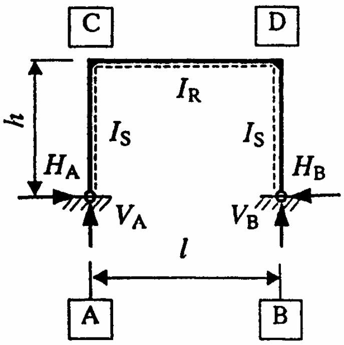
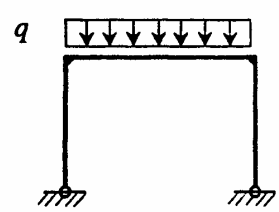
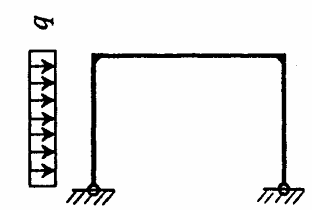
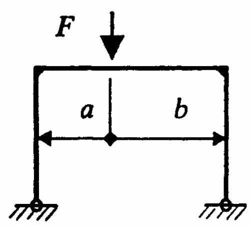
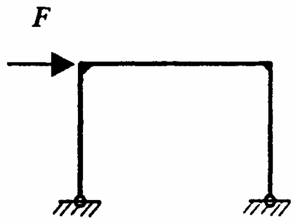
Egyszerű keretek [Piechatzek, Kaufmann, 1999]

Kétcsuklós keret

n = 1

$$k = \frac{I_R}{I_S} \cdot \frac{h}{l}$$

	Támaszerők	Hajlítónyomatékok
		$M_A = 0$ $M_B = 0$
	$V_A = V_B = \frac{q \cdot l}{2}$ $H_A = H_B = \frac{q \cdot l^2}{4 \cdot h \cdot (2 \cdot k + 3)}$	$M_C = M_D = -H_A \cdot h$ $M_F = \frac{q \cdot l^2}{8} - M_C$
	$V_A = -V_B = -\frac{q \cdot h^2}{2 \cdot l}$ $H_A = -\frac{q \cdot h}{8} \cdot \frac{11 \cdot k + 18}{2 \cdot k + 3}$ $H_B = \frac{q \cdot h}{8} \cdot \frac{5 \cdot k + 6}{2 \cdot k + 3}$	$M_C = \frac{q \cdot h^2}{2} + H_A \cdot h$ $M_D = -H_B \cdot h$
	$V_A = \frac{F \cdot b}{l}$ $V_B = \frac{F \cdot a}{l}$ $H_A = H_B = \frac{3 \cdot F \cdot a \cdot b}{2 \cdot h \cdot l \cdot (2 \cdot k + 3)}$	$M_C = M_D = -\frac{3 \cdot F \cdot a \cdot b}{2 \cdot l \cdot (2 \cdot k + 3)}$
	$V_A = -V_B = -\frac{F \cdot h}{l}$ $H_A = -H_B = -\frac{F}{2}$	$M_C = -M_D = \frac{F \cdot h}{2}$

Háromcsuklós keret

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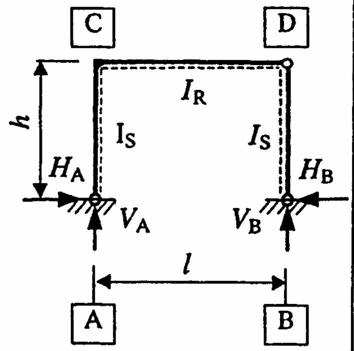

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n = 0

$$k = \frac{I_R}{I_S} \cdot \frac{h}{l}$$

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<tr>
<td>Támaszerők</td>
<td>

Hajlítónyomatékok

$M_A = 0$

$M_B = 0$

$M_D = 0$

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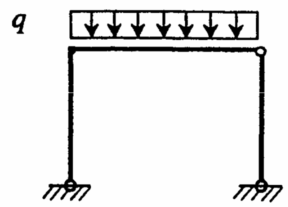

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$V_A = V_B = \frac{q \cdot l}{2}$

$H_A = H_B = 0$

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$M_C = 0$

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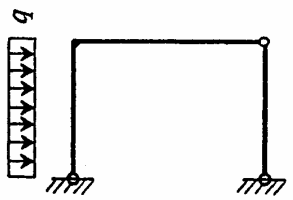

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$V_A = -V_B = -\frac{q \cdot h^2}{2 \cdot l}$

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$M_C = \frac{q \cdot h^2}{2}$

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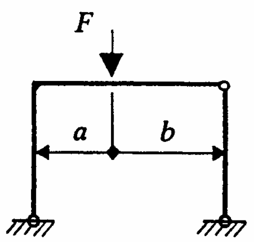

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$V_A = \frac{F \cdot b}{l}$

$V_B = \frac{F \cdot a}{l}$

$H_A = H_B = 0$

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$M_C = 0$

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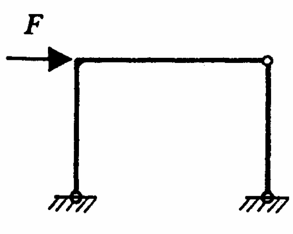

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$V_A = -V_B = -\frac{F \cdot h}{l}$

$H_A = -F$

$H_B = 0$

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$M_C = F \cdot h$

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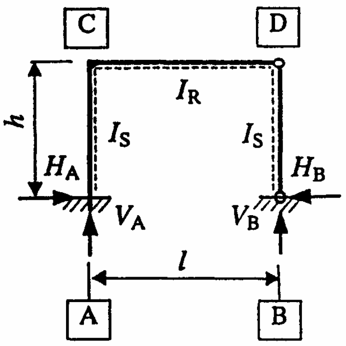
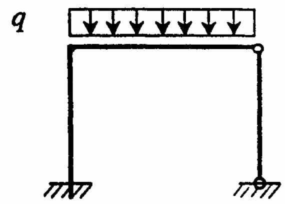
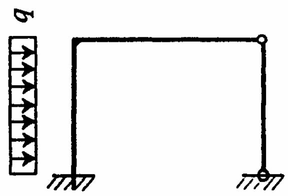
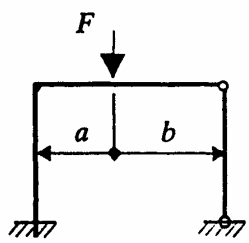
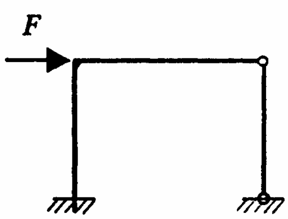
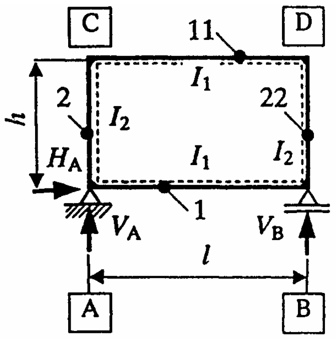
Befogott, ingalábas keret

	Támaszerők	Hajlítónyomatékok
	n=1 $k = \frac{I_R}{I_S} \cdot \frac{h}{l}$	
	Támaszerők	Hajlítónyomatékok $M_B = 0$ $M_D = 0$
	$V_A = \frac{q \cdot l}{2} - \frac{M_C}{l}$ $V_B = \frac{q \cdot l}{2} + \frac{M_C}{l}$ $H_A = H_B = 0$	$M_A = M_C = -\frac{q \cdot l^2}{8 \cdot (3 \cdot k + 1)}$
	$V_A = -V_B = -\frac{M_C}{l}$ $H_A = -q \cdot h$ $H_B = 0$	$M_A = -\frac{q \cdot h^2}{2} + M_C$ $M_C = \frac{q \cdot h^2 \cdot k}{6 \cdot k + 2}$
	$V_A = \frac{F \cdot b - M_C}{l}$ $V_B = \frac{F \cdot a + M_C}{l}$ $H_A = H_B = 0$	$M_A = M_C = -\frac{F \cdot a \cdot b \cdot (1+b)}{2 \cdot l^2 \cdot (3 \cdot k + 1)}$
	$V_A = -V_B = -\frac{M_C}{l}$ $H_A = -F$ $H_B = 0$	$M_A = -F \cdot h + M_C$ $M_C = \frac{3 \cdot F \cdot h \cdot k}{6 \cdot k + 2}$

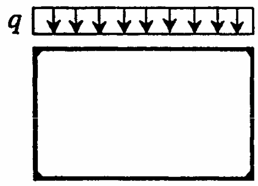
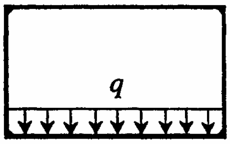
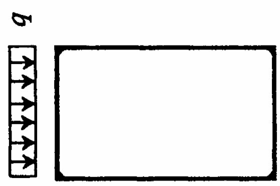
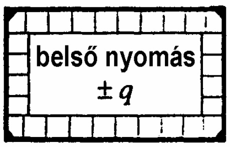
Derékszögű zárt keret

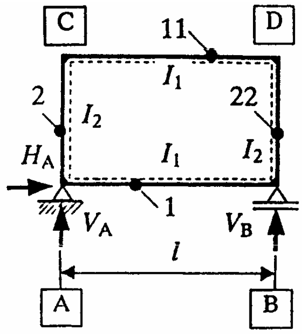


$$k_1 = \frac{I_1}{I_2} \cdot \frac{h}{l}$$

$$k_2 = 3 \cdot (k_1^2 + 4 \cdot k_1 + 3)$$

$$k_3 = 6 \cdot k_1 + 2$$

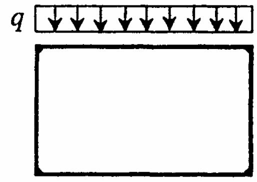
	Támaszerők	Normálerők
	$V_A = V_B = q \cdot l / 2$ $H_A = 0$	$N_2 = N_{22} = q \cdot l / 2$ $N_1 = -N_{11} = \frac{M_A - M_C}{h}$
	$V_A = V_B = q \cdot l / 2$ $H_A = 0$	$N_1 = -N_{11} = \frac{M_A - M_C}{h}$ $N_2 = N_{22} = 0$
	$V_A = -V_B = -\frac{q \cdot h^2}{2 \cdot l}$ $H_A = -q \cdot h$	$N_1 = -N_{11} = \frac{M_B - M_D}{h}$
	$V_A = V_B = 0$ $H_A = 0$	$N_1 = N_{11} = q \cdot h / 2$ $N_2 = N_{22} = q \cdot l / 2$



Hajlítónyomatékok

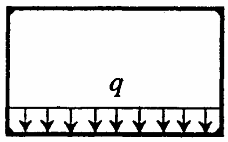
$$M_A = M_B = \frac{q \cdot l^2}{4} \cdot \frac{k_1}{k_2}$$

$$M_C = M_D = -\frac{q \cdot l^2}{4} \cdot \frac{2 \cdot k_1 + 3}{k_2}$$



$$M_A = M_B = -\frac{q \cdot l^2}{4} \cdot \frac{2 \cdot k_1 + 3}{k_2}$$

$$M_C = M_D = \frac{q \cdot l^2}{4} \cdot \frac{k_1}{k_2}$$

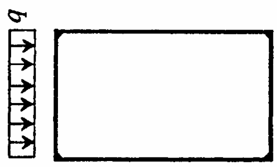


$$M_A = -\frac{q \cdot h^2}{4}\left(\frac{k_1^2 + 3 \cdot k_1}{2 \cdot k_2} + \frac{4 \cdot k_1 + 1}{k_3}\right)$$

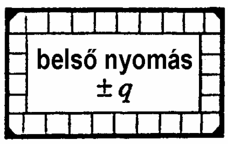
$$M_C = -\frac{q \cdot h^2}{4}\left(\frac{3 \cdot k_1(1 - k_1)}{2 \cdot k_2} - \frac{4 \cdot k_1 + 1}{k_3}\right)$$

$$M_B = -\frac{q \cdot h^2}{4}\left(\frac{k_1^2 + 3 \cdot k_1}{2 \cdot k_2} - \frac{4 \cdot k_1 + 1}{k_3}\right)$$

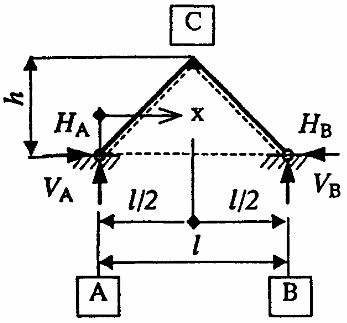
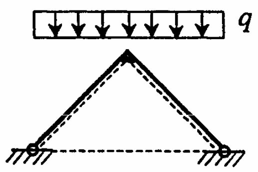
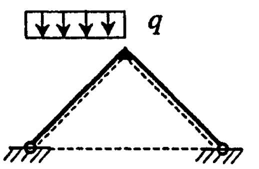
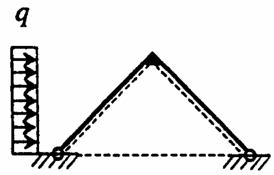
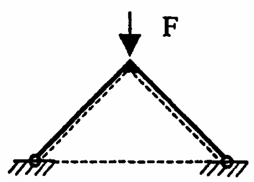
$$M_D = -\frac{q \cdot h^2}{4}\left(\frac{3 \cdot k_1(1 - k_1)}{2 \cdot k_2} + \frac{4 \cdot k_1 + 1}{k_3}\right)$$



$$M_A = M_B = M_C = M_D = \frac{q \cdot l^2}{4} \cdot \left(\frac{k_1 + 3}{k_2}\right) + \frac{q \cdot h^2}{4} \cdot \left(\frac{k_1^2 + 3 \cdot k_1}{k_2}\right)$$

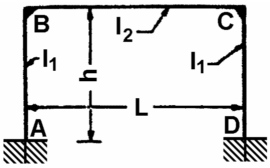


Egyenlőszárú zárt keret

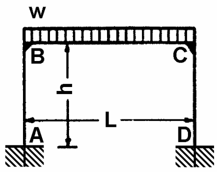
	*EI* = állandó	
	Támaszerők	**Hajlítónyomatékok** $M_A = 0$ $M_B = 0$
	$V_A = V_B = \frac{q \cdot l}{2}$ $H_A = H_B = \frac{5}{32} \cdot \frac{q \cdot l^2}{h}$	$M_C = -\frac{q \cdot l^2}{32}$ $\max M_F = \frac{9 \cdot q \cdot l^2}{512}$ $x = \frac{3}{16} \cdot l$ helyen
	$V_A = \frac{3}{8} \cdot q \cdot l$ $V_B = \frac{1}{8} \cdot q \cdot l$ $H_A = H_B = \frac{5}{64} \cdot \frac{q \cdot l^2}{h}$	$M_C = -\frac{q \cdot l^2}{64}$ $\max M_F = \frac{49 \cdot q \cdot l^2}{2049}$ $x = \frac{7}{32} \cdot l$ helyen
	$V_A = V_B = \frac{q \cdot h^2}{2 \cdot l}$ $H_A = \frac{11}{16} \cdot q \cdot h$ $H_B = \frac{5}{16} \cdot q \cdot h$	$M_C = -\frac{1}{16} \cdot q \cdot h^2$ $\max M_F = \frac{49 \cdot q \cdot h^2}{512}$
	$V_A = V_B = \frac{F}{2}$ $H_A = H_B = \frac{F}{4} \cdot \frac{l}{h}$	$M_C = 0$ $M_F = 0$

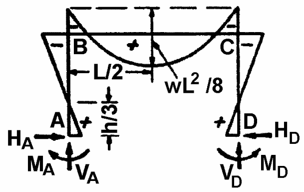
Befogott keretek vízszintes keretgerendával **[Kleinlogel, 1930]**

Befogott keretek megoszló terheléssel **[Owens, Knowles, 1992]**



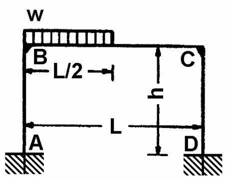
$$k = \frac{I_2}{I_1} \cdot \frac{h}{L} \quad N_1 = k + 2 \quad N_2 = 6k + 1$$

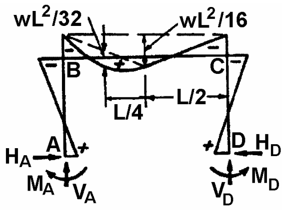




$$M_A = M_D = \frac{wL^2}{12N_1} \quad M_B = M_C = -\frac{wL^2}{6N_1} = -2M_A$$

$$M_{max} = \frac{wL^2}{8} + M_B \quad H_A = H_D = \frac{3M_A}{h} \quad V_A = V_D = \frac{wL}{2}$$

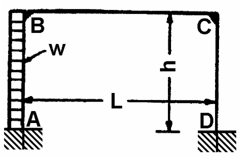


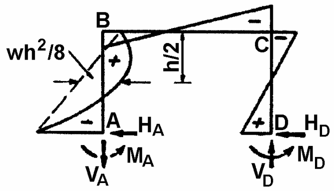


$$M_A = \frac{wL^2}{8}\left[\frac{1}{3N_1} - \frac{1}{8N_2}\right] \quad M_B = -\frac{wL^2}{8}\left[\frac{2}{3N_1} + \frac{1}{8N_2}\right]$$

$$M_D = \frac{wL^2}{8}\left[\frac{1}{3N_1} + \frac{1}{8N_2}\right] \quad M_C = -\frac{wL^2}{8}\left[\frac{2}{3N_1} - \frac{1}{8N_2}\right]$$

$$H_A = H_D = \frac{wL^2}{8hN_1} \quad V_D = \frac{wL}{8}\left[1 - \frac{1}{4N_2}\right] \quad V_A = \frac{wL}{2} - V_D$$



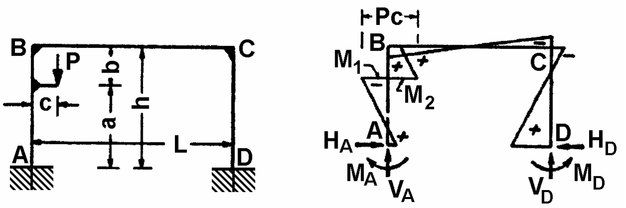


$$M_A = \frac{wh^2}{4}\left[-\frac{k+3}{6N_1} - \frac{4k+1}{N_2}\right] \quad M_B = \frac{wh^2}{4}\left[-\frac{k}{6N_1} + \frac{2k}{N_2}\right]$$

$$M_D = \frac{wh^2}{4}\left[-\frac{k+3}{6N_1} + \frac{4k+1}{N_2}\right] \quad M_C = \frac{wh^2}{4}\left[-\frac{k}{6N_1} - \frac{2k}{N_2}\right]$$

$$H_D = \frac{wh(2k+3)}{8N_1} \quad H_A = -(wh - H_D) \quad V_A = -V_D = -\frac{wh^2 k}{LN_2}$$

Befogott keretek koncentrált terheléssel

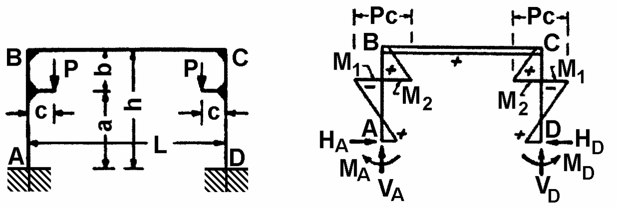


$$a_1 = \frac{a}{h} \qquad b_1 = \frac{b}{h}$$

$$X_1 = \frac{Pc}{2N_1}\left[1 + 2b_1k - 3b_1^2(k+1)\right] \qquad X_2 = \frac{Pcka_1(3a_1 - 2)}{2N_1} \qquad X_3 = \frac{3Pcka_1}{N_1}$$

$$M_A = +X_1 - \left(\frac{Pc}{2} - X_3\right) \qquad M_B = +X_2 + X_3 \qquad M_D = +X_1 + \left(\frac{Pc}{2} - X_3\right) \qquad M_C = +X_2 - X_3$$

$$H_A = H_D = \frac{Pc}{2h} + \frac{X_1 - X_2}{h} \qquad V_D = \frac{2X_3}{L} \qquad V_A = P - V_D \qquad M_1 = M_A - H_A a \qquad M_2 = M_B + H_D b$$

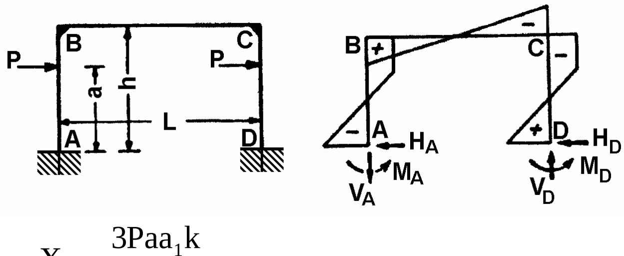


$$a_1 = \frac{a}{h} \qquad b_1 = \frac{b}{h}$$

$$X_1 = \frac{Pc}{2N_1}\left[1 + 2b_1k - 3b_1^2(k+1)\right] \qquad X_2 = \frac{Pcka_1(3a_1 - 2)}{2N_1}$$

$$M_A = M_D = \frac{Pc}{N_1}\left[1 + 2b_1k - 3b_1^2(k+1)\right] = 2X_1 \qquad M_B = M_C = \frac{Pcka_1(3a_1 - 2)}{N_1} = 2X_2$$

$$H_A = H_D = \frac{Pc + M_A - M_B}{h} \qquad V_A = V_D = P \qquad M_1 = M_A - H_A a \qquad M_2 = M_B + H_D b$$

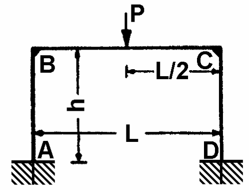


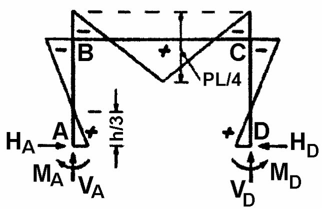
$$a_1 = \frac{a}{h} \qquad X_1 = \frac{3Paa_1k}{N_2}$$

$$M_A = -Pa + X_1 \qquad M_B = X_1 \qquad M_D = +Pa - X_1 \qquad M_C = -X_1$$

$$H_A = -H_D = -P \qquad V_A = -V_D = -\frac{2X_1}{L}$$

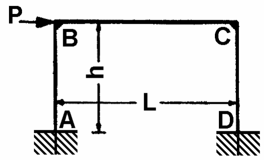
Befogott keretek koncentrált terheléssel

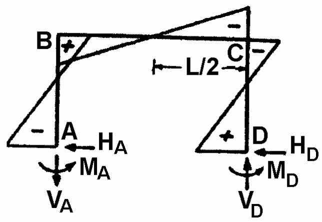




$$M_A = M_D = +\frac{PL}{8N_1} \qquad M_B = M_C = -2M_A$$

$$H_A = H_D = \frac{3M_A}{h} \qquad V_A = V_D = \frac{P}{2}$$

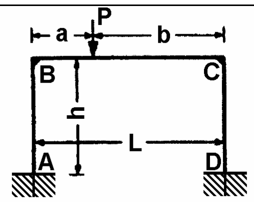


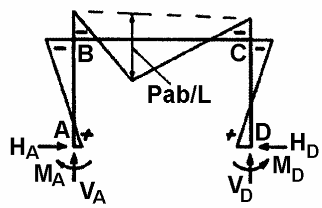


$$M_A = -\frac{Ph}{2}\cdot\frac{3k+1}{N_2} \qquad M_B = +\frac{Ph}{2}\cdot\frac{3k}{N_2}$$

$$M_D = +\frac{Ph}{2}\cdot\frac{3k+1}{N_2} \qquad M_C = -\frac{Ph}{2}\cdot\frac{3k}{N_2}$$

$$H_A = H_D = -\frac{P}{2} \qquad V_A = -V_D = -\frac{2M_B}{L}$$





$$a_1 = \frac{a}{L} \qquad b_1 = \frac{b}{L}$$

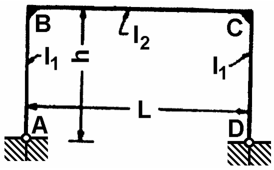
$$M_A = +\frac{Pab}{L}\left[\frac{1}{2N_1} - \frac{b_1 - a_1}{2N_2}\right] \qquad M_B = -\frac{Pab}{L}\left[\frac{1}{N_1} + \frac{b_1 - a_1}{2N_2}\right]$$

$$M_D = +\frac{Pab}{L}\left[\frac{1}{2N_1} + \frac{b_1 - a_1}{2N_2}\right] \qquad M_C = -\frac{Pab}{L}\left[\frac{1}{N_1} - \frac{b_1 - a_1}{2N_2}\right]$$

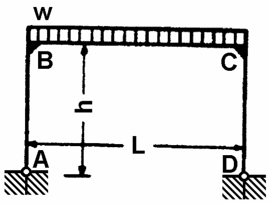
$$H_A = H_D = \frac{3Pab}{2LhN_1} \qquad V_A = Pb_1\left[1 + \frac{a_1(b_1 - a_1)}{N_2}\right] \qquad V_D = P - V_A$$

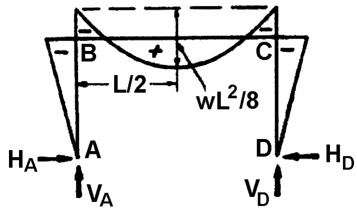
Csuklós keretek vízszintes keretgerendával [Kleinlogel, 1930]

Csuklós keretek megoszló terheléssel [Owens, Knowles, 1992]



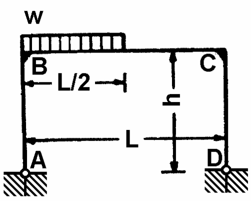
$$k = \frac{I_2}{I_1} \cdot \frac{h}{L} \qquad N = 2k + 3$$

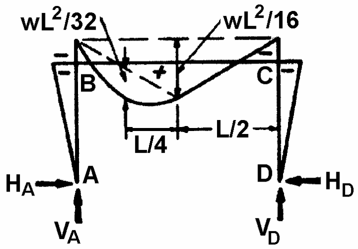




$$M_B = M_C = -\frac{wL^2}{4N} \qquad M_{max} = \frac{wL^2}{8} + M_B$$

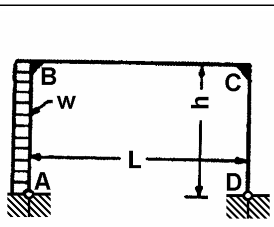
$$H_A = H_D = -\frac{M_B}{h} \qquad V_A = V_D = \frac{wL}{2}$$

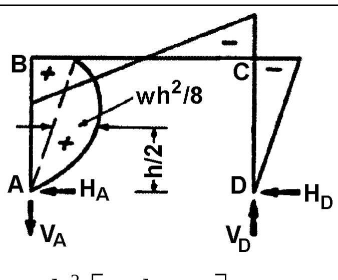




$$M_B = M_C = -\frac{wL^2}{8N}$$

$$H_A = H_D = -\frac{M_B}{h} \qquad V_A = \frac{3wL}{8} \qquad V_D = \frac{wL}{8}$$

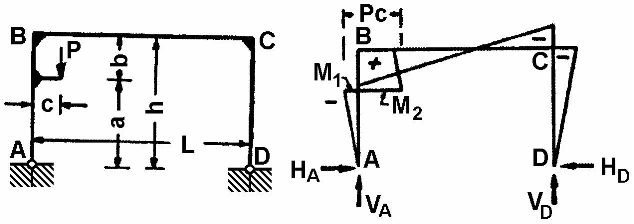




$$M_B = \frac{wh^2}{4}\left[-\frac{k}{2N} + 1\right] \qquad M_C = \frac{wh^2}{4}\left[-\frac{k}{2N} - 1\right]$$

$$H_D = -\frac{M_C}{h} \qquad H_A = -\left(wh - H_D\right) \qquad V_A = -V_D = -\frac{wh^2}{2L}$$

Csuklós keretek koncentrált terheléssel

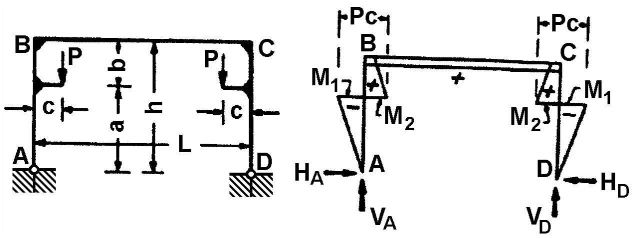


$$a_1 = \frac{a}{h}$$

$$M_B = \frac{Pc}{2}\left[\frac{(3a_1^2 - 1)k}{N} + 1\right] \quad M_C = \frac{Pc}{2}\left[\frac{(3a_1^2 - 1)k}{N} - 1\right]$$

$$H_A = H_D = -\frac{M_C}{h} \quad V_D = \frac{Pc}{L} \quad V_A = P - V_D$$

$$M_1 = -H_A a \quad M_2 = Pc - H_A a$$

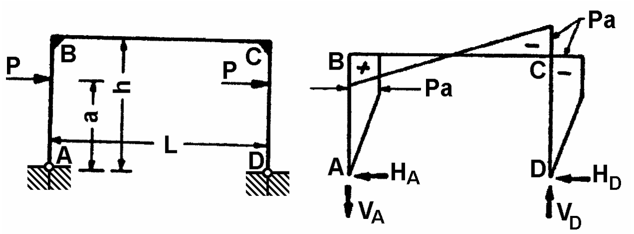


$$a_1 = \frac{a}{h}$$

$$M_B = M_C = \frac{Pc(3a_1^2 - 1)k}{N}$$

$$H_A = H_D = \frac{Pc - M_B}{h} \quad V_A = V_D = P$$

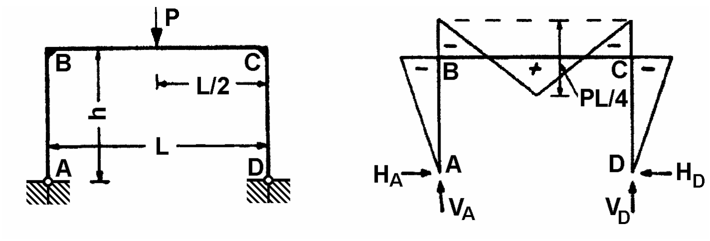
$$M_1 = -H_A a \quad M_2 = Pc - H_A a$$



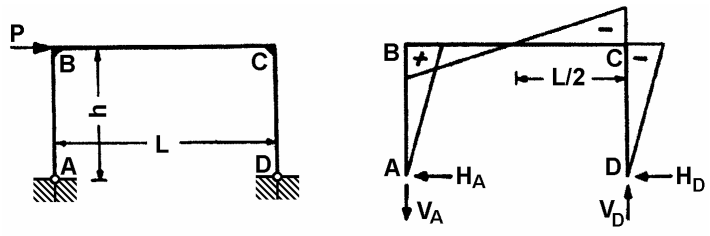
$$M_B = -M_C = Pa$$

$$H_A = H_D = P \quad V_A = -V_D = -\frac{2Pa}{L}$$

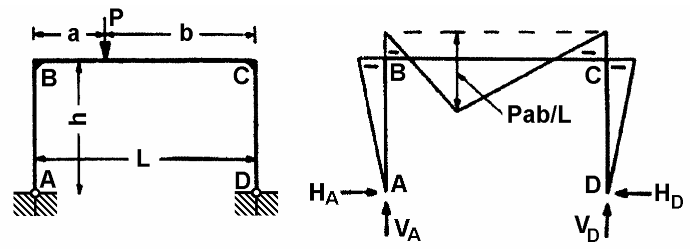
Csuklós keretek koncentrált terheléssel



$$M_B = M_C = -\frac{3PL}{8N} \quad H_A = H_D = \frac{-M_B}{h} \quad V_A = V_D = \frac{P}{2}$$



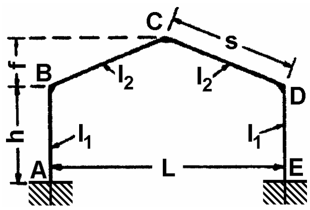
$$M_B = -M_C = +\frac{Ph}{2} \quad H_A = H_D = -\frac{P}{2} \quad V_A = -V_D = -\frac{Ph}{L}$$



$$M_B = M_C = -\frac{Pab}{L} \cdot \frac{3}{2N} \quad H_A = H_D = \frac{-M_B}{h} \quad V_A = \frac{Pb}{L} \quad V_D = \frac{Pa}{L}$$

Befogott keretek ferde keretgerendával [Kleinlogel, 1930]

Befogott keretek megoszló terheléssel [Owens, Knowles, 1992]

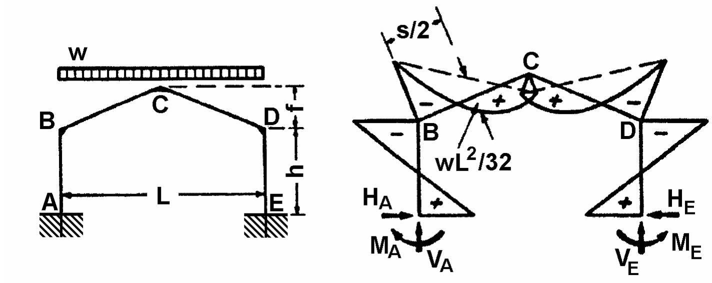


$$k = \frac{I_2}{I_1} \cdot \frac{h}{s} \qquad \phi = \frac{f}{h} \qquad m = 1 + \phi$$

$$B = 3k + 2 \qquad C = 1 + 2m$$

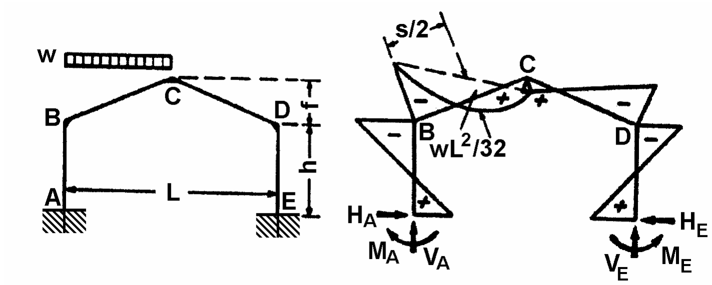
$$K_1 = 2\left(k + 1 + m + m^2\right) \qquad K_2 = 2\left(k + \phi^2\right)$$

$$R = \phi C - k \qquad N_1 = K_1 K_2 - R^2 \qquad N_2 = 3k + B$$



$$M_A = M_E = \frac{wL^2}{16} \cdot \frac{k(8 + 15\phi) + \phi(6 - \phi)}{N_1} \qquad M_B = M_D = -\frac{wL^2}{16} \cdot \frac{k(16 + 15\phi) + \phi^2}{N_1}$$

$$M_C = \frac{wL^2}{8} - \phi M_A + m M_B \qquad H_A = H_E = \frac{M_A - M_B}{h} \qquad V_A = V_E = \frac{wL}{2}$$

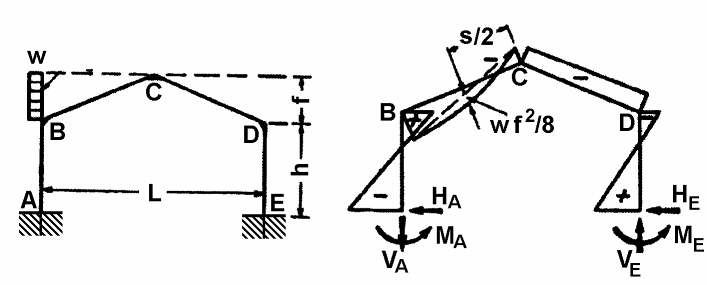


$$X_1 = \frac{wL^2}{32} \cdot \frac{k(8 + 15\phi) + \phi(6 - \phi)}{N_1} \qquad X_2 = \frac{wL^2}{32} \cdot \frac{k(16 + 15\phi) + \phi^2}{N_1} \qquad X_3 = \frac{wL^2}{32 N_2}$$

$$M_A = +X_1 - X_3 \quad M_B = -X_2 - X_3 \quad M_E = +X_1 + X_3 \quad M_D = -X_2 + X_3 \quad M_C = \frac{wL^2}{16} - \phi X_1 - m X_2$$

$$H_A = H_E = \frac{X_1 + X_2}{h} \qquad V_E = \frac{wL}{8} - \frac{2X_3}{L} \qquad V_A = \frac{wL}{2} - V_E$$

Befogott keretek megoszló terheléssel

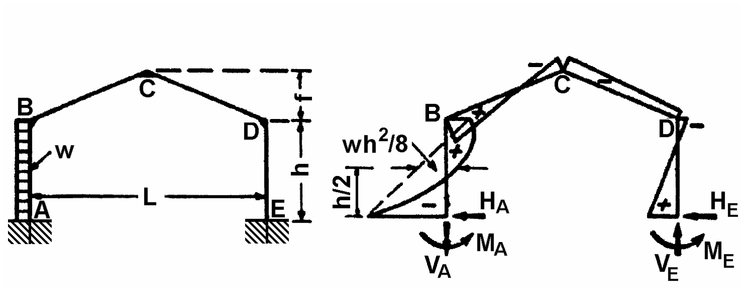


$$X_1 = \frac{wf^2}{8} \cdot \frac{k(9\phi + 4) + \phi(6 + \phi)}{N_1} \quad X_2 = \frac{wf^2}{8} \cdot \frac{k(8 + 9\phi) - \phi^2}{N_1} \quad X_3 = \frac{wfh}{8} \cdot \frac{4B + \phi}{N_2}$$

$$M_A = -X_1 - X_3 \quad M_B = +X_2 + \left(\frac{wfh}{2} - X_3\right) \quad M_E = -X_1 + X_3 \quad M_D = +X_2 - \left(\frac{wfh}{2} - X_3\right)$$

$$M_C = -\frac{wf^2}{4} + \phi X_1 + mX_2$$

$$H_E = \frac{wf}{2} - \frac{X_1 + X_2}{h} \quad H_A = -(wf - H_E) \quad V_A = -V_E = -\frac{wfh(2 + \phi)}{2L} + \frac{2X_3}{L}$$



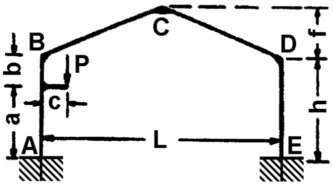
$$X_1 = \frac{wh^2}{8} \cdot \frac{k(k + 6) + k\phi(15 + 16\phi) + 6\phi^2}{N_1} \quad X_2 = \frac{wh^2 k(9\phi + 8\phi^2 - k)}{8N_1} \quad X_3 = \frac{wh^2(2k + 1)}{2N_2}$$

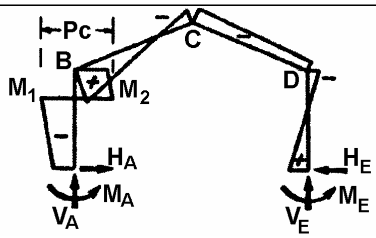
$$M_A = -X_1 - X_3 \quad M_B = +X_2 + \left(\frac{wh^2}{4} - X_3\right) \quad M_E = -X_1 + X_3 \quad M_D = +X_2 - \left(\frac{wh^2}{4} - X_3\right)$$

$$M_C = -\frac{wfh}{4} + \phi X_1 + mX_2$$

$$H_E = \frac{wh}{4} - \frac{X_1 + X_2}{h} \quad H_A = -(wh - H_E) \quad V_A = -V_E = -\frac{wh^2}{2L} + \frac{2X_3}{L}$$

Befogott keretek koncentrált terheléssel





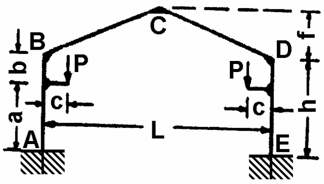
$$a_1 = \frac{a}{h} \qquad b_1 = \frac{b}{h} \qquad Y_1 = Pc\left[2\phi^2 - \left(1 - 3b_1^2 k\right)\right] \qquad Y_2 = Pc\left[\phi C - \left(3a_1^2 - 1\right)k\right]$$

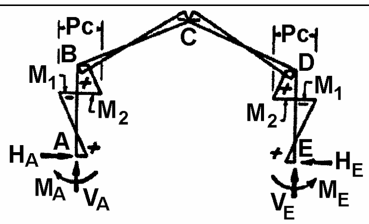
$$X_1 = \frac{Y_1 K_1 - Y_2 R}{2N_1} \qquad X_2 = \frac{Y_2 K_2 - Y_1 R}{2N_1} \qquad X_3 = \frac{Pc}{2} \cdot \frac{B - 3(a_1 - b_1)k}{N_2}$$

$$M_A = -X_1 - X_3 \quad M_B = +X_2 + \left(\frac{Pc}{2} - X_3\right) \quad M_E = -X_1 + X_3 \quad M_D = +X_2 - \left(\frac{Pc}{2} - X_3\right)$$

$$M_C = -\frac{\phi Pc}{2} + \phi X_1 + m X_2 \qquad M_1 = M_A - H_A a \qquad M_2 = M_B + H_E b$$

$$H_A = H_E = \frac{Pc}{2h} - \frac{X_1 + X_2}{h} \qquad V_E = \frac{Pc - 2X_3}{L} \qquad V_A = P - V_E$$



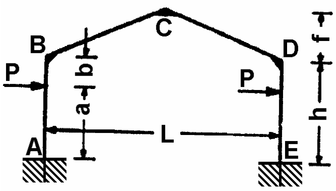


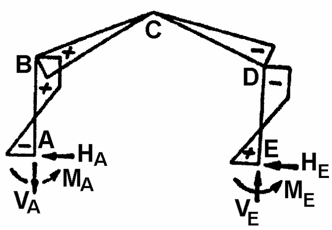
$$a_1 = \frac{a}{h} \qquad b_1 = \frac{b}{h} \qquad Y_1 = Pc\left[2\phi^2 - \left(1 - 3b_1^2\right)k\right] \qquad Y_2 = Pc\left[\phi C + \left(3a_1^2 - 1\right)k\right]$$

$$M_A = M_E = \frac{Y_2 R - Y_1 K_1}{N_1} \qquad M_B = M_D = \frac{Y_2 K_2 - Y_1 R}{N_1} \qquad M_C = -\phi\left(Pc + M_A\right) + m M_B$$

$$M_1 = M_A - H_A a \qquad M_2 = M_B + H_E b$$

$$H_A = H_E = \frac{Pc + M_A - M_B}{h} \qquad V_A = V_E = P$$

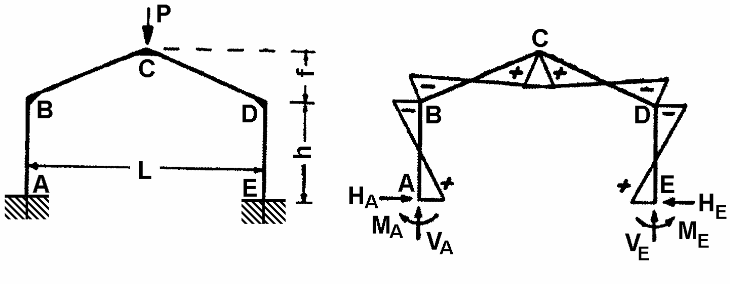




$$X_1 = \frac{Pa\left(B + 3b_1 k\right)}{N_2} \qquad M_A = -M_E = -X_1 \qquad M_B = -M_D = Pa - X_1 \qquad M_C = 0$$

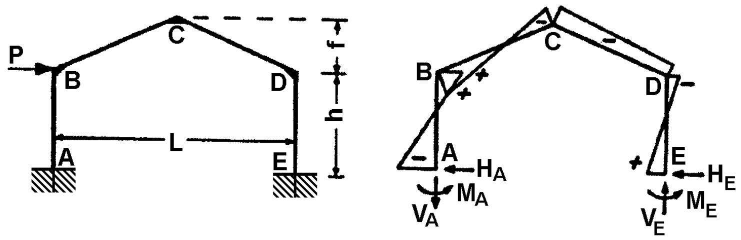
$$H_A = -H_E = -P \qquad V_A = -V_E = -2\left[\frac{Pa - X_1}{L}\right]$$

Befogott keretek koncentrált terheléssel



$$M_A = M_E = \frac{3PL(k + 2k\phi + \phi)}{4N_1} \quad M_B = M_D = -\frac{3PLkm}{2N_1}$$

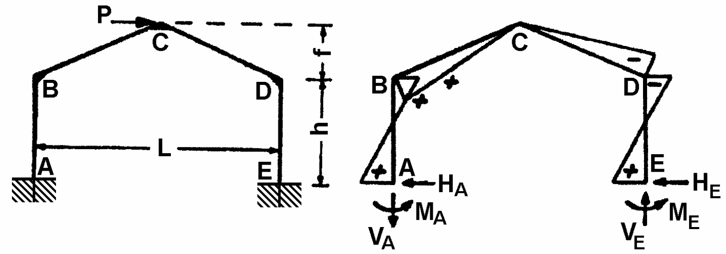
$$M_C = \frac{PL}{4} - \phi M_A + mM_B \quad H_A = H_E = \frac{M_A - M_B}{h} \quad V_A = V_E = \frac{P}{2}$$



$$X_1 = \frac{3Pf(k + 2\phi k + \phi)}{2N_1} \quad X_2 = \frac{3Pfmk}{N_1} \quad X_3 = \frac{PhB}{2N_2}$$

$$M_A = -X_1 - X_3 \quad M_B = +X_2 + \left(\frac{Ph}{2} - X_3\right) \quad M_E = -X_1 + X_3 \quad M_D = +X_2 - \left(\frac{Ph}{2} - X_3\right)$$

$$M_C = -\frac{Pf}{2} + \phi X_1 + mX_2 \quad H_E = \frac{P}{2} - \frac{X_1 + X_2}{h} \quad H_A = -(P - H_E) \quad V_A = -V_E = -\frac{Ph - 2X_3}{L}$$

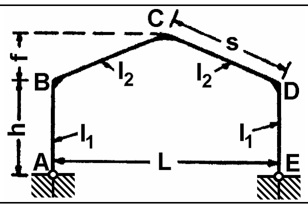


$$M_A = -M_E = -\frac{PhB}{2N_2} \quad M_B = -M_D = +\frac{3Phk}{2N_2} \quad M_C = 0$$

$$H_A = -H_E = -\frac{P}{2} \quad V_A = -V_E = -\frac{P(h + f) + 2M_A}{L}$$

Csuklós keretek ferde keretgerendával [Kleinlogel, 1930]

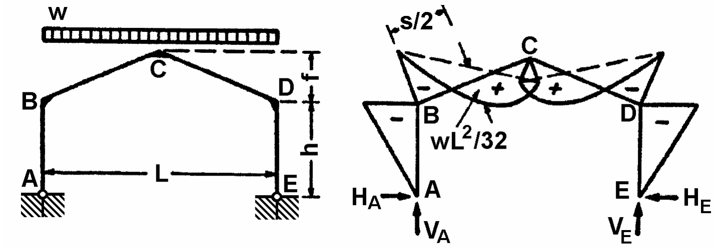
Csuklós keretek megoszló terheléssel [Owens, Knowles, 1992]



$$k = \frac{I_2}{I_1} \cdot \frac{h}{s} \qquad \phi = \frac{f}{h} \qquad m = 1 + \phi$$

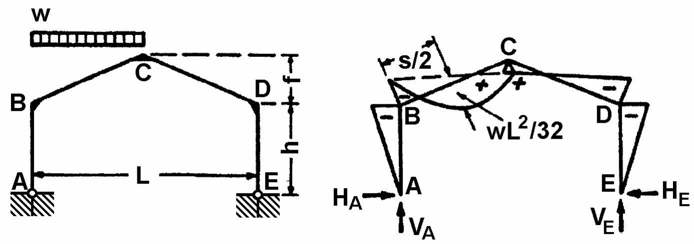
$$B = 2(k+1) + m \qquad C = 1 + 2m$$

$$N = B + mC$$



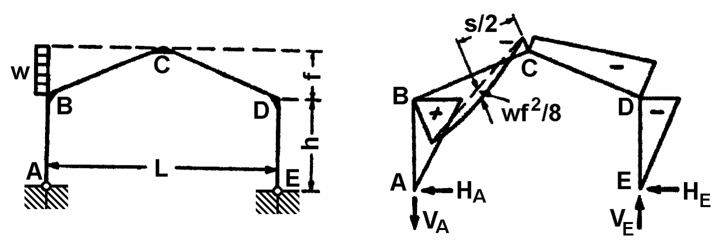
$$M_B = M_D = -\frac{wL^2(3+5m)}{16N} \qquad M_C = \frac{wL^2}{8} + mM_B$$

$$H_A = H_E = -\frac{M_B}{h} \qquad V_A = V_E = \frac{wL}{2}$$



$$M_B = M_D = -\frac{wL^2(3+5m)}{32N} \qquad M_C = \frac{wL^2}{16} + mM_B$$

$$H_A = H_E = -\frac{M_B}{h} \qquad V_A = \frac{3wL}{8} \qquad V_E = \frac{wL}{8}$$

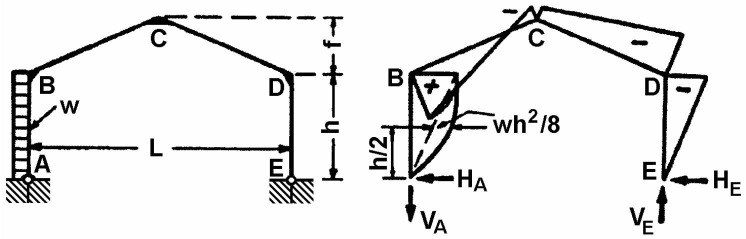


$$X = \frac{wf^2(C+m)}{8N}$$

$$M_B = +X + \frac{wfh}{2} \quad M_C = -\frac{wf^2}{4} + mX \quad M_D = +X - \frac{wfh}{2}$$

$$H_A = -\frac{X}{h} - \frac{wf}{2} \quad H_E = -\frac{X}{h} + \frac{wf}{2} \quad V_A = -V_E = -\frac{wfh(1+m)}{2L}$$

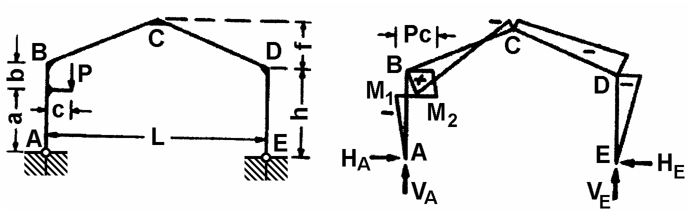
Csuklós keretek megoszló terheléssel



$$M_D = -\frac{wh^2}{8} \cdot \frac{2(B+C)+k}{N} \qquad M_B = \frac{wh^2}{2} + M_D \qquad M_C = \frac{wh^2}{4} + mM_D$$

$$H_E = -\frac{M_D}{h} \qquad H_A = -(wh - H_E) \qquad V_A = -V_E = -\frac{wh^2}{2L}$$

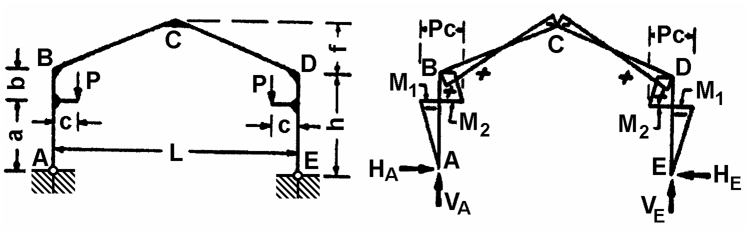
Csuklós keretek koncentrált terheléssel



$$a_1 = \frac{a}{h} \qquad X = \frac{Pc}{2} \cdot \frac{B + C - k\left(3a_1^2 - 1\right)}{N}$$

$$M_B = Pc - X \qquad M_D = -X \qquad M_C = \frac{Pc}{2} - mX \qquad M_1 = -a_1 X \qquad M_2 = Pc - a_1 X$$

$$H_A = H_E = \frac{X}{h} \qquad V_E = \frac{Pc}{L} \qquad V_A = P - V_E$$

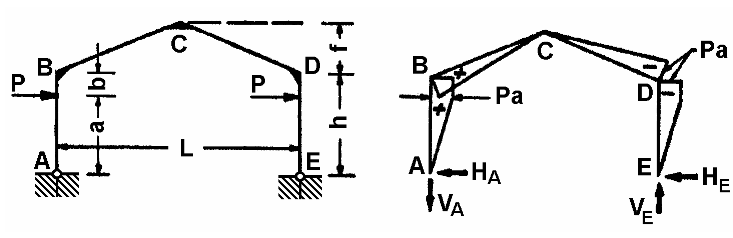


$$a_1 = \frac{a}{h}$$

$$M_B = M_D = Pc \cdot \frac{\phi C + k\left(3a_1^2 - 1\right)}{N} \qquad M_C = -\phi Pc + m\, M_B$$

$$M_1 = -a_1\left(Pc - M_B\right) \qquad M_2 = \left(1 - a_1\right)Pc + a_1 M_B$$

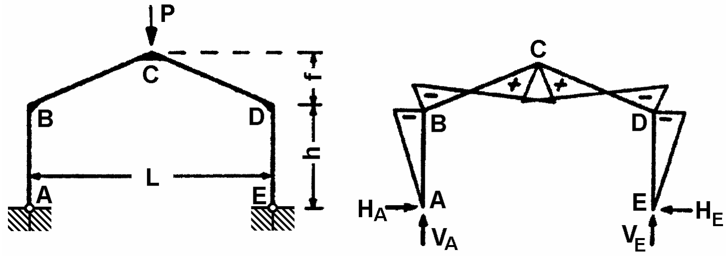
$$H_A = H_E = \frac{Pc - M_B}{h} \qquad V_A = V_E = P$$



$$M_B = -M_D = Pa \qquad M_C = 0$$

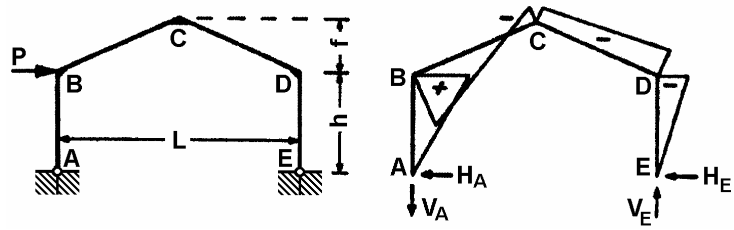
$$H_A = -H_E = -P \qquad V_A = -V_E = -\frac{2Pa}{L}$$

Csuklós keretek koncentrált terheléssel



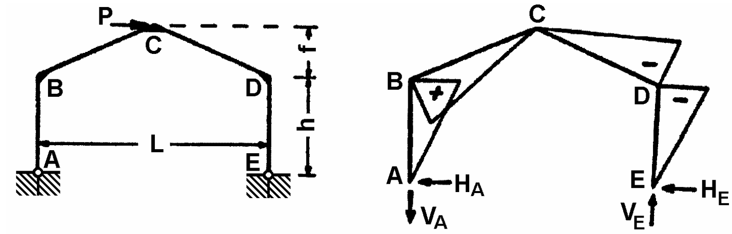
$$M_B = M_D = -\frac{PL}{4} \cdot \frac{C}{N} \qquad M_C = +\frac{PL}{4} \cdot \frac{B}{N}$$

$$H_A = H_E = -\frac{M_B}{h} \qquad V_A = V_E = \frac{P}{2}$$



$$M_D = -\frac{Ph(B+C)}{2N} \qquad M_B = Ph + M_D \qquad M_C = \frac{Ph}{2} + m\,M_D$$

$$H_E = -\frac{M_D}{h} \qquad H_A = -(P - H_E) \qquad V_A = -V_E = -\frac{Ph}{L}$$



$$M_B = -M_D = +\frac{Ph}{2} \qquad M_C = 0 \qquad H_A = -H_E = -\frac{P}{2} \qquad V_A = -V_E = -\frac{Phm}{L}$$