New failure model of finger-type bridge joint due to its asymmetric vibration

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Recently, the failure of finger-joints can often be observed. Most of the failure is due to the failure of the anchor bolts rather than of the plate itself. Here, a new asymmetric vibration failure model is proposed. The numerical results are shown that the asymmetric vibration of finger-joints is more important for the failure of anchor bolts which fasten a finger-joint to the deck than the traditional static mode.

Keyword: Finger joints, Asymmetric vibration, Real scale ABAQUS model

1. Introduction

Typically, finer-joints are designed by the concept of working stress design with a very large safety factor [1]. With such safety factor, it is hard to expect failure of finger-joints in the service condition. In this paper, we propose an asymmetric vibration mode to be considered for the design of the anchor bolts of finger-joints.

2. Simplified solution

According to the energy conservation principle of a deformable body, the sum of the kinetic energy and the deformation energy is constant. Therefore, the deformation energy measured at any two different times when the kinetic energy is zero should be identical to each other. The free body diagram suggested for the calculation of reaction R_{II} of mode-II is shown in fig.2. The anchor bolts should be designed against the maximum reactions in the two deformation modes discussed so far. The reaction of the anchor bolts in the two deformation modes RI and RII can be found in literature [2].

3. Numerical Model and Result

The finite element mesh for two typical finger joints, tapered type and regular type established by ABAQUS are shown in fig.2. The time-stress curves of the two finger-joints near the bolts and the change of kinetic energy are shown in Fig.3. We found that the predictions and the numerical results are very close to each other. The bolt reaction

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due to the asymmetric vibration is much larger than the traditional design value. The minimum value of kinetic energy is almost zero at the first cycle but it is not at subsequent cycles. This means that the simplified solving method would be valid for only the first cycle.

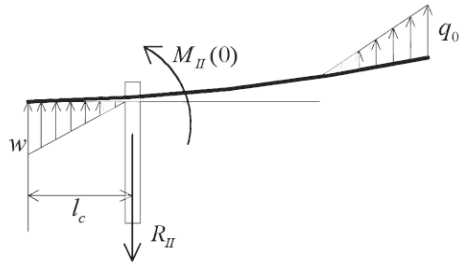

Fig.1. Diagram suggested for the calculation of reaction RI

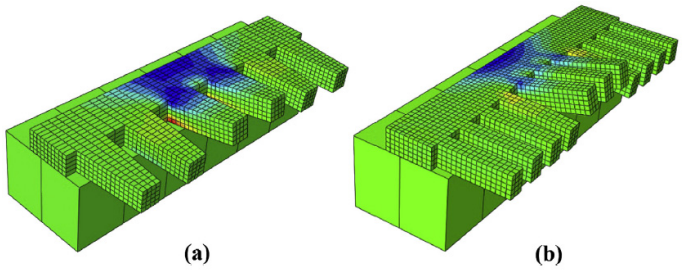

Fig.2. Finite element mesh for (a) tapered type and (b) regular type

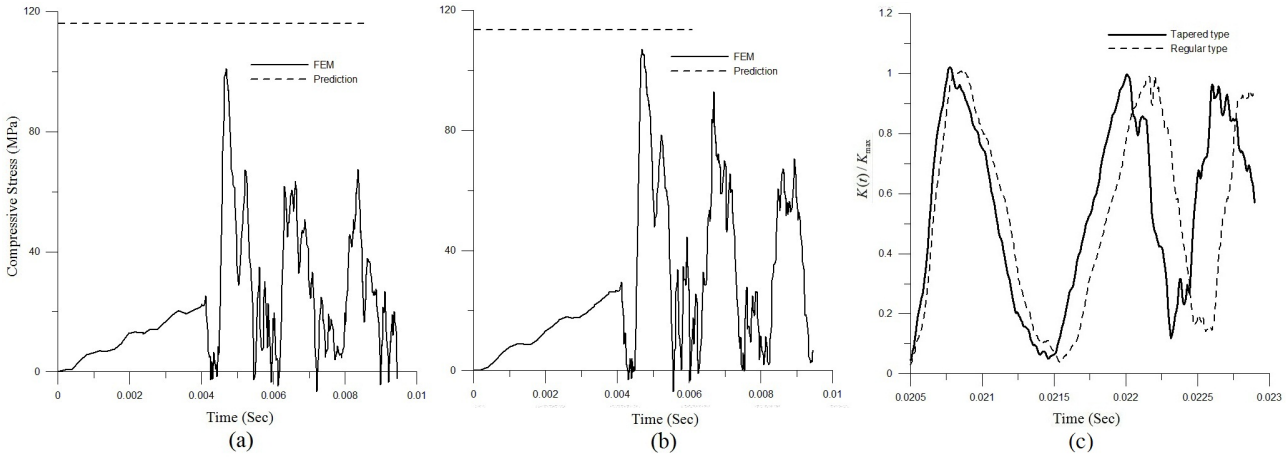

Fig.3. Stress of the actual scale finger-joint near the bolts for (a) the tapered, and (b) the regular finger-joint and (c)

4. Conclusions

It is shown that the asymmetric vibration of finger-joints is very important for the failure of anchor bolts which fasten a finger-joint to the deck. The joint-plate springs up as the load leaves out the joint-plate because of the deformation energy stored in the joint-plate. When the end moment is maximum, the reaction is maximum.

References

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