Simulation Analysis of Stadium Construction Relying on Multi-layer Formwork Support System

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Abstract. With the improvement of urbanization level, infrastructure construction is also in full swing. In the past, the stadium construction period is long and the cost is high, but the construction based on Multi-Layer Formwork Support System (MLFSS) is more and more applied. Based on this, this paper first analyses the basic theory of multi-layer formwork support system, then studies the stadium construction engineering measurement of multi-layer formwork support system, and finally gives the construction simulation analysis method based computer of multi-layer formwork support system.

Keywords: Stadium Construction, MLFSS

1. Introduction

With the continuous development of social economy, various infrastructures are also rising and improving, especially in the process of urbanization, the continuous construction of stadiums with the function of city image and business card puts forward new challenges and requirements for the planning and management of its construction process [1]. In the construction process of various stadiums and stadiums, scientific and reasonable planning schemes, construction methods and management process support and guarantee are needed.

At present, reinforced concrete structure has become the mainstream structure adopted by most buildings. In the construction process of this structure, the cast-in-place construction mode is mostly adopted. However, the construction period of this mode is long and the construction cost is high. In order to improve the adverse effect of cast-in-place construction, multi-layer formwork support system (Short for MLFSS in this paper) is used to distribute the load reasonably [2]. In addition, because the stress state and structural form of this time-varying structural system will change with time, and will be affected by the change of space position, therefore, it is necessary to make clear the pouring and removing time of MLFSS through scientific scheme, so as to meet the needs of stadium construction. It can be seen that the current MLFSS has become a commonly used method in construction, so the simulation analysis of the construction mode has important practical value.

2. Basic Theory of Multi-Layer Formwork Support System

2.1. Bearing mechanism of multi-layer formwork
In the construction structure of stadium with reinforced concrete structure, the support system composed of formwork support and concrete will change with time. Generally speaking, the stadium construction process based on MLFSS is composed of many processes. Through the decomposition of these specific processes, the state of the whole support system in the construction process is split and analyzed, so as to obtain the structural stability and reliability in each state.

Due to the great difference of the load influence on each process, such as the process of removing the formwork and pouring concrete, the calculation process of the MLFSS needs to be simplified, such as superimposing the load internal force, so as to facilitate the analysis.

2.2. Bearing principle of MLFSS
The construction load borne by the floor in the MLFSS has the characteristics of positive correlation between the force borne by the floor and the stiffness of the floor and negative correlation between the force borne by the floor and the stiffness of the elastic support [3]. The supporting structure in the MLFSS can be regarded as elastic support, as shown in Figure 1 below.

Figure 1. The supporting structure in the MLFSS

Under the action of load force, the load internal force of stadium floor will be distributed based on the stiffness of the floor and the deformation capacity of the lower elastic support. Therefore, in the process of calculating the load force, the load distribution of the support system should be considered.

2.3. Analysis model of elastic supported continuous beam
To establish the analysis model of elastic supported continuous beam of MLFSS, it is necessary to make specific assumptions for the model, as shown in Table 1 below.

| Aspects                                      | Assumptions               |
|----------------------------------------------|---------------------------|
| Removal of formwork support                  | No effect on structure    |
| Articulation                                 | Joint between support frame and floor |
| Concrete structure and formwork support      | Elastic structure         |
| Ground floor support                         | Infinite rigidity         |
| Cross bar and cross bracing in support frame | Ignore its impact         |
| Formwork panel & primary and secondary keel  | Ignore its impact         |

In the physical model level, the model support is assumed to be elastic support, in which the formwork support and floor structure are assumed to be elastic materials [4]. In the process of stadium construction simulation of MLFSS, the elastic support of the upper concrete is the lower floor, the stiffness of the floor is assumed to be equal to that of the elastic support.

3. Measurement and Analysis of Stadium Construction With Multi-Layer Formwork Support System
3.1. Erection scheme of formwork support frame

Taking a stadium as an example, the erection scheme of the support frame of the formwork support system is as follows: for the beam side plate split screw, the beam height < 600mm cannot be set with split bolt; if the beam height is more than 600 mm, it is necessary to set ≥14 split bolt, the first pair of pull screw is 250mm away from the beam bottom, and the spacing of split bolt along the beam length and beam height is ≤ 450mm.

The vertical cross bracing is set in the outer circle, and the vertical continuous fastener is set in the middle every 5 spans in the vertical and horizontal directions. The steel pipe cross bracing is 6-8m in width and 45 ° to 60 ° in the angle. The horizontal cross bracing is to set the fastener steel pipe horizontal cross bracing at the top of the frame body; when the erection height exceeds 8m, the fastener steel pipe horizontal cross bracing is set at the top and bottom layers, and the fastener steel pipe cross bracing is set at every 3-4 standard steps along the height in the middle. The template support system configuration of other projects is shown in Table 2.

| Aspects                | Assumptions                                      |
|------------------------|--------------------------------------------------|
| Shear wall             | Membrane covered wood formwork                   |
| Primary and secondary beams | Membrane covered wood formwork                  |
| Floor                  | Membrane covered wood formwork                   |
| Backing plate          | The length and width ≥ 15cm, and the thickness= 15mm |
| Beam bottom support    | The top of the pole is supported by adjustable support |
| Step length            | Beam bottom step length = 1.2m                   |

3.2. Construction organization arrangement of MLFSS

According to the overall construction process, the construction sequence of the main structure is as follows: the upper part has multi-layer reinforced concrete structure; the inclined column, curved beam, rest platform and inner stand are inserted in the middle of the structure construction [5]. After the steel pipe truss structure reaches the design strength after the steel column construction, the support installation, hoisting and roof panel installation are carried out alternately; the space steel pipe truss structure and the main structure are capped together. The column shaped formwork used in the project is processed in the factory, and the rest are processed and manufactured in the workshop on the construction site.

In addition, the formwork removal shall be based on the compressive strength report of concrete test blocks under the same conditions [6]. Before the removal, the team shall fill in the application form for formwork removal, which shall be signed by the project foreman and the project chief engineer. The removal sequence of formwork is opposite to the installation sequence. Generally, the formwork is first supported and then removed, and then the non bearing formwork is removed first, and then the bearing formwork.

4. Construction Simulation Analysis of Multi-Layer Formwork Support System

4.1. Model analysis of MLFSS

When building the structural model of stadium Multi-Layer Formwork Support System, it is layered based on its frame structure model. In the actual construction process of the stadium, based on the characteristics of its concrete system structure, the hierarchical structure is reasonably controlled. Secondly, the cross-section size of MLFSS should be formulated scientifically, so as to improve the calculation accuracy and reduce the influence of opening. In addition, the support system template support structure is constructed based on the fixed boundary, and the diversified control system is constructed.
4.2. Simulation parameter analysis of MLFSS
In the construction process of MLFSS structure of stadium, the finite element parameter analysis is carried out based on the actual form of stadium concrete frame structure, and the pole structure form of support frame is effectively managed. Based on the construction requirements of spacing, the actual spacing of poles is determined to control the structure of shear wall and improve the rationality of setting simulation parameters of MLFSS.

5. Conclusion
In summary, relying on MLFSS can effectively split the load in the process of stadium construction, and has short cycle and low cost, so it has been widely used. Through the simulation analysis of the construction of the MLFSS, it could effectively analyze the changes of the formwork support system with time and space elements, so as to determine the scientific construction division plan, and help to determine the reasonable process of pouring and removing the formwork of the Multi-Layer Formwork Support System.

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