Construction of pavers from drilling cuttings as an alternative for environmental management of waste

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INTRODUCTION

Almost 590,000 tons of solid waste were generated during drilling in 2019, of which 3,038.42 tons were hazardous waste.These consisting of small pieces made up of minerals from the drilled formations that are usually impregnated with water-based and/or oil-based muds, which have highly polluting components that are not only dangerous for the environment, but must also be disposed of with special care, This cuttings and fluids are disposed of in the soil, which produces changes in their physical, chemical, and microbiological properties, thus altering water quality through runoff-related processes and affecting the adjacent wildlife.

EXPERIMENTAL

1. Sample traverse

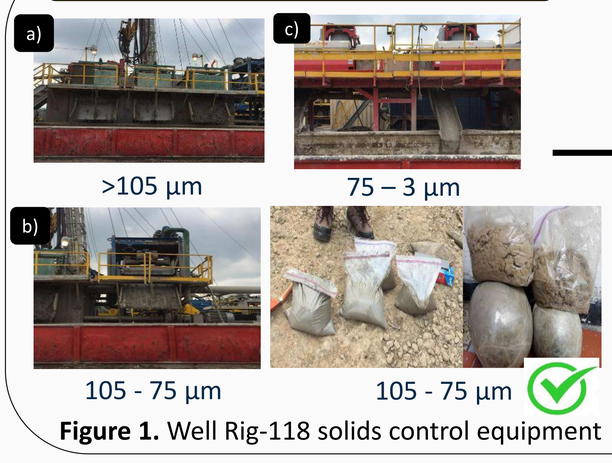


Figure 1. Well Rig-118 solids control equipment

2. Sample composition

Table 1. Geologic composition of drill cuttings in well Rig-118

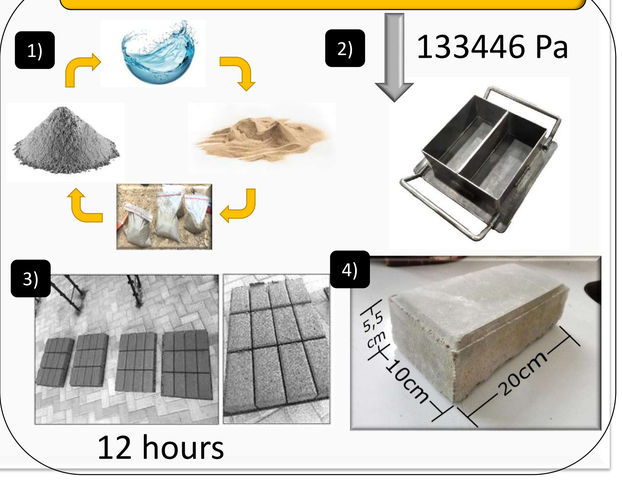
Type	Composition%	Description
Sand	60%	Quartzose, very fine grained, minor fine grained, colorless, sub spherical, good sorting. No hydrocarbon manifestation.
Claystone	40%	Medium to light gray, greenish-gray, moderately firm, sub-blocky; soluble; not calcareous.

3. Materials Ratio

Table 2. Ratio of materials used conventionally vs. ratio used with drill cuttings

Ratio of materials per kilogram of cement		
Material	Conventional [kg]	Experimental [kg]
Cement	1	1
Water	0,35	0,35
Sand	5,3	2,5
Cuttings	**0**	**2,5**

4. Pavers Production



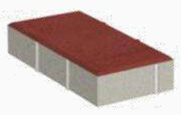
Economic Analysis

$4 USD/Bbl - $6 USD/Bbl

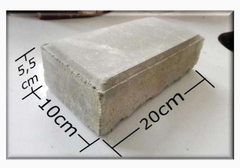
Table 7. Study field riprap disposal costs

Barrels of cuts (BBls)	Total cost of disposal (COP$)
1000	$15.000.000
2000	$30.000.000
3000	$45.000.000
4000	$60.000.000
5000	$75.000.000
6000	$90.000.000
7000	$105.000.000
8000	$120.000.000
9000	$135.000.000
10000	$150.000.000
11000	$165.000.000
12000	$180.000.000
13000	$195.000.000
14000	$210.000.000
15000	$225.000.000

In the field study a well was drilled to a depth of 7345 ft, and approximately 4640 barrels of riprap were generated (7345 ft = 4640 Bbls/cuts)



$400 and $600 COP



$60 COP

Using drilling gravel as raw material for the construction of the pavers, production costs are reduced by up to 85%

$$Cost\ of\ disposing\ of\ a\ barrel\ of cuttings = Unit\ cost * Pavers$$

Cost of a paving stone construction plant

(1) Semi-automatic hydraulic machine model AF 0013

(1) Transported cart

(1) 10x20x6 cm paving block mold

Table 8. Quotation for the implementation of a basic paving stone construction plant.

Quantity	Description	Unit Price
1	Semi-automatic hydraulic machine model AF 0013	$120.000.000
1	Conveyor trolley	$500.000
1	Mold for paving stone 10x20x6 cms	$15.000.000
1	Transportation	$2.000.000
	IVA (19%)	$26.125.000
	TOTAL	$163.625.000

The number of barrels of cuttings produced equals the initial investment costs for the paver plant.

$$Bbls\ of\ cuttings = \frac{initial\ investment}{\$5\ \frac{USD}{Bbls\ of\ cuttings} * TRM}$$

$$Bbls\ of\ cuttings = \frac{163.625.000}{5 * 3.000} = 10.908\ Bbls$$

$$Pavers\ built\ per\ barrel\ of\ cuttings = \frac{158987\ cm^3}{1020} = 155\ pavers$$

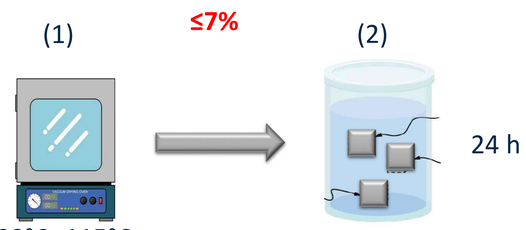
$$Cost\ of\ disposing\ of\ a\ barrel\ of cuttings = COP\ \$60 * 155 = COP\ \$9300$$

Cost reduction 38%.

Results and discussion

Pavers endurance tests

1 Water absorption (Aa%).



$$Absorption\ (Aa), \frac{kg}{m^3} = \left[\frac{M_h - M_s}{M_h - M_a}\right] * 1000$$

Mh = saturated (wet) mass of the sample in grams,
Ms = dry mass of the sample in grams,
Ma = water immersed and suspended mass of the sample in grams.

Table 3. Results of the water absorption test on pavers.

Specimen	Dry Weight (kg)	Saturated Weight (kg)	Absorption %
A	2400.8	2452.7	2.12
B	2324.0	2412.3	**3.66**

A: Pavers built with drilling gravel from well Rig-118
B: Commercial pavers.

2 Flexural strength or modulus of rupture test (Mr) .

Figure 2. Flexotraction measuring equipment of the Universidad Industrial de Santander.

Table 4. Flexural strength requirements, Modulus of rupture (Mr).

Modulus of rupture (Mr), Minimum, MPa	
Average	Individual
5.0	4.2
4.2	3.8

Table 5. Results of the flexural tensile test on pavers

Specimen	Sample ID	Maximum load (N)	Modulus of rupture (Mpa)
A	L5	6602.1	5.9
B	L6	8603.4	**5.5**

3 Abrasion resistance test.

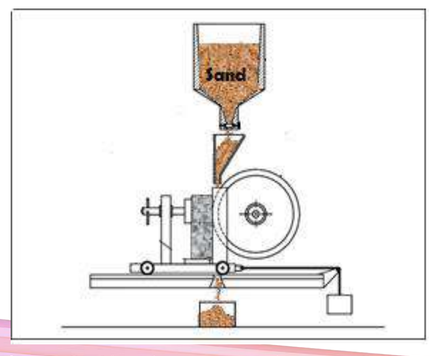


Figure 3. Abrasion test equipment. Source: Colombian Technical Standard 5147, Instituto de Normas Técnicas y Certificación (ICONTEC) 2002. Page 2

Table 6. Abrasion test results

Sample	Dimensions		Calibration factor	Footprint length (AB)	Corrected length (lh)
	Length (mm)	Width (mm)			
A	105	103	20.30	18.70	18
B	100	101	20.30	17.11	**17**

≤23 mm

Conclusion

According to the results of flexural, water absorption, and abrasion tests, the pavers are suitable for the construction of concrete pavers for foot traffic, vehicular traffic on pneumatic tires (including port and cargo terminal yards, airports, transportation terminals, service stations, warehouses, among others), and distributed static loads (from bulk storage) and have a service life of up to 30 years..

Acknowledges

The authors thank to the Materials Characterization Laboratory of the School of Civil Engineering of the Universidad Industrial de Santander and the School of Civil Engineering of the Universidad Pontificia Bolivariana for the characterization tests performed.

References

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