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# REPLACEMENT OF CRUSHER RUN AGGREGATE AS A VALUE REINFORCEMENT MATERIAL FOR REUSED WASTE OF CONSTRUCTION MATERIALS

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- Wastewater and water suppliers at Campo Grande, MS – Brazil are responsible for the systems' maintenance. This maintenance requires intervention on public pavement, and that leads to pavement pathologies.

# Introduction

- During the process of ditch backfilling, the conditions of the base, sub-base and subgrade of the pavement must be re-established to its previous state. The pavement must endure the same tension it did before the process – this makes such an activity a research topic.

- Crusher-run is commonly used in the ditch backfilling process, because it is easily applied and compressed, even at a high acquisition cost.
- Opening the ditch creates a high load of soil residue, for after those are removed their state is usually swamped - they and are then transported and stored on the company’s courtyard, occasioning an environmental passive.

- This research was encouraged in attention to the problem faced by the local company and in search of adequate reutilization for the inserted soil, also taking into consideration Civil Construction Waste (CCW). A methodology was developed via the California Support Index (CSI), aiming at technical viability in accordance to the requirements of the National Department of Transport Infrastructure (NDTI) pavement manual.

# Methodology

## 1. Civil Construction Waste (CCW) characterization

CCW was collected in a mineral waste site. Further criteria for the samples weren't necessary, since they come out of the crusher under uniform conditions, allowing for simplification of the sampling process.

## 2. Trace elaboration

Three traces were elaborated using the following proportions:

35% and 65% (TRACE 01)

50% and 50% (TRACE 02)

65% and 35% (TRACE 03),

of CWW and Soil respectively (all relations in weight).

We opted for using the soil previously taken out of the ditch and stored in the company's courtyard, since it generates an environmental passive for the company.

The procedure for specimen preparation using the CBR equipment was as described below:

**Step 1:** 7,00 kg of dry trace (100%) disposed on a metallic tray;

**Step 2:** 8% water added and mixed until homogenous trace achieved;

**Step 3:** Trace deposited in a cylinder with 1/5 of the height and compressed with socket 26 blows;

**Step 4:** Process repeated until the fifth part of the cylinder's height.

**Step 5:** Weight measurement of the cylinder containing the trace.

The five previous steps were repeated adding 10% and then 12% water.

**Step 6:** The cylinders were immersed in water for 96 hours, expansion data being taken every 24 hours, filling columns 1 to 4 of the table;

**Step 7:** After 96 hours the cylinder was taken out of the water and left in air for 15 minutes, in order for the water to run out of it.

**Step 8:** Introduction of the specimen through ISC compressing machine.

**Step 9**: Laying the data in tables.

### 3. Determining best trace

It was defined through value comparison between 2.54 and 5.08 mm of table, taking into consideration the NDTI’s Pavement Manual restrictions:

- Expansion being equal to or less than 0,5% and
- CSI equal to or higher than 60%.

# Results

- Optimum humidity:

  First we used trace 35% of CCW with 65% soil taken out of the ditch, testing humidity of: 8%, 10% and 12%. CSI values were compared in relation to resistance and, of all traces, the one that offered better results were the 10% ones. Thus, we considered 10% optimum humidity and the results of the tests were as following:

**Table 1**– (TRACE 01) with optimum humidity

| Results versus restriction | | | |
|---|---|---|---|
| **Physical index** | 35% CCW with 65% soil | | |
| | Test | Condition | Restriction |
| **ISC** | 16,54% | ≥ | 60% |
| **Expansion** | 0,11% | ≤ | 0,5% |

Results weren't satisfactory due to the low percentage of civil construction waste in the trace - that trace, like granulometry is an important factor when aiming for good resistance.

**Table 2** – (TRACE 02) with optimum humidity

| Results versus restrictions | | | |
|---|---|---|---|
| Physical index | 50% CCW with 50% Soil | | |
| | Test | Condition | Restriction |
| ISC | 50,13% | ≥ | 60% |
| Expansion | 0,06% | ≤ | 0,5% |

Once again normative restrictions weren’t met. However, it was possible to perceive an evolution in comparison to the previous tests, validating the importance of large aggregate granulometry in the composition of good resistance, as in the California Bearing Ratio (CBR) tests. It is also important to note that an increase in CCW lead to a decrease in expansion.

**Table 3** – (TRACE 03) – homogenous, optimum humidity.

| Results versus restrictions | | | |
|---|---|---|---|
| Physical index | 65% CCW with 35% Soil | | |
| | Test | Condition | Restriction |
| ISC | 76,46% | ≥ | 60% |
| Expansion | 0,06% | ≤ | 0,5% |

As predicted by previous analysis, the results show increasing resistance. Even though the results for 8% and 12% humidity didn't meet the requirements, the results were better than the previous composition's.

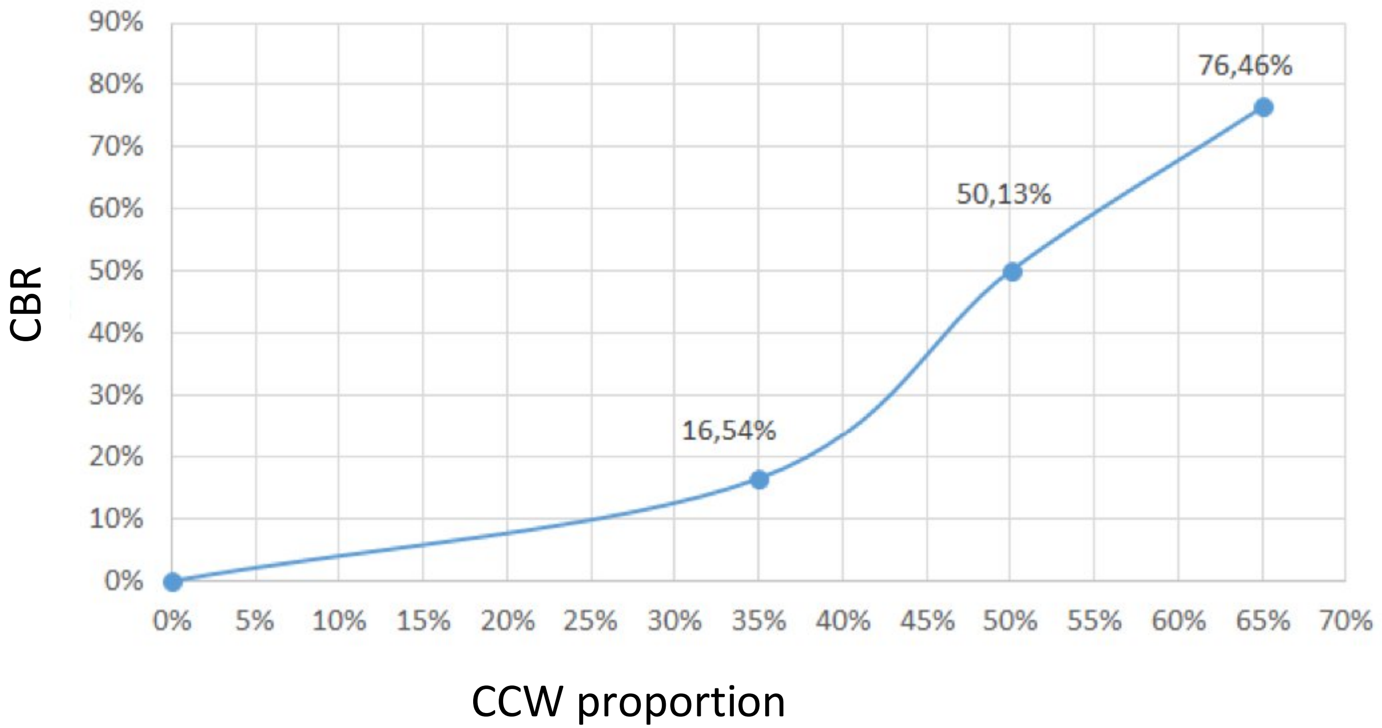
TRACE 03 also had a repeat test, altering the methodology by distributing weight in successive layers of CCW and soil, considering optimum humidity to be 10%.

The results of the layered tests (CCW, soil and water).

**Table 4** – (TRACE 03) – successive layers and optimum humidity.

| Results versus restrictions | | | |
|---|---|---|---|
| Physical index | 65% CCW with 35% soil | | |
| | Test | Condition | Restriction |
| ISC | 61,03% | ≥ | 60% |
| Expansion | 0,11% | ≤ | 0,5% |

# Resistance evolution

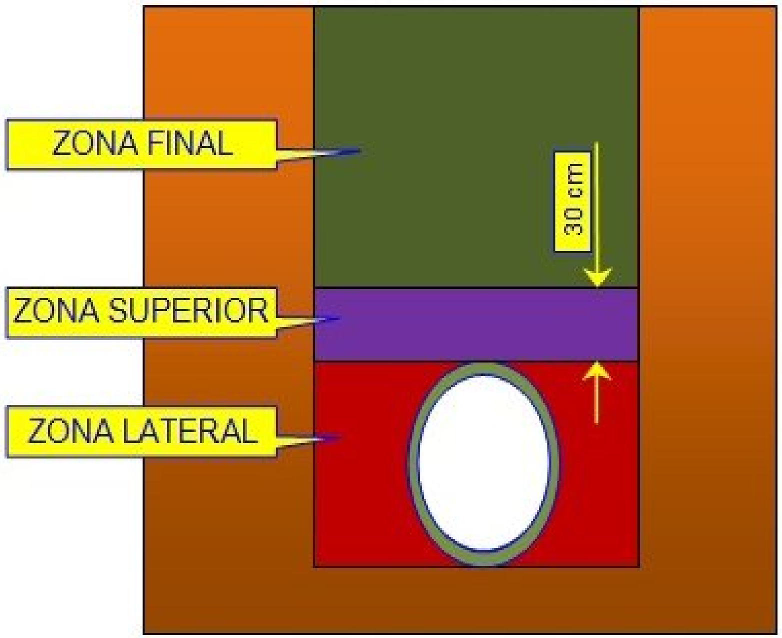



As predicted by previous analysis, the results show increasing resistance for optimum humidity of 10%. It's possible to note the data evolution on the resistance tests, the last trace being the only one that met the requirements of the norm.

# Backfilling execution

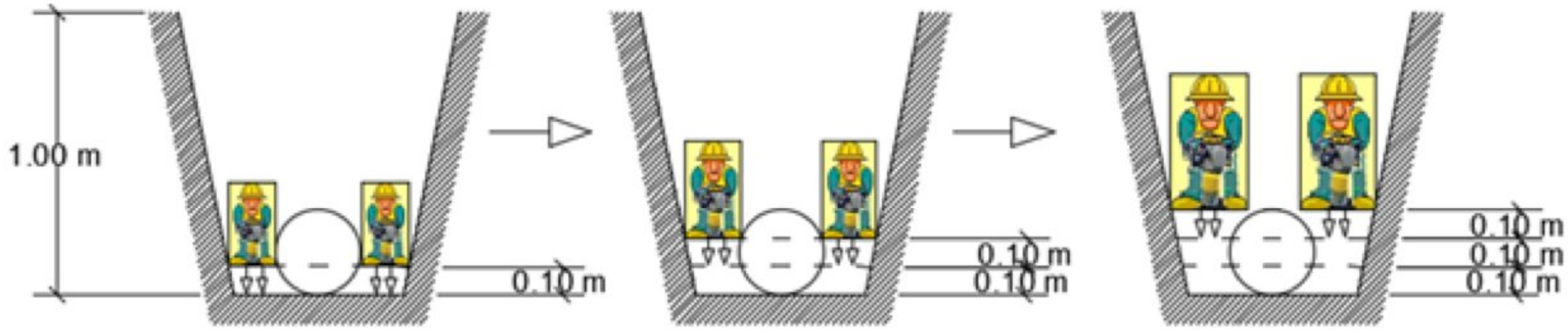
In order to apply the trace in the ditch, the classifications set out in NBR 7367, which are characterized by lateral zone, upper zone and end zone, will be taken into account. As the figure shows

Figure1: Compression zones

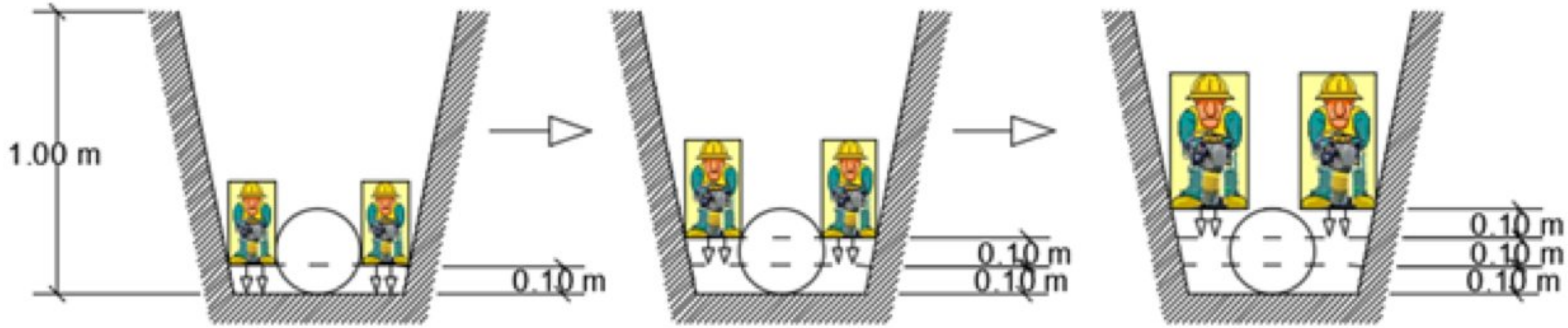


# Field compression

Lateral zones compression




Superior zones compression



# Discussion

- Other factors need to be taken in consideration to reach desired compression: degree of compression, layer thickness, deviation from optimum humidity and how adequate is the equipment.

- Trace 03 (65% CCW/35% ditch soil), 10% humidity, met the minimum requirement demanded by norm NDTI 172/2016 – ME, making it proper for ditch backfilling.

# Discussion

- Another relevant point was the evaluation of water percentages of 8%, 10% and 12%. 10% proved to be ideal in all traces' tests.

- It was also observed that beginning with TRACE 02, an increase in CCW occasioned a decrease in expansion. That is explained by the lesser water absorption capacity of CCW when compared to ditch soil – the larger aggregate expands itself in the presence of water way less than soil does, since its expansion occurs by filling the void spaces in the soil with water. Thus, a reduction in water absorption means elevated resistance.

# Discussion

- Homogenous tests in successive layers showed larger expansion in traces mixed in successive layers in relation to homogenous soil, but even so such a methodology proves itself viable in the execution of field backfilling without compromising the quality of the service.

- Although the proposed parameters are met, other tests should be proposed.

# Conclusion

- Taking into account the proposed methodology, the studies, tests and results, the chosen trace was proved to be viable in the composition of CCW and ditch soil for backfilling after the maintenance of water and wastewater distribution systems in the city of Campo Grande – MS.
- It is then evident the real possibility of using waste from civil construction for an environmental application that is also economically viable.
- Not utilising crusher run aggregate implies a reduction in the volume of crushed material produced, which contributes to lower environmental impact generated by mineral extraction.


THANK YOU!