

TM Homework 4

Timur Islamov

Feb 2024

[Link back to GitHub](#)

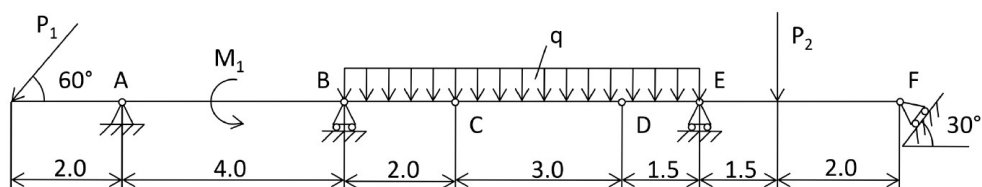
1 Task 1

1.1 Task description

Determine the reaction forces and the forces in the interim pins of the composite stud. The studs and acting forces are shown.

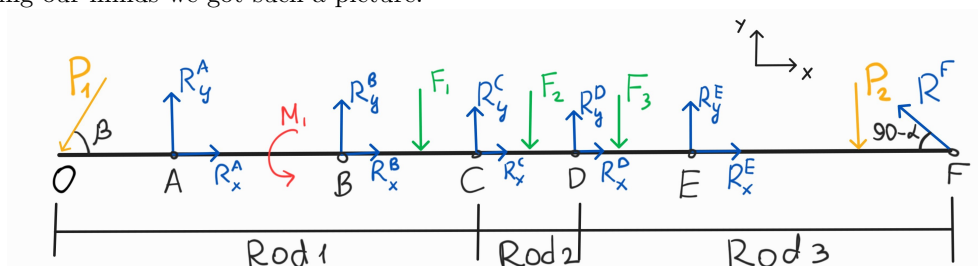
Needed variables:

$$P_1 = 6, P_2 = 10, M_1 = 30, q = 1.5.$$



1.2 Solution

Using our minds we got such a picture:



So, the research objects are rods OC, CD and DF.

Force analysis:

We are already given with some variables, and we can find some more:

$$F_1 = 2q = 3 \quad F_2 = 3q = 4.5 \quad F_3 = 1.5q = 2.25$$

And here are the unknown parameters we need to find: $R_x^A, R_y^A, \vec{R}^B, \vec{R}^E, \vec{R}^F, R_x^C, R_y^C, R_x^D, R_y^D$

$$\begin{aligned}
\text{Rod 1: } & \begin{cases} X - axis : -P_1 \cos(\beta) + R_x^A + r_x^C & = 0 \\ Y - axis : -P_1 \sin(\beta) + R_y^A + R^B - F_1 + R_y^C & = 0 \\ M_A : OA * P_1 \sin(\beta) + M_1 + AB * R^B - (AB + \frac{BC}{2})F_1 + (AB + BC) * R_y^C & = 0 \end{cases} \\
\text{Rod 2: } & \begin{cases} X - axis : -R_x^C + R_x^D & = 0 \\ Y - axis : -R_y^C + R_y^D - F_2 & = 0 \\ M_C : -\frac{CD}{2}F_2 + CD * R_y^D & = 0 \end{cases} \\
\text{Rod 3: } & \begin{cases} X - axis : -R_x^D - R^F \cos(\alpha) & = 0 \\ Y - axis : -R_y^D - F_3 + R^E - P_2 + R^F \sin(\alpha) & = 0 \\ M_D : -\frac{DE}{2}F_3 + DE * R^E - (DE + EP_2) * P_2 + (DE + EF) * R^F \sin(\alpha) & = 0 \end{cases}
\end{aligned}$$

Then we solve it using paper and pen or like smart guys - using python.
Then we code it and get the answer. You may see the code in the folder HW4.

Here is what we get as a result:

```
[{ r_ax: 4.63926237144912, r_ay: 13.4192286340600, r_b: -2.97307621135332,
r_cx: -1.63926237144912, r_cy: -2.25000000000000, r_dx: -1.63926237144912,
r_dy: 2.25000000000000, r_e: 11.6607142857143, r_f: 3.27852474289824}]
```

So, we got the answer.

1.3 Answers

HIGHLIGHTED ANSWERS ARE HERE

$$\begin{aligned}
R_x^A &= 4.64 \\
R_y^A &= 13.42 \\
R^B &= -2.97 \\
R_x^C &= -1.64 \\
R_y^C &= -2.25 \\
R_x^D &= -1.64 \\
R_y^D &= 2.25 \\
R^E &= 11.66 \\
R^F &= 3.28
\end{aligned}$$

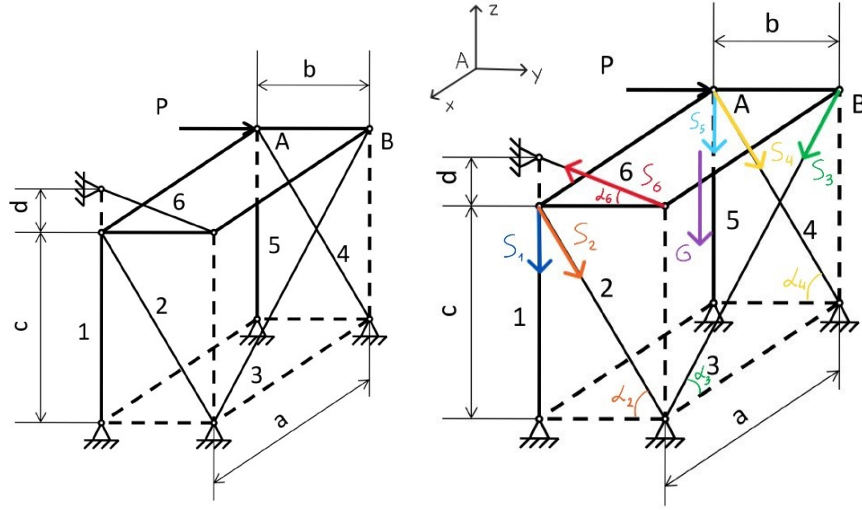
2 Task 2

2.1 Task description

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:

$$G = 10, P = 20, a = 8.5, b = 2.5, c = 3.5, d = 2$$



2.2 Solution

We have 5 fixed pin supports for 6 rods (1 - 6). So, we have 6 research objects = 6 rods.

Force analysis:

From the task we have \vec{G} , \vec{P} , and \vec{S}_1 , \vec{S}_2 , \vec{S}_3 , \vec{S}_4 , \vec{S}_5 , \vec{S}_6 - parameters we have to find.

Then we create a system of equations:

$$\begin{cases} X - axis : S_3 \cos(\alpha_3) & = 0 \\ Y - axis : S_2 \cos(\alpha_2) + S_4 \cos(\alpha_4) - S_6 \cos(\alpha_6) + P & = 0 \\ Z - axis : -S_1 - S_2 \sin(\alpha_2) - S_3 \sin(\alpha_3) - S_4 \sin(\alpha_4) - S_5 + S_6 \sin(\alpha_6) - G & = 0 \\ M_x^A : -G \frac{b}{2} - S_3 \sin(\alpha_3)b + S_6 \sin(\alpha_6)b & = 0 \\ M_y^A : S_1 a + S_2 \sin(\alpha_2)a - S_6 \sin(\alpha_6)a + G \frac{a}{2} & = 0 \\ M_z^A : S_2 \cos(\alpha_2)a - S_3 \cos(\alpha_3)b - S_6 \cos(\alpha_6)a & = 0 \end{cases}$$

Then we code the function to solve the system (see the .ipynb file in HW4 folder).

After running several times we get the correct solution:

```
[{s1: -8.750000000000000, s2: 10.7529065838033, s3: 0.0,  
s4: -34.4093010681705, s5: 23.0000000000000, s6: 8.00390529679106}]
```

So, we got the answer.

2.3 Answers

HIGHLIGHTED ANSWERS ARE HERE

$$\begin{aligned}S_1 &= -8.75 \\S_2 &= 10.75 \\S_3 &= 0 \\S_4 &= -34.41 \\S_5 &= 23 \\S_6 &= 8\end{aligned}$$

3 MEME

No comments...

