Overcoming
Concrete Pavement Objections

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Wisconsin Ready Mixed Concrete Association

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B.S. Civil Engineering (1988 – Iowa State University)
32 years experience in concrete industry

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Objections
Concrete pavements

Wisconsin Ready Mixed Concrete Association

1. Too expensive
2. Jointing – too complicated
3. Premature surface deterioration
4. Cracking
5. Difficult to repair after utility cut
6. "Thin" concrete pavements
7. Takes too long to build, too long to open to traffic

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Objection #1

Concrete pavements are too expensive

4

“We can’t afford concrete parking lots”

“We like concrete, it’s just too expensive”

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Objection #1

Too expensive

- Compared to structurally-equivalent asphalt pavement:
  - Oftentimes *slightly* more than asphalt
    - 10% - 15% higher **first cost**
  - Concrete pavements are sometimes *less expensive up front* than asphalt

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Objection #1

Too expensive

- Reasons for similar first cost to asphalt:
  - Asphalt significantly more expensive over past 13 years

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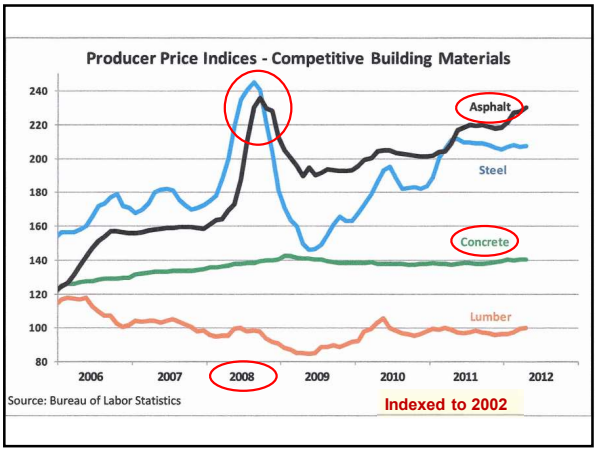

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Oil refinery

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New cracking towers –
2008 - 2010

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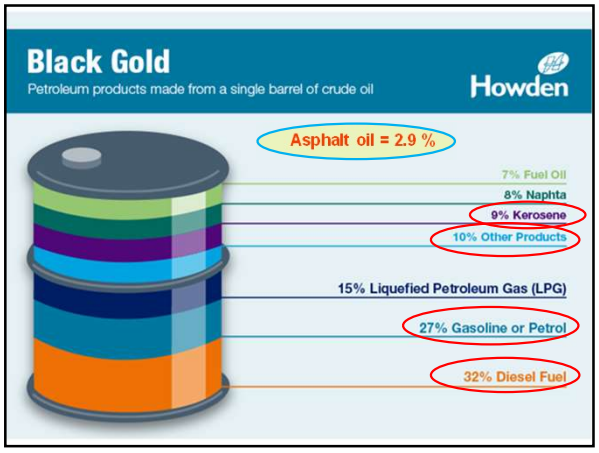
Black Gold
Petroleum products made from a single barrel of crude oil
Howden
Asphalt oil = 2.9 %
7% Fuel Oil
8% Naphta
9% Kerosene
10% Other Products
15% Liquefied Petroleum Gas (LPG)
27% Gasoline or Petrol
32% Diesel Fuel

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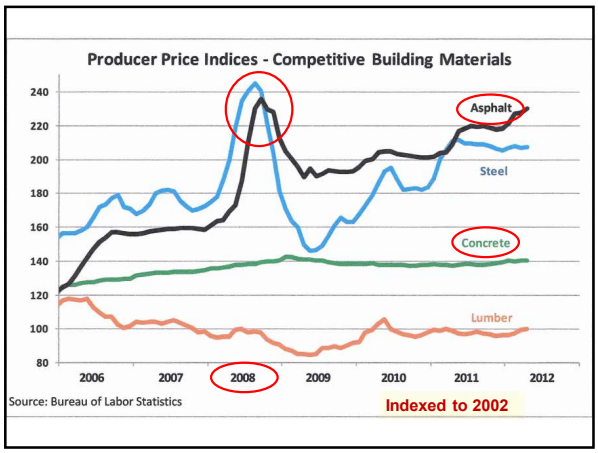

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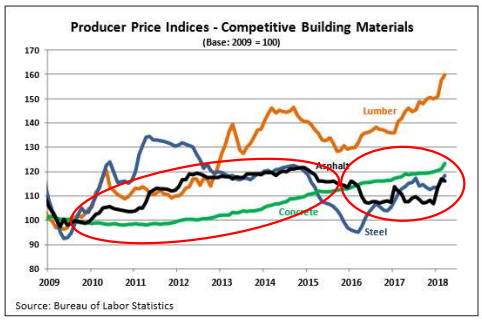
Competitive Materials Report Update: April 2018



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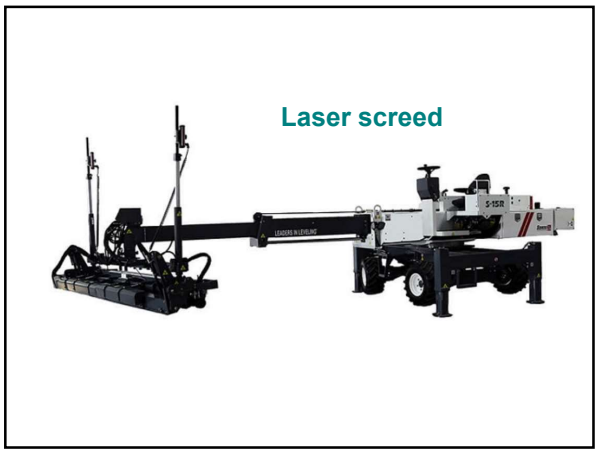
Objection #1

Too expensive

Wisconsin Ready Mixed Concrete Association

- Reasons for similar first cost to asphalt:
  - Asphalt significantly more expensive over past 13 years
  - Concrete paving technology – **3D laser screeds**

15



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Objection #1

Too expensive

Wisconsin Ready Mixed Concrete Association

- 3D laser screeds
  - High quality result
  - More efficient use of manpower and equipment
  - Higher output = more s.f. per day
  - **MORE contractors are doing concrete parking lots with laser screeds**

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Objection #1

Too expensive

More competition = more competitive pricing

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Despite concrete pavement's surprising affordability…

Decades of "asphalt momentum"

23

Despite concrete pavement's surprising affordability…

Business owners, general contractors, architects and civil-site engineers simply assume concrete pavement isn't an viable option

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Suggestion…

Request bids for a concrete parking lot alternate design

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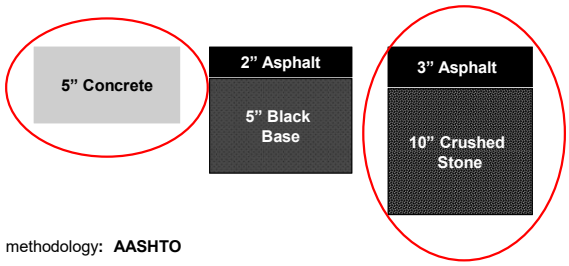
- Structurally-equivalent designs



methodology: **AASHTO**

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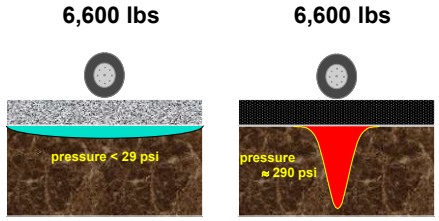
Rigid vs Flexible Pavements



Concrete's rigidity spreads the load over a larger area and keeps pressures on the subgrade low

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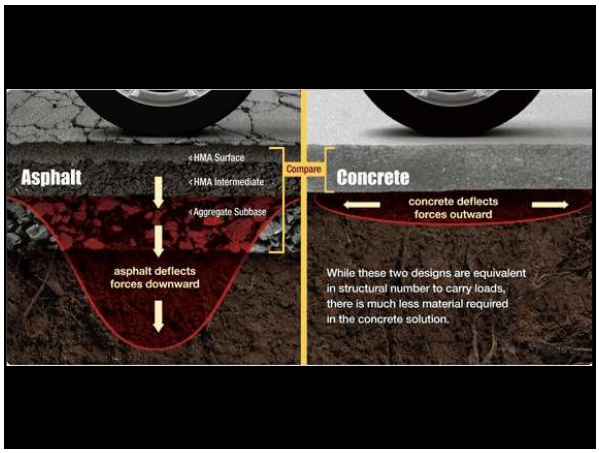

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Objection #1

Too expensive

Wisconsin Ready Mixed Concrete Association

- Reasons for similar first cost to asphalt:
  - Asphalt significantly more expensive over past 13 years
  - Concrete paving technology – 3D laser screeds
  - **More concrete parking lot contractors**

    = More competition = more competitive pricing

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Objection #1

Too expensive

Wisconsin Ready Mixed Concrete Association

- Example:
  - Rite Way Bus Company
    - La Crosse WI – 2018
    - Union concrete contractor
    - 5" concrete (unreinforced)
    - Existing granular subgrade
    - Empty school buses
  - Concrete was **less expensive than asphalt on first cost**

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CONCRETE PARKING LOT

Go-Riteway School Bus Facility

La Crosse, WI

Owner
Go-Riteway Transportation Group

Project Designer
Site Advice LLC
Milwaukee WI

Concrete Paving Contractor
Lewis Construction Inc
Schofield WI

Ready Mixed Concrete Supplier
River City Ready Mix

Project Description
Commercial school bus parking lot
Ready mixed concrete: 2,000 c.y.
Concrete paving area: 175,000+ s.f.
Concrete paving thickness: 5"
Completion Date: Fall 2018

GO RITEWAY TRANSPORTATION GROUP

2020

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Objection #1

Too expensive

Wisconsin Ready Mixed Concrete Association

- Maintenance costs?
  - Concrete pavements are less maintenance-intensive
  - Concrete paving doesn't require
    - Seal coats
    - Overlays
  - Lower "life-cycle costs"

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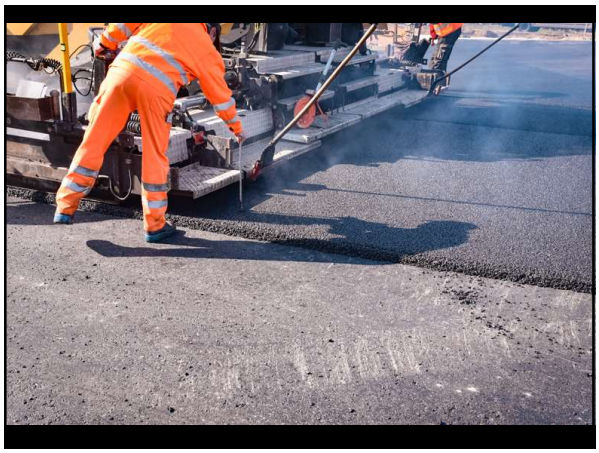

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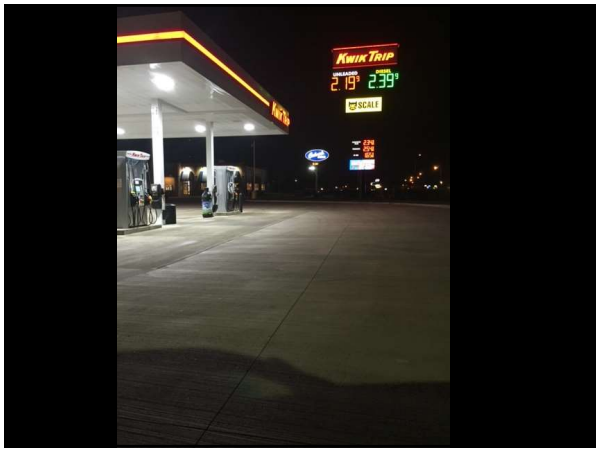

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Concrete is *less expensive* to illuminate

- **30% Brighter** at night

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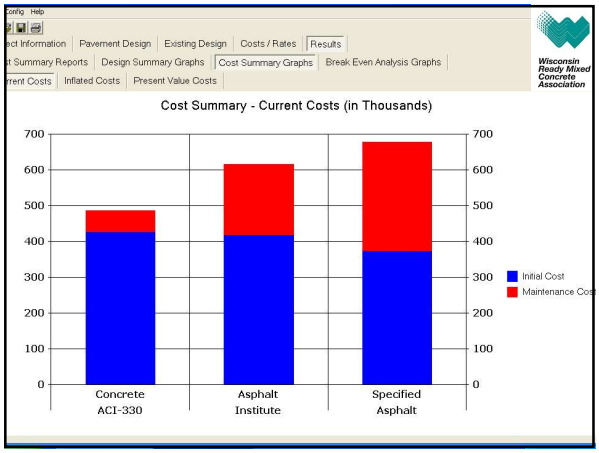

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Objection #2

Joints are too complicated

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Objection #2

Joints are too complicated

Wisconsin Ready Mixed Concrete Association

- **KEY**: Simplify your joint specification and joint layouts
  - Specify a standard joint design or plate (show typical standard drawings)
  - **Let concrete paving contractor work out the actual joint placement**
  - **Give the contractor some basic constraints**

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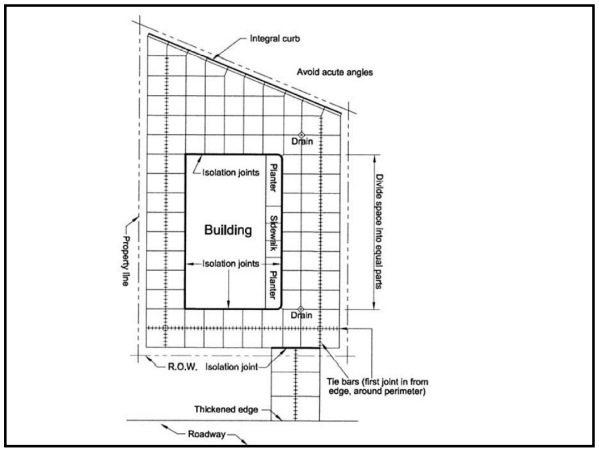

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Objection #2

Joints are too complicated

Wisconsin Ready Mixed Concrete Association

- **Saw cuts** (i.e. control joints)
  - Spacing (ft.) = 2 x D
  - **Example**
    - 4" thick concrete
    - Joint spacing = **2** x **4**" = **8 feet** x **8 feet** panels

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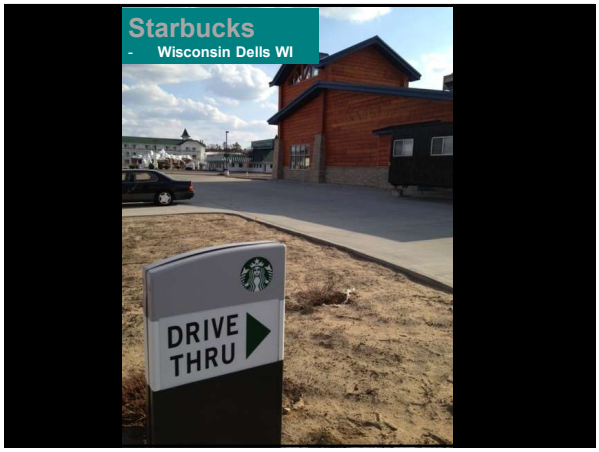

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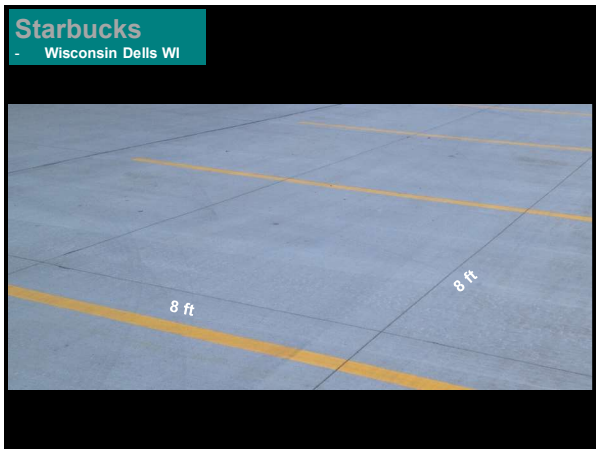

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Objection #2

Joints are too complicated

Wisconsin Ready Mixed Concrete Association

- **Saw cuts** (i.e. control joints)
  - Joint depth = ¼ x D (min.)
  - **Example**
    - 5" thick concrete pavement
    - **5** x **.25** = **1 ¼"** saw cut **depth** (minimum)

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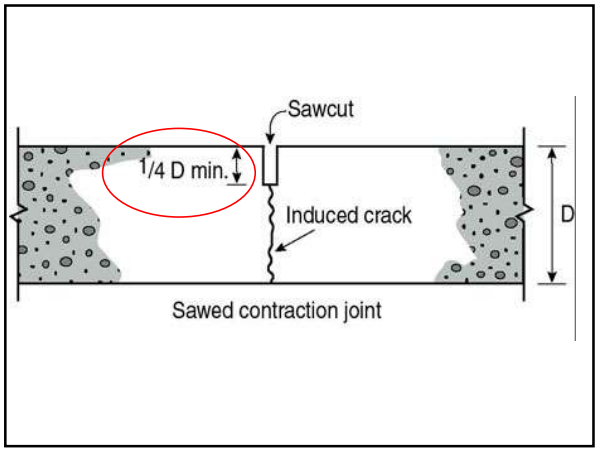

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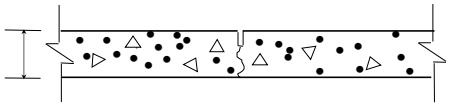
- ***Control*** **joint (a.k.a. "contraction" joint)**



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Objection #2

Joints are too complicated

Wisconsin Ready Mixed Concrete Association

- Control joints
  - Saw cut: early entry or conventional saw
  - Tooled
  - Load-transfer dowel bar baskets?
    - Only higher velocities, large trucks
    - Might consider them for lower velocity drive lanes at industrial facilities (lots of heavy trucks)

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Do we need smooth load-transfer dowel bars?

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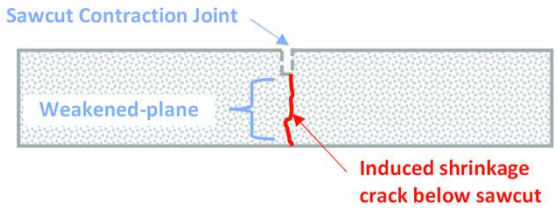
Rules for Designing Contraction Joints



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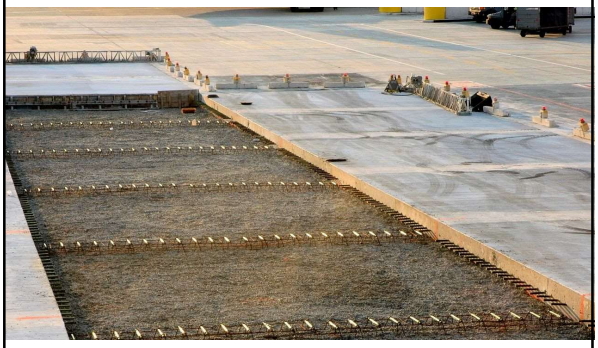

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Objection #2

Joints are too complicated

Wisconsin Ready Mixed Concrete Association

- Construction joints
  - Butt joint
  - Tied (deformed bars)
  - Keyway? – NO

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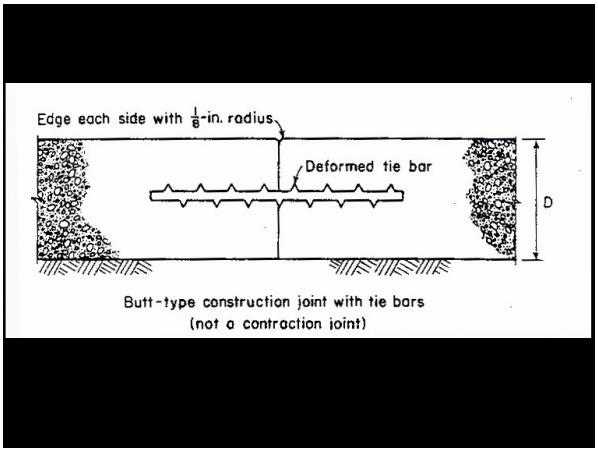

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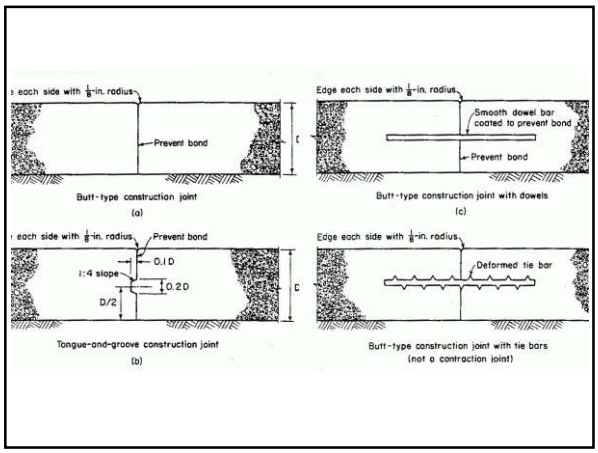
Prevent bond
Butt-type construction joint
(a)
Edge each side with 1/8-in. radius
Smooth dowel bar coated to prevent bond
Prevent bond
Butt-type construction joint with dowels
(c)
Prevent bond
0.1 D
1:4 slope
0.2 D
D/2
Tongue-and-groove construction joint
(b)
Edge each side with 1/8-in. radius
Deformed tie bar
Butt-type construction joint with tie bars
(not a contraction joint)

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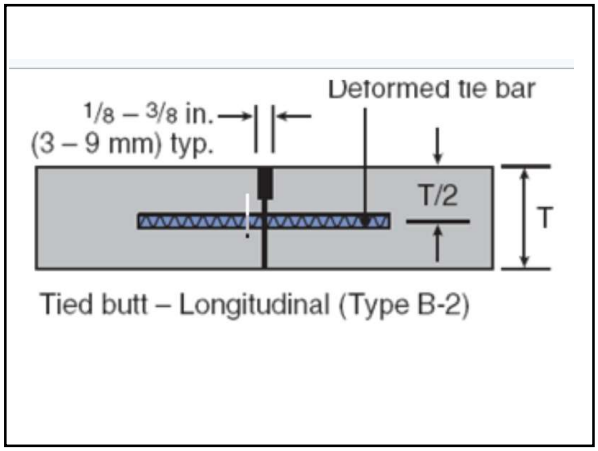
Deformed tie bar
1/8 – 3/8 in.
(3 – 9 mm) typ.
T/2
T
Tied butt – Longitudinal (Type B-2)

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Epoxy-coated deformed tie bars

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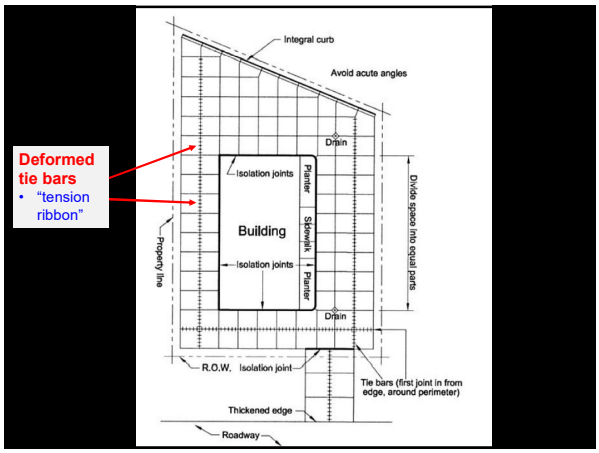
Deformed tie bars
• "tension ribbon"
Integral curb
Avoid acute angles
Drain
Isolation joints
Planter
Sidewalk
Building
Isolation joints
Planter
Drain
Property line
Divide space into equal parts
R.O.W.
Isolation joint
Tie bars (first joint in from edge, around perimeter)
Thickened edge
Roadway

67


Azusa Ave
1/2 MILES
(heavy axle loads)

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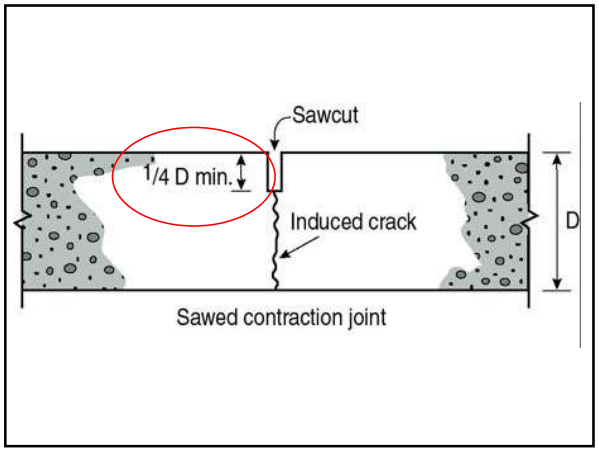
Sawcut
1/4 D min.
Induced crack
D
Sawed contraction joint

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Objection #2

Joints are too complicated

Wisconsin Ready Mixed Concrete Association

- Isolation joints
  - Formerly called “expansion joints”

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Objection #2

Joints are too complicated

Wisconsin Ready Mixed Concrete Association

- Isolation joints
  - **Isolate** concrete pavements from structures based below the frostline
    - Manhole structures, catch basins
    - Pavements poured against a concrete basement wall

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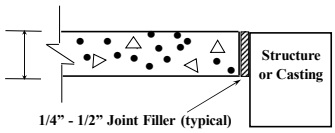
Jointing

- Joint cross sections
  - *Isolation* joint



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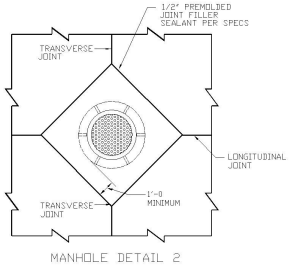
Jointing

- Jointing
  - Manhole or inlet



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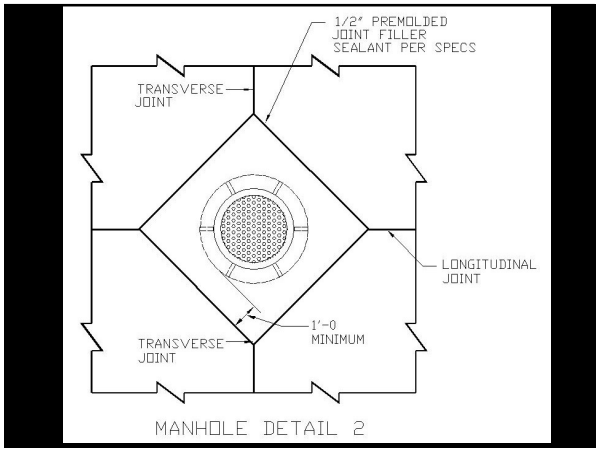

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Objection #3

Premature surface deterioration

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Objection #3

Premature surface deterioration

- Surface deterioration – EXAMPLES
  - Scaling

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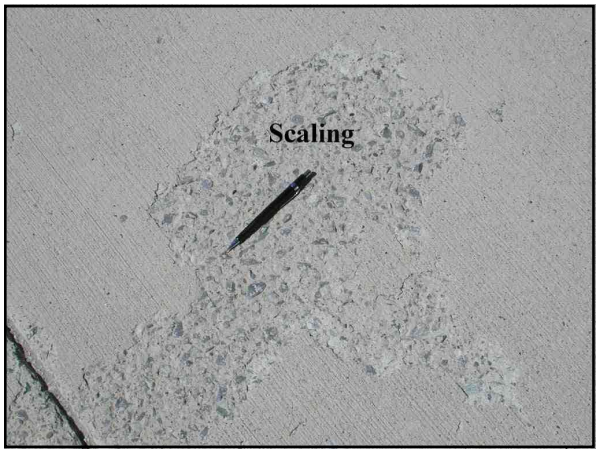

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Objection #3

Premature surface deterioration

- Surface deterioration – EXAMPLES
  - Popouts

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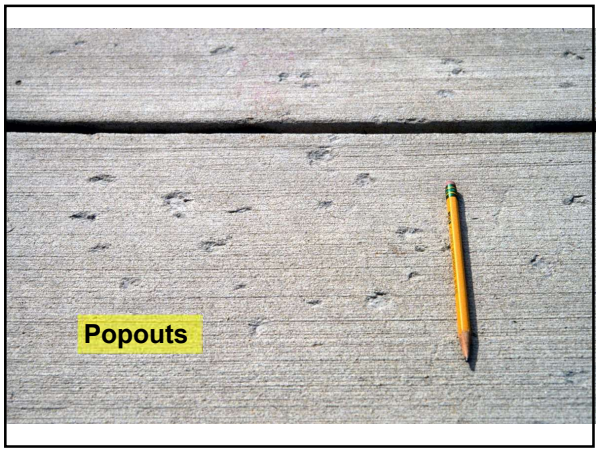

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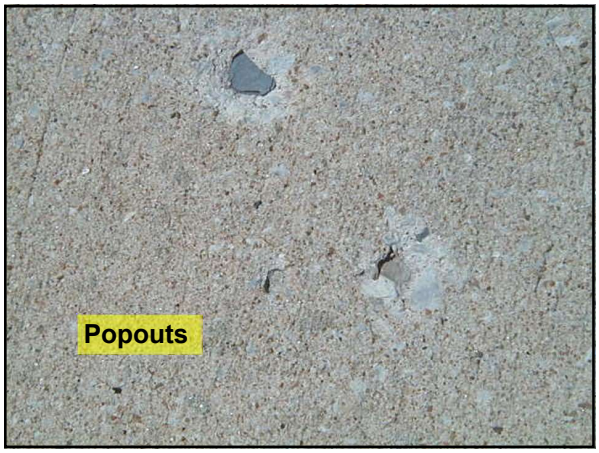

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Objection #3

Premature surface deterioration

Wisconsin Ready Mixed Concrete Association

- Eliminate surface deterioration by doing the following:
  - **Mix design**
    - Air-entrained
    - Low w/c ratio (*generally* < .45)
    - Coarse and fine aggregates with proven freeze-thaw durability
  - **Placing**
    - Avoid excessive water addition on the jobsite
    - Don't over-vibrate/consolidate the concrete

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Objection #3

Premature surface deterioration

Wisconsin Ready Mixed Concrete Association

- Eliminate surface deterioration by doing the following :
  - **Finishing**
    - Initial strike-off: laser or vibratory truss screed
    - Magnesium bull float & broom finish
    - Allow time for concrete to bleed
    - Broomed finish texture
    - NO steel trowels!
    - PROTECT surface from high winds (especially LOW HUMIDITY wind)
    - Don't over-finish! Less is MORE!

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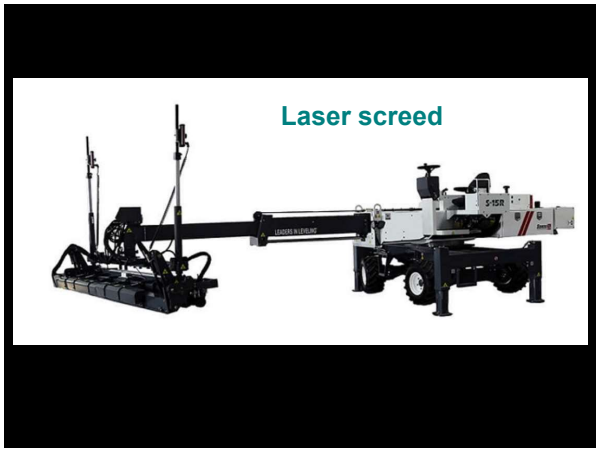

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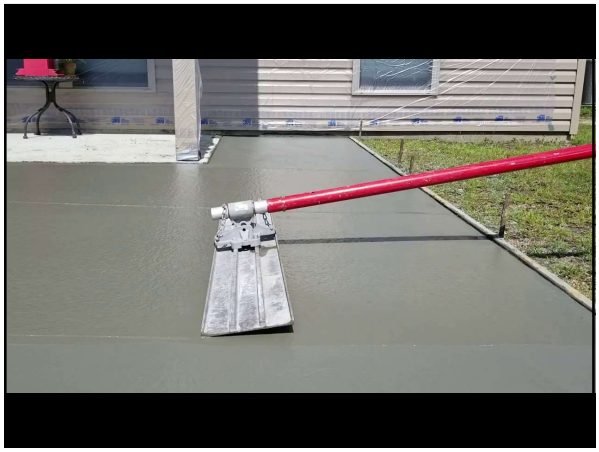

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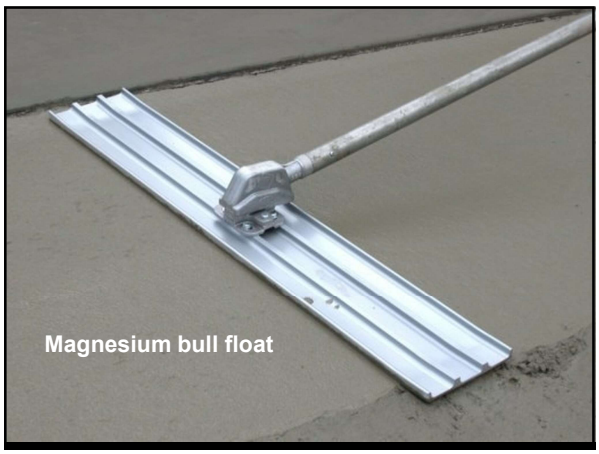

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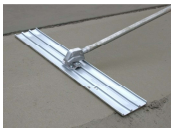
Objection #3

Premature surface deterioration

Wisconsin Ready Mixed Concrete Association

- Why MAGNESIUM?
  - Rough texture
  - "Tears" the fresh concrete surface
  - Opens up bleed water escape channels



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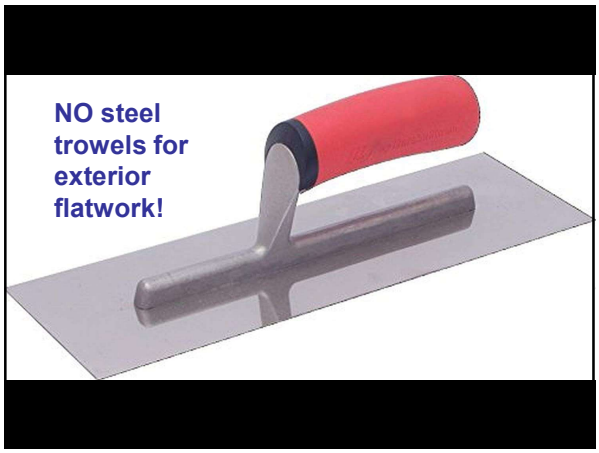

NO steel
trowels for
exterior
flatwork!

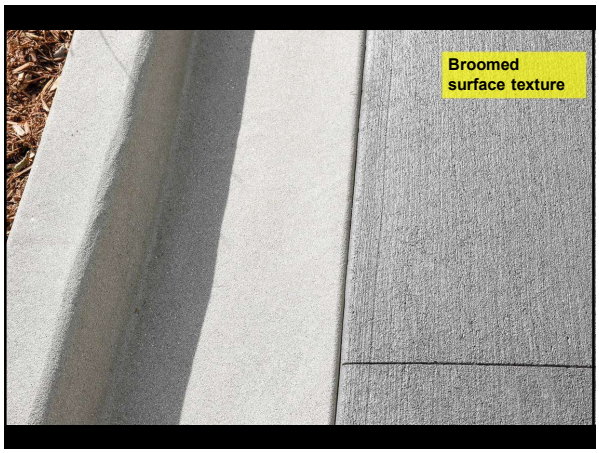
97


NO steel
trowels for
exterior
flatwork!

98


Broomed
surface texture

99



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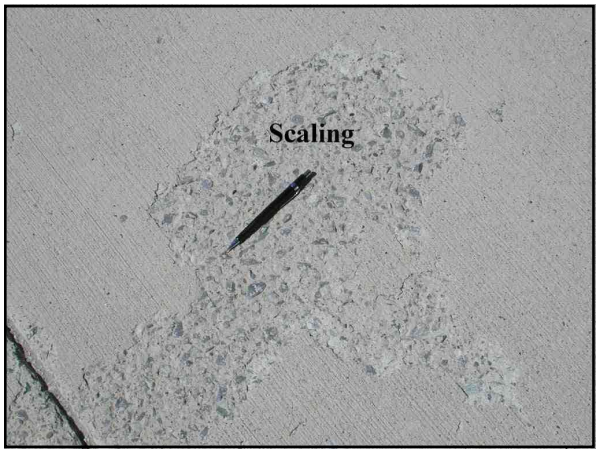

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Objection #3

Premature surface deterioration

Wisconsin Ready Mixed Concrete Association

- Eliminate surface deterioration by doing the following
  - **Curing**
    - Immediate application of curing compound or other curing method

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Objection #3

Premature surface deterioration

Wisconsin Ready Mixed Concrete Association

- Eliminate surface deterioration by doing the following
  - **Curing**
    - KEY: proper APPLICATION RATE
      - Don't under-apply curing compound
      - Should be no un-protected concrete
      - USE CURING COMPOUNT MANUFACTURER'S DOSAGE RATE!

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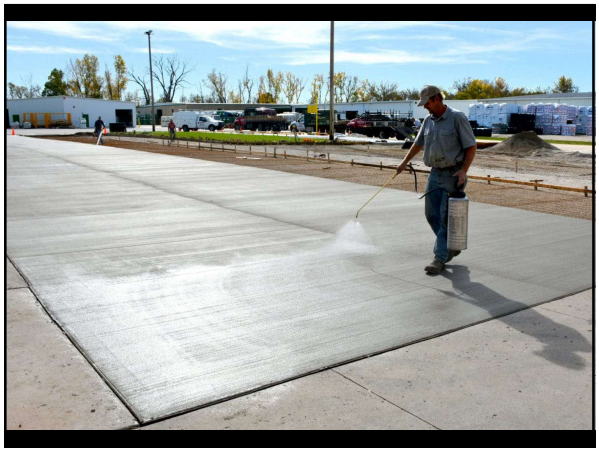

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Objection #3

Premature surface deterioration

- **Curing compounds**
  - Coverage rate: 200 s.f. / gallon
    - Per ASTM C309 and C1315

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111

Objection #3

Premature surface deterioration

- Premature deterioration isn't common, and can be minimized like any other building material
- Typical concerns, and preventative measurers:
  - Cracks
    - Drying shrinkage: proper CONTROL joints (spacing, depth, timing of sawing operations)
    - Structural overload cracking
      - Proper thickness design
      - Proper subgrade/base preparation (proof rolling, compaction, gradation)
  - Scaling
    - Proper finishing techniques – bull float, broom, curing (timing, proper coverage rate) – this is all quite normal
    - Cold and hot weather precautions as necessary
      - Cold weather – MUST use insulated blankets if cold night time temps are forecasted
  - Popouts
    - Confirm mix design is intended to exterior concrete
    - Project owner's expectations? Some popouts should be ok for most owners (remember: concrete pavement is a utilitarian piece of

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Objection #4

Cracking

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Objection #4

Cracking

- Three types
  - Plastic shrinkage cracks
  - Drying shrinkage cracks
  - Structural cracks

114

Objection #4

Cracking

- **Plastic** shrinkage cracks
  - Caused by
    - Premature drying of concrete *surface* while still plastic
    - Generally shallow in depth (1")
    - Generally short in length
    - Occurs in first hour or two after placement
  - Prevention
    - Fiber reinforcement
    - Evaporation retardant
    - Erect a wind break

115

116

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Objection #4

Cracking

- **Drying** shrinkage cracks
  - Easily controlled with proper CONTROL JOINTS
    - Proper timing of saw operations
    - Proper depth
    - Proper spacing
    - Proper location

118

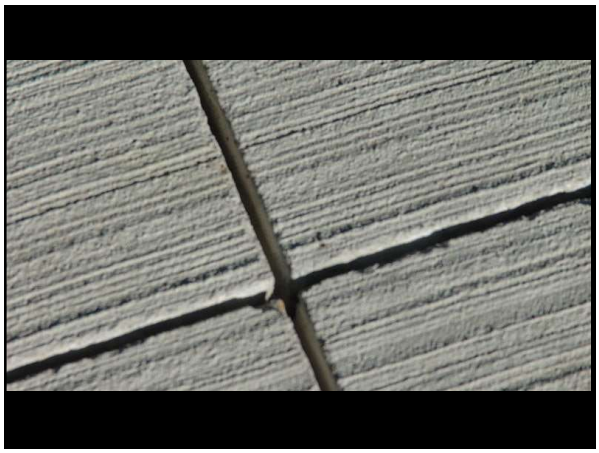
Objection #4

Cracking

- **Drying** shrinkage cracks
  - Easily controlled with proper CONTROL JOINTS
    - Proper timing of saw operations – when joint edges don't fall apart
    - Proper depth – 1/4 D (min), 1/3 D (max)
    - Proper spacing – 2 x D
    - Proper location

119

120



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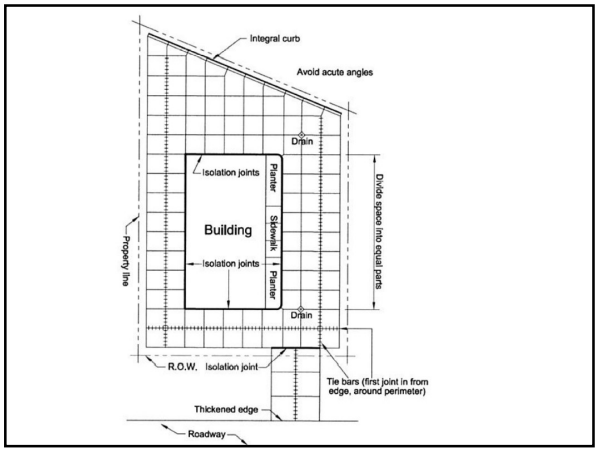

Integral curb
Avoid acute angles
Drain
Isolation joints
Planter
Building
Sidewalk
Isolation joints
Planter
Drain
Divide space into equal parts
Property line
R.O.W.
Isolation joint
Tie bars (first joint in from edge, around perimeter)
Thickened edge
Roadway

123

Objection #4

Cracking

- Structural cracks
- Prevention:
  - Appropriate concrete thickness design for intended vehicle type and frequency (trucks)

124

Objection #4

Cracking

- Structural cracks
- Prevention:
  - Proof roll subbase/subgrade to ensure proper support
  - Proper moisture
    - If geotech report lists the optimal subgrade moisture % (per proctor), strive for that amount

125

126

127

Objection #4

Cracking

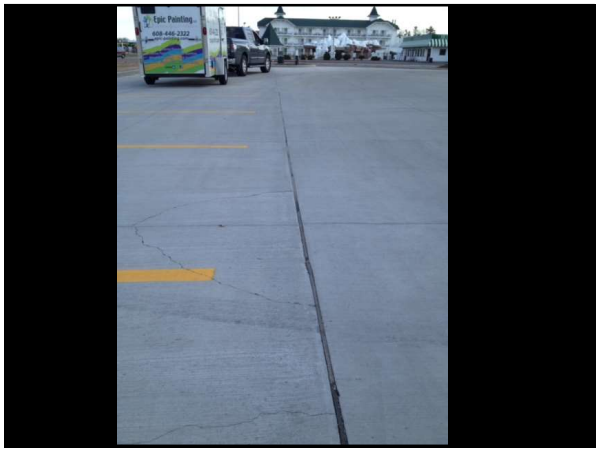
Wisconsin Ready Mixed Concrete Association

- Structural cracks
- Prevention:
  - Need EDGE SUPPORT
    - Tied curb and gutter
    - Thickened edge
    - NO “expansion” joints!

128

129

130



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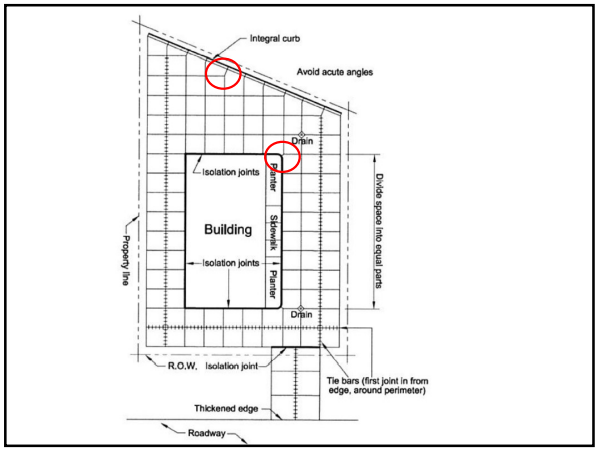
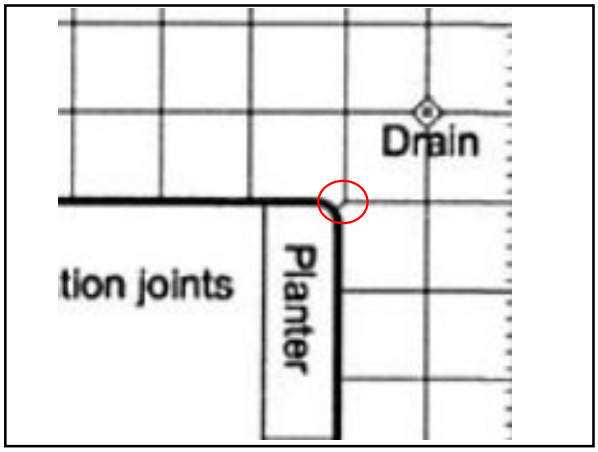
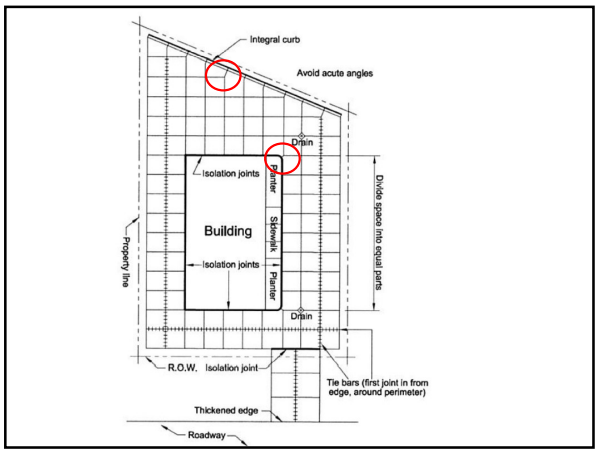

Integral curb
Avoid acute angles
Drain
Isolation joints
Planter
Sidewalk
Planter
Building
Isolation joints
Drain
Property line
Divide space into equal parts
R.O.W.
Isolation joint
Tie bars (first joint in from edge, around perimeter)
Thickened edge
Roadway

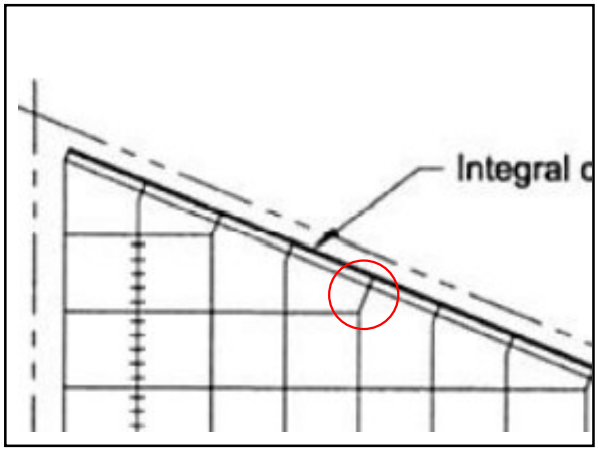
134


Drain
tion joints
Planter

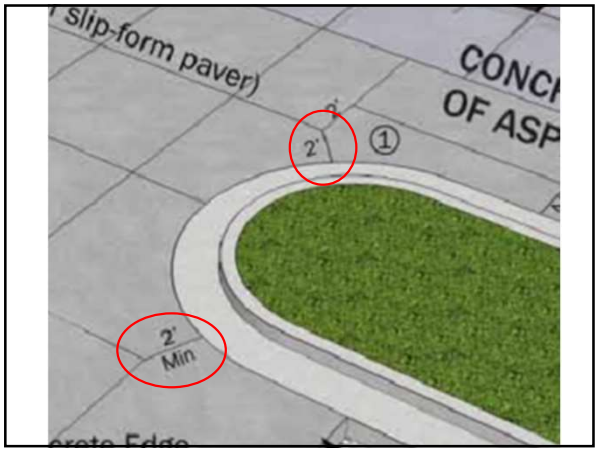
135


Integral curb
Avoid acute angles
Drain
Isolation joints
Planter
Building
Sidewalk
Isolation joints
Planter
Drain
Property line
Divide space into equal parts
R.O.W.
Isolation joint
Tie bars (first joint in from edge, around perimeter)
Thickened edge
Roadway

136

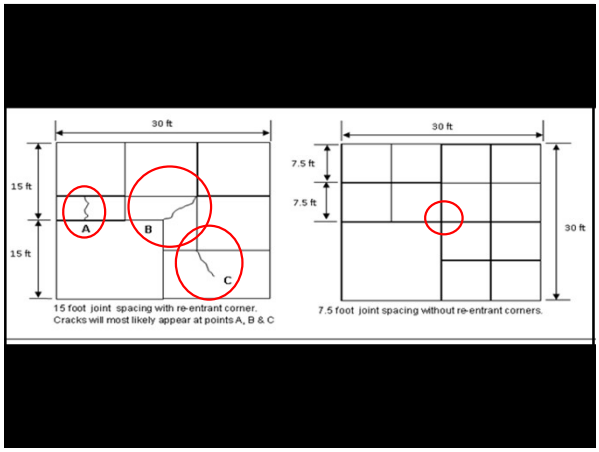

Integral

137


Slip-form paver)
CONC
OF ASP
2'
1
2'
Min

138

139


30 ft
15 ft
15 ft
A
B
C
15 foot joint spacing with re-entrant corner.
Cracks will most likely appear at points A, B & C
30 ft
7.5 ft
7.5 ft
30 ft
7.5 foot joint spacing without re-entrant corners.

140


Angle too
"sharp"

141

Wisconsin Ready Mixed Concrete Association

Objection #5

Utility cuts

142

Wisconsin Ready Mixed Concrete Association

"Concrete pavements are too difficult to remove/patch"

"Asphalt is much easier to repair/patch"

143

144


Asphalt patching (utility cut repair)

145


Asphalt patching (utility cut repair)

146


Asphalt patching (utility cut repair)

147


Asphalt patching (utility cut repair)

148


Asphalt patching (utility cut repair)

149


Asphalt patching (utility cut repair)

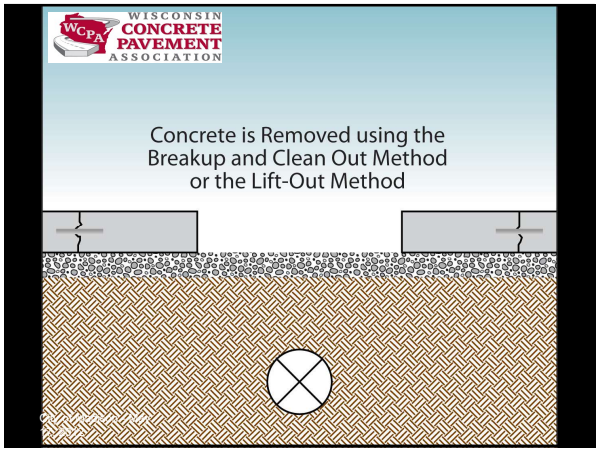
150

Objection #5

Utility cuts

- Full-depth concrete pavement repairs are a viable option
  - Saw
  - Remove old concrete
  - New concrete
    - High early-strength concrete
    - Open to traffic in 8 hours or less

151



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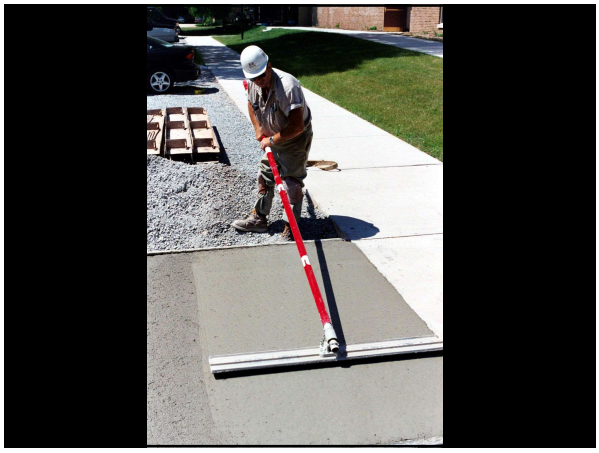
158



159

160

Wisconsin Ready Mixed Concrete Association

Objection #6

"Thin" concrete pavements

161

Wisconsin Ready Mixed Concrete Association

Objection #6

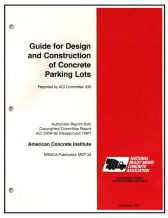
"Thin" concrete pavements

"I'm hesitant to specify a **4"** or **5"** concrete parking lot"

162

Concrete Thickness Requirements

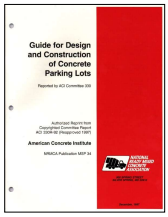
- ACI 330
  - "Guide for Design and Construction of Concrete Parking Lots"
  - Highly credible
    - *ACI Manual of Practice*



163

Concrete Thickness Requirements

- Design variables
  - Concrete strength
  - Soil support
  - Vehicle traffic
  - Design life



164

Design Tables

- Subgrade soil

Type of Soil	Support	k, pci	CBR	R	SSV
Fine-grained soils in which silt and clay-size particles predominate	Low	75-120	2.5-3.5	10-22	2.3-3.1
Sands and sand-gravel mixtures with moderate amounts of silt	Medium	130-170	4.5-7.5	29-41	3.5-4.9
Sands and sand-gravel mixtures relatively free of plastic fines	High	180-220	8.5-12	45-52	5.3-6.1

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Design Tables

- Traffic

Table 2.6(a) -- Traffic categories (Select A, A-1, B, C, or D for use with Table 2.6(b))

1. Car parking areas and access lanes--Category A (autos, pickups, and panel trucks only)
2. Truck access lanes--Category A-1
3. Shopping center entrance and service lanes--Category B
4. Bus parking areas, city and school buses
   - Parking area and interior lanes--Category B
   - Entrance and exterior lanes--Category C
5. Truck parking areas--Category B, C, or D

Truck type	Parking areas and interior lanes	Entrance and exterior lanes
Single units	Category B	Category C
Multiple units	Category C	Category D

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Design Tables

- Traffic

Traffic category	$k = 100$ (CBR = 3) M_R			
	650	600	550	500
A (ADTT = 0)	3.5	3.5	3.5	4.0
A-1 (ADTT = 1)	4.0	4.5	4.5	5.0
A-1 (ADTT = 10)	5.0	5.5	6.0	6.0
B (ADTT = 25)	5.0	5.5	6.0	6.5
B (ADTT = 300)	5.5	6.0	6.5	7.0
C (ADTT = 100)	6.0	6.0	6.5	7.0
C (ADTT = 300)	6.0	6.5	7.0	7.5
C (ADTT = 700)	6.5	6.5	7.0	7.5
D (ADTT = 700)	8.0	8.0	8.0	8.0

167

Design Tables

- Thickness determination

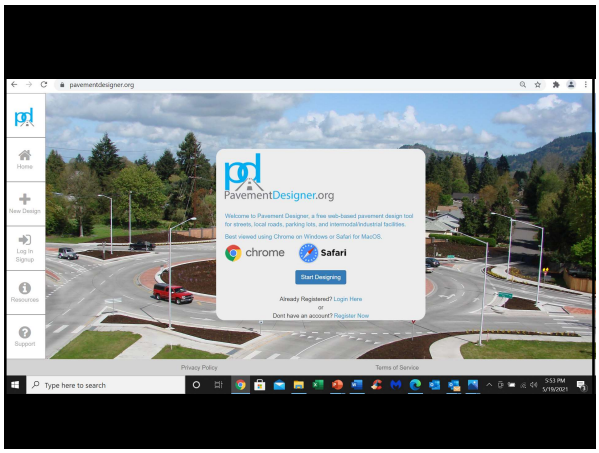
Table 2.6(a) -- Traffic categories (Select A, A-1, B, C, or D for use with Table 2.6(b))

1. Car parking areas and access lanes--Category A (autos, pickups, and panel trucks only)
2. Truck access lanes--Category A-1
3. Shopping center entrance and service lanes--Category B
4. Bus parking areas, city and school buses
   - Parking area and interior lanes--Category B
   - Entrance and exterior lanes--Category C
5. Truck parking areas--Category B, C, or D

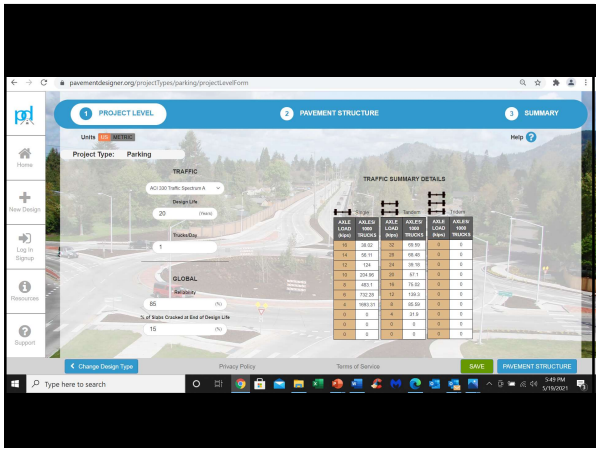
Truck type	Parking areas and interior lanes	Entrance and exterior lanes
Single units	Category B	Category C
Multiple units	Category C	Category D

Traffic category	$k = 100$ (CBR = 3) M_R			
	650	600	550	500
A (ADTT = 0)	3.5	3.5	3.5	4.0
A-1 (ADTT = 1)	4.0	4.5	4.5	5.0
A-1 (ADTT = 10)	5.0	5.5	6.0	6.0
B (ADTT = 25)	5.0	5.5	6.0	6.5
B (ADTT = 300)	5.5	6.0	6.5	7.0
C (ADTT = 100)	6.0	6.0	6.5	7.0
C (ADTT = 300)	6.0	6.5	7.0	7.5
C (ADTT = 700)	6.5	6.5	7.0	7.5
D (ADTT = 700)	8.0	8.0	8.0	8.0

168


PavementDesigner.org
Welcome to Pavement Designer, a free web-based pavement design tool for streets, local roads, parking lots, and intermodal/industrial facilities.
Best viewed using Chrome on Windows or Safari for MacOS.
chrome
Safari
Start Designing
Already Registered? Login Here
or
Dont have an account? Register Now
Privacy Policy
Terms of Service

169


1 PROJECT LEVEL
2 PAVEMENT STRUCTURE
3 SUMMARY
Project Type: Parking
TRAFFIC
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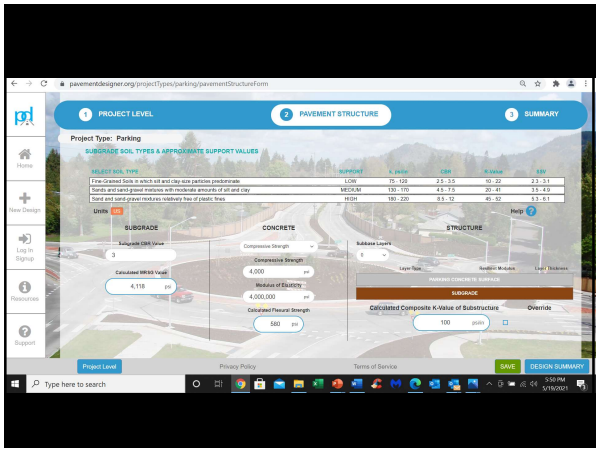
GLOBAL
Change Design Type
Privacy Policy
Terms of Service
SAVE
PAVEMENT STRUCTURE

170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2 PAVEMENT STRUCTURE
3 SUMMARY
Project Type: Parking
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Project Level
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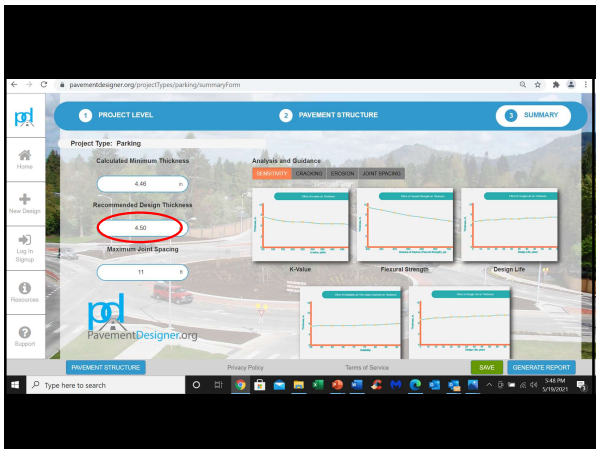
SAVE
DESIGN SUMMARY

171



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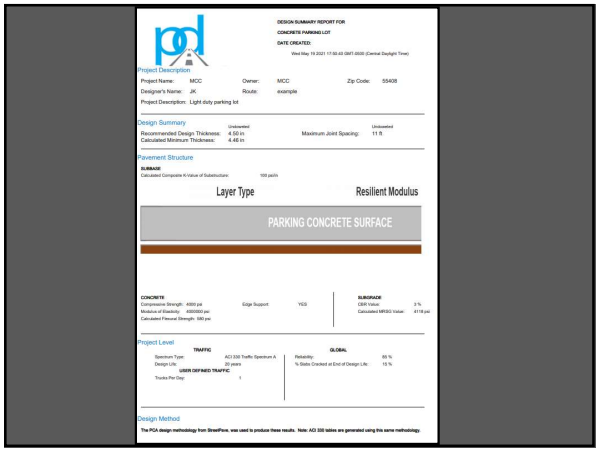

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Objection #6

"Thin" concrete pavements

Wisconsin Ready Mixed Concrete Association

- 4" – 5" unreinforced concrete parking lots are sufficient for most light-duty parking lots
- Justification:
  - ACI 330
  - PavementDesigner.org
  - Local experience

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Objection #6

"Thin" concrete pavements

- Generally speaking, 5" unreinforced concrete on typical upper-Midwest soils can easily handle light-duty passenger vehicles and significant truck traffic
- Many engineers elect to round up to 5" even if ACI 330 says 4" or 4.5"

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Objection #7

Concrete pavements take too long to build

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Objection #7

Concrete takes too long to build

- Generally-speaking….
  - "Normal" concrete pavements can handle passenger vehicles within 3 days, trucks within 5 days
  - Economical high-early strength concrete mixes allow traffic within 24 hrs of placement, or sooner (as little as 4-8 hours)

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Objection #7

Concrete takes too long to build

- Facts:
  - Concrete pavements don't require 28 days to cure prior to allowing traffic
  - Staged construction is always an option

179

Objection #7

Concrete takes too long to build

- Facts:
  - NOTE: concrete pavements, with proper subgrade prep and thermal protection, can be placed in late fall after asphalt plants have shut down

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Objections

Concrete pavements

1. Too expensive
2. Jointing – too complicated
3. Premature surface deterioration
4. Cracking
5. Difficult to repair after utility cut
6. “Thin” concrete pavements
7. Takes too long to build, too long to open to traffic

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Jason Kruger

Concrete Paving Consultant

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E-mail: jkruger@jskrugerconsulting.com

B.S. Civil Engineering (1988 – Iowa State University)

32 years experience in concrete industry

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