

Introduction to Dr. Iwasaki's Paper Entitled "Response Analysis of Civil Engineering Structures Subjected to Earthquake Motions"

Seismic design of Japanese bridges started in 1925, triggered by the extensive damage of the 1923 Kanto earthquake. "Drafted Structural Details of Road Structures," issued by Japan's Ministry of the Interior in 1925, recommended the use of static seismic analysis based on working stress design, which was used for a long time. "Design Specifications of Steel Bridges," issued by the Japan Road Association in 1964, was an important code used for design of a number of bridges during restoration after World War II and the early high economic growth periods that followed. There was no independent seismic design code in those days, so only limited descriptions were provided for seismic design, e.g., pages in the code related to seismic design numbered only 2 or 3, and seismic knowledge was limited. Most bridges damaged in the 1995 Kobe earthquake were designed based on this code.

Extensive damage in the 1964 Niigata earthquake initiated intensified research on the structural response and seismic design of bridges. Accomplishments of research were reflected in the 1971 "Guide Specifications on Seismic Design of Bridges" (Japan Road Association), the first design guidelines focusing on the seismic design of bridges. Pages of the main text and explanations related to seismic design increased to 30, and included the natural period dependent lateral seismic coefficient and preliminary evaluation of soil liquefaction assessment and unseating prevention devices. This was the first time that preliminary liquefaction assessment and unseating prevention devices innovated by Japanese bridge engineers were included in bridge codes.

The 1971 Guide Specification of Seismic Design of Bridges was compiled with other design codes and issued in 1980 as "Part V Seismic Design" of "Design Specifications of Highway Bridges" (Japan Road Association). Assessment of soil liquefaction based on F_L was introduced in Part V, but other parts remained almost unchanged.

Part V was completely revised in 1990 to include (1) new static analysis evaluating lateral force in continuous bridges based on the stiffness of superstructures and substructures, (2) safety evaluation (level 2) ground motion for the design of reinforced concrete columns, and (3) design response spectra and design-spectra-compatible ground acceleration for dynamic response analysis. This was the first in Japan to include safety evaluation ground motion and static design for ductility evaluation of bridge columns. Pages on code related to seismic design increased to 96 greatly enhanced as a modern seismic design code.

Based on the extensive damage sustained in the 1995 Kobe earthquake, Part V on seismic design was further revised in 1996 and 2002 to include lessons learned from this damage. Pages of code related to seismic design

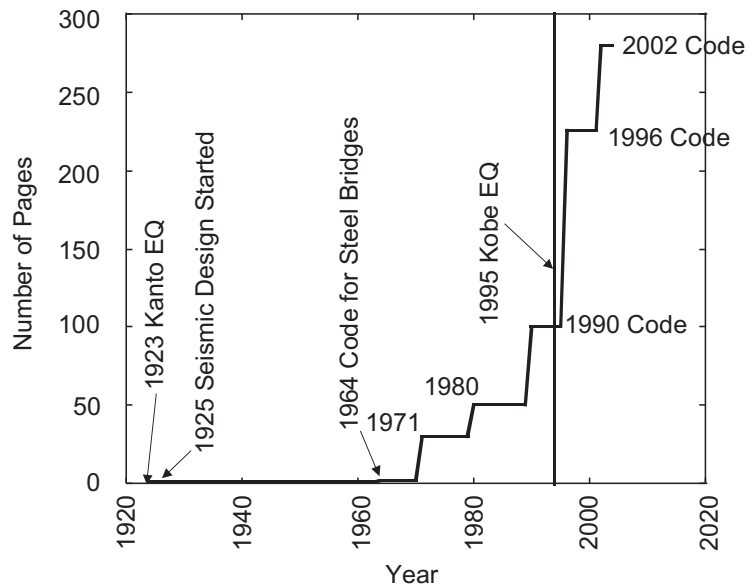


Fig. 1. Progress of Japanese seismic design codes of bridges.

increased to 227 in the 1996 code and 280 in the 2002 code.

Figure 1 shows the increase in the number of pages related to seismic design. Extensive improvement was conducted in 1990 and 1996. Although we have had over 80 years in experience of seismic bridge design, only in the last 15 years has seismic bridge design been enhanced to include modern requirements. Codes before the 1971 Guide Specification and the 1980 Part V on seismic design had insufficient scientific knowledge, although they were used for design in a number of bridges.

The paper by Dr. Iwasaki has contributed much to establishing modern seismic design codes for bridges. His contributions include, but are not limited to, the clarification of dynamic response characteristics of bridges based on extensive field measurements, the deployment of strong motion recording networks, the development of soil liquefaction evaluation based on F_L , and the development of ground motion attenuation equations. All of his activities and research helped enhance seismic design codes for bridges in Japan.

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