WHAT IS THE CURE TIME FOR ASPHALT?

By Dr. Grover Allen, Ph.D., P.E.

An engineer colleague recently reached out to me and asked, "what is the cure time for asphalt?" My initial response to his question was "are you referring to cold-mix asphalt?"

Cold-mix asphalt is a mixture of asphalt and a solvent and/or water, aggregates, reclaimed asphalt pavement (RAP) and other minerals typically used for patching and for repair of small sections of pavement. The asphalt and solvent portion, excluding the other components of the cold mixture, is often referred to as "cutback asphalt."

Evaporation, or curing, of these components – solvents and/or water – in a cold-mix asphalt leads to the hardening of the asphalt mixture. I assumed this was likely what my colleague was referencing with his question. Another thought occurred to me that he may be referring to an asphalt emulsion, which is an aqueous solution containing tiny droplets of suspended asphalt meant to be applied in ultra-thin layers on or within a pavement structure.

Asphalt emulsions also require the evaporation of water and a relatively short "cure time." However, it is not common or appropriate to refer to these products as "asphalt" without including some type of additional descriptors, such as "cold-mix", "cutback", or "emulsion." When the word "asphalt" is used without a descriptor, it is most commonly referring to an "asphalt mixture", which includes the heated liquid asphalt and aggregates that are compacted to build a typical roadway; otherwise, the term "asphalt" may be referring solely to the hot liquid asphalt portion of the mixture. "Hot-mix asphalt" is a term often used to refer to an asphalt mixture, and "warm-mix asphalt" may also be used to describe an asphalt mixture that is either processed with an additional additive or using foaming techniques that allow the temperature of the mixture to be reduced slightly, although the mixture is still very hot.

Simple answer

Asphalt is liquified by applying external heat, which allows it to be mixed, transported and compacted and the mixture rapidly hardens as heat dissipates and achieves full strength upon cooling to ambient temperature. Therefore, I want to make this as clear as possible – asphalt, which is the material used to build 94 percent of our roadway infrastructure in the U.S., does NOT have a cure time.

Asphalt begins to cool immediately after mixing and cooling continues during transport, construction and post-construction. It will typically gain full strength and can support traffic within minutes after construction but can take hours in rare cases, depending on lift-thickness, ambient conditions and other variables.

Complex answer

For the more technical readers, there are two key temperature ranges that should be considered to ensure that asphalt construction operations cease and traffic operations commence at the proper times:

1. Cessation temperature (internal asphalt temperature in which all construction operations must cease to prevent damage caused by construction equipment)

2. Maximum ambient temperature (internal asphalt temperature below which a newly constructed asphalt pavement has cooled sufficiently to be trafficked without causing premature damage)

The internal portion of an asphalt pavement during construction and immediately post-construction may be slower to cool than the surface. This effect can be much more pronounced for pavement lifts thicker than two inches, so internal temperature may be temporarily higher than surface temperature until equilibrium is reached. For pavement lifts two inches and thinner, the surface temperature is a more reasonable approximation of internal temperature during the cooling phase.

Asphalt Institute's MS-22 "Construction of Quality Asphalt Pavements" says the following about cessation temperature:

"Compaction should be completed before the internal mix temperature falls below what is referred to cessation temperature, typically around 175-180°F (80-82°C). The cessation temperature will vary from project to project. Therefore, it is important to establish a target cessation temperature at the beginning of each project."

Once an asphalt pavement has cooled to ambient temperature, surface temperature will closely trend with ambient air temperature, but due to the effects of surface heat radiation, pavement temperature is typically greater than the ambient air temperature. For example, if it is 90°F outside, the pavement surface may be up to

120°F or greater, depending on UV intensity and other factors. The precise post-construction maximum pavement temperature permitted for traffic opening will differ based on the climate and materials selected for construction.

Choosing a binder

Performance-graded asphalt binders are selected based on a design maximum pavement temperature 20 mm below the pavement surface. This design value is dependent on a maximum air temperature and the geographical latitude for a given region. For example, there is more than 99 percent reliability that a pavement temperature will not exceed 136.4°F (58°C) in Cleveland, Ohio. Therefore, a pavement constructed with a PG 58-28 grade binder in Cleveland, Ohio would be ready to open to traffic once the internal pavement temperature post-construction has cooled below the maximum design temperature of 136.4°F (58°C). In a hotter climate, such as my home state of Florida, a stiffer grade of asphalt, such as PG 76-22, is commonly specified.

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An asphalt grade that can support traffic at a temperature up to 76°C (168.8°F) means that a newly built roadway should be able to open to traffic very shortly after final roller pass occurs between 175-180°F. This matches closely with the language shown in the Florida Department of Transportation's (FDOT's) Specification Section 330-10: "To prevent rutting or other distortion, protect sections of newly finished dense-graded friction course and the last structural layer before friction course from traffic until the surface temperature has cooled below 160°F."

The specification then goes on to say the contractor may use artificial methods to cool the pavement and may be directed to do so when it is desirable to open the pavement at the earliest possible time. Therefore, the required time to open a newly constructed two-inch asphalt surface to traffic would generally be just a few minutes. Thicker lifts will take longer to cool internally, and in rarer cases of asphalt construction, it could take hours. DOT and airfield project engineers or other representatives present at the construction site may give the order when an asphalt pavement is ready to be opened to traffic.

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The lack of a cure time for asphalt, or its speed of construction, is one of the unique advantages of using asphalt as the primary roadway and airfield building material and an attribute which makes it uniquely different than portland cement concrete (PCC). The load-bearing capacity of PCC is normally measured and estimated according to its compressive strength over a slow curing time.

A typical strength-gain curve for PCC is:

- 1-day: 16%
- 3-day: 40%
- 7-day: 65%
- 14-day: 90%
- 28-day: 99%

Honest question

Back to my engineering colleague who asked, "what is the cure time for asphalt?" to which I responded, "are you referring to cold-mix asphalt?" He responded: "no; I'm referring to hot-mix asphalt."

Now, let me provide a little more background on my engineer colleague. He's no rookie. He's a very accomplished engineering professional. His engineering career has mostly encompassed working with structures, including concrete mix design, concrete construction, blast testing, blast mitigation, etc., and he's been practicing engineering for over 30 years. He will soon retire.

When he clarified his question, one thing occurred to me. If a structural engineer with decades of experience does not understand that asphalt does NOT "cure", there must be an abundance of other individuals involved in public service, infrastructure project planning, construction, design, life cycle analysis, infrastructure safety planning, user-delay analysis, etc. who also do not understand this.

At this point in the article, you already have more background about asphalt strength-gain than my engineer colleague with over three decades of engineering experience. That is the primary reason I felt compelled to write this one.

Misinformation

I wanted to better understand where he and others might be getting their information about asphalt, so I went to the Google search bar and typed in "What is the cure time for asphalt?" The results, which you can verify for yourself,

were very disappointing. Nearly every search result, including the following examples, falsely indicates there is a cure time associated with asphalt construction:

- "6-12 months"
- "It can take up to a full year for asphalt to cure, but within 30 days asphalt is cured to a point it can be driven on"
- "48-72 hours to dry completely"
- "Asphalt takes six to twelve months to fully cure and remains a little more susceptible to damage for that time"
- "The drying process happens in phases. Your asphalt may look and feel dry, but a complete curing typically takes much longer than three days."

Almost none of the information returned in the Google search accurately answers the precise question my colleague asked, which I admit, was quite surprising to me. At best, the information is extremely misleading, and at worst, it results in the implementation of poor infrastructure policy based on a misunderstanding of how asphalt gains strength after placement.

Now I understand why my colleague was confused about how asphalt hardens and why just about anyone else outside of the asphalt industry might be also. I learned a couple of lessons in this case –don't assume what others might know and understand, and always verify the information found on the internet.

If you have any asphalt-related questions, please do like my engineer colleague, and come to a trusted source of information, such as the Asphalt Institute. We can't eliminate misleading information on the internet, but we can provide accurate answers to questions like this, and even much tougher questions presented by practitioners, engineers, the general public, those interested in transportation and particularly those involved in making important transportation investment decisions impacting billions of dollars in infrastructure funding.

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