Impacts of Pavement Preservation and Recycled Materials on Sustainability

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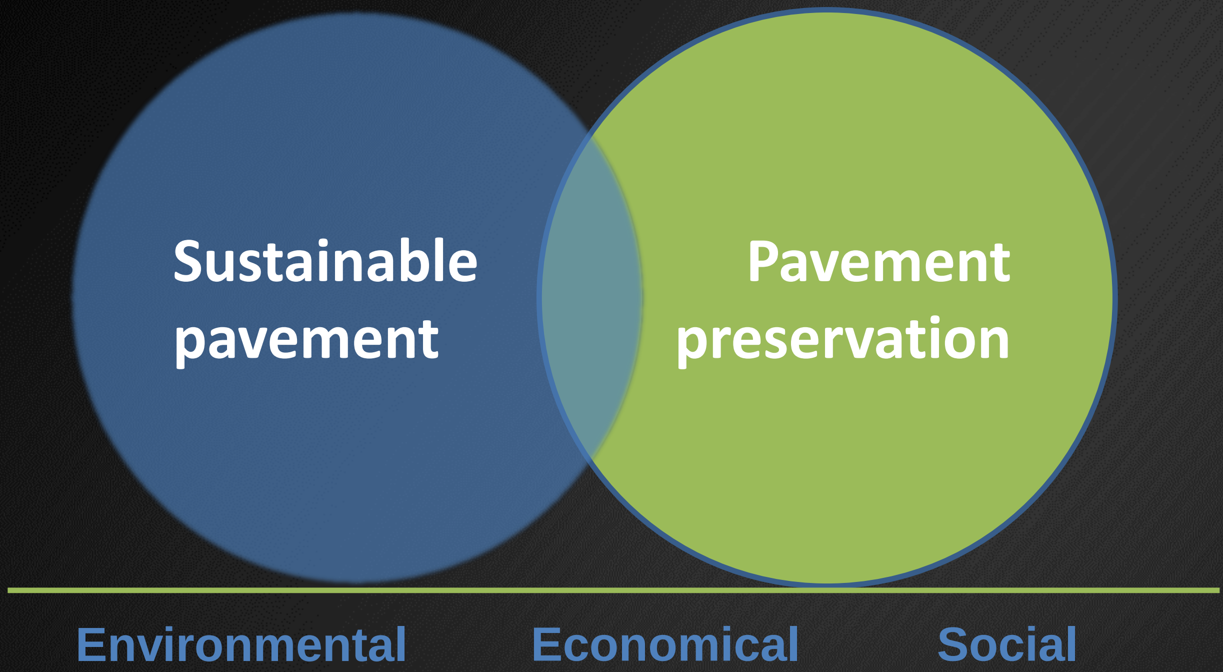
Agenda

- Focused on flexible pavements' life cycle
- High-RAP HMA
- In-place recycling
- Pavement preservation
- All with sustainability in mind

Sustainability – Pavement Preservation



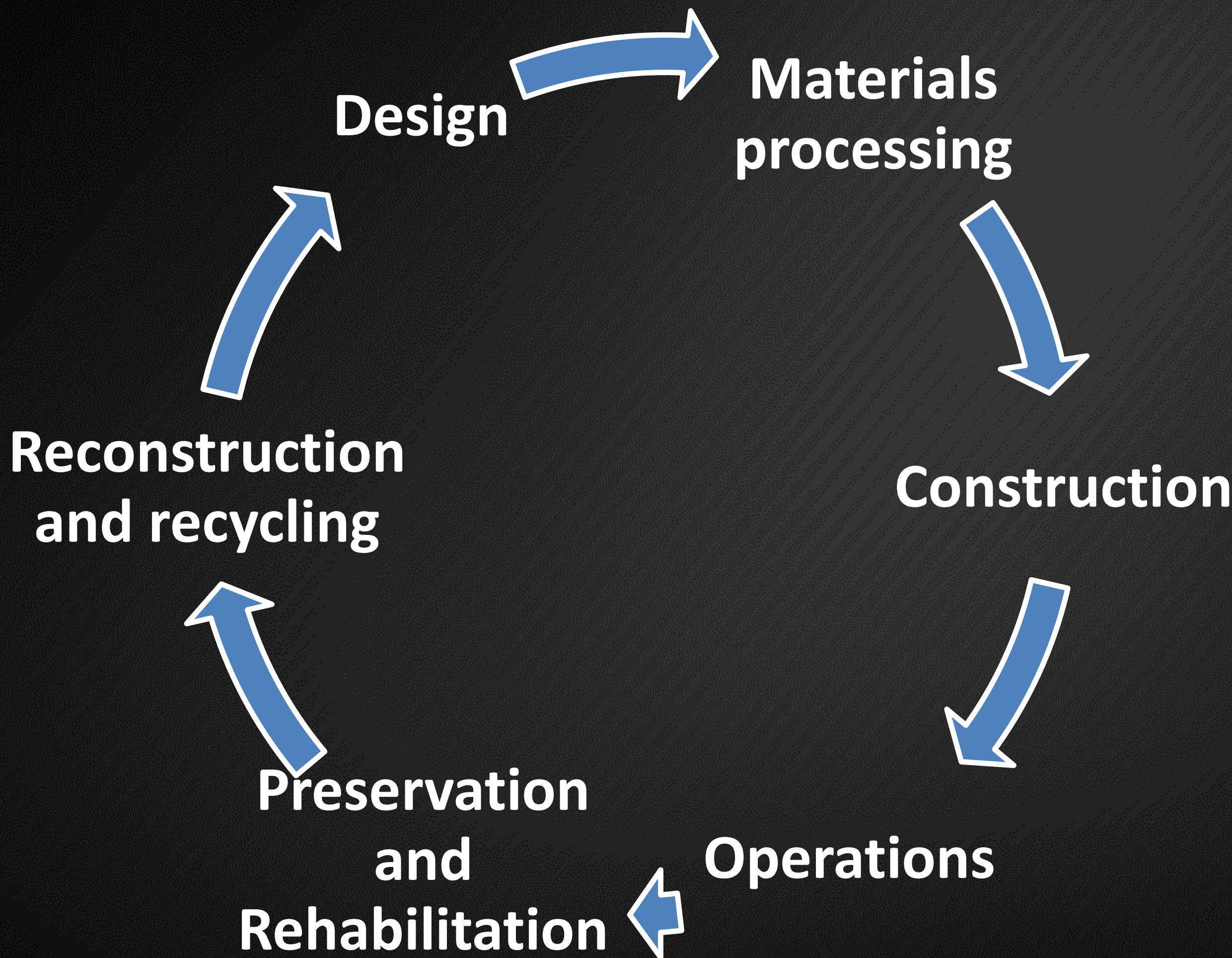
Programs and activities employing a network level, long-term strategy that enhances pavement performance by using an integrated, cost-effective set of practices that extend pavement life, improve safety, and meet road user expectations

A safe, efficient and environmentally friendly pavement which meets the needs of present-day users without compromising those of future generations.

Sustainability and pavement preservation

- Pavement preservation and recycling are inherently about sustainability
- Environmental – use of resources, reduction in emissions and energy
- Economical – savings over the life cycle, savings for the tax payer
- Social – longer cycle times before major rehab enhances the value to the motorists

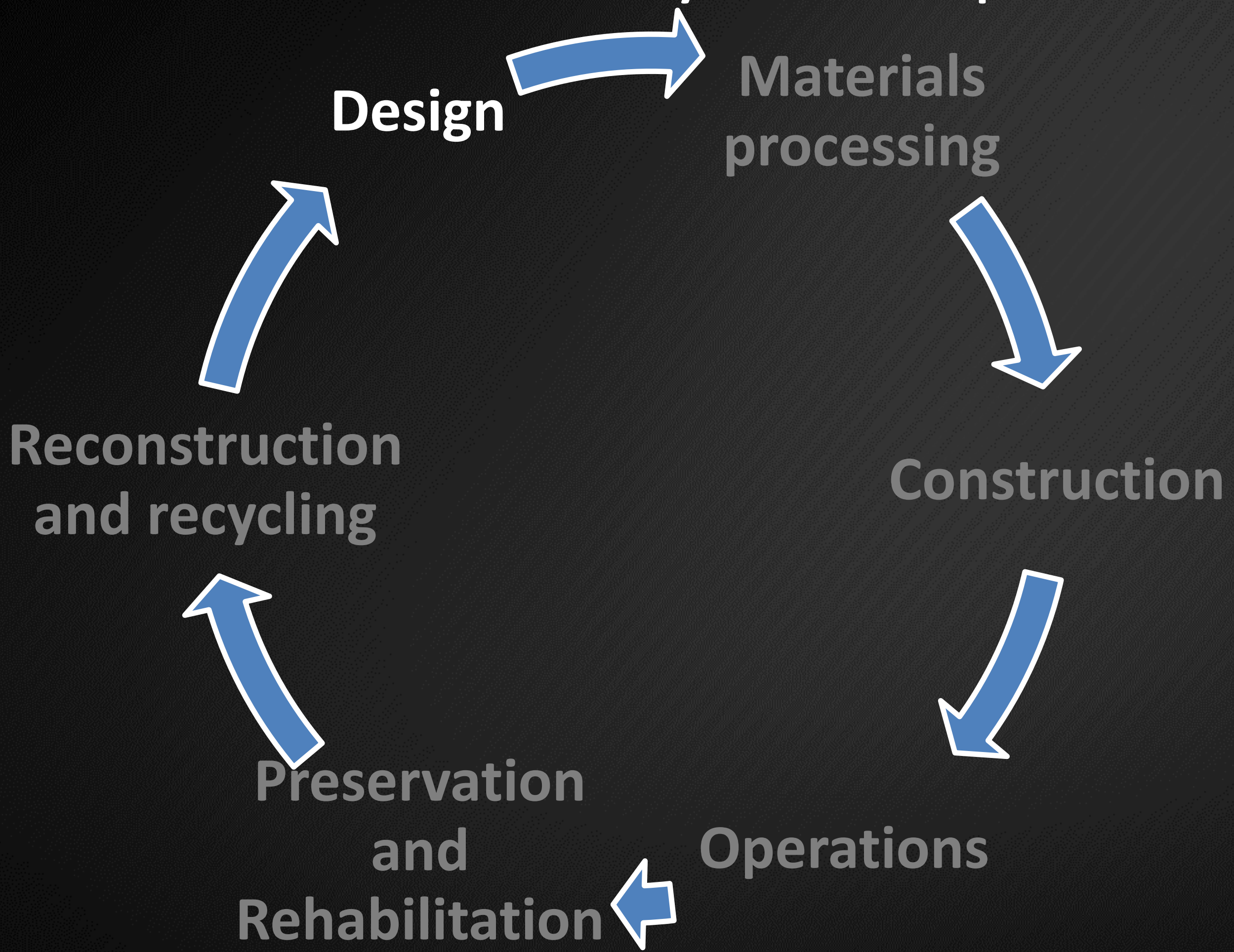
Life cycle of a pavement



From Nov. 14, 2012 meeting by the FHWA Sustainable Pavements Program Project Team

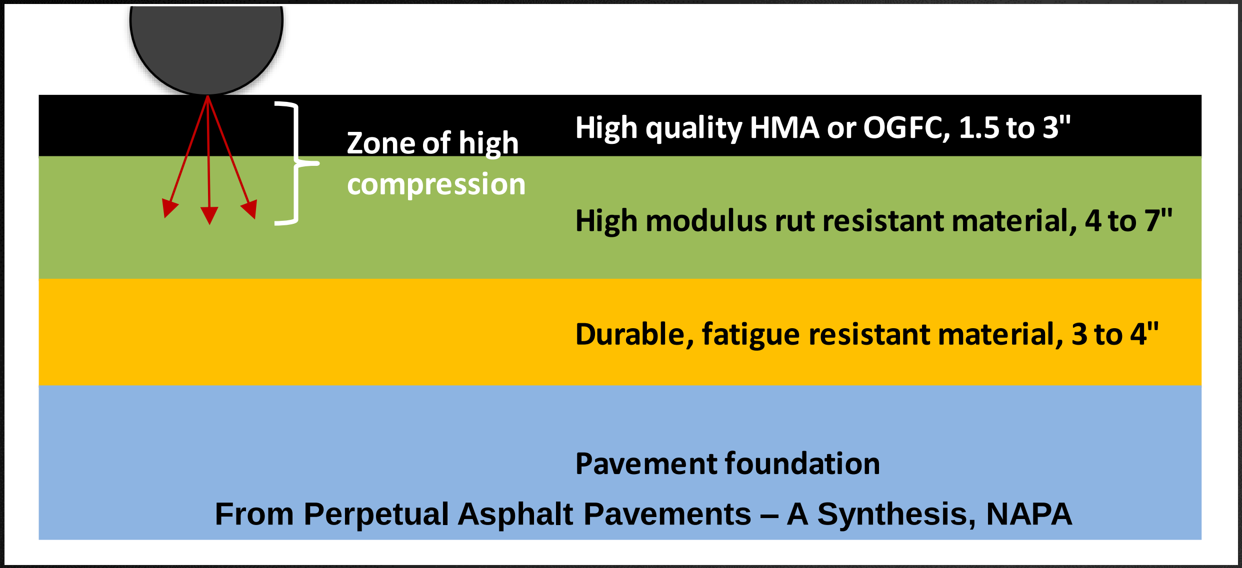
Design

Life cycle of a pavement



- Perpetual pavement design
- MEPDG

Design



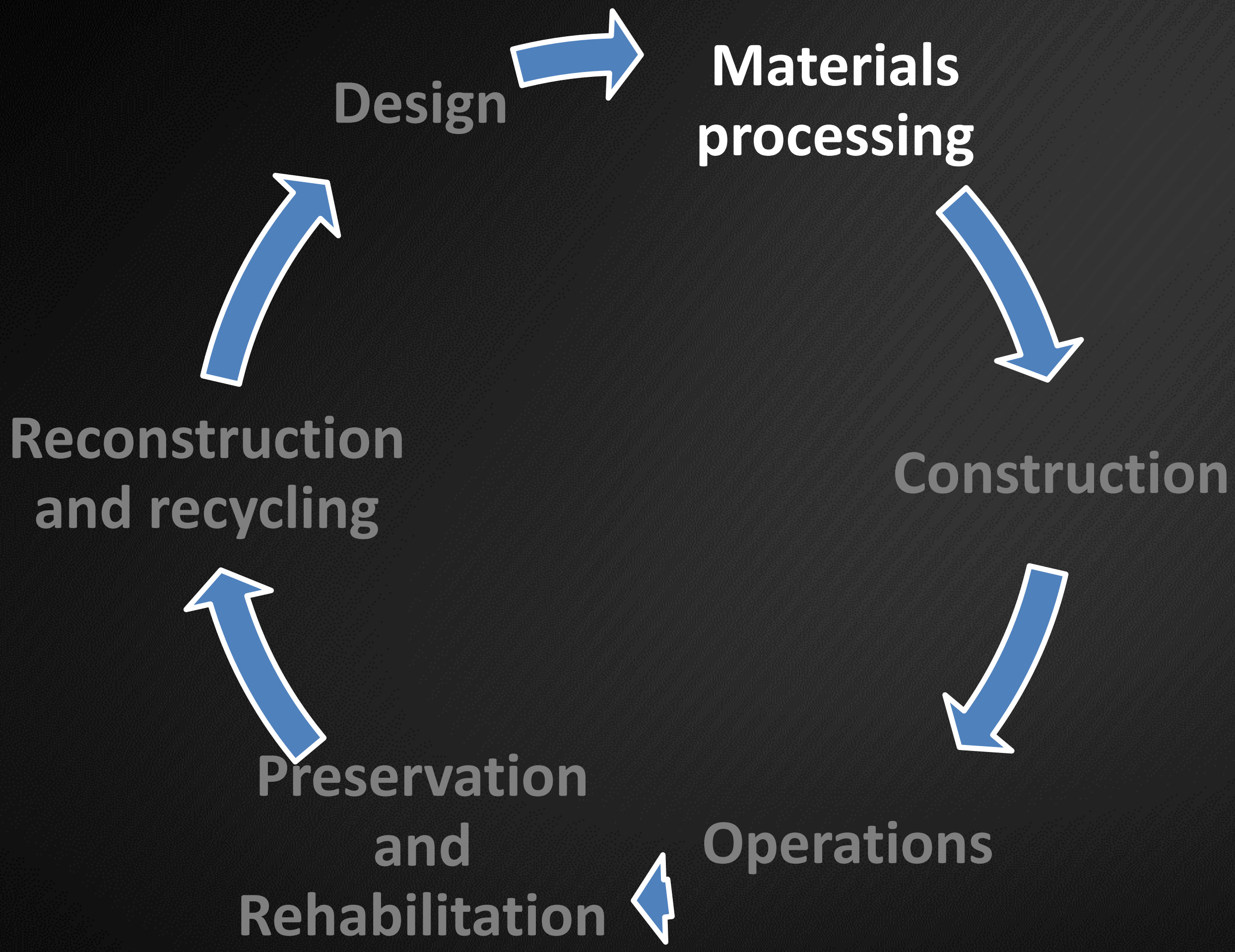
From Perpetual Asphalt Pavements – A Synthesis, NAPA

- Perpetual pavement concept – long life provides societal benefits and conserves natural resources
- Should ensure at least the top layers are recyclable
- Opportunities for use of high RAP in high modulus layer

- MEPDG – Identify stresses in the pavement structure (load or non-load) and relate them to performance

Materials and materials processing

Life cycle of a pavement



- Mix designs
- Warm mix
- RAP management
- Looking beyond processing and construction

Materials and processing

- Balanced mix design / performance-related tests
  - With high RAP contents, performance-based mix designs are increasingly important
    - RAP, RAS, rejuvenators, polymer, GTR
  - Some characterization in binder testing (ΔTc)

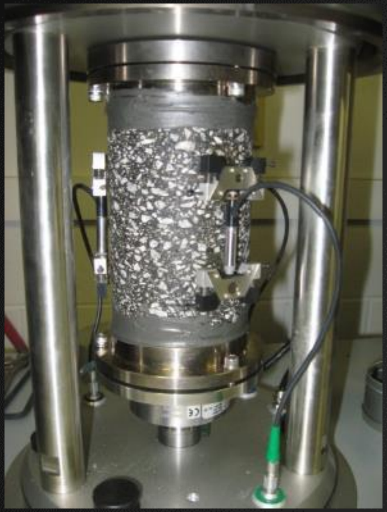

Rutting


Cracking…

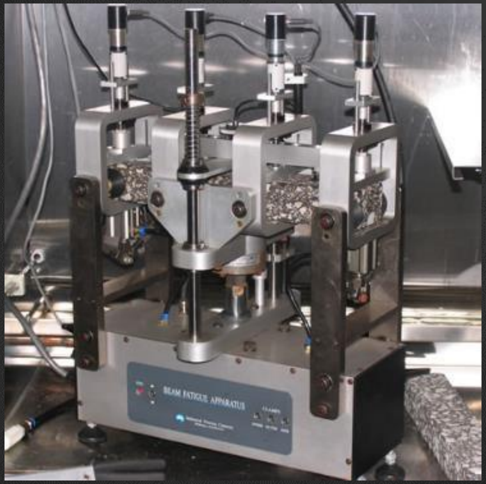
Materials and processing

- Performance-based mix design

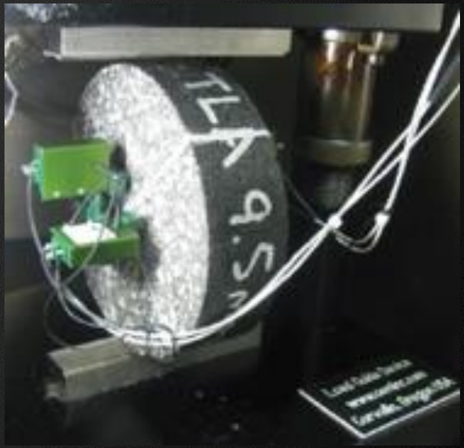
Dynamic modulus



Fatigue cracking

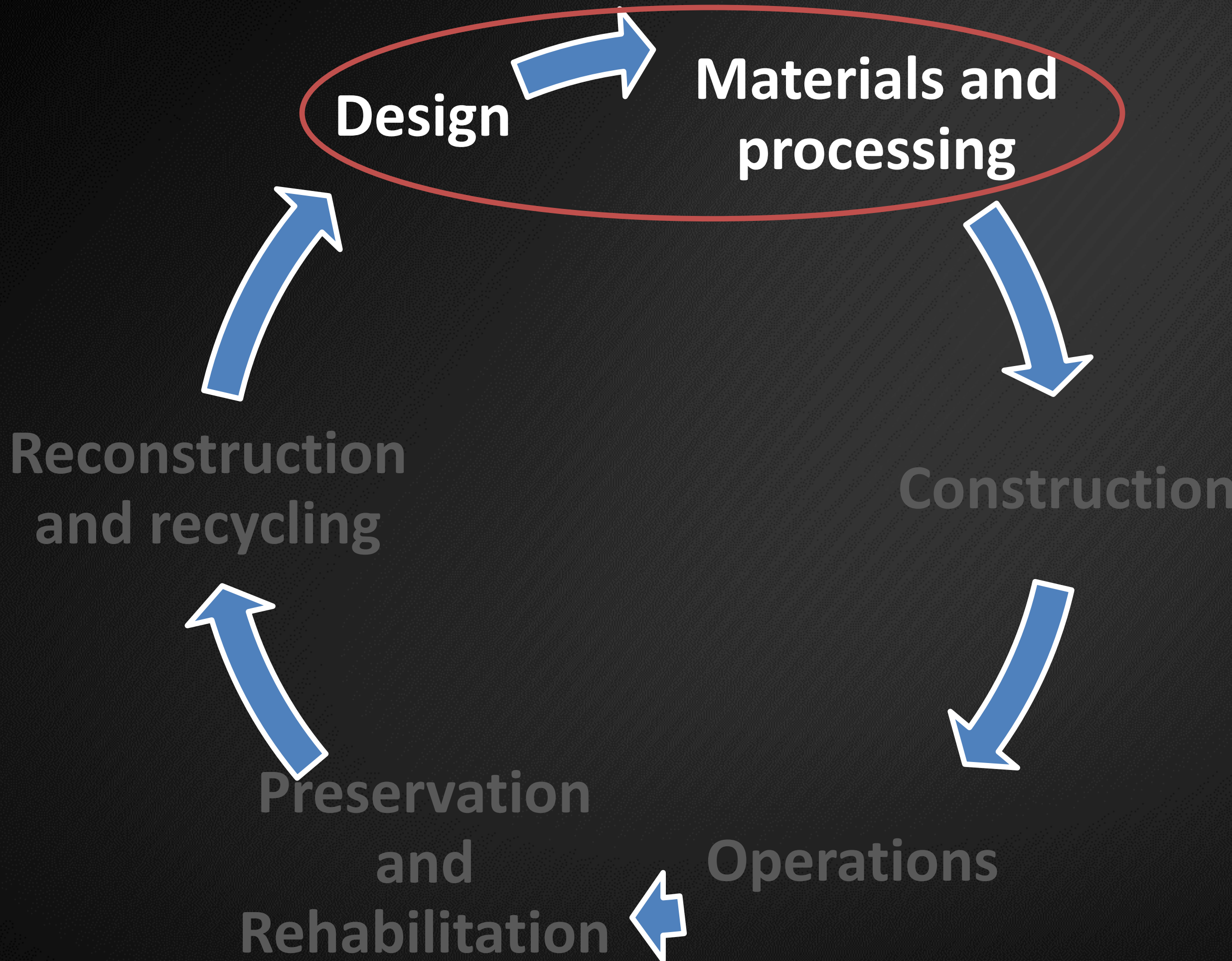


Thermal cracking



- Relate material characterization to pavement behavior

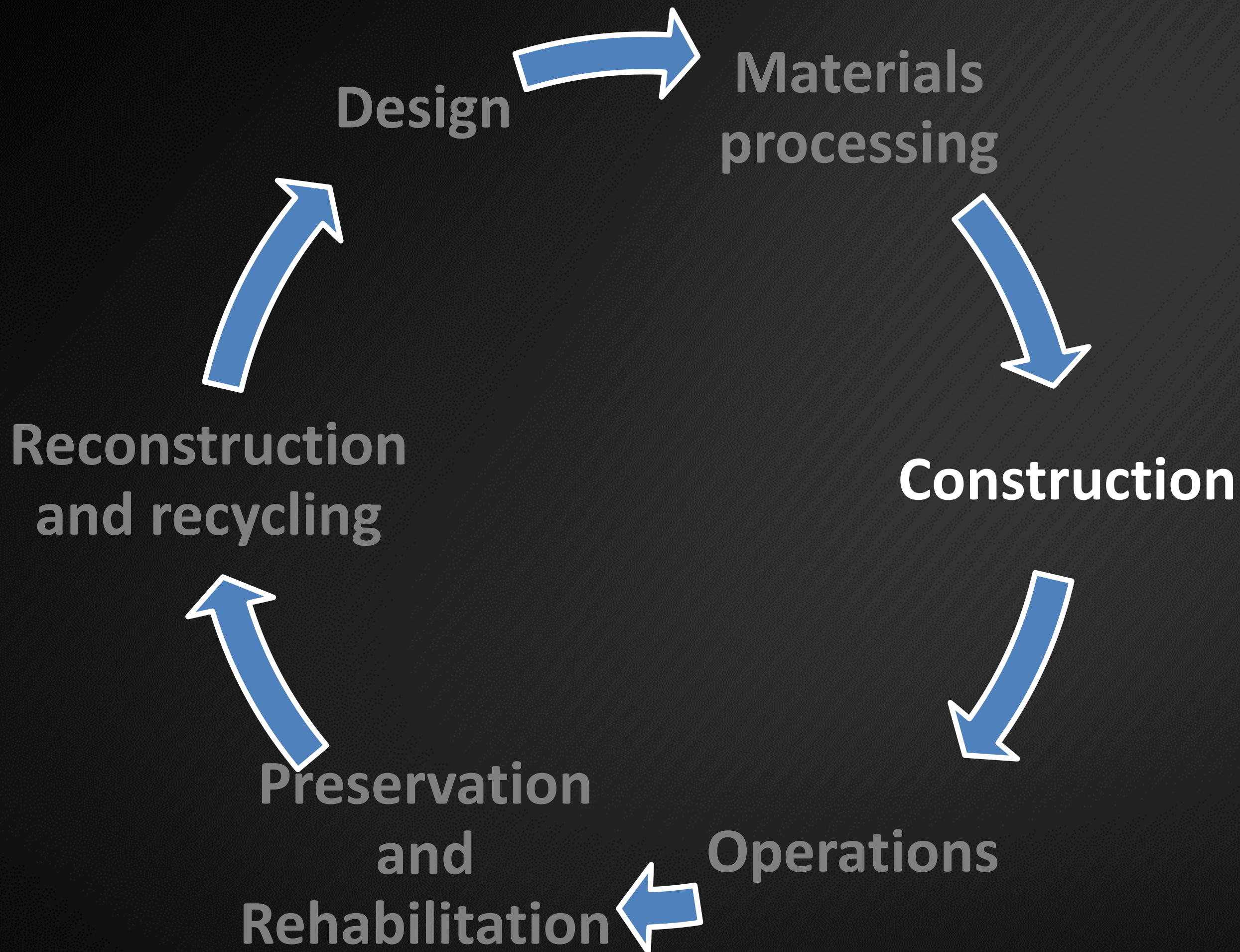
Life cycle of a pavement



Large gap!

Construction

Life cycle of a pavement



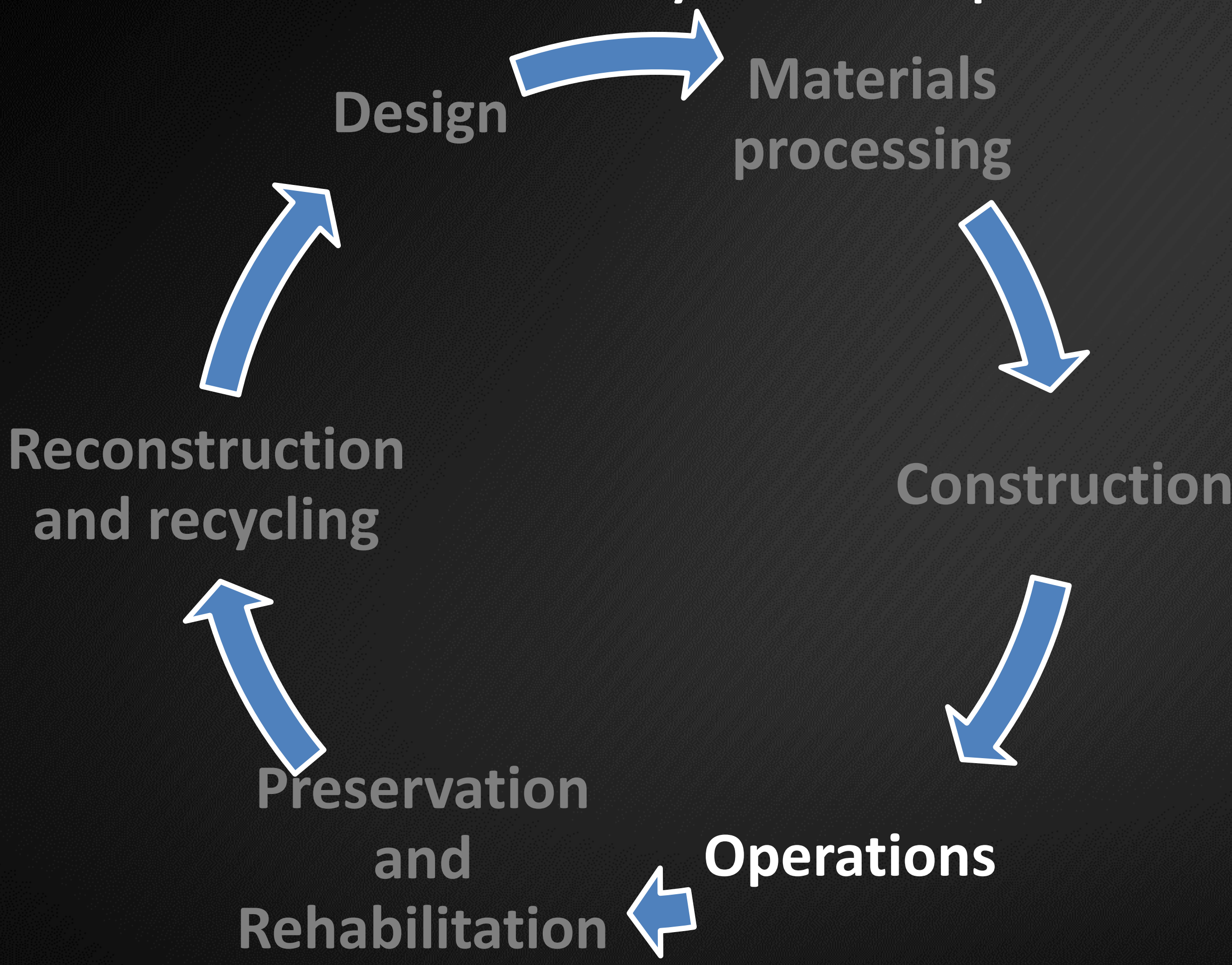
- Smoothness
- In-place recycling

Construction

- Importance of building and maintaining a smooth road – “driveability”
- The smoother the road, the more comfort to the driver and the lower the fuel consumption
- In-place recycling has the potential to reduce reconstruction time
- Pavement preservation keeps good roads good

Operations

Life cycle of a pavement

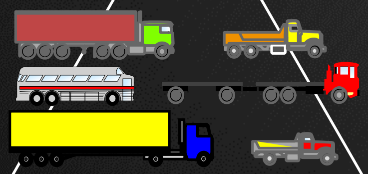


- Traffic during the life of the road is responsible for most of the energy use and GHG

Operations

98.0 to 99.5 %

0.5 to 2.0 %

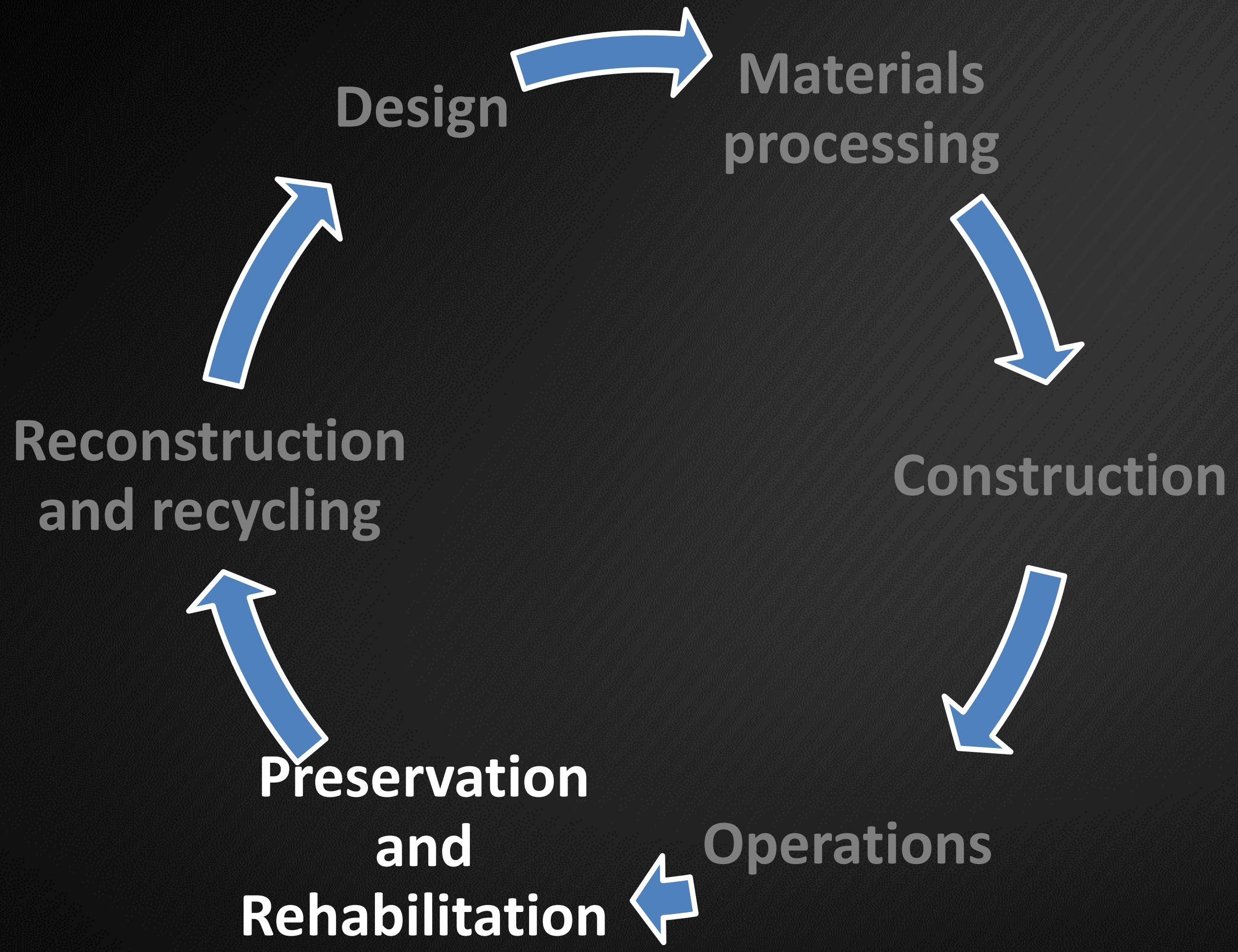


During the life of the road structure, road construction impact is negligible compared to traffic

From Francois Chaignon, Colas SA

Preservation and rehabilitation

Life cycle of a pavement



- Pavement preservation
- Extended life
- Energy and emissions

Pavement preservation

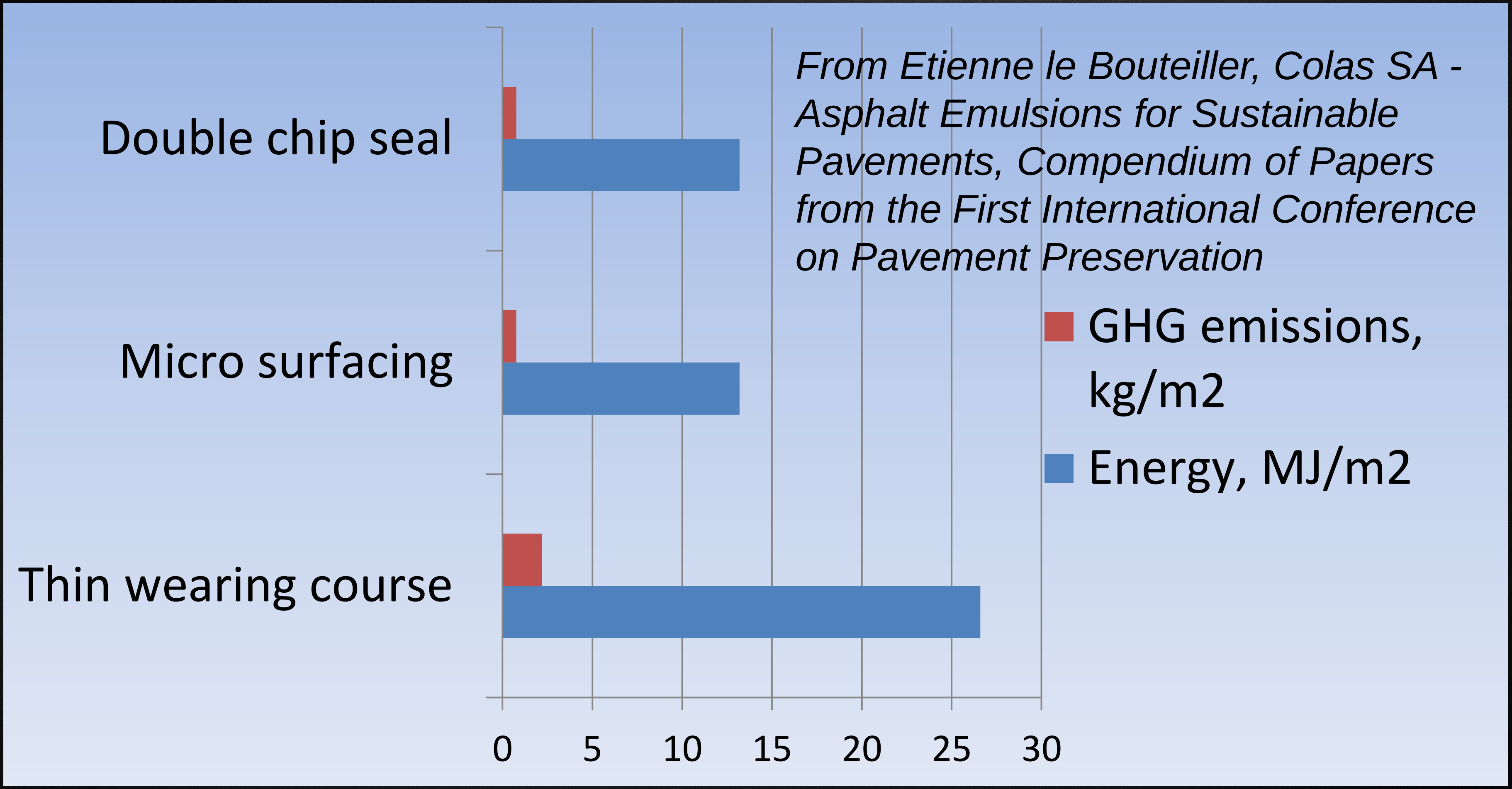
- Employs a network level, long-term strategy that enhances pavement performance by using an integrated, cost-effective set of practices that extend pavement life, improve safety and meet motorist expectations
  - Minor rehabilitation
  - Preventive maintenance
  - Routine maintenance

Preservation and rehabilitation

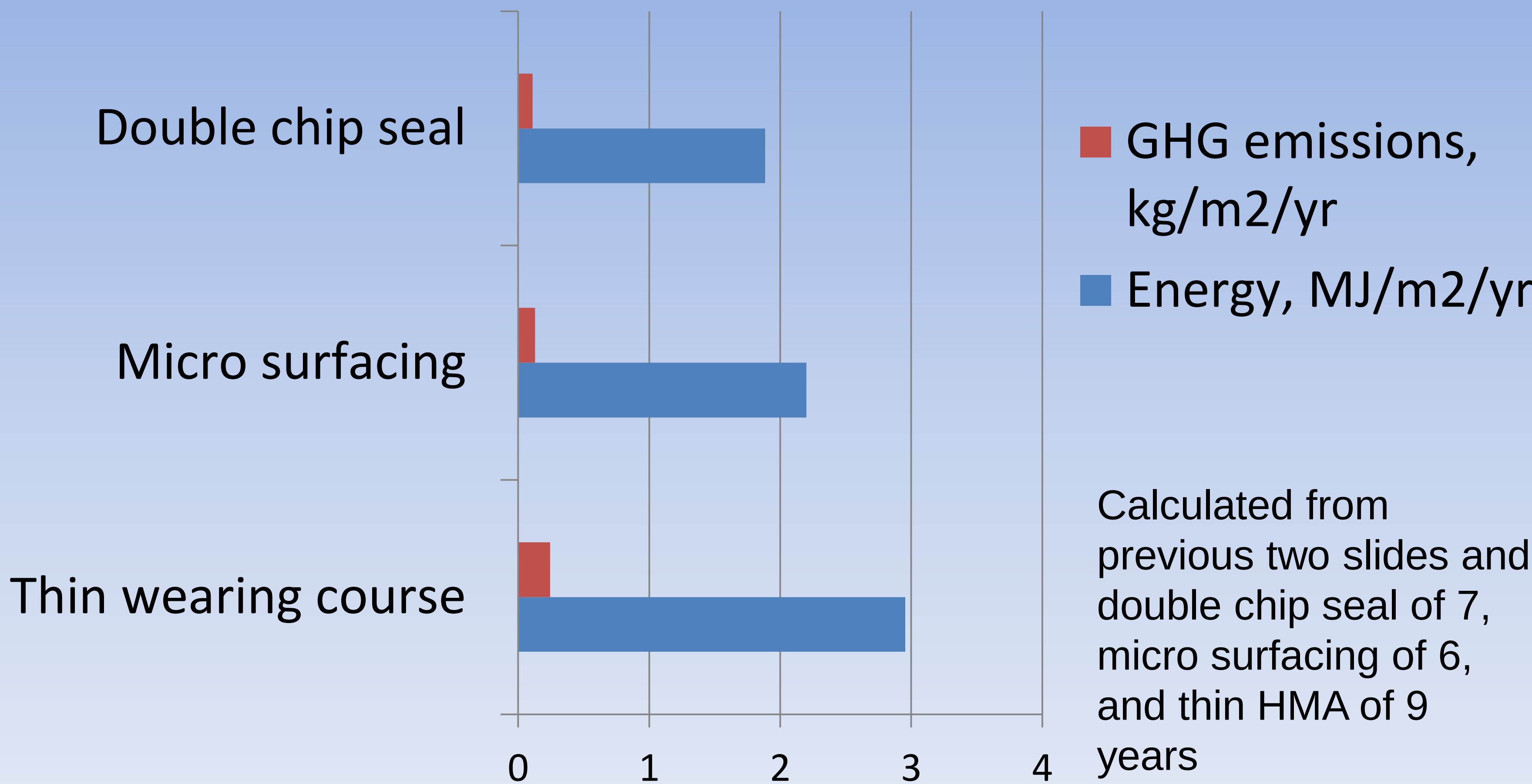
- Life extensions of preservation treatments on flexible pavements determined in a study of five states (*Cost Benefits of Pavement Preservation, Gary Hicks, Jan. 2010 CCSA presentation*)
  - Chip seals: 4 to 8 years
  - Slurry seals: 3 to 7 years
  - Micro surfacing: 3 to 8 years
  - Crack sealing: 0 to 4 years

  - Thinlay: 7 to 11 years (NCHRP Synthesis 464)

Preservation and rehabilitation

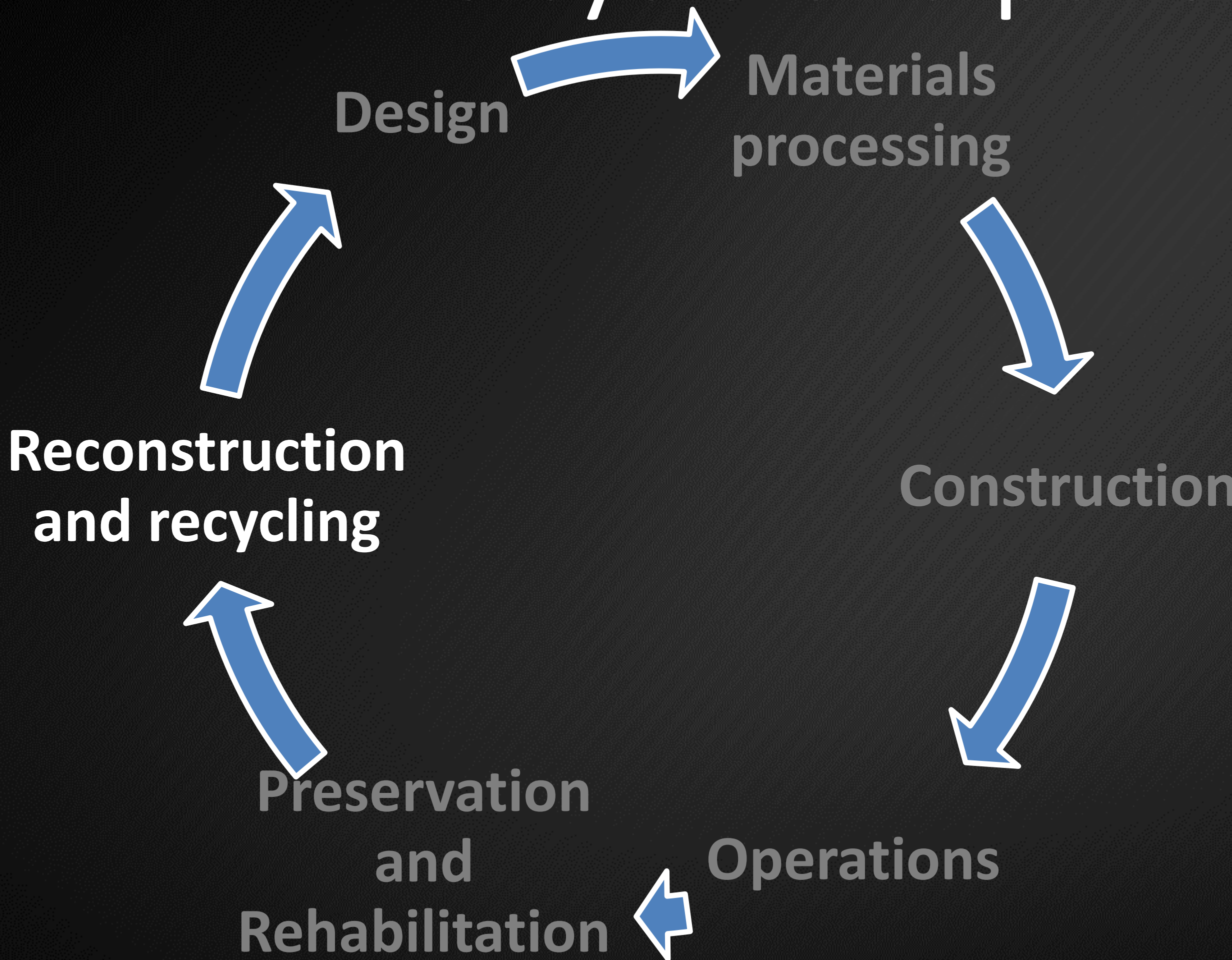


Preservation and rehabilitation



Calculated from previous two slides and double chip seal of 7, micro surfacing of 6, and thin HMA of 9 years

Reconstruction and recycling Life cycle of a pavement



- High RAP HMA
- In-place recycling
- Cold central plant recycling
- Full depth reclamation

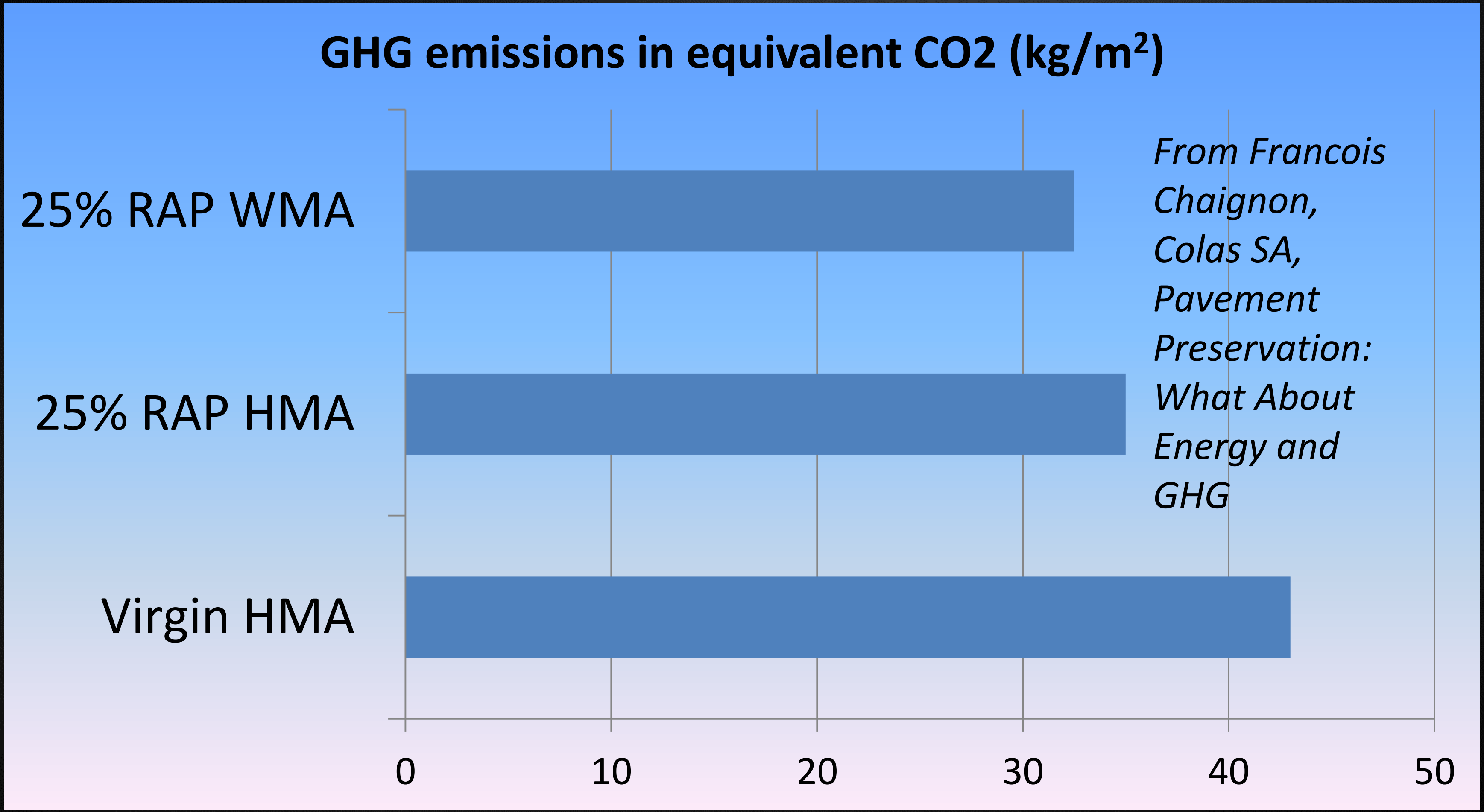
Recycling

- High RAP hot mix
- Hot in-place recycling
- Cold in-place recycling
- Cold central-plant recycling
- Full depth reclamation

Recycling – high RAP HMA

- 25 percent or higher RAP content
  - Interest in going much higher
- Preserves resources – aggregate, asphalt
- Growing RAP piles in the U.S.
- NAPA Best Practices for RAP and RAS Management, Black and Green - Sustainability
- NCHRP Report 752 – Mix design…
- Several efficient rejuvenators in the market

Recycling – high RAP HMA



Recycling – hot in-place recycling

- Hot in-place recycling (HIR) is an on-site, in-place, pavement rehabilitation method that consists of heating, scarifying, softening, mixing, placing and re-compacting the existing bituminous pavement.
  - Surface recycling
  - Repaving
  - Remixing

Recycling – CIR and CCPR

- Cold recycling consists of recycling asphalt pavement

RAP mix, with the resulting mix opened to traffic before
bei

– Col
ma ... a central
loc

Recycling – CIR and CCPR

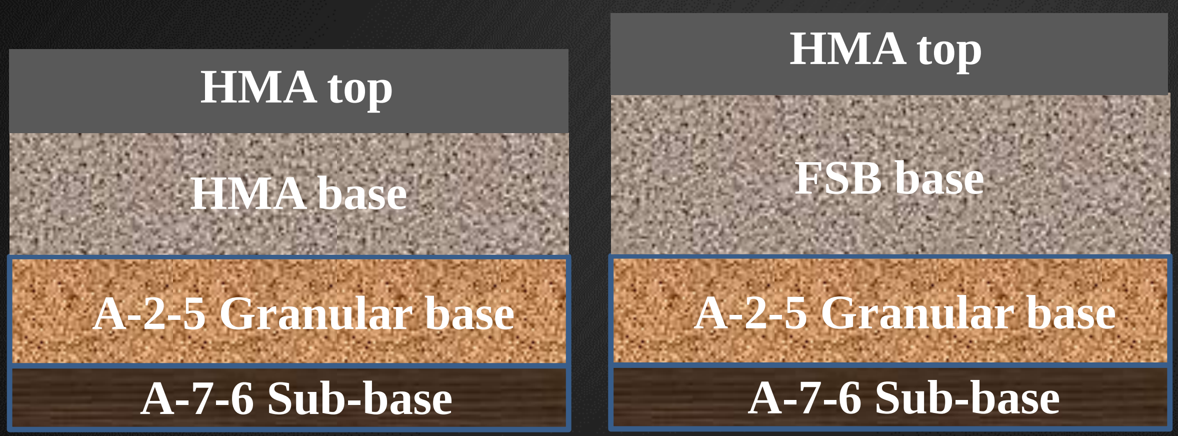
- *Sustainability of FSB Processes* by Charles W. Schwartz, University of Maryland, 2015 PPRA Fall Meeting (Niagara Falls, Ontario)
  - CIR with foamed asphalt compared to HMA structure (CIR replacing HMA base)
  - CCPR with foamed asphalt compared to HMA structure (CCPR replacing HMA base)

Recycling – CIR and CCPR

Emission Intensity Adjusted by Structure

Structural layer coefficient

- Foamed Stab. Base (FSB-CIR/CCPR): 0.32
- HMA base (19mm): 0.40

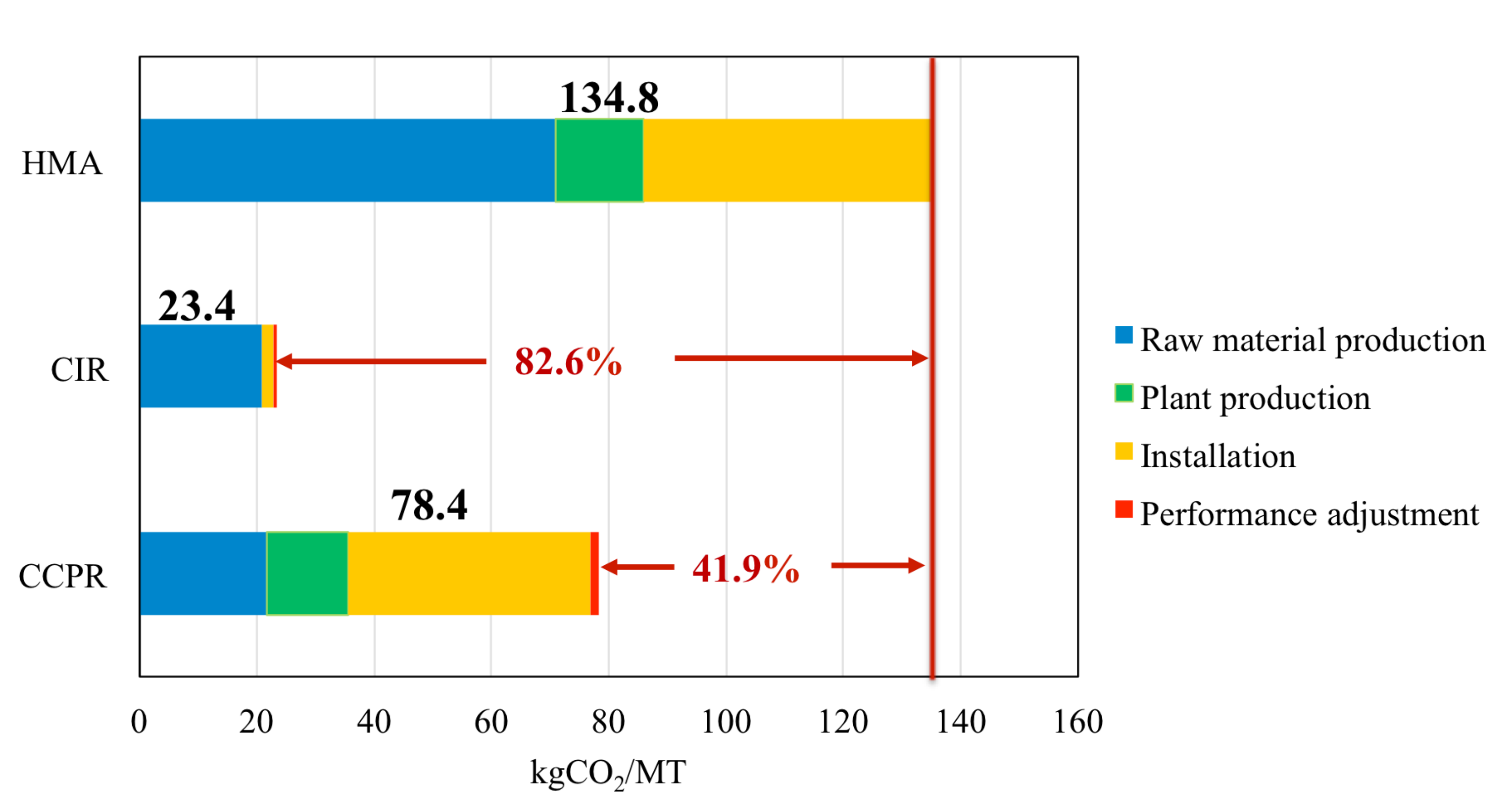


25% thicker
18% less dense

HMA Pavement **FSB Pavement**

Schwartz, University of Maryland

CIR/CCPR - Emission Intensity Comparison



Lower density nearly compensates for extra thickness.

Schwartz, University of Maryland

Univ. MD CIR/CCPR conclusions

- Cold-recycled FSB provides substantial GHG reductions vs. HMA. On a per ton basis:
  - 43% reduction for CCPR
  - 83% reduction for CIR
- For fair comparison, must factor in differences in density, structural characteristics:
  - AASHTO 93: 25% more FSB thickness vs. HMA
  - FSB 130 pcf vs. HMA 160 pcf
  - GHG reductions on an adjusted per ton basis:
    - 42% reduction for CCPR
    - 80% reduction for CIR

Schwartz, University of Maryland

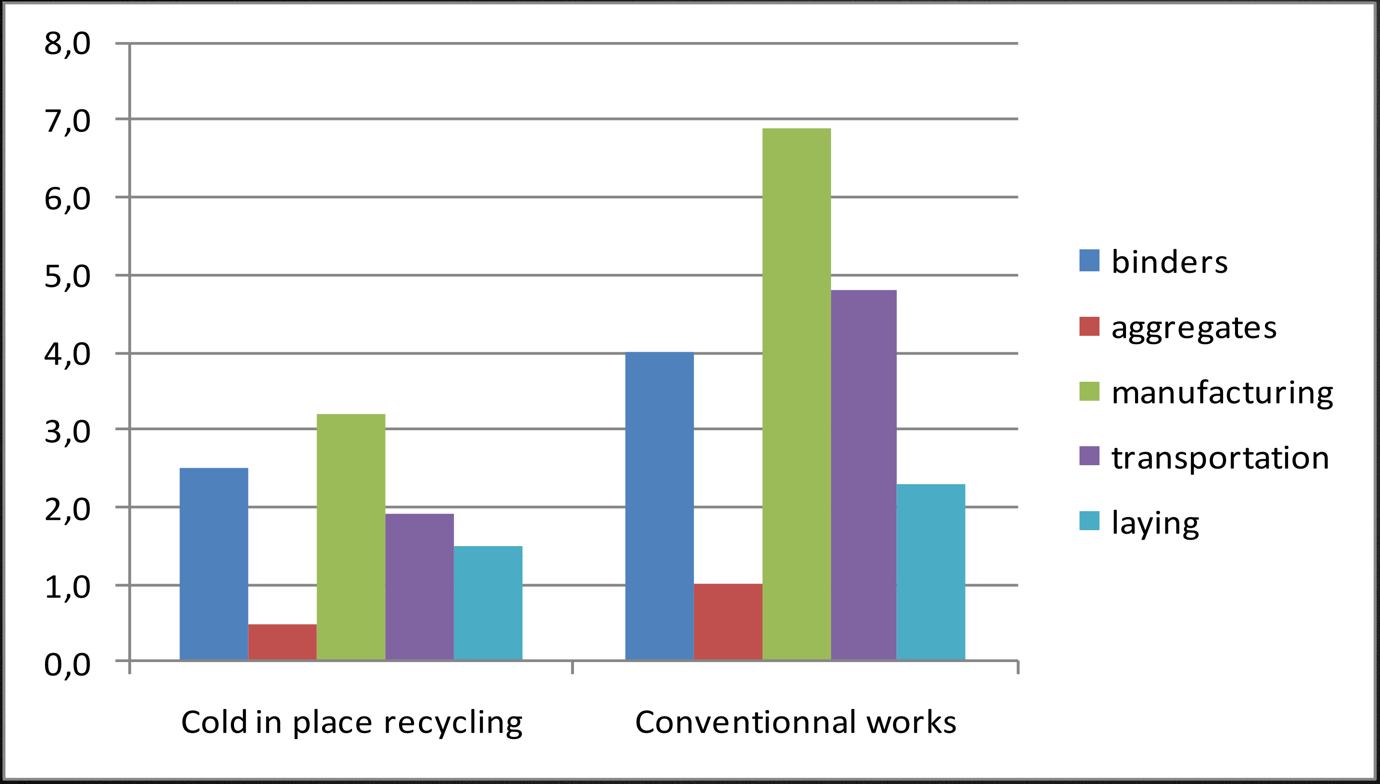
CIR case study (2007)

- County road n° RD 911 (Southwest France)
- 31,500 sq.m
- Basic design
  - Milling existing pavement 7 cm depth (i.e. 160 kg/sq.m of milled materials)
  - Laying a 4 cm AC binder course (i.e. 90 kg/sq.m)
  - Laying a 6 cm AC wearing course (i.e., 140 kg/sq.m)
- Alternative design
  - in place recycling of the existing pavement 7 cm depth
  - Laying a 4cm AC wearing course

Étienne le Bouteiller, Colas SA, IRC - PIARC International Seminar, New Deli, 2011

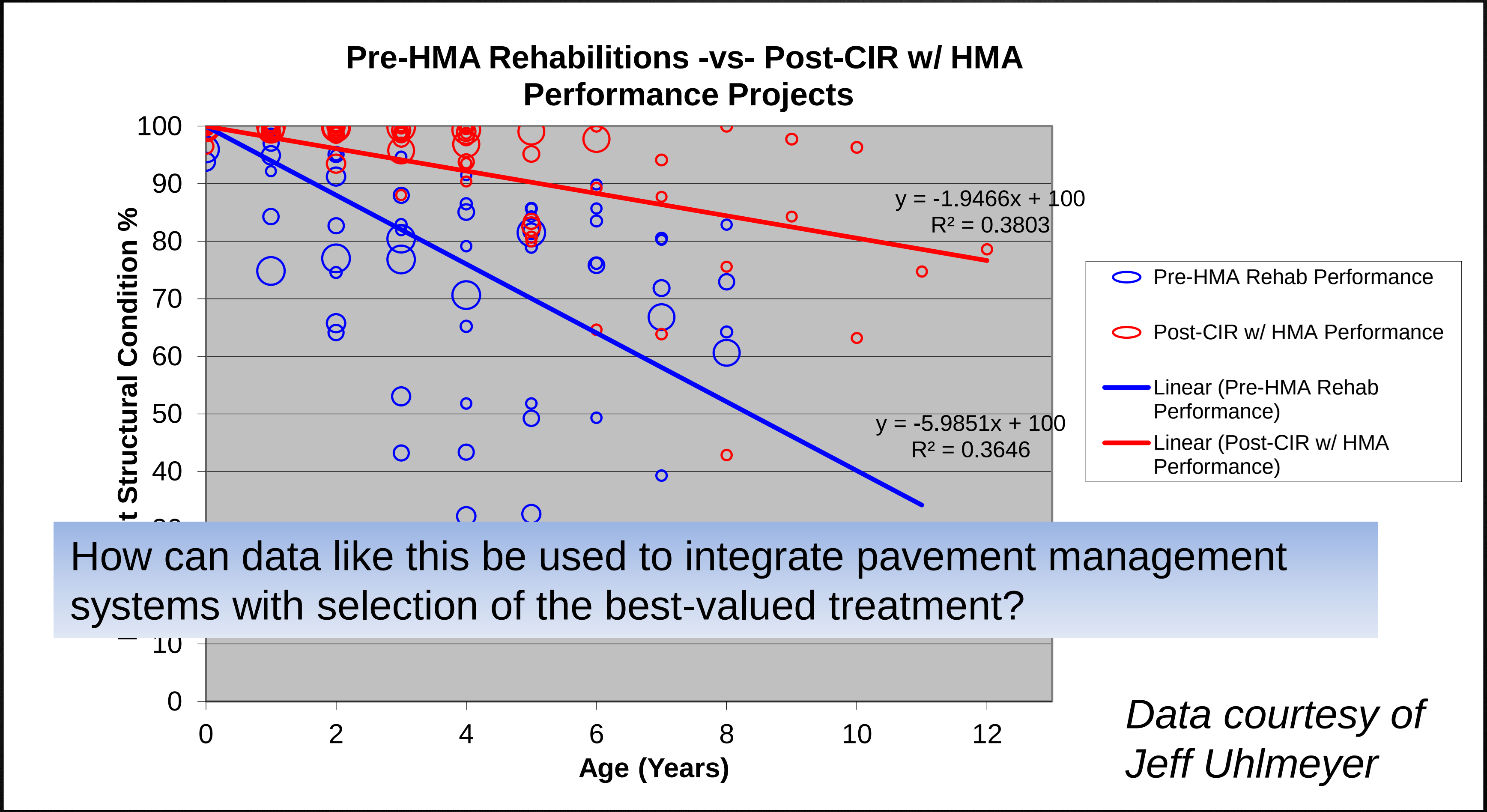
CIR case study

- Green house gas emissions (kg/sq.m)



Étienne le Bouteiller, Colas SA, IRC - PIARC International Seminar, New Deli, 2011

Recycling – CIR
Washington State DOT



How can data like this be used to integrate pavement management systems with selection of the best-valued treatment?

Data courtesy of Jeff Uhlmeyer

Recycling – full depth reclamation

- Full depth reclamation is a technique in which the full flexible pavement section and a predetermined portion of the underlying materials are uniformly crushed, pulverized, or blended, resulting in a stabilized base course; can further stabilize with cement, fly ash, foamed asphalt, emulsified asphalt

Recycling or reconstruction

- Case study – Washington Ave., Las Vegas, NV
- TRB Paper 08-2343
- FDR with emulsified asphalt considered instead of reconstruction
- FDR had a cost savings of 30 percent
- Construction time reduced:120 to 40 days
- 3000 fewer loads of materials were trucked on and off the project with FDR

Gaps

Focusing on RAP, preservation products, and recycling

- Balanced mix design with high-RAP content
  - Progress being made on binder properties needed to reduce durability issues with high RAP (and RAS), with or without rejuvenators
  - More progress is needed, with studies underway, on mix conditioning to simulate plant at field aging
  - More progress is needed, with studies underway, on mixture testing that predicts field performance

Gaps

Focusing on RAP, preservation products, and recycling

- Mix design and pavement design
  - There is no or little integration of mix design and pavement design, leading to over-design and wasted resources.
  - *INTEGRATION OF STRUCTURAL AND HMA MIXTURE DESIGN: WHY HASN'T TIDS BEEN DONE? Von Quintus and Hall, 2009 Annual TRB Meeting, Committees AFD60 & AFK50*

Gaps

Focusing on RAP, preservation products, and recycling

- Pavement preservation
  - Adoption of specifications by agencies with a regular program of preservation construction projects is still needed in some areas
  - Integration into pavement management systems

Gaps

Focusing on RAP, preservation products, and recycling

- In-place recycling
  - Adoption of specs by agencies with a regular program of projects is needed in many areas
    - Avoid specs that piece together information from several sources but don't mesh ("good intentions")
  - Lack of experienced contractors in some areas; expensive equipment. A continuing program will encourage investment.

Gaps

Focusing on RAP, preservation products, and recycling

- In-place recycling
  - Some research is needed on best QC practices and acceptance criteria
  - Non-use of these products due to lack of education and turf protection

Conclusions

- Sustainability and preservation / recycling are complimentary
- Better integration of and improvements in the steps of the pavement life cycle will result in sustainability improvements
- High-RAP content mixes save on the use of new aggregate and asphalt and have lower GHG emissions

Conclusions

- Preservation products extend the life of pavements, and emulsion-based products have a better carbon footprint
- In-place recycling has cost and time advantages with lower GHG emissions and energy use, but it is under-utilized

Thank you

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