Practice 1.1 Report

Liang Yifan (Лян Ифань)

1, The Task:

Design a road, that will connect the points 1 and 2 (in fig.1) and transfer the load P=105kN (105000N).

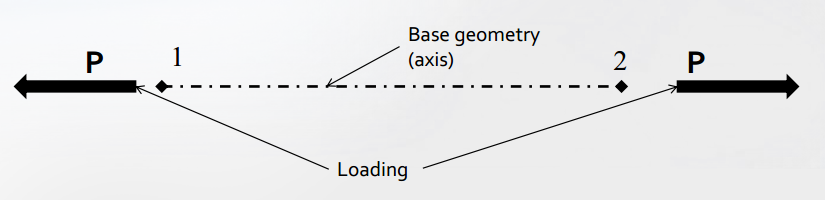


Fig. Force analysis of the task

In this task, only consider cross-sectional area and material as independent variables, ignore the other factors (such as the shape). So, use L-shape for all variants.

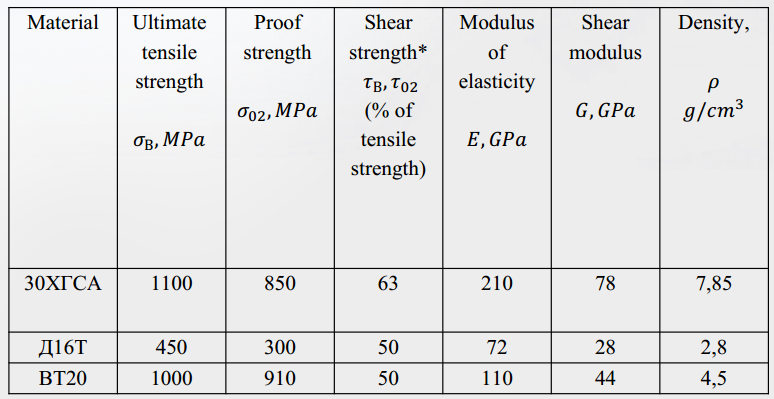
Geometry: The cross-section all along the rod is constant.

Loads: Pure tension load P leads to constant internal axial load N in the rod.

Requirements: no additional requirements.

Three material are allowable: Aluminum alloy D16T, Steel 30ХГСА and Titanium alloy ВТ20. Their ultimate tensile strength and density are as followed:

Table material parameters



2, Stress analysis

In pure tension case applied stresses are:

where F is the area of the section.

In this task N=105000N.

Assessment of the solution is based on safety factor and weight of the structure. The safety factor:

where is the ultimate tensile stress.

The weight of the length unit:

When it is optimum safety factor, is not satisfactory design, is overdesign. So the aim of the task is to find an appropriate group of material and shape such that the and the weight is as small as possible.

3, Variants design

Using L-shape for all the variants. Firstly, design some L-shape cross section with different area. The shapes and geometry parameters are as followed:

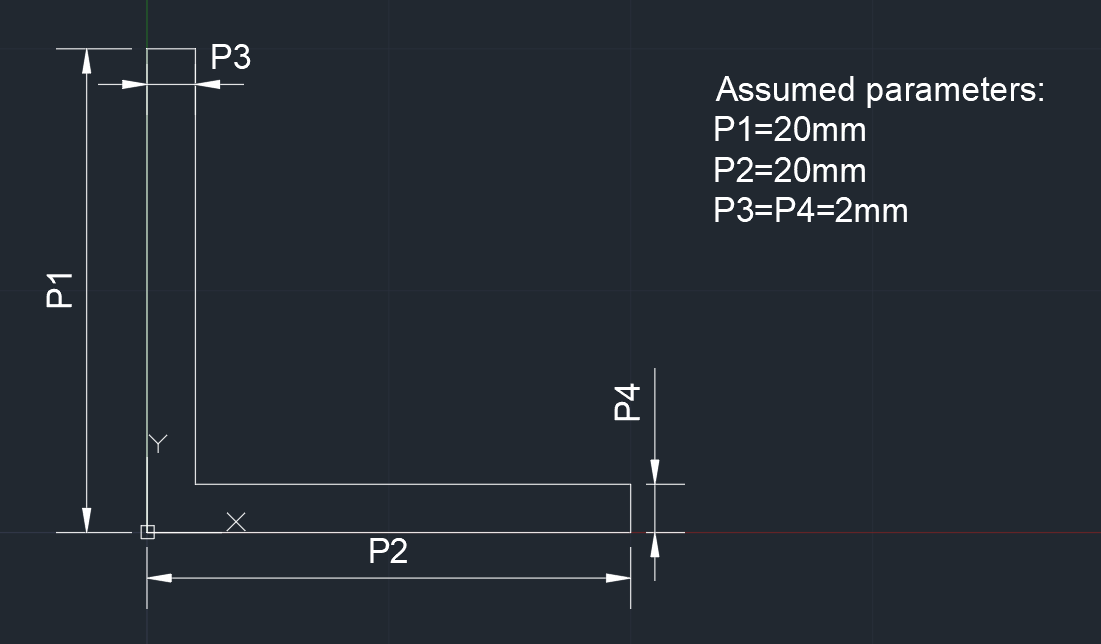


Fig. L-shape 1

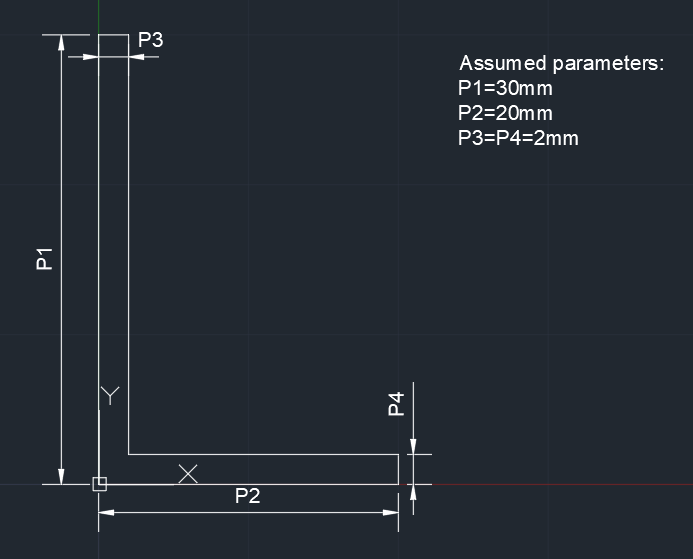


Fig. L-shape 2

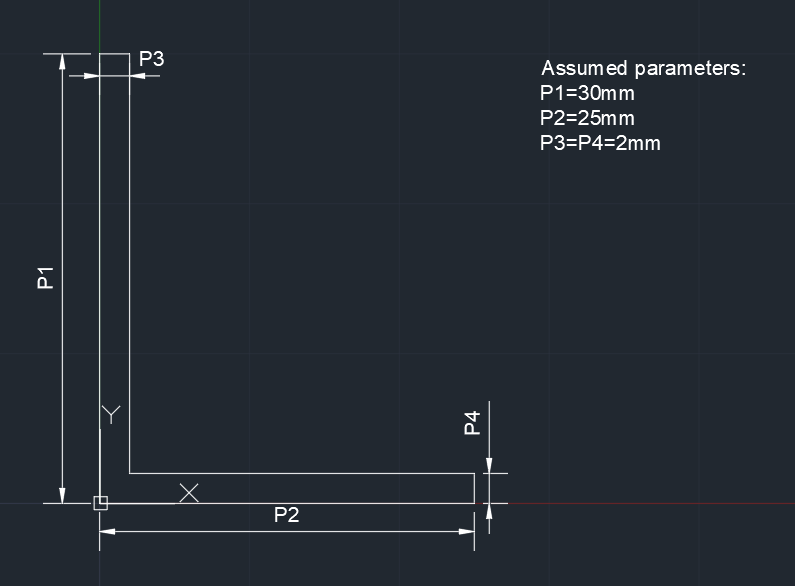


Fig. L-shape 3

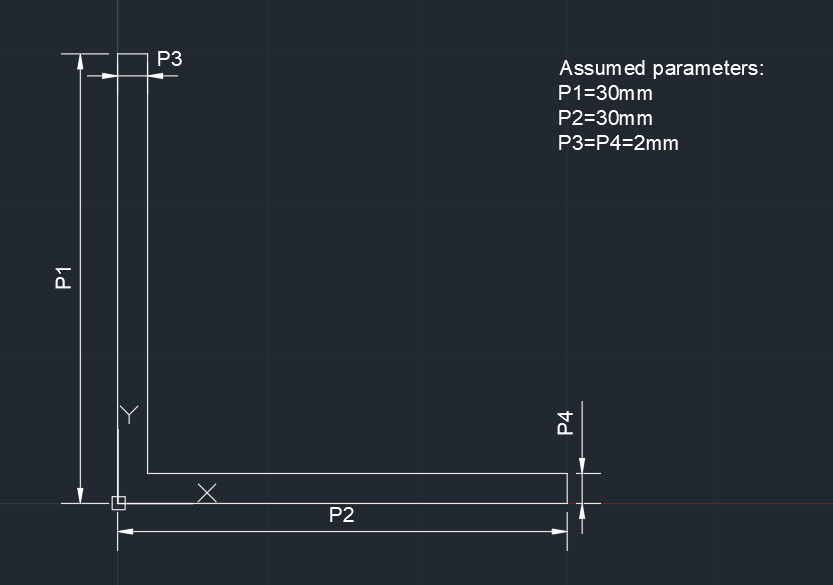


Fig. L-shape 4

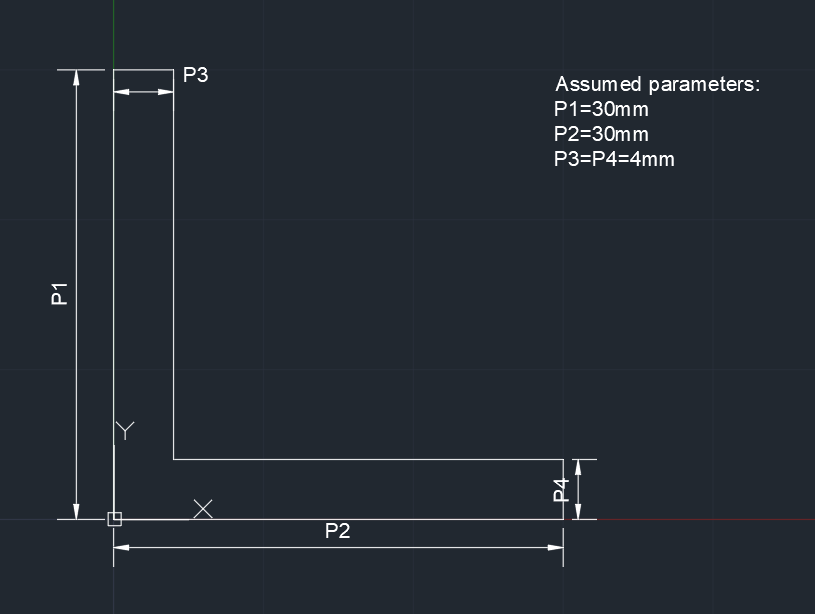


Fig. L-shape 5

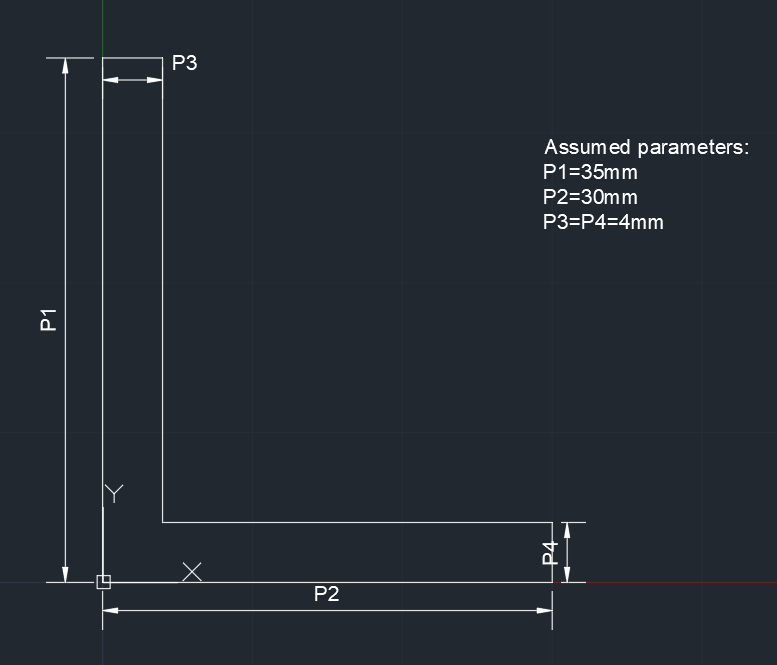


Fig. L-shape 6

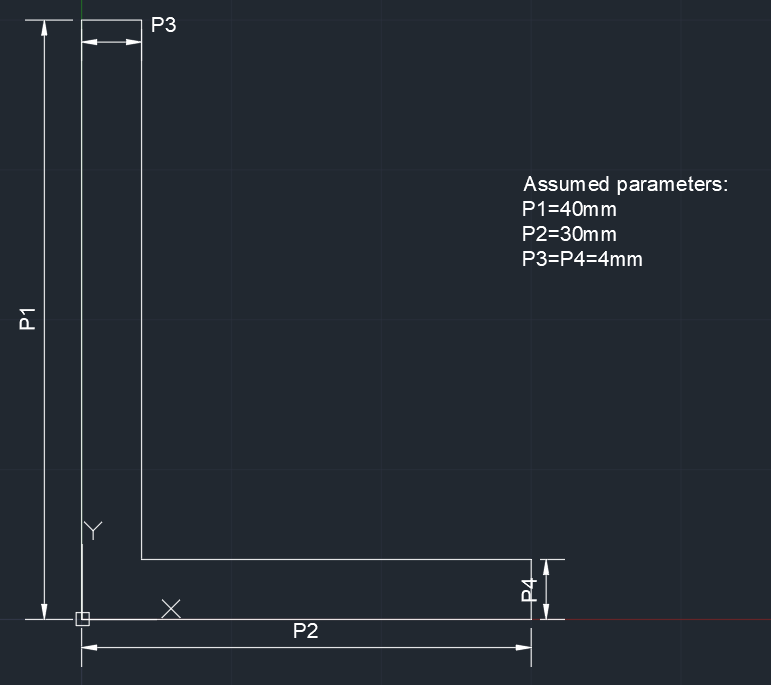


Fig. L-shape 7

Then arrange the variants with different materials and shapes. Calculate the cross-sectional area, safety factor and weight.

The results are as followed:

Table Results table



Through the table can find that the variant No.9 is the ideal case, with area 116, safety factor 1.104762 and weight 0.522kg/m.

4, The optimum variant

As we get the ideal area by calculation, the next step is to find the standard variant, which is chosen after standard higher value of area F of the optimum section 116. As it has a higher area, the safety factor would not be smaller than the former one.

Check the table of the standard variant:

Table Standard Variant Table



Through the table, can determine the final optimum variant and its geometry parameters.

Then draft the optimum section with dimensions:

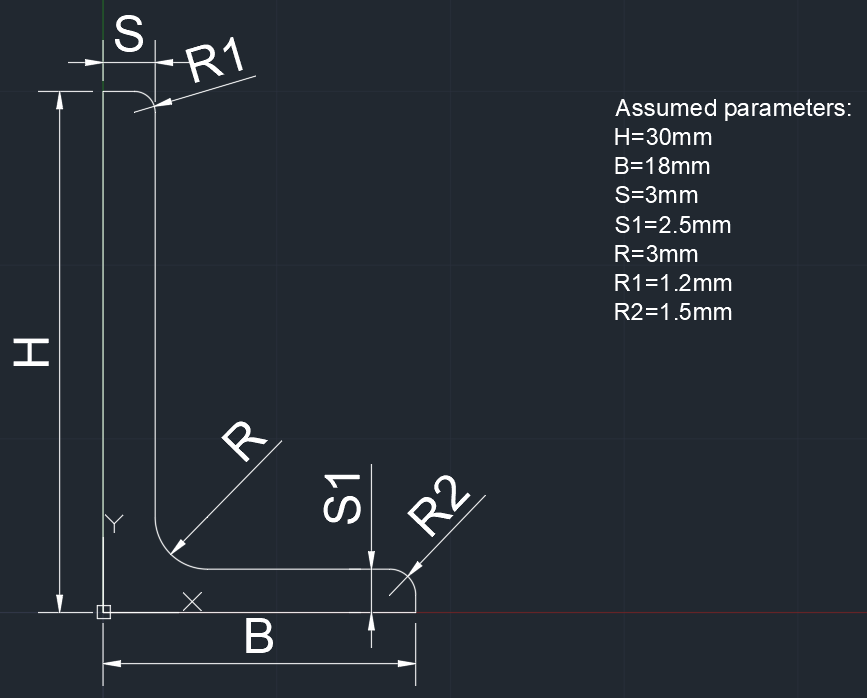


Fig. L-shape 8 (optimum)

And calculate the final safety factor and weight for the optimum variant:

Table The optimum variant



In the conclusion, the optimum variant is made with material Titanium alloy BT20, and its safety factor is 1.225138, its weight is 0.578878kg/m. Its shape is as the L-shape 8 shown in Fig.9.