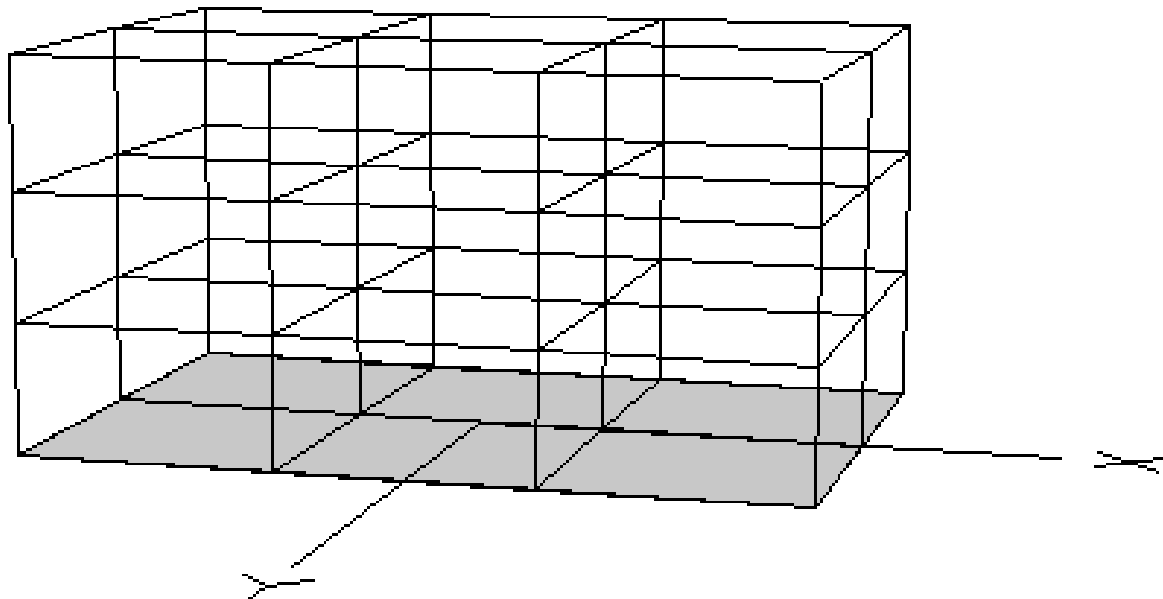


Basic Assumption

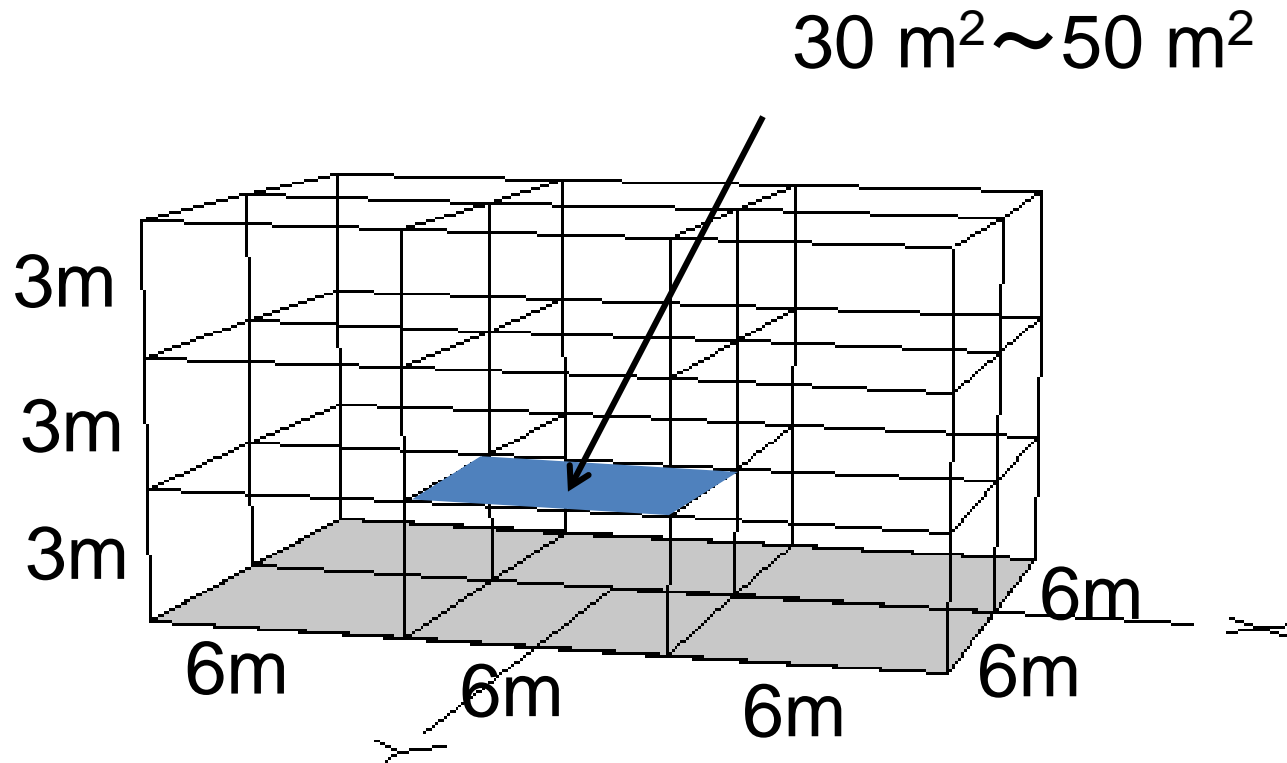
RC (Reinforced Concrete)

3 Story

2 × 3 Span

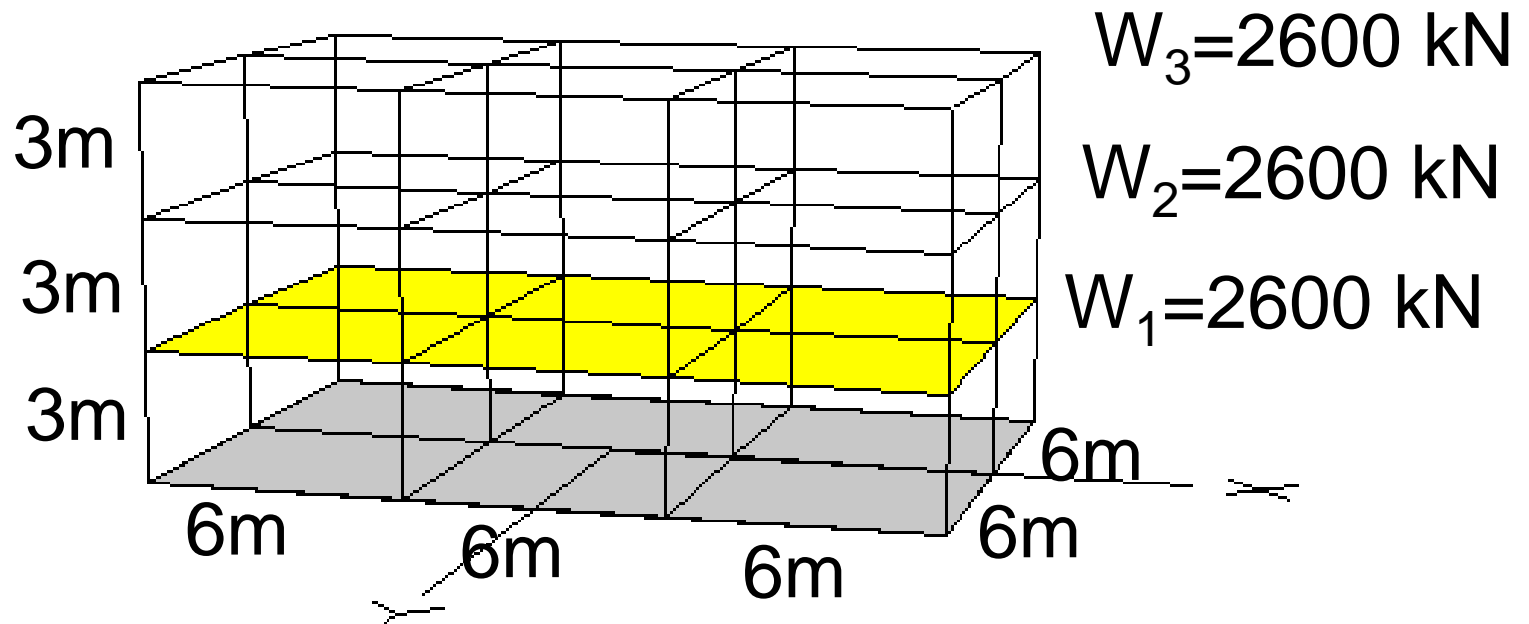


Span



Weight of Building

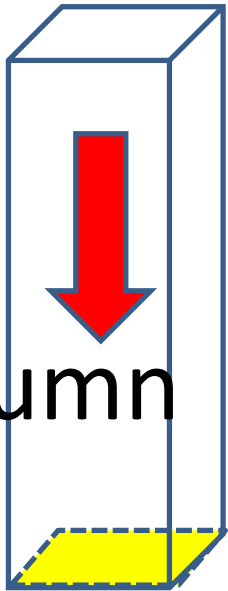
$$1.2 \text{ ton} / \text{m}^2 \approx 12 \text{ kN} / \text{m}^2$$



Concrete Strength

$$F_c = 240 \text{ (kg/cm}^2\text{)}$$
$$= 24 \text{ (MPa, N/mm}^2\text{)}$$

N



Column

area A

Axial Load

$$N = 0.2 F_c \times A$$

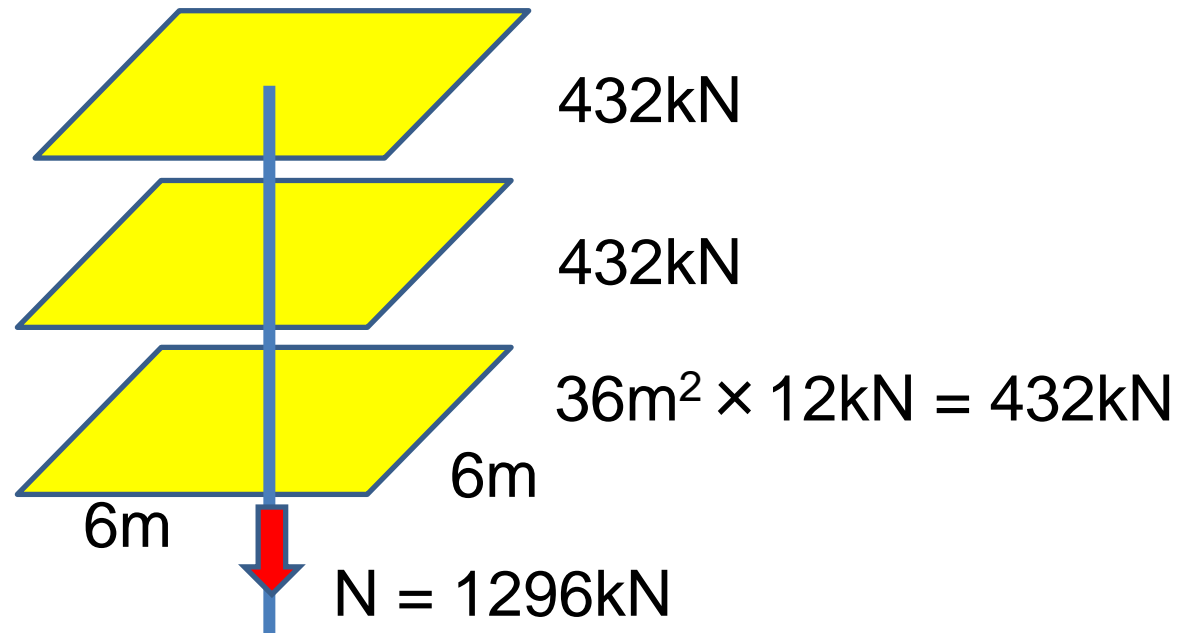
$$< (1/3) F_c \times A$$

Column Size

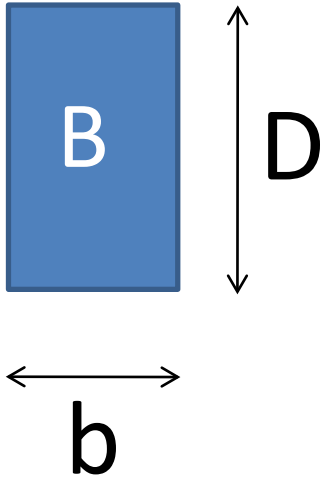


$$A = N / (0.2F_c) = 1296(\text{kN}) / 4.8(\text{N/mm}^2) = 2700 (\text{cm}^2)$$

$$\rightarrow 60\text{cm} \times 60\text{cm}$$



Beam Size



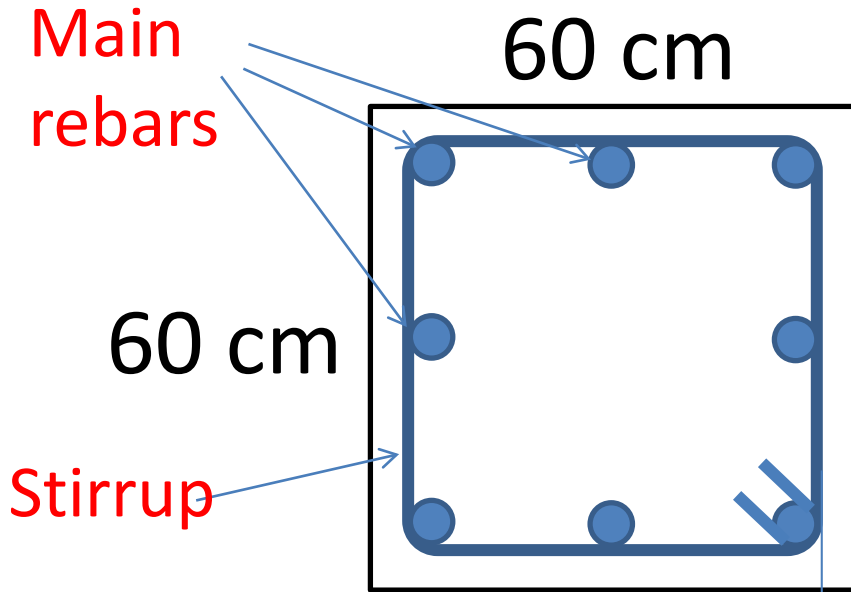
$$D \approx (\text{Span}) \times 1/10$$

$$D = 60 \text{ cm}$$

$$b \approx D \times 1/2$$

$$b = 30 \text{ cm}$$

Reinforcement in Column



Main rebars

60 cm

60 cm

Stirrup

D10 or D13

space 10 cm (edge)

15cm (middle)

→ 2-D13@100

Covering Concrete
> 40mm

Minimum rebar ratio =

$$\frac{\text{Total area of rebar}}{\text{Section area}}$$

> 0.8 %

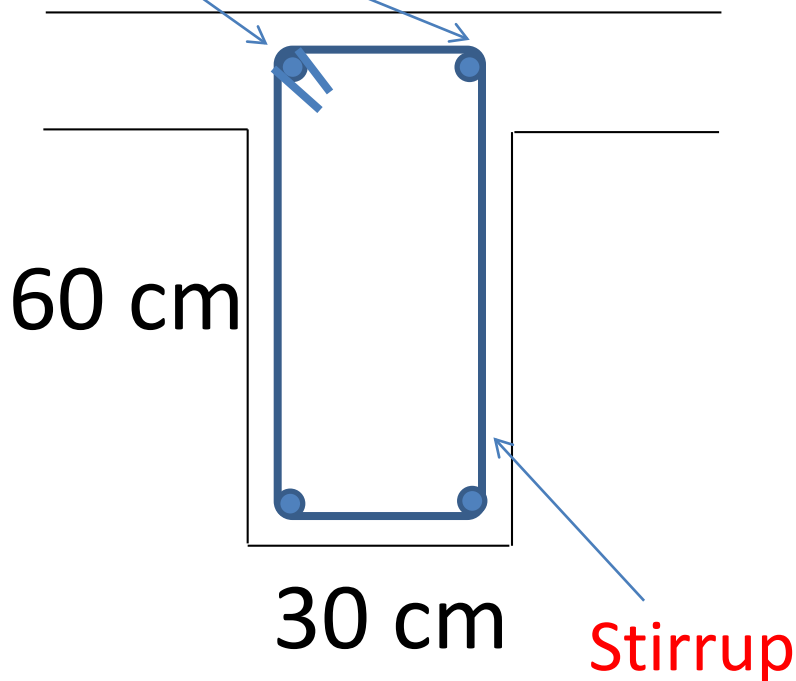
Total area of rebar

$$= 3600\text{cm}^2 \times 0.008 = 28.8 \text{ cm}^2$$

$$\rightarrow \text{D22 } (3.87\text{cm}^2) \times 8$$

Reinforcement in Beam

Main
rebars



Minimum rebar
ratio =

Tension side rebar area

Section area

> 0.4 %

Total area of rebar

$$= 1800\text{cm}^2 \times 0.004 = 7.2 \text{ cm}^2$$

$$\rightarrow \text{D22 } (3.87\text{cm}^2) \times 2$$

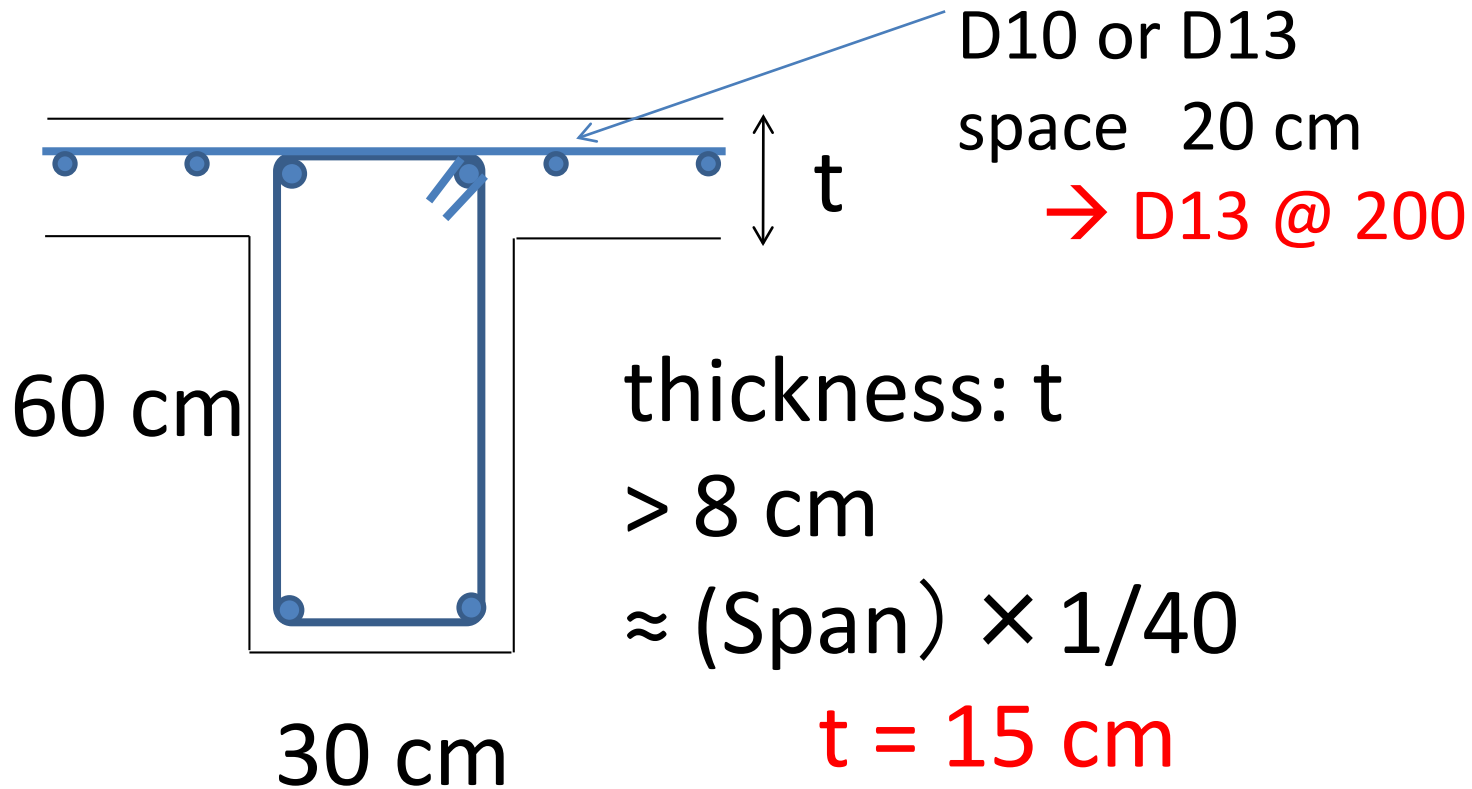
D10 or D13

space 15 cm (edge)

20cm (middle)

$$\rightarrow \text{2-D13@150}$$

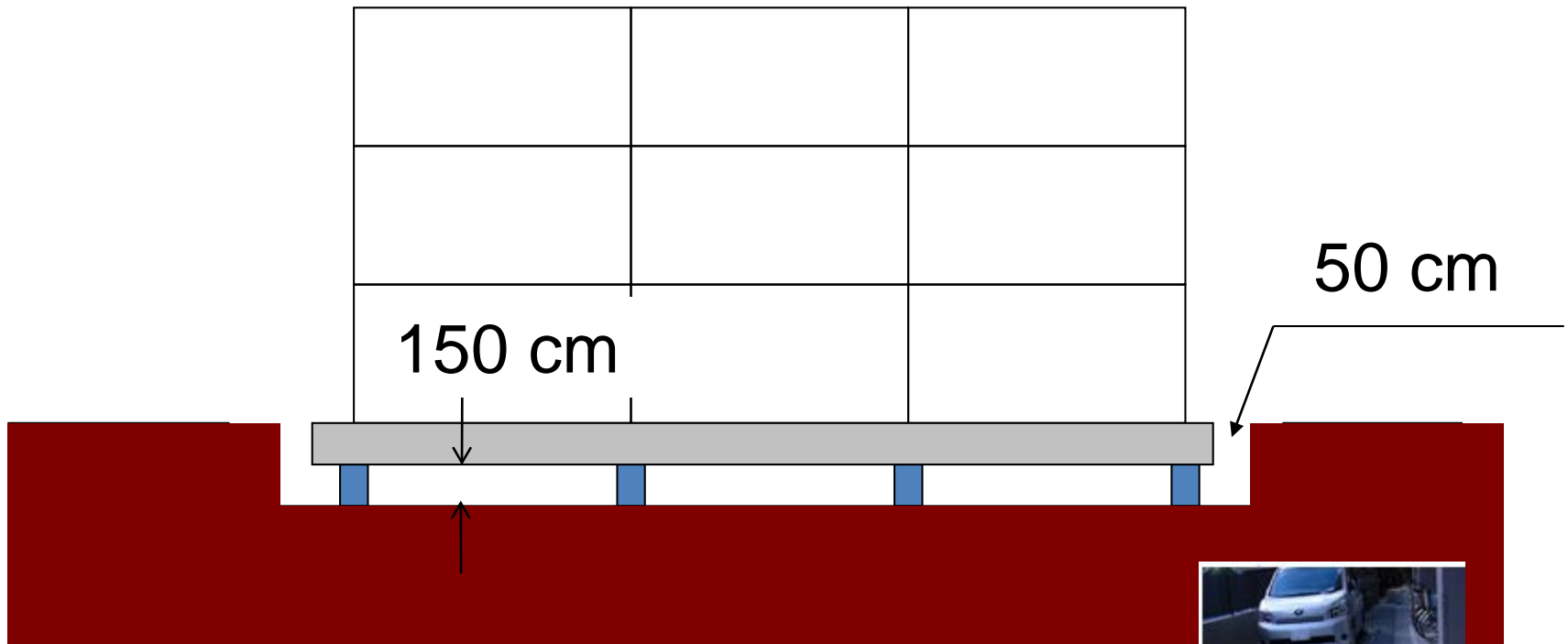
Reinforcement in Slab



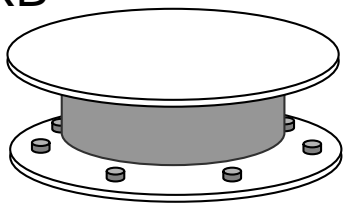
Strength of steel

Name	Tensile strength
SD295	3.0 (t/cm ²) = 295 (MPa, N/mm ²)
SD345	3.5 (t/cm ²) = 345 (MPa, N/mm ²)
SD390	4.0 (t/cm ²) = 390 (MPa, N/mm ²)

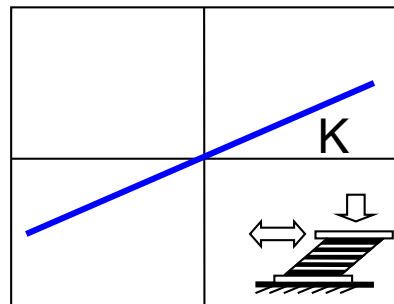
Design of Base Isolation Layer



Natural Rubber Bearing
NRB



水平力

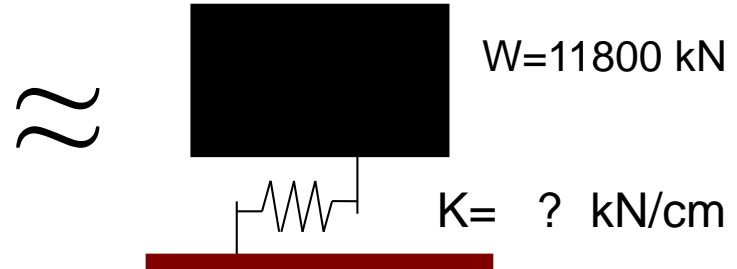
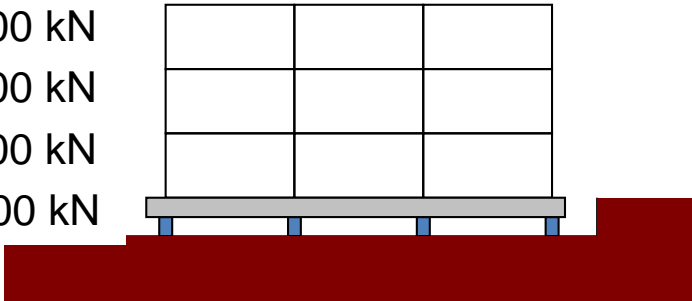


水平变形



Design of Base Isolation Period

$$\begin{aligned} W_3 &= 2600 \text{ kN} \\ W_2 &= 2600 \text{ kN} \\ W_1 &= 2600 \text{ kN} \\ W_B &= 4000 \text{ kN} \end{aligned}$$



Period Mass Weight

$$T = 2\pi \sqrt{\frac{m}{K}} = 2\pi \sqrt{\frac{W/g}{K}}$$

Stiffness

$$K = \left(\frac{2\pi}{T} \right)^2 \frac{W}{g}$$

$$K = \left(\frac{2\pi}{4} \right)^2 \frac{11800}{980} = 30 \text{ kN/cm}$$

Gravity acc.

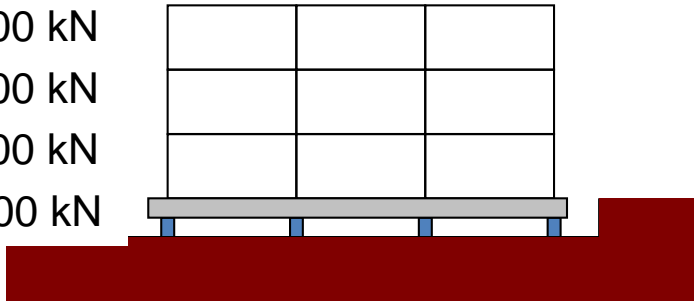
$$g = 980 \text{ cm/sec}^2$$

Target Period

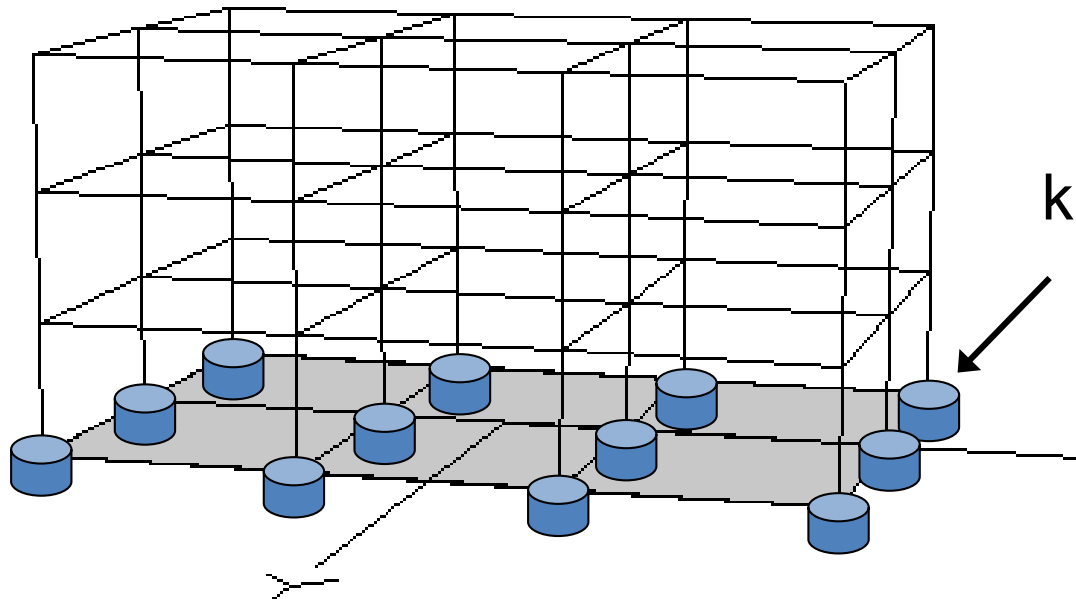
$$T = 4 \text{ sec}$$

Stiffness of isolator

$W_3=2600$ kN
 $W_2=2600$ kN
 $W_1=2600$ kN
 $W_B=4000$ kN

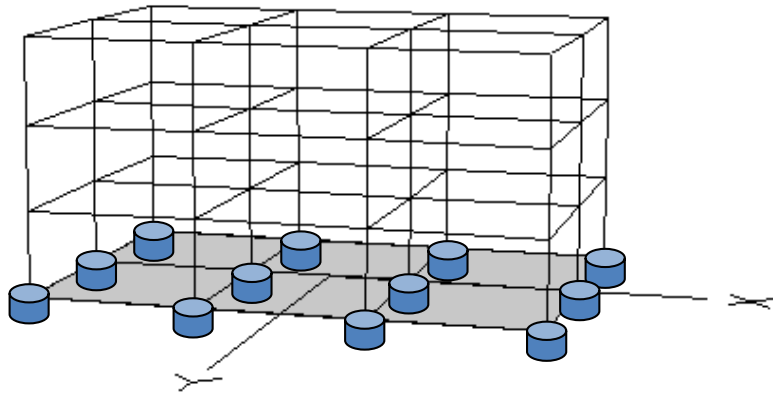


\approx

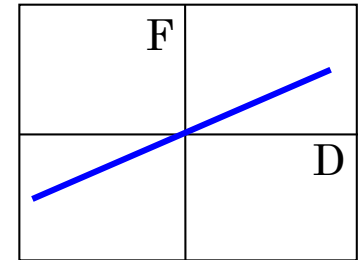
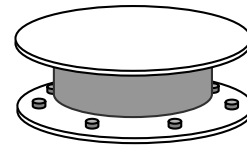


$$\begin{aligned}
 k &= K / 12 \\
 &= 2.5 \text{ kN/cm} \\
 &= \mathbf{0.25 \text{ kN/mm}}
 \end{aligned}$$

Stiffness of isolator

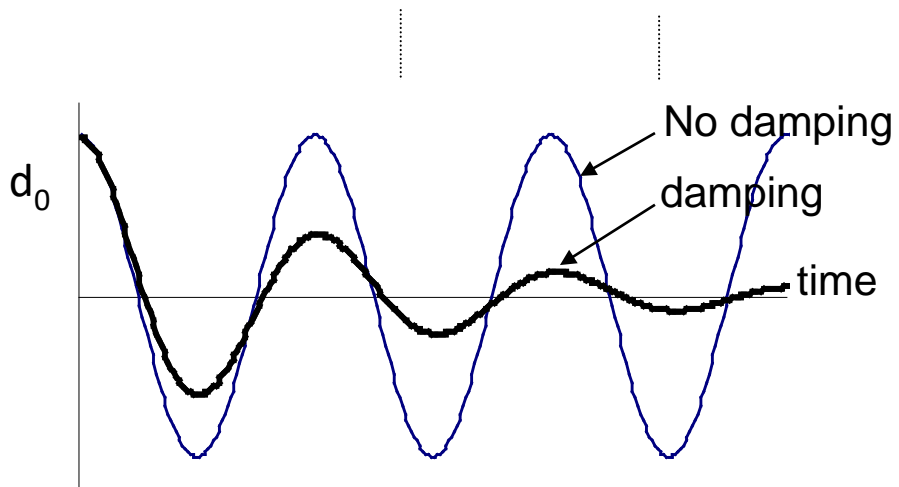
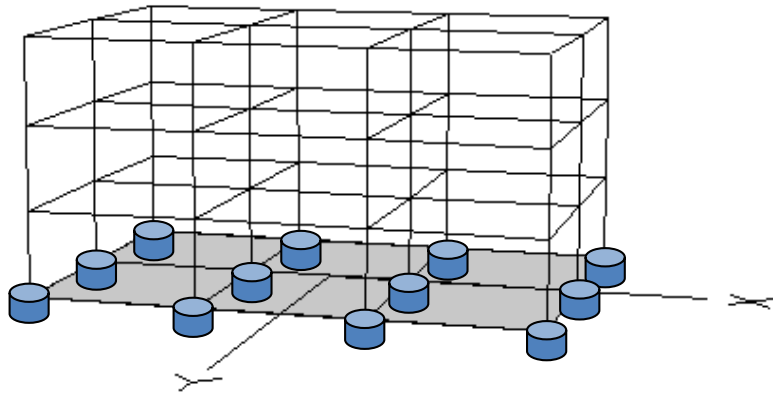


Natural Rubber Bearing (NRB)

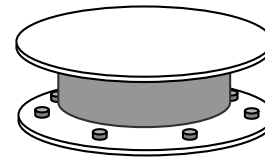
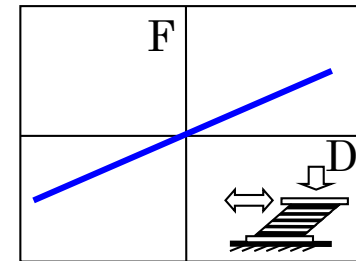
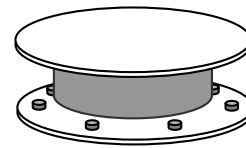


$K_0 = 0.25 \text{ kN/mm}$

Design of damper



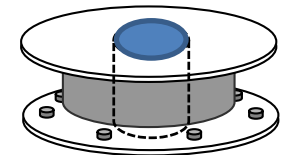
Natural Rubber Bearing (NRB)



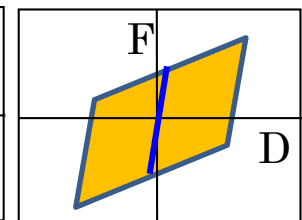
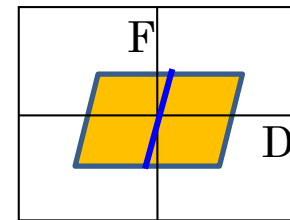
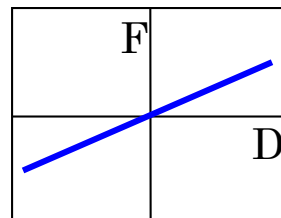
+



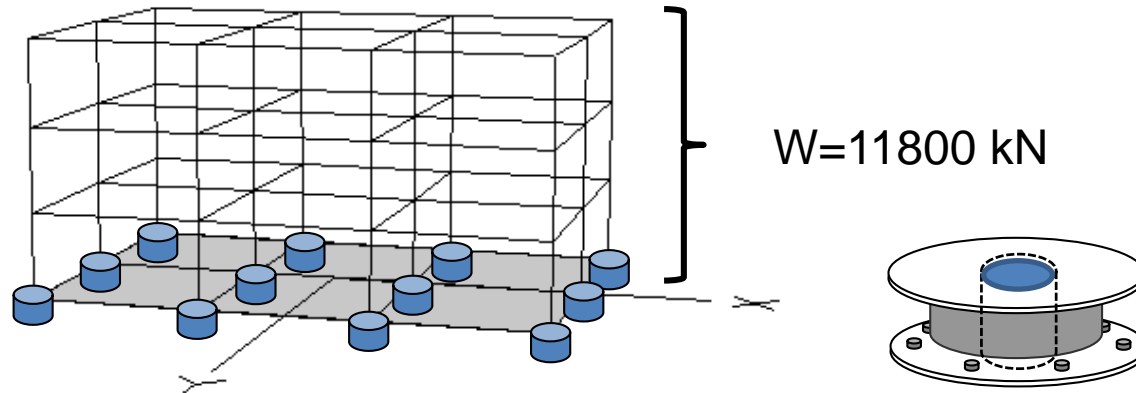
=



Lead Rubber Bearing (LRB)



Lead Rubber Bearing



$$F_y \approx 100 \text{ kN}$$

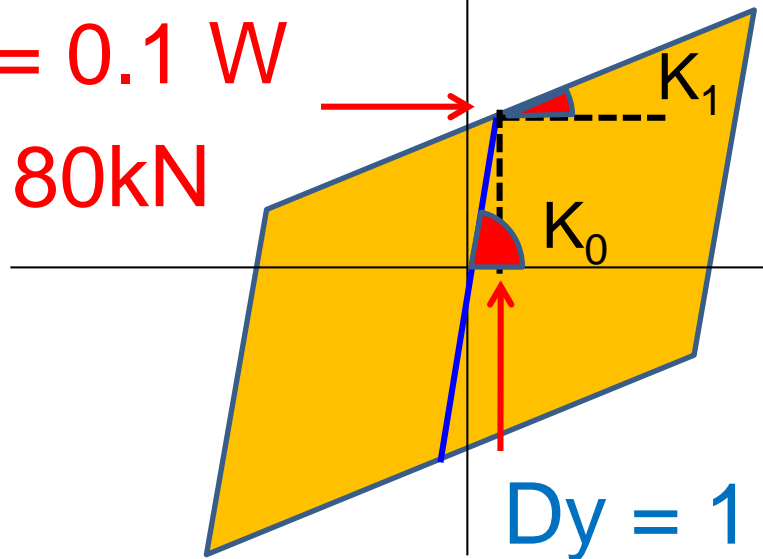
$$K_0 \approx 10 \text{ kN/mm}$$

$$K_1 / K_0 \approx 0.025$$

1/12

$$F_y = 0.1 W$$

$$= 1180 \text{ kN}$$



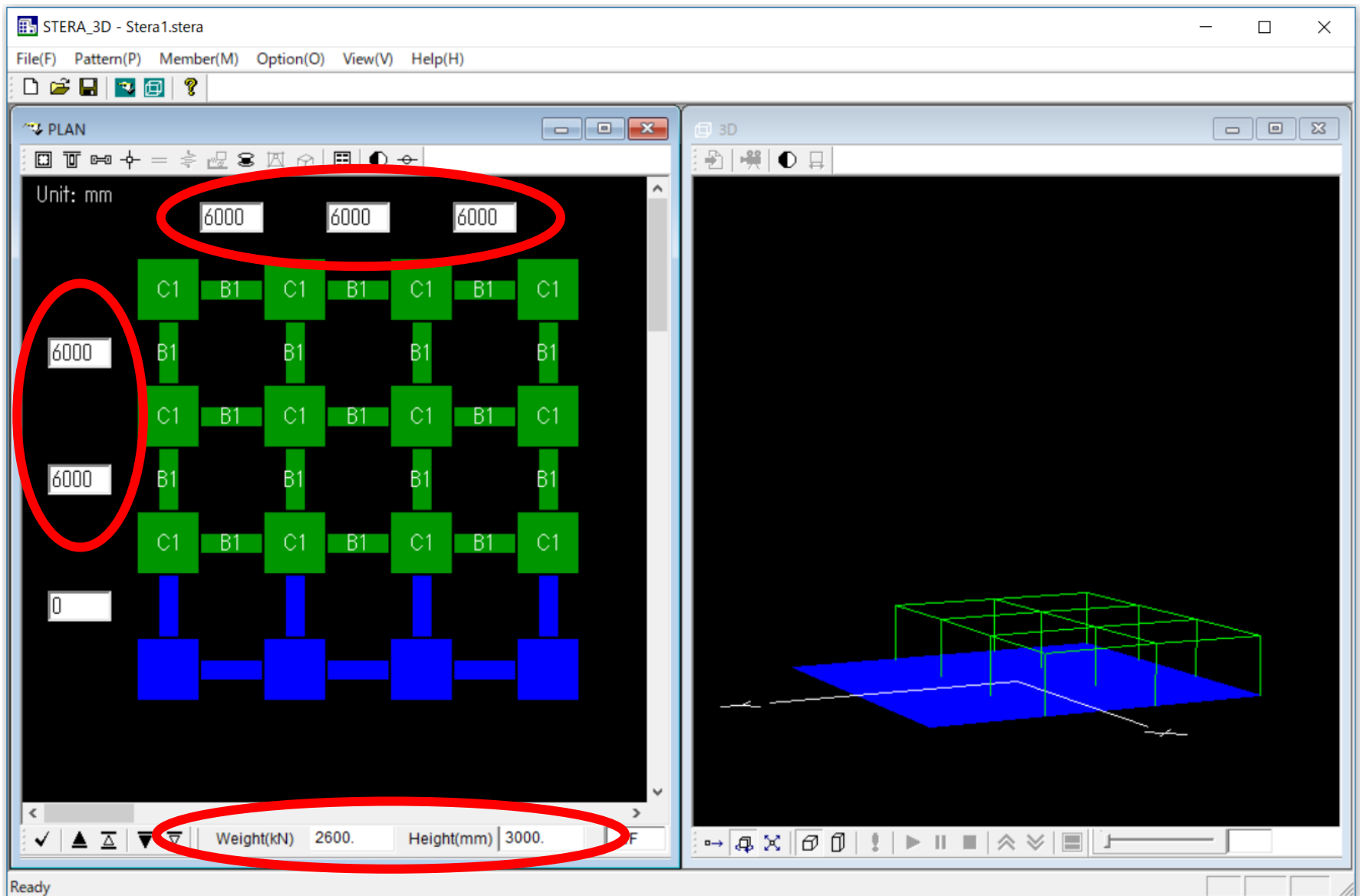
$$K_1 = 30 \text{ kN/cm}$$

$$K_0 = 1180 \text{ kN/cm}$$

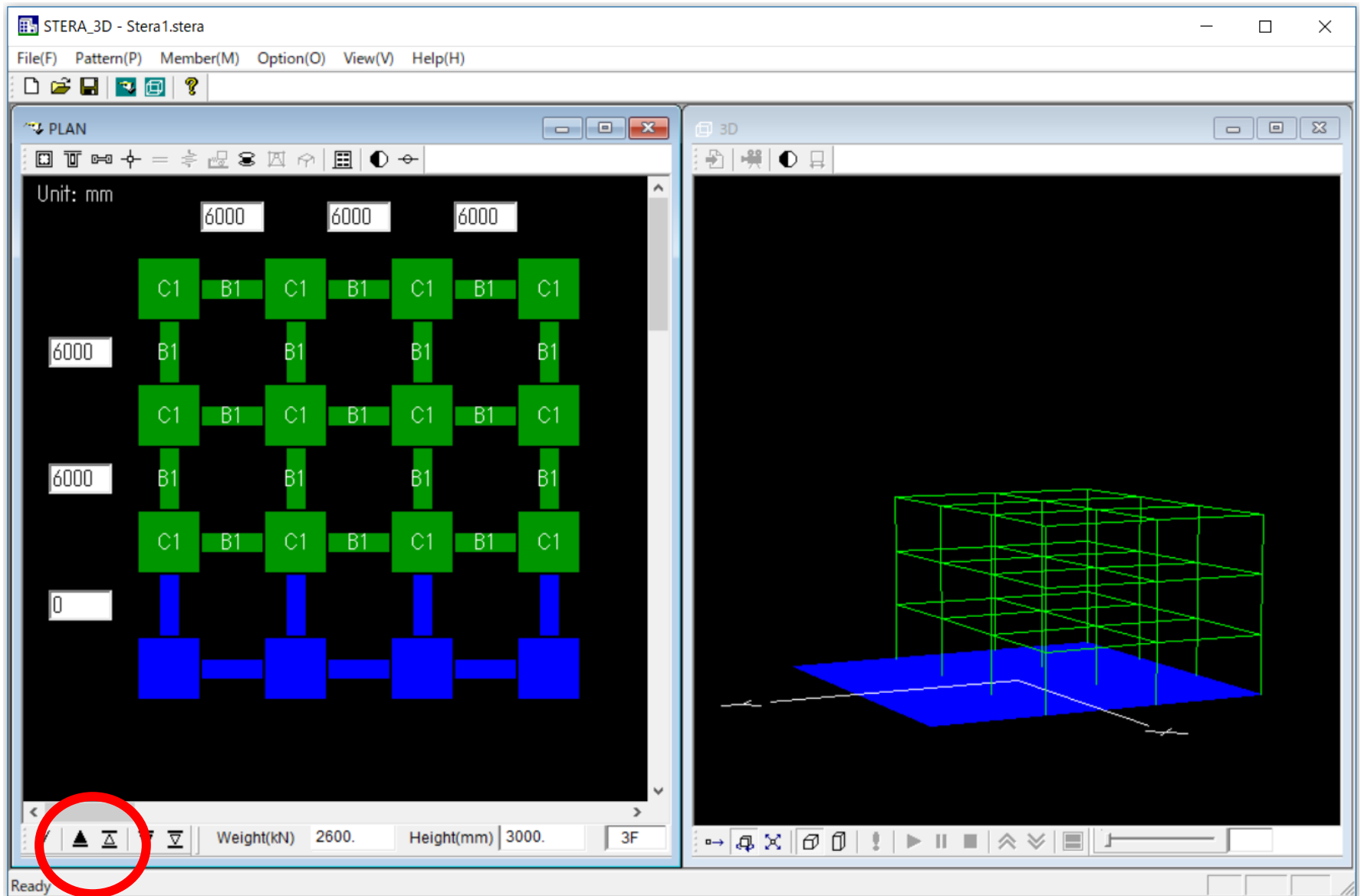
$$K_1 / K_0 \approx 0.025$$

$$D_y = 1 \text{ cm}$$

STERA 3D (Input of Size)



STERA 3D (Upper floor, copy)



STERA 3D (Column Input)

The screenshot displays the STERA 3D software interface. The main window shows a 3D model of a column structure with green and blue elements. A red circle highlights the 'Column' icon in the top toolbar. A 'Column Editor' dialog box is open, showing the 'COLUMN' configuration. The 'Type' list on the left has 'C1' selected. The 'Size (mm)' section shows 'B' as 600 and 'd1' as 40. The 'Main Reinforcement Bar' section shows 'corner' as 4 - D22, 'X-side' as 2 - D22, and 'Y-side' as 2 - D22. The 'SD' field is set to 295. The 'Shear Reinforcement Bar' section shows 'X-side' as 2 - D13 - @ 100 and 'Y-side' as 2 - D13 - @ 100. The 'Concrete (N/mm2)' section shows 'Fc' as 24. The 'OPTION' button is visible. The 3D model on the right shows a grid with a blue base and a green top, with a blue arrow pointing to the 'SD' field and the number '390'.

STERA_3D - Stera1.stera

File(F) Pattern(P) Member(M) Option(O) View(V) Help(H)

Unit: mm

6000 6000

6000

6000

0

C1 B1 C1 B1

C1 B1 C1 B1

C1 B1 C1 B1

C1 B1 C1 B1

Column Editor

COLUMN

Type

C1

C2

C3

C4

C5

C6

C7

C8

C9

C10

C11

C12

C13

C14

C15

C16

Copy

Size (mm)

B 600 d1 40

D 600 d2 40

Y-side

X-side

d2T

B

d1

Main Reinforcement Bar

corner 4 - D22

X-side 2 - D22

Y-side 2 - D22

SD 295

Shear Reinforcement Bar

X-side 2 - D13 - @ 100

Y-side 2 - D13 - @ 100

SD 295

Concrete (N/mm2)

Fc 24

OPTION

Import Export ADD OK

Weight(kN) 2600. Height(mm) 3000. 3F

Ready

390

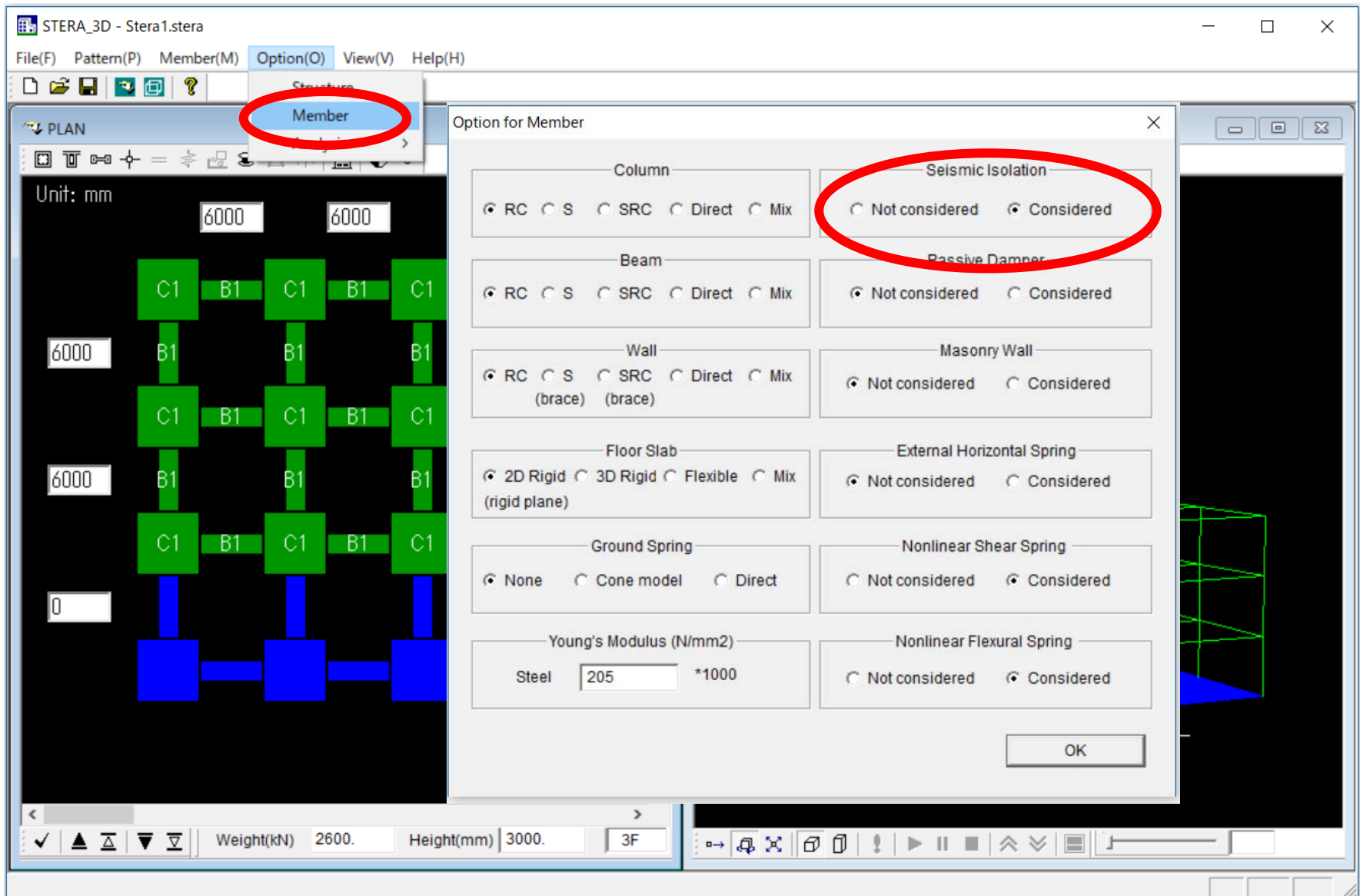
STERA 3D (Beam Input)

The image shows the STERA 3D software interface with a 3D model of a beam grid and a 'Beam Editor' dialog box. The 3D model displays a grid of beams (B1-B18) and columns (C1-C3) with dimensions of 6000 mm. The 'Beam Editor' dialog box is open, showing the following settings:

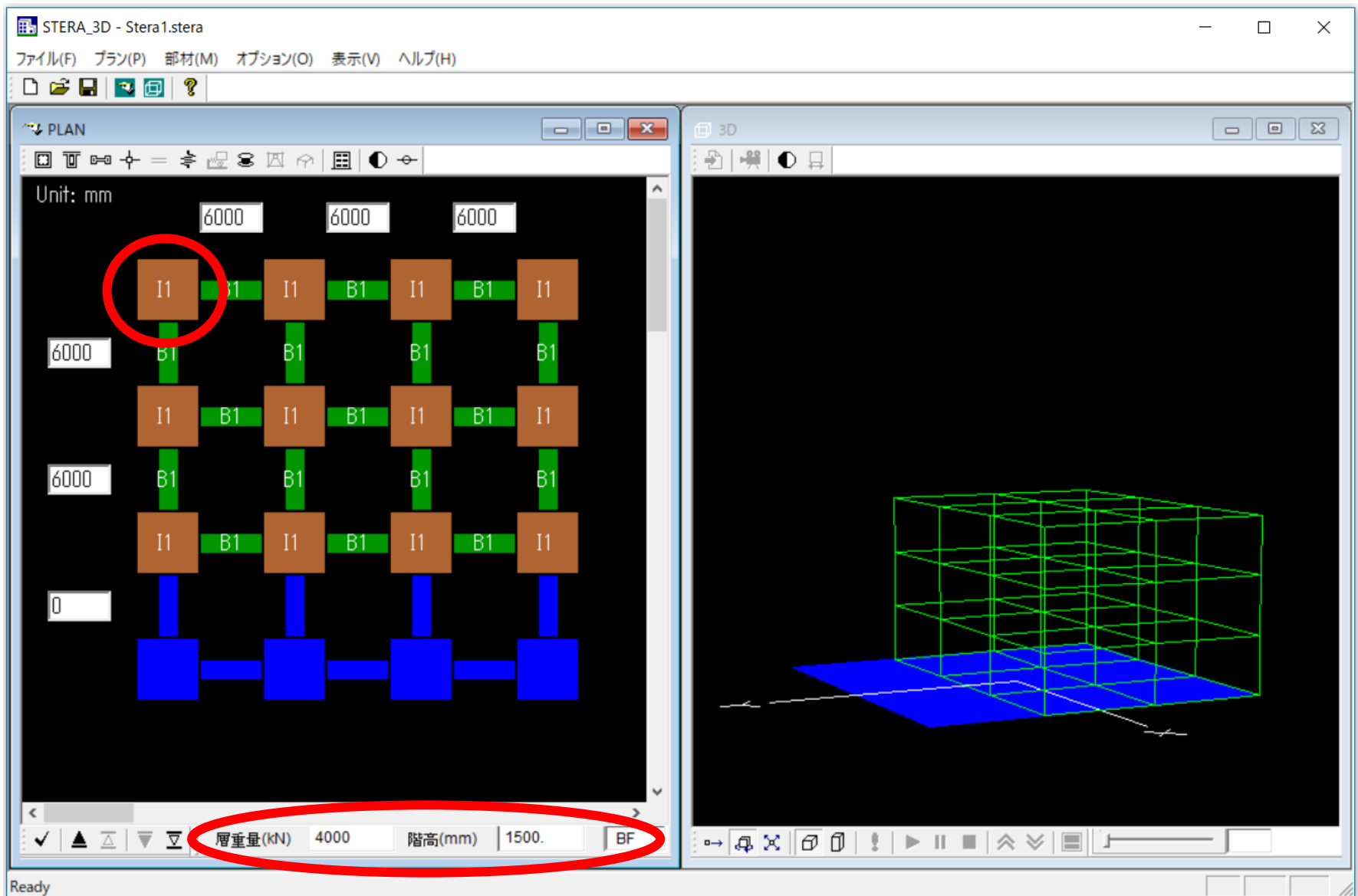
- BEAM**
- Type:** B1
- Size (mm):** B 300, d1 40, D 600, d2 40, S 150
- Main Reinforcement Bar:** TOP 2 - D22, BOTTOM 2 - D22
- Shear Reinforcement Bar:** 2 - D13 - @ 150
- Slab Reinforcement:** 1 - D13 - @ 200
- Concrete (N/mm²):** Fc 24

Three blue circles highlight the 'SD 295' values in the reinforcement fields. Arrows point from these circles to a large blue '390' value. A red circle highlights a toolbar icon in the top left corner. The status bar at the bottom shows 'Weight(kN) 2600.', 'Height(mm) 3000.', and '3F'.

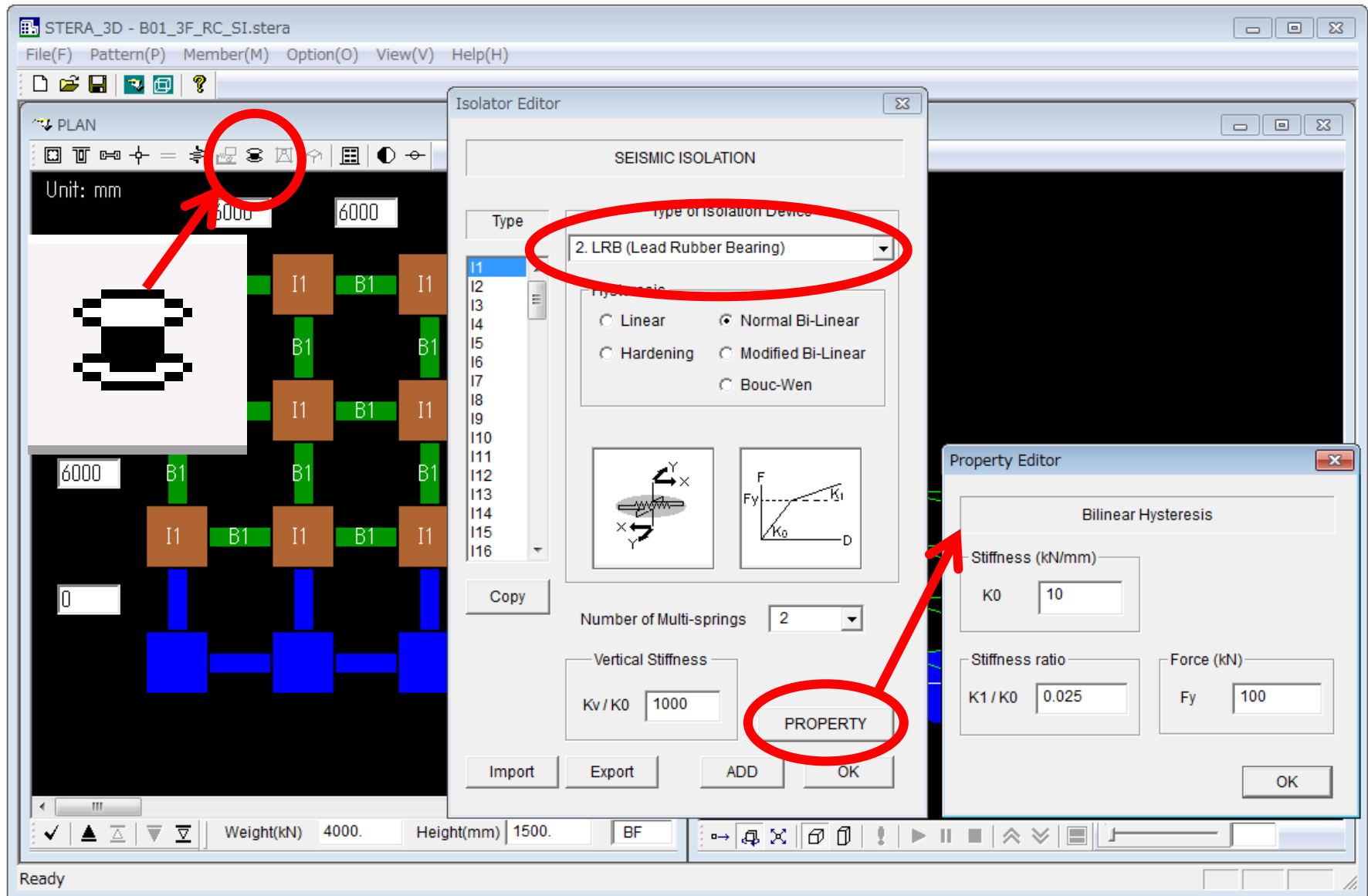
STERA 3D (consider Isolation)



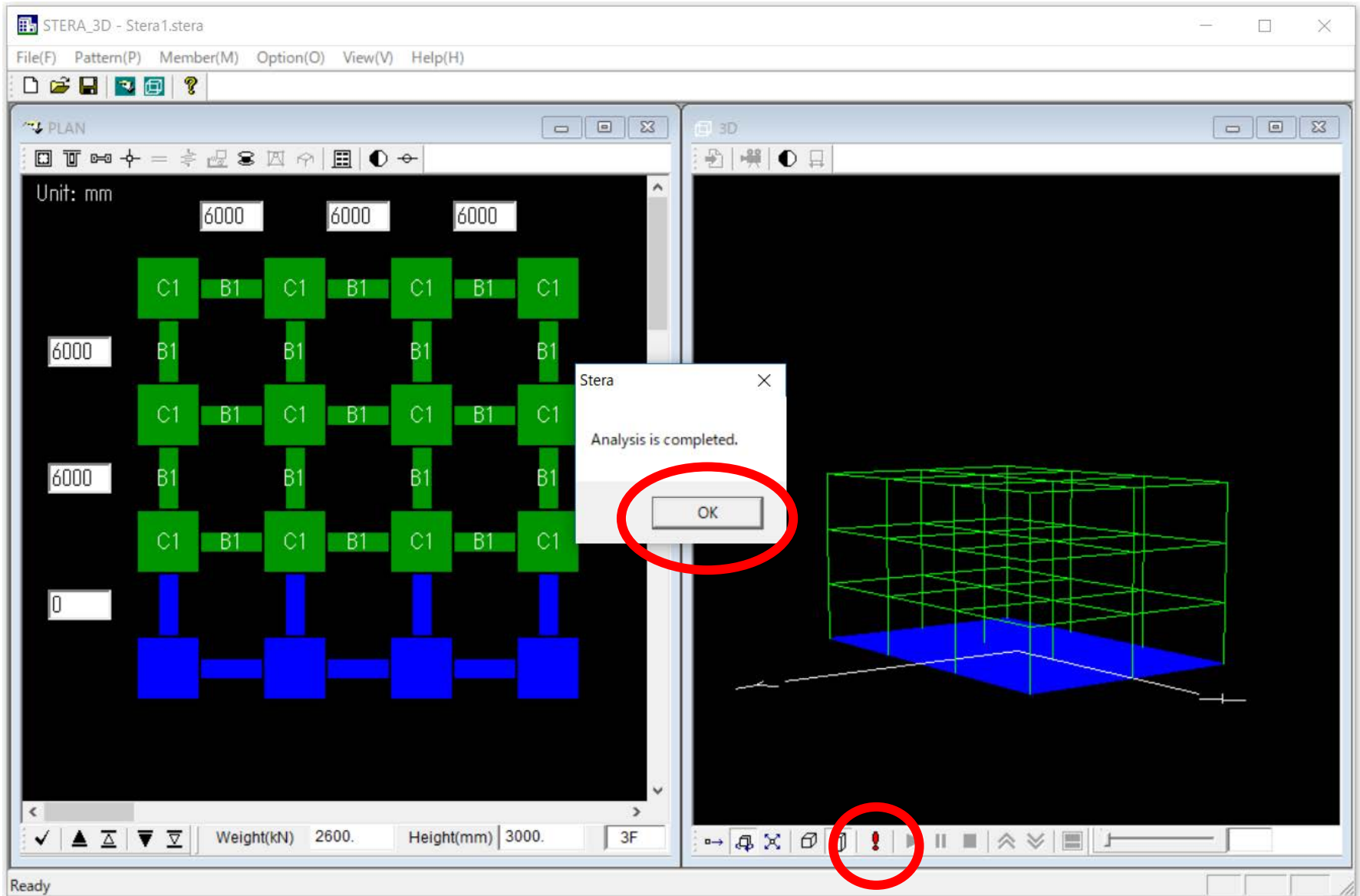
STERA 3D (setting SI member)



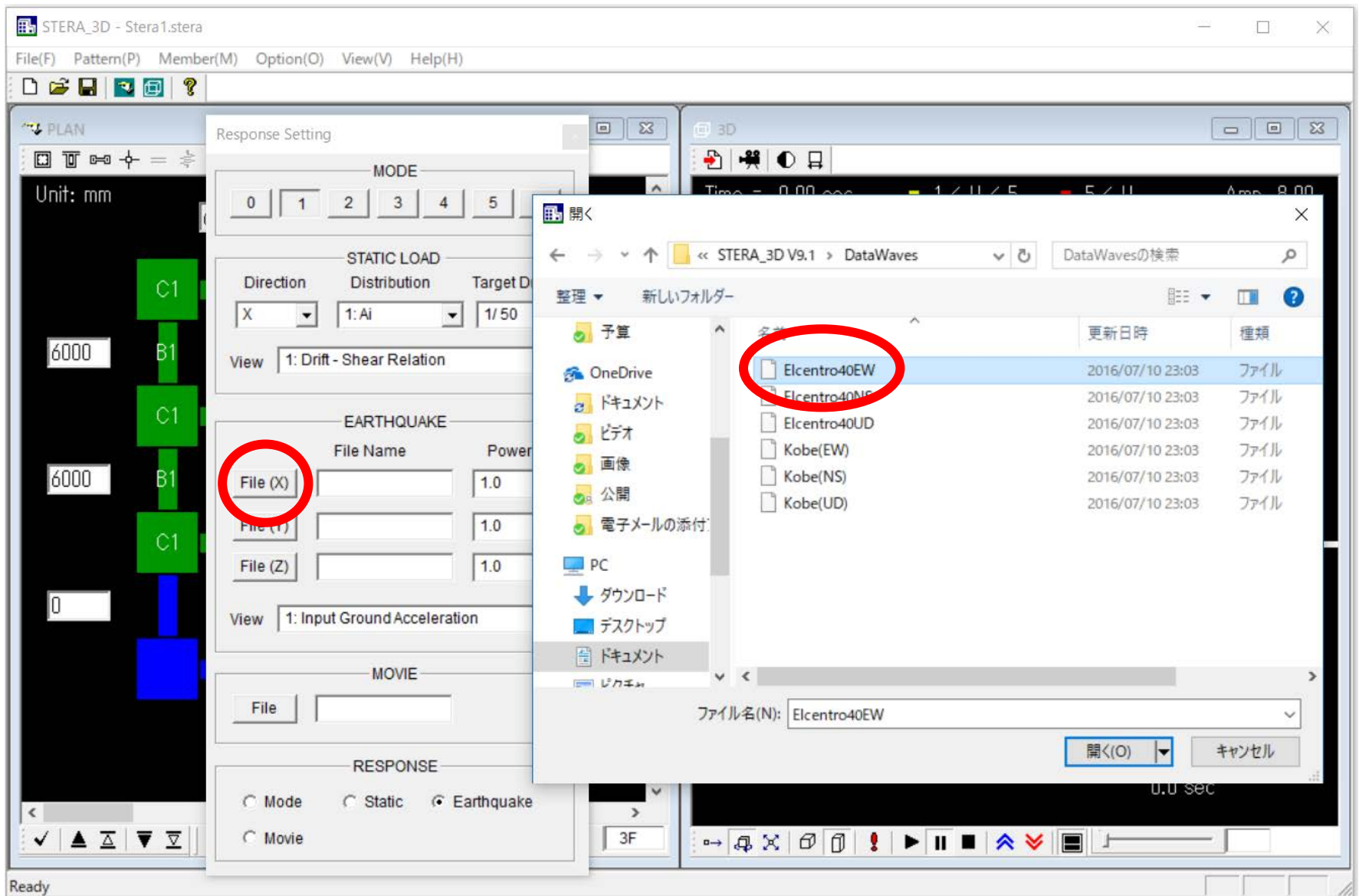
STERA 3D (SI devise)



STERA 3D (Analyze)



STERA 3D (Earthquake Response)



STERA 3D (Earthquake Response)

The screenshot displays the STERA 3D software interface, which is used for analyzing the earthquake response of structures. The interface is divided into several panels:

- PLAN Panel:** Shows a vertical cross-section of a building with three floors. The unit is set to mm. The floor levels are labeled I1, B1, I1, B1, I1. The height of each floor is 6000 mm. The base is labeled 0.
- Response Setting Panel:** Contains settings for the analysis mode, static load, earthquake, and response. The "MODE" section has buttons for 0, 2, 3, 4, 5, and 6. The "STATIC LOAD" section has dropdowns for Direction (X), Distribution (1: Ai), and Target Drift (1/50). The "EARTHQUAKE" section has a table for File Name and Power:

File Name	Power
File (X) Elcentro40EW	1.0
File (Y) Elcentro40NS	1.0
File (Z) Elcentro40UD	1.0

The "View" dropdown is set to "5: Base Shear - Top Drift" and is circled in red. The "MOVIE" section has a "File" input field. The "RESPONSE" section has radio buttons for Mode, Static, and Earthquake (selected), and a "Movie" option.
- 3D Panel:** Shows a 3D wireframe model of the building. The time is 15.00 sec. The displacement range is 1 < U < 5 (yellow) and 5 < U (red). The amplitude is 1.00. Below the 3D model is a 2D plot of the response, showing the ratio Q_i / W versus time. The plot shows a peak value of 0.2. The axes are labeled 10 and 10 cm. A legend indicates that the yellow dots represent the X-axis and the red dots represent the Y-axis.