14vo Congreso Iberoamericano de Pavimentos de Concreto

2do Congreso Iberoamericano de Pisos Industriales de Concreto

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Concrete Pavements of the United States- The Importance of Maintenance and Preservation

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ACPA AMERICAN CONCRETE PAVEMENT ASSOCIATION

IGGA International Grooving & Grinding Association
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Topics of Discussion

- Why Build Concrete Pavements?
- Ensuring longevity through proper maintenance
- Life cycle and cost impact of smooth roads

Focusing our mindset

As an industry we are realizing that when we find ways to improve our environmental impacts, we are simply identifying financial inefficiencies in our processes.

By improving the financial impact, we simultaneously improve our environmental impact.

Thus, if we put part of our focus on value engineering, we inadvertently make our process greener.

Como industria, estamos dándonos cuenta de que cuando encontramos formas de mejorar nuestro impacto ambiental, en realidad estamos identificando ineficiencias financieras en nuestros procesos.

Al mejorar el impacto financiero, simultáneamente mejoramos nuestro impacto ambiental.

Así, si enfocamos parte de nuestra atención en la ingeniería de valor, inadvertidamente hacemos que nuestro proceso sea más ecológico.

The opportunity for Long-Life Pavement

- Concrete pavement offers more structural support resulting in less deterioration of pavement subbase and a more resilient structure in instance of extreme weather events.
- When built correctly and properly maintained, Concrete has the potential to exceed design life.
- When two healthy paving industries compete, owner agencies experience the best unit price on both products

- El pavimento de concreto ofrece un mayor soporte estructural, lo que resulta en menos deterioro de la subbase del pavimento y una estructura más resistente frente a eventos climáticos extremos.
- Cuando se construye correctamente y se mantiene adecuadamente, el concreto tiene el potencial de superar la vida útil de diseño.
- Cuando dos industrias de pavimentación saludables compiten, las agencias propietarias obtienen el mejor precio unitario en ambos productos.

Why long-life concrete pavements?

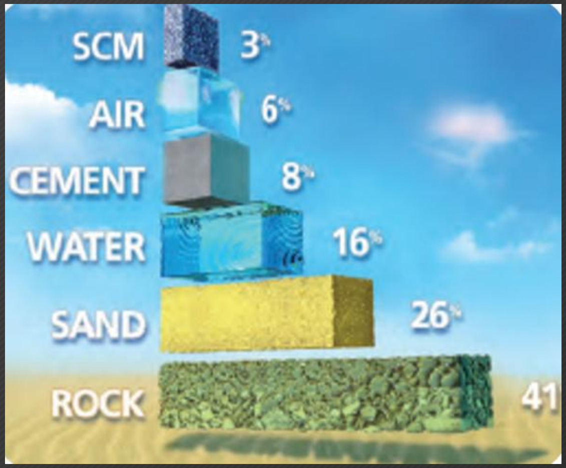
- Economically advantageous when designed with reasonable size, work zone parameters, and continuous programming
- Superior longevity when built by experienced contractors labor
  - Lane mile years vs. Lane miles per year
- Reduced price on all material prices due to the "threat" of competition
- Less mobilization for maintenance and reconstruction is environmentally and economically responsible.

- Económicamente ventajoso cuando se diseña con un tamaño razonable, parámetros de zona de trabajo y programación continua.
- Mayor longevidad cuando es construido por contratistas experimentados
  - Años de millas de carril frente a millas de carril por año
- Reducción de precios en todos los materiales debido a la "amenaza" de la competencia.
- Menos movilización para el mantenimiento y la reconstrucción es responsable tanto ambiental como económicamente.

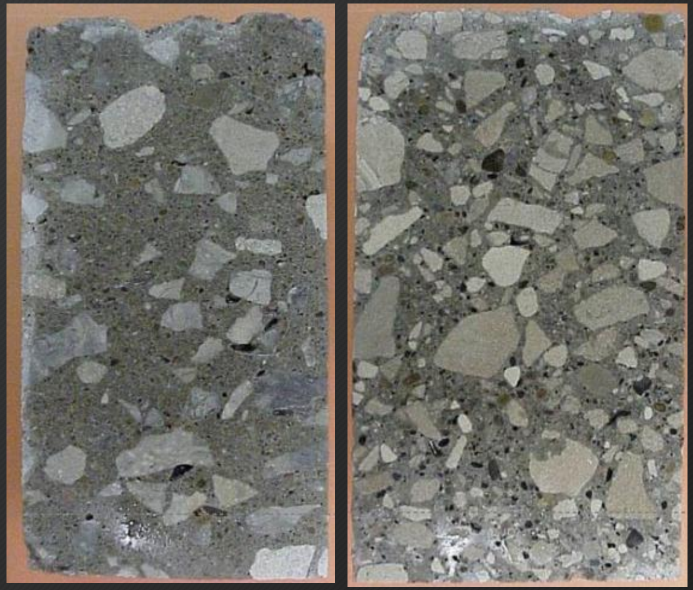
How to build a Long-life Pavement

The best way to preserve a pavement is to build a pavement that needs minimal preservation

- Performance Engineered Mixes (PEM) with an optimized gradation
- Introduction of mix technology
  - Admixtures (i.e. water reducers)
  - Macro fibers
  - Pozzolans
- Proper joint hardware alignment
- Adequate curing methods
- Proper joint layout
- Adequate joint sealing, surface texture, and smoothness
- Diamond grind at inception or a couple years in ← Cheap insurance



Traditional PEM



Optimized pavement designs

- Traditional design Manuals such as AASHTO 93 overdesigned concrete pavements based on too many compiled safety factors
- Los manuales de diseño tradicionales, como AASHTO 93, diseñaron en exceso los pavimentos de hormigón basándose en demasiados factores de seguridad compilados.

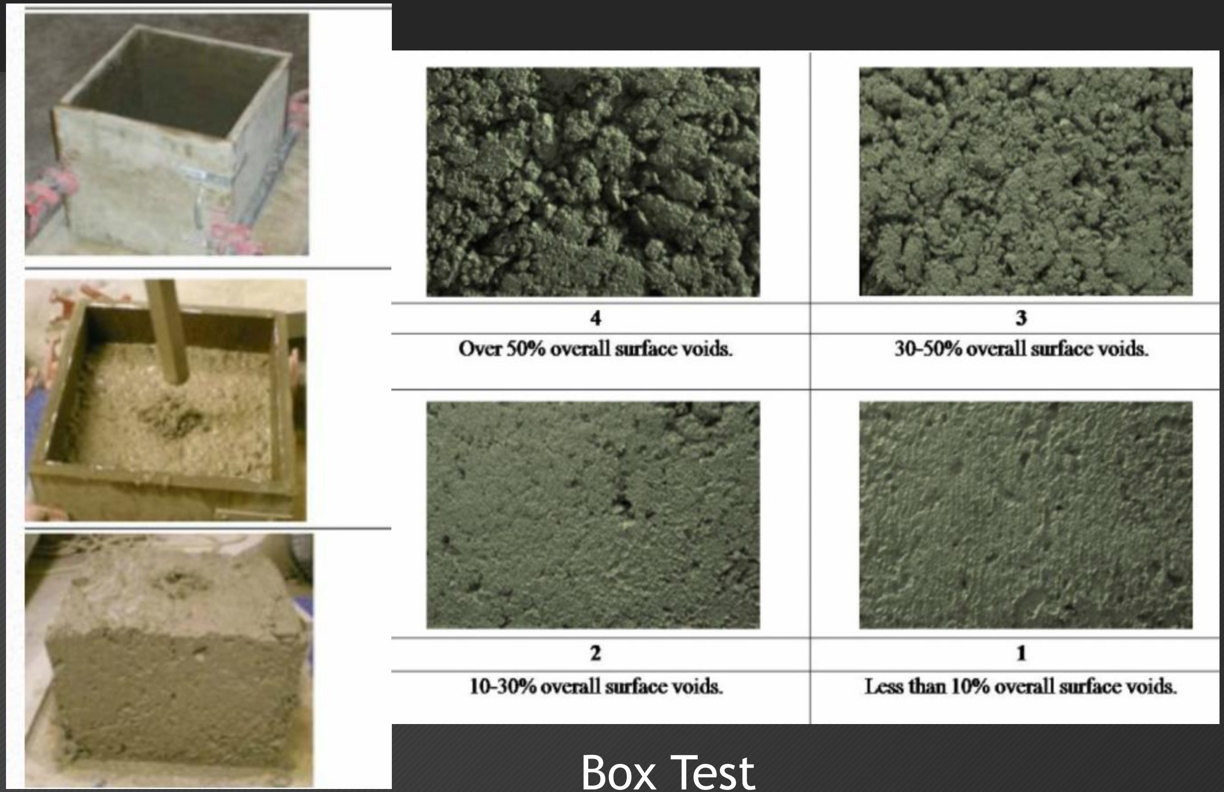
- AASHTO ME and PavementDesigner.org allow engineers to optimize a pavement cross section by considering the base, subbase, aggregates, mix design, etc.
- AASHTO ME y PavementDesigner.org permiten a los ingenieros optimizar una sección transversal del pavimento considerando la base, la subbase, los agregados, el diseño de la mezcla, etc.

Si sus pavimentos funcionan según lo diseñado, entonces es probable que su control de calidad sea suficiente.

New Quality Control Measures

<u>The Super Air Meter (SAM)</u>

Pruebas no sólo del contenido de aire, sino también de la estructura y calidad del aire



<u>Box Test</u>

Para determinar si el hormigón es adecuado para el encofrado deslizante, llene una caja con hormigón y vibre. Si el vacío superficial es inferior al 10 % y el asentamiento del borde es insignificante, el hormigón es adecuado para el encofrado deslizante.

<u>Wavelogics Rebel Sensor</u>

Coloque el disco negro en pavimentos de hormigón para obtener datos de resistencia sin hacer cilindros

¡Muy importante!

Like any successful industry, the concrete paving industry is not a water faucet that can be turned on and off at will

To ensure quality concrete roads are built, agencies must maintain a consistent program to maintain experience with contractors and their labor force

Como cualquier industria exitosa, la industria del pavimento de concreto no es un grifo que se puede abrir y cerrar a voluntad.

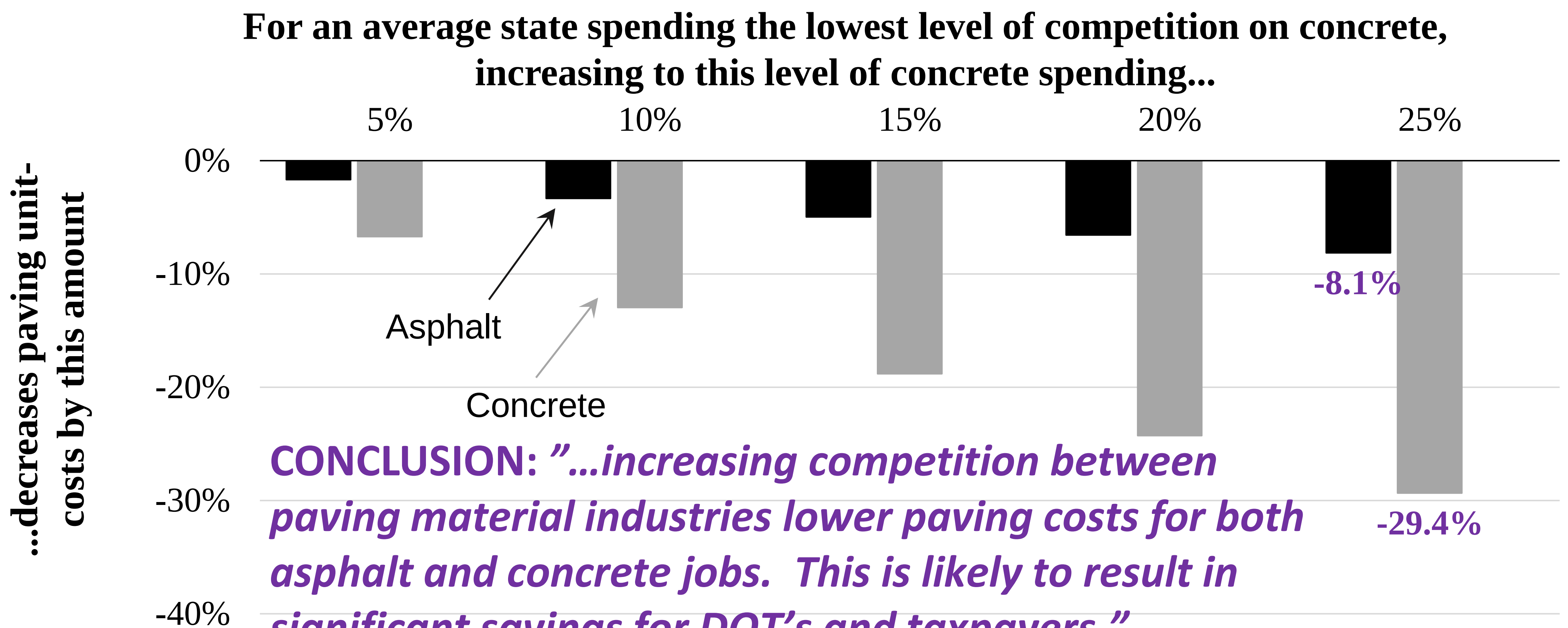
Para garantizar que se construyan carreteras de concreto de calidad, las agencias deben mantener un programa constante para mantener la experiencia con los contratistas y su mano de obra.

The first thing a contractor in New York State does when they are awarded a job, is buy a slip form paver. the last thing they do when the job is complete, is sell the slip form paver. This is no way to run a business or gain experience with the equipment.

Lo primero que hace un contratista en el estado de Nueva York cuando se le asigna un trabajo es comprar un pavimentador de deslizamiento. Lo último que hacen cuando el trabajo está completo es vender el pavimentador de deslizamiento. Esta no es una forma de operar un negocio ni de adquirir experiencia con el equipo.

INTER-INDUSTRY COMPETITION LOWERS COSTS

Allows Highway Agencies to do More with their Budgets



CONCLUSION: "...increasing competition between paving material industries lower paving costs for both asphalt and concrete jobs. This is likely to result in significant savings for DOT's and taxpayers."

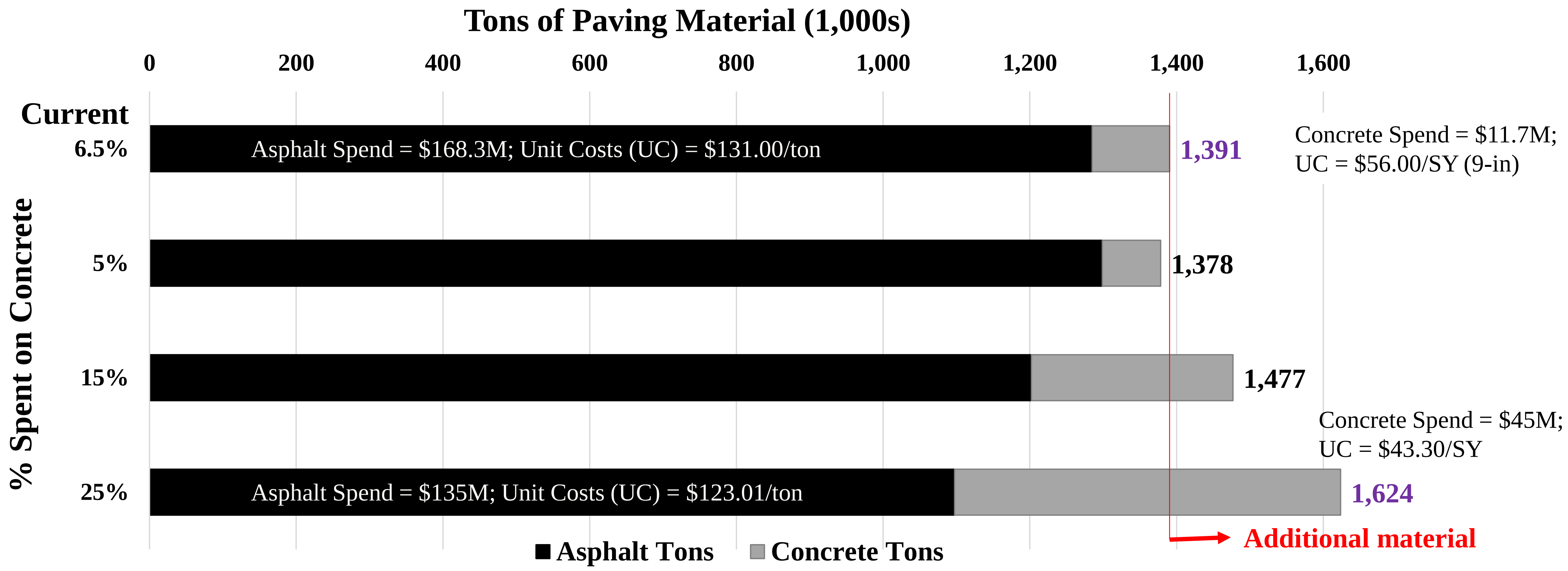
States with high industry competition pay ~ 8% and 29% less for asphalt and concrete pavements respectively vs. states with the low competition

Slide Courtesy of MIT,
https://cshub.mit.edu/sites/default/files/documents/CSHub%20Pavement%20Competition%20Topic%20Summary_Dec2017_FINAL.pdf

AGENCIES WITH A TWO-PAVEMENT SYSTEM GET MORE MATERIALS AT LOWER COSTS

Long Term

Example: CDOT Pavement Budget ≈ $180M



By marginally decreasing the purchases of asphalt tons, ColoradoDOT has the opportunity to purchase 16.8% more paving materials with the same $180 million

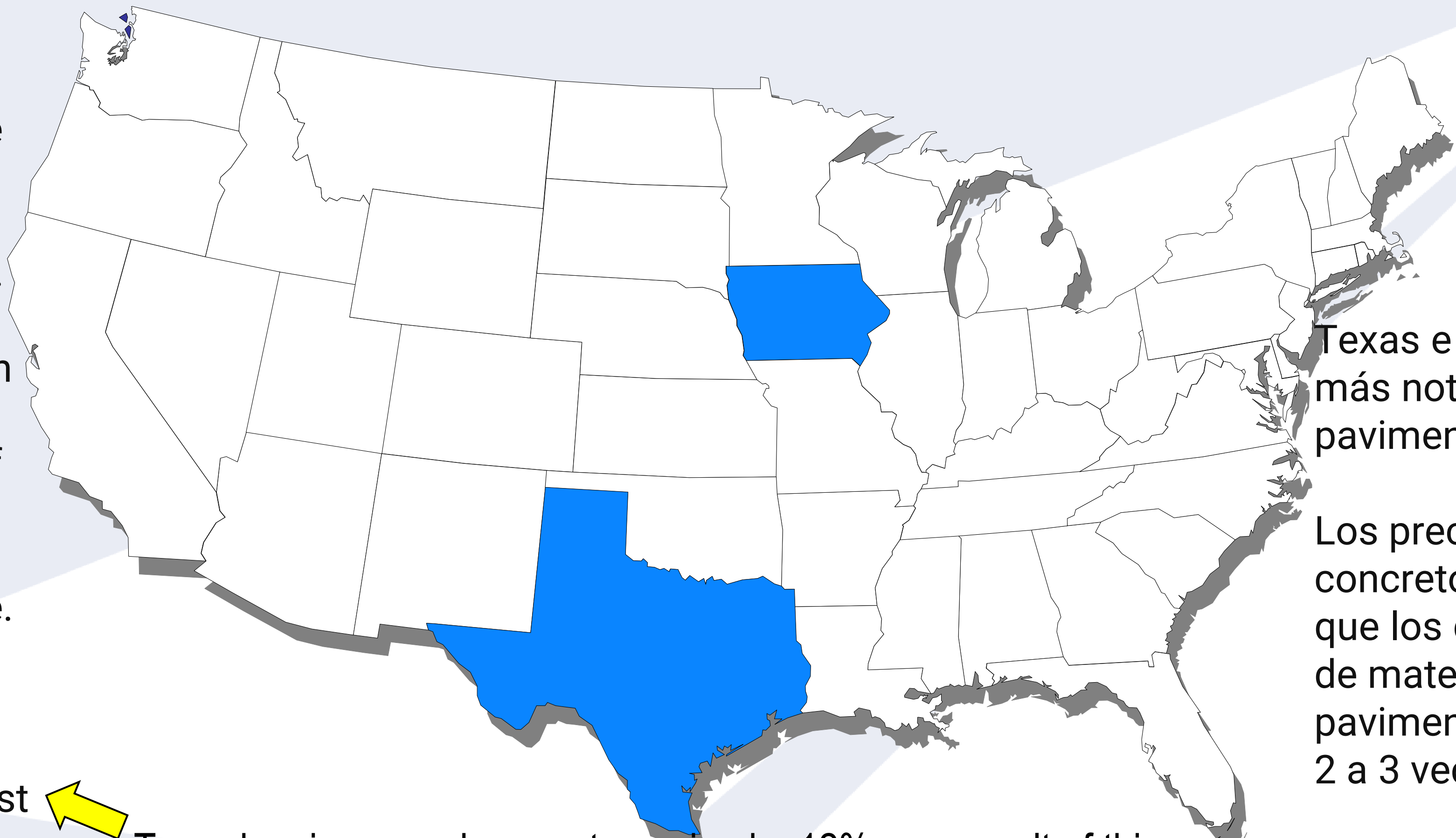
Prices based on Q4 2022 cost data published by CDOT
Assumed unit weight of concrete = 150 lbs/ft^3

The impact of strong concrete paving program

Texas and Iowa have the most notably high percentage of concrete paving budget in the U.S.

Concrete paving prices in Iowa are the same as asphalt per cubic yard of material placed, but concrete pavements enjoy 2-3x the design life.

Texas has a $10 Billion budget surplus over the next 10 years. The highest in the country by far.



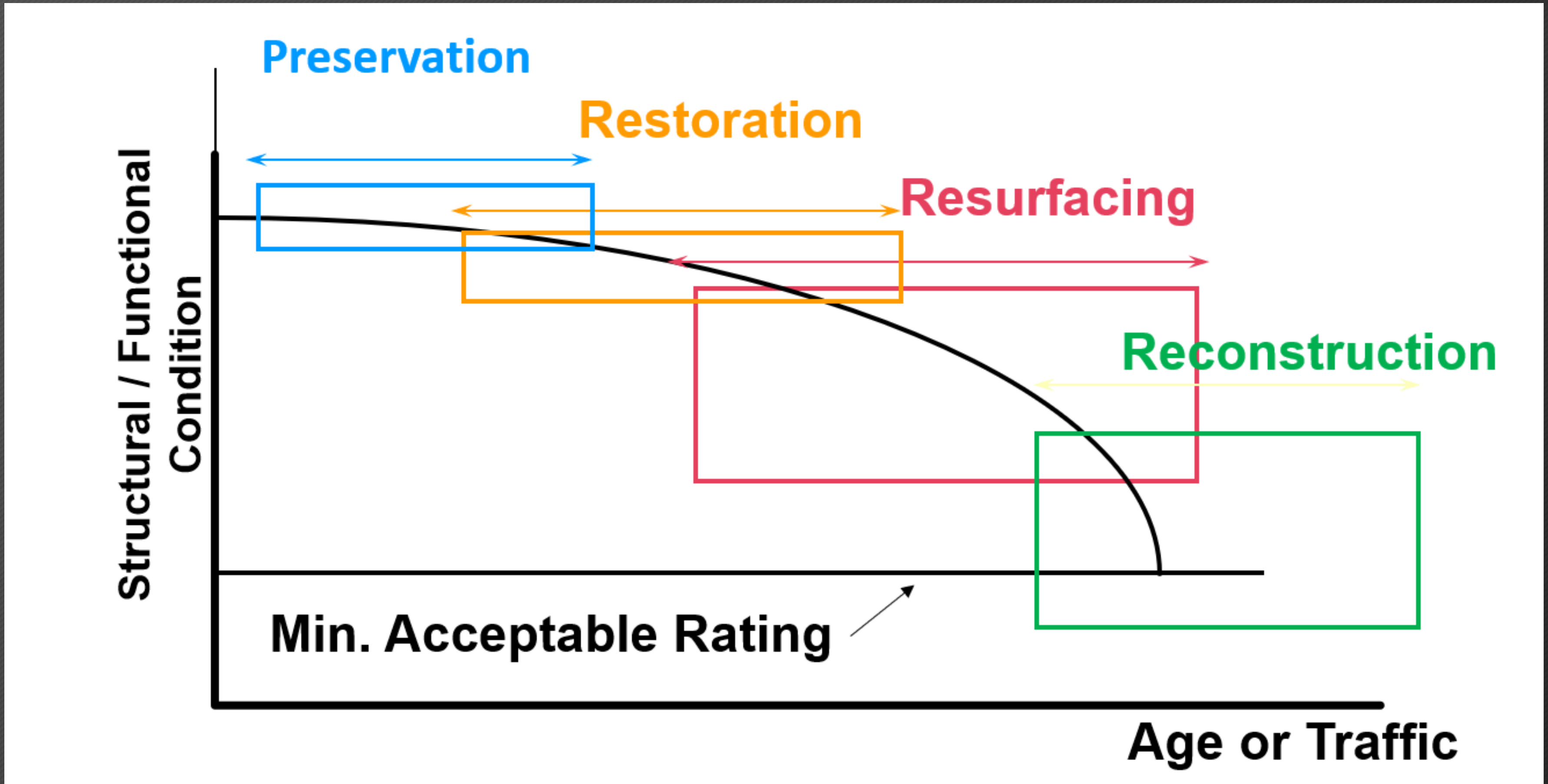
- Texas has increased concrete paving by 12% as a result of this surplus.
- Texas ha aumentado el pavimento de concreto en un 12% como resultado de este superávit.

Texas e Iowa tienen el porcentaje más notable de presupuesto para pavimentación de concreto en U.S.

Los precios de pavimentación de concreto en Iowa son los mismos que los de asfalto por yarda cúbica de material colocado, pero los pavimentos de concreto gozan de 2 a 3 veces la vida útil de diseño.

Texas tiene un superávit presupuestario de $10 mil millones durante los próximos 10 años. El más alto del país por mucho.

Rehabilitation Timing



World Bank's Evaluation

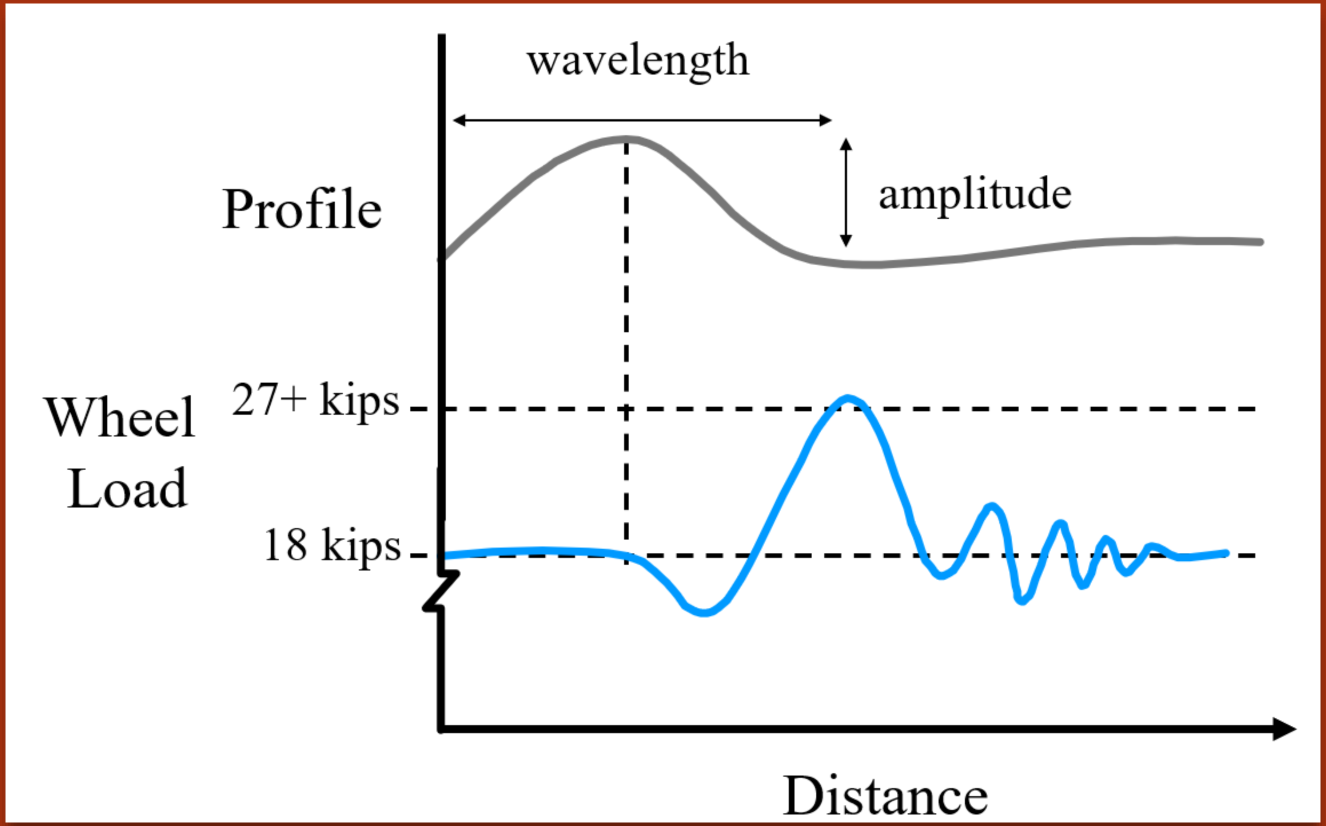
Transport Notes from the World Bank evaluated the relationship between maintenance timing and cost on South African highways.

- It was determined that 3 years of maintenance neglect resulted in 6 times the repair cost.
- 5 years of neglect resulted in up to 18 times the repair cost.

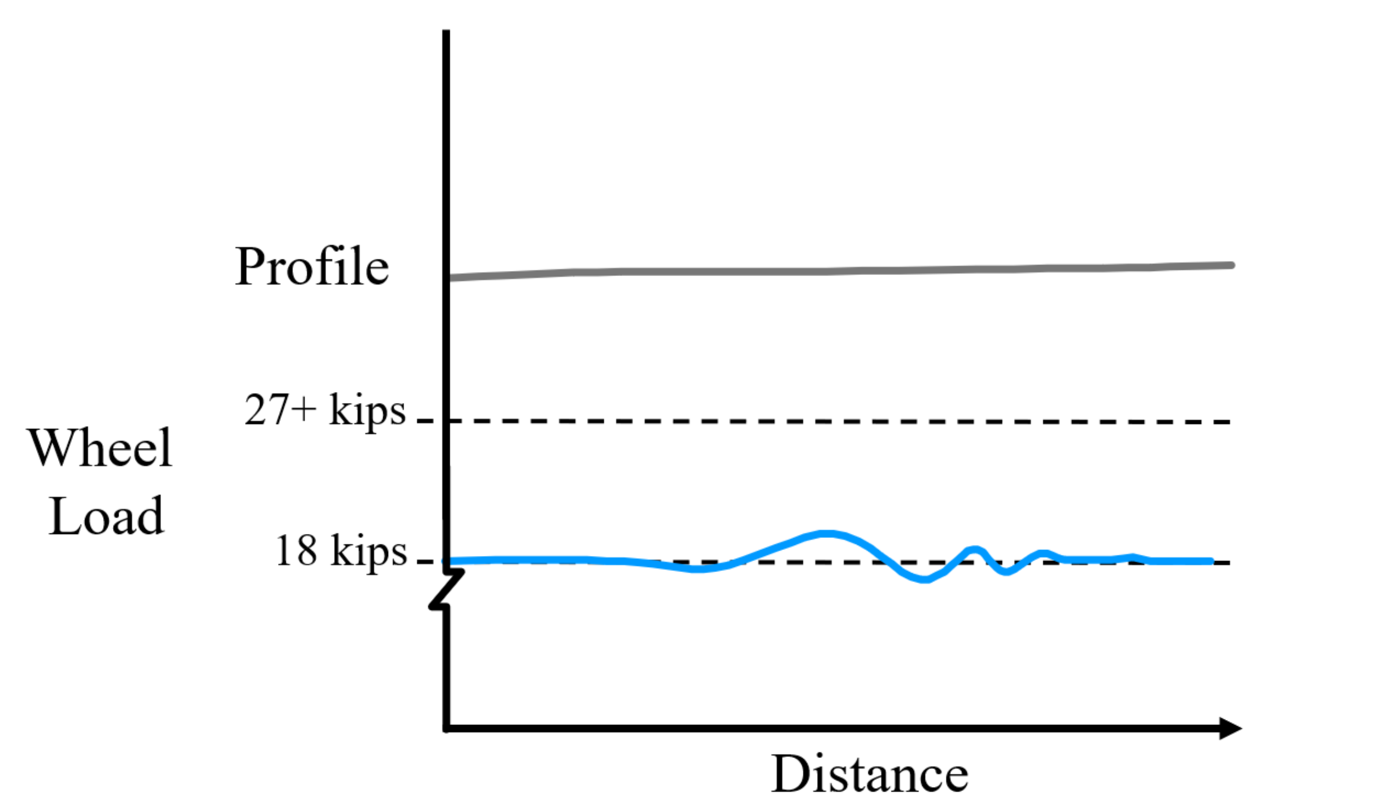
Las Notas de Transporte del Banco Mundial evaluaron la relación entre el momento del mantenimiento y el costo en las carreteras de Sudáfrica.

- Se determinó que tres años de descuido en el mantenimiento resultaron en un costo de reparación seis veces mayor.
- Cinco años de descuido resultaron en hasta dieciocho veces el costo de reparación.

Rough Pavement



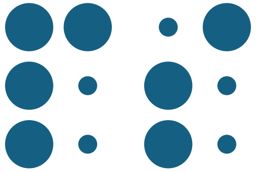
Smooth Pavement



Lane mile years vs Lane miles per year- An Example

Prioritizing projects

A newly constructed 5 lane mile pavement section is built with a 30 year life expectancy. This project will inject 150 lane mile years into the highway system, but only 5 lane miles per year.



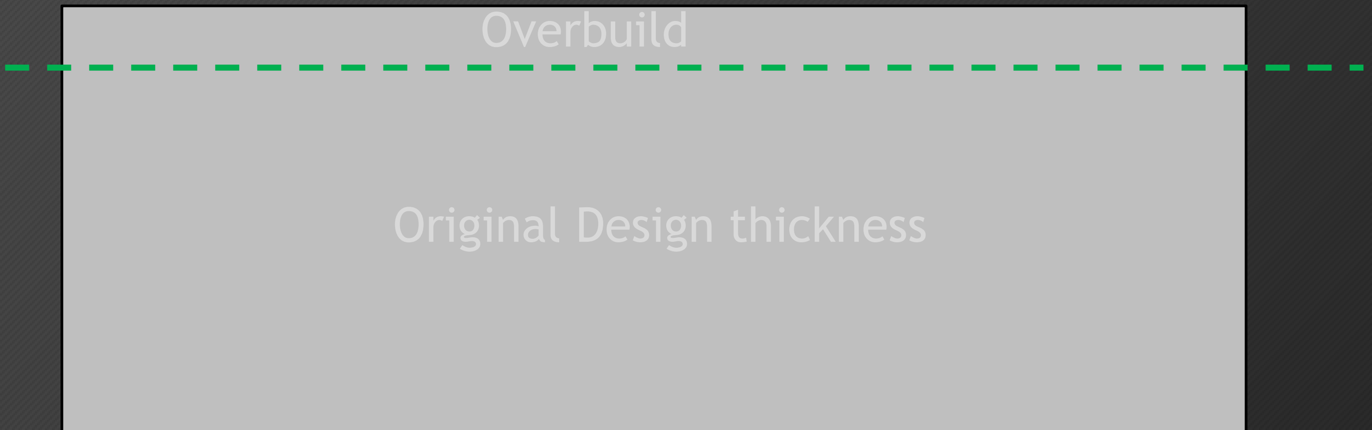
For an equal cost, the DOT could do a thin lift overlay of roughly 20 miles, but the life expectancy of that treatment is 7 years. This project will inject 140 lane mile years into the highway system, but a whopping 20 lane miles per year.

Which is the better investment?!

Despite the first project being a better long-term investment for the taxpayers and highway system, most owner agencies would opt for the 2nd project to achieve the most lane miles per year because of funding and public optic concerns.

Future savings with up scoping

- “The Rule of thumb is you will roughly double the life of a pavement by increasing its thickness by 1inch (2.5 cm)” –Mike Praul, Federal Highway Authority
- Project material costs are typically 30% of the total project cost in the U.S.
- Provides sacrificial section for multiple diamond grinding events without section loss concern.



Expanding the opportunity

Value Engineered

- Lets assume the 30 year design life pavement is 10" thick. The Engineer decides to up-scope an additional inch. This up-scope will result in doubling the design of the pavement to a 60 year design life. Adding an additional inch results in a 3% total project cost increase, which resulted in 3% less lane miles built, leaving the new project length at 4.85 lane miles.
- The new up-scoped project will inject 291 lane mile years into the highway system.
- We can resurface the pavement numerous times for ride quality and friction using diamond grinding.

- Supongamos que el pavimento de 30 años de vida útil tiene un espesor de 10". El Ingeniero decide aumentar el alcance en una pulgada adicional. Este aumento en el alcance resultará en duplicar el diseño del pavimento a una vida útil de 60 años. Agregar una pulgada adicional resulta en un aumento del 3% en el costo total del proyecto, lo que resultó en un 3% menos de millas de carriles construidos, dejando la nueva longitud del proyecto en 4.85 millas de carriles.
- El nuevo proyecto ampliado inyectará 291 millas de carril-año en el sistema de carreteras.
- Podemos volver a superficies el pavimento numerosas veces para mejorar la calidad del viaje y la fricción utilizando molienda con diamante.

How to mitigate highway noise?

Value Engineered

Block the noise with noise wall

Reduces noise by 5 to 10 dB

Costs roughly $20-51 per square foot of wall ($2-3.9 million per mile)

Prevent noise with NGCS

Reduces noise by 6 dB

Costs roughly $8-10 per square yard of pavement (<$100,000 lane mile)

Partial Depth Repairs (PDR)

Joint and crack sawing and sealing

$5 per linear foot
$47,000 per lane mile

Use-phase is the primary environmental impact

- Minor adjustments can show major impact
- When we save on use-phase carbon (fuel consumption) we also save our taxpayers at the pump

Los ajustes menores pueden mostrar un gran impacto.

Cuando ahorramos en carbono durante la fase de uso (consumo de combustible), también ahorramos a nuestros contribuyentes en la bomba.

Cost carbon calculators

- Built in Partnership with CPAM and MIT
- Identifies and quantifies opportunities for fuel economy improvement during use-phase
- Gives both a carbon and cost output associated with that savings

www.igga.net

Cost/Carbon Savings Calculator- Actual Project Data

- What is the environmental and Financial benefit of IRI improvement?
  - Fuel/Carbon Savings Calculator - IGGA | The International Grooving and Grinding Association

Example project

- Initial IRI: 98 in/mi (1.54 m/km)
- Actual Final IRI: 43 in/mi (0.68 M/km)
- AADT:39,152
- Percent trucks: 15%
- Length:6.6 miles (10.6km)
- Width: 4 lanes
- Cost to Grind: $4.60 sqyd

Cost Carbon Benefit Table

Print

Category	10 Year Benefit		20 Year Benefit	
	Cost ($)	Carbon (Metric Tons)	Cost ($)	Carbon (Metric Tons)
Fuel Savings for IRI	$3,918,999.72	4559.63	$7,837,999.45	9119.27
Carbon Sequestration		20.78		29.39
Cost of Grinding	($854,937.60)	(250.91)	($854,937.60)	(250.91)
Total (savings)	$3,064,062.12	4329.51	$6,983,061.85	8897.76

Kentucky Diamond ground 536 miles of interstate pavement from 2007-2012

- Estimated IRI Pre-Grind: 112 in/mi
- Estimated IRI Post-Grind: 75 in/mi
- Traffic Speed: 60 mph
- Average Daily Traffic: 30000
- Percent Trucks: 10 %
- Gasoline Cost Per Gallon: $ 3.5 USD
- Diesel Cost Per Gallon: $ 5 USD
- Length Of Road: 536 miles
- Total Project Lane Width (Cost Estimate): 12 feet
- Diamond Grinding Cost Per Yard: $ 2.75 USD

Cost Carbon Benefit Table

Print

Category	10 Year Benefit		20 Year Benefit
	Cost ($)	Carbon (Metric Tons)	Cost ($)
Fuel Savings for IRI	$144,935,113.43	345246.12	$289,870,226.85
Carbon Sequestration		4910.48	
Cost of Grinding	($10,376,960.00)	(10188.29)	($10,376,960.00)
Total (savings)	**$134,558,153.43**	**339968.32**	**$279,493,266.85**

Best way to reduce IRI? Diamond Grinding

Pavement Diamond Grinding is the only highway treatment that can be cost and carbon negative!

MIT's Concrete Sustainability HUB suggests that grinding and pavement repair should be conducted every 15-20 years to optimize carbon impact

Why Is It The Most Cost-Effective Preservation Technique?

- Material mining
- Material hauling
- Smaller crew than asphalt paving
- Rolling road closures

Before Grinding Deploy Proper Repairs

Least Invasive

- Joint and crack sealing
  - Prevents subbase degradation
    - Faulting
    - Rocking Slabs
    - Corner breaks

Moderately Invasive

- Partial depth repairs
- Dowel Bar retrofits
- Cross stitching
- Slab jacking

Most Invasive

- Full depth pavement repair



What is Diamond Grinding?

What is NGCS?- low noise highway for urban corridors

Tight blade spacing removing all positive surface texture

Add safety grooves for macro texture and hydroplaning prevention

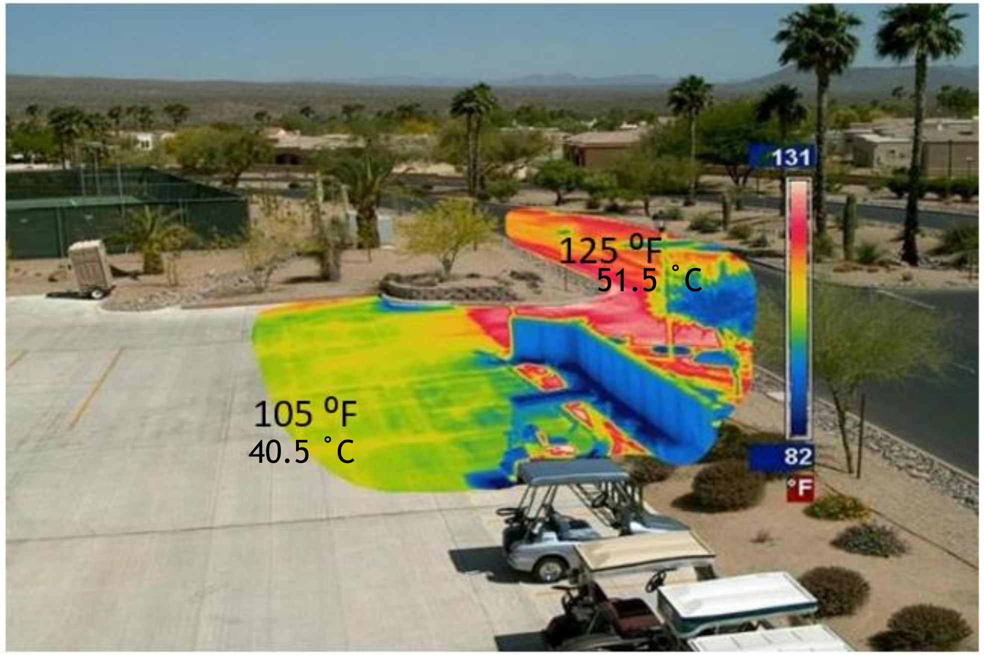
Note: A conventional grinding head has about 55 blades per foot while a NGCS head has about 80 blades per foot.

Fun Fact!

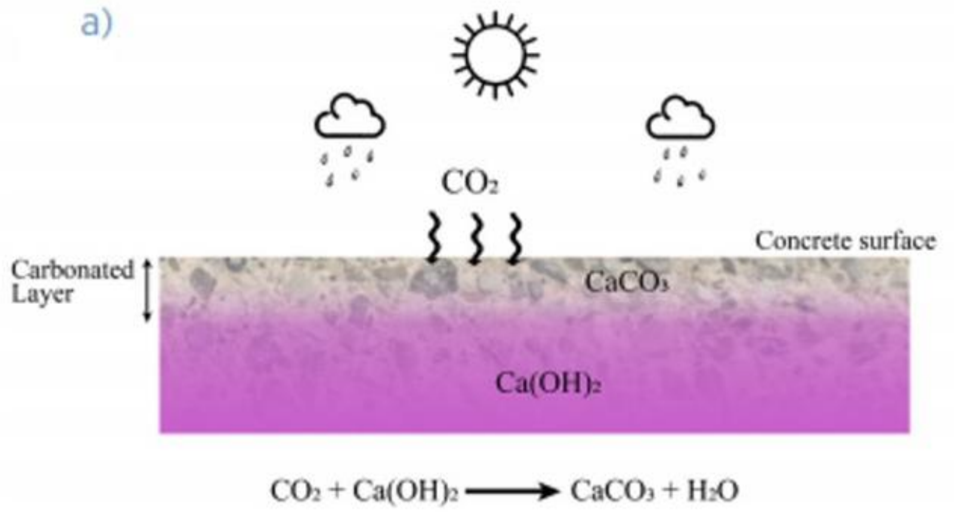
Las tasas de accidentes en superficies pulidas con diamante fueron un 40 % menores que en superficies sin pulir durante un período de 6 años y un 57 % menores en condiciones climáticas húmedas.

Marquette university research performed for Wisconsin transportation agency

Other benefits of Diamond Grinding



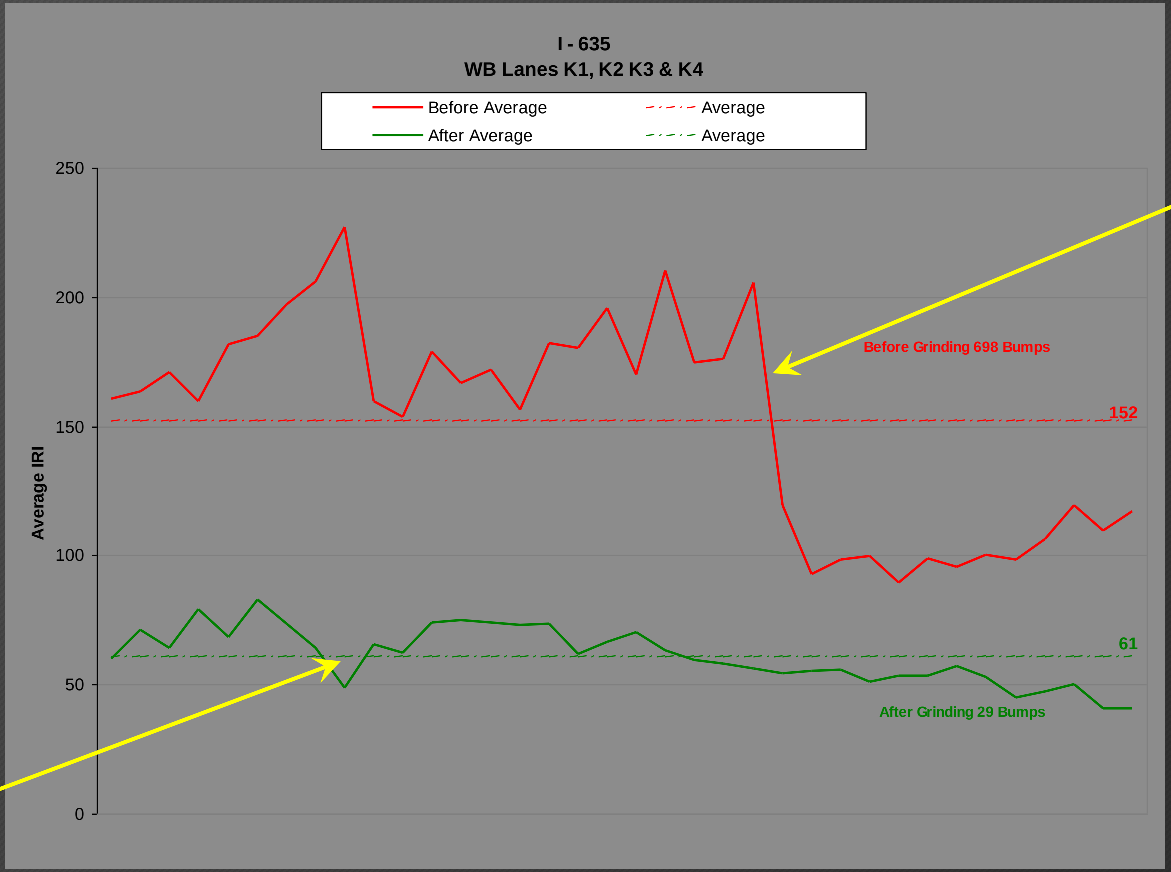
Albedo is the ability of surfaces to reflect sunlight



Year 0 to 10: 6298lbs of carbon sequestered

Year 10 to 20: 2609lbs of carbon sequestered

Improve International Roughness Index by 50-70%



Before Grinding

After Grinding

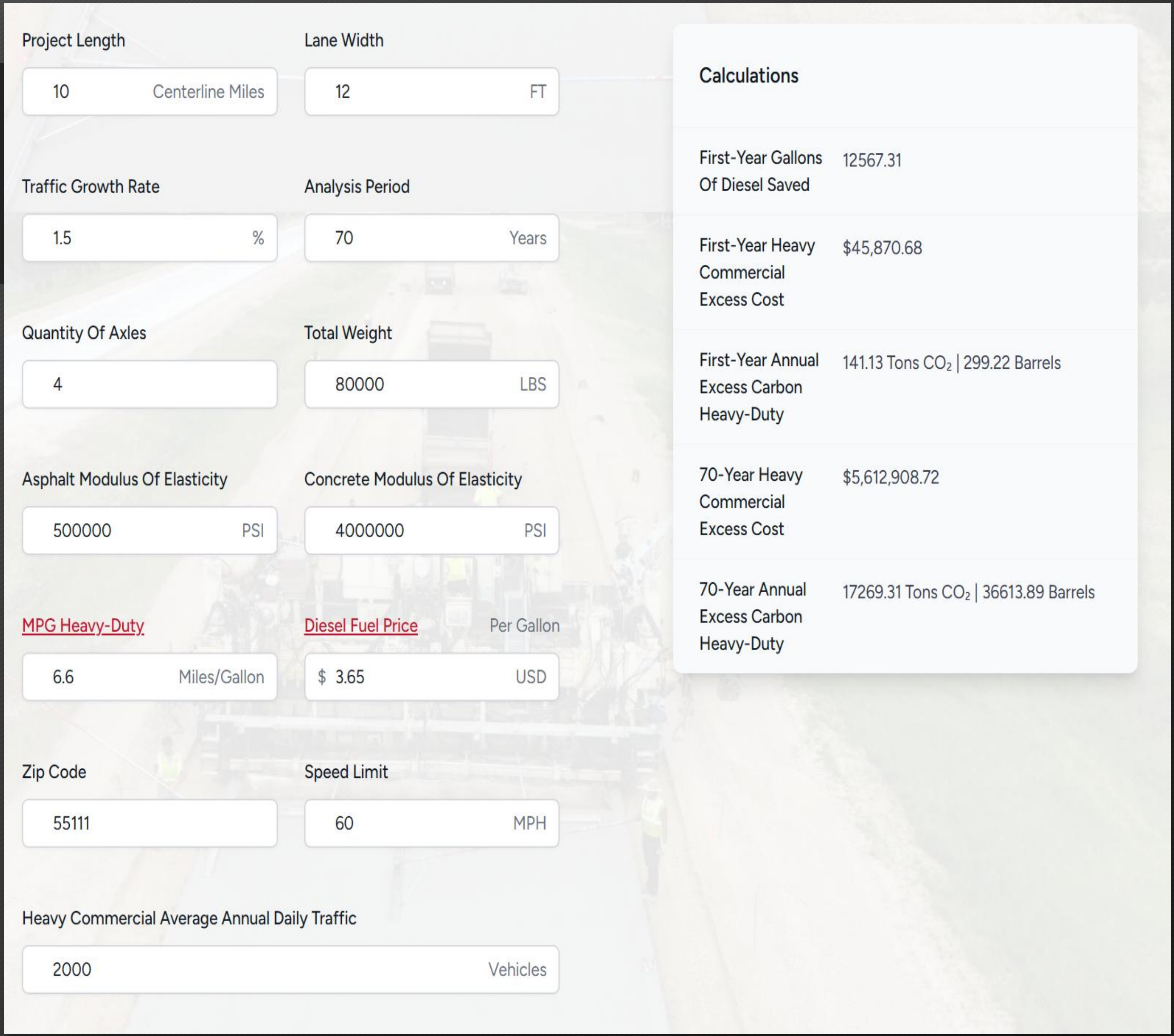
Rigid vs. Flexible Example

Input

- 10 miles interstate section
- 35-year design life
- Located in Minneapolis
- 2,000 trucks per day

Output

- $46,000 first year fuel savings
- $5.6 million in 35-year design life savings
- 17,000 metric tons of CO2 savings in 35-year design life



Interactive CPP Toolkit

- Helps DOT's and Designers select the appropriate repairs for PCC pavement to help optimize repair spending.

Identify your pavement's problem area. Click on the photo that represents your pavement problem:

Spalled Joints and Cracks

Faulted Joints

Subsurface Voids

Cracked Slabs

Low-Severity Longitudinal Cracks or Joints

Low-Severity Transverse Cracks

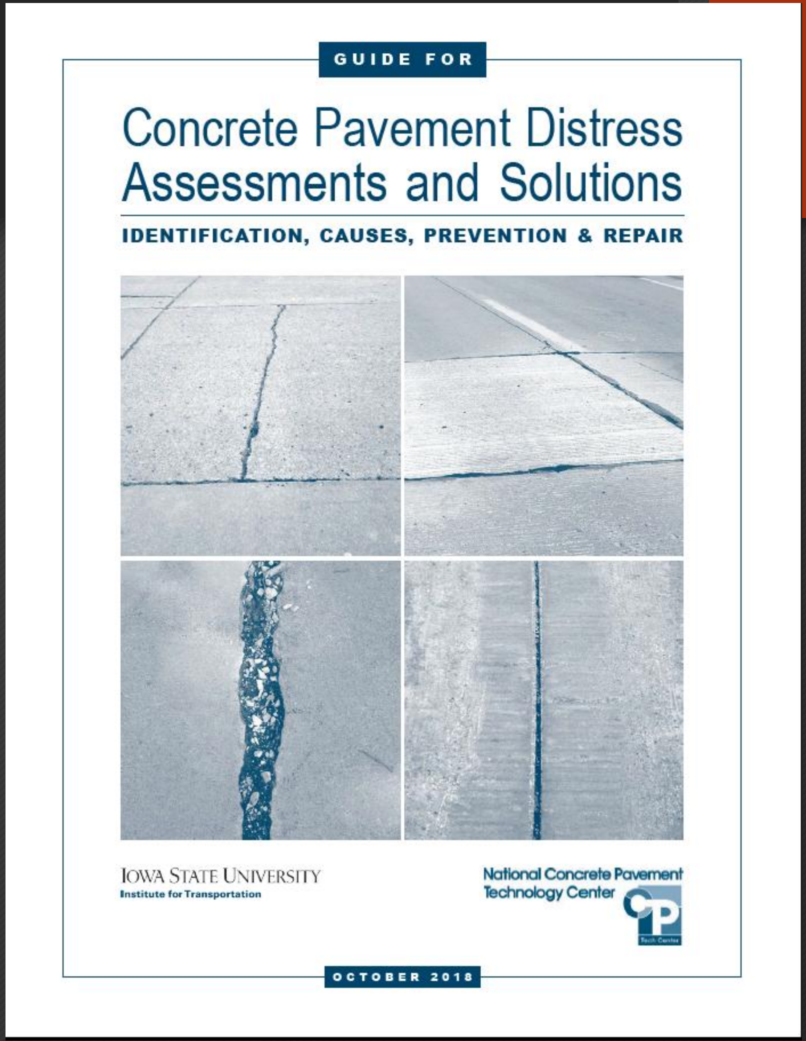
Slab Warping or Unevenness

Joint Sealant Failure

Hydroplaning on Pavement

Other resources

Pavement repair guides produced by the National Concrete Pavement Technology Center (CPTECH Center)



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