Analysis and Research on the Quality Detection of the Structural Entity of Civil Engineering Division in Lujiang's Gymnasium

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Abstract. The detection results in the article are gained through tests on the material strength, reinforcement location, scantling design and slab thickness of civil engineering division of Lujiang's gymnasium. As for the substandard parts, treatment proposals are put forward to ensure the project quality.

Project Overview

Gymnasium in Anhui Lujiang's sports center demonstartes itself in steel structure for rectangular plane. It measures 79.2m in width and 58.4m in height, consisting of 12 models of the main truss,10 specimens of Zhicheng truss,4 pin edge truss. Inside, the halfmoon supports the system and conical steel structure makes the roof.

The upper steel structure bearing sits in the top of the lower part of the reinforced concrete column and they are connected by a pre-buried bolt. Currently the civil engineering is completed in the mian, followed by successive welding of steel structure elements. The plan is shown below.

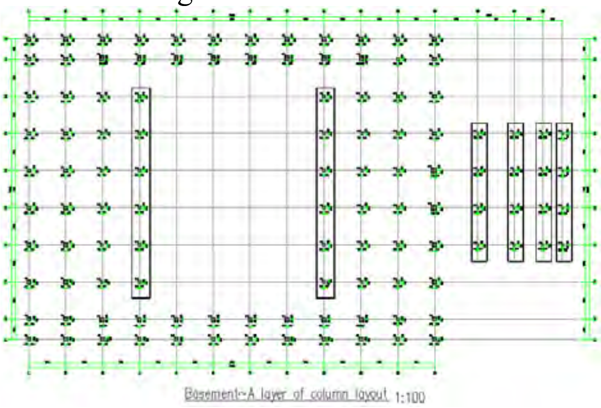

Fig. 1 Basement~A Layer of Column Layout

Test Content and Equipment

The test is authorized by the Bureau of Housing and Construction of Lujiang County. The strength of beams, boards, columns and concrete, the thickness of boards, the sectional reinfoecement allocation and the thickness of cover have been tested through applying device of ZBL-S210 digital concrete resiliometre,ZBL-U510 nonmetal ultrasonic detector, SW-180 reinforced position detector, NJJ-95B concrete radar detector, ZBL-T720 slab thickness tester and steel tape.

Testing Process and Result Evaluation of Beams, Boards and Columns

In the testing course, beams, boards and columns of the gymasium were randomly examined to inspect the quality of the structure is qualified or unqualified through the comparison of the surveillance and design standard. Any unqualifued parts were given treatment proposals in order to ensure the construction project.

Fig. 2 Stigma

Fig. 3 Beam-column Joints

Fig. 4 Cylindrical

Fig. 5 Using the Concreterebound Hammer to Test the Concrete Strength

Tab. 2-1 Column Evaluation of First Layer

Designed strength grade	componentid	axis number	carbonation depth(mm)	presumption of componentid strength(MPa)
C30	first layer column	first layer 1/H	0.5	31.4
		first layer 3/E	0.5	32.7
		first layer 1/B	0.5	31.5
		first layer 2/B	0.5	30.7
		first layer 3/B	0.5	31.8
		first layer 6/B	0.5	33.9
		first layer 9/B	0.5	32.8
		first layer 11/B	0.5	31.9
		first layer 12/D	0.5	30.2
		first layer 12/E	0.5	30.6
		first layer 12/F	0.5	34.7
		first layer 1/G	0.5	32.8
		first layer 3/J	0.5	31.7
		first layer 2/K	0.5	32.1
		first layer 5/J	0.5	34.6
		first layer 7/J	0.5	31.3
		first layer 9/J	0.5	32.0
		first layer 10/J	0.5	33.7
		first layer 13/J	0.5	33.9
		first layer 1/D	0.5	30.5
strength evaluation	presumption of concrete strength: $f_{cu,e} = 32.3Mpa$			

Tab. 2-2 Column Evaluation of Second Layer

designed strength grade	componentid	axis number	carbonation depth(mm)	presumption of componentid strength(MPa)
C30	second layer column	second layer 1/B	0.5	34.2
		second layer 2/B	0.5	32.6
		second layer 3/B	0.5	33.1
		second layer 1/D	0.5	31.9
		second layer 3/E	0.5	32.8
		second layer 1/G	0.5	32.9
		second layer 6/B	0.5	33.1
		second layer 9/B	0.5	32.6
		second layer 11/B	0.5	34.2
		second layer 12/G	0.5	31.9
		second layer 12/J	0.5	32.8
strength evaluation	presumption of concrete strength: $f_{cu,e} = 32.1Mpa$			

Tab. 2-3 Board Thickness Evaluation

components	axial position	design requirements	measured distance(mm)	deviation(mm)	test result
roof of the first layer	12-1/13--H-J	H=120	123	+3	compliance with design
roof of the first layer	12-1/13--H-G	H=120	116	-4	compliance with design
roof of the first layer	12-1/13--C-D	H=120	113	-7	noncompliance with design
roof of the first layer	10-11/A-O	H=120	123	+3	compliance with design
roof of the first layer	4-5/A-O	H=120	127	+7	compliance with design
roof of the first layer	0-1/C-D	H=120	121	+1	compliance with design
roof of the first layer	0-1/G-H	H=120	112	-8	noncompliance with design
roof of the second layer	11-12/H-G	H=120	118	-2	compliance with design
roof of the second layer	10-11/K-J	H=120	106	-14	noncompliance with design

Tab. 2-4 Top-beam Evaluation of Second Layer

designed strength grade	componentid	axis number	carbonation depth(mm)	presumption of componentid strength(MPa)
		11-12/J	0.5	30.3
		12/B-C	0.5	32.4
		2/A-B	0.5	34.6
		1-2/J	0.5	31.3
		2-3/J	0.5	32.2
C30	top-beam of second layer	4-5/J	0.5	33.7
		6-7/J	0.5	33.4
		2-3/B	0.5	30.9
		4-5/B	0.5	30.1
		6-7/B	0.5	30.2
stregth evaluation	presumption of concrete strength: $f_{cu,e}=31.9Mpa$			

Tab. 2-5 Roof Board Evaluation of First Layer

designed strength grade	componentid	axis number	carbonation depth(mm)	presumption of componentid strength(MPa)
	roof of first layer	G-H/11-12	0.5	32.6
C30		A-B/8-9	0.5	33.8
		K-L/8-9	0.5	34.0
stregth evaluation	presumption of concrete strength: $f_{cu,e}=31.9Mpa$			

Tab. 2-6 Evaluation of Column Stirrup Spacing

components	axial position	design requirements	measured distance(mm)	deviation(mm)	test result
second layer	12/G	Φ10@200 （non encrypted area)	216	+16	noncompliance with design
first layer	12/G	Φ10@200（non encrypted area)	174	-26	compliance with design
first layer	12/F	Φ12@100 (Encryption area)	101	+1	compliance with design
first layer	12/D	Φ10@200（non encrypted area)	190	-10	compliance with design

Tab. 2-7 Negative Reinforcement Spacing Evaluation of Second Layer

components	axial position	design requirements	measured distance(mm)	deviation(mm)	test result
second layer	11-12/G-H	@200	197	-3	compliance with design
	10-11/J-K	@200	197	-3	compliance with design
	8-9/K-L	@200	204	+4	compliance with design
	8-9/J-K	@200	224	+4	compliance with design

Tab. 2-8 Evaluation of Protective Layer of the Mian Reinforcement of the Column

components	axial position	protective layer design	measured distance(mm)	deviation(mm)	test result
second layer column	12/G	30	24	-6	/
first layer column	12/G	30	30	0	/
first layer column	12/F	30	22	-8	/
first layer column	12/D	30	15	-15	/

Treatment Result

Concrete Strength Examination Result of Randomly Selected Beams, Boards and Columns

(1) The presumed concrete strength value of the randomly selected columns in first layer is 32.3MPa. It meets the requirement of the designed strength of C30.

(2) The presumed concrete strength value of the randomly selected columns in second layer is 32.1MPa. It meets the requirement of designed strength of C30.

(3) The presumed concrete strength value of the randomly selected top-beams in second layer is 31.9MPa. It meets the requirement of designed strength of C30.

(4) The persumed concrete strength value of the randomly selected top-boards in first layer is 32.6MPa. It meets the requirement of designed strength of C30.

The Reinforcement Allocation Evaluation Result of Randomly Selected Beams, Boards and Columns

The stirrup spacing and the mian rib root number of the selected frame beams and columns basically meet the design requirements. The node spacing of stirrups and protective layer thickness basically meet the design requirements.

The Slab Thickness Evaluation Result

The thickness of the randomly selected slabs basically meet the design requirements.

The Appearance Quality of the Structure Evaluation Result

(1) Serious cases of boxwork, pitting surface, reinforcement exposure and corrosion have been detected in parts of the top-column joints.

(2) Between the pre embedded steel and the top of the top columns,breakoff phenomenon,slits of uneven width,reinforcement exposure and corrosion have been detected.

(3) Uncompacted concrete, reinforcement eposure are general phenomenon at the top of the static pressure box structure pole.

(4) Reinforcement exposure and corrosion have been detected at the bottom of some beams.

Treatment Proposals

(1) The breakoff between the pre embedded steel and the top of the top columns makes it detrimental for top column to bear the upper load of steel structure.

(2) As for the boxwork and pitting surface in column joints, hign strength mortar is suggested to be used.

(3) Rust cleaning in column joints and reinforcement exposure is necessary, which should be accompanied by the use of high strength mortar.

(4) As for the big danger hidden in the loose junction between the static pressure box structure pole and beams, high strength micro expansion mortar can be wiped in the junction to avoid corrosion of the tensile reinforcement. Meantime, the boom should be reinforced to enhance the reliability of the upper and lower end of connecting node.

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