Abstract

Indian Railways comprise a major part of the infrastructure in India. Most of the transportation of raw materials, goods, and people from different parts of the country is done by the railways. To cope with the ever-increasing demand, the maintenance of the infrastructure forms an integral part of Indian Railway system. A large number of bridges exist on the railway lines. Most of these bridges in the Indian Railway system that have been built several decades ago have deteriorated and damaged. Hence, it is necessary to do a “condition assessment” study on the existing bridges.

The performance of a bridge largely depends on working of the bearings. Huge normal and tractive loads are transferred to the substructure through the bearings. The mechanism involved in the working of roller and roller-rocker bridge bearings essentially involve oscillatory rolling contact. The tractive load coming on the bridge due to acceleration and braking of trains on the bridge, is transferred to the substructure through the bearings. This horizontal component of reaction, at the supports, contribute to the essential rolling mechanism in bearings. In this work, only the roller and roller-rocker bearings of the bridge structure are studied.

The normal and tangential pressure distribution generated during the rolling contact are computed using the minimum energy principle for bodies in rolling contact with dry friction (steady and transient) using the method proposed by Kalker. The stress analysis is performed using the Extended Finite Element Method (XFEM). In the XFEM, the crack is modelled independent of the finite element mesh and hence remeshing is not required while simulating crack propagation. A method is proposed to perform rolling contact fatigue crack propagation analysis using the contact and fracture mechanics theories in conjunction with fatigue laws. Crack Propagation analysis under fatigue loading is done for an example problem of a rolling contact between a cylinder and a flat plate. The number of cycles required for the crack to propagate are computed.

As a part of the project, “condition assessment” of bridges sponsored by the Indian Railways, field studies are conducted on bridges in the South Western Railway zone. Different sensors that measure strains, accelerations and displacements as the trains moves on the bridge, are mounted at specific locations on the bridge including the bearings. The data collected from a steel truss bridge, on the Torangallu – Hospet section, is used to obtain the normal and tangential loads coming on the rollers in a roller-rocker bearing. The contact algorithm is used to compute the normal and tangential pressure distribution. Fatigue crack growth simulations are carried out using the XFEM. The number of cycles in terms of the train passages required for a crack to propagate from an initial length to a final length are computed. It is observed that it takes lesser train passages for a crack which is closer to the contact region to propagate than a crack which is farther away from the contact zone.