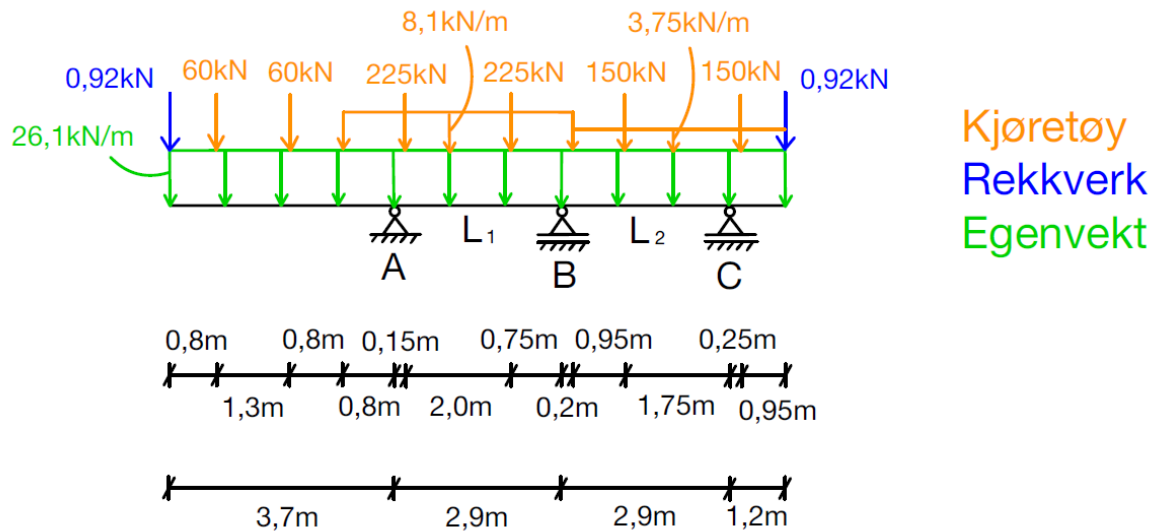


## VEDLEGG 4

### LASTBEREGNINGER

## TVERRETNING VED AKSE B, C OG D

### Lasttilfelle 1:



$$M_A * L_1 + 2 * M_B (L_1 + L_2) + M_C * L_2 = \sum \frac{q_{1,i}}{4} * L_{1,i}^3 + \sum \frac{q_{2,i}}{4} * L_{2,i}^3 + \sum P_{1,i} * L_1^2 \left[ \frac{a_{1,i}}{L_1} - \left( \frac{a_{1,i}}{L_1} \right)^3 \right] + \sum P_{2,i} * L_2^2 \left[ \frac{a_{2,i}}{L_2} - \left( \frac{a_{2,i}}{L_2} \right)^3 \right]$$

$$M_A * 2,9 + 2 * M_B (2,9 + 2,9) + M_C * 2,9 = \frac{26,1}{4} * 2,9^3 + \frac{8,1}{4} * 2,9^3 + \frac{26,1}{4} * 2,9^3 + \frac{8,1}{4} * 0,2^3 + \frac{3,75}{4} * 2,7^3 + 225 * 2,9^2 \left[ \frac{0,15}{2,9} - \left( \frac{0,15}{2,9} \right)^3 \right] + 225 * 2,9^2 \left[ \frac{2,15}{2,9} - \left( \frac{2,15}{2,9} \right)^3 \right] + 150 * 2,9^2 \left[ \frac{1,15}{2,9} - \left( \frac{1,15}{2,9} \right)^3 \right]$$

$$2,9M_A + 11,6M_B + 2,9M_C = 1537,12 \quad (1)$$

Likning (1) gir:

$$M_B = \frac{1537,12 - 2,9M_A - 2,9M_C}{11,6} \quad (2)$$

$$M_A = -\sum M \text{ til venstre for snittet}$$

$$M_A = -\left(-26,1 * 3,7 * \frac{3,7}{2} - 8,1 * 0,8 * \frac{0,8}{2} - 0,92 * 3,7 - 60 * 2,9 - 60 * 1,6\right)$$

$$M_A = 454,65 \text{ kNm} \quad (3)$$

$$M_C = \sum M \text{ til høyre for snittet}$$

$$M_C = 26,1 * 1,2 * \frac{1,2}{2} + 3,75 * 1,2 * \frac{1,2}{2} + 0,92 * 1,2 + 150 * 0,25$$

$$M_C = 60,10 \text{ kNm} \quad (4)$$

Likning (3) og (4) innsatt i (2) gir:

$$M_B = \frac{1537,12 - 2,9 * 454,65 - 2,9 * 60,10}{11,6}$$

$$M_B = 3,82 \text{ kNm}$$

$$V(0^+) = -\sum V \text{ til venstre for snittet}$$

$$V(0^+) = -(-0,92)$$

$$V(0^+) = 0,92 \text{ kN}$$

$$V(A^-) = -\sum V \text{ til venstre for snittet}$$

$$V(A^-) = -(-26,1 * 3,7 - 8,1 * 0,8 - 0,92 - 60 - 60)$$

$$V(A^-) = 224,08 \text{ kN}$$

$$V(A^+) = \frac{M_B - M_A}{L_1} - \sum \frac{q_{1,i} * L_1}{2} - \sum P_{1,i} * \frac{L_1 - a_{1,i}}{L_1}$$

$$V(A^+) = \frac{3,82 - 454,65}{2,9} - \frac{26,1 * 2,9}{2} - \frac{8,1 * 2,9}{2} - 225 * \frac{2,9 - 0,15}{2,9} - 225 * \frac{2,9 - 2,15}{2,9}$$

$$V(A^+) = -476,60 \text{ kN}$$

$$V(B^-) = \frac{M_B - M_A}{L_1} + \sum \frac{q_{1,i} * L_1}{2} + \sum P_{1,i} * \frac{a_{1,i}}{L_1}$$

$$V(B^-) = \frac{3,82 - 454,65}{2,9} + \frac{26,1 * 2,9}{2} + \frac{8,1 * 2,9}{2} + 225 * \frac{0,15}{2,9} + 225 * \frac{2,15}{2,9}$$

$$V(B^-) = 72,58 \text{ kN}$$

$$V(B^+) = \frac{M_C - M_B}{L_2} - \sum \frac{q_{2,i} * L_2}{2} - \sum P_{2,i} * \frac{L_2 - a_{2,i}}{L_2}$$

$$V(B^+) = \frac{60,10 - 3,82}{2,9} - \frac{26,1 * 2,9}{2} - \frac{8,1 * 0,2}{2} - \frac{3,75 * 2,7}{2} - 150 * \frac{2,9 - 1,15}{2,9}$$

$$V(B^+) = -114,83 \text{ kN}$$

$$V(C^-) = \frac{M_C - M_B}{L_2} + \sum \frac{q_{2,i} * L_2}{2} + \sum P_{2,i} * \frac{a_{2,i}}{L_2}$$

$$V(C^-) = \frac{60,10 - 3,82}{2,9} + \frac{26,1 * 2,9}{2} + \frac{8,1 * 0,2}{2} + \frac{3,75 * 2,7}{2} + 150 * \frac{1,15}{2,9}$$

$$V(C^-) = 122,61 \text{ kN}$$

$$V(C^+) = \sum V \text{ til høyre for snittet}$$

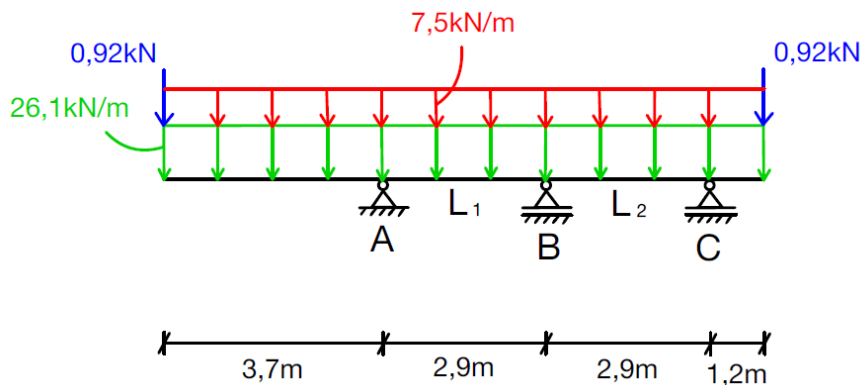
$$V(C^+) = -26,1 * 1,2 - 3,75 * 1,2 - 0,92 - 150$$

$$V(C^+) = -186,74 \text{ kN}$$

$$V(L^-) = \sum V \text{ til høyre for snittet}$$

$$V(10,7^-) = -0,92 \text{ kN}$$

### Lasttilfelle 3:



Gangtrafikk  
Rekkverk  
Egenvekt

$$M_A * L_1 + 2 * M_B (L_1 + L_2) + M_C * L_2 = \sum \frac{q_{1,i}}{4} * L_{1,i}^3 + \sum \frac{q_{2,i}}{4} * L_{2,i}^3 + \sum P_{1,i} * L_1^2 \left[ \frac{a_{1,i}}{L_1} - \left( \frac{a_{1,i}}{L_1} \right)^3 \right] + \sum P_{2,i} * L_2^2 \left[ \frac{a_{2,i}}{L_2} - \left( \frac{a_{2,i}}{L_2} \right)^3 \right]$$

$$M_A * 2,9 + 2 * M_B (2,9 + 2,9) + M_C * 2,9 = \frac{26,1}{4} * 2,9^3 + \frac{7,5}{4} * 2,9^3 + \frac{26,1}{4} * 2,9^3 + \frac{7,5}{4} * 2,9^3$$

$$2,9M_A + 11,6M_B + 2,9M_C = 409,74 \quad (1)$$

Likning (1) gir:

$$M_B = \frac{409,74 - 2,9M_A - 2,9M_A}{11,6} \quad (2)$$

$M_A = -\sum M$  til venstre for snittet

$$M_A = - \left( -26,1 * 3,7 * \frac{3,7}{2} - 7,5 * 3,7 * \frac{3,7}{2} - 0,92 * 3,7 \right)$$

$$M_A = 233,40 \text{ kNm} \quad (3)$$

$$M_C = \sum M \text{ til høyre for snittet}$$

$$M_C = 26,1 * 1,2 * \frac{1,2}{2} + 7,5 * 1,2 * \frac{1,2}{2} + 0,92 * 1,2$$

$$M_C = 25,30 \text{ kNm} \quad (4)$$

Likning (3) og (4) innsatt i (2) gir:

$$M_B = \frac{409,74 - 2,9 * 233,40 - 2,9 * 25,30}{11,6}$$

$$M_B = -29,35 \text{ kNm}$$

$$V(0^+) = -\sum V \text{ til venstre for snittet}$$

$$V(0^+) = -(-0,92)$$

$$V(0^+) = 0,92 \text{ kN}$$

$$V(A^-) = -\sum V \text{ til venstre for snittet}$$

$$V(A^-) = -(-26,1 * 3,7 - 7,5 * 3,7 - 0,92)$$

$$V(A^-) = 125,24 \text{ kN}$$

$$V(A^+) = \frac{M_B - M_A}{L_1} - \sum \frac{q_{1,i} * L_1}{2} - \sum P_{1,i} * \frac{L_1 - a_{1,i}}{L_1}$$

$$V(A^+) = \frac{-29,35 - 233,40}{2,9} - \frac{26,1 * 2,9}{2} - \frac{7,5 * 2,9}{2}$$

$$V(A^+) = -139,32 \text{ kN}$$

$$V(B^-) = \frac{M_B - M_A}{L_1} + \sum \frac{q_{1,i} * L_1}{2} + \sum P_{1,i} * \frac{a_{1,i}}{L_1}$$

$$V(B^-) = \frac{-29,35 - 233,40}{2,9} + \frac{26,1 * 2,9}{2} + \frac{7,5 * 2,9}{2}$$

$$V(B^-) = -41,88 \text{ kN}$$

$$V(B^+) = \frac{M_C - M_B}{L_2} - \sum \frac{q_{2,i} * L_2}{2} - \sum P_{2,i} * \frac{L_2 - a_{2,i}}{L_2}$$

$$V(B^+) = \frac{25,30 - (-29,35)}{2,9} - \frac{26,1 * 2,9}{2} - \frac{7,5 * 2,9}{2}$$

$$V(B^+) = -29,88 \text{ kN}$$

$$V(C^-) = \frac{M_C - M_B}{L_2} + \sum \frac{q_{2,i} * L_2}{2} + \sum P_{2,i} * \frac{a_{2,i}}{L_2}$$

$$V(C^-) = \frac{25,30 - (-29,35)}{2,9} + \frac{26,1 * 2,9}{2} + \frac{7,5 * 2,9}{2}$$

$$V(C^-) = 67,56 \text{ kN}$$

$$V(C^+) = \sum V \text{ til høyre for snittet}$$

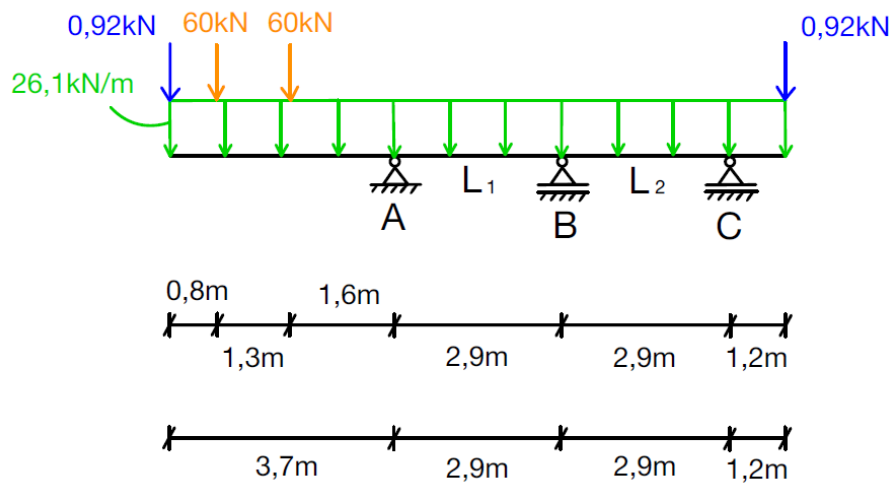
$$V(C^+) = -26,1 * 1,2 - 7,5 * 1,2 - 0,92$$

$$V(C^+) = -41,24 \text{ kN}$$

$$V(L^-) = \sum V \text{ til høyre for snittet}$$

$$V(10,7^-) = -0,92 \text{ kN}$$

Lasttilfelle 4:



Kjøretøy  
Rekkverk  
Egenvekt

$$M_A * L_1 + 2 * M_B (L_1 + L_2) + M_C * L_2 = \sum \frac{q_{1,i}}{4} * L_{1,i}^3 + \sum \frac{q_{2,i}}{4} * L_{2,i}^3 + \sum P_{1,i} * L_1^2 \left[ \frac{a_{1,i}}{L_1} - \left( \frac{a_{1,i}}{L_1} \right)^3 \right] + \sum P_{2,i} * L_2^2 \left[ \frac{a_{2,i}}{L_2} - \left( \frac{a_{2,i}}{L_2} \right)^3 \right]$$

$$M_A * 2,9 + 2 * M_B (2,9 + 2,9) + M_C * 2,9 = \frac{26,1}{4} * 2,9^3 + \frac{26,1}{4} * 2,9^3$$

$$2,9M_A + 11,6M_B + 2,9M_C = 318,28 \quad (1)$$

Likning (1) gir:

$$M_B = \frac{318,28 - 2,9M_A - 2,9M_C}{11,6} \quad (2)$$

$M_A = -\sum M$  til venstre for snittet

$$M_A = - \left( -26,1 * 3,7 * \frac{3,7}{2} - 0,92 * 3,7 - 60 * 2,9 - 60 * 1,6 \right)$$

$$M_A = 452,06 \text{ kNm} \quad (3)$$



$$M_C = \sum M \text{ til høyre for snittet}$$

$$M_C = 26,1 * 1,2 * \frac{1,2}{2} + 0,92 * 1,2$$

$$M_C = 19,90 \text{ kNm} \quad (4)$$

Likning (3) og (4) innsatt i (2) gir:

$$M_B = \frac{318,28 - 2,9 * 452,06 - 2,9 * 19,90}{11,6}$$

$$M_B = -90,55 \text{ kNm}$$

$$V(0^+) = -\sum V \text{ til venstre for snittet}$$

$$V(0^+) = -(-0,92)$$

$$V(0^+) = 0,92 \text{ kN}$$

$$V(A^-) = -\sum V \text{ til venstre for snittet}$$

$$V(A^-) = -(-26,1 * 3,7 - 0,92 - 60 - 60)$$

$$V(A^-) = -217,49 \text{ kN}$$

$$V(A^+) = \frac{M_B - M_A}{L_1} - \sum \frac{q_{1,i} * L_1}{2} - \sum P_{1,i} * \frac{L_1 - a_{1,i}}{L_1}$$

$$V(A^+) = \frac{-90,55 - 452,06}{2,9} - \frac{26,1 * 2,9}{2}$$

$$V(A^+) = -224,95 \text{ kN}$$

$$V(B^-) = \frac{M_B - M_A}{L_1} + \sum \frac{q_{1,i} * L_1}{2} + \sum P_{1,i} * \frac{a_{1,i}}{L_1}$$

$$V(B^-) = \frac{-90,55 - 452,06}{2,9} + \frac{26,1 * 2,9}{2}$$

$$V(B^-) = -149,26 \text{ kN}$$

$$V(B^+) = \frac{M_C - M_B}{L_2} - \sum \frac{q_{2,i} * L_2}{2} - \sum P_{2,i} * \frac{L_2 - a_{2,i}}{L_2}$$

$$V(B^+) = \frac{19,90 - (-90,55)}{2,9} - \frac{26,1 * 2,9}{2}$$

$$V(B^+) = 0,24 \text{ kN}$$

$$V(C^-) = \frac{M_C - M_B}{L_2} + \sum \frac{q_{2,i} * L_2}{2} + \sum P_{2,i} * \frac{a_{2,i}}{L_2}$$

$$V(C^-) = \frac{19,90 - (-90,55)}{2,9} + \frac{26,1 * 2,9}{2}$$

$$V(C^-) = 75,93 \text{ kN}$$

$$V(C^+) = \sum V \text{ til høyre for snittet}$$

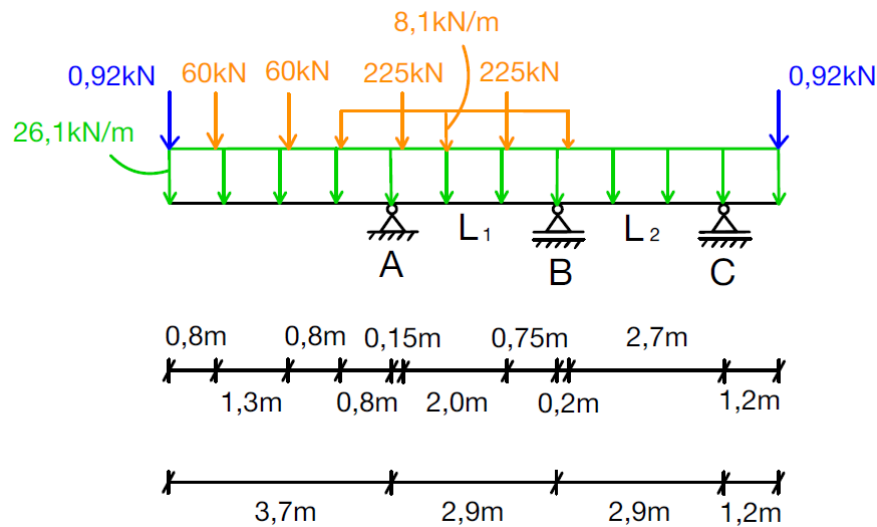
$$V(C^+) = -26,1 * 1,2 - 0,92$$

$$V(C^+) = -32,24 \text{ kN}$$

$$V(L^-) = \sum V \text{ til høyre for snittet}$$

$$V(10,7^-) = -0,92 \text{ kN}$$

Lasttilfelle 6:



Kjøretøy  
Rekkverk  
Egenvekt

$$M_A * L_1 + 2 * M_B (L_1 + L_2) + M_C * L_2 = \sum \frac{q_{1,i}}{4} * L_{1,i}^3 + \sum \frac{q_{2,i}}{4} * L_{2,i}^3 + \sum P_{1,i} * L_1^2 \left[ \frac{a_{1,i}}{L_1} - \left( \frac{a_{1,i}}{L_1} \right)^3 \right] + \sum P_{2,i} * L_2^2 \left[ \frac{a_{2,i}}{L_2} - \left( \frac{a_{2,i}}{L_2} \right)^3 \right]$$

$$M_A * 2,9 + 2 * M_B (2,9 + 2,9) + M_C * 2,9 = \frac{26,1}{4} * 2,9^3 + \frac{8,1}{4} * 2,9^3 + \frac{26,1}{4} * 2,9^3 + \frac{8,1}{4} * 0,2^3 + 225 * 2,9^2 * \left[ \frac{0,15}{2,9} - \left( \frac{0,15}{2,9} \right)^3 \right] + 225 * 2,9^2 * \left[ \frac{2,15}{2,9} - \left( \frac{2,15}{2,9} \right)^3 \right]$$

$$2,9M_A + 11,6M_B + 2,9M_C = 1097,09 \quad (1)$$

Likning (1) gir:

$$M_B = \frac{1066,43 - 2,9M_A - 2,9M_C}{11,6} \quad (2)$$

$M_A = -\sum M$  til venstre for snittet

$$M_A = - \left( -26,1 * 3,7 * \frac{3,7}{2} - 8,1 * 0,8 * \frac{0,8}{2} - 0,92 * 3,7 - 60 * 2,9 - 60 * 1,6 \right)$$

$$M_A = 454,65 \text{ kNm} \quad (3)$$

$$M_C = \sum M \text{ til høyre for snittet}$$

$$M_C = 26,1 * 1,2 * \frac{1,2}{2} + 0,92 * 1,2$$

$$M_C = 19,90 \text{ kNm} \quad (4)$$

Likning (3) og (4) innsatt i (2) gir:

$$M_B = \frac{1097,09 - 2,9 * 454,65 - 2,9 * 19,90}{11,6}$$

$$M_B = -24,06 \text{ kNm}$$

$$V(0^+) = -\sum V \text{ til venstre for snittet}$$

$$V(0^+) = -(-0,92)$$

$$V(0^+) = 0,92 \text{ kN}$$

$$V(A^-) = -\sum V \text{ til venstre for snittet}$$

$$V(A^-) = -(-26,1 * 3,7 - 8,1 * 0,8 - 0,92 - 60 - 60)$$

$$V(A^-) = 223,97 \text{ kN}$$

$$V(A^+) = \frac{M_B - M_A}{L_1} - \sum \frac{q_{1,i} * L_1}{2} - \sum P_{1,i} * \frac{L_1 - a_{1,i}}{L_1}$$

$$V(A^+) = \frac{-24,06 - 454,65}{2,9} - \frac{26,1 * 2,9}{2} - \frac{8,1 * 2,9}{2} - 225 * \frac{2,9 - 0,15}{2,9} - 225 * \frac{2,9 - 2,15}{2,9}$$

$$V(A^+) = -486,21 \text{ kN}$$

$$V(B^-) = \frac{M_B - M_A}{L_1} + \sum \frac{q_{1,i} * L_1}{2} + \sum P_{1,i} * \frac{a_{1,i}}{L_1}$$

$$V(B^-) = \frac{-24,06 - 454,65}{2,9} + \frac{26,1 * 2,9}{2} + \frac{8,1 * 2,9}{2} + 225 * \frac{0,15}{2,9} + 225 * \frac{2,15}{2,9}$$

$$V(B^-) = 62,97 \text{ kN}$$

$$V(B^+) = \frac{M_C - M_B}{L_2} - \sum \frac{q_{2,i} * L_2}{2} - \sum P_{2,i} * \frac{L_2 - a_{2,i}}{L_2}$$

$$V(B^+) = \frac{19,90 - (-24,06)}{2,9} - \frac{26,1 * 2,9}{2} - \frac{8,1 * 0,2}{2}$$

$$V(B^+) = -23,50 \text{ kN}$$

$$V(C^-) = \frac{M_C - M_B}{L_2} + \sum \frac{q_{2,i} * L_2}{2} + \sum P_{2,i} * \frac{a_{2,i}}{L_2}$$

$$V(C^-) = \frac{19,90 - (-24,06)}{2,9} + \frac{26,1 * 2,9}{2} + \frac{8,1 * 0,2}{2}$$

$$V(C^-) = 53,81 \text{ kN}$$

$$V(C^+) = \sum V \text{ til høyre for snittet}$$

$$V(C^+) = -26,1 * 1,2 - 0,92$$

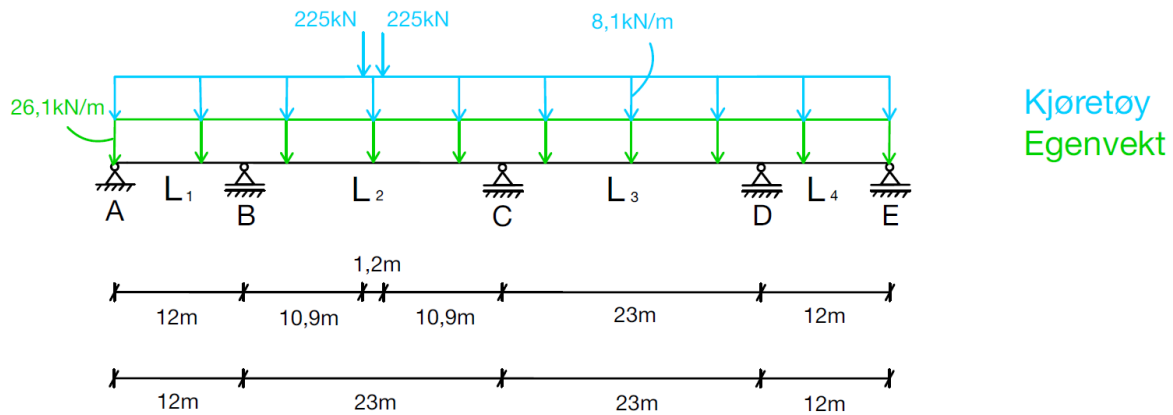
$$V(C^+) = -32,24 \text{ kN}$$

$$V(L^-) = \sum V \text{ til høyre for snittet}$$

$$V(10,7^-) = -0,92 \text{ kN}$$

## LENGDERETNING I KJØREFELT 1

### Lasttilfelle 7:



$$M_A = -\sum M \text{ til venstre for snittet}$$

$$M_A = 0$$

$$M_E = \sum M \text{ til høyre for snittet}$$

$$M_E = 0$$

$$M_A * L_1 + 2 * M_B(L_1 + L_2) + M_C * L_2 = \sum \frac{q_{1,i}}{4} * L_{1,i}^3 + \sum \frac{q_{2,i}}{4} * L_{2,i}^3 + \sum P_{1,i} * L_1^2 \left[ \frac{a_{1,i}}{L_1} - \left( \frac{a_{1,i}}{L_1} \right)^3 \right] + \sum P_{2,i} * L_2^2 \left[ \frac{a_{2,i}}{L_2} - \left( \frac{a_{2,i}}{L_2} \right)^3 \right]$$

$$M_A * 12 + 2 * M_B(12 + 23) + M_C * 23 = \frac{26,1}{4} * 12^3 + \frac{8,1}{4} * 12^3 + \frac{26,1}{4} * 23^3 + \frac{8,1}{4} * 23^3 + 225 * 23^2 * \left[ \frac{10,9}{23} - \left( \frac{10,9}{23} \right)^3 \right] + 225 * 23^2 * \left[ \frac{12,1}{23} - \left( \frac{12,1}{23} \right)^3 \right]$$

$$70M_B + 23M_C = 207\,828,00 \quad (1)$$

$$M_B * L_2 + 2 * M_C(L_2 + L_3) + M_D * L_3 = \sum \frac{q_{2,i}}{4} * L_{2,i}^3 + \sum \frac{q_{3,i}}{4} * L_{3,i}^3 + \sum P_{2,i} * L_2^2 \left[ \frac{a_{2,i}}{L_2} - \left( \frac{a_{2,i}}{L_2} \right)^3 \right] + \sum P_{3,i} * L_3^2 \left[ \frac{a_{3,i}}{L_3} - \left( \frac{a_{3,i}}{L_3} \right)^3 \right]$$

$$M_B * 23 + 2 * M_C(23 + 23) + M_D * 23 = \frac{26,1}{4} * 23^3 + \frac{8,1}{4} * 23^3 + \frac{26,1}{4} * 23^3 + \frac{8,1}{4} * 23^3 + 225 * 23^2 * \left[ \frac{10,9}{23} - \left( \frac{10,9}{23} \right)^3 \right] + 225 * 23^2 \left[ \frac{12,1}{23} - \left( \frac{12,1}{23} \right)^3 \right]$$

$$23M_B + 92M_C + 23M_D = 297\,081,45 \quad (2)$$

$$M_C * L_3 + 2 * M_D(L_3 + L_4) + M_E * L_4 = \sum \frac{q_{3,i}}{4} * L_{3,i}^3 + \sum \frac{q_{4,i}}{4} * L_{4,i}^3 + \sum P_{3,i} * L_3^2 \left[ \frac{a_{3,i}}{L_3} - \left( \frac{a_{3,i}}{L_3} \right)^3 \right] + \sum P_{4,i} * L_4^2 \left[ \frac{a_{4,i}}{L_4} - \left( \frac{a_{4,i}}{L_4} \right)^3 \right]$$

$$M_C * 23 + 2 * M_D(23 + 12) + M_E * 12 = \frac{26,1}{4} * 23^3 + \frac{8,1}{4} * 23^3 + \frac{26,1}{4} * 12^3 + \frac{8,1}{4} * 12^3$$

$$23M_C + 70M_D = 118\,802,25 \quad (3)$$

Likning (1) gir:

$$M_B = \frac{207\,828,00}{70} - \frac{23}{70} M_C \quad (4)$$

Likning (3) gir:

$$M_D = \frac{118\,802,25}{70} - \frac{23}{70} M_C \quad (5)$$

Likning (4) og (5) innsatt i (2) gir:

$$23 * \left( \frac{207\,828,00}{70} - \frac{23}{70} M_C \right) + 92 M_C + 23 \left( \frac{118\,802,25}{70} - \frac{23}{70} M_C \right) = 297\,081,45$$

$$92 M_C - 2 * \frac{23^2}{70} M_C = 297\,081,45 - \frac{23}{70} * (207\,828,00 + 118\,802,25)$$

$$M_C = 2468,08 \text{ kNm}$$

Likning (4) gir:

$$M_B = 2158,03 \text{ kNm}$$

Likning (5) gir:

$$M_D = 886,23 \text{ kNm}$$

$$V(A^+) = \frac{M_B - M_A}{L_1} - \sum \frac{q_{1,i} * L_1}{2} - \sum P_{1,i} * \frac{L_1 - a_{1,i}}{L_1}$$

$$V(A^+) = \frac{2158,03 - 0}{12} - \frac{26,1 * 12}{2} - \frac{8,1 * 12}{2}$$

$$V(A^+) = -25,36 \text{ kN}$$

$$V(B^-) = \frac{M_B - M_A}{L_1} + \sum \frac{q_{1,i} * L_1}{2} + \sum P_{1,i} * \frac{a_{1,i}}{L_1}$$

$$V(B^-) = \frac{2158,03 - 0}{12} + \frac{26,1 * 12}{2} + \frac{8,1 * 12}{2}$$

$$V(B^-) = 385,04 \text{ kN}$$

$$V(B^+) = \frac{M_C - M_B}{L_2} - \sum \frac{q_{2,i} * L_2}{2} - \sum P_{2,i} * \frac{L_2 - a_{2,i}}{L_2}$$

$$V(B^+) = \frac{2468,08 - 2158,03}{23} - \frac{26,1 * 23}{2} - \frac{8,1 * 23}{2} - 225 * \frac{23 - 10,9}{23} - 225 * \frac{23 - 12,1}{23}$$

$$V(B^+) = -604,82 \text{ kN}$$



$$V(C^-) = \frac{M_C - M_B}{L_2} + \sum \frac{q_{2,i} * L_2}{2} + \sum P_{2,i} * \frac{a_{2,i}}{L_2}$$

$$V(C^-) = \frac{2468,08 - 2158,03}{23} + \frac{26,1 * 23}{2} + \frac{8,1 * 23}{2} + 225 * \frac{10,9}{23} + 225 * \frac{12,1}{23}$$

$$V(C^-) = 631,78 \text{ kN}$$

$$V(C^+) = \frac{M_D - M_C}{L_3} - \sum \frac{q_{3,i} * L_3}{2} - \sum P_{3,i} * \frac{L_3 - a_{3,i}}{L_3}$$

$$V(C^+) = \frac{886,23 - 2468,08}{23} - \frac{26,1 * 23}{2} - \frac{8,1 * 23}{2}$$

$$V(C^+) = -462,08 \text{ kN}$$

$$V(D^-) = \frac{M_D - M_C}{L_3} + \sum \frac{q_{3,i} * L_3}{2} + \sum P_{3,i} * \frac{a_{3,i}}{L_3}$$

$$V(D^-) = \frac{886,23 - 2468,08}{23} + \frac{26,1 * 23}{2} + \frac{8,1 * 23}{2}$$

$$V(D^-) = 324,52 \text{ kN}$$

$$V(D^+) = \frac{M_D - M_C}{L_4} - \sum \frac{q_{4,i} * L_4}{2} - \sum P_{4,i} * \frac{L_4 - a_{4,i}}{L_4}$$

$$V(D^+) = \frac{0 - 886,23}{12} - \frac{26,1 * 12}{2} - \frac{8,1 * 12}{2}$$

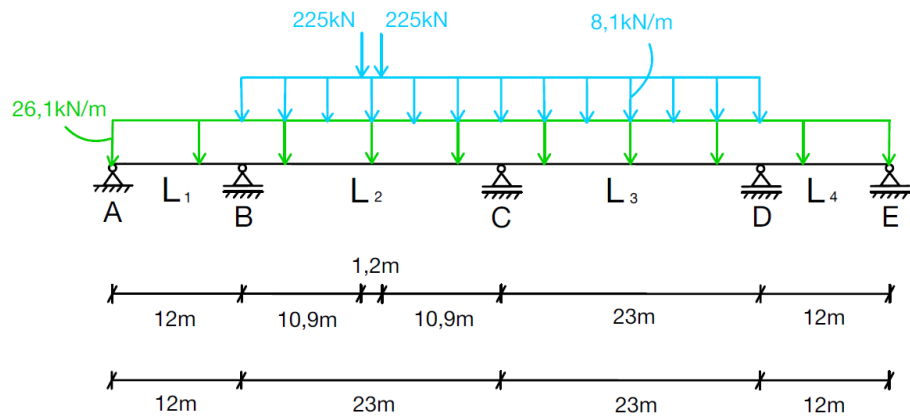
$$V(D^+) = -279,05 \text{ kN}$$

$$V(E^-) = \frac{M_E - M_D}{L_4} + \sum \frac{q_{4,i} * L_4}{2} + \sum P_{4,i} * \frac{a_{4,i}}{L_4}$$

$$V(E^-) = \frac{0 - 886,24}{12} + \frac{26,1 * 12}{2} + \frac{8,1 * 12}{2}$$

$$V(E^-) = 131,35 \text{ kN}$$

### Lasttilfelle 9:



Kjøretøy  
Egenvekt

$$M_A = -\sum M \text{ til venstre for snittet}$$

$$M_A = 0$$

$$M_E = \sum M \text{ til høyre for snittet}$$

$$M_E = 0$$

$$M_A * L_1 + 2 * M_B(L_1 + L_2) + M_C * L_2 = \sum \frac{q_{1,i}}{4} * L_{1,i}^3 + \sum \frac{q_{2,i}}{4} * L_{2,i}^3 + \sum P_{1,i} * L_1^2 \left[ \frac{a_{1,i}}{L_1} - \left( \frac{a_{1,i}}{L_1} \right)^3 \right] + \sum P_{2,i} * L_2^2 \left[ \frac{a_{2,i}}{L_2} - \left( \frac{a_{2,i}}{L_2} \right)^3 \right]$$

$$M_A * 12 + 2 * M_B(12 + 23) + M_C * 23 = \frac{26,1}{4} * 12^3 + \frac{26,1}{4} * 23^3 + \frac{8,1}{4} * 23^3 + 225 * 23^2 \left[ \frac{10,9}{23} - \left( \frac{10,9}{23} \right)^3 \right] + 225 * 23^2 \left[ \frac{12,1}{23} - \left( \frac{12,1}{23} \right)^3 \right]$$

$$70M_B + 23M_C = 204\,328,80 \quad (1)$$

$$M_B * L_2 + 2 * M_C(L_2 + L_3) + M_D * L_3 = \sum \frac{q_{2,i}}{4} * L_{2,i}^3 + \sum \frac{q_{3,i}}{4} * L_{3,i}^3 + \sum P_{2,i} * L_2^2 \left[ \frac{a_{2,i}}{L_2} - \left( \frac{a_{2,i}}{L_2} \right)^3 \right] + \sum P_{3,i} * L_3^2 \left[ \frac{a_{3,i}}{L_3} - \left( \frac{a_{3,i}}{L_3} \right)^3 \right]$$

$$M_B * 23 + 2 * M_C(23 + 23) + M_D * 23 = \frac{26,1}{4} * 23^3 + \frac{8,1}{4} * 23^3 + \frac{26,1}{4} * 23^3 + \frac{8,1}{4} * 23^3 + 225 * 23^2 * \left[ \frac{10,9}{23} - \left( \frac{10,9}{23} \right)^3 \right] + 225 * 23^2 \left[ \frac{12,1}{23} - \left( \frac{12,1}{23} \right)^3 \right]$$

$$23M_B + 92M_C + 23M_D = 297\,081,45 \quad (2)$$

$$M_C * L_3 + 2 * M_D(L_3 + L_4) + M_E * L_4 = \sum \frac{q_{3,i}}{4} * L_{3,i}^3 + \sum \frac{q_{4,i}}{4} * L_{4,i}^3 + \sum P_{3,i} * L_3^2 \left[ \frac{a_{3,i}}{L_3} - \left( \frac{a_{3,i}}{L_3} \right)^3 \right] + \sum P_{4,i} * L_4^2 \left[ \frac{a_{4,i}}{L_4} - \left( \frac{a_{4,i}}{L_4} \right)^3 \right]$$

$$M_C * 23 + 2 * M_D(23 + 12) + M_E * 12 = \frac{26,1}{4} * 23^3 + \frac{8,1}{4} * 23^3 + \frac{26,1}{4} * 12^3$$

$$23 * M_C + 70 * M_D = 115\,303,05 \quad (3)$$

Likning (1) gir:

$$M_B = \frac{204\,328,80}{70} - \frac{23}{70} M_C \quad (4)$$

Likning (3) gir:

$$M_D = \frac{115\,303,05}{70} - \frac{23}{70} M_C \quad (5)$$

Likning (4) og (5) innsatt i (2) gir:

$$23 * \left( \frac{204\,328,80}{70} - \frac{23}{70} M_C \right) + 92 M_C + 23 \left( \frac{115\,303,05}{70} - \frac{23}{70} M_C \right) = 297\,081,45$$

$$92 M_C - 2 * \frac{23^2}{70} M_C = 297\,081,45 - \frac{23}{70} * (204\,328,80 + 115\,303,05)$$

$$M_C = 2497,99 \text{ kNm}$$

Likning (4) gir:

$$M_B = 2098,21 \text{ kNm}$$

Likning (5) gir:

$$M_D = 826,42 \text{ kNm}$$

$$V(A^+) = \frac{M_B - M_A}{L_1} - \sum \frac{q_{1,i} * L_1}{2} - \sum P_{1,i} * \frac{L_1 - a_{1,i}}{L_1}$$

$$V(A^+) = \frac{2098,21 - 0}{12} - \frac{26,1 * 12}{2}$$

$$V(A^+) = 18,25 \text{ kN}$$

$$V(B^-) = \frac{M_B - M_A}{L_1} + \sum \frac{q_{1,i} * L_1}{2} + \sum P_{1,i} * \frac{a_{1,i}}{L_1}$$

$$V(B^-) = \frac{2098,21 - 0}{12} + \frac{26,1 * 12}{2}$$

$$V(B^-) = 331,45 \text{ kN}$$

$$V(B^+) = \frac{M_C - M_B}{L_2} - \sum \frac{q_{2,i} * L_2}{2} - \sum P_{2,i} * \frac{L_2 - a_{2,i}}{L_2}$$

$$V(B^+) = \frac{2497,99 - 2098,21}{23} - \frac{26,1 * 23}{2} - \frac{8,1 * 23}{2} - 225 * \frac{23 - 10,9}{23} - 225 * \frac{23 - 12,1}{23}$$

$$V(B^+) = -600,92 \text{ kN}$$

$$V(C^-) = \frac{M_C - M_B}{L_2} + \sum \frac{q_{2,i} * L_2}{2} + \sum P_{2,i} * \frac{a_{2,i}}{L_2}$$

$$V(C^-) = \frac{2497,99 - 2098,21}{23} + \frac{26,1 * 23}{2} + \frac{8,1 * 23}{2} + 225 * \frac{10,9}{23} + 225 * \frac{12,1}{23}$$

$$V(C^-) = 635,68 \text{ kN}$$

$$V(C^+) = \frac{M_D - M_C}{L_3} - \sum \frac{q_{3,i} * L_3}{2} - \sum P_{3,i} * \frac{L_3 - a_{3,i}}{L_3}$$

$$V(C^+) = \frac{826,42 - 2497,99}{23} - \frac{26,1 * 23}{2} - \frac{8,1 * 23}{2}$$

$$V(C^+) = -465,98 \text{ kN}$$

$$V(D^-) = \frac{M_D - M_C}{L_3} + \sum \frac{q_{3,i} * L_3}{2} + \sum P_{3,i} * \frac{a_{3,i}}{L_3}$$

$$V(D^-) = \frac{826,42 - 2497,99}{23} + \frac{26,1 * 23}{2} + \frac{8,1 * 23}{2}$$

$$V(D^-) = 320,62 \text{ kN}$$

$$V(D^+) = \frac{M_D - M_C}{L_4} - \sum \frac{q_{4,i} * L_4}{2} - \sum P_{4,i} * \frac{L_4 - a_{4,i}}{L_4}$$

$$V(D^+) = \frac{0 - 826,42}{12} - \frac{26,1 * 12}{2}$$

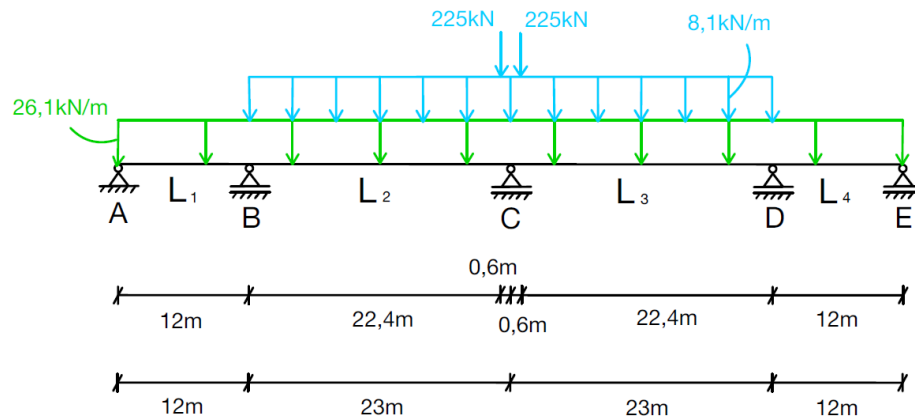
$$V(D^+) = -225,47 \text{ kN}$$

$$V(E^-) = \frac{M_E - M_D}{L_4} + \sum \frac{q_{4,i} * L_4}{2} + \sum P_{4,i} * \frac{a_{4,i}}{L_4}$$

$$V(E^-) = \frac{0 - 826,46}{12} + \frac{26,1 * 12}{2}$$

$$V(E^-) = 87,73 \text{ kN}$$

### Lasttilfelle 12:



Kjøretøy  
Egenvekt

$$M_A = -\sum M \text{ til venstre for snittet}$$

$$M_A = 0$$

$$M_E = \sum M \text{ til høyre for snittet}$$

$$M_E = 0$$

$$M_A * L_1 + 2 * M_B(L_1 + L_2) + M_C * L_2 = \sum \frac{q_{1,i}}{4} * L_{1,i}^3 + \sum \frac{q_{2,i}}{4} * L_{2,i}^3 + \sum P_{1,i} * L_1^2 \left[ \frac{a_{1,i}}{L_1} - \left( \frac{a_{1,i}}{L_1} \right)^3 \right] + \sum P_{2,i} * L_2^2 \left[ \frac{a_{2,i}}{L_2} - \left( \frac{a_{2,i}}{L_2} \right)^3 \right]$$

$$M_A * 12 + 2 * M_B(12 + 23) + M_C * 23 = \frac{26,1}{4} * 12^3 + \frac{26,1}{4} * 23^3 + \frac{8,1}{4} * 23^3 + 225 * 23^2 \left[ \frac{22,4}{23} - \left( \frac{22,4}{23} \right)^3 \right]$$

$$70M_B + 23M_C = 121\,272,16 \quad (1)$$

$$M_B * L_2 + 2 * M_C(L_2 + L_3) + M_D * L_3 = \sum \frac{q_{2,i}}{4} * L_{2,i}^3 + \sum \frac{q_{3,i}}{4} * L_{3,i}^3 + \sum P_{2,i} * L_2^2 \left[ \frac{a_{2,i}}{L_2} - \left( \frac{a_{2,i}}{L_2} \right)^3 \right] + \sum P_{3,i} * L_3^2 \left[ \frac{a_{3,i}}{L_3} - \left( \frac{a_{3,i}}{L_3} \right)^3 \right]$$

$$M_B * 23 + 2 * M_C(23 + 23) + M_D * 23 = \frac{26,1}{4} * 23^3 + \frac{8,1}{4} * 23^3 + \frac{26,1}{4} * 23^3 + \frac{8,1}{4} * 23^3 + 225 * 23^2 \left[ \frac{22,4}{23} - \left( \frac{22,4}{23} \right)^3 \right] + 225 * 23^2 \left[ \frac{0,6}{23} - \left( \frac{0,6}{23} \right)^3 \right]$$

$$23M_B + 92M_C + 23M_D = 217\,127,70 \quad (2)$$

$$M_C * L_3 + 2 * M_D(L_3 + L_4) + M_E * L_4 = \sum \frac{q_{3,i}}{4} * L_{3,i}^3 + \sum \frac{q_{4,i}}{4} * L_{4,i}^3 + \sum P_{3,i} * L_3^2 \left[ \frac{a_{3,i}}{L_3} - \left( \frac{a_{3,i}}{L_3} \right)^3 \right] + \sum P_{4,i} * L_4^2 \left[ \frac{a_{4,i}}{L_4} - \left( \frac{a_{4,i}}{L_4} \right)^3 \right]$$

$$M_C * 23 + 2 * M_D(23 + 12) + M_E * 12 = \frac{26,1}{4} * 23^3 + \frac{8,1}{4} * 23^3 + \frac{26,1}{4} * 12^3 + 225 * 23^2 \left[ \frac{0,6}{23} - \left( \frac{0,6}{23} \right)^3 \right]$$

$$23M_C + 70M_D = 118\,405,94 \quad (3)$$

Likning (1) gir:

$$M_B = \frac{121\,272,16}{70} - \frac{23}{70} * M_C$$

Likning (3) gir:

$$M_D = \frac{118\,405,94}{70} - \frac{23}{70} * M_C \quad (5)$$

Likning (4) og (5) innsatt i (2) gir:

$$23 * \left( \frac{121\,272,16}{70} - \frac{23}{70} M_C \right) + 92 M_C + 23 \left( \frac{118\,405,94}{70} - \frac{23}{70} M_C \right) = 217\,127,70$$

$$92 M_C - 2 * \frac{23^2}{70} M_C = 217\,127,70 - \frac{23}{70} * (121\,272,16 + 118\,405,94)$$

$$M_C = 1799,77 \text{ kNm}$$

Likning (4) gir:

$$M_B = 1141,11 \text{ kNm}$$

Likning (5) gir:

$$M_D = 1100,16 \text{ kNm}$$

$$V(A^+) = \frac{M_B - M_A}{L_1} - \sum \frac{q_{1,i} * L_1}{2} - \sum P_{1,i} * \frac{L_1 - a_{1,i}}{L_1}$$

$$V(A^+) = \frac{1141,11 - 0}{12} - \frac{26,1 * 12}{2}$$

$$V(A^+) = -61,51 \text{ kN}$$

$$V(B^-) = \frac{M_B - M_A}{L_1} + \sum \frac{q_{1,i} * L_1}{2} + \sum P_{1,i} * \frac{a_{1,i}}{L_1}$$

$$V(B^-) = \frac{1141,11 - 0}{12} + \frac{26,1 * 12}{2}$$

$$V(B^-) = 251,69 \text{ kN}$$

$$V(B^+) = \frac{M_C - M_B}{L_2} - \sum \frac{q_{2,i} * L_2}{2} - \sum P_{2,i} * \frac{L_2 - a_{2,i}}{L_2}$$

$$V(B^+) = \frac{1799,77 - 1141,11}{23} - \frac{26,1 * 23}{2} - \frac{8,1 * 23}{2} - 225 * \frac{23 - 22,4}{23}$$

$$V(B^+) = -370,53 \text{ kN}$$



$$V(C^-) = \frac{M_C - M_B}{L_2} + \sum \frac{q_{2,i} * L_2}{2} + \sum P_{2,i} * \frac{a_{2,i}}{L_2}$$

$$V(C^-) = \frac{1799,77 - 1141,11}{23} + \frac{26,1 * 23}{2} + \frac{8,1 * 23}{2} + 225 * \frac{22,4}{23}$$

$$V(C^-) = 641,07 \text{ kN}$$

$$V(C^+) = \frac{M_D - M_C}{L_3} - \sum \frac{q_{3,i} * L_3}{2} - \sum P_{3,i} * \frac{L_3 - a_{3,i}}{L_3}$$

$$V(C^+) = \frac{1100,16 - 1799,77}{23} - \frac{26,1 * 23}{2} - \frac{8,1 * 23}{2} - 225 * \frac{23 - 0,6}{23}$$

$$V(C^+) = -642,85 \text{ kN}$$

$$V(D^-) = \frac{M_D - M_C}{L_3} + \sum \frac{q_{3,i} * L_3}{2} + \sum P_{3,i} * \frac{a_{3,i}}{L_3}$$

$$V(D^-) = \frac{1100,16 - 1799,77}{23} + \frac{26,1 * 23}{2} + \frac{8,1 * 23}{2} + 225 * \frac{0,6}{23}$$

$$V(D^-) = 368,75 \text{ kN}$$

$$V(D^+) = \frac{M_E - M_D}{L_4} - \sum \frac{q_{4,i} * L_4}{2} - \sum P_{4,i} * \frac{L_4 - a_{4,i}}{L_4}$$

$$V(D^+) = \frac{0 - 1100,16}{12} - \frac{26,1 * 12}{2}$$

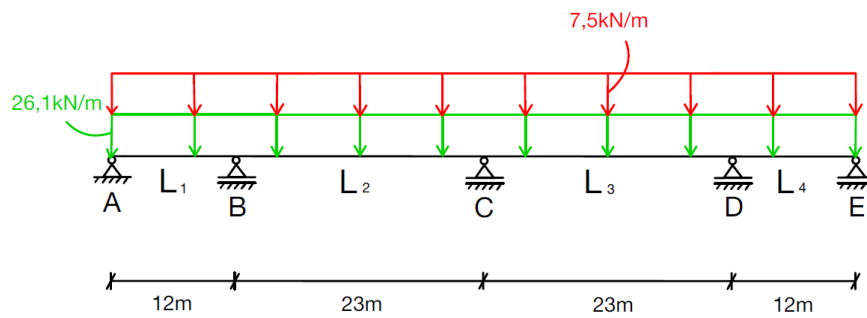
$$V(D^+) = -248,28 \text{ kN}$$

$$V(E^-) = \frac{M_E - M_D}{L_4} + \sum \frac{q_{4,i} * L_4}{2} + \sum P_{4,i} * \frac{a_{4,i}}{L_4}$$

$$V(E^-) = \frac{0 - 1100,16}{12} + \frac{26,1 * 12}{2}$$

$$V(E^-) = 64,92 \text{ kN}$$

### Lasttilfelle 14:



Gangtrafikk  
Egenvekt

$$M_A = -\sum M \text{ til venstre for snittet}$$

$$M_A = 0$$

$$M_E = \sum M \text{ til høyre for snittet}$$

$$M_E = 0$$

$$M_A * L_1 + 2 * M_B(L_1 + L_2) + M_C * L_2 = \sum \frac{q_{1,i}}{4} * L_{1,i}^3 + \sum \frac{q_{2,i}}{4} * L_{2,i}^3 + \sum P_{1,i} * L_1^2 \left[ \frac{a_{1,i}}{L_1} - \left( \frac{a_{1,i}}{L_1} \right)^3 \right] + \sum P_{2,i} * L_2^2 \left[ \frac{a_{2,i}}{L_2} - \left( \frac{a_{2,i}}{L_2} \right)^3 \right]$$

$$M_A * 12 + 2 * M_B(12 + 23) + M_C * 23 = \frac{26,1}{4} * 12^3 + \frac{7,5}{4} * 12^3 + \frac{26,1}{4} * 23^3 + \frac{7,5}{4} * 23^3$$

$$70M_B + 23M_C = 116\,718,00 \quad (1)$$

$$M_B * L_2 + 2 * M_C(L_2 + L_3) + M_D * L_3 = \sum \frac{q_{2,i}}{4} * L_{2,i}^3 + \sum \frac{q_{3,i}}{4} * L_{3,i}^3 + \sum P_{2,i} * L_2^2 \left[ \frac{a_{2,i}}{L_2} - \left( \frac{a_{2,i}}{L_2} \right)^3 \right] + \sum P_{3,i} * L_3^2 \left[ \frac{a_{3,i}}{L_3} - \left( \frac{a_{3,i}}{L_3} \right)^3 \right]$$

$$M_B * 23 + 2 * M_C(23 + 23) + M_D * 23 = \frac{26,1}{4} * 23^3 + \frac{7,5}{4} * 23^3 + \frac{26,1}{4} * 23^3 + \frac{7,5}{4} * 23^3$$

$$23M_B + 92M_C + 23M_D = 204\,405,60 \quad (2)$$

$$M_C * L_3 + 2 * M_D(L_3 + L_4) + M_E * L_4 = \sum \frac{q_{3,i}}{4} * L_{3,i}^3 + \sum \frac{q_{4,i}}{4} * L_{4,i}^3 + \sum P_{3,i} * L_3^2 \left[ \frac{a_{3,i}}{L_3} - \left( \frac{a_{3,i}}{L_3} \right)^3 \right] + \sum P_{4,i} * L_4^2 \left[ \frac{a_{4,i}}{L_4} - \left( \frac{a_{4,i}}{L_4} \right)^3 \right]$$

$$M_C * 23 + 2 * M_D(23 + 12) + M_E * 12 = \frac{26,1}{4} * 23^3 + \frac{7,5}{4} * 23^3 + \frac{26,1}{4} * 12^3 + \frac{7,5}{4} * 12^3$$

$$23M_C + 70M_D = 116\,718,00 \quad (3)$$

Likning (1) gir:

$$M_B = \frac{116\,718,00}{70} - \frac{23}{70}M_C \quad (4)$$

Likning (3) gir:

$$M_D = \frac{116\,718,00}{70} - \frac{23}{70}M_C \quad (5)$$

Likning (4) og (5) innsatt i (2) gir:

$$23 * \left( \frac{116\,718,00}{70} - \frac{23}{70}M_C \right) + 92M_C + 23 \left( \frac{116\,718,00}{70} - \frac{23}{70}M_C \right) = 204\,405,60$$

$$92M_C - 2 * \frac{23^2}{70}M_C = 204\,405,60 - 2 * \frac{23}{70} * 116\,718,00$$

$$M_C = 1660,97 \text{ kNm}$$

Likning (4) gir:

$$M_B = 1121,65 \text{ kNm}$$

Likning (5) gir:

$$M_D = 1121,65 \text{ kNm}$$

$$V(A^+) = \frac{M_B - M_A}{L_1} - \sum \frac{q_{1,i} * L_1}{2} - \sum P_{1,i} * \frac{L_1 - a_{1,i}}{L_1}$$

$$V(A^+) = \frac{1121,65 - 0}{12} - \frac{26,1 * 12}{2} - \frac{7,5 * 12}{2}$$

$$V(A^+) = -108,13 \text{ kN}$$

$$V(B^-) = \frac{M_B - M_A}{L_1} + \sum \frac{q_{1,i} * L_1}{2} + \sum P_{1,i} * \frac{a_{1,i}}{L_1}$$

$$V(B^-) = \frac{1121,65 - 0}{12} + \frac{26,1 * 12}{2} + \frac{7,5 * 12}{2}$$

$$V(B^-) = 295,07 \text{ kN}$$

$$V(B^+) = \frac{M_C - M_B}{L_2} - \sum \frac{q_{2,i} * L_2}{2} - \sum P_{2,i} * \frac{L_2 - a_{2,i}}{L_2}$$

$$V(B^+) = \frac{1660,97 - 1121,65}{23} - \frac{26,1 * 23}{2} - \frac{7,5 * 23}{2}$$

$$V(B^+) = -362,95 \text{ kN}$$

$$V(C^-) = \frac{M_C - M_B}{L_2} + \sum \frac{q_{2,i} * L_2}{2} + \sum P_{2,i} * \frac{a_{2,i}}{L_2}$$

$$V(C^-) = \frac{1660,97 - 1121,65}{23} + \frac{26,1 * 23}{2} + \frac{7,5 * 23}{2}$$

$$V(C^-) = 409,85 \text{ kN}$$

$$V(C^+) = \frac{M_D - M_C}{L_3} - \sum \frac{q_{3,i} * L_3}{2} - \sum P_{3,i} * \frac{L_3 - a_{3,i}}{L_3}$$

$$V(C^+) = \frac{1121,65 - 1660,97}{23} - \frac{26,1 * 23}{2} - \frac{7,5 * 23}{2}$$

$$V(C^+) = -409,85 \text{ kN}$$

$$V(D^-) = \frac{M_D - M_C}{L_3} + \sum \frac{q_{3,i} * L_3}{2} + \sum P_{3,i} * \frac{a_{3,i}}{L_3}$$

$$V(D^-) = \frac{1121,65 - 1660,97}{23} + \frac{26,1 * 23}{2} + \frac{7,5 * 23}{2}$$

$$V(D^-) = 362,95 \text{ kN}$$

$$V(D^+) = \frac{M_D - M_C}{L_4} - \sum \frac{q_{4,i} * L_4}{2} - \sum P_{4,i} * \frac{L_4 - a_{4,i}}{L_4}$$

$$V(D^+) = \frac{0 - 1121,65}{12} - \frac{26,1 * 12}{2} - \frac{7,5 * 12}{2}$$

$$V(D^+) = -295,07 \text{ kN}$$

$$V(E^-) = \frac{M_E - M_D}{L_4} + \sum \frac{q_{4,i} * L_4}{2} + \sum P_{4,i} * \frac{a_{4,i}}{L_4}$$

$$V(E^-) = \frac{0 - 1121,65}{12} + \frac{26,1 * 12}{2} + \frac{7,5 * 12}{2}$$

$$V(E^-) = 108,13 \text{ kN}$$