

GEOTECHNICAL SPECIAL PUBLICATION NO. 105

ENVIRONMENTAL GEOTECHNICS

PROCEEDINGS OF SESSIONS OF GEO-DENVER 2000

SPONSORED BY
The Geo-Institute of the American Society of Civil Engineers

August 5-8, 2000
Denver, Colorado

EDITED BY
T.F. Zimmie



ASCE *American Society
of Civil Engineers*
1801 ALEXANDER BELL DRIVE
RESTON, VIRGINIA 20191-4400

Abstract: The 12 papers included in this proceedings are quite diverse, and attest to the multidisciplinary nature of geoenvironmental engineering. The first section deals with landfill settlements, including municipal landfills as well as landfills utilizing recycled waste paper sludge, and the use of recycled materials in road construction and as a concrete aggregate. The second section deals with contaminant transport through waste contaminant barriers, the use of various materials for barrier systems, including slurry trench cutoff barriers. The third section deals with processes used in waste remediation projects, properties of a modified bentonite, and biological clogging.

Library of Congress Cataloging-in-Publication Data

Geo-Denver 2000 (2000 : Denver, Colo.)

Environmental geotechnics : proceedings of sessions of Geo-Denver 2000 : August 5-8, 2000, Denver, Colorado / sponsored by the Geo-Institute of the American Society of Civil Engineers ; edited by T.F. Zimmie.

p. cm. — (Geotechnical special publication ; no. 105)

Includes bibliographical references and index.

ISBN 0-7844-0519-0

1. Sanitary landfills—Congresses. 2. Sanitary landfills—Liners—Congresses.
3. Environmental geotechnology—Congresses. I. Zimmie, T.F. II. American Society of Civil Engineers. Geo-Institute. III. Title. IV. Series.

TD795.7 .G44 2000

628.4'4564--dc21

00-044143

Any statements expressed in these materials are those of the individual authors and do not necessarily represent the views of ASCE, which takes no responsibility for any statement made herein. No reference made in this publication to any specific method, product, process or service constitutes or implies an endorsement, recommendation, or warranty thereof by ASCE. The materials are for general information only and do not represent a standard of ASCE, nor are they intended as a reference in purchase specifications, contracts, regulations, statutes, or any other legal document. ASCE makes no representation or warranty of any kind, whether express or implied, concerning the accuracy, completeness, suitability, or utility of any information, apparatus, product, or process discussed in this publication, and assumes no liability therefore. This information should not be used without first securing competent advice with respect to its suitability for any general or specific application. Anyone utilizing this information assumes all liability arising from such use, including but not limited to infringement of any patent or patents.

Photocopies: Authorization to photocopy material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act is granted by ASCE to libraries and other users registered with the Copyright Clearance Center (CCC) Transactional Reporting Service, provided that the base fee of \$8.00 per article plus \$.50 per page is paid directly to CCC, 222 Rosewood Drive, Danvers, MA 01923. The identification for ASCE Books is 0-7844-0519-0/00/ \$8.00 + \$.50 per page. Requests for special permission or bulk copying should be addressed to Permissions & Copyright Dept., ASCE.

Copyright © 2000 by the American Society of Civil Engineers

All Rights Reserved.

Library of Congress Catalog Card No: 00-044143

ISBN 0-7844-0519-0

Manufactured in the United States of America.

Geotechnical Special Publications

- 1 *Terzaghi Lectures*
- 2 *Geotechnical Aspects of Stiff and Hard Clays*
- 3 *Landslide Dams: Processes, Risk, and Mitigation*
- 4 *Tiebacks for Bulkheads*
- 5 *Settlement of Shallow Foundation on Cohesionless Soils: Design and Performance*
- 6 *Use of In Situ Tests in Geotechnical Engineering*
- 7 *Timber Bulkheads*
- 8 *Foundations for Transmission Line Towers*
- 9 *Foundations & Excavations in Decomposed Rock of the Piedmont Province*
- 10 *Engineering Aspects of Soil Erosion, Dispersive Clays and Loess*
- 11 *Dynamic Response of Pile Foundations—Experiment, Analysis and Observation*
- 12 *Soil Improvement: A Ten Year Update*
- 13 *Geotechnical Practice for Solid Waste Disposal '87*
- 14 *Geotechnical Aspects of Karst Terrains*
- 15 *Measured Performance Shallow Foundations*
- 16 *Special Topics in Foundations*
- 17 *Soil Properties Evaluation from Centrifugal Models*
- 18 *Geosynthetics for Soil Improvement*
- 19 *Mine Induced Subsidence: Effects on Engineered Structures*
- 20 *Earthquake Engineering & Soil Dynamics II*
- 21 *Hydraulic Fill Structures*
- 22 *Foundation Engineering*
- 23 *Predicted and Observed Axial Behavior of Piles*
- 24 *Resilient Moduli of Soils: Laboratory Conditions*
- 25 *Design and Performance of Earth Retaining Structures*
- 26 *Waste Containment Systems: Construction, Regulation, and Performance*
- 27 *Geotechnical Engineering Congress*
- 28 *Detection of and Construction at the Soil/Rock Interface*
- 29 *Recent Advances in Instrumentation, Data Acquisition and Testing in Soil Dynamics*
- 30 *Grouting, Soil Improvement and Geosynthetics*
- 31 *Stability and Performance of Slopes and Embankments II*
- 32 *Embankment of Dams—James L. Sherard Contributions*
- 33 *Excavation and Support for the Urban Infrastructure*
- 34 *Piles Under Dynamic Loads*
- 35 *Geotechnical Practice in Dam Rehabilitation*
- 36 *Fly Ash for Soil Improvement*
- 37 *Advances in Site Characterization: Data Acquisition, Data Management and Data Interpretation*
- 38 *Design and Performance of Deep Foundations: Piles and Piers in Soil and Soft Rock*
- 39 *Unsaturated Soils*
- 40 *Vertical and Horizontal Deformations of Foundations and Embankments*
- 41 *Predicted and Measured Behavior of Five Spread Footings on Sand*
- 42 *Serviceability of Earth Retaining Structures*
- 43 *Fracture Mechanics Applied to Geotechnical Engineering*
- 44 *Ground Failures Under Seismic Conditions*
- 45 *In Situ Deep Soil Improvement*
- 46 *Geoenvironment 2000*
- 47 *Geo-Environmental Issues Facing the Americas*
- 48 *Soil Suction Applications in Geotechnical Engineering*
- 49 *Soil Improvement for Earthquake Hazard Mitigation*
- 50 *Foundation Upgrading and Repair for Infrastructure Improvement*
- 51 *Performance of Deep Foundations Under Seismic Loading*
- 52 *Landslides Under Static and Dynamic Conditions—Analysis, Monitoring, and Mitigation*
- 53 *Landfill Closures—Environmental Protection and Land Recovery*
- 54 *Earthquake Design and Performance of Solid Waste Landfills*
- 55 *Earthquake-Induced Movements and Seismic Remediation of Existing Foundations and Abutments*
- 56 *Static and Dynamic Properties of Gravelly Soils*
- 57 *Verification of Geotechnical Grouting*
- 58 *Uncertainty in the Geologic Environment*
- 59 *Engineered Contaminated Soils and Interaction of Soil Geomembranes*
- 60 *Analysis and Design of Retaining Structures Against Earthquakes*

- 61 *Measuring and Modeling Time Dependent Soil Behavior*
- 62 *Case Histories of Geophysics Applied to Civil Engineering and Public Policy*
- 63 *Design with Residual Materials: Geotechnical and Construction Considerations*
- 64 *Observation and Modeling in Numerical Analysis and Model Tests in Dynamic Soil-Structure Interaction Problems*
- 65 *Dredging and Management of Dredged Material*
- 66 *Grouting: Compaction, Remediation and Testing*
- 67 *Spatial Analysis in Soil Dynamics and Earthquake Engineering*
- 68 *Unsaturated Soil Engineering Practice*
- 69 *Ground Improvement, Ground Reinforcement, Ground Treatment: Developments 1987-1997*
- 70 *Seismic Analysis and Design for Soil-Pile-Structure Interactions*
- 71 *In Situ Remediation of the Geoenvironment*
- 72 *Degradation of Natural Building Stone*
- 73 *Innovative Design and Construction for Foundations and Substructures Subject to Freezing and Frost*
- 74 *Guidelines of Engineering Practice for Braced and Tied-Back Excavations*
- 75 *Geotechnical Earthquake Engineering and Soil Dynamics III*
- 76 *Geosynthetics in Foundation Reinforcement and Erosion Control Systems*
- 77 *Stability of Natural Slopes in the Coastal Plain*
- 78 *Filtration and Drainage in Geotechnical/Geoenvironmental Engineering*
- 79 *Recycled Materials in Geotechnical Applications*
- 80 *Grouts and Grouting: A Potpourri of Projects*
- 81 *Soil Improvement for Big Digs*
- 82 *Risk-Based Corrective Action and Brownfields Restorations*
- 83 *Design and Construction of Earth Retaining Systems*
- 84 *Effects of Construction on Structures*
- 85 *Application of Geotechnical Principles in Pavement Engineering*
- 86 *Big Digs Around the World*
- 87 *Jacked Tunnel Design and Construction*
- 88 *Analysis, Design, Construction, and Testing of Deep Foundations*
- 89 *Recent Advances in the Characterization of Transportation Geo-Materials*
- 90 *Geo-Engineering for Underground Facilities*
- 91 *Special Geotechnical Testing: Central Artery/Tunnel Project in Boston, Massachusetts*
- 92 *Behavioral Characteristics of Residual Soils*
- 93 *National Geotechnical Experimentation Sites*
- 94 *Performance Confirmation of Constructed Geotechnical Facilities*
- 95 *Soil-Cement and Other Construction Practices in Geotechnical Engineering*
- 96 *Numerical Methods in Geotechnical Engineering: Recent Developments*
- 97 *Innovations and Applications in Geotechnical Site Characterization*
- 98 *Pavement Subgrade, Unbound Materials, and Nondestructive Testing*
- 99 *Advances in Unsaturated Geotechnics*
- 100 *New Technologies and Design Developments in Deep Foundations*
- 101 *Slope Stability 2000*
- 102 *Trends in Rock Mechanics*
- 103 *Advances in Transportation and Geoenvironmental Systems Using Geosynthetics*
- 104 *Advances in Grouting and Ground Modification*
- 105 *Environmental Geotechnics*

Preface

This publication contains the twelve papers that were presented at GeoDenver 2000, August 5-8, 2000, an ASCE Geo-Institute conference held in Denver, Colorado. A wide range of topics is included, in the general area of geoenvironmental engineering. The title of this GSP, *Environmental Geotechnics*, was selected only to allow differentiation between this publication and accompanying sessions, versus other geoenvironmental publications and sessions which were part of the GeoDenver conference. The geotechnical profession appears to have settled on the usage of the term geoenvironmental engineering, which can loosely be defined as the application of geotechnical engineering principles to the solution of environmental problems.

The 12 papers included in this proceedings are quite diverse, and attest to the multidisciplinary nature of geoenvironmental engineering. The papers were organized into three sections, but there is a considerable amount of overlap between the sections. The first section, entitled landfills and recycled materials, deals with landfill settlements, including municipal landfills as well as landfills utilizing recycled waste paper sludge, and the use of recycled materials in road construction and as a concrete aggregate. The second section, barrier systems, deals with contaminant transport through waste contaminant barriers, the use of various materials for barrier systems, including slurry trench cutoff barriers. The third section, processes and properties, deals with processes used in waste remediation projects, properties of a modified bentonite, and biological clogging.

Each of the papers included in this volume received at least two positive peer reviews. Essentially the review process followed the same procedures used for the Journal of Geotechnical and Geoenvironmental Engineering of ASCE. All of the papers are eligible for discussion in the Journal of Geotechnical and Geoenvironmental Engineering, and are eligible for ASCE awards. The editor would like to thank the reviewers for the time and effort spent on the reviews. Reviewers were:

| | |
|--------------------|-----------------|
| Tarek Abdoun | Juan Quiroz |
| Carsten Floess | Pickett Simpson |
| Jonathan Howland | Mourad Zeghal |
| Christine LaPlante | |

Editor

Thomas F. Zimmie
Civil Engineering Department
Rensselaer Polytechnic Institute

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.