$$d_x = d_c + 4\left(\frac{x}{l}\right)^2\left(d_s - d_c\right),$$

where l is the theoretical span; it has been proved that a good variation of the cross sections is obtained by this equation.

The form of the centre line of the arches follows a funicular polygon to the dead load of the structure, which can be calculated from the above expression for d_x. The differential equation for the centre line is $\frac{d^2y}{dx^2} = \frac{g}{H}$, where g is the load per unit length and H the horizontal pressure. By integration

$$\frac{d_y}{d_x} = \frac{1}{H}\int g d_x + C;\ \left(\frac{d_y}{d_x} = 0, \text{ giving } x = 0 \text{ and } C = 0\right)$$

$$y = \frac{1}{H}\int d_x \int g d_x + C_1;$$

$(y = 0$, giving $x = 0$ and $C_1 = 0)$.

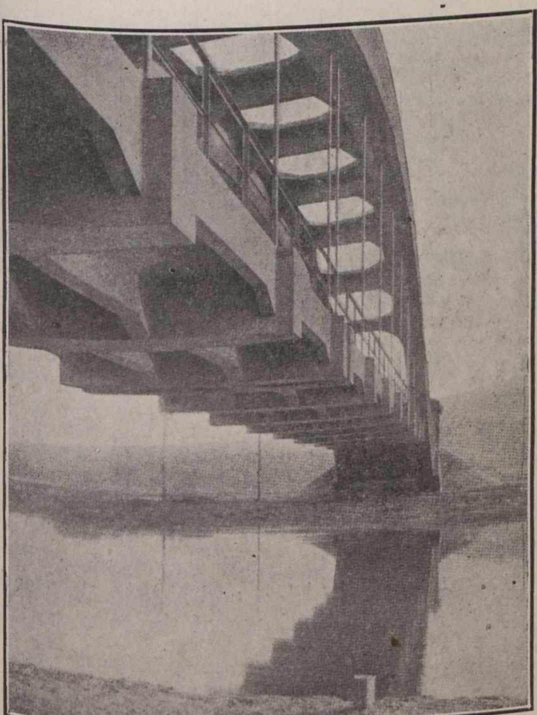

Fig. 3.

In calculating the ordinates at the various points of the centre line the integrations are replaced by summations and the rise of the arches chosen as 34 feet; the ordinates and the horizontal pressure can then be obtained from the equation for y. H for this bridge is 345 tons.

The arches, having no hinges, are statically indeterminate in the third degree. The general form of the equations by which the three unknown quantities (X_a, X_b and X_c) are calculated, are with the usual notation

$$X_a\delta_{aa} + X_b\delta_{ba} + X_c\delta_{ca} = \Sigma P_m\,\delta_{ma} + \delta_{at},$$
$$X_a\delta_{ab} + X_b\delta_{bb} + X_c\delta_{cb} = \Sigma P_m\,\delta_{mb} + \delta_{bt},$$
$$X_a\delta_{ac} + X_b\delta_{bc} + X_c\delta_{cc} = \Sigma P_m\,\delta_{mc} + \delta_{ct};$$

δ_{at}, δ_{bt} and δ_{ct} being the influences due to variations of temperature.

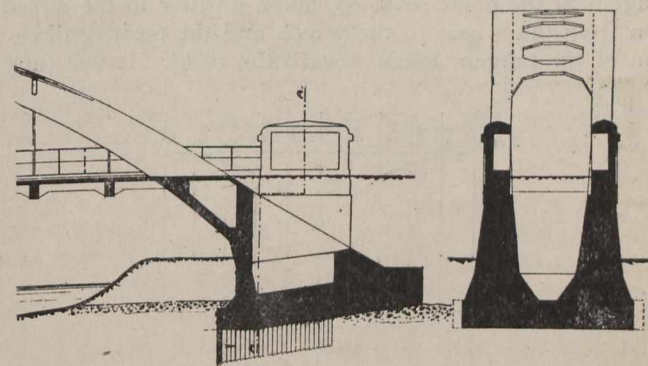

Fig. 5. Section A-A

From the theory of arches without hinges it is known that a very practicable statically determinate auxiliary system is obtained by introducing the normal force X_c, the transversal force X_b and the bending moment X_a at the crown of the arches as the statically indeterminate quan-

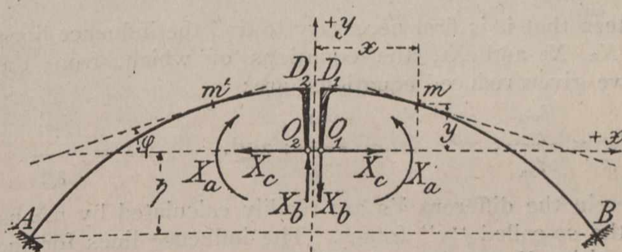

Fig. 6.

tities and allowing them to act upon the arch from a point O (see Fig. 6) in the symmetrical axis of the arch determined by

$$\delta_{ba} = \delta_{ab} = 0$$
$$\delta_{ca} = \delta_{ac} = 0$$

The equations for x will then be

$$X_a\delta_{aa} = \Sigma P_m\,\delta_{ma} + \delta_{at},$$
$$X_b\delta_{bb} = \Sigma P_m\,\delta_{mb} + \delta_{bt},$$
$$X_c\delta_{cc} = \Sigma P_m\,\delta_{mc} + \delta_{ct};$$

as $\delta_{cb} = \delta_{bc} = 0$, on account of the symmetry, and the statical determinate auxiliary system will be two curved beams with one fixed and one free end. (Fig. 6).

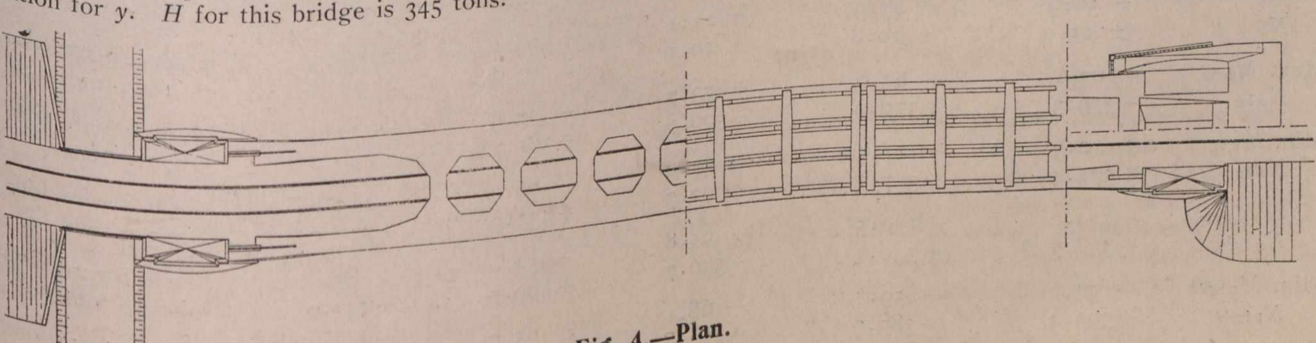

Fig. 4.—Plan.