Design and Construction of Highway Pavement Joint Systems

Types and Purpose of Different Joints

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The Types of Joints
Types of Joints

- Joint types:
  - Contraction
  - Construction
  - Isolation (and, if necessary, expansion)

- Each can occur in either the transverse or longitudinal directions.

- Also specialty joints (e.g., transitions, terminal joints in continuously reinforced, etc.).
Types of Joints

Transverse Contraction:

1 in. (25 mm) max. $T/4 - T/3$

Undoweled – Transverse (Type A-1)

Smooth dowel

Doweled – Transverse (Type A-2)
Maintaining Joint/Crack Continuity

- Aggregate Interlock
  - Maximum aggregate size is important
- Mechanical connection
  - Dowel bars
  - Tie bars – NOT FOR LOAD TRANSFER
- Subbase support
Even Tried a “Hinge Joint” Design

http://www.fhwa.dot.gov/pavement/concrete/hpcp/hpcp05.cfm
Joint Movement

\[ \Delta L = C \times L \left( \alpha \times \Delta T + \varepsilon \right) \]

where:

\[ \Delta L = \text{expected change in slab length, in. (mm)} \]
\[ C = \text{subbase/slab frictional restraint factor (0.65 for stabilized, 0.80 for granular)} \]
\[ L = \text{slab length, in. (mm)} \]
\[ \alpha = \text{concrete coefficient of thermal expansion} \]
\[ \alpha = (\text{AASHTO Test Method TP60-00}) \]
\[ \Delta T = \text{maximum temperature range, } ^{\circ}F \ (^{\circ}C) \]
\[ \varepsilon = \text{shrinkage coefficient of the concrete} \]
## Joint Movement

**Typical values for $\alpha$**  
(concrete coefficient of thermal expansion)

<table>
<thead>
<tr>
<th>Type of Coarse Aggregate</th>
<th>Concrete Coefficient of Thermal Expansion $(x \times 10^{-6}$ degree)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>°F</td>
</tr>
<tr>
<td>Quartz</td>
<td>6.6</td>
</tr>
<tr>
<td>Sandstone</td>
<td>6.5</td>
</tr>
<tr>
<td>Gravel</td>
<td>6.0</td>
</tr>
<tr>
<td>Granite</td>
<td>5.3</td>
</tr>
<tr>
<td>Basalt</td>
<td>4.8</td>
</tr>
<tr>
<td>Limestone</td>
<td>3.8</td>
</tr>
</tbody>
</table>
## Joint Movement

Typical values for $\varepsilon$ (shrinkage coefficient of concrete)

<table>
<thead>
<tr>
<th>Splitting Tensile Strength (ASTM C 496)</th>
<th>Concrete Coefficient of Shrinkage (strain)</th>
</tr>
</thead>
<tbody>
<tr>
<td>psi</td>
<td>MPa</td>
</tr>
<tr>
<td>&lt; 300</td>
<td>&lt; 2.07</td>
</tr>
<tr>
<td>400</td>
<td>2.76</td>
</tr>
<tr>
<td>500</td>
<td>3.45</td>
</tr>
<tr>
<td>600</td>
<td>4.14</td>
</tr>
<tr>
<td>&gt; 700</td>
<td>&gt; 4.83</td>
</tr>
</tbody>
</table>
Skewed Joints
Types of Joints

Longitudinal Contraction:

1/8 – 3/8 in. (3 – 9 mm) typ.

Untied – Longitudinal (Type A-3)

Deformed tie bar

Tied – Longitudinal (Type A-4)
Types of Joints

Transverse Construction:

Doweled butt – Transverse (Type B-1)

Deformed tie bar

Tied – Transverse (Type C-1) (Keyway optional)
Construction Joints (Headers)

- Header joints (also known as transverse construction joints) are built at the end of a section of pavement
  - Must be constructed at the end of a day’s run
  - Constructed due to significant paving delays
- Either formed or sawed
- No way to account for in layout planning
- If next to previously placed pavement, best to match header with existing transverse joint
Either two-part form with dowels or tiebars protruding through form or false-dowel attached to form face and dowels inserted upon form removal; consolidate concrete well at form
Sawed Header

- Paving continued through of header, pavement sawed back, dowel/tiebar holes drilled, and dowels/tiebars installed
Resuming Paving at Header

- If formed header, wait at least 6 hours before resuming paving.
- Paving equipment is repositioned over the joint to start the next placement.
- Some hand placement and hand vibration will be necessary on the start-up side of the header.
- Use previously-placed header as a guide for surface finishing to ensure a smooth transition.
Types of Joints

Longitudinal Construction:

- **Tied butt – Longitudinal (Type B-2)**
- **Deformed tie bar**

- **Keyed – Longitudinal (Type C-2)**
  - (Deformed tie bar optional)

Deformed tie bar

1/8 – 3/8 in. (3 – 9 mm) typ.

T/2
Keyways...
Relatively High Risk of Bad Const.
Types of Joints

Isolation:

- Thickened edge – Transverse (Type D-1)
  - 4.5 ft.
  - 1 in. (25 mm) max.

- Filler
  - 1.2T

- Bond breaker
  - 6 ft (2 m) typ.
  - 8 in. (200 mm)

- Sleeper slab – Transverse (Type D-3)
  - 1/2 – 1 in. (12 – 25 mm) max.

- Expansion cap

- Smooth dowel

- Doweled – Transverse (Type D-2)
  - T/2

- Fixture or Structure

- Undoweled – Longitudinal (Type D-4)
Isolation NOT the same as Expansion

- Expansion joints are very rarely used in jointed plain concrete pavements

*Proper Use of Isolation and Expansion Joints in Concrete Pavements:*

Specialty Joints
Concrete/Asphalt Transitions

11.5 – 15 ft. (3.5 – 4.5 m) min.

15 ft. (4.5 m) min.

12 in. (300 mm) min.

15 ft. (4.5 m) min.

2 in. (50 mm)

Dowel bars optional

11/2 in. (40 mm)

T > 7 in. (175 mm)

T + 3 in. (75 mm)

AC SURFACE

AC BASE

GRANULAR

AC SURFACE

AC BASE

Saw cut face

Saw cut face

6 ft. (2 m) max.

6 ft. (2 m) max.

[6 in. (150 mm) min.]
Terminal Joints in CRCP


Wide Flange Steel Beam Terminal Joint Design

Lug Anchor Terminal Joint Design
Continuously-Reinforced Pavement
Terminal Designs

Wide-Flange Beam

Anchor Lugs

Isolation joint (series)

Reinforced sleeper slab

Sleeper slab

Bridge or End of Project

Lugs

Anchor Lugs
Next up: Dowel and Tiebar Design Considerations