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<th>Title</th>
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Pavement Design Categories

There are three pavement structural design categories:

- “New” pavement design
- Pavement reconstruction design and
- Pavement rehabilitation design
“New” and Reconstruction Design

- Continuously Reinforced Concrete Pavement (CRCP)
- Jointed Concrete Pavement (JCP) or Concrete Pavement Contraction Design (CPCD)
Steel in CRCP:
- Contains longitudinal and transverse steel
- Does not contain transverse joints except at construction joints

The function of the longitudinal steel
- **NOT** to strengthen the concrete slab,
- But to control concrete volume changes due to temperature and moisture variations and
- Keep transverse cracks closed tightly.
Continuously Reinforced Concrete Pavement (CRCP)
CRCP Components

- Longitudinal Joint
- Longitudinal Steel
- Transverse Steel
- Tie Bars
- Longitudinal Steel
- 4” ACP Base
- 11” CRCP

OCT 29 2003
Jointed Concrete Pavement (JCP)

- **Steel & Joints in JCP:**
  - Transverse joints spaced at regular intervals
  - Transverse joints used to control temperature induced contraction and expansion
  - Smooth dowel bars used at transverse joints for load transfer
  - Transverse joints spaced at 15 foot intervals

- **The function of the longitudinal joints**
  - Used to control random longitudinal cracking
  - Longitudinal joints are tied together with tie bars
Jointed Concrete Pavement (JCP)
JCP Components

Dowel Bars

Tie Bars

ACP Base
Selection of Rigid Pavement Type

- CRCP provides excellent long-term performance requiring very low maintenance
- TxDOT policy is to utilize CRCP for new or reconstructed rigid pavements in Texas
- There are situations where jointed pavement may be desirable
Situations Where Jointed Pavement may be Desirable

- For JCP to be utilized, it must meet one of the following criteria:
  - Roadways controlled and maintained by another government entity
  - Aesthetic reasons where pedestrian traffic might interpret the randomly spaced cracks of CRCP with premature failure
  - Parking areas or roadways with crosswalks, adjacent parking, or sidewalks
For JCP to be utilized, it must meet one of the following criteria:

- Railroad crossings, approaches to structures or widening existing JCP

- Intersections and approaches in flexible pavement roadways associated with vehicle braking and acceleration which could cause shoving and rutting of an asphalt pavement

- Other situations approved by the Administration, after submittal of request and justification to the Materials & Pavements Section of the Construction Division (CST-M&P).
Other Situations Where JCP has been Used

- District experience
  - CRCP failures but good performing JCPs
    - When local aggregates were used and
    - Design traffic was not very high
- Urban Section with many leave-outs
- Selection of the same pavement design as adjacent section
Reconstruction

- **Reconstruction of Concrete Pavement**
  - Most invasive rehabilitation option, however, in many cases the most cost-effective
  - Used for pavements with many cracked slabs, subgrade and support instability, serious material distresses and roadway safety needs
  - Restoration and resurfacing of pavements in these conditions is usually less effective
  - May involve removal and replacement of parts of the pavement, limited to one lane or removal of the entire pavement, including support layers
Recycling Concrete Pavement

- Eliminates need for disposal by using the readily available pavement as an aggregate source for new concrete or subbase layers
- Recycling concrete pavement is a relatively simple process
  - Involves breaking, removing and crushing concrete from an existing pavement into a material with a specified size and quality.
  - Crushed concrete may be reused as an aggregate in new Portland cement concrete or any other structural layer.
Reconstruction - Recycling of Concrete Pavement

- TxDOT CRCP with Recycled Concrete Aggregate (RCA)
  - Rehab project in Houston, TX
  - I-10 between I-45 & Loop 610 West
  - Project Length: 5.8 miles
  - Existing CRCP: Constructed in 1968
  - 10 Lanes + HOV
  - No virgin aggregates used in concrete
    - All RCA (both coarse & fine aggregate)
- Good performance of CRCP with RCA in Illinois and Texas
- TxDOT Specification
  - Allows 100% coarse RCA
  - Waives soundness requirement
  - Use of coarse RCA is encouraged
Pavement Rehabilitation Design

- Bonded Concrete Overlay (CRCP)
- Unbonded Concrete Overlay (CRCP or JCP)
Bonded Concrete Overlay (BCO) on CRCP

- Concrete pavements designed and constructed with predicted traffic
  - Some sections are insufficient for today’s traffic demand
  - Insufficient thickness has often resulted in pavement distresses
    - Punchouts for CRCP
    - Mid-slab cracking or joint faulting in CPCD
  - BCO can be a cost-effective rehabilitation strategy to extend pavement life if:
    - Portland cement concrete (PCC) pavement is structurally sound (slab support is in good condition) except for the deficient thickness
In bonded concrete overlays:
- New concrete layer is applied to the surface of an existing PCC pavement
- Increases total thickness of the concrete slab
  - Reducing wheel load stresses and
  - Extending pavement life

Completed BCO projects in Texas
- Some have provided an additional 20-years of service
- Other projects did not perform well

Difference between good and poorly performing BCOs traced to bond strength between new and old concretes
Design and construction of BCOs involves the following:

- Evaluate the project’s candidacy for BCO
- Develop adequate slab thickness and steel designs
- Repair distresses in existing pavement
- Prepare surface of existing pavement for overlay
- If needed, place steel
- Place new concrete and provide for optimum curing
Bonded Concrete Overlay (BCO) ≤ 3 in
Bonded Concrete Overlay (BCO) \leq 5 \text{ in}
Unbonded Concrete Overlay (UBCO)

- Unbonded concrete overlay consists of:
  - Concrete layer ($\geq 5$ inches) on top of an existing concrete
  - With “separation interlayer” to separate new overlay and existing concrete
  - Feasible rehabilitation alternative for PCC pavement for practically all conditions
  - Most cost-effective when existing pavement is badly deteriorated due to reduction in repairs to existing pavement
Unbonded Concrete Overlay (UBCO)

- Unbonded CRCP concrete overlays may be used over CRCP, JCP, or jointed reinforced concrete pavement (JRPCP).
- Unbonded CRCP overlay uses the same design procedure as new CRCP.
- This use of unbonded CRCP overlay can:
  - Be credited for contributing to the structural capacity of existing concrete pavement and
  - Results in a thinner concrete pavement design than required for CRCP constructed on a new location.
Unbonded Concrete Overlay (UBCO)

- Design and construction of UBCO very similar to new construction; the procedure is as follows:
  - Evaluate the project’s candidacy for UBCO
  - Develop adequate slab and interlayer thickness and steel designs
  - Repair distresses in existing pavement
  - Place new concrete and provide for optimum curing

- If UBCO is placed over CPCD, shattered slabs must be removed and replaced

- If placed over CRCP, punchouts should be repaired through full depth repair (FDR)
  - Spalling, whether partial or half depth, does not require repairs; however, some districts repair them before placing an UBCO
Unbonded Concrete Overlay (UBCO)

- Layer directly beneath new CRCP slabs is always a bituminous layer in TxDOT designs
  - This holds regardless whether the subbase is cement treated or asphalt stabilized
  - The 1-inch bituminous layer over cement stabilized subbase is called “bond breaker”

- In UBCO, the existing PCC pavement (whether CPCD or CRCP) acts as a stabilized subbase like cement treated base (CTB)

- From a structural standpoint, UBCO is similar to TxDOT’s new CRCP system with CTB and bond breaker
Uncommon Concrete Pavement Types

- Thin Whitetopping
- Jointed Reinforced Concrete Pavement (JRCP)
- Precast Concrete Pavement
- Roller Compacted Concrete Pavement
Thin Whitetopping (TWT)

- Thin whitetopping (TWT)
  - 4 - 7 inch thick concrete overlay
  - Bonded to existing asphalt concrete pavement (ACP)
  - Creates composite section

- Normally constructed at intersections where rutting and shoving in asphalt pavement continue to occur

- May also be used in the following locations:
  - Access/exit ramps of interstate highways
  - Entire sections of urban roadways
  - Low-volume rural roads
  - Bus lanes
  - Parking areas
Thin Whitetopping (TWT)

ACP with Rutting

Whitetopping Panels in Excellent Condition
Thin Whitetopping (TWT)
Thin Whitetopping (TWT)
Thin Whitetopping (TWT)
Thin Whitetopping (TWT)

- Requirements
  - Adequate Support by Existing ACP
  - ≥ 4 inch ACP layer
  - Uniform support
  - Milling = better bond
  - Remove rutting > ½ inch
Jointed reinforced concrete pavement (JRCP)

- **Joints**
  - Contraction joints and reinforcing steel used to control cracking
  - Transverse joint spacing greater than that for JPCP (60 feet, old TxDOT standard)

- **Cracks**
  - Temperature and moisture stresses expected to cause cracking between joints
  - Reinforcing steel or steel mesh is used to hold these cracks tightly together

- **Load Transfer**
  - Dowel bars typically used at transverse joints
  - Assist in load transfer at transverse joints
  - Reinforcing Steel/Wire Mesh assists in load transfer across cracks
Jointed Reinforced Concrete Pavement (JRCP)
Precast Concrete Pavement
Roller Compacted Concrete Pavement (RCC)
## Total Lane Miles in PMIS, by Pavement Type, FY 2009 - 2012

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<tr>
<th>Pavement Type</th>
<th>Fiscal Year</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
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<tr>
<td>Flexible or Asphalt Concrete Pavement (ACP)</td>
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<td>178,591.5</td>
<td>178,953.8</td>
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<td>11,770.5</td>
<td>12,345.1</td>
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<td>3,988.5</td>
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<td><strong>STATEWIDE</strong></td>
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<th>Concrete Paving</th>
<th>Fiscal Year</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
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<td>7,613,213</td>
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<td>1081</td>
<td>709</td>
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<td>Number of Projects</td>
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<td>201</td>
<td>183</td>
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<td>Item Description</td>
<td>Number of Projects</td>
<td>Average Bid Price</td>
<td>Total Square Yards</td>
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<tr>
<td>Conc Pvmt (Cont Rein-CRCP)(8”)</td>
<td>139</td>
<td>56.47</td>
<td>2,809,999</td>
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<td>Conc Pvmt (Cont Rein-CRCP)(9”)</td>
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<td>Conc Pvmt (Cont Rein-CRCP)(15”)</td>
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<td>53.18</td>
<td>3,927,197</td>
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Max Bid Price
CRCP 15" = $160.29/SY

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<tr>
<th>CRCP Thickness (in)</th>
<th>≤ ¼ lane mile</th>
<th>≤ ½ lane mile</th>
<th>≤ one lane mile</th>
<th>≤ two lane miles</th>
<th>&gt; two lane miles</th>
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<tr>
<td>CRCP 8&quot;</td>
<td>73.07</td>
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<td>53.43</td>
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<td>CRCP 9&quot;</td>
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<td>54.00</td>
<td>44.65</td>
<td>38.19</td>
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<td>CRCP 10&quot;</td>
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<td>58.34</td>
<td>49.34</td>
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<td>CRCP 11&quot;</td>
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<td>43.75</td>
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<td>CRCP 12&quot;</td>
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<td>51.96</td>
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<td>45.00</td>
<td>52.50</td>
<td>52.50</td>
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## SiteManager Data, FY 2009 - 2013

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<th>Item Description</th>
<th>Number of Projects</th>
<th>Average Bid Price</th>
<th>Total Square Yards</th>
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<tr>
<td>Conc Pvm (Jointed-CPCD) (6”)</td>
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<td>2</td>
<td>35.50</td>
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The selection of a pavement type is not an exact science; but one in which the highway engineer must make a judgment on many varying factors such as traffic, soil, weather, materials, construction, maintenance, and environment.