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Editorial

The risks of ignoring information

The centenary of the Forth railway bridge has just been celebrated. It is a remarkable bridge but was over-designed in case it went the way of the Tay bridge. In 1879 the Tay was blown down in a storm. Its iron columns were faulty and it was badly designed, as admitted by Sir Thomas Bouch in the following dialogue with the examiner at the enquiry. The examiner was well aware of earlier problems in high winds.

> "Sir Thomas, did you in designing this bridge make any allowance for wind pressure"?
> "Not specially".
> "You made no allowance"? (in amazement).
> "Not specially".

However, the collapse of the Tacoma Narrows bridge is far more extraordinary as the destruction of suspension bridges by wind was by then very well documented. Bridges destroyed included the Union bridge over the Tweed at Berwick, Scotland (1820), the Brighton chain pier soon afterwards, and two bridges each of which was the longest ever constructed at the time—Colonel Ellet's over the Ohio river at Wheeling, West Virginia, which was over 1,000 ft long, destroyed in 1854, and the Canadian Niagara-Clifton, over 1,200 foot long, blown down in 1889. Telford's famous bridge over the Menai Straits was nearly blown down in 1826.

Eye-witness descriptions of the torsional vibrations of the Brighton and Wheeling bridges, shortly before their destruction, might equally well be applied to the Tacoma's collapse—so well captured in the well-known newsreel pictures of the event. At Brighton "the oscillating motion across the roadway... and of the great chains" were described, and for the Wheeling "there seemed to be a determined twist along the entire span, about one half of the flooring being reversed, and down went the immense structure from its dizzy height to the stream below". Similar, less pronounced effects, were observed much later in the Golden Gate, Thousand Islands, and Deer Isle bridges.

The Tacoma's construction was unique. The span weight in pounds per foot of the Golden Gate bridge was nearly four times greater, and of the George Washington bridge, New York, over 5.5 times greater. The relative torsion of the

George Washington, Transbay, Golden Gate, and Bronx-Whitestone bridges is 0.55, 1.84, 1.68, and 2.23 respectively. The Tacoma was 20.91.

Most remarkable of all, the above data was published in the report about the failure of the Tacoma to the Federal Works Agency in 1941. The following comments appeared in the same report: "The bridge was built to resist safely all static forces, including wind... there could be no possible question as to the adequacies of the design". What was not understood at that time was the aerodynamics of bridges. The shape and stiffness of the span truss was changed in later designs, after wind tunnel tests on bridge models. However, we may conclude that the Tacoma's design pushed the state of the art much further than was warranted in view of a wealth of other available information which was, apparently, ignored.

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(Extracts from an article to be published in full)