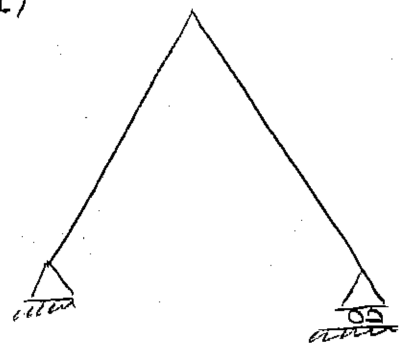
1) a)

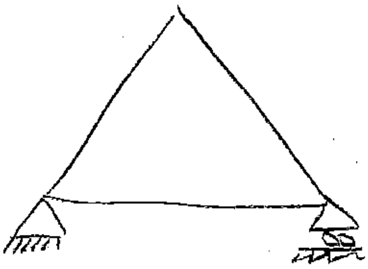


$D_I = m + r - 2j$

$D_I = 2 + 3 - 2 \cdot 3$

$D_I = -1 < 0$ $\Rightarrow$ Unstable

b)

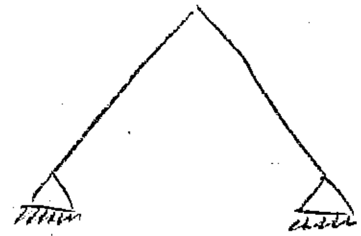


$D_I = m + r - 2j$

$D_I = 3 + 3 - 2 \cdot 3$

$D_I = 0$ $\Rightarrow$ Determinate

c)

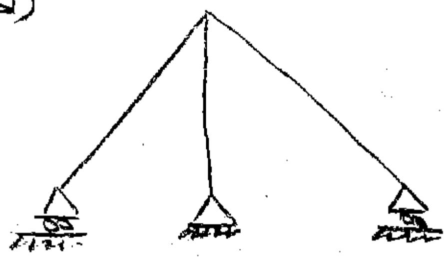


$D_I = m + r - 2j$

$D_I = 2 + 2 - 2 \cdot 2$

$D_I = 0$ $\Rightarrow$ Determinate

d)

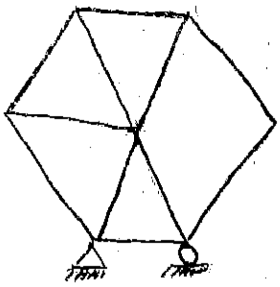


$D_I = m + r - 2j$

$D_I = 3 + 4 - 2 \cdot 4$

$D_I = -1 < 0$ $\Rightarrow$ Unstable

e)

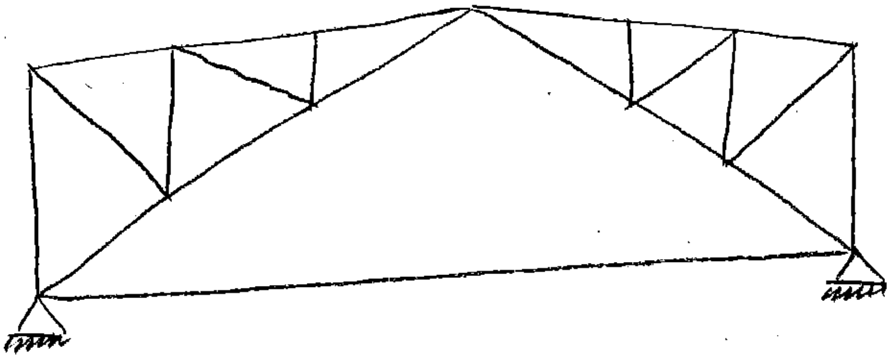


$D_I = m + r - 2j$

$D_I = 11 + 3 - 2 \cdot 7$

$D_I = 0$ $\Rightarrow$ Determinate

d)

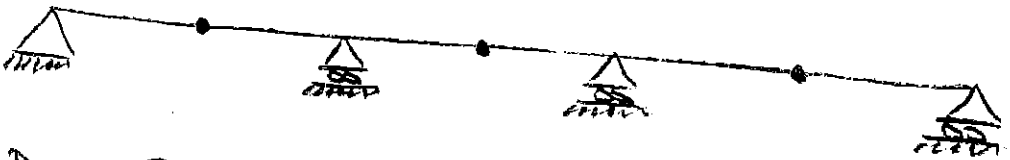


$D_I = m + r - 2j$

$D_I = 23 + 4 - 2.13$

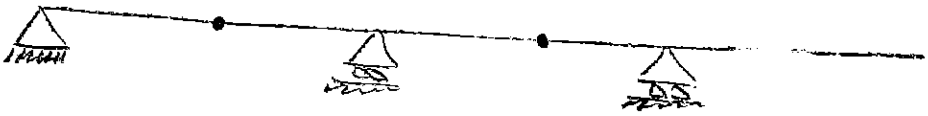
$D_I = 1 \Rightarrow$ Indeterminate

2) a)



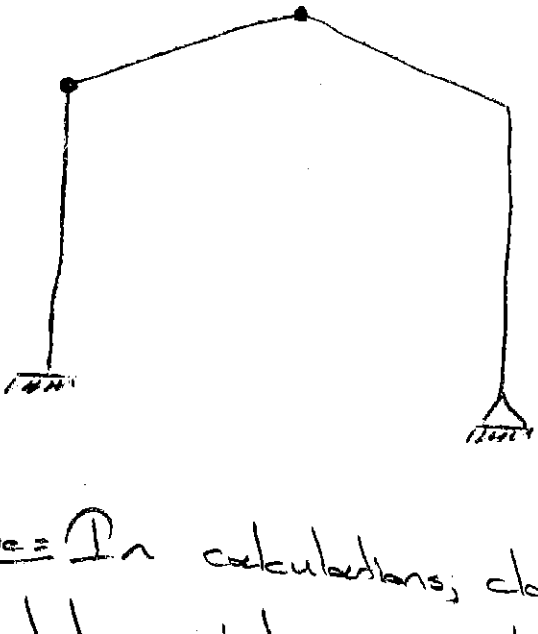
$D_I = 3.n + r - e - x = 3.0 + 5 - 3 - 3 = -1 < 0 \Rightarrow$ Unstable

b)



$D_I = 3n + r - e - x = 3.0 + 4 - 3 - 2 = -1 < 0 \Rightarrow$ Unstable

c)



$D_I = 3n + r - e - x$

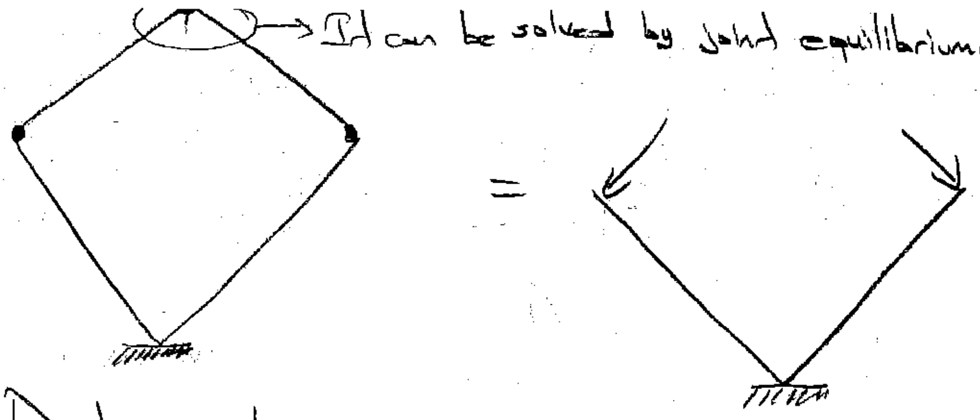
$D_I = 3.0 + 5 - 3 - 2$

$D_I = 0 \Rightarrow$ Determinate

Note: In calculations, closed loops adjacent to foundation are not taken into account.

d)

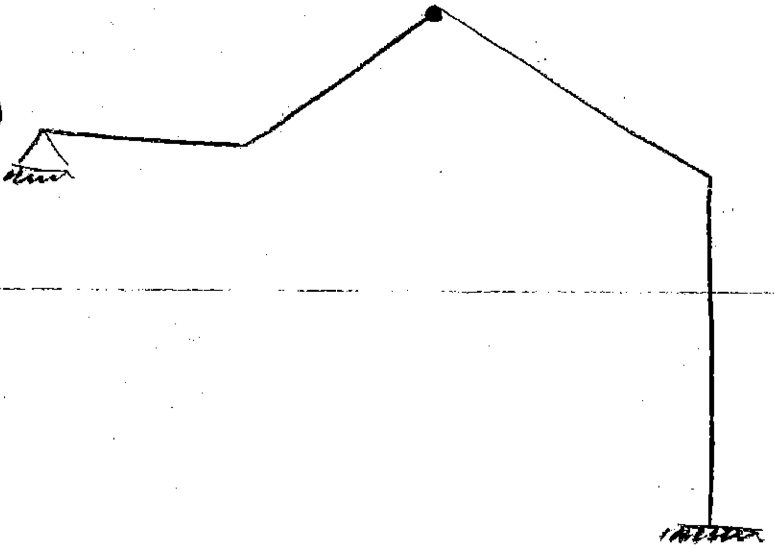
It can be solved by joint equilibrium.



Determinate

2 truss members are added to the system. (2nd Indeterminate).

e)

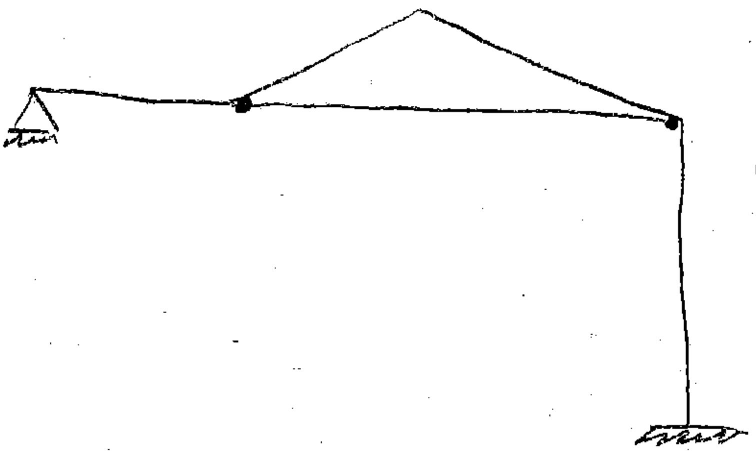


$D_I = 3n + r - e - x$

$D_I = 0 + 5 - 3 - 1$

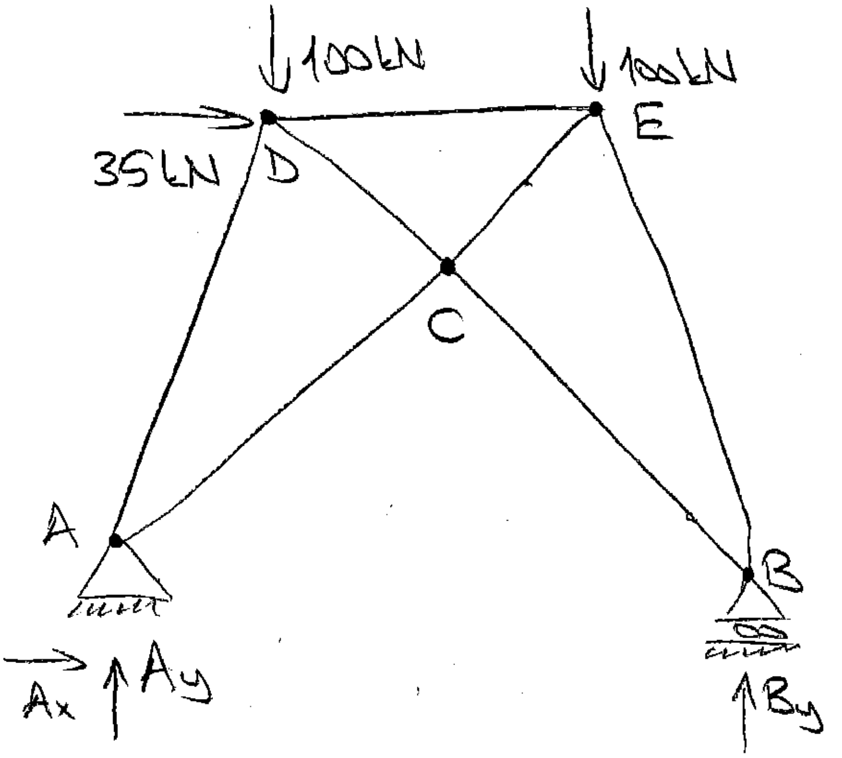
$D_I = 1 \Rightarrow$ Indeterminate

If we add one truss member to the above structure, we obtain the provided structure.



Therefore, this structure is Indeterminate (2nd degree).

3) Use unit dummy load method to obtain the displacement because this structure is statically determined



$$\Sigma M_A = 0 \Rightarrow 35.10 + 100.4 + 100.10 - 14.B_y = 0$$

$$B_y = 125\ kN$$

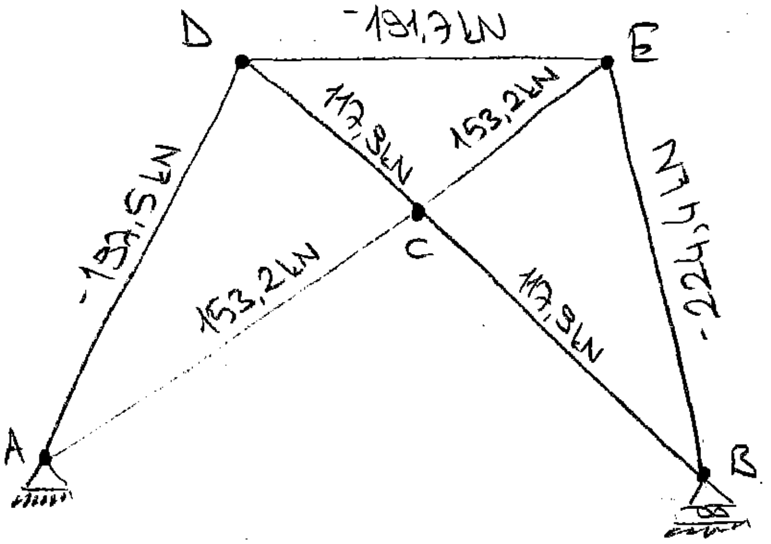
$$\Sigma F_y = 0 \Rightarrow A_y + B_y - 200 = 0$$

$$A_y = 75\ kN$$

$$\Sigma F_x = 0 \Rightarrow A_x + 35 = 0$$

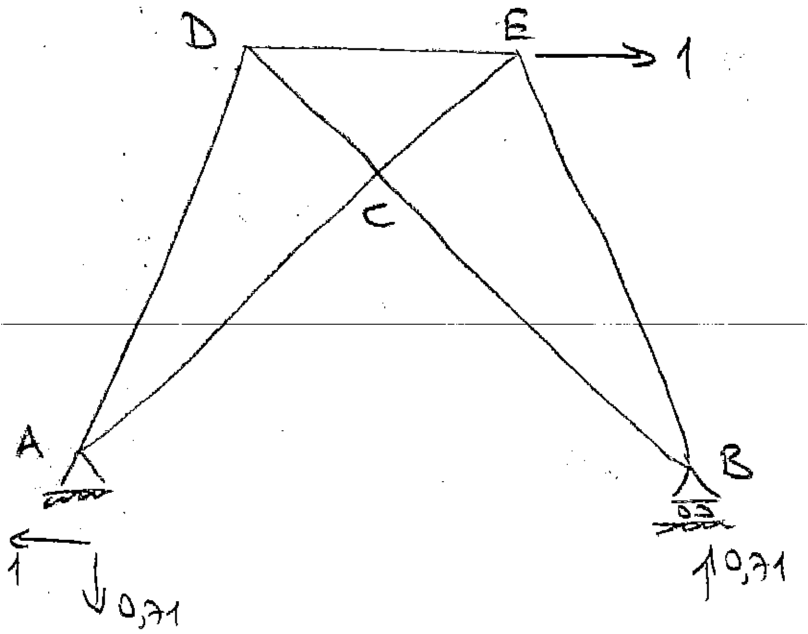
$$A_x = -35\ kN$$

The internal forces due to real forces are

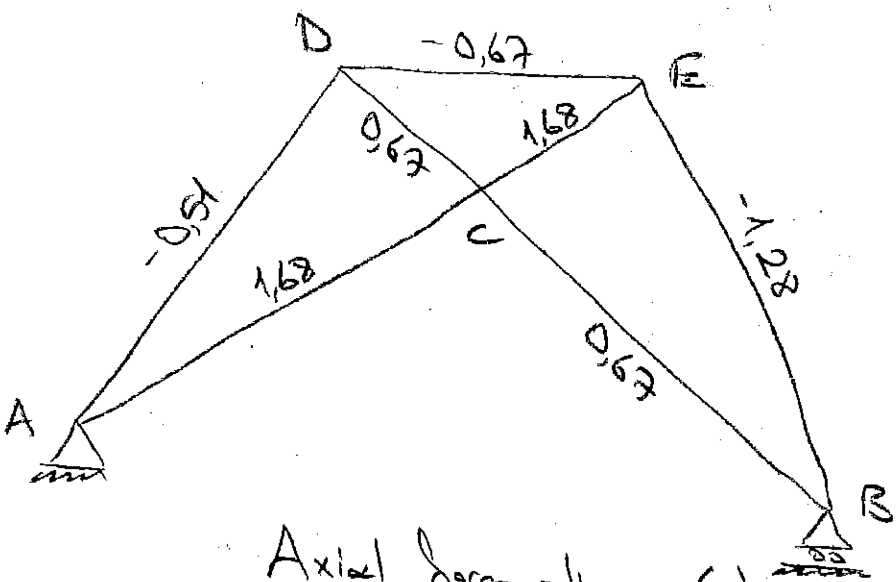


Axial force diagram (N)

Apply a unit force at point E.



The internal forces due to the above fictitious load are



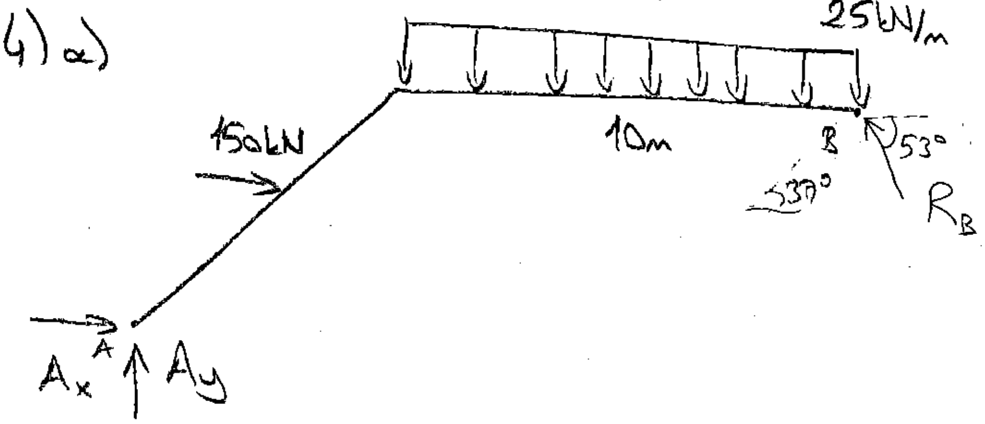
Axial force diagram (n)

Member	L (m)	N (kN)	n	N.n.L
AC	9,899	153,2	1,68	2.547,77
AD	10,77	-197,5	-0,51	1.084,81
BC	9,899	117,9	0,67	781,95
BE	10,77	-224,4	-1,28	3.093,49
DE	6	-191,7	-0,67	770,63
DC	4,243	117,9	0,67	335,17
CE	4,243	153,2	1,68	1.092,05

$$1.\ \Delta = \delta = \sum_{i=1}^{n=7} \frac{N_i \cdot n_i \cdot L_i}{E_i A_i}$$

$$\Delta = \frac{9.705,87}{EA} \quad (\rightarrow)$$

4) a)



$$\circlearrowleft^{+} \sum M_A = 0 \Rightarrow 0{,}6 \cdot R_B \cdot 8 + 0{,}8 \cdot R_B \cdot 16 - 25 \cdot 10 \cdot 11 - 150 \cdot 4 = 0$$

$$17{,}6\, R_B = 3.350$$

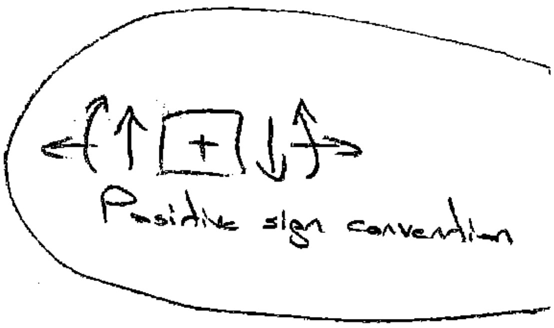
$$R_B = 190{,}33\,kN$$

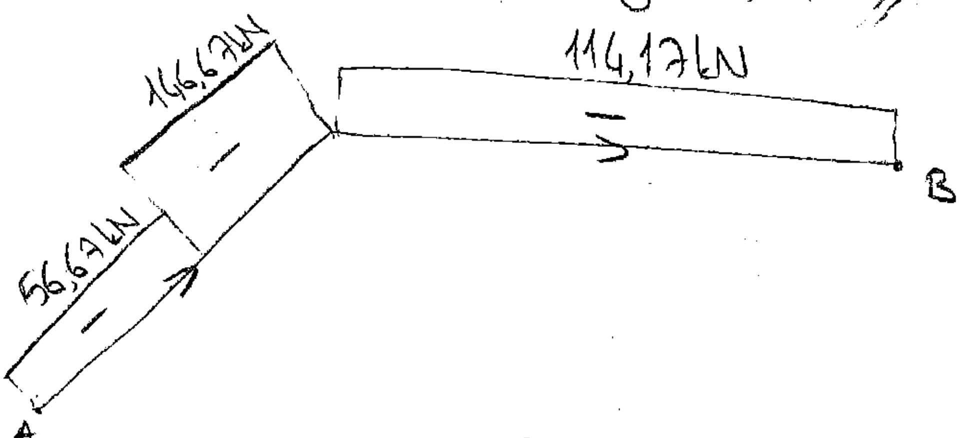
$$\xrightarrow{+} \sum F_x = 0 \Rightarrow A_x + 150 - 0{,}6 \cdot R_B = 0$$

$$A_x = -35{,}83\,kN$$

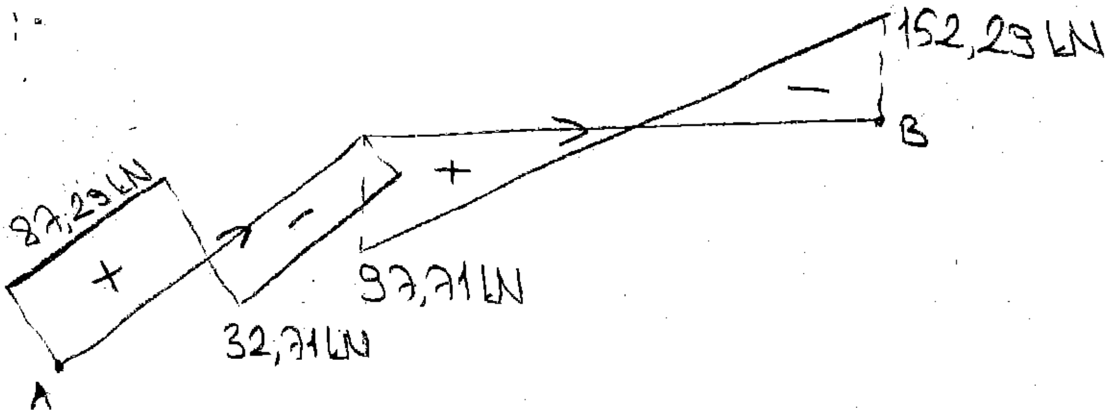
$$\uparrow^{+} \sum F_y = 0 \Rightarrow A_y + 0{,}8 \cdot R_B - 25 \cdot 10 = 0$$

$$A_y = 97{,}74\,kN$$

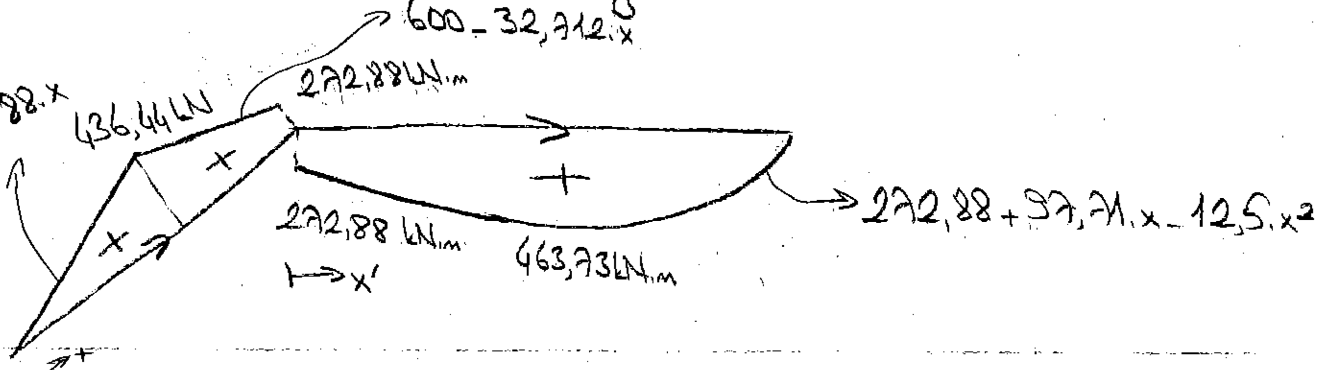




Axial force diagram (N)

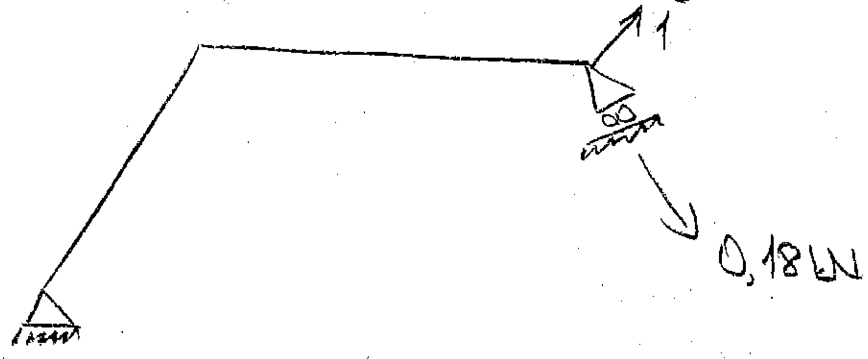


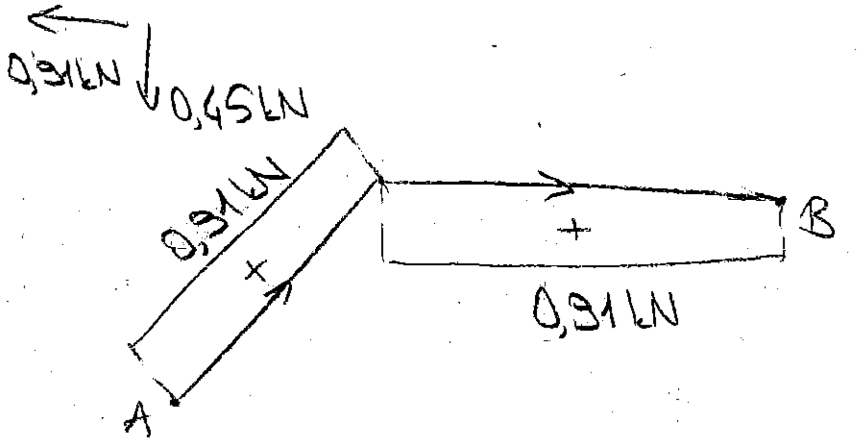
Shear diagram



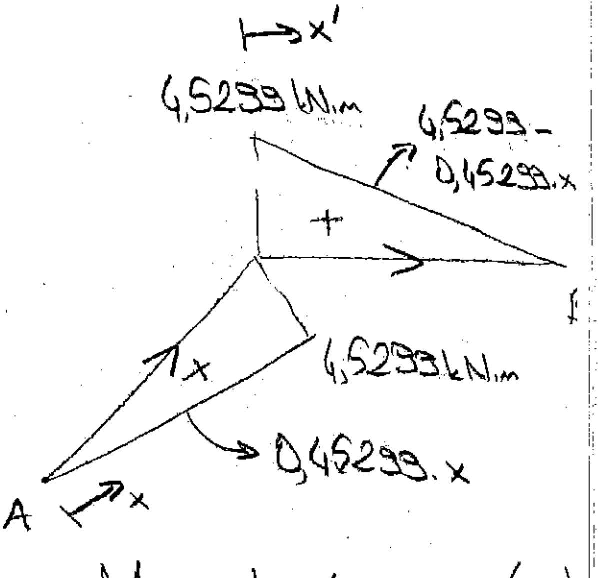
Moment diagram (M)

b) Apply a fictitious load of 1 along support B.



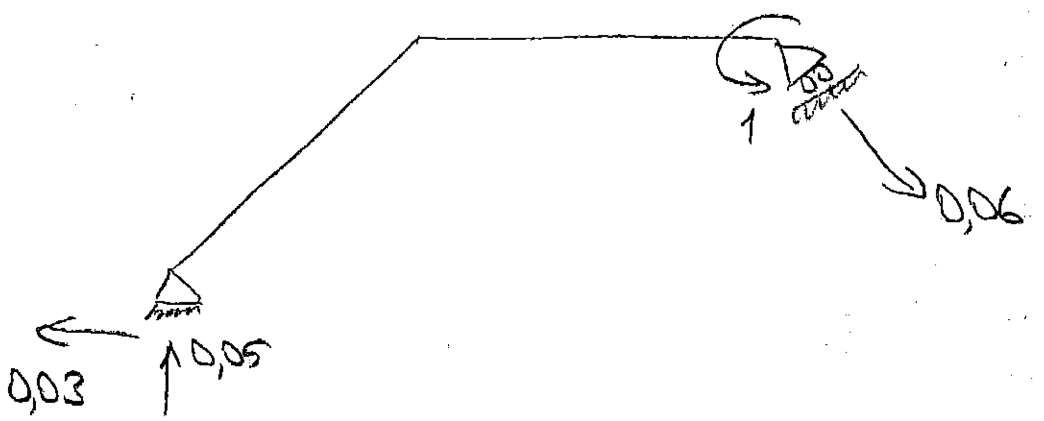


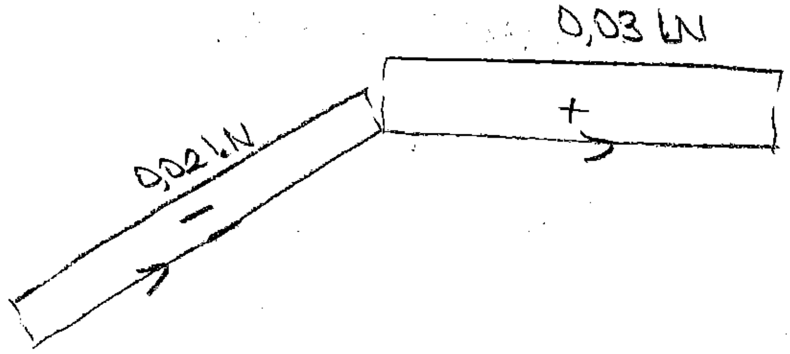
Axial force diagram (n_1)



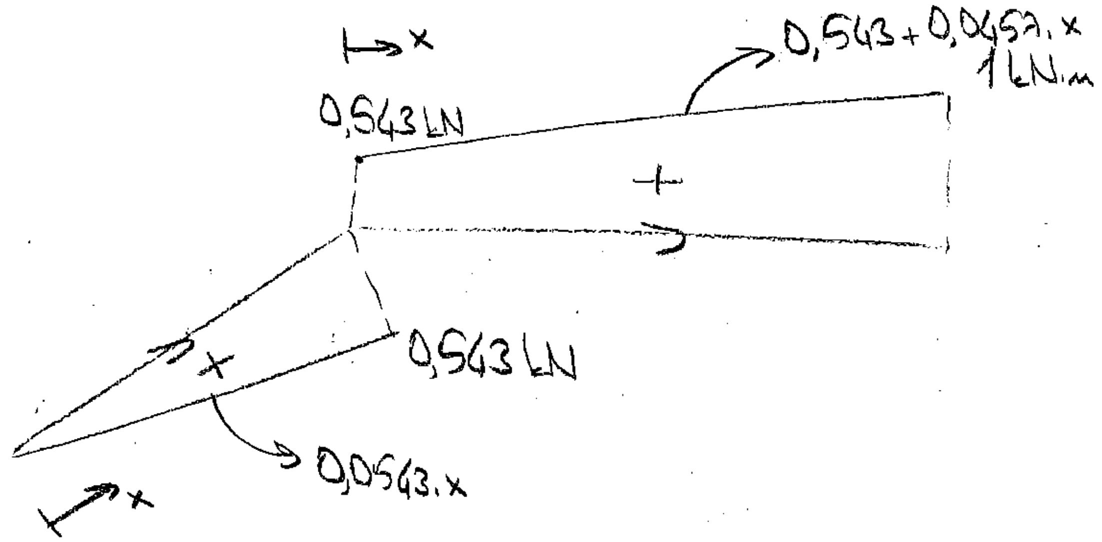
Moment diagram (m_1)

Apply a fictitious moment of 1 at support B.





Axial force diagram (n_2)



Moment diagram (m_2)

The displacement at the skew roller support B is

$$1.\Delta = \delta = \int \frac{M \cdot m_1 \cdot dx}{EI}$$

$$\Delta = \int_0^5 \frac{87,288.x.0,453.x\,dx}{EI} + \int_5^{10} \frac{(600-32,712.x).0,453.x.\,dx}{EI} +$$

$$\int_0^{10} \frac{(272,88+97,71-12,5x^2).(4,53-0,453x)\,dx}{EI}$$

$$\Delta = \frac{1}{EI} \cdot \left(13,180.x^3\Big|_0^5 + (135,89.x^2 - 5,694.x^3)\Big|_5^{10} + \right.$$

$$\left.\left(1.236,12.x + 159,50.x^2 - 33,63.x^3 + 1,42.x^4\right)\Big|_0^{10}\right)$$

$$\Delta = \frac{1}{EI} \cdot (1647,52 + 5.870,3 + 8.838,89)$$

$$\Delta = \frac{16.356,71}{EI}$$

The rotation at the skew roller support B is

$$1.\theta = \delta = \int \frac{M \cdot m_2 \cdot dx}{EI}$$

$$\theta = \int_0^5 \frac{87,288.x.0,0543.x.dx}{EI} + \int_5^{10} \frac{(600-32,712.x).0,0543.x}{EI} +$$

$$\int_0^{10} \frac{(272,88+97,71x-12,5x^2).(0,543+0,0453x).dx}{EI}$$

$$\theta = \frac{1}{EI} \cdot \left(1,58.x^3\Big|_0^5 + (-0,592.x^3 + 16,29)\Big|_5^{10} + (148,2.x + 32,76.x^2 - 0,77.x^3 -\right.$$

9

$$0{,}143 \cdot x^4 \Big) \Big|_0^{10} = \frac{197{,}49 + 703{,}67 + 2.555{,}92}{EI} = \frac{3.457{,}08}{EI} \quad (\curvearrowleft)$$

c) Include the axial deformations and recalculate the displacement

$$1 \cdot \Delta = \delta = \int \frac{M \cdot m_1 \cdot dx}{EI} + \int \frac{N \cdot n_1 \cdot dx}{EA}$$

$$= \frac{16.356{,}71}{EI} + \frac{-56{,}67 \cdot 0{,}91 \cdot 5}{EA} + \frac{-146{,}67 \cdot 0{,}91 \cdot 5}{EA} + \frac{-114{,}17 \cdot 0{,}91 \cdot 10}{EA}$$

$$= \frac{16.356{,}71}{EI} - \frac{7.856{,}58}{EI}$$

$$= \frac{8.500{,}13}{EI} \quad (\nearrow)$$

The rotation is

$$1 \cdot \theta = \delta = \int \frac{M \cdot m_2 \cdot dx}{EI} + \int \frac{N \cdot n_2 \cdot dx}{EA}$$

$$= \frac{3.457{,}08}{EI} + \frac{-56{,}67 \cdot -0{,}02 \cdot 5}{EA} + \frac{-146{,}67 \cdot -0{,}02 \cdot 5}{EA} + \frac{-114{,}17 \cdot 0{,}03 \cdot 10}{EA}$$

$$= \frac{3.457{,}08}{EI} - \frac{55{,}668}{EI}$$

$$= \frac{3.401{,}41}{EI}$$