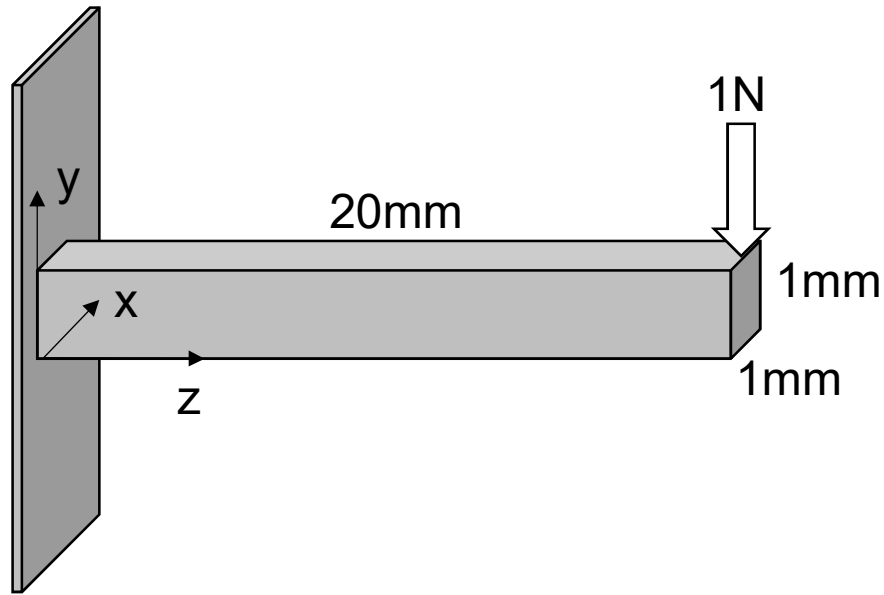


# Finite element analysis of beam bending

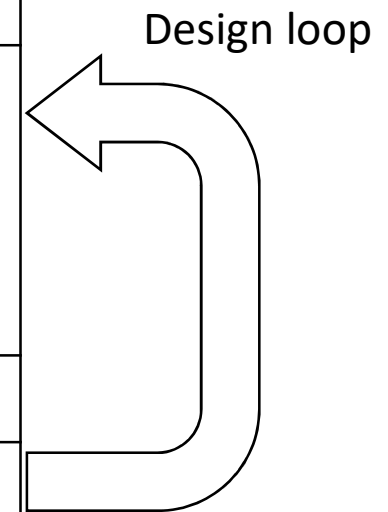


Displacement =  $\frac{P \cdot L^3}{3EI}$   
 $I = \frac{bh^3}{12}$  (second moment of area, geometrical moment of inertia)

Iron bar

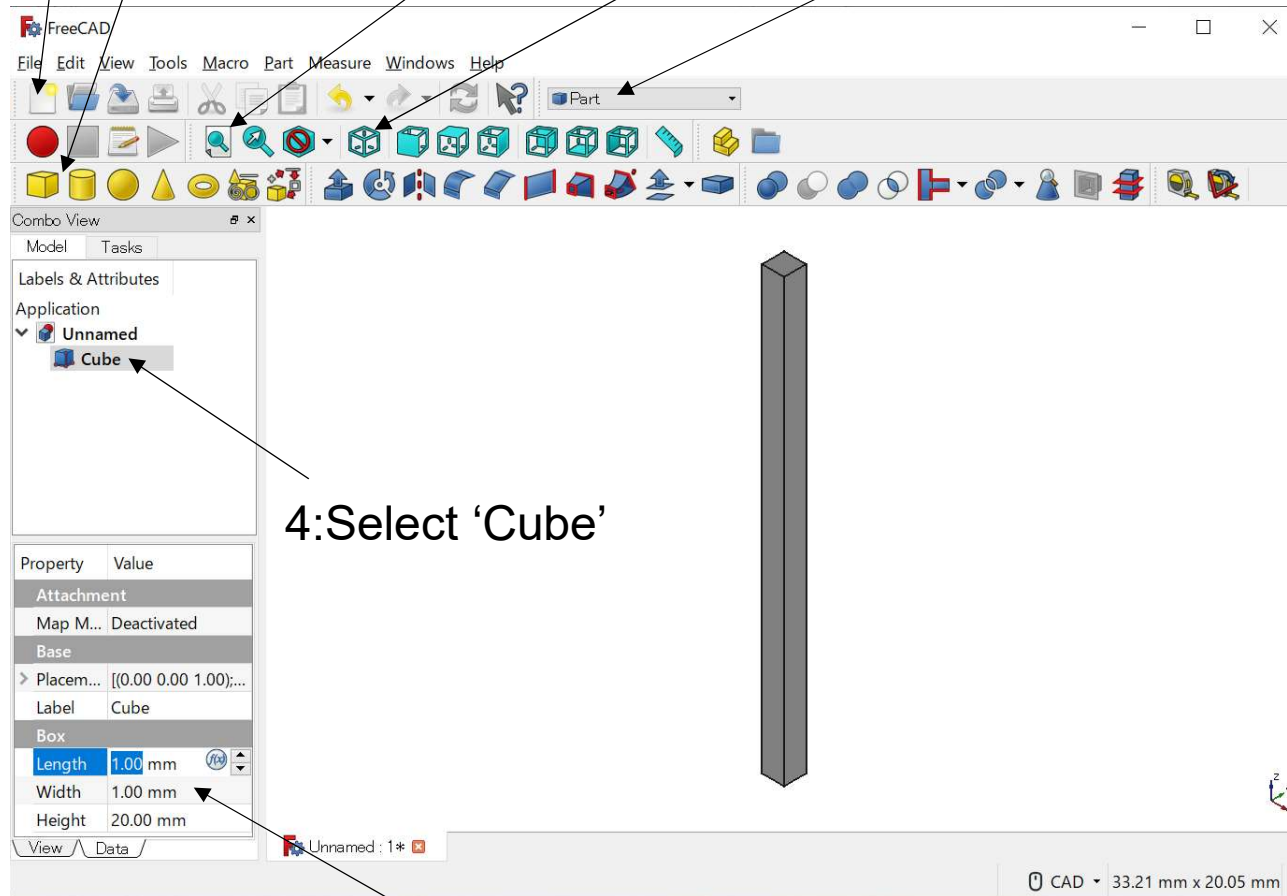
P	N	1
L	m	20e-3
E	Pa	210e9
I	m <sup>4</sup>	8.33e-14
Disp.	mm	1.52e-1

	workflow	software
pre-process1	Creating geometries Export geometries in STEP format	FreeCAD
pre-process2	Import geometries Creating mesh (discretizing) Assign Materials Set fix points Set loading points	FreeCAD
processing	Run simulations	FreeCAD
post-process	Check displacement and stress	FreeCAD



# Creating geometries on FreeCAD

- 1:New
- 2:Part
- 3:Cube solid
- 4:Select 'Cube'
- 5:Length=1mm, Width=1mm, Height=20mm
- 6:Set to axonometric view
- 7:Fits the whole content

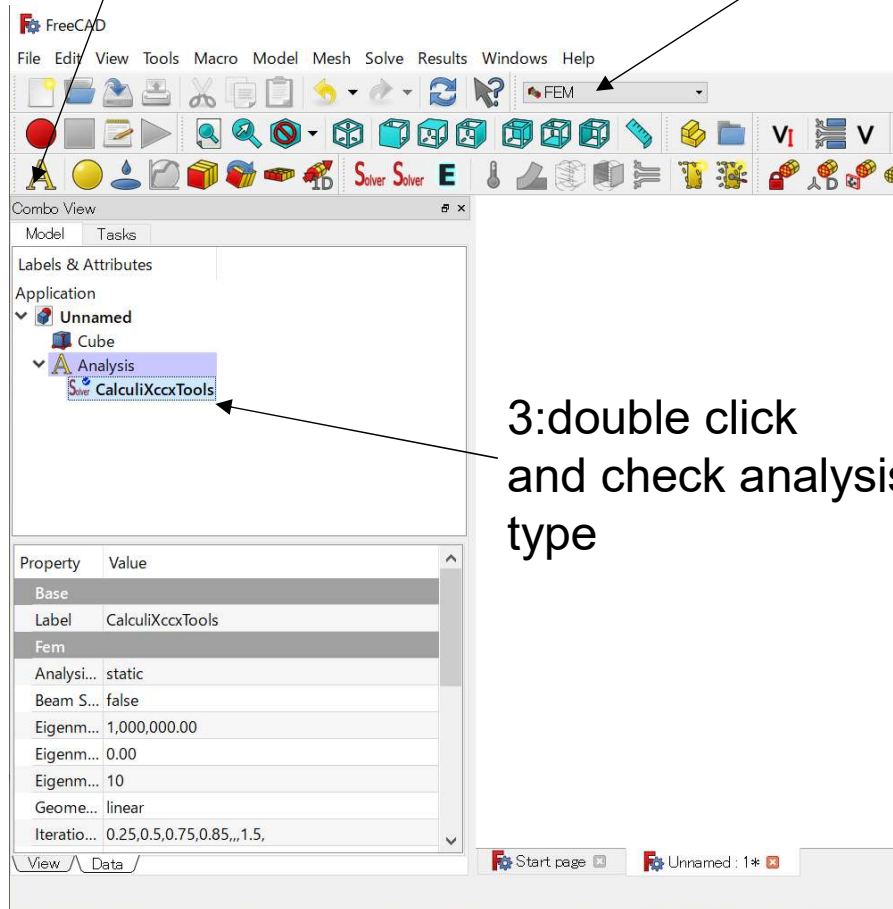


5:Length=1mm, Width=1mm, Height=20mm

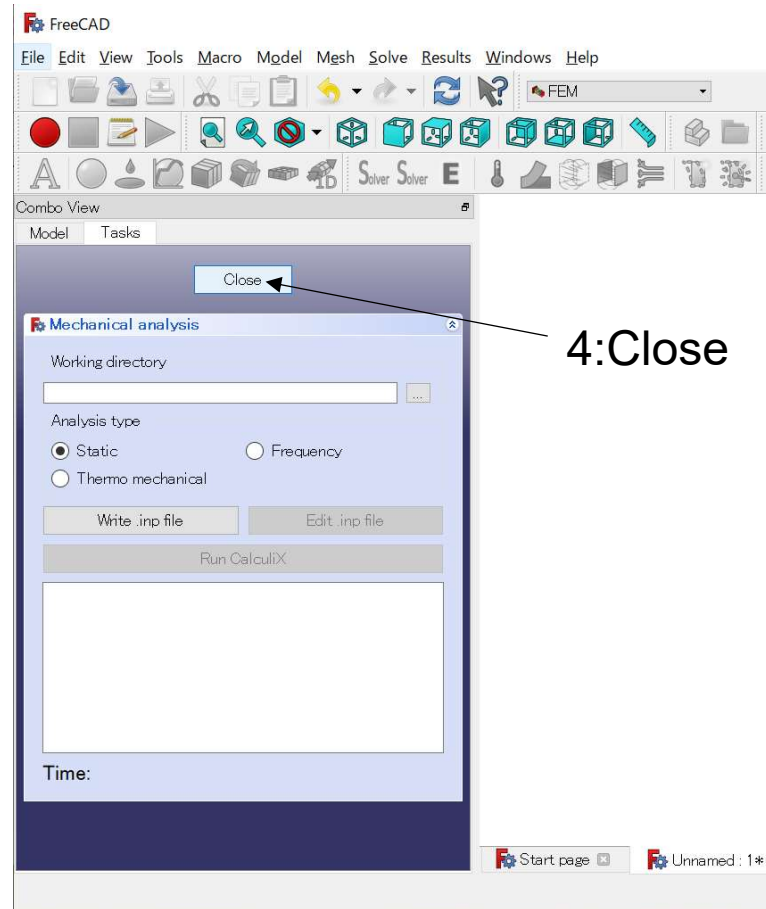
# Select analysis type

2:Creates an analysis

1:FEM



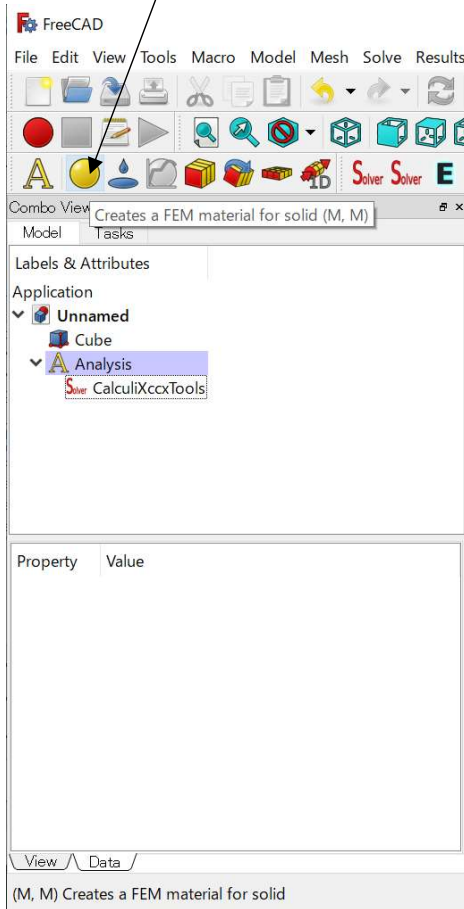
3:double click and check analysis type



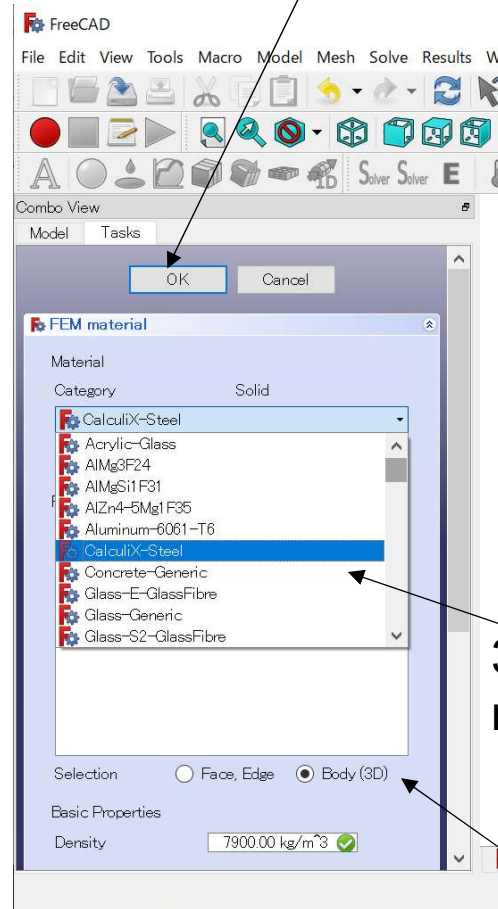
4:Close

# Assign material properties

1:Creates a FEM material

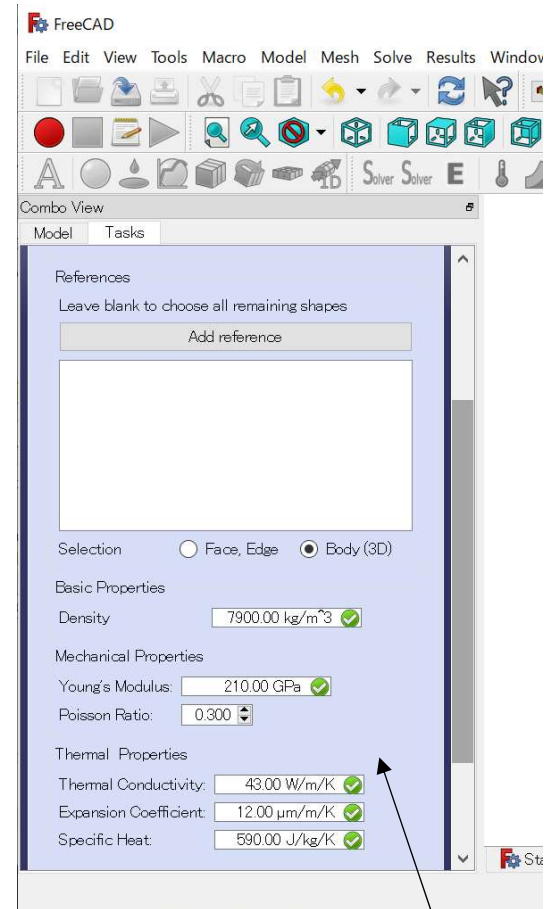


5:OK



3:Select material

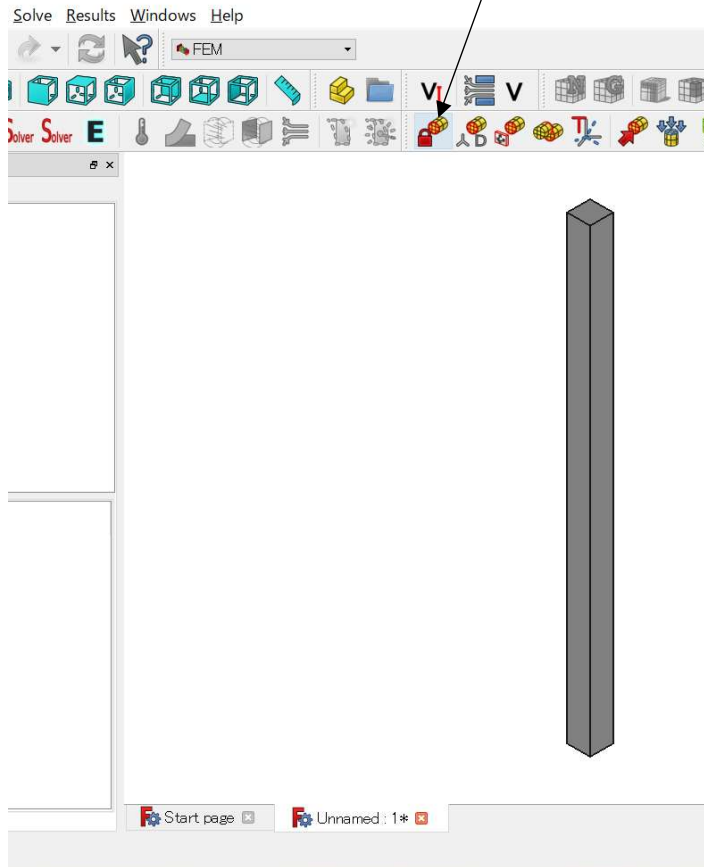
2:Body



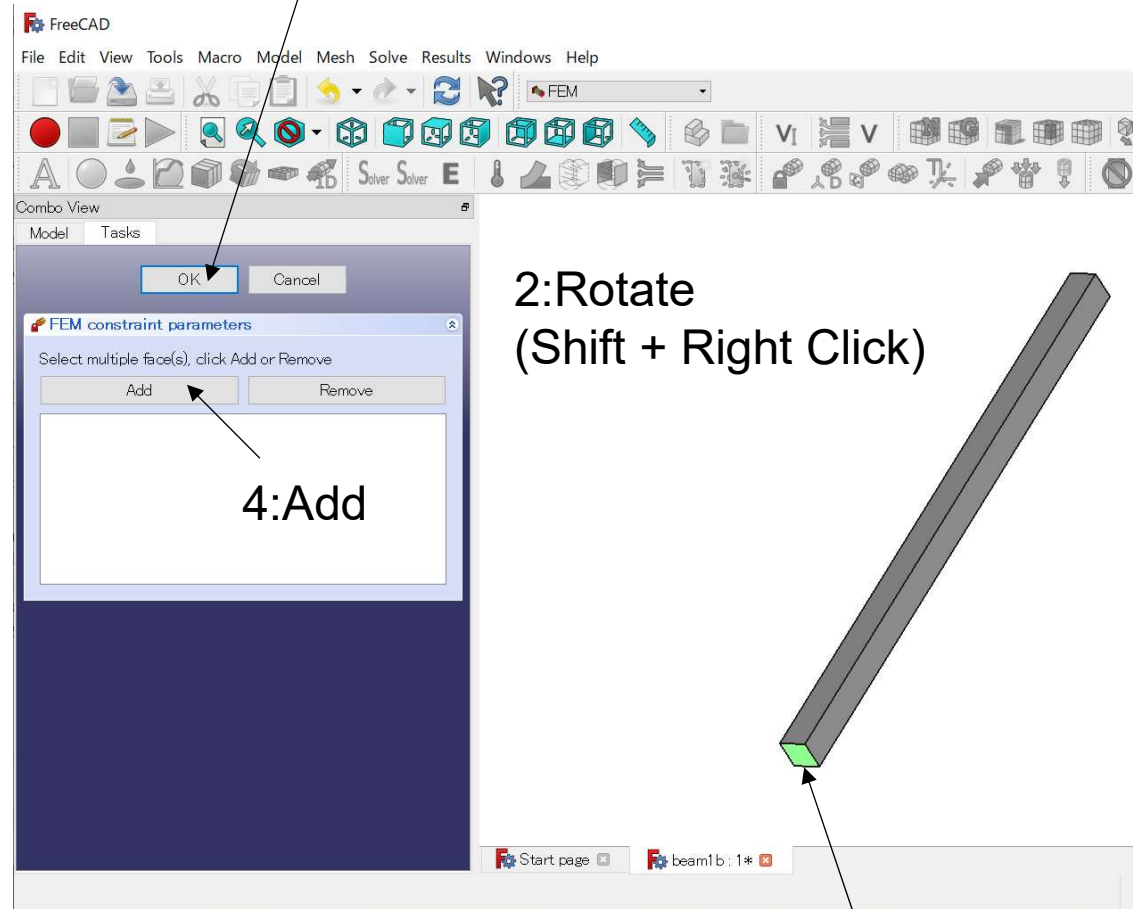
4:Check properties

# Fixed constraint

1:fixed  
geometric entity



5:OK



2:Rotate  
(Shift + Right Click)

3:Select  
z=0 face

# Load constraint (1N, -y direction)

1:force

2:Select z=20 face

3:Direction

4:Select edge parallel to y-direction

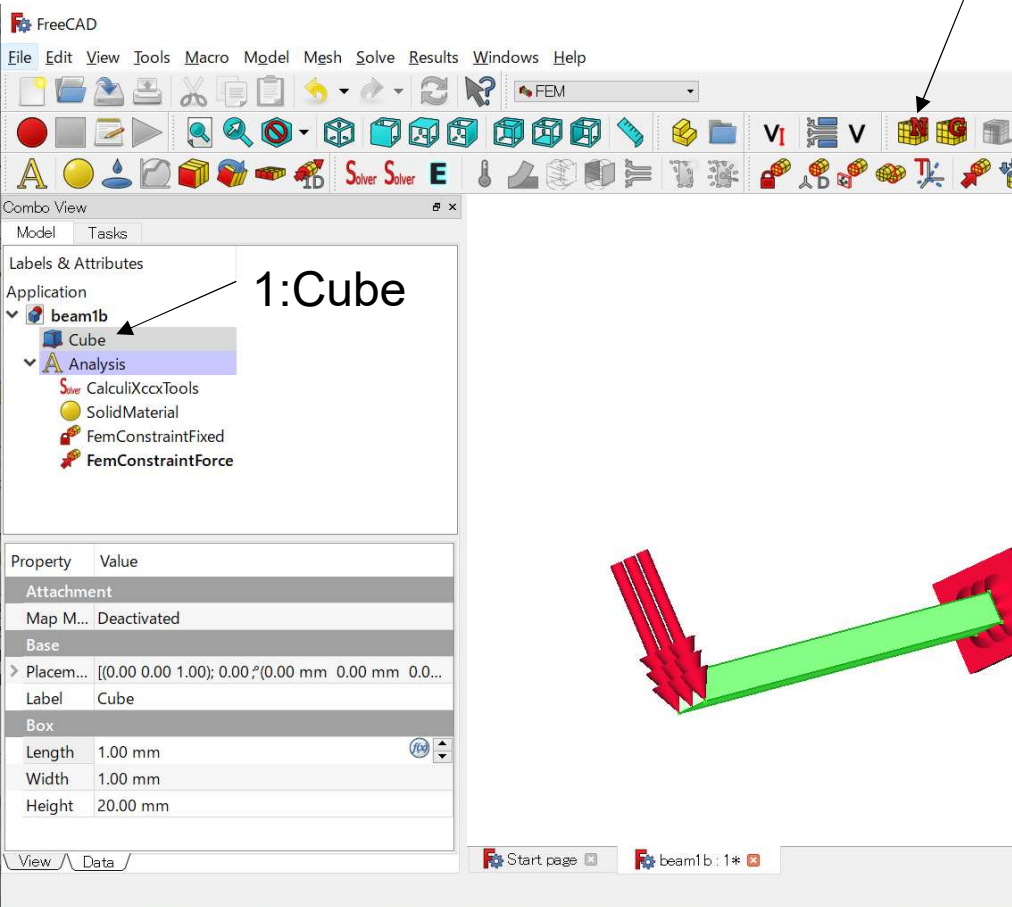
5:Reverse direction

6:OK

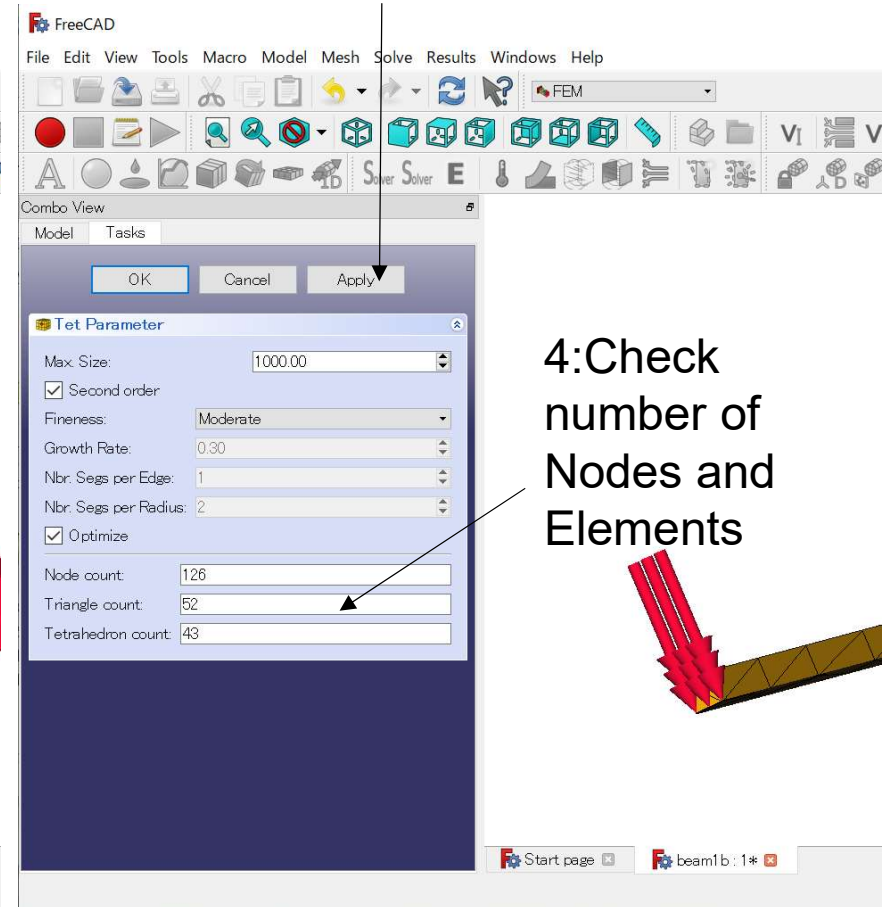
# Meshing

2:Netgen mesher

3:Apply



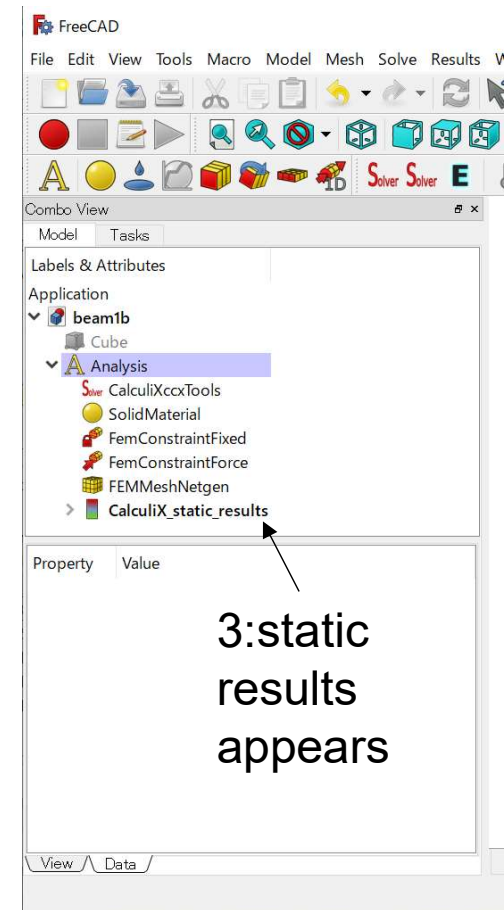
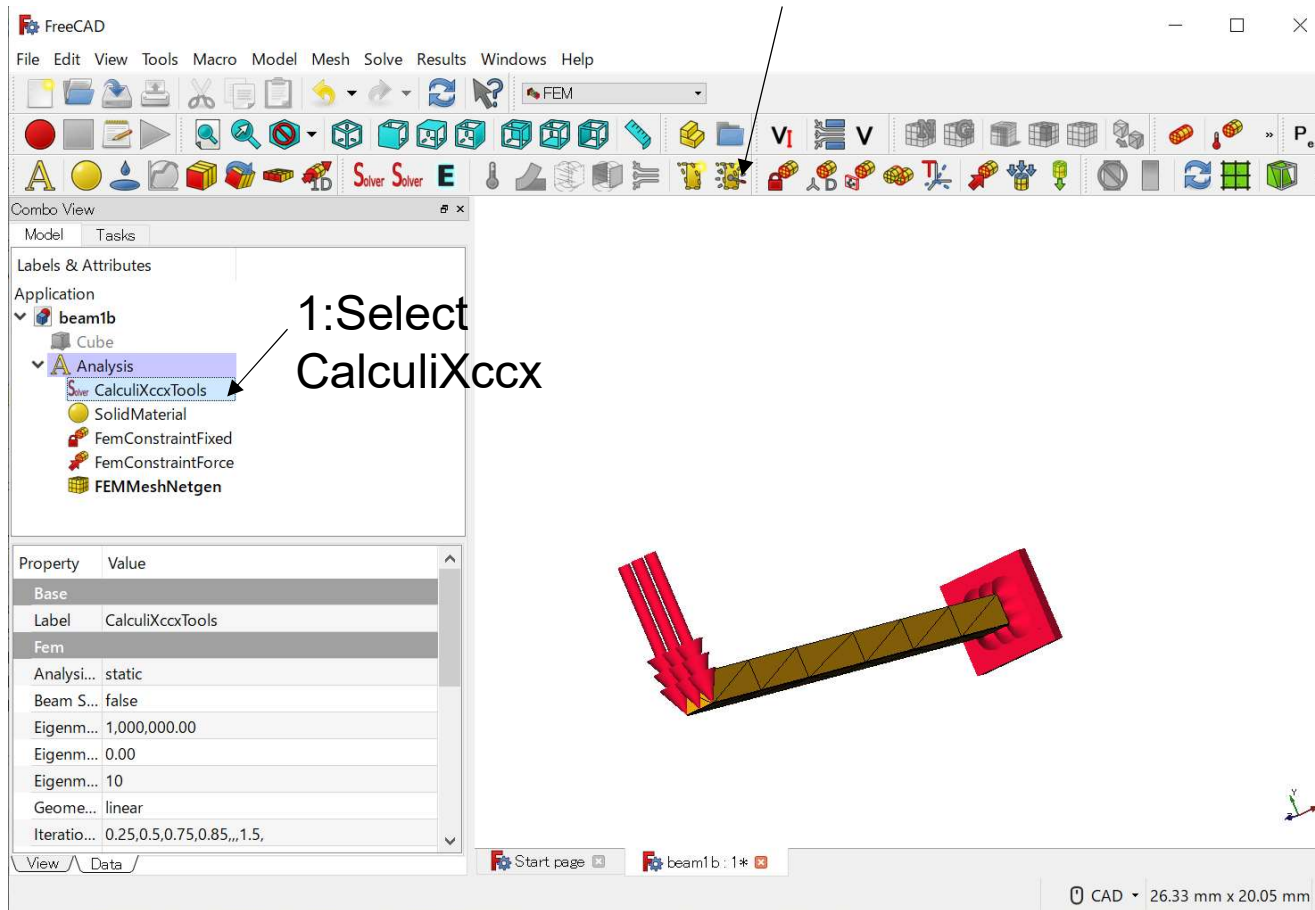
1:Cube



4:Check number of Nodes and Elements

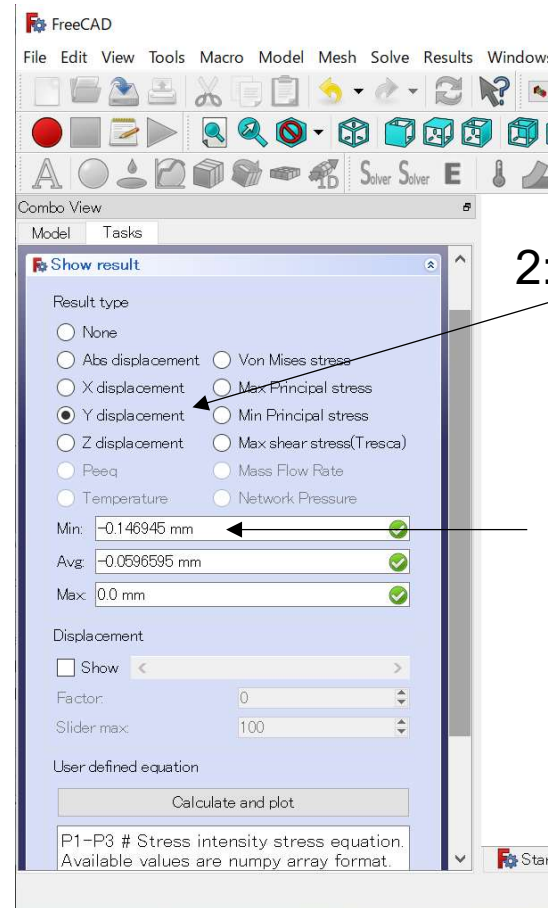
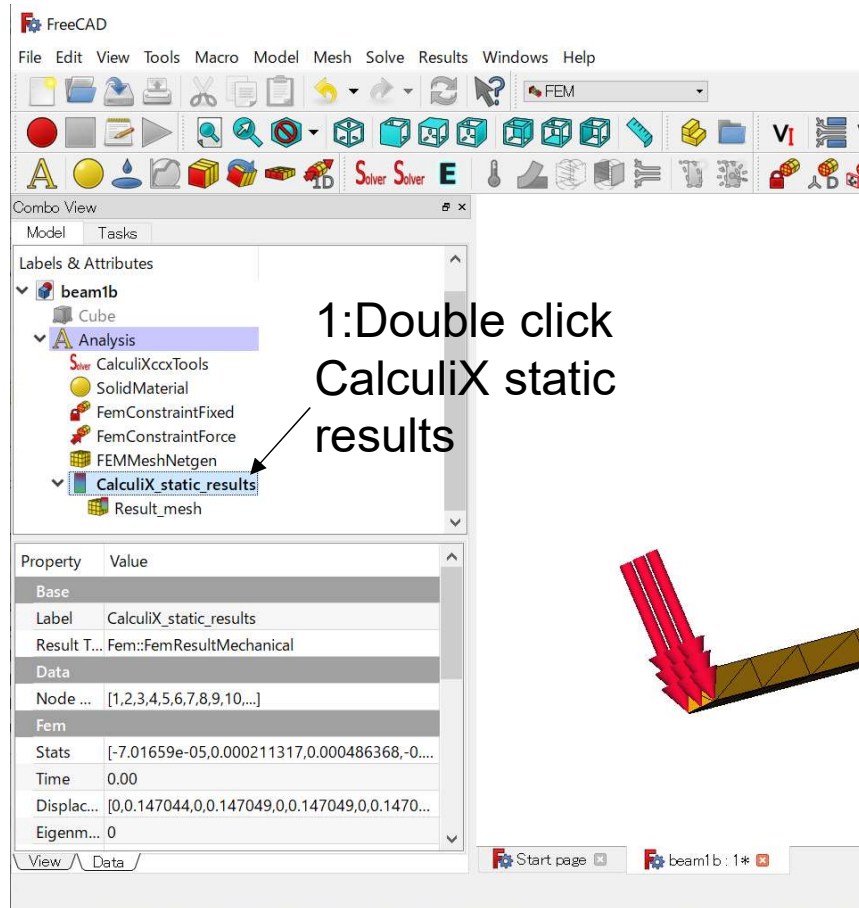
# Run calculation

2:Run calculation



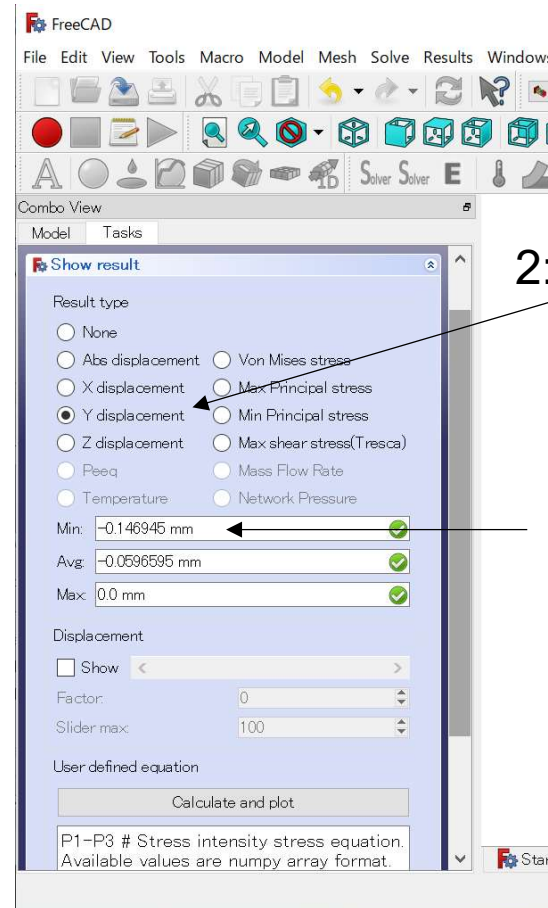
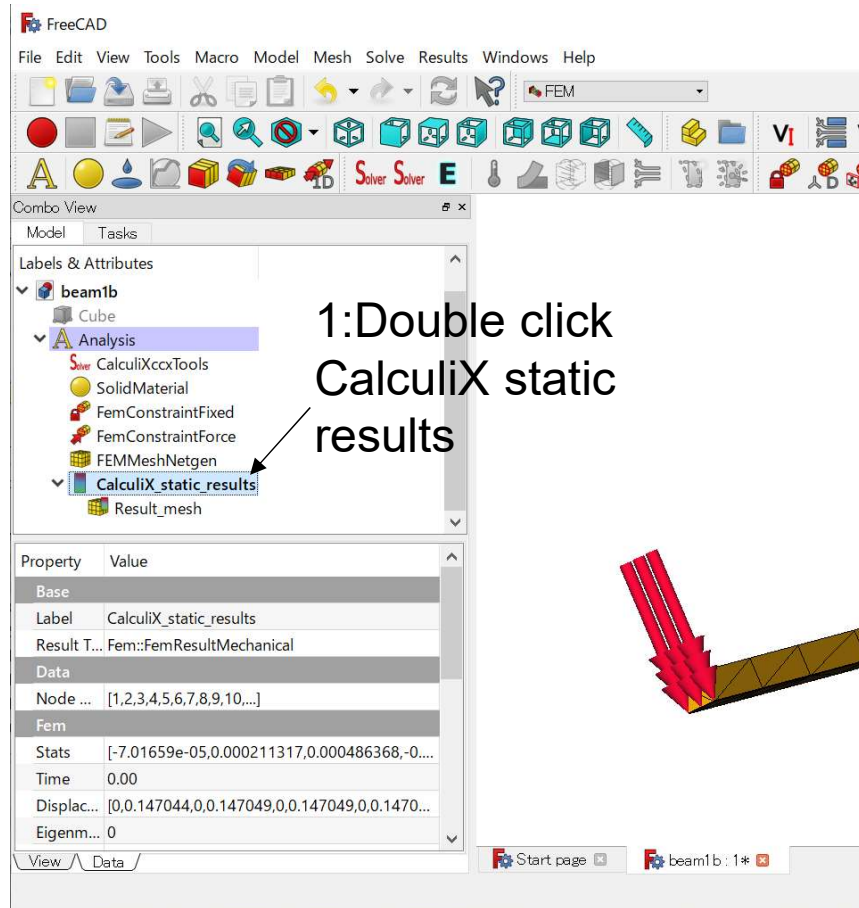


# Results (Displacement)



Theory	-0.152 mm
FEM	-0.147 mm

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