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Recycled Aggregates from Construction and Demolition Waste for Biogas Draining in Closed Landfills in Morocco

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Abstract: According to the national environmental report of 2010, the amount of waste generated from construction and demolition activities is around 1 million tons every year and still rising. Most of the time, construction and demolition waste end up in landfills mixed with the domestic waste or used to fill an old extraction field of natural aggregates while they can be put to use at the moment of closing landfills and more specially in draining the biogas. To evaluate that possibility, this study comes to compare the draining process based on natural aggregates through the literature with the one based on recycled aggregates from C&D waste, environmentally and economically. And how the recycled aggregates may react to the aggressive chemical composition of the biogas that may influence the draining process. Also the fact that mixing the C&D waste with the domestic waste causes automatically a differential settlement of the waste inflecting an enormous loss in the sealing of the landfill permitting the leak of the biogas to the air.

Key words: Recycled aggregates, gas draining, landfill, environment, air, domestic

INTRODUCTION

Recently, the world is confronted repeatedly to the question about the lack of naturel resources of all kind and specially those of the construction activity.

Adequate waste management and recycling lead to a decrease of consumption of naturel resources and of the amount of waste sent to dumping grounds

Many countries have already invested in the process of recycling aggregates from C&D waste for a reuse in concrete and road construction (Cuevas *et al*., 1994). This study comes to evaluate the situation of the C&D waste that ends up in a landfill mixed with the organic waste collected from the domestic activity.

When the C&D waste is mixed with the organic one we get to face the most dangerous problem that occurred in closed landfills which is the differential settlement of the waste. And that settlement makes the sealing to break, leaking out all the fermentation gas.

Stock piles of the C&D waste made separately from the organic waste must generate a reliable source of recycled aggregates, while closing the landfill, to be used mainly in draining the biogas. And provide an important economical reduce of the budget

GAS DRAINING IN THE LITERATURE

There's many industrial developments in gas draining used while closing landfills using geocomposites and different synthetic materials. But the mostly used way of draining is by using aggregates layer combined with drain collectors to allow the migration of the biogas from underground to the surface of the fill material. Even if it presents problems concerning its resistance regarding the corrosive composition of the biogas.

There was a study by Boo Hyun Nam on the evaluation of the Use of Reclaimed Concrete Aggregate in French Drain Applications in 2014 that resulted to quantifying the primary concerns with using RCA as a drainage material are the fines content and the precipitation of calcium carbonate to cause a reducing in filter fabric (geotextile) permittivity toward water.

But when it comes to gas draining, the reducing in filter fabric (geotextile) permittivity doesn't affect the main purpose of the gas drain and especially when the recycling process contains a part where the fines are separated from the aggregates (Parola and Wolfe, 1964; Ross *et al*., 1991).

Through the literature it has never been specified the exact characteristics of aggregates used as a gas draining material in closed landfills except for the followings that were mentioned in a report by the federal office of environment of Switzerland in 2009:

- A layer thicker than 0.3 m
- Porous fill material
- Mineral composition only
- The most durable

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Table 1: Proprieties of recycled concrete aggregates

Designation	Values
Adhered cement (% by mass)	52.3-55.0
Dry unit weight (km/m^3)	2370-2420
Water absorption (%)	4.88-6.27
Crushing value under 100 KN (%)	3.83-6.30

Table 2: Percent voids

Variable	Minimum	Average	Maximum
Voids (%)	44.30	43.90	42.60

Table 3: Common components of biogass

Components	Content
CH_4	50-75 Vol. %
CO_2	25-50 Vol. %
H_2S	0.005-0.5 mg S/m^3
NH_3	0-1 Vol. %
Water vapor	1-5 Vol. %
Dust	>5 um
N_2	0-5 Vol. %

CHARACTERIZATION OF RECYCLED AGGREGATES

The Table 1 presents some of the most important characteristics that should be verified in the recycled aggregates before use as a draining layer.

RCAs typically exhibit levels of high alkalinity as attributed to the component of mortar (Cook and Colvin, 1980) and this frequently causes the RCA-water mixture to reach pH levels of >11.

Percent voids: The percent void is in this paper, one of the most important characteristic that should be verified and it is related directly to the gradation distribution of the aggregates. In the study conducted by the result of the percent voids were as presented in Table 2. These values of the percent voids look very promising for a porous filling material for biogas draining.

INTERACTION OF THE RCA AND THE BIOGAS

Chemical composition of the biogas: In Table 3, we present a summary of the most common components of the biogas and their different concentrations.

Considering de difference in temperature between the waste and the one of the draining layer, the condensation of the water vapor from the anaerobic digestion may occurs on the surface of the aggregates

Reaction of the recycled aggregates: Due to the aggressive load of acids such as CO_2 and H_2S in the biogas, the recycled aggregates may react mainly because of the calcite left on their surface after the recycling process.

However and considering the high alkalinity of the mixture RCA-water, the reaction between the recycled concrete aggregates and the acidity in the biogas helps to reduce the corrosion of the pipes in the draining system that are made, most of the time, from ferrous materials. Impacting in a good way, the durability of the collection network and the methane gas monitoring installation.

ECONOMIC IMPACT

When using recycled aggregates as a porous fill for the gas draining layer it appears and without any calculation that the economic impact is very important and especially when we mention that the recycling process is the same as the one for producing natural aggregates except for the transportation cost that represents a huge part of the global cost of the filling material in the gas drain.

Francesco Di Maria present the recycling process mostly the same as the one for natural aggregates except for the manual preselecting and the use of the magnet for the extraction of ferrous materials.

That why, when it comes to the global cost of the fill material, we find that the transportation cost represent the most decisive factor on the economic viability and especially when the landfill is located in an area without any natural aggregates extraction potential.

CONCLUSION

Regarding the high availability of the raw material of construction and demolition waste on landfills, the recycling and the reuse of the recycled aggregates as a filling material for the gas draining look very promising and especially if it permits to avoid the differential settlement of the organic waste that causes the geomembrane and the clay barrier to crack.

And also due to the phenomenon of cementation due to rehydration, the recycled concrete aggregates should be separated from the fines, so that these fines that are able to cause the clogging of the filter fabric should be used over the geomembrane to help in the clogging of the cracks that may occur during the settlement of the organic waste as a result from the anaerobic digestion.

RECOMMENDATIONS

For the future, we consider a long term study on the durability of the recycled concrete aggregate as a draining layer and its reaction regarding the clogging of the filter fabric from calcite deposition.

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