Composite Stiffness of Asphalt and Deck and Its Influence on RD Joint

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Summary

Numerous fatigue cracks were observed recently in many long-time served orthotropic deck bridges. Especially the cracks initiating from rib-to-deck (RD) joint may produce asphalt surfacing damage and hence cause impact on traffic safety. For fatigue evaluation of RD joints, in most current design specifications, the asphalt surfacing is just treated as a layer dispersing wheel loads and the effect of composite stiffness of asphalt surfacing and deck plate is neglected. In this study, Full size experiment for 2 spans orthotropic bridge deck with asphalt surfacing were carried out to investigate the stress distribution around RD joints and a special indoor asphalt heating and cooling system was employed to study the real stress distribution around RD joint with considering asphalt temperature variation. The experiment results show that the most critical transversal load cases for fatigue damage of RD joint are wheel load ride on the RD joint and located around the adjacent RD joint. Moreover the transversal stresses around RD joint are significantly sensitive to the asphalt temperature and the most sensitive temperature range is 5 degree Celsius to 35 degree Celsius.

Keywords: orthotropic steel bridge deck; Fatigue crack; asphalt surfacing; temperature.

1. Introduction

Orthotropic steel decks (OSD) are widely used in the long span bridges, viaducts and movable bridges due to their lower deadweight and shorter construction time compared with concrete bridge decks [1]. However, in recent years many fatigue cracks around rib-to-deck (RD) were reported in OSDs after long time servicing. All the RD fatigue cracks were observed in the OSDs with closed ribs. The reason may be that the one side welding of the RD joint of closed rib is weaker than two sides welding and the closed rib constrains transverse torsion of deck plate [2].

In this study, the rubber heaters and dry ice are employed to heat and cool the asphalt surfacing continually respectively and the variation range of asphalt surfacing temperature is -18 degree Celsius to 60 degree Celsius.

2. Summary of full size OSD load test

The OSD specimen used in this study is 2600mm in width and 4300mm in length. the thickness of the deck plate is 12mm and the size of U rib is 320×240×6mm. The span of crossbeams is 2000mm. the longitudinal ends of the OSD specimen are supported by round steel bars. 80mm thickness Guss asphalt concrete was applied on the deck plate.

Two rubber plates are employed to simulate contact area of heavy truck dual wheel and the size of contact area of applied load is 200mm×200mm(rubber plate)+100mm(clearance distance)+200mm

×200mm(rubber plate)

3. Temperature influence on transversal stresses around RD joint

For the purpose to simulate the temperature variation from winter to summer in different areas, rubber heater and dry ice were employed in this study to heat and cool the asphalt surfacing respectively.

4. Conclusions and Discussion

In this study, the result of load tests shows that transversal affected range for stress of deck plate is limited in the adjacent RD joints; the maximum tensile stresses occur at the midway of the rib walls and the minimum stresses occur around RD joints and the most critical load case for crack type 1 and 2 is that the wheel load ride on the RD joint. Respect to crack type 3 and 4, the most critical load cases is the wheel load located around the RD joint.

The load test for load case S2-10 were carried out again with temperature variation and the result shows that the stresses of deck plate and around RD joint are significant sensitive to the asphalt surfacing temperature. It is observed that the most sensitive temperature range for the stress around RD joint is from 5 degree Celsius to 35 degree Celsius.

From this study, it could be suggested that for the fatigue test of RD joint in OSD, the critical load case is dual wheel load ride on the RD joint which will incline to cause type 1 or 2 fatigue crack around the RD joint and type 3 or 4 fatigue crack around adjacent RD joints. Moreover, it could be proposed that the influence of composite stiffness of asphalt and deck and temperature effect should be considered in the fatigue life evaluation of RD joints in OSD.

5. References

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