Hydroplaning Analysis

Computer Based Training Course
Outline

• Introduction
• Learning Objectives
• Hydroplaning Fundamentals
• Factors Affecting Hydroplaning
• Hydroplaning Prediction
• FDOT Hydroplaning Prediction Tool
FDOT Hydroplaning Guidance

• Quick reference document for those that will be using FDOT’s new Hydroplaning Prediction Tool

• The Hydroplaning Tool and Guidance are available at FDOT’s Roadway Drainage Office Website
Introduction

• Weather Related Crashes
  – Crashes that occur in the presence of adverse weather and/or slick pavement conditions

  – Over 1.2M weather related crashes per year
  – Over 410K injuries per year
  – Over 5,000 fatalities per year
Weather Related Crashes

Source: Federal Highway Administration Office of Operations
https://ops.fhwa.dot.gov/weather/q1_roadimpact.htm
Water on Pavement Surface

• Slippery When Wet!
  – Water reduces friction between tire & pavement
  – Tire treads are designed to drain water

• Hydroplaning!
  – Under Severe Circumstances (More water than treads can handle)
  – Water pressure lifts the tire up from the pavement
  – Little to no traction
  – Affects driver’s control of the vehicle
Learning Objectives

Objective 1
• Understand Different Types of Hydroplaning and their Causes

Objective 2
• Understand the Factors Affecting Hydroplaning

Objective 3
• Understand the Features of FDOT’s Hydroplaning Tool
• Understand the Inputs for Hydroplaning prediction
What is Hydroplaning?

- Condition that exists when a film of water or other contaminant is present at the tire/pavement interface and completely separates the tire from the pavement surface.
Dynamic Hydroplaning

• Occurs when there is more water than a tire can push away
Dynamic Hydroplaning

• Most frequent type
• FDOT’s Hydroplaning Prediction Tool
Viscous Hydroplaning

• Occurs on pavements with little or no micro texture
Viscous Hydroplaning

• Even a very thin film of water (less than 0.001 inch) may cause hydroplaning
Reverted-Rubber Hydroplaning

- Occurs when friction between tire and pavement generates excessive heat to the point where the tire rubber has melted.
Reverted-Rubber Hydroplaning

• Typically does not occur on roadways
• Rarely on runways with high speed aircrafts
What Affects Hydroplaning?

- Hydroplaning is a complicated phenomenon
- Improving Roadway and Pavement factors may help reduce hydroplaning

<table>
<thead>
<tr>
<th>Roadway and Pavement</th>
<th>Environmental</th>
<th>Driver</th>
<th>Vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Type</td>
<td>Rainfall Intensity</td>
<td>Speed</td>
<td>Tire Tread Design</td>
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<td>Rut Depth</td>
<td>Rainfall Duration</td>
<td>Accelerating or Braking</td>
<td>Tire Tread Depth</td>
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<td>Micro and Macro Texture</td>
<td>Temperature</td>
<td>Steering Maneuvers</td>
<td>Tire Pressure</td>
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<td>Permeability</td>
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<td>Longitudinal Grade</td>
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<td>Roadway Curvature</td>
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<tr>
<td>Pavement Depressions</td>
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</tbody>
</table>
Hydroplaning Prediction

• How much rain?

Rain Event

• How thick is the water on pavement surface?

Water Film Thickness (WFT)

• How fast can we go before hydroplaning?

Hydroplaning Speed (HPS)
Water Film Thickness (WFT) Models

- Gallaway
- U.K. Road Research Laboratory (UK RRL)
- New Zealand Modified (NZ Mod)
- PAVDRN
Gallaway WFT Model

\[ WFT = \frac{0.003726 \cdot MTD^{0.125} \cdot L^{0.519} \cdot I^{0.562}}{S^{0.364}} - MTD \]

- **WFT**: Water Film Thickness (in.)
- **MTD**: Mean Texture Depth (in.)
- **L**: Drainage Path Length (ft.)
- **I**: Rainfall Intensity (in./hr.)
- **S**: Total Slope (dimensionless)

• You do NOT need to memorize the equation
  – Know the INPUTS and their importance
Inputs for WFT Equation

\[
WFT = \frac{0.003726 \cdot MTD^{0.125} \cdot L^{0.519} \cdot I^{0.562}}{S^{0.364}} - MTD
\]
Why is Texture Important?

Water Flow

Total Flow

Water Film Thickness (WFT)

Texture Depth (MTD or MPD)

Pavement Surface

\[ WFT = \frac{0.003726 \cdot MTD^{0.125} \cdot L^{0.519} \cdot I^{0.562}}{S^{0.364}} \]

New Pavement

Old Pavement
Intermediate Variables

\[ S = \sqrt{S_G^2 + S_C^2} \]

\[ L = W \sqrt{1 + \left( \frac{S_G}{S_C} \right)^2} \]

\[ WFT = \frac{0.003726 \cdot MTD^{0.125} \cdot L^{0.519} \cdot I^{0.562}}{S^{0.364}} - MTD \]
Why Slope and Width of Pavement?

\[ S = \sqrt{S_G^2 + S_C^2} \]
\[ L = W \sqrt{1 + \left(\frac{S_G}{S_C}\right)^2} \]

\[ WFT = \frac{0.003726 \cdot MTD^{0.125} \cdot L^{0.519} \cdot I^{0.562}}{S^{0.364}} - MTD \]
Hydroplaning Speed (HPS) Models

- PAVDRN
- University of South Florida (USF)
- Gallaway
PAVDRN HPS Model

\[
HPS = \begin{cases} 
26.04 \cdot WFT^{-0.259} & \text{if } WFT < 0.094 \text{ in.} \\
3.09 \cdot \text{Max} \left( \frac{10.409}{WFT^{0.06}} + 3.507, \left[ \frac{28.952}{WFT^{0.06}} - 7.817 \right] \cdot MTD^{0.14} \right) & \text{if } WFT \geq 0.094 \text{ in.}
\end{cases}
\]

– HPS: Hydroplaning Speed

• You do NOT need to memorize the equation
• FDOT’s Hydroplaning Prediction (HP) Tool will do all the calculations for you
• Macro-enabled Excel (.xlsm file)
• User-Friendly
  – Select analysis option
  – Fill in the inputs
  – Get the outputs
FDOT’s Hydroplaning Prediction Tool

- Analysis Options
  - Deterministic
  - Risk Analysis
  - Basic Analysis
  - Continuous Analysis
- Sensitivity
- Probabilistic
FDOT’s Hydroplaning Prediction Tool

- **Analysis Options**
  - Deterministic
  - Risk Analysis
  - Basic Analysis
  - Continuous Analysis
  - Sensitivity
  - Probabilistic
Deterministic Analysis Options

- Risk Analysis

- Basic Analysis
  - Select “No” for both “Risk” and “Continuous” analysis options

- Continuous Analysis

<table>
<thead>
<tr>
<th>Analysis Options</th>
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<tbody>
<tr>
<td>Select Analysis Option</td>
</tr>
<tr>
<td>Risk Analysis?</td>
</tr>
<tr>
<td>(Per FDOT's Design Guidance)</td>
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<tr>
<td>Continuous Data?</td>
</tr>
</tbody>
</table>
Deterministic → Risk Analysis

- Based on FDOT’s Design Guidance
- Expected driver speed vs. Hydroplaning speed
- Gallaway WFT & PAVDRN HPS models
Deterministic → Risk Analysis: Predicted Driver Speed

- Depends on Rainfall Intensity
- Minimum speed for Hydroplaning Analysis = 45 mph

<table>
<thead>
<tr>
<th>Rainfall Intensity (in/hr)</th>
<th>Predicted Driver Speed (mph)</th>
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<tbody>
<tr>
<td>0.1</td>
<td>Design Speed – 0</td>
</tr>
<tr>
<td>0.25</td>
<td>Design Speed – 0</td>
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<tr>
<td>0.5</td>
<td>Design Speed – 6</td>
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<td>1</td>
<td>Design Speed – 8</td>
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<td>2</td>
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<tr>
<td>3</td>
<td>45 mph</td>
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<td>4</td>
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</table>
Deterministic → Risk Analysis Inputs

Pavement Inputs

Deterministic Analysis

- Longitudinal Grade (%): 3
- Surface Type: Open Graded Friction Course
- Permeability (in/hr): 0

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<td>Description</td>
<td>Shoulder</td>
<td>Lane 1</td>
<td>Lane 2</td>
<td>Buffer</td>
<td>Lane 4</td>
<td>Lane 5</td>
<td>Gore</td>
<td>Ramp</td>
<td>Shoulder</td>
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Pavement Texture (Please Select MTD or MPD below)
- Mean Texture Depth (in.): 0.067
- Mean Profile Depth (in.):
Deterministic → Risk Analysis Results

- Lane 2, Buffer Area, and Lane 5 – Not passing FDOT’s Design Criteria

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</table>
Deterministic → Basic Hydroplaning Analysis

• Select “No” for both Risk and Continuous options

```
Analysis Options

Select Analysis Option:
  Deterministic (Default): Show intermediate outputs? No

Risk Analysis? No (Per FDOT’s Design Guidance)

Continuous Data? No: For Rut depth, Cross Slope, and/or Texture
```

• Up to 12 model combinations

```
WFT & HPS Model Selection

<table>
<thead>
<tr>
<th>WFT Model</th>
<th>Hydroplaning Speed Model</th>
<th>Gallaway</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>PAVDRN</td>
<td>USE</td>
</tr>
<tr>
<td>Gallaway</td>
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<td>Y</td>
</tr>
<tr>
<td>UK RRL</td>
<td>Y</td>
<td>Y</td>
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<tr>
<td>NZ Mod.</td>
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<td>Y</td>
</tr>
<tr>
<td>PAVDRN</td>
<td>Y</td>
<td>Y</td>
</tr>
</tbody>
</table>
```

Notes on WFT and HPS Models
Please select as many models as needed.
Note 1: Risk Analysis is defaulted to Gallaway WFT and PAVDRN HPS models.
Note 2: Continuous Analysis uses only ONE model combination.
Deterministic → Basic Analysis Inputs

- Similar to Risk Analysis
- No Design Speed

### Pavement Inputs

#### Deterministic Analysis

<table>
<thead>
<tr>
<th>Pavement Texture</th>
<th>Open Graded Friction Course</th>
<th>Mean Texture Depth (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3</td>
<td>0.067</td>
</tr>
</tbody>
</table>

**Pavement Texture (Please Select MTD or MPD below)**

<table>
<thead>
<tr>
<th>Plane Number</th>
<th>Shoulder</th>
<th>Lane 1</th>
<th>Lane 2</th>
<th>Buffer</th>
<th>Lane 3</th>
<th>Lane 4</th>
<th>Gore</th>
<th>Ramp</th>
<th>Shoulder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Shoulder</td>
<td>Lane 1</td>
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<td>Buffer</td>
<td>Lane 3</td>
<td>Lane 4</td>
<td>Gore</td>
<td>Ramp</td>
<td>Shoulder</td>
</tr>
<tr>
<td>Cross Slope (%)</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>6</td>
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<tr>
<td>Width (ft.)</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>4</td>
<td>12</td>
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<td>12</td>
<td>12</td>
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</table>

![Relative Elevation graph](image)
Deterministic → Basic Analysis Inputs

• Additional Inputs (Depending on Models)
  – Environmental & Vehicle Inputs

<table>
<thead>
<tr>
<th>Environmental Inputs</th>
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</thead>
<tbody>
<tr>
<td>Deterministic Analysis</td>
</tr>
<tr>
<td>Rainfall Intensity (in/hr)</td>
</tr>
<tr>
<td>Temperature (deg. F)</td>
</tr>
</tbody>
</table>

<-- Note: Temperature is only needed for PAVDRN WFT Model

<table>
<thead>
<tr>
<th>Vehicle Inputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deterministic Analysis</td>
</tr>
<tr>
<td>Axle Weight (lbs)</td>
</tr>
<tr>
<td>Tire Pressure (psi)</td>
</tr>
<tr>
<td>Spindown (%)</td>
</tr>
<tr>
<td>Tread Depth (in)</td>
</tr>
</tbody>
</table>

<-- Note: Axle Weight is only needed for USF HPS Model
<-- Note: Tire Pressure is only needed for Gallaway and USF HPS models
<-- Note: Spindown is only needed for Gallaway HPS Model
<-- Note: Tread Depth is only needed for Gallaway HPS Model

• If you do NOT see these inputs, do NOT worry about them
### Water Film Thickness (WFT) Table

**Units: in.**

<table>
<thead>
<tr>
<th>Plane Number</th>
<th>1</th>
<th>2</th>
<th>3</th>
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<tr>
<td>PAVDRN</td>
<td>0.019</td>
<td>0.032</td>
<td>0.040</td>
<td>0.043</td>
<td>0.044</td>
<td>0.046</td>
<td>0.052</td>
<td>0.055</td>
<td>0.048</td>
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</table>

### Hydroplaning Speed (HPS) Table

**Units: mph**

<table>
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<tr>
<th>Plane Number</th>
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<th>3</th>
<th>4</th>
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<th>7</th>
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<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Shoulder</td>
<td>Lane 1</td>
<td>Lane 2</td>
<td>Buffer</td>
<td>Lane 4</td>
<td>Lane 5</td>
<td>Gore</td>
<td>Ramp</td>
<td>Shoulder</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A Parameter</td>
<td>WFT</td>
<td>Gallaway</td>
<td>17.72</td>
<td>16.77</td>
<td>16.34</td>
<td>16.23</td>
<td>16.14</td>
<td>16.05</td>
<td>15.93</td>
<td>15.83</td>
<td>15.98</td>
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</tr>
<tr>
<td></td>
<td>Gallaway</td>
<td>UK RRL</td>
<td>17.72</td>
<td>16.63</td>
<td>16.24</td>
<td>16.14</td>
<td>16.01</td>
<td>15.90</td>
<td>15.79</td>
<td>15.70</td>
<td>15.75</td>
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<tr>
<td></td>
<td>Gallaway</td>
<td>PAVDRN</td>
<td>18.05</td>
<td>17.38</td>
<td>17.06</td>
<td>16.98</td>
<td>16.95</td>
<td>16.89</td>
<td>16.73</td>
<td>16.65</td>
<td>16.83</td>
<td></td>
</tr>
</tbody>
</table>

### Water Film Thickness Results

- Gallaway: 0.025, 0.051, 0.071, 0.077, 0.082, 0.089, 0.098, 0.106, 0.094
- UK RRL: 0.029, 0.056, 0.077, 0.083, 0.092, 0.100, 0.109, 0.117, 0.113
- NZ Mod.: 0.018, 0.037, 0.050, 0.054, 0.056, 0.060, 0.065, 0.070, 0.058
- PAVDRN: 0.019, 0.032, 0.040, 0.043, 0.044, 0.046, 0.052, 0.055, 0.048

### Hydroplaning Speed Results

- Gallaway: 17.72, 16.77, 16.34, 16.23, 16.14, 16.05, 15.93, 15.83, 15.98
- UK RRL: 17.48, 16.63, 16.24, 16.14, 16.01, 15.90, 15.79, 15.70, 15.75
- PAVDRN: 18.05, 17.38, 17.06, 16.98, 16.95, 16.89, 16.73, 16.65, 16.83
Deterministic → Continuous Analysis

- Pavement Cross-Slope, Grade, and Texture change from one location to another

- Can be used only if continuous measurements are available
## Deterministic → Continuous Analysis Inputs

### Analysis Options

- **Select Analysis Option**: Deterministic (Default)
- **Risk Analysis**: No (Per FDOT’s Design Guidance)
- **Continuous Data**: Yes

### Input Table for Continuous Data Analysis

<table>
<thead>
<tr>
<th>Plane</th>
<th>Design Speed (mph)</th>
<th>Description</th>
<th>Width (ft.)</th>
<th>MPD (in.)</th>
<th>Rut Depth (in.)</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>45</td>
<td>Lane 1</td>
<td>12</td>
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</tr>
<tr>
<td>2</td>
<td>45</td>
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<tr>
<td>12</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

### Right Click to import Continuous Data File

- **Paste Options**: Select Cross Slope and Grade File
Deterministic → Continuous Analysis Results

Cross Slope Inputs

Longitudinal Grade Inputs

Drainage Path Results

Water Film Thickness Results

Hydroplaning Speed Results
Deterministic → Continuous Analysis Example

• Problem Statement
  – Increased number of crashes between mileposts 16.0 and 17.0, especially under wet conditions

• Available Data
  – Continuous Cross Slope and Grade

![Observed Crashes](image-url)
Deterministic → Continuous Analysis Example Results

Cross Slope ≈ 0

Increased Drainage Path Length

Increased Water Film Thickness

Hydroplaning Speed below Predicted Driver Speed!
FDOT’s Hydroplaning Prediction Tool

• Analysis Options
  – Deterministic
  • Risk Analysis
  • Basic Analysis
  • Continuous Analysis
  – Sensitivity
  – Probabilistic
Sensitivity Analysis

- Batch run for Basic Analysis

EQUIVALENT !!

Single Sensitivity Analysis Run

Total Number of Deterministic Analysis
= 6×4×2 = 48

- Number of Rainfall Intensities = 6
- Number of MPD Values = 4
- Number of Cross Slope Values = 2

Analysis Options

Select Analysis Option
- Sensitivity

WFT & HPS Model Selection
- Deterministic (Default)
- Sensitivity
- Probabilistic
# Sensitivity Analysis Inputs

- Minimum, Maximum, and Increment

### Pavement Inputs

<table>
<thead>
<tr>
<th>Select Surface Type (Y/N)</th>
<th>Longitudinal Grade (%)</th>
<th>Permeability (in/hr)</th>
<th>Mean Profile Depth (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dense Graded Friction Course</td>
<td>Y</td>
<td>Min: 1</td>
<td>0</td>
</tr>
<tr>
<td>Open Graded Friction Course</td>
<td></td>
<td>Max: 2</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inc.: 0.01</td>
<td>0.05</td>
</tr>
</tbody>
</table>

### Environmental Inputs

<table>
<thead>
<tr>
<th>Sensitivity Analysis</th>
<th>Rainfall Intensity (in/hr)</th>
<th>Temperature (deg. F)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min: 0.5</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>Max: 3</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>Inc: n/a</td>
<td></td>
</tr>
</tbody>
</table>

### Vehicle Inputs

<table>
<thead>
<tr>
<th>Sensitivity Analysis</th>
<th>Axle Weight (lbs)</th>
<th>Tire Pressure (psi)</th>
<th>Spindown (%)</th>
<th>Tread Depth (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min: 430</td>
<td>20</td>
<td>10</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>Max: 550</td>
<td>30</td>
<td>10</td>
<td>0.02</td>
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<tr>
<td></td>
<td>Inc: n/a</td>
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<td></td>
<td>n/a</td>
</tr>
</tbody>
</table>

Click Here to Run Sensitivity Analysis!

Note: Temperature is only needed for PAVDRN WFT Model

Note: Axle Weight is only needed for USF HPS Model

Note: Tire Pressure is only needed for Gallaway and USF HPS models

Note: Spindown is only needed for Gallaway HPS Model

Note: Tread Depth is only needed for Gallaway HPS Model
Sensitivity Analysis Inputs

• Rainfall Intensity
  – Minimum: 0.5 in/hr
  – Maximum: 3.0 in/hr
  – Increment: 0.5 in/hr

• Equivalent to running Basic Analysis 6 times
  – With 0.5, 1.0, 1.5, 2.0, 2.5, and 3.0 in/hr rainfall intensities
Sensitivity Analysis Results

Lots of results. Provided in a separate worksheet.
FDOT’s Hydroplaning Prediction Tool

- **Analysis Options**
  - Deterministic
  - Risk Analysis
  - Basic Analysis
  - Continuous Analysis
  - Sensitivity
  - Probabilistic
Probabilistic Analysis

- Are you sure the Rainfall is exactly 2.0 in/hr?
Probabilistic Analysis Inputs

- In terms of Distribution
  - Average (or Mean) & Coefficient of Variation (COV)
Probabilistic Analysis Results

• Also in terms of Distribution

Water Film Thickness Results

<table>
<thead>
<tr>
<th>Plane Number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<tbody>
<tr>
<td>Description</td>
<td>Lane 1</td>
<td>Lane 2</td>
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</tr>
<tr>
<td>PAVDRN Gallaway</td>
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<td></td>
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<tr>
<td>Mean (in.)</td>
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<td>0.043</td>
<td>0.025</td>
<td>0.043</td>
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<td>Stdev (in.)</td>
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<td>COV (%)</td>
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<td>12.1</td>
<td>17.4</td>
<td>12.1</td>
<td>17.4</td>
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<td>12.1</td>
<td>17.4</td>
<td>12.1</td>
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Hydroplaning Speed Results

<table>
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<th>3</th>
<th>4</th>
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<tbody>
<tr>
<td>Description</td>
<td>Lane 1</td>
<td>Lane 2</td>
<td>Lane 1</td>
<td>Lane 2</td>
<td>Lane 1</td>
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</tr>
<tr>
<td>PAVDRN Gallaway</td>
<td></td>
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<td></td>
<td></td>
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<td>Mean (mph)</td>
<td>68.0</td>
<td>59.1</td>
<td>68.0</td>
<td>59.1</td>
<td>68.0</td>
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<td>68.0</td>
<td>59.1</td>
<td>68.0</td>
<td>59.1</td>
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<td>Stdev (mph)</td>
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<td>3.2</td>
<td>1.9</td>
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<td>1.9</td>
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<td>1.9</td>
<td>3.2</td>
<td>1.9</td>
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<tr>
<td>COV (%)</td>
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<td>3.2</td>
<td>4.7</td>
<td>3.2</td>
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<td>4.7</td>
<td>3.2</td>
<td>4.7</td>
<td>3.2</td>
</tr>
</tbody>
</table>

Hydroplaning speed may range from 55 mph to 65 mph
Summary

Dynamic Hydroplaning

• Occurs when there is more water than a tire can push away
• Tire is NOT in contact with pavement
• Most frequent on Roadways

What Affects Hydroplaning?

• Pavement / Roadway Geometry (e.g., Lane Width, Slopes)
• Environmental Conditions (e.g., Rainfall)
• Driver Behavior (e.g., Speed)
• Vehicle Condition (e.g., Tire Pressure, Weight, Tread)
FDOT’s Hydroplaning Prediction Tool

- Built in MS Excel
- User-Friendly
  - Select Analysis Option
  - Fill in the Inputs
  - Obtain the Results
- Different Analysis Options
  - Understand what you need when you need it
- Consult FDOT’s Hydroplaning Guidance for detailed information and Step-by-Step procedures
- Refer to FDOT’s Design Manual (Section 210.2.4.2) and Drainage Manual (Section 3.9.4) for additional information regarding FDOT’s criteria on calculating hydroplaning risk
- The Hydroplaning Tool and Guidance are available at FDOT’s Roadway Drainage Office Website
Hydroplaning Analysis

Computer Based Training Course

Quiz
Q: When hydroplaning occurs, the tire is in contact with the pavement.

a) True
b) False
Question 2

Q: ____________ hydroplaning is the most frequent type of hydroplaning on roadways.

a) Dynamic
b) Viscous
c) Reverted-Rubber
Question 3

Q: Which of the following factors affect Hydroplaning Speed?

a) Pavement / Roadway Geometry
b) Environmental Conditions
c) Driver Behavior
d) Vehicle Condition
e) All of the above
Question 4

Q: FDOT’s recommended model for Water Film Thickness is:

a) U.K. Road Research Laboratory Model
b) New Zealand Modified Model
c) Gallaway Model
Q: FDOT’s recommended model for Hydroplaning Speed is:

a) University of South Florida Model
b) PAVDRN Model
c) U.K. Road Research Laboratory Model
Q: Based on FDOT’s Design Guidance, Hydroplaning Risk Analysis compares the Hydroplaning Speed against the ________________.

a) Design Speed
b) Speed Limit
c) Predicted Driver Speed
Question 7

Q: You are running FDOT’s Hydroplaning Risk Analysis. The results show that the Predicted Driver Speed 60 mph. The Hydroplaning Speed is found to be 50 mph. According to FDOT’s Design Guidance, this pavement is safe and hence accepted.

a) True
b) False
Q: Which of the following is NOT an input into the Hydroplaning Prediction tool?

a) Rainfall Intensity
b) Pavement Width
c) Pavement Cross-Slope
d) Speed Limit
Question 9

Q: Which of the following is NOT an output from the Hydroplaning Prediction tool?

a) Rainfall Intensity
b) Water Film Thickness
c) Hydroplaning Speed
d) Both (b) and (c)
Q: Which Analysis Option in the Hydroplaning Prediction tool should you choose when you want to run a batch of Deterministic Inputs?

a) No Options available
b) Sensitivity Analysis Option
c) Probabilistic Analysis Option
End of CBT