Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2014, 6(1):104-108

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

The steel structure analysis and optimization of C bridge crane

Yu-xi Liu*, Zong-zheng Ma, An-jie Yang and Xin-li Wang

Department of Mechanical Engineering, Henan Institute of Engineering, Zhengzhou, China

---

ABSTRACT

The steel structure for C Bridge Crane is mainly studied in this thesis. On the basis of the model , finite element analysis is been for the steel structure for C Bridge Crane stress and the stress displacement of the steel structure for C Bridge Crane are concluded. The structure optimization is been in order to provide the theoretical references for C Bridge Crane's design and analysis.

Key words: crane, Analysis of the Stress, Optimization

INTRODUCTION

The design bridge includes main bridge girder, end beam, C beam, beams and rails connecting components. And the aim is modeling and optimized using finite element method analysis (FEM).

Modeling

The model includes the main beam, C beam, carts end beam, connecting beams and rails and the main beam is welted[1-6]. So the outside the main beam steel is completed by stretching thin features and some necessary partitions and ribs are set. Then the main beam is connected by side beam and the trolley track is set in the main web. Then the figure 1 is the assemble structure.

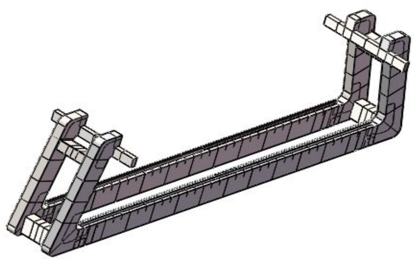

Fig.1 the assemble

Finite element analysis and optimization

The analysis target

The target of this analysis is verified the strength and stiffness of C bridge crane based on relevant national standards. And the focused sites are the C-beam arc transitions, the strength of the middle floor of the main beam and the maximum amount of deflection of the main beam.

Based on the object the SolidWorks software is used for three-dimensional digital modeling and the analysis is done by SolidWorks Simulation with static analysis.

three-dimensional models

The main structure of LHG16-16.67 hoist double girder crane is welted by steel plate with different spatial direction which can be seen from figure 2.

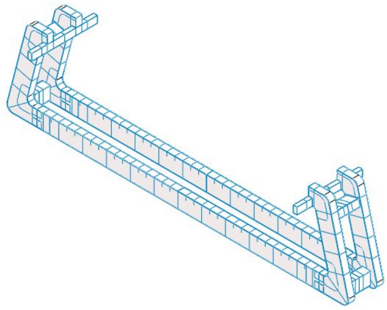

Fig.2 Main structure of LHG16-16.67 hoist double girder crane

Model of Steel

It can be seen that the LHG16-16.67 double girder bridge crane is mainly made of welded plates, so the main steel using surface modeling and the trolley track mode using standard soldering profile. Because of the symmetry around the steel structure, the analysis model is taken as 1/2 of the overall three-dimensional model which is shown in Figure 3.

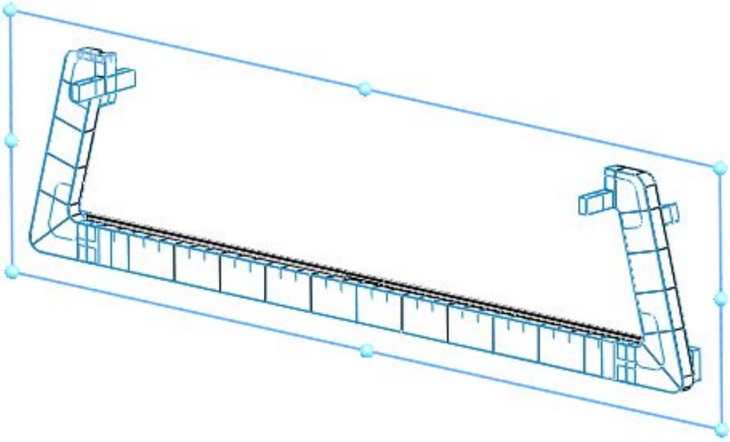

Fig.3 Model of analysis

Material Properties

LHG16-16.67 double girder bridge crane body adopts Q235 steel plate welded and the mechanical properties of materials are: elastic modulus 200GPa, Poisson's ratio 0.3, density 7.85 g/mm^3, the tensile strength of 375MPa and the yield strength of 235MPa.

Constraints

According to the actual situation, the static displacement constraints imposed on the end of the beam and symmetric constraint in the symmetry plane of the finite element model is used.

Load

The load is suffered onto crane girder in the middle section of track and dead weight of the crane is calculated based given characteristics of the structure and applied to the model automatically.

Lifting weight P_1=16t, the dead weight of the carP_1=2t, load impact factor $\phi_1 = 1.1$.

$$p = \frac{(P_1 + P_2) \times \phi_2}{2} = \frac{(16+2) \times 1.1 \times 9.8 \times 1000}{2} = 97 \times 10^3\, N$$

Discrete

Second-order triangular shell element discrete model is used and the mesh size is 70mm, the model number is 56500 and the nodes is113,000. The mesh model is shown in Figure 4.

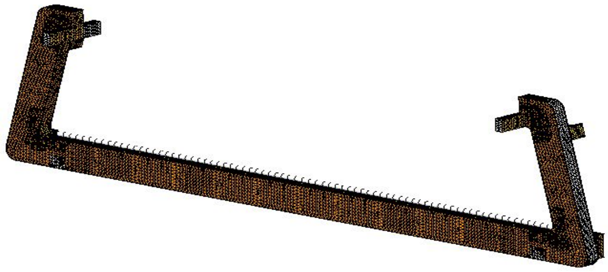

Fig.4 Mesh model

RESULTS AND DISCUSSION

Strength Analysis

The stress distribution of LHG16-16.67 double girder bridge crane main structural is shown in Figure 5. It can be seen from the figure that the maximum stress at the transition point of the arc in the C-beam and the value is σ_1=58.2MPa and the other large stress area is the lower panel of the main beam and the value is δ_2 =50.4MPa. Then the safety factor n can be calculated by $\frac{\sigma_s}{\sigma_1} = \frac{235}{58.2} = 4$ which meet the strength requirements.

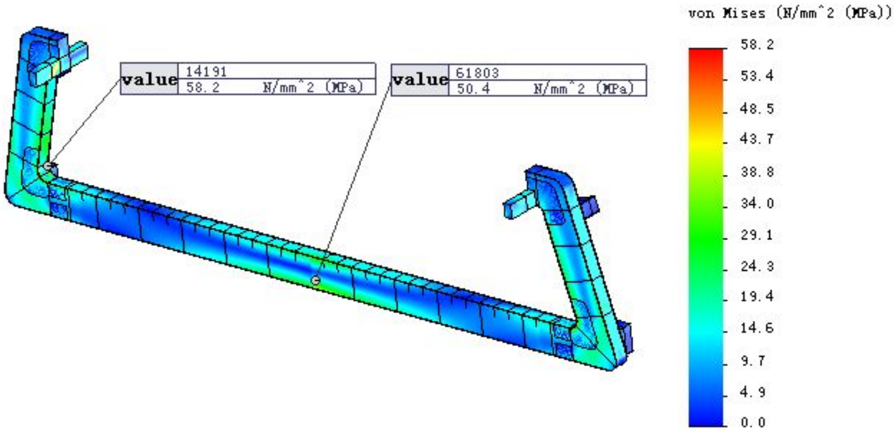

Fig.5 Stress distribution of the bridge

Stiffness Analysis

The deflection distribution of the LHG16-16.67 double girder bridge crane is shown in Figure 6. And the maximum deflection occurs in the lower middle of the main beam which the maximum amount under torsion S1 = 9.68mm.The length of the main beam is L = 17753mm and the maximum allowed under national standards deflection S = L/1000 = 17.75mm, so this type of crane deflection is less than 1/1000 and therefore meet the stiffness requirements.

It can be concluded that the strength and stiffness of the LHG16-16.67 double girder bridge crane meet the national standards.

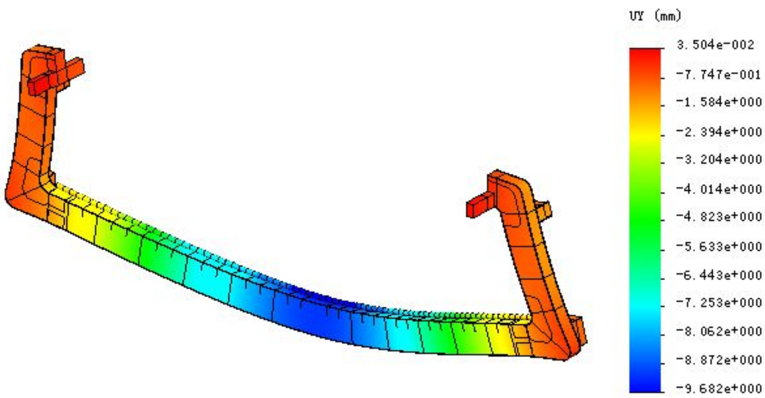

Fig.6 The deflection distribution of the LHG16-16.67

Optimization
From the above results that, the stiffness and strength is adequate but with a large safety factor which results in a waste of material cost. So the optimization is needed.

The first optimization
The first optimization is reducing the thickness of the plate by 1mm. It can be seen from the re-analyzed in figure 7 that the stress and the safety factor distribution. From the figure it can be get that the maximum stress σ = 86MPa and safety factor is 2.7 which still meet the strength requirements.

It can be confirmed from figure 8 that the maximum deflection is 10.65mm which is smaller than 17.75mm.

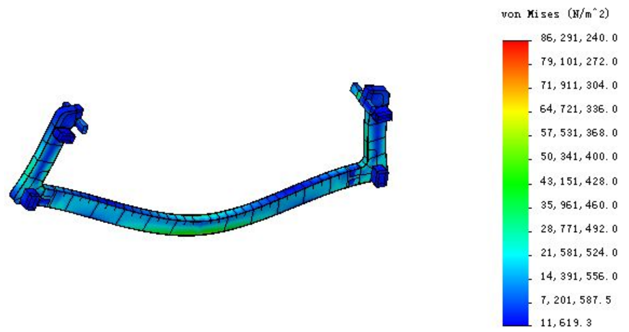

Fig.7 The Stress and safety factor of first optimization

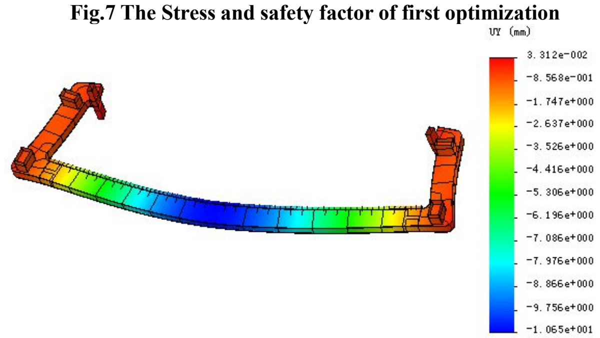

Fig.8 The deflection of first optimization

Second optimization
Due to the above results still meet the requirements , so the decrease of thickness is still done which the plate thickness decrease by 3mm while the plate thickness of 8mm reduce by 2mm.And the analysis results are shown in Figure 9, Figure 10.

It can be seen from Figure 9 that the stress σ=99.6MPa and the safety factor n = 235/99.6 = 2.3 which meet the strength requirements. It also can be obtained from figure 10 that maximum deflection amount S =15.59mm which still lower than 17.75mm.

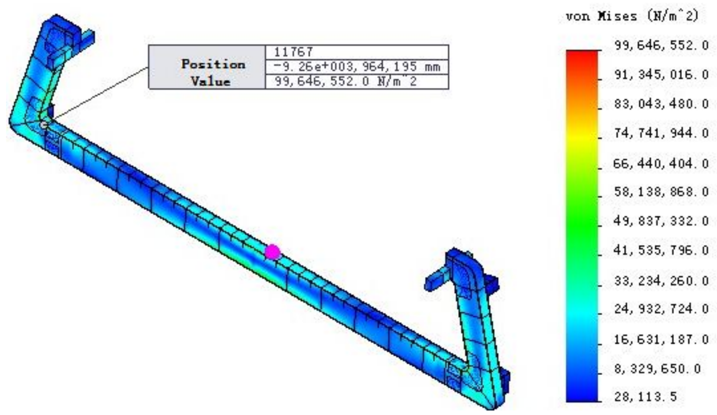

Fig9 The Stress and safety factor of second optimization

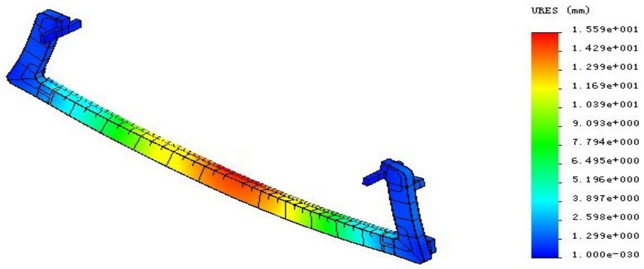

Fig. 10 The deflection of second optimization

CONCLUSION

From the analysis the above it can be concluded that this result is the optimal value to meet the strength requirements of stiffness and strength. After optimization of the thickness of the steel plate thickness of 10mm is reduced by 3mm while the thickness of the plate thickness reduction of 8mm is reduced by 2mm which saving of approximately 25% by weight of the steel sheet. Therefore, it can reduce the cost of the product.

REFERENCES

[1] YB, Pang; LF, Yu. Optimized design in blue peak double girder gantry crane truss girder, 1st Edition, Heavy Machinery Science and Technology Press, **2007**: 66-253.
[2] YJ,Qu. *Mechanical Research & Application,***2011**,3:22-25.
[3] LX, Meng; YD, Hu. *Chinese Journal of Construction Machinery,* **2011**, 2:127-133.
[4] CF, Teng; KY, Liu. *Chinese Journal of Construction Machinery*, **2011**, 2:194-199.
[5] WN, Zhang; WM, Cheng. *Chinese high-tech enterprises,* **2011**, 3:23-24.
[6] LJ, Wang; L, Zhang. *Mining machinery*, **2011**, 7:86-88.