

Roadway Construction/ Recycled Asphalt Paving Mixes

Part I

Recycled Asphalt Shingles in HMA

Presented to:

North Central Texas Council of Governments

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Introduction



WHAT WE KNOW



WHAT WAS DONE?



WHY IT WAS DONE?



WHAT WE'RE DOING?



WHAT TESTS?



WHAT IS STATE OF THE PRACTICE?



HOW IS IT PERFORMING?



Introduction



TYPICAL APPLICATIONS?



WHAT COST/BENEFITS?



LIST OF PROJECTS?



CONCLUSION



Q&A



RESOURCES



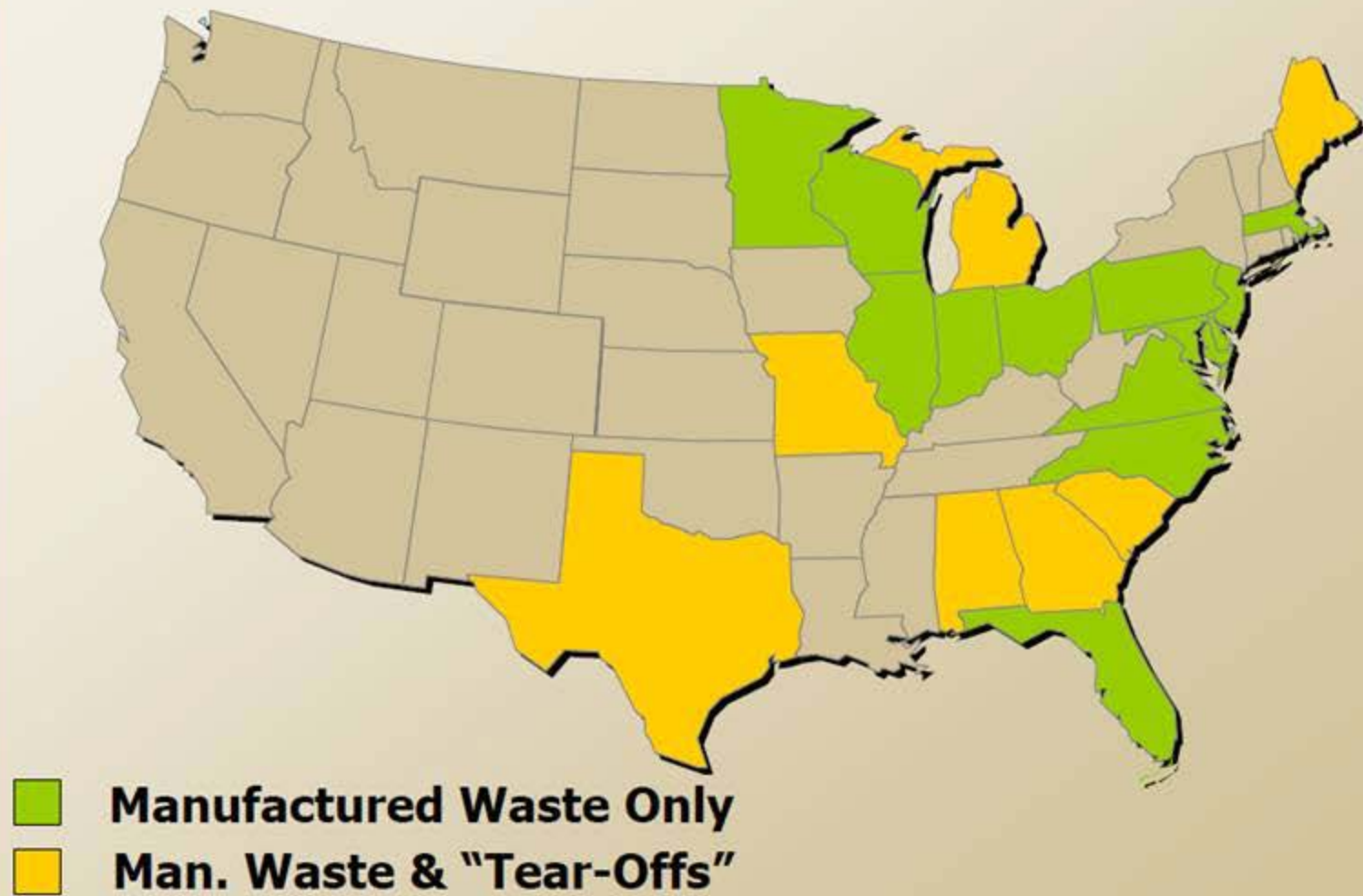
WHAT WE KNOW

Background

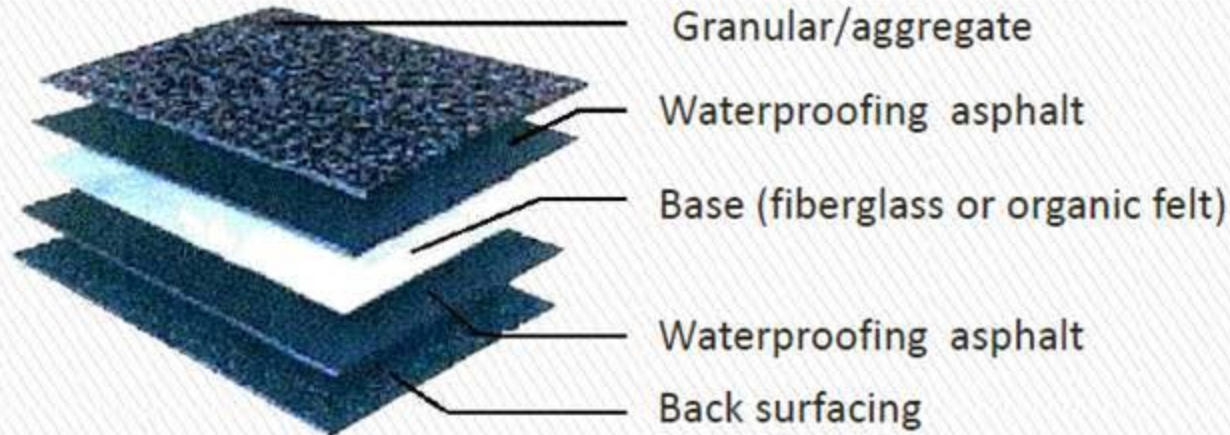
- Approximately 13 million tons of asphalt shingle waste is generated per year
 - Post manufacture (scrap): 1.5 million tons
 - Post consumer (tear-off): 11.5 million tons
- Less than 5% of shingle waste is recycled



National Use



There's A Lot Of Asphalt In Shingles



Component	Organic Felt	Fiberglass Mat
Asphalt cement	30-36%	19-22%
Felt (Fiber)	2-15%	2-15%
Mineral aggregate (#30)	20-38%	20-38%
Mineral filler/stabilizer	8-40%	8-40%

Shingle Asphalt is Stiffer Than Paving Asphalt

Binder	PG Grade	AC %
PG 64-22	67	5.2
RAP	87+	5.0
Shingles	96+	24.0



It's Good For The Environment!





WHAT WAS DONE?

Initial Research

SH 31, Navarro County – May, 1997

- Type C with AC-20
 - Section 1 – 5% man. Waste
 - Section 2 – 5% tear-offs
 - Section 3 - Control
- Initial construction issues with tear-offs section
- Overall performance good – comparable to control
- Part of first research project in Texas





WHY IT WAS DONE?

Why Recycled Shingles?

- A good source of asphalt
- Reduces landfill consumption
- Conserves natural resources





TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Allow Manufactured Waste

- Memo – March, 2006
- Treated the same as RAP – counter flow drum
- Up to 15%

Added Residential Tear-Off Shingles

- Memo – Feb., 2009
- Asbestos certification and testing
- Deleterious material <15%
- No direct flame for shingle material



- Special specifications
- Allows manufactured waste and residential “Tear-Offs”
 - Up to 5%
 - Test for asbestos
 - Deleterious limited to 0.5%
 - 100% passing 3/8” sieve
- RAS can be combined with
 - RAP
 - WMA
 - Substitute binders(lower binder grade)

RAS Specification

Table 1A
Maximum Allowable Amounts of Recycled Binder, RAP & RAS

Mixture Description & Location	Maximum Ratio of Recycled Binder ¹ to Total Binder (%)	Maximum Allowable % (Percentage by Weight of Total Mixture)		
		Unfractionated RAP ²	Fractionated RAP ³	RAS ⁴
Surface Mixes	35	10	20	5
Intermediate Mixes	40	15	30	5
Base Mixes	45	20	40	5



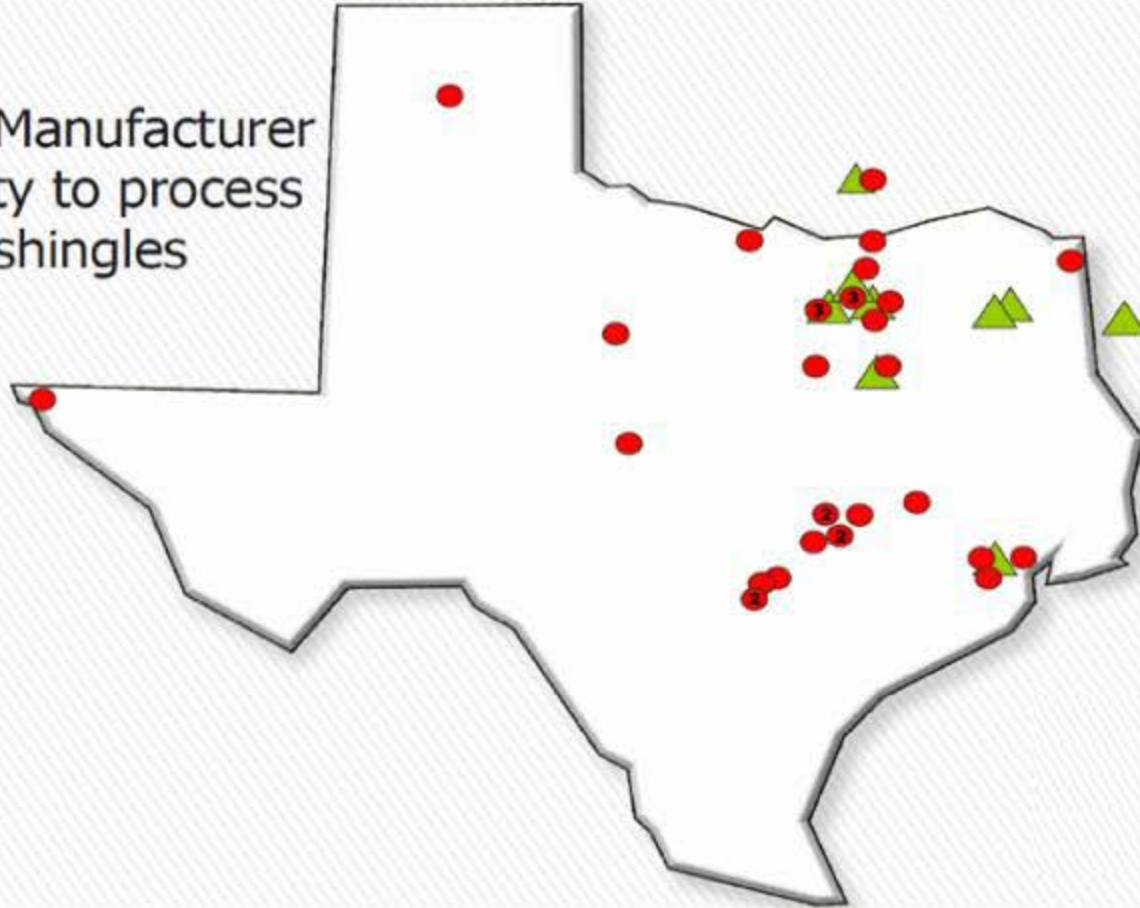


WHAT WE'RE DOING



Plants & Processors

- ▲ Shingle Manufacturer
- Capability to process asphalt shingles



Approved List

- Have met regulatory and specification requirements
- Have a quality control plan & asbestos testing plan in place
- Keep records of materials processed for chain of custody purposes

Texas Department of Transportation

Pre-Qualified Producers of Non-Hazardous Recycled Materials			
Producer	Contact Info	Recycled Material	Primary Application
Century Asphalt, Ltd. Melendy Plant 11913 FM 529 Houston, TX 77041	D. Nick Anders (713) 923-7250	Shingles (Pre-consumer & Post-consumer)	Asphalt Concrete
Cherry Crushed Concrete, Inc. 6131 Selinsky Houston, TX 77048	Leonard Cherry (713) 987-0000	Shingles (Pre-consumer & Post-consumer)	Asphalt Concrete
El Paso C&D Recycling 12520 E. Pelicano Drive El Paso, TX 79928	Jimmy Borrego (915) 256-1908	Shingles (Pre-consumer & Post-consumer)	Asphalt Concrete
Favers Supply Company Conroe Plant 9490 FM 1483 Conroe, TX 77306	Brandon Campbell (936) 756-6960 ext. 242 Randall Moore (936) 537-1131	Shingles (Pre-consumer & Post-consumer)	Asphalt Concrete
Favers Supply Company Huntsville Plant 1118 US 190 East Huntsville, TX 77340	Brandon Campbell (936) 756-6960 ext. 242 Juan Saenz (936) 537-1148	Shingles (Pre-consumer & Post-consumer)	Asphalt Concrete
R2R Recycling Amarillo Plant 13511 Indian Hill Road Amarillo, TX 79124	Kyle Shelton (806) 268-0162	Shingles (Pre-consumer & Post-consumer)	Asphalt Concrete
R2R Recycling Piano Plant 1304 13 th Street Piano, TX 75074	Al Perez (214) 517-7480	Shingles (Pre-consumer & Post-consumer)	Asphalt Concrete
R. K. Hall Construction 7474 South Stateline Texarkana, TX 75501	Brad Bankston (903) 715-2784	Shingles (Pre-consumer)	Asphalt Concrete
R.K. Hall Construction L & W Environmental 9611 Ironton Road Little Rock, AR 72206	Johnny Varnadore (501) 554-9705	Shingles (Pre-consumer & Post-consumer)	Asphalt Concrete
R.K. Hall Construction Swift Recycling 415 N. Plainview Road Ardmore, OK 73401	Randy Swift (417) 456-0642	Shingles (Pre-consumer & Post-consumer)	Asphalt Concrete

Considerations

- Shingle type
- Processing
- Blending
- Storage



Processing

- Proper Grind Size
 - Easier to design mixes
 - Alleviates issues with laydown
 - Facilitates better mixing in the drum



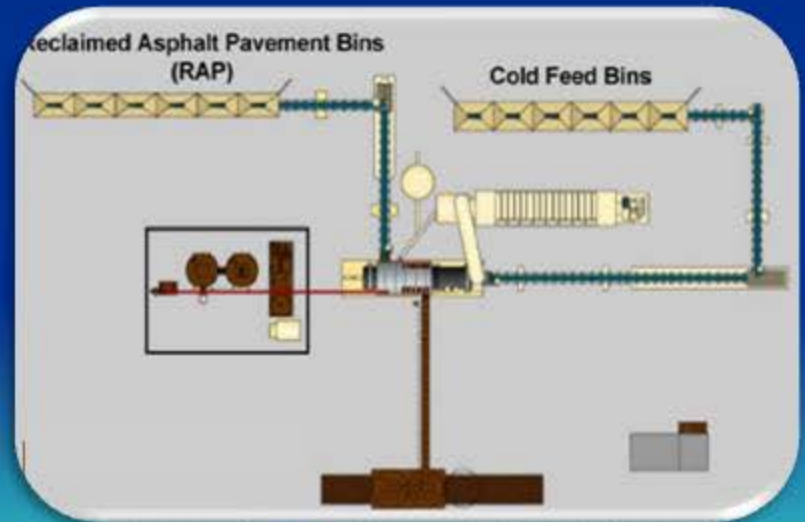
Most processors have gone to a finer grind since they first started.

Blending



Pre-blend

Blend during production



Storage

- Limited Storage Time
 - Processed materials wants to stick back together
 - Keep dry and/or drainable
 - Can pre-blend with RAP or sand





WHAT TESTS?

RAS Mix



Asbestos



Metal



Wood

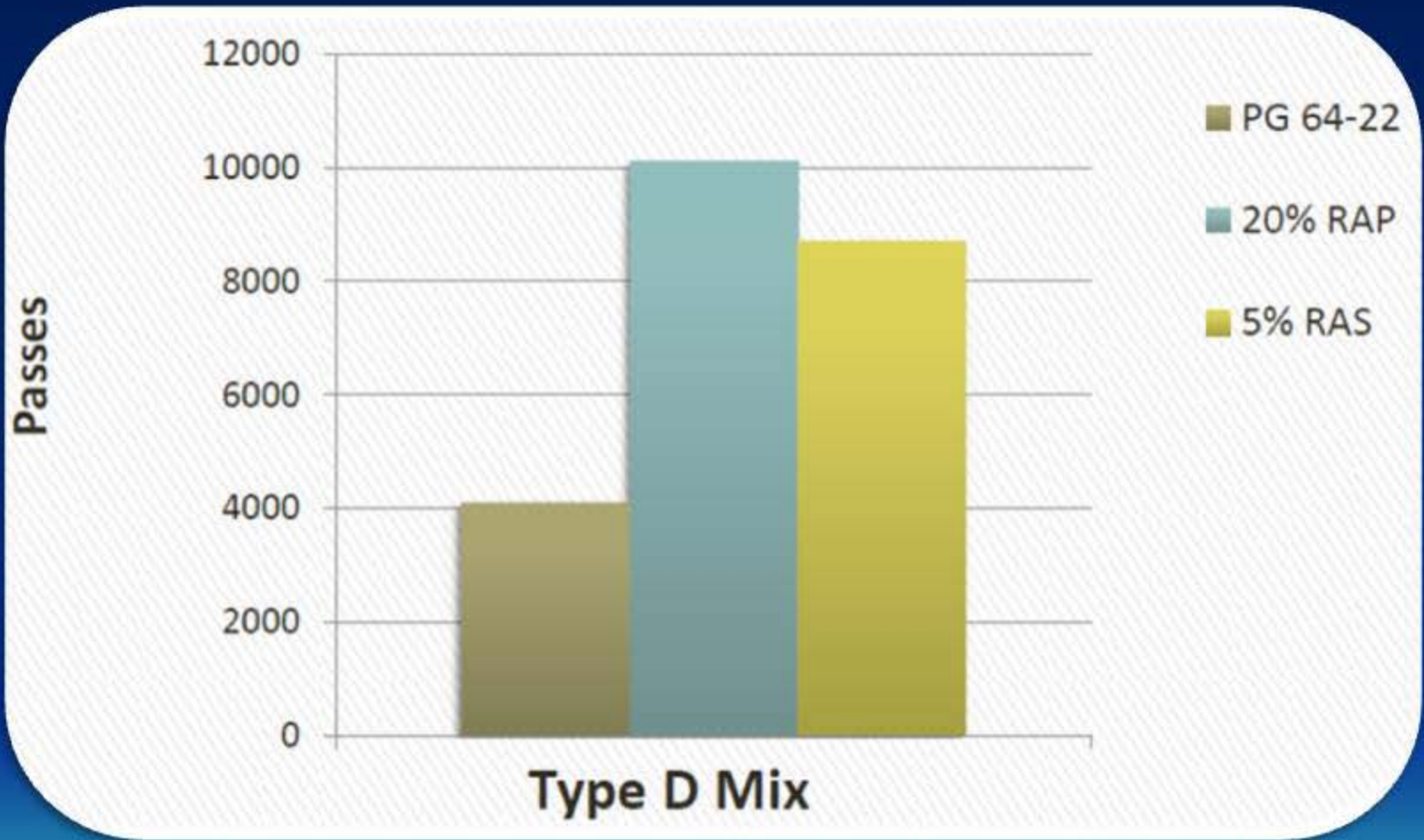


Test Procedures

- Tex-217F, Part III, “Determining Deleterious Materials in Recycled Asphalt Shingles”
 - Only asbestos-free shingles will be accepted for recycling
 - Nails should be removed from tear-off shingles during processing



Performance Testing - Hamburg



RAS Mixture and Binder Tests

- Dynamic modulus
- Stiffness of binders
- Low temperature cracking
- Fatigue





WHAT IS STATE OF THE PRACTICE?



Delivering Waste Shingles



Stockpiled Asphalt Shingles



Shingle Processing Equipment



Processed Shingle



HOW IT IS PERFORMING?

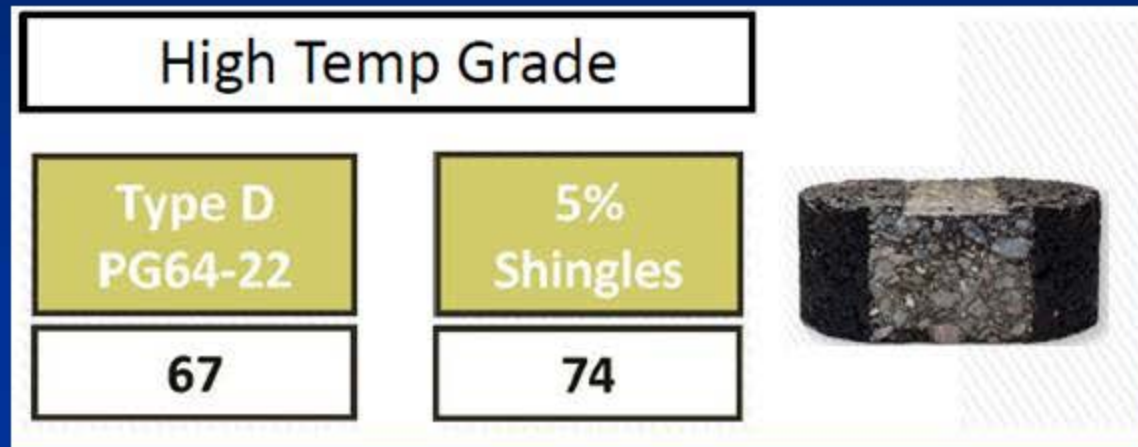
- Fatigue cracking
- Drier mixes
- Stiff mixes
- Raveling
- Premature failures

Well-designed HMA containing less than 5% ground recycled asphalt shingles may perform as well as conventional HMA



5% RAS

An addition of 5% RAS in the mix gives roughly one grade bump in the binder as shown by the DSR.



That same addition of 5% RAS in the mix shows the stiffness doubling as shown by the Hamburg Wheel Test



TYPICAL APPLICATIONS?

- Level-up courses
- Temporary roads & detours
- Bond breaker courses
- Base courses
- Low volume county roads
- Shoulders
- Airport mow stripes

Other Uses

- Structural fill, highway embankments
- Structural fill, retaining walls
- Cold patch, pothole repair
- Aggregate road base
- Dust and erosion control, rural roads





WHAT COST/BENEFITS?

- The primary economic driver for asphalt shingle recycling is virgin asphalt cost savings
- RAS becomes a partial replacement of virgin asphalt
- Potential savings of \$1.00 to \$5.00 per ton
- Tipping fee of \$30.00 to \$40.00 per load
- Grinding fee of \$35.00 to \$40.00 per ton
- Landfill disposal fee of \$120.00 per ton

Cost Savings Can Be Substantial

Price (\$/Ton)			
Type D PG 64-22	with 20% RAP	with 5% Shingles	with 15% RAP & 5% Shingles
\$40.70	\$36.71	\$35.61	\$32.62



Bottom Line



- An available 13 million tons of shingle waste, containing 25% liquid AC
- 3.25 million tons of reclaimable liquid AC
- At \$475.00 per ton that's **\$1.5 billion** worth of liquid asphalt every year



LIST OF PROJECTS?

TxDOT Projects with Average 17% RAP and 3% RAS

HWY	County	Mix Type	Tons
US 59	Wharton	3224 D SAC B PG76-22	35626
LP 197	Galveston	3224 D SAC A 76-22	19335
SH 96	Galveston	3224D SAC A PG 70-22	19335
BS 35C	Brazoria	D SAC A PG 76-22	9801
FM 563	Liberty	3224 D SAC B 64-22	15217



CONCLUSION

“We should treat our roads as assets, not consumables that can be used up, thrown away and replaced with new ones.”

- Don Brock, Astec Industries





Q&A

“High quality RAS Mix comprises Rock, Asphalt, RAS and Air. Regrettably, poor quality RAS Mix has the same ingredients”

Questions?



RESOURCES

- Recycled Materials Resource Center (RMRC)
<http://www.rmrc.unh.edu>
- California Integrated Waste Management Bureau (CIWMB)
<http://www.ciwmb.ca.gov/condemo/shingles>
- Construction & Demolition Recycling Association (CDRA)
<http://www.shingelrecycling.org>

Thank You!

Roadway Construction/ Recycled Asphalt Paving Mixes

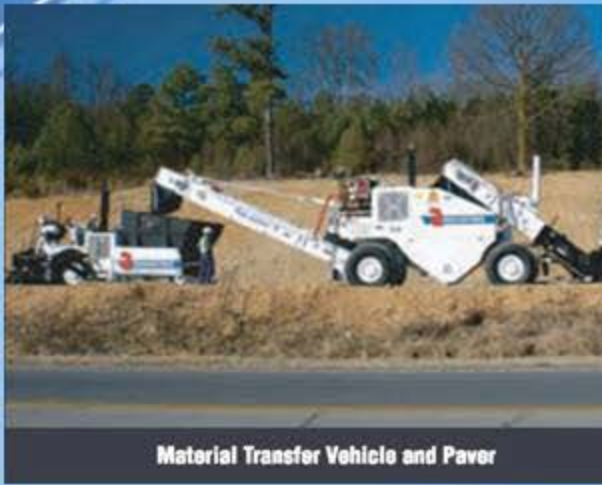
Part II: Recycled Asphalt Pavement in HMA

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Overview



Did you know....

In 2001, United States residents, businesses, and institutions produced nearly 232 million tons of solid waste, which is approximately 4.5 pounds of waste per person per day, up from 2.7 pounds per person per day in 1960. This means that 5% of the world's people generate 40% of the world's waste.

**The Obvious Path for
Redemption is to Recycle
our Waste!**

Recycled Quantities

The United States EPA reports that we recycle only 30% of our solid waste in this country. That means that of the 232 million tons of waste generated in the US, only 70 million tons were recycled away from landfills.

Pavement Recycling

- Of the 2.6 million miles of paved roads in the US, over 94 percent are surfaced with asphalt.
- Approximately 100,000,000 tons of asphalt pavement is removed from existing roads each year.
- Of that amount, 80% is recycled back into new pavement

Reclaimed asphalt pavement is the most recycled material in the world



Why Use RAP in HMA?

- Save Money
- Save Money
- Save Money



Why Use RAP in HMA?

- Environmental Stewardship
 - Conserve Natural Resources
 - Aggregates
 - Asphalt Binders
 - Reduces landfill waste
 - Save Energy (Reduced Hauling Distance)
- Government Mandate
 - Local and State
 - TCEQ

Environmentally Friendly

- Preserves the environment by reducing material taken to landfills
- At 100m tons, that's about 65m yd³ saved in landfill space
- No negative effect on air quality since emission requirements on RAP processing and HMA production (with RAP) must meet existing air quality requirements.

Stakeholder Mission & Vision

Provide a transportation system that is:

- Safe
- Efficient
- Environmental Sensitive
- Cost Effective

Reclaimed Asphalt Pavement

Must:

- Be safe
 - People
 - Environment
- Meet specifications
- Perform well
- Be readily available
- Be cost effective

Sources of RAP

Milling



Demolition



New Waste HMA and Plant Waste

- HMA Returned to Plant, due to...
 - Over Ordering
 - Weather Shut Downs
 - Visual Inspection
 - Temperature
- By-Product of HMA Plant Production
 - Start-Up Reject
 - Transitioning between Mix Designs

Fractionated RAP Processing



Stockpiled RAP Millings



Processing RAP

**Coarse
RAP**



Fine RAP

Mix Design

HMA with RAP

Mix Design

- Mix Designs
 - Conventional (Marshall or Hveem)
 - Performance Designed Mixtures
 - Coarse Matrix High Binder (CMHB)
 - Superpave (SP)
 - Stone Mastic Asphalt (SMA)
 - Avoid usage in PFC or OGFC

Combined Gradation

Hot Bin Grading plus RAP

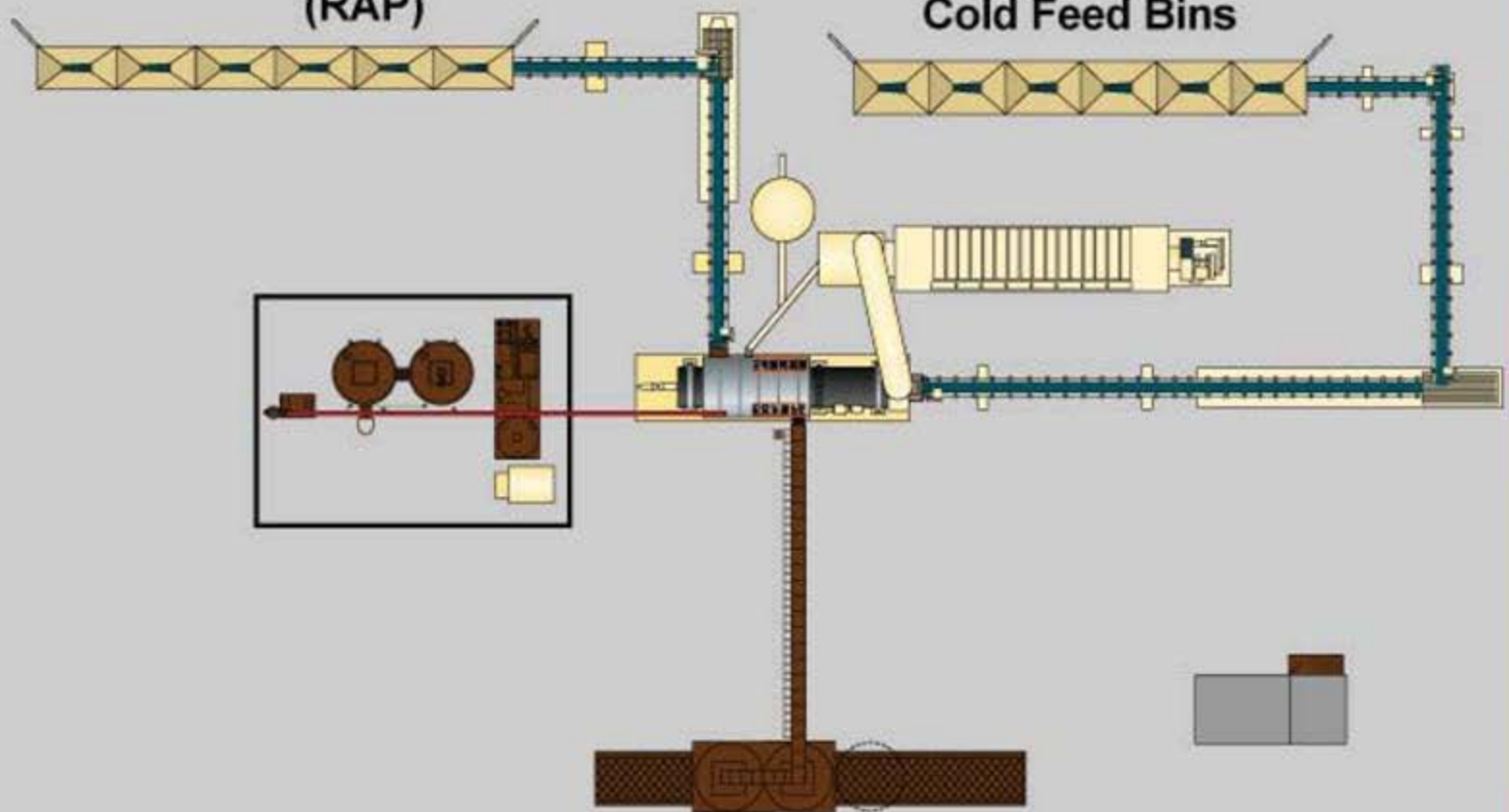
Sieve	Bin 4 (13%)	Bin 3 (19%)	Bin 2 (17%)	Bin 1 (36%)	RAP (15%)	Combined Grading
1"	100					100
¾"	94	100	100		100	99
3/8"	2	20	96	100	99	71
#4	1	4	18	98	83	52
#8			2	77	64	38
#30			2	44	39	22
#200			1.2	13.5	14.2	5.9

Plant Processing

Schematic Drawing

Reclaimed Asphalt Pavement
(RAP)

Cold Feed Bins



RAP Cold Feed Bins



Incorporating Processed RAP into HMA

Mixing
Drum



Batching RAP Mix



Storage
Silo

RAP Performance

- Widespread use began in mid-1970's
RAP adopted and permitted by TxDOT, Counties, Cities and Municipalities
- Depending on percent used, RAP can result in higher stabilities, but may be prone to long term cracking if measures are not taken during mix design process (binder evaluation)
- Conventional mix design requirements are applicable to RAP designs

List of Projects

Harris County Projects (Average 15% RAP)

County	Location	Mix Type	Tons
Harris	Lyons Camp	HC 340 D w/ 15% RAP	6,000
Harris	Highlands Area	HC 340 D w/ 15% RAP	10,000
Harris	Crosby Area	HC 340 D w/ 15% RAP	150,000
Harris	Harvey Camp	HC 340 D w/ 15% RAP	7,000
Harris	PCT 4	HC 340 D w/ 15% RAP	8,000

Cost/ Benefits of RAP

- Milling or Pavement Salvage Cost
 - Mill, haul and stockpile: \approx \$6.50/ton
 - Excavate, haul and stockpile: \approx \$7.00/ton
 - Reprocessing: \approx \$5.00/ton
- Virgin Material Cost
- Coarse Aggregate \approx \$12.00/ton
- Fine Aggregate \approx \$8.00
- PG Binder \approx \$450.00 (Highly Variable)

Cost Savings Using RAP

For a Typical 19.0MM Intermediate (TxDOT Type C)

% RAP	Per ton Savings \$ (Materials Only)	Notes
0	\$0.00	
15	\$3.40	
25	\$5.50	
40	\$6.80	

25% RAP in an intermediate 19.0MM will save approximately 11% per ton

Assuming a 3" lift for every 1 million re-surface dollar this will equate to approximately 2.2 lane miles of additional paving.

In Summary...

RAP Makes Sense

- Over 30 years of success
- Increases efficient use of material resources
- Technology available to produce, test, and use RAP efficiently
- Could be used to obtain LEED credits

RAP Makes Sense

- RAP has a long history of successful use
- Asphalt recycling is sustainable
- Asphalt recycling is economical
- Asphalt recycling works.



Questions?



Resources

- The Asphalt Institute
<http://www.asphaltinstitute.org>
- The national Center for Asphalt Technology (NCAT)
<http://www.eng.auburn.edu/center/ncat/>
- The Texas Hot Mix Asphalt and Aggregate Pavement Association (THMAAPA)
<http://txhotmix.org>

Thank You!