was followed by Stephenson in the Britannia and Conway Bridges and by Brunel in those really magnificent structures at Saltash and Chepstow, structures, all of them, that would to-day, far more cheaply and with perfect safety, be built on the American system, because for spans of 400 feet the ground has been trampled hard by experience. Both at Quebec and at New York there was no consolidation of the mental approaches or of the material methods. Suspicion attaches to Quebec that, perhaps, unconsciously, paucity of funds induced undue optimism in design. But at New York this did not apply. The bridge was devised at a period of unprecedented prosperity and abundance of cash and credit. But the ingrained habit of close calculation of stresses and the apportionment of liberal stresses led to the "tuning up" of its parts to use the words of a well-known American bridge designer.

The immediate result of the Quebec disaster was a demand by the public, voiced by the "Tribune," for investigation into the design of the Blackwell Island Bridge, and a strong denial of any need for this by the Bridge Department responsible for the design. This department would have gone steadily forward and opened the bridge as designed and with full loading. It was perfectly safe, in their judgment. However, in deference to the public outcry an inquiry was accepted. Two experts were appointed, Mr. Hodge, of Boller & Hodge, and Professor W. H. Burr. The first finds that with the four trolley car lines and the roadway and footway traffic, but without the elevated railway load, the bridge can even then only be made safe by taking off 1,000 pounds of dead load per linear foot of each truss. The second expert, who, perhaps, belongs to the tuning-up school, contrives to find safety even with the elevated railway load by the very doubtful expedient of a greater headway to the trolley cars and a still greater reduction of dead load. The "Engineering News" sums up the situation as an ability safely to carry not more than a third of the intended live load, or by removing dead weight somewhat over half the intended load.

There may be thousands of people on the bridge. Can it be contended that any real safety can be secured by so precarious a thing as a minimum headway of trolley cars? This will not bear a moment's consideration.

Both experts find that the bridge is unsafe for the designed original load, yet this designed load was increased by doubling the original two elevated railway tracks and by much extra dead weight; and no provision of extra strength was made for these additions, though already the stresses were largely in excess of the original specification, itself sufficiently liberal for high-unit stresses. The bridge is 8,600 feet long, the important cantilever spans being 1,182 feet, 630 feet, and 984 feet, with anchor arms of 469.5 feet and 459 feet. There are two piers on the island, forming the 630 foot span. This total length of 3,724.5 feet alone was investigated, the approaches being normal. The original design weighed 84,300,000 pounds, of which 13,300,000 pounds were in the form of nickel steel tension bars and pins. The loading—"congested live load"—was 12,600 pounds per linear foot, made up as follows: Two elevated railways, per foot, 3,400 pounds; four trolley lines, per foot, 4,000 pounds; 35½-foot road at 100 pounds, per foot, 3,550 pounds; two 11-foot footways at 75 pounds, per foot, 1,650 pounds, making a total of 12,600 pounds. The regular live load was estimated at half this, or 6,300 pounds per linear foot. The subsequent additions brought these figures up to 16,000 pounds and 8,000 pounds, respectively. The dead load had no allowance for snow! Wind was assumed at 2,000 pounds per linear foot, one-half fixed and one-half moving. The structural steel specification was excellent. The nickel steel was to have an elastic limit of 48,000 pounds, an ultimate strength of 85,000 pounds, and an elongation in 8 inches of 1,600,000 ÷ ultimate strength, while full-size members were to show the same figures, but an elongation of 9 per cent. in 18 feet. The other steel was to show 30,000 pounds elastic limit, shapes were to show 60,000 pounds ultimate, and eye bars 66,000 pounds ultimate, with an elongation in 8 inches of 1,500,000 ÷ ultimate strength.

The congested load and dead load combined stress allowances for nickel steel were 39,000 pounds in tension and 24,000 pounds in shear of pins and 48,000 pounds on pin bearing. Structural steel was allowed 24,000 pounds in tension and $24{,}000 - 100\frac{l}{r}$ in compression, r being the radius of gyration and l the length.

To deal with the reports fully would require much space. It is sufficient to point out that a nominal safety is only secured by severe thinning out of the loads. This cannot be held safe, for the cut-down loading might, any holiday, be exceeded under pressure. Both reports are made to the Bridge Commissioner of the city, and are very cleverly worded so that the public will be reassured, but they can only add to the misgivings of the expert. Professor Burr practically says: "You possess a very fine ¾-inch chain fit to hold a tiger. It has only a few links so small as ½-inch, so let this reassure you." But the expert knows the value of even one ½-inch link in a ¾-inch chain, and will interpret Professor Burr exactly as Professor Burr intends the Bridge Department to interpret him, and, looking through his telescope, the tiger must only be a very fine cat.

He does not agree that the very worst combination of loading should ever produce a stress "just under the elastic limit." He would limit stress at its worst to three-fourths of this.

While it is satisfactory to find the work good, it is very disturbing to find stresses exceeding by 15, 25, and even 47 per cent. in vital members the already high specified allowance. It is unexpected, too, to find that so much dead load can be eliminated. This helps somewhat. But surplus dead load seems unusual in American practice, embodying as it does much concrete.

To any engineer who knows New York and has seen the traffic on the existing bridges the present reports will not be at all reassuring, for they do but point to a constant future risk of the worst type. Messrs. Hodge & Burr are the mildest-mannered men we have ever read, but were this great bridge in England they would have effectually "scuttled the ship," for their reports, carefully worded as they are, are absolutely condemnatory. How comes it that the stresses are so much in excess of specifications already too liberal? So far there is no answer. Evidently a repetition of the Quebec inquiry is wanted to elucidate facts, for the early recurrence of serious discrepancy between estimate and fact in weights and stresses throws a very grave doubt on the thoroughness of the methods of quantity calculation in these huge structures. And is it not time that the whole subject of latticing of bridge members was investigated? A lattice bar adds weight to a bridge. It carries no load itself; it merely helps two separate bars to help each the other's stability. A solid plate does this better, as well as itself bearing a full share of stress. Lattices add an enormous load to a bridge, and count for so much working material, thus giving a fictitious value to the dead weight of a bridge. Lattices give a light appearance to a bridge; actually they add weight which does no primary work of load sustentation.

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