

Design of Fire Protection for Steel Girder Bridges

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Summary

From the lessons of many fire accidents of bridge, it concludes that the fire protecting member for bridge, which locates at an intersection of viaduct mainly, is necessary. The authors present the result of the heat transfer analysis for steel girder applied the fire protection material and the structural detail for fire protection in this paper.

Keywords: fire accident of bridge, fire curve, fire protecting material, heat transfer analysis, fire protection detail.

1. Introduction

In U.S.A (San Francisco, April 2007), the viaduct in urban area have had a serious damage by the big fire due to turning over of the tank lorry vehicle, that is, the steel girders over two spans fell down [1]. According to our analytical results, the composite girder bridge collapses due to fire, when the steel girder is heated up to 700°C [2]. From the lesson of these accidents and analytical results, it can say that the fire protecting member for bridge, which locates at an intersection of viaduct mainly, has to be attached on its under and both sides.

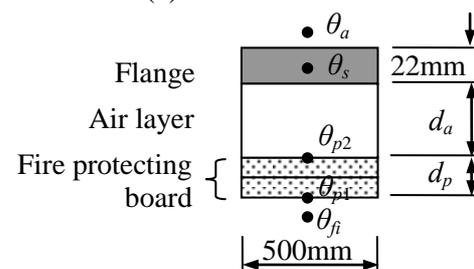
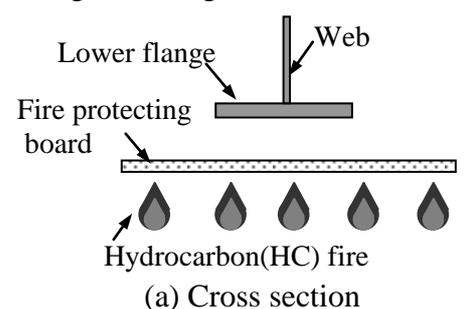
2. Design conditions of fire protection design for steel bridge

The conditions of fire protection design for viaduct made of steel girder are given in the following.

- 1) The Hydrocarbon curve is used as the fire load [3].
- 2) 400°C is taken for the allowable design temperature of steel plate [4].
- 3) As the fire protecting member, the ceramic board was applied and its thickness is taken for design parameter.
- 4) Also depth of air layer between steel flange plate and the fire protecting board is taken as the design parameter.

3. Heat transfer analysis for steel girder bridge

The heat transfer analysis for the lower flange (thickness: 22mm, width: 500mm) of I-girder bridge under Hydrocarbon curve was carried out as shown in *Fig.1*. The thickness of the fire protecting board (d_p) and the distance from fire protecting board to flange (d_a) are changed. Additionally, we also calculated the flange temperature without fire protection. The analytical results are shown in *Fig.2*.



(b) One dimensional model
Fig.1: Analytical model

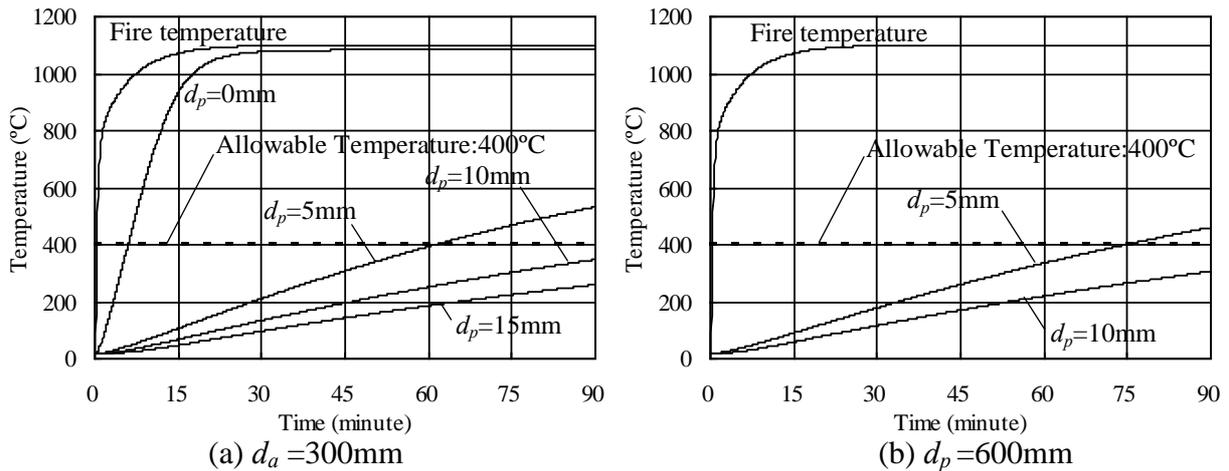


Fig.2: Temperature of lower flange plate

The analytical result shows that the flange temperature is kept under 400°C after fire time of 90 minutes, when the thickness of ceramic board has 10mm and the distance from board to lower flange is keeping the length of 300mm.

4. Structural detail for fire protection

The structural detail applied the fire protecting board at the lower and both side surfaces of the I-girder bridge is shown in Fig.3. The fire protecting board connected with the light weight steel frame is set up by the attachments at the under and both sides of the viaduct shown in this figure. From the result of fire design, the fire protecting board having the thickness of 10mm is fixed at the position of 300mm away from the lower flange plate.

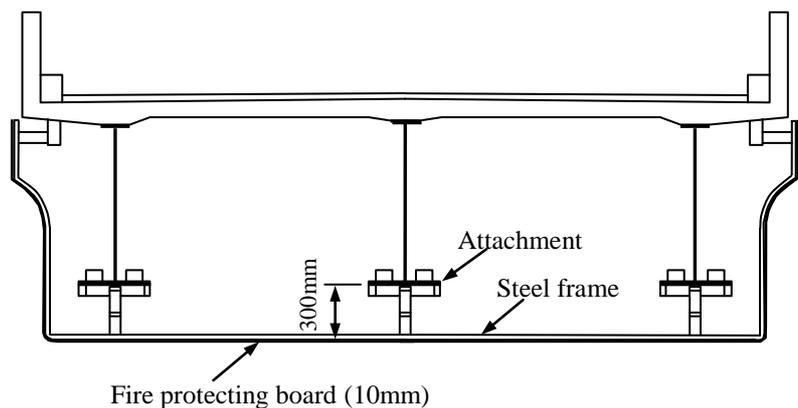


Fig.3: Structural detail for fire protection in I-girder

5. Conclusion

To prevent the fire damage of viaduct made of steel girders, a fire protecting design by using one dimensional finite difference method was carried out. The results obtained from this design shows that the flange temperature is kept under 400 °C after fire time of 90 minutes, when the thickness of ceramic board has 10mm and the depth from board to lower flange is keeping the length of 300mm. The structural detail for fire protecting of steel girders is also presented in this paper.

References

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