SEISMIC DESIGN, RESPONSE MODIFICATION, AND RETROFIT OF BRIDGES

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PREFACE

This is a lecture note for "Seismic Design, Response Modification and Retrofit of Bridges" at the Graduate Course of the Department of Civil Engineering, Tokyo Institute of Technology, Japan. The scientific and engineering knowledge on the earthquake engineering is described in this note with an emphasis on the application to bridges. Since the contents includes a broad senses on the structural engineering, the structural dynamics, the concrete engineering, the soil mechanics, foundation engineering, the engineering seismology, and the construction engineering, students are required to take those courses before studying this class.

Bridges are unique structures in their structural responses compared to other structures. They are longitudinally lengthy. There are various types of superstructures, substructures, and foundations as shown in Figs. P-1, P-2, P-3, and P-4 (Road Maintenance Technology Center 1996), with complex geometries and dynamic response characteristics. However, bridges have a lower degree of static indeterminacy than buildings. Hence failure of a part of structural element such as columns or foundations likely results in a collapse of the entire bridge system. Effect of the soil-structure interaction and the spatial variation of ground motions are significant in bridges than buildings. Since bridges are a vital component of transportation system, bridges should have sufficient seismic safety in an earthquake.

The 1989 Loma Prieta, the 1994 Northridge, the 1995 Kobe, the 1999 Taiwan and the Turkey earthquakes caused significant damage to bridges and these events together with the research triggered as a consequence of past earthquakes has led to significant advances in seismic engineering of bridges.

This lecture note shows the recent technologies for seismic design, seismic response modification, and seismic retrofit of bridges. Past seismic damage of bridges, characterizations of ground motion, dynamic response analysis methods, seismic response characteristics of bridges, and strength and ductility of reinforced concrete columns are also described.

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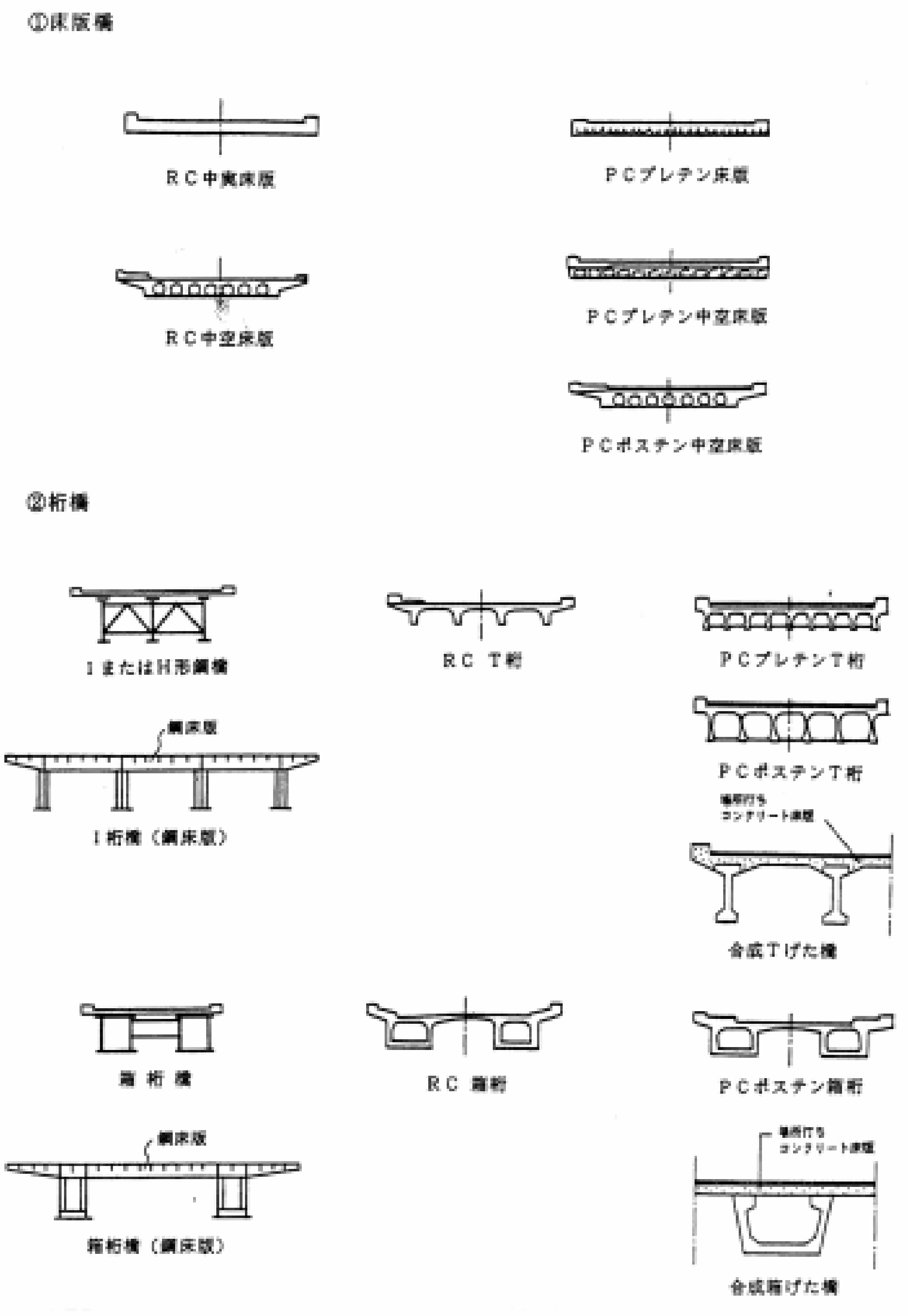


Fig. P-1　Types of Superstructure (1/2)

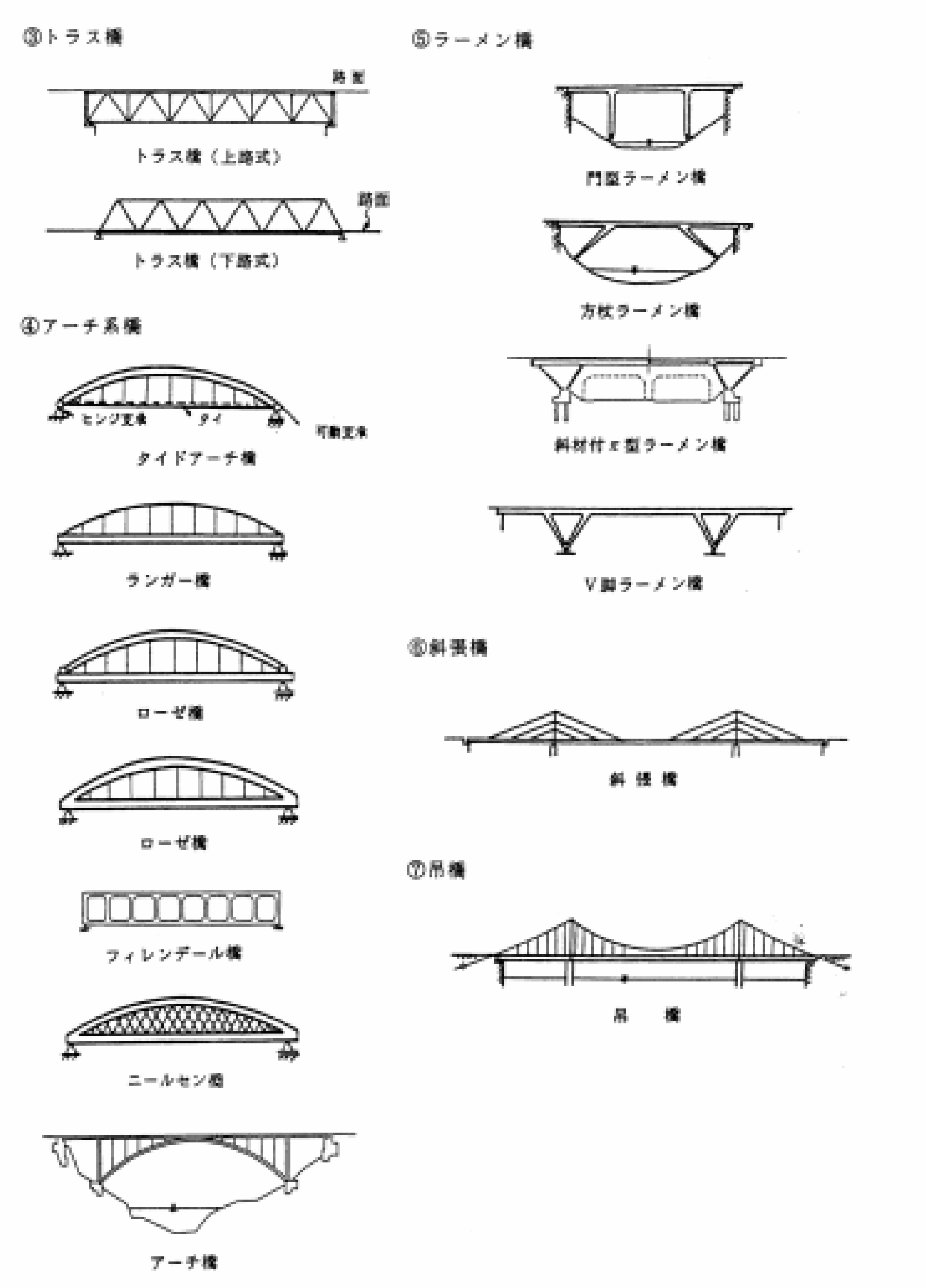


Fig. P-1 Types of Superstructure (2/2)

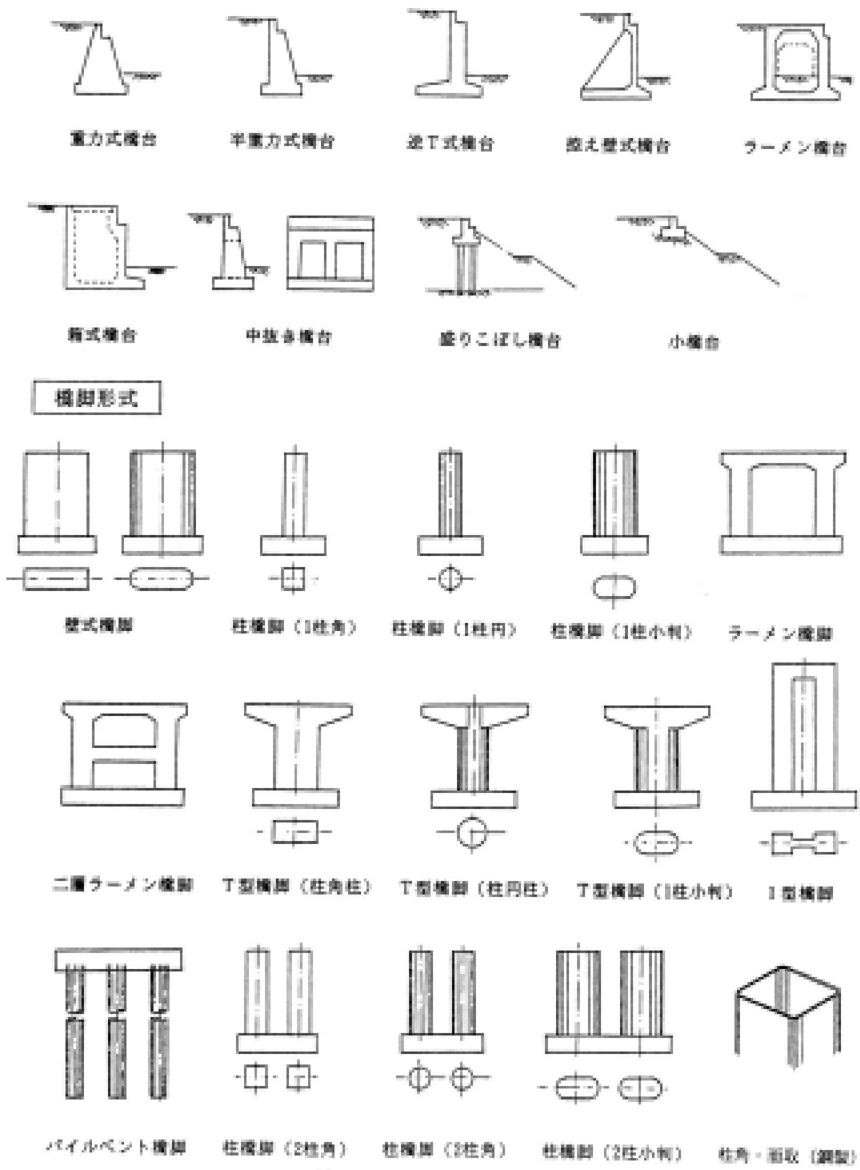
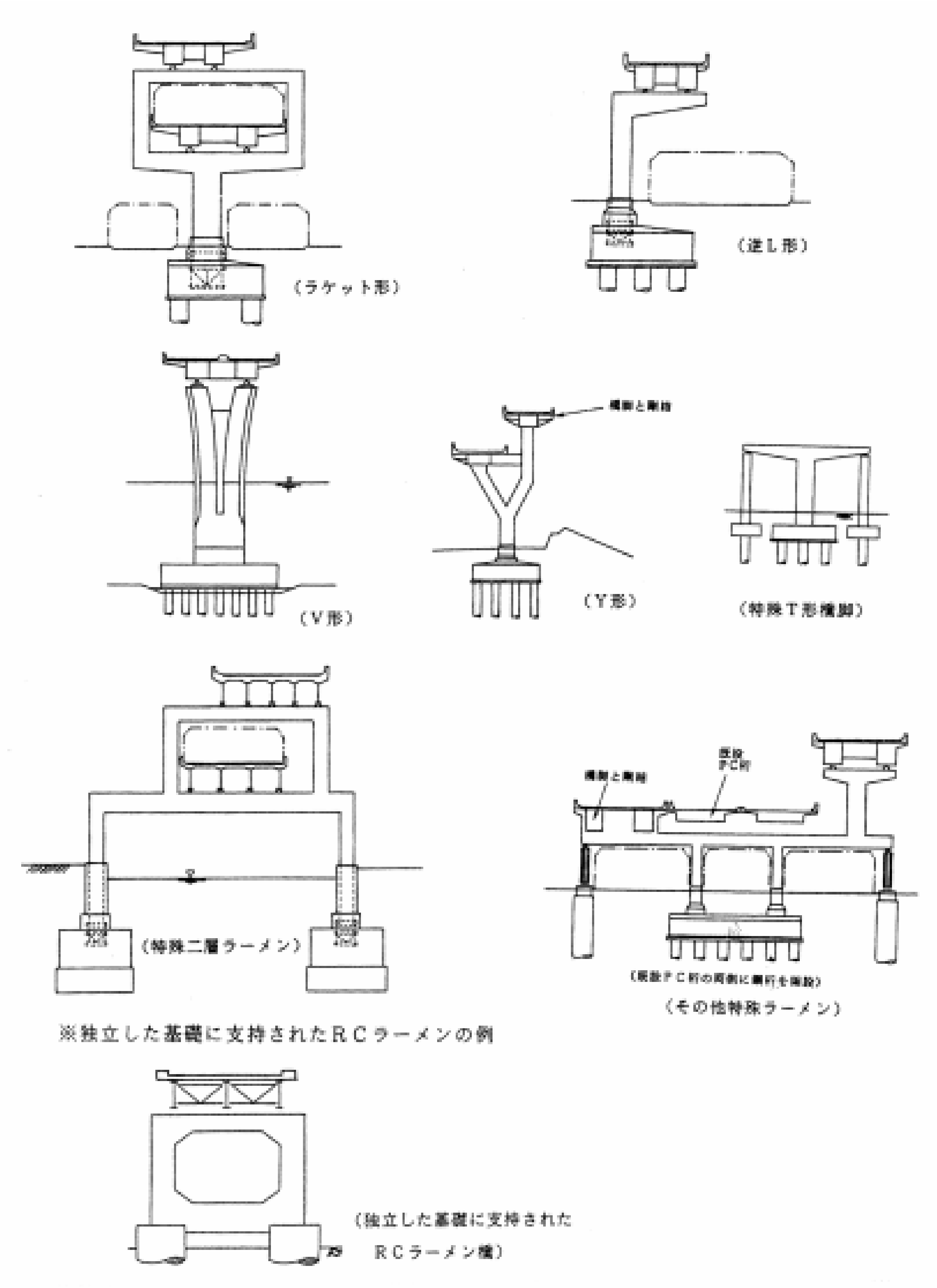


Fig. P-3 Types of Substructure (1/2)



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