# CORRESPONDENCE

## ON PAPERS PUBLISHED IN

## APRIL 1939 JOURNAL.

Paper No. 5197.

## "The Storstrøm Bridge." †

By GUY ANSON MAUNSELL, B.Sc. (Eng.), M. Inst. C.E., and JOHN FREEMAN PAIN, M.C., B.Sc. (Eng.), Assoc. M. Inst. C.E.

*Correspondence.*

**Mr. K. G. Mitchell,** of Simla, observed that in the Appendix (p. 428 §) the Authors gave the formula $\frac{1}{R} = \frac{5{\cdot}5p^2L}{EP}$ for the design of roller bearings, but they did not make it clear what value was assigned to $p$. British Standard Specifications (No. 153) gave the formula $P = 0{\cdot}28\,DL$, where $P$ denoted the total load on the roller in tons, $L$ the length of the roller in inches, and $D$ the diameter of the roller in inches. Taking that formula and substituting $\frac{1}{4}DL$ for $P$ in the Authors' formula, the value of $p$ became 37·6 tons per square inch, without allowance for tolerance in a battery of rollers.

A formula, which was a different form of that quoted by the Authors, was understood to be in common use on the Continent. It was $D = 0{\cdot}36\frac{AE}{bc^2}$, where $A$ denoted the total load, $b$ the total length of all the rollers in inches, and $c$ the permissible compressive stress. He had seen it stated that in that formula certain Continental regulations (including the Danish) allowed a value of $1{\cdot}2 \times 10^5$ lb., or 53·5 tons, for $c$. There again, no allowance was made for tolerance. That appeared to be altogether excessive. Would the Authors state what value they assigned to $p$ in their formula? It appeared to be quite independent of what preceded it.

**Dr. H. J. Nichols,** of Bombay, proposed to confine his remarks to the stiffened-arch navigation-spans, the design of which, in his opinion, possessed particularly attractive features. It was stated on p. 407 §

† Journal Inst. C.E., vol. 11 (1938–39), p. 391 (April 1939).

§ Page numbers so marked refer to the Paper. (Footnote (†) above.)—SEC. INST. C.E.

that the weight of steel in the three spans taken together was 3,460 tons, as compared with 3,060 tons for a normal through-type cantilever-design. In view of the absence generally of complicated shop-work in the arch-design, and of simplified erection and maintenance, could the Authors give comparative total costs, including the capitalized value of painting, etc., to represent the comparative outlays involved in the two cases? Could they also give an estimate of the secondary stresses induced at the top and bottom of the shortest (end) vertical hangers under the worst conditions of partial loading? There was nothing to be gained by designing hanger connexions rigid in the plane of the truss, and the experience recorded in respect of the cracking at the ends of some of the longer hangers would suggest another reason for avoiding too great rigidity at those points.

As railway spans, a consideration of controlling importance was the amount of deflexion upward or downward which occurred in the stiffening girders as a capacity load advanced from one end. Could the Authors give any experimental figures in that connexion, together with the calculated deflexions? An interesting feature of that type of design was that a point of contraflexure occurred in the stiffening girder ahead of an advancing load, and moved forward ahead of the load. Synchronous vibrations under railway loadings could not therefore build up. Although that applied to vertical oscillations, it was clear that appreciable lateral oscillations of the top chords could only occur by the twisting of the span as a whole, which in turn involved vertical oscillations of the two stiffening girders. It was to be expected, therefore, that lateral oscillations of the top chords or arch-ribs would be also controlled, and that had been confirmed by the remarks of the Authors on p. 447 §.

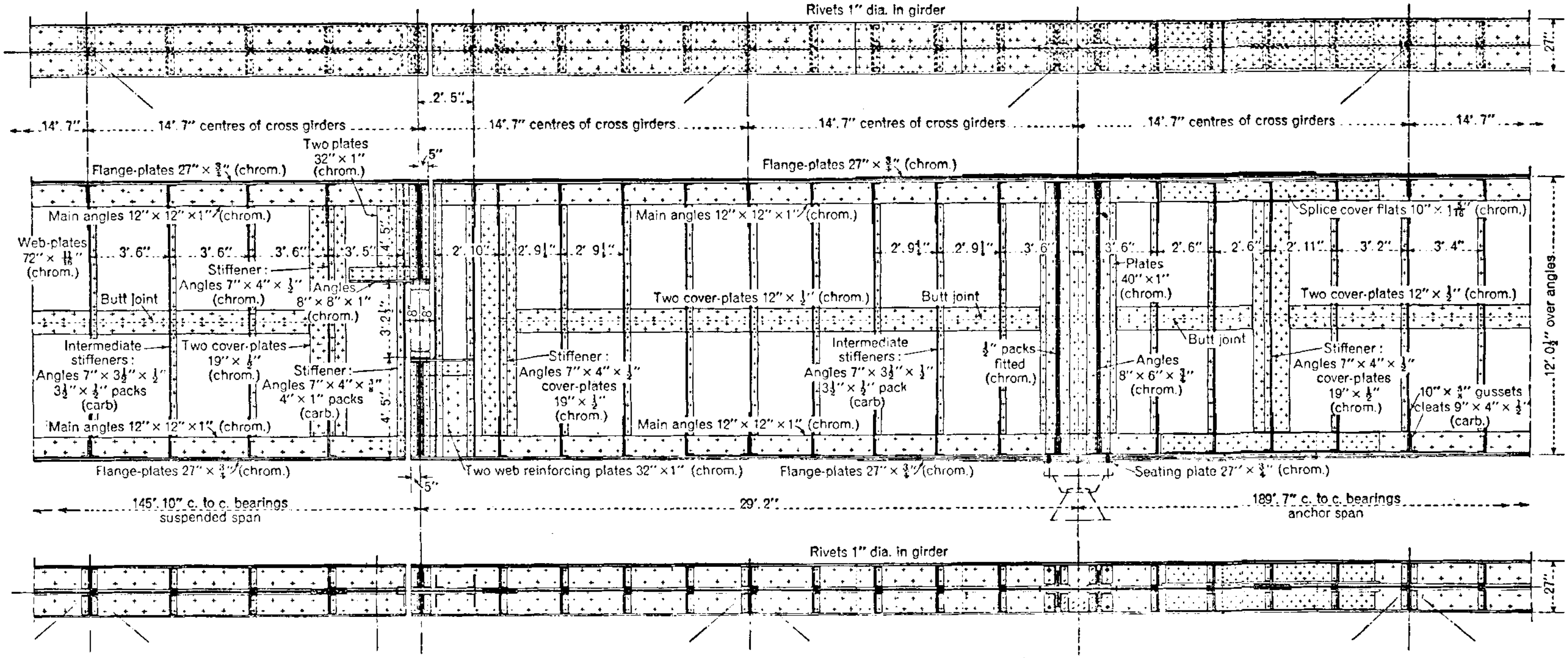
With regard to the expansion bearings, mounted on pairs of segmental rollers 28 inches in diameter, it would be of interest to know whether or not that type of bearing was actually cheaper in place than the more usual bearing on a nest of rollers. There appeared to be a considerably greater weight of metal involved, whilst to offset that there was a reduction in the number of rollers to be accurately ground. Although by using pairs of rollers larger tolerances in diameter could be accepted, it was perhaps more necessary that the diameter of each individual roller should be constant within fine limits in order to avoid distortion of the castings.

Lastly, he wished to call attention to the formula for the factor $y$ as applied to battened columns, given on p. 428 §. There appeared to be two misprints which required correction to make the expression homogeneous.

**The Authors,** in further reply to the Discussion and in reply to the Correspondence, observed that, with regard to the relative areas requiring to be painted on a plate- and lattice-girder design, it had been possible

§ *Ibid.*

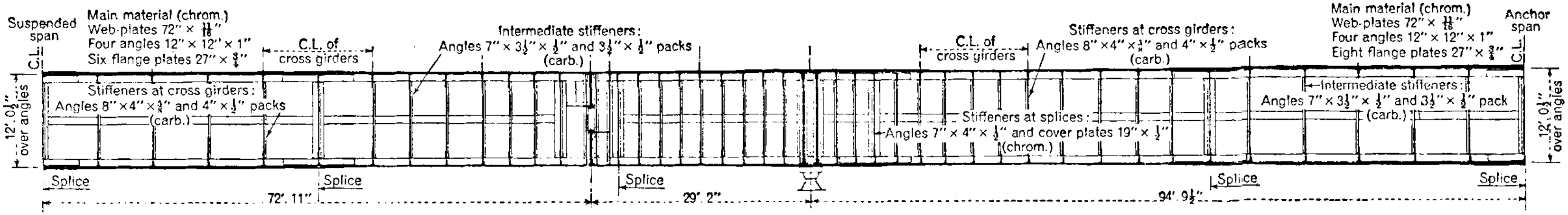
FIGS: 35.




TYPICAL DETAILS OF ANCHOR- AND SUSPENDED-SPAN MAIN GIRDERS.

Scale: 1 inch = 8 feet.

Feet 5 4 3 2 1 0 5 10 feet




HALF ELEVATION OF ANCHOR- AND SUSPENDED-SPAN MAIN GIRDERS.

Scale: 1 inch = 24 feet.

Feet 10 5 0 10 20 30 feet

Note:—
Chromador steel shown thus (chrom.)
Manganese " " " (mang.)
Carbon " " " (carb.)

DESIGN OF APPROACH-SPAN GIRDERS OF STORSTRØM BRIDGE.

to make some further calculations, in the light of which the statement on p. 406 § required some amplification. The ratio of the exposed area of a lattice-girder to that of a plate-girder of similar span was found to be 1·5 to 1 for the main girders only, but, when the whole of the deck and bracing of the Storstøm bridge (including the approaches) was considered, the ratio was found to be 1·3 to 1.

The elevation of one of the approach girders was given in *Figs. 35.* No special provision had been made to bond the concrete of the road and railway decks to the stringers, but there was no doubt that bonding actually took place. No advantage had been taken of the fact in the design of the stringers.

Detailed total comparative costs for the stiffened arch and lattice-girder design for the navigation-spans, and for multiple and two-roller bearings were, unfortunately, not available.

Referring to the rigidity of the hanger connexions in the plane of the truss, the Authors thought that the use of pin-joints at such points, whilst perfectly feasible, might have introduced an additional source of wear, due to the working of the hangers on the pins; it was difficult to design such a joint so that all parts were accessible for painting. The friction on pins, except those very small in relation to the width of the member connected, was quite sufficient to produce fixity at the joint under the range of secondary stresses normally encountered.

Referring to Mr. Mitchell's observations, the Authors pointed out that the Table on p. 428 § had been printed wrongly and should read :—

| Bearings with: | Combination (1), $p$: tons per square inch. | Combination (2), $p$: tons per square inch. |
|---|---|---|
| One or two rollers | 51·0 | 57·0 |
| Three or more rollers | 44·5 | 51·0 |
| Point-contact | 70·0 | 82·5 |

The load allowed by the Danish formula on bearings consisting of two rollers was approximately 1·8 times that given by the B.S.S. formula, and 1·4 times that for bearings with three or more rollers. The Continental formula quoted by Mr. Mitchell appeared to be of the same form as that specified by the Danish Authorities, the difference being only in the constant. With the permissible stress stated, the formula gave results about twice as great as those allowed by the B.S.S. for bearings with two rollers. The Authors were not aware of the experimental data upon which the B.S.S. formula was based, and without some evidence of the harmful effect of the high pressures permitted by the Continental formula it would appear unwise to condemn it.

§ *Ibid.*

The *formula for* $y$ (p. 428 §), *the factor* by which the unsupported length $l$ of battened columns should be multiplied, should read :—

$$y = 1{\cdot}1\sqrt{1 + 0{\cdot}5 \times \frac{I}{I_f} \times \left(\frac{c}{l}\right)^2 + T \times \frac{F_f \times C \times h}{5 \times E \times I_t}},$$

whilst in the Table of notation, following that formula, $1_f$ and $1_t$ should read $I_f$ and $I_t$ respectively.

---

Paper No. 5189.

## "Considerations on Flow in Large Pipes, Conduits, Tunnels, Bends, and Siphons." †

By James Williamson, M. Inst. C.E.

*Correspondence.*

**Mr. Herbert Addison,** of Giza, Egypt, considered that the various Papers on bends and siphons reviewed in the Author's Paper together formed a very interesting study in the dissolution of the belief that the energy loss in a bend depended only on the shape of the bend and not on the surface roughness. The Author had therefore done a valuable service in pointing out again that the flow through a bend was as dependent upon the roughness of the walls as was the flow through a straight pipe.

Mr. Addison's own contribution to the experimental information available, entitled " Experiments on the Flow of Water in Pipe-Bends " *, fully supported that conclusion. When comparing smooth brass bends with rough cast-iron bends of identical shape, he had found that, no matter how the component bends of the complete systems were built up, the total energy-loss in the smooth system was always less than the corresponding loss in the rough system ; and the ratio between the losses was greater even than the ratio between the losses in comparable straight lengths of pipe. The effect of roughness in increasing the loss through pipe-bends had more recently been discussed in a Paper by Mr. K. Hilding Beij, which described work carried out at the National Hydraulic Laboratory, Washington ‡.

Mr. Addison regretted that reference to the position of a bend relative

§ *Ibid.*

† Journal Inst. C.E., vol. 11 (1938–39), p. 451 (April 1939).

* Paper No. 5084. *Abstract published in* Journal Inst. C.E., vol. 6 (1936–37), p. 561 (October 1937). [The MS. and illustrations may be seen in the Institution Library.—Sec. Inst. C.E.]

‡ " Pressure Losses for Fluid Flow in 90-deg. Pipe Bends." Research Paper RP111 O.