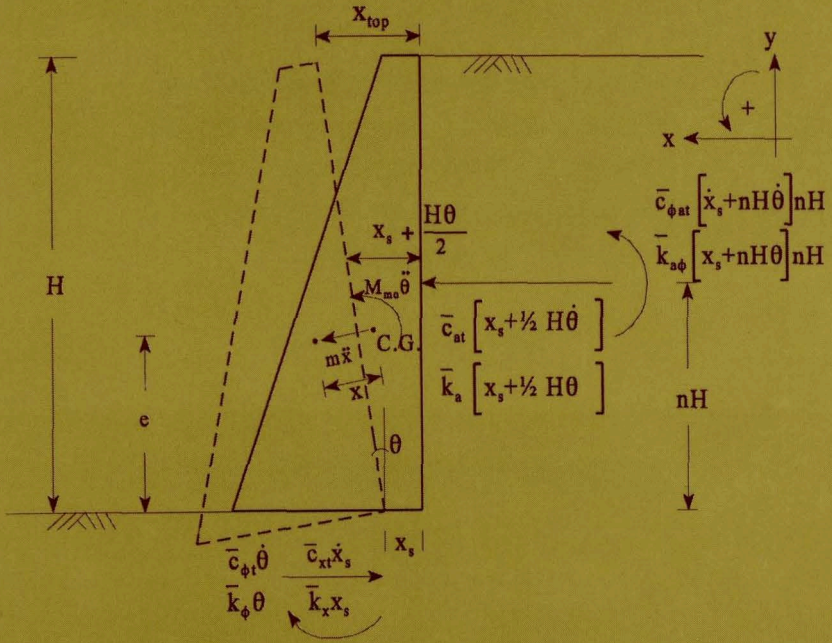
GEOTECHNICAL SPECIAL PUBLICATION NO. 60

ANALYSIS AND DESIGN OF RETAINING STRUCTURES AGAINST EARTHQUAKES



EDITED BY SHAMSHER PRAKASH

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ANALYSIS AND DESIGN OF RETAINING STRUCTURES AGAINST EARTHQUAKES

Proceedings of sessions sponsored by the
Soil Dynamics Committee of The Geo-Institute
of the American Society of Civil Engineers
in conjunction with the ASCE National Convention
in Washington, DC

November 10-14, 1996

EDITED BY SHAMSHER PRAKASH

Published by

ASCE American Society of Civil Engineers

345 East 47th Street
New York, New York 10017-2398

Abstract:
This proceedings, *Analysis and Design of Retaining Structures against Earthquakes*, contains both invited and contributed papers, which focus on the questions of 1) dynamic earth pressures on fixed and movable rigid and flexible walls; 2) displacements in translation and rotation of walls under earthquakes; 3) behavior of fills and abutments during earthquake; and 4) centrifuge tests on walls. Both analytical and experimental data have been presented on possible behavior of retaining structures under seismic loading. A study of this volume and other published literature shows considerable effort is being devoted to determination of realistic dynamic pressures, displacement in translation and rotation of retaining structures and behavior of fills for abutments. Since a synthesis of these studies is not currently available, there are no unified and generally acceptable solutions to the above questions. However, the discussions and presentations of the papers during the session does highlight the need for such solutions and more definite descriptions of unsolved problems.

Library of Congress Cataloging-in-Publication Data

Analysis and design of retaining structures against earthquakes : proceedings of sessions sponsored by the Soil Dynamics Committee of the ASCE Geotechnical Engineering Division in conjunction with the ASCE Convention in Washington, D.C., November 10-14, 1996 / edited by Shamsher Prakash.
p. cm. -- (Geotechnical special publication ; no. 60)
Includes bibliographical references and indexes.
ISBN 0-7844-0206-X
1. Retaining walls--Design and construction--Congresses. 2. Earthquake resistant design--Congresses. 3. Structural analysis (Engineering)--Congresses. I. Prakash, Shamsher. II. American Society of Civil Engineers. Geotechnical Engineering Division. Soil Dynamics Committee. III. ASCE National Convention (1996 : Washington, D.C.) IV. Series.
TA77.A53 1996 96-44715
624.1'64--dc20 CIP

Library of Congress Catalog Card No: 96-44715
ISBN 0-7844-0206-X
Manufactured in the United States of America.

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PREFACE

Retaining structure may be subjected to seismic loads and experience either deformations and/or increased earth pressures. These structures may be either rigid-masonry free-standing retaining walls for highways, sections of wing walls for hydraulic structures, and abutments of bridges. Flexible retaining structures are most often reinforced earth sections.

Rigid structures have been designed for dynamic earth pressures most of the time. A solution for displacements of rigid retaining walls was obtained by our Research Group at the University of Roorkee (India) in 1974 for the first time. Subsequently for the last two decades, their displacements were analyzed and designs based on permissible displacements were attempted. We have not reached a stage where acceptable analytical tools and design procedures for such structures are available. Studies on such structures during earthquakes is difficult because earthquakes cannot be made to order! Therefore, recourse is made to alternate studies, e.g. on centrifuge and, shake table models, and analytical studies and their comparison with performance records.

Thus this session is organized with the objective to identify the state of practice in analysis and design of retaining structures under dynamic loads and address the unsolved issues. The papers were, therefore, invited from authors both within and outside the USA. There are 5 contributions from the US and 3 from overseas. This session was held at the ASCE Fall Convention in Washington DC on November 12, 1996 and was sponsored by the Soil Dynamics Committee of the Geotechnical Engineering Division of ASCE.

It is the current practice of the Geotechnical Engineering Division that each paper published in a Geotechnical Special Publication (GSP) be reviewed for its content and quality. These special technical publications are intended to reinforce the programs presented at convention sessions or specialty conferences and to contain papers that are timely and may be controversial to some extent. Because of the need to have the GSP available at the convention, time available for reviews is generally not as long and reviews may not be as comprehensive as those given to papers submitted to the Journal of the Division. Still we had organized our review process in a timely manner. At least 2-positive reviews were obtained for each paper accepted for publication and discussion. In fact one paper will be published in the Journal based on our review process but was presented at this session. Thus there is hardly any difference in the purpose and technical status of contributions to this geotechnical special publication as compared to those in the Journal.

In accordance with ASCE policy, all papers published in this volume are eligible for discussion in the Journal of the Geotechnical Engineering Division and are eligible for ASCE awards. Reviews of papers published in this volume were conducted by the Soil Dynamics Committee of the Geotechnical Engineering Division. The following committee members or cooperating persons from the general membership reviewed these papers:

T. Crespellani	Panos Dakoulas
Ahmed W.M. Elgamal	W.D. Liam Finn
Steve Kramer	Sanjeev Kumar
Jeen-Shang Lin	Farrokh Nadim
Rowland Richards, Jr.	Glenn J. Rix
Raj Siddharthan	Cetin Soydemir
A.S. Veletsos	Mishac Yegian

Personal thanks go to Panos Dakoulas, Chairman of the Soil Dynamics Committee, for his help and support in organizing this session. I also want to thank all the experts who gave both the time and effort in reviewing the papers. Last but not least, thanks are due to all the authors who kindly accepted the invitation to contribute to this volume and to the session in Washington D.C.

Shamsher Prakash, F. ASCE
Professor of Civil Engineering
University of Missouri-Rolla
Rolla, Missouri

August 28, 1996

Session Organizer and Editor

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SEISMIC PRESSURES AGAINST RIGID WALLS

Guoxi Wu[1] and W.D. Liam Finn[2]

ABSTRACT

Simplified linear elastic analytical solutions are presented for the seismic pressures against rigid walls which agree closely with the exact solutions presented by Wood (1973). The finite element method is used to extend the analyses to nonhomogeneous elastic materials and to nonlinear soils. The finite element analyses give almost exact solutions for the elastic cases. Some practical guidelines are given for estimating the dynamic pressures for use in practice.

INTRODUCTION

Seismic pressures against retaining walls are usually determined using the Mononobe-Okabe method (Mononobe and Matsuo, 1929; Okabe, 1924). This method is based on the assumption that a wedge of soil bounded by the wall and the shear failure plane in the backfill moves as a rigid body under the peak vertical and horizontal ground accelerations or designated fractions thereof. Most commonly only horizontal inertia forces are included.

The Mononobe-Okabe method is based on the assumption that the wall can displace enough to permit a failure plane. Rigid walls, such as deep basement walls, do not satisfy the displacement criteria for shear plane development, and therefore the Mononobe-Okabe approach cannot be used. Matsuo and Ohara (1960) formulated an elastic solution to the seismic pressures against a rigid wall, but did not present any numerical values. Wood (1973) developed an exact analytical plane strain solution assuming elastic response of a uniform backfill. The solution is quite complicated and is usually applied approximately. Significant errors in estimating

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