The Right Mix at The Right Place
From Bike path...  
...to Local Road  
...to Interstate  
NAPA
For each there are:

- Good mixes
- Bad mixes
Mix Type Selection Factors

- Traffic
- Environment
- Subsurface Pavement Structure
- Existing Pavement Condition and Preparation
- Economics
Mix Types

- Dense Graded
- Open-Graded
- Stone Matrix Asphalt (SMA)

How to select mix for optimum performance & economics?
What’s in the Guide

- Pavement layers and traffic level definitions
- General surface preparation recommendations
- Mix Types
  - Definitions
  - Purpose
  - Materials
- Procedure for selecting mixes
- Examples
Recommended General Mix Types

- **Low Traffic**
  - High: DG, SMA
  - Mod: SMA, OGFC
  - Low: DG, SMA, OGFC

- **Medium Traffic**
  - High: DG, SMA, OGFC
  - Mod: SMA, OGFC
  - Low: DG, SMA, OGFC

- **High Traffic**
  - High: DG, SMA, OGFC
  - Mod: SMA, OGFC
  - Low: DG, SMA, OGFC

**Surface**

**Binder**

**Base**

**NAPA**
Pavement Layers

Full Depth HMA

HMA Surface Course
HMA Intermediate/Binder Course
HMA Base Course
Aggregate Base Course
Prepared Subgrade

HMA on Agg Base

Image of pavement layers with text labels.
# Traffic Definitions

<table>
<thead>
<tr>
<th>Traffic</th>
<th>ESAL’s</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>&lt;300,000</td>
<td>Local roads</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low truck traffic</td>
</tr>
<tr>
<td>Moderate</td>
<td>300,000 to 10,000,000</td>
<td>Med to high traffic</td>
</tr>
<tr>
<td></td>
<td></td>
<td>City streets/roads</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rural interstates</td>
</tr>
<tr>
<td>High</td>
<td>&gt;10,000,000</td>
<td>High traffic</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High % trucks</td>
</tr>
</tbody>
</table>
Recommended Mix Types
Surface Courses

Min Lift Thick Range, mm

Low Traffic
Medium Traffic
High Traffic

Mix Type
DFG 4.75
DFG 9.5
DFG 12.5
DFG 19
SMA 9.5
SMA 12.5
SMA 19.0
OGFC 9.5
OGFC 12.5
DCG 9.5
DCG 12.5
DCG 19.0

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Recommended Mix Types
Intermediate Courses

Mix Type
DFG 19.0  DFG 25.0  DCG 19.0  DCG 25.0  SMA 19.0

Min Lift Thick Range, mm
0 20 40 60 80 100 120 140

Low & Medium Traffic
High Traffic
Recommended Mix Types
Base Courses

Min Lift Thick Range, mm

<table>
<thead>
<tr>
<th>Mix Type</th>
<th>Medium Traffic</th>
<th>High Traffic</th>
</tr>
</thead>
<tbody>
<tr>
<td>DFG</td>
<td>19.0</td>
<td>37.5</td>
</tr>
<tr>
<td>DFG</td>
<td>25.0</td>
<td>37.5</td>
</tr>
<tr>
<td>DFG</td>
<td>37.5</td>
<td>37.5</td>
</tr>
<tr>
<td>DCG</td>
<td>19.0</td>
<td>25.0</td>
</tr>
<tr>
<td>DCG</td>
<td>25.0</td>
<td>37.5</td>
</tr>
<tr>
<td>ATPB</td>
<td>19.0</td>
<td>25.0</td>
</tr>
<tr>
<td>ATPB</td>
<td>25.0</td>
<td>37.5</td>
</tr>
<tr>
<td>ATB</td>
<td>37.5</td>
<td></td>
</tr>
</tbody>
</table>
## Fine v. Coarse Dense Mixes

<table>
<thead>
<tr>
<th>Fine-Graded</th>
<th>Coarse-Graded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Permeability</td>
<td>Allows thicker lifts *</td>
</tr>
<tr>
<td>Workability *</td>
<td>Increased macrotexture *</td>
</tr>
<tr>
<td>Thinner lifts *</td>
<td></td>
</tr>
<tr>
<td>Greater durability *</td>
<td></td>
</tr>
<tr>
<td>Smooth texture *</td>
<td></td>
</tr>
</tbody>
</table>

* < 1” (25 mm) NMS
## Dense Graded Materials

<table>
<thead>
<tr>
<th>Material</th>
<th>Low Traffic</th>
<th>Med Traffic</th>
<th>High Traffic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agg.</td>
<td>Gvl (limited)</td>
<td>Crushed Gravel &amp; Stone</td>
<td>Crushed Gravel &amp; Stone</td>
</tr>
<tr>
<td></td>
<td>Crushed Gvl. &amp; Stone</td>
<td>Mfg. &amp; Nat Sands</td>
<td>Mfg. &amp; Nat Sands</td>
</tr>
<tr>
<td></td>
<td>Mfg. &amp; Nat Sand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asphalt</td>
<td>Unmodified</td>
<td>Unmodified</td>
<td>Mod. Likely</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Unmodified</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>local experience</td>
</tr>
<tr>
<td>Other</td>
<td>RAP</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Antistrip by testing</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Recommended Minimum Lift Thicknesses
Dense Graded Mixes

Mix Type
Min Lift Thick Range, mm
Fine & Coarse Graded
Fine Graded
Coarse Graded

- Fine & Coarse Graded
- Fine Graded
- Coarse Graded

Mix Type:
- 4.75
- 9.5
- 9.5
- 12.5
- 12.5
- 19
- 19
- 25
- 37.5

Min Lift Thick Range, mm:
- 0
- 20
- 40
- 60
- 80
- 100
- 120
- 140
- 160

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# Dense-Graded Mix Layers

<table>
<thead>
<tr>
<th>Layer</th>
<th>Nominal Max Size Aggregate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4.75 &amp; 9.5 mm</td>
</tr>
<tr>
<td></td>
<td>12.5 mm</td>
</tr>
<tr>
<td></td>
<td>19 mm</td>
</tr>
<tr>
<td></td>
<td>25 &amp; 37.5 mm</td>
</tr>
<tr>
<td>Surface</td>
<td>Wear</td>
</tr>
<tr>
<td></td>
<td>Friction</td>
</tr>
<tr>
<td></td>
<td>Smooth</td>
</tr>
<tr>
<td></td>
<td>W, F &amp; S</td>
</tr>
<tr>
<td></td>
<td>Structure</td>
</tr>
<tr>
<td></td>
<td>Friction</td>
</tr>
<tr>
<td></td>
<td>Structure</td>
</tr>
<tr>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>Binder</td>
<td>Leveling</td>
</tr>
<tr>
<td></td>
<td>Smooth</td>
</tr>
<tr>
<td></td>
<td>Structure</td>
</tr>
<tr>
<td></td>
<td>Structure</td>
</tr>
<tr>
<td>Base</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Structure</td>
</tr>
</tbody>
</table>

- **Surface**: Wear, Friction, Smooth, W, F & S, Structure, Friction, Structure, N/A
- **Binder**: Leveling, Smooth, Structure
- **Base**: N/A, Structure
Selection Process Step 1: Determine total thickness

Example

- Reconstruction for downtown redevelopment.

6” (150 mm)

- Performance and appearance important
Step 2: Select surface course mix type & thickness

- Traffic loading
- Aggregate size
- Appearance
- Traffic Flow
Step 2: Select surface type & thickness

Relative Appropriateness

Low Traffic | Medium Traffic | High Traffic

High | Low Traffic | Medium Traffic | High Traffic

Mix Type

DG | SMA | OGFC | DG | SMA | OGFC | DG | SMA | OGFC

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Step 2: Select surface type & thickness
Step 2: Select surface type & thickness

- Mix - 9.5 mm DFG
- Thickness - 37.5 mm
Binder Grade vs. Depth

Example: Indianapolis, Medium Traffic, Slow

- LTPPBind Software
- Grade varies with
  - Location/Environment
  - Traffic level
  - Traffic speed
  - Reliability
  - Depth
PG vs. Depth
3-10 MESAL, Slow

Depth
-200 -175 -150 -125 -100 -75 -50 -25 0

Reliability
50 60 70 80 90 98
PG vs. Depth
3-10 MESAL, Fast
What Binders are Available

- 76-22
- 70-22
- 64-22 – Workhorse
- 58-22
PG vs. Depth
3-10 MESAL, Slow

Reliability vs. Depth

Depth
-200 -175 -150 -125 -100 -75 -50 -25 0

Reliability
50 60 70 80 90 98

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Step 2: Select surface type & thickness

- Mix - 9.5 mm DFG
- Thickness - 37.5 mm
- PG 70-22, 98% Rel.

37.5 mm

150 mm

112.5 mm
Recommended Minimum Lift Thicknesses
Dense Graded Mixes

- **Option 1:** Single lift 25 or 37.5 mm
- **Option 2:** Binder 12.5mm, Base 19mm

Mix Types:
- Fine & Coarse Graded
- Fine Graded
- Coarse Graded
Options

1 – Single lift 25 mm or 37.5 mm
   – Advantage - Reduced cost
     - Larger stone mixes use less binder
     - Single paver pass
   – Potential disadvantage
     - Smoothness – more lifts = more opportunities

2 – Binder 12.5 mm, Base 25 mm
   – Advantage – smoothness
   – Disadvantage – Cost
     - Use more binder
     - More paver passes
Binder Content vs. NMAS
Mix Binder Costs

- 9.5 mm = $18.64
- 12 mm = $16.84
- 19 mm = $15.04
- 25 mm = $13.28
- 37.5 mm = $12.28

Based on 400/ton AC cost.
Actual values not important. Difference in cost more relevant.
Step 2: Select surface type & thickness

- **Mix - 9.5 mm DFG**
- **Thickness - 37.5 mm**
- **PG 70-22, 98% Rel.**

- **Mix – 37.5 mm DG**
- **Thickness – 112.5 mm**
- **PG 64-22, >90% Rel.**
Option Comparison

Option 1:
- 25 mm, 112.5 mm thick ~ $22,700
- 37.5 mm, 112.5 mm thick ~ $21,100

Option 2:
- 12.5 mm, 50 mm thick ~$12,800
- 19 mm, 62.5 mm thick ~$14,300
- Total ~ $27,100

Difference
- Option 1 25 mm vs Option 2 = $4,400
- Option 1 37.5 mm vs Option 2 = $6,000
Thinner Surface

- New construction
- Overlay – structurally sound

Use when appropriate – Not just because you can
## Thinner Surfacing

<table>
<thead>
<tr>
<th>Mix</th>
<th>9.5 mm</th>
<th>12.5 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ½” Thick</td>
<td>1 ½” Thick</td>
<td></td>
</tr>
<tr>
<td>% AC</td>
<td>6.0</td>
<td>5.5</td>
</tr>
<tr>
<td>Coverage #/SY</td>
<td>165</td>
<td>220</td>
</tr>
<tr>
<td>AC, lbs</td>
<td>9.9</td>
<td>12.1</td>
</tr>
<tr>
<td>Agg.</td>
<td>155.1</td>
<td>207.3</td>
</tr>
<tr>
<td>Material Cost</td>
<td>$2.76/SY</td>
<td>$3.46/SY</td>
</tr>
</tbody>
</table>

Assumed Cost: AC $400/ton, Aggregate $10/ton

**Savings $4,928/lane-mile**
Mix Type Selection

- Traffic
- Environment
- Subsurface Pavement Structure
- Existing Pavement Condition and Preparation
- Economics
  - NMAS
  - Binder