The Space Design of High-Speed Railway Station Leading by the Architectural Structural Style

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Abstract. As the high-speed railway develops rapidly, a large number of high-speed railway stations are completed within a short time. However, the design of these railway stations also encounters some dilemmas: the gradually normalized station functions and passenger line model in the architecture design as well as the designers paying more attention to the effects of building facades deprive the style features from the railway station architecture, lacking the identifiability. The purpose of this study is to solve the problem. Through concluding the various station types and space features of current high-speed railway stations, this paper carries forward the importance of the structural style innovation to building space shape, specifically analyzes the four structural styles' innovative application in the design of high-speed railway station architectures and then expresses the significance of the architectural space design approaches leaded by the structural form to modern railway station design.

Introduction

At present, China is experiencing the era of high-speed railway prosperity and development and the great-scale railway stations sustain to construct. But under the background of the large-scale and fast construction, the railway station designs are also confronted with some dilemmas.

In the architectural design, the gradually normalized passenger line mode and solidified space and scale have been the objective causes for railway station buildings forming highly similar. For the design methods, the architects lay more emphasis on the façade effects but ignore the creation of the architectural internal space features which deprive the stations from the characters and make them be lack of identifiability[1]. The architecture structural systems are short of innovation which also further cause the simplification of railway station internal space as well as the separation and discordance between internal space and architecture forms. In general, we called them as "Two Coats" buildings.

How to avoid the monotonous mutual stimulation and create the distinct and clear-cut station buildings? During the design process, we try to take the expression of structural style as the key for space shape[2]. "Structure is building", breaks through the conventional models and creates the railway stations with distinctive characteristics.

The Space Characteristics and Structural Innovation of High-Speed Railway Station

The classification and space features of the basic stations. In line with different construction scales and different internal spatial forms, the railway stations could be divided into the super-huge type, large type and small and medium type.

The super-huge type railway station is featured by the large scale and adopting the elevated waiting hall layout[3]. And the traffic organization form is mainly the elevated layer "Entrance in Waist Part" or "Entrance in Terminal Part". For example, in 2014, the Hangzhou East Railway Station was put into operation and its main station applies the giant space truss structural system

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which demonstrates the beauty of dynamics sufficiently. The large type railway stations widely utilize the combination of pathway lateral entrance and elevated waiting hall. The pathway lateral size is the entrance hall with the same height with the platform, the waiting hall locates above the platform so that it forms two spaces with different elevations. The waiting hall could be more completed[4]. For example, the Taiyuan South Railway Station and Changsha South Railway Station are of this type. Due to the small scale and relatively single functions, the overall arrangement of small type railway station is usually adopting the pathway lateral layout forms. The entrance and waiting halls are most in the same spade and the spatial form are often quite simple, such as the Hengyang East Railway Station and the Hengshan West Railway Station.

The innovation of structural style. The large and super-huge type high-speed railway stations often use the long-span spatial structural system[5]. Starting from the structure type selection, the architects seek out the innovative structure system which possess advanced technologies, rational economics and reliable security so as to shape totally new architecture space form. The author figures that the innovation of the high-speed railway station structure system could be expressed in the following aspects: The building internal space is transparent and concise, it plays the decisive role of roof form in architectural space enclosure and conducts the space leading to the passengers; It adopts the new type structural forms, such as unit structure, double curved surface structure, oversized span structure and so forth. At the same time, it also utilizes the new type materials and implementation technologies so as to reduce the visual barriers as much as possible; The structural system reflects the building space directly, lessens the surplus decorations, shows the internal logic of the structural dynamics and shapes the spatial form with abundant rhythmical image and potency sense[6].

The Application of Four Structural Style in Station Architectures

In the past decade, our design institute has completed (or is conducting design) more than 200 railway stations. Including, we designed the large-scale railway stations for 12 provincial cities. In these programs, we realize the continuous innovation in architecture, structure and facilities. Particularly significant is the fact that stressing on the structural form to express the architectural space and form completes a batch of distinctive and high-quality buildings.

Unit structure. The Taiyuan South Railway Station adopts the unique steel-work unit structural system which is rare and classic steel-work unit large space transportation architecture in domestic railway stations. In the plan design phrase, the architects put up with the unit structural style which formed the large space through the permutation and combination of unit structure as well as continued to optimize the unit structure during the detailed design process. Meanwhile, it also skillfully connects the Taiyuan historical context and modern architecture technologies so as to form the charming the internal space form.

The size of single structural unit reaches to 43m×36m, the cover area surpasses 1500m^2(Fig. 1). The building internal structure totally express on the external form and the structural units are arranged orderly so that the load-carrying capability is clear, and the relationships are clear. Such kind of plain structural logical relationship could not only be reflected in the internal space of the building but also sufficiently demonstrate the truth and rationality of the structure. Apart from that, the units adopt the standard components manufacture, field installation and convenient and fast construction.

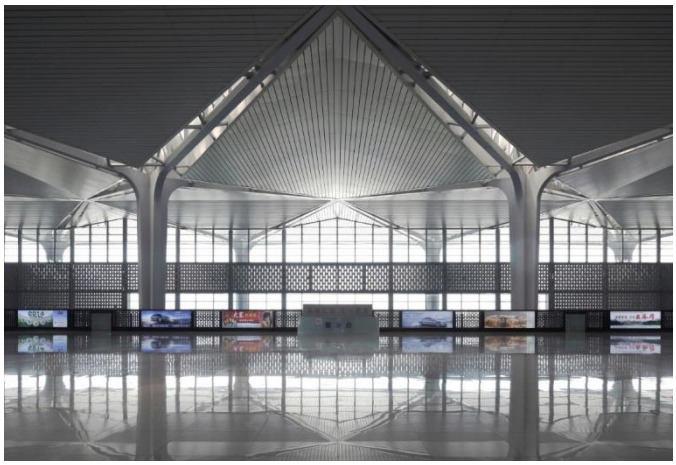

Figure. 1 The Hall of Taiyuan South Railway Station

The Suizhou South Railway Station under constructing is the newest railway station which utilizes the unit structure. The station building locates the south area of the Suizhou city and is one of the important nodes in Wuhan-Shiyan high-speed railway which is the most beautiful high-speed railway line of Hubei. The station building model takes the basic shape of ginkgo leaf as the design aspiration which integrates the leaf form and structural mold ingeniously. The station's hall consists of 24 structural units and externally forms the architecture image with high identification(Fig. 2). For the external part, the structural units apply the semi-transparent and colorful ETFE film wrap. Meanwhile, it also imports the natural light on the top. Through the structural chamber, the lights form the glittering and translucent shiners internally so as to provide the vivid and rich space experience for passenger waiting for train and having a rest.

Figure. 2 Facade of Suizhou South Railway Station

Tree Structure. Being located between Liuyang River and Xiang River, Changsha South Railway Station takes the dendritic steel structure system as the important architectural expression method. The huge roof is supported by interior and outdoor tree-shaped pillars. The pillars gradually separate on the top part to form the structural system with clear force transmission. It further reinforces the artistic appeal of the architecture as it works to bring the unique space experience for passengers. And a pair of "tree" columns in the main entrance possesses the 126 m gap which could support about 12,000m^2 roof of station building drop-off platform so as to offer the semi-outdoor space as shelter(Fig. 3). For the design of platform canopy, it also adopts the tree column design which softens the platform space and reduces the oppressing sensation.

Figure. 3 Tree Structure of Changsha South Railway Station

Large-span spatial structure. The large-span spatial structure becomes the common form for large scale junction station, bringing the integrated large space. The Xiangyang Dongjin Railway Station is the on-line elevated station building which is also the landmark in Xiangyang Dongjin New District. The primary station roof utilizes the large-span spatial network structure. On the roof, the empty and full alternate and the day lighting roof pours down on the south end which becomes the extensions with the main entrance arc-shaped canopy as well as forms the natural enclosure with the two flanks' glass curtain walls.

The far-reaching raked eaves of building facade creates the "Door of Xiangyang" architecture image. Internally, it is near to south and north ends so as to realize the large spatial overhangs and to guarantee the stability of structure. The full demonstration of structural form takes shape of natural building space and "facade". Integrating the central net rack, the elevated waiting hall forges the interior and outdoor integrated flow line with the lumpy ceiling, creating the comfortable waiting environment. Interior space following structure comes into being the fluent innervation type.

Arched monolayer steel shell structure. The Zhangjiajie West Railway Station is the largest junction station on the Qian Zhang Chang Railway and Zhang Ji Huai Railway. The station house roof utilizes the rhombus units and reconstructs the local traditional buildings' sloping roof which exquisitely combines the large-span structure and architecture form together(Fig. 4).

In the design of entrance overbridge roof, it adopts the arched monolayer steel mesh shell structure but gives up the suspended ceilings which totally exposures the rhythm and beauty of structural components so as to demonstrate the local cultural features.

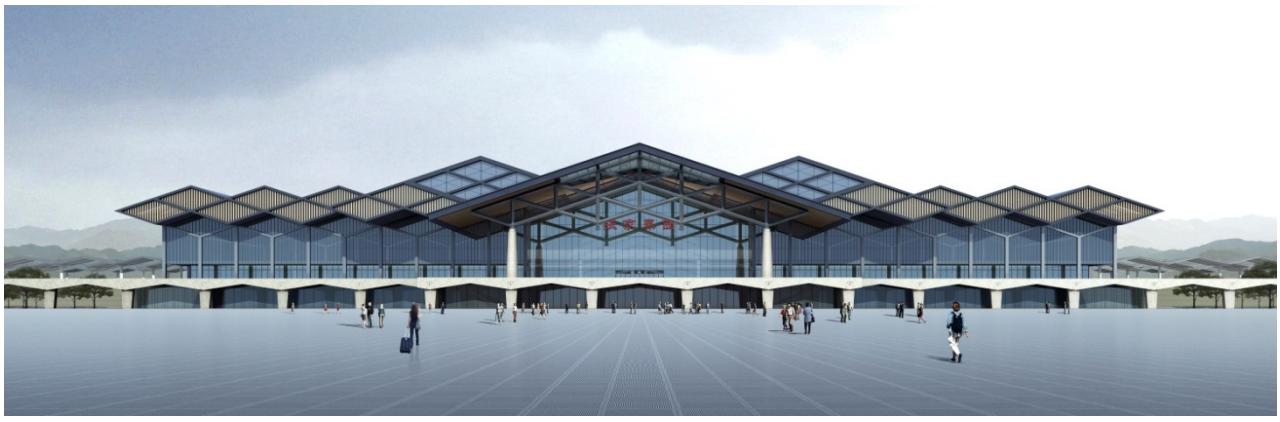

Figure. 4 Front Elevation of Zhangjiajie West Railway Station

Summary

In modern railway station architecture design, we abide by fully reflecting the internal functions, structural forms and spatial characteristic by external forms to prompt "structure is space, structure

is architecture" design philosophy[7], to restore the structure to the architecture form, fully demonstrate the structural technology beauty and finally reach the perfect unification among structure, space and architecture form. Under such design philosophy, it breaks the thinking model which unilaterally pursues the "facade effects" of architecture. We believe that there would be more railway station with distinct characteristics.

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