# fake_canton

File Name: C:\Rao\MERRA_Runs\fake_canton.dgpx

## Design Inputs

Design Life: 20 years
Design Type: FLEXIBLE

Base construction: May, 2021
Pavement construction: June, 2022
Traffic opening: September, 2022

Climate Data Sources (Lat/Lon): 32.5, -90

### Design Structure

| Layer type | Material Type | Thickness (in) |
|---|---|---|
| Flexible | Default asphalt concrete | 2.0 |
| Flexible | Default asphalt concrete | 3.0 |
| Flexible | Default asphalt concrete | 6.0 |
| NonStabilized | Crushed stone | 12.0 |
| Subgrade | A-7-6 | Semi-infinite |

| Volumetric at Construction: | |
|---|---|
| Effective binder content (%) | 13.3 |
| Air voids (%) | 7.0 |

### Traffic

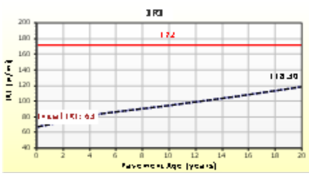
| Age (year) | Heavy Trucks (cumulative) |
|---|---|
| 2022 (initial) | 3,000 |
| 2032 (10 years) | 5,699,120 |
| 2042 (20 years) | 12,646,300 |

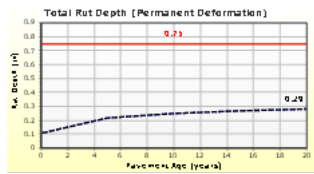
## Design Outputs

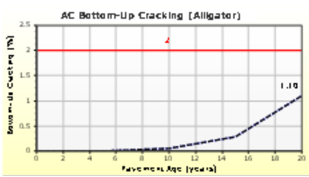
### Distress Prediction Summary

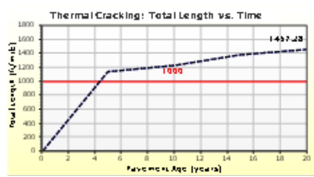
| Distress Type | Distress @ Specified Reliability | | Reliability (%) | | Criterion Satisfied? |
|---|---|---|---|---|---|
| | Target | Predicted | Target | Achieved | |
| Terminal IRI (in/mile) | 172.00 | 118.27 | 50.00 | 94.93 | Pass |
| Permanent deformation - total pavement (in) | 0.75 | 0.29 | 50.00 | 100.00 | Pass |
| AC bottom-up fatigue cracking (% lane area) | 2.00 | 1.10 | 50.00 | 75.56 | Pass |
| AC thermal cracking (ft/mile) | 1000.00 | 1457.28 | 50.00 | 25.40 | Fail |
| AC top-down fatigue cracking (ft/mile) | 2000.00 | 0.00 | 50.00 | 100.00 | Pass |
| Permanent deformation - AC only (in) | 0.25 | 0.06 | 50.00 | 100.00 | Pass |

## Distress Charts



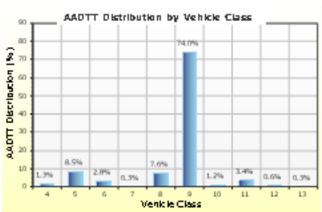



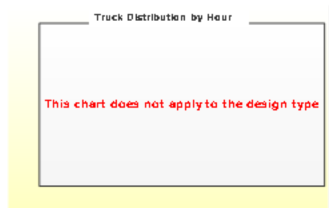



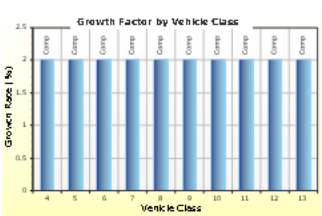

# Traffic Inputs

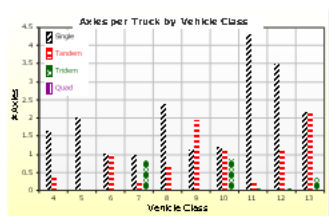
## Graphical Representation of Traffic Inputs

| | | | |
|---|---|---|---|
| Initial two-way AADTT: | 3,000 | Percent of trucks in design direction (%): | 50.0 |
| Number of lanes in design direction: | 2 | Percent of trucks in design lane (%): | 95.0 |
| | | Operational speed (mph) | 60.0 |




**Traffic Volume Monthly Adjustment Factors**

| Class 4 | Class 5 | Class 6 | Class 7 | Class 8 | Class 9 | Class 10 | Class 11 | Class 12 | Class 13 |
|---|---|---|---|---|---|---|---|---|---|

## Tabular Representation of Traffic Inputs

### Volume Monthly Adjustment Factors

Level 3: Default MAF

| Month | Vehicle Class | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| January | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| February | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| March | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| April | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| May | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| June | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| July | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| August | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| September | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| October | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| November | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| December | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |

### Distributions by Vehicle Class

| Vehicle Class | AADTT Distribution (%) (Level 3) | Growth Factor | |
|---|---|---|---|
| | | Rate (%) | Function |
| Class 4 | 1.3% | 2% | Compound |
| Class 5 | 8.5% | 2% | Compound |
| Class 6 | 2.8% | 2% | Compound |
| Class 7 | 0.3% | 2% | Compound |
| Class 8 | 7.6% | 2% | Compound |
| Class 9 | 74% | 2% | Compound |
| Class 10 | 1.2% | 2% | Compound |
| Class 11 | 3.4% | 2% | Compound |
| Class 12 | 0.6% | 2% | Compound |
| Class 13 | 0.3% | 2% | Compound |

### Truck Distribution by Hour does not apply

### Axle Configuration

| Traffic Wander | |
|---|---|
| Mean wheel location (in) | 18.0 |
| Traffic wander standard deviation (in) | 10.0 |
| Design lane width (ft) | 12.0 |

| Axle Configuration | |
|---|---|
| Average axle width (ft) | 8.5 |
| Dual tire spacing (in) | 12.0 |
| Tire pressure (psi) | 120.0 |

| Average Axle Spacing | |
|---|---|
| Tandem axle spacing (in) | 51.6 |
| Tridem axle spacing (in) | 49.2 |
| Quad axle spacing (in) | 49.2 |

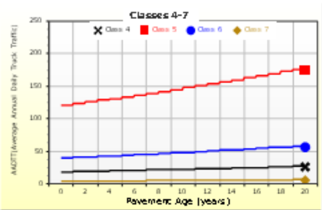
**Wheelbase does not apply**

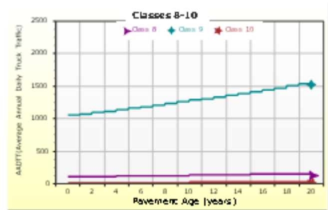
### Number of Axles per Truck

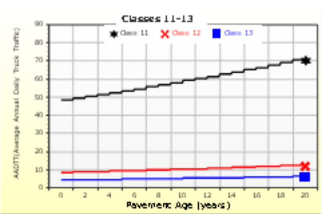
| Vehicle Class | Single Axle | Tandem Axle | Tridem Axle | Quad Axle |
|---|---|---|---|---|
| Class 4 | 1.62 | 0.39 | 0 | 0 |
| Class 5 | 2 | 0 | 0 | 0 |
| Class 6 | 1.02 | 0.99 | 0 | 0 |
| Class 7 | 1 | 0.26 | 0.83 | 0 |
| Class 8 | 2.38 | 0.67 | 0 | 0 |
| Class 9 | 1.13 | 1.93 | 0 | 0 |
| Class 10 | 1.19 | 1.09 | 0.89 | 0 |
| Class 11 | 4.29 | 0.26 | 0.06 | 0 |
| Class 12 | 3.52 | 1.14 | 0.06 | 0 |
| Class 13 | 2.15 | 2.13 | 0.35 | 0 |

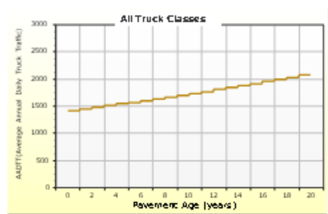
# AADTT (Average Annual Daily Truck Traffic) Growth

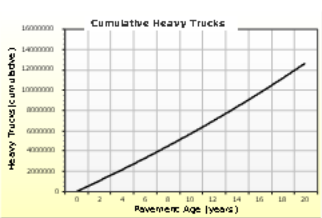
*** Traffic cap is not enforced**



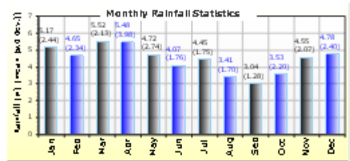



## Climate Inputs

### Climate Data Sources:

| Climate Station Cities: | Location (lat lon elevation(ft)) |
|---|---|
| US, MS | 32.50000 -90.00000 295 |

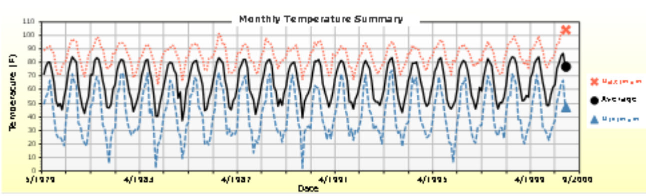


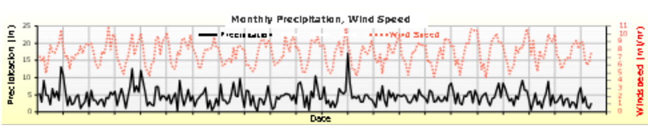

### Annual Statistics:

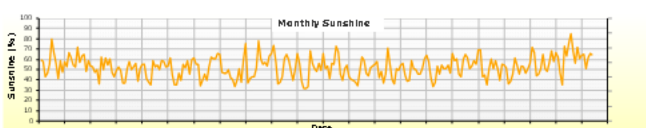
| | |
|---|---|
| Mean annual air temperature (ºF) | 65.25 |
| Mean annual precipitation (in) | 53.23 |
| Freezing index (ºF - days) | 25.53 |
| Average annual number of freeze/thaw cycles: | 22.31 |

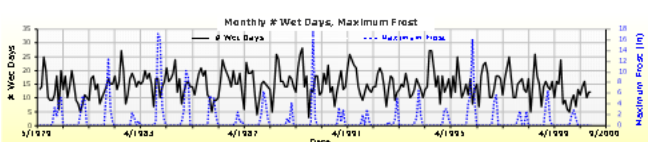
Water table depth (ft) 10.00

### Monthly Climate Summary:

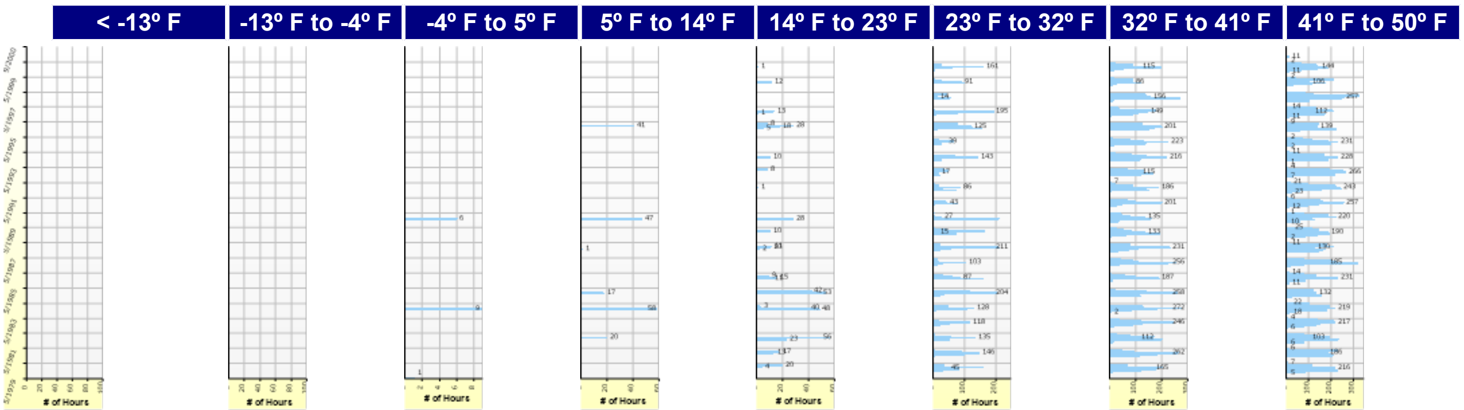


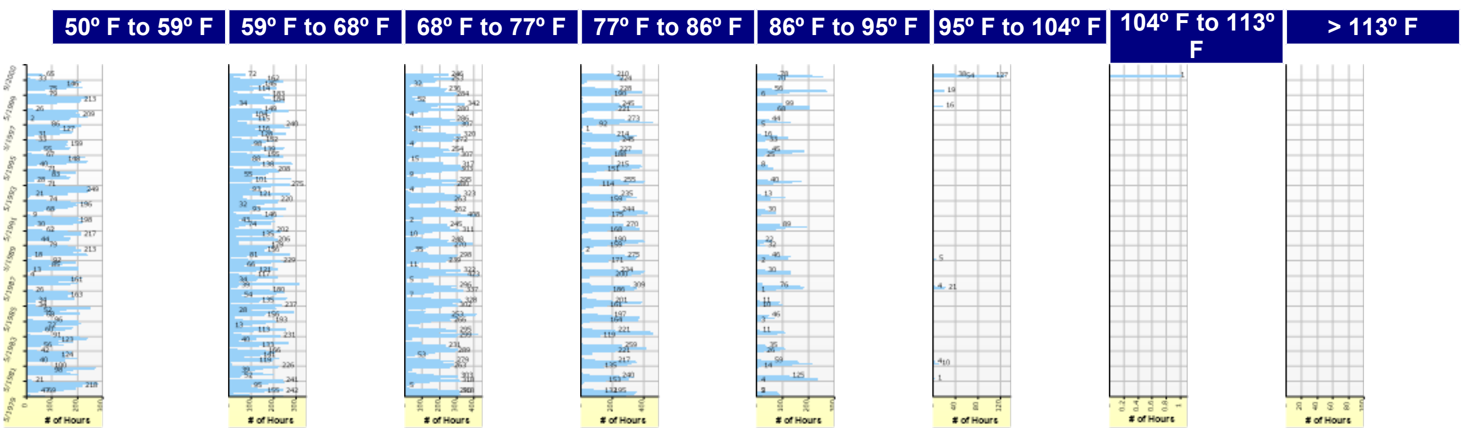



## Hourly Air Temperature Distribution by Month:



# Design Properties

## HMA Design Properties

| | |
|---|---|
| **Use Multilayer Rutting Model** | False |
| **Using G* based model (not nationally calibrated)** | False |
| **Is NCHRP 1-37A HMA Rutting Model Coefficients** | True |
| **Endurance Limit** | - |
| **Use Reflective Cracking** | True |

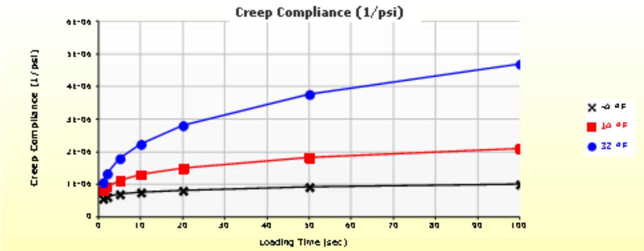
| **Structure - ICM Properties** | |
|---|---|
| AC surface shortwave absorptivity | 0.85 |

| Layer Name | Layer Type | Interface Friction |
|---|---|---|
| Layer 1 Flexible : Default asphalt concrete | Flexible (1) | 1.00 |
| Layer 2 Flexible : Default asphalt concrete | Flexible (1) | 1.00 |
| Layer 3 Flexible : Default asphalt concrete | Flexible (1) | 1.00 |
| Layer 4 Non-stabilized Base : Crushed stone | Non-stabilized Base (4) | 1.00 |
| Layer 5 Subgrade : A-7-6 | Subgrade (5) | - |

## Thermal Cracking

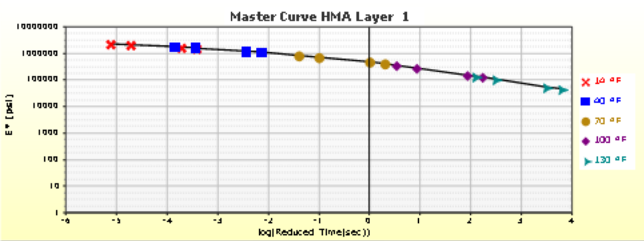
| Thermal Contraction | |
|---|---|
| Is thermal contraction calculated? | True |
| Mix coefficient of thermal contraction (in/in/ºF) | - |
| Aggregate coefficient of thermal contraction (in/in/ºF) | 5.0e-006 |
| Voids in Mineral Aggregate (%) | 20.3 |

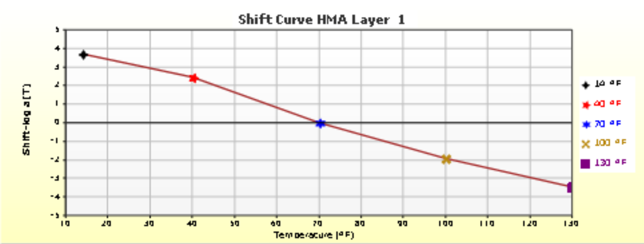
| Indirect Tensile Strength (Input Level: 3) | |
|---|---|
| **Test Temperature ( ºF)** | **Indirect Tensilte Strength (psi)** |
| 14.0 | 322.23 |

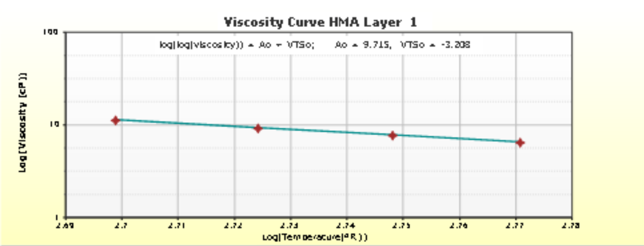



| Creep Compliance (1/psi) (Input Level: 3) | | | |
|---|---|---|---|
| **Loading time (sec)** | **-4 ºF** | **14 ºF** | **32 ºF** |
| 1 | 5.85e-007 | 8.21e-007 | 1.08e-006 |
| 2 | 6.35e-007 | 9.47e-007 | 1.35e-006 |
| 5 | 7.09e-007 | 1.14e-006 | 1.81e-006 |
| 10 | 7.71e-007 | 1.32e-006 | 2.26e-006 |
| 20 | 8.38e-007 | 1.52e-006 | 2.82e-006 |
| 50 | 9.35e-007 | 1.84e-006 | 3.77e-006 |
| 100 | 1.02e-006 | 2.12e-006 | 4.71e-006 |

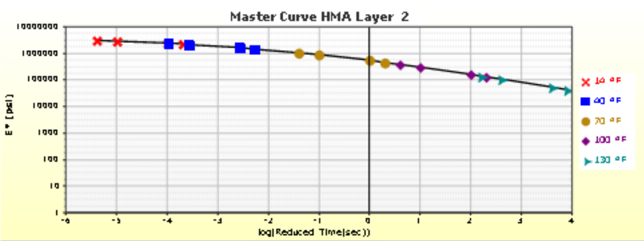
## HMA Layer 1: Layer 1 Flexible : Default asphalt concrete

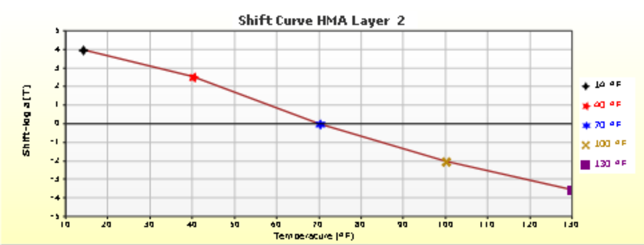


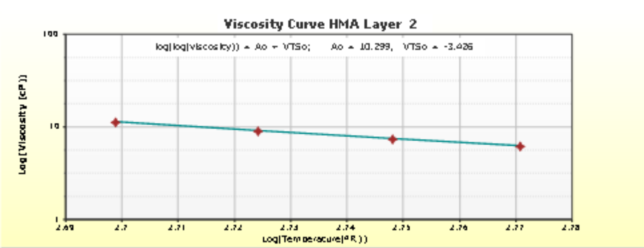



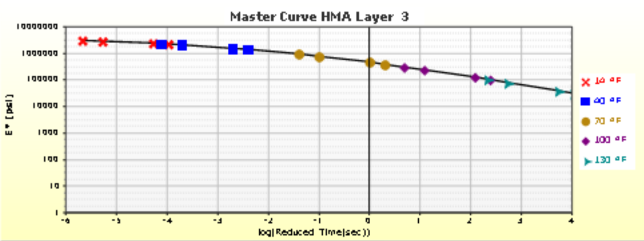
## HMA Layer 2: Layer 2 Flexible : Default asphalt concrete

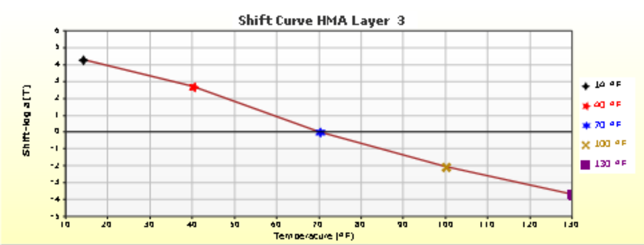


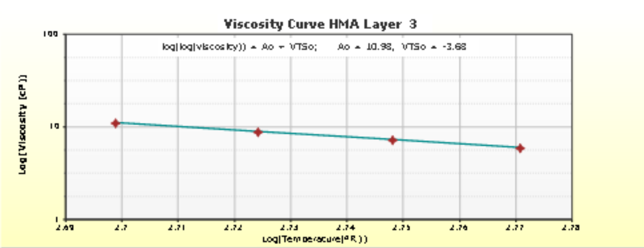



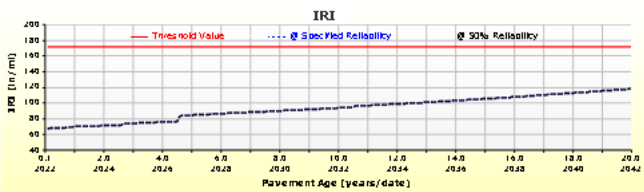
## HMA Layer 3: Layer 3 Flexible : Default asphalt concrete

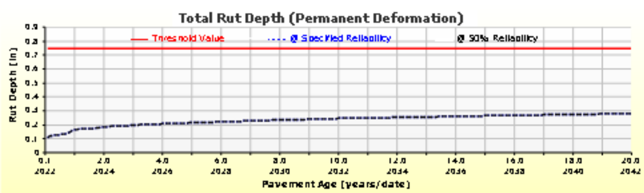


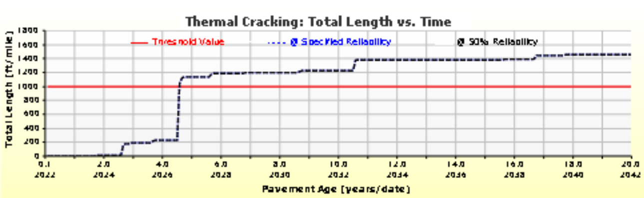



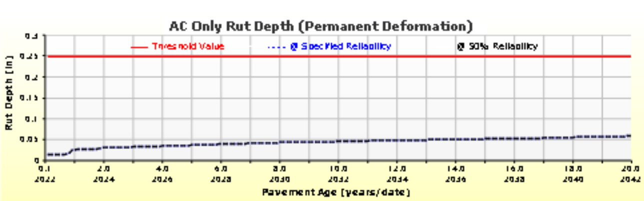



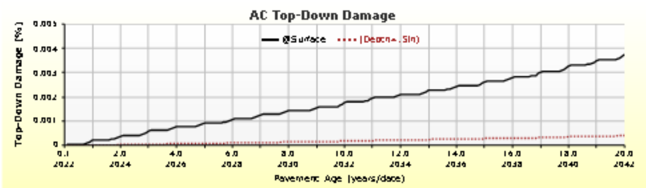
## Analysis Output Charts

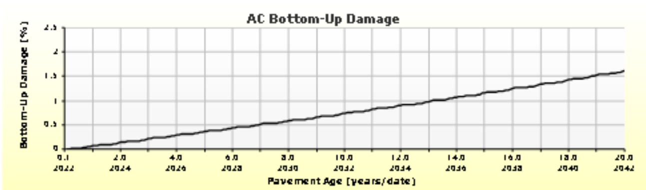


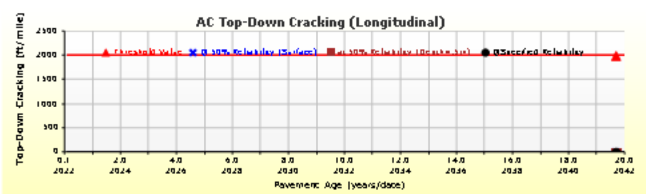



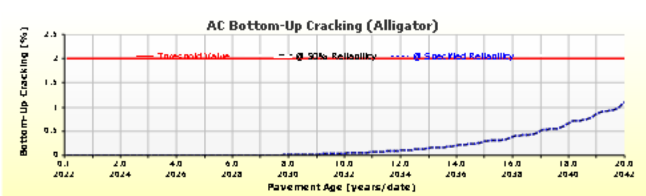



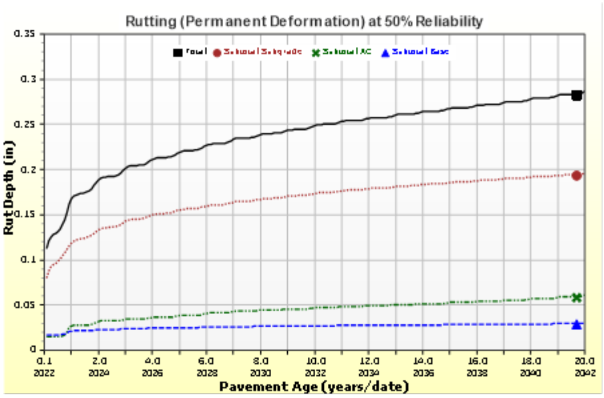





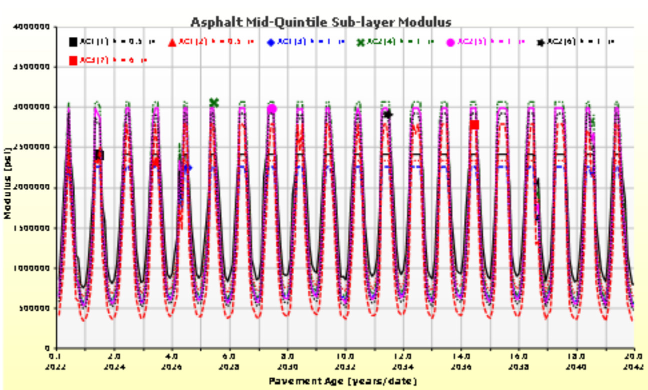




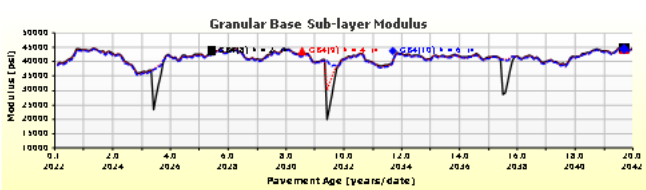




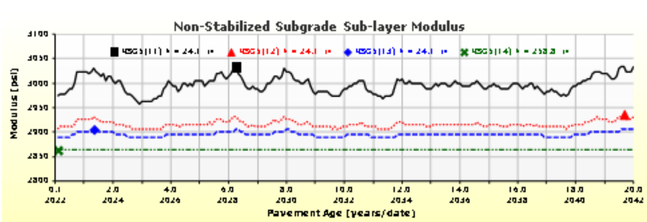
Rutting (Permanent Deformation) at 50% Reliability
Rut Depth (in)
Pavement Age (years/date)



Asphalt Mid-Quintile Sub-layer Modulus
Modulus (psi)
Pavement Age (years/date)

Granular Base Sub-layer Modulus
Modulus (psi)
Pavement Age (years/date)

Non-Stabilized Subgrade Sub-layer Modulus
Modulus (psi)
Pavement Age (years/date)

# Layer Information

## Layer 1 Flexible : Default asphalt concrete

| Asphalt | | |
|---|---|---|
| Thickness (in) | 2.0 | |
| Unit weight (pcf) | 140.8 | |
| Poisson's ratio | Is Calculated? | False |
| | Ratio | 0.35 |
| | Parameter A | - |
| | Parameter B | - |

### Asphalt Dynamic Modulus (Input Level: 3)

| Gradation | Percent Passing |
|---|---|
| 3/4-inch sieve | 100 |
| 3/8-inch sieve | 75 |
| No.4 sieve | 33.5 |
| No.200 sieve | 8 |

### Asphalt Binder

| Parameter | Value |
|---|---|
| Grade | Superpave Performance Grade |
| Binder Type | 76-22 |
| A | 9.715 |
| VTS | -3.208 |

### General Info

| Name | Value |
|---|---|
| Reference temperature (ºF) | 70 |
| Effective binder content (%) | 13.3 |
| Air voids (%) | 7 |
| Thermal conductivity (BTU/hr-ft-ºF) | 0.67 |
| Heat capacity (BTU/lb-ºF) | 0.23 |

### Identifiers

| Field | Value |
|---|---|
| Display name/identifier | Default asphalt concrete |
| Description of object | |
| Author | |
| Date Created | 10/30/2010 1:00:00 AM |
| Approver | |
| Date approved | 10/30/2010 1:00:00 AM |
| State | |
| District | |
| County | |
| Highway | |
| Direction of Travel | |
| From station (miles) | |
| To station (miles) | |
| Province | |
| User defined field 1 | |
| User defined field 2 | |
| User defined field 3 | |
| Revision Number | 0 |

## Layer 2 Flexible : Default asphalt concrete

| Asphalt | | |
|---|---|---|
| Thickness (in) | 3.0 | |
| Unit weight (pcf) | 143.4 | |
| Poisson's ratio | Is Calculated? | False |
| | Ratio | 0.35 |
| | Parameter A | - |
| | Parameter B | - |

### Asphalt Dynamic Modulus (Input Level: 3)

| Gradation | Percent Passing |
|---|---|
| 3/4-inch sieve | 89.4 |
| 3/8-inch sieve | 55.5 |
| No.4 sieve | 33.1 |
| No.200 sieve | 5.8 |

### Asphalt Binder

| Parameter | Value |
|---|---|
| Grade | Superpave Performance Grade |
| Binder Type | 70-22 |
| A | 10.299 |
| VTS | -3.426 |

### General Info

| Name | Value |
|---|---|
| Reference temperature (ºF) | 70 |
| Effective binder content (%) | 10 |
| Air voids (%) | 7 |
| Thermal conductivity (BTU/hr-ft-ºF) | 0.67 |
| Heat capacity (BTU/lb-ºF) | 0.23 |

### Identifiers

| Field | Value |
|---|---|
| Display name/identifier | Default asphalt concrete |
| Description of object | |
| Author | |
| Date Created | 10/30/2010 1:00:00 AM |
| Approver | |
| Date approved | 10/30/2010 1:00:00 AM |
| State | |
| District | |
| County | |
| Highway | |
| Direction of Travel | |
| From station (miles) | |
| To station (miles) | |
| Province | |
| User defined field 1 | |
| User defined field 2 | |
| User defined field 3 | |
| Revision Number | 0 |

## Layer 3 Flexible : Default asphalt concrete

| Asphalt | | |
|---|---|---|
| Thickness (in) | 6.0 | |
| Unit weight (pcf) | 143.4 | |
| Poisson's ratio | Is Calculated? | False |
| | Ratio | 0.35 |
| | Parameter A | - |
| | Parameter B | - |

### General Info

| Name | Value |
|---|---|
| Reference temperature (ºF) | 70 |
| Effective binder content (%) | 10 |
| Air voids (%) | 7 |
| Thermal conductivity (BTU/hr-ft-ºF) | 0.67 |
| Heat capacity (BTU/lb-ºF) | 0.23 |

### Asphalt Dynamic Modulus (Input Level: 3)

| Gradation | Percent Passing |
|---|---|
| 3/4-inch sieve | 89.4 |
| 3/8-inch sieve | 55.5 |
| No.4 sieve | 33.1 |
| No.200 sieve | 5.8 |

### Identifiers

| Field | Value |
|---|---|
| Display name/identifier | Default asphalt concrete |
| Description of object | |
| Author | |
| Date Created | 10/30/2010 1:00:00 AM |
| Approver | |
| Date approved | 10/30/2010 1:00:00 AM |
| State | |
| District | |
| County | |
| Highway | |
| Direction of Travel | |
| From station (miles) | |
| To station (miles) | |
| Province | |
| User defined field 1 | |
| User defined field 2 | |
| User defined field 3 | |
| Revision Number | 0 |

### Asphalt Binder

| Parameter | Value |
|---|---|
| Grade | Superpave Performance Grade |
| Binder Type | 64-22 |
| A | 10.98 |
| VTS | -3.68 |

## Layer 4 Non-stabilized Base : Crushed stone

| Unbound | |
|---|---|
| Layer thickness (in) | 12.0 |
| Poisson's ratio | 0.35 |
| Coefficient of lateral earth pressure (k0) | 0.5 |

### Modulus (Input Level: 3)

| | |
|---|---|
| **Analysis Type:** | Modify input values by temperature/moisture |
| **Method:** | Resilient Modulus (psi) |

| Resilient Modulus (psi) |
|---|
| 30000.0 |

| | |
|---|---|
| **Use Correction factor for NDT modulus?** | - |
| **NDT Correction Factor:** | - |

### Identifiers

| Field | Value |
|---|---|
| Display name/identifier | Crushed stone |
| Description of object | Default material |
| Author | AASHTO |
| Date Created | 1/1/2011 12:00:00 AM |
| Approver | |
| Date approved | 1/1/2011 12:00:00 AM |
| State | |
| District | |
| County | |
| Highway | |
| Direction of Travel | |
| From station (miles) | |
| To station (miles) | |
| Province | |
| User defined field 1 | |
| User defined field 2 | |
| User defined field 3 | |
| Revision Number | 0 |

### Sieve

| | |
|---|---|
| **Liquid Limit** | 6.0 |
| **Plasticity Index** | 3.0 |
| **Is layer compacted?** | True |

| | Is User Defined? | Value |
|---|---|---|
| Maximum dry unit weight (pcf) | False | 126.1 |
| Saturated hydraulic conductivity (ft/hr) | False | 1.526e-01 |
| Specific gravity of solids | False | 2.7 |
| Water Content (%) | False | 8.2 |

| User-defined Soil Water Characteristic Curve (SWCC) | |
|---|---|
| **Is User Defined?** | False |
| **af** | 11.0479 |
| **bf** | 0.9651 |
| **cf** | 0.9010 |
| **hr** | 160.0000 |

| Sieve Size | % Passing |
|---|---|
| 0.001mm | |
| 0.002mm | |
| 0.020mm | |
| #200 | 10.0 |
| #100 | |
| #80 | |
| #60 | |
| #50 | |
| #40 | |
| #30 | |
| #20 | |
| #16 | |
| #10 | |
| #8 | |
| #4 | 20.0 |
| 3/8-in. | |
| 1/2-in. | |
| 3/4-in. | 72.0 |
| 1-in. | |
| 1 1/2-in. | 85.0 |
| 2-in. | |
| 2 1/2-in. | |
| 3-in. | |
| 3 1/2-in. | 95.0 |

## Layer 5 Subgrade : A-7-6

| Unbound | |
|---|---|
| Layer thickness (in) | Semi-infinite |
| Poisson's ratio | 0.35 |
| Coefficient of lateral earth pressure (k0) | 0.5 |

### Modulus (Input Level: 2)

| | |
|---|---|
| **Analysis Type:** | Modify input values by temperature/moisture |
| **Method:** | Resilient Modulus (psi) |

| CBR | Resilient Modulus (psi) |
|---|---|
| 3.0 | 5161 |

| | |
|---|---|
| **Use Correction factor for NDT modulus?** | - |
| **NDT Correction Factor:** | - |

### Identifiers

| Field | Value |
|---|---|
| Display name/identifier | A-7-6 |
| Description of object | Default material |
| Author | AASHTO |
| Date Created | 1/1/2011 12:00:00 AM |
| Approver | |
| Date approved | 1/1/2011 12:00:00 AM |
| State | |
| District | |
| County | |
| Highway | |
| Direction of Travel | |
| From station (miles) | |
| To station (miles) | |
| Province | |
| User defined field 1 | |
| User defined field 2 | |
| User defined field 3 | |
| Revision Number | 0 |

### Sieve

| | |
|---|---|
| **Liquid Limit** | 51.0 |
| **Plasticity Index** | 30.0 |
| **Is layer compacted?** | False |

| | Is User Defined? | Value |
|---|---|---|
| Maximum dry unit weight (pcf) | False | 97.7 |
| Saturated hydraulic conductivity (ft/hr) | False | 8.946e-06 |
| Specific gravity of solids | False | 2.7 |
| Water Content (%) | False | 22.2 |

| User-defined Soil Water Characteristic Curve (SWCC) | |
|---|---|
| **Is User Defined?** | False |
| **af** | 136.4179 |
| **bf** | 0.5183 |
| **cf** | 0.0324 |
| **hr** | 500.0000 |

| Sieve Size | % Passing |
|---|---|
| 0.001mm | |
| 0.002mm | |
| 0.020mm | |
| #200 | 79.1 |
| #100 | |
| #80 | 84.9 |
| #60 | |
| #50 | |
| #40 | 88.8 |
| #30 | |
| #20 | |
| #16 | |
| #10 | 93.0 |
| #8 | |
| #4 | 94.9 |
| 3/8-in. | 96.9 |
| 1/2-in. | 97.5 |
| 3/4-in. | 98.3 |
| 1-in. | 98.8 |
| 1 1/2-in. | 99.3 |
| 2-in. | 99.6 |
| 2 1/2-in. | |
| 3-in. | |
| 3 1/2-in. | 99.9 |

## Calibration Coefficients

### AC Fatigue

$$N_f = 0.00432 * C * \beta_{f1} k_1 \left(\frac{1}{\varepsilon_1}\right)^{k_2 \beta_{f2}} \left(\frac{1}{E}\right)^{k_3 \beta_{f3}}$$

$$C = 10^M$$

$$M = 4.84\left(\frac{V_b}{V_a + V_b} - 0.69\right)$$

| | |
|---|---|
| k1: 3.75 | |
| k2: 2.87 | |
| k3: 1.46 | |
| Bf1: (5.014 * Pow(hac,-3.416)) * 1 + 0 | |
| Bf2: 1.38 | |
| Bf3: 0.88 | |

### AC Rutting

$$\frac{\varepsilon_p}{\varepsilon_r} = k_z \beta_{r1} 10^{k_1} T^{k_2 \beta_{r2}} N^{k_3 \beta_{r3}}$$

$$k_z = (C_1 + C_2 * depth) * 0.328196^{depth}$$

$$C_1 = -0.1039 * H_a^2 + 2.4868 * H_a - 17.342$$

$$C_2 = 0.0172 * H_a^2 - 1.7331 * H_a + 27.428$$

Where:

$H_{ac} = total\ AC\ thickness(in)$

$\varepsilon_p = plastic\ strain(^{in}/_{in})$
$\varepsilon_r = resilient\ strain(^{in}/_{in})$
$T = layer\ temperature(^\circ F)$
$N = number\ of\ load\ repetitions$

| | | |
|---|---|---|
| **AC Rutting Standard Deviation** | 0.24 * Pow(RUT,0.8026) + 0.001 | |
| AC Layer 1 | K1:-2.45 K2:3.01 K3:0.22 | Br1:0.4 Br2:0.52 Br3:1.36 |
| AC Layer 2 | K1:-2.45 K2:3.01 K3:0.22 | Br1:0.4 Br2:0.52 Br3:1.36 |
| AC Layer 3 | K1:-2.45 K2:3.01 K3:0.22 | Br1:0.4 Br2:0.52 Br3:1.36 |

### Thermal Fracture

$$C_f = 400 * N\left(\frac{\log C / h_{ac}}{\sigma}\right)$$

$$\Delta C = (k * \beta t)^{n+1} * A * \Delta K^n$$

$$A = 10^{(4.389 - 2.52 * \log(E * \sigma_m * n))}$$

$C_f = observed\ amount\ of\ thermal\ cracking(ft/500ft)$
$k = refression\ coefficient\ determined\ through\ field\ calibration$
$N() = standard\ normal\ distribution\ evaluated\ at()$
$\sigma = standard\ deviation\ of\ the\ \log\ of\ the\ depth\ of\ cracks\ in\ the\ pavments$
$C = crack\ depth(in)$
$h_{ac} = thickness\ of\ asphalt\ layer(in)$
$\Delta C = Change\ in\ the\ crack\ depth\ due\ to\ a\ cooling\ cycle$
$\Delta K = Change\ in\ the\ stress\ intensity\ factor\ due\ to\ a\ cooling\ cycle$
$A, n = Fracture\ parameters\ for\ the\ asphalt\ mixture$
$E = mixture\ stiffness$
$\sigma_M = Undamaged\ mixture\ tensile\ strength$
$\beta_t = Calibration\ parameter$

| | |
|---|---|
| Level 1 K: (0.13 * Pow(MAAT,2) - 11.68 * MAAT + 244.14) * 1 + 0 | Level 1 Standard Deviation: 0.14 * THERMAL + 343 |
| Level 2 K: (0.13 * Pow(MAAT,2) - 11.68 * MAAT + 244.14) * 1 + 0 | Level 2 Standard Deviation: 0.20 * THERMAL + 343 |
| Level 3 K: (0.13 * Pow(MAAT,2) - 11.68 * MAAT + 244.14) * 1 + 0 | Level 3 Standard Deviation: 0.2386 * THERMAL + 343 |

### CSM Fatigue

$$N_f = 10^{\left(\frac{k_1 \beta_{c1}\left(\frac{\sigma_s}{M_r}\right)}{k_2 \beta_{c2}}\right)}$$

$N_f = number\ of\ repetitions\ to\ fatigue\ cracking$
$\sigma_s = Tensile\ stress(psi)$
$M_r = modulus\ of\ rupture(psi)$

| | | | |
|---|---|---|---|
| k1: 0.972 | k2: 0.0825 | Bc1: 1 | Bc2:1 |

## Unbound Layer Rutting

$$\delta_a(N) = \beta_{s_1} k_1 \varepsilon_v h \left(\frac{\varepsilon_0}{\varepsilon_r}\right) \left| e^{-\left(\frac{\rho}{N}\right)^{\beta}} \right|$$

$\delta_a = permanent\ deformation\ for\ the\ layer$
$N = number\ of\ repetitions$
$\varepsilon_v = average\ veritcal\ strain(in/in)$
$\varepsilon_0, \beta, \rho = material\ properties$
$\varepsilon_r = resilient\ strain(in/in)$

| Base Rutting | | Subgrade Rutting | |
|---|---|---|---|
| k1: 0.965 | Bs1: 1 | k1: 0.675 | Bs1: 1 |
| Standard Deviation (BASERUT) 0.1477 * Pow(BASERUT,0.6711) + 0.001 | | Standard Deviation (BASERUT) 0.1235 * Pow(SUBRUT,0.5012) + 0.001 | |

## AC Cracking

### AC Top Down Cracking

$$FC_{top} = \left(\frac{C_4}{1 + e^{\left(C_1 - C_2 * log_{10}(Damage)\right)}}\right) * 10.56$$

| c1: 7 | c2: 3.5 | c3: 0 | c4: 1000 |
|---|---|---|---|

### AC Bottom Up Cracking

$$FC = \left(\frac{6000}{1 + e^{\left(C_1 * C_1' + C_2 * C_2' log_{10}(D*100)\right)}}\right) * \left(\frac{1}{60}\right)$$

$$C_2' = -2.40874 - 39.748 * (1 + h_{ac})^{-2.856}$$

$$C_1' = -2 * C_2'$$

| c1: 1.31 | c2: (0.867 + 0.2583 * hac) * 1 + 0 | c3: 6000 |
|---|---|---|

| Top down AC Cracking Standard Deviation | Bottom up AC Cracking Standard Deviation |
|---|---|
| 200 + 2300/(1+exp(1.072-2.1654*LOG10(TOP+0.0001))) | 1.13 + 13/(1+exp(7.57-15.5*LOG10(BOTTOM+0.0001))) |

## CSM Cracking

$$FC_{ctb} = C_1 + \frac{C_2}{1 + e^{C_3 - C_4 * log_{10}(Damage)}}$$

| C1: 0 | C2: 75 | C3: 2 | C4: 2 |
|---|---|---|---|

| CSM Standard Deviation |
|---|
| CTB*1 |

## IRI Flexible Pavements

C1 - Rutting
C2 - Fatigue Crack
C3 - Transverse Crack
C4 - Site Factors

| C1: 40 | C2: 0.4 | C3: 0.008 | C4: 0.015 |
|---|---|---|---|