

SEISMIC DESIGN OF BRIDGES

J.B.S. Huizing*

ABSTRACT:

Seismic Design of Bridges is a comprehensive set of 12 papers presented in Code and Commentary form. It sets out the recommendations of the Bridge Committee of the New Zealand National Society for Earthquake Engineering. The papers are aimed at experienced designers and authorities setting design standards. The procedures recommended are based on the present state of the art and represent good design practice in accordance with the latest developments in earthquake engineering as applied to bridges.

Subjects discussed include: design philosophy, seismic loading and ductility demand, capacity design principles and practice for ductile structures, a semi-empirical approach for structures of limited ductility, ductility capability and detailing for ductility, structural and non-structural details, bridge foundations, earth retaining structures, mechanical energy dissipating devices, dynamic analysis, structures requiring special studies and strengthening for seismic loads.

INTRODUCTION:1.0 Background -

Early in 1978 a working group concerned with the seismic design of bridges was formed on the initiative of and under the auspices of the New Zealand National Society for Earthquake Engineering. The first meeting of the working group was held on 13 April 1978.

The idea behind the formation of the group was to bring together a number of leading researchers and bridge designers and to provide them with the opportunity of discussing and appraising the rapid development during the seventies in bridge research and design. The new draft concrete design code, DZ 3101, and the experience gained in the use of the Highway Bridge Design Brief and its associated documents were of course highly relevant parts of these developments.

At the first meeting it was agreed that the objectives were to make recommendations concerning:

- Procedures for the seismic design of bridges and associated structures based on the present state of the art and aimed at practising engineers.
- Further research work required for resolving remaining uncertainties.
- Dissemination of the recommendations with explanations to practising bridge engineers.

In addition it was agreed that:

- Existing documents such as the Highway Bridge Design Brief and NZS 3101 P be used as a basis for the group's deliberations, but a completely fresh look should be taken at the content of these documents.
- The group's findings be presented as recommendations plus commentary aimed at expert bridge designers and authorities setting design standards and not as a "cook book" or code of practice for designers inexperienced in bridge design.
- The group's findings be published in the bulletin and presented at workshops.
- A wide range of bridge types and spans be examined.
- Consideration be given to the importance of the highway in an earthquake and to the economics of achieving seismic protection.

2.0 GROUP MEMBERSHIP:

The Management Committee in selecting the group members sought to cover the various parties most involved in the bridge design and research. The membership of the group was as follows:

Mr J.B.S. Huizing (Chairman)	Ministry of Works and Development
Mr J.F. McGuire (Secretary)	Ministry of Works and Development
Dr J.B. Berrill	University of Canterbury
Dr R.W.G. Blakeley	Ministry of Works and Development
Dr A.J. Carr	University of Canterbury

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		<u>Section</u>	<u>Title</u>	<u>Sub-Committee</u>
Mr H.E. Chapman	Ministry of Works and Development			
Mr L.G. Cormack	Consulting Engineer	7	Small Bridges	Fisher, Lanigan, Stockwell
Dr F.D. Edmonds	Ministry of Works and Development	8	Structural and Non-Structural Details	Lanigan, Preston, Fisher, Stockwell
Mr R.W. Fisher	New Zealand Railways			
Mr P.R. Goldsmith	University of Auckland	9	Earth Retaining Structures	Matthewson, Berrill, Wood
Dr J.M.O. Hughes	University of Auckland	10	Dynamic Analysis	Wood, Blakeley, Priestley
Dr A.G. Lanigan	Consulting Engineer	11	Bridges Requiring Special Studies	Priestley, Stanford, Carr
Mr M.B. Matthewson	Ministry of Works and Development	12	Strengthening of Bridges for Seismic Loads	McGuire, Fisher, Stanford, North
Mr P.J. North	Consulting Engineer			
Professor R. Park	University of Canterbury			
Mr R.L. Preston	Ministry of Works and Development			
Dr M.J.N. Priestley	University of Canterbury			
Mr P.R. Stanford	Ministry of Works and Development			
Mr M.J. Stockwell	Christchurch City Council			
Dr J.H. Wood	Ministry of Works and Development			

3.0 MODE OF OPERATION:

The group divided the topic into 12 sections and allocated responsibility for each section to a small sub-committee. The allocation was as follows, within each case the first named acting as initiator and editor:

<u>Section</u>	<u>Title</u>	<u>Sub-Committee</u>
1	Design Philosophy	Stanford, Cormack, Park
2	Design Loading and Ductility Demand	Berrill, Chapman, Priestley
3	Capacity Design Principles and Practice	Chapman, North, Park
4	Bridge Foundations	Edmonds, Carr, Goldsmith, North, Wood, Preston, Hughes
5	Detailing for Ductility and Ductility Capability	Cormack, Chapman, Park
6	Mechanical Energy Dissipating Devices	Blakeley, Cormack, Stockwell

The procedure followed was for sub-committees to prepare sections and submit them for scrutiny by the whole group. Thus although the proposals have been largely prepared by individuals in the sub-committees, they in general represent the consensus opinion of the wider group. In the case of Section 9 "Earth Retaining Structures", the group did not have the opportunity to scrutinize the proposals in detail although the approach was approved in principle.

The group met eight times between April 1978 and April 1980.

4.0 STATUS:

The recommendations made in the various reports following this introduction represent the considered opinion of the group as to good design practice is accordance with the latest developments in earthquake engineering as applied to bridges. In several areas they represent significant developments in the state of the art. The reports have no authority as a standard, but they may be used as a guide by designers. The reports have been written in a form suitable for adoption by authorities with responsibilities for preparing codes and design specifications.

In accordance with the Society's objectives it is proposed to organise workshops for practising designers on the application of these recommendations to specific examples.

The Structures Committee of the Road Research Unit had a direct interest in the research work which led to the formation of the working group. The Structures Committee is vitally concerned with the dissemination of the research findings and accordingly arranged financial support to the Society to aid publication of the reports and the running of the workshops.

5.0 CLOSURE:

It was a privilege to chair such a group of gifted and intelligent engineers.

I must admit that at regular intervals I was somewhat bemused by the learned discussion. However, most engineers love to explain their expertise to the less informed. In the process of these explanations it proved to be easy for the group to reach common ground.

The reports speak for themselves and it only remains for me to thank all the members of the working group for their time and effort.