

IDEAL Cracking Test: Development, Validation, and Applications

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SEAUPG Annual Meeting, Raleigh, NC
November 14, 2018

Outline

- Introduction
- Development of IDEAL cracking test
 - Concept, sensitivity, and repeatability
- Validation of IDEAL cracking test
- Applications of IDEAL cracking test
- Summary and conclusions

Introduction

- Currently, cracking is a major concern.
- NCHRP 9-57 selected 7 cracking tests, but they are not simple enough, especially specimen preparation.



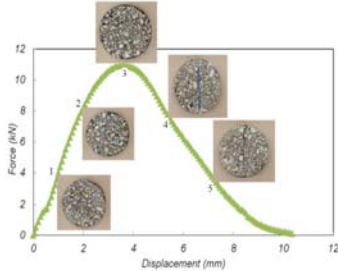
- Need a simple and performance-related cracking test.

Development of an IDEAL cracking test

- Criteria for IDEAL cracking test (IDEAL-CT)
 - **Simplicity:** no instrument, cutting, gluing, drilling, or notching;
 - **Practicality:** min. training needed for routine operation;
 - **Efficiency:** test completion within 1 min.;
 - **Test equipment:** cost less than \$10,000;
 - **Repeatability:** coefficient of variation (COV) less than 20 %;
 - **Sensitivity:** sensitive to asphalt composition (binder, others);
 - **Correlation to field:** a good correlation with field cracking.

Development of IDEAL-CT: concept

- IDEAL-CT description and typical result

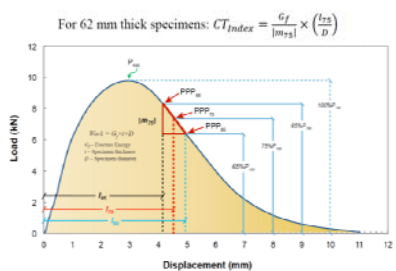


Test temperature: 25 °C
Loading rate: 50mm/min.
Specimen: cylindrical specimen without cutting, gluing, instrumentation, drilling, and notching.

Development of IDEAL-CT : concept

- CT_{index} Equation derived from fracture mechanics

For 62 mm thick specimens: $CT_{index} = \frac{G_f}{(m+1)} \times \left(\frac{t+z}{D}\right)$



Development of IDEAL-CT: sensitivity

- Aggregate gradation and mixes
 - Ctrl Mix: Virgin Agg. /PG64-22 (OAC=5.0%)
 - 20% RAP/PG64-22
 - 15% RAP/5% RAS/PG64-22
 - 20% RAP/PG64-28
 - 20% RAP/ PG64-34

Development of IDEAL-CT: sensitivity

- Sensitivity to RAP/RAS

Laboratory Mixes with PG64-22 and a Total of Binder Content of 5%

Mix	CT Index
virgin	~170
20%RAP	~45
15%RAP/5%RAS	~30

Development of IDEAL-CT: sensitivity

- Sensitivity to binder type

Laboratory 20% RAP Mixes with a Total Binder Content of 5%

Binder Type	CT Index
PG64-22	~45
PG64-28	~80
PG64-34	~125

Development of IDEAL-CT: sensitivity

- Sensitivity to binder content

Laboratory Virgin Mixes with PG64-22: OAC=5%

Binder Content	CT Index
OAC-0.5	~65
OAC	~170
OAC+0.5	~250

Development of IDEAL-CT: sensitivity

- Sensitivity to aging condition

Plant Virgin Mix with PG70-22: OAC=6.3%

Aging Condition	CT Index
4hr	~375
12hr	~287
24hr	~68

Development of IDEAL-CT: repeatability

- 3 replicates

Asphalt Mixes			CT Index	COV (%)
Laboratory mix	Sensitivity to RAP and RAS	Virgin	172.9	5.5
		20%RAP	42.8	23.5
		15%RAP/5%RAS	30.8	9.0
	Sensitivity to binder type	PG64-22	42.8	23.5
		PG64-28	82.4	13.8
		PG64-34	126.2	1.8
	Sensitivity to binder content	OMC-0.5	66.0	1.7
		OMC	172.9	5.5
		OMC+0.5	251.0	20.5
Plant mix	Sensitivity to aging conditions	4hr	374.5	12.1
		12hr	287.6	20.0
		24hr	68.9	15.1
	Sensitivity to air voids	5%	322.0	12.3
		7%	374.5	15.4
		9%	505.2	11.2

Validation of IDEAL-CT

- Correlation with established lab cracking tests
 - ▣ Texas overlay test
 - ▣ Illinois flexibility index test
- Correlation with field cracking performance
 - ▣ FHWA-ALF: fatigue cracking
 - ▣ Texas field test sections
 - ▣ LTPP-SPS10-Oklahoma test sections

Validation of IDEAL-CT: correlation with established lab tests

Validation of IDEAL-CT: correlation with field performance

- FHWA-ALF: fatigue cracking

Validation of IDEAL-CT: correlation with field performance

- US62: Reflective cracking

Application of IDEAL-CT

- Video
- Test equipment
- Test procedure
- Criteria
- QC/QA and mix design

Application of IDEAL-CT: Video

- <https://www.youtube.com/watch?v=OB4pQDB2Yfs>

Application of IDEAL-CT: test equipment

Application of IDEAL-CT: ASTM standard

Standard Test Method for Determination of Asphalt Mixture Cracking Resistance Using the Indirect Tensile Asphalt Cracking Test (IDEAL-CT) at Intermediate Temperature

1. Scope

1.1 This test method covers the procedures for preparation, testing, and measurement of asphalt mixture cracking resistance using cylindrical laboratory prepared or *unavailable* field collected specimens. Testing temperature shall be determined from the Long Term Performance (LTP) database at intermediate temperatures. The test method describes the determination of the cracking test index CT_{Index} and other parameters determined from the back-dilatation curve. These parameters *can be used* to rank the resistance of asphalt mixtures to cracking.

1.2 The values stated in SI units are to be *preferred* or *mandatory*. No other units of measurement are included in this standard.

1.3 The test of this standard references notes and footnotes which provide explanatory material. These notes and footnotes (including those in tables and figures) *shall not be considered* as requirements of the standard.

Application of IDEAL-CT: criteria

- 17 Texas mixes: dense-graded, Superpave, SMA, RAP/RAS mixes, and mixes with rejuvenators

OT: Cycles vs. Crack Progression Rate: $y = 26.23x^{-0.61}$, $R^2 = 0.97$

IDEAL-CT vs. OT: $y = 41.74x^{-0.61}$, $R^2 = 0.90$

Application of IDEAL-CT: criteria

- Proposed CT_{Index} criteria

Crack Progression Rate	CT_{Index}		OT Cycles
	Predicted Value	Recommended Criteria	
0.27	335	>320 (CAM)	800
0.28	316		727
0.39	187	>185 (TOM)	300
0.45	149		211
0.46	143	>145 (SMA)	199
0.55	108		125
0.56	105	>105 (Superpave)	119
0.72	70		62
0.75	66	>65 (Dense-graded)	56
1.00	42	Unacceptable	26

Application of IDEAL-CT: QC/QA/mix design

- QC/QA in the field
 - Simplest cracking test
 - Kentucky: check production consistency
- Balanced mix design
 - Volumetric requirements
 - Rutting requirement: Hamburg, APA, Fn, ...
 - Cracking requirement: IDEAL-CT, IFIT, SCB-Jc, OT, ...
 - Moisture damage

Summary and conclusions

- IDEAL-CT features: *simplicity, practicality, repeatability, sensitivity, and good correlation with field performance.*
- IDEAL-CT was validated with field cracking data.
- IDEAL-CT is ready for implementation:
 - ASTM standard is being finalized;
 - Test equipment and accessory are available; and
 - Draft criteria were developed.
- IDEAL-CT is not perfect. Watch air voids of specimens.

Acknowledgment

- Support for this research was provided by NCHRP IDEA program. The information presented is part of the **IDEA Project 195: Development of an IDEAL Cracking Test for Mix Design, Quality Control and Quality Assurance.**

 Thank You!