Design and Research of Steel Beam Double Break Support Platform in Long Span Steel Roof System

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Abstract

At present, the steel roofing containment systems are all constructed with mobile scaffolds. The erection speed is slow, the movement is inflexible, and it needs to be erected several times. Large-span high-level operation platforms are designed to avoid instability, and their working face is relatively narrow, which is not conducive to construction. Therefore, the construction quality is difficult to guarantee; at the same time, personnel may suffer safety accidents due to the problems of the stability of the upper and lower rack bodies. Therefore, this paper first analyzes the selection principle of the steel beam double break support platform and the steel beam double bleak support platform. The design was carried out, and then ANSYS Workbench analysis software was used to perform finite element analysis of the support platform and support frame, confirming the rationality, reliability and safety of the structure. After the successful design of the platform, it is a major breakthrough in the rapid installation of steel structure roof protection system, which can reduce safety risks, reduce labor costs for assembling scaffolds and boards, reduce labor intensity, and make the width of the operating platform no longer subject to site constraints. Construction efficiency has improved significantly, bringing good economic and social benefits.

Keywords

Steel structure, Steel beam double break support platform, inite element analysis.

1. Introduction

At present, the industrial building occupies half of the steel structure installation, and more and more industrial buildings also take the steel structure as the first choice. The span and height of the steel structure are also high and high, but at the same time it also brings challenges to the construction of the roof enclosure system. The C purlin, drawing bar, corner bracing, roof panel and other components are high installed. There are hidden dangers and visual effects in the operation of the work. Often, the quality of reinforcement and detailed treatment are not in place due to insufficient working face and safety considerations[1-4]. The study and application of the rapid installation of large span steel structure roof enclosure system is to use the beam of the steel structure workshop as the supporting system to build the construction operation platform, reduce the overall height of the construction, use the enclosure system to increase the safety performance, and at the same time increase the width of the working face arbitrarily, so that the installation face is wider, Using the universal wheel to make the operation platform more convenient, so as to avoid the security risk, improve the quality of the project, reduce the workers' expenditure and improve the work efficiency, so the economic and social benefits are remarkable.

At present, the steel structure is widely used in industrial plant, high-rise building, terminal building, railway station, railway station, thermal power plant, bridge and other fields. Especially in recent years, with the rise of electric business, the demand for modern logistics and storage will increase dramatically. By the end of 2013, China's logistics facilities totaled 550 million square meters, with a per capita storage area of 0.41 square meters[5-8]. 1/12 for the United States. According to the forecast of the largest logistics developer in China, China's per capita storage area is expected to reach 1.74 square meters in 2029, with a total supply of 2 billion 400 million square meters, an annual

increase of 10.3%, a new logistics facility of 1 billion 850 million square meters, and a reference to the domestic development level and the planning of the Ministry of housing and construction. Become a trillion market, with the continuous advance of the national "The Belt and Road" strategy, the steel structure in the vast overseas market will open up a broader space display skills to the full, for long-term development, so affect the safety of the steel beam, large span steel structure roofing enclosure system long quality and progress in double break support platform is more We study and discuss.

2. Design of Steel Beam Double Break Support Platform

2.1 Design Principle and Selection of Steel Beam Double Break Support Platform.

The design of steel girder double slope support platform should be considered according to the following principles:

(1) The support platform system includes a support platform panel system and a support platform support system, and the two parts should be designed separately. Analyze according to various stress conditions during the construction process to determine the most unfavorable combination of effects.

(2) When designing a support platform system, not only must the strength and stiffness of the platform be taken into consideration, but also how the platform material can better ensure the quality of the roof molding appearance. According to the quality requirements of the platform and the bracket deformation value, take 1/400 of the calculated span of the bracket platform components, and should be less than 2mm.

(3) The focus of the design support system is to consider the stability and safety of the support. At the same time, it should take into account the ease of assembly on the narrow site of the site, reducing labor costs and project cost needs.

(4) The selection of the overall steel-beam double-slope support platform system composed of the platform system and support system is to use as much as possible a stereotyped tool-type product to avoid time-consuming customization and increase the cost, and the stereotyped tool is characterized by the availability of turnaround and reuse. To better reduce the project cost.

2.2 Design of Support Platform.

The vertical rib of the supporting platform is H type steel beam (400 x 200 x 8mm), the horizontal rib is double channel steel (12#), the horizontal spacing of the carpenter's beam is 260~300mm, the platform is 5 meters high, and the transverse flute is five channels. The distance between the back and the corrugated is 800mm, 1200mm, 1200mm, 1000mm, 300mm, respectively, as shown in Figure 1. In the single block, the multi-layer plate is connected with the steel I-beam through the nail, and the steel I-beam and the double channel steel are connected to the whole by the special connection claw. The connection between the steel beams is connected by the additional reinforcing core band. In order to make the force of the platform reasonable and reliable, the core band pin is inserted tightly to ensure the integrity of the platform, and the hoisting ring is set on the steel I-beam in the symmetrical position to facilitate the hoisting of the platform.

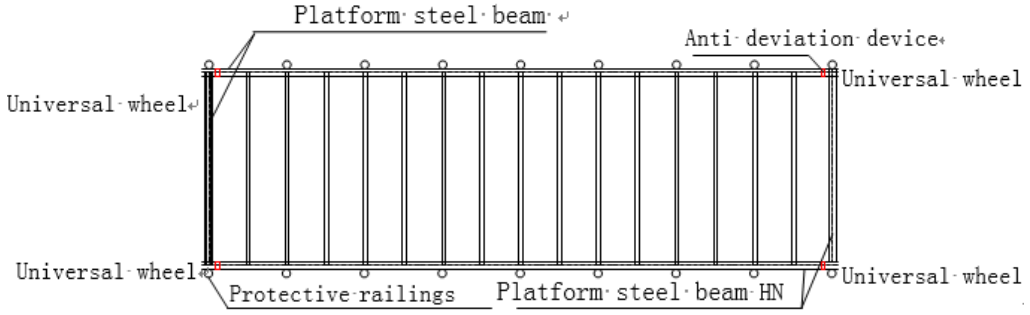

Fig. 1 Support Platform Sketch Map

2.3 Design of Bilateral Stents

Considering the temporary support properties of the steel beam double slope support platform, the most unfavorable conditions for the construction and construction, the discreteness of the test results, the various favorable conditions of the test site and the repeated use of the steel tubes, the principle of determining the length is calculated. The theoretical calculation results have 40% bearing capacity safety reserve relative to the test results, that is to say, the test results are in the test. The calculated bearing length is multiplied by 0.6 based on the calculated bearing length. With the above analysis method, the calculated length can be corrected by pressing.In order to prevent overload, a safety relief valve 2 is set up. Overload valve is installed on the pipeline of the turntable hydraulic motor 11, the telescopic hydraulic cylinder 8 and the luffing hydraulic cylinder 9, so as to prevent overload damage of the components[9-10].

(1) when there is no shear bracing, the calculated length is calculated by the following formula:

$$l_0 = 1.45(h + 2a)$$

(2) when only horizontal shear braces are installed, the calculated length is calculated by the following formula:

$$l_0 = 1.25(h + 2a)$$

(3) only when vertical shear braces are set up (with special fastener connections), the calculated length is calculated in the following way:

$$l_0 = 1.30(h + 2a)$$

(4) setting up horizontal shear braces and vertical shear braces at the same time (using special fastener connection) and calculating the length by the following calculation:

$$l_0 = 1.10(h + 2a)$$

The height of the frame is the following specifications: H=3600mm standard section, H=500mm heightening section, and the rack body adopts H type steel pipe support to erect the platform. In the steel frame, 1.5 square meters are welded to 100 * 60 square tubes. The ends of the square pipes are welded with L=100mm long, 10 10 * 8 angle steel and steel beam lower wing plates. According to the roof slope, the H beam is welded into the steel beam frame, as shown in Figure 2.

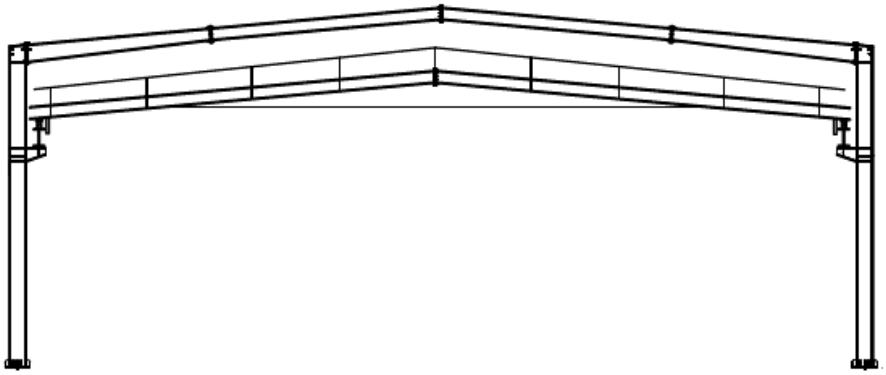

Fig. 2 Schematic Diagram of Bilateral Support Support

For the sake of reasonable force of the frame, the steel pipes and fasteners should be provided at the scene to connect several frames to the whole, and the angle plane should be connected to the platform. When the roof is constructed, the lateral pressure is transmitted to the platform, and the force on the platform is backward thrust. At this time, the frame supports the platform, and the fixed effect of the embedded system which is presupposed at the right angle of the lower end of the frame can not move the frame back. The buried part system counteracts the lateral pressure and the upward thrust of the platform.

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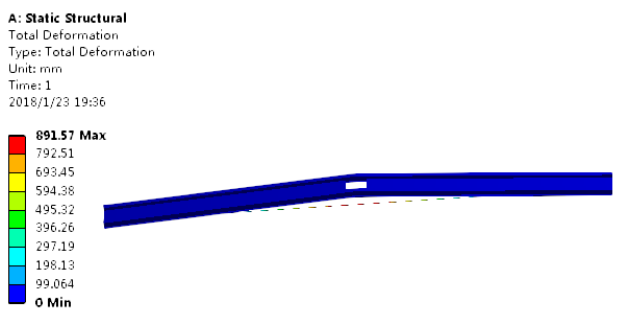
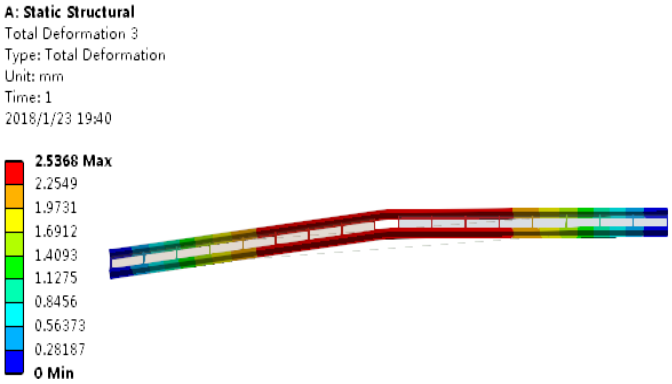
3. Finite Element Analysis of Steel Beam Double Break Support Platform

The ANSYS Workbench finite element software is used to simulate the supporting platform of the steel beam double slope support platform. The steel pipe specification is T48 x 3.2, the steel is Q235, and each rod is divided into 1 units. Depending on the actual situation, the corresponding constraints and concentrated loads are applied. Through the finite element model of supporting platform supported by vertical and no horizontal syncline under loading, the bearing capacity analysis is carried out, and the finite element analysis is carried out on the supporting platform of steel wire tension, board top and pure steel frame respectively in three kinds of state. The total deformation diagram in the three states is shown in Figure 3.



(a) Steel Wire with Wire Drawing

(b) Under the Top of the Plank

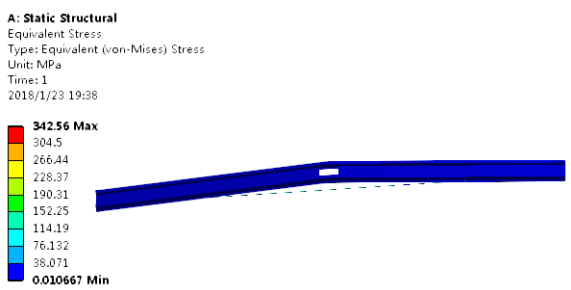


(c) Under Pure Steel Frame Structure

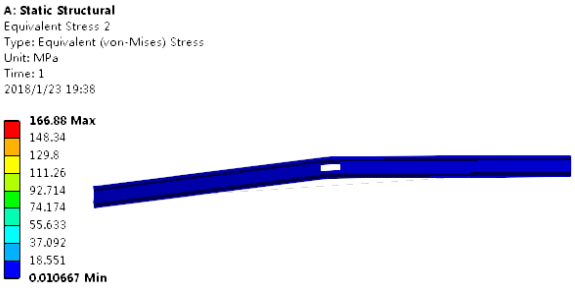
Fig. 3Total Deformable Diagram

According to the analysis result of the total deformation diagram, it is known that the deformation of the wire drawing line is 891.57mm, but it is a flexible part, the deformation amount is within its bearing range, and the whole support platform has almost no deformation at the same time. It increases the safety performance of the supporting platform, and the total change of the supporting platform under the top of the plank and the pure steel structure. The most massive shape is 2.5368mm, the maximum deformation occurs at the platform connection, and the safety performance of the platform meets the requirements without the wire drawing.

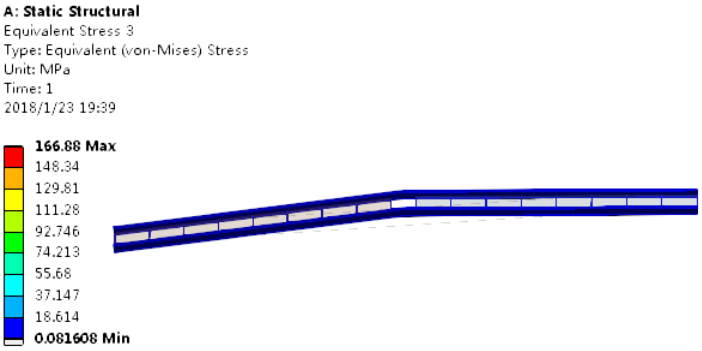
The stress in the three states is shown as shown in Figure 4.



(a) Steel Wire With Wire Drawing



(b) Under The Top of the Plank



(c) Under Pure Steel Frame Structure

Fig. 4 Schematic Diagram of Stress

It is known from the simulation results that the stress change of the supporting platform is little changed in three states, because the wire drawing line is a flexible part, the maximum stress value is 342.56MPa, and the maximum stress value of the supporting platform is the same and the maximum stress value is 166.88MPa under the top of the board and the pure steel structure. The maximum stress in the three states is all. It appears that the stress at the platform is far less than the yield strength, so the stress is within the safe range.

4. Conclusion

By analyzing the design principle and selection of the steel beam double slope support platform, the steel beam double slope support platform is designed, and the support platform and support frame are studied and analyzed with ANSYS Workbench analysis software, and the rationality, reliability and safety of the structure are confirmed. After the successful design of the platform, it is a major breakthrough in the rapid installation of the steel roof enclosure system. It will greatly improve the installation efficiency and safety of the top layer components. The changes in the size of the platform can adapt to the various spans of the workshop, reduce the rental cost of the mobile scaffolding, so that the reasonable staffing and optimization of the process flow will be made. Process, reduce unnecessary expenses, save costs for enterprises, bring good economic and social benefits.

References

[1] G .W .Zhang,G.Q. Zhu,G.L. Yuan, et al:Stability analysis of large span steel truss structure under local cooling from fire extinguishing system. The Structural Design of Tall and Special Buildings,2018,27(6).

[2] D.H.Gu,C.Xiao,X. F. Zhang, et al:Self-Diagnosing and Warning System of Wind-Induced Damage for Large-Span Spatial Steel Structure. Advanced Materials Research,2014,3255(971).

[3] L. Tian,J.P. Hao,J.P.Wei, et al: Integral lifting simulation of long-span spatial steel structures during construction. Automation in Construction,2016,70.

[4] Y.F.Luo,L.X.Qian,Y. Huang, et al: Overall stability of a long-span steel structure suspended with steel arches.Elsevier Inc,2005-06-15.

[5] S.L. Dong,Y. Zhao: The application and development of pretensioned long-span steel space structures in China.Elsevier Inc, 2002-06-15.
[6] Y. Bai,Y.J. Shi,Y.Q. Wang: Finite element analysis on temperature field of long-span steel structure under fire conditions.Elsevier Inc,2005-06-15.
[7] R. Baláž,M. Bagoňa:Preparation Measurements and Assessment of Roof Systems. Selected Scientific Papers - Journal of Civil Engineering,2014,9(2).
[8] E. Richard F,W. Kathryne L,L. William B, et al: Prevention of residential roof fires by use of a class "A" fire rated roof system. Journal of Long-Term Effects of Medical Implants,2004,14(2).
[9] A.L.S. Chan,T.T. Chow: Energy and economic performance of green roof system under future climatic conditions in Hong Kong. Energy & Buildings,2013,64.
[10] Y. K. Yang,I. S. Kang,M. Hee Chung, et al: Effect of PCM cool roof system on the reduction in urban heat island phenomenon. Building and Environment,2017,122.