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# Technical session 3a: Waste disposal and management

## Séances techniques 3a: Traitement et gestion des déchets

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## 1 INTRODUCTION

Technical Session 3a took place in 14th September, 2005 at 10:30-12:00. The session had about a hundred participants. The key persons of the session TS3a were as follows,

Session Chair: David E. Daniel (USA)
General Reporter: Craig H. Benson (USA)
Panelists: G. N. Pavlik (Russia)
M. E. G. Boscov (Brazil)
E. Fratalocchi (Italy)
D. Coumoulos (Greece)
Session Secretary: Hideo Komine (Japan)

Photo 1. Key persons of TS3a
(From left side, Professor Daniel, Professor Pavlik, Professor Boscov, Professor Fratarocchi, Professor Comoulous, Professor Benson, and the author)

## 2 OPENING OF SESSION

First of all, Professor David E. Daniel as the session chair introduced the general reporter and the panelists and announced the time schedule of the session. The session spent 30 minutes for the general report, 15 minutes for each panel presentation including the question and answer, and scant 30 minutes for discussion. All of the TS3a session was operated punctually, so the author as the session secretary would like to give my acknowledgement to all of kepersons of the session.

## 3 GENERAL REPORT

After the opening address by the session chair, Professor Craig H. Benson presented his general report concerning TS3a. The author has participated the International Conference of Soil Mechanics and Geotechnical Engineering many times and believes that the general report by Professor Benson is one of the most excellent presentations.

His general report provides an overview of the papers in Technical Session 3a: Waste Disposal and Management. The summary of his report is as follows:

Thirty-three papers were received for this TS3a session with authors from 17 nations. Five papers were received from North America, 2 from South America, 16 from Europe, 8 from Asia, and 2 from Australia. One of the papers from Asia was co-authored by a person from Africa. Thus, 6 of the 7 continents are represented in this session (no papers were received from Antarctica, which is not surprising!).

The papers can be segregated into 8 topics: contaminant transport issues, mechanics of waste containment, engineering properties of wastes and contaminated soils, nuclear waste containment, unsaturated soil issues, assessment of barrier materials, cutoff walls, and "other" topics. The number of papers in each category and the nations contributing these papers are summarized in Table 1. Some of the papers could have fit into more than one category, but are listed in only one category in Table 1.

The following sections provide a summary of the papers in each area, with emphasis on some papers of particular importance.

Table 1. Summary of papers in each category.

| Topic | No. Papers | Contributing Nations |
|---|---|---|
| Contaminant transport | 7 | Belgium, Brazil, Italy, Slovenia |
| Mechanics of waste containment | 8 | Australia, Bulgaria, Croatia, Germany, Japan, Spain, US |
| Wastes and contaminated soils | 5 | Australia, India, Japan, Singapore, UK |
| Nuclear waste containment | 4 | France, Japan, Sweden |
| Unsaturated soils | 3 | Germany, France, US |
| Barrier materials | 2 | Japan |
| Cutoff walls | 2 | Italy, Japan (with Kenyan author) |
| Other | 2 | US |

Note: Papers in "Other" category include a field study on the thermal properties and gas characteristics of solid waste landfills and a laboratory study on filtration properties of geotubes.

The general report of Professor Benson was finished punctually. After his presentation, Professor Daniel, Chair, invited the audience to ask brief questions and/or comments. One participant asked a question about the temperature in the waste-ground of waste disposal facility and the method to measure the temperature. The author of the corresponded paper replied to his querist and the audience.

## 4 PANEL PRESENTATIONS

Continually, the TS3a has had the presentation of panelists. The short titles of each panelist are as Table 2.

Table 2. Titles of panel presentation

| Panelist | Titles |
|---|---|
| G. N. Pavlik | Systemic analysis as method of predicting ground waters pollution |
| M. E. G. Boscov | Specifications and compaction control for liners |
| E. Fratalocchi | Design and construction of vertical and sidewall barriers |
| D. Coumoulos | Long term behavior of landfill covers |

The summary of the presentation by Prof. Pavlik is as follows.
She emphasized the importance of the systemic approach when investigating ecological problems. In her opinion, the systemic analysis is a scientific research strategy that widely employs mathematical apparatus but in the framework of systemic approach.
While solving ecological problems by the systemic analysis method she talked about seven main stages:

1. Limiting its complexity
2. Setting the problem
3. Setting up the hierarchy of goals
4. Determining the object of research limits
5. Defining the conceptual model
6. Modeling mathematically and identifying problem solving
7. Assessing possible strategies by means of imitational modeling, making calculation experiments and interpreting the results

She took the Voskresensk Minudobrenya Co. in the Moscow Region producing phosphoric acid and dumping the toxic waste in the direct proximity to the Saburovo water intake as an example to comprehensively investigate this kind of problem by means of systemic analysis method. While investigating this problem she followed all seven stages mentioned above.

The summary of the presentation by Prof. Boscov is as follows.
Her topic is the specification and compaction control for liners using tropical soils such as lateritic soils and saprolitic soils.

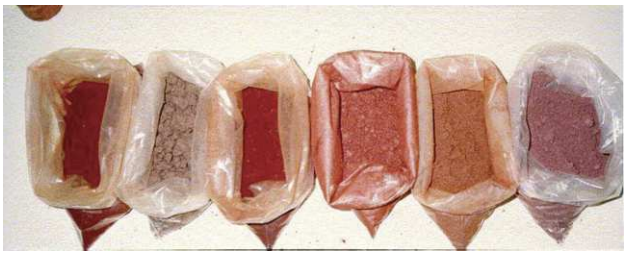

Photo 2. Tropical soils of which Prof. Boscov showed in her presentation.

She showed the necessary steps for using the tropical soils as clay-liner material. The necessary steps she showed are as follows:

1. Materials selection
2. Design criteria
3. Construction method
4. Control

These necessary steps may lead to very different material, construction and control specifications, when different climates, soils and operation procedures are considered.
She showed the update experimental data of compaction properties, shrinkage and expansion properties and hydraulic conductivity of tropical soils.

Finally, she identified the following essentials concerning her presentation:

1. Attributes for layers are clear
2. Available materials
3. Technology to use adequately materials
4. Control to assure expected performance
5. Use previous experience from dam and pavement construction

The summary of the presentation by Prof. Fratalocchi is as follows. The reporter has received the summary from Prof. Fratalocchi. So, her summary is reprinted below.

The contribution by Fratalocchi, Pasqualini and Stella, presented by E. Fratalocchi, introduced some discussion issues on vertical and sidewall barriers, showing some topics that they have been investigating at the Technical University of Marche (Ancona, Italy).

After an introduction on some key issues affecting the sidewall liner stability (e.g. the influence of temperature on the shear resistance at the interface involving geosynthetics, the improvement of the shear strength of mineral liners and interface of composite barriers), attention is focused on the influence of aging in leachate on the interface shear strength of one of the two most critical interfaces of a composite liner: the geotextile-geomembrane interface, which is continuously submerged in leachate.

Results of direct shear tests were shown on samples stored in the leachate collecting tank of a MSW landfill (in order to assure an active leachate), after different ageing, up to more than 3 years.

The ageing in leachate was found to significantly increase the interface shear strength (Figure 1); for all the 4 geotextile-geomembrane interfaces examined, the improvement was found to be appreciable within the first year of aging in leachate, and then it was found to be negligible. The increase in the shear strength strongly depends on the type of geotextile and geomembrane.

In order to investigate the reason of the improved shear strength, some of the samples aged in the leachate, after testing, were washed with water and tested again in leachate. These results showed that the increase in the shear strength is mainly due to the presence of chemical precipitates on the surface of the samples. The precipitates trapped into the geotextile and the scratches observed on the surface of the smooth GM were found to be also responsible of the increased shear strength.

In conclusion, the ageing in leachate seems to increase both peak and residual shear strength at the geomembrane-non woven geotextile interface; this result is particularly important when a new landfill has to be built on an old one. In general, the results show that stability analyses based on interface shear strength parameters obtained from non-aged geosynthetics give safe predictions.

As far as the vertical barriers are concerned, attention was focused on the self-hardening cut-off wall, made of a cement-bentonite mixture, which is one of the technologies that, if properly designed and constructed, can give a good performance in terms of confinement of pollutants. Among the key is-

sues related to this technology, the construction methods and associated problems were dealt with, referring in particular to the discontinuity due to the casting.

The authors showed the experimental program and procedure to prepare and test samples with casting discontinuities. The permeability trend over time measured on the composite samples was compared with the permeability trend of an ideal perfect sample, that is a sample of the same mixture where no preferential seepage through the discontinuity.

The results show that the casting discontinuities can compromise the overall hydraulic efficiency of a CB cut-off wall proportionally to the time elapsed between the castings (Figure 2). No loss of efficiency was found if the elapsed time does not exceed 2 weeks. The loss of efficiency was found to depend on the cement type and percentage. The authors pointed out that the results shown are on the safe side if applied to uneven discontinuities (e.g. created by excavation equipment) since the discontinuities of the samples investigated were smooth.

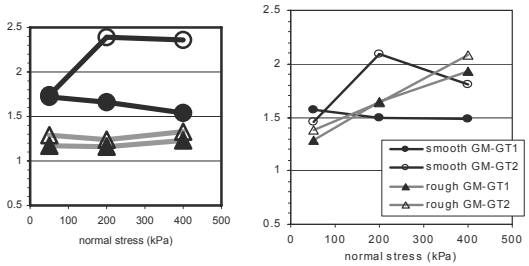


Figure 1. Ratio between the equivalent friction angles of the samples aged 9 months in leachate, $\phi_e(9)$, and the equivalent friction angles of samples submerged in leachate just before testing, $\phi_e(0)$.

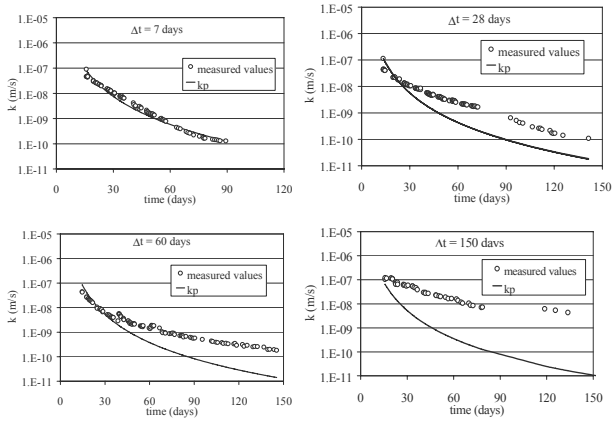


Figure 2. Composite sample of mixture M1: permeability versus time, measured and compared with the values of a perfect sample (Δt = elapsed time between castings of the composite samples).

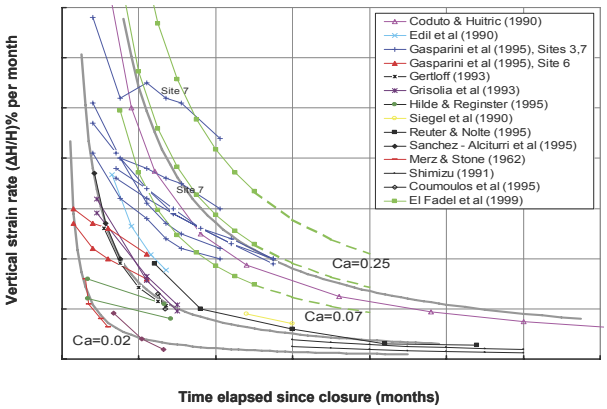


Figure 3 (a). The field data (1) of settlement of waste shown in the presentation of Prof. Coumoulos.

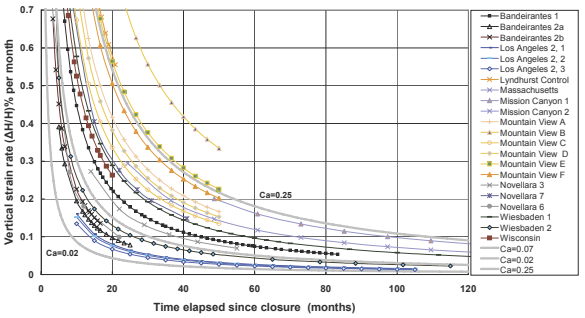


Figure 3 (b). The field data (2) of settlement of waste shown in the presentation of Prof. Coumoulos.

The summary of the presentation by Prof. Coumoulos is as follows. In his presentation, he reported very valuable experimental data about the long-term behavior of landfill covers. The contents of his presentation are based on investigating data of field performance. He showed much data about the vertical settlements of waste such as Fig. 3.

He pointed out that time of installation of the final capping and planning of future development of the site depends on settlement rates rather than total settlements. He also suggested that for the prediction of long term settlement behavior of landfill covers emphasis should be given to the decrease, i.e. the attenuation of settlement rates with time.

The conclusions of his presentation are as follows,

1. Plots of vertical strain rates vs. time are useful to predict attenuation of landfill settlement rates with time.
2. The approach presented is based on observations of settlement behaviour of the waste under self-weight after closure.
3. Plots of settlement strain rates vs. time are useful to compare settlement data from different landfills.
4. Data from various landfills yield similar pattern of attenuation of settlements
5. Landfill data collection should be encouraged to improve knowledge of the history of waste leading to better interpretation of settlement data.

## 5 DISCUSSIONS

After the panellist presentations, a lively and useful discussion occurred. In the discussion, several participants approached the microphone, asked their question, or offered some comments.

Professor Edil, one of the discussers, showed data concerning the relationship between the concentration of Tetramethylene Oxide and the elapse time. Furthermore, he emphasized that it was very difficult to determine the timing of the closing of waste disposal facilities based on chemical degradation.

Another discusser had the comment about long-term behavior of bentonite materials. Many participants had very interesting comments regarding the long-term behavior of facilities and materials.

Professor Daniel, the chairman of this session, was very pleased that each of the speakers stayed within their allotted time, so the session progressed on time and permitted time for discussion.

## REFERENCES

Benson, C. H. (2005), General Report on Technical Session 3a: Waste Disposal and Management, Preprints of 16th International Conference on Soil Mechanics and Geotechnical Engineering, pp. 179-185.