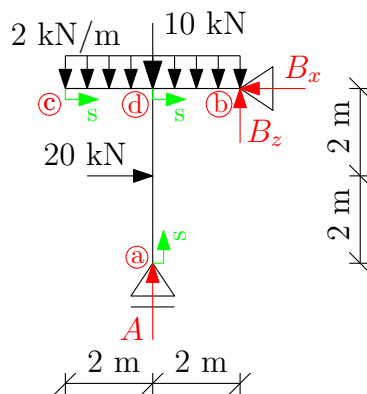


# Příklady k procvičení 7: Lomené nosníky

Zadání: Vykreslete průběhy vnitřních sil N, V a M.

## Příklad 7.1



### 1) Výpočet statické určitosti:

$$s = 3 - 2 - 1 = 0 \rightarrow \text{konstrukce je staticky určitá}$$

### 2) Výpočet reakcí:

$$\begin{aligned} \circlearrowleft b: & 10 \cdot 2 + 2 \cdot 4 \cdot 2 + 20 \cdot 2 - A \cdot 2 = 0, & \mathbf{A = 38 \text{ kN}} \\ \uparrow : & -2 \cdot 4 - 10 + A + B_z = 0, & \mathbf{B_z = -20 \text{ kN}} \\ \rightarrow : & -B_x + 20 = 0, & \mathbf{B_x = 20 \text{ kN}} \end{aligned}$$

$$\text{kontrola: } \circlearrowleft a: -20 \cdot 2 + B_z \cdot 2 + B_x \cdot 4 = 0, \mathbf{O.K.}$$

### 3) Výpočet důležitých hodnot:

interval (c,d):

$$\begin{aligned} N_{cd} &= 0 \text{ kN} & N_{dc} &= 0 \text{ kN} \\ V_{cd} &= 0 \text{ kN} & V_{dc} &= -2 \cdot 2 = -4 \text{ kN} \\ M_{cd} &= 0 \text{ kNm} & M_{dc} &= -2 \cdot 2 \cdot 1 = -4 \text{ kNm} \end{aligned}$$

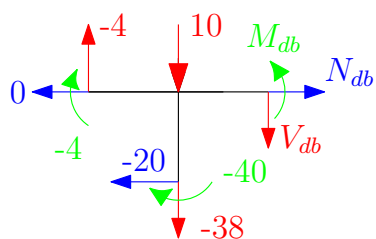
interval (a,e):

$$\begin{aligned} N_{ae} &= -38 \text{ kN} & N_{ea} &= -38 \text{ kN} \\ V_{ae} &= 0 \text{ kN} & V_{ea} &= 0 \text{ kN} \\ M_{ae} &= 0 \text{ kNm} & M_{ea} &= 0 \text{ kNm} \end{aligned}$$

interval (e,d):

$$\begin{aligned} N_{ed} &= -38 \text{ kN} & N_{de} &= -38 \text{ kN} \\ V_{ed} &= -20 \text{ kN} & V_{de} &= -20 \text{ kN} \\ M_{ed} &= 0 \text{ kNm} & M_{de} &= -20 \cdot 2 = -40 \text{ kNm} \end{aligned}$$

Styčník d:

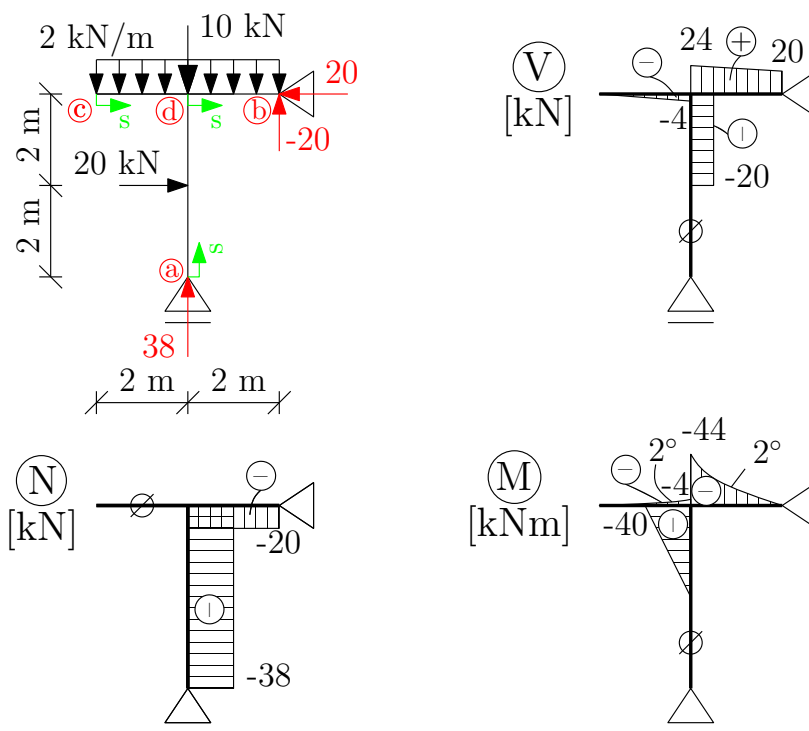


$$\begin{aligned} \rightarrow : \quad 20 + N_{db} &= 0, & N_{db} &= -20 \text{ kN} \\ \uparrow : \quad -4 + 38 - 10 - V_{db} &= 0, & V_{db} &= 24 \text{ kN} \\ \curvearrowright : \quad 4 + 40 + M_{db} &= 0, & M_{db} &= -44 \text{ kNm} \end{aligned}$$

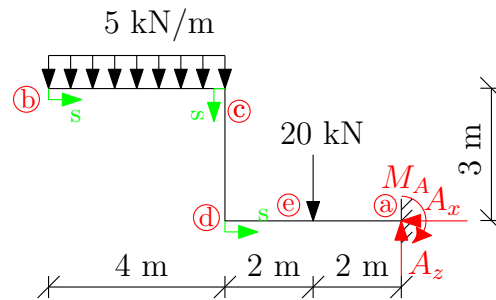
interval (d,b):

$$\begin{aligned} N_{db} &= -20 \text{ kN} & N_{bd} &= -20 \text{ kN} \\ V_{db} &= 24 \text{ kN} & V_{bd} &= 24 - 2 \cdot 2 = 20 \text{ kN} \\ M_{db} &= -44 \text{ kNm} & M_{bd} &= -44 + 24 \cdot 2 - 2 \cdot 2 \cdot 1 = 0 \text{ kNm} \end{aligned}$$

#### 4) Vykreslení:



## Příklad 7.2



### 1) Výpočet statické určitosti:

$$s = 3 - 3 = 0 \rightarrow \text{konstrukce je staticky určitá}$$

### 2) Výpočet reakcí:

$$\begin{aligned} \rightarrow : A_x &= 0, & A_x &= 0 \text{ kN} \\ \uparrow : A_z - 5 \cdot 4 - 20 &= 0, & A_z &= 40 \text{ kN} \\ \odot a : -M_A + 20 \cdot 2 + 5 \cdot 4 \cdot (4 + 2) &= 0, & M_A &= 160 \text{ kNm} \end{aligned}$$

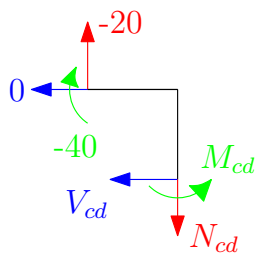
$$\text{kontrola: } \odot b : -20 \cdot 2 - 20 \cdot 6 + A_z \cdot 8 - M_A = 0, \text{ O.K.}$$

### 3) Výpočet důležitých hodnot:

interval (b,c):

$$\begin{aligned} N_{bc} &= 0 \text{ kN} & N_{cb} &= 0 \text{ kN} \\ V_{bc} &= 0 \text{ kN} & V_{cb} &= -5 \cdot 4 = -20 \text{ kN} \\ M_{bc} &= 0 \text{ kNm} & M_{cb} &= -5 \cdot 4 \cdot \frac{4}{2} = -40 \text{ kNm} \end{aligned}$$

Styčnick c:

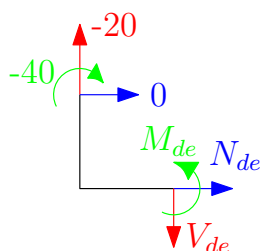


$$\begin{aligned} \rightarrow : -V_{cd} &= 0, & V_{cd} &= 0 \text{ kN} \\ \uparrow : -20 - N_{cd} &= 0, & N_{cd} &= -20 \text{ kN} \\ \odot : 40 + M_{cd} &= 0, & M_{cd} &= -40 \text{ kNm} \end{aligned}$$

interval (c,d):

$$\begin{array}{ll} N_{cd} = -20 \text{ kN} & N_{dc} = -20 \text{ kN} \\ V_{cd} = 0 \text{ kN} & V_{dc} = 0 \text{ kN} \\ M_{cd} = -40 \text{ kNm} & M_{dc} = -40 \text{ kNm} \end{array}$$

Styčnick d:



$$\begin{array}{ll} \rightarrow : N_{de} = 0, & N_{de} = 0 \text{ kN} \\ \uparrow : -20 - V_{de} = 0, & V_{de} = -20 \text{ kN} \\ \odot : 40 + M_{de} = 0, & M_{de} = -40 \text{ kNm} \end{array}$$

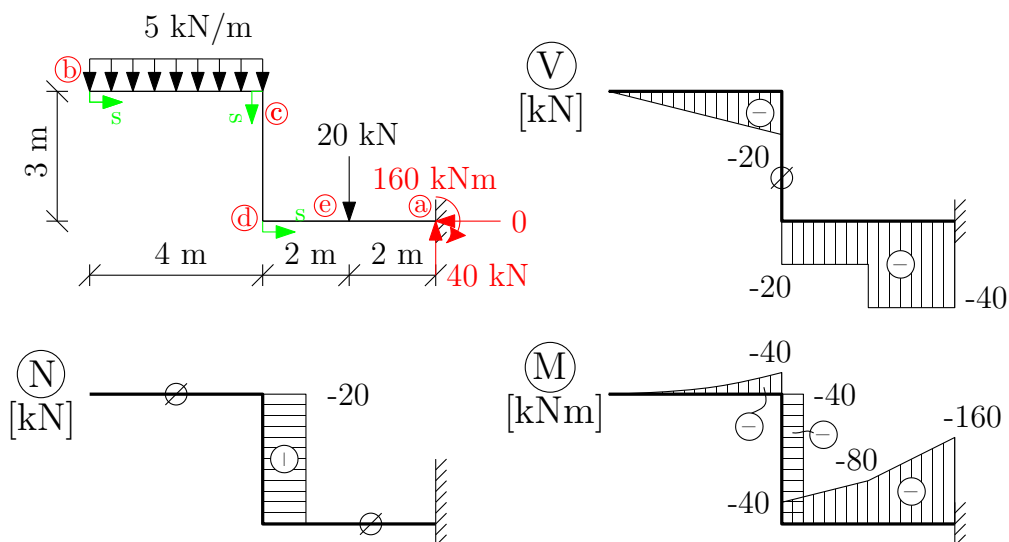
interval (d,e):

$$\begin{array}{ll} N_{de} = 0 \text{ kN} & N_{ed} = 0 \text{ kN} \\ V_{de} = -20 \text{ kN} & V_{ed} = -20 \text{ kN} \\ M_{de} = -40 \text{ kNm} & M_{ed} = -40 - 20 \cdot 2 = -80 \text{ kNm} \end{array}$$

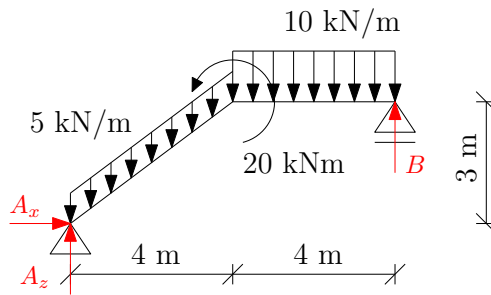
interval (e,a):

$$\begin{array}{ll} N_{ea} = 0 \text{ kN} & N_{ae} = 0 \text{ kN} \\ V_{ea} = -20 - 20 = -40 \text{ kN} & V_{ae} = -40 \text{ kN} \\ M_{ea} = -80 \text{ kNm} & M_{ae} = -80 - 40 \cdot 2 = -160 \text{ kNm} \end{array}$$

#### 4) Vykreslení:



### Příklad 7.3



#### 1) Výpočet statické určitosti:

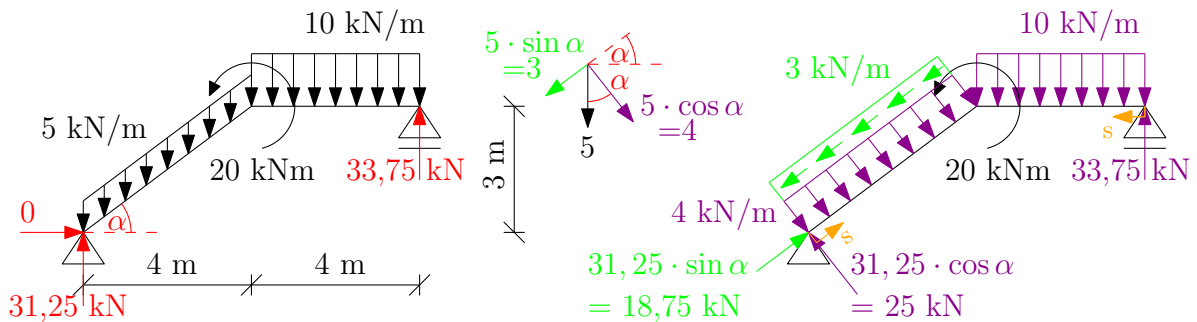
$$s = 3 - 2 - 1 = 0 \rightarrow \text{konstrukce je staticky určitá}$$

#### 2) Výpočet reakcí:

$$\begin{aligned} \rightarrow : A_x &= 0, & A_x &= 0 \text{ kN} \\ \odot a : -20 - 5 \cdot 5 \cdot 2 - 10 \cdot 4 \cdot (4 + 2) + B \cdot 8 &= 0, & B &= 33,75 \text{ kN} \\ \uparrow : A_z + B - 5 \cdot 5 - 10 \cdot 4 &= 0, & A_z &= 31,25 \text{ kN} \end{aligned}$$

$$\text{kontrola: } \odot b : -20 - A \cdot 8 + 5 \cdot 5 \cdot 6 + 10 \cdot 4 \cdot 2 = 0, \text{ O.K.}$$

Rozkreslení:



$$\begin{aligned} \sin \alpha &= \frac{3}{5} = 0,6 \\ \cos \alpha &= \frac{4}{5} = 0,8 \end{aligned}$$

#### 3) Výpočet důležitých hodnot:

interval (a,c):

$$\begin{aligned} N_{ac} &= -18,75 \text{ kN} & N_{ca} &= -18,75 + 3 \cdot 5 = -3,75 \text{ kN} \\ V_{ac} &= 25 \text{ kN} & V_{ca} &= 25 - 4 \cdot 5 = 5 \text{ kN} \\ M_{ac} &= 0 \text{ kNm} & M_{ca} &= 25 \cdot 5 - 4 \cdot 5 \cdot \frac{5}{2} = 75 \text{ kNm} \end{aligned}$$

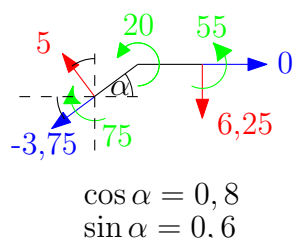
interval (b,c):

$$\begin{aligned}
 N_{bc} &= 0 \text{ kN} & N_{cb} &= 0 \text{ kN} \\
 V_{bc} &= -33,75 \text{ kN} & V_{cb} &= -33,75 + 10 \cdot 4 = 6,25 \text{ kN} \\
 M_{bc} &= 0 \text{ kNm} & M_{cb} &= 33,75 \cdot 4 - 10 \cdot 4 \cdot \frac{4}{2} = 55 \text{ kNm}
 \end{aligned}$$

extrém na intervalu (c,b):

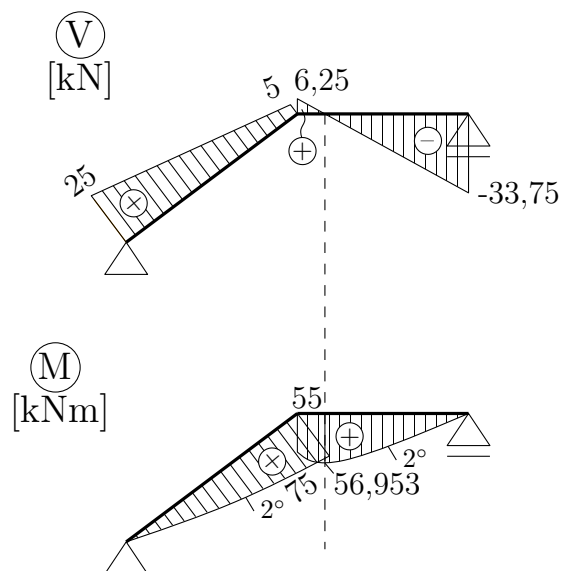
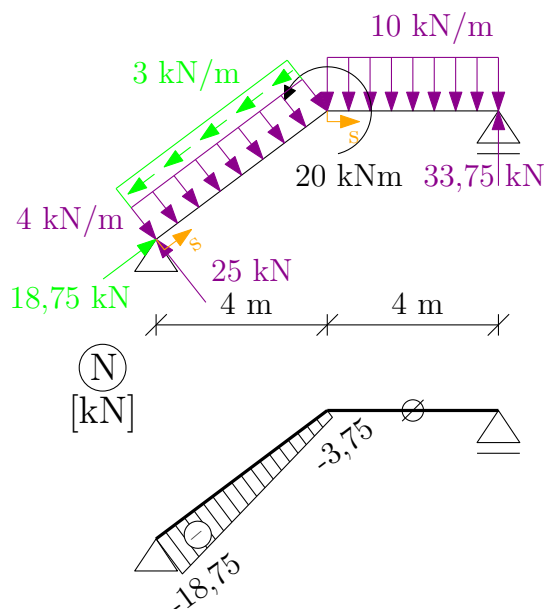
$$\begin{aligned}
 x_{ext} &= \frac{6,25}{10} = 0,625 \text{ m} \\
 M_{ext} &= 55 + 6,25 \cdot 0,625 = 56,953 \text{ kNm}
 \end{aligned}$$

Rovnováha na styčnicku c:

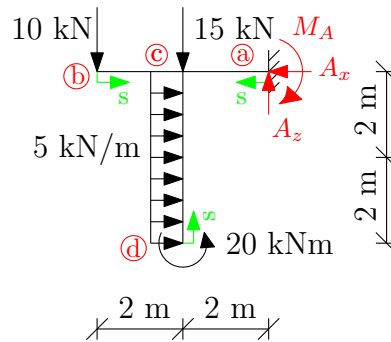


$$\begin{aligned}
 \rightarrow : & 0 - (-3,75) \cdot 0,8 - 5 \cdot 0,6 = 0, & \text{O.K.} \\
 \uparrow : & -6,25 - (-3,75) \cdot 0,6 + 5 \cdot 0,8 = 0, & \text{O.K.} \\
 \odot : & 55 + 20 - 75 = 0, & \text{O.K.}
 \end{aligned}$$

#### 4) Vykreslení:



## Příklad 7.4



### 1) Výpočet statické určitosti:

$$s = 3 - 3 = 0 \rightarrow \text{konstrukce je staticky určitá}$$

### 2) Výpočet reakcí:

$$\rightarrow : 5 \cdot 4 - A_x = 0, \quad \mathbf{A_x = 20 \text{ kN}}$$

$$\uparrow : A_z - 10 - 15 = 0, \quad \mathbf{A_z = 25 \text{ kN}}$$

$$\odot a : 20 + 10 \cdot 4 + 15 \cdot 2 + 5 \cdot 4 \cdot 2 - M_A = 0, \quad \mathbf{M_A = 130 \text{ kNm}}$$

$$\text{kontrola: } \odot b : -15 \cdot 2 + 5 \cdot 4 \cdot 2 + 20 - M_A + A_z \cdot 4 = 0, \quad \mathbf{O.K.}$$

### 3) Výpočet důležitých hodnot:

interval (b,c):

$$\begin{array}{ll} N_{bc} = 0 \text{ kN} & N_{cb} = 0 \text{ kN} \\ V_{bc} = -10 \text{ kN} & V_{cb} = -10 \text{ kN} \\ M_{bc} = 0 \text{ kNm} & M_{cb} = -10 \cdot 2 = -20 \text{ kNm} \end{array}$$

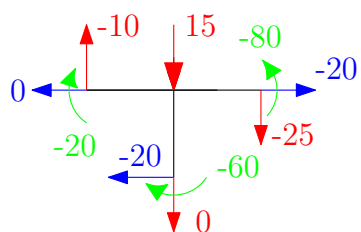
interval (d,c):

$$\begin{array}{ll} N_{dc} = 0 \text{ kN} & N_{cd} = 0 \text{ kN} \\ V_{dc} = 0 \text{ kN} & V_{cd} = -5 \cdot 4 = -20 \text{ kN} \\ M_{dc} = -20 \text{ kNm} & M_{cd} = -20 - 5 \cdot 4 \cdot \frac{4}{2} = -60 \text{ kNm} \end{array}$$

interval (a,c):

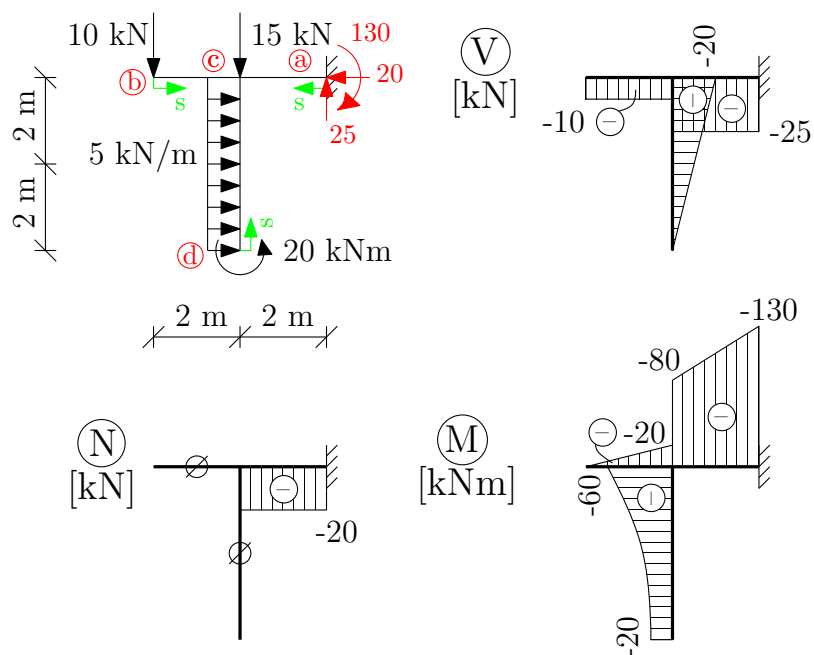
$$\begin{array}{ll} N_{ac} = -20 \text{ kN} & N_{ca} = -20 \text{ kN} \\ V_{ac} = -25 \text{ kN} & V_{ca} = -25 \text{ kN} \\ M_{ac} = -130 \text{ kNm} & M_{ca} = -130 + 25 \cdot 2 = -80 \text{ kNm} \end{array}$$

Rovnováha na styčnicku c:

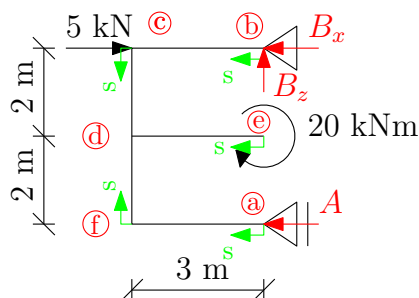


$$\begin{aligned} \rightarrow : & 0 - 20 - (-20) = 0, & \text{O.K.} \\ \uparrow : & -10 - (-25) - 15 = 0, & \text{O.K.} \\ \odot : & -(-20) - 80 - (-60) = 0, & \text{O.K.} \end{aligned}$$

4) Vykreslení:



### Příklad 7.5



1) Výpočet statické určitosti:

$$s = 3 - 3 = 0 \rightarrow \text{konstrukce je staticky určitá}$$



## 2) Výpočet reakcí:

$$\begin{aligned} \uparrow : \quad B_z &= 0, & \mathbf{B}_z &= \mathbf{0} \text{ kN} \\ \curvearrowright b : \quad -20 - A \cdot 4 &= 0, & \mathbf{A} &= \mathbf{-5} \text{ kN} \\ \rightarrow : \quad 5 - B_x - A &= 0, & \mathbf{B}_x &= \mathbf{10} \text{ kN} \end{aligned}$$

kontrola:  $\curvearrowright e : B_x \cdot 5 - 2 \cdot 2 - 20 - A \cdot 2 = 0, \mathbf{O.K.}$

## 3) Výpočet důležitých hodnot:

interval (b,c):

$$\begin{aligned} N_{bc} &= -10 \text{ kN} & N_{cb} &= -10 \text{ kN} \\ V_{bc} &= 0 \text{ kN} & V_{cb} &= 0 \text{ kN} \\ M_{bc} &= 0 \text{ kNm} & M_{cb} &= 0 \text{ kNm} \end{aligned}$$

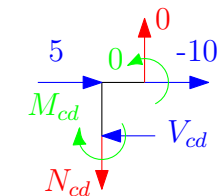
interval (e,d):

$$\begin{aligned} N_{ed} &= 0 \text{ kN} & N_{de} &= 0 \text{ kN} \\ V_{ed} &= 0 \text{ kN} & V_{de} &= 0 \text{ kN} \\ M_{ed} &= -20 \text{ kNm} & M_{de} &= -20 \text{ kNm} \end{aligned}$$

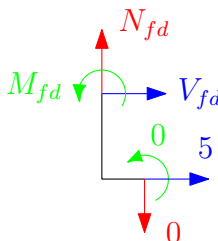
interval (a,f):

$$\begin{aligned} N_{af} &= 5 \text{ kN} & N_{fa} &= 5 \text{ kN} \\ V_{af} &= 0 \text{ kN} & V_{fa} &= 0 \text{ kN} \\ M_{af} &= 0 \text{ kNm} & M_{fa} &= 0 \text{ kNm} \end{aligned}$$

Styčnický c a f:



$$\begin{aligned} \rightarrow : \quad 5 - 10 - V_{cd} &= 0, & \mathbf{V}_{cd} &= \mathbf{-5} \text{ kN} \\ \uparrow : \quad N_{cd} &= 0, & \mathbf{N}_{cd} &= \mathbf{0} \text{ kN} \\ \curvearrowright : \quad M_{cd} &= 0, & \mathbf{M}_{cd} &= \mathbf{0} \text{ kNm} \end{aligned}$$



$$\begin{aligned} \rightarrow : \quad 5 + V_{fd} &= 0, & \mathbf{V}_{fd} &= \mathbf{-5} \text{ kN} \\ \uparrow : \quad N_{fd} &= 0, & \mathbf{N}_{fd} &= \mathbf{0} \text{ kN} \\ \curvearrowright : \quad M_{fd} &= 0, & \mathbf{M}_{fd} &= \mathbf{0} \text{ kNm} \end{aligned}$$

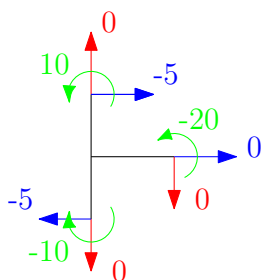
interval (c,d):

$$\begin{aligned} N_{cd} &= 0 \text{ kN} & N_{dc} &= 0 \text{ kN} \\ V_{cd} &= -5 \text{ kN} & V_{dc} &= -5 \text{ kN} \\ M_{cd} &= 0 \text{ kNm} & M_{dc} &= 5 \cdot 2 = 10 \text{ kNm} \end{aligned}$$

interval (f,d):

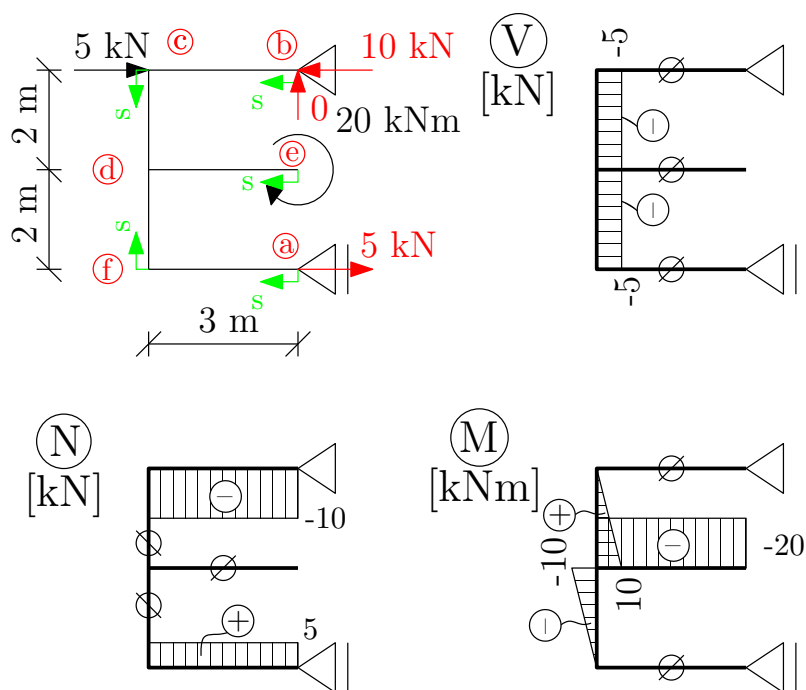
$$\begin{aligned} N_{fd} &= 0 \text{ kN} & N_{df} &= 0 \text{ kN} \\ V_{fd} &= -5 \text{ kN} & V_{df} &= -5 \text{ kN} \\ M_{fd} &= 0 \text{ kNm} & M_{df} &= -5 \cdot 2 = -10 \text{ kNm} \end{aligned}$$

Rovnováha na styčnicku d:

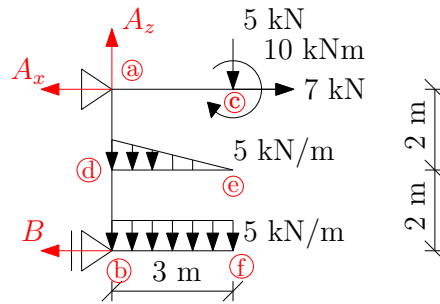


$$\begin{aligned} \rightarrow : & 0 - 5 - (-5) = 0, & \text{O.K.} \\ \uparrow : & , 0 = 0, & \text{O.K.} \\ \curvearrowright : & 10 - 20 - (-10) = 0, & \text{O.K.} \end{aligned}$$

#### 4) Vykreslení:



## Příklad 7.6



### 1) Výpočet statické určitosti:

$$s = 3 - 3 = 0 \rightarrow \text{konstrukce je staticky určitá}$$

### 2) Výpočet reakcí:

$$\begin{aligned} \uparrow : \quad A_z - 5 - 7,5 - 15 &= 0, & \mathbf{A_z = 27,5 \text{ kN}} \\ \circlearrowleft a : \quad -5 \cdot 3 - 10 - 7,5 \cdot 1 - 15 \cdot 1,5 - B_x \cdot 4 &= 0, & \mathbf{B_x = -13,75 \text{ kN}} \\ \rightarrow : \quad 7 - A_x - B_x &= 0, & \mathbf{A_x = 20,75 \text{ kN}} \end{aligned}$$

$$\text{kontrola: } \circlearrowleft b : \quad -15 \cdot 1,5 - 7,5 \cdot 1 + A_x \cdot 4 - 10 - 5 \cdot 3 - 7 \cdot 4 = 0, \quad \mathbf{O.K.}$$

### 3) Výpočet důležitých hodnot:

interval (c,a):

$$\begin{aligned} N_{ca} &= 7 \text{ kN} & N_{ac} &= 7 \text{ kN} \\ V_{ca} &= 5 \text{ kN} & V_{ac} &= 5 \text{ kN} \\ M_{ca} &= -10 \text{ kNm} & M_{ac} &= -10 - 5 \cdot 3 = 15 \text{ kNm} \end{aligned}$$

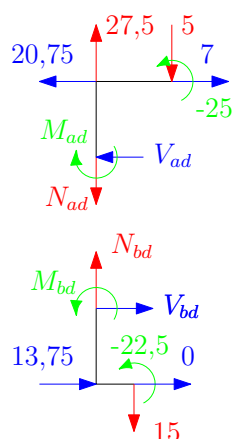
interval (e,d):

$$\begin{aligned} N_{ed} &= 0 \text{ kN} & N_{de} &= 0 \text{ kN} \\ V_{ed} &= 0 \text{ kN} & V_{de} &= \frac{5 \cdot 3}{2} = 7,5 \text{ kN} \\ M_{ed} &= 0 \text{ kNm} & M_{de} &= -\frac{5 \cdot 3}{2} \cdot 1 = -7,5 \text{ kNm} \end{aligned}$$

interval (f,b):

$$\begin{aligned} N_{fb} &= 0 \text{ kN} & N_{bf} &= 0 \text{ kN} \\ V_{fb} &= 0 \text{ kN} & V_{bf} &= 5 \cdot 3 = 15 \text{ kN} \\ M_{fb} &= 0 \text{ kNm} & M_{bf} &= -5 \cdot 3 \cdot 1,5 = -22,5 \text{ kNm} \end{aligned}$$

Styčníky a a b:



$$\rightarrow : 7 - V_{ad} - 20,75 = 0, \quad V_{ad} = -13,75 \text{ kN}$$

$$\uparrow : -N_{ad} - 5 + 27,5 = 0, \quad N_{ad} = 22,5 \text{ kN}$$

$$\odot : -25 - M_{ad} = 0, \quad M_{ad} = -25 \text{ kNm}$$

$$\rightarrow : 13,75 + V_{bd} = 0, \quad V_{bd} = -13,75 \text{ kN}$$

$$\uparrow : -15 + N_{bd} = 0, \quad N_{bd} = 15 \text{ kN}$$

$$\odot : M_{bd} - 22,5 = 0, \quad M_{bd} = 22,5 \text{ kNm}$$

interval (a,d):

$$N_{ad} = 22,5 \text{ kN}$$

$$N_{da} = 22,5 \text{ kN}$$

$$V_{ad} = -13,75 \text{ kN}$$

$$V_{da} = -13,75 \text{ kN}$$

$$M_{ad} = -25 \text{ kNm}$$

$$M_{da} = -25 - (-13,75) \cdot 2 = 2,5 \text{ kNm}$$

interval (b,d):

$$N_{bd} = 15 \text{ kN}$$

$$N_{db} = 15 \text{ kN}$$

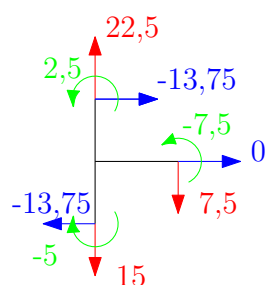
$$V_{bd} = -13,75 \text{ kN}$$

$$V_{db} = -13,75 \text{ kN}$$

$$M_{bd} = 22,5 \text{ kNm}$$

$$M_{db} = 22,5 - 13,75 \cdot 2 = -5 \text{ kNm}$$

Rovnováha na styčníku d:

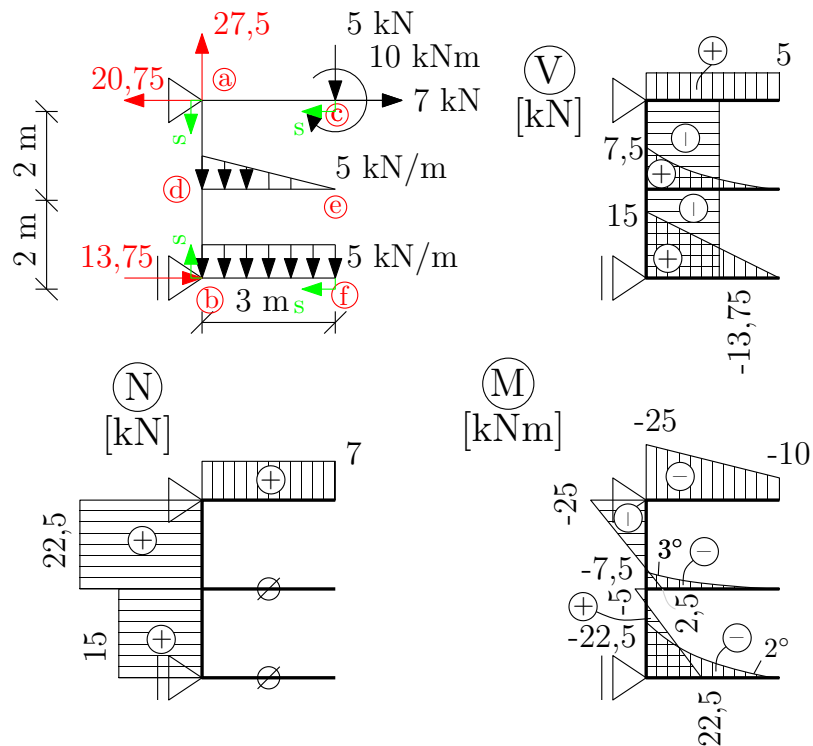


$$\rightarrow : 0 - 13,75 - (-13,75) = 0, \quad \text{O.K.}$$

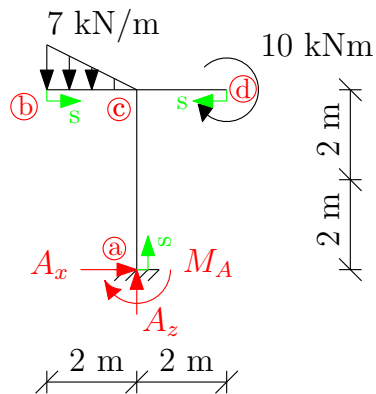
$$\uparrow : 22,5 - 7,5 - 15 = 0, \quad \text{O.K.}$$

$$\odot : 2,5 - 7,5 - (-5) = 0, \quad \text{O.K.}$$

#### 4) Vykreslení:



#### Příklad 7.7



##### 1) Výpočet statické určitosti:

$$s = 3 - 3 = 0 \rightarrow \text{konstrukce je staticky určitá}$$

##### 2) Výpočet reakcí:

$$\rightarrow : A_x = 0, \quad \mathbf{A_x = 0 \text{ kN}}$$

$$\uparrow : A_z - 7 \cdot 2 \cdot \frac{1}{2} = 0, \quad \mathbf{A_z = 7 \text{ kN}}$$

$$\odot a : M_A - 10 + 7 \cdot \frac{2}{3} \cdot 2 = 0, \quad \mathbf{M_A = 0,667 \text{ kNm}}$$

kontrola:  $\circlearrowleft b$ :  $M_A + A_x \cdot 4 + A_z \cdot 2 - 10 - \frac{7 \cdot 2}{2} \cdot \frac{2}{3} = 0$ , **O.K.**

### 3) Výpočet důležitých hodnot:

interval (b,c):

$$\begin{aligned} N_{bc} &= 0 \text{ kN} & N_{cb} &= 0 \text{ kN} \\ V_{bc} &= 0 \text{ kN} & V_{cb} &= \frac{-7 \cdot 2}{2} = -7 \text{ kN} \\ M_{bc} &= 0 \text{ kNm} & M_{cb} &= \frac{-7 \cdot 2}{2} \cdot \frac{4}{3} = -9,333 \text{ kNm} \end{aligned}$$

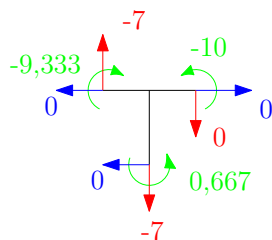
interval (d,c):

$$\begin{aligned} N_{dc} &= 0 \text{ kN} & N_{cd} &= 0 \text{ kN} \\ V_{dc} &= 0 \text{ kN} & V_{cd} &= 0 \text{ kN} \\ M_{dc} &= -10 \text{ kNm} & M_{cd} &= -10 \text{ kNm} \end{aligned}$$

interval (a,c):

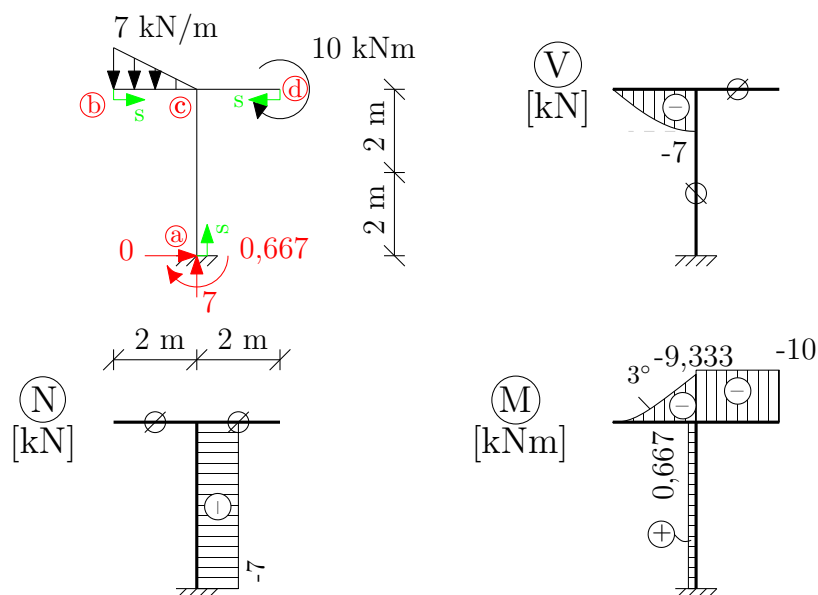
$$\begin{aligned} N_{ac} &= -7 \text{ kN} & N_{ca} &= -7 \text{ kN} \\ V_{ac} &= 0 \text{ kN} & V_{ca} &= 0 \text{ kN} \\ M_{ac} &= 0,667 \text{ kNm} & M_{ca} &= 0,667 \text{ kNm} \end{aligned}$$

Rovnováha na styčnicku:

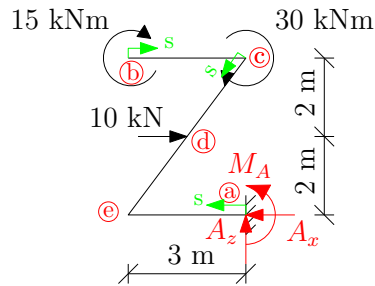


$$\begin{aligned} \rightarrow : & 0 = 0, & \text{O.K.} \\ \uparrow : & -7 - (-7) = 0, & \text{O.K.} \\ \circlearrowleft : & 0,667 - (-9,333) - 10 = 0, & \text{O.K.} \end{aligned}$$

### 4) Vykreslení:



## Příklad 7.8



### 1) Výpočet statické určitosti:

$$s = 3 - 3 = 0 \rightarrow \text{konstrukce je staticky určitá}$$

### 2) Výpočet reakcí:

$$\begin{aligned} \rightarrow : -A_x + 10 &= 0, & A_x &= 10 \text{ kN} \\ \uparrow : A_z &= 0, & A_z &= 0 \text{ kN} \\ \odot a : M_A - 10 \cdot 2 - 15 \cdot 3 - 30 &= 0, & M_A &= 65 \text{ kNm} \end{aligned}$$

$$\text{kontrola: } \odot b : M_A - 15 - 30 + 10 \cdot 2 - A_x \cdot 4 + A_z \cdot 3 = 0, \text{ O.K.}$$

### 3) Výpočet důležitých hodnot:

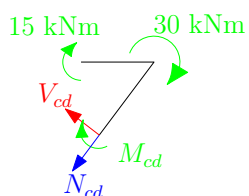
interval (b,c):

$$\begin{aligned} N_{bc} &= 0 \text{ kN} & N_{cb} &= 0 \text{ kN} \\ V_{bc} &= 0 \text{ kN} & V_{cb} &= 0 \text{ kN} \\ M_{bc} &= 15 \text{ kNm} & M_{cb} &= 15 \text{ kNm} \end{aligned}$$

interval (a,e):

$$\begin{aligned} N_{ae} &= -10 \text{ kN} & N_{ea} &= -10 \text{ kN} \\ V_{ae} &= 0 \text{ kN} & V_{ea} &= 0 \text{ kN} \\ M_{ae} &= 65 \text{ kNm} & M_{ea} &= 65 \text{ kNm} \end{aligned}$$

Styčnick c:



$$\begin{aligned} \swarrow : N_{cd} &= 0, & N_{cd} &= 0 \text{ kN} \\ \nwarrow : -V_{cd} &= 0, & V_{cd} &= 0 \text{ kN} \\ \odot : -M_{cd} - 30 - 15 &= 0, & M_{cd} &= -45 \text{ kNm} \end{aligned}$$

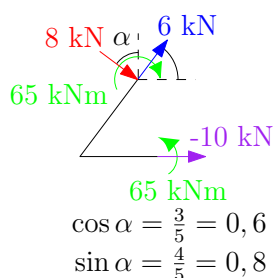
interval (c,d):

$$\begin{aligned} N_{cd} &= 0 \text{ kN} & N_{dc} &= 0 \text{ kN} \\ V_{cd} &= 0 \text{ kN} & V_{dc} &= 0 \text{ kN} \\ M_{cd} &= -45 \text{ kNm} & M_{dc} &= -45 \text{ kNm} \end{aligned}$$

interval (d,e):

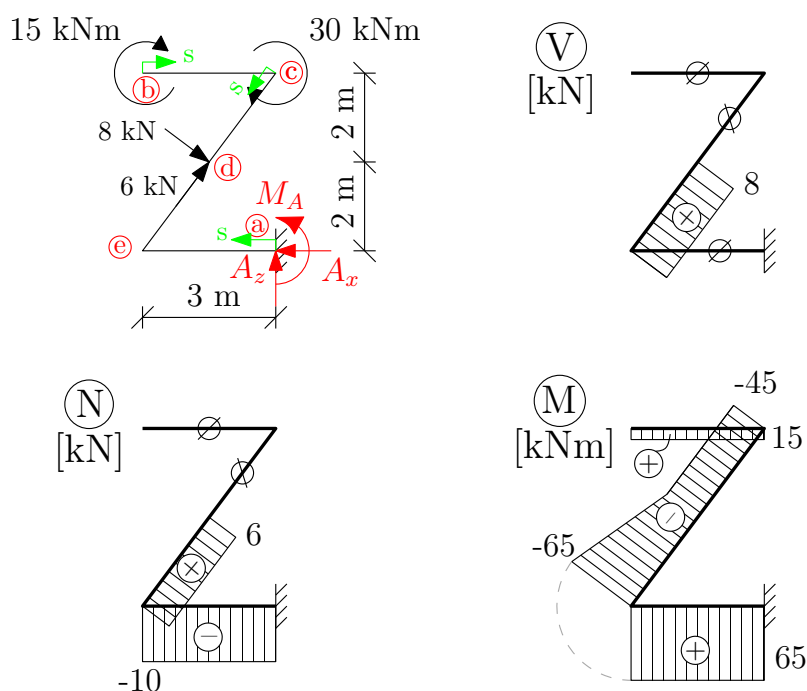
$$\begin{aligned} N_{cd} &= 10 \cdot 0,6 = 6 \text{ kN} & N_{dc} &= 6 \text{ kN} \\ V_{cd} &= 10 \cdot 0,8 = 8 \text{ kN} & V_{dc} &= 8 \text{ kN} \\ M_{cd} &= -45 \text{ kNm} & M_{dc} &= -45 - 8 \cdot 2,5 = -65 \text{ kNm} \end{aligned}$$

Rovnováha na styčnicku:



$$\begin{aligned} \rightarrow : & -10 + 6 \cdot 0,6 + 8 \cdot 0,8 = 0, & \text{O.K.} \\ \uparrow : & 6 \cdot 0,8 - 8 \cdot 0,6 = 0, & \text{O.K.} \\ \odot : & -65 + 65 = 0, & \text{O.K.} \end{aligned}$$

#### 4) Vykreslení:



**Prošba** V případě, že v textu objevíte nějakou chybu nebo budete mít námět na jeho vylepšení, ozvěte se prosím na [adela.pospisilova@fsv.cvut.cz](mailto:adela.pospisilova@fsv.cvut.cz).