



Growth in Warm Mix Asphalt Technology

CALTRANS Open House
Morro Bay, California
May 7, 2008



OUTLINE

- What are indicators & measures of growth?



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- What are indicators & measures of growth?
- What are the reasons for growth?

Indicators & measures of growth 1-4

Reasons for growth 1-3



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- What are typical performance results?



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- What are indicators & measures of growth?
- What are the reasons for growth?
- What are typical performance results?
- What's next?

Indicators & measures of growth 1-4

Performance results 1-3

Reasons for growth 1-3

What's next



INDICATORS & MEASURES OF GROWTH

1. The number of warm mix projects increases:

Indicators & measures of growth 1-4

Reasons for growth 1-3

Performance results 1-3

What's next



INDICATORS & MEASURES OF GROWTH

1. The number of warm mix projects increases:
< 10,000 tons of Evotherm laid in 2005



INDICATORS & MEASURES OF GROWTH

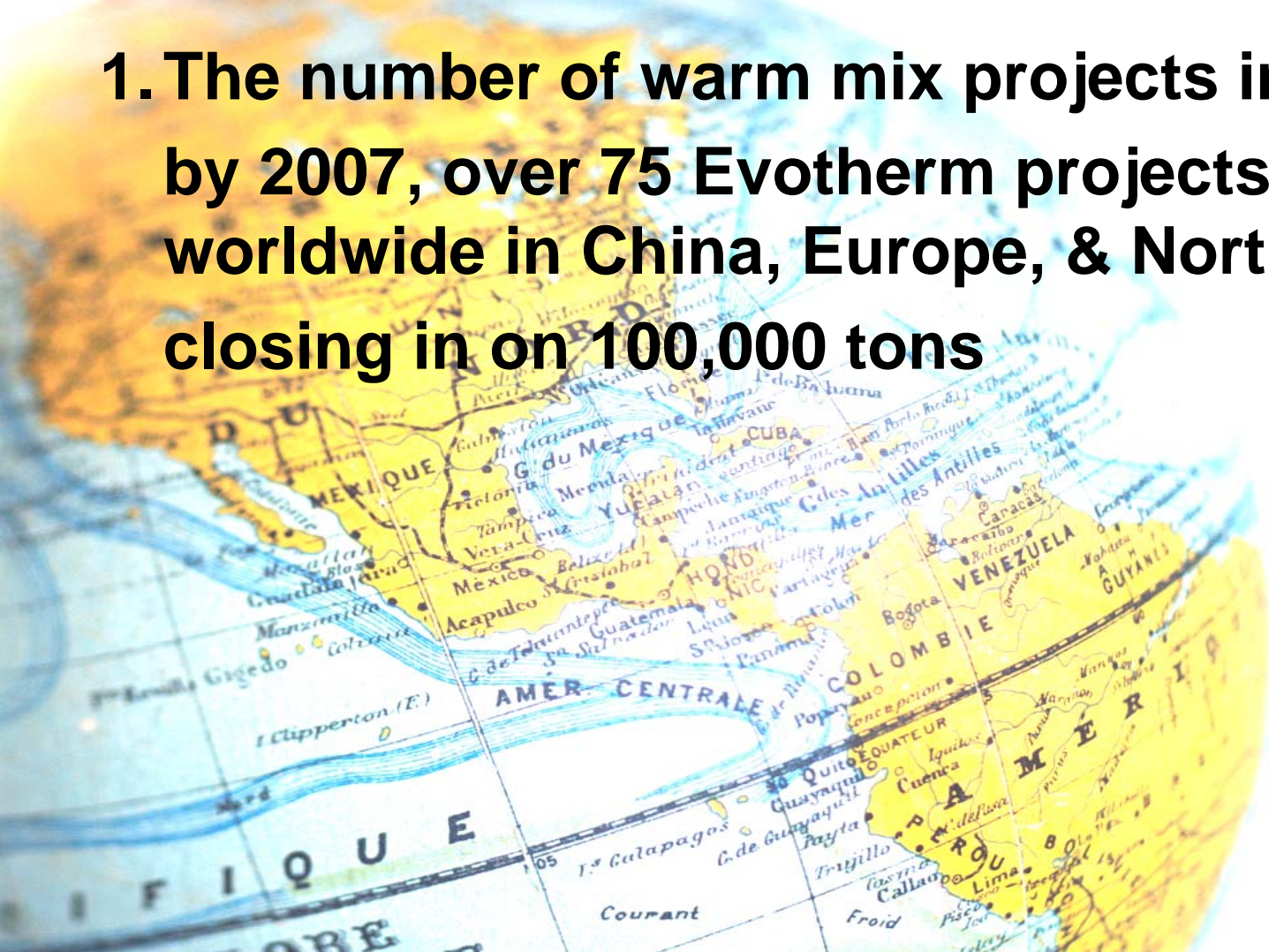
1. The number of warm mix projects increases: < 10,000 tons of Evotherm laid in 2005

Indianapolis, IN	PG 64-22	12.5 Dolomite, 10%RAP	680
Toronto (Aurora), Canada	PG 58-28	19.0 LS base & 9.5 LS surface	510
Kansas City, MO	PG 64-22	12.5 LS surface	330
Beijing, China	AC 20	13.2 LS surface	220
Calgary, Canada	120/150 pen	12.5 Silicate surface	750
Greenich, NY	AC 20	12.5 Dolomite surface	500
Toronto (Remara), Canada	PG 58-28	16.0 LS surface	1100
NCAT Test Track, AL	PG 67-22 & PG 76-22*	9.5 G**/LS surface & 12.5 G/LS base	270
San Antonio, TX	PG 64-22 & PG 84-22*	9.5 LS surface	740



INDICATORS & MEASURES OF GROWTH

**1. The number of warm mix projects increases:
by 2007, over 75 Evotherm projects
worldwide in China, Europe, & North America
closing in on 100,000 tons**





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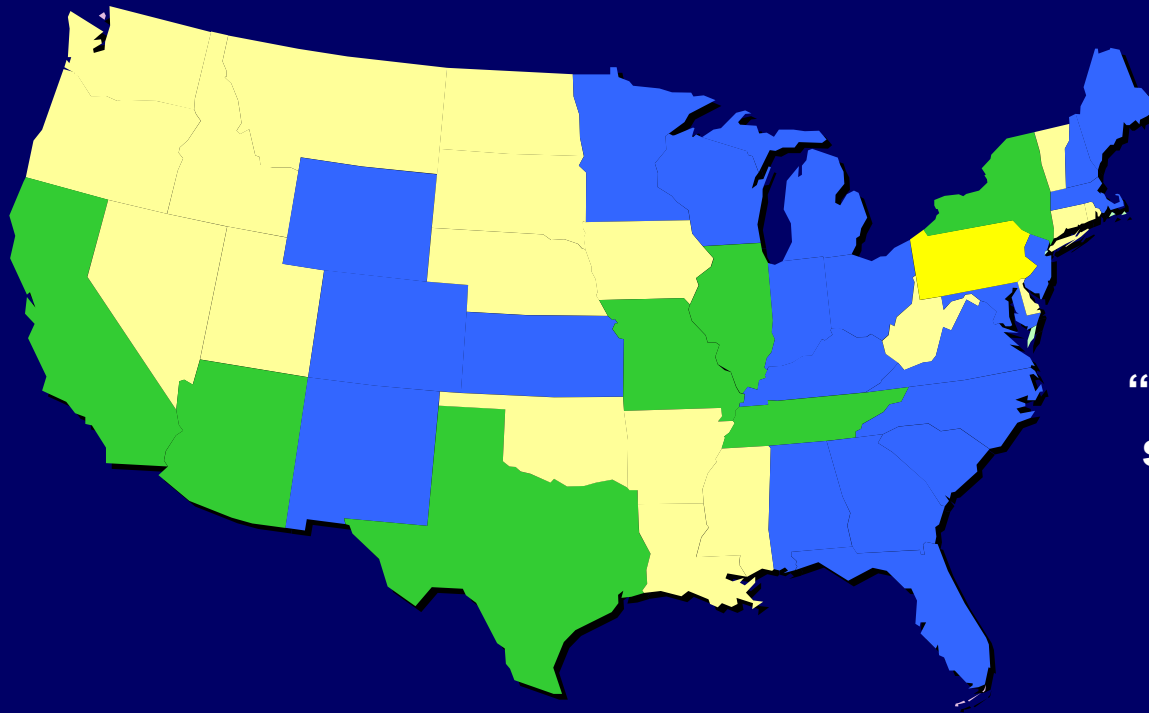
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closing in on 100,000 tons**

2008 forecast: 500,000 – 1,000,000 tons



INDICATORS & MEASURES OF GROWTH

2. Numerous municipalities, states, provinces, & countries are accepting provisional, supplemental specifications for WMA:



PA has created a “model” WMA specification



INDICATORS & MEASURES OF GROWTH

3. Proliferation of WMA technologies:

Indicators & measures of growth 1-4

Reasons for growth 1-3

Performance results 1-3

What's next



INDICATORS & MEASURES OF GROWTH

3. Proliferation of WMA technologies:

2005: There were three WMA technologies:

Aspha-min – foam zeolite

Sasobit – wax

Evotherm – surfactant



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2008: > 16 WMA Technologies



INDICATORS & MEASURES OF GROWTH

4. Federal, state, & association support increases to formalize tests, specs, & designs for WMA:

NCHRP studies due in '08 & '09

9-43 \$0.5 MM;

9-47 \$1.2 MM (D-18);

D-19 \$0.4 MM “Eval. of emission/fumes of WMA”
candidate for funding

NAPA “Best Practices Manual”

NAPA formalization of testing for emissions/fumes



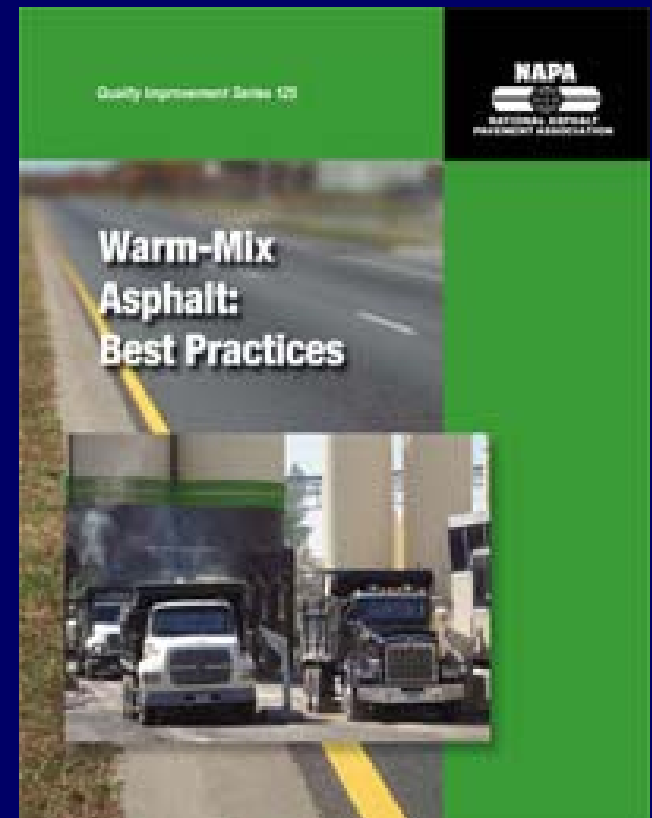
INDICATORS & MEASURES OF GROWTH

4. Federal, state, & association support increases to formalize tests, specs, & designs for WMA:

Standardization of WMA use:

“Best Practices Manual”
published by National
Asphalt Paving Association

German “Merkblatt” for
WMA est'd by BASt





REASONS FOR GROWTH

1. Sustainability continues as key driver

Indicators & measures of growth 1-4

Performance results 1-3

Reasons for growth 1-3

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REASONS FOR GROWTH

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Stack emissions dropped by $\frac{1}{2}$ the level of HMA

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Emissions & fumes studies from several testing labs have substantiated these emissions & fumes reductions.





REASONS FOR GROWTH

2. Improved compactability of WMA technologies has driven interest in high-altitude paving, cold-weather paving, & use with coarse mixes



REASONS FOR GROWTH

3. Good performance in lab & field as regards three main pavement failure modes:

Deformation

Cracking

Moisture damage



PERFORMANCE: NO DEFORMATION

HEAVY VEHICLE SIMULATOR TESTING

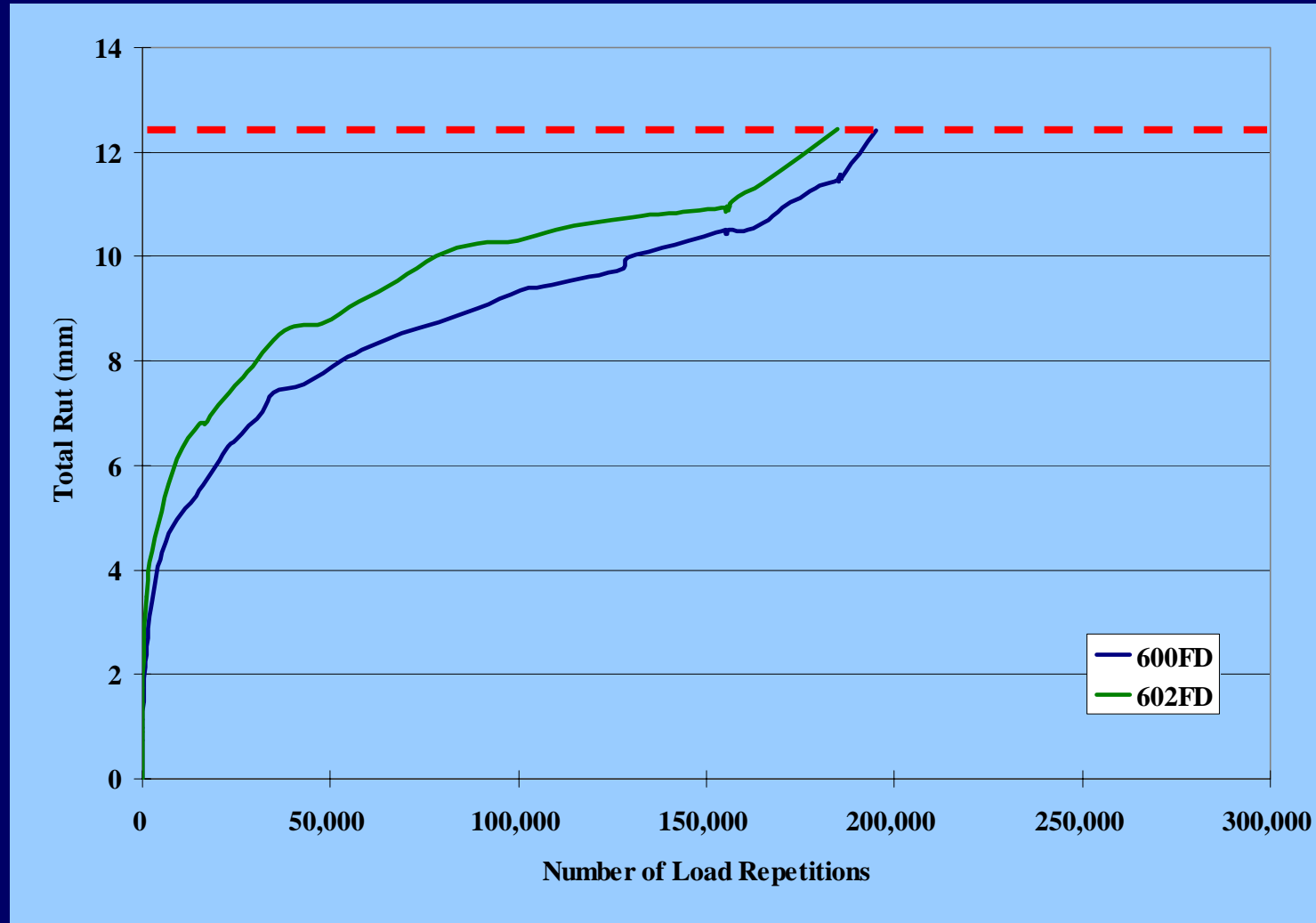


Research conducted by David Jones, University of California Pavement Research Center, Davis, California, for California Transportation Dept.



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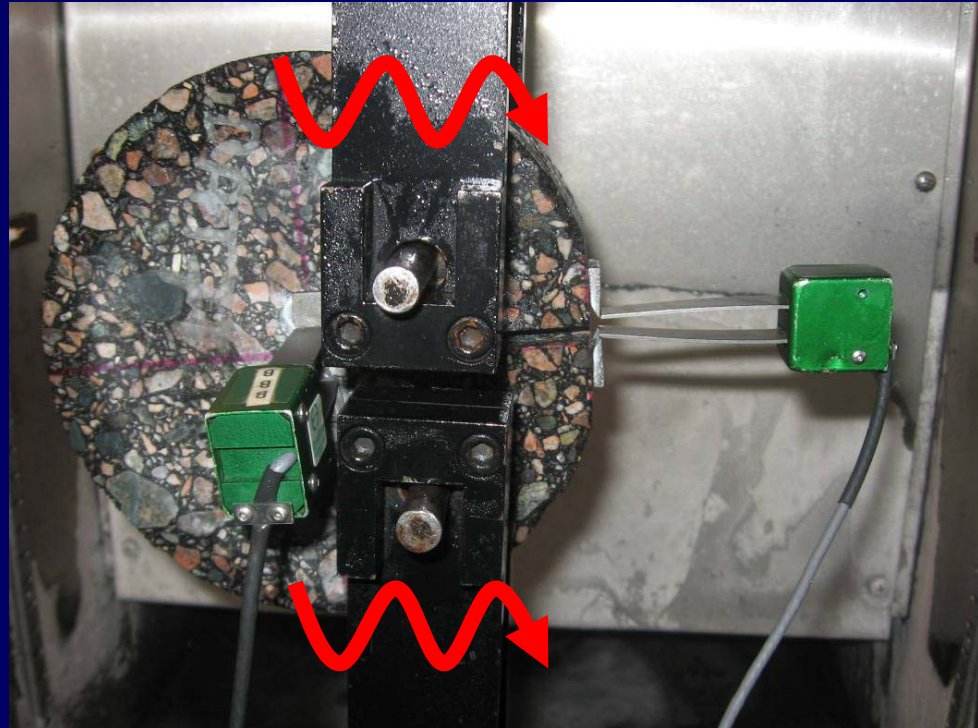


PERFORMANCE: REDUCED CRACKING

Small cut (mouth)
made in specimen



Sinusoidal load
applied



ASTM 7313-06 is also known as
Disk-Shaped Compact Tension Test or the DC(T) test

Research conducted by Prof. William Buttlar, University of Illinois, & P. Blankenship,
Asphalt Institute



PERFORMANCE: REDUCED CRACKING

Mix Type	Test Temperature (°C)	Mean Air Voids (%)	CMOD Fracture Energy (J/m ²)	δ_{25} Fracture Energy (J/m ²)
Warm-Mix	-10	6.9	1042	480
	-20		511	228
Hot-Mix	-10	6.6	697	328
	-20		506	225

A red arrow points from the CMOD Fracture Energy value of 1042 J/m² for Warm-Mix at -10°C to the value of 511 J/m² for Warm-Mix at -20°C, with the label "49.5%" indicating the percentage decrease.

~ 50% Higher fracture energy (resistance to Crack-Mouth Opening Deformation, CMOD) may be due to the lower heat-induced binder aging in Evotherm mixes compared to HMA controls.



WHAT'S NEXT

Specifications & mix design protocol created

Much larger individual projects

More WMA overlay of distressed PCC with rubberized crack filler

Asphalt Rubber WMA

High-RAP WMA

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THANK YOU

