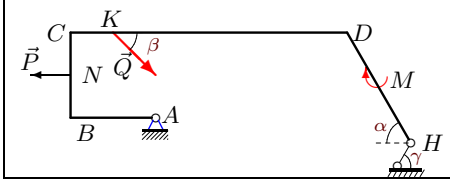
# Равновесие тяжелой рамы

Тяжелая однородная рама расположена в вертикальной плоскости и опирается на неподвижный шарнир $A$ и наклонный невесомый стержень $H$. К раме приложены горизонтальная сила $P$, наклонная сила $Q$ и момент $M$. Учитывая погонный вес рамы $\rho$, найти реакции опор.

*Кирсанов М.Н.* **Решебник. Теоретическая механика** с. 31.

**Вариант 1**

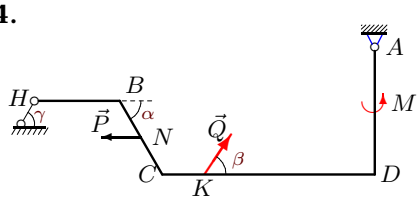
**C4.**




$\rho = 1$ кН/м, $P = 5$ кН,
$Q = 28$ кН, $M = 15$ кНм,
$\alpha = 60°$, $\beta = 30°$, $\gamma = 30°$,
$AB = 4$ м, $BC = 4$ м,
$CD = 13$ м, $DH = 6$ м,
$CK = 2$ м, $CN = 2$ м.

**Вариант 2**

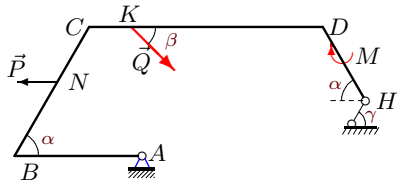
**C4.**




$\rho = 3$ кН/м, $P = 9$ кН,
$Q = 13$ кН, $M = 70$ кНм,
$\alpha = 60°$, $\beta = 60°$, $\gamma = 60°$,
$HB = 4$ м, $BC = 4$ м,
$CD = 10$ м, $DA = 6$ м,
$CK = 2$ м, $CN = 2$ м.

**Вариант 3**

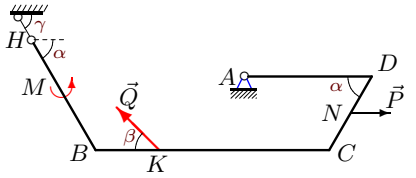
**C4.**




$\rho = 2$ кН/м, $P = 6$ кН,
$Q = 23$ кН, $M = 20$ кНм,
$\alpha = 60°$, $\beta = 30°$, $\gamma = 45°$,
$AB = 6$ м, $BC = 7$ м,
$CD = 11$ м, $DH = 4$ м,
$CK = 2$ м, $CN = 3$ м.

**Вариант 4**

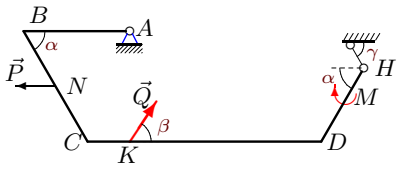
**C4.**




$\rho = 3$ кН/м, $P = 7$ кН,
$Q = 20$ кН, $M = 70$ кНм,
$\alpha = 60°$, $\beta = 30°$, $\gamma = 60°$,
$HB = 6$ м, $BC = 11$ м,
$CD = 4$ м, $DA = 6$ м,
$BK = 3$ м, $CN = 2$ м.

**Вариант 5**

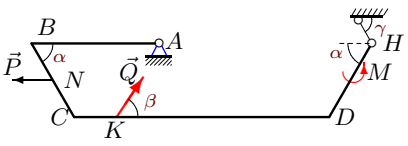
**C4.**




$\rho = 1$ кН/м, $P = 7$ кН,
$Q = 26$ кН, $M = 15$ кНм,
$\alpha = 60°$, $\beta = 60°$, $\gamma = 30°$,
$AB = 5$ м, $BC = 6$ м,
$CD = 11$ м, $DH = 4$ м,
$CK = 2$ м, $CN = 3$ м.

**Вариант 6**

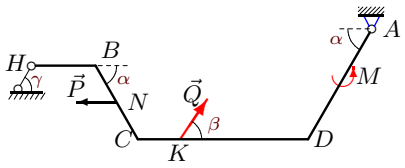
**C4.**




$\rho = 2$ кН/м, $P = 8$ кН,
$Q = 18$ кН, $M = 50$ кНм,
$\alpha = 60°$, $\beta = 60°$, $\gamma = 45°$,
$AB = 6$ м, $BC = 4$ м,
$CD = 12$ м, $DH = 4$ м,
$CK = 2$ м, $CN = 2$ м.

**Вариант 7**

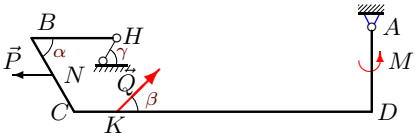
**C4.**




$\rho = 3$ кН/м, $P = 9$ кН,
$Q = 16$ кН, $M = 70$ кНм,
$\alpha = 60°$, $\beta = 60°$, $\gamma = 60°$,
$HB = 3$ м, $BC = 4$ м,
$CD = 8$ м, $DA = 6$ м,
$CK = 2$ м, $CN = 2$ м.

**Вариант 8**

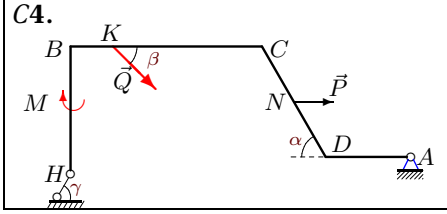
**C4.**




$\rho = 3$ кН/м, $P = 8$ кН,
$Q = 12$ кН, $M = 70$ кНм,
$\alpha = 60°$, $\beta = 45°$, $\gamma = 60°$,
$HB = 4$ м, $BC = 4$ м,
$CD = 14$ м, $DA = 4$ м,
$CK = 2$ м, $CN = 2$ м.

**Вариант 9**

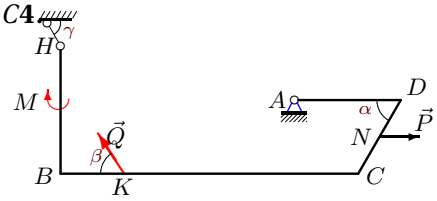
**C4.**




$\rho = 3$ кН/м, $P = 7$ кН,
$Q = 31$ кН, $M = 25$ кНм,
$\alpha = 60°$, $\beta = 30°$, $\gamma = 60°$,
$HB = 6$ м, $BC = 9$ м,
$CD = 6$ м, $DA = 4$ м,
$BK = 2$ м, $CN = 3$ м.

**Вариант 10**

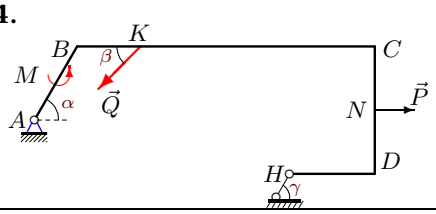
**C4**




$\rho = 3$ кН/м, $P = 9$ кН,
$Q = 35$ кН, $M = 25$ кНм,
$\alpha = 60°$, $\beta = 60°$, $\gamma = 60°$,
$HB = 6$ м, $BC = 14$ м,
$CD = 4$ м, $DA = 5$ м,
$BK = 3$ м, $CN = 2$ м.

**Вариант 11**

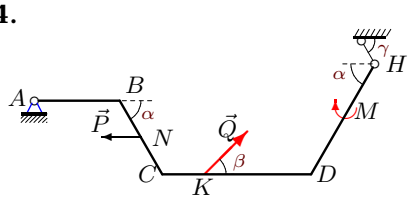
**C4.**




$\rho = 1$ кН/м, $P = 6$ кН,
$Q = 12$ кН, $M = 30$ кНм,
$\alpha = 60°$, $\beta = 45°$, $\gamma = 30°$,
$AB = 4$ м, $BC = 14$ м,
$CD = 6$ м, $DH = 4$ м,
$BK = 3$ м, $CN = 3$ м.

**Вариант 12**

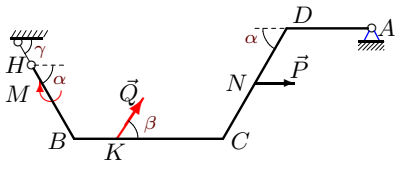
**C4.**




$\rho = 1$ кН/м, $P = 5$ кН,
$Q = 23$ кН, $M = 15$ кНм,
$\alpha = 60°$, $\beta = 30°$, $\gamma = 30°$,
$AB = 4$ м, $BC = 4$ м,
$CD = 7$ м, $DH = 6$ м,
$CK = 2$ м, $CN = 2$ м.

**Вариант 13**

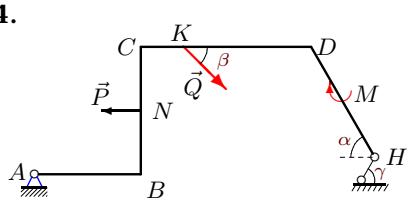
**C4.**




$\rho = 3$ кН/м, $P = 9$ кН,
$Q = 23$ кН, $M = 25$ кНм,
$\alpha = 60°$, $\beta = 60°$, $\gamma = 60°$,
$HB = 4$ м, $BC = 7$ м,
$CD = 6$ м, $DA = 4$ м,
$BK = 2$ м, $CN = 3$ м.

**Вариант 14**

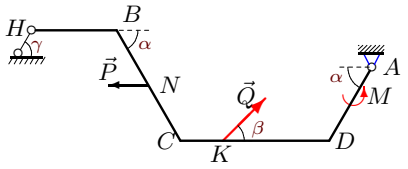
**C4.**




$\rho = 2$ кН/м, $P = 7$ кН,
$Q = 28$ кН, $M = 20$ кНм,
$\alpha = 60°$, $\beta = 45°$, $\gamma = 45°$,
$AB = 5$ м, $BC = 6$ м,
$CD = 8$ м, $DH = 6$ м,
$CK = 2$ м, $CN = 3$ м.

**Вариант 15**

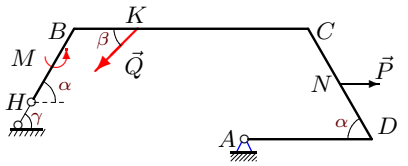
**C4.**




$\rho = 3$ кН/м, $P = 7$ кН,
$Q = 20$ кН, $M = 70$ кНм,
$\alpha = 60°$, $\beta = 30°$, $\gamma = 60°$,
$HB = 4$ м, $BC = 6$ м,
$CD = 7$ м, $DA = 4$ м,
$CK = 2$ м, $CN = 3$ м.

**Вариант 16**

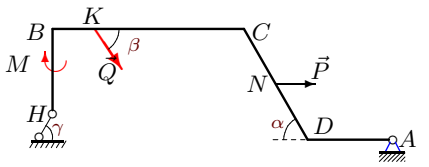
**C4.**




$\rho = 3$ кН/м, $P = 7$ кН,
$Q = 21$ кН, $M = 70$ кНм,
$\alpha = 60°$, $\beta = 30°$, $\gamma = 60°$,
$HB = 4$ м, $BC = 11$ м,
$CD = 6$ м, $DA = 6$ м,
$BK = 3$ м, $CN = 3$ м.

**Вариант 17**

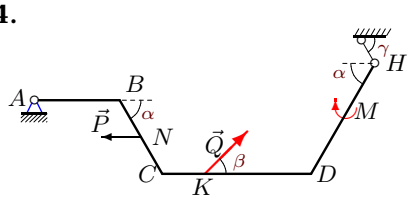
**C4.**




$\rho = 3$ кН/м, $P = 9$ кН,
$Q = 28$ кН, $M = 25$ кНм,
$\alpha = 60°$, $\beta = 60°$, $\gamma = 60°$,
$HB = 4$ м, $BC = 9$ м,
$CD = 6$ м, $DA = 4$ м,
$BK = 2$ м, $CN = 3$ м.

**Вариант 18**

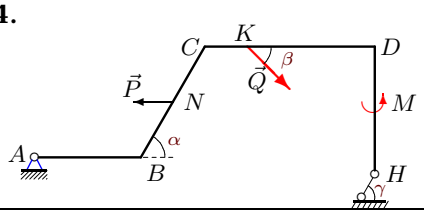
**C4.**




$\rho = 2$ кН/м, $P = 7$ кН,
$Q = 24$ кН, $M = 20$ кНм,
$\alpha = 60°$, $\beta = 45°$, $\gamma = 45°$,
$AB = 4$ м, $BC = 4$ м,
$CD = 7$ м, $DH = 6$ м,
$CK = 2$ м, $CN = 2$ м.

**Вариант 19**

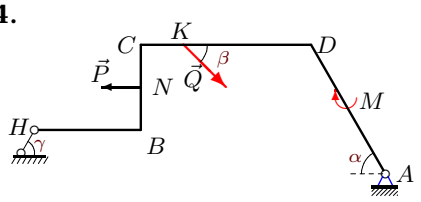
**C4.**




$\rho = 1$ кН/м, $P = 5$ кН,
$Q = 11$ кН, $M = 30$ кНм,
$\alpha = 60°$, $\beta = 30°$, $\gamma = 30°$,
$AB = 5$ м, $BC = 6$ м,
$CD = 8$ м, $DH = 6$ м,
$CK = 2$ м, $CN = 3$ м.

**Вариант 20**

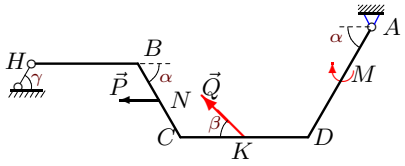
**C4.**




$\rho = 3$ кН/м, $P = 7$ кН,
$Q = 35$ кН, $M = 25$ кНм,
$\alpha = 60°$, $\beta = 30°$, $\gamma = 60°$,
$HB = 5$ м, $BC = 4$ м,
$CD = 8$ м, $DA = 7$ м,
$CK = 2$ м, $CN = 2$ м.

**Вариант 21**

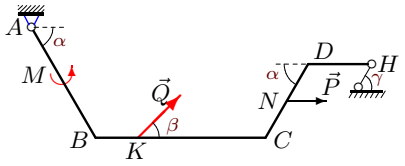
**C4.**




$\rho = 3$ кН/м, $P = 8$ кН,
$Q = 24$ кН, $M = 25$ кНм,
$\alpha = 60°$, $\beta = 45°$, $\gamma = 60°$,
$HB = 5$ м, $BC = 4$ м,
$CD = 6$ м, $DA = 6$ м,
$CK = 3$ м, $CN = 2$ м.

**Вариант 22**

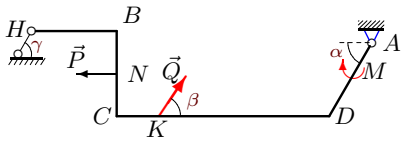
**C4.**




$\rho = 2$ кН/м, $P = 6$ кН,
$Q = 16$ кН, $M = 50$ кНм,
$\alpha = 60°$, $\beta = 30°$, $\gamma = 45°$,
$AB = 6$ м, $BC = 8$ м,
$CD = 4$ м, $DH = 3$ м,
$BK = 2$ м, $CN = 2$ м.

**Вариант 23**

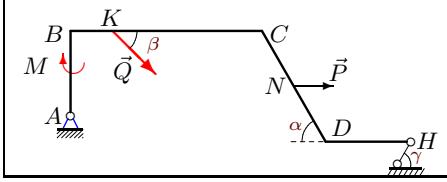
**C4.**




$\rho = 3$ кН/м, $P = 9$ кН,
$Q = 31$ кН, $M = 25$ кНм,
$\alpha = 60°$, $\beta = 60°$, $\gamma = 60°$,
$HB = 4$ м, $BC = 4$ м,
$CD = 10$ м, $DA = 4$ м,
$CK = 2$ м, $CN = 2$ м.

**Вариант 24**

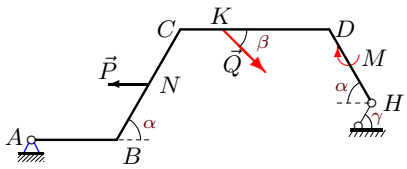
**C4.**




$\rho = 2$ кН/м, $P = 7$ кН,
$Q = 33$ кН, $M = 20$ кНм,
$\alpha = 60°$, $\beta = 45°$, $\gamma = 45°$,
$AB = 4$ м, $BC = 9$ м,
$CD = 6$ м, $DH = 4$ м,
$BK = 2$ м, $CN = 3$ м.

**Вариант 25**

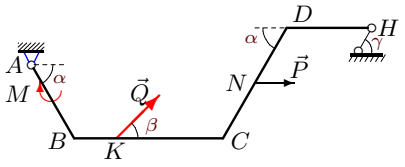
**C4.**




$\rho = 2$ кН/м, $P = 6$ кН,
$Q = 23$ кН, $M = 20$ кНм,
$\alpha = 60°$, $\beta = 30°$, $\gamma = 45°$,
$AB = 4$ м, $BC = 6$ м,
$CD = 7$ м, $DH = 4$ м,
$CK = 2$ м, $CN = 3$ м.

**Вариант 26**

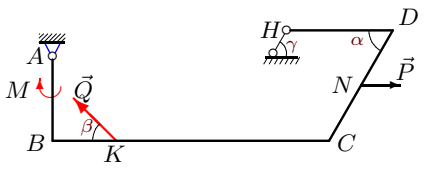
**C4.**




$\rho = 1$ кН/м, $P = 5$ кН,
$Q = 22$ кН, $M = 15$ кНм,
$\alpha = 60°$, $\beta = 30°$, $\gamma = 30°$,
$AB = 4$ м, $BC = 7$ м,
$CD = 6$ м, $DH = 4$ м,
$BK = 2$ м, $CN = 3$ м.

**Вариант 27**

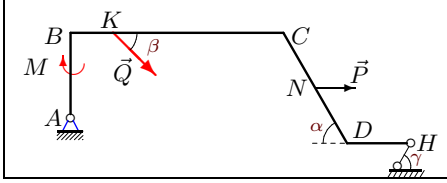
**C4.**




$\rho = 2$ кН/м, $P = 7$ кН,
$Q = 35$ кН, $M = 20$ кНм,
$\alpha = 60°$, $\beta = 45°$, $\gamma = 45°$,
$AB = 4$ м, $BC = 13$ м,
$CD = 6$ м, $DH = 5$ м,
$BK = 3$ м, $CN = 3$ м.

**Вариант 28**

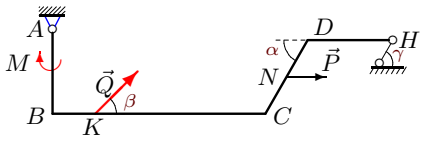
**C4.**




$\rho = 2$ кН/м, $P = 7$ кН,
$Q = 32$ кН, $M = 20$ кНм,
$\alpha = 60°$, $\beta = 45°$, $\gamma = 45°$,
$AB = 4$ м, $BC = 10$ м,
$CD = 6$ м, $DH = 3$ м,
$BK = 2$ м, $CN = 3$ м.

**Вариант 29**

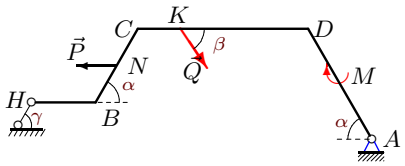
**C4.**




$\rho = 1$ кН/м, $P = 6$ кН,
$Q = 31$ кН, $M = 15$ кНм,
$\alpha = 60°$, $\beta = 45°$, $\gamma = 30°$,
$AB = 4$ м, $BC = 10$ м,
$CD = 4$ м, $DH = 4$ м,
$BK = 2$ м, $CN = 2$ м.

**Вариант 30**

**C4.**




$\rho = 3$ кН/м, $P = 9$ кН,
$Q = 22$ кН, $M = 25$ кНм,
$\alpha = 60°$, $\beta = 60°$, $\gamma = 60°$,
$HB = 3$ м, $BC = 4$ м,
$CD = 8$ м, $DA = 6$ м,
$CK = 2$ м, $CN = 2$ м.

Ответы

| | $M_A(Q)$ | $M_A(P)$ | $\Sigma_k M_A(G_k)$ | $h$ | $X_A$ | $Y_A$ | $R_H$ |
|---|---|---|---|---|---|---|---|
| 1 | -68.995 | 10.000 | -71.5 | 7.036 | -37.157 | 30.661 | 20.679 |
| 2 | -51.067 | -38.412 | 450.0 | -12.588 | -14.600 | 31.124 | 34.200 |
| 3 | -115.000 | 20.785 | -46.5 | 5.588 | -34.257 | 47.161 | 28.763 |
| 4 | -100.000 | 12.124 | 88.5 | -7.794 | 14.851 | 63.153 | 9.061 |
| 5 | 67.550 | -18.187 | -45.0 | 4.000 | -3.697 | 2.154 | 2.659 |
| 6 | -0.000 | -13.856 | -44.0 | 7.071 | -0.214 | 35.626 | 1.111 |
| 7 | -83.138 | -31.177 | 469.5 | -12.990 | -15.365 | 20.798 | 32.731 |
| 8 | -67.882 | -18.144 | 642.0 | -10.124 | -31.400 | 15.970 | 61.829 |
| 9 | 77.500 | -18.187 | 721.5 | -13.454 | -61.935 | 41.851 | 56.176 |
| 10 | -303.109 | 15.588 | 280.5 | -8.258 | 6.561 | 60.047 | -3.877 |
| 11 | -13.033 | -2.785 | -282.0 | 8.196 | -25.813 | 20.147 | 32.676 |
| 12 | 161.000 | -8.660 | -181.5 | 9.500 | -10.893 | 7.176 | 4.648 |
| 13 | -179.267 | 23.383 | 523.5 | -14.722 | -8.864 | 22.928 | 23.272 |
| 14 | -257.387 | 21.000 | -403.0 | 10.745 | -56.191 | 26.407 | 61.365 |
| 15 | -10.000 | -6.062 | 484.5 | -14.722 | -28.607 | 21.327 | 36.573 |
| 16 | 147.000 | -18.187 | 55.5 | -9.526 | -2.161 | 68.381 | 26.696 |
| 17 | 266.736 | -23.383 | 625.5 | -14.454 | -52.190 | 42.690 | 58.380 |
| 18 | 194.552 | -12.124 | -363.0 | 12.538 | 1.341 | 13.718 | 15.997 |
| 19 | -104.500 | 12.990 | -243.5 | 8.696 | -34.901 | 12.963 | 35.074 |
| 20 | -17.500 | 28.435 | 564.7 | -15.321 | -41.283 | 58.371 | 35.944 |
| 21 | -190.005 | -27.713 | 457.5 | -12.990 | 16.704 | 31.711 | 16.534 |
| 22 | 112.000 | 20.785 | -313.0 | 12.538 | -27.200 | 26.656 | 10.385 |
| 23 | -214.774 | -13.177 | 534.0 | -14.124 | -16.449 | 21.921 | 19.898 |
| 24 | -140.007 | -9.813 | -319.0 | 12.160 | -58.761 | 40.908 | 40.201 |
| 25 | -207.000 | 15.588 | -349.0 | 10.089 | -53.196 | 14.222 | 55.547 |
| 26 | 110.000 | 4.330 | -161.5 | 6.500 | -32.336 | 5.218 | 9.565 |
| 27 | -24.749 | 9.813 | -478.0 | 6.932 | -34.571 | -21.069 | 73.991 |
| 28 | -135.765 | -9.813 | -325.0 | 12.160 | -58.156 | 40.099 | 40.345 |
| 29 | 131.522 | 13.608 | -150.0 | 8.464 | -29.953 | -1.094 | 2.348 |
| 30 | 114.315 | 31.177 | 469.5 | -14.722 | -22.037 | 47.347 | 40.074 |