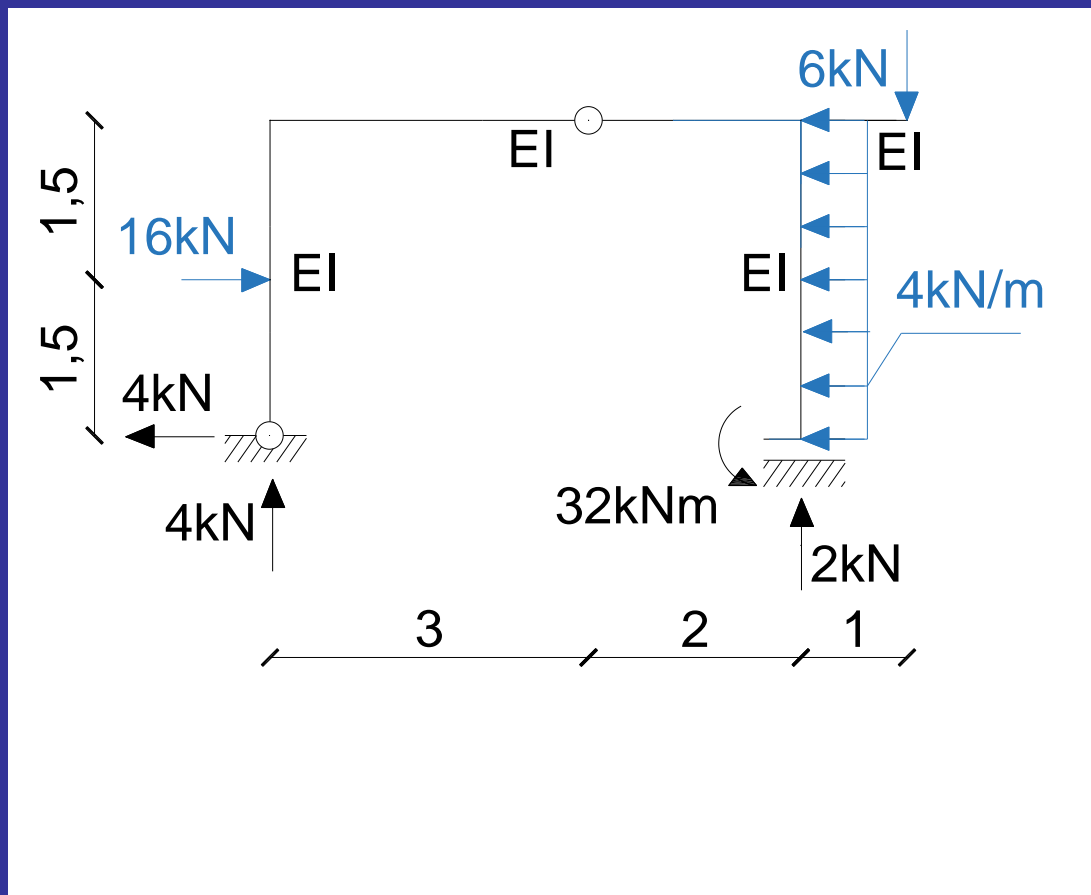
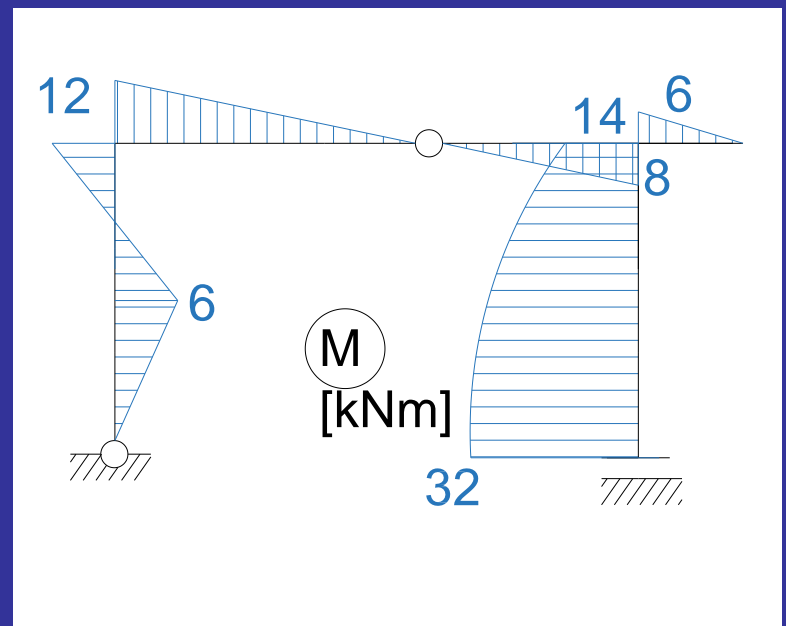
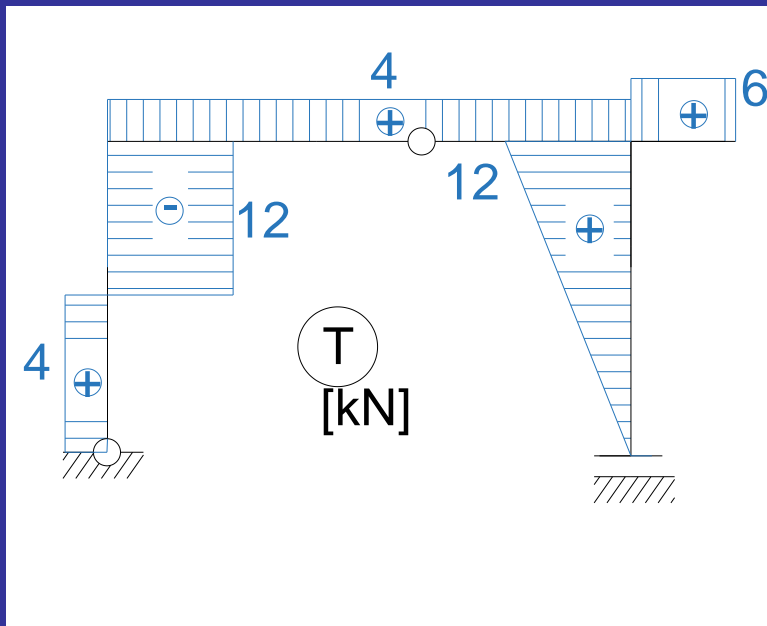
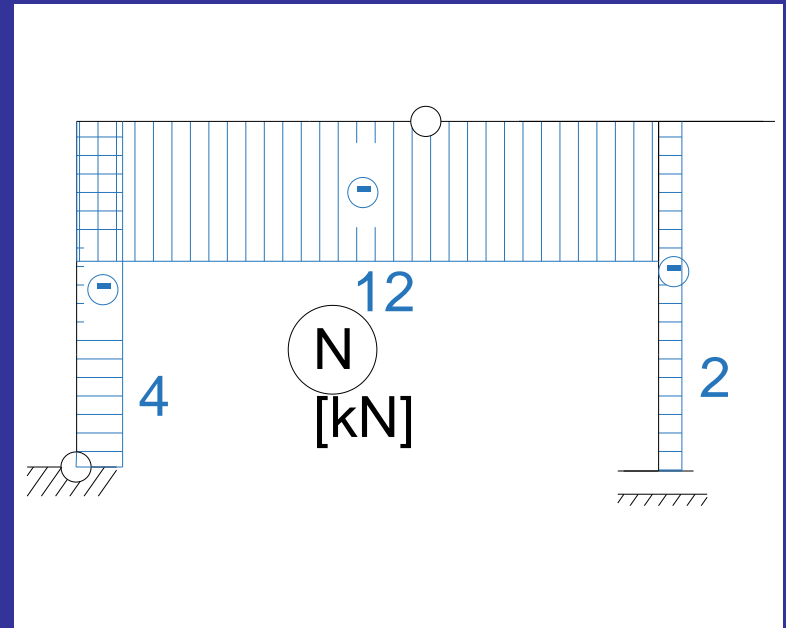
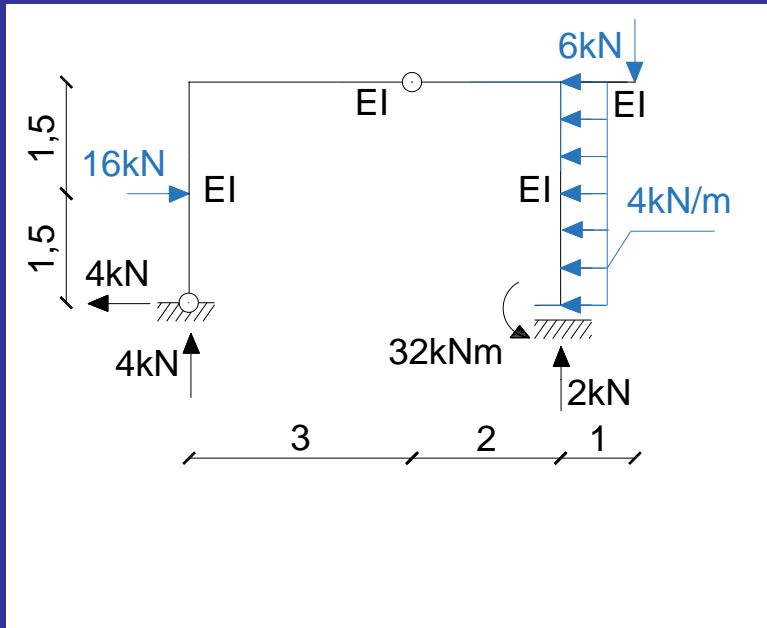


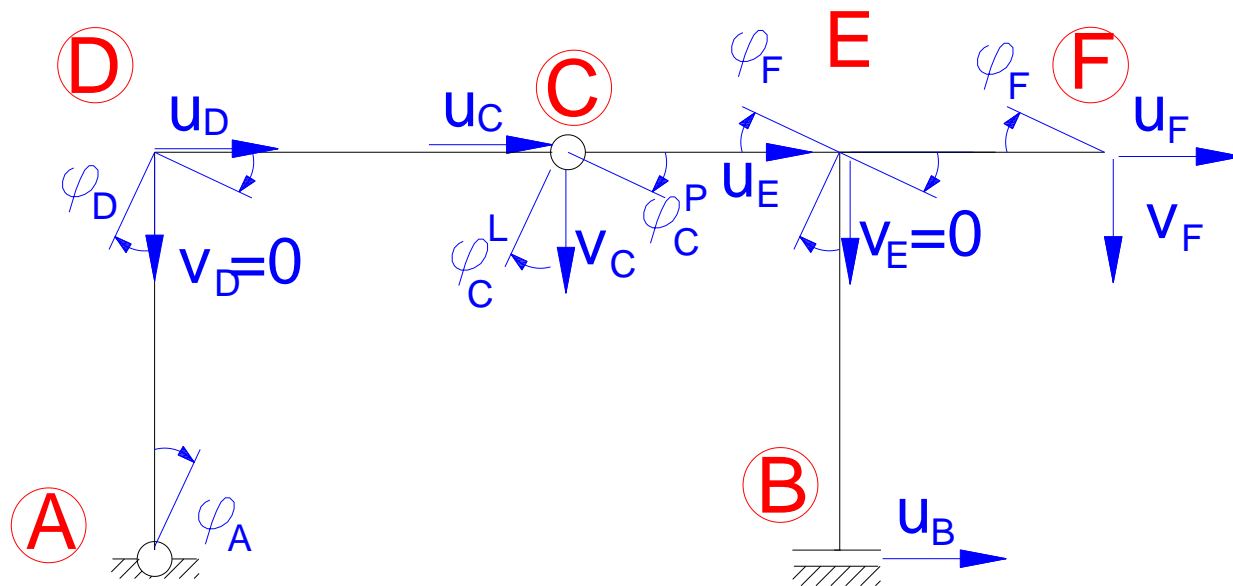
Obliczenia przemieszczeń z zasady prac wirtualnych:



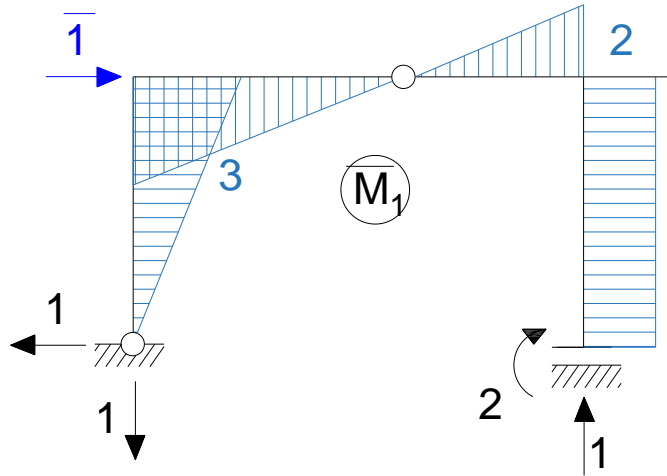
Wykresy sił wewnętrznych:



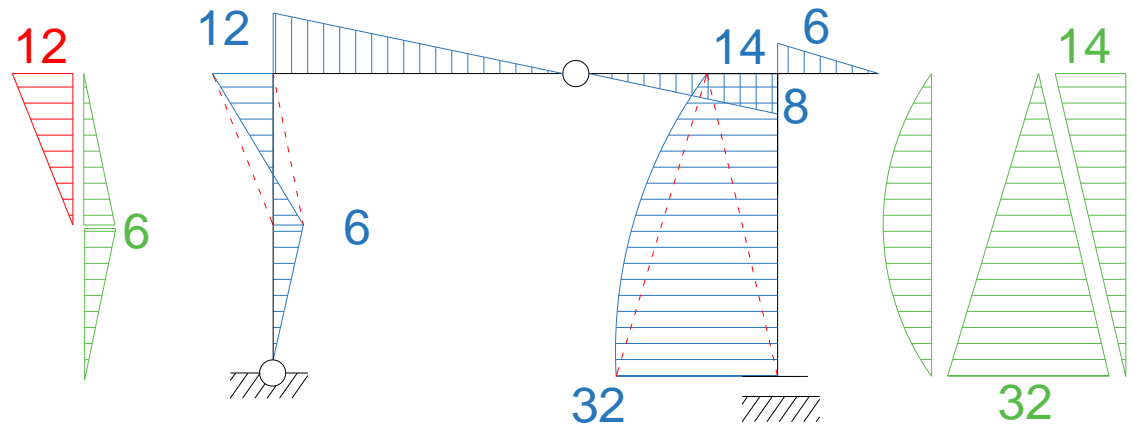
Odształcona postać ramy:



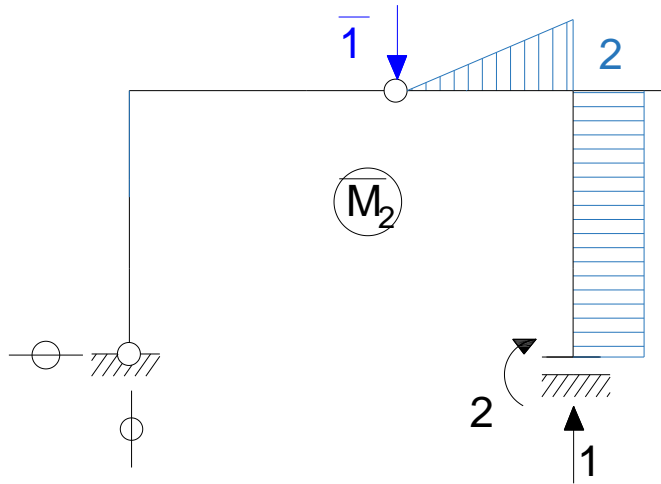
Wyznaczenie przemieszczeń z zasady prac wirtualnych:



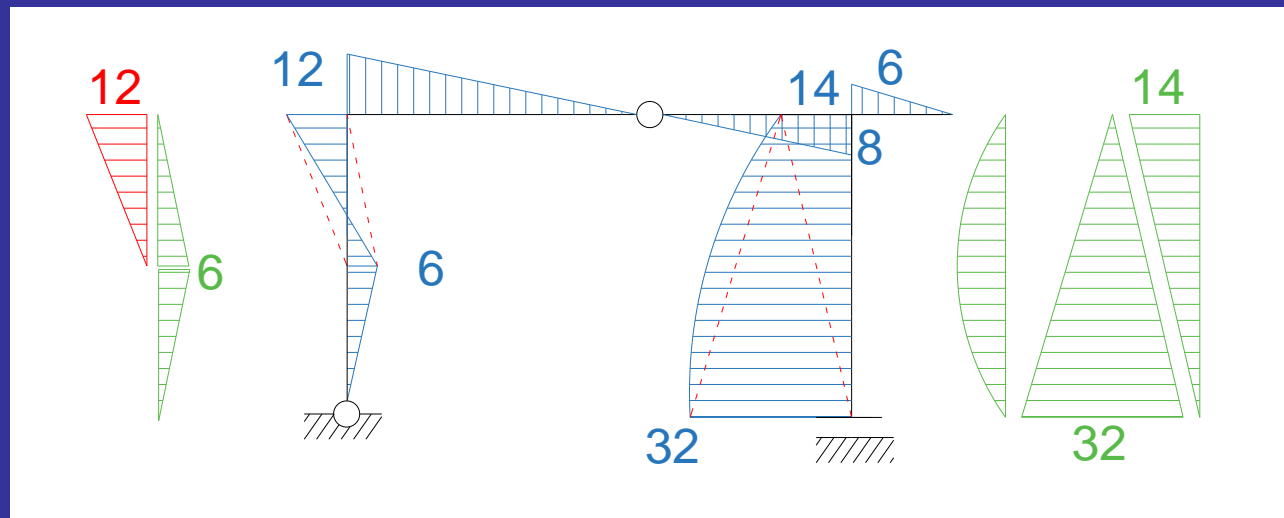
$$u_C = u_D = u_E = u_F = -\frac{635}{3EI}$$



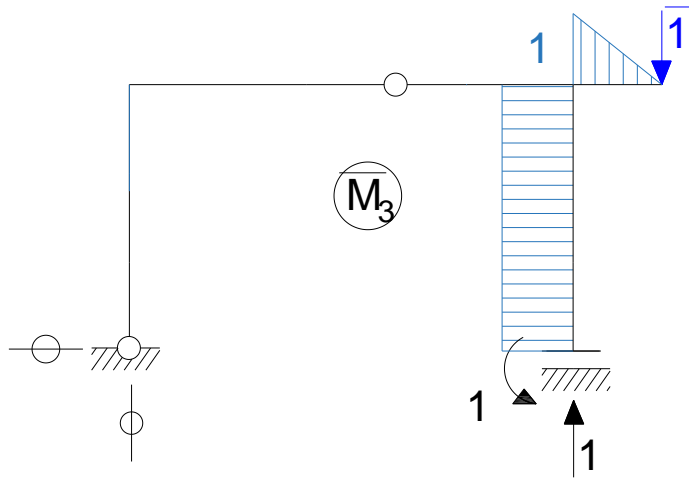
Wyznaczenie przemieszczeń z zasady prac wirtualnych:



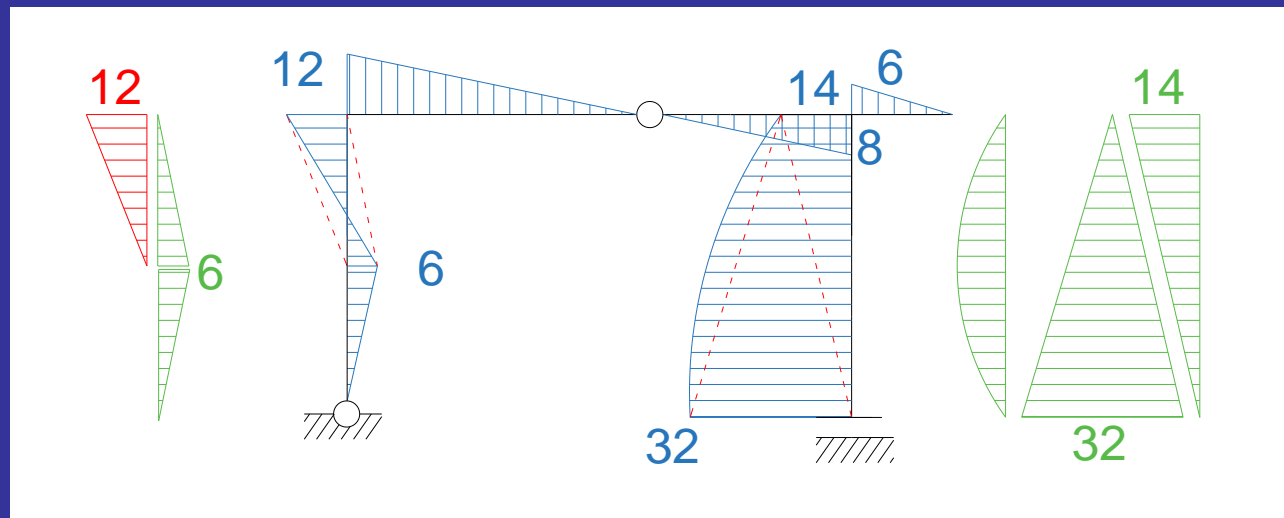
$$v_C = -\frac{500}{3EI}$$



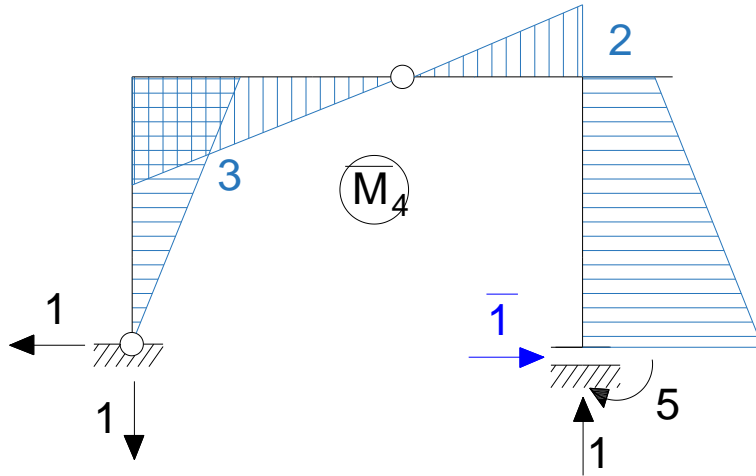
Wyznaczenie przemieszczeń z zasady prac wirtualnych:



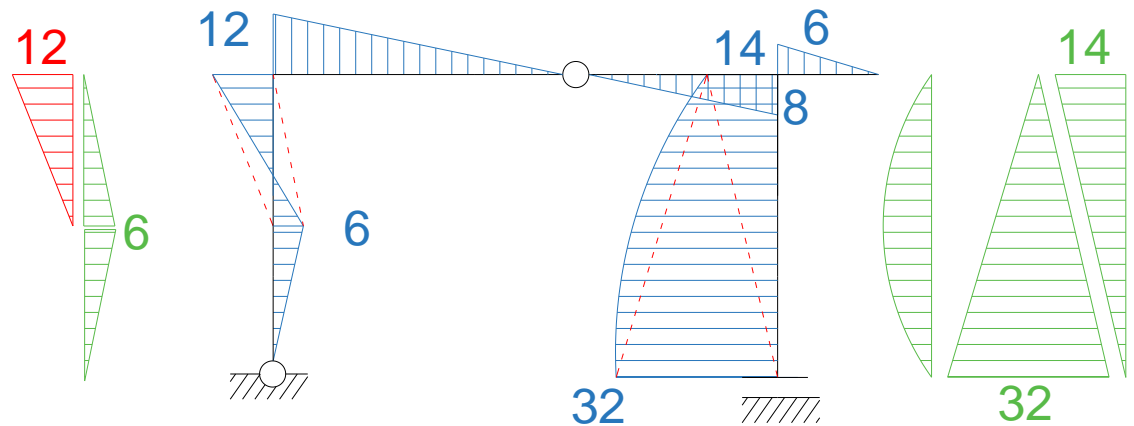
$$v_F = \frac{80}{EI}$$



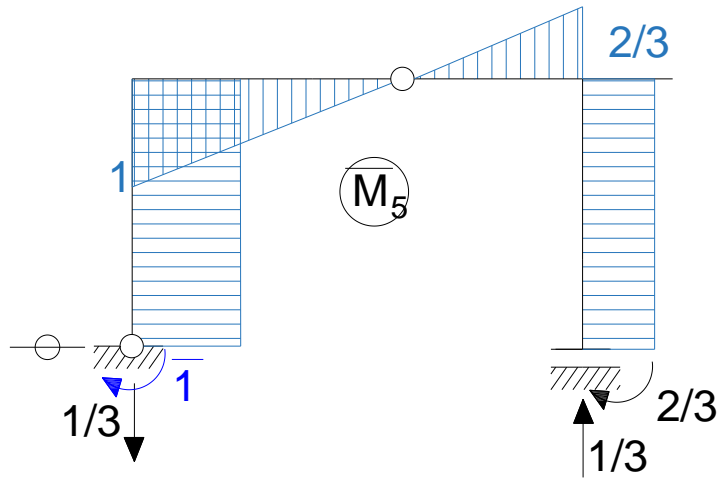
Wyznaczenie przemieszczeń z zasady prac wirtualnych:



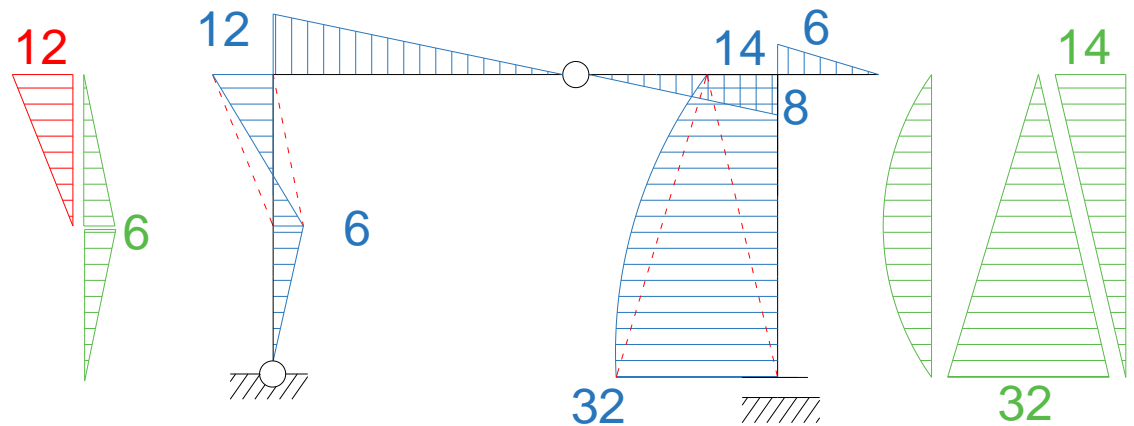
$$u_B = -\frac{2053}{6EI}$$



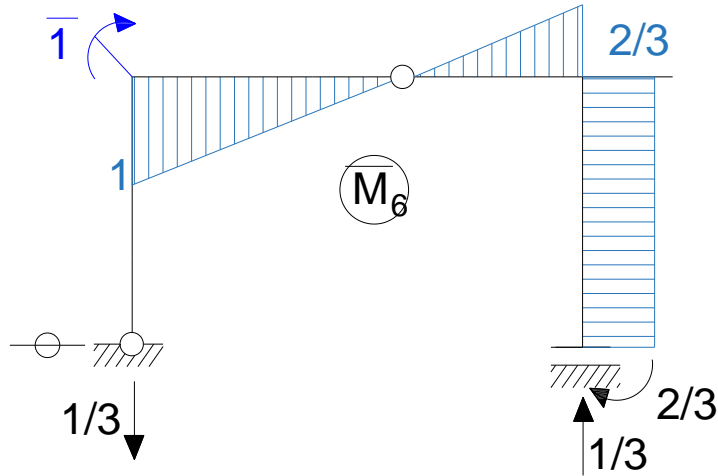
Wyznaczenie przemieszczeń z zasady prac wirtualnych:



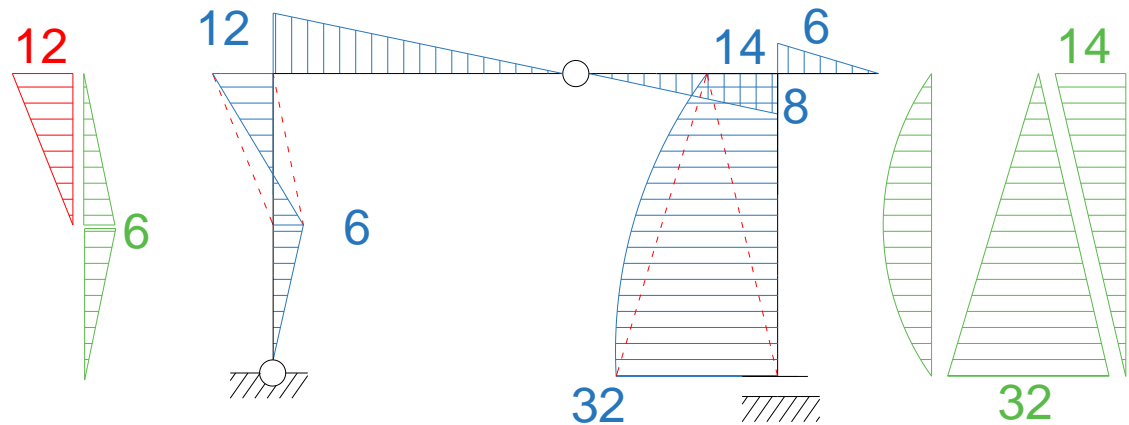
$$\varphi_A = -\frac{608}{9EI}$$



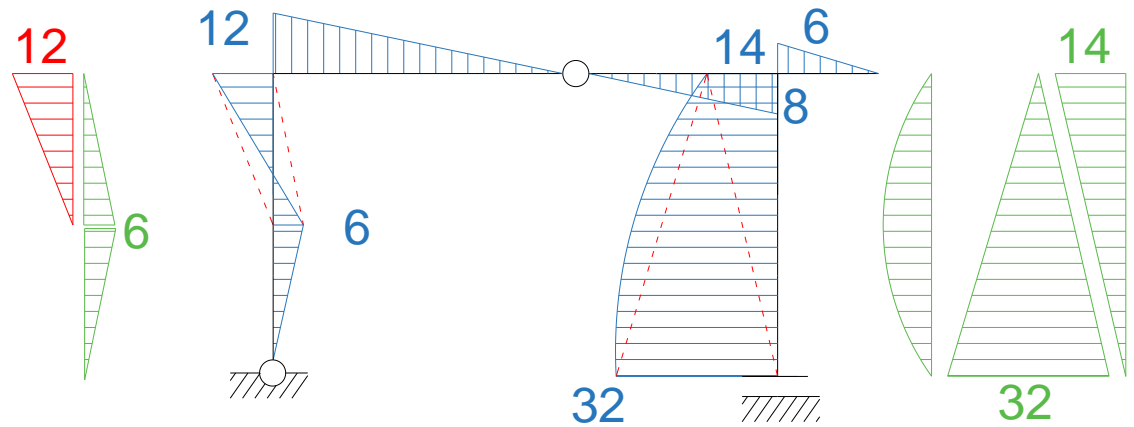
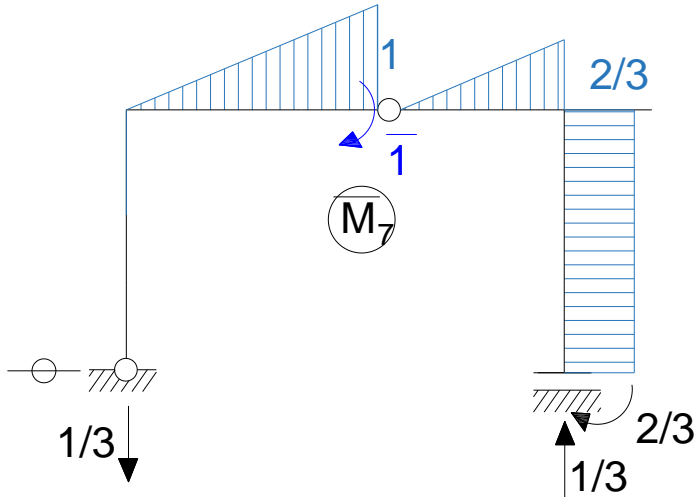
Wyznaczenie przemieszczeń z zasady prac wirtualnych:



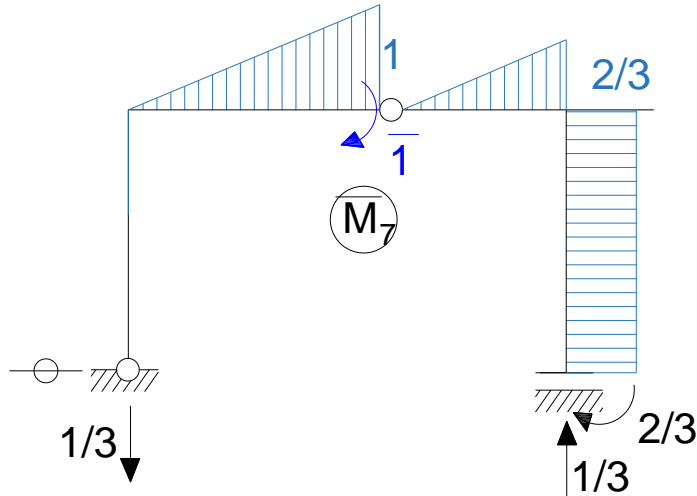
$$\varphi_D = \frac{1}{EI} \left(-\frac{1}{2} \cdot 12 \cdot 3 \cdot \frac{2}{3} \cdot 1 - \frac{1}{2} \cdot 8 \cdot 2 \cdot \frac{2}{3} \cdot \frac{2}{3} - \frac{1}{2} \cdot 14 \cdot 3 \cdot \frac{2}{3} - \frac{1}{2} \cdot 32 \cdot 3 \cdot \frac{2}{3} - \frac{2}{3} \cdot \frac{4 \cdot 3^2}{8} \cdot 3 \cdot \frac{2}{3} \right) = -\frac{608}{9EI}$$



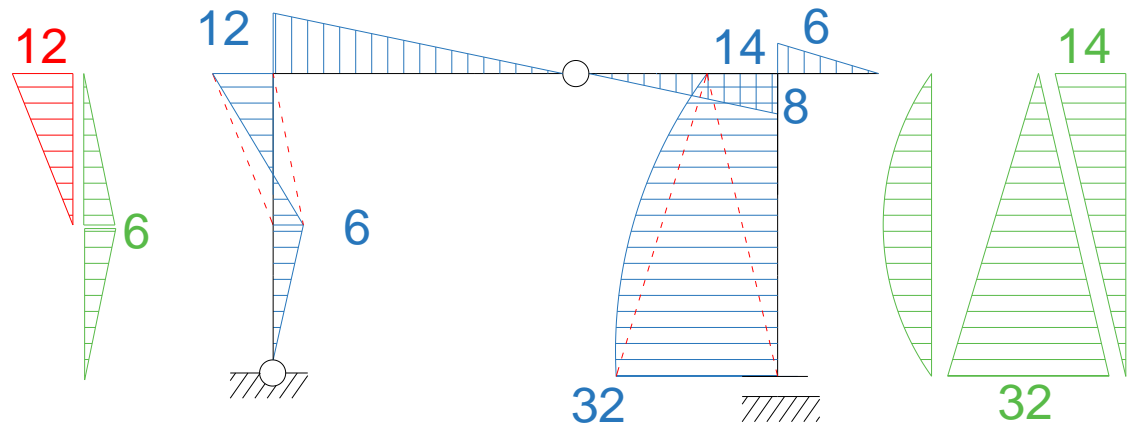
Wyznaczenie przemieszczeń z zasady prac wirtualnych:



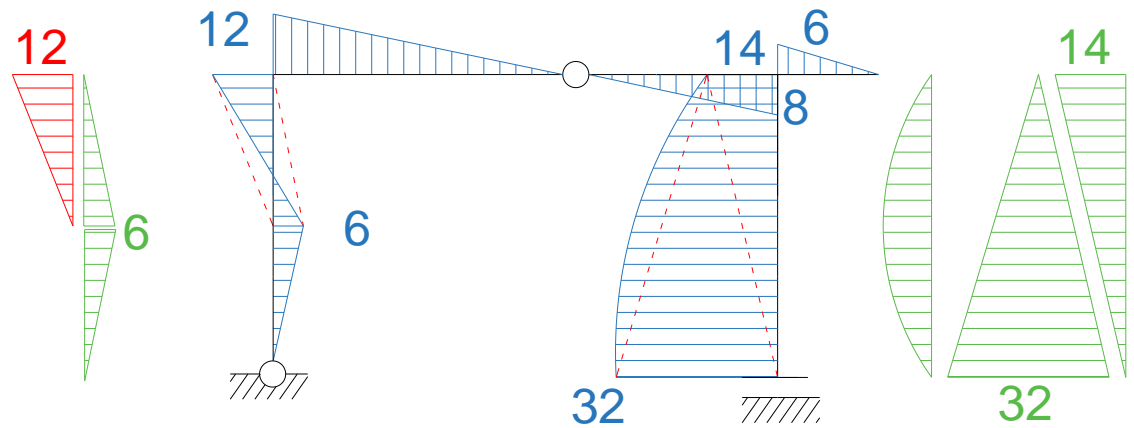
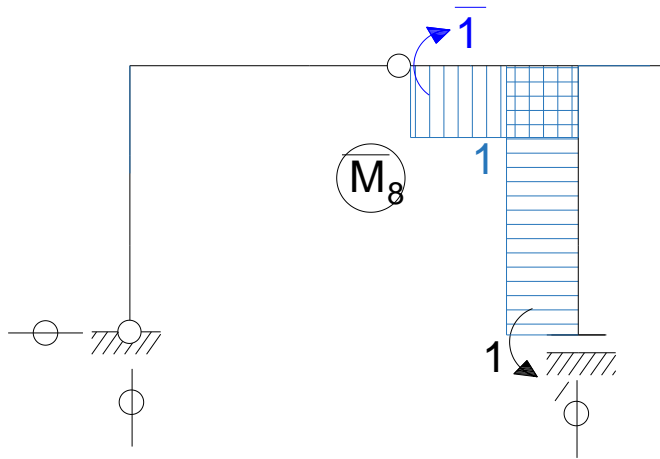
Wyznaczenie przemieszczeń z zasady prac wirtualnych:



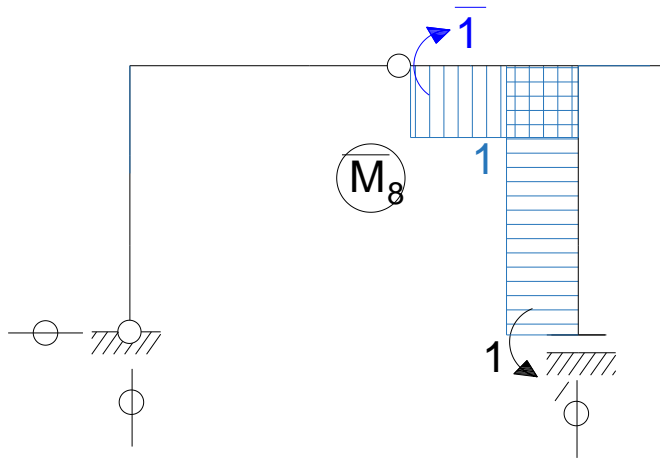
$$\varphi_C^L = \frac{1}{EI} \left(\frac{1}{2} \cdot 12 \cdot 3 \cdot \frac{1}{3} \cdot 1 - \frac{1}{2} \cdot 8 \cdot 2 \cdot \frac{2}{3} \cdot \frac{2}{3} - \frac{1}{2} \cdot 14 \cdot 3 \cdot \frac{2}{3} - \frac{1}{2} \cdot 32 \cdot 3 \cdot \frac{2}{3} - \frac{2}{3} \cdot \frac{4 \cdot 3^2}{8} \cdot 3 \cdot \frac{2}{3} \right) = -\frac{446}{9EI}$$



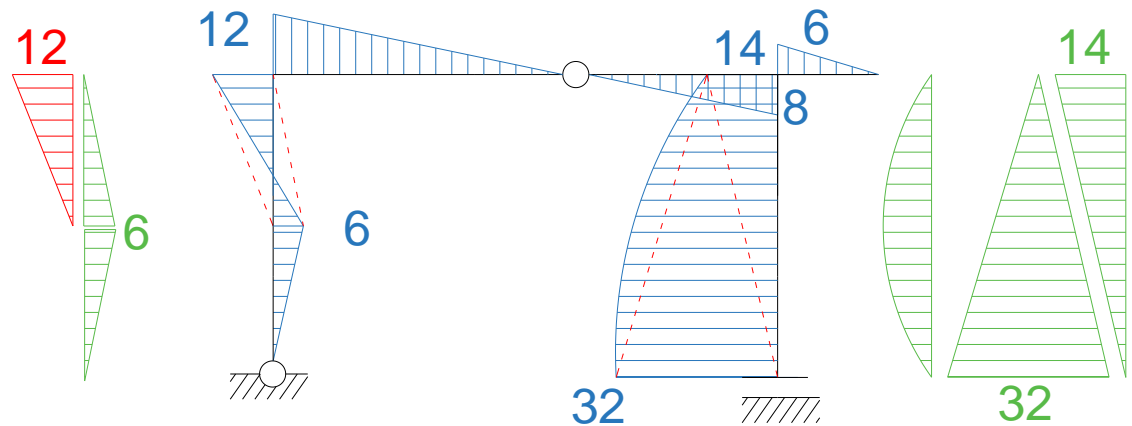
Wyznaczenie przemieszczeń z zasady prac wirtualnych:



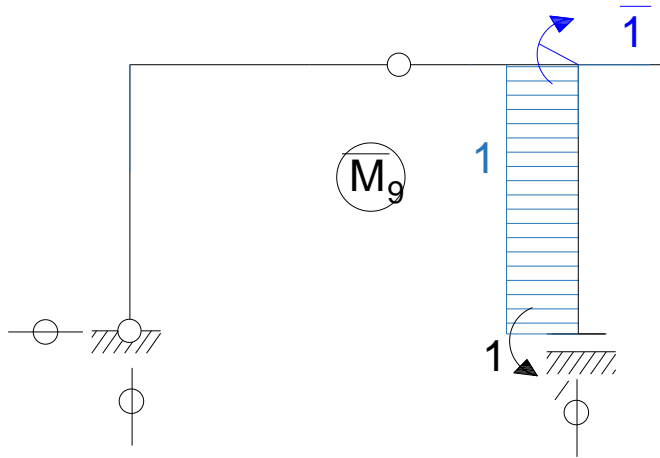
Wyznaczenie przemieszczeń z zasady prac wirtualnych:



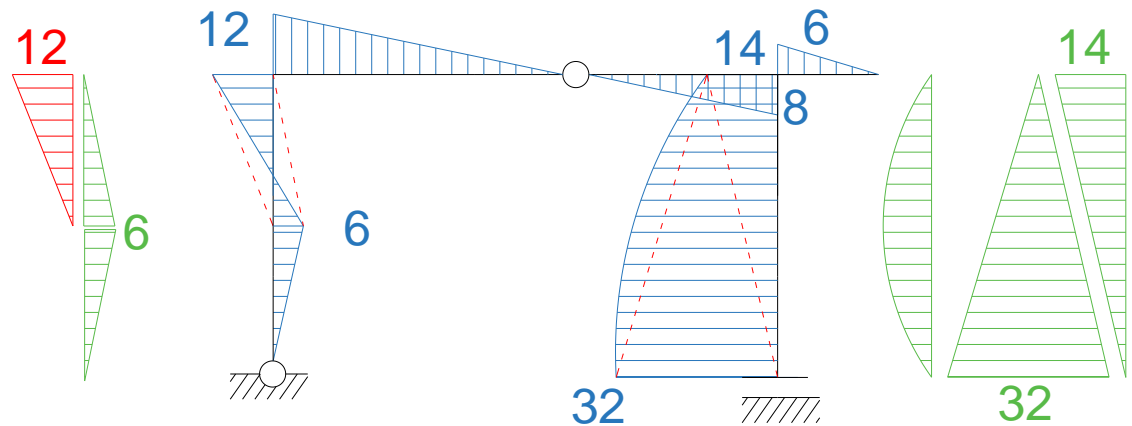
$$\varphi_C^P = \frac{1}{EI} \left(\frac{1}{2} \cdot 8 \cdot 2 \cdot 1 + \frac{1}{2} \cdot 14 \cdot 3 \cdot 1 + \frac{1}{2} \cdot 32 \cdot 3 \cdot 1 + \frac{2}{3} \cdot \frac{4 \cdot 3^2}{8} \cdot 3 \cdot 1 \right) = \frac{86}{EI}$$



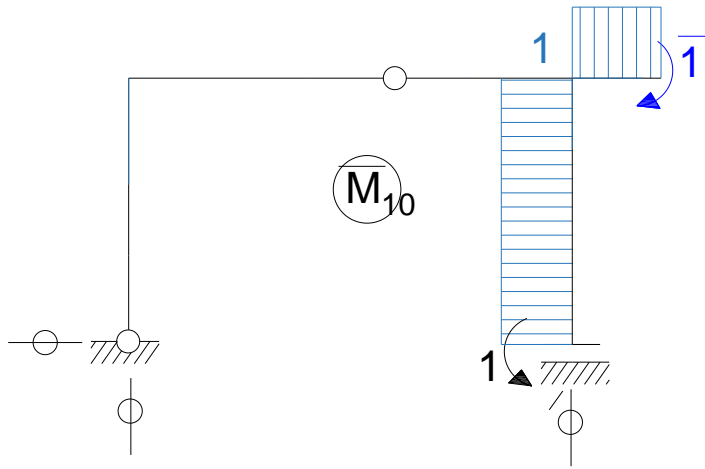
Wyznaczenie przemieszczeń z zasady prac wirtualnych:



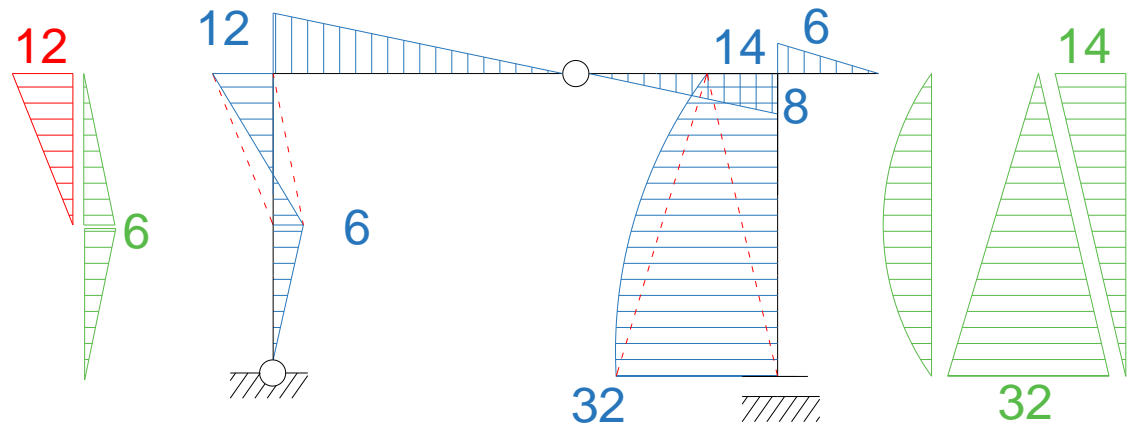
$$\varphi_E = \frac{1}{EI} \left(\frac{1}{2} \cdot 14 \cdot 3 \cdot 1 + \frac{1}{2} \cdot 32 \cdot 3 \cdot 1 + \frac{2}{3} \cdot \frac{4 \cdot 3^2}{8} \cdot 3 \cdot 1 \right) = \frac{78}{EI}$$



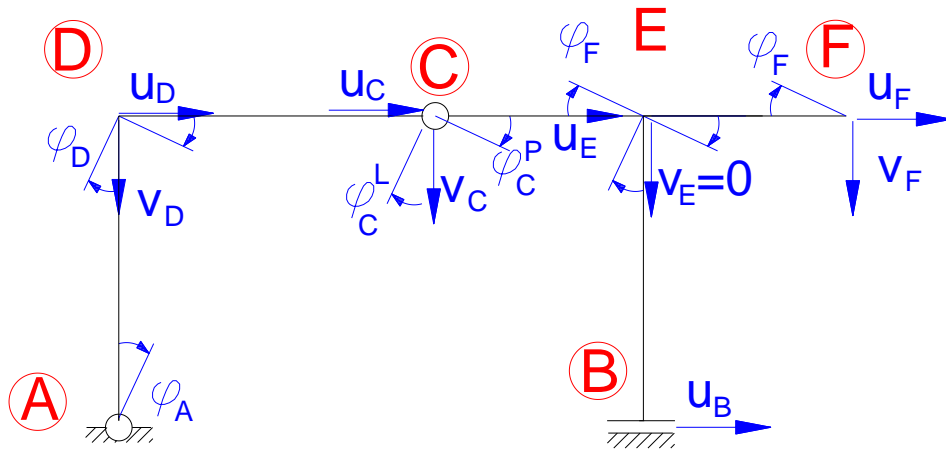
Wyznaczenie przemieszczeń z zasady prac wirtualnych:



$$\varphi_F = \frac{78}{EI} + \frac{1}{EI} \frac{1}{2} \cdot 6 \cdot 1 \cdot 1 = \frac{81}{EI}$$



Odkształcona postać ramy:



$$v_C = -\frac{500}{3EI}$$

$$u_C = u_D = u_E = u_F = -\frac{635}{3EI}$$

$$u_B = -\frac{2053}{6EI}$$

$$v_F = \frac{80}{EI}$$

$$\varphi_A = -\frac{608}{9EI}$$

$$\varphi_D = -\frac{608}{9EI}$$

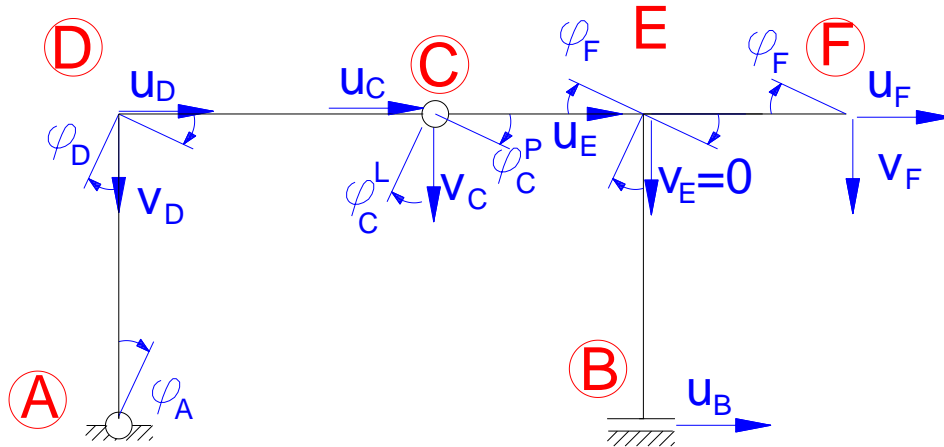
$$\varphi_C^L = -\frac{446}{9EI}$$

$$\varphi_C^P = \frac{86}{EI}$$

$$\varphi_E = \frac{78}{EI}$$

$$\varphi_F = \frac{81}{EI}$$

Odształcona postać ramy:



$$v_C = -\frac{500}{3EI} = -\frac{3000}{18EI}$$

$$u_C = u_D = u_E = u_F = -\frac{635}{3EI} = -\frac{3810}{18EI}$$

$$u_B = -\frac{2053}{6EI} = -\frac{6159}{18EI}$$

$$v_F = \frac{80}{EI} = \frac{1440}{18EI}$$

$$\varphi_A = -\frac{608}{9EI} = -\frac{1216}{18EI}$$

$$\varphi_D = -\frac{608}{9EI} = -\frac{1216}{18EI}$$

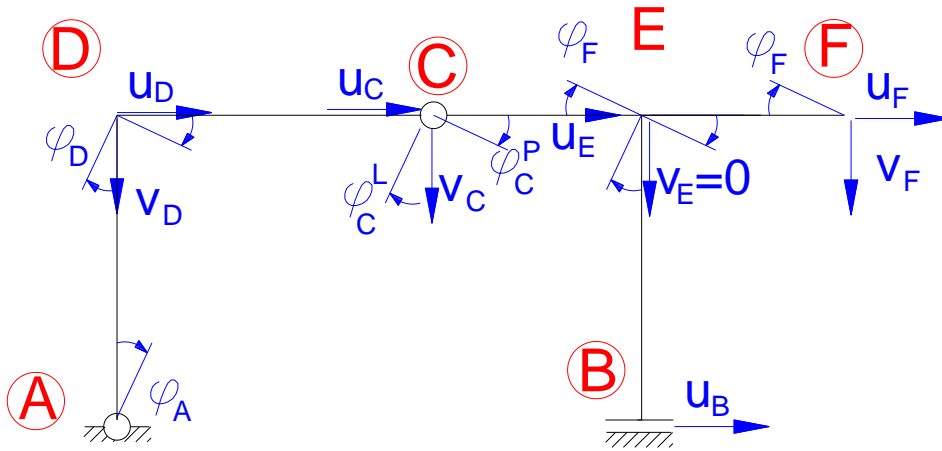
$$\varphi_C^L = -\frac{446}{9EI} = -\frac{892}{18EI}$$

$$\varphi_C^P = \frac{86}{EI} = \frac{1548}{18EI}$$

$$\varphi_E = \frac{78}{EI} = \frac{1404}{18EI}$$

$$\varphi_F = \frac{81}{EI} = \frac{1458}{18EI}$$

Odształcona postać ramy:



$$v_C = -3000a$$

$$u_C = u_D = u_E = u_F = -3810a$$

$$u_B = -6159a$$

$$v_F = 1440a$$

$$\varphi_A = -1216a$$

$$\varphi_D = -1216a$$

$$\varphi_C^L = -892a$$

$$\varphi_C^P = 1548a$$

$$\varphi_E = 1404a$$

$$\varphi_F = 1458a$$

Założenie $1/18EI=a \rightarrow$

$$v_C = -3000a$$

$$u_C = -3810a$$

$$u_B = -6159a$$

$$v_F = 1440a$$

$$\varphi_A = -1216a$$

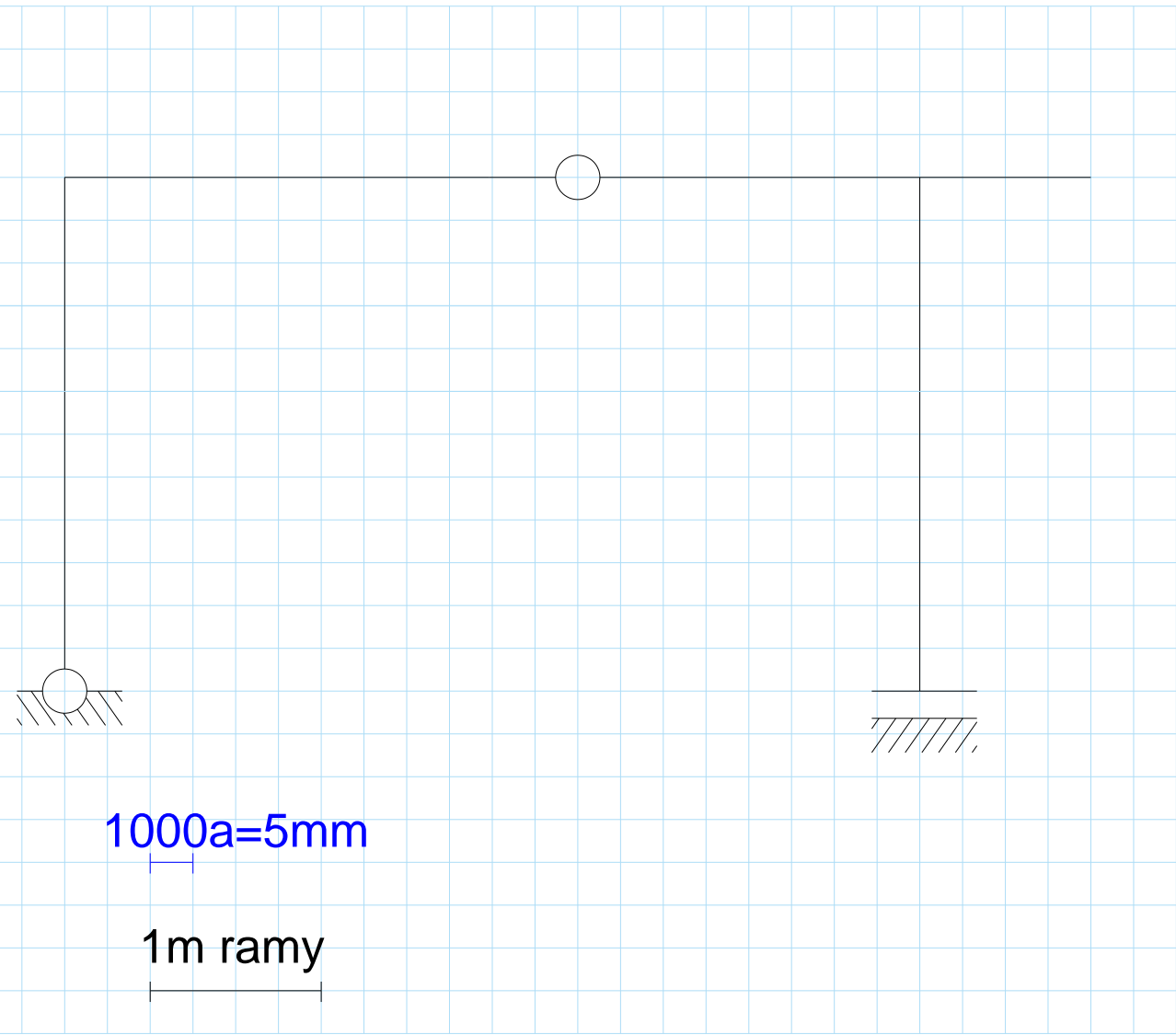
$$\varphi_D = -1216a$$

$$\varphi_C^L = -892a$$

$$\varphi_C^P = 1548a$$

$$\varphi_E = 1404a$$

$$\varphi_F = 1458a$$



1000a=5mm

1m ramy

$$v_C = -3000a$$

$$u_C = -3810a$$

$$u_B = -6159a$$

$$v_F = 1440a$$

$$\varphi_A = -1216a$$

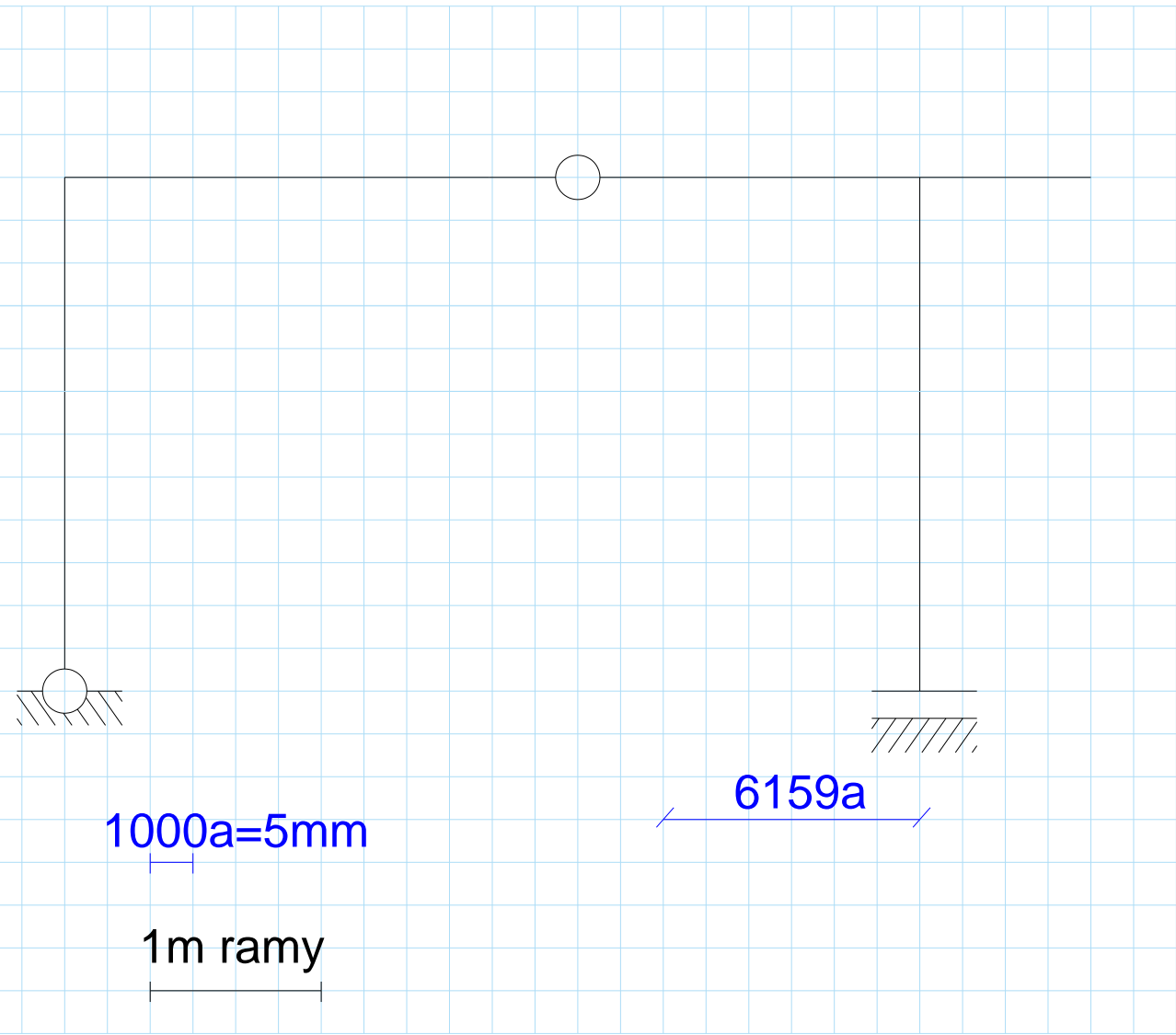
$$\varphi_D = -1216a$$

$$\varphi_C^L = -892a$$

$$\varphi_C^P = 1548a$$

$$\varphi_E = 1404a$$

$$\varphi_F = 1458a$$



$$v_C = -3000a$$

$$u_C = -3810a$$

$$u_B = -6159a$$

$$v_F = 1440a$$

$$\varphi_A = -1216a$$

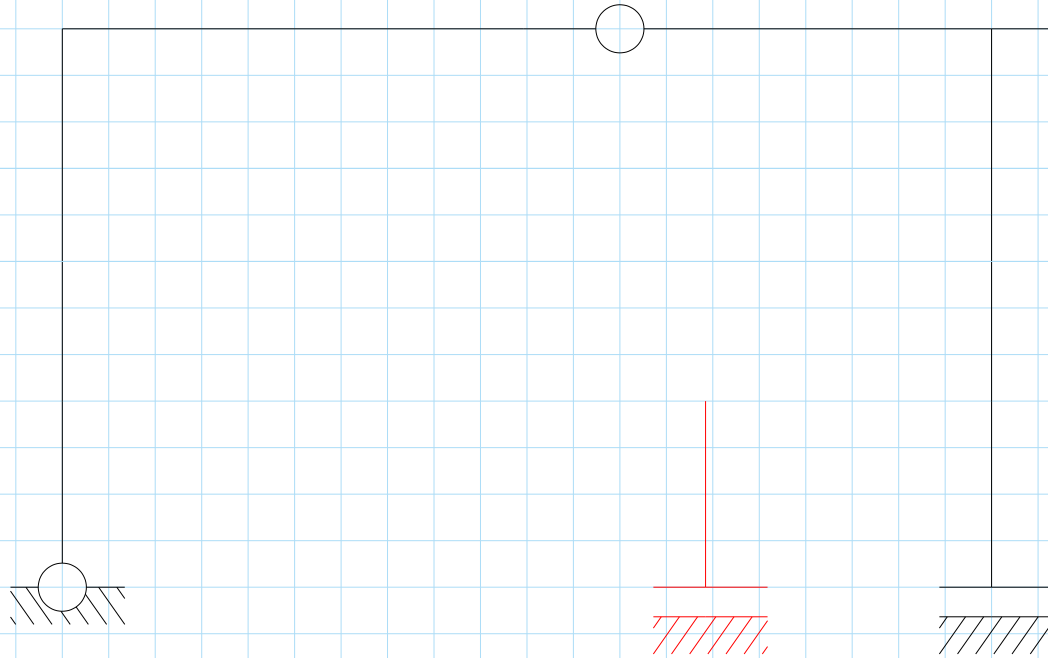
$$\varphi_D = -1216a$$

$$\varphi_C^L = -892a$$

$$\varphi_C^P = 1548a$$

$$\varphi_E = 1404a$$

$$\varphi_F = 1458a$$



$$1000a = 5\text{mm}$$

1m ramy

$$6159a$$

$$3810a$$

$$v_C = -3000a$$

$$u_C = -3810a$$

$$u_B = -6159a$$

$$v_F = 1440a$$

$$\varphi_A = -1216a$$

$$\varphi_D = -1216a$$

$$\varphi_C^L = -892a$$

$$\varphi_C^P = 1548a$$

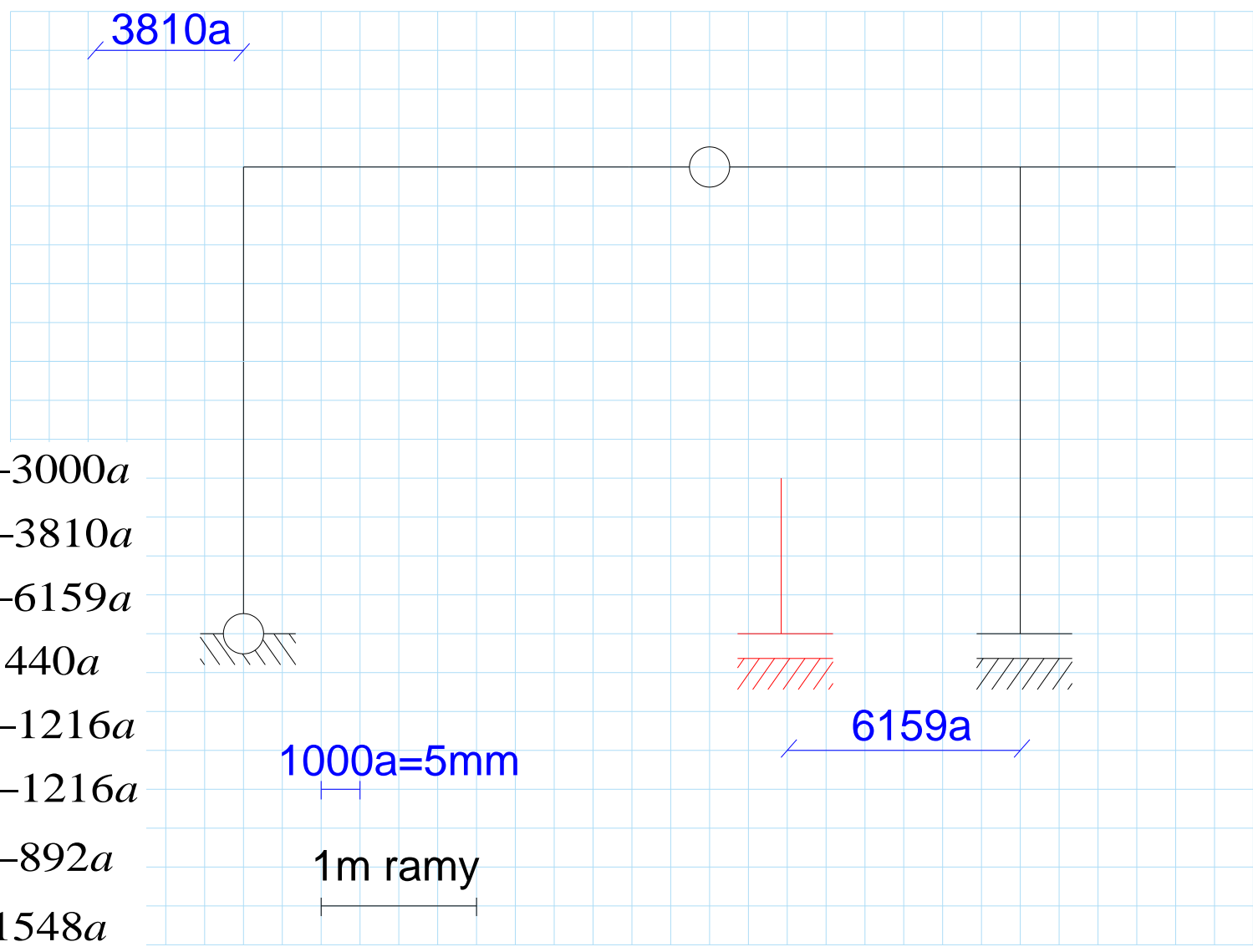
$$\varphi_E = 1404a$$

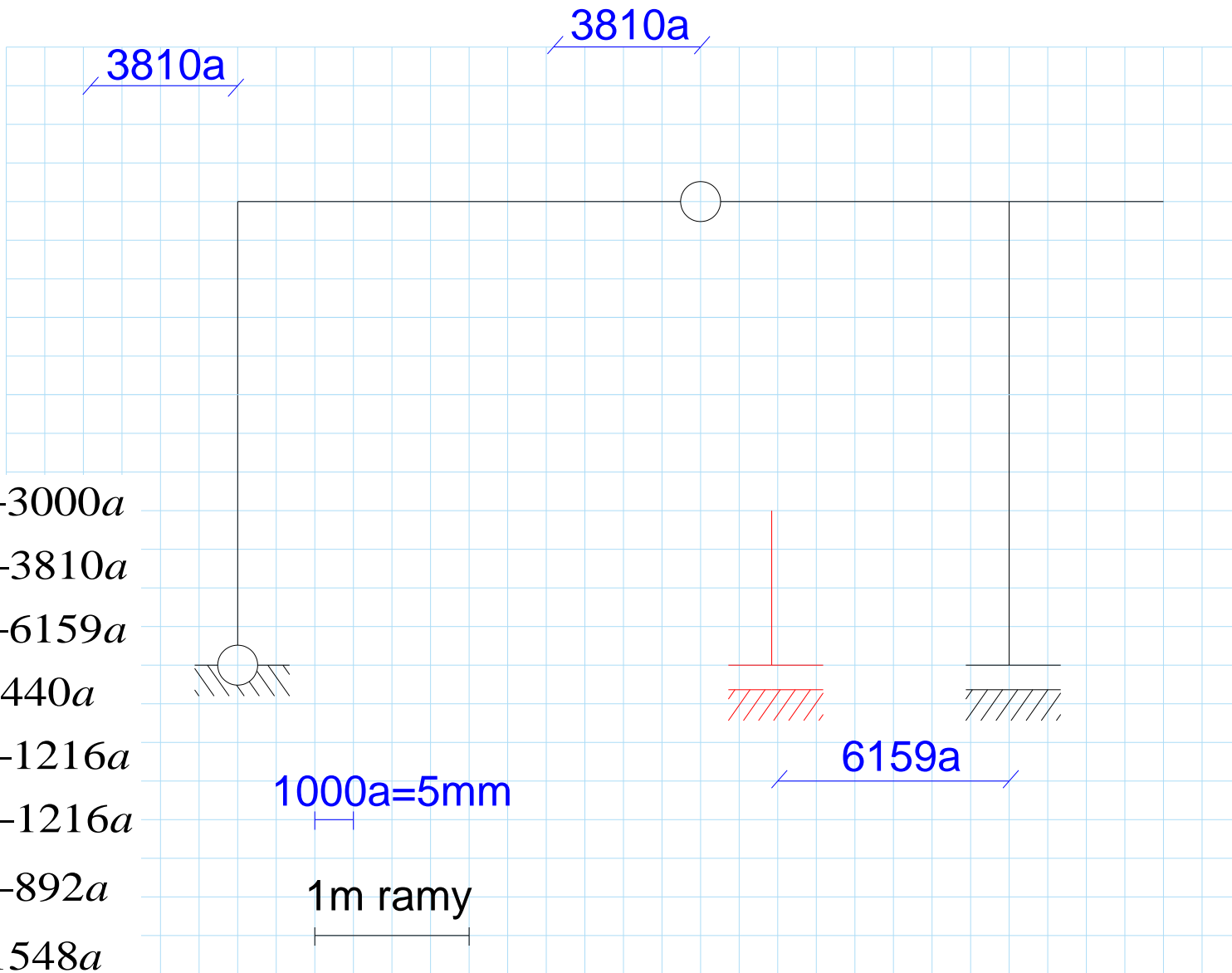
$$\varphi_F = 1458a$$

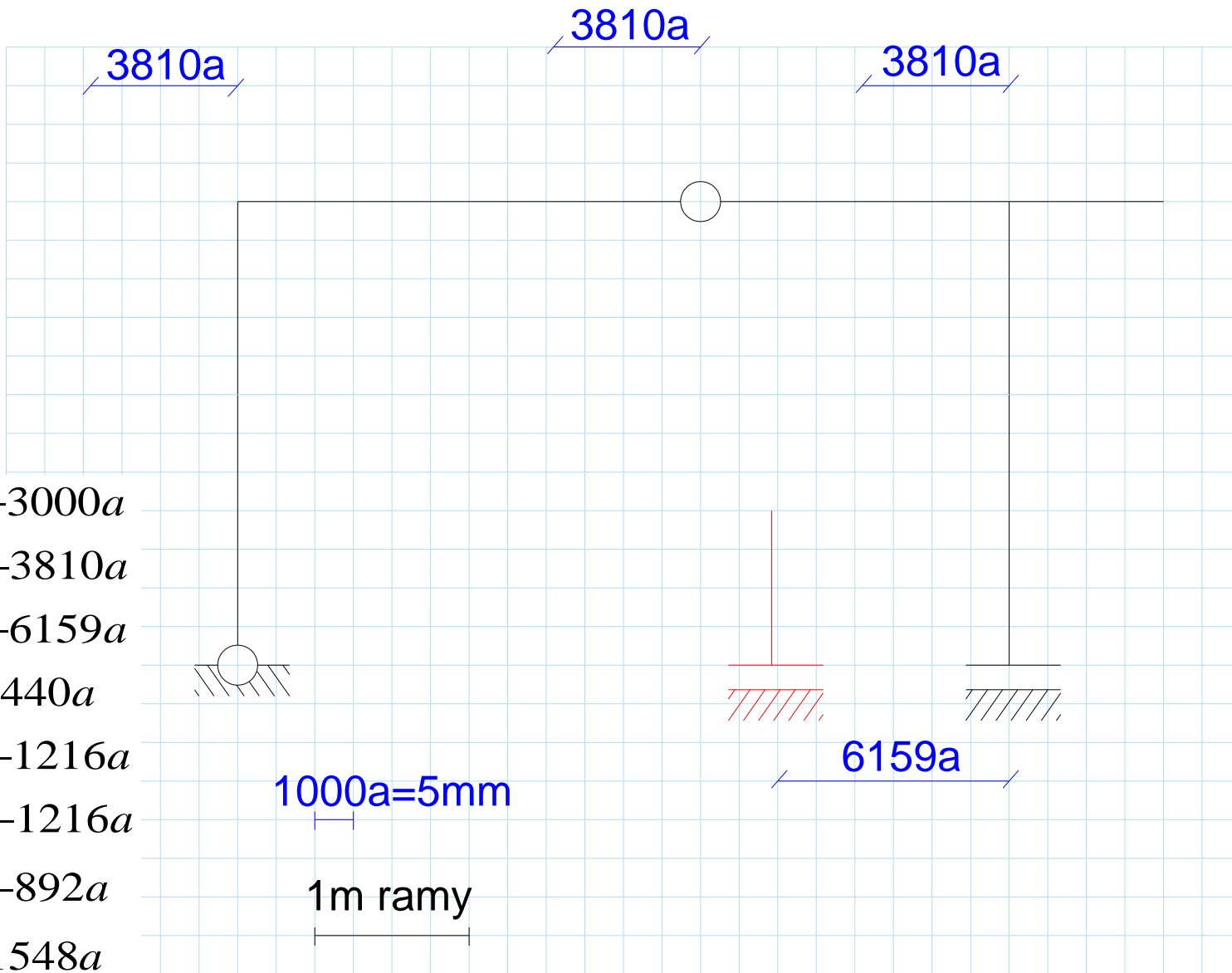
$$1000a = 5\text{mm}$$

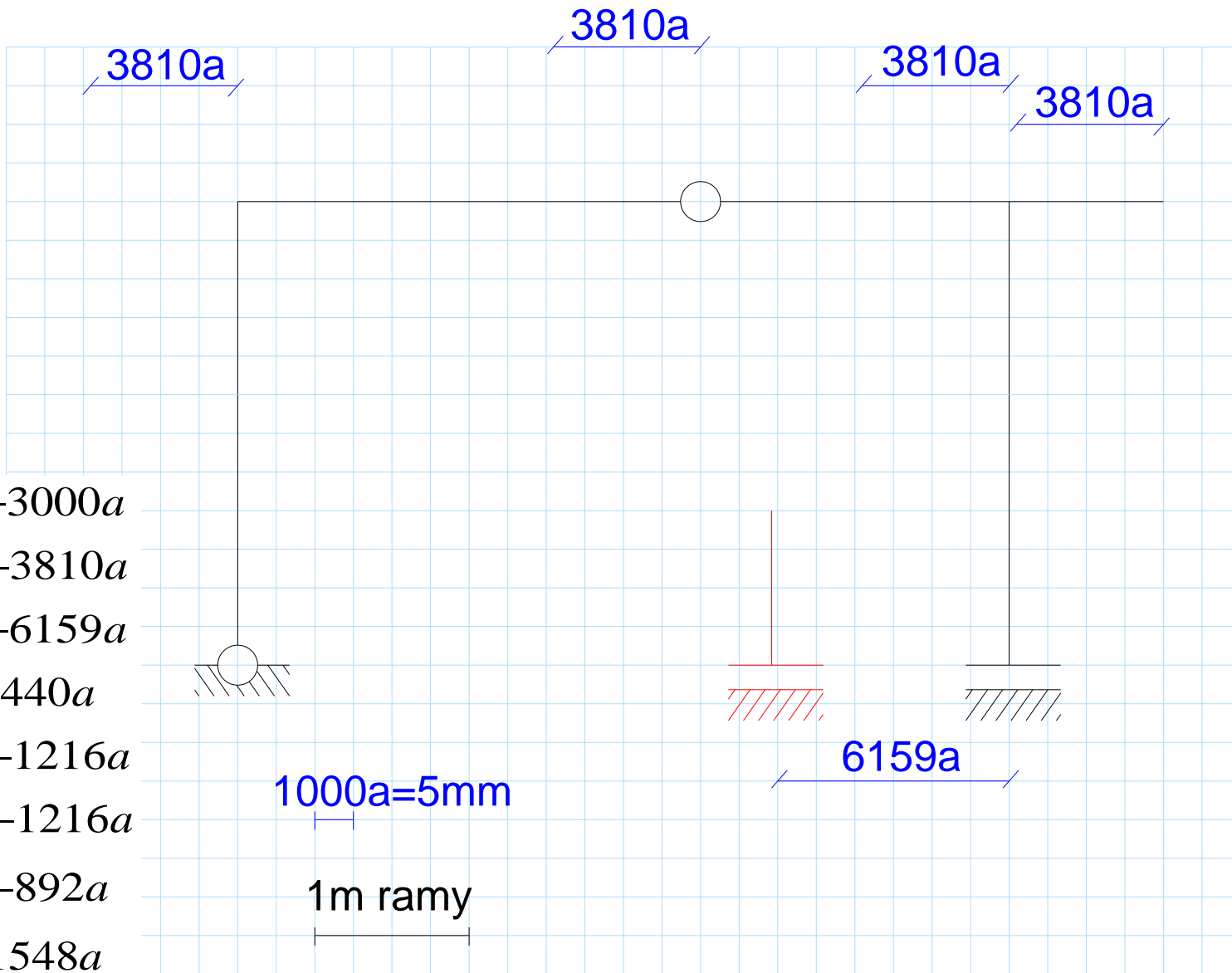
1m ramy

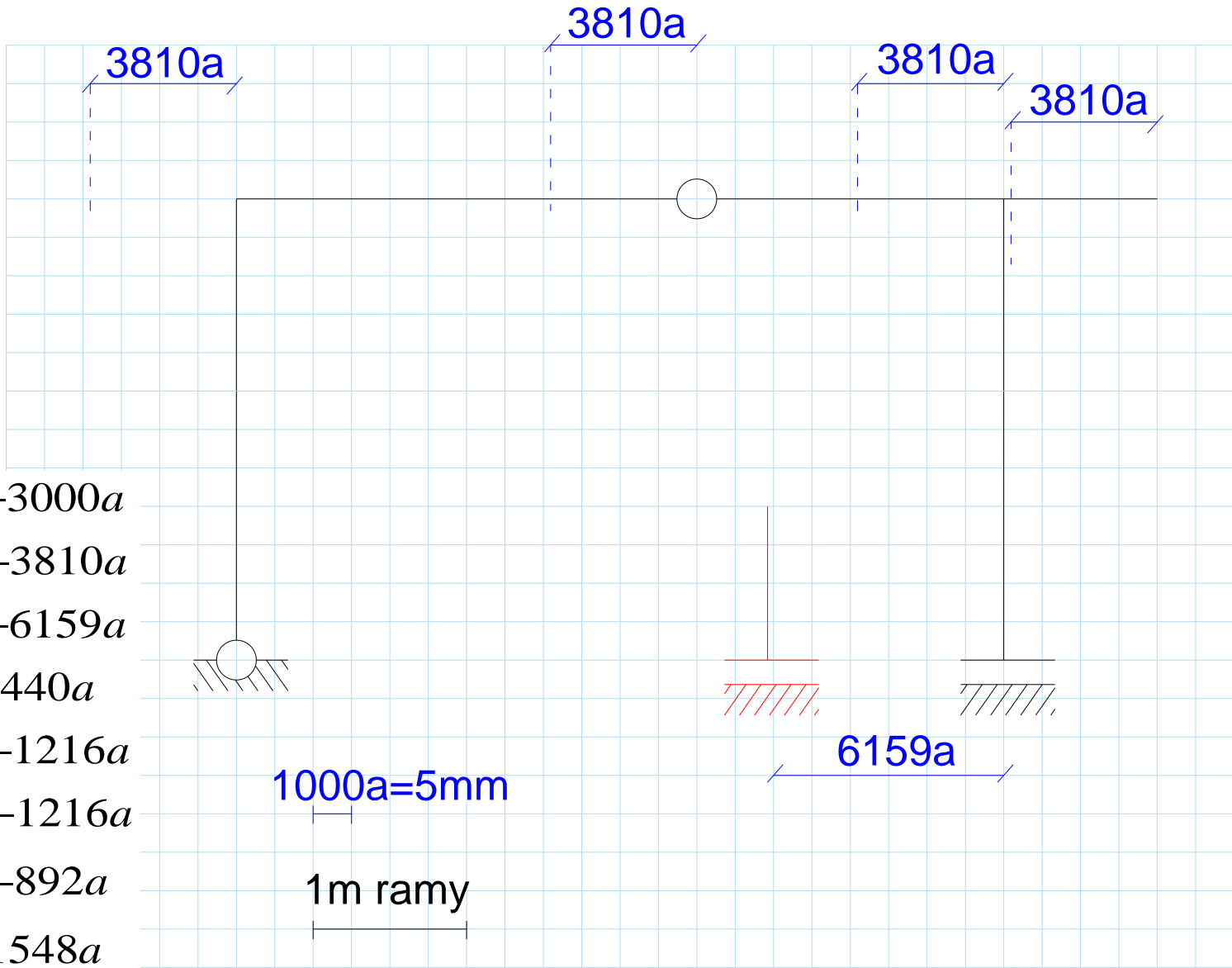
$$6159a$$











$$v_C = -3000a$$

$$u_C = -3810a$$

$$u_B = -6159a$$

$$v_F = 1440a$$

$$\varphi_A = -1216a$$

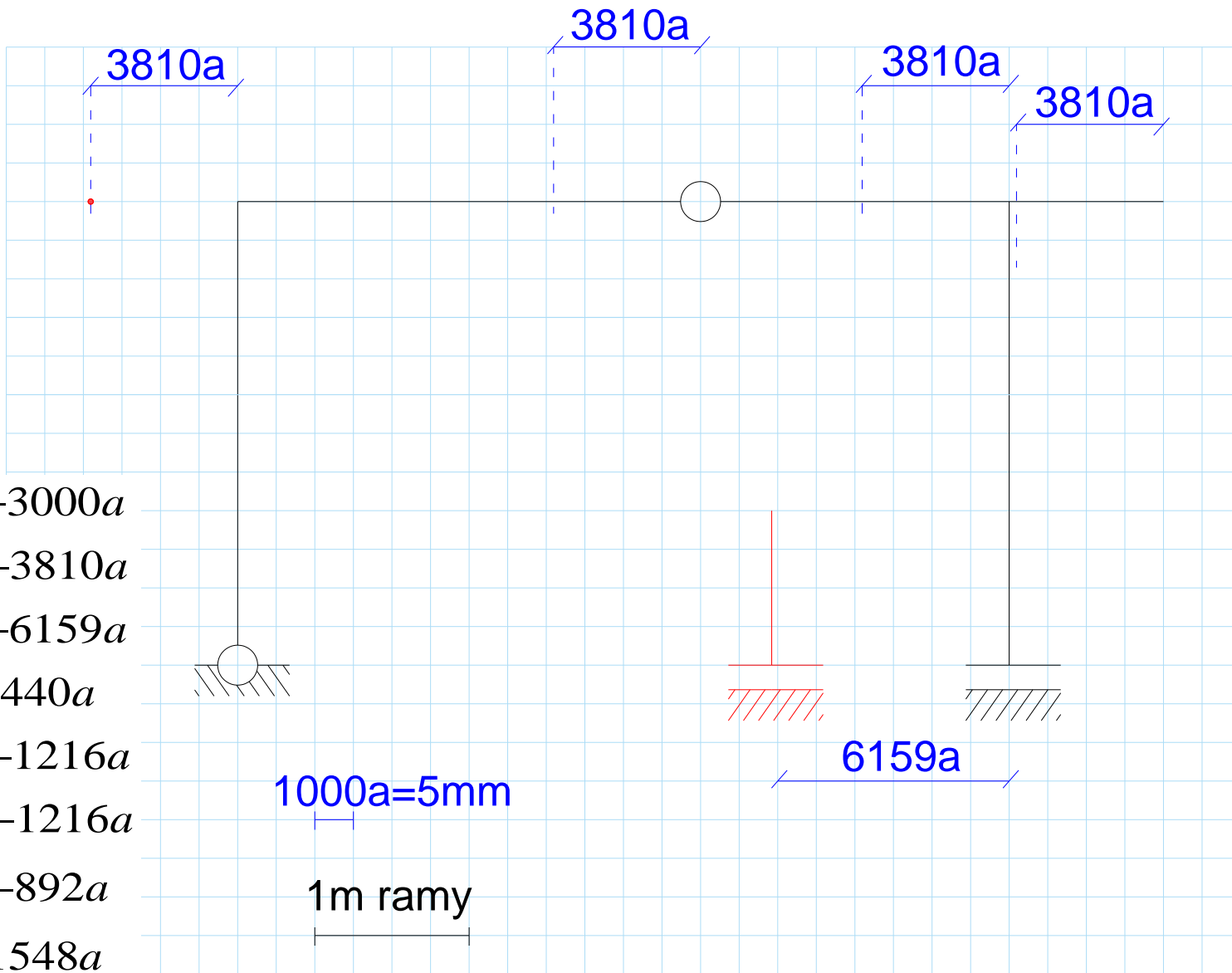
$$\varphi_D = -1216a$$

$$\varphi_C^L = -892a$$

$$\varphi_C^P = 1548a$$

$$\varphi_E = 1404a$$

$$\varphi_F = 1458a$$



$$v_C = -3000a$$

$$u_C = -3810a$$

$$u_B = -6159a$$

$$v_F = 1440a$$

$$\varphi_A = -1216a$$

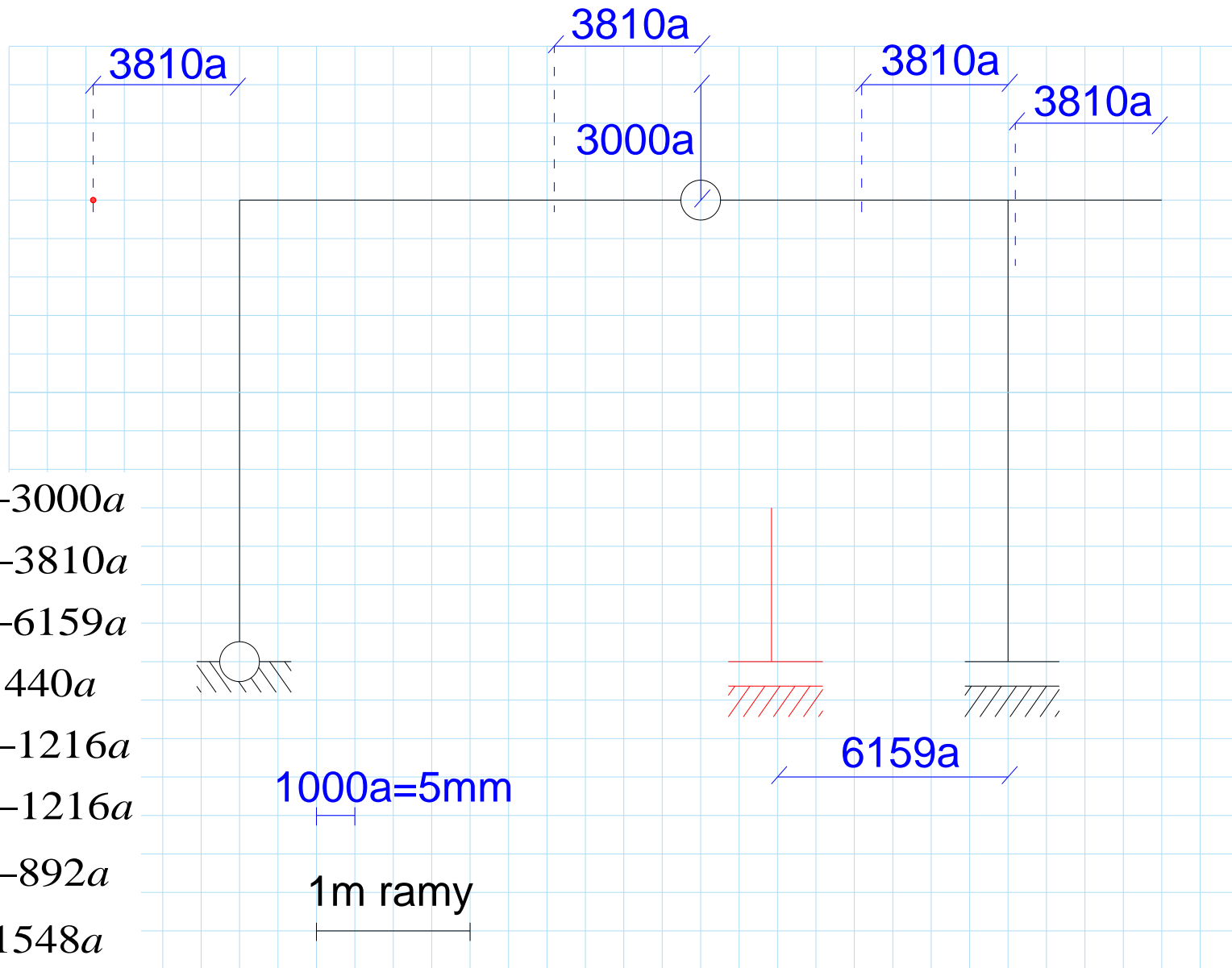
$$\varphi_D = -1216a$$

$$\varphi_C^L = -892a$$

$$\varphi_C^P = 1548a$$

$$\varphi_E = 1404a$$

$$\varphi_F = 1458a$$



$$v_C = -3000a$$

$$u_C = -3810a$$

$$u_B = -6159a$$

$$v_F = 1440a$$

$$\varphi_A = -1216a$$

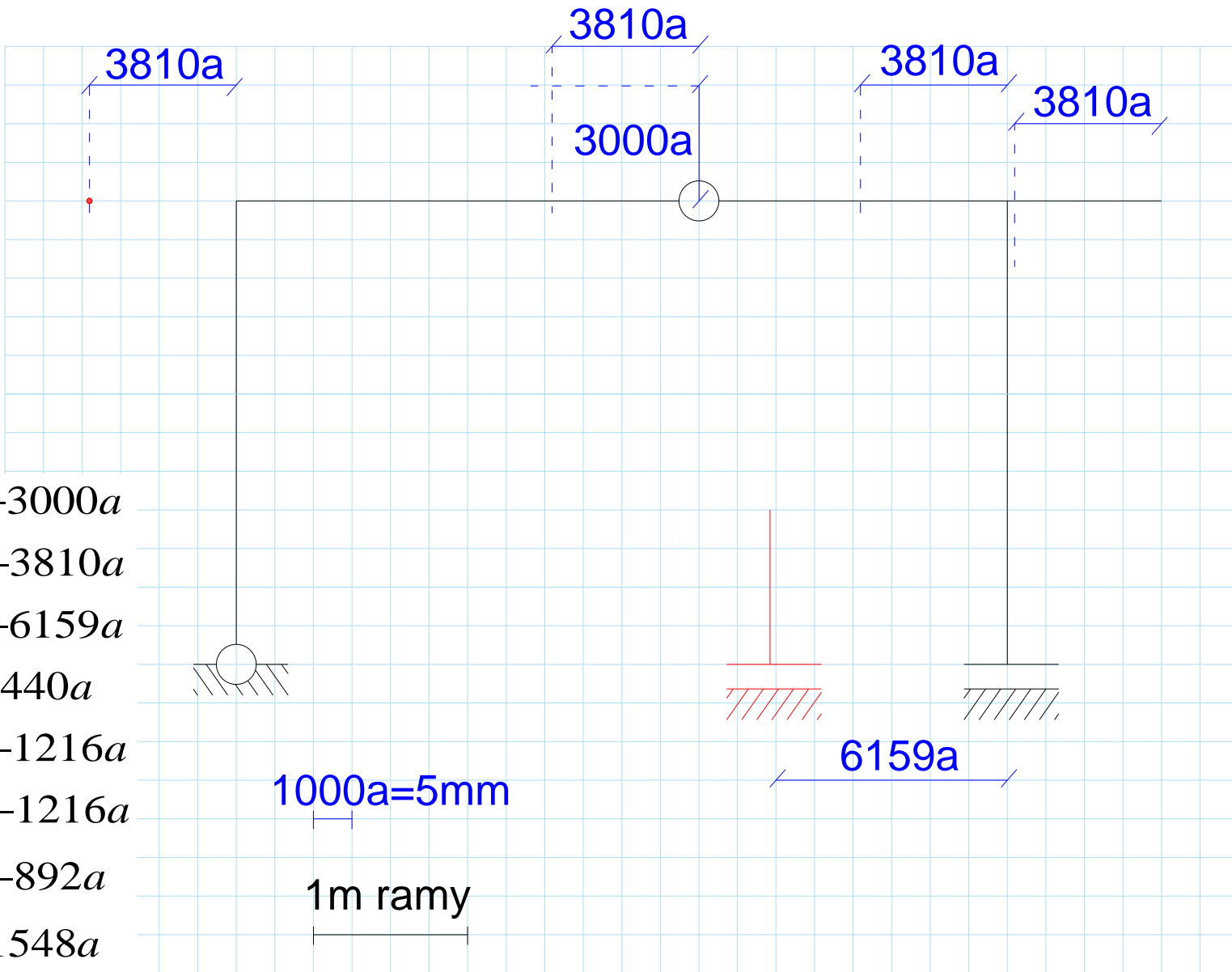
$$\varphi_D = -1216a$$

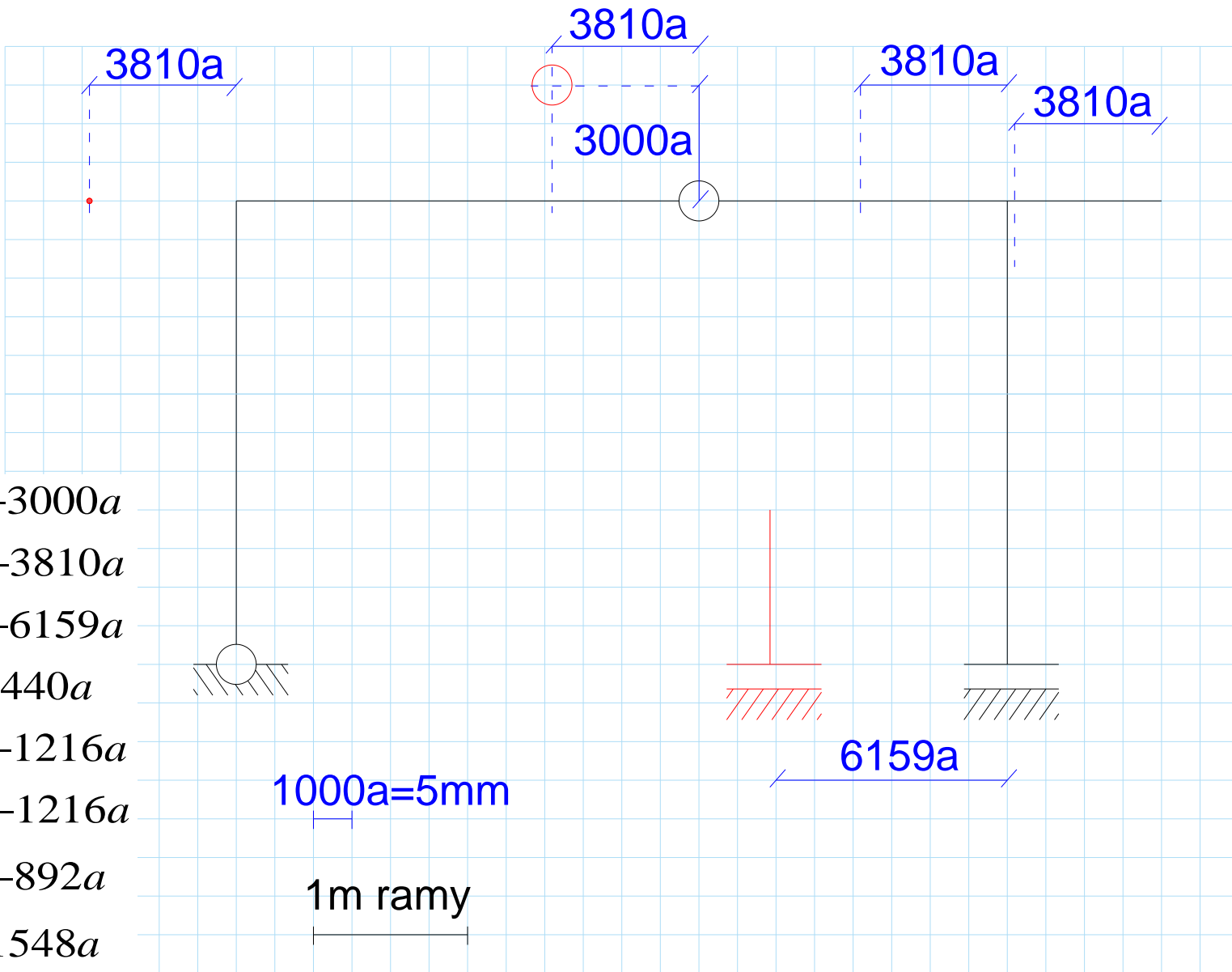
$$\varphi_C^L = -892a$$

$$\varphi_C^P = 1548a$$

$$\varphi_E = 1404a$$

$$\varphi_F = 1458a$$





$$v_C = -3000a$$

$$u_C = -3810a$$

$$u_B = -6159a$$

$$v_F = 1440a$$

$$\varphi_A = -1216a$$

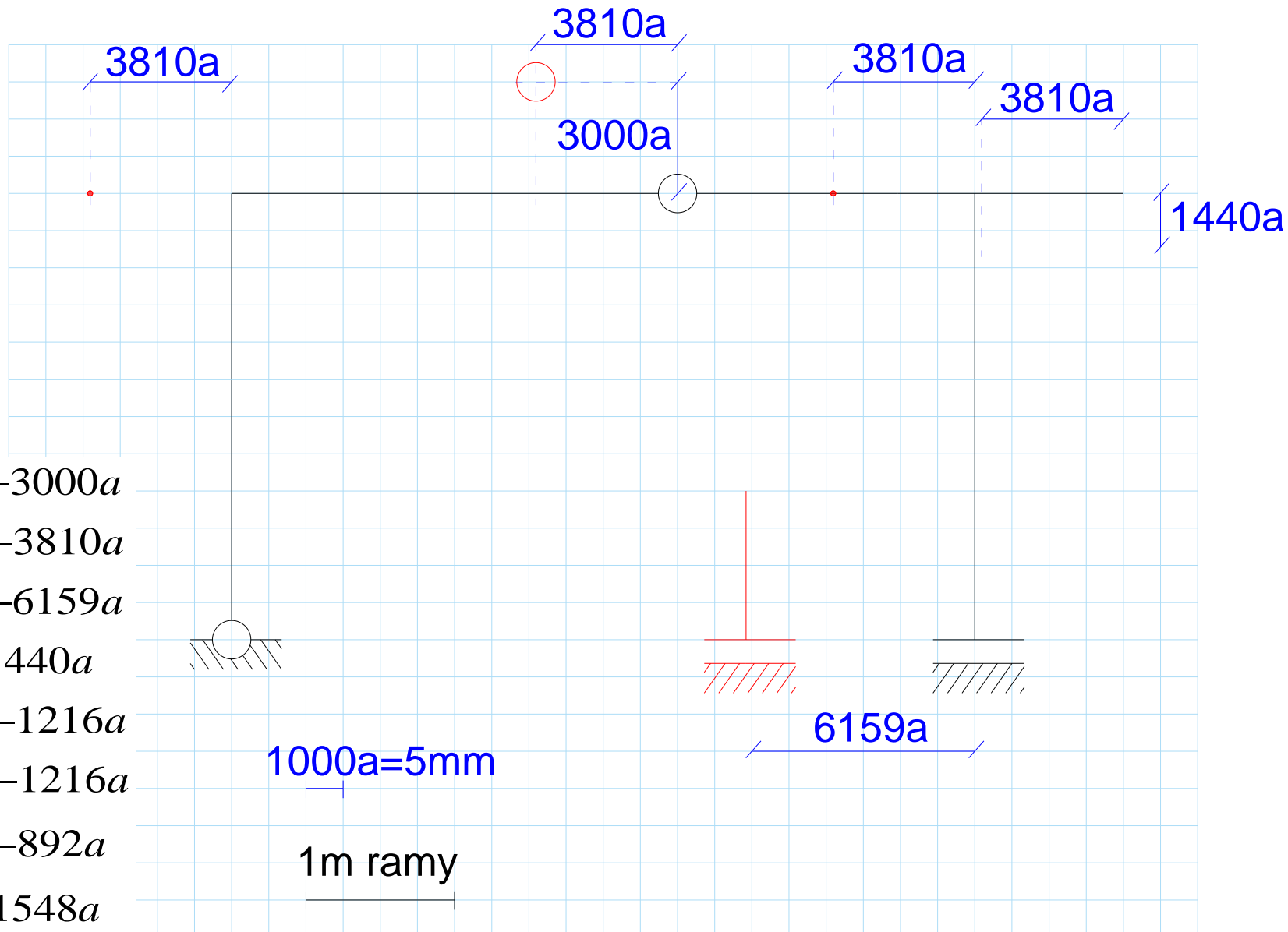
$$\varphi_D = -1216a$$

$$\varphi_C^L = -892a$$

$$\varphi_C^P = 1548a$$

$$\varphi_E = 1404a$$

$$\varphi_F = 1458a$$



$$v_C = -3000a$$

$$u_C = -3810a$$

$$u_B = -6159a$$

$$v_F = 1440a$$

$$\varphi_A = -1216a$$

$$\varphi_D = -1216a$$

$$\varphi_C^L = -892a$$

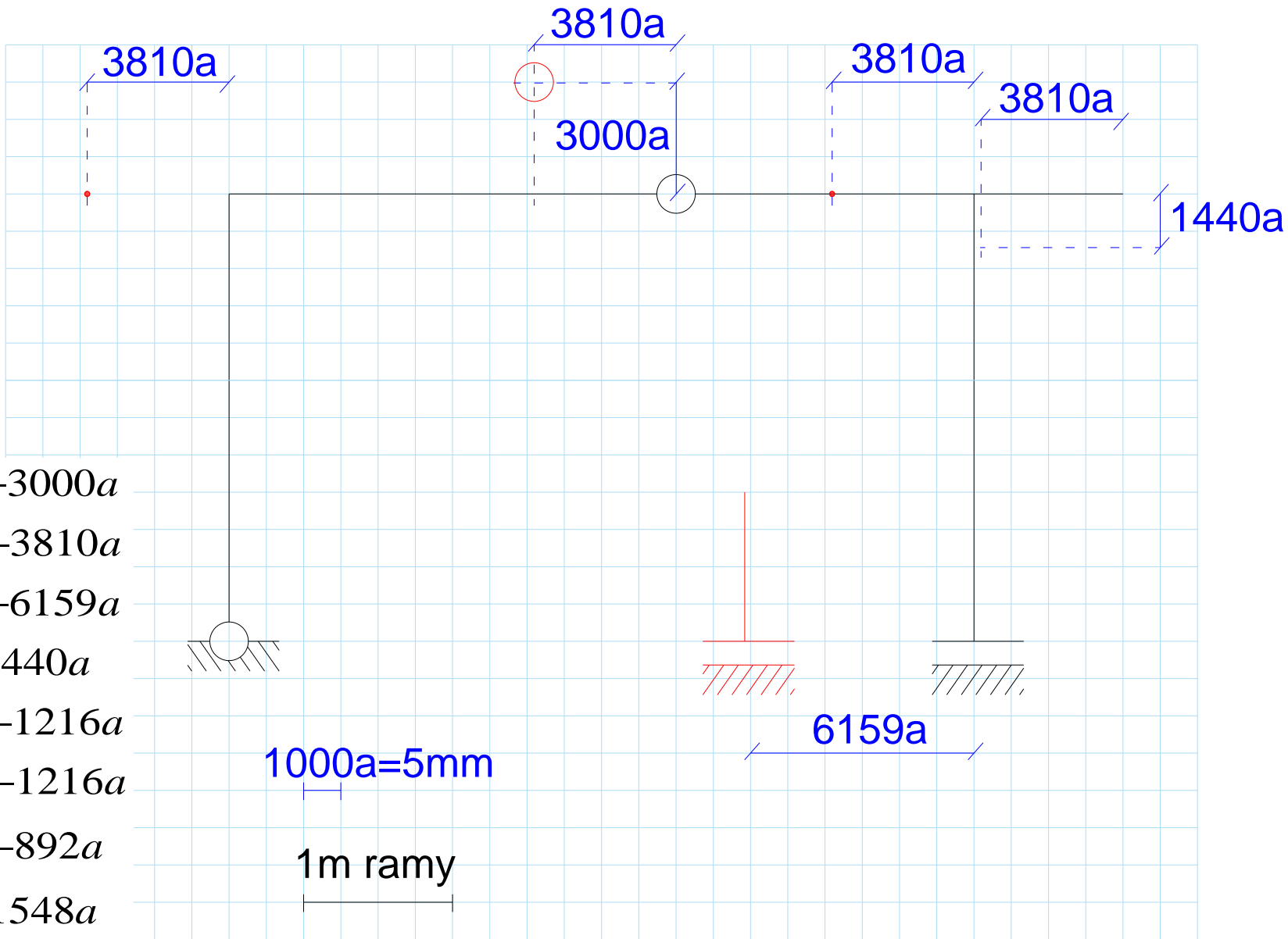
$$\varphi_C^P = 1548a$$

$$\varphi_E = 1404a$$

$$\varphi_F = 1458a$$

1000a=5mm

1m ramy



$$v_C = -3000a$$

$$u_C = -3810a$$

$$u_B = -6159a$$

$$v_F = 1440a$$

$$\varphi_A = -1216a$$

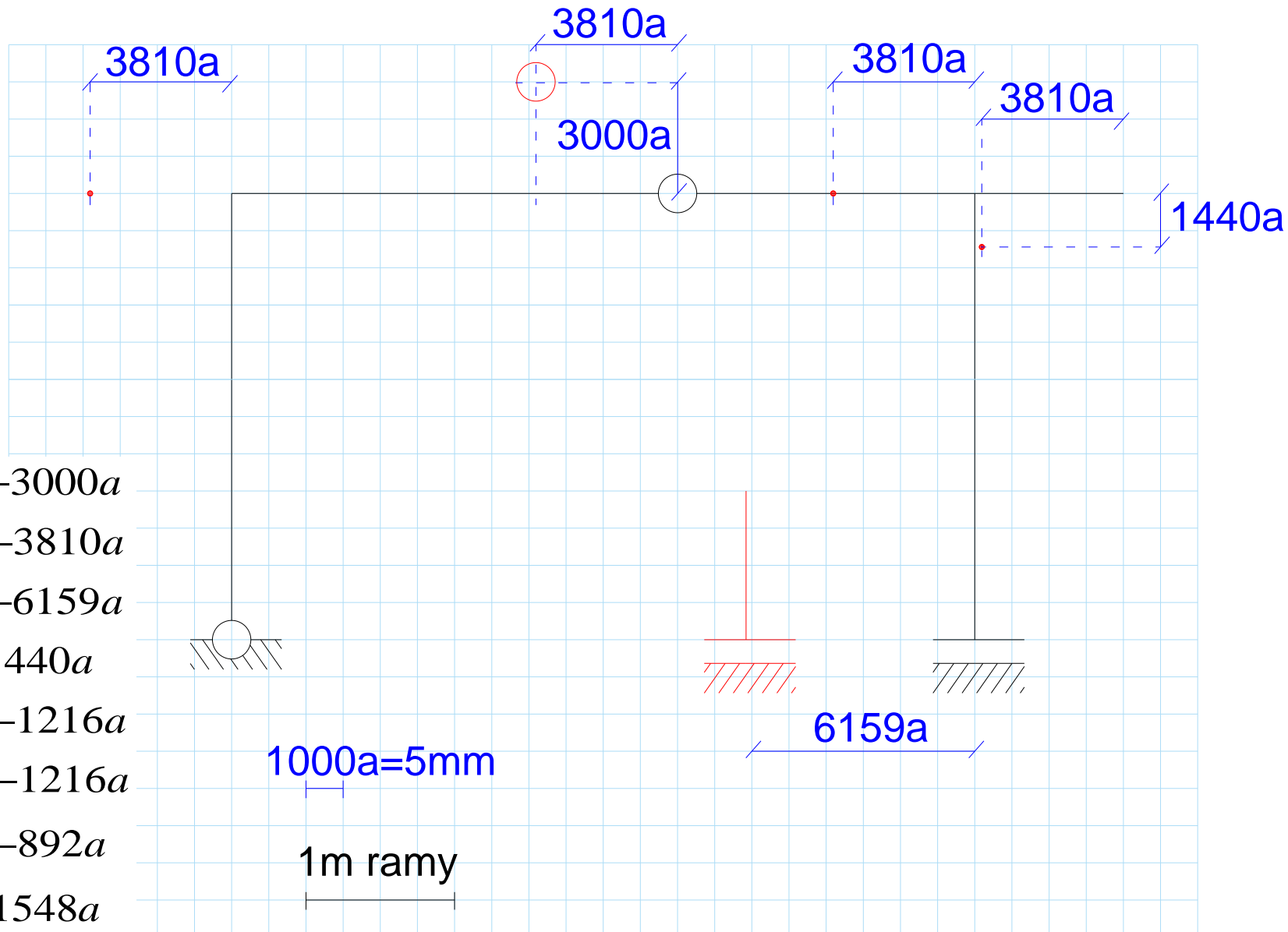
$$\varphi_D = -1216a$$

$$\varphi_C^L = -892a$$

$$\varphi_C^P = 1548a$$

$$\varphi_E = 1404a$$

$$\varphi_F = 1458a$$



$$v_C = -3000a$$

$$u_C = -3810a$$

$$u_B = -6159a$$

$$v_F = 1440a$$

$$\varphi_A = -1216a$$

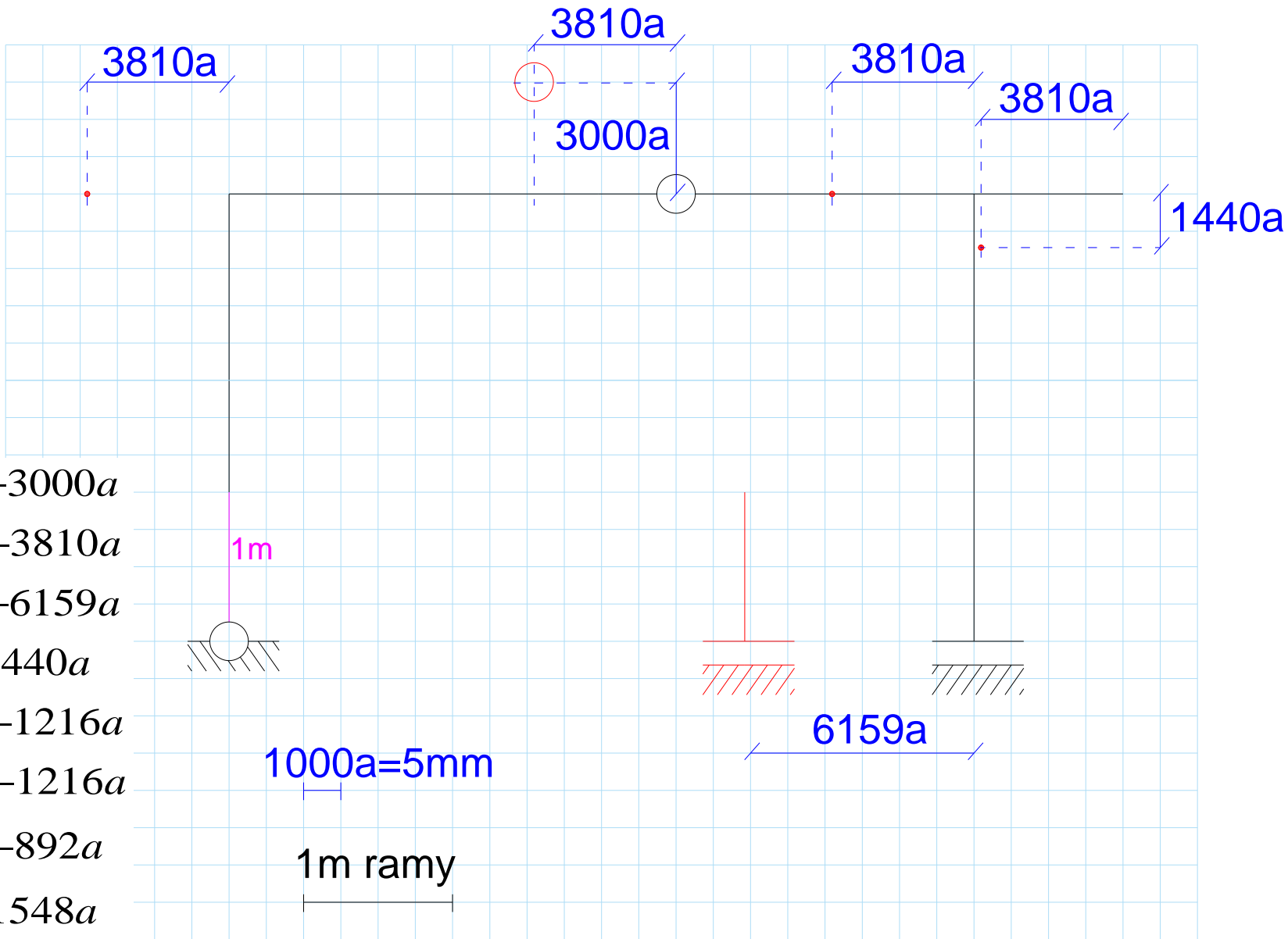
$$\varphi_D = -1216a$$

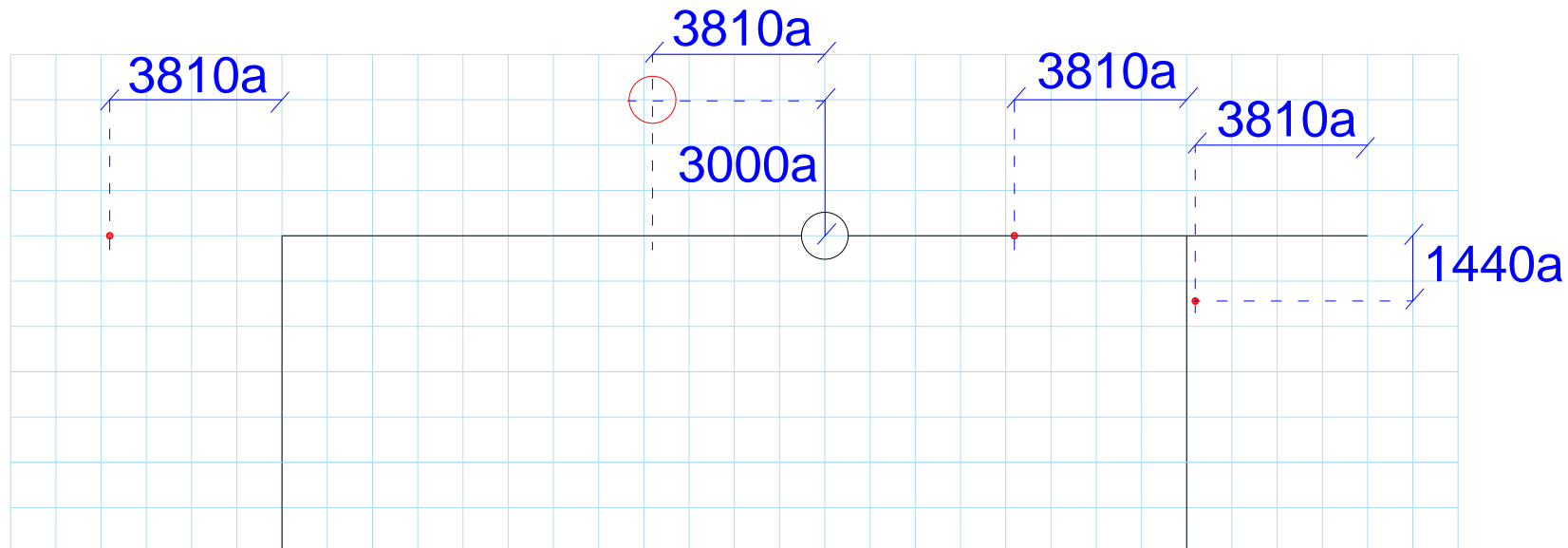
$$\varphi_C^L = -892a$$

$$\varphi_C^P = 1548a$$

$$\varphi_E = 1404a$$

$$\varphi_F = 1458a$$





$$v_C = -3000a$$

$$u_C = -3810a$$

$$u_B = -6159a$$

$$v_F = 1440a$$

$$\varphi_A = -1216a$$

$$\varphi_D = -1216a$$

$$\varphi_C^L = -892a$$

$$\varphi_C^P = 1548a$$

$$\varphi_E = 1404a$$

$$\varphi_F = 1458a$$

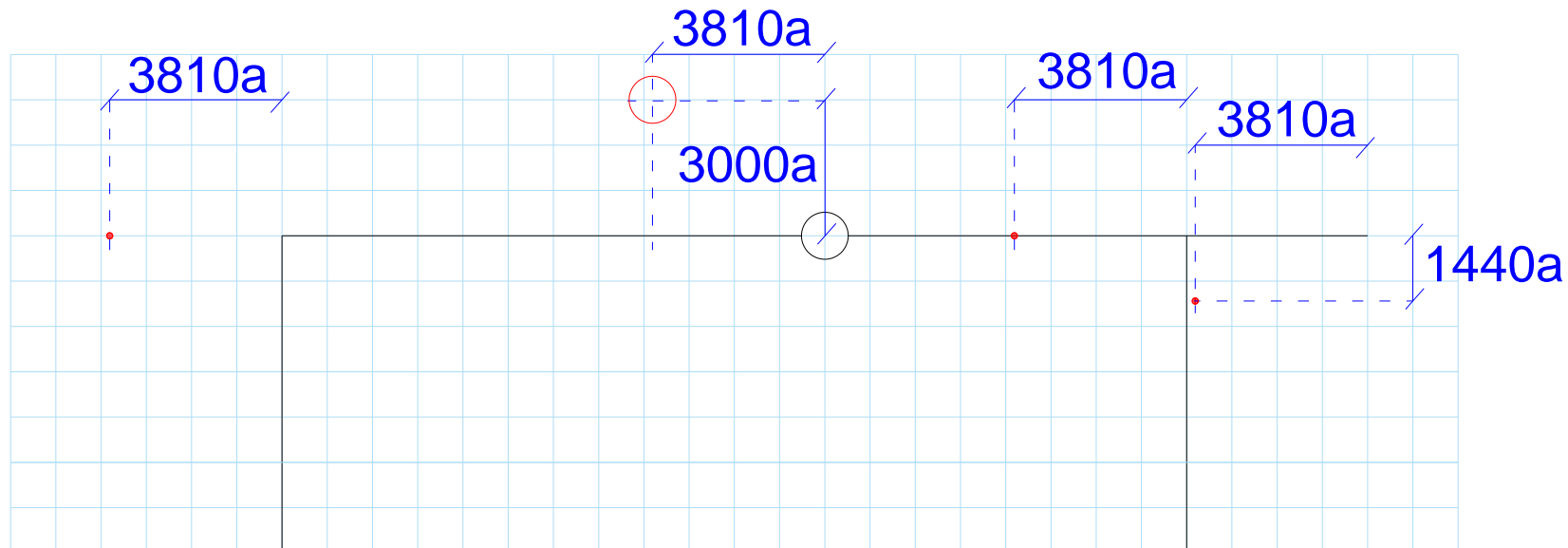
$$1216a$$

1m

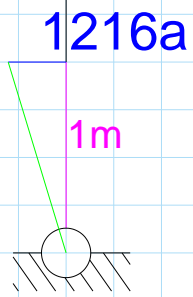
$$1000a = 5\text{mm}$$

1m ramy

$$6159a$$

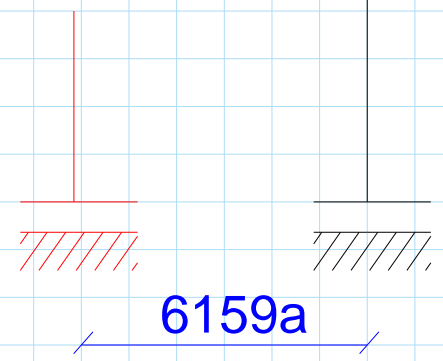


- $v_C = -3000a$
- $u_C = -3810a$
- $u_B = -6159a$
- $v_F = 1440a$
- $\varphi_A = -1216a$
- $\varphi_D = -1216a$
- $\varphi_C^L = -892a$
- $\varphi_C^P = 1548a$
- $\varphi_E = 1404a$
- $\varphi_F = 1458a$

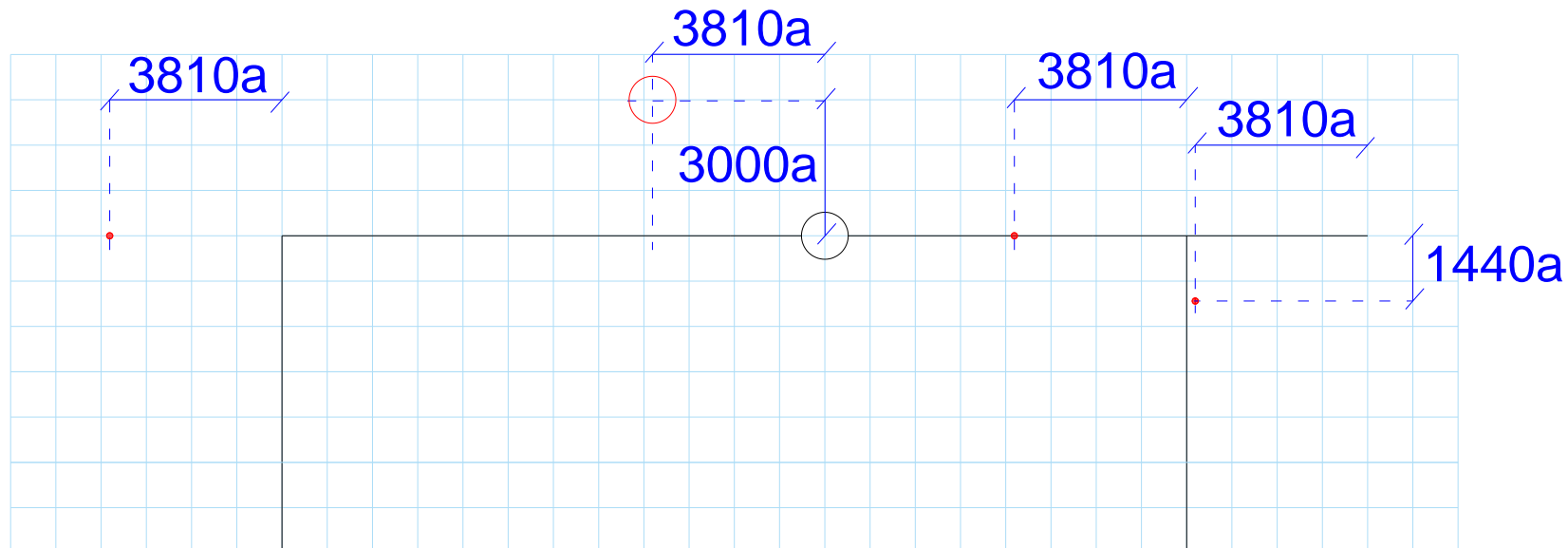


$1000a = 5\text{mm}$

1m ramy



$6159a$



- $v_C = -3000a$
- $u_C = -3810a$
- $u_B = -6159a$
- $v_F = 1440a$
- $\varphi_A = -1216a$
- $\varphi_D = -1216a$
- $\varphi_C^L = -892a$
- $\varphi_C^P = 1548a$
- $\varphi_E = 1404a$
- $\varphi_F = 1458a$

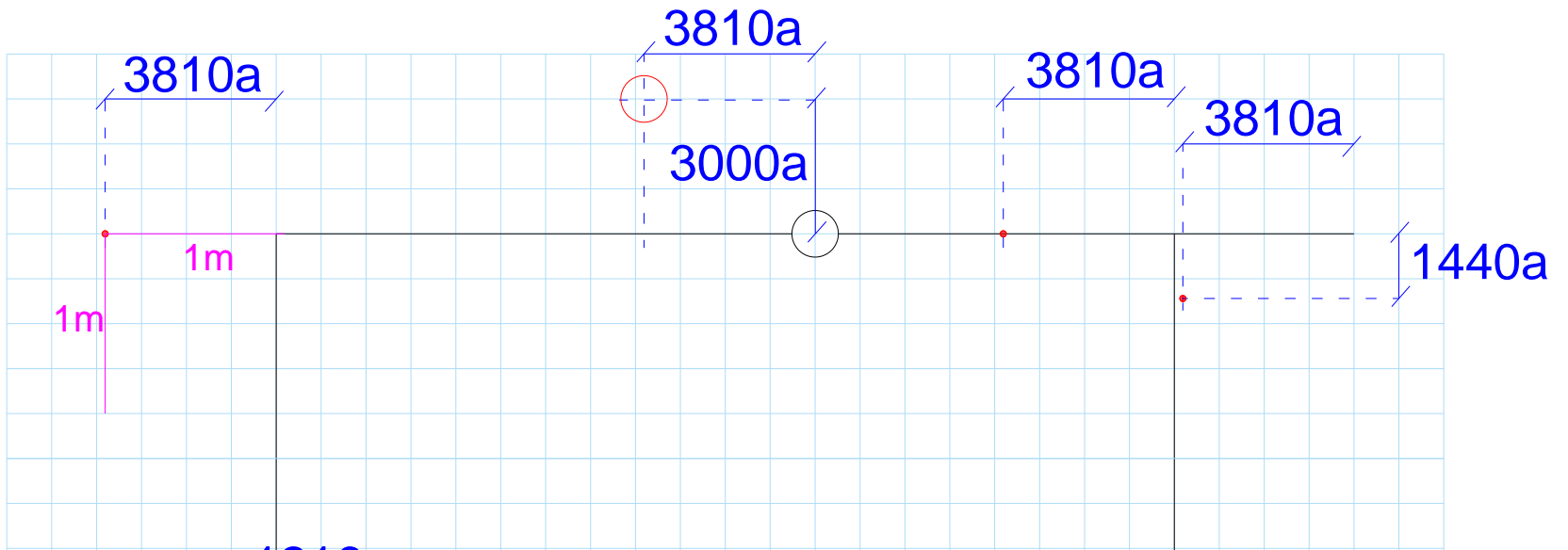
1216a

1m

1000a=5mm

1m ramy

6159a



$$v_C = -3000a$$

$$u_C = -3810a$$

$$u_B = -6159a$$

$$v_F = 1440a$$

$$\varphi_A = -1216a$$

$$\varphi_D = -1216a$$

$$\varphi_C^L = -892a$$

$$\varphi_C^P = 1548a$$

$$\varphi_E = 1404a$$

$$\varphi_F = 1458a$$

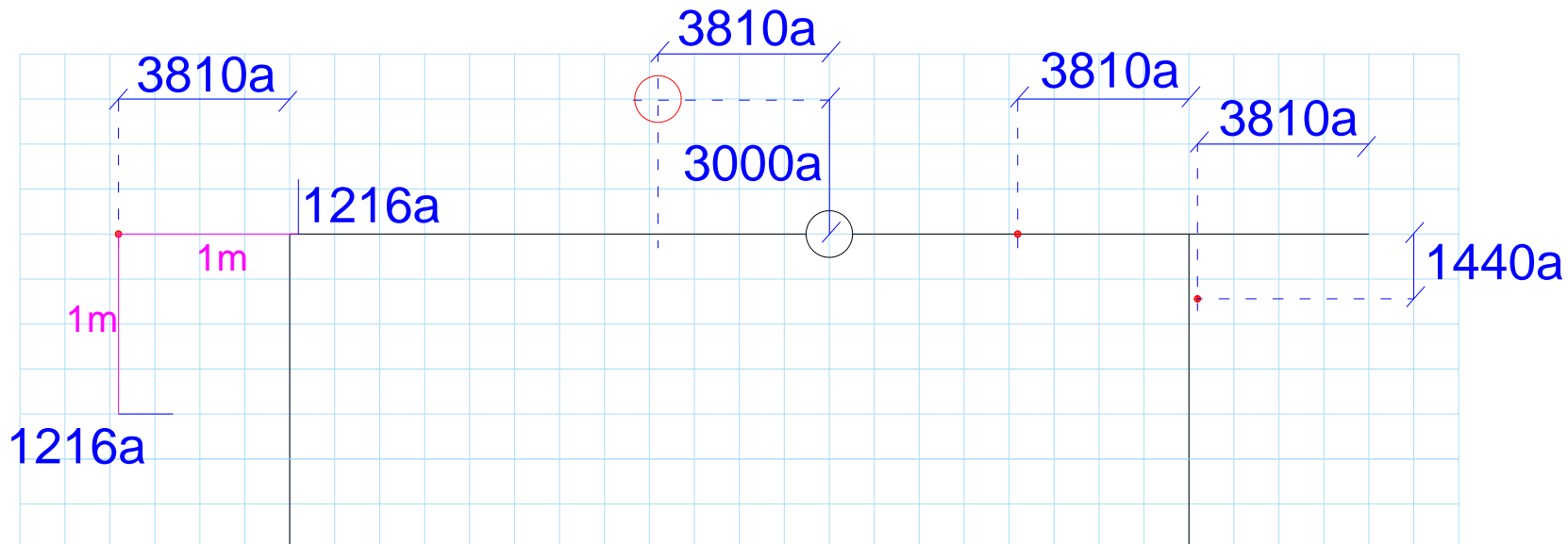
$$1216a$$

$$1m$$

$$1000a = 5mm$$

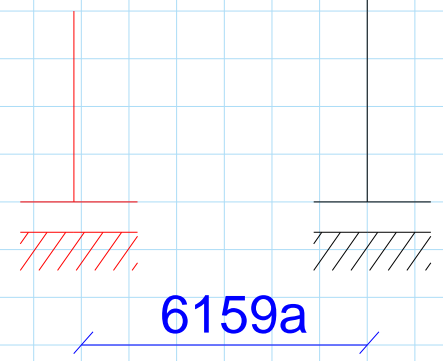
$$1m \text{ ramy}$$

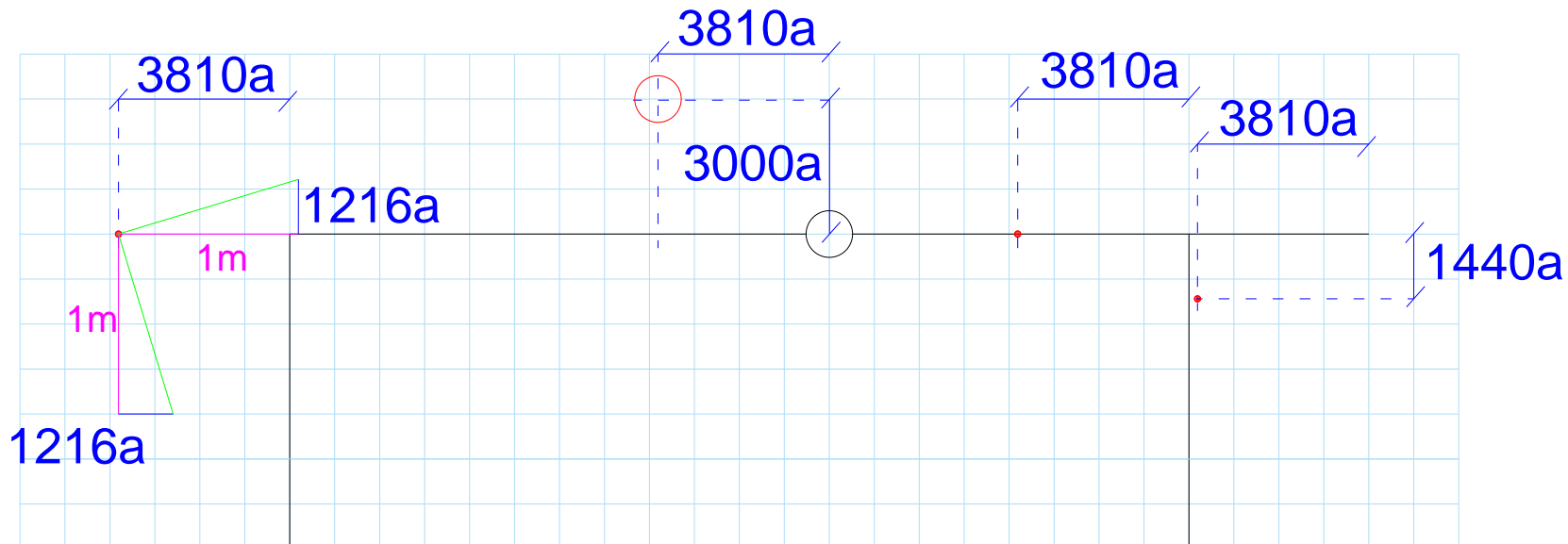
$$6159a$$



- $v_C = -3000a$
- $u_C = -3810a$
- $u_B = -6159a$
- $v_F = 1440a$
- $\varphi_A = -1216a$
- $\varphi_D = -1216a$
- $\varphi_C^L = -892a$
- $\varphi_C^P = 1548a$
- $\varphi_E = 1404a$
- $\varphi_F = 1458a$

$1000a = 5\text{mm}$
 1m ramy

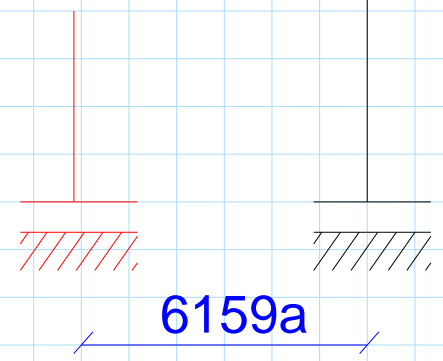


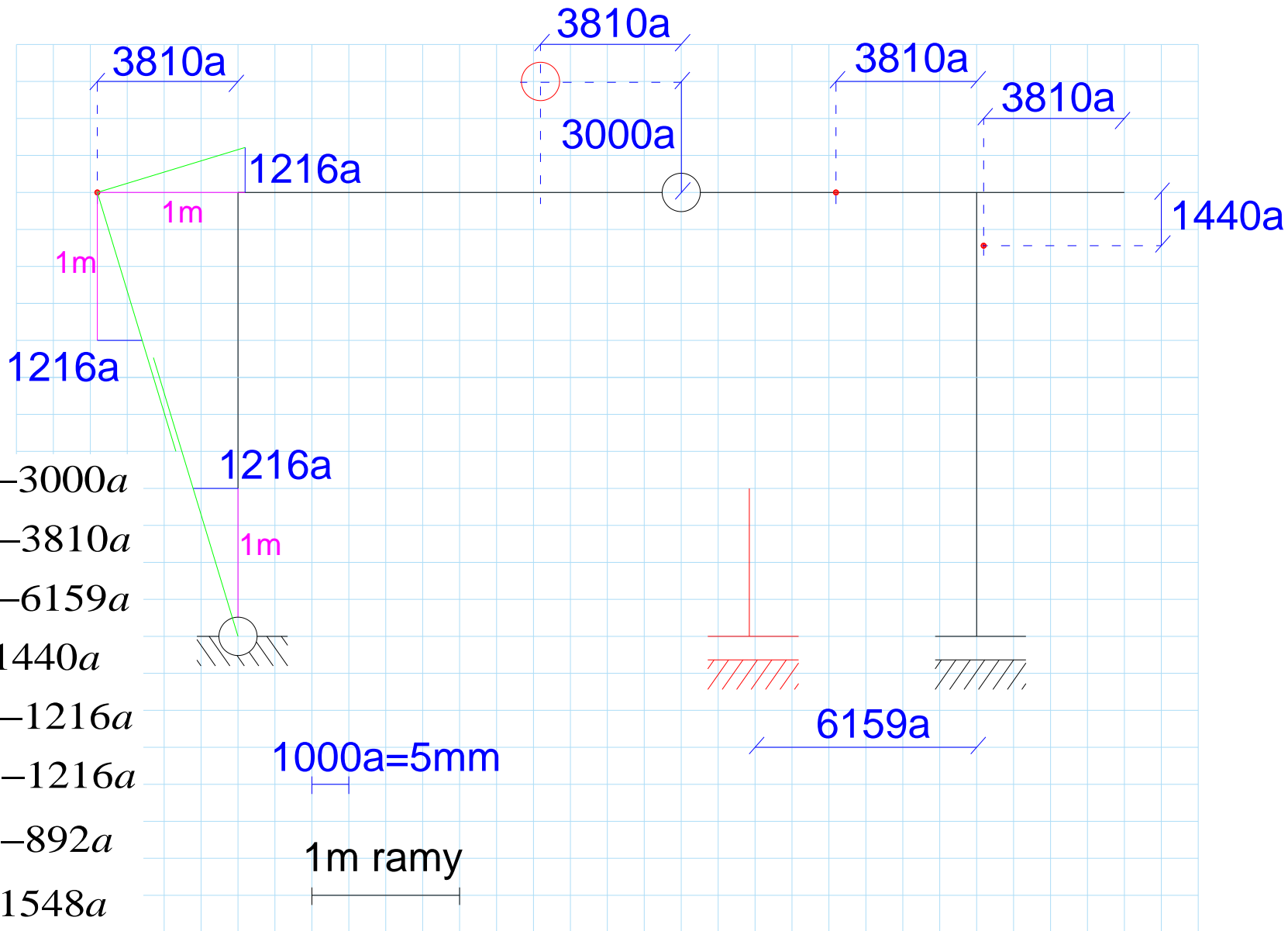


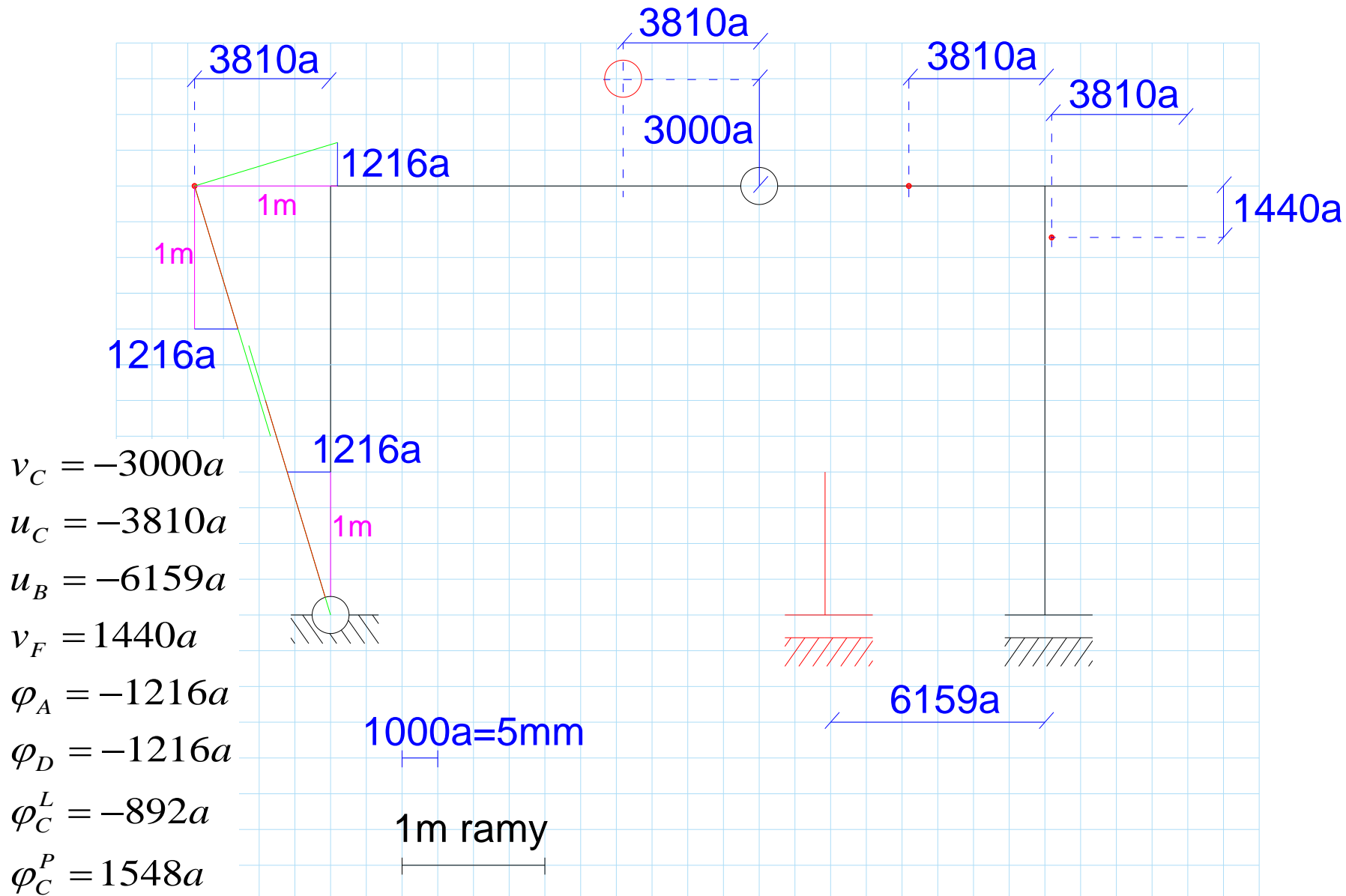
- $v_C = -3000a$
- $u_C = -3810a$
- $u_B = -6159a$
- $v_F = 1440a$
- $\varphi_A = -1216a$
- $\varphi_D = -1216a$
- $\varphi_C^L = -892a$
- $\varphi_C^P = 1548a$
- $\varphi_E = 1404a$
- $\varphi_F = 1458a$

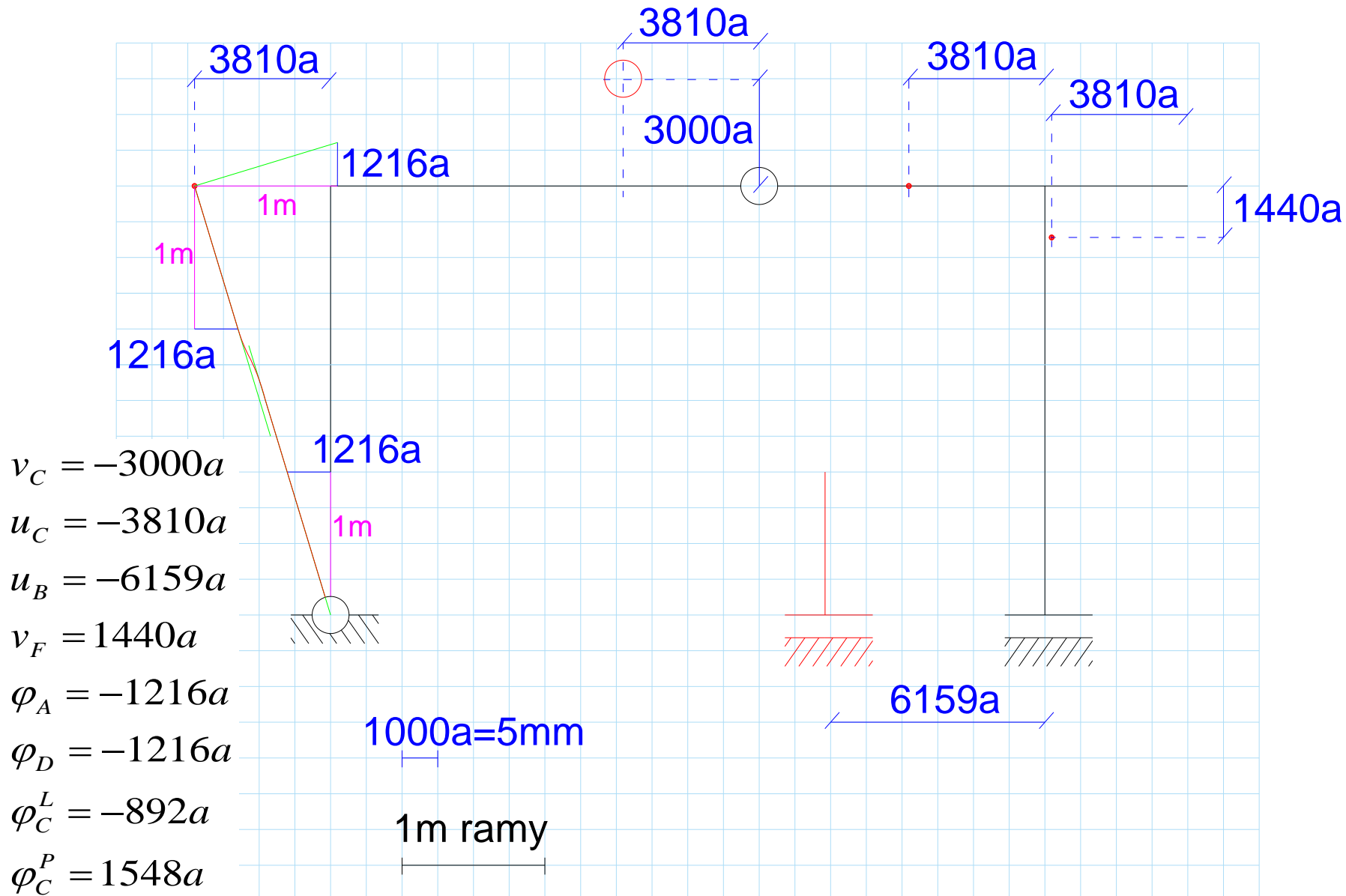
$1000a = 5\text{mm}$

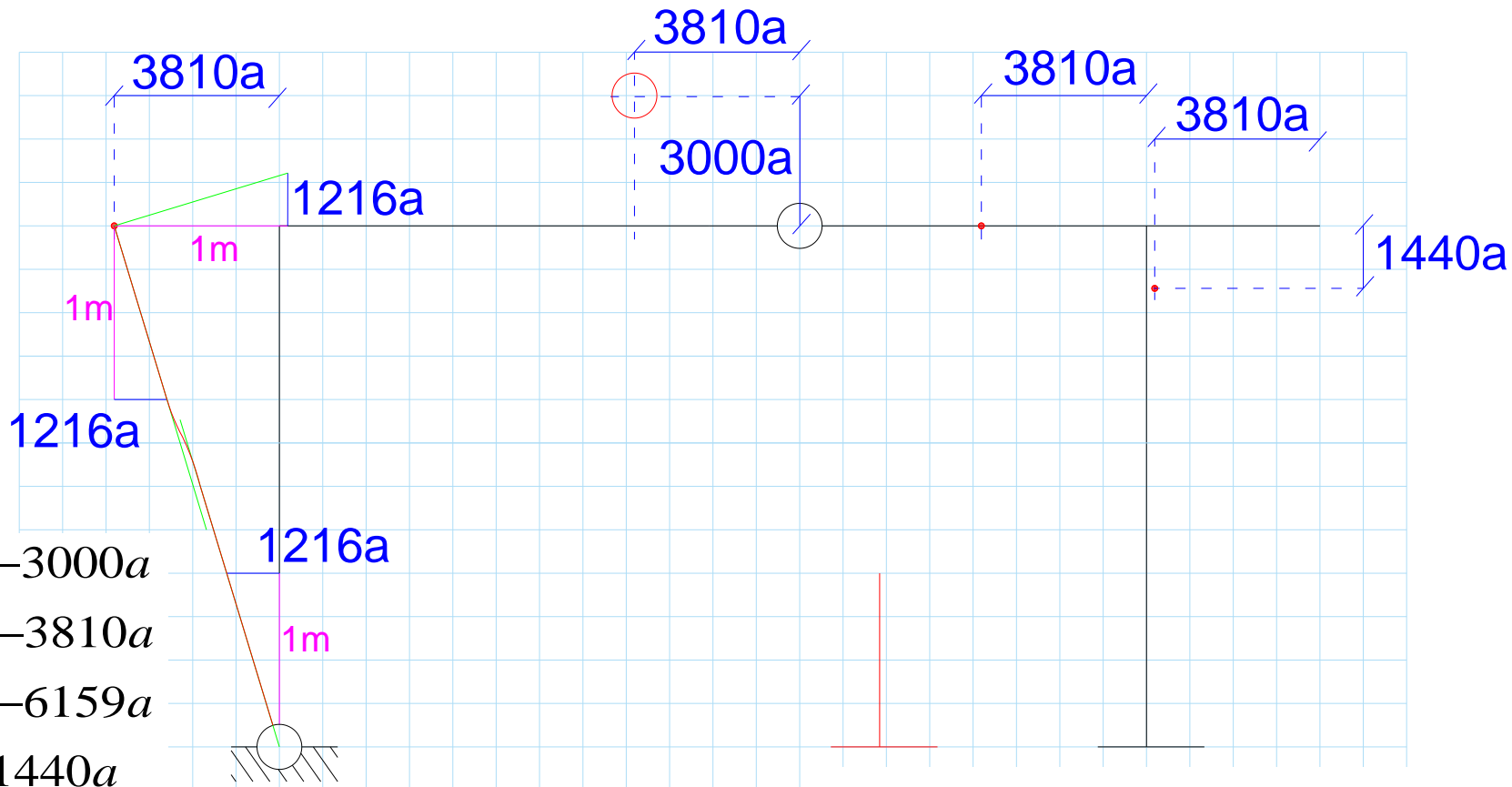
1m ramy







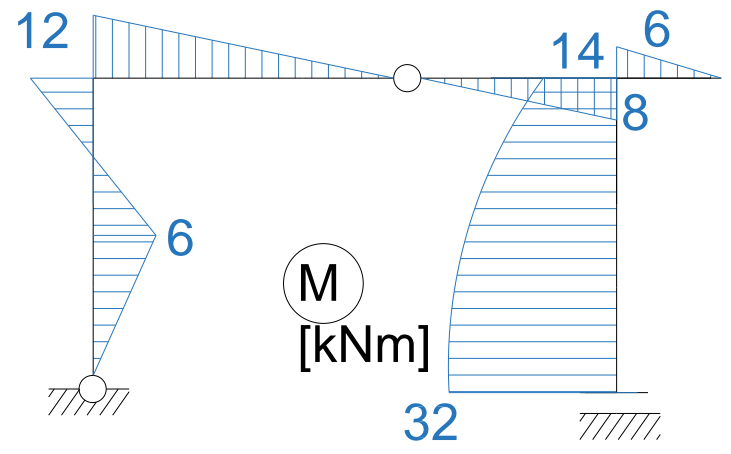




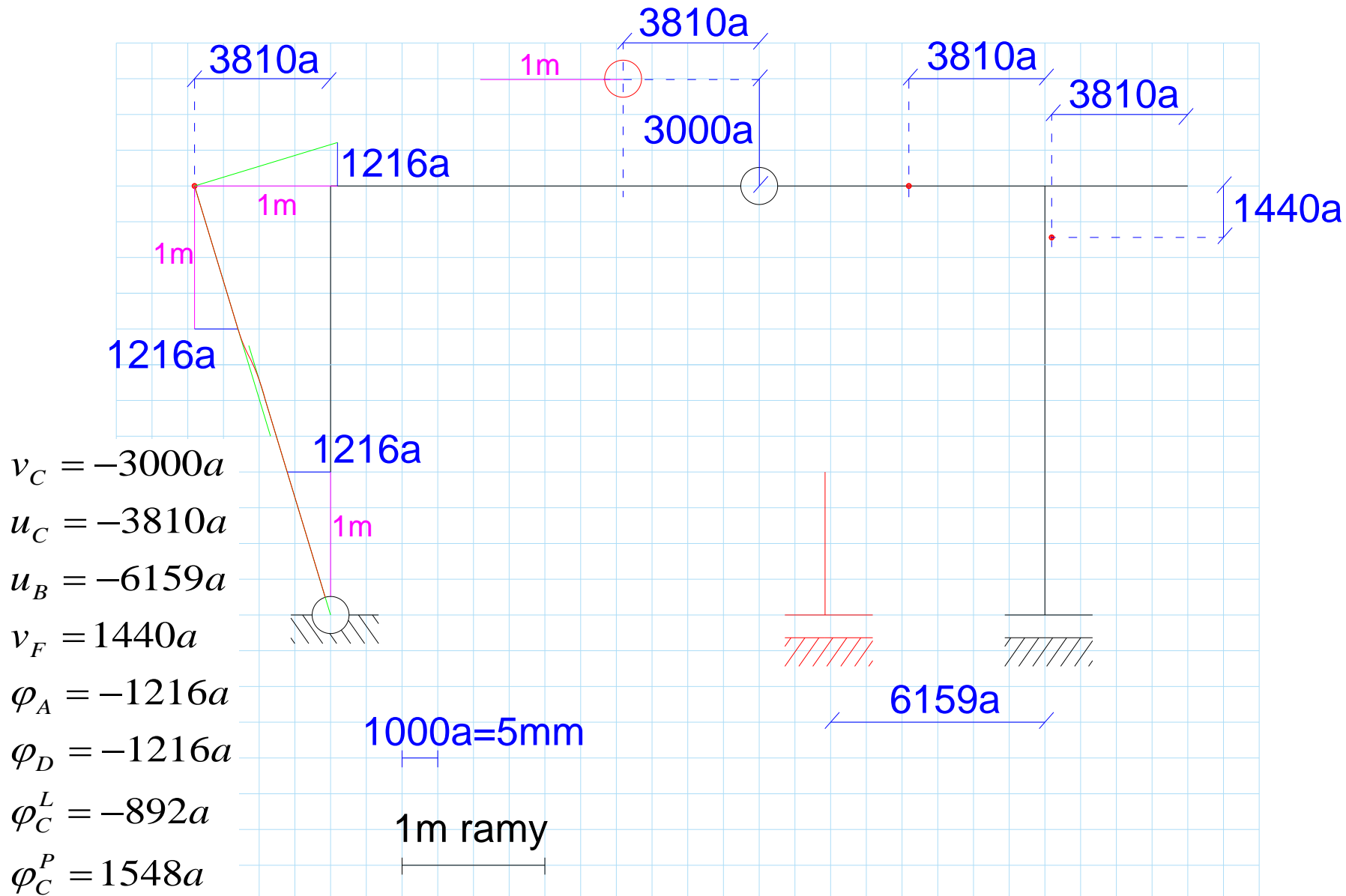
- $v_C = -3000a$
- $u_C = -3810a$
- $u_B = -6159a$
- $v_F = 1440a$
- $\varphi_A = -1216a$
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- $\varphi_C^L = -892a$
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- $\varphi_E = 1404a$
- $\varphi_F = 1458a$

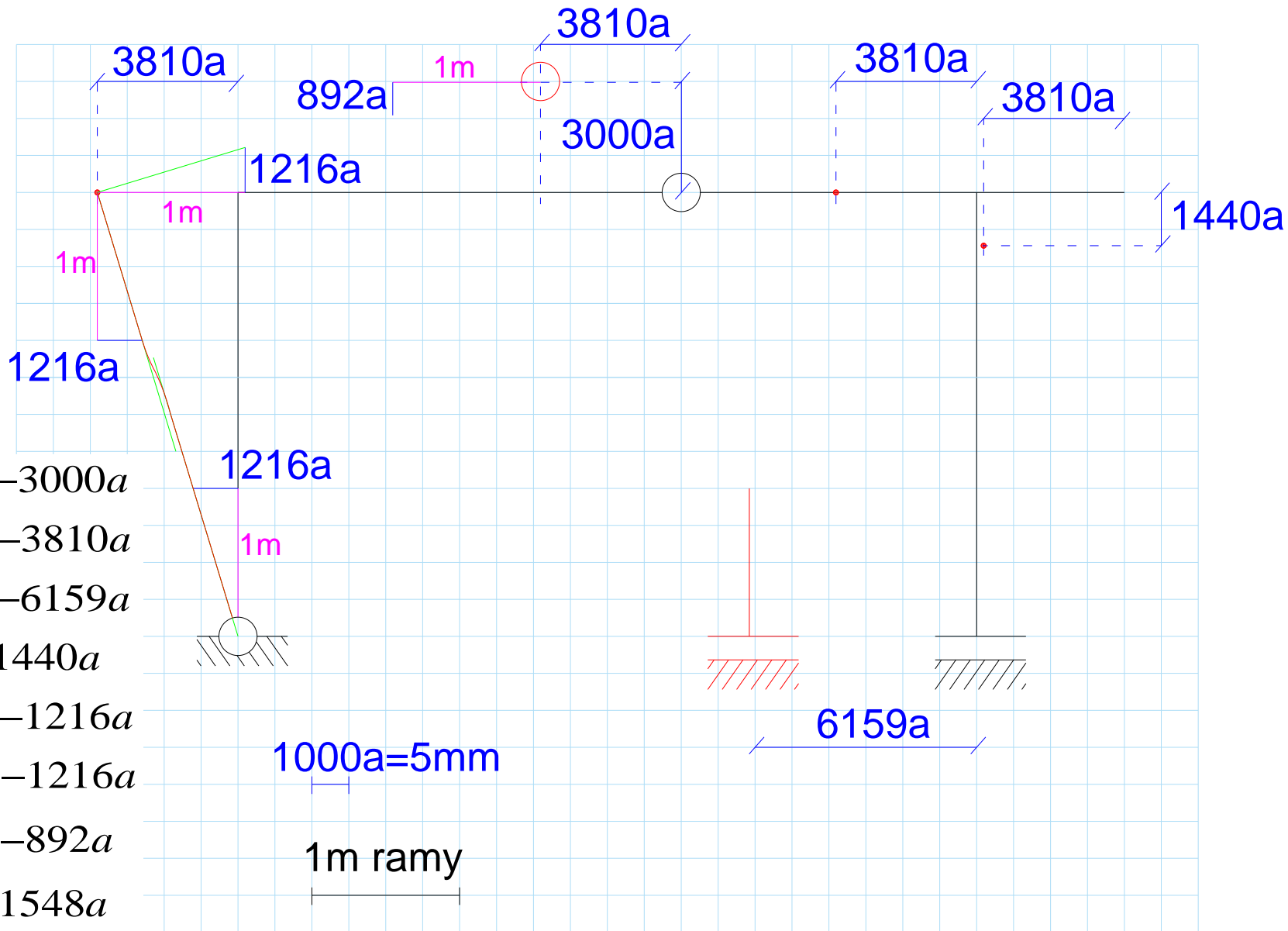
$1000a = 5\text{mm}$

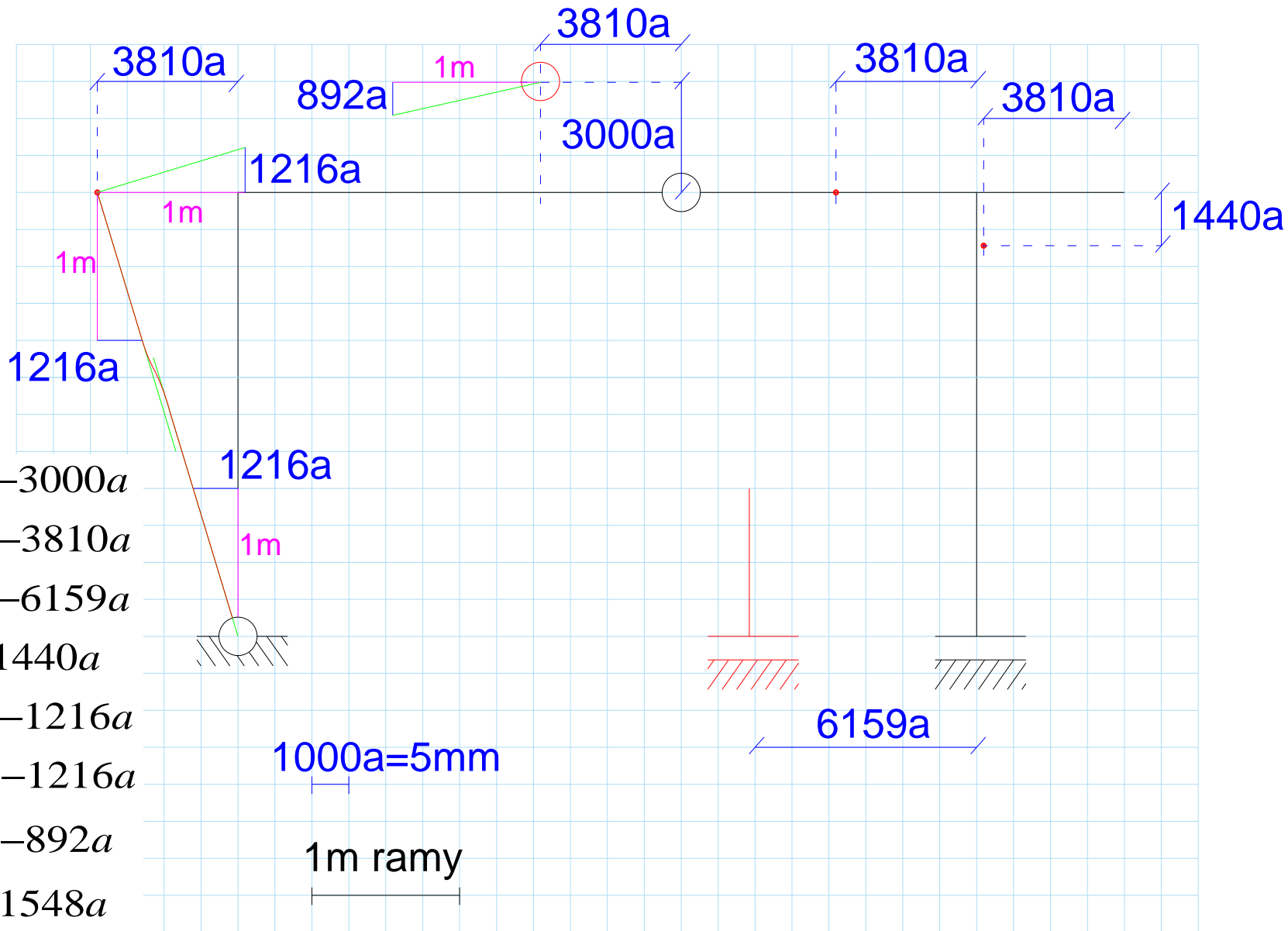
1m ramy

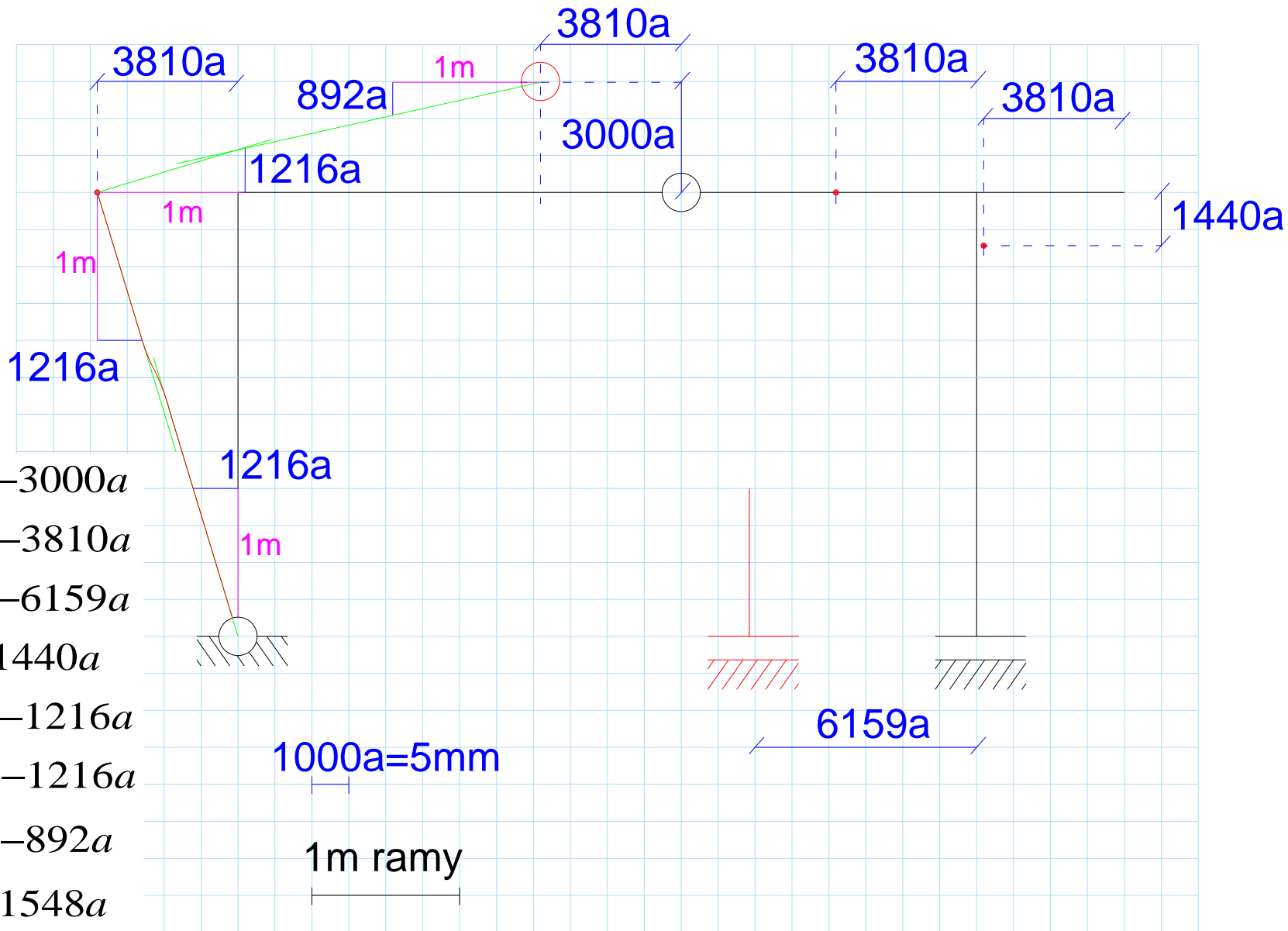


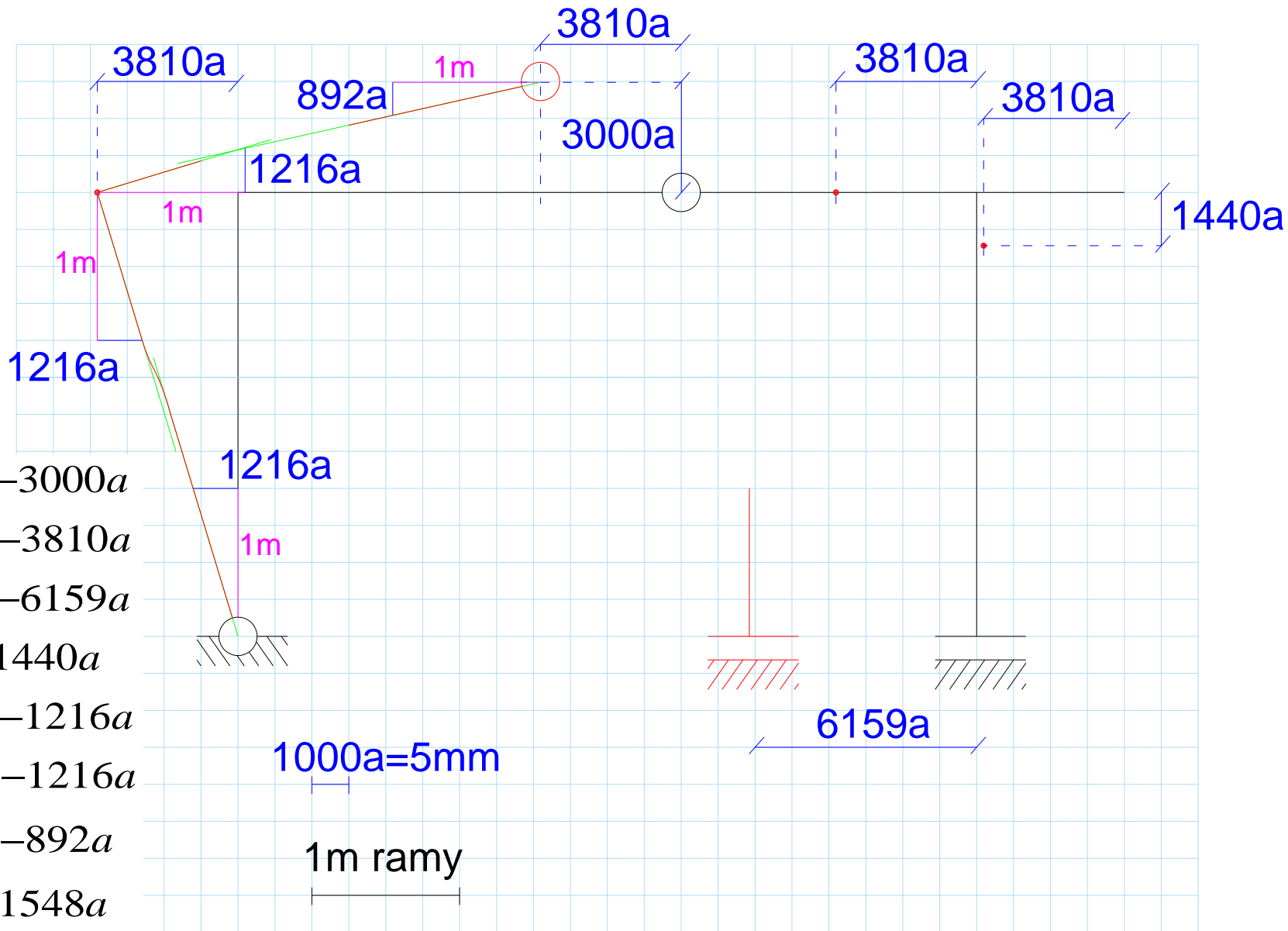
M [kNm]

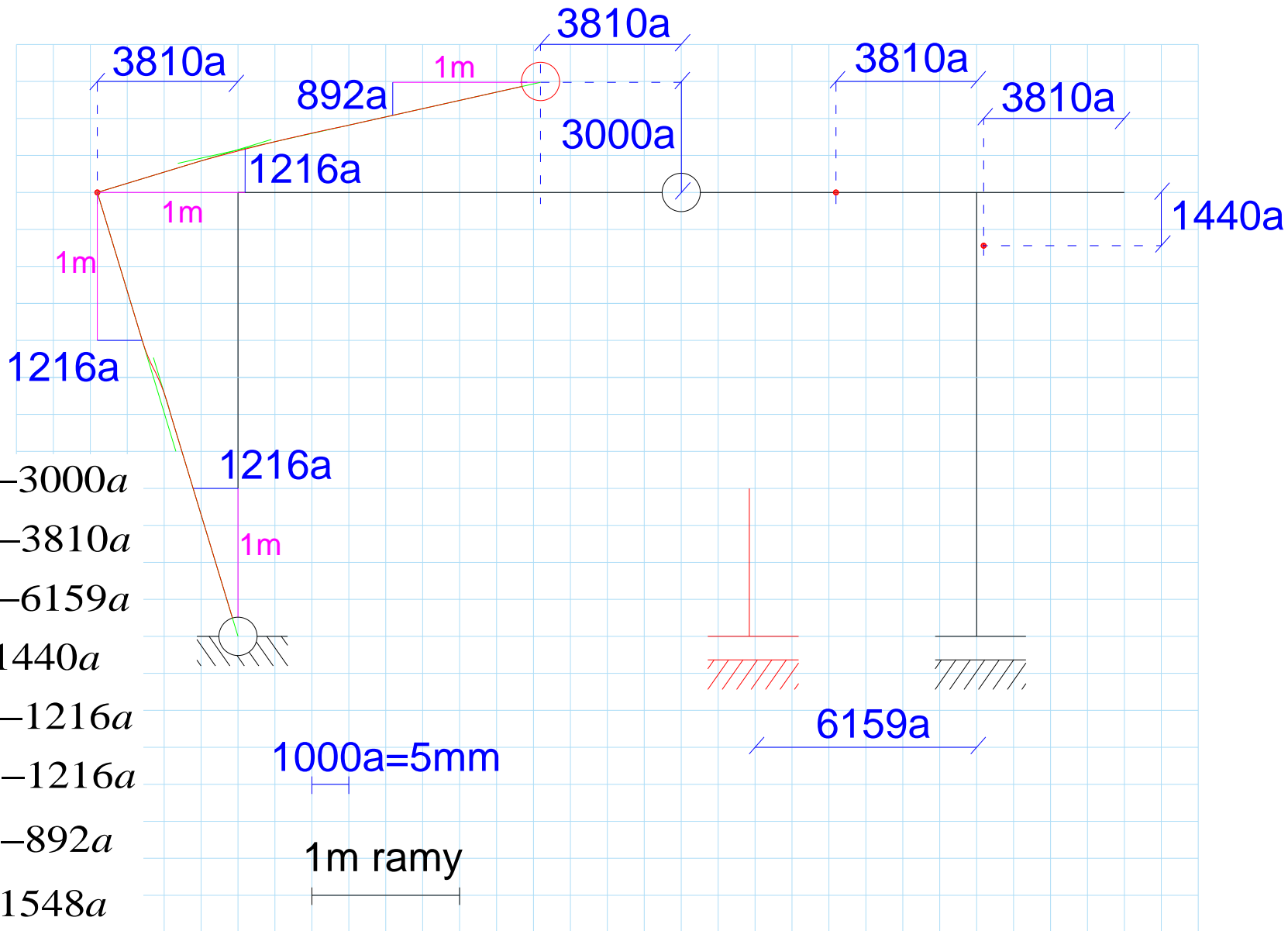


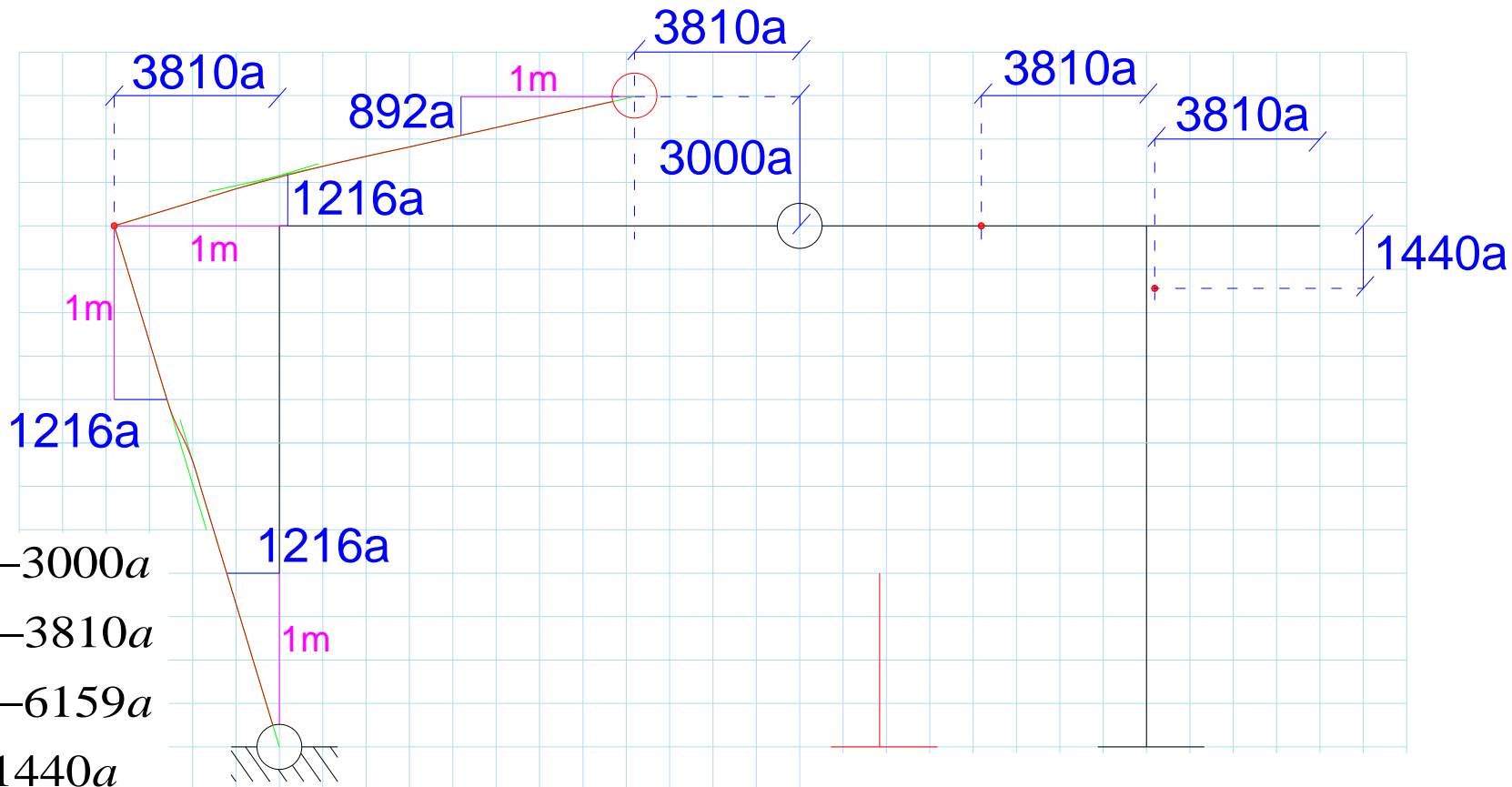






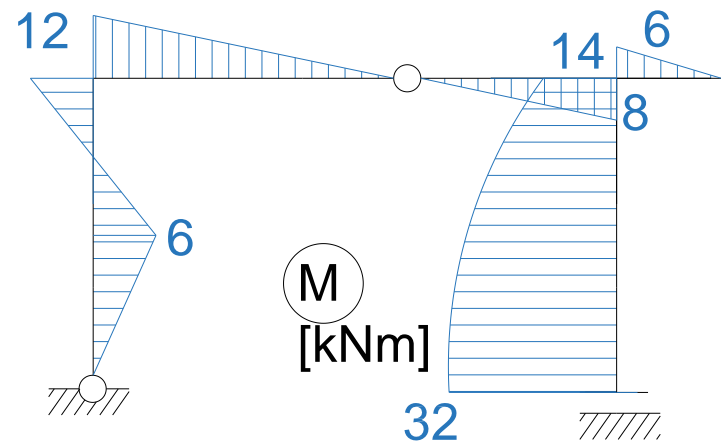




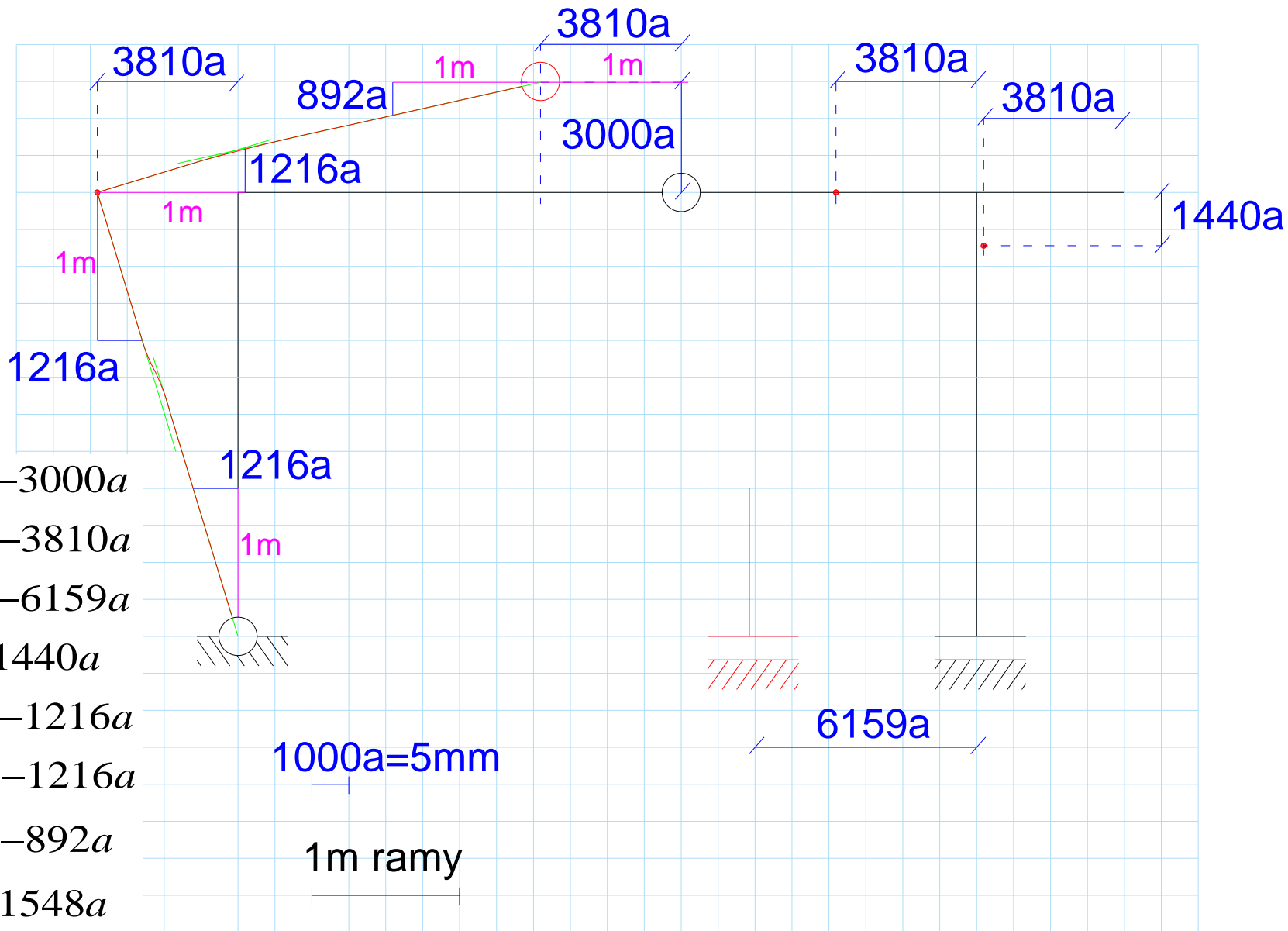


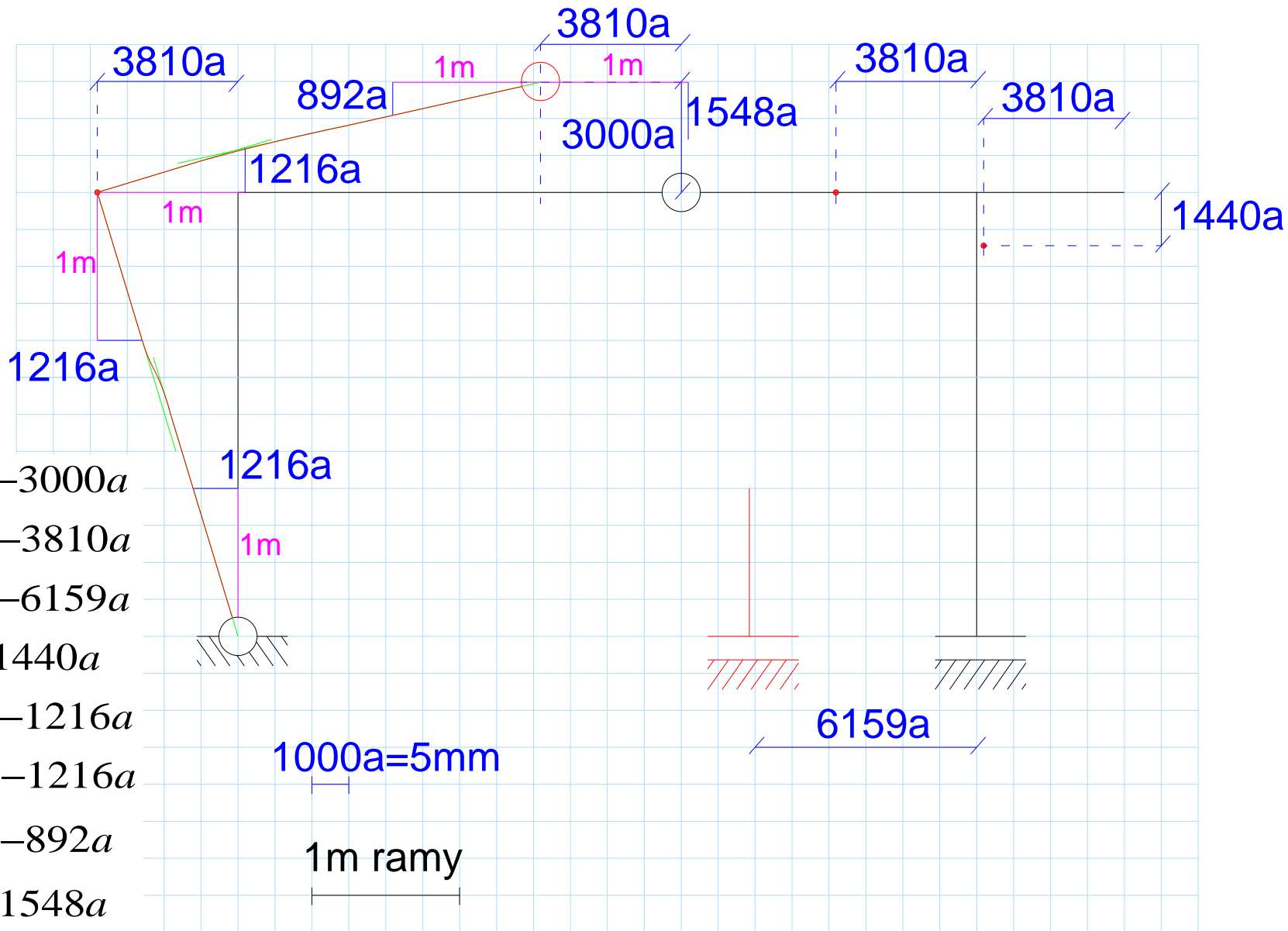
- $v_C = -3000a$
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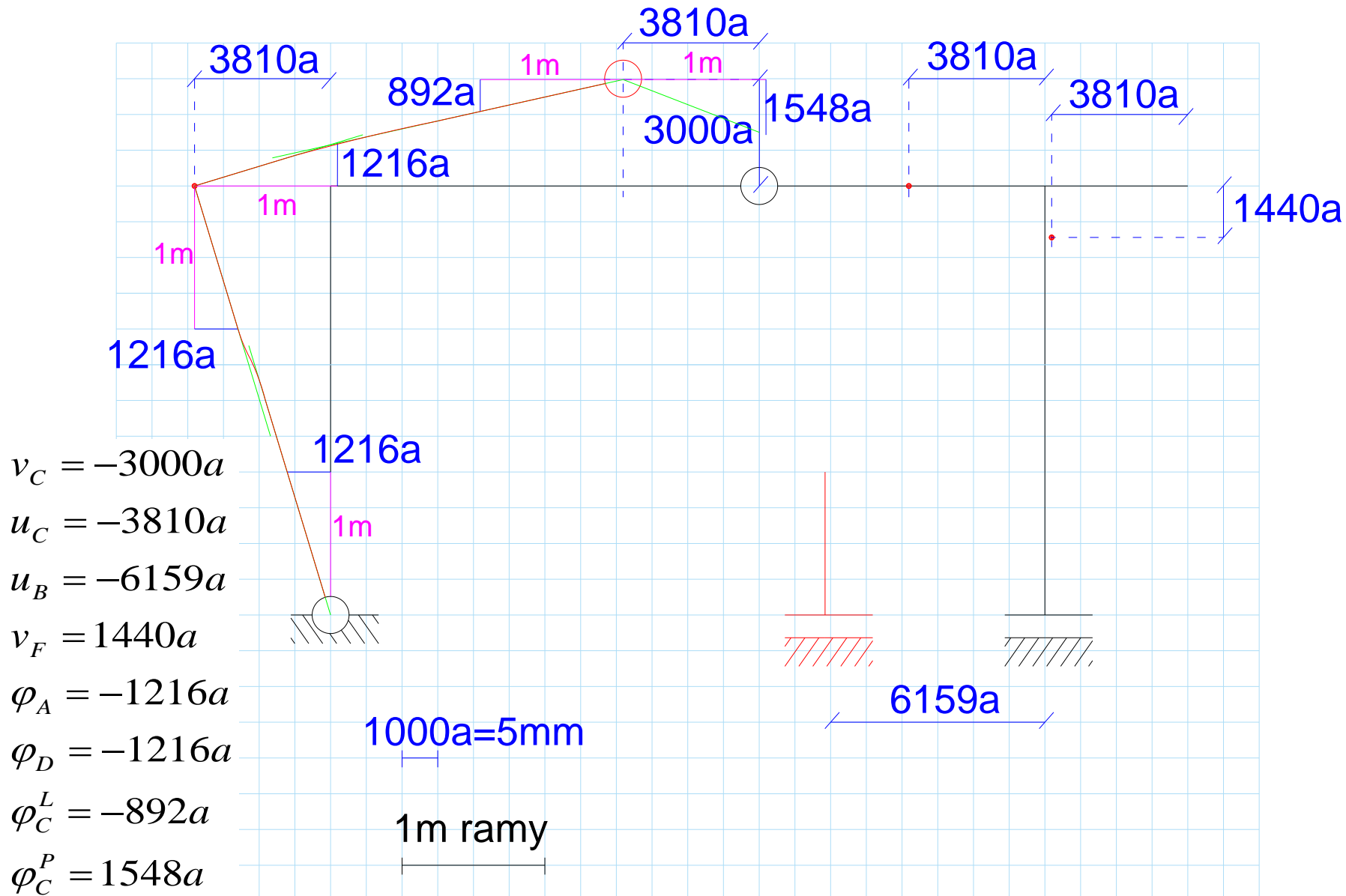
$1000a = 5\text{mm}$
 1m ramy

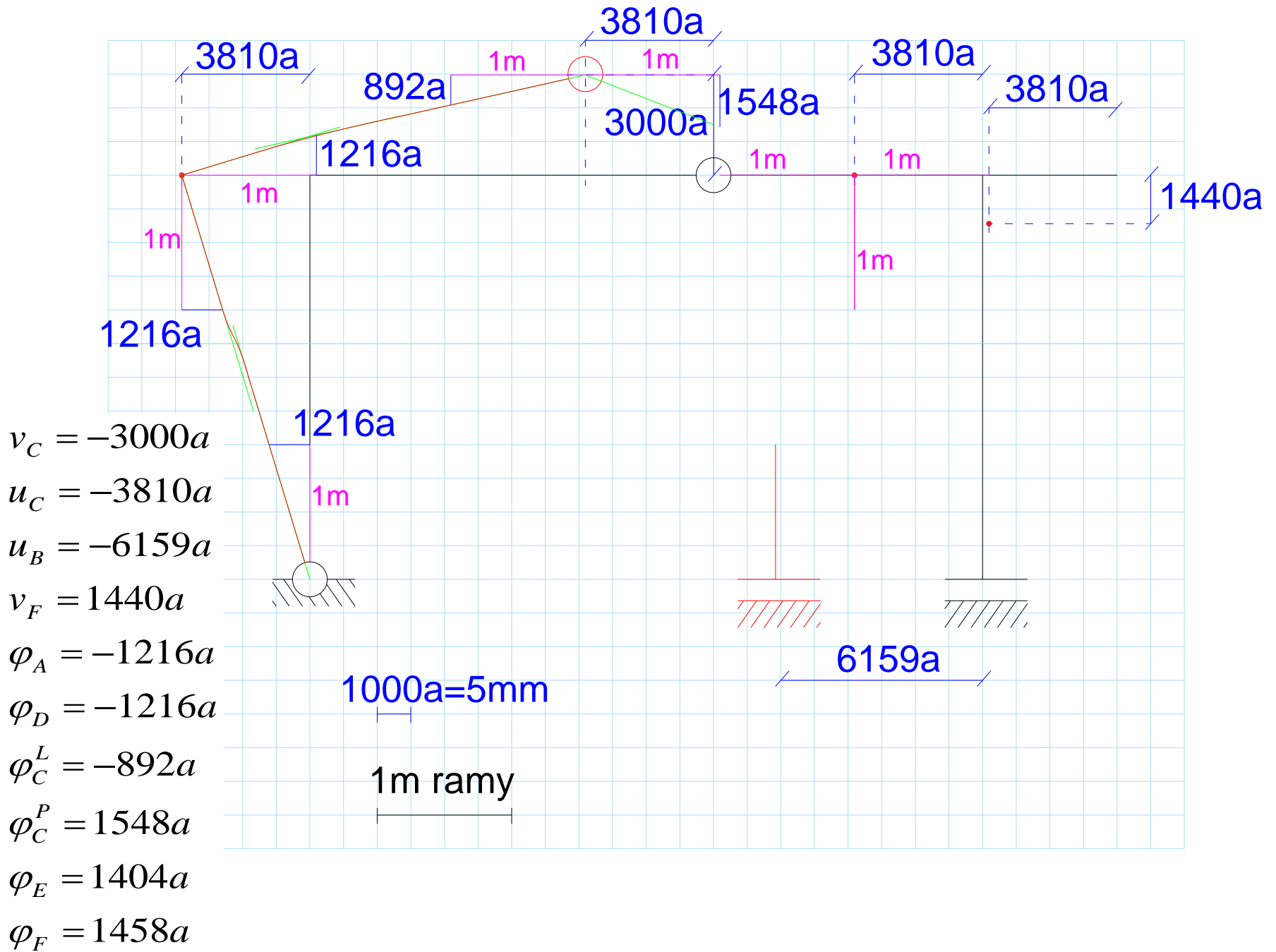


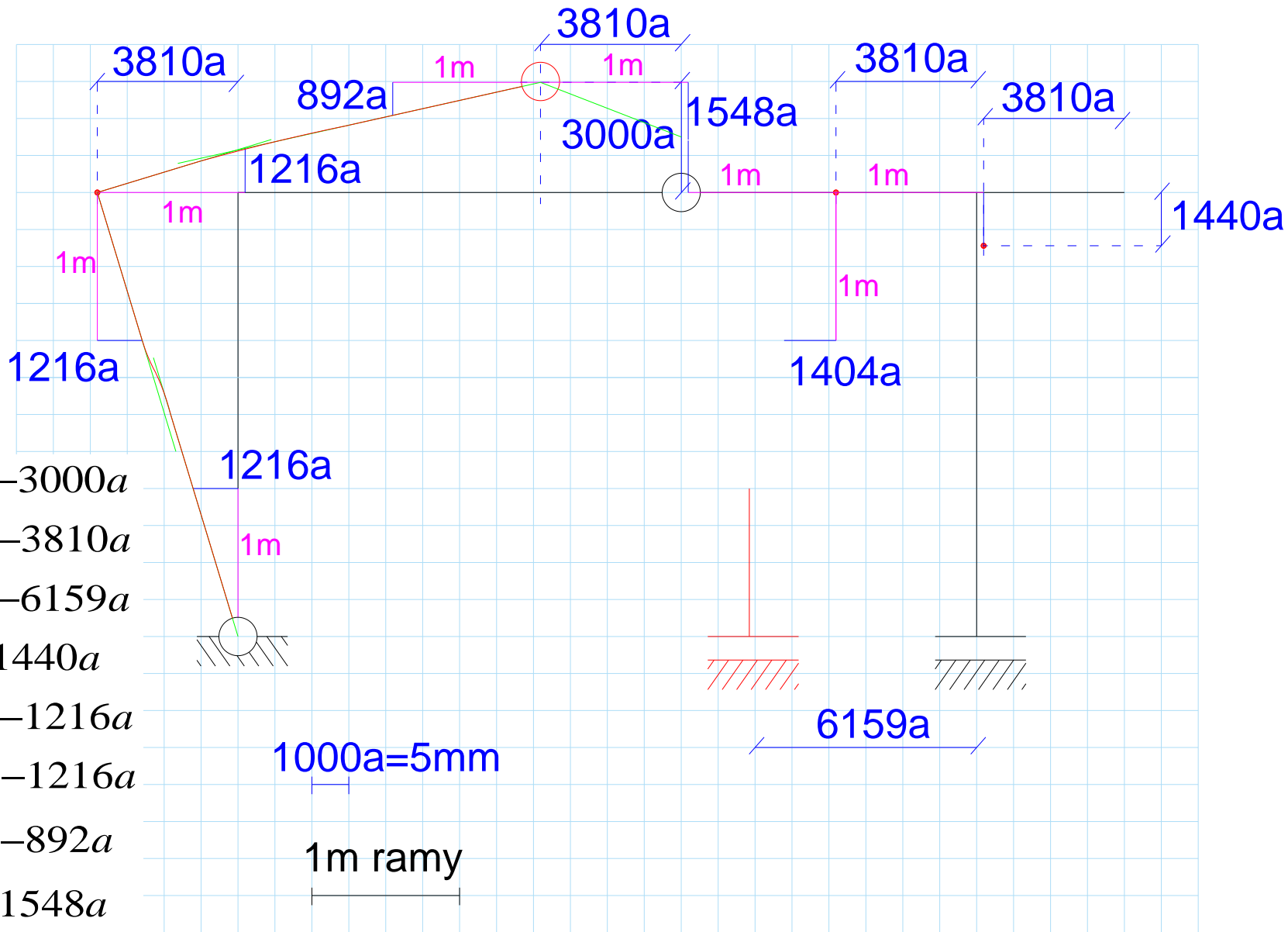
M
 [kNm]

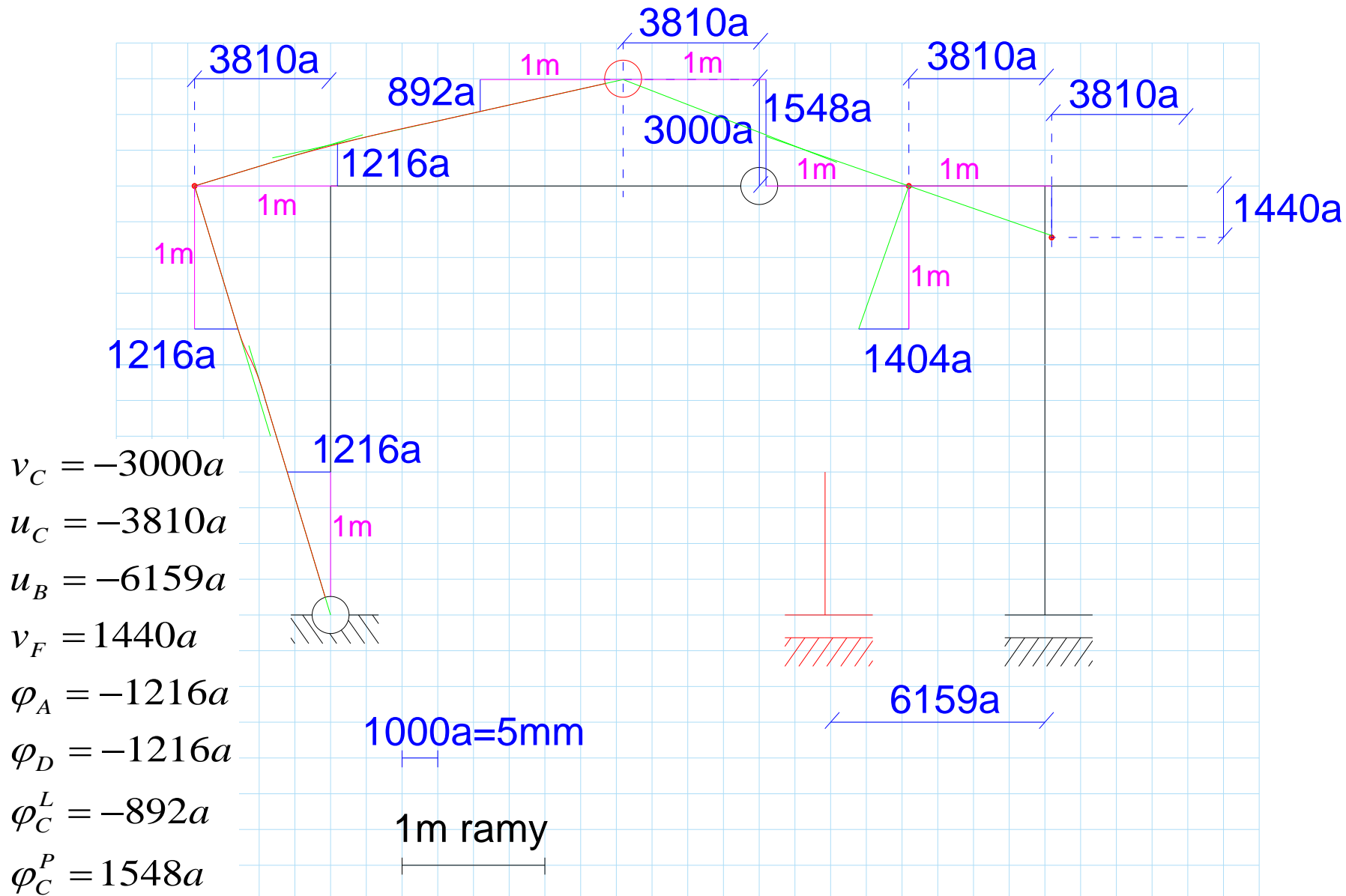


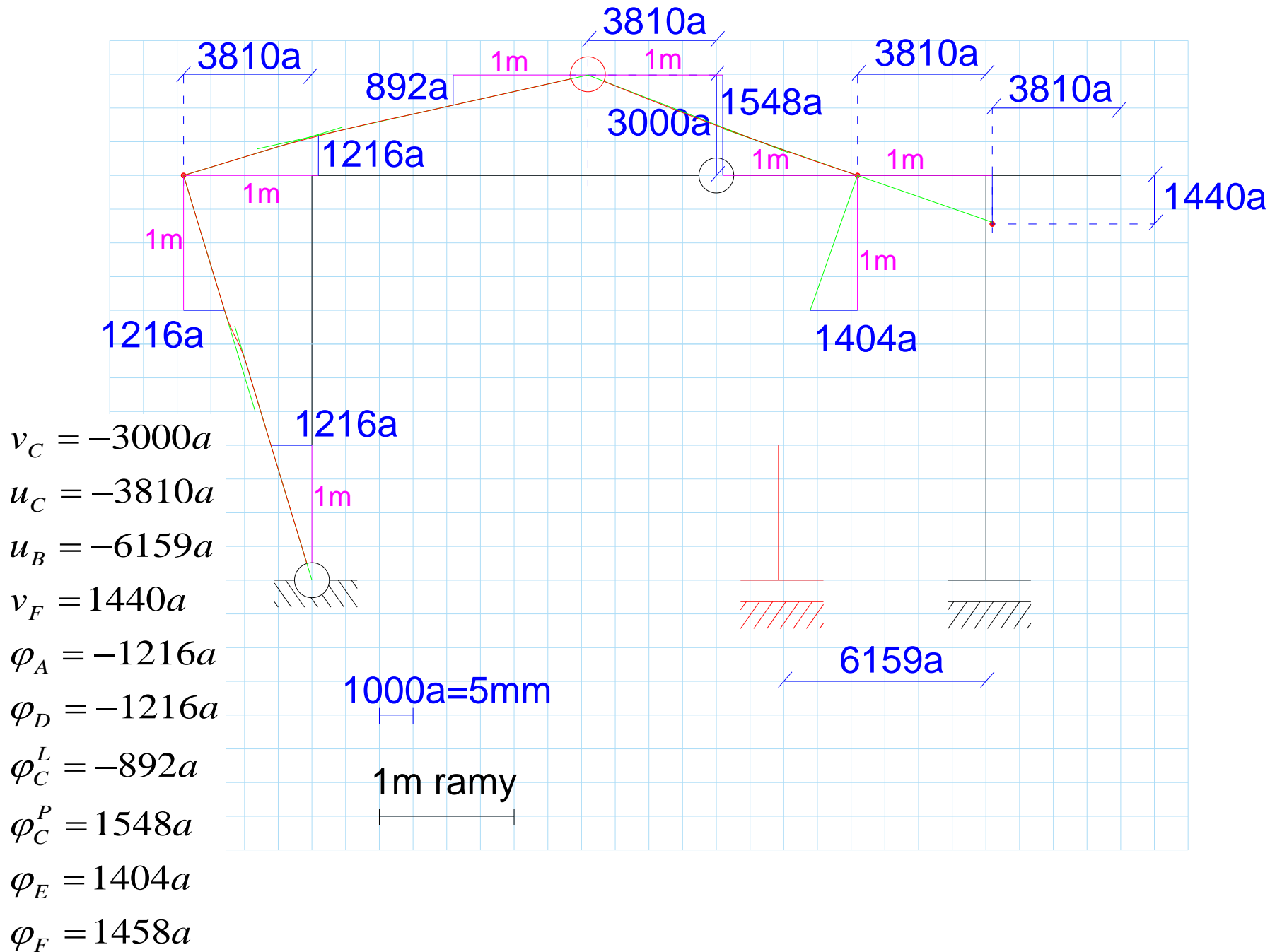


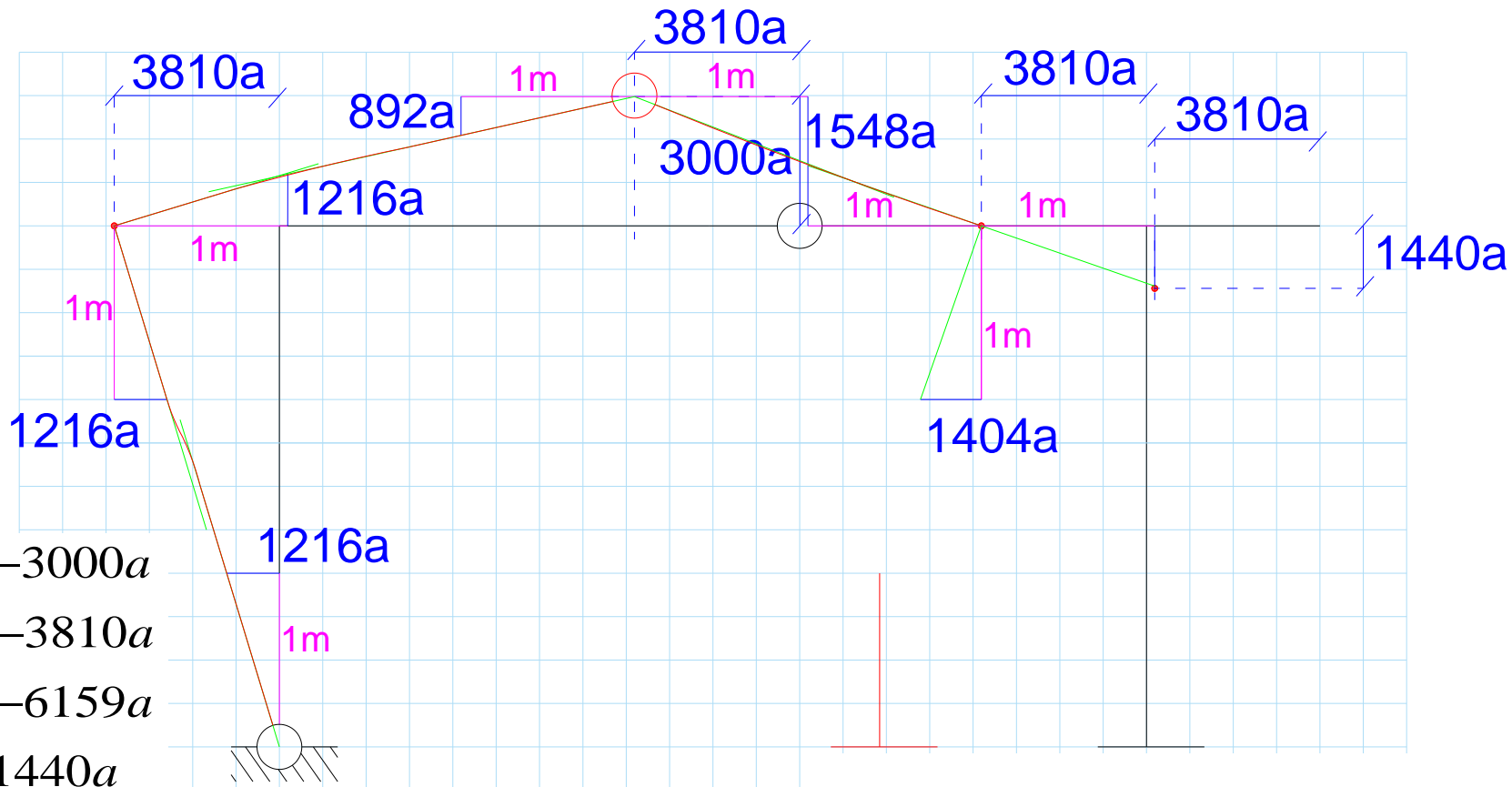






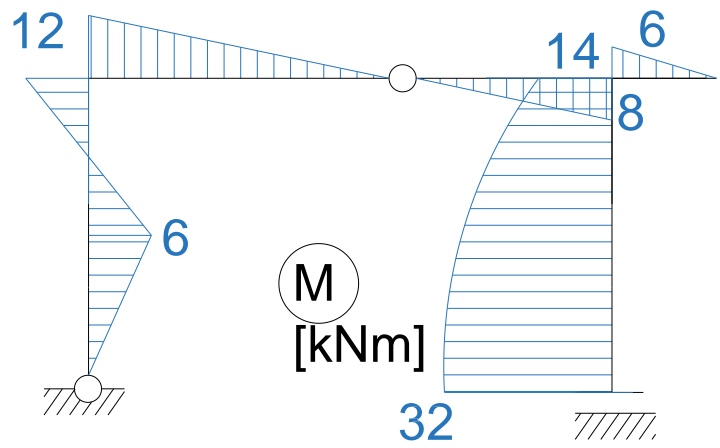


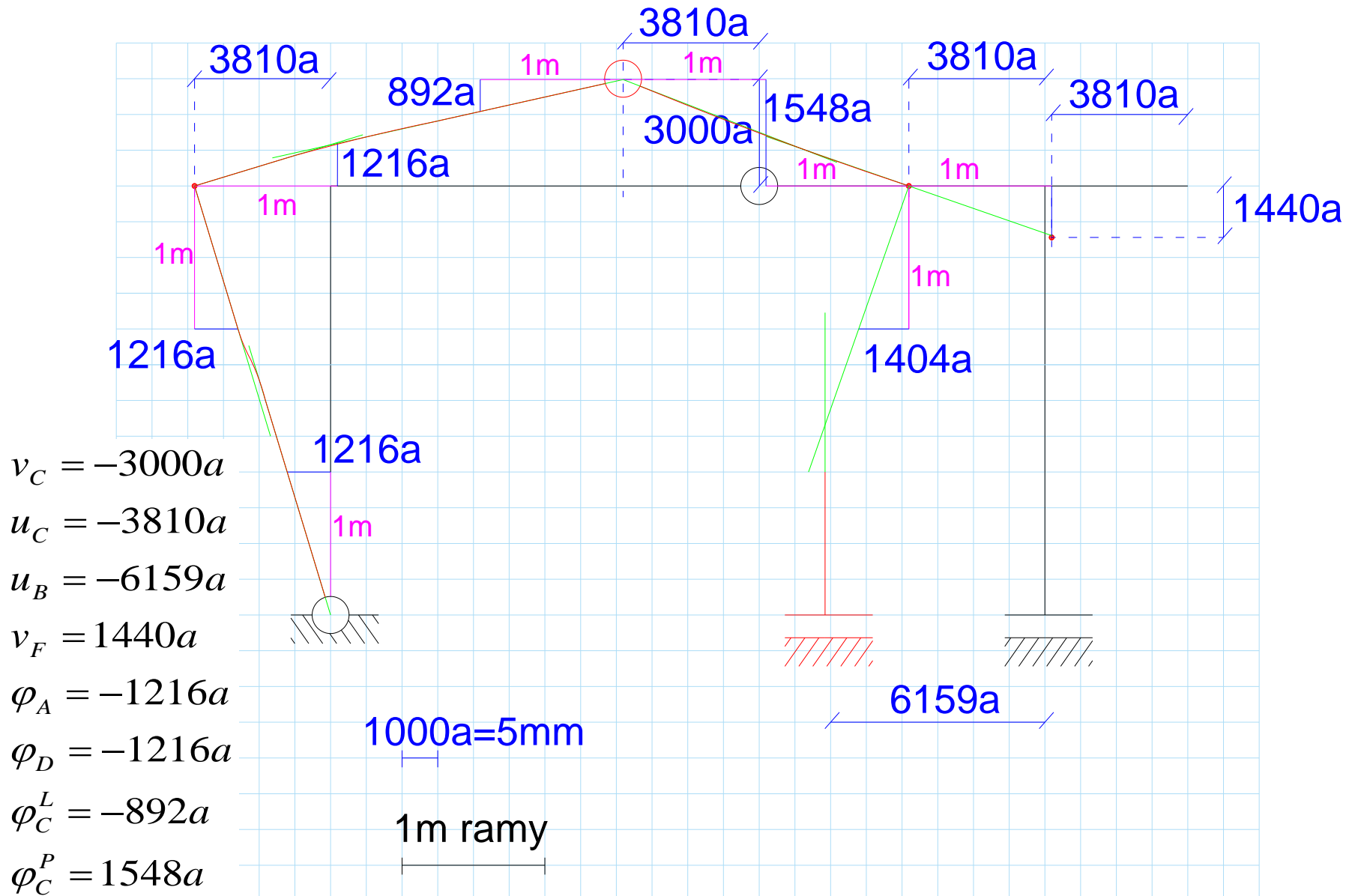


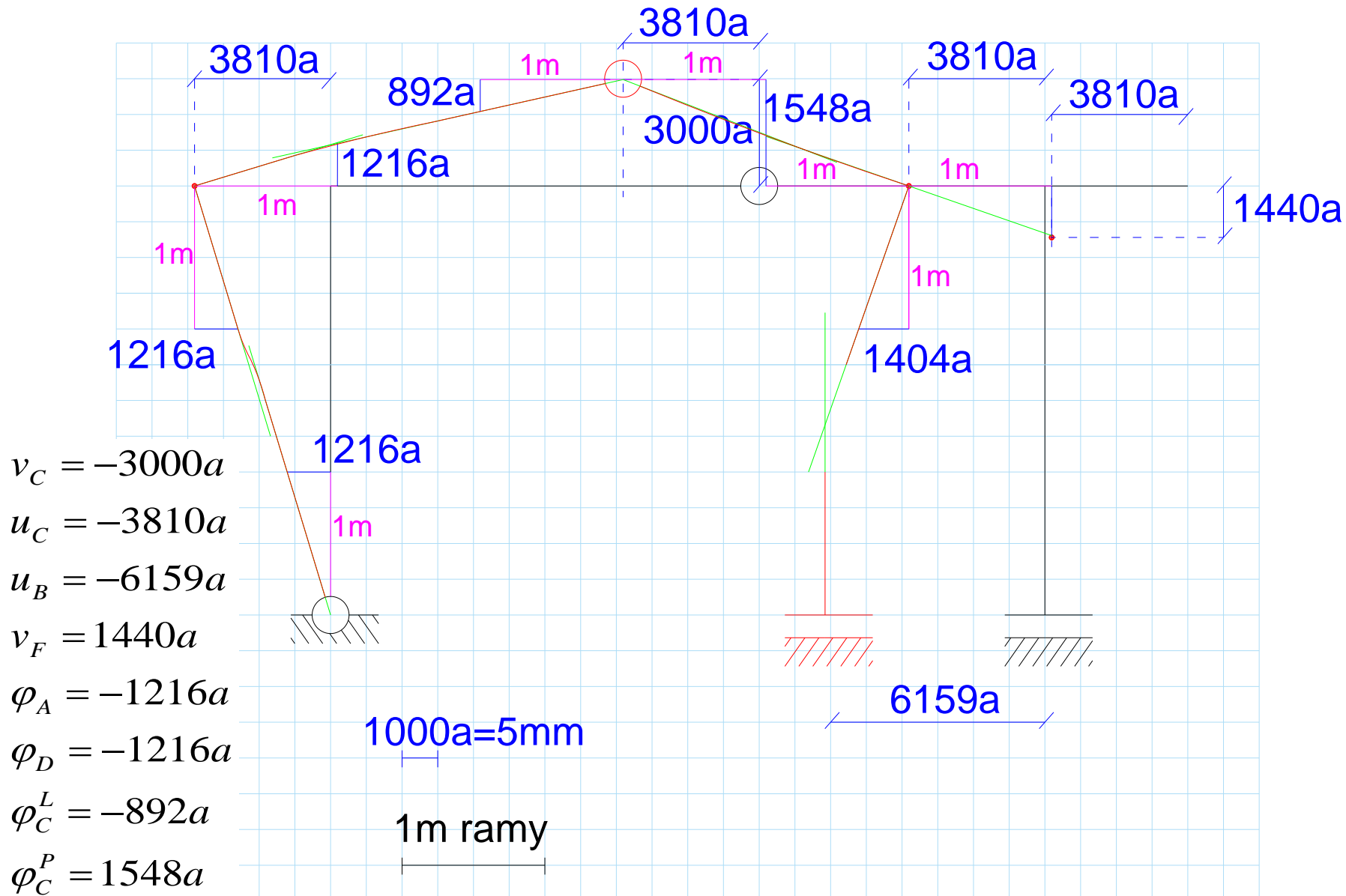


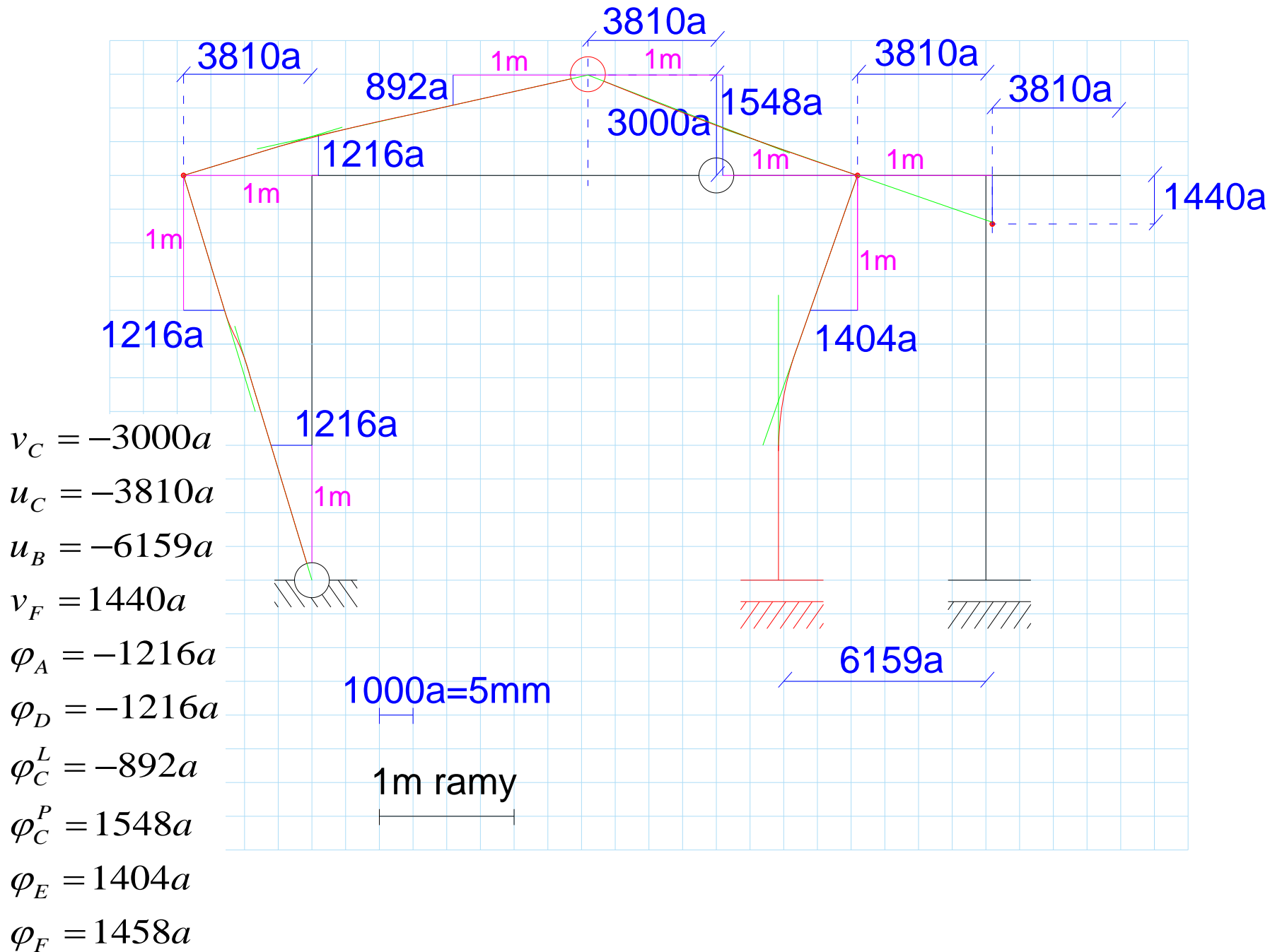
- $v_C = -3000a$
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- $\varphi_E = 1404a$
- $\varphi_F = 1458a$

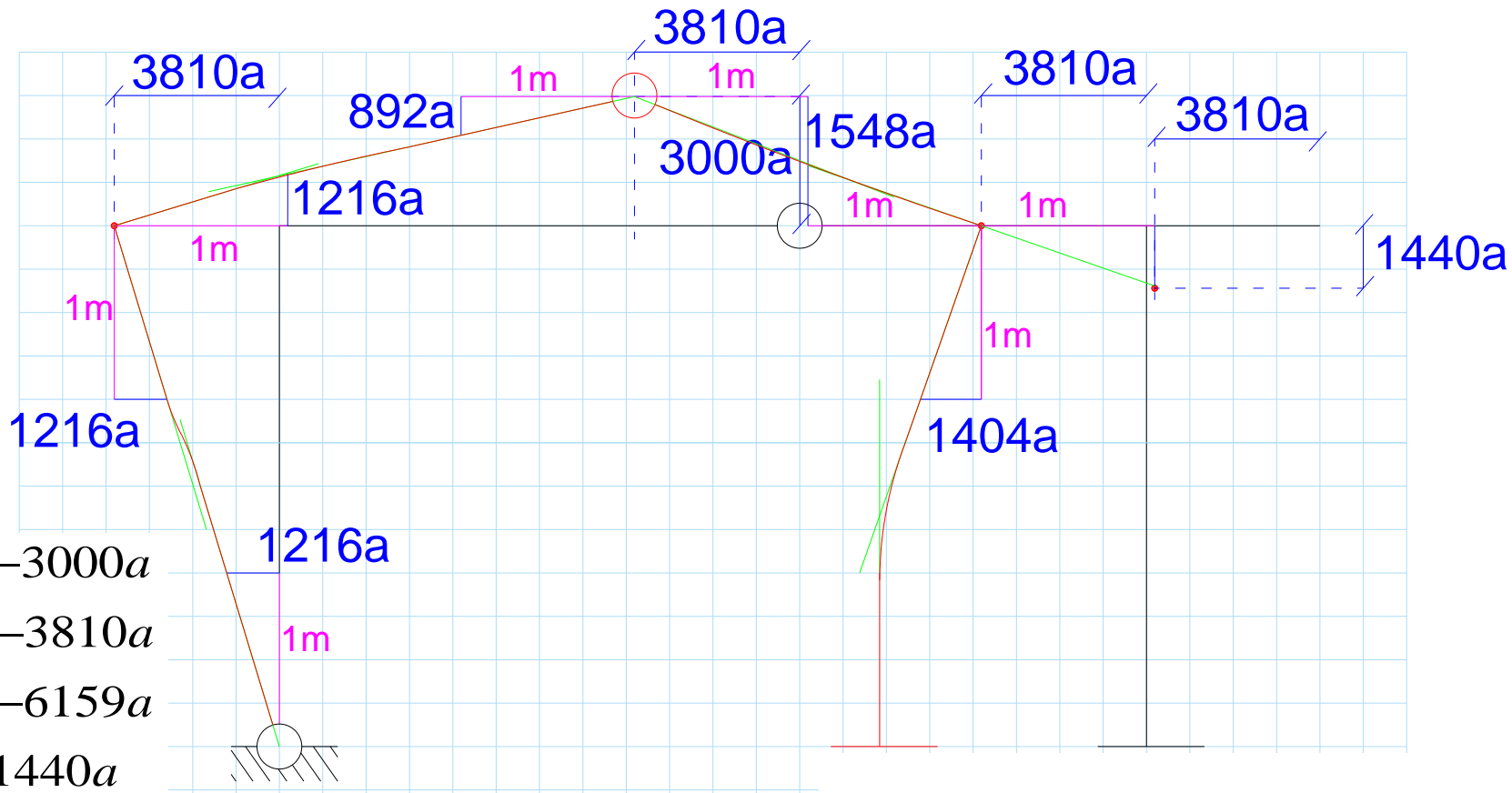
$1000a = 5mm$
 1m ramy





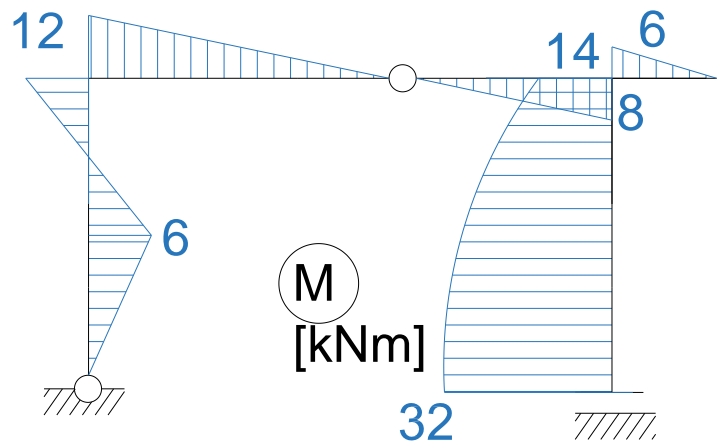


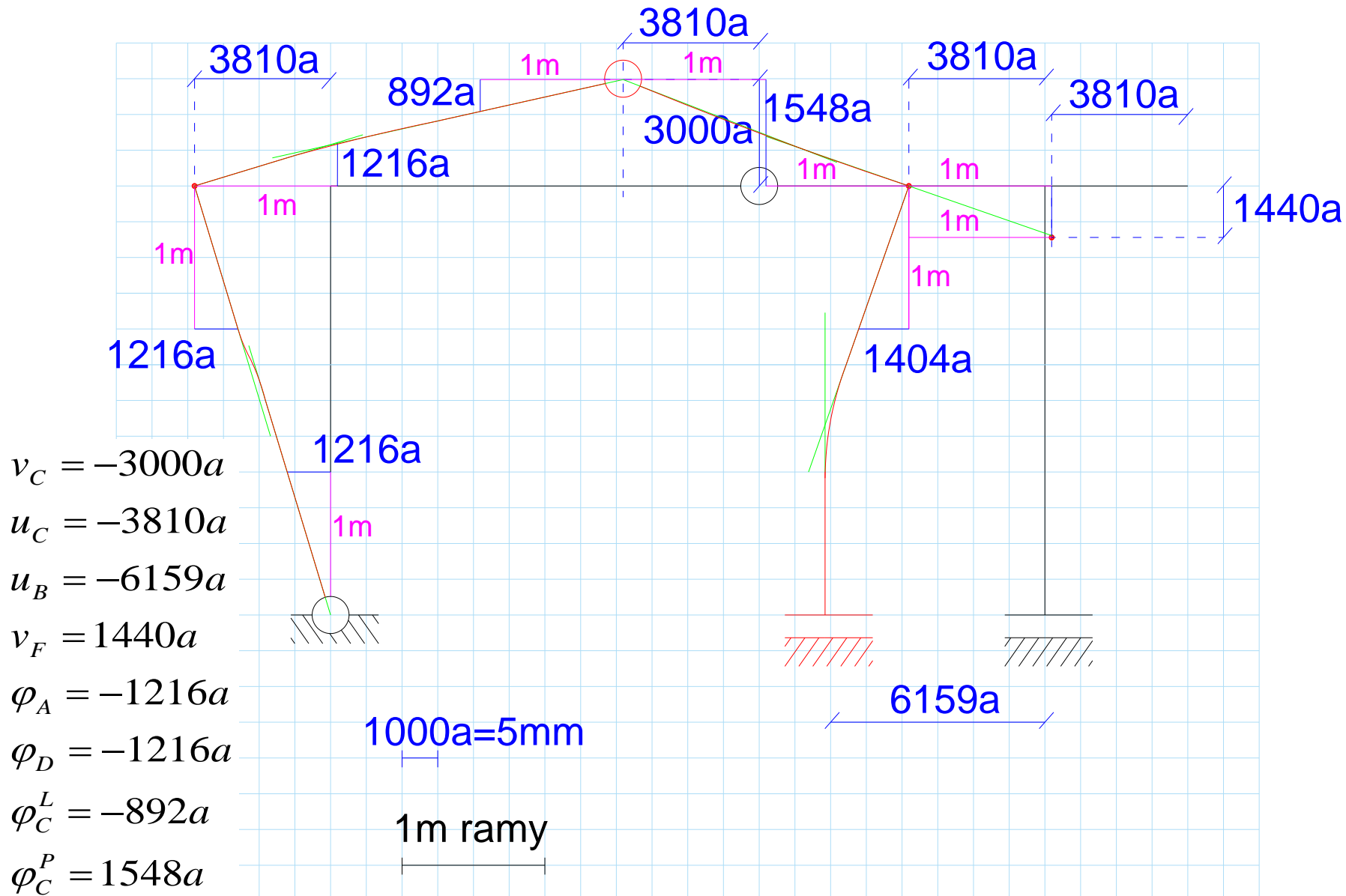


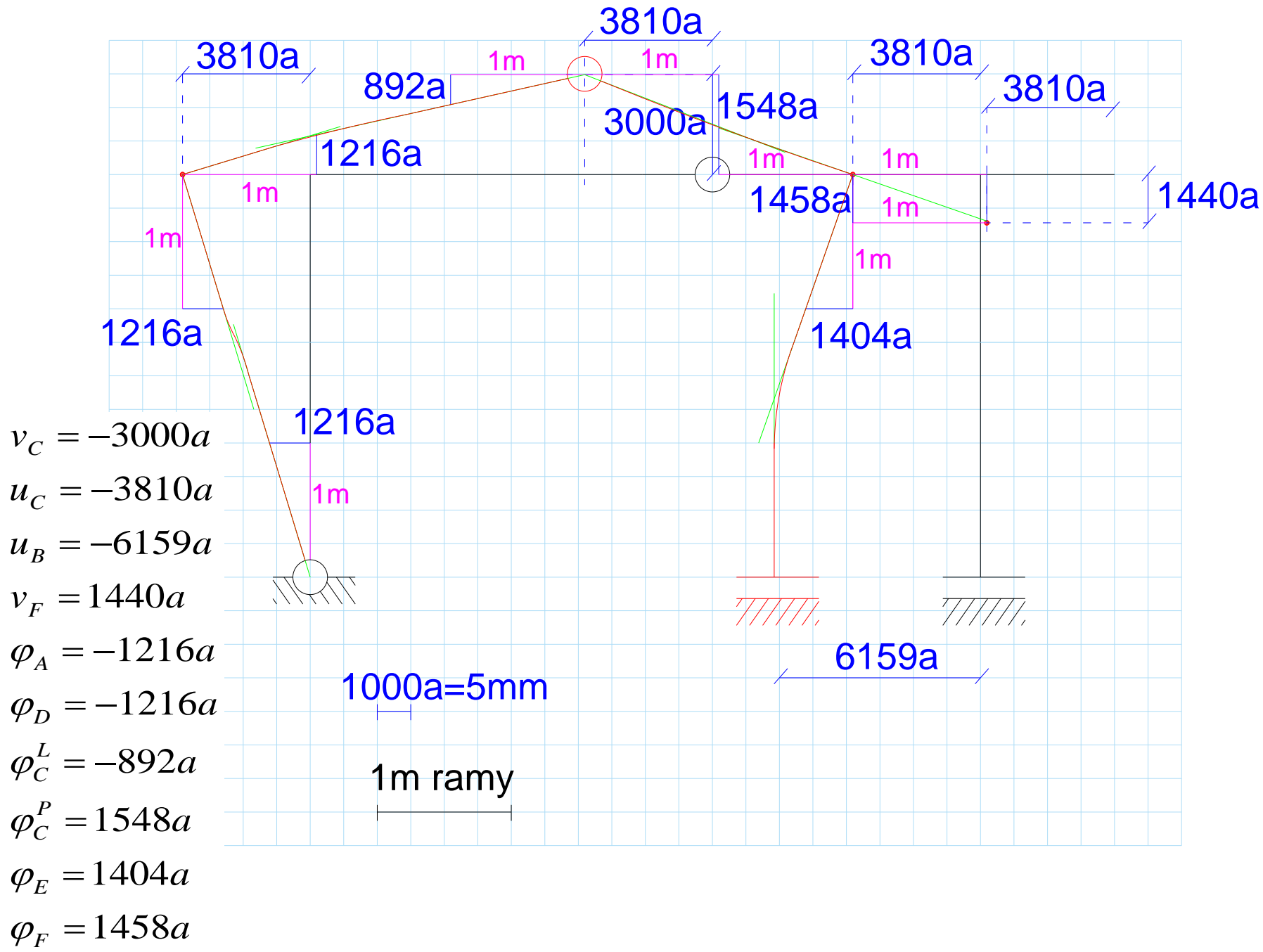


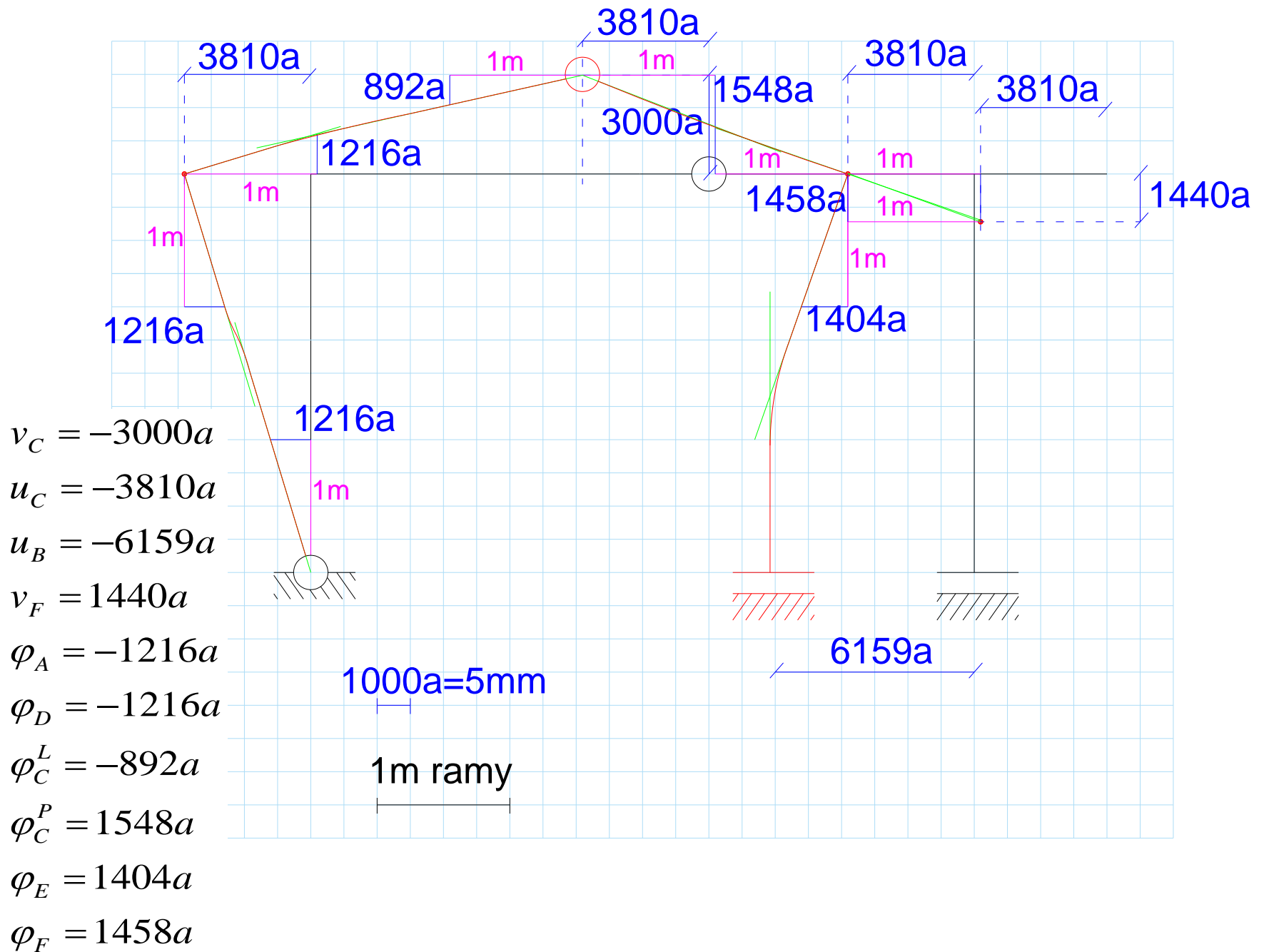
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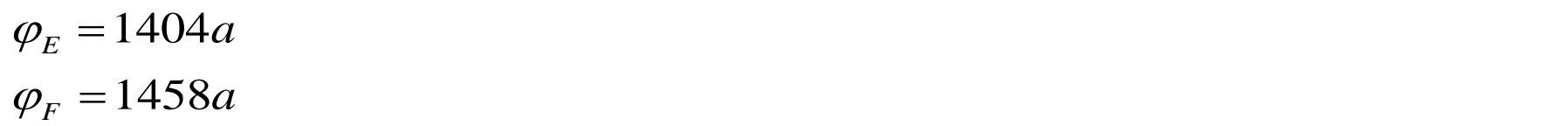
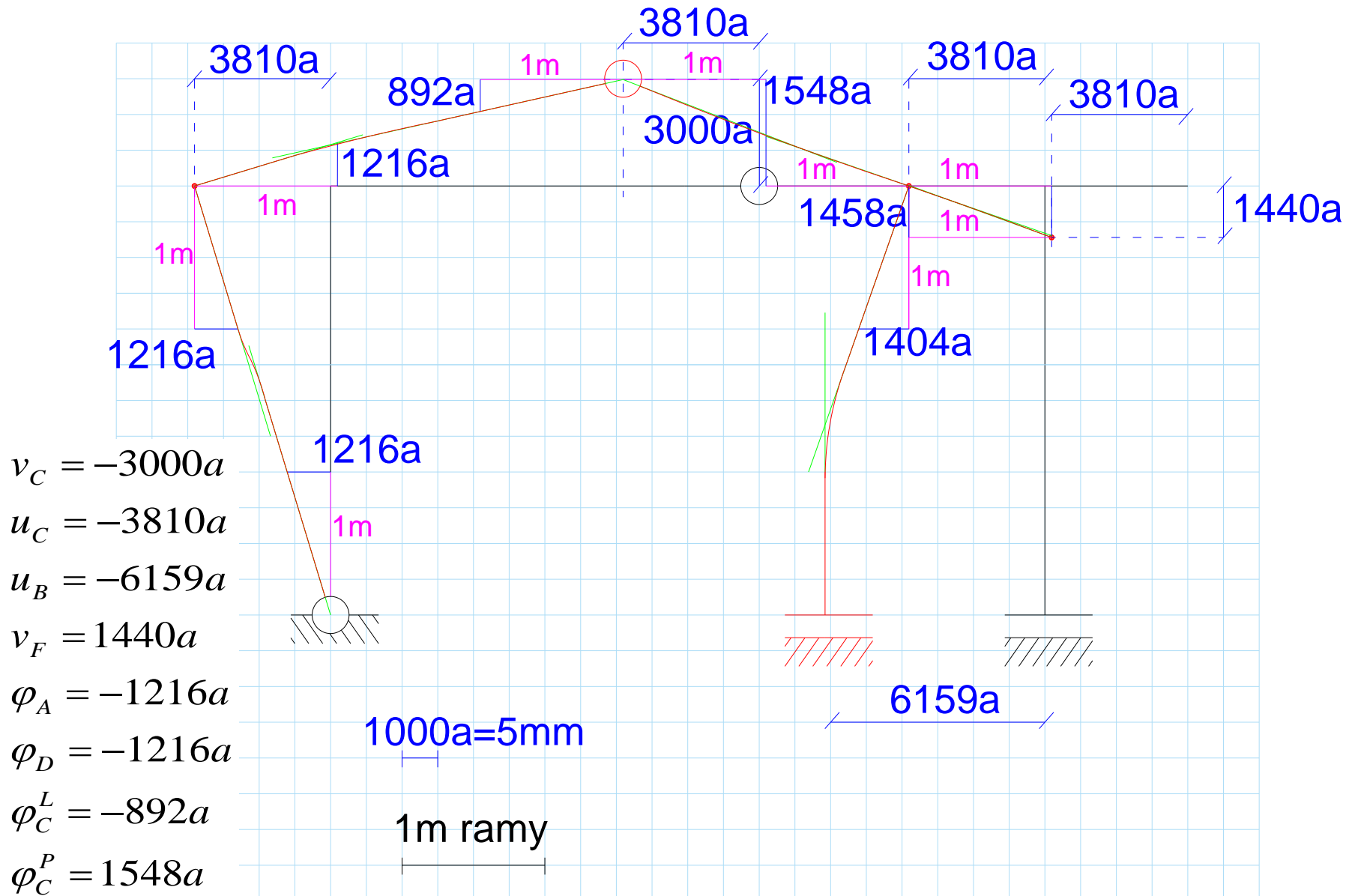
$1000a = 5\text{mm}$
 1m ramy

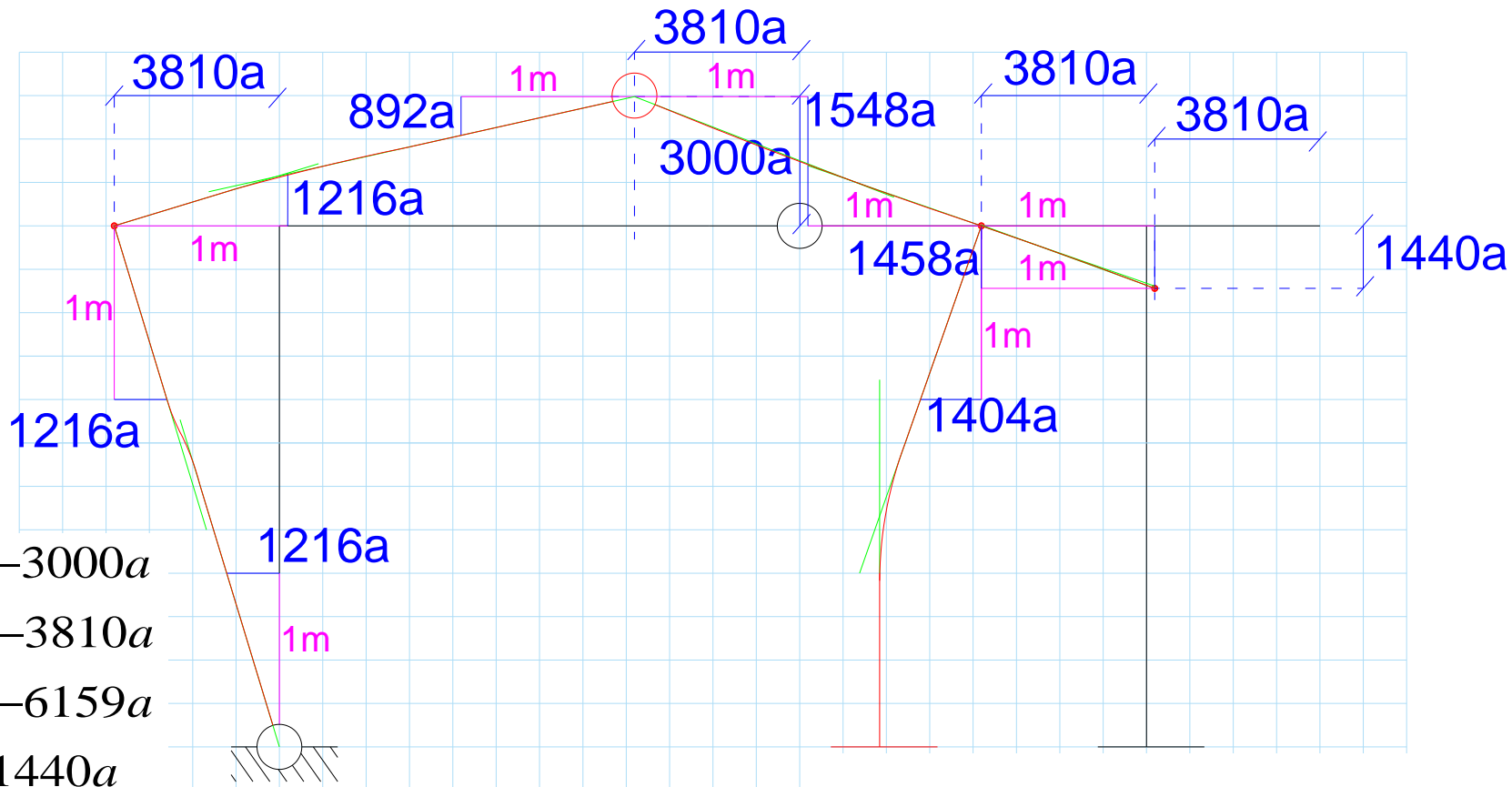






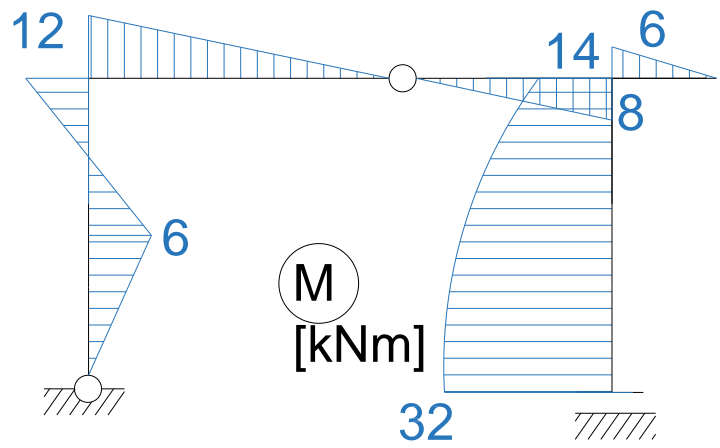






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