Asphalt Won’t Work for a Bridge Abutment – How to Design, Specify, Inspect and Test Concrete

2009 Michigan County Engineers Workshop

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Presentation Overview

► Concrete’s sustainability can make your county more “green”
► The economies of concrete pavements
► The various ways that concrete pavements can be used in your county, including:
  Θ New Construction
  or Reconstruction
  Θ Concrete overlays
  Θ Concrete roundabouts and intersections
► Specifications and materials for concrete pavements
► Construction inspection and testing
Concrete’s Sustainability

- **Improvements in Manufacturing Process**

  Cement manufacturing accounts for about 1.5% of manmade CO₂ and it’s getting better with a reduction of 35% of CO₂ production since 1975.

- **Recycling Key Focus to Improve Manufacturing Process**

  The industry utilizes more than 20 million tons of coal combustion by-products like fly-ash and bottom ash.

  In 2006, the Construction Materials Recycling Association estimated that approximately 125 to 140 million tons of concrete are recycled annually.
Concrete’s Sustainability

► Durability Means Longer Lasting, More Efficient Structures

► Concrete Reflectivity Means Energy Savings

Minimizes the effects that produce urban heat islands.

Light colored pavements also require less site lighting to provide safe night-time illumination levels, whether on parking lots, driveways, or sidewalks.

Concrete costs less in the long run

► Federally funded studies show that concrete Interstate pavements cost 13-28% less in the long run than asphalt Interstate pavements.

► Recent University of Minnesota studies in Olmsted and Waseca counties show that the use of concrete pavement saved up to 19% in the long run over the cost of using and maintaining similar asphalt roads.

► The same studies shows that maintenance costs were reduced 75% when concrete was used to pave roads in these counties.

► Advancements in concrete technology have reduced the cost of concrete paving while improving performance greatly
Recent Trends in Michigan

![Graph showing recent trends in Michigan](image)

**Comparable Sections, Different Costs**

<table>
<thead>
<tr>
<th>Concrete Option</th>
<th>Asphalt Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overlay of old hot mix asphalt (HMA)</td>
<td>Cost: $14.62 / square yard</td>
</tr>
<tr>
<td>New Concrete</td>
<td>new HMA</td>
</tr>
<tr>
<td>Old HMA</td>
<td>Old Concrete</td>
</tr>
<tr>
<td>Physical Life</td>
<td>Cost: $15,742 per square yard</td>
</tr>
<tr>
<td>Composite (2-years)</td>
<td>Composite (2-years)</td>
</tr>
<tr>
<td>4'</td>
<td>4'</td>
</tr>
<tr>
<td>Overlay of old concrete</td>
<td>Cost: $18.85 / square yard</td>
</tr>
<tr>
<td>New Concrete</td>
<td>New HMA</td>
</tr>
<tr>
<td>Old HMA</td>
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<td>Composite (2-years)</td>
</tr>
<tr>
<td>4'</td>
<td>4'</td>
</tr>
<tr>
<td>Reconstruction</td>
<td>Cost: $16.72 / square yard</td>
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<tr>
<td>New Concrete</td>
<td>new gravel base</td>
</tr>
<tr>
<td>New HMA</td>
<td>new gravel base</td>
</tr>
<tr>
<td>Physical Life</td>
<td>Cost: $18.85 / square yard</td>
</tr>
<tr>
<td>20-year Life</td>
<td>20-year Life</td>
</tr>
<tr>
<td>4'</td>
<td>4'</td>
</tr>
</tbody>
</table>

Steve Waalkes, PE
Michigan Concrete Paving Association
Concrete for Counties

- New Construction or Reconstruction
- Concrete Overlays
- Concrete Intersections and Roundabouts

Concrete Pavement Types for Counties

- Jointed Plain
  - Undoweled
  - Doweled
- Jointed Reinforced
Jointed Plain

Plan

Profile

10 – 20 ft

or

Jointed Reinforced

Plan

Profile

25 – 100 ft
Concrete Pavements
Thickness Design

- AASHTO Design Method
  - WinPAS software
- ACPA StreetPave software
- Typical Thicknesses:
  - Major/Minor Arterials: 8” to 10”
  - Collectors: 7” to 9”
  - Residential: 5” to 7”

Many consultants and engineers are knowledgeable in concrete design in your area. Also, contact Michigan Concrete Paving Association for assistance with your project.

Family of Concrete Overlays

- Concrete Overlays
- Existing Pavement
  - Concrete
    - Bonded Concrete Overlay
    - Unbonded Concrete Overlay
- Existing Pavement
  - Asphalt
    - Conventional Whitetopping Overlay
    - Ultra-Thin Whitetopping Overlay
Unbonded Concrete Overlay

► Consists of thick concrete layer (5” or greater) on top of an existing concrete pavement.
► Uses a “separation interlayer” to separate new overlay and existing concrete.

Unbonded Overlay
When to Use Unbonded Overlays

- Little or no remaining structural life
- Extensive and severe durability distress
- Medium to very heavy truck traffic
- Very weak or wet subgrade
- Other obstacles to reconstruction

Unbonded Overlay

Benefits
- Little pre-overlay repair needed
- Improved Structural Capacity.
  - Very Strong Base that can maintain traffic
  - Reduced Faulting, Pumping, & Loss of Support
- Can place on pavement in bad condition.
  - i.e. "D" cracked pavements, ASR, etc.
  - No future reflective cracking.
- Avoids reconstruction problems
  - Less construction time
Unbonded Overlay

Pre-overlay Repair

Unbonded overlays are less sensitive to underlying pavement condition than any other overlay type

May be needed:
- Repair/replace shattered or rocking slabs
- Repair punchouts in CRCP

Probably not needed:
- Repair of other slab cracking
- Repair of joint spalling
- Load transfer restoration

Unbonded Concrete Overlay

Separation Interlayer:
- Allows layers to act independently.
- Prevents distresses from reflecting into overlay.
- Materials that work:
  - Asphalt concrete
  - Some surface treatments
- Existing AC overlay can be used as interlayer but may need to be milled if excessively rutted, etc.
Unbonded Overlays

**Jointing**
- Mismatch joints.
- Saw joints d/3.

Overlay joints should be mismatched from working cracks too.

Unbonded Concrete Overlay

**Performance**
- Very Good
- Can be expected to perform for 20+ years.
  - Most failures are due to the use of inadequate separation layers.
Concrete Overlays in Michigan

- Whitetopping (concrete on asphalt)
- Thin Unbonded Concrete Overlays
  - Good choice for many city/county roads & streets
  - Existing concrete or composite pavement

Concrete Whitetopping

Mill and Fill with Concrete
Concrete Whitetopping

- Consists of thin concrete layer (typ. 4 in. or less) on top of an existing asphalt pavement.
- Specific steps are taken to bond the new concrete to the existing asphalt and to saw short joint spacing.
  - May or may not contain fibers

Concrete Whitetopping

- Designed to be a cost competitive mid-term fix
  - Actual initial cost bid prices
  - Has been shown to last longer than alternative paving materials
- Designed for minimal impact on traveling public
  - No earthwork required
  - Weekend closures
Thin Concrete Overlays of Composite Pavements or Existing Concrete Pavements

- New Concrete Overlay
- Asphalt Separator Layer
- Old Concrete Pavement

Concrete Overlays

- Not hard to construct
- Do not require extensive engineering expense – more field engineering than plans & survey
- Initial cost is competitive with other rehab options
- Can be constructed quickly with minimal traffic impact
Scoping/Design Issues for Whitetopping and Thin Unbonded Concrete Overlays

► Pre-Design Investigation
  ▪ Visual examination of pavement
    ► Check the profile grade line
    ► Repairs not typical, only needed for areas of extremely poor support, subgrade failure
  ▪ Cores
    ► The more, the better
Scoping/Design Issues
for Whitetopping and Thin Unbonded
Concrete Overlays

► Milling
  ▪ Reduces need for adj. structures, tie-ins to driveways, overhead clearances, etc.
  ▪ Roughened surface enhances bond

► Support
  ▪ Adequate asphalt thickness after milling?
    ► Minimum 3 inches desired
  ▪ Thicken up whitetopping in areas of weak support (over culverts, subgrade failures)

Scoping/Design Issues
for Whitetopping and Thin Unbonded
Concrete Overlays

► Thickness
  ▪ 4 inches typical in Michigan
  ▪ 3.5 inches common (2x4 forms)

► Design Life
  ▪ Can be estimated/predicted with software
  ▪ 10 to 15 years is target
  ▪ Properly designed & constructed, can be >20 years
Construction Steps

► Mill and clean the asphalt
► Place, finish, and cure the concrete
► Early-entry saws for control joints
► Open to traffic
  - 1500 to 3000 psi compressive, or
  - 350 to 550 psi flexural
  ► Actual number depends on amount of heavy commercial traffic

Traverse City, Cornillie Concrete
3.5" UTW, 1996
Cornillie Concrete, 2004

Cornillie Concrete, 2004
Why Concrete for Intersections?

► Use where asphalt has not performed
Construction of Concrete Intersections

Construction: MOT Options

Complete Closure with Detours

- Clear and understandable signing
- Sign indicating when reopens
Construction: MOT Options

Partial Closure with Detours

- Only one-leg closed
- Allow traffic on major roadway

Construction: MOT Options

Complete Closure During Time-Window

- Typically 7 p.m. to 6 a.m. window
- Night construction in sequences
- May require temporary pavement
Construction: MOT Options

Construction Under Traffic - by Lane

Phase 1 Phase 2 Phase 3 Phase 4

Construction: MOT Options

Construction Under Traffic - by Quadrant

Phase 1 Phase 2 Phase 3 Phase 4
Example

Stage 1
Construction Under Closure

Concrete Roundabouts for Local Agencies

- Alternative to traffic signal and cost associated with installation and maintenance
- Concrete handles turning movements better than asphalt
2-Lane Pinwheel

Concrete Roundabout
Opened to Traffic
Concrete Specifications and Materials

Durability by Design and Materials

Concrete Mix Design

Key requirements:
- Durability
- Right strength at the right time
- Workability / Placeability
- Cost effectiveness
Concrete Durability

► Need to ensure:
  - Proper air content (more is better!!)
  - Proper mixing
  - No addition of water
    ➤ To the mixer at the site
    ➤ To the surface of the slab
  - Proper & timely curing

Concrete Strength

► Pavements don’t fail due to low strength – they fail due to durability problems
► Need to focus less on strength, more on producing durable concrete
What are we looking for in a concrete specification?

- Well defined and achievable requirements.

What concrete specifications are currently available to us?

- MDOT specifications, 2003 Spec Book
  - Division 3 - Bases
  - Division 6 – Portland Cement Concrete Pavements
    - Section 601 PCC Pavement Mixtures
    - Section 602 Concrete Pavement Construction
    - Section 603 Concrete Pavement Restoration
    - Section 604 Contractor Quality Control for Concrete
    - Section 605 Concrete Quality Assurance
  - Division 7 – Structures
    - Section 701 Portland Cement Concrete for Structures
  - Division 8 – Incidental Construction
    - Section 801 Concrete Driveways
    - Section 802 Concrete Curb, Gutter and Dividers
    - Section 803 Concrete Sidewalk, Ramps and Steps
  - Division 9 – Materials
    - Section 901 Cement and Lime
    - Section 902 Aggregates
    - Section 903 Admixtures and Curing Materials
What concrete specifications are currently available to us?

- MDOT P1 Modified (High Performance Concrete) Special Provision
- Industry recommended or developed specifications and special provisions.
  - MCPA Durability Spec for Local Agencies (2006)
  - MCPA Local Ride Quality Spec
  - MCPA Concrete Whitetopping Spec
  - ACPA, PCA Guide Specifications

P1 Modified (High Performance Concrete Pavement)

- Improved Workability – finishers love it
- Increased Strength with Less Cement – better durability; lower cost
- Decreased Permeability – less moisture in pavement
- Helps Admixture Effectiveness – better air
- Assures Consistency of Mix – lower segregation potential
Proportion

Sample Mix Design Submittal

<table>
<thead>
<tr>
<th>Material</th>
<th>Type</th>
<th>Source</th>
<th>Sp. Gr.</th>
<th>SSD Wt. (lb)</th>
<th>Yield (ft³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement</td>
<td>ASTM C150 Type I</td>
<td>Essroc</td>
<td>3.15</td>
<td>368</td>
<td>1.87</td>
</tr>
<tr>
<td>Fly Ash</td>
<td>ASTM C618 Class F</td>
<td>Relent</td>
<td>2.55</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>Slag</td>
<td>ASTM C989 Gr. 120</td>
<td>Lafarge</td>
<td>2.89</td>
<td>108</td>
<td>0.48</td>
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<tr>
<td>Fine Agg.</td>
<td>MDOT 2N5</td>
<td>PH 75-5</td>
<td>2.67</td>
<td>1400</td>
<td>8.40</td>
</tr>
<tr>
<td>Intermed. Agg.</td>
<td>MDOT 26A</td>
<td>PH 75-5</td>
<td>2.67</td>
<td>762</td>
<td>4.57</td>
</tr>
<tr>
<td>Coarse Agg.</td>
<td>MDOT 6AA</td>
<td>PH 41-152</td>
<td>2.66</td>
<td>970</td>
<td>5.84</td>
</tr>
<tr>
<td>Water</td>
<td>Potable</td>
<td>Municipal</td>
<td>1.00</td>
<td>238</td>
<td>3.81</td>
</tr>
<tr>
<td>Fibers</td>
<td>Fibermesh</td>
<td>Propex</td>
<td>0.91</td>
<td>1.5</td>
<td>0.03</td>
</tr>
<tr>
<td>Air Entrain.</td>
<td>ASTM C260</td>
<td>Axim</td>
<td>0.91</td>
<td>1.5</td>
<td>0.03</td>
</tr>
</tbody>
</table>

Admixtures

- Air Entrainment: 1.4 oz./cwt. Axim AE260
- Water Reducer: ASTM C494 Type A
  - 4.0 oz./cwt. BASF Master Builders Polynean 900
  - 6.0 oz./cwt. BASF Master Builders Polynean 900
  - 8.0 oz./cwt. BASF Master Builders Polynean 900
- w/cm ratio: 0.45

Mix Design Submittals

Should also contain:

Strength results

- Overdesign for chance of low strength test results means that their strengths may need to be significantly higher than the design.
First Items to Check in a Mix Design Submittal

- MDOT Qualified Products List in the Materials Source Guide
- Aggregate pit numbers
- Cement, slag, and fly ash manufacturers / sources
- Cement content; total cementitious content
- Water / cementitious ratio
- If yield numbers given, check air content
- Any other spec requirements

Mix Design Approval Checklist

Concrete Mix Design Approval Checklist

Cementitious materials:
- From facility or manufacturer on MDOT Approved Manufacturers List? [MDOT Qualified Products List in the Materials Source Guide]
  - www.michigan.gov/mdot/
  - click “doing business” (on left)
  - click “Construction and Technology”
  - click “Manuals & Guides” (down the page)
  - click “Materials Source Guide”
- Cementitious materials content minimized (≤ 564 lb/cyd i.e. ≤ 6 sacks; max. of 658 lb/cyd i.e. ≤ 7 sacks)?
- Fly ash content ≤ 25% of total cementitious content?
- Slag cement (GGBFS) content ≤ 40% of total cementitious content?
- Total SCM (slag + fly ash) content ≤ 50% of total cementitious content?
- w/cm ratio ≤ 0.50 for fixed form or hand pours; w/cm ratio ≤ 0.45 for slipform?

Aggregates:
- From certified pits? (see Approved Manufacturers in Materials Source Guide)
- Proportion (by weight) of coarse to fine aggregates in range of 60/40 to 65/35 or higher?
- Combined aggregate gradation analyzed; mix design in a good zone on workability chart?
- Fineness modulus of fine aggregate (sand) analyzed and in higher range of 2.7 and above, 3.0 to 3.5, or higher works best?

Other:
- Admixtures from Qualified Products List? (see Materials Source Guide)

- Air entrainment usually around 0.5 to 1.0% to achieve 4-6% 
- Riser & water reducer usually up to 8 oz/cyd 
- High-range water reducers not usually recommended except for pumping or very low w/cm ratios? 
- Air contents checked against yield ratio?
- Fibers in the mix?
  - Synthetic fiber dosage rate usually 0.5% to 1.0% (1 bag per yard)
Key Points to Examine in a Mix Design Submittal

- Cement content – keep as low as possible
- Water / cement ratio – keep as low as possible
- Coarse / fine agg. ratio – 55/45 to 65/35
- Use well-graded aggregates – look at combined gradation
- Slump ≠ quality; Slump = workability; ∆ slump = variability
- Freeze-thaw durability = good air system

Aggregates

- 60% to 75% of the concrete’s volume
- Proportion (by weight) of coarse-to-fine aggregate is typically around 60/40
  - Usually ranges from 55/45 to 65/35
- Properties affecting concrete:
  - Shape
  - Freeze-thaw durability
  - LA Abrasion, soft particles, chert, alkali silica reactivity
  - Gradation
Rounded Aggregates

Cubical Aggregates
Flat, Elongated, and Angular Aggregates

Flat, Elongated, and Angular Aggregates

Intermediate Aggregates

Intermediate Aggregates

LIMESTONE CHIPS

PEA GRAVEL

SLAG AGGREGATE
Gradation

Gap Graded Mixes
- segregate more easily
- difficult to place
- higher amount of fines
- require more cement
- greater water demand
Gradation

- Well Graded Mixes
  - less prone to segregation
  - easier to place
  - lower amount of fines
  - require less cement
  - less water demand

Individual Gradations - Range

<table>
<thead>
<tr>
<th>MDOT 6AA Sieve</th>
<th>Coarse Agg. % Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5 in.</td>
<td>100</td>
</tr>
<tr>
<td>1.0 in.</td>
<td>95-100</td>
</tr>
<tr>
<td>½ in.</td>
<td>30-60</td>
</tr>
<tr>
<td>No. 4</td>
<td>0-8</td>
</tr>
<tr>
<td>No. 200 (LBW)</td>
<td>1.0 max</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MDOT 2NS Sieve</th>
<th>Fine Agg. % Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>¾ in.</td>
<td>100</td>
</tr>
<tr>
<td>No. 4</td>
<td>95-100</td>
</tr>
<tr>
<td>No. 8</td>
<td>65-95</td>
</tr>
<tr>
<td>No. 16</td>
<td>35-75</td>
</tr>
<tr>
<td>No. 30</td>
<td>20-55</td>
</tr>
<tr>
<td>No. 50</td>
<td>10-30</td>
</tr>
<tr>
<td>No. 100</td>
<td>0-10</td>
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<tr>
<td>No. 200 (LBW)</td>
<td>0-3</td>
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</tbody>
</table>
### Individual Gradations - Range

<table>
<thead>
<tr>
<th>MDOT 26A (Intermed. Agg.)</th>
<th>Sieve</th>
<th>% Passing</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>¾ in.</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>½ in.</td>
<td>95-100</td>
</tr>
<tr>
<td></td>
<td>⅜ in.</td>
<td>60-90</td>
</tr>
<tr>
<td></td>
<td>No. 4</td>
<td>5-30</td>
</tr>
<tr>
<td></td>
<td>No. 8</td>
<td>0-12</td>
</tr>
<tr>
<td></td>
<td>No. 200 (LBW)</td>
<td>3.0 max</td>
</tr>
</tbody>
</table>

### Combined Gradation

Excel spreadsheet

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>6AA 36%</th>
<th>26A 22%</th>
<th>2NS 42%</th>
<th>Combined 100%</th>
<th>Percent Retained</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>0.0</td>
</tr>
<tr>
<td>1 1/2</td>
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<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>0.0</td>
</tr>
<tr>
<td>1</td>
<td>96.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>98.6</td>
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<tr>
<td>3/4</td>
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<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>88.8</td>
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<tr>
<td>1/2</td>
<td>40.0</td>
<td>98.0</td>
<td>100.0</td>
<td>100.0</td>
<td>78.0</td>
</tr>
<tr>
<td>3/8</td>
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<td>79.0</td>
<td>100.0</td>
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<td>60.8</td>
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<tr>
<td>#30</td>
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<td>0.0</td>
<td>40.0</td>
<td>40.0</td>
<td>16.8</td>
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<tr>
<td>#50</td>
<td>0.0</td>
<td>0.0</td>
<td>12.0</td>
<td>15.0</td>
<td>6.3</td>
</tr>
<tr>
<td>#100</td>
<td>0.0</td>
<td>0.0</td>
<td>3.0</td>
<td>3.0</td>
<td>1.3</td>
</tr>
<tr>
<td>#200</td>
<td>0.0</td>
<td>1.0</td>
<td>1.0</td>
<td>2.0</td>
<td>1.1</td>
</tr>
</tbody>
</table>
Combined Gradation – Plot

**Combined Gradation - 8% to 18% limits each sieve (1 in. top size agg.)**

Coarseness & Workability Factors

\[
CF = \frac{\text{%Retained above } \frac{3}{8} \text{ in. sieve}}{\text{%Retained above #8 sieve}} \times 100
\]

\[
WF = \text{%Passing #8 sieve}
\]

* per James M. Shilstone, Sr., “Concrete Mixture Optimization,” Concrete International, June 1990

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Steve Waalkes, PE
Michigan Concrete Paving Association
**Workability Chart**

- COARSE :: AGGREGATE SIZE :: FINE
- SANDY
- WELL GRADED
  (for Mixtures with Max. Size <3/4")
- WELL GRADED
  (for Mixtures with Max. Size 1-1/2" to 3/4")
- CONTROL LINE
- ROCKY

**0.45 Power Chart**

Combined Gradation - 0.45 Power Curve, 1" Nom. Max. Size
Fibers

Synthetic Fibers

- Reduce shrinkage
- Improve impact and shatter resistance
- Better abrasion resistance
- More concrete toughness (post-crack integrity)
- Typical dosage rate: 1.5 lb/cyd
Inspection & Testing
Keys to a Good Concrete Project

► Open communication; good organization
► Consistent supply of materials = good project flow
► Construction is a material handling business!

Contractor Quality Control
Testing Plan

► Sampling and Testing (at a minimum)
  - Concrete Slump, Temperature, and Air
    ► On the first load and on subsequent loads if directed by Engineer for each grade of concrete delivered each day.
    ► During placement at minimum of once per hour
    ► Quality Control tests may coincide with the tests required for acceptance cylinders.
  - Concrete Strength
    ► Determine strength on samples taken at least once every 200 yards.
Bases

- Section 301 Subbase (p. 163)
  - 301.01 Construction
    - Construct the subbase to plan grade within a tolerance of plus one inch.
    - Do not place subbase on frozen, soft or unstable or rutted subgrade.

- Section 302 Aggregate Base Courses (p. 164)
  - 302.03 A. Placing and compacting
    - Tickets for each load verifying source and other information
    - Uniform gradation with no contamination
    - Compaction requirements

Mixing Concrete
### Table 601-1, Time Between Charging Mixer and Placing Concrete

<table>
<thead>
<tr>
<th>Type of Unit</th>
<th>Concrete Temperature (ASTM C 1064)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;60°F</td>
</tr>
<tr>
<td>Open Top Trucks</td>
<td>60</td>
</tr>
<tr>
<td>Open Top Agitating Units</td>
<td>60</td>
</tr>
<tr>
<td>Closed Top Agitating Units and Truck Mixers</td>
<td>90</td>
</tr>
<tr>
<td>Truck Mixers and Closed Top Agitating Units with Water-Reducing Retarding Admixture</td>
<td>120</td>
</tr>
</tbody>
</table>

All times shown are in minutes.

### Mixing Concrete

**Addition of Water at Placement Site**

- Do not add more water than the approved mix design will allow based on maximum water content and max w/c material ratio.
- Document all water being added
- Allow minimum 30 revs of truck mixer at mixing speed before discharge
Concrete Testing

- Temperature, Slump, Yield, Air Content
- Concrete must be between 45 and 90 degrees F at the time it is placed.
- Slump – not to exceed 3 inches typically
- Yield within limits -0% to +2%

Air Content

- Pressure meter or roll-a-meter
- 5% to 8% (6.5% ±1.5%)
  - Stay on high side
  - Spot-check the in-place air content behind concrete placement
Inspection also needed for:

Placing Forms

Placing Concrete

Texturing

Curing

Vibration
Don’t bless the slab

Don’t be cheap with the curing compound
Key Points
for Good Durability

► Start with good, durable materials
► Air = freeze-thaw durability
► Mix it properly
► Minimize cement content; use SCM’s at appropriate amounts & times
► Minimize water
► Cure!!!

Summary

► Design – keep it simple
► Specs – use MDOT specs, special provisions where needed
► Mix Design – look at gradations
► Inspection – open communication, teamwork is key; keep an eye on air content
► Durability – good air system and good curing are critical; finishing techniques, minimizing use of water also key
It’s all in the design!!

Alpena Community College and the World Center for Concrete Technology
What is the WCCT?

► Over 43,000 square feet of training facility dedicated to the education and training of concrete industry personnel
► Fully automated, computer controlled concrete masonry production facility
► Testing laboratories using state-of-the-art equipment for soils, aggregates, and concrete
► Modern classrooms with full computer access for delivering classes around the world
► Opened in 2000, 10 year anniversary activities planned for 2010!!!
ACC’s A.A.S. Degree in Concrete Technology

Started in late 1960’s as one of original associate’s degree programs by Portland Cement Association

► 2-year degree program covering:
► Construction Inspection and Testing
► Aggregates
► Cementitious materials
► Concrete Masonry
► Ready-mixed Concrete
► Admixtures
► Precast and Prestressed
ACC’s A.A.S. Degree in Concrete Technology

Job Opportunities:
- Management
- Quality Control
- Inspection
- Sales
- Research & Development
- Technical Service
- Production/Supervision
- Engineering

DEVELOPING A SKILLED WORKFORCE

Steve Waalkes, PE
Michigan Concrete Paving Association
What is happening now at ACC and the WCCT?

► Online courses
  ► Cementitious Materials
  ► Concrete Masonry Technology
  ► Admixtures for Concrete
  ► Optimizing Concrete Mixes
  ► Aggregates
  ► Basic Concrete Mix Proportioning
  ► Introduction to Concrete Technology
  ► And many more upcoming!!!

We have qualified students now for summer internships and full-time employment

For more information on the program and hiring interns or graduates, see me or email to kellerc@alpenacc.edu!!!
Questions / Discussion?

Thank you for your time.