METZGER/McGUIRE
P.O. Box 2217 Concord, NH 03302 (800) 223-6680
Known by the Floors We Protect

Better Industrial Floors Through Better Joints

By Steve Metzger

Twenty years ago I wrote "The Concepts of Industrial Floor Joint Sealants" for ***Concrete Construction***. Now, I regret having used the word "sealant." The goal of restoring a jointed surface should be filling the gap, not sealing it.

A floor joint is an interruption in an otherwise smooth surface. In an industrial floor, the joint needs to be protected from hard wheels. By filling rather than sealing it, you protect the edges of the joint from damage.

Over the past 20 years, material handling vehicles running on smaller, harder wheels have handled heavier loads at higher speeds. Has the concrete industry kept pace by developing more durable joints to protect floors? Do architects, contractors, and owners know current industry standards? Is the importance of a durable joint system understood? I would like to answer a firm yes to all these questions but I cannot.

American Concrete Institute (ACI) and Portland Cement Association (PCA) publications tell how to design and build joint systems with better−than−adequate edge protection. Too few specifiers or contractors follow this advice. Many of the ineffective joint designs and joint fillers from 10 years ago are still being used today. And otherwise good industrial floors are still deteriorating rapidly at the joints.

Joint Enemies

Hard wheels are the joints' worst enemy. Take a 4−inch−diameter hard wheel, add a heavy vehicle with several thousand pounds of load, and you have the perfect concrete destroyer. Floors must be able to withstand abuse from impact, concentrated loads, and abrasion at the most vulnerable part−the joint.

Delayed shrinkage is the other major enemy. Studies show that major slab−on−grade shrinkage can occur long after concrete is placed. Norman Henning, former president of Twin Cities Testing in St. Paul, Minnesota, found that at the beginning of the heating season only 20% of slab−on−grade shrinkage had taken place after 30 days. Only about 60% occurred within the first year. These findings show that some joints will open more after filling, even if the filling is deferred for several months. To perform well, a joint system must accommodate these late movements.

Requirements for an industrial floor joint system that works

A good industrial floor joint system resists hard−wheel loadings and tolerates delayed joint opening. To do this the system must be:

- Invisible
- Forgiving
- Durable
- Practical

You can see invisible joints but vehicles never feel them. Filled joints should be nearly flush and narrow to provide minimal exposure to hard wheels. There's no impact as hard wheels cross the joint and no deflection of the joint filler.

Forgiving joint systems allow the concrete to contract and expand. Because of delayed shrinkage, joints will try to open wider. If joint details restrict movement, the slab may crack instead. Joints also must be able to accommodate some compression as slabs expand. For instance, if a slab is poured in the fall and joints are filled in winter, they'll get tighter in the summer as the slab expands.

In durable joint systems. the concrete edge is supported by a filler that provides long−term support. If there's no support, concrete at the joint is almost certain to chip or spall. Using a 1−year filler in a 10−year floor is foolish and wastes the

owner's money.
To be practical, a joint system has to be compatible with concrete, the construction process, and the service environment. A joint filler isn't practical if using it requires joint surfaces to be exceptionally clean. Joint forming systems aren't practical if they require a lot of finesse in handling or if the joints can't be easily filled. And a joint isn't practical if it can't take the beating of hard−wheel traffic.

Joint Problems in Industrial Floors

Despite heavy educational efforts by ACI, PCA, and others, some floors are still built with joint systems not suited for industrial use. These systems violate one or more of the requirements mentioned above.

Left−in−place metal keys. Used for years to form construction joints, metal keys have no place in floors exposed to hard−wheel traffic. In theory a metal key makes sense; it should provide load transfer from pour to pour. But when shrinkage occurs, the lip of the female side is placed in a cantilevered position. Material handling vehicles soon break off this lip.

Metal key construction joints aren't forgiving or durable in industrial applications; they don't accommodate shrinkage or stand up to hard−wheel traffic. They also are not practical because they don't provide for use of a filler.
Plastic crack−inducing strips. In theory, these joints also make sense. If they are inserted plumb, they can induce the desired shrinkage crack and they offer minimum wheel exposure. But they often end up out of plumb because of the finishing process. When this happens, a cantilevered nose is created which is soon broken off by hard−wheel traffic.

To avoid disturbing the strip, finishers may go easy when working next to the joint. The strip also leaves an edge vulnerable to hard−wheel traffic after the joint opens.
Joints made with plastic strips aren't forgiving or durable on industrial floors. They don't accommodate shrinkage and the joint edge may not be densified. Because the strip is so thin, it requires finesse to keep it plumb, aligned, and butted end to end. Many times this isn't practical. Also, this joint system doesn't provide for subsequent filling.

Elastometric joint fillers. Elastometric materials (such as polyurethane) at best only seal the joints by theoretically expanding and contracting with joint movement. In an industrial floor the joint must be protected from hard wheels, not just sealed. Elastometric materials in any traffic−bearing industrial floor are worthless. They permit joint edge deterioration.

Elastometric fillers deflect under load, so vehicles hit the joint. The
elastometrics don't make durable joints because they provide no edge support or protection. And they aren't practical because they require a very clean bond surface inside the joint.

"Macho" epoxies. High strength and super−strong adhesion are usually desired properties. In a floor joint, though, they result in rapid and severe deterioration. The purpose of a control joint is to induce a shrinkage crack, then accommodate the shrinkage movement.

High strength epoxies restrain the movement, often causing a crack next to the joint. Also, high−strength epoxy materials are frequently brittle, not a good characteristic for a filler subjected to frequent hard−wheel impact.

Hard epoxy joint systems aren't forgiving because they restrict movement. And they aren't practical because they may be too brittle to resist impact loads from hard wheels.

The Industry Standard Joint System

Saw cut joints filled with semi−rigid epoxy best meet requirements for joint performance. The saw cut is narrow. The epoxy has a relatively low strength and a Shore D and A hardness of about 50 and 80, respectively. This system performs better than any other any other joint system on the market. But the best isn't perfect. Problems can still occur.

Saw cuts can be made too early or too late. Cutting too early causes raveling at the joint edges, an invitation to later trouble. Floors cut too late may crack at an unplanned location. Or a crack may form in front of the saw cut, creating an irregular joint opening that can't be filled properly. If the saw cut isn't deep enough to induce the crack, the crack forms somewhere else and shifts maintenance worries to that location. If the cut is too wide, more filler is exposed hard wheels and vehicles bounce more as they cross the joint.

If the saw cut isn't filled to full depth, the joint won't resist load as well. A semi−rigid epoxy poured over a soft backer rod is worthless.

Separation nearly always occurs at some of the joints because joints are almost always filled before the slab starts shrinking. But when semi−rigid epoxy separates as shrinkage occurs, it hasn't failed. It's doing precisely what its designed to do−relieve stress on the slab.

Industrial Joints

To ensure top joint performance, designers need to address these problems in the specifications.

Improving Joint System Quality

Specifications should tell the contractor the width of cut and depth of cut needed. Make sure that the contractor times joint sawing correctly, taking jobsite temperature into account. A good contractor knows when to saw to avoid uncontrolled cracking.

All parties, including the owner, should understand that epoxy separation doesn't constitute a joint failure. Have the specifications call for a two−stage installation. The first installation would be the normal filling procedure, deferred as long as possible to allow for concrete shrinkage. A second stage touch up would take place just before project turnover or at a defined period after the first filling.

Another option is having the normal filling done just before occupancy, then having the owner responsible for maintenance. The owner, designer, and contractor can decide responsibility, as long as the refill issue is addressed. Otherwise, the unsuspecting applicator will get the headache as is often the case now. When a floor is already in service it's foolish to let edges spall while arguments over responsibility delay needed touch−up work.

The semi−rigid epoxy(s) should be specified by properties and name. Requiring joints to be filled with a nameless semi−rigid epoxy is too vague. Be specific, ask for credentials and references that verify, not imply, longevity. Remember that an "or equal" clause in a specification almost always ends up meaning "or cheaper." Consider the economic life of the floor, not today's cost of epoxy.

The specifications and drawings also should call for the filler to be installed full depth.

A first−class floor soon becomes a second−class slab if the joints aren't properly designed, specified, and installed. Just as with the floor itself, you have only one chance to do the right job.