Overcoming Modern Roadway Environmental Challenges

By Michael Durante

The road construction industry will play a crucial role in achieving agency-driven carbon-reduction goals. America alone has nearly seven million lane miles of paved road, enough to drive oneself to the moon and back more than 15 times. As the primary infrastructure underpinning America's $25 trillion economy, roadways cover more than one-third of the ground area of our major cities. Their maintenance requires in excess of 350 million metric tons of virgin asphalt annually. The demands of this vital infrastructure are as endless as they are insatiable.

The Emerging Two-Budget Paradigm

The weighted life cycle average (LCA) of the U.S. road system is a mere 12 years and represents in net present value (NPV) roughly $2 trillion in replacement costs. On top of this financial burden, the NPV of the system's carbon footprint – for routine maintenance – approaches another $100 billion in carbon equivalents (CO_{2e}).

That's before you take into consideration the carbon cost related to the cars and trucks that travel on it. When you add on-road vehicular pollution, which totals some 1.6 billion metric tons annually, the NPV of our road systems' CO_{2e} jumps to nearly $600 billion!

Traditionally, public works agencies have had a single financial budget to manage. But it is increasingly becoming likely that soon they will be facing either a self-imposed or a federally regulated carbon-reduction budget as well. Meeting these twin goals will require of our public agencies a level of imagination, innovation, perseverance and commercial partnering rivaling that required by the Space Race decades ago. The paving industry must adapt if we are to adequately support our public works clients.

The city council associated with a large agency customer recently ruled that all public works contracts of a certain value must include Envision (ENV) verification from the Institute for Sustainable Infrastructure going forward. We do not think this is an anomaly. ISI was established for public works projects in cooperation with the American Public Works Association (APWA), the American Council of Engineering Companies (ASCE) and the Zofnass Program for Sustainable Infrastructure at the Harvard University Graduate School of Design. It is modeled after the U.S. Green Building Council's (USGBC) LEED qualification for building construction.

Challenge 1: Traffic Pollution

EPA technical data shows that as much as two-thirds of atmospheric nitrogen (NO_2) contamination – a leading greenhouse gas and the primary photochemical smog precursor – is emitted from mobile sources. Nearly half of all Americans live within maximum exposure range of near-roadway pollution or within close proximity to high-AADT (annual average daily traffic) volume roads, according to the most recent U.S. Census.

To make matters worse, airborne nitrite gases have a half-life ranging from 100 to 150 years. The EPA believes NO_2 concentrations from vehicles and near roadways are appreciably higher than those measured at monitors in the current EPA network.

Challenge 2: Urban Heat Islands

As if traffic pollution was not enough of a challenge, the growth in urbanization and changing land use coupled with ever-rising vehicular emissions intensifies Urban Heat Island effect (UHI) in big cities. UHI intensity itself is highly correlated to air-toxin levels. In addition, heat-related stresses from O_3 levels correlate to health concerns for humans, including asthma and more serious pulmonary and cardio disorders.

Though UHI intensity depends on many factors, the thermodynamic properties of surface materials like roads greatly amplify the temperature profiles at the local scale – making our public thoroughfares an ideal target for improvements.

Conventional asphalt paving materials can reach peak summertime temperatures of 150°F or more, transferring excess heat to the air above them and heating stormwater as it runs off the pavement into waterways, adversely affecting watershed ecology. Further, asphalt binder begins to experience exponential oxidation at temperatures as low as 70°F and hyper-photo-degradation at 120°F. Studies have shown that even modest improvements in asphalt temperature can materially extend the service life of this vital community asset.

Agency consortia promoting heat-reducing infrastructure best practices, such as the Global Cool Cities Alliance, are growing rapidly. Los Angeles, Phoenix and other major metropolitan areas are leading the way with active "cool pavement" paving programs.

Challenge 3: Roadway Microplastic Pollution

The newest arrival to road-related environmental concerns is microplastic contamination. Researchers are now predicting that the extensive use of plastics will create a global plastics crisis equal to the aforementioned human-induced challenges.

As much as 85 percent of the microplastics that end up in our environment come from roads. They are a material contributor to poor air quality and oceanic contamination. The primary culprits are tire and brake-pad wear-off from cars and trucks.

Scientists even have a name for roadway microplastic accumulations: "road-associated microplastic particles," conveniently abbreviated "RAMPs." All this adds new meaning to what happens when the rubber meets the road. Both urban and highway stormwater runoff collect RAMP, creating an obvious pathway for microplastic contaminations from land-based sources to a community's local aquatic environment, and then beyond to major waterways such as rivers, lakes and oceans.

Challenge 4: Road-Level Precipitation

Water has long been the enemy of roadways. Not only does it hasten asphalt and concrete degradation; when precipitation creates ponding or ice formations, it creates hazardous road conditions and encourages harmful mold and bacteria growth.

Quick-drying pavements help promote safer driving conditions, reducing hydroplaning and precipitation-related visibility impairment, and discouraging ice formation. Further, a roadway that is self-cleaning could also help mitigate mold and bacteria growth on asphalt and concrete infrastructures.

Research has shown that super-hydrophilic surfaces, much like gecko lizards in the natural environment, can shed water for rapid displacement of skid-creating conditions from rain to ice to snow. When photo-catalyst-enhanced or super-hydrophilic surfaces are exposed to ultraviolet radiation (UV), surface water disperses more rapidly in comparison with untreated substrates, significantly reducing moisture penetration that can otherwise critically damage roadways, runways, and highly vulnerable longitudinal joints and rumble strips, as well as reduce traffic accidents.

Conclusion: Carbon Capturing Pavements are Cool

Pavement Technology, Inc. (PTI) has been providing America's largest public works and transportation industry agencies with innovative pavement preservation technologies for nearly 50 years. At the EarthX 2019 environmental symposium, we formally introduced our state-of-the-art family of **P**lus**Ti**™ smog-eating-road penetrants. These unique pavement preservation solutions combine field-proven pavement preservation technology with photo-reactive materials that decompose toxic pollutants and microplastics while creating solar-reflective "cool pavements."

These field- and laboratory-verified solutions deploy Photo Catalytic Technology (PCT) to transform asphalt and concrete pavements into air-purifying, heat-reducing change agents to improve the quality of life in our cities. By combining PCT with traditional Maltene Replace Technology (MRT), these roadway preservation materials extend asphalt pavement life by 50 percent or more – reducing repaving budget requirements *and* asphalt manufacturing emissions by extending the time intervals between repaving cycles.

Plus**Ti**™ products are an economical yet robust "retrofit" technology for existing transportation infrastructure. They have been tested and proven to:

- **Reduce vehicular emissions by up to 60%**
- **Mitigate the effects of urban heat islands by quadrupling asphalt solar reflectance values**
- **Decompose tire-wear particles and other roadway microplastic debris**
- **Meet or exceed LEED and ENV standards**

We welcome inquiries from agencies interested in substantially advancing their long-term goal of reaching net zero-carbon emissions. For more information, visit www.smogeatingroads.com or contact mdurante@pavetechinc.com.

The problem IS the solution.

The cost of constructing and maintaining America's roadways accounts for a giant carbon footprint approaching $600 billion annually in carbon dioxide equivalents. What if we could transform those millions of miles of roadways into the healthy equivalent of millions of acres of trees?

UHI Mitigating – reducing pavement emissivity as much as 400%

Smog-Eating – capturing up to 60% of vehicular emissions

Shedding Water – creating super-hydrophobic pavement that accelerates water dispersion

Sustainable – doubling the interval between repaving

Stormwater Purifying – decomposing roadway microplastics

Problem solved.

Pavement Technology, Inc. proudly introduces the **P**lus**Ti**™ family of life-extending roadway penetrants—an integrated approach to roadway asset management that significantly extends the surface life of asphalt and concrete pavements while providing road departments, urban planners, environmental engineers and sustainability managers with a way to aggressively reduce the carbon footprint of America's roadways. For every mile of treated pavement, air quality improvement is equivalent to planting 20 acres of trees.

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