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## The Canadian Engineer.

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## THE MECHANICAL ACTION AND RESULTANT EFFECTS OF MOTIVE POWER AT HIGH SPEEDS ON BRIDGES.

The following report was presented to the Association of Railway Superintendents of Bridges and Buildings at its recent session in Chicago, by Geo. W. Andrews, J. E. Grenier, and Walter G. Berg.

"The subject which your committee has been called upon to investigate is one which has been before the engineering profession for years, but up to the present time no one has been able to definitely formulate any positive law of action, or even to indicate in an approximate manner just what injurious effects quickly-moving loads have upon bridges.

"We all know that trains rushing over a bridge will cause shocks, tremors, and vibrations. We can feel these effects by standing on the structure, and we realize that the heavier structure is less shaken than the lighter. But if called upon to state in accurate terms the amount of increased strain due to those moving loads, your committee must plead ignorance. The effects are there, they can be measured, and instruments can be made which will register them. These measurements, however, must necessarily cover such a broad field that in all probability no one committee will even be able to arrive at any conclusions worth speaking about. Your committee must ask to be excused if they have found it beyond their power to present to the association any original matter, but have resorted to the old trick of embracing in this report a resumé of the facts presented and the experience gained by others, and compiling this information so as to represent our present knowledge on the extremely erratic action of motive power on bridges.

"The attempted determination of impacts can be divided into three classes:—

"1. Those which are purely theoretical and which are of no interest to this association.

"2. Those which had for their object the measurement of the stretch of the various members of a bridge during the passage of trains. These tests are practically limited to those made by European investigations on riveted bridges, the results of which indicated that impacts decreased as the length of the span increased, and in a rather uncertain and erratic manner, that impacts in the various members of the same span are a vague function of the length of moving load required to cause the maximum strain in the member considered. Members of your committee made about one hundred tests of this character, but results were not sufficiently positive to justify their presentation in this report.

"3. Those which had for their object the measurement of the deflection of the structure as a whole.

"Among investigators who have endeavored to measure centre deflections by mechanical means, perhaps no one has gone further into the question than Prof. S. W. Robinson, M. Am. Soc. C.E., who invented an instrument which accurately measured the deflection of bridges. The results of Professor Robinson's experiments were presented before the American Society at the June meeting, 1895, and show that the increase of strain due to vibrations caused by unbalanced locomotive drivers is 28 per cent. of the maximum strain caused by the passing train when statically considered. He observed also that the increased strains due to vibrations caused by the body of the train were 50 per cent. greater than the corresponding part of the train statically considered. Moreover, since he found certain cases in which the dynamic strains produced by the train load itself were greater than those caused by the engine, he was of the opinion that in designing bridges 50 per cent. should be allowed for impacts, instead of the 28 per cent. which he found in his diagram. He also found that the cumulative vibrations, depending upon certain relations between the load and bridge, were particularly prejudicial. Among these are the relation between the circumference of the driver and the panel length, and the relation between the wheel spacing and the panel length.

"In actual practice it is the custom of different engineers to make variable allowance for the effects of impact. For example, some roads will assume that bridges under 100-feet span are subjected to impacts of varying amounts, while spans of greater length are subjected to no impact. Others assume that the strains caused by live loads are twice as great as those caused by the dead load only, regardless of the length of span. Some specifications allow a certain impact varying from 100 per cent. for very short spans to nothing for spans of 500 feet and over. Others, again, will allow for varying impacts, depending upon the ratio of the minimum stress to the maximum.