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Thin Asphalt Overlay Considerations

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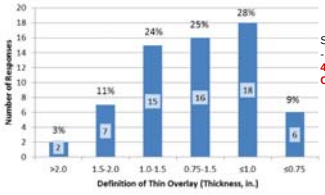
How is "thin lift" asphalt defined?

- Thin Lift Overlays have been defined as surface mixes ranging from ≤ 3/4" to < 2.0" compacted thickness.
- They are not typically intended to strengthen the pavement structure, but instead to address functional problems as part of Pavement Preservation
- Typically dense-graded mixtures, but can be gap-graded or open-graded



State survey responses - NCHRP Synthesis 464: Thin Asphalt Concrete Overlays

There is not a nationally-accepted definition of thin lift asphalt. The concept varies from state to state.

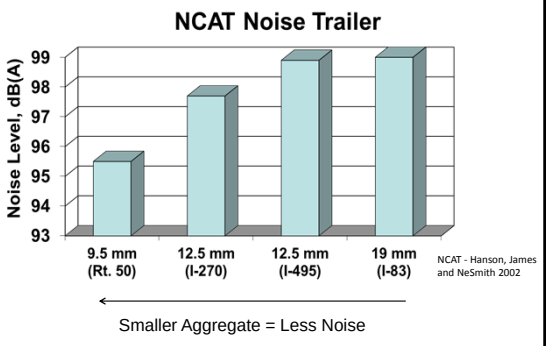
How is "thin lift" asphalt used?

- Some use it as a pavement preservation tool, applying more frequent, thinner overlays in order to prevent a pavement from attaining a significant loss in serviceability.
- Some use thin, dense-graded or gap-graded asphalt lifts for pavement maintenance to seal pavements and restore a smooth riding surface.
- Some use thin open-graded asphalt lifts for safety to reduce potential for hydroplaning, wet-weather spray, and nighttime glare of headlights on wet pavement.

Benefits of Thin Asphalt Overlays

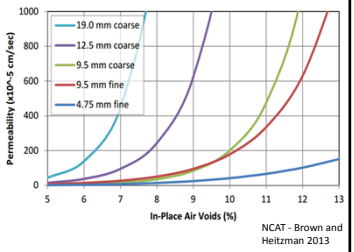
- **Long service, low life-cycle cost**
- **Can handle heavy traffic**
- **Can be constructed quickly, minimizing traffic delays**
- **Protects existing pavement**
- **Seals the surface**
- **Reduces rate of pavement deterioration**
- **Corrects surface deficiencies**
- **Restores skid resistance**
- **Can be recycled**
- **Aesthetically pleasing**
- **Safe**
- **Quiet**
- **Smooth**
- ***Looks and feels new to the traveling public***

Noise Reduction



Impermeability

As the Nominal Maximum Aggregate Size gets smaller, the size of the individual air void spaces decreases. Therefore, at the same percentage of in-place air voids, thin lift asphalt mixes are inherently less permeable.

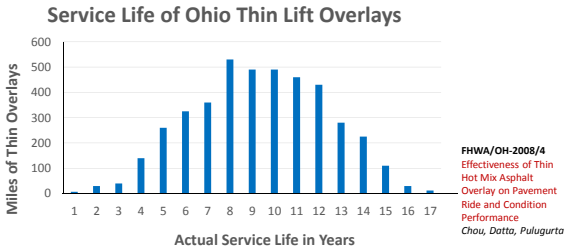


NCAT - Brown and Heitzman 2013

Permeability in a coarse-graded 12.5mm Superpave surface mix in Oklahoma. The allowable gradation band was subsequently fined up as one step in a program to address permeability issues. Roadway density in this area was approximately 93% of G_{mm}.

Service Life of Thin Asphalt Overlays

Total Miles = 4075
No. of Sections = 1923
Mean Service Life = 9.1 yrs
St. Dev. = 3.0 yrs



FHWA/OH-2008/4
Effectiveness of Thin Hot Mix Asphalt Overlay on Pavement Ride and Condition Performance
Chou, Datta, Pulugurta

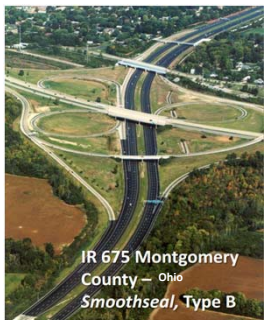
Project Selection - Thin Asphalt Overlays

The quality of the pavement being overlaid *greatly* influences the expected service life of thin asphalt overlays.

A thin asphalt overlay applied to a pavement which is not structurally sound will have a short service life, no matter what type of material is used or how well it is constructed.

It is critical to select the correct type of project for a thin lift overlay to ensure a long service life!

Project Selection - High Volume Projects?



While thin asphalt overlays are often used for low to moderately trafficked roadways, they can successfully be used on high volume roadways as well.

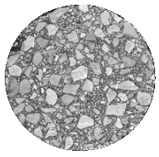
Components of a Basic Evaluation for Potential Thin Asphalt Overlay Candidate Projects

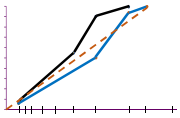
- **Visual Survey**
- **Structural Assessment**
  - No structural improvement required
- **Drainage Evaluation**
  - What changes are needed
- **Functional Evaluation**
  - Ride quality
  - Skid resistance
- **Discussion with Maintenance Personnel**
- **Utilize pavement management data if available**

Thin Lift Mix Types

Dense-Graded **:** has a well-distributed aggregate gradation throughout the entire range of sieves used, typically lab-molded to 4% air voids.

- It is by far the most commonly-specified type of mix for all lifts within a pavement structure, including thin surface lifts.

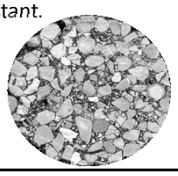


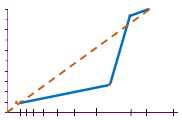


Thin Lift Mix Types

Gap-Graded **:** has a high coarse-aggregate content (typically 70 - 80%), a high binder content (typically > 6%), and a high mineral filler content (typically > 8%), but few intermediate-sized particles, typically lab-molded to 4% air voids.

- The high binder and filler content make it durable and the stone-on-stone contact makes it rut resistant.

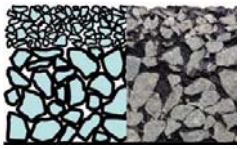


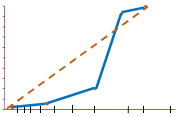


Thin Lift Mix Types

Open-Graded **:** are designed to have a high percentage of air voids (typically 18-22%) by using uniformly-graded aggregates with minimal fines.

- These mixes drain readily to reduce surface spray and glare for enhanced safety.





Binder Selection Considerations

- For Superpave mixes, most states do not differentiate between binders specified for thin lift overlays and those for their regular mix usages. (Most select based on regional climate history and expected traffic level).
- Many states require polymerized binders if specifying premium mixes such as Stone Matrix Asphalt or Permeable Friction Course, both of which can be designed for thin overlays.

Aggregate Selection Considerations

- For thin lift mixes, the Nominal Maximum Aggregate Size (NMAS) should be 1/2", 3/8", or No. 4. The lift thickness should be 3 to 5 times the NMAS.
- 1/2" NMAS mixes should maintain a gradation on the fine side of the maximum density line for dense-graded mixes used in 1.5" lifts (3x NMAS).
- The aggregate must be capable of withstanding the design traffic loads without rutting or polishing.

How does the VMA requirement change with NMAS?

NMAS	37.5mm		25.0mm		19.0 mm		12.5mm		9.5mm		4.75mm	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Sieve Size (mm)	% Passing											
50.0	100	-	-	-	-	-	-	-	-	-	-	-
37.5	90	100	100	-	-	-	-	-	-	-	-	-
25.0	-	90	90	100	100	-	-	-	-	-	-	-
19.0	-	-	-	90	90	100	100	-	-	-	-	-
12.5	-	-	-	-	-	90	90	100	100	-	100	
9.5	-	-	-	-	-	-	-	90	90	100	95	100
4.75	-	-	-	-	-	-	-	-	-	90	90	100
2.36	15	41	19	45	23	49	28	58	32	67	-	-
1.18	-	-	-	-	-	-	-	-	-	-	30	55
0.075	0	6	1	7	2	8	2	10	2	10	6	13
VMA	11.0		12.0		13.0		14.0		15.0		16.0	

Calculating Binder Demand

If the air void percentage is always 4.0% for dense-graded mixtures, and the VMA requirement increases by 1.0% with each successively smaller NMAS mix, what does that mean for the average expected binder content of each mix?

It should increase in a fairly uniform manner

If the binder percentage increases in a fairly uniform manner, shouldn't the aggregate surface area for each mix also increase in a fairly uniform manner?

Interpolating Average Gradation from Control Points

NMAS	37.5mm	25.0mm	19.0 mm	12.5mm	9.5mm	4.75mm
Sieve Size (mm)	Average % Passing					
50.0	100	-	-	-	-	-
37.5	95	100	-	-	-	-
25.0	79	95	100	-	-	-
19.0	70	84	95	100	-	-
12.5	58	69	78	95	100	100
9.5	52	61	69	84	95	97.5
4.75	38	44	50	60	68	95
2.36	28	32	36	43	47.5	65
1.18	20	22	25	30	33	42.5
0.600	13	16	18	21	23	30
0.300	9	11	12	15	16	21
0.150	5	7	8	10	10	14
0.075	3.0	4.0	5.0	6.0	6.0	9.5

Calculating Aggregate Surface Area from Average Gradations

Table 8.1. Surface Area Factors	
Sieve Size	**Surface Area Factors**
% Passing Maximum Sieve Size	2
% Passing No. 4	2
% Passing No. 8	4
% Passing No. 16	8
% Passing No. 30	14
% Passing No. 50	30
% Passing No. 100	60
% Passing No. 200	160

Careful - S.A. calcs are not as objective as they appear to be!

The large increase in average surface area indicates the need for a larger binder content and corresponding VMA

NMAS	37.5mm	25.0mm	19.0 mm	12.5mm	9.5mm	4.75mm
Surface Area	18.0	21.8	25.5	30.1	31.5	44.3
Δ S.A.	-	3.8	3.7	4.6	1.4	12.8
VMA min.	11.0	12.0	13.0	14.0	15.0	16.0

Illinois' 4.75mm mix requires a minimum 18.5% VMA

Moisture Considerations

At the plant:

- Thin lift mixes are composed of a high percentage of fine aggregate
- Fine aggregate stockpiles have higher moisture contents than coarse aggregate stockpiles
- Attention must be given to the proper drying of all aggregates, which may mean slowing down
- Moist aggregates contribute to stripping and also tenderness issues with mixes

Bonding Considerations

On the project:

- Because the overlay is thin, the interface between the old and new pavement is in close proximity to the shear forces created by vehicles during turning and braking movements.
- Therefore, the tack coat between the old surface and the new overlay is especially important

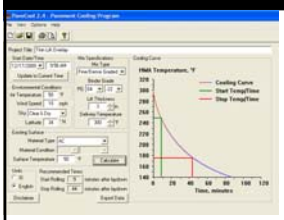
Cooling Considerations

On the project:

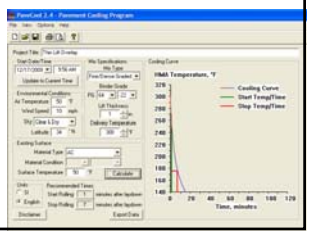
- Realize that when paving thin lifts, each ton goes a long way and the paver can get down the road very quickly
- Don't allow the paver to leave the rollers behind. If the paver must travel fast, incorporate an additional roller.
- Thin lifts cool very rapidly and need to be compacted more quickly than thicker lifts

Hello-o-o-o-o back there!

Time Available for Compaction



3 Inch Lift
50°F Air, Surface Temp
Mix Delivery temp - 300°F
44 minutes to complete compaction operations

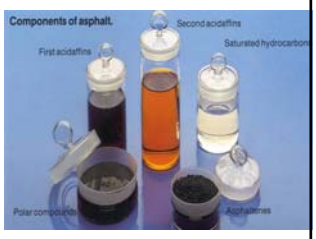


1 Inch Lift
50°F Air, Surface Temp
Mix Delivery temp - 300°F
7 minutes to complete compaction operations

Temperature Considerations

At the plant:

- There is a temptation to run the plant much hotter because of the faster heat loss of HMA placed in thin lifts
- This will volatilize the light fractions of the binder much more quickly and prematurely age the mix



Rolling Considerations

On the project:

- Rolling strategies depend on the type of thin lift
- For Superpave and SMA, you *may* be able to use a vibratory roller - check for roughness, broken aggregate
- Otherwise, use static rollers. (may be able to use pneumatic on Superpave)

Rolling Considerations

On the project:

- For PFCs and OGFCs, use only static rollers, and one or two passes to seat the mix onto the existing surface. The mix is intended to be permeable, so don't overcompact.
- Don't use pneumatic rollers on OGFC and SMA mixes because they pick up badly

QC/QA Considerations

Determining roadway density on thin lifts:

- Difficult to get accurate, repeatable results from thin (< 1-1/2") roadway cores
- If the thickness is at least 1", thin lift nuclear gauges or electromagnetic gauges could be used
- Roller patterns are often set and documented as sole source of QC/QA

Questions?