

PIERO GEMDENELLI  
MILANO

VOL.100 NO.GT8. AUG. 1974

# JOURNAL OF THE GEOTECHNICAL ENGINEERING DIVISION

PROCEEDINGS OF  
THE AMERICAN SOCIETY  
OF CIVIL ENGINEERS



BITCOLD

R

ASCE

1974

6

2-R-56

# AMERICAN SOCIETY OF CIVIL ENGINEERS

## BOARD OF DIRECTION

### President

Charles W. Yoder

### President-elect

William M. Sangster

### Past President

John E. Rinne

### Vice Presidents

William R. Gibbs

Dean F. Peterson

Ivan M. Viest

L. A. Woodman

### Directors

William C. Ackerman

Amos J. Alter

B. Austin Barry

Robert D. Bay

Walter E. Blessey

Bevan W. Brown, Jr.

Archie N. Carter

Clarence W. E. Davies

Lyman R. Gillis

Albert A. Grant

Paul C. Hassler, Jr.

Hugh W. Hempel

Elmer B. Isaak

Russel C. Jones

Thomas C. Kavanagh

Oscar T. Lyon, Jr.

John E. McCall

Jack McMinn

Irvan F. Mendenhall

Cranston R. Rogers

Christopher G. Tyson

## EXECUTIVE OFFICERS

Eugene Zwoyer, *Executive Director*

Don P. Reynolds, *Assistant Executive Director*

Joseph McCabe, *Director—Education Services*

Edmund H. Lang, *Director—Professional Services*

Paul A. Parisi, *Director—Publication Services*

Albert W. Turchick, *Director—Technical Services*

William D. French, *Director—Support and Administrative Services*

William N. Carey, *Secretary Emeritus*

William H. Wisely, *Executive Director Emeritus*

William S. LaLonde, Jr., *Treasurer*

Robert H. Dodds, *Assistant Treasurer*

## COMMITTEE ON PUBLICATIONS

Walter E. Blessey, *Chairman*

Jack H. McMinn, *Vice Chairman*

Bevan W. Brown, Jr.

Archie N. Carter

Clarence W. E. Davies

John E. McCall

## GEOTECHNICAL ENGINEERING DIVISION

### Executive Committee

Roy E. Olson, *Chairman*

George F. Sowers, *Vice Chairman*

Joseph M. DeSalvo

Kenneth L. Lee, *Secretary*

Jack W. Hill, *Management Group E Contact Member*

John Lysmer

### Publications Committee

E. T. Selig, *Chairman*

G. B. Clark

David J. D'Appolonia

C. M. Duke

James M. Duncan

R. D. Ellison

H. L. Gill

D. H. Gray

D. J. Hagerty

Kaare Hoeg

H. M. Horn

J. R. Hall, Jr.

Izzat M. Idriss

H. Y. Ko

R. J. Krizek

C. C. Ladd

L. J. Langfelder

T. K. Liu

Ulrich Luscher

Gholamreza Mesri

Victor Milligan

N. Morgenstern

Donald J. Murphy

Iraj Noorany

P. C. Rizzo

W. G. Shockley

D. H. Shields

C. V. Giriya Vallabhan

A. S. Vesic

R. J. Woodward, Jr.

S. G. Wright

T. H. Wu

R. N. Yong

Kenneth L. Lee, *Exec. Comm. Contact Member*

## PUBLICATION SERVICES DEPARTMENT

Paul A. Parisi, *Director*

### Technical Publications

Richard R. Torrens, *Editor*

Robert D. Walker, *Associate Editor*

Geraldine Cioffi, *Assistant Editor*

Katherine Holzapfel, *Editorial Assistant*

Patricia A. Goldenberg, *Editorial Assistant*

Evelyn Greenspan, *Editorial Assistant*

Nadja Landau, *Editorial Assistant*

Frank J. Loeffler, *Draftsman*

### Information Services

Irving Amron, *Editor*

## CONTENTS

<b>Soil Liquefaction by Torsional Simple Shear Device</b> <i>by Isao Ishibashi and Mehmet A. Sherif</i> . . . . .	871
<b>Theory of Consolidation for Clays</b> <i>by Gholamreza Mesri and Anoushiravan Rokhsar</i> . . . . .	889
<b>Seismic Shear Waves in Engineering</b> <i>by Harold M. Mooney</i> . . . . .	905
<b>Reducing Negative Friction with Bitumen Slip Layers</b> <i>by Alphonsus I. M. Claessen and Endre Horvat</i> . . . . .	925

---

### DISCUSSION

Proc. Paper 10695

---

<b>Lateritic Gravel Evaluation for Road Construction</b> , by J. W. S. de Graft-Johnson, Harbhajan S. Bhatia, and A. A. Hammond (Nov., 1972. Prior Discussion: Sept., 1973). <i>closure</i> . . . . .	947
<b>Analysis of Ultimate Loads of Shallow Foundations</b> , by Aleksandar S. Vesić (Jan., 1973. Prior Discussions: Oct., Nov., 1973). <i>closure</i> . . . . .	949

→

---

This Journal is published monthly by the American Society of Civil Engineers. Publications office is at 345 East 47th Street, New York, N.Y. 10017. Address all ASCE correspondence to the Editorial and General Offices at 345 East 47th Street, New York, N.Y. 10017. Allow six weeks for change of address to become effective. Subscription price to members is \$8.00. Nonmember subscriptions available; prices obtainable on request. Second-class postage paid at New York, N.Y. and at additional mailing offices. HY, GT.

The Society is not responsible for any statement made or opinion expressed in its publications.

<b>Constructional Deformations in Rockfill Dam</b> , by Arthur Penman and Andrew Charles (Feb., 1973. Prior Discussions: Aug., Dec., 1973, Mar., 1974).	
<i>errata</i> . . . . .	952
<b>Model Studies on Mechanics of Jointed Rock</b> , by Herbert H. Einstein and Ronald C. Hirschfeld (Mar., 1973. Prior Discussion: Jan., 1974).	
<i>closure</i> . . . . .	952
<b>Low Velocity Penetration of Kaolin Clay</b> , by James D. Murff and Harry M. Coyle (May, 1973. Prior Discussion: Jan., 1974).	
<i>closure</i> . . . . .	953
<b>Numerical Analysis of Electro-Osmotic Flow in Soils,</b> <sup>a</sup> by Roland W. Lewis and C. Humpheson (Aug., 1973).	
by Ramanath K. Katti and Trimbak V. Pavate . . . . .	953
<b>Failure Loads of Vertical Anchor Plates in Sand,</b> <sup>a</sup> by William James Neely, John Gordon Stuart, and James Graham (Sept., 1973).	
by Gopal Ranjan . . . . .	954
<b>Residual Strength and Landslides in Clay and Shale,</b> <sup>a</sup> by Herbert L. Noble (Sept., 1973. Prior Discussion: May, 1974).	
by Yudhbir . . . . .	956
<b>Reinforced Earth Retaining Walls,</b> <sup>a</sup> by Kenneth L. Lee, Bobby Dean Adams, and Jean-Marie J. Vagneron (Oct., 1973).	
by L. R. Hermann, Karl M. Romstad, Chih-Kang P. Shen, and Jerry C-Y Chang . . . . .	958
by Robert P. Chapuis . . . . .	962
by David J. Naylor . . . . .	964
<b>Finite Element for Rock Joints and Interfaces,</b> <sup>a</sup> by Jamshid Ghaboussi, Edward L. Wilson, and Jeremy Isenberg (Oct., 1973).	
by Mysore Nataraja . . . . .	966
<b>Accuracy of Equilibrium Slope Stability Analysis,</b> <sup>a</sup> by Stephen G. Wright, Fred H. Kulhawy, and James M. Duncan (Oct., 1973).	
by Daniel Reséndiz . . . . .	967
<b>Experiments in Expandable Tip Piling,</b> <sup>a</sup> by Thomas L. Adams and Fred C. Stepanich (Nov., 1973).	
by Biskur K. Ramiah and S. P. Raghunath . . . . .	970

---

<sup>a</sup>Discussion period closed for this paper. Any other discussion received during this discussion period will be published in subsequent Journals.