Papers Nos. 5158 and 5201.

"Some Experiments on the Lateral Oscillation of Railway Vehicles." †

By RALFE DAVIDSON DAVIES, M.A., Ph.D., Assoc. M. Inst. C.E.,

and

"The Vertical Path of a Wheel Moving Along a Railway Track." ††

By Professor CHARLES EDWARD INGLIS, O.B.E., M.A., LL.D., F.R.S., M. Inst. C.E.

Mr. C. W. Clarke, of Bombay, referring to Dr. Davies's Paper, pointed out that it was stated that the composite tire profile shown in *Fig. 20* (p. 250 §) was adopted in order to increase the amount of wear necessary to make the tire fit the rails. Although a composite coning of the tire profile might result in better riding of a coach, he did not think the composite tire profile was introduced with that object in view. The chamfering of the outside portion of the wheel tread had been standard practice in America for some time, and was adopted in order to produce more even wear on the nose and wing rails of standard crossings, and consequently to increase the life of crossings. With the ordinary coned tire it was found that considerable wear of the wing rail and battering of the nose in crossings took place, owing to the varying profiles of tires between the form when new and that of a tire worn to condemning profile. With a composite coning of the tire, as wear took place the part with the 1 in 20 slope extended into the 3 in 20 slope. The extension of the 1 in 20 slope, due to wear, tended to distribute the pressure between the tire and rail more evenly on the nose and wing rails of standard crossings, the wing rails of which were ramped to accommodate the 1 in 20 slope of a new tire.

A composite tire profile of 1 in 20, chamfered on the outside to 1 in 8, was adopted as the Indian Railway Standard for both broad- and metre-gauge stock in 1932, in order to increase the life of crossings.

He drew attention to the "Duplex" bogie coach constructed by the Swiss Locomotive and Machine Works. Besides having independently-rotating wheels, those bogies had the wheels canted inwards so as to be

† Journal Inst. C.E., vol. 11 (1938–39), p. 224 (March 1939).

†† *Ibid.*, p. 262.

§ Page numbers so marked refer to the Papers. (Footnotes († and ††) above.)—SEC. INST. C.E.

normal to the centre-lines of the rails, which were canted inwards about 1 in 20. The result was that cylindrical tires could be used and the inclination of the wheels and rails gave the desired amount of centering action.

In the introduction to the Paper it was stated that railway vehicles, when travelling at high speed, tended to develop a lateral oscillation. He felt that that was not accurate, as he knew of cases where lateral oscillation was most marked at speeds between 35–40 miles per hour, but was damped considerably at 60 miles per hour.

Also, it was stated that the only cure for bogie-hunting was to withdraw the vehicle from service and re-turn the tires to their original profile. Had any damping or controlling arrangement to prevent bogie-swivelling and the lateral sliding of the wheel tread across the rail-table been attempted ?

Referring to Professor Inglis's Paper, Mr. Clarke observed that the curves showing the wheel-paths appeared to be the loci of the points of contact between the tread of the wheel and the rail. The actual paths of an axle moving slowly along a continuous rail would be different from those shown in *Fig. 2* (p. 264 §), as the axle-descent would be increased owing to the elasticity of the wheel-centre and tire. The axle-descent, he thought, was a measure of the resistance to rolling of the wheel (total rolling resistance less journal friction), as it indicated the continuous slope the wheel had to climb as it moved along the rail. In his opinion, one of the greatest practical advantages of using stiffer rail and wheel sections was the reduction in the effort required to overcome rolling resistance, especially at starting, and he thought the effect of a stiffer rail in that respect was as great as that claimed for roller bearings when substituted for plain bearings. At the same time, it was equally necessary to use stiffer wheel-centres, and such examples as the "Boxpok" wheel-centres (cast steel disk-wheels) fitted to the latest heavy American locomotives, and the triangular rim section for spoked wheel-centres, used in the latest British locomotives and the locomotives of the German State Railways, illustrated the trend in development. He noted that the Paper showed that speed had no dynamic effect on a rail-joint in perfect condition. However, he had often found rail-joints with more than a $\frac{3}{8}$-inch gap between the rails, and with one end of a rail standing $\frac{1}{8}$ inch proud of the adjacent rail. In the case of 5-foot 6-inch gauge wagon stock, the tare weight was less than 12 tons, and the weight of a pair of wheels, axle, and axleboxes was almost 2 tons. In such cases, at a track speed of 45 miles per hour, the wheel-movement could exceed $\frac{5}{8}$ inch, and the vertical acceleration could exceed $30g$.

Apart from any question of rail impacts or bad riding, the vertical acceleration of the wheel contributed largely, in his opinion, to the excessive wear of horncheeks ; stiffer rails would help to reduce that wear.

§ *Ibid.*

Mr. W. J. Doak, of Brisbane, referring to the question of coned versus cylindrical treads, thought it relevant to point out that on the Queensland Railways cylindrical treads and level rails had always been the practice. It was interesting to note, therefore, in engineering periodicals that the authorities had found it advisable to reduce the coning of wheels and canting of rails for the running of the Coronation Scot in England.

There was little doubt that coning was originally adopted to facilitate the withdrawal of patterns from moulds; the rails were then canted to correspond, and conservatism prevented any change when cast-iron wheels were abandoned. He had never been convinced of the necessity of having so much clearance between wheel flanges and rail heads, and thought, moreover, that there seemed to be a very good case for making rails with the heads flared out to the same angle as the wheel flanges.

Railway men had seen the sharp top corners of some sections of rails worn off in a very short time by the intense shearing effect of the fillet connecting treads to flanges. Common sense suggested that new rails and new wheels should have approximately the same profile at the surfaces of contact, and if, then, unnecessary clearances could be reduced, lateral oscillations could probably be rendered negligible.

The revolutionary idea of having independently-rotating wheels had more reason behind it than simply improving the passage around curves and minimizing wear. Fixed axles would be much more trustworthy than rotating ones because of the elimination of stress-reversal. It was well known that axles had to be made of comparatively enormous size because of that stress reversal, and that even then fatigue cracks developed.

Those cracks were accentuated by the damage done by press fitting, and elaborate precautions were taken in surface rolling to minimize that trouble.

Mr. Doak was of the opinion that the advent of roller bearings should revolutionize design, and he pointed out that any such reduction of unsprung weight would be of great value.

Dr. Davies, in reply, stated that he had the "Duplex" bogie in mind in referring to "a bogie having independently-rotating wheels" (p. 251 §); he had examined and travelled in a coach fitted with those bogies. The design possessed undoubted advantages, but he believed that the extra cost was considerable.

He had been at some pains to find a satisfactory device for suppressing the lateral motion of the wheels. That illustrated in *Fig. 19* (facing p. 227 §) had been successful on the model, but had not effected much improvement in practice. The failure might possibly have been due to the plays of the journals in the brasses, which could not be entirely eliminated; if so, the device might be more successful with axleboxes having roller bearings.

Professor Inglis observed that he had no reply to make.

§ *Ibid.*