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

Band: 2 (1936)

Artikel: Experiments on photo-elasticity

Autor: Tesa, V.

DOI: https://doi.org/10.5169/seals-3320

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Experiments on Photo-Elasticity.

Spannungsoptische Untersuchungen.

Recherches photoélasticimétriques.

Dr. Ing. V. Tesař,
Paris.

At the present stage of the art of the engineer the solution of internal stresses in complicated structures is being considerably helped by experimental research. The most usual methods are based on the measurement of strains, the acoustical properties of vibrating cords, the variation in electric resistance of certain bodies, and the use of high frequency electric currents. All these methods yield excellent results, but they give information only in relation to those few points on which the measuring apparatus is mounted.

The case is altogether different as regards experiments carried out on models with the aid of polarised light, that is to say by the method of photo-elastic measurement. Under Question IVa the author has drawn attention to the value of such experiments in relation to problems of reinforced concrete construction, and what was said there applies, with little alteration, to steel work also.

Photo-elastic investigations facilitate the determination of rational forms of structure, of whatever nature, and allow the solution of internal stresses where other methods are ineffective. M. *Mesnager*, originator of the photo-elastic method, set up a laboratory for researches on small scale models by the aid of polarised light as early as 1900 at the Ecole Nationale des Ponts et Chaussées in Paris, and as an example of the experimental work recently carried out in this laboratory a brief description will now be given of investigations made in connection with the bridge at Neuilly. A description of this interesting work and of the methods of calculation applied to it has already been given by M. *Pascal*, and the present writer will confine himself to the experimental photo-elastic tests.

The subject of these was a central portion of the bridge (Fig. 1). The design of the model is shown in Fig. 2, and it should be noticed that the investigation had reference to the dead load of the bridge. It will be clear from these figures that the central portion of the bridge construction involves serious difficulties if attacked either by the usual methods of calculation or by experimental methods other than photo-elasticity, for it does not form a collection of

elements that can be dealt with according to the ordinary rules of strength of materials; the necessary conditions for this are not fulfilled.

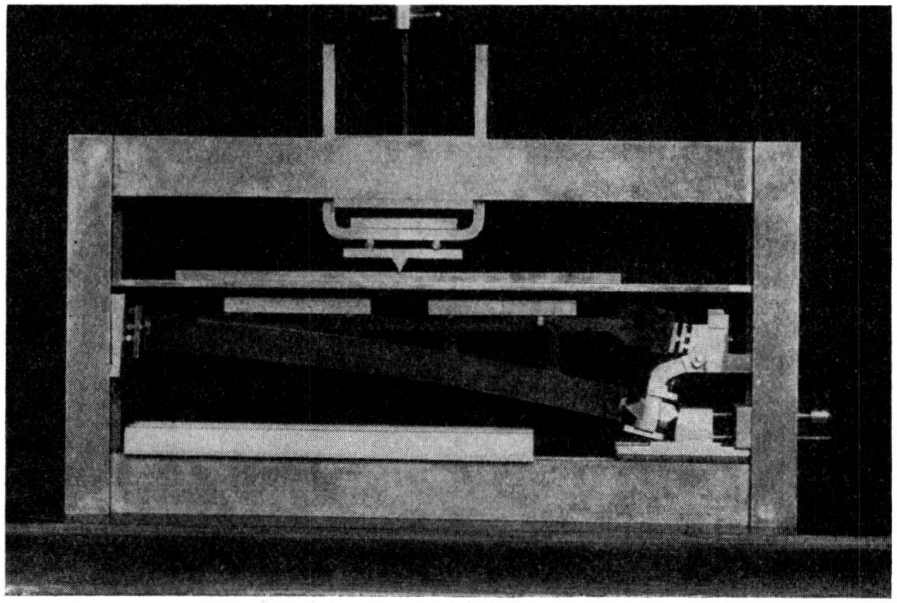

Fig. 1.

The model was made of xylonite to a scale of 2 cm to a metre and was subjected, apart from the external vertical loads, to the reactions of the missing

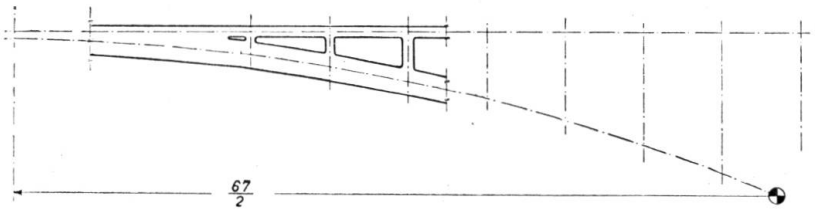

Fig. 2.

part of the bridge, such reactions having been determined by calculation and by other experimental methods to which M. *Pascal* has referred in his paper.

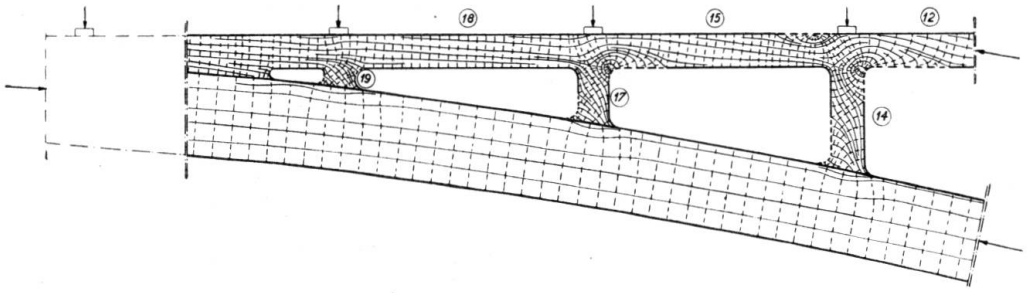

Fig. 3.

The photograph in Fig. 1 shows the experimental lay-out of the model with the system of loads, which were applied to a scale of 1 kg for 5 tonnes. The model was observed by polarised light in straight lines between two crossed

nicols, thus obtaining the isoclinal lines from which in turn could be derived the isostatic lines (Fig. 3). By subsequent quantitative measurements it was

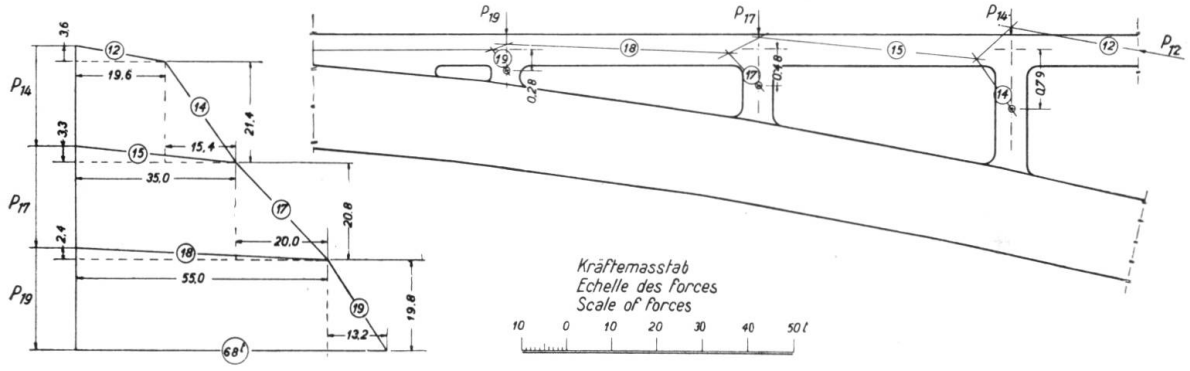

Fig. 4.

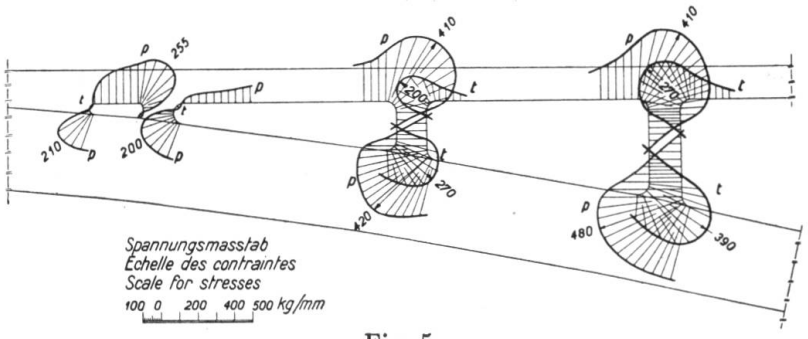

Fig. 5.

possible to fix the curve of pressure and plot the corresponding cremona diagram (Fig. 4).

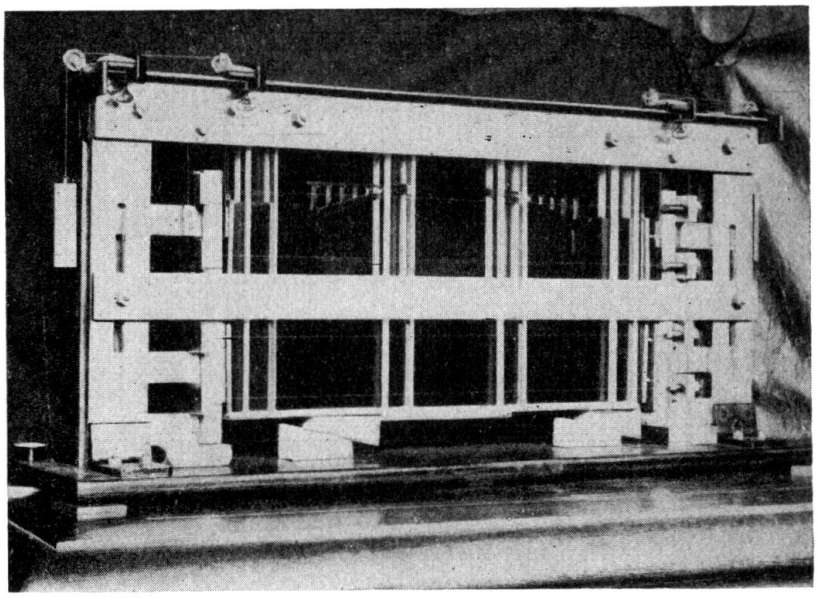

Fig. 6.

Fig. 5 is a diagram showing the stresses as measured along the edge of the verticals in the portion of the bridge under consideration.

In conclusion a few photographs will be given to indicate the experimental arrangement of the researches carried out in the Laboratoire des Ponts et

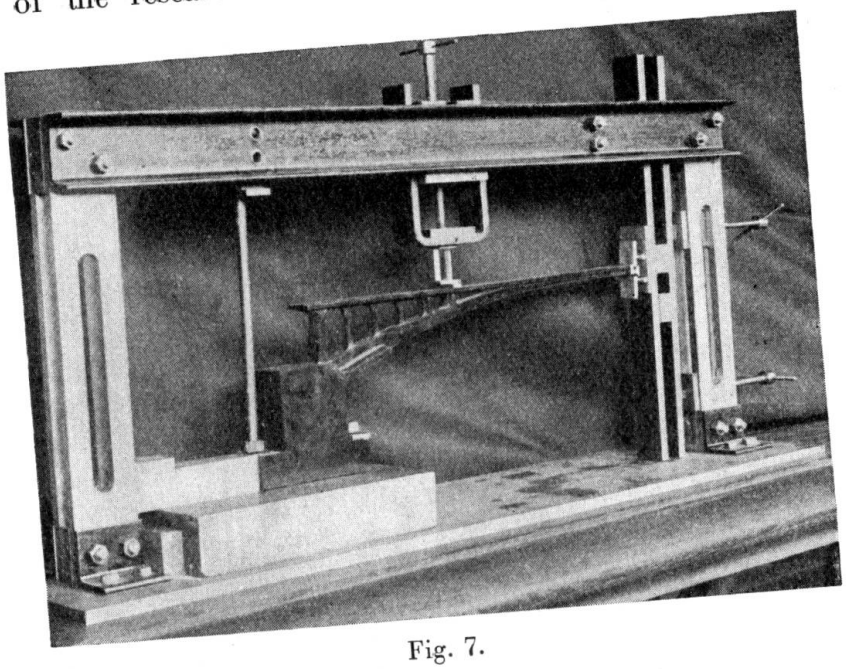

Fig. 7.

Chaussées at Paris for the Jirásek bridge at Praha. Fig. 6 represents the xylonite model of an arch of the bridge enclosed in a frame for the application of the

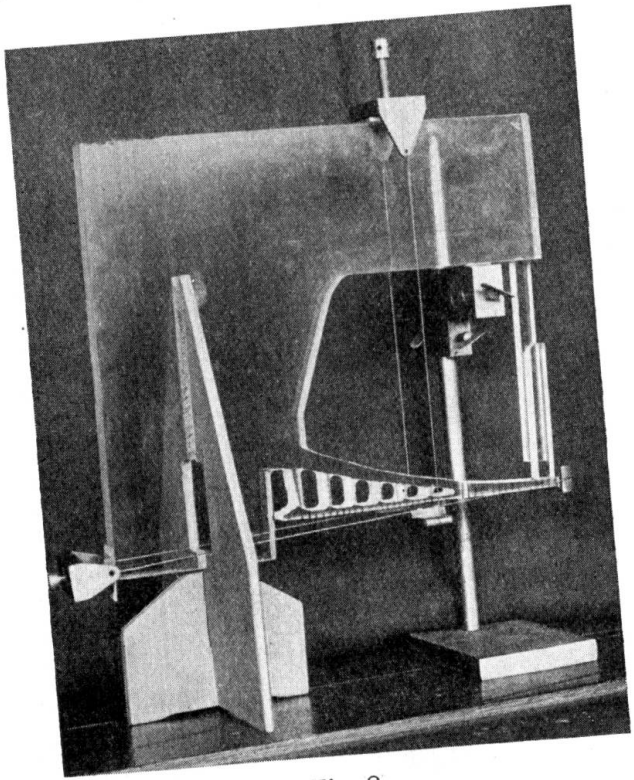

Fig. 8.

loads. Fig. 7 shows the three-dimensional model of one half of the same bridge set up for comparative investigation. Fig. 8 shows the glass model loaded by

a vertical force and the horizontal thrust, and finally Fig. 9 gives photographs of the details of the end fixation of the arch, obtained directly by polarised light

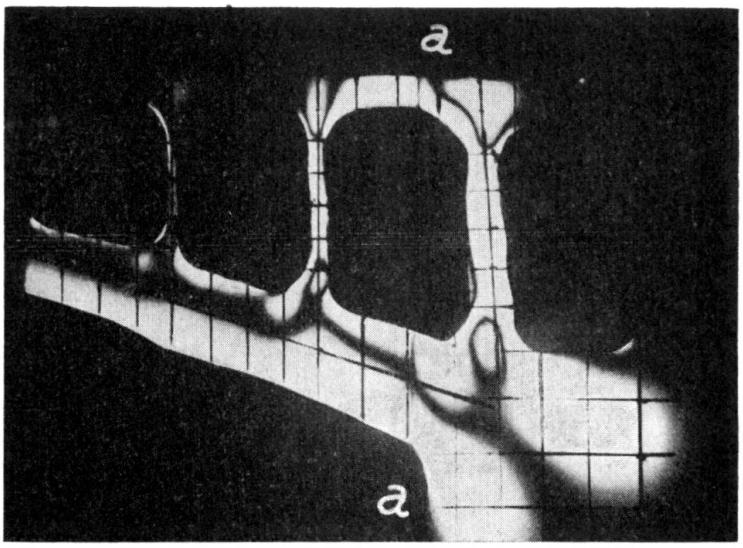

Fig. 9.

in straight lines, with the vertical and horizontal positions of the crossed planes of polarisation.