

# Design and Analysis of Large-span Structure of A Sales Campaign Centre

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**Keywords:** 21m single span framework for multi-channel seismic resistance, strong column and weak beam, the combination of fasting plasma beam.

**Abstract.** This essay has introduced design of the second seismic fortification lines of 21m single span roof layer frameworks in a real-estate center, mainly explained the realization of multi-defence system of seismic engineering in the structure from conceptual design of structures and presented the application of composite open-web beam in large-span concrete structure. This system can pre-establish the location and order of the structure hinge through calculating pillar reinforcement by beam-end solid distribution rebar and achieve the overall yield mechanism of strong column and weak beam through reasonable structure, ensuring that structures under strong earthquakes have sufficient ductility deformation to absorb seismic energy to achieve the performance objectives not be brought down by the earthquake, and meeting the design specifications and the actual use requirements.

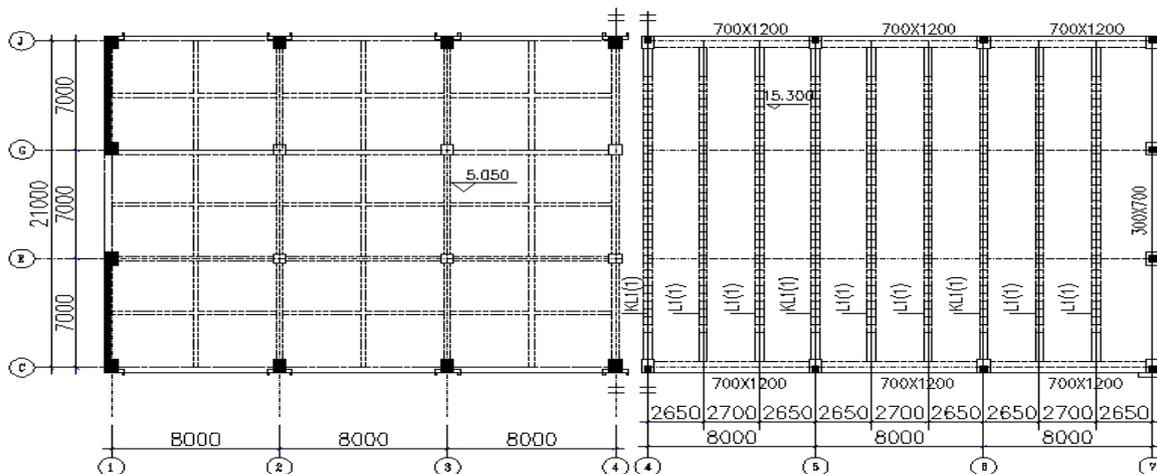


Figure1 floor plan of the second layer

Figure2 floor plan of roof structure

## Project Overview

The project is a business building integrated into sports with total length of 114.2m. Its central joints are divided into two parts, the right part is the sales and business center and the left part is the sports center. The essay only describes the design overview of the left side of the sports center. The sports center is in the form of two-story building with length 51.8m and width 21m. The first floor is the fitness center and business, mechanical and electrical space while the second floor is the basketball court of 21m × 51.8m across, which roof is for the tennis courts. The main level and profile of the structure are shown as the following Figure 1-3.

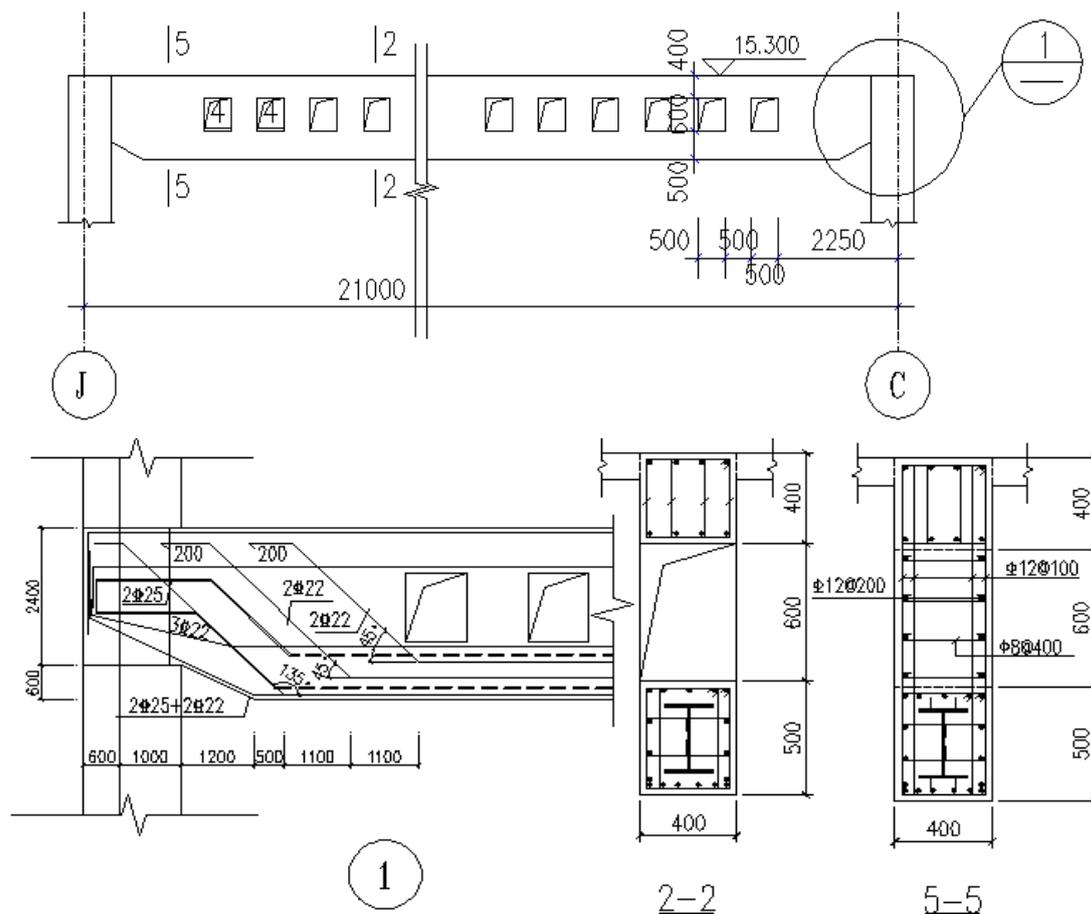


Figure3

## The Structural System and the Cross-component Selection

### The structural system

Due to the functional requirements, the second floor basketball court needs to be the large space, removing two rows of vertical central column to form a 21m single span frame structure. Roof is for the outdoor tennis courts with larger load. Departure from the seismic point of view, it is not suitable to take single long span frame structure as an anti-side for the system. Therefore, under the premise of meeting the construction requirements the project adds a shear wall at both ends on both sides of the longitudinal cross, so that vertical side forms as the first channel of the seismic line of defense for four shear wall while the second seismic line of defense for the framework of a single cross-frame shear force of the wall system. Due to the building functional requirements, the horizontal side is designed as multi-cross-frame. The project's seismic intensity is 7 degrees and the grouping of the design earthquake is the first group. The basic design of earthquake acceleration is 0.1g, the category of construction site is Class II, the framework of seismic rating is three, shear wall rating is two and the slab column concrete strength grade is C30.

### The roof span beam

Limited to the architectural features and design requirements, the roof cross is not set cantilever cross-level constant and large cross central bending moments. As the result the beam end bending moments need to be fully balanced by the column. Program A uses pre-concrete beam, the beam height and weight which are quite larger, and with pre-stressed both sides of the column by the great force and reinforcement uneconomical; Program B uses steel and concrete composite beams. And due to beams from different materials, joint construction is complex and uneven force, node hinged handle, structural redundancy is less, which can not be effectively formed a second seismic line of defense. And due to post-high maintenance costs, program B is also excluded. Program C uses concrete fastening truss beam with high beam 1.5m. With less stiffness loss, this program greatly

reduces the weight, the role of the earthquake and the corresponding decrease of the beams of internal forces. Mechanical and electrical lines go from the fastening part through increasing indoor clearance. To enhance the bottom chord of the tensile strength in the last quarter of the type just to form the bottom chord of steel reinforced concrete, while enhancing the overall fastening beam shear and flexural capacity. Large span beam detail is shown as picture 3.

### The Structure Calculation and Analysis

The overall analysis uses three-dimensional analysis software SATWE (2008 Edition) and PMSAP computational analysis. As considering the overall impact of large cross-beam of the roof on the structure, the large cross-Beam " I " changes of surface beam simulation; large cross-beam analysis uses fastening truss model and the Excel spreadsheet program, on the real beam, fastening part of the upper and lower chord review design.

#### The first seismic line of defense

The first analysis is small earthquakes in the overall model to determine the shear wall as the first line of defense must have the strength and stiffness and energy dissipation of ductile, and the whole structure of the primary reinforcement design.

#### The second seismic line of defense

Taking into account the framework as a second seismic line of defense, the structure shall be subjected to the shear wall to redistribution of internal forces the hinge to unload the force to the framework. Under major earthquake the shear wall will be damaged while absorbing a large amount of seismic force, and if structural stiffness is reduced earthquake decreases. On specific analysis the framework structure takes the single specimens of re-role of small earthquakes under the stress analysis and becomes a pure framework due to non-shear wall, ensuring that the framework can be used as a second seismic line of defense in the destruction of the shear wall to continue to bear the earthquake without collapse. Adopting seismic design, the structure controls hinge parts of the framework and the order of the hinge to form a strong column and weak beam overall yield mechanism.

**Establish the Hinge Location and Sequence of the Framework.** Point A in Figure 4 is the first hinge controlling point; point B is the second one; point D is the third one, strictly controlling of the point C at the column strength to ensure that not a hinge to prevent the upper part of a large cross-formed institutions collapsed.

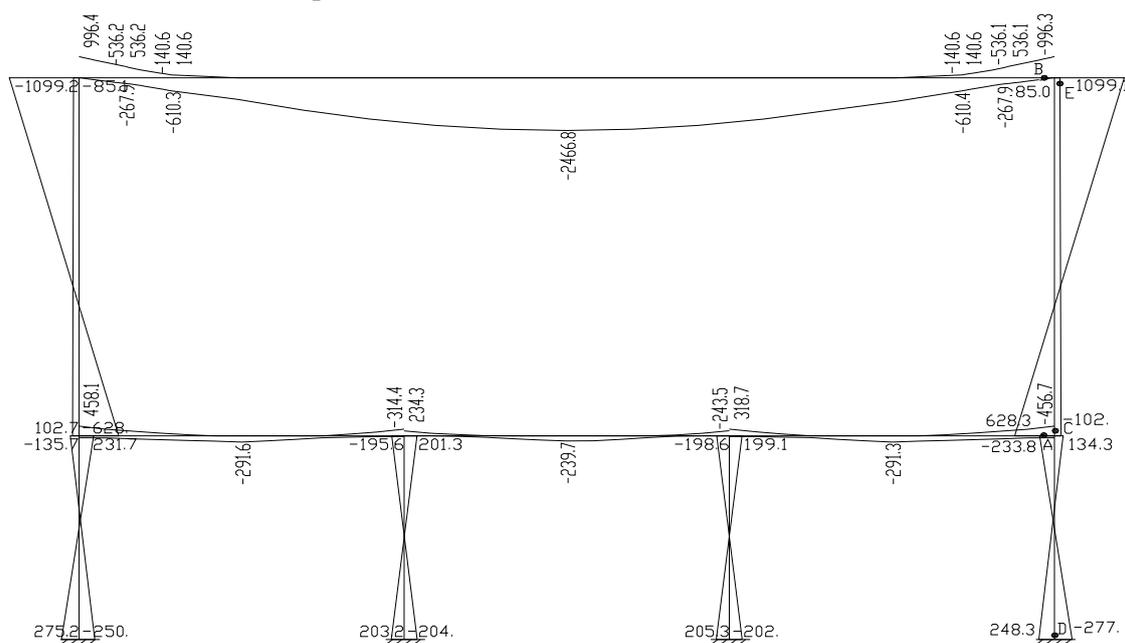


Figure4 moment envelope diagram of single specimen frame

**Methods of Controlling Hinge Being Out.** From the overall analysis of the diagram of the frame

shear wall structure and initial reinforcement, it is obviously that A, B, two points at the Beams mean values of MA, MB, and the amount of reinforcing steel ASA, ASB, from single specimens of pure framework results, it is that A, B, two points at the corresponding moment, including the network value of MA1, MB1, compare MA1 and MA, MB1 and MB, MA1, MB1 are much larger than the MA, MB, indicating that the framework has to play a second seismic line of defense. A point beam reinforcement value takes the beginning; due to the moment value corresponding to point A beam end corresponding to the bending moment envelope value is greater than the early reinforcement by single specimens of pure framework. A point in the shear wall destruction after the earthquake under the beam end will inevitably hinge. Follow M B1 to adjust point B beam end reinforcement, so as to maintain flexibility. Under subsequent strong earthquake, put point B the beam end to the first hinge, and prevent the column before the hinge. According to seismic code 6.2.2, the column ends amplification factor takes 1.1 under the three seismic moments. Due to the column and beam cross-section is double reinforcement and side cross-beam gluten is typically less than the end of tendons, the actual control of the column reinforcement can be simplified to:

$$A_{sc} = \frac{1.1 f_{kb} A_{sb} h_b}{f_{kc} h_c} \quad (1)$$

hb for Liang gluten and bottom tendons work together to distance  
 hc reinforced column on both sides work together to point distance  
 The Asb for beam top with a solid surface reinforced  
 Asc column on both sides with real reinforced  
 fkb fkc standard values for the beams reinforced strength

Due to point B column by column reinforced ribs, and nodes reinforced through flexural capacity when compared with the analysis of frame shear wall, point C can guarantee where point A beam hinge column for flexibility to achieve the target of strong column and weak beam earthquake. Point D can be single specimens of pure framework of analysis to adjust the reinforcement, so that the hinge in the beam area of the hinge rear. The middle of the beams reinforced not adjust the hinges so that when the earthquake dissipation of more seismic energy. Through the above processing, the basic building can be achieved three earthquake performance objectives

### Design of the Cross-beam

By fasting the overall analysis of the truss model, the cross-beam could ensure that the curved shear strength of the various parts are not overrun and the interception of single specimens of pure framework for the analysis of shear-bending internal force envelope results, reviewing of force analysis of the various parts of the fasting plasma beam. It is mainly analyze the bending of the solid web and fasting part of the upper and lower chord of the curved cut the tension and compression capacity. The rectangular hole on each side 1/2 beam range of vertical stirrups calculates Press  $Asv > 1.3V/fyv$  to value (V for shear envelope value), the rectangular holes up and down by the pressure chord and tension chord is analyzed according to steel reinforced concrete compression members and tension object checking, internal force values that the details of the corresponding specifications. Deflection calculation is taken the hole at the weakest section stiffness calculations. Crack is checked in accordance with relevant regulations, the Department omitted.

### Construct

A large span floor is designed into a one-way board, set constructor temperature distribution along a large cross-beam direction, tendons, and reduced the slab reinforcement to beam bending strength increases.

Large cross-beam side lower part of the type is adjusted up bending 450 anchored into the side beams to enhance the cross-beams end to end shear capacity. Steel end set end plate, to enhance the anchoring force

### Conclusion

The phenomenon of the Wenchuan earthquake that the framework structure of large numbers of earthquake damage of the column hinge has fully illustrated that the previous design "strong column and weak beam yield mechanism is an ideal seismic yield mechanism. Many factors will lead to lower the possibility of its reality. For important structural or important parts of the structure, the designer should focus on the conceptual design in the overall structure and local structures, to avoid the blind to look at the multi-channel seismic line of defense in the earthquake as an important protective effect on the lives and property of students from the calculation results. Also, designers should be clear with the local parts of the seismic design concept and reasonable structure, to avoid local to strengthen the basic seismic principles to change the strong column and weak beam.

This essay provides a design thinking network for the hinge location and sequence of frame structures under earthquake, using a simple implementation with reinforced to achieve strong column and weak beam yielding mechanism, rather than structural flexibility analysis of internal forces as a guarantee the basis of strong column and weak beam yielding mechanism, which can achieve a strong column and weak beam yielding mechanism regardless of the much earthquake intensity. There are many factors for the formation of a strong beam weak column, including the beam increasing the coefficient, the actual increase of the slab reinforcement to beam end reinforcement and surface contribution to the beam stiffness. How to eliminate the influence of these factors remains to be further studied. Designers should consciously weaken the influence that these aspects above caused to strong column and weak beam yielding mechanism from calculation and structure.

This essay makes a useful attempt to single-span cross-frame structural floor system selection. The system has not diminished much more frequent stiffness while reducing self-weight. The overall reinforcement helps Floor, pre-stressed floor greatly reduced, and the deflection of cracks is under effective control.

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