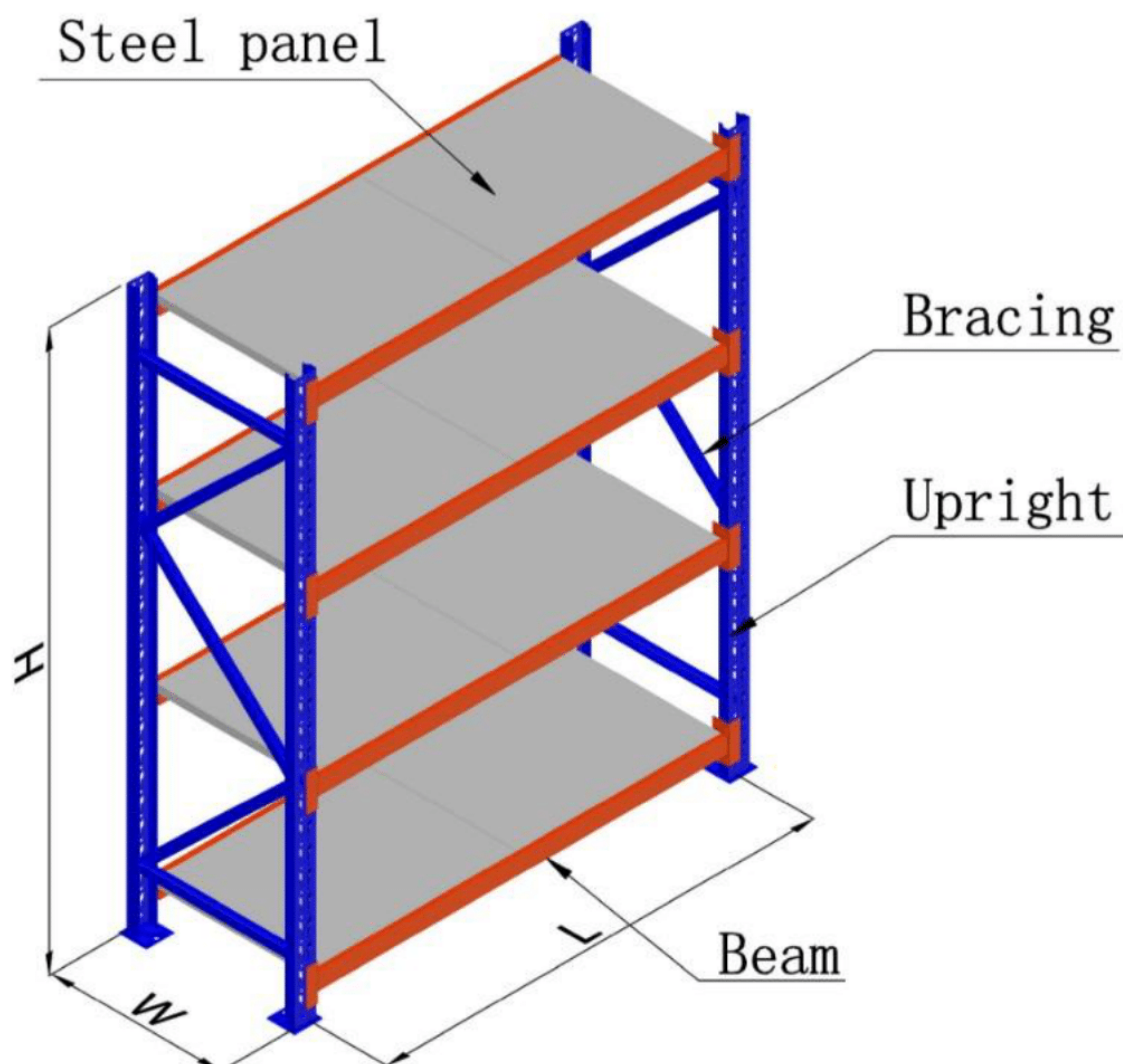


Technical Illustration

1. Shelf diagram



2. Basic parameter table of the shelf

Category	Specification	Layers	Load capacity	Remarks
Metal shelf	W2000*D600*H2000mm	4	300kg/layer	Upright: 80*40*1.0mm , Beam: P60*40*1.0mm, Steel panel: t0.5mm
Metal shelf	W1500*D600*H2000mm	4	300kg/layer	Upright: 80*40*1.0mm , Beam: P60*40*0.8mm, Steel panel: t0.5mm

3. Load-bearing analysis of each load-bearing component

Category	Specification	Dimension	Loading	Remarks
Frame	C80*40*1.0	D600*H2000	1200KG	Each Frame loading: 300kg*4=1200kg
Beam	P60*40*1.0	2000	150KG	Loading/layer: 300kg
Beam	P60*40*0.8	1500	150KG	Loading/layer: 300kg

Stiffener	Rib27*0.5	560	75 KG	Loading/layer: 300kg 4 Stiffener
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5. Description of the main load-bearing components

1) shelf--uprights

The shelf column is made of Q355 steel, and the specification is a special cold-rolled column C80*40*1.0*H2000mm. Its cross-section is shown in the figure. Through calculation, the section parameters of the column are as follows:

$$A=1.72\text{cm}^2; I_x=3.7\text{cm}^4; I_y=18\text{cm}^4; i_x=1.47\text{cm}; i_y=3.23\text{cm}$$

The clear height between beams is 600mm, according to this calculation, $\lambda_y=18.6$.

According to the relevant design standards of steel structures, the safety factor of materials is taken as 2, the safety factor of impact load is taken as 1.2, the safety factor of column members is taken as 1.2, and the load factor is taken as 1.25. The comprehensive safety factor is:

$$2 \times 1.2 \times 1.2 \times 1.25 = 3.6$$

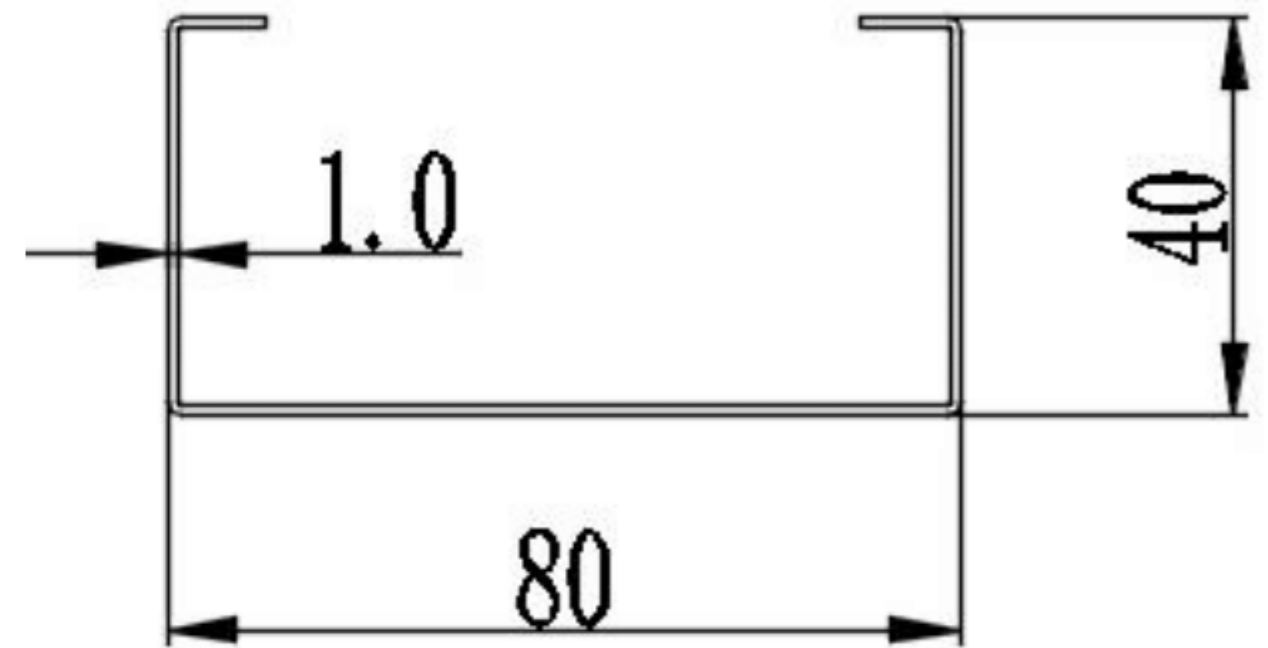
The axial allowable stress of the column is

$$[\sigma] = 355\text{Mpa} \times 0.9823 / 3.6 = 96.9\text{ Mpa}$$

The load of the column frame is 1200 kgf. The actual working stress of the column is

$$\sigma = (1200 \times 9.8\text{N} / 2) / 1.72\text{cm}^2 = 34.2\text{ Mpa}$$

It can be concluded that $\sigma < [\sigma]$, the bearing capacity of the column fully meets the bearing requirements.



2) shelf--beams

The material of the Beam is Q235, the specification is a step tube beam P60*40*1.0*L2000mm, and the load requirement is 150 kgf.

According to the relevant design codes for steel structures, the safety factor of the material is 1.2, and the structural factor is 1.15. The comprehensive safety factor is: $1.2 \times 1.15 = 1.38$. Therefore, the allowable normal stress is

$$[\sigma] = 235 / 1.38 = 170.3$$

The cross section of the Beam is shown in figure. By calculation, the section parameters of the Beam are as follows:

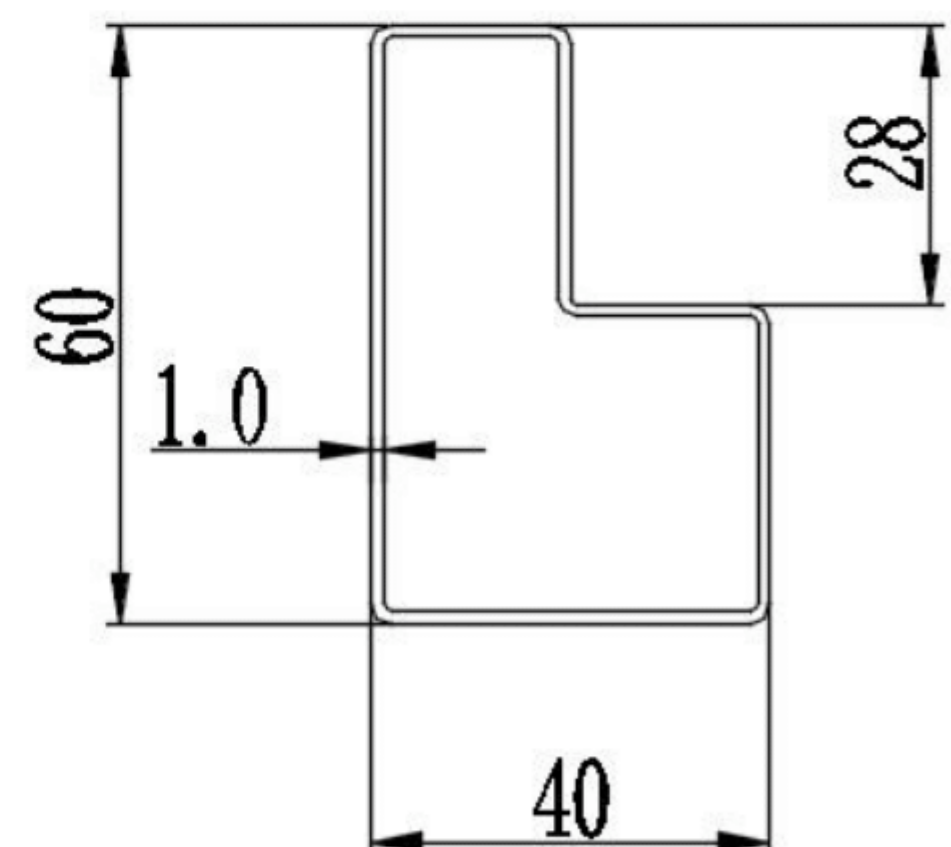
$$A=1.95\text{cm}^2; I_x=7.7\text{cm}^4; I_y=3.9\text{cm}^4; W_x=2.34\text{cm}^3;$$

$$W_y=1.7\text{cm}^3$$

① Intensity calculation

The average load of the Beam is 150 kgf. Based on this calculation, on the section of the beam, the maximum bending moment on the section is

$$M_{\max} = 368\text{ N} \cdot \text{m}$$



And further calculate the maximum bending normal stress on the section is

$$\sigma_{\max} = 157.3 \text{ MPa}$$

It can be concluded that, $\sigma_{\max} < [\sigma]$, the bending normal stress of the Beam fully satisfies the strength condition.

② Calculation of stiffness

According to the cross-sectional parameters and bearing capacity of the Beam, the maximum deflection of the Beam is calculated as

$$f_{\max} = 10 \text{ mm}$$

It can be obtained that $f_{\max} < L/200$ and $f_{\max} < 15 \text{ mm}$, the rigidity of the Beam fully satisfies the rigidity condition.

3) shelf--beams

The material of the Beam is Q235, the specification is a step tube beam P60*40*0.8*L1500mm, and the load requirement is 150 kgf.

According to the relevant design codes for steel structures, the safety factor of the material is 1.2, and the structural factor is 1.15. The comprehensive safety factor is: $1.2 \times 1.15 = 1.38$. Therefore, the allowable normal stress is

$$[\sigma] = 235 / 1.38 = 170.3$$

The cross section of the Beam is shown in figure. By calculation, the section parameters of the Beam are as follows:

$$A = 1.57 \text{ cm}^2; I_x = 6.18 \text{ cm}^4; I_y = 3.15 \text{ cm}^4; W_x = 1.88 \text{ cm}^3; W_y = 1.37 \text{ cm}^3$$

① Intensity calculation

The average load of the Beam is 150 kgf. Based on this calculation, on the section of the beam, the maximum bending moment on the section is

$$M_{\max} = 276 \text{ N} \cdot \text{m}$$

And further calculate the maximum bending normal stress on the section is

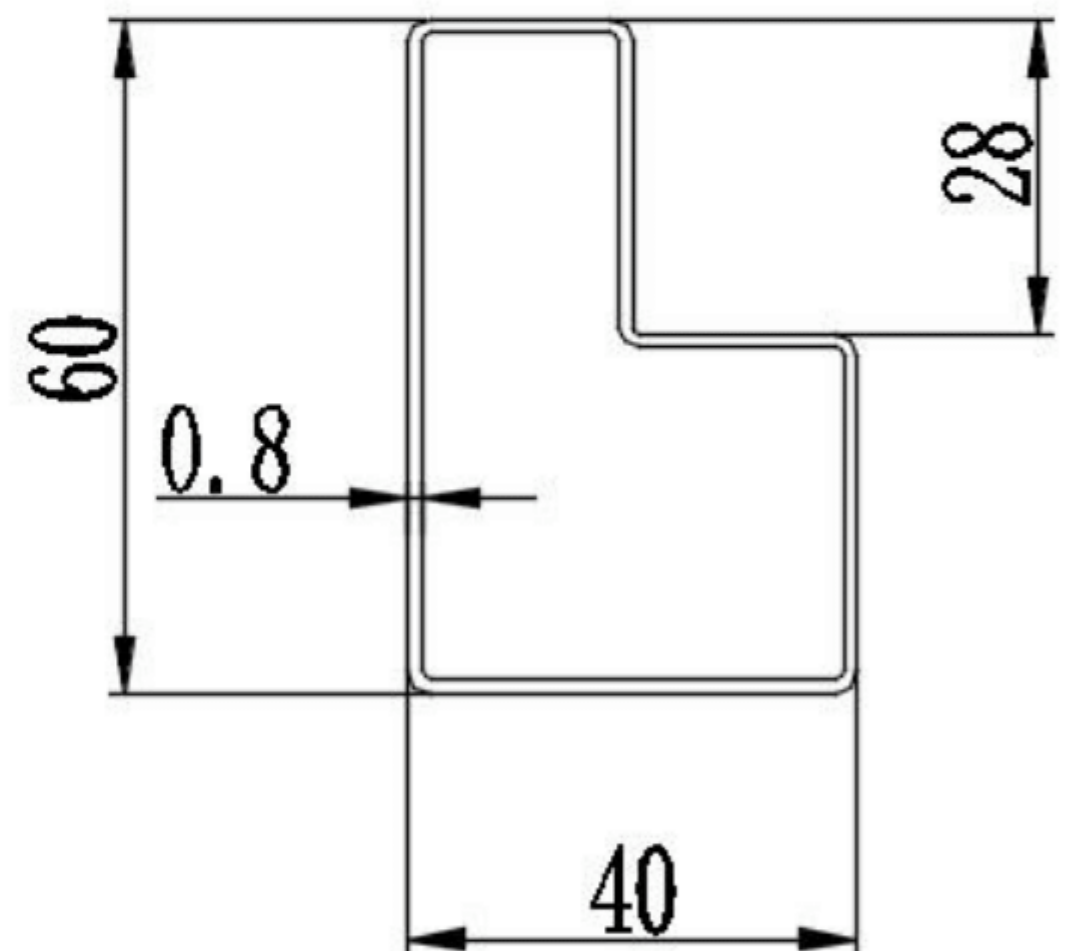
$$\sigma_{\max} = 146.8 \text{ MPa}$$

It can be concluded that, $\sigma_{\max} < [\sigma]$, the bending normal stress of the Beam fully satisfies the strength condition.

② Calculation of stiffness

According to the cross-sectional parameters and bearing capacity of the Beam, the maximum deflection of the Beam is calculated as

$$f_{\max} = 5.3 \text{ mm}$$



It can be obtained that $f_{max} < L/200$ and $f_{max} < 15\text{mm}$, the rigidity of the Beam fully satisfies the rigidity condition.

4) Stiffener

The material of the Stiffener is Q235, the specification is reinforced ribs of steel panel Rib27*0.5*L560mm, and the load requirement is 75 kgf.

According to the relevant design codes for steel structures, the safety factor of the material is 1.8, and the structural factor is 1.3. The comprehensive safety factor is: $1.8 \times 1.3 = 2.34$. Therefore, the allowable normal stress is

$$[\sigma] = 235 / 2.34 = 100.4$$

The cross section of the Stiffener is shown in figure. By calculation, the section parameters of the Stiffener are as follows:

$$A = 0.53\text{cm}^2; I_x = 1.53\text{cm}^4; I_y = 1.21\text{cm}^4; W_x = 0.55\text{cm}^3; W_y = 0.81\text{cm}^3$$

① Intensity calculation

The average load of the Stiffener is 75 kgf. Based on this calculation, on the section of the beam, the maximum bending moment on the section is

$$M_{max} = 52 \text{ N} \cdot \text{m}$$

2 And further calculate the maximum bending normal stress on the section is

$$\sigma_{max} = 94.5 \text{ MPa}$$

It can be concluded that, $\sigma_{max} < [\sigma]$, the bending normal stress of the Stiffener fully satisfies the strength condition.

② Calculation of stiffness

According to the cross-sectional parameters and bearing capacity of the Stiffener, the maximum deflection of the Stiffener is calculated as

$$f_{max} = 0.6 \text{ mm}$$

It can be obtained that $f_{max} < L/500$ and $f_{max} < 2 \text{ mm}$, the rigidity of the Stiffener fully satisfies the rigidity condition.

