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Introduction: Taking the Time to Look Ahead

Transformational change is underway and, as a forward-thinking organization, we are preparing for the future. Our blue-ribbon panel of experts created an exciting and bold vision for concrete pavement and its role in the rapidly changing world around us.
Although we cannot predict the future, we know, based on experience, we can influence outcomes.

Twenty years ago, ACPA brought together a group of public officials, members of academia, and industry officials for a concrete pavement visioning session.

That effort culminated in a “blueprint” for creating a new generation of pavements and was a catalyst for the “Concrete Pavement Road Map,” a successful action plan that made concrete pavements better, answered agency challenges, and taught valuable lessons.

Major research and technology development areas were intentionally advanced, creating today’s generation of successful concrete pavement design, construction, resurfacing, rehabilitation, maintenance, and technology transfer opportunities.

A New Blue-Ribbon Panel

Two decades after this first visioning session, ACPA assembled another blue-ribbon panel of 25 experts for a facilitated discussion. The diverse group of experts envisioned the future of transportation in general and concrete pavements specifically, and their role in 2040.

The group discussed and considered factors including: increasing truck traffic and heavier loads; autonomous vehicles; e-commerce, distribution of goods; dedicated freight network possibilities; climate change; and alternative roadway ownership models.

The group also discussed “disruptive forces,” unpredictable and unforeseeable developments that can have profound and lasting impacts on transportation and society.

Their facilitated discussions took place in the context of the following four key questions:

1. What will transportation look like in 2040?
2. What will agencies’ needs be for pavement solutions?
3. What role may concrete and cement-based pavement solutions play?
4. How can we make it happen?

From this blue-ribbon panel’s efforts, a vision of the future of concrete pavement in the US transportation system emerged.

Photo and paragraph show the VISION2040 blue-ribbon panel of experts. They are (left to right) in groups, as shown:

4. David Howard, Koss Construction Co.; 5. Dan King, Iowa Concrete Paving Association; and 6. Tom Van Dam, NCE.


(Missing from photo: Bill Cuerton, NY State Chapter-ACPA; Gary Fick, The Transact Group; Mark Snyder, Pavement Engineering and Research Consultants, LLC; Leif Wathne, ACPA, and Bill Davenport, ACPA.)
Pavements for highways, streets, and other applications will continue their role in personal mobility and commerce, while also melding with other technologies to serve a greater role in society.
Change is Coming
By 2040 the U.S. population is expected to grow by just under 70 million, increasing to nearly 390 million people.

With this significant population growth will come a sizeable growth in freight, estimated by USDOT to be as much as 43 percent by 2040. Freight movement will become more multimodal and e-commerce will expand, but with 80 percent of U.S. communities only reachable by road, freight trucking will continue to dominate as the primary means to move goods.

By 2040, most of the U.S. population will live in megaregions comprised of urban areas surrounded by growing suburban and exurban areas.

Evolving with the ideals of millennials and newer generations, urban areas will transform as livable communities with open spaces, plazas, and greater and more flexible mobility options, and roadways will increasingly be designed to integrate into this new environment.

Freight will move between megaregions and across the nation on dedicated freight corridors (or a defined freight network) largely via autonomous, connected trucks.

The efficiency of moving vehicles and freight on roadways will increase as driverless vehicle technology allows vehicles to drive closer together while moving safely. Dedicated freight corridors will be designed for maximum longevity and minimal service interruption.

By 2040, total roadway (centerline) mileage is likely to be similar to the mileage today, with only incremental growth expected. The gains in vehicle and freight capacity will come through more efficient use of existing roadway capacity, and efficiencies associated with heavier truck load limits and platooning connected vehicles in designated truck lanes. Road trains will evolve to include both trucks and passenger vehicles.

Pavements will serve more purposes than just being transportation surfaces. By 2040, technology will lead to “complete streets,” which use pavements as a platform to store energy, generate electricity and treat water.

Storage and distribution of electricity will be integrated into roadway designs, and vehicle enhancements will be aided by in-road magnetic induction and wireless charging.

Highways and streets will be safer in the future, thanks to safety-enhanced vehicle and pavement designs. Smart highway/roadway pavement integration with smart vehicles will enhance vehicle-roadway connectivity for safety, lane optimization and less traffic congestion.

By 2040, such technology is likely to be used for critical transportation corridors to communicate desired and relevant information to owners and users.

Studies also indicate technology will evolve to allow the use of heated lanes to improve safety and reduce the reliance on deicing chemicals.
Owner/agency needs of the future

Public agencies’ needs will reflect those of our changing society, where advanced technologies, sustainability, and resilience are essential.
An Enormous Challenge
To meet the challenges of moving more people and goods on a constrained and continually aging roadway network, owners/agencies will need adaptable, resource-efficient pavements with reliable long-term performance.

Pavements will need to accommodate and protect sensing and measurement technologies needed for heavier trucks and connected vehicles of the future. They will also need more sophisticated evaluation tools to help manage and optimize roadway networks for traffic volume, vehicle loadings and sustainable construction/operation considerations.

Pavement Adaptability — Owners/agencies will need improved and adaptable pavement design solutions that will allow pavements to serve multiple functions and accommodate the addition of emerging technologies, particularly in urban areas. By 2040, land in congested urban areas is likely to be too valuable to allow the pavement surface to serve only one function. Owners/agencies will strive to incorporate utilities and emerging technologies for energy generation, energy storage, signaling, and condition measurement directly within the pavement structure.

Capitalize on Current Assets — For the entire system and particularly the vast rural road network, agencies will require solutions that extend pavement service life in a cost-effective, sustainable way, and in a manner that better capitalizes on the equity in the existing roadway structure. Pavement material durability and longevity will be an even more important consideration than it is today, particularly along freight corridors, evacuation routes and pavements that serve high levels of traffic in critical links of the transportation network. Agencies will increasingly demand solutions that require fewer interventions for resurfacing, rehabilitation or replacement and the traffic disruption that accompanies these activities.

Responsible Stewardship of Resources — Although recycling and reuse will continue to be important to sustainable construction, look for greater awareness of “use-phase” sustainability benefits, which will be driven by the need to minimize the energy usage and carbon dioxide impact from roadways. By 2040, agencies will regularly apply life-cycle assessment tools to help document the economic, environmental and societal impact of their roadway assets.

Need for Resilience — Owners/agencies will place a greater emphasis on resilience, designing critical roadways to withstand and function during and immediately following intense climate events, particularly in populated areas along coasts and flood plains. Design standards, specifications and codes will be improved to ensure that major evacuation and first-responder routes can withstand and perform reliably after being inundated (submerged).

Safety Goals — Safety will remain a top priority for agencies and owners, who will embrace and implement technologies that reduce traffic injuries and fatalities, such as connected and autonomous vehicles, as well as pavement technologies that augment their implementation. The focus on safety will also require strategies that reduce the frequency of road rehabilitation and the associated risks of accidents.

Instilling Competition — With the continuing need for efficient use of available funds, agencies will focus on inter-industry competition for pavement construction. Funding and construction contracting approaches will increasingly focus on speed of construction, long-term durability, adaptability, technology inclusion, and best value vs. low-bid practices, especially as public agencies rely more on industry for innovation and implementation of the latest technologies.
Concrete pavements are poised to play a strong role in helping meet future transportation opportunities. To meet this potential, currently emerging concrete technologies must advance, mature, and set the stage for even more innovation.
Meeting agency needs will require capitalizing on the longevity and versatility of concrete pavement and cement-based solutions. Performance engineered mixtures, optimized pavement designs, thin concrete overlays, modular paving, and auto-pilot paving technologies are all envisioned to play an important role.

Pavement Solutions—Cast-in-place and precast concrete pavements will be a natural marriage for incorporating and protecting in-pavement sensors related to any of the various smart pavement technologies. These will include vehicle-to-infrastructure and infrastructure-to-vehicle communication, as well as sensors for pavement condition self-assessment monitoring.

Concrete pavements can meet these needs by taking advantage of their naturally stable platform, and the versatility to embed and protect high-end technology.

With significant growth in freight volumes predicted, trucks are likely to be even heavier in the future. For new freight corridors, heavy-load concrete pavements can accommodate the platooned and channelized trucks with their increased axle loads and higher tire pressures.

Concrete pavement design methods can already account for these changes and some experience already has proven concrete pavement an effective solution for such scenarios.

Precast pavements designed to be used in a modular fashion may provide maximum adaptability and flexibility in urban areas.

Modular pavements allow for multifunctionality and ease of utility access, enhancing the opportunities for context-sensitive and smart pavement designs meeting the challenge for adaptability facing owners/agencies.

Improvements to thin concrete overlay solutions for existing pavements are particularly important for the 2040 vision.

With anticipated resource constraints, concrete overlays will continue to be long-lasting, competitive resurfacing alternatives to the current and default approach of using hot- and warm-mix asphalt overlays.

Rapid-setting concrete mixes will also contribute to placement and repair strategies, allowing faster project delivery.
The blue-ribbon panel anticipates new materials will be developed, including new or modified cements, self-healing cements, structural fibers, and polymer modifiers.

The panel also anticipates nanotechnology will be a key to advancing performance and imparting new characteristics to engineered materials.

A next generation, state-of-the-art mechanistic-empirical pavement design method will take into account new materials, increased recycled materials content, internal curing, composite structure interactions and panel size effects, and will create a paradigm shift in concrete pavement designs.

In addition, improved construction practices and innovative subgrade treatments will be accounted for as well.

Performance Engineered Mixtures (PEM)—Whether in the urban context, for freight corridors or for rural overlays, concrete pavement mixtures will deliver their intended service life consistently to meet the blue-ribbon panel’s vision for 2040.

The PEM program currently underway is being led by the Federal Highway Administration, along with industry, State DOTs and the National Concrete Pavement Technology Center.

These advances will allow thinner concrete resurfacing and will impart features that provide long life for roadways designed for various traffic loadings and environmental conditions.

As a result, 1.5- to 3-inch-thick, durable concrete overlay solutions will be constructed quickly, opened to traffic shortly after construction, and provide a smooth, safe and fuel-efficient riding surface.

These innovative resurfacing methods will allow agencies to better capitalize on existing pavement structures, further enhancing their equity value and reducing current and future costs.

The emphasis on design, construction and specification of efficient pavement structures are central to the blue-ribbon panel’s 2040 vision.

The program is focused on providing resources for agencies, contractors, material suppliers, with the aim of allowing the roadbuilding community to specify, design and build with concrete mixtures that will be reliable and sustainable for their intended use and environment.

Optimized aggregate gradations, increased use of recycled materials and enhancing concrete durability are all goals for the performance engineered mixtures program.

By 2040, a host of tests measuring engineering properties that relate to pavement performance will be common. As a result, contractors will be able to deliver durable, economical concrete pavement mixtures every time.
Concrete pavements designed for maximum durability will minimize the need for shut-downs related to pavement maintenance and rehabilitation. Accelerated concrete mixtures and innovative traffic control procedures will augment these benefits and minimize impact to users during construction.

Innovations for rapid one-pass reconstruction and auto-pilot pavers will ultimately improve consistency of paving, leading to ultra-smooth surfaces.

One-pass paving will allow the removal, processing and placement of concrete and base/subbase layers in a single pass of a paving train.

The panel anticipates auto-pilot paving machines, which will be slipform paving machines equipped with sensors that link paver speed, vibration frequency and concrete rheology sensors. This will allow the machine to adjust to mixture variations and maintain constant extrusion pressure.

These and other innovations present an exciting vision of the role concrete pavements can play to help agencies evolve their road systems to meet the new demands of the future.

An important aspect of increasing durability will be optimization of cement chemistry by the manufacturer for the given environment, along with a shift away from field-blending different cements by the contractor. This will be increasingly important as the energy sector moves toward new sources of power generation.

Construction Efficiencies and Equipment Innovations—Speed of construction will continue to be a major factor in project/material selection. This will require the refinement and further improvement of accelerated concrete mixtures (including specialty cements) that have demonstrated long-term performance.
Advancement happens with intentional efforts. The 2040 vision is in our reach if we demonstrate purpose and focus, if we dare to take risks, and if we invest and collaborate with our partners effectively along the way.
Given all the societal and technological changes anticipated in the years ahead, concrete pavements are poised to play a critical role in this future. Success will require a shared responsibility between transportation agencies and the concrete paving industry.

Although the industry is primarily responsible for innovation, US highway agencies are responsible for implementing the innovations. Agencies can fully marshal both innovation and cost competitiveness for the 2040 vision by actively facilitating healthy and spirited competition between industries involved in the production of paving materials.

ACPA, as the voice of the concrete pavement industry, will work with our partners to develop an action plan that details a comprehensive research, development and technology deployment program to advance concrete pavement solutions that respond to future opportunities and challenges.

The industry’s actions will be crafted and advanced through collaborative efforts with many stakeholders, including agencies and academia. The CP Tech Center and MIT will be central partners in these efforts.

The action plan will build on current R&D efforts, such as performance-engineered mixtures, pavement design optimization, equipment automation and advanced materials.

We believe the concrete pavement industry is uniquely positioned to tackle the formidable challenges of the future.

ACPA is energized and positioned to lead the way through effective engagement and collaboration with all stakeholders.

Together we can all work to drive technology, evolve best practices, and grasp the opportunities that come with change.

This provides us all an opportunity to optimize materials, equipment, and paving processes to meet the challenges and opportunities envisioned for 2040 and beyond.

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