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Tech Brief

JOINTED PRECAST CONCRETE PAVEMENT PANEL FABRICATION AND INSTALLATION CHECKLISTS

INTRODUCTION

Precast concrete pavement (PCP) technology is gaining wider acceptance in the U.S. for rapid repair and rehabilitation of concrete pavements, as well as for reconstruction of heavily trafficked asphalt concrete intersections. Widespread use in the U.S. is fairly recent, with most projects in service less than about 10 years. PCP technology is being used for intermittent repairs (both full-depth repairs and full panel replacement) and for continuous applications (longer-length/wider-area rehabilitation) with service life expectations of at least 20 years for repairs and at least 40 years for continuous applications, without significant future corrective treatment. Available PCPs include jointed PCP with reinforced or prestressed panels installed singly or in a continuous series.

For PCP construction, for repair as well as for rehabilitation applications, panel installation quality is important for the long-term performance of PCP. The proper seating of the panels on the base and the load transfer across transverse joints are critical design and construction elements. The support under the panels needs to be firm (strong), uniform and non-erodible and the load transfer across transverse joints needs to be robust. In addition, the precast concrete panels, fabricated under controlled environment at a precast plant, and other materials used during the precast panel installation need to meet quality requirements as defined by the project plans and specifications.

The as-constructed PCP quality is affected by the three phases of a PCP project

1. Project plans and specification development – typically highway agency responsibility.
2. Panel fabrication – typically the precaster responsibility. However, the overall panel quality responsibility lies with the prime contractor as the precaster serves as a subcontractor to the prime contractor.
3. Panel installation – prime contractor responsibility. The panel installation is the most critical part of the project. Even with the best plans and specifications and quality panel fabrication, if the panels are not installed well, the project will not last long and will fail prematurely. Therefore, it is important that there is a strong focus on the quality of panel installation, within the context of the project requirements, to ensure that the project is successful both in the short term and in the long term.

U.S. Department of Transportation
Federal Highway Administration

A PCP may incorporate the following design approaches:

1. For transverse joint load transfer
    a. Panels with dowel bar and tie bar slots at the panel surface
    b. Panels with dowel bar and tie bar slots at the panel bottom
    c. Panels with a combination of surface slots and ducts for dowel bar installation
2. For panel bedding support
    a. Grade-placed panels – panels are placed directly over a thin bedding layer, typically cemented concrete sand, that is placed over the graded and compacted granular base
    b. Grout-supported panels – panels are set at the desired elevation over the base using a leveling lift system that maintains a small gap (1/2 in. to 1 in.) between the panel and the base. The gap is then filled with a rapid-setting bedding grout.

This guide set of checklists for the construction of PCP is intended for highway agency construction personnel. However, the checklists should be of use for the contractor personnel too. The checklists presented here follow the flow of typical PCP project construction activities. The checklists are not intended to replace the agency's QA and the contractor's QC activities, but rather to supplement and reinforce these activities to ensure a quality product is constructed. Agency and contractor personnel using the checklists should be knowledgeable in PCP construction and PCP technology. Depending on the type of PCP being used for a specific project and the project plans and specifications, not all the items in the checklists may be applicable. The user will need to determine which items are pertinent to their specific project.

PROJECT SPECIFIC REQUIREMENTS

A typical PCP project will involve the following work items:

1. Removal of existing pavement
    a. For existing concrete, generally only the distressed concrete panels are removed. However, several agencies require removal of the concrete slab and the base layer.
    b. For existing asphalt concrete (AC) pavement, the AC layer and all or part of the base layer may be removed.
2. Preparation of the base. This step may require addition of base material. The base is graded and compacted if granular. A thin cemented-sand bedding layer may be placed over the granular base. A rapid-setting lean concrete base (RSLCB) may be used if the existing base has been removed.
3. Installation of precast concrete panels.
4. Application of rapid-setting high strength dowel slot grout.
5. Application of rapid-setting bedding grout.
6. Surface grinding, if required
7. Joint sealing, if required.

The construction of a PCP project is governed by project-specific plans and specifications. The plans and specifications establish the PCP system requirements, construction requirements, project submittals, and the end-product quality requirements. For larger PCP projects, the specifications also incorporate the requirement for a test section, typically, the first night of panel installation.

The following are important submittals needed to be provided before panel installation begins:

1. Precaster's panel fabrication QC plan
2. Contractor's panel installation QC plan (QCP)
3. Work area safety plan
4. Emergency management plan.

Ideally, the contractor's QCP should ensure elimination of placement of marginal panels and other materials and use of marginal construction processes. Key elements of the QCP are listed below:

1. Do not fabricate panels if concrete requirements are not met
2. Do not ship panels if panel requirements are not met
3. Do not install damaged panels
4. Stop panel installation if process is disrupted – equipment breakdown, poor bedding grout, etc.

The highway agency may wish to expand this list to include unplanned circumstances that may be anticipated, which would result in quality problems during construction.

CHECKLISTS

The following PCP panel fabrication and installation related checklists are provided as guidance to highway agencies:

A. Fabricated Panel Pre-Shipping Checklist.
B. Panel Post-Shipping (At-Site) Checklist.
C. On-Site Equipment Checklist.
D. On-Site Materials Checklist.
E. Work Area Preparation Checklist.
F. Panel Placement Checklist.
G. Dowel Bar and Tie Bar Slot Grouting Checklist.
H. Dowel Bar Slot Patching Checklist (if grout not used).
I. Clean-up Operation and Opening to Traffic Checklist.

JOINTED PRECAST CONCRETE PAVEMENT PANEL FABRICATION AND INSTALLATION CHECKLISTS
January 2019

Project Name/ID:
Date:
Checklist Completed By:
Checklist Verified/Approved By:

Note: Check each applicable item within each applicable checklist. In the "Status" column, mark YES if check conducted and no issues noted; mark NO if no check conducted; and mark NOTE if deviation(s) from the specification requirements is(are) present. The note should correspond to the checklist item number. Each note should detail the deviation(s) and how the deviation(s) was(were) resolved.

ITEM	ITEM DESCRIPTION	STATUS
A	FABRICATED PANEL PRE-SHIPPING CHECKLIST	
A1	Check dimensional tolerances as detailed in the project specification.	
A2	Check location/spacing of dowel bar slots and dowel bars. At one project slots for a few panels did not match up with dowel bar locations, requiring on-site widening of slots.	
A3	Check surface texture - broom finish, turf finish or tined, as per project specification.	
A4	Check panel curing age - Panels are required to be cured at the fabrication site for at least 14 days.	
A5	Check panel condition (spalling, cracking).	
A6	Check foam gasket condition for bottom slot panels (if used).	
A7	Check lifting sling details.	
	a. Equal length of slings.	
	b. Use of swivel lift plates with coil bolts.	
	c. Lifting locations at 1/5th the length from each edge.	
	d. Ensure all lifting inserts are equally engaged during lifting operation and the panel load is equally distributed across the four inserts/slings..	
A8	Check proper dunnage placement on the trucks.	
	a. Three-point dunnage for non-planar (warped) panels.	
	b. Four-point dunnage for regular rectangular or trapezoidal panels with uniform thickness.	
A9	Check for sand-blasting of slot faces if curing compound used over the slot faces.	

ITEM	ITEM DESCRIPTION	STATUS
B	PANEL POST-SHIPPING (AT SITE) CHECKLIST	
B1	Check panel identification - Panel type and number, as applicable. This is very important for non-planar panels and panels with varying dimensions at a project. Check for mis-labeling of panels. For non-planer panels, it is necessary that each panel be placed at the correct (designated) location.	
B2	Check panel condition (spalling, cracking) - Spalled or cracked panels should not be shipped to the project site unless authorized by the Engineer.	
B3	Check foam gasket condition for bottom slot panels (if used). Contractor should have extra foam gasket at site to replace damaged foam gasket.	

ITEM	ITEM DESCRIPTION	STATUS
C	ON-SITE EQUIPMENT CHECKLIST	
C1	Check crane capacity. It must be acceptable for largest/heaviest panel and to accommodate the longest swing distance. Otherwise, crane toppling would be a possibility. Same concern would apply to non-crane equipment used to install panels.	
C2	Check availability of excavator and other equipment for existing pavement removal.	
C3	Check availability of sawing equipment availability on site to trim panels, to widen slots or to extend work area.	
	a. Availability of full-depth saw to extend work area if necessary.	
	b. Availability of full-depth or hand-held saw to trim panels if necessary. Hand-held saw to widen slots (as a last recourse).	
C4	Check availability of dummy panel(s) with bottom slots for end of shift use for continuous panel placement. Use of AC cold mix to fill the gap is not recommended as the AC removal during the next shift can damage the embedded dowel bars.	
C5	Check availability of gang drill (s) for drilling dowel bar and tie-bar holes in existing pavement.	
C6	Check availability of grout mixers, including backups. Grout mixers tend to clog and having a backup mixer saves time.	
C7	Check availability of vibratory roller compactors for granular base compaction.	
C8	Check availability of vibratory plate compactors for granular base perimeter compaction.	
C9	Check availability of grading equipment. If auto-grading equipment with a total station system is used, a backup equipment should be available in case of malfunction of the GPS-based total station system.	
C10	Check availability of come-along units to pull the next panel tightly towards a previously placed panel to minimize the transverse joint gap. This is done while the panel is still held by the crane about an inch or so over the base.	

ITEM	ITEM DESCRIPTION	STATUS
D	ON-SITE MATERIALS CHECKLIST	
D1	Check leveling Bolts – Bolts should be the right size and length needed (At one project the contractor brought 300 bolts, but the wrong size (diameter)).	
D2	Check bedding grout packaging (For grout supported panels) - It should be rapid set and must match the submittal information. At one project, the vendor mixed up the bags with ordinary bedding grout, requiring a set time of about 12 hours, resulting in FAILURE TO OPEN TO TRAFFIC penalty for the contractor.	
D3	Check undersealing grout packaging (For grade supported panels) - It should be rapid set and must match the submittal information.	
D4	Check dowel bar slot grout/patching material packaging. It should be rapid set and must match the submittal information.	
D5	Check packaging of epoxy for drilled/grouted dowel bars. It should be rapid set and must match the submittal information.	
D6	Check cemented-sand bedding layer mixture - This mixture should be pre-mixed and supplied in a ready-mix truck. The mixture as supplied, pre-mixed, should be one part cement and not more than six parts concrete sand.	
D7	Check availability of grout cube molds - The right number of molds required for that night's testing must be available.	
D8	Check dowel bar diameter, length and coating. Most agencies require use of epoxy-coated (green color) dowel bars.	
D9	Check tie bar diameter, length and coating. Most agencies require use of epoxy-coated (green color) tie bars.	

ITEM	ITEM DESCRIPTION	STATUS
E	WORK AREA PREPARATION CHECKLIST	
E1	Check Work Area Saw-cutting.	
	a. Work area width - Should be panel width plus 1 to ½ in.	
	b. Work area length - For individual slab replacement, length should be panel length plus ½ to ¾ in.	
	c. Work are length - For continuous panel placement, length should be the total length of the panels, plus ¼ in. (for joint width) times the number of panels, plus ½ to ¾ in. for the joint between the last panel and the existing pavement.	
	d. For narrow work area width, extend width or trim panel width.	
	e. For shorter work area length, extend the length of work area and re-drill dowel bar holes.	
	f. For longer work area length, extend work area to allow placement of dummy panel. Develop appropriate treatment for the end using another panel or using high-early strength concrete.	
E2	Check Granular Base finishing.	
	a. Require moisture application, if necessary, to achieve required compaction level.	
	b. Check base grading. Final grading should be verified with a straightedge and string-line to ensure minimum gap will be available for the bedding grout/cemented-sand bedding layer.	
	c. Check base compaction within interior of the work area and along the perimeter of the work area.	
	d. Perform base compaction testing as per project specifications.	
E3	Check cemented-sand bedding layer, if used (over a granular base only).	
	a. Check grading. Final grading should be verified with a straightedge and string-line.	
	b. Check base compaction within interior of the work area and along the perimeter of the work area.	
	c. Check thickness - ideally should be ½ to 1 in. over the compacted and graded granular base.	
	d. Monitor moisture application (typically by hand spraying). Uncontrolled rate of application must be managed.	
	e. Check set/strength at time of panel placement.	
	f. Perform cemented-sand strength testing as per project specifications.	

E4	Check rapid-setting lean concrete base (RSLCB).	
	a. Check thickness - It should be 4 to 6 in. or as specified.	
	b. Check set/strength at time of panel placement.	
	c. Perform strength testing as per project specifications.	
	d. Check finishing and grade control. Final grading should be verified with a straightedge and string-line.	

ITEM	ITEM DESCRIPTION	STATUS
F	PANEL PLACEMENT CHECKLIST	
F1	Check base final grade.	
	a. Check panel corner locations, typically for the first panel for continuous placement.	
	b. Check panel interior grade - Verify grade uniformity using a 10 ft or longer straightedge.	
	c. Check for minimum gap for grout-supported panels. Verify that there are no high points.	
F2	Check application of caulking vertically at existing pavement longitudinal joints (work area corner locations) to prevent grout loss.	
F3	Check application of the joint filler board over the dowel bars at the joint face with exposed dowel bars, if required by plans.	
F4	Check application of bond-breaker material at the joint face with embedded dowel bars.	
F5	Check application of bond-breaker material over the exposed lengths of the dowel bars at the existing pavement or at the previously placed panel.	
F6	Check that panel corners are protected with shims taped to the panel corner locations.	
F7	Check panels are carefully positioned at intended location and set down carefully.	
	a. Check centering of slots and dowel bars.	
	b. Check centering of slots and tie bars, if used.	
F8	Check requirements for the panel to existing pavement joints.	
	a. Check transverse joint gap - it should be 1/4 to 1/2 in.	
	b. Check vertical elevation difference at the transverse joint. Diamond grinding is required if >1/8 in.	
F9	Check for panel to panel requirements.	
	a. Check transverse joint gap - it should be 1/4 to 1/2 in.	
	b. Check vertical elevation difference at the transverse joint - grinding required if >1/8 in.	

F10	Check longitudinal joint gaps.	
	a. Check longitudinal joint gaps - they should be 1/4 to 3/4 in.	
	b. Check vertical elevation difference at the longitudinal joints - grinding required if >1/8 in.	
F11	For grade-placed panels, check application of undersealing grout using the 6 to 9 ports at the panel surface.	
F12	For grout-supported panels, check that the contractor has conducted a few trial runs with grout production off-site, so he does not do trial runs at the site. Otherwise, this would waste precious time and could end up using poor quality grout in the beginning of the grouting operation.	
	a. Engagement of the leveling lifts – Check that the bearing plates separates from the panel bottom.	
	b. Check that at least four leveling bolts are used per panel.	
	c. Check that pneumatic impact wrench or similar equipment is used to turn the leveling bolts and set each panel at the specified surface elevation.	
	d. Check gap under the panels at the grout ports to verify that minimum grout depth is available.	
	e. Confirm the sequence of grout application - from lower elevation ports to the higher elevation ports. The same sequence should be used for all panels.	
	f. Check that the first few gallons of grout at start of production are wasted, until grout with proper consistency is obtained.	
	g. Check that the grout mixer is cleaned as needed to prevent clogging.	
	h. Check that grout flow test is performed at the start of the grouting operation and each time the grout mixer is cleaned and restarted.	
	i. Check to make sure grout samples are obtained for cube testing.	
F13	Dummy panel use.	
	a. Check to ensure that dummy panels are used as stipulated in project plans and specification. Dummy panels protect exposed dowel bars at the end of the last installed panel and speed up existing pavement removal during the next shift.	
	b. Check to ensure that compacted cold AC mix is not used to fill the gap left at the end of panel placement. The compaction process and the mix removal operation may damage the embedded dowel bars.	

ITEM	ITEM DESCRIPTION	STATUS
G	DOWEL BAR AND TIE BAR SLOT GROUTING CHECKLIST	
G1	Check that the contractor has conducted a few trial runs with grout production off-site, so he does not do trial runs at the site. Otherwise, this would waste precious time and could end up using poor quality grout in the beginning of the grouting operation.	
G2	Confirm the sequence of grout application - from lower elevation slots to the higher elevation slots. The same sequence should be used for all panels.	
G3	Check and clean the grout mixer as needed to prevent clogging.	
G4	Apply slot grout.	
	a. Using ports for bottom slot panels.	
	b. Using narrow-mouth surface openings for top slot or full-depth slot panels.	
	c. Apply grout along the joint gaps as required by plans and specification.	
	d. Waste the first few gallons of grout at start of production until grout with proper consistency is obtained.	
	e. Obtain grout samples for cube testing.	

ITEM	ITEM DESCRIPTION	STATUS
H	DOWEL BAR SLOT PATCHING CHECKLIST, IF GROUT NOT USED	
H1	Ensure that slot opening at joint face is blocked (barricaded) by joint filler board, pre-placed in the joint gap or by other approved method. The patching material must not enter the joint gap.	
H2	Verify proper preparation of the patching material, as per submittal, with or without addition of fine aggregate.	
H3	Check that samples for strength testing are prepared and stored properly.	
H4	Verify that the patching material fills the slots properly and tamping is applied, if necessary .	

ITEM	ITEM DESCRIPTION	STATUS
I	CLEAN UP OPERATION and OPENING TO TRAFFIC CHECKLIST	
I1	Check that the work area is cleaned-up before opening to traffic. All excess grout collected at the panel surface should be removed as soon as possible before it hardens. Leaving grout over the panel surface will impact surface texture, requiring grinding to restore surface texture.	
I2	Check that temporary lane marking is applied, as required	
I3	Check the bedding grout breaks. Do the grout strengths meet the opening to traffic strength requirement?	
I4	Check the dowel slot grout breaks. Do the grout strengths meet the opening to traffic strength requirement?	
I5	Check the dowel bar patching material breaks. Do the patching material strengths meet the opening to traffic strength requirement?	
I6	Ensure that opening to traffic is authorized only if grout and patching material strength requirements are met and work area has been cleaned up.	

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