Questions and Answers
from Tech Tuesday Webinar on
Pavement Design for Designers & Non-Designers and Why You Should Care
November 18, 2025

Q1 - When considering carbon emission impacts it would be interesting to establish a base for concrete pavements. Such as no matter what to install any road it will be necessary to generate X tons based on labor and materials to get to the point in which the road will be paved. Then we could consider all the pavement designs and their carbon impacts vs cost vs longevity. (Agency, IA)

ANSWER:

Your question has two distinct components.

1. Establishing a baseline ("X tons of CO_2 no matter what") We agree with the premise that any roadway project will inherently generate a certain amount of CO_2 associated with material production, transportation, and construction. However, we do not believe a single universal "baseline" is feasible. Pavements vary significantly by design, thickness, material sources, and local conditions, and CO_2 intensities of materials can differ from region to region. Because of this variability, a standardized baseline applicable everywhere would not be meaningful.

That said, it *is* practical to establish a project-specific CO_2 baseline—analogous to a preliminary cost estimate. This can be done by quantifying embodied carbon at three stages of project development:

Pre-Bidding / Project Development

- The agency identifies the bid items subject to CO_2 requirements (e.g., concrete pavement, granular base, asphalt shoulders, dowels, etc.) and prepares estimated quantities.
- For each item and sub-item, the agency uses the Industry-Wide Average environmental product declaration (EPD) to estimate its CO_2.
- Summing these values yields the project's preliminary CO_2 target, which serves as the baseline.

Bidding

- Contractors submit their estimate of CO_2 value with their bid, representing their commitment relative to the baseline.
- Individual item-level CO_2 data is not made public to maintain confidentiality.

- During bid evaluation, the agency may request the contractor's internal "CO_2 budget" (itemized estimates) to verify assumptions and quantities.

As-Built

- As construction progresses, actual quantities are tracked and EPDs are used to calculate the as-built CO_2.
- If quantities change, the agency updates the baseline accordingly and evaluates contractor performance against the revised overall target.
- Contractors are not required to match their itemized estimates; only the overall project CO_2 target must be met.

2. **Comparing pavement designs based on carbon, cost, and longevity**
   This second part requires a full Life Cycle Assessment (LCA). As we (Eric and Jim) noted, a meaningful comparison must consider:

   - **Initial construction CO_2**,
   - **Rehabilitation/maintenance CO_2**, and
   - **Use-phase CO_2** (primarily related to pavement smoothness and vehicle fuel consumption).

   A pavement with low initial embodied carbon—for example, a very thin design—might deteriorate quickly, require frequent repairs, and have high use phase impacts because it's rough resulting in high total lifetime CO_2. Conversely, a thicker or more durable pavement may have higher initial emissions but lower overall life-cycle CO_2 due to reduced maintenance needs and better long-term smoothness and stiffness.

   Utilizing LCA and LCCA to evaluate potential pavement section options is the best and most thorough way to make an informed decision that balances both costs and environmental impacts of a project.

Q2 - What are your thoughts on the built-in thermal gradient included as input in Pavement ME? The way it works It seems to me it is more like a calibration coefficient rather than an actual material/system property. (Contractor, PA)

ANSWER:

We've encountered this question many times, and in several respects we agree with your observation. In practice, the built-in thermal gradient in Pavement ME behaves more like a calibration factor than a true material or structural property. However, while we understand the concern, we also believe that any efforts to try and calibrate this factor could be better focused on developing other aspects such as the optimization procedures we discussed.

The reason for our position is that this parameter is difficult to measure directly and nearly impossible to control. On any project, the thermal gradient can vary significantly depending on paving time (morning vs. midday vs. late afternoon), weather conditions, and numerous other site-specific factors. Because it changes continuously, developing a calibration and assigning it a different single value is very complicated.

While some designers have evaluated alternate built-in thermal gradients, few have done this with accurate field data and none (that we are aware of), have performed this with a full calibration of Pavement ME (which would be necessary to ensure accurate results with altering such a sensitive parameter).

Given these constraints—and considering its strong influence on predicted curling/warping behavior—we believe the most reliable approach is to use the software's default calibrated value. That value reflects the best fit to observed field performance across a broad range of projects.

Q3 - How do you tackle potential failures with lowering cement content in the mix to increase pavement durability. The producers tend to "juice" the mixes to make sure they have enough overdesign strength not to have any failures, but at the same time we get mixes with 30% higher strength than design strengths. (Agency, VA)

ANSWER:

This is an excellent question and highlights why the industry is moving toward Performance-Related Specifications (PRS). In practice, concrete pavements seldom fail because the compressive strength is too low. Instead, most failures occur because of durability issues, loss of uniform support, or design/construction deficiencies—such as excessive joint spacing or the absence of dowels where they are needed. Strength is simply the easiest parameter to measure, so it often receives disproportionate attention.

A more effective approach is to follow the framework established in **AASHTO R 101, "Developing Performance Engineered Concrete Pavement Mixtures."** This specification shifts the focus from traditional prescriptive requirements to performance indicators that actually govern long-term pavement behavior. While strength remains one parameter, equal or greater emphasis is placed on:

- Shrinkage
- Durability (e.g., freeze-thaw resistance)
- Permeability/transport properties

– Workability and consolidation characteristics

When a concrete mixture demonstrates low shrinkage, low permeability, good durability, and good workability—and when it is constructed properly (e.g., smoothness, proper curing, uniform support)— strength is rarely a concern or an issue; and producers no longer need to “juice” their mixes, and agencies benefit from pavements that are more durable, longer lasting, and better aligned with actual performance needs.

From a designer’s perspective, it’s important to note that durability factors are not considered within modern pavement design tools. Changing the cement content within Pavement ME will have a small impact on the predicted performance (typically a beneficial one), but may have significant positive impacts in the field (so long as the concrete is constructable). This is where coordination and partnership between materials and design engineers is needed to bridge the gaps in the project development process.

Q4 - Do fibers help the performance of concrete overlays? (Agency, MT)

ANSWER:

As discussed in the presentation, the benefit of fibers in concrete overlays is highly context-dependent. Fibers do not significantly increase concrete strength, and therefore they do not reduce required overlay thickness. A fiber-reinforced overlay will generally crack at roughly the same stress level and at around the same time as a conventional mix.

Where fibers *do* provide meaningful benefit is in **post-crack performance**. A crack in a concrete pavement is not inherently problematic—every joint is essentially a controlled crack. Problems arise when cracks behave poorly. Fibers help maintain crack integrity, which can improve how well the pavement serves the public or extend the service life of the overlay before rehabilitation is required.

That said, the value of fibers is project-specific. Thicker overlays (e.g. 10-inch overlay) require a higher quantity (more) fibers than thinner overlays (e.g. a 4 inch overlay); which will significantly increase material costs.

For this reason, we recommend conducting a **cost–benefit analysis**—similar to the evaluation shown in our presentation for drainage improvements—to determine whether the expected performance extension justifies the additional cost for the specific overlay design.