Appendix F

# AASHTOWARE Pavement ME Design Input Guide

This appendix contains guidance for designing new and reconstructed pavement for KYTC using AASHTOWare's Pavement ME software for mechanistic-empirical design. It identifies key inputs specific to pavement design of Kentucky's roadways. A web-based procedure is described for preparing routine designs, which designers can use for most new and reconstructed pavements in Kentucky. However, for some designs, designers will often need to make direct use of Pavement ME. Guidance in this document will help the designer select appropriate inputs for Pavement ME. However, this document *is not a substitute* for in-depth understanding and training on the mechanistic empirical pavement design process and Pavement ME software.

Users should bear in mind that all inputs to the Pavement ME should be *average* values.

## F.1 Project Level Performance Criteria

Except for the initial IRI, all performance criteria apply to the end of the design life selected. Values shown in **Exhibits F-1** and **F-2** should be used for all asphalt and concrete pavement projects in Kentucky. These are the most critical inputs that the trial design must achieve or exceed.

### Exhibit F-1: Asphalt Performance Criteria and Reliability

| **Criteria** | Threshold Limit | Reliability |
|---|---|---|
| Initial IRI (in./mile) | 63 | |
| Terminal IRI (in./mile) | 160 | 95 |
| AC top-down fatigue cracking – longitudinal (ft./mile) (*) | 2000 | 90 |
| AC bottom-up fatigue (alligator) cracking (percent) | 10 | 95 |
| AC thermal cracking (transverse) (ft./mile) (*) | 1000 | 90 |
| Permanent deformation - total pavement (in.) | 0.25 | 95 |
| Permanent deformation - AC only (in.) (*) | 0.25 | 90 |

(*) Threshold Limits are national default values in Pavement ME, and 90% reliability is used in these cases.

### Exhibit F-2: Concrete Performance Criteria and Reliability

| **Criteria** | Threshold Limit | Interstate |
|---|---|---|
| Initial IRI (in./mile) | 63 | |
| Terminal IRI (in./mile) | 160 | 95 |
| JPCP Transverse Cracking (percent) | 10 | 95 |
| Mean joint faulting (in.) | 0.10 | 95 |

The initial IRI is the predictive value for newly-constructed pavement. A typical value is 63 in./mi for both hot mix asphalt (HMA) and Portland cement concrete pavement (PCCP) surfaces. The bottom-up cracking, total deformation and IRI were used at 95% reliability in the web-based development of the Kentucky pavement design program. Pavement ME users may use 90% reliability if the trial design at 95% proves burdensome.

## F.2 Design Life

A 20-year design life is recommended when preparing structural designs in Pavement ME.

The design life could also be set to a higher value that insures failure to determine the actual mode and time of failure.

## F.3 Local Calibration Factors

Kentucky has selected a number of sites to develop local calibration factors for use in Pavement ME designs. At those sites, some initial distress data and site-specific information on traffic and pavement layers were collected to test the default or national calibration models. Based on those runs, state modelers and researchers from the Kentucky Transportation Center (KTC) synthesized the local calibration factors that have been developed by many DOT agencies. Several rounds of Pavement ME runs were used to test the synthesized local calibration factors to minimize the gap between model-calculated distresses and the initial distress data collected from the calibrated sites. Modelers and KTC researchers decided to use the synthesized local calibration factors for any Kentucky Pavement ME runs until a calibration study using the multi-year distress data from the calibration sites is completed.

**Exhibits F-3** and **F-4**, respectively, display the synthesized calibration factors for asphalt and concrete pavements. Designers should use the factors in all Pavement ME (Version 2.3.1)runs for new or reconstructed pavements.

Exhibit F-3: Synthesized Asphalt Local Calibration Coefficients for KY Pavement ME Runs

| Distress | Parameter: K=national, B=local | National | KY Local Calibration Factors |
|---|---|---|---|
| AC Fatigue | Bf1 | 1 | 10 |
| | Bf2 | 1 | 0.95 |
| | Bf3 | 1 | 1.1 |
| AC Rutting | Br1 | 1 | 0.405 |
| | Br2 | 1 | NC |
| | Br3 | 1 | NC |
| Thermal Facture | $K_t$ - Level 1 K | 1.5 | 4.5 |
| | Level 2 K | 0.5 | 4 |
| | Level 3 K | 1.5 | 4.5 |
| Base Rutting; Coarse-Grained Materials/Soils | K1-granular (2.03) | | |
| | Bs1-Granular | 1 | 0.1 |
| Subgrade Rutting; Fine-Grained Materials/Soils | K1-fine(1.35) | | |
| | Bs1-Fine | 1 | 0.15 |
| AC Bottom UP Cracking | C1-bottom | 1 | 0.75 |
| | C2-bottom | 1 | 1.05 |
| | C3-bottom | 6000 | 5000 |
| AC Top Down Cracking | C1-top | 7 | 5.00 |
| | C2-top | 3.5 | 3.00 |
| | C3-top | 0 | NC |
| | C4-top | 1000 | NC |
| IRI | C1-flex [Rutting] | 40 | 20 |
| | C2-flex [Fatigue] | 0.4 | 0.5 |
| | C3-flex [Thermal] | 0.008 | 0.01 |
| | C4-flex [Site Factor] | 0.015 | 0.02 |
| IRI | C1-flex over PCC | 40.8 | NC |
| | C2-flex over PCC | 0.575 | NC |
| | C3-flex over PCC | 0.0014 | NC |
| | C4-flex over PCC | 0.0083 | NC |

**NC = No Change with respect to National Default Value.**

Exhibit F-4: Synthesized Concrete Local Calibration Coefficients for KY Pavement ME Runs

| Distress | Coefficients | National/ MEPDG | KY Local Calibration Factors |
|---|---|---|---|
| **JPCP: Joint Faulting** | **C1** | **1.0184** | NC |
| | **C2** | **0.91656** | NC |
| | **C3** | **0.0021848** | NC |
| | **C4** | **0.000883739** | NC |
| | **C5** | **250** | NC |
| | **C6** | **0.4** | NC |
| | **C7** | **1.83312** | NC |
| | **C8** | 400 | NC |
| **JPCP: Transverse or Fatigue Cracking** | **C1** | **2** | NC |
| | **C2** | **1.22** | NC |
| | **C3** | **1** | NC |
| | **C4** | **-1.98** | NC |
| **JPCP: IRI** | **C1 (Cracks)** | **0.8203** | **0.82** |
| | **C2 (Spall)** | **0.4417** | **1.17** |
| | **C3 (Fault)** | **1.4929** | **1.43** |
| | **C4 (Site Factor)** | **25.24** | **66.8** |
| **CRCP: Punchouts (PO)** | **C1 (Fatigue)** | **2** | NC |
| | **C2 (Fatigue)** | **1.22** | NC |
| | **C3 (PO)** | **216.8421** | NC |
| | **C4 (PO)** | **33.15789** | NC |
| | **C5 (PO)** | **-0.58947** | NC |
| | **C6 (Crack Width)** | **1** | NC |
| **CRCP: IRI** | **C1 (PO)** | **3.15** | NC |
| | **C2 (Site Fac.)** | **28.35** | NC |

**NC = No Change with respect to National Default Value.**

## F.4 Traffic Inputs

Compared to other design procedures, Pavement ME requires more comprehensive and sophisticated traffic inputs. The software needs extensive traffic data, categorized into four types of inputs:

- Base year truck traffic volume (AADTT)
- Traffic volume adjustment
    - Monthly adjustment factors
    - Vehicle class distribution
    - Hourly truck distribution
    - Traffic growth factors
- Axle load distribution factors
- General Traffic inputs
    - Number of axles per truck
    - Axle configuration
    - Wheel base

Pave-ME required traffic data can be obtained through WIM, automatic vehicle classification (AVC), and vehicle counts. The base year truck traffic volume and traffic volume adjustment factors can be obtained from WIM, AVC, and vehicle counts. ALS can only be determined from WIM data.

**Exhibit F-5** shows required project-level data for Pavement ME runs on Kentucky projects. Designers should request data (including vehicle class distributions, if not selected as default by the forecaster), from Central Office planning staff using the Traffic Data Request Form (**Exhibit F-6)**.

### Exhibit F-5: Required Project Level Traffic Data

| | |
|---|---|
| Number of Lanes | Project Specific Information |
| Operational Speed | **70 mph (interstate); 55 mph (all other facilities)** |
| Percent trucks in design direction | Project Specific Information |
| Percent trucks in design lane | Project Specific Information |
| Two-way AADTT | Project Specific Information |

Values for operational speed represent the posted truck speed limit. Traffic data obtained from Central Office planning staff (see **Exhibit F-6**) for the project should receive precedence. Otherwise, Kentucky default traffic data presented in **Exhibits F-11**, **F-13**, **F-14** and, **F-15** are to be used in lieu of the national default values installed in Pavement ME.

# Exhibit F-6: Project Specific Traffic Data Form

| | | | |
|---|---|---|---|
| | | | Fill in the Blue cells with your own information |
| | | | These fields draw their information from a lookup table |
| | | | **READ THIS COLUMN BEFORE YOU ASK ABOUT ANYTHING!!! IT MAY HAVE THE ANSWER YOU SEEK!!!** |
| **A Requester Provided Information** | | | |
| Full District-Item Number | | 03-2042.11 | This field should be entered first. The required format is "10-0123.05" |
| District | | 3 | |
| Emars Number | Default | | |
| | Override | | |
| Function | | | Format: FD04 |
| Fund | | | Must be a number below 10,000 |
| Type of Project | Default | SIGNING | |
| | Override | | |
| Six year Plan County Information | 1st County | WARREN | |
| | 2nd County | DAVIESS | |
| 1st SYP Route | Route | WN 9007 | |
| | BMP | 20.246 | |
| | EMP | 37.143 | |
| 2nd SYP Route | Route | WN 9007 | |
| | BMP | 61.557 | |
| | EMP | 72.264 | |
| Route information you wish to use | County name | Franklin | |
| | County # | 37 | |
| | Prefix | US | |
| | Rd Number | 127 | |
| | Suffix | | |
| | Section Default | 000 | |
| | Section Override | | |
| | Full Route ID | 037-US-0127 -000 | |
| | Begin MP | 0 | |
| | End MP | 1.5 | |
| Functional Class | | 2 - Rural Principal Arterial | |
| Current Year | | 2017 | |
| Project Letting Year | | 2018 | |
| Project Construction Year | | 2020 | |
| Number of Lanes (All Directions) | | 4 | |
| 1 or 2 way | | Two way | |
| Are trucks prohibited in a lane? | | | |
| Pavement Type | | Asphault | |
| 6yrPlan | | 2016 and past | |
| O/P | | P | |
| 20 Project Description | Default | I-65 SPUR CORRIDOR SIGNING; EXISTING NATCHER PARKWAY FROM I-65 INTERCHANGE (EXIT 2) IN WARREN CO. EXTENDING NORTH TO THE US 60 INTERCHANGE IN DAVIESS CO. TO MEET INTERSTATE STANDARDS. (2016BOP) | |
| | Override | | |
| **B Overall Volume Information** | | | |
| ADT Station | | 037520 | |
| Functional Class | | 2 | The functional Class of the traffic station you selected in cell F2 |
| Route ID | | 037-US-0127 -000 | The route ID for the ADT Station [last updated on 2/10/2016] |
| Beginning Milepoint | | 0 | The beginning milepoint of the ADT station [last updated on 2/10/2016] |
| Beginning Milepoint Intersection Description | | Anderson County Line | The description of the intersection at the beginning of the count station [last updated on 2/10/2016] |
| EMP | | 0.787 | The ending milepoint of the ADT station [last updated on 2/10/2016] |
| Ending Milepoint Intersection Description | | Ky 2820 (Green Wilson Rd/Mills | The description of the intersection at the end of the count station [last updated on 2/10/2016] |
| Route Description | | Us Highway 127 S, West Plaza Connector Rd, Wilkinson Blvd, Holmes St, Us Highway 127 N | The name or names of the road that makes up the traffic station [last updated on 2/10/2016] |
| Last Count | | 16358 | |
| Last Count Year | | 2013 | More recent counts may be available elsewhere. |
| Prior Count | | 17154 | The most recent count prior to the last count (year not specified). |
| Station Impact Year | | 0 | The year in which a stations traffic was impacted by development, realignment, etc. (if available) [last updated on 2/10/2016] |
| Year Station Added | | 0 | The year that the station was added (if available) [last updated on 2/10/2016] |
| Other Station Information | | | Any other information available for this traffic station |
| 2010 to 2040 County Population GR | | 1.6% | |
| Project Volume ADT Growth Rate you wish to use | | -1.0% | *DO NOT TYPE A VALUE IN THE CELL! USE THE CELL'S DROP-DOWN MENU OR YOU WILL GET AN ERROR MESSAGE!* |
| 2017 Current Year Volume ADT | Default | 15,713 | |
| | Override | 2,000 | |
| **C Truck Volume Information** | | | |
| Truck Count Station ID | Default | 037520 | |
| | Override | | |
| Truck Count Station Functional Class | | 2 | |
| Truck Count Year | | 2013 | |
| Truck Volume from TS lookup | | 1139 | |
| Truck Volume (ADT) Growth Rate | Default | 1.0% | |
| | Override | | |
| 2017 Truck Volume (ADT) | Default | 1,185 | |
| | Override | 3,000 | |
| 2017 FC Average Truck percentage of ADT | | 13.2% | |
| 2017 Truck Percentage of overall ADT | | 150.0% | |
| 2017 Non-Truck Percentage | | -50.0% | |
| **D 2020 Construction year Information** | | | |
| 2020 Total Volume ADT | | 1,864 | |
| 2020 Truck Volume ADT | | 3,091 | |
| 2020 Truck Volume in Design Direction | | 1,762 | |
| 2020 Truck Volume in Design Lane of Design Direction | | 758 | |
| 2020 Trucks as a percent of ADT | | 165.81% | **TRUCKS AS A PERCENT OF VOLUME CANNOT EXCEED 100%!** |
| 2020 Percent of Trucks in Design Direction | | 57.00% | |
| 2020 Percent of Trucks in Design Lane of Design Direction | | 43.00% | |
| Non-Truck volume Growth Rate | | 7.05% | Growth rate of the volume of non-trucks |
| *Truck Percent (ADT) Growth Rate* | | *3.4%* | *growth rate of trucks as a percent of ADT* |

**Exhibits F-7** through **F-10** contain some national default traffic data used as default values in Pavement ME.

### Exhibit F-7: Axle Configuration (national default values)

| | |
|---|---|
| Average axle width (ft.) | 8.5 |
| Dual Tire Spacing (in) | 12 |
| Quad axle spacing (in) | 49.2 |
| Tandem axle spacing (in) | 51.6 |
| Tire pressure (psi) | 120 |
| Tridem axle spacing | 49.2 |

### Exhibit F-8: Lateral Wander (national default values)

| | |
|---|---|
| Design lane width (ft.) | 12 – could be changed in some instances |
| Mean wheel location (in) | 18 |
| Traffic wander standard deviation (n) | 10 |

The design lane width value represents the width of the through lane; the default setting is 12 feet. The input entry is in the Lateral Wander section of the traffic inputs. If the lane width for a specific project is less than 12 feet, enter the correct width. If the lane width exceeds 12 feet (e.g., on a single lane ramp), the designer may leave this entry as 12 feet.

### Exhibit F-9: Wheelbase (national defaults, only applicable to JPC design) Data

| | |
|---|---|
| Average spacing of long axles (ft.) | 18 |
| Average spacing of medium axles (ft.) | 15 |
| Average spacing of short axles(ft.) | 12 |
| Percent trucks with long axles | 61 |
| Percent trucks with medium axles | 22 |
| Percent trucks with shot axles | 17 |

## Exhibit F-10: Axles per Truck (national default values)

| Vehicle Class | Single | Tandem | Tridem | Quad |
|---|---|---|---|---|
| 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 |

## Axle Load Spectra, use national defaults

**Exhibits F-11** through **F-15** present some default traffic data for Kentucky. These are developed or suggested by Central Office planning staff and should be used if project-level data are not available.

Vehicle Class Distribution (VCD) is critical traffic data, which often varies by roadway class. Kentucky default values of those are shown in **Exhibit F-11**. They should be used only if no project-level data (see Exhibit F-6) are available.

## Exhibit F-11: Default Kentucky Truck Traffic Distribution by Functional Class

| | **Vehicle Class (**)** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Functional Class (*)** | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 1 | 3.7% | 12.2% | 2.2% | 0.4% | 7.0% | 69.5% | 0.9% | 2.6% | 1.3% | 0.2% |
| 2 | 7.0% | 34.9% | 5.2% | 1.0% | 8.6% | 38.8% | 3.4% | 0.8% | 0.2% | 0.1% |
| 6 | 6.8% | 54.4% | 8.2% | 3.2% | 7.9% | 18.2% | 1.1% | 0.0% | 0.0% | 0.0% |
| 7 | 10.1% | 61.6% | 8.4% | 1.1% | 7.1% | 11.0% | 0.6% | 0.0% | 0.0% | 0.0% |
| 8 | 7.0% | 82.1% | 2.2% | 1.0% | 5.0% | 2.4% | 0.2% | 0.0% | 0.0% | 0.1% |
| 9 | 9.6% | 32.7% | 21.1% | 2.7% | 13.1% | 15.4% | 4.0% | 0.1% | 0.1% | 1.1% |
| 11 | 6.6% | 22.2% | 4.4% | 0.6% | 8.4% | 53.4% | 1.6% | 1.6% | 0.9% | 0.4% |
| 12 | 7.9% | 41.6% | 7.2% | 1.3% | 10.9% | 29.3% | 0.8% | 0.7% | 0.1% | 0.1% |
| 14 | 6.1% | 38.8% | 5.0% | 1.5% | 9.5% | 37.5% | 0.6% | 0.8% | 0.2% | 0.0% |
| 16 | 18.1% | 69.3% | 5.1% | 0.3% | 3.5% | 2.2% | 0.7% | 0.0% | 0.0% | 0.7% |
| 17 | 8.3% | 55.1% | 1.1% | 0.1% | 33.9% | 0.8% | 0.7% | 0.0% | 0.0% | 0.0% |
| 19 | 6.8% | 28.5% | 31.0% | 6.3% | 8.8% | 11.8% | 4.5% | 0.4% | 0.0% | 1.8% |

Source: 2014 – 2016 ATR Data

(*) Functional Class:

1. Rural Interstate
2. Rural Principal Arterial
6. Rural Minor Arterial
7. Rural Major Collector

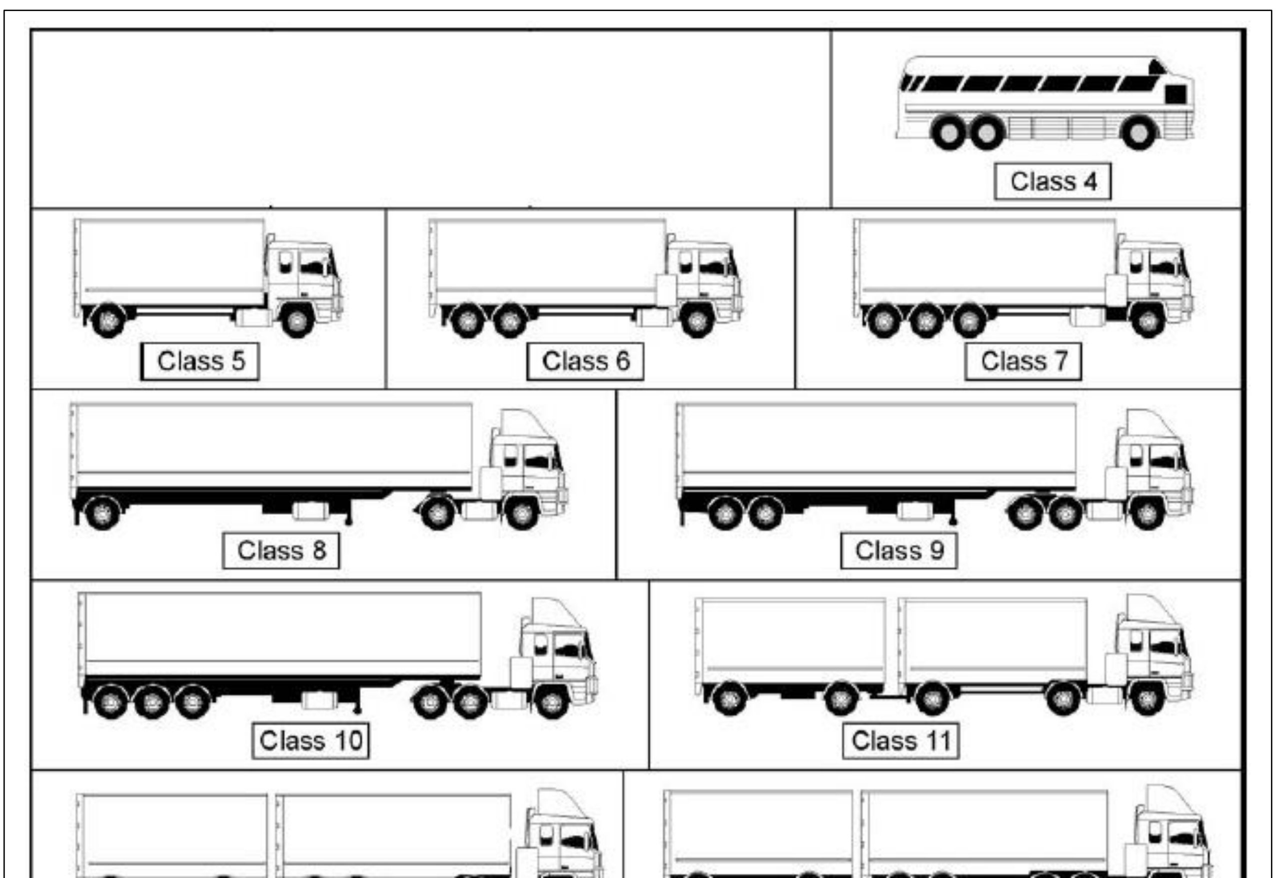
8. Rural Minor Collector
9. Rural Local
11. Urban Interstate
12. Urban Other Freeway and Expressways
14. Urban Other Principal Arterial
16. Urban Minor Arterial
17. Urban Collector
19. Urban Local

(**) Vehicle Class [See **Exhibit F-12** for truck class representative pictures]

1. Motor Cycles
2. Passenger Cars (With 1- or 2-axle Trailers)
3. Two-Axle, 4-tire Single Units [Pickup or Van with 1- or 2-axle Trailers)
4. Buses (Includes Handicap-Equipped Bus and Mini School Bus)
5. Two-Axle, 6 Tire Single Units
6. Three Axle Single Units
7. Four or More Axle Single Units
8. Four or Less Axle Single Trailers
9. Five Axle Single Trailers
10. Six or More Axle Single Trailers
11. Five or Less Axle Multi-Trailers
12. Six Axle Multi-Trailers
13. Seven or More Axle Multi-Trailers

- Passenger Vehicles (1-3)
- Buses [4]
- Single Unit (SU) Trucks [5-7]
- Multi-Unit (MU) /Combination Trucks [8-13]
- SU-Trailers [8-10]
- MU-Trailers [11-13]

## Exhibit F-12: FHWA Vehicle Class



## Exhibit F-13: Default Kentucky Seasonal Adjustment Factors

| Month | Adjustment |
|---|---|
| Jan | 0.86 |
| Feb | 0.92 |
| Mar | 1.00 |
| Apr | 1.03 |
| May | 1.03 |
| Jun | 1.05 |
| Jul | 1.05 |
| Aug | 1.05 |
| Sep | 1.05 |
| Oct | 1.03 |
| Nov | 0.99 |
| Dec | 0.94 |
| **TOTAL** | **12.00** |

Source: 2014 – 2016 ATR Data

**Exhibit F-14** shows default linear traffic growth rates developed and recommended by Central Office planning staff for use in Pavement ME. The default values are based on functional class and should be used when project-level data on truck traffic growth (see **Exhibit F-6**) are not available from the Division of Planning. These values represent increases in truck traffic during pavement life.

## Exhibit F-14: Default Kentucky Truck Traffic Growth Rates

| Functional Class | Truck Volume Growth Rate (Linear) (%) |
|---|---|
| FC 1 | 1 |
| FC 2 | 1 |
| FC 6 | 0.5 |
| FC 7 | 0.5 |
| FC 8 | 0.5 |
| FC 9 | 0.5 |
| FC 11 | 1 |
| FC 12 | 1 |
| FC 14 | 0.5 |
| FC 16 | 0.5 |
| FC 17 | 0.5 |
| FC 19 | 0.5 |

**Exhibit F-15** shows default values for hourly traffic distributions in Kentucky. The default values are based on functional class and should be used for any concrete design in Pavement ME.

## Exhibit F-15: Default Kentucky Hourly Distribution Factors

| | Functional Class | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 6 | 7 | 8 | 9 | 11 | 12 | 14 | 16 | 17 | 19 |
| Hour | Rural Interstate | Rural Principal Arterial | Rural Minor Arterial | Rural Major Collector | Rural Minor Collector | Rural Local | Urban Interstate | Urban Freeway | Urban Principal Arterial | Urban Minor Arterial | Urban Collector | Urban Local |
| 0 | 2.23% | 1.15% | 0.61% | 0.55% | 0.48% | 0.43% | 1.75% | 1.10% | 1.21% | 0.81% | 0.37% | 0.35% |
| 1 | 1.97% | 1.04% | 0.49% | 0.44% | 0.34% | 0.42% | 1.53% | 0.96% | 1.09% | 0.61% | 0.22% | 0.27% |
| 2 | 1.84% | 1.04% | 0.58% | 0.36% | 0.19% | 0.11% | 1.44% | 0.85% | 1.02% | 0.48% | 0.13% | 0.22% |
| 3 | 1.92% | 1.22% | 0.70% | 0.39% | 0.17% | 0.37% | 1.53% | 1.15% | 1.18% | 0.37% | 0.12% | 0.05% |
| 4 | 2.20% | 1.63% | 0.83% | 0.60% | 0.90% | 0.27% | 1.91% | 1.58% | 1.59% | 0.67% | 0.19% | 0.08% |
| 5 | 2.74% | 2.69% | 2.04% | 1.57% | 1.27% | 1.75% | 2.78% | 2.72% | 2.56% | 1.66% | 0.52% | 1.12% |
| 6 | 3.41% | 4.23% | 3.69% | 3.72% | 3.98% | 4.86% | 4.05% | 4.54% | 3.96% | 4.93% | 2.07% | 5.60% |
| 7 | 4.03% | 5.56% | 5.81% | 5.69% | 4.46% | 7.01% | 4.76% | 6.08% | 5.06% | 5.93% | 8.30% | 8.40% |
| 8 | 4.73% | 6.16% | 6.62% | 6.75% | 5.45% | 7.00% | 5.60% | 7.19% | 5.76% | 7.98% | 5.24% | 7.23% |
| 9 | 5.37% | 6.63% | 7.40% | 7.51% | 6.17% | 4.72% | 6.07% | 7.25% | 6.44% | 6.07% | 5.62% | 6.08% |
| 10 | 5.78% | 6.83% | 7.65% | 7.87% | 7.44% | 8.06% | 6.24% | 6.87% | 6.85% | 6.41% | 6.07% | 7.52% |
| 11 | 5.96% | 6.90% | 7.46% | 7.92% | 7.85% | 6.45% | 6.37% | 6.91% | 7.08% | 6.42% | 7.01% | 5.52% |
| 12 | 5.99% | 6.96% | 7.42% | 8.08% | 7.78% | 6.49% | 6.38% | 6.79% | 7.42% | 6.79% | 7.87% | 7.47% |
| 13 | 6.03% | 6.93% | 7.59% | 7.87% | 7.38% | 8.00% | 6.45% | 6.73% | 7.14% | 6.81% | 7.13% | 8.52% |
| 14 | 6.02% | 7.00% | 7.79% | 8.19% | 7.56% | 6.90% | 6.49% | 6.89% | 6.67% | 8.89% | 10.20% | 8.97% |
| 15 | 5.99% | 6.82% | 8.06% | 8.43% | 7.94% | 9.13% | 6.42% | 6.44% | 6.44% | 7.80% | 8.58% | 9.19% |
| 16 | 5.81% | 6.24% | 6.95% | 7.14% | 7.47% | 9.31% | 5.99% | 6.28% | 6.40% | 7.34% | 9.04% | 8.41% |
| 17 | 5.43% | 5.38% | 5.60% | 5.24% | 6.56% | 4.42% | 5.37% | 5.23% | 5.75% | 5.47% | 7.52% | 4.73% |
| 18 | 4.98% | 4.18% | 4.09% | 3.75% | 5.30% | 4.43% | 4.76% | 4.17% | 4.63% | 3.96% | 4.92% | 3.32% |
| 19 | 4.49% | 3.30% | 2.83% | 2.73% | 4.42% | 2.32% | 3.84% | 3.09% | 3.52% | 3.37% | 3.32% | 2.36% |
| 20 | 3.97% | 2.70% | 2.15% | 2.04% | 3.17% | 2.47% | 3.16% | 2.41% | 2.80% | 2.58% | 2.30% | 1.28% |
| 21 | 3.48% | 2.23% | 1.67% | 1.50% | 1.89% | 3.58% | 2.70% | 1.93% | 2.26% | 1.87% | 1.81% | 2.46% |
| 22 | 3.04% | 1.82% | 1.17% | 0.98% | 1.14% | 0.98% | 2.37% | 1.55% | 1.78% | 1.74% | 0.90% | 0.47% |
| 23 | 2.60% | 1.39% | 0.81% | 0.68% | 0.68% | 0.52% | 2.03% | 1.29% | 1.37% | 1.06% | 0.56% | 0.36% |

Source: 2014 – 2016 ATR Data

## F.5 Climate Data

Pavement ME climate inputs are based on project location. The current version (2.3.1) of Pavement ME contains files with historical climate data for the following locations:

- Frankfort
- Jackson
- Lexington
- Louisville (Bowman Field and Louisville International Airport)
- London
- Paducah

Very small differences in Pavement ME outputs have been observed among different climate stations across Kentucky. A virtual station can be created and used if the project is not in close proximity to the available stations. Stations in adjacent states may also be used. Other user inputs of climate data include longitude, latitude, elevation, and depth of water table. Users enter the water table depth at the project location using the average annual depth option.

# F.6 Pavement Structure Data

## F.6.1 HMA Bound Materials

HMA mixture properties are shown in **Exhibit F-16**. They should be used for both base and surface courses. A lower nominal maximum aggregate size (NMAS) is used for surface courses. Most values shown in **Exhibit F-16** represent the Kentucky default values of mixture properties for PG64-22 and PG76-22 mixtures, for AADTT Classes 2, 3 and 4.

### Exhibit F-16: Mixture Volumetric of HMA Mixtures

| **Mixture Volumetric** | |
|---|---|
| Unit Weight | See Class Tables Below |
| Effective Binder Content | See Class Tables Below |
| Ari Voids | See Class Tables Below |
| Poisson's Ratio | 0.35 (Default) |
| **Mechanical Properties** | |
| Dynamic Modulus | Level 3 (Select Gradation Parameters from Class Tables or project specific information if available |
| HMA Estar Predictive Model | Use Viscosity Based Model (nationally calibrated) |
| Reference Temperature | 70 |
| Asphalt Binder | Select Appropriate Binder Grade |
| Indirect Tensile Strength | Calculated by software |
| Creep Compliance | Level 3 Default |
| **Thermal** | |
| Thermal Conductivity | 0.67 |
| Heat Capacity | 0.23 |
| Thermal Contraction | Calculated by software |

Exhibit F-16 (continued): For AADTT Class 3 and 4 (*)

| **PG64-22** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| NMAS | Unit Weight | % Eff AC by Vol | Avg % Solid | Air voids (%) | % Pass. 3/4" | % Pass. 3/8" | % Pass. #4 | Pass. #200 |
| 0.38 | 148.9 | 11.36 | 92.8 | 7.2 | 100.00 | 95.00 | 66.42 | 5.55 |
| 0.50 | 148.4 | 10.54 | 93.3 | 6.7 | 99.99 | 85.38 | 58.46 | 5.28 |
| 0.75 | 150.2 | 9.38 | 93.1 | 6.9 | 95.50 | 68.45 | 42.10 | 4.59 |
| 1.00 | 151.5 | 8.51 | 93.3 | 6.7 | 85.71 | 61.41 | 37.85 | 4.70 |
| 1.50 | 151.8 | 7.95 | 93.2 | 6.8 | 78.49 | 56.52 | 32.93 | 4.50 |
| **PG76-22** | | | | | | | | |
| 0.38 | 148.8 | 11.48 | 92.7 | 7.3 | 99.93 | 94.63 | 64.59 | 5.46 |
| 0.5 | 148.5 | 10.79 | 92.9 | 7.1 | 100.00 | 84.60 | 56.40 | 4.80 |
| 0.75 | 150.1 | 9.40 | 92.9 | 7.1 | 96.29 | 73.54 | 44.54 | 4.66 |
| 1.00 | 151.4 | 8.61 | 93.3 | 6.7 | 85.72 | 61.37 | 36.19 | 4.60 |

Exhibit F-16 (continued): For AADTT Class 2 (*)

| **PG 64-22** | | | | | | | |
|---|---|---|---|---|---|---|---|
| NMAS | Unit Weight | % Eff AC by Vol | Air Voids (%) | % Pass. 3/4" | % Pass. 3/8" | % Pass. #4 | Pass. #200 |
| 0.38 | 148.2 | 11.27 | 7.0 | 99.82 | 95.15 | 66.24 | 5.37 |
| 0.50 | 148.8 | 10.60 | 6.3 | 99.85 | 84.42 | 57.68 | 4.87 |
| 0.75 | 150.0 | 9.49 | 6.5 | 94.73 | 71.70 | 46.37 | 4.81 |
| 1.00 | 150.9 | 8.75 | 6.4 | 85.95 | 61.32 | 39.14 | 4.66 |

Source: SiteManager Materials data

| (*) AADTT Class | AADTT Range |
|---|---|
| 2 | <600 |
| 3 | 600 to 2,999 |
| 4 | >= 3,000 |

## F.6.2 PCC Materials and Construction Parameters

The following parameters should be used for PCC pavement construction; these parameters are those which are most likely to vary or change based on specific design situations. All other design parameters should remain at the national default values.

### F-17: Unbound Materials (Soil Subgrade)

| **PCC Design Parameter** | **Value** |
|---|---|
| Compressive Strength | 5,000 psi |
| Joint Spacing | 15 feet |
| Dowel Diameter | 8”- 9 to be 1.25 everything else 1.5 inches |
| Cement Type | Type I |
| Cement Content | 564 lbs/yd |
| W/C ratio | 0.42 |
| Aggregate Type | Limestone |
| PCC coefficient of thermal expansion (in/in/ºF x 10^-6) | 4.9 |
| Curing Method | Curing Compound |
| All other Parameters set to defaults | |

## F.6.3 Unbound Materials – Aggregate Bases

**Exhibit F-18** presents key Kentucky default values for unbound aggregate bases.

### F-18: Unbound Materials (Aggregate Bases)

| **Unbound Materials** | |
|---|---|
| Poisson’s Ratio | 0.35 |
| Coefficient of lateral earth pressure | 0.50 |
| **Modulus Level 2** | See DGA/CSB table below |
| **Gradation** | See DGA/CSB table below |

(a) Crushed Stone Base (CSB):

| | **Gradation** | | | | | | |
|---|---|---|---|---|---|---|---|
| **MR** | **2-1/2"** | **1-1/2"** | **3/4"** | **3/8"** | **#4** | **#30** | **#200** |
| 45,000 | 100.0 | 99.0 | 76.3 | 45.5 | 29.0 | 11.3 | 6.4 |

(b) Dense Grade Aggregate (DGA)

| | **Gradation** | | | | | |
|---|---|---|---|---|---|---|
| **MR** | **1"** | **3/4"** | **3/8"** | **#4** | **#30** | **#200** |
| 35,000 | 100.0 | 94.8 | 65.0 | 45.1 | 17.1 | 9.5 |

Source: SiteManager Materials data

Plasticity Index and values other than gradation should remain at the national default values for unbound material types (DGA/CSB). Any of the unbound layer should be compacted. Consult the Division of Materials for additional guidance on these values for project-level concerns.

## F.6.4 Unbound Materials – Subgrade Soils

**Exhibit F-19** presents the key inputs required for the soil subgrade. Similar to project-level traffic input data, KYTC's Geotechnical Branch should be contacted for information on project-specific soil input properties. A blank sheet of project-specific data obtainable from the Geotechnical Branch is shown in **Exhibit F-20**.

## F-19: Unbound Materials (Soil Subgrade)

| **Unbound Materials** | |
|---|---|
| Poisson's Ratio | 0.35 |
| Coefficient of lateral earth pressure | 0.50 |
| **Modulus** | Project Level Information ($CBR_{AASHTO}$ = 5.29Ln($CBR_{KY}$)-3.91),<br>Or (Kentucky default values based on soil type) |
| **Gradation/Sieve** | Project specific gradation or Kentucky default values based on soil type |

Pavement ME uses resilient modulus (MR) at level 1 and also supports use of the California bearing ratio (CBR) as a Level 2 input for subgrade characterization. It uses the following relationship to convert CBR to resilient modulus:

$$\mathbf{MR = 2555(CBR)^{0.6}}$$

While the CBR test is typically conducted at a range of moisture contents and compactive efforts, the design CBR is selected based on the degree of compaction and moisture content expected in the field. In Pavement ME, when the design CBR is used as an input to determine subgrade MR, the moisture content and density values associated with the input CBR must also be used.

Kentucky CBR compactive effort differs from the AASHTO CBR protocol. The user should first obtain the average Kentucky CBR values for the project and then convert them to AASHTO CBR as shown in **Exhibit F-18** and the following equation before entering the converted values into the software.

$$\mathbf{CBR_{AASHTO} = 5.29*Ln(CBR_{KY})-3.91}$$

If there are no project-specific data available from the Geotechnical Branch, the equivalent AASHTO CBR should be calculated from the Kentucky CBR based on the project average. Predominant soil type should be used to represent other soil properties. **Exhibit F-19** contains Kentucky's default values for all soil properties**.** Default values should only be used if project-level data (see Exhibit F-20) are not available.

## Chemical Soil Stabilization

Chemical soil stabilization may be achieved by either adding hydrated lime or Portland cement to the roadway subgrade as directed by the Geotechnical Branch within the Division of Structural Design.

This layer would be modeled in the PaveME software as another subgrade layer of finite thickness, generally 8 – 12 inches in depth.  The soil parameters for this layer should be consistent with those that would be present for this soil prior to stabilization.  The geotechnical division staff should be contacted for any project level inputs of these stabilized layer for their design. In the absence of any project level data, the following MR values should be used for Pave-ME design of those stabilized layers:

- Cement Stabilized Soils: 100,000 psi
- Lime Stabilized Soils: 60,000 psi

The default gradation values shown in F-19 should be used for those stabilized layers by knowing the AASHTO soil type in the absence of project level information from geotechnical division.

F-20: Kentucky Default Soil Subgrade properties based on AASHTO Soil Class

| AASHTO Class | Soil Property | Average | | | Sieve Size | Average |
|---|---|---|---|---|---|---|
| A-1 & A-2 | Water Content (%) | 15.89 | | | #200 | 38.59 |
| | Liquid Limit (%) | 18.78 | | | #40 | 65.30 |
| | Plastic Limit (%) | 11.67 | | | #10 | 85.06 |
| | Plasticity Index (%) | 7.07 | | | #4 | 89.70 |
| | Max. Dry Density (pcf) | 111.03 | | | 3/8 in. | 94.05 |
| | Opt. Moisture Content (%) | 13.44 | | | 3/4 in. | 98.39 |
| | Specific Gravity | 2.664 | | | 1 in. | 99.47 |
| | KY CBR | 10.85 | | | 2 in. | 100.00 |
| | AASHTO CBR | 8.70 | | | 3 in. | 100.00 |

| AASHTO Class | Soil Property | | Average | | Sieve Size | Average |
|---|---|---|---|---|---|---|
| A-4 & A-5 | Water Content (%) | | 18.32 | | #200 | 72.56 |
| | Liquid Limit (%) | | 26.96 | | #40 | 85.54 |
| | Plastic Limit (%) | | 19.48 | | #10 | 92.75 |
| | Plasticity Index (%) | | 7.51 | | #4 | 96.15 |
| | Max. Dry Density (pcf) | | 109.97 | | 3/8 in. | 97.80 |
| | Opt. Moisture Content (%) | | 15.37 | | 3/4 in. | 99.21 |
| | Specific Gravity | | 2.682 | | 1 in. | 99.54 |
| | KY CBR | | 8.85 | | 2 in. | 99.97 |
| | AASHTO CBR | | 7.62 | | 3 in. | 100.00 |

**F-20 (continued):**

| AASHTO Class | Soil Property | Average | | Sieve Size | Average |
|---|---|---|---|---|---|
| A-6 | Water Content (%) | 20.73 | | #200 | 79.83 |
| | Liquid Limit (%) | 35.34 | | #40 | 90.60 |
| | Plastic Limit (%) | 18.87 | | #10 | 94.93 |
| | Plasticity Index (%) | 16.42 | | #4 | 98.00 |
| | Max. Dry Density (pcf) | 107.41 | | 3/8 in. | 99.00 |
| | Opt. Moisture Content (%) | 16.83 | | 3/4 in. | 99.74 |
| | Specific Gravity | 2.701 | | 1 in. | 99.89 |
| | KY CBR | 6.01 | | 2 in. | 100.00 |
| | AASHTO CBR | 5.57 | | 3 in. | 100.00 |

| AASHTO Class | Soil Property | Average | | Sieve Size | Average |
|---|---|---|---|---|---|
| A-7-5 | Water Content (%) | 24.34 | | #200 | 88.32 |
| | Liquid Limit (%) | 53.02 | | #40 | 96.44 |
| | Plastic Limit (%) | 32.14 | | #10 | 99.57 |
| | Plasticity Index (%) | 21.13 | | #4 | 99.76 |
| | Max. Dry Density (pcf) | 92.53 | | 3/8 in. | 99.89 |
| | Opt. Moisture Content (%) | 25.36 | | 3/4 in. | 100.00 |
| | Specific Gravity | 2.696 | | 1 in. | 100.00 |
| | KY CBR | 4.90 | | 2 in. | 100.00 |
| | AASHTO CBR | 4.50 | | 3 in. | 100.00 |

| AASHTO Class | Soil Property | Average | | Sieve Size | Average |
|---|---|---|---|---|---|
| A-7-6 | Water Content (%) | 23.41 | | #200 | 87.38 |
| | Liquid Limit (%) | 52.65 | | #40 | 94.09 |
| | Plastic Limit (%) | 21.74 | | #10 | 97.27 |
| | Plasticity Index (%) | 30.89 | | #4 | 98.63 |
| | Max. Dry Density (pcf) | 100.27 | | 3/8 in. | 99.39 |
| | Opt. Moisture Content (%) | 21.20 | | 3/4 in. | 99.85 |
| | Specific Gravity | 2.706 | | 1 in. | 99.93 |
| | KY CBR | 3.81 | | 2 in. | 100.00 |
| | AASHTO CBR | 3.17 | | 3 in. | 100.00 |

**F-20 (continued):**

| AASHTO Class | Soil Property | Average | | Sieve Size | Average |
|---|---|---|---|---|---|
| A-7 (A-7-5 & A-7-6) | Water Content (%) | 23.47 | | #200 | 87.43 |
| | Liquid Limit (%) | 52.67 | | #40 | 94.23 |
| | Plastic Limit (%) | 22.36 | | #10 | 97.41 |
| | Plasticity Index (%) | 30.31 | | #4 | 98.70 |
| | Max. Dry Density (pcf) | 99.80 | | 3/8 in. | 99.42 |
| | Opt. Moisture Content (%) | 21.45 | | 3/4 in. | 99.86 |
| | Specific Gravity | 2.705 | | 1 in. | 99.94 |
| | KY CBR | 3.88 | | 2 in. | 100.00 |
| | AASHTO CBR | 3.26 | | 3 in. | 100.00 |

Source: Geotechnical Database

F-21: Blank Soil Profile Data Sheet from Geotechnical Branch for Project-Specific Soil Data

Drilling Firm:
For: Division of Structural Design
Geotechnical Branch

**Geotechnical Soil Profile Data Sheet**

Printed:

Page of

| | | |
|---|---|---|
| Project ID: ___________ <br> Item Number: ___________ | County: _____ <br> Route: _____ | Project Type: ______________ <br> Project Manager: ________________ |

| Location | Hole No. | Samp. No. | Depth | % Silt | % Clay | P L | L I | P I | AASHTO | UNIFIED | CBR | Cut / Fill | Nat Moist | Opt Moist | Max Dry Density | D-50 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| Summary statistics for all project bag samples (Repeats on all pages) | | % Silt | % Clay | P L | L I | P I | CBR | Nat Moist | Opt Moist | Max Dry Density | D-50 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Minimum | | | | | | | | | | |
| | Maximum | | | | | | | | | | |
| | Average | | | | | | | | | | |
| | Std. Dev. | | | | | | | | | | |