Polyurea stands out as a joint filler.

Significant strides have been made in evaluating and exploiting control joint designs. New concrete mix designs and improved placement techniques for slab- on-grade floors have led to new thinking in the design and treatment of control joints. The increased accuracy in calculating concrete shrinkage allows greater precision in designing control joints for protection against random cracking.

Recent thought suggests that placing joints at closer intervals provides better assurance. Naturally, increasing the number of joints also increases the scope of protecting the joint edges and fascia and of sealing the joints against unwanted intrusions.

Failure to properly fill control joints may result in moisture migration and debris filling the joint, impacting adjacent slab sections. This is not an insignificant problem, and when it happens, consequent sub-base and slab distress may occur, rocking slabs and even displacing slabs. These problems are unpredictable, depending largely on exposure and usage, and may occur long after a project is complete.

More attention was given to the effects of traffic over the joints, with fascia spalling being the major structural problem. Epoxy materials were developed to fill the control joints and protect joint configurations. Shor D 65-80, or semi-rigid, epoxy was used. See Figure 1.

These materials can’t accept joint movement, especially in the loaded or shear planes. Semi-rigid epoxy hasn’t been used successfully at less than full depth due to the punch down of material that might occur if a point load is experienced by the material at any location.

Fascia disbondment has been an acceptable trade-off to protect from the development of spalled fascia areas in warehousing and other intensive traffic facilities. Due to the propensity of epoxy to disbond, control joints are filled full depth by manufacturers’ recommended practices and in-field punch down performance history.

Softer materials such as polyurethane and silicone are unsuitable for fascia protection and debris accumulation. They will seal the joints against water intrusion, as long as they are not disbonded by punch down or debris accumulation.

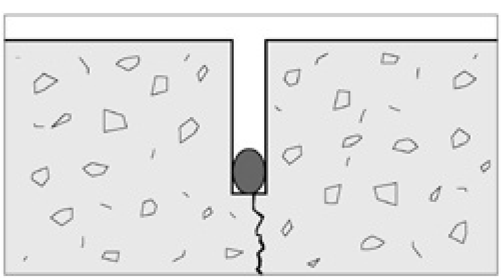

Figure 1: Typical control joint detail filled with semi-rigid epoxy.

So what is the current state of control joint filling? Until 1995, it has been semi-rigid epoxy, filled full depth in control joints, usually disbonded from the joint fascia.

Current rationale

Control joints are tooled or, more often, saw cut features that give a newly placed slab planes of weakness at designated locations. These weakened planes induce the slab to crack during cure time shrinkage and later at slab loading time.

State of the art practice requires that control joint depth be at least ¼ of the overall slab thickness at the location of joint placement. Typically that translates to 1 1/5-inch-deep control joints in 6-inch-thick slabs, 2-inch-thick in 8-inch slabs, and so forth.

The width of the control joint has been controlled by the ability of tools and saw blades to maintain plumb. That means about 3/16 inches wide for tooled joints up to 2 inches deep, and 1/8 inches wide for saw blades to the same depth.

Since epoxy will crack or disbond during its life cycle (and usually sooner than later), it has been the accepted practice to expend a little more material, sometimes neglecting proper joint preparation.

This lack of attention to preparation left undetected the presence of partial bonded fascia areas and other control joint imperfections. These areas frequently break down quickly during slab use. Accelerated slab distress and subsequent rehabilitation follow, as poor performance impacts the owner's business.

Three characteristics of a joint filler material determine successful joint filling.

Compression: This describes the ability of the filling product to properly absorb loading. Ideally, a joint-filling product should allow for the heaviest loads to be carried across the joint without allowing filler deflections which damage the joint edge.

Adhesion: This plays an important part in maintaining the bond to the joint fascia during and after slab shrinkage. The ability to remain adhered to the joint fascia maintains the sealing aspect of the product and addresses moisture intrusion.

Compression, adhesion, and elongation determine successful control joint filling.

Elongation: With adhesion, this allows the joint filler product to move with the deflections of the slab due to loading. This also allows the filler to follow shrinkage and thermal movement of the slab. Ideally, a product would display sufficient elongation to maintain adhesion, even after the completion of slab shrinkage without pulling the concrete fascia loose.

An ideal control joint filler should:

- Be compressible, yet protect the joint fascia from spalling.
- Adhere to the joint fascia areas without being affected by punch-down forces.
- Withstand curing shrinkage stresses and subsequent joint cycling caused by temperature and loading.

Where does this idealized system leave the historical products?

Polyurethane has low compression values. The soft material does not offer much protection against breaking joint edges under heavy traffic.

Flexible or semi-rigid epoxy systems seemed to address the compression problems. When installed well after slab shrinkage is complete, epoxy may offer reasonable sealant qualities as long as it remains bonded to the joint fascias.

In polyurethane and epoxy systems, the three idealized characteristics tend to work against each other.

As general construction techniques turn more to slab-on-grade construction, engineers have started to encounter more slab problems directly attributable to control joint design and treatment.

Meanwhile, the constant market drive for quicker completion is forcing concrete designs to allow the earliest possible use of new installations. The same market forces also push for early completion of joint filling operations, reducing flexible epoxy systems' ability to maintain adhesion for adequate joint sealing in the face of slab shrinkage.

Filling control joints in green concrete has not been practical. The continued shrinkage of the concrete presents too much stress to epoxy materials.

Filling control joints in low temperature environments has not been available without special attention to epoxy cure characteristics. This has required either raising temperatures or tenting and hoarding heat over epoxy installations to meet cure requirements.

These special circumstances have proven problematical until a new technology could overcome the special conditions mentioned above as well as perform the basic three functions required.

Polyurea as joint filler

Polyurea has been gaining acceptance as the bridge between joint filling and joint sealing. All aspects of control joint protection requirements may be met with the use of a semi-stiff Shor A 75 material that will accept up to 15% joint movement, some vertical displacement, and will not disbond under any but the most severe punch down pressures. Polyurea joint filler may be installed in green concrete and installed in refrigerated spaces without raising the temperature of the space to promote curing.

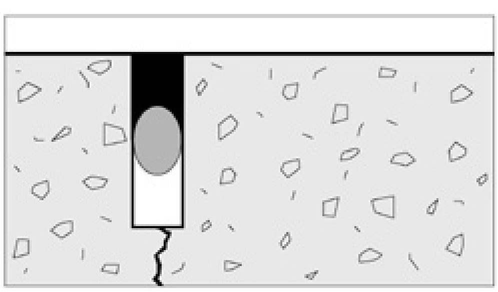

Figure 2: Recommended polyurea control joint filler configuration with backer rod set to maximum ¾- to 1-inch depth.

To develop the best performance from the new product, manufacturers of polyurea joint fillers recommend less than full depth application of material, as in Figure 2.

Adding a backer rod eliminates three-point adhesion and reduces the amount of polyurea required for each joint. This reduction in material saves costs that more than offsets any price difference in the cost of polyurea, compared to the cost of typical semi-rigid epoxy filler. In most instances, the material savings will result in a lower cost-per-foot installed.

In 1994, development of a new polyurea produced elastomeric systems demonstrating unique characteristics. These include:

Rapid cure: 15-minute initial gel and one hour for return to service.

Elongation: 250% to 350%.

Adhesion to concrete: 450 psi.

Compressive strength: supports heavy steel-wheeled traffic–shore “A” 72 to 75.

Insensitive to moisture.

Auto-reactive: cures in temperatures down to minus 40º F.

Resistant to wide range of chemical exposure.

Generally inert with long working life of at least five years.

As field installations of these systems continued, it was discovered that typical control joint applications could be made at less than full depth, resulting in using about ½ the volume of product to achieve the required performance. The unique combination of compressive, adhesive, and elongation characteristics made these products ideal for addressing the specific issues surrounding control joint dynamics.

Even when installed well before complete concrete cure (less than 28 days), the elongation capabilities, together with the adhesive strengths, allowed the polyurea products to fulfill the sealant aspects of the installation while maintaining the compressive values necessary to transfer the loads and protect the joint edges and fascia.

Additionally, polyurea has the ability to cure in the presence of moisture evident in green slabs and still maintain bond. This has promoted earlier placement of the filler, accelerating project schedules.

Polyurea joint filler has been successfully used to seal control joints in green slabs used for tilt-up construction. These control joints experience less than 15% failure upon removal of the stacked panels, greatly accelerating control joint work once the base slab is cleaned and made ready for occupancy.

Installing polyurea filler in active refrigerated space is possible without temperature modification because low-temperature (minus 25º F) curing primers have been developed that meet the low temperature cure characteristics of polyurea. Where priming is not required, polyurea joint filler may be installed at temperatures as low as minus 40º F.

In addition to the miles of control joints now installed with polyurea products, several unusual repairs have been performed on curled and rocking slabs, where full depth installations have actually been used to “cement” the slab elements together, eliminating the unwanted movement and stabilizing the entire floor. Polyurea has been used as doweling adhesive with great success.

Polyurea has added new dimensions to successful early installation and has expanded the use of joint filler material to other time- and cost-saving functions not previously considered.

The advent of this new polymer technology offers the engineer new joint configurations that lower costs and accelerates schedules. The contractor benefits from the same technology, while the owner is the ultimate beneficiary of the technology, saving money at the initial installation and during the slab's life cycle.