Simulation and application of a new type of slideway beam based on MIDAS jacking construction method

LI Qin\textsuperscript{1, a}, Jian Gao\textsuperscript{1, b} and Qiuyue Zhang\textsuperscript{1, c}

1 College of Civil Engineering and Architecture, Shandong University of Science and Technology, Qingdao, Shandong, 266590, China
\textsuperscript{a}q15615610522923@163.com, \textsuperscript{b}422252270@qq.com, \textsuperscript{c}13615426280@163.com

**Abstract.** In order to ensure the continuous box girder jacking method in the process of construction safety in Jingzhou City, Mongolia and China Railway Bridge jacking construction method of process engineering background, research on continuous box girder pushing process in the first two layer 8 laminated I-beam spell 56B security control problem model in the process of construction, the slide beam. Based on the control principle of adaptive method, a finite element model of slideway beam during incremental launching is built by MIDAS, and the range of deformation and internal force of the whole structure of slipway beam is put forward during construction. Through monitoring and measuring the deformation of the slideway beam during the incremental launching process, we get the test data and compare with the theoretical value, so as to guide the safety control of the slipway beam during the pushing construction of the continuous box girder. The research results show that during the incremental launching of continuous box girder, the slideway beam can meet the requirements of deformation and internal force. The safety control technology adopted can effectively guide the engineering construction, and the method is feasible.

1. Introduction

Since its successful application in ager bridge in Austria in 1959, the jacking method has been developed rapidly in the history of bridge construction in the world. In 1977, China first used the jacking method to build the dijiahe bridge\textsuperscript{[1]}. Shao H et al\textsuperscript{[2]} first carried out the research of jacking construction in China. Liu S\textsuperscript{[3]} carried out the research of internal force analysis in the stage of jacking construction earlier, established the simplified model of internal force calculation of continuous beam in combination with the engineering practice, and carried out the detailed calculation and analysis. Liang A et al\textsuperscript{[4]} used MATLAB tools to study the dynamic analysis of the construction internal force and displacement of the continuous beam bridge with constant cross section constructed by one-way (two-way) single point (multi-point) jacking method.

However, from many research results, it can be seen that: at present, there is little research and analysis on the slideway beam in the process of bridge jacking construction. A large number of engineering examples show that the slideway surface of the concrete jacking beam is in contact with each other, and the concrete beam is not tensile under compression. The deformation of the slideway beam will make the slide at the bottom of the beam hollow, resulting in the uneven stress distribution of the beam, resulting in the cracking of the concrete beam. Therefore, we need to study one A new type of slideway beam can ensure the smoothness of the slideway surface during the beam concrete pouring and jacking construction, and effectively solve the cracking problem of the jacking concrete beam caused by the former slideway irregularity.
2. Finite element solid model of slideway beam

2.1 Introduction to finite element model. (1) Unit division. The model of slideway beam is built by hexahedral solid element, and the material is Q235 steel. The calculation model is 3 × 6.5 m beam section. The longitudinal length of the contact between the slideway beam and each transverse distribution beam in the middle is about 700 mm, and the longitudinal length of the contact part is 14 × 50 mm; the longitudinal length of the contact part with both ends is 350 mm, and the longitudinal length is 7 × 50 mm; the beam section without the contact transverse distribution beam is divided into 30 × 200 mm units. In the transverse direction, the connecting steel plate and I-beam flange plate are divided into 28 units, of which the transverse length of 4 units is the same as the thickness of I-beam web, and only one unit is divided in the transverse direction of I-beam web. The connection steel plate is divided into one unit vertically, I-beam flange plate is divided into two units and web plate is divided into five units. The model of slideway beam is shown in Fig. 1.

![Model axonometric drawing](image1)
![Model elevation](image2)
![Model side view](image3)

Fig. 1 Finite element model of slideway beam

(2) Calculation load

In the process of launching, the box girder web is always located above the slideway girder, and the two transverse slideway girders are symmetrically arranged. It is considered that the two girders are equally divided into the box girder weight and evenly distributed in the vertical and horizontal directions. Surface pressure is proposed to simulate the dead weight of box girder, and it is calculated that the applied surface pressure is 260 kN/m. The pressure load model is shown in Fig. 2.

![Calculation load](image4)

Fig. 2 Calculation load
(3) boundary conditions

The calculation model takes one section of the slideway beam, and the boundary condition is simplified as the boundary condition of three span continuous beam. Considering that there is no horizontal sliding between the slideway beam and the transverse distribution beam, the horizontal direction is also constrained at the constraint of each span. The contact length between the slideway beam and the transverse distribution beam in the longitudinal direction is about 0.7m, and the boundary conditions at the two ends are 0.35m and 0.7m in the middle restrict the X, y and Z directions. The boundary conditions of the model are shown in Fig. 3.

![Fig. 3 Boundary conditions](image)

(4) connection simulation between I-beam and connecting plate

In the actual situation of the slideway beam, the I-beam and the connecting plate are only welded at the outermost edge of the outer I-beam. The rigid connection is used for the connection of the model, and the rest of the joints connecting the steel plate and the I-beam contact part are connected by spring element. The connection between connecting plate and I-beam is simulated by spring in horizontal direction.

(5) calculation conditions

According to the possible position of the box girder during the jacking process and considering the unfavorable stress condition of the slideway girder, this model can be divided into three situations according to the longitudinal loading position: three span full load, two span load in the middle and one span load in the side span. In the actual construction process, most cases are three span full load, so this paper simulates one of the working conditions of the finite element model, and carries out the numerical simulation analysis.

2.2 analysis of calculation results

| Working condition     | Deformation                              | Result      |
|-----------------------|------------------------------------------|-------------|
| Integral deformation  | Maximum vertical (mm) (mm)               | -1.09       |
|                       | Maximum longitudinal (mm)               | 0.13        |
|                       | Relative slip (mm)                       | 0.15        |
|                       | Maximum vertical (mm)                   | -1.09       |
| Connecting plate      | Maximum value of the first principal stress (MPa) | 40.94       |
|                       | Maximum value of the third main stress (MPa) | -52.14      |
|                       | Maximum vertical (mm)                   | -1.06       |
| I-beam                | Maximum value of the first principal stress (MPa) | 34.69       |
|                       | Maximum value of the third principal stress (MPa) | -57.9      |
The overall deformation cloud diagram of the slideway beam is shown in Fig. 4-5.

The cloud diagram of top connecting steel plate is shown in Fig. 6-8.

The cloud chart of I-beam is shown in Fig. 9-11.
3. Field test of bearing capacity of slideway beam

3.1 preloading scheme of slideway beam. The standard section of 6.7m long slideway beam is selected for preloading above the erected slideway beam. The maximum construction load of the jacking section beam (45.7m) is 1623.5t, the maximum load weight is about 1.2 times of the maximum construction load, and the maximum load weight per linear meter is 40.96t. Set up the preloading platform on the already installed slideway beam for 40%, 60%, 100%, 110% and 120% loading, arrange the dial indicator at the bottom of 1/4 span, 1/2 span and 3/4 span of the slideway beam to observe the deflection of the slideway beam, and measure the compression of the sand box before and after preloading.

3.2 pre compression test results of slideway beam. When the slideway beam is preloaded to 120% of the maximum construction load, there is no crack in the processing weld of the slideway beam. The measured deflection on site (the reading of dial indicator minus the compression of the sand box) is as follows: the measured deflection of the East 1/4 span is 2.13mm, the measured deflection of the East 3.1mm, the measured deflection of the east 3/4 span is 2.2mm, the measured deflection of the West 1/4 span is 2.08mm, the measured deflection of the west 3/4 span is 2.9mm, and the measured deflection of the west 3/4 span is 2.04mm.

The fulcrum under the slideway beam is the sand box, which is welded and reinforced with the slideway beam. The dial indicator is fixed on the longitudinal distribution beam, and the longitudinal distribution beam is connected with the transverse distribution beam. Considering the settlement of the sand box in the preloading process, the measured deflection value will be larger than the actual deflection value.

4. Summary
It can be seen from the test results that the slideway beam is still deformed after unloading, which indicates that the measured deflection includes elastic deflection and inelastic deflection when the
slideway beam is preloaded. In addition, the fulcrum under the slideway beam is the sand box, which is welded and reinforced with the slideway beam, the dial indicator is fixed on the longitudinal distribution beam, and the longitudinal distribution beam is connected with the transverse distribution beam. In consideration of the settlement of the sand box during the preloading process, the theoretical calculation value is the elastic deformation of the slideway beam, so the measured value will be slightly greater than the theoretical calculation value, and the test results are consistent with the analysis. In the test results, the elastic deformation of the slideway beam is close to the theoretical calculation value. When the maximum construction load is 120%, the structure has no abnormal phenomenon. It can be considered that the slideway beam is in a safe state.

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