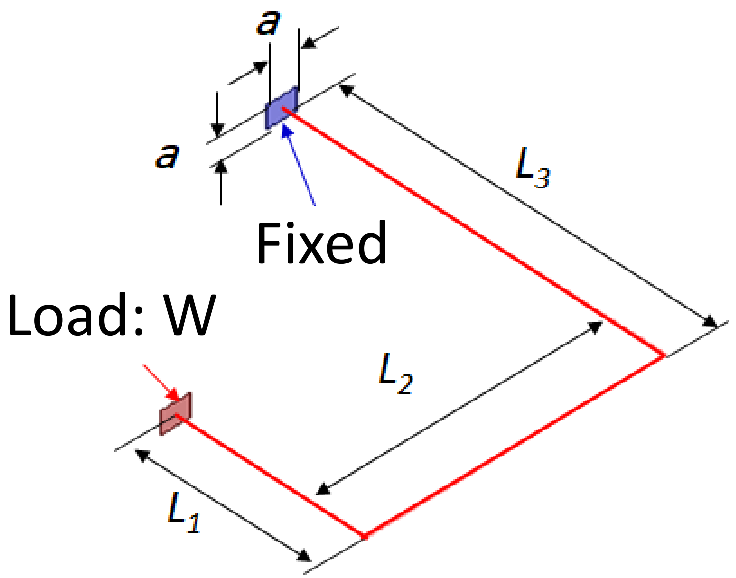
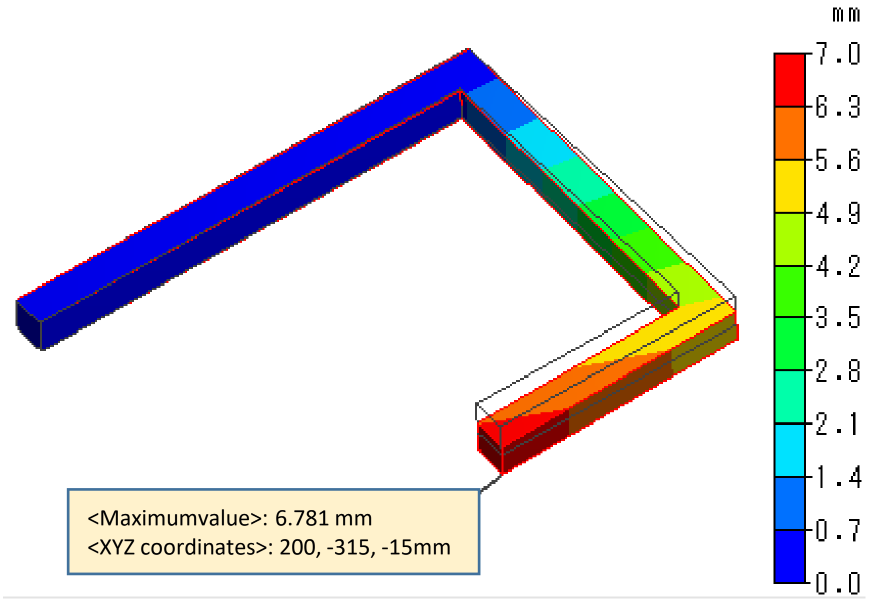
Bending of J-shaped Cantilever

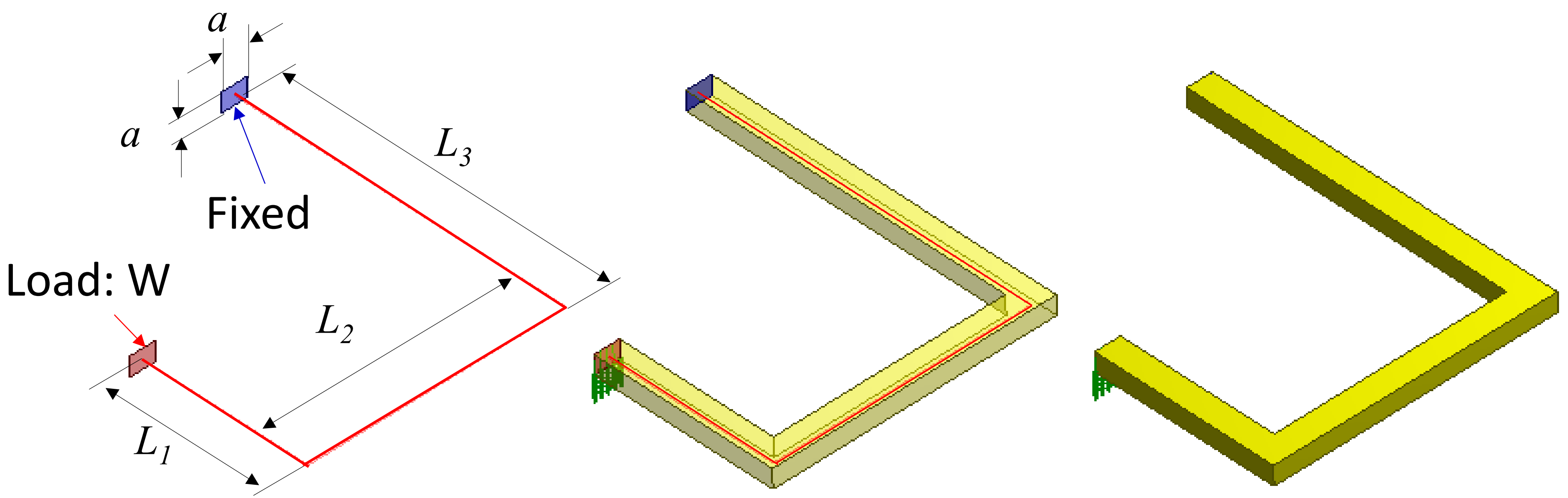




Murata Software Co., Ltd.

Analysis Model

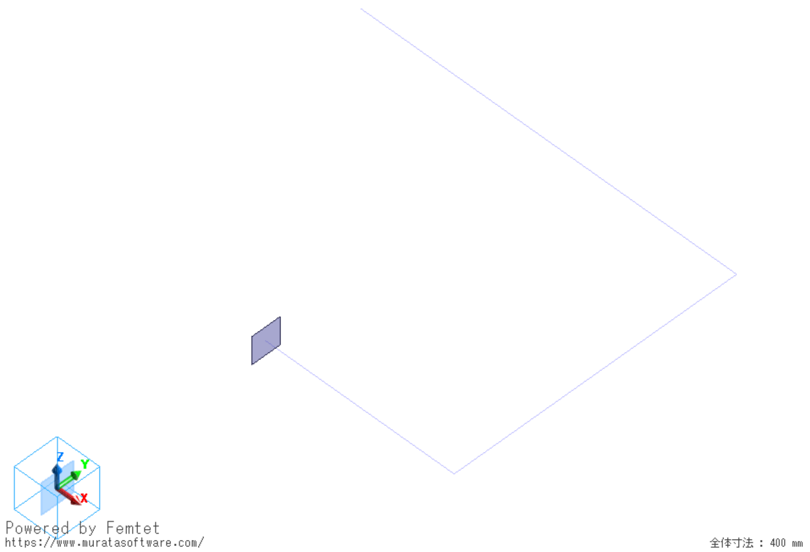
Solves bending (δ) of a model where:
a=30mm, L_1=200mm, L_2=300mm, L_3=400mm, W=1000N



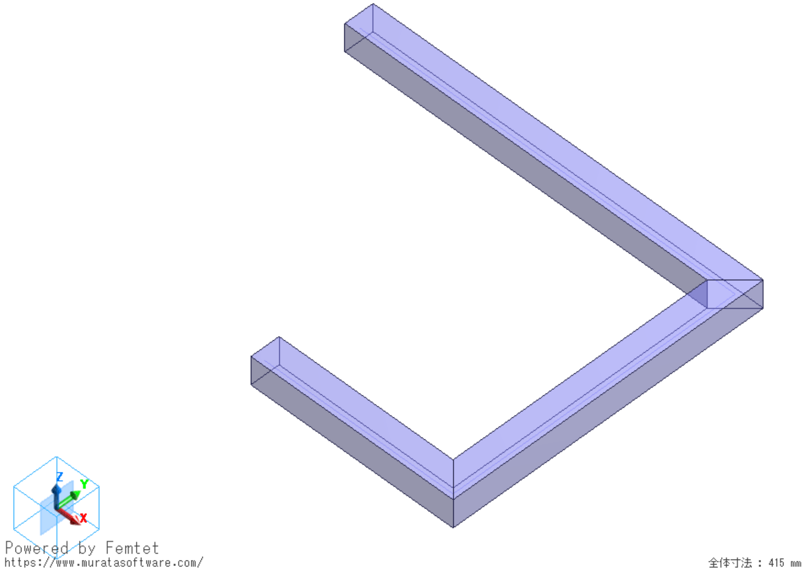
Analysis Model

Analysis Model Making

(1) Creates L1, L2, and L3 by wire bodies.
(2) Unites the wires by [Convert]-[Wire Bodies to Wire Bodies].
(3) Switches a drawing plane to Y-X plane
and creates a cross section by Sheet body > [Box].
(4) Sweep a cross section and united wires.



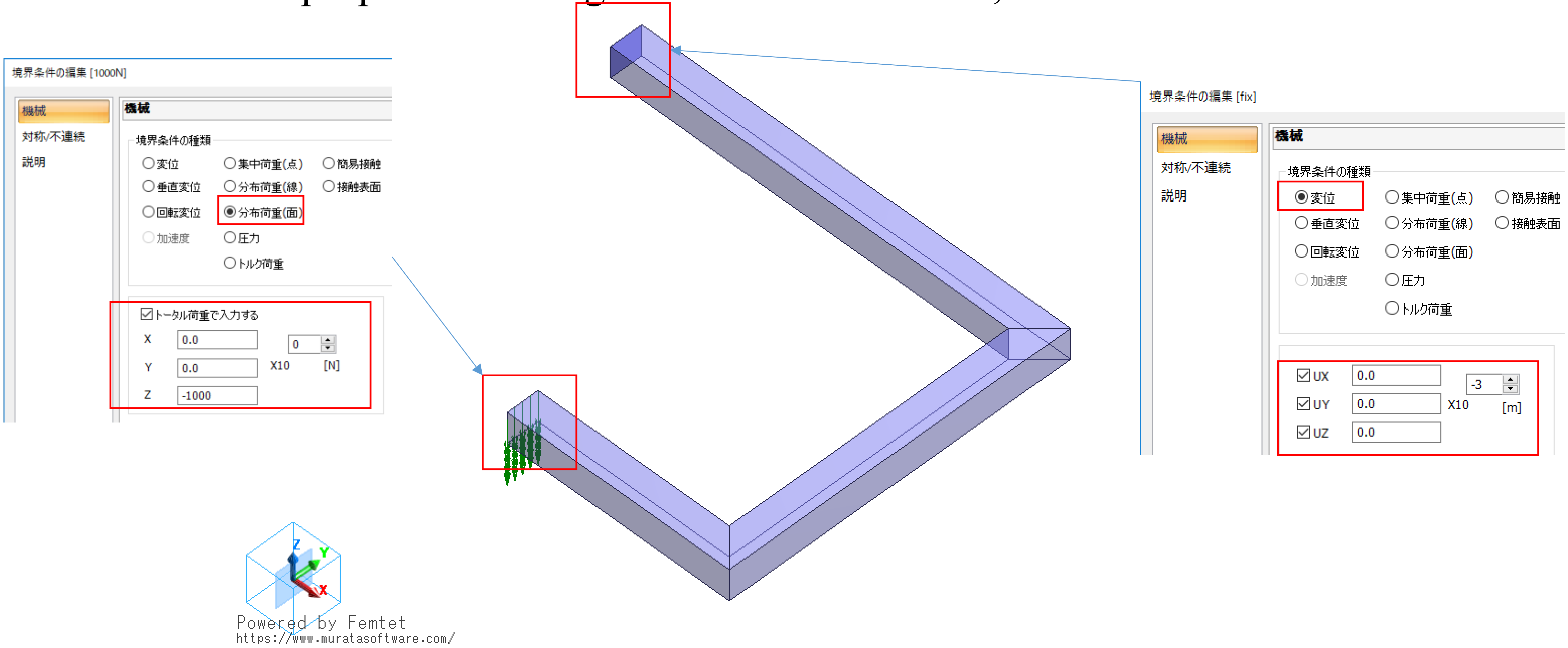
引きのばし前



引きのばし後

Analysis Conditions

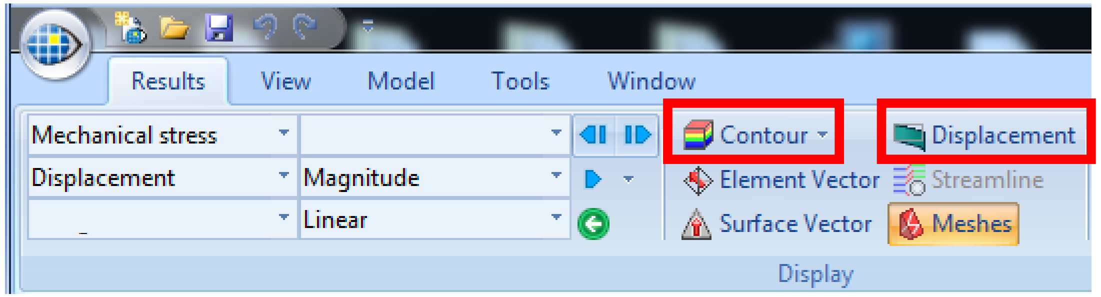
- Mechanical stress static analysis
- General mesh size: 7.5mm
- Material properties: Young's modulus E=200GPa, Poisson's ratio v=0.3

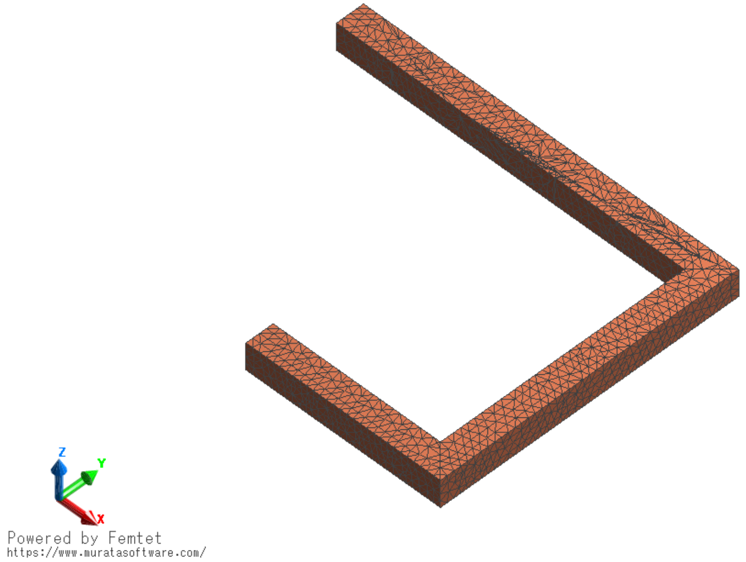


Boundary Conditoin Setting

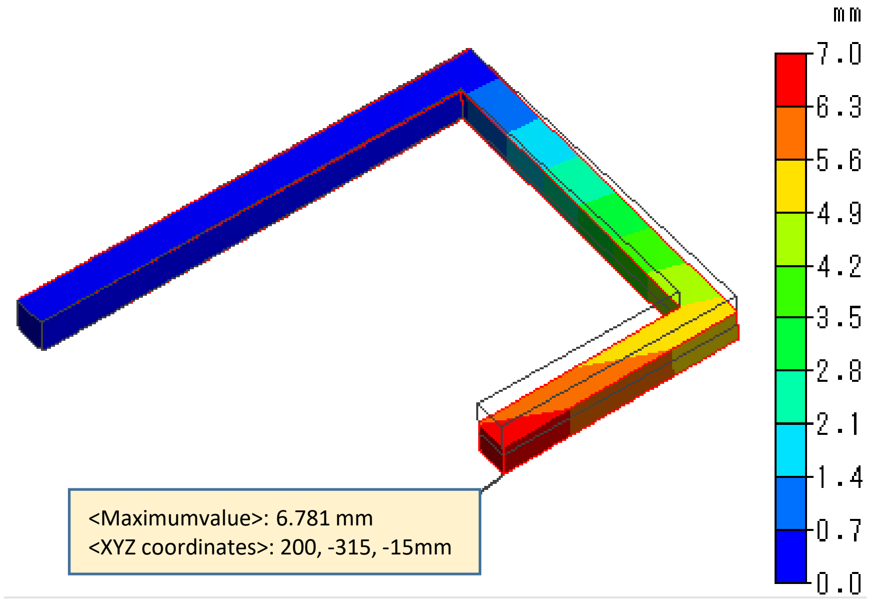
Analysis Results

Theoretical value of material mechanics = 6.74mm
Analysis result = 6.78mm





Meshing



Displacement Contour

Theoretical Solution

A square-section bar with a side length of (**a**) is bent at a right angle in the horizontal plane. One end face of the bar is fixed, while a vertically downward load (**W**) is applied to the other end face. The deflection (δ) at the loaded end can be calculated using the following equation.

(**Ub**) is elastic energy stored in the square lumber by bending moment.

$$U_b=\int \frac{Mx^2}{2EI}dx= \frac{1}{2EI}\left[\int_0^{L_1}(Wx)^2dx+\int_0^{L2}(Wx)^2dx+\int_0^{L3}\{W(x-L_1)\}^2dx\right]$$
$$= \frac{W^2}{6EI}(L_1^3+L_2^3+L_3^3-3L_1L_3^2+3L_1^2L_3)$$

(**Ut**) is the elastic strain energy stored in the bar due to the torsional moment.

$$U_t=\frac{1}{2GI_p}\{(WL_1)^2L_2+(WL_2)^2L_3\}$$

Applying Castigliano's theorem to the total elastic strain energy stored in the bar, and assuming $I=a^4/12$ and $I_p=k\,a^4$,

$$\delta= \frac{\partial(U_b+U_t)}{\partial W}= \frac{W}{a^4}\left[\frac{4}{E}\{L_1^3+L_2^3+L_3^3-3L_1L_3(L_3-L_1)\}+\frac{1}{kG}L_2(L_1^2+L_2L_3)\right]$$

The value (k) is a constant appearing in the relationship among the angle of twist (Θ), the shear modulus (**G**), and the torsional moment (**T**) for a square bar of side length (**a**) and length (**L**) subjected to torsion.

$$\Theta= \frac{TL}{k a^4 G}$$

In this analysis, ($k = 0.1406$) is used.