OCILLATIONS IN RAILWAY BRIDGES

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Abstract

When a locomotive passes over a railway bridge, dynamic or impact stresses are produced in the bridge by the “hammer blows” of the locomotive. In designing railway bridges, this impact effect was allowed for in a Board of Trade Regulation by the Pencoyd formula, which states that the moving load has to be multiplied by a fraction depending on the span L which is $\mathrm{I} + \frac{300}{300+L}$. It was felt for a long time that this method was inadequate. In March 1923 the Department of Scientific and Industrial Research appointed a committee and staff of engineers to investigate impact effect in railway bridges, which resulted in the compilation of some valuable experimental data. It was not until this work was finished that it was discovered that the springs of a locomotive play a very important part in the impact effect in medium span bridges.

Professor C.E. Inglis, a member of the Bridge Stress Committee, was responsible for building up a sound mathematical theory which takes into account various bridge and locomotive characteristics, including the frequency and damping of the locomotive springs.

This thesis is an investigation as to how far this mathematical theory agrees with experiment. A channel girder bridge, of 18ft span, was constructed at the Engineering Laboratory, Cambridge University. The bridge consisted of a 15 in. x 4 in. channel resting on knife edges, and the “hammer blow” was produced by two gear wheels rotating in mesh, carrying out-of-balance weights. The gear wheels were driven by an electric motor through a flexible coupling. On this experimental bridge certain cases were examined, which would correspond in practice to the following:

(1) Bridge alone, with a pulsating force applied at the centre.

(2) Bridge with a central concentrated load and a pulsating force.

(3) Bridge with a central load on springs and a pulsating force.

(4) Bridge with a central load on springs, with fluid damping and a pulsating force.

(5) Bridge with a central load on springs, with a solid friction damping and a pulsating force. This is the case of the “skidding locomotive” placed at the centre of a bridge.

This investigation has proved that there is very close agreement between experimental values and the predictions of Professor Inglis’ mathematical analysis.