6 L'étude de la flèche (2) d'un chargeur sur chenilles pour tout terrain se ramène schématiquement au dessin indiqué. Les forces $\overrightarrow{A_{1/2}}$, $\overrightarrow{B_{10/2}}$, $\overrightarrow{M_{5/2}}$ et $\overrightarrow{D_{3/2}}$ schématisent les actions exercées par les solides (1), (3), (5) et (10).

a) Tracer les diagrammes des efforts normaux, tranchants et des moments fléchissants.

b) On impose une contrainte admissible en flexion de 8 daN.mm^{-2}. **Déterminer** l'épaisseur b minimum à donner à la section K.

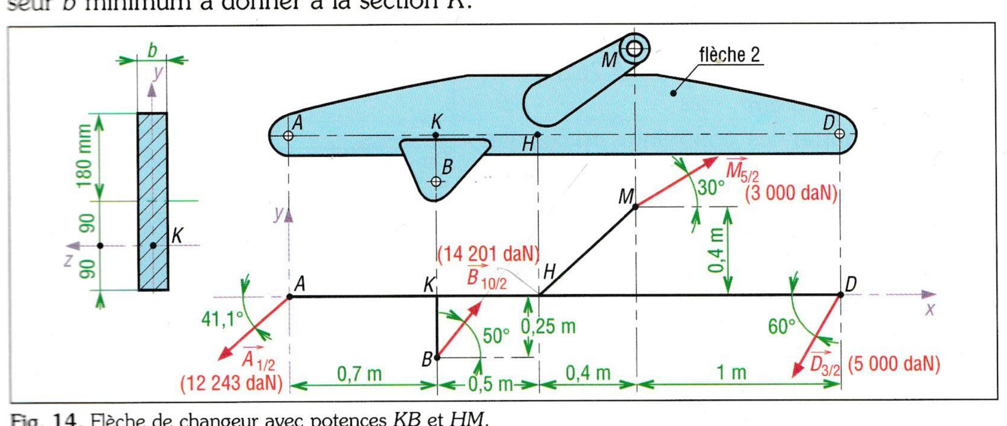


Fig. 14. Flèche de changeur avec potences KB et HM.

Réponse : $N_{maxi} = 9\,226$ daN ; $T_{maxi} = 8\,048$ daN ; $M_{f\ maxi} = 79\,150$ Nm ; $b = 39{,}3$ mm.

Translation of the problem

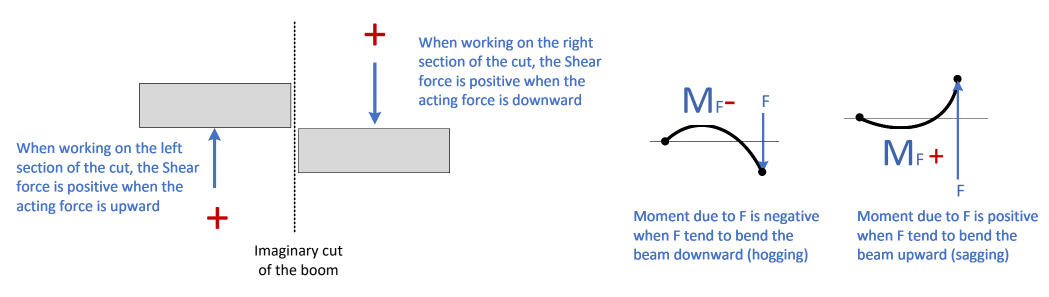
The study of an all terrain track loader's boom can be schematically reduce to the drawing below. Forces A1/2, B10/2, M5/2 D3/2 stand for the actions exerted by parts (1),(3),(5) and (10).

A) Draw the Normal, Shear and bending moment diagrams.
B) The allowable bending stress is 8 daN.mm-2. Find the minimum thickness b for the section at point K.

Answers:
- Maximum Normal Force: **9226 daN**
- Maximum Shear Force: **8048 daN**
- Maximum Bending Moment: **7915 Nm**
- Minimum Thickness: **b = 39.3 mm**

My Analysis Start Here

Sign Convention



Finding forces components

From given data

$A_{1/2x}$ = 12243*cos(41.1) = **9226 daN**
$A_{1/2y}$ = 12243*sin(41.1) = **8048 daN**

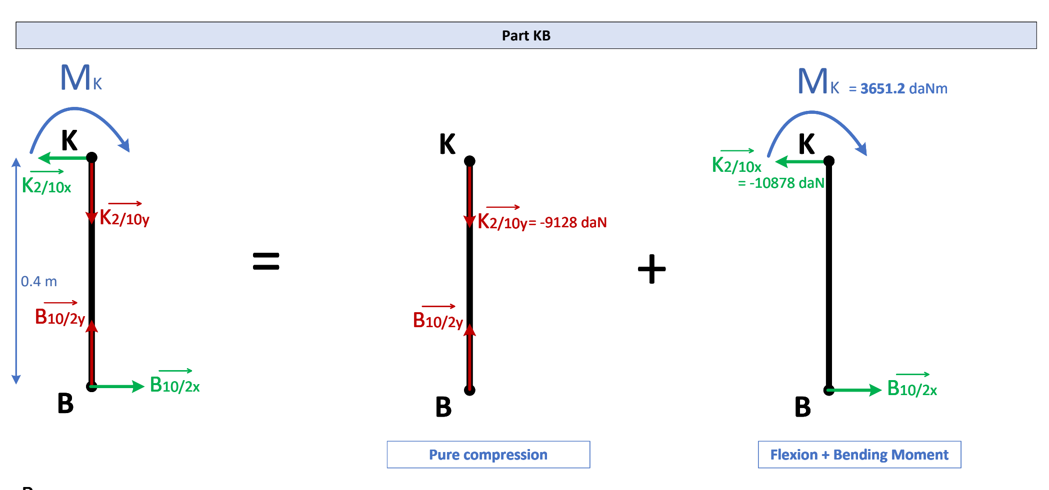
$B_{10/2x}$ = 14201*cos(50) = **9128 daN**
$B_{10/2y}$ = 14201*sin(50) = **10878 daN**

$M_{5/2x}$ = 3000*cos(30) = **2598 daN**
$M_{5/2y}$ = 3000*sin(30) = **1500 daN**

$D_{3/2x}$ = 5000*cos(60) = **2500 daN**
$D_{3/2y}$ = 5000*sin(60) = **4330 daN**

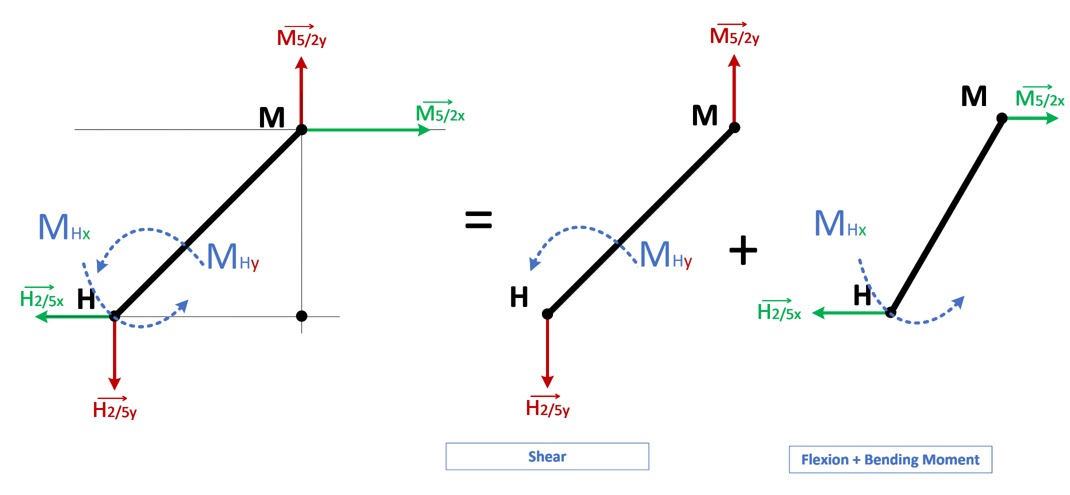
The beam is composed of 3 parts all subject to combined stress:
- **Part AD**
- **Part KB**
- **Part HM**

Part KB

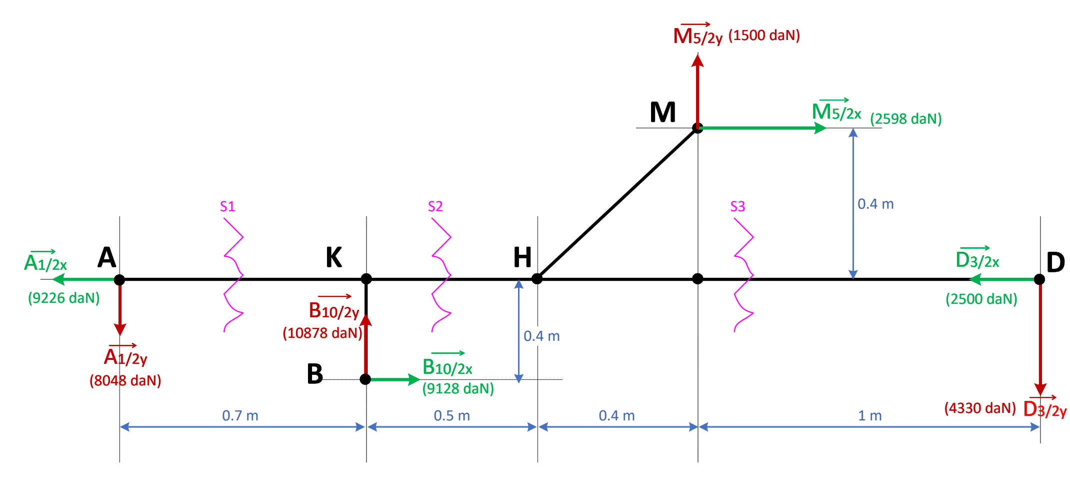


$B_{10/2x}$ create **Mk**, internal moment wich prevent BK from turning
Mk = 0.4*9128 = **3651.2 daNm**.

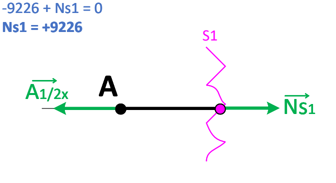
Part HM



Finding the Normal Forces

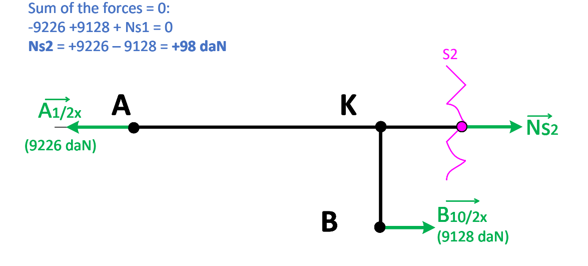


 # Section S1
Sum of the forces along the x axis = 0:
-9226 + Ns1 = 0
Ns1 = +9226



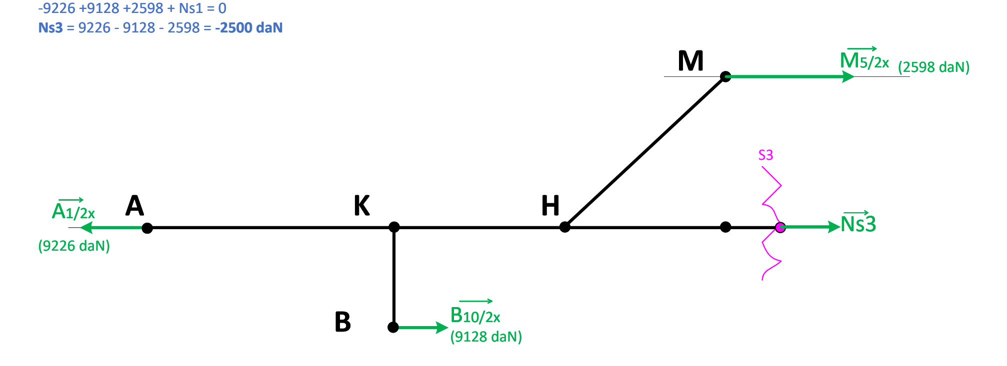
 # Section S2

Sum of the forces = 0:
-9226 +9128 + Ns1 = 0
Ns2 = +9226 – 9128 = **+98 daN**

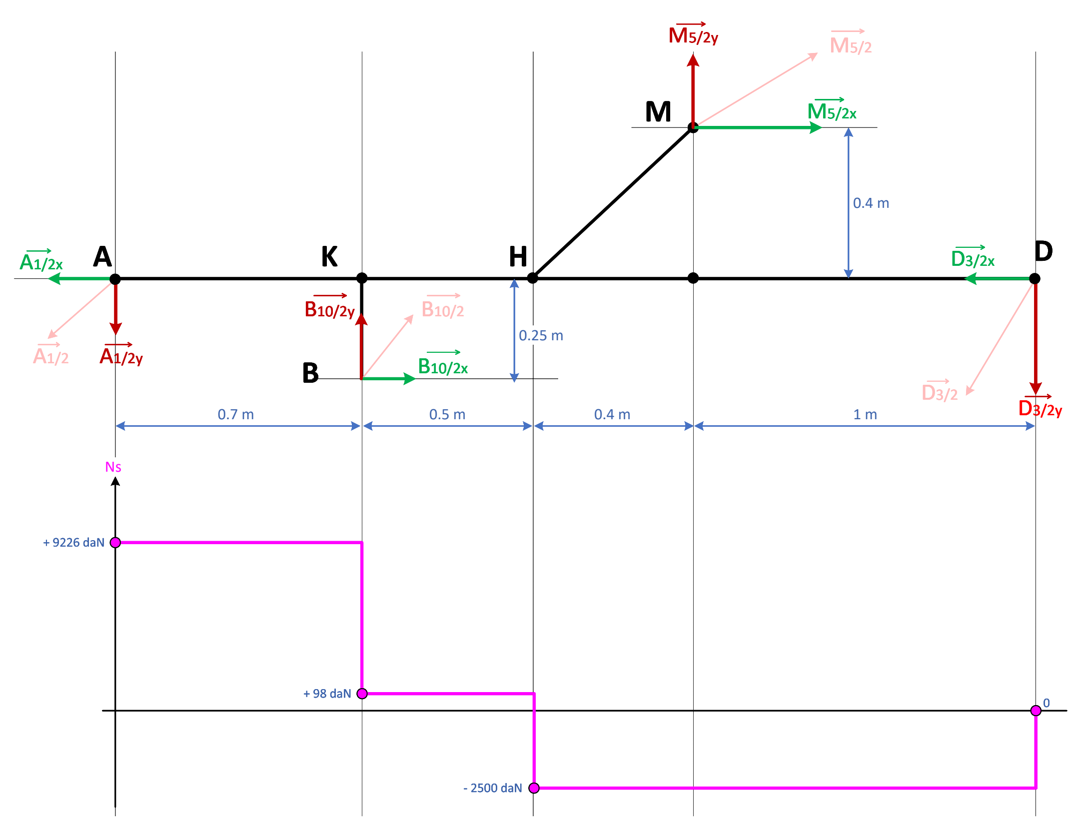


 # Section S3

Sum of the forces = 0:
-9226 +9128 +2598 + Ns1 = 0
Ns3 = 9226 - 9128 - 2598 = **-2500 daN**



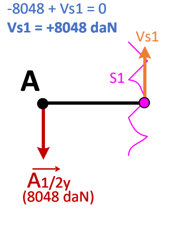
Drawing the normal force diagram



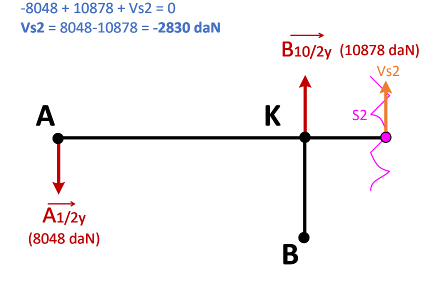
=> The Maximum normal force is equal to **9226 daN**

Finding the shear Forces

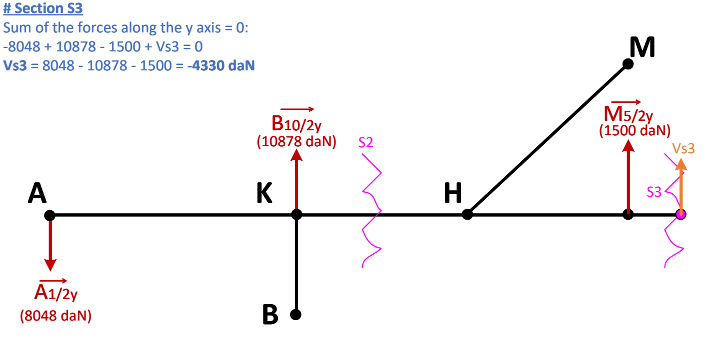
 # Section S1
Sum of the forces along the y axis = 0:
-8048 + Vs1 = 0
Vs1 = +8048 daN

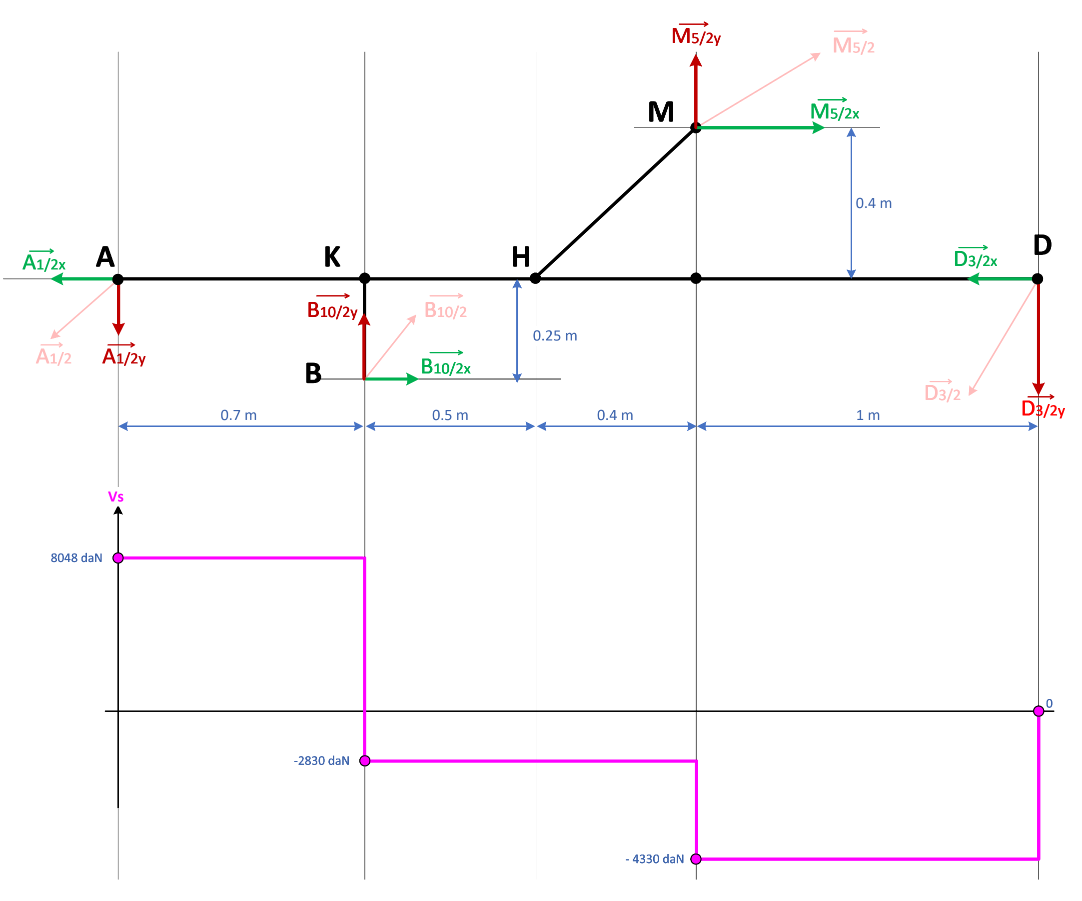


 # Section S2
Sum of the forces along the y axis = 0:
-8048 + 10878 + Vs2 = 0
Vs2 = 8048-10878 = **-2830 daN**



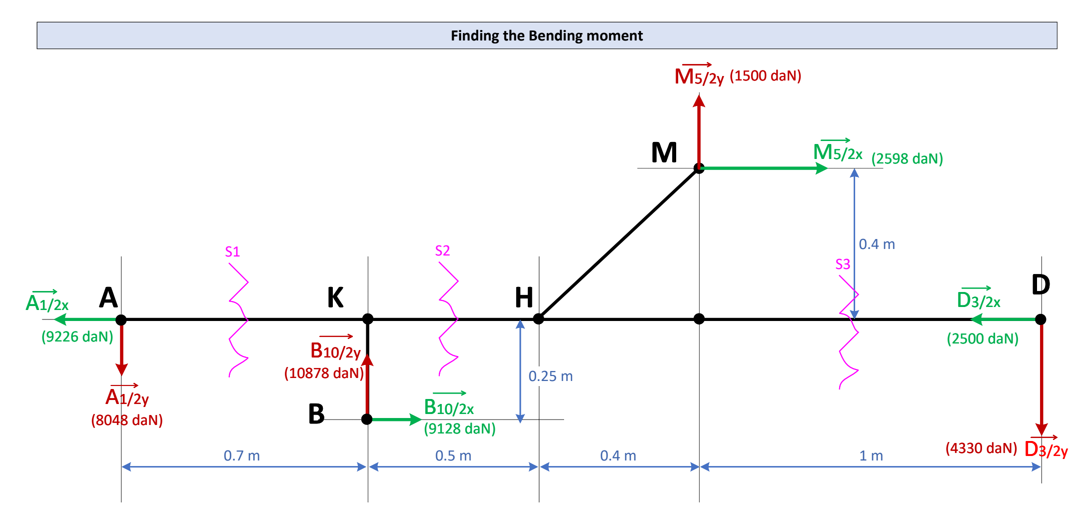
 # Section S3
Sum of the forces along the y axis = 0:
-8048 + 10878 - 1500 + Vs3 = 0
Vs3 = 8048 - 10878 - 1500 = **-4330 daN**





=> The Maximum shear force is equal to **+8048 daN**

Finding the Bending moment

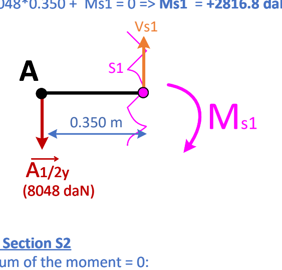


 # Analysis

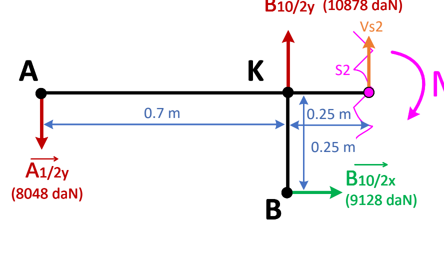
To compute the bending moment, all the forces along the y axis must be taken into consideration. As well as the forces at point B and M along the x axis

 # Section S1

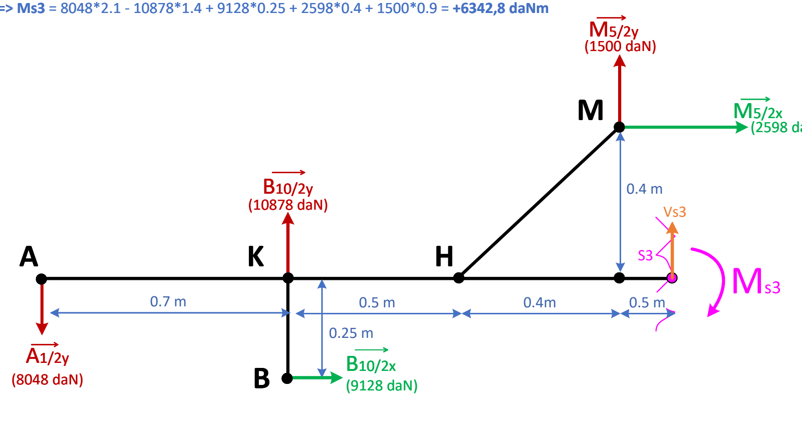
$A_{1/2y}$ is hogging the beam, so its moment is negative.
Sum of the moment = 0:
-8048*0.350 + Ms1 = 0 => **Ms1 = +2816.8 daNm**



 # Section S2
Sum of the moment = 0:
- 8048*0.95 + 10878*0.25 - 9128*0.25 + Ms2 = 0
=> Ms2 = 8048*0.95 - 10878*0.25 + 9128*0.25 = **+7208,1 daNm**



 # Section S3
Sum of the moment = 0:
- 8048*2.1 + 10878*1.4 - 9128*0.25 - 2598*0.4 - 1500*0.9 + Ms3 = 0
=> Ms3 = 8048*2.1 - 10878*1.4 + 9128*0.25 + 2598*0.4 + 1500*0.9 = **+6342,8 daNm**



 # Moment at point D
Sum of the moment = 0:
- 8048*2.6 + 10878*1,9 - 9128*0.4 +2598*0.4 - 1500*1.4 + M_D = 0
=> M_D = 8048*2.6 - 10878*1.9 + 9128*0.25 + 2598*0.4 + 1500*1.4 = **+5677,8 daNm**