

## ***Cross Slope Typical Section Details & Constructability***



**Richard Hewitt, P.E.**

**State Construction Pavement Engineer - FDOT**

**María Irizarry, E.I.**

**Design Manual Engineer - FDOT**

### ***Cross Slope Training Outline***

- ◆ What contractor's need & how best to detail it on typical sections:
  - ✓ Milling & Paving Equipment
  - ✓ Milling & Paving Scenarios
  - ✓ Typical Section Information
  - ✓ Plans Prep Manual Updates

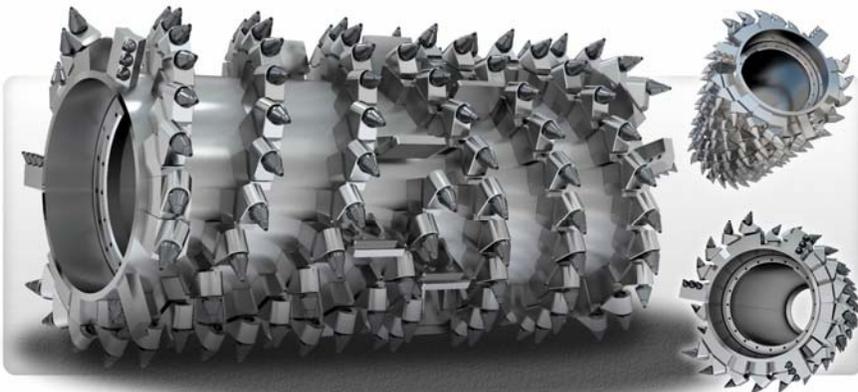


## Milling



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## Milling Drum



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## Milling Drum



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## Milling Drum



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## Milling Drum



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## Grinder



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## *Milling Machine*

- ◆ Two Controls to Set – one for each side
  - ✓ Set milling depth on each side

OR

- ✓ Set depth at control point (one side) & cross slope from that point



## *Milling Machine Controls*



## *Milling Machine*

- ◆ Typical Section must provide either:
  - ✓ One Constant Milling Depth for the lane
    - Set both controls to same depth
  - ✓ Depth on One Side & Cross Slope
    - Set one control to depth & other to slope
    - Typical Section must have a milling control point, for lane or set of adjoining lanes
    - So operator knows which control to set to depth (which side of lane)



## *Milling Machine*

- ◆ Most milling is done with two passes per lane
  - ✓ Typically 6ft to 7ft milling drum width



## Paving



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## Paving with Material Transfer Vehicle (aka Shuttle Buggy)



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## *Paving*



## *Paving Equipment*

- ◆ 8-10 ft wide screed
  - ✓ Typical (& preferred) screed width is 10 ft
  - ✓ Consider minimum paver width on bike paths
- ◆ Extendable screeds allow paving to 20ft width

## *Paver Screed*



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## *Pavement Depth Checker*

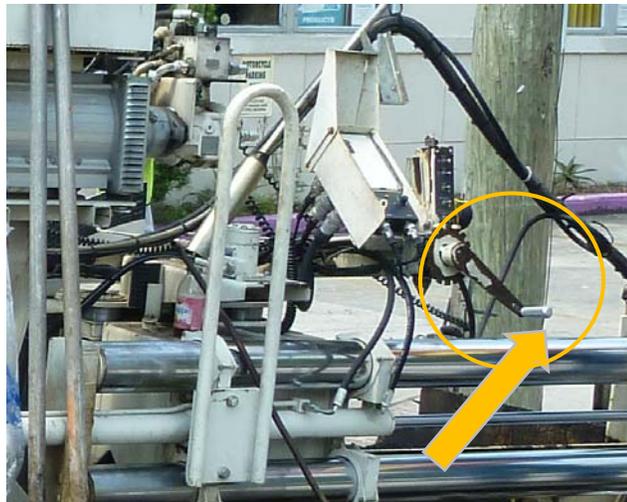


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### *Paver Depth Controls*



### *Paver Depth Controls*



*Checking slope with 4ft level*



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*Paver Cross Slope Control*



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## *Joint Matcher*



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## *Paving Equipment*

- ◆ Controls
  - ✓ Depth is set manually by paving crew
  - ✓ Paver has electronic cross slope control
  - ✓ Paver has electronics to ensure longitudinal smoothness

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## *Paving Equipment*

- ◆ Typical Section must either provide:
  - ✓ One Uniform Thickness for the lane
    - Set same thickness on each side of paver
    - Don't list it as "Average" on the Typical Section Details
  - ✓ Depth on One Side & the Cross Slope
    - Specify depth on one side and slope
    - Requires a profile grade point
      - minimum of one per set of adjoining lanes



## *Milling & Paving*

- ◆ Accuracy
  - ✓ Provide Slopes to nearest 0.1%
    - Most Slope Controls only go to tenths
      - On typical section list slope as 1.8% (or 0.018)
  - ✓ Provide Depths to nearest 1/4"
  - ✓ More precise plan values will be modified to tenths by project personnel



## *Milling & Paving Equipment*

- ◆ On site today, outside
- ◆ We have an entire session dedicated to the discussion of milling & paving equipment
  - ✓ Presentations by equipment manufacturers
  - ✓ Walk around & Discussion Outside



## *Four “Tools in the Tool Box”*

- ◆ Milling
  1. Constant Depth
    - Slope: matches existing - variable
  2. Constant Slope
    - Depth: depends on existing - variable
- ◆ Paving
  3. Constant Thickness - Standard Paving
    - Slope: matches slope of surface being paved on
  4. Constant Slope – Overbuild
    - Thickness: varies depending on surface paving on

Project scenarios are a combination of the 4 options



## *Typical Section Scenarios*

- ◆ Match Existing = no cross slope correction
  1. Mill for Depth, Pave Constant Thickness
- ◆ Cross Slope Correction
  2. Mill for Slope, Pave Constant Thickness
  3. Mill for Depth, Pave Slope Overbuild
  4. Mill for Slope, Pave Slope Overbuild



## *Match Existing*

- ◆ Keep in mind with Match Existing contractor is trying to maintain:
  - ✓ Spread Rate
  - ✓ Longitudinal Smoothness (the ride)
  - ✓ Match existing slope
- ◆ All three tend to counter each other so slope is sacrificed
- ◆ Final pavement won't always match existing



### *Match Existing Typical Section Check List*

- ◆ Mill for Depth
- ◆ Pave Constant Thickness



### *Match Existing Typical Section Check List*

- ◆ Mill for Depth
  - ✓ Provide Single, Uniform Milling Depth (not an Avg)
- ◆ Pave Constant Thickness
  - ✓ Provide Uniform Thickness (not an Avg)
- ◆ Don't include a Design Slope
  - ✓ Can either match existing or mill & pave to a design slope
  - ✓ Contractor can't do both
- ◆ Recommend leaving existing slope off the typical
  - ✓ If shown, clearly identify it as "existing slope"
    - Otherwise may get confused as design slope



## *Cross Slope Corrections*

- ◆ Next three scenarios
  - ✓ Options for cross slope correction



## *Cross Slope Modifications*

- ◆ End goal is the design slope
- ◆ Slope Correction achieved by:
  - ✓ Milling for slope
  - ✓ Paving overbuild
  - ✓ Both
- ◆ Minor slope adjustments ARE made with “constant thickness” asphalt
  - ✓ Therefore, provide exact constant thickness AND design cross slope on Typical Section



## *Mill Slope Pave Constant Thickness*

- ◆ Cross Slope Modification
  - ✓ Mill for Slope,
  - ✓ Pave Constant Thickness Structural & Friction



## *Typical Section Check List Mill Slope, Pave Constant Thickness*

- ◆ Mill for Slope
  - ✓ Provide Exact Milling Depth on one side of lane
  - ✓ Provide Milling Control Point on same side of lane
  - ✓ Provide Exact Desired Cross Slope
    - No +/- Spec provides allowable construction tolerances
    - Adjacent lanes can just show slope, don't need control point on every lane
- ◆ Pave Constant Thickness
  - ✓ Provide Uniform Thickness for each Course
  - ✓ Provide Design Slope – see explanation on “Cross Slope Modifications” slide
- ◆ Don't list Average (Depths or Thicknesses)



## *Mill Depth Correct Slope with Overbuild*

- ◆ Cross Slope Modification
  - ✓ Mill for Depth
  - ✓ Correct Slope with Overbuild
  - ✓ Pave Constant Thickness Structural / Friction Course Asphalt



## *Mill Depth Correct Slope with Overbuild*

- ◆ Mill for Depth
  - ✓ Provide Single, Uniform Milling Depth (not an Average)
- ◆ Pave Slope with Overbuild
  - ✓ Provide Desired Cross Slope for Overbuild
  - ✓ Provide a Profile Grade Point & Thickness at that point
    - Adjacent lanes can just show slope, don't need control point on every lane
  - ✓ Don't specify mixes or min and max thicknesses, let Spec dictate mix used
  - ✓ Eliminate Existing Slope, or if listed, clearly identify it as "existing"
  - ✓ For each Lane, provide Table of Greatest Overbuild Thicknesses (for each 500ft section of pavement)
- ◆ Pave Constant Thickness
  - ✓ Provide Single, Uniform Paving Thickness (not an average)
  - ✓ Provide Design Slope – see explanation on "Cross Slope Correction" slide



## Overbuild

- ◆ AVG Thickness for a Typical Section
  - ✓ Useful for determining plan quantity, however,
  - ✓ Not useful for setting up paver
- ◆ For paver set up, provide:
  - ✓ Control Point
  - ✓ Exact thickness at control point
  - ✓ Cross Slope
- ◆ Average Thickness Table at a regular frequency is useful
  - ✓ Helps contractor plan the work
  - ✓ One pass, two passes, etc.



## Overbuild

- ◆ July 2013 Specs allow overbuild to “taper to zero”
- ◆ Type SP-9.5 and SP-12.5 mixes
- ◆ Must have at least 1.5” of dense-graded asphalt on top of the overbuild



## *Mill for Slope Correct Slope with Overbuild*

- ◆ Mill for Slope
  - ✓ Provide Exact Milling Depth on one side of lane
  - ✓ Provide Milling Control Point on same side of lane
    - Adjacent lanes can just show slope, don't need control point on each lane
  - ✓ Provide Exact Target Cross Slope
    - Spec provides allowable construction tolerances
- ◆ Pave Slope with Overbuild
  - ✓ Provide Target Cross Slope for Overbuild
  - ✓ Provide a Profile Grade Line/Control Point & Thickness at that point
    - Adjacent lanes can just show slope, don't need control point on each lane
  - ✓ Don't specify mixes or min and max thicknesses, let Spec dictate
  - ✓ Eliminate Existing Slope, or if listed, identify it as existing
  - ✓ For each Lane, provide Table of Greatest Overbuild Thicknesses (per 500ft)
- ◆ Pave Constant Thickness
  - ✓ Provide Single, Uniform Paving Thickness (not an Avg)
  - ✓ Provide Design Slope – see explanation on “Cross Slope Modification” slide



## *Constructability*

- ◆ Visit Projects under Construction
  - ✓ Talk to Contractors - Ask Questions
- ◆ Attend a Project Progress Meeting
  - ✓ Typically held weekly to discuss issues
- ◆ Talk to Contractor after project is built
  - ✓ Get Feedback on your plans
- ◆ Attend Sessions at Design Expo



## ***Cross Slope Correction & Typical Sections***



**María J. Irizarry, E.I.**  
(850) 414-4317  
maria.irizarry@dot.state.fl.us



## ***Typical Sections***

- ◆ Evaluate existing pavement conditions
  - ✓ Field verify
    - Full DTM



- Roadway width
- Evaluate Cross Slopes
- Tangent Sections
- Every 100 ft



## Typical Sections

### ◆ Evaluate existing pavement conditions

#### ✓ Field verify

- Full DTM
- Vehicle Mounted Scanner



- Determine Roadway Limits
- Out of Tolerance
- Request DTM

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## Typical Sections

### ◆ Typical Sections and Details

- ✓ Milling and layering details shall be shown in plans
- ✓ Tabulate existing cross slope at 100' intervals where needed
- ✓ **Exhibits** in **PPM** Volume 2, Chapter 6

### ◆ Refer to FDOT **Flexible Pavement Design Manual** for guidance

<http://www.dot.state.fl.us/rddesign/PM/pcs/FlexiblePavementManualMarch152008.pdf>

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## Typical Sections

- ◆ Resurfacing
  - Match Existing
  - Cross Slope Correction



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## Match Existing (PPM Vol.1, Introduction)

This term is used when the existing cross slopes are to remain. This is applicable to constant depth milling and resurfacing projects.

**Match Existing**



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## Typical Sections

- ◆ Resurfacing
  - ✓ Match Existing
    - Existing cross slope is to remain.
    - Allowable ranges
      - **Table 25.4.6** or **Table 25.4.7** in **PPM** Volume 1, Chapter 25.
      - (<http://www.dot.state.fl.us/rddesign/>)



## Typical Sections

- ◆ Resurfacing

**Table 25.4.6 Roadway Cross Slopes**

Facility or Feature	Standard	Allowable Range
Two-Lane Roads	0.02	0.015-0.030
Multilane Roads	0.02	0.015-0.040
Shoulders	0.06	Adjacent Lane Cross Slope- 0.080
Parking Lanes	0.05	0.015-0.050

The multilane standard cross slope value shown is applicable for up to two lanes in one direction. See Section 2.1.5 for additional guidance.

Existing multilane curb and gutter sections may have outside lanes with a maximum cross slope of 0.05.

Existing curb and gutter sections originally constructed with a parabolic crown section may be resurfaced using a series of tangents with a cross slope range from 0.015 to 0.05.

The maximum algebraic difference between adjacent through lanes shall not exceed 0.06.

When existing shoulders are to remain, the algebraic difference between the shoulder slope and adjoining roadway pavement slope shall be  $\leq 0.07$ .

Parking spaces and access aisles dedicated to serving persons with disabilities shall have cross slopes no steeper than 0.02 (1:50) in any direction.

**PPM** Volume 1, Chapter 25



## Typical Sections

### ◆ Resurfacing

**Table 25.4.7 Freeway Cross Slopes**

Facility or Feature	Standard	Allowable Range
Travel Lanes	0.02*	0.015-0.025
Travel Lanes	0.03*	0.025-0.035

\* Applies to lanes as designated in Figure 2.1.1.

The algebraic difference in cross slope between adjacent travel lanes shall not exceed 0.04. The maximum algebraic difference in cross slope between a through lane and an auxiliary lane at a turning roadway terminal shall meet Table 2.1.4.

Paved shoulder cross slopes do not need to be corrected if they meet the values in Table 25.4.6 and the algebraic difference in cross slope between the shoulder and adjacent travel lane is 0.07 or less.

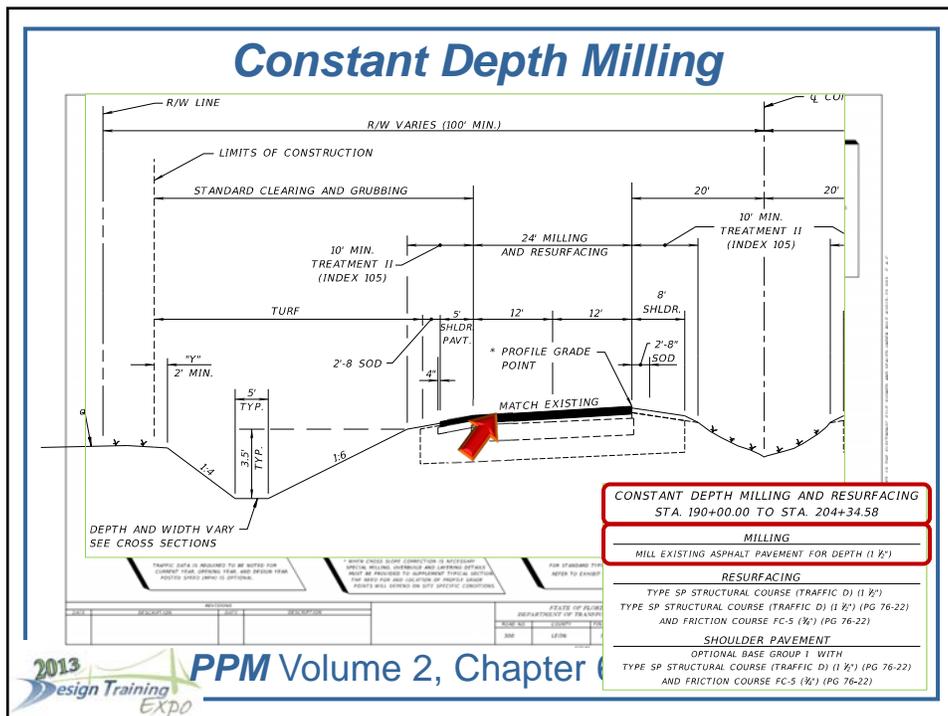
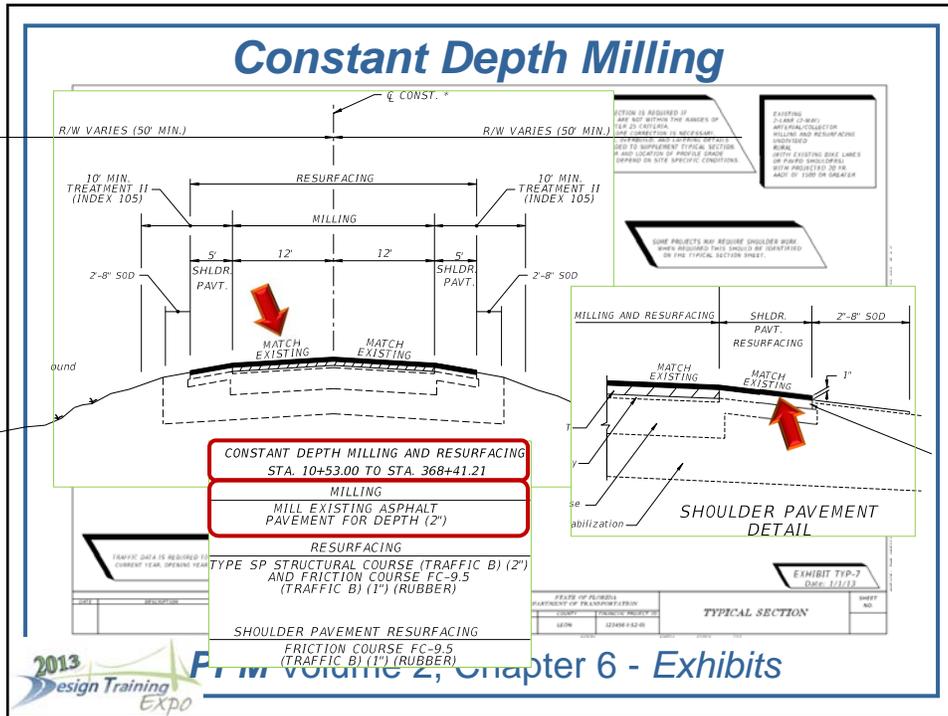


**PPM** Volume 1, Chapter 25

## Match Existing

- ◆ Constant depth milling
- ◆ Resurface at constant thickness





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## Typical Sections

- ◆ Resurfacing
  - Match Existing
  - Cross Slope Correction
    - Method



- ✓ Variable depth milling
- ✓ Constant depth milling & Overbuild
- ✓ Variable depth milling & Overbuild

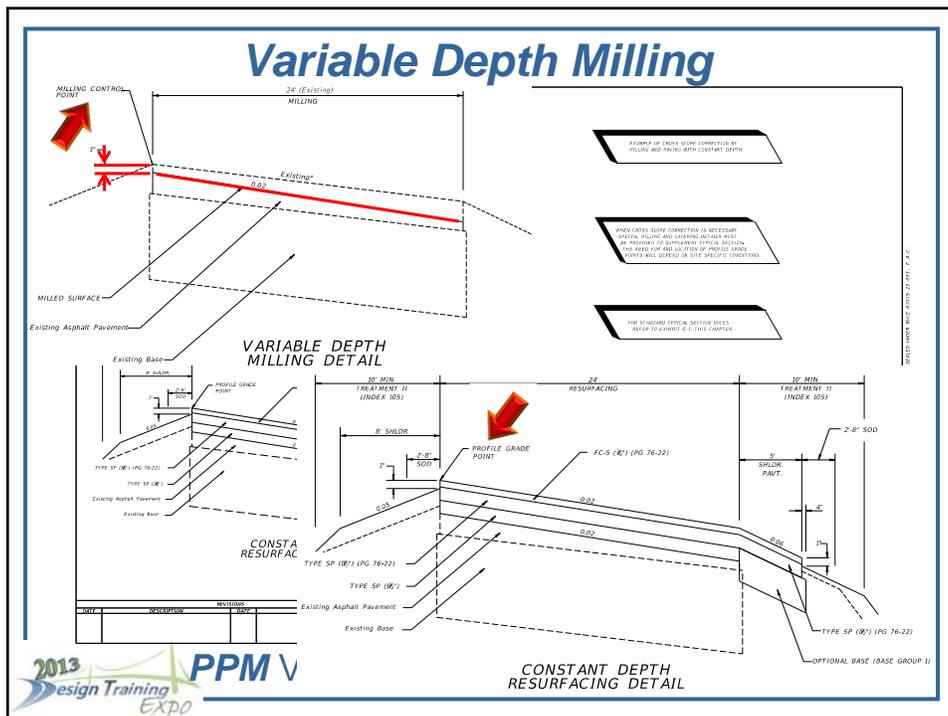
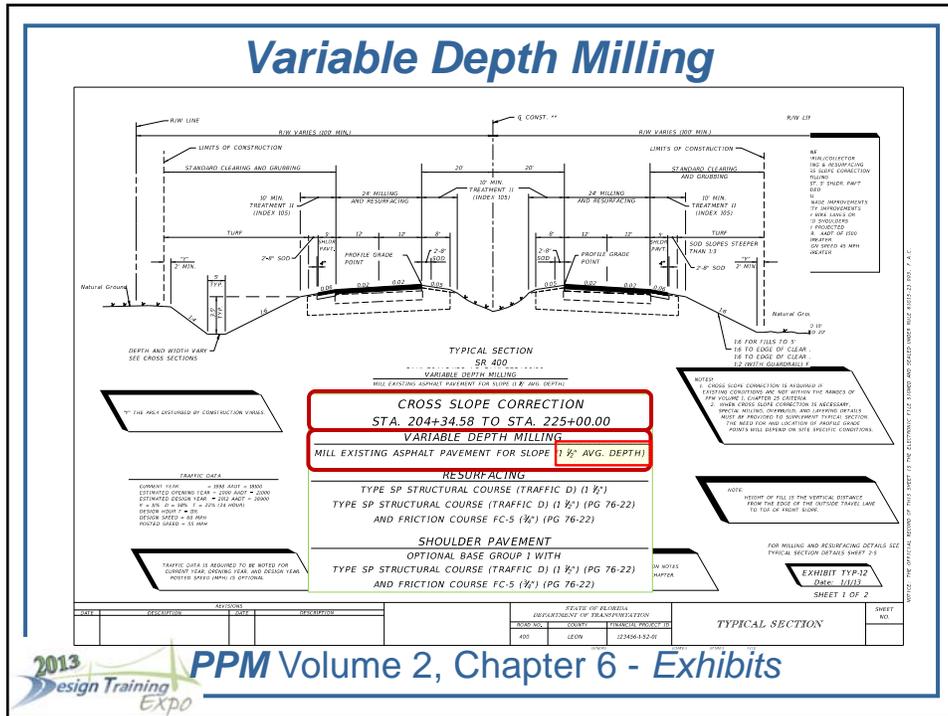
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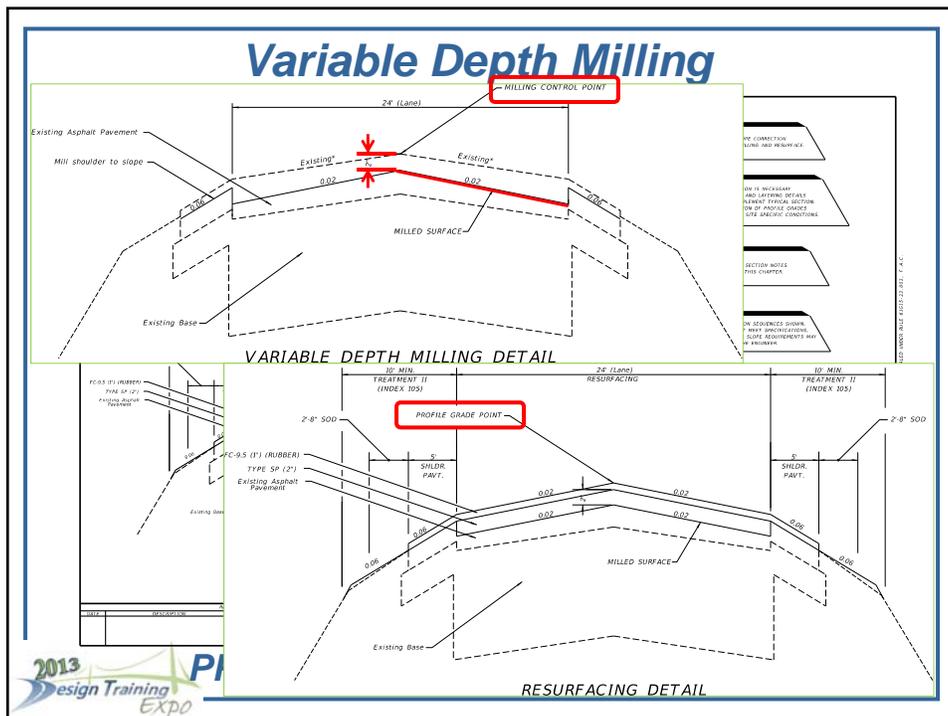
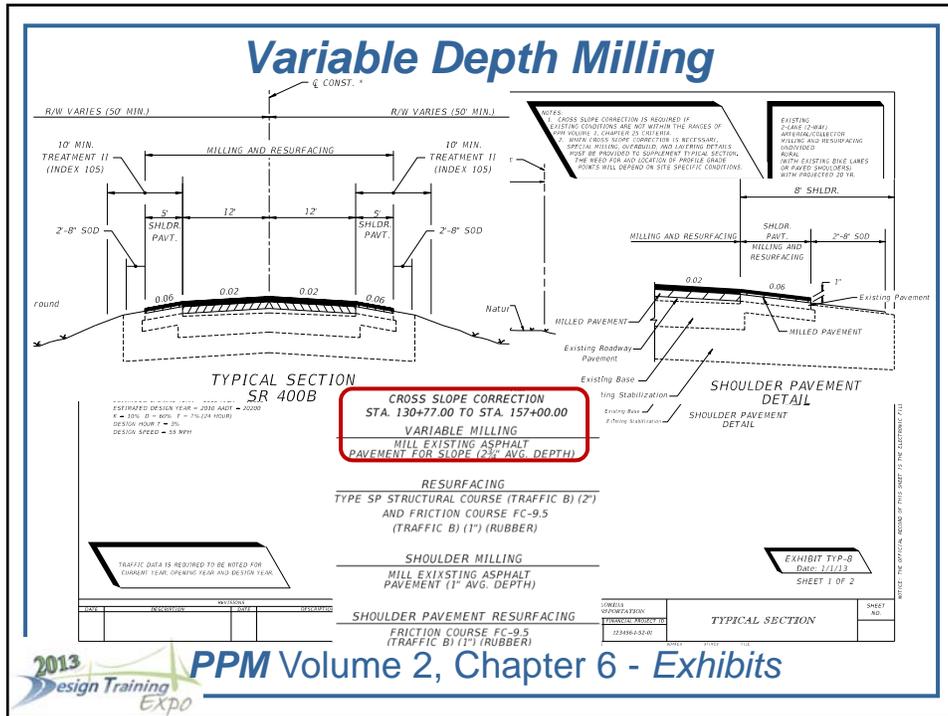
## Variable Depth Milling

- ◆ Slope correction by:
  - ✓ Variable depth milling
- ◆ Resurface at constant thickness



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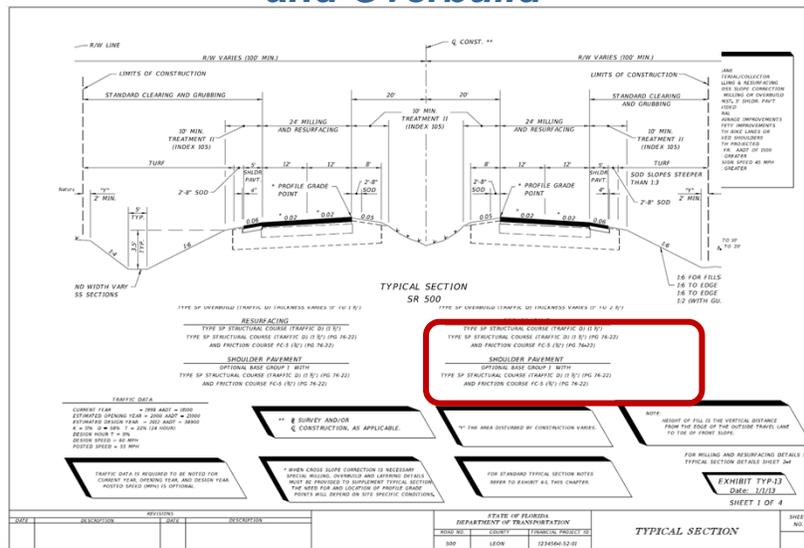


## Constant Depth Milling and Overbuild

- ◆ Constant depth milling
- ◆ Slope Correction by Overbuild
- ◆ Resurface at constant thickness



## Constant Depth Milling and Overbuild



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## Constant Depth Milling and Overbuild

**OVERBUILD AND RESURFACING DETAIL**

**EXAMPLE OF CROSS-SLOPE CORRECTION BY CONSTANT DEPTH MILLING AND OVERBUILD**

NOTE: CROSS-SLOPE CORRECTION IS REQUIRED: MILLING, OVERBUILD, AND OPENING DETAILS MUST BE ADJUSTED TO ALIGNMENT TYPICAL SECTION FOR LEFT AND RIGHT HANDS. NOTES WILL DEPEND ON SITE SPECIFIC CONDITIONS.

FOR STANDARD TYPICAL SECTION NOTES REFER TO EXHIBIT 6-1, THIS CHAPTER.

INDICATED CONSTRUCTION AND/OR UNDER-DRAIN REQUIREMENTS MUST BE SPECIFIED. THESE AND OTHER REQUIREMENTS MUST BE CONSIDERED BY THE ENGINEER.

STA. 600+10.00 TO STA. 620+00.00

EXISTING PAVEMENT CROSS SLOPES		EXISTING PAVEMENT CROSS SLOPES	
STATION	EASTBOUND LANES	STATION	EASTBOUND LANES
600+00	0.02	610+00	0.02
600+10	0.02	610+10	0.02
600+20	0.02	610+20	0.02
600+30	0.02	610+30	0.02
600+40	0.02	610+40	0.02
600+50	0.02	610+50	0.02
600+60	0.02	610+60	0.02
600+70	0.02	610+70	0.02
600+80	0.02	610+80	0.02
600+90	0.02	610+90	0.02
600+100	0.02	610+100	0.02

**EXHIBIT TYP-10**  
DATE: 1/1/13  
SHEET 3 OF 4

DATE	REVISION	BY	DESCRIPTION

STATE OF FLORIDA		TYPICAL SECTION DETAILS	SHEET NO.
DDP	LEON		

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## Constant Depth Milling and Overbuild

**TYPICAL SECTION SR 500B**

**EXAMPLE OF CROSS-SLOPE CORRECTION BY CONSTANT DEPTH MILLING AND OVERBUILD**

NOTE: CROSS-SLOPE CORRECTION IS REQUIRED: MILLING, OVERBUILD, AND OPENING DETAILS MUST BE ADJUSTED TO ALIGNMENT TYPICAL SECTION FOR LEFT AND RIGHT HANDS. NOTES WILL DEPEND ON SITE SPECIFIC CONDITIONS.

INDICATED CONSTRUCTION AND/OR UNDER-DRAIN REQUIREMENTS MUST BE SPECIFIED. THESE AND OTHER REQUIREMENTS MUST BE CONSIDERED BY THE ENGINEER.

TRAFFIC DATA IS REQUIRED TO BE NOTED FOR: CURRENT YEAR, OPENING YEAR AND DESIGN YEAR.

TRAFFIC DATA

STA. 10+52.00 TO STA. 130+77.00

CURRENT YEAR = 1998 ADIT = 1970

ESTIMATED OPENING YEAR = 2002 ADIT = 1980

ESTIMATED DESIGN YEAR = 2030 ADIT = 2030

K = 100.00 = 0.01 (1" = 10.00 HOURS)

DESIGN HOUR T = 30

DESIGN SPEED = 55 MPH

**CROSS-SLOPE CORRECTION**

STA. 10+53.00 TO STA. 130+77.00

MILL EXISTING ASPHALT PAVEMENT FOR DEPTH (2")

OVERBUILD FOR SLOPE

TYPE SP OVERBUILD (TRAFFIC B) THICKNESS VARIES (10" TO 12")

RESURFACING

TYPE SP STRUCTURAL COURSE (TRAFFIC B) (2") AND FRICTION COURSE (TRAFFIC B) (1") (TRAFFIC B) (1") (RUBBER)

SHOULDER MILLING

MILL EXISTING ASPHALT PAVEMENT (1" AVG. DEPTH)

SHOULDER PAVEMENT RESURFACING

FRICTION COURSE (TRAFFIC B) (1") (TRAFFIC B) (1") (RUBBER)

**EXHIBIT TYP-9**  
DATE: 1/1/13  
SHEET 1 OF 2

DATE	REVISION	BY	DESCRIPTION

STATE OF FLORIDA		TYPICAL SECTION	SHEET NO.
500B	LEON		

PAVEMENT (1" AVG. DEPTH)

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## Constant Depth Milling and Overbuild

**OVERBUILD AND RESURFACING DETAIL**

\* TYPE OF OVERBUILD THICKNESSES (OVER FOOT SPECIFICATION MAY)

EXAMPLE OF CROSS SLOPE CORRECTION BY CONSTANT DEPTH MILLING AND OVERBUILD

WHERE CROSS SLOPE CORRECTION IS NECESSARY, SPECIAL MILLING, RESURFACING AND OVERBUILD SHALL BE PROVIDED TO SUPPLEMENT TYPICAL SECTION, THE DESIGN AND APPLICATION OF SPECIAL SECTIONS SHALL BE DETERMINED ON SITE SPECIFIC CONDITIONS.

MINIMUM CORRECTION REQUIRED SHALL BE DETERMINED BY BEST PRACTICES, TYPICAL AND CROSS SLOPE PROFILES MAY BE CONSULTED BY THE ENGINEER.

FOR STANDARD TYPICAL SECTION NOTES REFER TO EXHIBIT 04, THIS CHAPTER.

**EXHIBIT TYP-06**  
Date: 1/1/13  
SHEET 2 OF 2

SECTION				DATE OF PLANNING		SHEET NO.	SHEET TOTAL
NO.	DESCRIPTION	DATE	REVISION	DATE	DESCRIPTION		

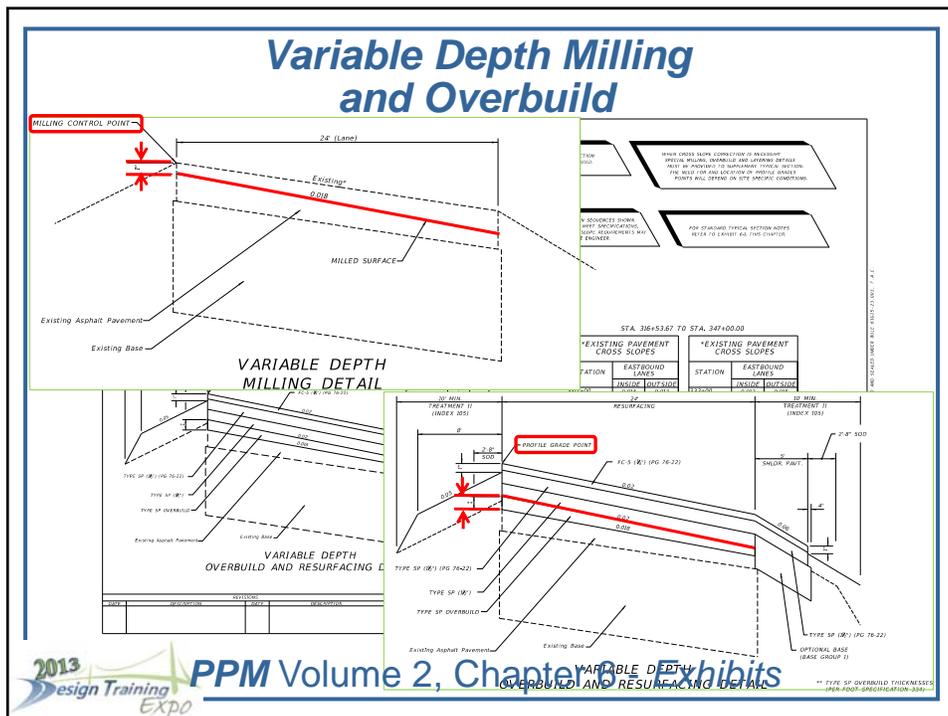
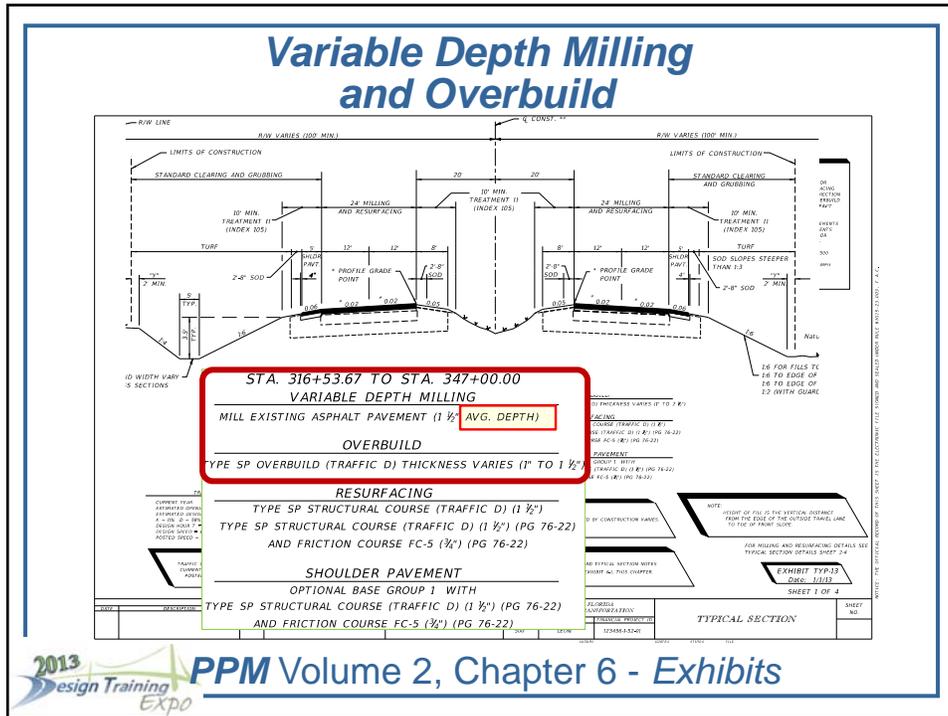
**PPM Volume 2, Chapter 6 - Exhibits**

DESIGNER	CHECKED	DATE	PROJECT NO.

## Variable Depth Milling and Overbuild

- ◆ Slope correction by:
  - ✓ Variable depth milling
  - ✓ Overbuild
- ◆ Resurface at constant thickness

**PPM Volume 2, Chapter 6 - Exhibits**



## Summary

- ◆ **Match Existing cross slope**
  - ✓ **Allowable ranges**
    - Table 25.4.6 or Table 25.4.7 in PPM Volume 1, Chapter 25.
- ◆ **Cross Slope Correction**
  - ✓ **Determine appropriate cross slope correction method and constructability**
    - Variable depth milling
    - Constant depth milling & Overbuild
    - Variable depth milling & Overbuild
  - ✓ **Correction method in milling and resurfacing details (*PPM Vol.2, Chapter 6 – Exhibits*)**



## Questions



Rich Hewitt, P.E.  
 State Construction Pavement Engineer  
 (386) 943-5305  
[richard.hewitt@dot.state.fl.us](mailto:richard.hewitt@dot.state.fl.us)

María J. Irizarry, E.I.  
 Design Manual Engineer  
 (850) 414-4317  
[maria.irizarry@dot.state.fl.us](mailto:maria.irizarry@dot.state.fl.us)



*Thank You*

