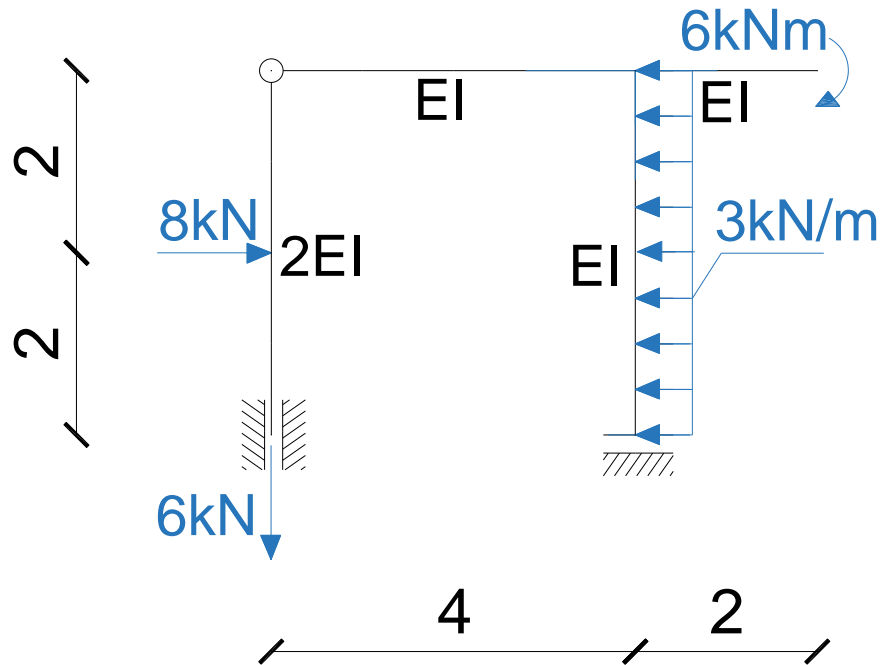
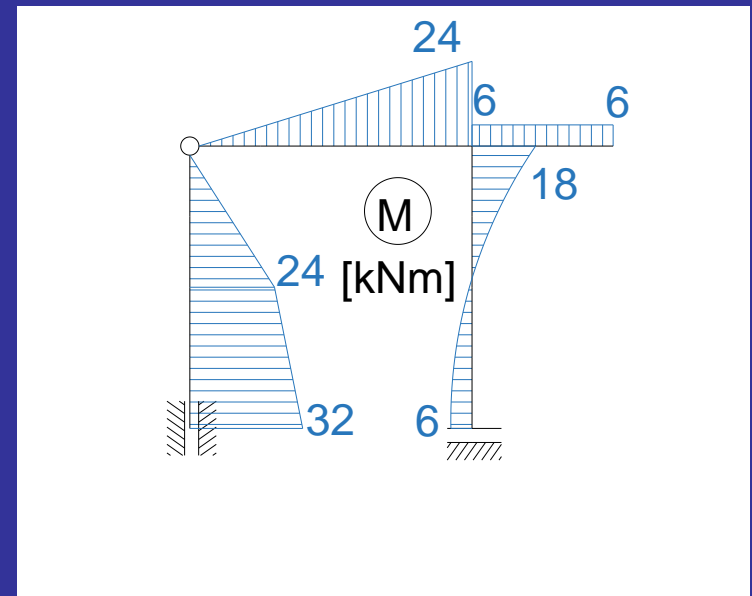
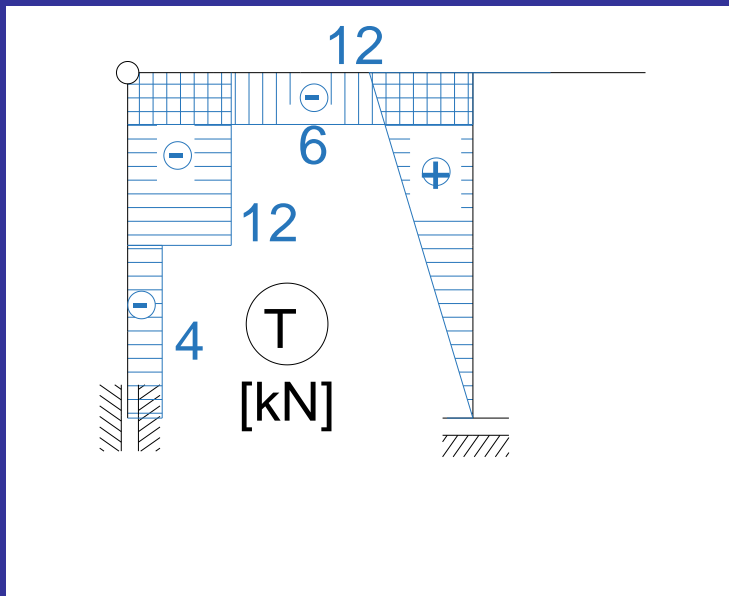
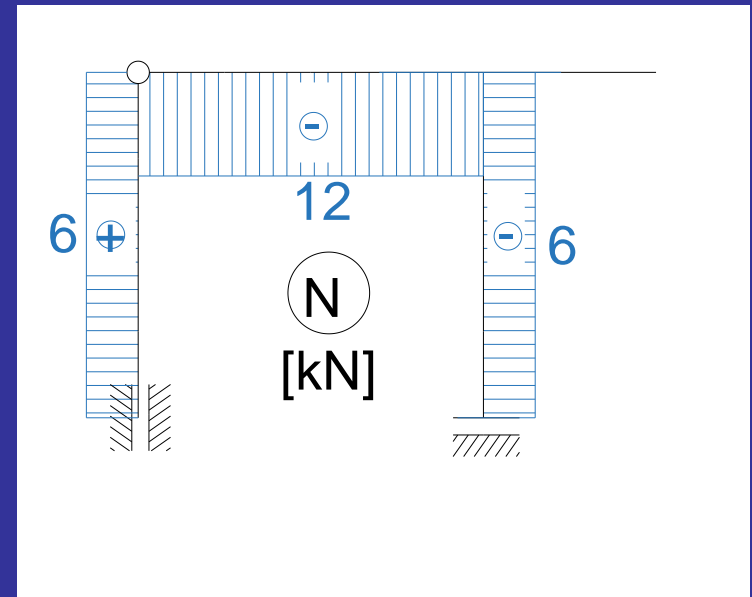
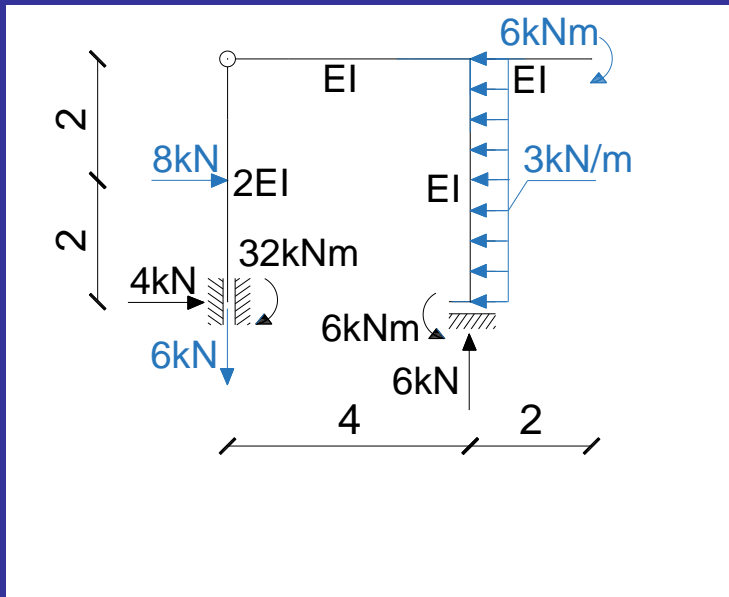


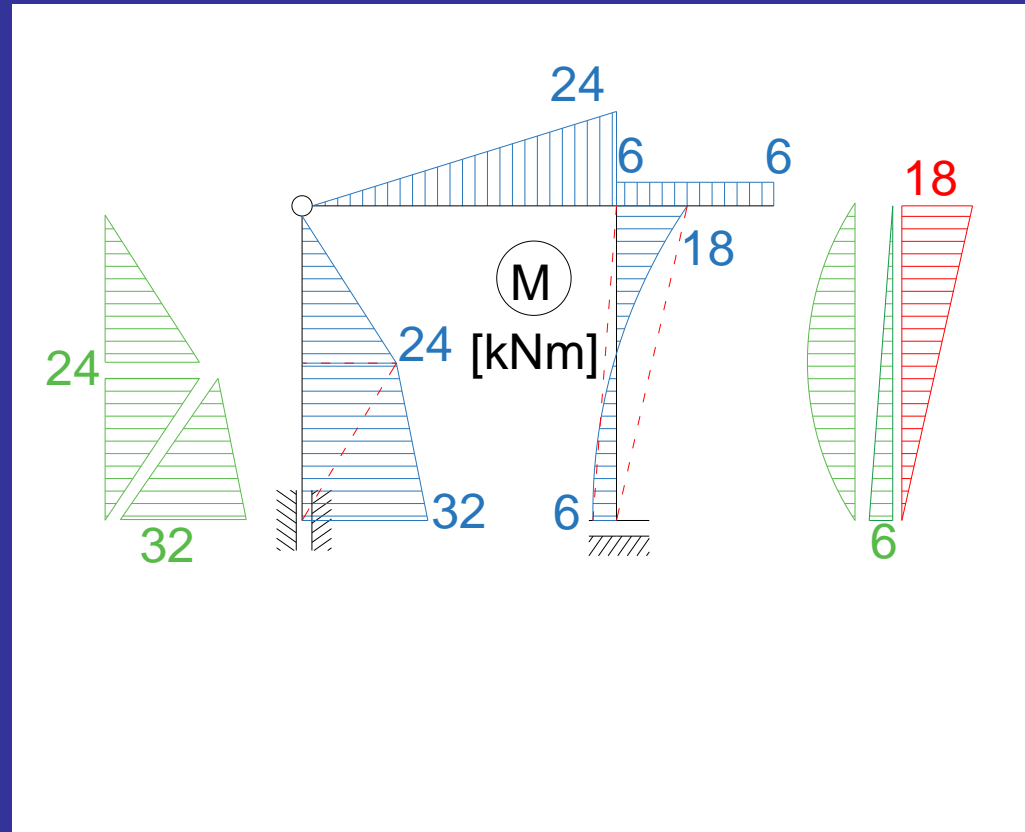
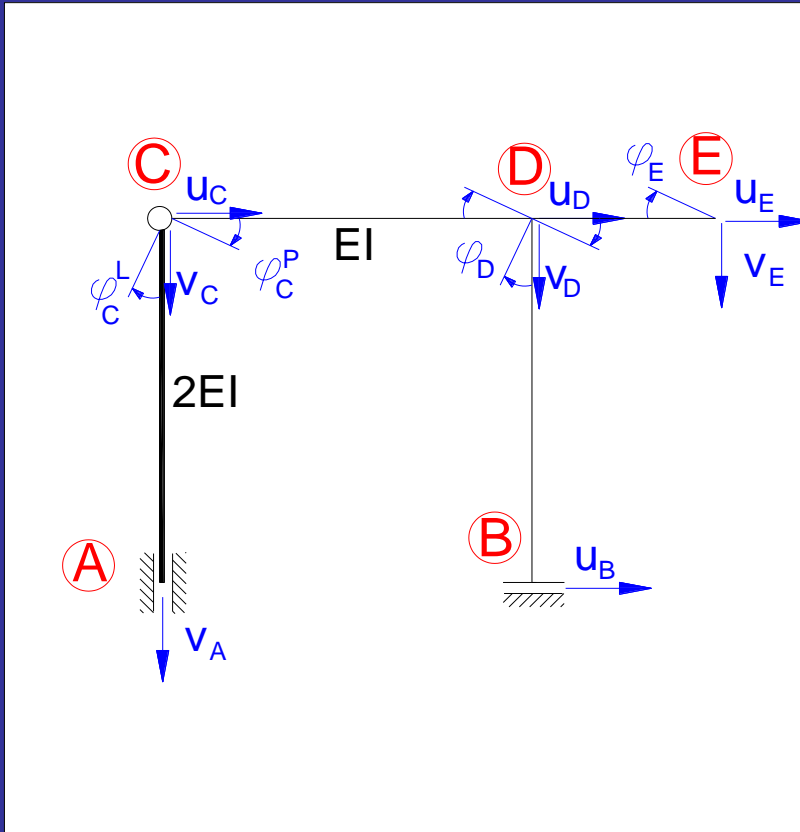
# Obliczenia przemieszczeń z zasady prac wirtualnych:



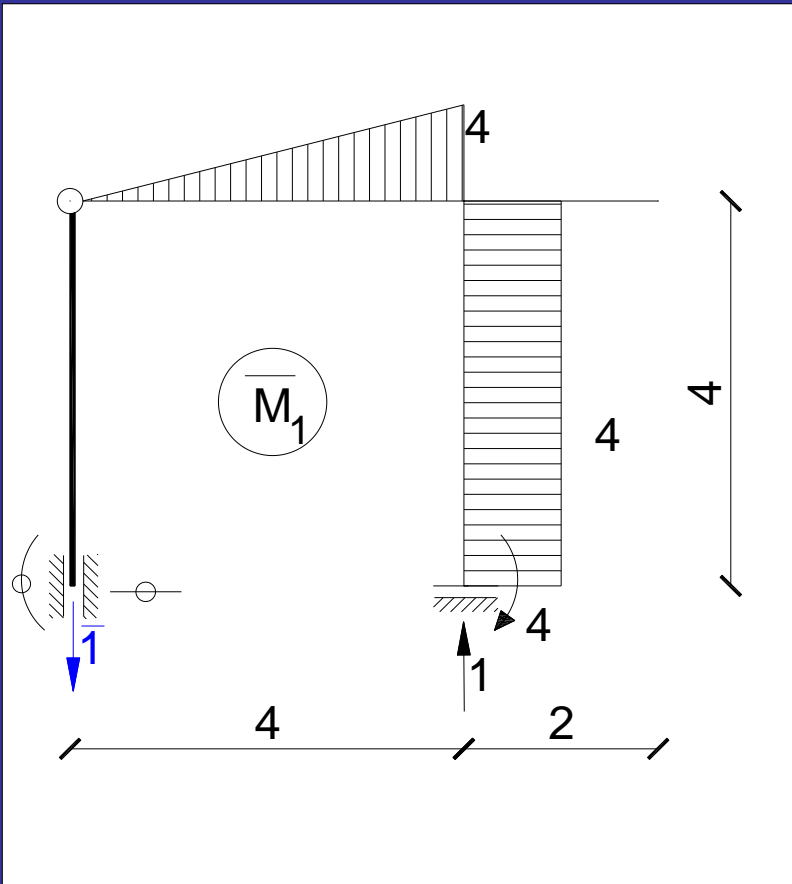
# Wykresy sił wewnętrznych:



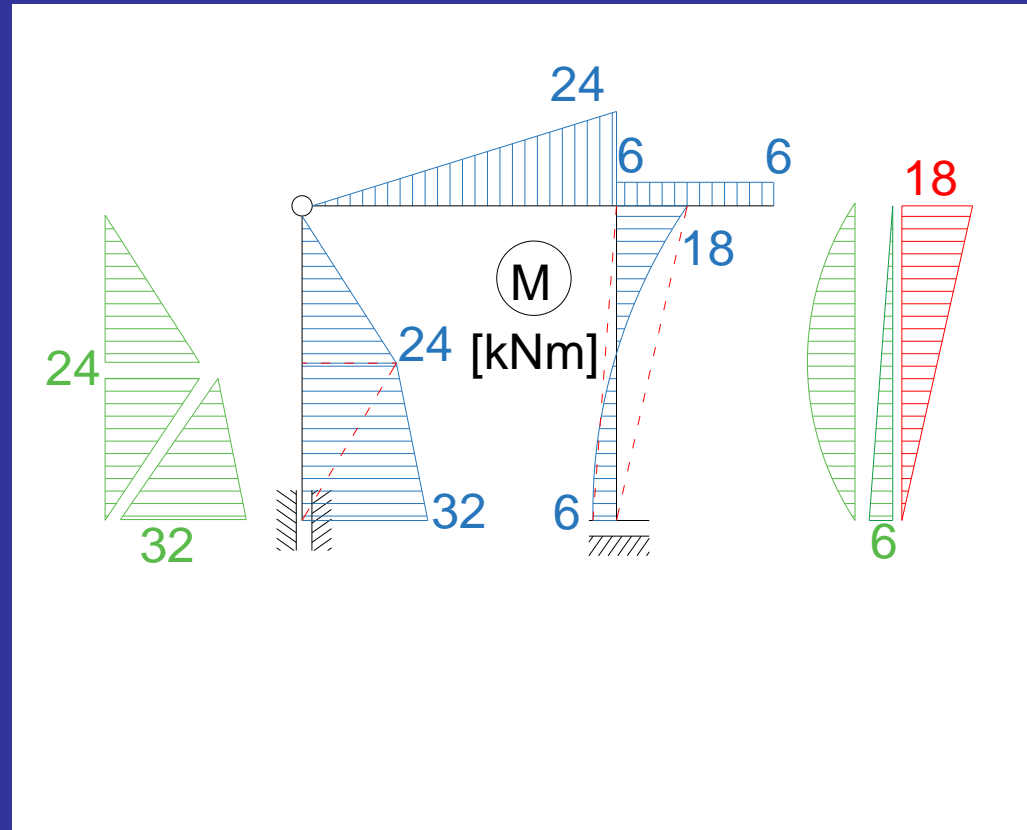
# Obliczenia przemieszczeń z zasady prac wirtualnych:



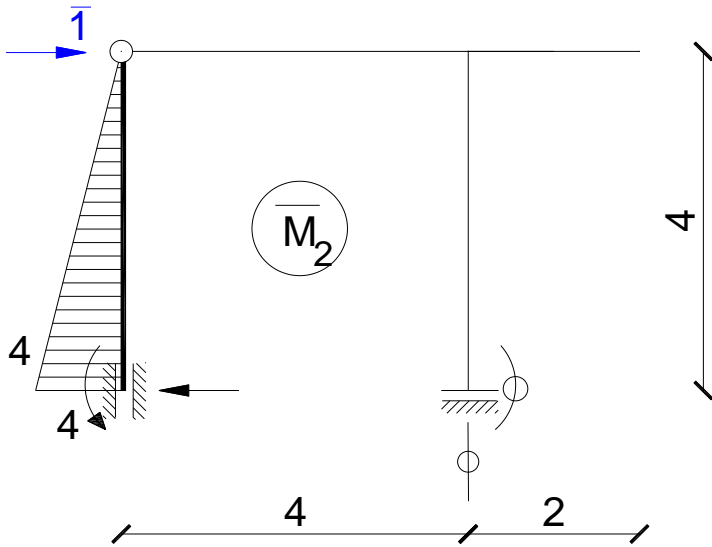
# Obliczenia przemieszczeń z zasady prac wirtualnych:



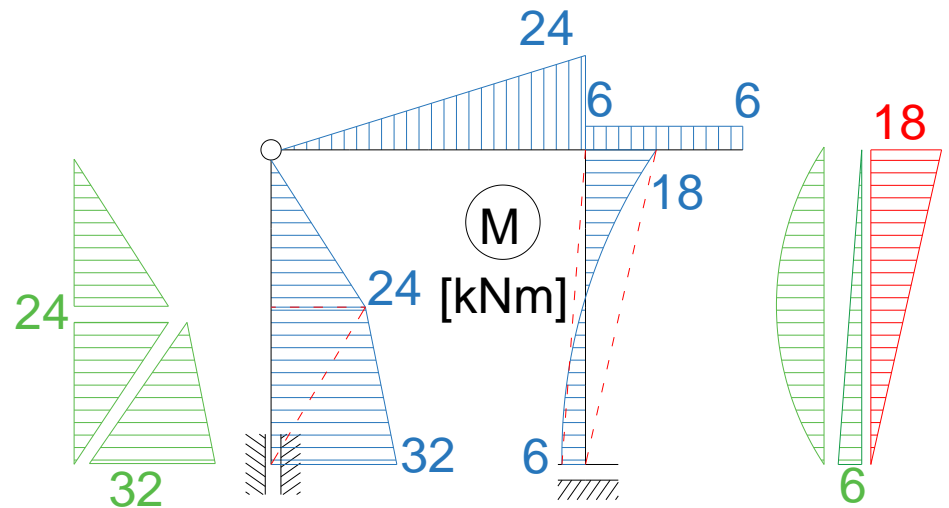
$$v_A = v_C = \frac{160}{EI}$$



# Obliczenia przemieszczeń z zasady prac wirtualnych:

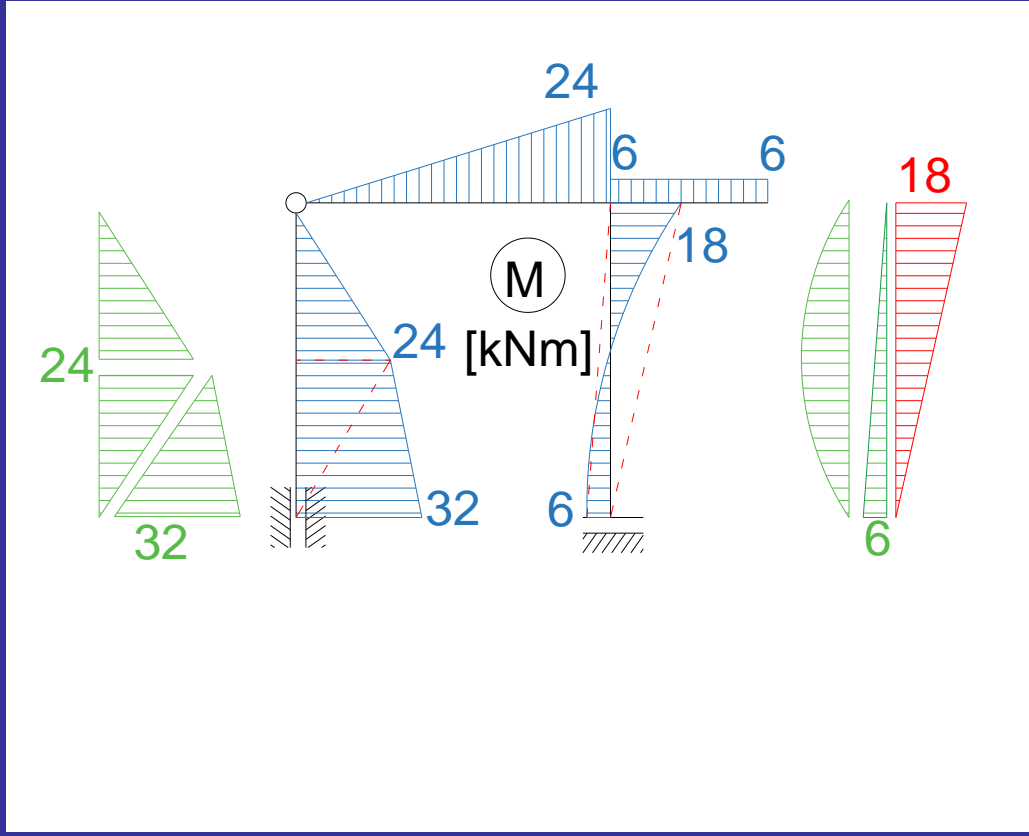
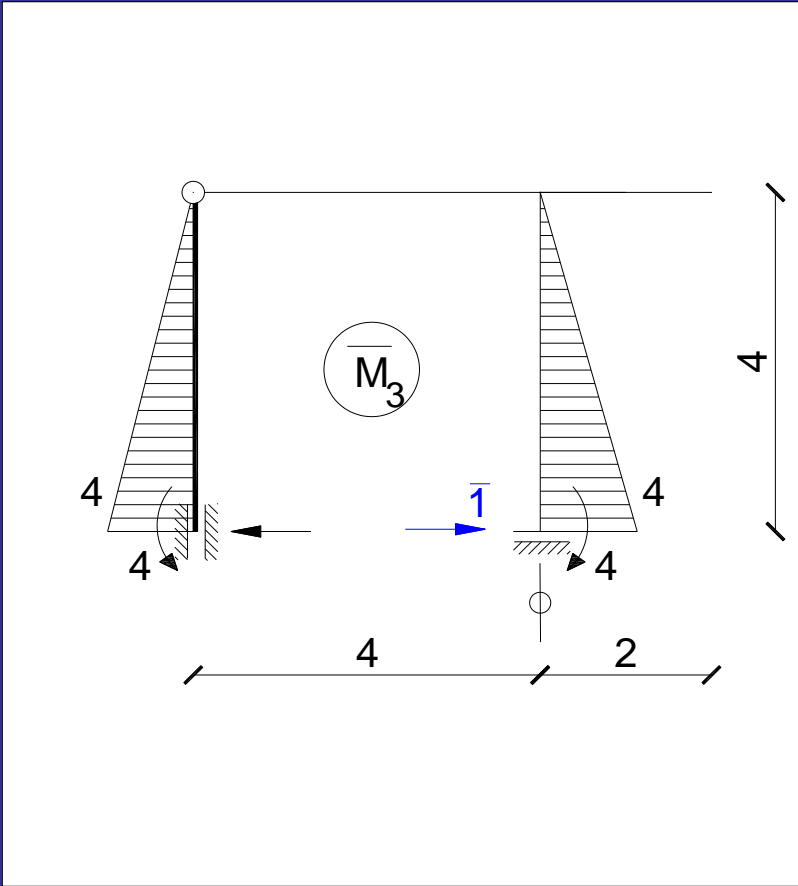


$$u_C = u_D = u_E = -\frac{304}{3EI}$$

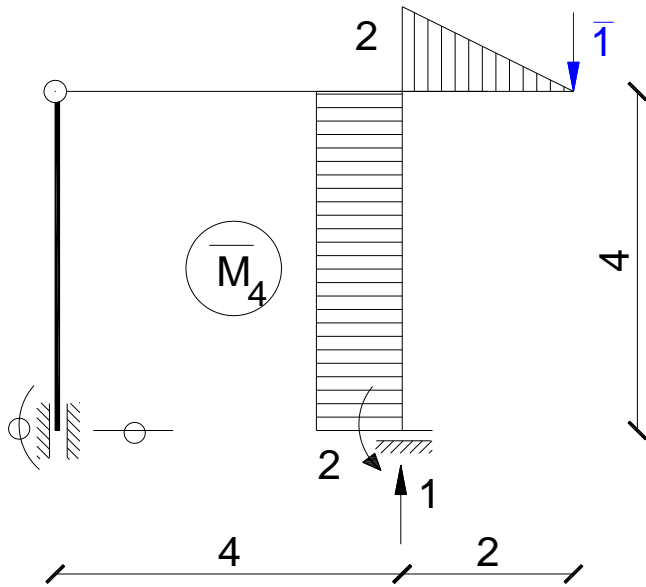


# Obliczenia przemieszczeń z zasady prac wirtualnych:

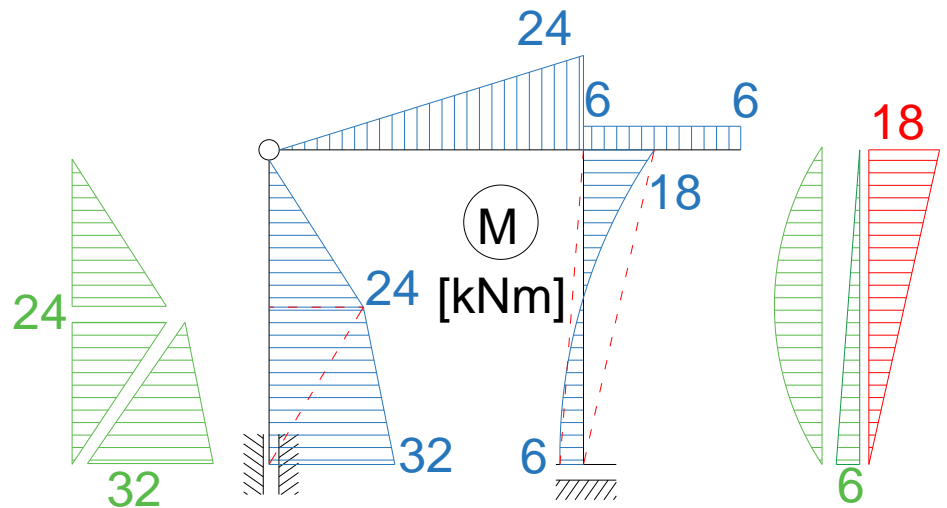
$$u_B = -\frac{352}{3EI}$$



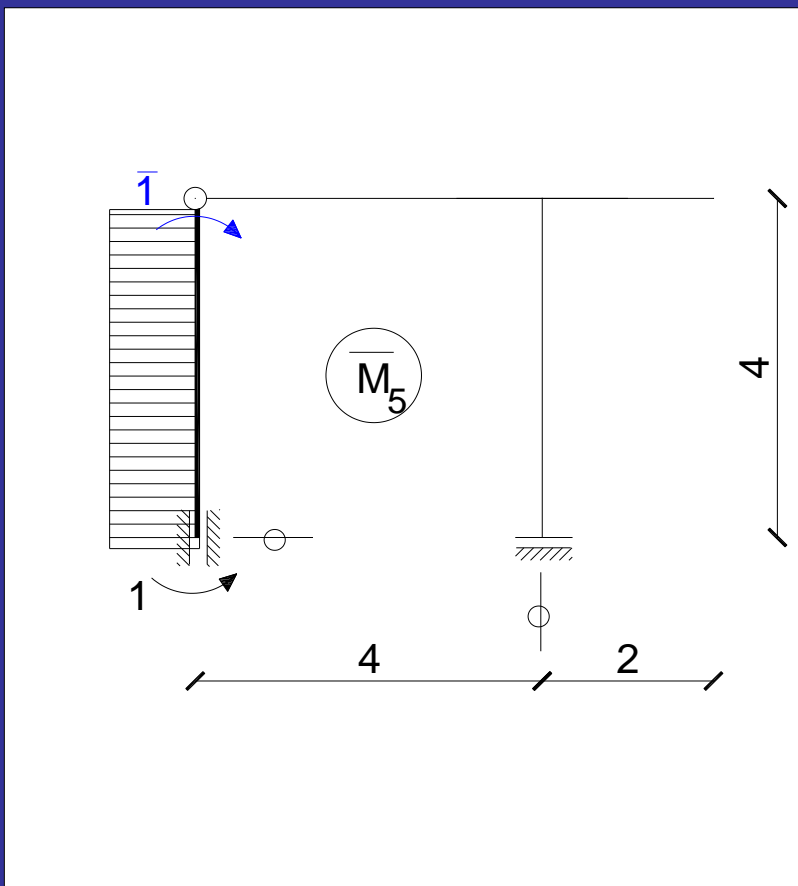
# Obliczenia przemieszczeń z zasady prac wirtualnych:



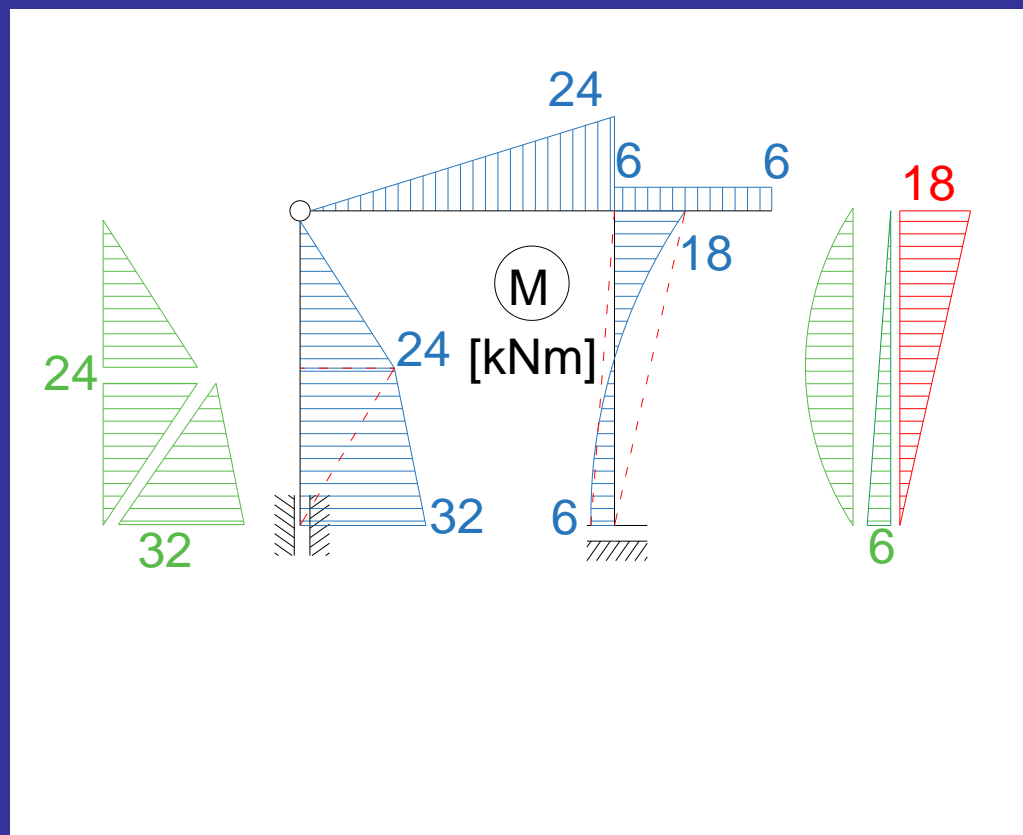
$$v_E = -\frac{4}{EI}$$



# Obliczenia przemieszczeń z zasady prac wirtualnych:

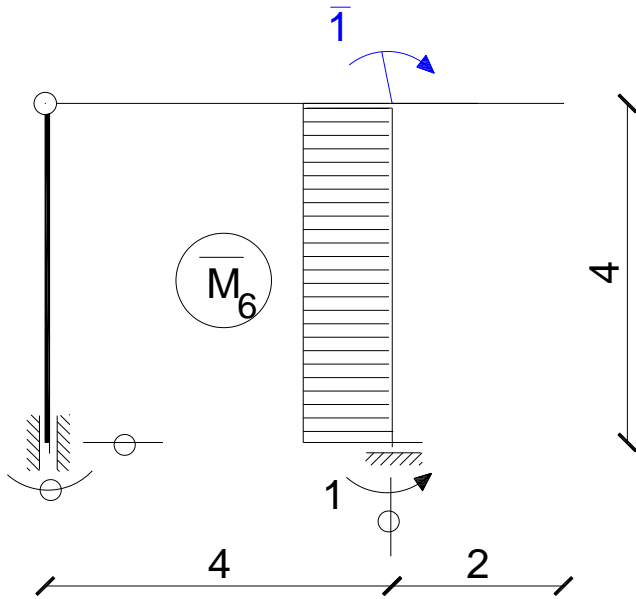


$$\varphi_C^L = -\frac{40}{EI}$$

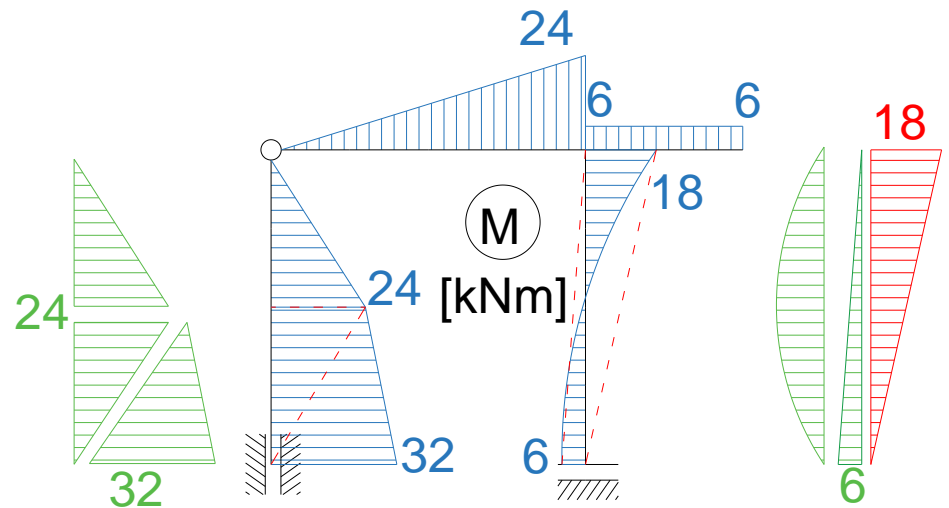




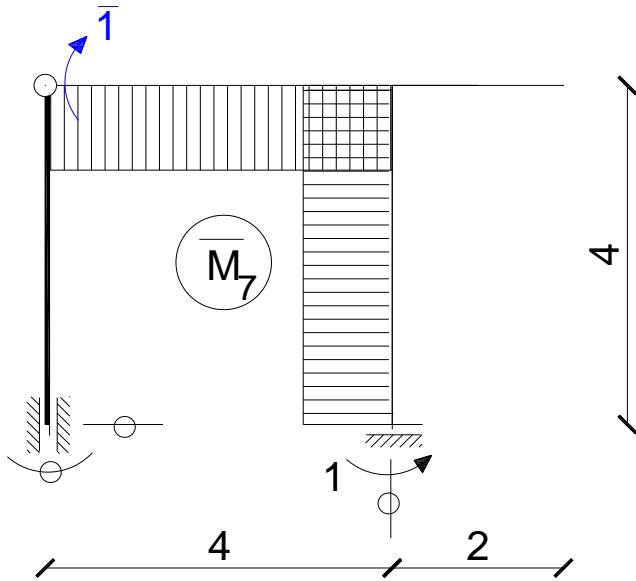
# Obliczenia przemieszczeń z zasady prac wirtualnych:



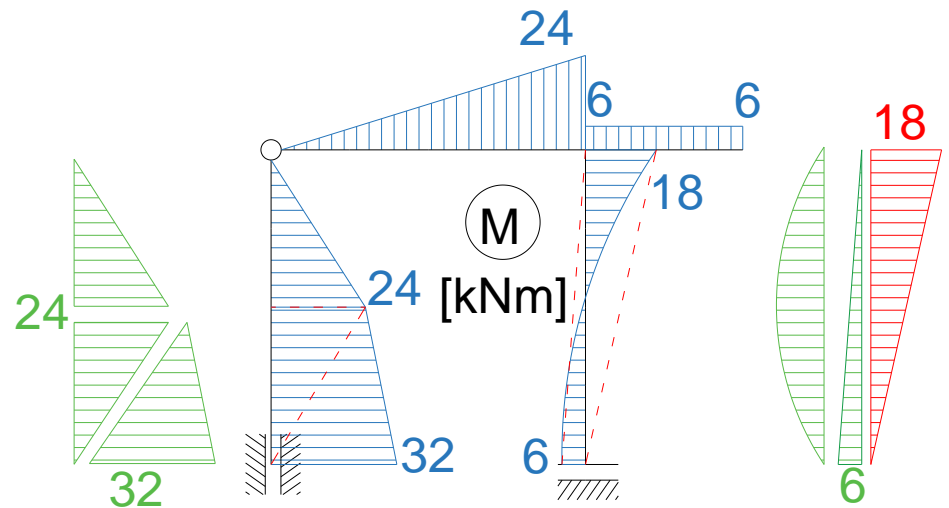
$$\varphi_D = -\frac{8}{EI}$$



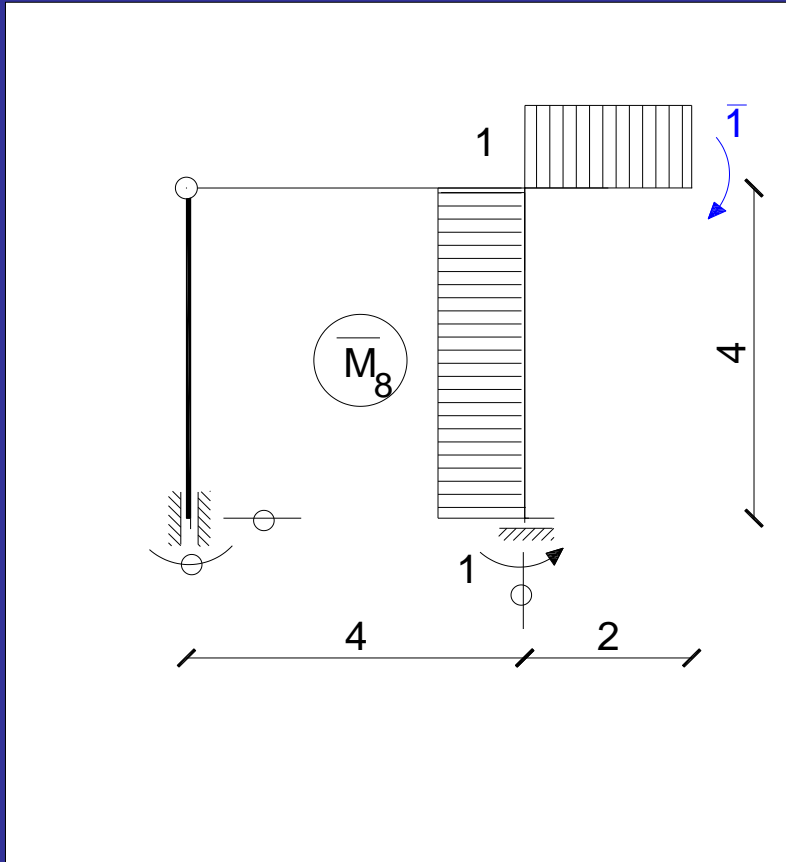
# Obliczenia przemieszczeń z zasady prac wirtualnych:



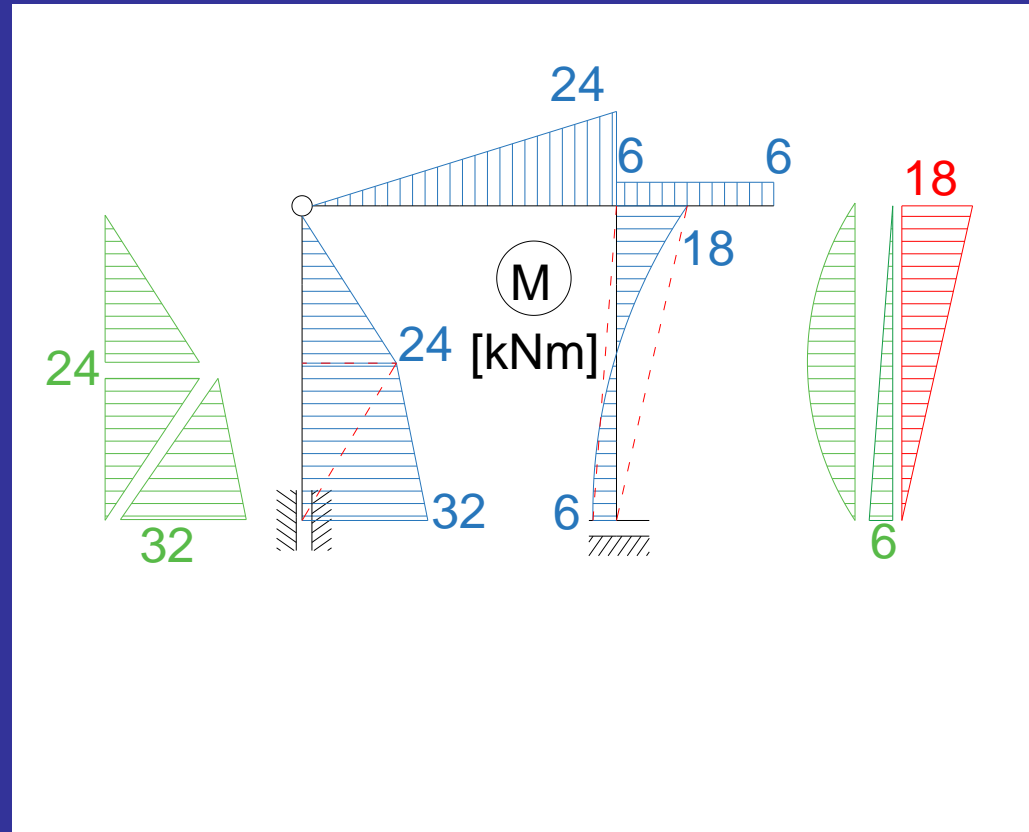
$$\varphi_C^P = -\frac{8}{EI} + \frac{1}{EI} \left( -\frac{1}{2} \cdot 24 \cdot 4 \cdot 1 \right) = -\frac{56}{EI}$$



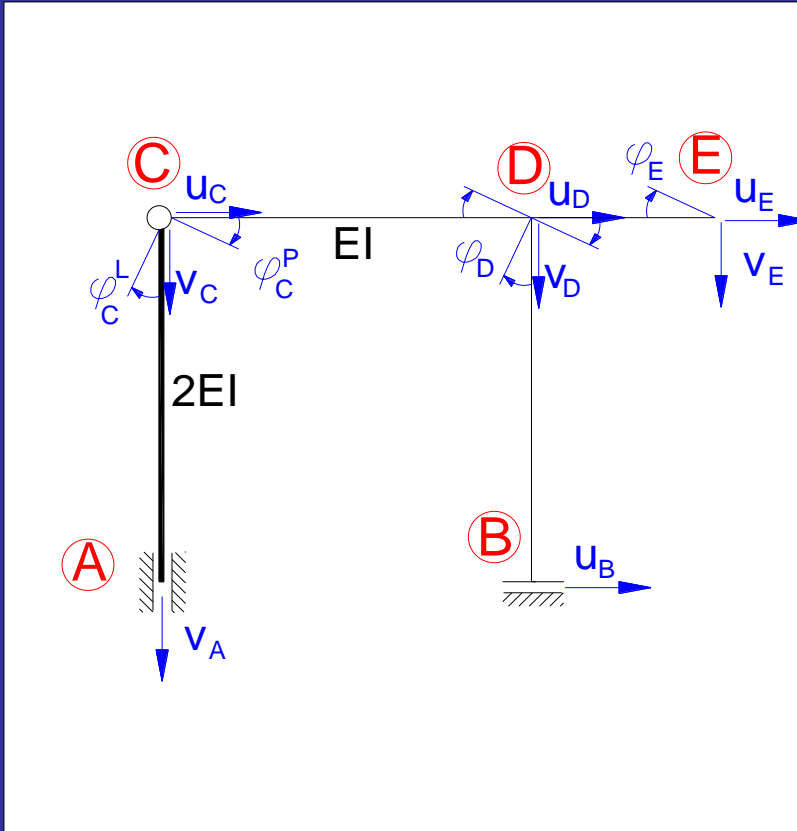
# Obliczenia przemieszczeń z zasady prac wirtualnych:



$$\varphi_E = -\frac{8}{EI} + \frac{1}{EI}(6 \cdot 2 \cdot 1) = \frac{4}{EI}$$



# Odształcona postać ramy:



Założenie  $1/3EI = a \rightarrow$

$$v_A = v_C = \frac{160}{EI} = \frac{480}{3EI}$$

$$u_C = u_D = u_E = -\frac{304}{3EI}$$

$$u_B = -\frac{352}{3EI}$$

$$v_E = -\frac{4}{EI} = -\frac{12}{3EI}$$

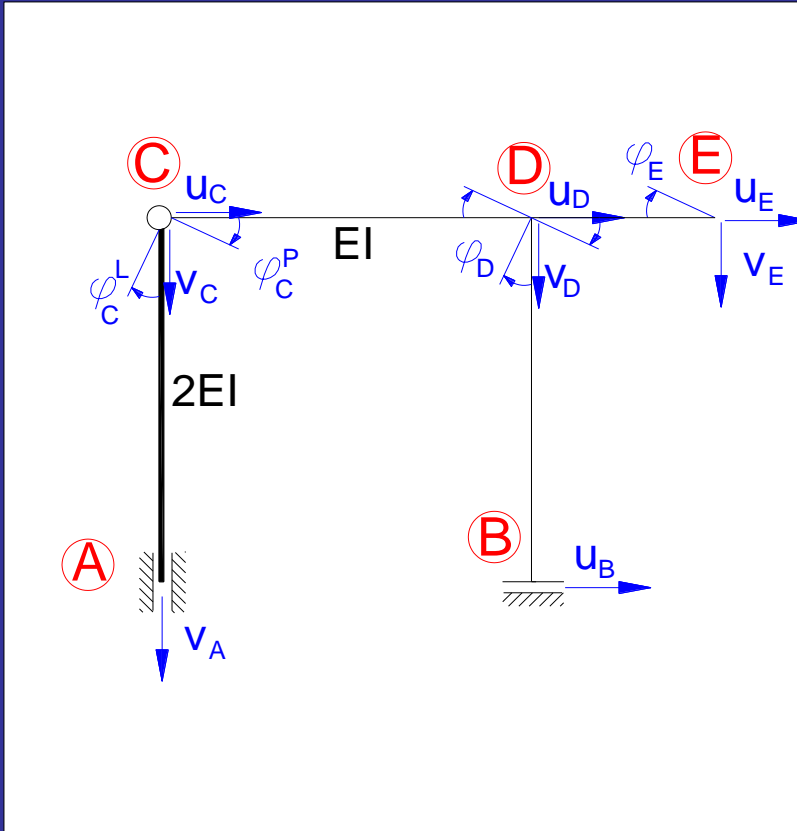
$$\varphi_C^L = -\frac{40}{EI} = -\frac{120}{3EI}$$

$$\varphi_C^P = -\frac{56}{EI} = -\frac{168}{3EI}$$

$$\varphi_D = -\frac{8}{EI} = -\frac{24}{3EI}$$

$$\varphi_E = \frac{4}{EI} = \frac{12}{3EI}$$

# Odształcona postać ramy:



Założenie  $1/3EI=a \rightarrow$

$$v_A = v_C = \frac{160}{EI} = \frac{480}{3EI} = 480a$$

$$u_C = u_D = u_E = -\frac{304}{3EI} = -304a$$

$$u_B = -\frac{352}{3EI} = -352a$$

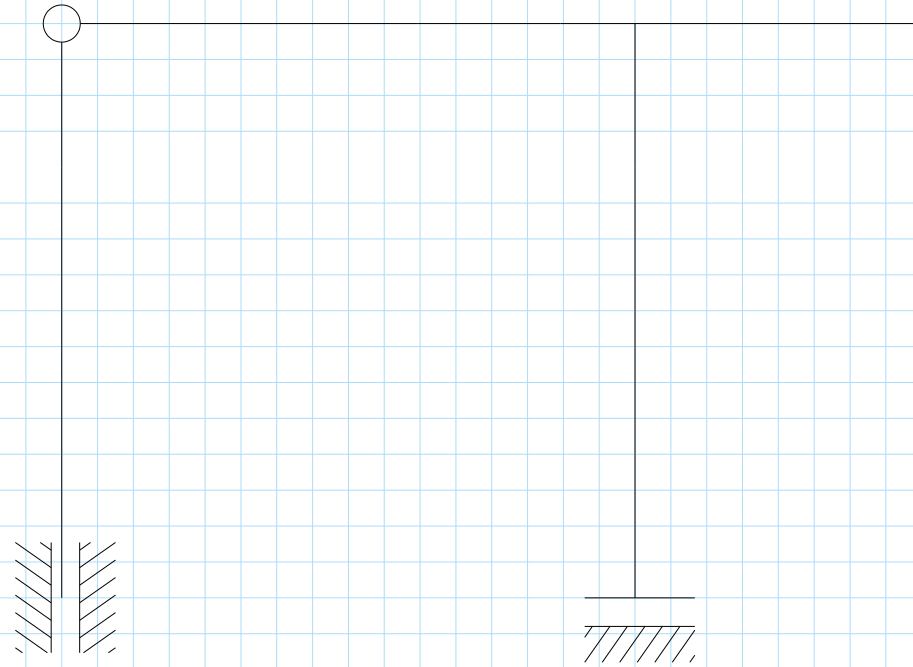
$$v_E = -\frac{4}{EI} = -\frac{12}{3EI} = -12a$$

$$\varphi_C^L = -\frac{40}{EI} = -\frac{120}{3EI} = -120a$$

$$\varphi_C^P = -\frac{56}{EI} = -\frac{168}{3EI} = -168a$$

$$\varphi_D = -\frac{8}{EI} = -\frac{24}{3EI} = -24a$$

$$\varphi_E = \frac{4}{EI} = \frac{12}{3EI} = 12a$$



$$v_A = v_C = 480a$$

$$u_C = u_D = u_E = -304a$$

$$u_B = -352a$$

$$v_E = -12a$$

$$\varphi_C^L = -120a$$

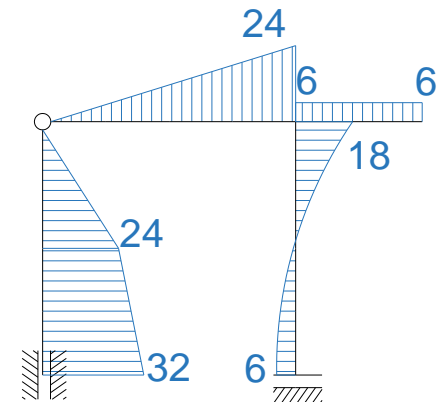
$$\varphi_C^P = -168a$$

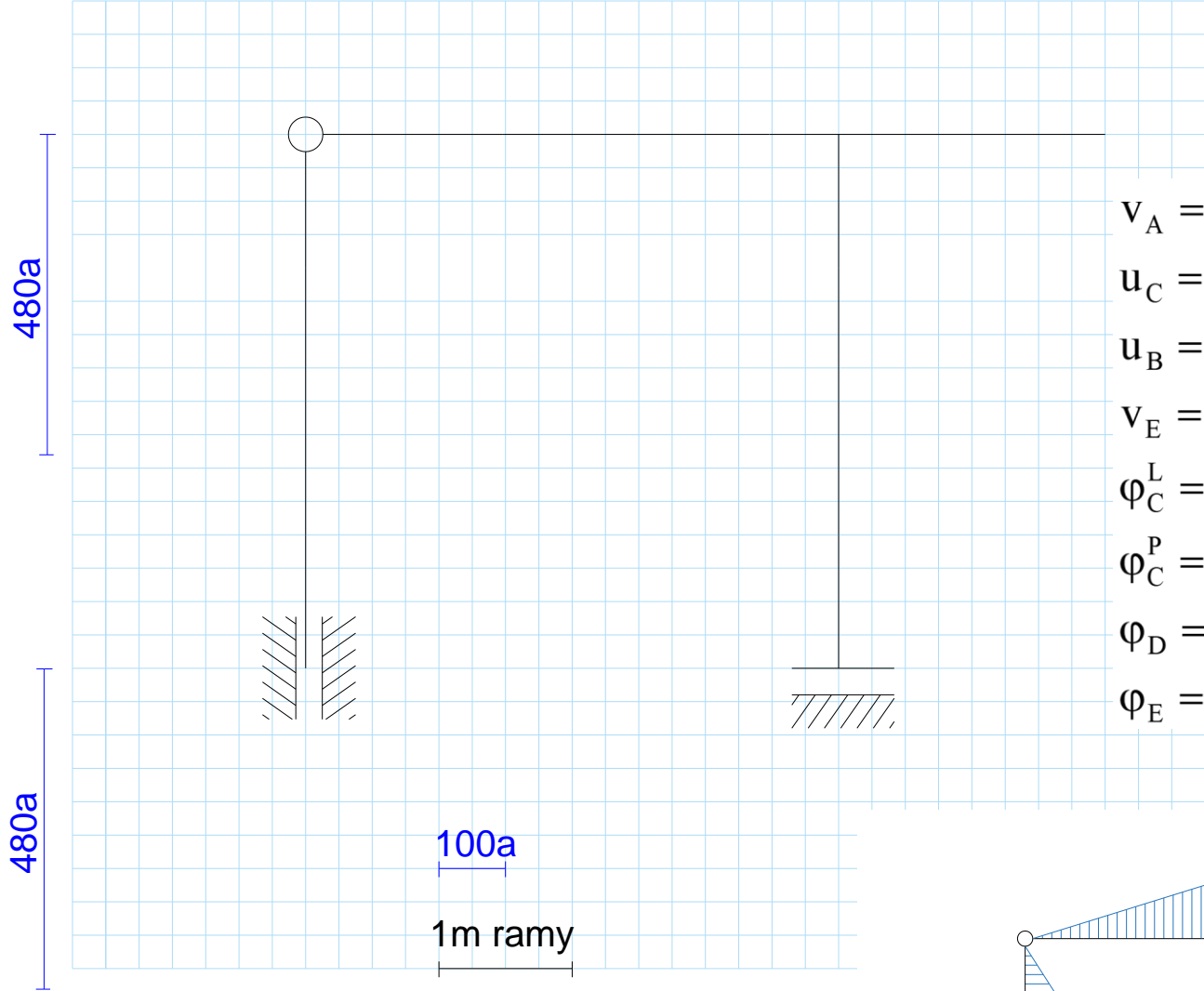
$$\varphi_D = -24a$$

$$\varphi_E = 12a$$

100a

1m ramy





$$v_A = v_C = 480a$$

$$u_C = u_D = u_E = -304a$$

$$u_B = -352a$$

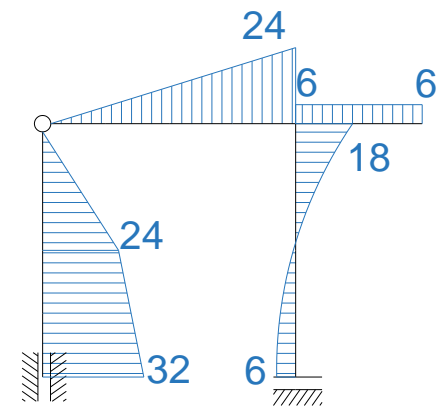
$$v_E = -12a$$

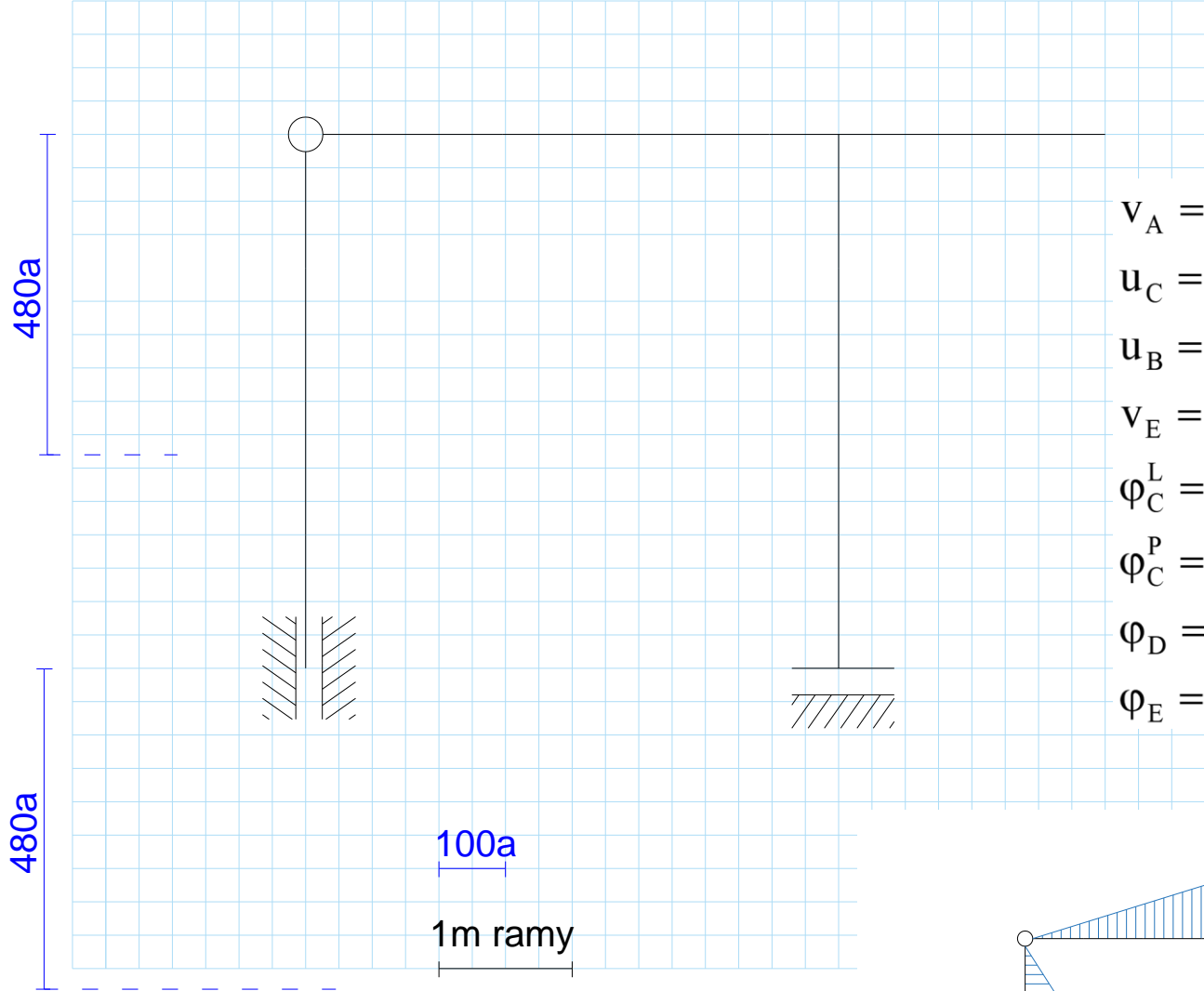
$$\varphi_C^L = -120a$$

$$\varphi_C^P = -168a$$

$$\varphi_D = -24a$$

$$\varphi_E = 12a$$





$$v_A = v_C = 480a$$

$$u_C = u_D = u_E = -304a$$

$$u_B = -352a$$

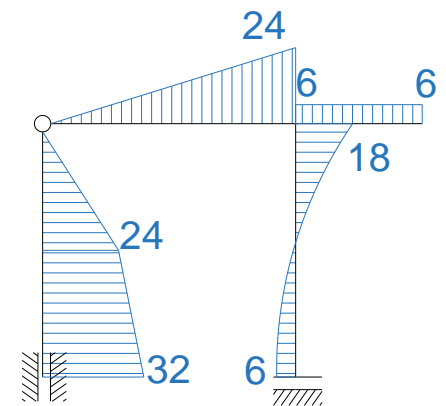
$$v_E = -12a$$

$$\varphi_C^L = -120a$$

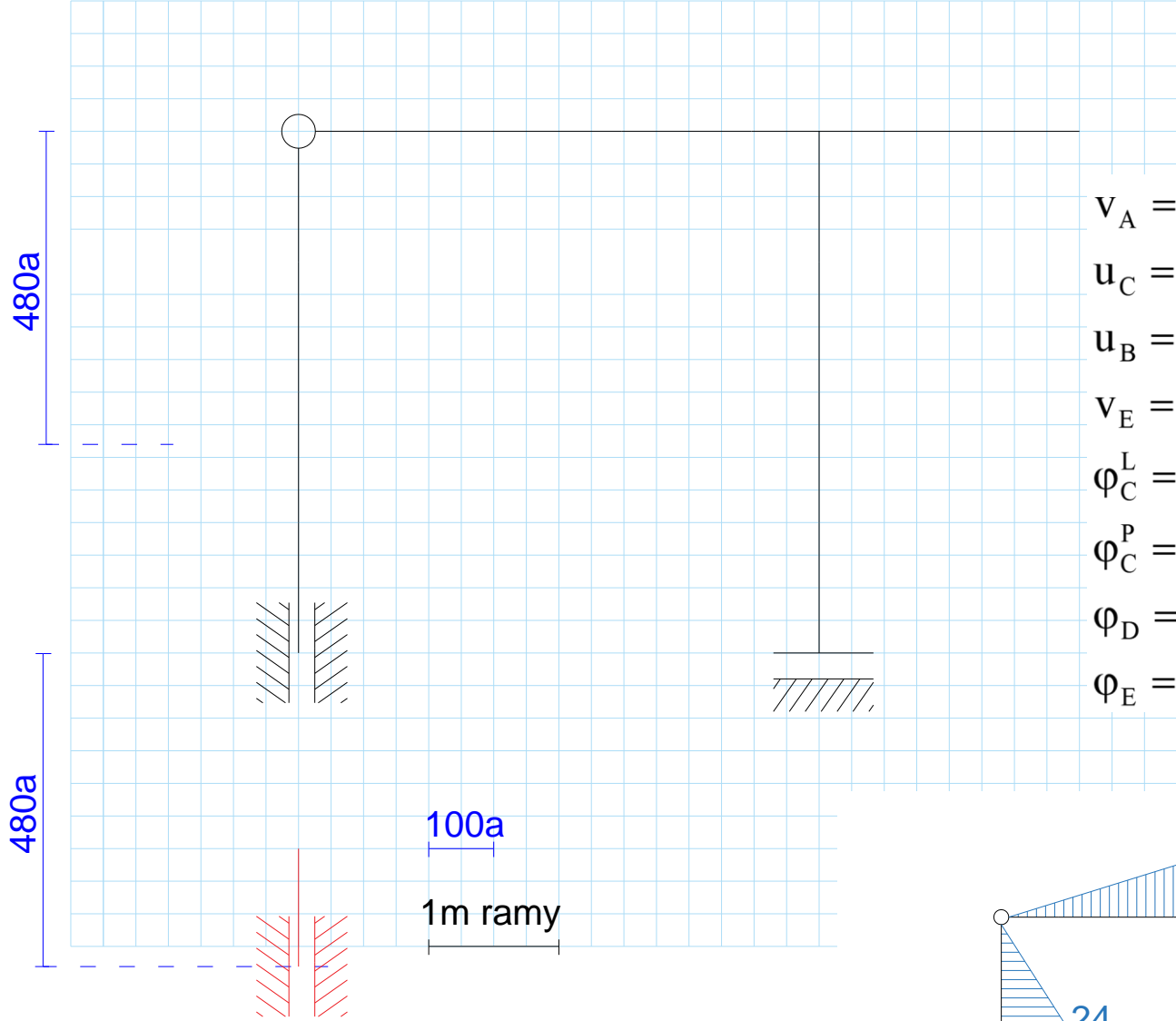
$$\varphi_C^P = -168a$$

$$\varphi_D = -24a$$

$$\varphi_E = 12a$$







$$v_A = v_C = 480a$$

$$u_C = u_D = u_E = -304a$$

$$u_B = -352a$$

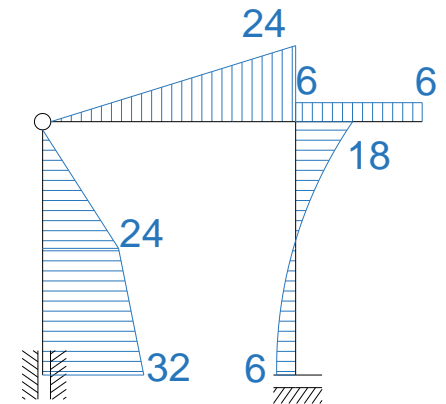
$$v_E = -12a$$

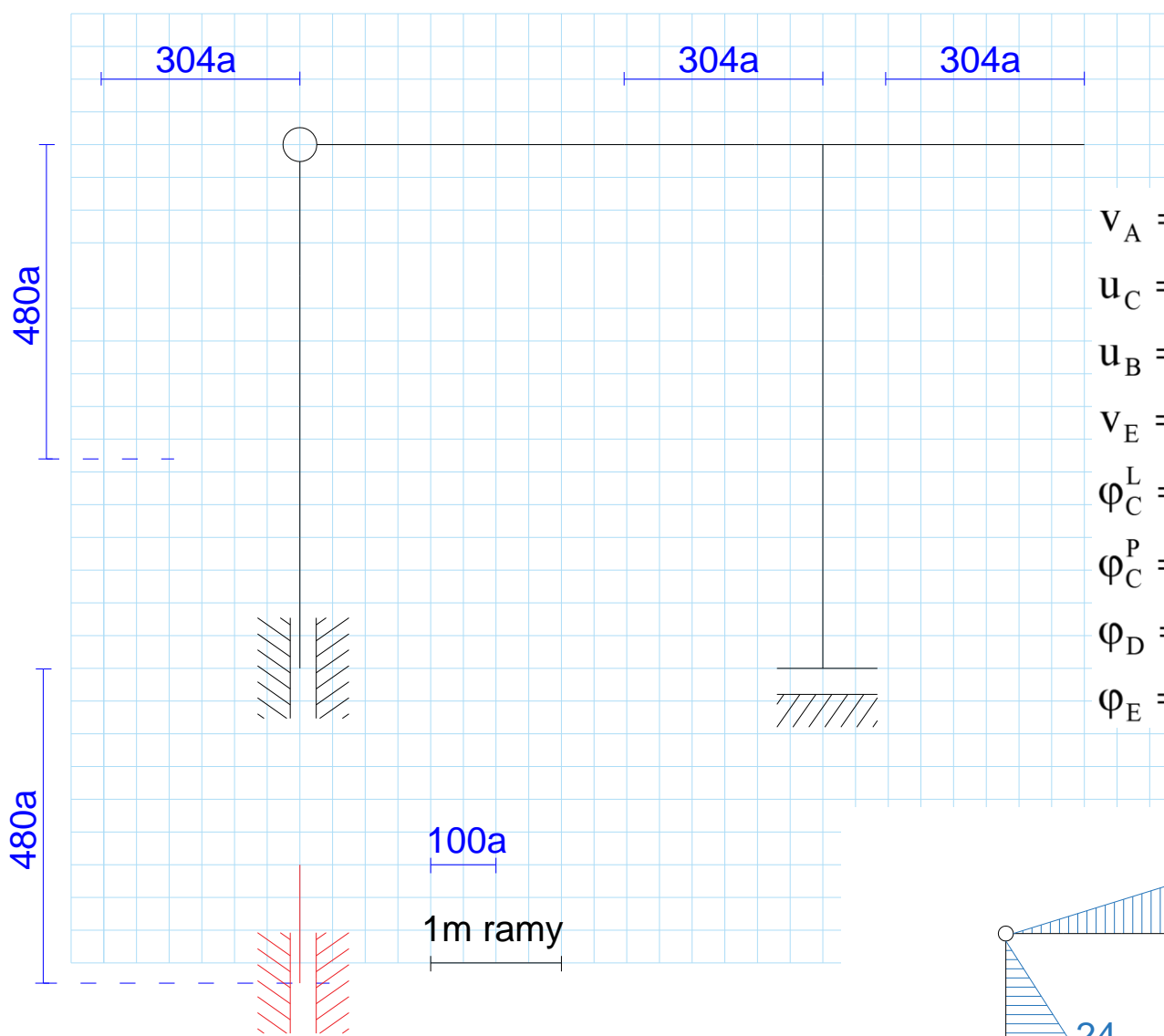
$$\varphi_C^L = -120a$$

$$\varphi_C^P = -168a$$

$$\varphi_D = -24a$$

$$\varphi_E = 12a$$





$$v_A = v_C = 480a$$

$$u_C = u_D = u_E = -304a$$

$$u_B = -352a$$

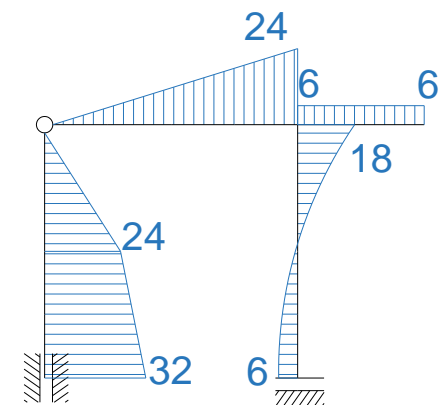
$$v_E = -12a$$

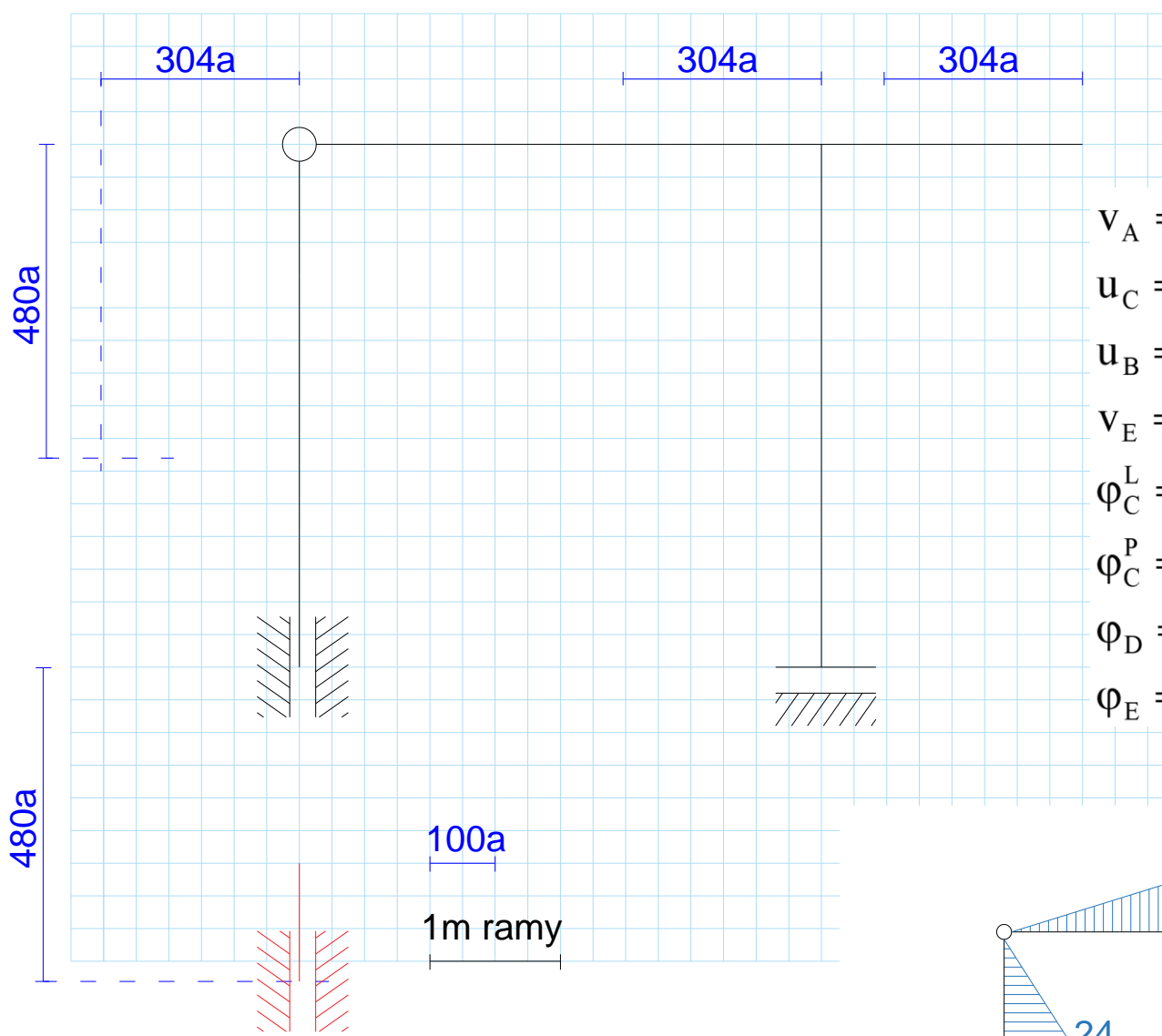
$$\varphi_C^L = -120a$$

$$\varphi_C^P = -168a$$

$$\varphi_D = -24a$$

$$\varphi_E = 12a$$





$$v_A = v_C = 480a$$

$$u_C = u_D = u_E = -304a$$

$$u_B = -352a$$

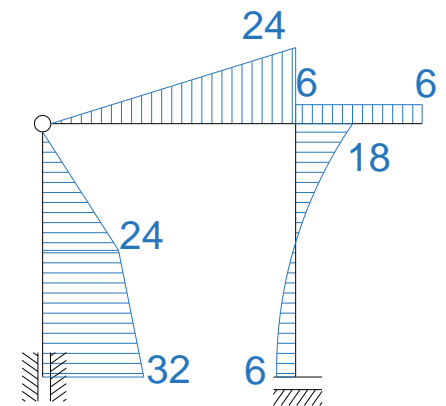
$$v_E = -12a$$

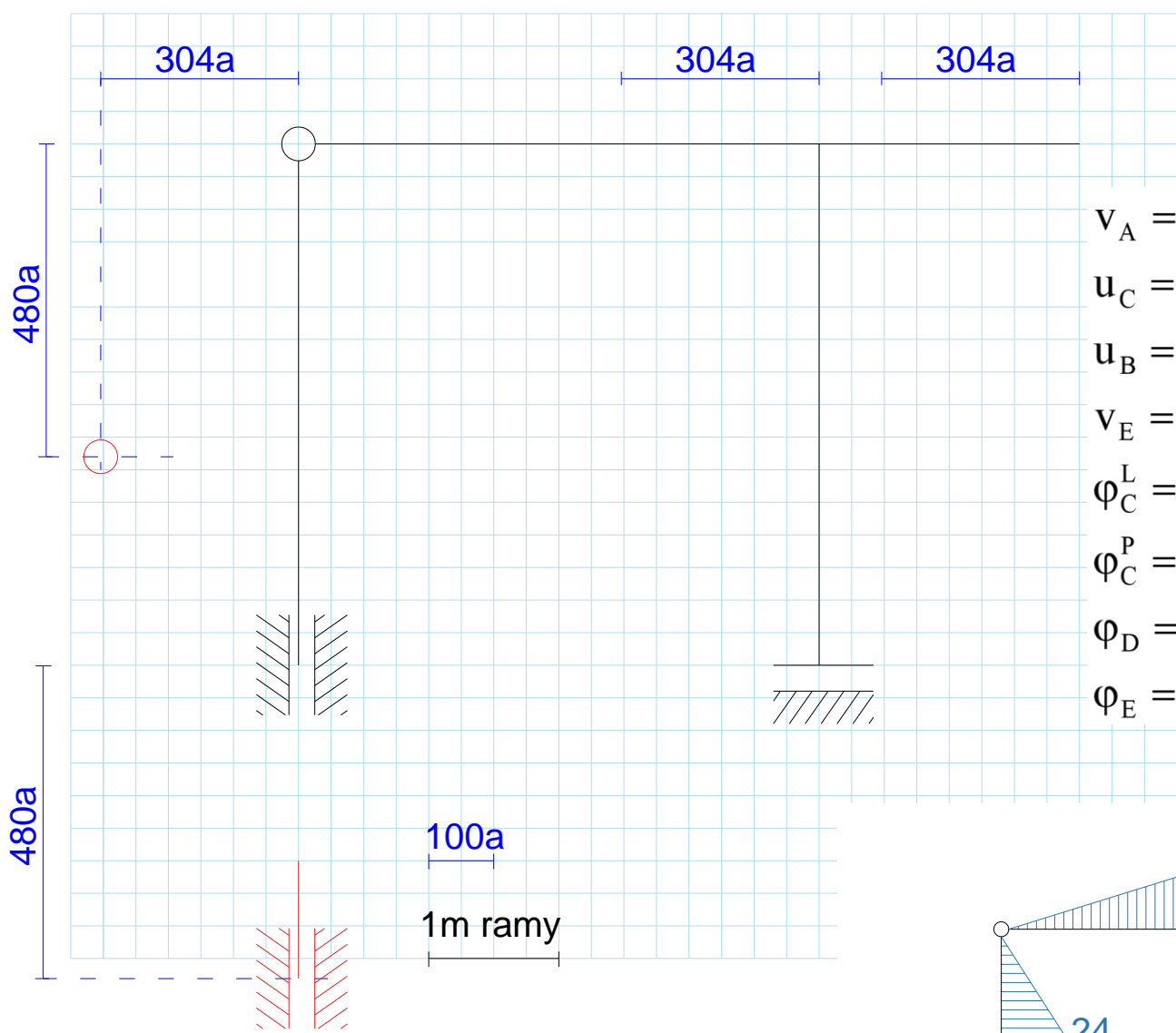
$$\varphi_C^L = -120a$$

$$\varphi_C^P = -168a$$

$$\varphi_D = -24a$$

$$\varphi_E = 12a$$





$$v_A = v_C = 480a$$

$$u_C = u_D = u_E = -304a$$

$$u_B = -352a$$

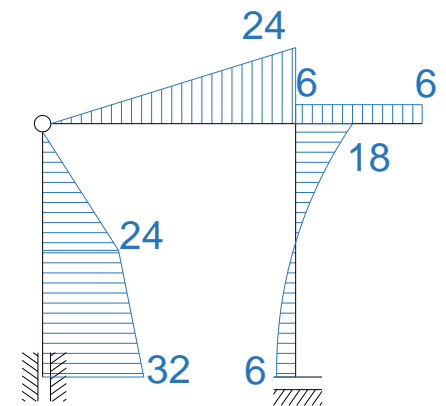
$$v_E = -12a$$

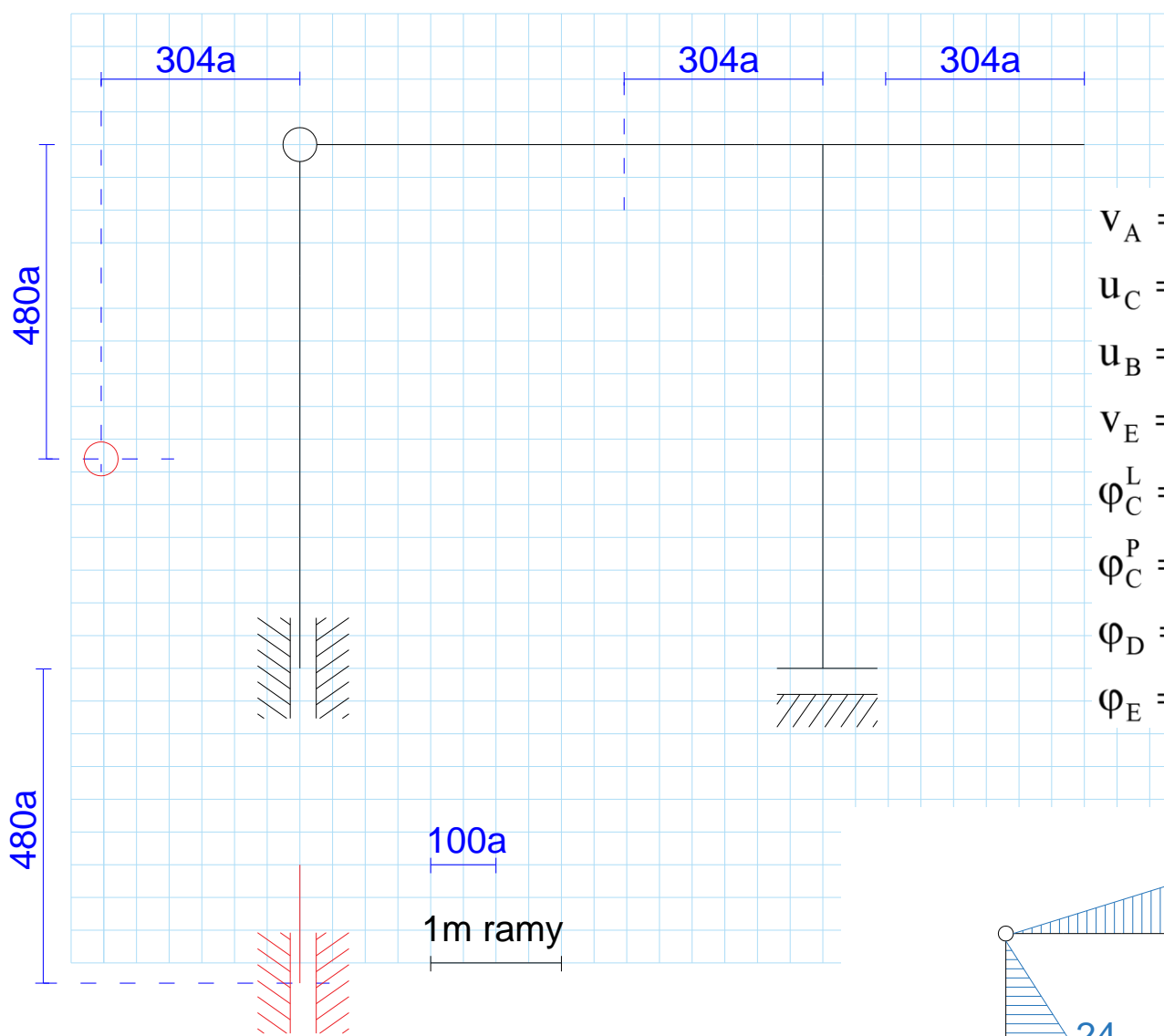
$$\varphi_C^L = -120a$$

$$\varphi_C^P = -168a$$

$$\varphi_D = -24a$$

$$\varphi_E = 12a$$





$$v_A = v_C = 480a$$

$$u_C = u_D = u_E = -304a$$

$$u_B = -352a$$

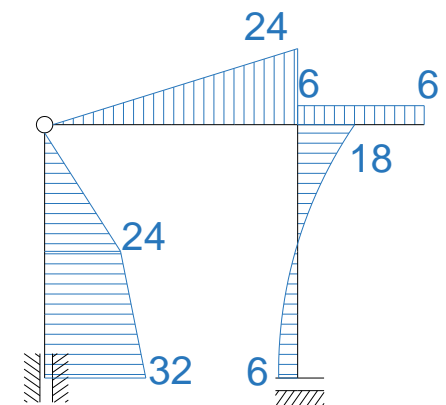
$$v_E = -12a$$

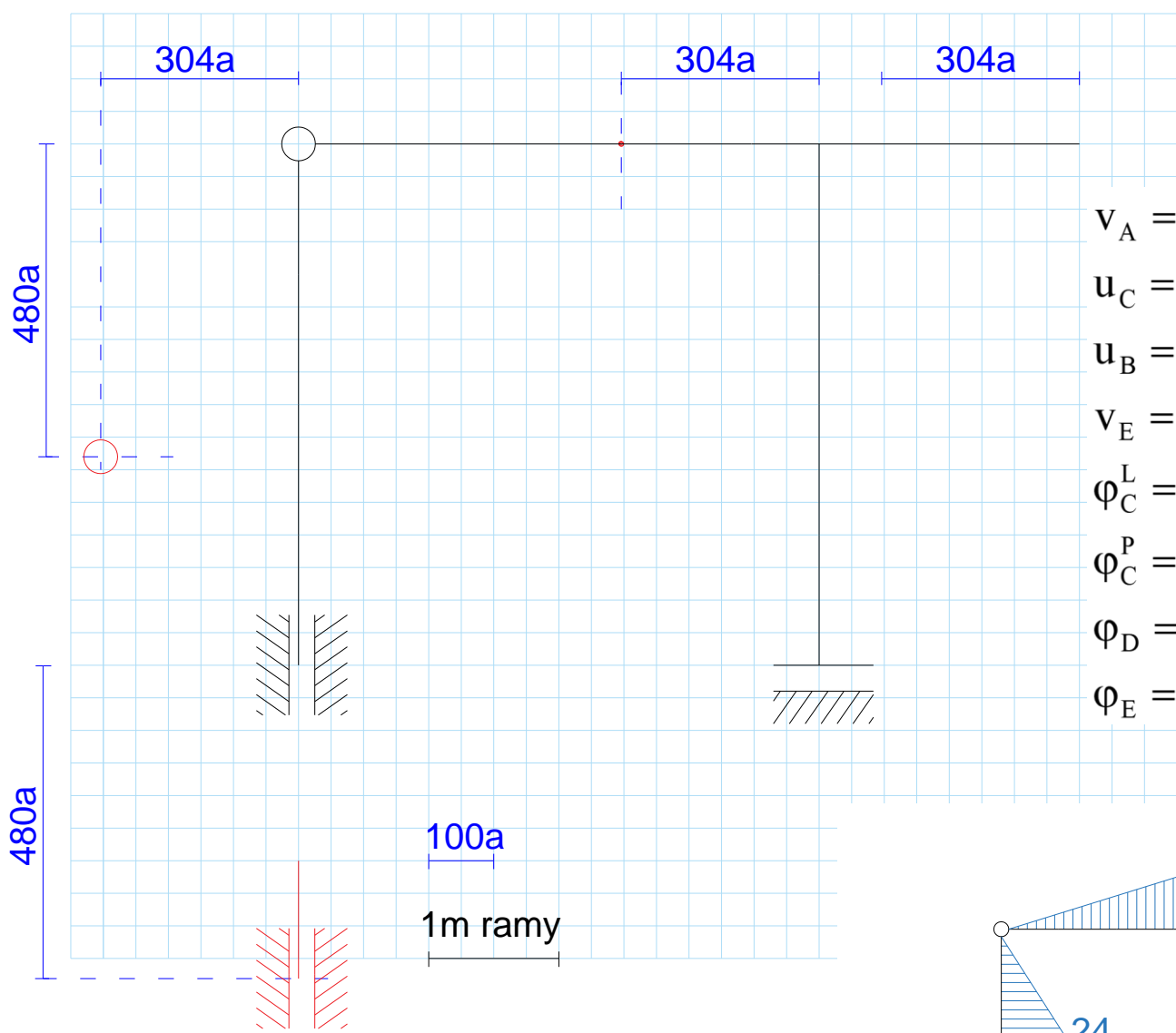
$$\varphi_C^L = -120a$$

$$\varphi_C^P = -168a$$

$$\varphi_D = -24a$$

$$\varphi_E = 12a$$





$$v_A = v_C = 480a$$

$$u_C = u_D = u_E = -304a$$

$$u_B = -352a$$

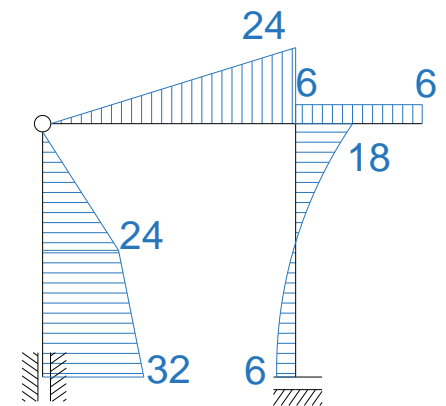
$$v_E = -12a$$

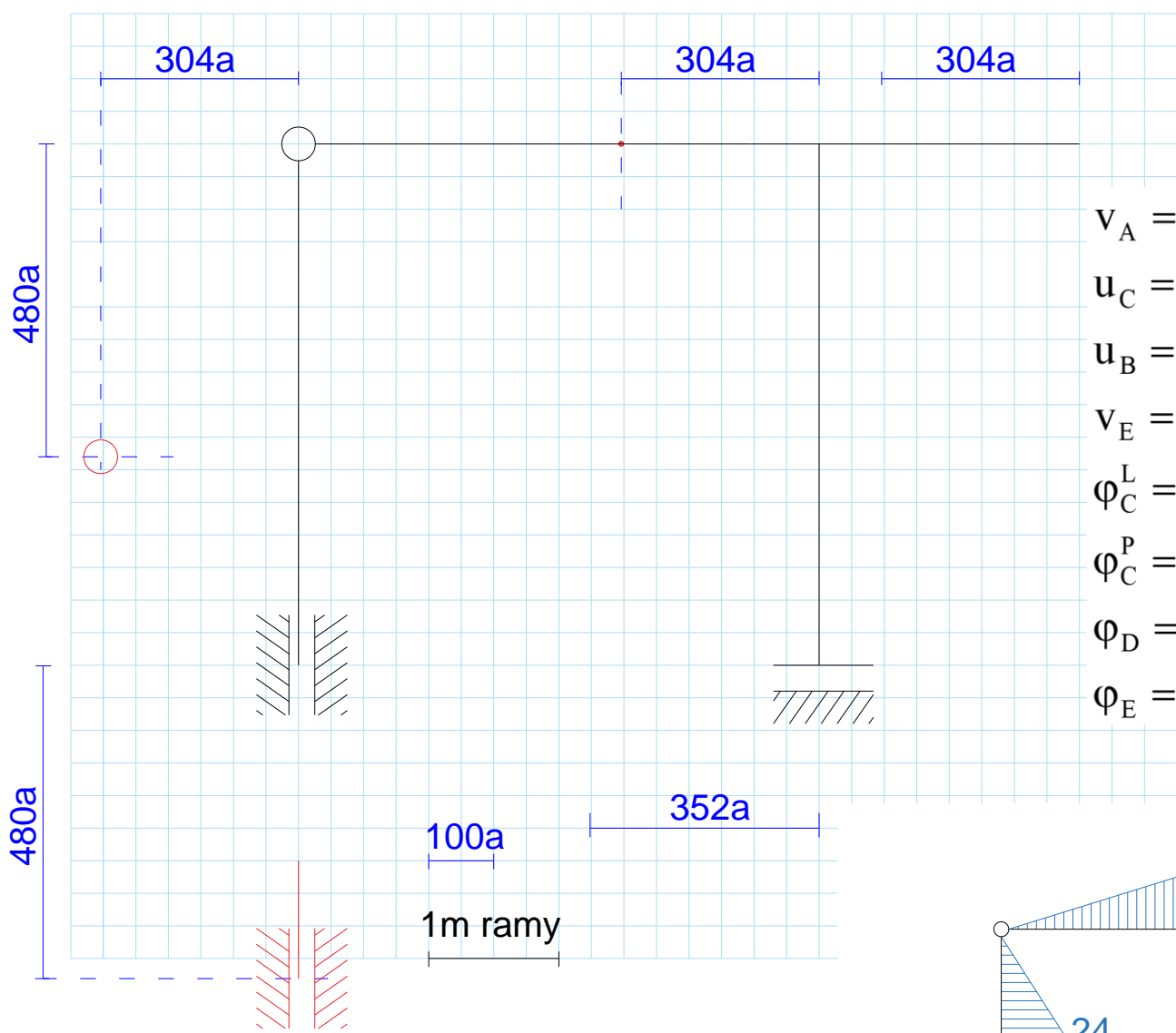
$$\varphi_C^L = -120a$$

$$\varphi_C^P = -168a$$

$$\varphi_D = -24a$$

$$\varphi_E = 12a$$





$$v_A = v_C = 480a$$

$$u_C = u_D = u_E = -304a$$

$$u_B = -352a$$

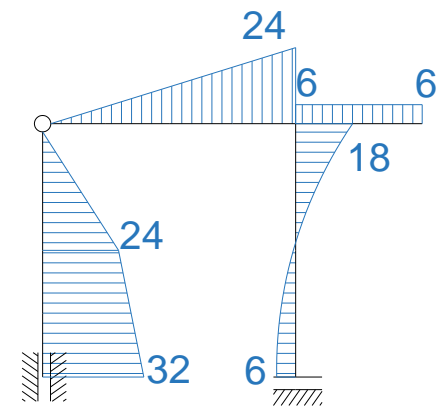
$$v_E = -12a$$

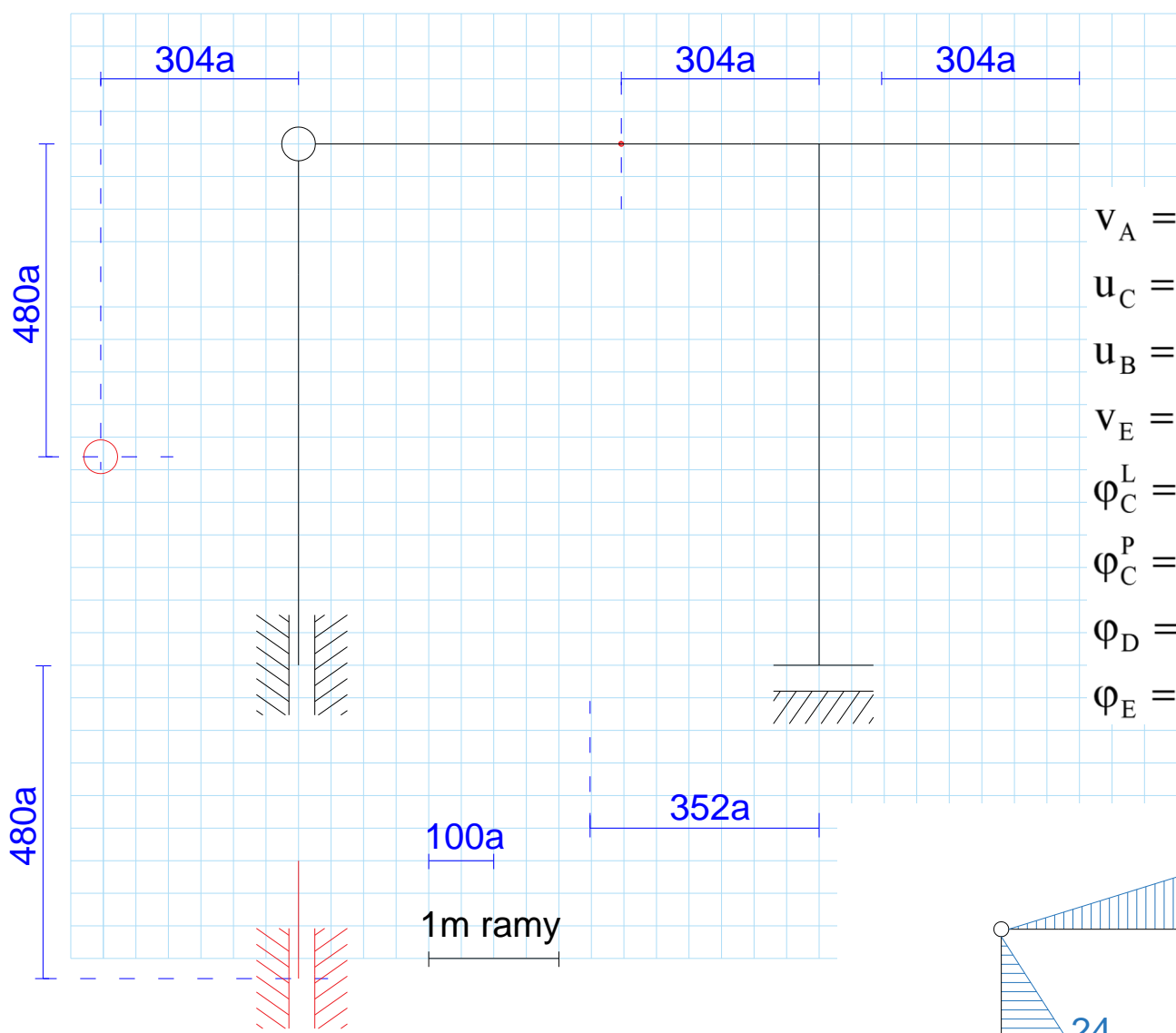
$$\varphi_C^L = -120a$$

$$\varphi_C^P = -168a$$

$$\varphi_D = -24a$$

$$\varphi_E = 12a$$





$$v_A = v_C = 480a$$

$$u_C = u_D = u_E = -304a$$

$$u_B = -352a$$

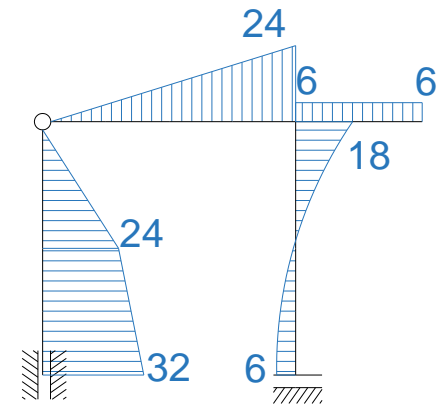
$$v_E = -12a$$

$$\varphi_C^L = -120a$$

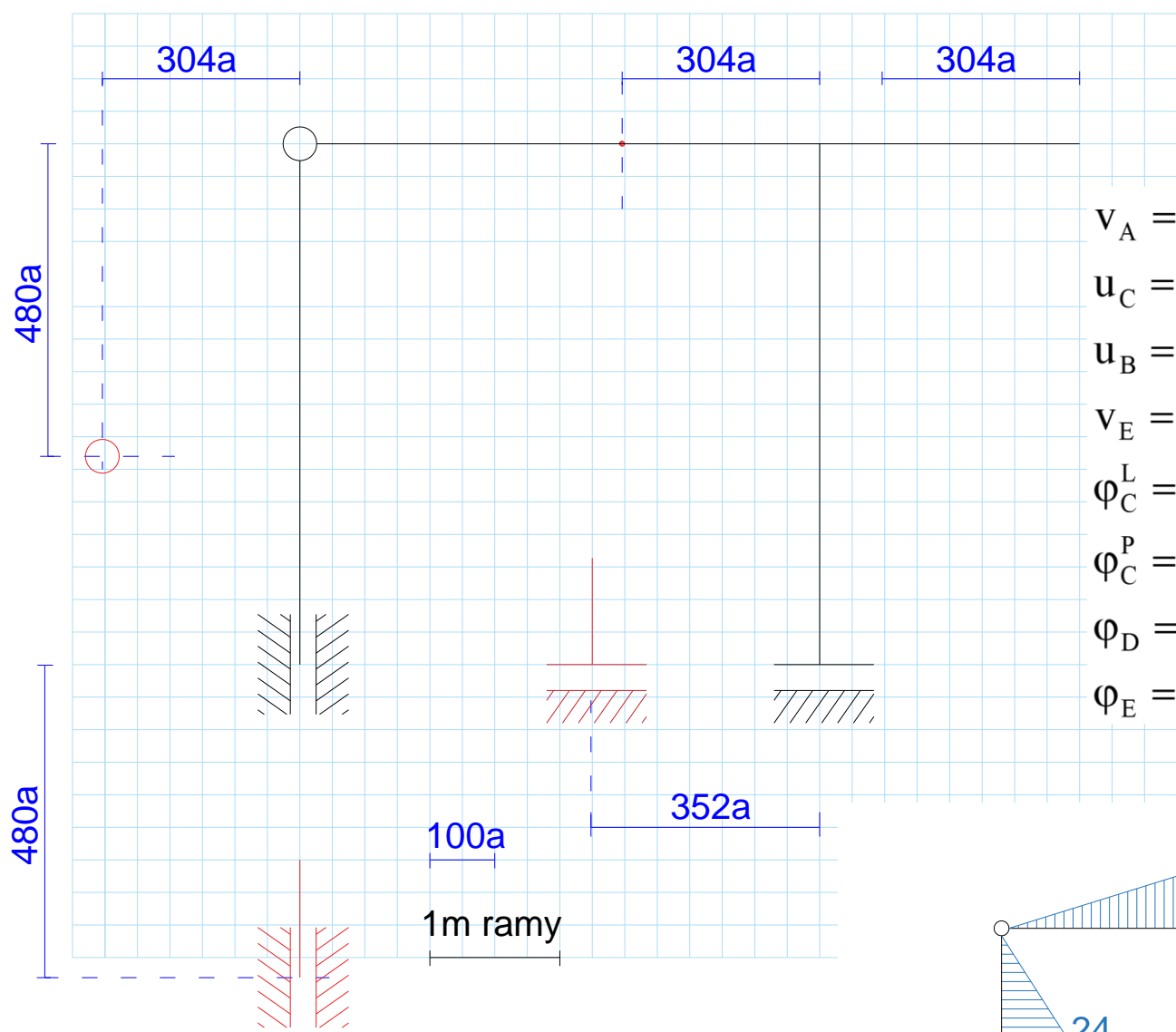
$$\varphi_C^P = -168a$$

$$\varphi_D = -24a$$

$$\varphi_E = 12a$$







$$v_A = v_C = 480a$$

$$u_C = u_D = u_E = -304a$$

$$u_B = -352a$$

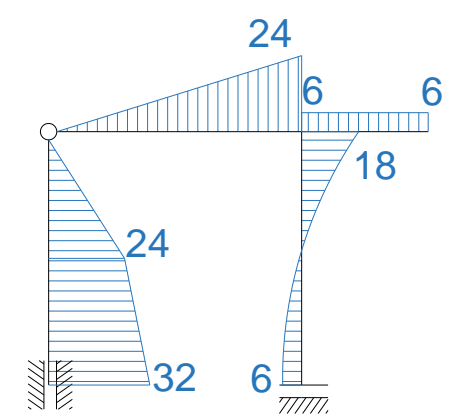
$$v_E = -12a$$

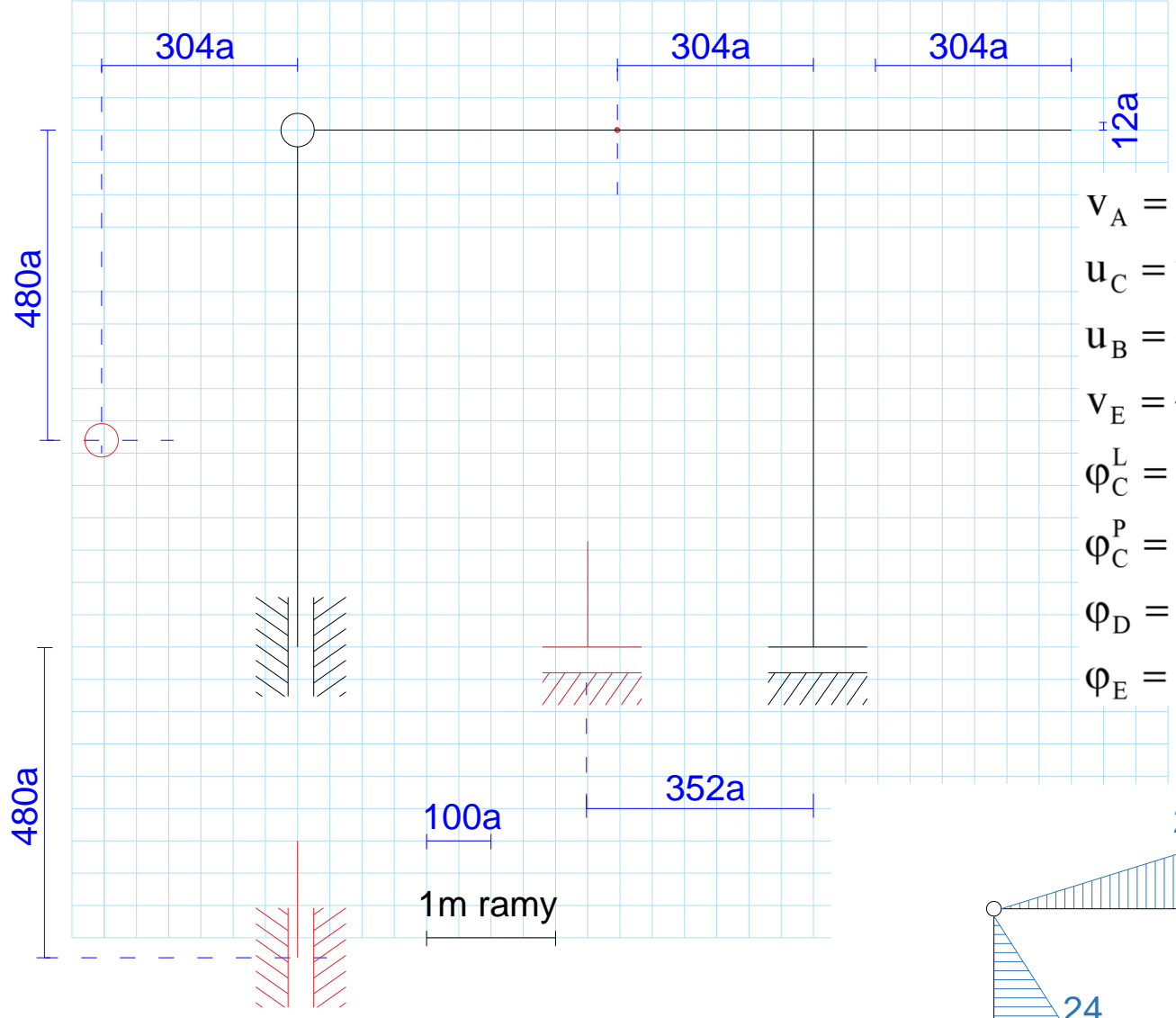
$$\varphi_C^L = -120a$$

$$\varphi_C^P = -168a$$

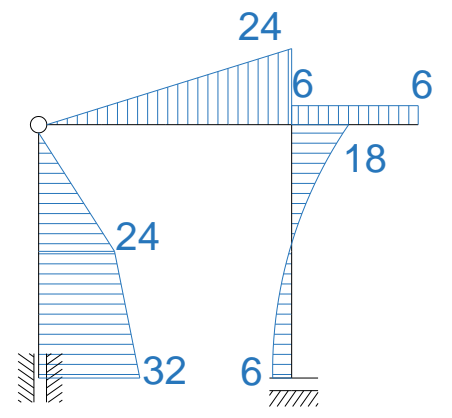
$$\varphi_D = -24a$$

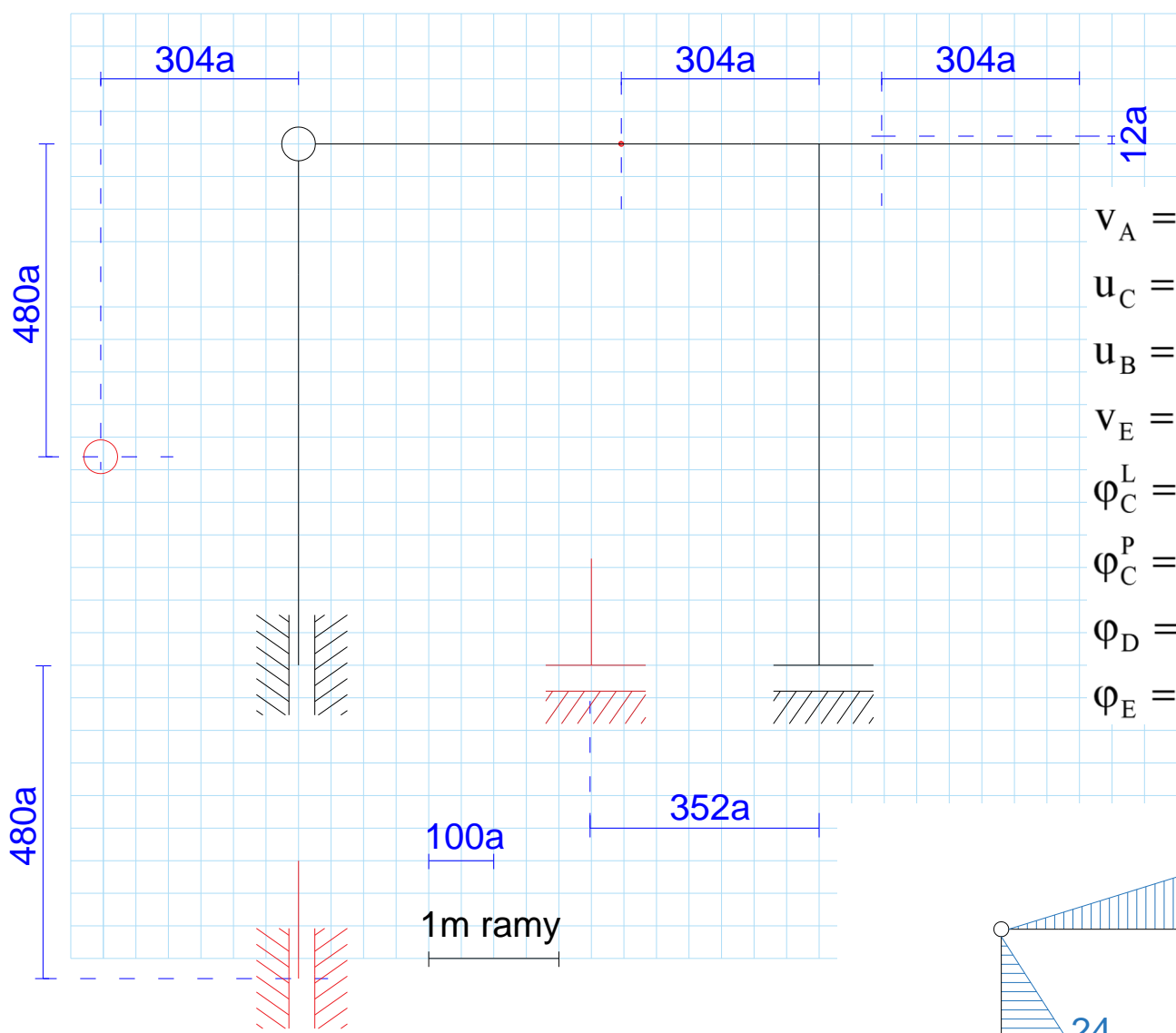
$$\varphi_E = 12a$$





- $v_A = v_C = 480a$
- $u_C = u_D = u_E = -304a$
- $u_B = -352a$
- $v_E = -12a$
- $\varphi_C^L = -120a$
- $\varphi_C^P = -168a$
- $\varphi_D = -24a$
- $\varphi_E = 12a$





$$v_A = v_C = 480a$$

$$u_C = u_D = u_E = -304a$$

$$u_B = -352a$$

$$v_E = -12a$$

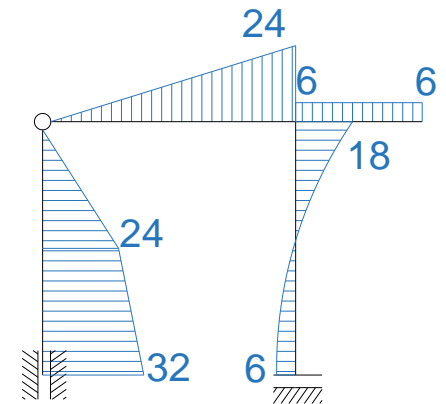
$$\varphi_C^L = -120a$$

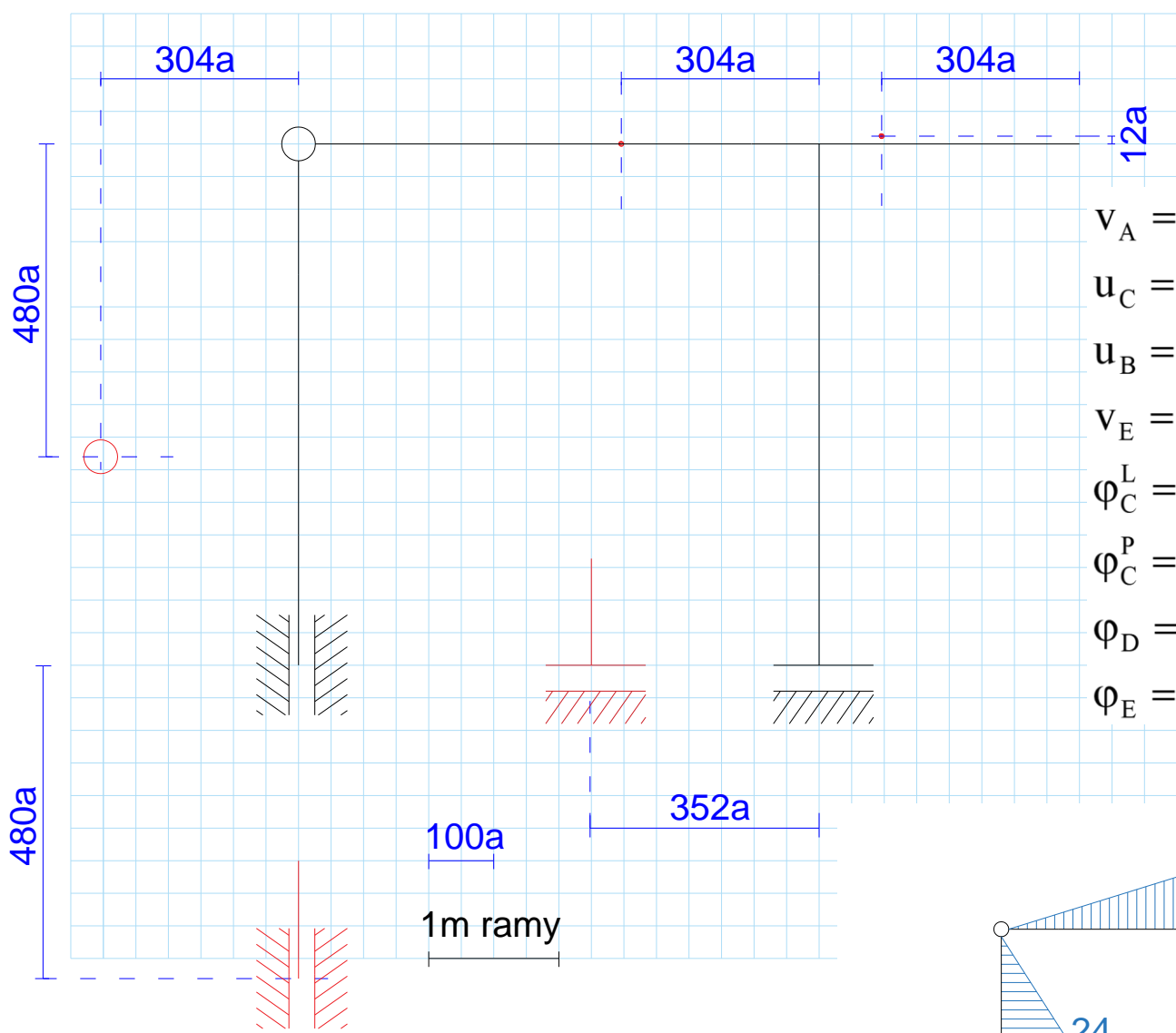
$$\varphi_C^P = -168a$$

$$\varphi_D = -24a$$

$$\varphi_E = 12a$$

100a  
1m ramy





$$v_A = v_C = 480a$$

$$u_C = u_D = u_E = -304a$$

$$u_B = -352a$$

$$v_E = -12a$$

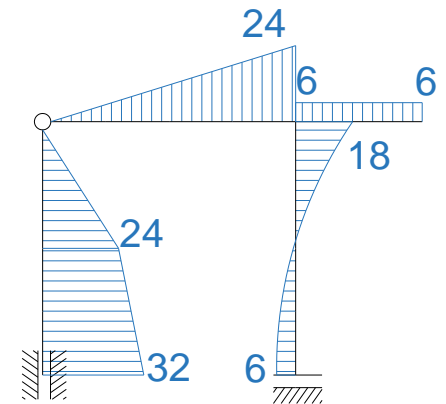
$$\varphi_C^L = -120a$$

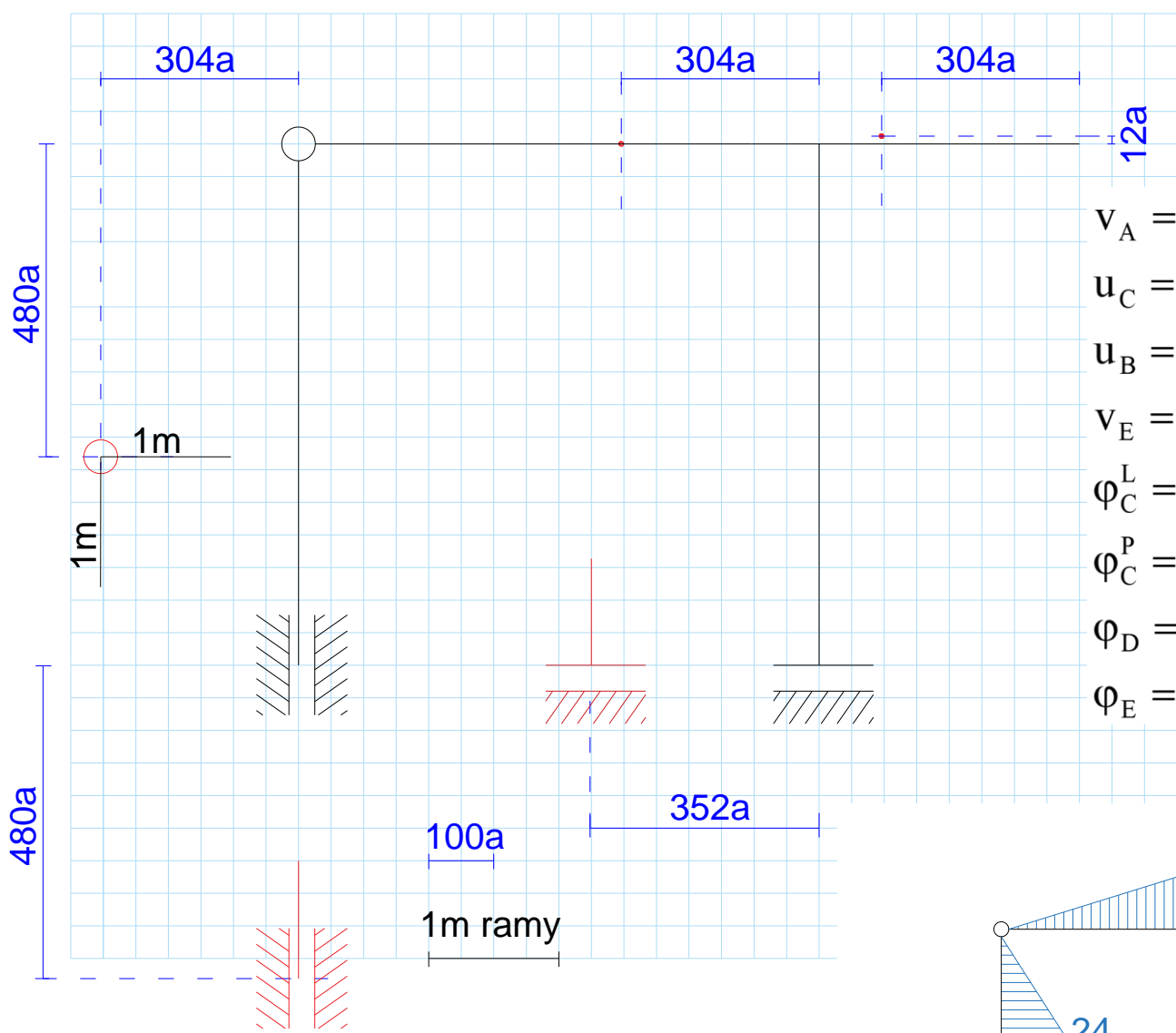
$$\varphi_C^P = -168a$$

$$\varphi_D = -24a$$

$$\varphi_E = 12a$$

100a  
1m ramy





$$v_A = v_C = 480a$$

$$u_C = u_D = u_E = -304a$$

$$u_B = -352a$$

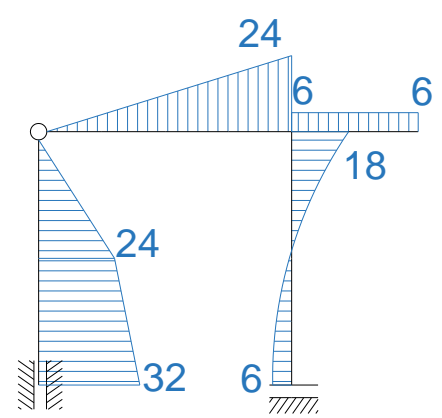
$$v_E = -12a$$

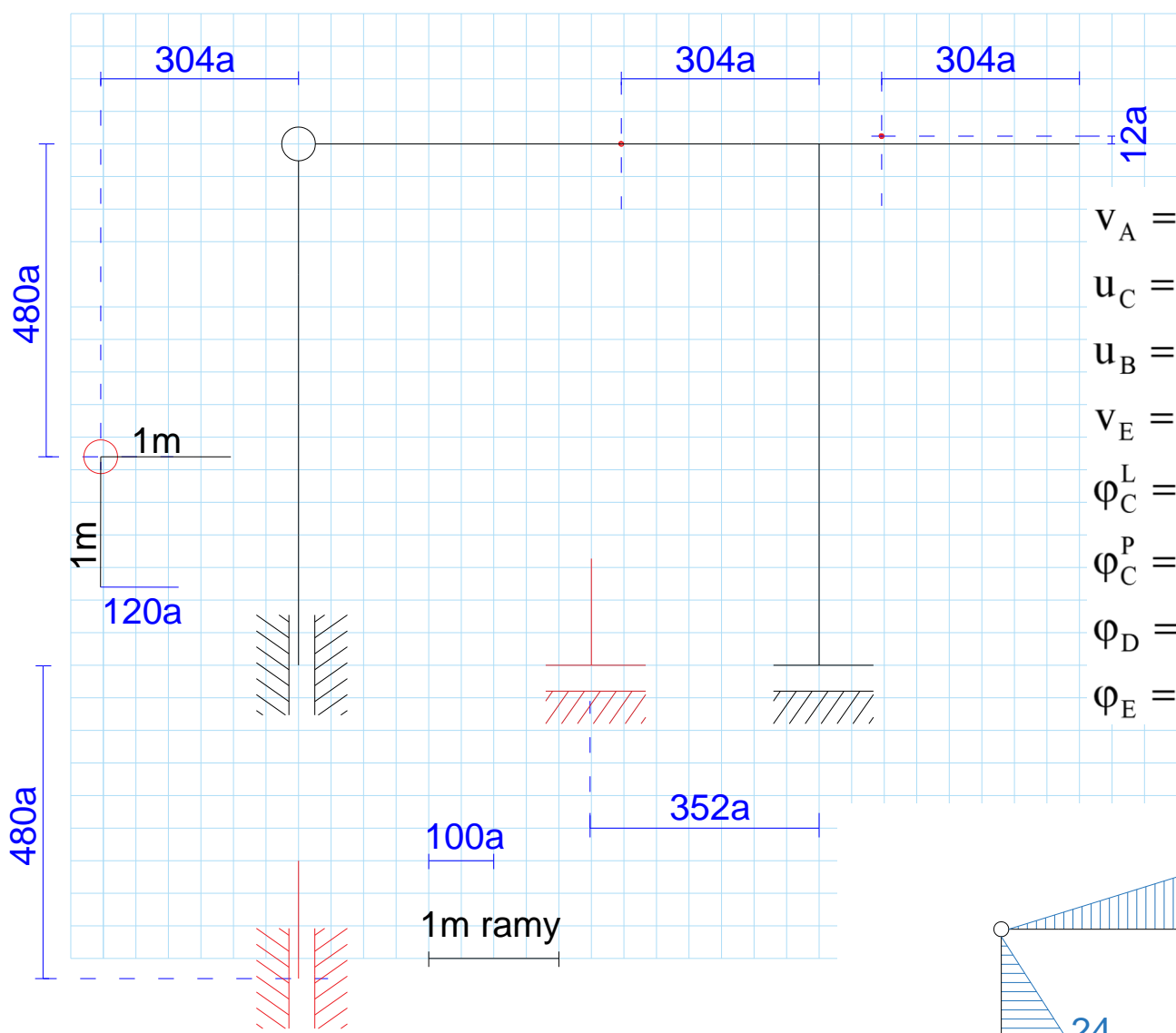
$$\varphi_C^L = -120a$$

$$\varphi_C^P = -168a$$

$$\varphi_D = -24a$$

$$\varphi_E = 12a$$





$$v_A = v_C = 480a$$

$$u_C = u_D = u_E = -304a$$

$$u_B = -352a$$

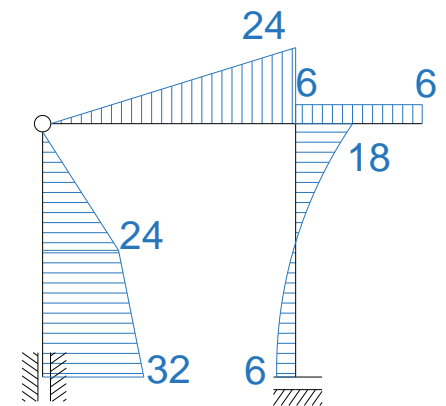
$$v_E = -12a$$

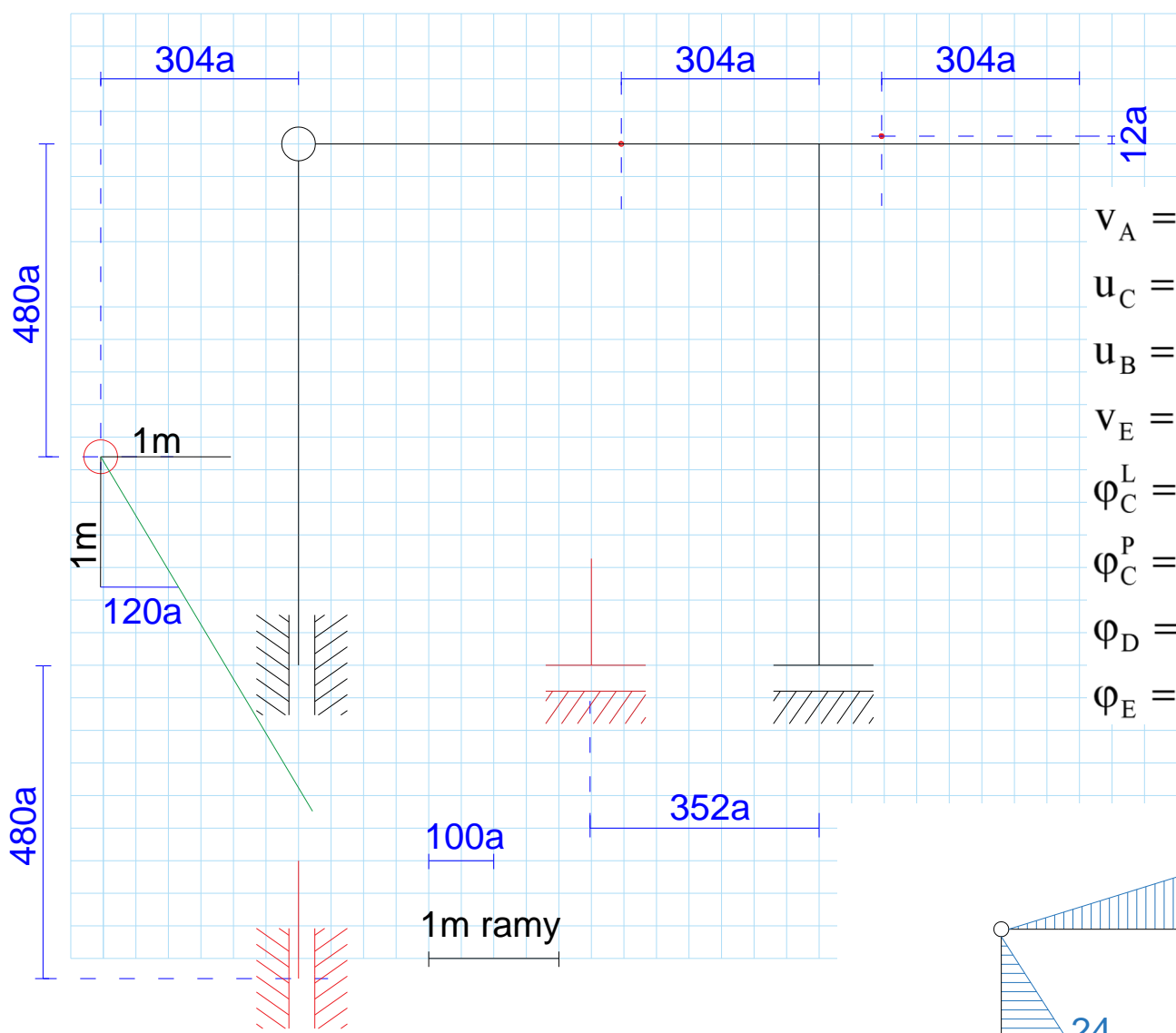
$$\varphi_C^L = -120a$$

$$\varphi_C^P = -168a$$

$$\varphi_D = -24a$$

$$\varphi_E = 12a$$





$$v_A = v_C = 480a$$

$$u_C = u_D = u_E = -304a$$

$$u_B = -352a$$

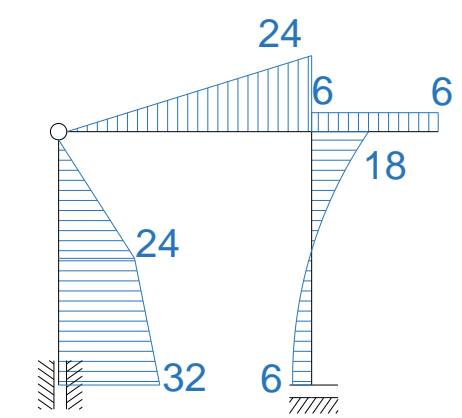
$$v_E = -12a$$

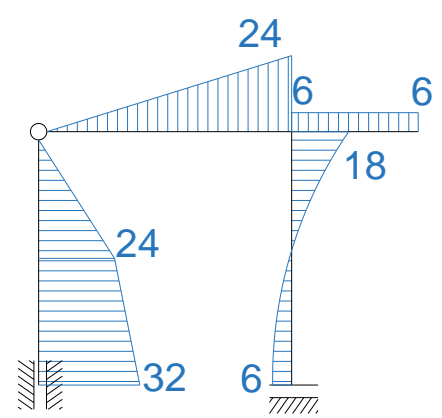
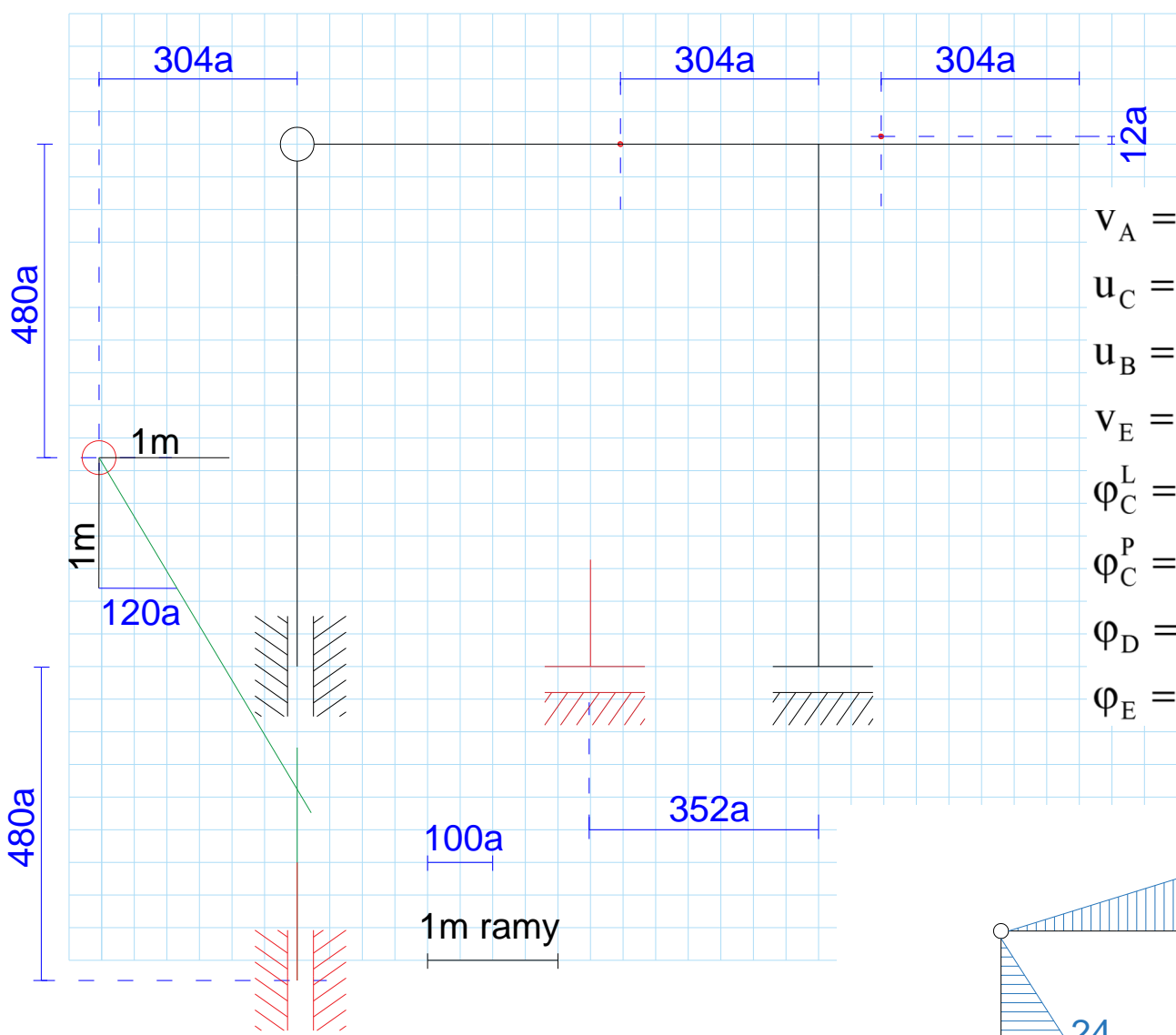
$$\varphi_C^L = -120a$$

$$\varphi_C^P = -168a$$

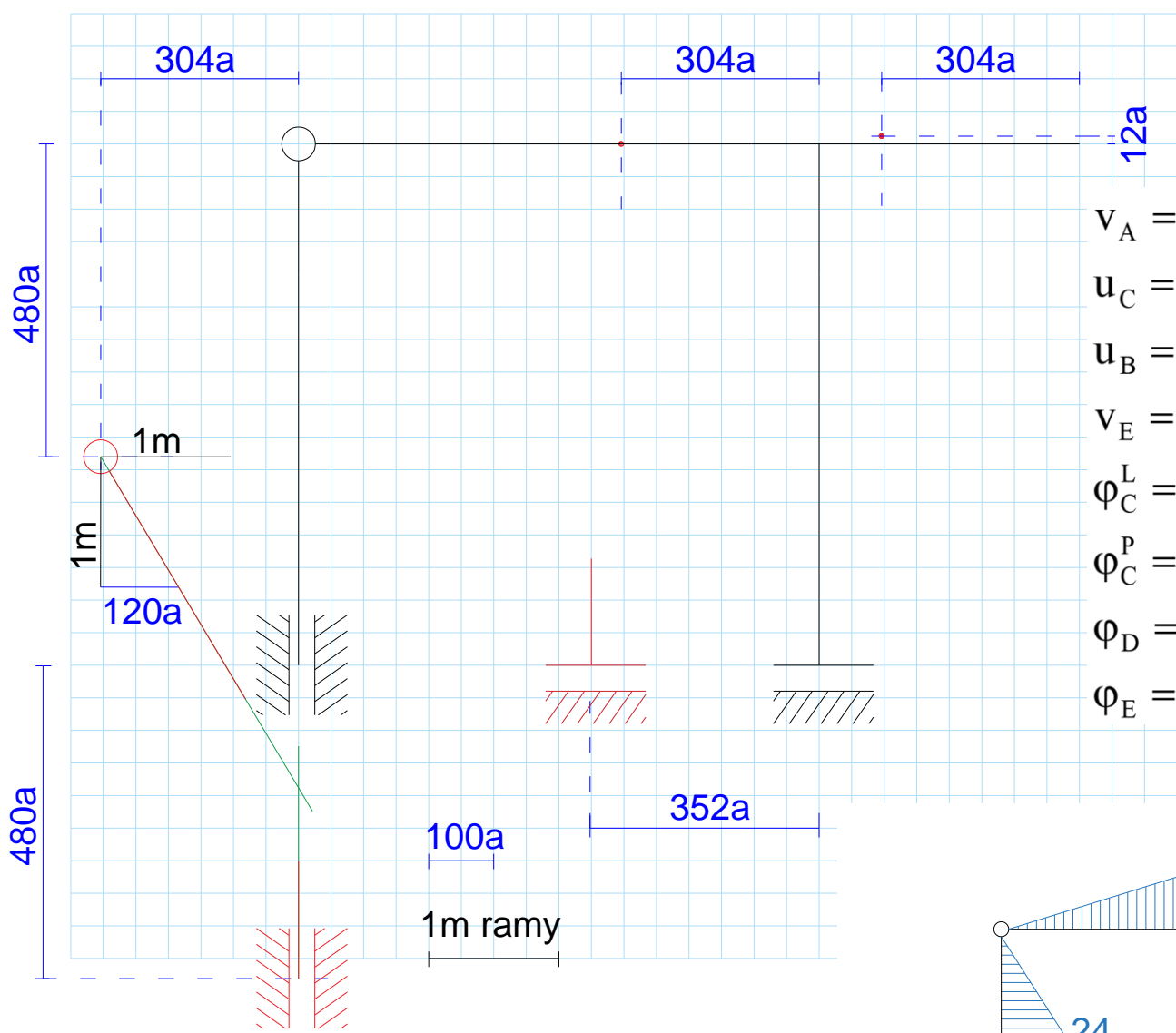
$$\varphi_D = -24a$$

$$\varphi_E = 12a$$









$$v_A = v_C = 480a$$

$$u_C = u_D = u_E = -304a$$

$$u_B = -352a$$

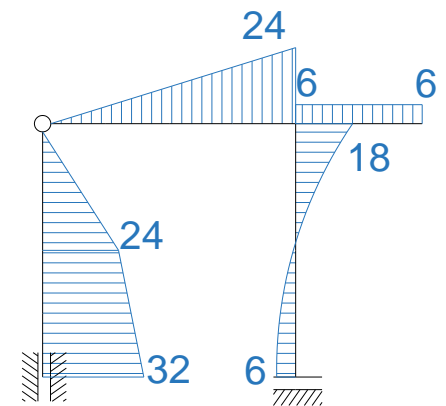
$$v_E = -12a$$

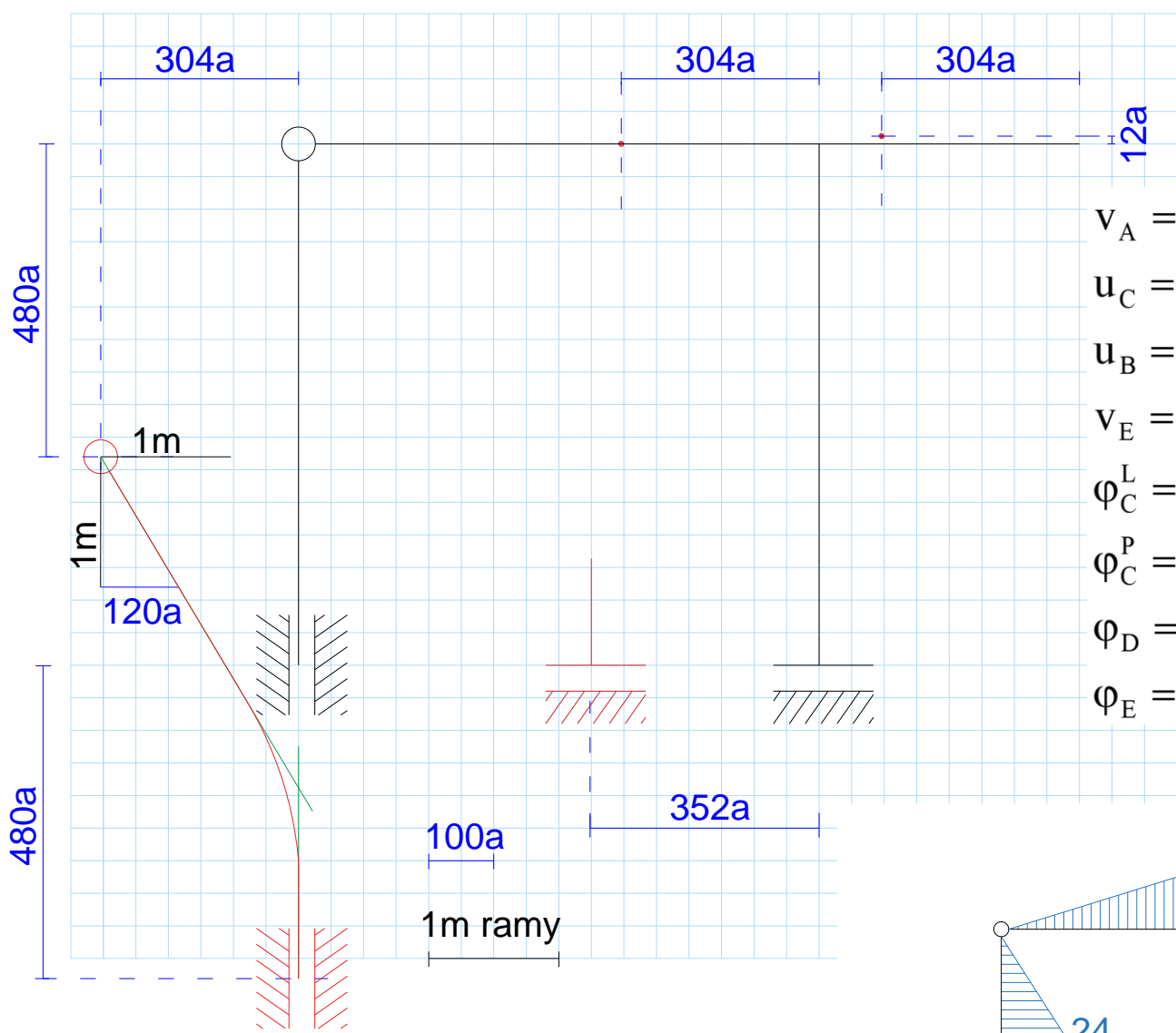
$$\varphi_C^L = -120a$$

$$\varphi_C^P = -168a$$

$$\varphi_D = -24a$$

$$\varphi_E = 12a$$





$$v_A = v_C = 480a$$

$$u_C = u_D = u_E = -304a$$

$$u_B = -352a$$

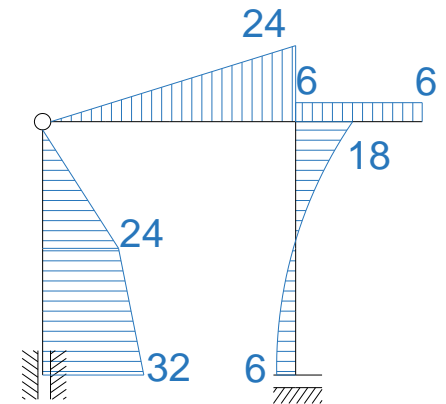
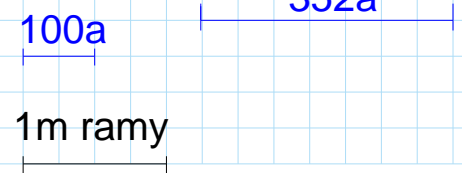
$$v_E = -12a$$

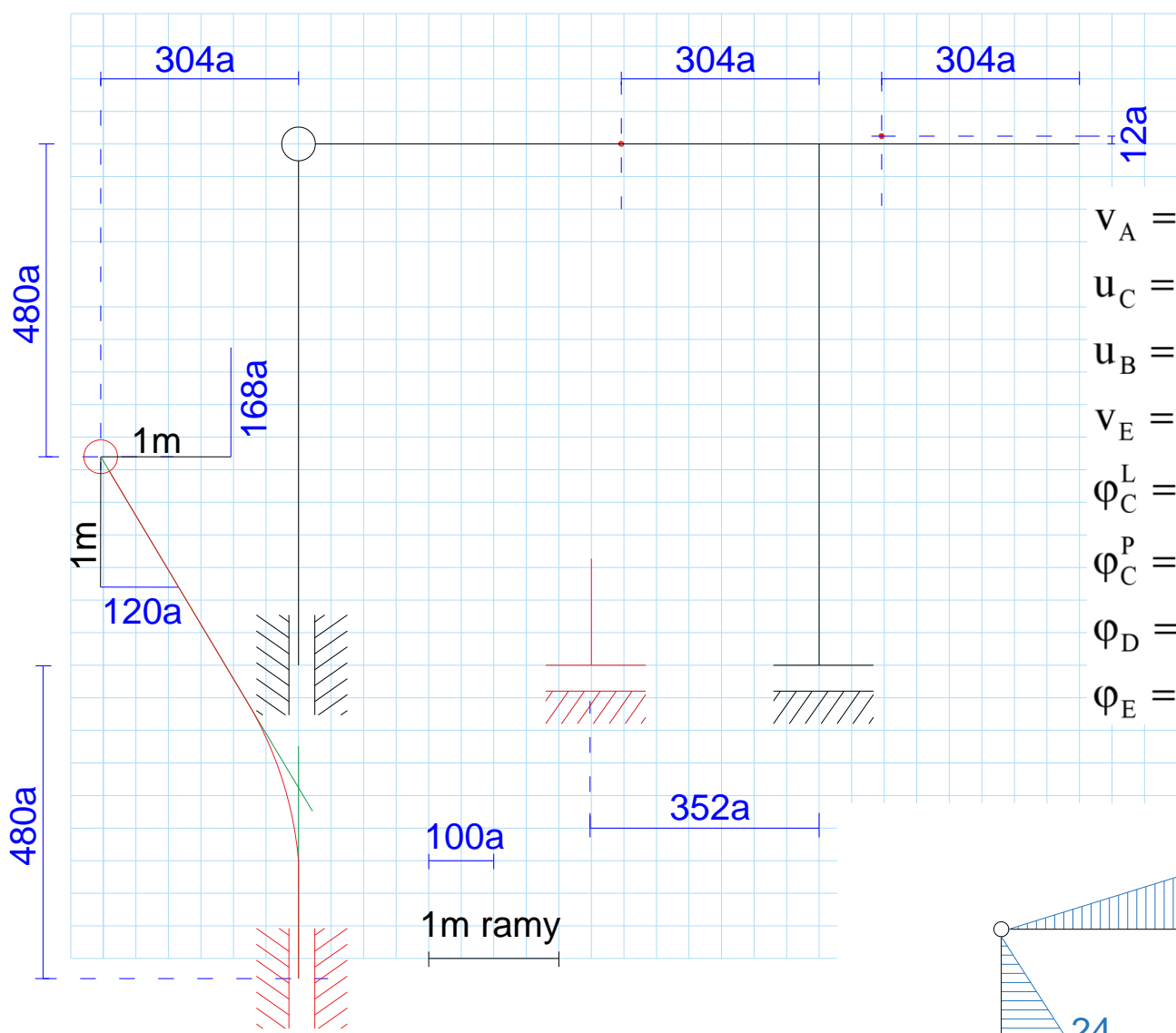
$$\varphi_C^L = -120a$$

$$\varphi_C^P = -168a$$

$$\varphi_D = -24a$$

$$\varphi_E = 12a$$





$$v_A = v_C = 480a$$

$$u_C = u_D = u_E = -304a$$

$$u_B = -352a$$

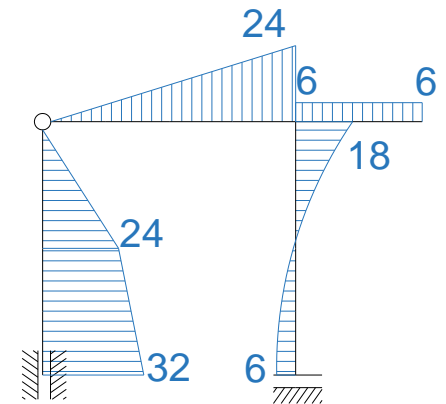
$$v_E = -12a$$

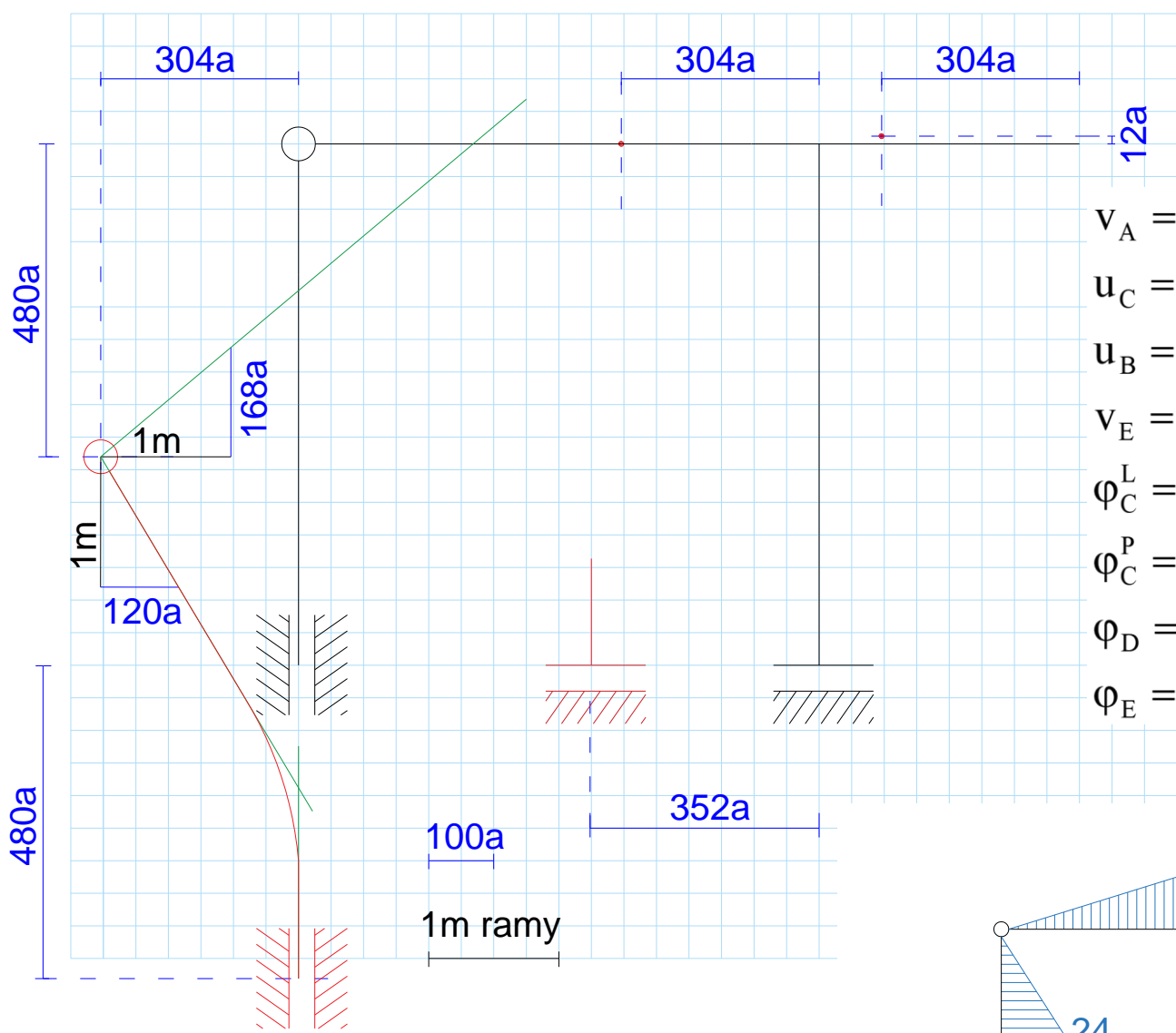
$$\varphi_C^L = -120a$$

$$\varphi_C^P = -168a$$

$$\varphi_D = -24a$$

$$\varphi_E = 12a$$





$$v_A = v_C = 480a$$

$$u_C = u_D = u_E = -304a$$

$$u_B = -352a$$

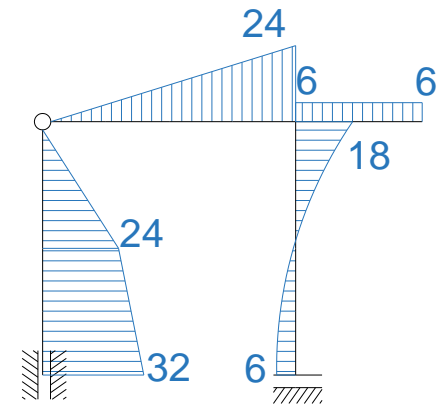
$$v_E = -12a$$

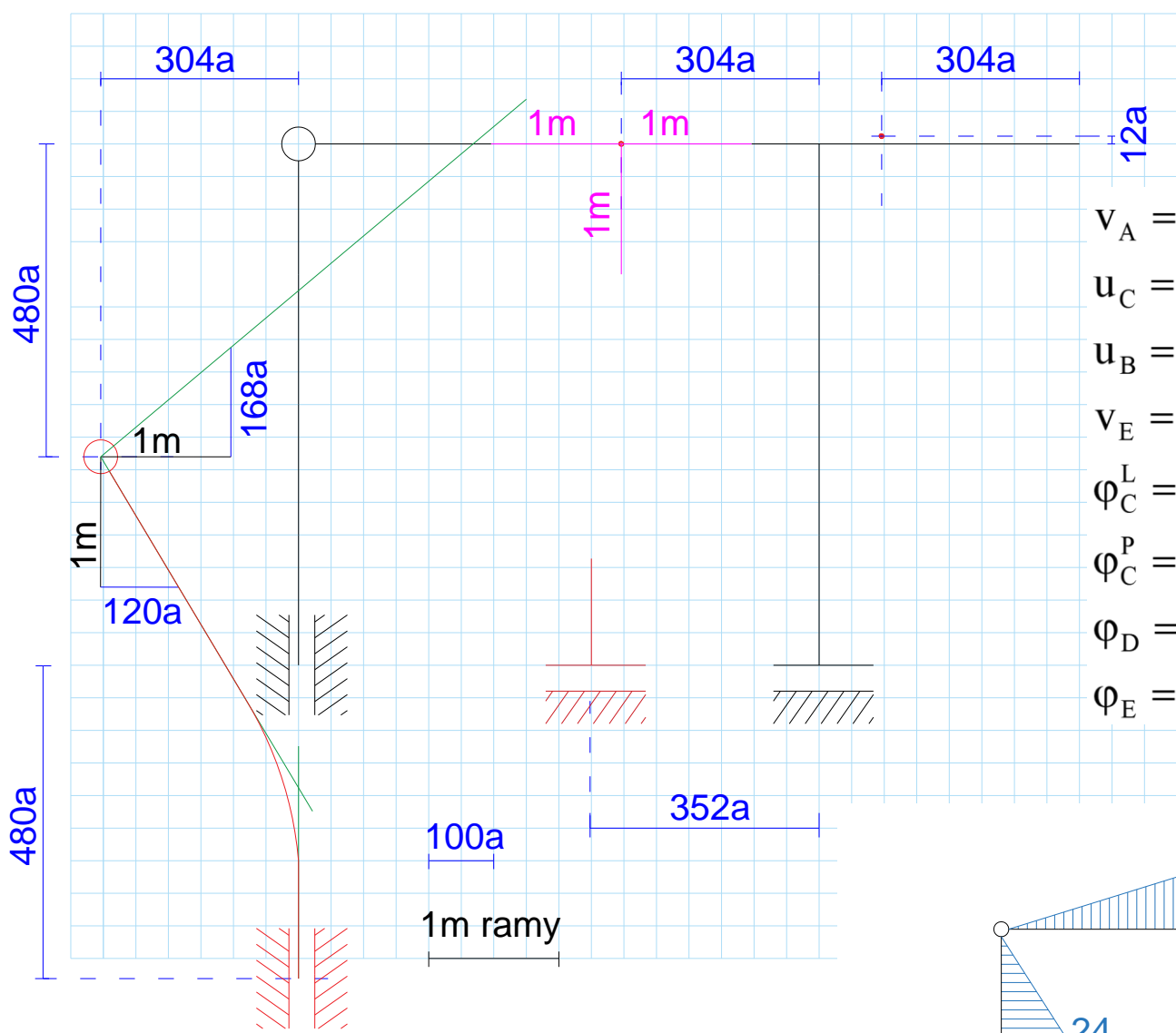
$$\varphi_C^L = -120a$$

$$\varphi_C^P = -168a$$

$$\varphi_D = -24a$$

$$\varphi_E = 12a$$





$$v_A = v_C = 480a$$

$$u_C = u_D = u_E = -304a$$

$$u_B = -352a$$

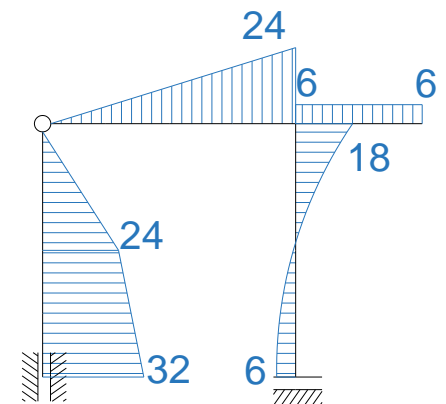
$$v_E = -12a$$

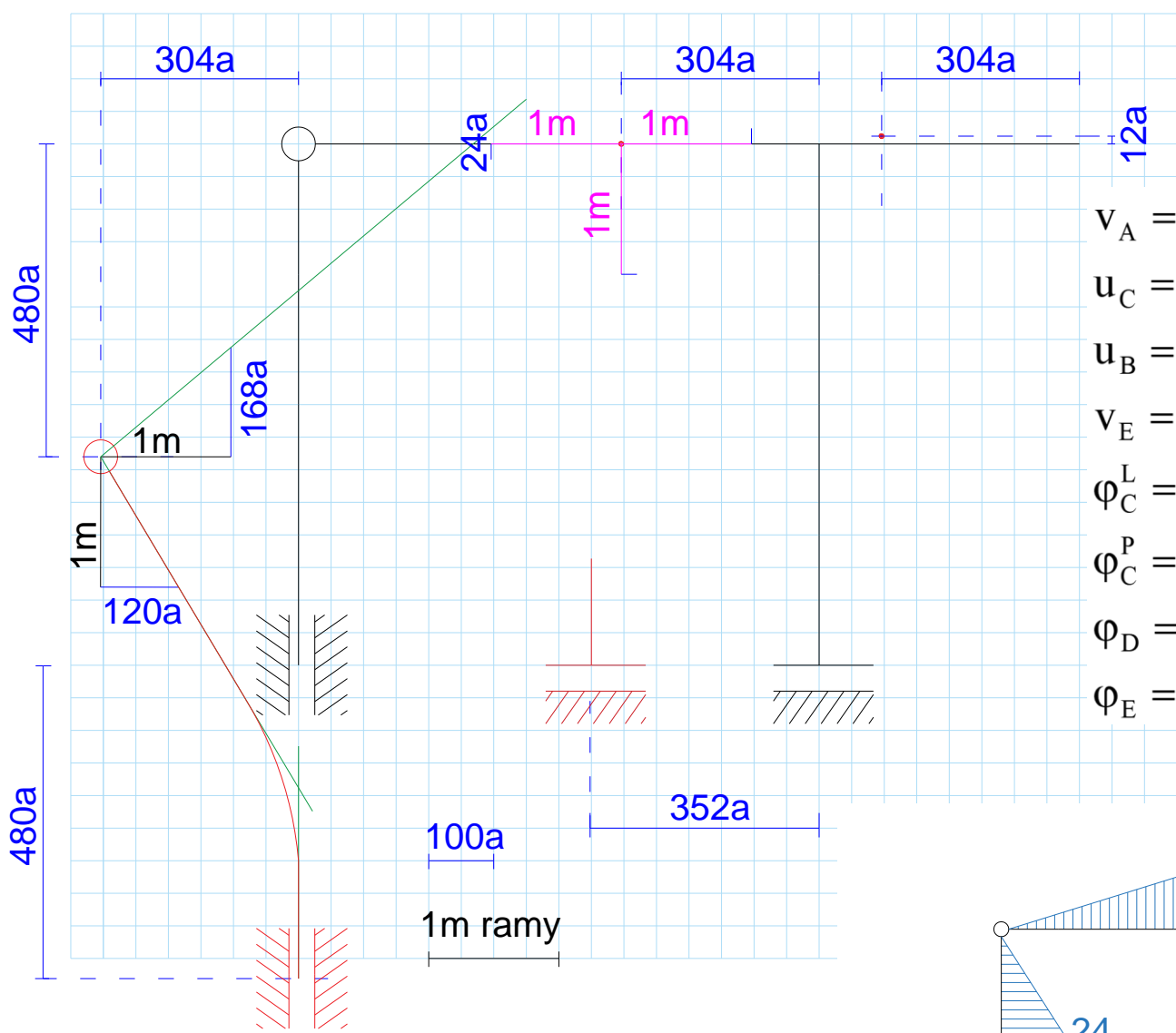
$$\phi_C^L = -120a$$

$$\phi_C^P = -168a$$

$$\phi_D = -24a$$

$$\phi_E = 12a$$





$$v_A = v_C = 480a$$

$$u_C = u_D = u_E = -304a$$

$$u_B = -352a$$

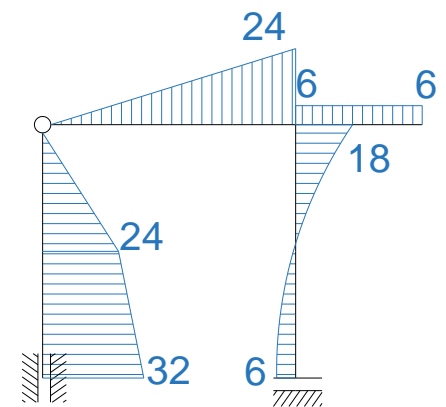
$$v_E = -12a$$

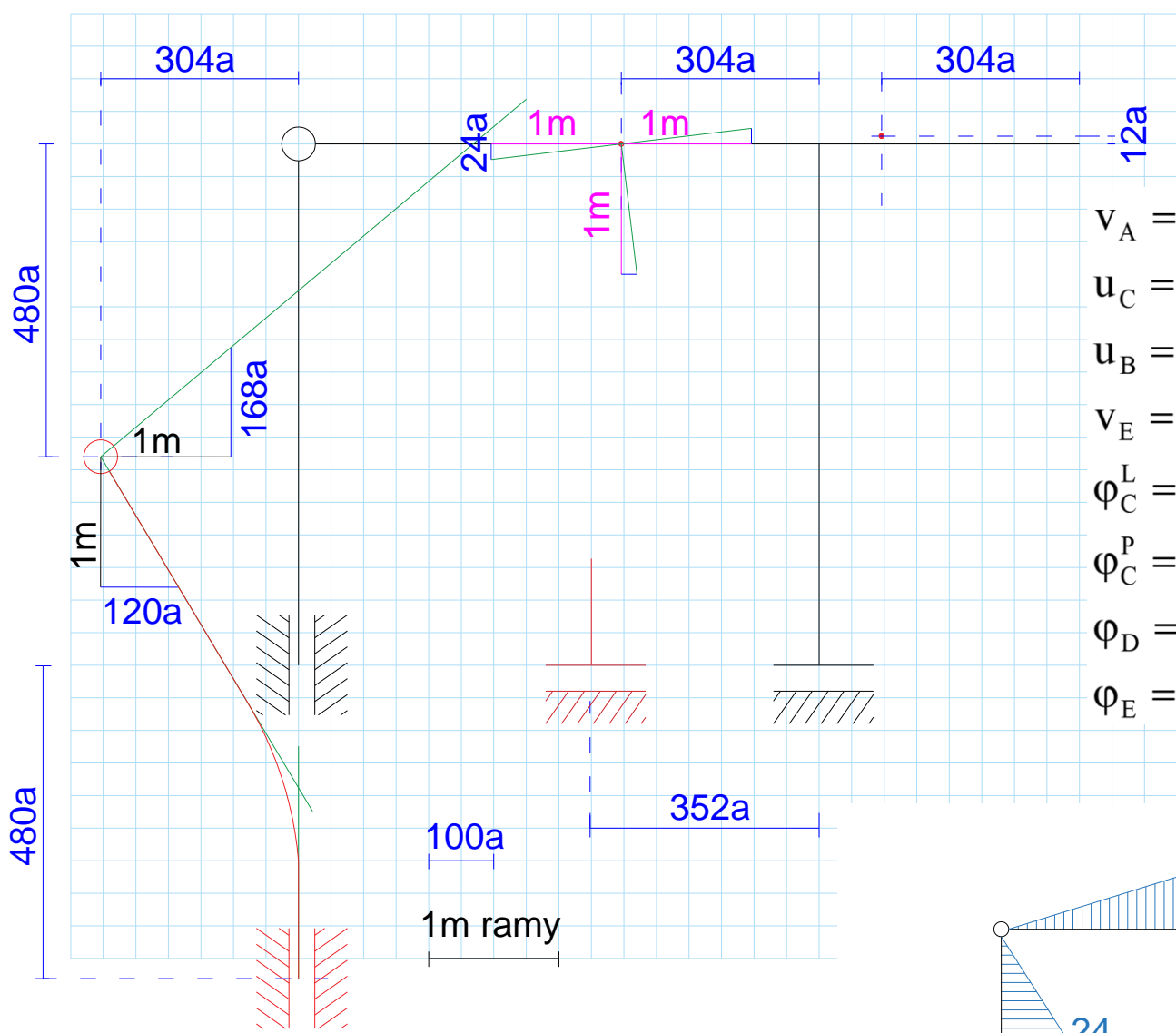
$$\varphi_C^L = -120a$$

$$\varphi_C^P = -168a$$

$$\varphi_D = -24a$$

$$\varphi_E = 12a$$





$$v_A = v_C = 480a$$

$$u_C = u_D = u_E = -304a$$

$$u_B = -352a$$

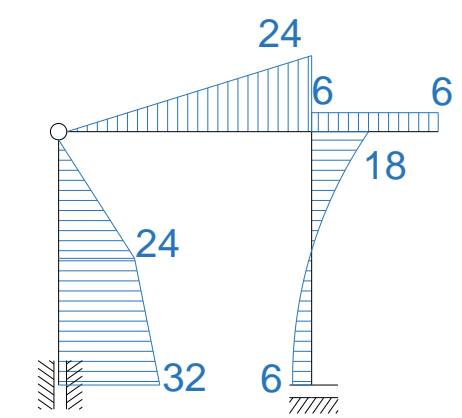
$$v_E = -12a$$

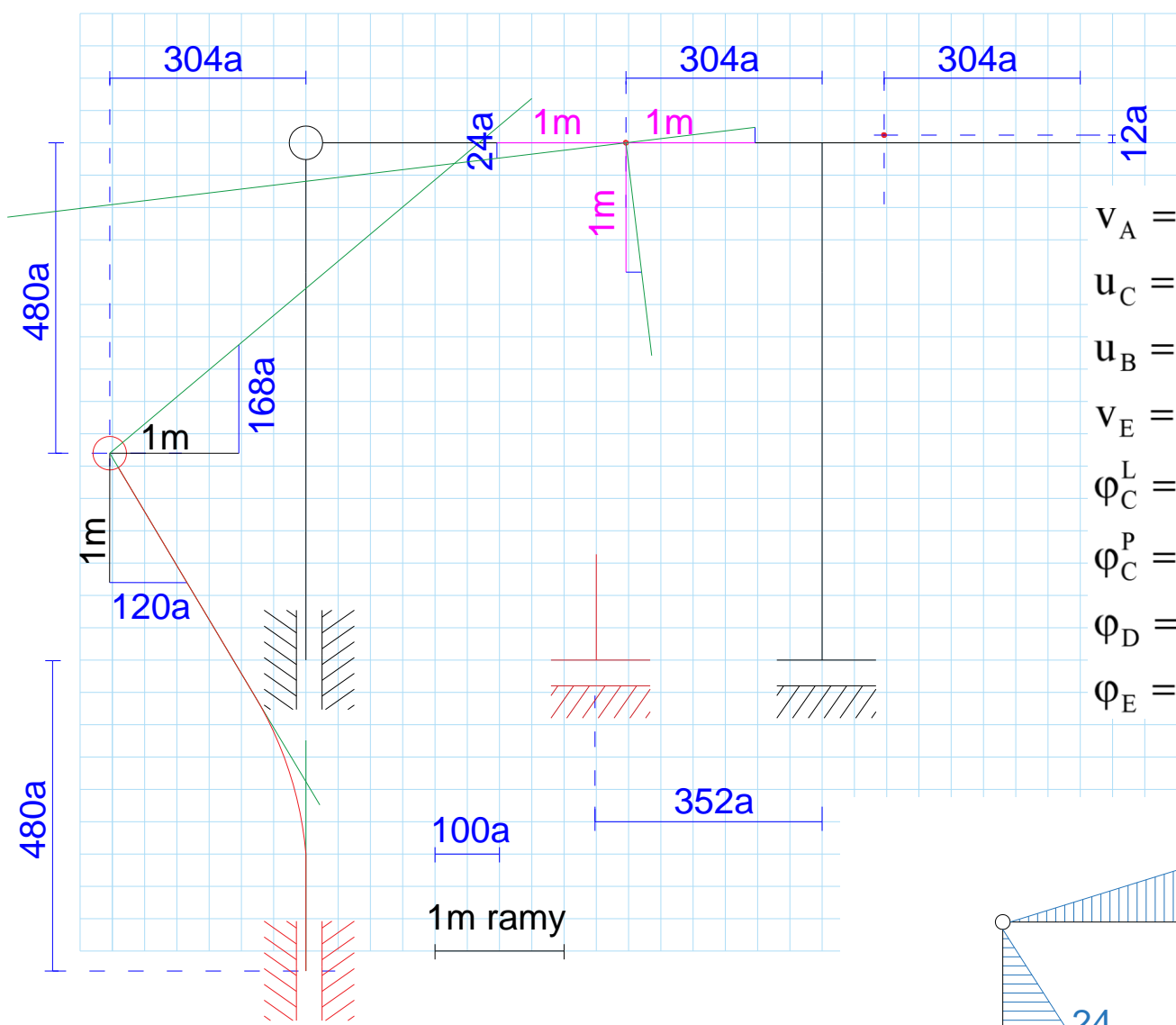
$$\varphi_C^L = -120a$$

$$\varphi_C^P = -168a$$

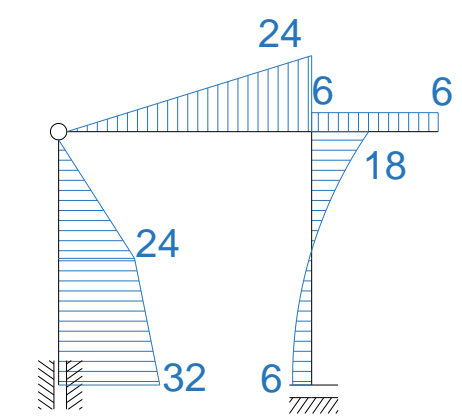
$$\varphi_D = -24a$$

$$\varphi_E = 12a$$

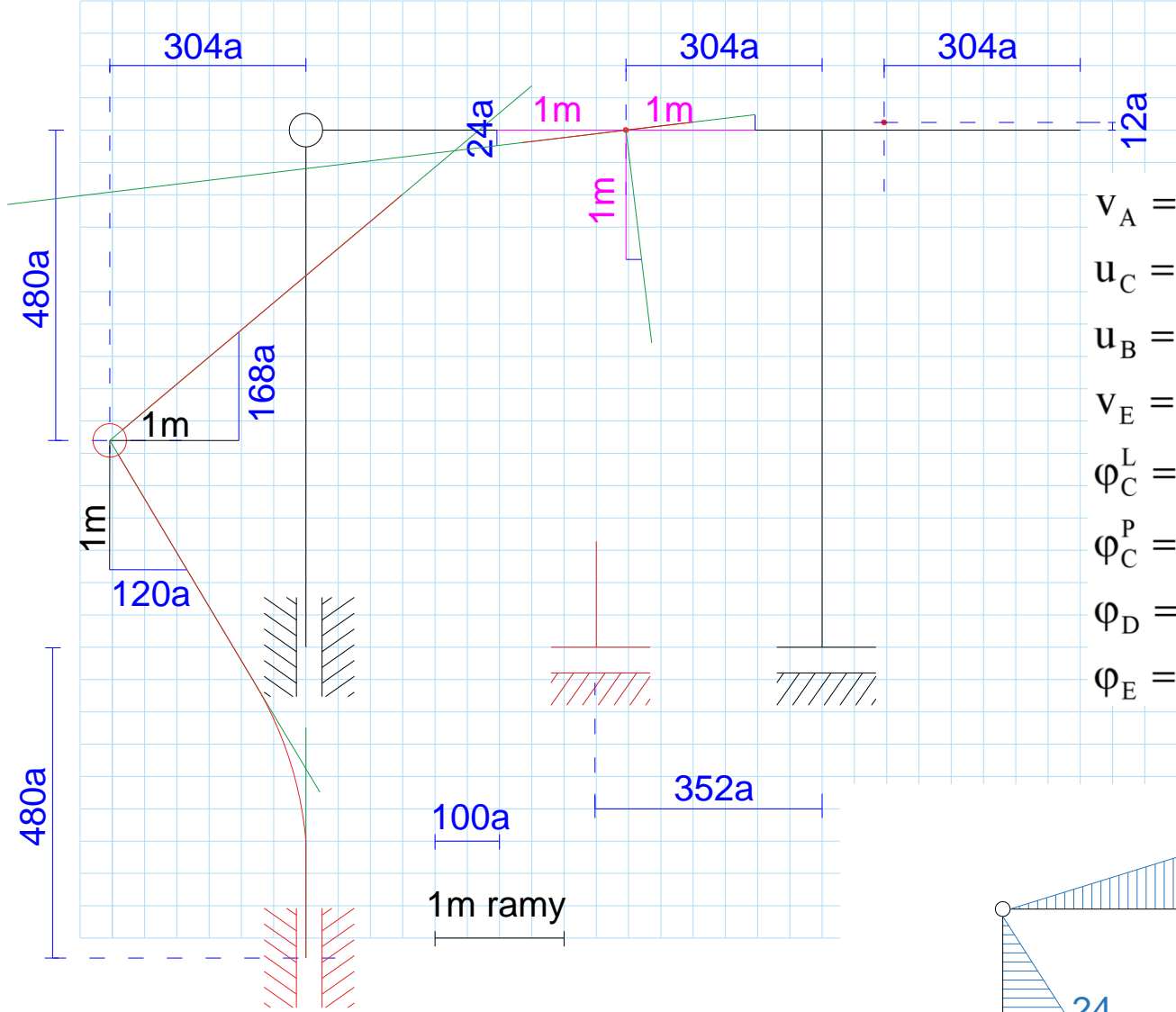




- $v_A = v_C = 480a$
- $u_C = u_D = u_E = -304a$
- $u_B = -352a$
- $v_E = -12a$
- $\varphi_C^L = -120a$
- $\varphi_C^P = -168a$
- $\varphi_D = -24a$
- $\varphi_E = 12a$







$$v_A = v_C = 480a$$

$$u_C = u_D = u_E = -304a$$

$$u_B = -352a$$

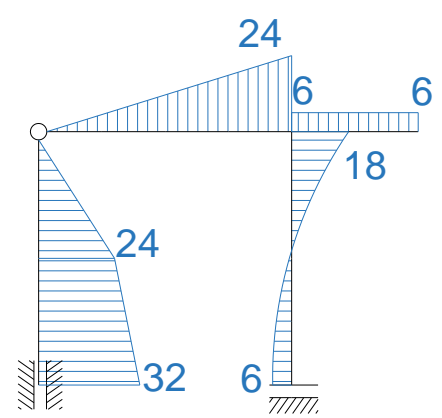
$$v_E = -12a$$

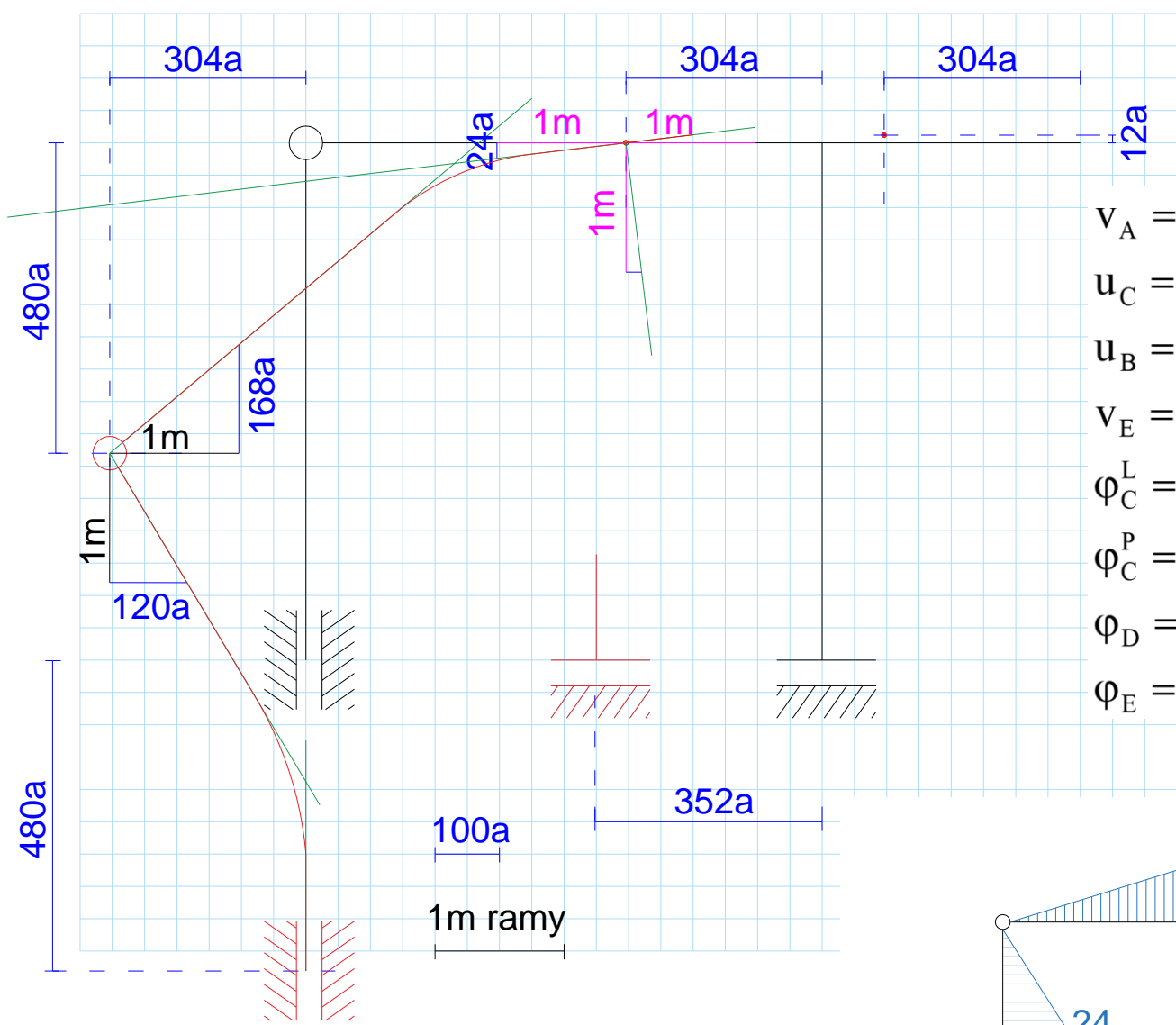
$$\varphi_C^L = -120a$$

$$\varphi_C^P = -168a$$

$$\varphi_D = -24a$$

$$\varphi_E = 12a$$





$$v_A = v_C = 480a$$

$$u_C = u_D = u_E = -304a$$

$$u_B = -352a$$

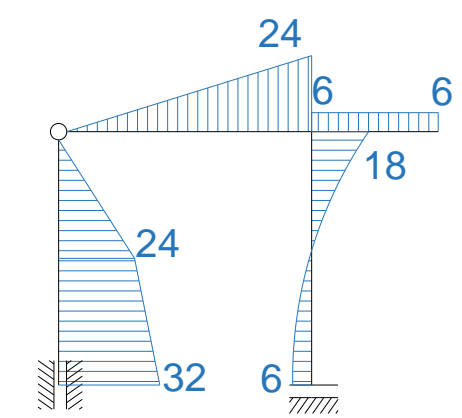
$$v_E = -12a$$

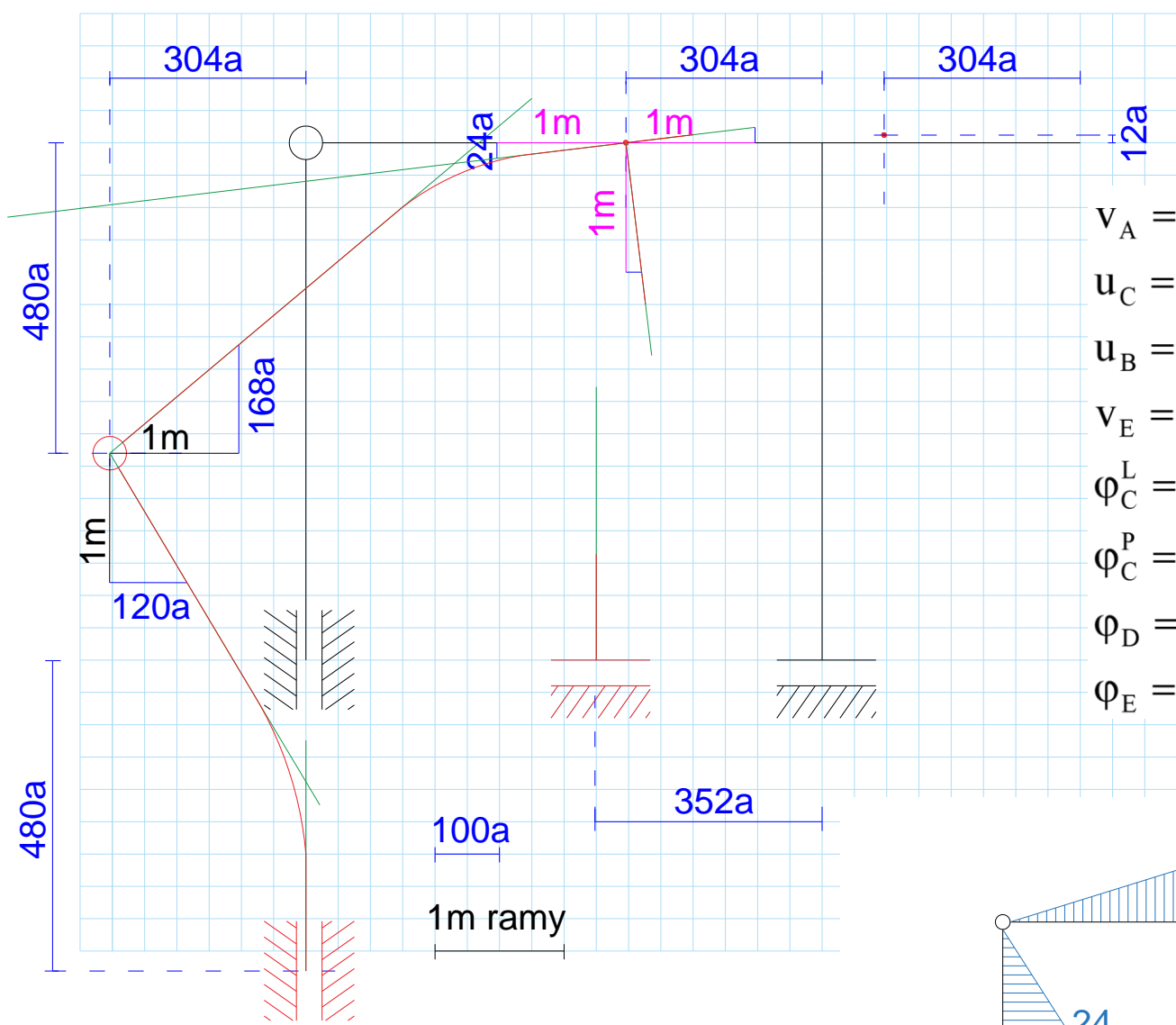
$$\varphi_C^L = -120a$$

$$\varphi_C^P = -168a$$

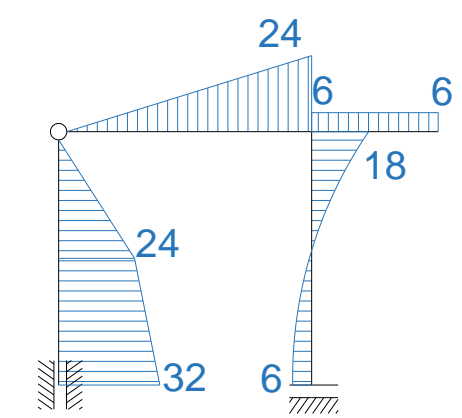
$$\varphi_D = -24a$$

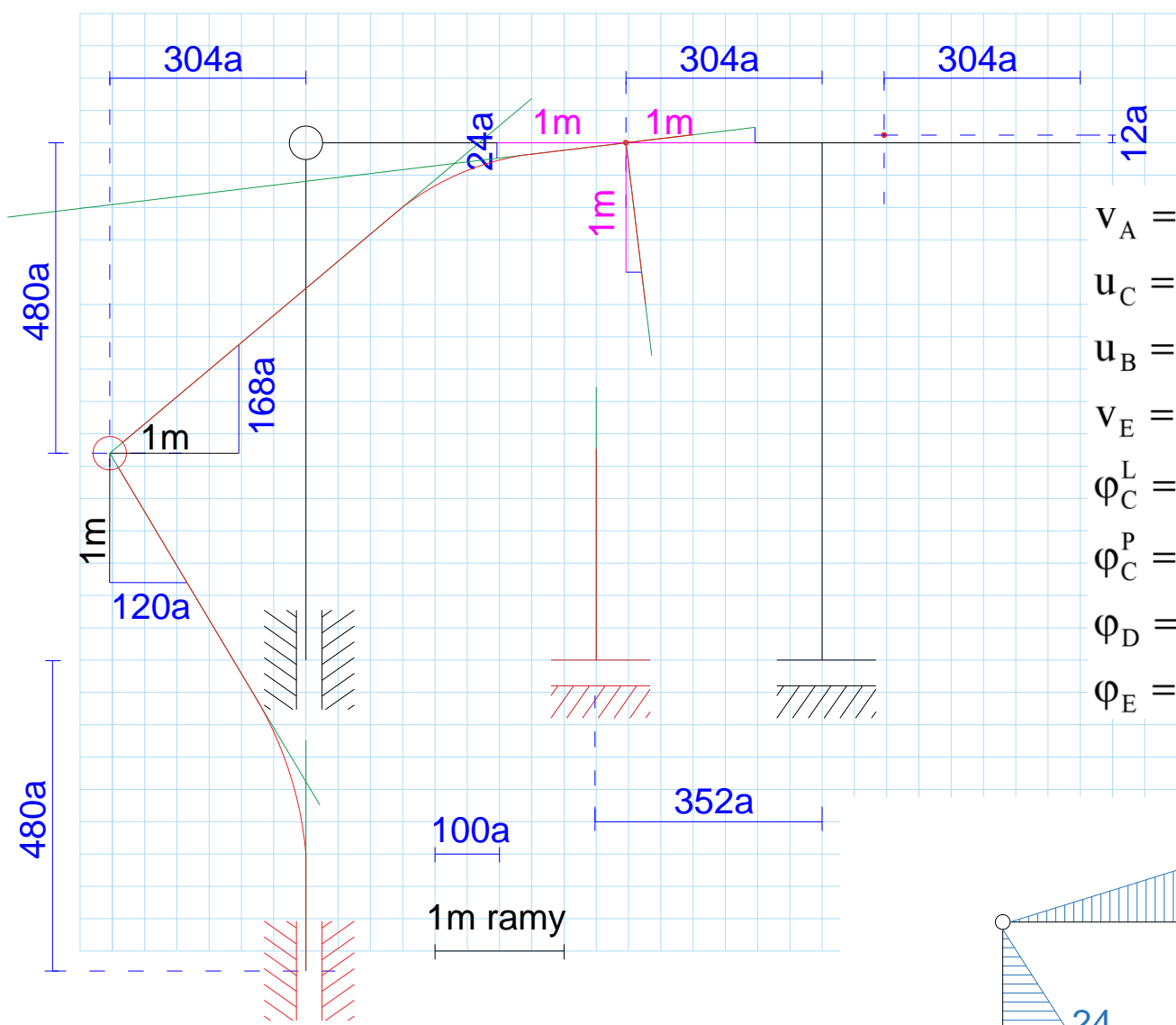
$$\varphi_E = 12a$$





$v_A = v_C = 480a$   
 $u_C = u_D = u_E = -304a$   
 $u_B = -352a$   
 $v_E = -12a$   
 $\varphi_C^L = -120a$   
 $\varphi_C^P = -168a$   
 $\varphi_D = -24a$   
 $\varphi_E = 12a$





$$v_A = v_C = 480a$$

$$u_C = u_D = u_E = -304a$$

$$u_B = -352a$$

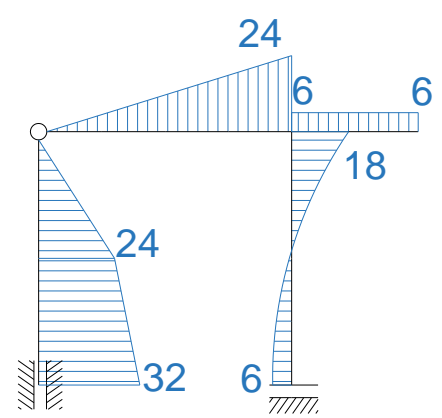
$$v_E = -12a$$

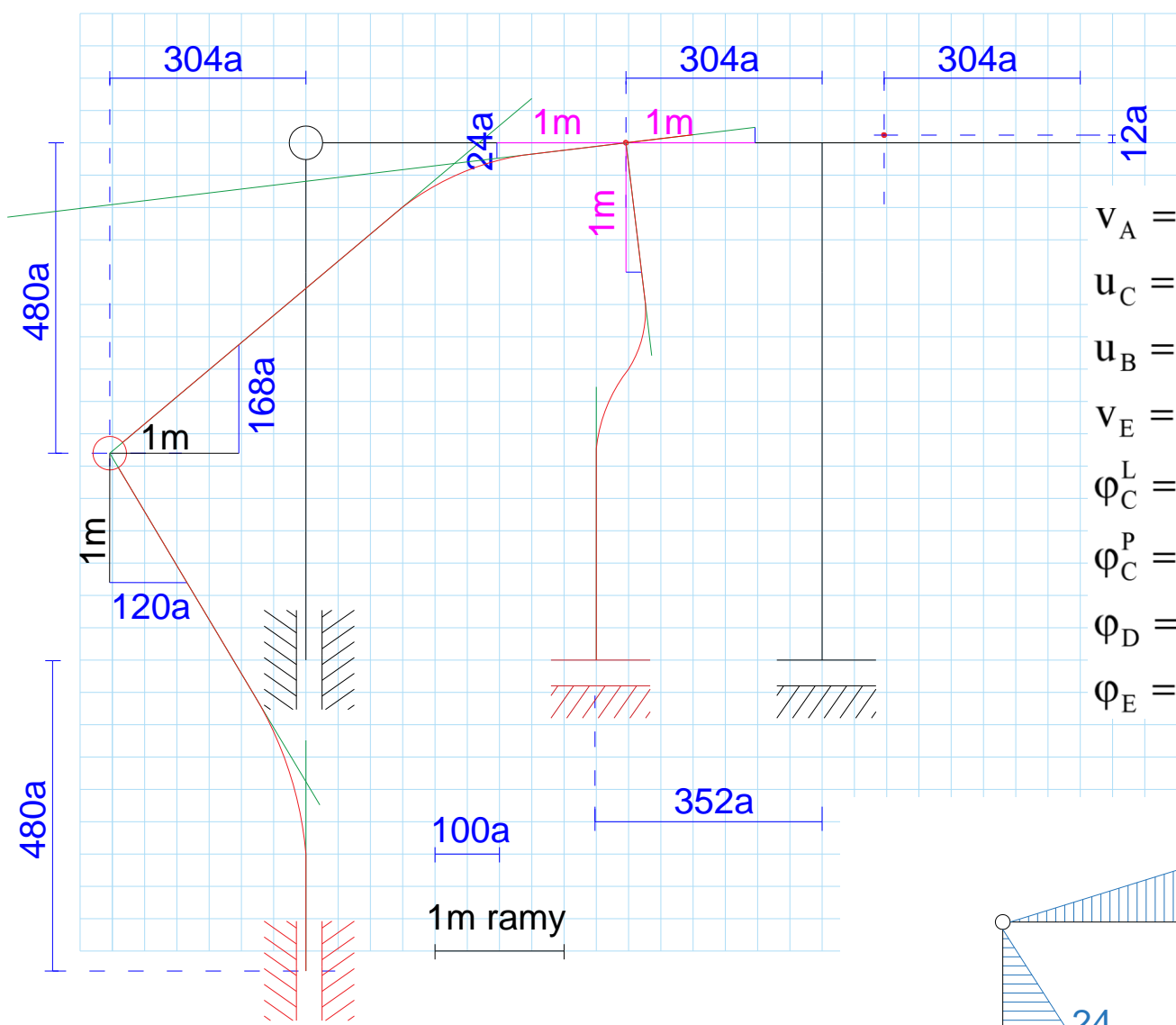
$$\varphi_C^L = -120a$$

$$\varphi_C^P = -168a$$

$$\varphi_D = -24a$$

$$\varphi_E = 12a$$





$$v_A = v_C = 480a$$

$$u_C = u_D = u_E = -304a$$

$$u_B = -352a$$

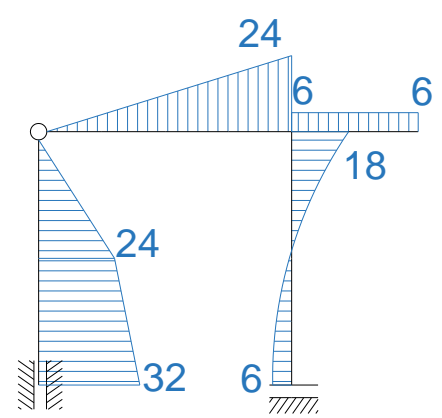
$$v_E = -12a$$

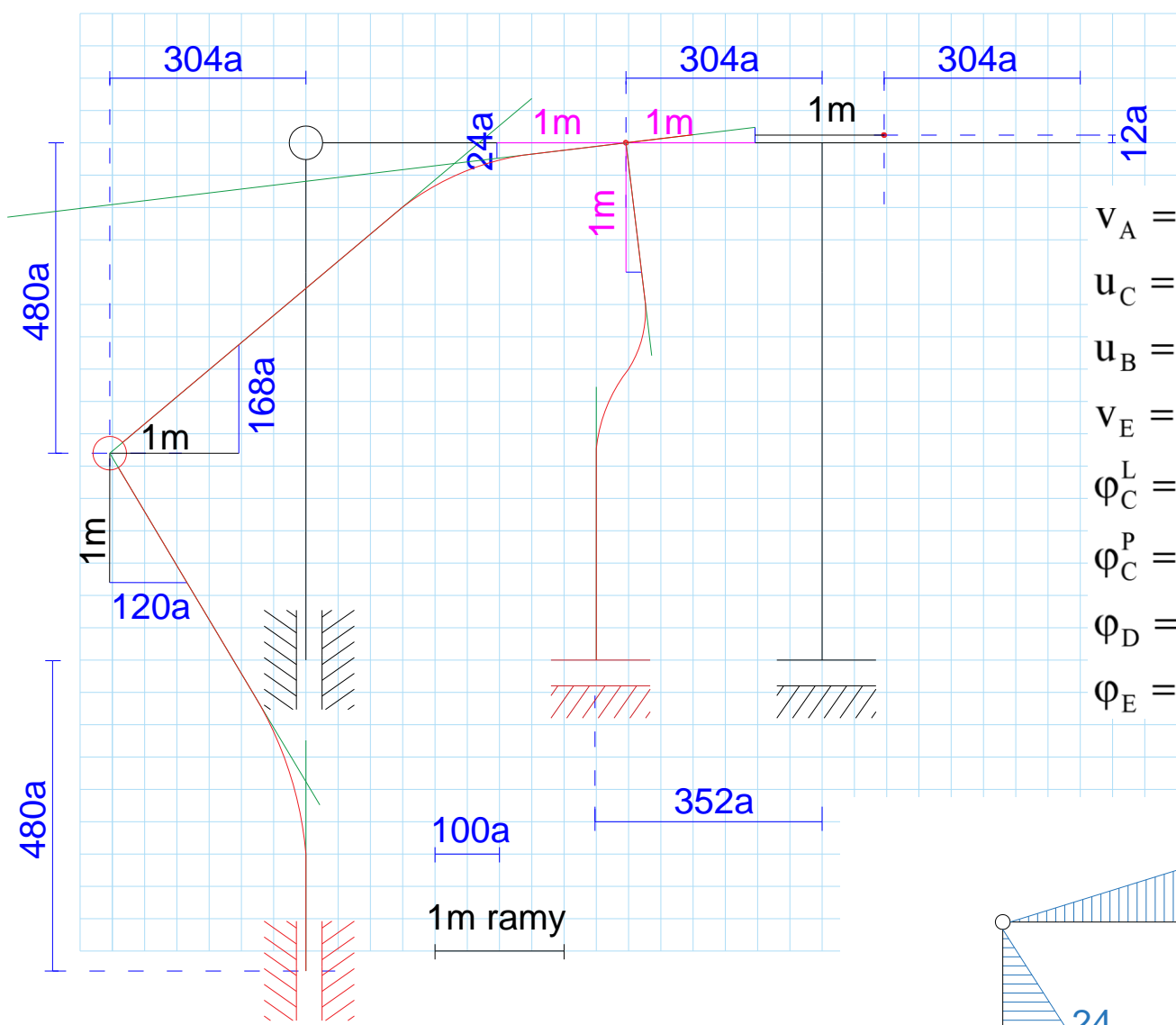
$$\varphi_C^L = -120a$$

$$\varphi_C^P = -168a$$

$$\varphi_D = -24a$$

$$\varphi_E = 12a$$





$$v_A = v_C = 480a$$

$$u_C = u_D = u_E = -304a$$

$$u_B = -352a$$

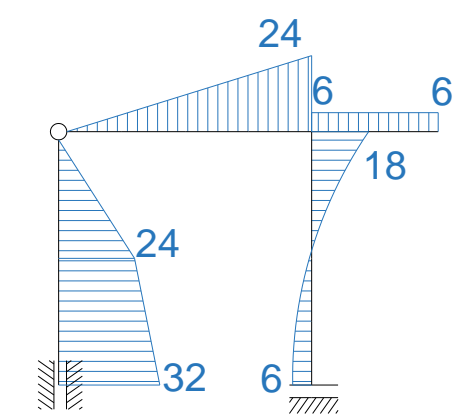
$$v_E = -12a$$

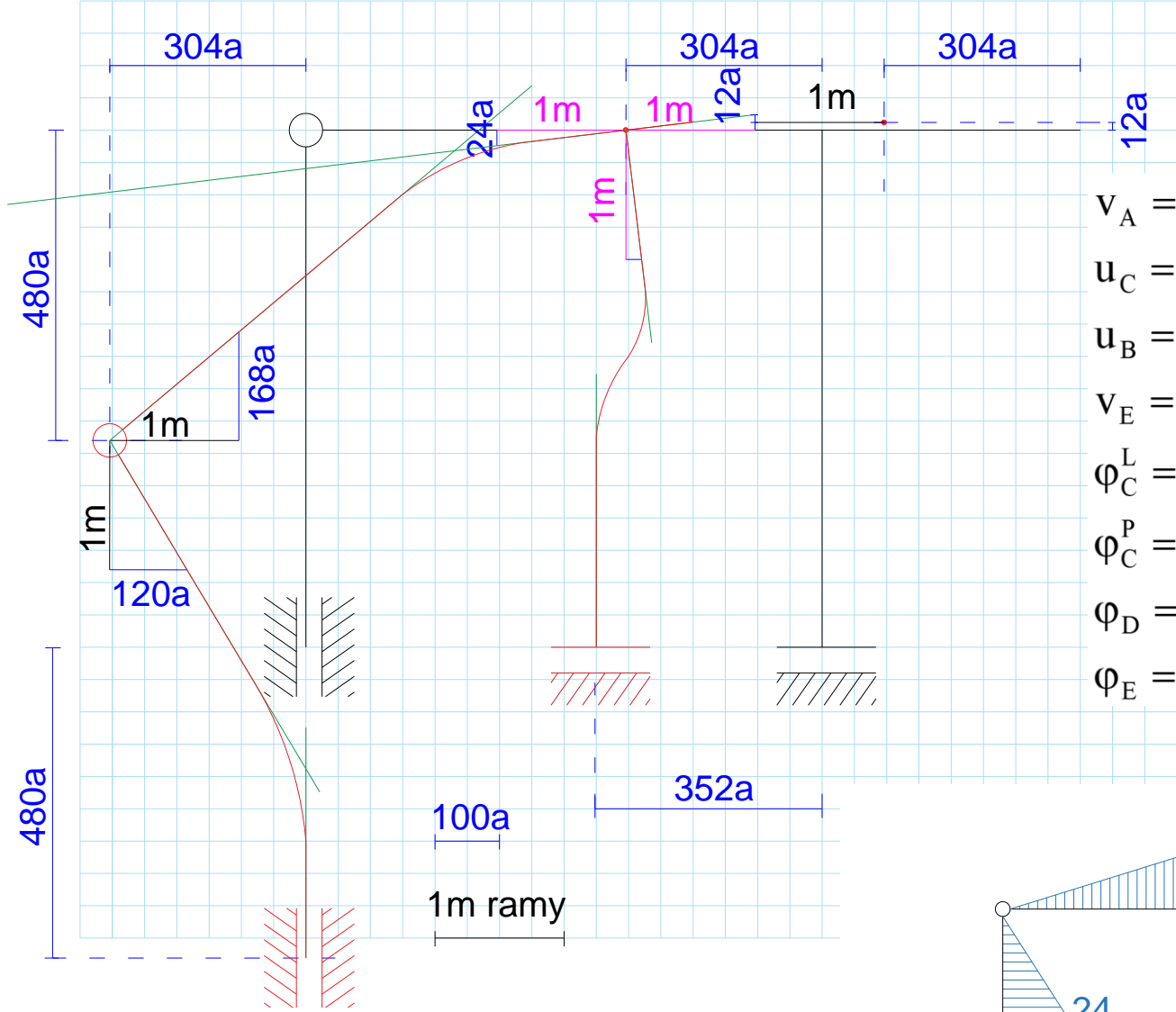
$$\varphi_C^L = -120a$$

$$\varphi_C^P = -168a$$

$$\varphi_D = -24a$$

$$\varphi_E = 12a$$





$$v_A = v_C = 480a$$

$$u_C = u_D = u_E = -304a$$

$$u_B = -352a$$

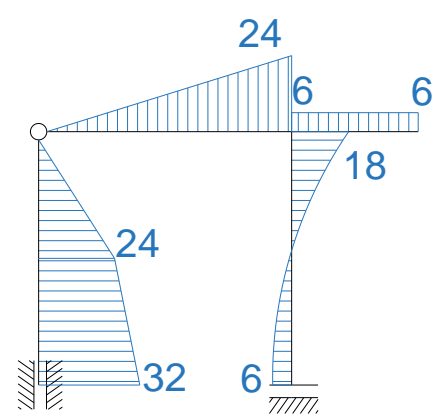
$$v_E = -12a$$

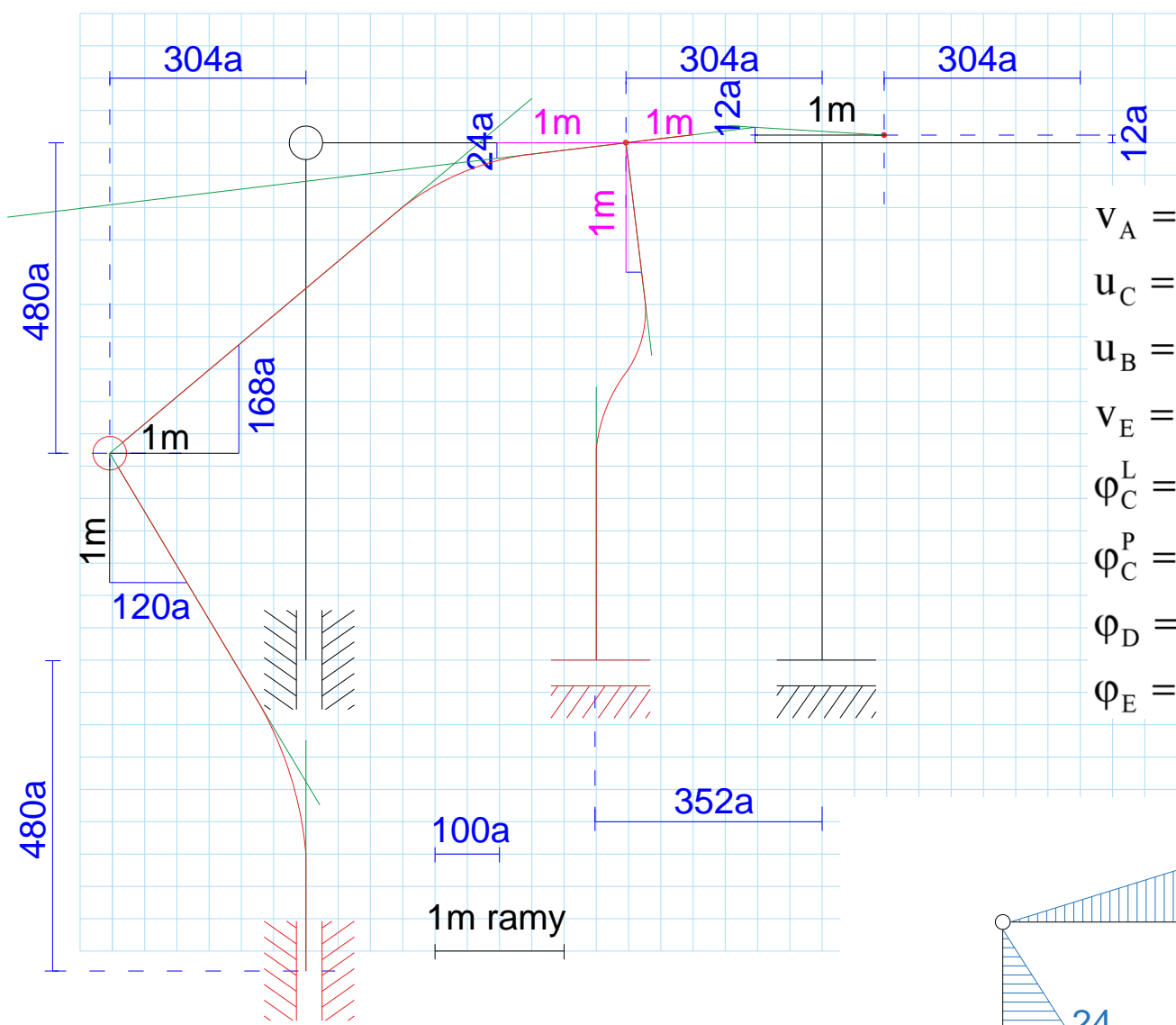
$$\varphi_C^L = -120a$$

$$\varphi_C^P = -168a$$

$$\varphi_D = -24a$$

$$\varphi_E = 12a$$





$$v_A = v_C = 480a$$

$$u_C = u_D = u_E = -304a$$

$$u_B = -352a$$

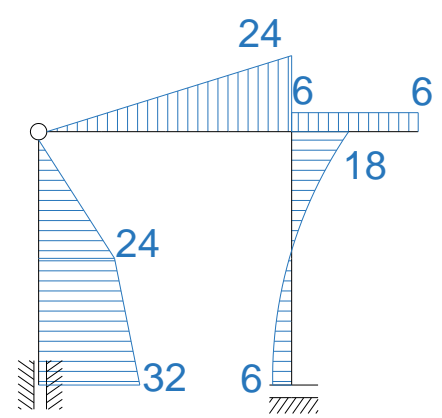
$$v_E = -12a$$

$$\varphi_C^L = -120a$$

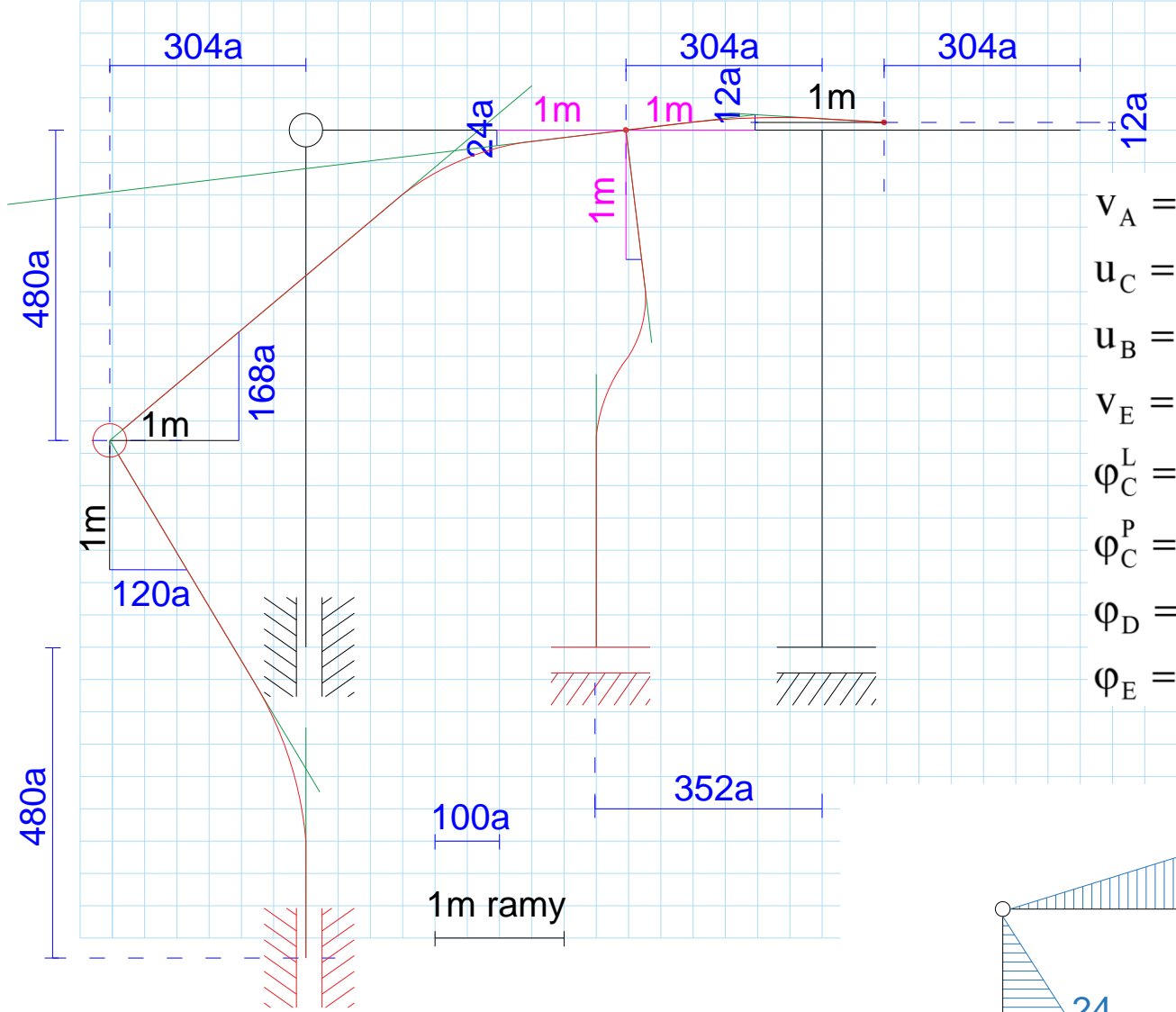
$$\varphi_C^P = -168a$$

$$\varphi_D = -24a$$

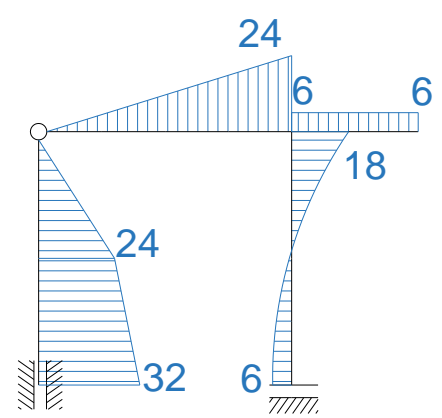
$$\varphi_E = 12a$$

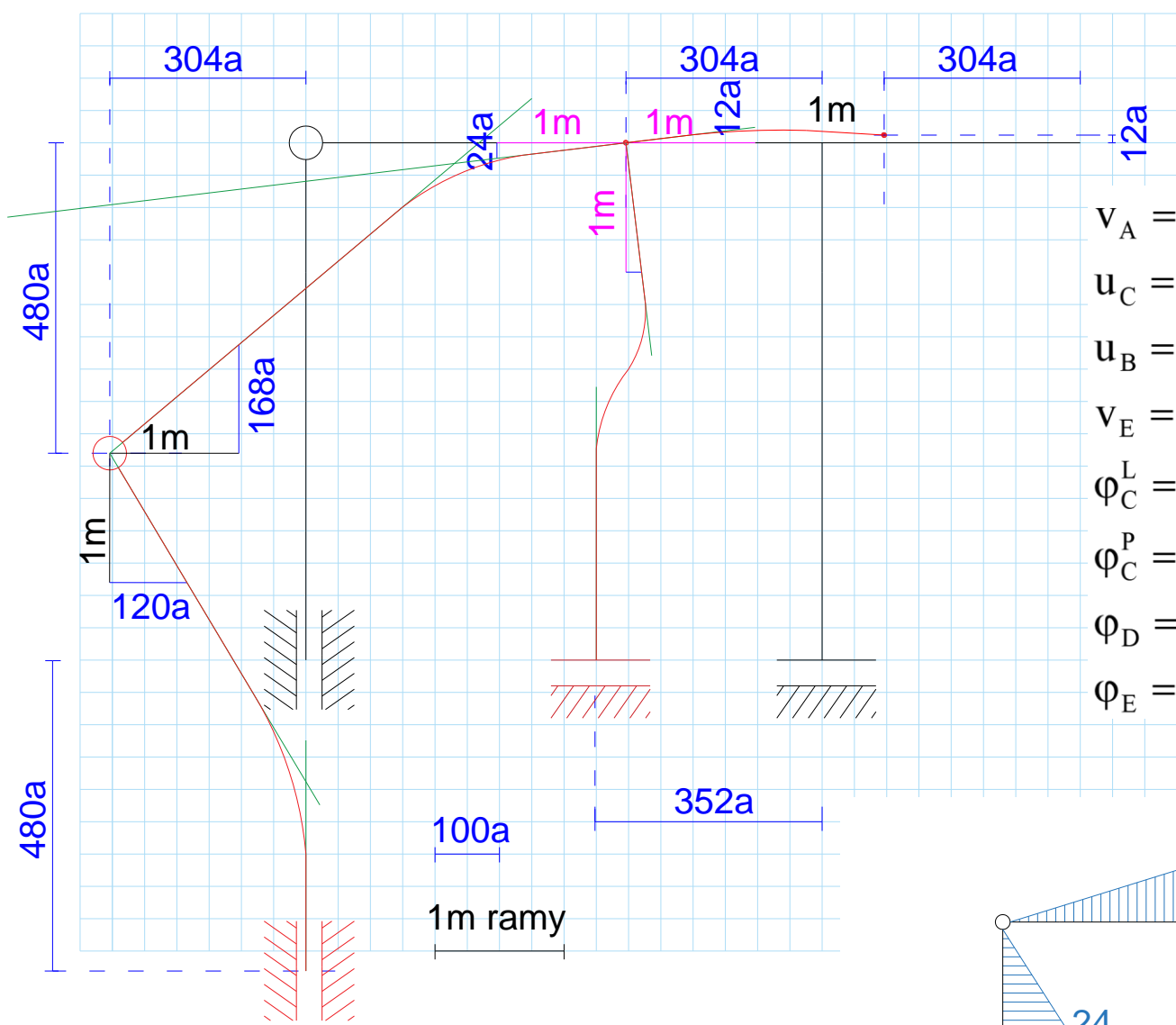




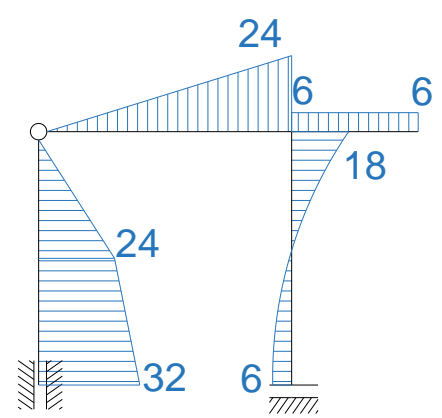


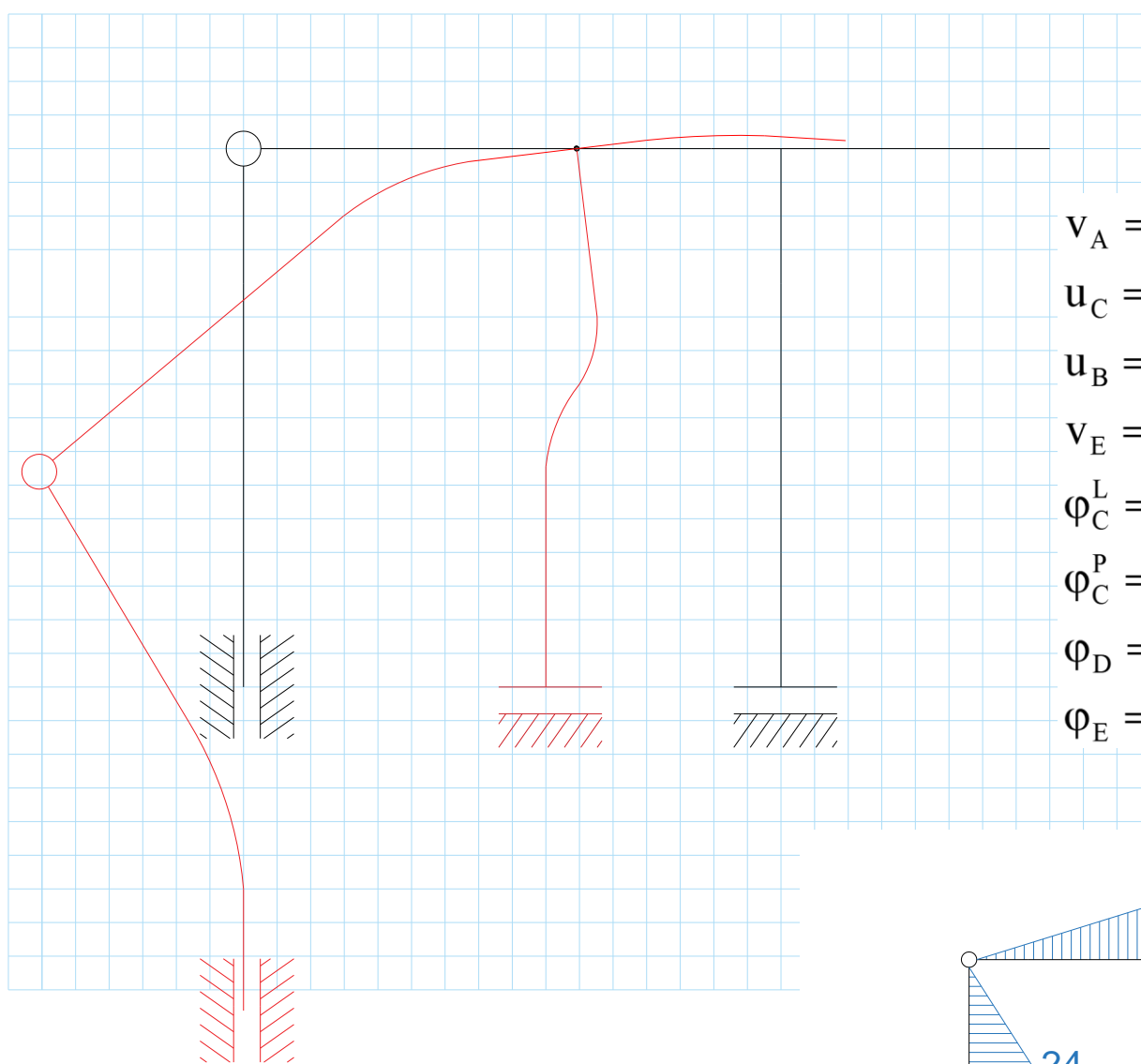
$100a$   
 $352a$   
 $1m$  ramy





1m ramy





$$v_A = v_C = 480a$$

$$u_C = u_D = u_E = -304a$$

$$u_B = -352a$$

$$v_E = -12a$$

$$\varphi_C^L = -120a$$

$$\varphi_C^P = -168a$$

$$\varphi_D = -24a$$

$$\varphi_E = 12a$$

