

Innovations for Durable Floors

by Greg K. Fricks and Nigel K. Parkes

Innovations in the concrete construction industry are making the difference between the ordinary and the exceptional in floor quality and durability. Distribution Plus Inc. (DPI), specializing in large food distribution centers, has high expectations for quality in its constructed facilities. That's why DPI specified shrinkage compensating concrete (SCC) slabs with a traprock surface hardener for a state-of-the-art distribution facility in Upper Marlboro, Md.

The standard of industrial floor that DPI was looking for when it specified this slab was clear, but DPI remained flexible enough to consider new products and systems that might further enhance the finished floor slab's quality and durability. With this open-minded approach, the contractor, Fricks Floor Systems, had the opportunity to use a combination of innovative products and proven techniques in the construction of this industrial concrete floor.

Based on decades of quality

industrial construction experience, Fricks proposed two new products for use that are examples of important innovations in the concrete flatwork industry:

-The Diamond Dowel System replaced conventional square dowels and offered improved load transfer and reduced restraint.

-Armor-Edge joint assemblies allowed the contractor to install a durable joint detail to exacting tolerances with no welding or grinding.

These two product innovations made the difference between a typical

industrial floor and one that we feel could be described as the most durable floor in the industry.

Load transfer without restraint

Differential shrinkage in adjacent slabs induces restraint and increases the likelihood of out-of-joint cracking.

The Diamond Dowel System, produced by PNA Construction Technologies, is a plate dowel designed to allow for this differential shrinkage. The system uses a combination of the steel plate's geometry and compressible side fins in the plastic pocket former



Product innovations in dowels and joint assemblies improve concrete industrial slab quality and ease installation.



Left: the plate dowel pocket former is nailed to the form prior to casting the first slab.



Above: Additional reinfocement in column detailing provides protection against re-entrant cracking. Left: Hand troweling of the joints ensures that the joints are flat.

to ensure that the plate does not restrain lateral movement while still transferring the total vertical load. The original design called for traditional square dowels and clips, but DPI was convinced to use the diamond plate dowels upon learning that Fricks had become advocates of the new system because of its many advantages.

Response of concrete workers

We asked the concrete construction crew what they liked about the diamond

plate dowel system over the traditional round or square dowel systems. They replied:

-The diamond plate dowel overcomes the typical problems we have with misaligned round or square dowels that are often bumped or placed out of position during construction.

-The plate dowel components are easier to set. Removal is simplified since we have to handle them only once; there is no need to pull dowels and replace them after the forms are removed.

-The finished slab has fewer random cracks.

-The plastic pocket formers are simply nailed to the form and cast into the first slab. It is easy for us to insert the plates into the first slab right before the second slab is placed.

-Cleanup around the slab is easier because the dowels are not in the way. We can still fine grade before inserting the diamond plate dowels, and the plates don't stick out as far as the old round dowels. There's less of a tripping hazard when working around the slab.

Explaining advantages



Conventional dowels have to be removed to allow for the removal of edge forms. They then must be replaced before the adjacent slab is placed. Unless workers take extreme care

during this operation, they easily can hollow out a cone-shaped hole in the freshly placed concrete, which can reduce the load-bearing capacity of the dowel significantly. The replacement of round or square dowels requires the same care to prevent the green concrete from becoming fractured at the interface of the joint. It is often difficult to explain to site operatives the difference between tapping the dowels back in and beating them back in when production rates are at stake. The new diamond plate dowel eliminates these concerns.

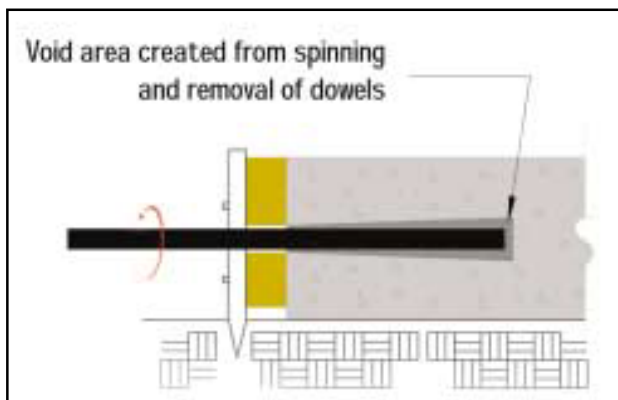
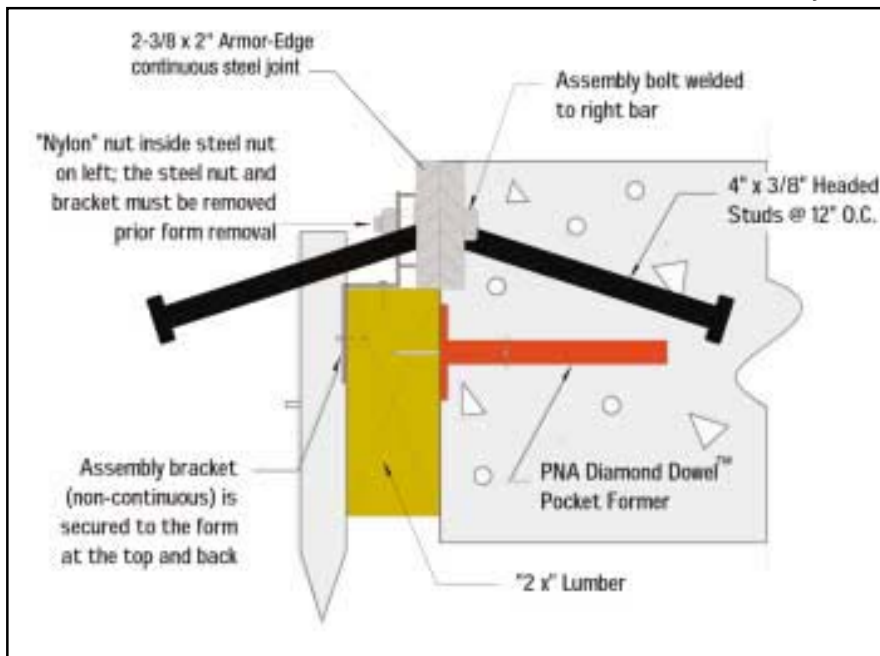
Especially when SCC is used, elimination of slab restraint can be critical. With SCC, the concrete is designed to expand within the first 7 days to compensate for the normal drying shrinkage, then return to its original size. To achieve this we must reduce all restraint caused by subgrade friction or dowels. The diamond plate dowel system eliminates restraint caused by misaligned dowels in construction joints, and it is also minimizes the likelihood of out-of-joint cracking.

Improved joint protection

Joint failure (spalling at the joints) is the most frequent complaint from owners of industrial concrete floors.



Left: The diamond plate dowel system allows for differential shrinkage in adjacent slab placements, allowing the joint to open freely and provide total load transfer. Below: an assembly diagram of the diamond plate dowel system and the continuous steel joint.



Left: A void area is created when dowels are spun for removal. Spinning and pulling out the dowels are necessary to remove the forms. The void minimized the dowel's effectiveness in load transfer.

DPI recognized the need for good joint protection and specified steel armored joints. The Armor-Edge joint assembly was used for the very first time on this project. This fully fabricated assembly was developed by PNA to improve the tolerances of armored joints,

prevent secondary spalling to the outer edge of the steel bars and reduce the labor required for installation.

Response of workers

Some of the comments from the Fricks' installers about working with the armored joint assembly are as follows:

-The armored edge assembly is much easier to set than conventional armored joints. It is easier to keep straight and to keep both sides flush during the concrete pour.

-These steel joints require less work because we set both sides at once.

We don't need a welder to set the second side.

-We don't have to return and grind off the welds after both sides have been placed. That means we don't have to worry about scratching the concrete surface with the machines when we grind off the tack welds.

Explaining the edge assembly

The joint assembly is constructed with two cold-rolled steel bars. These bars are flatter and provide a square edge to finish up to. This improved top surface prevents the typical secondary spalling to the outer edge of the bar that often occurs with more conventional site-fabricated armored joints. Hand finishing against the armored edge during the strike-off and initial setting of the concrete ensures the flatness across the joints. This was followed up with trowel machines to achieve the same burnished trowel finish all the way up to the joint.

Site testing and QC

Designs incorporating the use of SCC in slabs can produce exceptionally durable floors. But, in order for these designs to work properly, efforts must be made to ensure that the concrete mix is expanding at the right rate for the reinforcement design. The contractor must understand this importance and be able to test the concrete expansion onsite.

On this project, tests were run on trial mix designs before the start of the

project to ensure that proper expansion was achieved and to allow adequate time to react to any problems or concerns that were encountered. Both the ASTM C 878 "Restrained Expansion Test for SCC" and a double-check with the FFS jar expansion test were performed onsite daily to verify that the optimum expansion was achieved.

The necessity for low restraint in SCC slabs means that the subgrade must be extremely flat. With this (and the cost implications of excess concrete yield) in mind, it is our opinion that the fine grading always should be the responsibility of the flooring contractor. On the DPI project, Fricks Floor Systems had to meet a subgrade requirement of $\pm 1/10$ foot. The general contractor provided the additional subgrade material needed and was responsible for removing excess material.

Success lies in the details

Concrete will surprise you, and SCC is no exception. As with any industrial floor slab, success lies in the details. Contractors should always be aware of the potential for random cracks and should take steps to prevent them.

Fricks' site personnel went to great lengths on the DPI project to look for situations that could cause re-entrant cracks and to make sure that additional reinforcement was located to reduce crack potential and, in case cracks did occur, to hold them tight.

The joint layout also was given great attention, particularly where mezzanine columns fell in the middle of pours and didn't line up with the main building columns. Isolation material and additional reinforcement were placed at these locations.

Summary

This industrial slab was designed to reduce floor joints and cracks. The quality construction methods and innovative products adopted contributed to the project's success. The owner's receptiveness to innovation and high expectations translated into a finished industrial slab that is flat and durable not only at the center of the slab but

also at the joints. These innovative products and attention to detail will reduce future maintenance and repair costs for both the slabs and the equipment they carry for the life of the facility.

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For information on PNA, call 800-542-0214, visit www.pna-inc.com on the Web.

PROJECT PARTICIPANTS

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Industrial Concrete Floor Contractor:
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Products Supplier
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