Fatigue Performance of AL-Sabtea Bridge Under the Effects of Dynamic Vehicle Loads

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ABSTRACT

Composite bridge consists of different materials such as the girder made of steel or precast that connected with deck concrete slab by means of shear connectors to work as one. In the present study, AL-SABTEA composite bridge in Diyala, Iraq that was designed and constructed inherently to work as full interaction. The interior composite concrete steel girder is selected as a case study because it represents the worst case. Representation of composite steel bridge throughout the present study was done using finite elements approach by ANSYS software with different parameters to assess the efficiency of the composite bridge under the effects of static based on Iraqi and AASHTO specifications as well as dynamic and fatigue loading according to AASHTO specification using actual dimensions and mechanical properties.

Push-out test was also done to compare displacement results with the model established by ANSYS which proved that the proposed numerical model can represent the shear connector's behavior. It is recognized that the difference in the results of displacement of the latter comparison is small (5%) between experimental test and ANSYS model.

The effect modelling of shear connector was studied by the representation of channel shear connectors through elements of COMBIN39 element in comparison with using solid elements. The deflection difference between these two models is also small (2.5% to 3.7%).

The results showed that the deflection and stresses according to the Iraqi specification are more than AASHTO specification but still within permissible safe limits, furthermore, dynamic analysis which was done with different truck loading and velocity speed showed that truck HS20 gives deflection and stresses more than other trucks. In addition, as the velocity increases, the deflection and stresses under the effect of a specific load increase, due to increase in kinetic energy.

The fatigue analysis results indicated that the damage index at top face of the concrete deck slab, interface between concrete and steel girder and at bottom of steel flange girder for all load cases do not reach to unity and the maximum value is less than 0.2% in the case of HS20 loading. The fatigue damage at present time for Al-SEBTEA bridge if checked by adopting any methodology do not also reach 0.0045 for 10 years. The worst case of analysis result indicated that the maximum damage index occurs in the bottom face of composite steel girder that represent accumulative fatigue at this point.

Visual basic code was written as analytical solutions to calculate the number of shear connectors under the effects of static and fatigue loadings and also estimate the number of cycles during the bridge life. The relationship between the fatigue stress with stress ratio appeared as the fatigue stress increase when the stress ratio increase in a positive direction that is mean in the range of $R \geq 0$ up to 1. The fatigue stress increases with the decrease in reverse stress ratio in the range of (-1) up to zero in case of R=0.

In final assessment the results of deflection and stresses and fatigue stress within permissible are limited according to AASHTO code for all models.