Research on the Economy of Assembled Steel Structure Building
Jian-feng LI, Qi-hui ZHAO and Lu-lu HAO
School of Civil Engineering, Xi Jing University, Xi'an 710123

Keywords: Prefabricated building, Steel structure, Cost analysis.

Abstract. The assembled steel structure housing system is a new residential structure system, has the advantages of light weight, good seismic performance, short construction period, green environmental protection, Recyclable many advantages, component factory construction, is a new technology focused on the promotion of the country in recent years. In this paper, through the selection of structure selection and structure analysis of the assembled steel structure system, the overall construction cost are analyzed, discussed the influence factors of assembled steel structure building system, put forward a reasonable way to reduce the construction cost of the assembled steel structure, has the reference value to the building structure selection and cost analysis.

Introduction
China as the world's largest steel producing country with an annual output of 7 tons, excess production capacity of nearly 1 tons, while China's energy consumption per unit building area is 2 times higher than in developed countries, construction waste, construction dust is one of the main sources of pollution in the city. The development of steel construction in China is facing great challenges and opportunities, but the current steel structure in our country accounted for only 5%, while the developed countries accounted for more than 50%, affordable housing construction speed, earthquake disaster housing reconstruction speed needs to be further improved. At the beginning of 2016 issued by the "China Central Committee and the State Council on Further Strengthening the administration of city planning and construction of a number of opinions" put forward, China should strive to use about 10 years time, the prefabricated construction accounted for the proportion of new buildings reached 30%. Ministry of housing and urban rural development clearly put forward to promote the use of steel residential buildings. The steel structure industry "13th Five-Year" overall development planning objectives are: 2020, the national steel structure was more than doubled in 2014 to reach 80 million tons, ~1 million tons; steel exports more than quadrupled in 2014, reached 10 million tons, accounting for 10% of the total steel structure; steel structure steel from the current "Q345, Q235", transition "Q345, Q390"; the overall key technology of steel structure design, construction, monitoring and so on to reach the international advanced level of [1].

Analysis on the Main Forms and Characteristics of Assembled Steel Structure Building
The assembly type steel structure building is refers to the standard design, the industrial production, the assembly construction, the integrated decoration, the information management, the intelligent application, the standard component steel structure building. The development of prefabricated steel structure building is a major change in the construction industry, is an important measure to promote the supply side structural reform and new urbanization development, is conducive to saving resources, reduce pollution, improve construction quality and safety level of labor productivity and to promote the construction industry and the industrialization of deep integration, foster new energy, new industries and promote to resolve the overcapacity.

Generally speaking, the assembly building is divided into three parts: prefabricated concrete structure system, assembled steel structure system, assembly type hybrid structure system.

According to the mechanical characteristics of the assembled building, it can be divided into: frame system, double lateral force resisting system, tube structure system [2].

Main features of prefabricated steel structure building
The steel structure housing construction will greatly reduce the sand, stone, ash content, the
materials used are mainly green to the degradation of the material in the demolition of buildings, most of the materials can be recycled or degraded, will produce a lot of garbage, in accordance with the requirements of green building.

It is easy to realize the standardization of design and management of information, so as to greatly improve production efficiency, reduce production costs, with the factory's digital management, the cost of the entire assembly building will be higher and higher.

Most of the building products (such as wall panels, interior panels, laminated, balcony, air conditioning board, Eucalyptus ladder, precast beams, prefabricated columns) completed by the workshop production and processing, to achieve the transfer from field operation to the factory.

The use of building, decoration integrated design, construction, decoration can be synchronized with the main construction.

The use of mechanical and even automated assembly operations, greatly reducing the casting operation.

The steel structure system can be used in residential building to give full play to the good ductility of steel structure, plastic deformation ability, and excellent wind resistance [3].

**Commonly Used Steel Structure System**

From the current domestic and foreign common structural systems are: cold-formed thin-walled steel system, steel frame structure, steel frame support structure, steel frame shear wall structure[4].

Cold-formed steel system: according to the amount of steel keel spacing modulus cloth, steel keel between various cloth supporting system, keel frame on both sides of the installation structure sheet and thermal insulation materials and surface decoration materials, forming a very reliable "ribbed type structure" is generally used only for 1~2 layer houses, renovation project in the construction or temporary.

Steel frame structure: this system is the most widely used in multi-storey steel structure residential buildings. It is composed of vertical and horizontal loads and vertical and horizontal loads. The advantage of this kind of structure is that the layout is flexible, which can provide a wide space, which is convenient for the user to design two times to meet the needs of all kinds of life. The lateral displacement of steel frame structure is poor, and the lateral deformation of the structure is large, so it is generally suitable for the following 10 layers.

Steel frame support structure: the system in the vertical and horizontal direction of the two directions along the column height of the vertical support system to strengthen the structure of the lateral stiffness. Support the use of steel, angle steel or steel pipe production. The form of support can be used X type, K type, type, inverted herringbone. In strong earthquake area, eccentric brace can be used, because of its good ductility and energy dissipation performance. Because the wall should be arranged to support, so there are many restrictions on the construction of the hole layout, but because it is pure steel structure, the construction speed is also the fastest.

The steel frame shear wall structure, the principle and the steel braced frame structure is similar, the framework will be arranged in a certain number of prefabricated steel shear wall or composite wall, the shear component borne by the shear wall supported shear frame columns bear small. The utility model has the advantages of flexible arrangement and convenient use of the frame structure, and has the advantages of larger lateral stiffness and better structural rigidity than the supporting structure.

**Cost Analysis of Assembled Steel Structure System**

The cost of cast in place concrete construction consists of direct cost, indirect cost, profit and tax (value-added tax, additional tax). Direct costs include labor costs, material costs, machinery costs, including the cost of indirect management fees, fees. Direct cost is the main part of civil engineering, the cost of construction projects will have a direct impact. Therefore, in the case of other costs unchanged, the traditional cast in place construction of the consumption of people, materials, machines, and so on are directly related to the level of social development. We would like
to reduce the construction cost, only the adjustment of enterprise management cost, but if excessive pursuit of low cost, it will cause bad influence on the quality and duration of the project.

The characteristics of the traditional cast-in-situ architecture: there is a lot of work wet site construction because the concrete construction and maintenance needs a long time, and now China demographic dividend is gradually weakened, labor cost, material cost, mechanical cost has a direct relationship with the level of social development.

The cost of the assembled steel structure building is composed of direct cost (labor cost, material cost, mechanical cost, measure fee), indirect cost (enterprise management fee, fee), profit and tax (VAT, surtax). The direct cost is the main part of the construction cost, but also the basis for the calculation of the construction cost, so the change of the direct charge plays a decisive role in the change of the project cost. And the prefabricated components have been charged VAT, so the tax will be offset in this part of the cost.

The characteristics of assembled steel structure building is compared with traditional cast-in-situ construction site of wet work is greatly reduced, prefabricated transported to the site to install, the installation fee includes the installation of prefabricated components used by professional machinery and part of the labor costs, saving 40% than traditional construction in the labor cost, and short construction time[5]. Greatly reduce the construction cost. But in the actual construction process, prefabricated high cost, transport distance and prefabricated also determines the level of the cost, especially the need to prefabricated carry two times more increase in construction costs, so we should choose the pre factory near in the actual construction, to reduce the cost of prefabricated units, under the table 1 shows the assembled steel structure building and the traditional cast-in-situ construction comparison table.

<table>
<thead>
<tr>
<th>Project</th>
<th>Traditional cast in place construction</th>
<th>Prefabricated steel structure building</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load-bearing member</td>
<td>All of the load-bearing members (columns, beams, plates, walls) are pouring in the construction site, there are a lot of wet work site and concrete curing time is long</td>
<td>1 vertical component prefabricated, horizontal member by composite form; 2 vertical component of the horizontal connection by setting a certain width of cast-in-place concrete with connections; connecting the 3 horizontal component and vertical component reinforced laminated using reserve cast-in-situ connection; 4 prefab rate is 60.3%.</td>
</tr>
<tr>
<td>Partition</td>
<td>Block masonry</td>
<td>Prefabricated light wall, on-site assembly</td>
</tr>
<tr>
<td>Decoration</td>
<td>The inner wall, the cylinder need to plaster, putty, paint</td>
<td>Most of the prefabricated parts need not be plastered</td>
</tr>
<tr>
<td>Exterior insulation</td>
<td>Need to be done on the outer wall layer, paste or spray insulation layer, and then do insulation layer</td>
<td>Prefabricated insulation layer, no need to do cement mortar leveling layer</td>
</tr>
<tr>
<td>Formwork and support</td>
<td>Formwork and steel pipe support</td>
<td>Only a small number of panels (about 20% of the cast-in-place type) and dedicated support (about the cast of the current 50%)</td>
</tr>
<tr>
<td>External scaffolding</td>
<td>Cantilever scaffold</td>
<td>Dedicated external scaffolding, each assumed height of 2 floors, about the cast of the type of 30%</td>
</tr>
</tbody>
</table>

**Some Suggestions on Reducing the Cost of Assembling Steel Structure System**

In the assembled steel structure, the proportion of the peripheral structure is large, which is the main source of the cost of the prefabricated components. To reduce the cost of prefabricated components can be from the following two aspects.
Enterprise Aspect [6]

Optimal design. The production enterprises of prefabricated parts can carry out the standardized production, reduce the cost of the prefabricated components and reduce the total cost.

Improve the installation level. The installation cost of prefabricated components is one of the major components of the assembly cost of construction, the installation of a heavy tower crane, installation speed directly determines the cost of installation. In the field of construction, should be segmented by water to improve the installation speed, reduce costs.

Reduce the transport distance of prefabricated components. The distance of the prefabricated components determines the level of cost, especially some prefabricated components need to be carried out two times, and the cost of construction is increased. Therefore, in the practical construction, it is necessary to choose the prefabricated factory with a relatively close distance. In order to reduce costs.

Industry Aspect

The government's policy orientation: the relevant government departments should fully research the market, establish and perfect the relevant laws and regulations, the precast production enterprises can carry out standardized production, reduce the cost of prefabricated template, thereby reducing the total cost of.

Form a complete industrial chain. The architectural design, building construction, the production of prefabricated components, the general contracting management model, which to a certain extent, reduce the cost of construction projects, improve the economic efficiency of the assembly.

Epilogue

Based on the above analysis, we can draw the following conclusions:

The structural system of steel structure is mainly composed of cold-formed steel frame, steel frame structure, steel frame support structure and steel frame shear wall structure. At present, domestic and foreign commonly used steel structure of the main forms of the wall are: light masonry wall and light plate wall.

Through the analysis of the cost of the traditional cast in place construction and the assembled steel structure building, the total cost of the assembled steel structure building. The direct cost is the main part of the construction cost, but also the basis for the calculation of the construction cost, so the change of the direct charge plays a decisive role in the change of the project cost.

According to the analysis of the development from the government introduced a correct policy to guide the assembly type steel structure construction; improve construction level, reduce the installation cost of prefabricated components, to control the total cost of assembled steel structure; reduce the transport distance of prefabricated components, choose the nearest component factory, reduce transportation costs, and reduce the total cost of.

Reference


