



DRY PROCESS RUBBER USE IN ASPHALT PAVEMENTS

REDMOND CLARK, PHD

ASPHALT PLUS, LLC

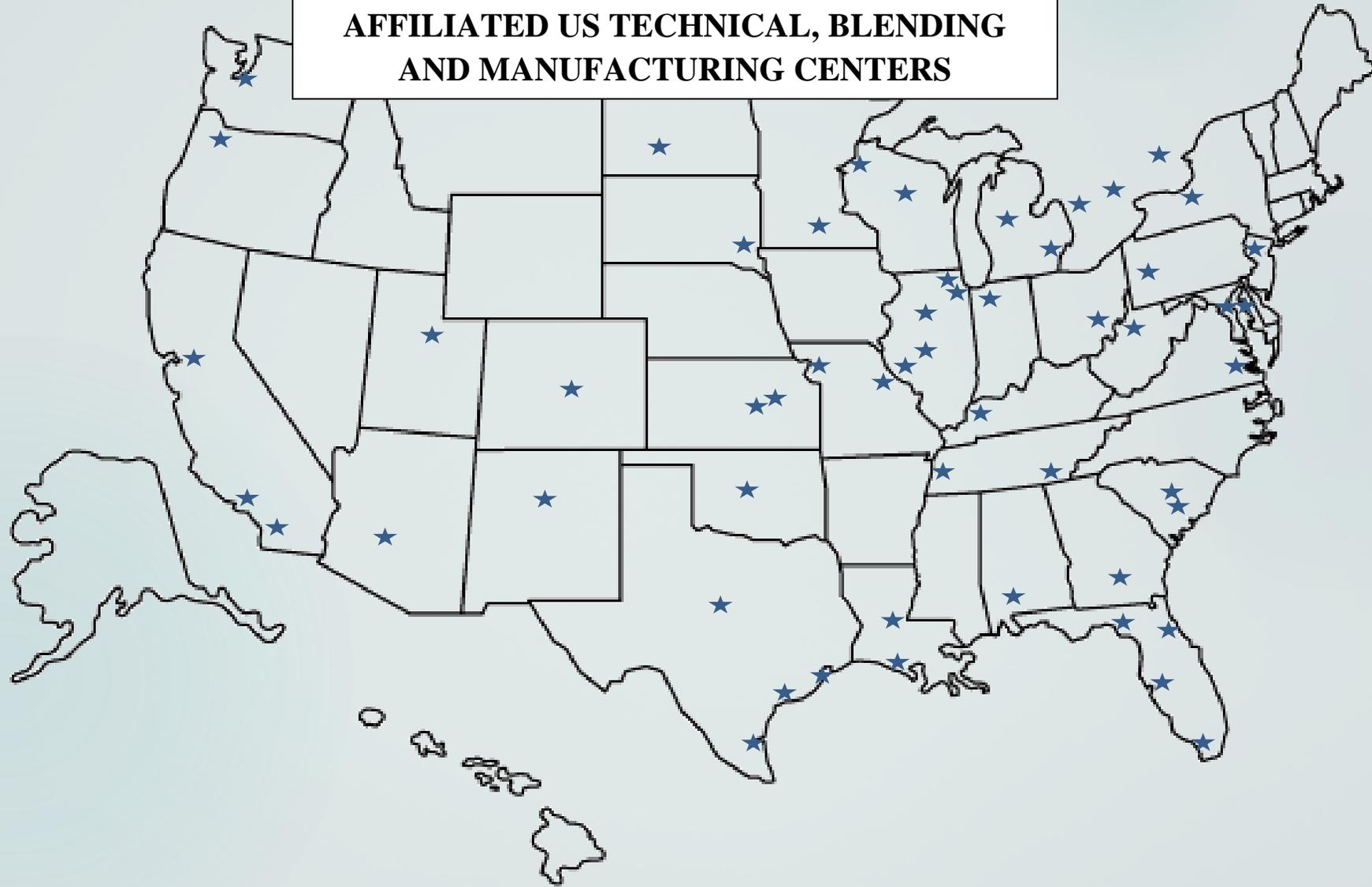
CARY, IL

WWW.ASPHALTPLUS.COM

ASPHALT PLUS LLC A PART OF CBL INDUSTRIAL SERVICES

- ▶ CHEMICAL AND EQUIPMENT MANUFACTURER
- ▶ SERVING A RANGE OF DOMESTIC AND INTERNATIONAL INDUSTRIES
- ▶ COMPANY DEVELOPS ENGINEERED SUSTAINABILITY TECHNOLOGIES
- ▶ WE USE RUBBER AS A PART OF AN ENGINEERED CHEMICAL PROCESS DESIGNED TO IMPROVE THE PERFORMANCE OF ASPHALT PAVEMENTS
- ▶ MORE THAN 60 DOMESTIC AND INTERNATIONAL LOCATIONS IN NA

**AFFILIATED US TECHNICAL, BLENDING
AND MANUFACTURING CENTERS**



ASPHALT PLUS BACKGROUND

- ▶ COMPANY FOUNDED TO RESEARCH USE OF CRUMB RUBBER IN ASPHALT
- ▶ 13 YEARS EXPERIENCE IN RUBBERIZED ASPHALT FIELD APPLICATIONS USING DRY-INJECTED ENGINEERED CRUMB RUBBER
- ▶ APPROACHING 3 MM TONS IN SERVICE,

CURRENT STATUS OF DOMESTIC RECYCLED RUBBER MARKETS

- ▶ 6-8 BILLION LBS PER YEAR
- ▶ REUSE MARKETS CHALLENGED
 - ▶ OVER 50% OF RECYCLED RUBBER BURNED OR THROWN AWAY
 - ▶ EPA IS IN EARLY STAGES OF SHUTTING MASS BURNERS DOWN
 - ▶ ABOUT 25% OF RECYCLED RUBBER USED AS CRUMB
 - ▶ PLAYING FIELDS MARKET UNDER PRESSURE
 - ▶ ASPHALT USE FLAT: ABOUT 4% OF RECYCLED TIRES
 - ▶ SMALLER, DISAGGREGATED MARKETS BEING CREATED
- ▶ MAJOR RECYCLERS HAVE GONE THROUGH RESTRUCTURING
- ▶ INDUSTRY NEEDS NEW MARKETS SCALED TO RUBBER PRODUCTION

ATTITUDE OF ASPHALT AND RUBBER MARKET PLAYERS

- ▶ TIRE INDUSTRY: INTERESTED BUT NOT INVESTING
- ▶ ENVIRONMENTAL COMMUNITY: FOCUSED ELSEWHERE
- ▶ ENVIRONMENTAL REGULATORS
 - ▶ CAN REGULATE WASTE
 - ▶ CAN'T MAKE MARKETS
- ▶ DOTS
 - ▶ LIMITED MONEY
 - ▶ CHANGE RESISTANT
- ▶ CONTRACTORS NOT INTERESTED IN RUBBER
 - ▶ HARD TO USE
 - ▶ EXPENSIVE
- ▶ **IF ISSUES NOT ADDRESSED, NO MARKET...**

ASPHALT PAVEMENT OFFERS LARGE
MARKET POTENTIAL FOR RUBBER

HOW DOES RUBBER GET THERE???

LET'S DRILL DOWN...

NATIONAL ASPHALT MARKET

- ▶ MORE THAN 90% OF ALL US PAVEMENTS ARE ASPHALT
- ▶ INFRASTRUCTURE SPENDING EXPANDING
- ▶ 350 MM – 500 MM TONS OF ASPHALT PER YEAR
- ▶ MARKET SEGMENTED:
 - ▶ HOT AND WARM MIX ASPHALT : 80-90%
 - ▶ MODIFIED ASPHALT: 10-20%

WHAT IS MODIFIED ASPHALT?

- ▶ LIQUID ASPHALT (CALLED "BINDER") IS THE GLUE THAT HOLDS ASPHALT TOGETHER
- ▶ MODIFIED ASPHALT: CHEMICALLY ALTERED BINDER, USUALLY WITH SYNTHETIC RUBBER POLYMERS LIKE SBS
 - ▶ SBS IS A PRIMARY INGREDIENT OF TIRES
 - ▶ MELTS IN BINDER, MAKES MIX TOUGHER
- ▶ MODIFIED ASPHALT USED IN MOST DIFFICULT PAVING APPLICATIONS
 - ▶ HEAVY TRUCK TRAFFIC
 - ▶ SLOW-MOVING, STOP AND GO TRAFFIC
 - ▶ CLIMATE EXTREMES
- ▶ EXPENSIVE, BUT MODIFIED ASPHALT CAN LAST 25-50% LONGER THAN REGULAR ASPHALT

HOW DOES RECYCLED TIRE RUBBER WORK IN ASPHALT?

- ▶ WHEN ADDED TO BINDER AS A CRUMB RUBBER, RUBBER ABSORBS LIGHTER BINDER COMPONENTS, SOFTENS, SWELLS
- ▶ MAKES ASPHALT BINDER THICKER AND MORE FLEXIBLE
- ▶ TIRE RUBBER MODIFIED BINDER TOUGH LIKE MODIFIED ASPHALT
- ▶ DIFFERENT CHEMISTRY
 - ▶ TIRES ARE "VULCANIZED"
 - ▶ CRUMB RUBBER CAN'T MELT
 - ▶ GRAINS OF RUBBER STAY INTACT IN BINDER
 - ▶ CRUMB RUBBER ACTS LIKE FLEXIBLE AGGREGATE

HOW IS GROUND TIRE RUBBER ADDED TO ASPHALT?

- ▶ TWO METHODS USED TO ADD RUBBER:
 - ▶ WET PROCESS:
 - ▶ BINDER "COOKED" WITH RUBBER AT HIGH TEMPERATURES ½ HR. OR MORE
 - ▶ NO MATERIAL CHEMICAL REACTION
 - ▶ DRY PROCESS:
 - ▶ RUBBER MIXED WITH HOT AGGREGATE AND BINDER DURING MIX PRODUCTION
 - ▶ RUBBER SOFTENS AND SWELLS BEFORE THE MIX IS PLACED AND COMPACTED
- ▶ ***HANDLED PROPERLY, BOTH PERFORM LIKE POLYMER MODIFIED ASPHALTS IN THE LAB/FIELD***

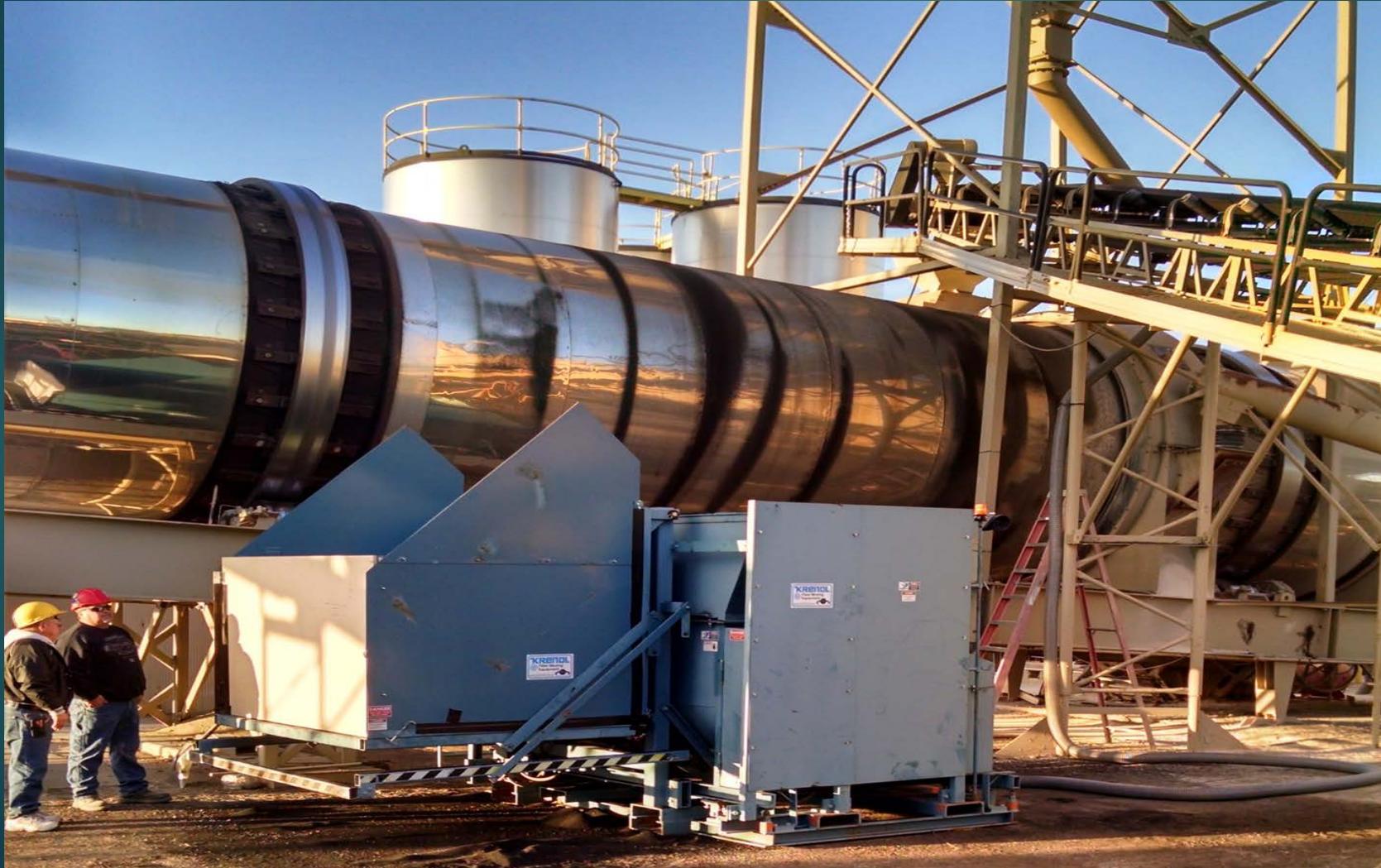
THE WET PROCESS



THE DRY PROCESS



PNEUMATIC INJECTION UNIT



BAGGED, DELIVERED, ENGINEERED RUBBER



TRANSPORT TO UNIT, LOAD IN UNIT



UNIT REPLENTISHMENT



METERED FEEDING AND INJECTION



FEED INTO PLANT



INJECTION POINT

MODIFIED ASPHALT IS THE POINT OF
MARKET ENTRY FOR RUBBER



WHY HASN'T RUBBER PENETRATED ASPHALT MARKETS?

- ▶ MODIFIED ASPHALT MARKET CONSUMES ABOUT 100,000 T OF RECYCLED RUBBER
- ▶ MARKET POTENTIAL IS 625,000 T
- ▶ MARKET IS FLAT: NOT MUCH GROWTH
- ▶ WHAT IS HOLDING RUBBER BACK?
 - ▶ DOT CONCERNS
 - ▶ EARLY FOCUS ON WET PROCESS
 - ▶ WET PROCESS QUALITY CONTROL ISSUES
 - ▶ CONTRACTOR RESISTANCE
 - ▶ ECONOMICS

DOT CONCERNS

- ▶ RUBBER ASPHALT HISTORY
- ▶ LACK OF PROPER QC
- ▶ NO PERFORMANCE/COST ADVANTAGE
- ▶ LAB TEST SHORTCOMINGS
- ▶ INSTITUTIONAL RESISTANCE TO NEW TECHNOLOGY

EARLY FOCUS ON WET PROCESS

- ▶ SUPERPAVE QUALITY CONTROL SYSTEM FOCUSES ON INGREDIENTS TO MIX
- ▶ MODIFIED BINDERS HAVE TO MEET PERFORMANCE TESTING
- ▶ WET PROCESS PRODUCES A RUBBER-MODIFIED BINDER THAT CAN BE TESTED BEFORE USE.
- ▶ WET PROCESS IS EASIER FOR REGULATORS TO CONTROL
- ▶ A PERFECT FIT...

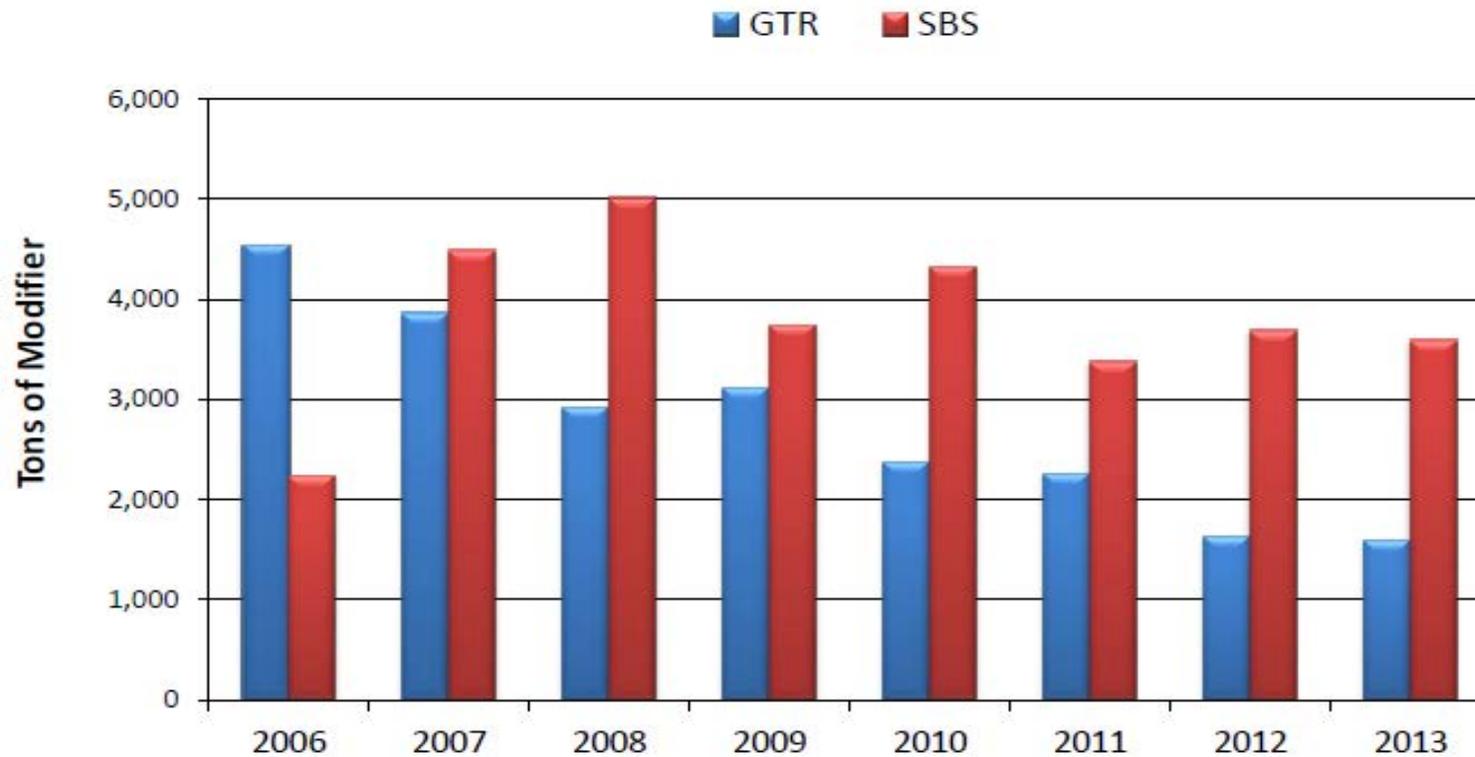
WET PROCESS QUALITY CONTROL ISSUES

- ▶ AFTER COOKING, RUBBER GRAINS REMAIN INTACT
- ▶ UNLESS AGITATED, RUBBER WILL SEPARATE FROM BINDER DURING TRANSPORT AND STORAGE
- ▶ THIS CHANGES THE MIXES: SOME WITH TOO MUCH RUBBER, SOME WITH TOO LITTLE
- ▶ PAVEMENTS WILL FAIL PREMATURELY IF THIS HAPPENS

CONTRACTOR RESISTANCE

- ▶ CONTRACTORS HAVE A NUMBER OF ISSUES WITH WET PROCESS RUBBER ASPHALTS:
 - ▶ RUBBER SETTLES IN STORAGE TANKS
 - ▶ RUBBERIZED BINDERS REQUIRE STRONGER PUMPS
 - ▶ RUBBER CAN BLOCK FILTERS, TRAPS IN PLANT
 - ▶ THE ASPHALT IS STICKY
 - ▶ STICKS TO TRUCKS
 - ▶ STICKS TO TOOLING
 - ▶ STICKS TO ROLLERS
- ▶ GIVEN A CHOICE, CONTRACTORS WILL USE POLYMERS

FLORIDA TRENDS IN PMA AND CRMA



ECONOMICS

- ▶ POLYMER MODIFICATION COSTS
 - ▶ \$6-7 PER TON OF MIX IN CHEMICAL COSTS
 - ▶ \$0.50 PER TON OF MIX IN HANDLING, TRANSPORT AND WASTE ISSUES
 - ▶ TOTAL PRODUCTION COSTS: \$6.50 - \$7.50 PER MIX TON
- ▶ WET PROCESS MODIFICATION COSTS
 - ▶ \$7-\$10 PER TON OF MIX IN RUBBER/PROCESSING COSTS (DEPENDS ON RUBBER GRAIN SIZE)
 - ▶ \$0.50 PER TON OF MIX IN HANDLING, STORAGE, CHEMICALS, TRANSPORT AND WASTE ISSUES
 - ▶ TOTAL PRODUCTION COSTS: \$7.50-\$10.50 PER MIX TON

DOTS HAVE EVERY REASON TO SAY NO TO RUBBERIZED ASPHALT

- ▶ PRIMARY WET PROCESS “SUCCESSSES” HAVE OCCURRED IN STATES WHERE RUBBER USE IS MANDATED, REGARDLESS OF COST
- ▶ THERE HAS TO BE A BETTER WAY...

CAN THE DRY PROCESS IMPROVE ASPHALT MARKET PENETRATION?

- ▶ QUALITY CONTROL
- ▶ DOT RESISTANCE
- ▶ CONTRACTOR RESISTANCE
- ▶ ECONOMICS
- ▶ PERFORMANCE

DRY PROCESS QUALITY CONTROL

- ▶ ENGINEERED RUBBER MANUFACTURED: ISO, ASTM COMPLIANT
- ▶ DRY PROCESS ADDITIONS USE ACCURATE, ENGINEERED FEEDERS TO METER ADDITIONS
- ▶ THE RUBBER-ASPHALT COMPOSITE CANNOT SEPARATE
- ▶ DRY PROCESS QUALITY CONTROL BETTER THAN WET PROCESS

DOT RESISTANCE

- ▶ DRY PROCESS HISTORY MUCH BETTER
- ▶ SIGNIFICANTLY IMPROVED QC
- ▶ PERFORMANCE/COST ADVANTAGE
- ▶ LAB TEST CAPABILITIES IMPROVING
- ▶ INSTITUTIONAL RESISTANCE TO NEW TECHNOLOGY
 - ▶ COST-EFFECTIVE SUSTAINABILITY
 - ▶ IMPROVED ROAD LIFE
 - ▶ SAFER/QUIETER ROADS
- ▶ SPECIFICATION PROCESS ACCELERATING

DRY PROCESS CONTRACTOR ACCEPTANCE

- ▶ NO SPECIAL TANKS, MIXERS OR PUMPS; JUST A MODIFIED FIBER MACHINE
- ▶ SINCE RUBBER IS ADDED LIKE AGGREGATE, NO SETTLING, FILTER BLOCKAGE OR BUILD-UP IN PLANT
- ▶ DRY PROCESS ADDITIVES ELIMINATE STICKINESS
 - ▶ MATERIAL SLIDES EASILY OFF TRUCK BEDS
 - ▶ NO BUILD-UP IN PAVER
 - ▶ NO ROLLER PICK-UP
 - ▶ HANDLES LIKE STANDARD HOT MIX

DRY PROCESS ECONOMICS

- ▶ DRY PROCESS MODIFICATION COSTS
 - ▶ \$3-\$4 PER TON OF MIX IN RUBBER/PROCESSING COSTS (DEPENDS ON RUBBER GRAIN SIZE)
 - ▶ \$0.50 PER TON OF MIX IN HANDLING, STORAGE, CHEMICALS, TRANSPORT AND WASTE ISSUES
 - ▶ TOTAL PRODUCTION COSTS: \$3.50-\$4.50 PER MIX TON

ECONOMICS COMPARISON

- ▶ WET PROCESS MODIFICATION COSTS: \$7.50-\$10.50 PER MIX TON
- ▶ POLYMER MODIFICATION COSTS: \$6.50 - \$7.50 PER MIX TON
- ▶ DRY PROCESS MODIFICATION COSTS: \$3.50-\$4.50 PER MIX TON

LOOKS PROMISING, BUT WHAT
HAPPENS IN THE FIELD?



THE GEORGIA EXPERIENCE

- ▶ GA DOT CREATED OPEN SPECIFICATIONS: ALLOW PMA, CRMA DRY AND WET
- ▶ BINDER, PAVEMENT MUST MEET PERFORMANCE SPECIFICATIONS
- ▶ PROGRAM IS EVOLVING, BUT RESULTS ARE STRIKING
- ▶ ONE MILLION TONS IN SERVICE FOR UP TO A DECADE, HEAVY TRAFFIC ROADS

FIELD PERFORMANCE EVALUATION

- ▶ THREE INTERSTATE PROJECTS UP TO 17 MILES IN LENGTH
 - ▶ PMA CONTROL PAVEMENT ALONGSIDE DRY PROCESS RUBBER PAVEMENT
 - ▶ UP TO TEN YEARS SERVICE LIFE TO DATE
- ▶ ONE STATE HIGHWAY
 - ▶ WET AND PMA CONTROL SURFACES
- ▶ RUBBERIZED PAVEMENTS COMPARED TO CONTROLS BY INDEPENDENT RESEARCHERS: CORING, FIELD INSPECTIONS
 - ▶ COMPARABLE RUTTING AND CRACKING PERFORMANCE
 - ▶ COMPARABLE RAVELLING, PUSHING, BLEEDING
- ▶ NEARLY 2000 LANE MILES IN SERVICE IN GA

I-20 SMA/PEM 5 YEAR RESULTS

Item		Westbound	Eastbound
Rut Depth (1/16 inch)	section 1	0	0
	section 2	0	0
	section 3	0	0
	section 4	0	0
Cracking (%)		0	0
Raveling (%)		0	0
Bleeding (%)		0	0
Pushing (%)		0	0

I-75 10 YEAR FIELD RESULTS



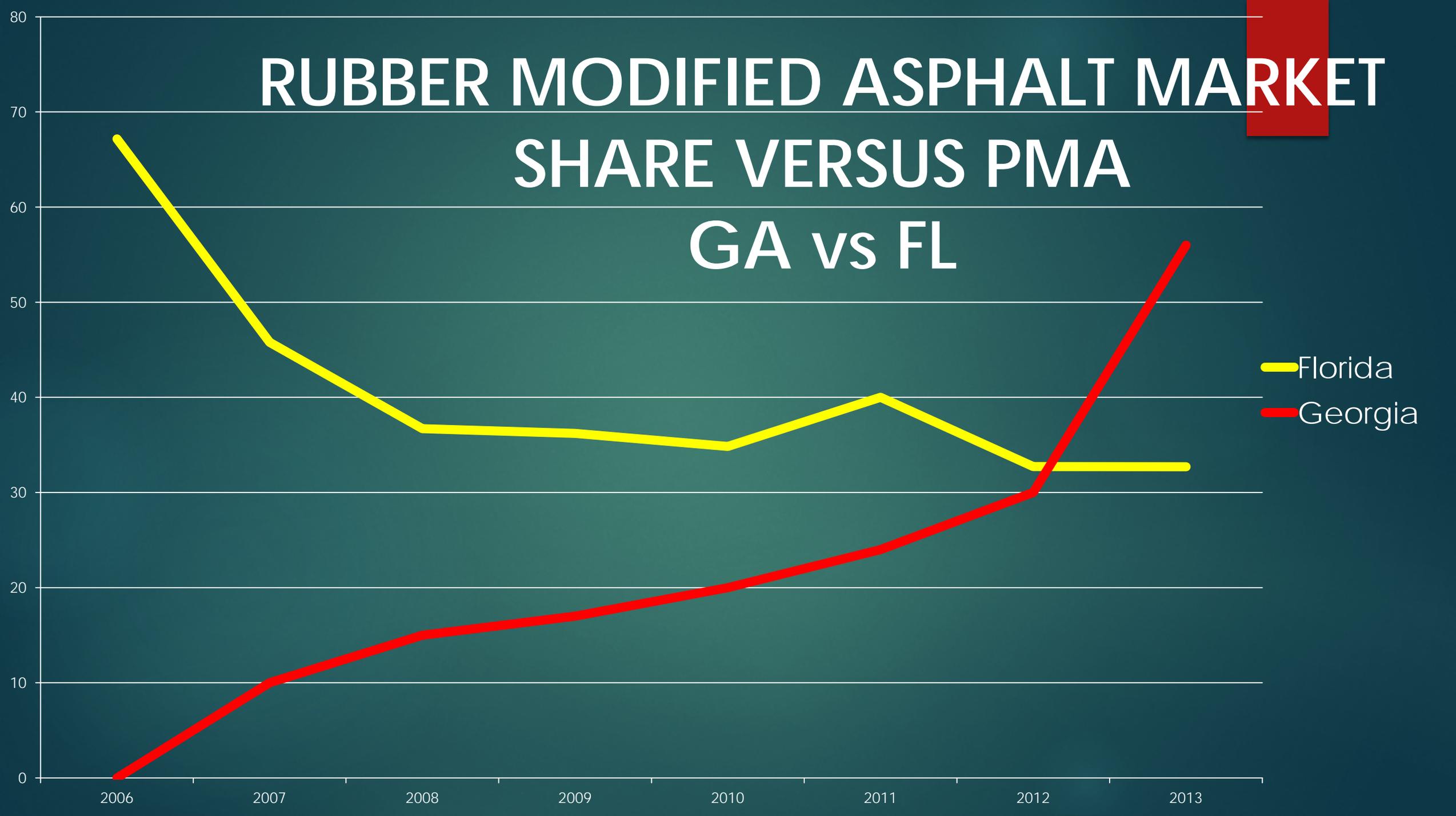
Item	Control PEM	Rubberized PEM
Rut Depth (1/16 inch)	section 1	0
	section 2	0
	section 3	0
	section 4	0
	section 5	0
	section 6	0
	section 7	1
	section 8	1
Cracking (%)	0	0
Raveling (%)	0	0
Bleeding (%)	0	0
Pushing (%)	0	0

HOW HAS THE MARKET RESPONDED?

- ▶ OPEN SPECIFICATION: WET, DRY, PMA ALLOWED
- ▶ LET THE MARKET CHOOSE
- ▶ USER SELECTION: CHEAPEST, EASIEST TO USE
- ▶ WET PROCESS SHUT OUT
- ▶ DRY PROCESS MADE MAJOR GAINS IN MARKET PENETRATION

RUBBER MODIFIED ASPHALT MARKET SHARE VERSUS PMA GA vs FL

Florida
Georgia



PROJECT EXPERIENCE



DOES THE DRY PROCESS WORK IN GA?

Dense Graded Mixes						
Contractor	Project #	Plant#	Mix Type	Tonnage	Route	County
ER Snell	CSSTP-M00-00(821)	80	12.5mm SP	22,419	SR140	Gwinnett
ER Snell	CSSTP-M00-00(832)	80	12.5mm SP	26,220	SR9	Gwinnett
ER Snell	CSSTP-008-00(578)	80	12.5mm SP	18,629	SR124	Gwinnett
The Lions Group	CSSTP-M003-00(754)	53	12.5mm SP	17,293	SR8	DeKalb
Reeves/Tugalo	CSNHS-M003-00(900)	91	12.5mm SP	10,744	SR17	Habersham
Reeves	CSSTP-M003-00(936)	37	12.5mm SP	7,212	SR26	Laurens
Reeves	CSSTP-M003-00(494)	46	12.5mm SP	14,736	SR28	Richmond
Reeves	M004173	15	12.5mm SP	20,000	SR10	Richmond
Reeves	CSNHS-M003-00(932)		12.5mm SP	17,293	SR27	Sumter
Reeves	CSSTP-M003-00(765)	4	12.5mm SP	10,971	US441	Baldwin
Reeves	CSSTP-M003-00(765)	4	19mm SP	1,071	US441	Baldwin
Reeves			12.5mm SP	2,000	SR26	Houston
Reeves/Baker	CSSTP-M003-00(910)		12.5mm SP	8,000	SR307	Chatham
Reeves/Baker	MLP00-0307-00(008)		12.5mm SP	6,000		Chatham
Reeves/Baker			19mm SP	6,200		Chatham
Reeves	M004271/72		12.5mm SP	22,000	SR247	Bibb
Baldwin	Various			50,000		
Southern	Various			1,000		

Open Graded Mixes

Contractor	Project #	Plant#	Mix Type	Tonnage	Route	County
Scruggs	CSNHS-M003-00(998)		PEM	28,049	I-75	Lowndes
Reeves	NH-IM-520-1(15)01		PEM	19,000	I-20/I-520	Richmond
Reeves	M004271/72		OGFC	3,000	SR247	Bibb
Reeves	CSNHS-M003-00(890)		OGFC	10,000	SR319	Tift
Reeves	CSNHS-M003-00(560)		OGFC	562	I-75	Houston/Peac h
Reeves	NHIMO-0075-		PEM	10,900	I-75	Bibb

SMA Mixes

Contractor	Project #	Plant#	Mix Type	Tonnage	Route	County
Reeves	NH-IM-520-1(15)01	15	SMA	10,744	I-20/I-520	Richmond
Reeves	City Of Tifton		SMA	300		Tift
Reeves	NHIMO-0075-02(211)		SMA	26,500	I-75	Bibb
Reeves	NH000-0520-01(017)		SMA	13,652	I-520	Richmond

MULTIPLE PROJECTS ACTIVE IN TEN STATES

- ▶ COLD AND WARM CLIMATE APPLICATIONS
- ▶ 30 MILES OF PAVEMENT LAID LAST WEEK IN THREE STATES

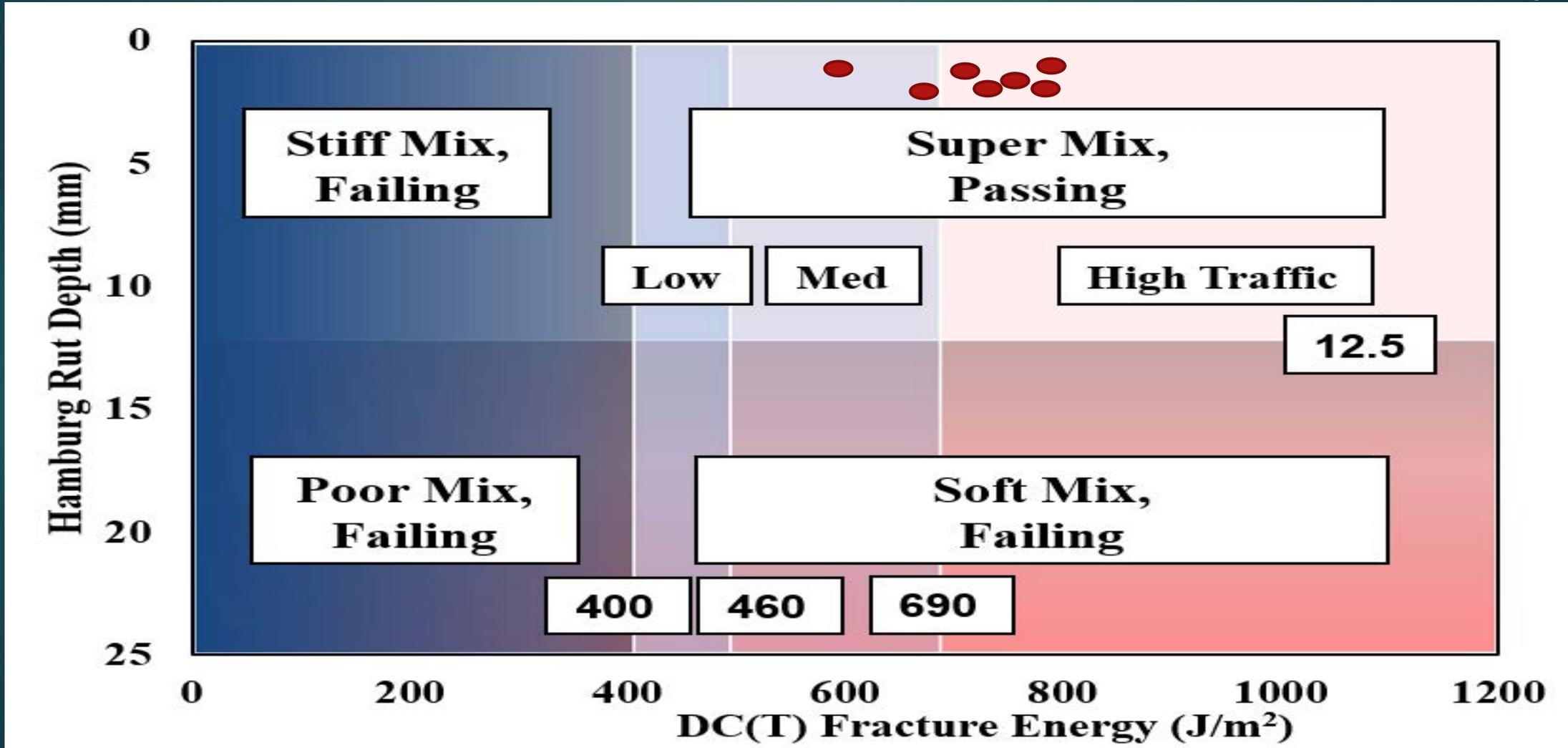
COLD CLIMATE PROJECTS



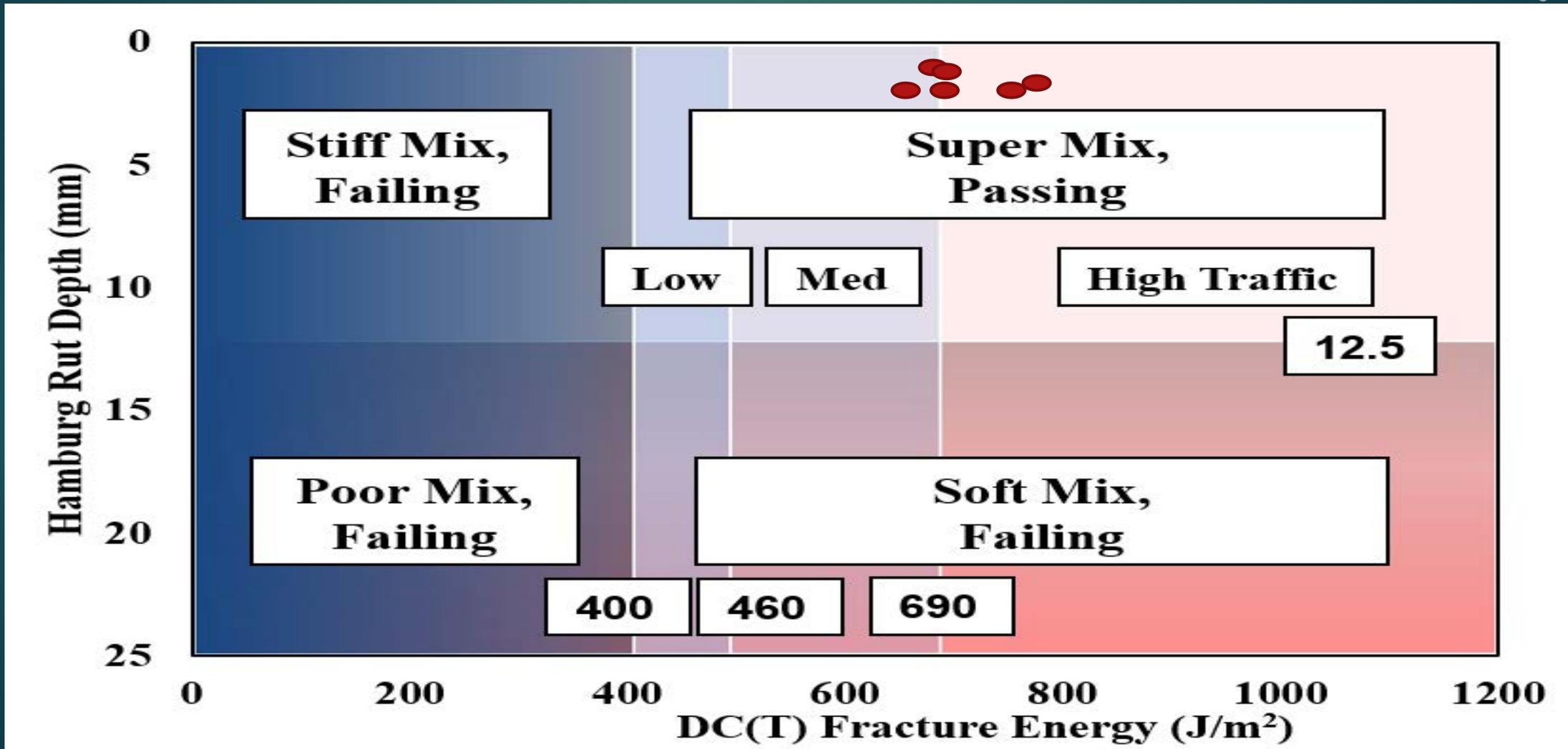
I-88 MAIN LINE AND SHOULDER DRY PROCESS MODIFIED SMA PAVING



HAMBURG/DCT PMA DESIGN PLOT



HAMBURG/DCT CRM DESIGN PLOT



DRY PROCESS NATIONAL PROGRESS

- ▶ APPROXIMATELY 5,000 MILES PLACED IN SOUTHERN, NORTHERN US
- ▶ APPROACHING 3 MM TONS IN SERVICE
- ▶ COMPETITIVE PERFORMANCE WITH PMA
- ▶ STATES CONSIDERING EXPANDING THEIR SPECIFICATIONS TO INCLUDE DRY PROCESS

IMPACT ON GATEKEEPERS



IMPACT ON CONTRACTORS

- ▶ 50% REDUCTION IN MA COSTS
- ▶ NEW BUSINESS LINE
- ▶ NO CHANGE TO PRODUCTION PROCESS/EASE OF USE
- ▶ CREATES OPPORTUNITY TO EXPAND THE USE OF RUBBER TO NEW, NON-MA MARKETS
- ▶ GIVES THEM A SUSTAINABILITY STORY TO TELL

IMPACT ON STATE DOTs

- ▶ NO LOSS IN PAVEMENT PERFORMANCE
- ▶ BETTER QC
- ▶ PASS-THROUGH SAVINGS
- ▶ LONGER PAVEMENT LIFE
- ▶ MORE ABR POSSIBLE WITH RUBBER (KEY DEVELOPMENT)
- ▶ RE-RECYCLING BENEFITS/LOWER FUTURE COSTS
- ▶ MORE SUSTAINABLE PAVEMENTS

CONCLUDING THOUGHTS

- ▶ RUBBER HAS A PLACE IN ASPHALT
- ▶ DRY PROCESS EFFECTIVE, ONLY SELF-SUSTAINING MARKET
- ▶ NO MANDATE, OPEN SPECIFICATION WELCOME
- ▶ LET THE MARKET SORT OUT THE BEST APPROACH
- ▶ MODIFIED ASPHALT FIRST, WIDER USE REQUIREMENT LATER
- ▶ MODIFIED MARKET POTENTIAL: ONE BILLION LBS.
- ▶ ALL ASPHALT MARKET POTENTIAL: SIX BILLION LBS.
- ▶ TEST MARKET PENETRATION: 60%

CHALLENGES AHEAD

- ▶ STATE DOTS ARE MAJOR BARRIER TO ENTRY
 - ▶ NEED RELEVANT FIELD DATA
 - ▶ BETTER ECONOMIC DATA
 - ▶ PROJECTS THEY CAN SEE AND TRACK: PRODUCT ON THE GROUND!
 - ▶ DEMONSTRATE EFFECTIVE QUALITY CONTROL/ENGINEERED SYSTEMS
- ▶ AVOID THE TRAP OF QC/WET PROCESS ALONE
 - ▶ ENCOURAGE MIX PERFORMANCE TESTING
- ▶ DEVELOP A QC FOCUS WITH RUBBER RECYCLERS
- ▶ FUTURE MARGIN ISSUES

THANK YOU!

REDMOND CLARK

847-404-4713

RCLARK@ASPHALTPLUS.COM

WWW.ASPHALTPLUS.COM