FOCUS ON INDUSTRIAL FLOORS

A COLLECTION OF TECHNICAL ARTICLES ON
INDUSTRIAL FLOOR DESIGN & CONSTRUCTION

FROM INITIAL DESIGN THROUGH THE FIRST YEAR

How To Avoid Common Floor Problems

Joints...The Key to Floor Durability

Ten Reasons Why You Should Care Which Joint Filler is Used in Your New Facility

The First Year in the Life of Your New Floor

Before You Build...

HOW TO AVOID COMMON FLOOR PROBLEMS

20 Steps You Can Take to Avoid Common Floor Deficiencies

In any given year our staff will inspect several hundred industrial floor slabs, many of which have problems to some degree. While problems vary in severity, they are seldom unique. Rather, they tend to be the result of the same mistakes time and time again.

The purpose of this technical paper is to share our observations in the hope that you can avoid these common mistakes on your current or future projects.

PROBLEMS IN THE DESIGN PHASE

1. Loosely Drafted Construction Documents

When contractors review plans and specs they can soon determine the capabilities of the designer and "the tone" of the project. A tightly drafted floor spec and complete floor details will tell the contractor that the floor is of critical importance. Avoid wide open material and procedural specs that basically allow the contractor to design the floor. Show the proposed joint layout, provide complete jointing details, specify allowable concrete additives, list acceptable products by name, minimize the use of the broad term "or equal." In construction, the term "or equal" is often interpreted as "or cheaper."

By drafting tight construction documents you are not saying that you won't listen to a concrete contractor's suggestions, many of which may be excellent. You are simply making it incumbent upon him to fully justify each recommendation.

2. Specifying or Allowing Additives

There are numerous concrete additives on the market, all claiming wonderful benefits. But what is not always apparent are the possible side effects the additives cause. For example, some additives delay the appearance of bleed water, thus delaying the finishing. Others may allow more rapid slab shrinkage, adding to curl problems.

Concrete additives can be helpful in achieving certain results (better finishing characteristics, etc.), but they should never be considered a substitute for a good basic mix design, proper placement by qualified contractors and adequate curing.

3. Minimize Shrinkage and Curl

Excessive (or rapid) shrinkage and slab edge curl can affect even the best designed floor. You can minimize shrinkage and curl by paying attention to the proper mix design.

a. *Use the largest aggregate possible. Coarse aggregate occupies space without shrinking.*
b. *Water and cement both add significantly to shrinkage and curl. Insist upon a low water/cement ratio from the ready mix supplier.*
c. *Avoid high strength concrete mixes. Concrete strength is measured by compressive strength, and floors seldom, if ever, fail in compression. To achieve higher strengths you must use more cement, which adds to shrinkage and curl.*

Many in the industry equate low slump with low shrinkage. This is true to a degree, but aggregate size and water/cement ratio are likely of greater importance.

4. Joint Spacing; Closer, More Square

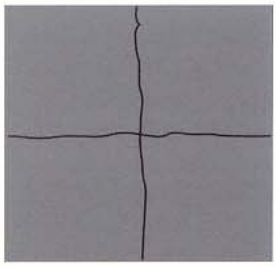
The trend over the past decade has been to make slab panels larger, and thus have fewer joints. The reasons most commonly cited are:

a. *It costs money to create and fill more joints.*
b. *In theory, it costs the owner more in floor maintenance if he has more joints.*
c. *Designers are extending the spacing between columns, which in turn tends to extend joint spacing.*

These reasons are all valid, but we often fail to consider the effect of normal shrinkage on joints. As a rule of thumb, a typical 6" thick slab may shrink 1/8" in every 20'. Thus, a 1/8" cut every 20' will eventually open to 1/4". This means the joint has opened 100%. Consider what this means to a semi-rigid epoxy joint filler that may be able to accommodate only 5-10% expansion. By bringing your joints closer together you minimize the degree of filler-to-concrete separation that will occur.

Now consider random cracking. The larger the slab panel, the greater the potential for random cracking. It all comes down to a choice between joints or cracks, and joints are definitely less expensive than cracks. To cut and properly fill a joint will cost approximately $2-$2.50/lf, and you have an aesthetically pleasing floor. And joints are relatively easy to maintain. Random cracks, on the other hand, are unsightly and will cost $3-$5/lf to cut out (chase) and fill. And cracks are much more difficult and expensive to maintain than joints.

Now lets talk about the panel shape. Concrete shrinkage causes an even stress build-up across the slab. Thus, a 15'x15' panel shrinks equally across all directions. But if you have a 15'x20' panel, the stress will be greater across the 20' dimension.

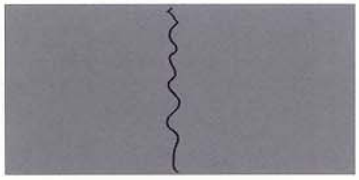


Cracking of Oversized Panels

HOW TO AVOID COMMON FLOOR PROBLEMS

It is quite likely a crack will occur dividing the 20′ span into two 10′ segments.

The bottom line is this: you have a choice between joints or cracks. You can reduce the effects of cracking by heavily reinforcing the slab. But reinforcing does not prevent cracks...it merely holds them tight at best. And reinforcing costs money. You need to consider the trade-offs carefully in your design.

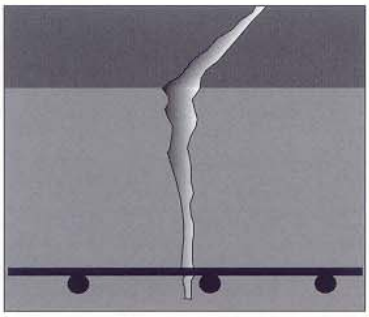


Cracking of Irregular Panels

5. The Myths of Mesh

The first myth about mesh is that it will prevent cracking. It doesn't. It merely holds the cracks tight, *if* properly placed. The second myth is that mesh adds compressive strength to the slab, if properly placed. It doesn't. The third is that the mesh can be properly placed, as in the top half of the slab. If you were to core 100 projects, it's almost a guarantee that you will find the mesh on the grade or in the bottom half of the slab about 90% of the time. In view of this, why specify mesh at all? If you need to reinforce the slab, consider using reinforcing bars chaired to the proper height.

One more point should be made about mesh. If it does end up in the bottom half of the slab, it may actually add to both the frequency of cracking and the surface width of your cracks. And you paid extra for this.



Effects of Mesh Near Bottom

6. Dowel the Construction Joints

The ideal floor is one where all slab panels work together in unison as traffic passes over the joints. Construction joints create a total separation between panels, thus creating the potential for one panel to deflect under load while the adjacent panel stays up, resulting in joint edge spalling. The use of smooth dowels at construction joints can assure that both panels work together under load.

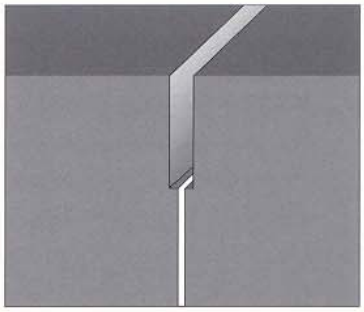
To be effective dowels must be properly spaced and aligned and greased on one end to allow for joint movement.

7. Construction Joints Should Be Saw Cut

Construction joints have two major disadvantages.

a. The edges may be inherently weak because they are finished less densely than the rest of the surface.
b. Unlike a saw cut joint, there is no base to support the eventual joint filler.

We recommend that all construction joints in traffic paths be saw cut to a depth of 1". Saw cutting removes (or at least reveals) weak edges and creates a base for the filler. Additionally, saw cut joints will look neater and stand up to traffic longer without maintenance.



Saw Cut Construction Joint

8. Don't Over-Specify Flatness

Some owners and designers specify higher flatness numbers than they really need. There are several disadvantages to this practice:

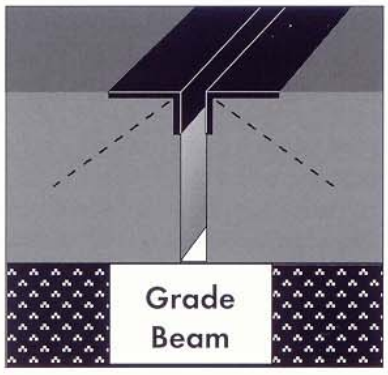
a. A higher flatness number will result in higher concrete bids
b. If the flatness number is too high, the concrete contractor assumes that flatness is the primary criteria for the floor. Durability must always be the primary criteria of any floor.

Before you specify a flatness number we suggest that an acceptable existing floor be tested. Many, if not most, conventional warehouse floors can get by with a F35-40. If no acceptable floor is available to measure, contact a flatness consultant such as FACE Consulting (1-800-FNUMBER) for advice and assistance.

9. Joints at Doorways Through Walls

Joints where two separate slabs meet at doorways, such as at fire walls or into separate storage rooms (coolers, etc.), are frequently found to be suffering severe spalling. Sometimes the cause is that this was a butted joint and never filled.

In some cases the designer used a premolded filler to isolate the two slabs. Both approaches are wrong and inappropriate. If hard wheeled vehicles will pass over this junction, an armored joint should be provided. The most durable armoring is usually a steel angle assembly.



Armored Joints at Doorways

10. Properly Specifying the Floor Joint Filling

Some owners and designers still tend to treat floor joint filling as an afterthought, something incidental to the actual floor. This thinking fails to recognize that;

a. Because joints are an interruption in the surface, joint filling must be considered as a vital link in the floor surface system.

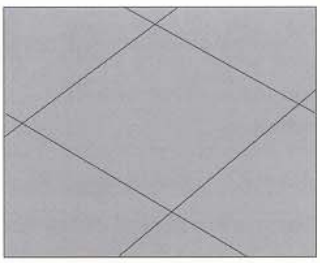
HOW TO AVOID COMMON FLOOR PROBLEMS

10. Specifying the Floor Joint Filling (Cont'd)

b. Each joint is a potential impact point for the wheels of material handling vehicles.

c. Since joints will continue to open for a year or two during the extended shrinkage period of the floor, joints are in effect the most vulnerable part of the floor surface.

Our literature contains extensive technical information on floor joint filling, so I won't duplicate that information here. But several critical points need to be reinforced;



Joints Are Part of the Floor Surface

a. Joint fillers should be specified in Section 03250, not 07900.

This helps make the distinction that floor joints are to be "filled," not "sealed."

b. To be effective as an edge protector, the filler must fill the entire saw-cut, taking advantage of the support offered by the base of the saw cut. Specify clearly that the filler must be installed full depth with no compressible backer rod allowed, and provide proper details in your structural drawings.

c. Do not merely specify "Product X or equal." By doing so you are tacitly implying that joint filling is not one of your major concerns. There are more than one hundred semi-rigid fillers on the market, with dramatic variables in their quality and cost. If you allow an unnamed "equal," you will likely end up with the cheapest filler, not the best filler for your floor.

d. The filler(s) you specify must match the operational demands of the floor. Fillers fall into two categories; heavy duty and moderate duty. If your facility will have heavy loads, hard (solid) wheels, or frequent traffic, specify a heavy duty filler by name.

When preparing your bid documents, remember this: the filling of joints with the most expensive product on the market will cost you $1.25 to $1.75/lf. The repair of a joint allowed to spall due to improper filler or filler installation will cost $3 - $10/lf., not to mention the downtime for repairs. Joint filling is the last place you want to cut corners.

PROBLEMS IN THE BIDDING PHASE

11. Pre-Qualify Your Concrete Contractors

With the introduction of equipment such as the Lazer Screed®* many new concrete contractors have emerged. But floor construction remains as much art as science, and there is no substitute for experience. We recommend that concrete contractors be pre-qualified. Ask them to identify a few projects that

11. Pre-Qualify Your Concrete Contractors (Cont'd)

are 4-5 years old, and talk to the owners. Your floor is too valuable to risk to an inexperienced contractor.

12. Hold a Pre-Bid Conference

Meet with your short-listed contractors before the bids are taken. Stress your demands for quality, discuss schedules, job conditions, availability of good aggregate, specs and drawings, etc. Listen to recommendations made, and make the contractors justify their reasons.

PROBLEMS IN THE CONSTRUCTION PHASE

13. Hold a Pre-Construction Conference

At least one week before the start of work hold a jobsite conference. Insist on the attendance of the owner, designer, GC/CM, concrete contractor, ready mix supplier, accessory suppliers (additives, joint fillers, etc.), the testing lab and any trades whose work might interfere with or affect the floor placement. This will be your last opportunity to discuss job conditions, mix design, schedules, pour sequence, light and ventilation, temperature, access, curing, etc. Raise all questions now rather than after the work starts.

14. Inspect the Finish Grade

A well compacted, even grade is critical. The base must have no hard or soft spots, no high or low points. Inconsistencies will cause sub-grade drag which will result in cracking. The best verification of adequate finished grade is to proof-roll it with a heavy vehicle such as a cement truck.

15. Start Curing Procedures Promptly

Once the finishing is complete, the curing process should begin immediately. Retention of moisture is critical to ensure complete cement hydration, which yields stronger and more durable concrete.

Our preference for curing is the use of a moisture retention sheet for at least seven days.

Uneven Grade Can Cause Cracking

We have seen the best experience with sheets having one plastic face and the opposite face of burlap or a synthetic absorptive material. The concrete should be re-misted whenever the sheet is temporarily removed (for cutting, etc.) or as dictated by conditions.

16. Cutting of Contraction (Control) Joints

The most difficult element in cutting is the timing. This is one prime example of the art/science equation. Cut too early and joint edges will ravel. Cut too late and the slab may already be cracking due to tensile stress brought about by shrinkage.

We are advocates of the new breed of early cut saws which are used within the first few hours after final finishing. There

HOW TO AVOID COMMON FLOOR PROBLEMS

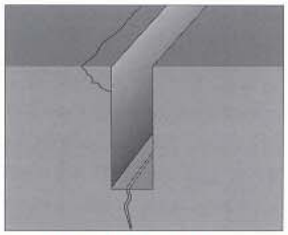
16. Cutting of Contraction (Control) Joints

are three critical things to remember in the cutting operation;

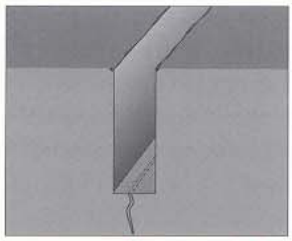
a. The timing should be such that the cut is clean, not disturbing the adjacent aggregate.

b. The blade should be appropriate for the aggregate it must cut through.

c. The base plate of the saw must be replaced in strict compliance with the saw manufacturer's instructions. Failure to comply can result in micro-fracturing of the joint edges.



Micro-Fracturing

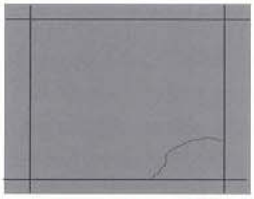


Joint Edge Ravel From Early Cutting

Some in the industry prefer to use the early-cut saws to relieve the slabs surface tension, then come back later and re-cut the joints with a conventional saw. This can be a good practice if the slab did not crack beneath the cut, or if there is evidence of micro-fracturing on the edges.

17. Avoid Premature Loading on Slabs

Concrete does not usually reach its optimum compressive strength until 14-28 days. It is always wise to avoid or at least minimize heavy loads (rack delivery, etc.) until the slab has reached adequate strength. If access must be granted, insist that material handling vehicles have pneumatic tires. All vehicles crossing the slab should be diapered.



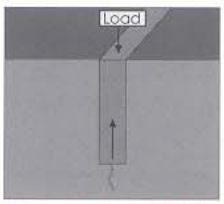
Cracking Caused by Crane Outrigger

In the case of tilt-up construction, the push for access is intense. If at all possible, keep ready-mix trucks and cranes off the floors and especially off panel corners.

18. Proper Filling of Floor Joints

Assuming your specs and details have been properly prepared, the next critical issue in joint filling is the timing. Concrete will have significant shrinkage for a period of 1-2 years. As shrinkage occurs, the joints grow wider. Thus, you should delay your joint filling until the last possible opportunity.

In this manner you will minimize the amount of filler-to-concrete separation that occurs. After timing, the most critical element in filling is the depth of the filler. As cited earlier, a filler is most supportive of loads when the filler itself is supported by the bottom of a saw cut.



Properly Filled, Functioning Joint

Our surveys indicate that more than 70% of all projects suffer cheating in the filler installation. Refer to our Tech Sheet T-7 ***Preventing/Detecting Deficient Joint Filler Installations*** for a complete explanation of why cheating occurs and how to prevent and detect it.

Another important issue is the finished profile of the filler. Since one goal in filling is to avoid impact points, a filler should be finished flush with the floor surface. This is best achieved by over-filling, allowing the filler to cure into a solid, then shaving the filler off flush with a razor.

19. Provide for Correction of Filler Separation

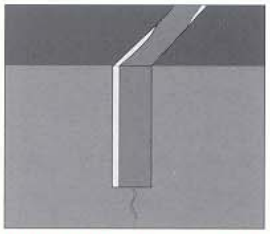
No matter how long you are able to defer your filler installation, filler-to-concrete separation will still occur. This is because a filler that is firm enough to support traffic cannot be flexible enough to accommodate significant joint opening.

There are two basic means to provide correction of separation;

a. Provide in your specs a call-back provision, obligating the installer to return to the project six months after occupancy to refill all voids credit card width or greater.

or

b. Have the owner accept responsibility for refilling separation as part of his maintenance operations.



Joint Filler Separation

For further discussion of this subject and the refilling process read our technical sheet T5.

20. Use Common Sense in Crack Correction

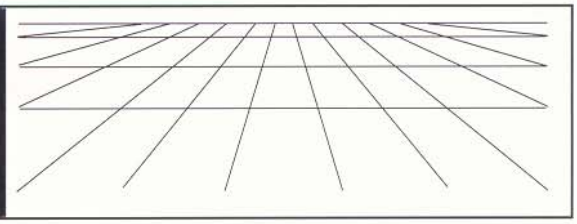
There are very few slabs placed that do not have cracks. Hairline, occasional cracks need not necessarily be of concern, since aggregate interlock will keep the panel structurally sufficient. If numerous cracks occur, or if cracks are wider than hairline, an evaluation is called for.

One problem we frequently see is the practice of filling cracks with a structural epoxy, with the idea of welding the slab back together. This procedure is often done by pressure injecting epoxy into drilled port holes. The trouble comes in that the crack may still be active. If you weld an active crack, you will likely develop a new crack adjacent to the repaired one. Our advice is generally not to structurally weld any crack (or joint) if it can be avoided.

SUMMARY

Clearly, the twenty recommendations offered in this article won't prevent all floor problems. But they may help avoid very common and very preventable problems that occur over and over. We hope you find this article of value and further hope you will call or write us if we can help you in any way to achieve higher quality, more durable industrial floors.

JOINTS...
The Key to Floor Durability



This article was written to help the reader understand the critical function joints play in determining the long-term durability of a conventional industrial floor. To achieve this objective, it is necessary to change your perception of what floors are, what joints are, and why floors and joints should always be considered together.

SLABS + JOINTS = SYSTEM

The floor in a typical industrial building is not "a" floor at all. In actuality, it is "many" floors. Consider a 90,000 square foot floor: construction joints at 30', intermediate joints at 15'; making 15' x 15' grids. Each joint, by formed edge or induced crack, creates a break in the floor. Thus, there are really 400 separate slabs, divided by ***and*** linked by joints. Ideally these 400 slabs will work in unison as if they were one floor. Joint design and construction alone will determine this.

Joints do more than just break a floor into smaller masses. They also create interruptions in the wearing surface. Since a material-handling vehicle cannot cross the slab without crossing over joints, joints are also transition points. You cannot, therefore, treat floors and joints as separate items. Joints must be considered as an integral part of the "floor system".

FUNCTION DETERMINES JOINT DESIGN

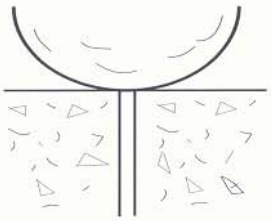
The function of an industrial floor is to serve as a work platform, supporting the movement of material handling vehicles carrying raw materials or merchandise. Floors that are smooth and interruption-free allow optimum movement and productivity. Joints serve several functions within floors: they are the ends of pours; they induce shrinkage cracks to follow straight lines; they allow for seasonal slab expansion/contraction; and they provide the linkage between smaller slab segments. To accommodate all these functions, joint design must incorporate the four following principles:

1. *Narrowness*
2. *Plumbness*
3. *Load Transfer*
4. *Protectability*

Narrowness

Narrowness is a common sense issue. Narrow joints offer less exposure to hard wheels than wider joints. Narrow joints cost less to protect, depending on the joint design. Accordingly, we are advocates of 1/8" diamond blade cuts, or the use of early-cut saws such as the SOFF CUT®. We are strongly against plastic channel inserts which create wide joints.

When considering joint width, consider that the joint will never again be as narrow as the day you create it. This is due to concrete shrinkage. As a rule, most concrete shrinks 1/8" in 20'. How wide a joint ends up will depend on its original width, the mix design, and joint spacing.



Joints should be kept as narrow as possible

Plumbness

Any joint created out-of-plumb is a potential problem. If the angle is significant, it creates an overhang condition that will soon be broken off by heavy loads. We oppose the use of insert-type control joints for this reason. All too often the inserts end up angled due to difficulty in the insertion of a thin strip into aggregate-loaded concrete (and displacement during subsequent finishing operations). We advocate saw cutting control joints which results in joints that are plumb.

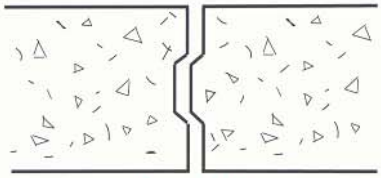
Load Transfer

Earlier we stated that the best floor is one where all the small slab segments work together as if one. We are primarily addressing the effects of heavy loads crossing joints. If one slab segment drops under load, the edge of the opposite segment is exposed to wheel impact. Ideally, adjacent segments should work together and support each other. This support, or linkage, is called load transfer.

CONSTRUCTION JOINTS

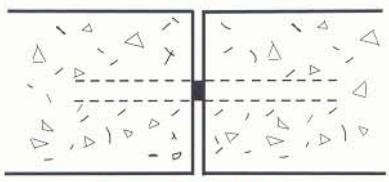
Construction joints create a total separation between slab segments, and thus each segment may move independently unless we provide a form of linkage for load-transfer purposes. For years, the keyed joint was a common means of load transfer. But keys usually prove ineffective once the joint opens (due to normal shrinkage) or the slab edges curl upward. When either of these common phenomena occur, one or both slab panels may deflect under load and shear off the key, eliminating any load-transfer.

The best assurance of positive load transfer at construction joints is the use of dowels.



Keyed Joint

Dowels with proper thickness, length, spacing, alignment, and installation provide the necessary linkage between slab segments. They are best used in conjunction with flat bulkhead forms since alignment is easier.

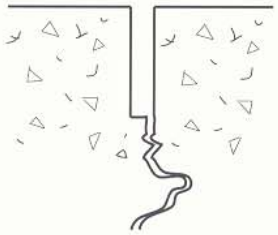


Doweled Butt Joint

JOINTS...The Key to Floor Durability

CONTROL JOINTS

The purpose of a control (contraction) joint is to guide the expected shrinkage crack in a straight line by weakening the slab on that predetermined line. A saw cut is the most common type of control joint. Below the joint a crack will form, winding its way around the large aggregate. This is called *aggregate interlock*, and it is a form of load transfer. Aggregate interlock can be an effective means of load transfer if we take proper precautions. For example, we need to keep the joint from opening too wide. This can be accomplished by using smaller joint spacing (15' centers instead of 20') and minimizing shrinkage with a leaner concrete mix. Larger aggregate also enhances aggregate-interlock capabilities.



Saw Cut
Control Joint

We stated earlier that a rule of thumb is that conventional concrete may shrink at a rate of 1/8" in 20'. Thus, for heavy duty floors, the use of smooth dowels should be considered to ensure positive load transfer.

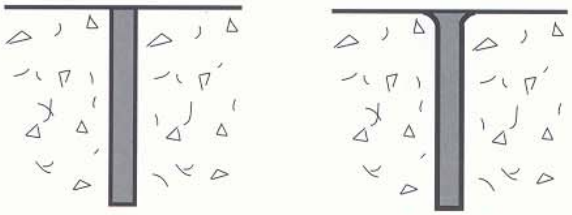
Protectability

A joint is an interruption in the floor surface, and is thus an impact point for hard wheels. Hard wheels will break off the edges of unprotected joints, a process called edge spalling. There is one single best method of preventing edge spalling–fill the joint to restore surface continuity.

To be effective the filler must support loads without deflecting, thus supporting the joint edge. A saw cut provides the most protectable joint since the filler is in full contact with the edge.

In the past tooled joints were common. But the major problem with tooled joints is that they expose the filler to probable deterioration. The filler flares out at the top and tapers to zero thickness at its outer point. When the joint opens, this thin filler web will be broken off by wheeled traffic. Once that occurs, concrete edge damage will quickly follow.

If a joint must be tooled as part of the finishing process, then we recommend coming back later and saw cutting the tooled joint. The cut should be as narrow as possible (1/8") and 1/2" to 1" deep depending on the anticipated traffic loads. Saw cutting creates both a reservoir for the filler and helps remove any weak joint edges.



Avoid tooled edges

JOINT FILLERS-THE CRITICAL EDGE

The joint filler used to fill your control and construction joints is truly the critical edge in providing and maintaining durable, efficient industrial floors. Having discussed proper joint design, one would think that filling is a relatively simple topic. Not so. But, it is a common sense topic. Much of our literature is dedicated to educating designers, owners and contractors on how to select the proper joint filler and how to ensure it is installed properly.

We strongly encourage you to investigate and educate yourself fully on joint filling issues through our literature and contact us anytime you have questions or concerns regarding joint filler selection or installation issues.

Additional Technical Publications Available from Metzger/McGuire

- **Joint Filler Tech Series**
  A series of comprehensive technical sheets covering all aspects of joint filler properties and installation;

  T2 The Concept of Industrial Floor Joint Fillers
  T3 How to Specify Industrial Floor Joint Fillers
  T4 Filling Joints in Treated or Covered Floors
  T5 Joint Filler Separation; Causes, Corrections
  T6 Typical Questions About Floor Joint Fillers
  T7 Preventing / Detecting Deficient Joint Filler Installations
  T8 Freezer and Cooler Joint Filler Installations

- **The Myth of Flexible Fillers**
  Industrial floor joint fillers are sometimes sold on the basis that they can accommodate extreme movement and adequately deflect load. This article examines the balance between movement and load deflection and debunks the myths about products that claim to achieve both.

- **Concrete Floors...Path to Productivity**
  Your concrete floor is your primary work surface. Defects in your floor are costing you big $$$ in lower productivity and greater expenses in vehicle maintenance and repair. See how much a defect really costs.

- **Cracks and Deteriorated Joints**
  Why did your last floor crack so much? Why did your joint edges deteriorate to the point that your vehicles are suffering excessive wear? Here are the causes, and how you can prevent them.

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TEN REASONS WHY YOU SHOULD CARE WHAT FLOOR JOINT FILLER IS USED IN YOUR NEW FACILITY

1. The Floor is the Most Important Part of Your Building

The reason you are building is to add operational floor space. In today's highly competitive environment, you must be sure that the floor will allow you to operate at maximum productivity. The quality and durability of your floor will be a major factor in your productivity.

2. All Floors Have A Built-In Problem...the Joints

The ideal concrete floor would be one that offers a continuous surface with no interruptions. Unfortunately, floors must have joints to help prevent random cracking as the concrete shrinks. Each joint is a potential impact point as material handling vehicles cross the floor.

3. Joints Are Vulnerable to Damage from Vehicles

Despite concrete's relative hardness, it's actually vulnerable at its edges, especially at joint edges where impact from hard material handling vehicle wheels can cause breakage or wear. This process of deterioration is called spalling. Joint edge deterioration accelerates rapidly if left uncorrected and can seriously compromise the functional utility of your facility floor.

4. Spalled Joints Cause MHV Problems

Once joint edges spall they cause severe damage to vehicles. Wheel/tire wear becomes dramatic. Vehicles suffer damage to wheels, axles, bearings, wiring connections, etc. You can't be competitive if your material handling vehicle maintenance and repair becomes a major expense.

Deteriorated joints can cause extensive damage to material handling vehicles, resulting in reduced operational productivity and excessive MHV maintenance and repair costs.

5. Spalled Joints Cause Significant Productivity Losses

Every time you pull a vehicle from service, for repair, it costs you productivity. Every time a vehicle driver slows down or detours to avoid a deficient floor joint, you lose productivity. Every time a load is tipped, you lose. If you multiply each incident by the number of vehicles you operate, and by the hours you operate, your productivity losses can be huge.

6. The Function of a Filler is to Support and Protect

A proper joint filler will support material handling vehicle loading without deflecting. In supporting the loads, the filler also supports and protects the relatively weak joint edges from impact-related damage. A proper filler will restore the floor surface continuity lost when the joints were created.

7. All Joint Fillers Do Not Support and Protect Equally

The American Concrete Institute (ACI) guidelines call for a filler to have a minimum hardness of Shore A80. It should be noted that this is a "minimum." If your facility will run high rack stackers/pickers, or if vehicles have small, hard wheels, A80 may be insufficient. The proper joint filler for your facility is the one that will accommodate your operations, and not deflect under load.

8. Cheap Fillers are Often the Most Expensive

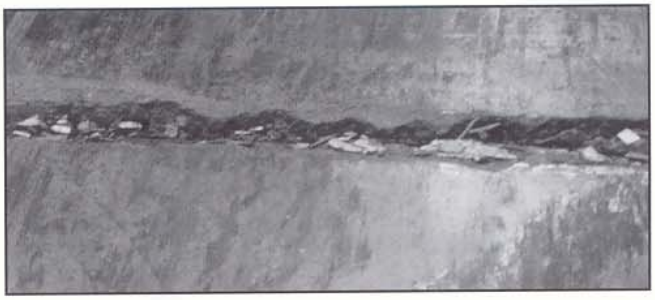
When you decide to build you likely assumed your facility would serve you for many years. It is therefore logical that you will need a filler that will last for many years. The reason some fillers are cheaper is that they use cheaper raw materials which deteriorate sooner. When cheaper fillers become brittle or break down, they must be replaced. Two "cheap" installations are far more expensive than one quality installation. Choosing a quality filler now will pay dividends for many years to come.

9. Who Will Decide Which Filler is Used?

With the durability of your floor and the productivity of your operations at stake, who will make the critical decision on which filler will be used? All too often it will be made by the caulking contractor. That often happens when the architect/engineer specifies "MM-80 or Equal." There are at least 80 so-called "or equal" fillers on the market and they vary dramatically in quality and performance. If you want the protection that only Metzger/McGuire products offer, then insist upon them.

10. You Have Only One Chance to Protect Your Industrial Floor Joints...Before You Build

Selecting the right joint filler is a "dollar and sense" issue. The cost of filling joints with a Metzger/McGuire filler is generally $1.25 to $1.75 per lineal foot. The cost of repairing joints that were filled with a cheap or inadequate filler will run between $3.00 and $10.00 per lineal foot, in addition to your productivity losses and vehicle damage. Caring about the joint filler to be used is a wise investment of your time. Don't hesitate to call on us if we can be of any service in making the right decision.



Joint deterioration is gradual but inevitable when an inferior filler is chosen or if a filler is installed poorly. As the deterioration increases, the cost of repairs increase and your productivity decreases.

THE FIRST YEAR IN THE LIFE OF *YOUR NEW FLOOR*

As owner or manager of a new industrial facility you are probably still in the process of settling in. Although you may not have noticed, your concrete floor is also adjusting to its environment.

Have you looked at your floor recently? If you do, chances are you will notice cracks that weren't there when you first moved in. You may also notice that the filler in your floor joints has separated from the concrete edge. When vehicles cross joints, you may hear a "thump," or feel the slab vibrate.

Should you be concerned about these changes? Should you contact the architect, engineer, or general contractor? Should you ignore the possible problems, or attempt to correct them?

The purpose of this article is to tell you about your floor...how it was built, why you are seeing changes, what the changes mean to you, and what, if anything, you should do. Consider this article a primer on floors, an owner's manual. Our focus is on joints and cracks since these constitute more than 70% of owner floor problems.

What is a Concrete Floor Slab?

A concrete slab is comprised of cement, coarse and fine aggregate, water and possibly additives. Your floor may or may not be reinforced with steel (mesh, rebars, etc.). After the concrete was placed, it was densely finished on the surface and then cured. The process sounds simple, but it's not.

Placing a concrete floor is as much art as science. Due to variables such as people, materials, mix design, weather, grade conditions, etc., no two floors are ever exactly the same. But the one constant is that for at least the first year or two, your floor will undergo changes...it may settle, it will get harder, and it will definitely shrink in size.

Fact#1 - All Floors Shrink

All concrete mixes include a large amount of water, which is needed for workability and to make the cement react. When the concrete hardens, it still contains much of this water, which will eventually evaporate over a long period of time. As the water evaporates, the result is that the concrete shrinks in lateral dimension. All floor slabs shrink, including yours. The big questions are how fast and how much.

HOW FAST?

After concrete is placed, an effort will be made to initially retain the water until the cement is fully reacted (hydrated). This process is called "curing" the slab. Proper curing yields a stronger, more durable floor. After the curing process, the shrinkage rate of the slab escalates initially, then progressively slows down.

CONCRETE SLAB SHRINKAGE RATE

One Portland Cement Association (PCA) study* indicates that a 6" slab-on-grade has a typical shrinkage rate of:

First 30 Days	15%
Next 335 Days	50%
Total, One Year	65%

** PCA Development Bulletin #103*

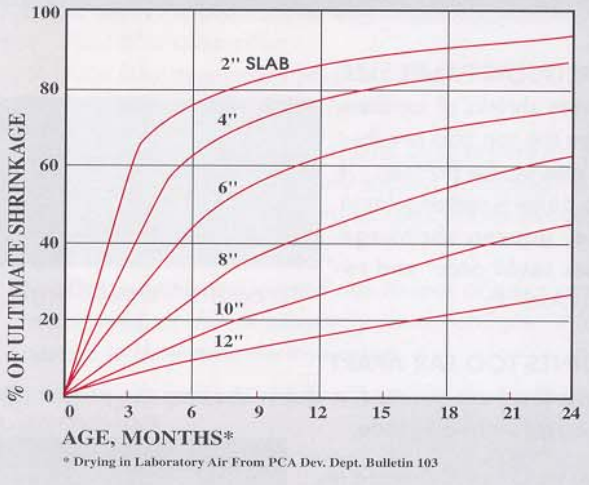
Your floor is shrinking as you read this article!

HOW MUCH?

How much a slab-on-grade will shrink in dimension will depend on a number of variables, including, but not limited to, slab thickness, water-to-cement ratio, size of the large aggregate, etc. As a general rule, you can assume that a 6" thick slab will shrink 1/8" in every 20 lineal feet.

TECH NOTES

An 8" thick slab will shrink at a slower rate than a 6" slab, if all other factors are equal.



* Drying in Laboratory Air From PCA Dev. Dept. Bulletin 103

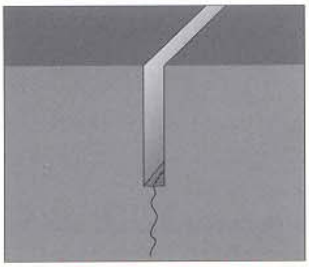
Fact #2 - Shrinkage Means Cracking

Imagine taking a section through your floor slab. Since the top of the slab is exposed to the air, allowing moisture to evaporate, it can dry fairly rapidly. As it dries out, tension is created on the surface. The bottom is also shrinking, but at a slower rate. This creates additional tension and can cause cracking of the slab.

THE FIRST YEAR IN THE LIFE OF YOUR NEW FLOOR

To relieve the shrinkage tension in long runs of concrete, the slab is cut into smaller segments. These cuts are called contraction (control) joints. They weaken the slab at regular intervals, causing the slab to crack beneath the cut instead of randomly. Thus, a control joint can be considered a designed crack.

To be effective, a contraction/control joint must be cut deep enough to weaken the slab, and early enough before the shrinkage tension exceeds the tensile strength of the concrete. If not, random cracking will occur. But proper jointing doesn't always prevent all cracking. There are numerous reasons for cracking, including:



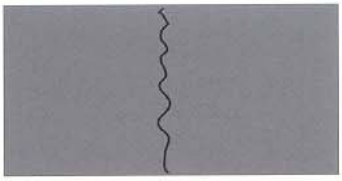
Contraction / Control Joints

A. SUB-GRADE DRAG

As a slab section contracts, it drags across the base it is placed upon. If that base is uneven, restraint is caused that could result in slab cracking.

B. IRREGULAR PANEL SIZE

Concrete shrinks at an even rate on the top and another even rate on the bottom. If a slab panel is rectangular in shape, uneven shrinkage stresses could occur and result in cracking.

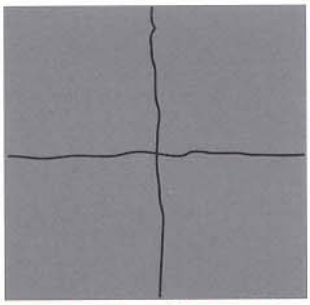


Irregular Panel Shape

C. JOINTS TOO FAR APART

PCA studies have resulted in charts showing the proper joint spacing for slabs-on-grade.

Proper spacing will depend on a number of variables related to shrinkage rates (water-cement ratio, aggregate size, slab thickness, etc.) If joints are spaced too widely, cracks can occur even in square-shaped slab panels.



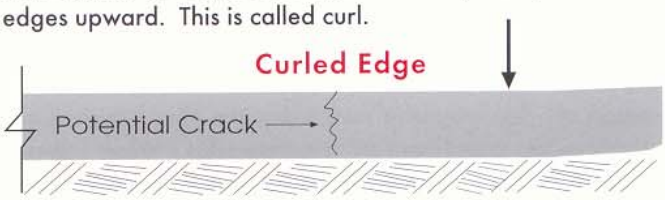
Oversized Panels

TECH NOTES

A common rule of thumb is that joint spacing should not exceed three times the slab thickness. For example, a 6" slab, joint spacing should not exceed 3x6 or 18 feet. Consult ACI and PCA documents for more specific information

D. JOINT EDGE CURL

We stated earlier that the top of a slab shrinks at a faster rate than the bottom. As shrinkage occurs, it is quite possible that tension from the rapid shrinkage on the top can pull the slab edges upward. This is called curl.



If the edge raises too far off the grade, imposed loads can cause the slab to crack.

There are numerous other causes of cracking. It may take an expert to determine the causes of your cracking.

But there are several things you need to know about cracking:

1. Most cracks, if narrow, will not affect the structural integrity of your slab.
2. Reinforcement (steel mesh, rebar, etc.) will not prevent cracking. It merely keeps the cracks tight.
3. Most cracks are wider at the top than at the bottom due to shrinkage rate differential. In fact, many cracks never extend to the bottom of the slab.

Cracking is a normal function of concrete shrinkage. Cracks do not make a floor bad unless they interfere with operations, or lead to surface problems.

Fact #3- Shrinkage Widens Joints

We stated earlier that contraction/control joints are, in essence, designed cracks to compensate for anticipated shrinkage. We also stated that shrinkage is a long-term phenomena, with significant shrinkage lasting about two years. Thus, it can also be presumed that joints will continue to open for several years.

Let's assume that your contraction/control joints in your 6" slab were cut with a 1/8" diamond blade at 20' centers. You can expect that 1/8" joint to eventually be 1/4" wide. This fact will have profound effect on your joint filler.

Fact #4- Shrinkage Affects Fillers

The present American Concrete Institute (ACI) and PCA recommendations call for the use of a semi-rigid epoxy joint filler for the joints in industrial concrete floors. The function of the filler is to refill the cuts and thus support wheel loads as they pass from slab panel to panel. The filler also supports and protects the joint edges against damage caused by hard wheel impact and loads.

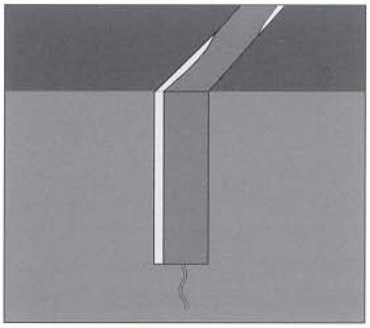
THE FIRST YEAR IN THE LIFE OF YOUR NEW FLOOR

To provide this support the filler, must be fairly stiff (semi-rigid). Our **MM-80** semi-rigid epoxy was developed in the late 60's for floor joints and remains the standard for the industry to this day. But **MM-80**'s load-supporting relative hardness also means it has minimal expansion capability, and will not expand as the joints open wider due to shrinkage. The same is true of all other semi-rigid fillers.

TECH NOTES

The timing of joint filling often relates to project size. Smaller buildings take less time to complete, and thus filling is done earlier. ACI recommends that joint filling be deferred as long as possible; later is better.

In a typical construction project, the floor joint filling is performed when the concrete is still fairly new, with most of its shrinkage yet to come. As the joints open wider, something must yield, preferably not the concrete. Thus **MM-80** is designed to separate adhesively from the concrete. It usually separates in a leap-frog pattern, jumping from side-to-side.



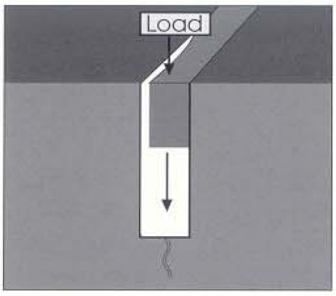
Joint Filler Separation

If this is what your joint filler looks like, the **MM-80** (or other filler) is performing as intended. Joint filler separation is not a failure– it is a practical solution to the inevitable concrete shrinkage.

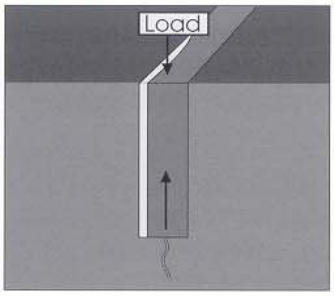
It is important at this point to explain the proper method of joint filling.

We know that the floor will shrink, and we know the filler will separate. So how can the filler still be effective in its functions of load support and edge protection?

To be effective, the filler must be installed full joint depth. A shallow filler will be driven down into the empty joint after separation occurs. When a filler is installed full depth, the base of the cut helps **MM-80** resist deflection-under-load, even after moderate separation.



Wrong



Right

Take a look at your filler. If it has dropped below the surface of the floor, it may not have been filled full depth.

To test for depth, simply drill a 1/8" hole through the filler. If it is not full depth, contact your general contractor promptly, since the joint edges are vulnerable to damage (spalling).

It is also important that the top of a properly installed filler be flush with the surface. The basic principle behind **MM-80** is that it restores the continuity of the slab surface, thus allowing traffic to flow with no interruptions or impact points.

What to Do About Cracks

Since there are so many possible causes for cracking, all we can do in the context of this article is provide you with some general guidelines.

Crack Repair Guidelines

1. *If you have occasional cracks, don't be too alarmed. But if you have many cracks, contact your architect/ engineer or an independent consultant and ask him to determine the cause(s).*
2. *Remember that your floor is still going through its shrinkage process. Don't do anything to a crack that will restrict its movement. If you "weld" the crack with a structural epoxy, you may end up with a crack parallel to the first.*
3. *Whenever possible, do not widen a crack (by sawcutting, etc.) Wider cracks mean more wheel exposure.*

What to Do About Joints

There are several problems that may occur at joints during the first year. The most common problems are:

1. *Joint filler separation*
2. *Joint filler depression (due to shallow filling).*
3. *Joint edge deterioration (spalling).* *

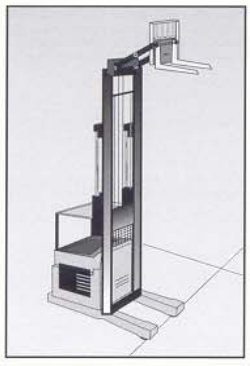
The objective of any correction should be to restore the joint to its original load-carrying capacity without restricting the movement that may come with continued concrete shrinkage.

** Note on Joint Edge Spalling*

Spalling may have occurred due to lack of edge protection at void, or due to inherently weak concrete. It is important to determine the true cause.

Conclusion

Your floor is probably the most important element of your building because it is the work platform for your operations. Therefore, it is vital that you monitor its condition during the first two years, and have minor deteriorations corrected before they become major problems that interfere with your productivity.



OUR MISSION

The facility owner is our ultimate client. Working direct, or as part of a design/contracting team, it is our goal to help the owner obtain and maintain the highest quality floor possible. We will achieve this by providing the owner and the industry with superior products, dedicated service and continuing education.

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