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Evaluation of Granular Material Degradation in Repeated Load Triaxial Test

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Objective

- This study aims to evaluate the resistance of two granular material's mechanical degradation during testing in Repeated Load Triaxial (RLT) using the idea of Índice de Degradação Proctor - IDP (Proctor Compaction Degradation Index), in other words a RLTDI (Repeated Load Triaxial Degradation Index).

Methods and Materials

- Mechanical characterization test: Los Angeles (LA) abrasion, Treton and Slake Durability.
- Index degradation (IDP and RLTDI) to measure the degradation of granular materials during the Proctor compaction test and Repeated Triaxial Loading tests (permanent deformation test and resilient modulus test).
- Two typical granite-gneiss granular materials from different Brazilian quarries.
  - Three different granulometric distribution.

Los Angeles Abrasion (LA)

DNER-ME 035/98 Standard test method

- Evaluate the toughness, abrasion resistance and hardness of this aggregate

Treton

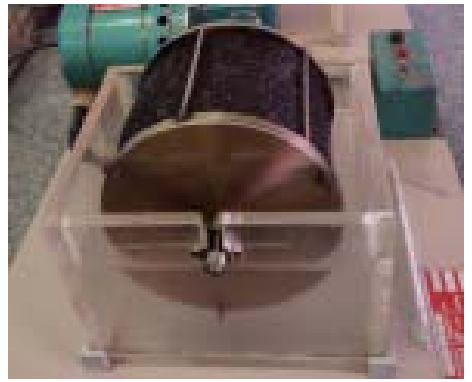
DNER ME 399/99 Standard test method

- Evaluate the loss, due to shock , of the stone material in Treton device.

Slake Durability test

ASTM D4644–08 Standard Test Method

- Evaluate the breakage and rock alteration (durability) in contact with water.



IDP – Índice de Degradação Proctor

DNER-ME 398/99

The objective of this analysis in this research is to see where there were major breaks: in the compaction or in the repeat load triaxial test.

IDP conditions in this study:

- new size distribution standard to adjust the quantity of available material,
- sample homogenization at optimum moisture content,
- modified Proctor energy,
- three samples molded in 10x20cm tripartite cylinder.

Reasons for changes:

To adjust the quantity of available material and for better comparison to RLTDI results.

IDP – Índice de Degradação Proctor

Calculation: average of the percentage differences between the mean percentage and the gradation percentage passing for each sieve.

Size Distributions	% passing						
	Original standard particle size	Chosen standard particle size for this study	Particle size after compaction				Percentage Difference (D)
			Sample 1	Sample 2	Sample 3	Average	
1 " - 25.0 mm	100	100					
3/8" - 9.5 mm	65	69					
# 4 - 4.8 mm	50	53					
#10 - 2.0 mm	35	38					
# 40 - 0.40 mm	20	20					
#200 - 0.075 mm	5	10					

$$IDP = \frac{\sum D}{5}$$

RLTDI – Repeated Load Triaxial Degradation Index

Two different size distribution were studied for two materials.

The RLT test:

- nine dynamic tests (permanent deformation before resilient modulus),
- at least 150,000 cycles for permanent deformation test,
- one stress stage for sample at permanent deformation test,
- frequency of 1 or 2 Hz.

The degradation index after the RLT test is calculated the same way as an IDP. In this case, each RLTDI had to be calculated for nine samples.

All samples after the RLT tests were deranged and sieved as IDP procedure, and with these results it was possible to analyze the final particle size distribution to compare degradation

RLTDI – Repeated Load Triaxial Degradation Index

RESILIENT MODULUS

Sample	Stress (kPa)	
	σ_d	σ_3
1	69	69
2	207	69
3	309	103

Sample	Stress (kPa)	
	σ_d	σ_3
1	21	21
2	41	
3	62	
4	34	34
5	69	
6	103	
7	51	51
8	103	
9	155	
10	69	69
11	137	
12	206	
13	103	103
14	206	
15	309	
16	137	137
17	275	
18	412	

PERMANENT DEFORMATION

Sample	Stress (kPa)	
	σ_d	σ_3
1	50	50
2	100	
3	150	
4	80	80
5	160	
6	240	
7	120	120
8	240	
9	360	

Procedure




IDP

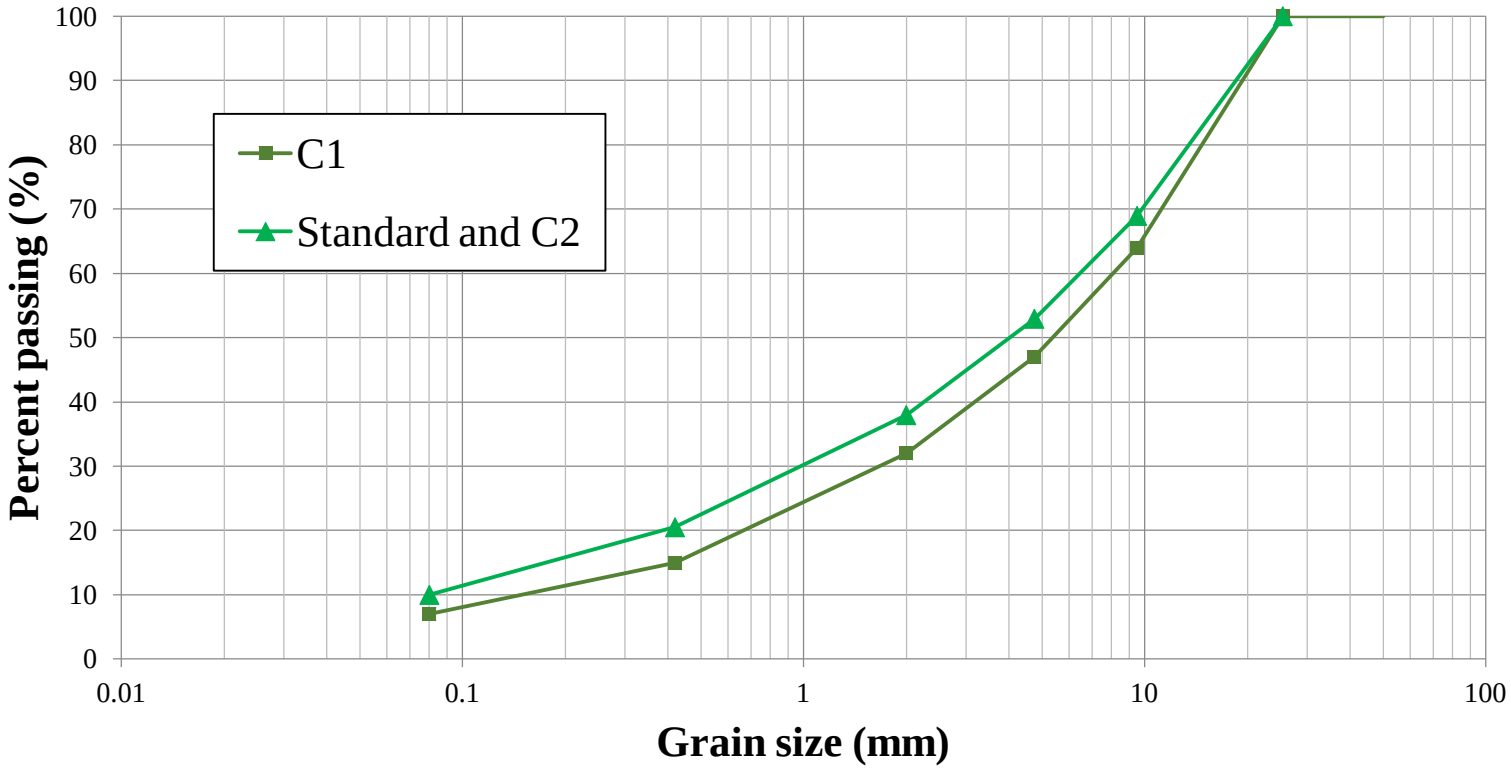




RLTDI

Material

Size Distributions	% Passing	
	C1	C2
1 " - 25.0 mm	100.0	100
3/8" - 9.5 mm	64.0	68.9
# 4 - 4.8 mm	47.0	52.9
#10 - 2.0 mm	32.0	37.9
# 40 - 0.40 mm	15.0	20.5
#200 - 0.075 mm	7.0	10.0



Material

Description	Material 1		Material 2	
	C1	C2	C1	C2
OMC (%)	4.9	5.4	5.0	5.7
γdmax (g/cm³)	2.288	2.111	2.223	2.03
γcoarse (g/cm³)	2.62		2.64	
γfine (g/cm³)	2.7		2.6	
Absorption (%)	0.8		0.5	

Results and Analysis

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			-	

- The IDP of the material 1 showed little breakage during compaction and the IDP for the aggregate material 2 was slightly greater than for the material 1, but in accordance with a granite-gneiss.

Remembering: Materials with standard curves were only subjected to Proctor compaction

Results and Analysis

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	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
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Trenton (%)		24			-	
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Slake Durability test (%)		99.5			-	

- The degradation value for curves of material 1 showed no significant difference after RLT indicating that the material degradation most occurred along the Proctor compaction.

Conclusions

- For both materials the most breaks and abrasion occurred during the compaction process, but all of the materials showed few breakages;
- Tests efforts, LA and Treton, were consistent but it is necessary to try more flexible criteria for granular layers;
- It is important make an evaluation of the degradation resistance using an image technique to measure the effects of degradation on angularity, texture, sphericity and form.

Thank you

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