Asphalt Construction

Best Construction Practices

Delaware T²/LTAP Center

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Delaware T²/LTAP

University of Delaware

Delaware Center for Transportation

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Delaware T² Center

- T² Centers or LTAPs located in all 50 states
- Funded by FHWA and state DOTs
- Mission – promote training, tech transfer, research implementation at local level
- Delaware T² hosted by University of Delaware, part of Delaware Center for Transportation
- Delaware T² funded by FHWA and DelDOT

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The Preliminaries

Today's Instructor:

- Matheu J. Carter, P.E. – Municipal Engineering Circuit Rider

Restrooms, etc.

Standard Reminders:

- Cell phones, pagers, beepers, walkie-talkies
- Sidebar conversations

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More Preliminaries

- Questions – any time
- We're a small crowd – let's keep it interactive and informal
- Sharing of thoughts or examples – any time
- These slides will be posted on our website – see link on your notes

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Outline

- Introduction
- Pavement Distress
- Contract management
- Pre-construction meeting
- Surface preparation
- Materials
- Transport
- Placement
- Compaction
- Inspection
- Safety
- Pavement Preservation

Introduction

- This is a basic course
  - If you're new to the field, don't sweat it
  - If you're a veteran, don't be afraid to pitch in

- No substitute for a full understanding of asphalt surfacing design, construction, and quality control

- No substitute for experience

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Introduction

If you take nothing else away, remember words like:

- Weather
- Segregation
- Compaction
- Temperature
- Homogeneity
- Drainage

Kirkwood to Tybouts - North of Red Lion, March 15, 1923

Introduction

- Properly designed, prepared, constructed, and maintained asphalt surface should last 10-15 years, depending upon a host of variables

- Many asphalt surfaces last much longer, but that's an unrealistic expectation

- Failure to insist on quality at each step (i.e., site preparation, materials, transportation, placement, compaction) usually insures premature pavement distress

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Introduction

Disclaimer, caution, warning, plea

- In order to talk about best construction practices, we must look at real construction examples
  - We will see poor practices in some
  - We will see safety violations
  - We will see all sorts of things to poke at
- We should look at those things
  - We should discuss the good, the bad, the ugly
- But let's acknowledge
  - None of us has ever run the perfect job – let he without sin…
  - And some of this will come off "holier than thou"

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Best Construction Practices

- Ideal conditions
- That which promises to deliver optimal performance
- Leads to enhanced performance
- Top of the game

BCP Limitations

What limits ability to implement BCPs?

- Funding
- Weather
- Space
- Right of way
- Antecedent conditions
- Degree of control
  - Yours
  - Contractors
- Equipment logistics
  - Tack truck

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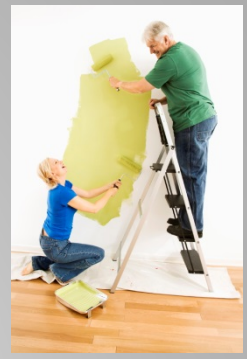
Asphalt ≠ Paint



- BUT, we'll use the analogy anyway
  - Would we hire a painter without being specific?
  - Would we paint over a dirty wall board?
    - Over flaky, chipping paint?
    - Over water damaged boards?
  - Would we use old cheap paint?
    - Old dirty brushes?
  - Would we store the paint in the cold garage overnight?
    - Use it without stirring?
  - Would we apply it in one ½" coat?
  - Would we pay for it without inspecting it?
  - Would we pay for it if it wasn't what we asked for?
- No – so let's not do this with asphalt either

Pavement Distress

- Flexible pavements fail via two basic mechanisms
  - Environmental stresses
    - Temperature
    - Oxidation
  - Structural issues
    - Subsurface condition
    - Construction
    - Drainage
- Our goal - avoid or defer these
- Understanding how pavements fail will help us construct them better
- So, we'll take a few moments to explore some typical distresses

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Pavement Distress

- Raveling
  - Disintegration from surface downward; loss of aggregate particles
  - Causes include binder aging, poor mixture quality, segregation, insufficient compaction
- Bleeding
  - Presence of free binder on surface
  - Causes include excess bituminous binder, low air void content

Photo E-1 . Raveling in Local Pavement, Medium Severity

Photo E-2 . Raveling in Local Pavement, High Severity

Photos: Ohio DOT

Photo E-3 . Bleeding in Local Pavement, Medium Severity

Photo E-4 . Bleeding in Local Pavement, High Severity
High Severity shows most aggregates covered with asphalt.

Pavement Distress

- Base failure
  - Deformation in the form of bumps, dips, lipping, stepping causing pitch, roll, jarring
  - Causes include base or subgrade failure
- Settlement
  - Uniform dip in longitudinal profile (lateral)
  - Causes include poor base or subgrade, poor drainage
  - Not load induced

Photo E-12 . Base Failure in Local Pavement, High Severity

Photo E-13 . Base Failure in Local Pavement, High Severity

Photos: Ohio DOT

Photo E-14 . Settlement in Local Pavement, Low Severity

Photo E-15 . Settlement in Local Pavement, Medium Severity

Pavement Distress

- Transverse cracking
  - Cracks at approx. right angles to pavement centerline
  - Causes include thermal shrinkage of the binder, age hardening of binder
- Wheel track cracking
  - Cracks within/near wheel tracks, eventually resembling alligator skin
  - Causes include fatigue failure of the asphalt

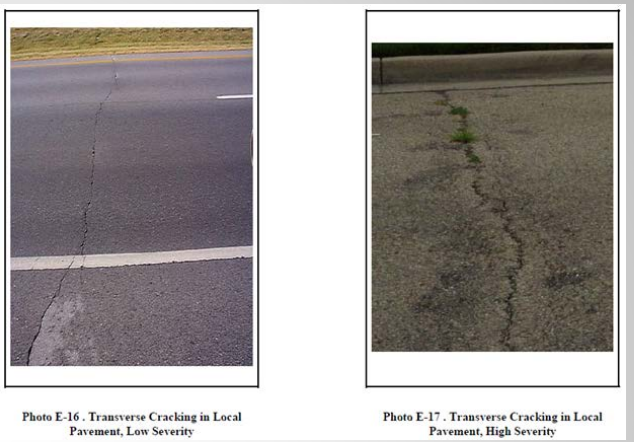

Photo E-16 . Transverse Cracking in Local Pavement, Low Severity

Photo E-17 . Transverse Cracking in Local Pavement, High Severity

Photos: Ohio DOT

Photo E-18 . Wheel Track Cracking in Local Pavement, High Severity

Photo E-19 . Wheel Track Cracking in Local Pavement, High Severity

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Pavement Distress

- Longitudinal cracking
  - Cracks/breaks approx. parallel to pavement centerline
  - Causes include poor lane joint construction, reflection of rigid base, aging of binder
- Edge cracking
  - Crescent shaped or longitudinal cracks w/in 1' of pavement edge
  - Causes include inadequate base or subgrade

Photo E-20 . Longitudinal Cracking in Local Pavement, High Severity

Photos: Ohio DOT

Photo E-21 . Edge Cracking in Local Pavement, Medium Severity

Photo E-22 . Edge Cracking in Local Pavement, High Severity

Pavement Distress

- Rutting
  - Vertical deformations of surface along wheel tracks
  - Causes include consolidation or lateral movement of pavement layers under traffic
- Map cracking
  - Interconnected longitudinal and lateral cracks resembling a map
  - Causes include aging, thermal contraction; not load induced
  - Different from alligator or wheel load cracking

Photo E-9 . Rutting in Local Pavement, Medium Severity

Photo E-10 . Rutting in Local Pavement, High Severity

Photos: Ohio DOT

Photo E-11 . Map Cracking in Local Pavement, Medium Severity

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Pavement Distress

- Surface disintegration, debonding, potholes
  - Isolated loss of surface
  - Causes include freeze-thaw, poor bonding of (thin) layers, weak base or subgrade
- Patching
  - Isolated replacement of lost or deteriorated pavement
  - Reaction to degraded pavement condition; causes vary

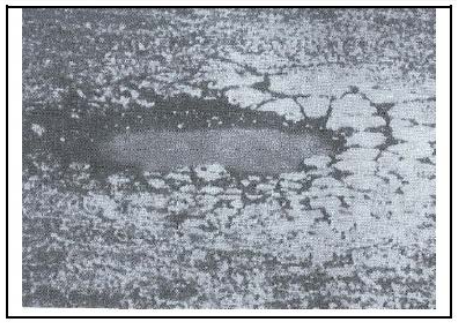

Photo E-7 . Pothole in Local Pavement, Medium Severity

Photo E-8 . Debonding in Local Pavement, Medium Severity

Photo E-5 . Patching in Local Pavement, High Severity

Photo E-6 . Patching in Local Pavement, High Severity

Photos: Ohio DOT

Pavement Distress

- Common themes we just heard
  - Aging
  - Thermal effects
  - Freeze-thaw
  - Subgrade failure
  - Base failure
  - Drainage
  - Mix quality
  - Segregation
  - Compaction
- Think about these as we go through various elements of asphalt construction

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Contract Management

- Goal
  - Minimize claims
- But that's not all, right?
  - Get product that meets our needs
  - Pay price that's reasonable, fair, transparent
- News flash - it is okay for the contractor to do well (make money)
  - Just not rich beyond the pale
  - And your agency must do well too
  - Good contract management – you can have both

Contract Management

- The advertised bid, request for proposal, or solicitation (together with any addenda, signed contracts, etc.) are the things you can explicitly enforce
- Anything not in those documents that you want depends upon the good will of the contractor, your relationship, and to some extent, "best construction practices" and "standards of care"
- Moral – detailed, well thought out bid documents are your best gateway to the project you wanted

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Contract Management

- Using DelDOT specifications
  - If you are part of DelDOT, well that's what you use
  - If you are with a municipality or other agency, you can use
    - No cost to you
    - Contractors (should) already know them
    - They cover all the ground you could ever imagine
    - But they may cover things you don't want to pay for
    - Avoid cherry picking – if you want to exclude something, note it in your contract documents
    - Claims avoidance – one good way to expose yourself is to enforce your contract documents unevenly

http://www.deldot.gov/information/pubs_forms/manuals/standard_specifications/index.shtml

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Contract Management

If your bid specifications refer in whole/part to DelDOT specs, make sure you've read them; some relevant parts highlighted below

- Division 400 et.seq. – bituminous (asphalt) pavements
- Division 760 – milling
- Division 823 – hot mix, hot laid bituminous concrete
- Don't forget Supplemental, Standard, and Special provisions

- If you stumble on some of it, are unsure of parts, are intimidated by the specs, call/email the T²/LTAP Center – that's why we're here

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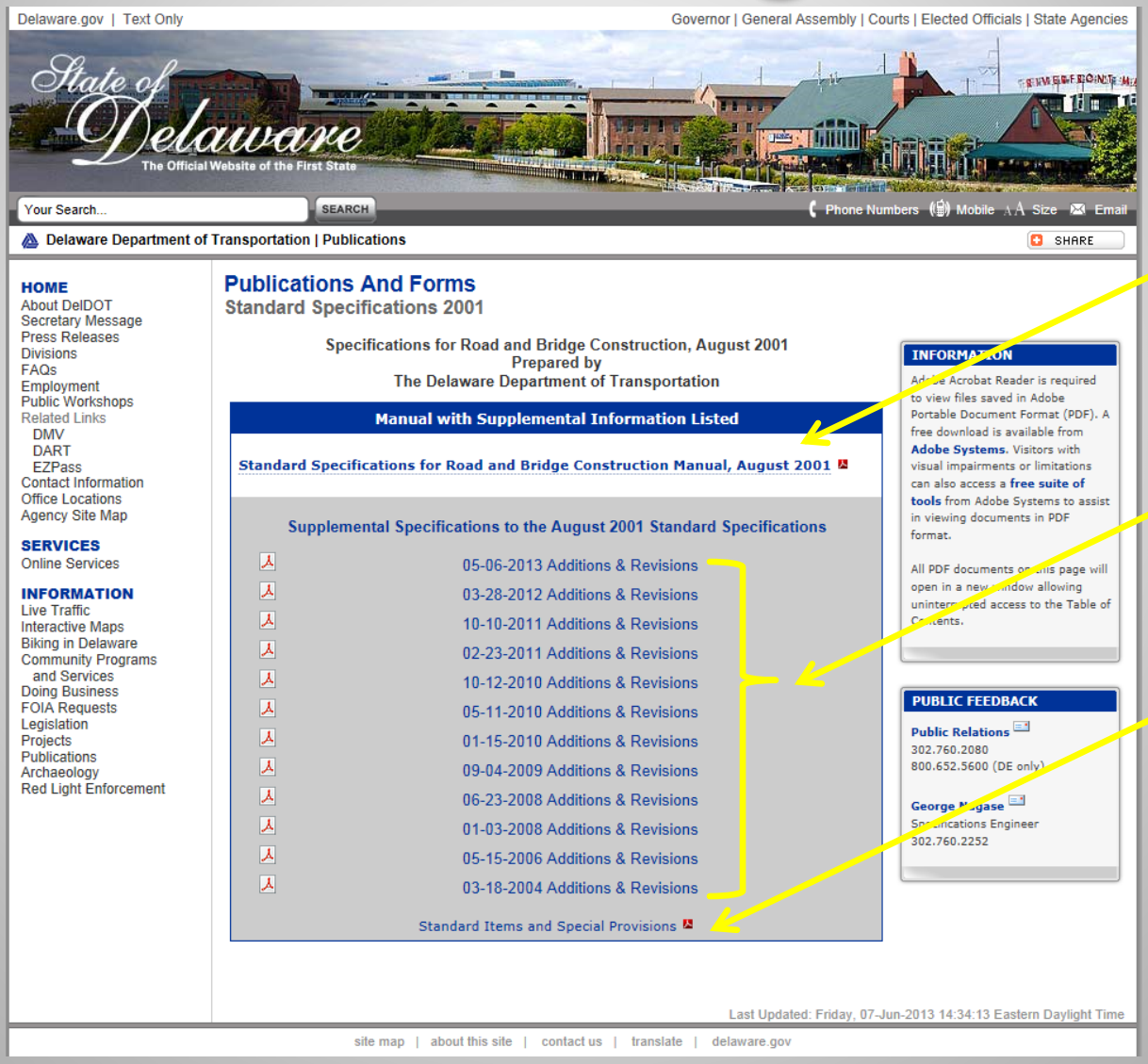
Contract Management



Contract Management

- In some minds
  - Not every job warrants a 400 page set of contract documents
- Specs are less than specific?
  - Now there's a problem?
  - Time to get creative
- DelDOT specs can still be used as a reference for "best construction practices"
  - But you won't have the leverage of having specifically referenced them in your bid package

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Pre-Construction Meeting

- Best relationships are based on:
  - Communication
  - Trust
  - Verification
  - Mutual respect

- Preconstruction meeting is one good place to begin building these

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Pre-Construction Meeting

- All parties should send representative who have decision making authority
  - Owner, contractor, regulators, others
- Owner (or owner's representative) should control the meeting
- Owner should be firm with expectations, but express a desire for a cooperative relationship
- This is about the last chance any of the parties have to raise an issue before it's too late – it's easier to talk about it now rather than later

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Pre-Construction Meeting

- Have the right parties there from your side, their side, and others (if appropriate)

- Make the first move
  - Establish high expectations and trust in them
  - Then make it clear you intend to verify their quality

- What quality job did you solicit?
  - High quality, premium?
  - Average, run of the mill, old college try?
  - Dollar store?
  - Point being – get the job you asked for and will pay for

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Pre-Construction Meeting

- Preconceived notions?
  - Don't let them be a secret; now's the time to tell the contractor
- Pet peeves?
  - This is the time
- This is where you draw their attention to… stuff
  - Expectations
  - Concerns
  - Problem property owners
  - Utilities
  - Special drainage issues

Pre-Construction Meeting

- Even if you haven't specifically referenced DelDOT specifications (or equivalent)
  - Talk here as if you had
  - This will begin to establish the project's notion of "best construction practices"
  - If you get no push back here, you'll be better leveraged to enforce these specs later
- Careful though
  - If you haven't been specific in your bid package, you don't get to push as hard
  - Balance

Surface Preparation

- Areas where underlying materials are weak must be prepared prior to new surface application
  - Would you simply paint over drywall in your house that was water damaged?
  - Or would you replace the damaged material first?

- New asphalt over potholes, excessive cracking, debonding, etc.
  - Probability of premature failure increases

- A building is only as good as its foundation

Surface Preparation

- Existing surface may be milled prior to new asphalt or new surface may be placed directly upon existing

- Milling is a great opportunity to correct the cross slope (crown) and or drainage issues
  - But if all you tell them is "mill two inches," they may or may not

Photo: Wyoming LTAP

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Surface Preparation

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Surface Preparation

Some common pre-surfacing repairs

- Crack sealing (¼”+)
- Patching potholes (thoroughly; no throw and go)
- Base/subgrade replacement
- Leveling course (aka “wedge and level”)
- Milling
- Concrete slab repairs
- Drainage repairs/improvements
- Utility replacement (i.e., “you are not cutting my street six months after I pave”)

Surface Preparation

- Base preparation is often compromised – mistake

- Areas of structural failure (alligator cracking, failed utility cuts, large potholes, etc.) may require removal to depths of 8”-16” or even greater to provide sound base

- Utilities? Don’t forget to adjust manholes, water valves, storm grates, etc.

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Surface Preparation

Regardless of whether surface is milled, surface must be swept free of dirt, debris, and oils

- Otherwise, debonding is likely to occur
- Think how well you could glue two boards together if you first sprinkled the bottom one with sawdust
- Dust, dirt, oils, etc. all act as bond breakers
  - We don't like bond breakers

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Materials

- Know what you've specified and know what you're receiving
- You are the project owner
- You are writing the checks
- You are entitled to the project you specified
  - Hot Mix Asphalt vs. Warm Mix Asphalt
  - 9.5 mm, 12.5 mm, 19.0 mm, etc.
  - Superpave vs. Marshall vs. Hveem
  - Superpave Performance Grade specification
    - PG - Performance Grade - i.e., PG 64 -22
    - 64˚C (147 ˚F) – avg 7-day max pavement design temperature (˚C)
    - -22˚C (-8 ˚F) – minimum pavement design temperature (˚C)
  - Recycled asphalt materials (RAP, RAS)?

Materials

- DelDOT's design overview
  - Fall 2013

Pavement Design Guidelines

Pavement Material Lift Thicknesses		
Material	**Minimum**	**Maximum**
Type C (3/8")	1.25"	2"
Type B	2.25"	4"
BCBC	3"	6"
GABC	--	8"
Soil Cement	--	--
Road Bed	--	--

Binder Grades		
Traffic Characteristics	**Traffic Flow**	**Binder Grade**
Low to Moderate Trucks & Buses	Constant, Fast	PG 64-22
High Trucks & Buses	Constant, Fast	PG 70-22
High Trucks & Buses	Stopping/Standing, Slow	PG 76-22

Gyrations	
Roadway Characteristics	**No. of Gyrations**
Lower Volume Roads (Light Truck Volume)	115
Higher Volume Roads (Normal Truck Volume)	160

Materials

Binder grades

- PG 64-22
- PG 70-22
- PG 76-22

- There are others
  - These are what we use in Delaware, for the most part
- One is not better than the other
  - A big screwdriver is not better than a small one
  - It's just more expensive
  - It might be the wrong tool for the job
  - Try using a big screwdriver to fix your glasses

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Materials

Binder grades

- PG 64-22
  - Low/moderate truck volume
  - Speed of trucks is considered “fast”
  - Typical candidates: subdivision streets, local roadways, some minor arterials, shoulders of mainline roads, etc.
- PG 70-22
  - >10,000,000 ESALs
  - High volumes of fast moving trucks
  - Think: Rt 13, Rt 1 (free flowing, non congested areas)
- PG 76-22
  - High volume of slow moving trucks
  - Lots stopping and starting (congested areas, intersections)
  - Candidates: roads near plants with heavy equipment accessing the roadway, toll plazas, traffic signals

Materials

What's an ESAL?

- It's a little complicated, but…
- Evens out the impact of vehicles in design
- Equivalent single axle load – ESAL
  - Assume a typical automobile weighs 2,000-7,000 pounds
  - Passenger vehicle, fully loaded, will generate about 0.003 ESALs
  - A fully loaded tractor-trailer will generate up to 3 ESALs
- Point being
  - Trucks are a BIG deal
  - Hondas, not our worst worry
- Let's leave it at that

Materials

In the future, you may see these:

- MP-19 Grades at 64°C
  - PG 64S-22 "Standard" = PG 64-22
  - PG 64H-22 "Heavy" = PG 70-22
  - PG 64V-22 "Very Heavy" = PG 76-22
  - PG 64E-22 "Extreme" = PG 76-22
    - Note MP-19 uses "High" & "Heavy" interchangeably
    - Standard "S" = traffic < 10 million ESALs, > 70 km/h
    - Heavy "H" = traffic 10-30 million ESALs, 20-70 km/h
    - Very Heavy "V" = traffic > 30 million ESALs, < 20km/h
    - Extreme "E" > 30 million ESALs, < 20km/h, toll plazas
- And let's leave that at that, too

Materials

- What's this "gyrations" thing?
  - Think of it as something that simulates compaction
  - In a gyratory compactor,
    - Sample is subjected to a load
    - Sample is inclined at 1.25°
    - Sample rotates at 30 revolutions per minute
    - Result - a sample particle orientation similar to that achieved in the field after roller compaction
- See? Simple.

20-yr Traffic Loading (in millions of ESALs)	Number of Gyrations		
	$N_{initial}$	N_{design}	N_{max}
< 0.3	6	50	75
0.3 to < 3	7	75	115
3 to < 10*	8 (7)	100 (75)	160 (115)
10 to < 30	8	100	160
≥ 30	9	125	205

* When the estimated 20-year design traffic loading is between 3 and < 10 million ESALs, the agency may, at its discretion, specify $N_{initial}$ = 7, N_{design} = 75 and N_{max} = 115.

Source: http://www.pavementinteractive.org/article/Superpave-Mix-Design/

Materials

Gyrations

- The properties of the mixes are slightly different to accommodate the needs of the road
- Only two gyrations used in Delaware
  - 115 is used in areas where the ESALS (not ADT) are between 0 and 300,000
  - 160 is used in areas where the ESALS (not ADT) are > 300,000

Materials

Carbonate vs. Non-Carbonate

- Non- Carbonate stone is more resistant to polishing than carbonate stone

- The use of Non-Carbonate stone is beneficial in areas where:
  - The ADT is greater than 8000 vpd AND the speed limit is greater than 35 mph
  - There are known skidding problems in the area

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Materials

Mat thickness

- C mix
  - 9.5mm (standard)
    - Min lift thickness = 1.25”
    - Max lift thickness = 2:
  - 4.75mm
    - Min lift thickness = 0.5”
    - Max lift thickness = 1.25”
  - 12.5 mm
    - Min lift thickness = 1.5”
    - Max lift thickness = 2.5”

- Why a minimum thickness?

Materials

Mat thickness

- B mix*
  - Min = 2.25”
  - Max = 4”
  - *When B is being paid for as BCBC, the mix can be placed in lifts up to 6”
- BCBC
  - Min = 3”
  - Max = 6”
- Why a maximum thickness?

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Materials

Material stockpiles
- Properly segregated?
- Homogenous?
- Moisture content?

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Materials

RAP – Recycled Asphalt Pavement

- In Delaware: 1997-2013 average grade is PG 88-16
- FHWA-under 20% RAP no need to change grade
  - Over 25% one should use a blending chart
- Three DelDOT absolutes
  - PG 70/76-22 - maximum is 10% replacement
  - PG 64-22 - maximum is 20% replacement
  - PG 58/64-28 - maximum is 40% replacement
- Point being – you'll probably get some RAP and that's okay – but they should be telling you

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Materials

RAS – Recycled Asphalt Shingles

- Shingles, new or old, are far stiffer than RAP
  - New Shingle Waste: PG 115-16
  - RAS since 2012: PG 142-10
  - Post Consumer RAS: PG 160-10
  - [Compare to RAP PG: 88-16]
- The finer RAS is ground, the more asphalt released

- DelDOT committed to use of RAP and RAS in pavements
- DelDOT - one of the most liberal policies for RAP/RAS
- So – locals will likely have RAP/RAS in their asphalt

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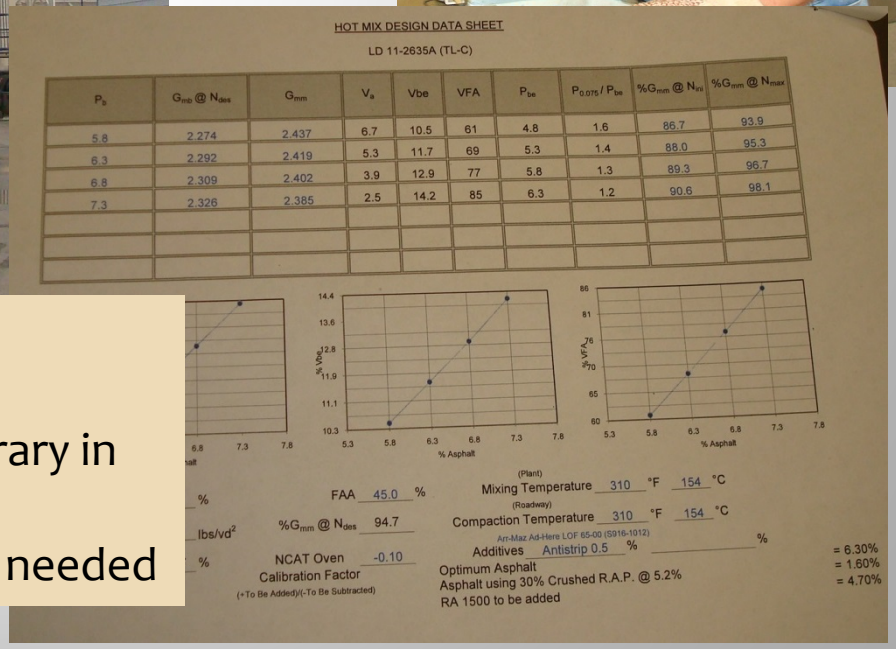
Materials



HOT MIX DESIGN DATA SHEET

LD 11-2635A (TL-C)

P_b	G_{mb} @ N_{des}	G_{mm}	V_a	Vbe	VFA	P_{be}	$P_{0.075}$ / P_{be}	$\%G_{mm}$ @ N_{ini}	$\%G_{mm}$ @ N_{max}
5.8	2.274	2.437	6.7	10.5	61	4.8	1.6	86.7	93.9
6.3	2.292	2.419	5.3	11.7	69	5.3	1.4	88.0	95.3
6.8	2.309	2.402	3.9	12.9	77	5.8	1.3	89.3	96.7
7.3	2.326	2.385	2.5	14.2	85	6.3	1.2	90.6	98.1

FAA 45.0 %

%G_{mm} @ N_{des} 94.7

NCAT Oven Calibration Factor -0.10

(+To Be Added)/(-To Be Subtracted)

(Plant) Mixing Temperature 310 °F 154 °C

(Roadway) Compaction Temperature 310 °F 154 °C

Art-Maz Ad-Here LOF 65-00 (S916-1012)

Additives Antistrip 0.5 %

Optimum Asphalt = 6.30%

Asphalt using 30% Crushed R.A.P. @ 5.2% = 1.60%

RA 1500 to be added = 4.70%

Asphalt plant

- Complex
- Nothing arbitrary in the mix
- Lots of QAQC needed

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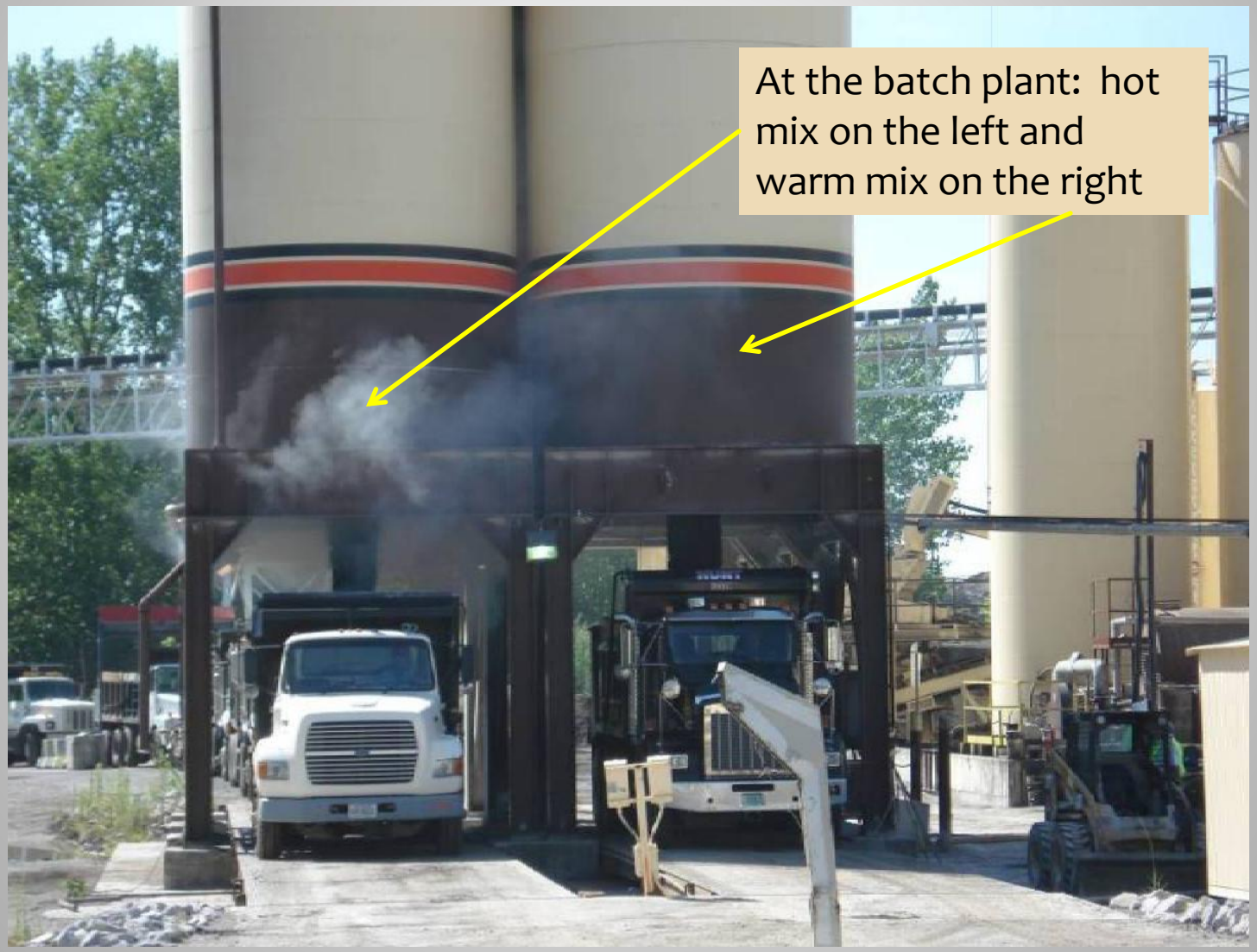
Materials



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Materials

- Yield
  - Typical compacted unit density – 151.5 #/cubic foot[1]

$$\frac{\text{Length (feet) x width (feet) x density (\#/cf) x compacted thickness (inches)}}{\text{(12 inches/foot) x (2000 \#/ton)}}$$

  - Example: 1 mile 24' wide with 2" final thickness of 9.5 mm Type C mix

$$\frac{\text{5280 ft x 24 ft x 151.5 \#/cf x 2"}}{\text{(12 inches/foot) x (2000 \#/ton)}} = 1599.84 \text{ tons}$$

  - And I care why?
    - Assuming each truck ticket shows 22 tons, you would expect ~73 trucks; if only 70 truckloads were delivered, you may have been shorted on your area or thickness or the compaction may be inadequate
    - If 78 truckloads were delivered and you're paying by the ton, they may be putting down a thicker mat to boost their invoice

1: 2008 DelDOT Superpave production summary for most Type B & C mixes assuming 93% compaction

Transport of Materials

- Trucks
  - Sufficient number of trucks
  - Coordinate with plant for continuous supply of material
- Truck bed
  - Clean and free of deleterious material (dirt, gravel, debris)
  - Smooth and free of major dents and depressions
- Release agent
  - Emulsified oil, soap solution, citrus compounds, etc.
  - No diesel fuel
- Material tickets
  - Collect tickets
  - Check job mix for compliance with specifications
  - Use unit weight to determine approximate yield

Placement

- Paver basics
  - Tractor provides power and carries mix from hopper to screed
    - Material feed system – hopper, slat conveyer, conveyor flow gates, augers
  - Screed provides initial density and smoothness
- Push rollers and truck hitches
  - Truck rests against push rollers – paver pushes truck
  - Truck does not bump paver – paver "picks up" the truck
  - Keep rollers clean and free rolling
- Material feed system
  - Transports material to augers
  - Gates regulate amount of material carried to augers
  - Goal – constant head of material in front of screed

Placement

- Screed
  - Establishes thickness, initial texture and compaction
  - Screed plate should be smooth & not warped
  - Depth of mat is increased as front of screed is pivoted up, decreased as it is pivoted down; thickness change happens gradually (over five lengths of the tow bar)
  - Screed vibrates to provide initial compaction
  - Screed extensions can be hydraulic or fixed and can create changes in slope
  - Screed heater – preheat to ~300˚F prior to paving for a more uniform mat surface and to prevent mix sticking to screed
  - Screed should not be in contact with mat during preheating

Placement

Weather considerations

- ≥40˚F ambient air temperature (for 1”-2” lifts)[1]
- Frozen or wet surfaces – no paving
- Precipitation – no paving if it is raining/snowing or if impending precipitation will prevent proper completion of the section

Photo: Wyoming LTAP

1: DelDOT specifications, Table 401-A

Placement

Temperature

- Typically, 50°F and rising

Table 401-A			
Minimum Ambient Air Temperature for Placement of Types of Bituminous Material			
Material Type	*1" (25 mm) Lift or Less*	*1.25 to 2" (32 mm to 50 mm) Lift*	*Greater than 2.25 to 3" (56 mm to 75) Lift*
B	50 °F (10 °C)	40 °F (4 °C)	32 °F (0 °C)
C	50 °F (10 °C)	40 °F (4 °C)	N/A

Note:

Type B - Dense graded base and binder course
Type C - Dense graded surface course

Source: Supplemental Specifications to the August 2001 Standard Specifications (Revised May 6, 2013)

Placement

- Tack coat
  - Clean surface first
  - Apply tack uniformly
  - 0.05 to 0.15 gallons/square yard
  - Apply to no more of the surface than will be completed that day
  - Apply to contact surfaces of curbs, gutters, manholes, etc.
  - Emulsion is brown and will turn black when it “breaks”

Tack Application

Delaware
T²/LTAP

Delaware T²/LTAP

Tack Application

- Relative application rates
  - "401.07 Application of Tack Coat. A tack coat diluted with 50% water shall be applied on all dry and broom cleaned portland cement concrete and bituminous pavement surfaces. Tack coat shall be applied at a rate of 0.05 to 0.15 gal/yd^2, at a temperature of 70 to 160 °F. The application rate appropriate for the surface being overlaid shall have prior approval of the Engineer. The tack coat should be a thin, uniform coating sufficient to bond the overlay to the underlying pavement. Tack coat shall be applied using pressurized distributing equipment with a spray bar or other approved distribution system. Tack coat shall be applied in advance of the hot-mix operation, but no further than is anticipated for the current day's hot-mix operation. All contact surfaces of curbing, gutters, manholes, and other facilities shall be coated with a uniform coat of hot asphalt cement (tack) or other approved bituminous material just before the mixture is placed."
  – DelDOT Standard Specifications for Road and Bridge Construction August 2001

Tack Application

Photo: FHWA

- Too little
  - Bond won't be achieved
- Too thin
  - Thin is okay, thin is desirable
  - But uniform, complete coverage
- Non-uniform
  - You're not looking to bond some of the pavement
- Too thick
  - Can create slip plane
  - Can work up to top course
- Application rate – consider existing surface
  - Oxidized? Milled? Fat/flushed? Open-textured or tight/dense?
- Applied to clean, dry surface

Delaware T²/LTAP

Tack Application

Relative application rates

- Rate should vary with the condition of the surface being paved
- Objective
  - Apply a sufficient quantity of material
  - Result - thin, uniform coating of material covering the entire pavement surface
- Matching the application rate to the condition of the existing surface is key

Table 1 – Typical Application Rates

Existing Pavement Condition	Application Rate * (gallons/sy)		
	Residual	Undiluted	Diluted (1:1)
New Asphalt	.03 to .04	.05 to .06	.10 to .12
Oxidized Asphalt	.05 to .06	.08 to .09	.15 to .18
Milled Surface (asphalt)	.05 to .06	.08 to .09	.15 to .18
Milled Surface (PCC)	.04 to .05	.06 to .08	.12 to .15
Portland Cement Concrete	.04 to .05	.06 to .08	.12 to .15
Vertical Face	**	**	**

* Rates shown are for slow-setting asphalt emulsions (SS1, SS1H) containing approximately 60% bituminous material.

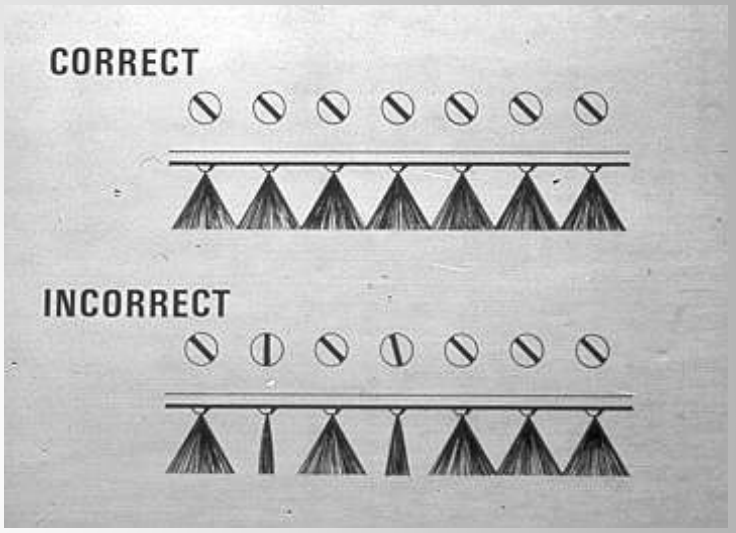
** Longitudinal construction joints should be treated using a rate that will thoroughly coat the vertical face without running off.

Rates listed are in accordance with the recommendations from NCHRP Research project 09-40 (Reference A)

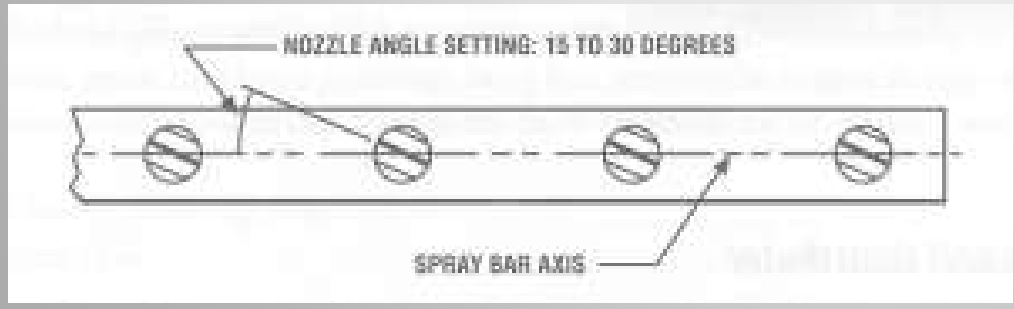
Source: Flexible Pavements Of Ohio; Technical Bulletin: Proper Tack Coat Application (19Sept2012)

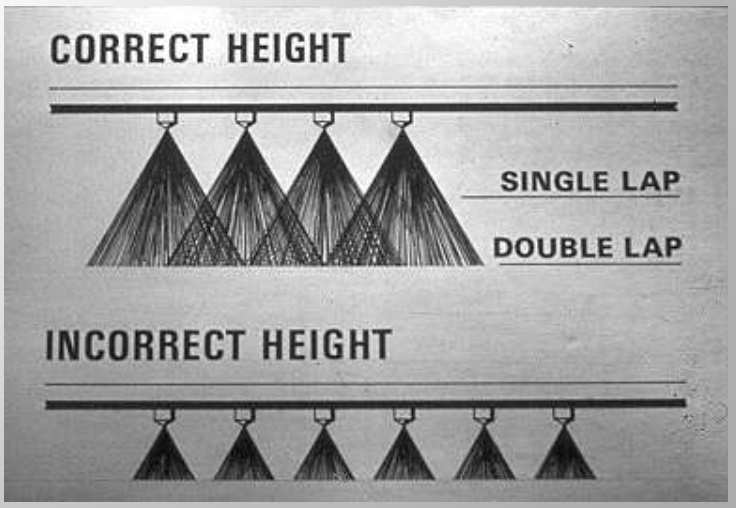
Tack Application

- Clean nozzles
- Nozzle orientation
- Height of bar
- Varying weight of truck
- Single lap, double, triple?



Source: Asphalt Institute





Tack Application

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- Look closely
- What do you see?
- Double overlap?
- Triple?
- What about spray bar height?

Delaware T²/LTAP

Tack Application

- Don't forget – tack vertical surfaces
  - Curbs
  - Gutters
  - Cold pavement joints
  - Structures
  - Faces of longitudinal and transverse joints

  - However:
    - "…it was recommended that if the free edge of the longitudinal joint was not cut back to a vertical surface, and if the mix along the joint was clean, then a tack coat would not normally be needed. There has been no reported evidence that the use of tack coat significantly increases the durability of the longitudinal joint under traffic." *Guidelines for Using Prime and Tack Coats*, FHWA, July 2005.

Placement

- Paver warmed up, screed preheated, grades and crown are set
- Material arrives
  - Check load slip – is this what we ordered?
  - Check temperature as truck bed empties into paver hopper
- Slat conveyor transports mix to load the augers – keep material about mid height on the augers for uniform distribution
- Paver starts moving and keeps moving
- Check the mat – cross slope, mat thickness and texture

Check Mat Thickness

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Placement

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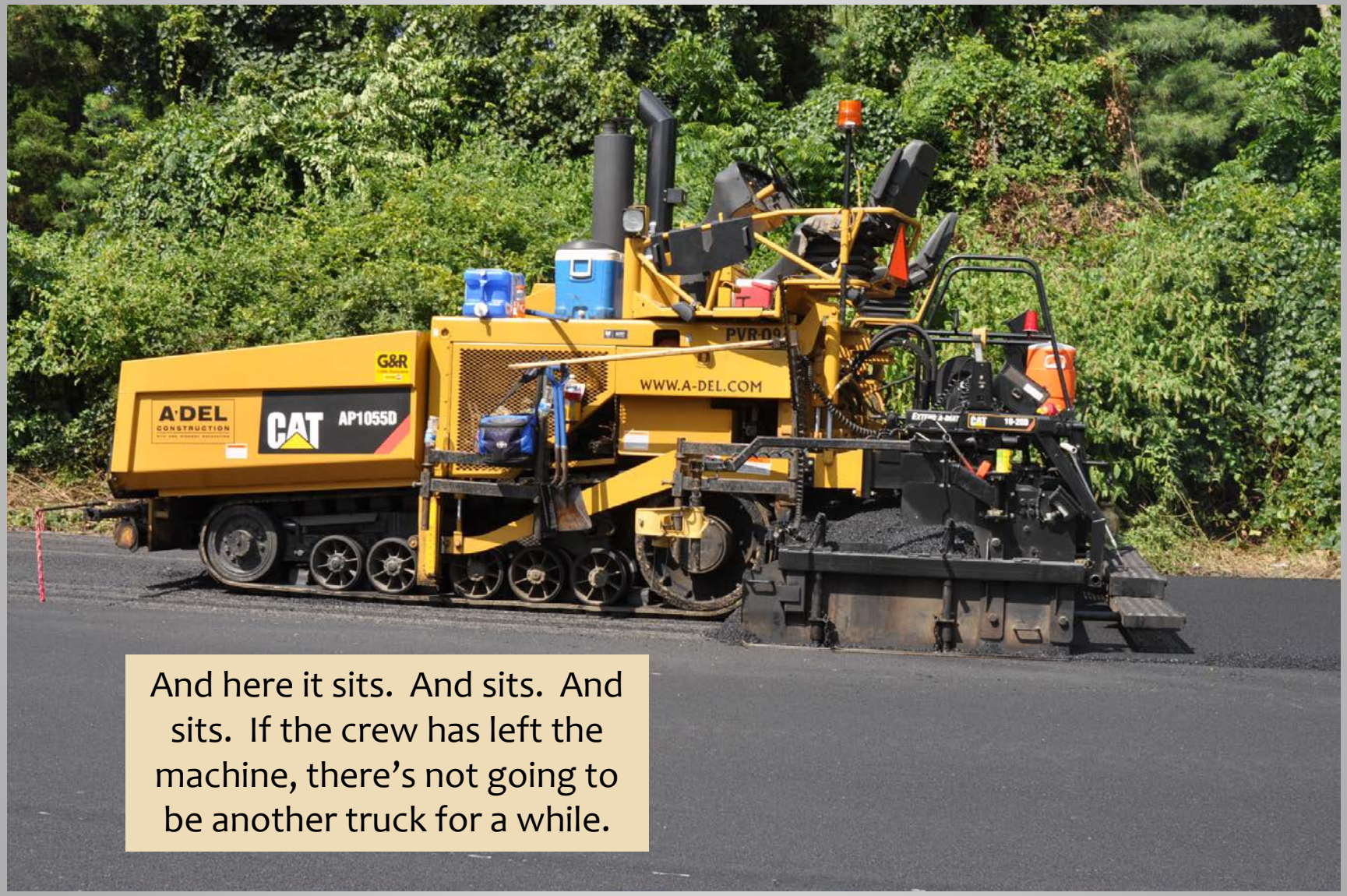

And here it sits. And sits. And sits. If the crew has left the machine, there's not going to be another truck for a while.

Placement

- Keep the paver moving
- Every time it stops, differentials in temperature and compaction will result in noticeable bumps in the mat
- When one truck is empty, another truck should be waiting to back up to the paver
- On smaller jobs, this is harder to accomplish, but no less important
- If a truck isn't ready, better to stop with a full hopper of hot material and get moving at paving speed as soon as possible after it arrives (like we saw in last picture)

Placement

Placement

Delaware T²/LTAP

- Keep those augers full…
- But not too full

Delaware T²/LTAP

Placement

- Transverse joints (beginning and end)
  - Butt joint versus feather joint
  - Saw cut or mill the butt joint edge if necessary to get a clean edge
  - Tack the edge for good bond
  - Minimize luting and do not broadcast material onto the mat
- Longitudinal joints
  - Stagger these if multiple lifts
  - Clean and tack the edge
  - Overlap with second pass just enough to allow proper compaction and kneading of the joint
  - Minimize luting and do not broadcast material onto the mat

Placement

- "Umm, did you say 'yute?'
- "No, I said 'lute'."
- "Oh. Ah, what's a 'lute?""

Delaware
T²/LTAP

Placement

Longitudinal joints – looks like this is reasonably prepared for rolling

Placement

Longitudinal joints

- Joints between lanes are commonly susceptible to moisture damage and other failures
- Causes of failure
  - Low density at the unconfined edge when the first lane is paved
  - Temperature and environmental forces
  - Insufficient material between passes for roll down to match
  - Residual stress occurring at the wheel path
  - Irregular joint lines
- Too little or no overlap, the joint may be starved of material and can result in large voids or very low in-place densities

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T²/LTAP

Placement

Making a straight first pass is crucial for a successful longitudinal joint

Versus

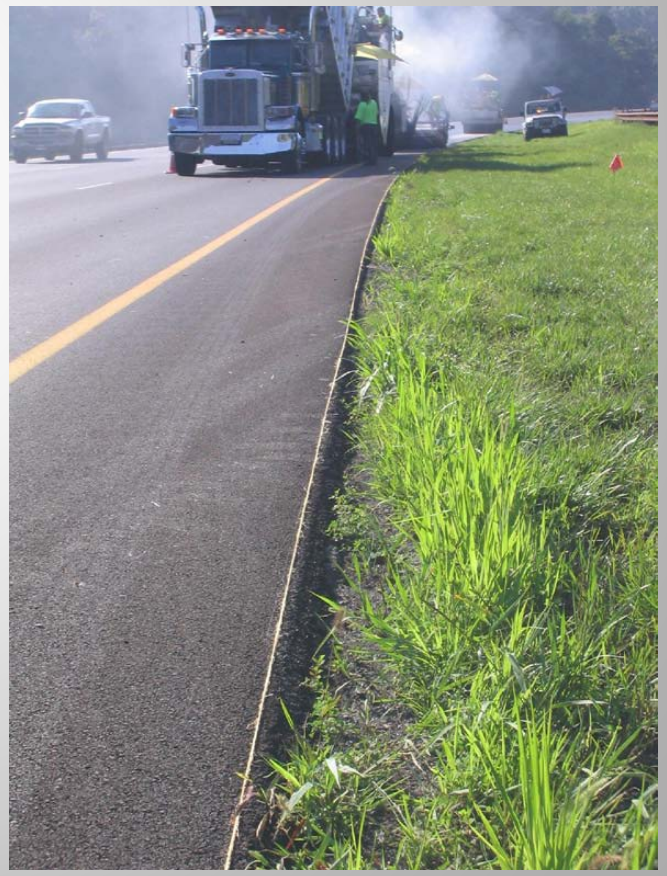


Photo: DelDOT

Placement

Properly referenced layout

Photo: DelDOT

Delaware
T²/LTAP

Placement

And not…

Photo: DelDOT

Placement

Subsection 401.08 Placing Bituminous Mixtures.

- The Contractor is required to carefully plan the placement of the surface course to ensure that the joints in the surface course will correspond with the traffic lanes.
- Longitudinal joints must be parallel to the centerline.
- The Contractor must establish and follow reference lines or other approved markings to control the true alignment of the longitudinal joints.

Delaware T²/LTAP

Placement

Starter Crack

- First pass – right lane?
- Unrestrained edge cooled
- Crown may break at lane edge
- Maybe inadequate tack
- Second pass broke it
- You can start getting water under the pavement right away (that's sarcasm)

Delaware T²/LTAP

Placement

Let's watch a little – keep an eye out

- Loaded augers
- Idled paver
- Roller activity
- Use of lutes
- Segregation

Placement

- Segregation – your best shot at early pavement distress and failure
- Lots of opportunities for it at the batch plant and in truck loading, but you won't see as much of that, so…
- At the site:
  - Unloading the truck into the hopper – don't dribble it in
  - Folding hopper wings – this should be a rarity
  - Slat conveyor/augers running too fast – separates fines
  - Stopping and starting the paver – mat temperature differential
  - Insufficient material on the augers
  - Broadcasting loose material onto the mat (just say no to the lute)
  - Loose material from the hopper or truck

Delaware
T²/LTAP

Placement

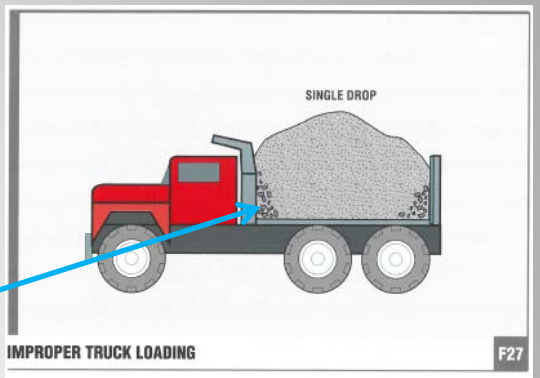
Segregation

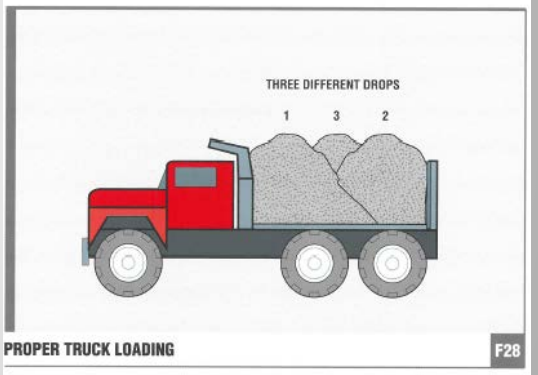
- "What's that fella doing?"
- "Oh, he's cleaning his truck off in front of the paver."
- "Isn't that going to cause segregation and break the bond between the old and new pavement?"
- "Why yes… yes it is."
- "So that's where we will have a premature pavement failure?"
- "Indeed."

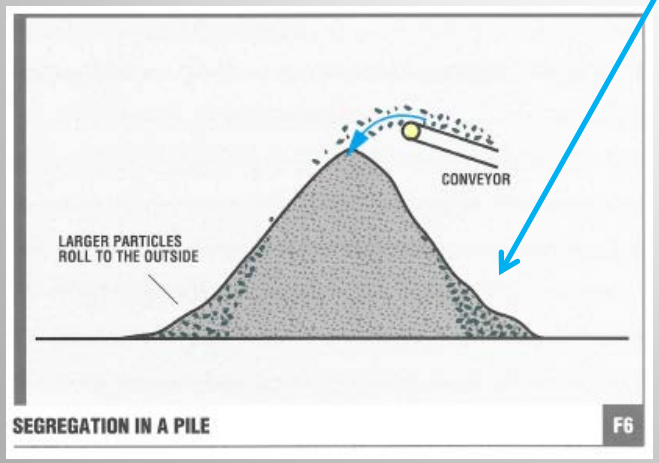
Segregation

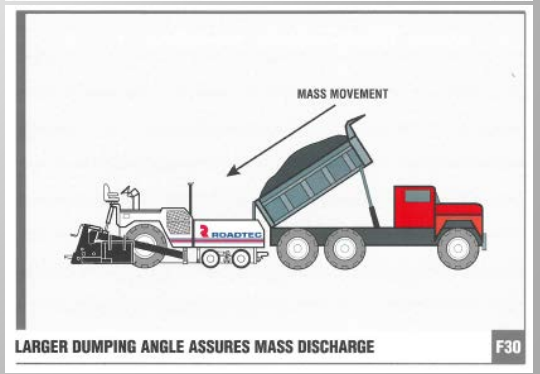
- Origins everywhere
  - In the stockpile
  - As it's loaded
  - In the batch plant
  - Loading the truck
  - Unloading the truck
  - In the paver
  - Etc.

Larger particles separate from finer particles… every chance they get









Source: J. Don Brock, Ph.D., P.E., James G. May, & Greg Renegar, "Segregation: Causes and Cures," Technical Paper T-117, ASTEC, 2003

Segregation

It's just sloppy

Segregation

- Some ways to avoid
  - Know what's going on at the plant
  - Unload trucks correctly
    - Partial bed raise before tailgate release
  - Designate a truck cleanout area – away from paving area
  - Limit dumping of wings
    - Sends coarser, colder material to middle of paver
  - Keep the paver moving
  - Lots of paver segregation opportunities
    - Newer pavers resolve some of these
    - Easy flowing mixes more forgiving
  - Coordinate for continuous material delivery

Figure 8.11 Fine Aggregate Segregation of HMA on the Roadway

Source: Construction of Hot Mix Asphalt Pavements, Manual Series No. 22, Second Edition, Asphalt Institute

Compaction


No, no, no, no, no… what are they doing walking all over your mat and broadcasting material and using that lute excessively?
Yes, yes, yes, yes (safety vests)

Compaction

Delaware T²/LTAP

- Keep that first roller right up behind the paver
- If he isn't scaring the guy on the paver, he isn't close enough!

Compaction

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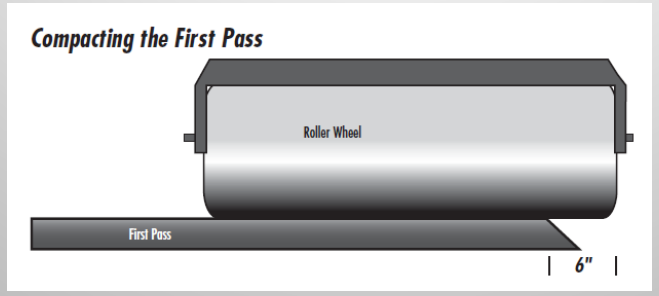
The roller operator can ruin the mat or save it

Some keys

- # of rollers
- Size of rollers
- Patterns
- Mat temp
- Tender zone management



Compaction

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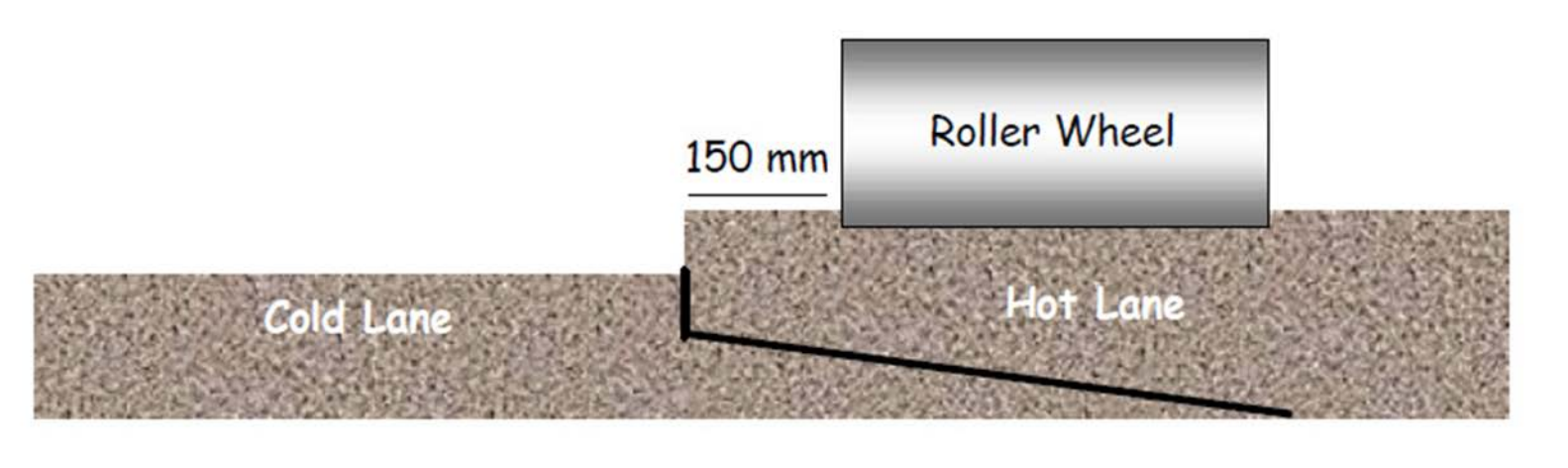
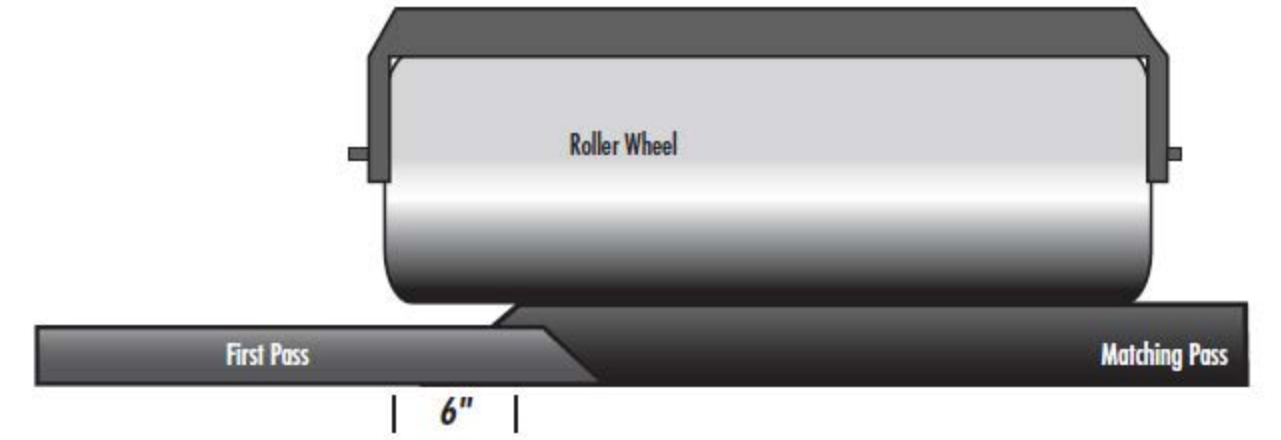
Impact on longitudinal joint





Compaction

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If there are manholes and curbs and inlets to go around, may need one of these finish rollers or even a plate tamper

Compaction

- Compaction is (almost) everything
  - Strength, stability, resistance to rutting, reduction of moisture penetration, reduction of oxidation, fatigue resistance, reduction of low temperature cracking
- Thinner mat allows less time to achieve compaction
- Lower mix temperature allows less time to achieve compaction
- Lower air and surface temperature allows less time to achieve compaction
- Thinner mat under windy conditions allows less time to achieve compaction

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Compaction

- Typical hot mix asphalt temperatures:
  - At the plant: 270˚F - 325˚F
  - In truck/hopper at site: 265˚F - 320˚F (lose 5˚F - 25˚F)
  - Placed mat at back of screed: 265˚F - 315˚F
  - Compaction no longer possible: 175˚F - 185˚F
- Warm mix asphalt could be 50˚F - 100˚F lower
- Check temperatures
  - "Stick in" thermometer is better
  - Infrared thermometer will suffice (more convenient)

Vibratory Roller

Delaware T²/LTAP

Compaction

- Compaction equipment
  - Vibratory rollers
  - Static wheel rollers
  - Pneumatic tired rollers
  - Plate tampers
- Right type, size, and number of equipment
- Used correctly
  - Rolling pattern
  - Number of passes
  - Consistent, low speed
  - Slow stops/starts
  - Gradual directional changes
  - Park only on cold mat

Delaware
T²/LTAP

Compaction

Let's watch a bit more

- Little different kind of job
- Thin lift
- 4.75 mm
- PG 64-22 tack

Inspection

- Contractor must:
  - Have proper equipment in good working order
  - Have access to asphalt in sufficient quantities that meets your specifications
  - Avoid segregation of material at all steps
  - Affect high quality transverse and longitudinal joints
  - Ensure thickness specified (± ¼”) is consistently placed
  - Ensure minimum 90% compaction (base mixes; 92% surface)
  - Provide smooth surface
  - Use best construction practices
  - Protect the surfaces and ensure a good product

Inspection

- Quality Assurance

J.W. French conducts a soil density test on the Bear to State Road construction project – 1947

Delaware T²/LTAP

Inspection

- Inspection techniques and tools
  - Digital camera – shoot tons of pics – the good and the bad
  - Video camera – generally not needed, but if you have one…
  - Daily notes (“diary”) – detailed
  - Talk to the foreman throughout the day, understand what’s going on, what problems they’re having, and what they’re doing about them
  - Raise questions
    - If you don’t understand why they’re doing something or how, ask – better to appear uninitiated than accept a bad job
    - If they’re not performing per your expectations, don’t wait to raise the issue – do it early, directly, and professionally

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Safety Edge

- Best Safety Practice
  - Part of DelDOT's practice
  - Unconfined edge ≥ 2"

Safety

That's right – everyone on the job should be briefed on safety and wearing appropriate personal protective equipment

- Safety briefings
- ANSI Class 3 safety vests – everyone who will step foot in the right of way
- Hard hats – as appropriate for the equipment and activity on site
- Steel toed safety boots – as appropriate for the individual's activities

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Safety

VIPs and guests can get hurt too – so no exceptions

Delaware
T²/LTAP

Pavement Markings

Don't forget

- Stop bars
- Shark's teeth
- Center lines
- Edge lines
- Parking lanes

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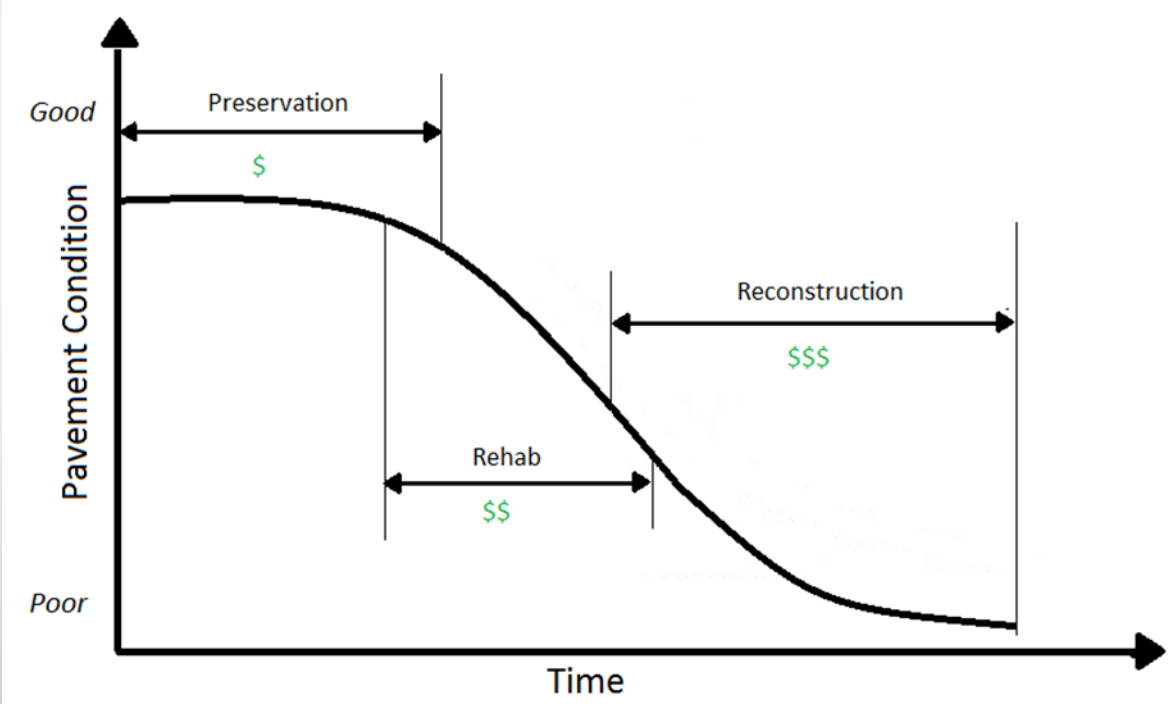
Pavement Preservation

A pavement needing reconstruction is not going to get much worse…

A pavement in fair condition can quickly deteriorate into poor condition



Source: Derek Pearson, "Deterioration and Maintenance of Pavements," Institute of Civil Engineers, 2012

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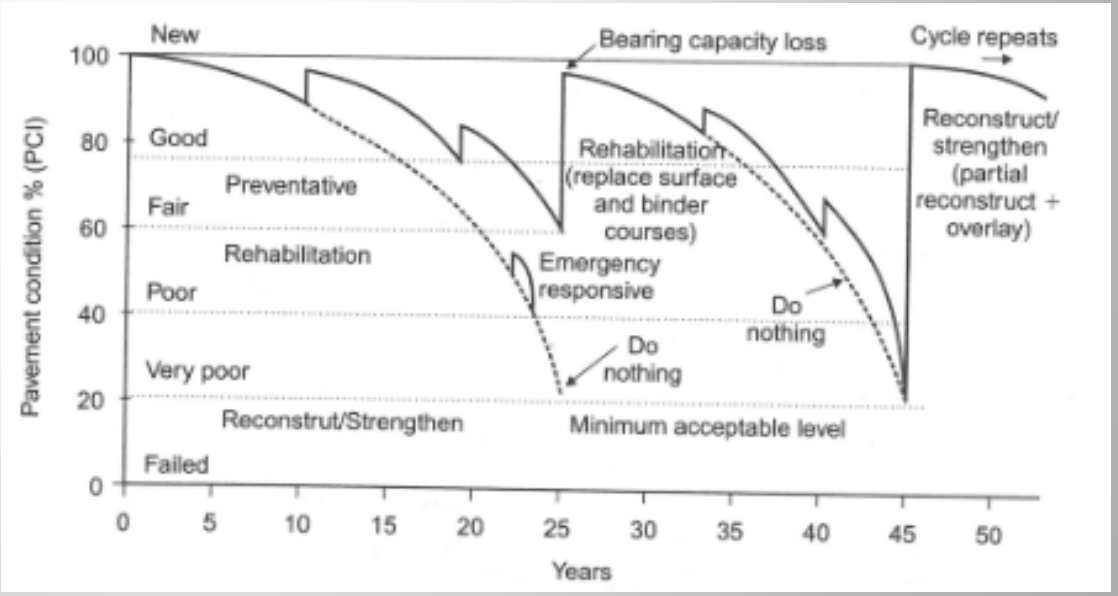
Pavement Preservation

Application of pavement preservation

- Preventative
  - e.g., Crack sealing
- Rehabilitation
  - e.g., Thin lift overlay
- Reconstruction
  - e.g., Mill and overlay



Source: Derek Pearson, "Deterioration and Maintenance of Pavements," Institute of Civil Engineers, 2012

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Pavement Preservation

P² Toolkit

- Crack seal
- Fog seal
- Chip seal
- Slurry seal
- Microsurface
- Thin lift overlay
- Full depth reclamation
- Cold in-place recycling
- Hot in-place recycling
- Fabrics making a comeback?

Resources

- Hot-Mix Asphalt Paving Handbook 2000, US Army Corps of Engineers (a bit dated, but good starting point)
- The Asphalt Handbook, Asphalt Institute
- Construction of Hot Mix Asphalt Pavements (Manual Series No. 22), Asphalt Institute
- DelDOT Standard Specifications
- Delaware T² Center

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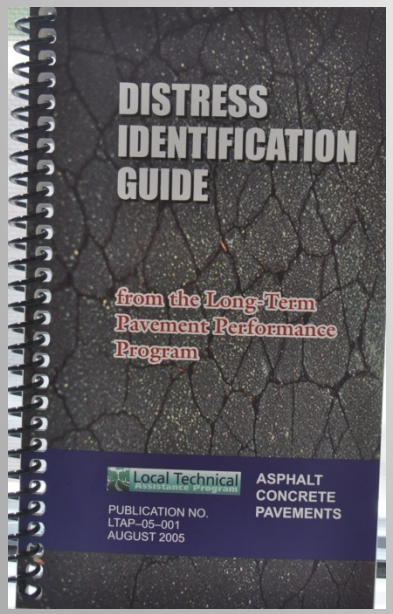
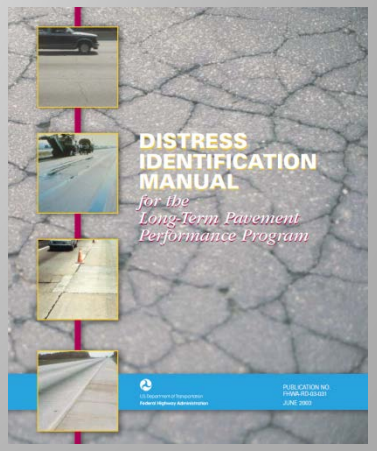
Resources

- Distress Identification Guide (from the Long-Term Pavement Performance System)



- Distress Identification Manual (from the Long-Term Pavement Performance System)
  - Big boy version of the pocket guide
  - http://www.fhwa.dot.gov/publications/research/infrastructure/pavements/ltpp/reports/03031/03031.pdf



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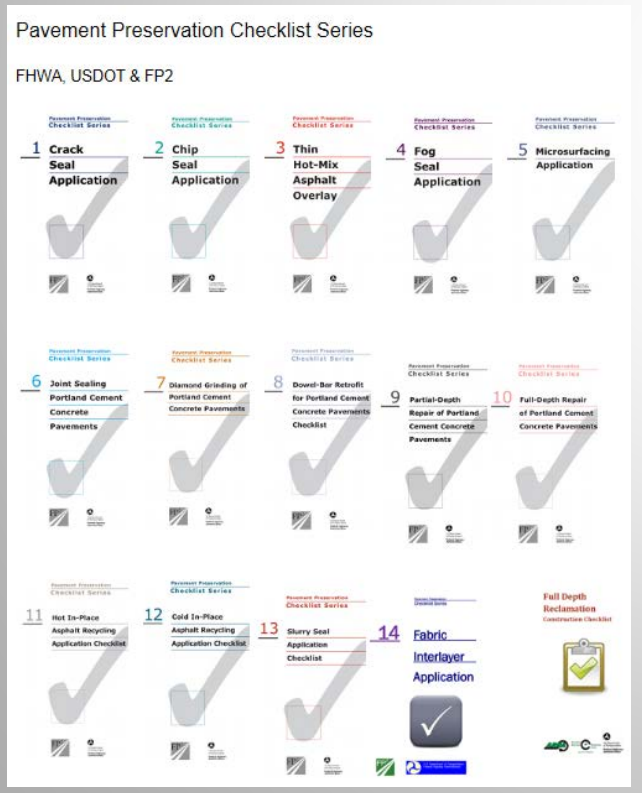
Resources

- Pavement Preservation Checklist Series
  - https://www.pavementpreservation.org/fhwa-resources/fhwa-preservation-brochures/



- Basic, quick, overviews
  - Crack seal
  - Chip seal
  - Thin lift asphalt
  - Fog seal
  - Microsurfacing
  - Hot in-place recycling
  - Cold in-place recycling
  - Slurry seal
  - Paving fabric interlayer
  - Full depth reclamation

Future Questions/Needs

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