Evaluation of Granular Material Degradation in Repeated Load Triaxial Test

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1 Introduction

Pavements, comprising both streets and roads, are very important to social and economic development of a nation. So it´s important take in to account the permanent deformation on pavement design because it's due to traffic repetition loads that cause plastic deformation of the pavement layers. Granular materials are extensively used as base and sub-base of asphalt pavements. According to PÉREZ *et al.* (2006), the granular layers have significant role in the behavior of pavements and the pavement life depends on their quality and response.

The importance of mechanical resistance of aggregates and the high employment rate of the CBR (California Bearing Ratio) for granular layers in Brazil reflects the need to advance in the knowledge of their mechanical behavior. As stated by BERNUCCI *et al.* (2010), the granular material must have the ability to withstand breakage, degradation and abrasion, thus it is necessary to evaluate the toughness characteristics, abrasion resistance and hardness of the evaluated aggregates. Lima and Motta (2015) analyzed the influence of different grain sizes for the same graded stone using the idea of *Índice de Degradação Proctor - IDP* (Proctor Compaction Degradation Index).

This study aims to evaluate the resistance of two granular materials' mechanical degradation during testing in Repeated Load Triaxial (RLT).

2 Methods and Materials

To evaluate the mechanical resistance of granular materials is necessary to perform mechanical characterization test and use an index to measure the degradation of granular materials, which allows also to identify where there were greater breaks and / or abrasion during the test: Proctor compaction test or Repeated Triaxial Loading tests (permanent deformation test and resilient modulus test).

In this study were performed tests and analysis of the index (IDP) for two typical granular materials used in recent pavement constructions in Rio de Janeiro, Brazil. Both granite-gneiss from different Brazilian regions. The material 1 has been previously analyzed by Lima and Motta (2015) for another equation.

The tests provided are Los Angeles (LA) abrasion (DNER-ME 035/98), Treton (DNER ME 399/99) and Slake Durability Test (ASTM D4644-08) to determine: wear and impact, loss shock stony material, stability and durability of the soil and rocks when exposed to the rapid wetting and service environment, respectively.

The index used here is based on DNER ME 398/99 standard, but the particle size adopted, energy, and the sample cylinder were similar of RLT tests to adjust the quantity of available material and for better comparison. Materials with standard curves were only subjected to Proctor compaction. All samples after the RLT tests were derange and sieved, and with these results it was possible to analyze the final particle size to compare degradation.

Three samples in tripartite cylinder 10x20 cm at optimum moisture content and modified Proctor energy compaction were choose to obtain the standard degradation index of each graded stone. Nine dynamic permanent deformation testing with at least 150,000 cycles and with different stress stages (one stress stage for sample) were performed for two different particle sizes distributions of these materials. The degradation rate after the RLT test is calculated the same way as an IDP: average of the mean percentage differences of the samples for each sieve.

The results displayed at Table 1 are preliminary results to know the mechanical resistance of these two studied materials. They will still be carried out: analysis with images of aggregates before and after tests requests, more fine graduated granite-gneiss stone and analysis of pebble, for example.

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3 Results and Analysis

Table 1 shows the standard particle size distribution adopted and the results of IDP (Degradation Index), also the granulometric curves C1 and C2 performed in RLT and the results of the degradation index after RLT (RLTDI - Repeated Load Test Degradation Index) for each test material. In Table 1, it can be seen that the IDP of the material 1 showed that there is little breakage of the material during compaction, results considered relevant to the type of material. However, the IDP for the aggregate material 2 was slightly greater than for the material 1, but still considered low value and in accordance with a granite-gneiss.

The degradation value for curves of material 1 showed no significant difference after repeated load tests indicating that the material had a slight drop during the triaxial but most occurred along the Proctor compaction for preparing test sample. In the case of the material 2, the RLTDI also indicated that the majority of the degradations occurred for this material in the compaction test. Both materials with C1 distribution showed closer degradation index while the C2, mainly of material 2, showed a much lower amount of degradation. Nevertheless, worth pointing out that this difference was due to 0.075 mm opening sieve which retained more particles to the material 2.

The shock resistance value of Treton (24%) for material 1 was smaller than the LA abrasion (41%), indicating it is less aggressive because generates less fines and wear, although cause more breaks. The Slake durability test (99.5%) showed little loss in moist environment, that is, high durability in the environment for this type of stone. These results were already presented by Lima and Motta (2015). For material 2 was conducted only LA test (43%) resulting close to the material 1, and other tests are assumed to similar values for the sake of be for granite-gneiss.

Table 1: Degradation Index for two Brazilian granite-gnaisse crushed stone

Size Distributions	% Passing					
	Material 1			Material 2		
	Standard IDP	C1 RLTDI	C2 RLTDI	Standard IDP	C1 RLTDI	C2 RLTDI
1" – 25.0 mm	100	100	100	100	100	100
3/8" – 9.5 mm	69	64	68.9	69	64	68.9
#4 – 4.8 mm	53	47	52.9	53	47	52.9
#10 – 2.0 mm	38	32	37.9	38	32	37.9
#40 – 0.40 mm	20	15	20.5	20	15	20.5
#200 – 0.075 mm	10	7	10.0	10	7	10.0
Degradation Index	8.47	7.24	6.17	11.08	7.46	2.19
Trenton (%)	24			-		
LA (%)	41			43		
Slake Durability test (%)	99.5			-		

4 Conclusions

The short study reported here showed that even thought a RLT test consists of more than thousands of load applications, these loads tend to have small degradations effects on granite-gneiss crushed stone, in comparison with the loads applied during proctor compaction test. Lima and Motta (2015) had reported such results and the results of a second granite-gneiss crushed stone confirms that the most breaks and abrasion occurs during the compaction process. Also IDP showed few breakages of both materials, which was expected.

The tests efforts were consistent but it is necessary to try more flexible criteria for granular layers and it is important make an evaluation of the degradation resistance using an image technique.

References

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