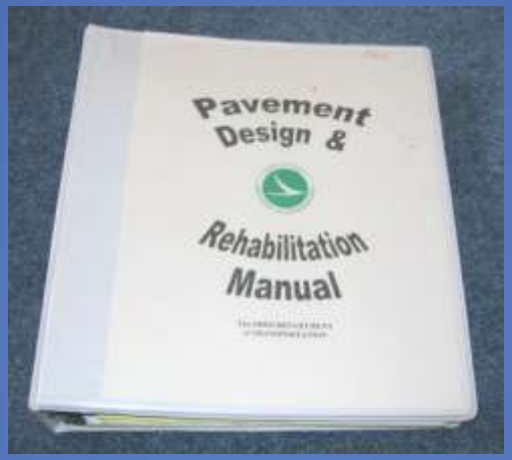
# Engineering and Performance Considerations for Asphalt Base and Composite Pavements

# ODOT Pavement Design Manual

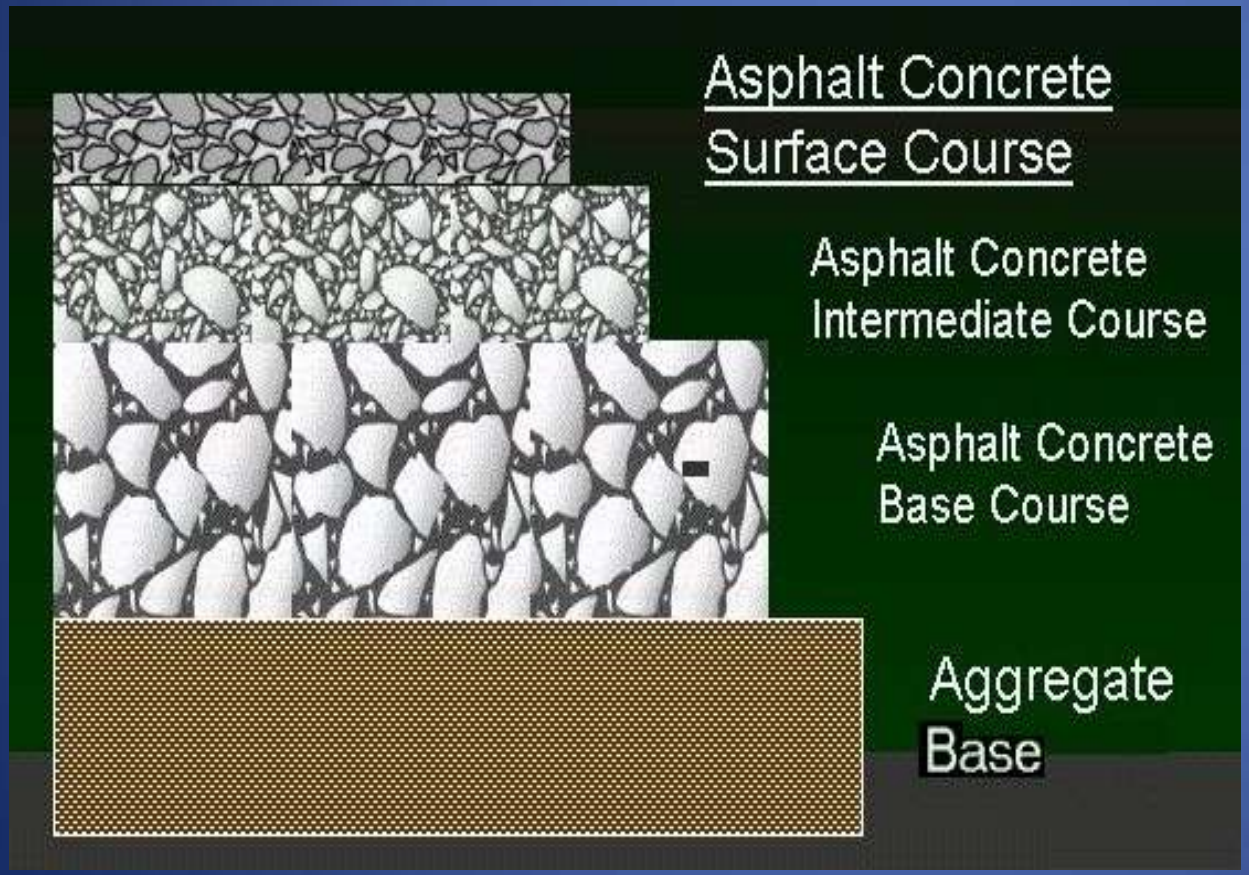
http://www.dot.state.oh.us/Divisions/Engineering/Pavement/Pages/Publications.aspx




Section 200, Pavement Design Concepts

- 300, Rigid Pavement Design
- 400, Flexible Pavement Design
- 500, Minor Rehabilitation

# Typical Asphalt Base Pavement




441, Type 1, etc.

441 Type 2, etc.

301(3” min.) or

302 (4” min)

304

on Prepared Subgrade, item 204, stabilized item 206

# Ensuring Good Performance in Flexible Pavement Design and Construction:

accomplished through:

- Proper structural (thickness) design for the existing soil, anticipated loads and existing pavement condition for overlays.
- Optimum number of layers to facilitate stability, smoothness and economy
- Selection of the appropriate mix types for each of the layers to achieve stability, smoothness and economy
- Construction that complies with or exceeds the specifications for uniformity, smoothness and compaction(QC/QA and FQCS)

# Asphalt base pavement performance

- Pavements with an asphalt base have a long and successful performance history on Ohio Highways
- This experience has shown that :
- Asphalt base is a long-life pavement
- Asphalt surfaces last longer on asphalt base
- Maintenance of an asphalt base pavement is simple, inexpensive and fast.
- Asphalt surfaces are smoother and quieter
- Asphalt is the sustainable pavement

# Asphalt base is the real long-life pavement

No asphalt base pavement on Ohio's Interstate system has ever required replacement or major rehabilitation – see the study: Economic Evaluation of Ohio's Flexible and Rigid Interstate Pavements at: http://www.flexiblepavements.org/images/ecoeval.pdf

The Perpetual Pavement Concept – base that lasts indefinitely with just surface maintenance

# Asphalt surfaces last longer on asphalt base

- The average life of an asphalt surface on new construction is > 15 years
- The average life of the first overlay is > 10 years
- Master Craftsman Awards
- See FHWA study, “Performance Trends of Rehabilitated AC Pavements” Publication No. FHWA-RD-00-165 or NAPA “Best buy’ brochure
- See ODOT study of thin overlays summary article in Ohio Asphalt Fall/Winter 2009:

  http://ohioasphalt.turn-page.com/

# Maintenance of an asphalt base pavement is simple, inexpensive and fast.

- Maintenance consists of mill and fill and crack filling
- Maintenance of traffic is easier
- Do it overnight , if needed

# Maintenance of Traffic Considerations

- Advantages of the Asphalt base pavement
  - Speed of Construction
  - Quick Release to Traffic
  - Facilitate rapid changes in MoT
  - Reduced Congestion

# Asphalt surfaces are smoother, quieter and look better

- Smoothness is important on high speed roadways: greater comfort, economy and less maintenance
- Paint markings last longer and are more visible on asphalt
- See our award photos at http://www.flexiblepavements.org/awards

# Asphalt is the sustainable pavement

- Reclaimed asphalt pavement (RAP) is 100% recyclable (reusable)
- Warm Mix reduces energy and emissions at the plant and paving site
- Porous asphalt for stormwater management
- Perpetual pavement
- LEED certification points  (NAPA brochures)
- Half the carbon footprint of PCC
- Visit: http://www.flexiblepavements.org/sustainable_pav.cfm

# For more information on asphalt base pavement performance:

- "Economic Evaluation of Ohio's Flexible and Rigid Interstate Pavements“
- visit the "Sustainable Pavement' page.
- Also, visit the Federal Highway Administration's LTPP home page at http://www.fhwa.dot.gov/pavement/pub_details.cfm?id=8 to view the Tech Brief, "Performance Trends of Rehabilitated AC Pavements"
- ODOT research project report, (1) SJN 14783, Evaluation of Variation in Pavement performance between Districts, Univ. of Toledo, Dr. E. Chou, et. al., 2004 on the ODOT website at http://www.dot.state.oh.us/Divisions/Planning/SPR/Research/reportsandplans/_layouts/listform.aspx?PageType=4&ListId={7914B63D-DF9D-4762-92FF-4674BE7DD96A}&ID=36&ContentTypeID=0x0100A87157BC16FE6843984E26CC694CAAAB
- “Asphalt Base Pavements – The Best Value in Pavements” View the PDF at http://www.flexiblepavements.org/sites/www.flexiblepavements.org/files/ohio-asphalt-pdf/ashaltbaseartl.pdf

# More information:

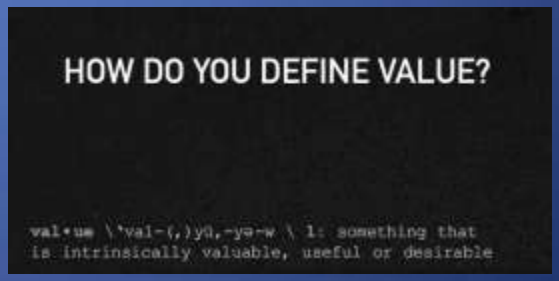

## “Matter of Fact” brochure

Find at:
http://matteroffact.turn-page.com/

## “How do You Define Value” brochure

Find at

http://www.flexiblepavements.org/sites/www.flexiblepavements.org/files/value2.pdf



# Composite Pavement – asphalt on concrete

Composite pavements are:

- old concrete pavement overlaid with asphalt
- concrete base (Item 305 or RCC) with an asphalt wearing course
- other types including brick

# Kinds of concrete pavement and base

- Reinforced (Item 451) – characterized by steel mesh reinforcement, doweled transverse joints and tied longitudinal joints,
- Plain (Item 452) – Has load transfer as 451 but no reinforcing mesh.  Uses a short (15’) joint spacing to prevent mid slab cracks
- Concrete base (Item 305) – like 452
- Roller Compacted concrete –lean concrete placed like asphalt with low W/C ratio, no steel

# Reinforced concrete engineering and performance

- Transverse and longitudinal joints are used to control cracking
- Load transfer is the critical element at joints.
- Transverse joints with dowels, longitudinal joints with tie bars
- Reinforcing mesh allows longer (21') joint spacing with the expectation that mid-panel cracks will form but the steel will hold them tightly together and not allow further deterioration. Hairline cracks (less than approximately 1/8 inch (3 mm) wide) are common, even expected, in reinforced pavements and are little cause for concern. Wider cracks likely mean the steel has failed and the cracks are going to deteriorate and need repair. (ODOT PDM)

# Non-reinforced (plain) concrete engineering and performance

- Uses doweled transverse and tied longitudinal joints for load transfer, no mesh.
- uses shorter (15’) joint spacing in attempt to eliminate mid-panel cracking. Any cracks in non-reinforced pavement, even hairline, are likely to deteriorate and require repair
- Given the high temperature variations and heavy truck traffic in Ohio, aggregate interlock is not effective and faulting is the primary result.
- Adequate concrete cover is needed to transfer stresses between the concrete and the dowel bars. Because of the required concrete cover, the minimum thickness of concrete pavement is 8 inches

# Composite Pavement Performance

- Some pavements have been built new with a concrete base and an asphalt wearing surface
- An asphalt overlay is the most common rehabilitation treatment for a deteriorated concrete pavement
- But, an asphalt surface on a concrete base is not the best performing application of asphalt
- The problem is reflection cracking
- ODOT warns that reflection cracking is inevitable in composite pavement (PM 504.04)
- Reflective cracking leads to accelerated deterioration and shortened life

# Univ. of Toledo study

- “Overlays on flexible pavements perform better and last longer than on composite pavements”
- “Replacing composite pavements through reconstruction will also help improve long term performance”
- ODOT research project report, (1) SJN 14783, Evaluation of Variation in Pavement performance between Districts, Univ. of Toledo, Dr. E. Chou, et. al., 2004

## Disposition of I-71, Columbus to Cleveland, pavements from the Gibboney Study

| | | | original pavement type | | Present pavement type | | | |
|---|---|---|---|---|---|---|---|---|
| County | Begin Log | End Log | Rigid (concrete) | Flexible (Asphalt base) | Flexible (Asphalt base) | Fractured Slab (FS) | Composite | Rigid (concrete) |
| FRA | 28.92 | 29.9 | | Flexible | Flexible | | | |
| DEL | 0 | 11.5 | | Flexible | Flexible | | | |
| DEL | 11.5 | 17.23 | rigid | | | FS | | |
| MRW | 0 | 19.93 | rigid | | | FS | | |
| RIC | 0 | 20.64 | rigid | | Flexible | | | |
| ASD | 0 | 16.14 | rigid | | Flexible | | | |
| WAY | 0 | 7.1 | rigid | | Flexible | | | |
| MED | 0 | 6.06 | rigid | | Flexible | | | |
| MED | 6.06 | 9.56 | rigid | | Flexible | | | |
| MED | 9.56 | 26.68 | rigid | | Flexible | | | |

# Roller Compacted Concrete (RCC)

Can be economical for pavement that must sustain trucks loads - placed 4-10 in. thick - Low cement content  and fly ash
Surface adequate for industrial applications, but not residential or retail
Cracking and reflection cracking are the performance issues
“not all it’s cracked up to be”

# Saw-Cut Joints

- Need to saw within 12 hours to avoid uncontrolled cracking

- 1/3 depth of slab, Maximum 20 ft. intervals.


RCC park lot


Asphalt surface over RCC base

Asphalt surface on RCC base


Asphalt surface on RCC base

# Ensuring best performance of an asphalt overlay on concrete

- Make adequate structural repairs to restore load transfer between slabs at cracks and joints
- Place a structurally adequate overlay
- Take measures to control reflection cracking
- Provide adequate ongoing maintenance

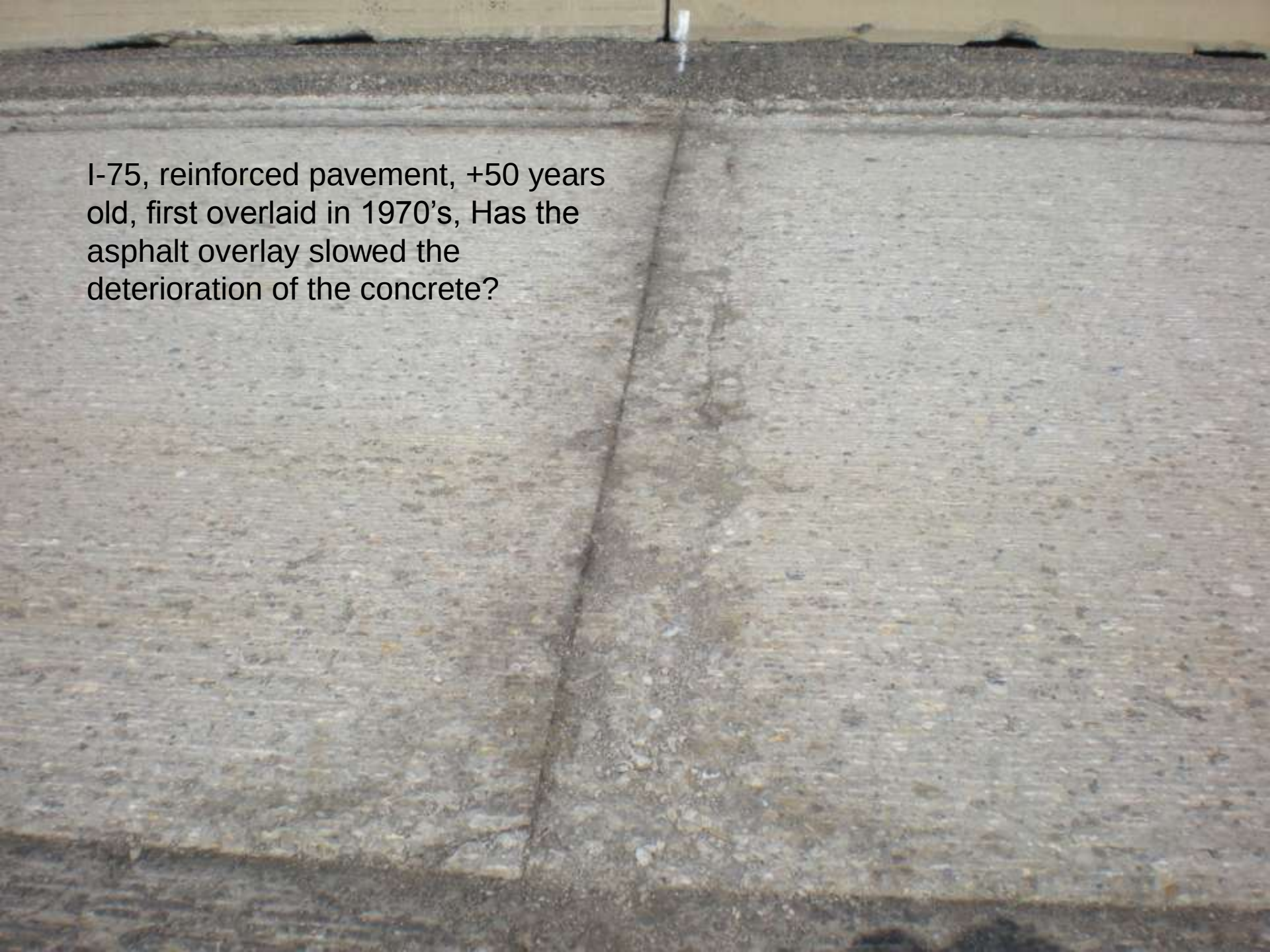
# restore load transfer

Concrete pavement restoration (CPR):

- Retrofit subsurface drainage
- joint repair, item 255
- dowel bar retrofit, Item 258,
- undersealing, SS 812
- Crack and joint sealing, Item 423

# structurally adequate overlay

- Asphalt overlay, min. 3”, slows deterioration?
- Scarify, rubber tack (702.13)
- ODOT uses UTOVER program
- AASHTO, Chapter 5.6, evaluation and design methods
- Asphalt Institute, MS-17 procedures


I-75, reinforced pavement, +50 years old, first overlaid in 1970’s, Has the asphalt overlay slowed the deterioration of the concrete?

# Control of reflection cracking

- Extra thickness of overlay
- Saw and Seal (item 413) recommended for overlay placed over exposed concrete (PM 504.4.1)
- Fabrics and geogrids – only on longitudinal joints
- Crack relief layer (3.5 in. OG AC base)
- Fractured slab treatments

# ongoing maintenance

- Crack Sealing with Routing, Type 1, for well-defined, moving joints and cracks
- Crack filling with type II, III or IV fiber filled crack filler on longitudinal cracks and random transverse cracks

## Conclusions and Recommendations

Many advantages of asphalt base pavement:

- Asphalt base is the real long-life pavement
- Asphalt surfaces last longer on asphalt base
- Maintenance of an asphalt base pavement is simple, inexpensive and fast.
- Asphalt surfaces are smoother and quieter
- Asphalt is the sustainable pavement

## Conclusions and Recommendations

- Composite pavements are necessary and useful for extending the life of a concrete pavement
- Composite pavements will have maintenance issues from early in their life.
- Don’t start with a composite pavement
- For a new pavement:
  - Costs are more competitive now
  - Performance is the basis for differentiation
  - Selection is a judgment of value

# Questions?