UTILIZATION OF THE GERMANY RECOMMENDATION E 1-7 GDA IN THE CLASSIFICATION OF THE MUNICIPAL SOLID WASTE FROM RIO DE JANEIRO - BRAZIL

ID 058

André V.A. BORGATTO[1], Ronaldo L.S. RIZZO[1], Cláudio F. MAHLER[2]

[1] M.Sc. and PhD Student of Environmental Geotechnical, UFRJ/COPPE/ Rio de Janeiro, BRAZIL /Leichtweiss Institute for Hydraulic Engineering, Department of Waste Management, Technical University of Braunschweig, GERMANY
[2] Federal University of Rio de Janeiro, UFRJ/COPPE/ Department Civil Engineering, Rio de Janeiro, BRAZIL
aborgatto@gmail.com

ABSTRACT

The following work describes the classification of municipal solid waste (MSW) of Rio de Janeiro/RJ/Brazil according to the established criteria by the German recommendation DGGT E 1-7 GDA (1994). This recommendation deals with the identification and description of residues according to waste mechanics. These studies will give to the environmental control agencies and the companies responsible for the final residues disposal a new approach about the geotechnical characteristics of the waste.
The residues are classified regarding the type, identification and its condition. From the determination of the residue type the indications for the analysis into groups of substances are obtained in a second step.
The dimensions of the waste particles were emphasized considering their size, length and volume. In this way, materials with one significant dimension (e.g. rope), two significant dimensions (e.g. foil), three significant dimensions (e.g. coconut, volumes) and small particles (e.g. grain) were identified and separated.
The results had shown that in the Rio de Janeiro sample the percentage of waste with 1 significant dimension and 2 significant dimensions is higher than in Germany.

Key Words: MSW, Morphologic Classification, Sanitary Landfill, Fiber Reinforcement.

INTRODUCTION

In the past few years the world concerning about the Municipal Solid Waste (MSW) issue is growing. In Metropolitan Centers, where the available spaces for waste disposal are becoming rare, the situation is even more problematic. As a consequence various tentative have been made to make longer the lifespan of these areas.
These studies presented usually lack of knowledge about the characteristics and behavior of the MSW. This fact produces harmful and unexpected consequences. Slope stability problems in MSW landfills have occurred all over the world, including Brazil, as for

example the sliding occurred in 1991 at Bandeirantes sanitary landfill, located in São Paulo city.
This paper has therefore as objective the application of a morphologic classification of Brazilian MSW based on the German regulation DGGT (1994) – E 1-7 GDA. The results found using this classification give information for a better analysis of MSW landfill stability by including the fiber reinforcement effects.

TEST PROCEDURES

The first activity carried out was the identification of the residues from the location where the samples have been collected. This identification comprehends the following points:

- Amount of residue received (t/day);
- Type of the residues;
- Origin of the residues;
- Supply type;
- Estimation of the homogeneity of the residues.

Sampling

The samples were collected in the MSW storage and redirection shed of COMLURB* in Jacarepaguá-Rio de Janeiro.
Once the samples collection was done, these were taken to an external area where they were deposited on a plastic blanket in the interior of a square formed by wood rulers with the 2.00 x 2.00 m dimension, having as purpose the execution of the homogenization process and quartering.
The sampling procedure was repeated until approximately the acquisition of a sample with the volume of a COMLURB's standard container, witch means, approximately 50 kg of MSW was obtained.

Physic Characterization Carried Out

At COMLURB's laboratory the following physical analyzes had been made:

- Determination of water content;
- Distribution of the substances groups according to the regulation established by the German DGGT (1994);
- Analysis of the pieces sizes that compose the groups of substances established by the German regulation DGGT (1994);
- Morphological classification by groups of substances established by the German regulation DGGT (1994).

Water Content

After the collection the buckets were weighed and in sequence led to the selection table for the residue separation and placement into trays that were taken to the oven, remaining there

* Municipal Company of Urban Cleaning

at a temperature of 70 ºC until a constant value had been reached (at least 48 to 72 hours). Through this procedure the water content of the samples was determined. The water content was determined for each group of substances.

Distribution Into Substances Groups

The distribution into groups of substances consists of the MSW samples separation as defined in German regulation DGGT (1994). These samples are separated in such a way that each group of substances presents characteristics of similar materials regarding to the mechanical behavior and biochemistry stability. The groups of substances are:

- **Big Pieces:** big residual substances, composed by diverse components as furniture, mattress, etc;
- **Paper/Cardboard:** residual substances basically composed by paper or paper similar fibers, like cardboards, paper packing, carpets, diaper, etc;
- **Soft Plastics:** residues composed basically of soft synthetic substances or with similar characteristics, like soft plastic packing, plastic foils, textiles, soft rubber, soft leather, etc.;
- **Hard Plastics:** residues composed basically of hard synthetic substances, like rigid plastic packing, PET bottles, rigid plastics, rigid leather, hard rubber, etc;
- **Metals:** ferrous metal and non-ferrous metal;
- **Minerals:** residues that basically are composed by mineral substances or present similar mechanical or biological behavior (inert) like glass, ceramic, soil, etc;
- **Wood**;
- **Organic:** residues that have natural origin, organic, e.g. vegetables, grass cuttings, plants, dry leaves, etc.

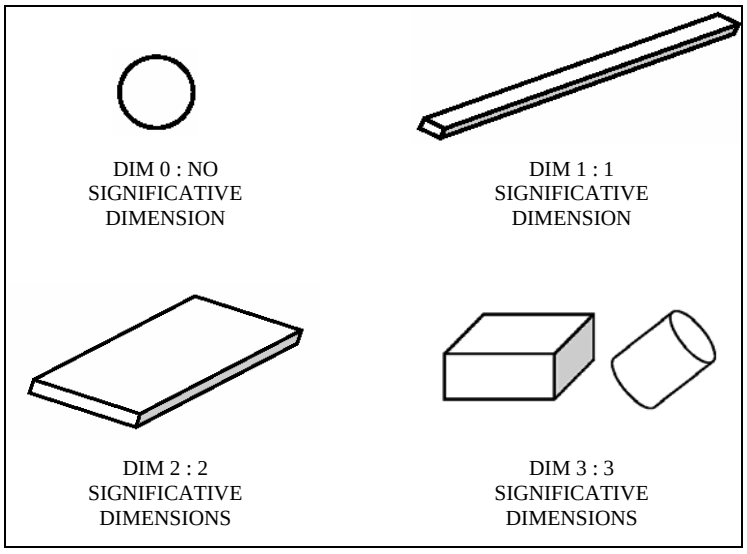

Figure 1.: Parameters considered in the morphologic classification of the MSW.

Morphologic Classification of the MSW

The morphologic classification of the MSW was carried out based on the German regulation DGGT (1994) intending to classify the residues regarding its form and size according to relevant mechanical characteristics. Each group of substance was submitted to this geometric description considering the parameters observed in Figure 1.
The MSW was also classified according with the pieces sizes. The fraction bigger than 120 mm was visually separated and again visually separated into 500 mm and 1000 mm sizes. The remaining fraction was sieved according to the proceeding applied for soils following the Brazilian technical regulation NBR-7181. Two sieves for big dimensions were primary used, the 40 and 8 mm mesh. The fraction that passed was sieved into seven different diameter sizes (37.5, 25, 19, 9.5, 4.75, 2.36 and 2mm).

RESULTS

Classification Into Groups of Substances

The values of the classification into groups of substances are given in percentage of the total mass related to dry weight. The result is presented in Figure 2.

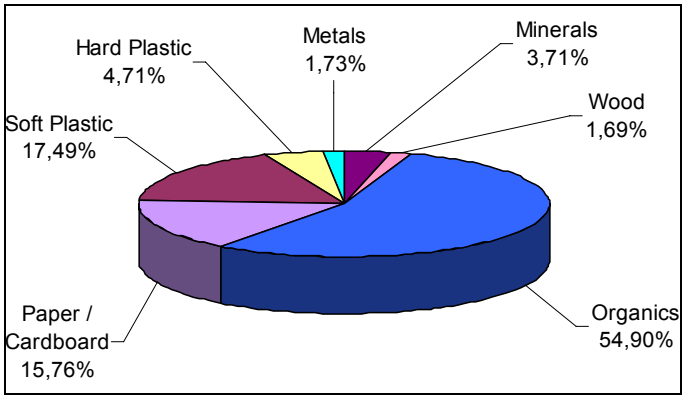

Figure 2.: Groups of MSW substances studied.

Classification According the Morphology

As described before the classification according to the morphology is a combination of sieving and description of the geometrical dimensions. The morphologic classification of the substances groups is shown in Figure 3. The results are also given in relation to the total dry mass of the sample.

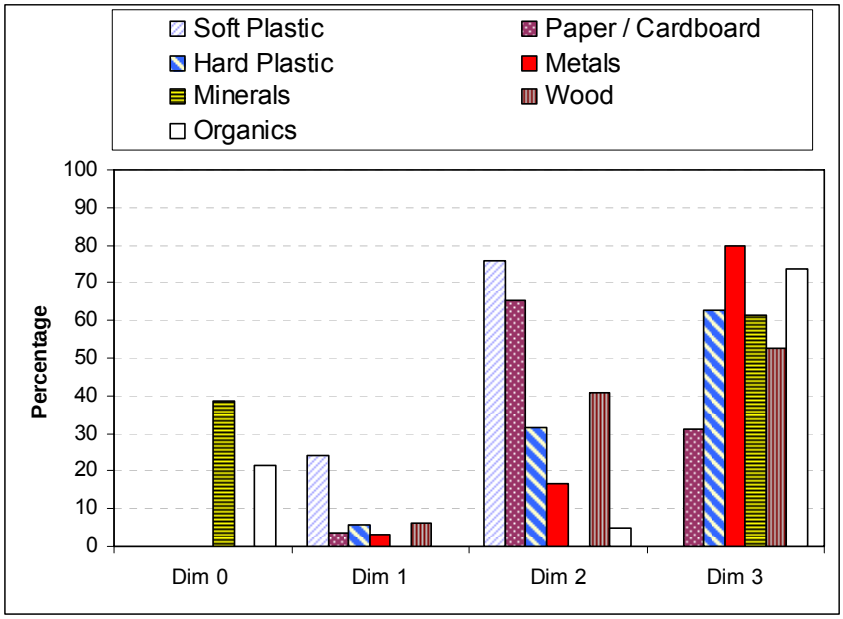

Figure 3.: Morphologic classification of the studied MSW substances groups.

Considering the waste mechanics, regarding the increments of shear resistance, the percentage of fiber materials with dimension 1 and 2 are the most interesting due to the reinforcement generated. In analogy with the reinforced soils, the amount of fibers in the mass influences the reinforcement gain.

At the soft plastics group it was noticed that the material with the dimension 2 is composed mostly (~ 76 %) by plastic bags, plastic packing, textiles materials, etc.

At the paper and cardboard group, the dimension 2 is composed by paper sheets, cardboards, newspaper, smashed packing boxes type Tetra Pak, etc (~65 %). The dimension 3 is composed by cardboard boxes, packings, among other materials. One important point to be observed is that materials that compose the "dimension 3" group can, inside the landfill body, become dimension 2 materials because the smashing resulting due to the loading.

At the hard plastics group, the high percentage of dimension 3 is explained by materials such as PETs bottles, different types of plastic packings, etc. Again, as at the hard plastics group, the metal group shows a high percentage of dimension 3 materials, which is explained by the presence of food cans, vegetal oil cans, drink cans, etc.

The mineral group presented materials with 0 dimension like small pieces of ceramic and glass. The percentage of dimension 3 is represented, in its majority, by glass recipients.

The wood group presented materials like wood foils (dimension 2), boxes and packages (dimension 3).

At organic group was found rests of food and organics in general that depending of its size and shape were placed at 0 and 3 group. The high percentage of dimension 3 is explained by the presence of voluminous materials such as coconuts, oranges, among others.

The sum of the obtained results for all the groups of substances can be observed through Figure 4.

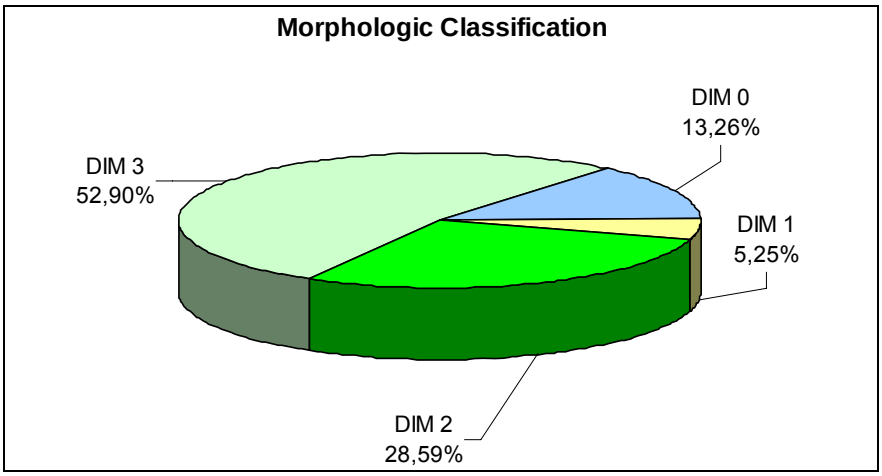

Figure 4 - Sum of the obtained results through the morphologic classification of the studied MSW substances groups.

Through the visual analyze of the sample, the fraction bigger than 120 mm was separated into 120, 550 and 1000 mm sizes. After that the residues passed through the 40 and 8 mm sieves. The passing fraction was sieved using the small diameters mesh sieves ending the process. (the value in tab 1 is also % in retained weight; all values are related to dry weight) The fraction of each sieving process of the substances groups is indicated into the Table 1.

Table 1.: Results from the sieving process.

Group of Subst.	Visual Analysis			Sieves % in retained weigh							
	1000 - 500 mm	500 - 120 mm	120 - 40 mm	40 mm	8 mm	1"	¾"	⅜"	4	8	10
Paper Cardboard	-	26,47	68,3	5,23	-	-	-	-	-	-	-
Soft Plastic	23,57	41,43	34,13	0,87	-	-	-	-	-	-	-
Hard Plastic	-	12,43	84,62	2,95	-	-	-	-	-	-	-
Metal	-	-	97,82	2,18	-	-	-	-	-	-	-
Mineral	-	24,56	31,78	10,5	6,9	4,78	3,56	5,69	3,01	5,76	3,52
Wood	-	10,12	76,34	13,5	-	-	-	-	-	-	-
Organic Mater	0	0	21,45	17,5	12	6,89	9,35	7,69	8,32	8,54	7,97
Total (%)	4,12	13,09	36,66	11,4	7	3,96	5,27	4,43	4,68	4,9	4,51

The total percentage of each group of substances was calculated as the percentage of each size divided by the percentage of each group of substance presents into the MSW sample.
In order to give an example of the results produced by the MSW morphologic classification use, stability analyses have been carried out in a generic section of a sanitary landfill. At the first analyze the classic method based on the soil mechanics was used (without considering the fiber reinforcement) and at the second analysis a software developed in Germany called GGU-Stability that considers the fiber reinforcement. The results are presented in Table 2.

Table 2.: Comparison between the analyses methods of stability.

Section 01 Fresh MSW						
Parameters	Classic Methods (without fiber reinforcement)			Presented Method (with fiber reinforcement)		
	r_u=0,0	r_u=0,2	r_u=0,5	r_u=0,0	r_u=0,2	r_u=0,5
Friction Angle (º)	30,00	30,00	30,00	30,00	30,00	30,00
Cohesion (kN/m2)	15,00	15,00	15,00	15,00	15,00	15,00
Specific weight (kN/m3)	10,00	10,00	10,00	10,00	10,00	10,00
Internal Angle of Cohesion ζ (º)	-	-	-	35,00	35,00	35,00
Correction Factor α	-	-	-	0,50	0,50	0,50
Apparent Cohesion (kN/m2)	-	-	-	125,00	125,00	125,00
Safety Factor (SF)	1,72	1,44	1,00	2,43	2,15	1,72

As expected the fiber reinforcement leads to higher values for the safety factor. However, the fiber effect should be used for the landfill planning under the Brazilian conditions very carefully once the collapse can occur due to other reasons as fire inside the landfill body, pore pressure caused by leachate recirculation, etc.

CONCLUSIONS

1. The morphologic classification of MSW is very valuable for waste mechanics analysis since it depends on the shape and size of the waste particles. By determining these new MSW characteristics it was possible to include in the slope stability analyses the effect of fiber reinforcement, because the materials presented dimension (dimension 1+2 – fiber material) and part size (40mm) with percentages compatible with recommendations in previous studies. When comparing fiber reinforced soil, the concentration and size of the fibers are also compatible, being able to apply the effect of reinforcement despite the mechanical behaviour difference between soil and MSW.

2. Percentages of materials with dimension 1 and 2 - the fiber materials responsible for the reinforcement effect on the MSW shear strength - had presented value (33.84%) above the concentration level in literature (25.0%) for fresh waste, inducing even higher values of reinforcement than already presented.
3. Practice shows that a landfill can collapse due many reasons such as the high pore pressure inside the mass, poor compaction, fire, new building operation in the landfill, etc. For this reason the fiber reinforcement should be considered for back analysis in case studies of accidents. For the planning of new landfill areas and the maximum final slope it should be used very carefully, because the results may put a safety on it which could not represent the reality.

ACKNOLEDGEMENTS

The authors would like to register their acknowledgement to COMLURB from the city of Rio de Janeiro, for the research permission in its MSW unit of Jacarepaguá. CAPES, CNPQ and FAPERJ for their financial support and Technical University of Braunschweig, LWI - Department of Wastemanagement of their technical support.

REFERENCES

1. BORGATTO, A.V.A (2006): Study of the Fiber Effect and Morphology in the Stability of MSW Landfills. M.Sc. Dissertation, Federal University of Rio De Janeiro, COPPE, Civil Engineering Program, Department of Geotechnics, Rio de Janeiro, RJ, 157p.(in Portuguese)
2. COMLURB (1999): Gravimetrical analysis of the waste from Rio de Janeiro City, RJ. (in Portuguese)
3. COMLURB (2005): Gravimetrical and Microbiological characterization of the MSW from Rio de Janeiro City, RJ. (in Portuguese)
4. DGGT, Deutsche Gesellschaft f_r Geotechnik (1994): Empfehlungen des Arbeittskreises "Geotechnik der Deponien und Altlasten". E 1-7: Identifizierung und Beschreibung von Abfallen (Entwurf). Bautechnik 71, Helf 9, Berlin: Wilhelm Ernst & Sohn.
5. KOLSCH, F. (1993): The Bearing Behaviour of Domestic Waste and Related Consequences for Stability. Proceedings Sardinia 93, Fourth International Landfill Symposium, S. Margherita di Pula, Cagliari, Ita1y, 11-15 october 1993, p.1393 - 1410.
6. MAHLER, C.F.; BURIN, E. & OLIVEIRA, F.J.P (1998): Reflections on the Stability of a Municipal Sanitary Landfill. Environmental Geotechnics, Vol. 1, 3d International Congress of Environmental Geotechnics, Lisboa Sept/1998.