

Yunmin Chen
Xiaowu Tang
Liangtong Zhan
Editors

Advances in Environmental Geotechnics

Proceedings of the International Symposium
on Geoenvironmental Engineering in
Hangzhou, China, September 8-10, 2009



ZHEJIANG UNIVERSITY PRESS
浙江大学出版社



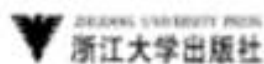
Springer

**Yunmin Chen
Xiaowu Tang
Liangtong Zhan**

Advances in Environmental Geotechnics

**Proceedings of the International Symposium
on Geoenvironmental Engineering in
Hangzhou, China, September 8-10, 2009**

With 1,091 figures



Editors

Prof. Yunmin Chen
Department of Civil Engineering
Zhejiang University
388 Yuhangtang Road, Hangzhou 310058
China
E-mail: chenyunmin@zju.edu.cn

Prof. Xiaowu Tang
Department of Civil Engineering
Zhejiang University
388 Yuhangtang Road, Hangzhou 310058
China
E-mail: tangxiaowu@zju.edu.cn

Prof. Liangtong Zhan
Department of Civil Engineering
Zhejiang University
388 Yuhangtang Road, Hangzhou 310058
China
E-mail: zhanlt@zju.edu.cn

ISBN 978-7-308-06597-9
Zhejiang University Press, Hangzhou

ISBN 978-3-642-04459-5 e-ISBN 978-3-642-04460-1
Springer Heidelberg Dordrecht London New York

Library of Congress Control Number: 2009934114

© Zhejiang University Press, Hangzhou and Springer-Verlag Berlin Heidelberg 2010

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilm or in any other way, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the German Copyright Law of September 9, 1965, in its current version, and permission for use must always be obtained from Springer-Verlag. Violations are liable to prosecution under the German Copyright Law.

The use of general descriptive names, registered names, trademarks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

Cover design: Frido Steinen-Bros, EStudio Calamar, Spain

Printed on acid-free paper

Springer is a part of Springer Science+Business Media (www.springer.com)


Preface

The International Symposium on Geoenvironmental Engineering (ISGE 2009) was held on September 8-10, 2009 in Hangzhou, China. ISGE 2009 was organized by MOE Key Laboratory of Soft Soils and Geoenvironmental Engineering, Zhejiang University, Chinese Institution of Soil Mechanics and Geotechnical Engineering (CISMGE), and Chinese Chapter of International Geosynthetics Society (CCIGS), under the auspices of ISSMGE TC5, sponsored by K. C. Wong Education Foundation, and National Natural Science Foundation of China, as well as Zhejiang University Zeng Guo-Xi Lecture Fund.

Issues associated with Environmental Geotechnics continue to be a major preoccupation for governments, public and private organizations and the general community worldwide. The Chinese Government has been putting great effort on environmental issues including sanitary disposal of solid waste, reuse of industrial wastes, remediation of contaminated land, prevention of groundwater contamination, environmental risk assessment, ecological techniques, etc. China also has much to share on the opportunities, challenges and responsibilities for environmental geotechnics with other countries, especially the developing countries.

Under the conference theme, "Reclamation of the Past and Toward a Sustainable Geoenvironment", 168 abstracts in total were received and 125 papers in total were reviewed and accepted for publication in this proceeding. This proceeding encloses 2 Zeng Guo-Xi Lectures, 26 Invited Lectures and 97 papers. The topics covered include basic and advanced theories for modeling of geoenvironmental phenomena, testing and monitoring for geoenvironmental engineering, municipal solid wastes and landfill engineering, sludge and dredged soils, geotechnical reuse of industrial wastes, contaminated land and remediation technology, applications of geosynthetics in geoenvironmental engineering, geoenvironmental risk assessment, management and sustainability, ecological techniques and case histories. This proceedings include papers authored by core members of ISSMGE TC5 (International Society of Soil Mechanics and Geotechnical Engineering - Environmental Geotechnics) and geoenvironmental researchers from more than 23 countries and regions (i.e., Albania, Austria, Bengalese, Brazil, Canada, China, France, German, Hong Kong, India, Iran, Indonesia, Japan, Korea, Macau, Malaysia, Portugal, Russia, Taiwan, UK, USA, Uzbekistan, Vietnam).

It is our desire that the proceedings of International Symposium on Geoenvironmental Engineering (ISGE2009) provide an opportunity for the exchange of views among academic researchers, practical engineers and administration officers. "Advances in Environmental Geotechnics" presents the latest development in this interdisciplinary field.



Prof. Yunmin CHEN
Chairman, Organizing Committee of ISGE 2009

Contents

The 2009 Zeng Guo-Xi Lecture

SYSTEMS ENGINEERING THE DESIGN AND OPERATION OF MUNICIPAL SOLID WASTE LANDFILLS TO MINIMIZE CONTAMINATION OF GROUNDWATER

C.R. Kerry ROWE (3)

STATIC AND SEISMIC ANALYSIS OF SOLID WASTE LANDFILLS

Pedro Simão Sáico e PINTO (19)

Invited Lectures

MODELING APPLIED TO ENVIRONMENTAL GEOTECHNICS

Mario MANASSERO, Andrea DOMENJANNI and Guido MUSSO (57)

MODELING DOMINANT TRANSPORT PROCESSES IN ONE-DIMENSIONAL CONTAMINANT TRANSPORT

K.C. Nirmdala PETER, M. R. MADHAV, E. Sathaba REDDY and T. V. BHARAT (90)

THE VECTOR SUM METHOD: A NEW APPROACH TO CALCULATING THE SAFETY FACTOR OF STABILITY AGAINST SLIDING FOR SLOPE ENGINEERING AND DAM FOUNDATION PROBLEMS

Xia-Pan GE (99)

ACID MINE DRAINAGE FROM ABANDONED MINE SITES: PROBLEMATIC AND RECLAMATION APPROACHES

Bruno BUSSIÈRE (111)

EFFECT OF MgO ADDITIVE ON PREVENTING LEAKAGE OF Cr(VI) FROM A FLY ASH

Jin-Chun CHAI, Takamori HINO and Nobuyuki NISHINO (126)

ENVIRONMENTAL GEOTECHNICS RELATED TO LANDFILLS OF MUNICIPAL SOLID WASTES

Yun-Min CHEN and Tony L.T. ZHAN (132)

TDR MEASUREMENT SYSTEM AND THE APPLICATION OF TDR IN GEOENVIRONMENTAL ENGINEERING

Ren-Peng CHEN, Wei CHEN, Yun-Min CHEN (153)

THE STATUS OF ENGINEERING TECHNICAL STANDARDS OF WASTE SANITARY LANDFILL TREATMENT IN CHINA

Yi-Yin DONG (163)

CHALLENGES ASSOCIATED WITH THE DESIGN OF COVERS

Debjay G. FREDLUND and J. STANSON (168)

GEOTECHNICAL ASPECTS OF LANDFILL CLOSURE AND AFTERCARE

Erwin GARTUNG, Wolf-Ulrich HENKEN-MELLIES, Jürgen KANITZ and Hans-Günter RAMKE (188)

DEWATERING SLUDGE USING ELECTROKINETIC GEOSYNTHETICS

S. GLENDINNING, J. A. HALL, J. LAMONT-BLACK, C. J. F. P. JONES, D. T. HUNTLEY, C. WHITE and A. FOURIE (204)

FULL-SCALE PRACTICE OF ECOLOGICALLY BASED LANDFILL OF MUNICIPAL SOLID WASTE: TO ACCELERATE THE BIOLOGICAL CONVERSION INSIDE LANDFILL AND COVER LAYERS

Pin-Jing HE (217)

GASOLINE CONTAMINATED SITES: POLLUTANT TRANSPORT AND REMEDIATION

Li-Ming HU, Jay N. MEEGODA, Irene M. C. LO, Yan LIU, Sheng-Yan GAO and Zhao-Qun WU (221)

CONTAMINATED LAND AND ENVIRONMENTAL DAMAGE: AN ANALYSIS OF CURRENT REMEDIAL STRATEGIES AND FUTURE DEVELOPMENTS

Stephan A. JEFFERIS (236)

IN-SITU CONTAINMENT FOR WASTE LANDFILL AND CONTAMINATED SITES

Takeshi KATSUMI, Toru INUI and Masashi KAMON (248)

APPLICATION OF ELECTRICAL RESISTIVITY FOR CEMENT SOLIDIFIED/STABILIZED HEAVY METAL CONTAMINATED SOILS

Song-Yu LIU, Yan-Jun DU, Lei CHEN, Zhi-Bin LIU and Fei JIN (259)

RECENT RESEARCH ON THE HYDROGEOLOGICAL AND SETTLEMENT CHARACTERISTICS OF LANDFILLED MUNICIPAL SOLID WASTE

D. J. RICHARDS, W. POWRIE and R. P. BEAVEN (265)

GEOSYNTHETIC FUNDAMENTALS IN LANDFILL DESIGN

Gregory N. RICHARDSON and Aiguo ZHAO (275)

APPLICATION OF SHEAR STRENGTH OF SOLID WASTE AND MULTILAYER LINER IN LANDFILLS

Jian-Yong SHI, Xue-De QIAN, Jun-Gao ZHU and Ye-Ping LI (286)

AN APPLICATION OF CENTRIFUGE MODEL IN ENVIRONMENTAL GEOTECHNICS ASSESSMENT OF SOFT GEOLOGICAL BARRIER SUBJECTED TO PILE CONSTRUCTIONS IN WASTE DISPOSAL SITE

Jiro TAKEMURA, Binesh AMATYA and Osamu KUSAKABE (295)

REMOVAL OF HEAVY METAL FROM AQUEOUS SOLUTIONS USING CHINESE LOESS SOIL.

Xiao-Wu TANG, Yan WANG and Zhen-Ze LI (314)

COUPLED THERMO-HYDRO-CHEMO-MECHANICAL MODELING FOR GEOENVIRONMENTAL PHENOMENA

Hywel R. THOMAS, Philip J. VARDON and Yu-Chao LI (320)

REMEDICATION TECHNOLOGIES FOR CONTAMINATED SITES

Albert T. YEUNG (328)

ADVANCES ON BUFFER/BACKFILL PROPERTIES OF HEAVILY COMPACTED GAOMIAOZI BENTONITE

Wei-Min YE, Qiong WANG, Yong-Gui CHEN and Bao CHEN (370)

A PRELIMINARY UNDERSTANDING ON PERFORMANCE OF BARRIERS FOR MSW LANDFILLS IN SOUTHERN CHINA

Tony L. T. ZHAN, Yan-Min CHEN and Xiao-Wu TANG (380)

ROLE OF SOIL WATER IN CEMENT-BASED TREATMENT OF DREDGED MATERIALS

Wei ZHU and C.F. CHIU (395)**Basic and Advanced Theories for Modeling of Geoenvironmental Phenomena**

NUMERICAL SIMULATION OF ELECTRO-OSMOSIS IN SOFT CLAY

Liming HU, Wei-Ling WU and Zhao-Qun WU (407)

RESEARCH ON COEFFICIENT OF BRITTLE STRESS DROP OF BRITTLE-PLASTIC ROCKS AND ITS APPLICATION

Gui-Cai SHI, Xiu-Ran GE and Yan-De LU (413)

DYNAMIC STABILITY ANALYSIS OF LANDFILL SLOPE IN DUSHANBE, TAJIKISTAN

Xue-Tao WANG, Tenny G. BERRHE, Stephen WEBB and Wei WU (420)

HIGH-SPEED AND LONG RANGE FLOW ANALYSIS MODEL OF WASTE BODY AFTER SANITARY MSW LANDFILLS SLOPE UNSTABILITY

Zhao-Hong QIU, Yan-Min CHEN and Xiao-Gang WANG (426)

ONE-DIMENSIONAL CONSOLIDATION OF AQUITARD CONSIDERING NON-DARCY FLOW

Zhong-Yu LIU, Jiao-Chao YUE and Li-Yun SUN (430)

SITE EFFECT ANALYSIS OF SHIRVAN GTL REFINERY, USING EQUIVALENT LINEAR SOIL BEHAVIOR (NE OF IRAN)

Ahmad ADIB, Navar EBADATI and Kobra HEYDARZADEH (435)

DATA DIVISION METHOD OF SAND LIQUEFACTION SAMPLES BASED ON SELF-ORGANIZING MAPS

Si-Si LIU and Ming-Hua ZHAO (443)

GOM-SVM PREDICTOR FOR LAND SUBSIDENCE AT FINISHED UNDERGROUND MINING

Zheng-Wen XIE and Xiao-Yu LIANG (449)

A FULLY COUPLED THERMO-HYDRO-MECHANICAL MODEL FOR METHANE HYDRATE RESERVOIR SIMULATIONS

Huo-Lang FANG (455)

NUMERICAL SIMULATION OF DYNAMIC RESPONSES IN TRANSVERSELY ISOTROPIC FLUID-SATURATED ELASTIC SEABED UNDER WAVE ACTIONS

Zhou-Duan HENG, Wang-Tong HE, Sun ZHIL and Chen-Ming WEI (462)

SOLUTIONS FOR A COMPLETELY SATURATED POROUS ELASTIC SOLID WITH IMPEDED BOUNDARIES

Ze-Hai CHENG, Jian Zhong XIA, Yan-Min CHEN, Dao-Sheng LING and Bing ZHU (467)

THE THREE-DIMENSION SATURATED-UNSATURATED SEEPAGE ANALYSIS UNDER ATOMIZED RAIN OF HYDROPOWER PROJECT WITH HIGH SLOPE

Huan-Ling WANG and Wei-Yu XU (473)

STUDY ON UNLOADING ROCK MASS CONSTITUTIVE RELATIONSHIP

Jie LIU, Jian-Lin LI, Xiao-Hu WANG, Jian-Jun QU and Tong ZHU (480)

DESTRUCTURATION CONSTITUTIVE MODEL FOR SOFT CLAY

Xiao-Jun YU and Di-Hong QI (487)

IDENTIFICATION OF DAMPING RATIOS OF SOIL-STRUCTURE SYSTEM SUBJECTED TO AMBIENT EXCITATION

Zhi-Ying ZHANG, Qiang PAN, Cheng-Du CHO and Zhao-Chao GAO (492)

Testing and Monitoring for Geoenvironmental Engineering

LABORATORY FLUME STUDIES ON CONSOLIDATION OF SOFT SILTY SEABED SOIL UNDER WAVE ACTIONS

Ying LIU, Hong-Jun LIU, Xie-Hai WANG and Min-Sheng ZHANG (499)

CHARACTERISTICS OF SHEAR STRENGTH OF UNSATURATED WEAK EXPANSIVE SOIL

Wei-Min YE, Yu-Wei ZHANG, Bao CHEN and Shi-Fang ZHANG (505)

ON THE DETERMINATION OF THE SOIL-WATER CHARACTERISTIC CURVE USING THE PRESSURE PLATE EXTRATOR

Hui CHEN, Chang-Fu WEI, Rong-Tao YAN, Pan CHEN and Pan-Pan YI (511)

ZERO VALENT IRON TO REMOVE THE ARSENIC CONTAMINATION FROM NATURAL GROUNDWATER: BATCH AND COLUMN EXPERIMENT

M. A. ABEDIN, Takeshi KATSUMI, Toru INUI and Masashi KAMON (515)

SIMULATION TESTS OF BIODEGRADATION AND COMPRESSION OF MUNICIPAL SOLID WASTE

Jun-Liang LIU, Han KE, Tony L. T. ZHAN and Yuo-Min CHEN (521)

COMPATIBILITY OF TROPICAL SOIL AND BENTONITE MIXTURES SUBJECTED TO CHEMICAL SOLUTIONS

Thiago Luis Coelho MORANDINI and Adilson do Lago LEITE (525)

DEVELOPMENT OF SEDIMENT MONITORING DURING HEAVY RAINFALLS

Chih-Ping LIN, Chih-Chang CHUNG, Yu-Chia CHANG and Tzong-Shen CHANG (531)

RESEARCH ON RELATIONS OF ENGINEERING INDEXES AND MICROSTRUCTURE FEATURE VALUES TO SATURATED SOFT SOIL

Yong XU, Ji-Chao ZHANG, Wu-Ping LI and He YI (537)

SHEAR STRENGTH BEHAVIOR OF BENTONITE MODIFIED BY TETRAMETHYLAMMONIUM CATIONS

Bate BATE and Susan E. BURNS (543)

MONITORING OF LANDFILL SETTLEMENT BY MEANS OF HORIZONTAL INCLINOMETERS

*Xiao-Bing XU, Hai-Yan WEI, Tony L. T. ZHAN, Yuo-Min CHEN and Yuo-Sheng WANG (549)***Municipal Solid Wastes and Landfill Engineering**

EFFECT OF THICKNESS OF HYDRAULIC BARRIER ON THE INTEGRITY OF A COVER SYSTEM SUBJECTED TO DIFFERENTIAL SETTLEMENTS

Bhambhani V. S. VISWANATHAN and Sathiyamoorthy RAJESH (555)

SEISMIC RESPONSE CHARACTERISTICS OF MUNICIPAL SOLID WASTE LANDFILLS

Xiao-Jing DENG, Xiao-Jing KONG and De-Gao ZOU (561)

STUDY ON SOIL PROPERTIES OF THE EARLY ECOLOGICAL RESTORATION FOR A CHEMICAL LANDFILL IN HUAINAN

Wen FAN, Jiu-Ping YAN and Hai-Ping LIU (567)

GEOTECHNICAL SITE CHARACTERIZATION OF MUNICIPAL SOLID WASTE LANDFILL IN UZBEKISTAN

Kobilyon KHOLMATOV, Diana KILASHIMOVA, Wei WU and Marufjon MUSAEV (571)

AMBIENT NOISE SITE INVESTIGATION OF A REPRESENTATIVE MSW LANDFILL IN BISHKEK, KYRGYZSTAN

Thiep DOANH, Xiao-Tao WANG, Stephen WEBB and Wei WU (578)

ANALYSES ON APPLICABILITY OF ET COVERS IN HUMID AREAS

Wen-Jie ZHANG and Yuo-Min CHEN (584)

IN-SITU TESTS AND SLOPE STABILITY ANALYSIS OF MUNICIPAL SOLID WASTE LANDFILL

Hsin-Yu SHAN and Tsao-Hsien FAN (590)

EFFECT OF MUNICIPAL SOLID WASTE COMPOSITION ON PERMEABILITY

Harris RAMLI, Mastura AZMI, F. AHMAD and M. M. ALI (596)

STUDY ON THE DUNCAN-CHANG MODEL PARAMETERS OF STRESS COMPRESSION FOR MUNICIPAL SOLID WASTE

Zhao-Yong ZHANG, Chang-Fu WU and Yuo-Min CHEN (602)

STUDY ON PARAMETER SENSITIVITY OF THE COMBINATION FAILURE OF LANDFILL WITH A DAM

Fan TU, Fang-Qiang CHANG, Zhao-Yan XIAO and Xiao-Jie WU (607)

MODEL TESTS ON DEFORMATION BEHAVIOR OF BENTONITE MIXED SOIL LAYER SUBJECTED TO A LOCAL SUBSIDENCE IN LANDFILL

Shigeyoshi IMAIZUMI, Yasuo SHINOZAKI, Kengo KUDO and Takuya YOSHINAO (615)

FACTORS AFFECTING SLOPE STABILITY OF LANDFILL COVERS

Manoj DATTA (620)

ONE-DIMENSIONAL, SETTLING BEHAVIOR OF A GROUP OF SOIL MATERIALS IN STATIC WATER ASSUMING COASTAL LANDFILL.

*Shuichi NAGAOKA, Yuta NABESHIMA, Kenichi SATO, Shotaro YAMADA, Tomosaki HACHIMURA
and Tetsuya MIYAHARA* (625)

EXPERIMENTAL STUDY ON THE NONLINEAR CHANGE OF SATURATED HYDRAULIC CONDUCTIVITY OF WASTE SOIL.

Ying ZHAO, Qiang XUE, Bing LIANG and Lei LIU (629)

LANDFILL GAS GENERATION AND TRANSPORT IN BIOREACTOR LANDFILL

Qi-Lin FENG, Lei LIU, Qiang XUE and Ying ZHAO (633)

DEVELOPMENT OF A COMPUTER SOFTWARE FOR PREDICTING LANDFILL SETTLEMENT AND ITS STORAGE CAPACITY

Yao-Shang WANG, Han KE, Tony L. T. ZHAN, Xiao-Chen JIAN, Yun-Min CHEN and Zhe FU (637)

INFLUENCE OF RAINFALL PATTERN ON THE INFILTRATION INTO LANDFILL EARTHEN FINAL COVER

Guo-Wei JIA, Tony L.T. ZHAN, Yun-Min CHEN and D. G. FREDLUND (641)

MUNICIPAL SOLID WASTE MANAGEMENT AFTER WENCHUAN EARTHQUAKE.

Hua TAO (646)

FIELD INVESTIGATION ON THE FEASIBILITY OF LEACHATE RECIRCULATION IN CHENGDU MSW LANDFILL, CHINA

Ji-Wu LAN, Tony Liang-Tong ZHAN, Yun-Min CHEN, Han KE, Zhao LIU and Guo-Qing LU (649)**Sludge and Dredging Soils**

REUSE OF POND SEDIMENT BY MIXING WITH STABILIZERS AND SHREDDED PAPER

Yasuyuki NABESHIMA and Seichi TOMOHISA (657)

LABORATORY STUDY ON ELECTROKINETIC DEWATERING OF SEWAGE SLUDGE

Yuan FENG, Tony L. T. ZHAN, Yun-Min CHEN and Quan-Fang ZHANG (662)

HYDRAULIC CONDUCTIVITY EVALUATION OF VERTICAL CUTOFF WALLS BEARING FILTER CAKE FROM SLUG TEST ANALYSIS

The-Ban NGUYEN, Chulho LEE, Yonghoon AHN and Hangeok CHOI (666)

FILTRATION PERFORMANCE OF TWO-LAYERED NONWOVEN GEOTEXTILES

Li-Fang LIU, Liao-Ying Ji, Fu-Wen GUO, Qian-Li WANG and Xiao-Jie YANG (672)

REASONABLE CONSTRUCTION MANAGEMENT IN FILL LOADING WITH VACUUM CONSOLIDATION METHOD BASED ON FEM ANALYSES

*Mohammad SHAHIDUZZAMAN, Yoshitiko TANABASHI, Hiroshi KAWABATA, Yufeng JIANG
and Satoshi SUGIMOTO* (675)

FINITE ELEMENT NUMERICAL ANALYSIS TO INTERACTION OF BURIED SPIRAL STEEL PLASTIC COMPOSITE PIPE WITH SURROUNDING SOILS

Xiang-Yong ZENG, An-Fu DENG, Bing ZHENG and Xiao-Dong GUO (683)

EXPERIMENTAL STUDY ON ENGINEERING PROPERTIES OF A DREDGED SEDIMENT SOLIDIFIED BY COMMON CEMENTITIOUS MATERIALS

Feng CHEN and Bang-Min QIN (687)

IMPROVING SOFT GROUND AND SLUDGE BY OVER-PRESSURE VACUUM CONSOLIDATION SYSTEM

Yu-Wei JIN and Ben NIU (699)

CHANGING IN THE PHYSICAL PARAMETERS OF DUMPS OF THE COAL-MINING INDUSTRY OF KANSK-ACHINSK (SIBERIAN) COAL FIELD AND POSSIBILITY OF THEIR REMEDIATION

E.V. SLAVIS, E.N. OGORODNIKOVA and E.A. KARPUKHINA (694)

DYNAMIC REACTION ANALYSIS OF TAILING DAMS UNDER EARTHQUAKE

Boo-Lin XIONG, Xi-Liang WANG and Chun-Jiao LU (697)

Geotechnical Reuse of Industrial Wastes

USE OF RECYCLED COPPER SLAG IN CEMENT-TREATED SINGAPORE MARINE CLAY

S. H. CHEW and S. K. BHARATI (705)

EXPERIMENTAL STUDY ON THE ENGINEERING PROPERTIES OF TWO INCINERATION BOTTOM ASH OF MUNICIPAL SOLID WASTES

Jian-Ming ZHANG, Min-Yan HU and Si-Fa XU (711)

UTILIZATION OF COAL ASH AS RECYCLING MATERIAL. OPTIONS IN VIEW POINT OF GEOENVIRONMENT

Ahmad RIFA'I, Noriyuki YASUFUKU, Kiyoshi OMINE and Kazuyoshi TSURU (715)

STUDY ON THE ENGINEERING PROPERTY OF MIXED-SOIL FLY ASH

Yu-Sheng LUO, Jing LI and Andrew CHAN (721)

EXPERIMENTAL STUDY ON TREATMENT OF OVER-WETTED CLAYS USING CALCIUM CHLORIDE

Ying-Ying ZHANG, Yan-Jun DU, Song-Yu LIU and Fan ZHANG (728)

MECHANICAL AND CHEMICAL PROPERTIES OF ASH MOLTEN SLAG MIXED WITH BENTONITE

Fujio IGARI and Shigeyoshi IMAZUMI (734)

AN APPLICABILITY OF DEHYDRATED CAKE PRODUCED FROM QUARRY TO IMPERMEABLE MATERIAL WITH HEAVY METAL ADSORPTION

Ryo SUETAKE, Kenichi SATO, Miyako TAKEIDA and Morimoto TATSUDO (740)

UNCONFINED COMPRESSIVE STRENGTH OF MIXTURE OF PHOSPHOGYPSUM-FLY ASH-LIME-CLAY

Zhi-Hong QI, Xue-Yuan XU, Mi-Lin ZHU and Yang HU (745)

ADSORPTION BEHAVIOR AND MECHANISM OF Cu(II) ON ACTIVATED FIRMIANA SIMPLEX LEAF

Qiong TANG, Xiao-Bin YANG, Man-Man HU, Yun-Min CHEN, Yan WANG and Nai-Yu KOU (749)

Contaminated Land and Remediation Technology

PURIFICATION OF Cr(VI)-CONTAMINATED SOIL BY FERMENTATION OF ORGANIC MATTER

Kiyoshi OMINE, Noriyuki YASUFUKU and Kazuya TAMURA (755)

AN OVERVIEW OF STABILIZATION/SOLIDIFICATION TECHNIQUE FOR HEAVY METALS CONTAMINATED SOILS

Yan-Jun DU, Song-Yu LIU, Zhi-Bin LIU, Lei CHEN, Fan ZHANG and Fei JIN (760)

CASE STUDY ON INFLUENCES OF OIL CONTAMINATION ON GEOTECHNICAL PROPERTIES OF COASTAL SEDIMENTS IN THE YELLOW RIVER DELTA

Jiang-Gang JIA, Qiong WU, Xiang-Mei MENG, Xiu-Juan YANG, Zhong-Nian YANG and Geng-Cheng ZHANG (767)

BIOREMEDIATION OF WATER CONTAMINATED WITH BTEX, TPH AND TCE UNDER DIFFERENT

ENVIRONMENTAL CONDITIONS

C.K. LEE, J. H. LI, S.S. DONG and H. SHIM (772)

HYSTERETIC RETENTION OF Pb(II) IN KAOLIN COLUMN

Zhen-Ze LI, Yun-Min CHEN, Xiao-Wu TANG Yan WANG and Qiang TANG (777)

EXPERIMENTAL STUDY ON THE MECHANISM OF ACTION OF IONIC SOIL STABILIZER ON RED CLAY OF WUHAN

Wei XIANG, De-Shan CUI and Fei AI (781)

EFFECTS OF SURFACE-ACTIVE AGENT ON MECHANICAL BEHAVIORS OF LOESS

Nai-Yu KOU, Xiao-Wu TANG, Quan-Fang ZHANG, Yun-Min CHEN and Qiang TANG (786)

EDTA-ENHANCED ELECTROKINETIC EXTRACTION OF CADMIUM FROM A NATURAL CLAY OF HIGH BUFFER CAPACITY

*Ying-Ying GU, Albert T. YEUNG and Hong-Jiang LI (790)***Applications of Geosynthetics in Geoenvironmental Engineering**

APPLICATIONS OF GEOGRID REINFORCED SOIL RETAINING WALL WITH WRAP-AROUND FACING IN RAILWAY

Guang-Qing YANG, Qiao-Tong ZHOU, Bao-Jun ZHANG and Jun-Xia DING (799)

TEST STUDY ON ENGINEERING PROPERTIES OF GABION STRUCTURES

Gao-Lin YANG, Xiang-Jing HUANG and Yu-Liang LIN (805)

PULLOUT TEST STUDY ON INTERFACE FRICTION CHARACTERISTICS OF REINFORCEMENTS WITH RED SANDSTONE AS FILLER

Yu-Liang LIN, Gao-Lin YANG, Yan LI and Xiang-Jing HUANG (812)

APPLICATION OF GEOMEMBRANE AS CARBON CAPTURE AT PALM OIL MILL

Andriyan SUHENDRA and Amelia MAKMUR (817)

INTERFACE FRICTIONAL PROPERTY BETWEEN SAND AND GEOMEMBRANE

Jun-Li GAO, Meng-Xi ZHANG and Wen-Jie ZHANG (822)

COVERED ANAEROBIC LAGOONS WITH HDPE GEOMEMBRANE: EXPERIENCES IN DEVELOPING ASIAN COUNTRIES

Hae-Boom NG, Chang-Wei QI and Xiao-Ming TAN (828)

LESSONS LEARNED FROM THE NUMERICAL MODELLING OF A RETAINING WALL WITH NON-UNIFORM REINFORCEMENTS

Xiang-Jing HUANG, Ze LIU and Vicari M. (834)

EXPERIMENTAL STUDIES OF ARCHING EFFECT AND GEOSYNTHETIC DEFORMATION IN LOCAL SUBSIDENCE PROBLEM

Deng GAO, Bin ZHU, Yun-Min CHEN, Tony L. T. ZHAN and Xiang-Zhi WANG (840)

A LARGE-SCALE RAMP MODEL TEST ON COMPOSITE LINER SYSTEMS

*Wei-An LIN, Tony L. T. ZHAN, Yun-Min CHEN and Sheng HE (846)***Geoenvironmental Risk Assessment, Management and Sustainability**

URBAN NIGHT SOIL TRANSPORTATION AND TREATMENT IN CHINA

Ting LIU, Zhu-Lei CHEN and Lie YANG (853)

STUDY ON THE RELATIONSHIP BETWEEN LANDSLIDES, DEBRIS FLOWS AND THE MODERN

RIVER GEOLOGICAL PROCESSES

Ming-Xin ZHENG (859)

SEISMIC DAMAGE CHARACTERISTICS OF RURAL ADOBE-WOOD BUILDING IN GANSU PROVINCE INDUCED BY THE WENCHUAN GREAT EARTHQUAKE

AI-Lan CHE, Zhi-Jian WU, Jun-Jie SUN and Jing-Hua QI (865)

EFFECTIVE FACTORS ON AMPLIFICATION IN CHABAHAR CITY, SOUTHEAST OF IRAN

Ahmad ADIB and Kobra HEYDARZADEH (872)

POST DISASTER INFORMATION MANAGEMENT: ISSUES RELATED TO MITIGATION ACTIVITIES IN IRAN

Ahmad ADIB and Vahid Hosseini JENAB (879)

ANALYSIS AND EVALUATION ON HYDROFRACTURE FAILURE IN AN ASPHALT CONCRETE CORE ROCK-FILL DAM: A MAOPINGXI DAM CASE

Xin-Hua Zhou and Xi-Bao RAO (883)

GEOENVIRONMENTAL RISK ASSESSMENT IN ALBANIA

L. BOZO and G. J. IKONOMI (890)

STUDY ON DEBRIS FLOW HAZARD DISCRIMINANT ANALYSIS AND ZONING OF ONE DUMP

Shi-Guo SUN, Shao-Ze FENG, Ting-Ting JIANG, Hua XIAO and Sheng-Hua ZHANG (893)**Ecological Techniques and Case Histories**

SUSTAINABLE DESIGN BASED ON NEAR NATURE CONSTRUCTION METHOD—A CASE STUDY

Hsueh-Yoo CHUA, Hsiao-Chou CHAO and Chang-Tsun CHEN (901)

ENGINEERING GEOLOGICAL PROPERTIES OF THE SATURATED CLAY FOUNDATION AT THE SOUTHERN EDGE OF MU US DESERT IN CHINA

Sheng-Rui SU and Fang-Qiang SUN (907)

GEOLOGY CONSIDERATION INFLUENTIAL IN URBAN DEVELOPMENT AND VULNERABILITY OF THE GORGAN REGION (NE IRAN)

Naser EBADATI, Ahmad ADIB and Reza MAGSOODLOOZAD (911)

PROTECTION TECHNOLOGY AND APPLICATIONS OF GABION

Gao-Lin YANG, Zhu-Zhu LIU, Gui-Lin XU and Xiang-Jing HUANG (915)

A PARAMETRIC STUDY ON EVALUATION OF STABILITY OF COLUMN TYPE DM IMPROVED GROUND

Masaki KITAZUME (920)

CASE STUDY ON GEOENVIRONMENTAL EFFECTS OF PRESS-IN PILES INSTALLATION

Jian-Xin SONG, Tong-He ZHOU and Yuan-Cheng GUO (926)

A CONSTRUCTION CASE OF RAMPS LOCATED ON THE EXPANSIVE SOIL FOR HIGHWAY INTERCHANGE

He-Ping YANG, Xiao Ni and Jie XIAO (930)

ANALYSIS OF THE DEEP-SEATED CONCRETE SLAB FOR SETTLEMENT CONTROL AT BRIDGE APPROACH EMBANKMENT

Yan SUN, Yi-Qiang XIANG, Dong-Mei GUO and Ting-Ting ZHANG (935)

APPLICATION OF GEOCELL IN THE ECOLOGICAL PROTECTION OF ROCK SLOPE

Xin-Jun ZOU and Ming-Hua ZHAO (940)

APPLICATION OF GEOMEMBRANE AS CARBON CAPTURE AT PALM OIL MILL

Andryan SUHENDRA¹ and Amelia MAKMUR²

ABSTRACT: Global warming is the most important issue in last decade that causes a climate change. Global warming is triggered by greenhouse effect, whereas the process by absorption and emission of infrared radiation by atmospheric gases increases the temperature. Methane is one of the gases, which contribute to increase the greenhouse effect and predicted 20 times larger than Carbon Dioxide potential impact. However, methane can be used as alternative resources energy such as biogas. Methane is produced from organic waste like biomass, animal and human waste, also the palm oil mill's waste. In West Indonesia where the expansions of palm oil fields grow faster, the increasing methane gases become a serious matter. One of the alternative solutions to minimize that methane's impact is by using an aerobic bio-digestion process. HDPE geomembrane, one of the geosynthetics products can be used to captures the methane gases and led in them by using a pipeline to the biogas converter. The installation processes of geomembrane are including patterning, deploying, anchoring and seaming of HDPE geomembrane. As a carbon capture in Palm Oil mill, HDPE geomembrane contribute to reduce the greenhouse effect, provide an alternative energy and for the future hopefully will save our environment.

KEYWORDS: global warming, methane, carbon capture, HDPE geomembrane, biogas, anaerobic bio-digestion process

INTRODUCTION

The spectacular expansion of palm oil mill in Indonesia; especially in West Indonesia, not only generate income for inhabitant in that the region, but in the other hand it's also left a serious problem behind with the palm oil mill's waste. That waste potent to produce the methane gases (CH_4), which predict will be increasing the greenhouse gases effect 20 times larger than Carbon Dioxide. Contribution of several gases to increase the greenhouse effect is shown on the figure below.

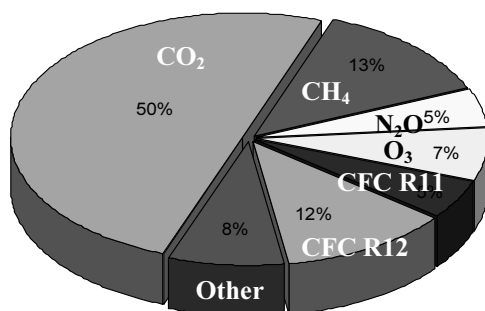


Fig. 1 Percentage contribution of several gases that increasing the greenhouse effect

Palm Oil Mill effluent as known as POME is a liquid waste of palm oil mill, which has 100 times potential as a pollutant waste than another municipal waste. That potential effect will increase the greenhouse effect, if there is no action to treat that entire palm oil mill's waste. The Biological Oxygen Demand of untreated POME average 25,000 mg/liter (Ojonoma & Nnennaya, 2007). Anaerobic biodigestion system can solve the problem of greenhouse gases effect of palm oil mill effluent and also give several benefits:

- Re-use the POME as an alternative source energy
- Create an electricity power
- Reduce the unpleasant odor
- Re-use the POME as a fertilizer
- Reduce the impact of greenhouse gases

Based on the research, 50 million tons of biomass has 1.4 trillion cubic meters potential of biogas or equivalent to 337 MW electrical power generations.

POME TREATMENT SYSTEM

The conventional treatment system of POME is use biological system, by utilizing the microbe to reduce BOD and neutralizing the acidity of POME.

¹ Lecturer of Bina Nusantara University, Jakarta. Member of Indonesian Society of Geotechnical Engineering (ISSMGE) and International Geosynthetic Society Indonesia Chapter (INA-IGS). Email:andryan@geosinindo.co.id

² Lecturer of Bina Nusantara University, Jakarta. Member of Indonesian Society of Geotechnical Engineering (ISSMGE) and International Geosynthetic Society Indonesia Chapter (INA-IGS). Email:amelia1935@binus.edu

This conventional system need open lagoon with size depend on the volume of POME will be treated. These are 3 phases of POME Treatment, such as:

Preliminary Treatment

This phase consist of de-oiling and acidifying pond.

At first phase, POME from fat-pit delivers to de-oiling pond, and then transferred to acidifying pond. The temperature and acid density at acidifying pond is kept constant in high condition to ensure the oil content at the POME surface still liquid.

The POME will be remained at acidifying pond during 4 to 5 days to increase the acid density for making easier the next process.

Anaerobic Biodigestion Treatment

The purpose of this treatment is to change the complex organic mass into the simple one.

There are 2 phases on an-aerobic biodigestion treatment i.e. primary and subsequent anaerobic alternation lagoon.

Primary alternation lagoon

In this pond, the complex organic mass will be changed to volatile acid by using an acid bacterial. BOD and COD will be decreased in neutral condition at lagoon during 40 days.



Fig. 2 Primary Lagoon

Subsequent anaerobic alternation lagoon

In this lagoon, the volatile acid changes into an acetate acid and then it will become the gases of CO, CH₄, H₂S, and H₂O.

Further Treatment

The further treatment of POME consists of 2 lagoons: facultative and aerobic lagoon.

Facultative lagoon

The aerobic oxidation occurs at the surface and in that time the an-aerobic fermentation of sedimentation is also occurred, as a consequence the value of BOD and COD will be decreased.

Aerobic lagoon

Bacterial need oxygen for proliferating, so in this place they will get it and all the process will decrease BOD and COD value.



Fig. 3 Subsequent Lagoon

BIOGAS

The biggest component of biogas, which produced from POME treatment, is methane gas; for 600 kg – 700 kg of POME can produce biogas approximately 20 m³ (Goenadi, 2006).

The process of methane can be divided into 3 stages: hydrolysis, aetogenesis (dehydrogenesis) and metanogenesis (Sorensen, 2004).

At first phase (hydrolysis phase), the complex biomass is decomposited to a simple glucose by using microorganism enzyme as catalyst. The important thing in this process is the result of a simpler chemistry for the next phase.

The second phase will change glucose into an acetate acid and broken off the long acid chain become the short one finally it will produce an acetate acid as a final product.

The third phase is the changing process of biogas from acetate acid by using fermentation of metanogenic bacterial.

As an illustration, in case of palm oil mill process 100 ton of fresh fruit bunches (FFB) per hour, will produce 50 m³/hour of POME (assumed 55% of FFB with unit weight 1.1g/cm³, Kartiman, 2008). If the mill operates 10 hours/day, the volume of POME will be