结构计算

Structural calculations

1． 相应的要求

1. Appropriate requirements

顶架承重能力：大于 100kg/m^2

Top shelf weight capacity: > 100kg/m^2

底架承重能力：大于 250kg/m^2

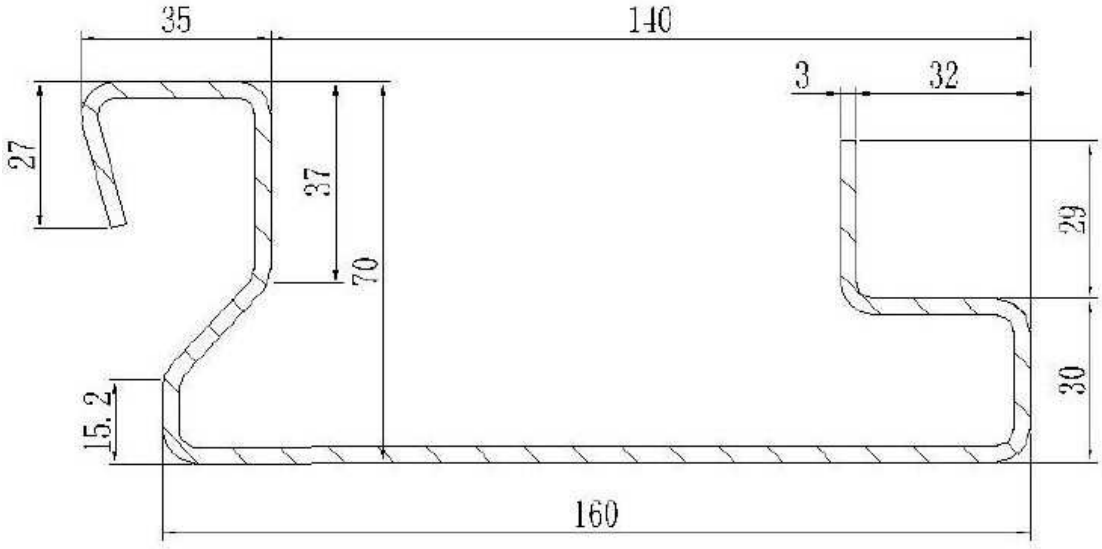
Chassis weight capacity: > 250kg/m^2

2.顶梁强度计算

2． top beam intensity calculation

a） 顶梁截面几何性质

a) the nature of the top beam cross-sectional geometry



I=4.113x$10^6$$mm^4$

W =I/y=4.113x106/91.77=44.82x$10^3$$mm^3$

b）当载荷为 100kg/m^2 时：

b) when the load is 100kg/m^2

取永久载荷分项系数 1.4，可变载荷分项系数 1.4

To take a permanent load partial coefficient 1.4, variable load partial factor 1.4

活动载荷量=（6.055x2.435）X100=1474kg

Activities load capacity =（6.055x2.435）X100=1474kg

顶架自重=360kg

Top shelf weight=360kg

总载荷=1834kg

Total load = 1834kg

每根纵梁载荷=917kg

Each stringer load = 917kg

梁上均布载荷 q=F/L=1.4x917/5635=0228kg/mm

Beam uniform load q = F / L = 1.4x917/5635 = 0228kg/mm

$M_{max}=ql^2/8=0.228x5635^2/8=0.905x10^6$kg/mm

$\sigma_{max}=M_{max}/（\gamma*W）=0.905x10^6/（1.05x44.82x10^3）=188N/mm^2＜215N/mm^2$

$\omega/l=5/384xql^3/（EI）=5/384x（0.163x9.8x5635^3）/（2.06x10^5x4.113x10^6）=4.39/1000=1/228$

底架强度计算

Chassis strength calculation

a） 载荷情况

a) load case

取永久载荷分项系数 1.4，可变载荷分项系数 1.4

To take a permanent load partial coefficient 1.4, variable load partial factor 1.4

活载荷=250kg/m^2

Live load = 250kg/m^2

总面积=6055x2435=14.74m^2

Total area = 6055x2435=14.74m^2

总载荷=250x14.74=3686kg

Total load = 250x14.74 = 3686kg

空底框架上各组装件的总重量=225kg

Empty frame on the bottom of each assembly = 225kg total weight

除空底框架之外的总载荷=3686+225=3911kg

In addition to empty bottom frame Total load than = 3686 +225 = 3911kg

长边梁：5635mm，62.7kg

Long edge beam: 5635mm, 62.7kg

短边梁：2135mm，22kg

Short edge beam: 2135mm, 22kg

横梁：2325mm，9.2kg

Beam: 2325mm, 9.2kg

叉口梁：2425mm，31.9kg

Crossings beam: 2425mm, 31.9kg

30x30 横梁：2320mm，4.1kg

30x30 beam: 2320mm, 4.1kg

b） 受力面积计算

b) calculate the force area

长边主梁受力面积=20x5635=0.1127m^2

Longitudinal girder force area = 20x5635=0.1127m^2

短边主梁受力面积=20x2135=0.0427m^2

Short side main beam force area=20x2135=0.0427m^2

横梁受力面积=50x2251=0.1125m^2

Beam force area=50x2251=0.1125m^2

叉口梁受力面积=33x2251x2=0.07428x2=0.1486m^2

Crossings beam force area=33x2251x2=0.07428x2=0.1486m^2

底架受力总面积=0.1127x2+0.0427x2+0.1125x7+0.1486x2=1.3958m^2

The total area of Chassis force=0.1127x2+0.0427x2+0.1125x7+0.1486x2=1.3958m^2

c） 计算各梁所受的力

c) calculating the force of the beam

各部分受到的压强=3911/1.3958=2802kg/m^2

Each part by pressure=3911/1.3958=2802kg/m^2

长边主梁受到的力=2802x0.1127=315.79kg

The long side of the main beam by force=2802x0.1127=315.79kg

短边主梁受到的力=2802x0.0427=119.65kg

Short side of the main beam by force=2802x0.0427=119.65kg

横梁受到的力=2802x0.1125=315.23kg

The force on beam=2802x0.1125=315.23kg

叉口梁受到的力=2802x0.07428x2=208.13x2=416.26kg

Crossings by force beam=2802x0.07428x2=208.13x2=416.26kg

d） 得到各梁的受力情况（考虑自重和侧板）

d) to obtain the force of the beam (considering weight and side panels)

i. 短边主梁：有梁上均布载荷 q=1.4x（119.65+22+80）/2135=0.1453kg/mm

i. short side main beam: a beam uniform load q = 1.4x (119.65 +22 +80) / 2135 = 0.1453kg/mm

ii. 横梁：有梁上均布载荷 q=1.4x（315.23+9.2）/2251=0.2017kg/mm

ii. Beam: There beam uniform load q = 1.4x (315.23 +9.2) / 2251 = 0.2017kg/mm

iii. 叉口梁：有梁上均布载荷 q=1.4x（416.26+31.9+4.1）/2251=0.2813kg/mm

iii. Crossings Beam: There beam uniform load q = 1.4x (416.26 +31.9 +4.1) / 2251 = 0.2813kg/mm

iv. 长边主梁：有梁上均布载荷 q=1.4x（315.79+62.7+200）/5635=0.1438kg/mm

v. longitudinal girder: Yes beam uniform load q = 1.4x (315.79 +62.7 +200) / 5635 = 0.1438kg/mm

有集中载荷，如图所示：

Have concentrated load, as shown:

e） 强度验算

e) strength checking

I. 短边主梁

I. Short side main beam

1.抗压强度验算

1.A compressive strength checking

$M=1/8ql^2=1/8x0.1453x2135^2=82789kg/mm$

$\sigma=M/(\gamma*W)=82789/(1.05X41.73X10^3)=18.52N/mm^2<215N/mm^2$

式中 为塑性发展系数，在这里材料为 Q235A,取 γ=1.05，下同

The plastic coefficient of development, Material is Q235A, γ=1.05

2.挠度验算 The deflection calculation

$\omega/l=5/384xql^3/(EI)=5/384x(0.1453x9.8x2135^3)/(2.06x10^5x30148x10^6)=0.2/1000$

II. 横梁 Beam

1. 抗弯强度验算 Compressive strength calculation

$M=1/8ql^2=1/8x0.2017x2251^2=127752kg/mm$

$\sigma=M/（\gamma*W）=127752/(1.05x13.99x10^3）=85.23N/mm2＜215N/mm2$

2. 挠度验算 The deflection calculation

$\omega/l=5/384xql^3/(EI)=5/384x(0.2017x9.8x2251^3)/(2.06x10^5x0.792x10^6)=1.8/1000$

III. 叉口梁 Fork beam

1. 抗压强度验算 Compressive strength calculation

$M=1/8ql^2=1/8x0.2813x2251^2=178168kg/mm$

$\sigma=M/（\gamma*W）=178168/（1.05X22.5X10^3）=73.91N/mm2＜215N/mm2$

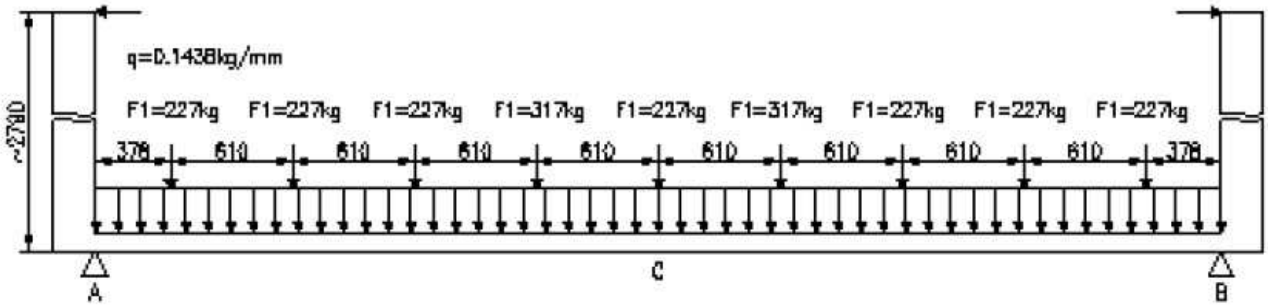
2. 挠度验算 The deflection calculation

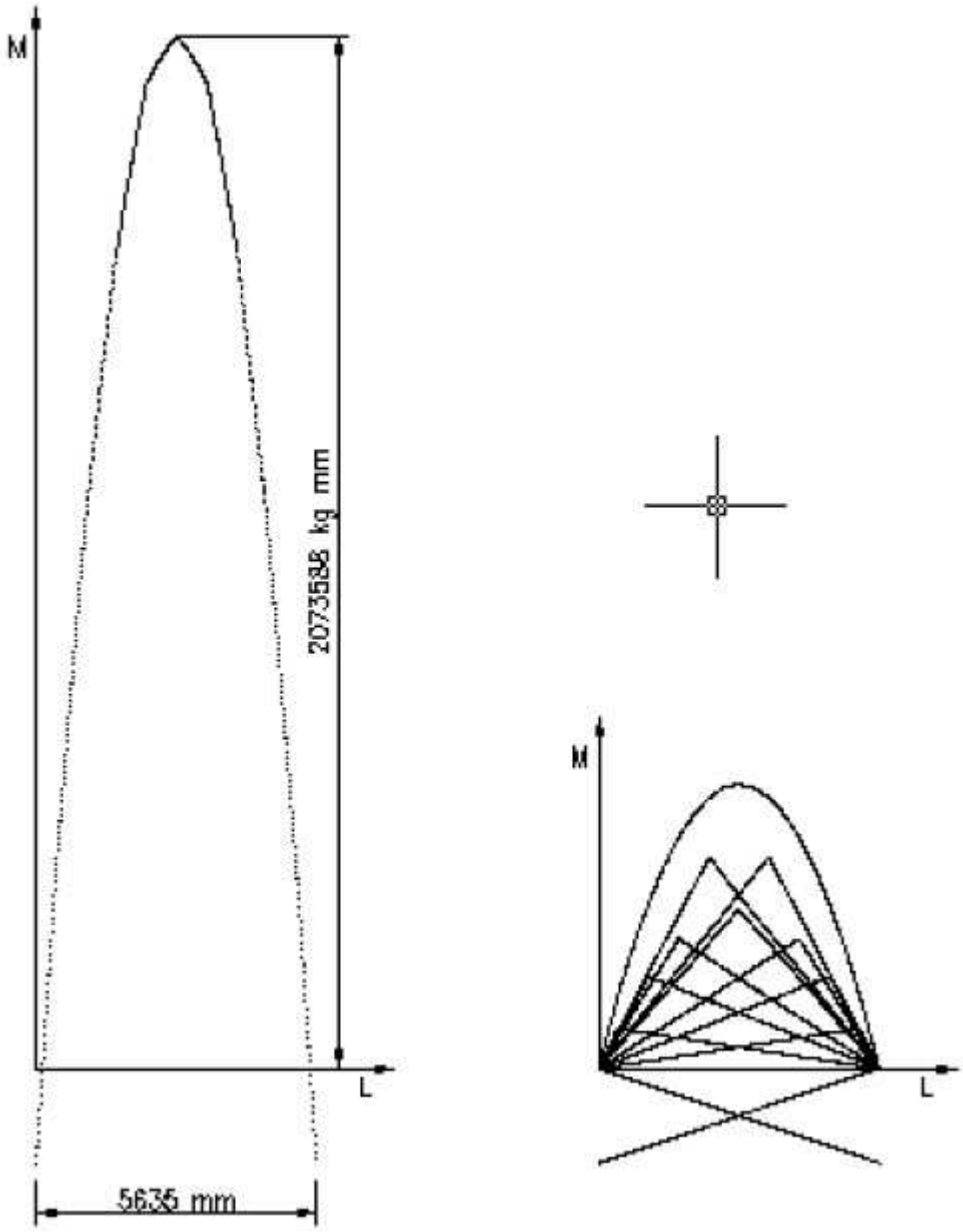
$\omega/l=5/384xql^3/(EI)=5/384x(0.2813x9.8x2251^3)/(2.06x10^6x1.26x10^6)=1.58/1000$

IV. 长边主梁 Long girder

3. 抗弯强度验算 Compressive strength calculation

当地板受到 250kg/m² 的载荷时，底梁的受力图和弯矩图如下所示：The sill of diagram and bending moment diagram show as below when the local board by a load of 250 kg/m2





左图为底梁弯矩图，右图为各分力在底梁上产品的弯矩图。Bottom beam bending moment diagram is on left picture, Each component on the bottom of beam bending moment diagram of the product is on right picture.

得底梁上最大弯矩 maximum bending moment on the bottom beam M_{max}、=2.0736x10^{6}kg/mm

σ=M/（γ*W）=2.0736x10^6/（1.05x41.73x10^3）=463.78N/mm2＞215N/mm2(不符合要求)

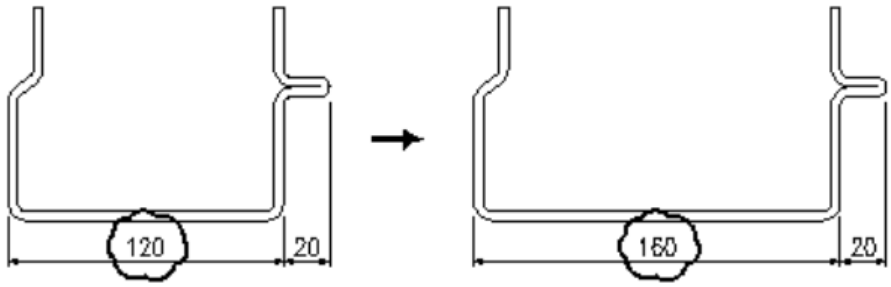
为了能满足 250kg/㎡的要求，需要加强底梁。根据经验，底梁高度取 170～180 ㎜

Need to strengthen the bottom beam to meet the requirements of 250 kg/m2。According to the experience, the height of bottom beam need to reach 170～180 mm.

比较合理，经济。To be reasonable and economic

建议把底梁的高度从 140㎜ 改为 180㎜,

Suggested that the height of bottom beam to be changed from 140㎜ to 180㎜



修改以后，其惯性矩 I 由原来的 $30148x10^{6}mm^{4}$ 变成 $6.426x10^{6}mm^{4}$，截面模

With its moment of inertia I of $30148x10^{6}mm^{4}$ into $6.426x10^{6}mm^{4}$, section modulus after the modification

数 W 由原来的 $41.73x10^{3}mm^{3}$ 变成 $70.21x10^{3}mm^{3}$，把刚才的 M_{max} 代入，

Changing the value W from $41.73x10^{3}mm^{3}$ onto $70.21x10^{3}mm^{3,}$ and substitute M_{max}

得 σ=M/（γ*W）=2.0736x10^6/（1.05x70.21x10^3）=276N/mm^2

把底梁的材料从 Q235 改为 Q345，这样子，在 250kg/m^2 的情况下，底梁能满足要求。

With the bottom beam material Q345 instead of Q235, thus, It can meet on 250kg/m^2

总结：原来的底梁不能满足 250kg/m^2 的要求，为了能满足 250kg/m^2 的要求，

Conclusion:: It can't meet 250kg/m^2 under old bottom beam,

建议将底梁高度由原来的 140mm 改为 180mm，材料由原来的 Q235 改为 Q345.

To suggest that change the bottom beam height from 140mm onto 180mm, to use the material Q345 instead of Q235

1. 挠度计算 The deflection calculation

挠度 1=5⁄384xql^3/EI=5⁄384x(0.1438x9.8x5635^3）/2.06x10^{5}x6.426x10^6）=2.48x10^{-3}

挠度 2=K_wxFl^2/EI=1.11x227x9.8x5635^2/(2.06x10^{5}x6.426x10^6）=59.23x10^{-3}

挠度 3=K_wxFl^2/EI=0.5x89.6x x9.8x5635^2/(2.06x10^{5}x6.426x10^6）=10.53x10^{-3}

ω/l=2.48x10^{-3}+59.23x10^{-3}+10.53x10^{-3}=72.24x10^{-3}

总结：防震级别*（8.1 级）Conclusion: Seismic rate* 8.1