Oedometers tests in compacted tropical soils in the State of Rio de Janeiro, Brazil.

ABSTRACT

Oedometersand secondary oedometrictests with controlled shear rates were performed in two soils from the Baixada Fluminense region, in the city of São João do Meriti – Rio de Janeiro, Brazil. The soils in question are deposited on non-compacted soft soil with the addition of Municipal Solid Waste (MSW). Both samples of compacted soil were excavated at a depth of 10.0 m, and undisturbed samples were collected..

Keywords: oedomerters,edometric, sand, clay, tension

1. INTRODUCTION

This edometric compression test, commonly called “conventional consolidation test”, is the oldest and best known type for determining soil compressibility parameters. The test consists of the axial compression of a specimen, confined laterally, by applying vertical pressures, with a duration of 24 hours and a predefined load ratio.

2. MATERIAL AND METHODS

2.1 Sample Collection

The experimental ground of study was established in 2010 to study the construction of landfills on layers of non-compacted soft soils with the addition of Municipal Solid Waste (MSW), a common environmental problem throughout the country (Mahler, 2018). Moreover, the region where the samples were collected is in São João do Meriti, located in the Metropolitan Region of Rio de Janeiro (22°47'40.5"S 43°21'05.9"W).

Two undisturbed samples were collected in the field. Point 1 in the slope Region and Point 2 in the Central Region of the development. The samples were 25x25x25 centimeters in size. They were rapidly paraffined and protected, in order to not lose humidity. Therefore, they would not undergo changes during transport to the laboratory, where they were placed in a moisture chamber. For safety factors, Point 1 was chosen for appearing to be more clayey and Point 2 for having higher settlements, as previous mention by Deere e Patton (1971).

2.2 Oedometric

The edometric compression test procedure follows the following steps:

Molding of the specimen with the help of a beveled ring to reduce disturbances in the sample during carving; Placement of the ring, with the soil, in the rigid cell that should contain a porous stone at its base with filter paper, to allow the water to drain from the specimen; Assembly of the top plate, or "top cap", which should also contain a porous stone; Displacement meter adjustment for vertical displacement measurements; Application of vertical loads in a loading ratio. For this test, the first loading stage was 0.031 (kg/cm2), with 8 loading stages that were applied to the sample, that is, the loading variation was 0.031; 0.062; 0.125; 0.250; 0.500; 1,000; 2,000 and 4,000 (kg/cm2), and three discharging stages 2,000; 1,000;

0.500 (kg/cm2). Each charging stage must last for 24 hours. During each loading stage, vertical compression measurements of the sample are made as a function of time, for times 0, 0.1, 0.25, 0.50, 1, 2, 4, 8, 15, 30, 60, 120 and 240 minutes. With these data, consolidation curves are constructed, that is, displacement versus time. For the case of cohesive soils, the Casagrande Method is used. In the process of consolidation, the dissipation of pore pressures in the sample occurs. Considering that the degree of consolidation of the sample for a given time factor Tv is identical to the average percentage of pore-pressure dissipation, at the end of the consolidation process (U = 100%) the increase in the effective vertical stress along the entire the thickness of the sample will be equal to the total stress increment applied to the top of the sample. With the deformation values, at the end of each loading stage, a curve of the effective stress versus the deformation produced by the increase of this stress is constructed. This curve can be displayed in various ways, such as vertical effective stress versus void ratio, vertical effective stress versus specific volumetric strain.

The DS test was performed in accordance with standard ASTM 2974 soil procedures, to determine the shear stress (Zhao et al, 2014).. Six tests were carried out at two different points in saturated state, with initial tensions of 75 kPa, 150 kPa and 300 kPa for both points. The sample cell has 36 cm² in area (6 cm x 6 cm), is horizontally split and secured by two screws. The adopted shear velocity was 0.043 mm.min-1. The DS tests were carried out with flooding for at least one night.

2.3 SecondaryOedometric

With the aim of comparing the creep behavior of the soil, creep-type edometric tests (P1 and P2) were carried out on the soil for effective stress levels equal to those previously defined.
The creep study at the points was carried out for an effective stress equal to that found at a depth of 10m (corresponding roughly to the middle of the urban solid waste deposit) plus the stress associated with the construction of a landfill, of large dimensions in plan, with 10m high (landfill = 20kN/m3). Thus, in the tests, we have a value of 210kPa (= 50 + 160kPa) as the effective creep stress,
Creep-type edometric tests were carried out with load steps lasting 24 hours, except for the step corresponding to the effective creep tension, which lasted for 14 days, as described above. After the sample saturation phase (± 24h), the load step corresponding to the effective “resting” tension was applied, immediately followed by the creep step (active for 14 days). This was followed by a load cycle until the oedometer's load capacity was exhausted, ending the test with a discharge cycle.
The interpretation of the results of the creep-type oedometric tests must be done with care, as they are based on intact samples collected at a depth of 4m, different from the depth under study in the referred tests. In this way, they are unfeasible. Quantitative interpretations, although it is possible to elaborate qualitative extrapolations regarding field behavior.

3. RESULTS AND DISCUSSION

3.1 Oedometric

Table 1 - Informative table with average density coefficient values for the 2 points:

Oedometric Test$c_v$ouc_hx 10^{-3}

P1	vertical	37,09
P2	vertical	40,66

The graphs below show the void ratio vs effective vertical stress curve for the different tests performed (figures 1 and 2):

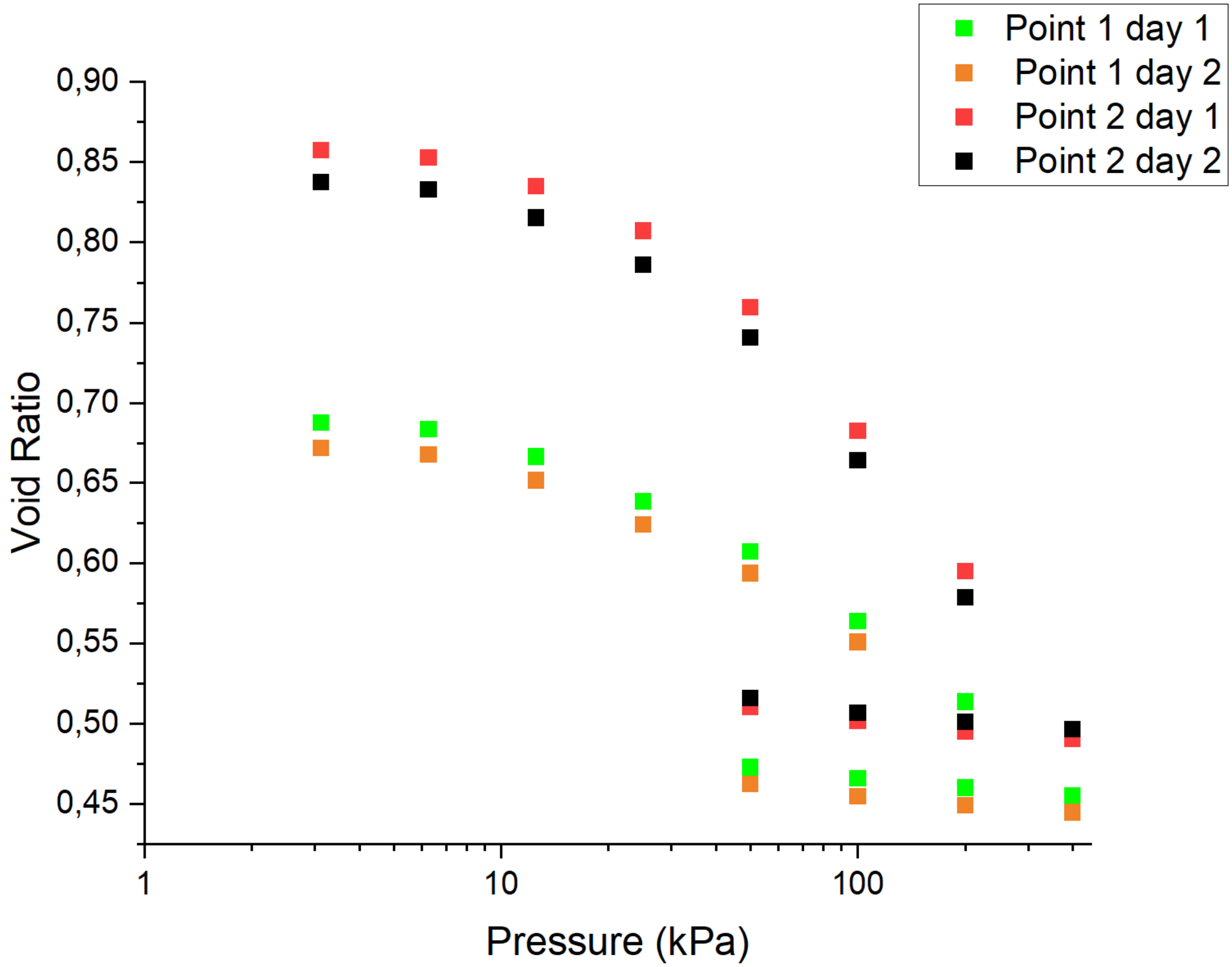

Figure 1: Point 1 and 2 - Void ratio in the different tests

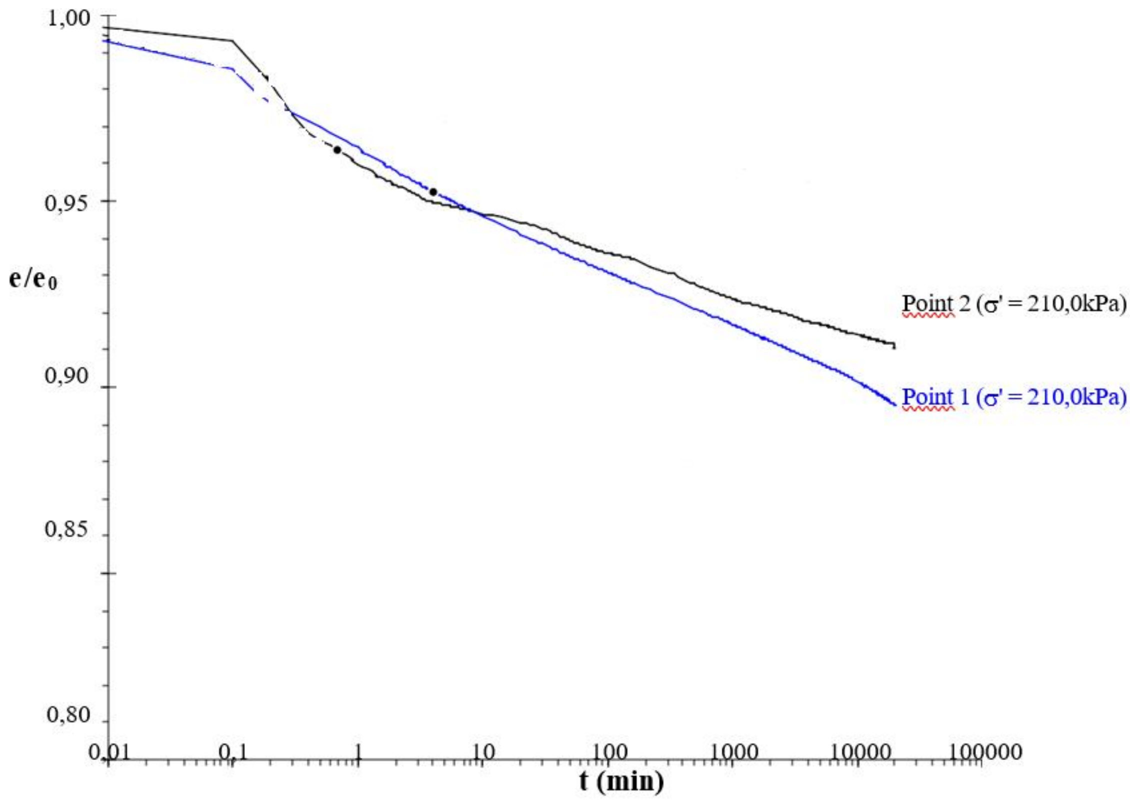

Figure 2: Point 1 and 2 - Void Index in the different minutes (secondary oedometric)

Table 2 - Informative table with average deformation in the creep tension for the 2 points:

Test	C_α Creep Tension (kPa) 210,0
P1	0,023
P2	0,028

Nascimento (2008) found very close results for the silty clay of the Canal do Porto da Baixada Santista in the region of IlhaBarnabé, with an average cv of 79.57 x 10^{-3} cm²/s and a standard deviation of 27.67 x 10^{-3} cm²/s.

4. CONCLUSION

In sample/point 1, a final void ratio was observed in the saturated case lower than in the natural case, as expected. The difference between the initial and final voids index in the saturated soil was also greater. The tests carried out can be considered similar to the twins, in which the sample is tested in the natural and saturated state, in order to have a view of the saturation effect, which was proven.

In the case of sample/point 2, the values of the final void index, of the sample tested in the natural and saturated state, are similar. However, the initial values of the voids ratio of the saturated sample are higher, so that the variation of the voids index in the saturated soil is greater and the greater deformation of the saturated sample was also confirmed.

There was a small difference in the initial moistures of the samples, but not significant.

The compaction coefficient results are typical for soils of this type, with a mean of 39.43 x 10^{-3} cm²/s and a standard deviation of 15.80 x 10^{-3} cm²/s.

Finally, it is worth noting that all the soils present a certain heterogeneity, which justifies certain differences in the characteristics of the soils collected, although from the same area and subject, in principle, to the same conditions of compaction.

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