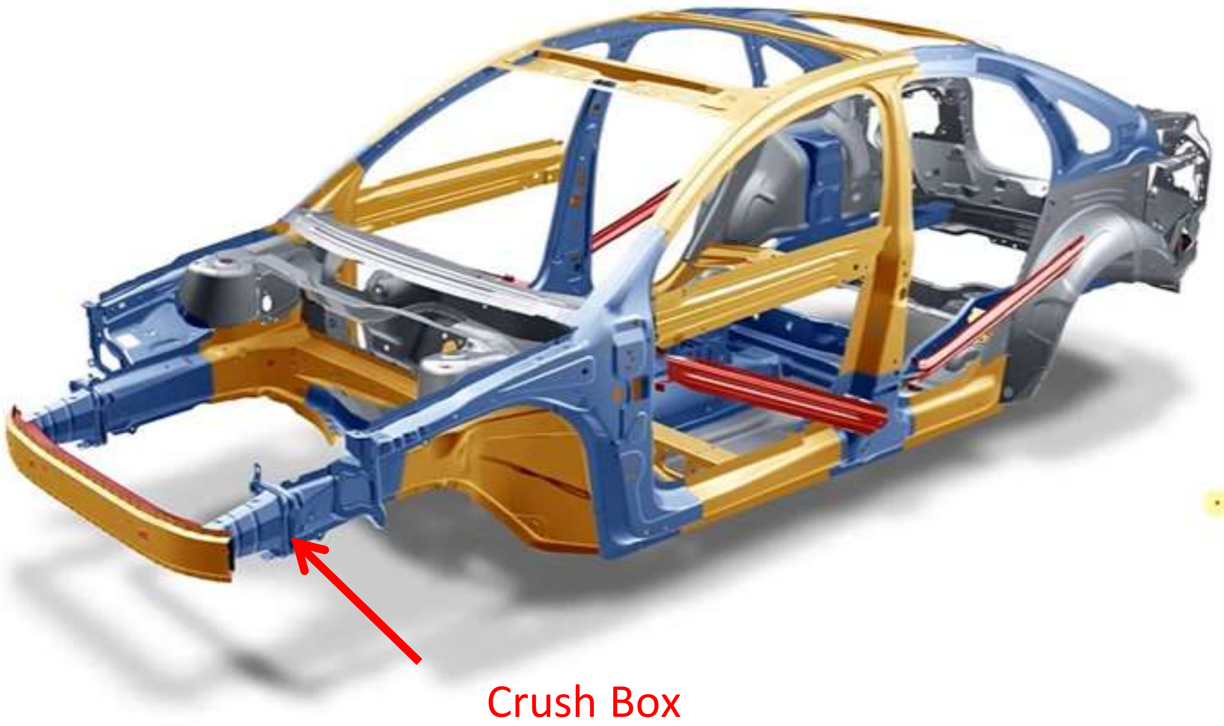
Impact Analysis of Crush Box


Crush Box


2013 HONDA CIVIC
INSURANCE INSTITUTE
FOR HIGHWAY SAFETY
CEN1302

Crash Box

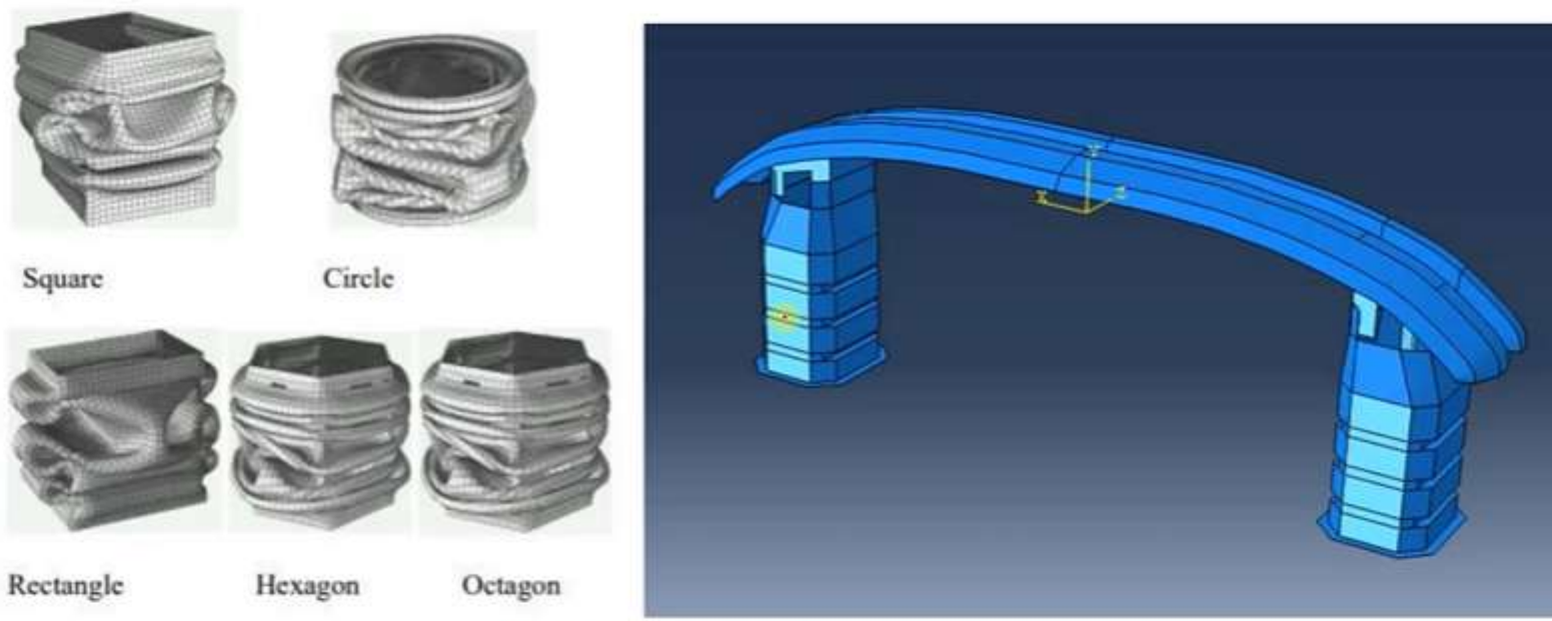
- CRASH box is one of the most important part for a safe passenger vehicle .
- The main function of crash box is to absorb the impact load .
- Since all the impact load is absorbed by crash box. Less force is transferred to the occupants .

Crash Box

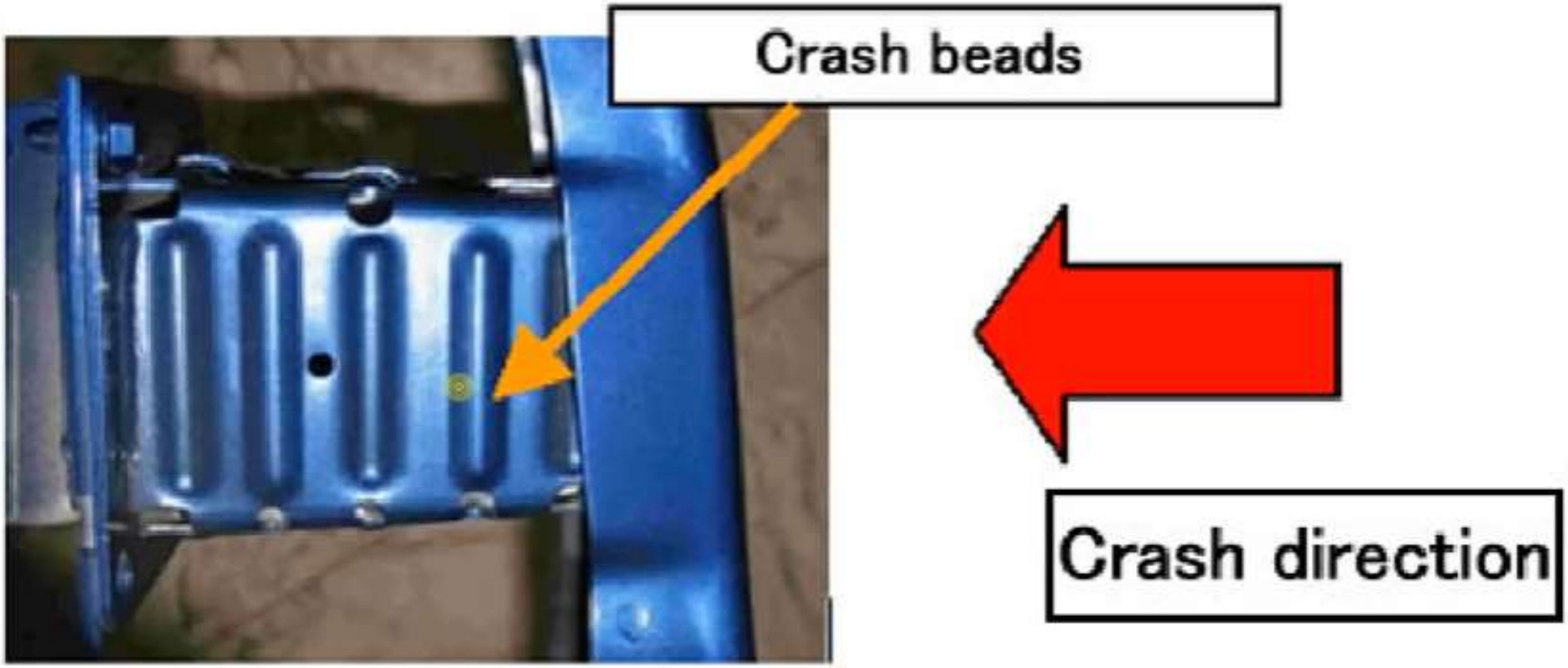
- Crash Box is Tube shaped object, which is located near bumper and chassis.
- Crash box in automobiles helps to reduce impact energy during the collisions .
- During impact, the shock energy is converted into strain energy by crumpling of the crash box.
- Crash box plays very important role for safety of the vehicle and the reduction of repair cost when the vehicle meet the low speed collisions.

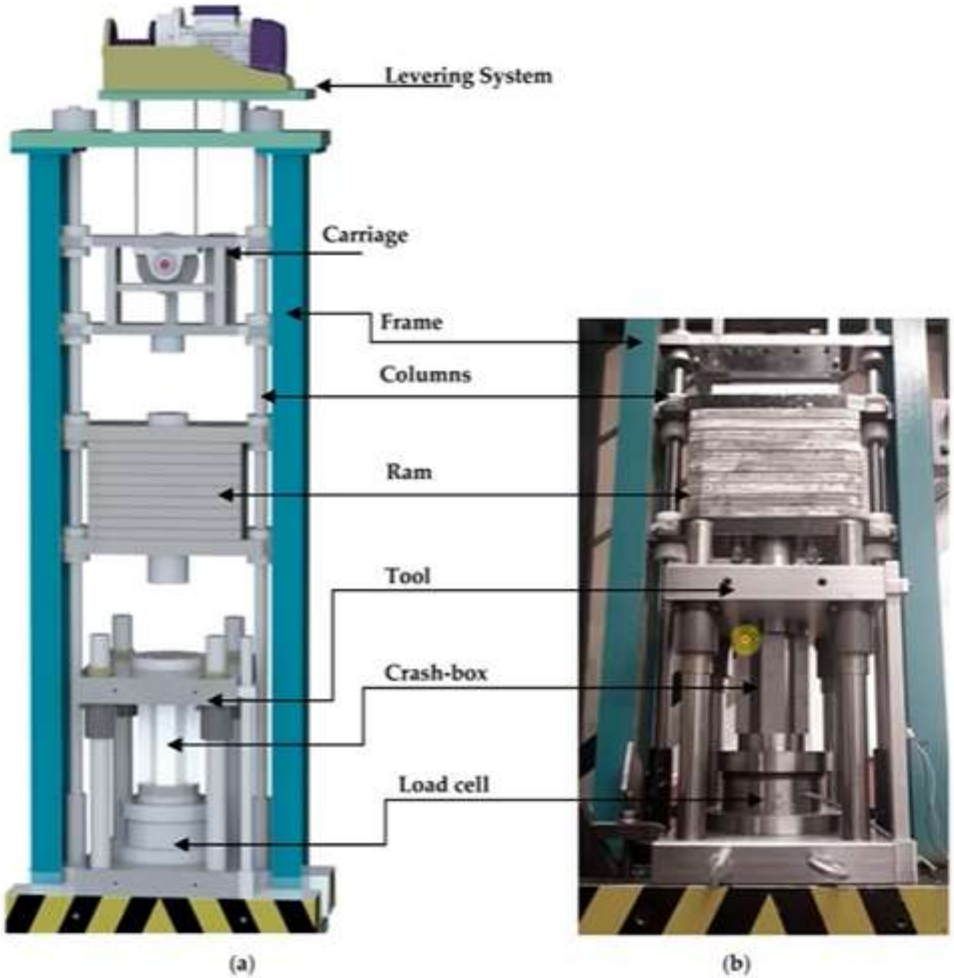
Design of crash box

- The crash box are designed in such a way that it does not bend during collision .
- Instead the crash box should crumple .
- If the crash box bends, the it absorbs lesser energy and the shock load will be transferred to other parts and the occupant .

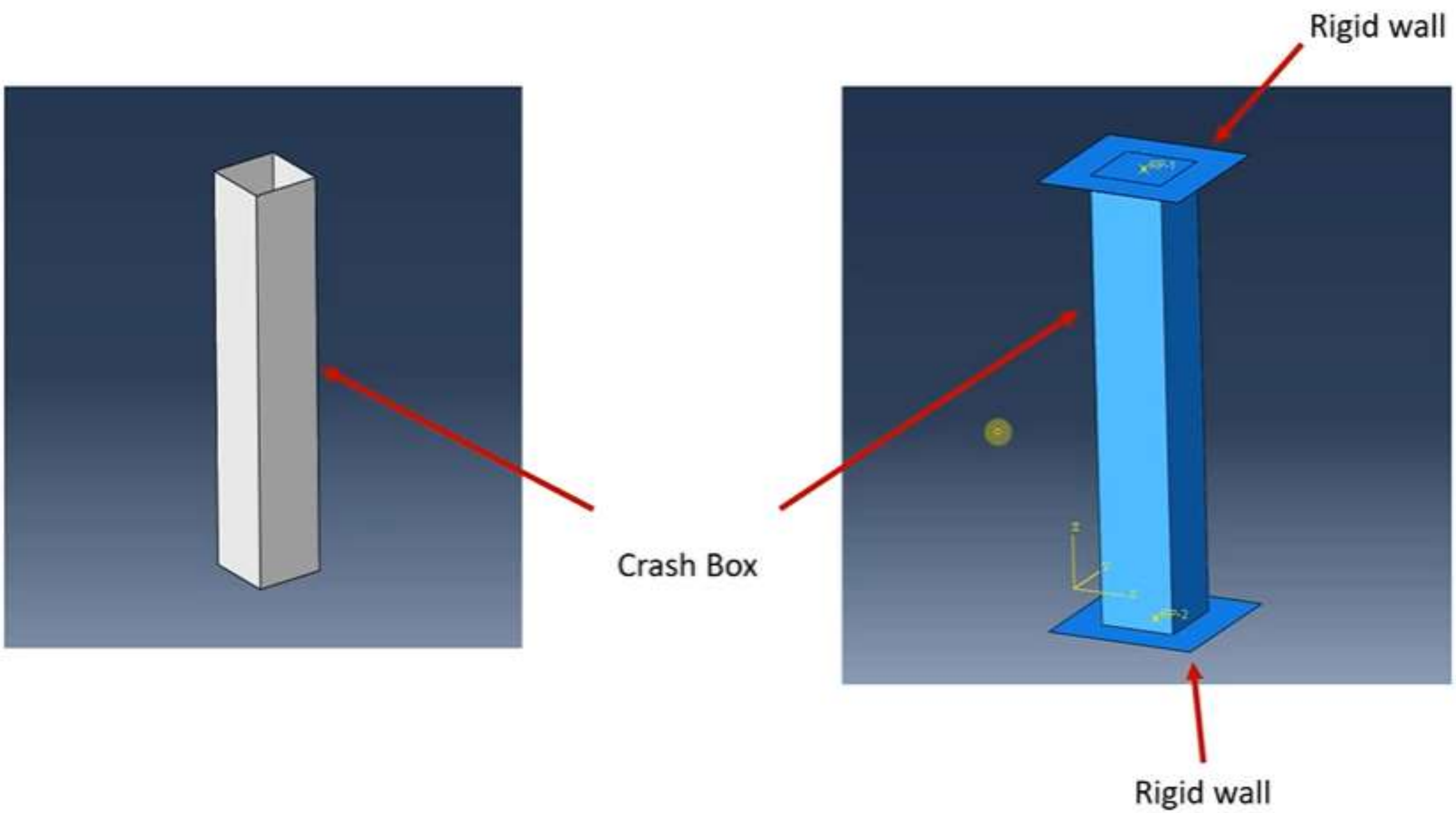


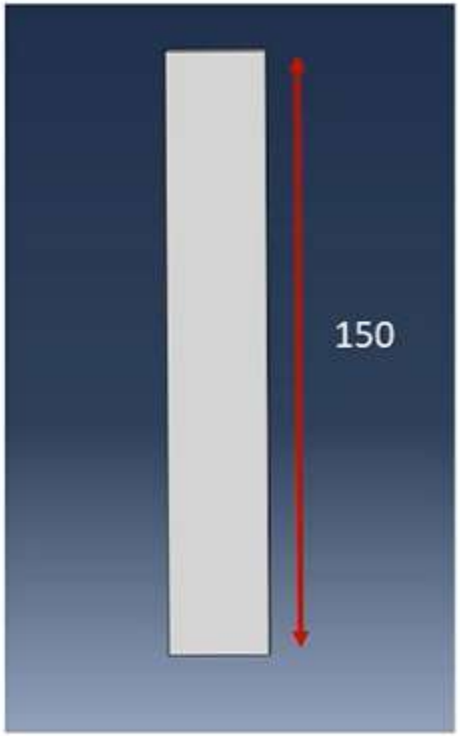
▲ Various Crush Box Shapes and Practice Models

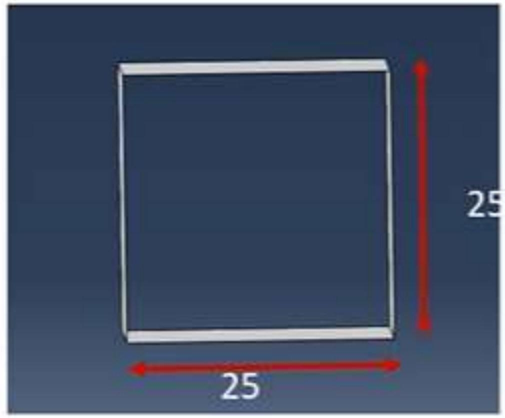

Crash beads
Crash direction



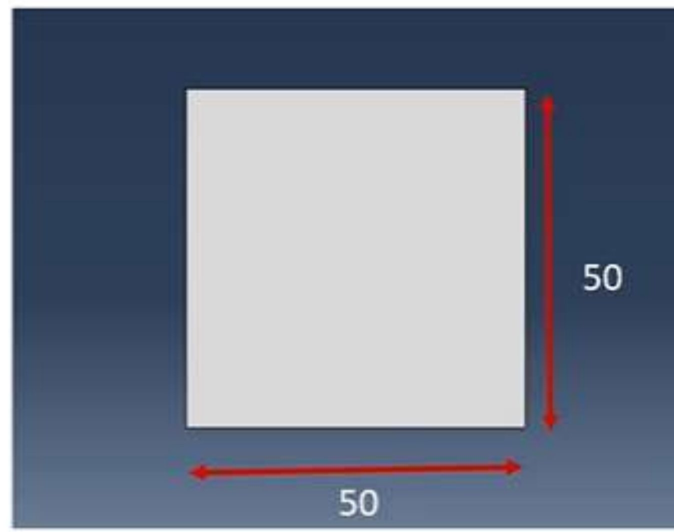
Experimental Set-Up for Crush Analysis


Rigid wall
Crash Box
Rigid wall





Thickness = 1mm



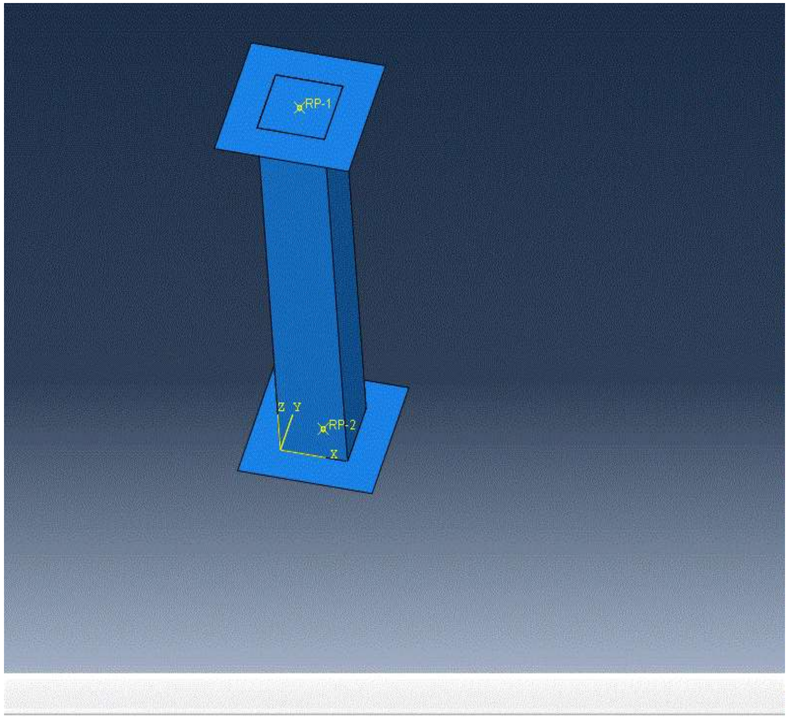
Material details

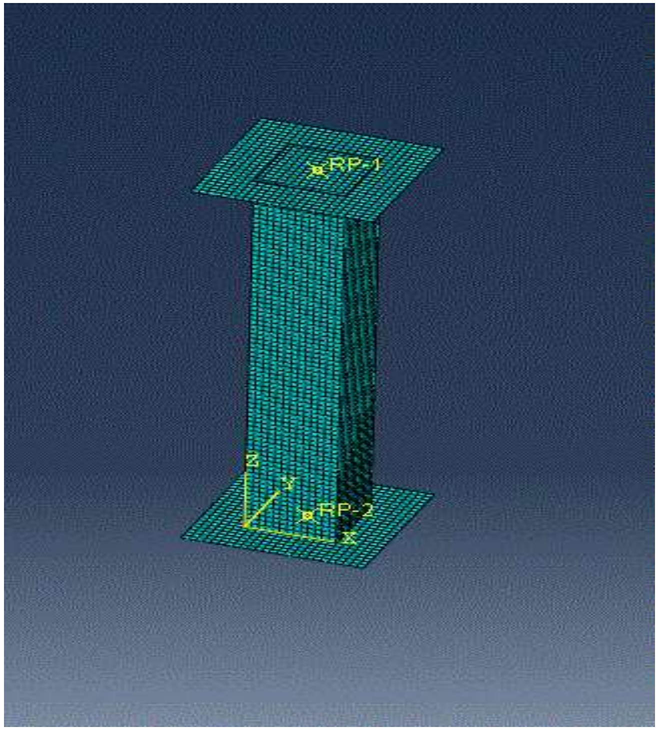
name	Aluminum
Density	2900 kg/m^3 2.9 e^{-6} kg/mm^3
Young modulus	69000 Mpa / $N\text{-}mm^{-2}$
Poisson ratio	0.29

Non-Linear Property of Aluminium

Yield Stress (Mpa)	Plastic strain (mm/mm)
120	0
160	0.05
200	0.07
220	0.1
240	0.15

Assembly And Meshing

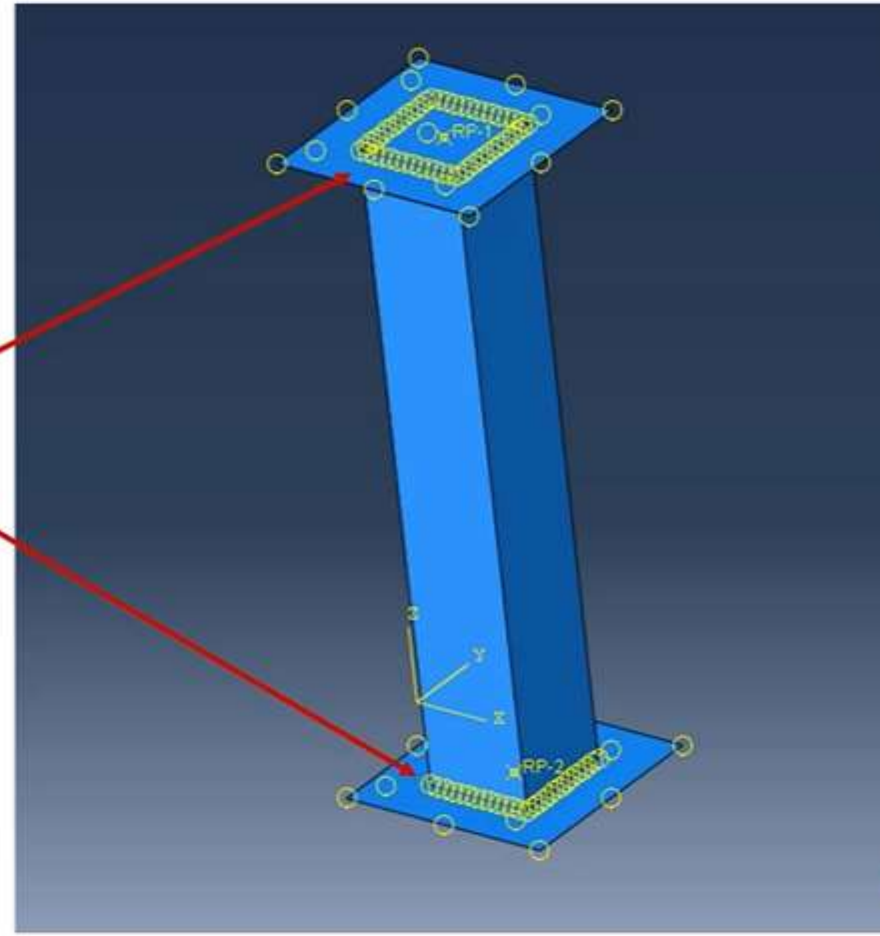


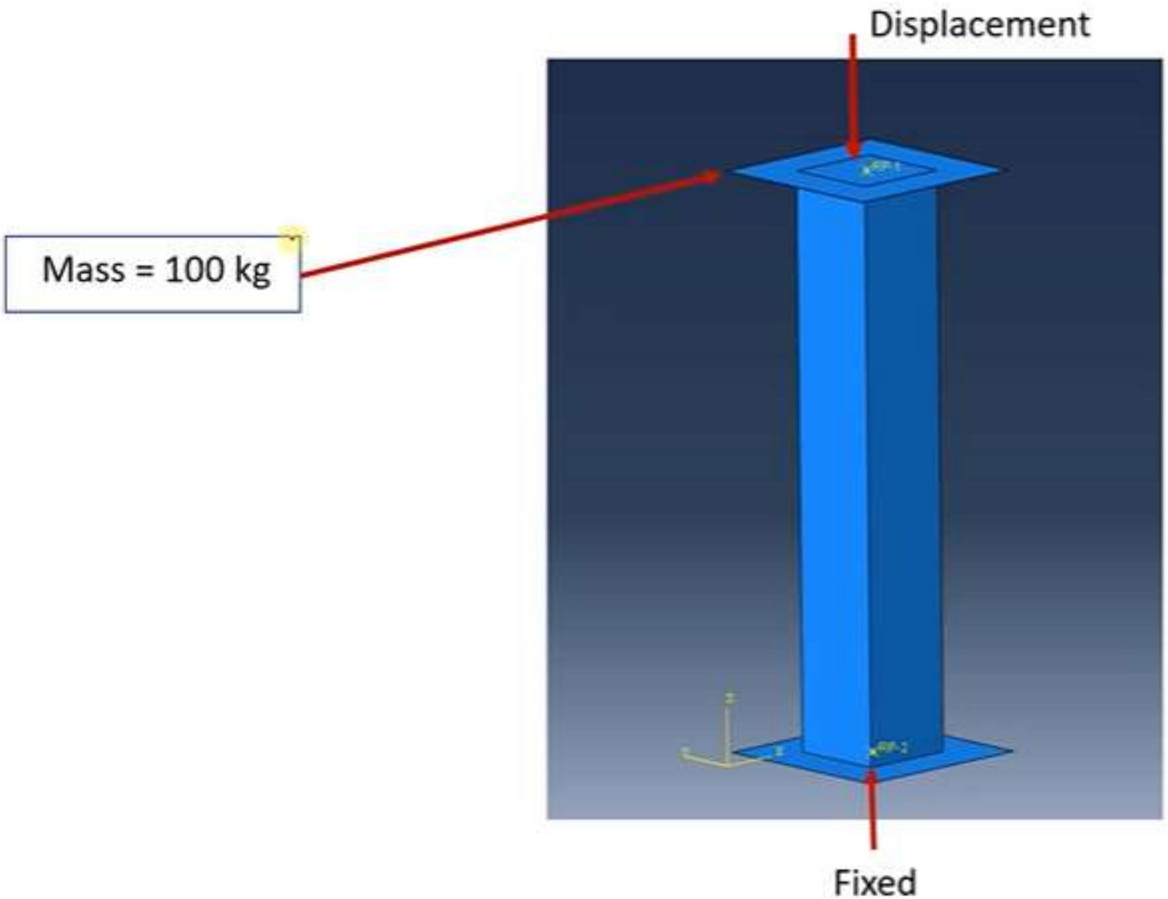


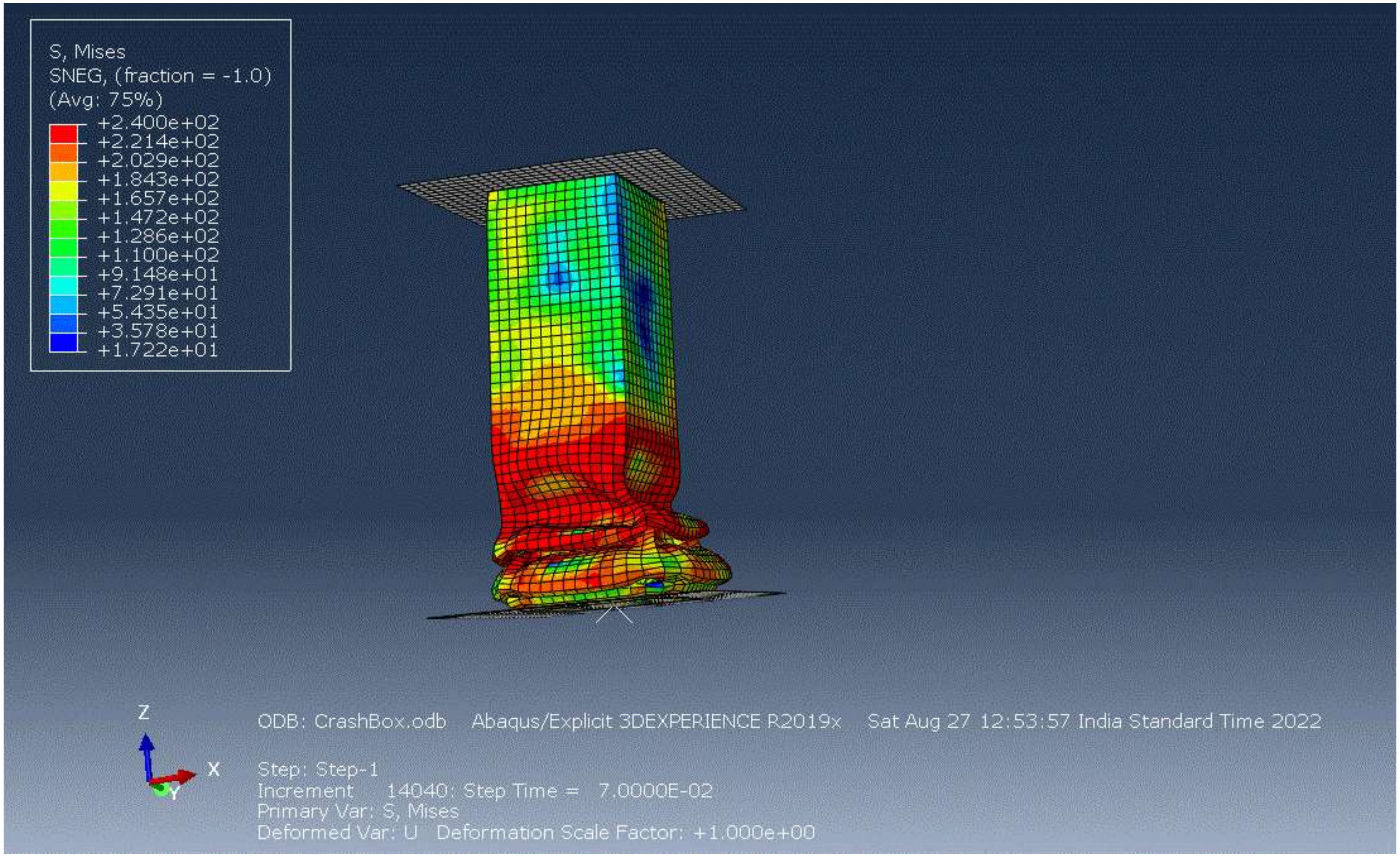
Interaction manager

- Self contact is allowed with friction coefficient 0.2 .
- Walls constrained as rigid body.

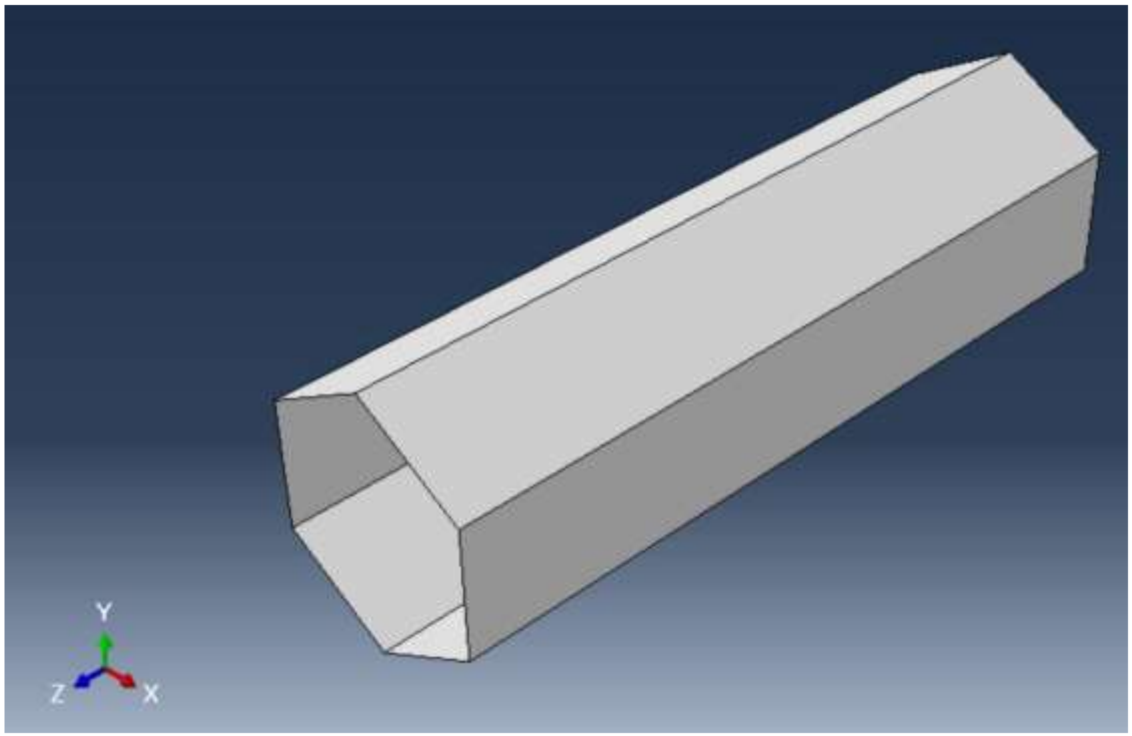
Tie Contact

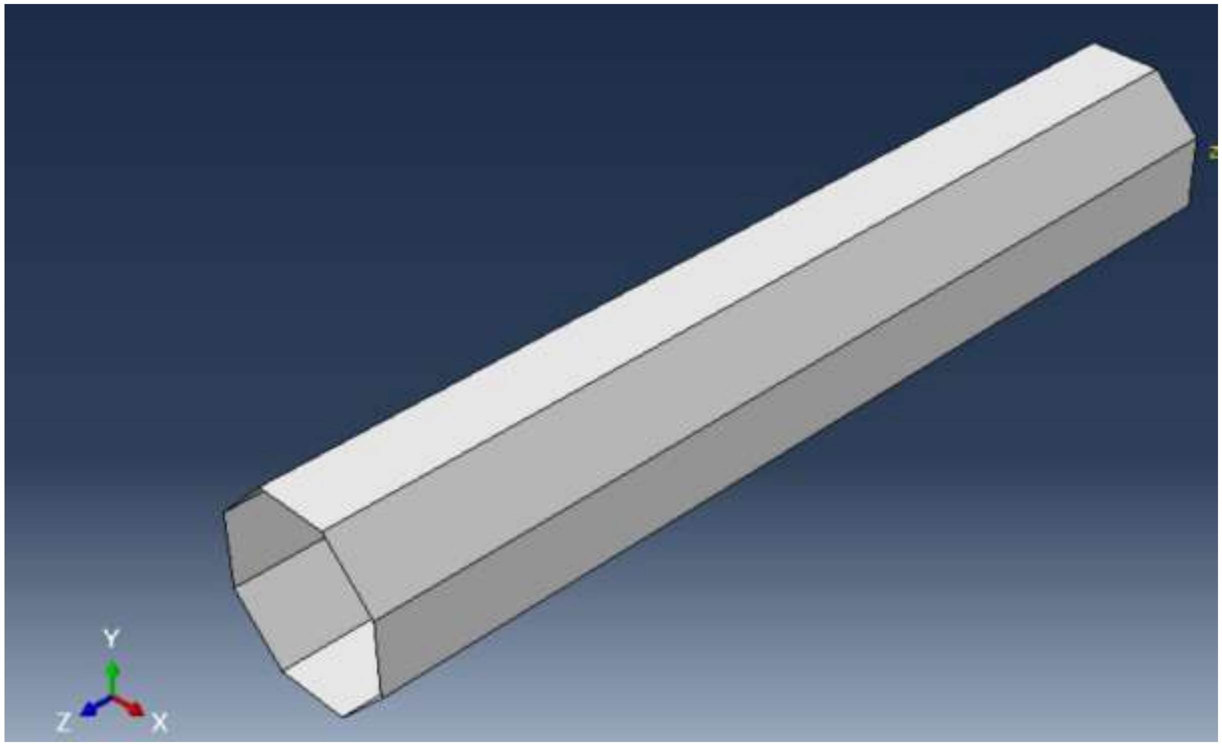



Displacement
Mass = 100 kg
Fixed



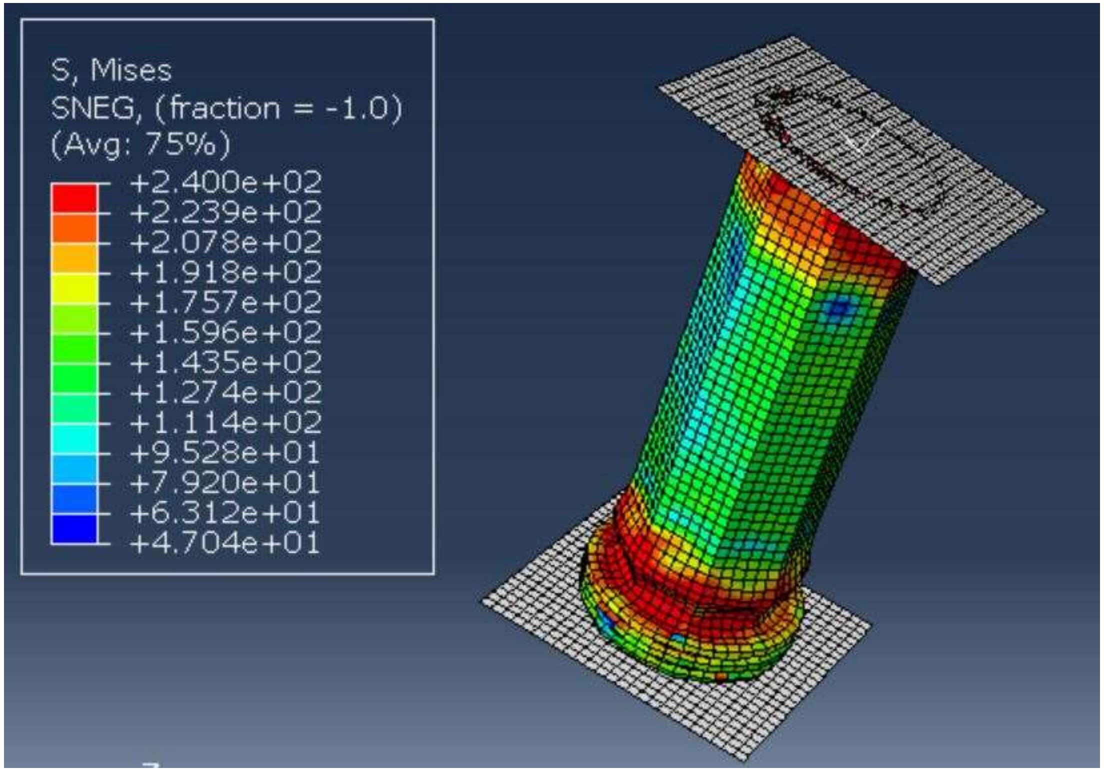
Crumpling Of Square Profile Crush Box


Y
Z
X



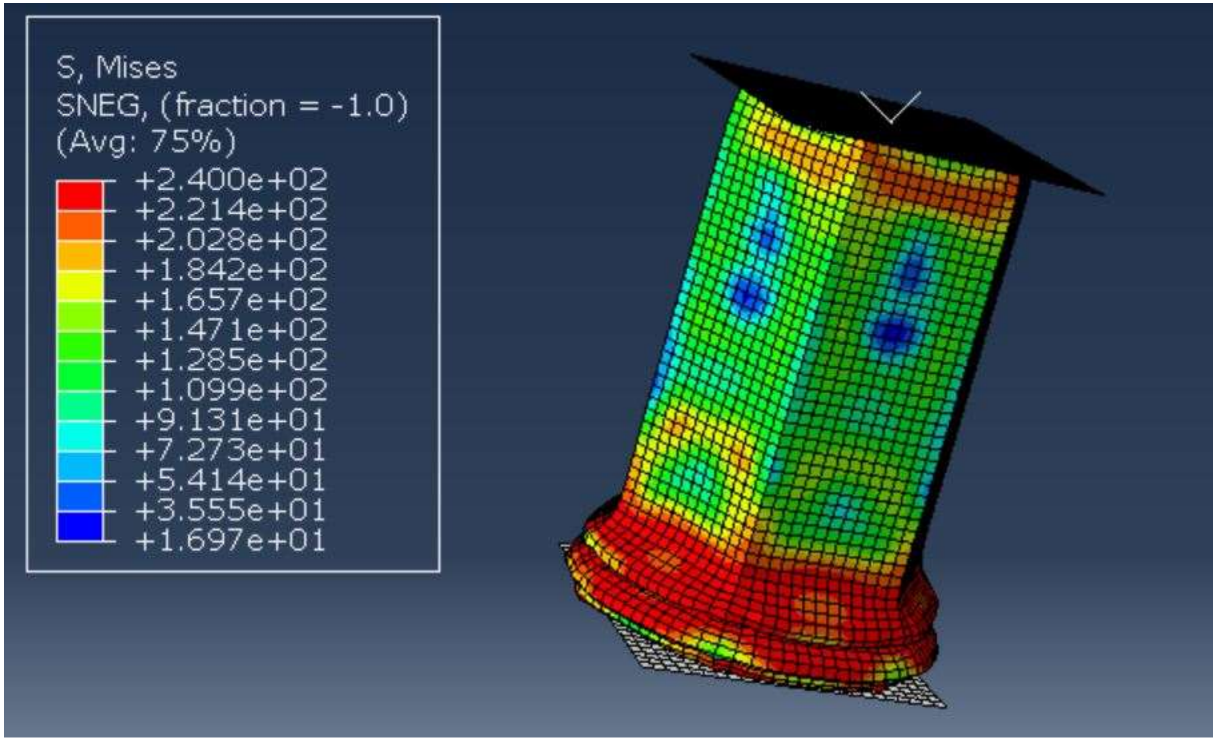
Y
Z
X

Octagon Profile

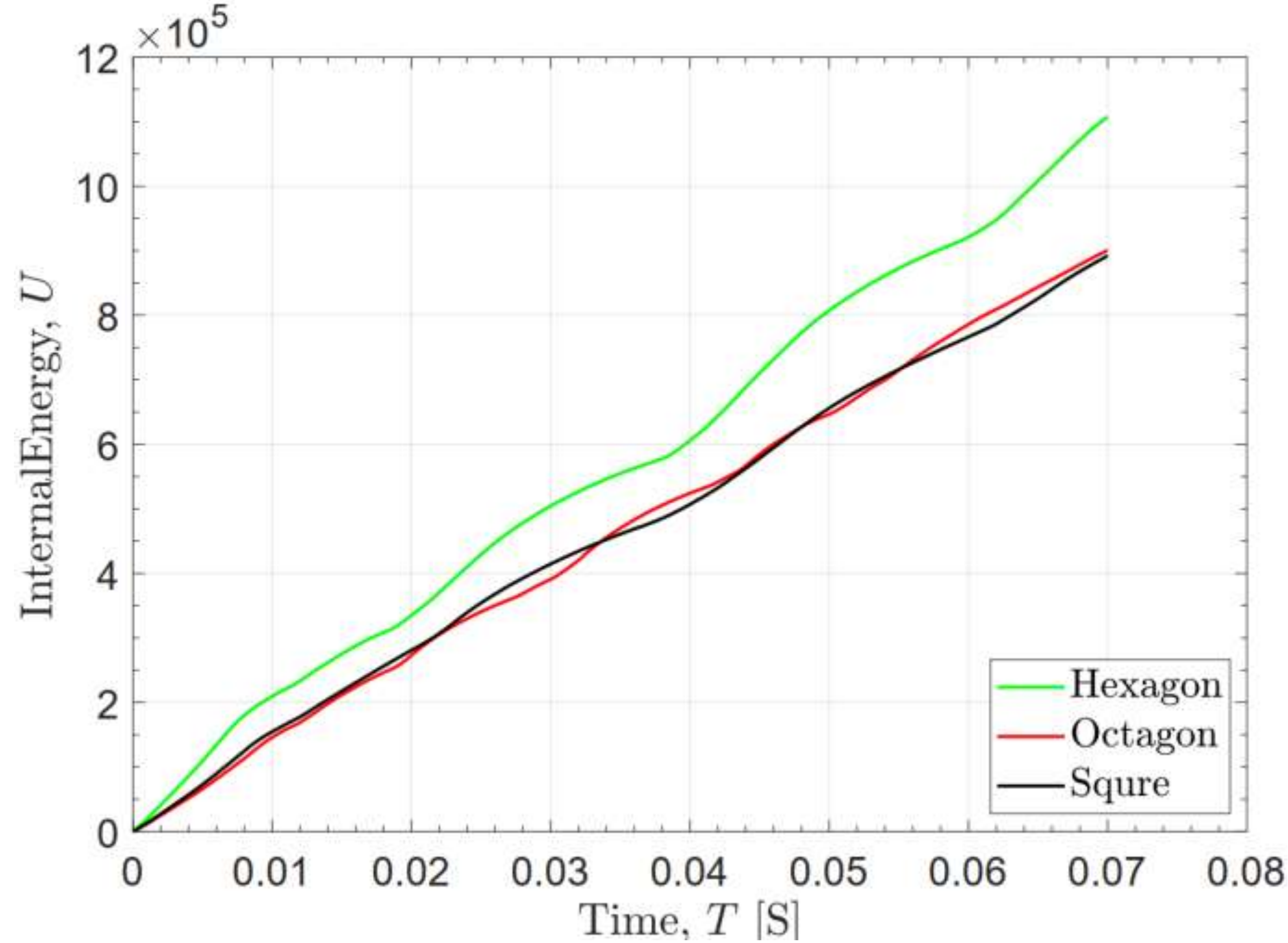


Crumpling of Octagon Profile Crush Box

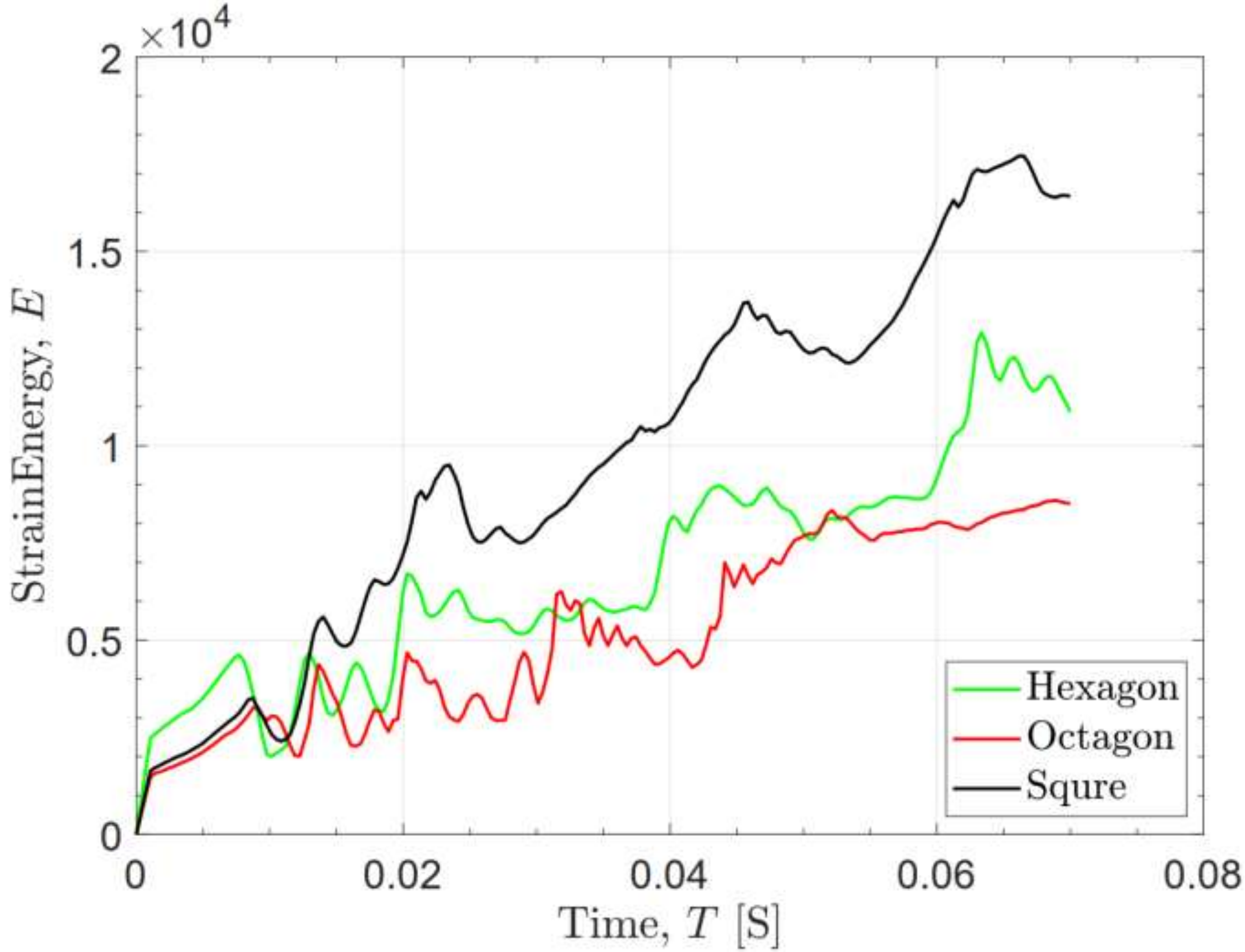
Hexagon Profile



Crumpling of Hexagon Profile Crush Box

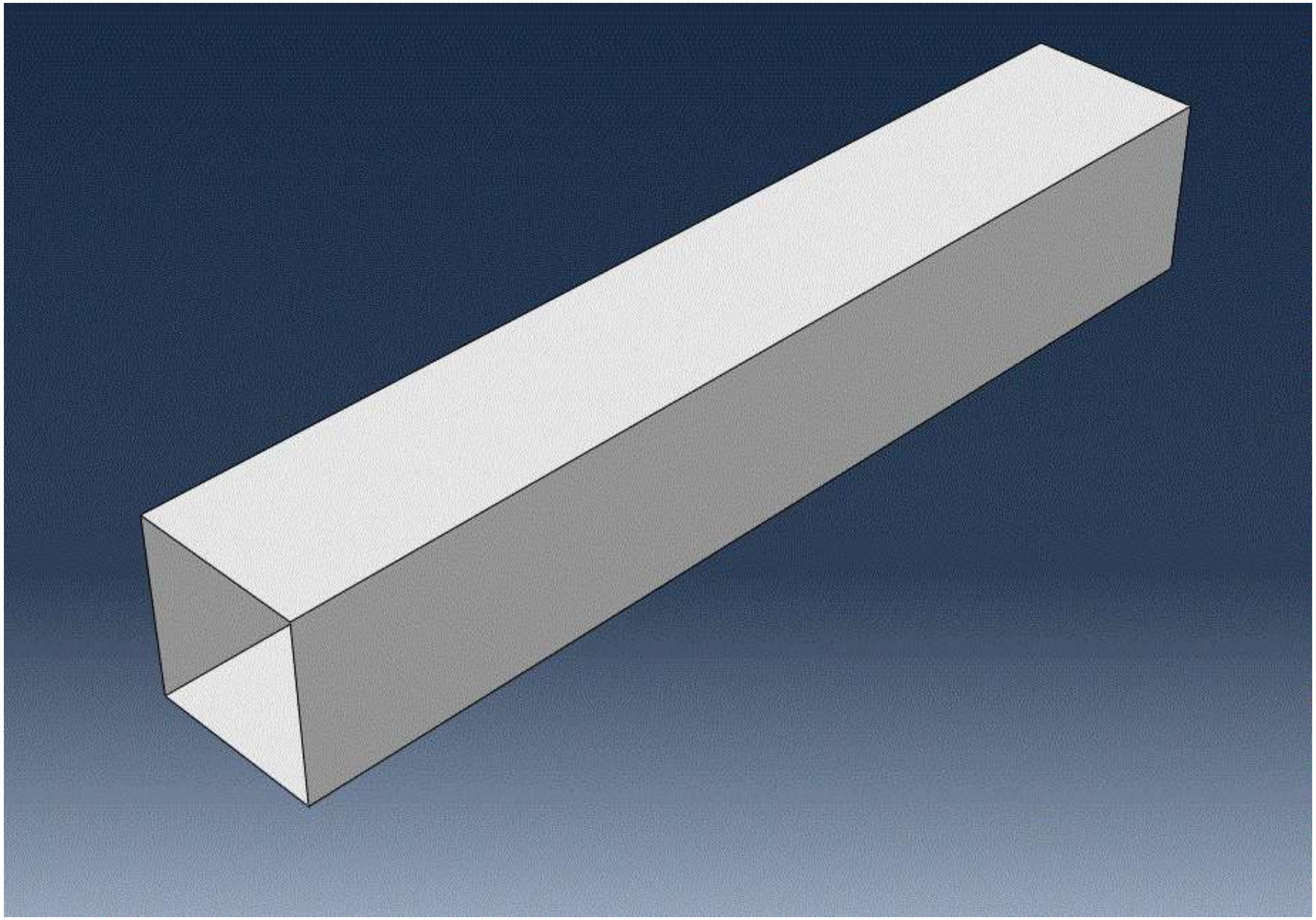


Comparison of change in Internal energy of the Crush Box with respect to time for Different Profiles

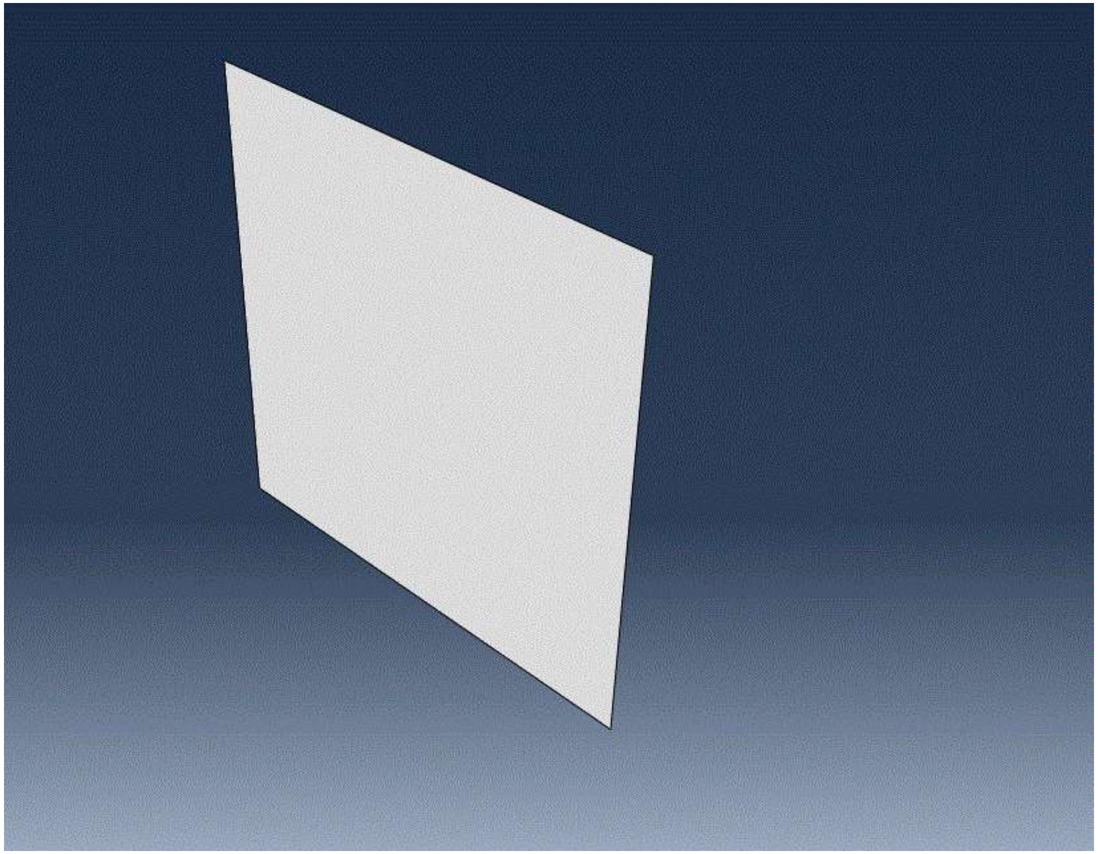


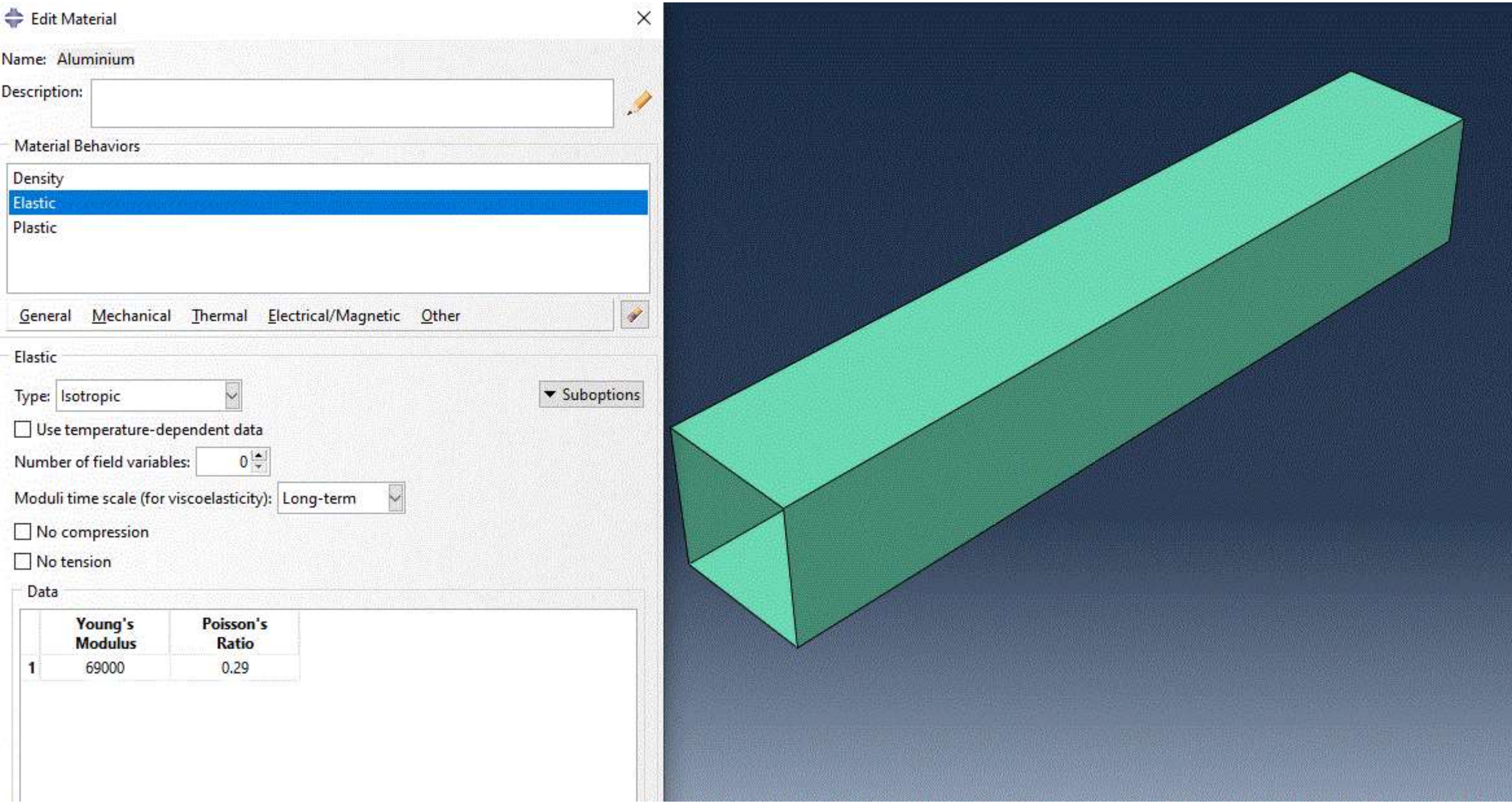
Comparison of change in strain energy of the Crush Box with respect to time for Different Profiles

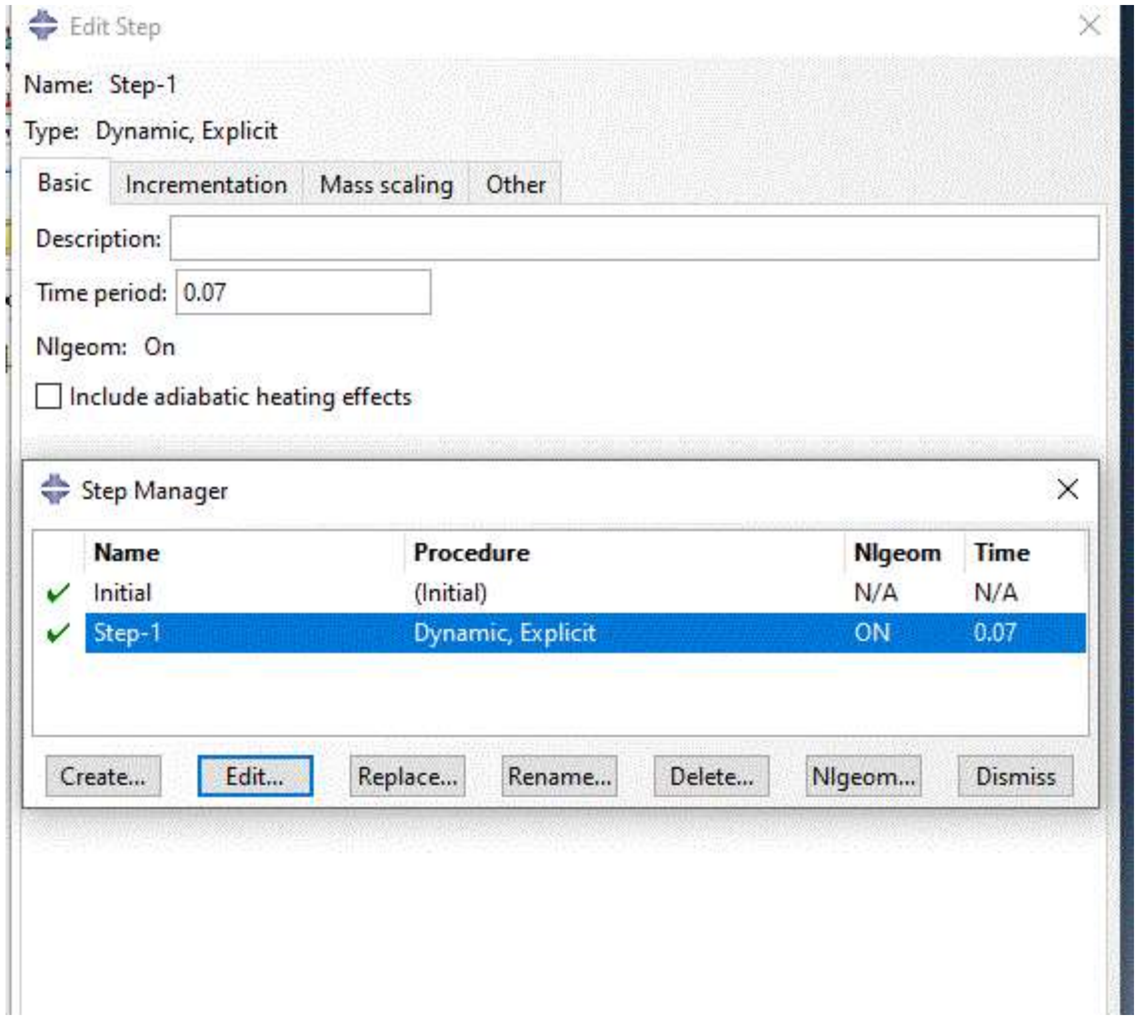
Extra slides: Steps taken For FEM Analysis of Crush Box

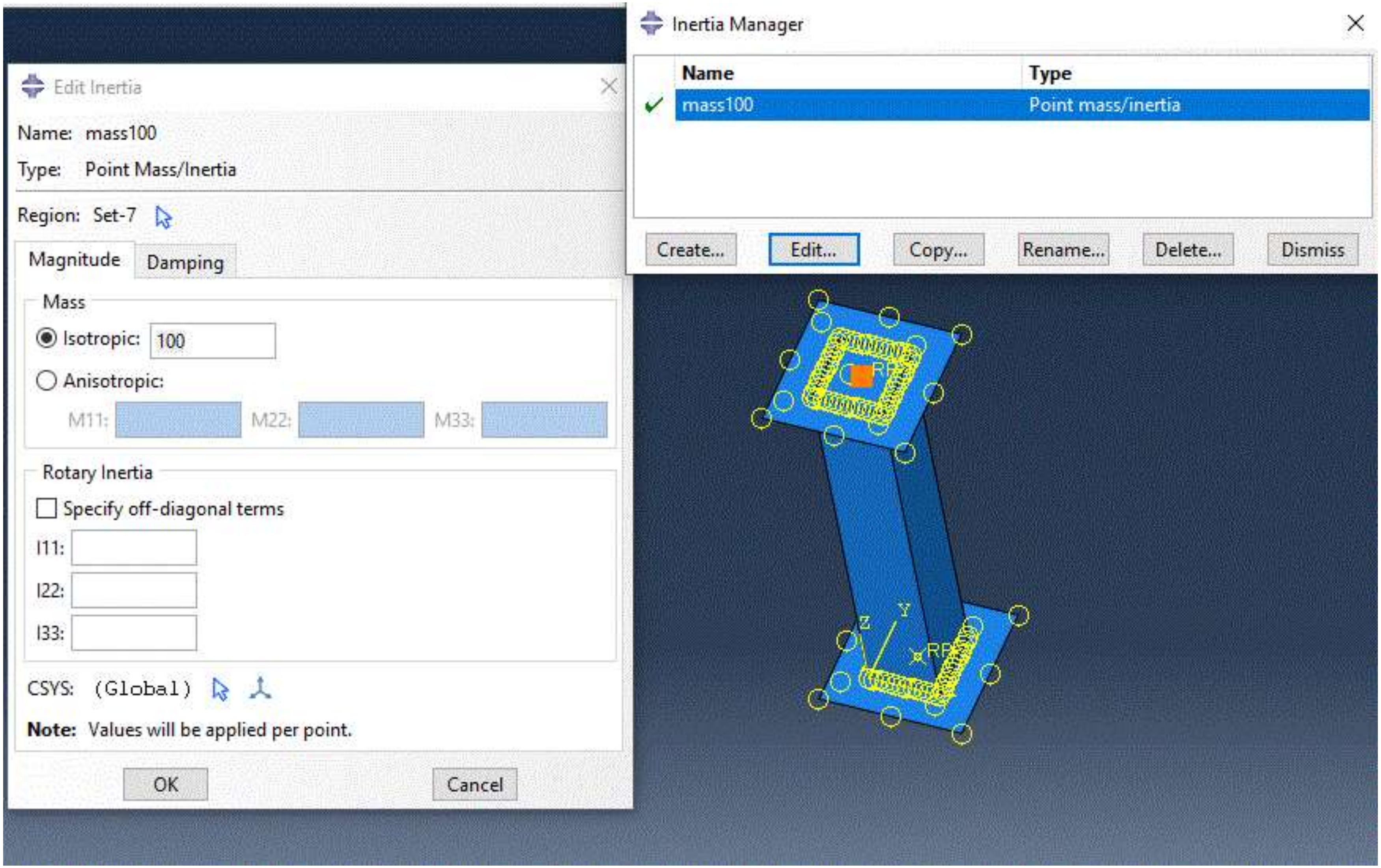


Rigid Plate



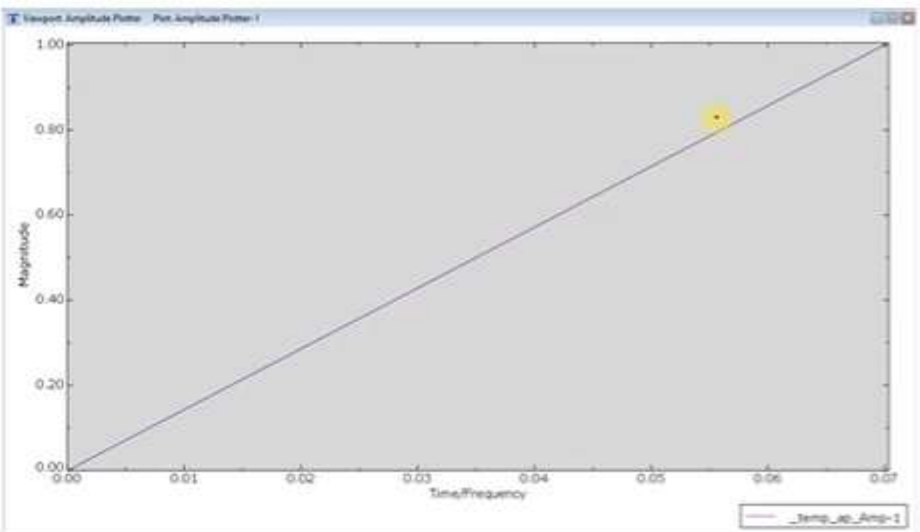

Edit Material
Name: Aluminium
Description:
Material Behaviors
Density
Elastic
Plastic
General
Mechanical
Thermal
Electrical/Magnetic
Other
Elastic
Type: Isotropic
Suboptions
Use temperature-dependent data
Number of field variables: 0
Moduli time scale (for viscoelasticity): Long-term
No compression
No tension
Data
Young's Modulus
Poisson's Ratio
1
69000
0.29


Edit Step
Name: Step-1
Type: Dynamic, Explicit
Basic
Incrementation
Mass scaling
Other
Description:
Time period: 0.07
Nlgeom: On
Include adiabatic heating effects
Step Manager
Name
Procedure
Nlgeom
Time
Initial
(Initial)
N/A
N/A
Step-1
Dynamic, Explicit
ON
0.07
Create...
Edit...
Replace...
Rename...
Delete...
Nlgeom...
Dismiss

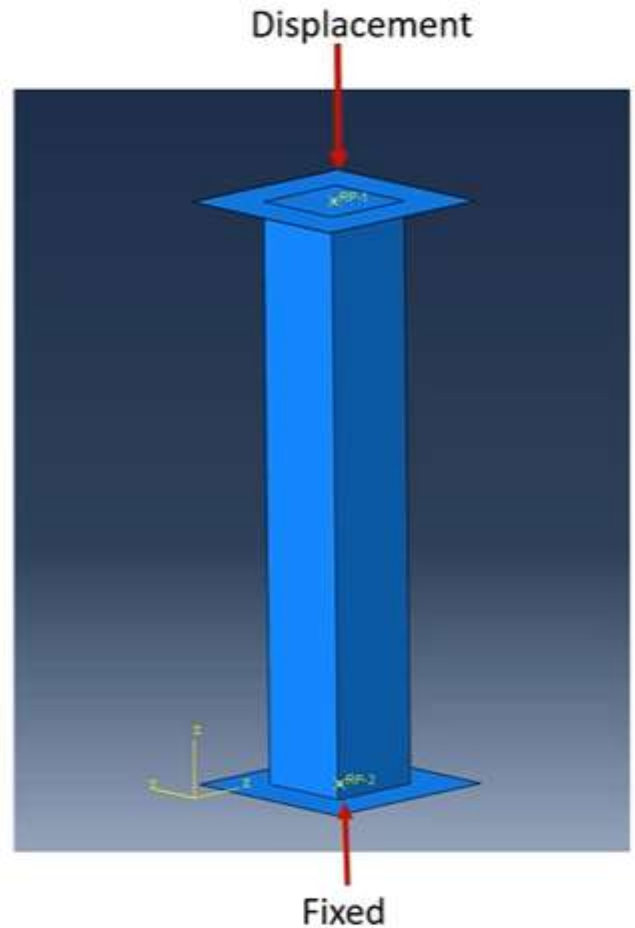

Edit Inertia
Name: mass100
Type: Point Mass/Inertia
Region: Set-7
Magnitude
Damping
Mass
Isotropic: 100
Anisotropic:
M11:
M22:
M33:
Rotary Inertia
Specify off-diagonal terms
I11:
I22:
I33:
CSYS: (Global)
Note: Values will be applied per point.
OK
Cancel
Inertia Manager
Name
Type
mass100
Point mass/inertia
Create...
Edit...
Copy...
Rename...
Delete...
Dismiss

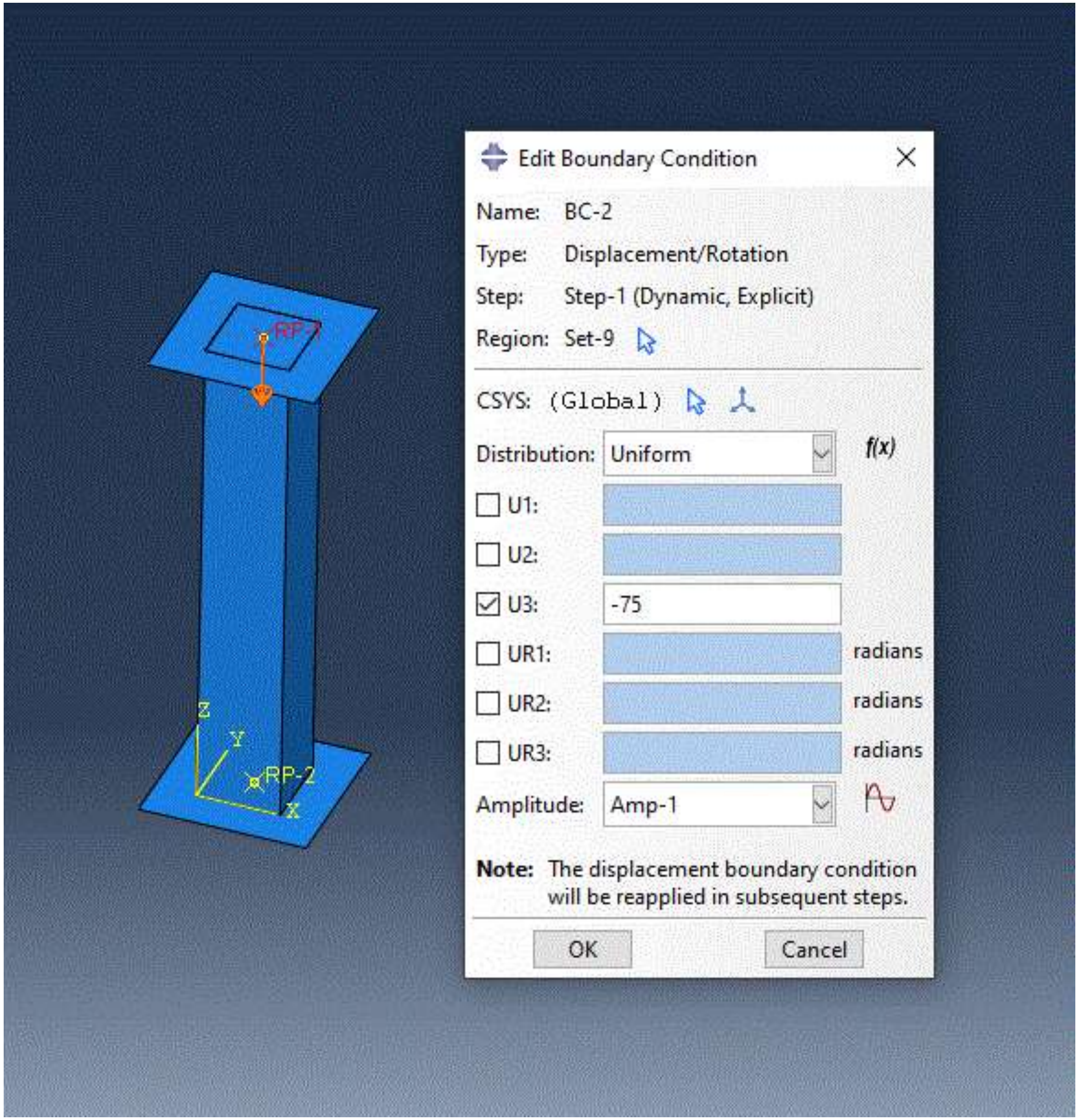
Boundary conditions

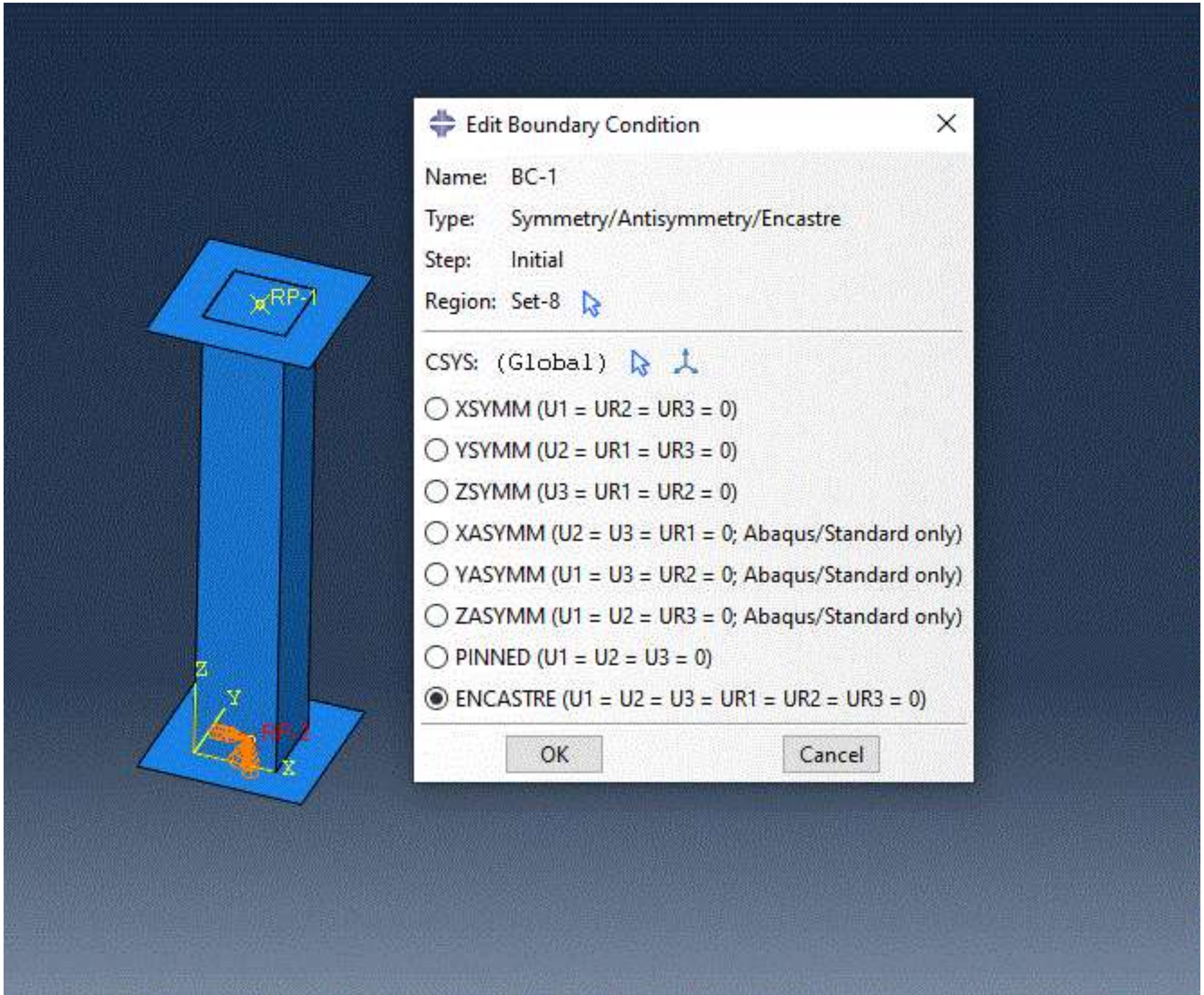
- Bottom walls is fixed
- Top wall is provided displacement of 75 mm.



0	0
0.07	1




Edit Boundary Condition
Name: BC-2
Type: Displacement/Rotation
Step: Step-1 (Dynamic, Explicit)
Region: Set-9
CSYS: (Global)
Distribution: Uniform
f(x)
U1:
U2:
U3: -75
UR1: radians
UR2: radians
UR3: radians
Amplitude: Amp-1
Note: The displacement boundary condition will be reapplied in subsequent steps.
OK
Cancel
RP-1
RP-2
Z
Y
X



Edit Boundary Condition
Name: BC-1
Type: Symmetry/Antisymmetry/Encastre
Step: Initial
Region: Set-8
CSYS: (Global)
XSYMM (U1 = UR2 = UR3 = 0)
YSYMM (U2 = UR1 = UR3 = 0)
ZSYMM (U3 = UR1 = UR2 = 0)
XASYMM (U2 = U3 = UR1 = 0; Abaqus/Standard only)
YASYMM (U1 = U3 = UR2 = 0; Abaqus/Standard only)
ZASYMM (U1 = U2 = UR3 = 0; Abaqus/Standard only)
PINNED (U1 = U2 = U3 = 0)
ENCASTRE (U1 = U2 = U3 = UR1 = UR2 = UR3 = 0)
OK
Cancel
RP-1
Z
Y
X

$V = \sqrt{2gh}$

$g = 9.8 \text{ m/s}^2$
$= 9810 \text{ mm/s}^2$

$h = 75 \text{ mm}$

$V = 1213 \text{ mm/s}$

Time $t = d/v = 75/1213$

$t = 0.062 \text{ s}$

$= 0.07 \text{ s}$

V= impact velocity
g = acceleration due to gravity
h = height