ASPHALT PAVEMENT SUSTAINABILITY & RESILIENCY

PAPA BUS TOUR JULY 2019 JOSEPH SHACAT, DIRECTOR OF SUSTAINABLE PAVEMENTS



NAPA Overview





Let's start with Sustainability



"Nor indeed would a farmer, however old, hesitate to answer any one who asked him for whom he was planting: '...I should not merely receive these things from my ancestors, but **should also hand them on to the next** generation."

- Cicero, On Old Age, 44 B.C.





What is Sustainability? The U.N. says...

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

- United Nations, World Commission on Economic Development: Our Common Future, "Bruntland Report" (1987)

What is a sustainable pavement? FHWA says...

- Sustainable pavements should:
- Achieve the engineering goals for which they were constructed
- Preserve and (ideally) restore surrounding ecosystems
- Use financial, human, and environmental resources economically
- Meet human needs such as health, safety, equity, employment, comfort, and happiness





Reclaimed Asphalt Pavement

99+% of pavements are recycled

- 76.2 million tons of RAP used (2017)
 - 21.5 million barrels of oil
 - 72+ million tons of aggregate
 - \$2.1 billion in savings
- Pennsylvania
 - 3.2 million tons of RAP (2018)
 - Average percent RAP used
 - 15.9% (2018); 14.7% (2017)





Warm Mix Asphalt

Developed in Europe to reduce CO₂ emissions

- 147.7 million tons of WMA (2017)
 - 38.9% of total market
- Pennsylvania
 - 13.2 million tons in 2017
 - 65% at reduced temp.
 - 18% chemical additive 2018
 - 55% chemical additive 2017







Life Cycle Considerations

Perpetual Pavements

- Designed to never experience structural rutting or cracking
- PennDOT has earned 8 perpetual pavement awards



Life Cycle Considerations

Pavement Smoothness

- Vehicle wear and tear
- Pavement wear and tear
- Fuel efficiency
- Noise
- Safety



Asphalt.

AMERICA RIDES ON US

SMOOTHNESS

MATTERS

Smooth Pavements Save Fuel and Even Small Changes Can Make a Big Difference



Resiliency and Asphalt Pavements



What is Resilience?

No common definition

- AASHTO cited 8 definitions related to transportation infrastructure
- Many faces of resilience
 - But none, by itself, represents the whole







Resilience – The elephant and the 6 blind men



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https://www.myeducator.com/reader/web/1293a/chapter01/j596n/

Resilience and Asphalt Pavements

Natural disasters

- Hurricanes, floods, earthquakes, landslides, tornadoes
- Damaged roads affect mobility
 - Emergency services
 - Access to medical care
 - Food supplies
 - Commerce
- With unexpected events, the key is to quickly restore service

resilience road

exploring your authentic life path



beth koritz, lpc

Resilience – Earthquake Response





- 8 major transportation corridors severely damaged
- All 8 major roads repaired within 5 days

Anchorage, AKDecember 1, 2019

https://www.theverge.com/2018/12/8/18128983/alaska-earthquake-roads-fixed-anchorage-damage

Resilience – Earthquake Response

- Ridgecrest, CA
 - July 4 & 5, 2019
- Back-to-back earthquakes damage Highway 178
- Temporary repairs completed within hours
- Permanent repairs completed less than 10 days later, within a single shift





https://www.sbsun.com/2019/07/04/6-6-magnitude-earthquake-southwest-of-searles-valley-in-san-bernardino-countyis-felt-throughout-the-southland/

Resilience – Hurricanes





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• August 2017

https://www.nytimes.com/2018/09/19/climate/humans-hurricanes-causes-effects.html

Resilience – Speed of Hurricanes

- Hurricane Michael severely damaged U.S. 98 in Franklin County, Florida (October 2018)
- 40-mile stretch of highway affected, 15 miles badly damaged
- Lanes were reopened to traffic after every shift





Resilience – Warm Mix to the Rescue

- What happens when local plants can't operate?
- Use of warm mix studied after Hurricane Katrina
- Haul distances up to 8-10 hours can be used with warm mix technology
- Fine graded mixes are more easily compacted





SERRI Report 70015-011

Full Scale Testing of Hot-Mixed Warm-Compacted Asphalt for Emergency Paving



http://driveasphalt.org/resource-library/full-scale-testing-of-hot-mixed-warm-compacted-asphalt-for-emergency-paving

Resilience – Warm Mix to the Rescue U.S. 34, Colorado, 2013

- 3-hr. haul distances
- Late season paving at high elevation
- Steep canyons with little sun and high winds
- Warm mix was key to getting the job done





https://www.roadsbridges.com/asphalt-paving-able-reconnect

https://www.cpr.org/2016/09/29/brace-yourself-northern-colorado-us-34big-thompson-canyon-closure-is-almost-here/

Resilience and Asphalt Pavements <u>Climate change</u>

- Coastal flooding, groundwater rise, hotter temperatures
- The key is to plan for expected changes





http://seagrant.soest.hawaii.edu/coastal-and-climate-science-and-resilience/ccs-projects/building resilience-to-coastal-hazards-and-climate-change-in-hawaii/

Resilience – Sea Level Rise



• Caused by king tides and shifting currents

•

3,000+ residents October 27, 2015

https://www.ajc.com/blog/politics/supermoon-rising-sea-levels-put-tybee-island-access-underwater/kE3PD96bMn0XJDPSHt0JtO/

Resilience – Hotter Temps

- Use climate forecasts rather than historical data for pavement design
- Integrate design changes into routine maintenance overlays
- Can be cost effective if planned appropriately

https://www.bostonglobe.com/metro/2019/07/11/clim ate-change-means-roads-should-built-differently-unhresearchers-say/iU35VmsG3L02gbFsY0F10J/story.html

Climate change means roads should be built differently, UNH researchers say

By Alyssa Lukpat Globe Correspondent, July 11, 2019, 1:42 p.m.



Harrison Avenue in the South End is in poor shape. It is cracked, crevassed, and noticeably uneven. (FILE 2009)

Researchers at the University of New Hampshire say governments should start building roads with different and thicker asphalt now so they will be ready to withstand the effects of climate change in the future.



Resilience – Will Roads Melt as the Temperatures Heat Up?

- Climate models provide long-term expected temperature changes
- Adjust binder grades to accommodate predicted conditions
- Time scale of changes is decades
- Can be a part of routine maintenance overlays



https://www.wired.com/story/this-scary-map-shows-how-climate-change-will-transform-your-city/?verso=true

FHWA references for pavement resilience

Impact of Environmental Factors on Pavement Performance in the Absence of Heavy Loads (FHWA-HRT-16-078) www.fhwa.dot.gov/publications/research/infrastructure/pavements/ltpp/16078/16078.pdf Climate Change Adaptation for Pavements (FHWA-HIF-15-015) www.fhwa.dot.gov/pavement/sustainability/hif15015.pdf Vulnerability Assessment and Adaptation Framework, Third Edition (FHWA-HEP-18-020) www.fhwa.dot.gov/environment/sustainability/resilience/adaptation framework Adaptation Decision-Making Assessment Process (ADAP) (FHWA-HEP-17-004) www.fhwa.dot.gov/environment/sustainability/resilience/ongoing and current research/teacr/adap Synthesis of Approaches for Addressing Resilience in Project Development (FHWA-HEP-17-082) www.fhwa.dot.gov/environment/sustainability/resilience/ongoing and current research/teacr/synt hesis

ECHBRIEF npact of Environmenta actors on Pavement LTPF rformance in the Absence f Heavy Loads

WA Publication No.: FHWA-HRT-16-07 HWA Contact: Jack Springer, HRDI-30, (202) 493-3144 ack.springer@dot.gov

his document is a technical summary of the Federal ighway Administration Long-Term Pavement formance Program report, Analysis of the Study of vironmental Effects in the Absence of Heavy Loads HWA.HRT.16.084)

The Long-Term Payement Performance (LTPP) Program onitors the performance of pavements constructed sing different materials that are subject to varied traffi ads across many climates. One experiment categor eveloped by the program for study is the effect the ironment has on pavement deterioration. The data alvsis results summarized in this TechBrief use tes ctions from an LTPP Specific Pavement Studies (SPS) periment, Study of Environmental Effects in the ence of Heavy Loads (SPS-8), matched with tes actions from other LTPP experiments that have normal uck traffic to compare and show the proportion of tota nage caused by environmental effects. This analysis which looked at data collected over a 15-year period, also entified many practical design and materials effects uding some very informative results

itiated as part of the Strategic Highway Resea ogram, the primary purpose of the SPS-8 experimen s to characterize the impact of environmental factor

PAVEMENT ASSOCIATION

CLIMATE CHANGE ADAPTATION FOR PAVEMENTS

TechBrief

Vulnerability Assessment and Adaptation Framework

FEDERAL HIGHWAY ADMINISTRATION OFFICE OF PLANNING, ENVIRONMENT, & REALT

TEACR Engineering Assessment

Adaptation Decision-Making Assessment Process (ADAP

Introductio

Sentember 2016

The Adaptation Decision-Making Assessment Process (ADAP) is proposed as a tool for plann and designers to account for the increasing role of climate change in the design of civil worl projects. ADAP is intended as a risk-based tool to aid decision makers in determining which ject alternative makes the most sense in terms of life cycle cost, resilience, regu olitical settings, etc. ADAP provides a framework for generating the information needed to ntify preferred approaches to project design based up tailored to meet an agency's specific requirements. Although the framework lays out specifi

mate changes and (2) for the design of new infrastructure projects. For new projects, it is tended to be applied during the planning stage of project development so as to provide th

P was also designed to be general enough to apply to the entire spectrum of climat hway infrastructure, from a small drainage culvert on a country road to a comple idge in a major urban area. Determining which facilities/projects ADAP should be applied to vill be a policy decision made by each agency. Agencies may choose to apply ADAP to existing or eet certain criteria related to cost, importance, potential vulnerability, etc. ADAP may not be hould inform an agency's thinking about climate change vulnerability and adaptation options. inally. ADAP is designed from the perspective of assessing a single asset, but it could be easily dapted to consider more system-level considerations, such as a system of culverts within a atershed. The language in this document assumes that a single asset is being evaluated. If a

em approach is taken, then the same ADAP steps should also be followed, but adjusted as eeded to account for system-level considerations he ADAP steps are captured in the decision tree in Figure 1. As can be seen, not all steps are required in all situations. The process is setup to minimize the evaluation process in situations where the consequences of asset failure are low and where the cost of adapting to climate change is relatively small. The steps are explained in more detail in the following section:

Synthesis of Approaches for Addressing **Resilience in Project Development**





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PAVING FOR PERFORMANCE: Built to Perform

www.AsphaltPavement.org/P4P

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