# The Mystery of Pavement Expansion

## Joints in Concrete Pavements: Part I of III

By Randell C. Riley, P.E.

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An old friend of mine in the concrete paving industry out of Louisiana used to say, "I've seen all kinds of joints in my time. I've seen expansion joints, keyed joints, doweled joints and sawed joints, but the only good type of joint I ever saw was a beer joint." That pretty much sums up the experience of many when it comes to joints in concrete pavements, and for this reason they usually want to put as few joints as possible in the pavement. But is that the right thing to do?

Understanding proper jointing technique requires a basic understanding of the nature of the material that we work with every day, i.e. concrete. A simple fact is that as long as you are using durable aggregates and the basic types of portland cement, a concrete pavement is as long as it will ever be on the day it is built. Generally, when I make this comment in my presentations on concrete fundamentals it raises the eyebrows and occasionally the hackles of more than a few skeptics that have heard recent news reports of pavement blowups, particularly in spring or summers first hot days. So, is it a true statement?

Shrinkage in concrete pavement occurs for a couple of reasons. As the cement hydrates, water combines chemically with the portland cement to form some of the binding agents that hold the concrete together. The excess or free water also leaves the concrete matrix through simple evaporation. Both of these actions result in less space being occupied by the hydrated cement gel and ultimately the concrete. To most people the combination of these two actions is broadly termed "drying shrinkage" though in reality there is more going on than simple drying.

For concrete pavement typical of that used in paving applications, the aggregates are also a factor in the shrinkage of the concrete, principally due to their behavior characteristics associated with thermal expansion and contraction. The temperature range in which you and I can actually work "comfortably" placing concrete is about 35 degrees F to 105 degrees F. Concrete placement in this temperature range ensures that any expansion that occurs in the concrete due to aggregate expansion resulting from increases in temperature will not exceed that of the initial drying shrinkage. Again, the short form of that long-winded explanation is that "concrete is never any longer than the day it is built."

So, what about those blowups that the skeptics will point to? Blowups are caused by compressive forces building up in the slabs for two typical reasons. In the bitter cold of Illinois' winter, when the maintenance crews are spreading sand and salt in the middle of a snow fight, incompressibles infiltrate and pack the joints present in the concrete pavement. This happens because, when the pavement is cold, the joints are open to the maximum amount due to thermal shrinkage of the pavement. In the spring and summer months, as the concrete expands, the now filled and packed joints do not leave any room for the expansion to occur. Though the expansion is less than the initial shrinkage, it is still real. The slabs are forced into compression. If the joints are packed tightly enough, a blowup occurs; what has grown is not the concrete, but rather the gap between adjacent concrete slabs.

What is the most effective way to control the width of the gap? The answer is pretty simple – shorter joint spacing. Though shortening the joint spacing creates more joints, the gap between adjacent slabs is actually less. Keeping a smaller gap between the adjacent slabs ensures that only smaller materials can infiltrate the joint. When the gap gets small enough, materials on the scale of clay and dirt are all that can get into the joints. Under the compression generated from thermal expansion of the pavement, these finer particles can move much easier than coarser particles, hence the compression still

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builds but at a significantly lower rate and at a more uniform distribution across the joint face of adjacent slabs. The end result is minimizing or elimination of blowups.

Another benefit of the smaller gap resulting from the use of shorter slabs is better aggregate interlock between adjacent slabs. Smaller gaps keep the pavement much more tightly locked together. Longer panels widen the gap, and if the gap is too wide, greased smooth steel dowel bars are required in each contraction joint to allow the thermal movements to occur while still transferring load between adjacent slabs. That costs money! Shorter joints under circumstances typical of parking lot construction allow us to eliminate dowels and create a more economical pavement that is more competitive with the competing material.

The second part of the blowup phenomena is the state's past history of the use of aggregates that were not resistant to freeze-thaw damage. As the concrete containing these aggregates experiences repeated cycles of saturated winter freezing and thawing, micro-cracks form in the aggregate and migrate out into the matrix. Micro-cracks take up space resulting in concrete expansion, hence furthering buildup in compressive forces. This can also contribute to pavement blowups.

Fortunately, in Illinois, a program was begun in 1982 to eliminate the use of these "d"-cracking (durability cracking) aggregates. Though they are still out there in service in some of the pavements, most of these are gradually fading away as they reach the end of their service life. Durable aggregates are also essential in eliminating the blowup phenomenon and that problem has been solved.

So, next time you have a discussion with a potential client regarding the construction of concrete parking lots and the issue of highway blowups as a deterrent is raised, tell him "I have a solution – more joints." I guarantee that your solution will be a surprise, but now you will also have the answer as to why this is so.

**Next time - "Then Why Expansion Joints?"**

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