Book Review

Planning and Design of Bridges, by M. S. Troitsky. Published by John Wiley & Sons, Inc., New York, 1994. $69.95, 318 pp.

M. S. Troitsky has provided the engineering community with a "paper-based" expert system. It is paper-based because, in today's computer jargon, that is the label increasingly given to that item traditionally called a book, and it is an expert system because the jacket of this particular book tells us that it is "an exhaustive guide to the 80 percent of bridge planning and design that most engineers and planners learn only through years of experience." This claim is well founded. Michael Troitsky, who is Professor Emeritus of Civil Engineering at Concordia University and author of the texts *Cable-Stayed Bridges* and *Prestressed Steel Bridges*, departs from the technical nature of his previous books and, in doing so, presents an informative and insightful guide to the more qualitative aspects of building a bridge.

Planning and Design of Bridges begins with a comprehensive and entertaining history of bridge design. Dr. Troitsky reports that the first man-made bridge on record was built in 780 BC across the Euphrates at Babylon. He extends his descriptions from the Ancient period through the Middle Ages and all the way up to an undetermined time in the future when the Gibraltar Strait Bridge will be erected. Along the way, the reader is introduced to virtually every type of bridge and bridge material, including vines and monkeys.

Chapters 2–4 address bridge planning topics. An equation is derived that is used to find the optimal bridge location, considering traffic flow. Angle of crossing considerations and related cost analysis techniques are presented. Also, bridge approach guidelines and site investigation logistics are briefly discussed. Although much of the material of the book is applicable to bridges over highways or gorges, the fourth chapter deals entirely with river crossing concerns, including bridge opening calculations and the effects of scour and erosion.

The next five chapters primarily address structural aspects of bridge design. The main components of a bridge (substructure and superstructure) are introduced, and an economical analysis of optimal bridge span length is presented. Dr. Troitsky presents a general, yet highly informative, overview of steel superstructures. He explains under what conditions plate girders are preferable to rolled beams, outlines the advantages of composite construction, and introduces the most common types of trusses and arches. His concise description of construction techniques is useful and well written, especially the sections pertaining to suspension and cable-stayed bridges. The use of reinforced and prestressed concrete, as an alternative to steel, for bridges is then discussed; specifically, the applicability of different designs (including deck-girder, box-girder, arch, and cable-stayed bridges) is examined, as well as construction considerations appropriate for each type. A general discussion of prestressing methods is also presented. Common types of piers and abutments and their respective materials are discussed in the substructure chapters.

The tenth chapter on aesthetics in bridge design is introduced by the author's comment that "the foundation of aesthetics is of the subjective order," but the section entitled "Requirements for Bridge Aesthetics" opens with the seemingly contradictory statement that "bridges may be considered beautiful when they fulfill the requirements discussed below." However, Dr. Troitsky lends credence to this weighty claim by presenting a comprehensive and insightful list of artistic

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factors, including conformity with environment, pleasing outline and proportions, symmetry and simplicity, and harmony and contrast. He also supplies an equally interesting list of "don'ts" where he lays blame for lack of beauty on the indifference of designers, cost competition among contractors, and absence of art standards for bridges, among other things. The chapter ends with a discussion about the artistic design of various types of steel bridges.

In the eleventh chapter, entitled "Specifications and Codes," an exhaustive list of United States and Canadian specifications for steel and concrete bridges is given. Code provisions for all types of bridge loadings and methods of determining load distributions are presented. Also, substructure forces such as stream current, earth pressure, and earthquake motion are discussed. The section on seismic design contains a flowchart that suggests a design procedure based on the 15th edition of the AASHTO *Standard Specifications for Highway Bridges*. The sections of the AASHTO standards that are relevant for earthquake design are applicable to "bridges of conventional steel and concrete girder and box girder construction with spans not exceeding 500 ft." Dr. Troitsky provides the titles and subheadings of these sections (and associated commentary) in outline form.

Chapters 12–14 serve as a synopsis of all the material covered in the preceding chapters. Although some of the information is redundant, these chapters address a great deal of the qualitative concerns that are encountered when building a bridge. First, methodological trends in the design of bridges are examined. The primary purpose of a bridge is to serve the requirements of transport; however, Dr. Troitsky points out that, in the past, bridges also served as monuments, fortresses, and even shopping malls. He also states modern bridges are sometimes additionally required to be aesthetically pleasing and advance scientific research through the implementation of an innovative design. After discussing basic bridge parameters, he briefly describes some theoretical methods of preliminary design that he expounds upon more fully in the next chapter. Preliminary design topics include work sequence, local conditions, and span design for reinforced concrete and steel bridges.

Chapter 14 examines methods for comparing alternative bridge designs. Specific factors that are addressed include material and building costs, conditions of fabrication and erection, and performance. Dr. Troitsky provides numerous examples, both quantitative and qualitative, for different crossing situations.

The final chapter is an overview of the evolution of computer use in bridge analysis. Dr. Troitsky describes how computers were first implemented as an efficient tool to perform numerical computations and then were employed for drafting design. He then goes on to marvel at the realization of integrated design, analysis, and drawing systems and offers a detailed description of one such system, BRADD-2. Other systems discussed include the art-design New Image System, the expert BDES system, and AASHTO's BDS. The use of microcomputers for bridge design and analysis is also considered, and a survey of two DCA software packages (STRUCTURAL DESIGNER and STEEL DETAILER) is given.

Planning and Design of Bridges is relatively unique among modern textbooks. It is intentionally bereft of the heavily computational nature of a reinforced concrete or steel design text, yet it provides the reader with an insightful understanding of these materials and their advantages and limitations. It is somewhat similar in scope and tone to A. C. Liebenberg's *Concrete Bridges: Design and Construction*, but Dr. Troitsky's book is even less technical and, of course, is not limited to one bridge material. It is also not a coffee-table book filled only with historical anecdotes and engaging pictures, but it does have some of each. So, what *is* it? It is an excellent book for undergraduate and graduate engineering and architecture students who want to learn the practical matters of building a bridge.

The main shortcoming of the book is one common to many first edition texts. Namely, there are numerous errors, especially in the early chapters. For instance, Dr. Troitsky states that the Bayonne bridge (1652 ft span) is the longest steel arch bridge in the world. However, the New River Gorge bridge (1700 ft span) in West Virginia has held this record for almost 20 years. More troubling, however, are the errors that crop up in various mathematical derivations. Some are relatively benign, such as the swapping of a ϕ for a θ in certain places. But, other errors are more serious and lead to dimensionally incorrect final expressions for traffic work and bridge span cost. Fortunately, however, the expressions are not very involved, and the derivations are complete enough so that the errors can be easily spotted.

I assume that the second edition will correct these shortcomings.

The only other recommendation I would make for future editions is that some of the figures need to have more descriptive captions. The figures I refer to are composites where each subfigure has a letter assigned to it, but the captions do not properly identify them. However, these few drawbacks should not dissuade the reader from purchasing *Planning and Design of Bridges* in its current form.

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