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Sanitary landfill technology – Application for rehabilitation of uncontrolled waste dumping site – A case study

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ABSTRACT: Environmental damage in Matosinhos area due to uncontrolled solid waste dumping led municipal authorities to develop a site rehabilitation program. The engineered solution transforming the dumping area in a sanitary landfill site following environmental protection standards is presented in this paper.

1 INTRODUCTION

Matosinhos is a municipality with an area of 62 Km^2 and 155 000 inhabitants located in the metropolitan area of Porto in the portuguese north-western region, where for decades, municipal solid waste (MSW) was uncontrolled disposed of on the land originating serious environmental problems.

Recent portuguese policy for solid waste is based on modern concepts of waste management, with emphasis for selective collection systems, recycling and treatment by incineration technology in the metropolitan areas of Lisbon and Porto; and by sanitary landfill technology for all the other municipalities in the country. Following this objectives the municipality of Matosinhos decided to rehabilitate the dumping area by means of the construction of a sanitary landfill for a design period of five years.

2 THE PROBLEM

2.1 Introduction

Matosinhos MSW dumping area is located at Pinguela village in the northern Leça river-side (known as one of the heaviest polluted portuguese rivers), where it is estimated that 700 000 tonnes of MSW have been disposed since 1978, occupying a volume of more than 10^6 m^3. The authorities wanted to solve this problem recovering the dumping area simultaneously with a daily deposition of about 200 tonnes of waste.

2.2 Rehabilitation design

The technical approach for the solution was based on successive steps for closing parts of the dumping area, while new cells for waste disposal and other constructions were built (see Figure 1).

The action program was established in three phases:

A) closing the largest and oldest waste cell;

B) construction of the sanitary landfill composed by: a) supporting zone (administrative building, workshops, control building and car-parking); b) deposition area (three impermeabilized cells for MSW); and c) infrastructures for environmental protection (aerated lagoon for leachate treatment, storm water drainage system, collection systems for leachate and biogas drainage, biogas burning

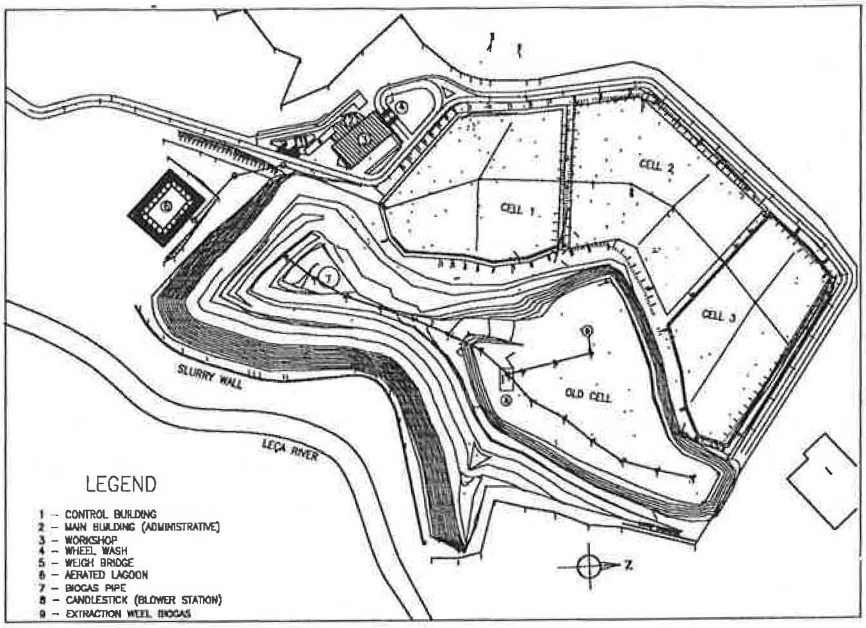

Figure 1 - Plan of Matosinhos sanitary landfill

system) d) complementary infrastructures (wheel wash, fences, entrance area);

C) old waste transfer to the new impermeabilized cells. The waste transfer to the new cells had two major moments: in the first one about ¼ of the maximum height of cells n.1 and n.2 were filled with old waste; in the second one the disposal of new waste started in cell 1. The closure of the dumping area was made by covering the waste with soil simultaneously with the mentioned actions and consisted in the following:

1. landscape modelling due to the necessity of slopes stabilisation, construction of an access to the top of the cell and placement of the flare to burn the biogas;

2. construction of a slurry wall in the adjacent river-side of Leça. The objective was to stop the river pollution due to leachate coming from the cell. In the interior part of the wall it was placed a drain to collect the leachate to two wells localised in the south end of the wall, from where the leachate is pumped to the lagoon for treatment. This solution showed to be about 50% less expensive than waste transference to a new cell;

3. construction of a drainage ditch along the North and West slopes for collection to leachate treatment plant. This drain was buried due to the fact that all the landfill infrastructures were constructed in this side of the dump;

4. biogas and leachate collection systems construction on the top of the dump. The gas drainage system is composed by trench drains with a three branches star configuration with a ϕ 175mm HDPE pipe wrapped with gravel. The system is connected with the biogas wells and has variable

lengths (20 to 40m in the horizontal and 4 to 5m in the vertical). The biogas wells with ϕ 500 mm have about 10m depth and placed inside HDPE drilled pipes with ϕ 200 mm wrapped with gravel. The horizontal biogas drainage system is composed by HDPE pipes with ϕ 200 and ϕ 300 mm placed over an earth pad, in its lowest levels there are drains to collect the condensed. This system is connect with the biogas burning unity;

5. To minimise leachate production the top and the north, east and west slopes were impermeabilized;
6. construction of a stormwater drainage system. To control the effects of stormwater run off on the slopes a drainage system was built;
7. A 2000 m^3 capacity aerated lagoon was constructed to treat the leachate. The aeration is achieved by 3 floating turbines working 16 hours per day. All the leachate coming from the old dump and from the new cells flows to the lagoon.

2.3 Geotechnical characterisation of the area

The area is placed on the edge of the Porto granite over a gneiss and micaxystus formation.

The survey was made by means of deep drills, holes and permeability tests. The mechanical drills done along the river Leça showed: 0.80m of vegetal soil; alluvium from 0.80 to 2.5m; clayed sands from 2.5 to 2.8m; water table between 2.8 to 3.4m; granitical sands from 2.8 to 4.5m; ochre to grey xystus from 4.5 to 5.7m. And finally, from 5.7 to 9.0m a more or less foliate grey gneiss.

The old dump is placed over the alluvium of the river with maximum thickness of 2m and with a small and superficial water table.

Tests at 1m depth showed permeability coefficients of about 10^{-6} to 10^{-7} m/s.

The particular conditions of the substratum at 5m depth was determinant for the choice of the solution of slurry wall to stop the river Leça water pollution by the waste leachate.

It is important to note that under the cell number 1 there was a spring water that was removed and protected. Piezometers were installed to monitoring the quality of the water that remains in use.

3 GEOSYNTHETICS

3.1 New cells

The base and the slopes of the new cells have the following constitution: natural soil (hard gneiss with low permeability); geotextile; geomembrane and geotextile. Over this structure the leachate drainage system composed by perimetric and central trenches was constructed.

The geotextile placed between the natural soil and the geomembrane has as main functions the separation and protection of the geomembrane against puncture and tear. In this base it was chosen a polypropylene geotextile F-33S with characteristics showed in Table 1.

The joints were executed by double sewing.

It is important that the geomembrane placed between the two geotextiles act as barrier to fluids (leachate and biogas). In this base it was chosen a HDPE geomembrane G-HD60 (Table 2).

Table 1 - characteristics of geotextiles

Properties	unit	F-33S	F-2B
mass per unit area	g/m^2	250	140
Tensile strength	KN/m	12	7
Tear strength	N	320	160
Puncture resistance	KN	1.1	0.6
Water Permeability	cm/seg	13 x 10^{-2}	8 x 10^{-2}
$O_{90\%}$	micron	65	85

Table 2 - characteristics of geomembranes

Properties	unit	G-HD60	G-HD40
thickness	mm	1.5	1.0
Tensile strength yield	KN/m	0.96	0.65
Tear resistence	N	200	133
Puncture resistence	N	355	231

The joints were executed by double welding.

The geotextile placed over the geomembrane (F-33S) has as main functions the mechanical protection of the membrane and also to act as a filter in the leachate drainage system.

3.2 Closure of the old dump

After stabilisation of the slopes a system composed by a 1 mm geomembrane (G-HD40) between two geotextiles was used to cover the old cell. Afterwards, a 1m thickness of vegetal soil was placed over the geotextile in which vegetation was planted. In the more inclined slopes a sheet of HDPE geocells was placed being the vegetal soil placed inside the cells.

4. WORKING CONTROL

The landfill working control is done in a well equipped laboratory for quality monitoring of the solid, liquid and gaseous phases of the MSW by means of periodical analysis using atomic absorption spectrophotometry, plasma emission, gaseous chromatography. Climatic and topographic information are also registered for landfill physical control. The efficiency of the geosynthetics, namely, the barrier effect of the geomembrane in the cells is controlled by the water quality in the piezometers. The geomembrane used in the covering of the old dump has shown some tearing after the deposition of new waste against the slope.

5. CONCLUSIONS

The sanitary landfill of Matosinhos is in operation since 1995. Until now it can be said that its behaviour is very close to that it was expected in the design phase, mainly in what concerns the tightness of the impermeabilization system and the drainage of leachate and biogas. Geotextile and geomembrane used on the top cover to seal old cell of waste must be at least 250 g/m^2 and HD 1.5mm in order to support strength due to friction between new waste and geomembrane.

6. REFERENCES

Russo M.A.T., Vieira J.M.P (1995) Landscaping Recovery of Old Mines by Adequate Landfill Architecture. In *Proceedings Sardinia 95, Fifth International Landfill Symposium* (Edited by Christensen T.H., Cossu R. and Stegmann), Vol. 3 pp. 679-684. CISA Publisher, Cagliari.

Vieira J.M.P, Russo M.A.T. (1995) Design of a Regional Solid Waste Management Program Based on Landfill Technology. In *Proceedings Sardinia 95, Fifth International Landfill Symposium* (Edited by Christensen T.H., Cossu R. and Stegmann R.), Vol. 3 pp. 127-132. CISA Publisher, Cagliari