PREFACE

This report is a major revision of the Federal Highway Administration publication ‘Seismic Retrofitting Manual for Highway Bridges,’ which was published ten years ago in 1995 as report FHWA/RD-94-052. This edition expands the coverage of the previous publication by including procedures for evaluating and retrofitting retaining structures, slopes, tunnels, culverts, and pavements, in addition to bridges. It is published in two parts as follows:

Part 1: Bridges

Part 2: Retaining Structures, Slopes, Tunnels, Culverts, and Pavements

Whereas Part 1 maintains the basic format of the retrofitting process described in the 1995 report, major changes have been made in this revision to include current advances in earthquake engineering, field experience with retrofitting highway bridges, and the performance of bridges in recent earthquakes in California and elsewhere. It is the result of several years of research with contributions from a multidisciplinary team of researchers and practitioners.

In particular, a performance-based retrofit philosophy is introduced similar to that used for the performance-based design of new buildings and bridges. Performance criteria are given for two earthquake ground motions with different return periods, 100 and 1000 years. A higher level of performance is required for the event with the shorter return period (the lower level earthquake ground motion) than for the longer return period (the upper level earthquake ground motion). Criteria are recommended according to bridge importance and anticipated service life, with more rigorous performance being required for important, relatively new bridges, and a lesser level for standard bridges nearing the end of their useful life.

Minimum recommendations are made for screening, evaluation and retrofitting according to an assigned Seismic Retrofit Category. Bridges in Category A need not be retrofitted whereas those in Category B may be assessed without a detailed evaluation, provided certain requirements are satisfied. Bridges in Categories C and D require more rigorous evaluation and retrofitting, as required. Various retrofit strategies are described and a range of related retrofit measures explained in detail, including restrainers, seat extensions, column jackets, footing overlays, and soil remediation.

This manual comprises 11 chapters and six appendices as follows:

Chapter 1 gives a complete overview of the retrofitting process including the philosophy of performance-based retrofitting, the characterization of the seismic and geotechnical hazards, the assignment of the Seismic Retrofit Category, and summaries of recommended screening methods, evaluation tools, and retrofit strategies. Topics in this chapter are described in greater detail in the following 10 chapters.

Chapters 2 and 3 describe the characterization of the seismic and geotechnical hazards.
Chapter 4 presents two screening and prioritization methods, with examples of each method.

Chapters 5, 6 and 7 describe six evaluation methods, of increasing rigor, for the detailed assessment of demand and capacity, using either a component-by-component approach, or a system approach for a complete bridge.

Chapters 8, 9, 10 and 11 describe retrofitting measures for bearings, seats, columns, piers, cap beams, column-to-cap joints, abutments, and foundations. Remedial techniques for hazardous sites are also addressed.

Appendices A through D provide supplementary material on conducting site-specific geotechnical investigations, the evaluation of geotechnical hazards, fragility curve theory, and the calculation of capacity/demand ratios for bridge components.

Appendices E and F present two examples illustrating the application of the component capacity/demand method (Method C) to multi-span concrete and steel highway bridges, respectively.

A glossary and lists of abbreviations, symbols, and references are also included.

It is noted that this manual was developed while the U.S. Department of Transportation was transitioning to metric units. As a consequence, example problems are presented in SI units. Future editions may however use Customary U.S. Units to reflect the current movement in many State DOTs back to customary units.