Best Practices in the Design and Construction of Airfield Composite Pavements

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Outline

- Types and Design – HMA on PCC only
- Why Composite – when and when not?
- PWC ASG -19 Design Procedure
- FAA Design Procedure
- Composite Pavements - Cracking
- Case History Runway 05-23 Upgrade

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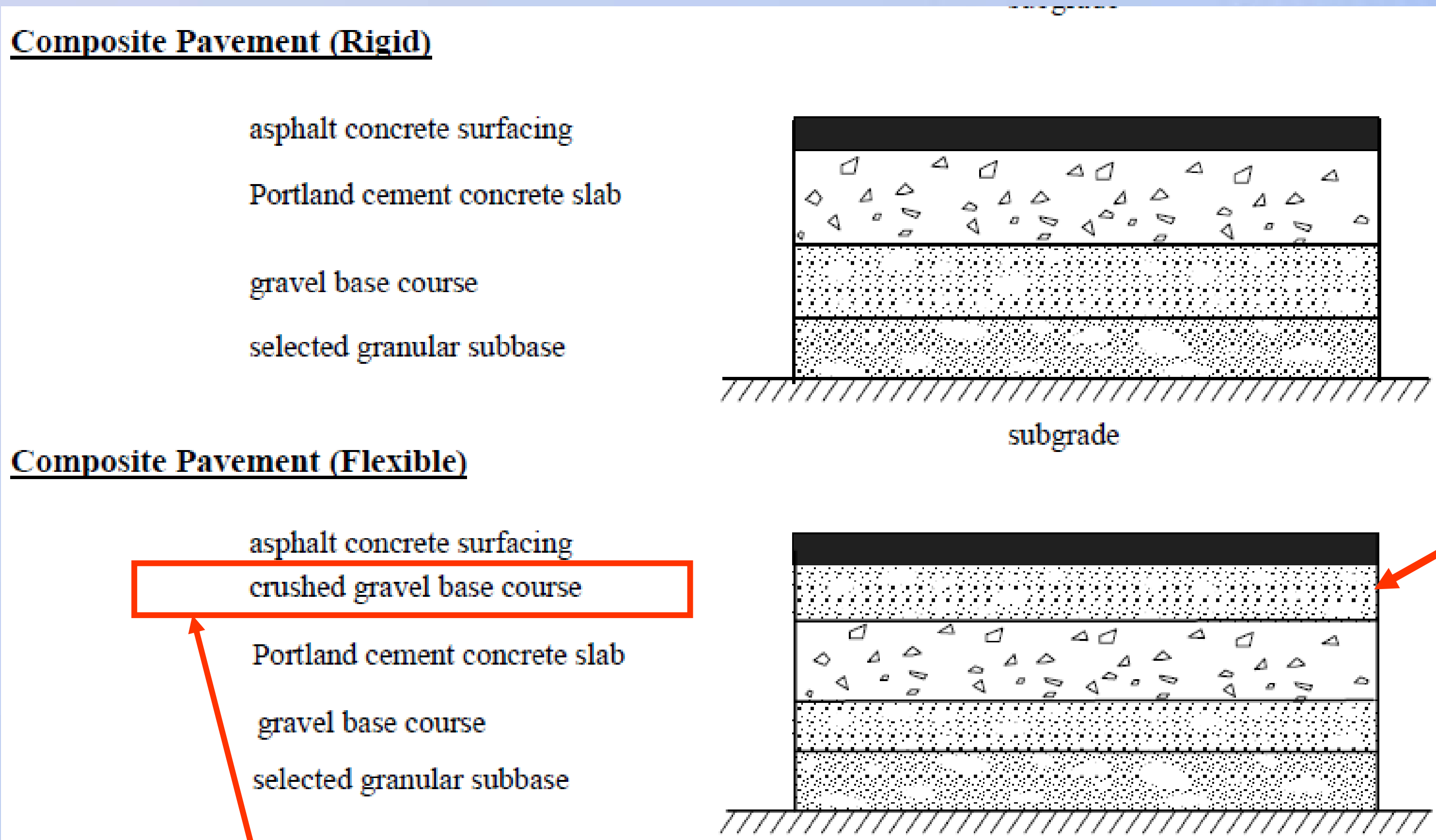
Two Types of Composite HMA on PCC Pavement



"Gravel Sandwich" BAD Practice and Poor Performance

Should only be HMA or CSB

Problems with Gravel "Sandwich" Construction

Still an option in ASG-19, but outlawed in FAA

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Why Composite Pavement?

- Strengthening of existing concrete for increased air traffic or increased aircraft loading.
- Restore surface condition or “grade” of existing concrete with new “surface” layer – strengthening not key issue.
- Keep basic concrete “structural” and load distributing properties; do localized concrete repairs and then overlay all including repaired areas to upgrade.
- Composite “overlay” can be done “at night” to minimize operational disruption – main reason. (“I never worked on concrete overlay” - GN)

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When Composite Solutions May Not Work

- Large increase in aircraft loadings such that composite overlay is so thick and overall structure becomes a flexible pavement but this restoration may be uneconomical/impractical.
- Concrete is badly deteriorated such that “rigid” load distribution properties are lost and it also acts like a flexible pavement (thick overlay).
- Concrete slab stepping has too much movement – but possible if you can stabilize slabs first.

Consider – full reconstruction, rubblization, slab jacking first and replacement with rigid or flexible depending on available grade interfaces.

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Composite Pavement Design Methods

- PWC ASG -19 (AK-68-12) (1992)
- FAA Advisory Circular 150/5320-6E (2009)

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ASG-19 DESIGN METHODOLOGY

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Composite Design using ASG-19

- Note ASG-19 states that if asphalt overlay exceeds 25 cm or the depth of existing slab then you have to treat the composite section as “flexible”
- For cosmetic or roughness issues use minimum 5 cm asphalt overlay or mill/replace
- ASG -19 Design is really for “strengthening” not regrading

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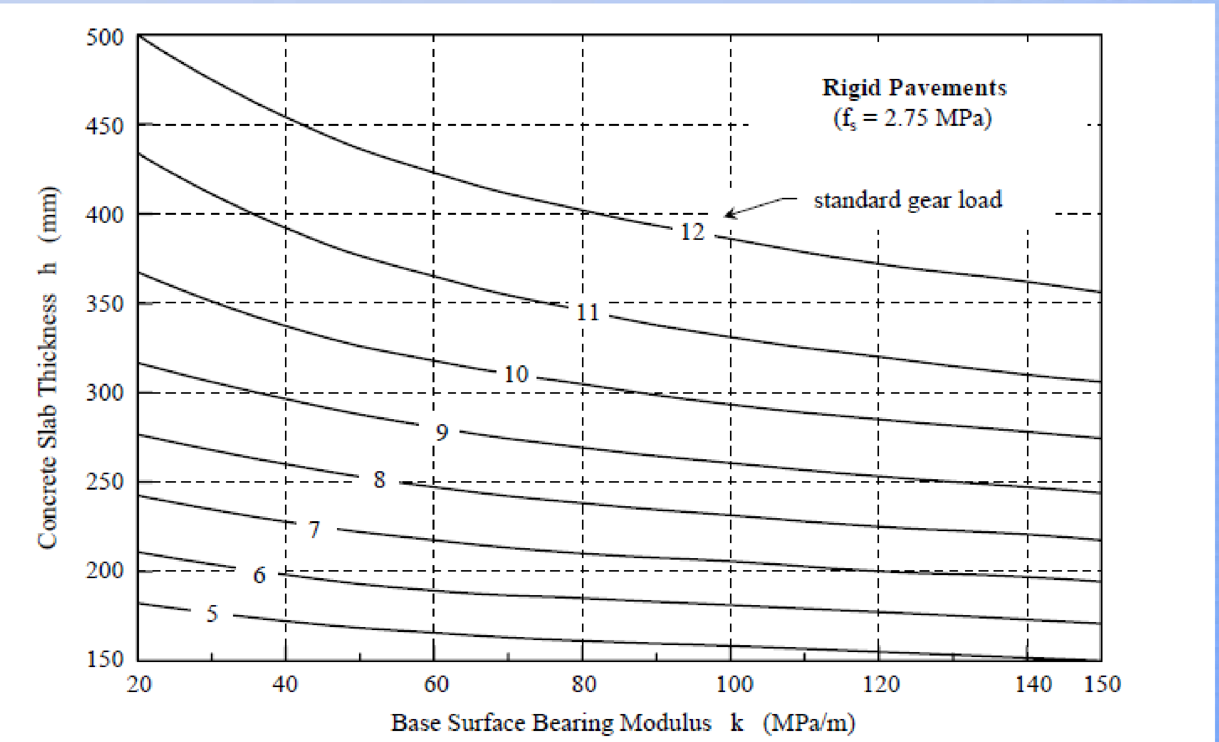
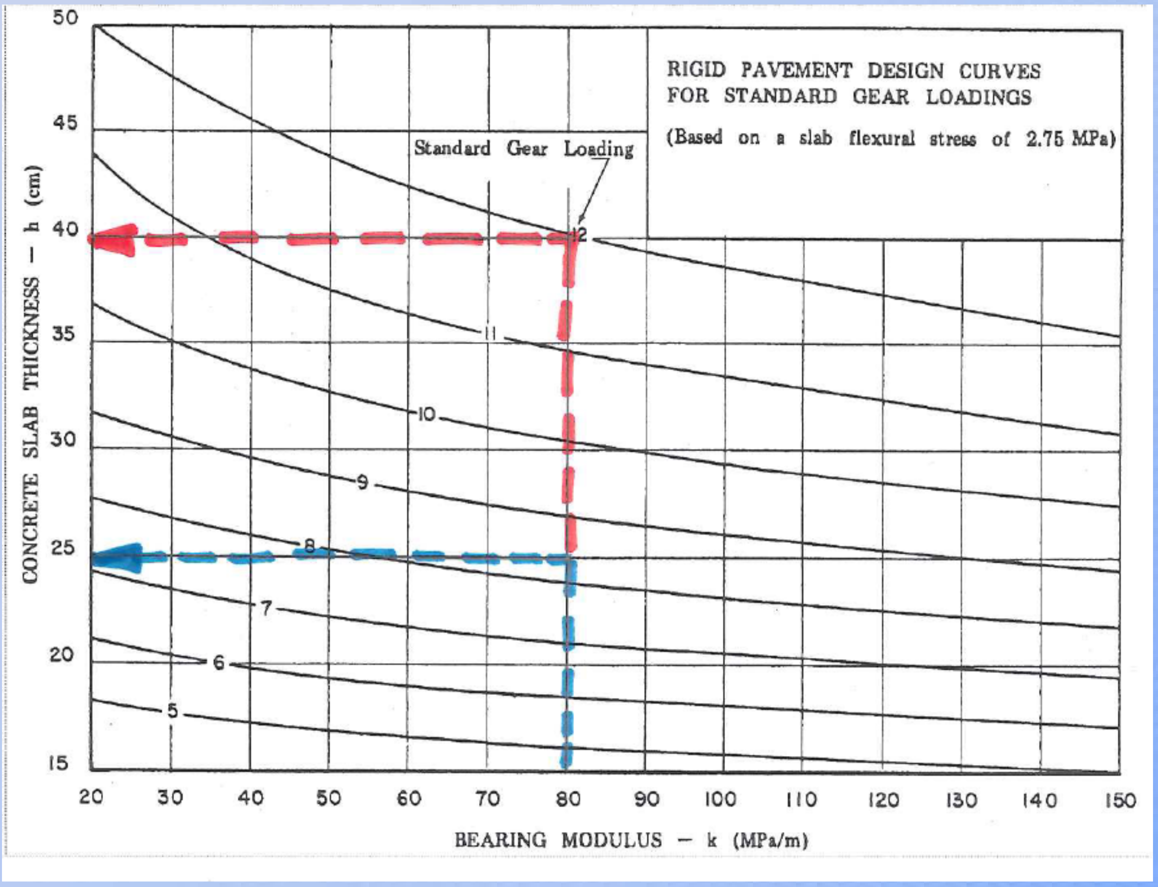
ASG- 19 Strengthening Overlay Design

- Design “rigid pavement” slab for critical aircraft as per usual ASG-19 method and rigid pavement design chart Figure 3.4.2.



ASG-19 Example Overlay Design

- First Design Equivalent Rigid Pavement with new critical aircraft (DC-9-32 (ALR 8.4) to new B747-400 (ALR 12)).



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Use ASG-19 Overlay Formula and Equivalent Rigid Slab Chart (Fig. 3.2.2)

- T (overlay thickness(cm)) =

  1.67 (F * h_d – h) where

F = factor dependent on slab "k" (MPa/m) (80/.825)
h_d = thickness of slab for new aircraft (cm) (40 cm)
h = existing slab thickness (cm) (25 cm)

Solution for example = 13.36 cm overlay

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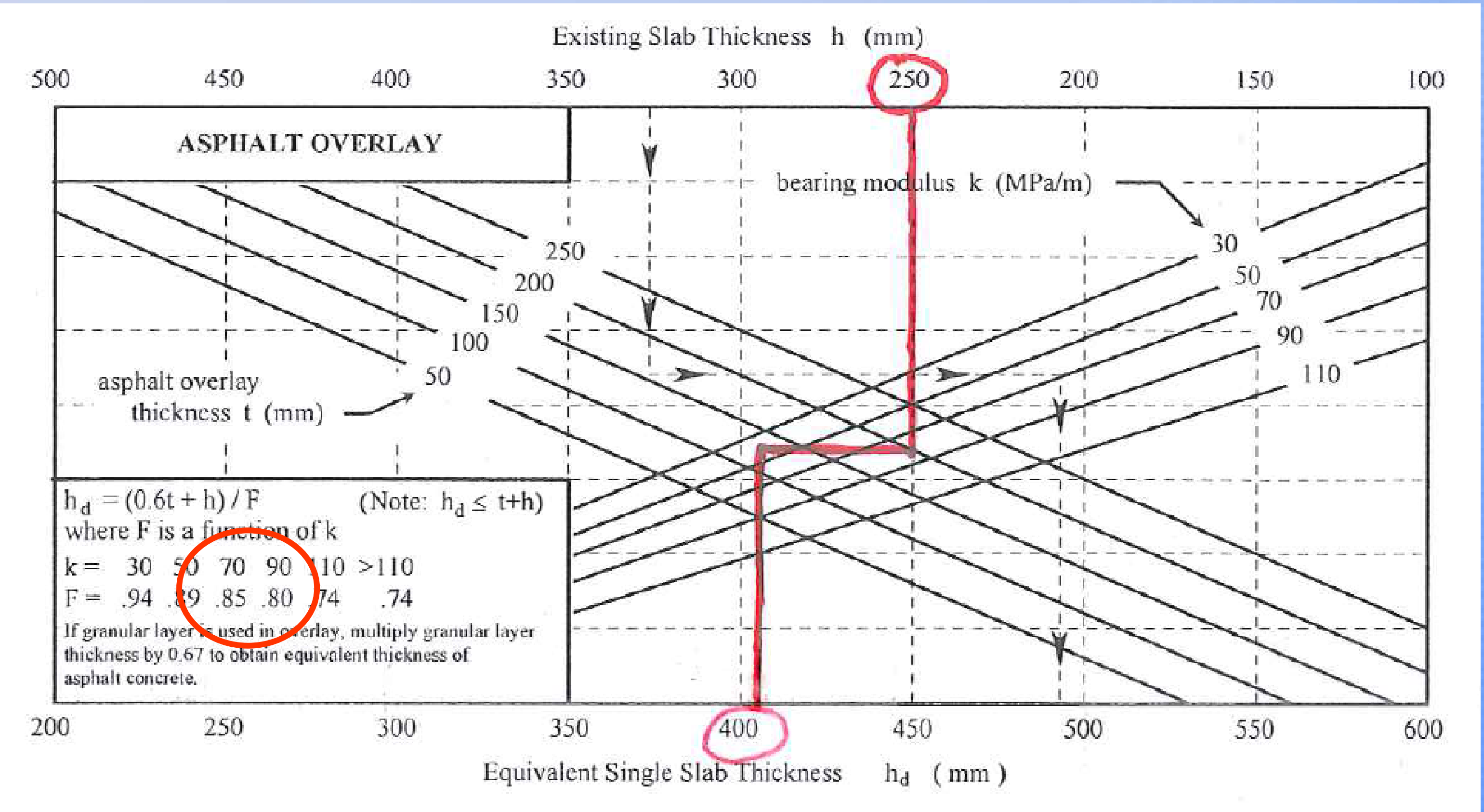
Equivalent Single Slab Thickness with Asphalt Overlay



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Limitations of ASG-19 Composite Pavement Overlay Design

- Does not introduce any factor for condition of existing concrete so need to do major maintenance first (re/re existing slabs that are not PLR(ALR) 8.4) – **very important**. Find the poor performing slabs relative to sound pavement and then upgrading to **uniform** level.
- Does not consider previous traffic.
- Does not consider new traffic mix.
- Does not consider “grade” issues – so if you are correcting “crown” or bad slopes do leveling courses first and also taper section at edges to reduce overlay depth where it is not needed.

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FAA DESIGN METHODOLOGY

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Composite Design using FAA 150/5320-6E

- More complicated than ASG-19; but more rational as well – as long as you use correct data.
- Uses FAARFIELD program (FAA Rigid and Flexible Iterative Layer Design).
- Inputs include Structural Condition Index (SCI) of the existing rigid pavement; existing pavement layer moduli; design life and forecast traffic.
- Either use actual pavement SCI (≤ 100) or upgrade bad slabs to use an SCI of 100 (like ASG-19) but need to find out how much life left in existing PCC.

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Data Required to use FAARFIELD and Where to get It

- SCI derived from Pavement Condition Index (PCI). PCI method is defined in ASTM D 5340 (Standard Test Method for Airport Pavement Condition Index Survey). SCI uses only 6 of 15 distress criteria – the structural ones.
- SCI can be computed automatically if you have MicroPAVER.
- Other pavement moduli from NDT (like HWD) or engineering judgment from pavement construction history and FAA design manual.

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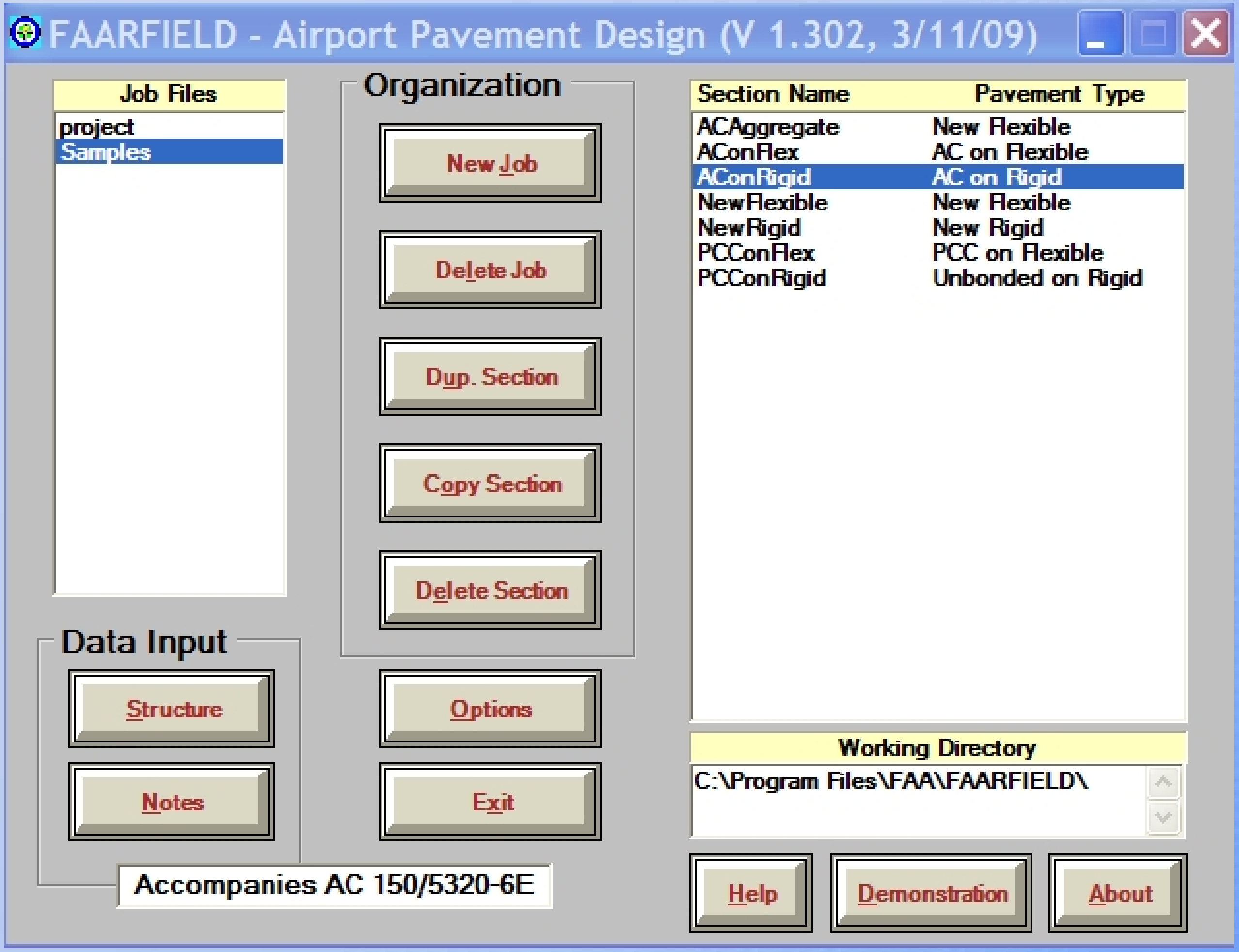
FAARFIELD Screen – “AC on Rigid”



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FAARFIELD with SCI ≤ 100

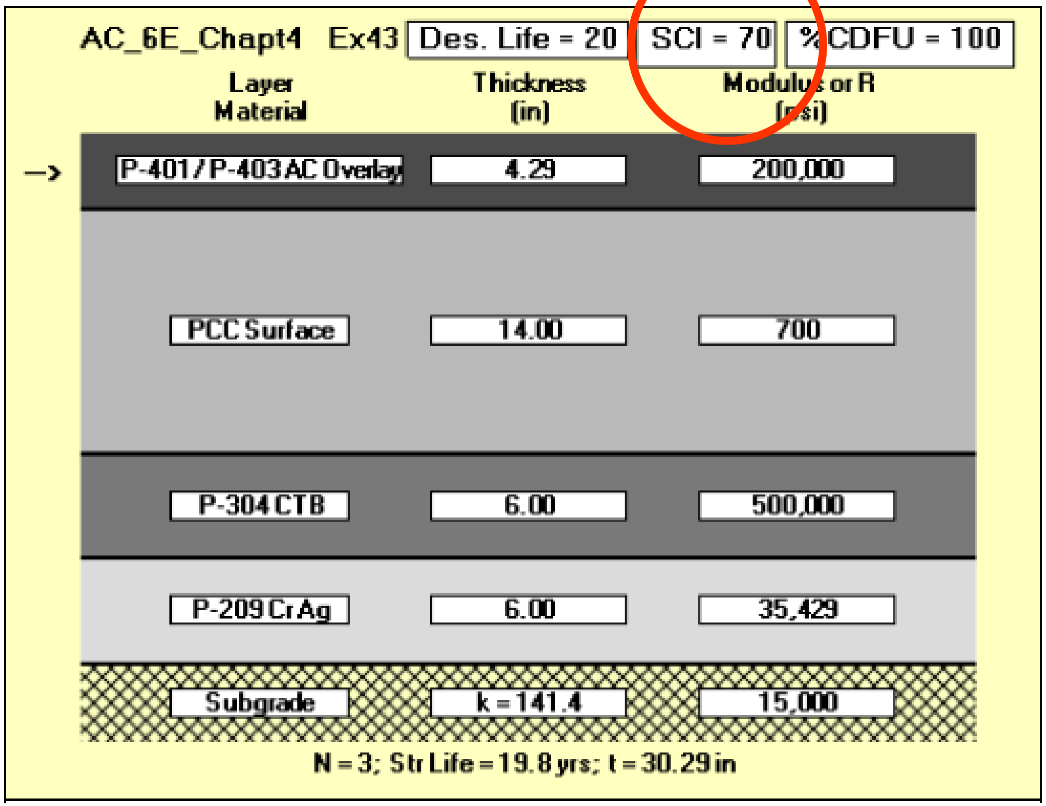

FIGURE 4-5. DESIGN EXAMPLE OF FLEXIBLE OVERLAY ON EXISTING RIGID PAVEMENT WITH SCI 70

FAARFIELD iterates with base and overlay deteriorating at same rate until design life is achieved.

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FAARFIELD with SCI = 100

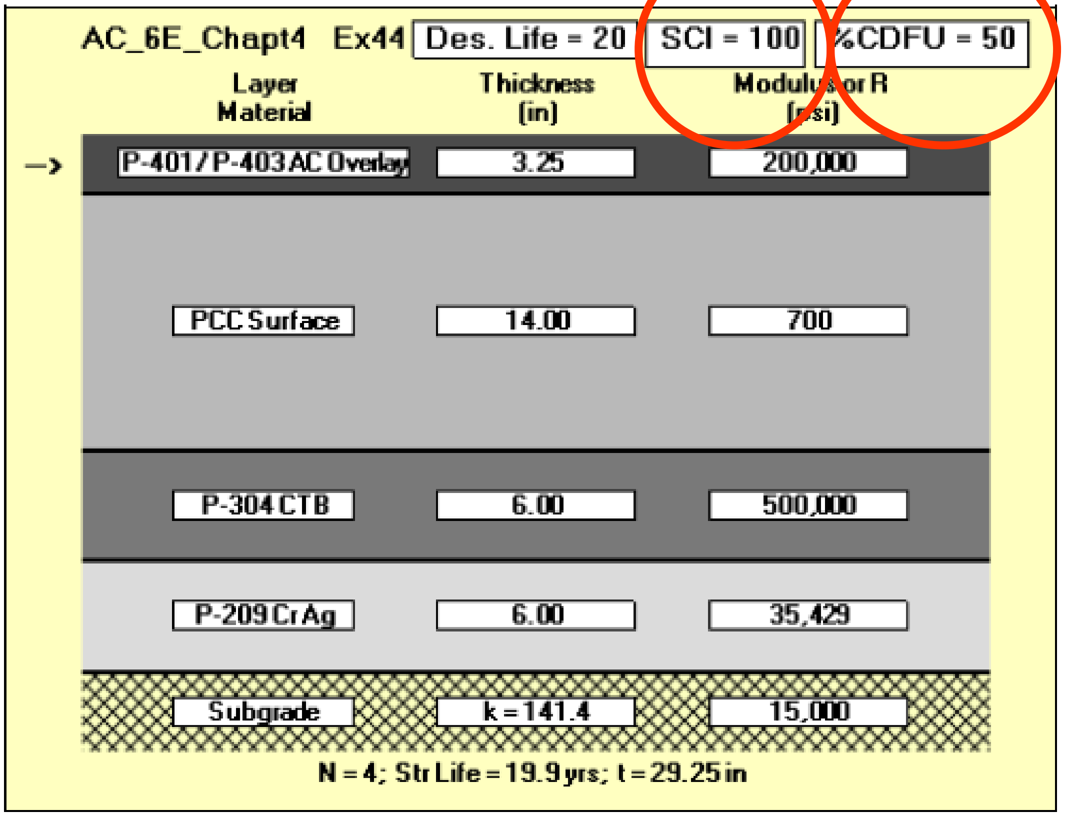

FIGURE 4-6. DESIGN EXAMPLE OF FLEXIBLE OVERLAY ON EXISTING RIGID PAVEMENT WITH SCI 100

Use SCI 100 for good pavement and heavier aircraft or after repair of distressed slabs

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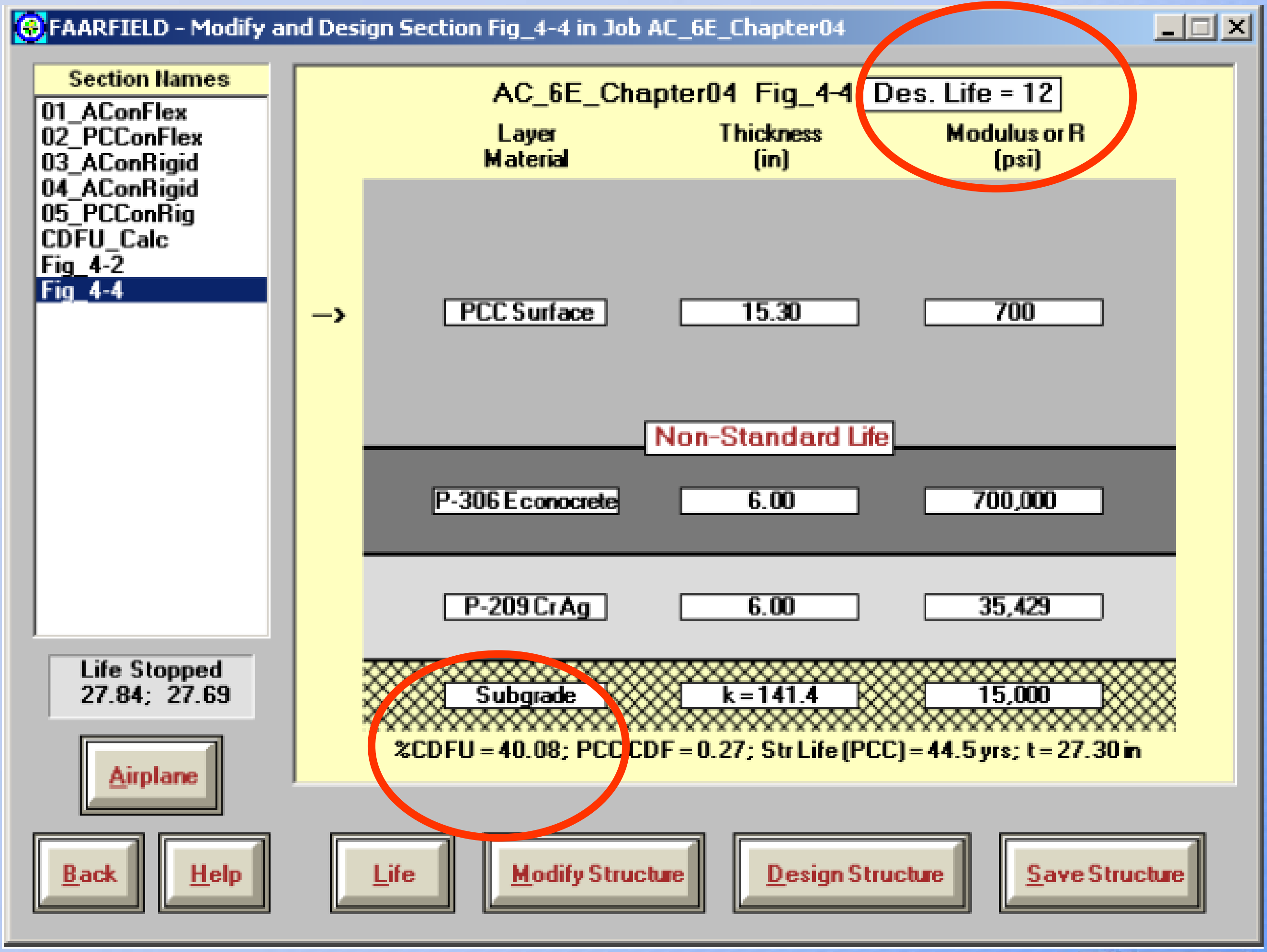
Calculate CDFU at Time of Overlay



Limitations of FAARFIELD

- SCI is a “visual” condition index derived from the PCI which is also visual – make sure you get good field data and supplement with NDT
- Based on FAA test strips and construction material specifications – please ensure your proposed materials are at least equal to FAA construction specifications
- Always need an aircraft mix for design – not for a single “critical” aircraft (different from ASG-19)
- Its a “black box” so if you are not comfortable using the software, get professional assistance

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Composites and Reflection Cracking

- Use Coarser Aggregate Binders in Lower Course Asphalt layers.
- Engineering Fabrics and Asphalt Reinforcement (Paveprep on joints and Glassgrid overall) – we are **NOT** talking **prevention** of reflection cracking over the anticipated design life.
- Rubberized or specialty asphalt mixes-premium.
- Overlay Thickness – in more benign climates 150 mm works well. In very cold climates – get the crack sealant out!

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CASE STUDY – Runway 05-23 Toronto Pearson International 2005

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Repair and Overlay Runway 05-23 at YYZ in 2005

- Mostly a CAT III electrical upgrade project which was about 70% of the budget and took 3 years (but major composite pavement work took one season – plus design work).
- South end (05 end) was the first slipformed runway pavement in Canada when it was constructed in 1969. Runway 05-23 is the longest east-west runway at YYZ (3,390m or 11,120ft) and it gets a lot of use.
- By 2004, the pavement had been in service for 35 years and was certainly showing its age.

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Runway 05-23 Upgrade - Composite

Composite Section – Original PCC 1969

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Four Repair Alternatives

- 1. Remove/replace 133 cracked slabs in middle 30 m and add thin HMA overlay
- 2. Thick HMA overlay with no slab repair
- 3. Rubblization and thick HMA overlay
- 4. Full reconstruction of concrete pavement in middle 30 m of runway

Best for Life Cycle Costing (LCC) is last one but not practical for airport operational reasons.

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Slab Repair at South End

- Stretched 3-Day Weekends at Toronto to get 70% of 28-day strength
- Very High Early Strength Concrete?
  - 2-3 hours to 70% of 28 day is available
  - Significant Workability Issues
  - Long Term Performance?

Selected Pavement Repair Method

- The repair of individual slabs in the central keel was selected and a 100 mm HMA overlay was placed after CAT IIIa conduits and light cans installed – to smooth everything out.
- Closures limited to 3-day+ “long weekends” which allowed high early cement slabs to reach sufficient strength to be opened to traffic prior to overlay

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Selected Pavement Repair Method

- HMA overlay was only done after all concrete repairs.
- Subdrains were replaced in selected areas after “video” investigations – very important for long term performance.
- New asphalt shoulders (maintenance) were added as the concrete repair work progressed.

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Excavation of Cracked Slabs

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Surface Prior to Removal

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Slabs Removed – CSB intact

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Drilling Dowels for Load Transfer

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Rough Surface Texture for Overlay

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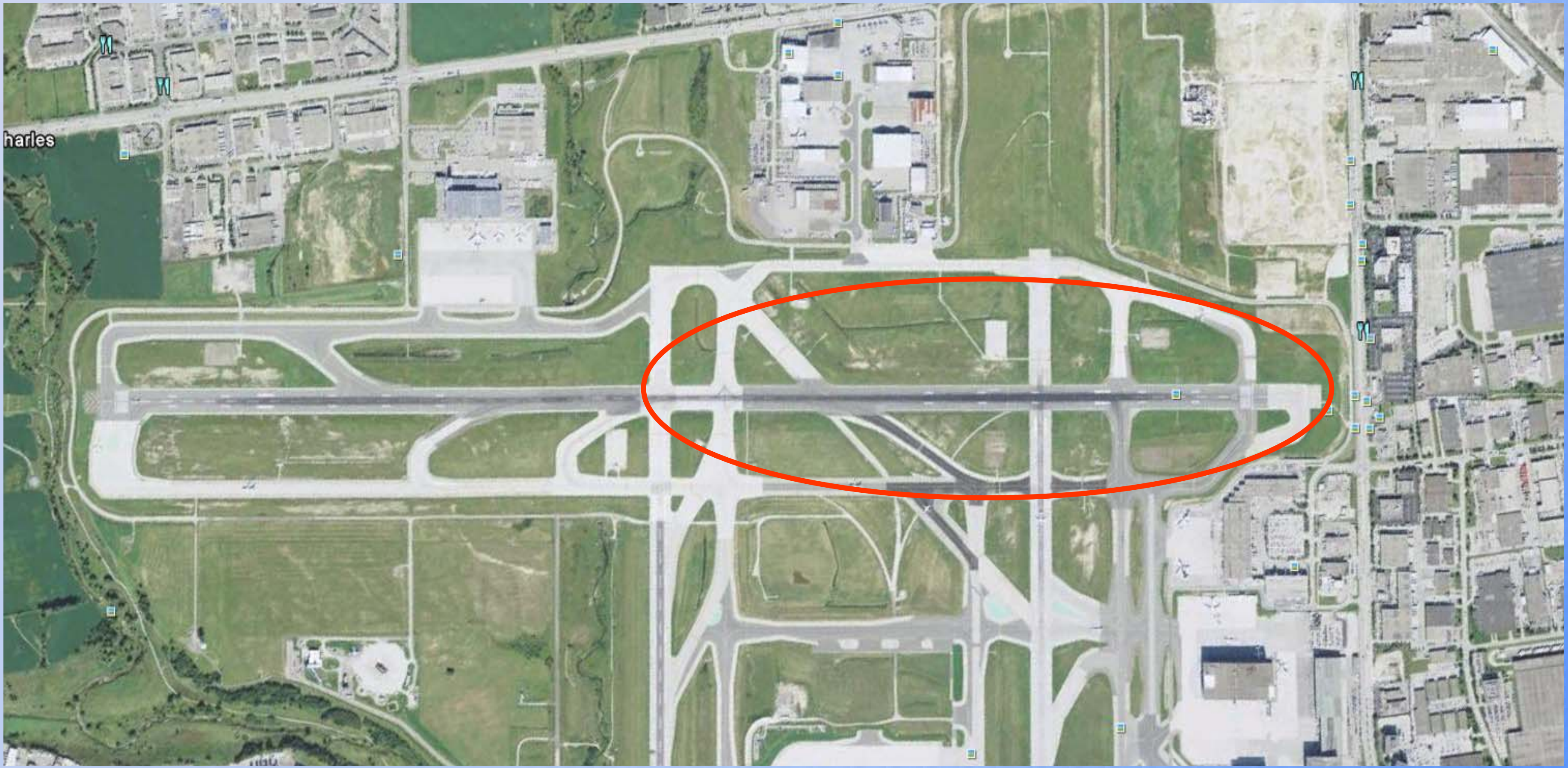
Echelon Paving with Shuttle Buggy

Runway 05-23 Upgrade - Flexible



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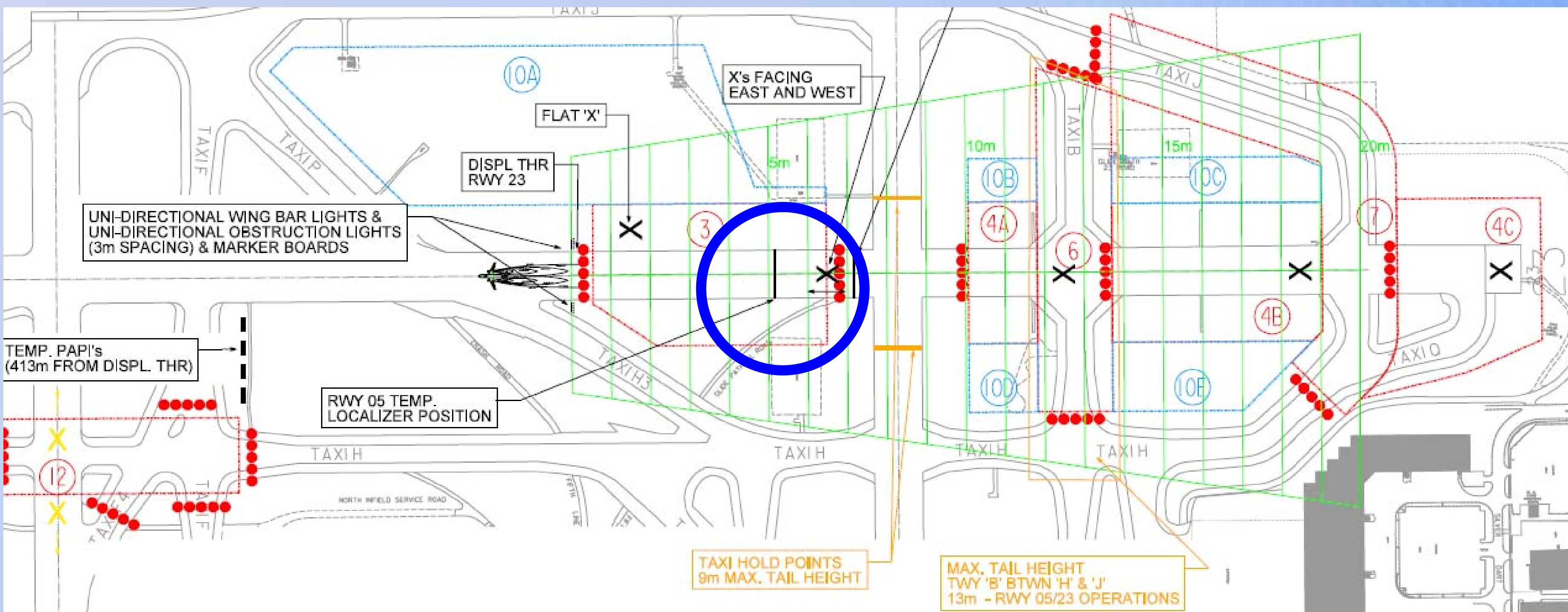
North End - Mill and Overlay with Temporary Localizer for Rwy 05



05 Landing Direction

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Temporary Localizer for Runway 05

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Inset Light Coring and Milling at 23 End

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Existing HMA at 23 End

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Wheel Cutter for Conduit Trenches

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CAT IIIa Cores and Conduit Trenches

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Excavation for Shoulder Widening

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Paving with Shuttle Buggy

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Echelon Paving at North End

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Finished HMA Surface – Joints?

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