Bridge problems in Albania

Autor(en): **Giadri, G.**

Objekttyp: **Article**

Zeitschrift: **IABSE congress report = Rapport du congrès AIPC = IVBH Kongressbericht**

Band (Jahr): **2 (1936)**

PDF erstellt am: **21.07.2024**

Persistenter Link: https://doi.org/10.5169/seals-3308

IVb 8

Bridge Problems in Albania.

Über Brückenprobleme in Albanien.

Le calcul des ponts en Albanie.

G. Giadri, Ingenieur,
Generalsekretär des Arbeitsministeriums Tirana.

The problem under discussion here has reference to special statical investigations carried out on a hingeless reinforced concrete arch bridge of 55 m span, built at Gomsice in Northern Albania and opened to public traffic in 1933 (Fig. 10). Normally, in Albania, the more important structures are designed by engineers of the Ministry of Public Works, but in the present case the Statical Office had the task of checking the plans put forward by the Italian-Albanian firm who were contractors for the work, and of confirming its stability by reference to first principes. An account will be given here of the methods adopted by the structural department in accomplishing this object, which were partly of their own devising.

To determine the three supernumerary unknowns for the built-in arch reference was made simultaneously to two statically indeterminate systems, based respectively on the assumption of a built-in beam and on that of a two-hinged arch.

A knowledge of the influence lines for the moments M_{oa} and M_{ob} of the built-in beam, together with that for the horizontal thrust H_o in the two-hinged arch, made it possible to determine the influence lines for the moments at the springing M_a and M_b and, also for the horizontal thrust H of the built-in arch, directly and definitely, without making use of the centre of gravity of the elastic weights.

The first step in determining M_{oa} and M_{ob} was to determine the moment M_β in a beam freely supported on one end and built-in at the other end, after which the fixation was assumed to be cut through in the usual way and the *Maxwell-Mohr* deflection line was determined from the load ordinates $\frac{x}{l} \cdot \frac{1}{J}$ due to an auxiliary moment $M_\beta = 1$, subsequently dividing by the elastic reaction at the support where the end fixation had been cut through (Fig. 4).

In this way x_s represented the length of the arch, corresponding to the distance measured between the left-hand support and the load ordinate (Fig. 2). From M_α which was the lateral inversion of M_β, and from M_β itself, the Statical Office were now able by a simple method to derivè the influence lines of M_{oa} and M_{ob} for the built-in beam.

Here the governing factor was the end inclination τ of the influence lines for M_α and M_β (Fig. 4). On applying the moments M_{oa} and M_{ob} to this angle τ for the built-in beam, M_{oa} and M_{ob} were made to operate to the right and left of the points of fixation of the arch.

Reference to the condition of equilibrium $\Sigma M = 0$ served to determine the relationship $M_{ob} = M_\beta - M_{oa} \cdot \tau$ on the right-hand side, and the relationship $M_{oa} = M_\alpha - M_{ob} \cdot \tau$ on the left. On solving these two equations for M_{oa} and M_{ob}, and on substituting $M_{oc} = \frac{M_{oa} + M_{ob}}{2}$ and $M_{od} = \frac{M_{oa} - M_{ob}}{2}$, the result is $M_{oc} = \frac{M_\alpha + M_\beta}{2(1+\tau)}$ and $M_{od} = \frac{M_\alpha - M_\beta}{2(1-\tau)}$. These simple expressions enabled the influence lines for M_a and M_b of the built-in arch to be calculated without reference to other loading schemes except that required for determining the moments in the beam due to the horizontal thrust H_o of the two-hinged arch. The expression $M_{od} = M_d$ could be regarded as a final result, enabling the effects of one-sided loading of the built-in arch to be taken into account. $M_d = \frac{M_a - M_b}{2}$ acts quite independently and causes no horizontal thrust when the two-hinged arch is loaded in either of its hinges. Hence M_d could be separated from $M_c = \frac{M_a + M_b}{2}$ which gives rise to a horizontal thrust (Fig. 5).

The remaining problem was then limited to the examination of a doubly indeterminate statical system, the available basis of reference being the two-hinged arch. Here the end slope τ_o of the influence line for horizontal thrust H_o played a similar part to the end

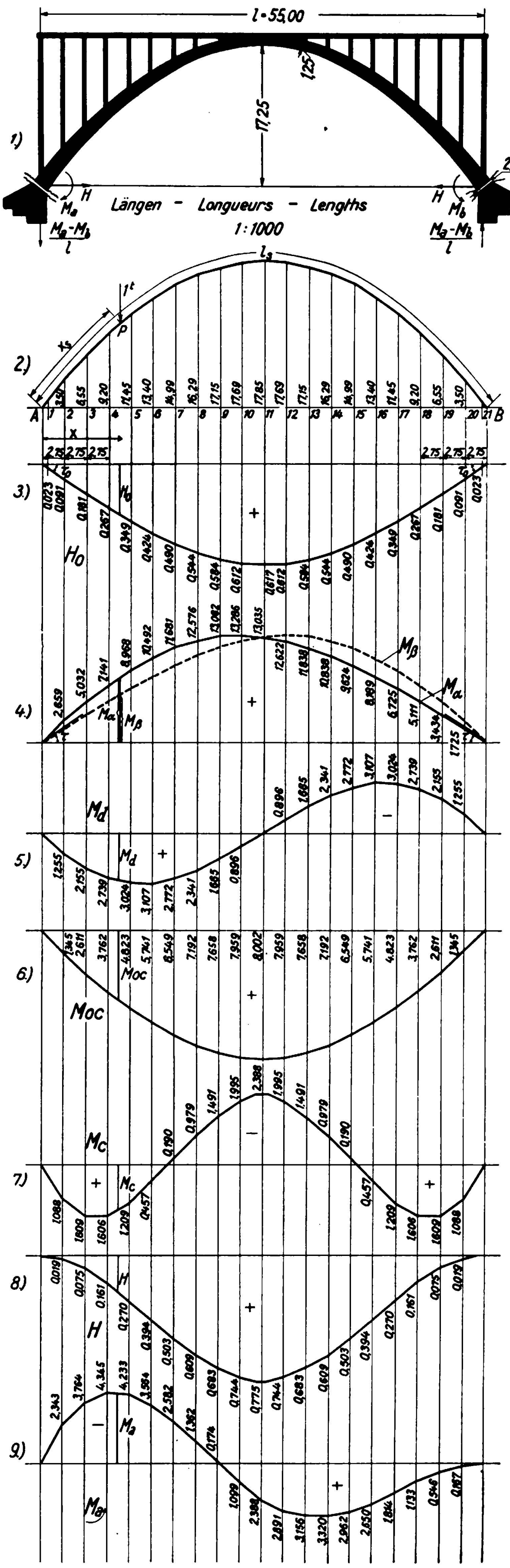

Fig. 1—9. Influence lines for the indeterminate quantities H, H_a and M_b.

slope angle τ in the influence line for M_β in Fig. 3. On loading the hinges of the two-hinged arch with the redundant H and M_c and, equating the horizontal forces at one hinge, the relationship $H = H_o - M_c \cdot 2\,\tau_o$ is reached, from which the influence line of horizontal thrust H may be determined. The influence line of M_c could then rapidly be determined.

Adopting the notation $X_c = M_a + M_b$ and introducing at both hinges $M_c = -\frac{1}{2}$ due to an auxiliary force $X_c = -1$, there was obtained firstly the equation

$$M_c = +\frac{1}{2} \cdot \frac{\int\left(\frac{1}{2} - \tau_o \cdot y\right) \frac{M_o\, ds}{J}}{\int\left(\frac{1}{2} - \tau_o \cdot y\right)^2 \frac{ds}{J}}$$

wherein $\int\left(\frac{1}{2} - \tau_o \cdot y\right)^2 \frac{ds}{y}$ is identified with the constant value δ_{cc}.

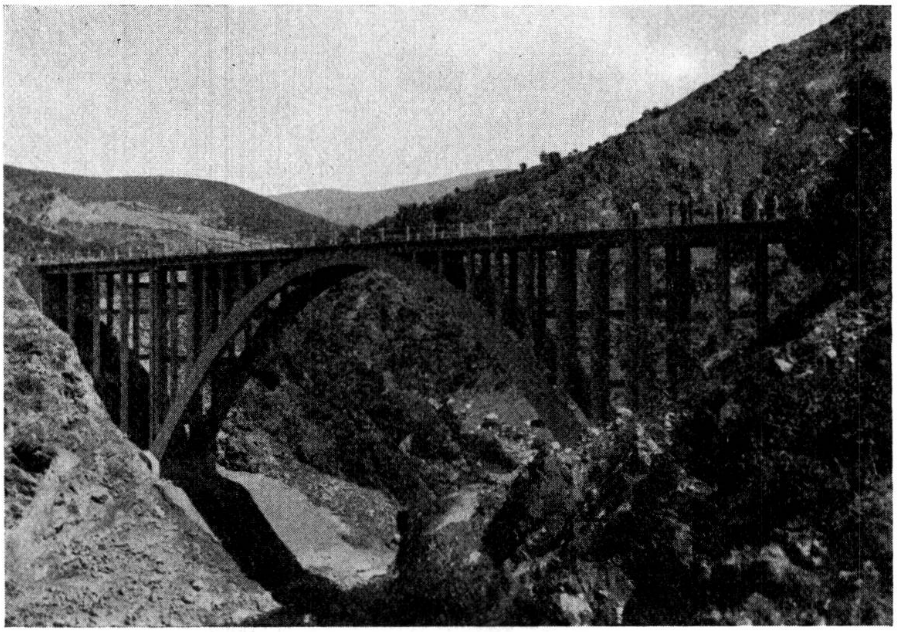

Fig. 10.

Gomsice-Bridge.

On separating the dividend term into two factors and introducing $M_{oc} \cdot \delta_{zz} = \int \frac{M_o \cdot ds}{J}$ and $H_o \cdot \delta_{hh} = \int \frac{y \cdot M_o \cdot ds}{J}$ the value of M_c appears as a function of known magnitudes and there is obtained

$$M_c = \frac{M_{oc} \cdot \delta_{zz}}{4\,\delta_{cc}} - \frac{H_o \cdot \tau_o \cdot \delta_{hh}}{2\,\delta_{cc}}$$

wherein the two constants δ_{zz} and δ_{hh} were found from $\int \frac{ds}{J}$ and $\int y^2 \frac{ds}{J} + \int \frac{ds}{F}$ respectively (Fig. 7). By the value $\int \frac{ds}{F}$ account was taken of the influence of normal forces. In the case of the dividend terms representing redundant quantities the effect of the normal forces was neglected, since the bridge had a rise of 17.85 m. Finally from $M_c + M_a$ the influence line for the redundant moment M_a could be determined. The influence line for the unknown quantity M_b was found by analogy from M_a (Fig. 9).

A temperature effect of $t = \pm 20^0$ C could easily be calculated from δ_{hh}, δ_{cc} and E ω tl.

On the basis of these considerations it was desired to reach an immediate verdict as to the statical performance of the arch. The usual method of calculating built-in arches is simple enough, but it requires the calculation of beam moments for three loading systems. The treatment of the three supernumerary quantities independently of one another is bound up with the condition that the displacements represented by terms of opposite sign cancel out, and this involves a fourth operation, namely, the determination of the centre of gravity of the elastic weights. The supernumerary quantities must themselves be regarded as deriving from general equations which cannot be independently evolved. In confining the calculation of the beam moment to only two systems of loading, and in eliminating reference to the centre of gravity of the elastic weights, the Statical Office of the Albanian Ministry of Public Works believe they have discovered a simplified process for the calculation of influence lines of the supernumerary quantities for built-in arches.

Finally it should be mentioned that the Statical Office have likewise arrived at their own formulae for the calculation of continuous girders. By means of the formulae the influence lines for the moments over the supports in girders which are continuous over three or four spans can be very easily determined, provided that the influence line of the moments over the supports in a girder continuous over two spans is already known. The method has been applied to the solution of various problems in reinforced concrete. It offers the advantage that an alteration in the moment of inertia can very easily be taken into account, and also that it dispenses with the unilluminating tables which are otherwise necessary.