A.L.R. MERRIFIELD DISCUSSES SOME ASPECTS OF

WIND AND RAILWAY ENGINEERING

A SEVERE storm on the morning of 10 April 1968 was the direct cause of the loss of the ferry steamer *Wahine* in the Wellington harbour entrance, and of considerable damage to the city. Statistics relating to the storm were well recorded, and subsequently the Meteorological Service estimated it to be of a severity only likely to occur once in 150 years.

In view of these records, it is interesting to review some investigations into the effects of winds on railway operation. Widely known was the storm of 28 December 1879 which blew down the Tay bridge in Scotland. The bridge was not a sound one and wind speeds were estimated at about 75 miles per hour.

At very much the same time that this was in the forefront of engineering attention in Britain, J. P. Maxwell (Railway Manager to the Public Works Department) presented a paper to the Institution of Civil Engineers on the railways of New Zealand. During the discussion of this paper, John Carruthers, formerly Engineer-in-Chief to the P.W.D., spoke of the very recent accident near the 35-mile peg on the Rimutaka Incline.

"... A train started up the Incline with two passenger-carriages in front, then an ordinary brake-van, then an engine, then two loaded goods vans and an Incline brake. A gust of wind came and blew the passenger-carriages and the passenger brake-van completely off the line. As far as he understood, the carriages were not overturned, and did not touch the road until they were nearly at right angles to the train. The Incline brake-van was thereupon detached and sent back for assistance, leaving the loaded goods-vans attached to the engine. In about five minutes another gust of wind blew the loaded goods-vans off the line ..."

Carruthers calculated that a pressure of 27 lb. per sq.ft. was required to topple the carriages and, assuming the 1875 design of box-wagon part-loaded to approximate 8 tons in total weight, 66 lb. per sq.ft. to overturn these. It may be thought that should the wind be able to strike upward under vehicle floors, a lower pressure may overturn them. This can readily be shown not to be so to any significant extent, a conclusion which was confirmed during recent wind-tunnel tests conducted for the N.Z.R.

In a more recent accident near Pigeon Bush, a "Wairarapa" class railcar was derailed. Applying the same consideration, this suggests that a pressure of 22.5 lb. per sq.ft. had to be exerted.

It is interesting to assess the wind-speeds involved. Current British engineering practice is to estimate wind loads according to a Standard Code of Practice published in 1970, actual pressures being estimated and then multiplied by a safety factor. These forces are based on the average wind speed during a gust lasting 3 seconds, and the probability that this will be exceeded once in 50 years.

Pressure	Gust Speed
22.5 lb/sq.ft.	89 m.p.h.
27 "	102 "
66 "	160 "

During the *Wahine* storm the weather stations in Wellington city yielded consistent records which suggested the average wind speed was 60 to 100 m.p.h. gusting up to 130 m.p.h., over a period of four hours. The more exposed stations at Mt. Hawkins and Otorongo Bay recorded maximum gusts of 147 and 167 m.p.h. respectively.

The other major influence is that of topography. Wind velocities can be increased either by having to cross a ridge or by being funnelled through a suitably shaped valley. In the former case, turbulence on the leeward side of the ridge may give rise to worse problems than those found on the windward side. Thus for known winds in excess of 100 m.p.h. to occur in the open within 30 miles of the Siberia accident site

Photograph: A. P. Godber.

The "Wairarapa Mail" of bygone days descending the 1 in 15 Rimutaka Incline from Summit to Cross Creek. It is emerging from Siberia Tunnel and crossing the deep gully down which high winds are prone to sweep during north-westerly gales.

in the Rimutaka ranges suggests John Carruthers' estimate to be feasible. Additionally, Siberia gully is a natural wind-funnel. This analysis ignores his statement that the carriages did not just overturn, but were swept bodily off the rails.

For many years now it has been N.Z.R. practice to provide substantial wind-breaks at critical points; these being either substantial paled barriers or belts of trees.

Technical interest in this problem has revived since the 1950s, with the proposal of a deviation of the North Island Main Trunk between Utiku and Mangaweka. This route requires three viaducts more than 200 feet high. The initial designs were for concrete bridges of cantilevered box girders to carry both the railway and State Highway No. 1. Later it was decided to make this purely a railway deviation.

When the original designs were being considered it was realised that the Rangitikei valley tended to funnel wind and that this was a potential danger to both road and rail traffic. Accordingly a series of wind-tunnel tests were carried out in 1966. These confirmed some surprising facts. Under severe gust conditions it was shown that vehicles could topple *into* the wind, due to violent eddying on their leeward side. Similarly, a solid wall type of wind-break was too dangerous to road vehicles. Air needed to filter through the barrier to both fill and to sweep away eddies in the lee of the barrier.

Three years later the Railways Department commissioned further tests aimed specifically at halving the overturning moment on rolling stock exposed to a wind velocity of 100 m.p.h. This was part of the investigations for the railway - only scheme now being built. Again some surprising facts emerged. One proposal for a wind-break was shown to worsen matters. More important, it was shown that wind from = 25° of the horizontal was no more dangerous than a horizontal wind, and that winds striking downward at greater than 25° were distinctly worse.

These tests are recognised to not be exhaustive, so the final form of wind-breaks on the Utiku-Mangaweka deviation should be interesting in their resolution of the practical and theoretical problems.

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