International Journal of Technical Research and Applications e-ISSN: 2320-8163,
www.ijtra.com Volume 3, Issue 4 (July-August 2015), PP. 149-151

FINITE ELEMENT MODELING METHOD OF PREFABRICATED STEEL-CONCRETE COMPOSITE BRIDGE

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Abstract- Steel-concrete composite bridge has been widely used in recent years, it can take full advantage of the characteristics of the steel and concrete, greatly saves the cost of bridge. Traditional composite structure, pouring concrete in the erection of steel beams, this method of construction causing long bridge construction period and the place concrete quality is not reliable. Against the disadvantages, Scholars put forward the concept of prefabricated composite structures. According to the analysis of its stress, this paper put forward the Finite element modeling method of Prefabricated Steel-Concrete Composite Bridge, it can accurately simulate each construction stage.

Keywords- Prefabricated Composite, Finite element modeling method, construction stage

I. INTRODUCTION

Steel-concrete composite bridge is the structure which steel beam and concrete deck can work together[1], it can take full advantage of the characteristics of the steel and concrete , greatly saves the cost of bridge. The concrete deck of fabricated steel-concrete composite is made of segments[2].Lifting prefabricated concrete deck on the steel beam after it reache the predetermined strength, then the welding embedded shear key, let steel beam and concrete deck to form a composite structure. Considering the limit of hoisting capacity, the concrete is made of segments, and the concrete deck is made up of prefabricated and cast layers. The steel beam beared the weight of prefabricated concrete deck, the steel-concrete composite structure beared the weight of cast concrete. It can maximum performance of the composite structures.

With the rapid development of computer technology, Finite element analysis of engineering structures is increasingly becoming an important analytical tool. Fabricated steel-concrete composite bridge as a new structure, the construction process is different from the conventional composite structure bridge, therefore, the finite element analysis method is different from the conventional combination structure. This paper will introduced prefabricated steel-concrete composite structure modeling method in detail.

II. THE SIMULATION OF THE BEAM

This article selects the Midas/civil 2012 for finite element analysis, the finite element model is a Single chip of the fabricated steel composite structure, its Structure is shown in figure 1.The concrete deck is made up of 30cm prefabricated and 10cm cast layers, the Steel structure cross section is shown in figure 2.In the model, the material of steel beam is Q345, the material of concrete is C50.

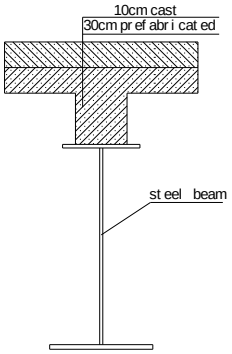

Figure 1 the section of fabricated steel composite structure (unit:cm)

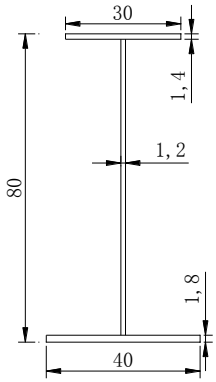

Figure 2 the section of steel beam (unit:cm)

In this paper, the span of steel beam is 20m, the element

length in the finite element model are taken as 1m. the cross section reference points are in the upper part of the unit, end of the node is shifted down to the support position(floor center), the supports node and beam nodes are connected by rigid connections.

In the actual project hoisting bridge, the concrete deck is lifting on the beam which deformation has already occurred under the influence of gravity. In order to accurately simulate the construction process, the nodes of deck and I-beam are set into a group in the model, the nodes of deck and I-beam are connected by Compression spring. The concrete deck group contains only elements and no node.

III. THE SIMULATION OF COCRETE DECK

The concrete deck is made up of 30cm prefabricated and 10cm cast layers, when the concrete of concrete deck has not yet to reach the strength, cast concrete only action as weight load on the concrete deck. Cast concrete structure activation on concrete hardening phase, in this phase, the group of concrete deck contains only elements and no nodes.

IV. THE SIMULATION OF THE CONNECTION BETWEEN STEEL BEAM AND CONCRETE DECK

When the concrete deck is lifting, prefabricated deck as weight load applied on the top of the beam, selecting only compression spring to simulate. Concrete deck and steel beam formed a composite structure by welding, choosing rigid connection to simulate this working conditions.

V. THE SIMULATION OF CONSTRUCTION PHASE

There are five full-bridge construction：erect steel I-beam, hoist Prefabricated concrete deck, weld concrete deck, Pour the cast layer of concrete deck, cast concrete layer to achieve strength. The information contained in each construction stage as follows:

The construction phase one: erect steel I-beam. The activated structure: the elements and nodes of steel beam, the nodes of concrete nodes, the nodes of supports. The activated boundary conditions: The rigid connection between steel beam and supports. The activated load: the weight of structure. The model of construction phase one is shown in Figure 3.

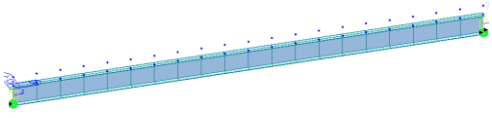

Figure 3 The model of construction phase one

The construction phase two: hoist Prefabricated concrete deck. The activated structure:the nodes of concrete deck. The activated boundary conditions: The only compression spring between steel beam and concrete deck. The model of construction phase two is shown in Figure 4.

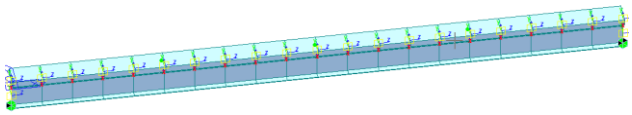

Figure 4 The model of construction phase two

The construction phase three: weld concrete deck. Passivation boundary conditions: The only compression spring between steel beam and concrete deck. The activated boundary conditions:the rigid connection between steel beam and concrete deck. The model of construction phase three is shown in Figure 5.

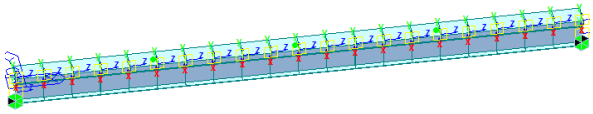

Figure 5 The model of construction phase three

The construction phase four: Pour the cast layer of concrete deck. The activated load: the weight of cast layer.The model of construction phase four is shown in Figure 6.

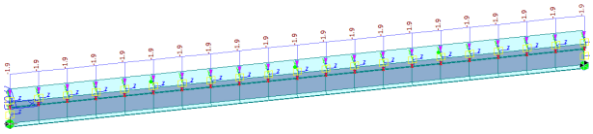

Figure 6 The model of construction phase four

The construction phase five: cast concrete layer to achieve strength. The activated structure: the structure of cast layer. The model of construction phase four is shown in Figure 7.

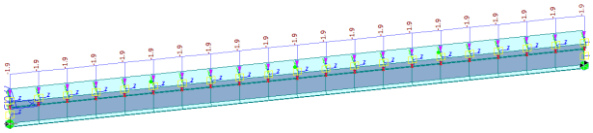

Figure 7 The model of construction phase five

VI. RESULT ANALYSIS

The displacement contours of prefabricated Steel-Concrete Composite Bridge,the Stress contours of steel beam, the Stress contours of prefabricated deck, the Stress contours of cast concrete layer are shown as follow:

(1)The displacement contours of prefabricated Steel-Concrete Composite Bridge is shown in Figure 8.The maximum displacement is shown in the middle section, Value of 1.3cm. Through the displacement deformation contours, concrete deck and steel beam shows good deformation coordination, the results show that the finite element can be used to simulate the assembly structure.

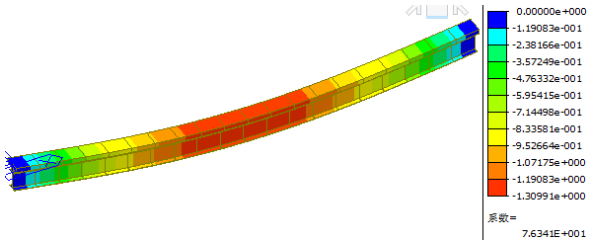

Figure 8 The displacement contours (unit: mm)

(2) The Stress contours of steel beam is shown in Figure 9. The maximum stress is shown in the middle section, Value of 43.25MPa, conform to the characteristics of simply supported beams.

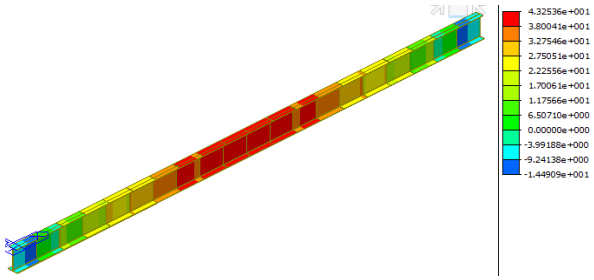

Figure 9 The The Stress contours of steel beam (unit:MPa)

(3) the Stress contours of prefabricated deck is shown in Figure 10. he maximum stress is shown in the middle section, Value of 3.56MPa.

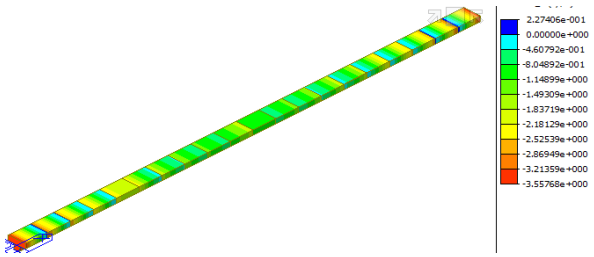

Figure 10 The The Stress contours of prefabricated deck (unit: MPa)

(4)The Stress contours of cast concrete layer is shown in Figure 11. This shows that the cast concrete layer has no Stress, conform to the characteristics of prefabricated steel-soncrete composite bridge.

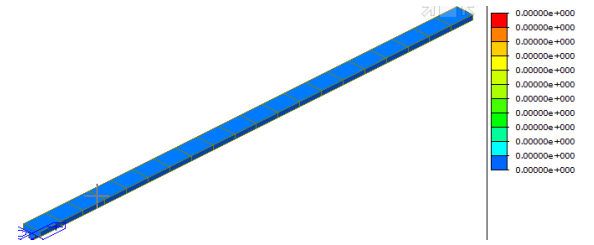

Figure 11 The The Stress contours of cast concrete layer (unit: MPa)

VII. CONCLUSION

This paper introduces the concept of prefabricated steel-concrete composite bridge, introduced its construction process, analysis of its mechanical characteristics, and then put forward the finite element simulation method of prefabricated steel-concrete composite bridge, The conclusions are as following.

(1) The node of concrete deck and steel beam activated at the same time, implement the concrete deck lifting in the deformation position of beams, consistent with the actual project.

(2) When lifting Bridge Road board, use the only compression spring between steel beam and concrete deck, accurate simulation of the state that concrete deckt before welding.

(3) Welding concrete deck, passivate the only compression spring between steel beam and concrete deck and activated the rigid connection between steel beam and concrete deck. Concrete deck and steel beam shows good deformation coordination, it shows that the finite element can be used to simulate the assembly structure.

(4)Use the Construction stage joint cross section to simulating the cast concrete layer, When the cast layer not reach the strength, we use the load of weight to simulating. When the cast layer achieve its strength, we activated the elements of cast layer, and let the weight coefficient of 0.

(5)As it shows in the deformation contours, concrete deck and steel beam shows good deformation coordination, meets the mechanical characteristics of composite structures. Through the stress contours of prefabricated concrete deck and cast layer, the cast concrete layer has no stress. Conform to the characteristics of prefabricated steel-soncrete composite bridge. It Shows that this finite element modeling method proposed in this paper can accurately simulate the construction process fabricated composite structure.

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