Technical Information Bulletin (TIB):

Treatment of Cracks and Joints in Concrete

GENERAL OVERVIEW

Concrete will crack in all but the smallest slabs. Good concrete design and installation can control and minimize cracking. However, it's likely that the owner or contractor will have to treat cracks and joints during the concrete's service life.

Proper crack and joint design and treatment is critical to longevity, performance, and aesthetics of concrete structures, particularly those to receive resinous coating systems. A concrete joint's purpose is to allow anticipated movement or control anticipated movement, while a crack in concrete indicates movement has occurred and possibly still occurring. It is the job of the designer and contractor to take this movement, or potential movement, into account to achieve the performance and aesthetics required by the owner.

It's relatively simple to treat cracks and joints in concrete that will not be coated or covered, while concrete that will be coated or covered becomes more of a challenge. We will primarily consider concrete that is to be coated in this bulletin, although the concepts presented here are also pertinent to repairing cracks and joints of uncoated concrete.

As you read this guide, you may note many seemingly contradictory considerations. Crack and joint design have numerous competing requirements: wide joints vs. narrow, semi-rigid filler vs. flexible sealant, joints through coatings vs. seamless, etc. It is critical for the designer to take many competing considerations into account to produce the best design balance, yet accept the reality that it may be impossible to fully meet all requirements. For example, it may be desired to protect a joint's edge from deterioration due to heavy traffic through use of semi-rigid joint filler. Yet allowing movement of the joint is also desired. But a 'load bearing' joint material is necessarily stiff. So the designer is faced with competing requirements and material properties, in this case providing flexibility vs. stiffness, accepting some degree of 'failure' or lower expectations as a result. Therefore everyone involved should realize that moving cracks and joints will most likely be maintenance items, even with the best design. Not only can good communication of the realities of design and repair constraints to all parties involved lessen future 'problems,' it can also promote proper evaluation and maintenance for improved service life and performance.

Wolverine Coatings Corporation (WCC) has numerous Technical Detail Drawings (TDD) of the typical joint and crack scenarios encountered. Have them ready for reference. Design of the TDD's utilize the concepts and considerations presented in this bulletin, so studying both resources in conjunction will promote a better understanding of the ideas. Also the word 'joints' will occasionally be used in place of 'cracks and joints' for easier reading. The two will be specifically differentiated when necessary.

ADDITIONAL RESOURCES

Wolverine Coatings Corporation (WCC) has developed this bulletin along with other technical information to help all interested parties, from specifiers to applicators to owners, have a better understanding of the considerations, materials, and techniques required for proper installation. Consult all relevant information before using WCC materials.

WCC Technical Information Bulletins
TIB: N/A

WCC Technical Detail Drawings
TDD: Control Joint Treatment (Seamless)
TDD: Expansion Joint Treatment (Seamless)
TDD: Moving Control Joint
TDD: Moving Expansion Joint

WCC Technical Data Sheets
TDS: N/A

WCC Safety Data Sheets
SDS: N/A

SAFETY

Prior to commencing work, carefully read and follow all SDS (formerly MSDS), Technical Data Sheets, and any Instruction Manuals for products and equipment used during installation. Following the safety regulations of jobsite, local, state, and federal authorities is the responsibility of the installation company, general contractor, and/or facility owner.

DISCLAIMER

This Document does not purport to address all applicability and safety concerns, if any, associated with its use. It is the responsibility of the user to determine applicability of the information and to establish appropriate safety practices.

DEFINITIONS

- Expansion Joint – A joint in concrete which allows known or anticipated movement. They are assumed to move during the concrete's service life.
- Isolation Joint – A moving joint to separate building components such as wall/floor interface, column foundation/floor interface, or machine foundation/floor interface. These joints may have vertical as well as horizontal movement due to settlement, further compounding sealing concerns.
- Construction Joint – A joint or seam between successive sections or placements of concrete. Some concrete projects, particularly large ones, cannot be placed at one time. Construction joints are the interfaces between these placements. Construction joints can be wisely placed to act as control joints or expansion joints, but normally construction joints are not considered moving joints. Yet it's wise to expect some movement.

DEFINITIONS (CONTINUED)

- Control (Contraction) Joint – A planned joint in concrete to guide where concrete will crack during its cure and service life. Concrete contracts while it cures, so it is very susceptible to cracking while in its curing phase. Additionally there are certain geometries which will make cracking more likely. Therefore to reduce random cracking, well designed concrete will have cut or tooled joints to encourage controlled, predetermined cracking along the installed joint. Since the majority of curing, and therefore contraction, takes place in the first year, older concrete will be less susceptible to contraction cracking, as well as being less susceptible to movement due to this contraction. Expect substantial joint movement in the first year, particularly in the first three months of cure. Control joints are not intended to move substantially after the first year, but most joints have some movement because of slab curling, reduced aggregate interlock, vibration, and temperature fluctuation.
- Crack – A crack is a point in concrete where internal and/or external stress overcomes the strength of the concrete. Cracks may be structural where the concrete cracks through making them subject to movement. Other cracks may occur only on the surface and can not move. Surprisingly, a crack may not indicate future movement as stress is now relieved and the concrete possibly stable. A savvy designer or contractor can study cracks that have occurred in concrete and make reasonable assumptions about structural stability, potential movement, and applicable treatment methods.
- Elongation - A property of a material indicating how far it can stretch without breaking. Elongation is not an indicator of stiffness.
- Modulus (Modulus of Elasticity or Young's Modulus) – A property of a material indicating flexibility. A high modulus material is stiffer. A low modulus material is more flexible. Modulus does not indicate elongation.
- Elongation vs. Modulus (Stiffness) - It is common to confuse, and sometimes equate, elongation and modulus. But they are very different material properties, having little if anything to do with each other. A very high modulus material like steel may have very high elongation even though it is very stiff. While cast iron with its much lower stiffness has only a fraction of the elongation of steel. It is important to understand that it will take much more force to deflect the stiffer steel a given amount than the less stiff cast iron. But the cast iron may quickly fail because of its low elongation. Think of modulus as an indicator of the force required to deflect a material a given amount, while elongation is an indicator of how much deflection it can withstand.
- Sealant – A flexible (lower modulus) material, normally with higher elongation, which adheres two adjoining materials and prevents the passage of gases, dust, liquids, etc. into or out of the assembly at that point.
- Semi-Rigid Joint Filler – A stiffer (higher modulus) material used to fill control joints and cracks to protect concrete edges from deterioration by carrying a higher portion of the load from traffic than flexible sealants. Semi-rigid joint filler can withstand only limited movement. Its stiffer design requirements may over-stress the bond between the joint wall and the filler. Additionally, the filler may split within itself. Disbonding and/or splitting do not necessarily indicate material or installation failure; it may only indicate excessive movement requiring further treatment.
- Concrete Slab Curling – A condition that occurs because of differential 'drying' of concrete. Since the exposed surface of curing concrete will 'dry' faster than the bottom of the slab if left unprotected, the surface will shrink more than the bottom. This imbalance stresses the concrete and makes it curl. Curling will occur at the joints and edges of concrete. Since curling raises the edges, additional stresses may be placed on exposed joint edges. All concrete curls to a degree, but excessive curling can actually raise the edge off the sub-base and cause the slab to 'rock' and/or break under load, making crack and joint design more difficult because of excessive, multi-plane movement.
- Joint Shouldering – Crack and joint edge deterioration due to traffic, impact, and other loads. A joint or crack is a discontinuity in concrete which can act as a stress concentrator. The larger the discontinuity, the greater the stress concentration. Once deterioration begins, it often accelerates requiring much more extensive repair.
- Joint Punch Through – Over-stressing of a joint filler or sealant due to loading or impact bearing directly into the joint. Since joints are normally small, the loading has to be small (point load), or else the load would bear or impact on the surrounding concrete. Most or all of the stress is directed into the material. Examples of point load that can cause joint punch through are metal edges, high heels, etc. Additionally, if the joint has a coating or other type of covering over it, the coating may be overstressed even though the sealant or filler does not fail.
- The stresses sealants and fillers bear in moving cracks and joints is concentrated by irregular geometry and/or rough and uneven sidewalls, contributing to premature failure. Straight, strong, even joint walls will maximize joint life.

GENERAL CONSIDERATIONS

- Concrete will contract substantially in its 1st year of life due to cure and water loss. About 30% of this contraction will occur in the first 30 days. In its first year of life, the concrete will have experienced 80-90% of its total contraction due to curing. The balance of curing contraction will occur slowly after the first year. Joint sealants (and/or the coatings placed over them) installed during the first year of life will be subject to substantial movement which may result in premature failure.
- Movement distributed over wider joints will greatly lengthen sealant/filler life by causing less strain on the material and less stress on the sidewall bond. This concept is easily illustrated by stretching both a long and a short rubber band the same amount. The longer rubber band is more easily grasped and will stretch more easily. Wider joints normally minimize stress on joint sealers/fillers.
- Wider joints are great for joint sealant/filler life because movement is spread out over a longer distance. But wider joints expose joint edges to harsh traffic and impact as well as being more prone to punch through. Joint sealants by nature cannot carry load without flexing, so rolling loads and impacts are borne almost entirely by the edges. Impacts and loads are increased greatly with wider joints. The edges will be subject to shouldering or even breaking off completely. Consider rebuilding the joint with stronger material, narrowly re-cutting the joint, and then applying semi-rigid joint filler to carry more load.
- Wider joints are more subject to joint punch through from impacts, point loads, high heels, etc. This is a significant concern when applying a rigid flooring system over wide joints. Consider re-cutting wide joints through the coating and filling with appropriate material.
- Since leaving cracks exposed after coating is typically not an option, widen cracks and fill with semi-rigid joint filler to better withstand point loads and protect cracking edges. Then apply coating over the prepared crack.
- Expanding concrete will narrow joints and cracks, and will squeeze joint sealant/filler, causing it to expand upward. If this expansion causes the joint material to significantly rise above the surface, normal use can damage the sealant. Bulging sealant/filler can also crack rigid coatings applied over it. Consider a wider joint to minimize joint material bulge. Consult pertinent WCC TDD's for recommended treatment.
- It is good practice to install joint materials when the concrete is at normal service temperature. Since concrete expands and contracts with temperature changes, cracks and joints expand and contract in response. If the service temperature of the slab is different from the installation temperature, joint material will have to withstand movement due to this initial temperature change in addition to movement due to normal service, increasing the likelihood of failure.
- For concrete subject to temperature swings, apply sealant or filler while the concrete temperature is in the lower to middle part of the range.
- For joints expected to move substantially, it is good practice for joint sealant's depth not to exceed the width. Installing sealant too deep can cause overstressing of the bond to the sidewalls as well as overstressing the sealant itself. Prior to filling, press closed cell backer rod into the joint to regulate the depth.
- If the joint is to be exposed to heavy traffic, it is good practice to remove the relatively brittle concrete around the joint and rebuild it with resinous material having higher tensile and compressive strength. Re-cut joint completely through the repair material and install semi-rigid joint filler.
- Normally all cracks and joints move. Some move very little and are classified as 'non-moving,' but it is good practice to assume movement in a joint or crack rather than none.
- All cracks and joints move when concrete temperature changes.
- All cracks and joints move when the concrete is subject to vibration.
- The design width of joint sealant/filler is dependent on the amount of movement anticipated (or known) and flexibility of the desired joint material. Joint sealant/filler flexibility is readily available from data sheets. Amount of movement will most likely be an assumption unless extensive testing is carried out. Good practice is to over-design the joint, especially in areas with irregular geometry and multi-plane movement.
- In many cases, the stress a joint's wall can withstand is the limiting factor for how much movement a sealed or filled joint can tolerate without 'failure'. For example, if a stiff (high modulus) material is used (which may or may not have adequate elongation), as the joint moves and the material is stretched, the force the material exerts on the joint wall will ramp up quickly. Since concrete has very low strength in tension, the joint may fail by separating from the wall, even though the material has lots of elongation left. Because of the material's high modulus, elongation in this case was meaningless! It could stretch a 100 times its original size, but if it overstresses the joint wall, high elongation has no bearing on performance.

GENERAL CONSIDERATIONS (CONTINUED)

- More flexible (lower stiffness or modulus) materials deflect more easily under a given load. So it would seem the ideal filler or sealant would have low modulus and high elongation. This may be fine for sealants and fillers not exposed to loads. But as in the case of joints in floors subject to high traffic, it is desirable for the sealant or filler to carry some of the load to better protect joint edges, rather than easily deflect and expose the joint edges to impact.

JOINTS AND CRACKS IN COATED CONCRETE

COATING OVER MOVING JOINTS (SEAMLESS)

When considering proper design of moving joints, it is wise to understand that any flooring system applied over a moving joint cannot stop movement. Rather, a flooring system can only allow for movement. Therefore proper application and design of coatings over a moving joint is critical, especially in cases of chemical exposure or waterproofing where a crack in the coating system is by definition a breach of protection.

A coating system applied over a moving joint must be able to withstand stresses caused by movement or else remain isolated from the movement. Thick, flexible membranes applied under the coating system and over the joint isolates the relatively rigid coating system from movement. Thicker membranes further reduce the likelihood of failure due to movement, but increase the likelihood of punch through failure. Along with flexible under-coats, a more flexible coating system may be chosen to withstand movement.

Reinforcement can also be installed in the coating system to help it withstand tensile stresses. Options include fabric, fiberglass or carbon fiber mat, and/or use of internally reinforced coatings. It is good practice to use a combination of reinforcement and isolation in cases of high movement and/or when the coating system is necessarily rigid, as is the case with highly chemical-resistant coatings and linings.

COATINGS WITH EXPOSED JOINTS (HONORED)

Honoring joints (cutting a coating system over joints) is the safest way to guard a coating against cracking due to movement. But this method may not meet aesthetic requirements. Also recutting joints in a coating may introduce enough discontinuity in the surface to cause failure under heavy traffic. Additionally, exposed joint sealants may not meet design requirements of the environment, such as chemical-resistance or wear-resistance.

To minimize failure of coatings at re-cut joints, ensure the joints are cut completely through the coating system and filled appropriately.

In high traffic or high abuse areas, it is good practice to completely rebuild the area around joints with stronger material, such as epoxy mortar or putty, to reduce the likelihood of failure. The joints are then re-cut and filled with semi-rigid joint filler to better protect the joint's edge.

CONCRETE CRACKS WITH COATING SYSTEMS

Normally it is not aesthetically or functionally desirable to have exposed cracks after a coating system is applied. Since repaired cracks 'disappear' after coating, it is impossible to re-cut them to allow movement (like can be done with joints) because their location is unknown. Therefore cracks must be properly sealed before installing a coating system to minimize cracks 'telegraphing' through the coating.

Widen out cracks at least 3 times their width or 3/8" minimum, preferably with a "v" notch. Then install semi-rigid joint filler to withstand some movement, but still offer more load resistance than a highly flexible joint sealant.

If movement is anticipated at the crack, use reinforcement and/or isolation measures to minimize the likelihood of cracking.

CRACK AND JOINT REPAIR MATERIALS

Refer to WCC TIB: Basic Concrete Repair Guide for a discussion of materials available to repair cracks and joints. The materials discussed in that TIB are useful for all types of crack and joint repairs. In addition to those repair materials, our IntegraFlex line of flexible epoxies is available for filling and sealing cracks and joints. Self-leveling grade is for horizontal surfaces only. Putty grade may be used for horizontal and vertical applications. For higher chemical resistance requirements, contact WCC for a recommendation.

WOLVERINE COATINGS CORPORATION'S MOST POPULAR CRACK AND JOINT REPAIR PRODUCTS

TrowelEase1160	General Purpose Surfacing Mortar – 1/8" to 8"
TrowelEase1162	Flexiblized Surfacing Mortar – 1/8 to 8"
TrowelEase1181	Epoxy Block Filler – Up to ½" on vertical surface
FlashPatch1221	Fast Cure Repair Putty
BondTite1101	Fortified with AVR 200 – Field Prepared Repair Putty
CoveEase1901	Epoxy Cove Gel used as Repair Putty
BondTite1101	Clear, Highly Self-Leveling Epoxy Primer – 5 to 50 mils
LiquaTile1184	Pigmented Self-Leveling Epoxy Coating – 12 to 50 mils
IntegraFlex1980	Pigmented Flexible Self-Leveling Membrane – 20 to 125 mils
IntegraFlex1921	Gray, Self-Leveling Epoxy Joint Filler
IntegraFlex1922	Gray, Putty-Grade (Vertical) Epoxy Joint Filler

TIB: Cracks and Joints in Concrete - Rev 191219

SAFETY

For your safety, all required personal protection equipment should be used when operating machinery or handling chemicals. Concrete dust is a source of silica particles and other hazardous materials that can cause silicosis and other illnesses. Proper safety equipment and methods are the responsibility of the installation company, general contractor, and/or facility owner.

WARRANTY

Wolverine Coatings Corporation warrants its products to be free from defects in material and workmanship. Wolverine Coatings Corporation's sole obligation and Buyer's exclusive remedy in connection with the products shall be limited, at Wolverine Coatings option, to either replacement of products not conforming to this Warranty or credit to the Buyer's account in the invoiced amount of the nonconforming products. Any claim under this warranty must be made by the Buyer to Wolverine Coatings in writing within five (5) days of Buyer's discovery of the claimed defect, but in no event later than the expiration of the applicable shelf life, or one year from the ship date, whichever is earlier. Buyer's failure to notify Wolverine Coatings of such nonconformance as required herein shall bar Buyer from recovery under this warranty.

Wolverine Coatings makes no other warranties about the product. No other warranties, whether expressed, implied, or statutory, such as warranties of merchantability or fitness for a particular purpose, shall apply.

Any recommendation or suggestion relating to the use of the products made by Wolverine Coatings, whether in its technical literature, or in response to specific inquiry or otherwise, is based on data believed to be reliable; however, the products and information are intended for use by Buyers having requisite skill and know-how in the industry, and therefore it is for the Buyer to satisfy itself of the suitability of the products for its own particular use and it shall be deemed that Buyer has done so, at its sole discretion and risk. Variation in environment, changes in procedure of use, or extrapolation of data may cause unsatisfactory results.

LIMITATION OF LIABILITY

Wolverine Coatings Corporation's liability on any claims based upon Wolverine Coatings Corporation's negligence or strict liability, for any loss or damage arising out of, connected with, or resulting from the use of the products, shall in no case exceed the purchase price allocable to the products or parts thereof which give rise to the claim. In no event shall Wolverine Coatings Corporation be liable for consequential or incidental damages.

LITERATURE REVISION

Published literature is subject to change without notice. Wolverine Coatings Corporation is constantly formulating innovative products, new technologies, and practices. Please check www.wolverinecoatings.com for the latest product data sheets.

WOLVERINE COATINGS corporation

Wolverine Coatings Corporation
5969 Highway 221 | Roebuck, SC 29376
Tel: (864) 587-3144 | Fax: (864) 587-3147
e-mail: sales@WolverineCoatings.com
website: www.WolverineCoatings.com