

A Cracking Methodology to Assess Fracture and Fatigue Properties of Asphalt Concrete Mixtures with Overlay Tester

Presented

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Presentation Outline

- **General Introduction**
 - *Review of Crack Test Methods*
 - *Scope of the Thesis*
- **Overlay Tester and Current Performance Index**
- **Alternative Cracking Analysis Methodology**
- **Assessment of Proposed Analysis Methodology**
- **Summary and Conclusions**
- **Acknowledgements**

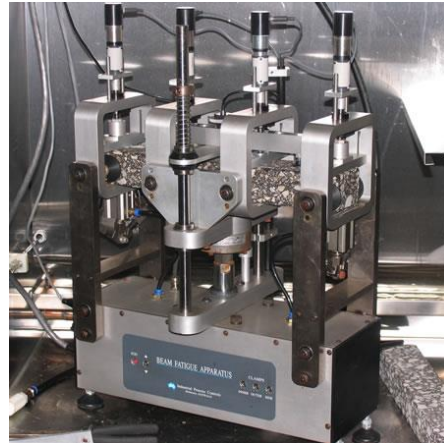
Determining Cracking Resistance

Why the pavement community is interested on the cracking behavior of AC mixtures?

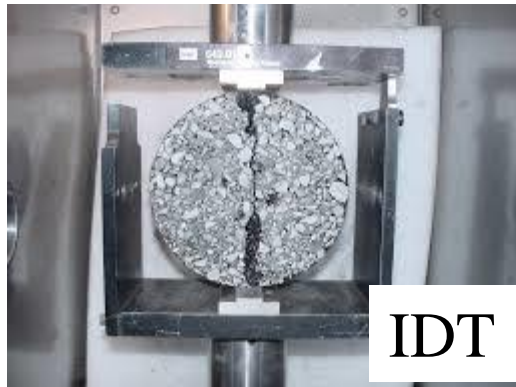


Fenix

Four-point Bending



SCB



IDT



OT



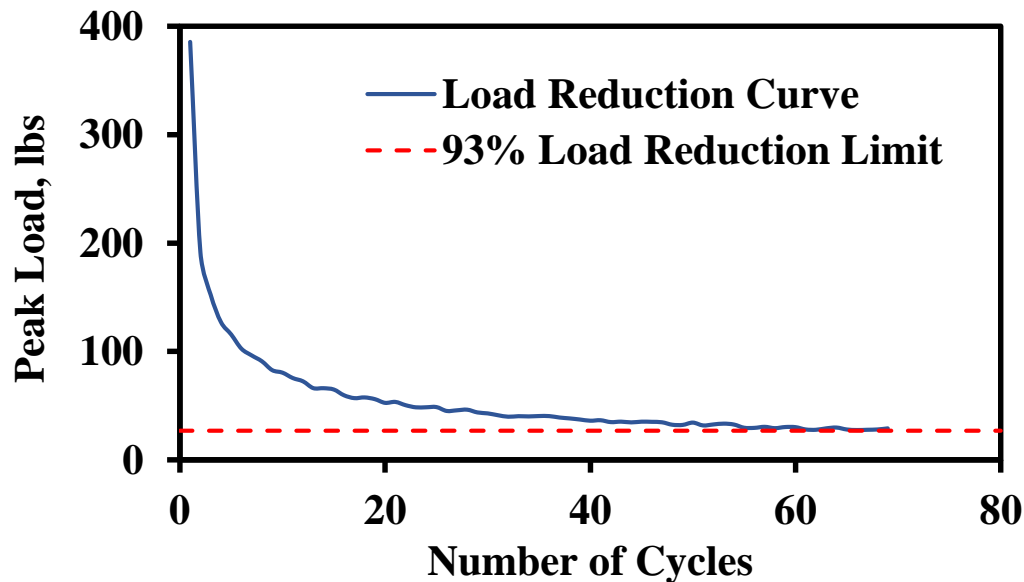
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Overlay Tester (OT) Test

Why the pavement community is interested on the cracking behavior of AC mixtures?

OT Test:

- Test method is outlined on Tex-247-F
- Displacement control mode
- Number of cycles to failure
- 93% load reduction failure criterion



Typical cracking failure on OT specimen

Research Methodology

Sources of Variability

Asphalt
Concrete
Materials

- ✓ Natural heterogeneity from HMA

Specimen
Preparation
Process

- ✓ Proposed Detailed Gluing Method

Testing
Method

- ✓ Investigation of Test Response Curves

Data
Analysis

- ✓ Alternative Parameters and Failure Criteria

■ Main Challenge

- The *high variability* of the *number of cycles* to failure

Included Asphalt Mixtures

1. TOM
2. SMA D
3. SP C
4. Type C
5. SP D 1
6. Type D
7. SP D 2

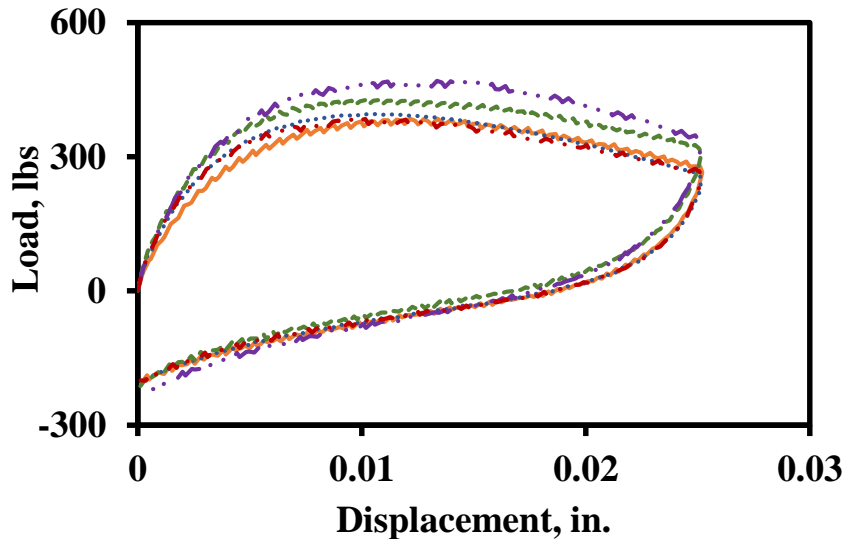


Consistency of OT Raw Data

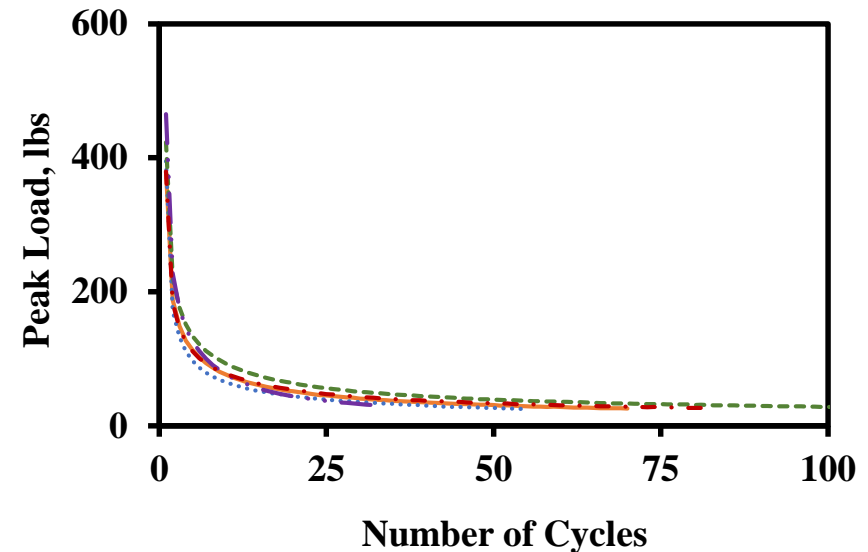
What are the weaknesses and strengths of the current OT test?

Consistency of Raw Data from OT Test

Hysteresis loops from first cycle



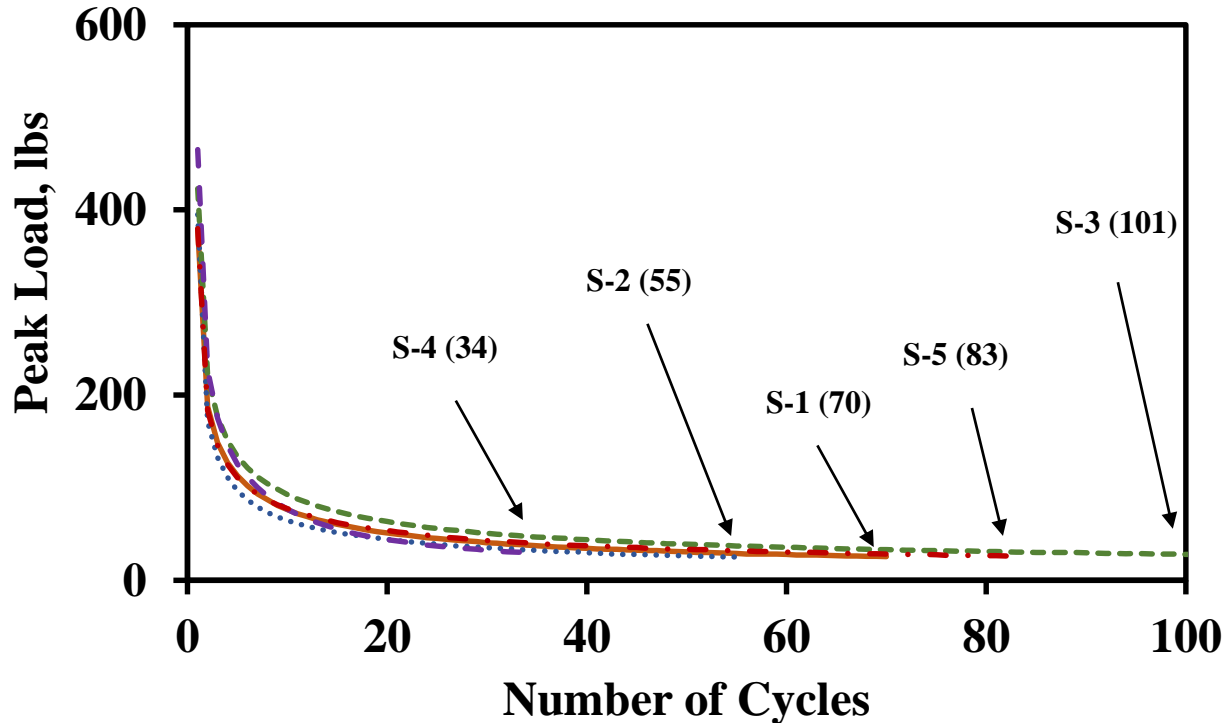
Load reduction curves



The similar patterns from the first hysteresis loops and load reduction curves point out to the consistency of the raw data, despite the high variability in the number of cycles to failure

Weaknesses and Strengths of OT Test

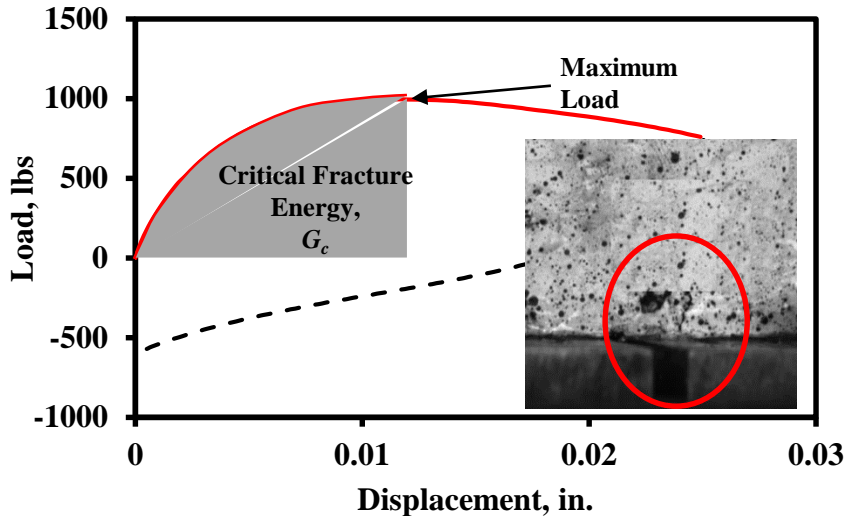
What are the weaknesses and strengths of the current OT test?



The number of cycles to failure may not be the best parameter to measure the response of AC specimens during the OT test

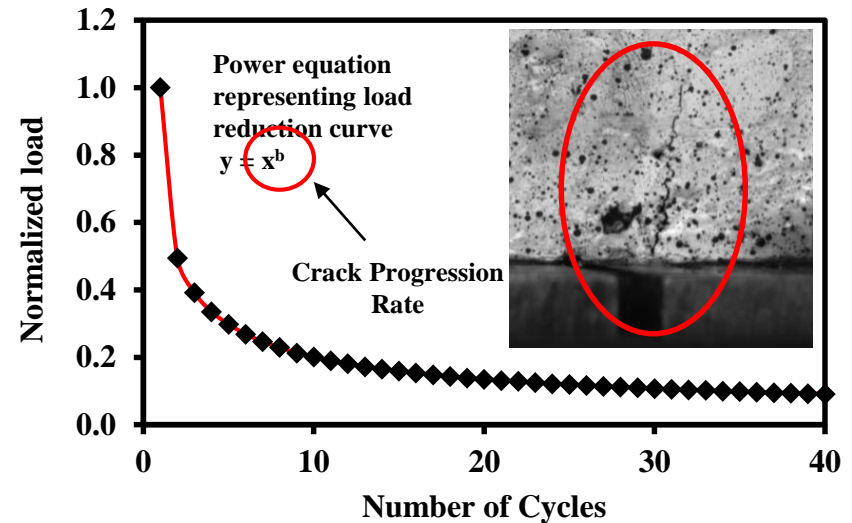
Alternative Data Interpretation

Can fracture and fatigue properties of AC mixtures be measured with the OT test?



Crack Initiation

The critical fracture energy represents the energy required to initiate a crack



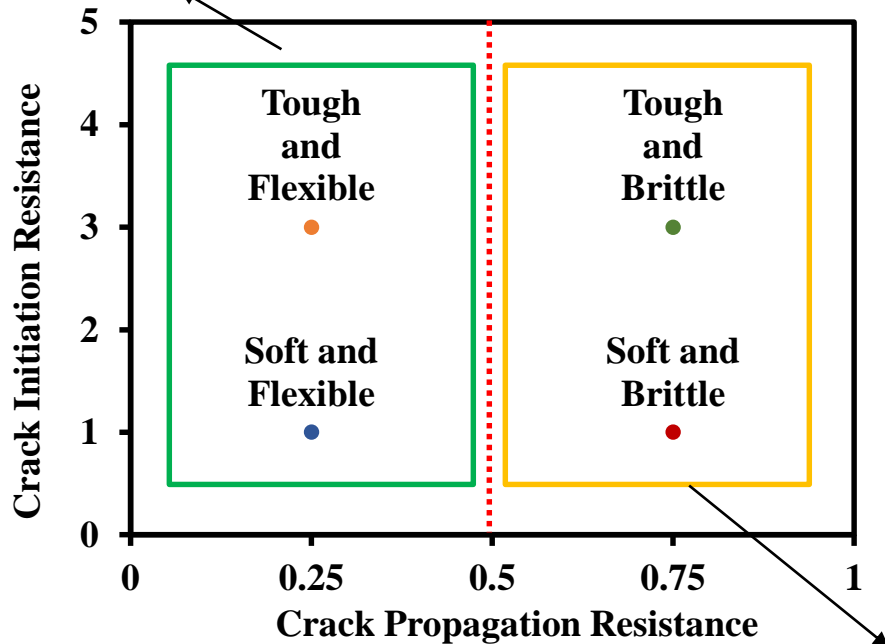
Crack Propagation

The crack progression rate represents the flexibility of the mix to attenuate the propagation of the crack

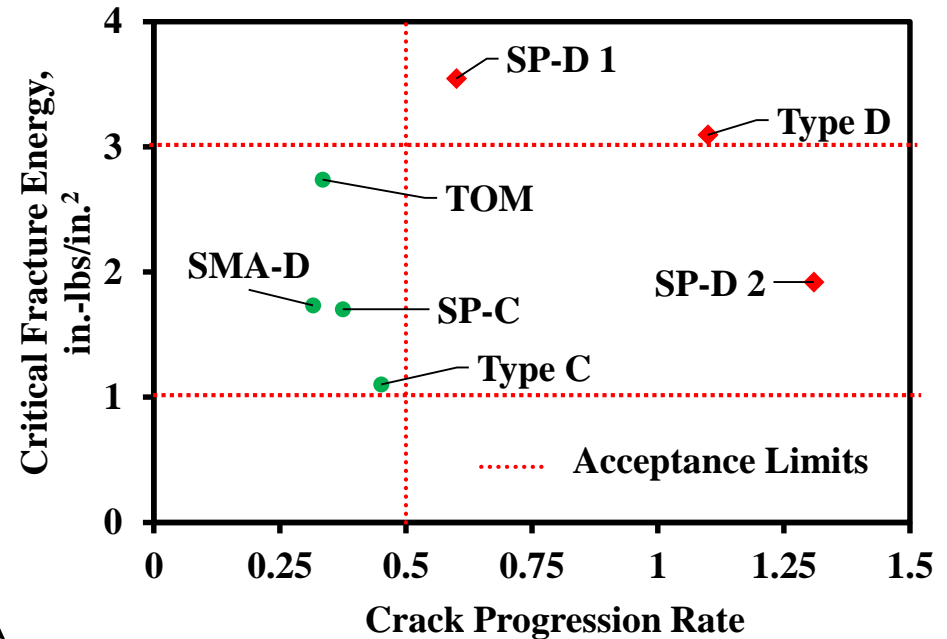
Cracking Design Interaction Plot

Can fracture and fatigue properties of AC mixtures be measured with the OT test?

Crack Resistant Mixes



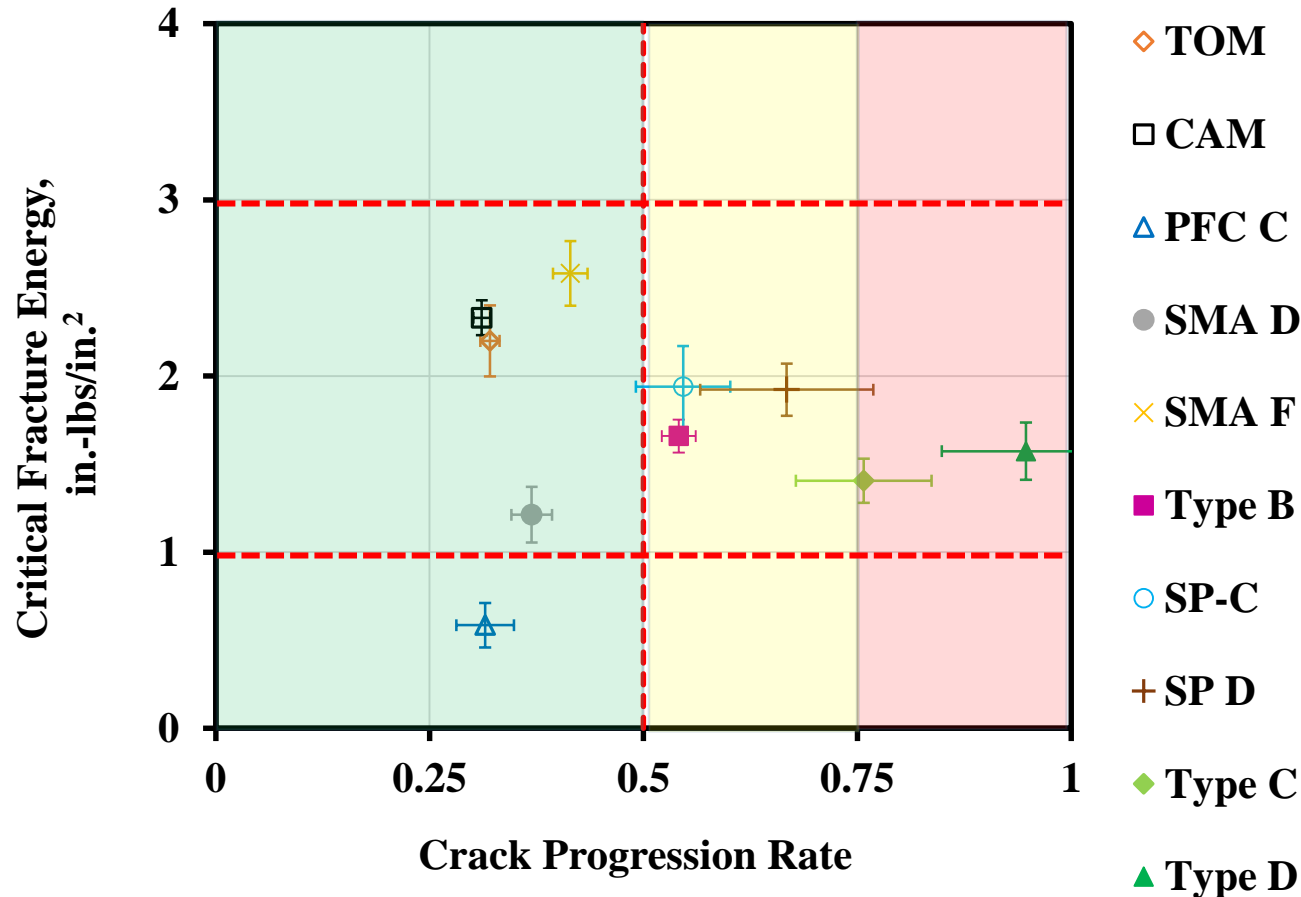
Crack Susceptible Mixes



- ✓ The acceptance limits for the *critical fracture energy* is derived from the current limits for the *IDT tensile strength*

Cracking Performance of AC Mixes on Texas

Can fracture and fatigue properties of AC mixtures be measured with the OT test?



- ✓ More than 350 OT results from 125 different mix design were evaluated with the proposed cracking parameters and design interaction plot for OT test

Typical Variability of OT Results

Can fracture and fatigue properties of AC mixtures be measured with the OT test?

Typical Variability of Proposed Performance Indices

Mix	Critical Fracture Energy, in.-lbs/in. ²		Crack Progression Rate		Number of Cycles to Failure	
	Median	COV	Median	COV	Median	COV
TOM	2.2	8%	0.32	4%	1000	NA
CAM	2.3	4%	0.31	3%	1000	NA
PFC	0.5	25%	0.31	11%	1000	NA
SMA-D	1.2	14%	0.36	7%	847	20%
SMA-F	2.6	7%	0.41	5%	182	23%
Type-B	1.7	5%	0.50	6%	117	27%
SP-C	2.0	11%	0.53	10%	94	31%
SP-D	1.9	9%	0.67	15%	47	30%
Type-C	1.4	8%	0.73	10%	46	27%
Type-D	1.6	9%	0.95	10%	20	32%

- ✓ The proposed performance indices presented COVs less than 15%, except for PFC mix
- ✓ The COVs for the number of cycles to failure was higher than 20%

The acceptable variability degree for a crack test was set as a **COV ≤ 20%**



Summary and Conclusions

Can the proposed OT test be implemented as a routine crack test?

- The current number of cycles to failure may not be the best parameter to be used as a performance index for the OT test
- The raw data from the OT is consistent from replicate specimens (first hysteresis loops and load reduction curves)
- The OT test can be divided into two distinctive phases, crack initiation (First hysteresis loop) and crack propagation (load reduction curve), to comprehensively predict the fracture and fatigue properties of AC mixes

- A ***cracking methodology*** and corresponding ***performance indices*** is proposed to assess the ***fracture and fatigue response*** of AC specimens during the ***OT test*** in a more ***repeatable and reliable*** manner

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Thank you

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