9.3.1.

Tests on a transductor-controlled locomotive

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SOME THREE YEARS AGO 'English Electric' supplied locomotives to British Railways to operate on the 25kV ac industrial frequency system, and one of these locomotives, No. E3100, was subsequently equipped with secondary tap-changing with transductor control. These developments were fully described in The English Electric Journal of March, 1961.

More recently, this transductor control was modified to give automatic notchless tractive effort at any constant level selected by the driver, so as to give ease of operation and to be able to make better use of the available adhesion. At the same time the mechanical design of the locomotive was also modified to incorporate weight transfer compensation by means of air cylinders. With the traction motors connected in parallel and transductor control it was possible to operate with a steep tractive effort/speed characteristic.

With all these features designed to give good adhesion performance, British Railways felt justified in arranging special tests to establish the advantages of this equipment. Testing took place between Crewe and Stafford during May, 1963. The test train is shown in Fig 1 with locomotive No. E3100 hauling a dynamometer car with its associated mobile test units and three electric locomotives on rheostatic brake. The train was controlled from the dynamometer car and was capable of absorbing a drawbar pull of up to 75,000lb.

Fig 1 An 'English Electric' 25kV ac locomotive hauling a dynamometer car and test units between Crewe and Stafford, May 1963. The three other electric locomotives included in the train are rheostatically braked

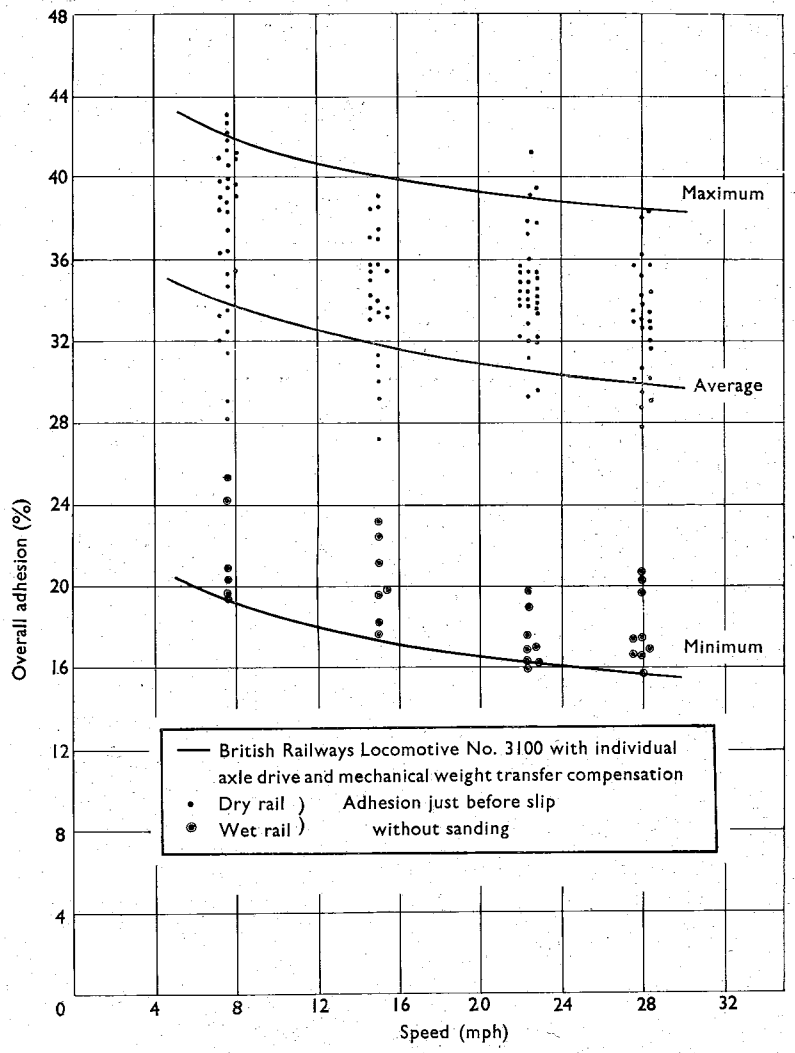

Fig 2 Results of one of the series of tests, showing the variation of overall adhesion

In all, some six hundred tests were made during three weeks of testing. Tests were carried out at controlled constant speeds and the tractive effort was raised with smooth control to the point of wheelslip. Under favourable rail conditions this involved repeated working at tractive efforts of up to three times the continuous rating of the equipment.

An outstanding and somewhat unexpected feature of these tests was the high tractive effort maintained on numerous occasions under dry rail conditions. Fig 2 shows the spread of results for one series of tests when tractive efforts up to 43·3% overall adhesion were obtained.

A noticeable feature was the stability of the equipment during the early stages of wheelslip. For instance, it was possible to allow one axle to slip and, by increasing motor currents on the non-slipping motors, to obtain an increase in drawbar pull, the slipping motor still contributing an appreciable tractive effort. This stability was the result of having the very steep characteristic which is possible with the smooth control system and traction motors in parallel, coupled with good riding bogies with inherent low weight transfer properties and weight transfer compensation.

A direct comparison was not possible between this locomotive and a conventional locomotive under similar operating conditions. Nor was it possible to make a direct comparison from these tests with the much publicized continental single-motor bogie with coupled axles. The tests were carried out on a strictly statistical approach with the intention of comparing the locomotive with and without certain features under similar adhesion conditions. For instance, tests were made with traction motors in series, equalised and in parallel, and with and without weight transfer compensation.

Tests were incomplete in that a locomotive was not available with conventional notching capable of working at the high current values necessary to slip the wheels under favourable rail conditions. Nevertheless, these tests demonstrated the excellent performance of this locomotive under a wide range of working conditions and enabled the Chief Electrical Engineer of British Railways to conclude, 'It is evident that this design performs as well as, or even better than, designs incorporating single-motor bogies, without the mechanical complications of the latter, while preserving the simplicity and easy maintenance associated with individual axle drive'.[1]

The tests are covered in more detail in a paper presented to the Institution of Mechanical Engineers[2].

References

1 The Presidential Address by Mr. S. B. Warder, The Institution of Locomotive Engineers, 23rd September, 1963.

2 Control of Tractive Effort on Electric Tractors, H. W. Lucas and A. S. Robertson, Institution of Mechanical Engineers, 28th November, 1963.

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