Discussion Session 5.1 / Séance de Discussion 5.1

Managing contaminated sites

Gestion des sites contaminés

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ABSTRACT: This paper consists in a short report of Discussion Session 5.1 - "Managing Contaminated Sites", summarizing up the main topics of the presentations by the Discussion Leader and Panelists, as well as the relevant discussions from the floor.

1 INTRODUCTION

The subject of Session 5.1 – "Managing Contaminated Sites"- is related to the Theme Lecture "Environmental Issues of Geotechnical Engineering" presented by Dr. M. Kamon, which comprised a detailed analysis of the state of technical knowledge of environmental issues, with a focus on the minimization of the environmental negative impact of waste.

Luiz Guilherme de Mello acted as Discussion Leader of this Session. The Panelists, who made short formal presentations, and respective Panel Lectures were: D. Coumoulos ("Prediction of Settlements of MSW in Landfills"), M. Manassero ("Use of Combined Techniques for Remediation of Polluted Sites"), S. Pamucku ("Remedial Technologies for Contaminated Sites") and T. Zimmie ("Case History on Vertical Barriers to Isolate a Contaminated Site"). The Session Reporter was M. Eugenia Boscov.

The 11 papers submitted to Session 5.1 dealt with:

- Restoration of hydrocarbon contaminated site;
- Electro-kinetically enhanced reduction of [(Cr)VI] in contaminated soils;
- Capping of very soft wastes;
- Drainage systems subjected to leachate flow;
- Evaluation of geotechnical barriers;
- Stability of clay suspensions in the presence of surfactant and DNAPL;
- Sensitivity analysis of a contaminant transport model;
- Hydraulic loading capacity for groundwater recharge sites;
- Protection measures for debris flow;
- Formation of tailings dam beaches;
- Sanitary landfill settlement.

The overview of papers to Session 5.1 shows that 7 papers concern remediation and confinement, one of which being related to a case study, and 4 papers were related to problems in degraded sites. This may be a reflex of the proportionally recent involvement of geotechnical engineers in this area of expertise and work in the frame of Environmental Geotechnics.

2 PRESENTATION OF THE DISCUSSION LEADER

The main strategies of managing contaminated sites are containment and remediation. While containment is strongly based on geotechnical issues, remediation is a multidisciplinary task involving geotechnical, physical, chemical, biological and probably other areas of expertise.

Topics of containment techniques still under discussion among geo-environmental engineers are: materials, design criteria, construction methods, short-term monitoring to allow acceptance of works, and long term monitoring to ensure and document long-term performance.Issues about materials comprise the utilization of local materials, reutilization of waste by-products and development of new synthetic materials or composites.

Since so far local soils have been the most employed materials, relevant soil properties for containment are already established: saturated and unsaturated permeability, compatibility, diffusion, and attenuation or retention capacity.

Another area of concern is the integrity of capping system and vertical barriers, the latter being relatively difficult to access and monitor to insure performance.

Tropical soils were mentioned as an example of utilization of local materials. Compacted tropical soil usually have higher permeability coefficients than stipulated to CCLs. Furthermore, index properties (grading curve and Atterberg limits) do not correlate adequately with geotechnical properties, what has enhanced the search for new methods to screen unsuitable soils. Tropical lateritic clays show low swelling and high shrinkage, pointing out the need to review practical lessons and routine criteria for soils acceptance in construction of CCLs; they may present high retention capacity due to peculiar mineralogical composition and microstructure, generating a better CCL than other soils that comply with the routine acceptance criteria.

As an example, a research about the evaluation of the migration of ^{226}Ra through the bottom CCL of the wastewater disposal reservoirs of an industrial plant was presented.

The local soil, natural candidate for the construction of the CCL, is a red lateritic clay, forming a 6-m-thick superficial layer at the disposal site. The top of this layer will be excavated to the depth of 1 or 2 m, and compacted in order to achieve a more resistant and less permeable bottom layer.

Radium concentrations were analyzed in samples of the natural soil and of the fluid to be disposed of in the reservoirs (actually, a synthetic effluent produced in a pilot plant and treated with lime, very similar to the prospective treated leachate). The high radium concentration in the natural soil, compared to the treated leachate, indicated the need to employ a more concentrated solution in the diffusion test to visualize the diffusion mechanism.

Diffusion tests were carried out with soil samples compacted inside a diffusion cell in conditions similar to the soil to be compacted in the clay liner (optimum water content and maximum dry unit weight at Proctor energy).

The tests were carried out for 15 days and were interrupted when there was still a transient chemical flux. The soil specimens were divided into four slices of equal thickness, which were oven dried at 105-110°C. ^{226}Ra concentrations were determined for a background sample, the four soil layers, the original solution and the solution after 15 days in contact with

the soil sample. An instrumental method for ^{226}Ra analysis in soil was developed. Results are presented in Table 1.

Table 1. Radium concentrations (Boscov et al 2001).

Sample	Dry mass	Activity per mass (*)	Activity (*)
	g	Bq/kg	Bq
Layer 1 -Top	55.87	6258.35	349.71
Layer 2	58.67	13.87	0.81
Layer 3	57.11	3.35	0.19
Layer 4	56.10	3.35	0.19
Total	227.75		350.90

* After deduction of the background activity of the soil.

Results showed that most of ^{226}Ra which diffused from the solution into the soil was retained in the upper layers of the sample, and that just a small percentage of ^{226}Ra migrated to the subjacent layers: 99.7% of the initial mass of radium was retained in the upper 4.5cm of the soil layer..

The permeability coefficient is 10^{-5} m/s for the natural soil (porous colluvial lateritized soil) and 10^{-9} m/s for the compacted soil.

Considering that the clay liner will have a low permeability coefficient when properly designed and constructed, the most important mechanisms for radium migration through the subsoil in the wastewaters reservoir will be diffusion and adsorption. Diffusion test results showed a high retention of radium in the upper layers of the soil, surpassing the effects of migration by diffusion, even if the solution concentration is extremely high (the test solution was much more concentrated than the prospective treated leachate to be disposed of).

The Discussion Leader concluded his presentation proposing a few discussion topics for the session:

- Degree (level) of containment or remediation;
- Acceptable risk limit concentrations of pollutants;
- Prediction of water and contaminant migration rates through cover system and barriers;
- Evaluation of environmental risks for containment systems.

3 PANELISTS DISCUSSIONS

Dr. Coumoulos focused on settlements and settlement ratios in the final capping system, as generated in MSW disposal areas.

Some relevant aspects to be considered in the analysis of waste settlements are the high temperatures and high pressures occurring in the waste mass.

The discussion was centered mostly in the prediction of waste settlements.

It was stated that waste from different parts of the world have very similar behavior, but there is overall lack of data, either from initial or long-term settlements.

There was agreement about the difficulty of estimating settlements resulting from the fact that the age of refuse, and consequently the rate of settlement, varies along depth. Lower layers may be submitted to biodegradation and secondary compression, whereas upper layers are submitted to compaction efforts.

A full case history of a waste fill is difficult to obtain. One suggestion from the floor was to combine chronological data from newspapers, inquiries and other with the thorough MSW composition characterization from bottom to top. However, the Discussion Leader and the Session Reporter feel that this line of research may not arrive at positive results.

The best method to fit field measurements was also discussed.

Other question referred to gas and leachate pressures, which should be considered in stability analysis as they are known to have caused local instabilities in some landfills in the past, but are very difficult to measure and to separate.

Dr. Manassero emphasized two important aspects of remediation:

- The need to express aspects of practical application; despite the fact that remediation is being studied in many research centers, there is not sufficient number of established case histories;
- The difficulty in dealing with polluted areas, because of the complexity of boundary conditions, soil profiles and types of contaminants in the field; it may even be very difficult to evaluate the contaminant distribution in subsoil.

One point of discussion was the concern with rebound and duration of remediation. Is there a method to predict the duration of remediation? Upon monitoring results, how should extrapolation of behavior along time be carried out? Should there be a limit concentration to stop?

The problem of characterizing soils and water background threshold levels was also addressed, as well as the need to standardize cleaning up limits combined with risk assessment. Decontamination levels must be debated, among others, with health professionals.

Dr. Pamucku discussed remedial technologies for contaminated sites by means of physical/chemical systems for soils not amenable to hydraulic treatments.

The electrochemical stabilization of [Cr(VI)] to [Cr(III)] is a very promising in-situ alternative, as it may reduce hazard without removing [Cr(VI)] from the soil.

One point of discussion was the use of this technique for other pollutants; for substances that degrade in the ground, extraction may not be the right technique.

Dr. Zimmie presented a case study of a landfill for soil contaminated by PCBs, contained by bentonite slurry walls. Routine control tests were performed during construction work to assure integrity of the walls.

Questions from the floor were related to the integrity and the gas permeability of the walls. It was mentioned that in the UK there are recommendations to employ geomembranes because of gas pressure and to avoid methane percolation through the slurry walls.

Another point of discussion was related to the evaluation of the permeability of the slurry wall, referring to test fluid and test equipment.

Description by the Panelist of a localized failure that occurred during construction, led to the discussion from the floor that the cause could have been related to the high gas pressures existing in the area to be isolated.

REFERENCES

Boscov, M.E.G.; Cunha, I.I. & Saito, R. 2001. Study of radium migration through clay liners in waste disposal sites. *The Science of the Total Environment* 266(1-3): 259-264.