Selection of hollow steel plate deck for floor system of long-span suspension bridges

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Selection of Hollow Steel Plate Deck for Floor System of Long-Span Suspension Bridges

Choix d'une section métallique fermée pour le tablier des ponts suspendus de longue portée

Zur Wahl eines stählernen Hohlkastens für das Deckensystem weitgespannter Hängebrücken

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1. Introduction

This contribution on planning of structures and its relationship with construction methods is for the additional study on the "Planning of Floor System at Long-Span Suspension Bridges" which was classified in Theme IIb in the Preliminary Report.

When a floor system is planned at a long-span suspension bridge provided with stiffening truss girders, many kinds of floor system can be proposed as discussed in the Preliminary Report.

In this paper the relationship of planning of the floor system of hollow steel plate deck with its fabrication method examined in detail.

2. Evaluation of Floor System

In the Preliminary Report, the authors examined several possible floor systems, which are a floor system, (1) with reinforced concrete slab, (2) with closed steel grating floor, (3) with precast concrete steel grating floor, (4) with prefabricated steel deck plate sandwiching concrete, (5) with prefabricated composite girder, (6) with orthotropic steel plate deck, and (7) with hollow steel plate deck, to evaluate which floor system would be the most suitable for a long-span suspension bridge with stiffening trusses. At the study, structural features of various floor systems were examined and compared with one another on such conditions as fabrication, erection, maintenance, economy and so on, by making a decision matrix.

As a result, it might be considered to be generally advantageous to provide the bridge with a lighter floor system instead of a heavier concrete floor system. Furthermore, among the steel floor systems a new type of hollow steel plate deck was proved to be better than an ordinary orthotropic steel plate deck.

Prof. F. Moses pointed out at his General Report at the Congress that the present study was interesting from the viewpoint that various types of deck for the floor system were examined about their cost and weight with comparative designs, and also

about their performance or function with a decision matrix, at the decision process.

However, it is quite necessary to examine the hollow steel plate deck in more detail to know if there might be some practical problems at its fabrication and erection.

3. Fabrication of Hollow Steel Plate Deck

Hollow steel plate deck developed by the authors has such a cross section as shown in Photo. 1, and consists of two face plates and core plates which are installed diagonally between face plates.

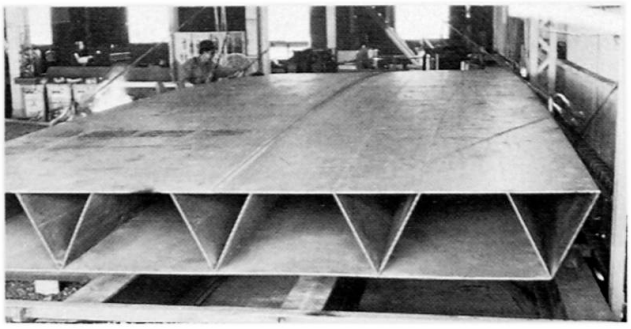
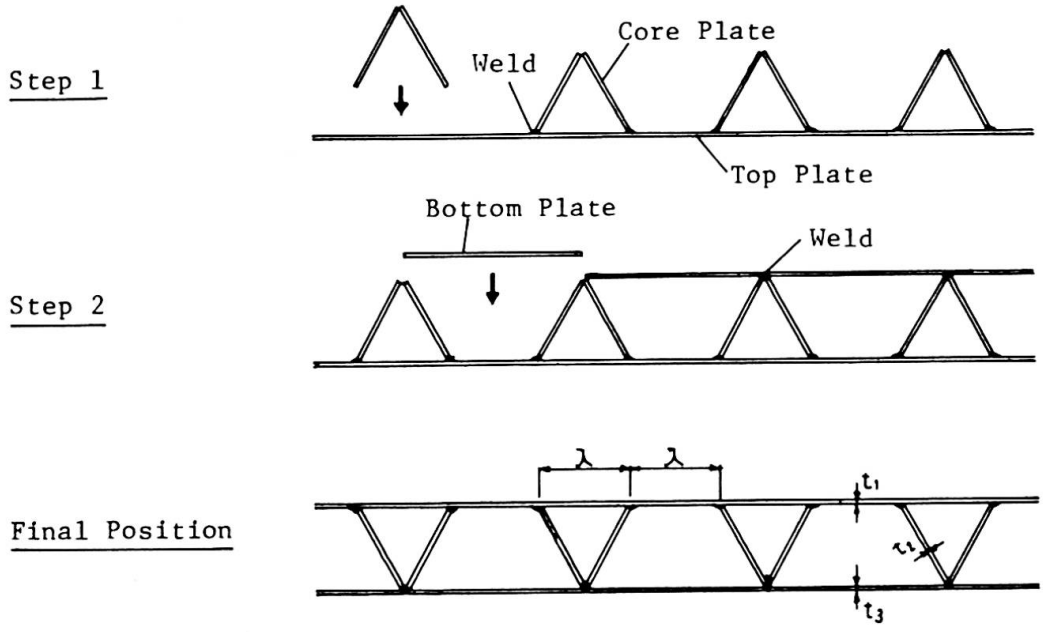


Photo. 1 Section of Hollow Steel Plate Deck

Fig. 1 is illustrating the fabrication sequence of this deck. The fabrication operation is done by reversing a top plate and a bottom plate. First of all, core plates are welded in a triangular form to a steel plate which will serve as a top face plate. Then, band-type bottom face plates are welded to the top of triangularly-formed core plates.



Note: For Highway Bridge,
Steel Plate Thickness:

Top Plate	t_1 =	12 mm
Core Plate	t_2 =	8 mm
Bottom Plate	t_3 =	9 mm
Interval of Core Plate	$\lambda \leq$	340 mm

Fig. 1 Fabrication Sequence of Hollow Steel Plate Deck

Photo. 2 shows welding of core plates to a top face plate by an automatic welding machine.

Photo. 3 gives a picture of a hollow steel plate deck for a foot-way bridge just before the fabrication is over at a shop. In this case, it has a span length of 20m, width of 3m, depth of 40cm and it was designed for a uniform live-load of 500kg/m².

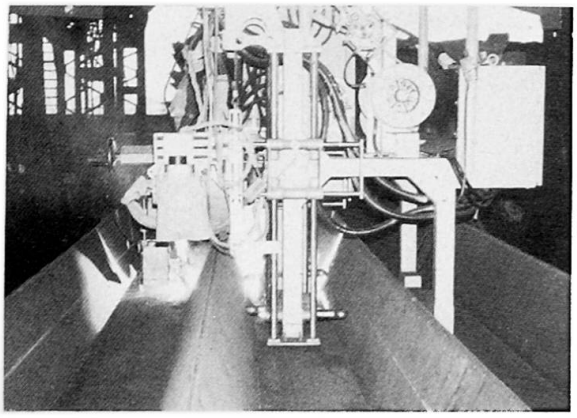


Photo. 2 Welding Operation

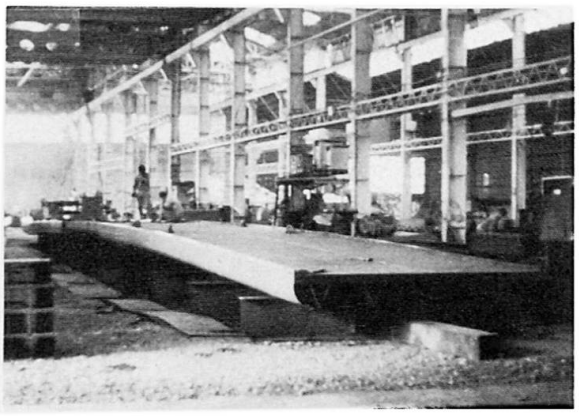


Photo. 3 Overall View of Hollow Steel Plate Deck

4. Features and Problems of Hollow Steel Plate Deck

Since the hollow steel plate deck provides a floor with great lateral and torsional rigidities, it has a greater load-carrying capacity as verified by loading tests. Also, Mr. G. F. Fox pointed out at his Summary Report at the Congress that this was an interesting structure because of its greater shearing resistance.

In the case of planning for a roadway bridge, its height can be reduced from one fortieth to one fiftieth of its span length. To apply this deck to a floor system at a suspension bridge with stiffening trusses, it can be set on main cross beams of the trusses directly without stringers. Therefore, it might be advantageous for a floor system of long-span suspension bridge from the point of aerodynamic stability of a bridge, because of a small height of this floor system compared with an ordinary floor system using stringers. However, as Dr. W. C. Brown discussed at the Free Discussion for Theme IIb in the Congress, the aerodynamic stability of floor has to be examined thoroughly not only from their local behavier, but from overall bridge behavier.

As mentioned above, since at the fabrication of this deck, welding operation for major components of the deck is performed only in one direction, less welding distorsion and easier fabrication can be observed. Since it makes a closed section, however, it is difficult to make inspection for welded parts after fabricated.

There will be still uncertainties in the construction method of this floor system at a long-span suspension bridge. For example, there will be some problems at the erection of the deck and at its connection with supporting shoes on cross beams and with expansion joints, etc.. Therefore, to make a more reliable decision a more detailed examination has to be done through more detailed practical informations together with application of a probabilistic approach to uncertainties.

5. Conclusion

At the present study on the selection of a hollow steel plate deck for a floor system at a long-span suspension bridge with stiffening trusses, greater load-carrying capacity, better aerodynamic stability due to its small height, easier prefabrication and economy compared with ordinary floor systems, could be confirmed in a certain way, supporting the engineering judgement at the proposed decision processes in the Preliminary Report.

However, there will be still uncertainties at the construction method of this floor system at a long-span suspension bridge. More detailed evaluation has to be done through more detailed engineering informations for various uncertainties to make a more reliable decision.

SUMMARY

The authors have shown - in the Preliminary Report - the advantages of a hollow steel plate deck instead of the ordinary floor systems, for a long-span suspension bridge with stiffening trusses. The present study is intended for evaluating; the hollow steel plate deck for its fabrication, features and problems.

RESUME

Les auteurs ont montré - dans le Rapport Préliminaire - les avantages d'un tablier métallique de section fermée au lieu des tabliers ordinaires, dans le cas de ponts suspendus de longue portée, en poutres à treillis. On présente ici les caractéristiques et les problèmes liés à la fabrication du tablier métallique de section fermée.

ZUSAMMENFASSUNG

Im Vorbericht haben die Autoren die Vorteile eines als Pfahlhohlkasten ausgebildeten Fahrbahnträgers gegenüber anderen Deckensystemen dargelegt für den Fall weitgespannter Hängebrücken. Diese Studie berichtet über die charakteristischen Eigenschaften und die Herstellungsprobleme des obgenannten Deckensystems.