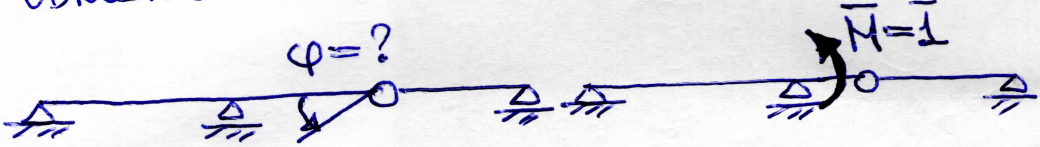
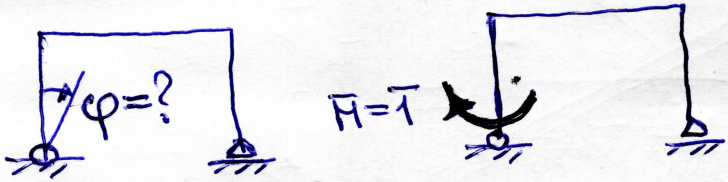
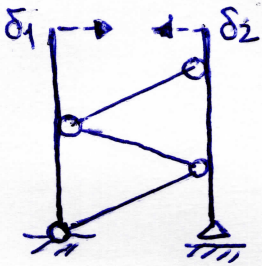
MECHANIKA BUDOWLI – ROZDZIAŁY 4, 5

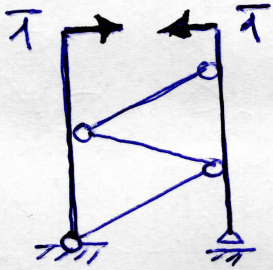
PRZEMIESZCZENIA W UKŁADACH STATYCZNIE WYZNACZALNYCH

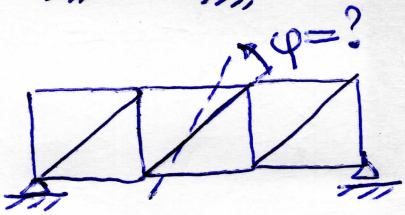
* PRZYJĄĆ JEDNOSTKOWE OBCIĄŻENIE WIRTUALNE ODNOŚNIE SZUKANEJ WIELKOŚCI GEOMETRYCZNEJ:

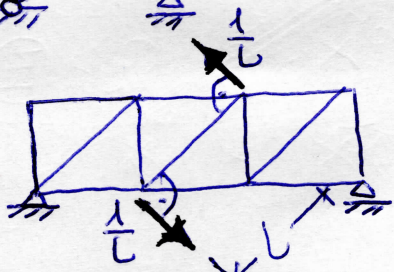


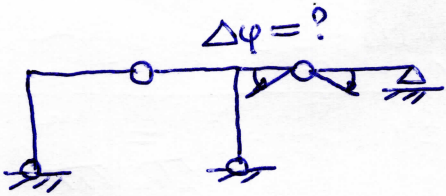










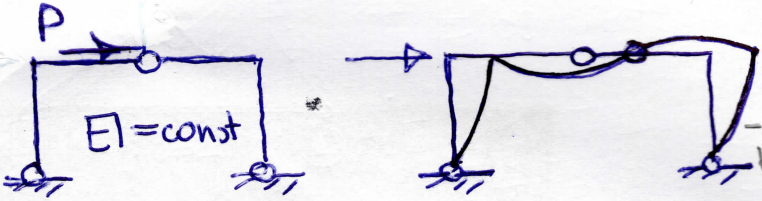


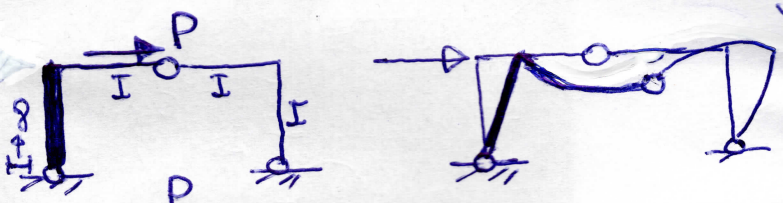
NASZKICOWAĆ LINIĘ UGIĘCIA (STAN PRZEMIESZCZEŃ) PODANEGO UKŁADU BEZ WYKONYWANIA OBLICZEŃ

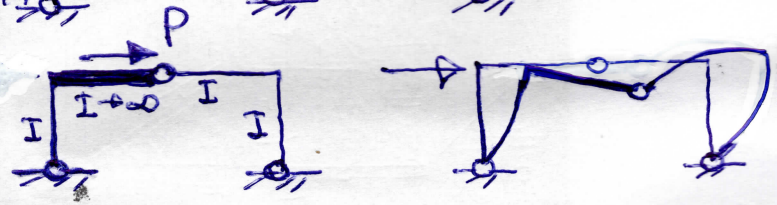
2

UWAGI DODATKOWE

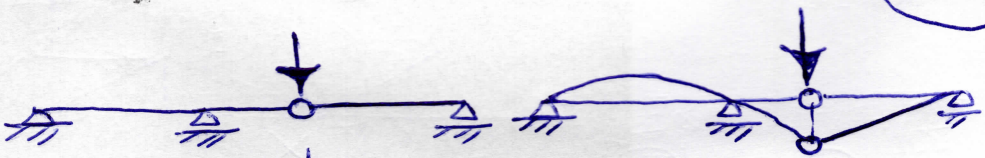
Układ symetryczny, obc. antysymetr. – na osi symetrii brak ugięcia pionowego



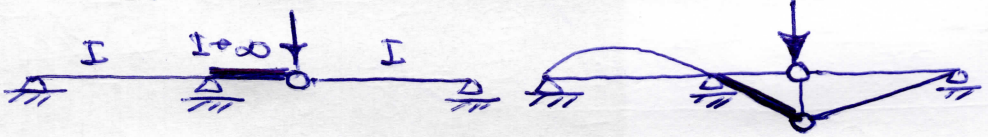


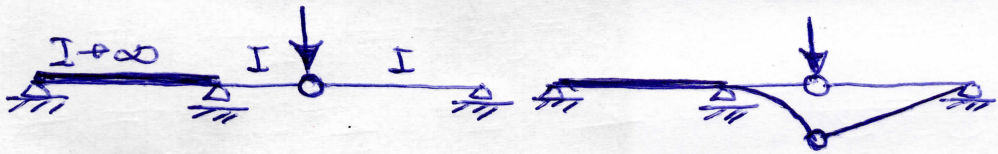


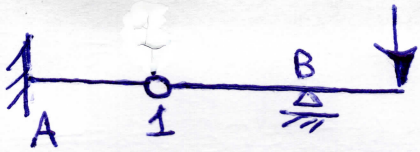
Układ nie jest symetryczny – brak reguły



EI = const



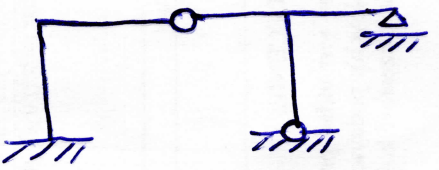


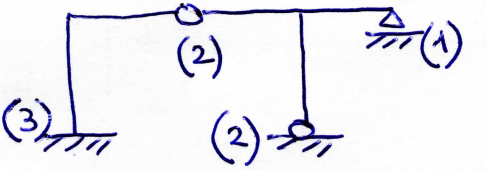


warianty:

1) EI = const
2) A-1 EI → ∞, pozostałe EI
3) 1-B EI → ∞, pozostałe EI

OKREŚLIĆ STOPIEŃ STATYCZNEJ NIEWYZNACZALNOŚCI PODANYCH UKŁADÓW



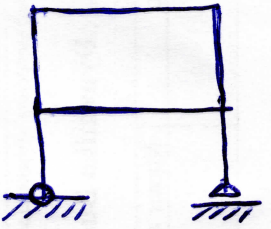


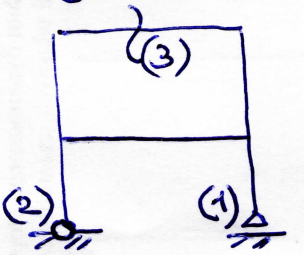
liczba tarcz $t=2$

liczba reakcji $r=3+2+2+1=8$

$n=r-3t=2$

zewn.



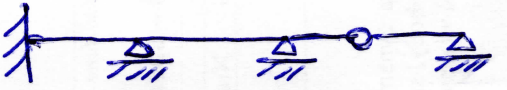


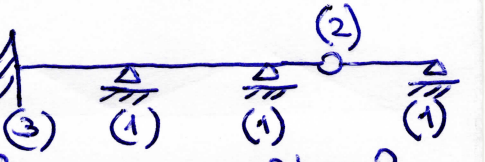
$t=1$

$r=2+1+3=6$

$n=r-3t=3$

wewn.

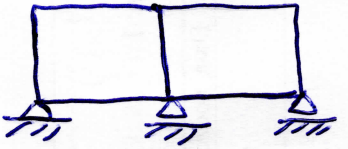


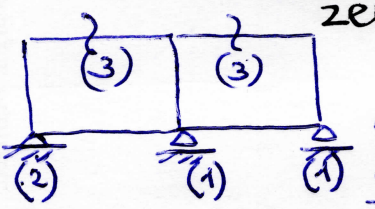


$t=2$ $r=3+3$ $2=8$

$n=r-3t=2$

zewn.



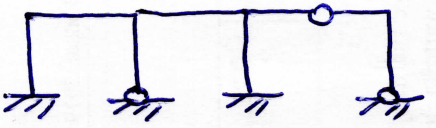


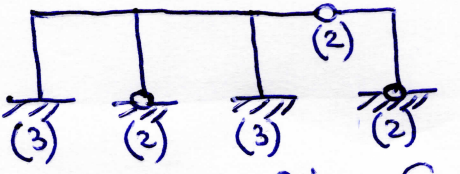
$t=1$

$r=10$

$n=r-3t=7$

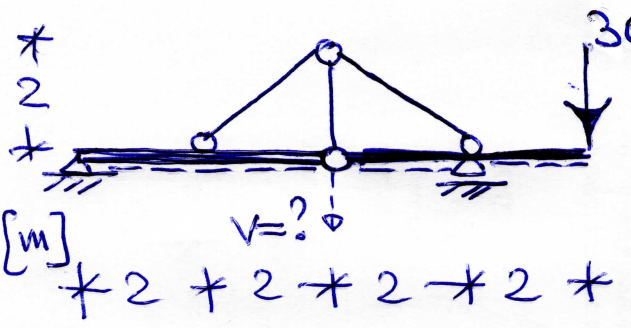
zewn. + wewn.





$t=2$ $n=12$ $n=r-3t=6$

zewn.

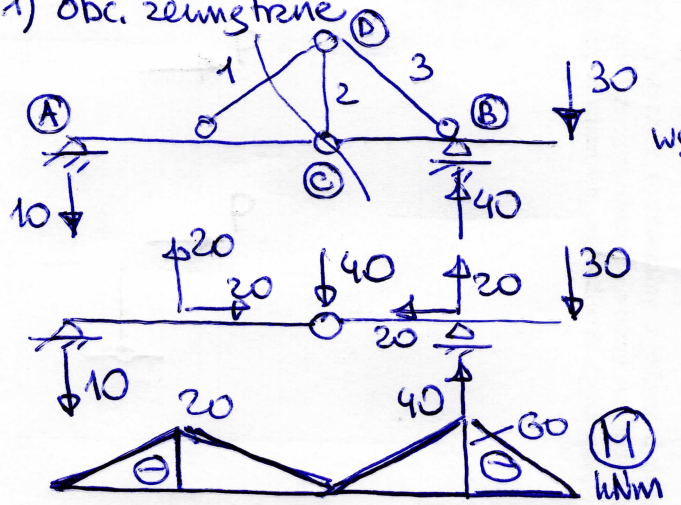


belka $EI = 10^4\ kNm^2$

pręty mają $EA = 10^5\ kN$

dodatkowo: $EA \to \infty$

1) obc. zewnętrzne

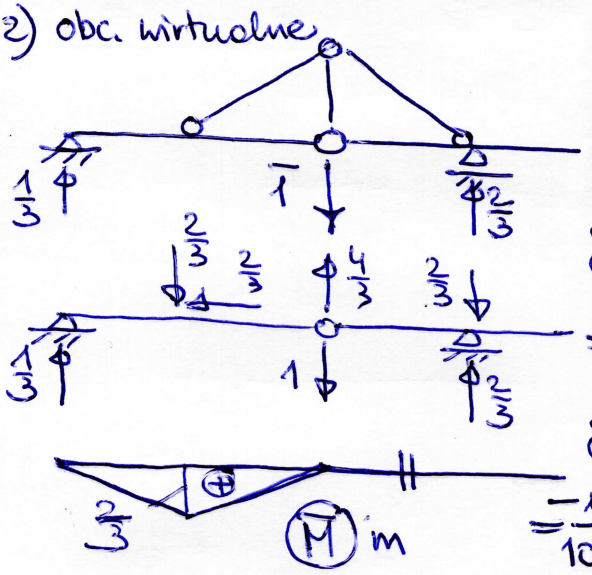


$\Sigma M_C^L = 0 \Rightarrow S_1 = 20\sqrt{2}\ kN$

węzeł D $S_3 = 20\sqrt{2}\ kN$

$S_2 = -40\ kN$

2) obc. wirtualne



$\Sigma M_C^L = 0 \Rightarrow S_1 = -\frac{2\sqrt{2}}{3}$

węzeł D $S_3 = -\frac{2\sqrt{2}}{3}$

$S_2 = \frac{4}{3}$

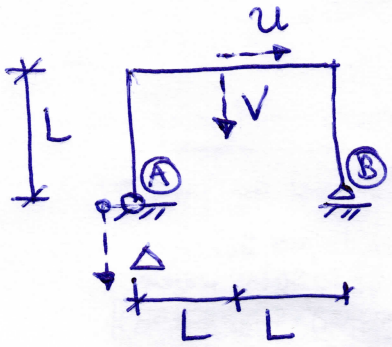
$$\delta_M = \int_L \frac{M\bar{M}}{EI} ds =$$

$$= -\frac{1}{10^4} \cdot 2 \cdot \frac{1}{2} \cdot 220 \cdot \frac{2}{3} \cdot \frac{2}{3} =$$

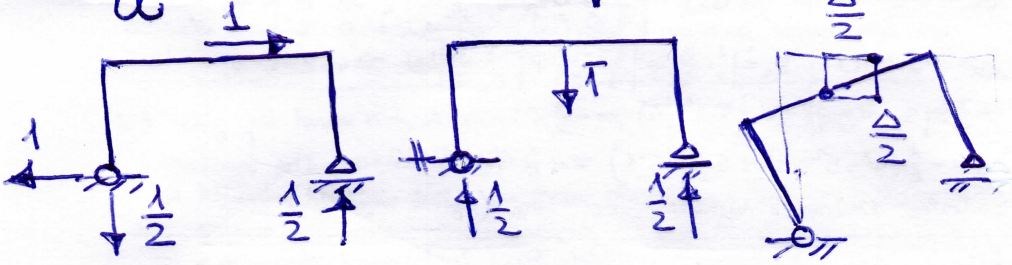
$$\delta_N = \sum \frac{S_i \bar{S}_i}{EA_i} l_i =$$

$$= \frac{-1}{10^5} \left(2 \cdot 20\sqrt{2} \cdot \frac{2\sqrt{2}}{3} \cdot 2\sqrt{2} + 40 \cdot \frac{4}{3} \cdot 2 \right) =$$

$$\delta = \delta_M + \delta_N =$$



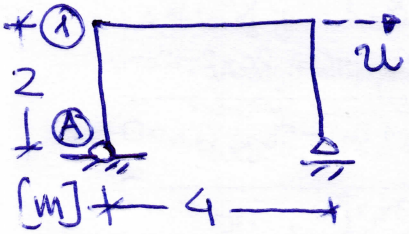
Obliczyć u i V na skutek osiadania podpory (A) równego Δ. Naszkicować stan przemieszczeń układu



$u = -\Delta \cdot \frac{1}{2}$ $\quad V = +\Delta \cdot \frac{1}{2}$

Pytanie: czy punkt (B) przemieści się w poziomie?

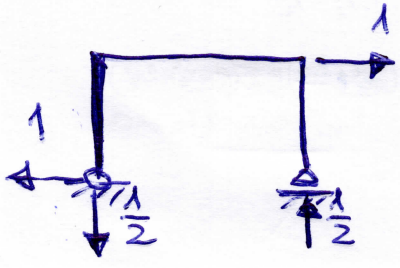
Obliczyć u na skutek równomiernego ogrzania elementu A-1 o $t_0 = 20°C$ względem temperatury montażu $\alpha_t = 10^{-5} \frac{1}{°C}$. Naszkicować stan przemieszczeń układu

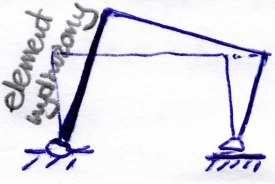


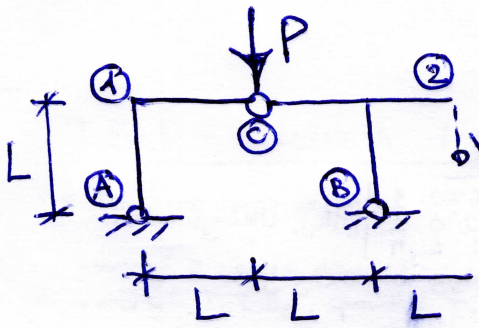
$\bar{N}_{A-1} = \frac{1}{2} = const$

$u = \int_L \bar{N} \alpha_t t_0 ds = \frac{1}{2} \cdot 10^{-5} \cdot 20 \cdot 2 =$

$= 0{,}02\ cm$



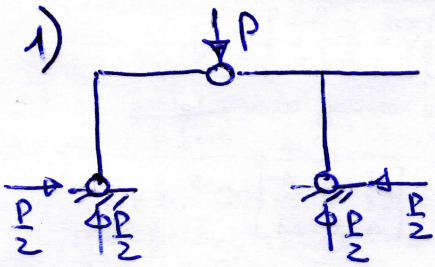


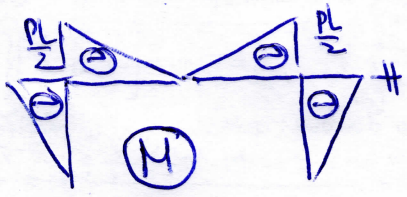


$EI = const$

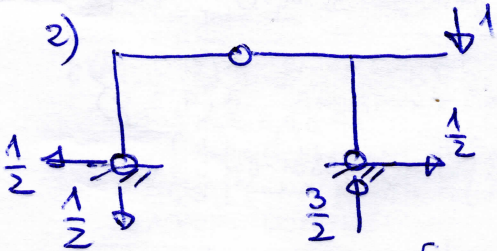
$V = ?$

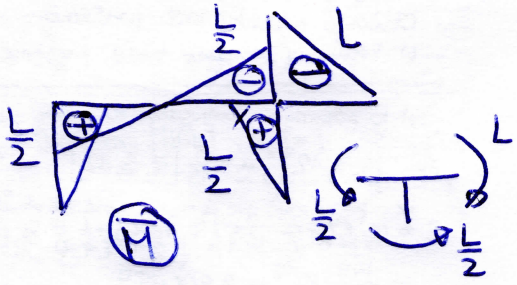
1)



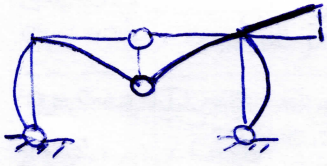


2)





$$\delta = \int_L \frac{M\bar{M}}{EI} ds = \frac{1}{EI}\left[-\frac{1}{3}\cdot L \cdot \frac{PL}{2}\cdot\frac{L}{2} - \underbrace{\frac{1}{3}\cdot L\cdot\frac{PL}{2}\cdot\frac{L}{2}}_{=0} + \frac{1}{3}L\cdot\frac{PL}{2}\cdot\frac{L}{2} - \frac{1}{3}L\cdot\frac{PL}{2}\cdot\frac{L}{2}\right] = -\frac{PL^3}{6EI}$$



polecenia domowe:

obliczyć V (składowa pionowa wektora przemieszczenia w p. 2)

pod drobiazgiem:

- wychylenia poziomego p. B o $\Delta = \frac{L}{10}$
- wmontowanie elementów w węźle (1) z błędem kątowym