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TxDOT's Sustainable Pavements

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What do Sustainable Practices Look Like?

- Consider Cost
- Consider Function
- Consider Performance
- Consider Quality
- Consider Life Cycle
- Consider Safety
- Consider Technological Advances
- Consider Energy Use
- Consider Impacts to Human and Natural Environment

TxDOT's Sustainable Pavements

- This overview covers:
  - the Types of Sustainable Pavements used by TxDOT
  - This Sustainability is Translated through:
    - Air Quality Benefits
    - Use of Recycled Materials
    - Safety Aspects
    - Water Quality Benefits
    - Noise Reduction Benefits
    - Cost Savings
    - Other Benefits

Warm Mix Asphalt (WMA) and Hot Mix Asphalt (HMA) Statistics

- TxDOT typically uses:
  - 5-15 million tons/year of HMA
- TxDOT is increasing use of WMA
  - 40+ projects completed as of October 2009
  - More than 1.25 million tons of WMA has been produced and placed since 2006

Recycled Asphalt Pavement and Recycled Asphalt Shingles used in HMA and WMA

Benefits: Less Raw Material and Cost Savings

- RAP, RAS, and Substitute Binders have the potential to save TxDOT between $50 million and $150 million each year and it is good for the environment
- These materials can also help control price fluctuations because less raw material is used

HMA

Using RAP and RAS

Benefits: Cost Savings

HMA PG (cost per ton)

- Cost of 100% (PG76) virgin mix = $48.10
- PG 76 mix w/20% RAP = $41.48
  ($6.62 saving = 13.8%)
- PG 76 mix w/15% RAP + 5% RAS = $37.82
  ($10.29 savings = 21.4%)
- PG 70 mix w/15% RAP + 5% RAS = $36.06
  ($12.04 savings = 25.0%)
- PG 64 mix w/15% RAP + 5% RAS = $33.04
  ($15.06 savings = 31.3%)

Warm Mix Asphalt (WMA)

- **Warm Mix Asphalt (WMA) is defined as additives or processes that allow a reduction in the temperature at which asphalt mixtures are produced and placed**

WMA

Benefits: Reduced Emissions, Smoke, Odor, Fuel Consumption

WMA
Benefits: Reduced Emissions

- Use of 90% WMA, 20% RAP and 2% RAS avoids approximately 113,300 tons/year of CO2 emissions

- Approximately equal to removing CO2 emissions from:
  - 19,600 vehicles, or
  - 11,500,000 gallons of gasoline, or
  - 238,000 barrels of oil, or
  - equivalent to the CO2 emissions from powering electricity to 12,400 homes/year.[1]

[1] http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results

WMA

- **Other Benefits:**
  - **More Durable Pavement: Less oxidized + less absorption = better fatigue life**
  - **Better in-place densities**
  - **WMA is relatively insensitive to variations in compaction temperature**
  - **Wider Paving Window: Winter Paving and Night Paving**

Permeable Friction Course Asphalt

- Permeable Friction Course Asphalt (PFC) is an overlay that is used on existing roadway
- PFC is best used in areas prone to wet weather accidents. (undivided highways, curves, intersections)
- There are two types of PFC:
  - PFC Asphalt-Rubber (A-R) which contains rubber from recycled scrap tires
  - PFC-Performance Grade (PG) which contains Performance Grade Asphalt, fiber and lime

PFC

- PFC Asphalt-Rubber (A-R) is generally recommended to overlay concrete
- PFC-Performance Grade (PG) is typically recommended for maximum water spray reduction
- 2.2 million tons of both types of PFC projects between 2004 – July, 2010

PFC

- Expected life for both types of PFC is 10-14 years, expected life for conventional overlay is 7 years
- The cost for both PFCs is typically $20 to $30 per ton higher than conventional overlay. This cost is offset by the longer expected life of PFC compared to conventional overlays

Type D HMA

PFC A-R

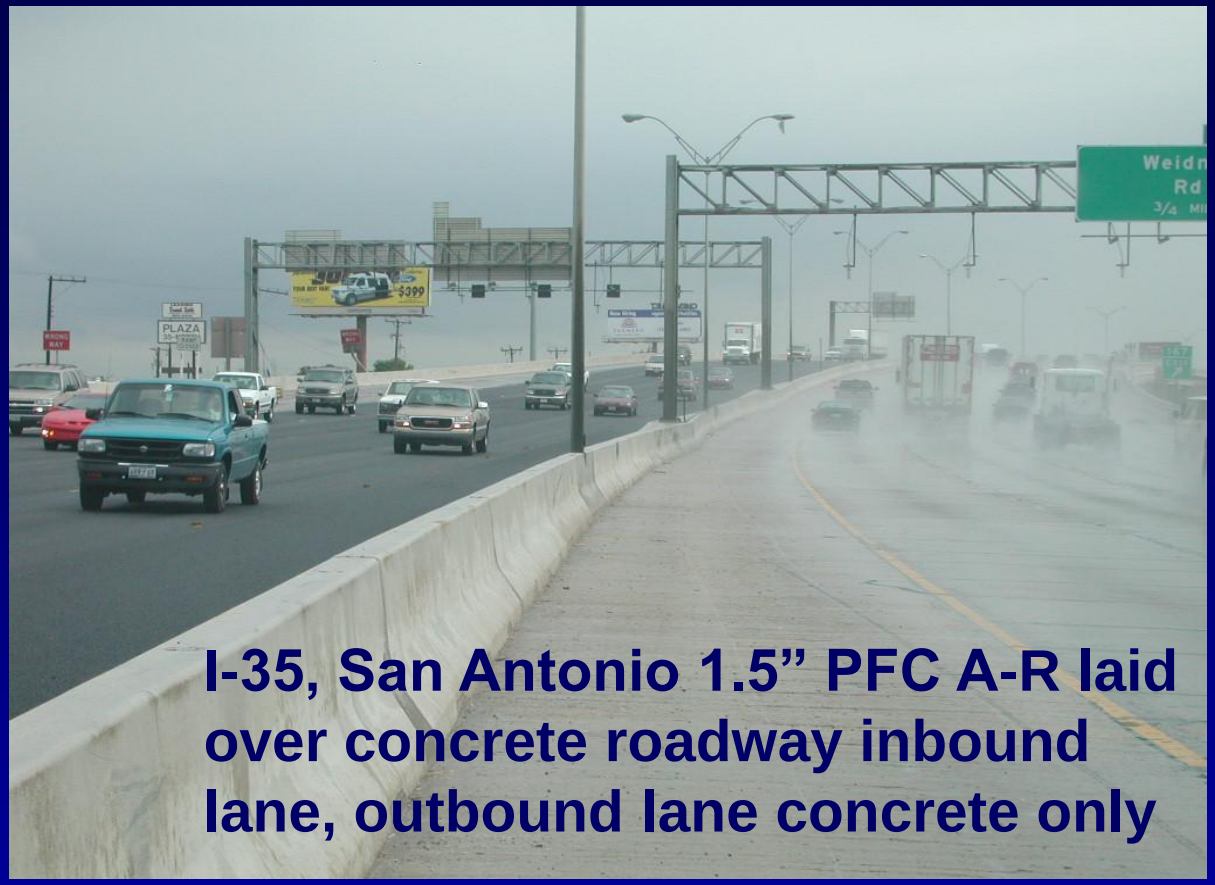
After 9 years: PFC A-R in the Lufkin District shows minimal wear

PFC A-R

Benefits: Safety

- Significant reduction in major accidents after the PFC A-R overlay is placed
- Drains the water off the roadway quicker
- Reduces spray and glare
- Improves visibility of traffic markings
- Coarse macro-texture of PFC A-R improves frictional characteristics which:
- Improves the skid resistance
  - A study of the PFC R-A overlay on I-35 in San Antonio showed a skid resistance of more than 200%
- Reduces the risk of hydroplaning

PFC A-R



I-35, San Antonio 1.5” PFC A-R laid over concrete roadway inbound lane, outbound lane concrete only

Typical Use:

- Surface course on high-speed roadways
- PFC Asphalt Rubber (A-R) is recommended as an overlay on concrete pavement

PFC A-R

Climatic & Accident Data
IH 35 San Antonio: Before and After P FC A-R Overlay

July 2001-June 2002

- Total Precipitation:
  - 31.78 inches
- Total Days with…
  - Measurable precipitation: 69
- Major Accidents: 85
- Major Accidents on Days with Precipitation: 39

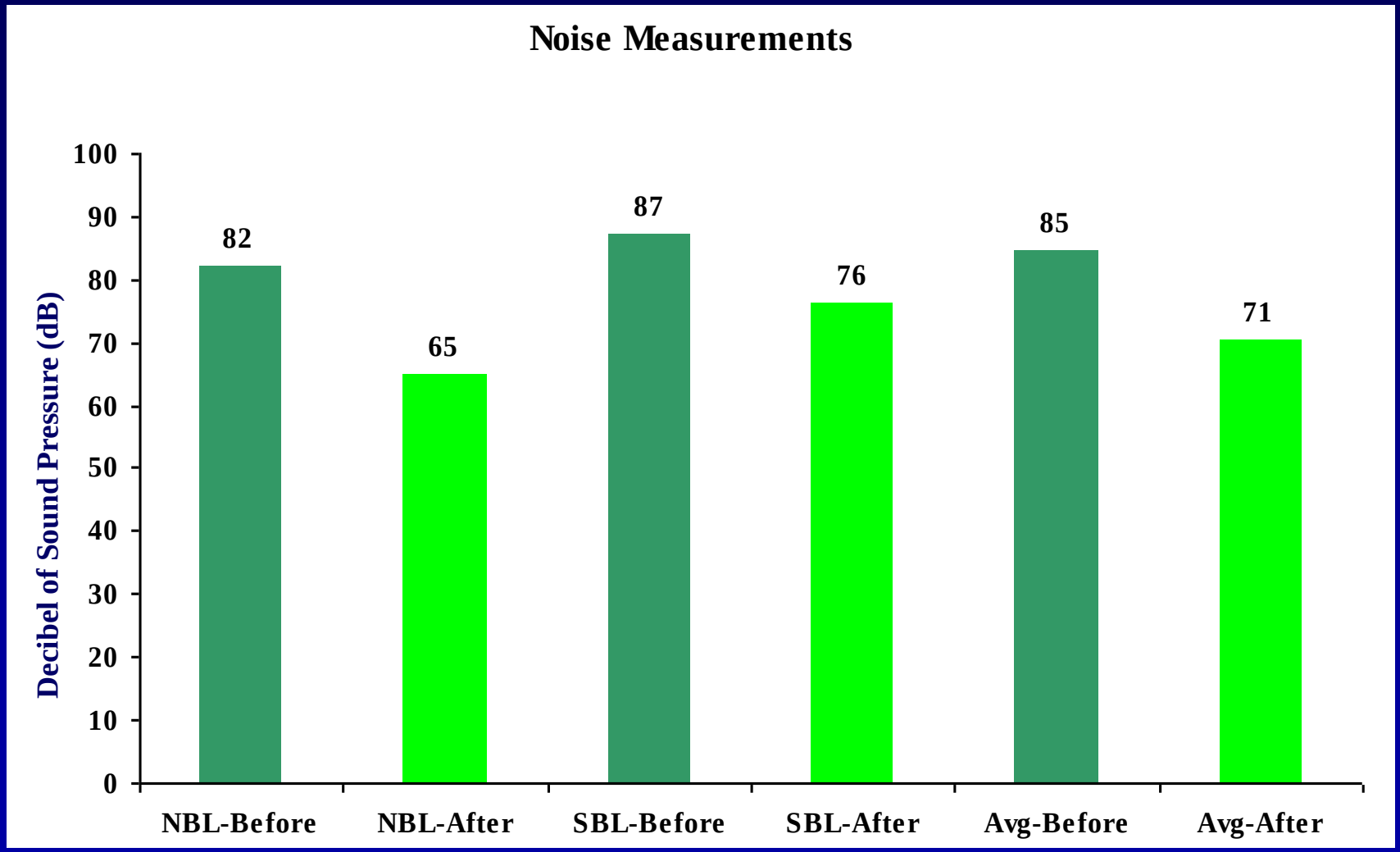
Nov 2003-Oct 2004

- Total Precipitation:
  - 32.63 inches
- Total Days with…
  - Measurable precipitation: 99
- Major Accidents: 48
- Major Accidents on Days with Precipitation: 19

Climate data obtained from National Oceanographic and Atmospheric Administration

PFC A-R

Benefits: Reduced Traffic Noise Levels



PFC A-R

Benefits: Ride Quality

- According to a Tex DOT Technical Advisory from February 11, 2003, a study done on I-35 in San Antonio showed that PFC A-R improves ride comfort
- Ride quality was measured using the International Roughness Index (IRI) with a high-speed inertial profiler
- The results showed an approximate 61% improvement in ride quality

PFC PG

Benefits: Improved Water Quality

- A TxDOT study discovered that the storm water quality significantly improved after PFC PG is placed. It is believed that the PFC PG slows the flow and filters the water

Constituent	Conventional Asphalt	PFC PG
Total Suspended Solids (TSS) (mg/L)	117.8	8
TKN (mg/L)	1.13	0.54
NO3/NO2-N (mg/L)	0.43	0.40
Total P (mg/L)	0.13	0.23
Dissolved P (mg/L)	0.036	0.077
Total Copper (mg/L)	26.8	5.7
Total Lead (mg/L)	12.6	0.7
Total Zinc (mg/L)	167	45
Dissolved Copper (mg/L)	5.9	3.9
Dissolved Lead (mg/L)	0	0
Dissolved Zinc (mg/L)	47	34
COD (mg/L)	64	30

PFC PG

Benefits: Safety and Water Quality

- PFC PG reduces splash and spray, minimizing wash-off of pollutants from vehicles and pavements during storms

Recycled Concrete and Flyash used in Concrete Pavement, HMA and Sub-grade

- TxDOT usually uses:
  - 0.25 – 4 Million tons/year of Flyash
  - 0.6 Million tons/year of crushed concrete

Recycled Concrete and Flyash used in Concrete Pavement, HMA and Sub-grade

- For 2008, TxDOT used 695,000 tons recycled concrete and 272,000 tons of flyash

Recycled Concrete and Flyash used in Concrete Pavement, HMA and Sub-grade

Benefits: Reduced Emissions

- This use is approximately equal to reducing 279,337 metric tons of CO_2 emissions. [2]
- This reduction is approximately equal to removing CO_2 emissions from:
  - 53,000 vehicles, or
  - 31,400,000 gallons of gasoline, or
  - 650,000 barrels of oil, or
  - equivalent to the CO_2 emissions from powering electricity to 34,000 homes/year. [3]
- In addition, TxDOT recovered 1,300,000 tons of concrete for recycling in 2008 for future use in construction.

[2] http://www.epa.gov/climatechange/wycd/waste/calculators/Warm_home.html and http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results

[3] http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results

Contacts and Reference Material

- **Woody Raine – TxDOT, GSD (Recycling Info)**
  - **E: WRAINE@dot.state.tx.us**
  - **T: 512.302.2422**
- **Robert Lee – TxDOT, CST (Specifications)**
  - **E: RLEE1@dot.state.tx.us**
  - **T: 512.506.5938**
- **Current TxDOT Research 0-5836: Performance of Permeable Friction Course (PFC) Pavements Over Time**
  - **Develop PFC Performance Database**
  - **Functionality (noise, permeability)**
  - **Durability (raveling, possibly rutting & cracking)**
  - **Safety (skid resistance, accident history)**
  - **Produce guidelines for PFC design, construction, & maintenance**
- www.txdot.gov/business/contractors_consultants/recycling/asphalt_shingles.htm
- http://www.txdot.gov/business/contractors_consultants/recycling/speclist.htm
- http://www.txdot.gov/business/contractors_consultants/recycling/speclist2.htm


Questions?