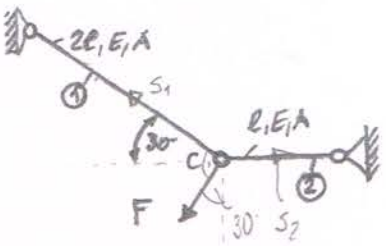
ZA SISTEM ŠTAPOVA PRIKAZAN NA SLICI NACI:

a) SILE U ŠTAPOVIMA I IZDUŽENJA/SKRAĆENJA ŠTAPOVA

b) ODREDITI NOVI POLOŽAJ TAČKE C, TJ. HORIZONTALNO I VERTIKALNO POMJERANJE

POZNATO JE: F, ℓ, E, A

(1°)

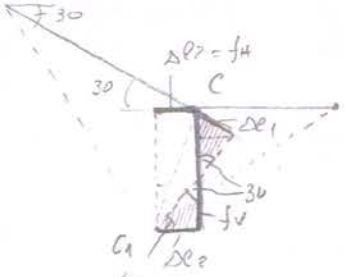


$\Sigma F_V = 0 \quad S_1 \frac{1}{2} - F\frac{\sqrt{3}}{2} = 0 \quad \underline{S_1 = F\sqrt{3}}$

$\Sigma F_H = 0 \quad S_2 - F\frac{1}{2} - S_1\frac{\sqrt{3}}{2} = 0 \quad S_2 = \frac{F}{2} + F\sqrt{3}\frac{\sqrt{3}}{2} = \underline{2F = S_2}$

$\Delta\ell_1 = \frac{S_1 2\ell}{EA} = \frac{2F\ell\sqrt{3}}{EA}$

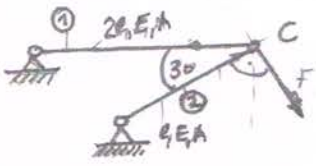
$\Delta\ell_2 = \frac{S_2 \ell}{EA} = \frac{2F\ell}{EA}$



$f_{cH} = \Delta\ell_2$

$f_{cV} = \frac{\Delta\ell_1}{\sin 30} + \frac{\Delta\ell_2}{tg\,30}$

(2°)

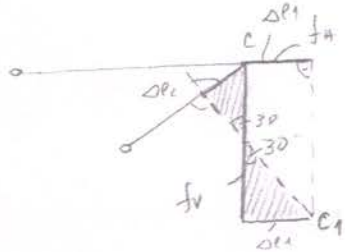


$\Sigma F_V = 0 \quad S_2 \cdot \frac{1}{2} - F\frac{\sqrt{3}}{2} = 0 \quad \underline{S_2 = F\sqrt{3}}$

$\Sigma F_H = 0 \quad -S_1 + S_2\frac{\sqrt{3}}{2} + \frac{F}{2} = 0 \quad S_1 = S_2\frac{\sqrt{3}}{2} + \frac{F}{2} = \underline{2F = S_1}$

$\Delta\ell_1 = \frac{2F \cdot 2\ell}{EA} = \frac{4F\ell}{EA}$

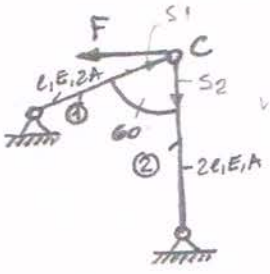
$\Delta\ell_2 = \frac{F\sqrt{3}\cdot\ell}{EA}$



$f_H = \Delta\ell_1$

$f_V = 2\Delta\ell_2 + \frac{\Delta\ell_1}{tg\,30}$

(3°)

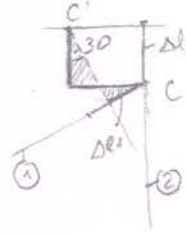


$\Sigma F_H = 0 \quad S_1\frac{\sqrt{3}}{2} - F = 0 \quad S_1 = \frac{2F}{\sqrt{3}} = \frac{2F\sqrt{3}}{3}$

$\Sigma F_V = 0 \quad S_1\frac{1}{2} - S_2 = 0 \quad S_2 = \frac{S_1}{2} = \frac{2F\sqrt{3}}{3}\cdot\frac{1}{2} \quad \underline{S_2 = F\frac{\sqrt{3}}{3}}$

$\Delta\ell_1 = \frac{2F\sqrt{3}}{3}\cdot\frac{\ell}{2E\cdot 2A} \quad \Delta\ell_1 = \frac{F\ell\sqrt{3}}{3EA}$

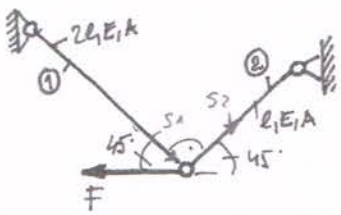
$\Delta\ell_2 = \frac{F\sqrt{3}}{3}\frac{2\ell}{EA} \quad \Delta\ell_2 = \frac{2F\ell\sqrt{3}}{3EA}$



$f_V = \Delta\ell_2$

$f_H = \Delta\ell_2 \cdot tg\,30 + \frac{\Delta\ell_1}{\cos 30}$

(4°)

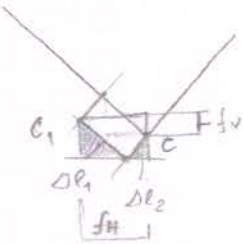


$\Sigma F_V = 0 \quad -S_1\frac{\sqrt{2}}{2} + S_2\frac{\sqrt{2}}{2} = 0 \quad \Rightarrow S_1 = S_2$

$\Sigma F_H = 0 \quad -F + S_1\frac{\sqrt{2}}{2} + S_2\frac{\sqrt{2}}{2} = 0 \quad S_1 = S_2 = \frac{F}{\sqrt{2}} = \frac{F\sqrt{2}}{2}$

$\Delta\ell_1 = \frac{F\sqrt{2}}{2}\cdot\frac{2\ell}{EA} = \frac{F\ell\sqrt{2}}{EA}$

$\Delta\ell_2 = \frac{F\sqrt{2}}{2}\cdot\frac{\ell}{EA}$



$f_H = \frac{\Delta\ell_1}{\sqrt{2}} + \frac{\Delta\ell_2}{\sqrt{2}}$

$f_V = \frac{\Delta\ell_1}{\sqrt{2}} - \frac{\Delta\ell_2}{\sqrt{2}}$

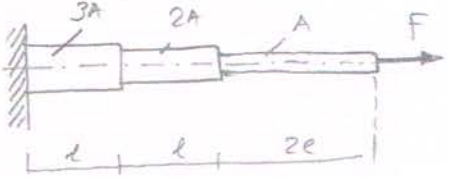
ZA GREDNI NOSAČ STEPENASTOG POPREČNOG PRESJEKA, KOJI JE OPTEREĆEN KAO NA SLICI ODREDITI:

a) NAPONE U POJEDINIM DIJELOVIMA NOSAČA I MAKSIMALNI NAPON;

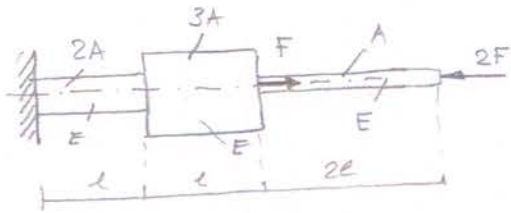
b) UKUPNO IZDUŽENJE NOSAČA

DATO JE: F, ℓ, A, E

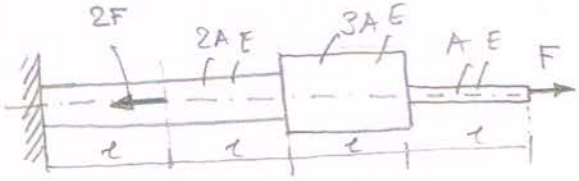
1°



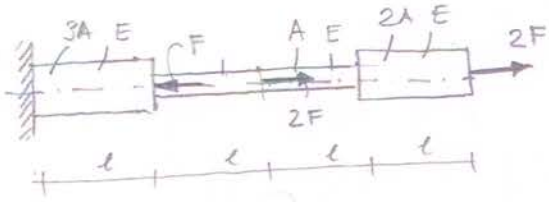
2°



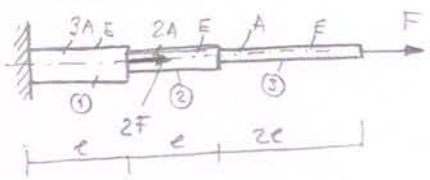
3°



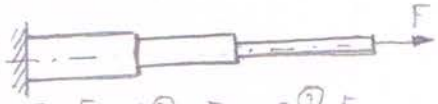
4°



1°



1)

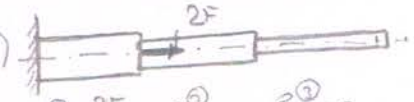


$\delta_2^{(1)} = \frac{F}{3A}$; $\delta_2^{(2)} = \frac{F}{2A}$; $\delta_2^{(3)} = \frac{F}{A}$

$\Delta\ell^{(1)} = \frac{F\ell}{E3A}$; $\Delta\ell^{(2)} = \frac{F\cdot\ell}{E2A}$; $\Delta\ell^{(3)} = \frac{F\cdot 2\ell}{EA}$

$\Delta\ell^{(1)}_{uk} = \frac{F\ell}{E3A} + \frac{F\cdot\ell}{E2A} + \frac{2F\ell}{EA} = \frac{17F\ell}{6EA}$

2)



$\delta_2^{(1)} = \frac{2F}{3A}$; $\delta_2^{(2)} = 0$ $\delta_2^{(3)} = 0$

$\Delta\ell^{(1)} = \frac{2F\cdot\ell}{E3A}$; $\Delta\ell^{(2)} = 0$ $\Delta\ell^{(3)} = 0$

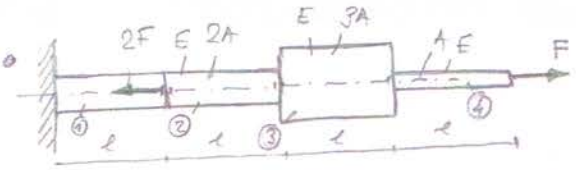
$\Delta\ell_{uk} = \frac{2F\ell}{3EA}$

a) $\left.\begin{aligned}\delta_2^{(1)} &= \frac{F}{3A} + \frac{2F}{3A} = \frac{F}{A}\\ \delta_2^{(2)} &= \frac{F}{2A} + 0 = \frac{F}{2A}\\ \delta_2^{(3)} &= \frac{F}{A} + 0 = \frac{F}{A}\end{aligned}\right\} \Rightarrow \delta_{max} = \frac{F}{A}$

b) $\Delta\ell_{uk} = \Delta\ell_{uk}^{(1)} + \Delta\ell_{uk}^{(2)}$

$\Delta\ell_{uk} = \frac{17F\ell}{6EA} + \frac{2F\ell}{3EA} = \frac{21}{6}\frac{F\ell}{EA}$

2°



a) $\delta_2^{(1)} = \frac{F}{2A} - \frac{2F}{2A} = -\frac{F}{2A}$; $\delta_2^{(2)} = \frac{F}{2A}$; $\delta_2^{(3)} = \frac{F}{3A}$; $\delta_2^{(4)} = \frac{F}{A}$

$\delta_{2max} = \frac{F}{A}$ NA DIJELU ④

b) $\Delta\ell_{uk} = \Delta\ell_{uk}^{F} + \Delta\ell_{uk}^{-2F}$

$\Delta\ell_{uk}^{F} = \frac{F\cdot 2\ell}{E\,2A} + \frac{F\ell}{E\,3A} + \frac{F\ell}{EA} = \frac{F\ell}{EA}\left(2+\frac{1}{3}\right) = \frac{5}{3}\frac{F\ell}{EA}$

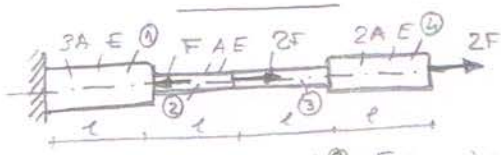
$\Delta\ell_{uk}^{2F} = -\frac{2F\cdot\ell}{E\,2A} = -\frac{F\ell}{EA}$

$\Delta\ell_{uk} = \frac{5}{3}\frac{F\ell}{EA} - \frac{F\ell}{EA} = \frac{F\ell}{EA}\left(\frac{5}{3}-1\right) = \frac{2F\ell}{3EA}$

3° R: $\delta_2^{(1)} = -\frac{F}{A}$; $\delta_2^{(2)} = -\frac{F}{3A}$; $\delta_2^{(3)} = -\frac{2F}{A}$; $\delta_{2max} = -\frac{2F}{A}$

$\Delta\ell_{uk}^{2F} = -\frac{17F\ell}{3A}$; $\Delta\ell_{uk}^{F} = \frac{5F\ell}{6EA}$; $\Delta\ell_{uk} = -\frac{29}{6}\frac{F\ell}{EA}$

4°



a) $\delta_2^{(1)} = \frac{F}{3A}(2+2-F) = \frac{F}{A}$; $\delta_2^{(3)} = \frac{F}{A}(2+2) = \frac{4F}{A}$

$\delta_2^{(3)} = \frac{2F}{A}$; $\delta_2^{(4)} = \frac{2F}{2A} = \frac{F}{A}$ $\delta_{2max} = \delta_2^{(2)} = \frac{4F}{A}$

b) $\Delta\ell_{uk} = \Delta\ell_{uk}^{2F} + \Delta\ell_{uk}^{2F} + \Delta\ell_{uk}^{F}$

$\Delta\ell_{uk} = \frac{2F\ell}{E3A} + \frac{2F\cdot 2\ell}{EA} + \frac{2F\cdot\ell}{E2A} + \frac{2F\ell}{E3A} + \frac{2F\cdot\ell}{EA} - \frac{F\ell}{E3A}$

$\Delta\ell_{uk} = \frac{F\ell}{EA}\left(\frac{2}{3}+4+1+\frac{2}{3}+2-\frac{1}{3}\right) = \frac{8F\ell}{EA}$

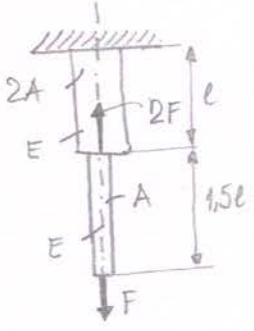
ZADATAK

ZA GREDNI NOSAČ STEPENASTOG POPREČNOG PRESJEKA, KOJI JE OPTEREĆEN KAO NA SLICI, ODREDITI:

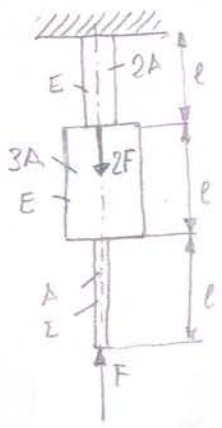
a) NAPONE U POJEDINIM DIJELOVIMA NOSAČA I MAKSIMALNI NAPON

b) UKUPNO IZDUŽENJE NOSAČA

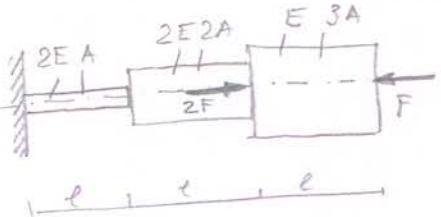
1°



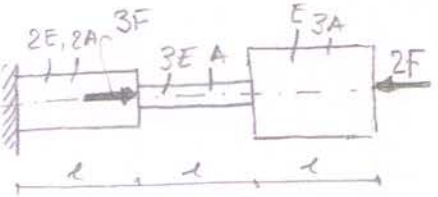
2°



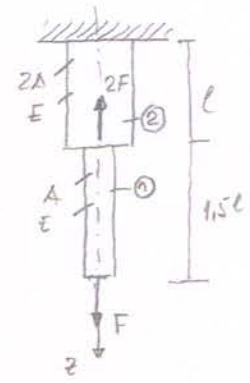
3°



4°



1°



a) $\sigma_2^{(1)} = \sigma_2^{F} + \sigma_2^{2F} = \frac{F}{A} + 0 = \frac{F}{A}$

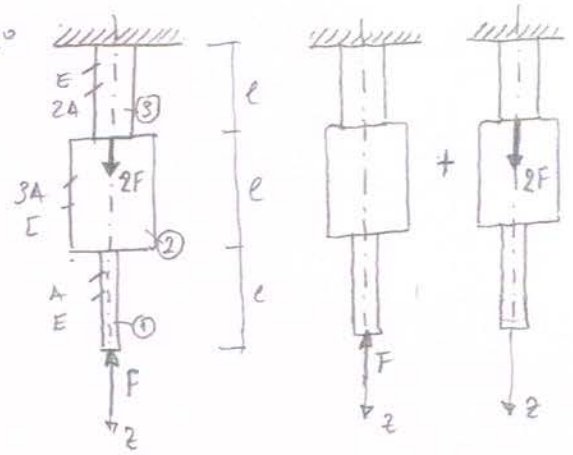
$\sigma_2^{(2)} = \sigma_2^{F} + \sigma_2^{2F} = \frac{F}{2A} - \frac{2F}{2A} = -\frac{F}{A}$

$\Big\} \sigma_{max} = \sigma_2^{(1)} = \sigma_2^{(3)} = \frac{F}{A}$

b) $\Delta l_{uk} = \Delta l_{uk}^{(1)} + \Delta l_{uk}^{(3)} = \Delta l_{uk}^{(1),F} + \Delta l_{uk}^{(1),2F} + \Delta l_{uk}^{(2),F} + \Delta l_{uk}^{(2),2F}$

$\Delta l_{uk} = \frac{F \cdot 3\ell}{2 \cdot E \cdot A} + 0 + \frac{F\ell}{E\,2A} - \frac{2F\ell}{E\,2A} = \frac{F\cdot\ell}{EA}\left(\frac{3}{2} + \frac{1}{2} - 1\right) = \frac{F\ell}{EA}$

2°



a) $\sigma_2^{(1),F} = -\frac{F}{A}$; $\sigma_2^{(2),F} = -\frac{2F}{3A}$; $\sigma_2^{(3),F} = -\frac{F}{2A}$

$\sigma_2^{(1),2F} = 0$; $\sigma_2^{(2),2F} = 0$; $\sigma_2^{(3),2F} = \frac{2F}{2A} = \frac{F}{A}$

$\sigma_2^{(1)} = -\frac{F}{A} + 0 = -\frac{F}{A}$; $\sigma_2^{(2)} = -\frac{2F}{3A} + 0 = -\frac{2F}{3A}$

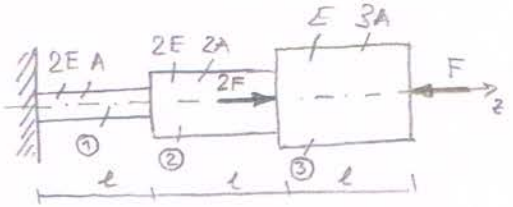
$\sigma_2^{(3)} = -\frac{F}{2A} + \frac{2F}{3A} = \frac{F}{6A}$ $\qquad \sigma_{2max} = \sigma_2^{(1)} = \frac{F}{A}$

b) $\Delta\ell^{(1),F} = \frac{-F\cdot\ell}{EA}$ $\qquad \Delta\ell^{(2),F} = \frac{-F\ell}{E\cdot 3A}$ $\qquad \Delta\ell^{(3),F} = \frac{-F\cdot\ell}{E\,2A}$

$\Delta\ell^{(1),2F} = 0$ $\qquad \Delta\ell^{(2),2F} = 0$ $\qquad \Delta\ell^{(3),2F} = \frac{2F\cdot\ell}{E\cdot 2A}$

$\Delta l_{uk} = -\frac{F\ell}{EA} - \frac{F\ell}{3EA} - \frac{F\ell}{2EA} + 0 + 0 + \frac{2F\ell}{2EA} = \frac{F\ell}{EA}\left(-1 - \frac{1}{3} - \frac{1}{2} + 1\right) = -\frac{5}{6}\frac{F\ell}{EA}$

3°



a) $\sigma_2^{(1)} = \frac{-F}{A} + \frac{2F}{2A} = 0$

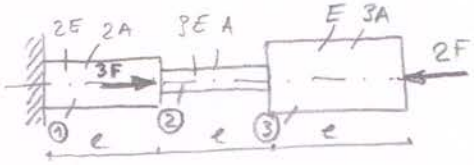
$\sigma_2^{(2)} = \frac{-F}{2A} + \frac{2F}{2A} = \frac{F}{2A}$ $\qquad \sigma_{max} = \sigma_2^{(2)} = \frac{F}{2A}$

$\sigma_2^{(3)} = \frac{-F}{3A}$

b) $\Delta\ell^{(1)} = \frac{-F\cdot\ell}{2E\cdot A} + \frac{2F\cdot\ell}{2EA} = \frac{F\ell}{2EA}$; $\Delta\ell^{(2)} = \frac{-F\ell}{2E\cdot 2A} + \frac{2F\ell}{2E\cdot 2A} = \frac{F\ell}{4EA}$

$\Delta\ell^{(3)} = \frac{-F\cdot\ell}{E\,3A} \Rightarrow \Delta l_{uk} = \Delta\ell^{(1)} + \Delta\ell^{(2)} + \Delta\ell^{(3)} = \frac{F\ell}{EA}\left(\frac{1}{2} + \frac{1}{4} - \frac{1}{3}\right) = \frac{7F\ell}{12EA}$

4°



a) $\sigma^{(1)} = \frac{-2F}{2A} + \frac{3F}{2A} = \frac{F}{2A}$

$\sigma^{(2)} = \frac{-2F}{A}$ $\qquad \Rightarrow \sigma_{max} = \sigma^{(2)} = -\frac{2F}{A}$

$\sigma^{(3)} = \frac{2F}{3A}$

b) $\Delta\ell^{(1)} = \frac{-2F\ell}{2E\cdot 2A} + \frac{3F\ell}{2E\cdot 2A} = \frac{F\ell}{4EA}$

$\Delta\ell^{(2)} = \frac{-2F\ell}{3E\,A}$

$\Delta\ell^{(3)} = \frac{2F\ell}{E\cdot 3A}$

$\Rightarrow \Delta l_{uk} = \Delta\ell^{(1)} + \Delta\ell^{(2)} + \Delta\ell^{(3)}$

$\Delta l_{uk} = \frac{F\ell}{EA}\left(\frac{1}{4} - \frac{2}{3} + \frac{2}{3}\right) = \frac{F\ell}{4EA}$