Exploration of Problem of Graduation Design of Architectural Engineering

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Abstract: The graduation design of architectural engineering major is the most important part of cultivating students. I have been guiding the graduation design of undergraduates for many years, and found many common mistakes of students. The summary is as follows for reference of teachers and students. The structural is irregular, the floor is locally discontinuous, plane arrangement of components are unreasonable, the initial estimation of component section size is unreasonable, the layout position and number of components are not clear, and the elevation on the board is inaccurate. I hope you can put an end to the above problems in the future graduation design and get good results in the graduation design.

1. Introduction

Graduation design is the most comprehensive link in undergraduate teaching practice. It trains students' ability to comprehensively apply the basic theories and professional knowledge they have learned in the past four years, exercise students' ability to analyze and solve problems, let students begin to understand the application of norms, prepare students for the start of their career.

The traditional title of graduation design of architectural engineering major is reinforced concrete multilayer frame structure design in China. The design includes three aspects. First, according to the purpose of the building architectural drawing is drew. Second, structural arrangement and structural calculation is carried out. Three, structure construction drawing is drew. For most of the areas in the earthquake zone in China, so the undergraduate graduation design requirements for seismic design.

According to the graduation design of civil engineering major in our school in recent five years (since the implementation of the new standard), the most common problem students have in structural design is the determination of structural arrangement scheme. This part of the design main investigation is the students' ability of conceptual design. The main concept points appear in different chapters of different textbooks, and the graduation project requires the comprehensive application of these knowledge points. This article carries on the simple analysis to Graduation design of architectural engineering, clarifies the concept, provides everybody reference.

2. Problems in the Layout of the Structure

2.1 Design of Rule Structure.

During the graduation oral defense, an occasional phenomenon occurred. It was suddenly found that there was an irregular problem in the structural arrangement scheme of a student, and the conventional design method was adopted for the subsequent structural calculation and design.

The code for seismic design of building structures [1] gives a strict definition of the irregular structure, which can be divided into plane irregularity and vertical irregularity. In the design of the architectural structure of the graduation project, two problems are mainly involved which are the concave and convex irregularity and the floor local discontinuity.

The first is the concave and convex irregularity. It means that the dimension of the concave side of the structure plane is greater than 30% of the total dimension of the corresponding projection

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direction. When students are making architectural plans, concave and convex on the plane will often appear. When determining structural units, seismic joints should be appropriately set up to divide a complex building plane into more regular structural units. It should be noted that the post-pouring belt can replace the settlement joint but not the shock-proof joint. The setting of shock-proof joint should try to achieve three stitches to be one.

The second is the floor locally discontinuity. Floor local discontinuity refers to the sharp change of floor size and plane stiffness, such as the effective floor width less than 50% of the typical floor width, the hole area more than 30% of the floor area, and larger split-level floors and so on.

2.2 Plane Arrangement of Structural Members and Determination of Section Size.

The first is the Plane arrangement of structural members . There are three kinds of structural members in frame structure: plate, beam and column., which arrangement directly affects the rationality of structural scheme and structural calculation method. The weak link in the graduation design is the plane layout of the structure.

The first part of the design is to determine the column network according to the architectural scheme. The economic column net spacing of the frame structure is 5~8 meters, preferably not more than 9m. But many students habitually set up pillars at the intersection of each vertical and horizontal wall, making the column network too small and the scheme not reasonable enough.

The span of the main beam is the spacing of the columns. Only one of the two directions can be arranged in the main beam, which depends on the load-bearing scheme of the structure. The lateral lateral stiffness of the building is relatively poor compared with the longitudinal, so in general, the transverse arrangement of the main beam will help improve the overall seismic capacity of the building, and the transverse load-bearing system is more reasonable.

The secondary beam should be perpendicular to the main beam. During the layout, only one secondary beam should be arranged in the middle span of the main beam to make the main beam bear unfavorable forces that the mid-span bending moment is large. At least 2 secondary beams should be uniformly arranged. At the same time, the spacing of the secondary beams is the span of the plate, and the span of the one-way plate should not exceed the requirement of 3 meters. The spacing of the secondary beams should be controlled between 1.5 and 2.5m, not more than 3m. The economic span of the secondary beam is between 4 and 6m.

After the position of column, primary and secondary beam is determined, the grid size of the plate is determined, and the calculation scheme of the plate is determined according to the ratio of the long side to the short side. Article 10.1.2 of code for design of concrete structure [2] clearly stipulates that when the ratio of long side to short side is less than 2.0, it shall be calculated by two-way plate, while when it is larger than 3.0, it shall be calculated by one-way plate, and when the ratio of the two is between 2.0 and 3.0, it shall be calculated by two-way plate. When calculated according to one-way plate, sufficient distribution should be arranged along the long side to construct reinforcement. Graduation design in most cases is to belong to the board grid long side and short side ratio between 2.0~3.0, but the hand calculation are processed in accordance with the one-way board, must let the students make clear that this hand is ok, but not the most reasonable.

The second is the initial estimation of section size of components.

The thickness of the plate should ensure the requirements of building function and stiffness. In order to have sufficient stiffness, the thickness of the continuous plate is generally set at 1/40 of its span, while that of the simply supported plate is set at 1/35, and that of the cantilever plate is set at 1/12. Article 10.1.1 of code for design of concrete structures [2] also stipulates the minimum thickness of cast-in-place reinforced concrete slabs, and reasonably determines the thickness of slabs on the basis of meeting the above two requirements. If the thickness of the plate exceeds 120mm, it indicates that the structural layout plan is not reasonable enough and should be adjusted.

The size of beam section must ensure the structural stiffness and reasonable shear span ratio to avoid excessive deflection deformation and oblique section collapse. Generally, the beam span height ratio is estimated based on experience, and then checked in the structural calculation. Generally, it is reasonable to take the height of main beam to be 1/15~1/10 of its span, and the height of secondary

beam to be 1/18~1/12 of its span. It is reasonable to take the width of the rectangular beam from 1/3 to 1/2 of its height [3].

The size of column section is estimated according to the limit of axial compression ratio and the requirement of high span ratio so as to ensure ductility and avoid short column. In the initial evaluation, simple statistics of load can be made according to the subordinate area of typical middle column on the board. Meanwhile, the design value of axial force of the bottom column under vertical load can be calculated by reducing the living load of the floor according to article 4.1.2-2 of building structure load code. Since the height of section relative to compression zone with symmetric reinforcement of large eccentric compression column is approximately equal to the axial compression ratio of column, it is reasonable to control the axial compression ratio under vertical load at 0.6~0.7, slightly higher than the limit relative compression zone height, in the initial estimation from the perspective of designing the column as a large-eccentric member with better ductility. In the subsequent structural calculation, according to the seismic grade of the structure, the axial compression ratio under the seismic action combination is checked. After determining the section size of the column, the height-span ratio should be checked according to the height of the column, and the height-span ratio of the control column should be more than 4, shear-span ratio more than 2, to avoid the formation of short columns [4].

3. Common Problems in Construction Drawings of Structural Plane Layout

3.1 The Layout Position and Number of Components are not Clear.

In engineering design, the plane layout of the structure and the reinforcement of the plate are often expressed in the same diagram. Students' drawings are usually based on the results of computer calculations to draw the reinforcement of the plate, while the expression of the plane layout of the structure is ignored. The main problems are reflected in the following aspects.

Firstly, the positioning dimensions of components are not complete enough. The figure mainly expresses the position of the axis, while the off-axis size and section size of the beam are often not marked, so it is difficult to determine the specific position of the beam and the real size of the plate. It is difficult to determine the relationship between adjacent columns without labeling the section size or positioning size of the column.

Secondly, no component number or incomplete number. The general undergraduate graduation design requires the structural calculation and section design of a plane frame. Many students did not express the frame number and the number of the remaining components on the structure plane layout plan, and the relationship between the drawings was lost. Some students mistakenly believe that the number of axes is the number of frames. In fact, the plane frames with the same layout of components and load area should be numbered with the same number. The frames should be numbered from left to right or from bottom to top. he frame beams, frame columns, secondary beams and constructional columns that have been included in the frame are merged and numbered. The components that appear in the plan should be numbered.

3.2 There are Many Problems in the Layout Plan of Stair Structure.

Due to the limitation of the drawing proportion of the structural plan, it is generally required to express the structural layout and reinforcement diagram of the stairwell separately. The structural plane layout and component number expression of the stairwell are the most error-prone places in the graduation design drawings every year. The position of the ladder beam and platform beam, and the platform plate and the enclosure wall are very confused.

Stair is divided into board type stair and beam type stair according to the different way that transfers load. The slab stair is suitable for the case where the horizontal projection length of the stair segment does not exceed 3m. Plate stair transfer load as follows. The load of inclined plate and flat plate is transferred to platform beam, then to constructional column, and finally to floor frame beam. At the intersection of platform plate and external wall, platform beam should also be set up inside the

wall, and the height of platform beam and floor frame beam is half a layer different, so constructional column should be set up on the frame beam for vertical transfer of force. Beam stairs are suitable for large span. In order to reduce the thickness of the inclined plate, inclined beams are set on both sides of the inclined plate, and the load on the plate in the ladder section is transferred to the platform beam through the inclined beam, and the rest members are arranged with the same plate stairs. In the structural plan layout of stairs, the location and section size of the inclined slab, inclined beam, platform beam, constructional column and other components must be expressed. Generally, the plane of the bottom layer, standard layer and top layer is drawn to fully express. In order to make the numbering of various components more clear and intuitive, the stair structure section also is drawn for detailed expression.

3.3 The Elevation of the Board is not Accurate and Comprehensive.

Some students mark building heights directly or not at all. The structural elevation shall be on the reinforced concrete slab, while the building elevation shall be on the upper part of the slab surface, with a difference of thickness of the surface layer in the middle, which is the thickness of the surface layer. The structural elevation of the toilet shall be 20-30mm lower than that of the floor slab.

3.4 Expression of Top Column Section.

The top of the house frame column and frame beam cast together, are covered by roof board, so in addition to part of the extension to the parapet top of the constructional column, the rest of the column section is not visible, to draw the outline of the column with dotted line. But quite a few students blacken the section of the top floor column like the floor column [5].

4. Attach Importance to the "Norms" and Learn to Apply the Norms

"Norm" is a law and regulation based on exploration, design, construction and acceptance of civil construction industry. It is advanced, scientific and serious. It is very necessary to strengthen the study and understanding of norm in graduation design stage. Students should learn to find specifications in norm, be familiar with specifications of norm, understand specifications of norm, apply specifications, and develop rigorous design habits.

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