Determine the reaction forces and the forces in the interim pins of the composite stud. The studs and acting forces are shown.
Needed variables:
$P_1 = 12,\ P_2 = 18,\ M_1 = 36,\ q = 1.4.$

1

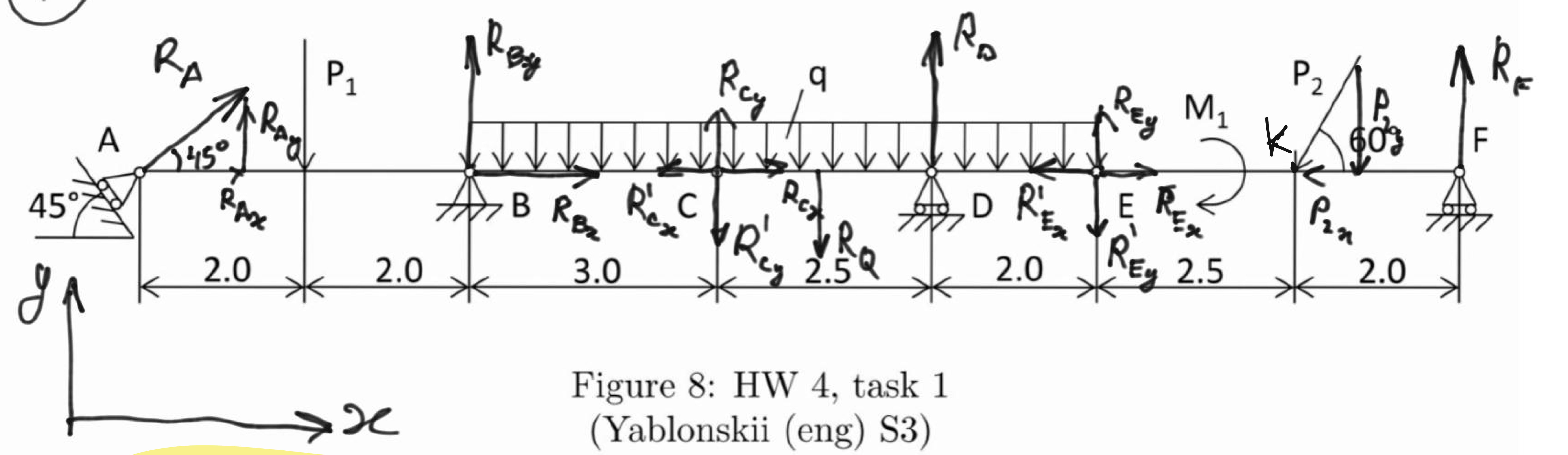

Figure 8: HW 4, task 1
(Yablonskii (eng) S3)

Research objects:

Rod AC, Rod CE, Rod EF

Connections: A - roller support, B - pin joint, C - pin joint, D - roller support, E - pin joint, F - roller support

Methodology: static analysis, system is in equilibrium

Force analysis:

Rod AC:

Unknown: R_{A_x} - ?, R_{A_y} - ?, R_{B_x} - ?, R_{B_y} - ?, R_{C_x} - ?, R_{C_y} - ?

Known: $R_{A_x} = R_{A_y} = \dfrac{R_A}{\sqrt{2}}$; $P_1 = 12$; $R_{C_x} = R'_{C_x}$; $R_{C_y} = R'_{C_y}$, $R_{Q_1} = BC \cdot q$

due to connection in C — resulting force on BC

Rod CE:

Unknown: R'_{C_x} - ?, R'_{C_y} - ?, R_D - ?, R_{E_x} - ?, R_{E_y} - ?

Known: $R'_{C_x} = R_{C_x}$, $R'_{C_y} = R_{C_y}$, $R_{E_x} = R'_{E_x}$, $R_{E_y} = R'_{E_y}$; $R_{Q_2} = CE \cdot q$

due to connection in C — due to connection in E — resulting force on CE

Rod EF:

Unknown: R'_{E_x} - ?, R'_{E_y} - ?, R_F - ?

Known: $R'_{E_x} = R_{E_x}$, $R'_{E_y} = R_{E_y}$, $M_1 = 36$, $P_{2x} = P_2 \cdot \cos 60^\circ$; $P_{2y} = P_2 \cdot \sin 60^\circ$

due to connection in E

Solution:

Rod AC:

$\sum x$: $R_{A_x} + R_{B_x} + R_{C_x} = 0 \Rightarrow \frac{R_A}{\sqrt{2}} + R_{B_x} + R_{C_x} = 0$

$\sum y$: $R_{A_y} + R_{B_y} + R_{C_y} - P_1 - R_{Q_1} = 0 \Rightarrow \frac{R_A}{\sqrt{2}} + R_{B_y} + R_{C_y} - P_1 - BC \cdot q = 0$

$\sum M_A(F_i)$: $-\frac{AB}{2} \cdot P_1 + AB\, R_{B_y} + AC\, R_{C_y} - R_{Q_1} \cdot \frac{BC}{2} = 0$

Rod CE:

$\sum x$: $-R'_{C_x} + R_{E_x} = 0 \Rightarrow -R_{C_x} + R_{E_x} = 0$

$\sum y$: $-R'_{E_y} - R_{Q_2} + R_D + R_{E_y} = 0 \Rightarrow -R_{C_y} + R_D + R_{E_y} - CE \cdot q = 0$

$\sum M_C(F_i)$: $-R_{Q_2} \cdot \left(\frac{CE}{2}\right) + CD\, R_D + CE\, R_{E_y} = 0$

Rod EF:

$\sum x$: $-R'_{E_x} - P_{2x} = 0 \Rightarrow -R_{E_x} - \frac{P_2}{2} = 0$

$\sum y$: $-R'_{E_y} - P_{2y} + R_F = 0 \Rightarrow -R_{E_y} - \frac{\sqrt{3}\, P_2}{2} + R_F = 0$

$\sum M_E(F_i)$: $-M_1 - EK\, P_{2y} + EF\, R_F = 0 \Rightarrow -\frac{EK \cdot \sqrt{3}}{2} P_2 + EF\, R_F - M_1 = 0$

There we have 9 unknowns:

R_A, R_{Bx}, R_{By}, R_{cx}, R_{cy}, R_{Ex}, R_{Ey}, R_D, R_F

And we have 9 equation, so the problem is solvable.

Answer obtained using python:

$R_A \approx 10.62$

$R_{Bx} \approx 1.49$

$R_{By} \approx 10.178$

$R_{cx} \approx -9$

$R_{cy} \approx -1.487$

$R_{Ex} \approx -9$

$R_{Ey} \approx 1.072$

$R_D \approx 3.74$

$R_F \approx 16.66$

(2)

Determine the reaction forces in rods supporting a thin horizontal rectangular plate of weight G under action of force P applied along the side AB. The constructions and the acting forces are shown.
Needed variables:
$G = 18,\ P = 30;$
$a = 4,\ b = 4.5,\ c = 3.5.$

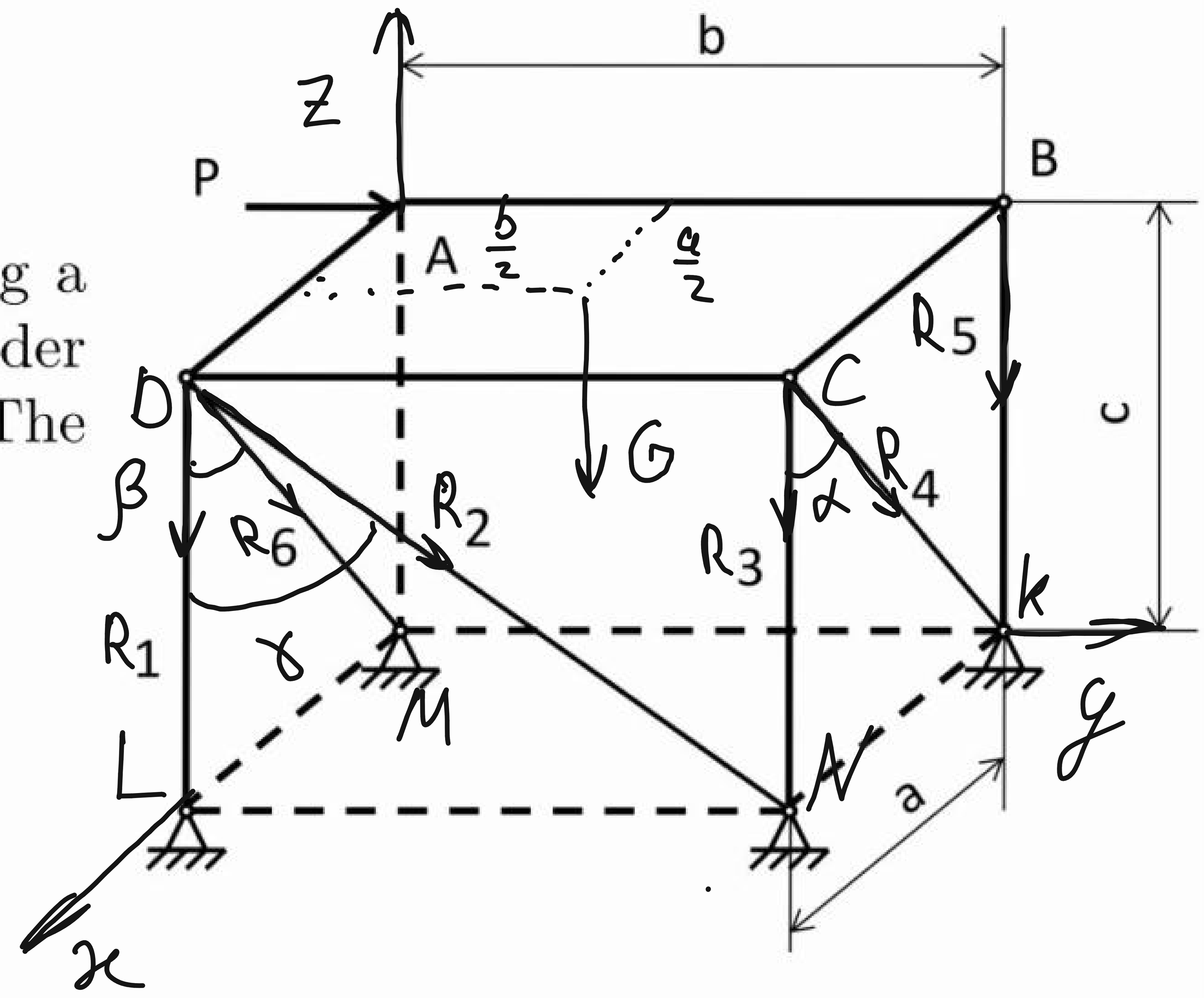

Figure 9: HW 4, task 2
(Yablonskii (eng) S6)

Research object:

Thin horizontal rectangular plate ABCD

Connections: ideal rods DL, DM, DN, CN, Ck, BK

Methodology: Static analysis, system is in equilibrium

Force analysis:

Unknown: $R_1 - ?,\ R_2 - ?,\ R_3 - ?,\ R_4 - ?,\ R_6 - ?$

Known: $G = 18,\ P = 30;\quad \alpha = \arctan\frac{a}{c},\ \beta = \arctan\frac{a}{c}$

$\gamma = \arctan\frac{b}{c}$

Solution:

$\gamma = 90 - \alpha$

$\beta = 90 - \beta = \alpha$

$\Sigma x: \ -\overset{R_{6x}}{R_6\cdot\sin\beta} - \overset{R_{4x}}{R_4\cdot\sin\alpha} = 0$

$\Sigma y: \ \overset{R_{2y}}{R_2\cdot\sin\gamma} + P = 0$

$\Sigma z: \ -G - R_1 - \overset{R_{6z}}{R_6\cos\beta} - \overset{R_{2z}}{R_2\cos\gamma} - R_3 - \overset{R_{4z}}{R_4\cdot\cos\alpha} - R_5 = 0$

$\Sigma M_x(F_i): \ -G\cdot\frac{b}{2} - R_3\cdot b - R_5\cdot b - \underset{R'_{4z}}{R_4\cdot\cos\alpha}\cdot b - \underset{R'_{2y}}{R_2\cdot\sin\gamma}\cdot c - P\cdot c = 0$

$$\Sigma M_y: G\cdot\frac{a}{2} + R_3\cdot a + a\cdot\underbrace{R_4\cdot\cos\alpha}_{R_{4z}} - c\cdot\underbrace{R_4\sin\alpha}_{R_{4x}} - c\cdot\underbrace{R_6\cdot\sin\beta}_{R_{6x}} +$$

$$+ a\cdot R_1 + a\cdot\underbrace{R_6\cdot\cos\beta}_{R_{6z}} + a\cdot\underbrace{R_2\cos\alpha}_{R_{2z}} = 0$$

$$\Sigma M_z: a\underbrace{R_4\sin\alpha}_{R_{4x}} + a\cdot\underbrace{R_2\sin\gamma}_{R_{2y}} = 0$$

We have 6 unknowns: $R_1, R_2, R_3, R_4, R_5, R_6$

And we have 6 equations, so problem is solvable.

Answers obtained using pythons

$R_1 \approx 40.583$

$R_2 \approx -38$

$R_3 \approx -24.556$

$R_4 \approx 39.863$

$R_5 \approx -10.694$

$R_6 \approx -39.863$