IOP Conference Series: Earth and Environmental Science

A Simplified Calculation Model for the Rail Layer in Harbinxi Railway Station

To cite this article: Bao Biyu 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **643** 012184

A Simplified Calculation Model for the Rail Layer in Harbinxi Railway Station

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Abstract. Considering the particularity of the station house withstanding dynamic load as well as the characteristics of frame structure, the discrete analysis was used to study the finite element structure of the station house. By comparative analysis on various element simulation approaches, this paper studied the rational approach to simplify the model so as to achieve a more realistic stress status for computation results.

1. Project Overview

The Harbinxi Railway Station project is located at the crossing of Haxi New District and Qunli New District in Harbin city, Heilongjiang province. The project is eight kilometers from the Harbin Railway Station and twenty-five kilometers from the Taiping international airport. Harbinxi Railway Station project consists of the North and South station houses, the elevated station house, the equipment room and else construct. It is designed to possess eight basic platforms with a size of 450mx12mx1.25m. Under the station houses pass the Metro Line 4 and Line 5.

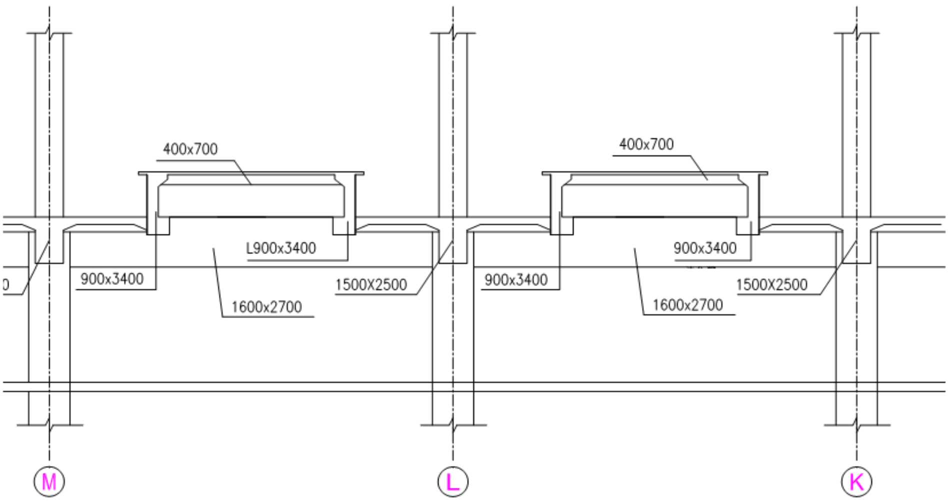

Figure 1 Vertical section of the rail layer for Harbinxi Railway Station layout

The rail layer of the Harbinxi Railway Station lies at the construction plane D to axis R and between axis 7 and axis 10. It has a capacity of twenty-two lanes, four high-speed railways and eighteen normal railways.

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2. Comparison of the Computation Models of Levelled Layer and Unlevelled Layer

With regard to the hybrid bridge-and-building structure of the rail layer in the railway station, it was supposed to be designed and calculated according to both building structure and bridge structure. This project used SAP2000 and Midas Civil applications to conduct a discrete analysis on finite elements. Guided by Midas analysis, the results of the computation model were then reviewed by SAP2000. This paper only studied and analyzed the selection of Midas model.

Known from the vertical section diagram of the rail layer in Figure 1, the platform board and platform beam along with the frame of transverse main beam were consolidated together. Given that the height of the platform beam is 3.4 m, in the midst of platform structure simulation, two simulation approaches were used to determine the rational model-building method.

2.1 Model of Unlevelled Layer

The model of the unlevelled layer will be built in accordance with the actual structure. The model simulates both the platform and the beam. Plate element is used for the platform to simulate the expected real stress condition. The unlevelled model was shown in Figure 2.

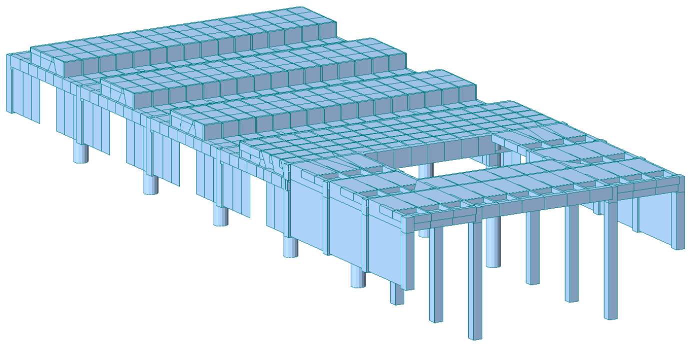

Figure 2 Computation model before levelling

The calculation results for the internal force of the main cross-beam 1600 x 2700 mm under deal load and temperature effects were shown in Figures 3 to 6. By analysis on the computation results in the light of railway design specifications, the calculated bending moment value under overall heating-up and cooling operation modes were apparently larger, which was close to the bending moment value under dead load. In architectural design, the action of integrated structure was taken into account as a whole. Therefore, temperature became a negligible factor. Normally the internal force caused by temperature changes was reduced and even neglected. In this model, the temperature element plays an equivalent role to the dead load element in affecting structure. Thereupon, such calculation result is extremely irrational.

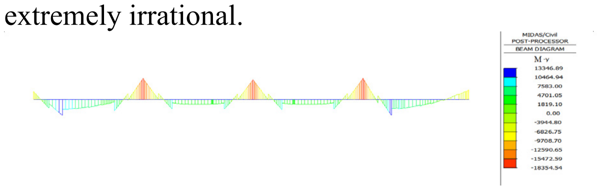

Figure 3 Bending moment diagram of the main cross-beam 1600 x 2700 mm under dead load

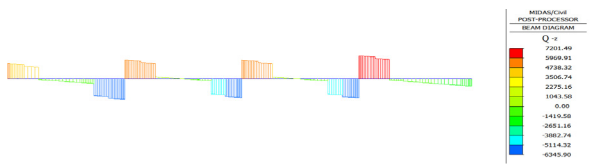

Figure 4 Shear diagram of the main cross-beam 1600 x 2700 mm under dead load

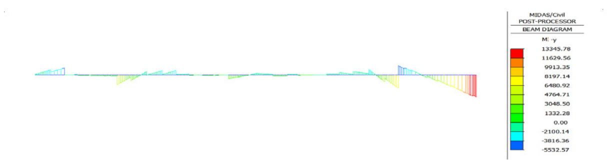

Figure 5 Bending moment diagram of the main cross-beam 1600 x 2700 mm under systematic heating-up

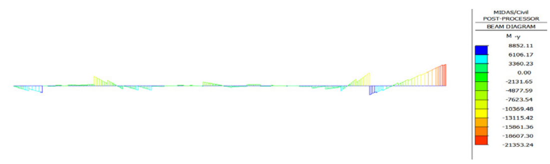

Figure 6 Bending moment diagram of the main cross-beam 1600 x 2700 mm under systematic cooling

2.2 Levelled Model

By studying the Computation Model I, we found that the constraint is too strong in the process of simulating the platform beam and the main cross-beam. Consequently, it generated huge internal forces under temperature impact. However, in real plate-girder structure, the partial internal force would be released through structural deformation due to the temperature changes. In view that the live load on the platform plate-girder was relatively less, the load of platform plate and the load on the platform were directly added on the platform beams in the form of concentrated force to reduce the temperature impact when the beam plates were consolidated. Therefore, the specific simplified model of platform load was shown in Figure 7.

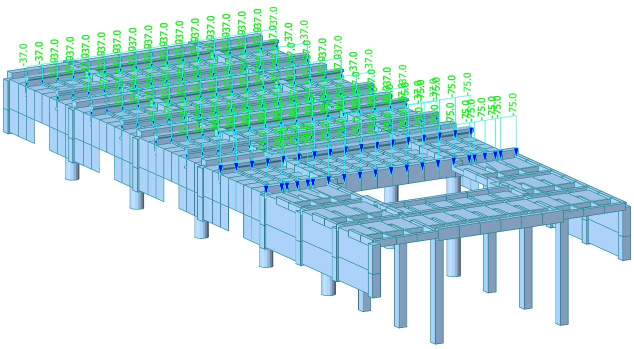

Figure 7 Computation model after levelling

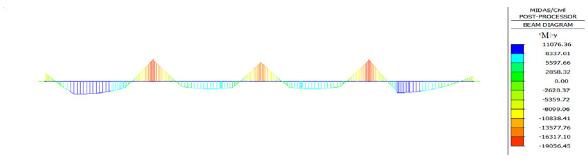

Figure 8 Bending moment diagram of the main cross-beam 1600 x 2700 mm

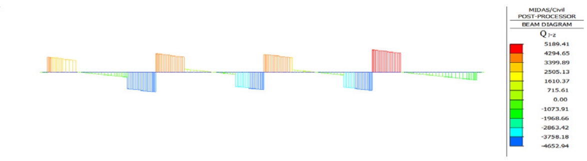

Figure 9 Shear diagram of the main cross-beam 1600 x 2700 mm under dead load under dead load

Table 1 Comparison of shear force calculation results under dead load before levelling and after levelling

Location	Unlevelled		Levelled	D-value
	Shear force (kN)			
1st Mid-span				
1st Mid-pier	6345		4652.9	26.7%
2nd Mid-span				
2nd Mid-pier	5857		4123.4	29.6%
3rd Mid-span				
3rd Mid-pier	7201.5		5189.4	27.9%
4th Mid-span				

Table 2 Comparison of the bending moment calculation results before levelling and after levelling under dead load effect

Location	Unlevelled	Levelled	D-value
	Bending Moment (kN.m)		
1st Mid-span	13325.8	11076.4	16.9%
1st Mid-pier	-18108	-19056.4	5.2%

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2nd Mid-span	8107	6320.4	22.0%
2n Mid-pier	-16818.4	-16316.2	3.0%
3rd Mid-span	8342.4	6366	23.7%
3rd Mid-pier	-18354.5	-18726.4	2.0%
4th Mid-span	13346.9	9619	27.9%

In view of the internal force results of two models under dead load, the two models possessed relatively adjacent internal force at the cross section of middle pier. In comparison to the computational result of the SAP model, the actual result was acceptable within the error range.

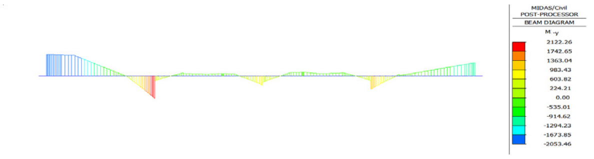
Figure 10 Bending moment diagram of the main cross-beam 1600 x 2700 mm under systematic heating-up

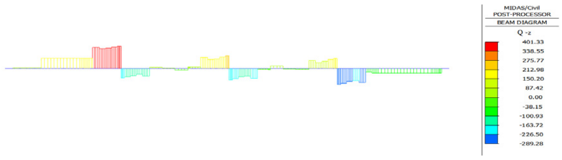
Figure 11 Shear diagram of the main cross-beam 1600 x 2700 mm under systematic heating-up condition

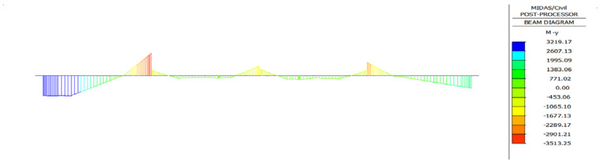
Figure 12 Bending moment diagram of the main cross-beam 1600 x 2700 mm under systematic cooling condition

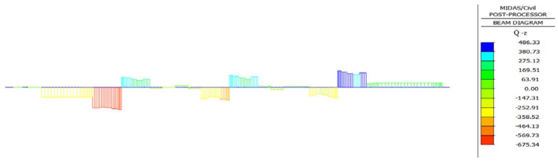
Figure 13 Shear diagram of the main cross-beam 1600 x 2700 mm under systematic cooling condition

Figures 10 to 13 show the internal force of the cross frame beam after the model was levelled under the conditions of systematic increase and decrease in temperature. The bending moment which arose by temperature had accounted for 20~30% bending moment of the dead load, yet it still stayed within the reasonable range.

3. Conclusion

Through comparison and analysis on the simulation approaches of two different units, the thesis finally chose the levelled simplified model to conduct the simulation analysis on the structure. Accordingly, the test result is more favorable to reflect the real stress status of the structure.

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