

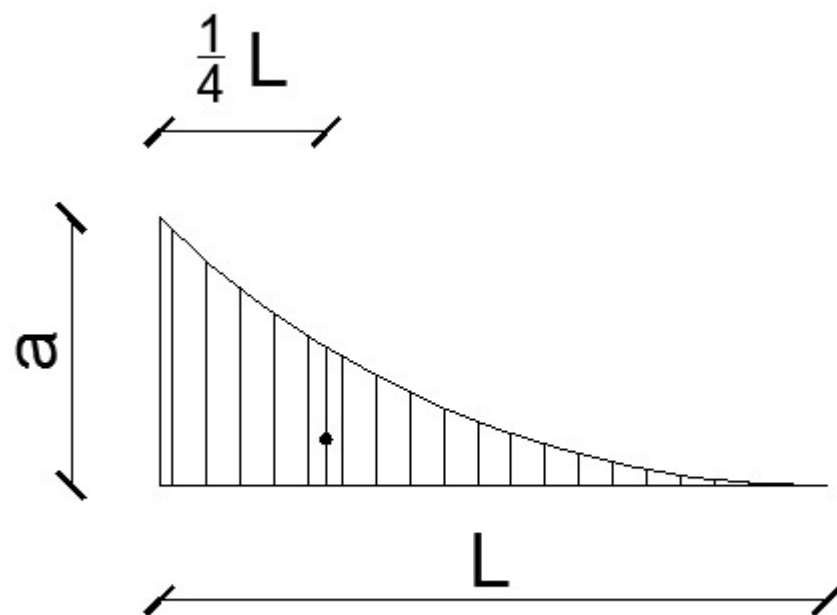
Wykład nr 2

Z Mechaniki Budowli

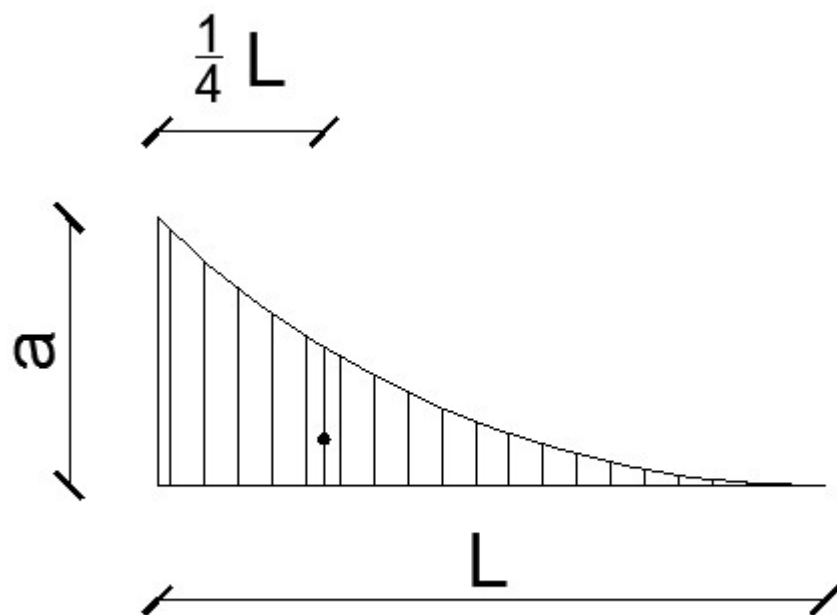
Liczenie przemieszczeń

z Zasady Prac Wirtualnych

Pole parabol:

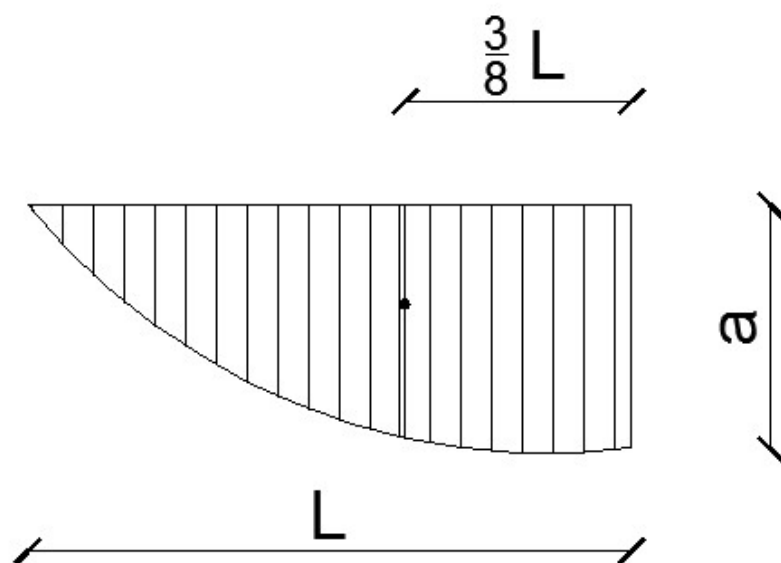


Pole paraboli:

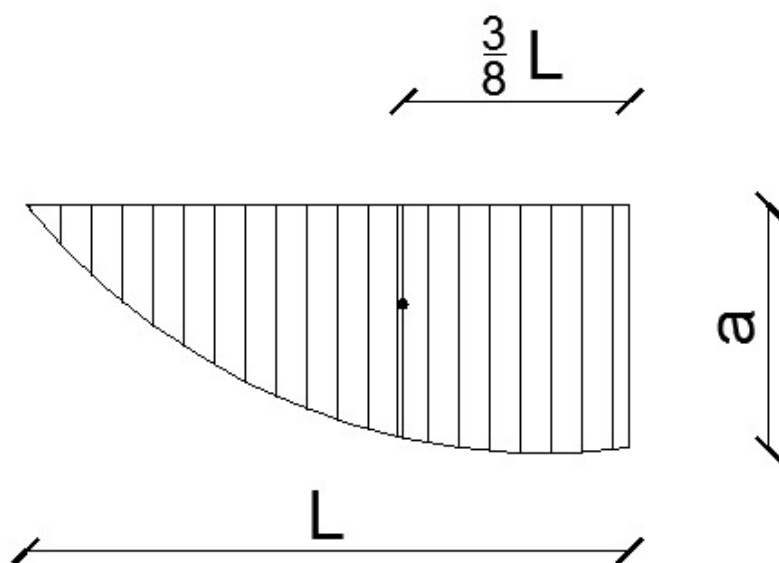


$$P_{paraboli} = \frac{1}{3} \cdot a \cdot L$$

Pole parabol:

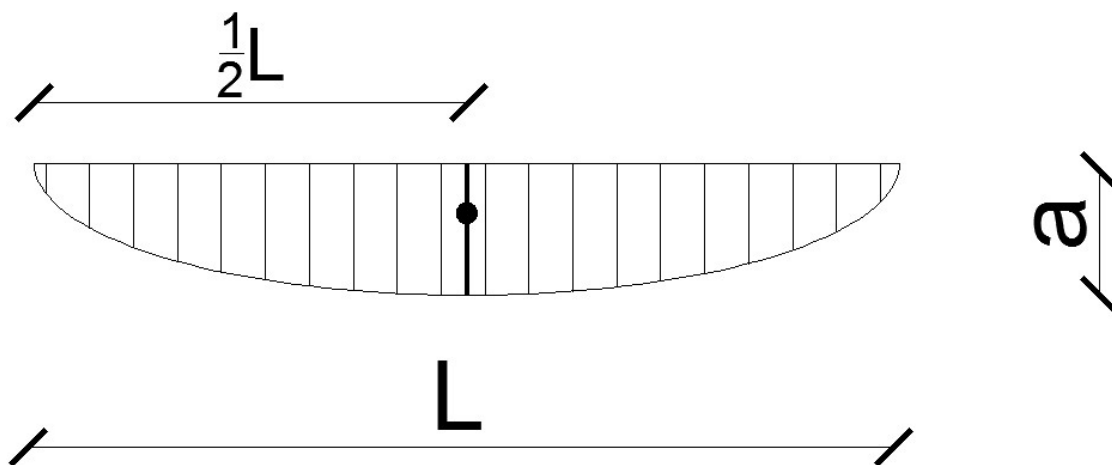


Pole parabol:



$$P_{paraboli} = \frac{2}{3} \cdot a \cdot L$$

Pole parabol:

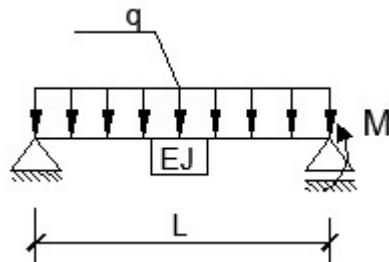


$$P_{paraboli} = \frac{2}{3} \cdot a \cdot L$$

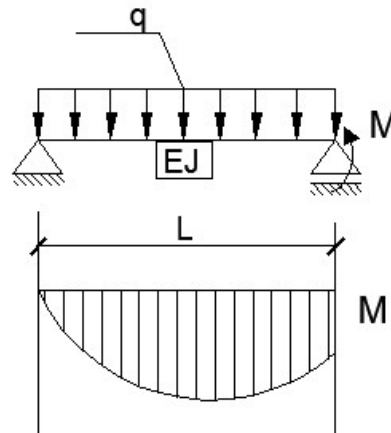
Przed całkowaniem graficznym wykresy należy rozbić na proste formy:

- prostokąty,
- trójkąty ,
- parabole

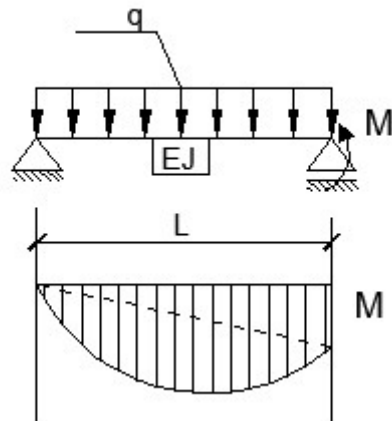
Przykłady rozbijania wykresów:



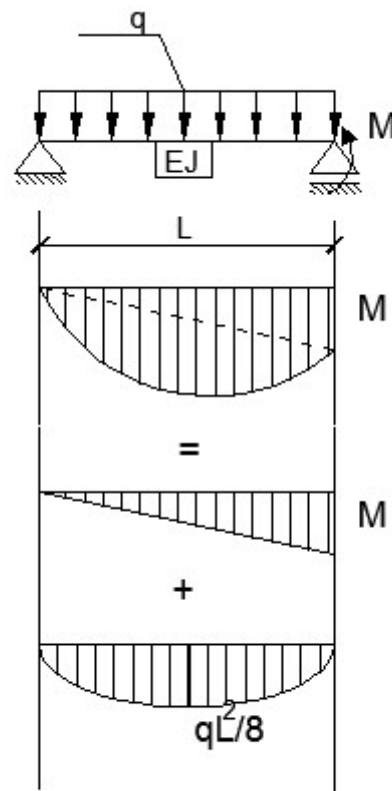
Przykłady rozbijania wykresów:



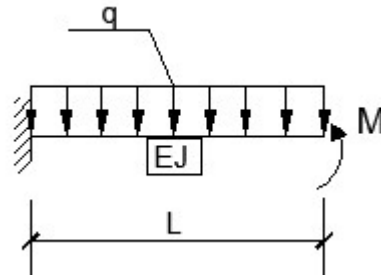
Przykłady rozbijania wykresów:



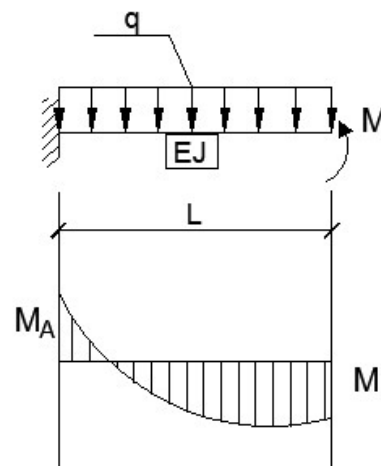
Przykłady rozbijania wykresów:



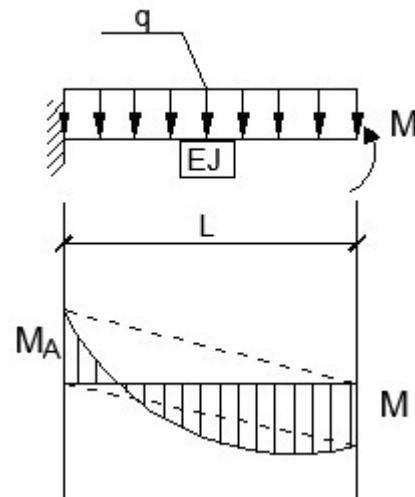
Przykłady rozbijania wykresów:



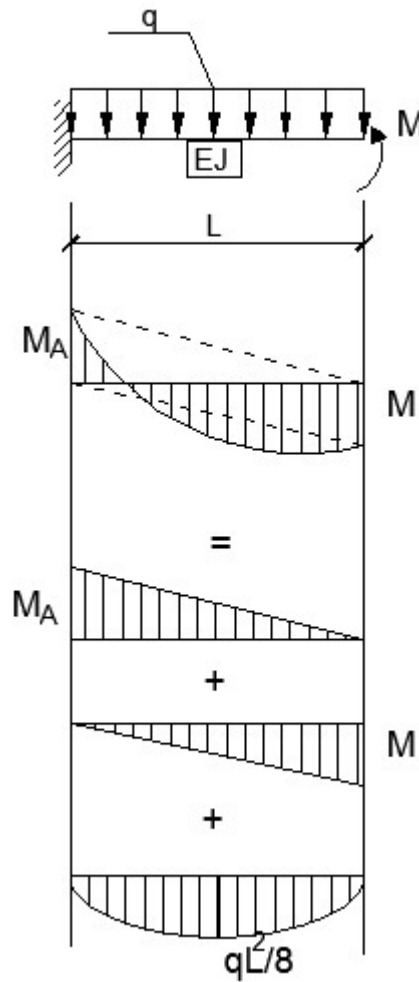
Przykłady rozbijania wykresów:



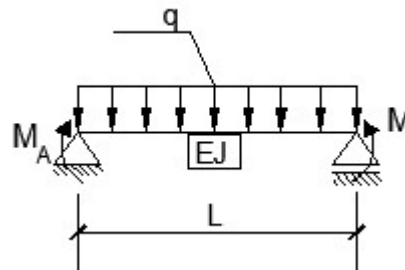
Przykłady rozbijania wykresów:



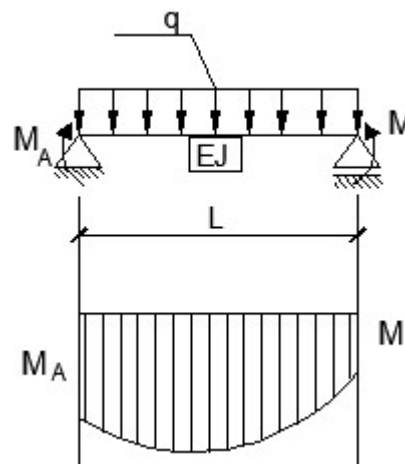
Przykłady rozbijania wykresów:



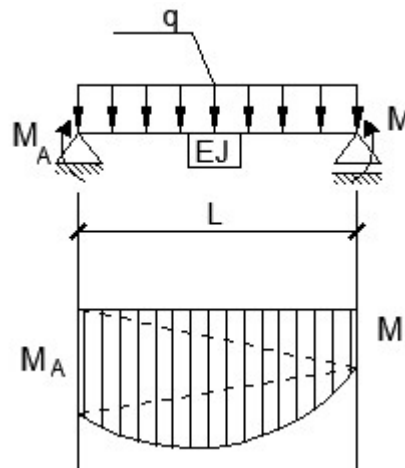
Przykłady rozbijania wykresów:



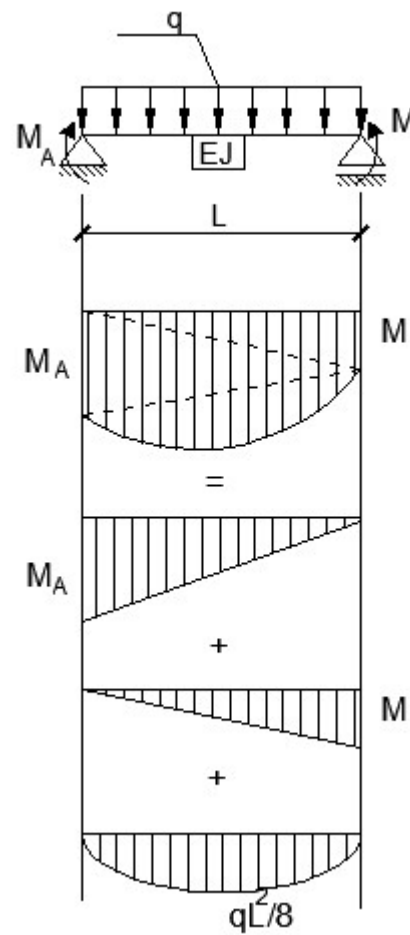
Przykłady rozbijania wykresów:



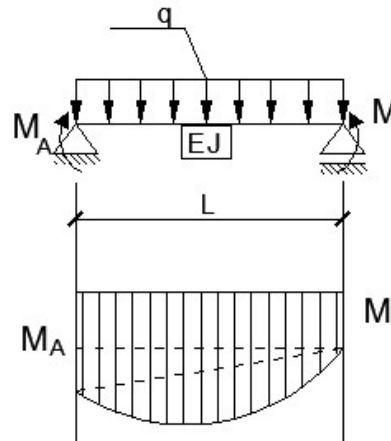
Przykłady rozbijania wykresów:



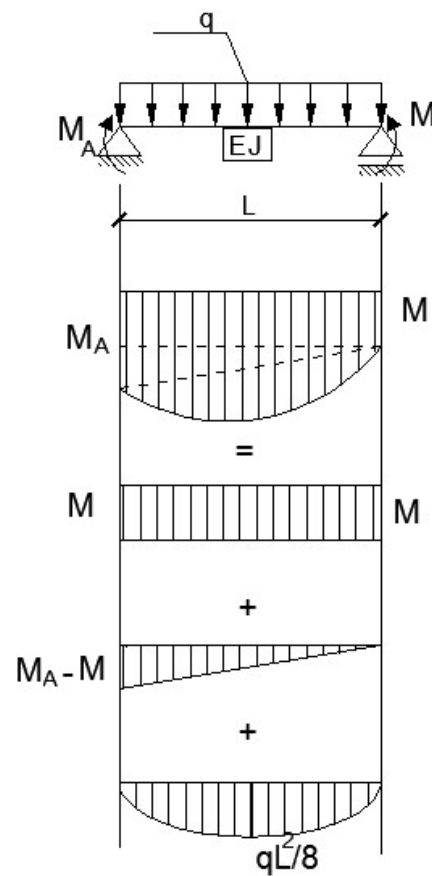
Przykłady rozbijania wykresów:



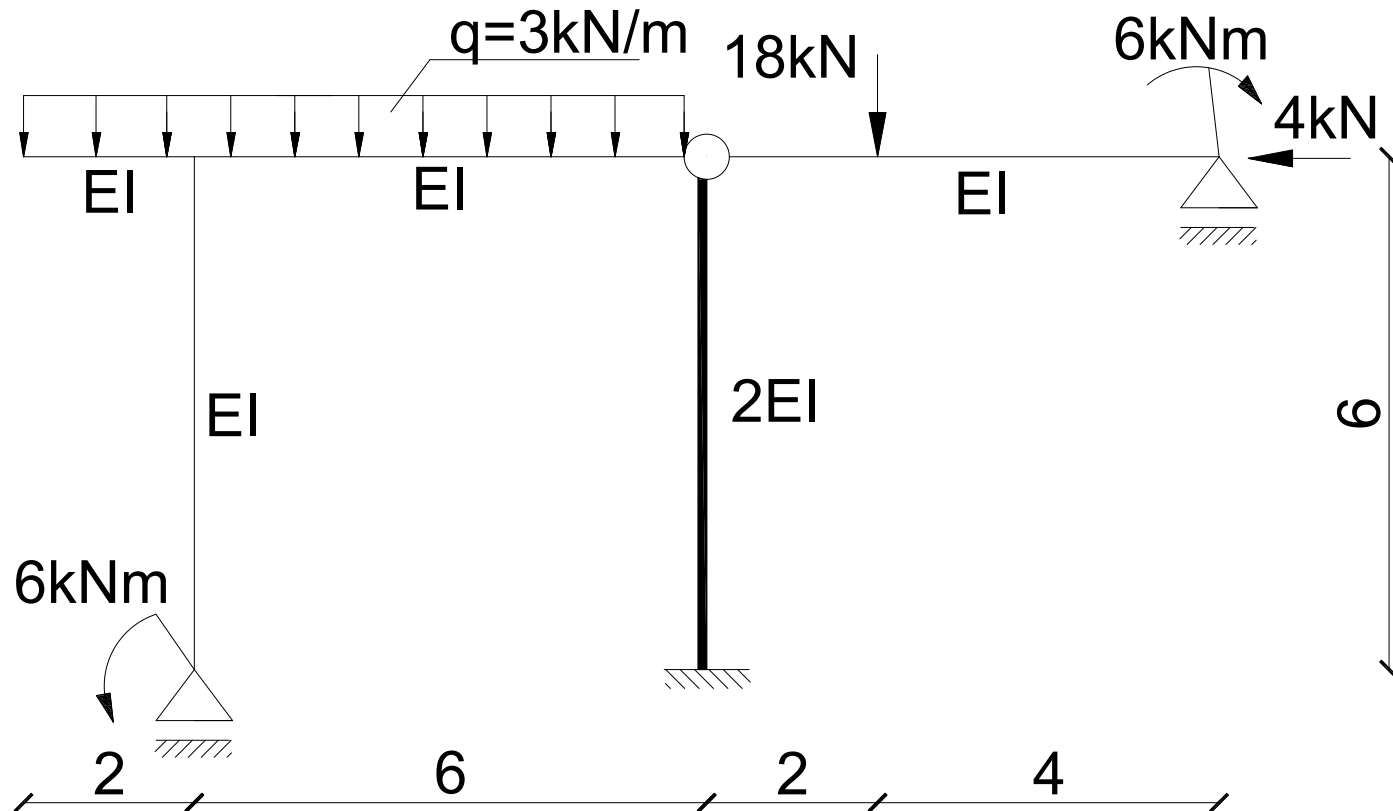
Przykłady rozbijania wykresów:



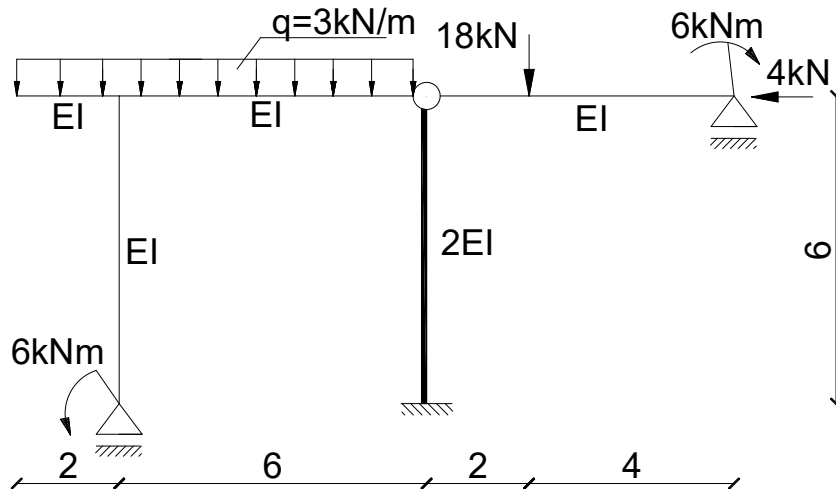
Przykłady rozbijania wykresów:



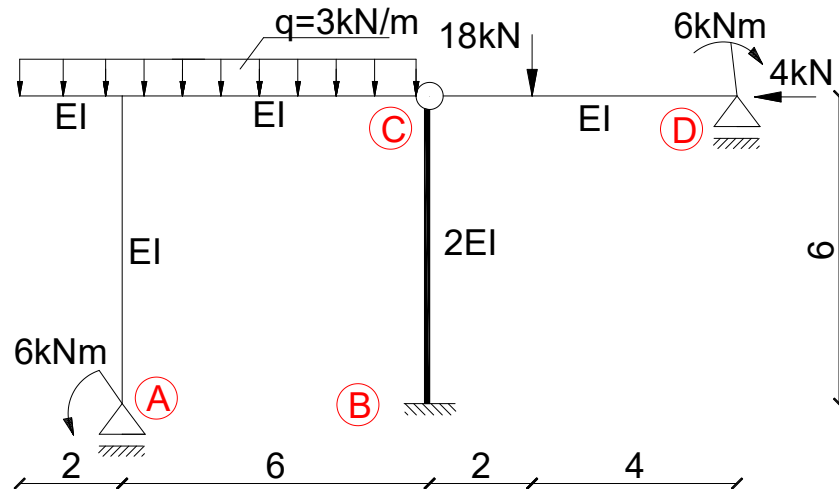
Obliczenia przemieszczeń z zasady prac wirtualnych:



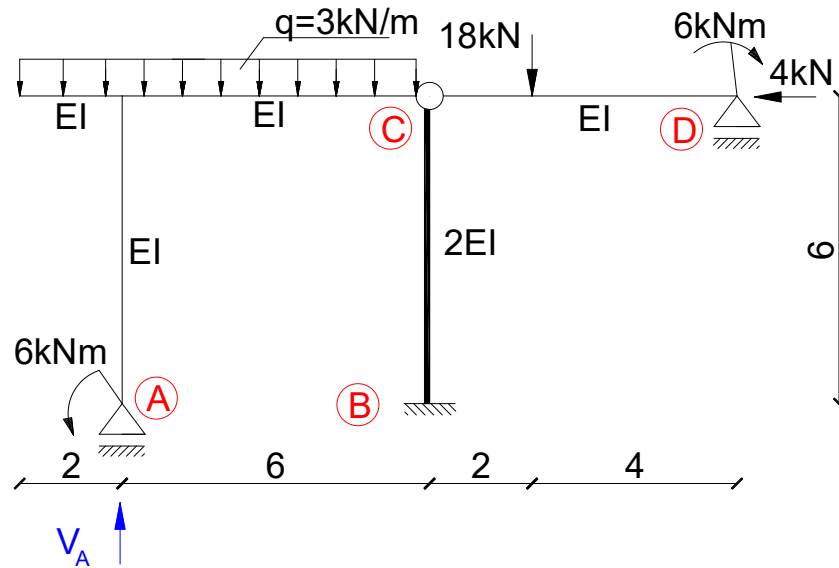
Wyznaczenie reakcji:



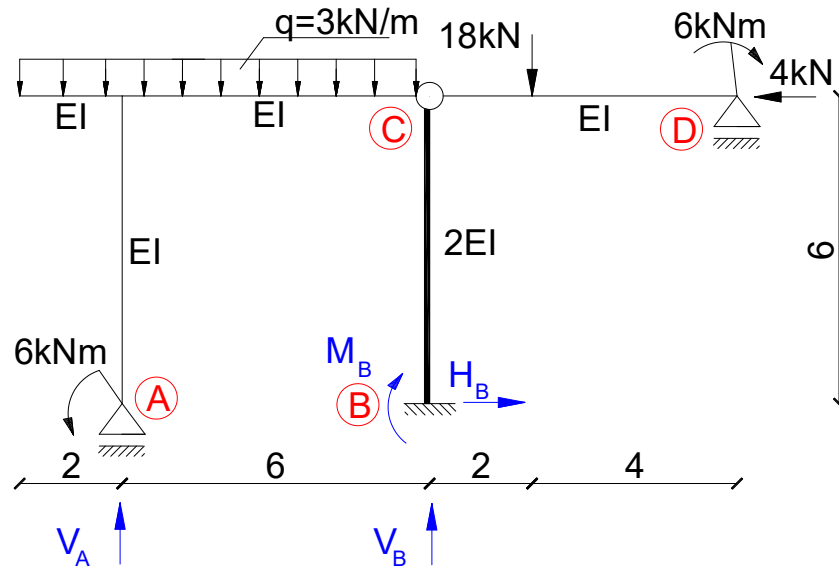
Wyznaczenie reakcji:



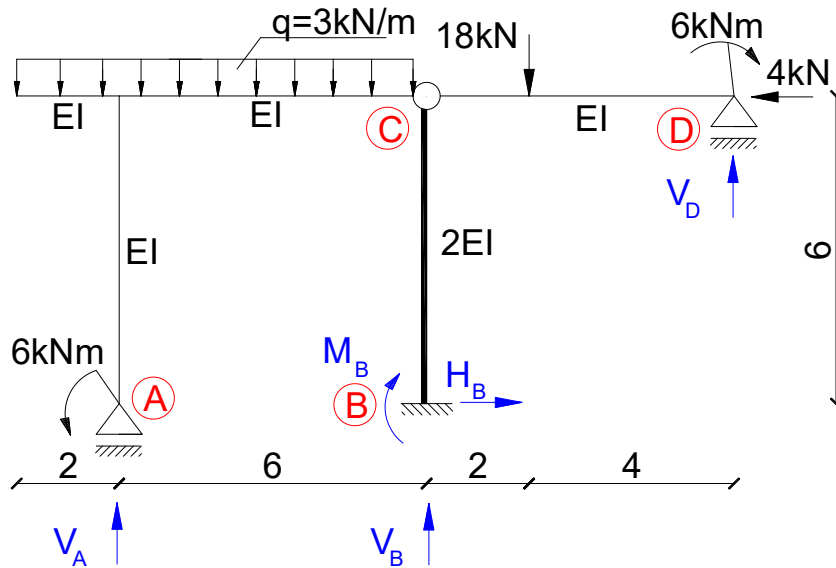
Wyznaczenie reakcji:



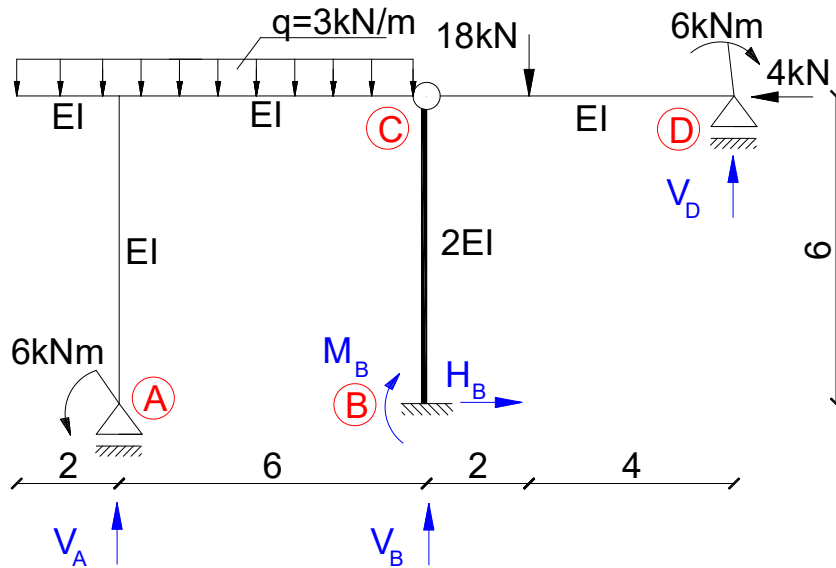
Wyznaczenie reakcji:



Wyznaczenie reakcji:

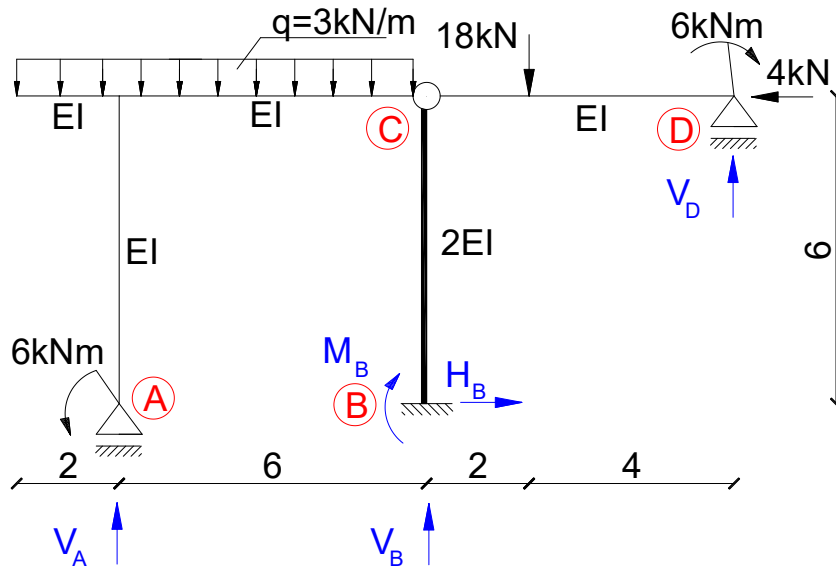


Wyznaczenie reakcji:



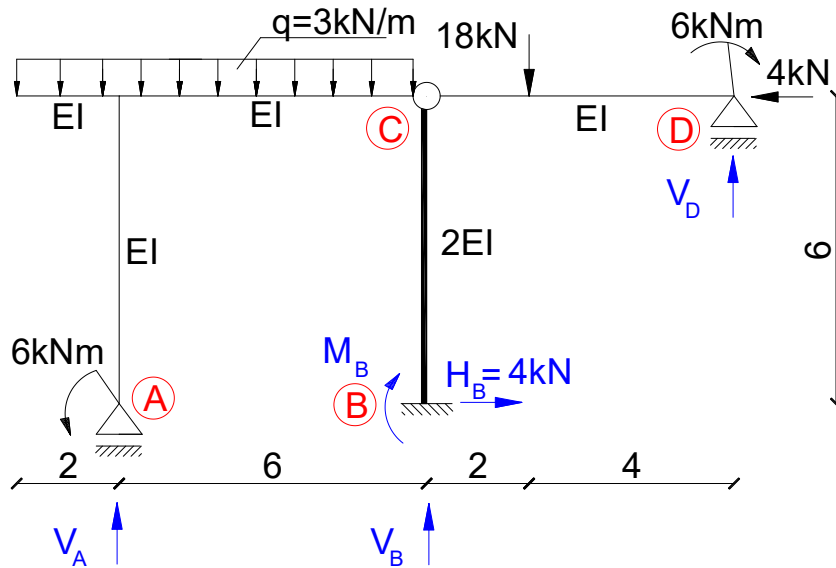
$$\sum R_x = -4 + H_B = 0$$

Wyznaczenie reakcji:



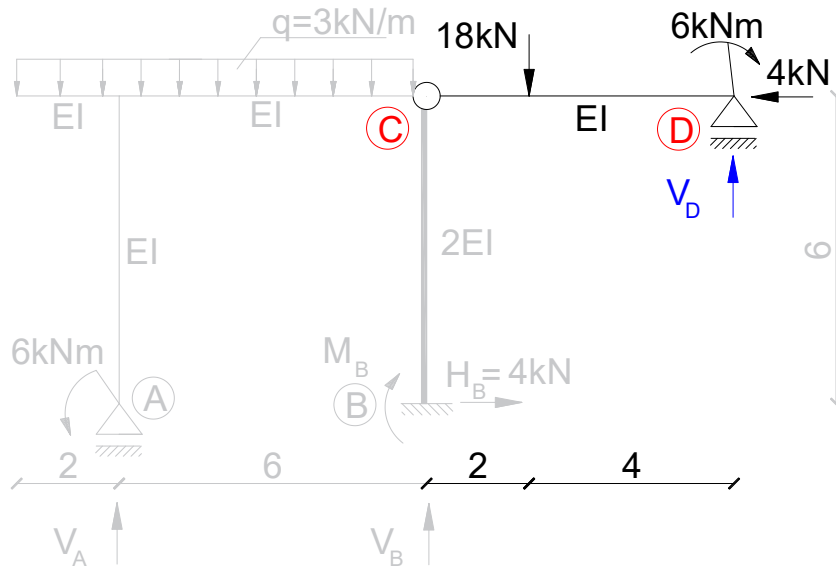
$$\sum R_x = -4 + H_B = 0 \rightarrow H_B = 4 \text{ kN}$$

Wyznaczenie reakcji:



$$\sum R_x = -4 + H_B = 0 \rightarrow H_B = 4 \text{ kN}$$

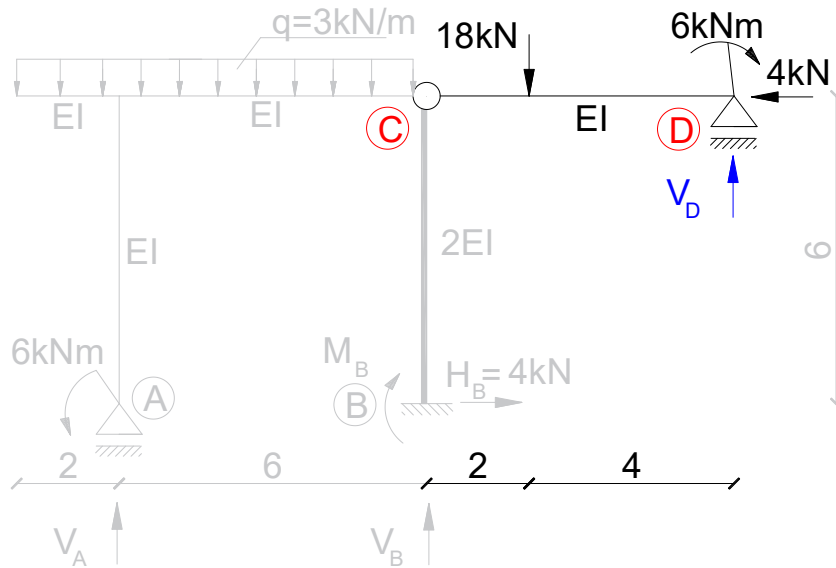
Wyznaczenie reakcji:



$$\sum R_x = -4 + H_B = 0 \rightarrow H_B = 4kN$$

$$\sum M_C^P =$$

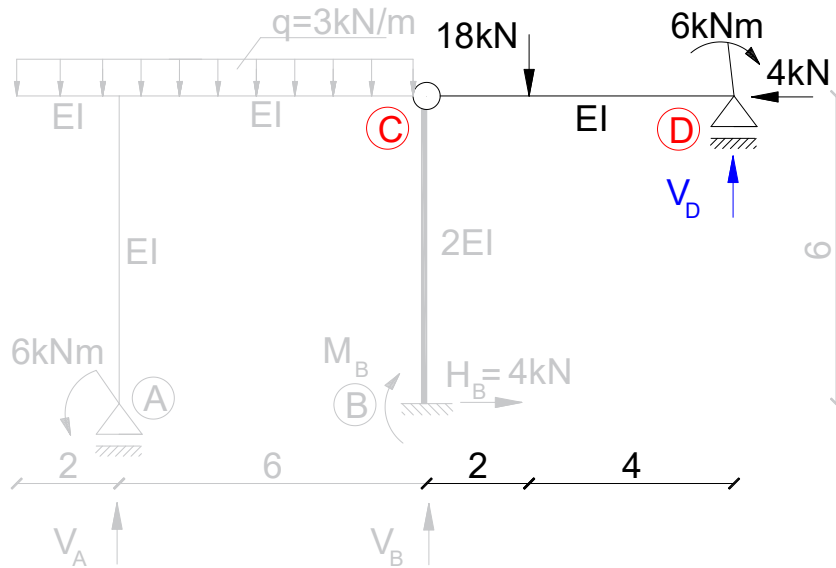
Wyznaczenie reakcji:



$$\sum R_x = -4 + H_B = 0 \rightarrow H_B = 4kN$$

$$\sum M_C^P = 18 \cdot 2 + 6 - 6V_D = 0$$

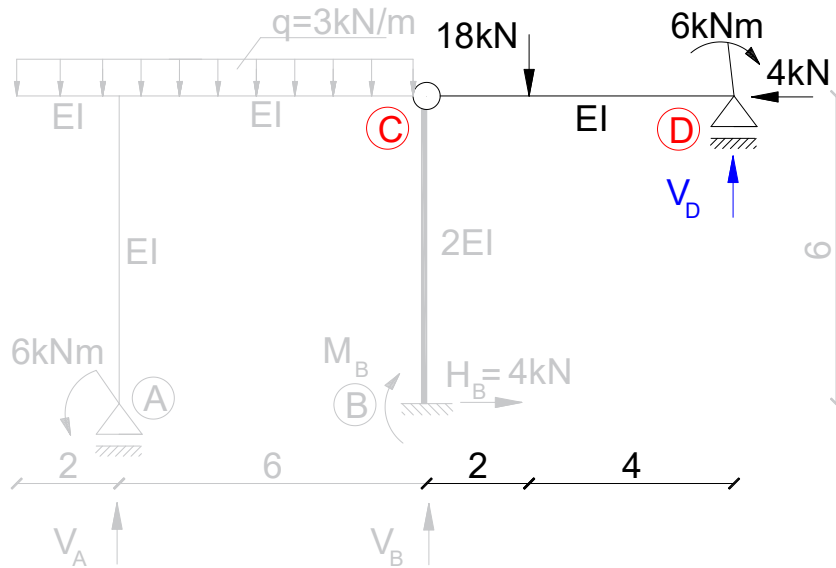
Wyznaczenie reakcji:



$$\sum R_x = -4 + H_B = 0 \rightarrow H_B = 4kN$$

$$\sum M_C^P = 18 \cdot 2 + 6 - 6V_D = 0$$

Wyznaczenie reakcji:



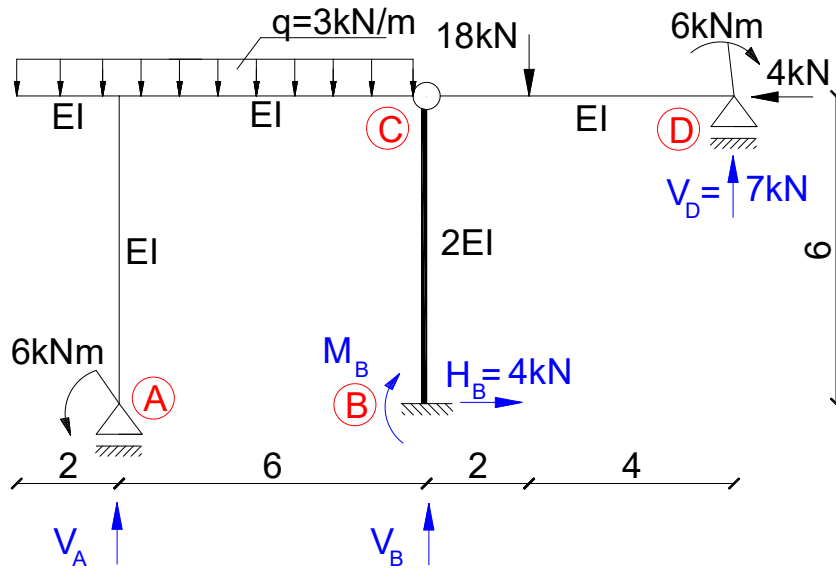
$$\sum R_x = -4 + H_B = 0 \rightarrow H_B = 4kN$$

$$\sum M_C^P = 18 \cdot 2 + 6 - 6V_D = 0$$

$$\downarrow$$

$$V_D = \frac{36 + 6}{6} = 7kN$$

Wyznaczenie reakcji:



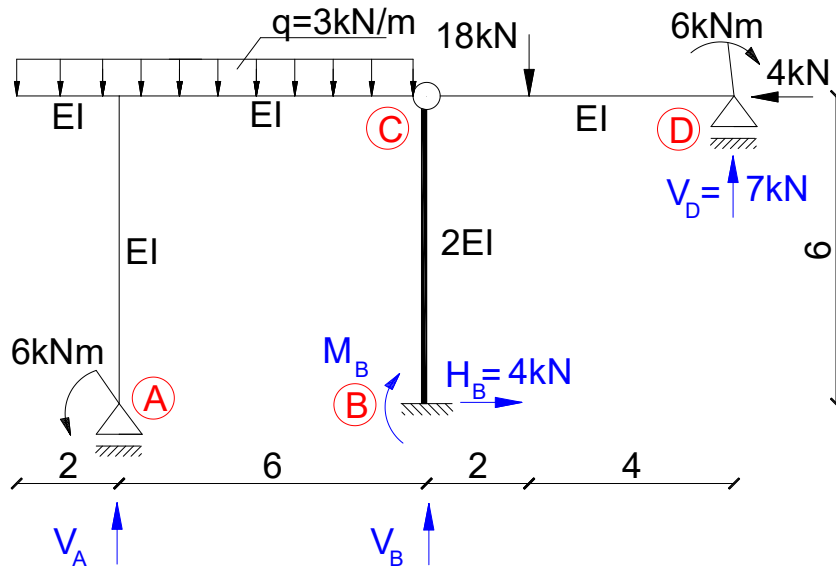
$$\sum R_x = -4 + H_B = 0 \rightarrow H_B = 4 \text{ kN}$$

$$\sum M_C^P = 18 \cdot 2 + 6 - 6V_D = 0$$

$$\downarrow$$

$$V_D = \frac{36 + 6}{6} = 7 \text{ kN}$$

Wyznaczenie reakcji:



$$\sum R_x = -4 + H_B = 0 \rightarrow H_B = 4 \text{ kN}$$

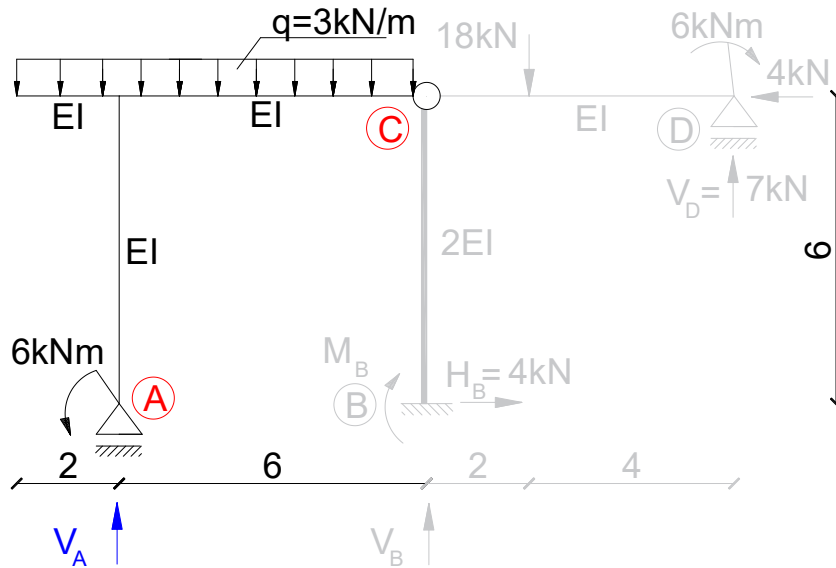
$$\sum M_C^P = 18 \cdot 2 + 6 - 6V_D = 0$$

$$\downarrow$$

$$V_D = \frac{36 + 6}{6} = 7 \text{ kN}$$

$$\sum M_C^L =$$

Wyznaczenie reakcji:



$$\sum R_x = -4 + H_B = 0 \rightarrow H_B = 4\text{kN}$$

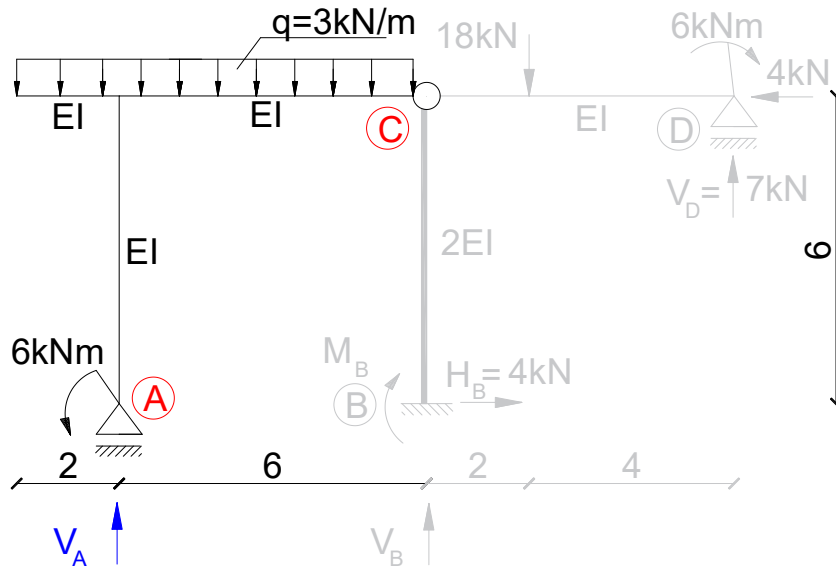
$$\sum M_C^P = 18 \cdot 2 + 6 - 6V_D = 0$$

↓

$$V_D = \frac{36 + 6}{6} = 7\text{kN}$$

$$\sum M_C^L =$$

Wyznaczenie reakcji:



$$\sum R_x = -4 + H_B = 0 \rightarrow H_B = 4\text{ kN}$$

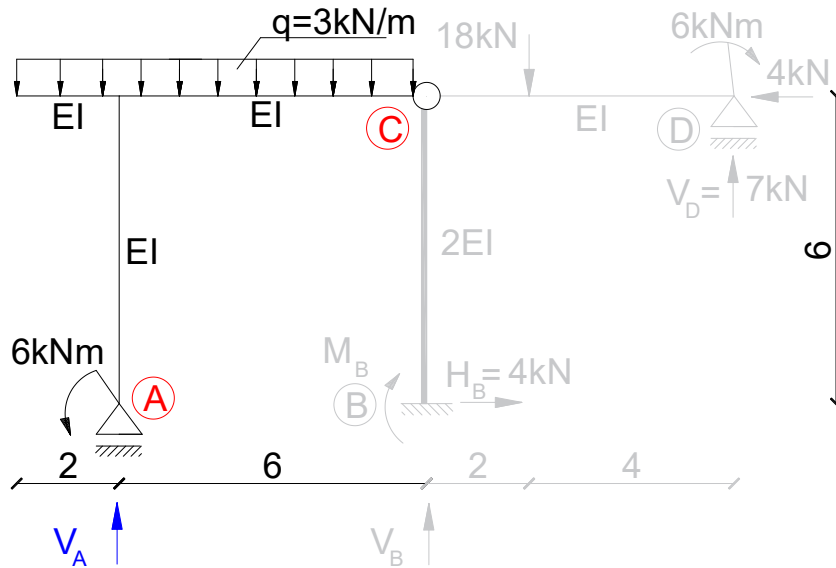
$$\sum M_C^P = 18 \cdot 2 + 6 - 6V_D = 0$$

↓

$$V_D = \frac{36 + 6}{6} = 7\text{ kN}$$

$$\sum M_C^L = -3 \cdot 8 \cdot 4 - 6 + 6V_A = 0$$

Wyznaczenie reakcji:



$$\sum R_x = -4 + H_B = 0 \rightarrow H_B = 4\text{ kN}$$

$$\sum M_C^P = 18 \cdot 2 + 6 - 6V_D = 0$$

↓

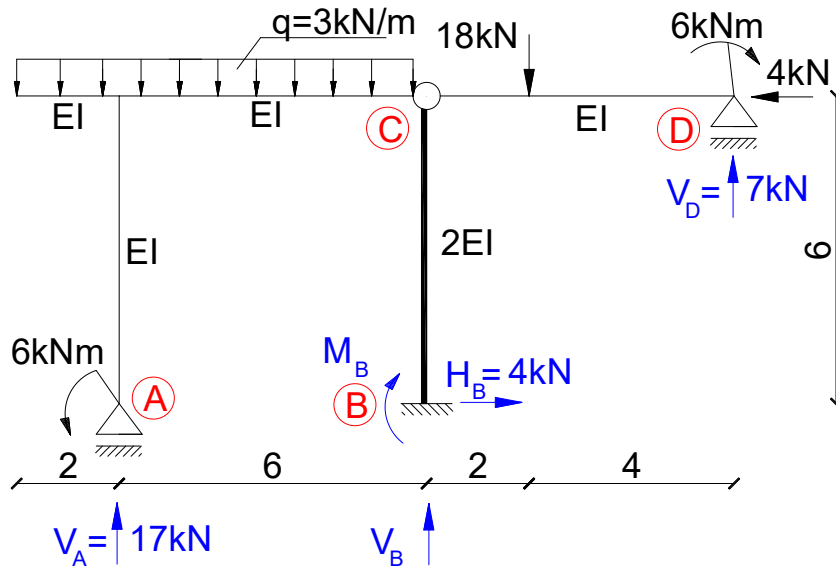
$$V_D = \frac{36 + 6}{6} = 7\text{ kN}$$

$$\sum M_C^L = -3 \cdot 8 \cdot 4 - 6 + 6V_A = 0$$

↓

$$V_A = \frac{96 + 6}{6} = 17\text{ kN}$$

Wyznaczenie reakcji:



$$\sum R_x = -4 + H_B = 0 \rightarrow H_B = 4 \text{ kN}$$

$$\sum M_C^P = 18 \cdot 2 + 6 - 6V_D = 0$$

↓

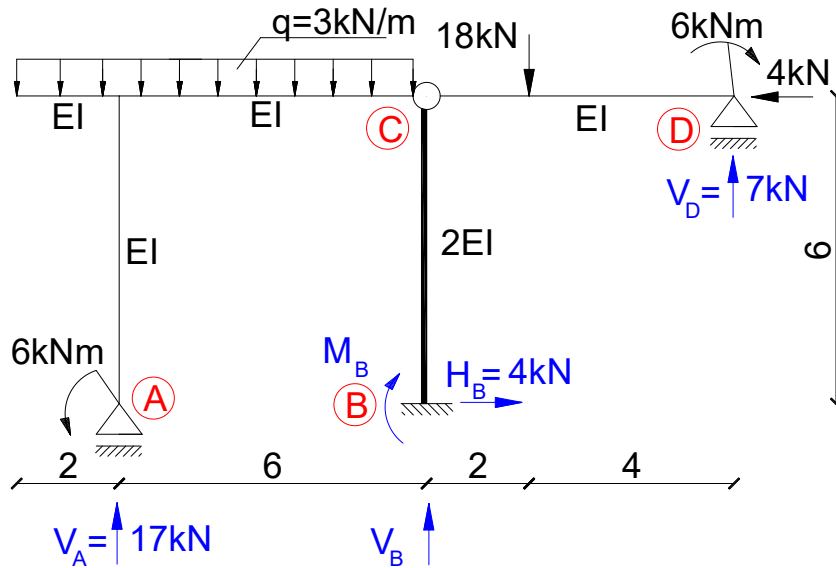
$$V_D = \frac{36 + 6}{6} = 7 \text{ kN}$$

$$\sum M_C^L = -3 \cdot 8 \cdot 4 - 6 + 6V_A = 0$$

↓

$$V_A = \frac{96 + 6}{6} = 17 \text{ kN}$$

Wyznaczenie reakcji:



$$\sum R_Y =$$

$$\sum R_x = -4 + H_B = 0 \rightarrow H_B = 4 \text{ kN}$$

$$\sum M_C^P = 18 \cdot 2 + 6 - 6V_D = 0$$

↓

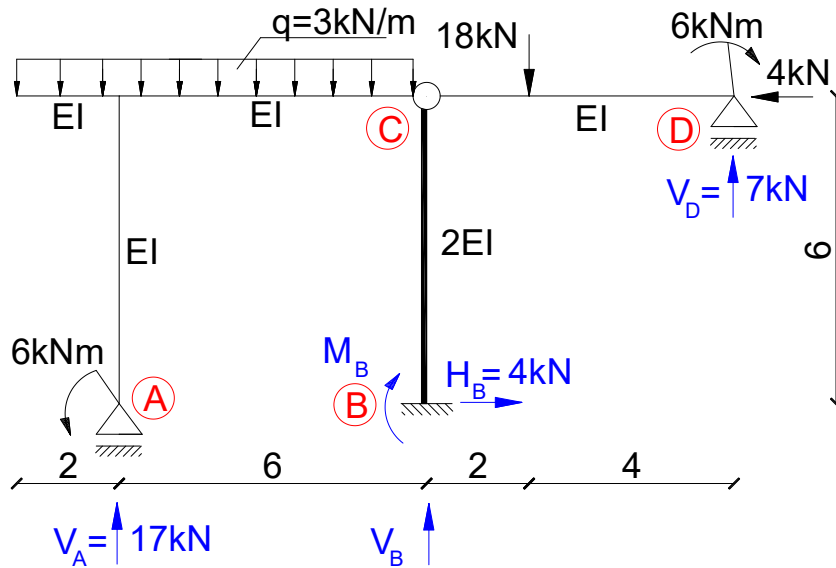
$$V_D = \frac{36 + 6}{6} = 7 \text{ kN}$$

$$\sum M_C^L = -3 \cdot 8 \cdot 4 - 6 + 6V_A = 0$$

↓

$$V_A = \frac{96 + 6}{6} = 17 \text{ kN}$$

Wyznaczenie reakcji:



$$\sum R_Y = 17 - 3 \cdot 8 + V_B - 18 + 7 = 0$$

$$\sum R_x = -4 + H_B = 0 \rightarrow H_B = 4 \text{ kN}$$

$$\sum M_C^P = 18 \cdot 2 + 6 - 6V_D = 0$$

↓

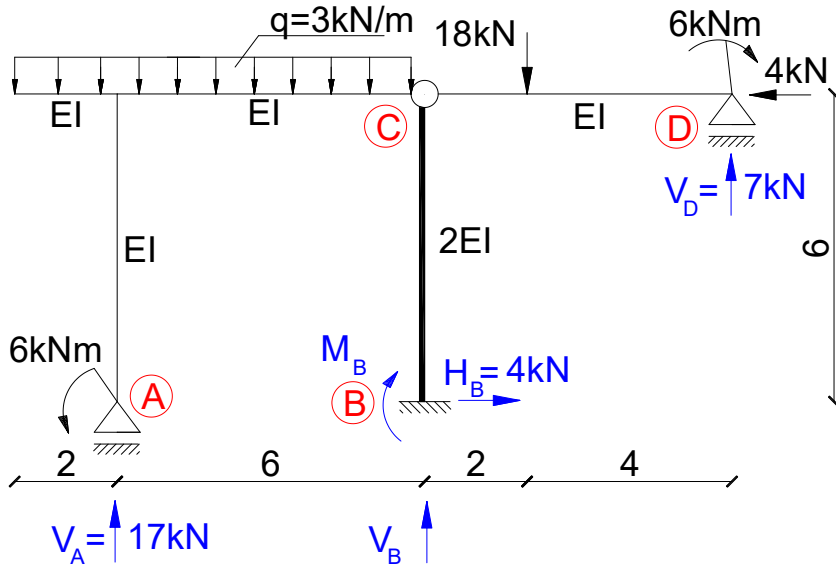
$$V_D = \frac{36 + 6}{6} = 7 \text{ kN}$$

$$\sum M_C^L = -3 \cdot 8 \cdot 4 - 6 + 6V_A = 0$$

↓

$$V_A = \frac{96 + 6}{6} = 17 \text{ kN}$$

Wyznaczenie reakcji:



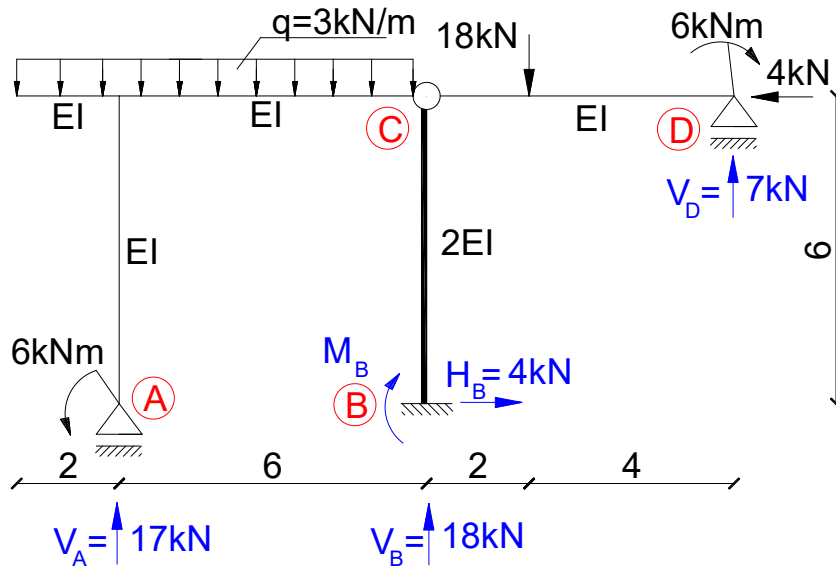
$$\sum R_Y = 17 - 3 \cdot 8 + V_B - 18 + 7 = 0$$
$$\downarrow$$
$$V_B = 18 \text{ kN}$$

$$\sum R_x = -4 + H_B = 0 \rightarrow H_B = 4kN$$

$$\begin{aligned} \sum M_C^P &= 18 \cdot 2 + 6 - 6V_D = 0 \\ &\downarrow \\ V_D &= \frac{36 + 6}{6} = 7 \text{ kN} \end{aligned}$$

$$\sum M_C^L = -3 \cdot 8 \cdot 4 - 6 + 6V_A = 0$$
$$\downarrow$$
$$V_A = \frac{96 + 6}{6} = 17 \text{ kN}$$

Wyznaczenie reakcji:



$$\sum R_Y = 17 - 3 \cdot 8 + V_B - 18 + 7 = 0$$

$$\downarrow$$

$$V_B = 18 \text{ kN}$$

$$\sum R_x = -4 + H_B = 0 \rightarrow H_B = 4 \text{ kN}$$

$$\sum M_C^P = 18 \cdot 2 + 6 - 6V_D = 0$$

$$\downarrow$$

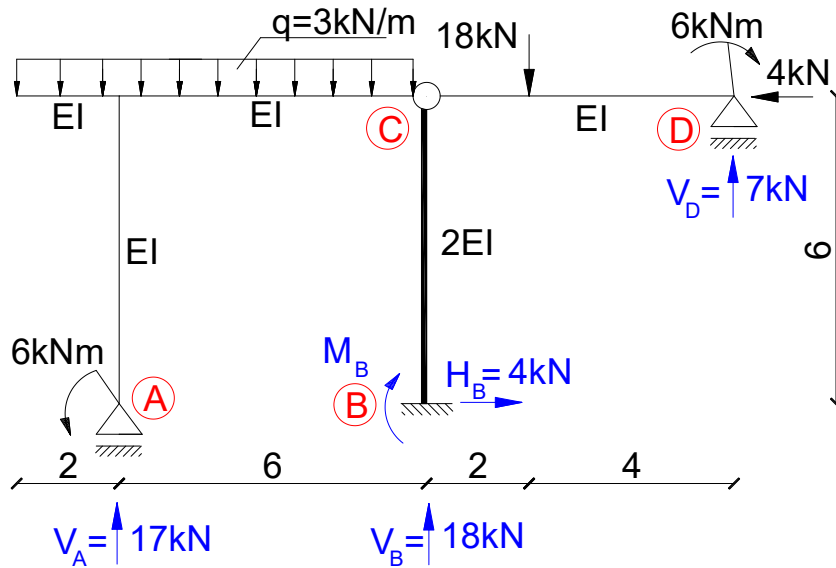
$$V_D = \frac{36 + 6}{6} = 7 \text{ kN}$$

$$\sum M_C^L = -3 \cdot 8 \cdot 4 - 6 + 6V_A = 0$$

$$\downarrow$$

$$V_A = \frac{96 + 6}{6} = 17 \text{ kN}$$

Wyznaczenie reakcji:



$$\sum R_Y = 17 - 3 \cdot 8 + V_B - 18 + 7 = 0$$

$$\downarrow$$

$$V_B = 18 \text{ kN}$$

$$\sum M_C^D =$$

$$\sum R_x = -4 + H_B = 0 \rightarrow H_B = 4 \text{ kN}$$

$$\sum M_C^P = 18 \cdot 2 + 6 - 6V_D = 0$$

$$\downarrow$$

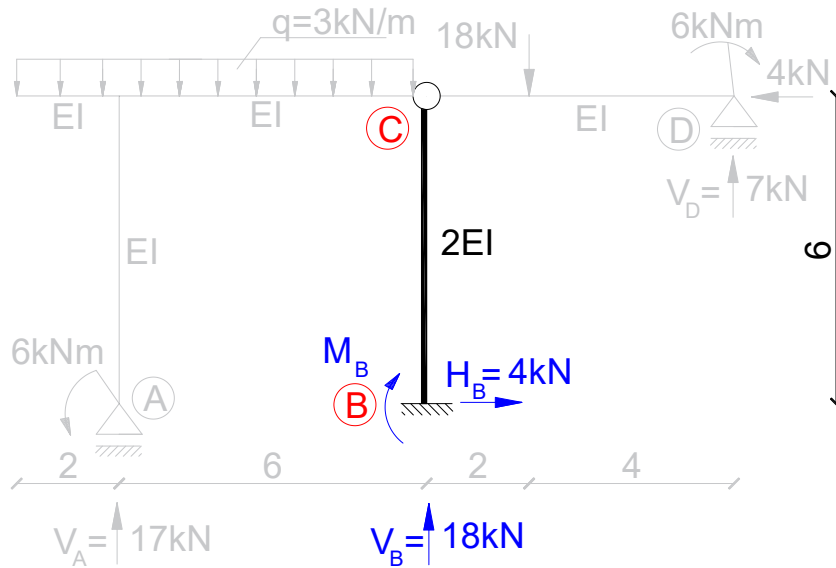
$$V_D = \frac{36 + 6}{6} = 7 \text{ kN}$$

$$\sum M_C^L = -3 \cdot 8 \cdot 4 - 6 + 6V_A = 0$$

$$\downarrow$$

$$V_A = \frac{96 + 6}{6} = 17 \text{ kN}$$

Wyznaczenie reakcji:



$$\sum R_Y = 17 - 3 \cdot 8 + V_B - 18 + 7 = 0$$

$$\downarrow$$

$$V_B = 18 \text{ kN}$$

$$\sum M_C^D =$$

$$\sum R_x = -4 + H_B = 0 \rightarrow H_B = 4 \text{ kN}$$

$$\sum M_C^P = 18 \cdot 2 + 6 - 6V_D = 0$$

$$\downarrow$$

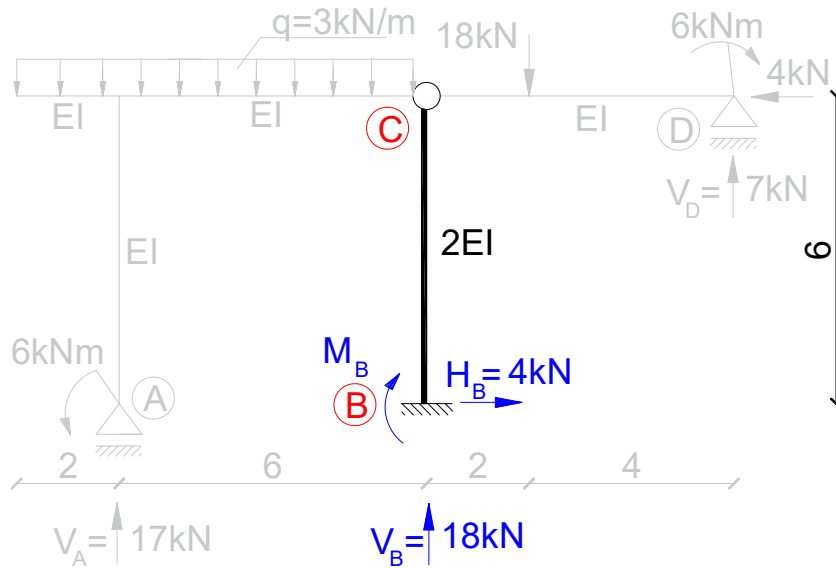
$$V_D = \frac{36 + 6}{6} = 7 \text{ kN}$$

$$\sum M_C^L = -3 \cdot 8 \cdot 4 - 6 + 6V_A = 0$$

$$\downarrow$$

$$V_A = \frac{96 + 6}{6} = 17 \text{ kN}$$

Wyznaczenie reakcji:



$$\sum R_Y = 17 - 3 \cdot 8 + V_B - 18 + 7 = 0$$

$$\downarrow$$

$$V_B = 18 \text{ kN}$$

$$\sum M_C^D = -4 \cdot 6 + M_B = 0$$

$$\sum R_x = -4 + H_B = 0 \rightarrow H_B = 4 \text{ kN}$$

$$\sum M_C^P = 18 \cdot 2 + 6 - 6V_D = 0$$

$$\downarrow$$

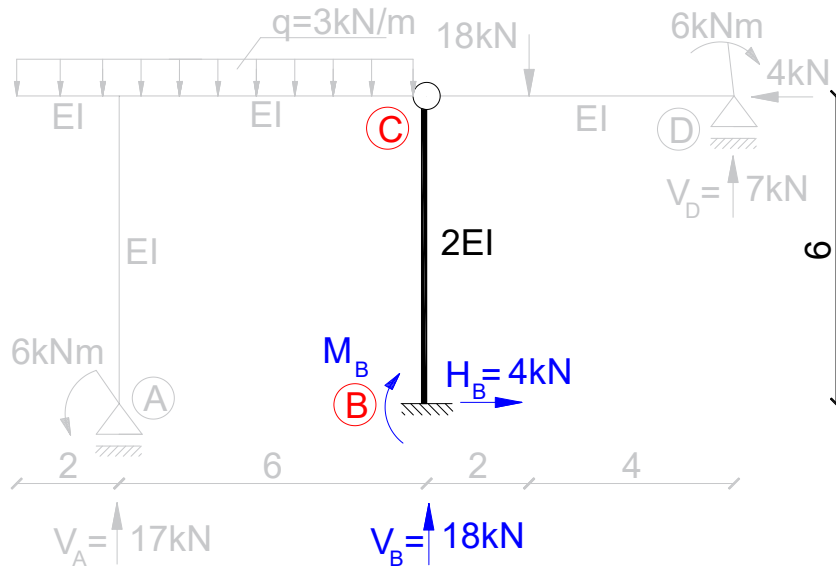
$$V_D = \frac{36 + 6}{6} = 7 \text{ kN}$$

$$\sum M_C^L = -3 \cdot 8 \cdot 4 - 6 + 6V_A = 0$$

$$\downarrow$$

$$V_A = \frac{96 + 6}{6} = 17 \text{ kN}$$

Wyznaczenie reakcji:



$$\sum R_Y = 17 - 3 \cdot 8 + V_B - 18 + 7 = 0$$

$$\downarrow$$

$$V_B = 18 \text{ kN}$$

$$\sum M_C^D = -4 \cdot 6 + M_B = 0 \rightarrow M_B = 24 \text{ kNm}$$

$$\sum R_x = -4 + H_B = 0 \rightarrow H_B = 4 \text{ kN}$$

$$\sum M_C^P = 18 \cdot 2 + 6 - 6V_D = 0$$

$$\downarrow$$

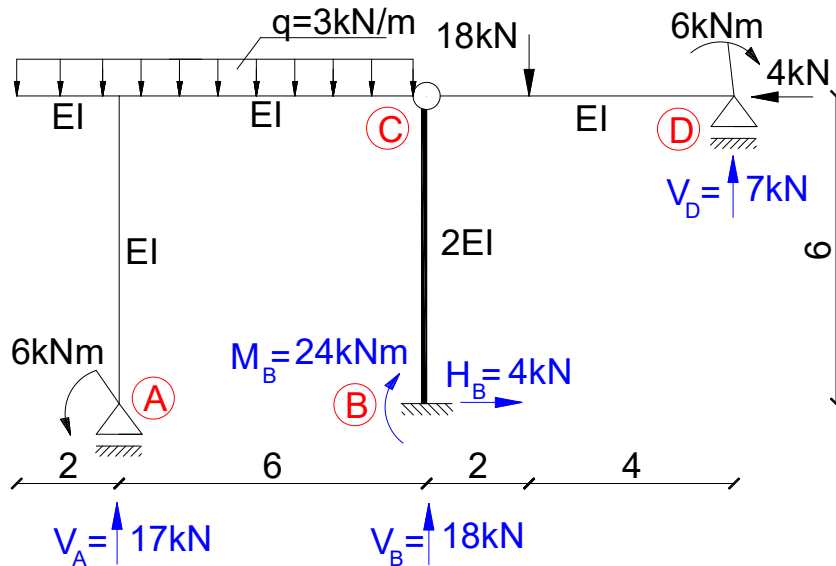
$$V_D = \frac{36 + 6}{6} = 7 \text{ kN}$$

$$\sum M_C^L = -3 \cdot 8 \cdot 4 - 6 + 6V_A = 0$$

$$\downarrow$$

$$V_A = \frac{96 + 6}{6} = 17 \text{ kN}$$

Wyznaczenie reakcji:



$$\sum R_Y = 17 - 3 \cdot 8 + V_B - 18 + 7 = 0$$

$$\downarrow$$

$$V_B = 18\text{kN}$$

$$\sum M_C^D = -4 \cdot 6 + M_B = 0 \rightarrow M_B = 24\text{kNm}$$

$$\sum R_x = -4 + H_B = 0 \rightarrow H_B = 4\text{kN}$$

$$\sum M_C^P = 18 \cdot 2 + 6 - 6V_D = 0$$

$$\downarrow$$

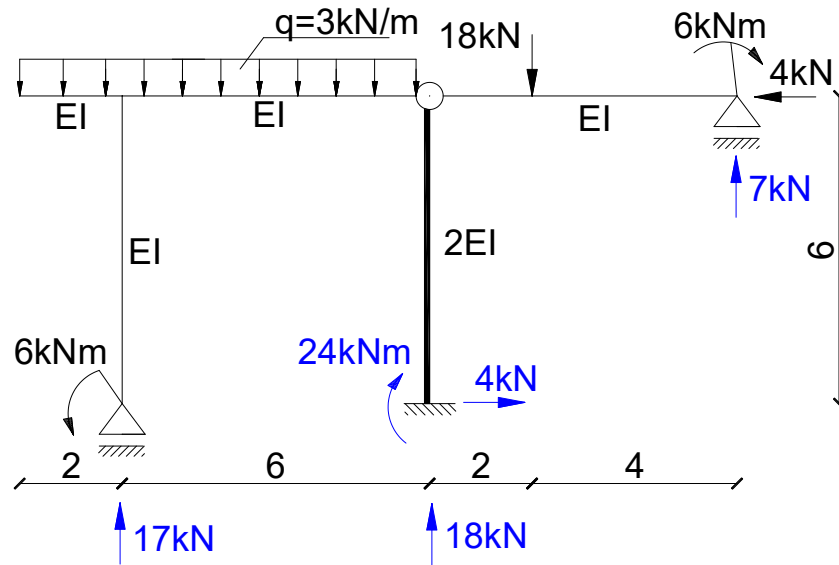
$$V_D = \frac{36 + 6}{6} = 7\text{kN}$$

$$\sum M_C^L = -3 \cdot 8 \cdot 4 - 6 + 6V_A = 0$$

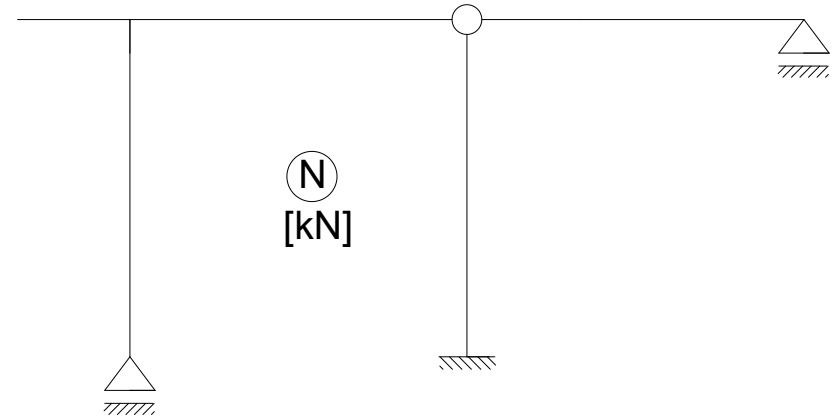
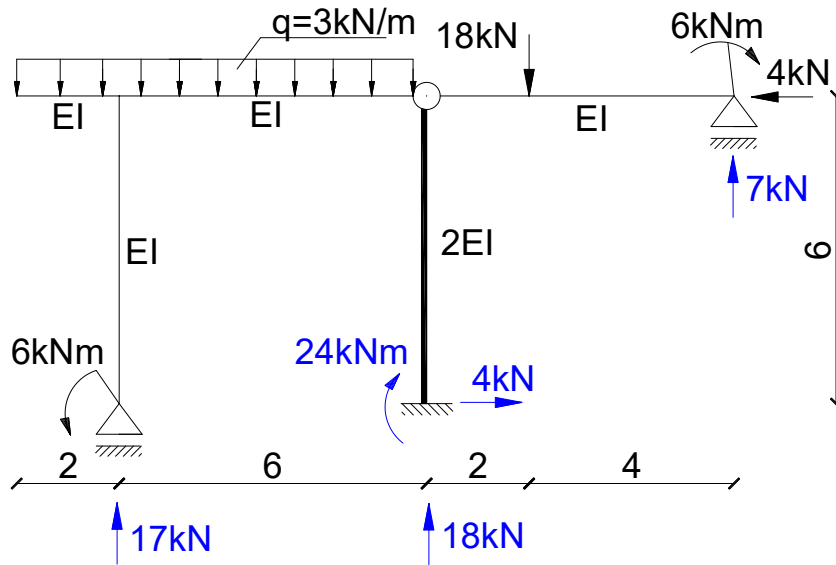
$$\downarrow$$

$$V_A = \frac{96 + 6}{6} = 17\text{kN}$$

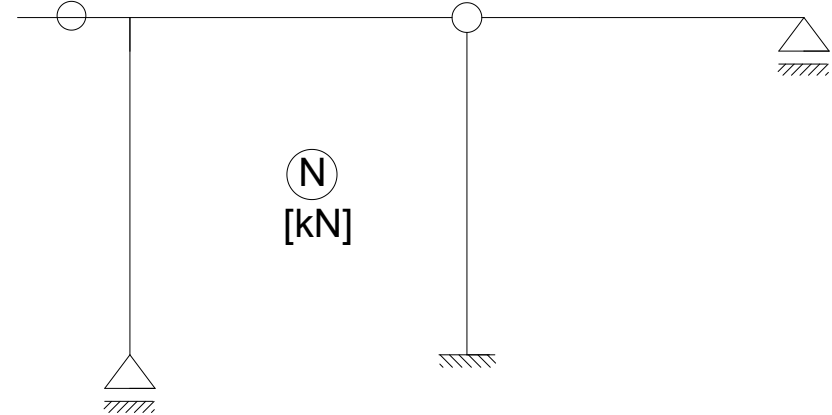
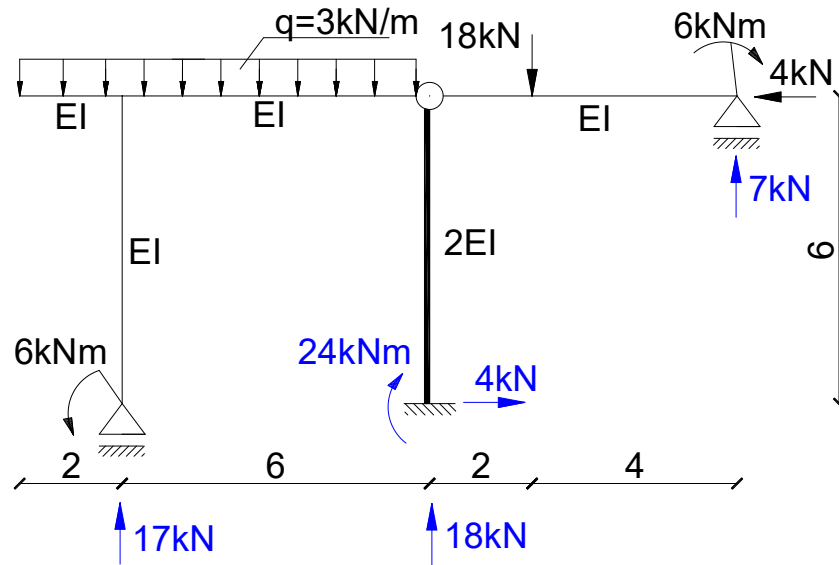
Wykresy sił wewnętrznych:



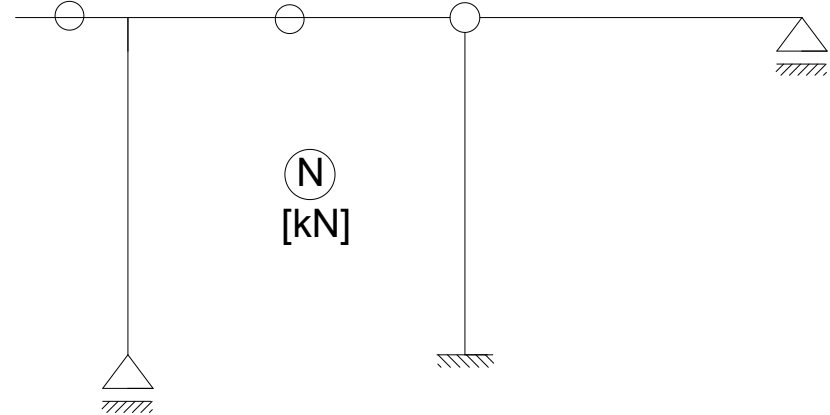
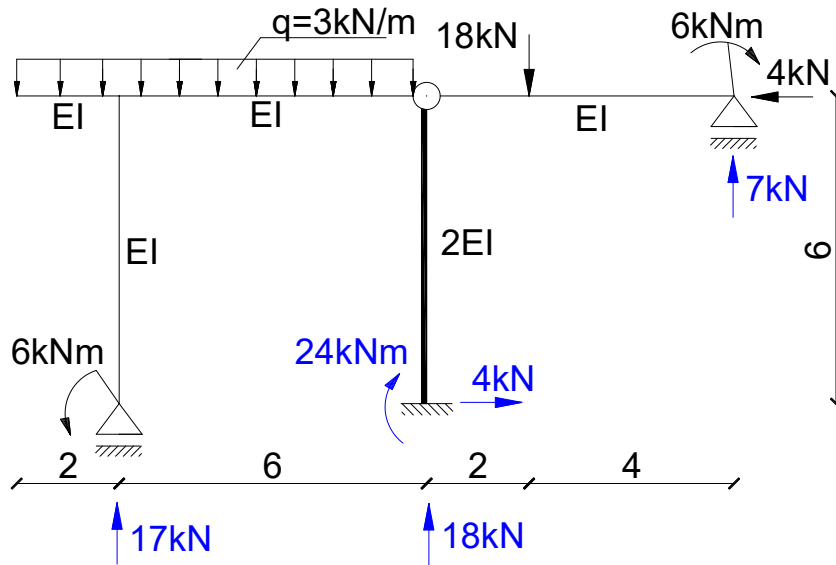
Wykresy sił wewnętrznych:



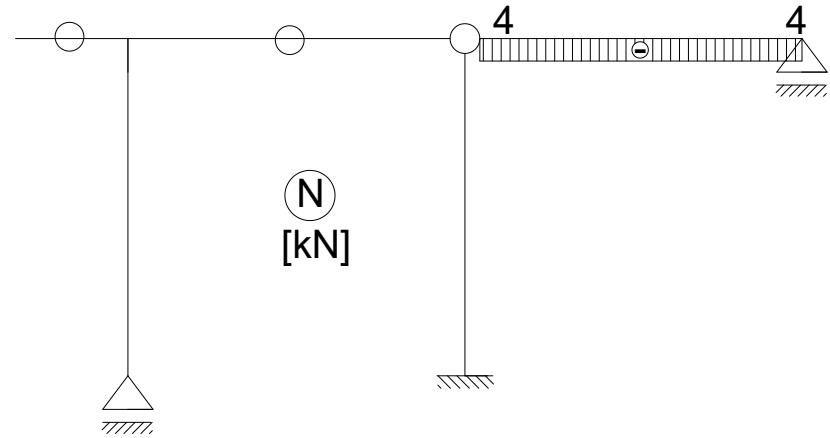
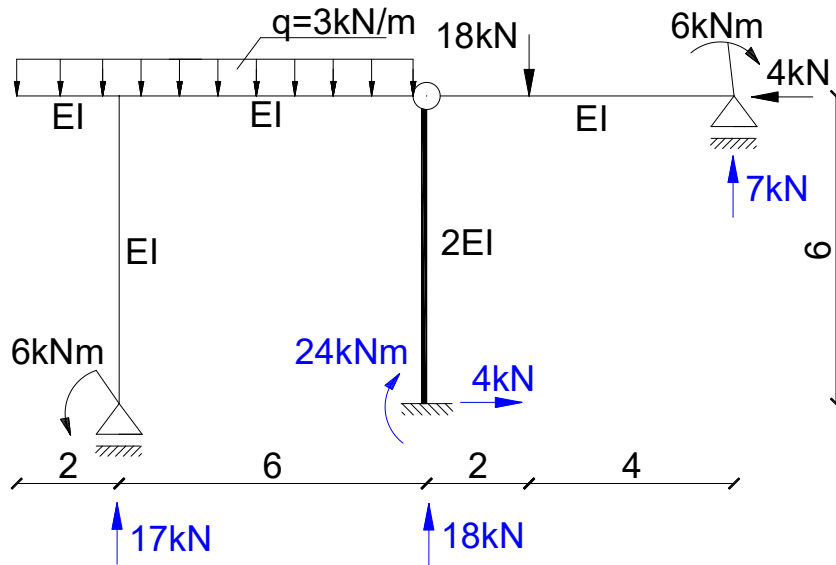
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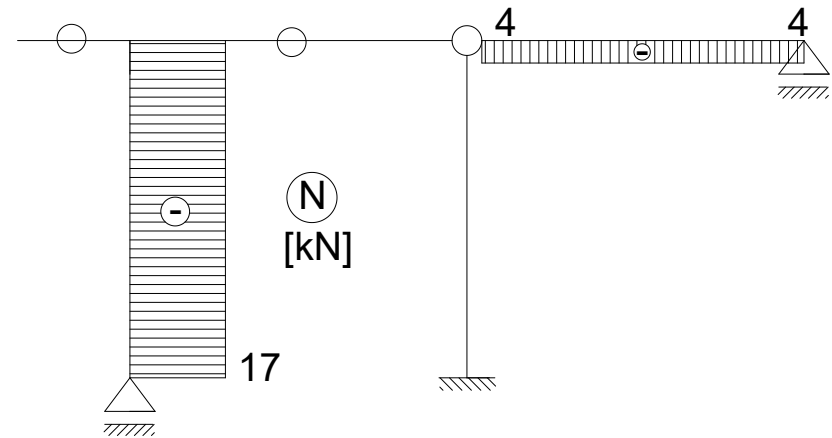
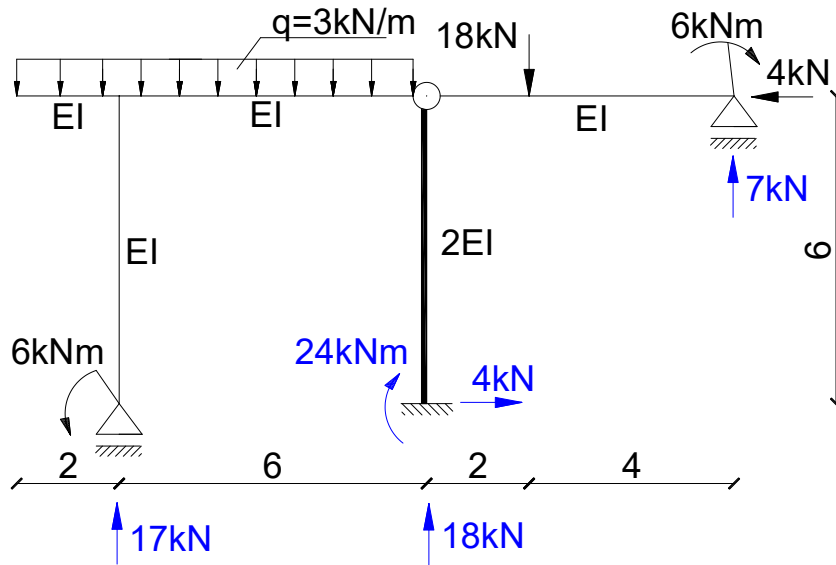
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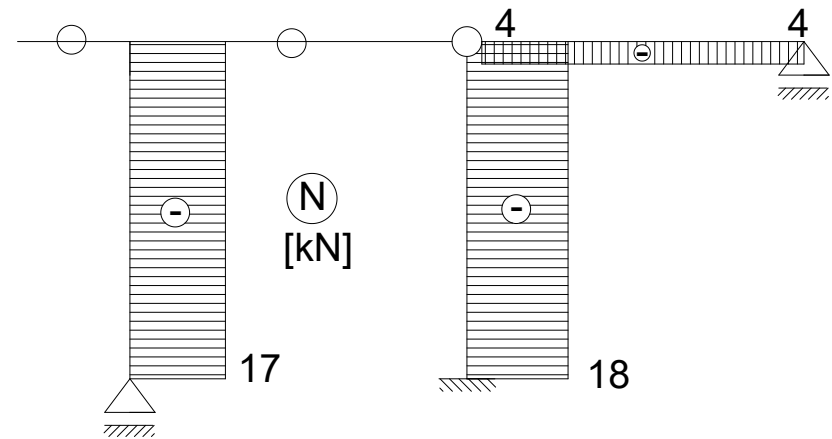
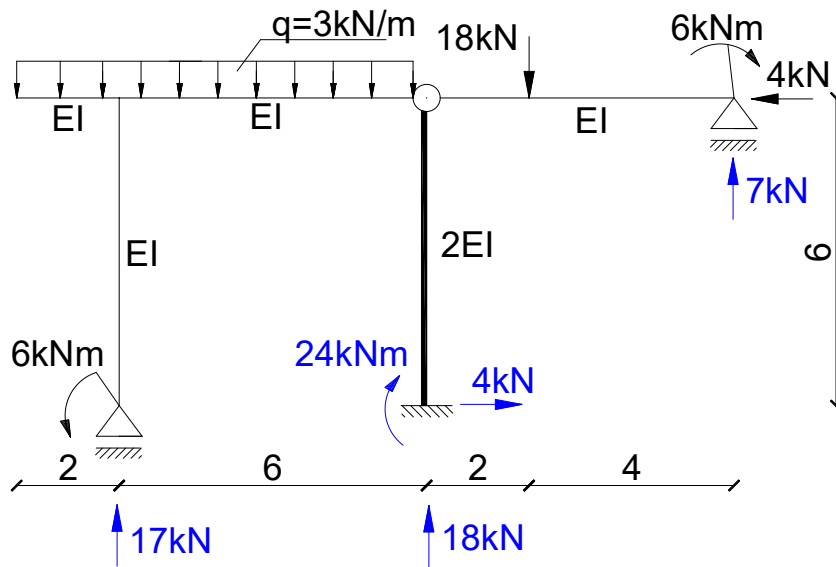
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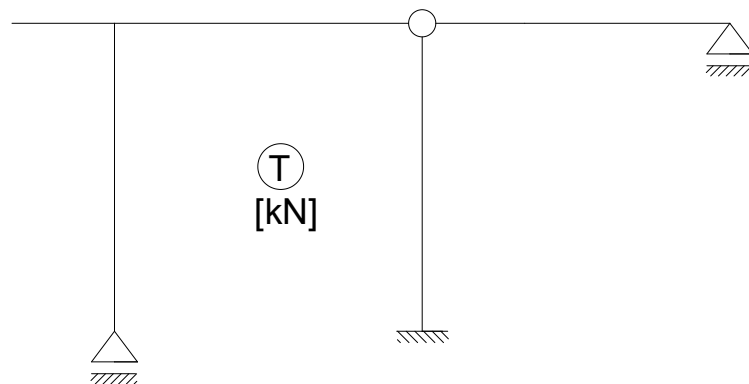
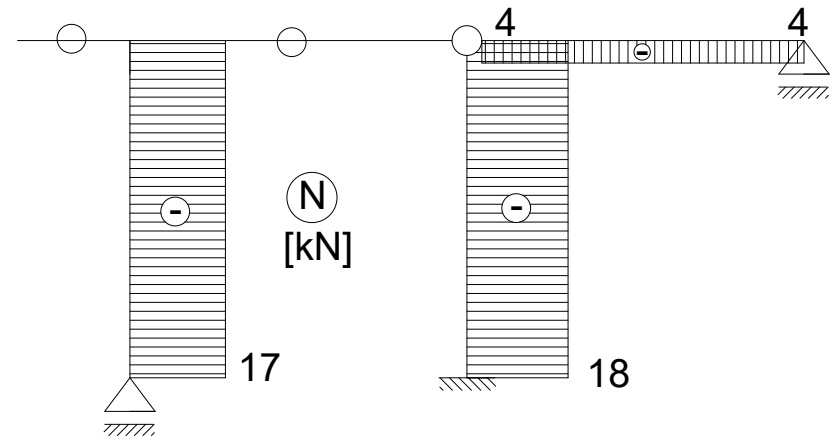
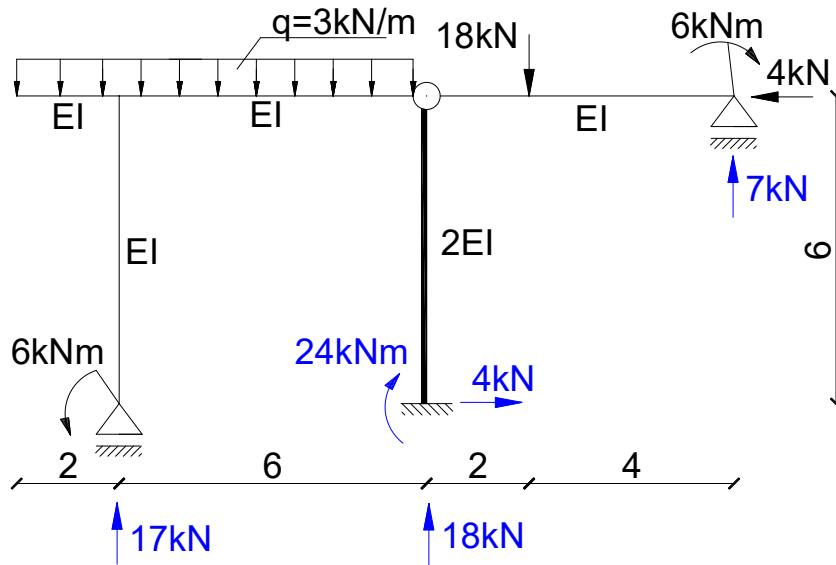
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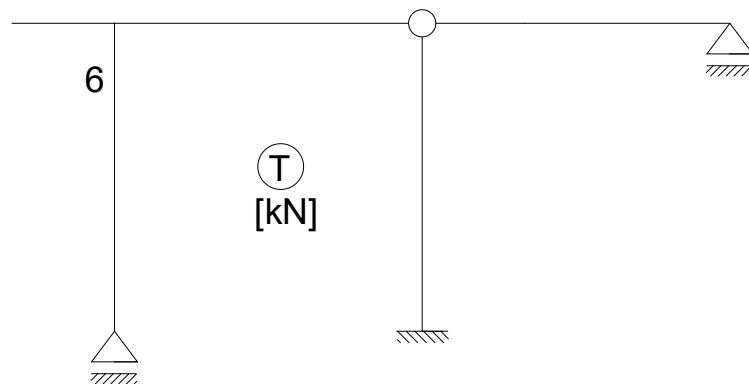
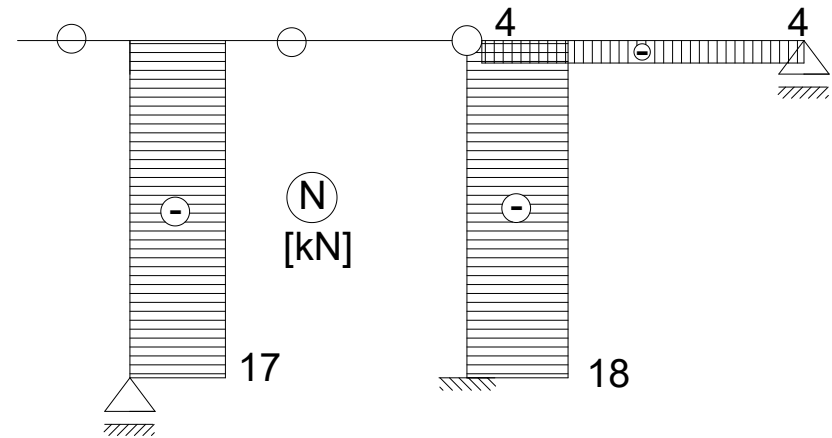
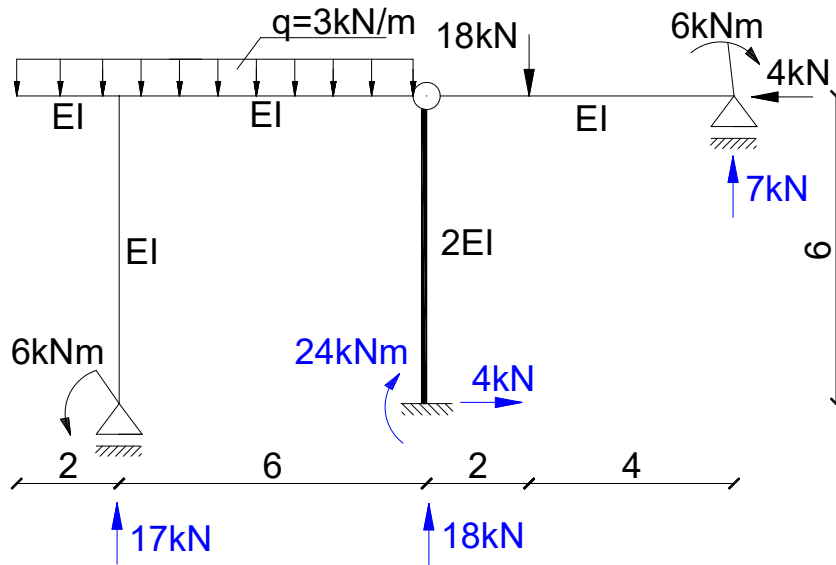
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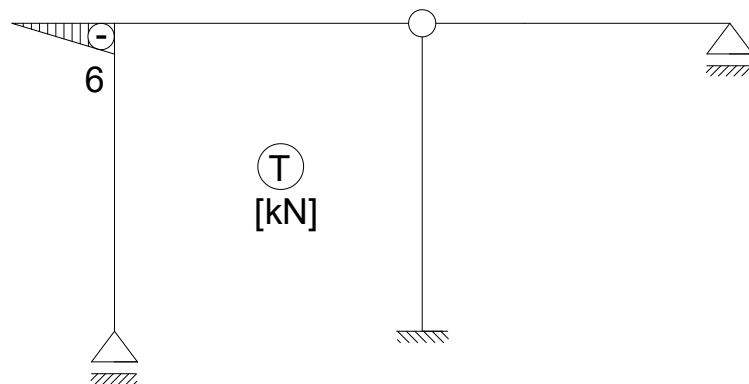
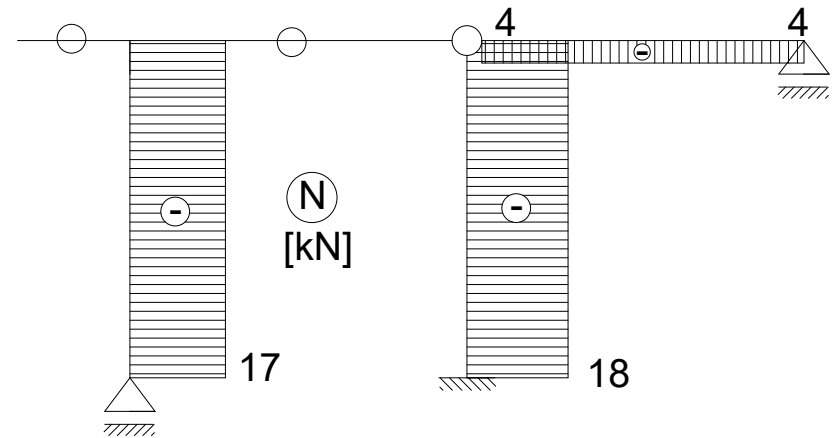
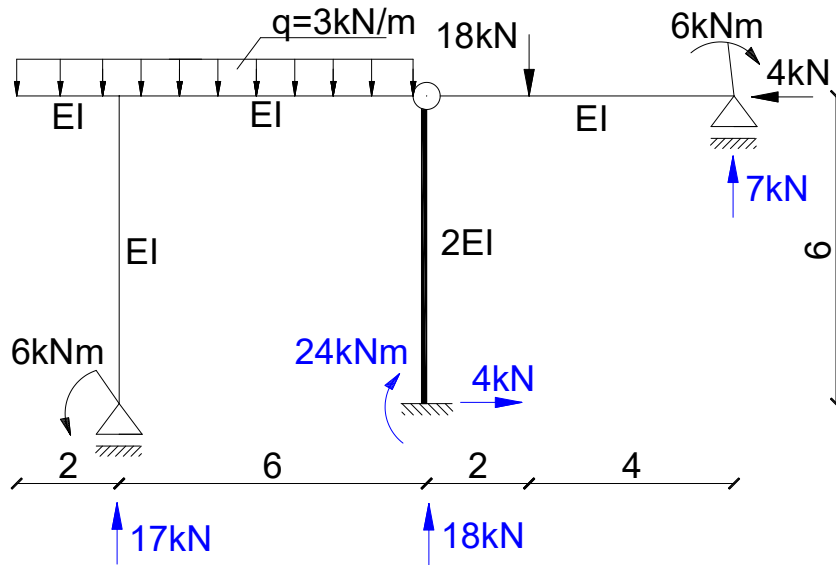
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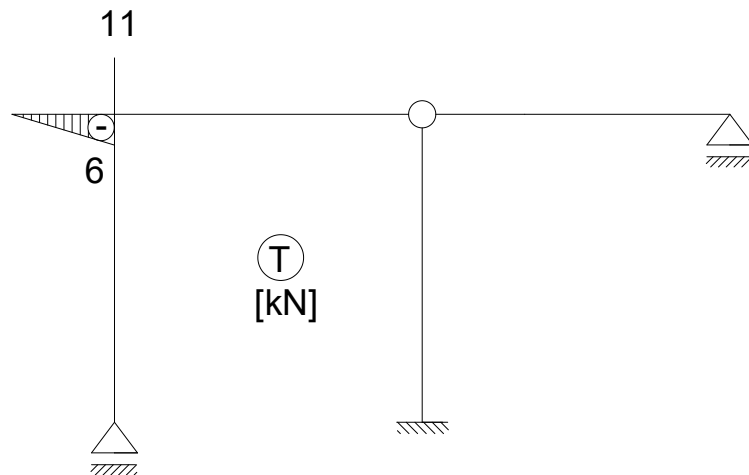
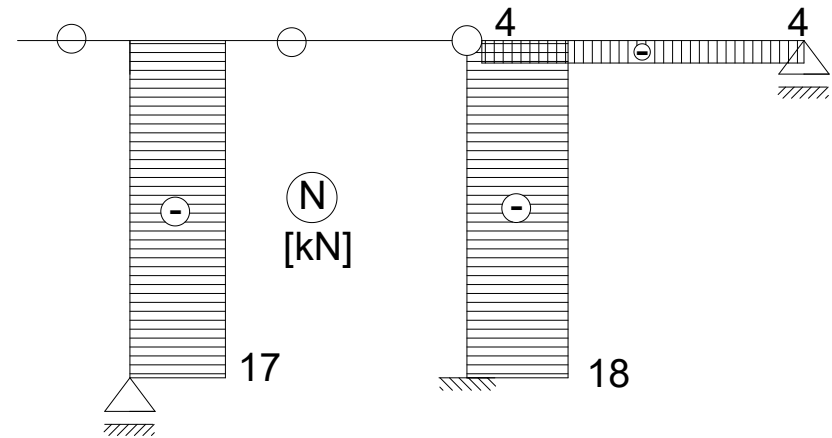
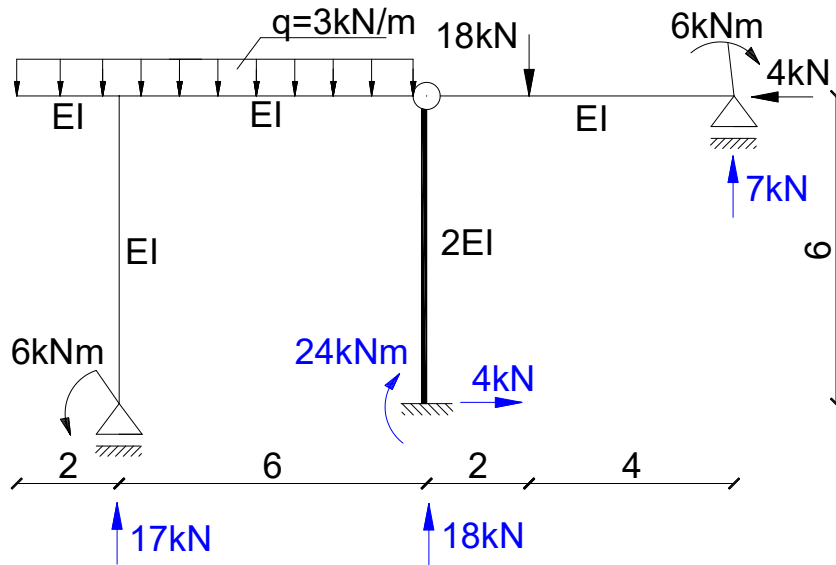
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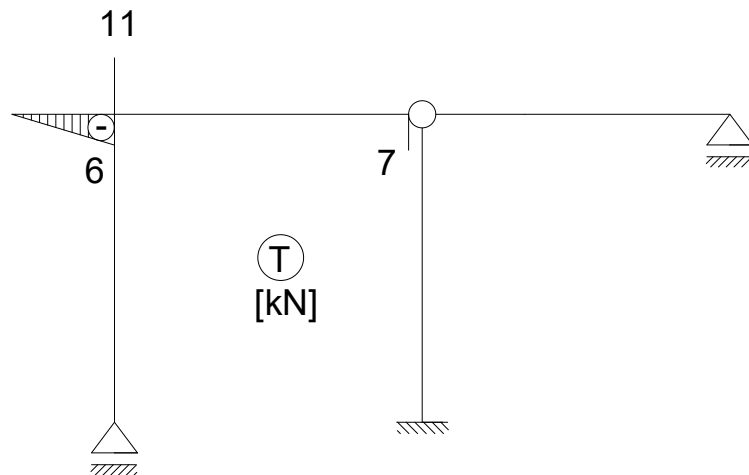
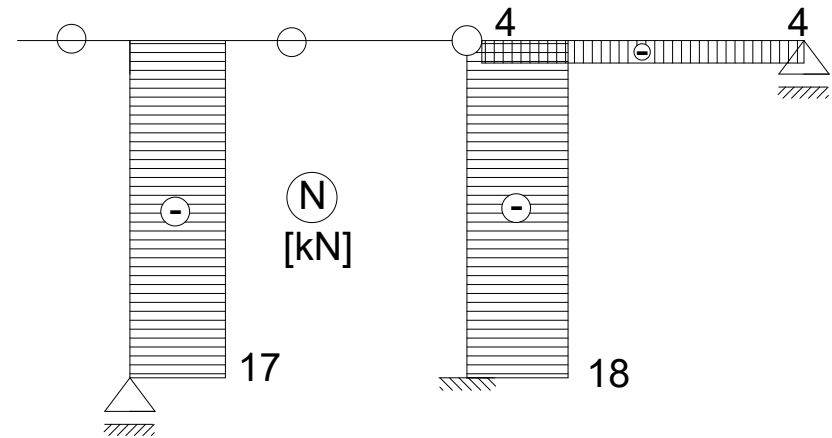
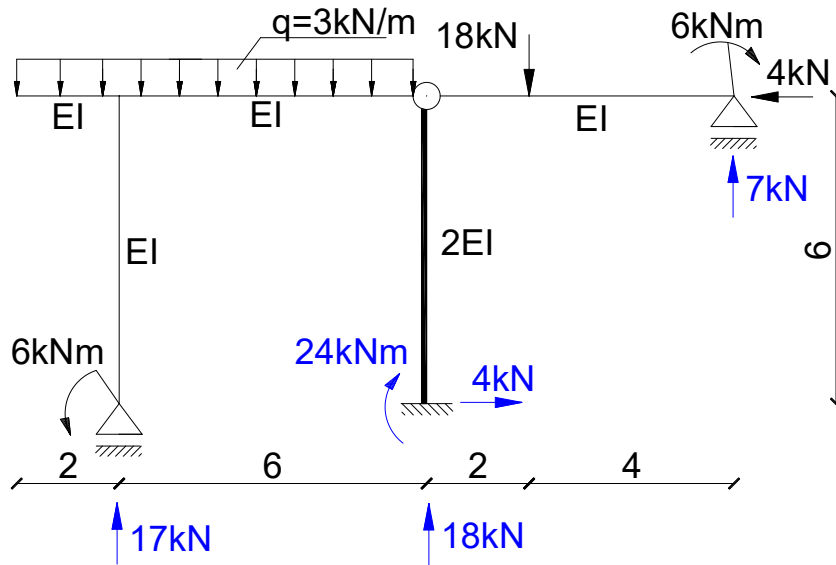
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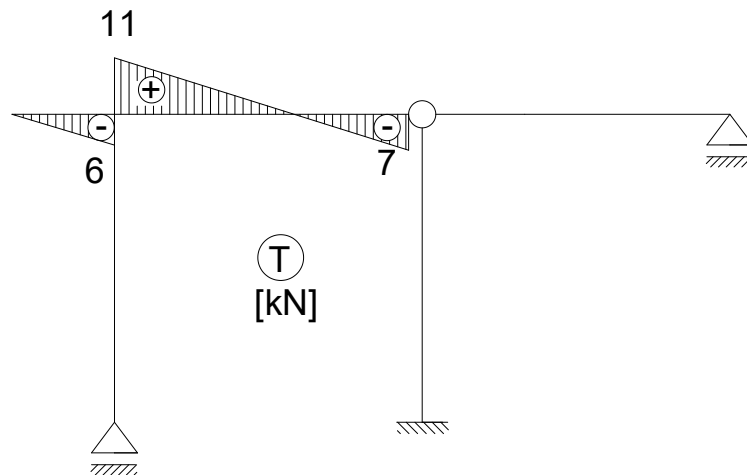
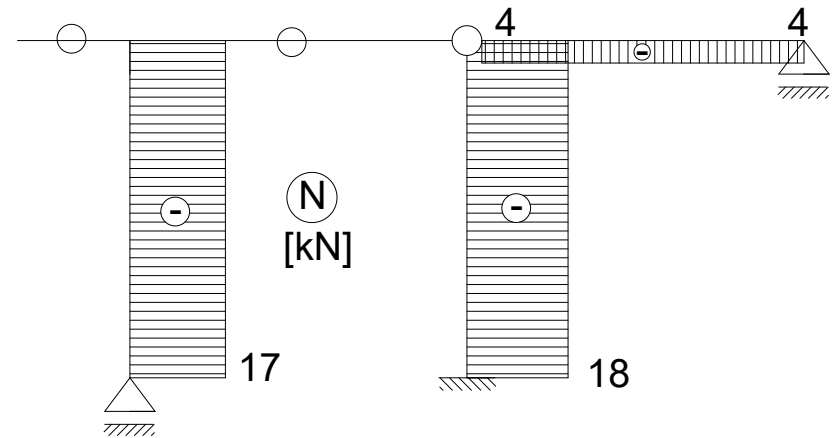
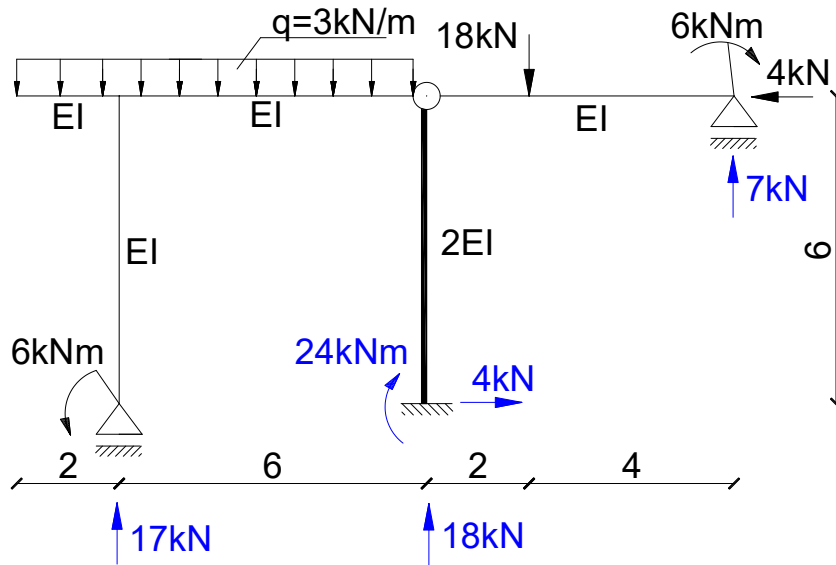
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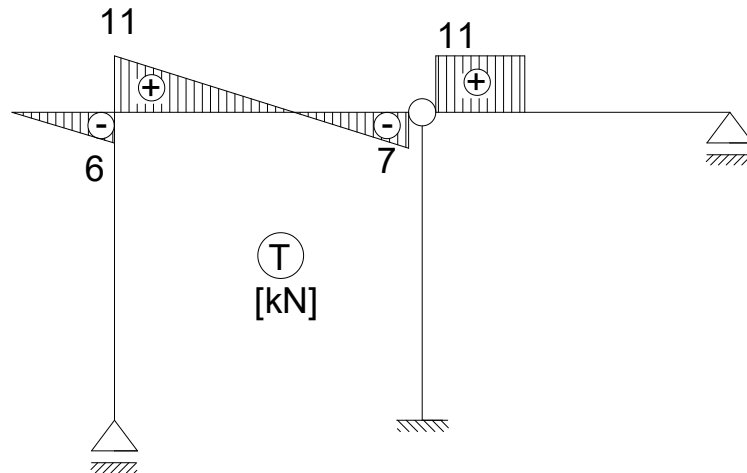
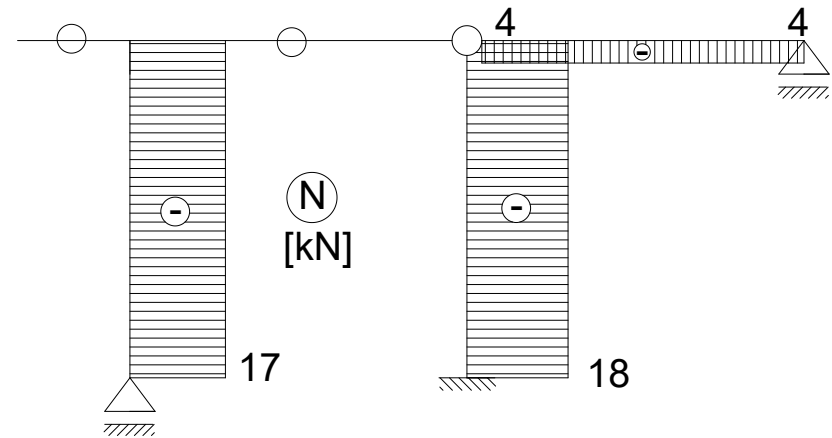
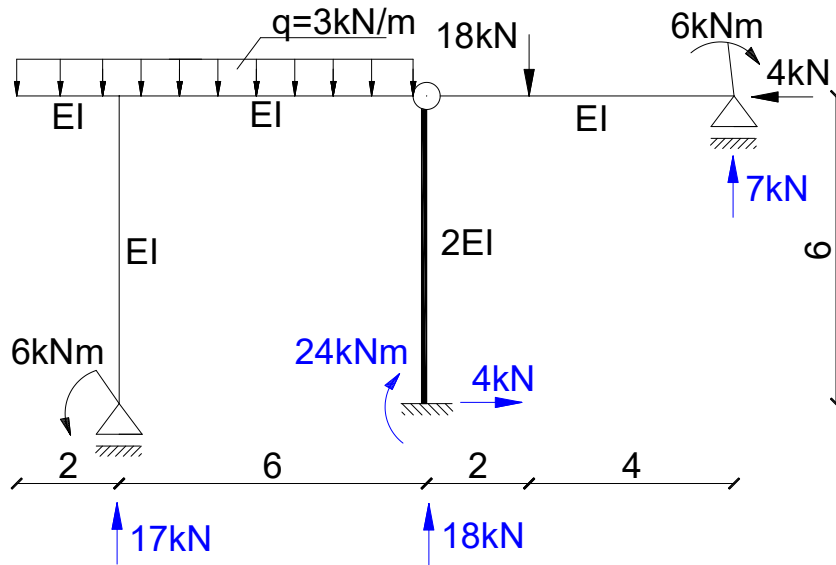
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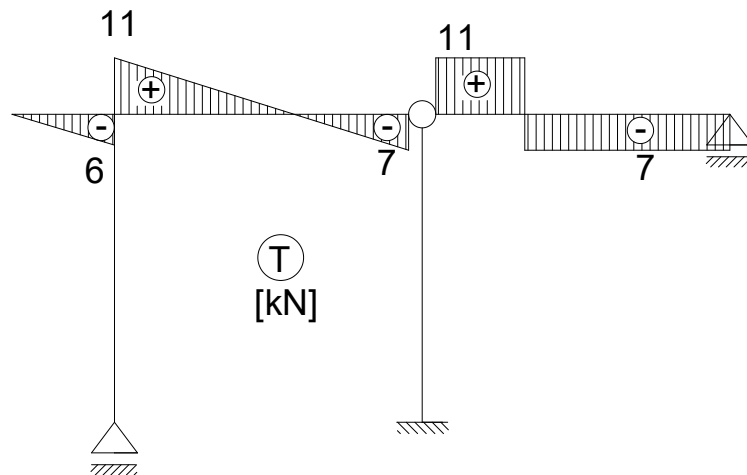
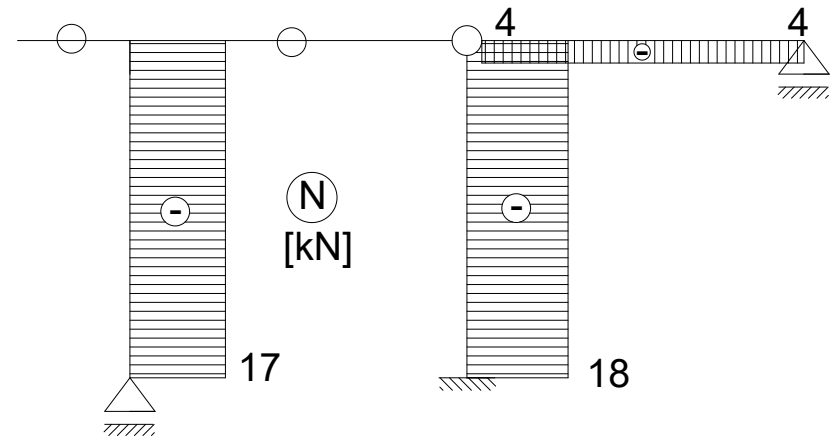
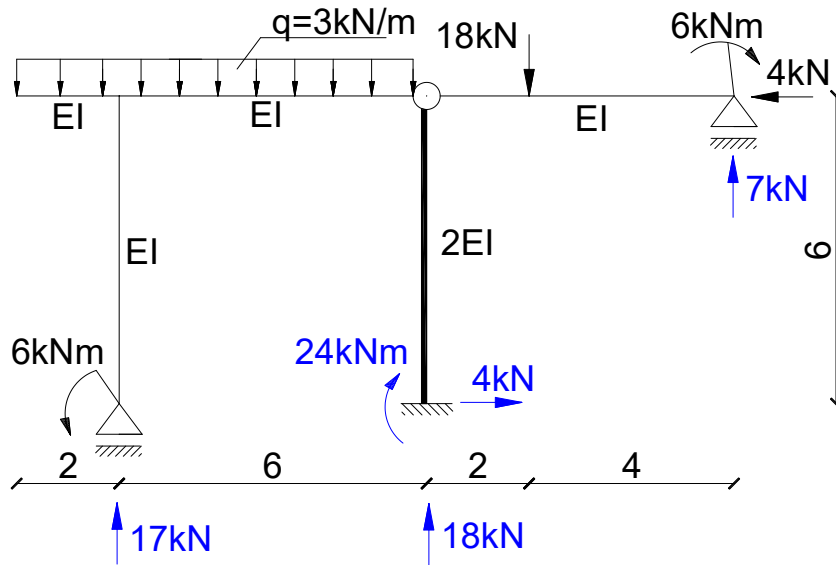
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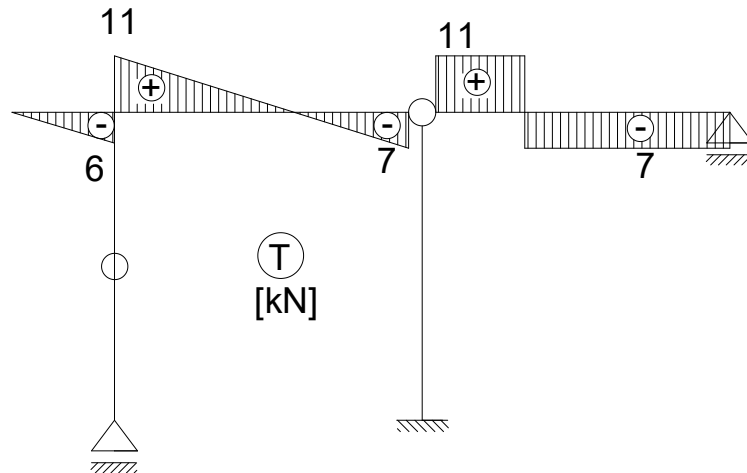
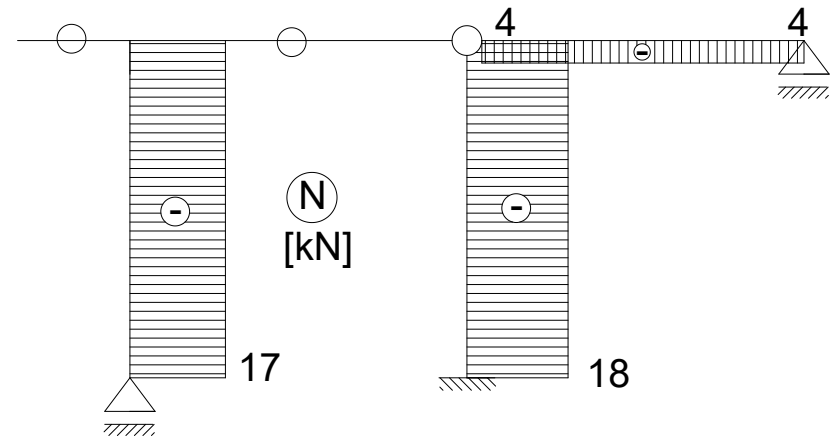
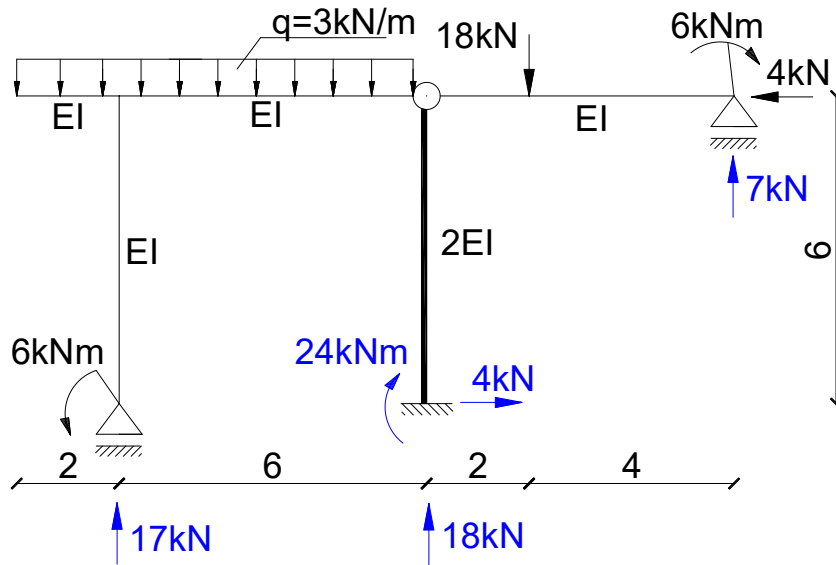
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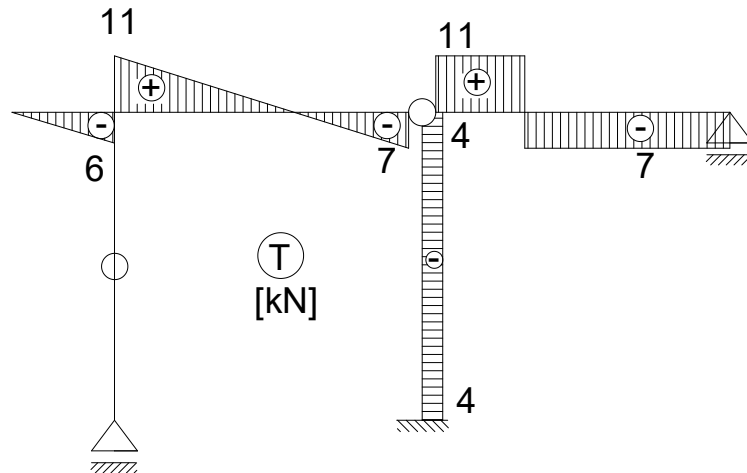
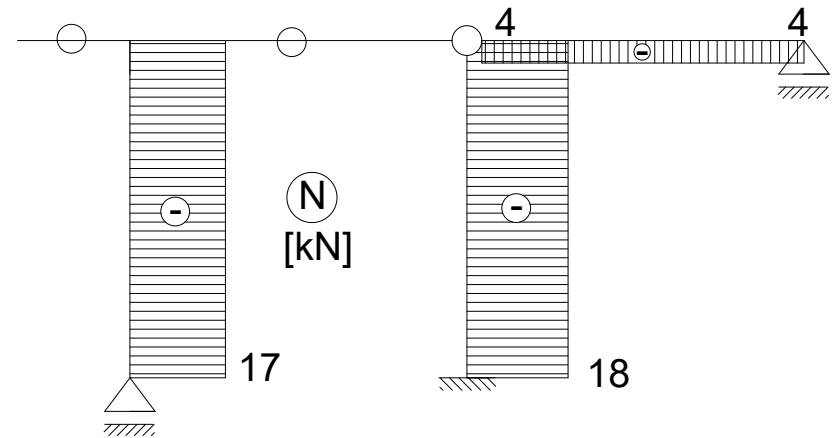
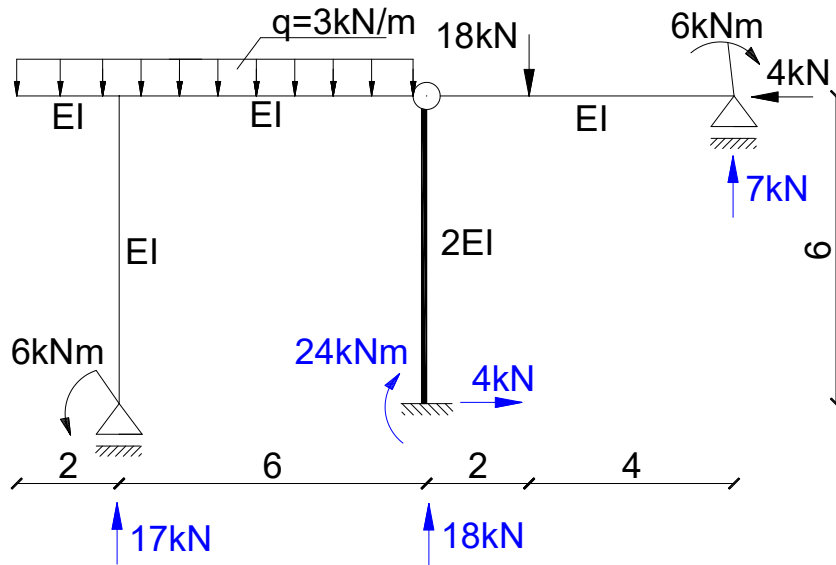
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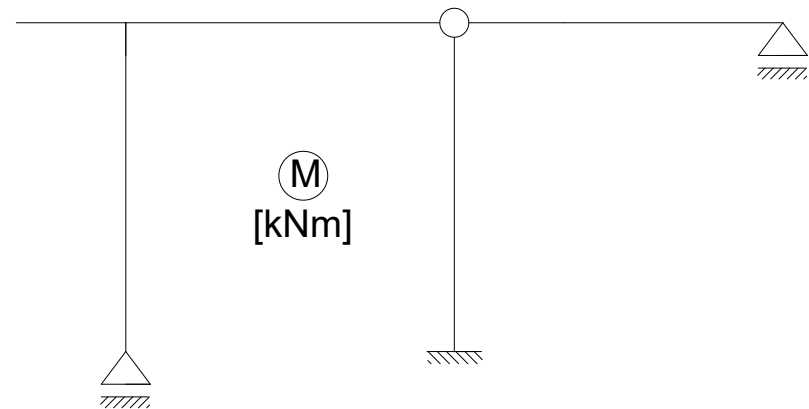
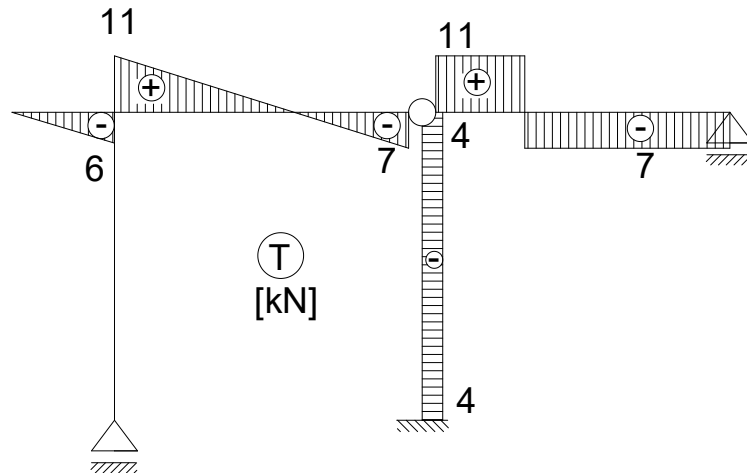
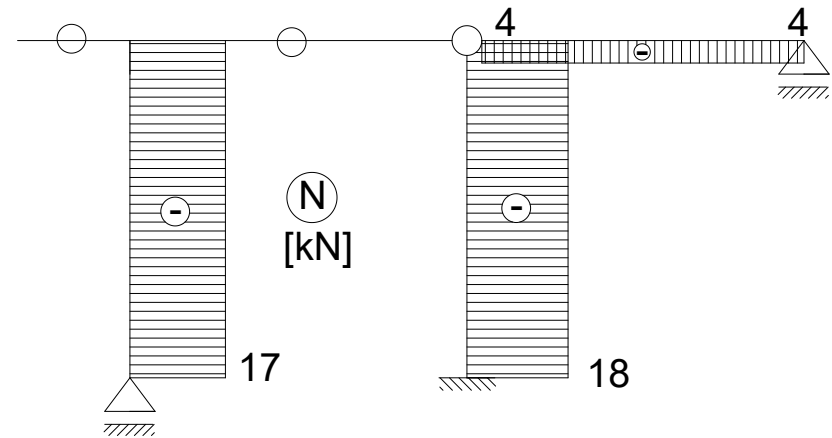
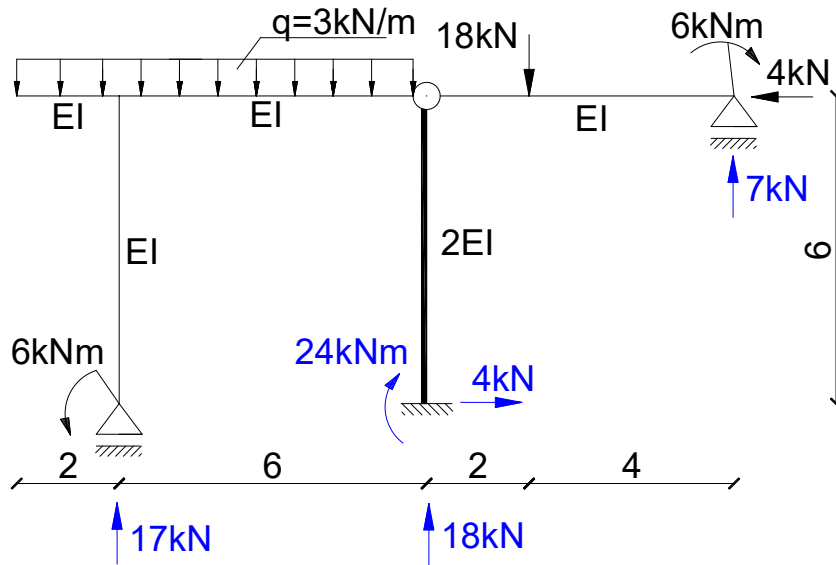
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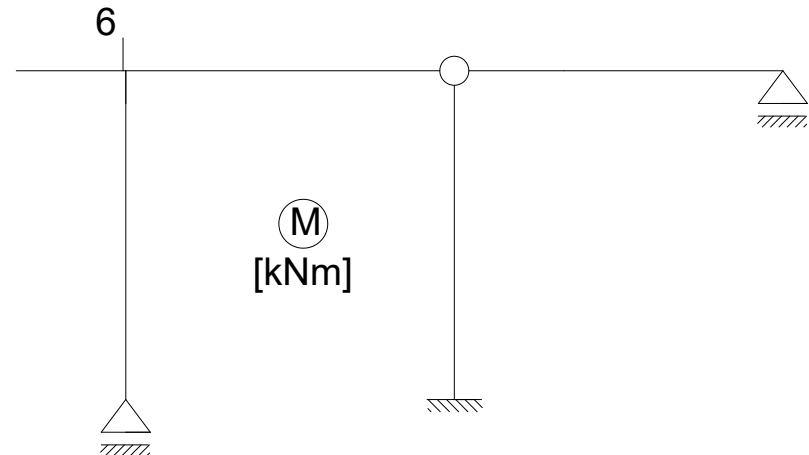
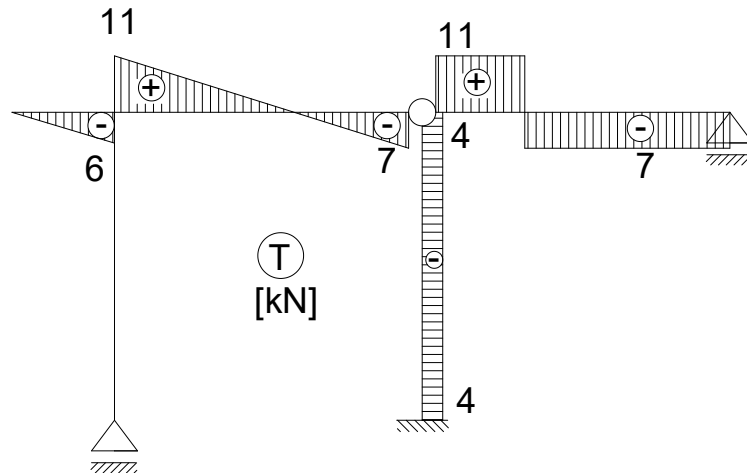
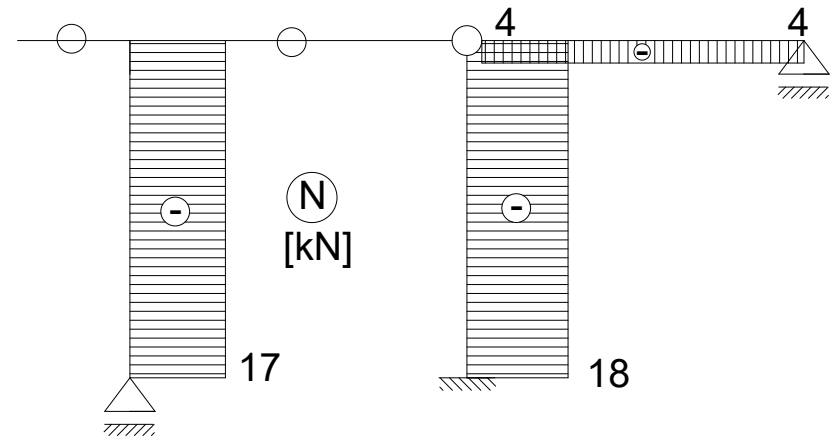
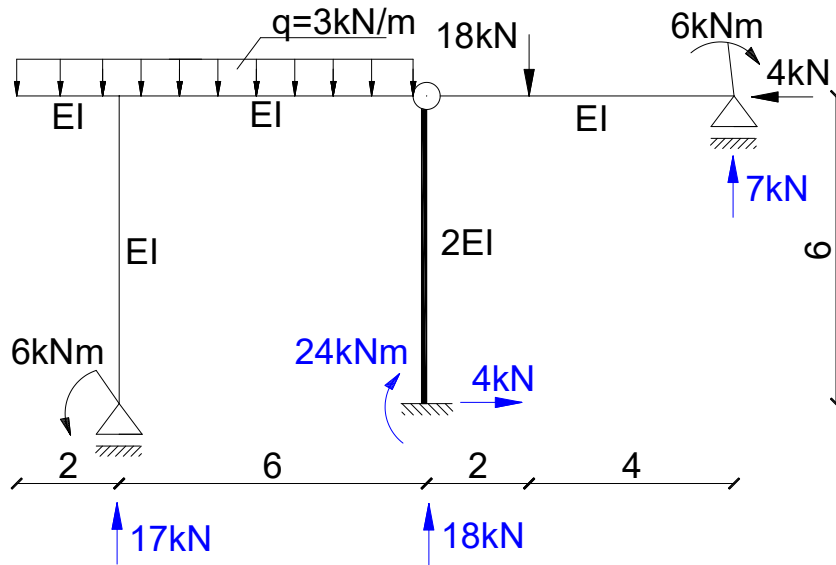
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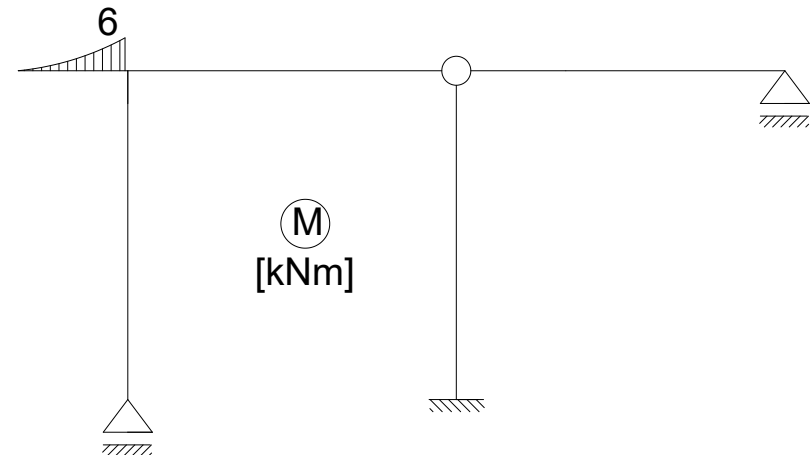
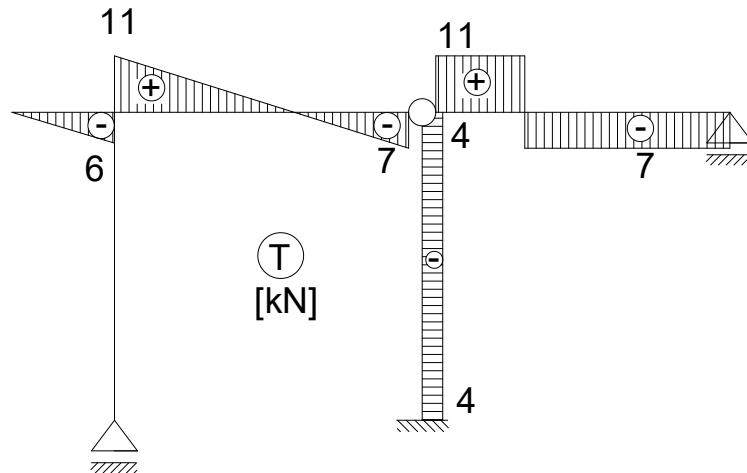
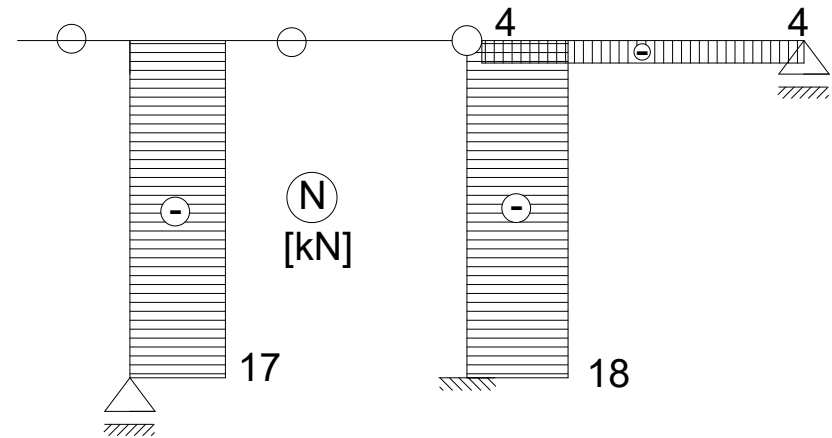
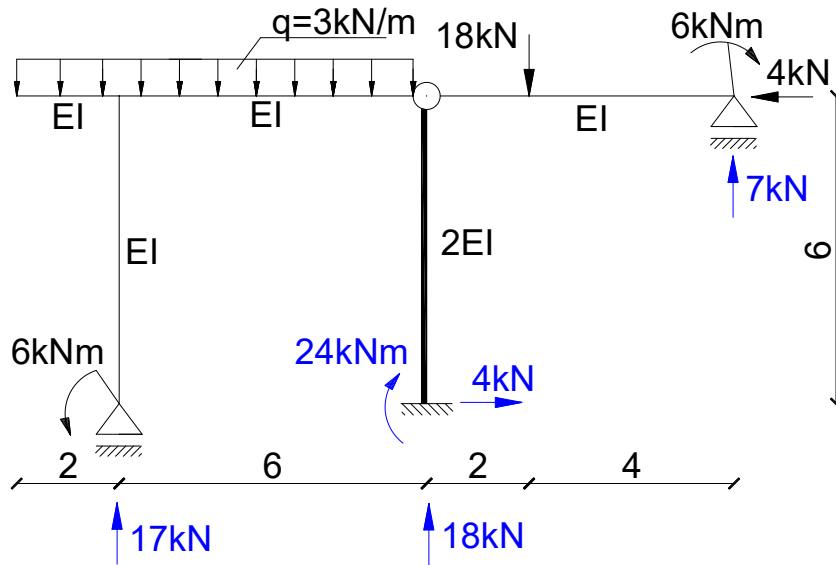
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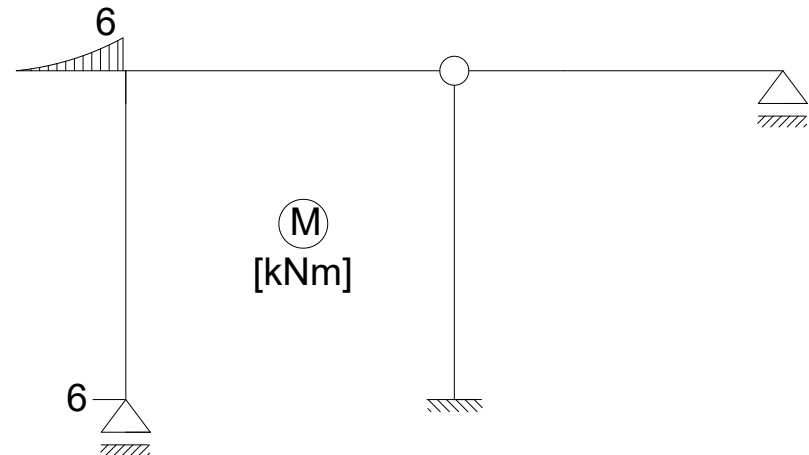
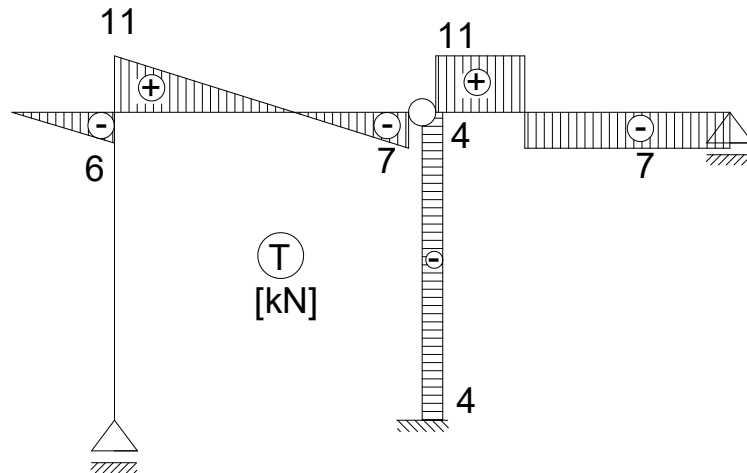
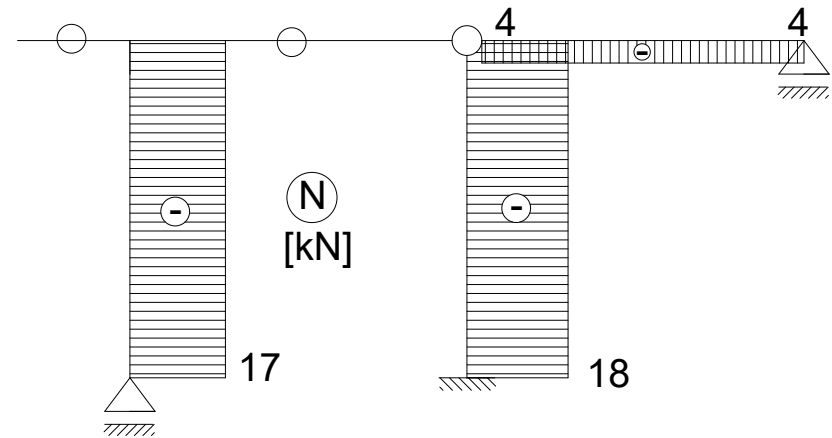
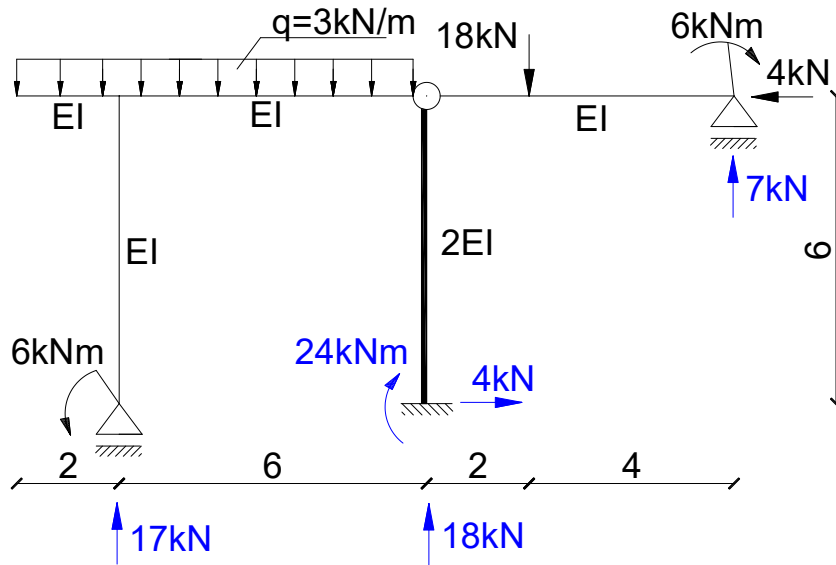
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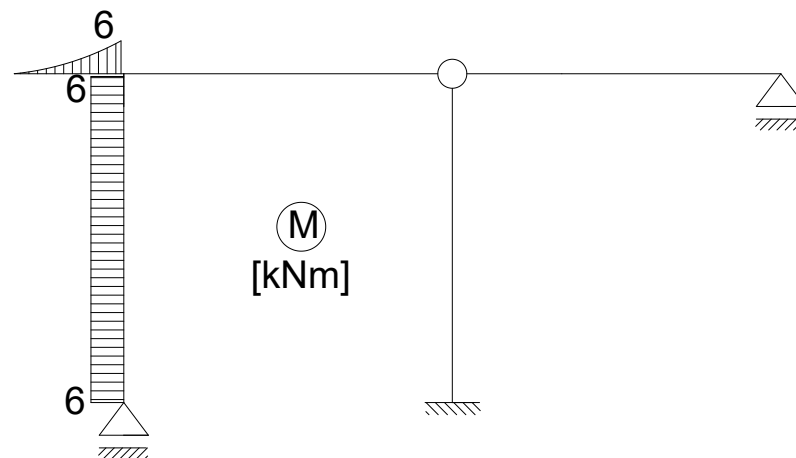
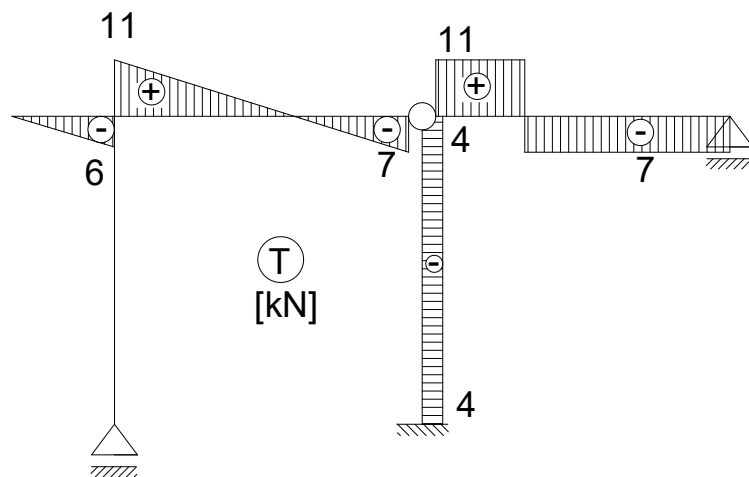
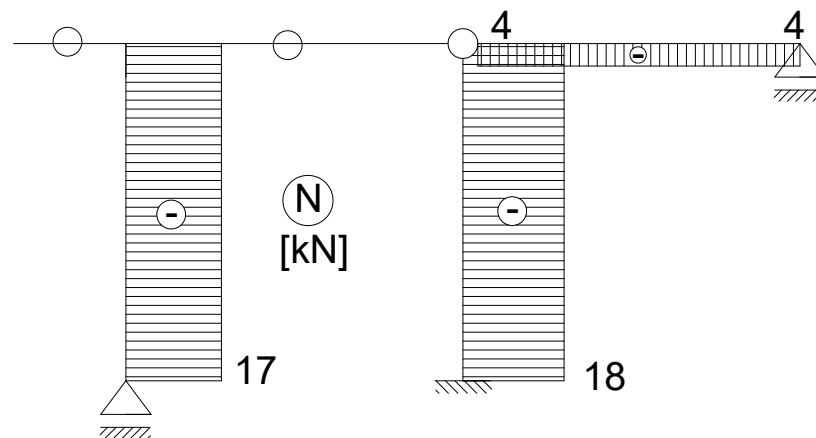
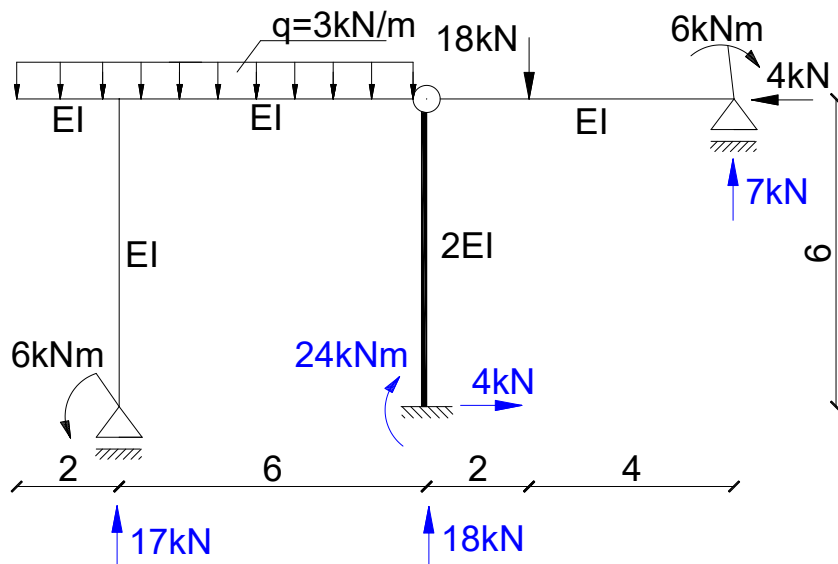
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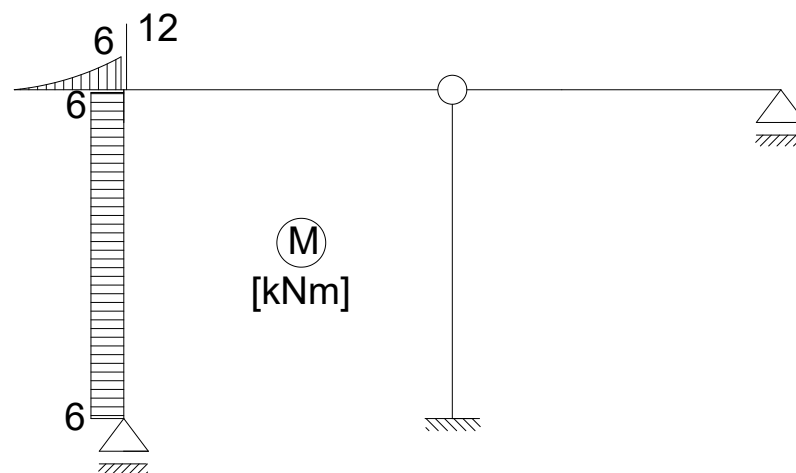
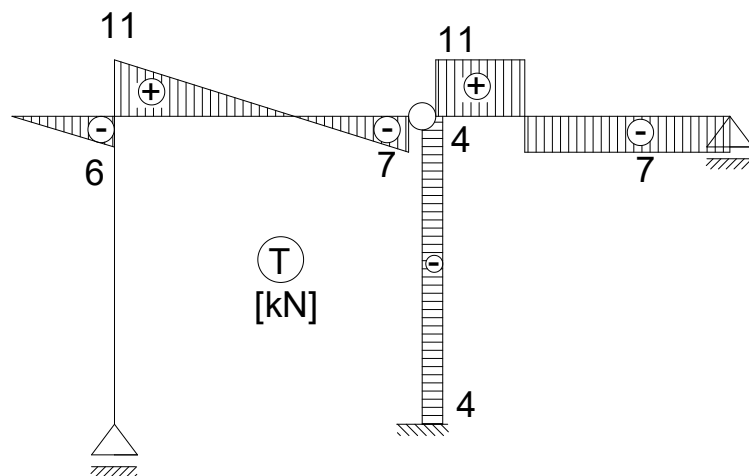
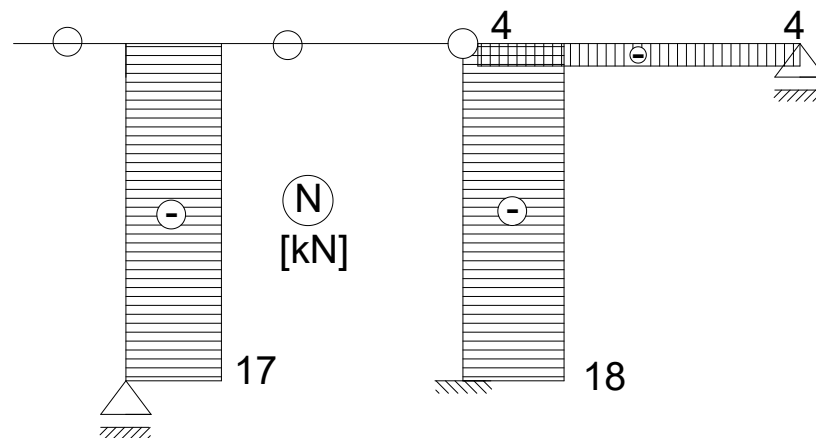
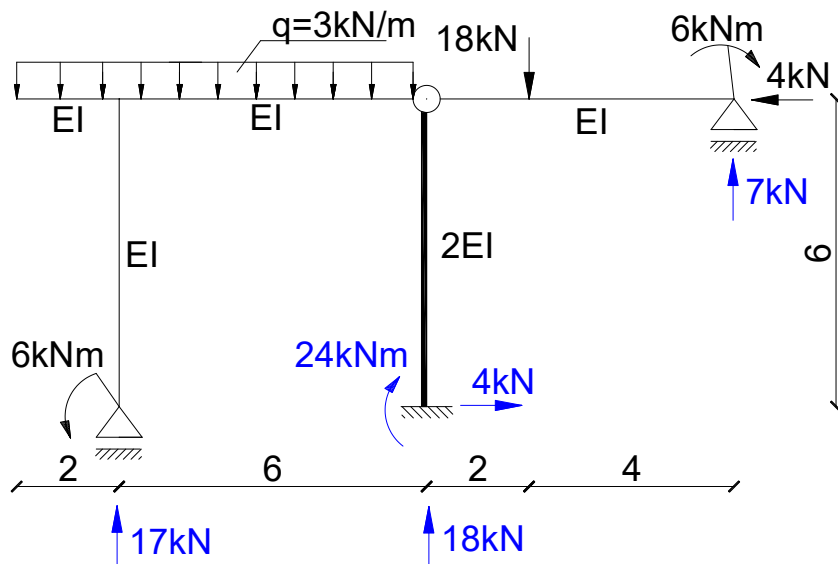
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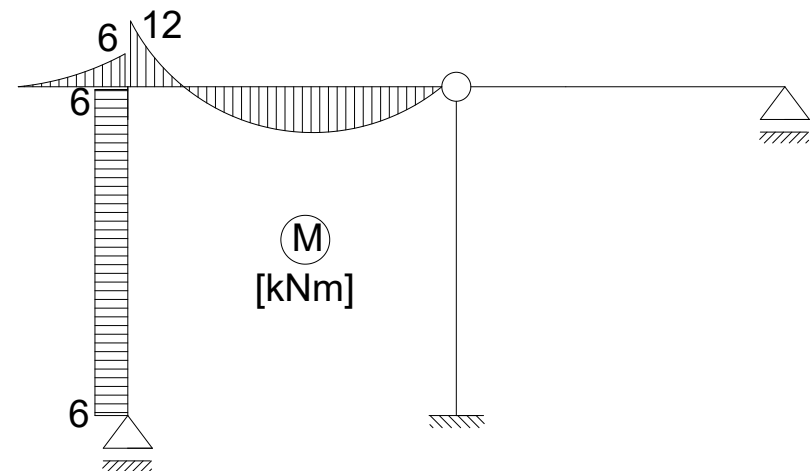
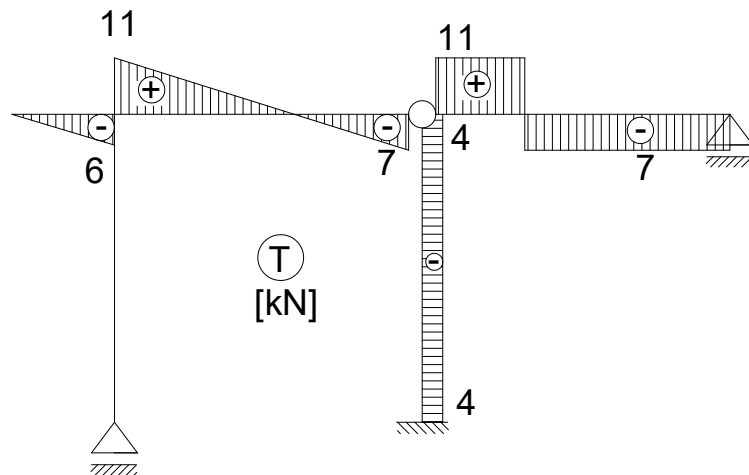
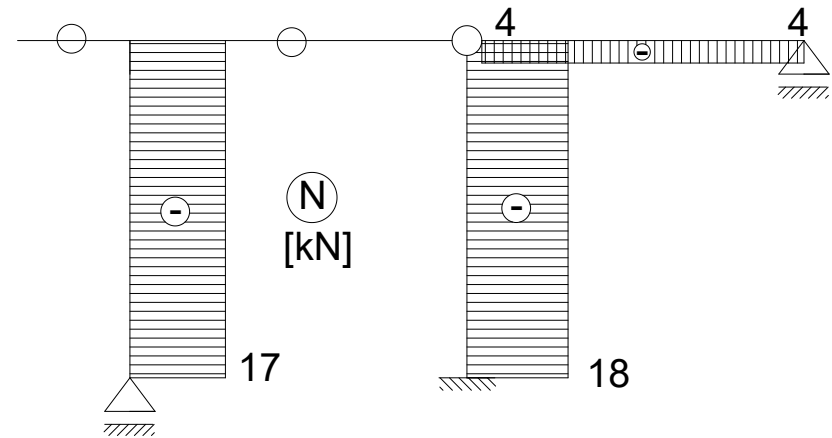
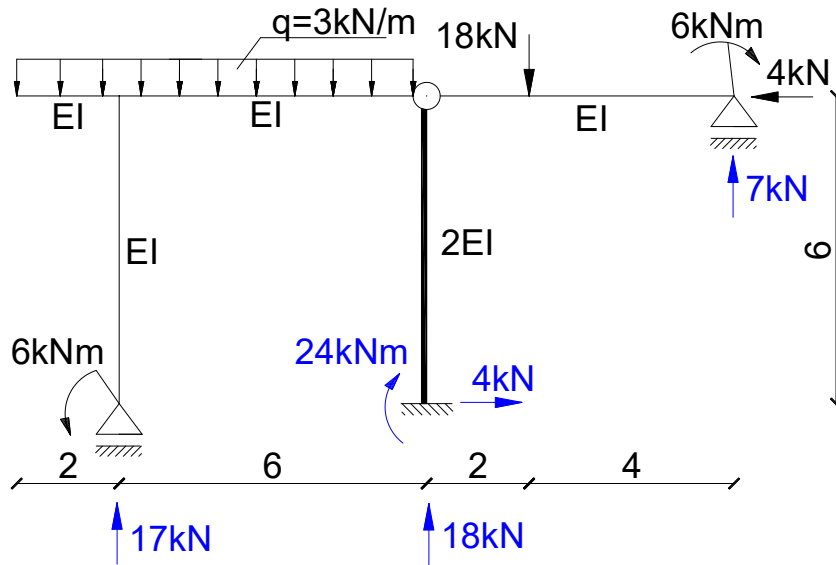
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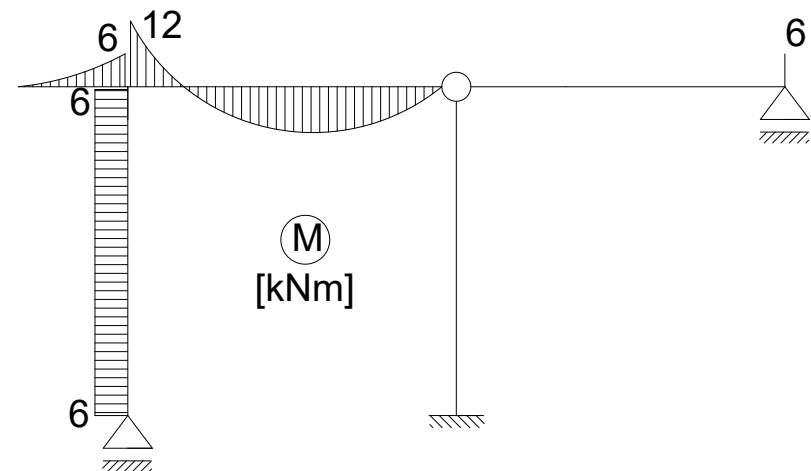
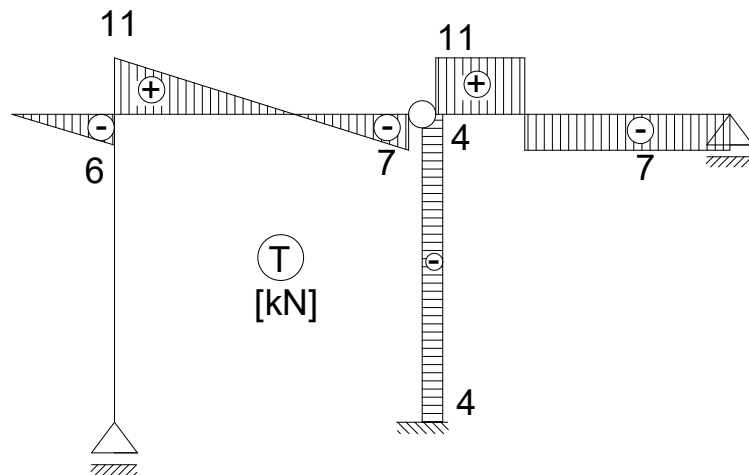
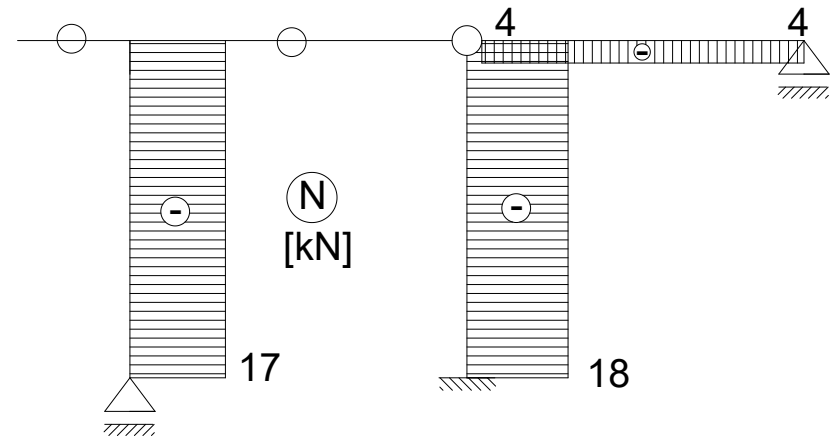
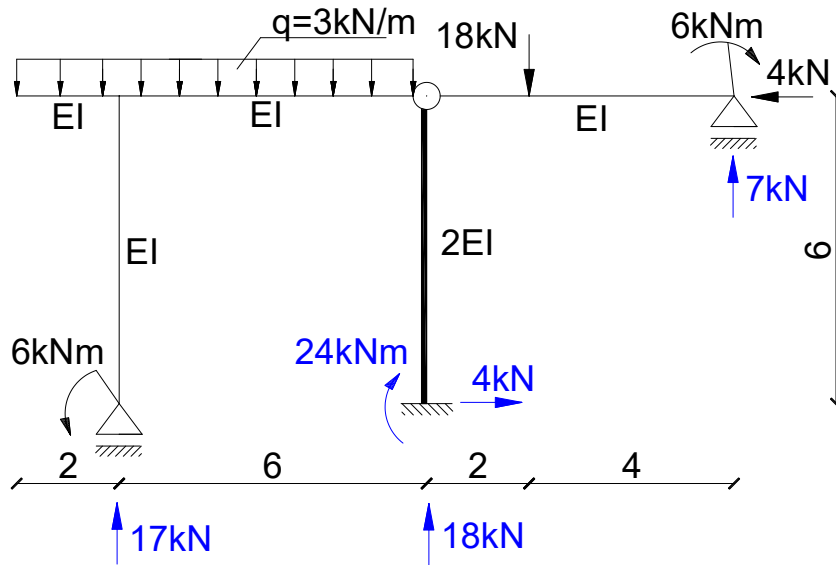
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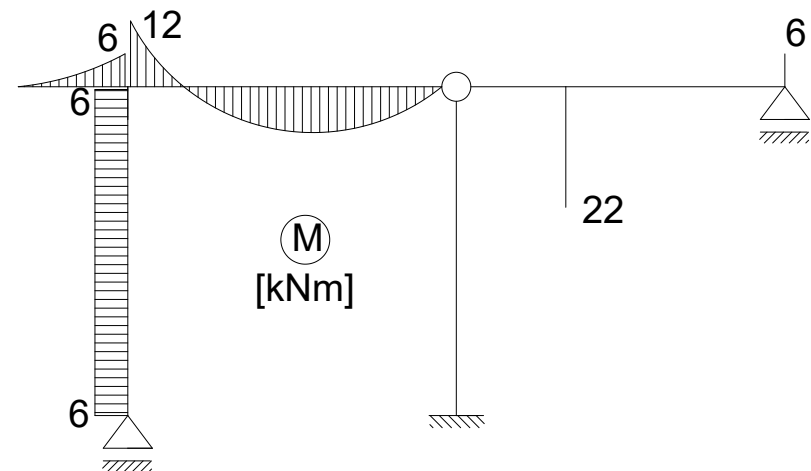
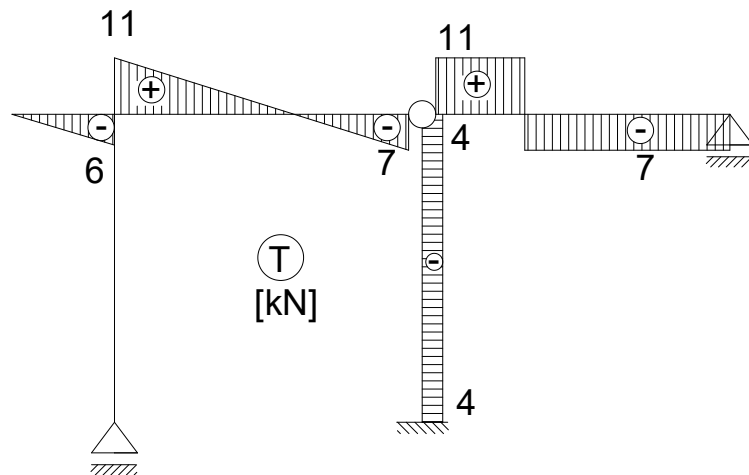
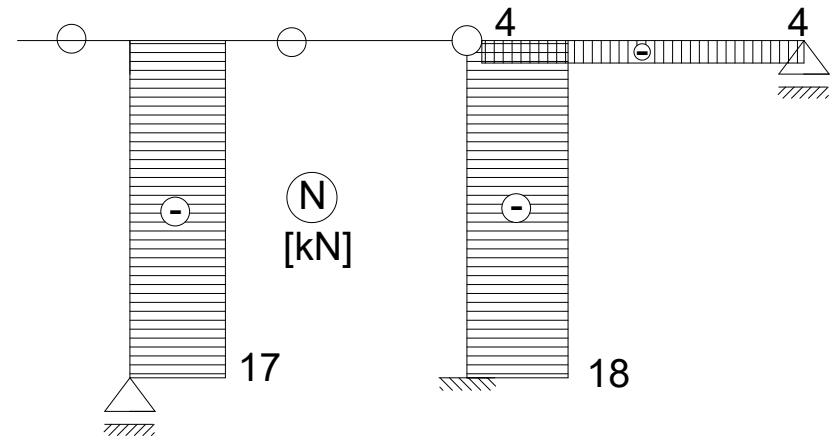
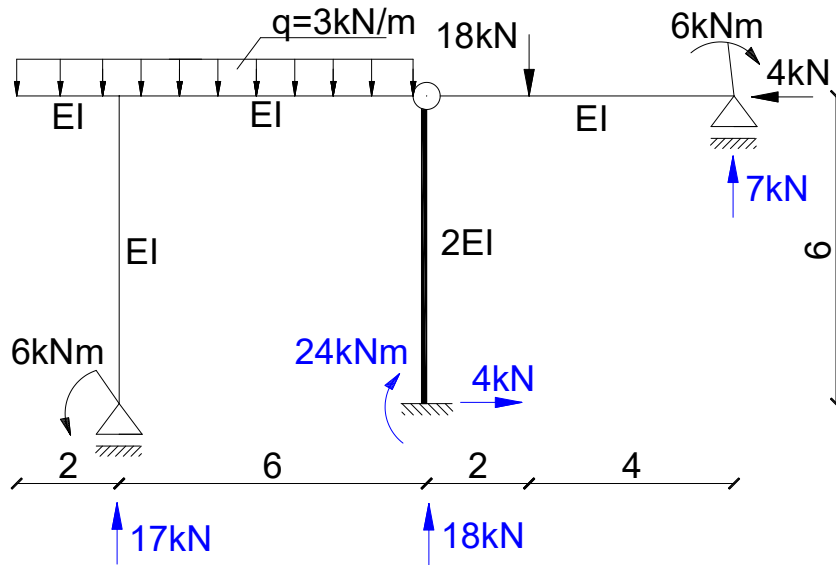
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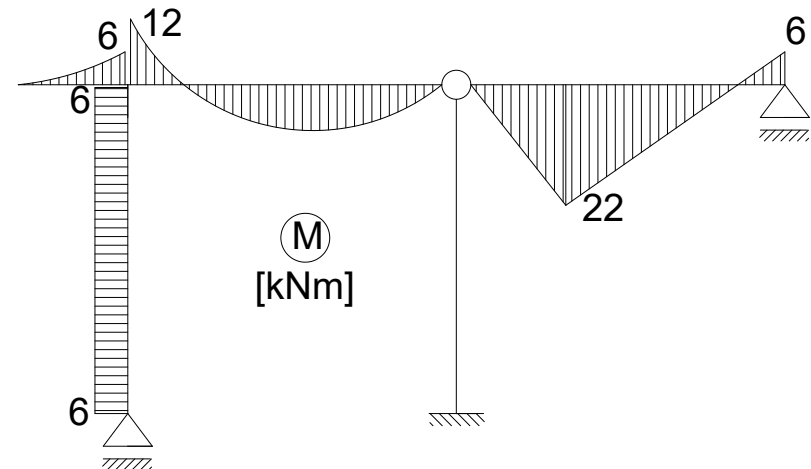
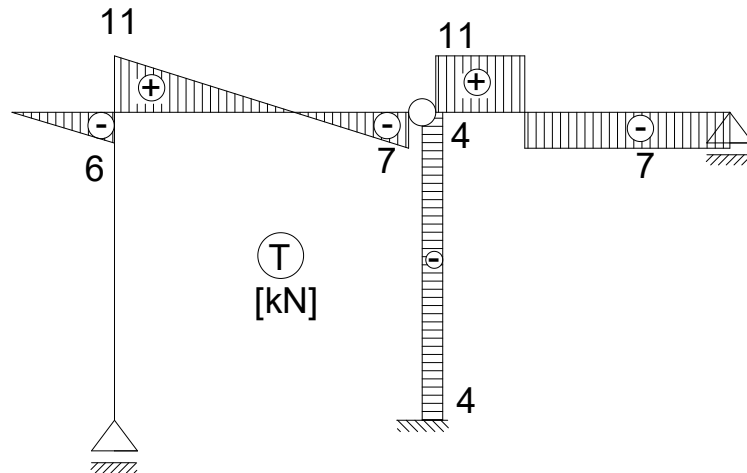
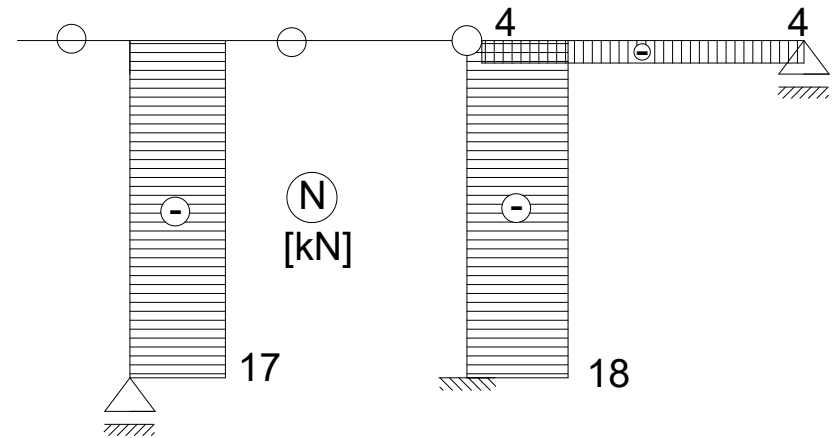
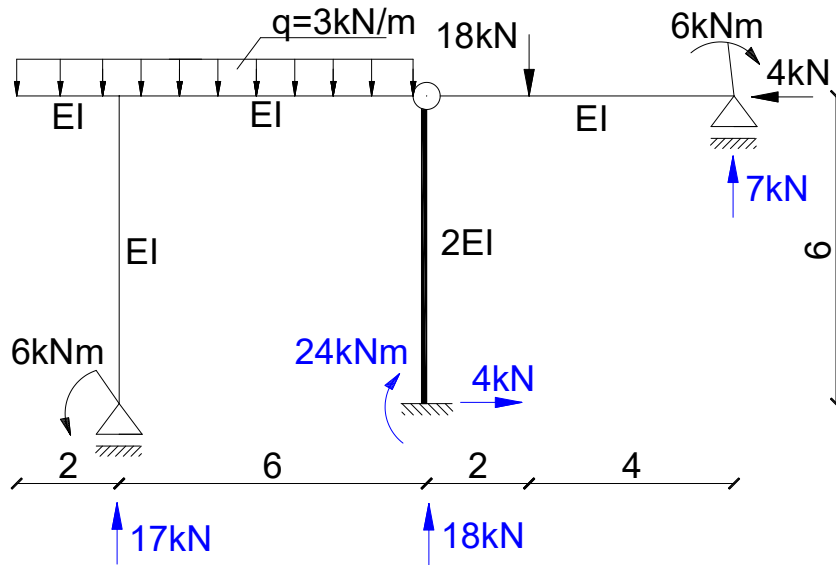
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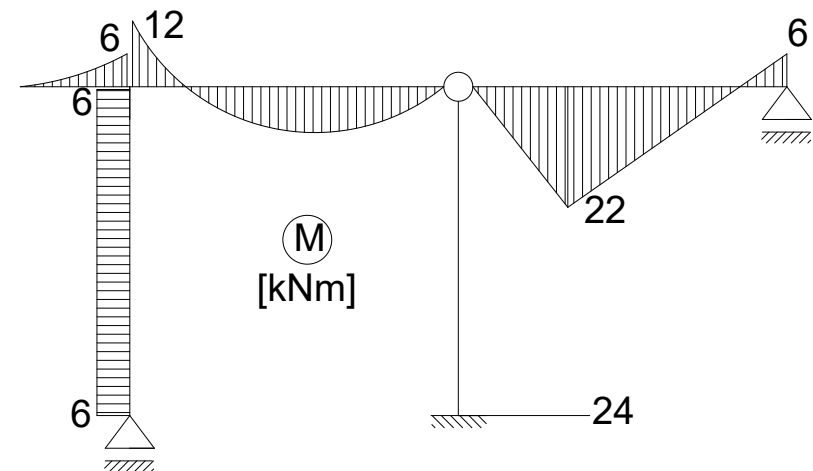
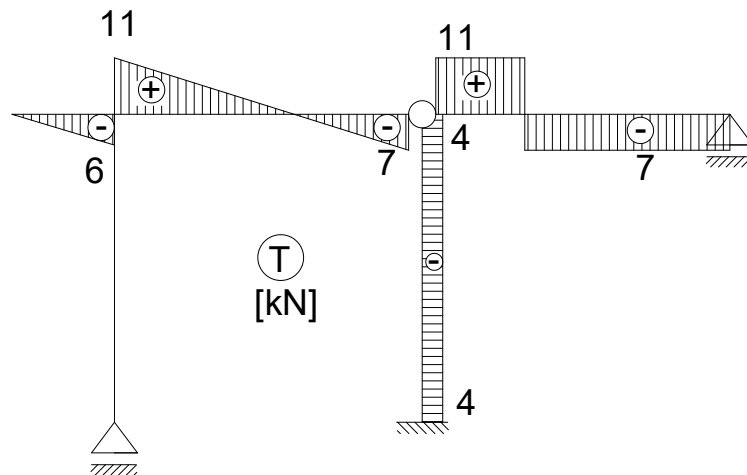
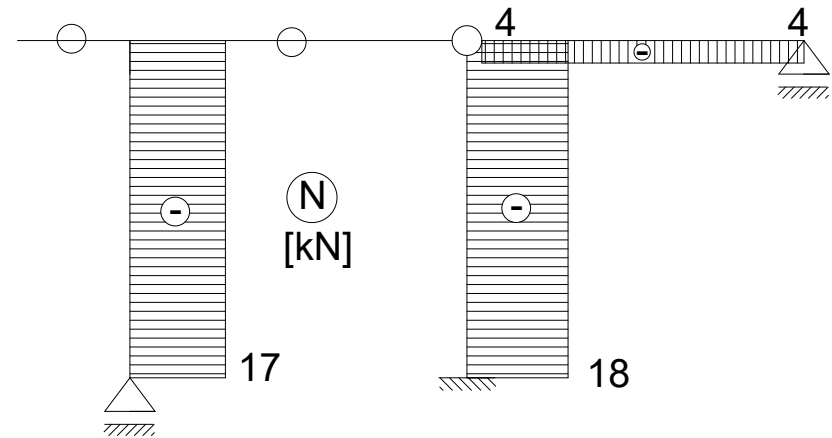
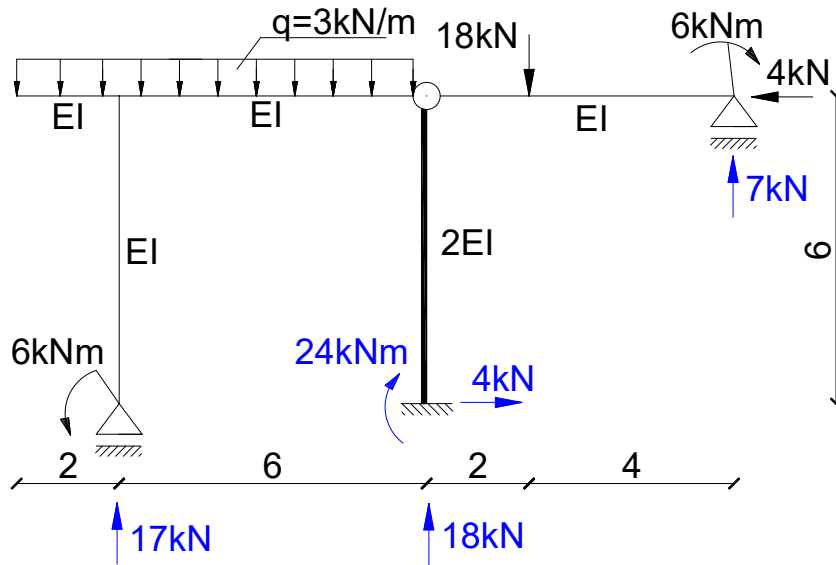
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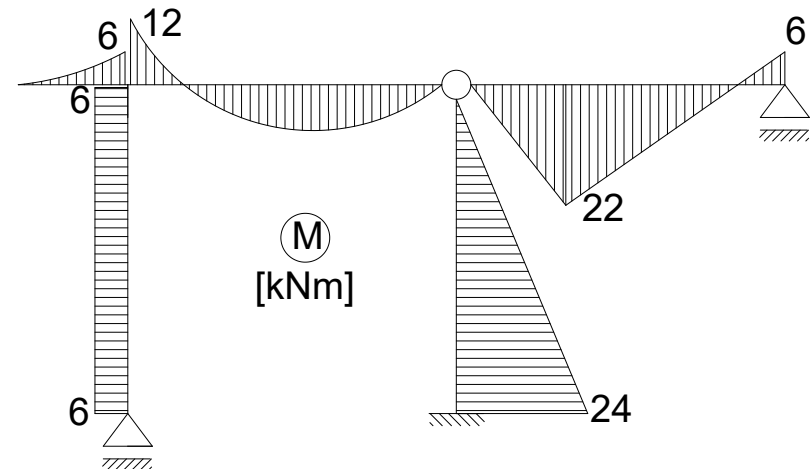
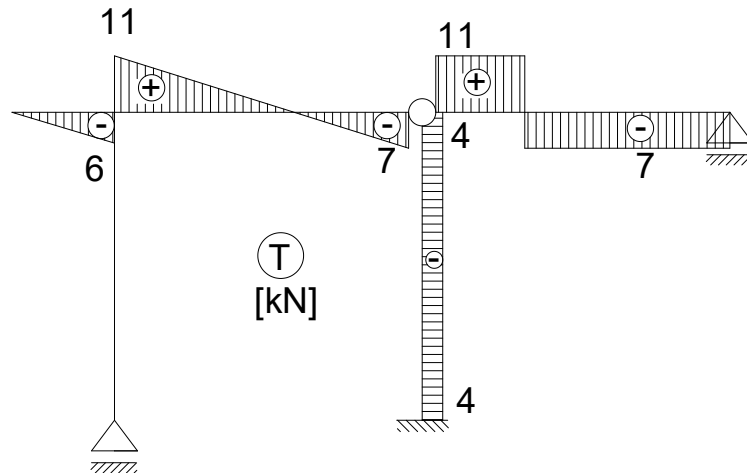
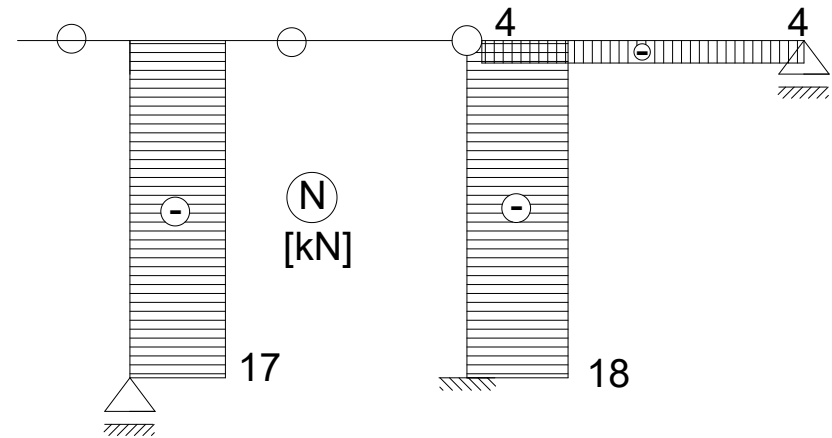
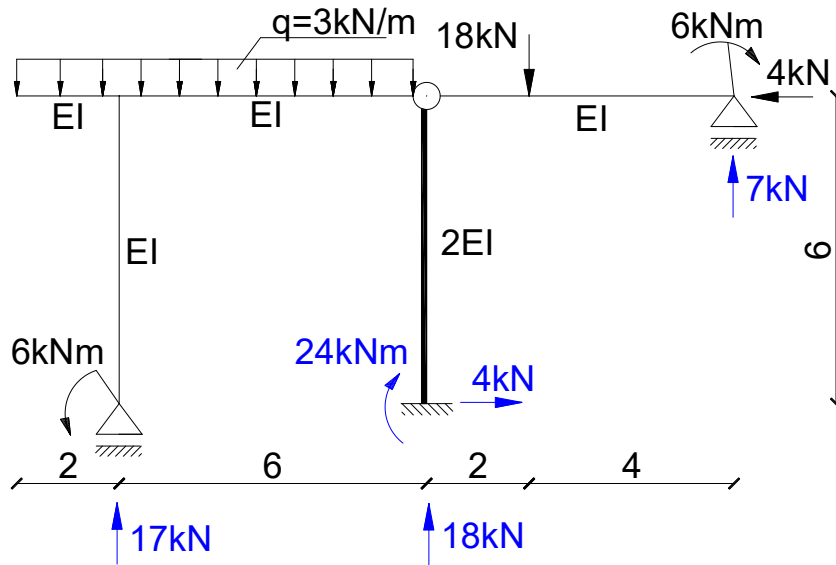
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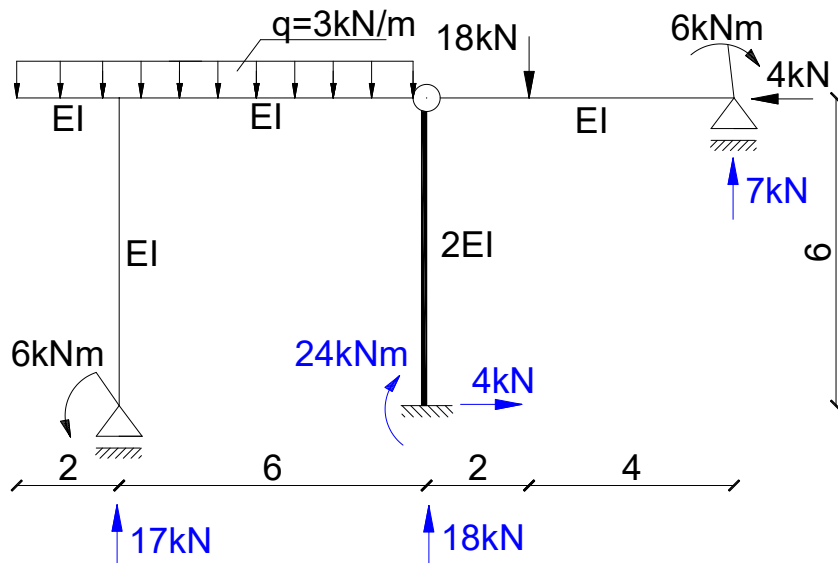
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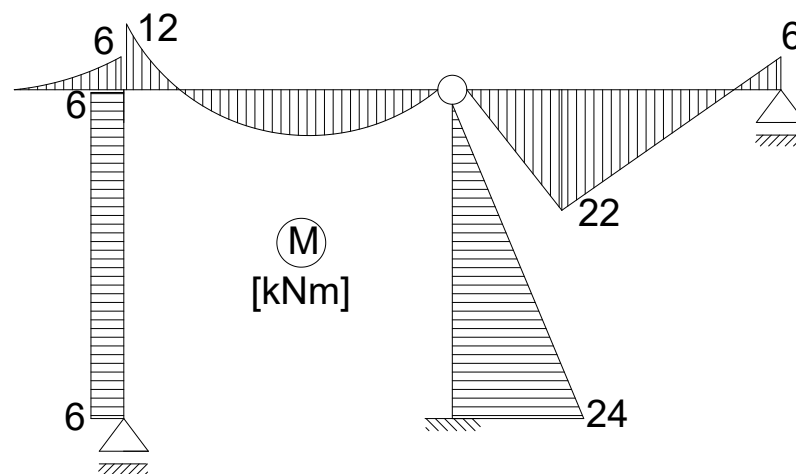
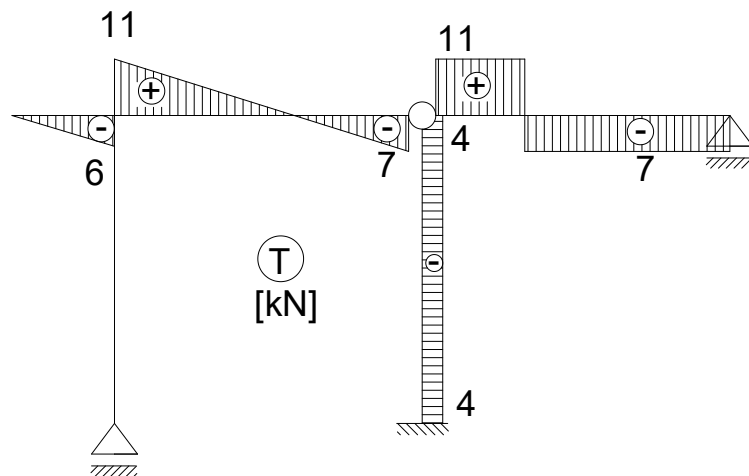
Wykresy sił wewnętrznych:



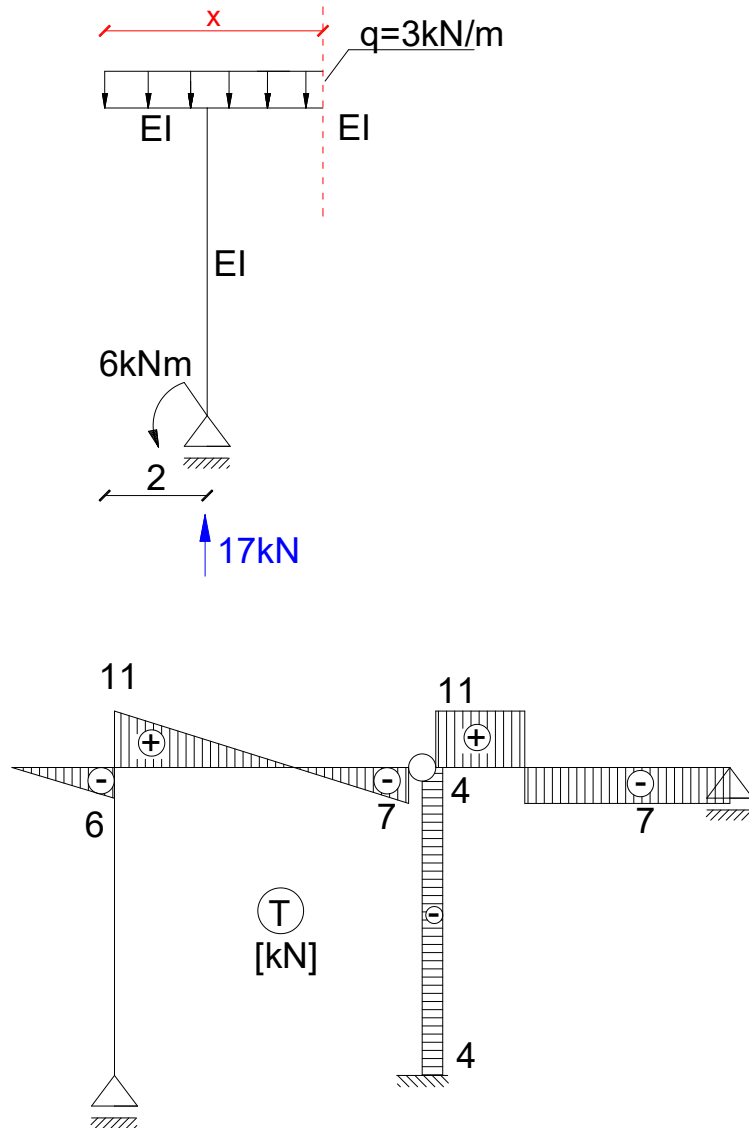
Wykresy sił wewnętrznych:



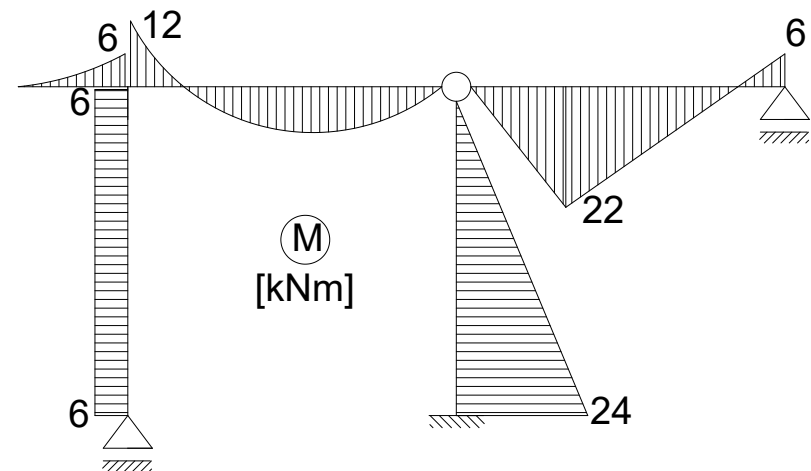
Wyznaczenie ekstremum:



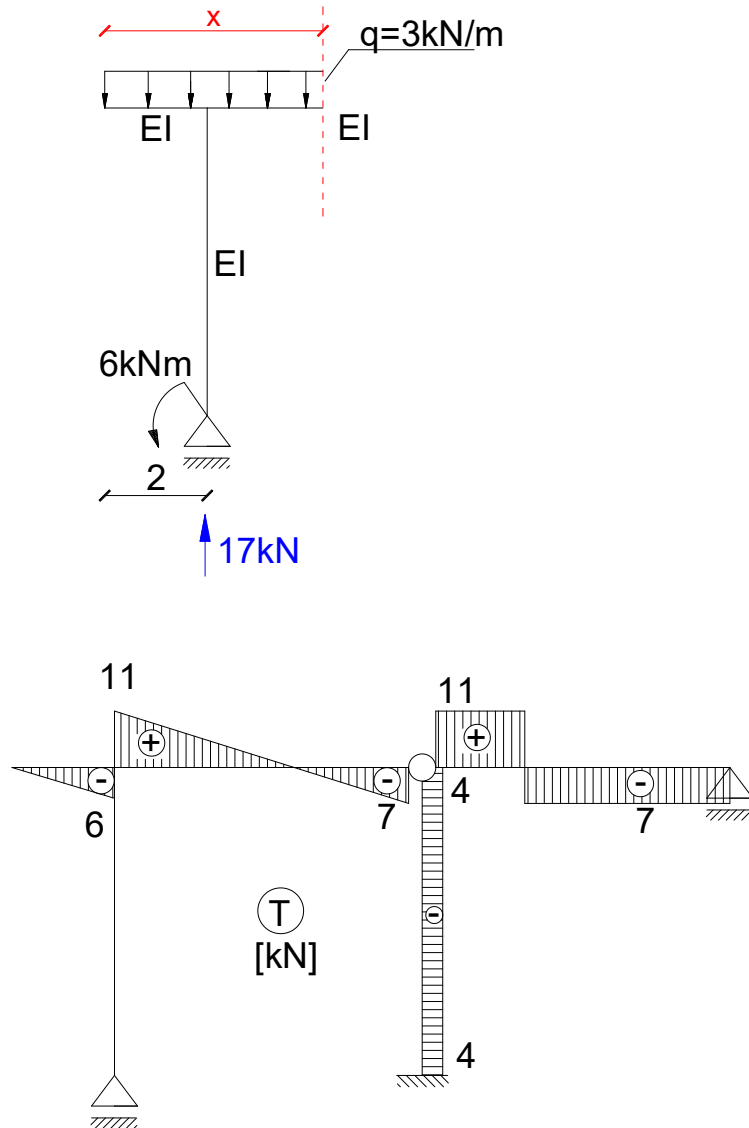
Wykresy sił wewnętrznych:



Wyznaczenie ekstremum:

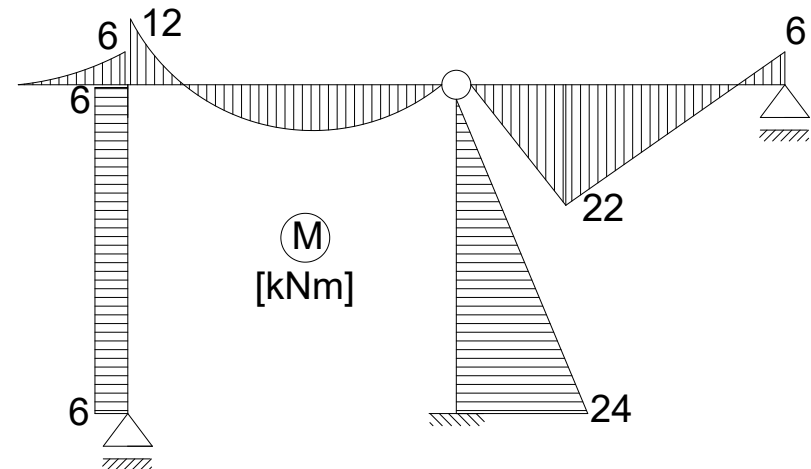


Wykresy sił wewnętrznych:

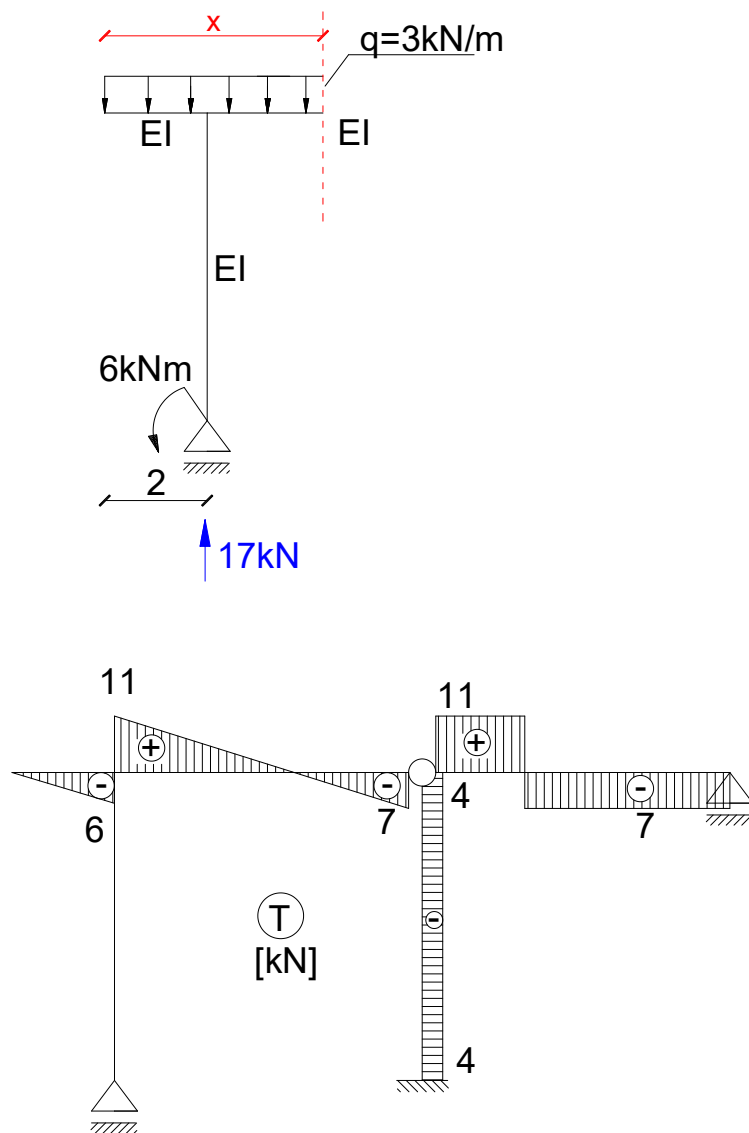


Wyznaczenie ekstremum:

$$T[x] = 17 - 3x = 0$$

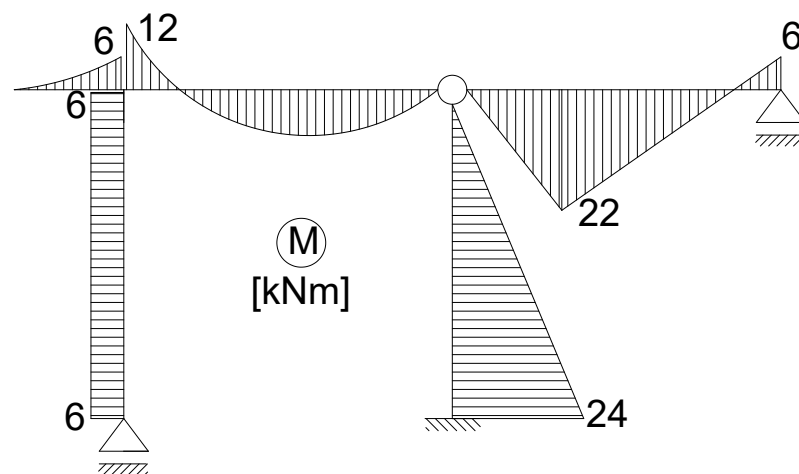


Wykresy sił wewnętrznych:

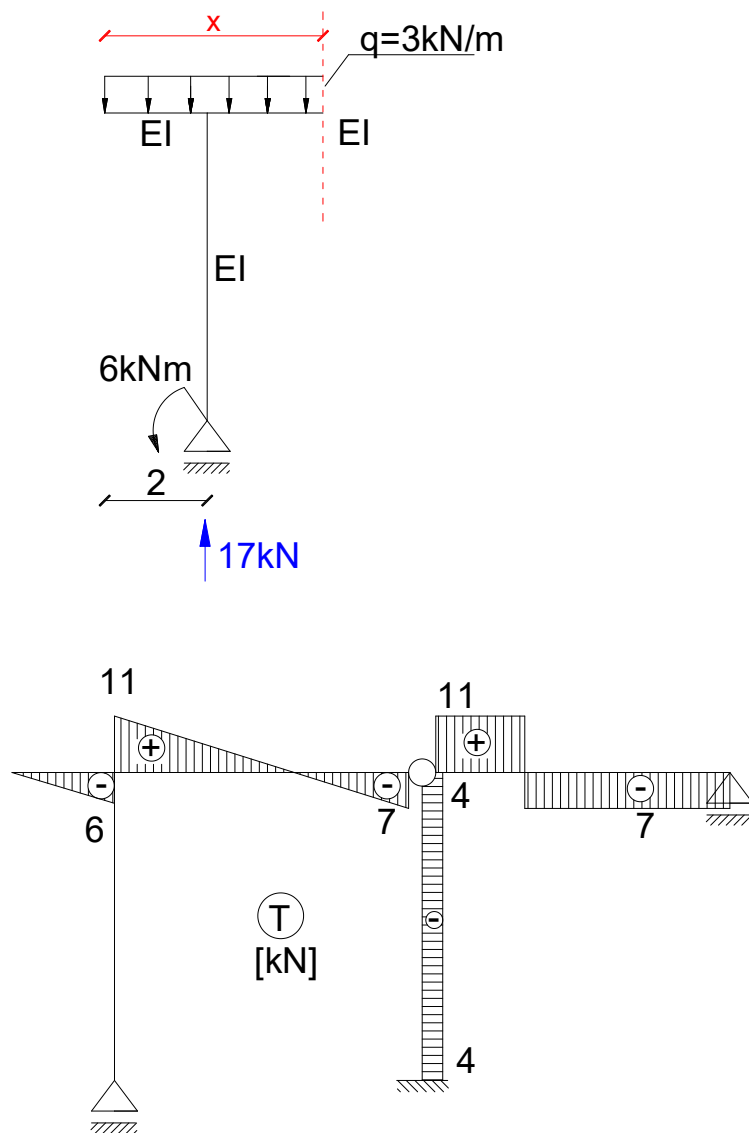


Wyznaczenie ekstremum:

$$T[x] = 17 - 3x = 0 \rightarrow x = \frac{17}{3}$$

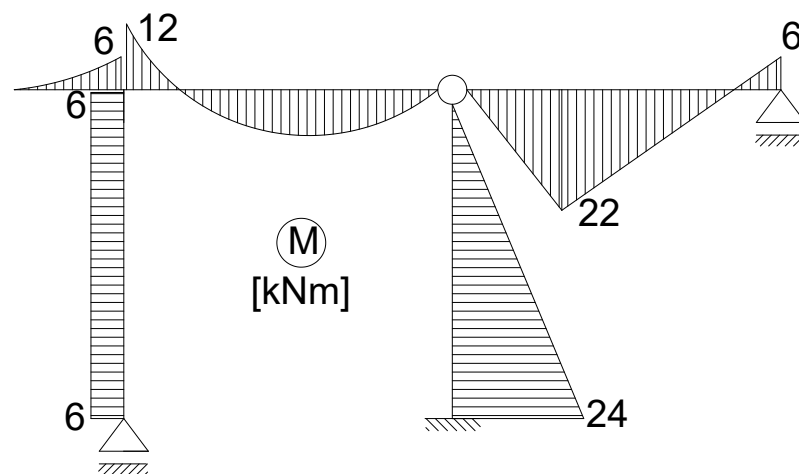


Wykresy sił wewnętrznych:

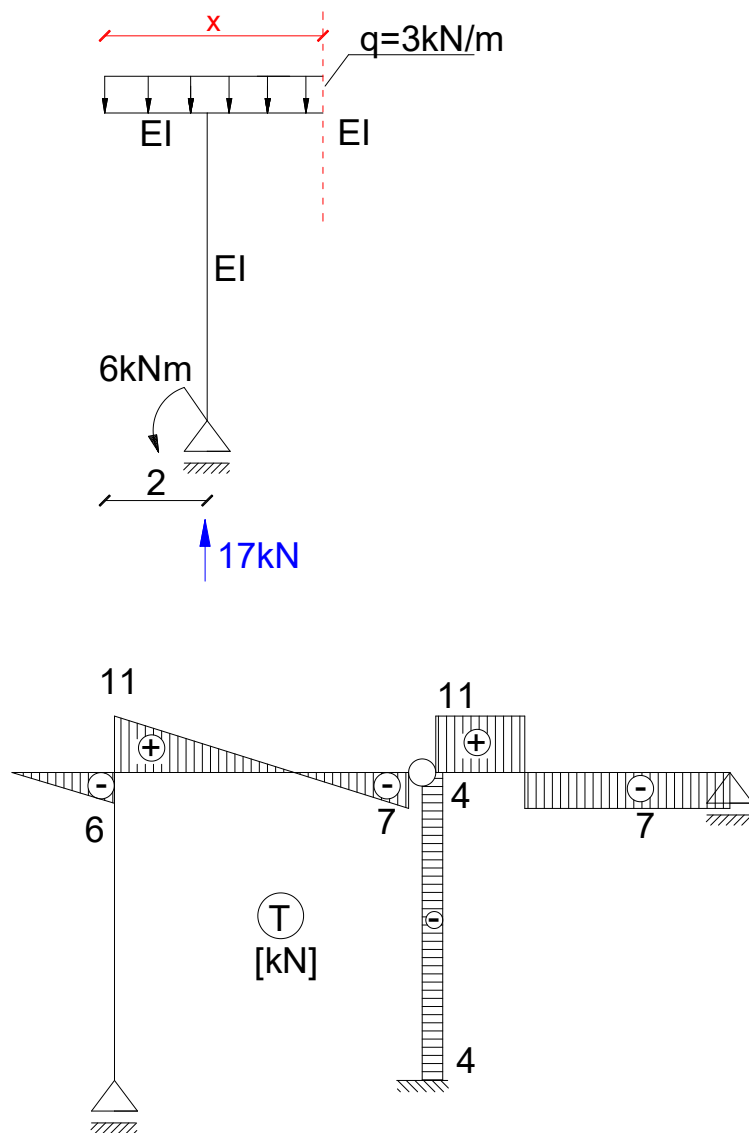


Wyznaczenie ekstremum:

$$T[x] = 17 - 3x = 0 \rightarrow x = \frac{17}{3} = 5,67 \text{ m}$$



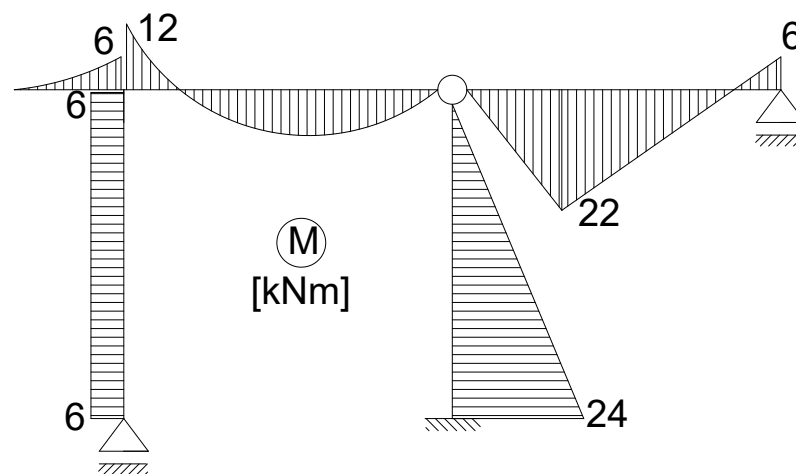
Wykresy sił wewnętrznych:



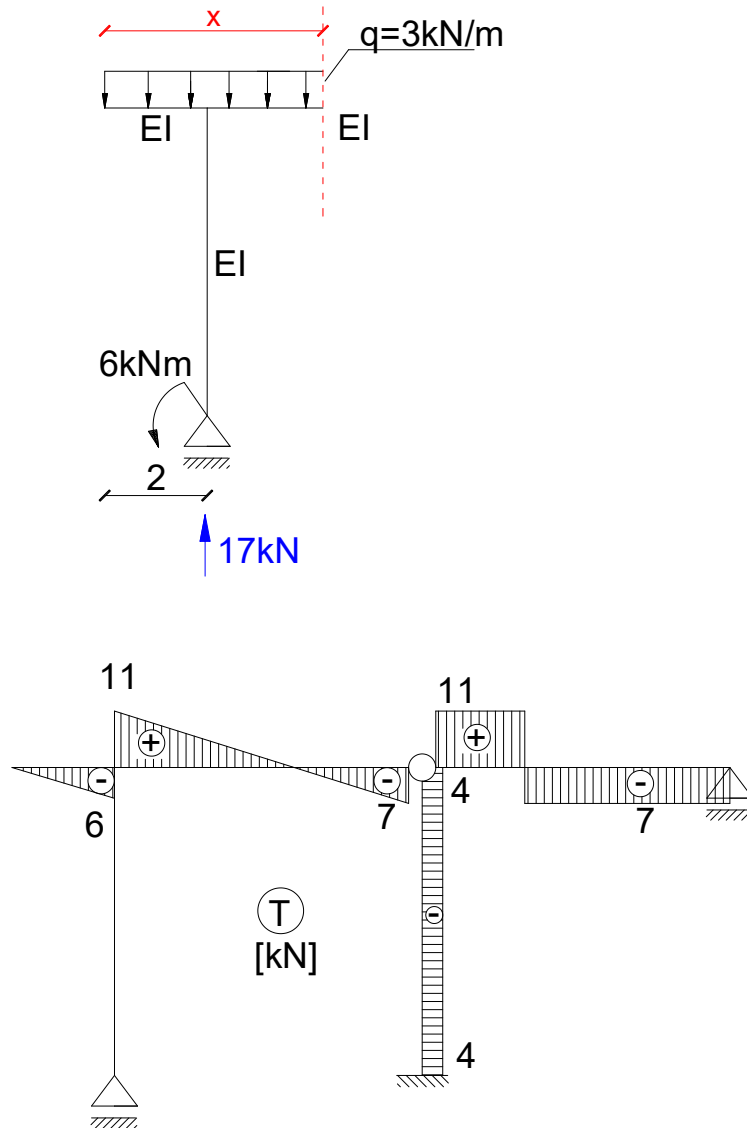
Wyznaczenie ekstremum:

$$T[x] = 17 - 3x = 0 \rightarrow x = \frac{17}{3} = 5,67m$$

$$M[x = 5,67] =$$



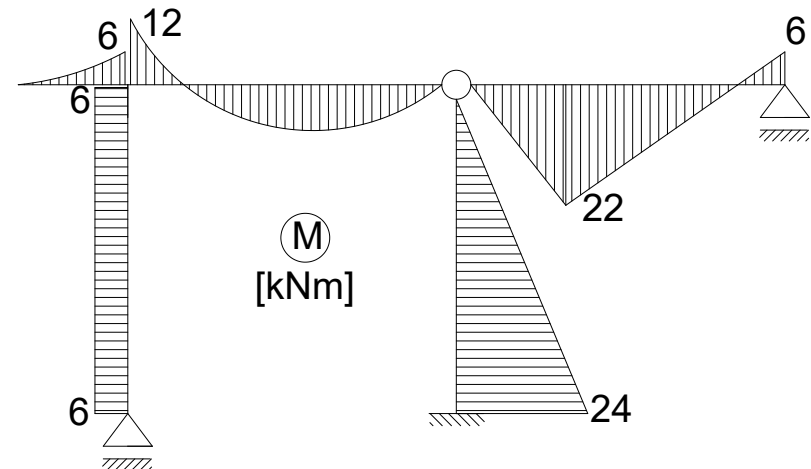
Wykresy sił wewnętrznych:



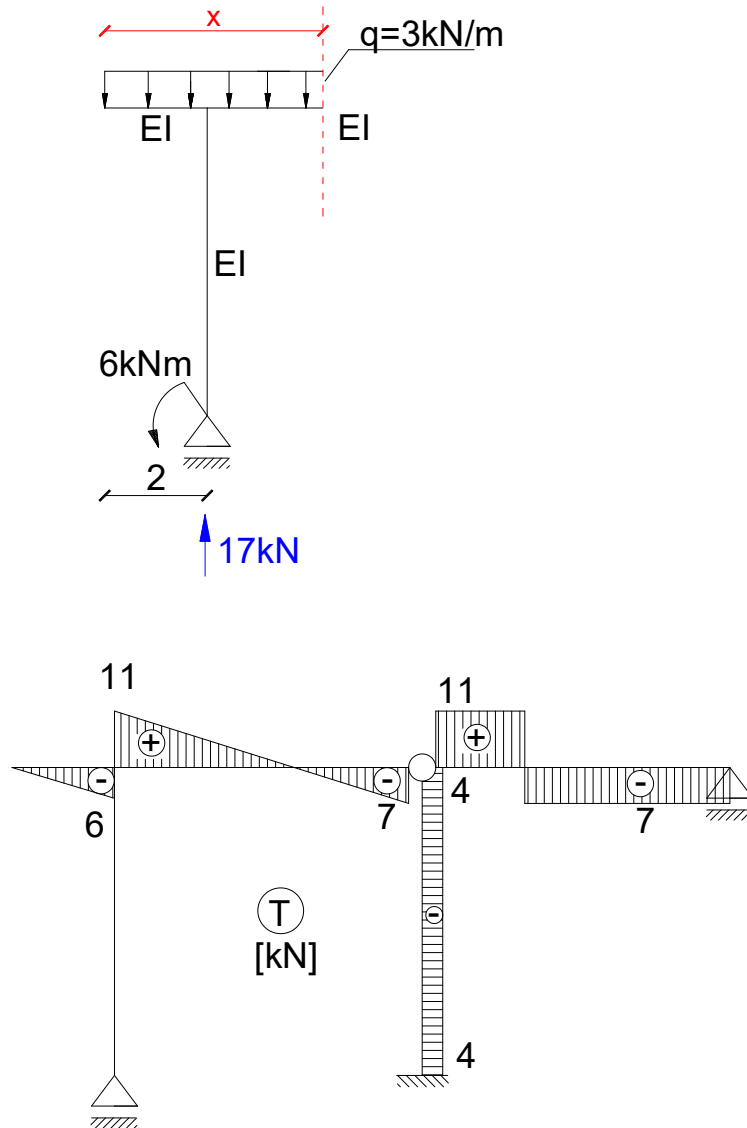
Wyznaczenie ekstremum:

$$T[x] = 17 - 3x = 0 \rightarrow x = \frac{17}{3} = 5,67 \text{ m}$$

$$M[x = 5,67] = -6 + 17 \cdot (5,67 - 2) - 3 \cdot \frac{5,67^2}{2}$$



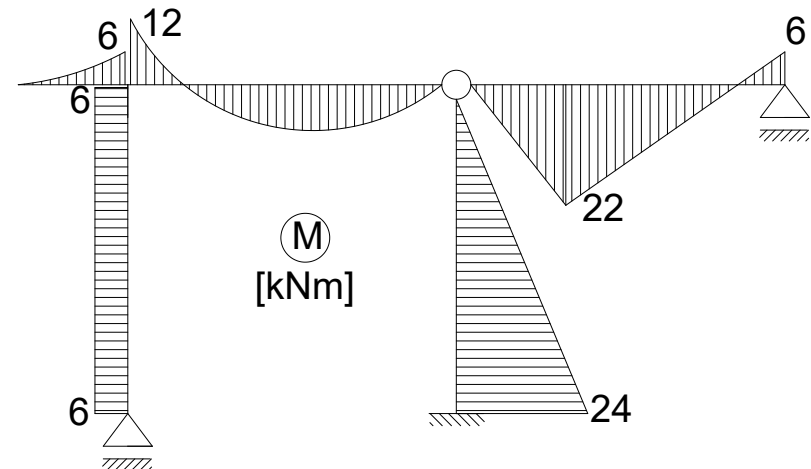
Wykresy sił wewnętrznych:



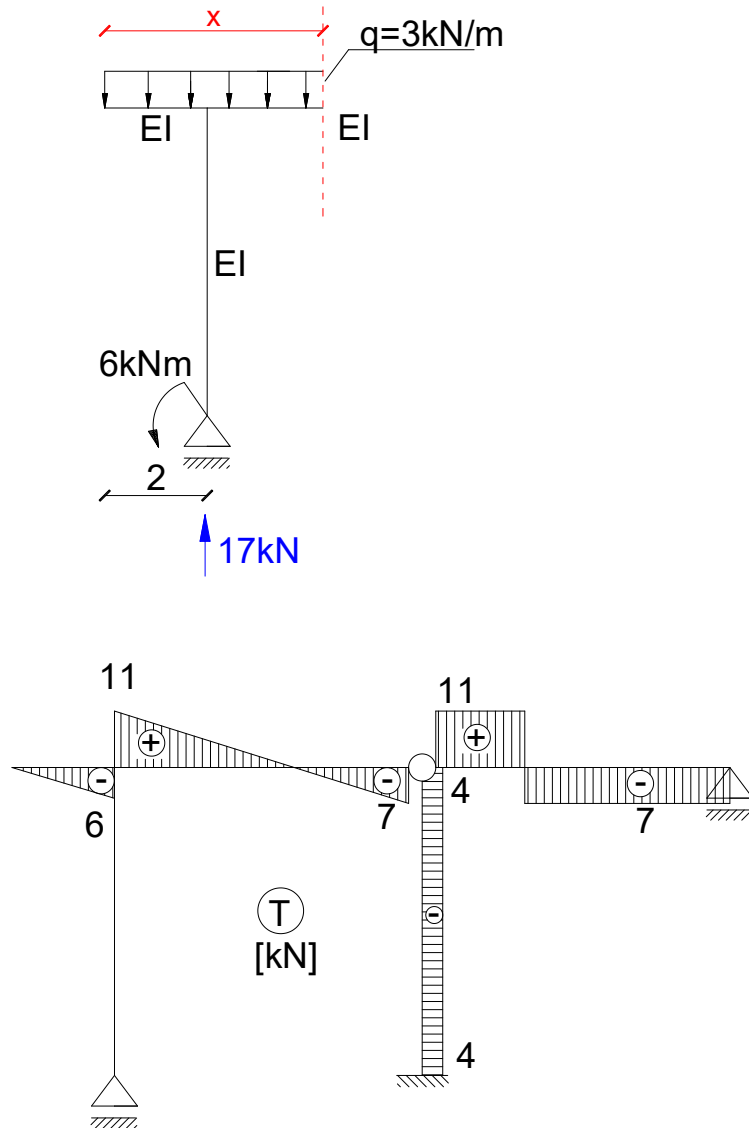
Wyznaczenie ekstremum:

$$T[x] = 17 - 3x = 0 \rightarrow x = \frac{17}{3} = 5,67 \text{ m}$$

$$M[x = 5,67] = -6 + 17 \cdot (5,67 - 2) - 3 \cdot \frac{5,67^2}{2} = 8,17 \text{ kNm}$$



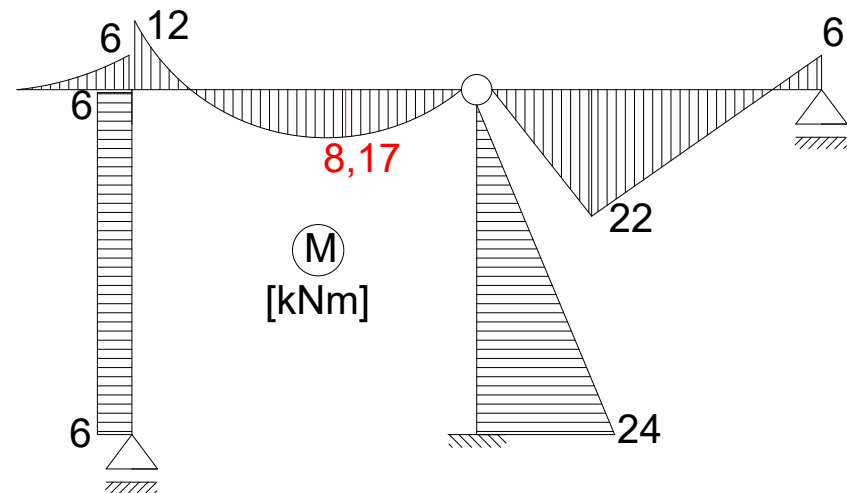
Wykresy sił wewnętrznych:



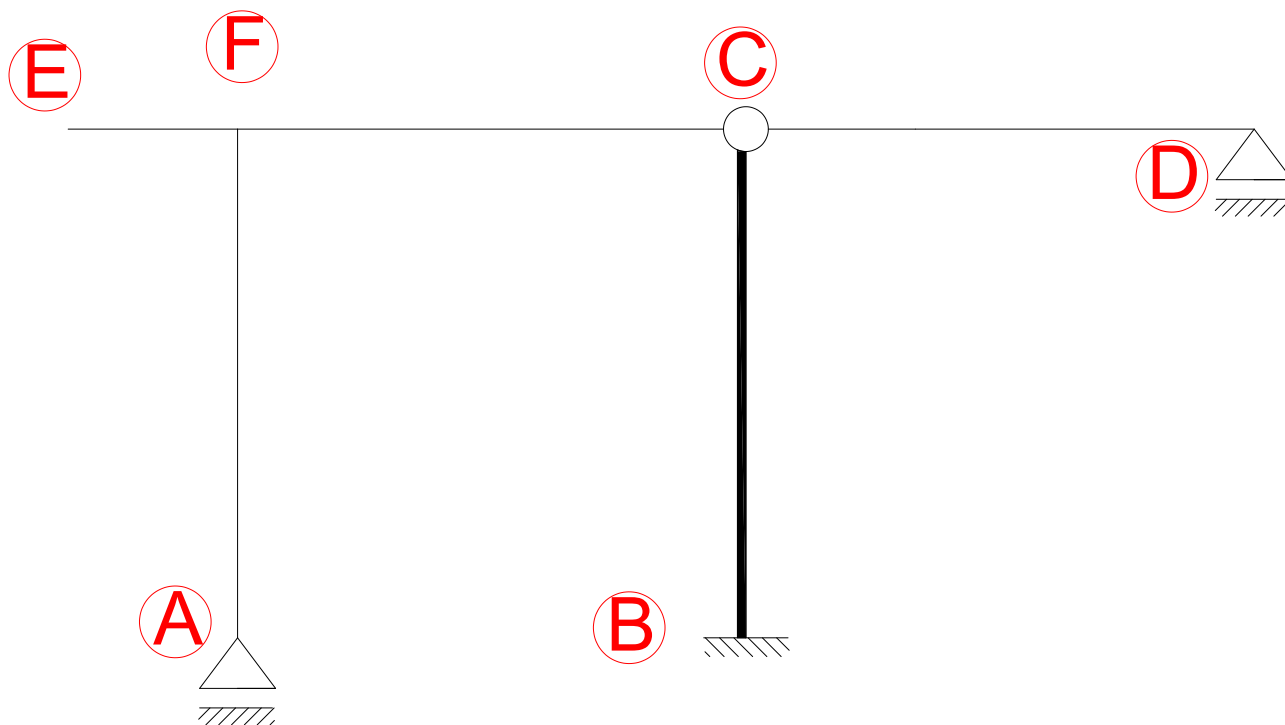
Wyznaczenie ekstremum:

$$T[x] = 17 - 3x = 0 \rightarrow x = \frac{17}{3} = 5,67 \text{ m}$$

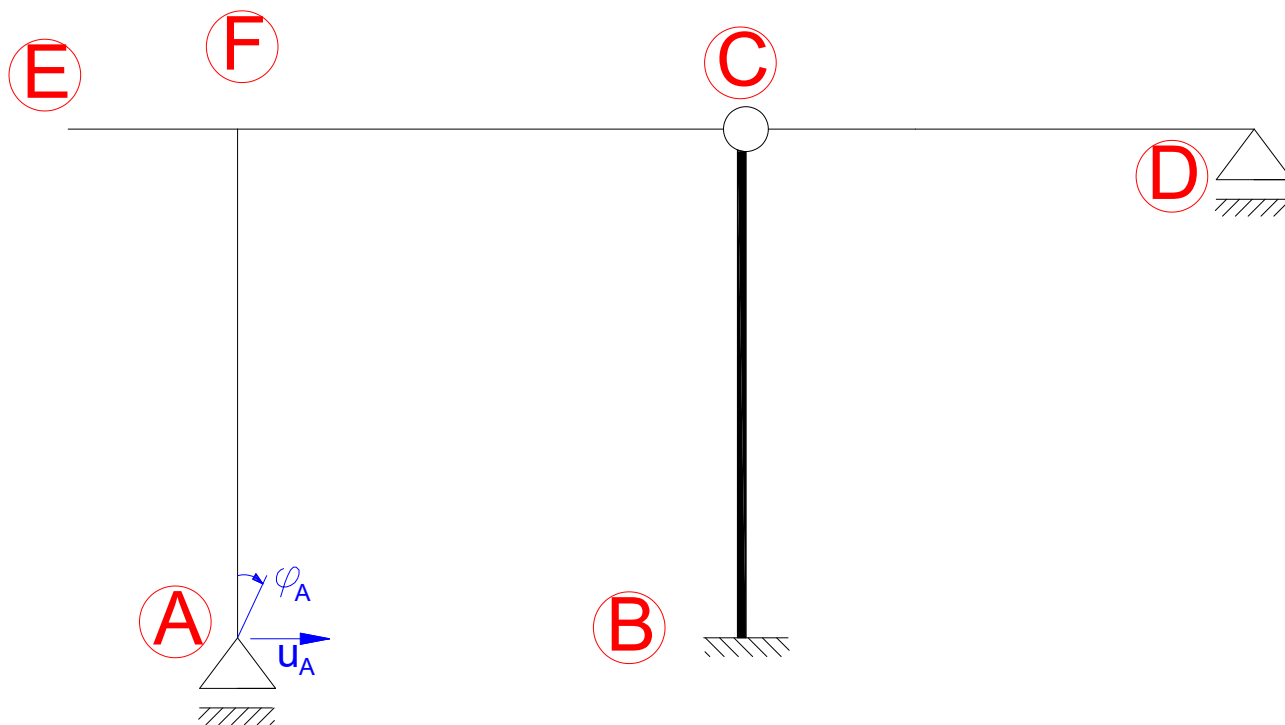
$$M[x = 5,67] = -6 + 17 \cdot (5,67 - 2) - 3 \cdot \frac{5,67^2}{2} = 8,17 \text{ kNm}$$



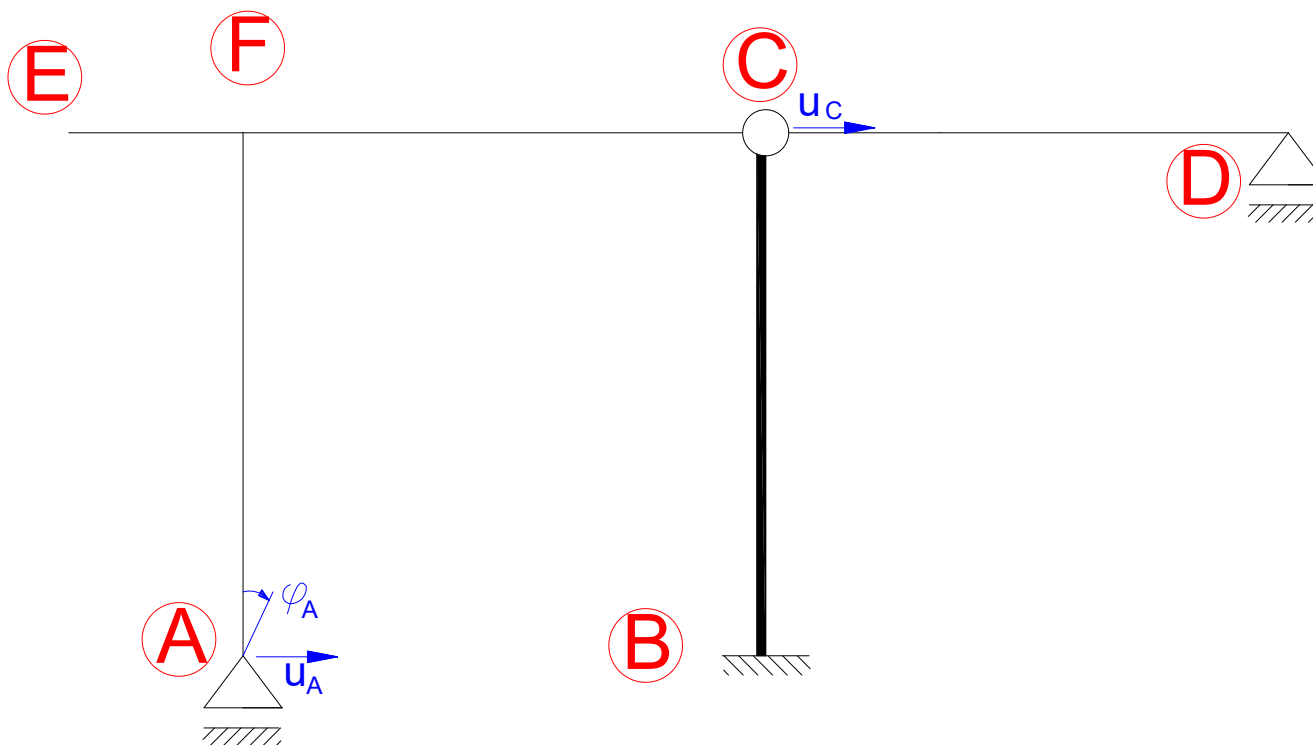
Obliczenia przemieszczeń z zasady prac wirtualnych:



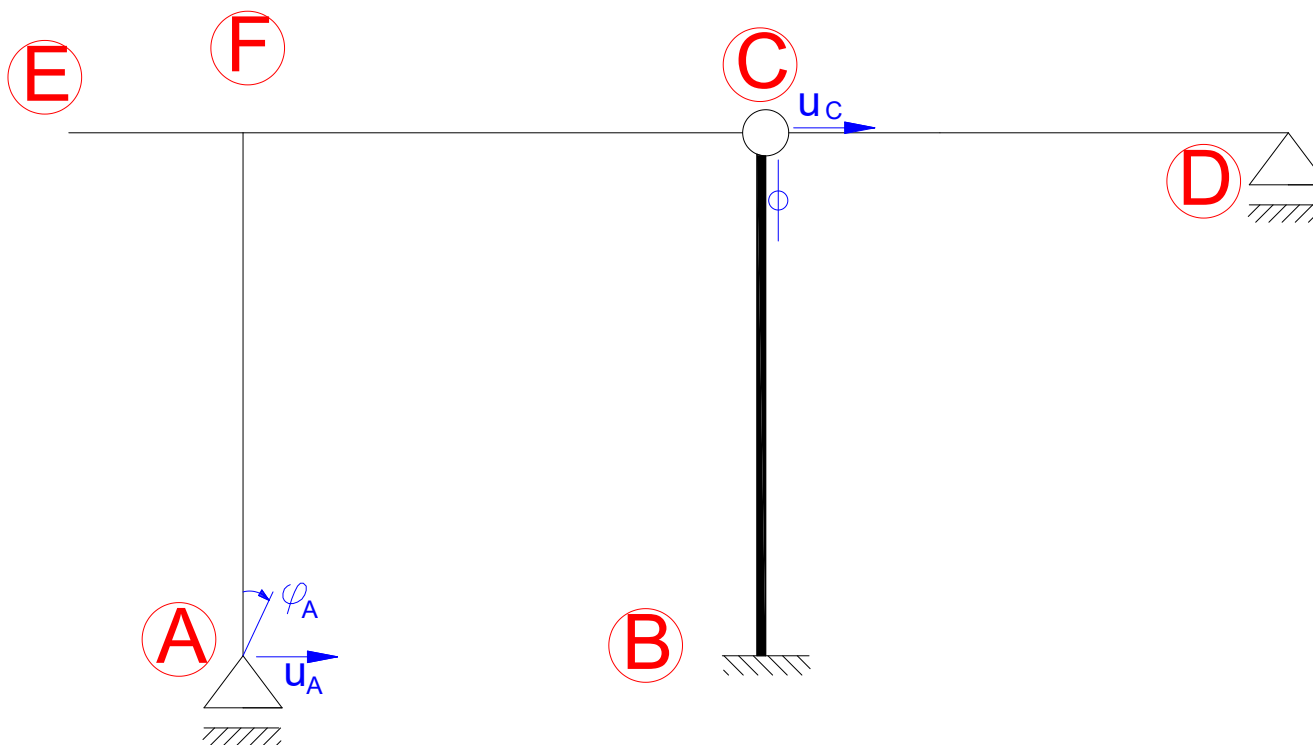
Obliczenia przemieszczeń z zasady prac wirtualnych:



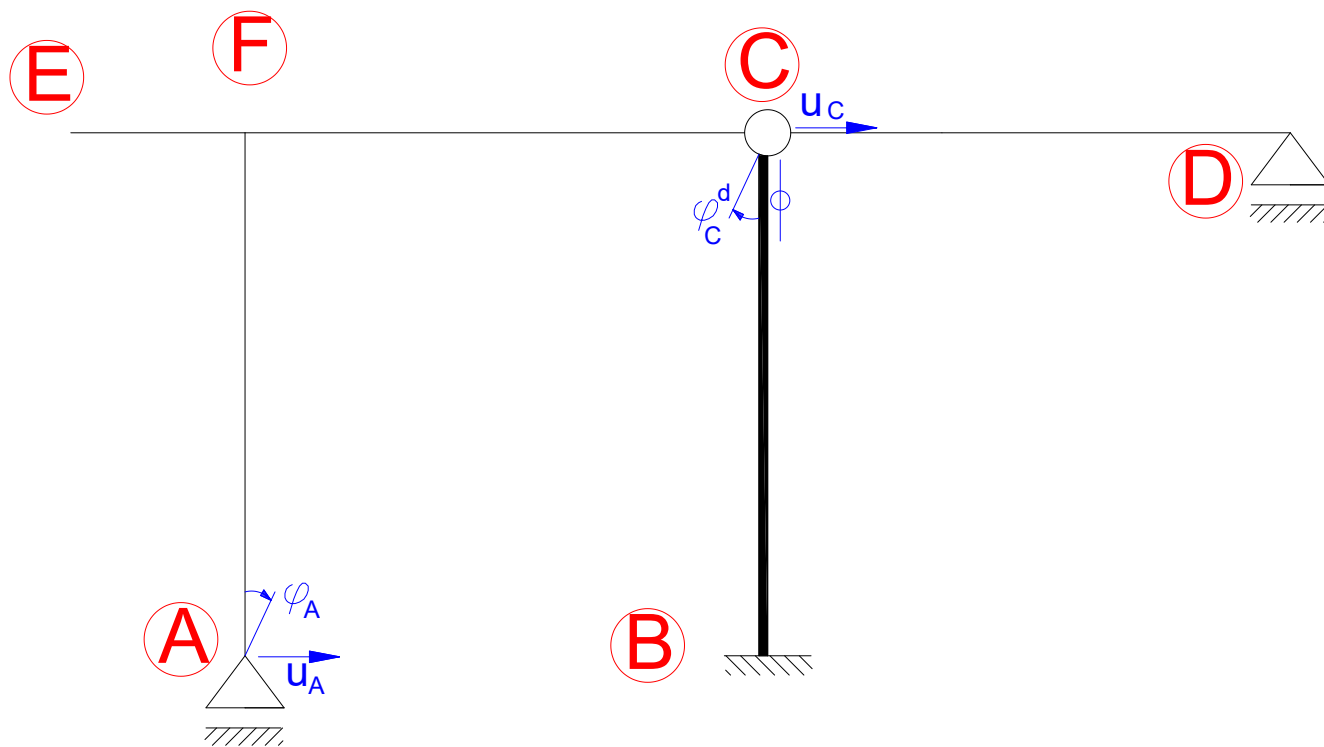
Obliczenia przemieszczeń z zasady prac wirtualnych:



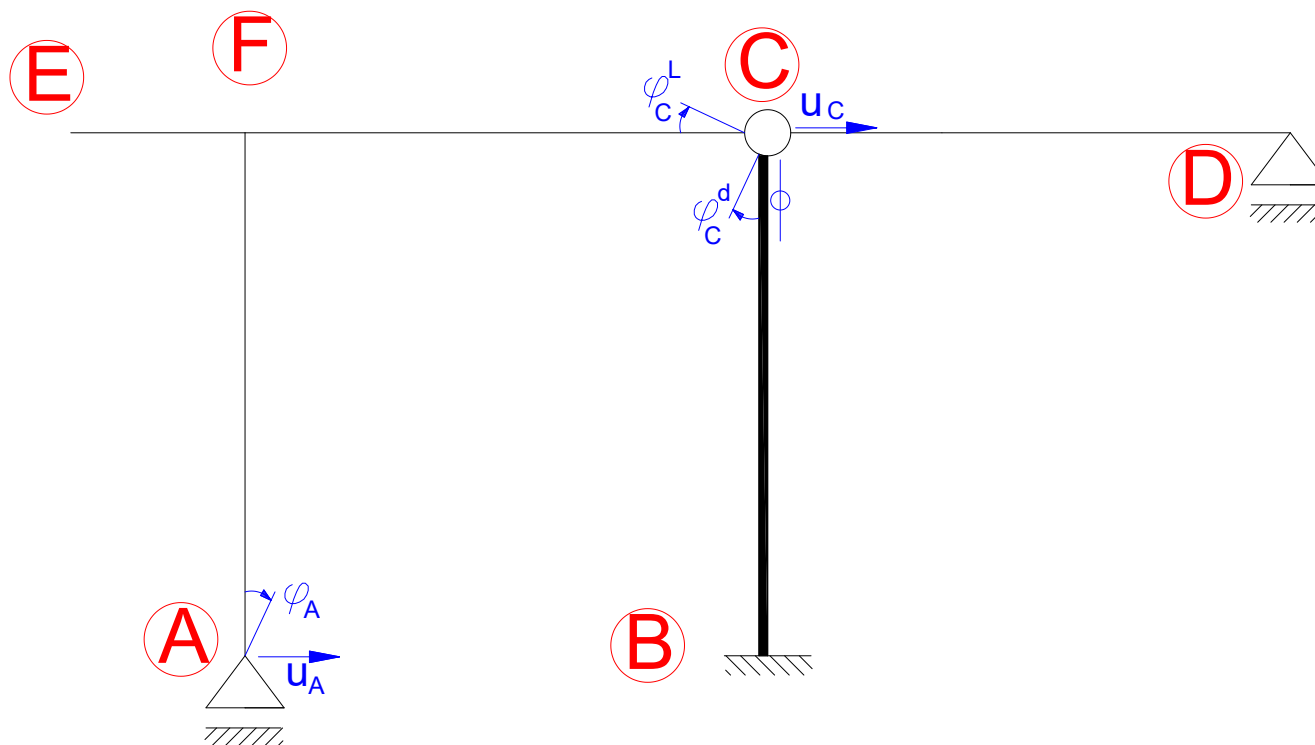
Obliczenia przemieszczeń z zasady prac wirtualnych:



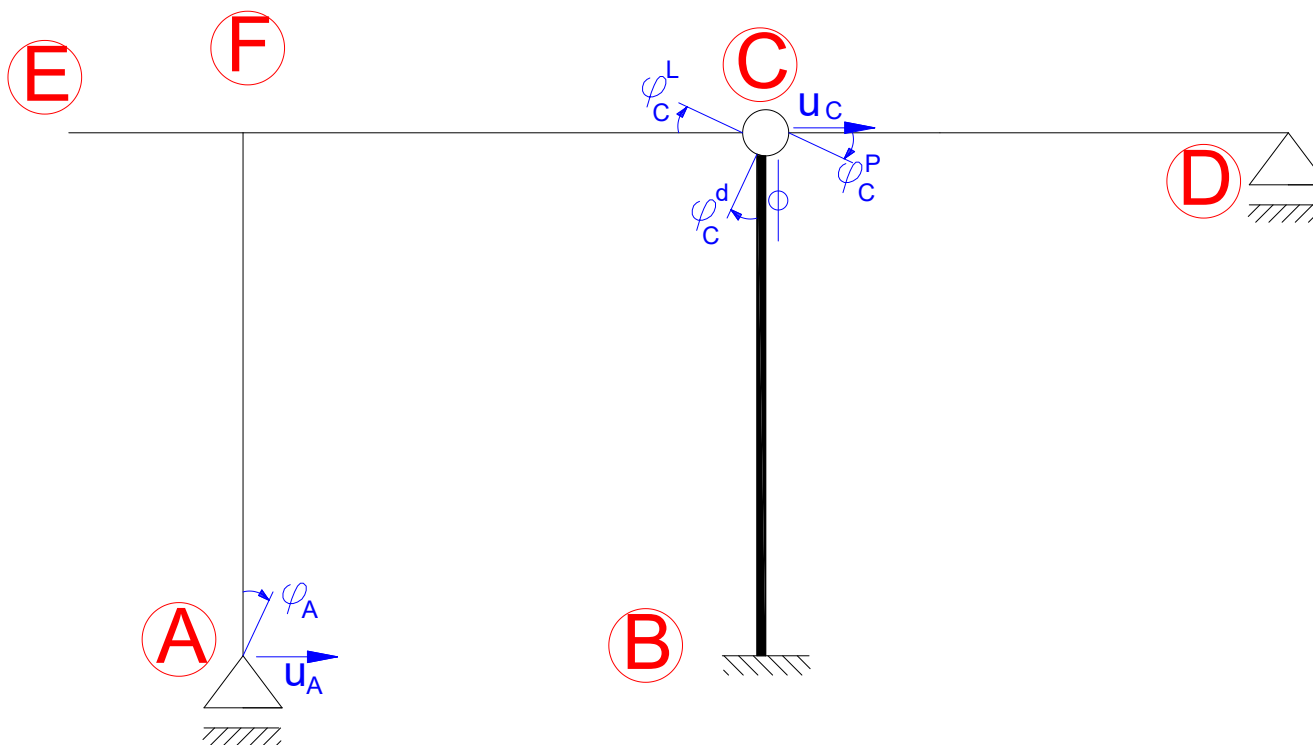
Obliczenia przemieszczeń z zasady prac wirtualnych:



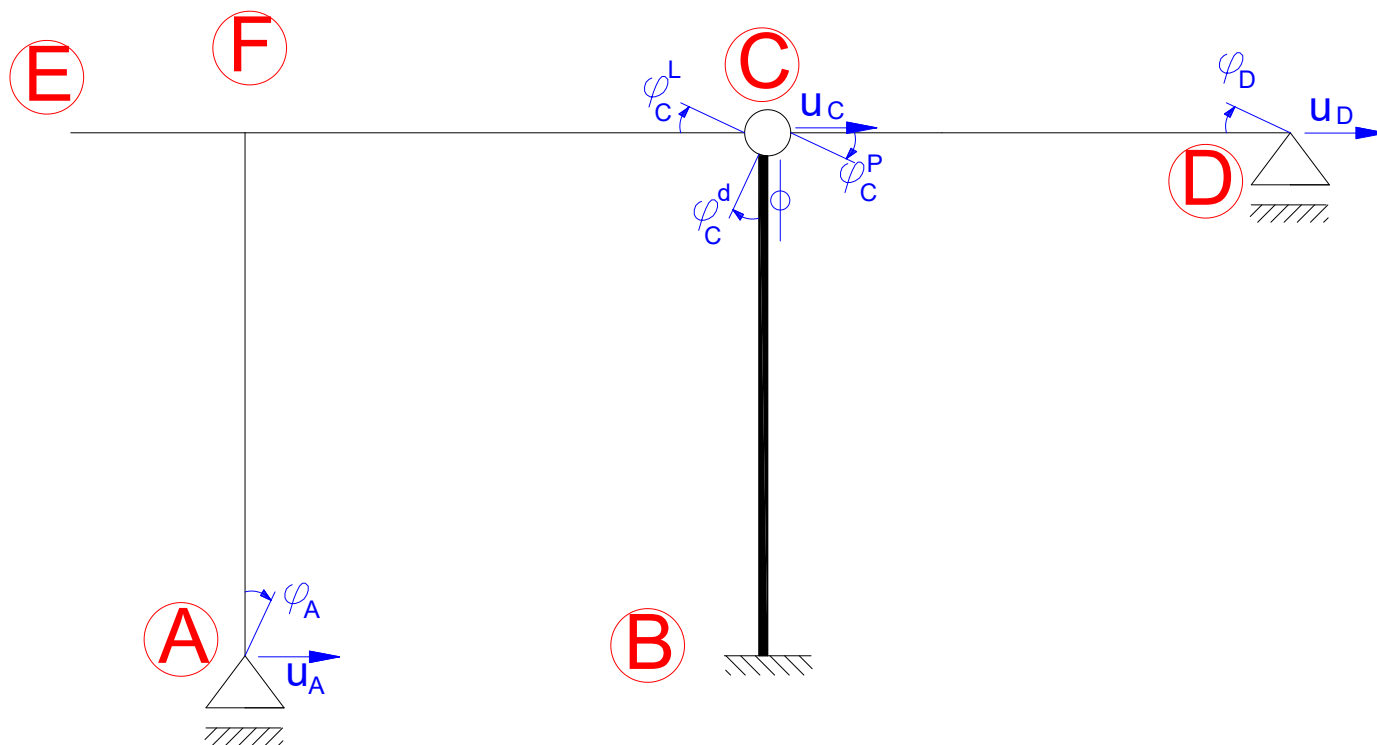
Obliczenia przemieszczeń z zasady prac wirtualnych:



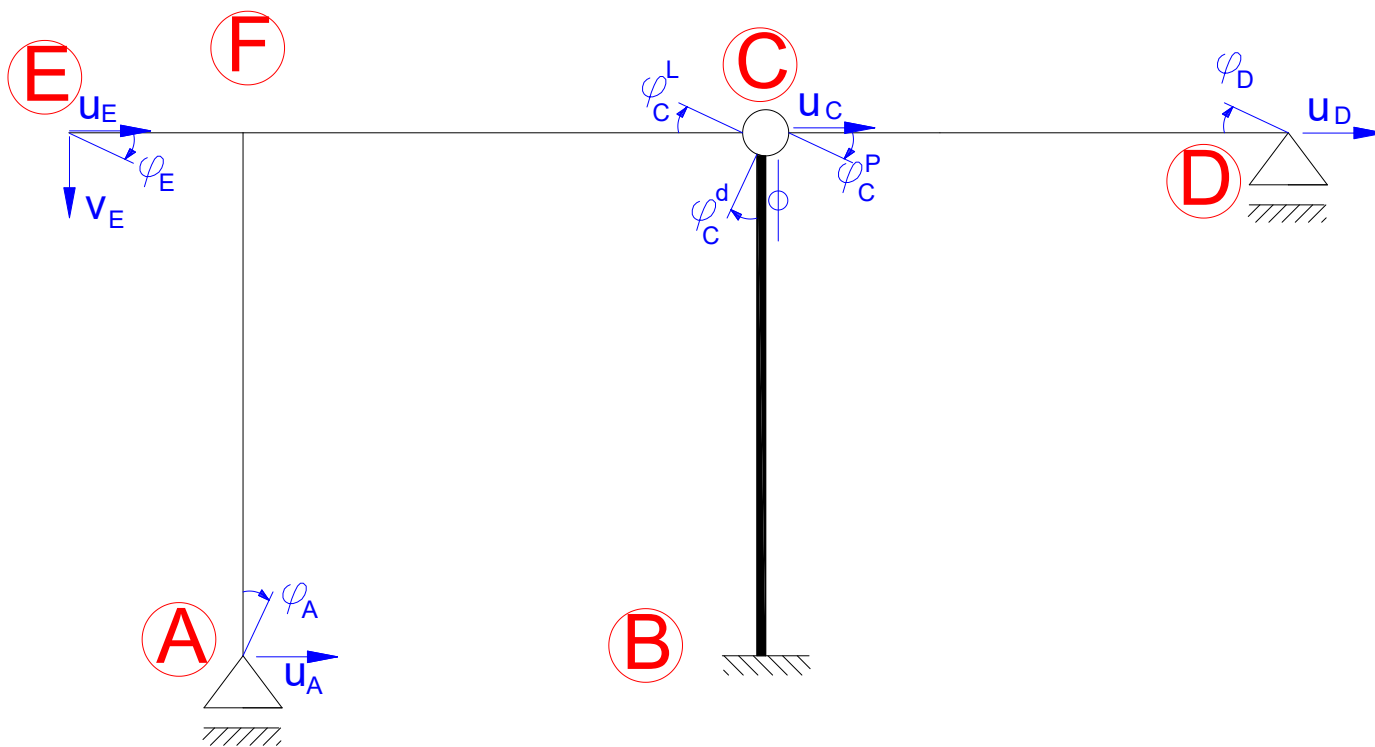
Obliczenia przemieszczeń z zasady prac wirtualnych:



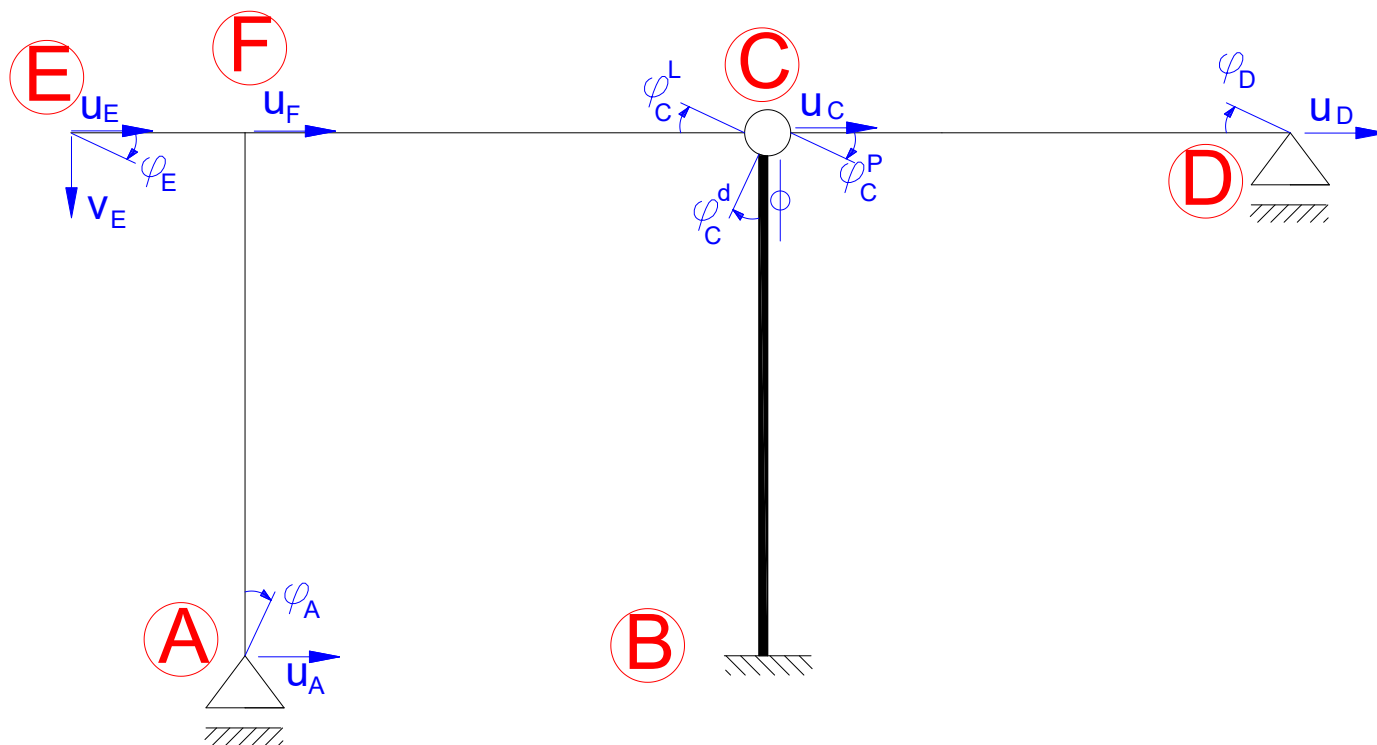
Obliczenia przemieszczeń z zasady prac wirtualnych:



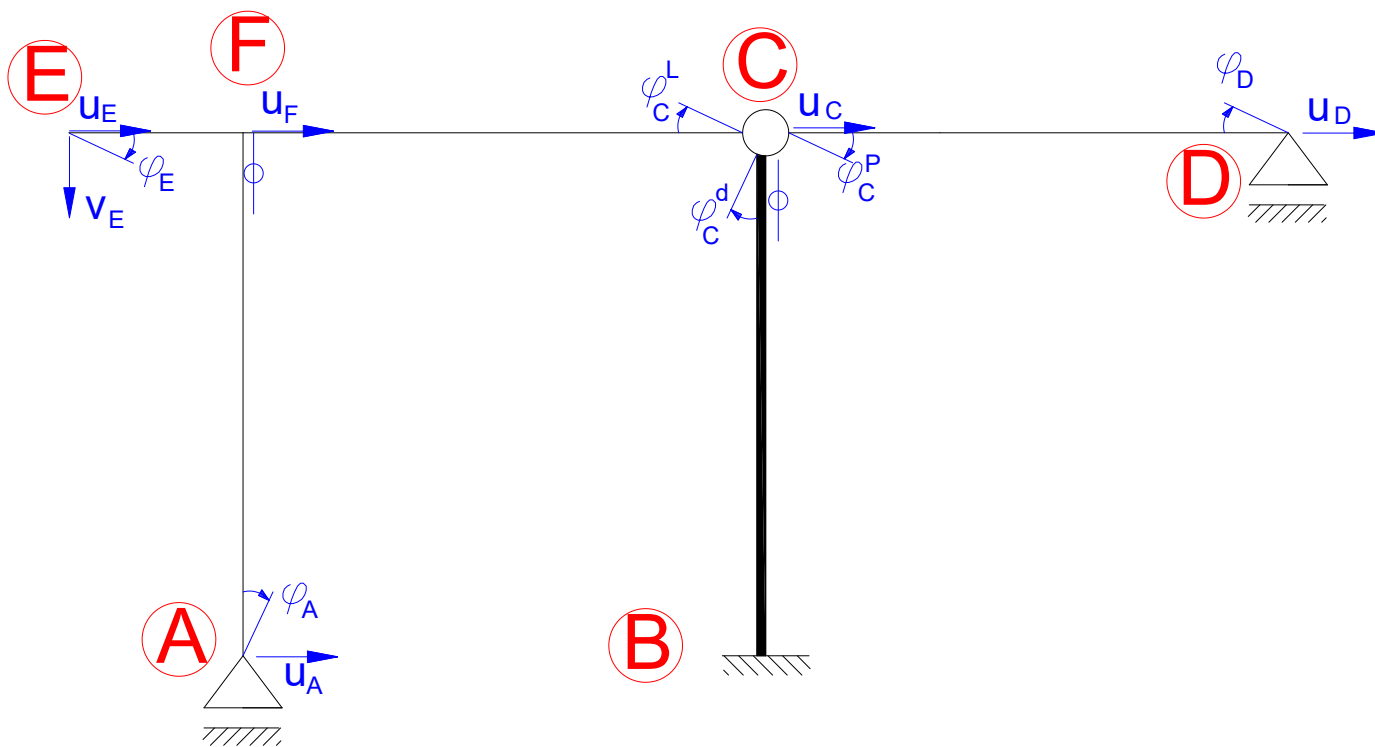
Obliczenia przemieszczeń z zasady prac wirtualnych:



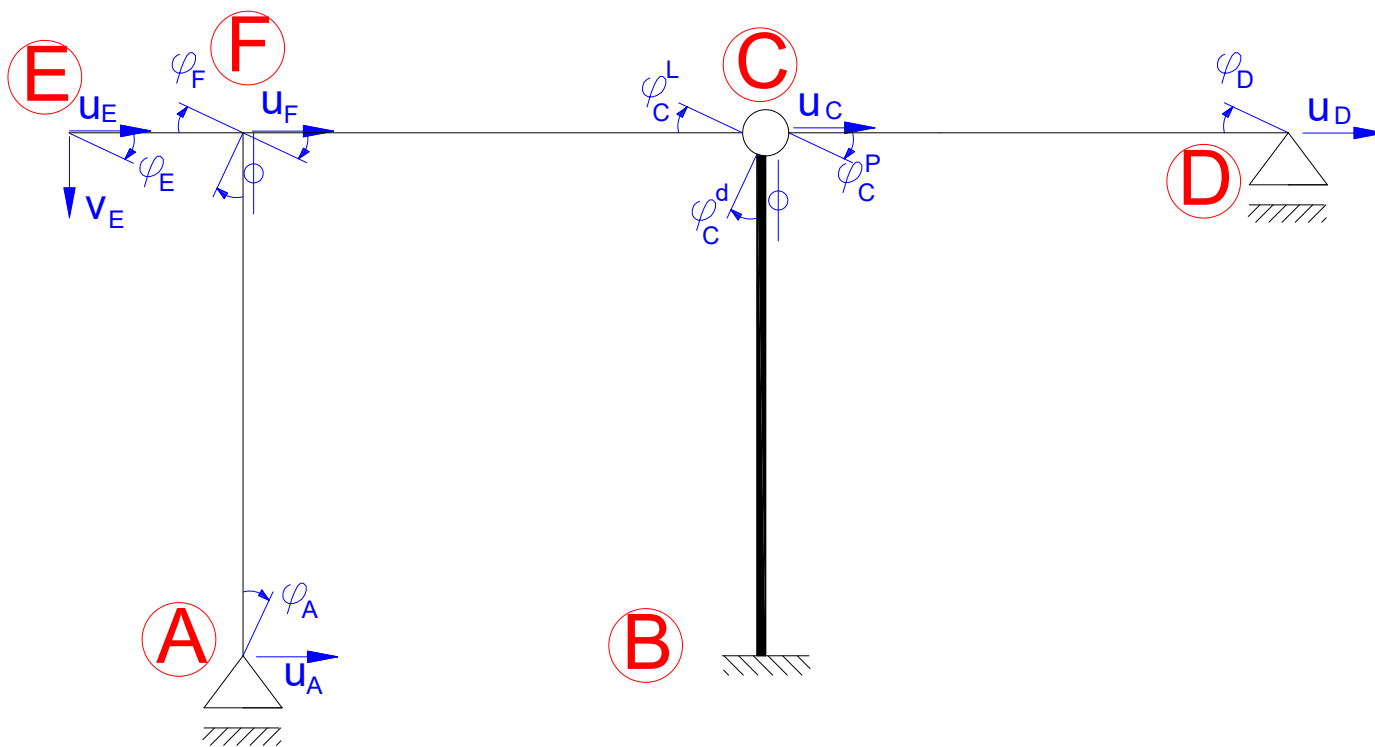
Obliczenia przemieszczeń z zasady prac wirtualnych:



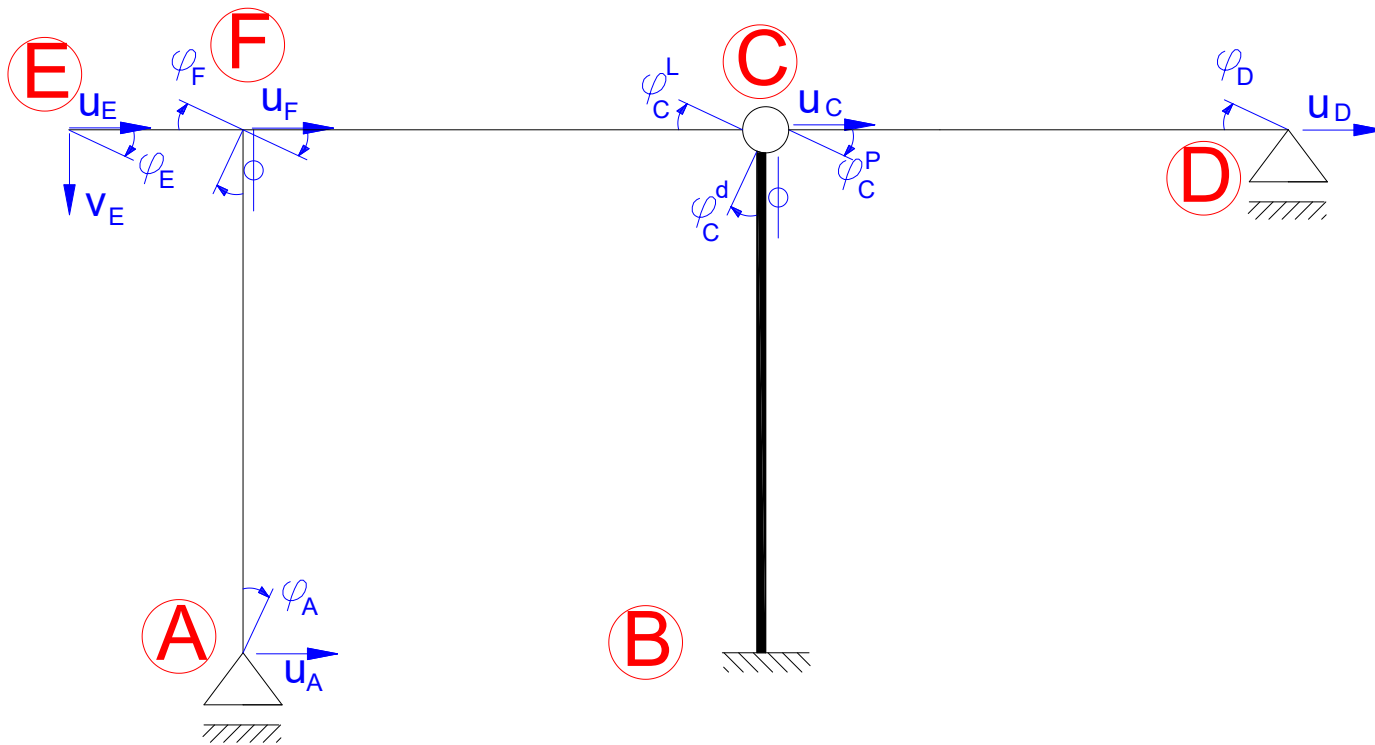
Obliczenia przemieszczeń z zasady prac wirtualnych:



Obliczenia przemieszczeń z zasady prac wirtualnych:

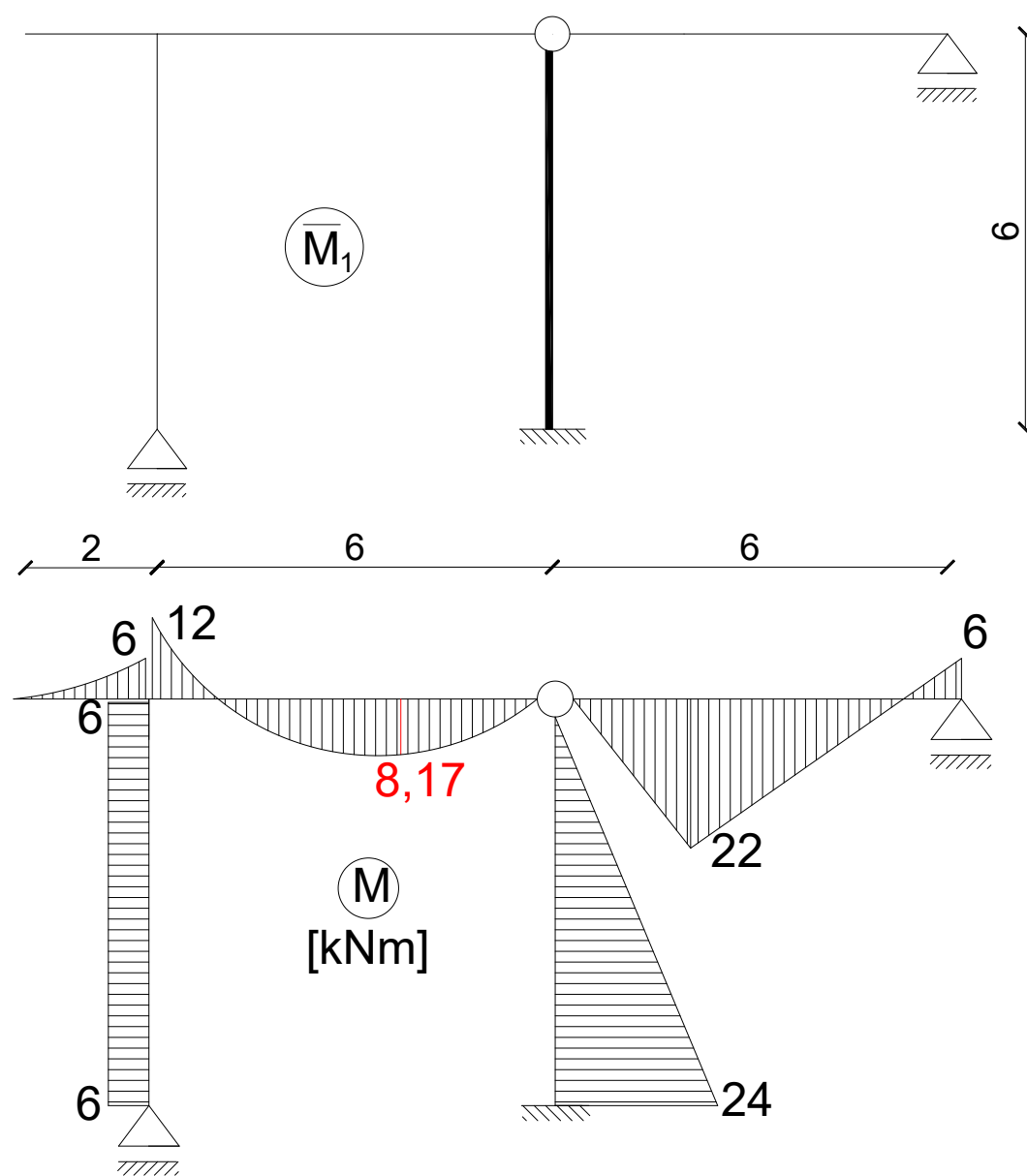


Obliczenia przemieszczeń z zasady prac wirtualnych:



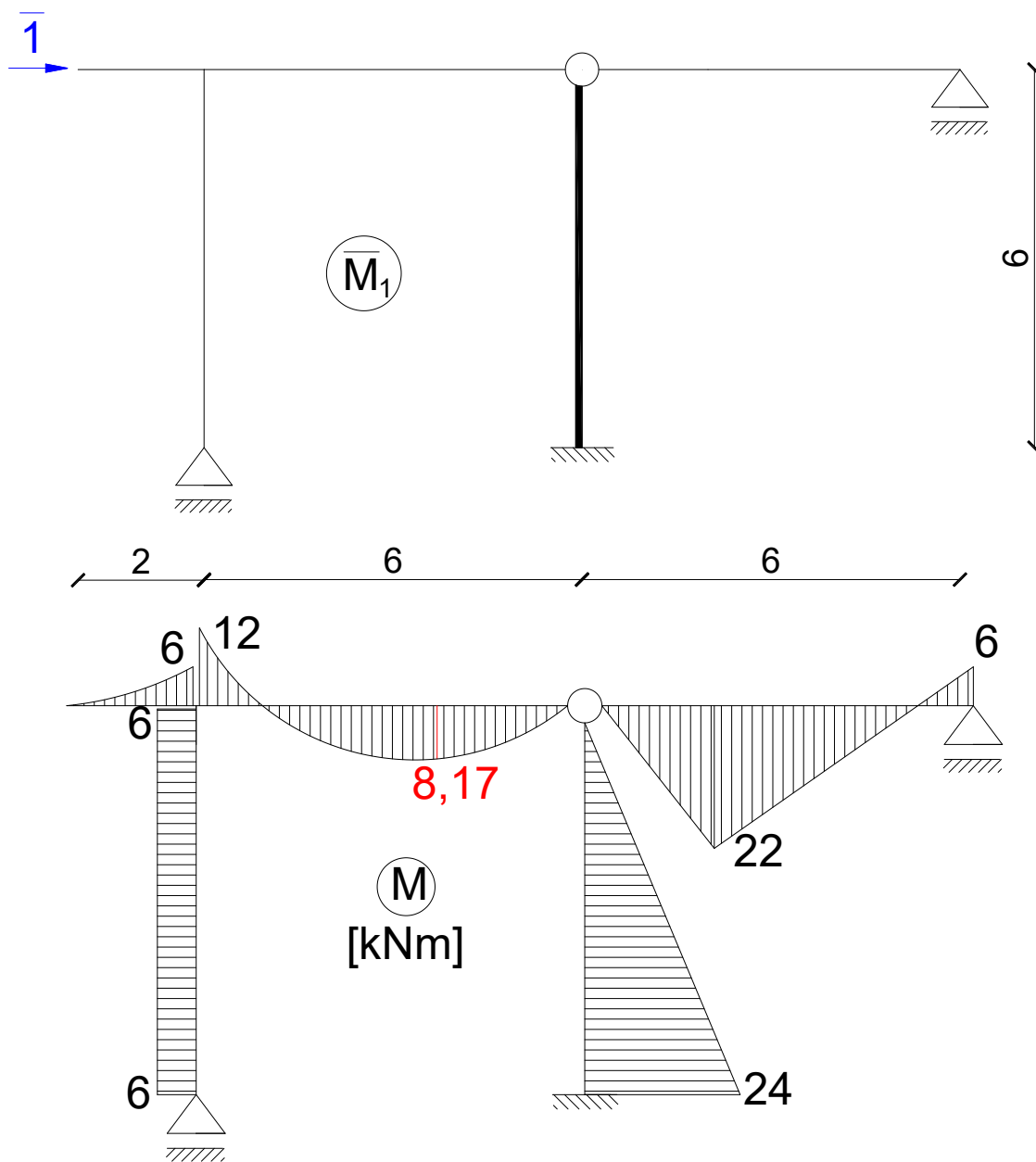
$$u_E = u_F = u_C = u_D$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



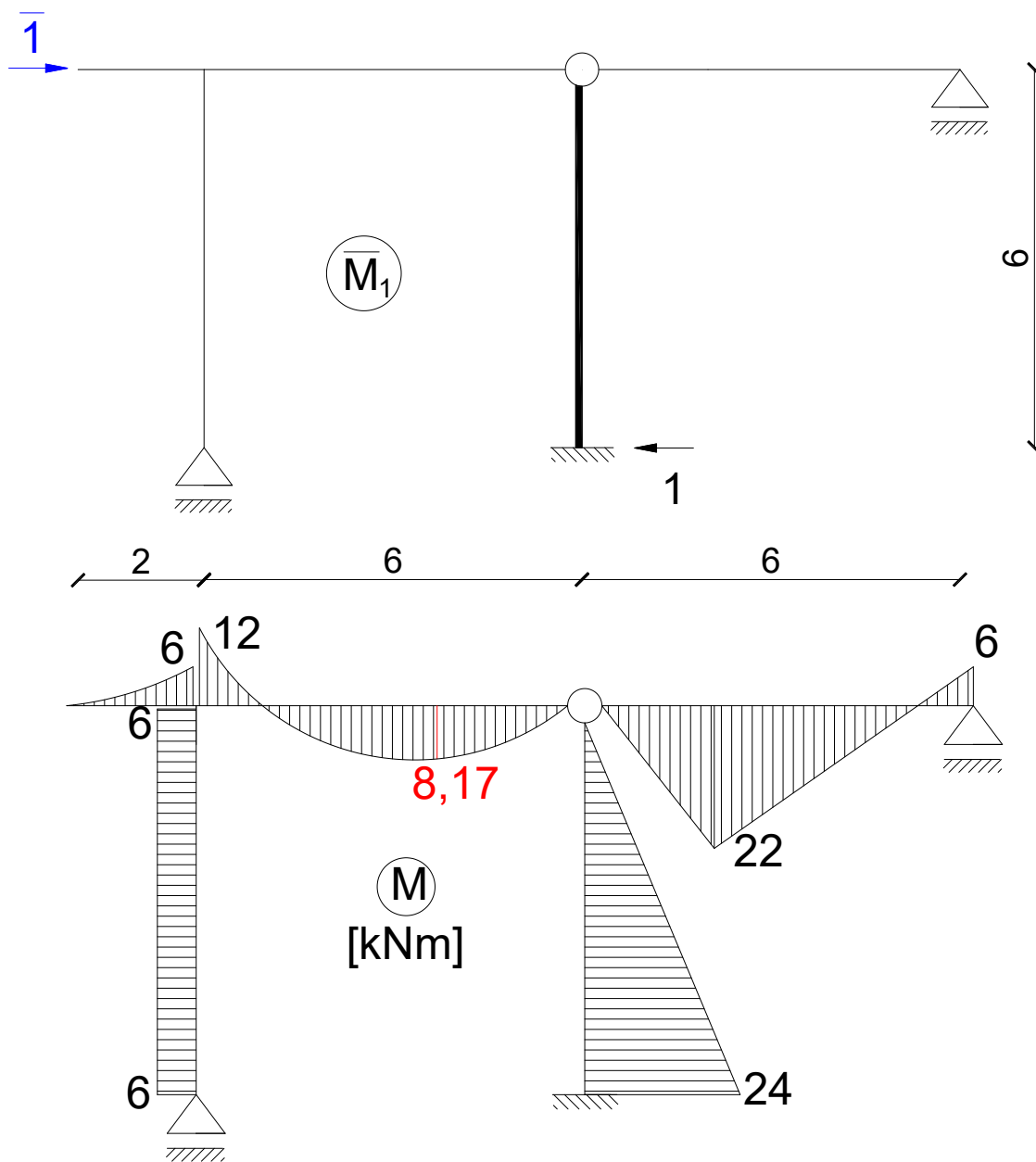
$$u_E = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



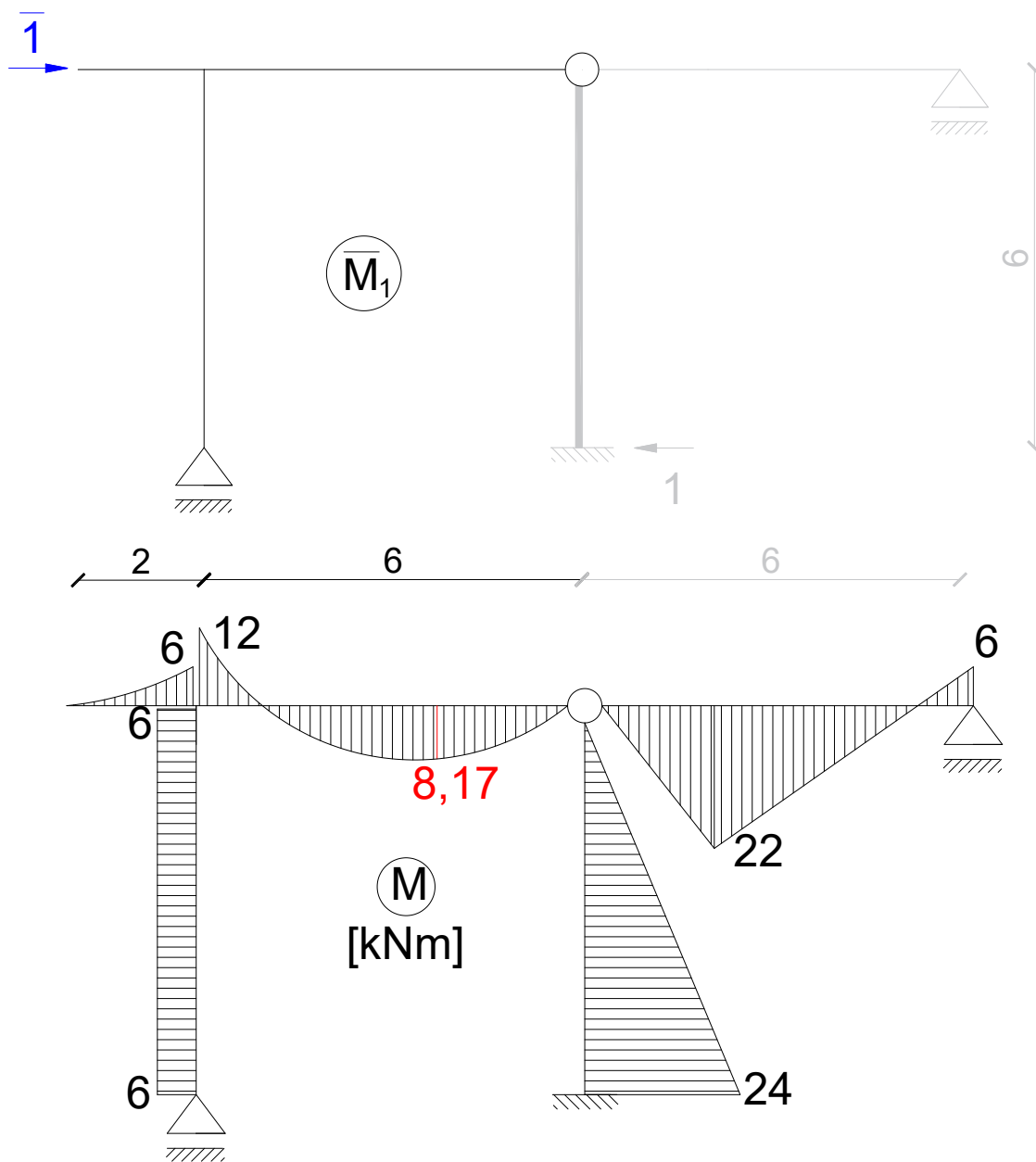
$$u_E = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



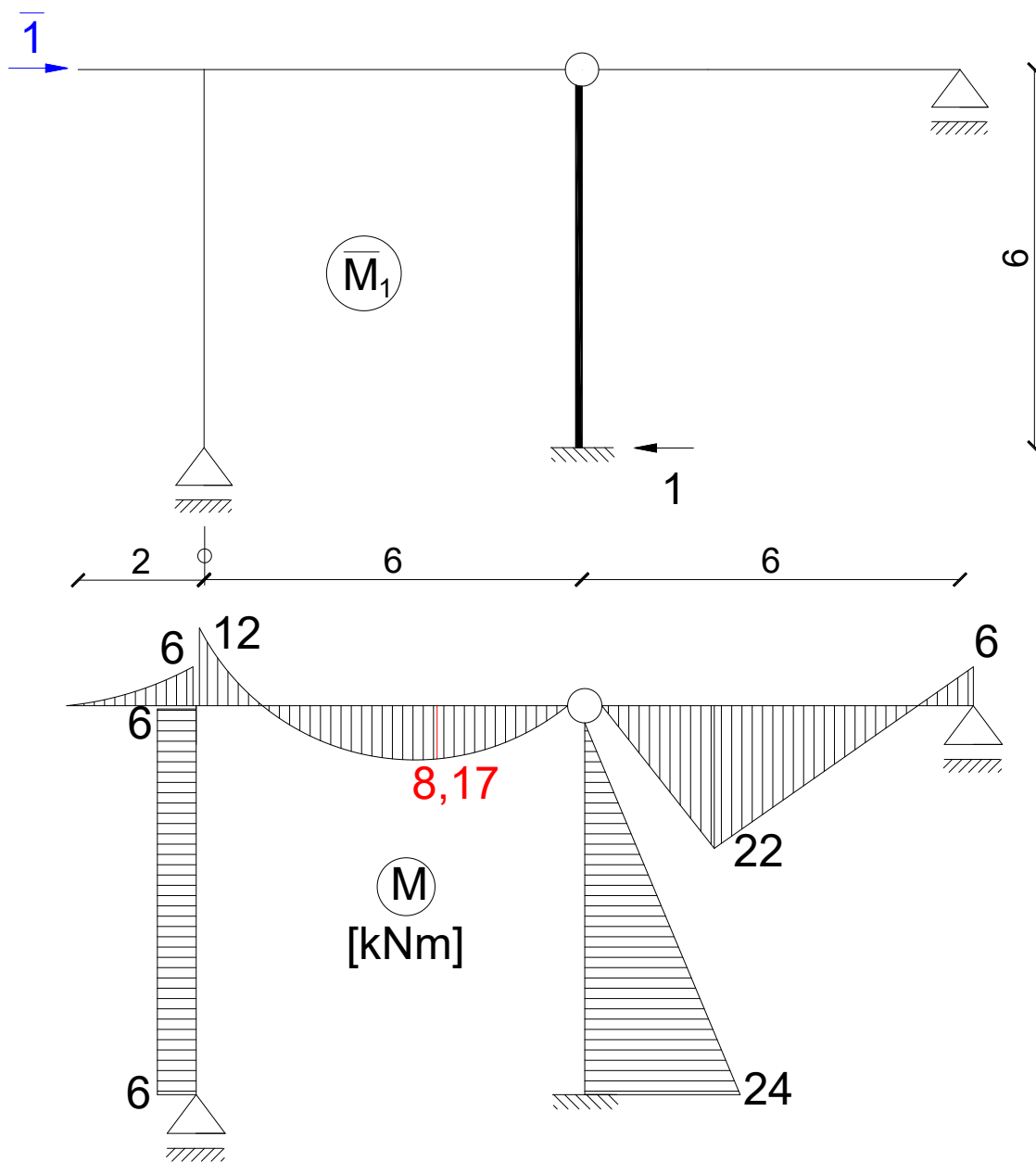
$$u_E = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



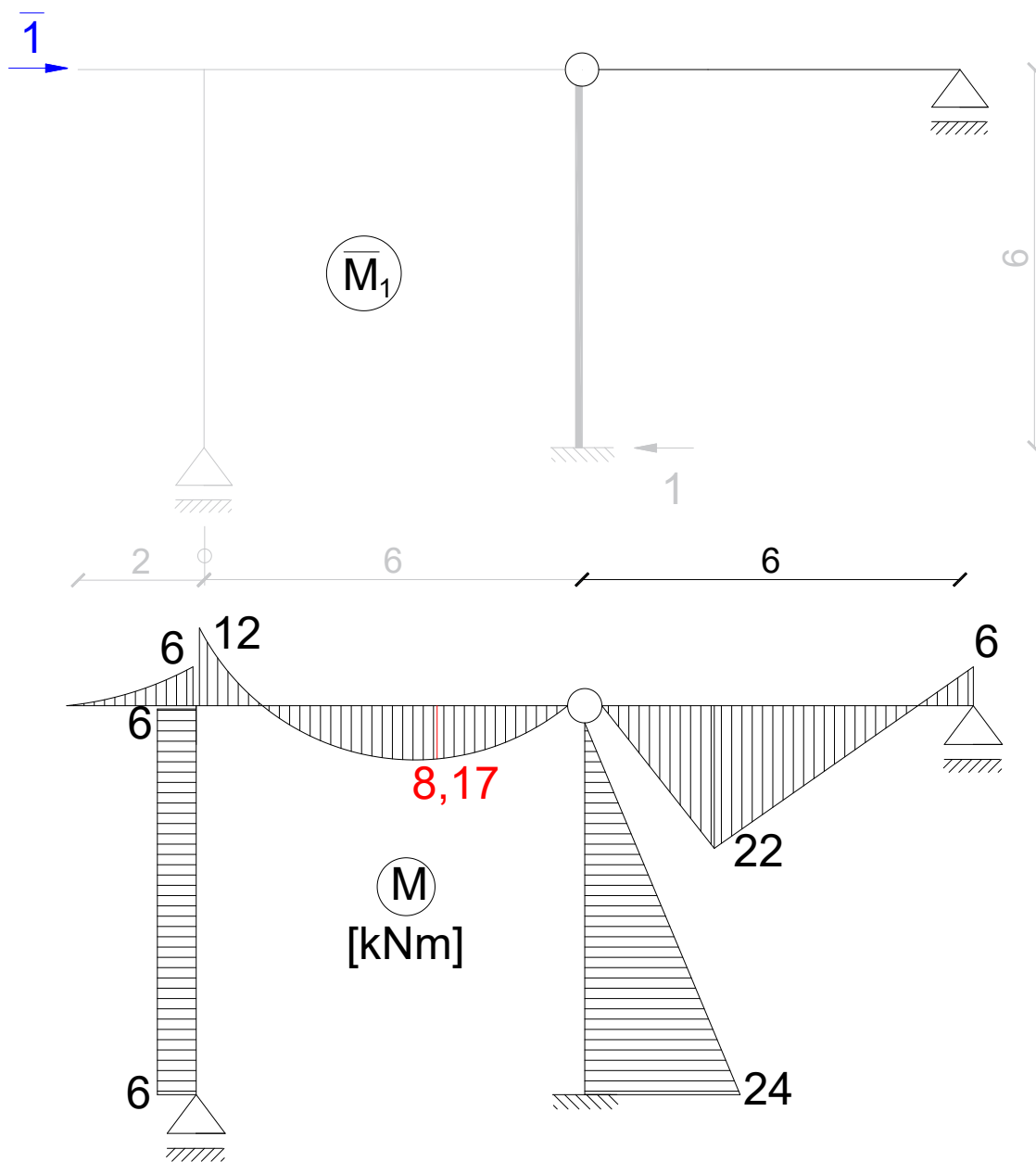
$$u_E = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



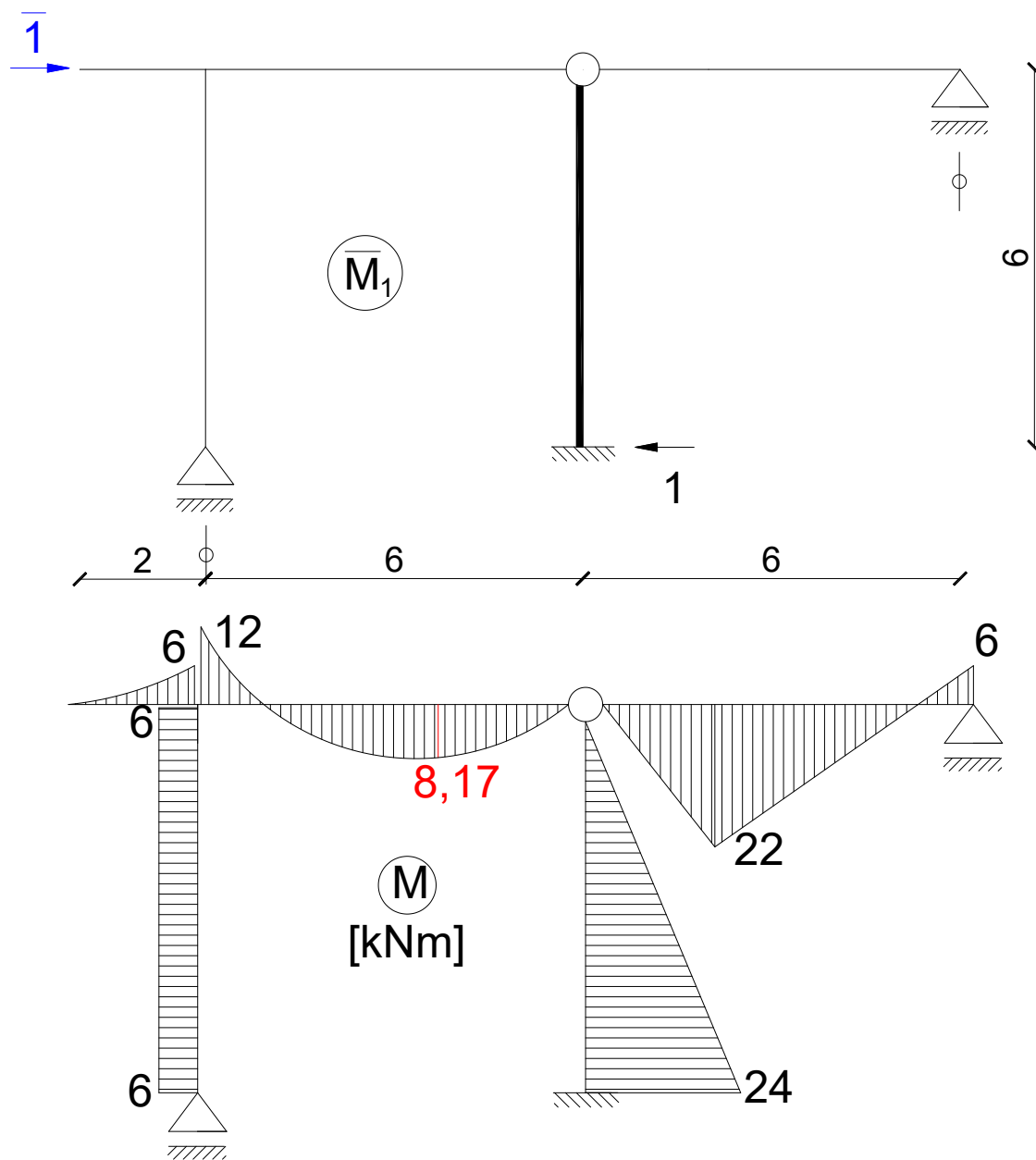
$$u_E = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



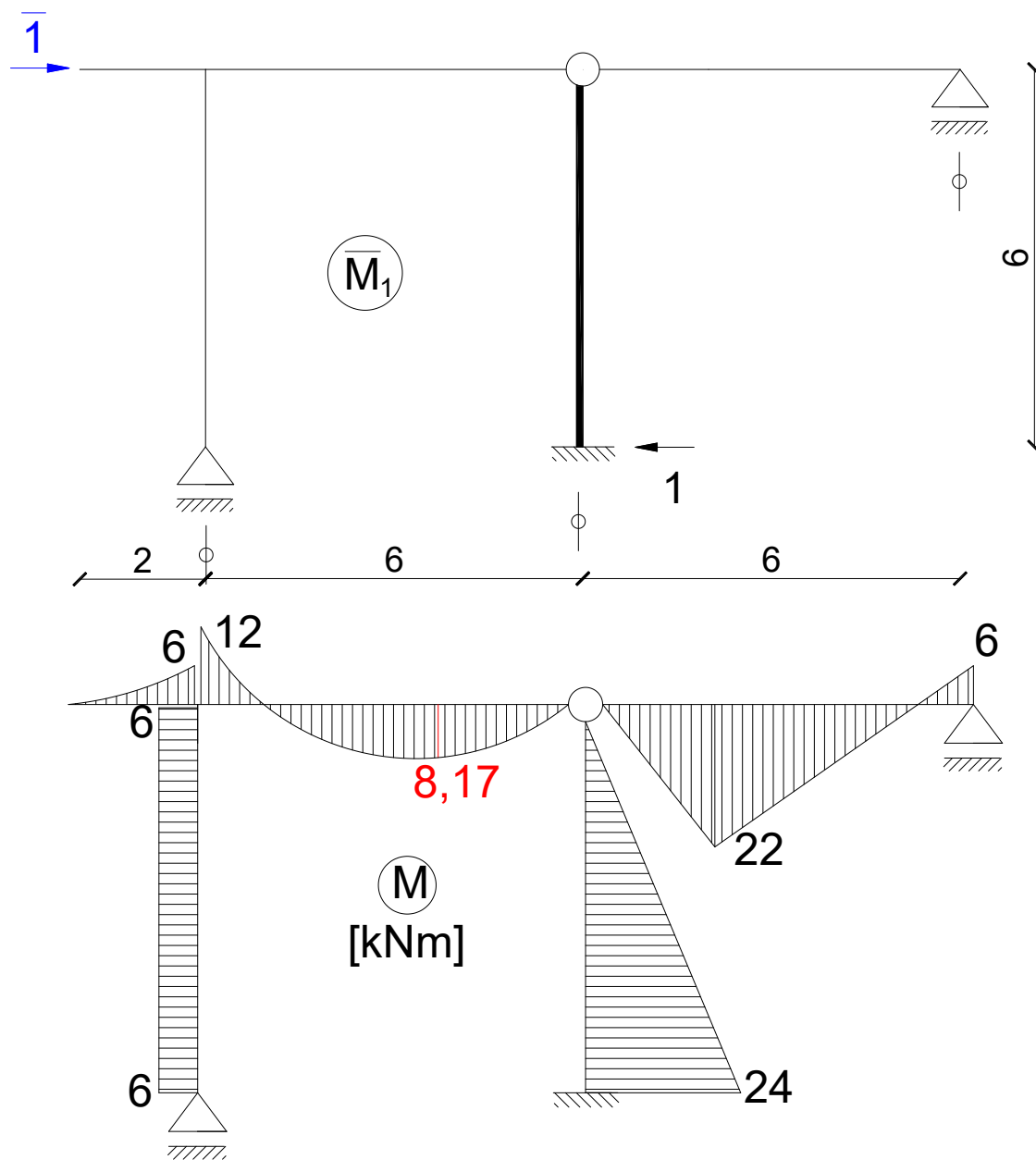
$$u_E = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:

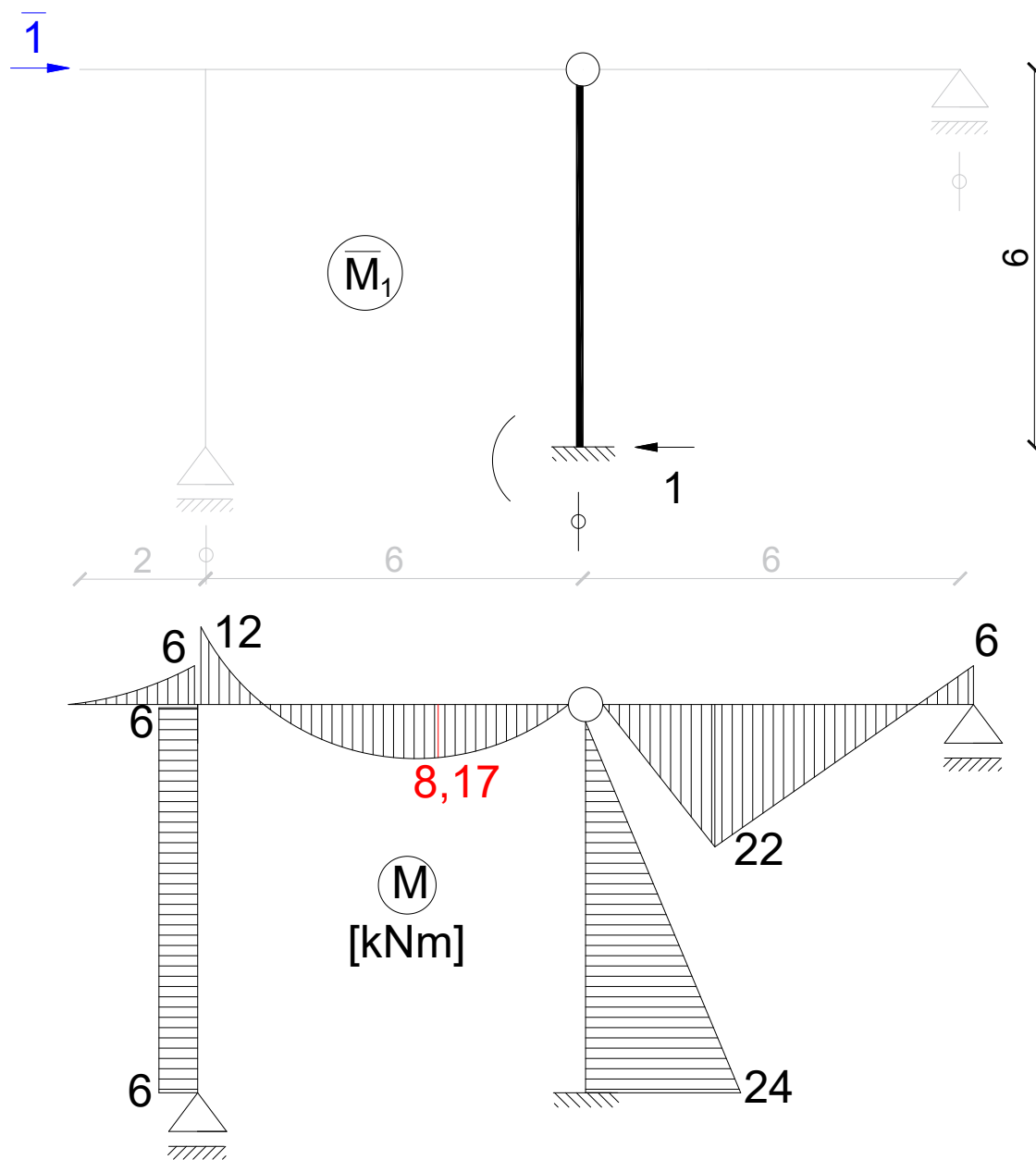


$$u_E = ?$$

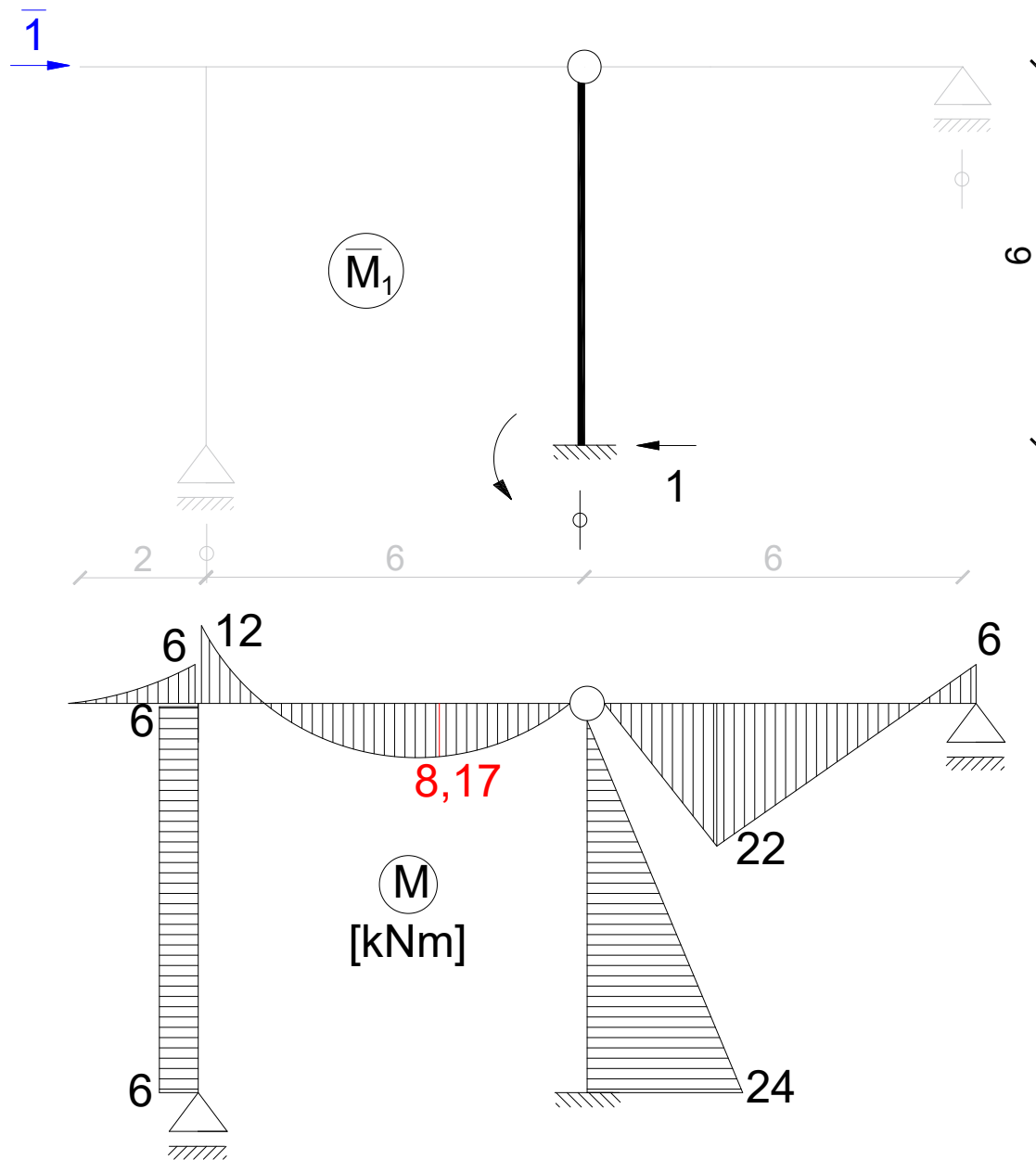
Obliczenia przemieszczeń z zasady prac wirtualnych:



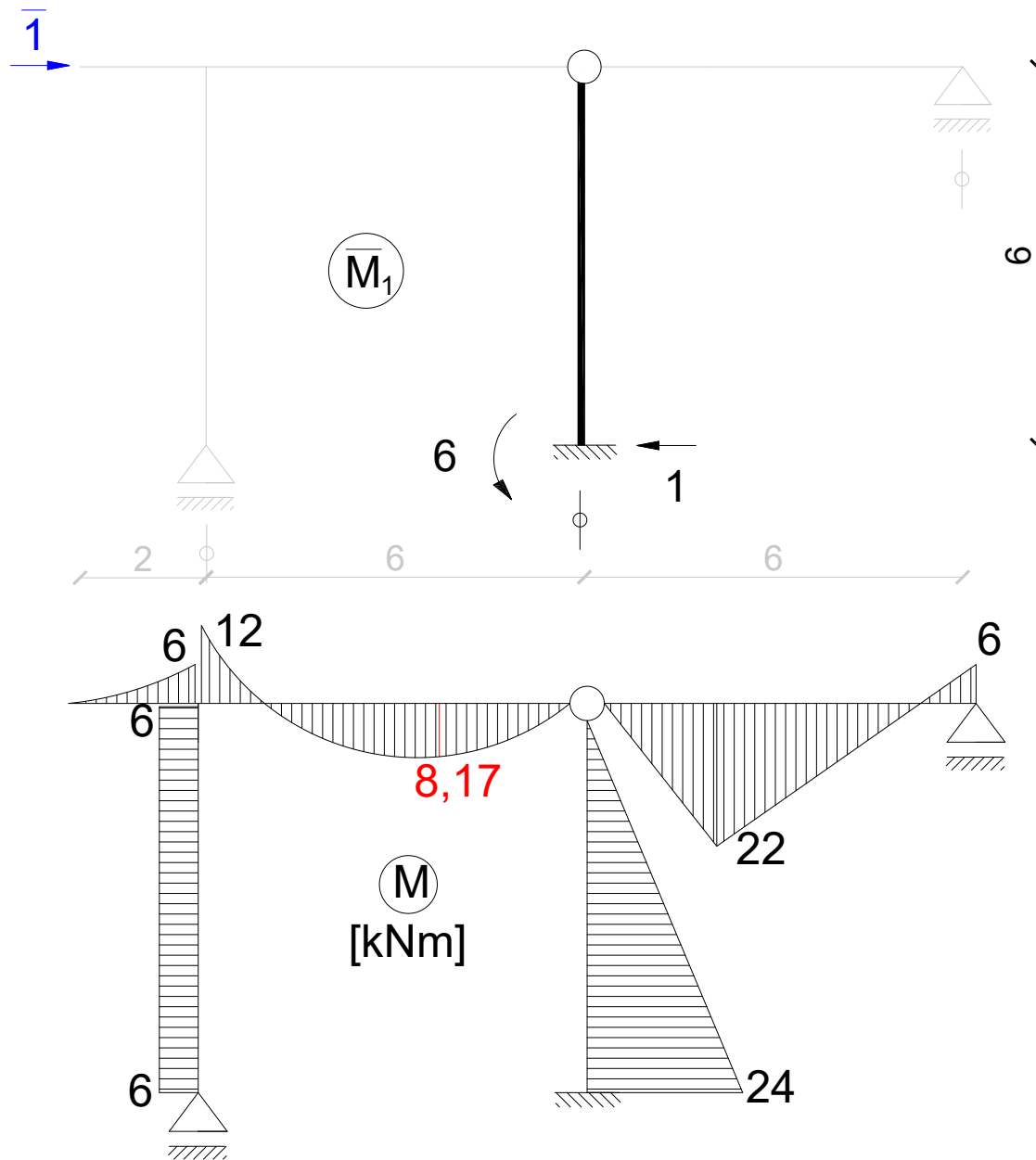
Obliczenia przemieszczeń z zasady prac wirtualnych:



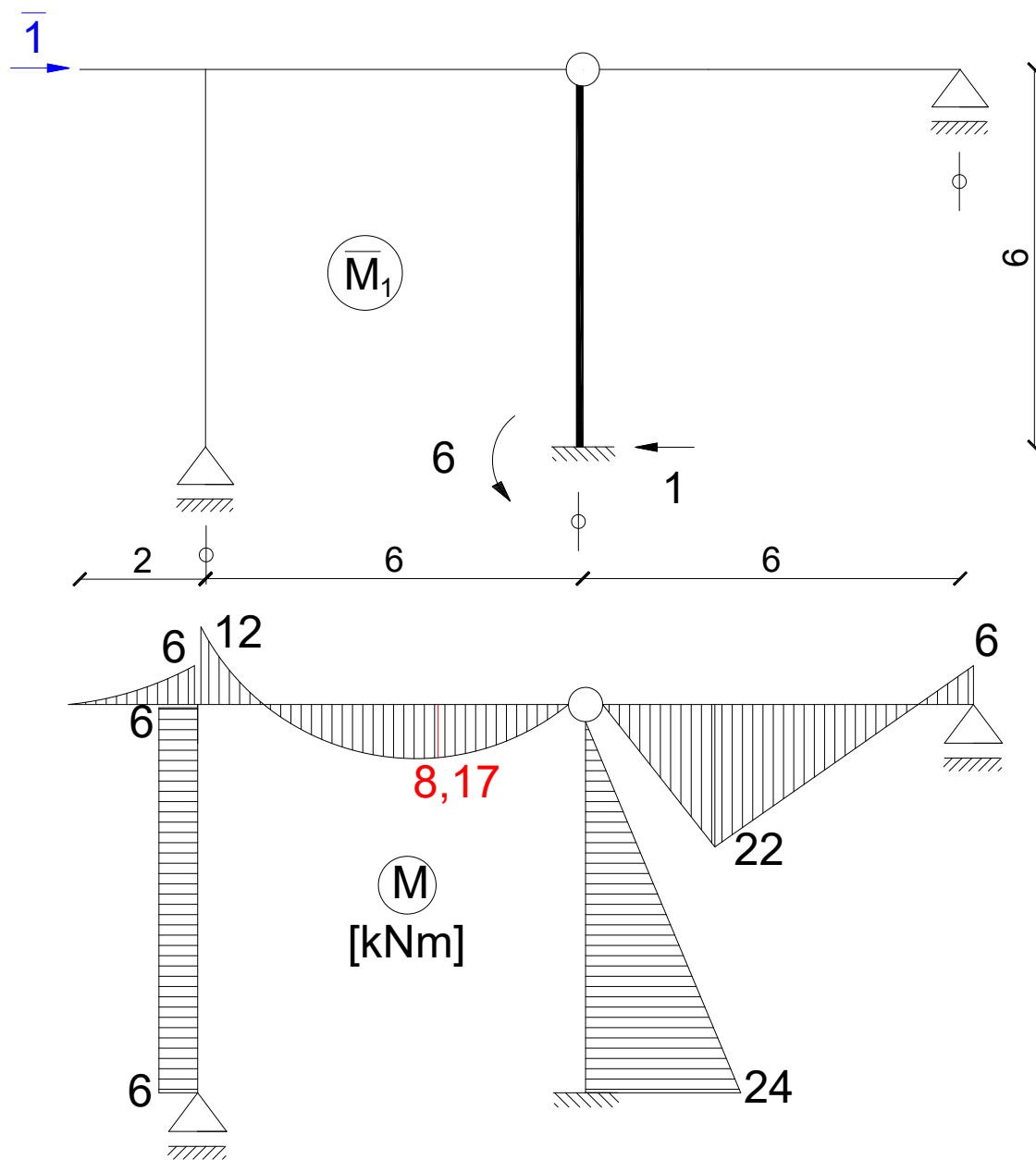
Obliczenia przemieszczeń z zasady prac wirtualnych:



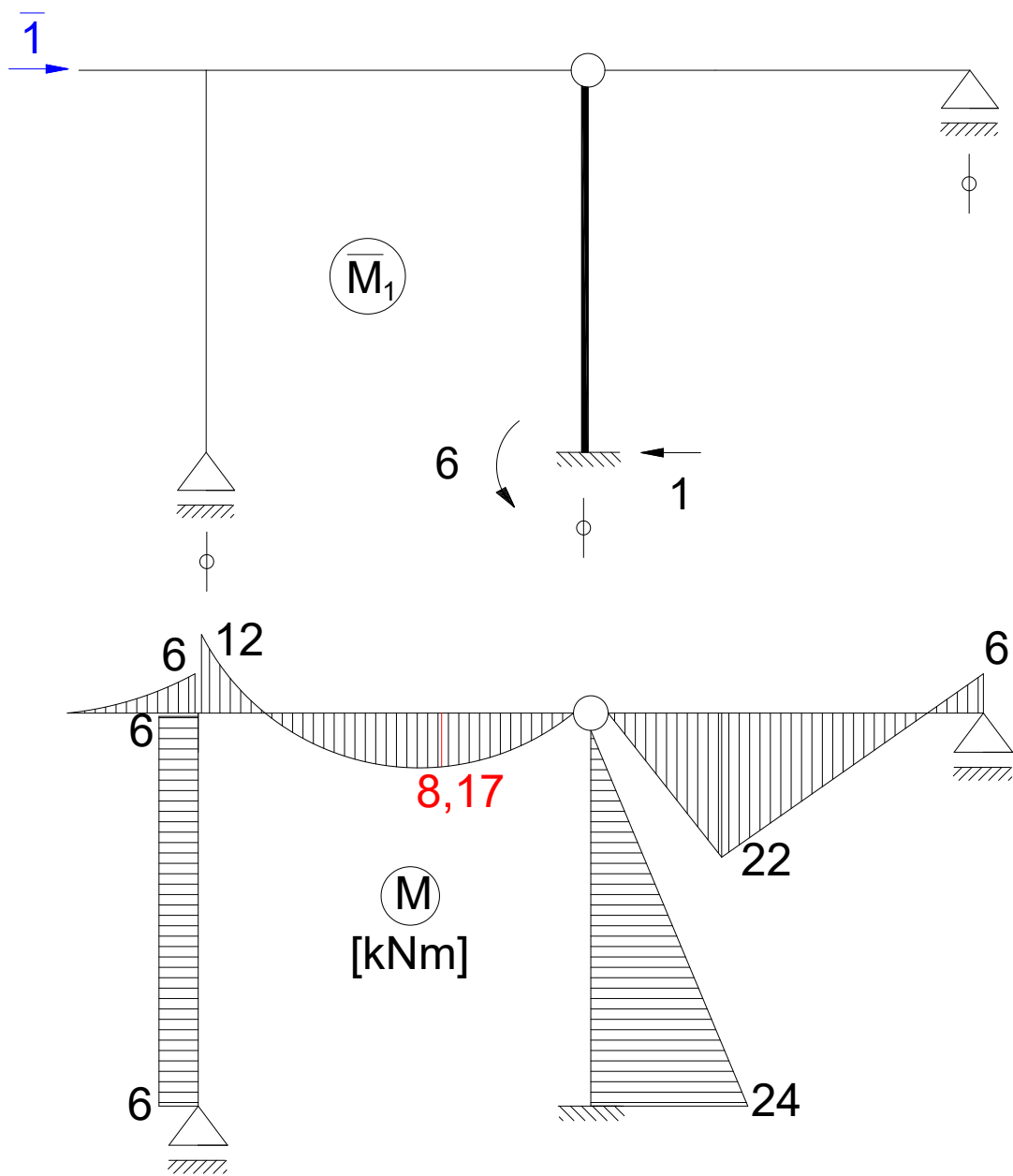
Obliczenia przemieszczeń z zasady prac wirtualnych:



Obliczenia przemieszczeń z zasady prac wirtualnych:

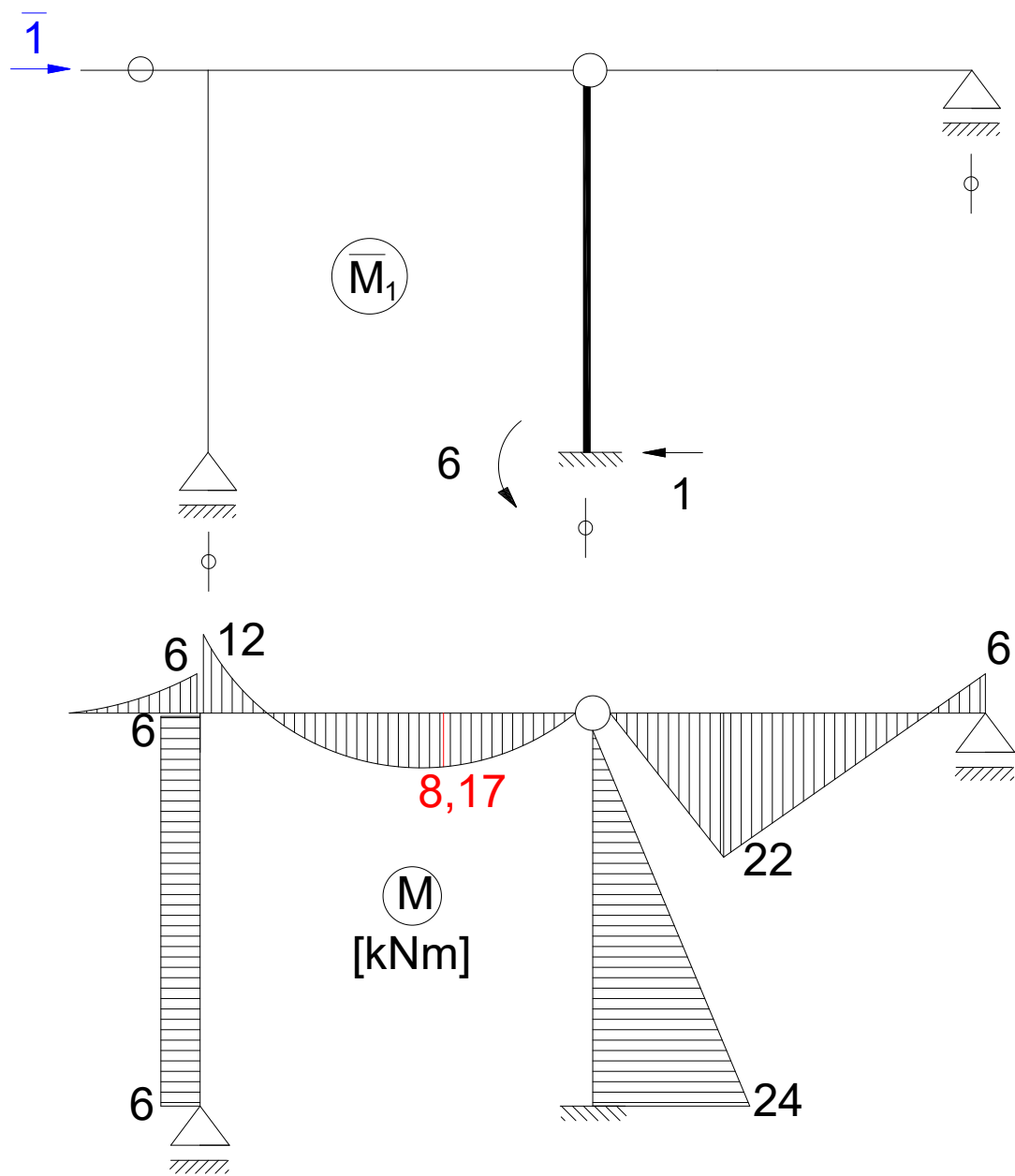


Obliczenia przemieszczeń z zasady prac wirtualnych:

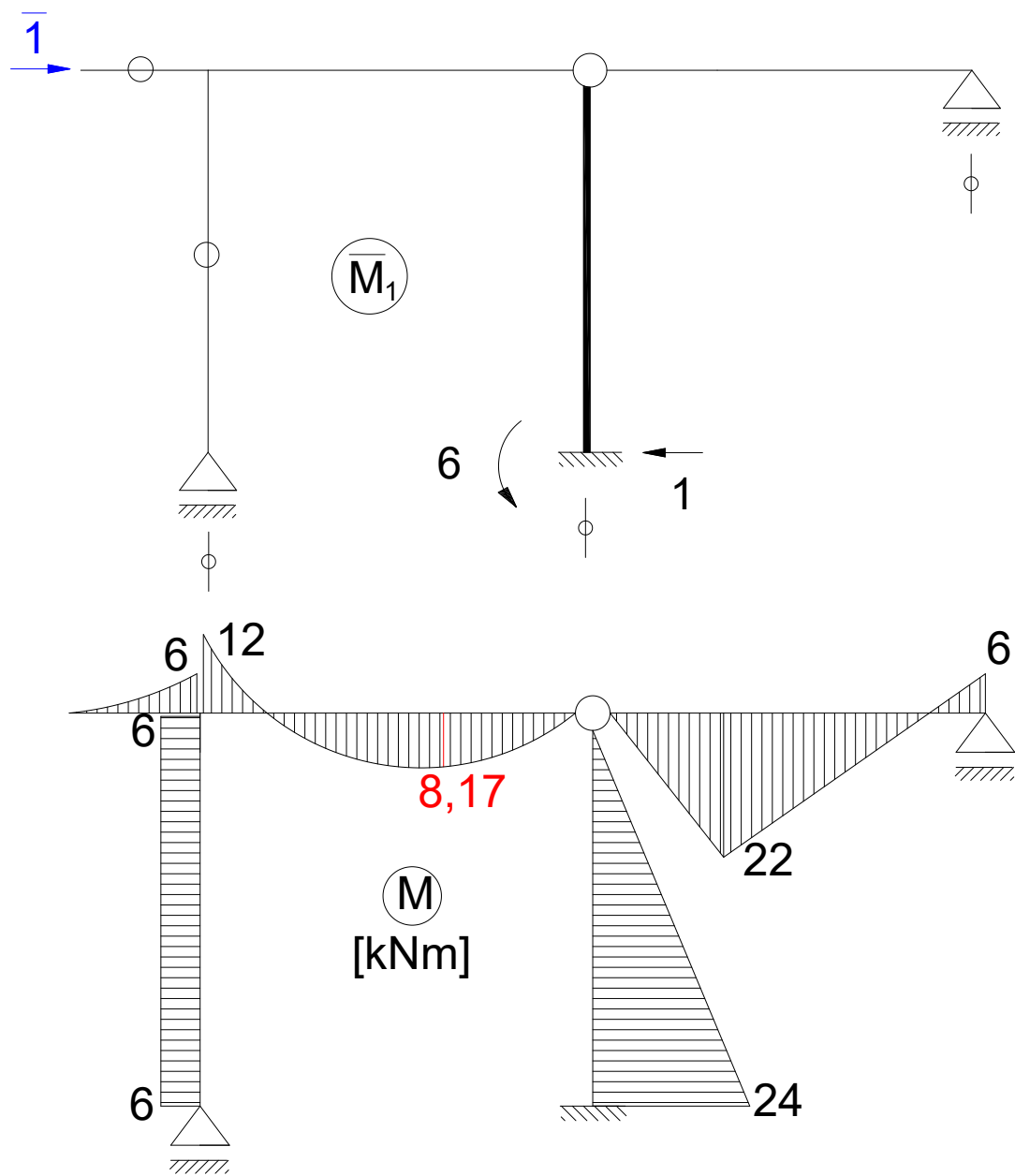


$$u_E = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:

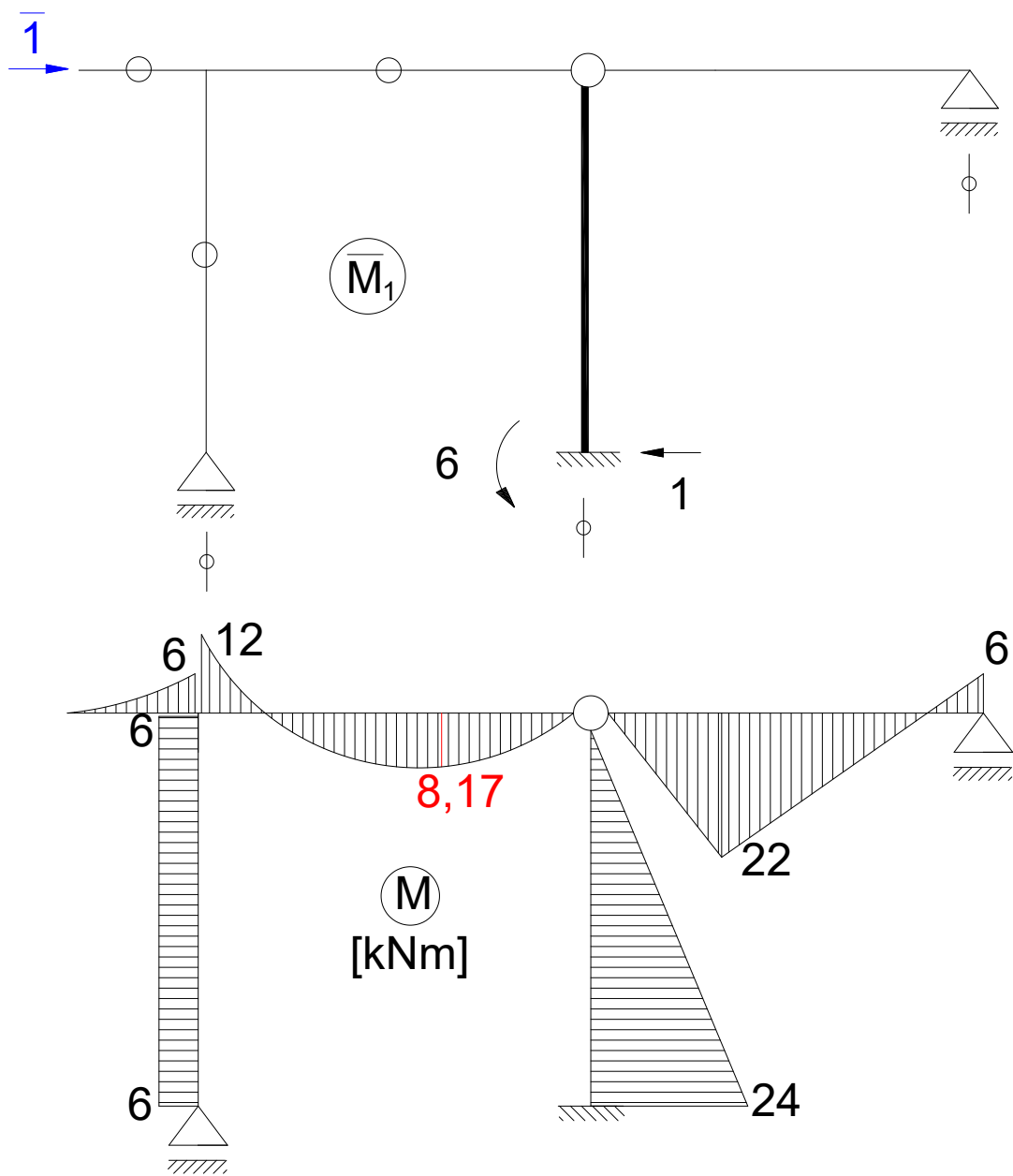


Obliczenia przemieszczeń z zasady prac wirtualnych:

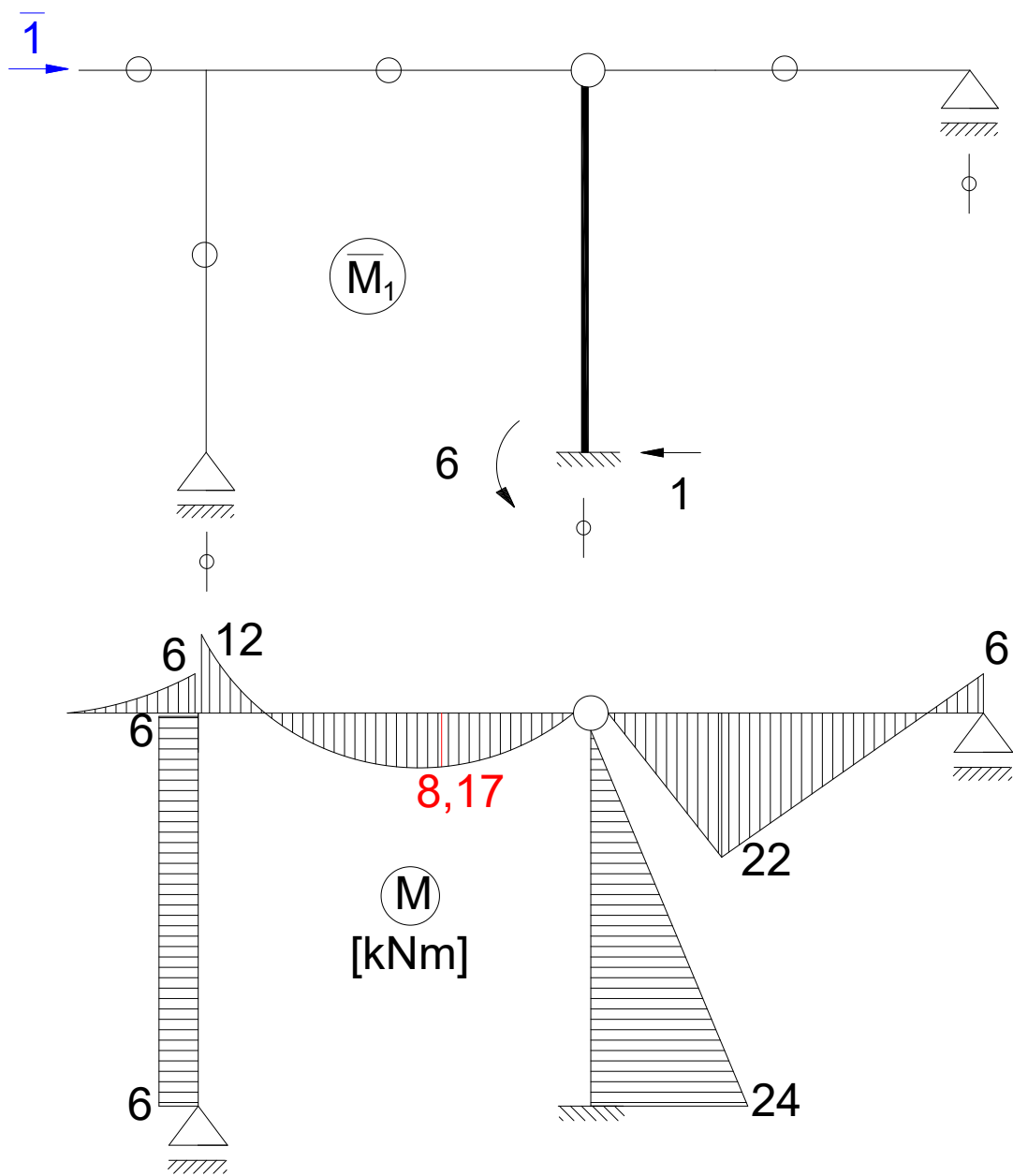


$$u_E = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:

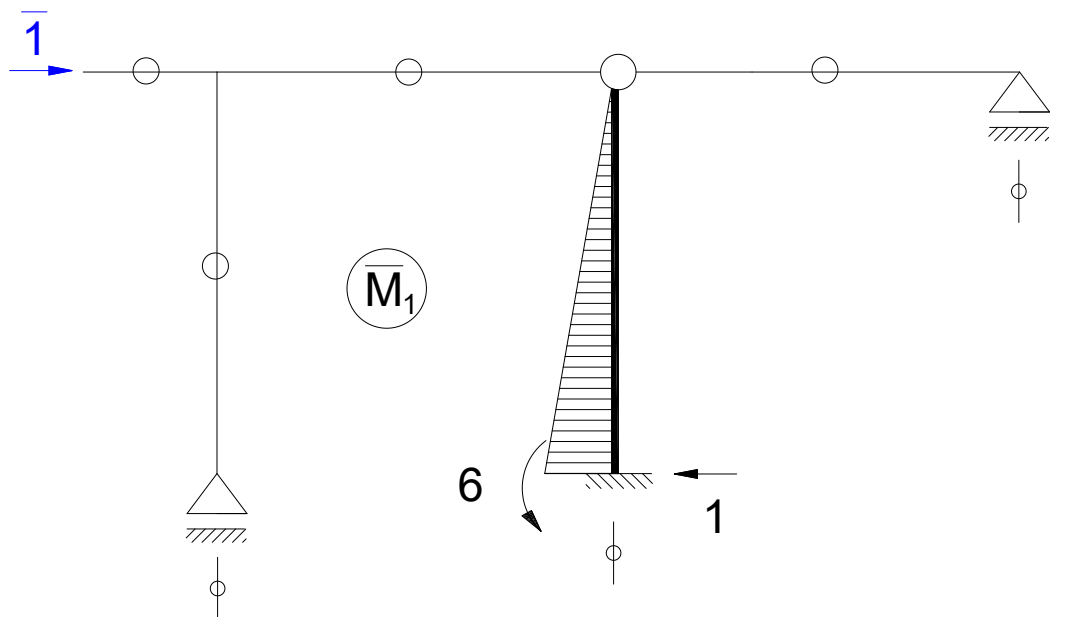


Obliczenia przemieszczeń z zasady prac wirtualnych:

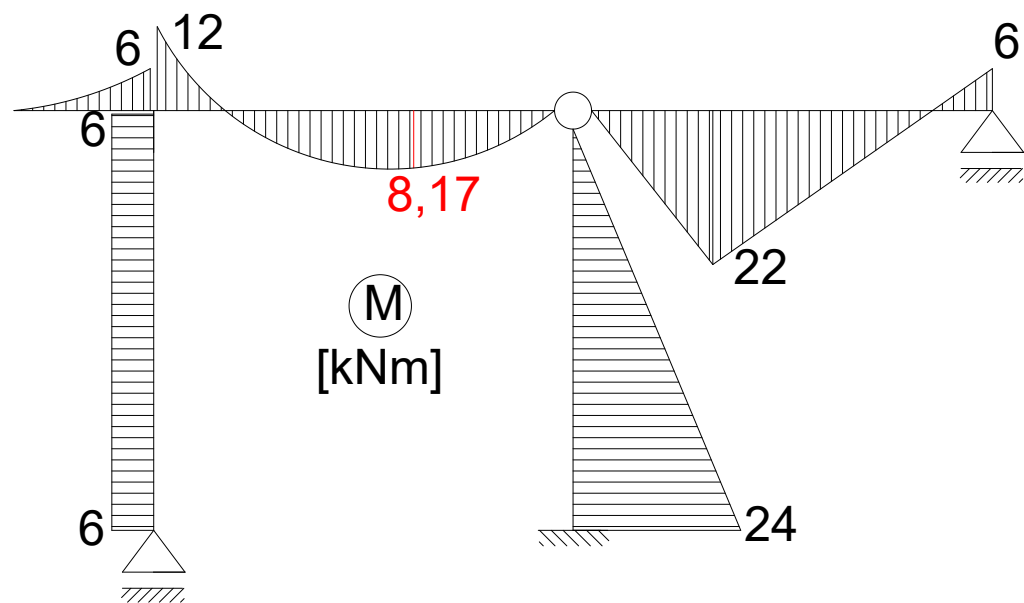


$$u_E = ?$$

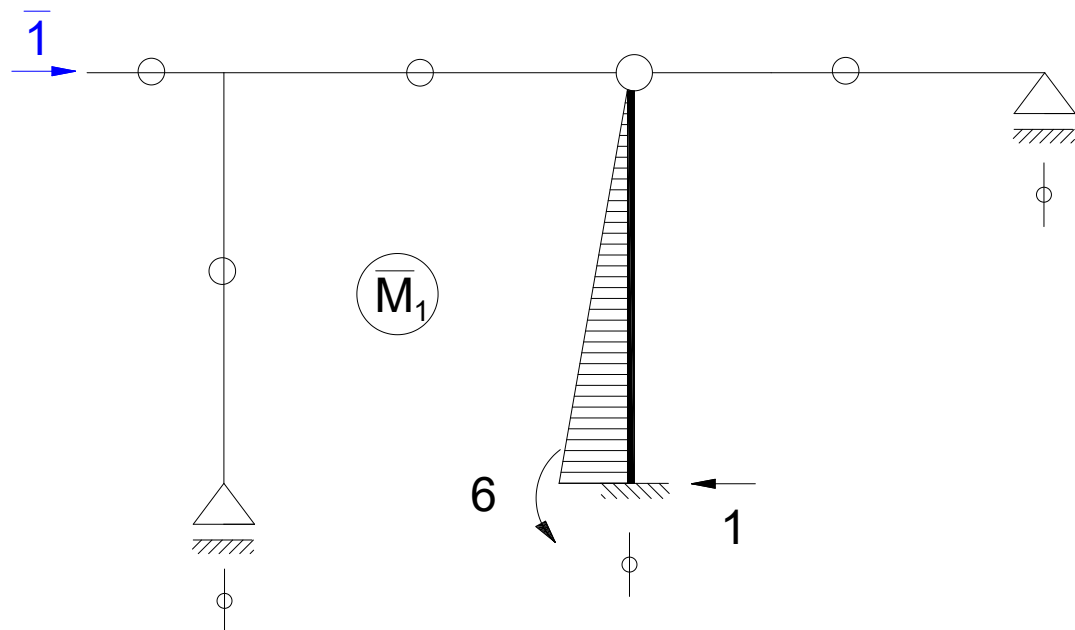
Obliczenia przemieszczeń z zasady prac wirtualnych:



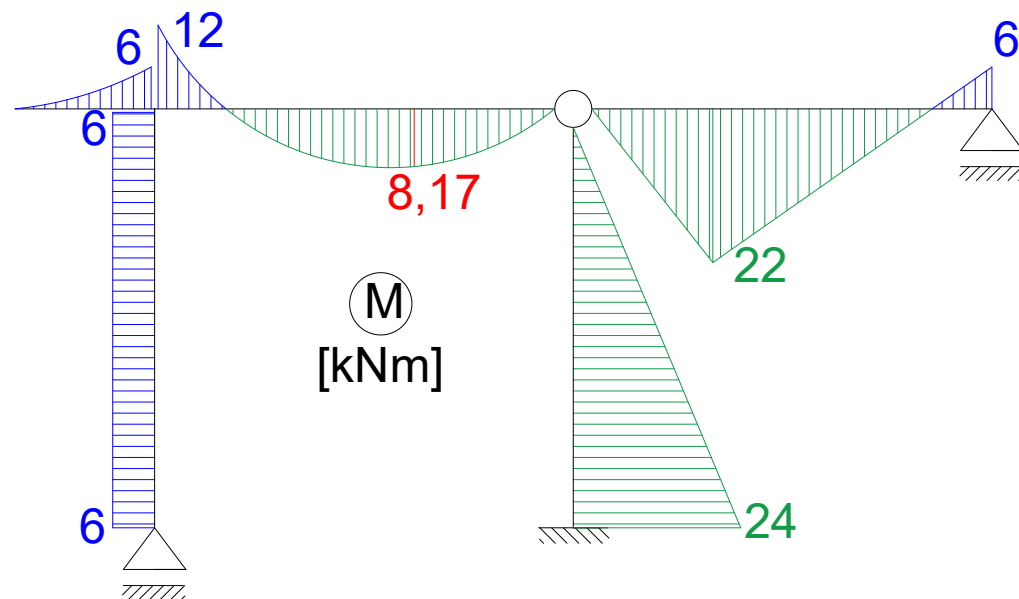
$$u_E = ?$$



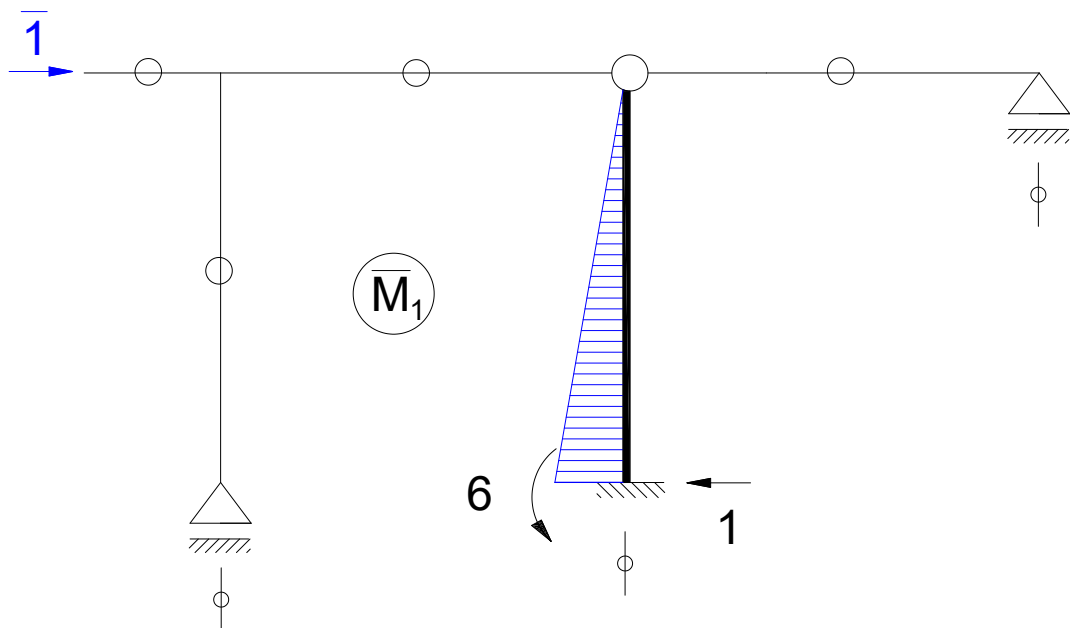
Obliczenia przemieszczeń z zasady prac wirtualnych:



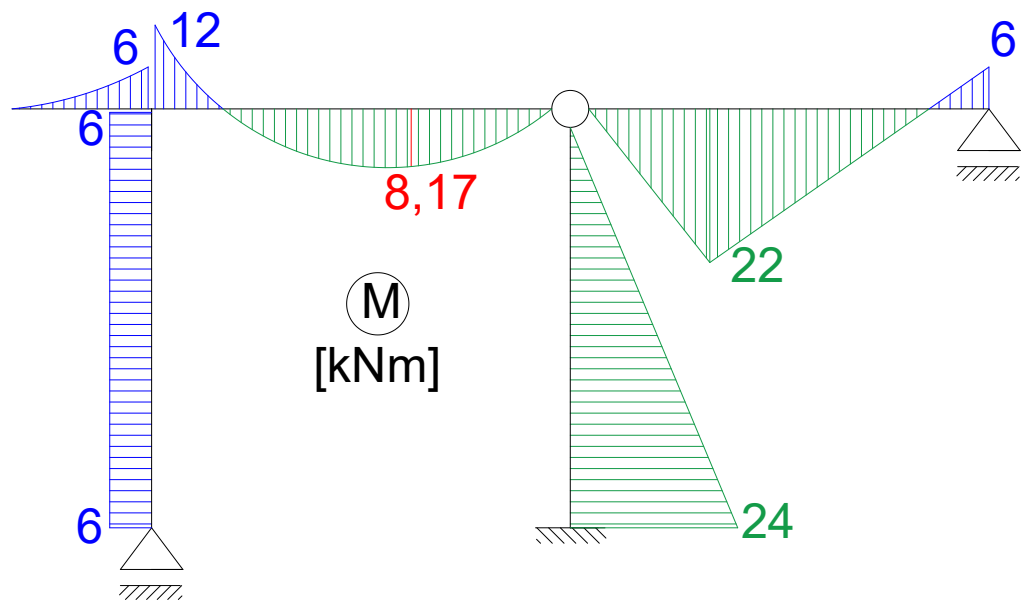
$$u_E = ?$$



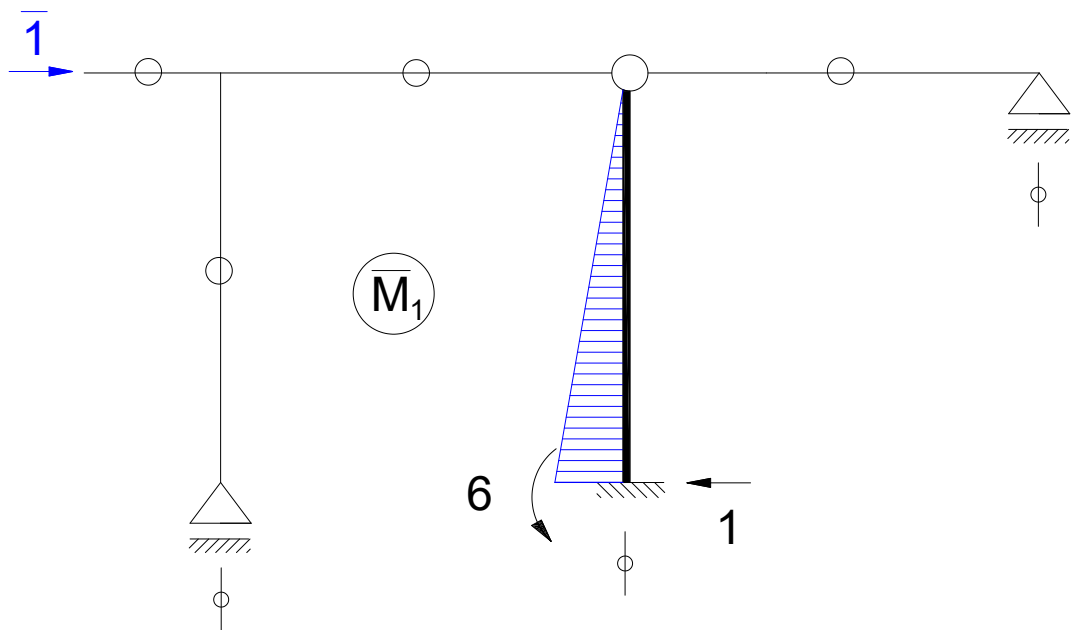
Obliczenia przemieszczeń z zasady prac wirtualnych:



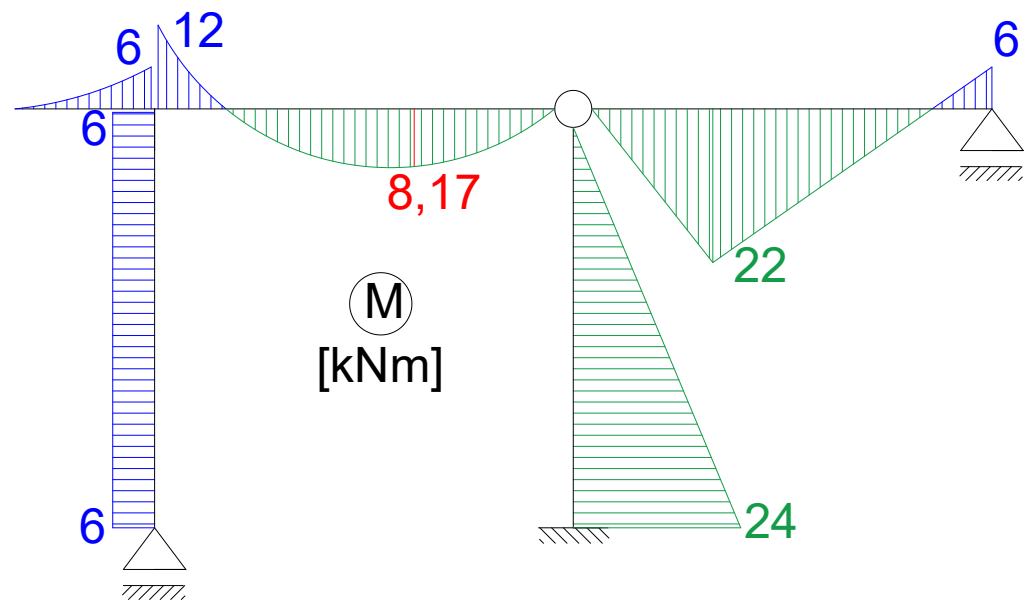
$$u_E = ?$$



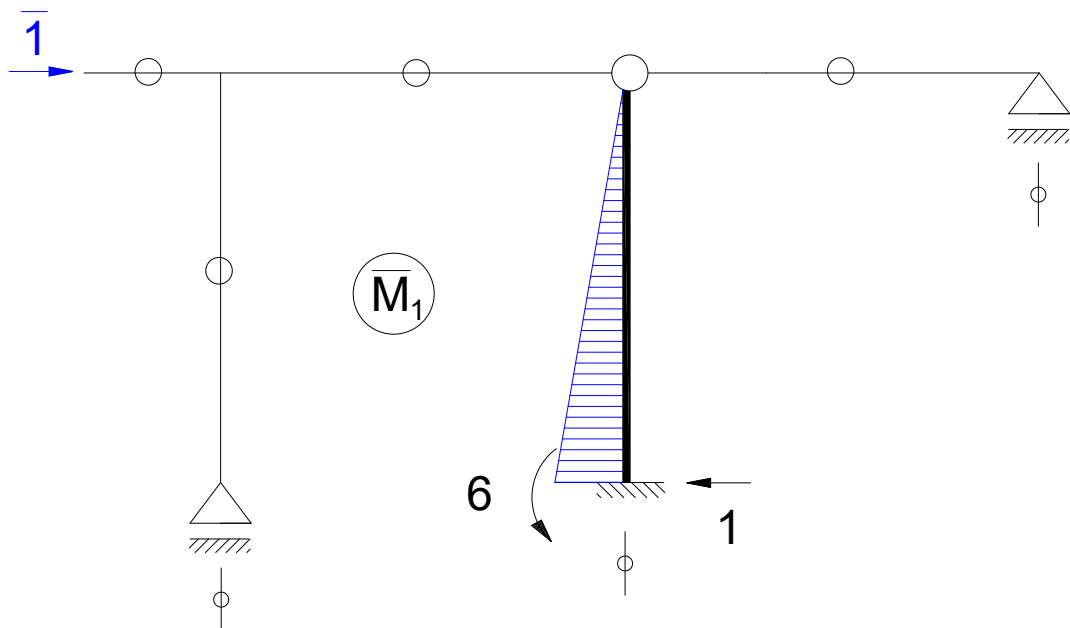
Obliczenia przemieszczeń z zasady prac wirtualnych:



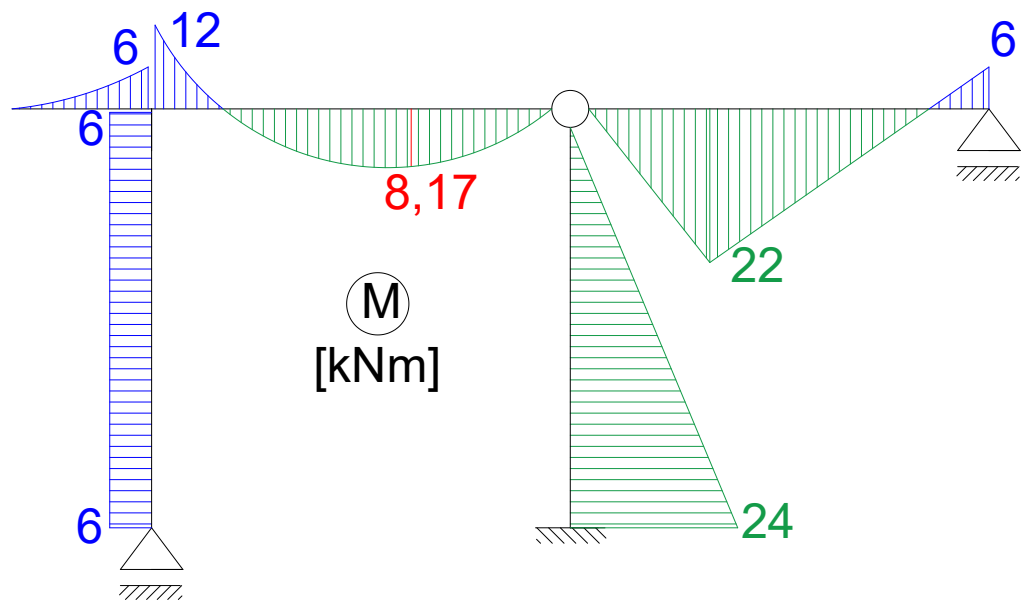
$$u_E = \frac{1}{2EI}$$



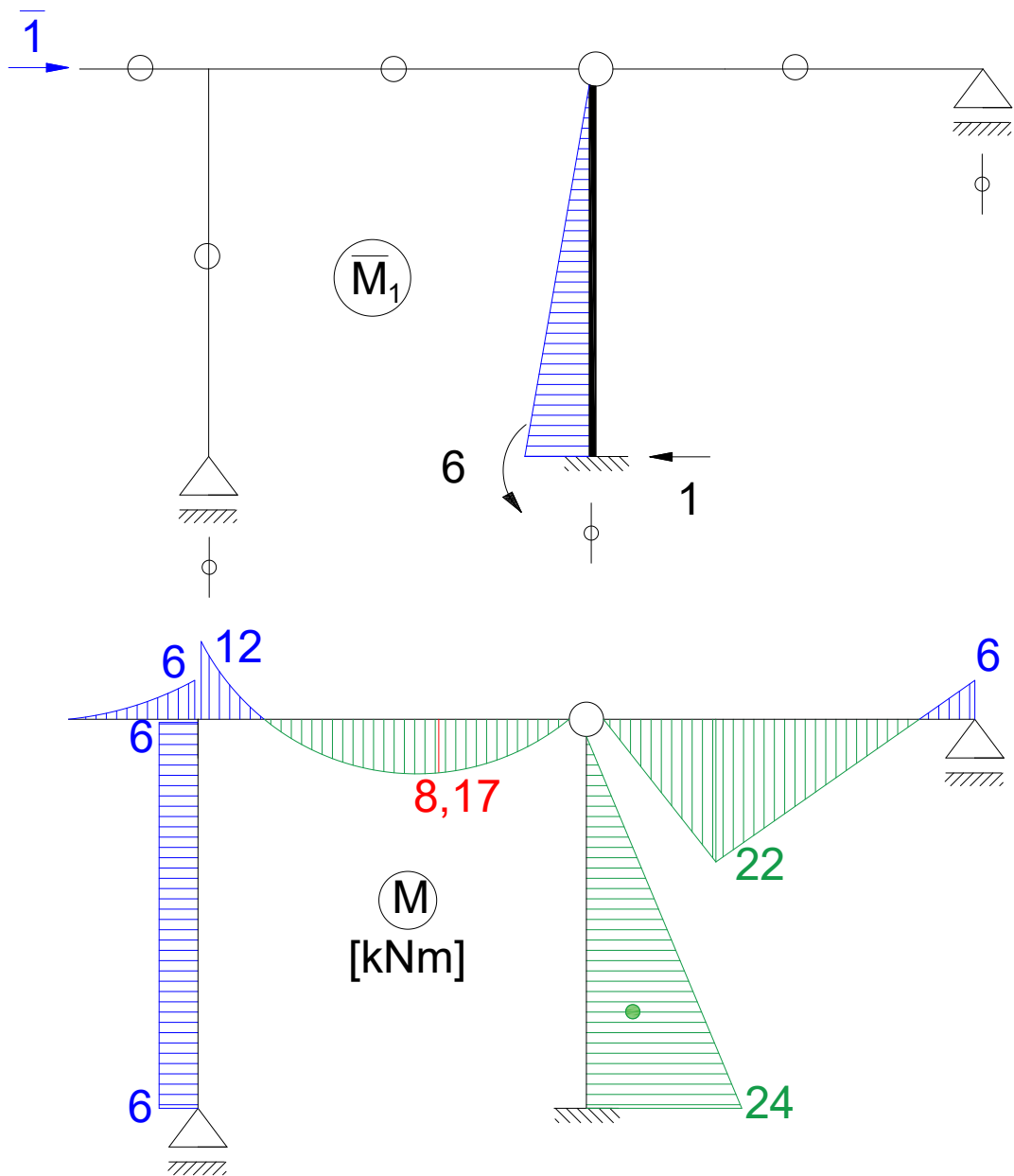
Obliczenia przemieszczeń z zasady prac wirtualnych:



$$u_E = \frac{1}{2EI} \left(-\frac{1}{2} \cdot 24 \cdot 6 \cdot \right)$$

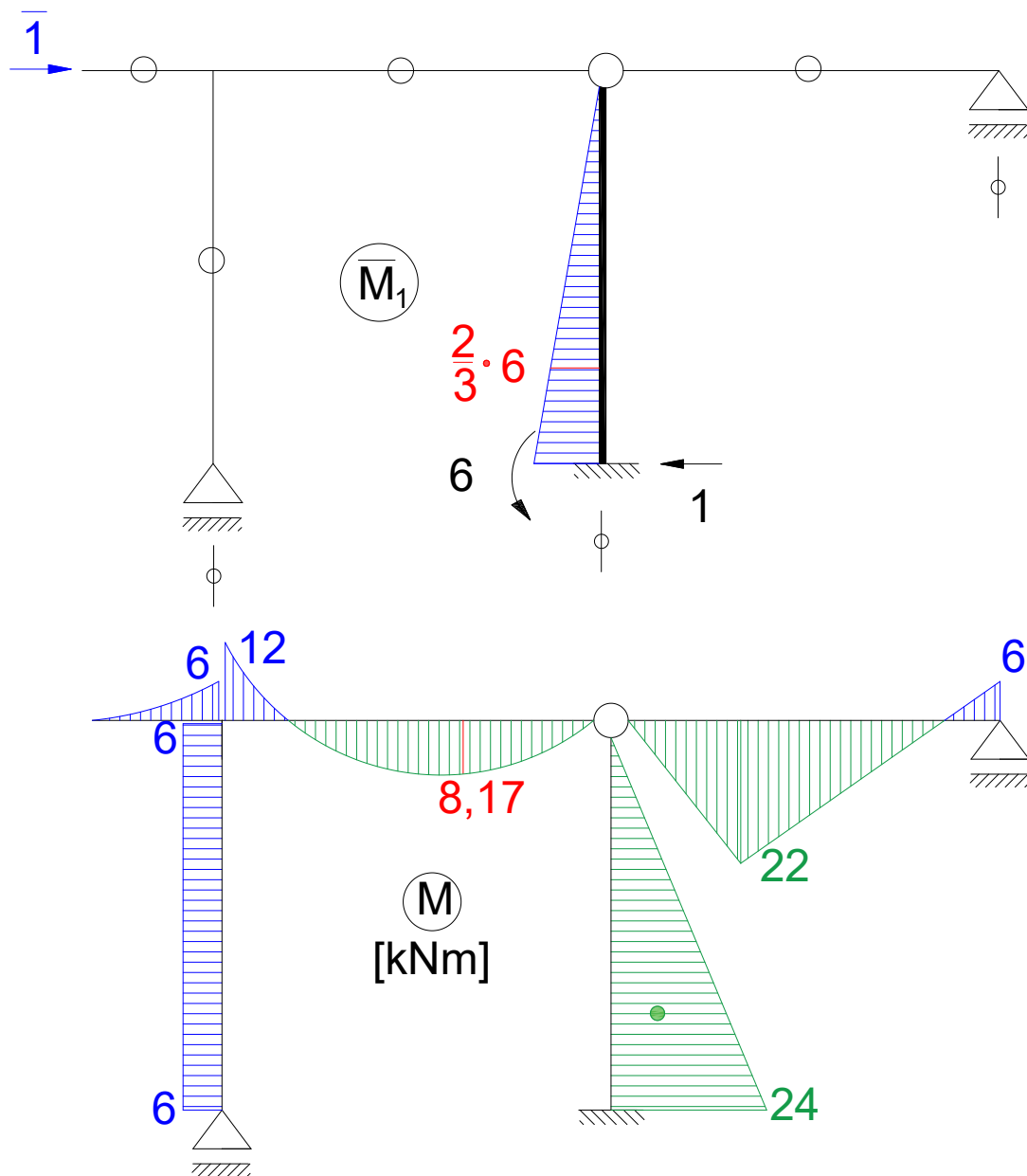


Obliczenia przemieszczeń z zasady prac wirtualnych:



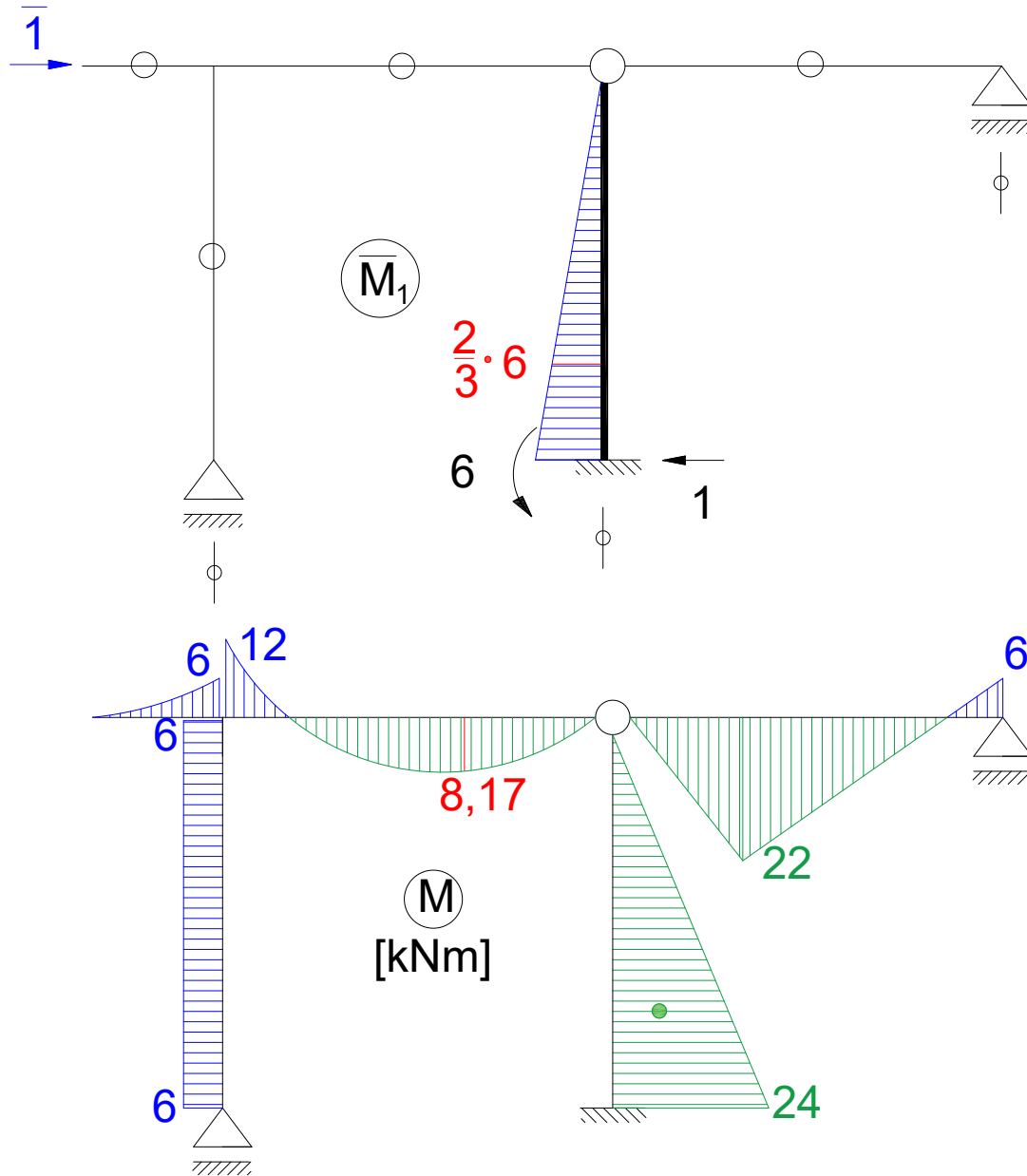
$$u_E = \frac{1}{2EI} \left(-\frac{1}{2} \cdot 24 \cdot 6 \cdot \right)$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



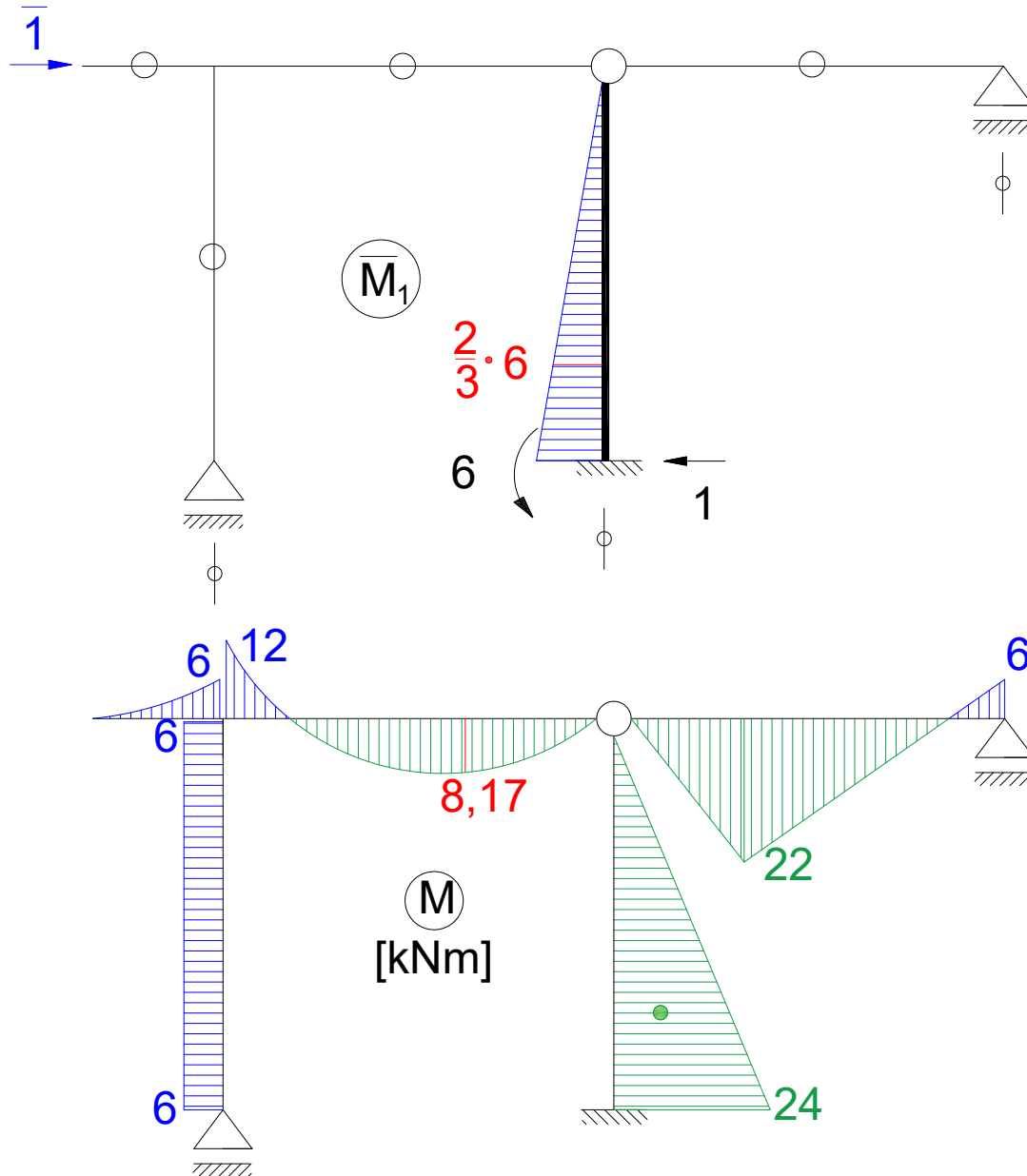
$$u_E = \frac{1}{2EI} \left(-\frac{1}{2} \cdot 24 \cdot 6 \cdot \right)$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



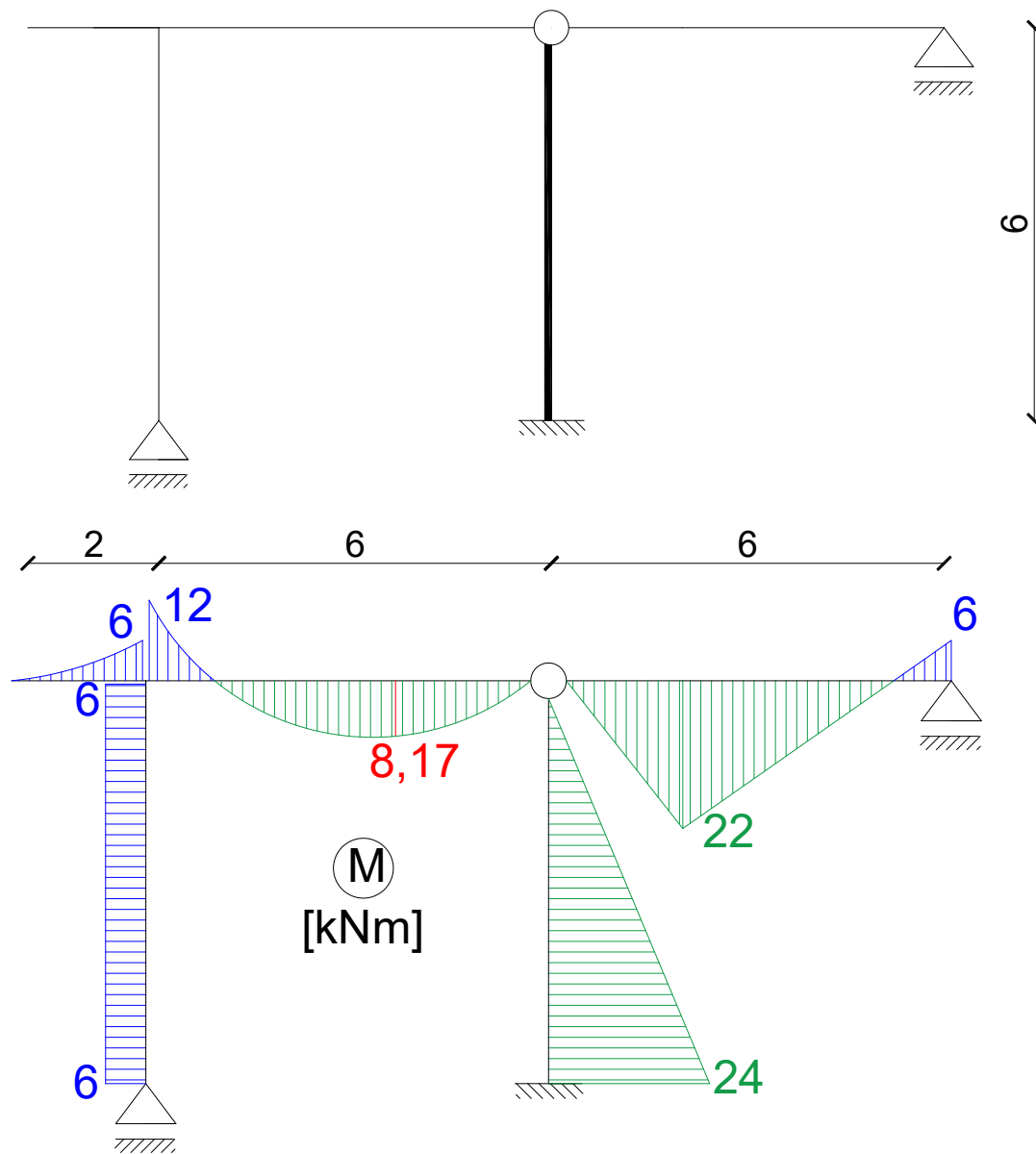
$$u_E = \frac{1}{2EI} \left(-\frac{1}{2} \cdot 24 \cdot 6 \cdot \frac{2}{3} \cdot 6 \right)$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



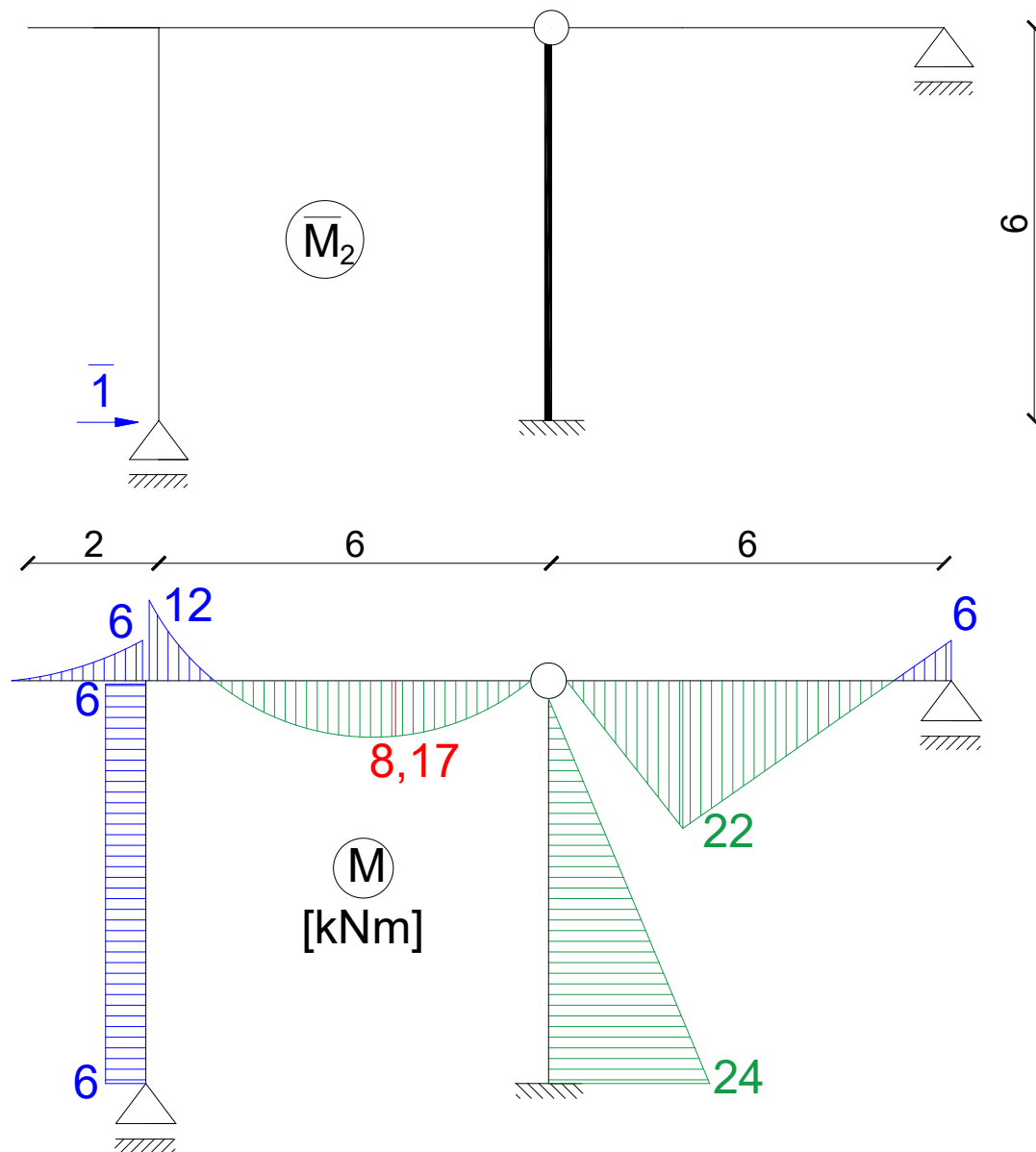
$$u_E = \frac{1}{2EI} \left(-\frac{1}{2} \cdot 24 \cdot 6 \cdot \frac{2}{3} \cdot 6 \right) = -\frac{144}{EI}$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



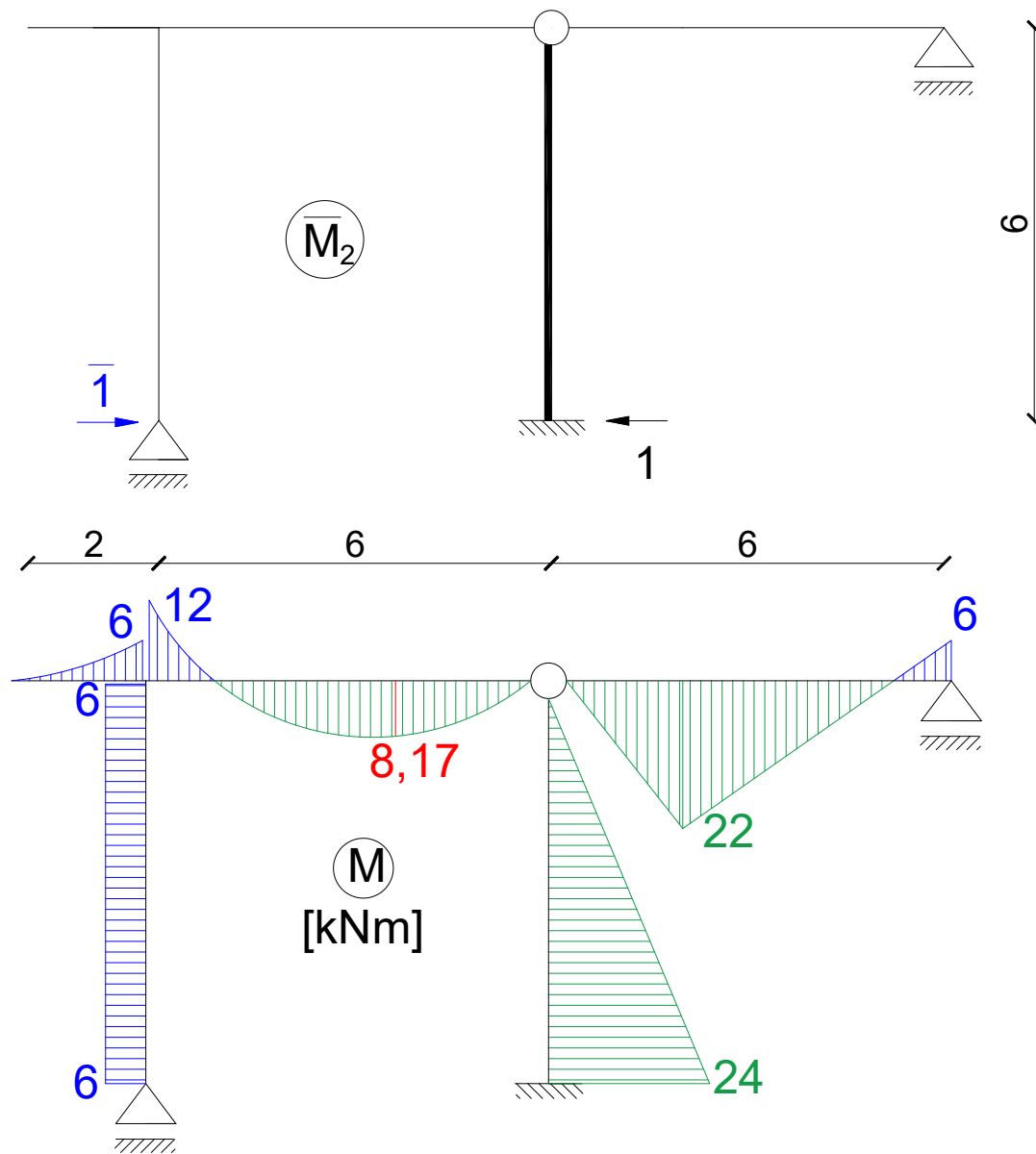
$$u_A = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



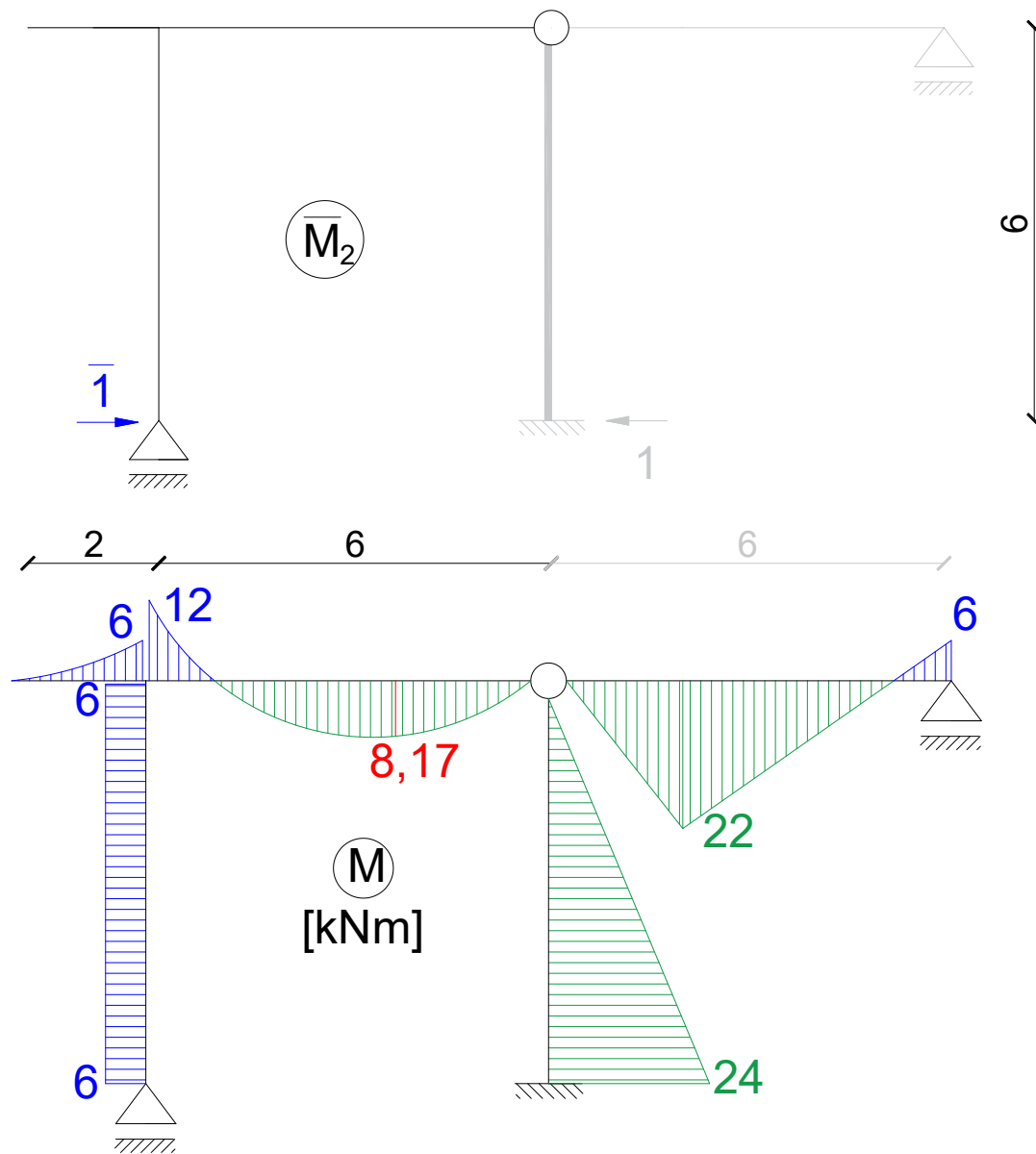
$$u_A = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



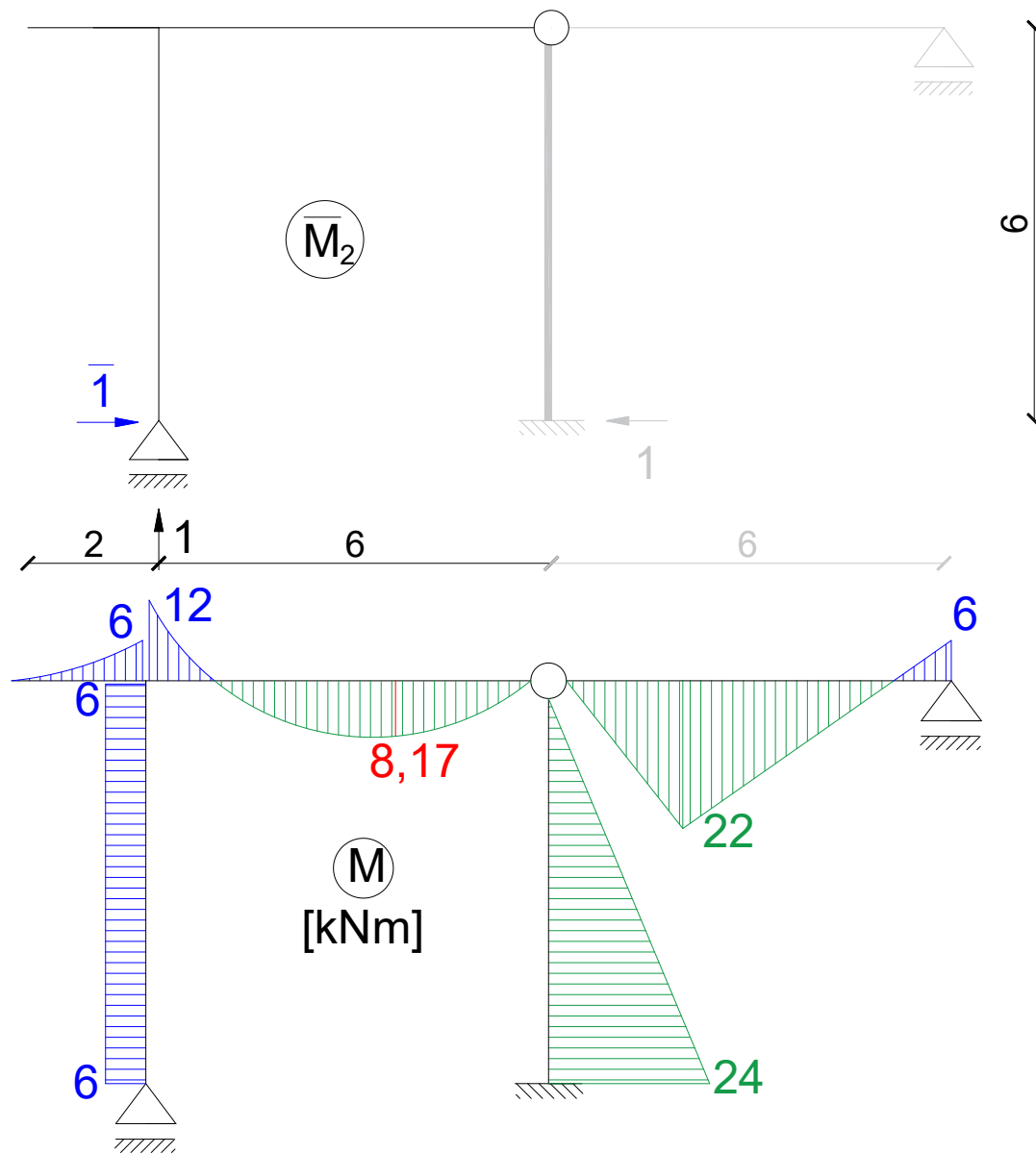
$$u_A = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



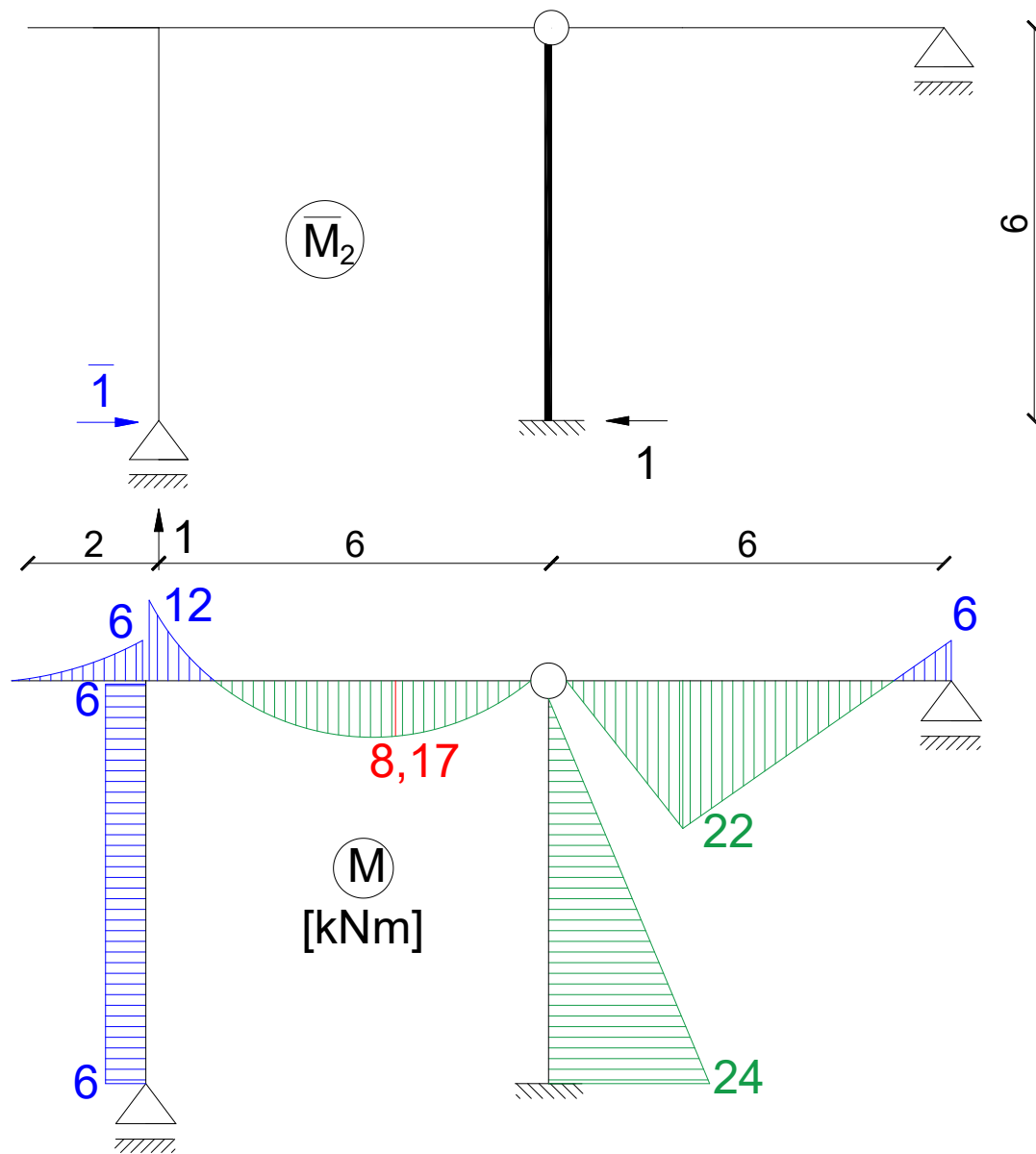
$$u_A = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



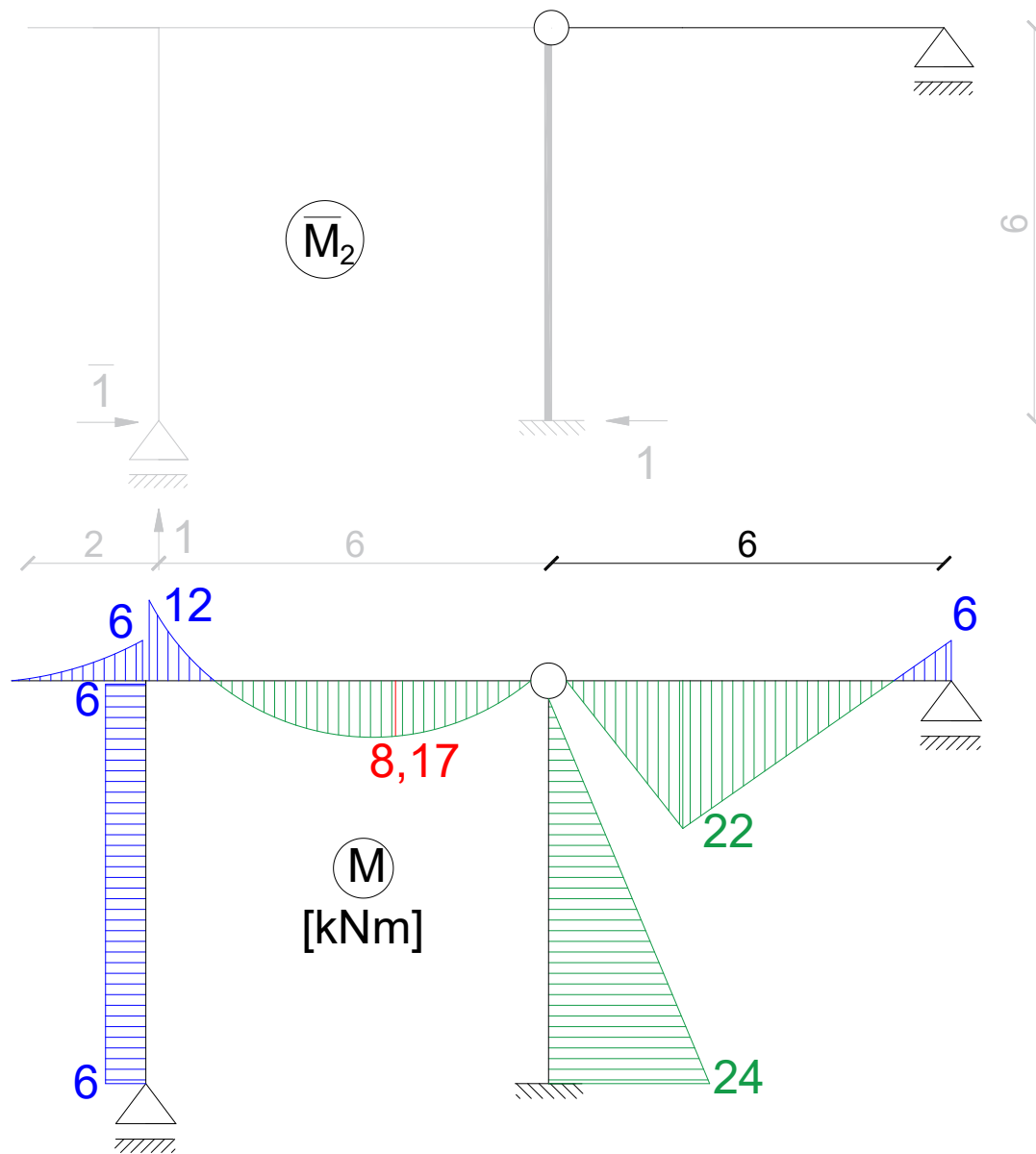
$$u_A = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



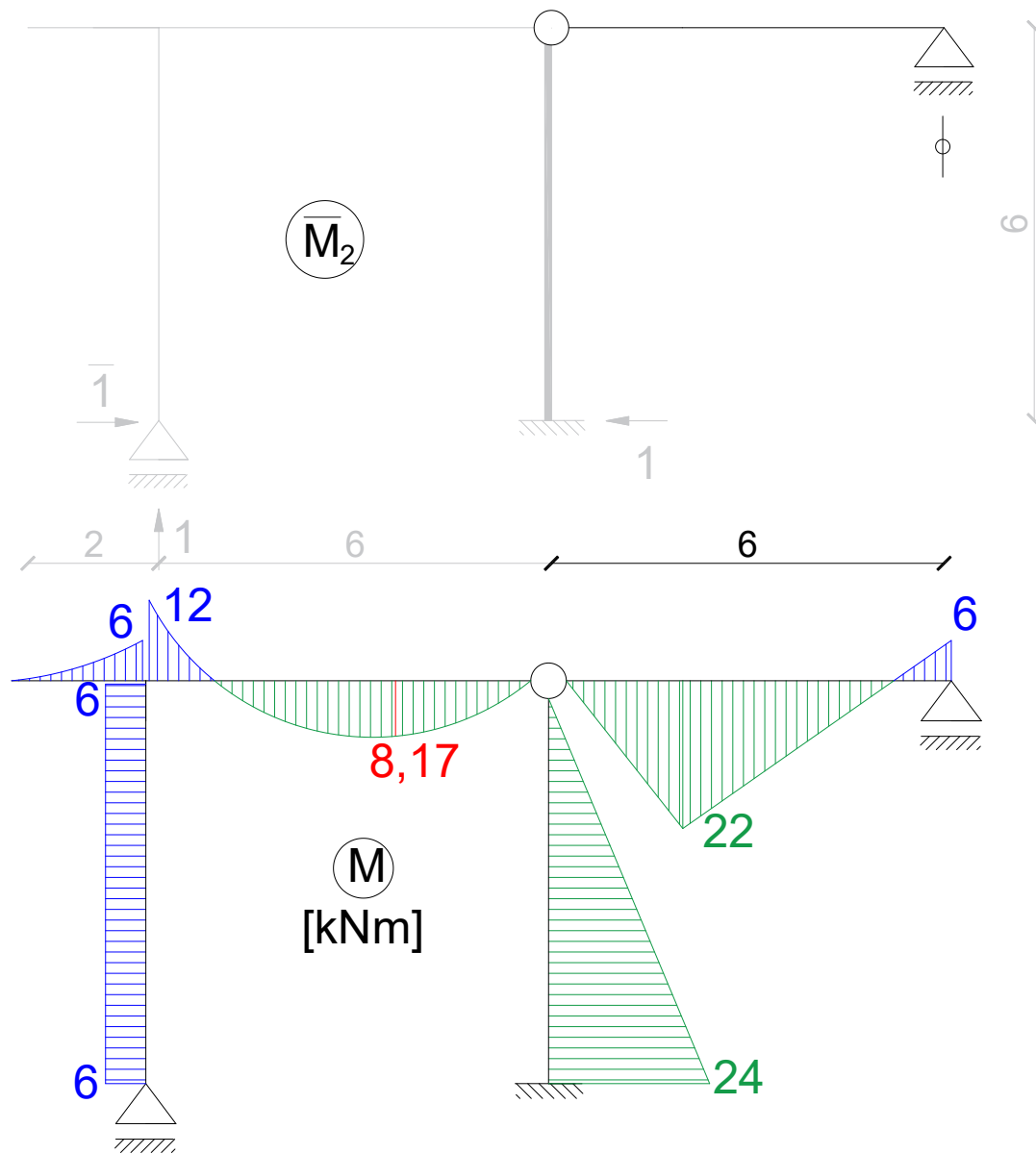
$$u_A = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



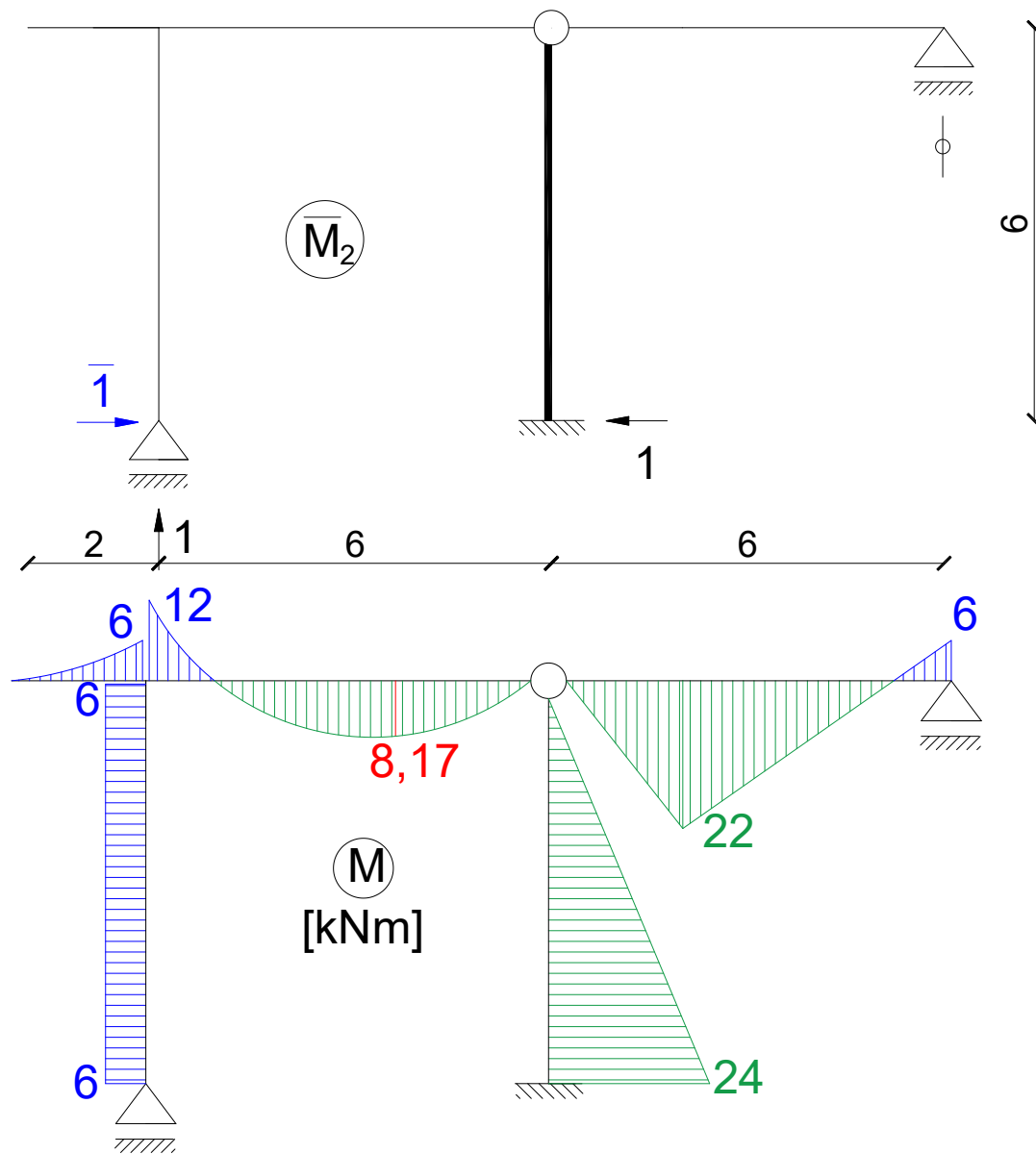
$$u_A = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



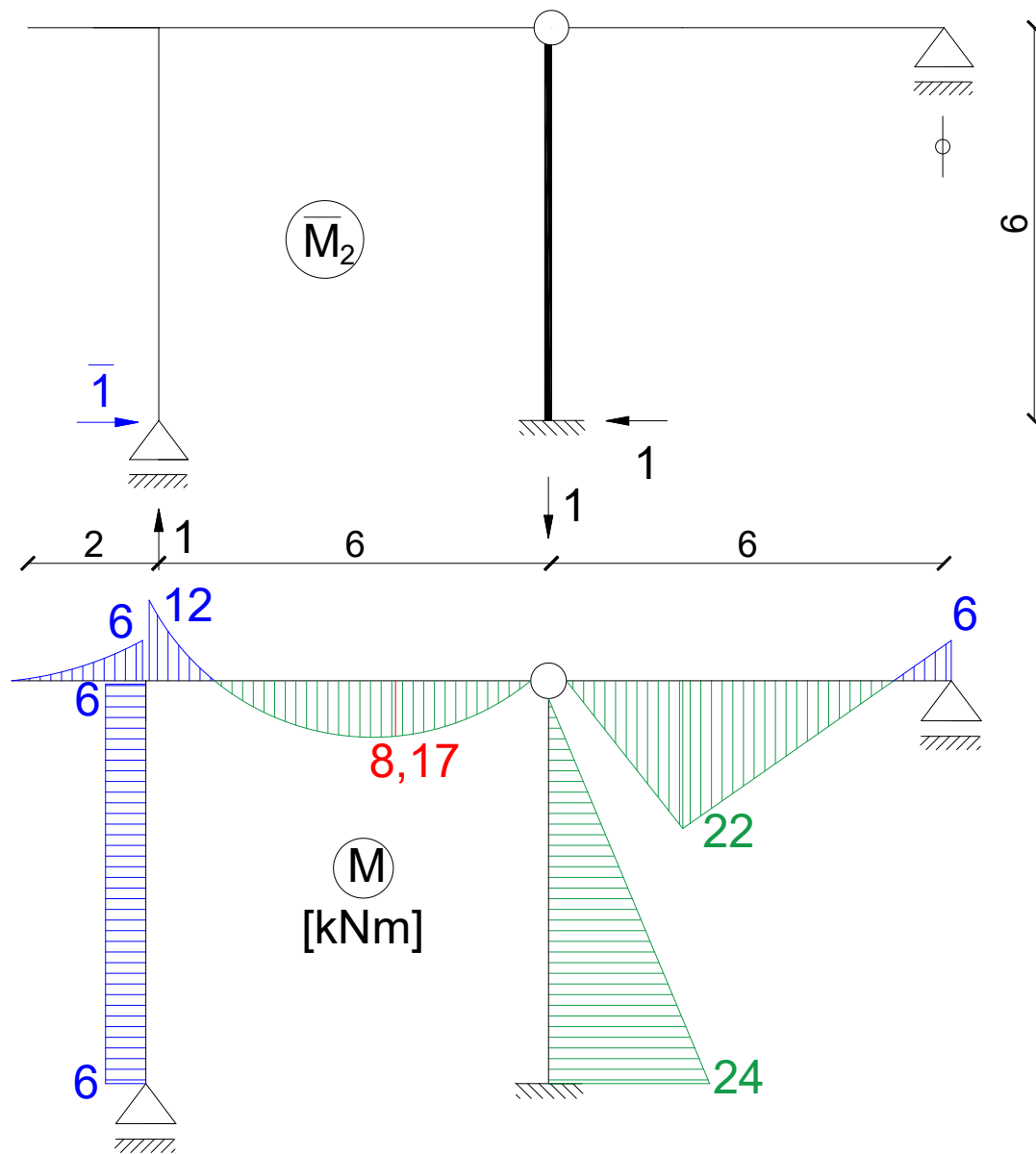
$$u_A = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



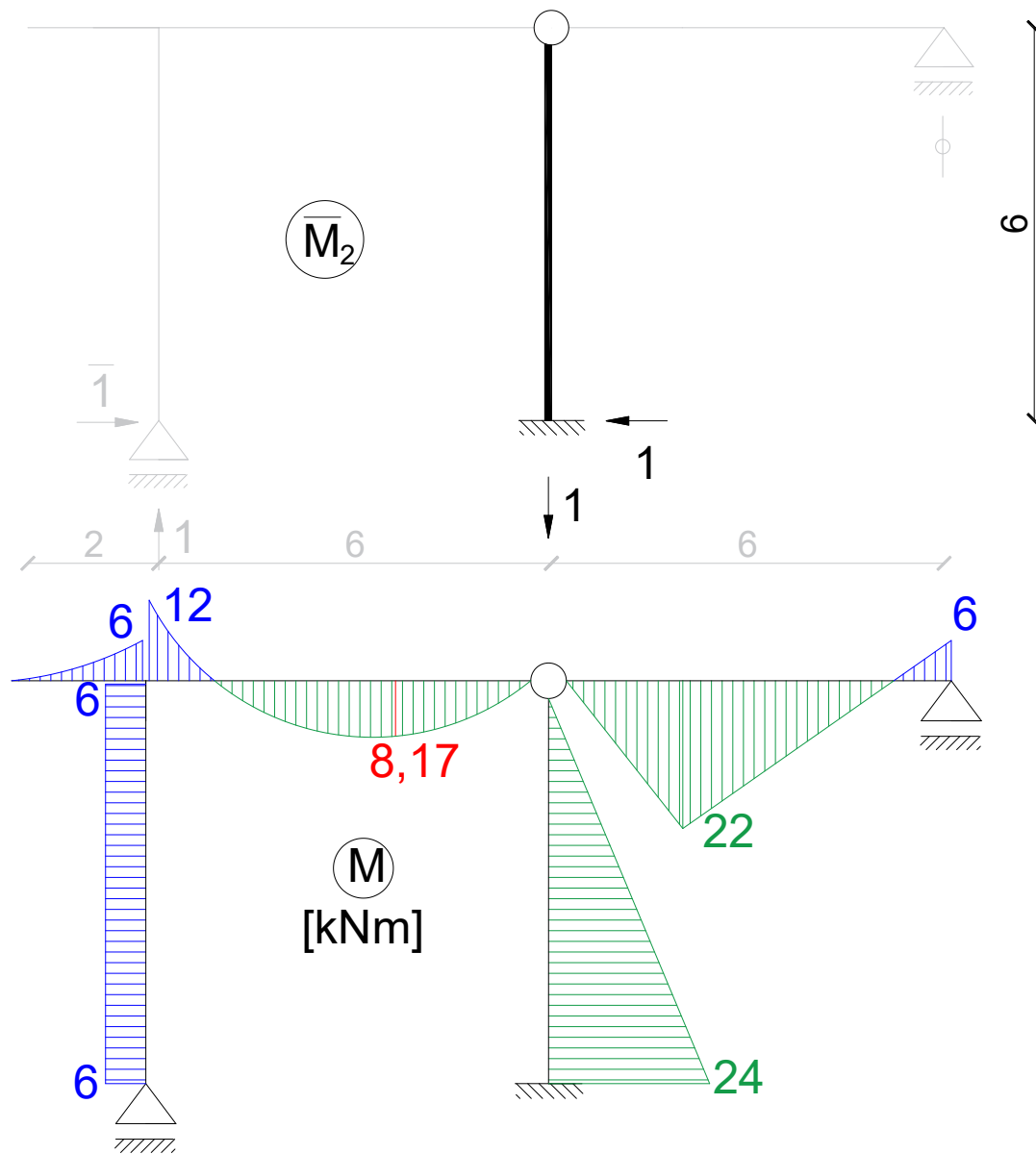
$$u_A = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



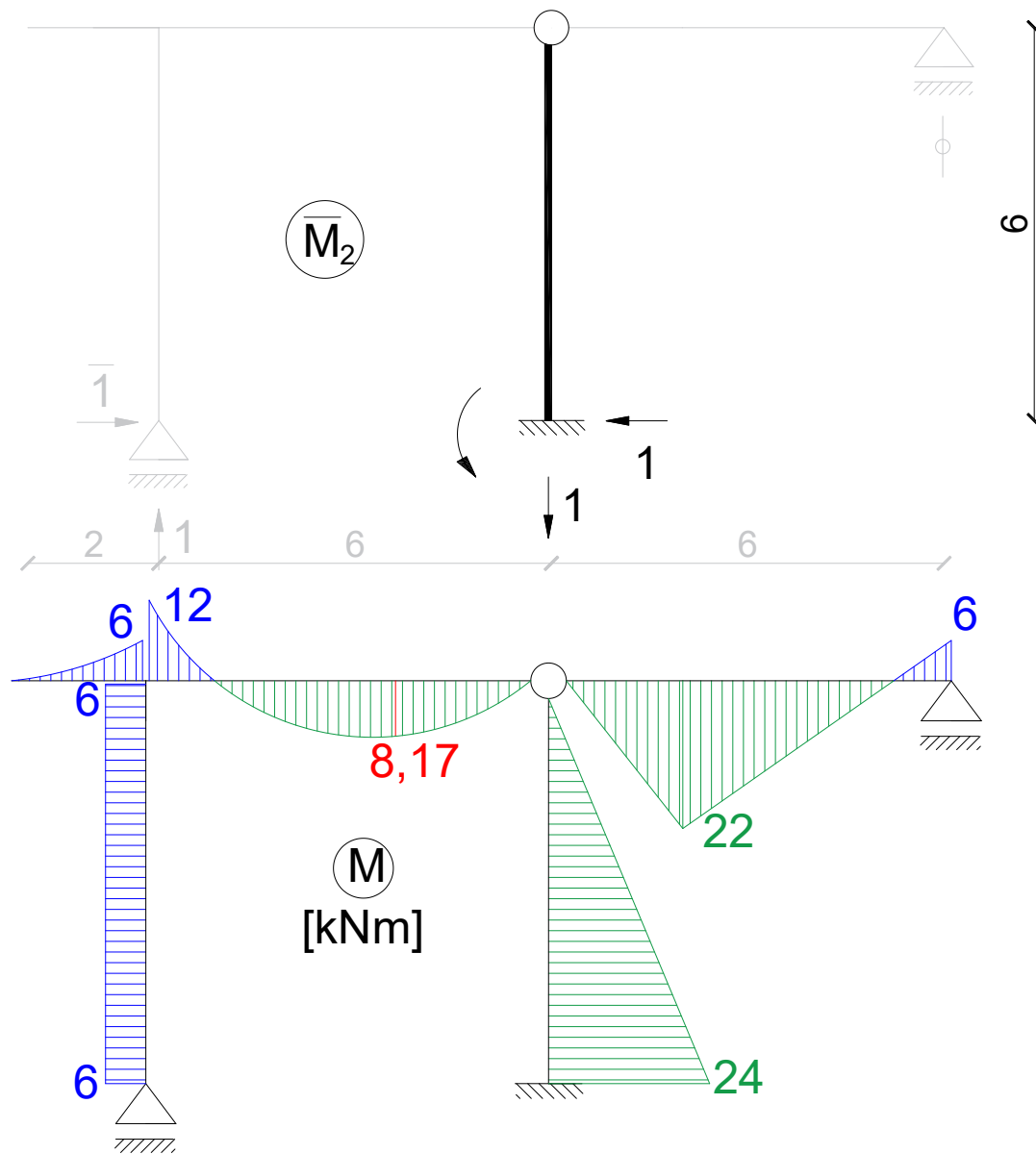
$$u_A = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



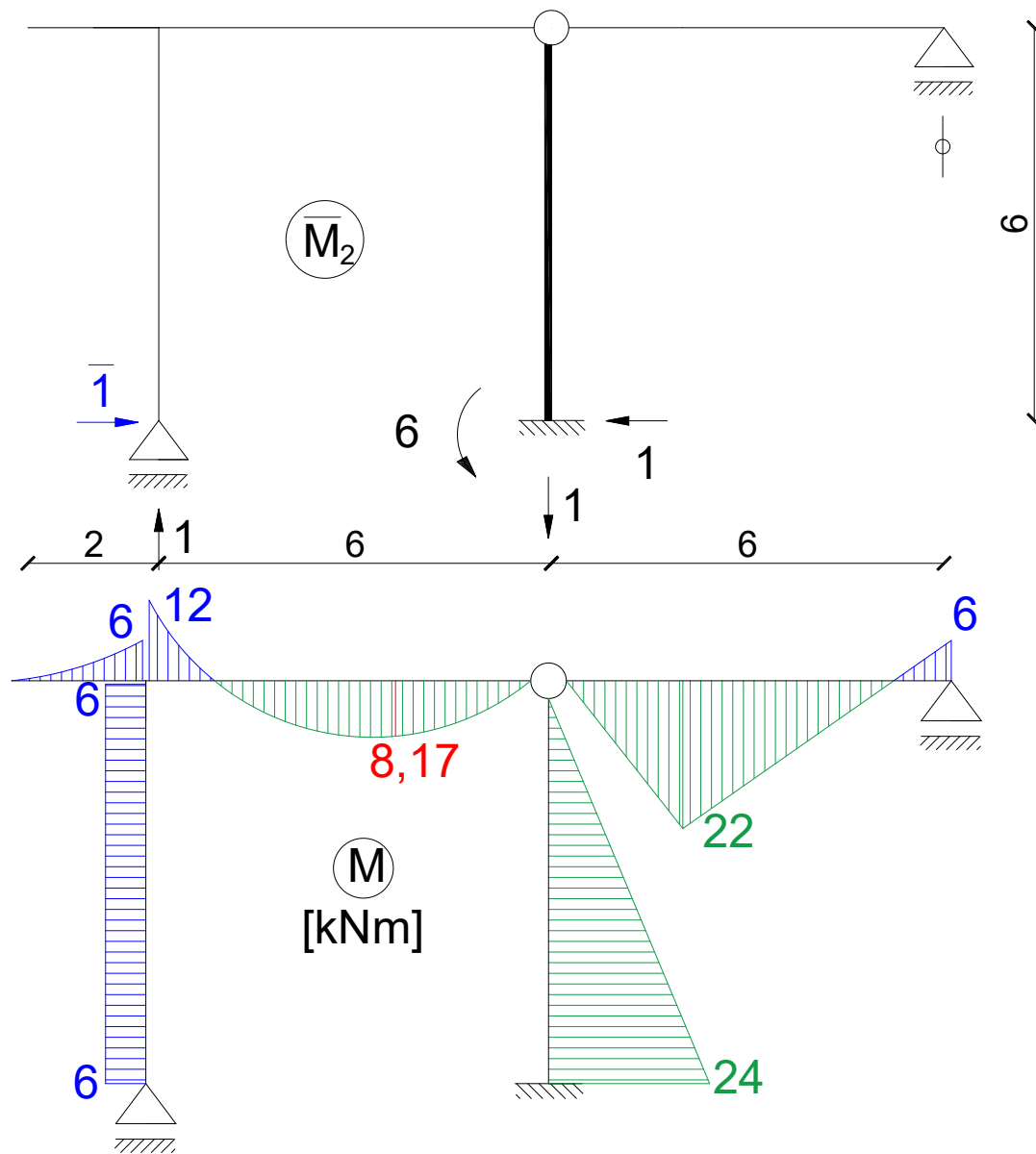
$$u_A = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



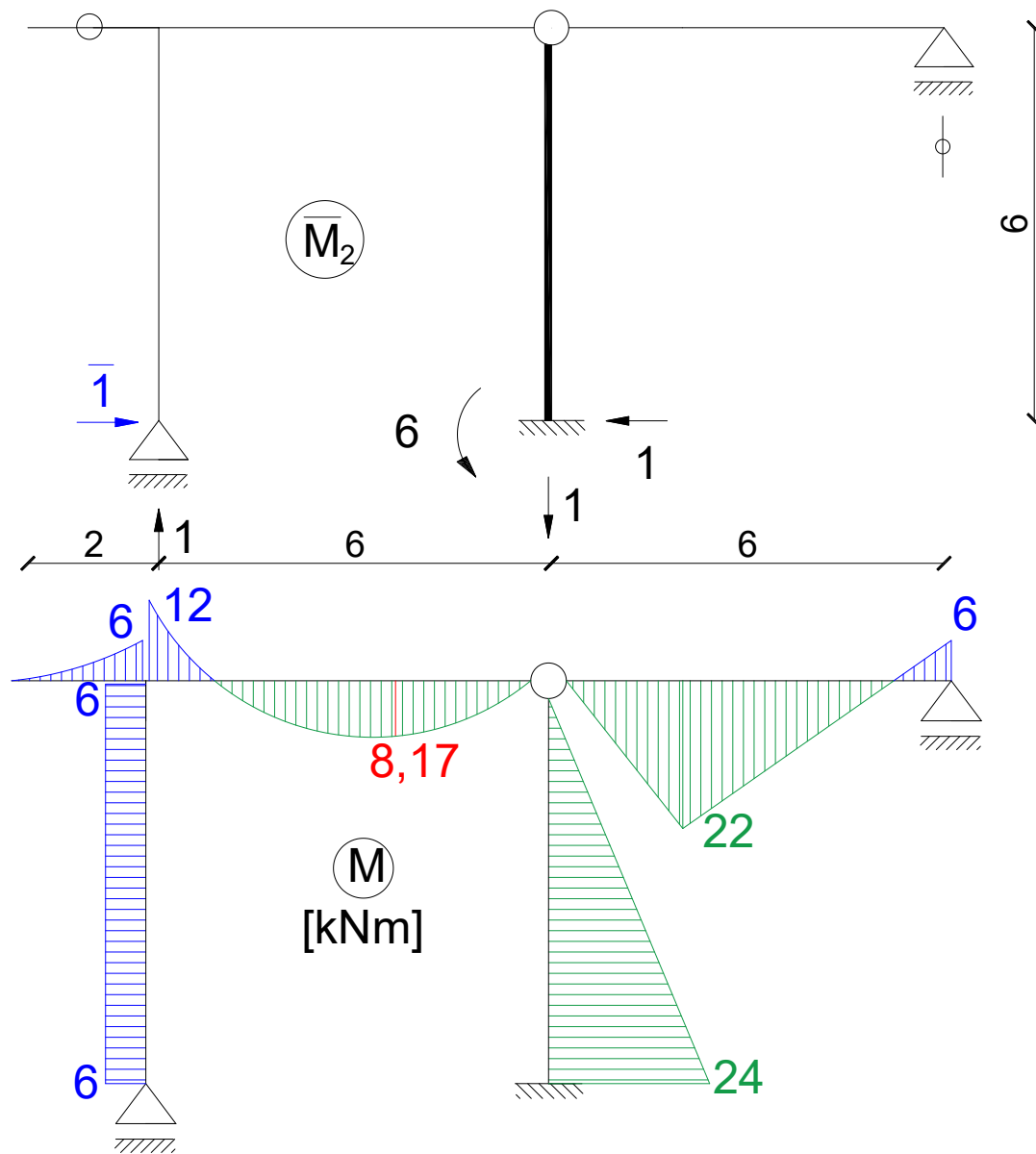
$$u_A = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



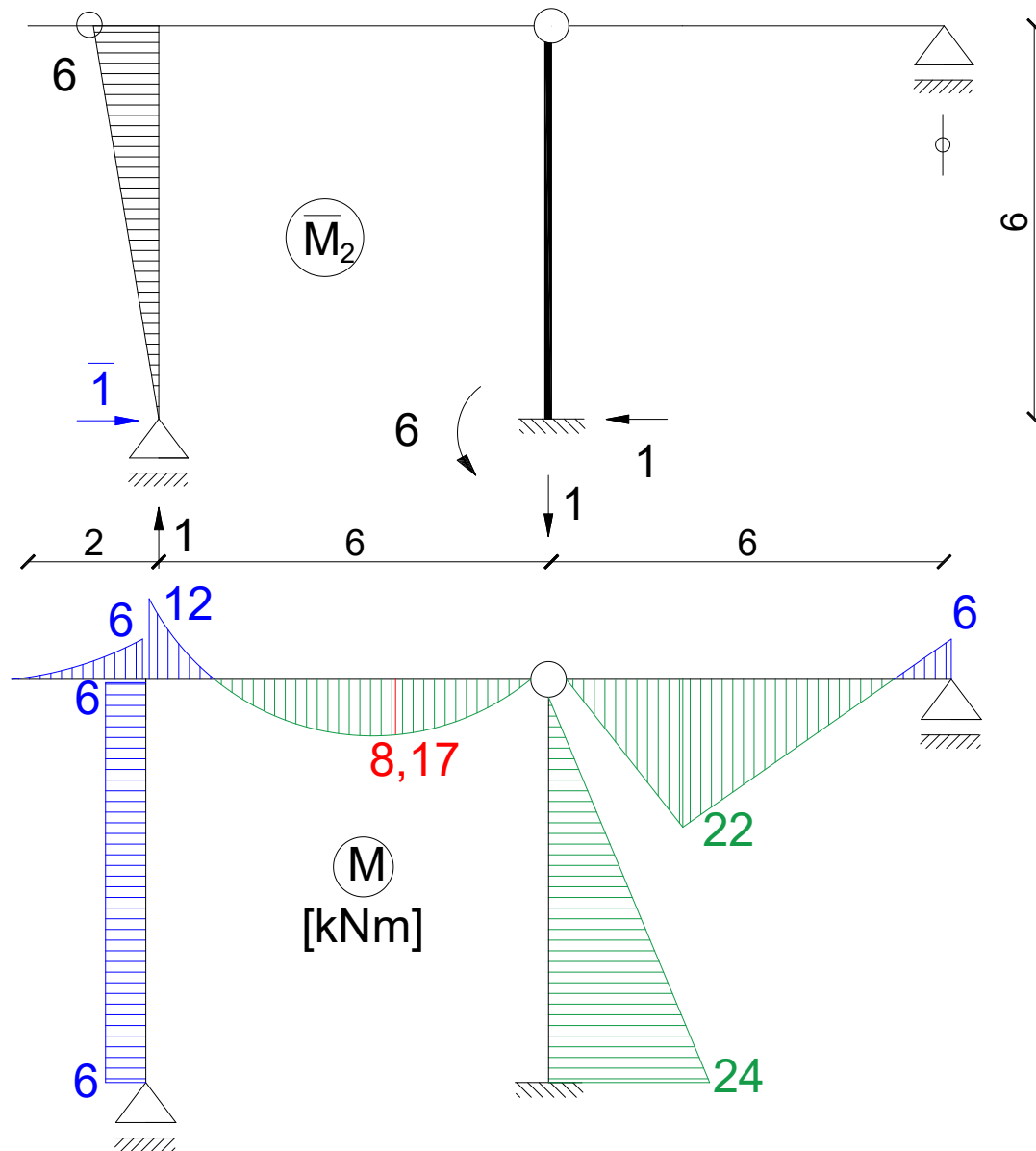
$$u_A = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



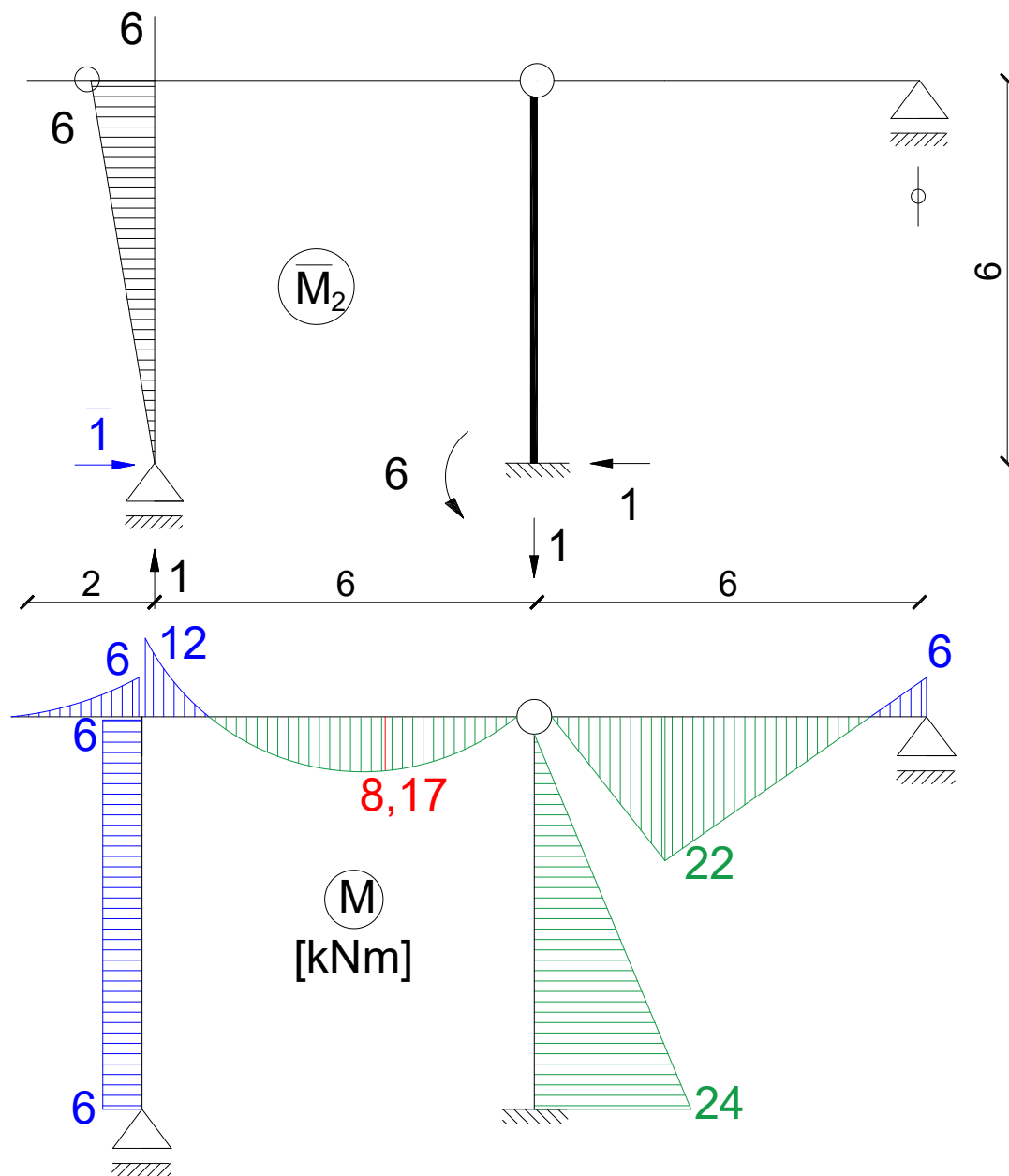
$$u_A = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



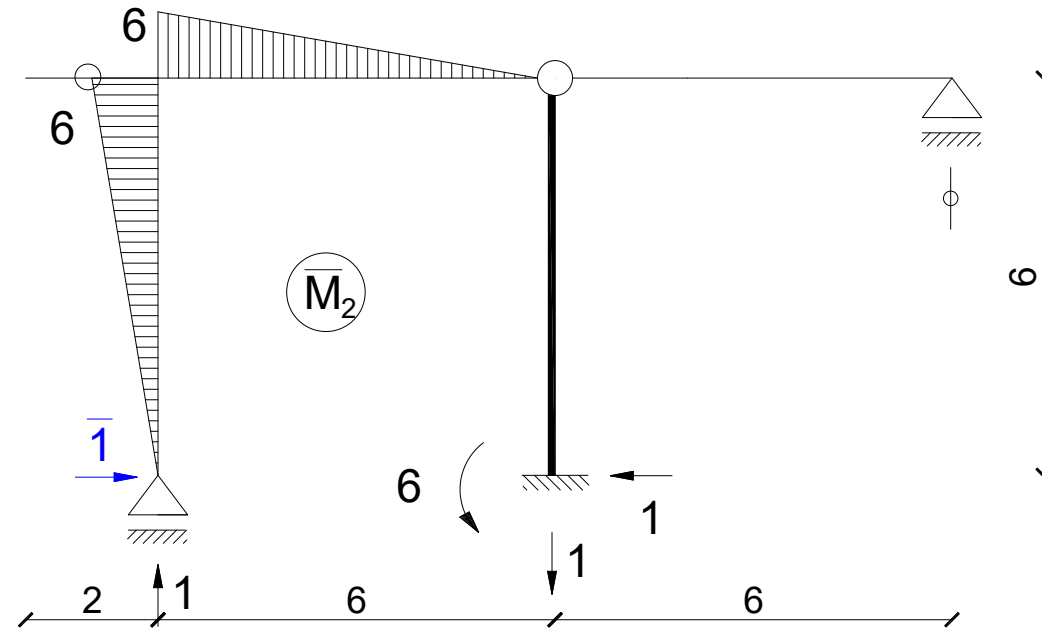
$$u_A = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:

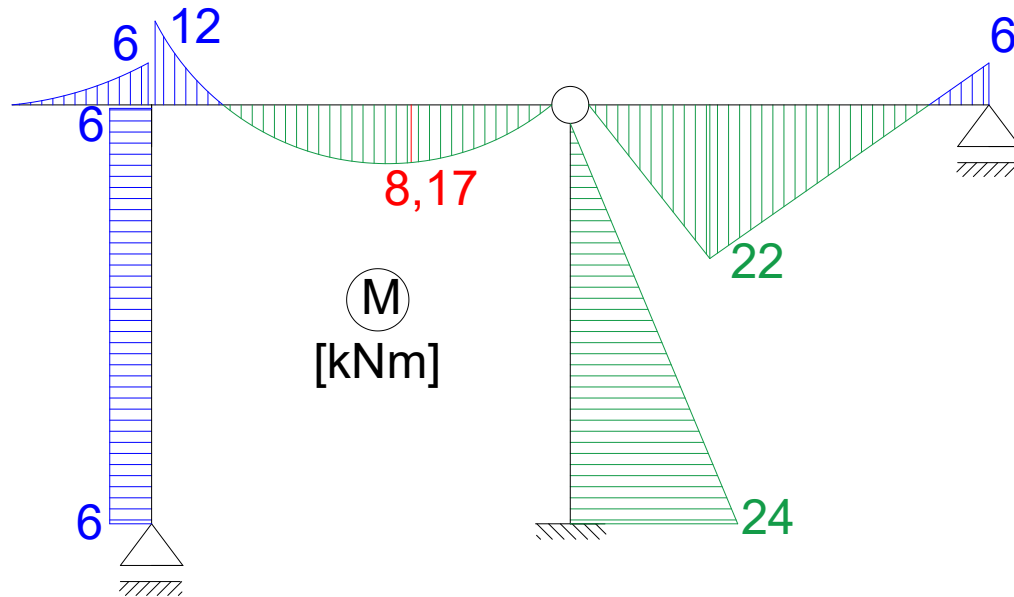


$$u_A = ?$$

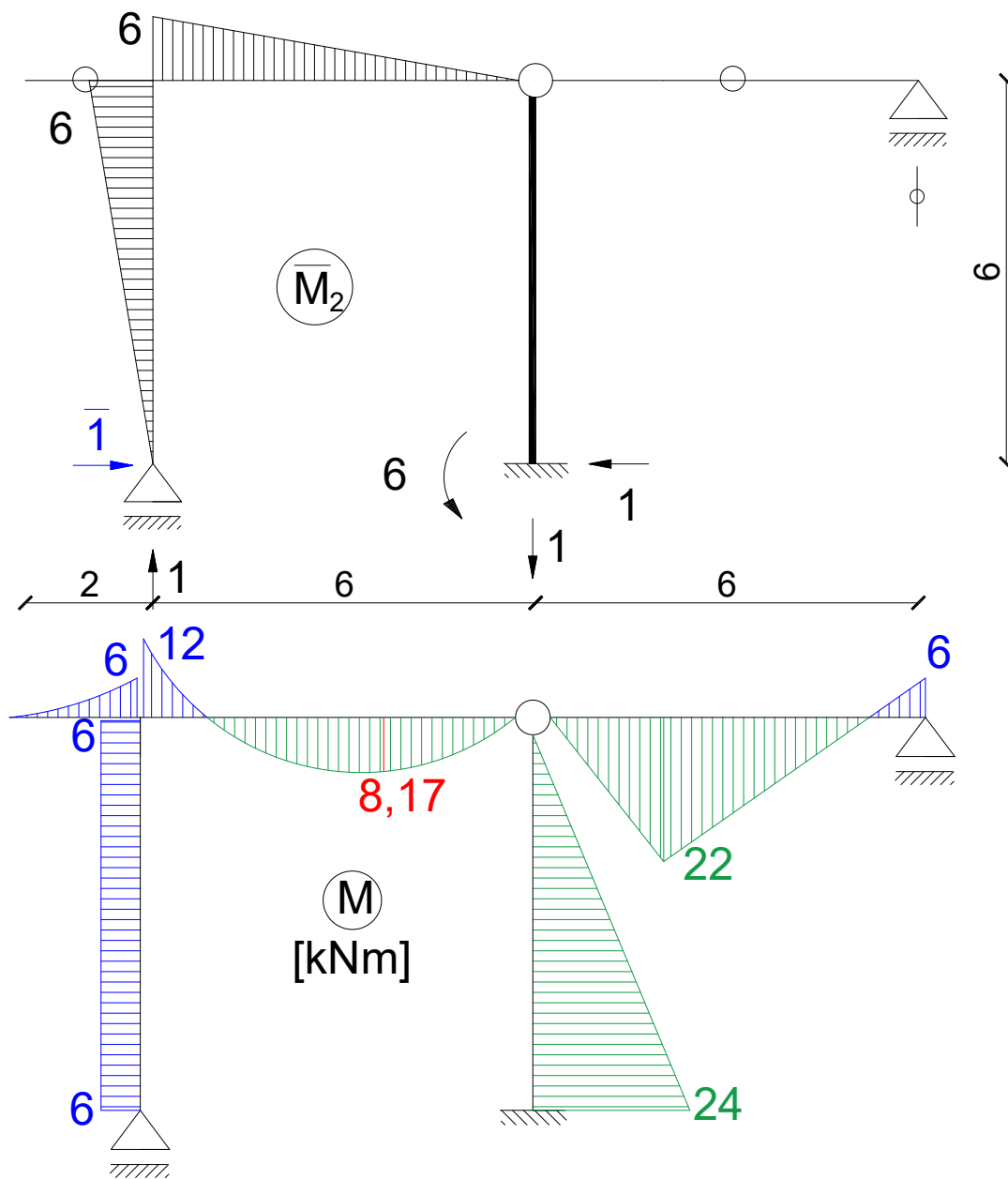
Obliczenia przemieszczeń z zasady prac wirtualnych:



$$u_A = ?$$

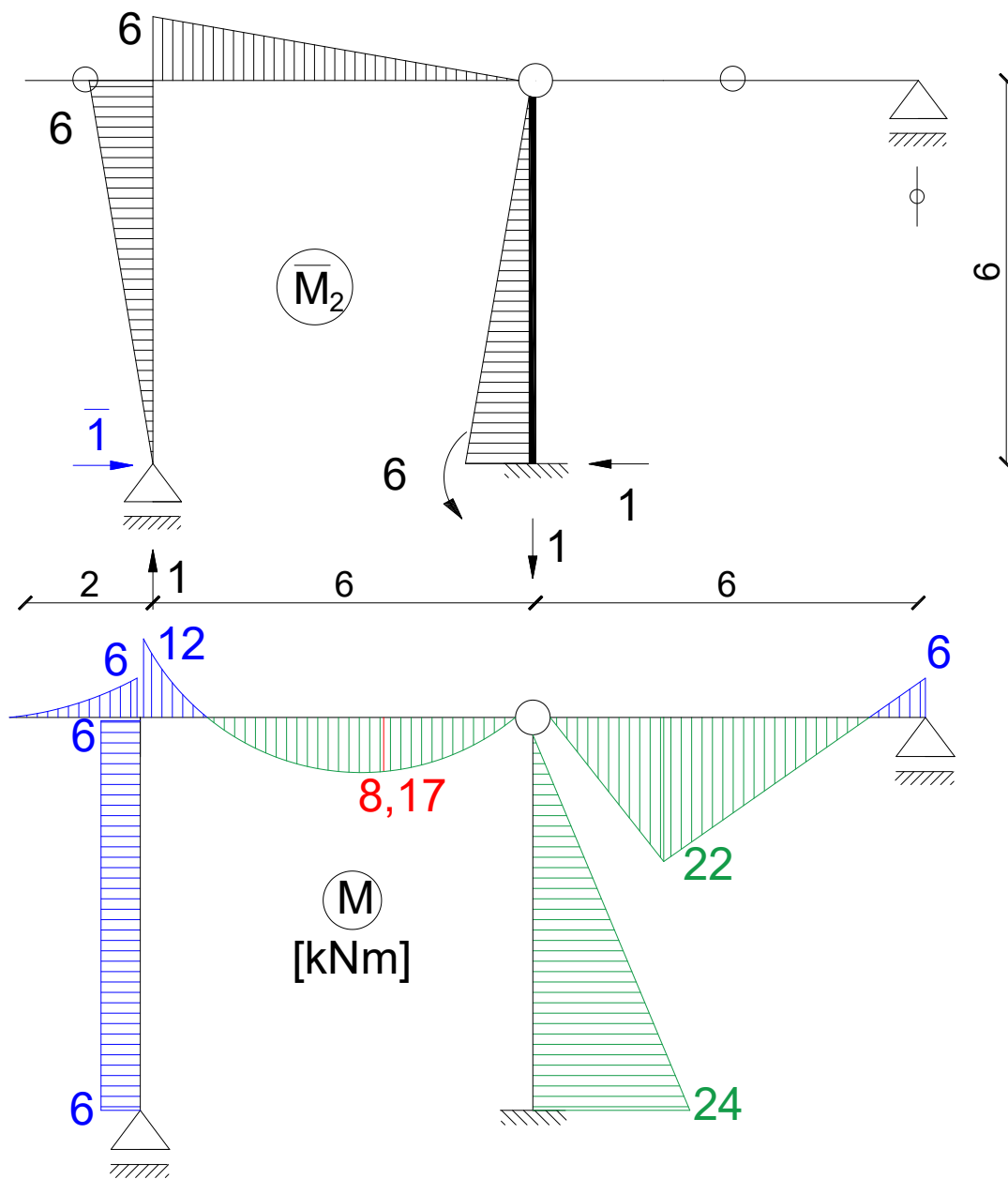


Obliczenia przemieszczeń z zasady prac wirtualnych:



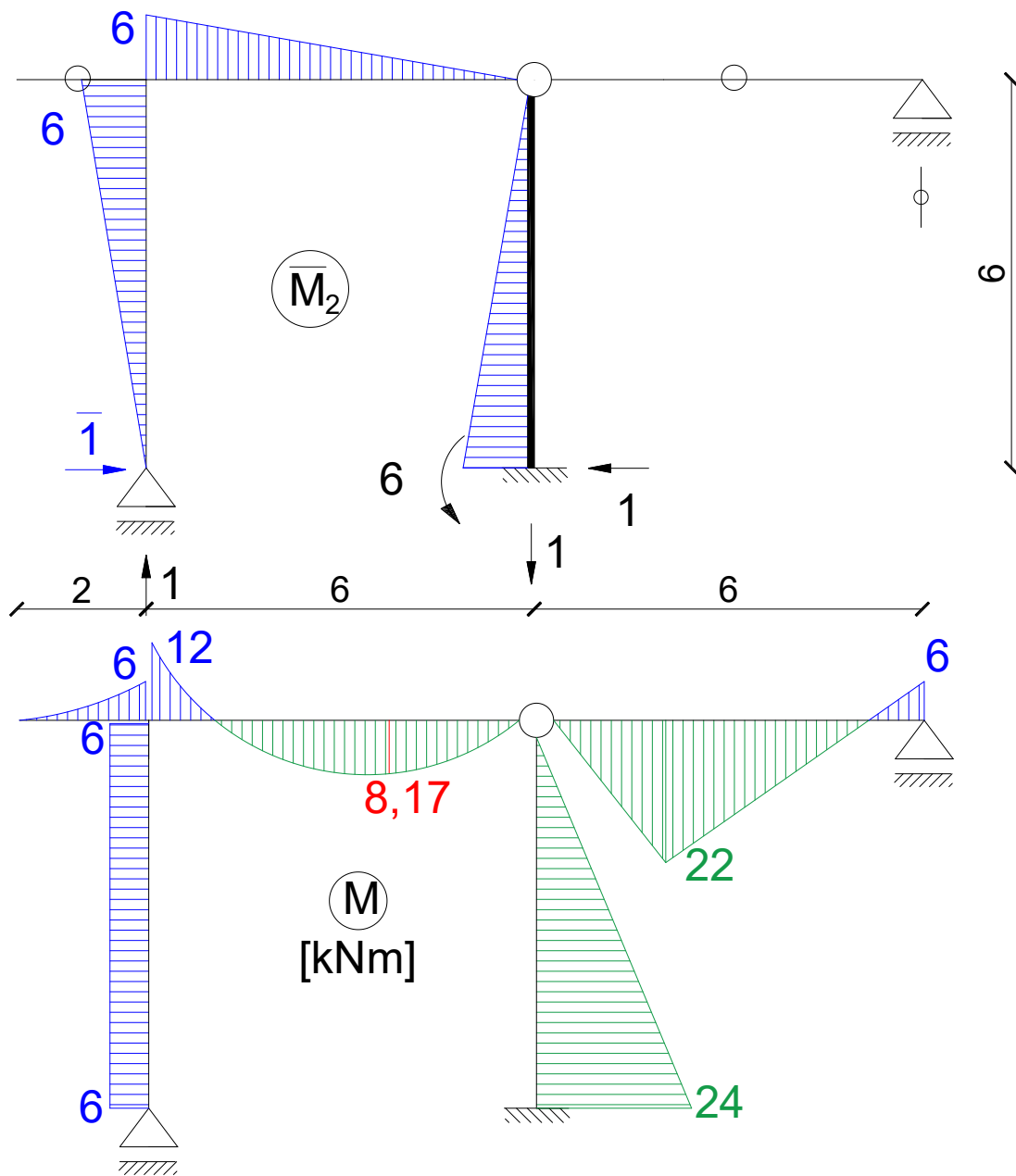
$$u_A = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



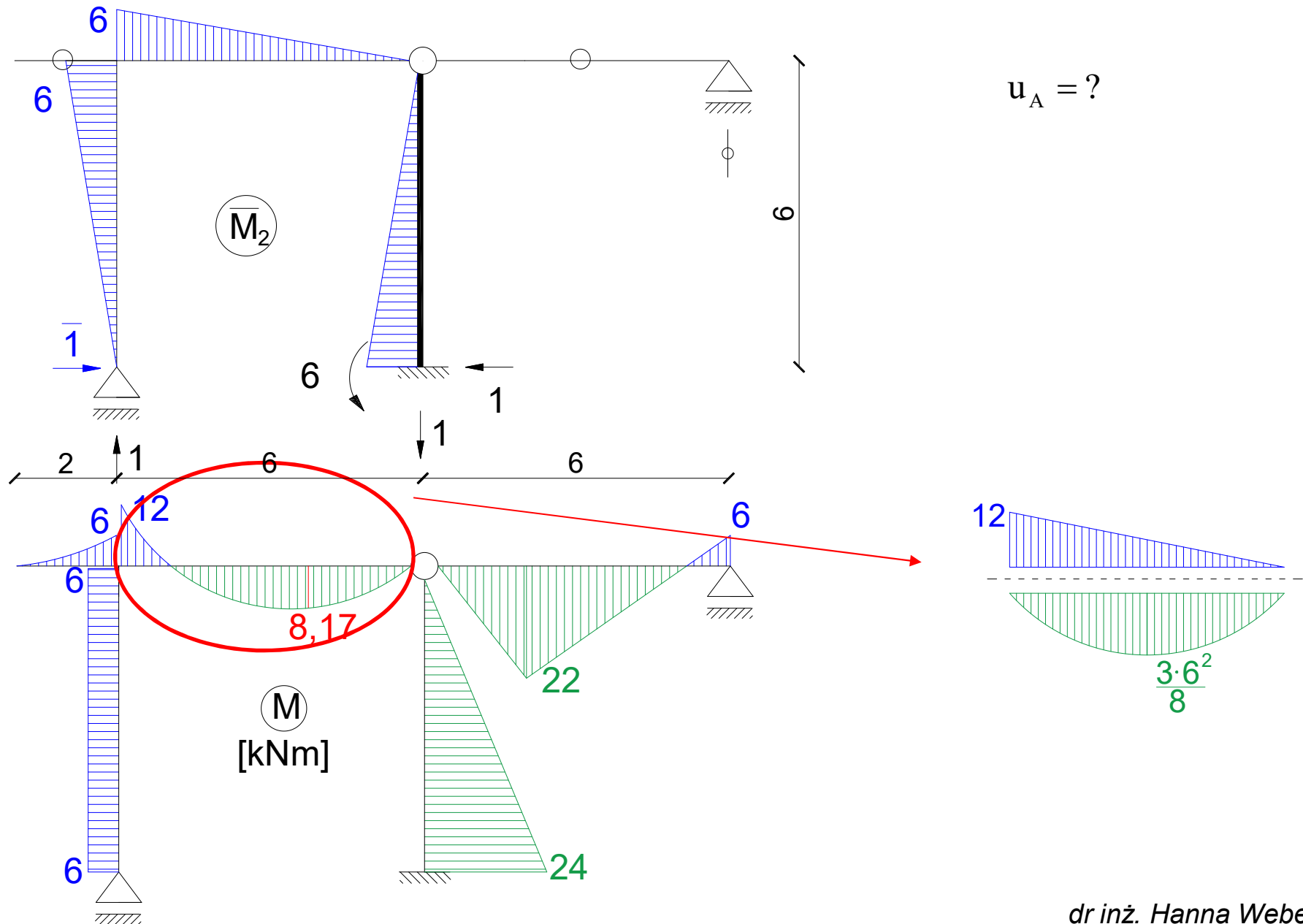
$$u_A = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:

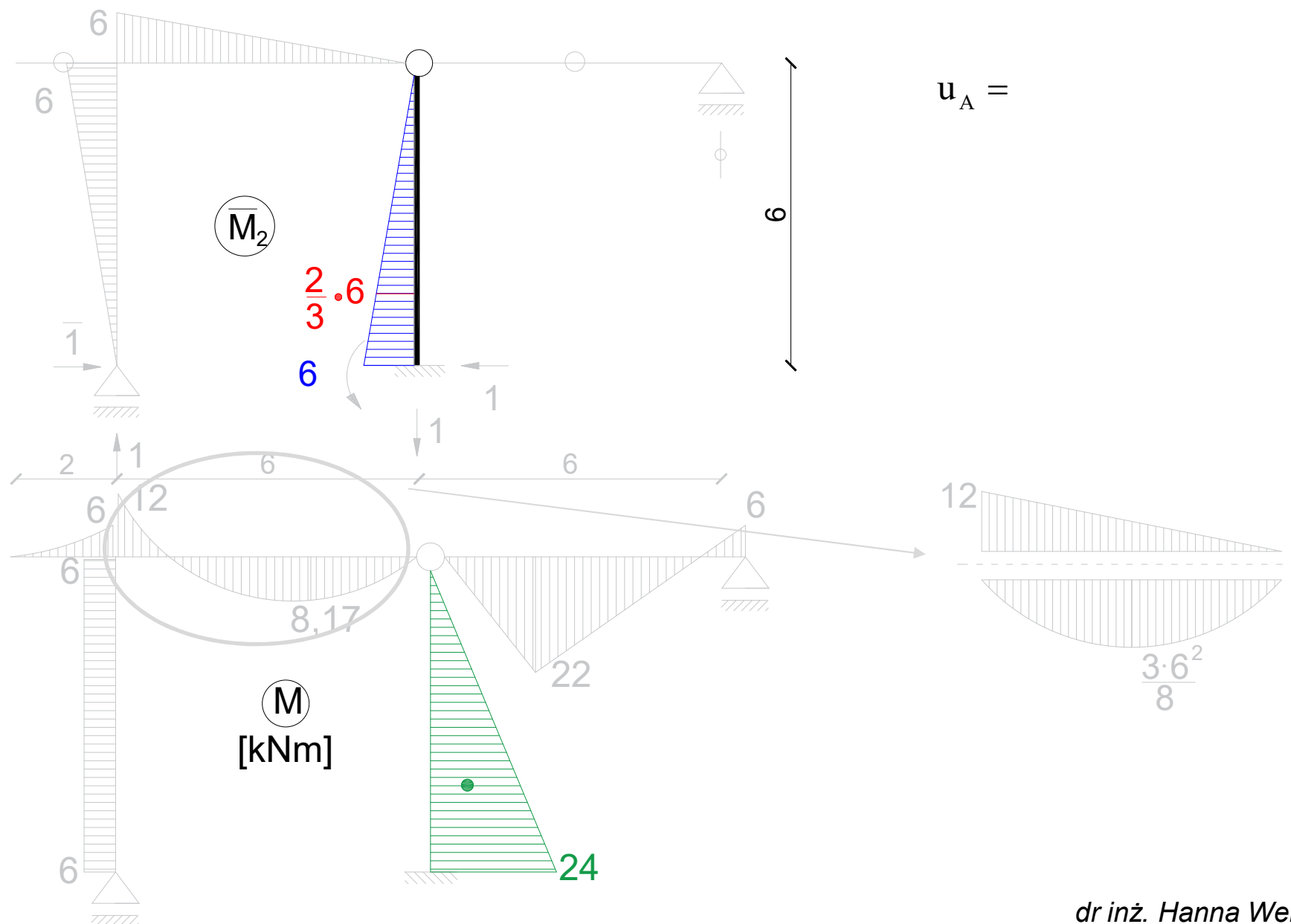


$$u_A = ?$$

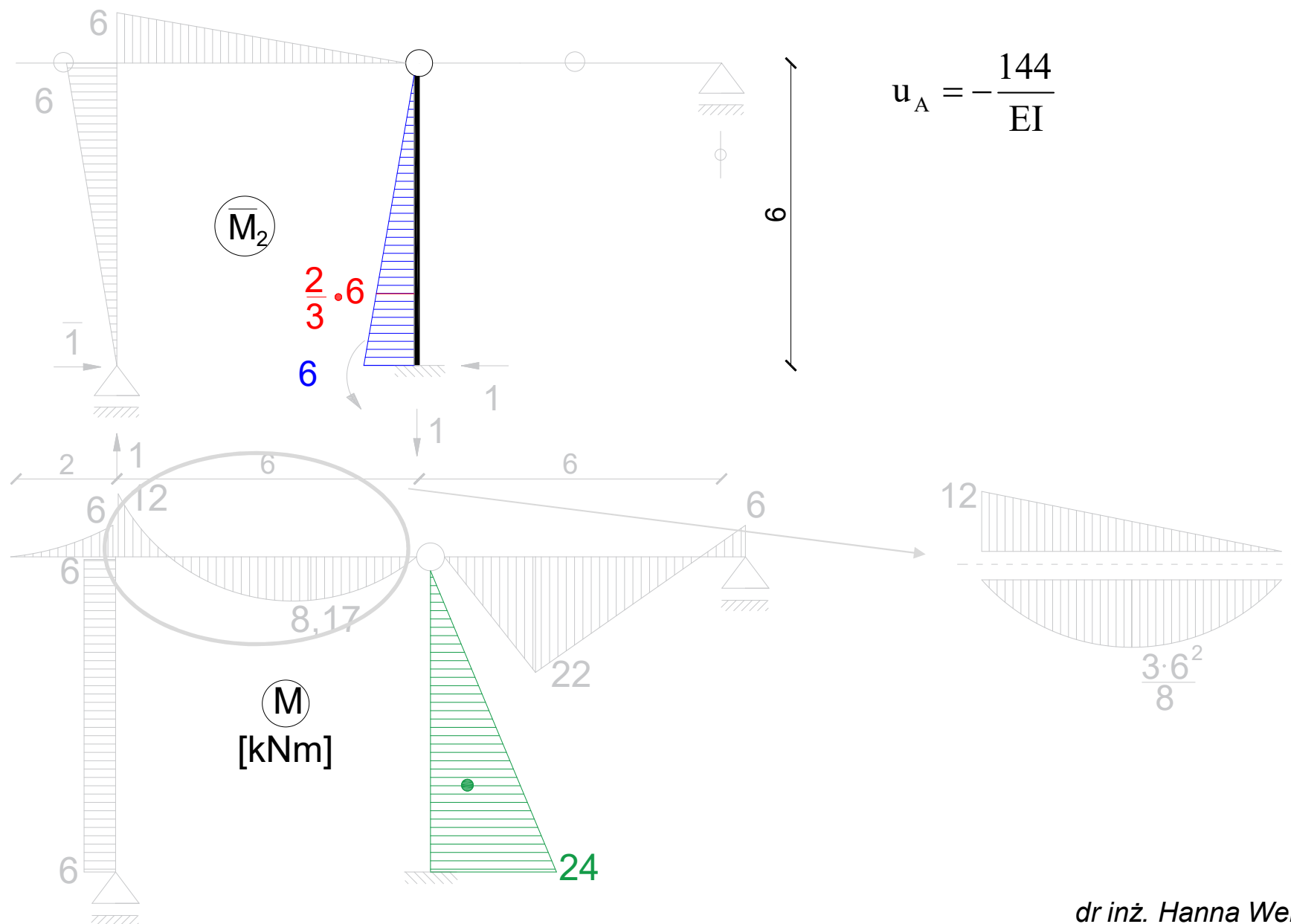
Obliczenia przemieszczeń z zasady prac wirtualnych:



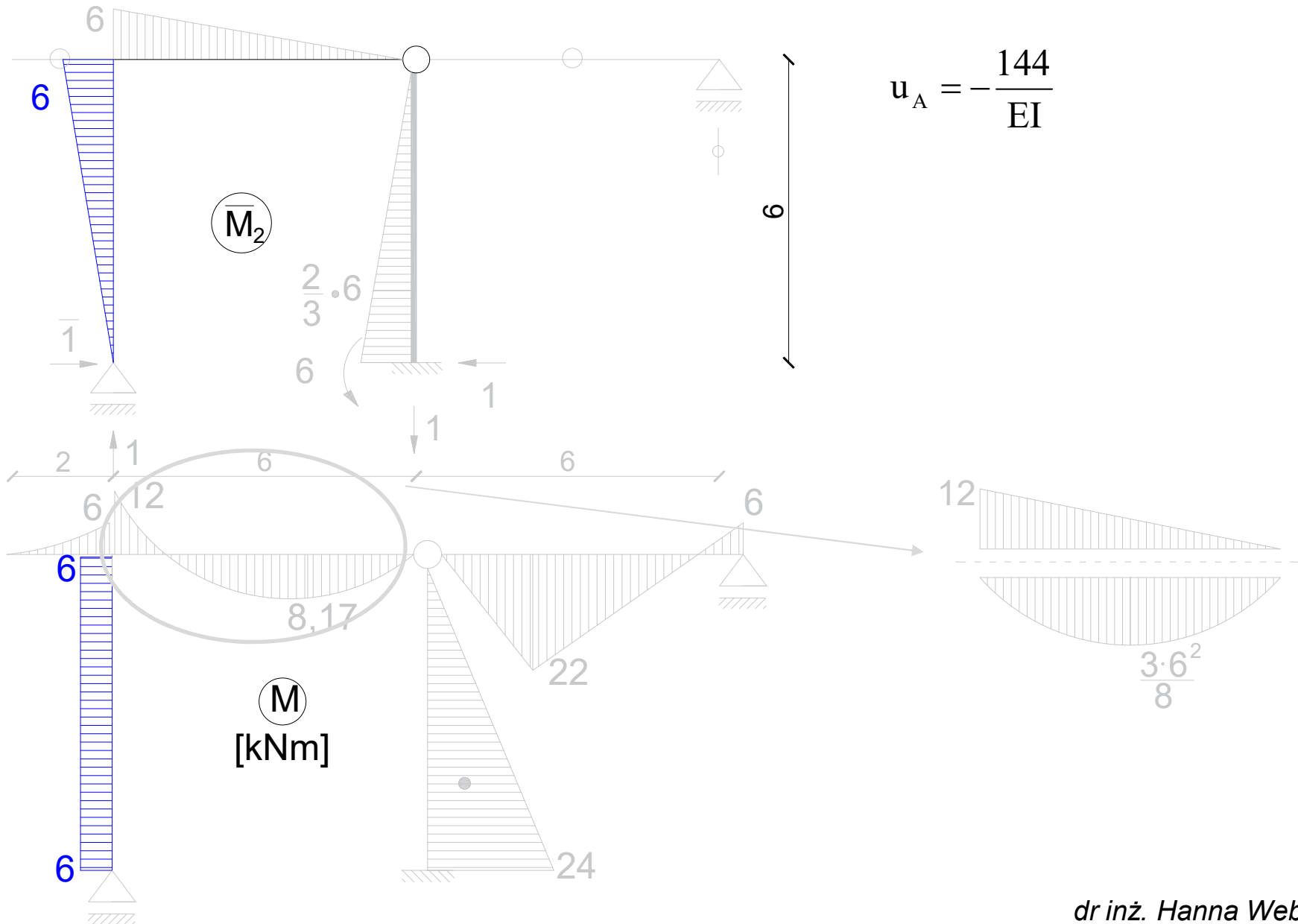
Obliczenia przemieszczeń z zasady prac wirtualnych:



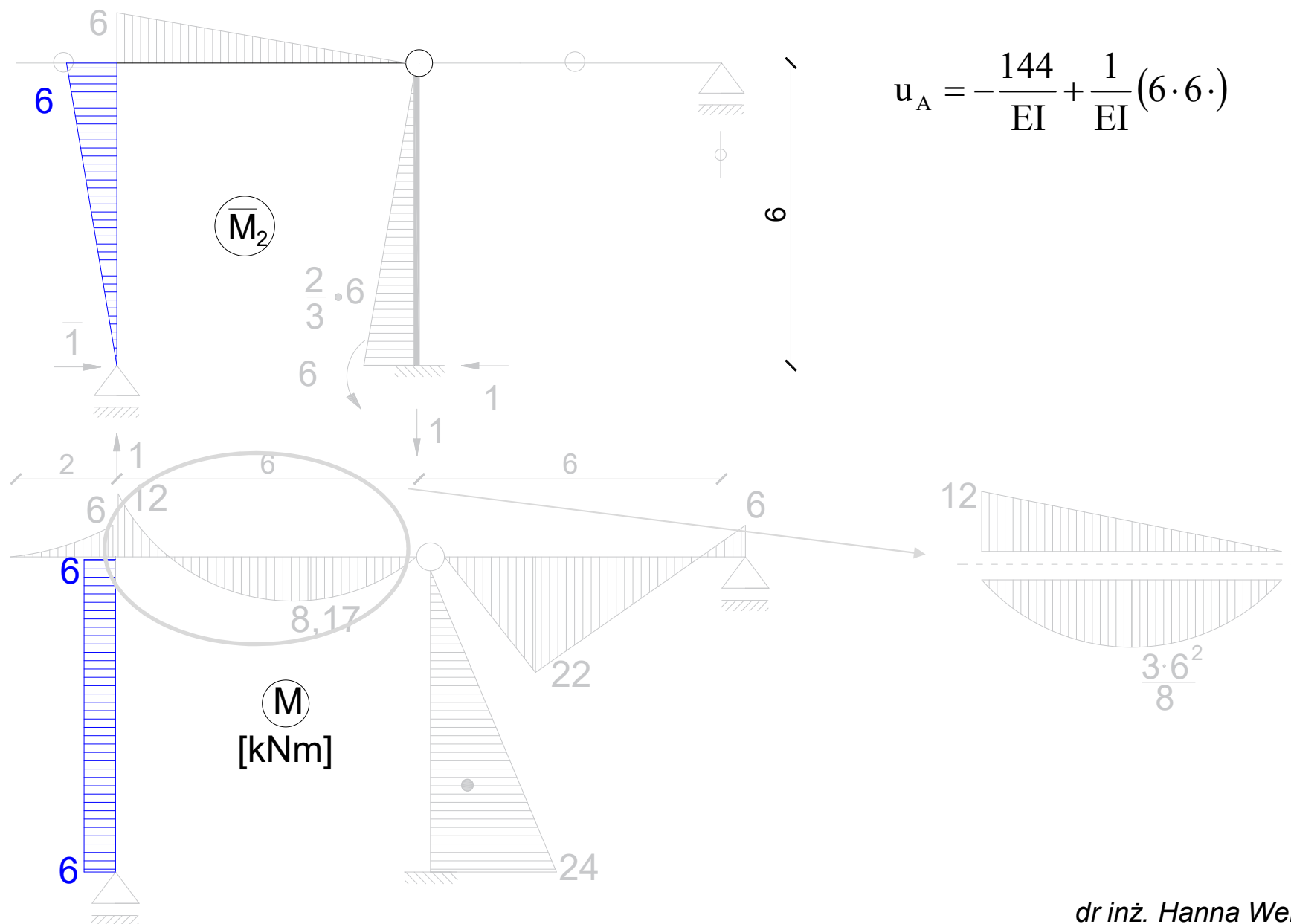
Obliczenia przemieszczeń z zasady prac wirtualnych:



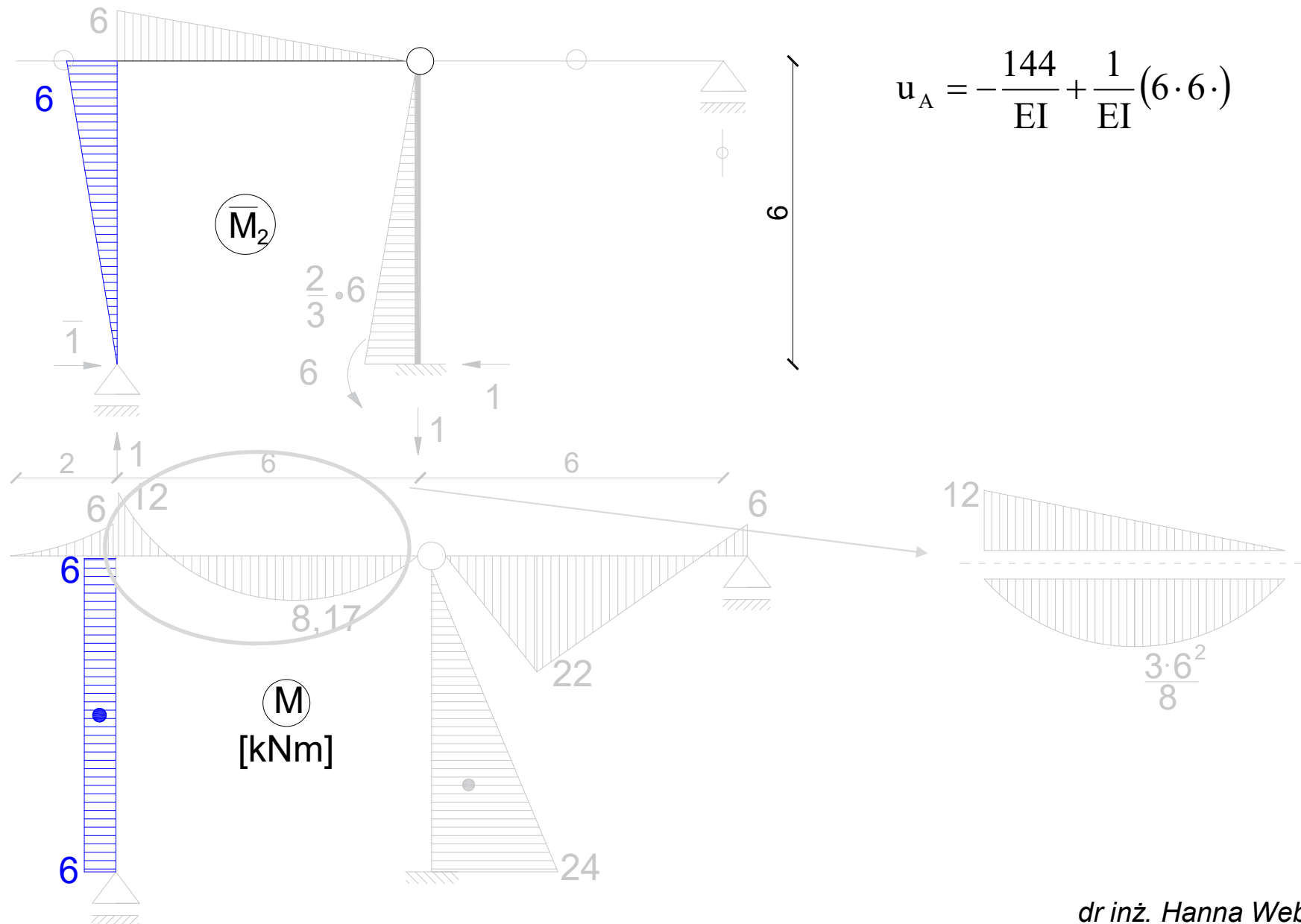
Obliczenia przemieszczeń z zasady prac wirtualnych:



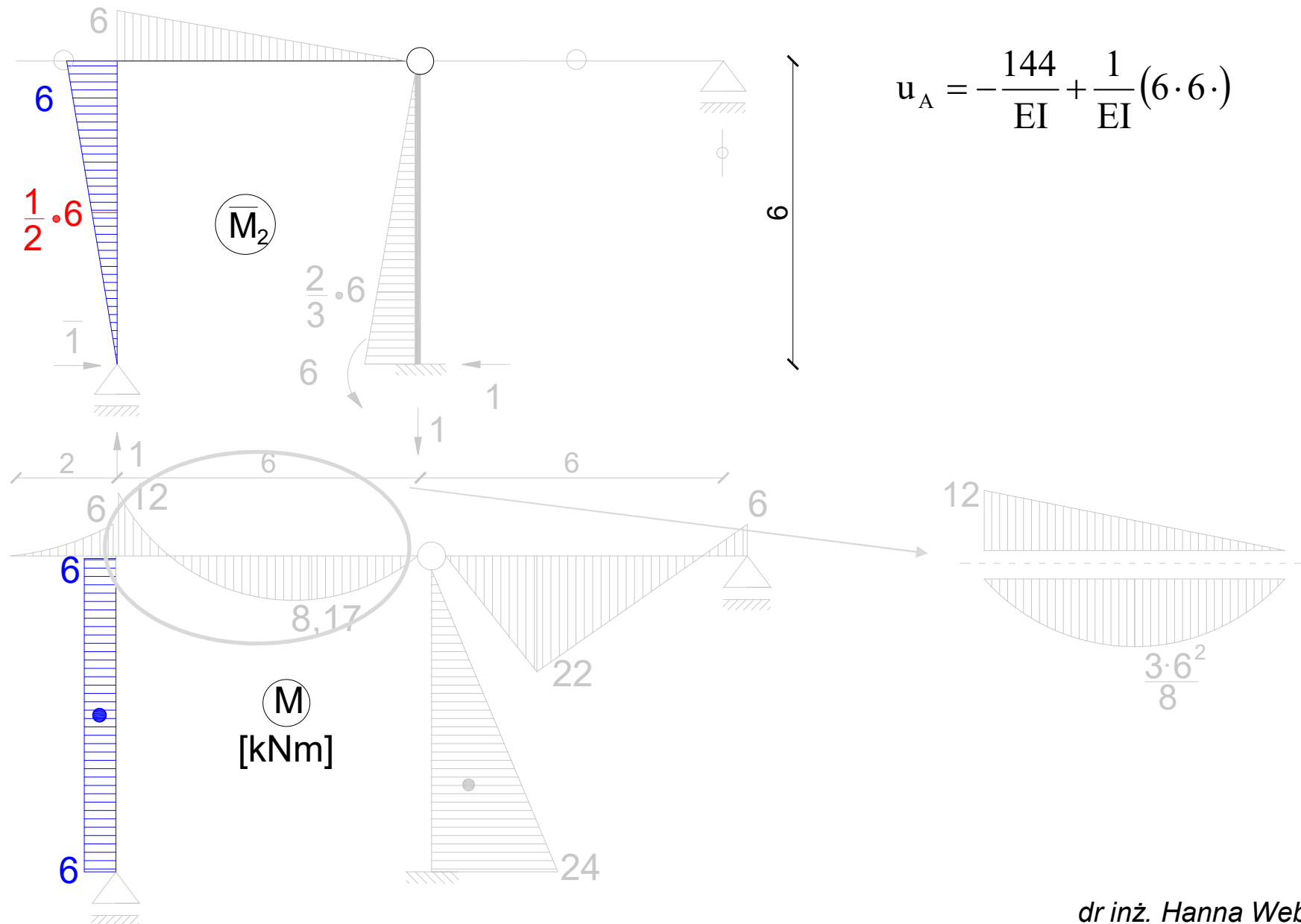
Obliczenia przemieszczeń z zasady prac wirtualnych:



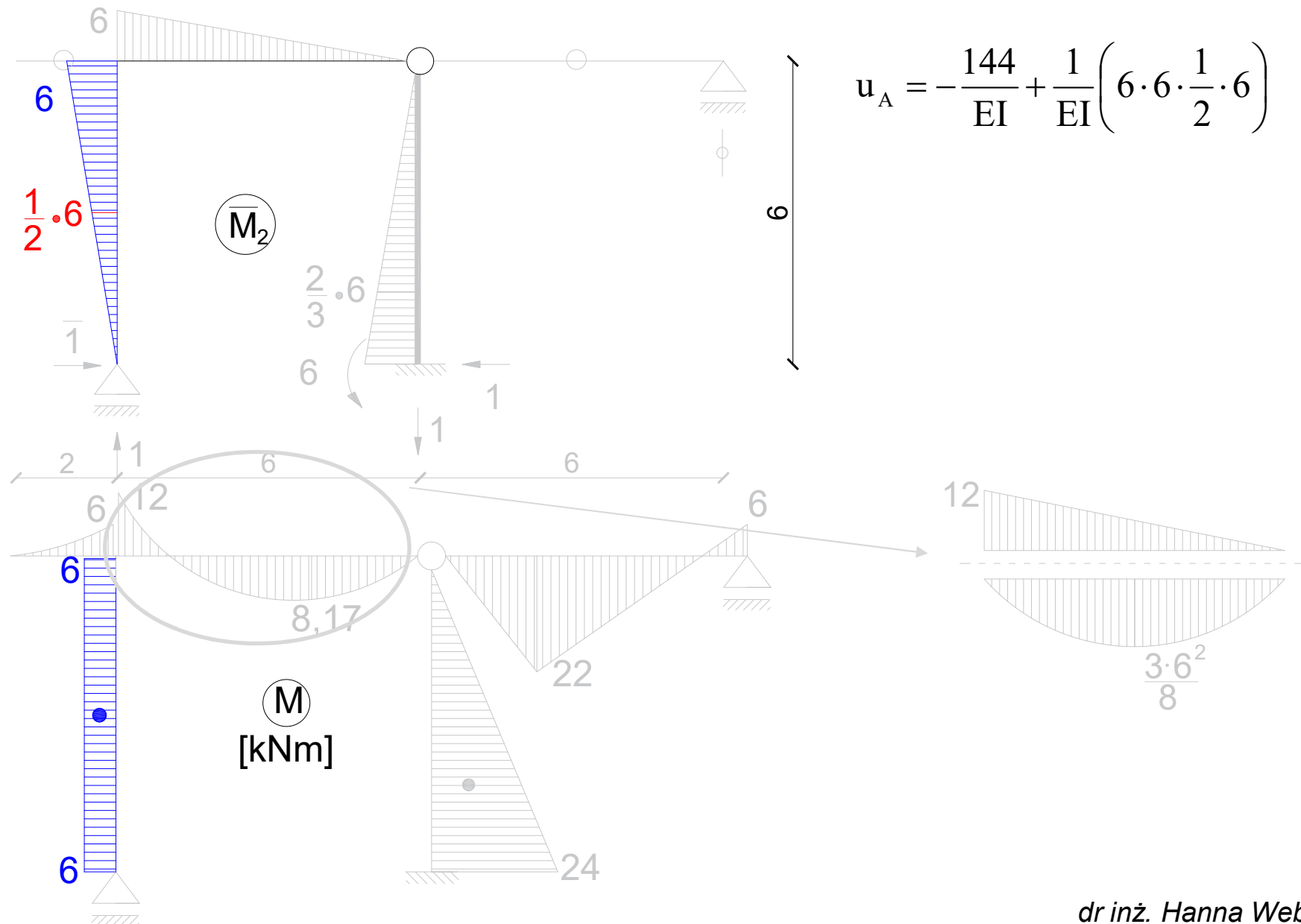
Obliczenia przemieszczeń z zasady prac wirtualnych:



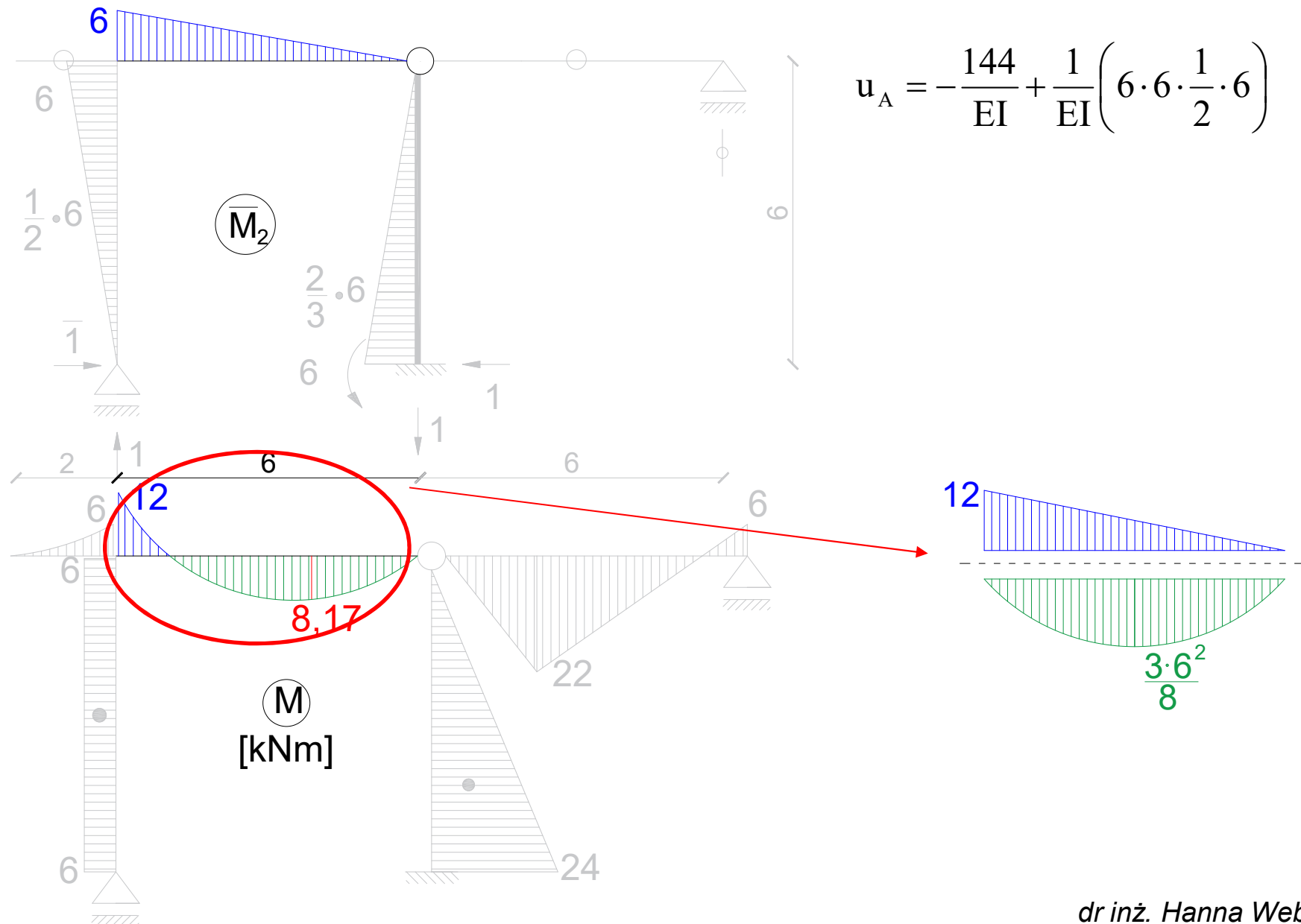
Obliczenia przemieszczeń z zasady prac wirtualnych:



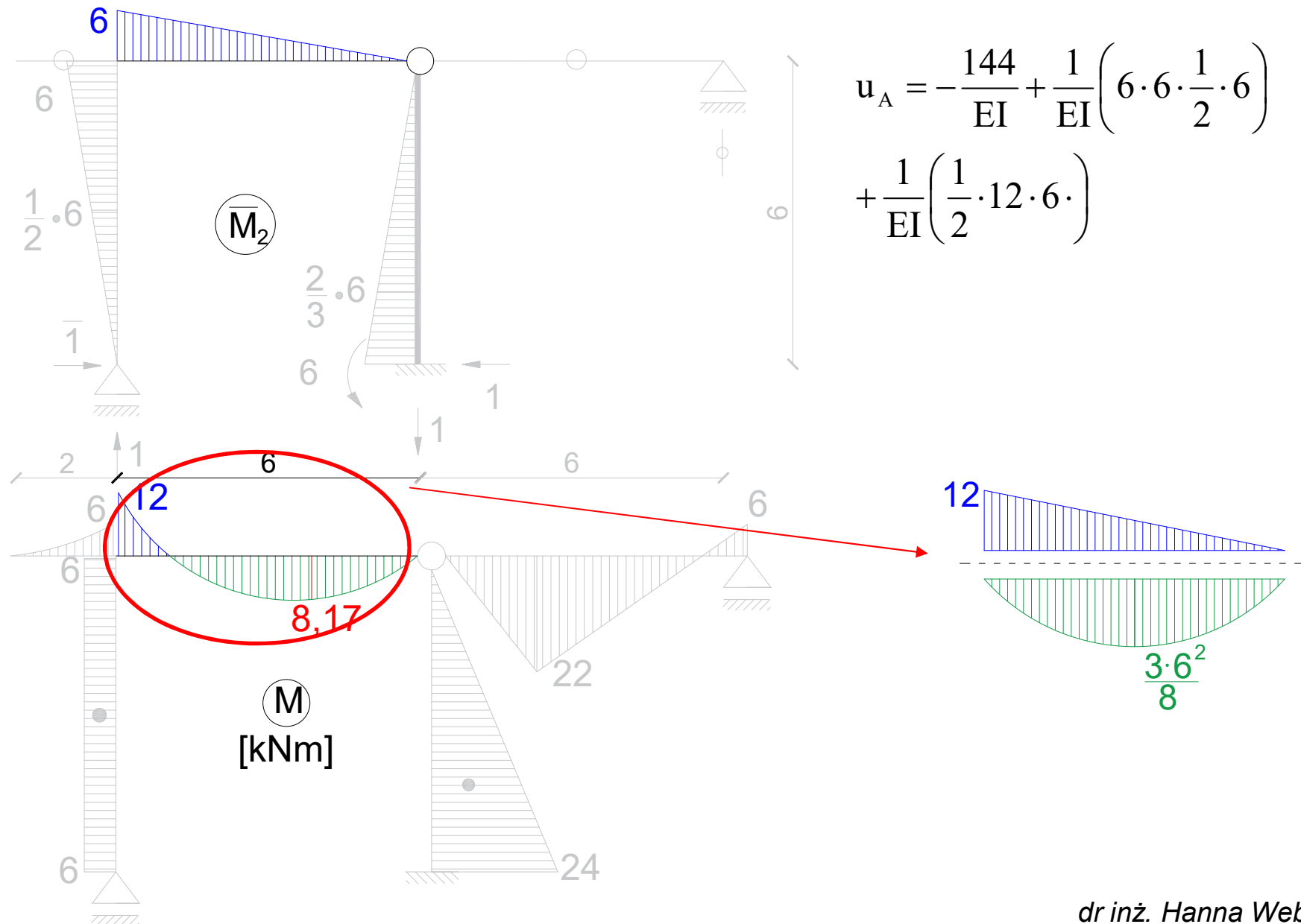
Obliczenia przemieszczeń z zasady prac wirtualnych:



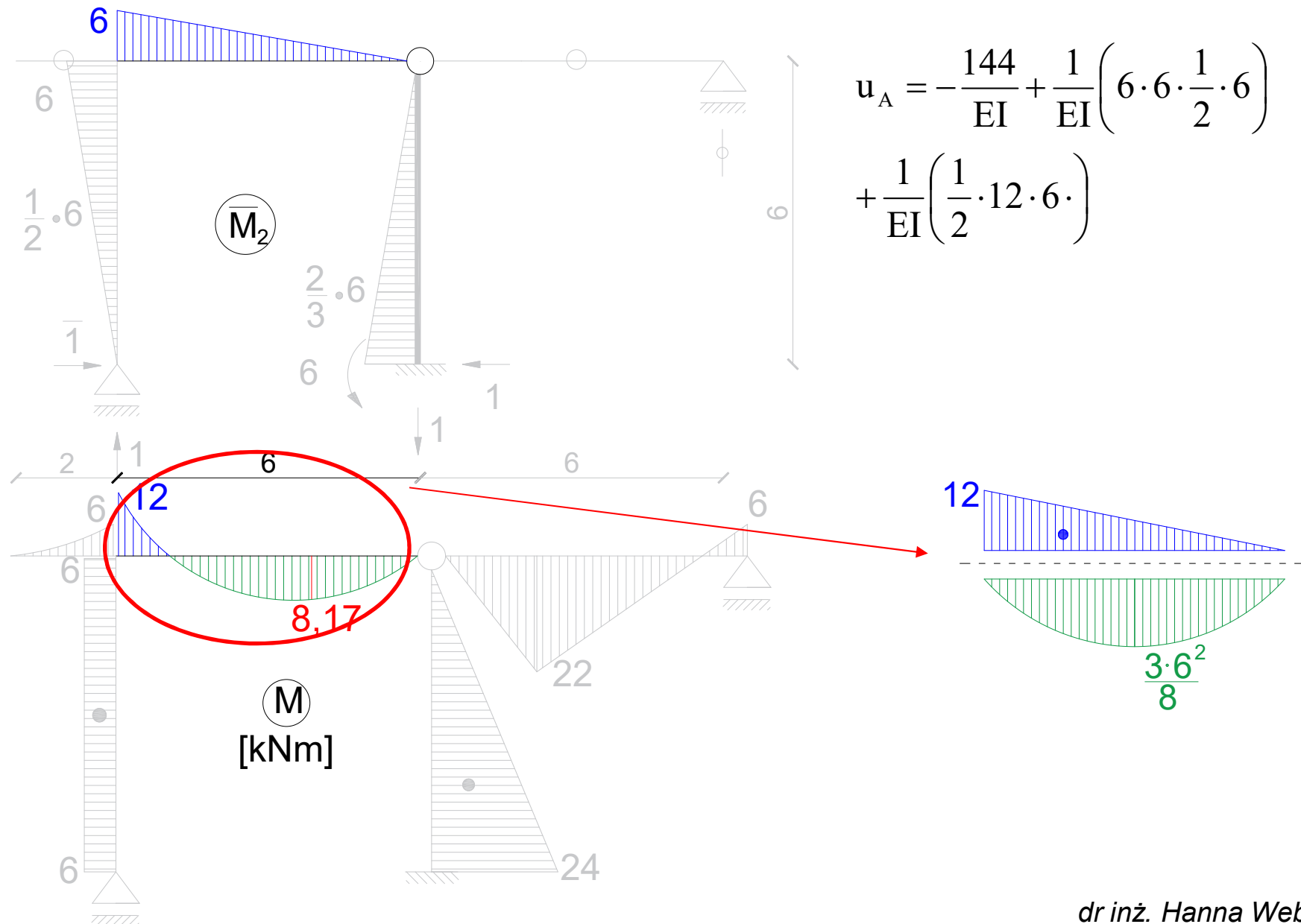
Obliczenia przemieszczeń z zasady prac wirtualnych:



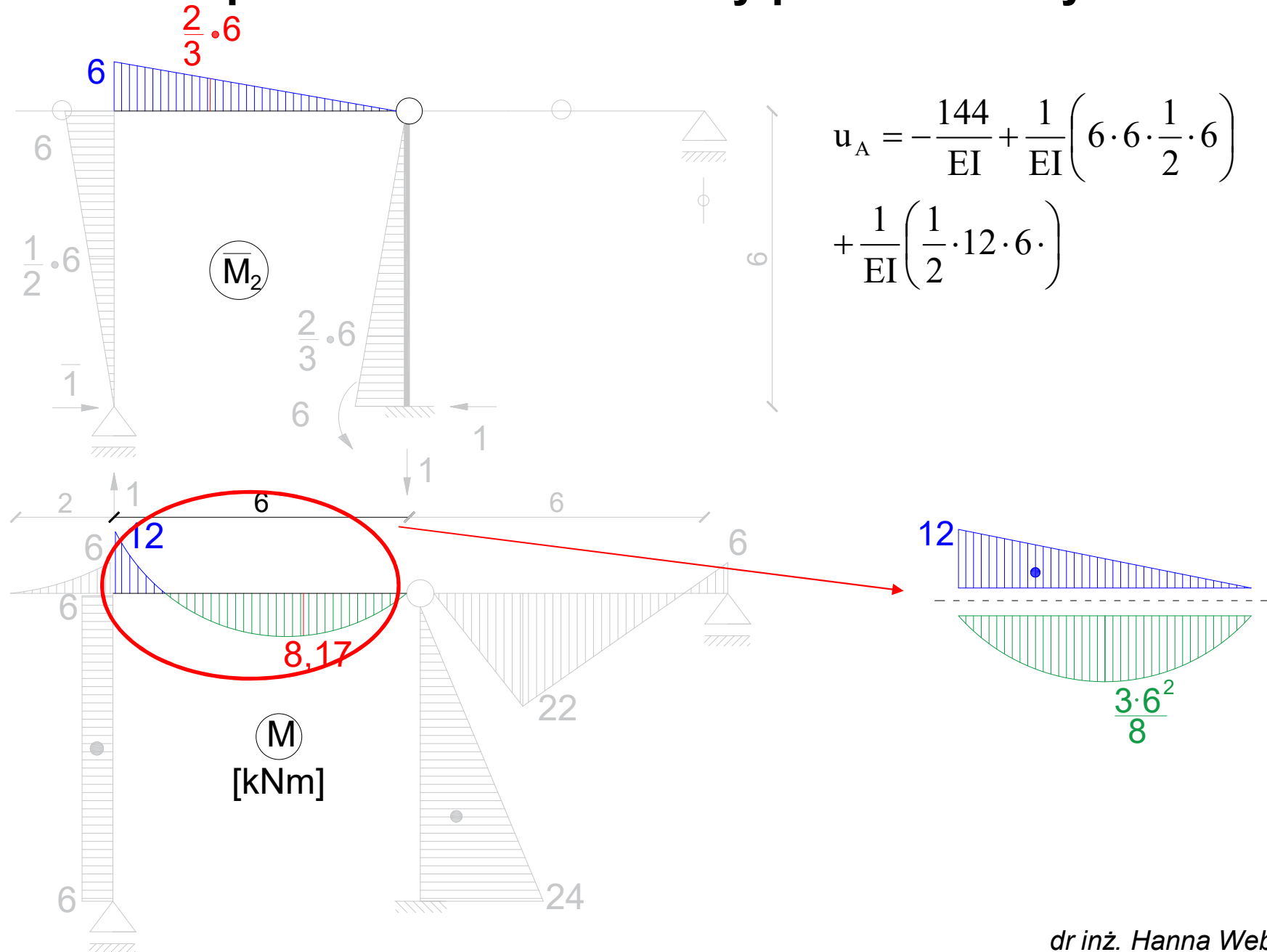
Obliczenia przemieszczeń z zasady prac wirtualnych:



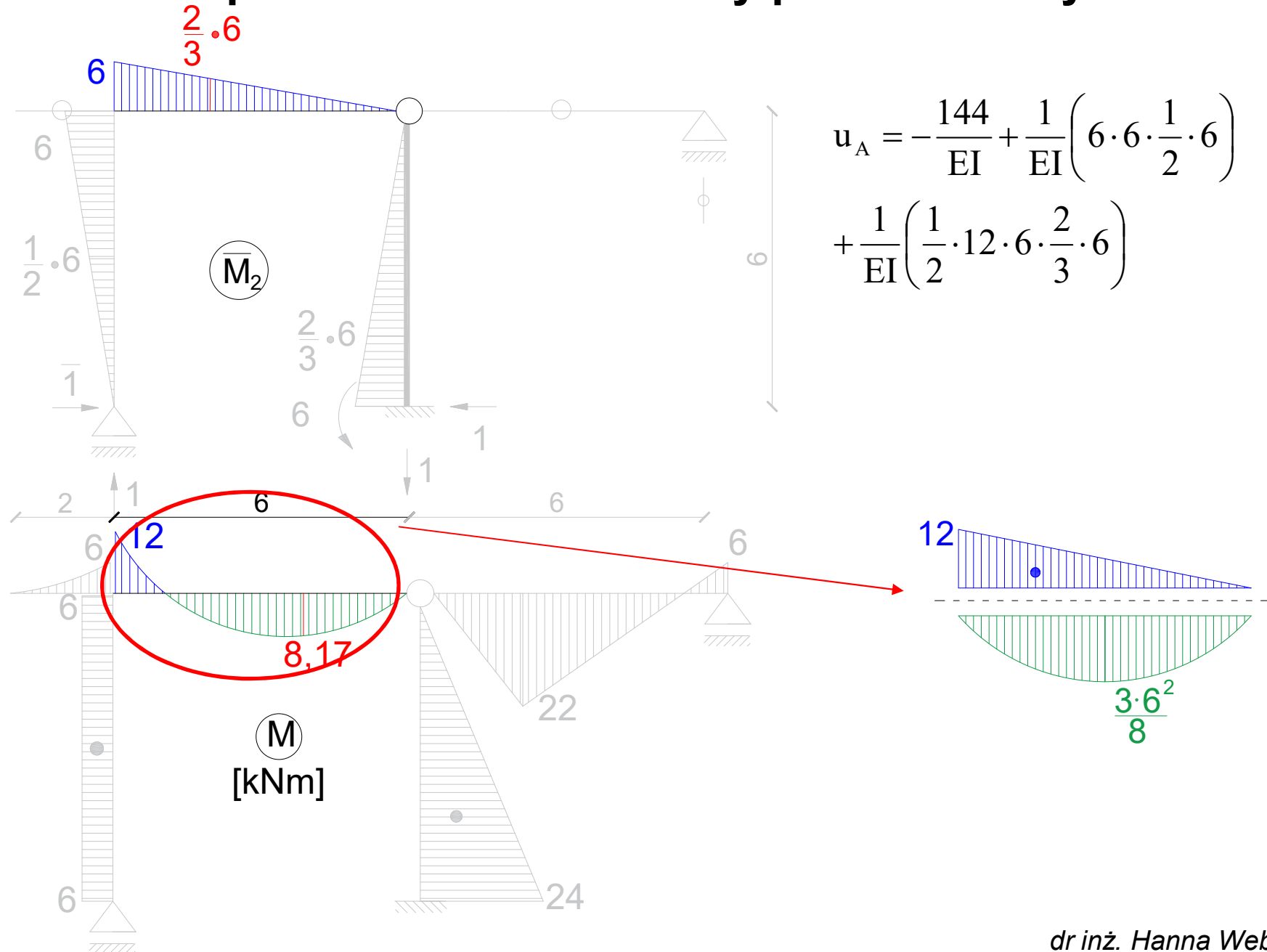
Obliczenia przemieszczeń z zasady prac wirtualnych:



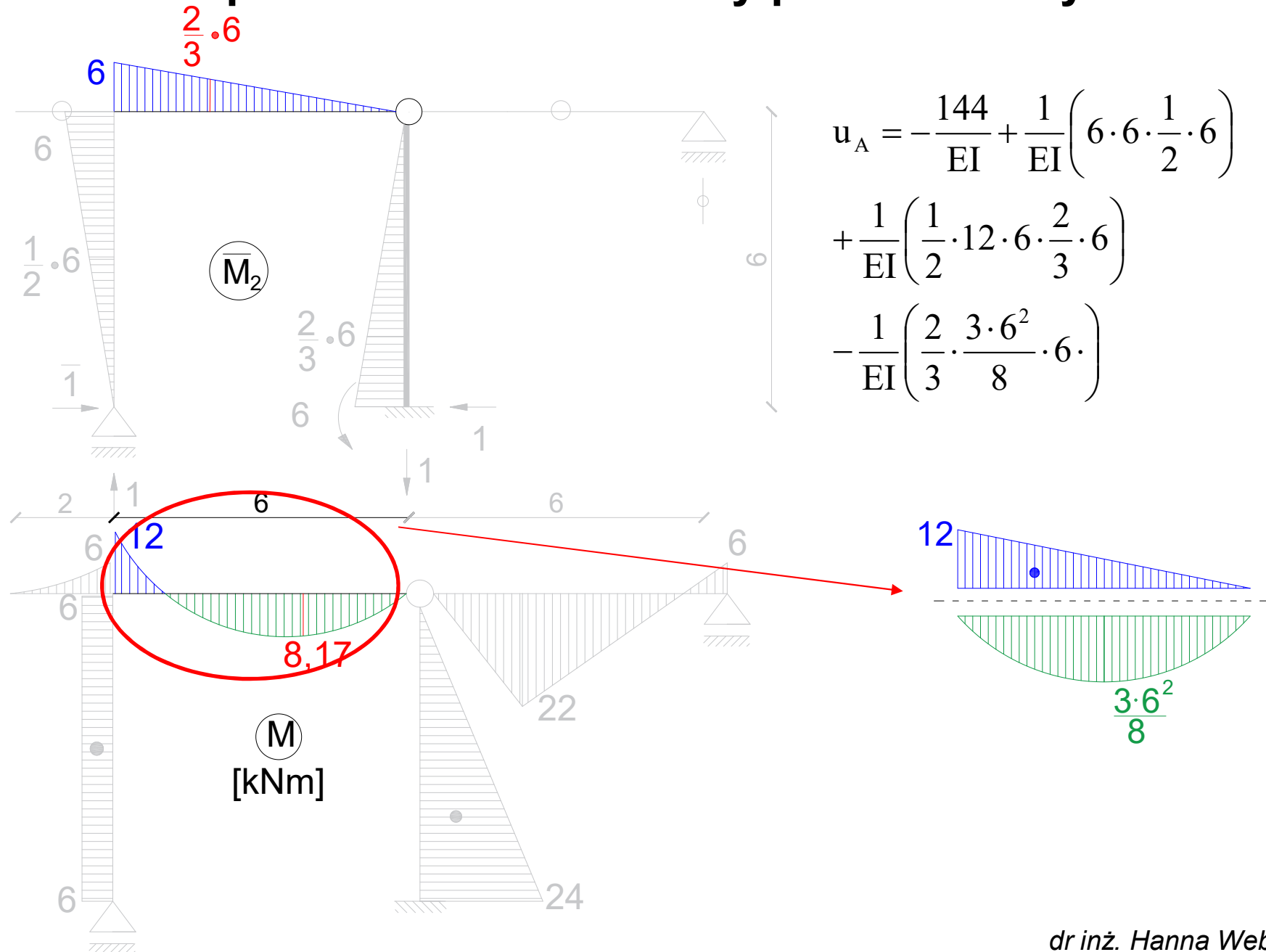
Obliczenia przemieszczeń z zasady prac wirtualnych:



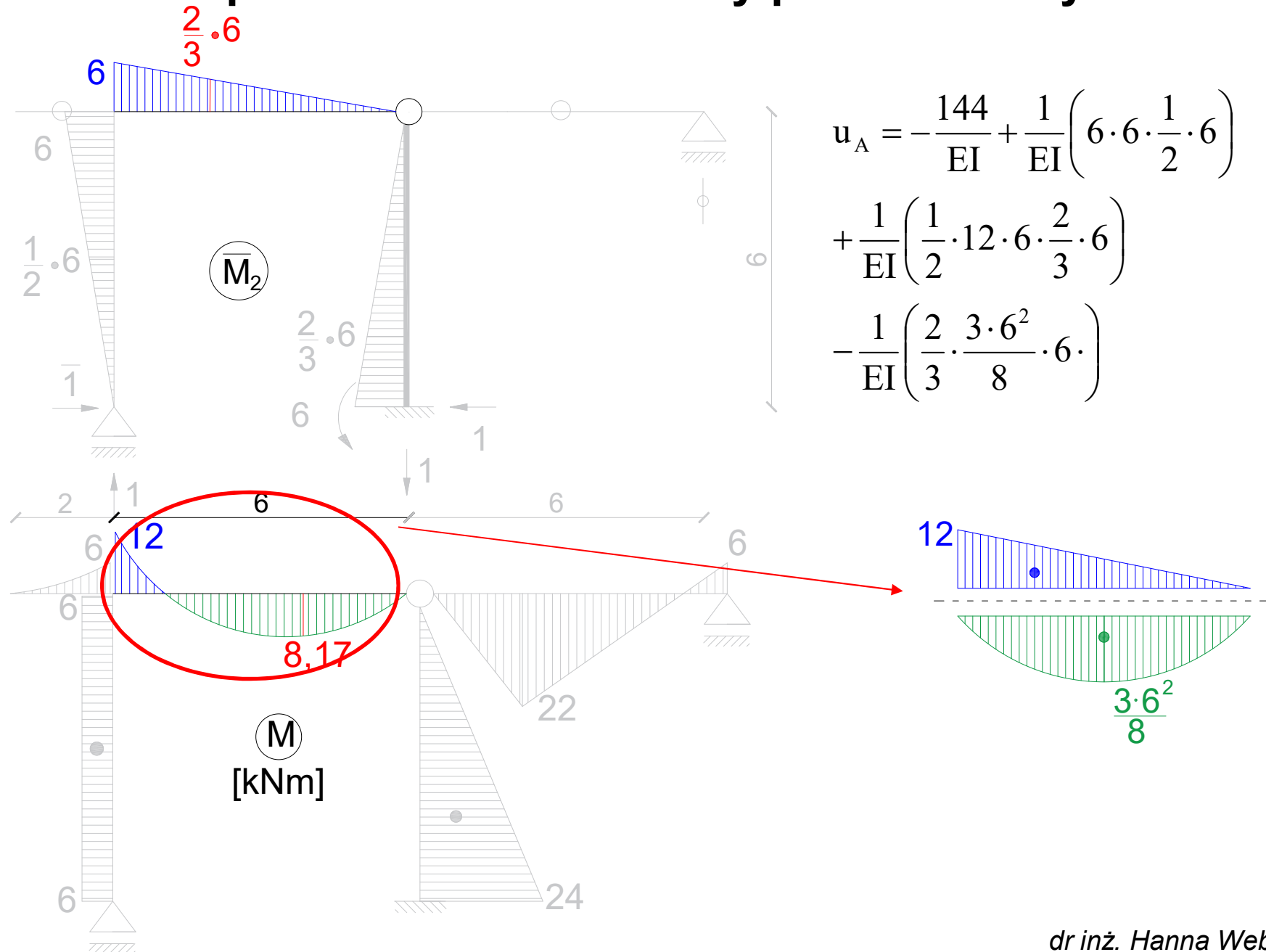
Obliczenia przemieszczeń z zasady prac wirtualnych:



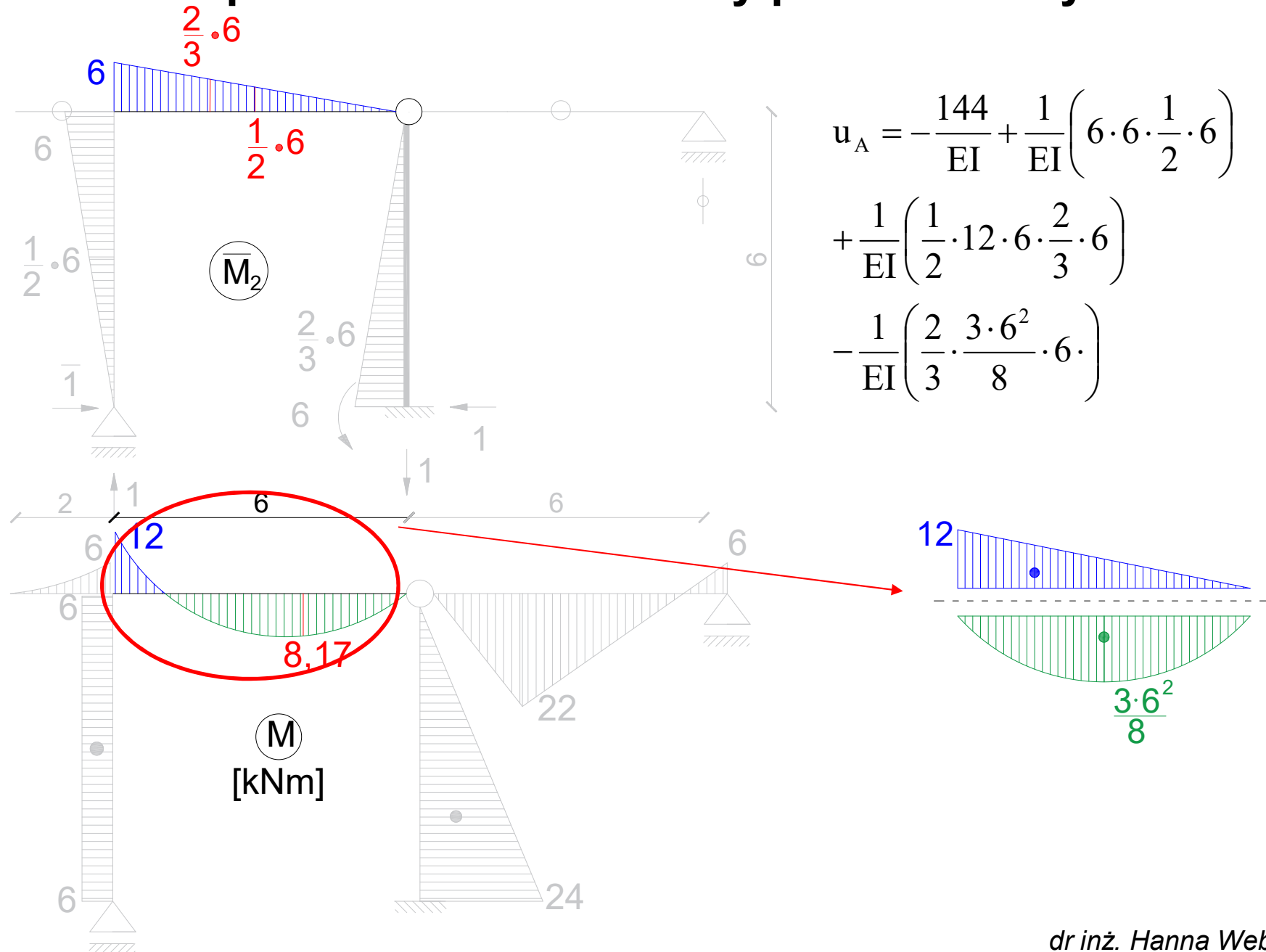
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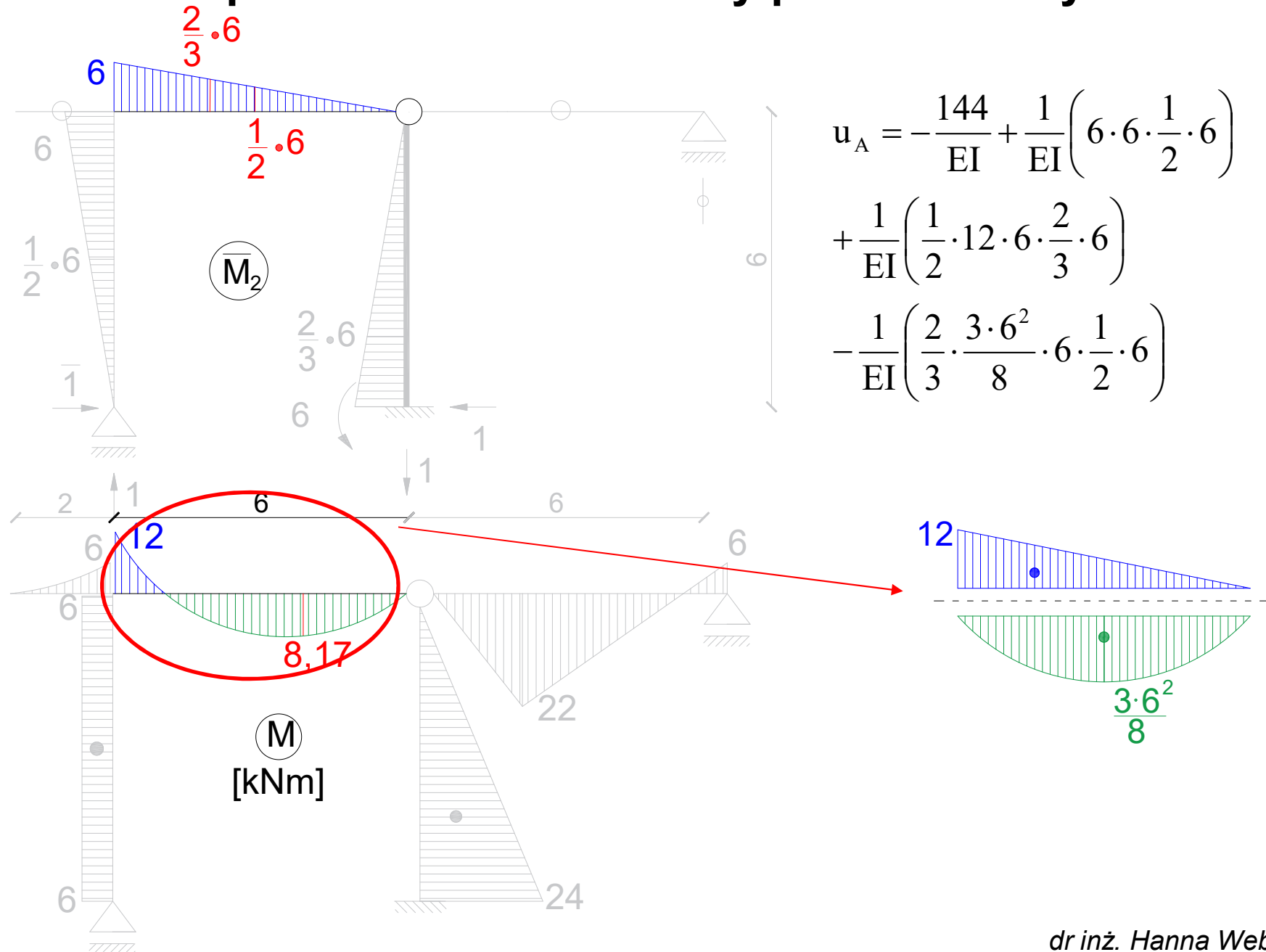
Obliczenia przemieszczeń z zasady prac wirtualnych:



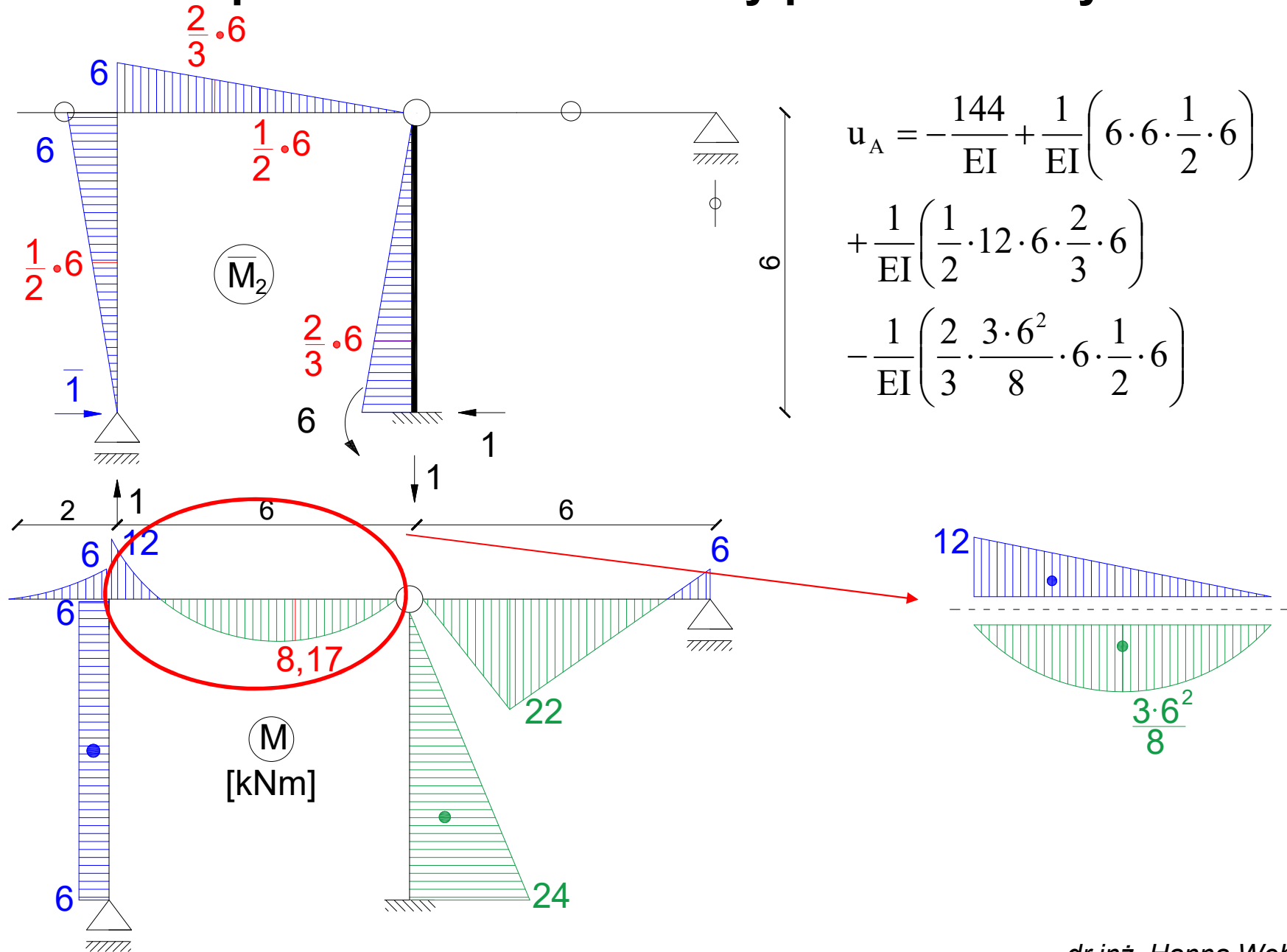
Obliczenia przemieszczeń z zasady prac wirtualnych:



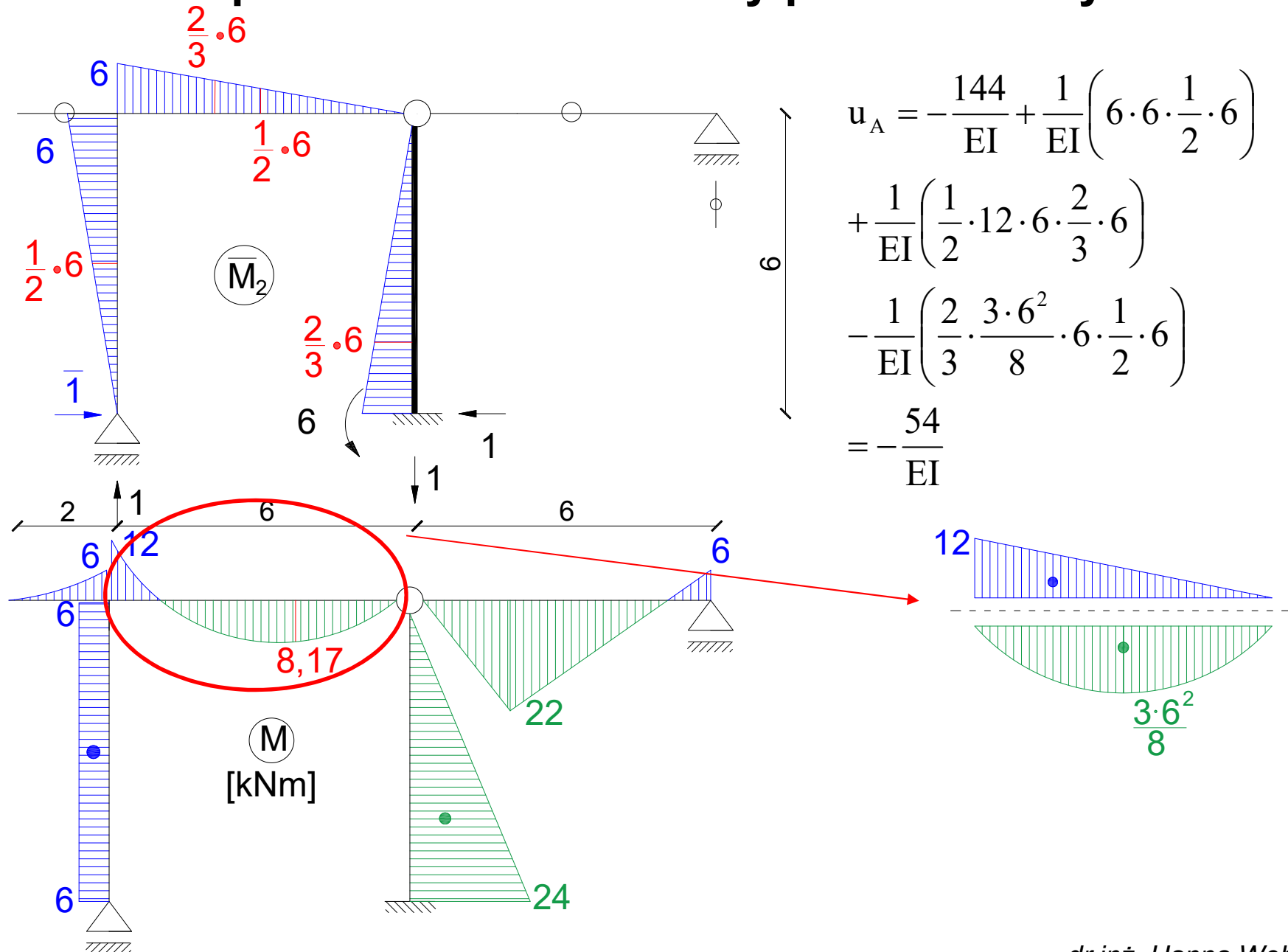
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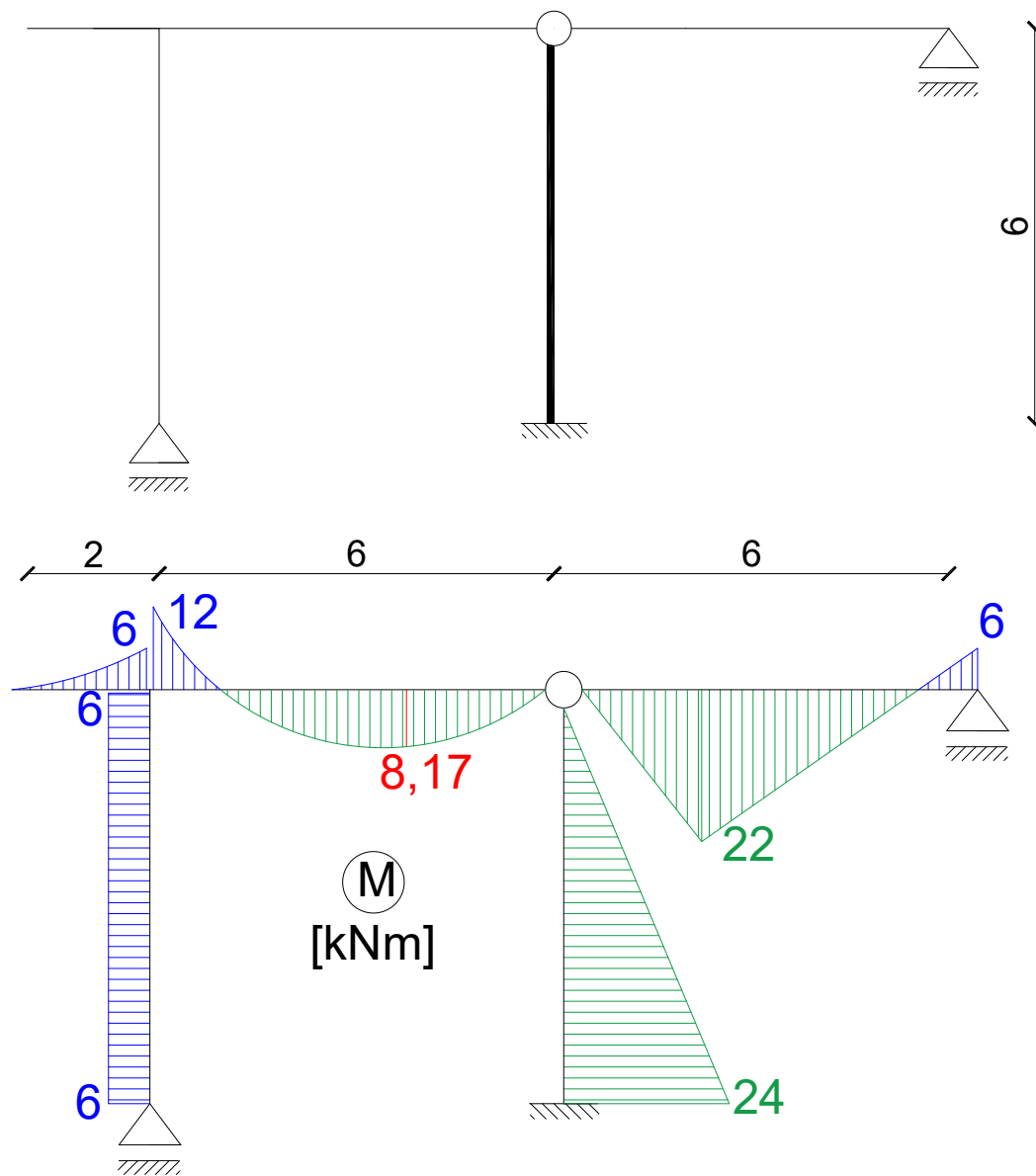
Obliczenia przemieszczeń z zasady prac wirtualnych:



Obliczenia przemieszczeń z zasady prac wirtualnych:

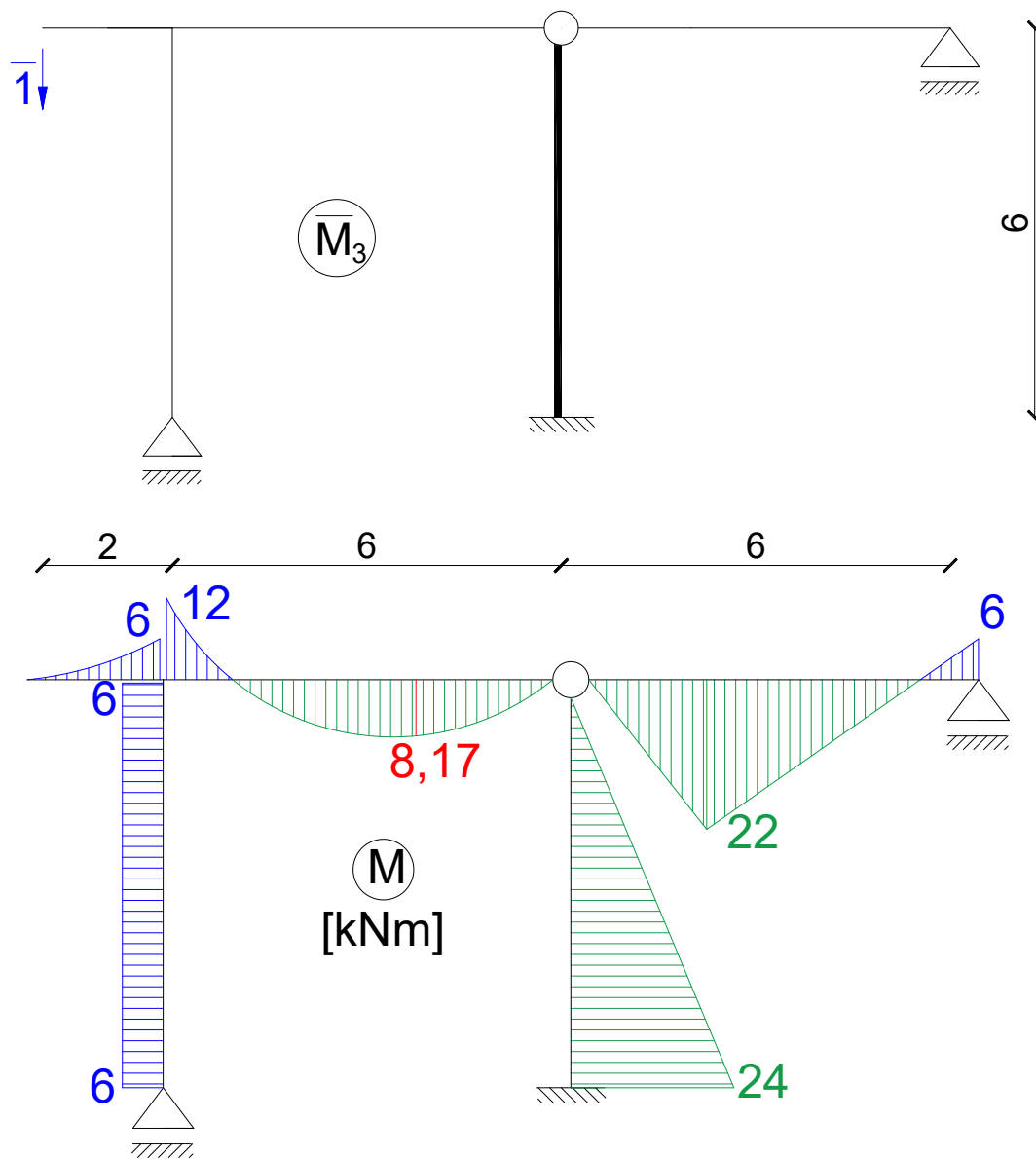


Obliczenia przemieszczeń z zasady prac wirtualnych:



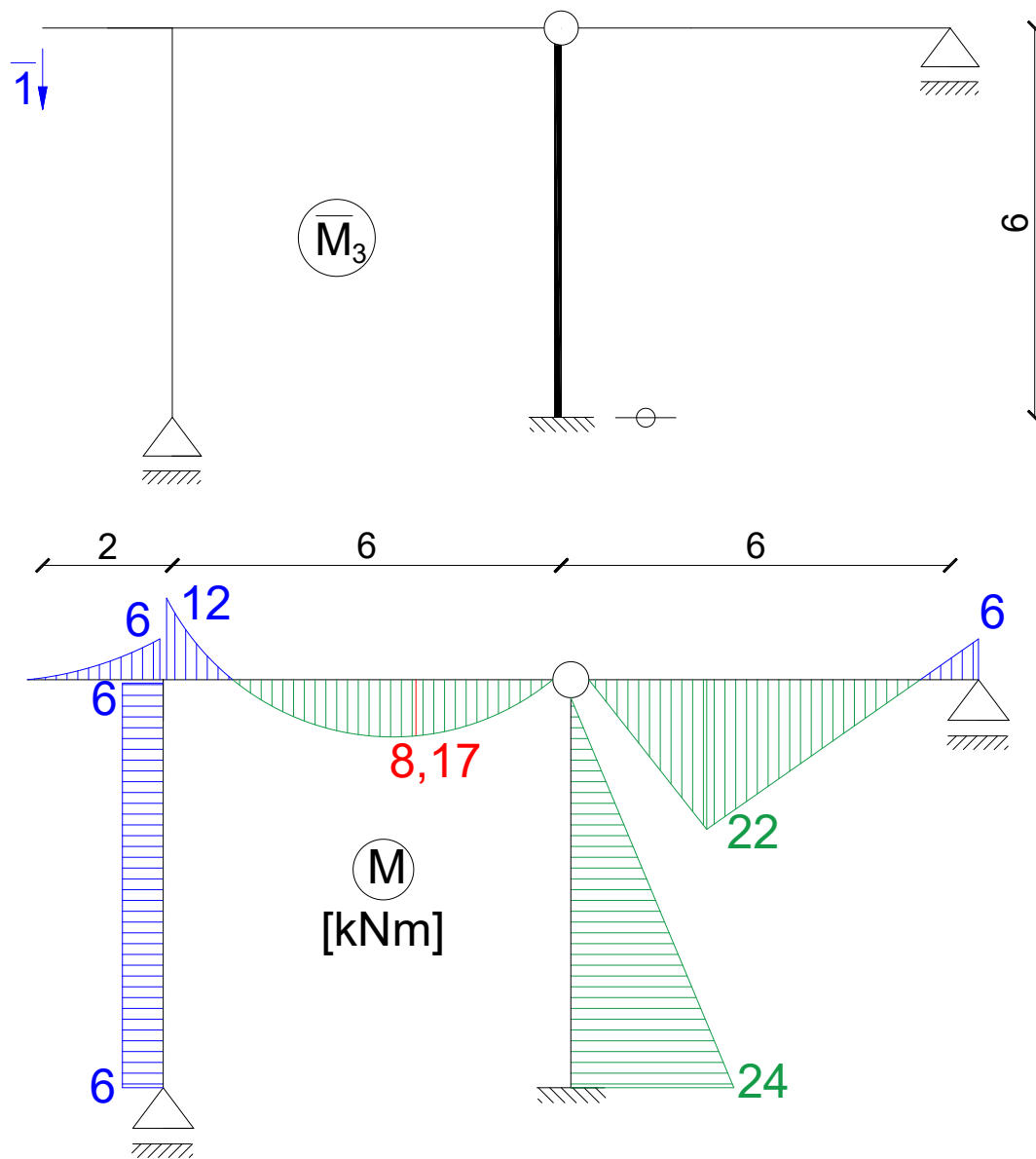
$$v_E = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



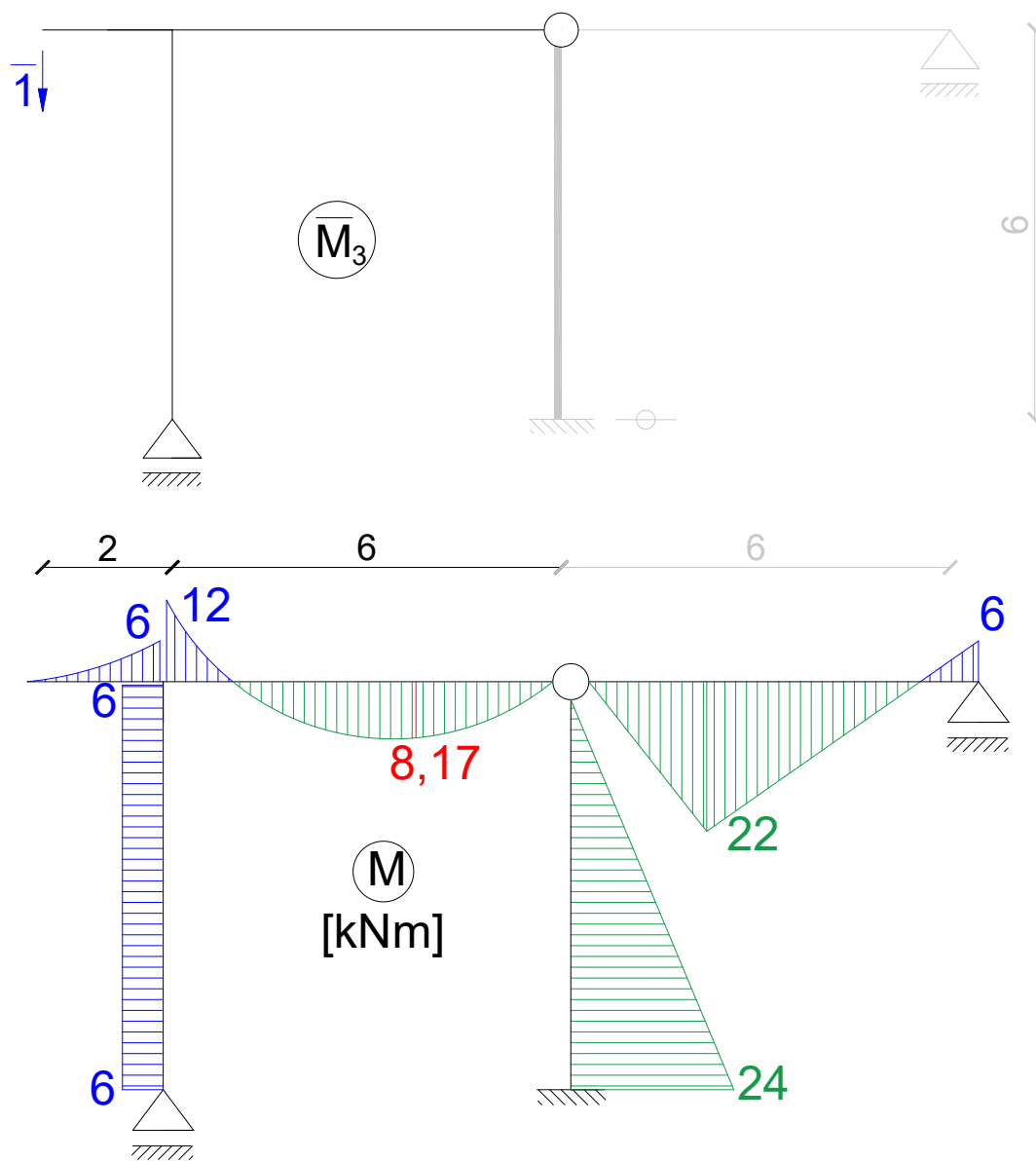
$$v_E = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



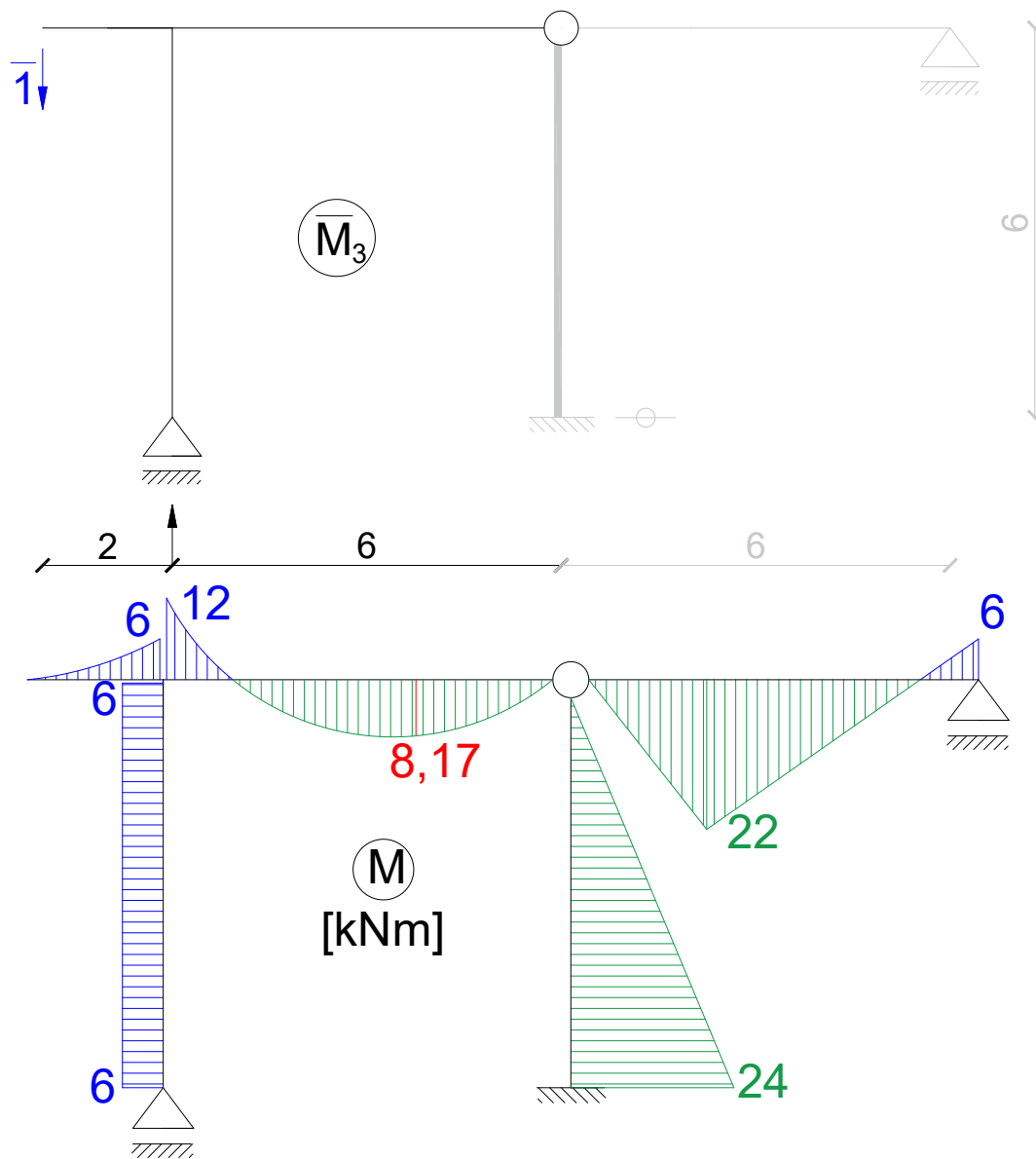
$$v_E = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



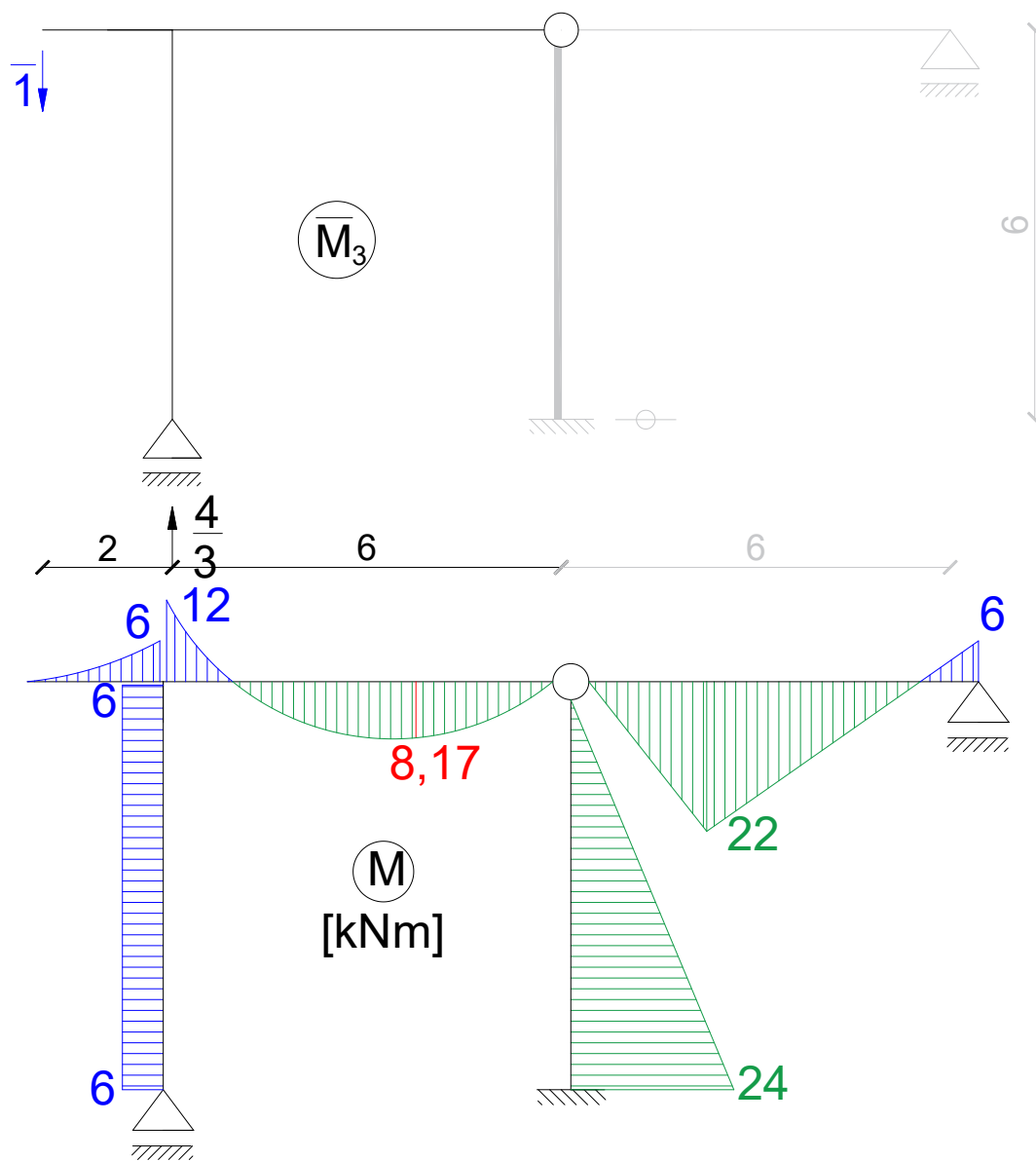
$$v_E = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



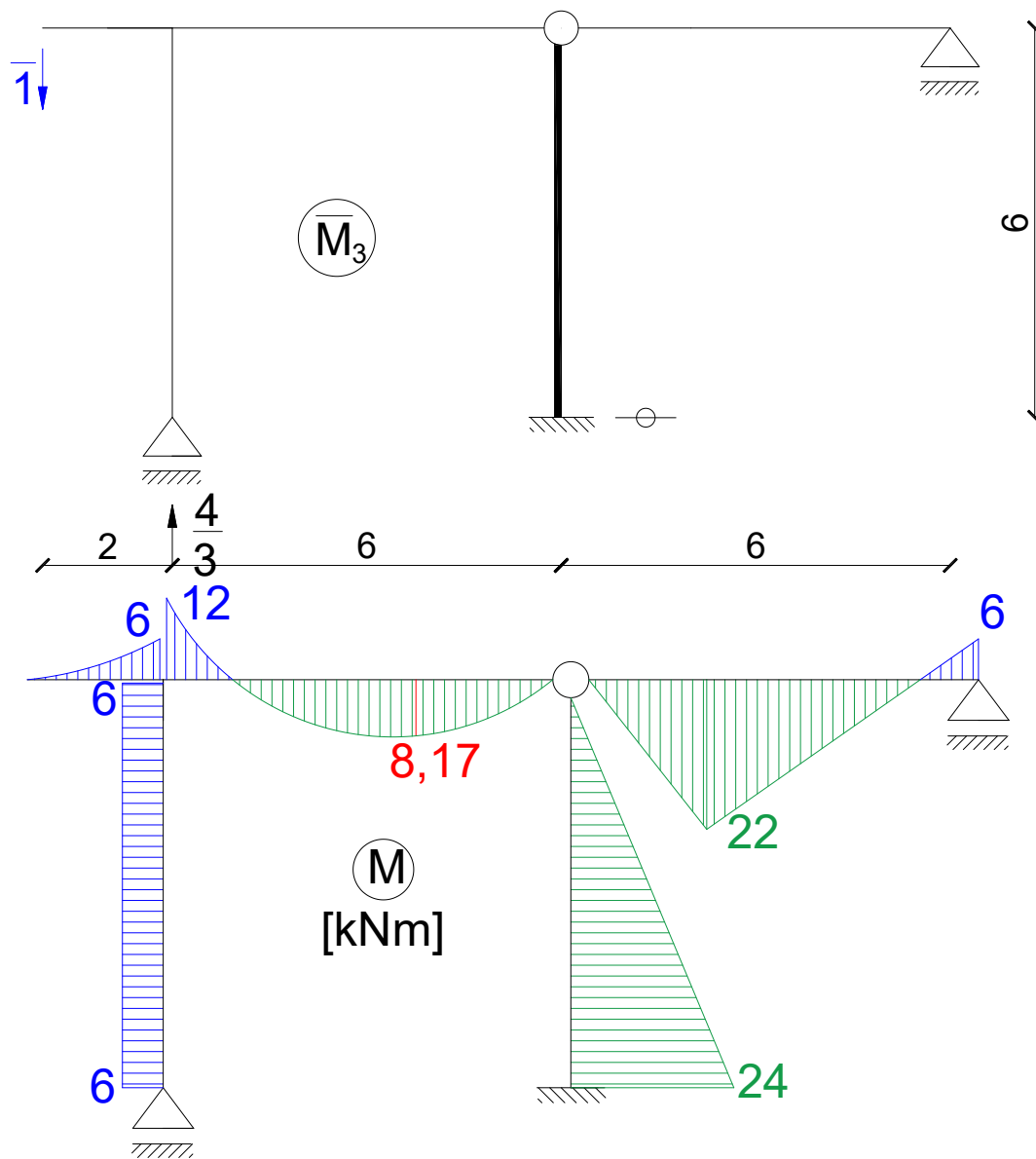
$$v_E = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:

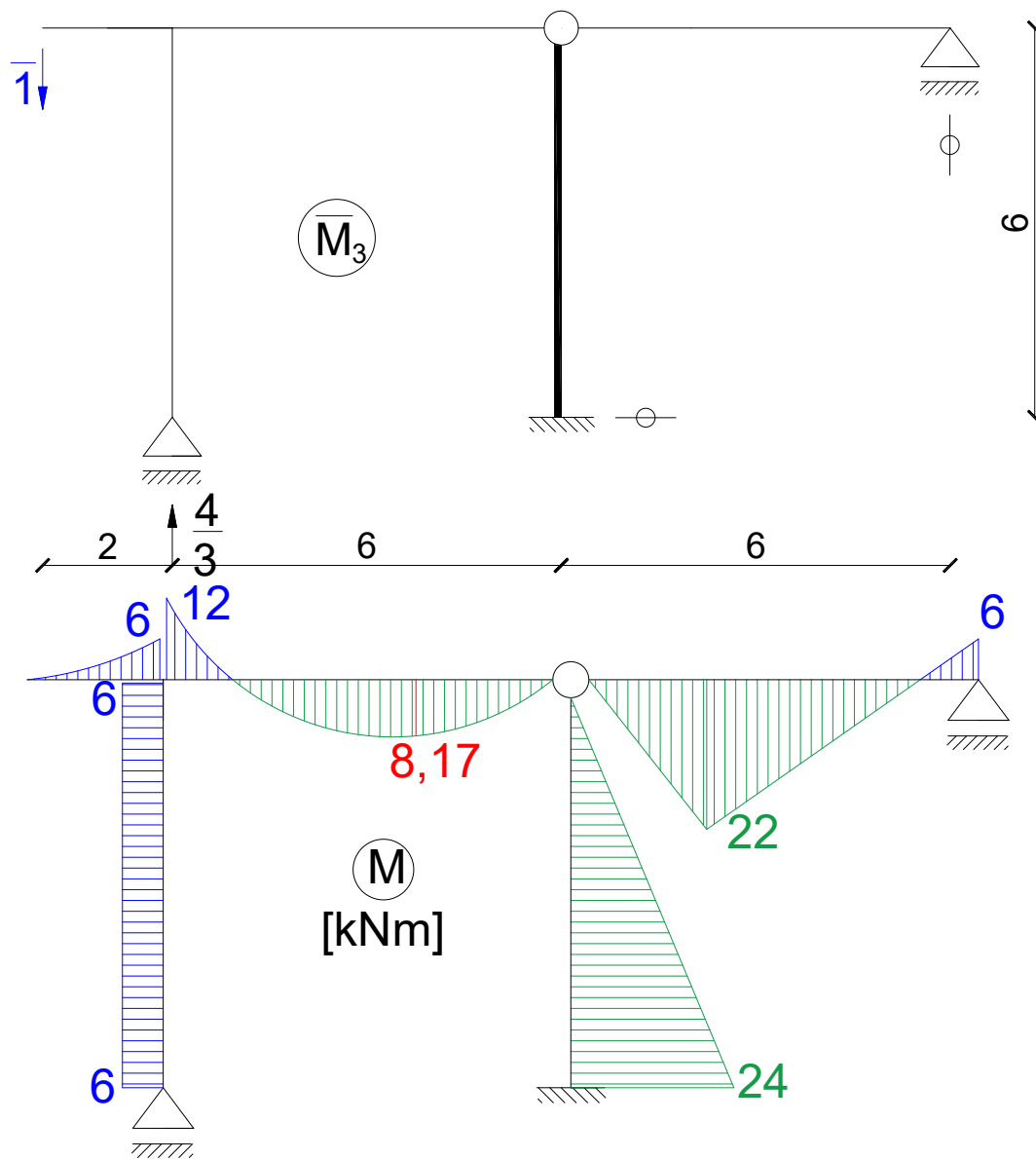


$$v_E = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:

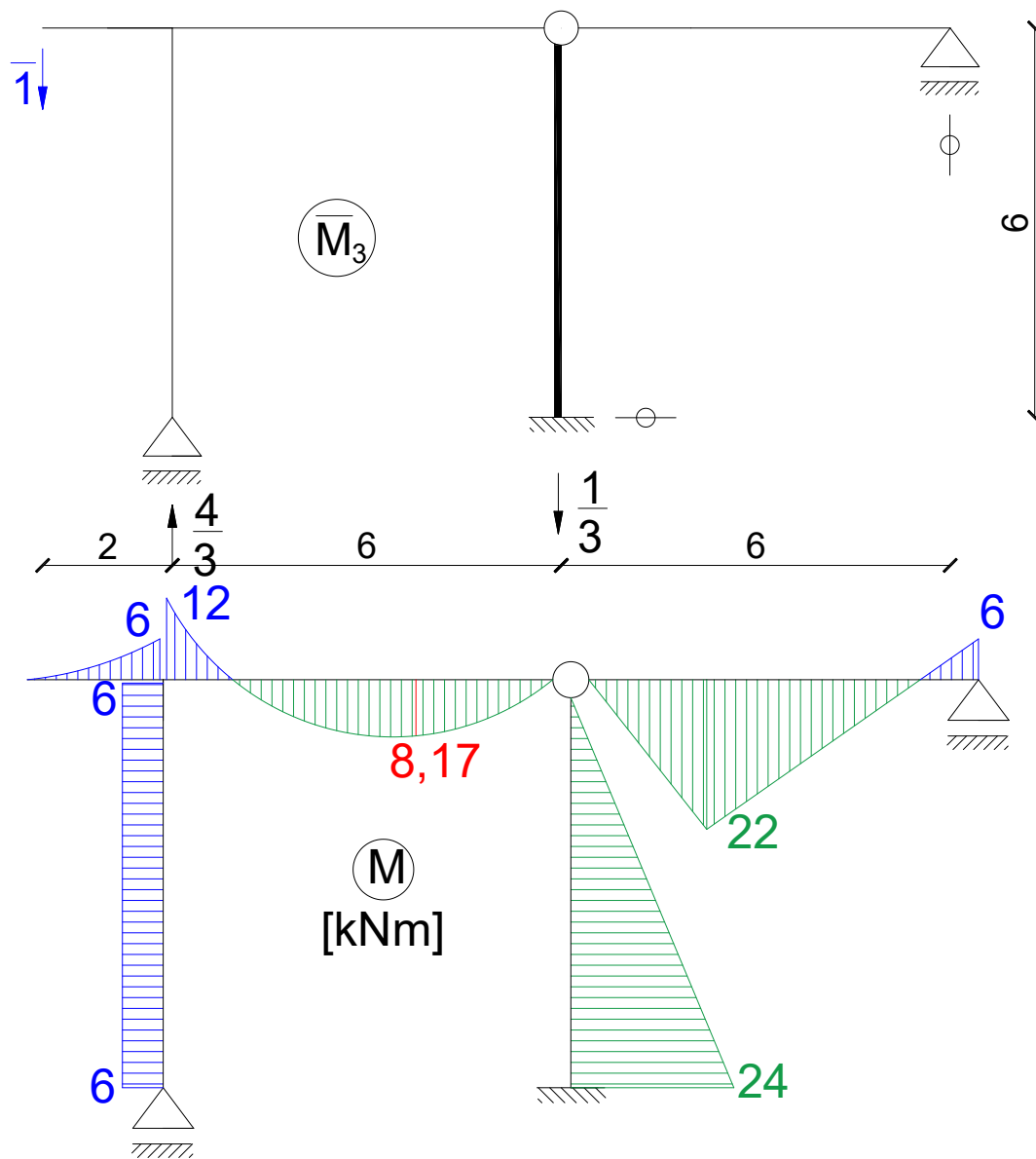


Obliczenia przemieszczeń z zasady prac wirtualnych:



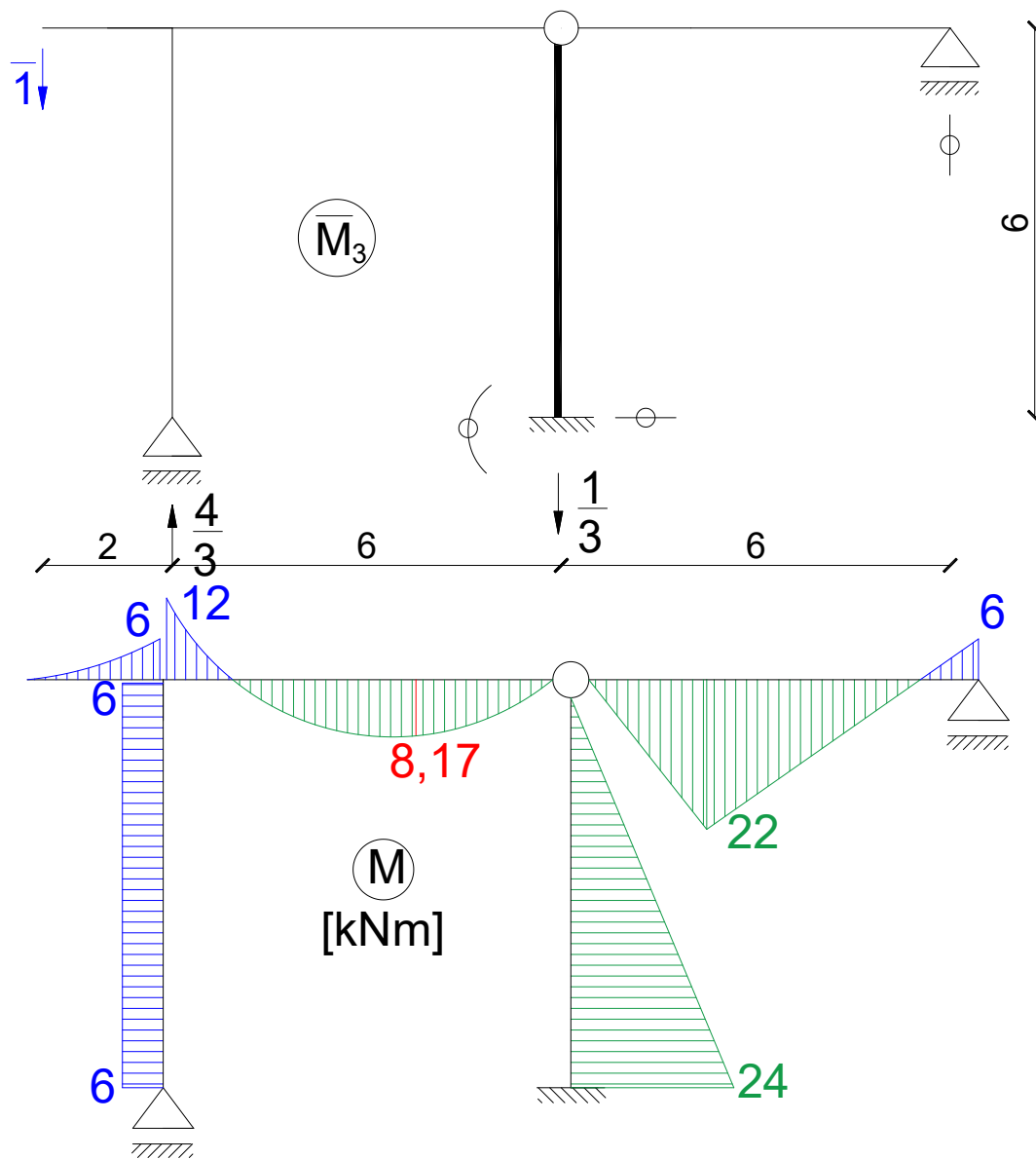
$$v_E = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



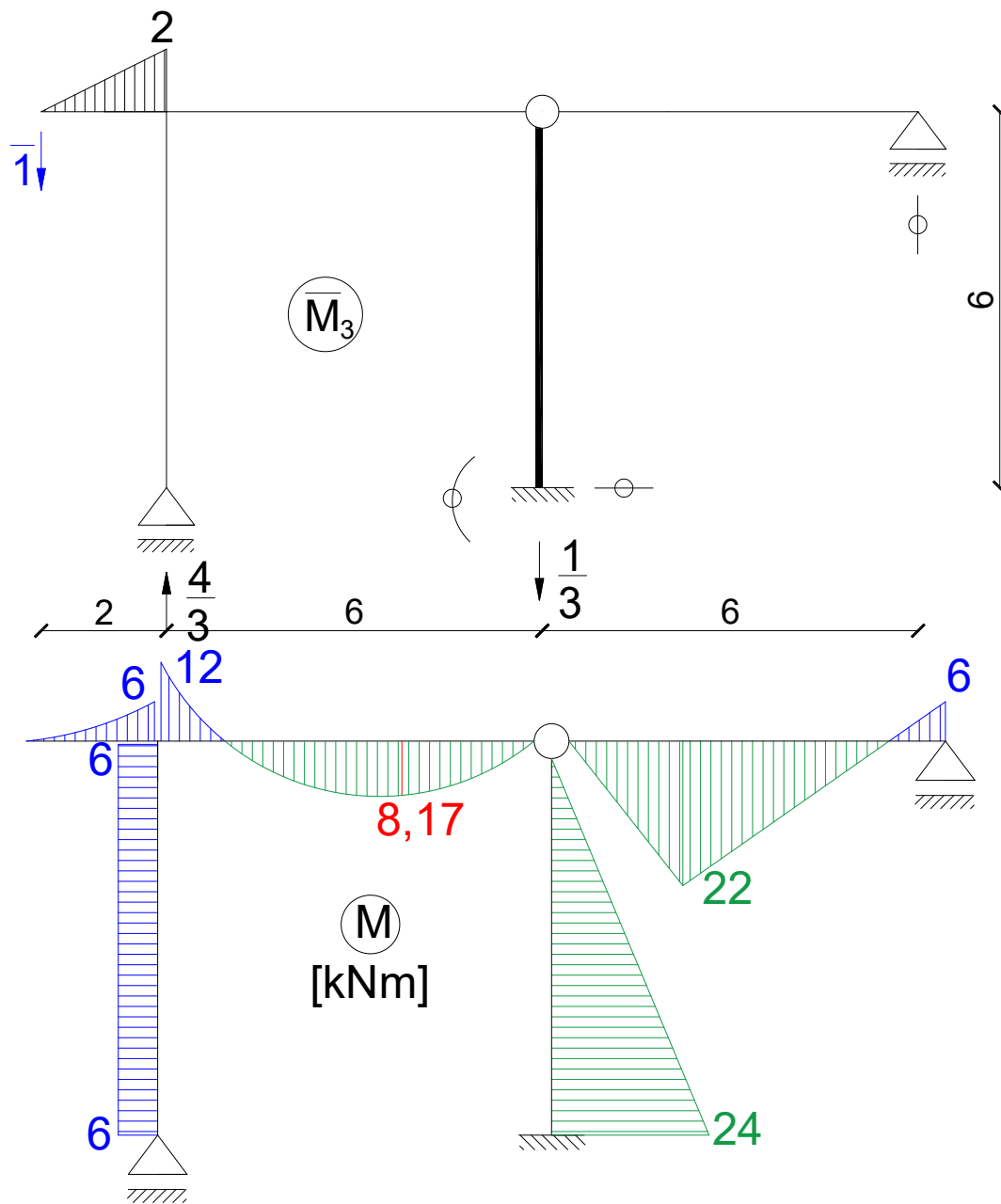
$$v_E = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



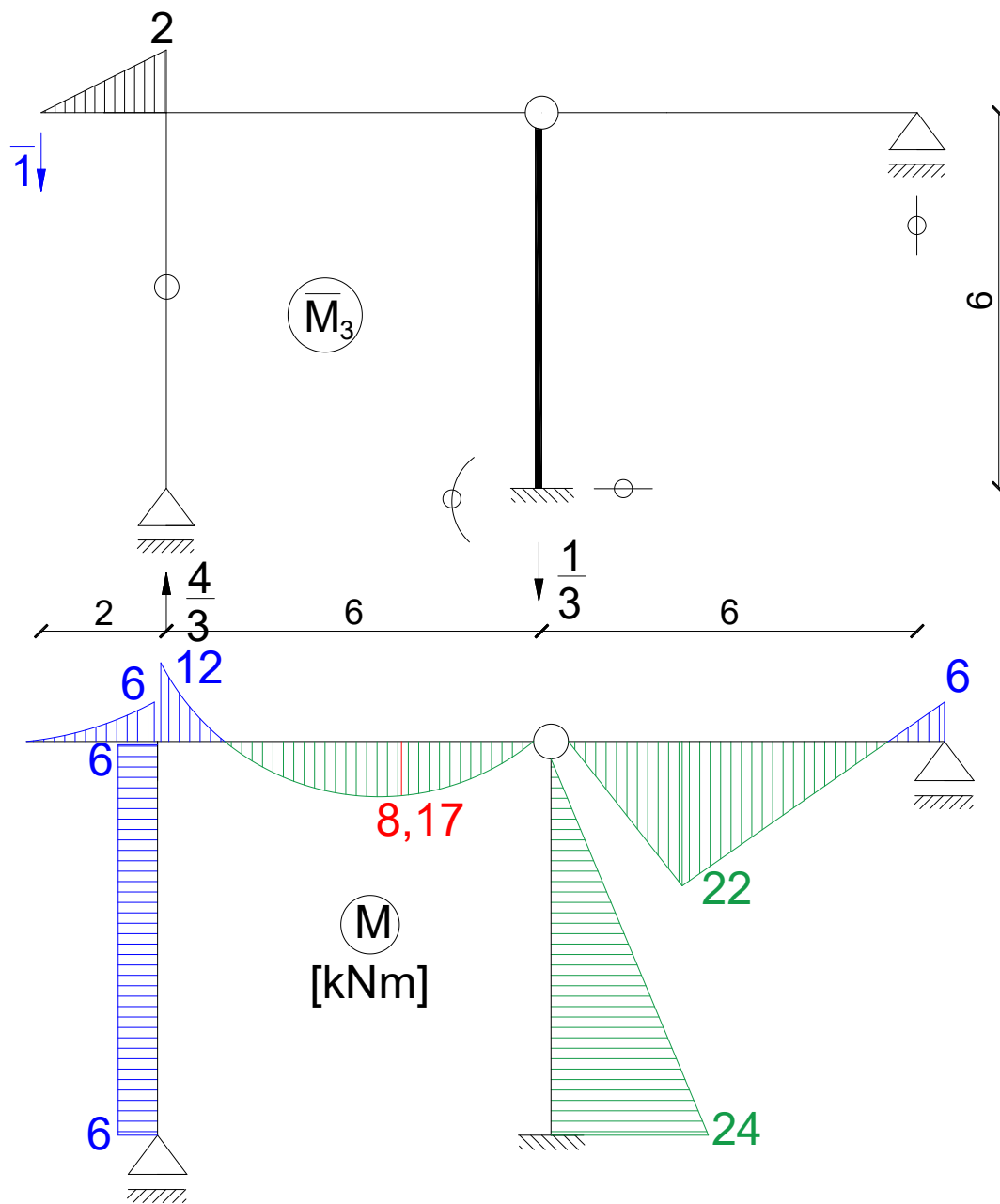
$$v_E = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



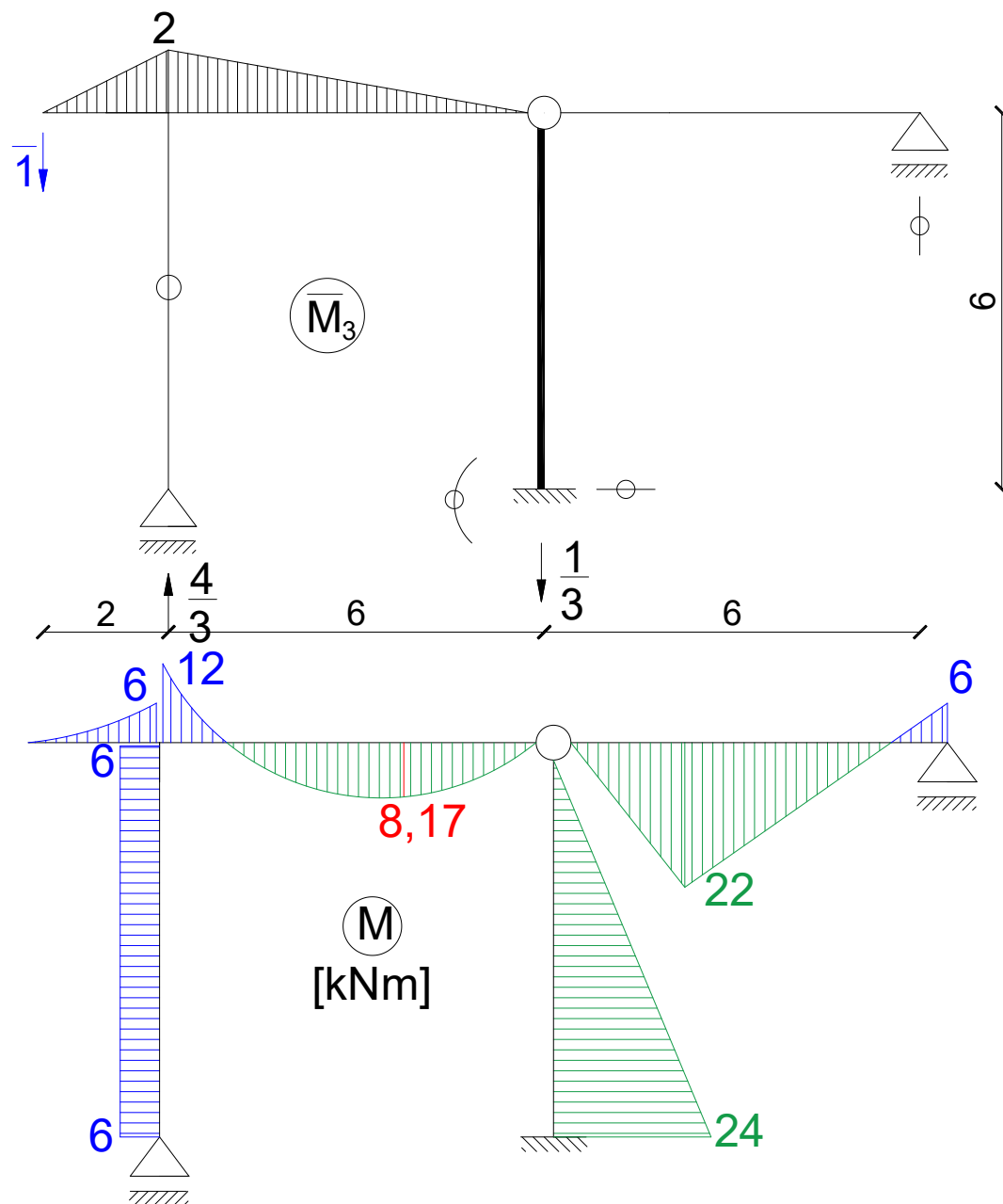
$$v_E = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



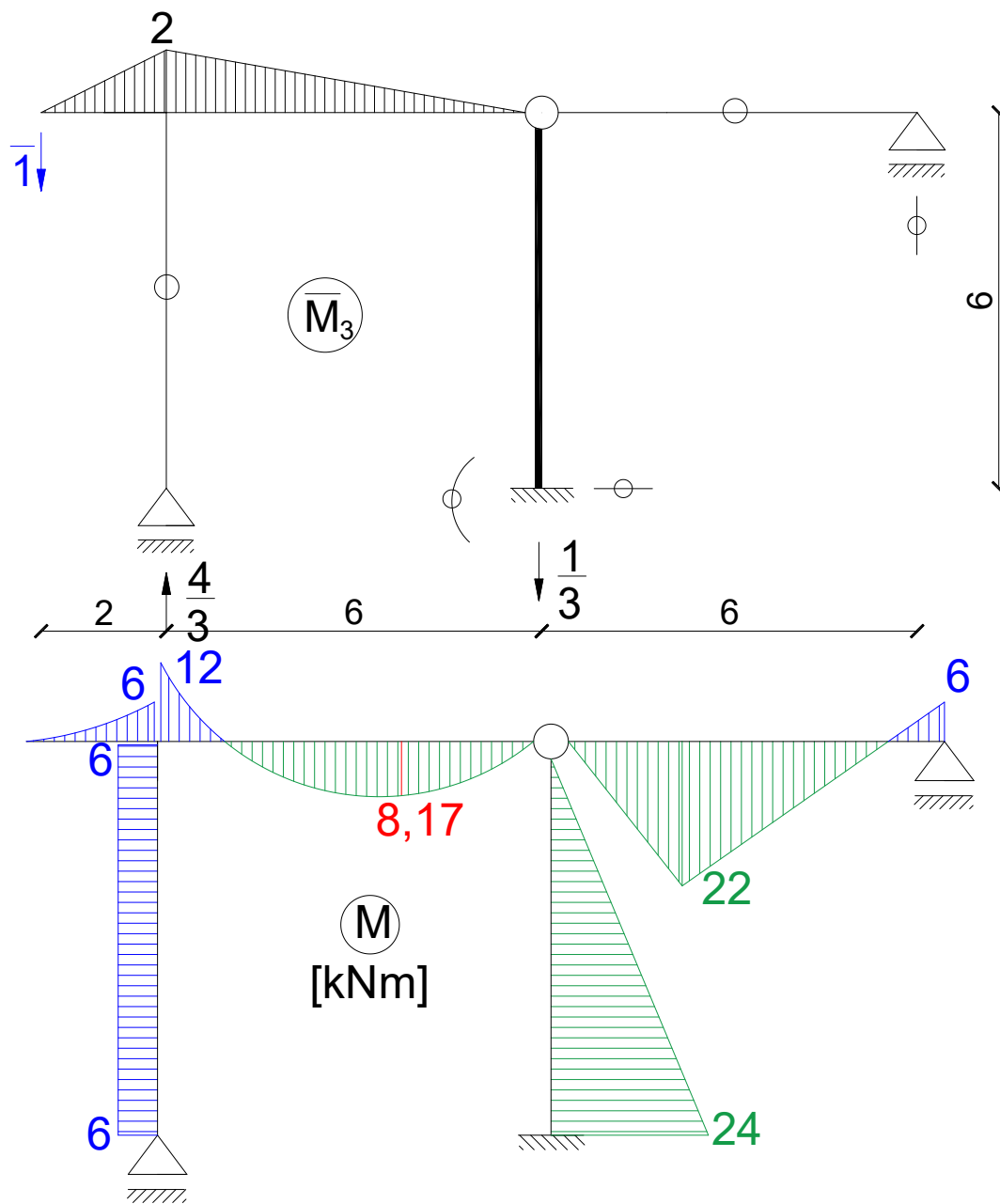
$$v_E = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



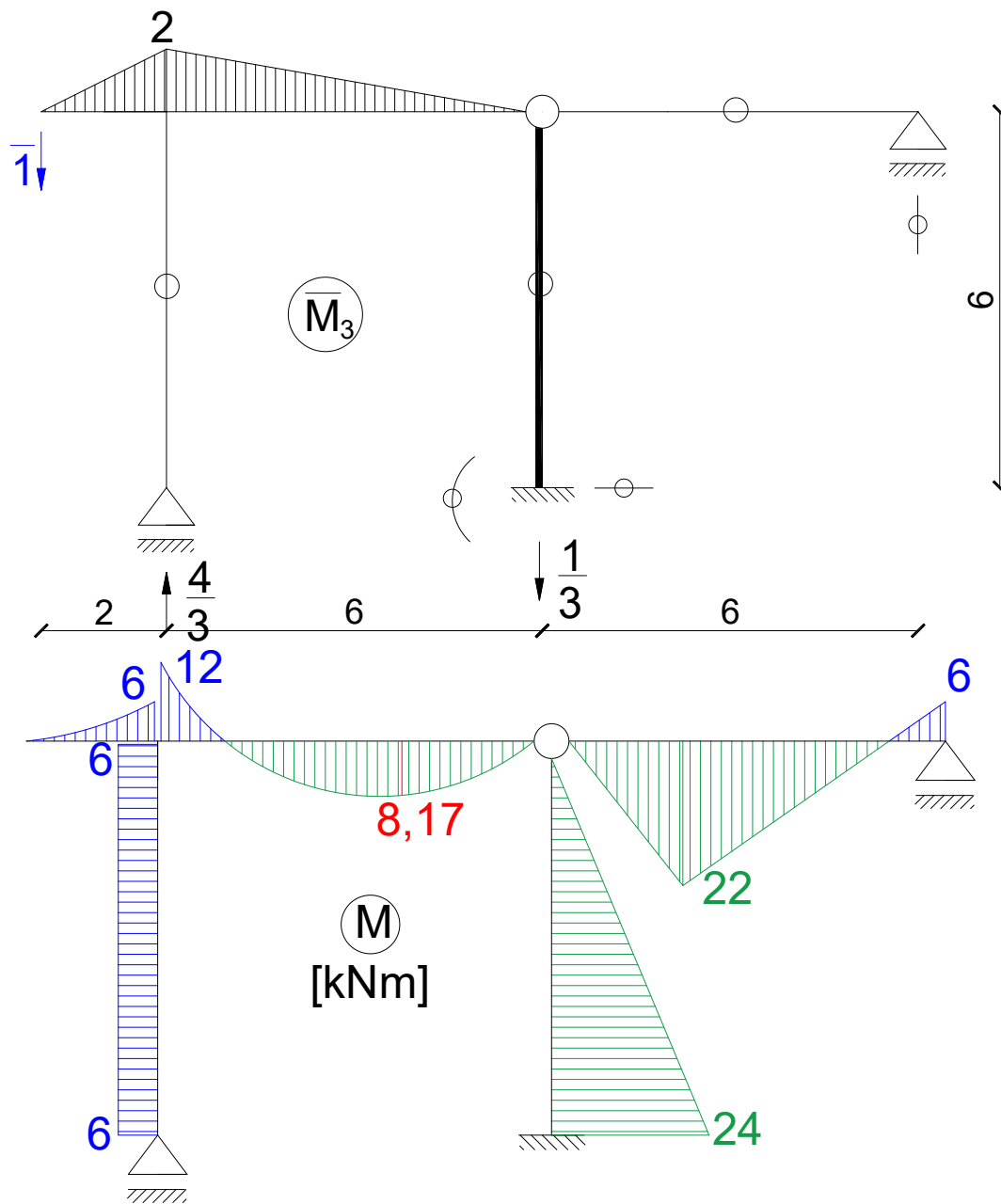
$$v_E = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



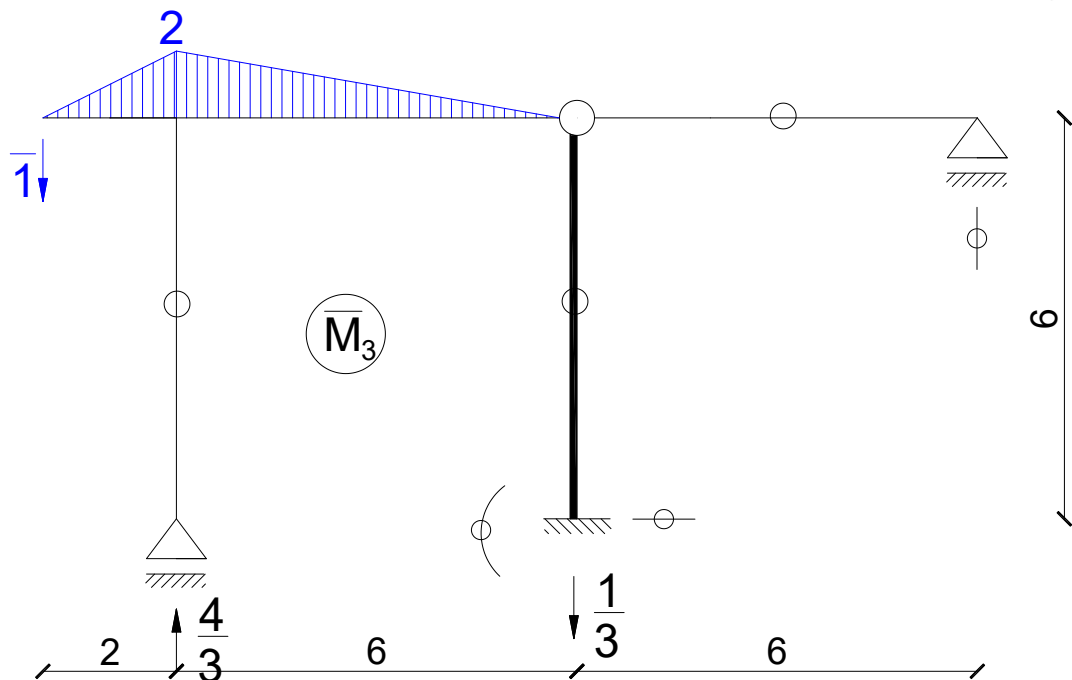
$$v_E = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:

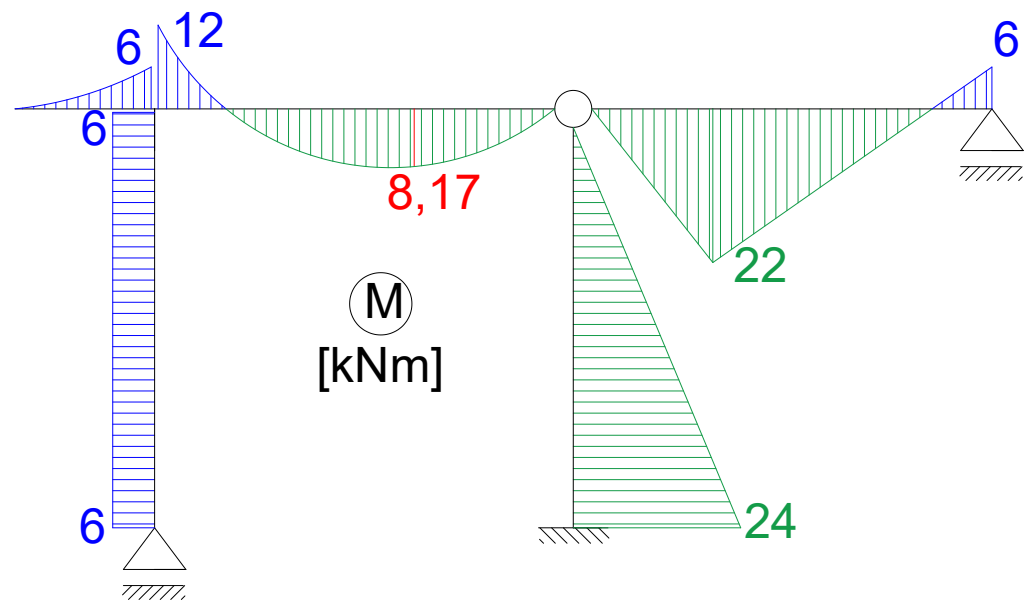


$$v_E = ?$$

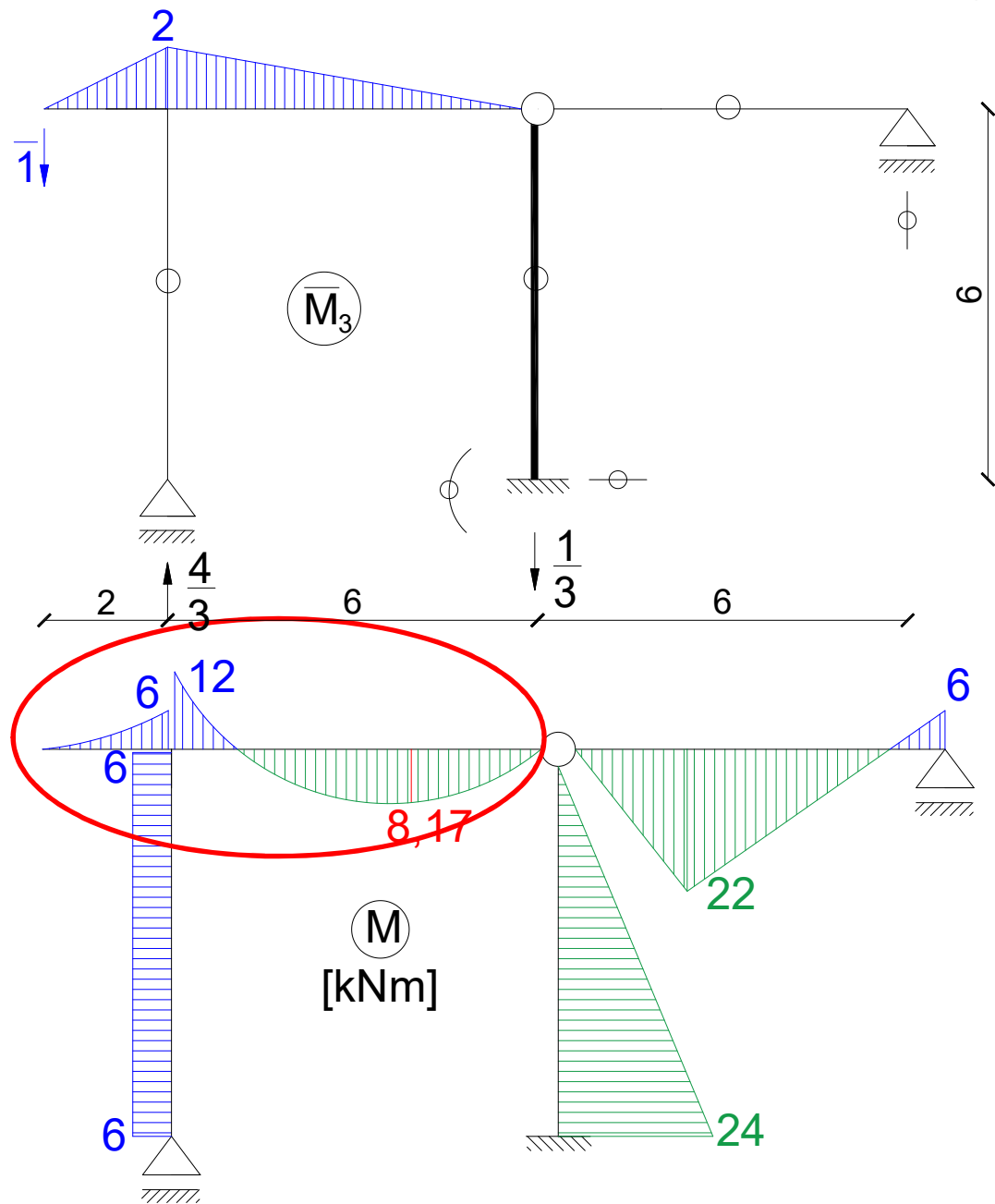
Obliczenia przemieszczeń z zasady prac wirtualnych:



$$v_E = ?$$

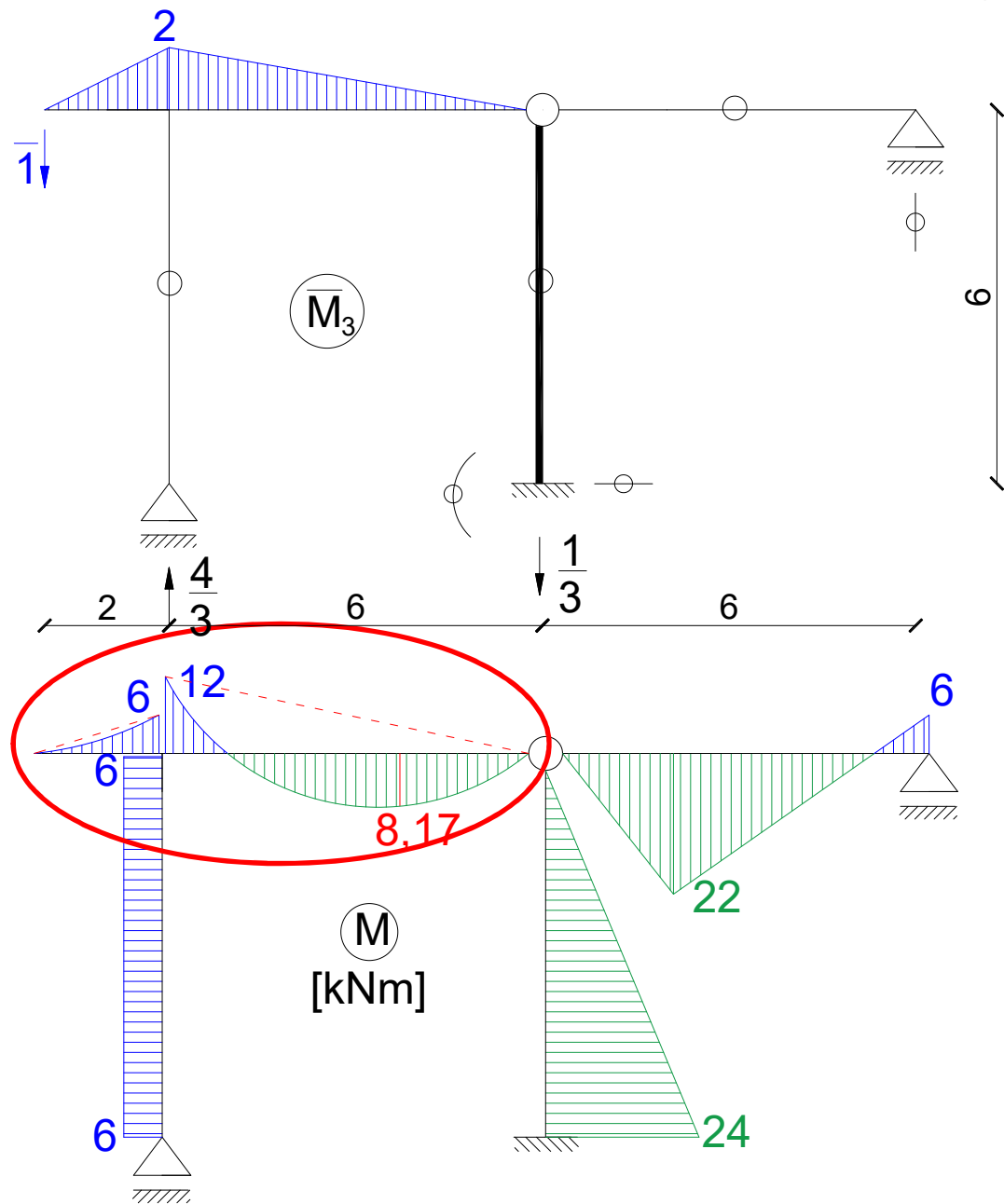


Obliczenia przemieszczeń z zasady prac wirtualnych:



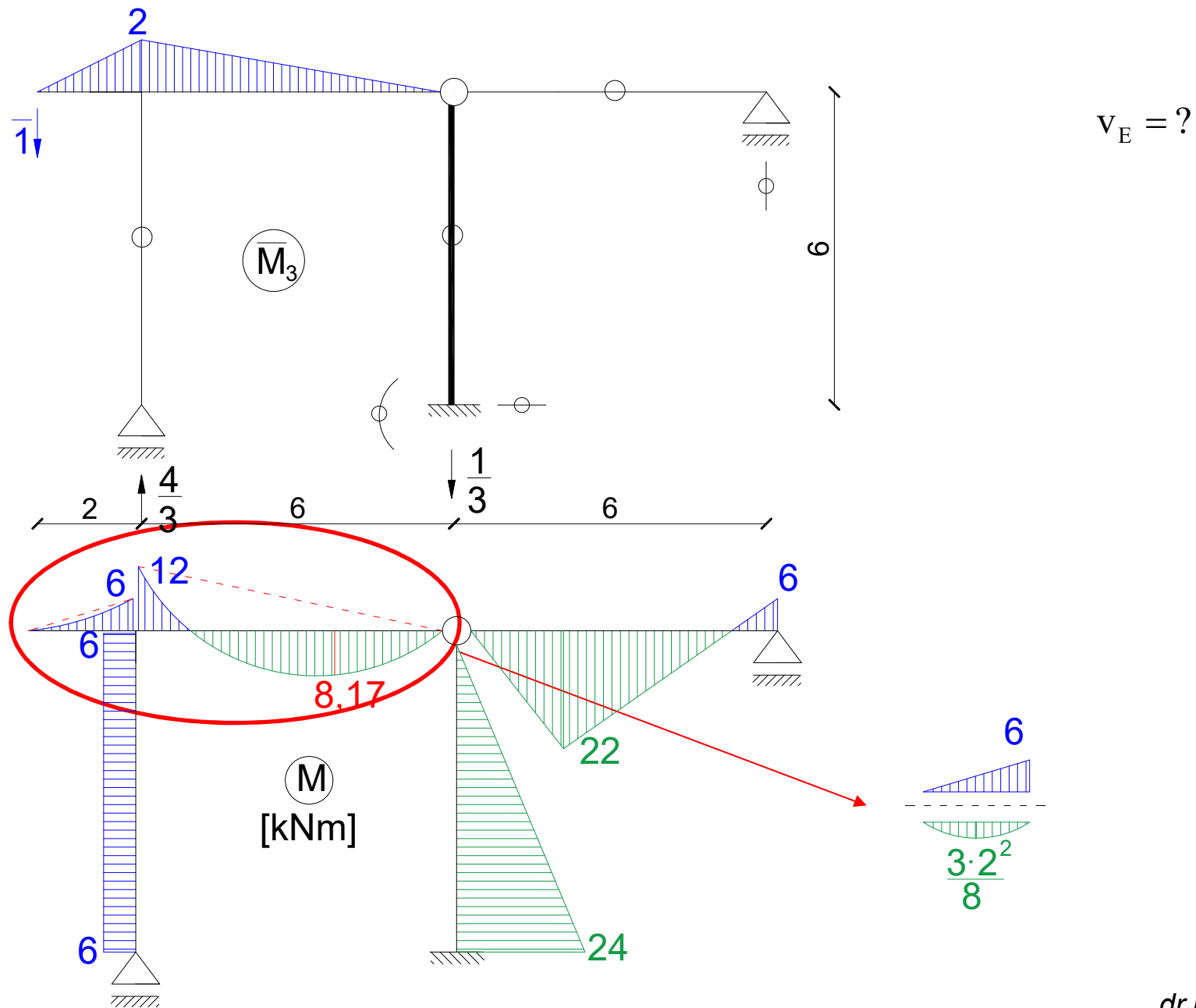
$$v_E = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:

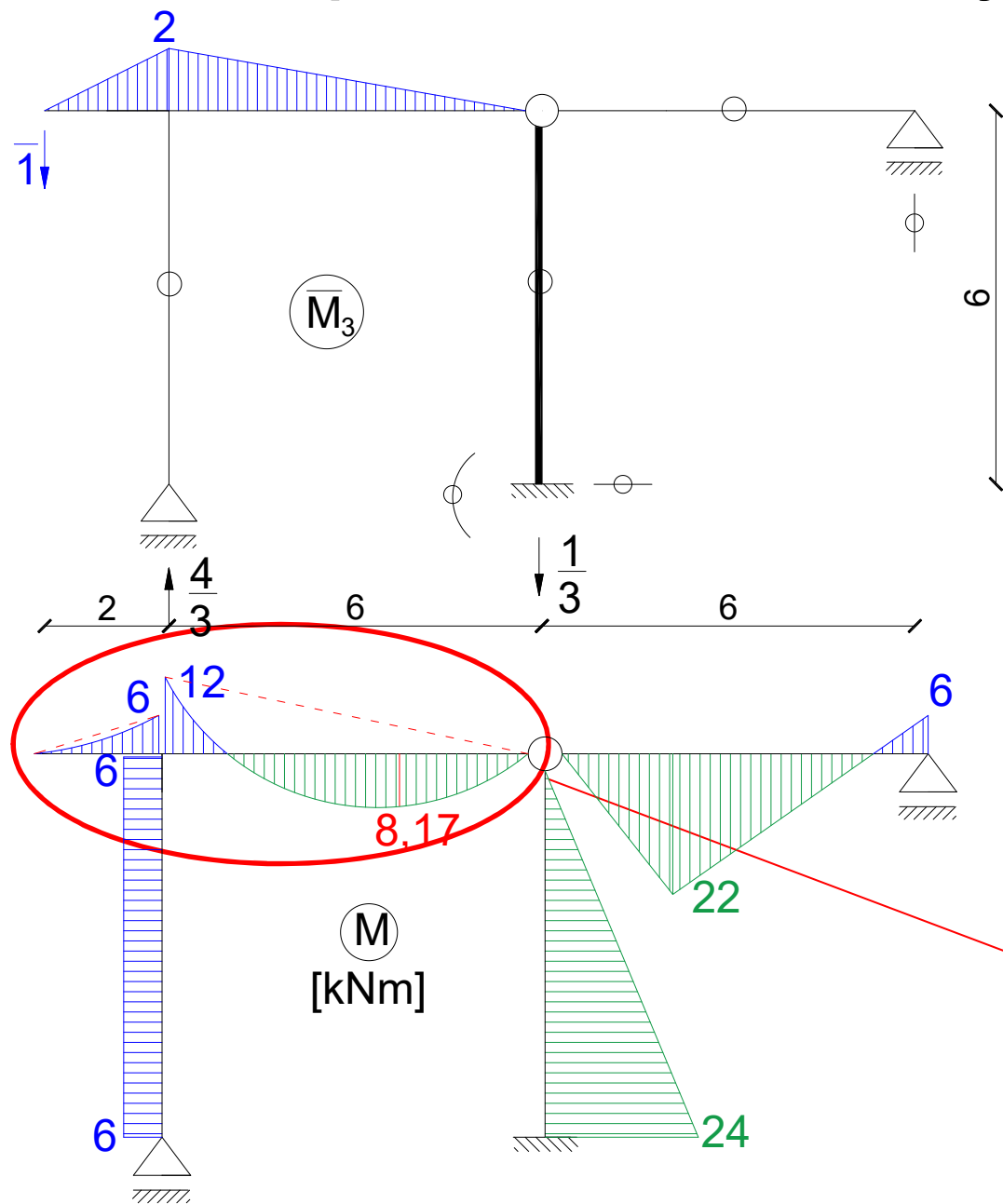


$$v_E = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:

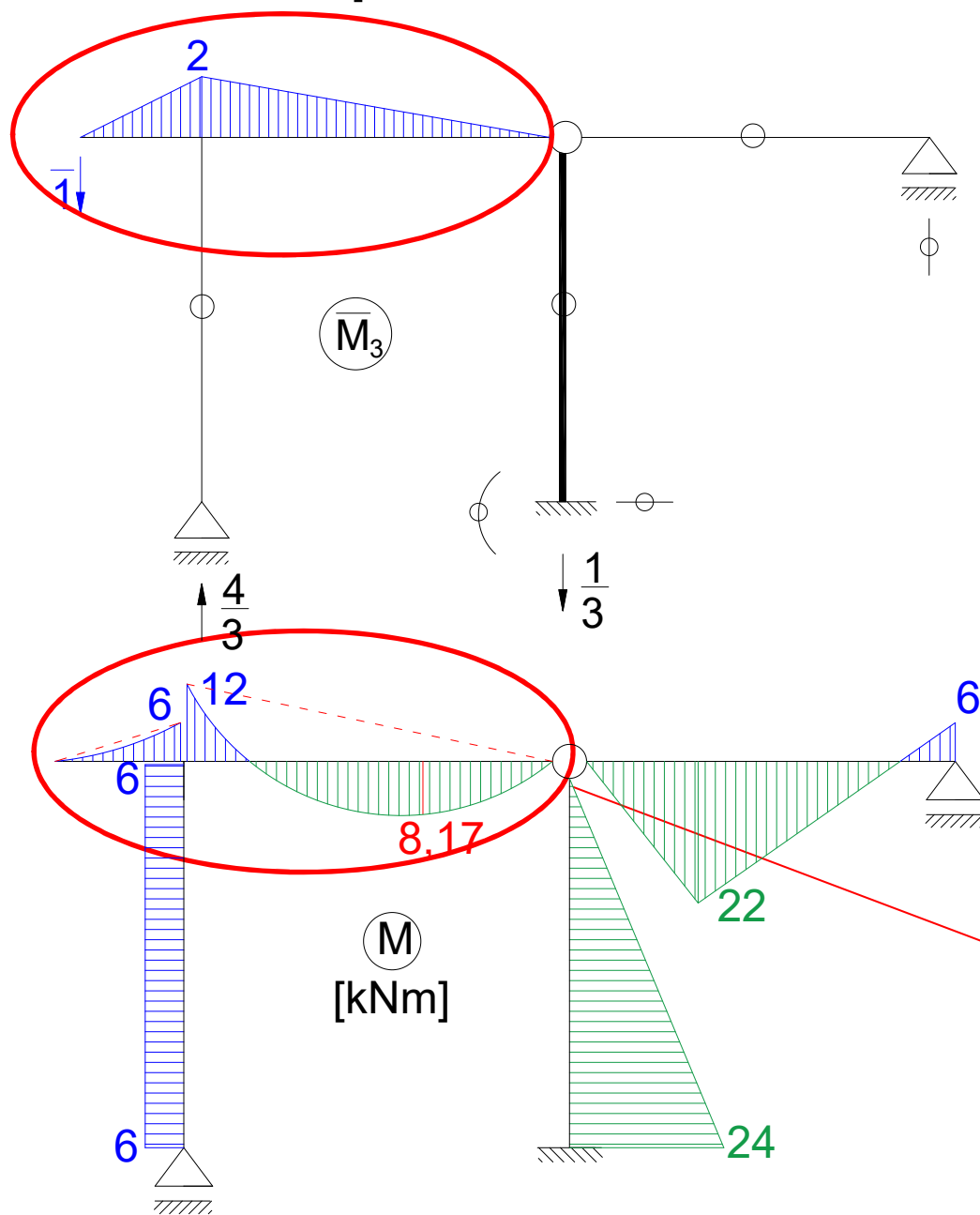


Obliczenia przemieszczeń z zasady prac wirtualnych:

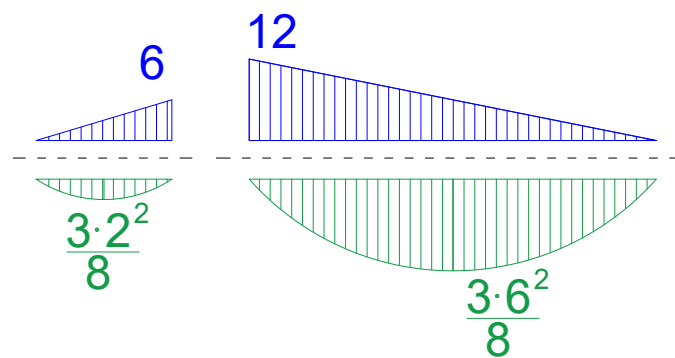


$$v_E = ?$$

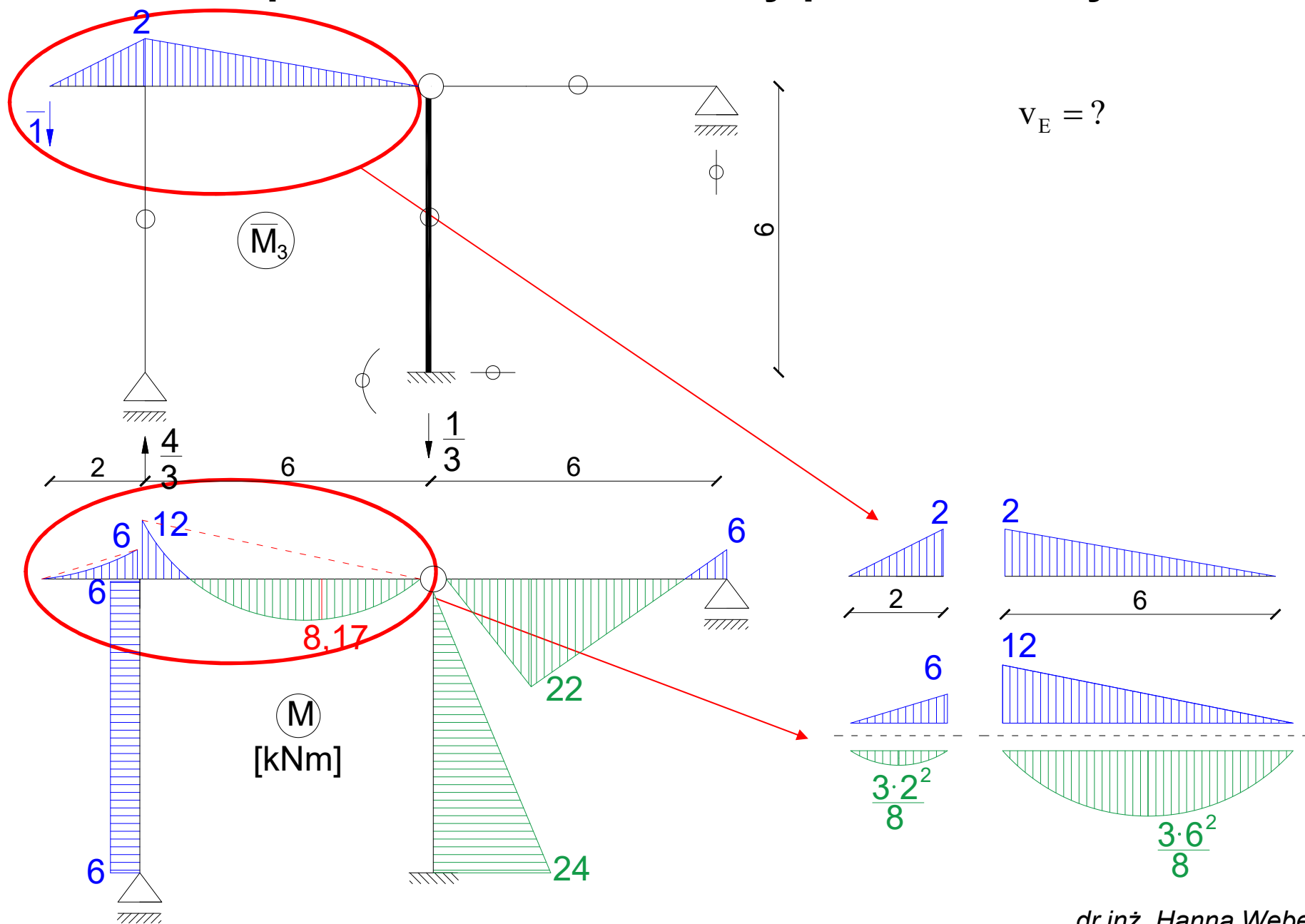
Obliczenia przemieszczeń z zasady prac wirtualnych:



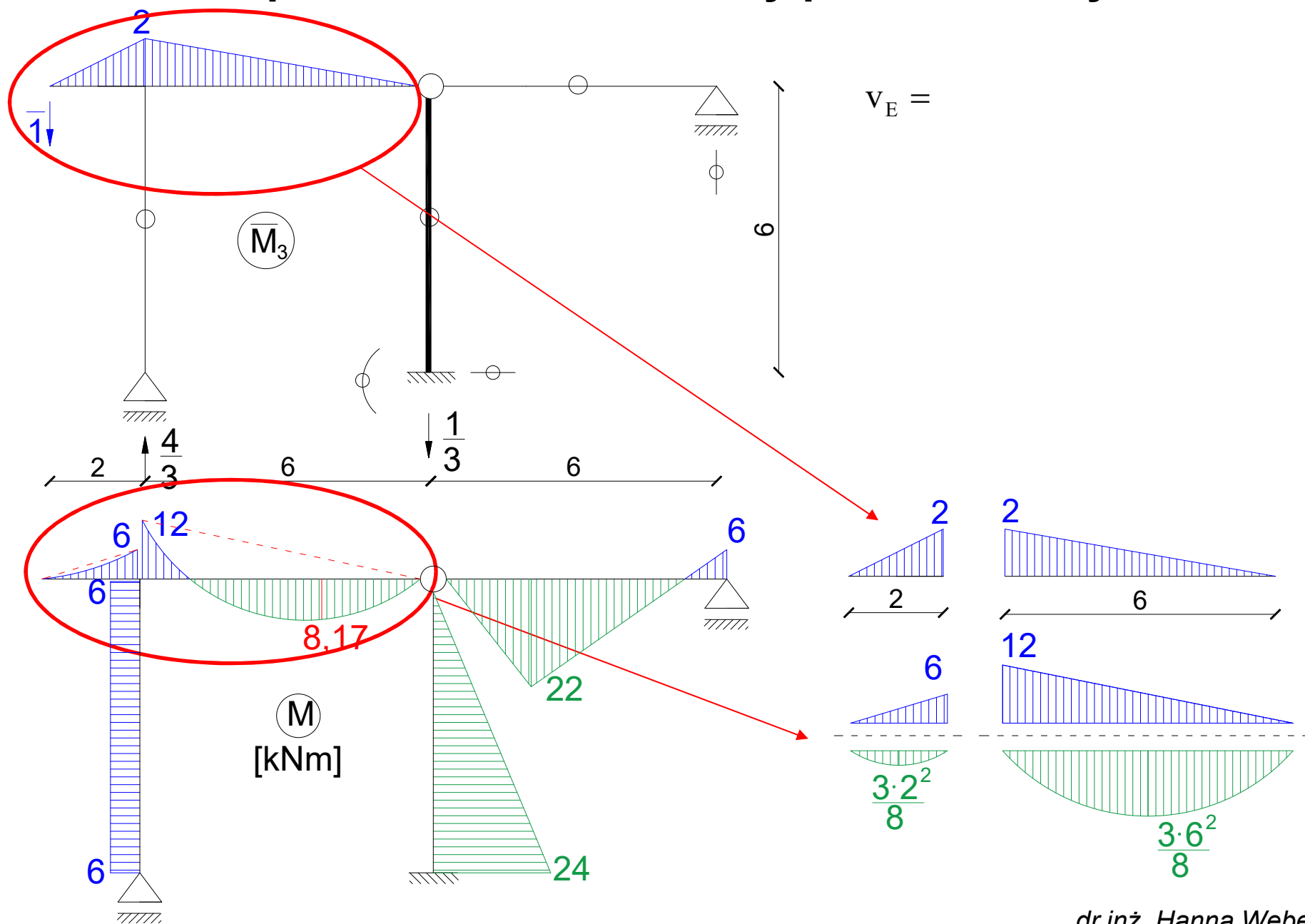
$$v_E = ?$$



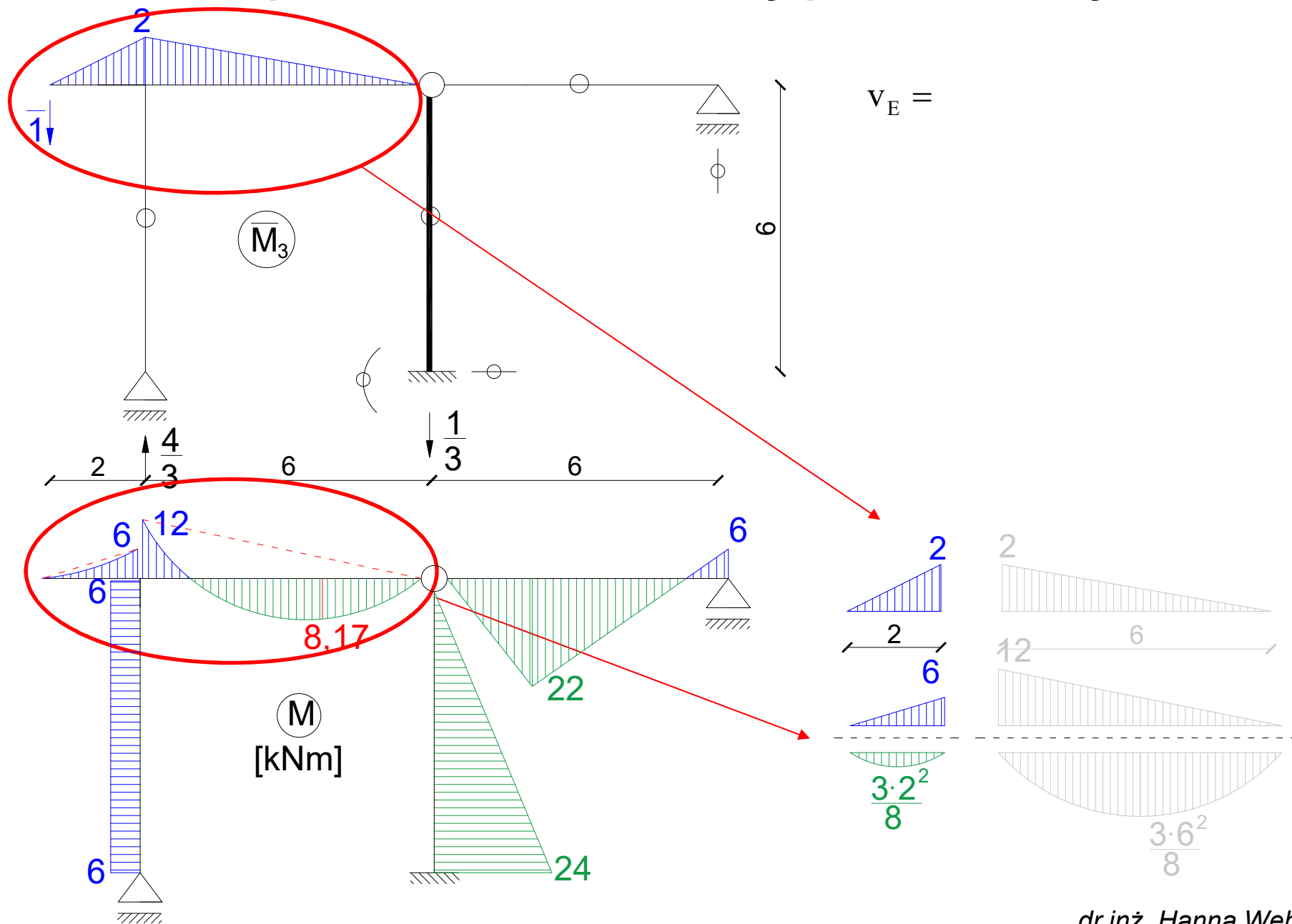
Obliczenia przemieszczeń z zasady prac wirtualnych:



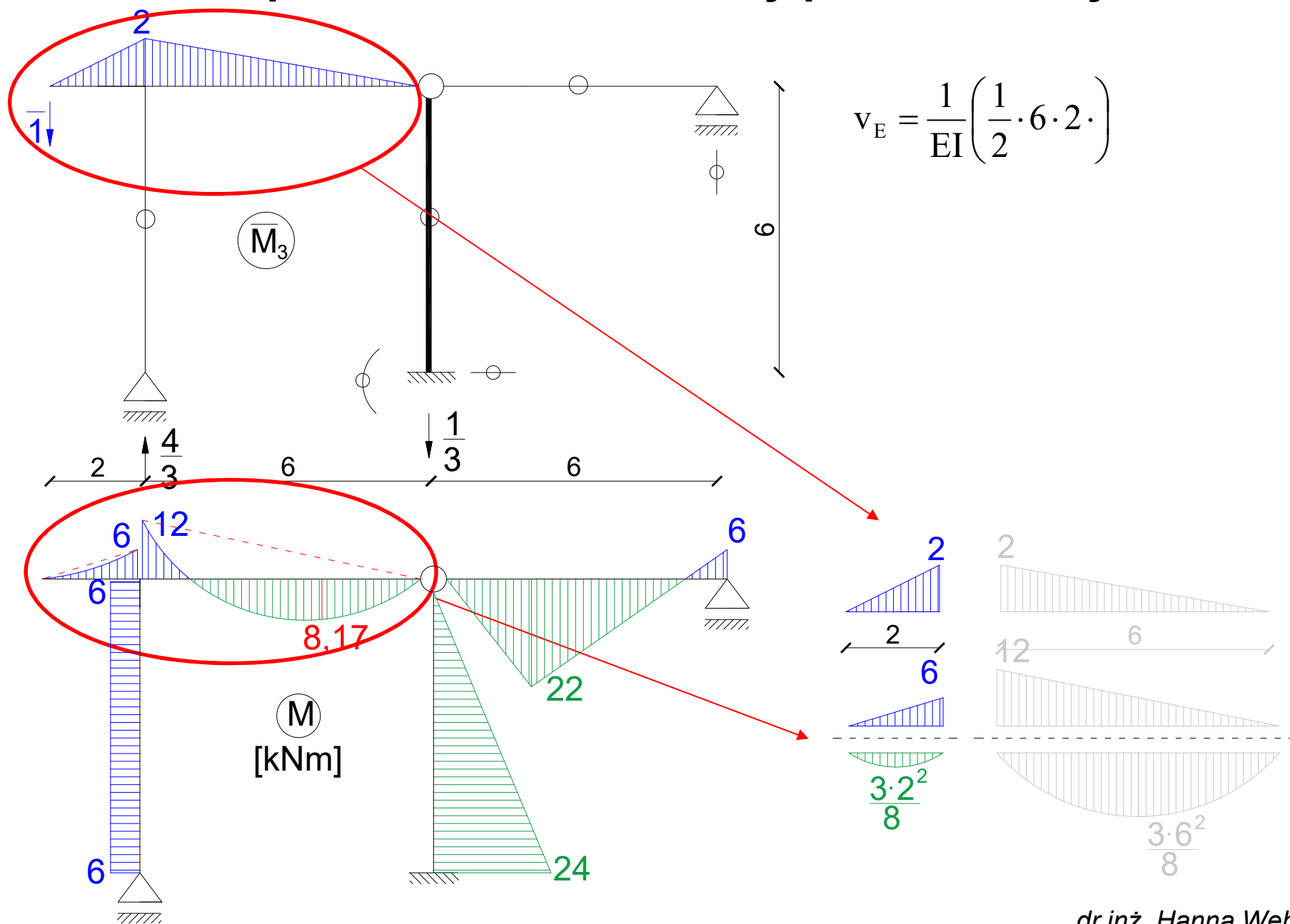
Obliczenia przemieszczeń z zasady prac wirtualnych:



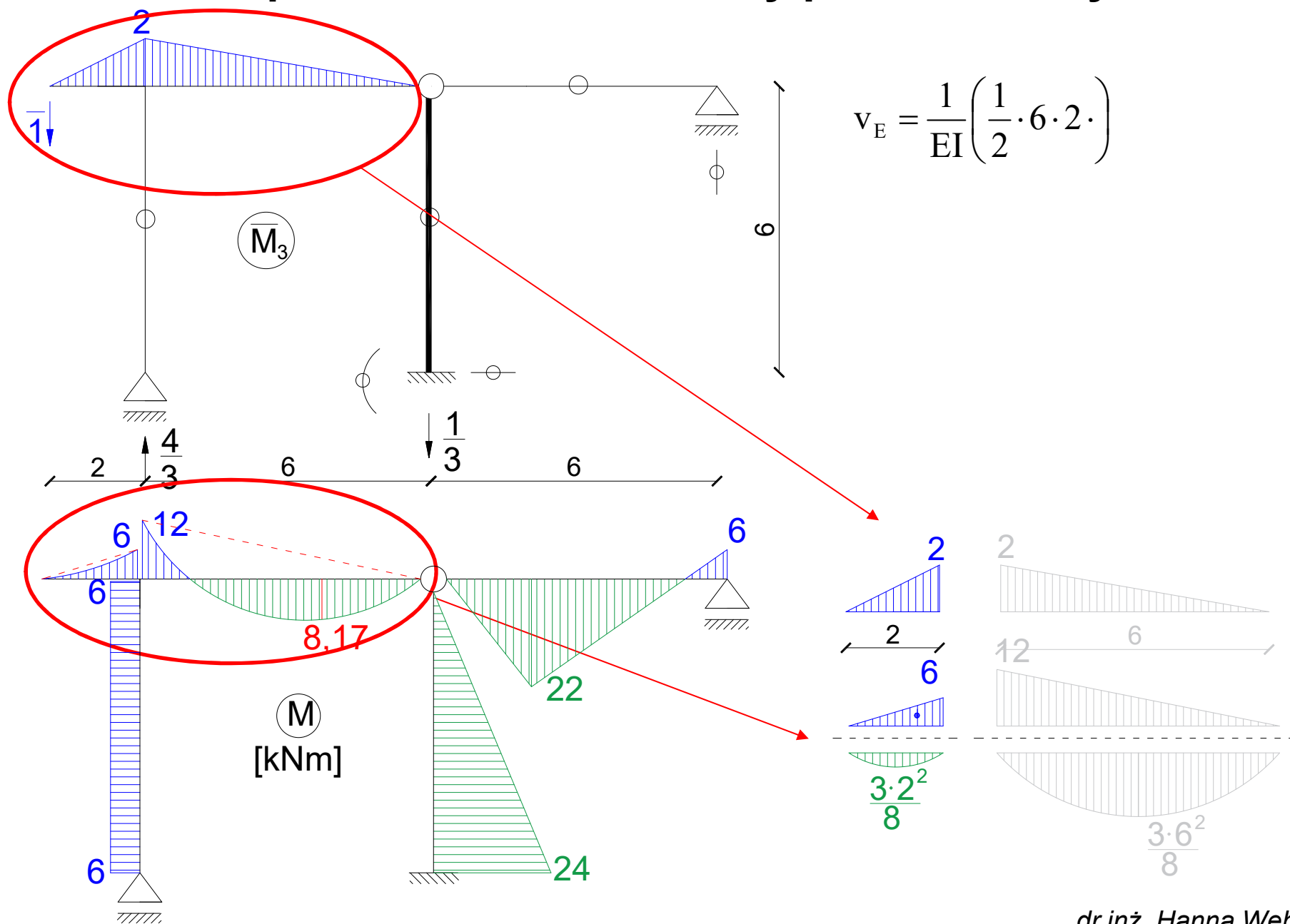
Obliczenia przemieszczeń z zasady prac wirtualnych:



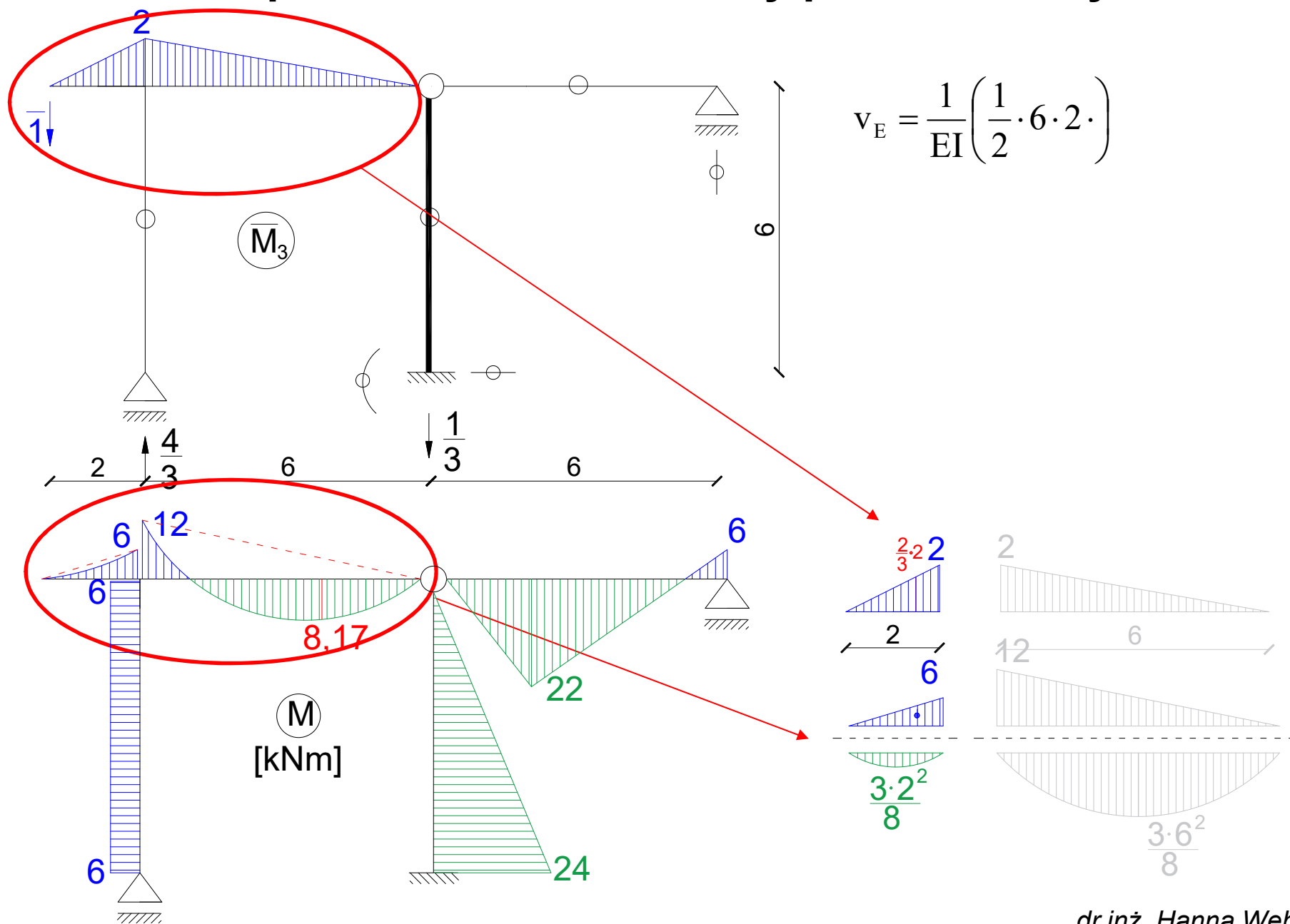
Obliczenia przemieszczeń z zasady prac wirtualnych:



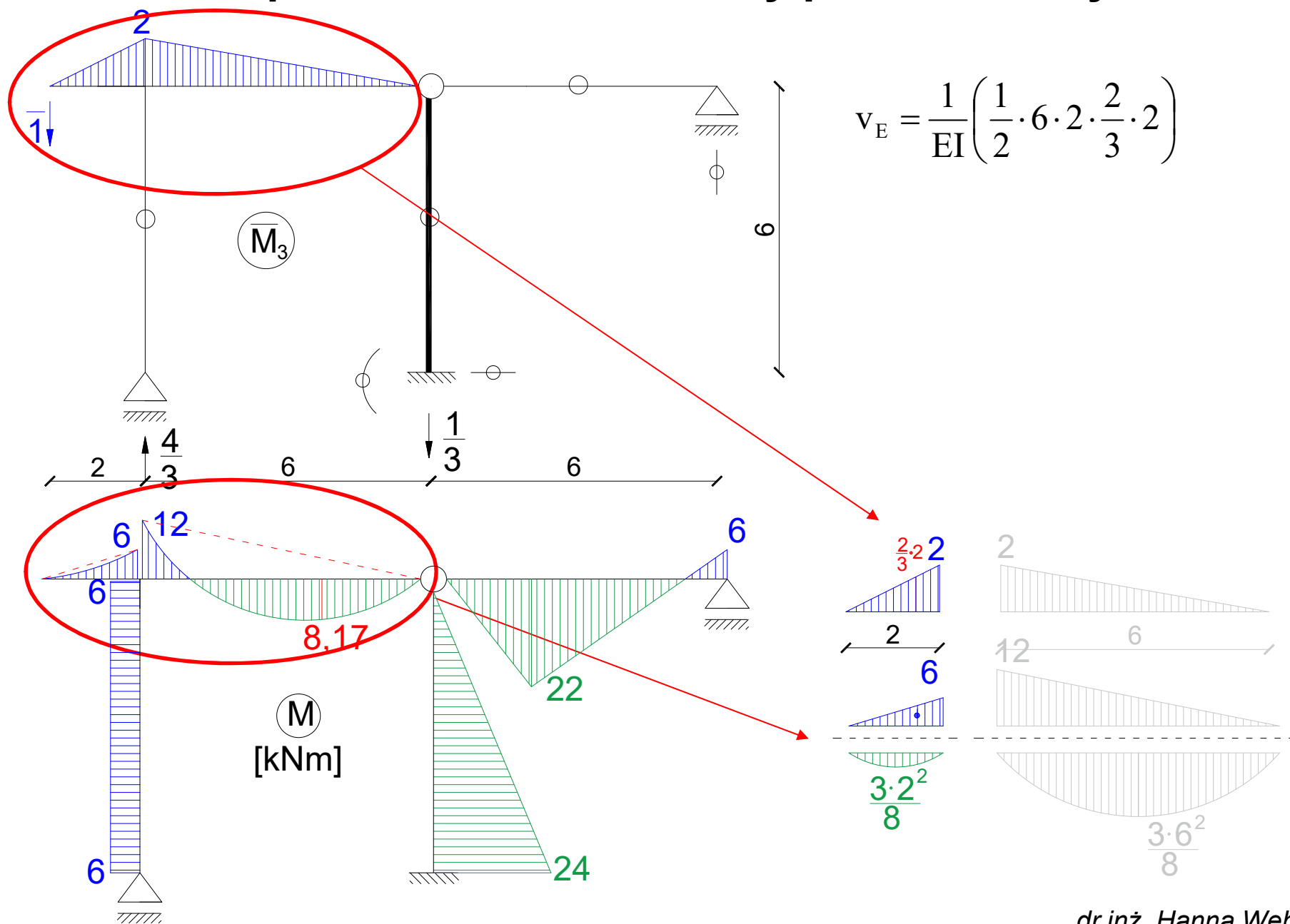
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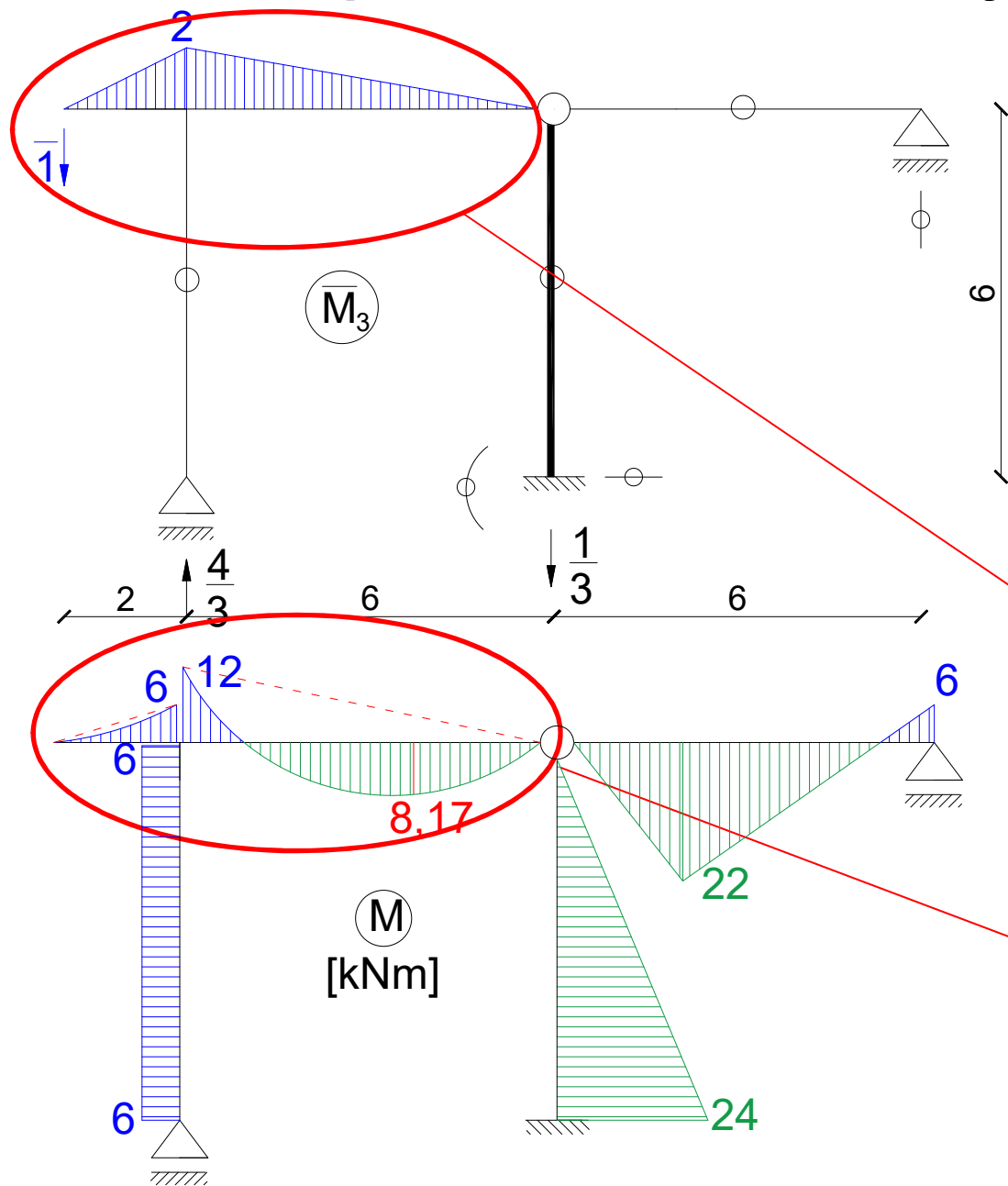
Obliczenia przemieszczeń z zasady prac wirtualnych:



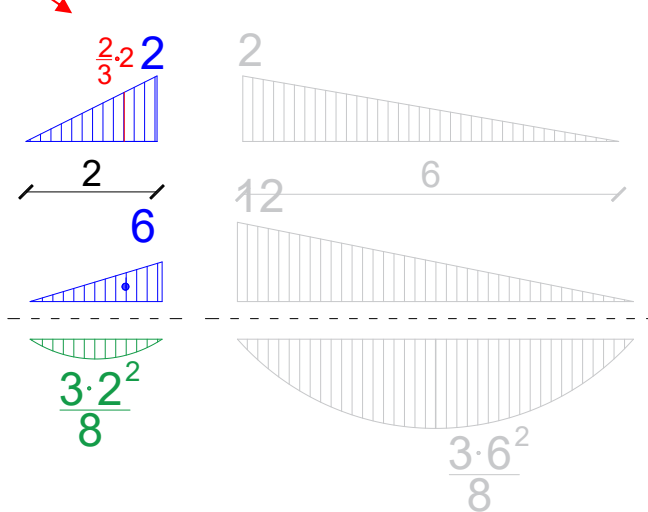
Obliczenia przemieszczeń z zasady prac wirtualnych:



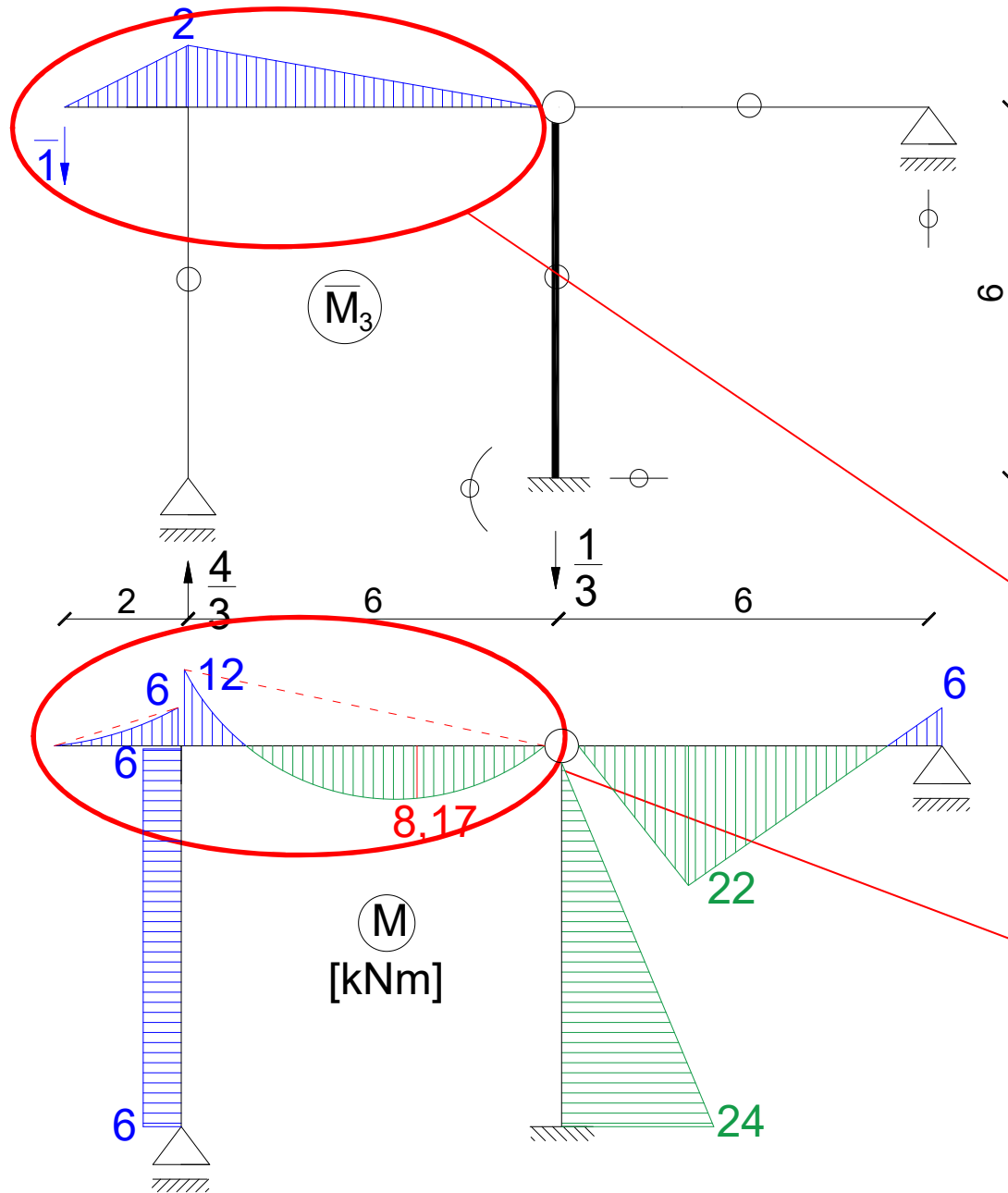
Obliczenia przemieszczeń z zasady prac wirtualnych:



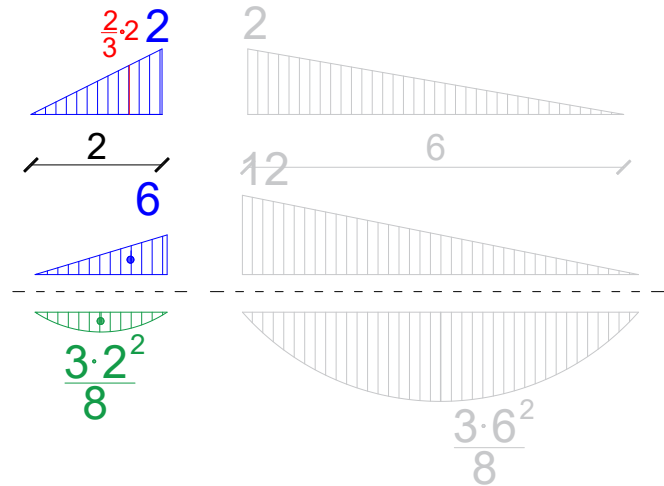
$$v_E = \frac{1}{EI} \left(\frac{1}{2} \cdot 6 \cdot 2 \cdot \frac{2}{3} \cdot 2 \right) - \frac{1}{EI} \left(\frac{2}{3} \cdot \frac{3 \cdot 2^2}{8} \cdot 2 \cdot \right)$$



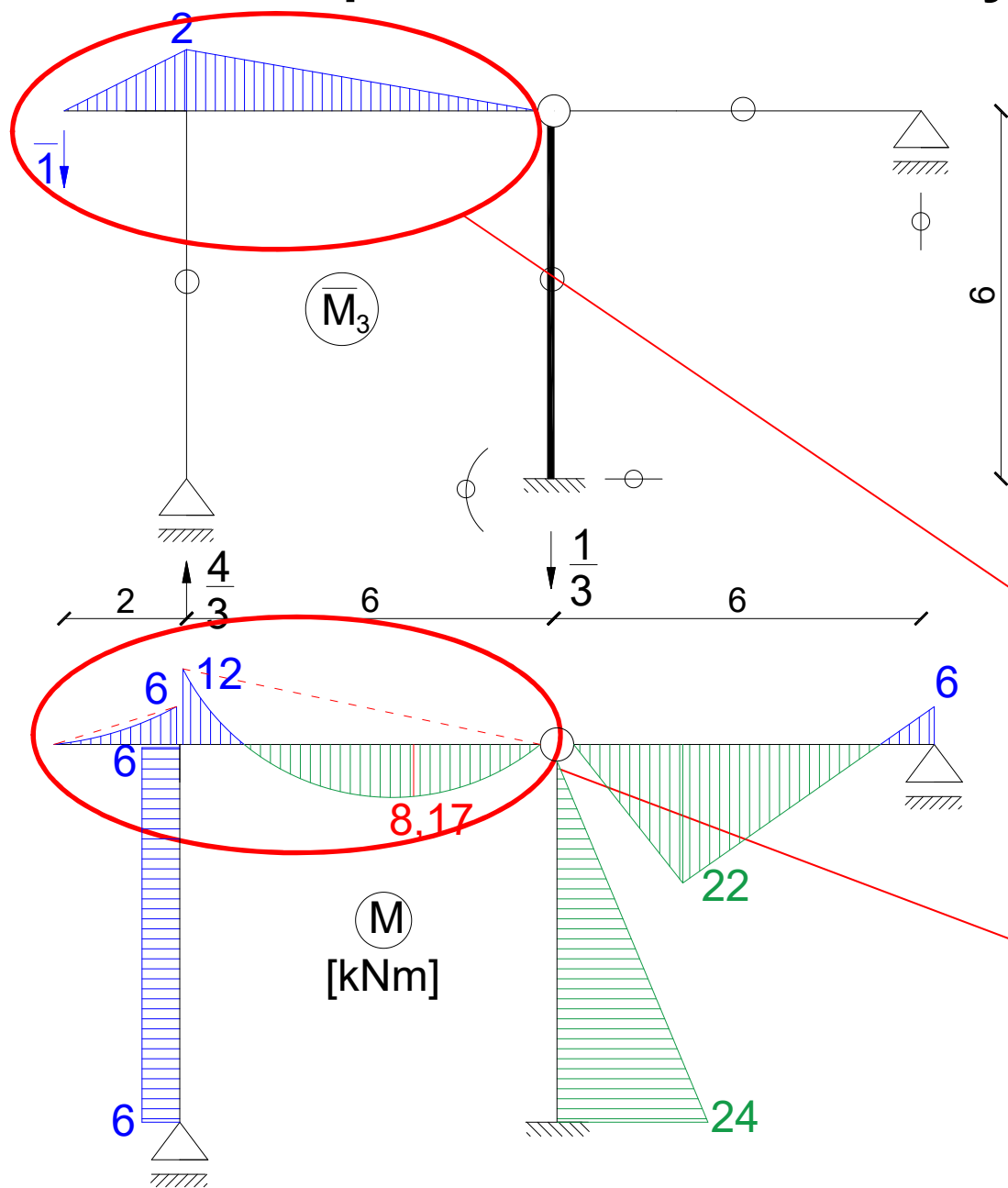
Obliczenia przemieszczeń z zasady prac wirtualnych:



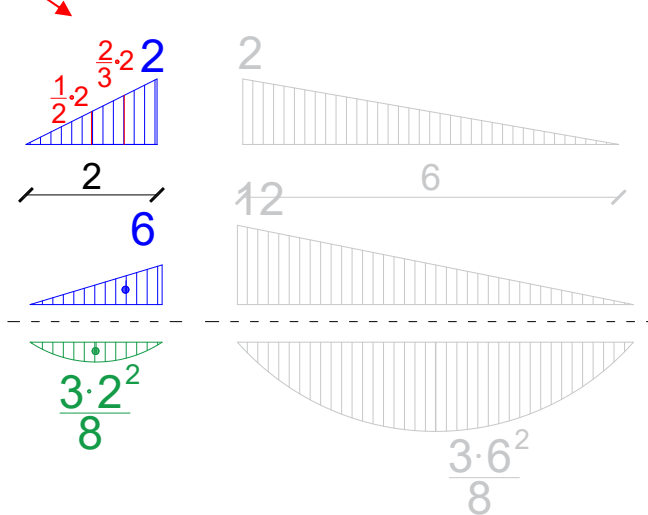
$$v_E = \frac{1}{EI} \left(\frac{1}{2} \cdot 6 \cdot 2 \cdot \frac{2}{3} \cdot 2 \right) - \frac{1}{EI} \left(\frac{2}{3} \cdot \frac{3 \cdot 2^2}{8} \cdot 2 \cdot \right)$$



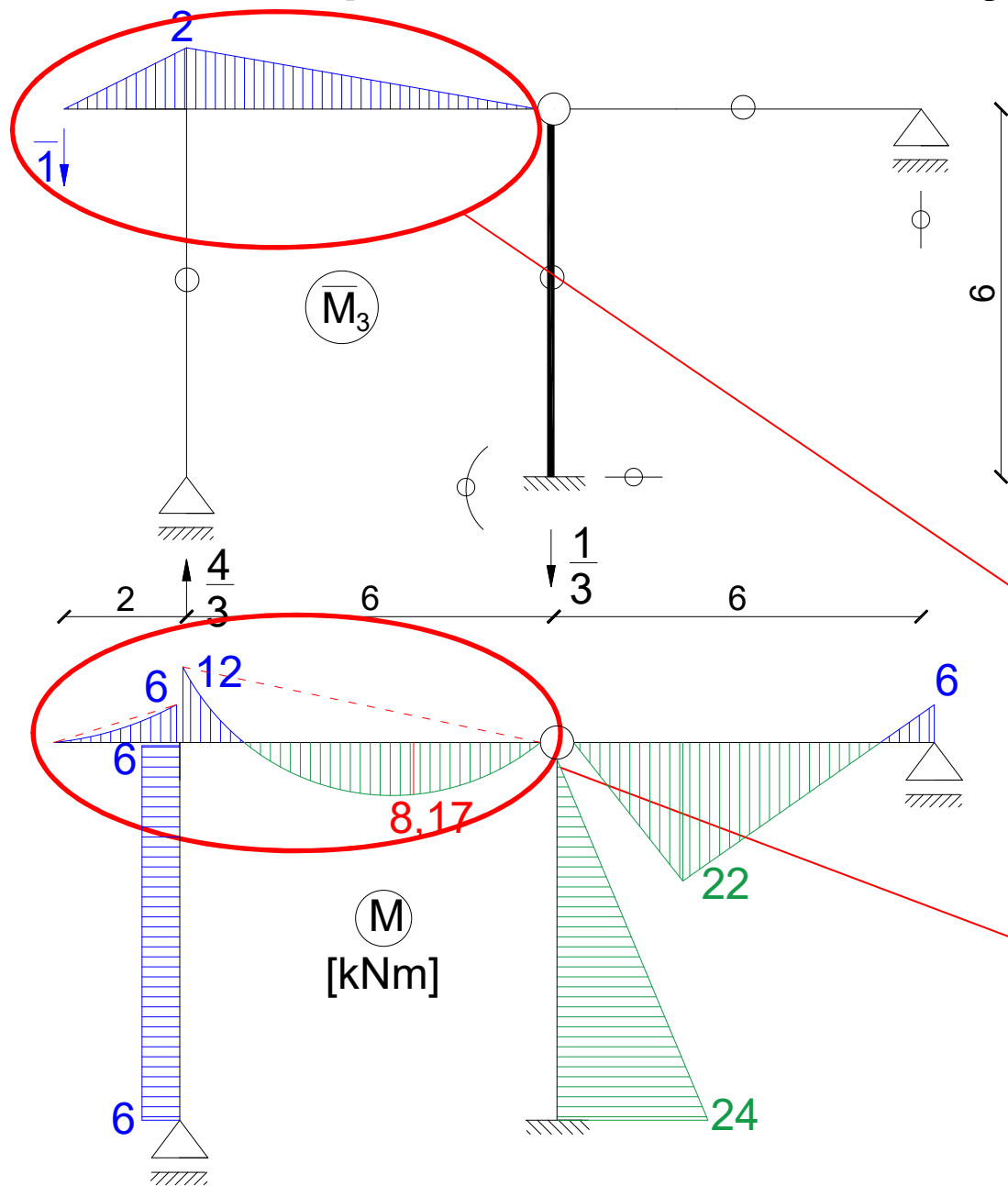
Obliczenia przemieszczeń z zasady prac wirtualnych:



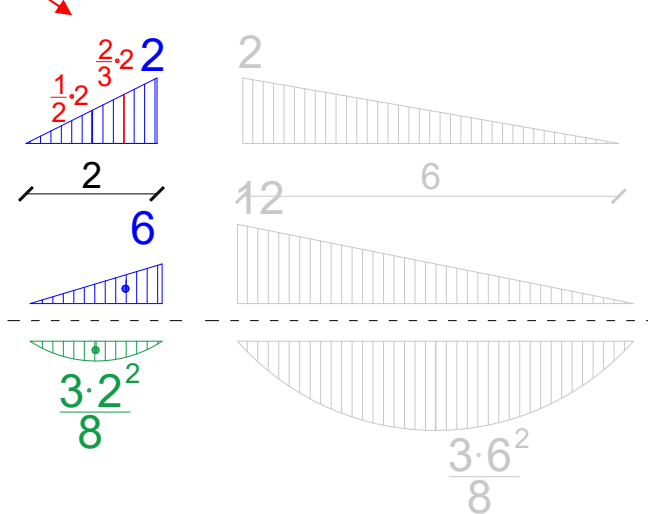
$$v_E = \frac{1}{EI} \left(\frac{1}{2} \cdot 6 \cdot 2 \cdot \frac{2}{3} \cdot 2 \right) - \frac{1}{EI} \left(\frac{2}{3} \cdot \frac{3 \cdot 2^2}{8} \cdot 2 \cdot \right)$$



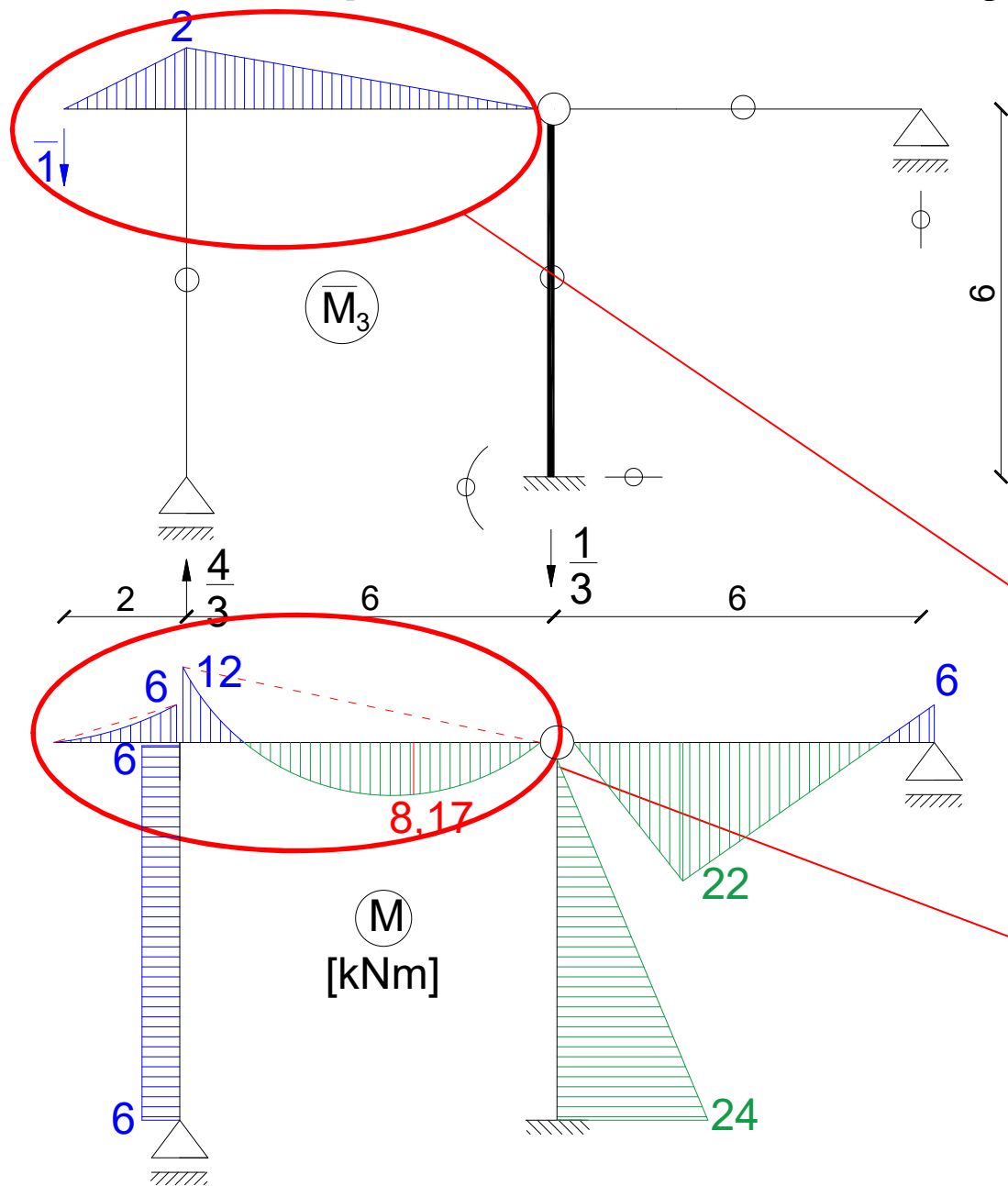
Obliczenia przemieszczeń z zasady prac wirtualnych:



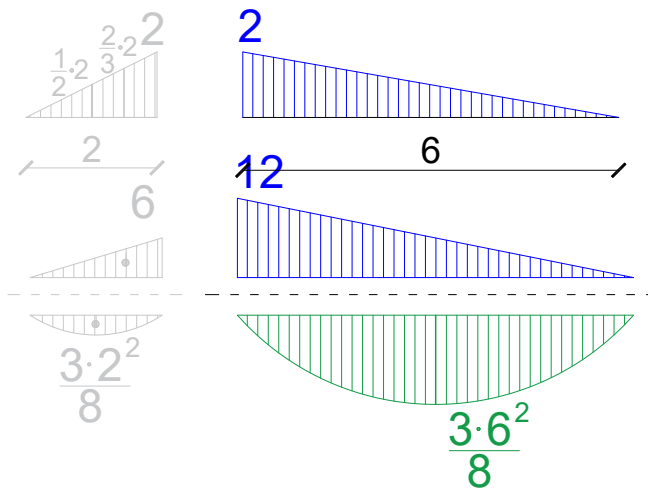
$$v_E = \frac{1}{EI} \left(\frac{1}{2} \cdot 6 \cdot 2 \cdot \frac{2}{3} \cdot 2 \right) - \frac{1}{EI} \left(\frac{2}{3} \cdot \frac{3 \cdot 2^2}{8} \cdot 2 \cdot \frac{1}{2} \cdot 2 \right)$$



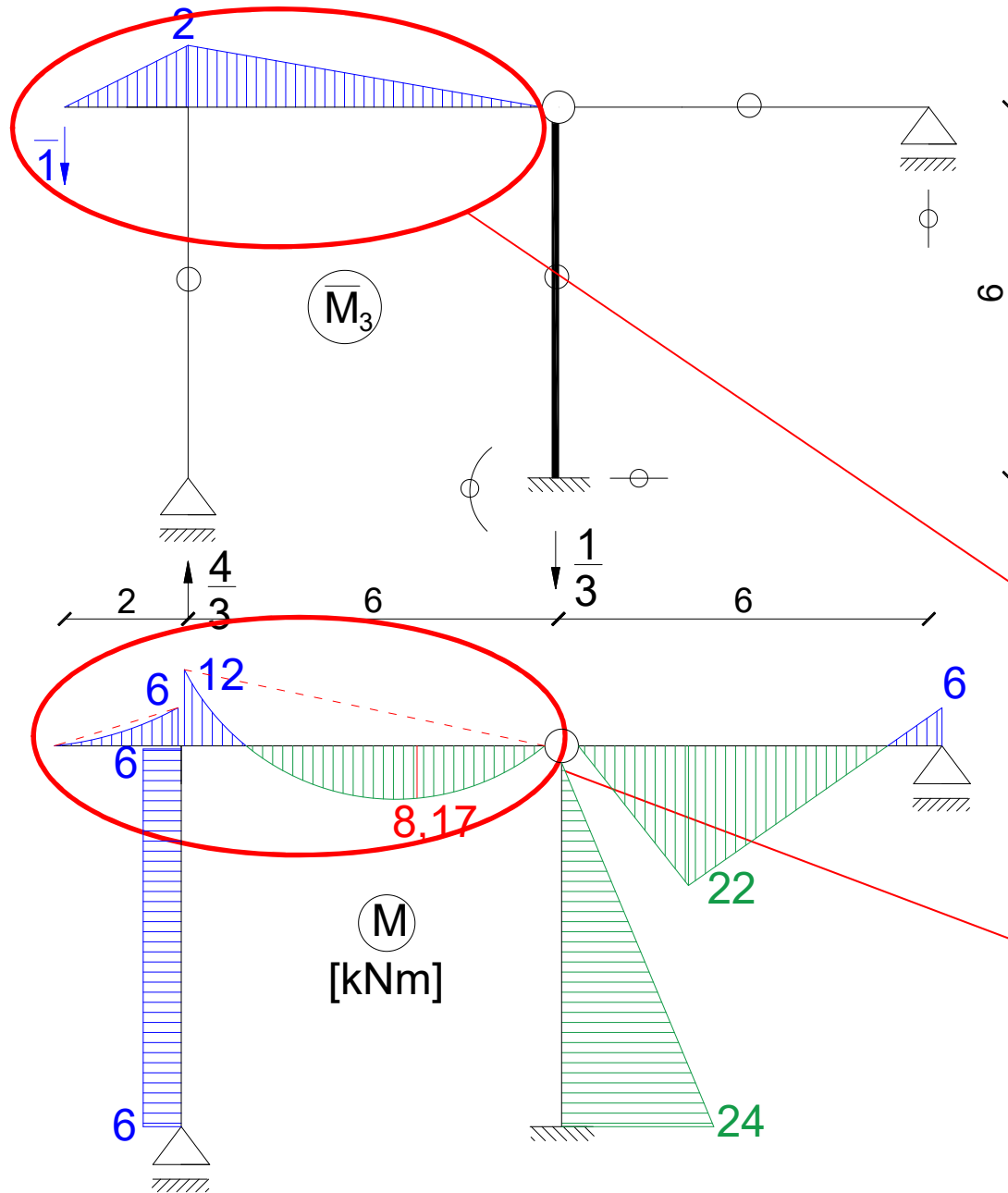
Obliczenia przemieszczeń z zasady prac wirtualnych:



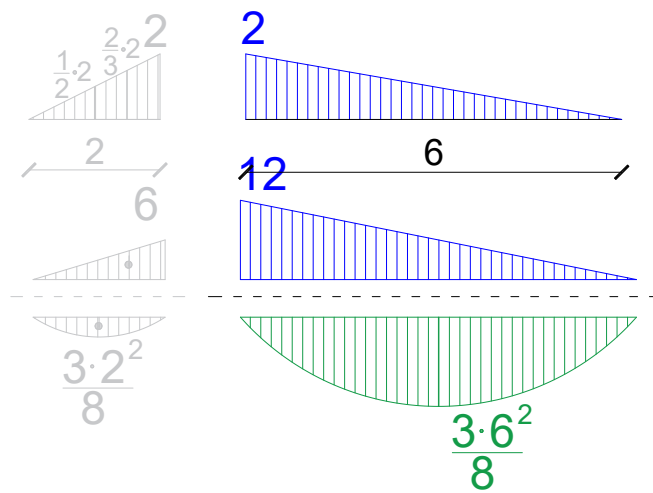
$$v_E = \frac{1}{EI} \left(\frac{1}{2} \cdot 6 \cdot 2 \cdot \frac{2}{3} \cdot 2 \right) - \frac{1}{EI} \left(\frac{2}{3} \cdot \frac{3 \cdot 2^2}{8} \cdot 2 \cdot \frac{1}{2} \cdot 2 \right)$$



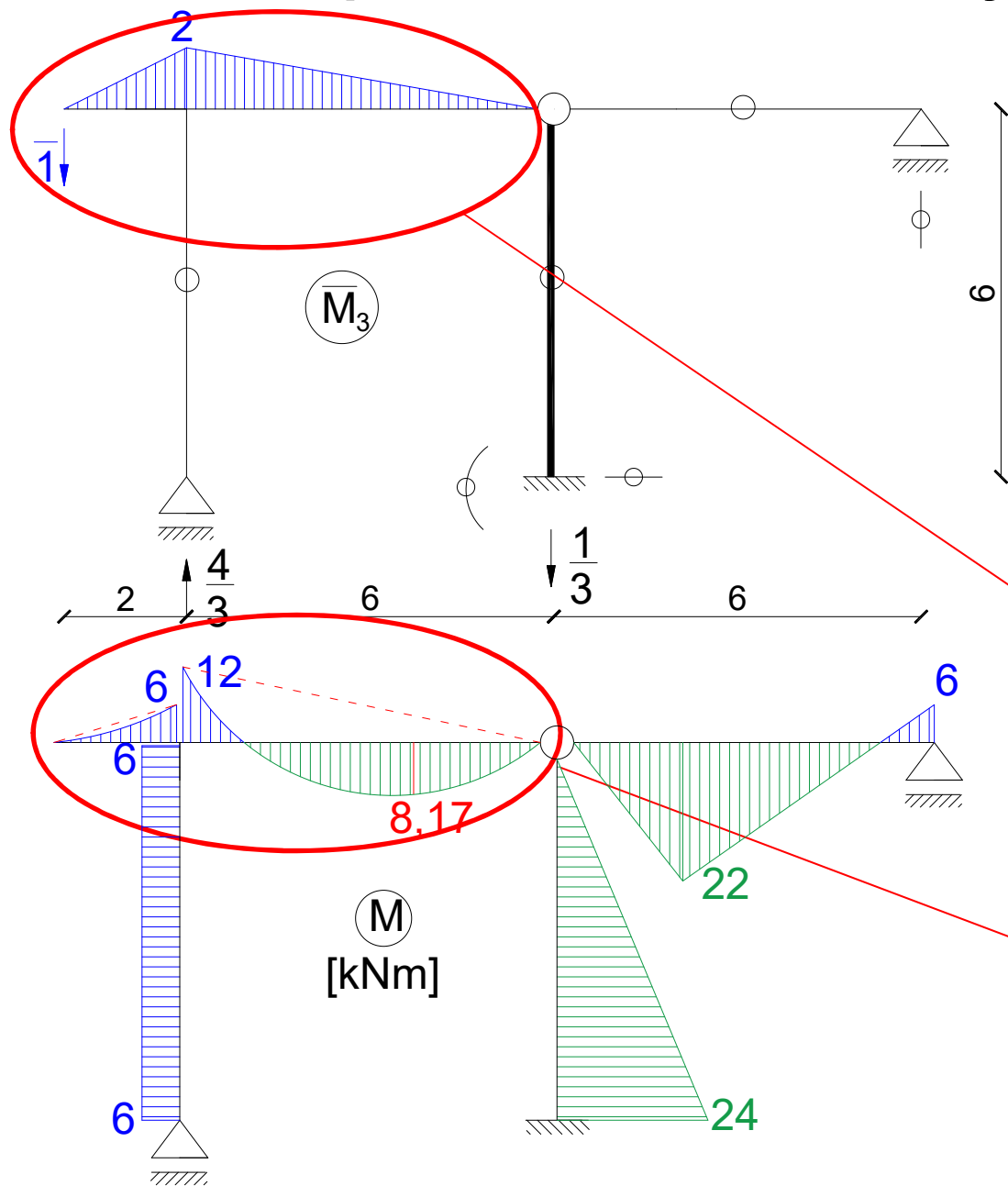
Obliczenia przemieszczeń z zasady prac wirtualnych:



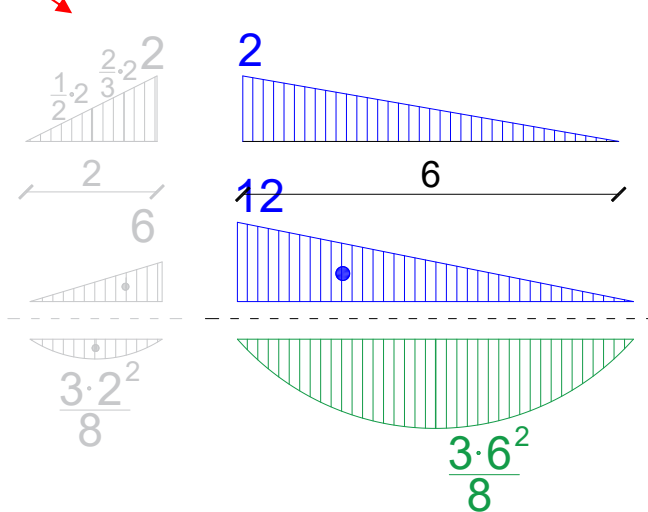
$$v_E = \frac{1}{EI} \left(\frac{1}{2} \cdot 6 \cdot 2 \cdot \frac{2}{3} \cdot 2 \right) - \frac{1}{EI} \left(\frac{2}{3} \cdot \frac{3 \cdot 2^2}{8} \cdot 2 \cdot \frac{1}{2} \cdot 2 \right) + \frac{1}{EI} \left(\frac{1}{2} \cdot 12 \cdot 6 \cdot \right)$$



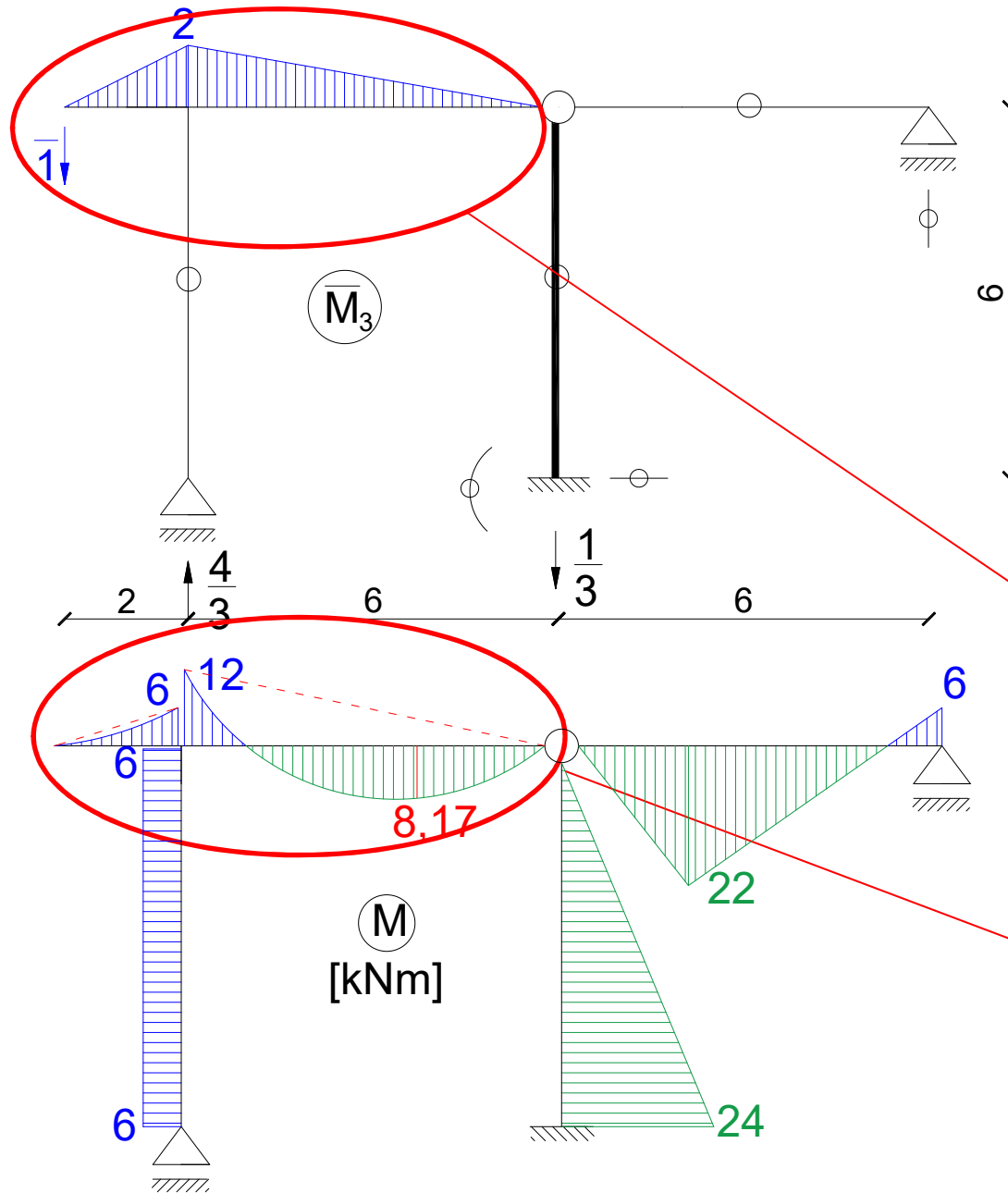
Obliczenia przemieszczeń z zasady prac wirtualnych:



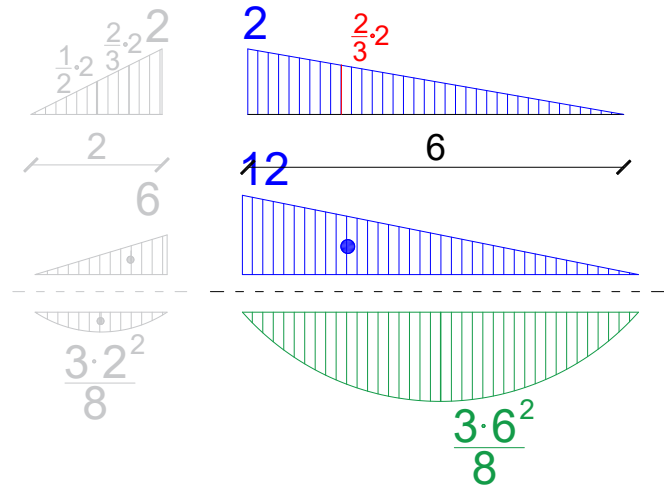
$$v_E = \frac{1}{EI} \left(\frac{1}{2} \cdot 6 \cdot 2 \cdot \frac{2}{3} \cdot 2 \right) - \frac{1}{EI} \left(\frac{2}{3} \cdot \frac{3 \cdot 2^2}{8} \cdot 2 \cdot \frac{1}{2} \cdot 2 \right) + \frac{1}{EI} \left(\frac{1}{2} \cdot 12 \cdot 6 \cdot \right)$$



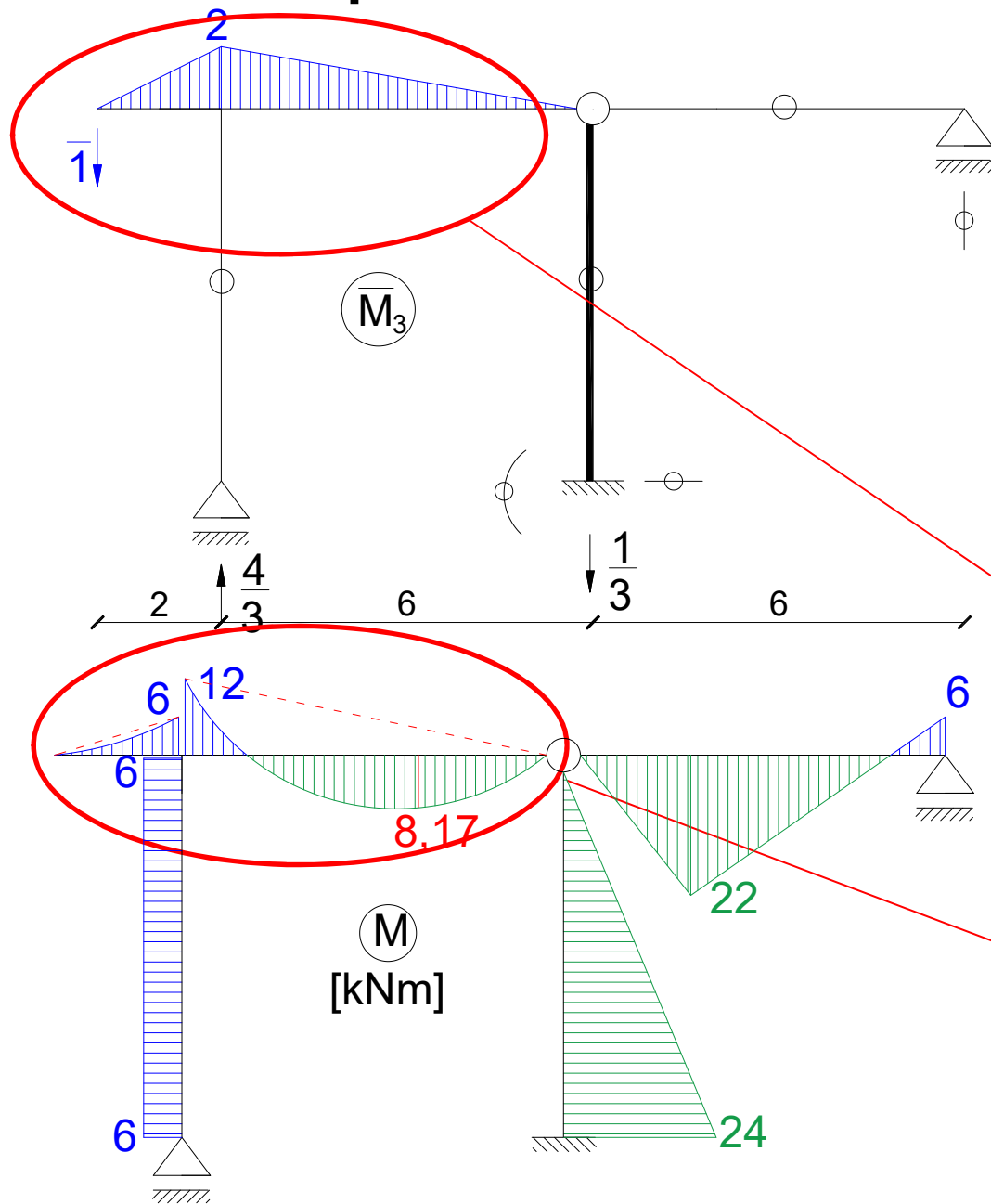
Obliczenia przemieszczeń z zasady prac wirtualnych:



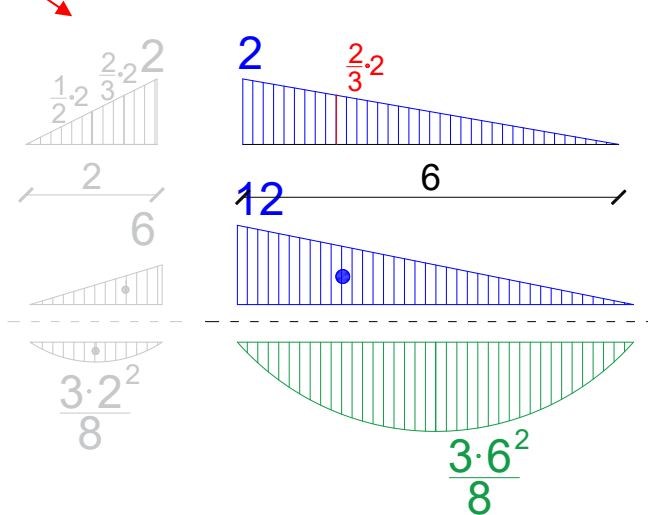
$$v_E = \frac{1}{EI} \left(\frac{1}{2} \cdot 6 \cdot 2 \cdot \frac{2}{3} \cdot 2 \right) - \frac{1}{EI} \left(\frac{2}{3} \cdot \frac{3 \cdot 2^2}{8} \cdot 2 \cdot \frac{1}{2} \cdot 2 \right) + \frac{1}{EI} \left(\frac{1}{2} \cdot 12 \cdot 6 \cdot \right)$$



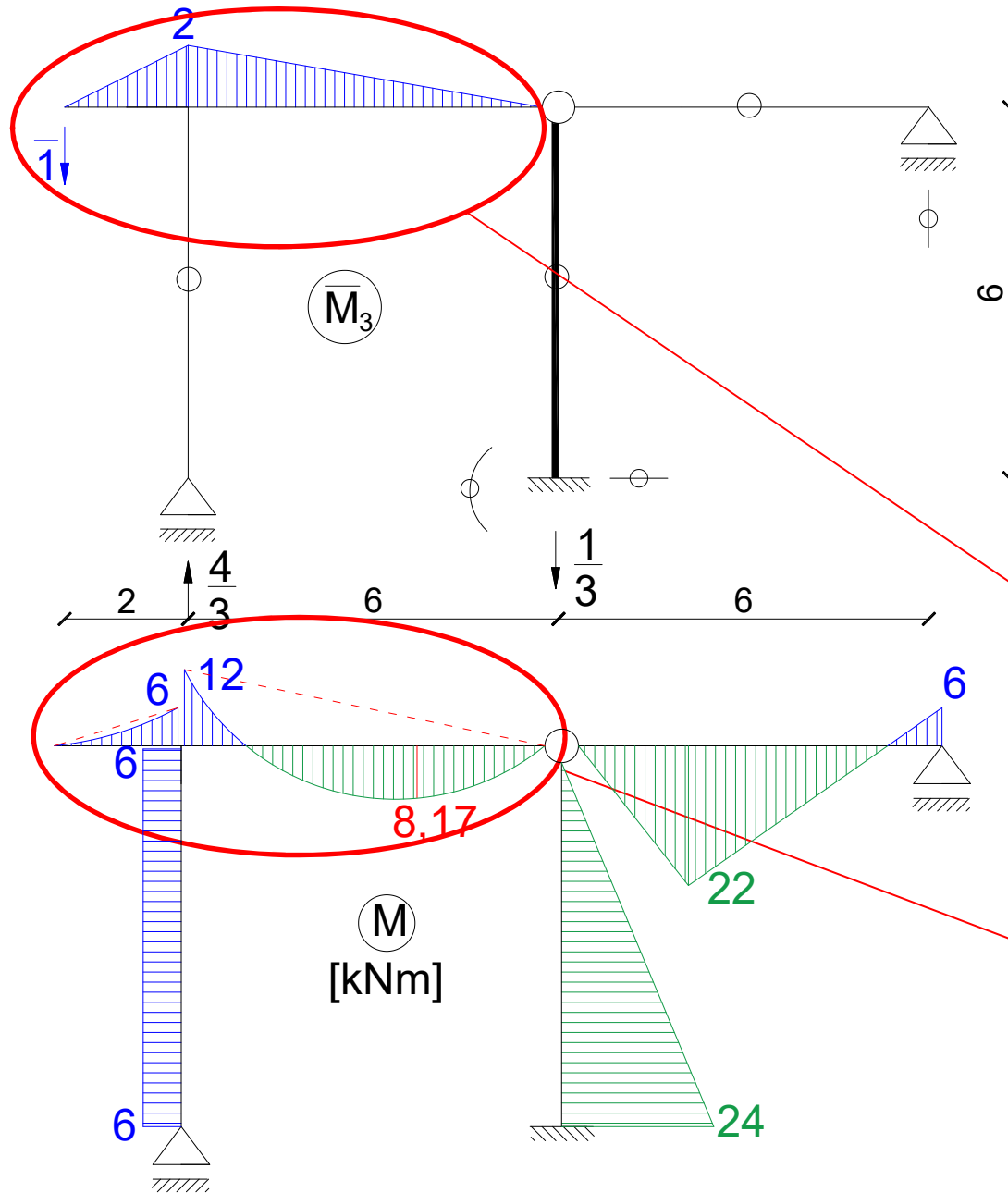
Obliczenia przemieszczeń z zasady prac wirtualnych:



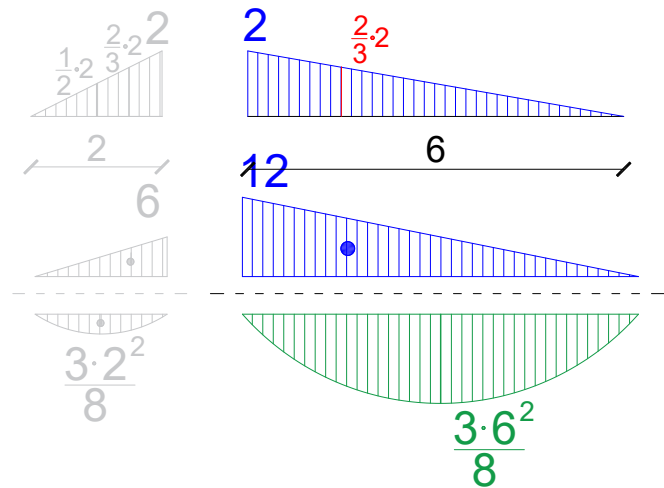
$$v_E = \frac{1}{EI} \left(\frac{1}{2} \cdot 6 \cdot 2 \cdot \frac{2}{3} \cdot 2 \right) - \frac{1}{EI} \left(\frac{2}{3} \cdot \frac{3 \cdot 2^2}{8} \cdot 2 \cdot \frac{1}{2} \cdot 2 \right) + \frac{1}{EI} \left(\frac{1}{2} \cdot 12 \cdot 6 \cdot \frac{2}{3} \cdot 2 \right)$$



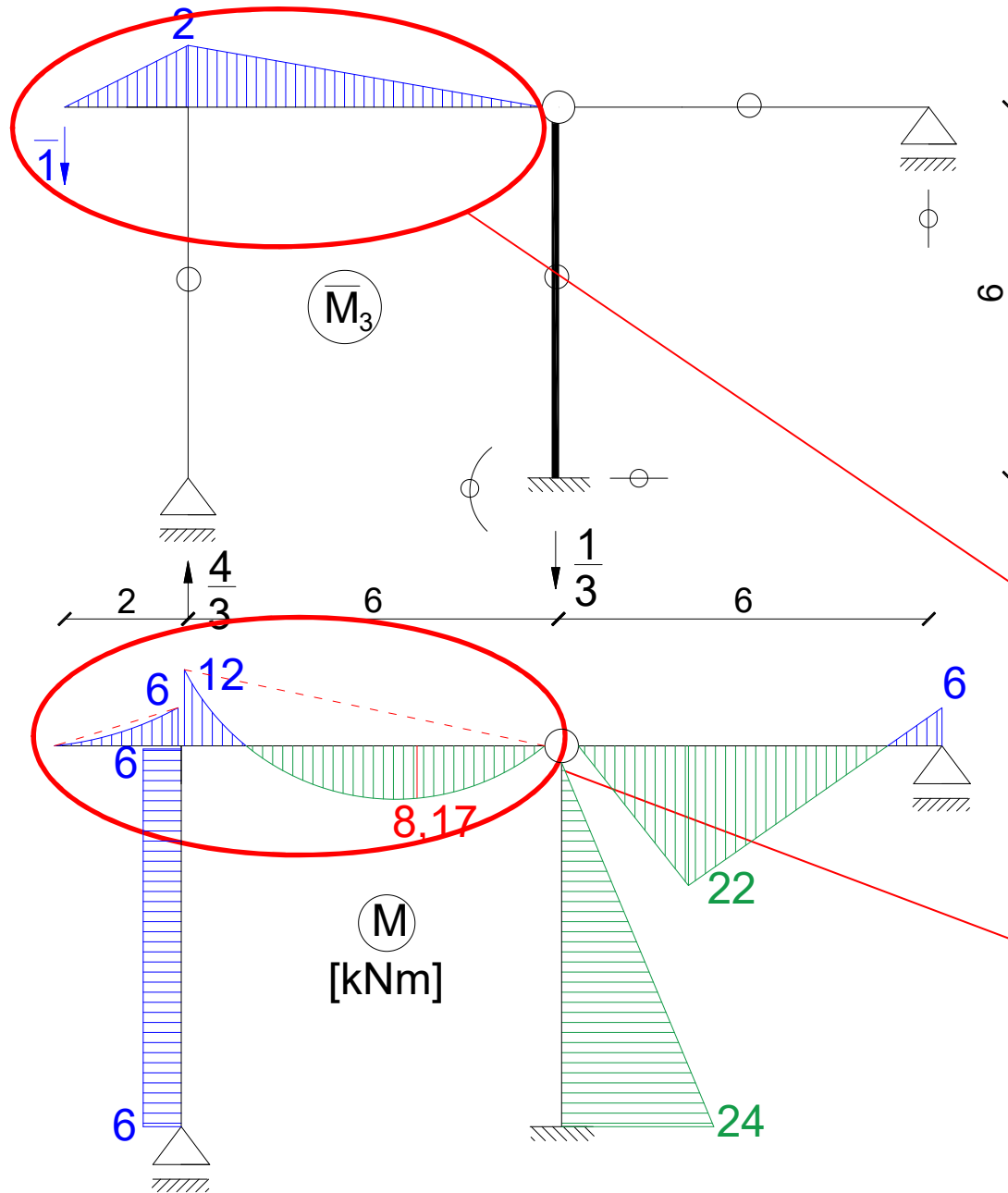
Obliczenia przemieszczeń z zasady prac wirtualnych:



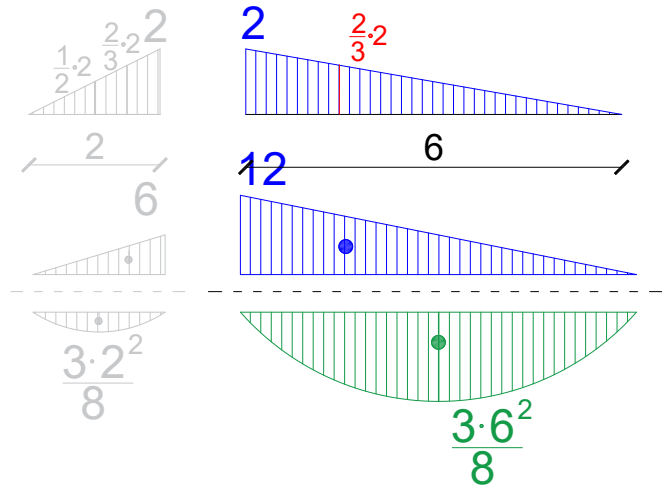
$$\begin{aligned} v_E = & \frac{1}{EI} \left(\frac{1}{2} \cdot 6 \cdot 2 \cdot \frac{2}{3} \cdot 2 \right) \\ & - \frac{1}{EI} \left(\frac{2}{3} \cdot \frac{3 \cdot 2^2}{8} \cdot 2 \cdot \frac{1}{2} \cdot 2 \right) \\ & + \frac{1}{EI} \left(\frac{1}{2} \cdot 12 \cdot 6 \cdot \frac{2}{3} \cdot 2 \right) \\ & - \frac{1}{EI} \left(\frac{2}{3} \cdot \frac{3 \cdot 6^2}{8} \cdot 6 \cdot \right) \end{aligned}$$



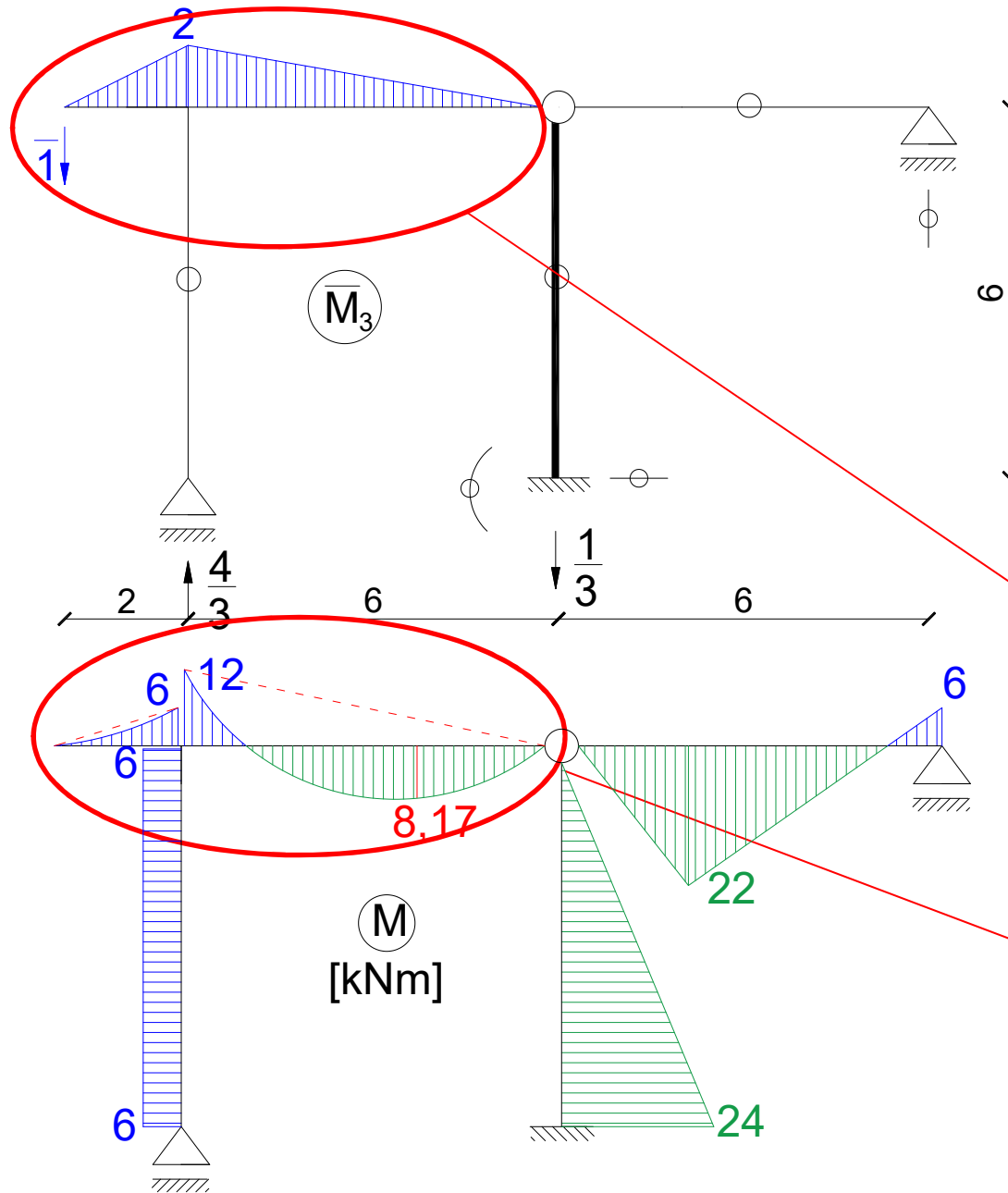
Obliczenia przemieszczeń z zasady prac wirtualnych:



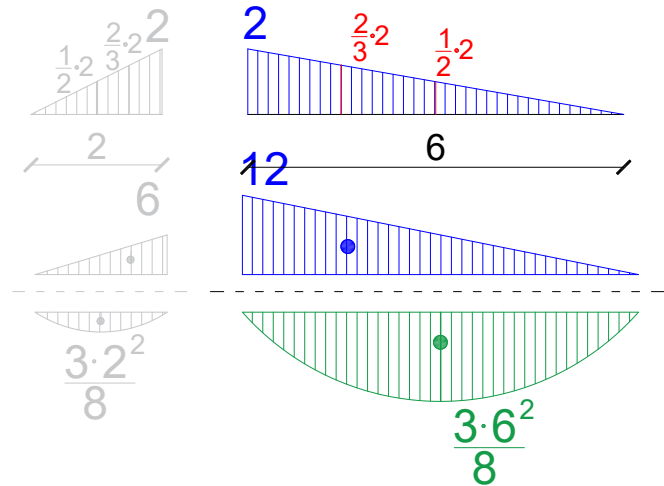
$$v_E = \frac{1}{EI} \left(\frac{1}{2} \cdot 6 \cdot 2 \cdot \frac{2}{3} \cdot 2 \right) - \frac{1}{EI} \left(\frac{2}{3} \cdot \frac{3 \cdot 2^2}{8} \cdot 2 \cdot \frac{1}{2} \cdot 2 \right) + \frac{1}{EI} \left(\frac{1}{2} \cdot 12 \cdot 6 \cdot \frac{2}{3} \cdot 2 \right) - \frac{1}{EI} \left(\frac{2}{3} \cdot \frac{3 \cdot 6^2}{8} \cdot 6 \cdot \right)$$



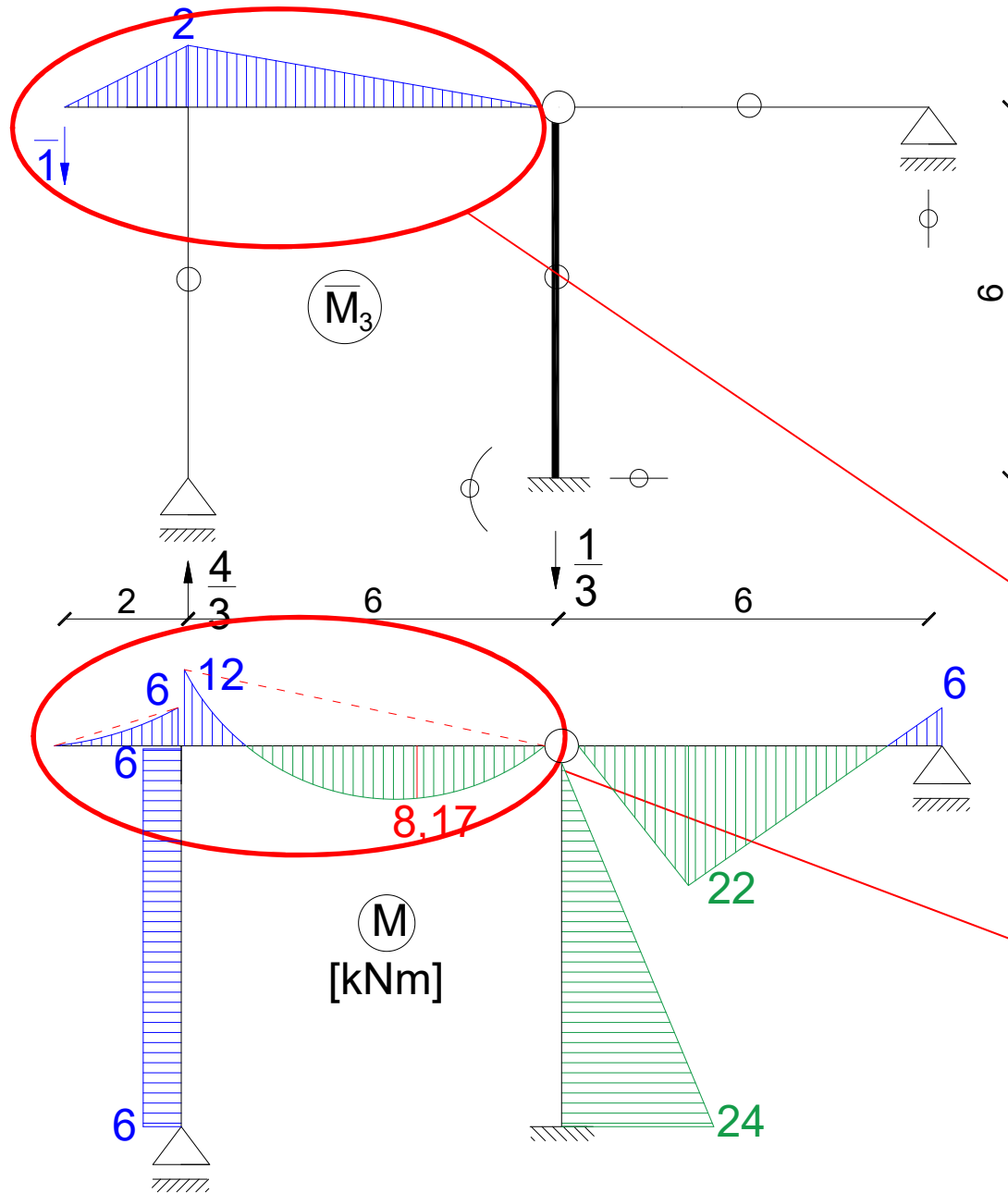
Obliczenia przemieszczeń z zasady prac wirtualnych:



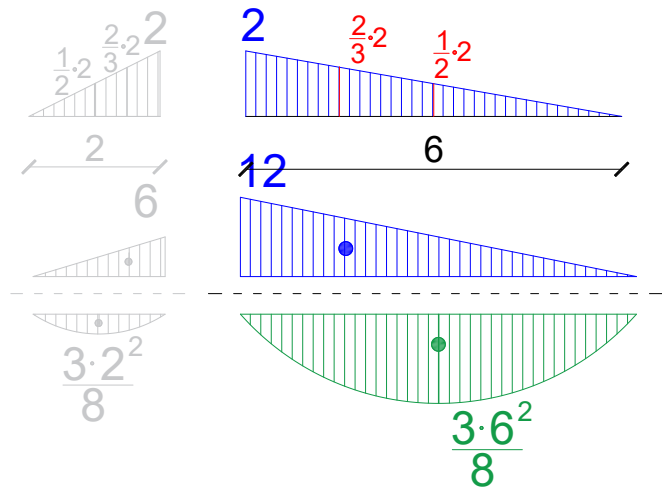
$$\begin{aligned} v_E = & \frac{1}{EI} \left(\frac{1}{2} \cdot 6 \cdot 2 \cdot \frac{2}{3} \cdot 2 \right) \\ & - \frac{1}{EI} \left(\frac{2}{3} \cdot \frac{3 \cdot 2^2}{8} \cdot 2 \cdot \frac{1}{2} \cdot 2 \right) \\ & + \frac{1}{EI} \left(\frac{1}{2} \cdot 12 \cdot 6 \cdot \frac{2}{3} \cdot 2 \right) \\ & - \frac{1}{EI} \left(\frac{2}{3} \cdot \frac{3 \cdot 6^2}{8} \cdot 6 \cdot \right) \end{aligned}$$



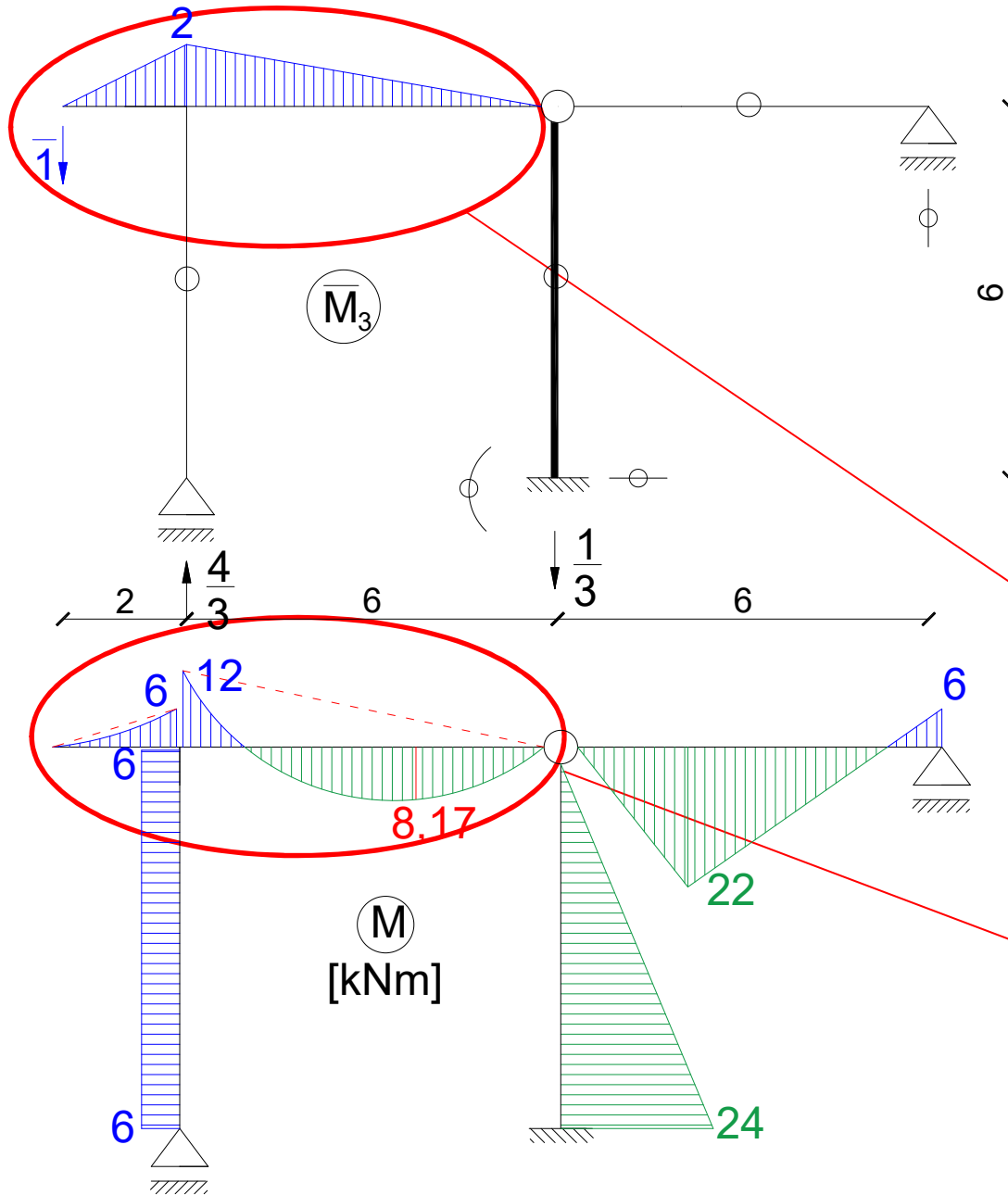
Obliczenia przemieszczeń z zasady prac wirtualnych:



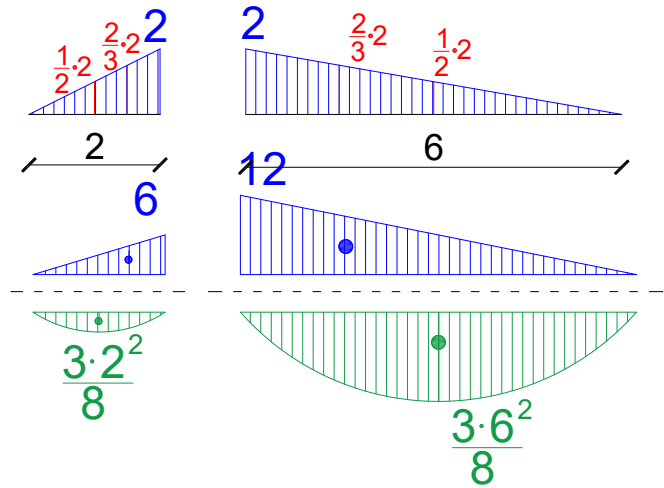
$$v_E = \frac{1}{EI} \left(\frac{1}{2} \cdot 6 \cdot 2 \cdot \frac{2}{3} \cdot 2 \right) - \frac{1}{EI} \left(\frac{2}{3} \cdot \frac{3 \cdot 2^2}{8} \cdot 2 \cdot \frac{1}{2} \cdot 2 \right) + \frac{1}{EI} \left(\frac{1}{2} \cdot 12 \cdot 6 \cdot \frac{2}{3} \cdot 2 \right) - \frac{1}{EI} \left(\frac{2}{3} \cdot \frac{3 \cdot 6^2}{8} \cdot 6 \cdot \frac{1}{2} \cdot 2 \right)$$



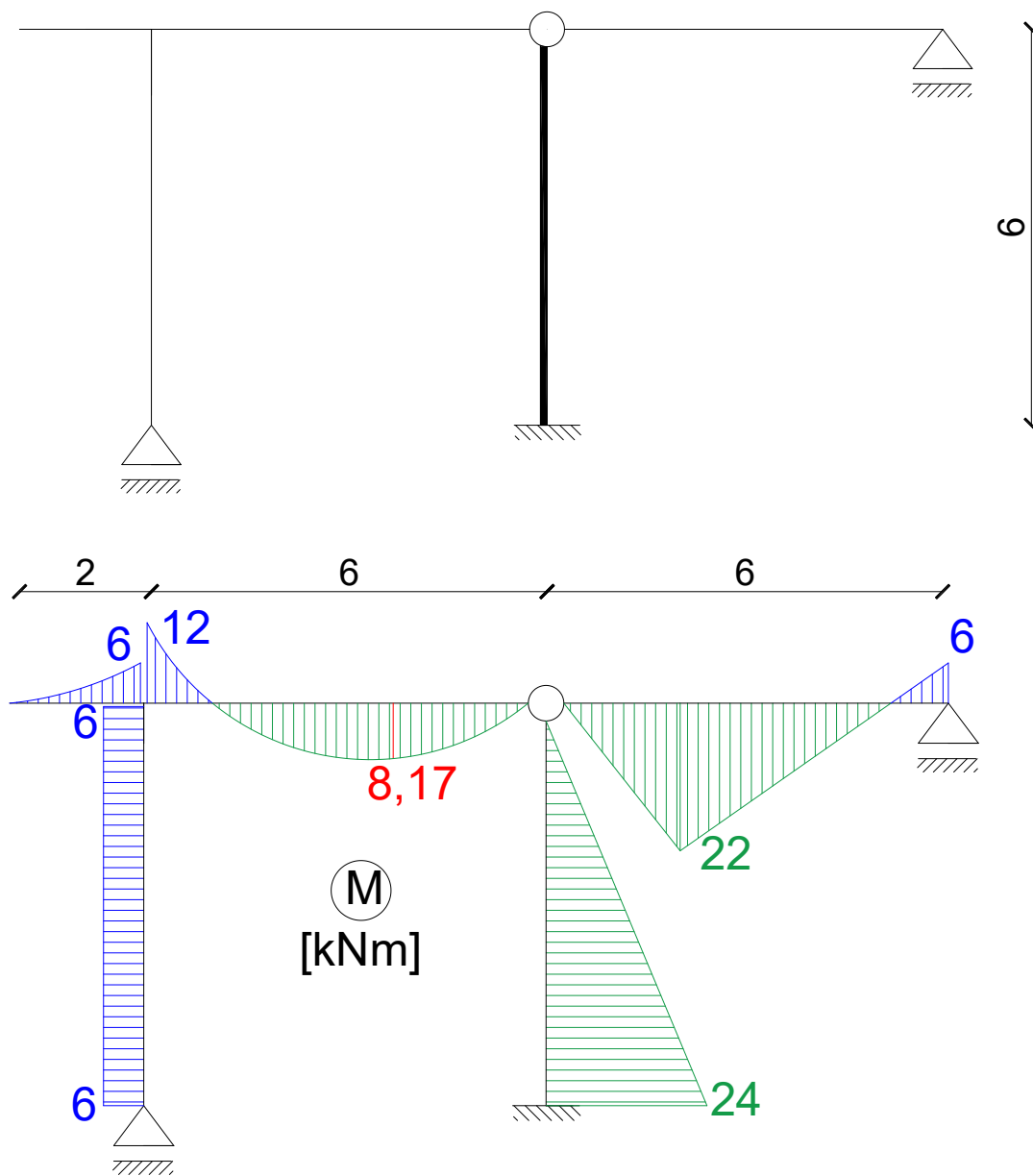
Obliczenia przemieszczeń z zasady prac wirtualnych:



$$\begin{aligned} v_E &= \frac{1}{EI} \left(\frac{1}{2} \cdot 6 \cdot 2 \cdot \frac{2}{3} \cdot 2 \right) \\ &\quad - \frac{1}{EI} \left(\frac{2}{3} \cdot \frac{3 \cdot 2^2}{8} \cdot 2 \cdot \frac{1}{2} \cdot 2 \right) \\ &\quad + \frac{1}{EI} \left(\frac{1}{2} \cdot 12 \cdot 6 \cdot \frac{2}{3} \cdot 2 \right) \\ &\quad - \frac{1}{EI} \left(\frac{2}{3} \cdot \frac{3 \cdot 6^2}{8} \cdot 6 \cdot \frac{1}{2} \cdot 2 \right) = \frac{0}{EI} \end{aligned}$$

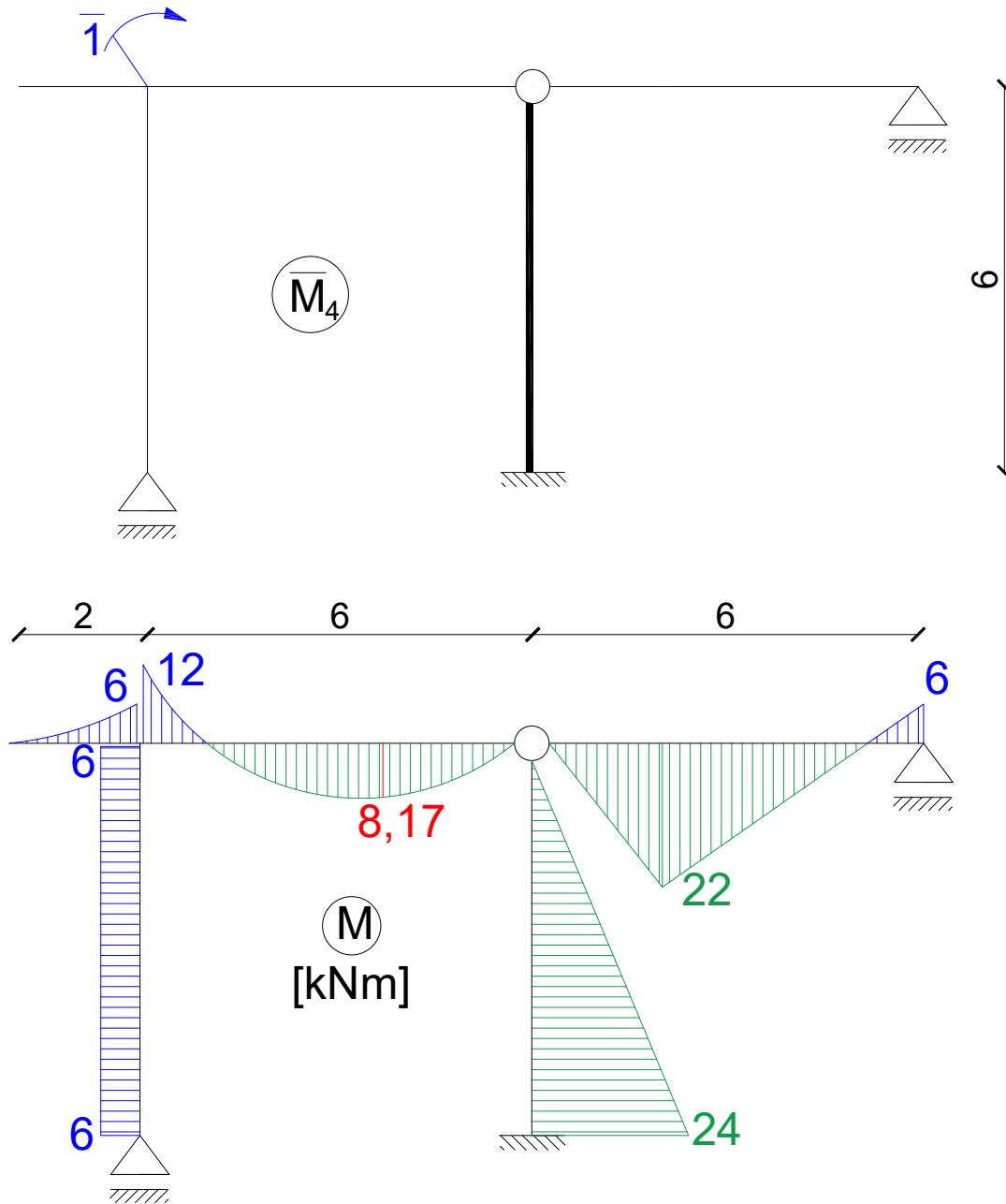


Obliczenia przemieszczeń z zasady prac wirtualnych:



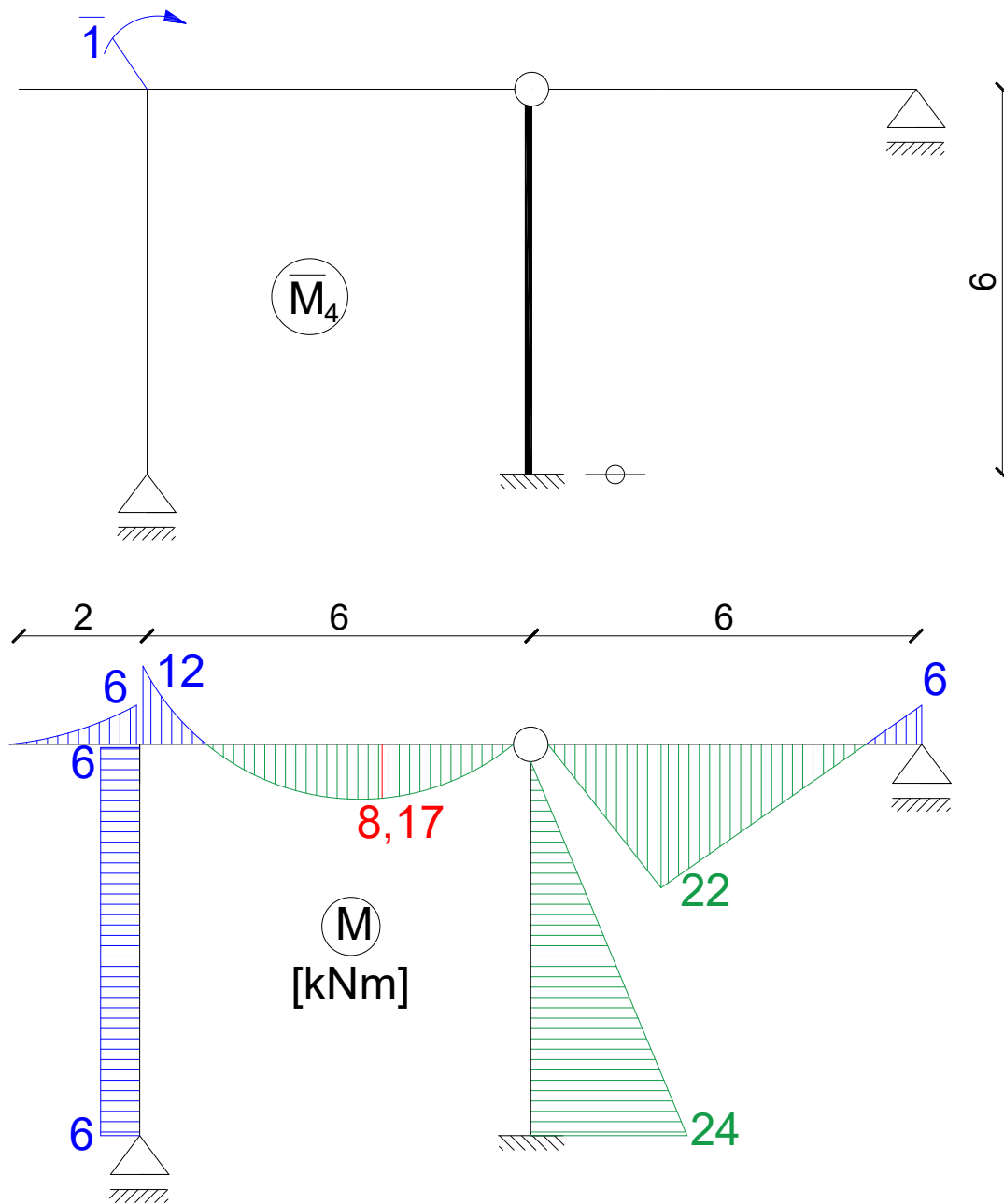
$$\varphi_F = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



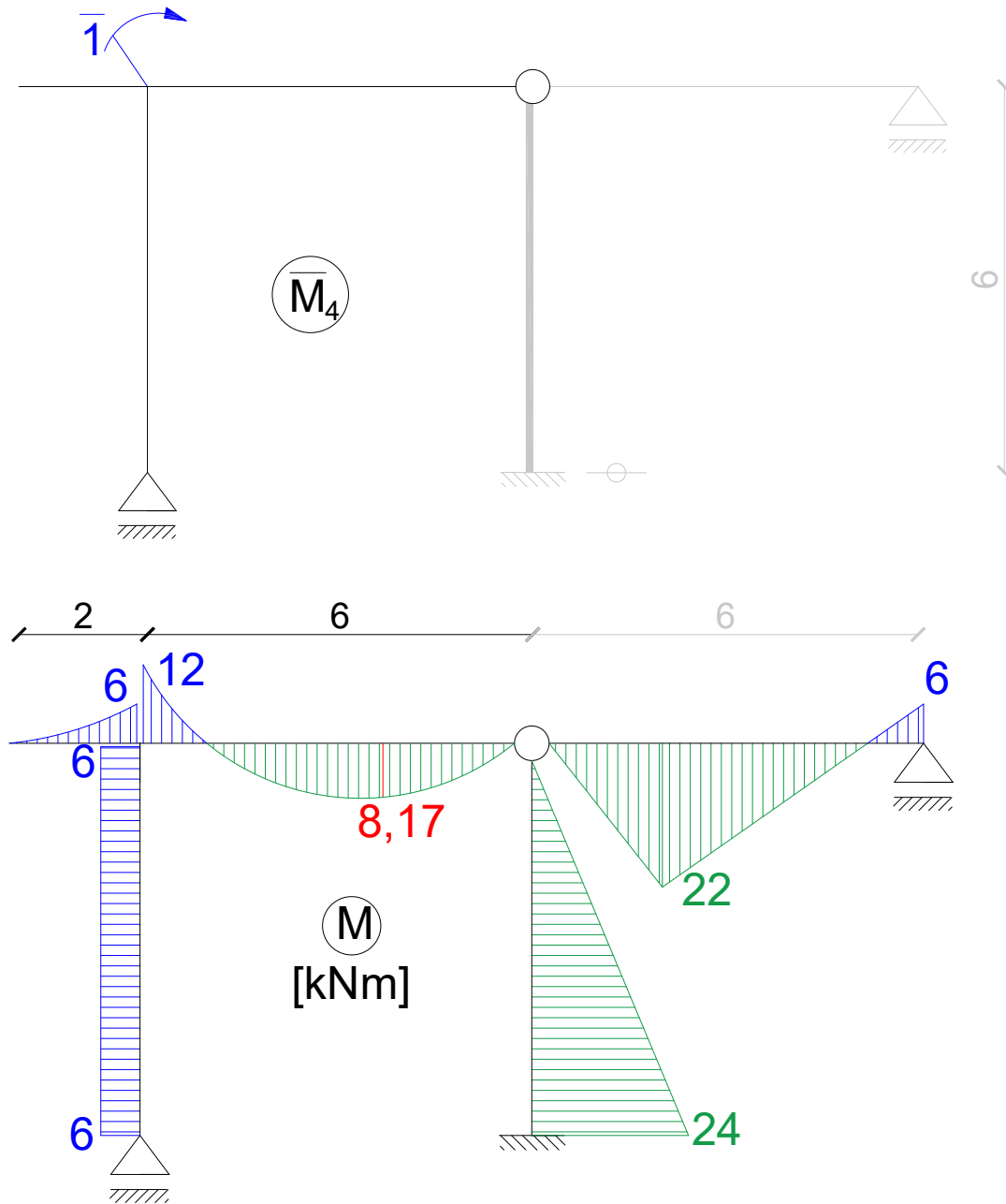
$$\varphi_F = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



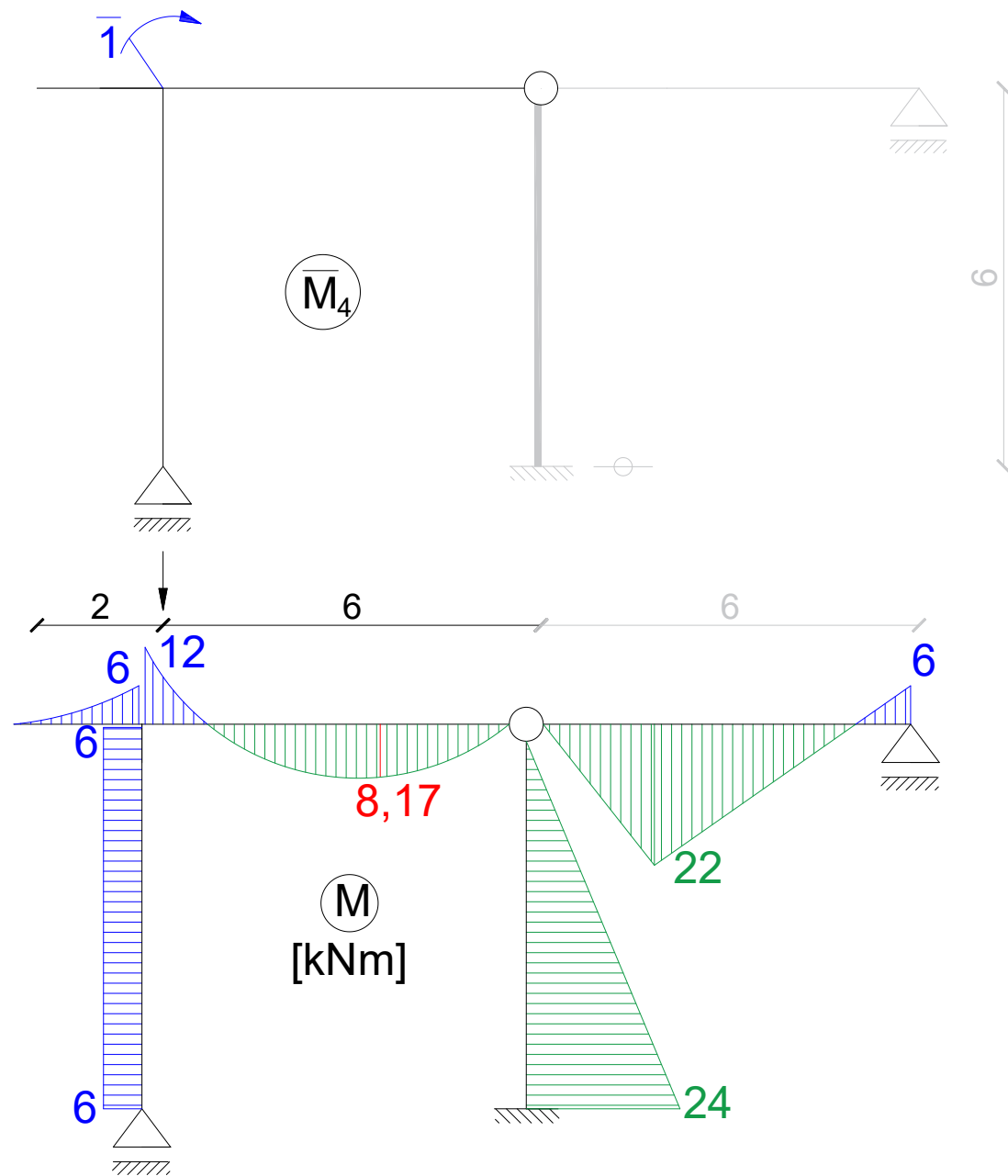
$$\varphi_F = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



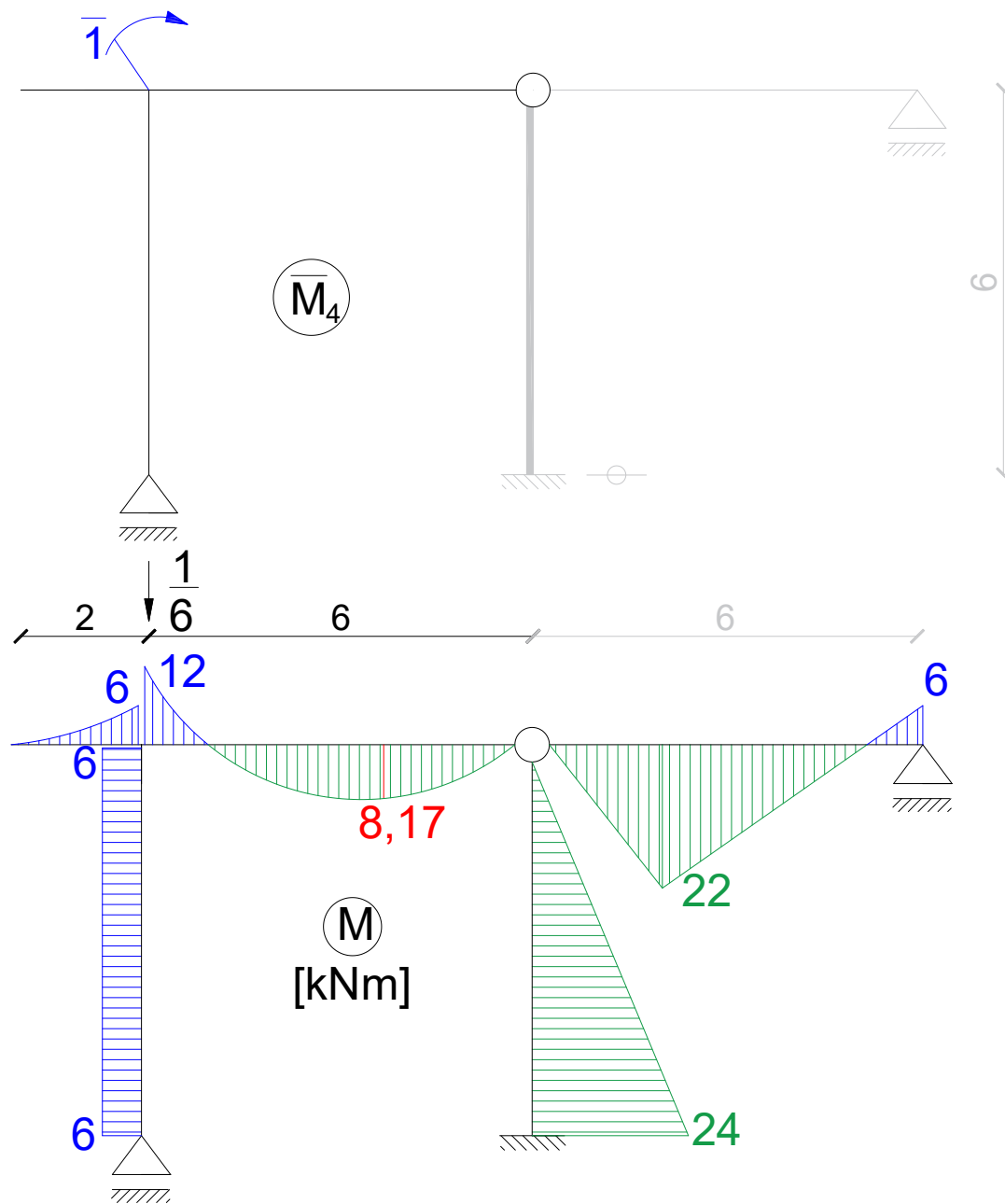
$$\varphi_F = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



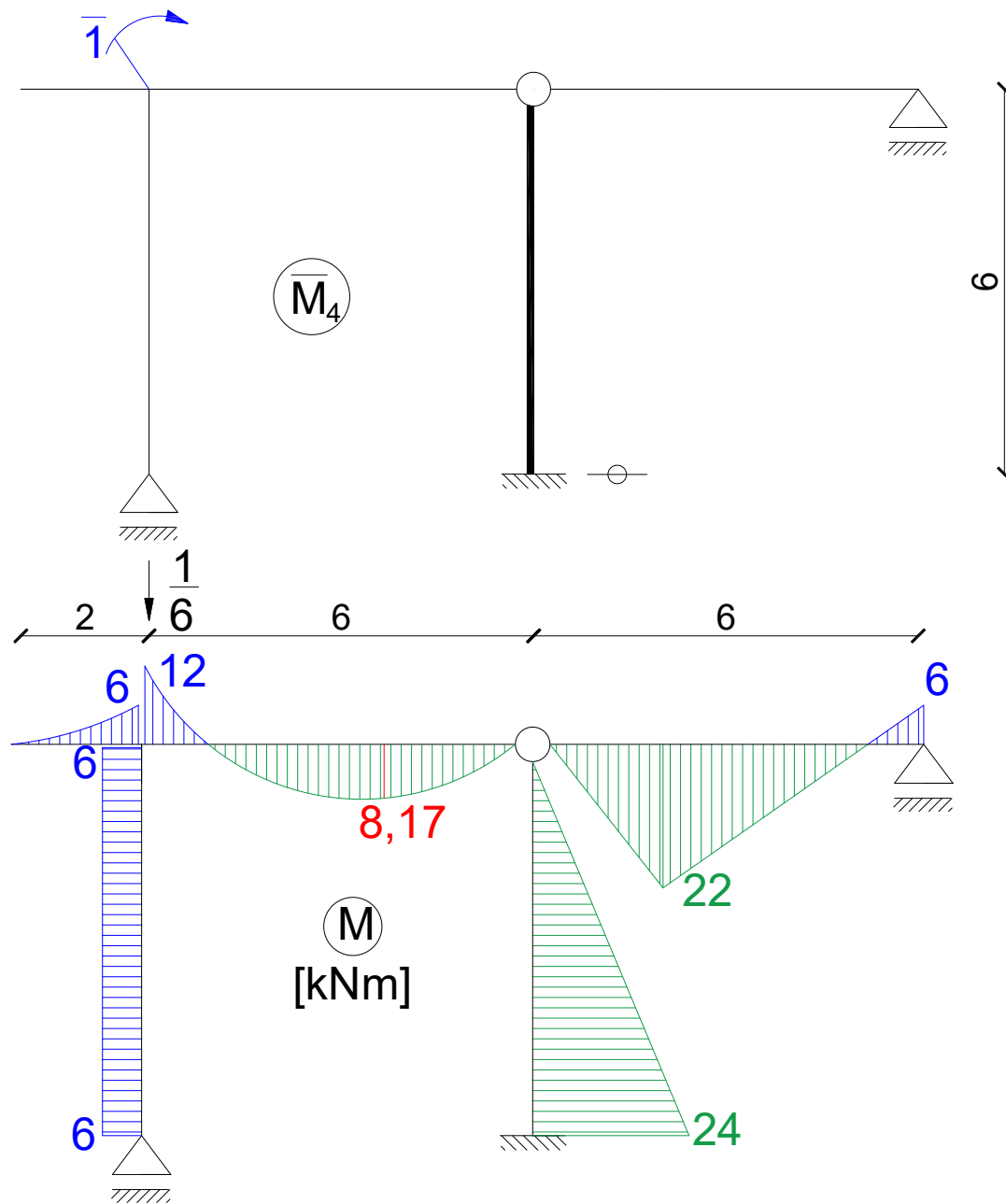
$$\varphi_F = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



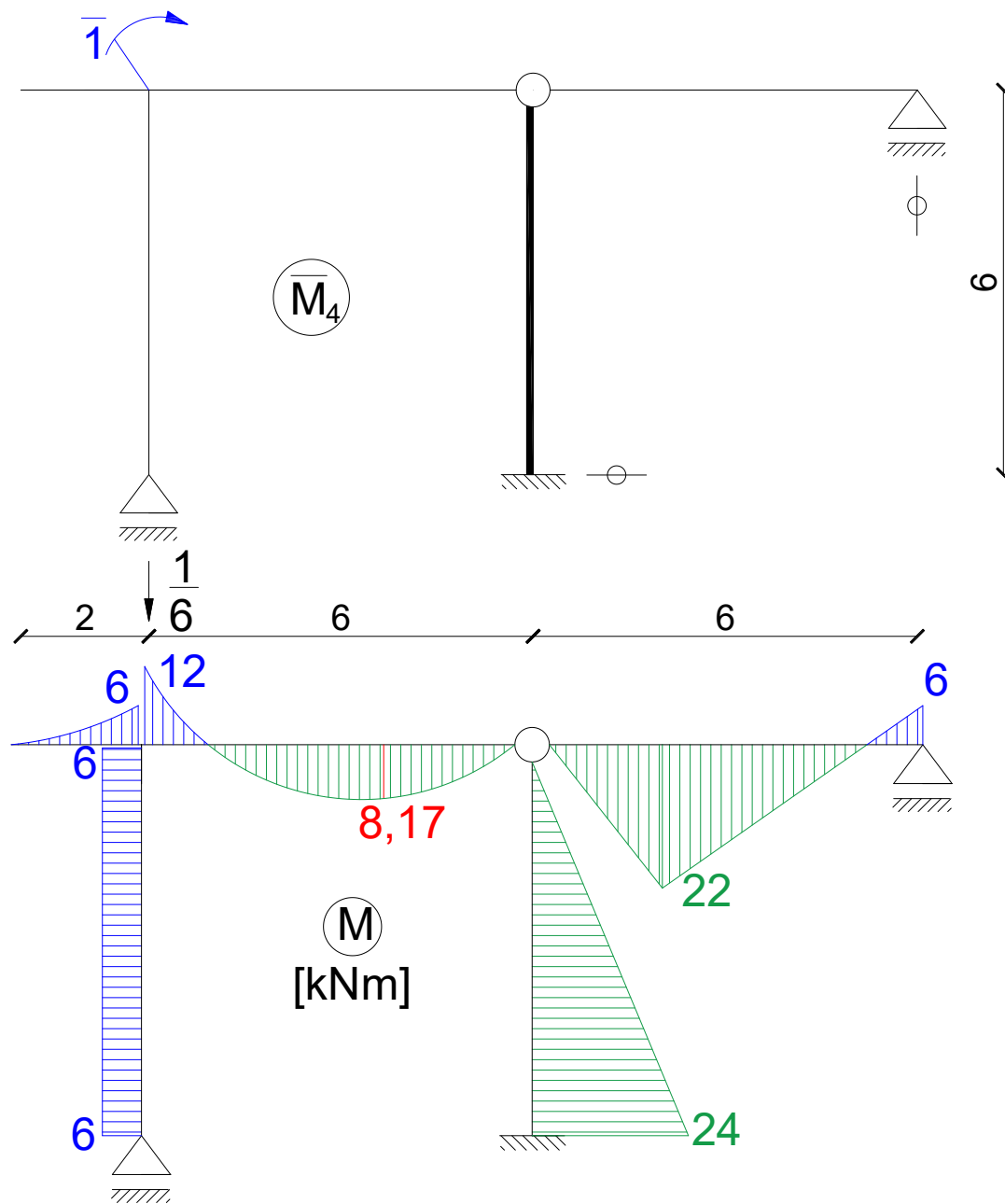
$$\varphi_F = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



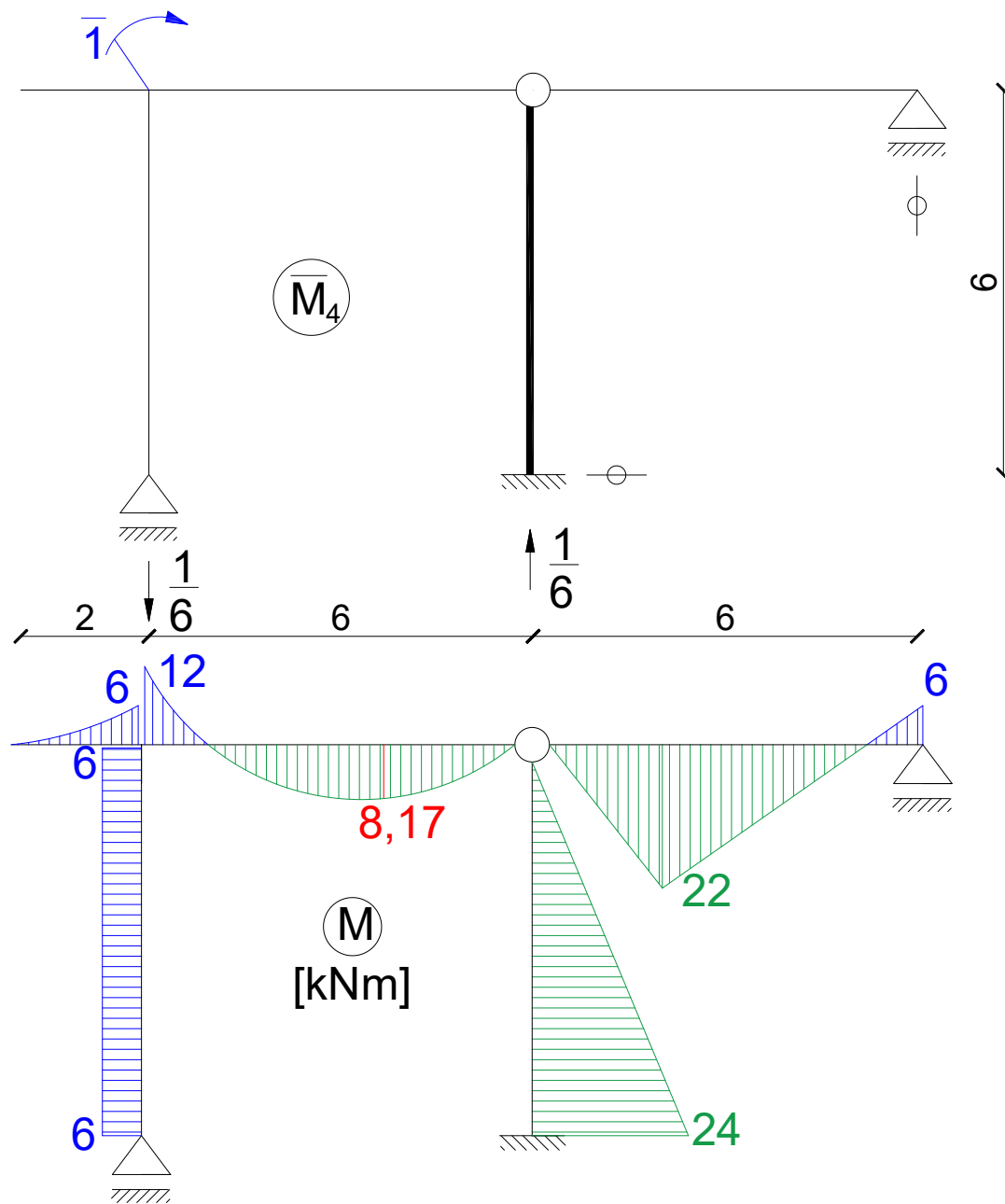
$$\varphi_F = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



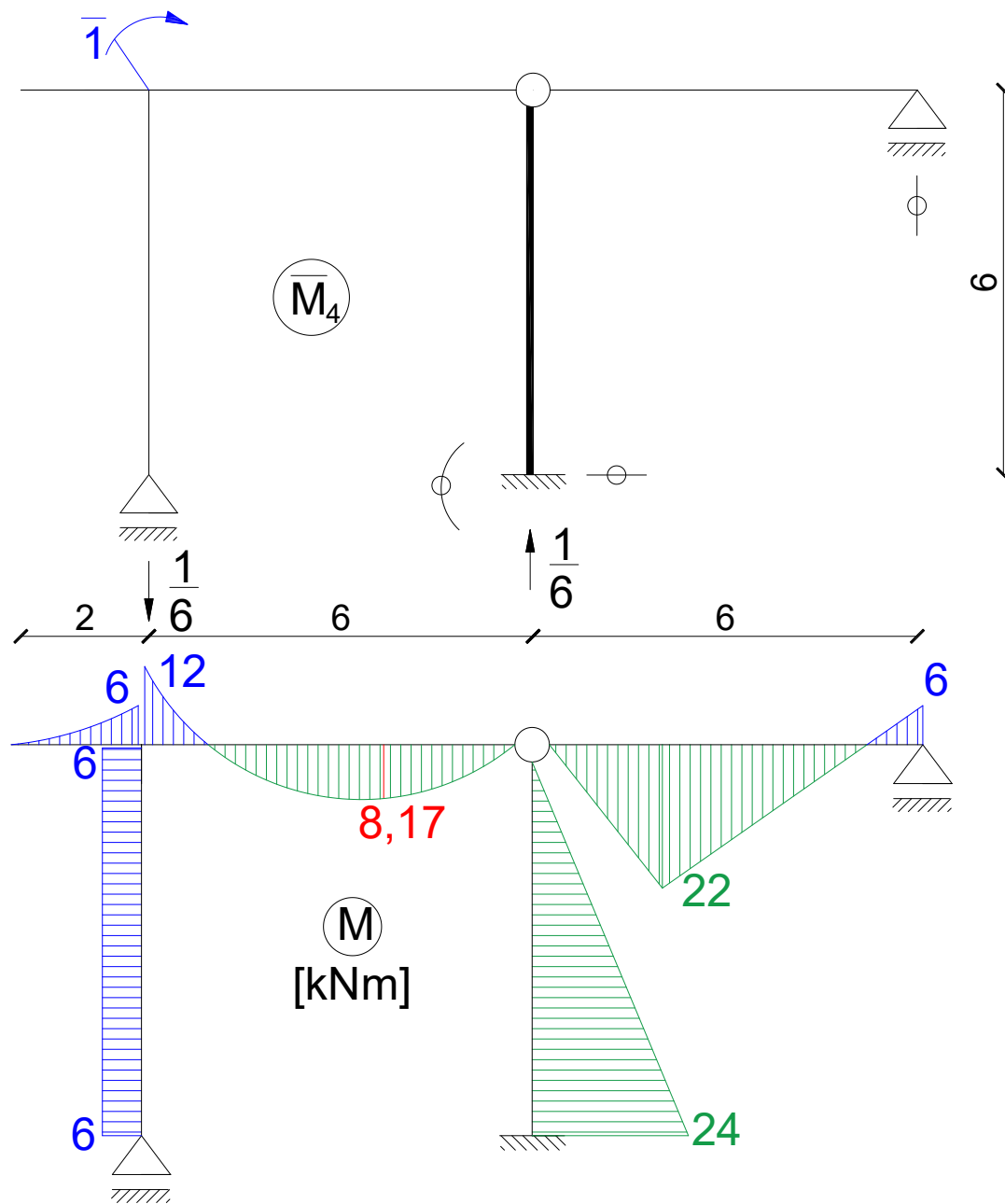
$$\varphi_F = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



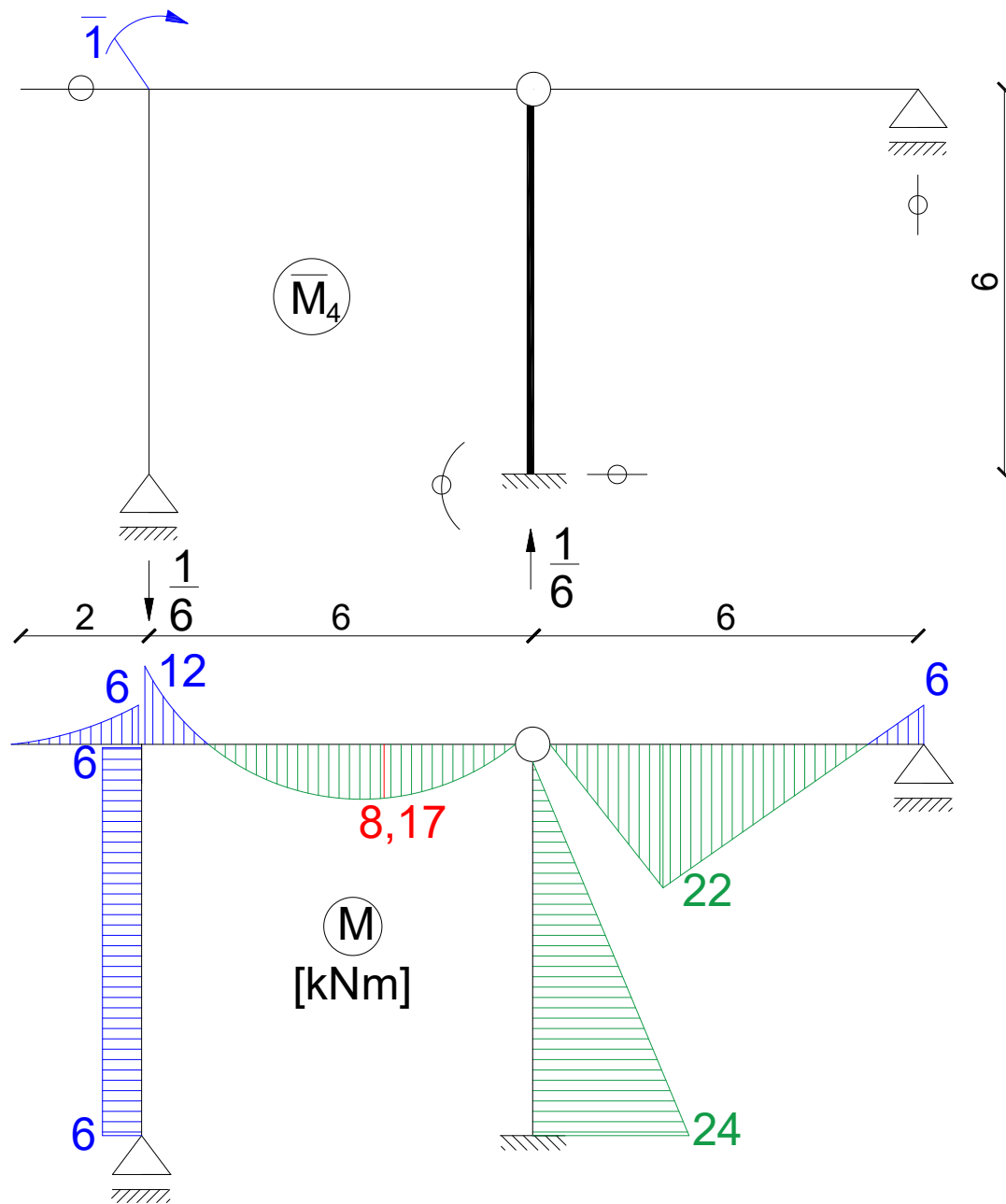
$$\varphi_F = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



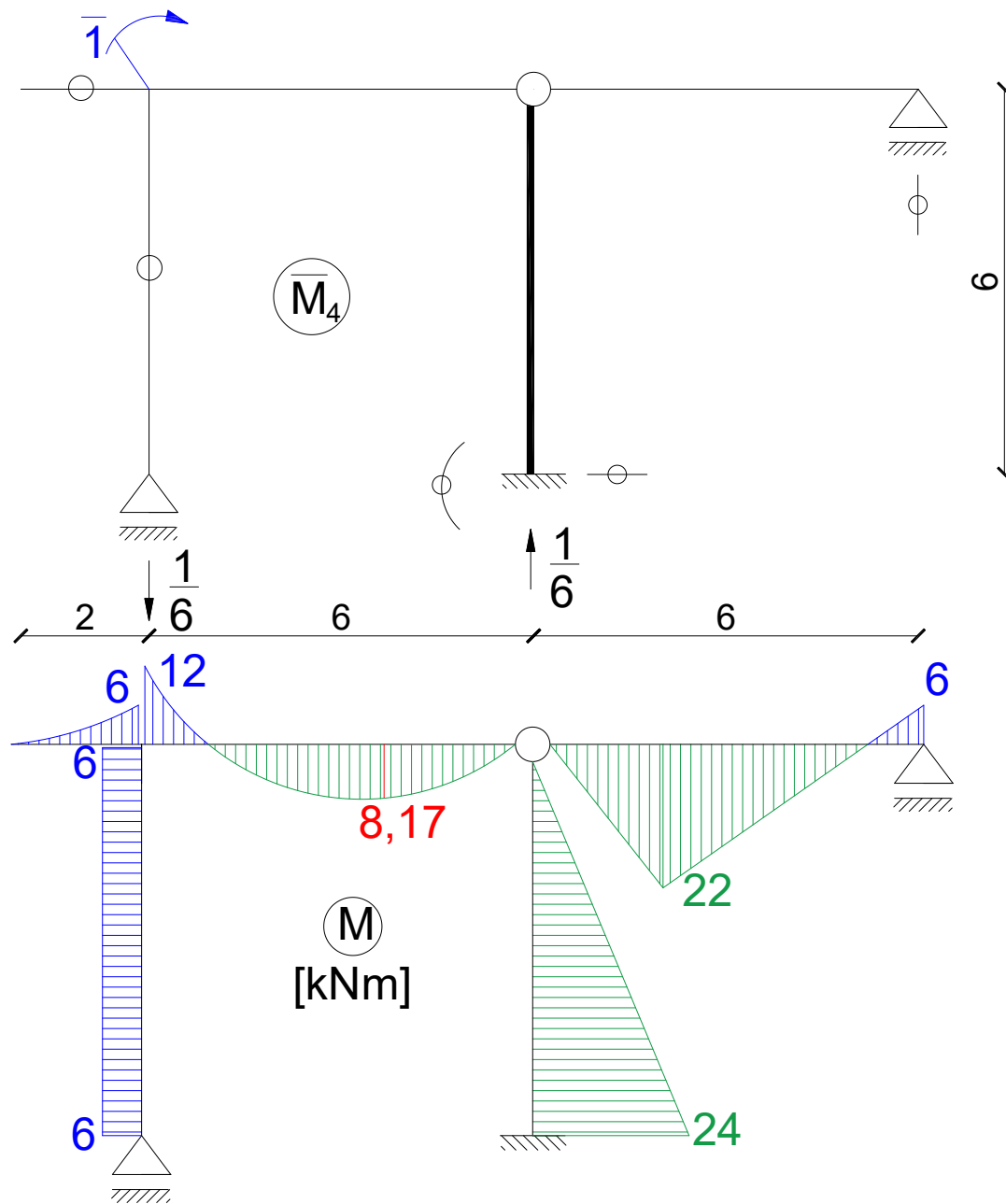
$$\varphi_F = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



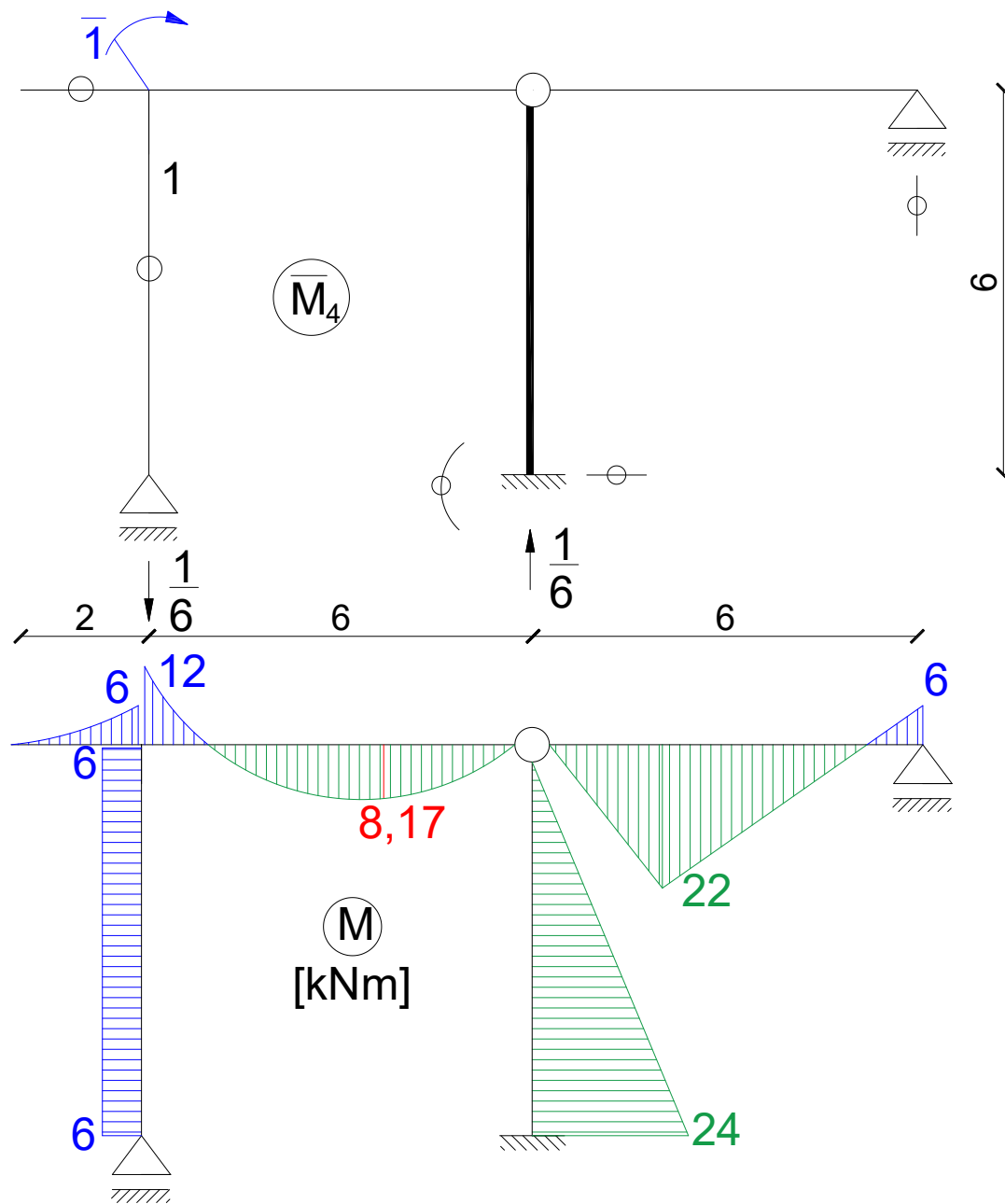
$$\varphi_F = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:

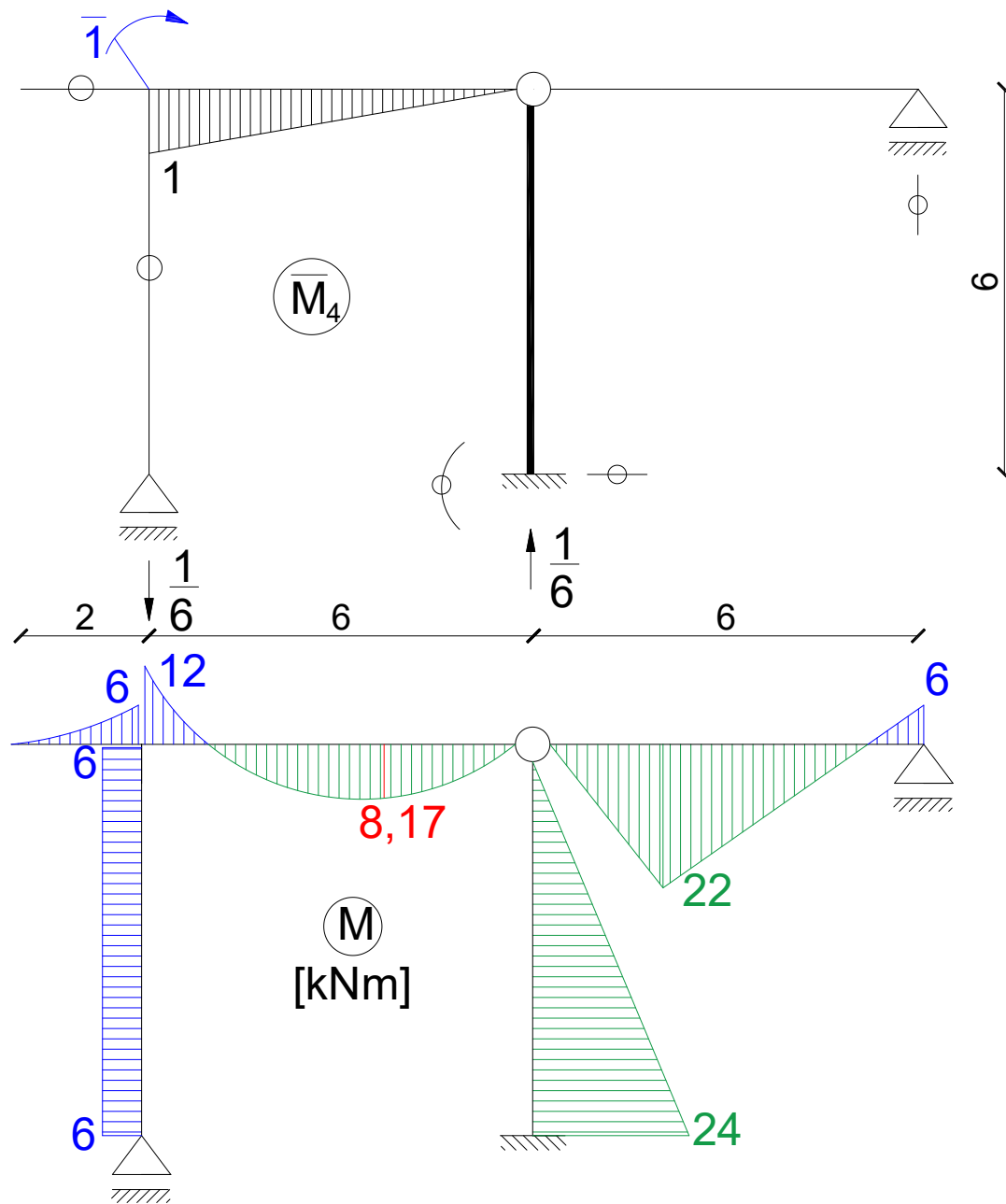


$$\varphi_F = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:

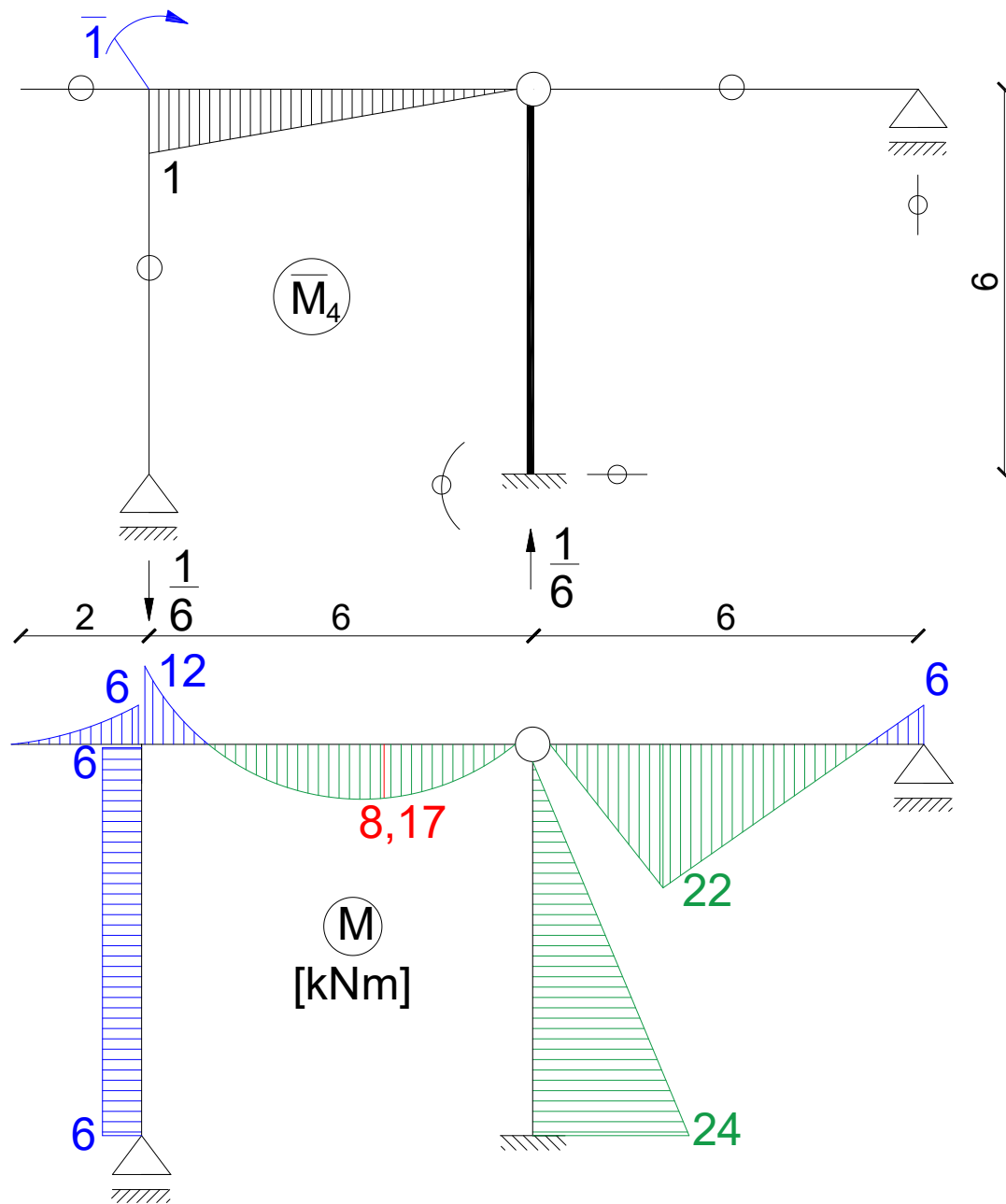


Obliczenia przemieszczeń z zasady prac wirtualnych:



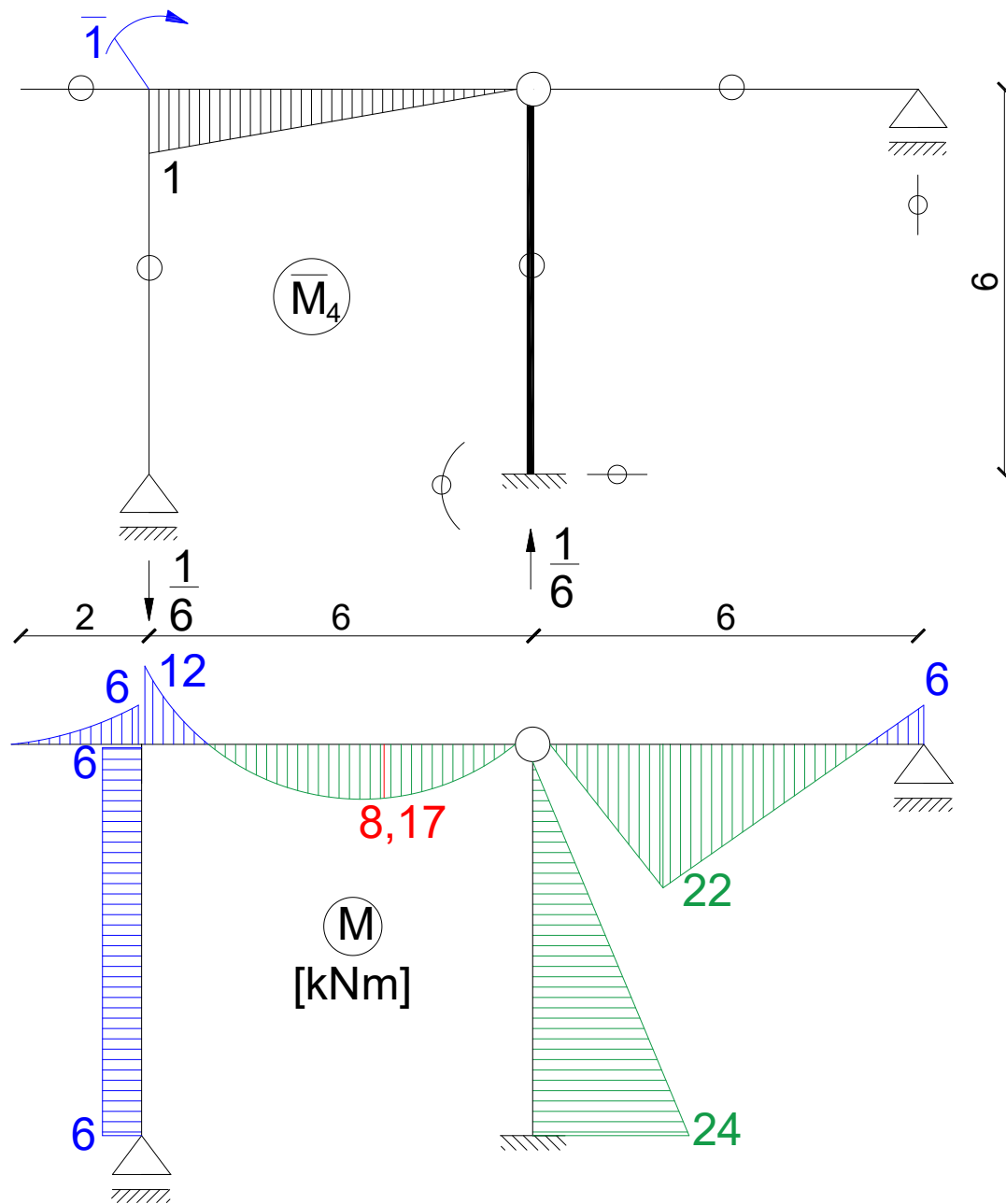
$$\varphi_F = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:



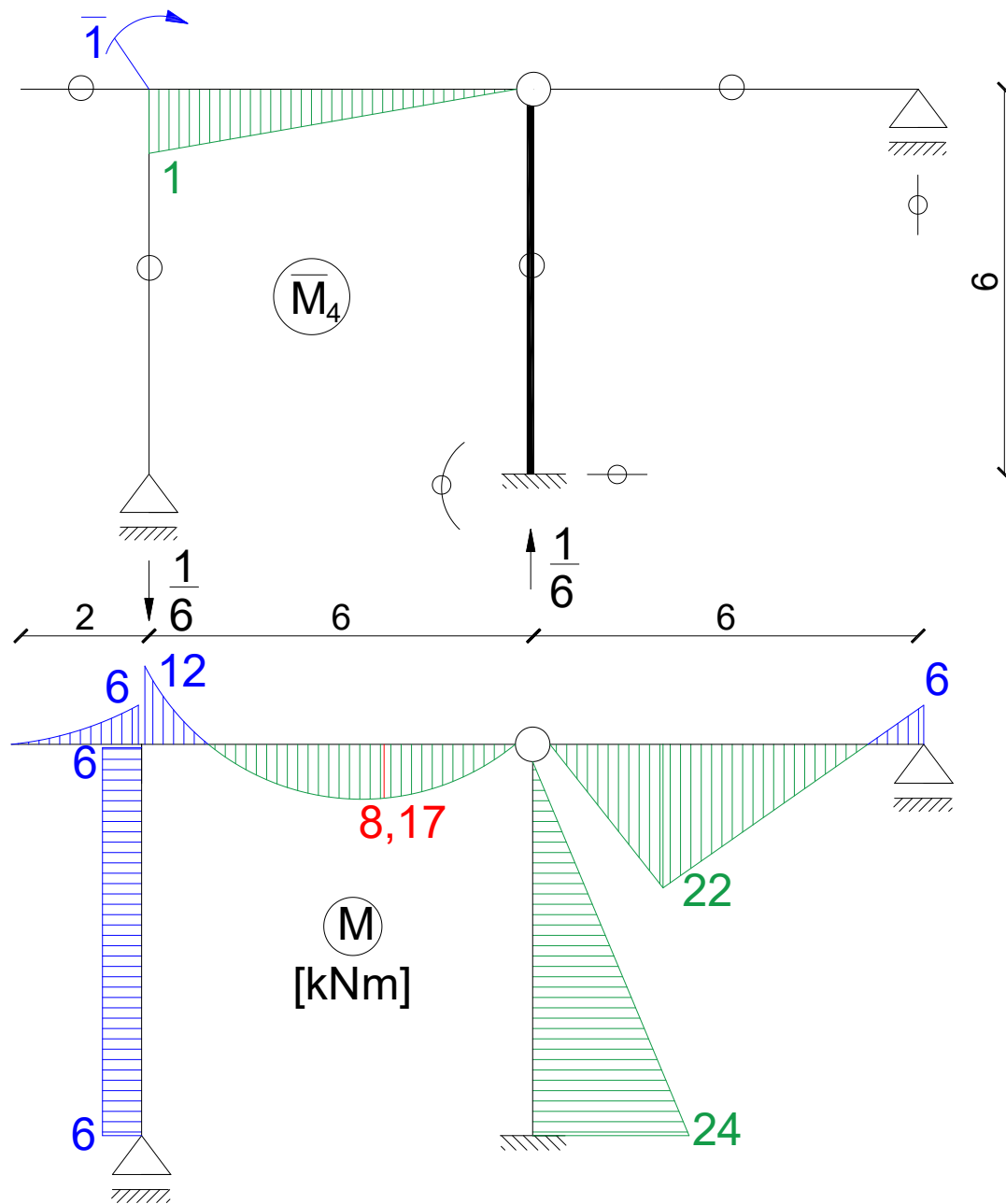
$$\varphi_F = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:

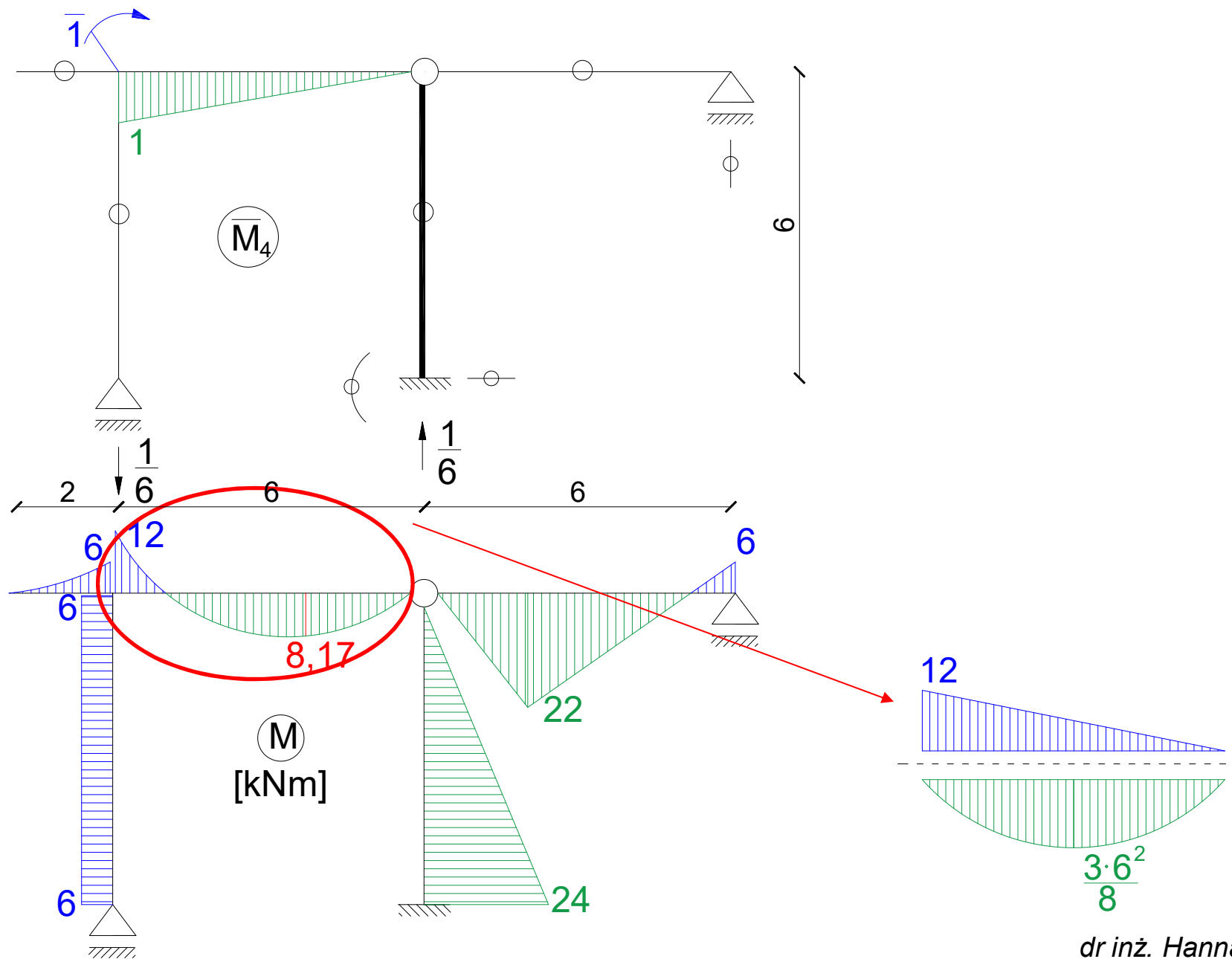


$$\varphi_F = ?$$

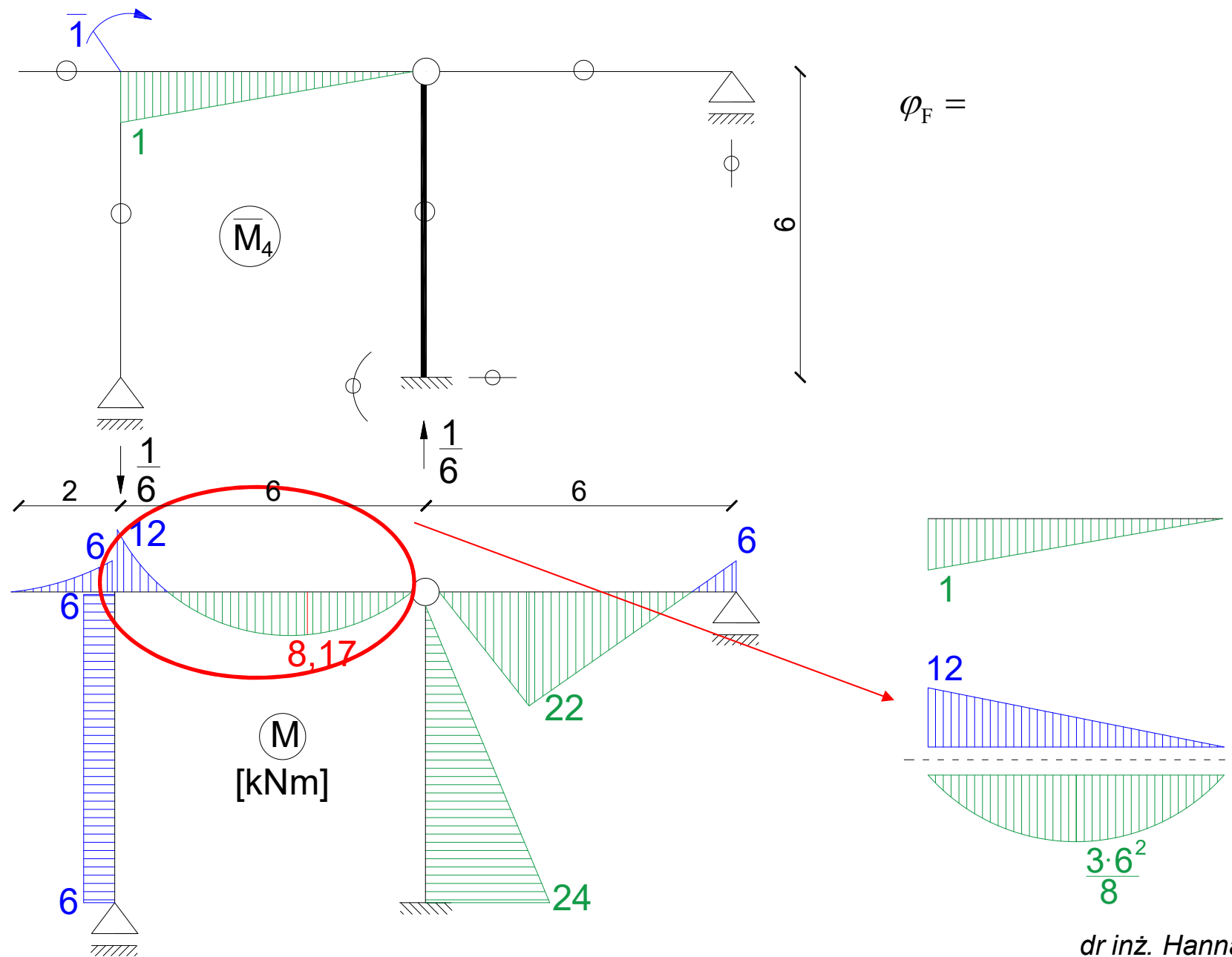
Obliczenia przemieszczeń z zasady prac wirtualnych:



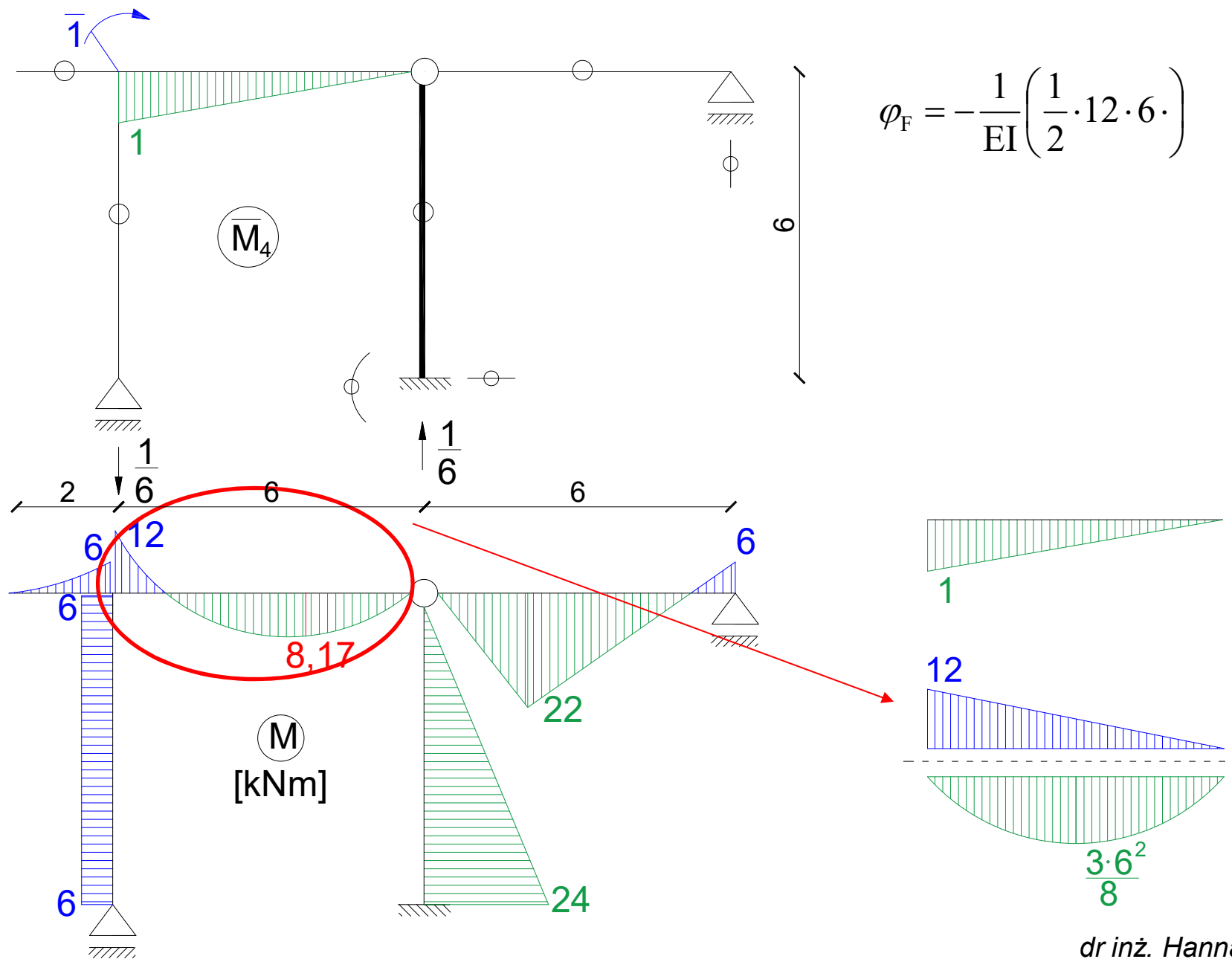
Obliczenia przemieszczeń z zasady prac wirtualnych:



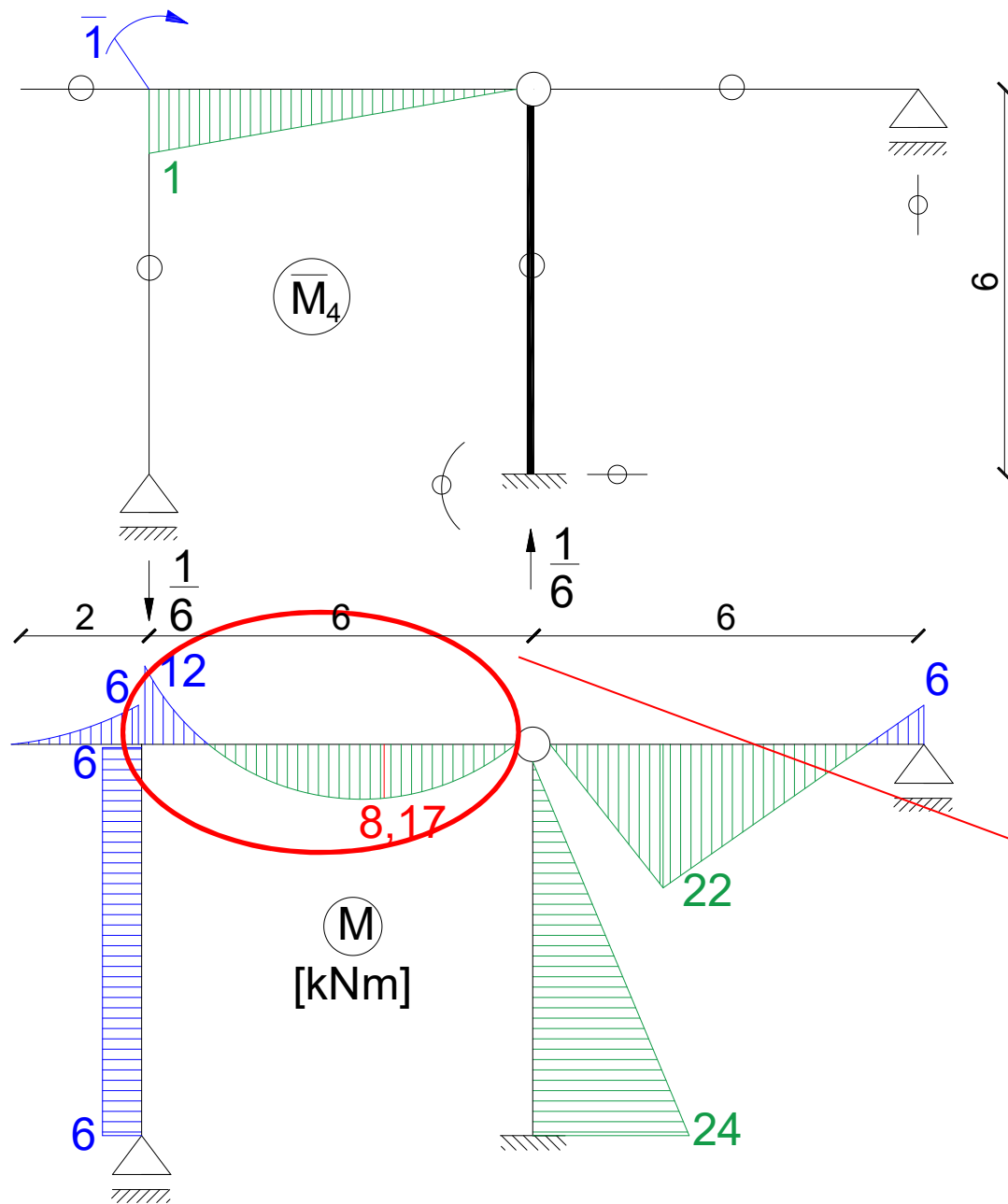
Obliczenia przemieszczeń z zasady prac wirtualnych:



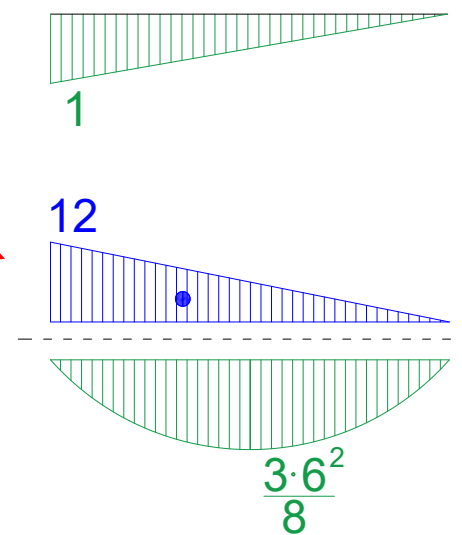
Obliczenia przemieszczeń z zasady prac wirtualnych:



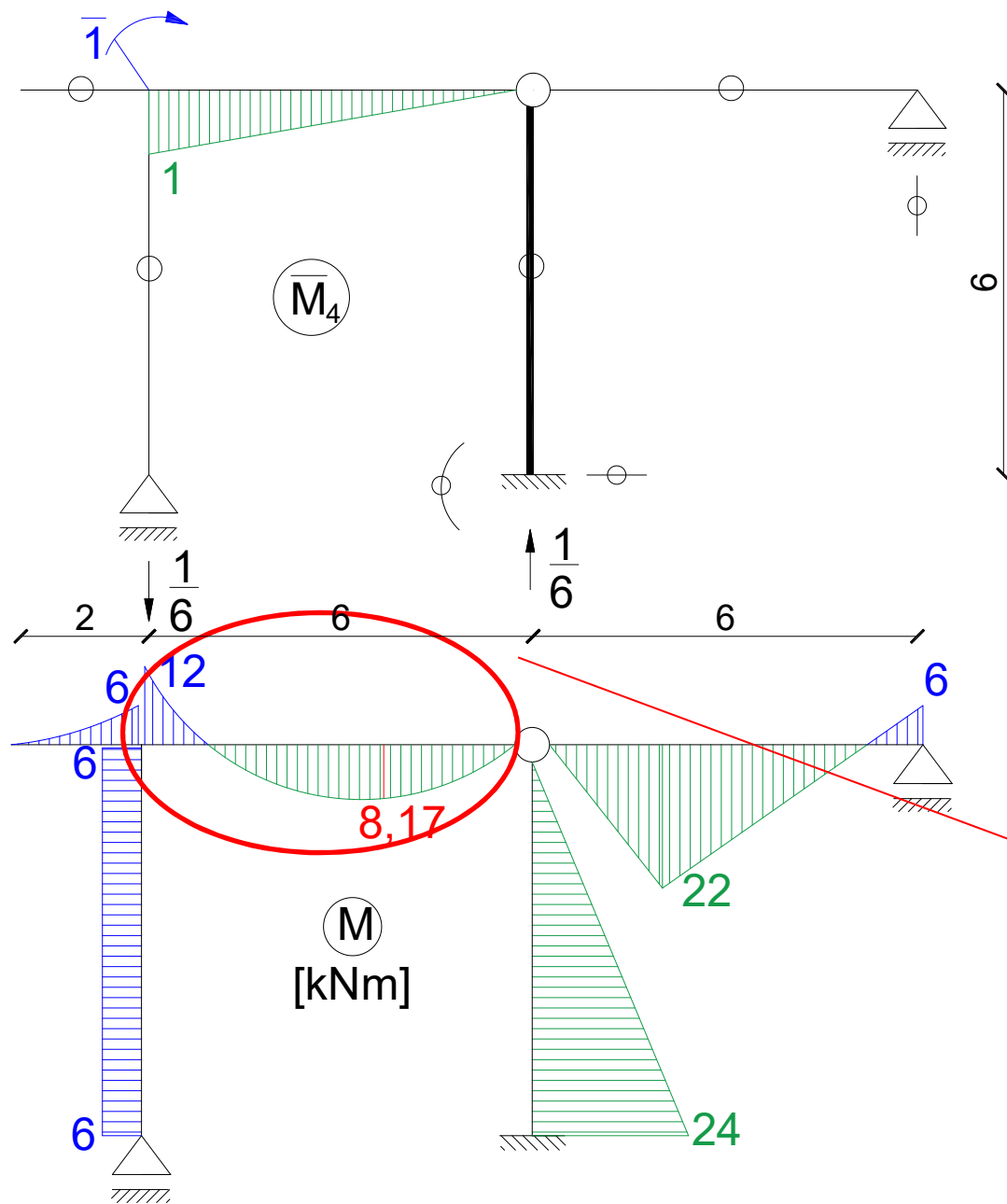
Obliczenia przemieszczeń z zasady prac wirtualnych:



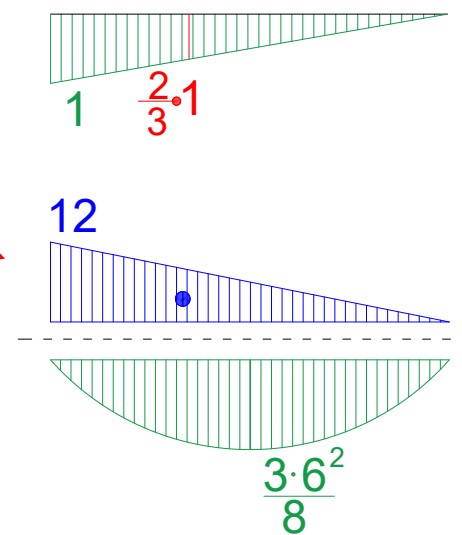
$$\varphi_F = -\frac{1}{EI} \left(\frac{1}{2} \cdot 12 \cdot 6 \cdot \right)$$



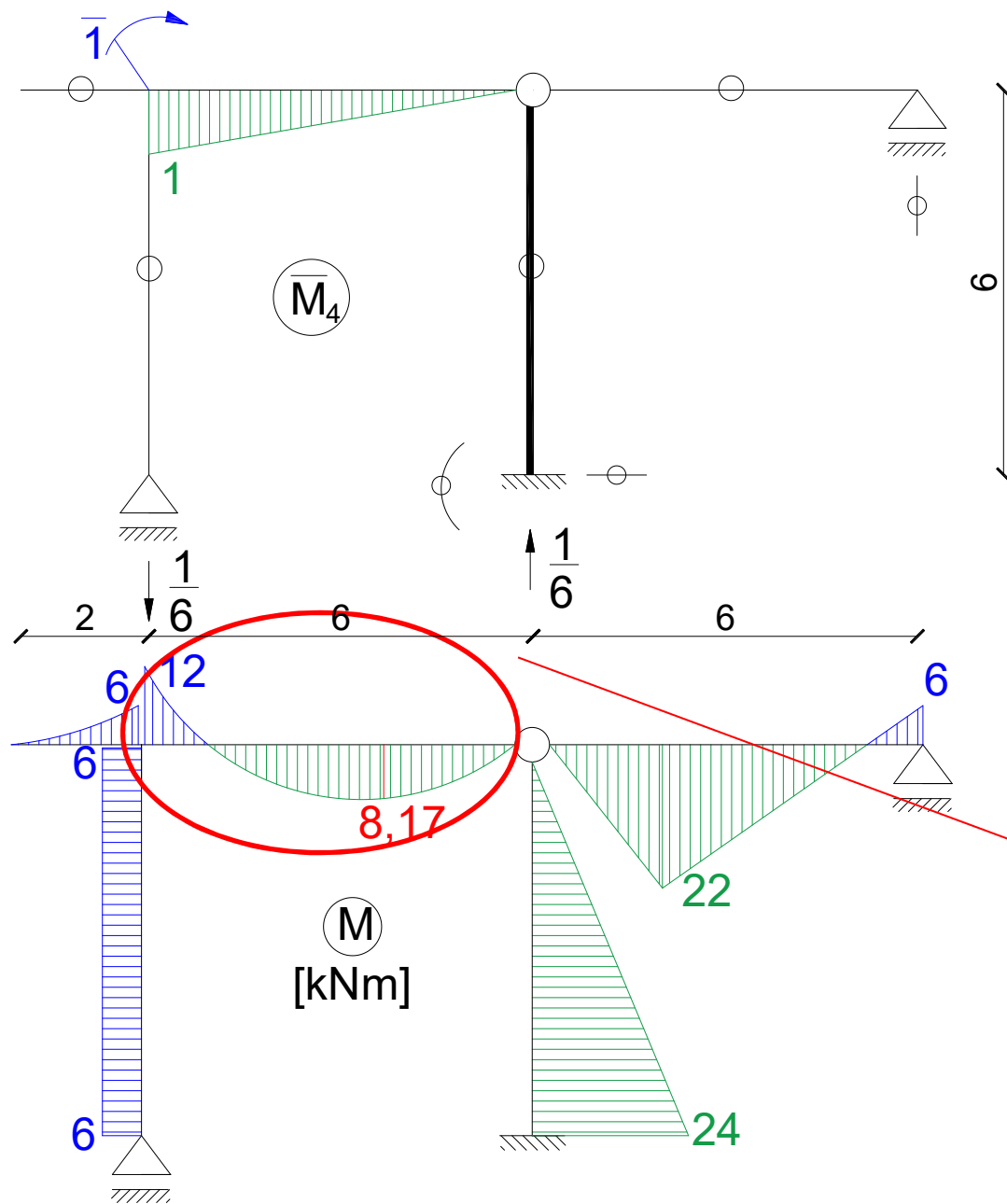
Obliczenia przemieszczeń z zasady prac wirtualnych:



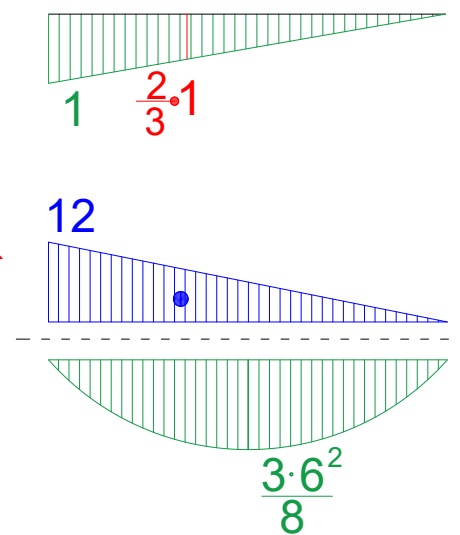
$$\varphi_F = -\frac{1}{EI} \left(\frac{1}{2} \cdot 12 \cdot 6 \cdot \right)$$



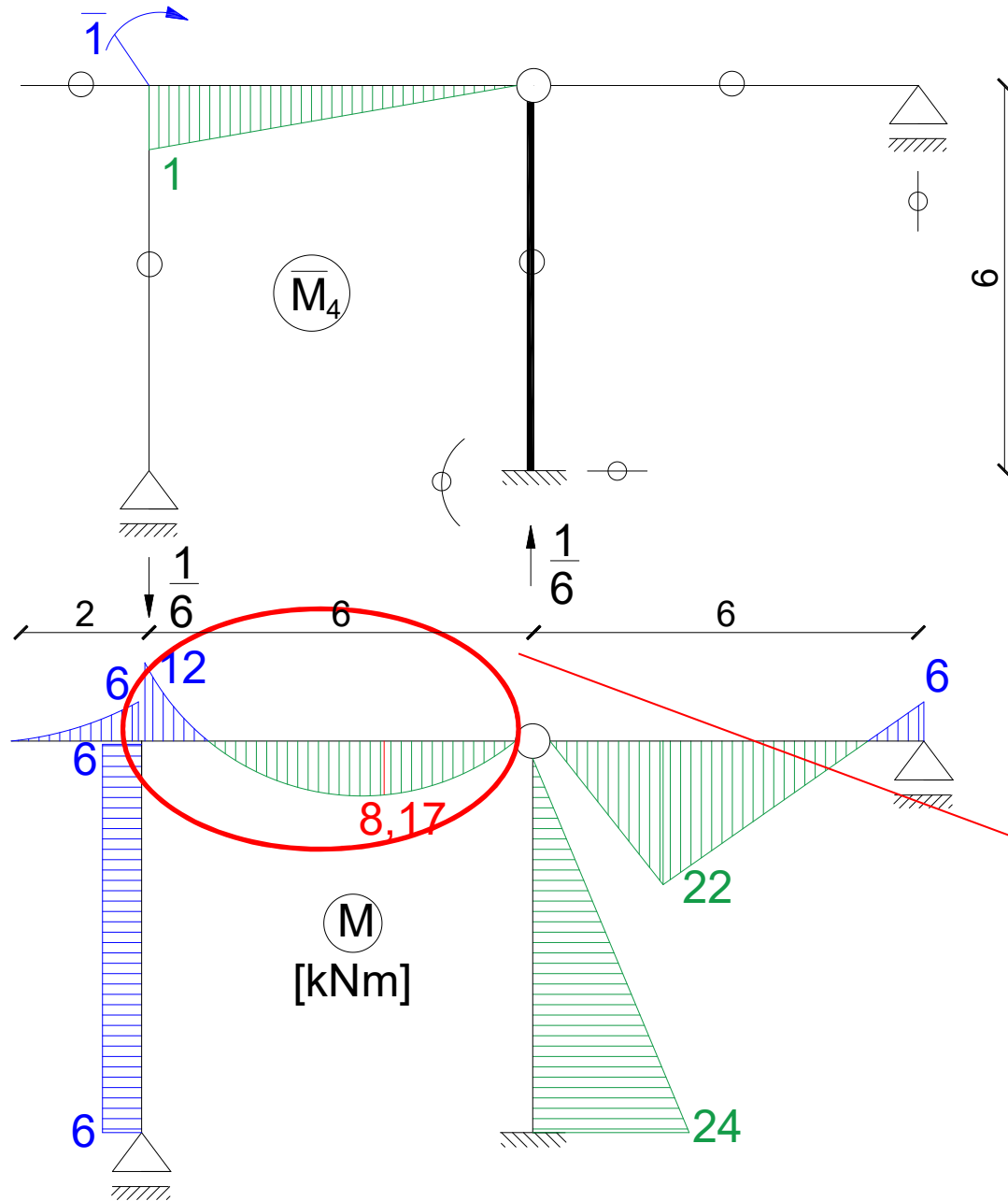
Obliczenia przemieszczeń z zasady prac wirtualnych:



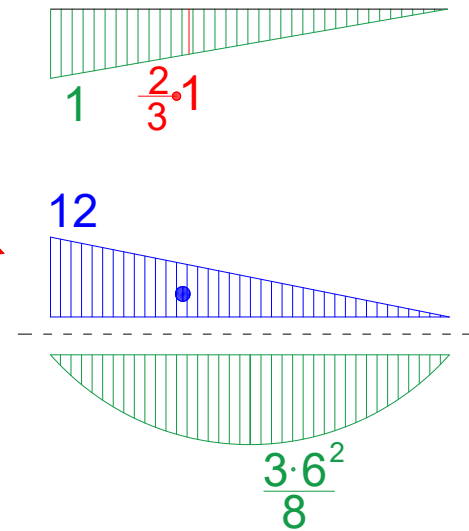
$$\varphi_F = -\frac{1}{EI} \left(\frac{1}{2} \cdot 12 \cdot 6 \cdot \frac{2}{3} \cdot 1 \right)$$



Obliczenia przemieszczeń z zasady prac wirtualnych:

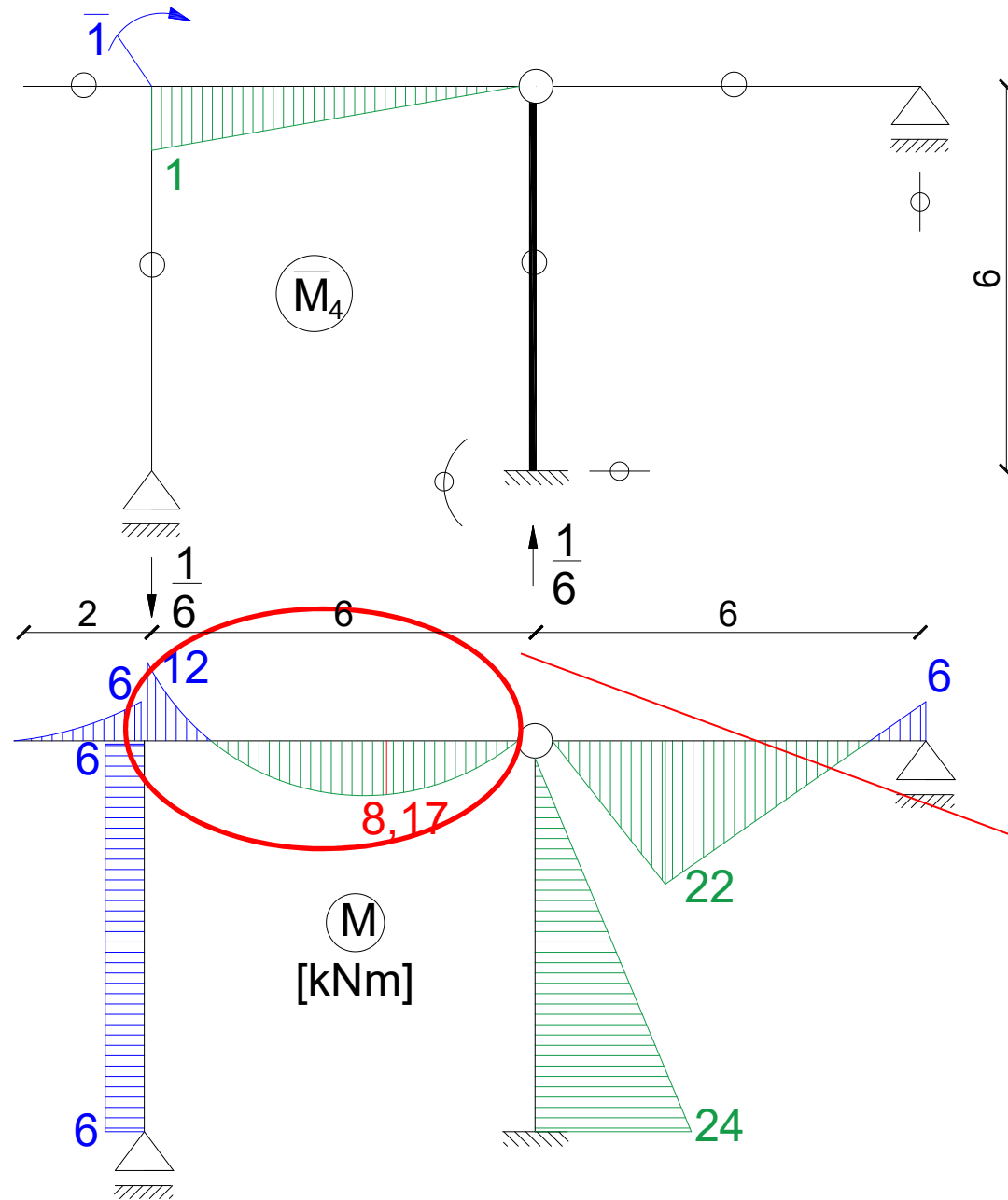


$$\varphi_F = -\frac{1}{EI} \left(\frac{1}{2} \cdot 12 \cdot 6 \cdot \frac{2}{3} \cdot 1 \right) + \frac{1}{EI} \left(\frac{2}{3} \cdot \frac{3 \cdot 6^2}{8} \cdot 6 \cdot \right)$$

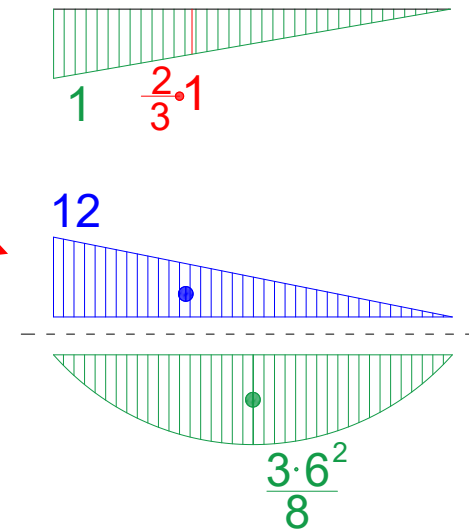


dr inż. Hanna Weber

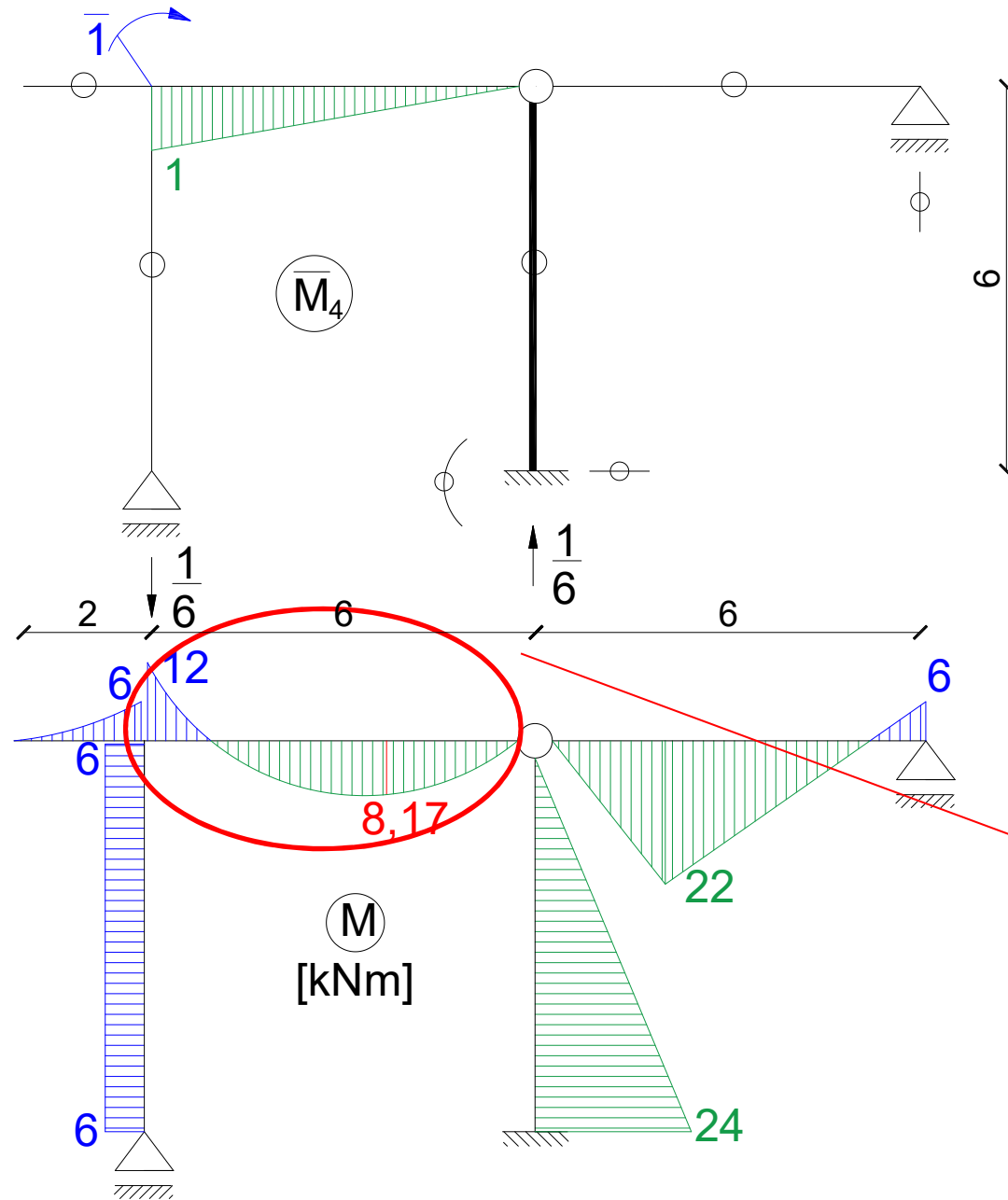
Obliczenia przemieszczeń z zasady prac wirtualnych:



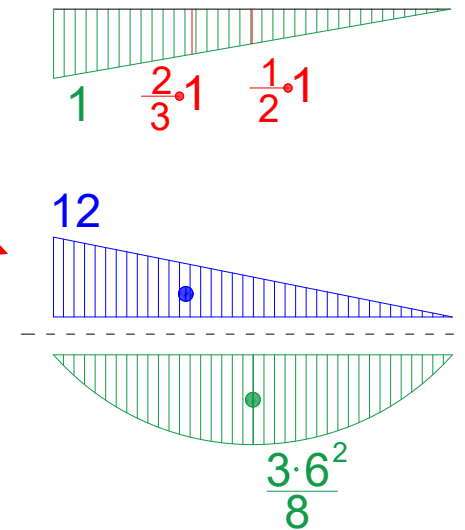
$$\varphi_F = -\frac{1}{EI} \left(\frac{1}{2} \cdot 12 \cdot 6 \cdot \frac{2}{3} \cdot 1 \right) + \frac{1}{EI} \left(\frac{2}{3} \cdot \frac{3 \cdot 6^2}{8} \cdot 6 \cdot \right)$$



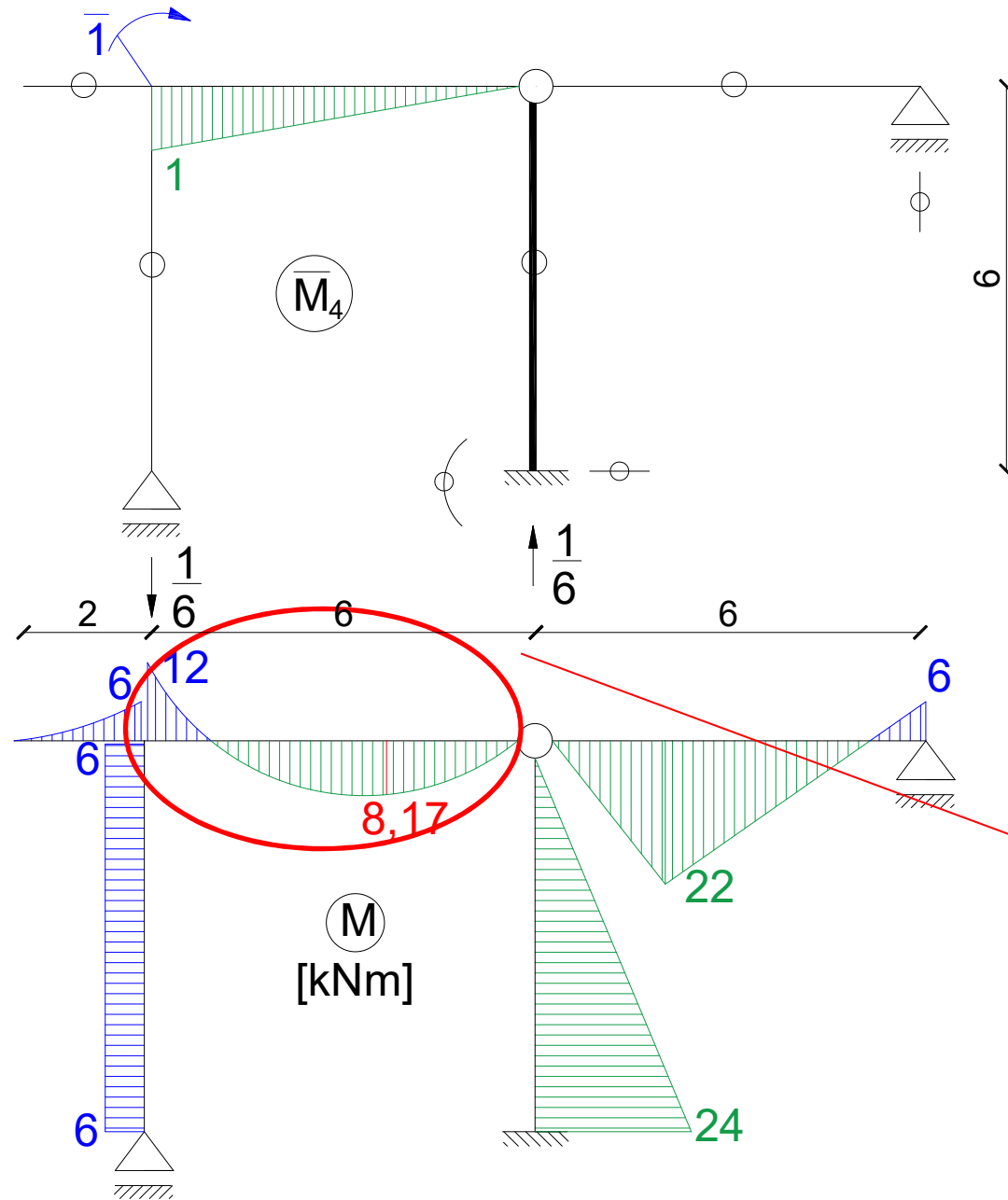
Obliczenia przemieszczeń z zasady prac wirtualnych:



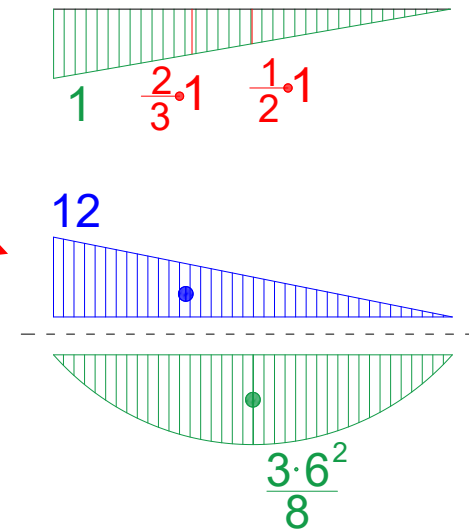
$$\varphi_F = -\frac{1}{EI} \left(\frac{1}{2} \cdot 12 \cdot 6 \cdot \frac{2}{3} \cdot 1 \right) + \frac{1}{EI} \left(\frac{2}{3} \cdot \frac{3 \cdot 6^2}{8} \cdot 6 \cdot \right)$$



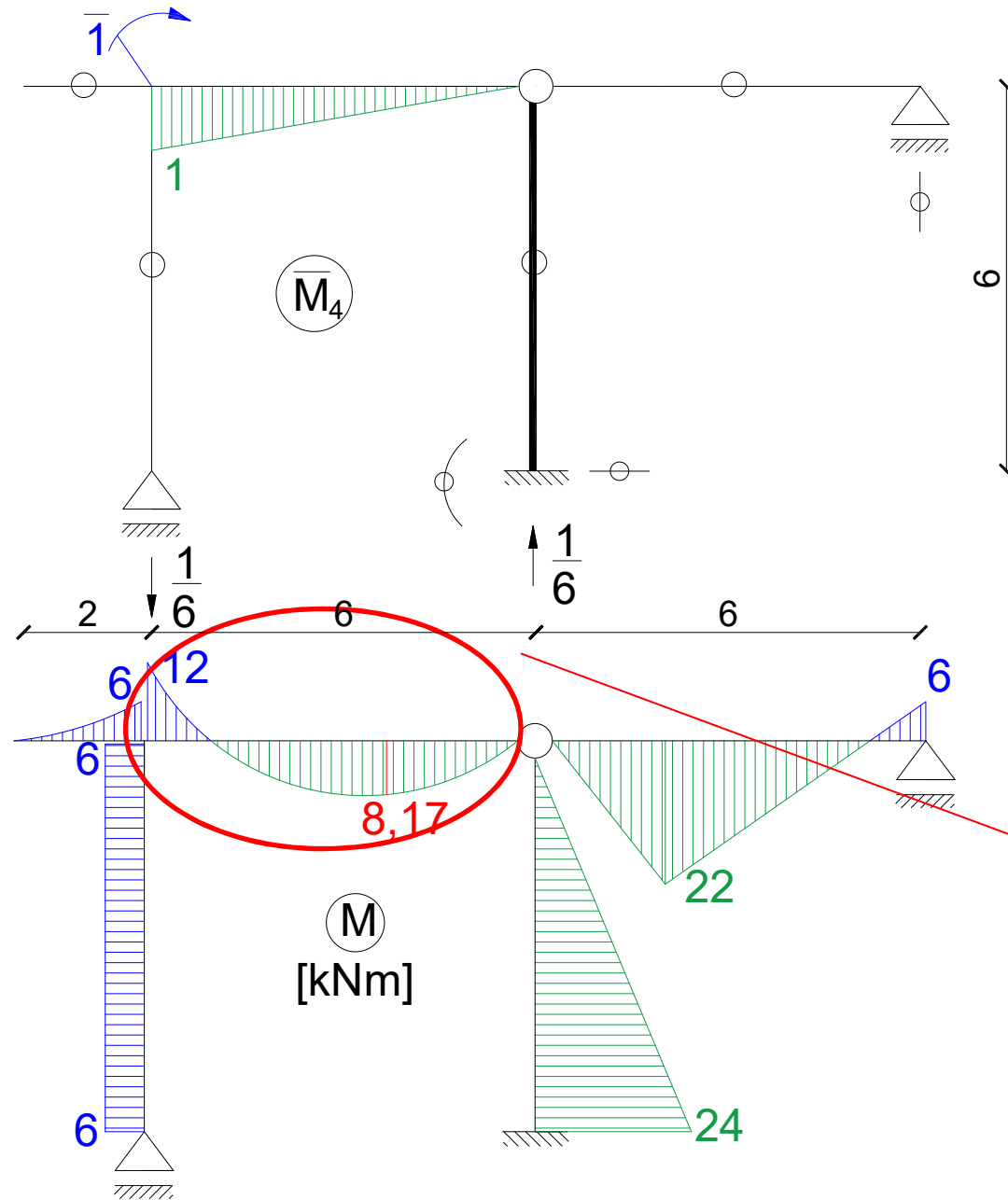
Obliczenia przemieszczeń z zasady prac wirtualnych:



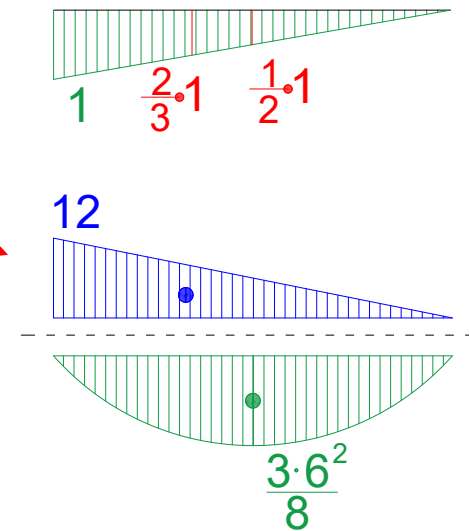
$$\varphi_F = -\frac{1}{EI} \left(\frac{1}{2} \cdot 12 \cdot 6 \cdot \frac{2}{3} \cdot 1 \right) + \frac{1}{EI} \left(\frac{2}{3} \cdot \frac{3 \cdot 6^2}{8} \cdot 6 \cdot \frac{1}{2} \cdot 1 \right)$$



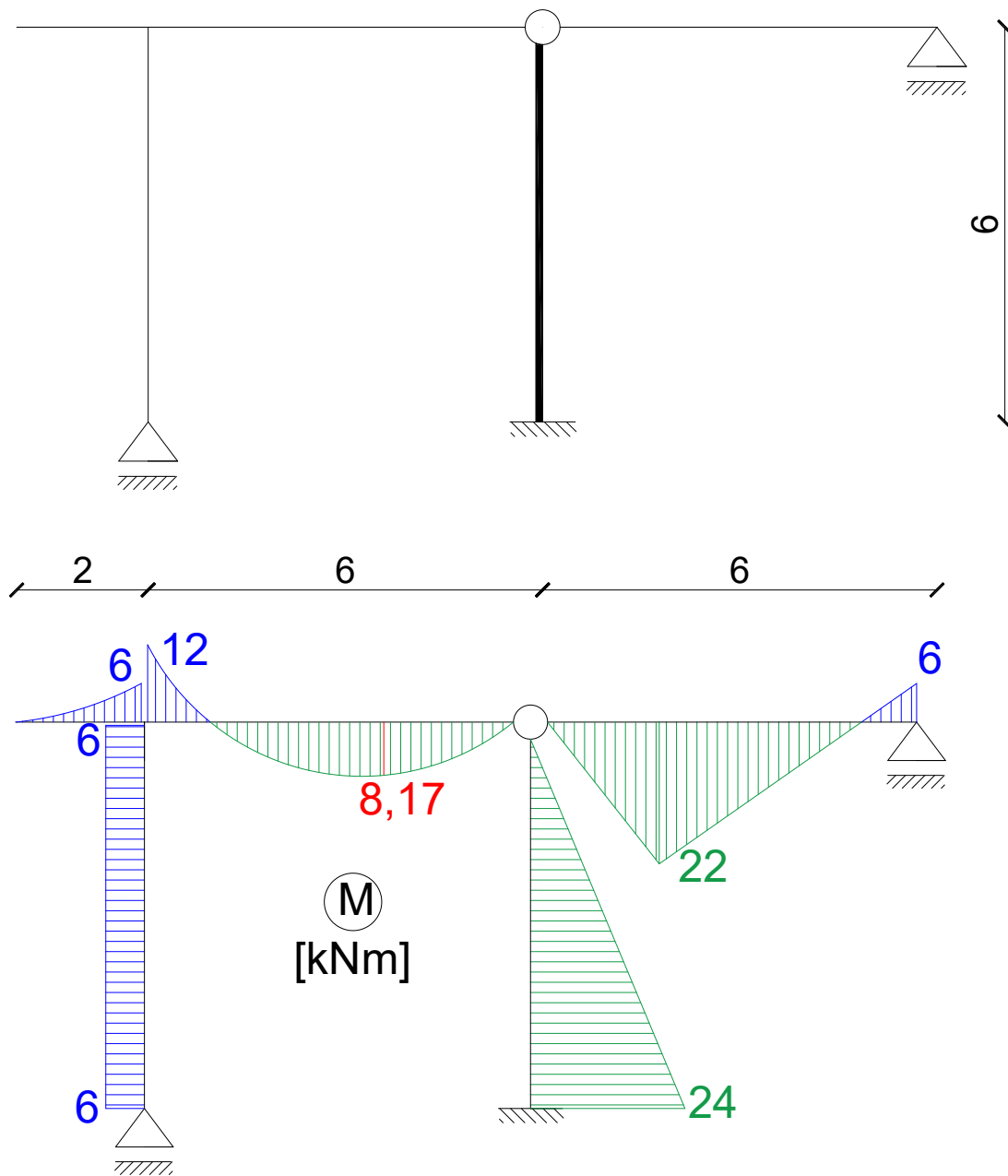
Obliczenia przemieszczeń z zasady prac wirtualnych:



$$\varphi_F = -\frac{1}{EI} \left(\frac{1}{2} \cdot 12 \cdot 6 \cdot \frac{2}{3} \cdot 1 \right) + \frac{1}{EI} \left(\frac{2}{3} \cdot \frac{3 \cdot 6^2}{8} \cdot 6 \cdot \frac{1}{2} \cdot 1 \right) = \frac{3}{EI}$$

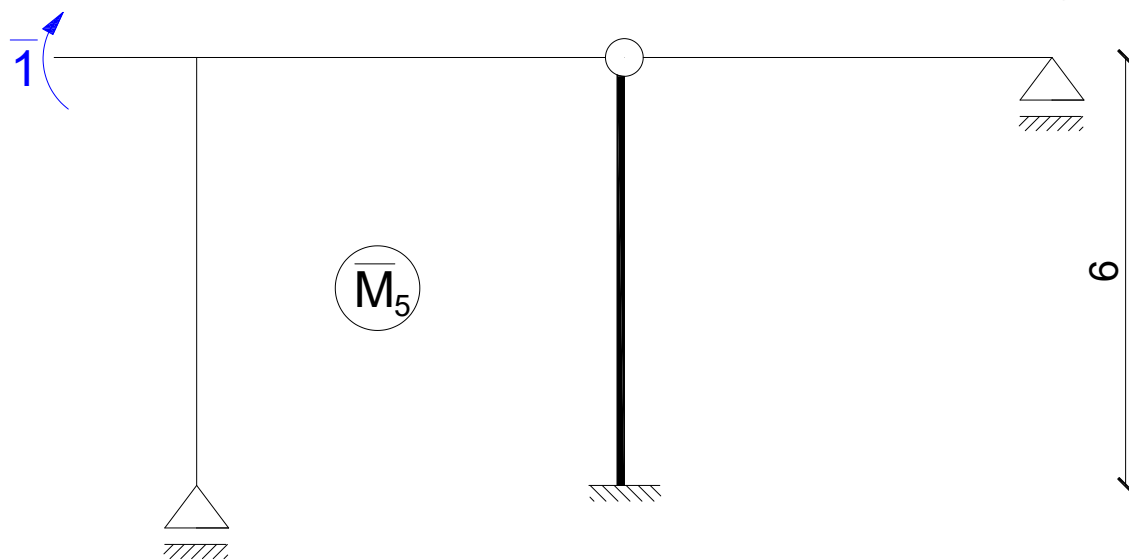


Obliczenia przemieszczeń z zasady prac wirtualnych:

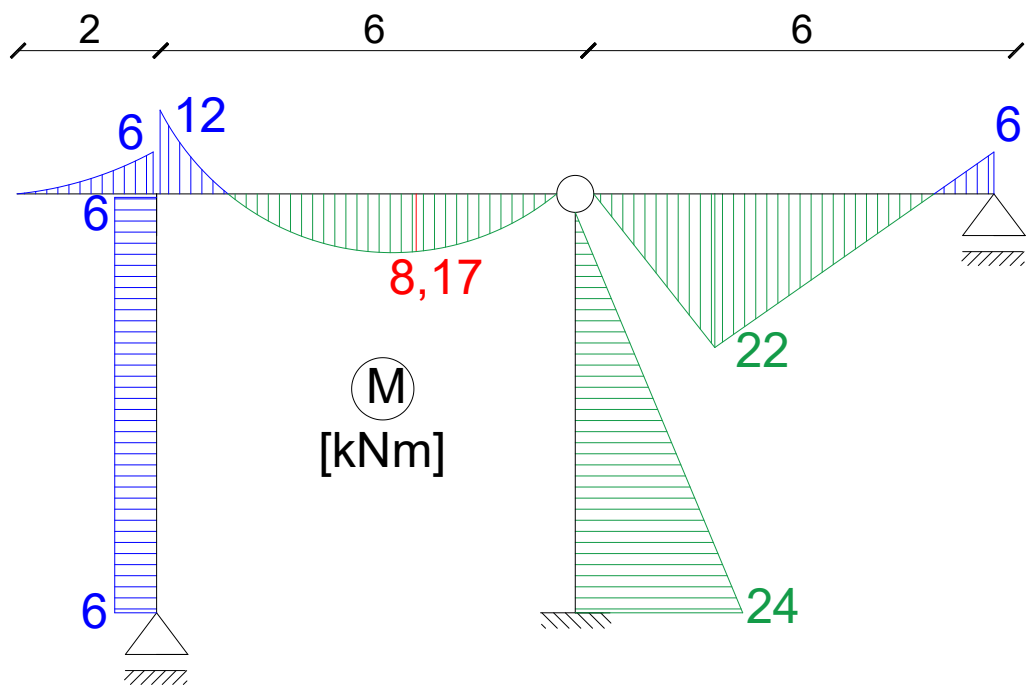


$$\varphi_E = ?$$

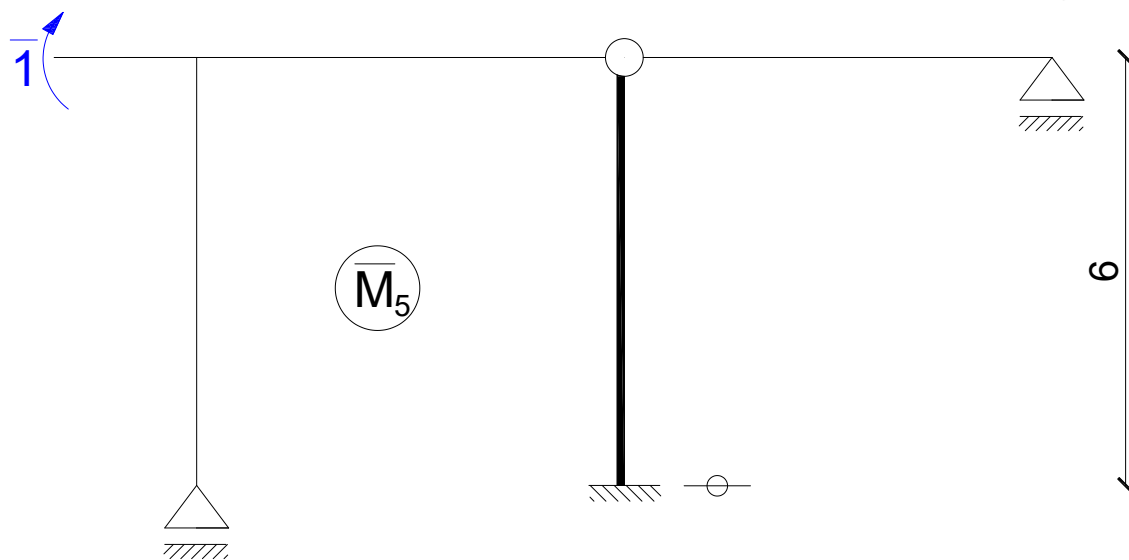
Obliczenia przemieszczeń z zasady prac wirtualnych:



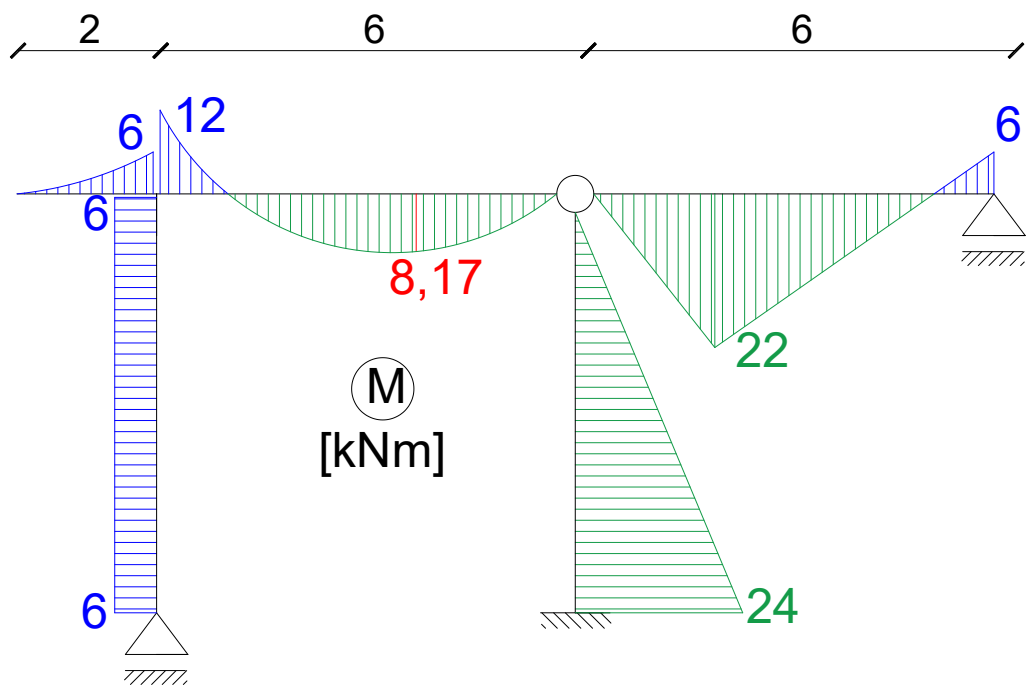
$$\varphi_E = ?$$



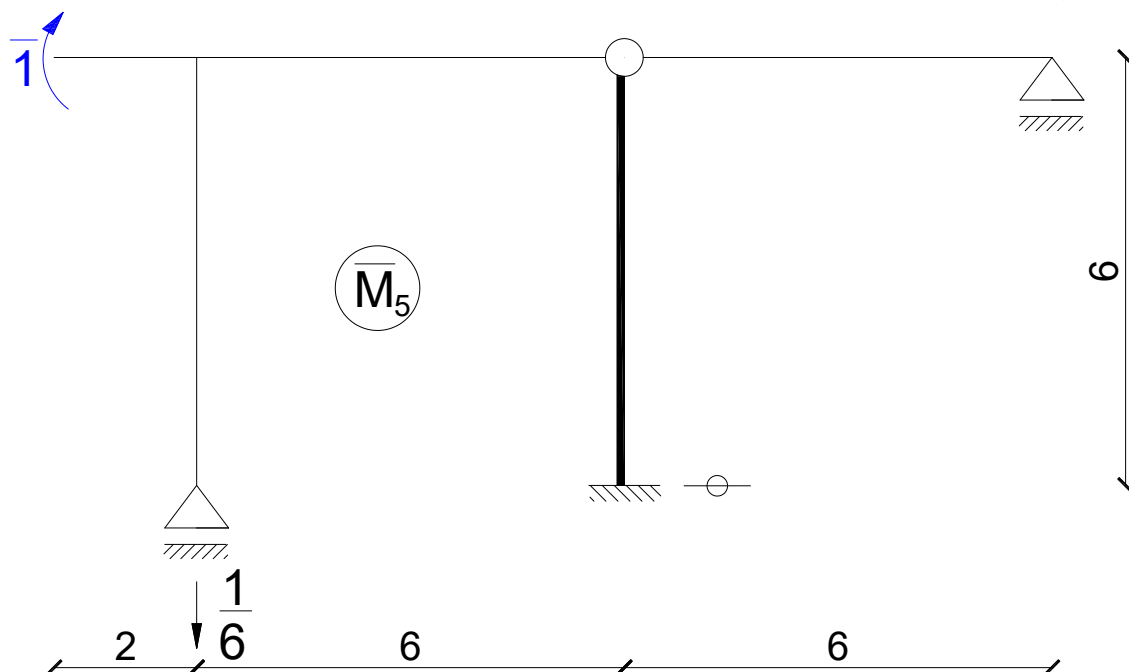
Obliczenia przemieszczeń z zasady prac wirtualnych:



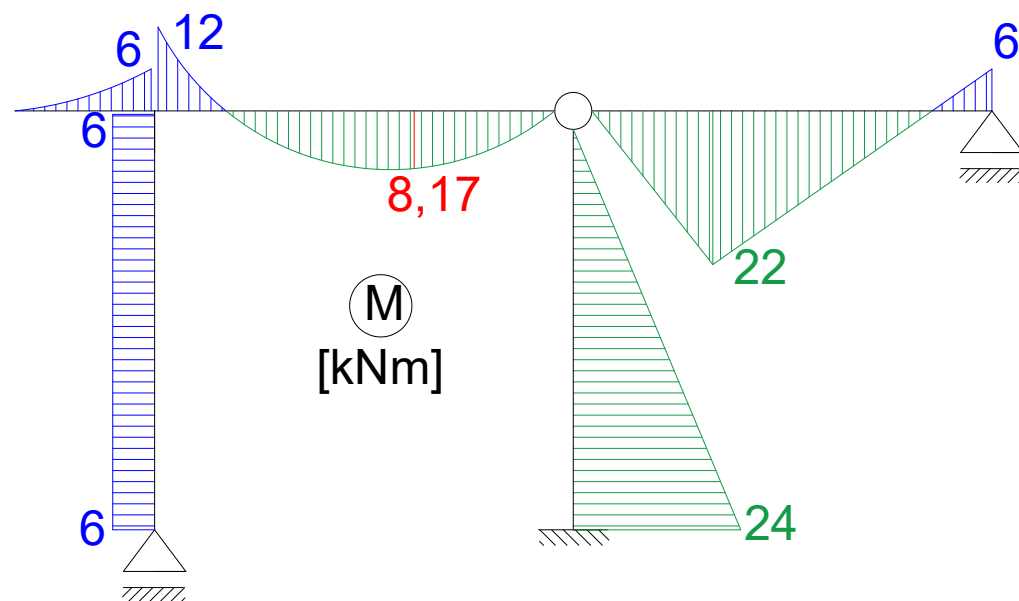
$$\varphi_E = ?$$



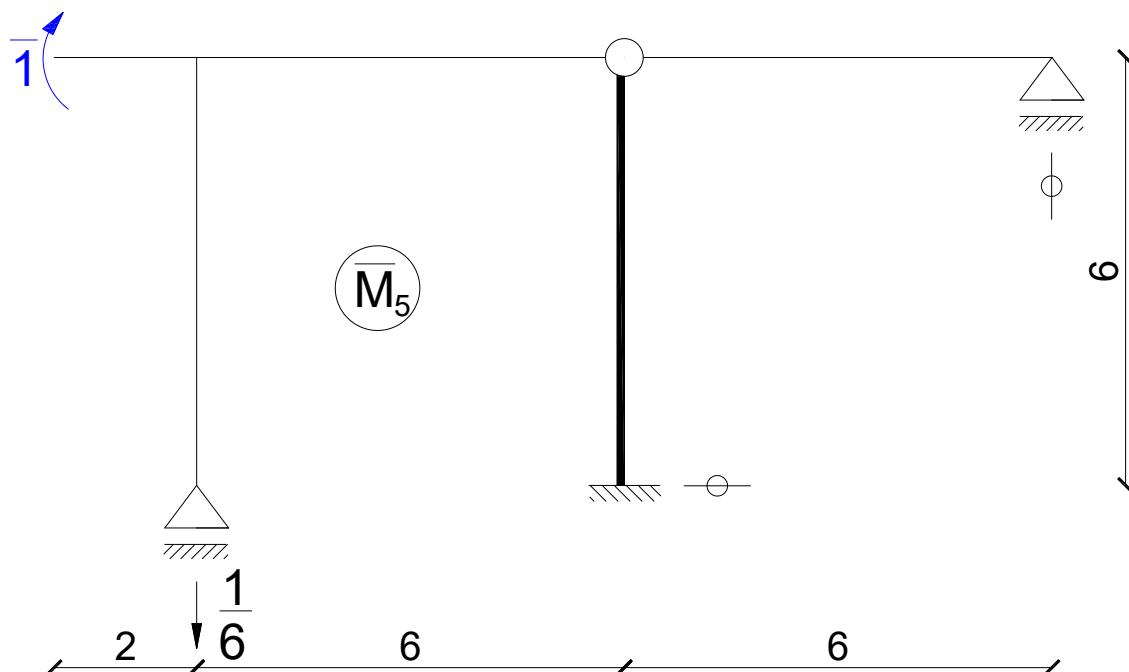
Obliczenia przemieszczeń z zasady prac wirtualnych:



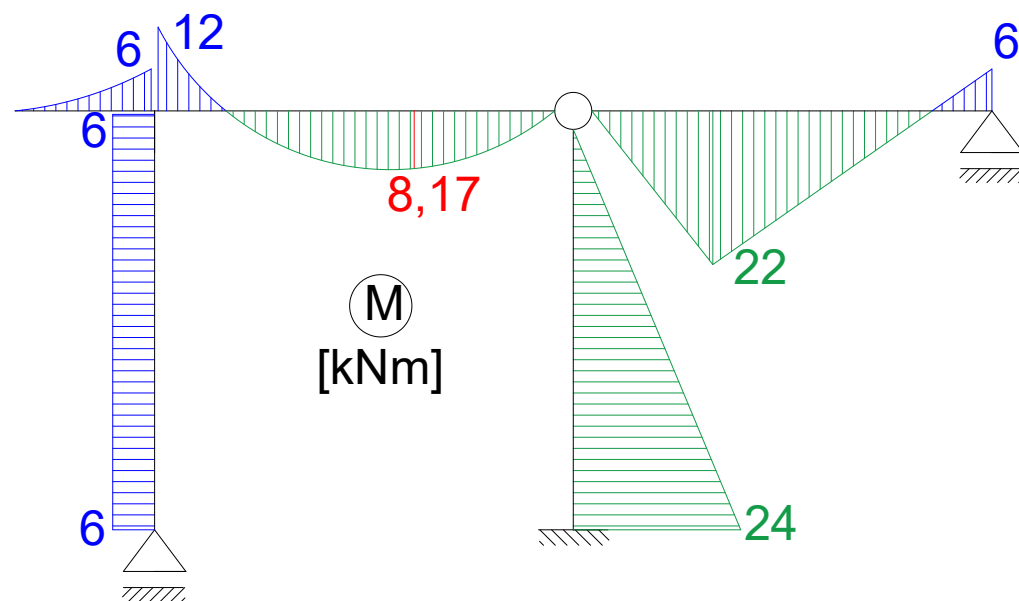
$$\varphi_E = ?$$



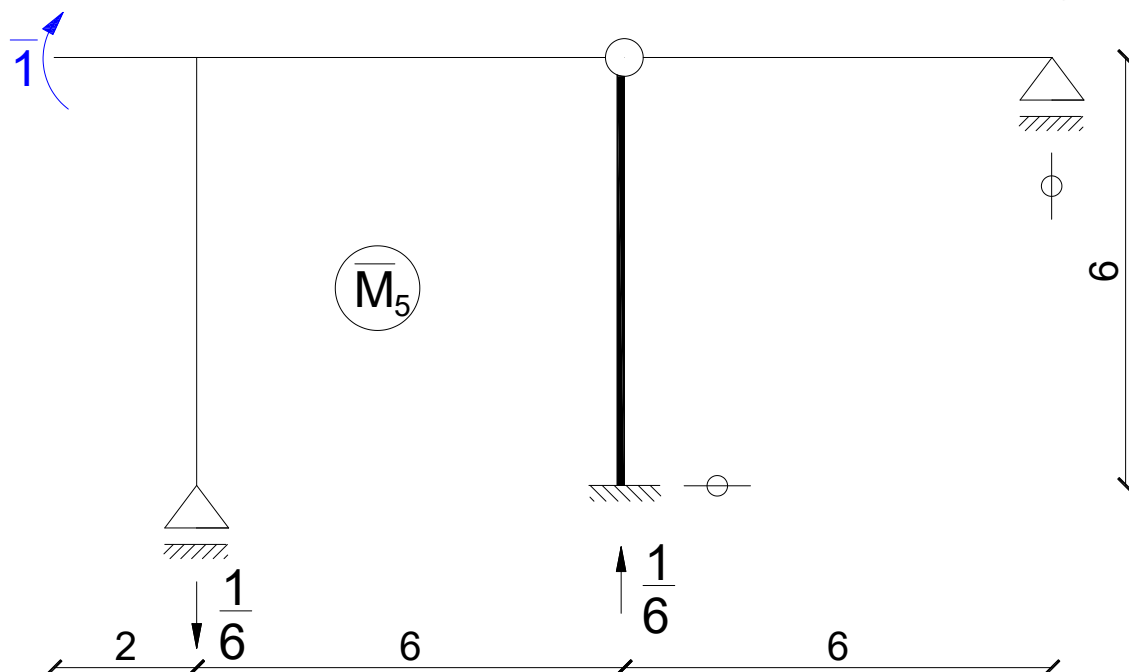
Obliczenia przemieszczeń z zasady prac wirtualnych:



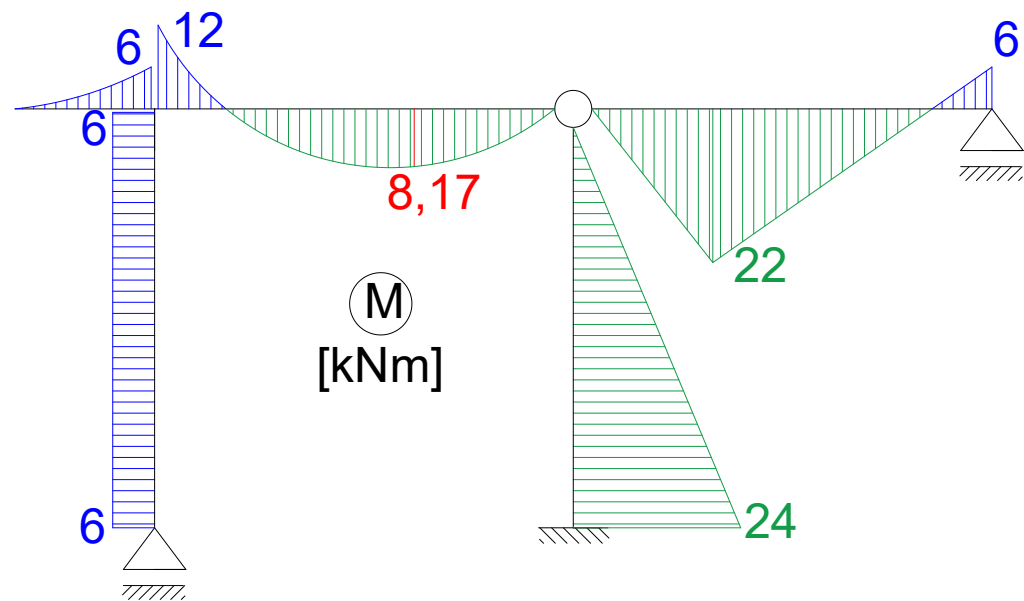
$$\varphi_E = ?$$



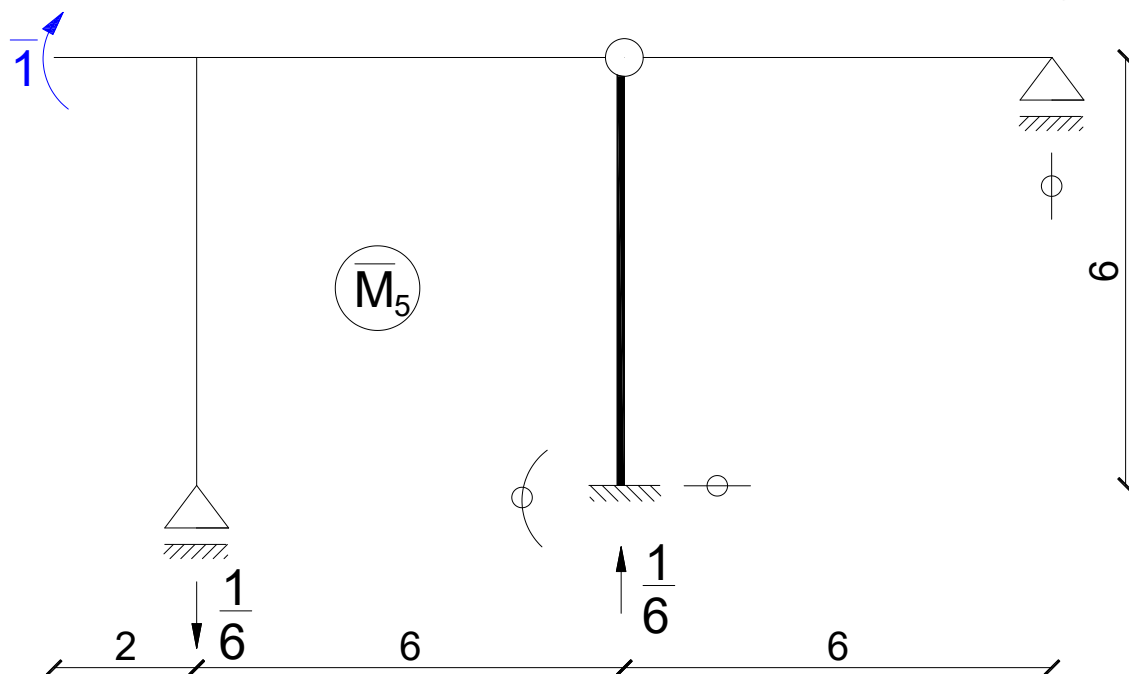
Obliczenia przemieszczeń z zasady prac wirtualnych:



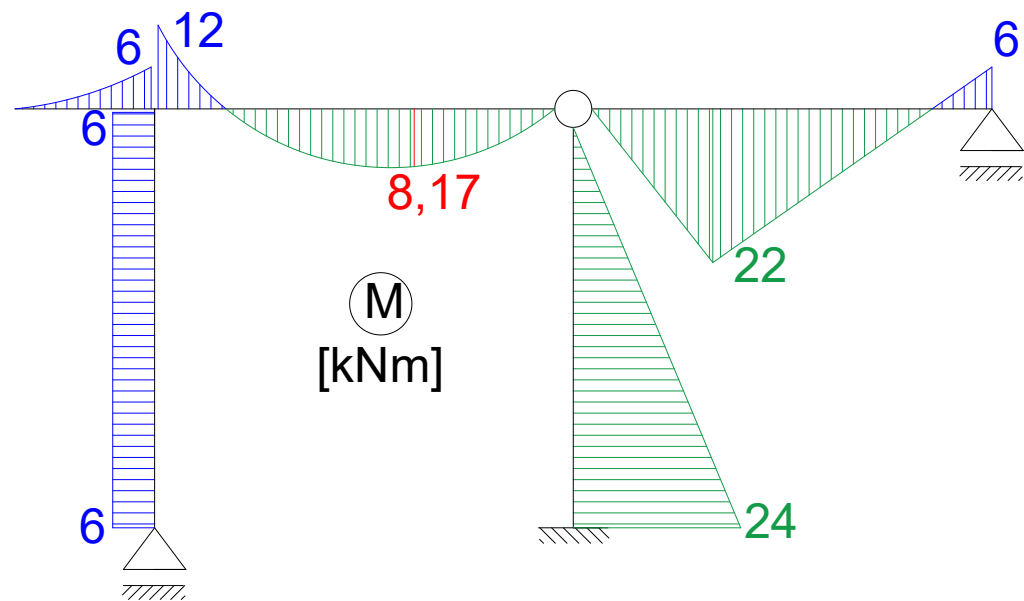
$$\varphi_E = ?$$



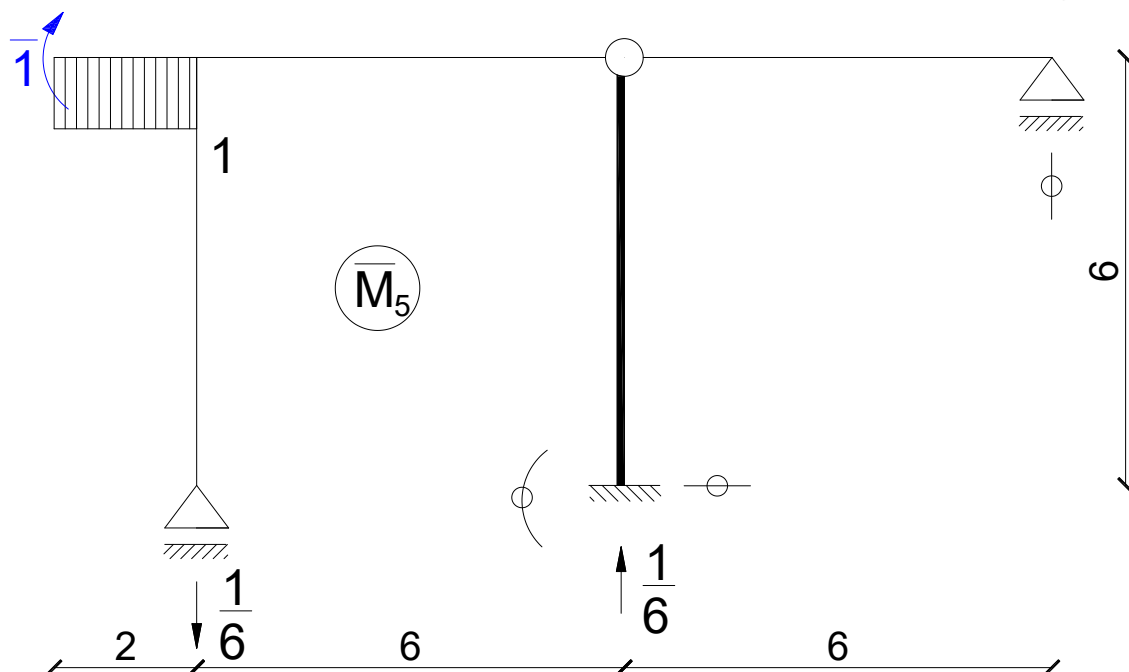
Obliczenia przemieszczeń z zasady prac wirtualnych:



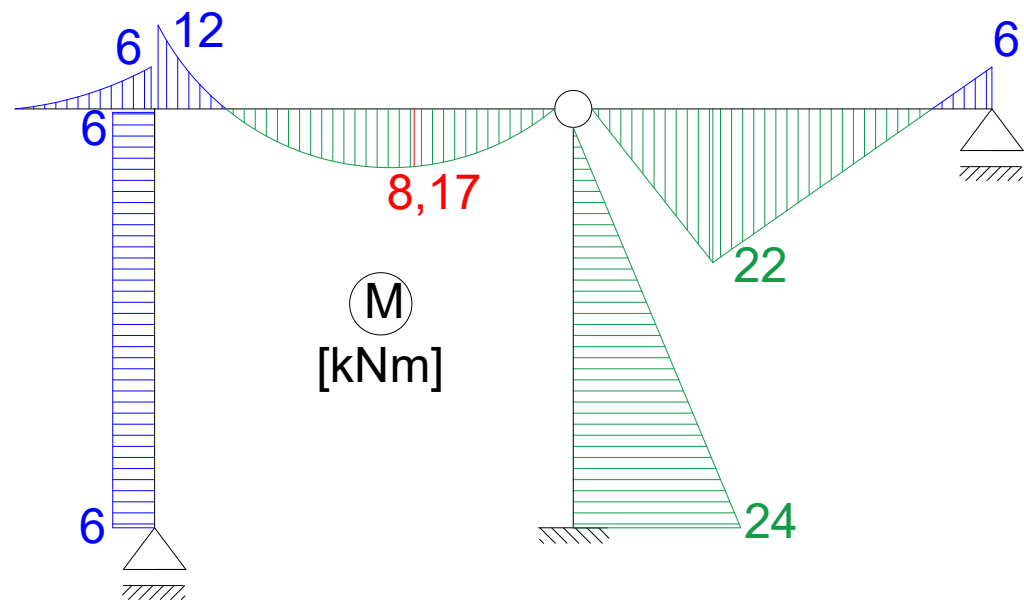
$$\varphi_E = ?$$



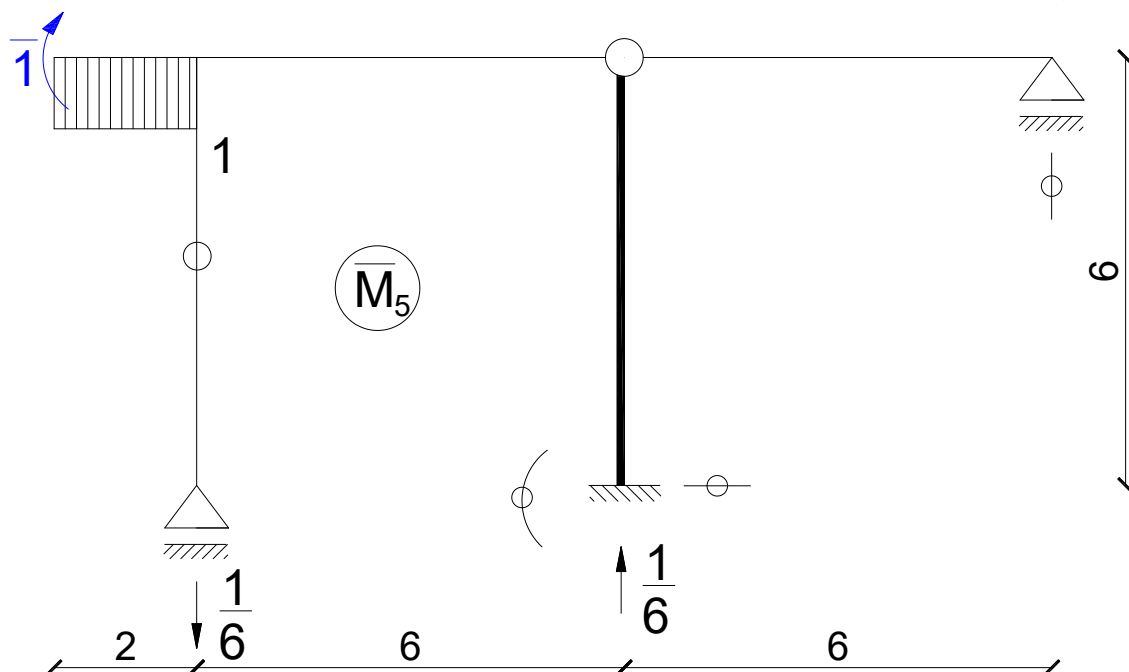
Obliczenia przemieszczeń z zasady prac wirtualnych:



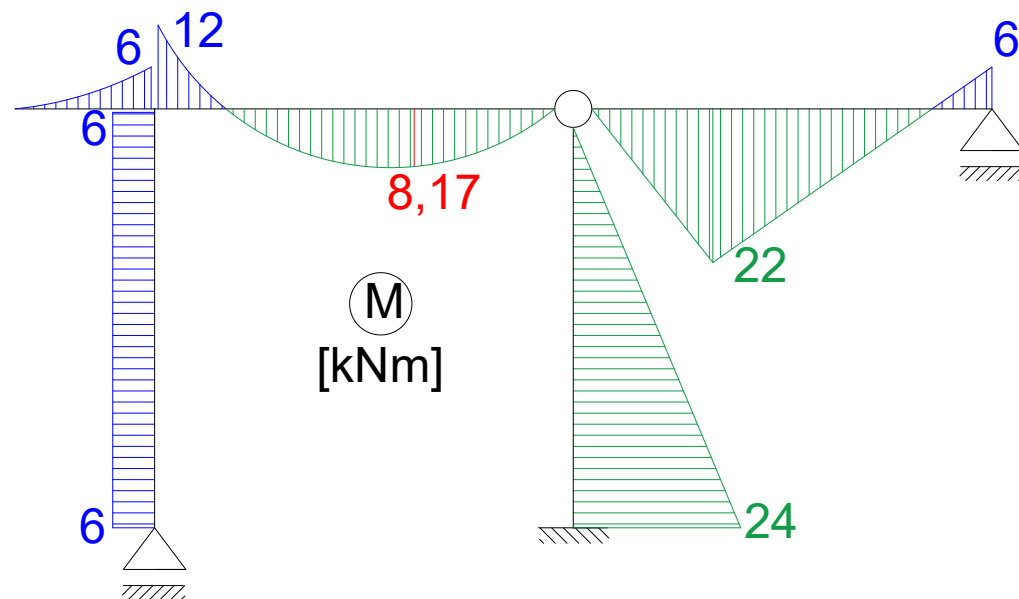
$$\varphi_E = ?$$



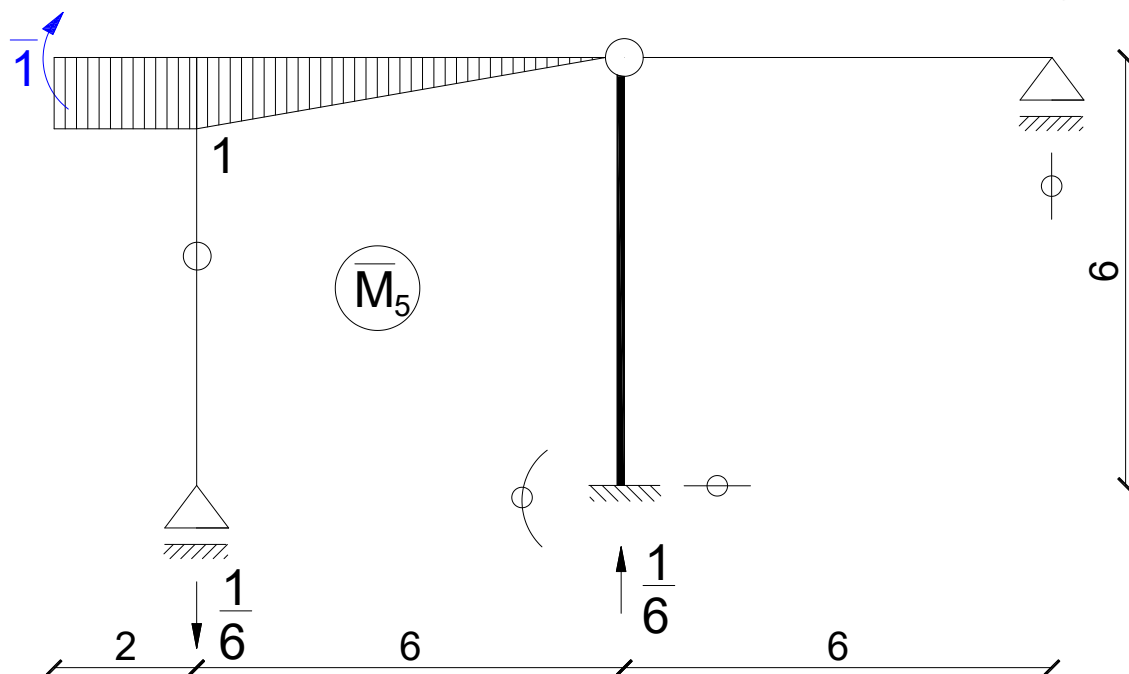
Obliczenia przemieszczeń z zasady prac wirtualnych:



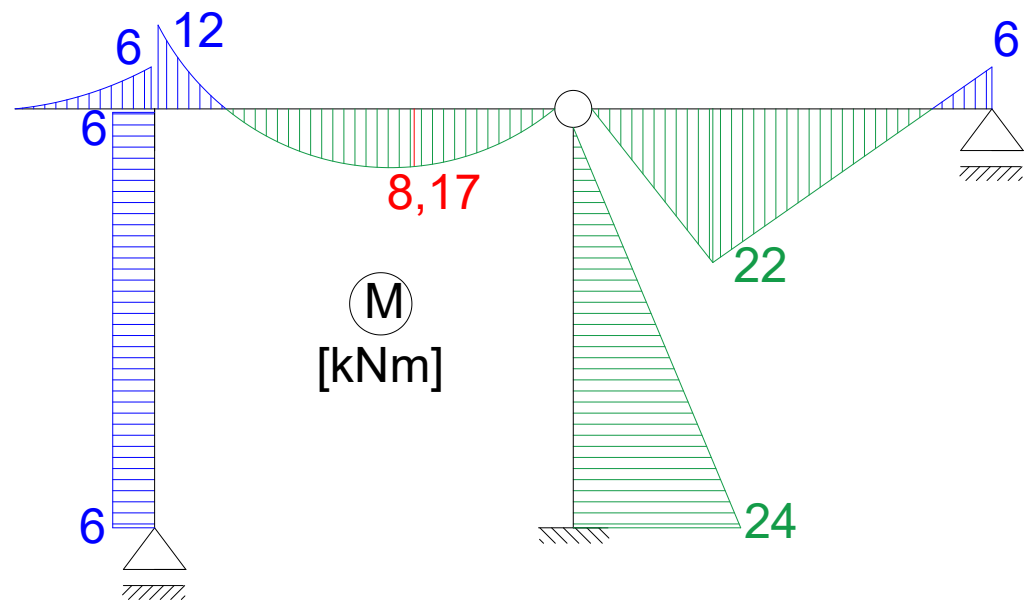
$$\varphi_E = ?$$



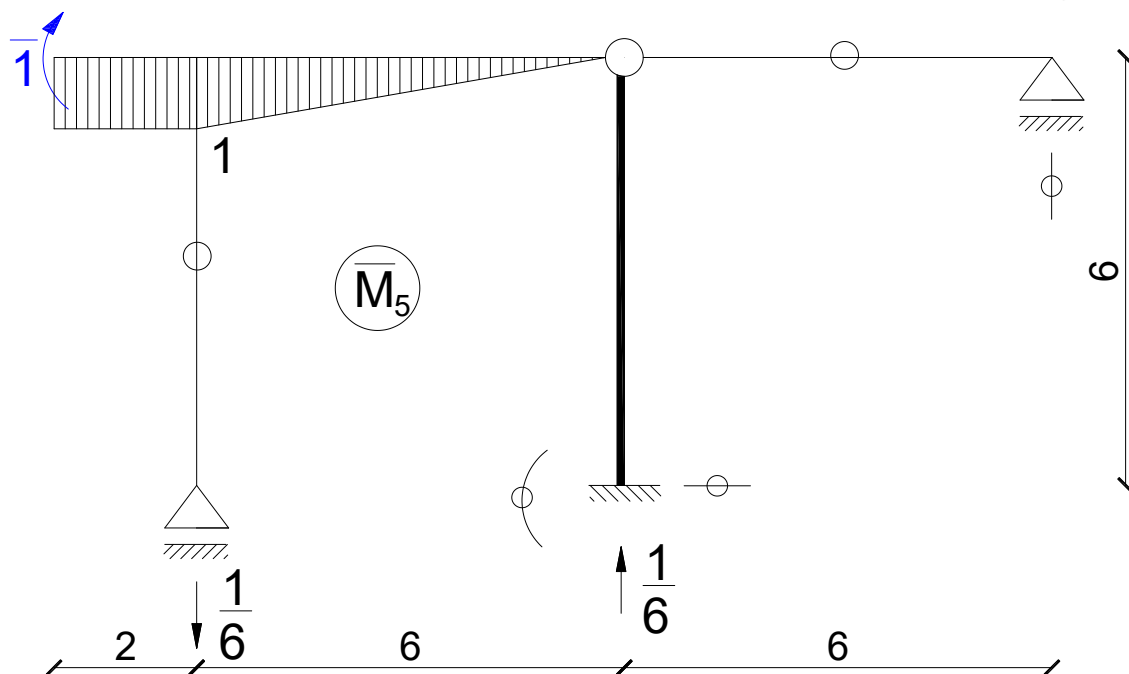
Obliczenia przemieszczeń z zasady prac wirtualnych:



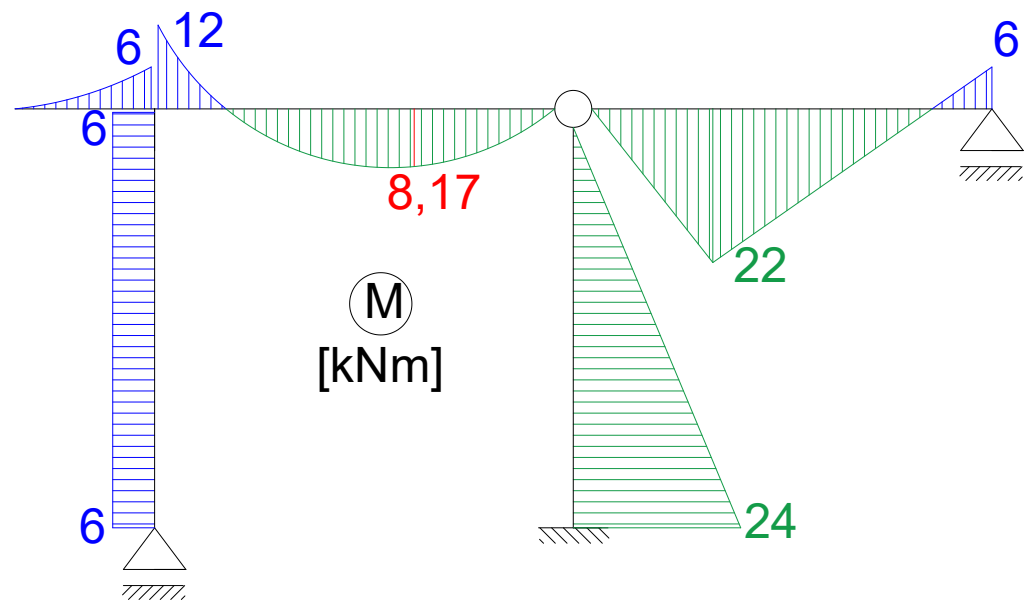
$$\varphi_E = ?$$



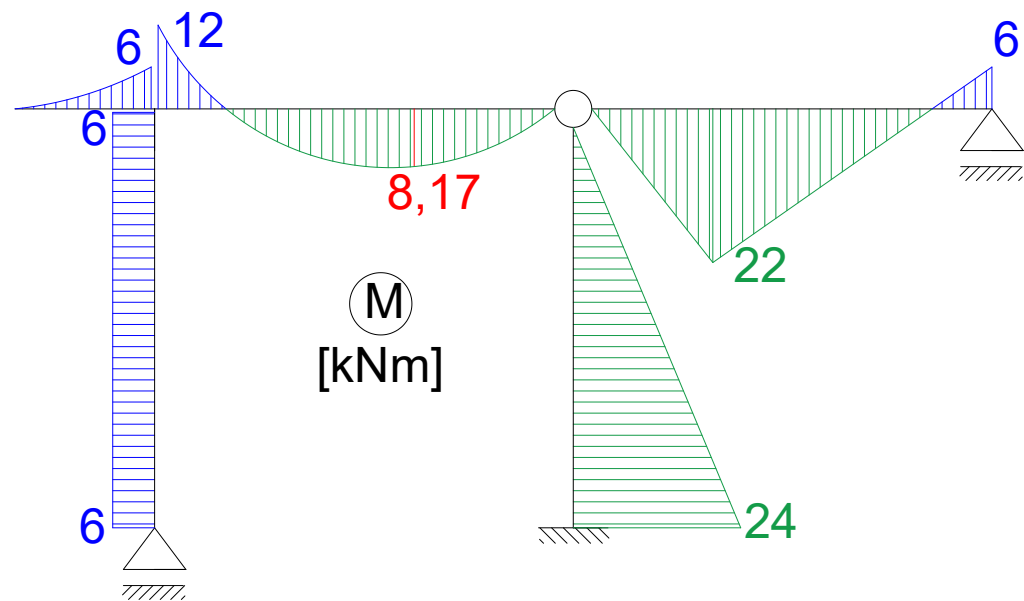
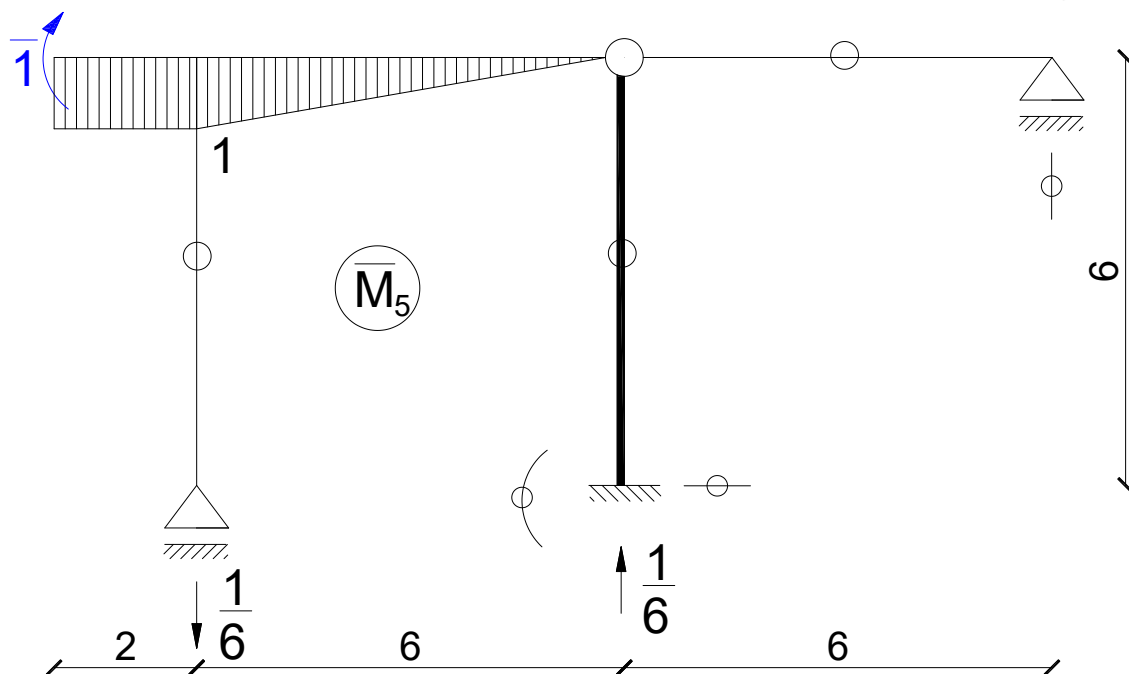
Obliczenia przemieszczeń z zasady prac wirtualnych:



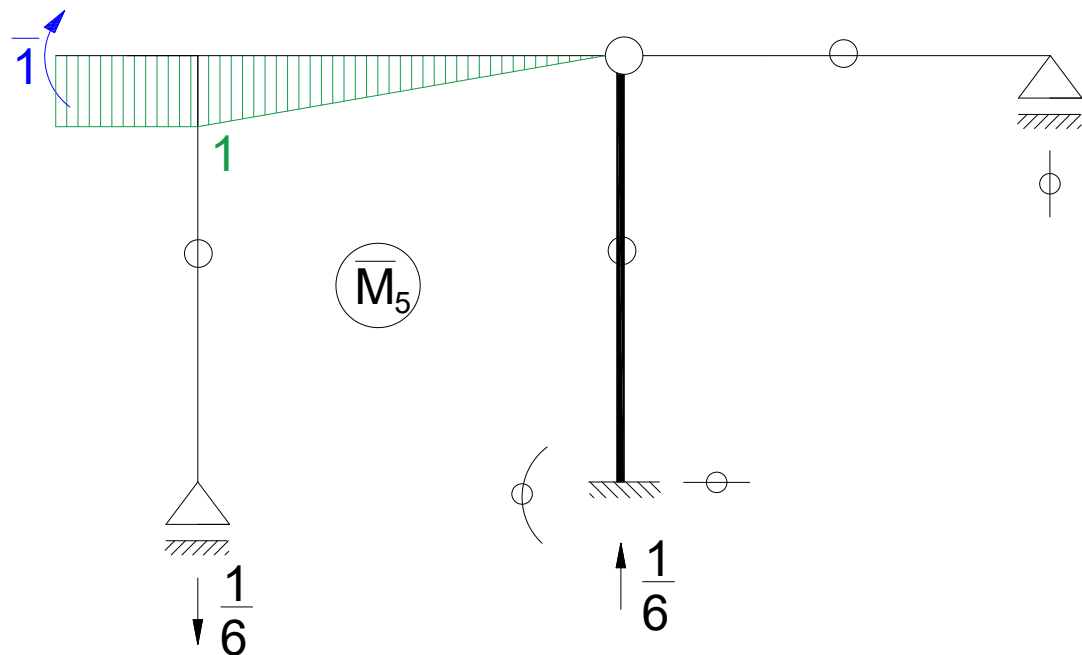
$$\varphi_E = ?$$



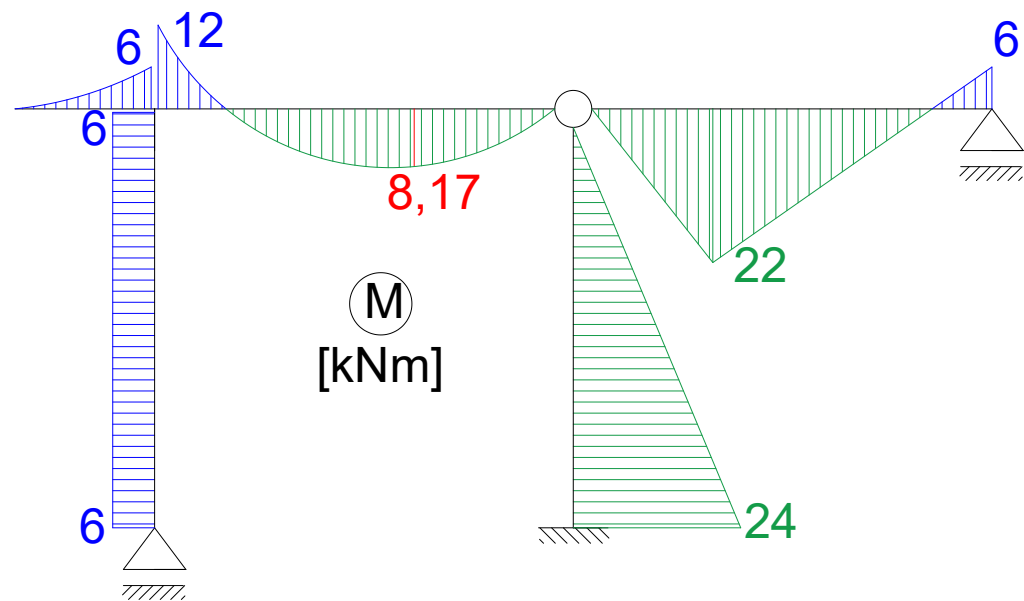
Obliczenia przemieszczeń z zasady prac wirtualnych:



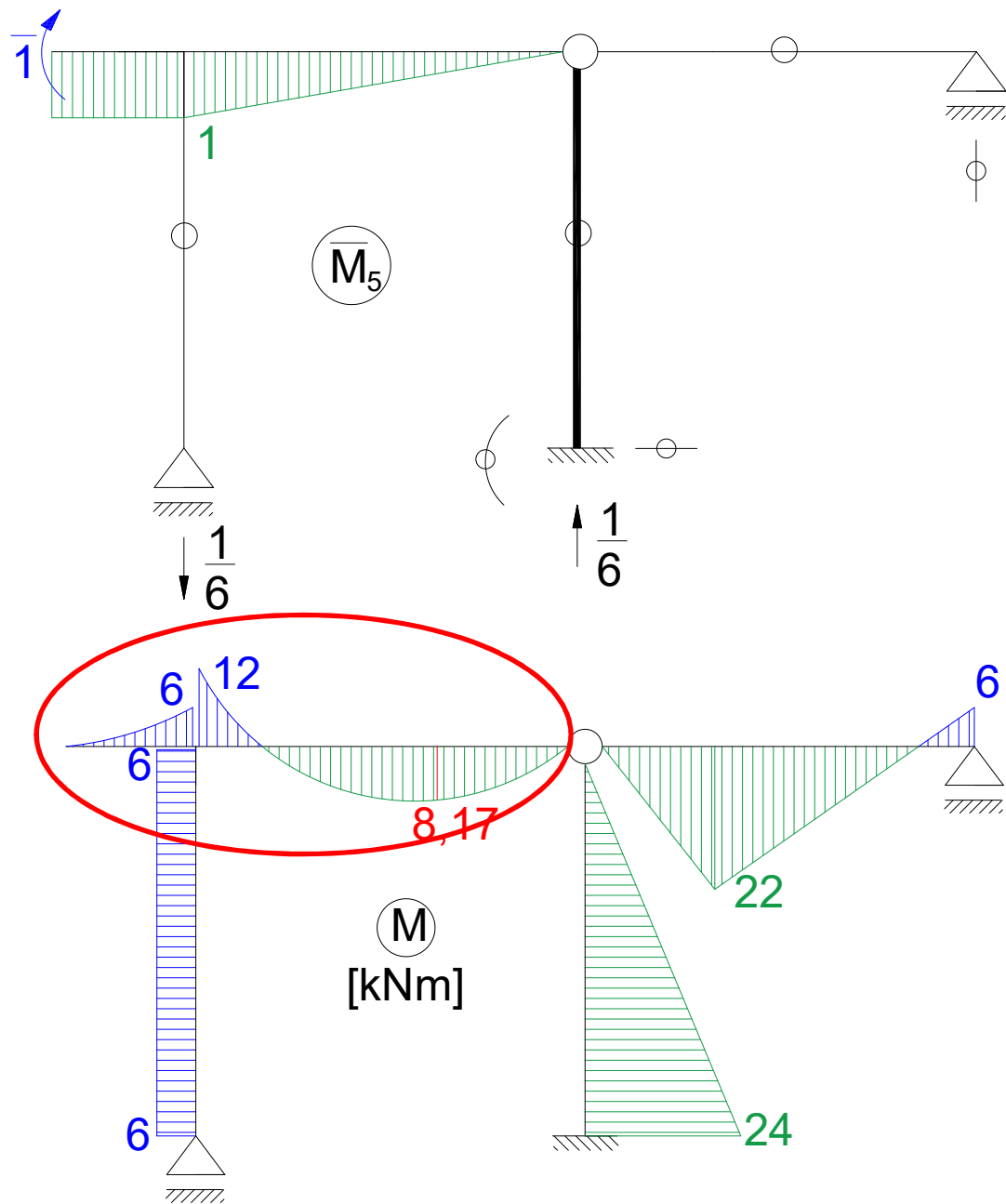
Obliczenia przemieszczeń z zasady prac wirtualnych:



$$\varphi_E = ?$$

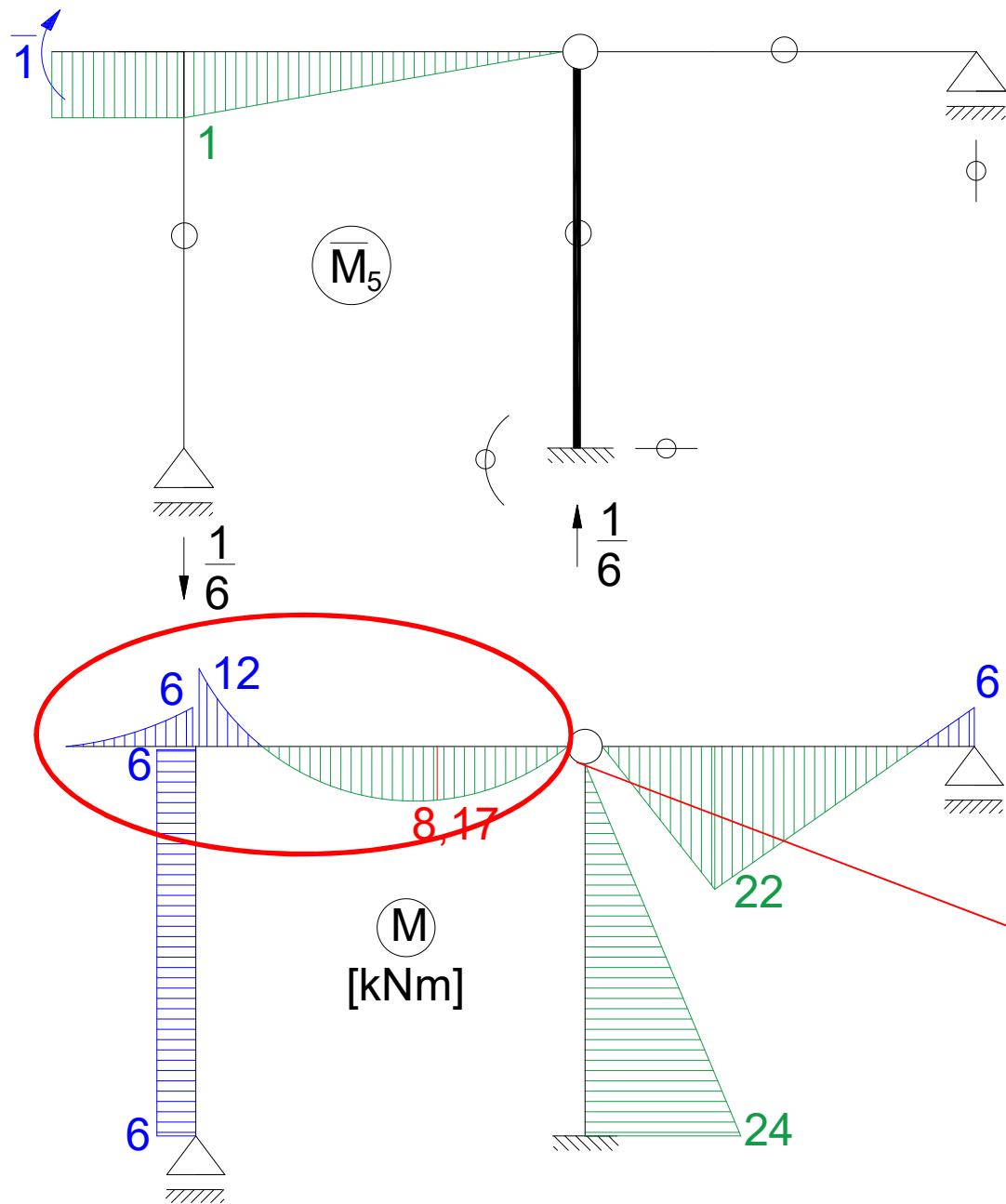


Obliczenia przemieszczeń z zasady prac wirtualnych:

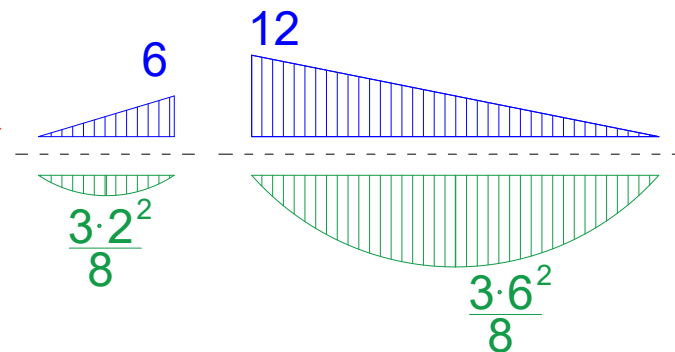


$$\varphi_E = ?$$

Obliczenia przemieszczeń z zasady prac wirtualnych:

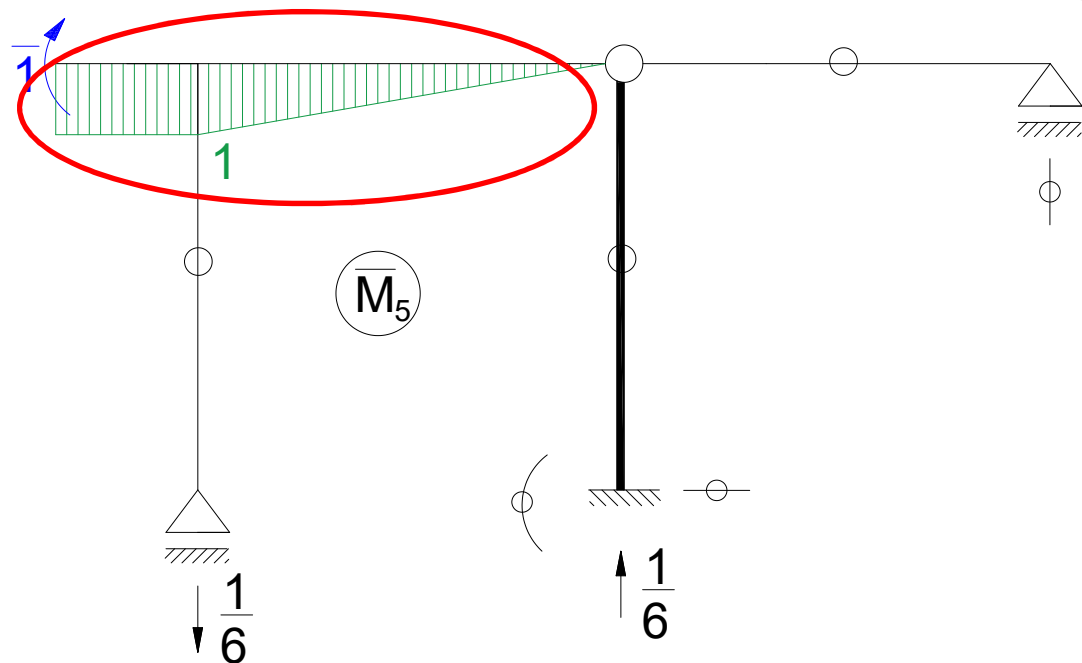


$$\varphi_E = ?$$

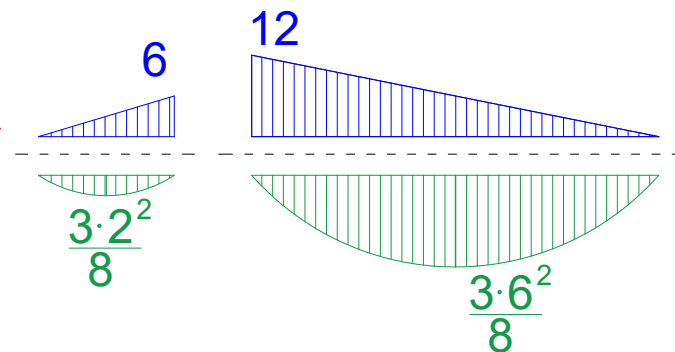
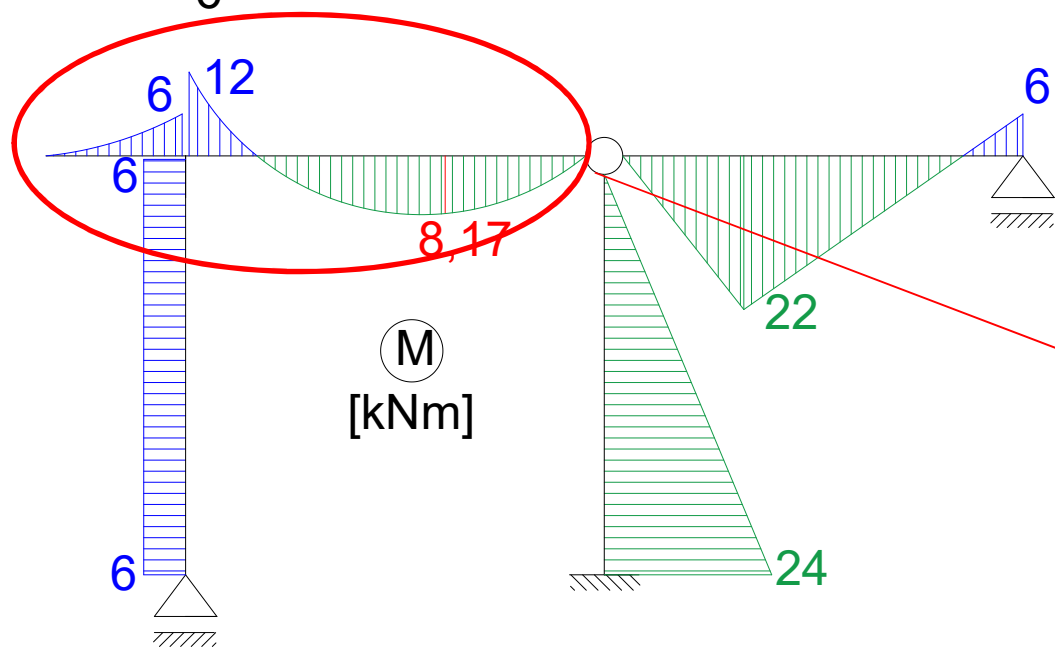


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Obliczenia przemieszczeń z zasady prac wirtualnych:

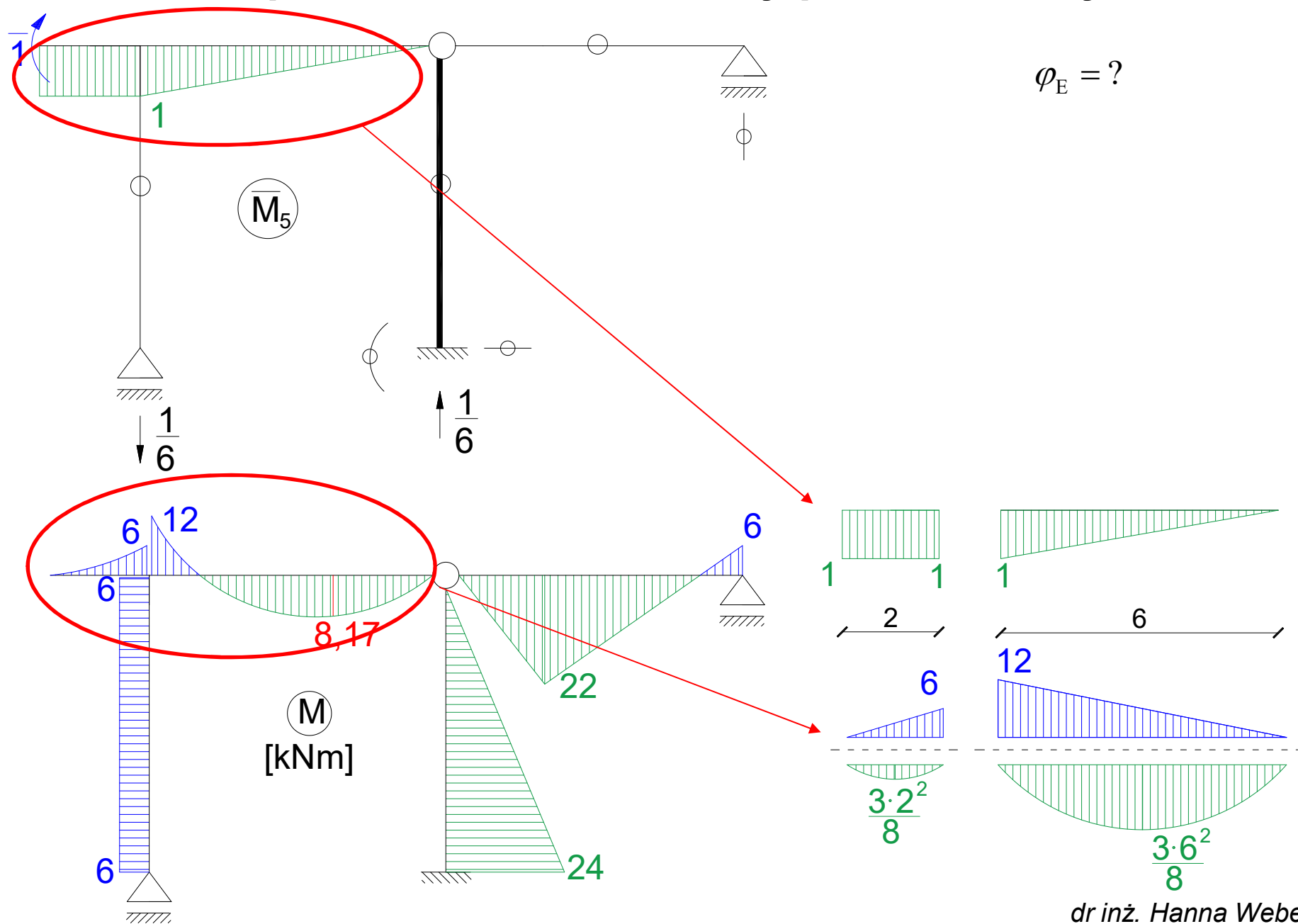


$$\varphi_E = ?$$

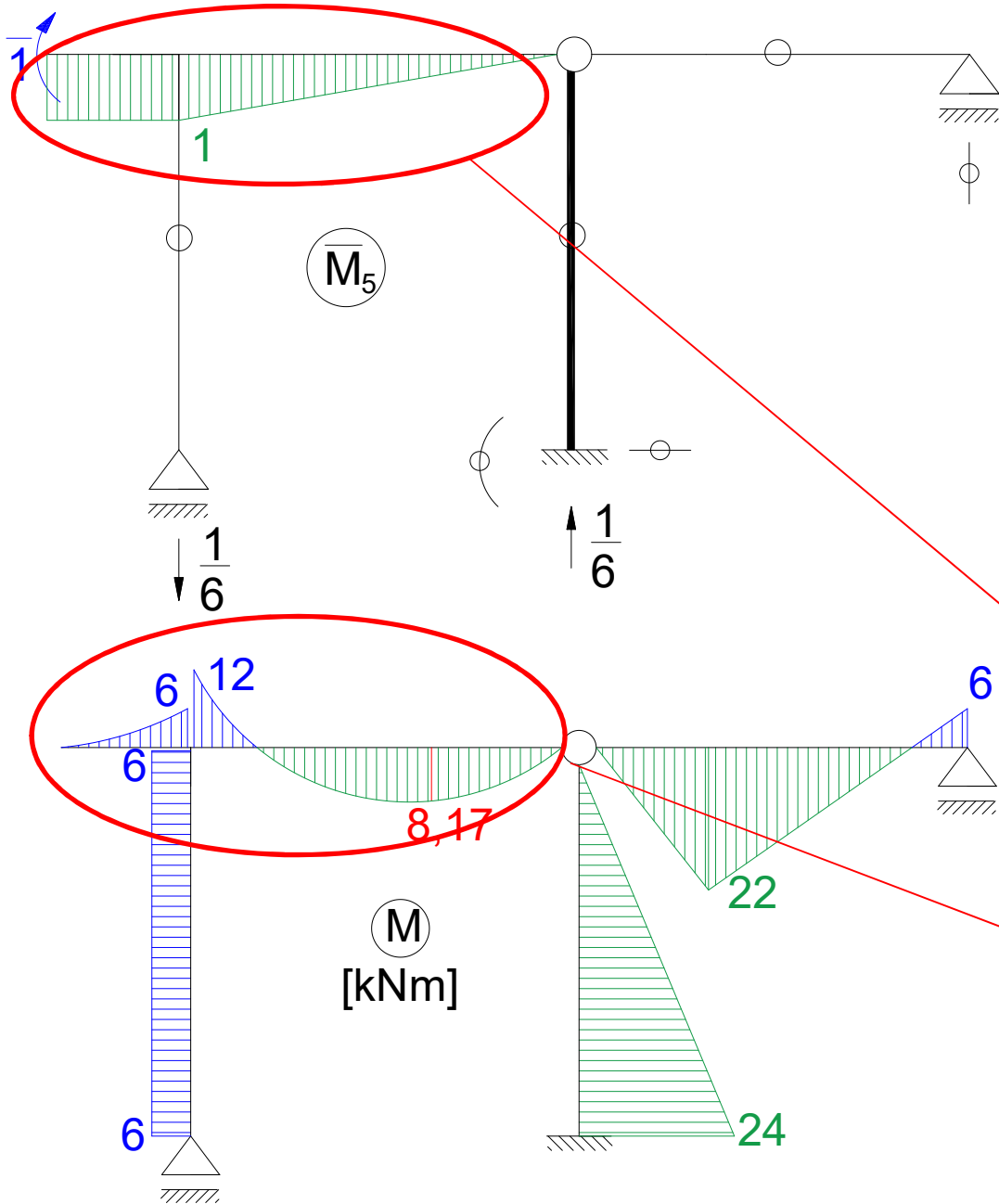


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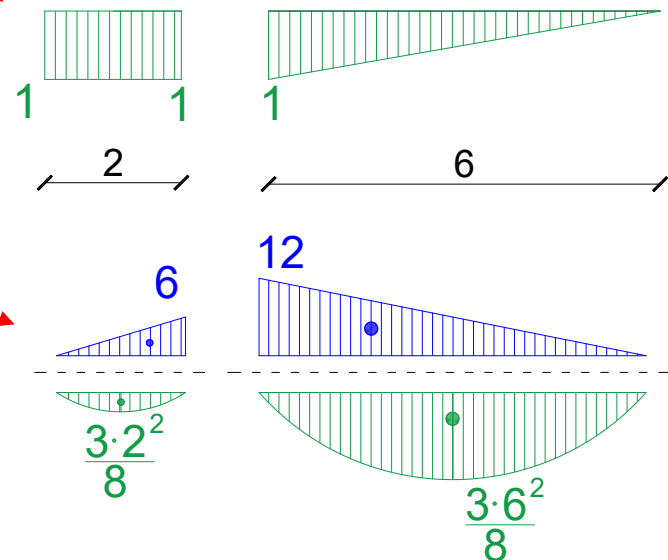
Obliczenia przemieszczeń z zasady prac wirtualnych:



Obliczenia przemieszczeń z zasady prac wirtualnych:

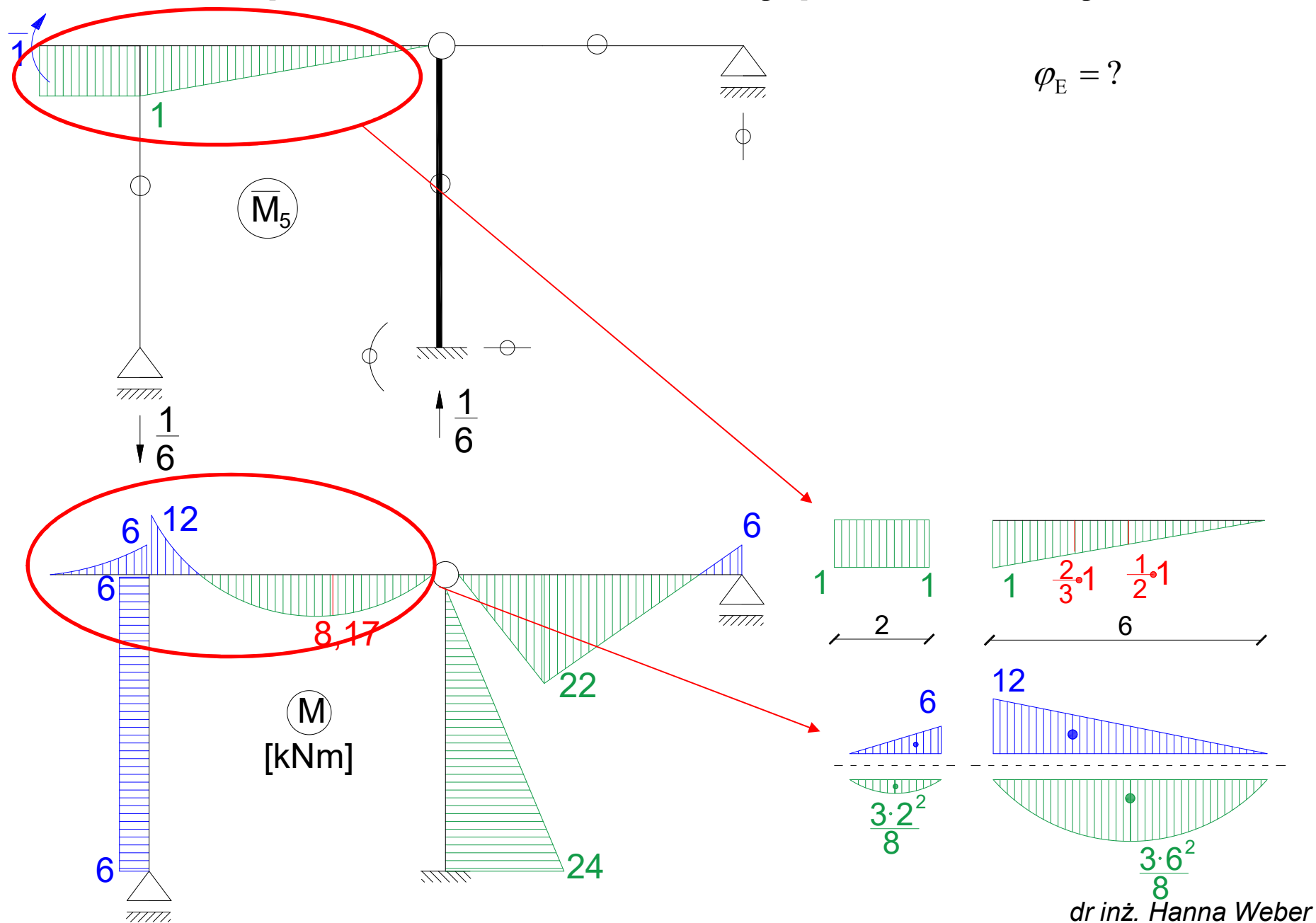


$$\varphi_E = ?$$

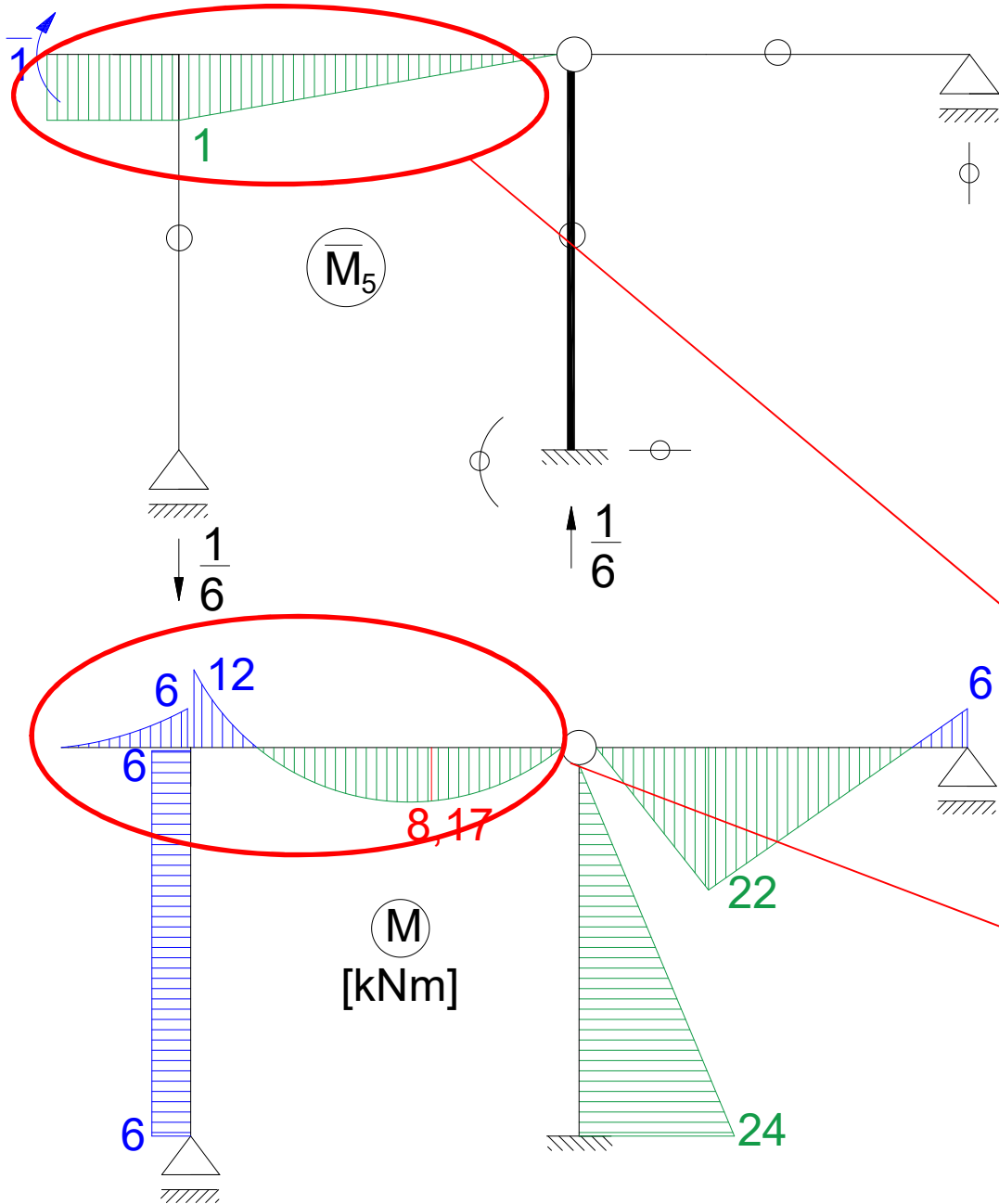


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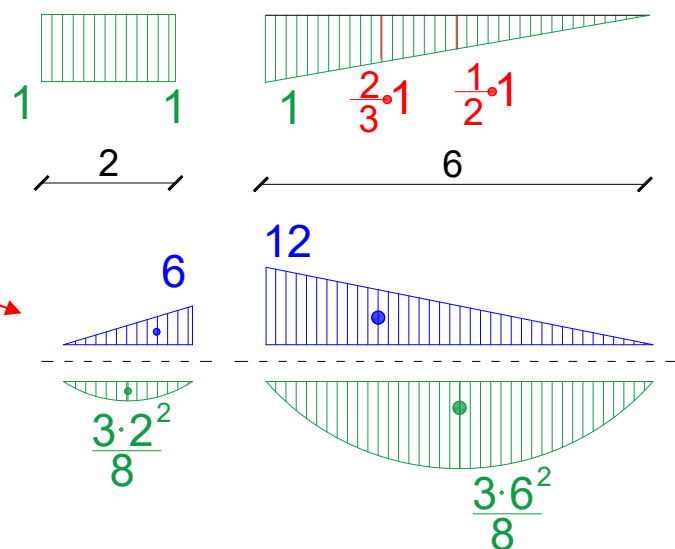
Obliczenia przemieszczeń z zasady prac wirtualnych:



Obliczenia przemieszczeń z zasady prac wirtualnych:

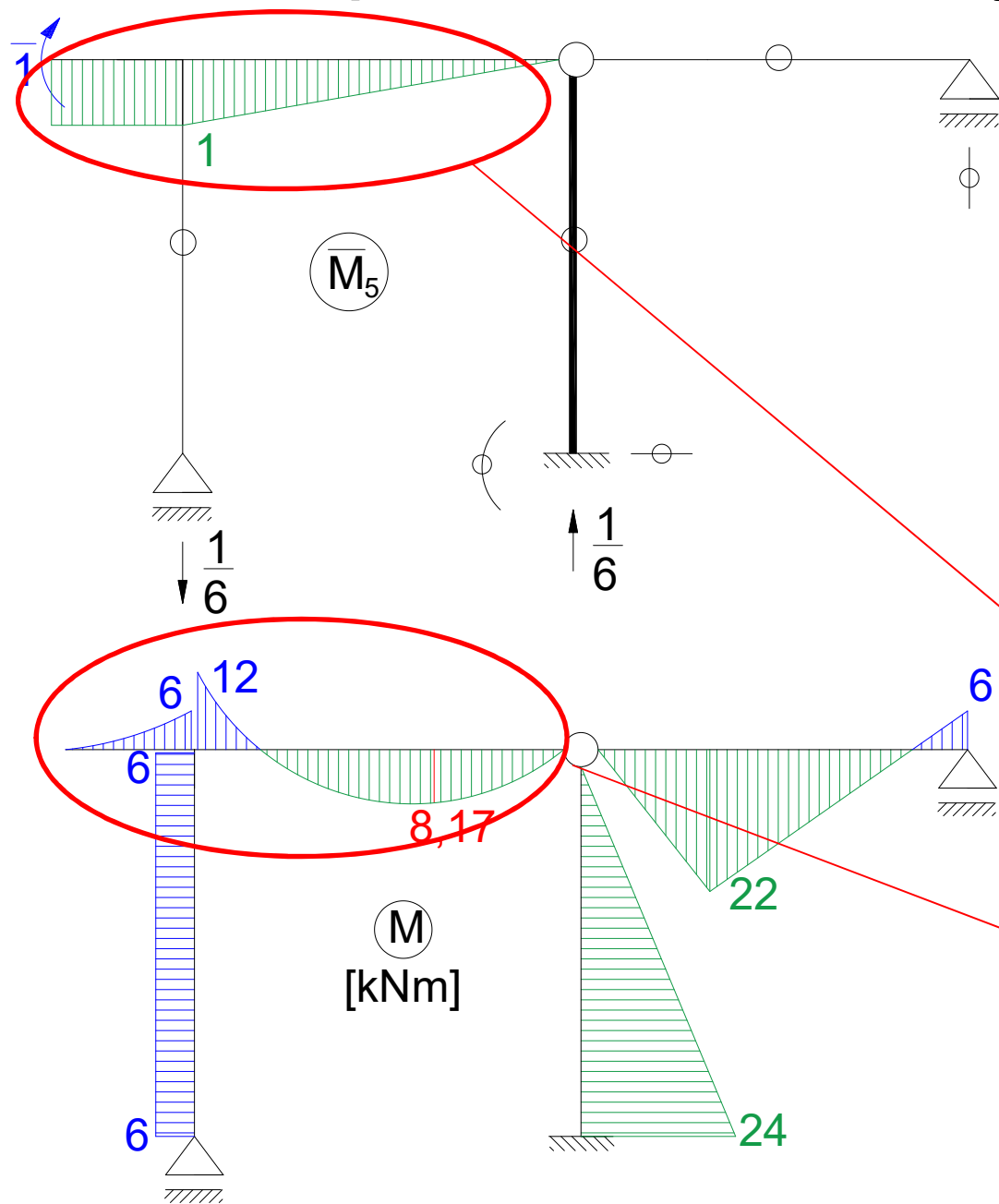


$$\varphi_E = \frac{1}{EI} \left(-\frac{1}{2} \cdot 6 \cdot 2 \cdot 1 \right)$$

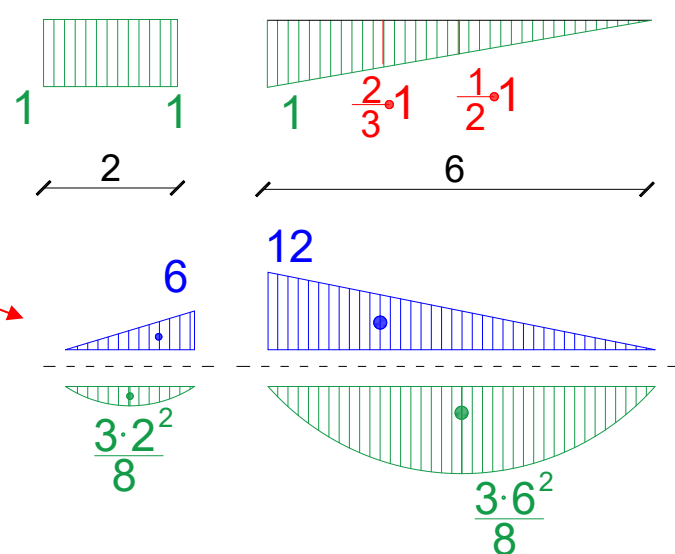


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Obliczenia przemieszczeń z zasady prac wirtualnych:

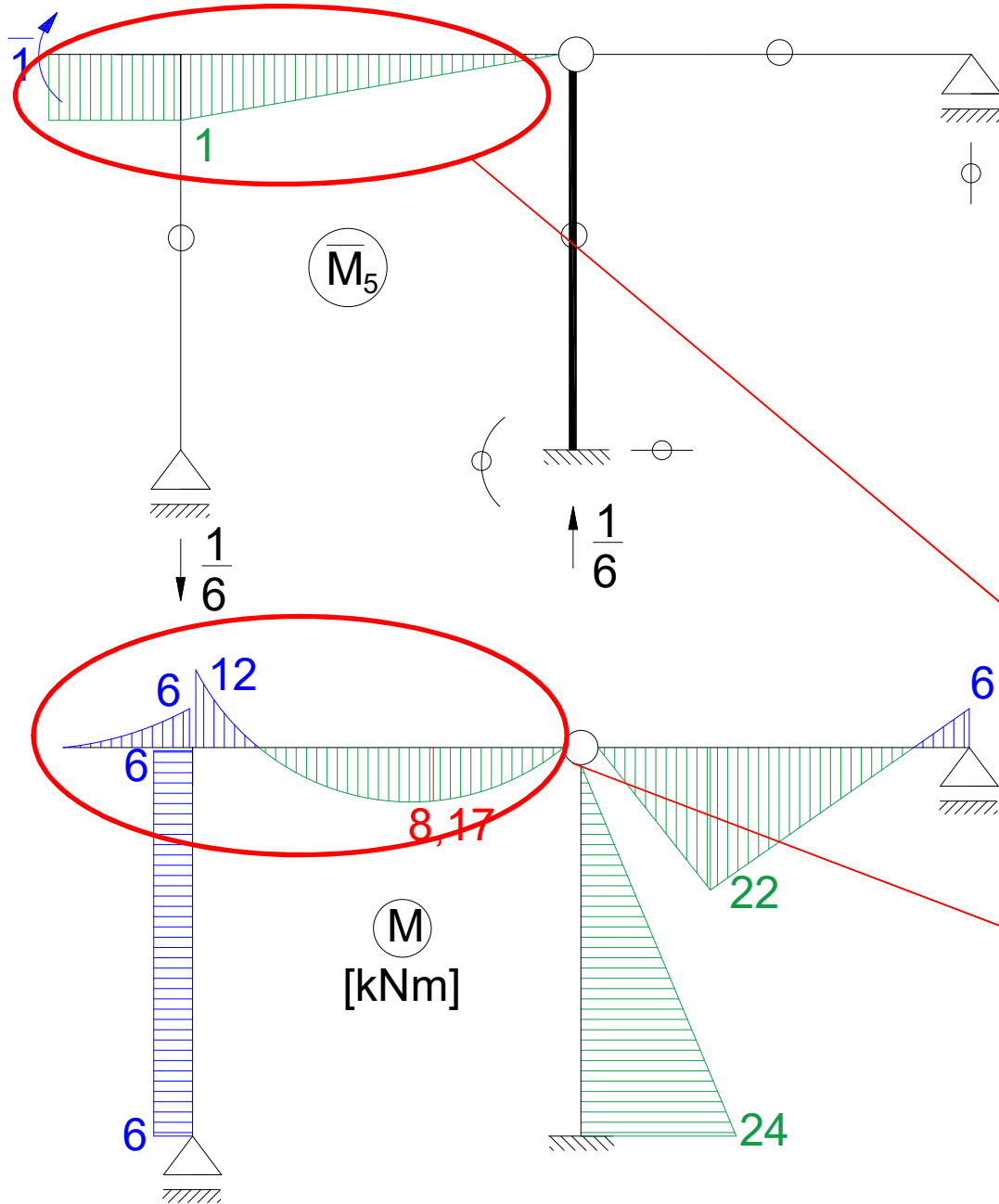


$$\varphi_E = \frac{1}{EI} \left(-\frac{1}{2} \cdot 6 \cdot 2 \cdot 1 \right) + \frac{1}{EI} \left(\frac{2}{3} \cdot \frac{3 \cdot 2^2}{8} \cdot 2 \cdot 1 \right)$$

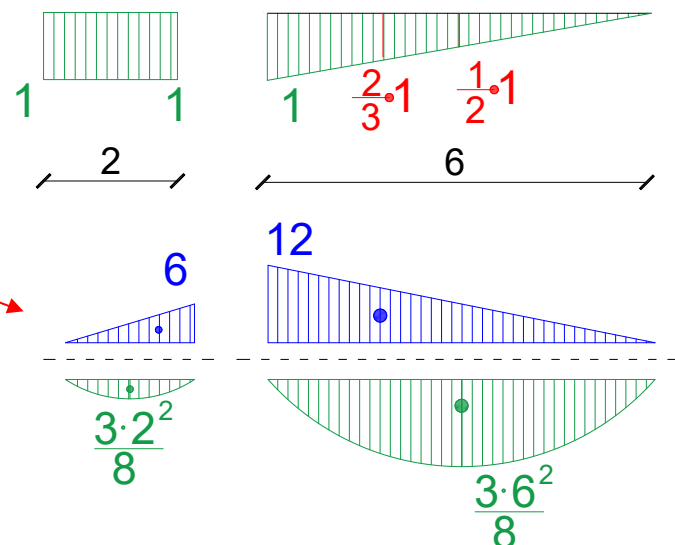


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Obliczenia przemieszczeń z zasady prac wirtualnych:

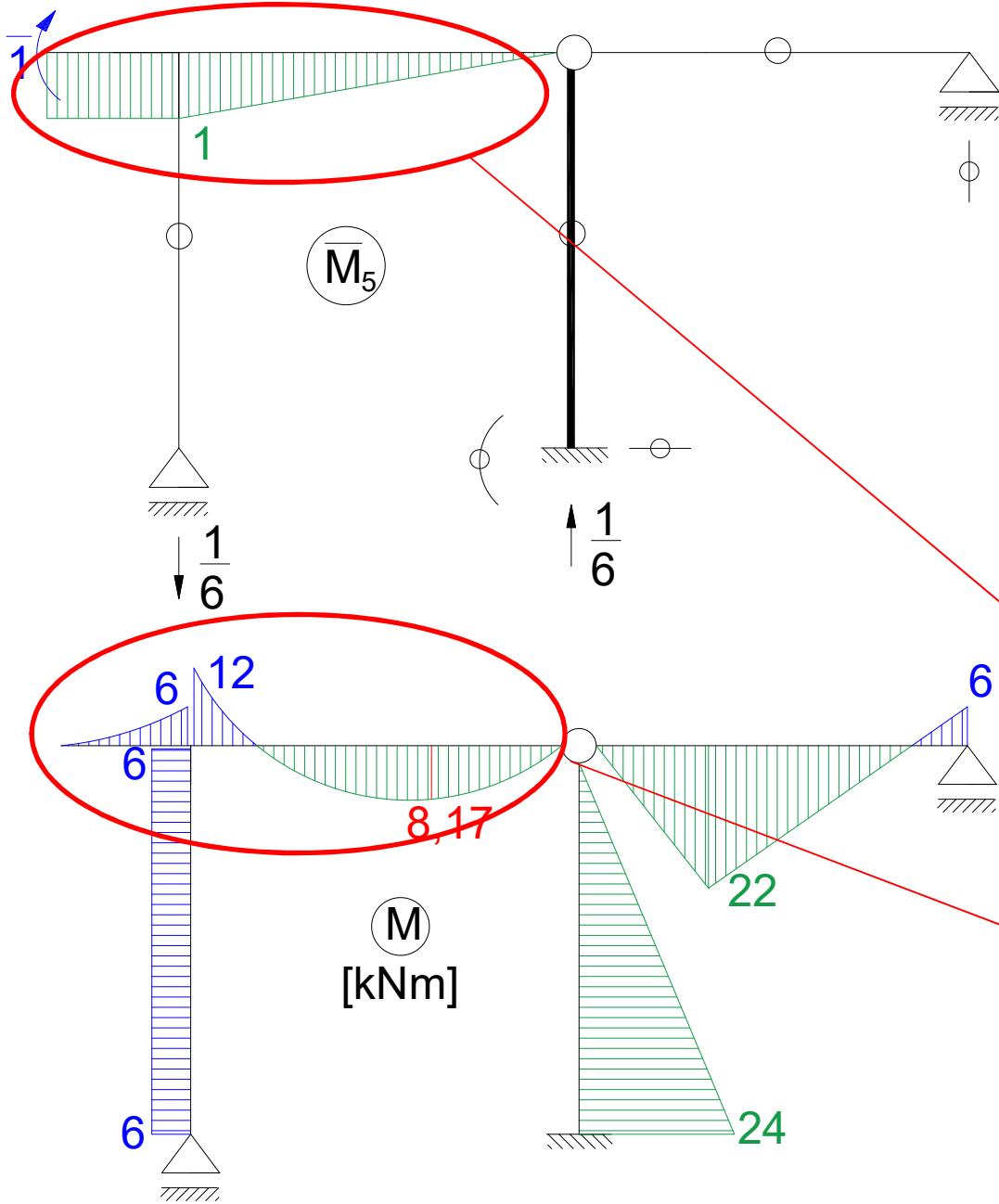


$$\varphi_E = \frac{1}{EI} \left(-\frac{1}{2} \cdot 6 \cdot 2 \cdot 1 \right) + \frac{1}{EI} \left(\frac{2}{3} \cdot \frac{3 \cdot 2^2}{8} \cdot 2 \cdot 1 \right) - \frac{1}{EI} \left(\frac{1}{2} \cdot 12 \cdot 6 \cdot \frac{2}{3} \cdot 1 \right)$$

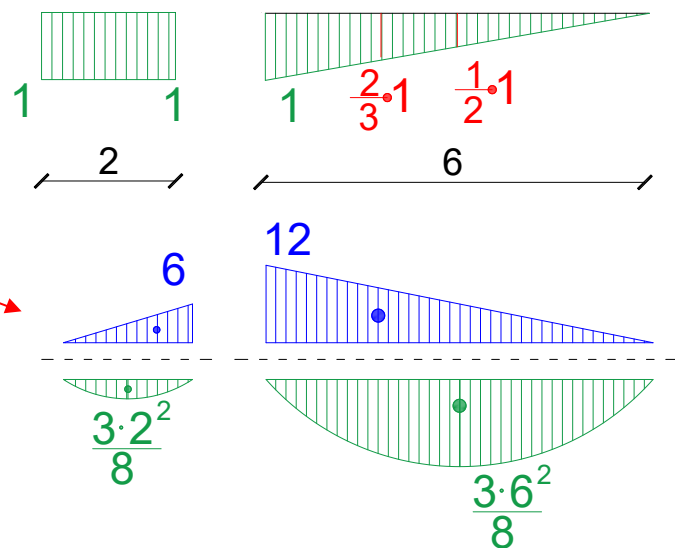


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Obliczenia przemieszczeń z zasady prac wirtualnych:

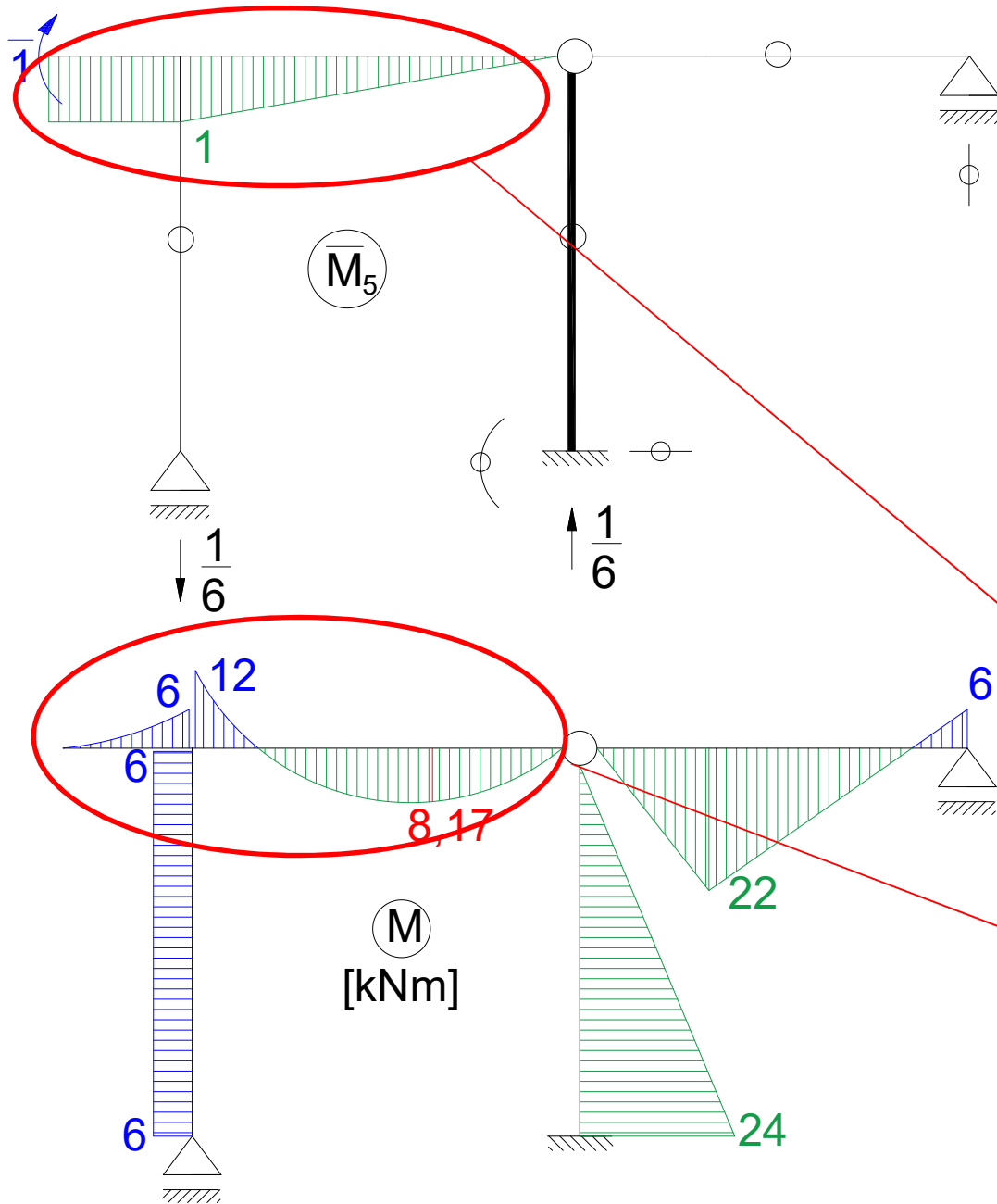


$$\begin{aligned}\varphi_E = & \frac{1}{EI} \left(-\frac{1}{2} \cdot 6 \cdot 2 \cdot 1 \right) \\ & + \frac{1}{EI} \left(\frac{2}{3} \cdot \frac{3 \cdot 2^2}{8} \cdot 2 \cdot 1 \right) \\ & - \frac{1}{EI} \left(\frac{1}{2} \cdot 12 \cdot 6 \cdot \frac{2}{3} \cdot 1 \right) \\ & + \frac{1}{EI} \left(\frac{2}{3} \cdot \frac{3 \cdot 6^2}{8} \cdot 6 \cdot \frac{1}{2} \cdot 1 \right)\end{aligned}$$

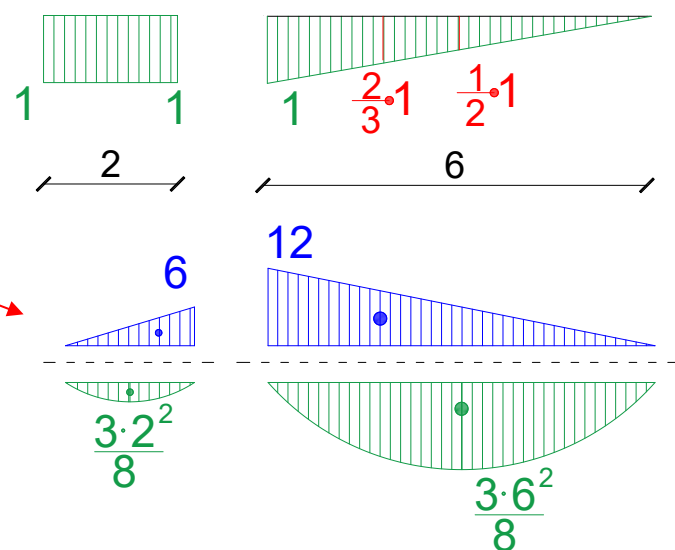


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Obliczenia przemieszczeń z zasady prac wirtualnych:



$$\begin{aligned}\varphi_E &= \frac{1}{EI} \left(-\frac{1}{2} \cdot 6 \cdot 2 \cdot 1 \right) \\ &+ \frac{1}{EI} \left(\frac{2}{3} \cdot \frac{3 \cdot 2^2}{8} \cdot 2 \cdot 1 \right) \\ &- \frac{1}{EI} \left(\frac{1}{2} \cdot 12 \cdot 6 \cdot \frac{2}{3} \cdot 1 \right) \\ &+ \frac{1}{EI} \left(\frac{2}{3} \cdot \frac{3 \cdot 6^2}{8} \cdot 6 \cdot \frac{1}{2} \cdot 1 \right) = -\frac{1}{EI}\end{aligned}$$



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