

It's Your Density

George McFly said, "I'm your density." If you don't know who McFly was, ask a GenX person. George was confused, but the topic does take us back to the future, because asphalt pavement density (wow, this is a strained metaphor), was, is, and will be one of the driving (can't help ourselves) factors in durable asphalt roads. Okay, enough silliness.

As stated brilliantly (but not particularly originally) in *Density Demonstration Projects and Related Specifications*, a TechBrief associated with the Federal Highway Administration (FHWA) Accelerated Implementation and Deployment of Pavement Technologies (AID-PT) program, "although several factors can influence the performance of an asphalt pavement, one of the most important factors is in-place density." Density is simple. Take a certain mass and squeeze it into a smaller volume and you have greater density.

AID-PT came to this conclusion from studying twenty-nine field demonstration projects performed by state Departments of Transportation. It reaffirms what we have known for a long time. Yet, density continues to be a problem on many projects, resulting in pavements that experience shorter lifespans than they should. It's correctable.

Commonly, asphalt specifications will require a minimum of 92 percent density. What does that mean? This is in reference to the maximum theoretical gravity (Gmm) for a given mix. In other words, a mix is designed, a sample is put together in a laboratory, and the maximum density is determined in a controlled setting. We don't expect to achieve that in the field application; we don't need perfection. But we do need to approach that ideal. Nine-two percent is easily achievable with performance asphalts, modern equipment, and qualified contractors. Yes, it gets a bit trickier around longitudinal joints (and we'll talk about that in a future article) and areas around manholes, but even there, a good contractor can achieve great results.

But better is better. AID-PT concluded that a one percent increase in density above the target rate can extend the service life of the asphalt pavement by ten percent. What does that mean to you? Simplistically, if you expect your asphalt overlay to last 15 years, a one percent increase in density may extend that a year and a half. Now, realize that conditions vary and there are limits on that. You are unlikely to consistently achieve, say, 98 percent, so realistically, you can bump up into the 95-96 percent with many projects, but you can do the math on what that might get you in terms of lifespan of the pavement. So, better is better.

So, how do you achieve better density? Well, there are many fundamentals that go into durable pavement, including surface preparation, high quality mixes, proper application of tack, avoiding segregation, weather conditions, and the art and science of rolling the mix.

The Density Equation

$$D = \frac{m}{V}$$



Departments of Transportation and other large agencies have well-developed specifications for asphalt pavement and you can adopt them as your own. For example, Division 400 of the Delaware Department of Transportation (DeDOT) Standard [Specifications](#) for Road and Bridge Construction establishes performance for the contractor.

Regardless of the specification you use, it is imperative that you establish expectations for your contractor. This begins with your contract specifications, because without them, you are left to the goodwill of the contractor and the standards of care of the industry. Your best contractors will appreciate well-developed specifications to establish a fair bidding environment.

But it doesn't end there. A pre-construction meeting is a great opportunity to ask questions of the contractor and reinforce those expectations. Confirm the mix that will be used and the source. Ask how many trucks will be used and how the contractor will ensure an even delivery of material that will keep the operation moving without trucks sitting (and cooling) at the site. What is their plan for how many rollers and what size. What is their rolling pattern and number of passes?

Next is game day. You have to inspect. You just have to. Your inspector doesn't have to be a world-renowned expert in paving; some general knowledge can suffice. By the way, the Delaware T2/LTAP Center offers a training workshop, Best Asphalt Construction Practices, free to local agency personnel; keep an eye out for the next session.

Insist that a real paver be used to lay down the mix (don't let them spread it with skid steers; we're begging you). Your inspector should examine the paver and rollers to see that they are in good working order. Mix tickets should not just be collected but examined – ensure that the right mix has been delivered. The contractor should follow the rolling pattern, realizing that there may be changes if they recognize something in the mix that calls for it (they should be communicating with your inspector about any such changes and those changes should be noted in the daily inspector report).

But what did we learn from AID-PT? If you haven't already paused to read their [report](#), give it a read. They found that just by increasing the number of roller passes, better density can be achieved. Now, there are limits there, as well. As the mat cools, it will reach a point where you are just crushing aggregate, so don't over-do it. On the other hand, this reinforces one of those best practices – the breakdown roller should be right on top of the paver. If the roller isn't running right up to the back of the paver, it's not making the best of that hot mix when the highest impact on density can be achieved. And in cooler weather, an additional roller may be necessary to get the needed passes in before the mat cools.



Finally, quality assurance. Smaller agencies often skimp on this. Who was it that said, “trust but verify?” You should have a good working relationship with your contractors, built on mutual trust. But we all do our best when we know someone is looking. So look. Quality assurance starts with inspection and documentation, but your projects should include some testing. Smaller agencies will need to seek the services of an independent firm, and yes there will be some additional cost, but it is important to assure that you are getting the performance

you are paying for. Testing can include in-place density readings (usually performed with a nuclear test gauge), post-construction pavement cores examined in a laboratory, and samples of the mix taken from behind the paver (again, examined in a laboratory). A paving operation of any significance should at least include in-place density readings. Larger ones should see some pavement cores. Laboratory testing of the mix is the one to grow into.

Without in-place testing, you have no means to incentivize performance and are left with, “it looks nice.” That isn’t helpful if the overlay is prematurely distressed. With testing, you can specify minimum payment limits for the contractor and if you like, stretch them with incentives to exceed your, say, 92 percent minimum density requirement.

Remember, it’s your density to have durable asphalt pavement!

The Delaware T²/LTAP Center’s Municipal Engineering Circuit Rider is intended to provide technical assistance and training to local agencies and so if you have construction management questions or other transportation issues, contact Matt Carter at matheu@udel.edu or (302) 831-7236.