Safety Inspection and Assessment on a Light Steel Portal Frame Workshop

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Abstract. Combining with a light steel portal frame workshop, the safety inspected and assessed through the detections and design checking which had higher practical reference value for similar structures.

Introduction

The Security appraisal of the structure is an important basis for quality assessment of the building, but also the fundamental basis for evaluation of in-service buildings, It played important roles in improving the quality of construction projects, saving the capital of the state and enterprises, to ensure production safety and the lives and property. In this paper, we will practical engineering of safety detection and evaluation.

Project Overview

This engineering was monolayer form of light steel structure. Load-bearing structure of the portal frame, the Span of 78m (three cross), and the length of 102m, The roof system uses glass cotton double-layer color steel roof and put into use in 2007. In order to understand the status of project quality and safety of the light steel plant safety assessment. The layout showed in figure 1. The inner structural arrangement showed in figure 2.

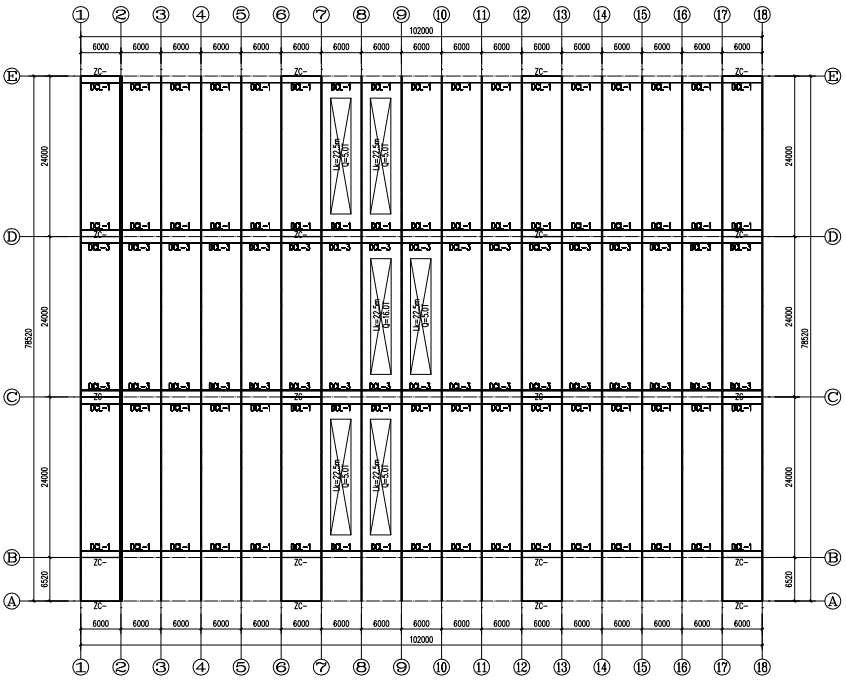

Fig. 1 Plane Arrangement Chart

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Fig. 2 Inner Structural Arrangement

Test items and analysis

Conditions of Use Survey

Through the inspection, it found that Crane arrangement did not match with the design drawings. Now the cranes arranged with A~B-axis span having 3×5t, B~C-axis span having 2×5t, C~D axis span having no crane role, it was consistent with the rest of the structural role of basic design. The environment of the building was normal, non-corrosive medium effect. For the project using in a short time, there was no maintenance and reinforcement, expansion, disasters and accidents and the foundation conditions were in good condition.

Material performance testing

Verified by the original inspection data, we find that the materials of mechanical properties of steel columns and beams, chemical composition, mechanical properties of high strength bolts meet the design requirements.

Structure and component geometry size detection

The dimensions and detail dimensions of the components were measured using the steel tape measure, vernier caliper, external calipers, detection component wall thickness of the web and tied were inspected by ultrasonic thickness gage, the results show that the structure axis dimensions accord with design requirements, the part detection results shown in Table 1.

Tab 1 Part Detection Results

Component	Section size /mm	
	Design size	Measured size
Column 1	H500×220×8×10	500×220×7.32×9.67
Beam 1	H750~450×200×6×10	H750~450×200×5.6×9.67
Skylights column	H250×180×6×8	H250×180×5.6×7.62
Tied 1	89×3.5	89×3.25
Purlin	180×70×20×2.5	180×70×20×2.25

Structural defects, damage and corrosion detection

All the major components were no cracks. Meanwhile, local deformation and corrosion by the means of observing, the paint film thickness was measured by paint film thickness gauge and the joint quality of the high strength bolt was tested by the means of hammer. The test results showed that it was no corrosion phenomena and a local deformation of angle between the pillars supporting, the paint film thickness and the joint quality could be obtained based on meet the specification requirements.

The detection of structure component and Connection

Using the vernier caliper, steel tape and the metal ultrasonic thickness gage, the size of the data was measured then the ratio of rod slenderness and the width to thickness were checking. Using the metal ultrasonic flaw detector (NDT), the joint quality of the weld were Scanned. Lastly, the quality

of high strength bolts connected the number of leakage threaded through visual were inspected by visual examination.

Fortunately, all the data was very good. For the weld appearance was good and met Ⅱ quality standard, and the joint quality of the high strength bolt could meet the requirements too. Most of the inner joint quality of the weld grade could meet II or III level standard.

Structure integrity

It found that the layout of the knee brace was different from the layout of design after the checking of integral structure. In addition, it was lack of one component of knee brace on main girder, it was having too big gap in seam joining position, it wasn't have the components of knee brace and tie bar in the place of skylight part.

Enclosure structure connection

After the inspecting of the Enclosure structure connection and the joint structure the structure was reasonable which meet the current national standards requirements, the connection was right and meet the current national standards requirements, the component selection and arrangement of reasonable which had no adverse effects on the security of main structure.

Design check

The structure model was established using the designing software of PKPM according to the structure and tectonic of the actual stress state and the current national standard limit bearing capacity conditions respectively. The checking results were as follows:

1) Flange's ratio of width to thickness of steel column (H600×250×7.32×9.67) was overrun, the calculated value of 12.548, allow the value of 12.380. Depth-thickness ratio of steel beam (H750~450×200×5.6×9.67 and H450~750×200×5.6×9.67) was overrun, the calculated value of 103.689, allow value of 56.452.

2)Crane beam (DCL-1) : the crane beam section is H400×6×310×12×240×8, the span is 6m, having three 5 T intermediate system crane, $L_K = 22.5\text{m}$. After the examination, the crane beam free flange width and thickness overhanging ratio was overrun ($B_f/T_f = 12.667 > \left[B_f/T_f\right] = 12.380$), and the maximum stress of flange off-gauge was overrun ($\sigma_M = 338.220 > [\sigma_M] = 310\text{Mpa}$), the ratio of vertical deflection off-gauge and beam span was overrun ($L/\text{f} = 609.85 < \left[L/\text{f}\right] = 1000$).

3) Crane beam (DCL-3) : the crane beam section H750×6×290×14× 200×10, the span is 6m, having one 16 T intermediate system crane and , one 5 T intermediate system crane. The crane beam strength, stability, deflection and construction measures all meet code requirements after the checking.

4) Column feet, beams and columns and bracket meet the standard and force-bearing demand.

5) Rigid tie (XG1~3), the design section is Ø89×3.5, the actual size is Ø89×3.25 (i_x = 30.3, λ=198< [220]), met the requirements. Joint connection [2-M20 (H.S.B)] complied with structural requirements.

6) Rigid tie (XG-4), the design section is Ø459×5.0, the actual size is Ø159×4.75 (i_x = 54.56, λ=110< [220]), met the requirements. Joint connection [2-M20 (H.S.B)] complied with structural requirements.

7) Roof skylight frame was lack of rigid tie bar, and can't meet the requirements of paragraph 5 of article 4.5.2 in 1 refers.

8) The arrangement of the roof horizontal bracings and column-and-brace were reasonable, met the requirements.

9) The strength, stability, deflection of the roof and wall purlin met the requirements of specification.

Safety evaluation and suggestion

Safety evaluation

The structure system assessed according with the observation, inspection and design checking.

The results are as following.

Component safety evaluation. The safety level of the component according to the bearing capacity (including structure and connection) project were identified which considered the material performance, structure, defects, corrosion, too much damage deformation and deviation factors.

Each component safety can assess as following. The beam unit can assess for class b. Crane beam (DCL-1) can be assessed as class c; Crane beam (DCL-2) can be judged to be a level; Continuous span purlin can assess into class a.

Structure system safety evaluation. Considering the foundation, the upper bearing structure and maintenance structure the structure system safety evaluated. Foundation safety rating for A level. According to the structure layout and construction support system testing and combining with the design review results the upper bearing structure security is B level. The bearing retaining structure design of purlins can be rated as class A from the results of the strength, stability, deflection. From the non-bearing retaining structure, connected to the main structure of the security and effect observation of the results of the analysis, it can be rated as grade A. The building envelope system safety rating can be evaluated as grade A.

Suggestions

According to the results of testing and the design review, the project problems made the following proposals:

1) Column-and-brace role is resisting the lateral loads, the capacity of resistance to horizontal load is reduced when have the existence of bending, local deformation the stability of both within and outside plane. So it should be correct or reinforce.

2) The knee brace can reduce the out plane effective length. Component level stability can not meet the requirements, so it need for welding for lack of brace position.

3) The panel seam gap larger location should be treated because larger gap can not meet the normal requirement of stress.

4) Strength and stiffness of crane beam (DCL-1) checking can not meet the requirements which not only affect on the safety of the structure but also on the structure performance. So the beam which can't meet the requirements must be reinforced.

5) The position, depth-thickness ratio could not meet the requirements, should be constructed in accordance with the design requirements for welding stiffening rib.

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