

**A SYSTEM OF USEFUL  
FORMULAE, ADAPTED TO THE  
PRACTICAL OPERATIONS OF  
LOCATING AND CONSTRUCTING  
RAILROADS**

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649389315

A system of useful formulae, adapted to the practical operations of locating and constructing railroads by Simeon Borden

Except for use in any review, the reproduction or utilisation of this work in whole or in part in any form by any electronic, mechanical or other means, now known or hereafter invented, including xerography, photocopying and recording, or in any information storage or retrieval system, is forbidden without the permission of the publisher, Trieste Publishing Pty Ltd, PO Box 1576 Collingwood, Victoria 3066 Australia.

All rights reserved.

Edited by Trieste Publishing Pty Ltd.  
Cover @ 2017

This book is sold subject to the condition that it shall not, by way of trade or otherwise, be lent, re-sold, hired out, or otherwise circulated without the publisher's prior consent in any form or binding or cover other than that in which it is published and without a similar condition including this condition being imposed on the subsequent purchaser.

[www.triestepublishing.com](http://www.triestepublishing.com)

**SIMEON BORDEN**

**A SYSTEM OF USEFUL  
FORMULAE, ADAPTED TO THE  
PRACTICAL OPERATIONS OF  
LOCATING AND  
CONSTRUCTING RAILROADS**



A  
SYSTEM  
OF  
USEFUL FORMULÆ,  
ADAPTED TO THE PRACTICAL OPERATIONS OF  
LOCATING AND CONSTRUCTING  
RAILROADS:

A PAPER READ BEFORE THE BOSTON SOCIETY OF CIVIL ENGINEERS,  
DECEMBER, MDCCCLIX.

UNIVERSITY OF  
COLUMBIA  
BY SIMÉON BORDEN,  
CIVIL ENGINEER.

BOSTON:  
CHARLES C. LITTLE AND JAMES BROWN.  
MDCCCL.

718-1  
121

Entered according to Act of Congress, in the year 1866, by  
**CHARLES C. LITTLE AND JAMES BROWN,**  
in the Clerk's Office of the District Court of the District of Massachusetts.

GIFT  
J. Foster Hagg

**BOSTON:**  
PRINTED BY WILLIAM CRADY, OF  
EXCHANGE STREET.

THE  
LIBRARY  
OF THE  
CONGRESS

## P R E F A C E .

---

THE formulæ contained in the following pages were written, as their title indicates, for an original paper, which was read before and discussed by the Boston Society of Civil Engineers.

The Society, having accumulated a number of original papers, appointed a committee to examine and report upon the expediency of having them published. After much consideration, the committee reported that, with their limited resources and present necessities, it would be improper to incur the expense of printing, but recommended an early publication of this paper; and for that purpose the manuscript has been placed in the hands of the publisher.

Notwithstanding the obvious importance of constructing the curves of a railroad upon the best practical locations, and giving to their forms or alinement the greatest degree of regularity practicable, the investigation, or, which is more probable, the publication of anything like a system of convenient formulæ to aid the young engineer, and such others as have not had the advantage of a good mathematical education, in the proper performance of this character of work, it is believed has not yet found a place

upon the shelves of our libraries or book-stores. To supply this deficiency in the library of the civil engineer, particularly the railroad engineer, is the object of the present paper.

It is not pretended that all the formulæ contained in this paper are original. The principles which have governed the investigations for computing the elements required for tracing curves, where their localities are such as to admit of the most simple and convenient methods, have, it is believed, been published, and are known by most engineers who have been engaged in the construction of railroads, since the commencement of the railroad system. Neither is it pretended that the system of formulæ is complete, or that it contains formulæ suited to every case that can arise. The writer can only say, that after considerable experience in the construction of railroads, he does not recollect a case presenting itself which would not be solved by some one of the formulæ; and it is believed that, with slight modifications, such as any geometer would be able, without difficulty, to make, they may be adapted to all common or ordinary cases.

Curves in a railroad, unless their radius be very large, are known to be objectionable; but the contour of the surface, the existence of valuable buildings, of streams, rivers, ponds, oceans, etc., in the line between the points which it is desired to connect, render the adoption of curves necessary. It is likewise a well-established fact, that the greater the degree of regularity and precision exercised in the construction of curves, the more safely and easily can trains be run over them.

The main objects of the formulæ are twofold; viz., that of enabling the engineer to mark out the curves of a railroad with the greatest degree of



precision and convenience, and to locate them in situations the most desirable. To render this subject clear and perspicuous to every one who may have occasion to locate or mark out curves, upon railroads and other places, the paper is commenced with the investigation of the most simple problems, which are succeeded by the more intricate; each case being illustrated with diagrams, and accompanied by examples of computation.

The subject of switches and frogs being blended with the elements of turnout curves, has been considered in connection with them; and in their arrangement the same objects have been kept in view; and, for this end, each case has been likewise accompanied with a diagram and an example of computation.

To render the work more useful, there have been added formulæ for computing the cubic contents of excavations and embankments, and a formula for computing the difference in height to be observed in laying down the rails upon a railroad curve, based upon its radius and the velocity of the cars.

Boston, December, 1850.



# CONTENTS.

---

SECTION	PAGE
1.—The subject of connecting straight lines of different bearings by simple curves considered, with an investigation of formula for ascertaining the necessary elements . . . . .	3
2.—Demonstration of the formula for angles of deflection for locating a simple curve. . . . .	4
3.—Field operations for locating or laying out simple curves described . . . . .	5
4.—Hints to young engineers . . . . .	7
5.—The subject of dividing curves into a series or system of long chords considered and recommended, with practical hints. . .	7
6.—The convenience of making the termination of the long chords correspond with even stations considered and recommended	8
7.—A method of correcting the location of tangent points from a re-survey considered and explained . . . . .	9
8.—Formulae for ascertaining the necessary elements for locating simple curves, with examples of computation. . . . .	10
9.—A method of laying out simple curves by a system or series of long chords described, with practical examples of computing the necessary elements. . . . .	13
10.—Field operations of laying out simple curves by means of long chords described . . . . .	15
11.—The office and field labors connected with laying out simple curves by the aid of long chords, further considered. . . . .	17
12.—Further field operations of laying out simple curves described. .	18