02/04/03

Micro-Deval Study

Background

Two NCAT reports (NCAT Report Nos. 02-09 and No. 98-4) have shown that the Micro-Deval Test is a good indicator of coarse aggregate quality for aggregates that will be exposed to water. The Micro-Deval Test provides predictive information about abrasion resistance and durability of aggregates. Unlike the LA Abrasion Test, the Micro-Deval Test is performed in the presence of water. Some aggregates are weaker when wet than when they are dry. Aggregates that are susceptible to water damage may do poorly on the Micro-Deval Test while performing well on the LA Abrasion Test. Therefore, the results of the Micro-Deval test are not expected to correlate with the LA Abrasion Test.

NCAT Report No.98-4 found that a maximum loss of 18% delineated poor aggregate from good and fair aggregates. NCAT Report No. 02-09 references a specification that sets the maximum loss by the AADT of the roadway and the type of rock. The following table is a summary of that specification.

Application		Aggregate Type	Max. Loss
Asphalt Wearing Course	AADT > 2500 Per Lane	Igneous and Metamorphic Gravel	5%
		Traprock, Diabase, and Andesite	10%
		Dolomitic Sandstone, Granite, Gneiss	15%
	AADT < 2500 Per Lane		17%
Asphalt Base Course			21%

For simplification, test results in this study will be compared to an 18% maximum value.

The Colorado Department of Transportation (CDOT) has traditionally used the LA Abrasion with a percentage of wear of 45 percent or less when tested in accordance with AASHTO T 96. This test and specification have failed to identify aggregates that are not durable and are not abrasion resistant on the roadway. Further, the LA Abrasion has no means to identify aggregates that lose durability when subjected to water and/or freezing. For these reasons, the CDOT Central Laboratory purchased a Micro-Deval Abrasion Machine to determine if the Micro-Deval Test could predict the roadway performance of commonly used Colorado aggregates in CDOT mixes.

AASHTO's TP 58-00 is titled *Standard Test Method for Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus* and is a standard procedure to perform the Micro-Deval Test. A sample of aggregates of a standard gradation is soaked

in 2 liters of tap water for a minimum of one hour. The sample is then rotated in a jar mill with a charge of 5000 grams of 9.5 mm diameter steel balls at 100 rpm for 2 hours. The loss is the amount of material passing the 1.18 mm sieve, expressed as a percent by mass of the original sample.

The Study

CDOT's Region Materials Engineers (RMEs) were asked to nominate aggregates of known performance on the roadway for inclusion in the study. Nineteen aggregates with known histories of performance in Colorado were rated by the RMEs and were sampled for the study. Aggregates were rated Good, Fair, or Poor based on field performance. As was done in the NCAT studies, the ratings were based on the experiences the raters had with pavement performance. RMEs were asked to only rate those aggregates that they felt they had enough pavement performance experience with to properly characterize performance. When RMEs reported conflicting ratings, Lottman data was used to better categorize aggregate performance. It is important to keep in mind that construction, binder, and other deficiencies can contribute to the poor performance of a pavement. A poorly performing pavement cannot be 100% attributable to the aggregate alone. Therefore, RME ratings of aggregate performance are not likely to be 100% accurate.

Results

The following table is color coded with the RME's ratings of the aggregates. They are in order based on their Micro-Deval performance. LA Abrasion values are also included. Aside from aggregate 18, the aggregates performed much as predicted by the RMEs. Aggregate 18 was rated by just one RME and may have been more accurately rated had more RMEs had experience with this aggregate.

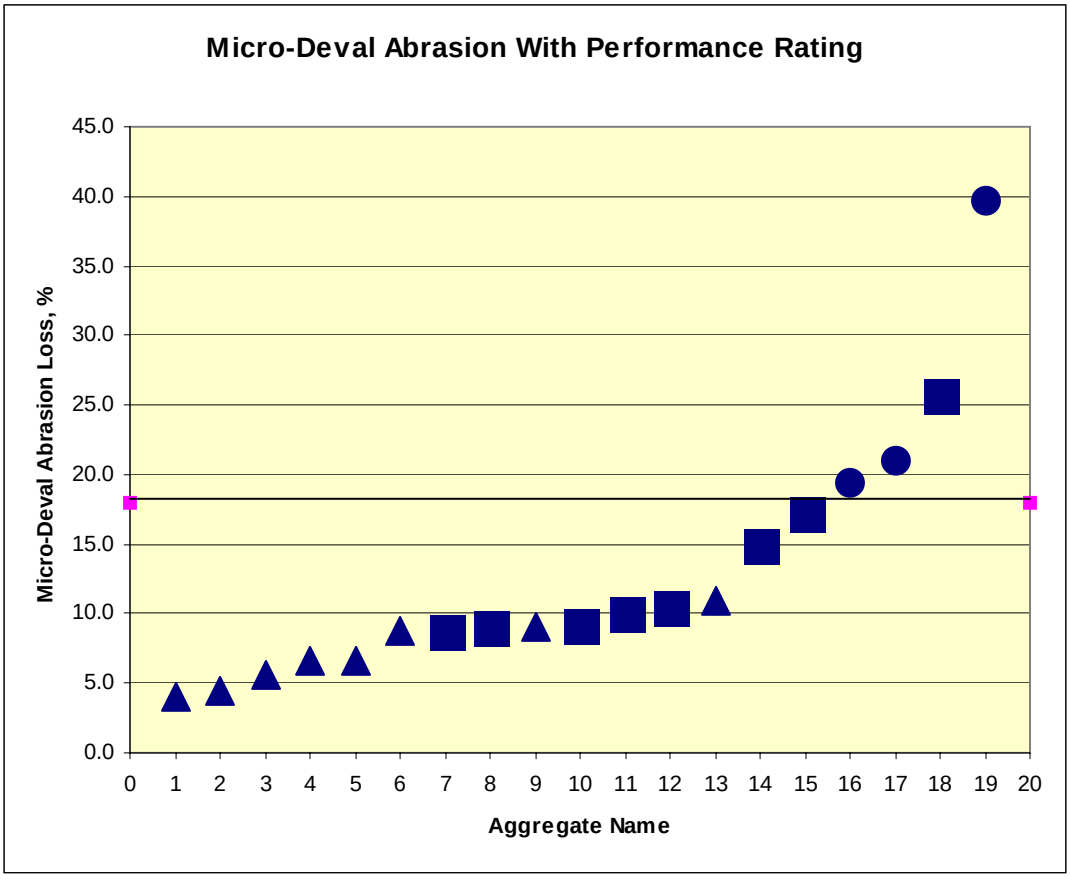
There is a clear break at 15% loss. Fifteen percent should be considered for the maximum percent loss when a specification is written. At 15%, two more marginal pits are identified.

Rated by RMEs
Good
Fair
Poor

Aggregate	Test 1 % Loss	Test 1 % Loss	Test Difference	Average MD % Loss	LA Abrasion % Loss
1	4.0	4.0	0.02	4.0	29.
2	4.4	4.5	0.09	4.5	17
3	5.5	5.6	0.12	5.5	17
4	6.7	6.6	0.14	6.6	24
5	6.5	6.8	0.32	6.6	20
6	8.8	8.6	0.25	8.7	30
7	8.5	9.1	0.65	8.8	21
8	8.9	9.1	0.15	9.0	31
9	9.3	8.8	0.57	9.1	34
10	9.0	9.4	0.41	9.2	31
11	10.2	10.1	0.12	10.1	21
12	10.1	10.8	0.67	10.4	38
13	10.3	11.6	1.24	11.0	23
14	15.2	14.8	0.38	15.0	46
15	17.7	16.9	0.74	17.3	32
16	19.4	19.4	0.01	19.4	26
17	21.7	20.3	1.41	21.0	29
18	25.6	25.9	0.30	25.7	31
19	39.9	39.3	0.62	39.6	44

The following chart visually demonstrates the values in the table above.

Rated by RME	
Good	Triangle
Fair	Square
Poor	Hexagon



The tables below demonstrate that the Micro-Deval test is a better predictor of aggregate performance than is the LA Abrasion test. The table on the left is in order of how the aggregates performed on the Micro-Deval test. The LA Abrasion value for each aggregate is in the second column. The table on the right reorders the aggregates by their LA Abrasion values. The table on the left has better color delineation (of pavement performance) of good, fair, poor than does the table on the right. As expected, the Micro-Deval Test does not correlate well with the LA Abrasion test.

Aggregate	LA Abrasion % Loss
1	29
2	17
3	17
4	24
5	20
6	30
7	21
8	31
9	34
10	31
11	21
12	38
13	23
14	46
15	32
16	26
17	29
18	31
19	44

Aggregate	LA Abrasion % Loss
3	17
2	17
5	20
7	21
11	21
13	23
4	24
16	26
1	29
17	29
6	30
8	31
18	31
10	31
15	32
9	34
12	38
19	44
14	46

The table below shows the precision required by AASHTO TP 58. All pairs of test values were well within these limits.

Aggregate Abrasion Loss (Percent)	Coefficient of Variation (Percent of Mean)	Acceptable Range of Two Results (Percent of Mean)
5	10.0	28
12	6.4	18
17	5.6	16
21	5.3	15

Conclusions

1. The Micro-Deval Test is a better indicator of aggregate quality than is the LA Abrasion Test.

2. A specification setting the maximum loss at 18% would eliminate the three pits that are considered "Poor" through years of experience.

3. Fifteen percent should be considered as a maximum loss when a Micro-Deval specification is written.

Acknowledgements

Thank you to the many technicians throughout the state who sampled and submitted aggregates for this study. Thank you to the Region Materials Engineers who put their time and thoughts into rating the aggregates they were familiar with. A special thanks goes to Paul Smith and Mike Smith of the Aggregate/Concrete Unit of the Central Laboratory. Both spent many hours learning a new test procedure and practicing the procedure to ensure that study results would not be affected by operator errors. Every pair of test results was well within the acceptable range. This doesn't occur without careful and conscientious attention to detail.