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9th Revised & Enlarged Ed.

A photograph of a large bridge under construction. Two yellow cranes are visible, one on the left and one on the right, both lifting a large, curved steel bridge segment. The bridge is supported by a barge in the water. In the background, there are industrial structures and a city skyline.

Design of Steel

Structures - 2

Dr. Ramchandra & Virendra Gehlot

DESIGN OF STEEL STRUCTURES-2

(A Book for under-graduate and post-graduate students)

[S.I. UNITS]

9th Revised and Enlarged Edition

DR. RAMCHANDRA

BE, M.E. (Hons.), Ph.D. (Roorkee at present I.I.T., Roorkee)
Retired Professor Department of Structural Engineering
M.B.M. Engineering College J.N.V. University,
JODHPUR (Rajasthan)

VIRENDRA GEHLOT

B.E. (Civil)
Consultant Engineer
JODHPUR (Rajasthan)
[E-mail: viren224@yahoo.co.in]



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viren224@yahoo.co.in

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OUR TEACHERS and
PARENTS

LIST OF THE PAPERS PUBLISHED BY

Prof. Dr. Ram Chandra and Virendra Gehlot***

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- *5. “Stub Column Tests on Indian Standard H-Beams”, Journal of the Institution of Engineers (India), Volume 51, No. 11, C.I. 6, July, 1971.
- *6. “Kani’s Iteration Method I-Analysis of Continuous Beams” The Indian Engineer, Volume XIV, No. 6 June, 1970.
- *7. “Kani’s Iteration Method II Analysis of Frames”, The Indian Engineer”, Volume XIV, No. 8 August, 1970.
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- **11. ‘Stresses in Reinforcing Steel Bars, HYSD of Grade Fe 415’ Futuristic Construction Materials and Technique (FCMT 2004, Feb. 21-22, 2005) Department of Structural Engineering Faculty of Engineering, JN Vyas University, Jodhpur.

PREFACE TO THE NINTH EDITION

Ninth edition of this book July (2006) is based on 'Bridge Rules' (adopted in 1941, revised in 1964 and reprinted in 1989, and IS : 800-1984 as amended in 1997.

Authors have distributed present test in this book in thirty two chapters, [that is, in FIVE - PARTS], namely (1) Steel Bridges and Influence-line diagrams for axial forces (the stresses) for the various members of different types of truss girders, (2) Special steel Structures (3) Aluminium Structures, (4) Analysis of Structures, and (5) Introduction to Special structures.

In part I, Steel Bridges of different types have been listed along with 'Historical Development of these types as per need of larger and larger spans. Four chapters of 'Influence line Diagrams' have been clubbed with part-I. In part II, 'Design of Guyed steel Chimneys' a fresh Chapter has been included. Chapter of Steel Tanks have been separately described those for 'Rectangular Steel Tanks (RST)', 'Circular Steel Tanks (CST)' and 'Pressed Steel Tanks (PST).

Two chapters of design of 'Thin-walled/Cold Formed (Light Gauge. Steel Columns and Tension Members) and flexural members have been given.

Plastic (Ultimate Load Method) of Analysis has been distributed in five chapters. Concept of Instantaneous Centre of Rotation (ICR) for both rectangular frames and pitched-slope (gable) frames has been explained to calculate angles of rotations after formation of plastic hinges in frames for their different segments. A new chapter for plastic (Ultimate Load Method) of analysis has been given. So also, a new chapter has been devoted to include 'Influence of Axial and Shear forces on the fully plastic-moment of resistance of the member cross-sections.

In Part IV, chapter for Method of Tension Coefficients illustrates the determination of forces in the members of determinate and indeterminate frames. Similar to various other subjects, this subject is also very vast. In Part V, the vastness of this subject has been emphasized by introducing (i) Orthotropic Steel Bridges and Tension

Load Cable Structures, (ii) Space Steel Structures and (iii) Stressed Skin Steel Buildings.

Photo-plates for steel fixed and movable bridges, High rise (multi-storey) buildings and towers have been given for better understanding and illustration.

Authors express their sincere thanks for their colleagues, members of staff in various engineering colleges and students for appreciating efforts made by them.

Authors also express their personal thanks for the Publisher Shri Pawan Kumar Sharma (Scientific Publishers (India), Jodhpur) for getting the book in nice-form and so also appreciate Shri Rajesh Ojha for setting the complete text, tables and diagrams beautifully.

Authors shall welcome and appreciate the suggestions from the readers for the further improvement of the book.

**Ramchandra
Virendra Gehlot**

PREFACE TO THE FIRST EDITION

In this book, the author with his long teaching experience in the subject has made an attempt to present the subject matter of design of steel structures in a way which lays emphasis on the fundamentals keeping in view the difficulties experienced by the students. Every basic principle, method, equation or theory has been presented in simplified manner. The metric system of units has been followed throughout the text. Indian Standard Specifications, Bridge Rules, Code of Practice for the design of Steel Bridges (published by Railway Board) and Standard Specifications, and Code of Practice for Road Bridges (published) by the Indian Road Congress) have been used. The book is intended for the use of degree, diploma and A.M.I.E. students in various branches of engineering. The book deals with analysis and design of structures.

The book has been sub-divided into three parts: (1) Design of Steel Bridges, (2) Design of Steel and other Structures and (3) Analysis of Structures. Design of Steel Bridges includes deck type and through type bridges for metre gauge and broad gauge for railways and steel bridges for highways. Analysis of Structures includes Influence Lines for Stresses in Frames, Analysis of Space Frames, and Analysis of Secondary Stresses.

Each topic is thoroughly described. A number of design problems including problems from examinations of the University of Jodhpur and A.M.I.E. have been solved to illustrate the theory and practice. Informations from the various Codes and Indian Standards with ready references make the book useful for the practising engineers. Slide Rule computations accuracy is adequate for the design and has been followed. In spite of careful scrutiny of the manuscript it is possible that some typological and computational errors are still left. The author shall be highly obliged to anyone who brings these errors to his notice.

The author is thankful to Shri J.N. Srivastava and other colleagues who have very generously helped with their suggestions.

The author is also thankful to the University of Jodhpur, Jodhpur and the Institution of Engineers, India for allowing the use of examination questions.

Suggestions from the readers for the improvement of the book are welcome.

21 July, 1971

RAMCHANDRA

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32.7 Flexibility, C1, due to sheet Deformation	938		
32.8 Flexibility, C2, due to sheet Fasteners	941		

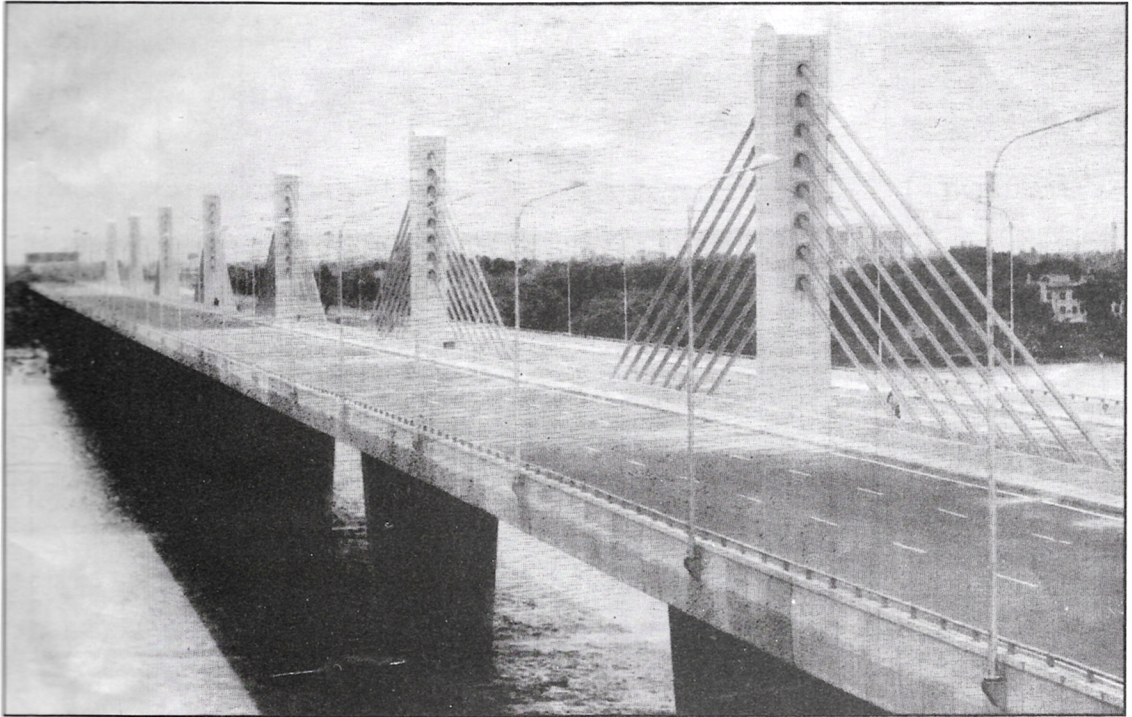


Photo-Plate 1.1. CABLE STAYED (BRIDGE) HARP TYPE



Photo-Plate 1.2. SUSPENSION BRIDGE



Photo-Plate 1.3. TIED ARCH BRIDGE

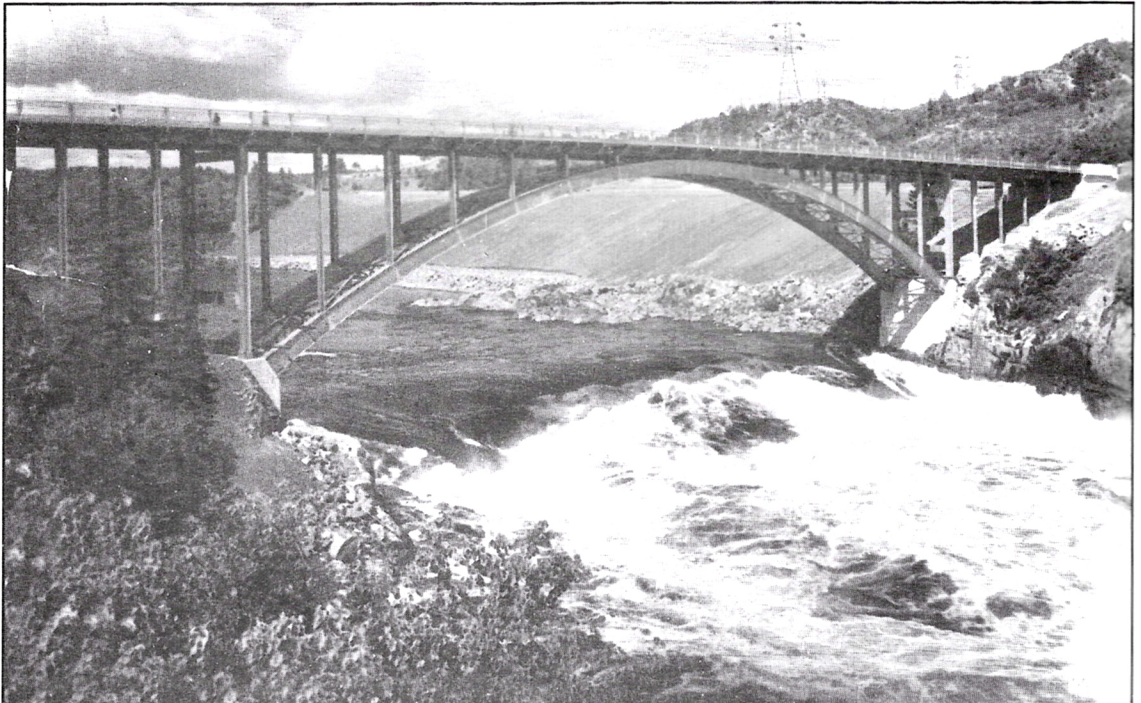


Photo-Plate 1.4. BRACED RIB ARCH BRIDGE

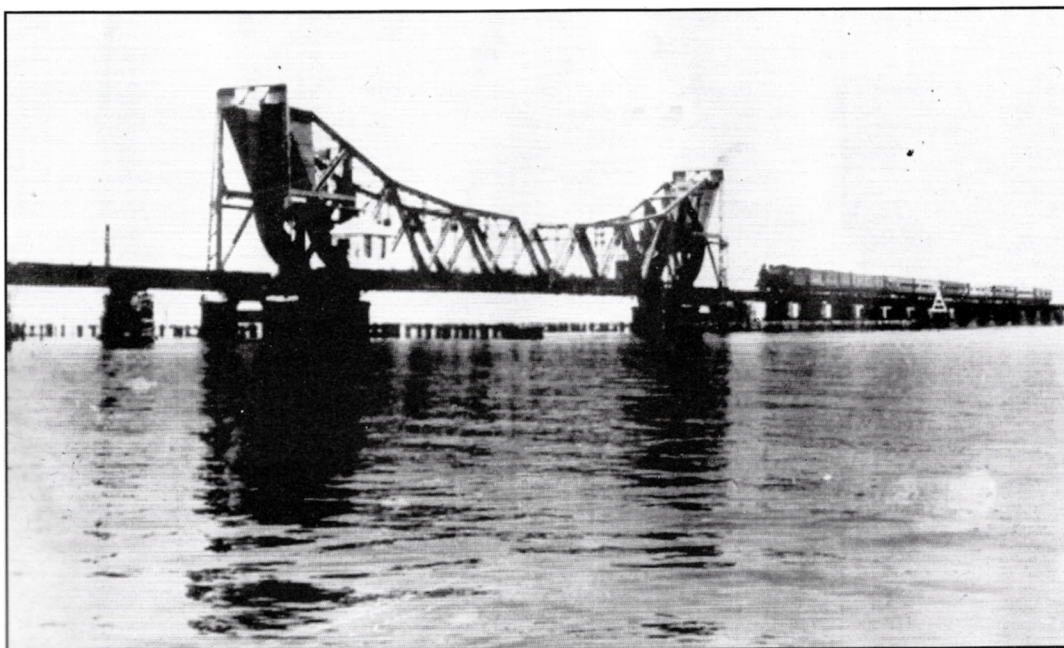
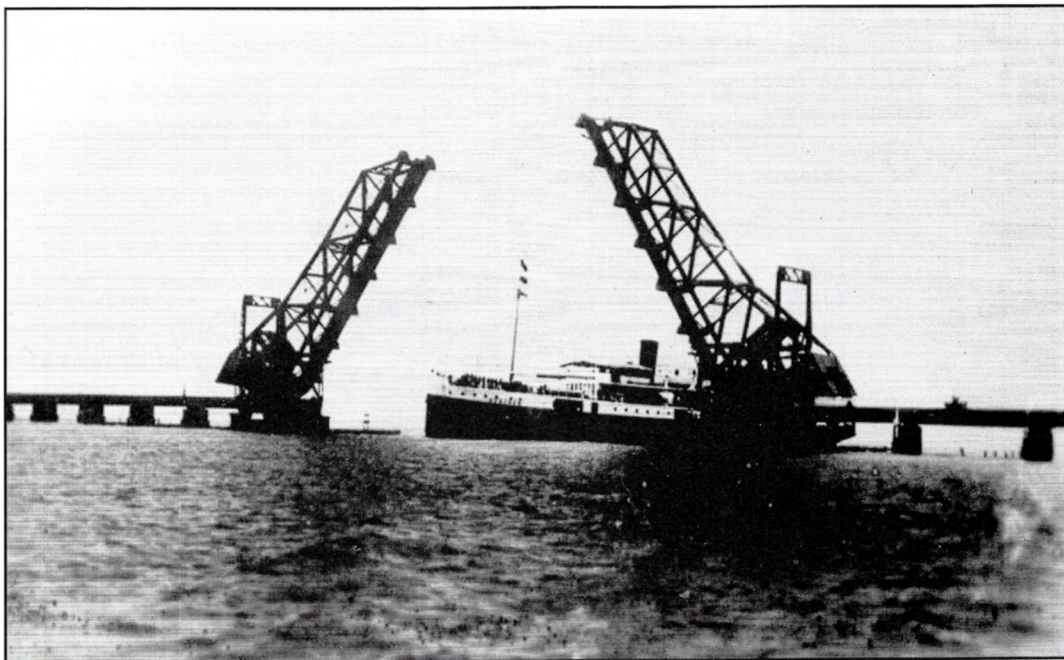


Photo-Plate 1.3. DOUBLE BASCULE BRIDGE
 IN OPEN POSITION
 IN CLOSED POSITION
(Pampan Bridge, Near Rameshwarm)

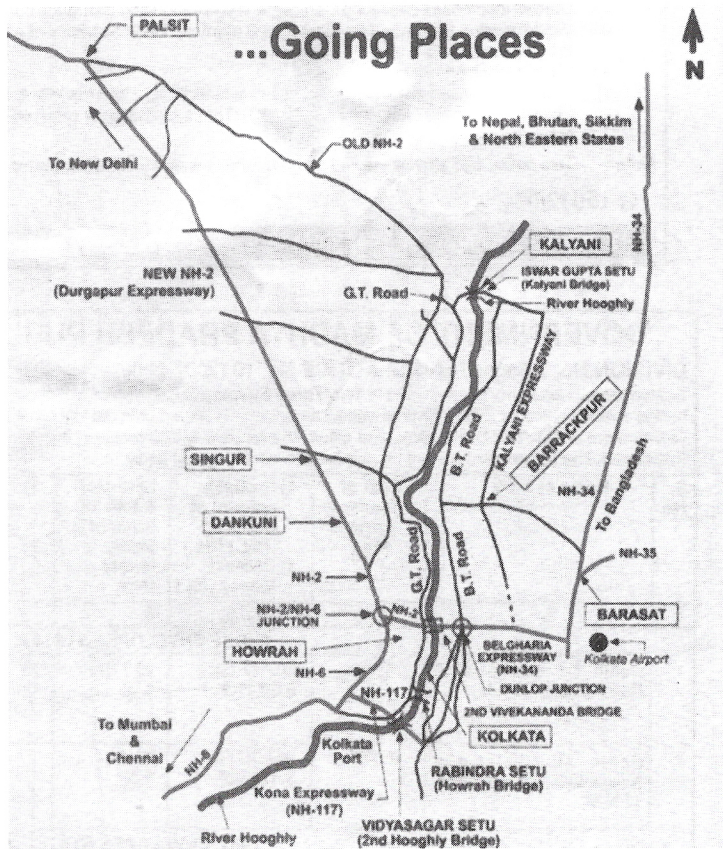


Photo-Plate 1.6. LOCATION OF BRIDGES IN KOLKATA

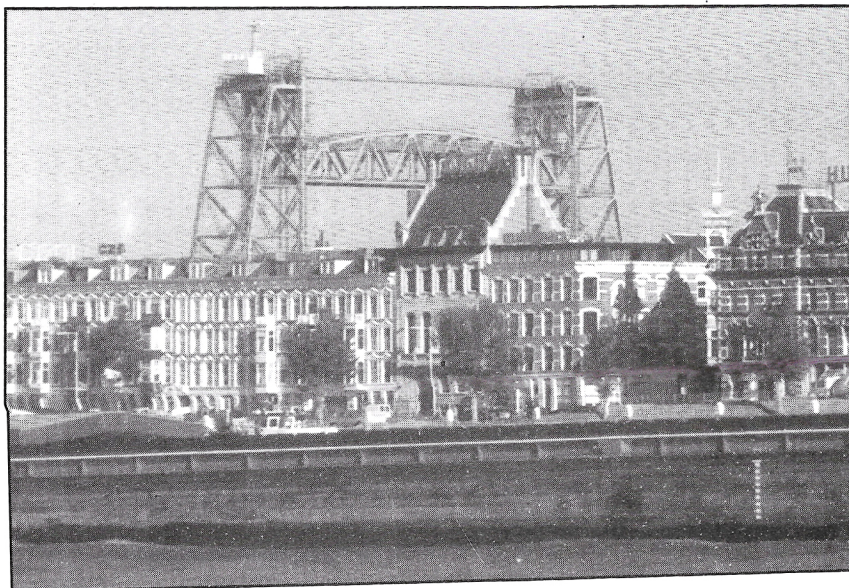


Photo-Plate 1.7.
VERTICAL LIFT
BRIDGE IN OPEN
POSITION

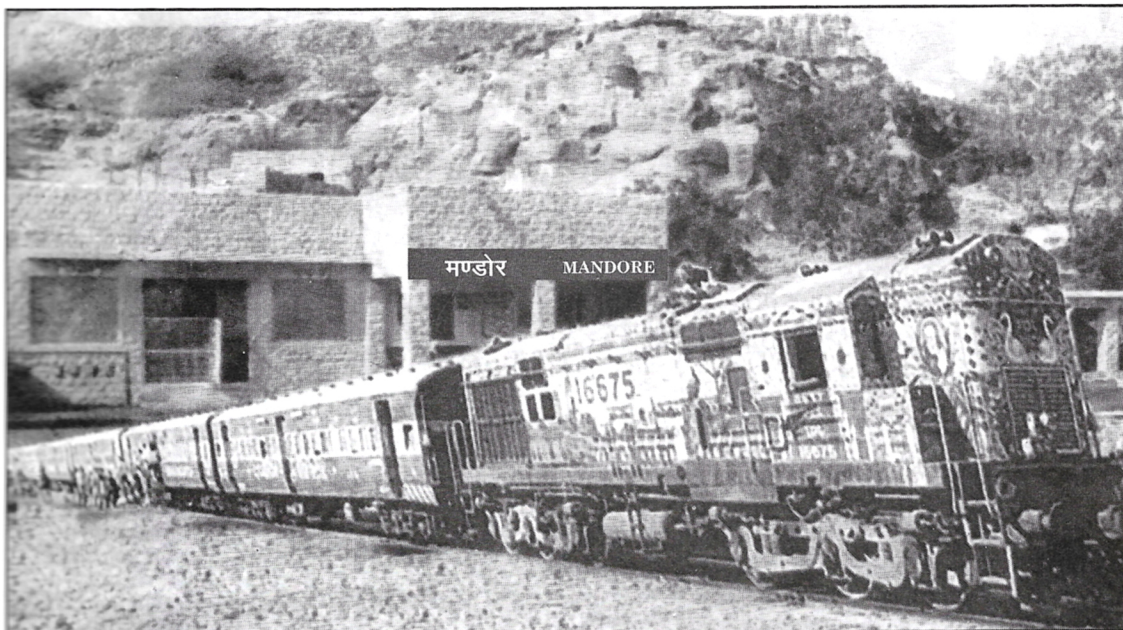


Photo-Plate 2.1. BROAD GAUGE- RAILWAYS



Photo-Plate 2.2. NARROW GAUGE RAILWAYS

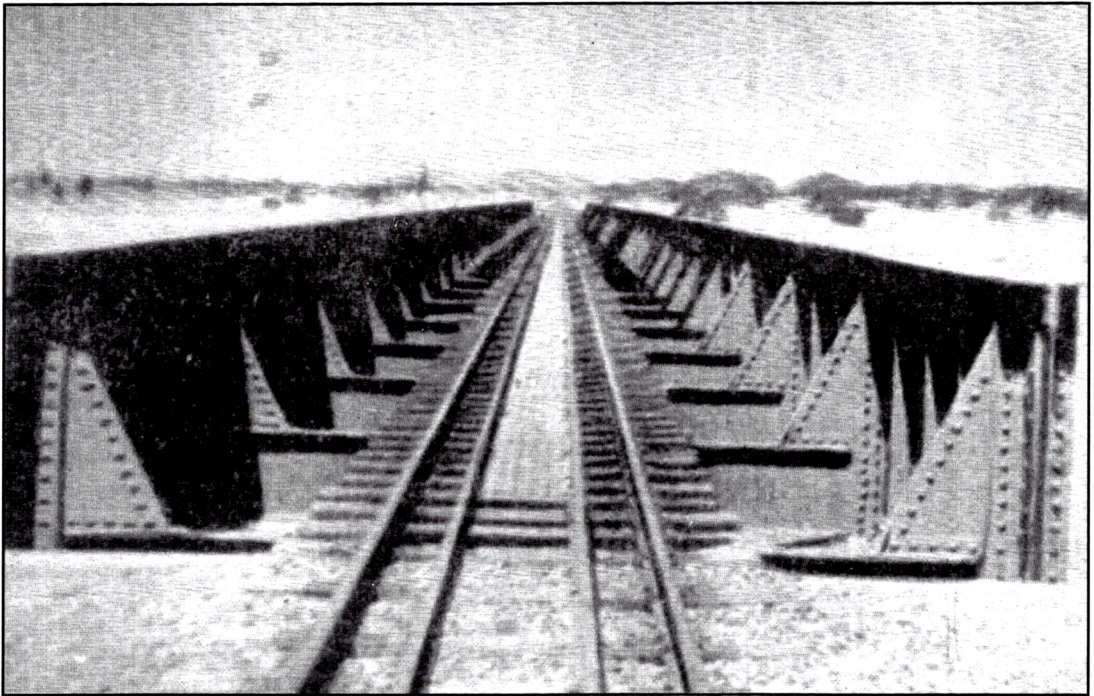
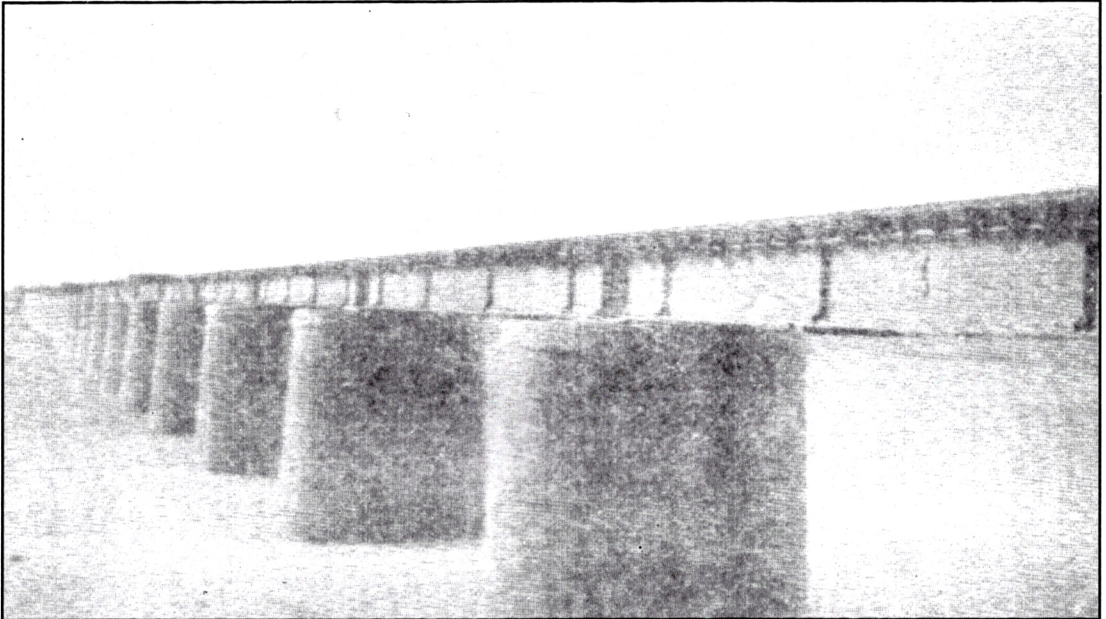


Photo-Plate 3.1.

Above: Deck Type Plate Girder Bridge in front elevation

Bottom: Through Type Plate Girder Bridge in side Elevation

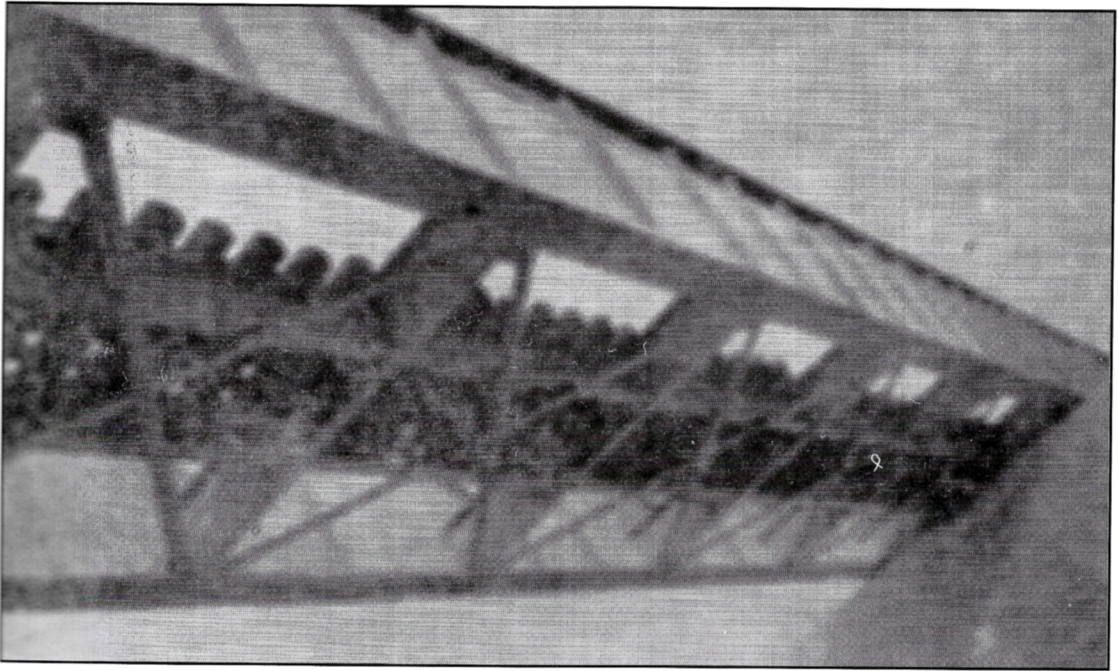


Photo-Plate 3.2. Through Type Plate Girder Bridge Stringers, Cross-girders and Cross-bracings are seen from bottom side

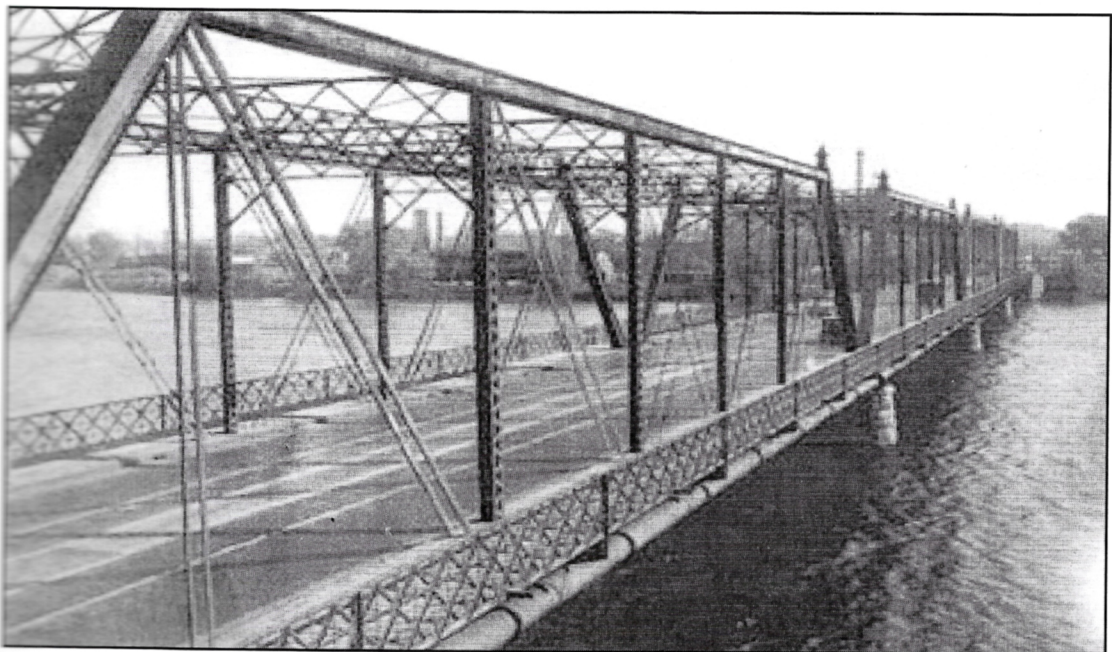


Photo-Plate 4.1.

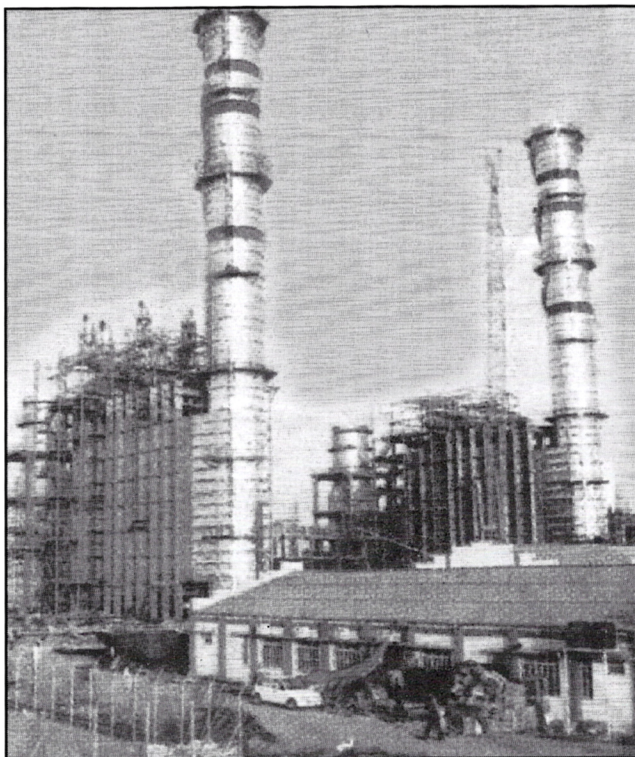


Photo-Plate 11.2. Self-supporting Steel Chimney

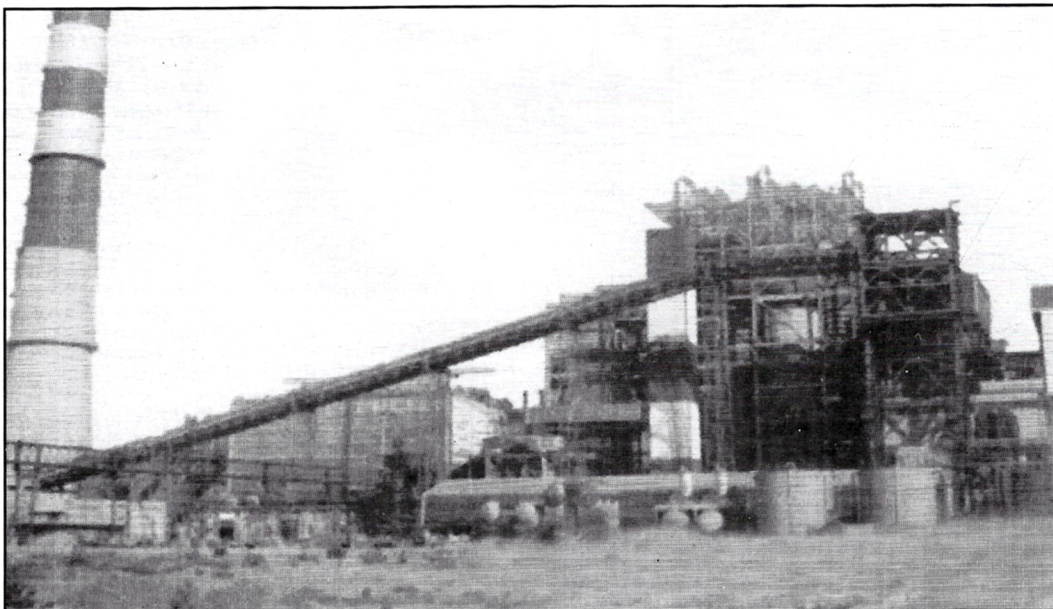


Photo-Plate 11.3. Self-supporting Steel Chimney

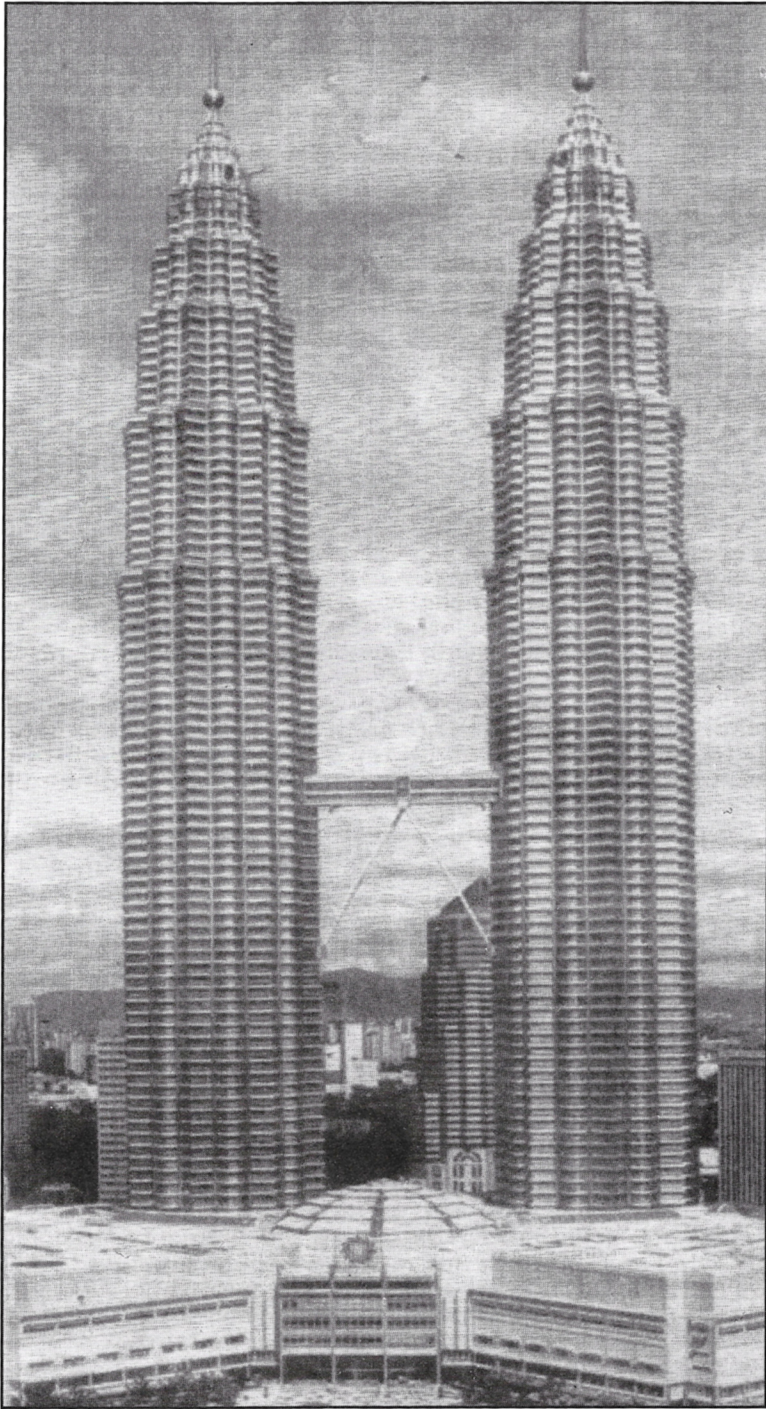


Photo-Plate 18.1. PETRONAS TWIN TOWERS, QUALALAMPUR (MALAISIA)
452 m in Height, 88 Storeys, built in 1997

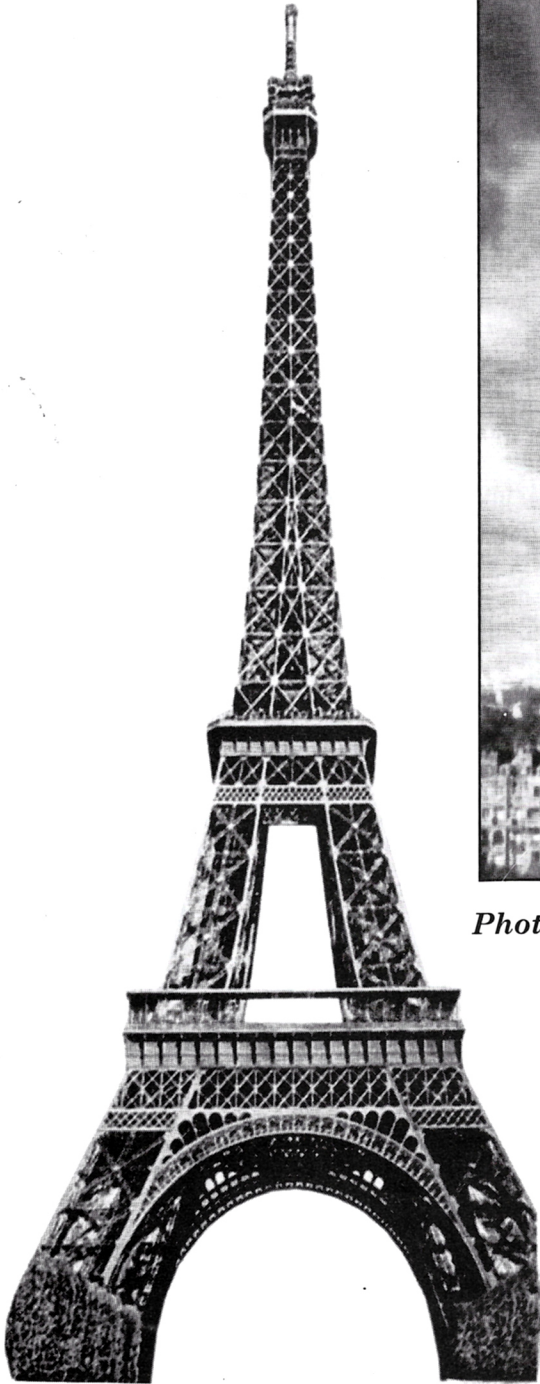


Photo-Plate 26.1. EIFFEL TOWER
(320 m in Height) PARIS, (FRANCE)

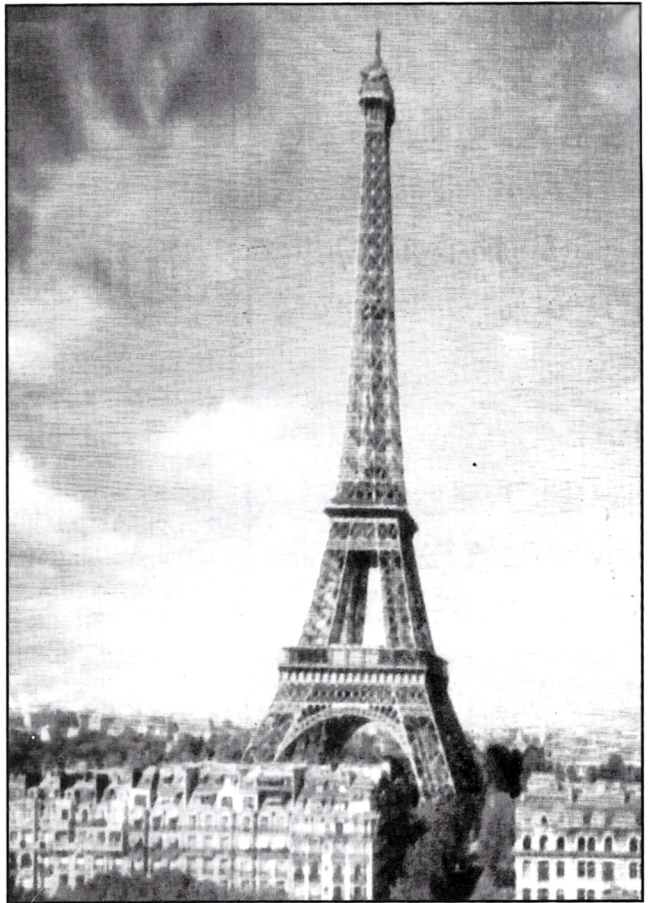


Photo-Plate 26.2. EIFFEL TOWER
(320 m in Height) PARIS, (FRANCE)