LIVE-LOAD STRESSES IN RAILWAY BRIDGES: WITH FORMULAS AND TABLES

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LIVE-LOAD STRESSES

IN

RAILWAY BRIDGES

WITH

FORMULAS AND TABLES

BY

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PREFACE

STRESSES caused by moving concentrated loads are treated in this book by the combined use of influence lines and algebraic methods. The influence line is connected by this treatment with tables of moment sums and load sums in a new and entirely practical manner.

The heart of the text is contained in equations (7) and (8). These give an easy and exact solution of the maximum live-load stresses in any structure whose influence lines can be drawn, replacing, for the more complicated structures, such as cantilever and swing bridges, arches, etc., the old method of placing the wheel loading by trial and scaling the influence-line ordinates under the loads.

A second feature of the text is the application of equations (7) and (8) to the simpler structures, such as girder bridges (with and without panels), pier reactions, and Pratt trusses (with inclined and horizontal chords), in which these equations are transformed and simplified to meet the requirements of these ordinary cases. This leads to a series of simple formulas to meet the needs of every-day designing. To illustrate the application of these formulas, fully worked-out examples are given.

The text is supplemented by a very complete set of tables, the usefulness of which is at once apparent. The greater part of the matter in these tables is new. A table similar to Table 3 was made by Mr. Josiah Gibson, C.E., and published in the *Engineering News*, June 21, 1906; and a table similar to Table 11 is given by Mr. J. P. J. Williams in the *Engineering News* of Oct. 1, 1914. Tables similar to Tables 6, 8, and 9 are found in the "Structural Engineers' Handbook" by Dean Milo S. Ketchum and in the "Design of Steel Bridges" by Mr. F. C. Kunz.

The author wishes to acknowledge his indebtedness to the American Bridge Company for material assistance, and in particular to Mr. O. E. Hovey, Assistant Chief Engineer of this company, for his encouragement and help. The author also desires to acknowledge the valuable suggestions made in the revision of the original text by Professor F. H. Constant, of the Civil Engineering Department of Princeton. To Professor William H. Burr of Columbia University, the writer is permanently indebted for the logical and thorough instruction received from him as a student.

G. E. B.

PRINCETON UNIVERSITY
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LIVE-LOAD STRESSES

ARTICLE I.

INFLUENCE LINES. DEFINITION AND USES.

INFLUENCE lines are useful in determining the position of live load on a bridge to produce maximum effect. They offer also a convenient method of deriving general algebraic formulas for stresses and rules for maximum when the general relations between influence lines and algebraic formulas are once understood; and in the case of the more complex problems of skew bridges, arches, cantilever bridges, etc., the influence lines themselves serve as a most direct method for the determination of the maximum live-load stresses.

An influence line may be defined as a line showing the variation in any function caused by a single *unit* load as it moves across the bridge. Vertical loads only will be considered. The function may be a reaction, bending moment, shear, stress, deflection, or any quantity whatsoever at a given part of a bridge, provided that its value is a function of the position of the unit load on the bridge.

Refer to Fig. 1a. Consider the span AB, and let Z be any function at the fixed position C on the span L. If the load unity moves across the span AB and the value of Z be calculated for each position of the unit load and its value z plotted below the corresponding position of this load as an ordinate from a horizontal base line, the locus of the plotted points will be the influence line for Z. For example, if Z be the bending moment at the fixed section C in a beam of span L, the influence line will be as shown in Fig. 1b. In plotting influence lines, ordinates repre-