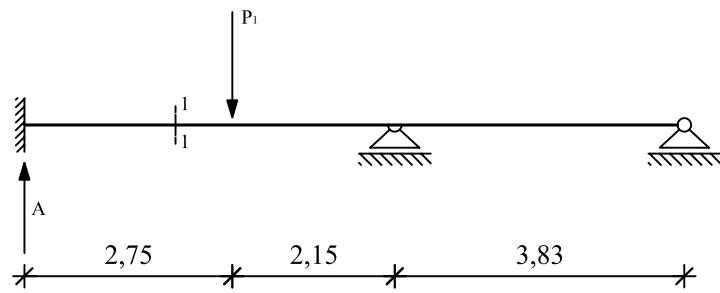
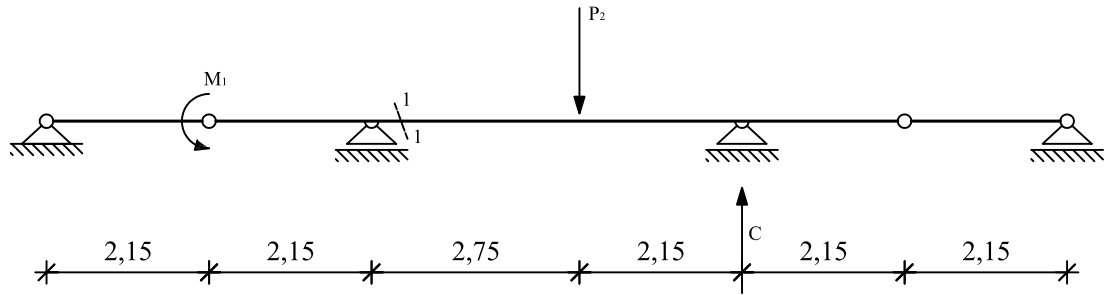


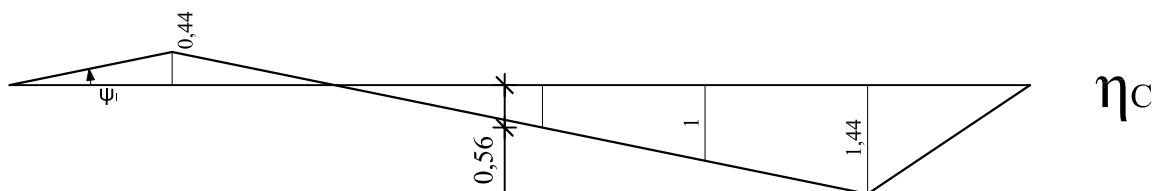
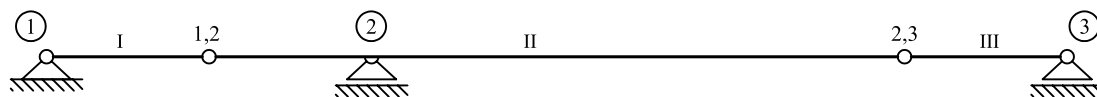
# GRAĐEVNA STATIKA 2

- 3. Program-

Hajdarovac Elis

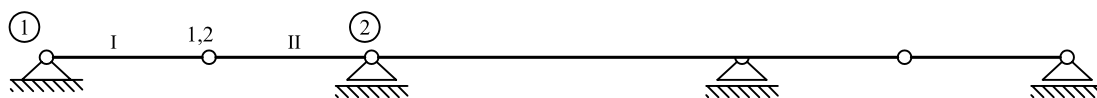
0082026728





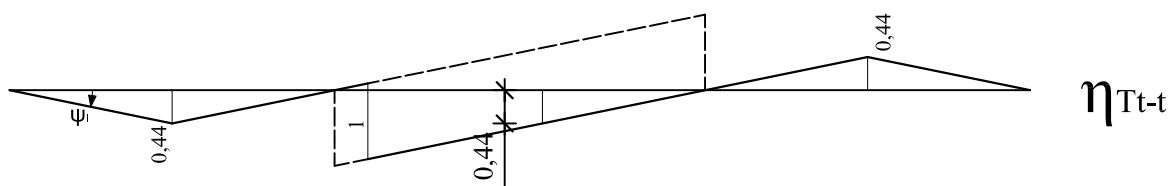
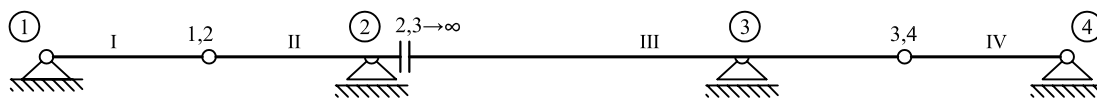
$$\psi_I = \frac{0,44}{2,15}$$

$$C = 82 \cdot \frac{0,44}{2,15} + 72 \cdot 0,56 = 57,10 \text{ kN}$$



$$\psi_I = 1$$

$$M_{t-t} = 82 \cdot 1 = 82 \text{ kNm}$$

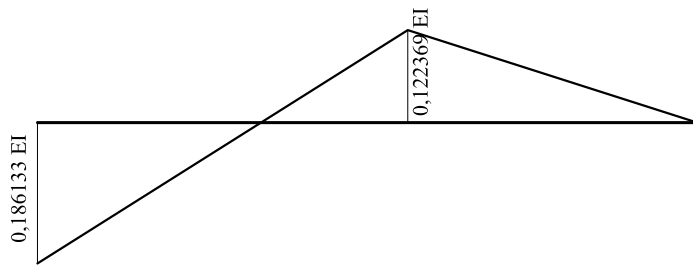
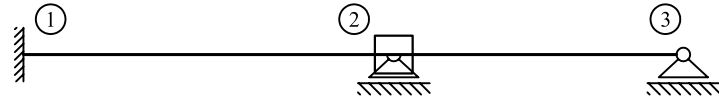


$$\psi_I = \frac{0,44}{2,15}$$

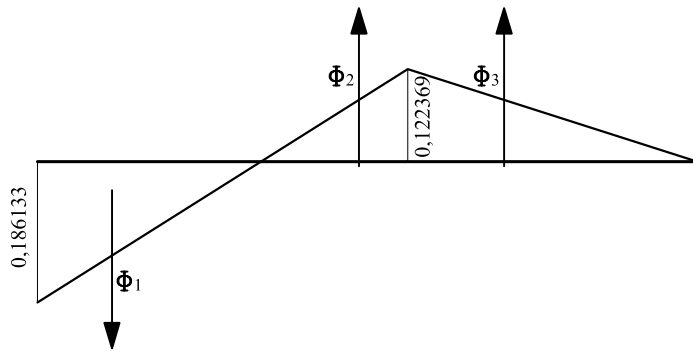
$$T_{t-t} = -\frac{0,44}{2,15} \cdot 82 + 72 \cdot 0,44 = 14,90 \text{ kN}$$

Reakcija A:

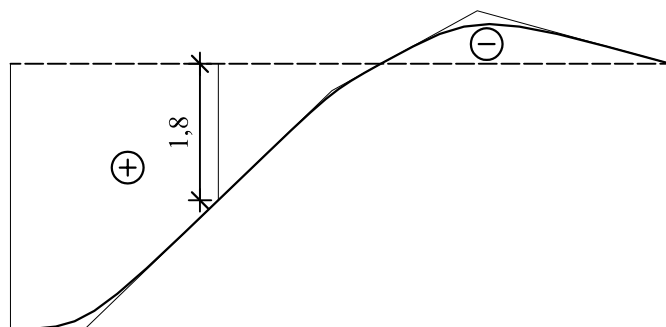
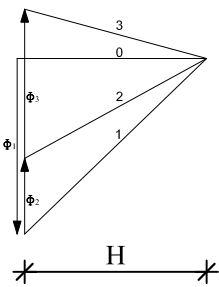
Osnovni sistem za IMP:



M



K



\eta\_A

---

$$k_{12} = EI / l_{12} = EI/4,9 \text{ kNm}$$

$$k_{23} = EI / l_{23} = EI/3,83 \text{ kNm}$$

Utjecajna linija za reakciju A:

Kinematički postupak:

$$\bar{\psi}_{12} = \frac{1}{4,9}$$

Momenti upetosti:

$$\bar{M}_{12} = \bar{M}_{21} = -6 \cdot k_{12} \cdot \bar{\psi}_{12} = -6 \cdot \frac{EI}{4,9} \cdot \frac{1}{4,9} = -\frac{6}{24,01} EI$$

Ukupni momenti:

$$M_{12} = 2 \cdot k_{12} \cdot \varphi_2 + \bar{M}_{12}$$

$$M_{21} = 4 \cdot k_{12} \cdot \varphi_2 + \bar{M}_{21}$$

$$M_{23} = 3 \cdot k_{23} \cdot \varphi_2$$

Jednadžba ravnoteže čvora 2:

$$M_{21} + M_{23} = 0$$

$$4 \cdot \frac{EI}{4,9} \cdot \varphi_2 - 6 \cdot \frac{EI}{4,9} \cdot \frac{1}{4,9} + 3 \cdot \frac{EI}{3,83} \cdot \varphi_2 = 0$$

$$1,59962 \cdot \varphi_2 = \frac{6}{24,01}$$

$$\varphi_2 = 0,15622$$

$$M_{12} = 2 \cdot \frac{EI}{4,9} \cdot 0,15622 - 6 \cdot \frac{EI}{4,9} \cdot \frac{1}{4,9} = -0,186133 \cdot EI$$

$$M_{21} = 4 \cdot \frac{EI}{4,9} \cdot 0,15622 - 6 \cdot \frac{EI}{4,9} \cdot \frac{1}{4,9} = -0,122369 \cdot EI$$

$$M_{23} = 3 \cdot \frac{EI}{3,83} \cdot 0,15622 = 0,122365 \cdot EI$$

---

$$\Phi_1 = \frac{2,96 \cdot 0,186133}{2} = 0,275477$$
$$\Phi_2 = \frac{1,94 \cdot 0,122369}{2} = 0,118698$$
$$\Phi_3 = \frac{3,83 \cdot 0,122369}{2} = 0,234337$$

Mjerilo duljina :

1cm :: 1m

Mjerilo kutova:

1cm :: 0,118698

Polna udaljenost:

$$H = \frac{1}{n} = \frac{1}{3,5}$$

Duljine kutova u poligonu kutova na crtežu:

$$\bar{\Phi}_1 = \frac{1}{0,118698} \cdot 0,275477 = 2,321 \text{ cm}$$

$$\bar{\Phi}_2 = \frac{1}{0,118698} \cdot 0,118698 = 1,0 \text{ cm}$$

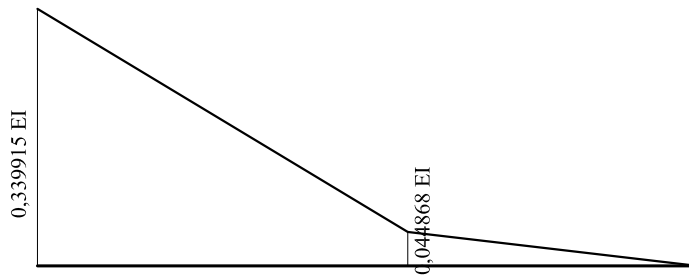
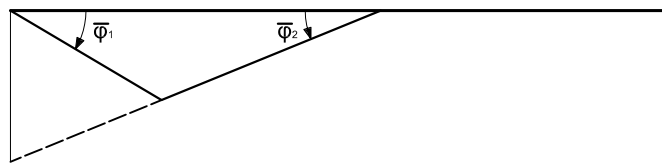
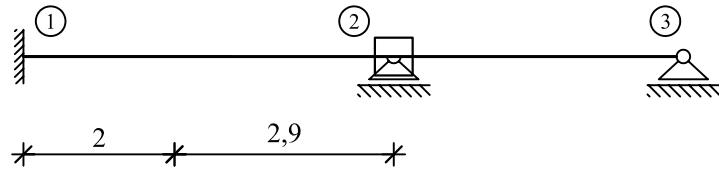
$$\bar{\Phi}_3 = \frac{1}{0,118698} \cdot 0,234337 = 1,974 \text{ cm}$$

$$\bar{H} = \frac{1}{0,118698} \cdot \frac{1}{3,5} = 2,407 \text{ cm}$$

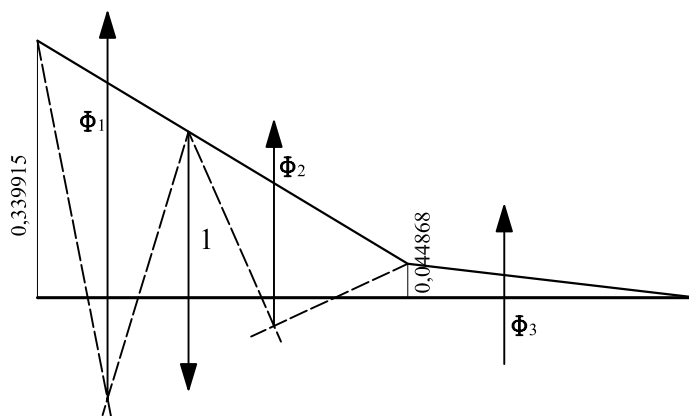
$$A = \eta \cdot P_1 = \frac{1}{3,5} \cdot 1,8 \cdot 147 = 0,514 \cdot 147 = 75,56 \text{ kN}$$

Moment u presjeku t-t:

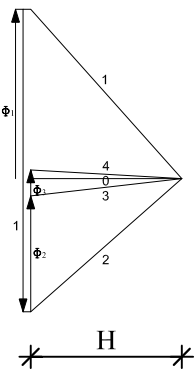
Osnovni sistem za IMP:



M



K



$\eta_{Mt-t}$

---

Utjecajna linija za moment u presjeku t-t:

Kinematički postupak:

$$\bar{\varphi}_1 = -\frac{2,9}{4,9} \qquad \bar{\varphi}_2 = \frac{2,0}{4,9}$$

Momenti upetosti:

$$\bar{M}_{12} = -4 \cdot k_{12} \cdot \bar{\varphi}_1 - 2 \cdot k_{12} \cdot \bar{\varphi}_2 = -4 \cdot \frac{EI}{4,9} \cdot \left(-\frac{2,9}{4,9}\right) - 2 \cdot \frac{EI}{4,9} \cdot \frac{2}{4,9} = \frac{760}{2401} EI$$

$$\bar{M}_{21} = -2 \cdot k_{12} \cdot \bar{\varphi}_1 - 4 \cdot k_{12} \cdot \bar{\varphi}_2 = -2 \cdot \frac{EI}{4,9} \cdot \left(-\frac{2,9}{4,9}\right) - 4 \cdot \frac{EI}{4,9} \cdot \frac{2}{4,9} = -\frac{220}{2401} EI$$

Ukupni momenti:

$$M_{12} = 2 \cdot k_{12} \cdot \varphi_2 + \bar{M}_{12}$$

$$M_{21} = 4 \cdot k_{12} \cdot \varphi_2 + \bar{M}_{21}$$

$$M_{23} = 3 \cdot k_{23} \cdot \varphi_2$$

Jednadžba ravnoteže čvora 2:

$$M_{21} + M_{23} = 0$$

$$4 \cdot \frac{EI}{4,9} \cdot \varphi_2 + 3 \cdot \frac{EI}{3,83} \cdot \varphi_2 = \frac{220}{2401} EI$$

$$1,59962 \cdot \varphi_2 = \frac{220}{2401}$$

$$\varphi_2 = 0,057281$$

$$M_{12} = 2 \cdot \frac{EI}{4,9} \cdot 0,057281 + \frac{760}{2401} EI = 0,339915 \cdot EI$$

$$M_{21} = 4 \cdot \frac{EI}{4,9} \cdot 0,057281 - \frac{220}{2401} EI = -0,044868 \cdot EI$$

$$M_{23} = 3 \cdot \frac{EI}{3,83} \cdot 0,057281 = 0,044868 \cdot EI$$



---

$$\Phi_1 = \frac{0,339915+0,21949}{2} \cdot 2 = 0,559405$$
$$\Phi_2 = \frac{0,21949+0,044868}{2} \cdot 2,9 = 0,3833191$$
$$\Phi_3 = \frac{0,044868 \cdot 3,83}{2} = 0,085922$$

Mjerilo duljina :

1cm :: 1m

Mjerilo kutova:

1cm :: 0,25

Polna udaljenost:

$$H = \frac{1}{n} = \frac{1}{2}$$

Duljine kutova u poligonu kutova na crtežu:

$$\bar{\Phi}_1 = \frac{1}{0,25} \cdot 0,559405 = 2,23762 \text{ cm}$$

$$\bar{\Phi}_2 = \frac{1}{0,25} \cdot 0,3833191 = 1,53327 \text{ cm}$$

$$\bar{\Phi}_3 = \frac{1}{0,25} \cdot 0,085922 = 0,34368 \text{ cm}$$

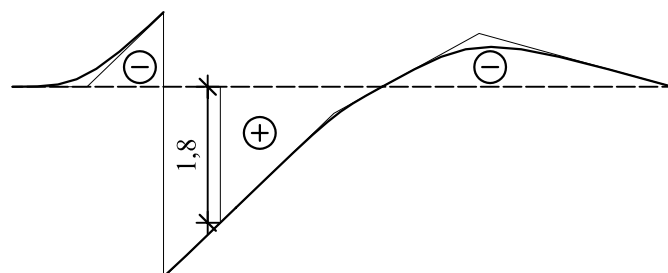
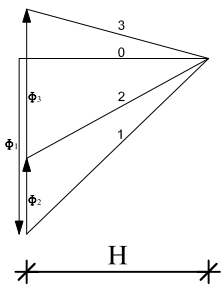
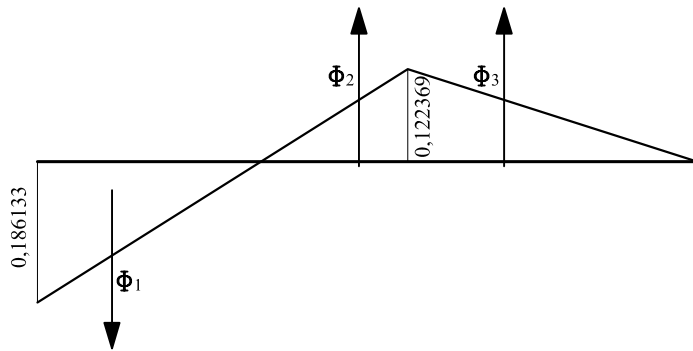
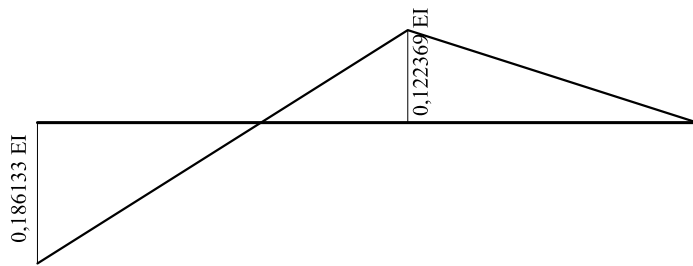
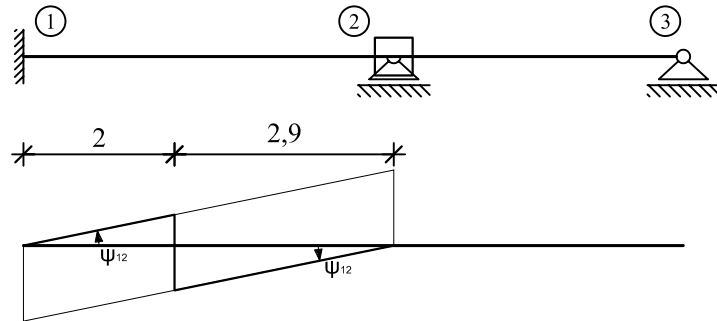
$$\bar{1} = \frac{1}{0,25} \cdot 1 = 4 \text{ cm}$$

$$\bar{H} = \frac{1}{0,25} \cdot \frac{1}{2} = 2 \text{ cm}$$

$$M_{t-t} = \eta \cdot P_1 = \frac{1}{2} \cdot 0,5723 \cdot 147 = 0,286 \cdot 147 = 42,04 \text{ kN}$$

Poprečna sila u presjeku t-t:

Osnovni sistem za IMP:



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Utjecajna linija za poprečnu silu u presjeku t-t:

Kinematički postupak:

$$\bar{\psi}_{12} = +\frac{1}{4,9}$$

Momenti upetosti:

$$\bar{M}_{12} = \bar{M}_{21} = -6 \cdot k_{12} \cdot \bar{\psi}_{12} = -6 \cdot \frac{EI}{4,9} \cdot \frac{1}{4,9} = -\frac{6}{24,01} EI$$

Ukupni momenti:

$$M_{12} = 2 \cdot k_{12} \cdot \varphi_2 + \bar{M}_{12}$$

$$M_{21} = 4 \cdot k_{12} \cdot \varphi_2 + \bar{M}_{21}$$

$$M_{23} = 3 \cdot k_{23} \cdot \varphi_2$$

Jednadžba ravnoteže čvora 2:

$$M_{21} + M_{23} = 0$$

$$4 \cdot \frac{EI}{4,9} \cdot \varphi_2 - 6 \cdot \frac{EI}{4,9} \cdot \frac{1}{4,9} + 3 \cdot \frac{EI}{3,83} \cdot \varphi_2 = 0$$

$$1,59962 \cdot \varphi_2 = \frac{6}{24,01}$$

$$\varphi_2 = 0,15622$$

$$M_{12} = 2 \cdot \frac{EI}{4,9} \cdot 0,15622 - 6 \cdot \frac{EI}{4,9} \cdot \frac{1}{4,9} = -0,186133 \cdot EI$$

$$M_{21} = 4 \cdot \frac{EI}{4,9} \cdot 0,15622 - 6 \cdot \frac{EI}{4,9} \cdot \frac{1}{4,9} = -0,122369 \cdot EI$$

$$M_{23} = 3 \cdot \frac{EI}{3,83} \cdot 0,15622 = 0,122365 \cdot EI$$

---

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$$\Phi_3 = \frac{3,83 \cdot 0,122369}{2} = 0,234337$$

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1cm :: 1m

Mjerilo kutova:

1cm :: 0,118698

Polna udaljenost:

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Duljine kutova u poligonu kutova na crtežu:

$$\bar{\Phi}_1 = \frac{1}{0,118698} \cdot 0,275477 = 2,321 \text{ cm}$$

$$\bar{\Phi}_2 = \frac{1}{0,118698} \cdot 0,118698 = 1,0 \text{ cm}$$

$$\bar{\Phi}_3 = \frac{1}{0,118698} \cdot 0,234337 = 1,974 \text{ cm}$$

$$\bar{H} = \frac{1}{0,118698} \cdot \frac{1}{3,5} = 2,407 \text{ cm}$$

$$A = \eta \cdot P_1 = \frac{1}{3,5} \cdot 1,8 \cdot 147 = 0,514 \cdot 147 = 75,56 \text{ kN}$$