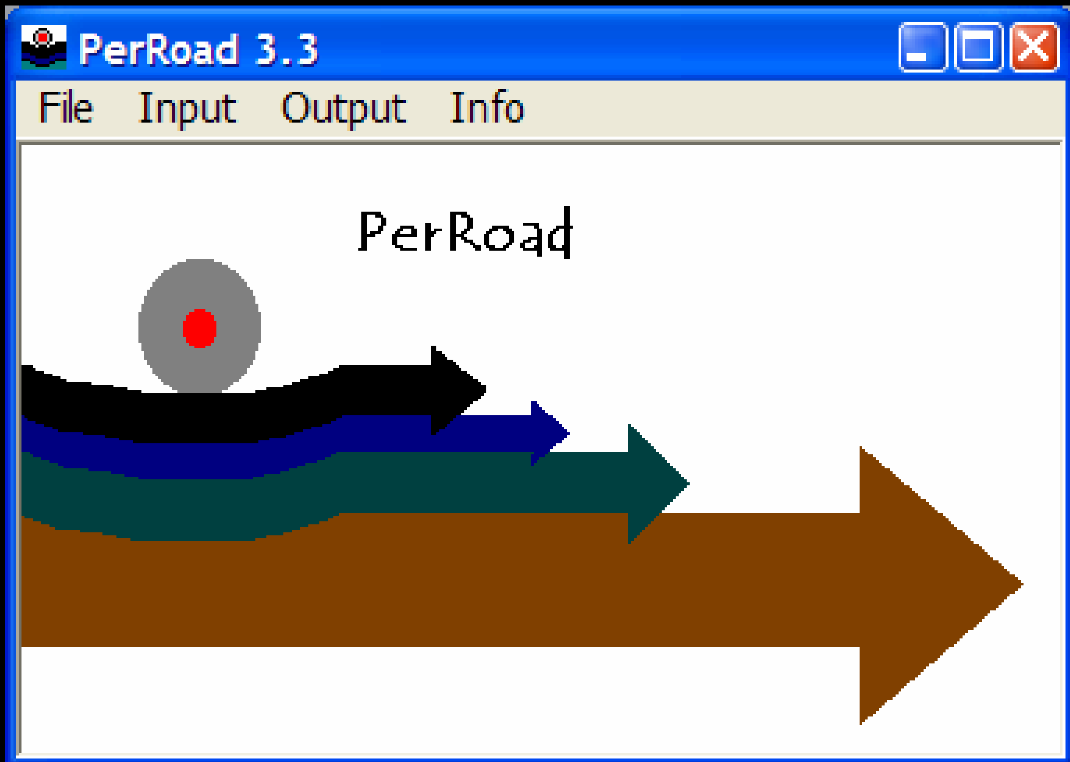
# Comparing PerRoad and the MEPDG





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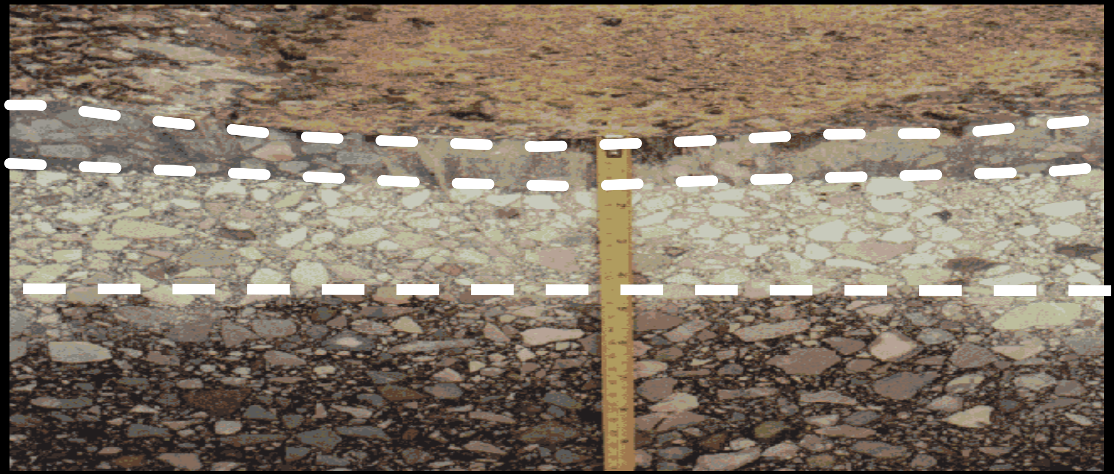
# Goal of Perpetual Pavement Design

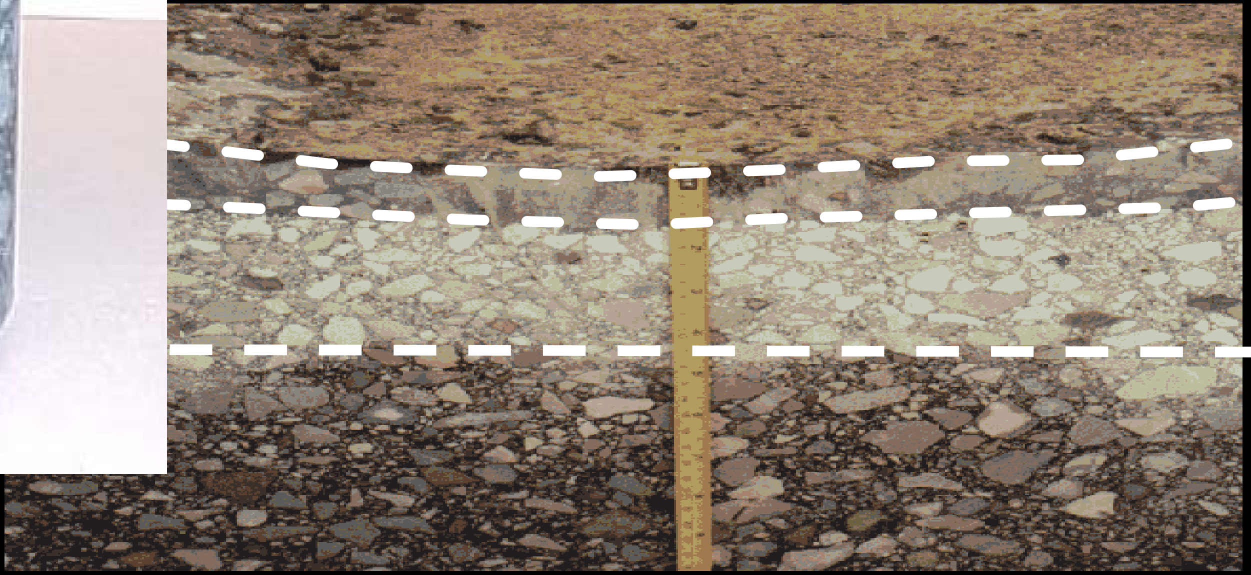
- Design the structure such that there are no deep structural distresses
  - Bottom up fatigue cracking
  - Structural rutting
- All distresses can be quickly remedied from surface
- Result in a structure with ‘Perpetual’ or ‘Long Life’



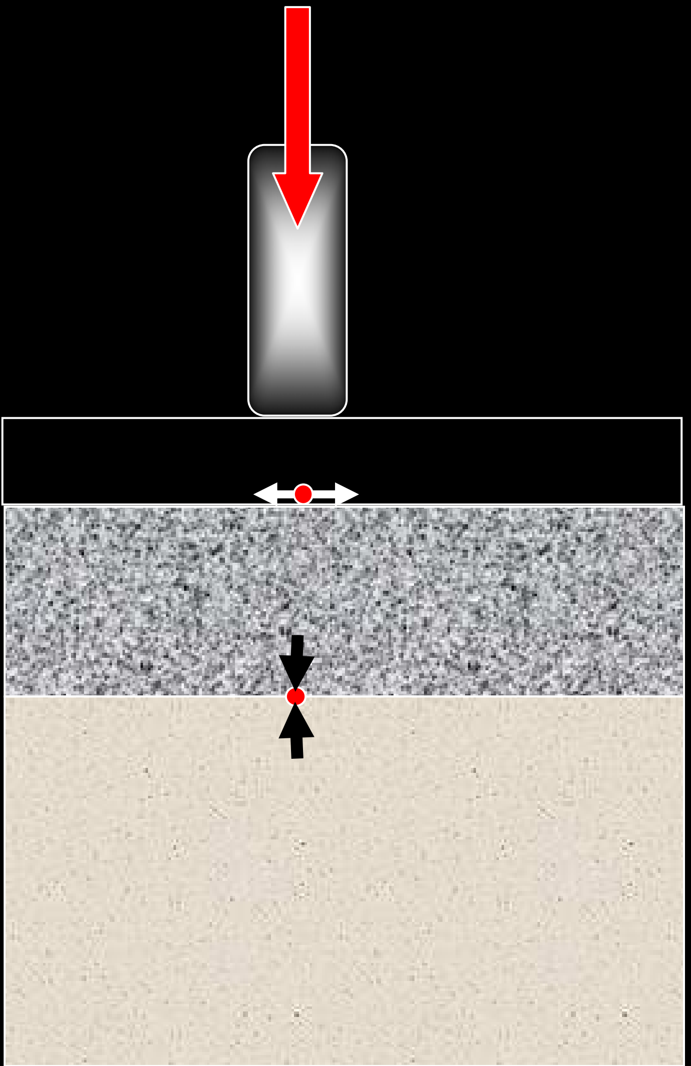
# Surface Distresses Only

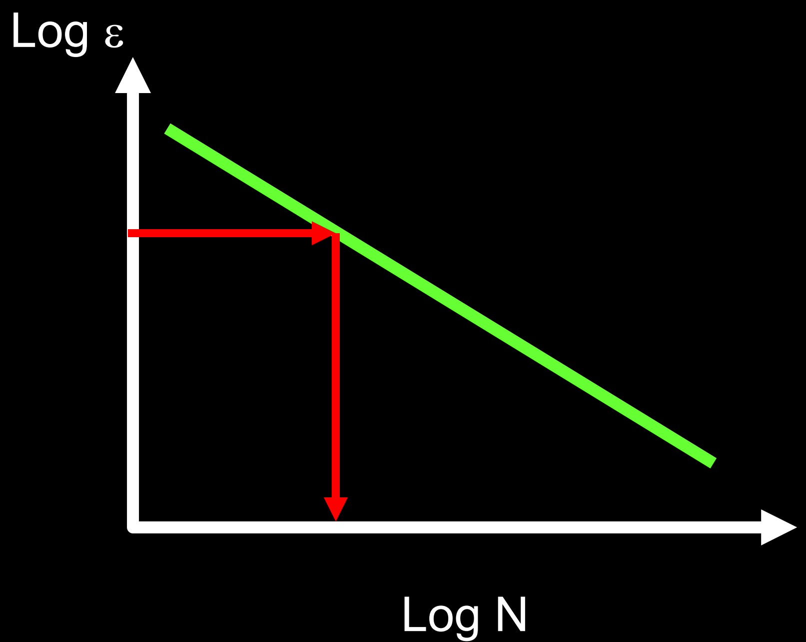
Top Down Cracking

Non-Structural Rutting



# M-E Design Fundamentals

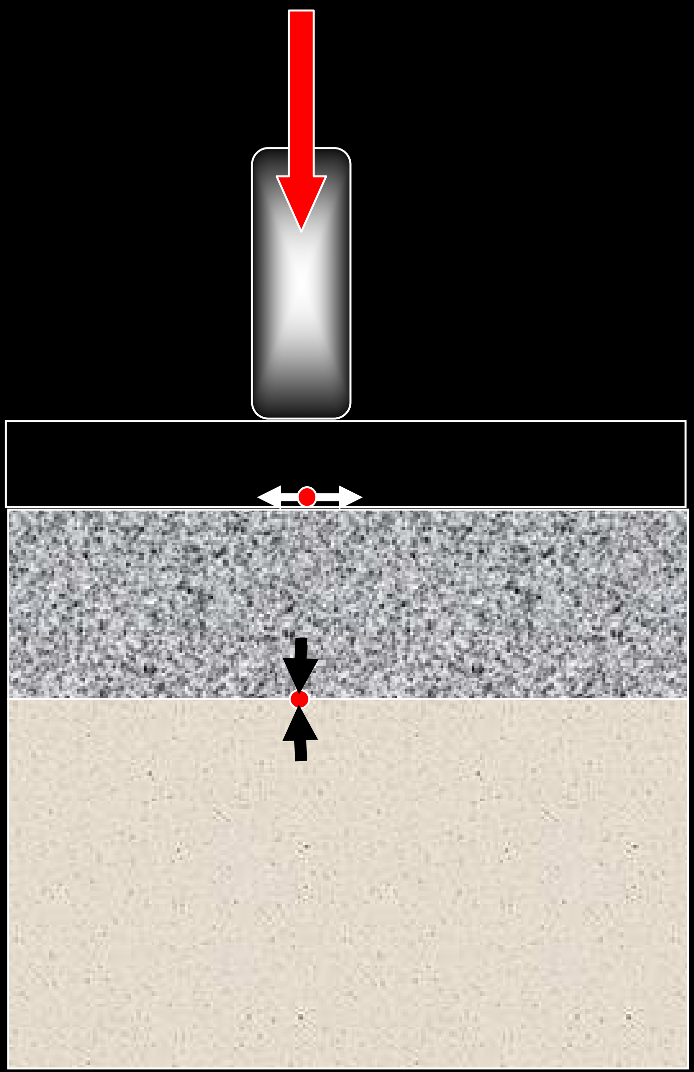


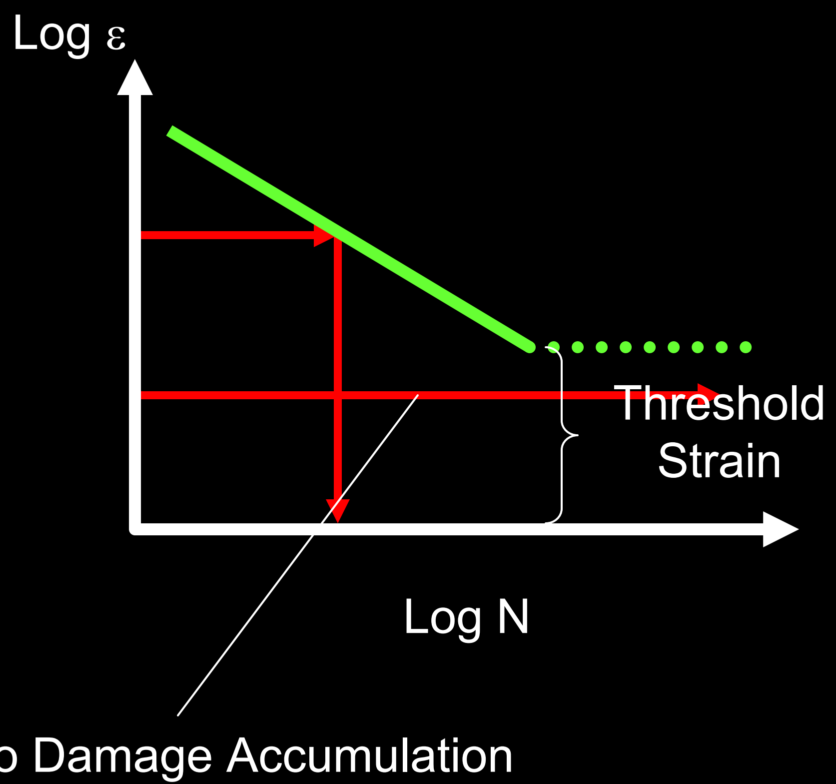



Miner's Hypothesis

$$D = \sum \frac{n}{N}$$

# M-E Perpetual Pavement Design






Miner's Hypothesis

$$D = \sum \frac{n}{N}$$

# Similarities Between PerRoad and MEDPG

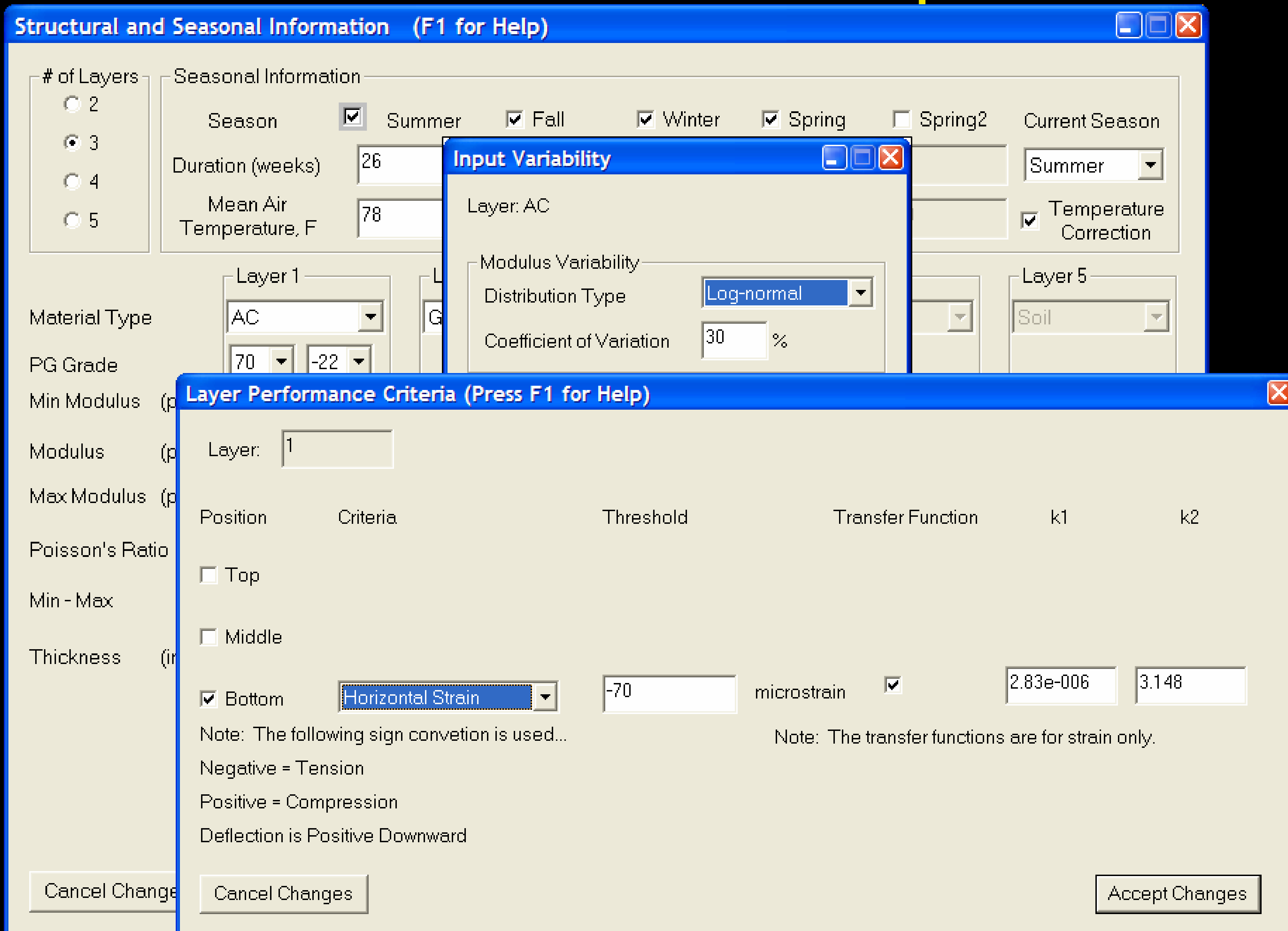
- Both use layered elastic analysis
  - PerRoad: WESLEA
  - MEPDG: JULEA
- Both use load spectra
- Both simulate seasonal effects
- Both can incorporate endurance limit
- Both predict specific modes of distress
  - Strain-based transfer functions

*The differences are in the level of complexity*

# Key Differences Between PerRoad and MEPDG

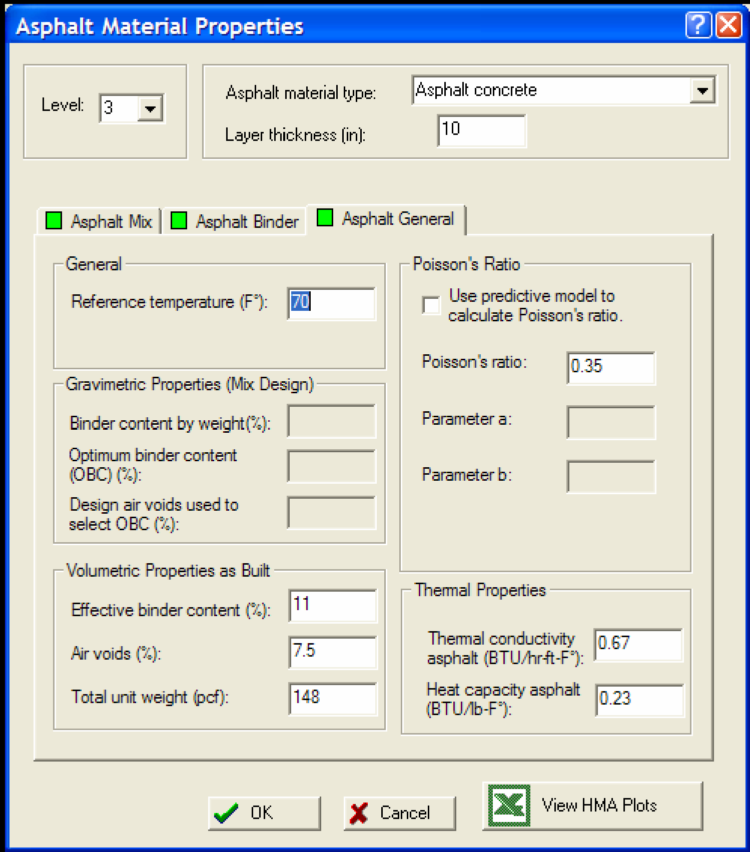
- Treatment of reliability
  - MEPDG: reliability applied after prediction of average pavement distresses
  - PerRoad: reliability modeled using Monte Carlo simulation that considers input variability
- Computer run time
  - MEPDG: > 40 minutes
  - PerRoad: < 3 minutes
- Selection of endurance limits
  - MEPDG: bottom-up fatigue in AC only
  - PerRoad: User-defined at top, mid and bottom of any layer

# PerRoad Structural Inputs



# MEPDG Structural Inputs

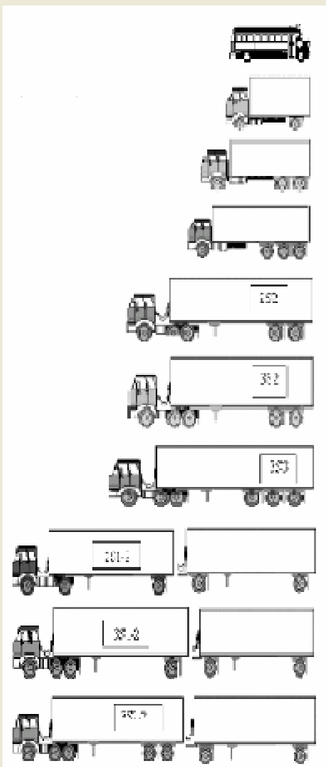
- Required inputs depend on level of design
- Ultimately, modulus of each layer is determined
- Examples of asphalt input data…
  - E* (frequency, temperature)
  - G* (temperature)
  - Mixture volumetrics
  - Thermal conductivity
  - Heat capacity
  - Surface shortwave absorptivity



# PerRoad Traffic

**Vehicle Type Distribution (Press F1 for Help)**

Roadway Functional Classification: Rural Interstate



| Vehicle Classification | % AADTT | Single | Tandem | Tridem |
|---|---|---|---|---|
| | | Average Number of Axles Per Vehicle | | |
| 4 | 1.2 | 1.62 | 0.39 | 0 |
| 5 | 9.4 | 2 | 0 | 0 |
| 6 | 3.3 | 1.02 | 0.99 | 0 |
| 7 | 0.5 | 1 | 0.26 | 0.83 |
| 8 | 7.4 | 2.38 | 0.67 | 0 |
| 9 | 68.9 | 1.13 | 1.93 | 0 |
| 10 | 1.2 | 1.19 | 1.09 | 0.89 |
| 11 | 6.1 | 4.29 | 0.26 | 0.06 |
| 12 | 0.8 | 3.52 | 1.14 | 0.06 |
| 13 | 1.2 | 2.15 | 2.13 | 0.35 |
| Total | 100 | | | |

Cancel Changes | Accept Changes

Input Load Spectra by Vehicle Type

Current Configuration: Single

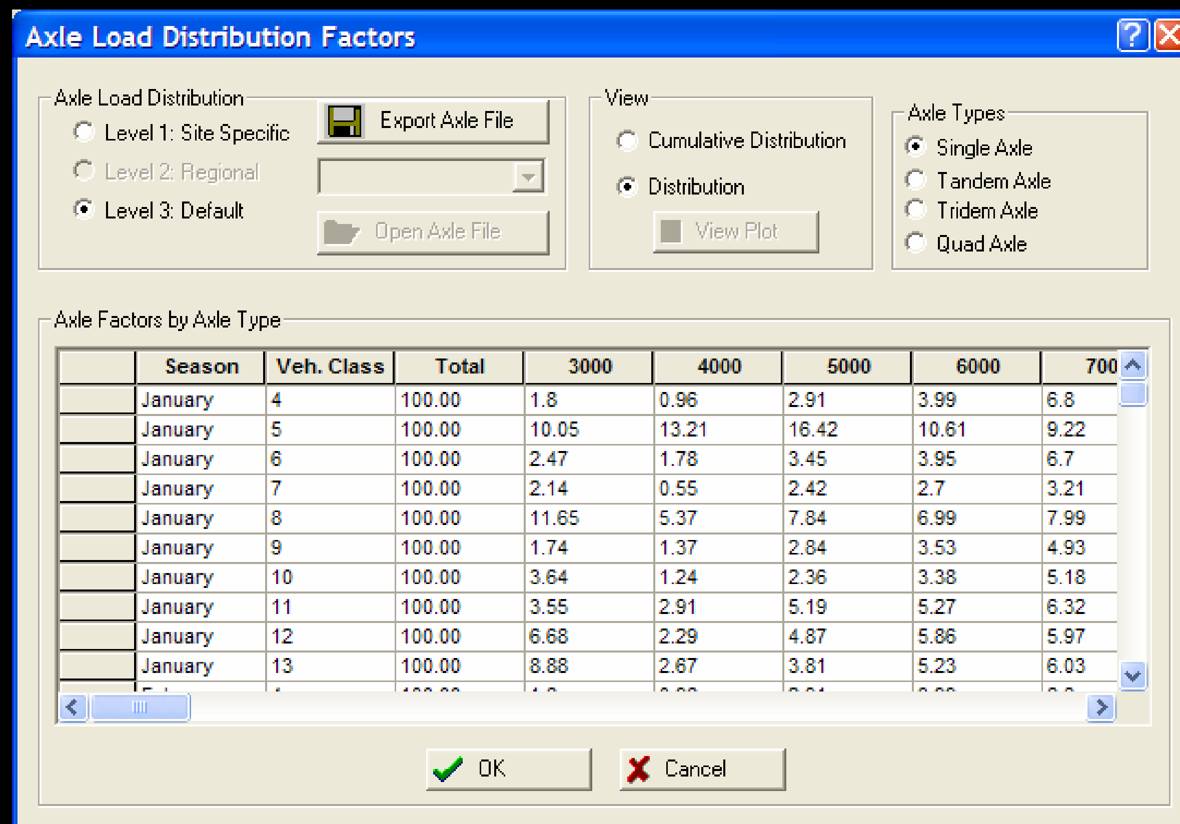
| | % Axles |
|---|---|
| 98 | 0 |
| 00 | 0 |
| 02 | 0 |
| 04 | 0 |
| 06 | 0 |
| 08 | 0 |
| 10 | 0 |
| 0+ | 0 |
| tal | 100 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 22-24 | 0.68 | 46-48 | 0 | 70-72 | 0 | 94-96 | 0 |

Cancel Changes | Import Load Spectra | Save Load Spectra | Accept Changes

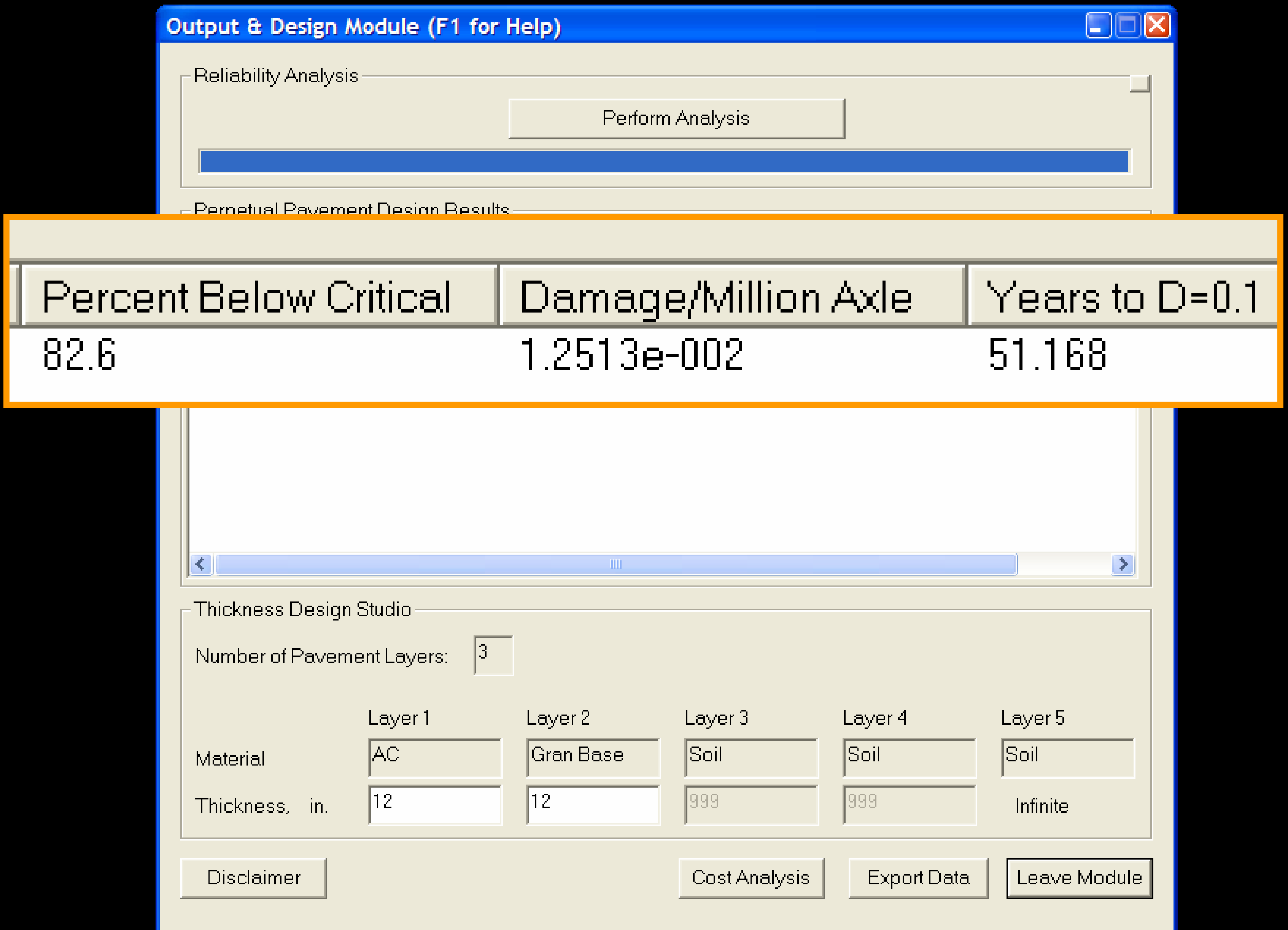
# MEPDG Traffic

- Very detailed traffic characterization
  - Monthly adjustments
  - Daily adjustments
  - Tire spacings and placement

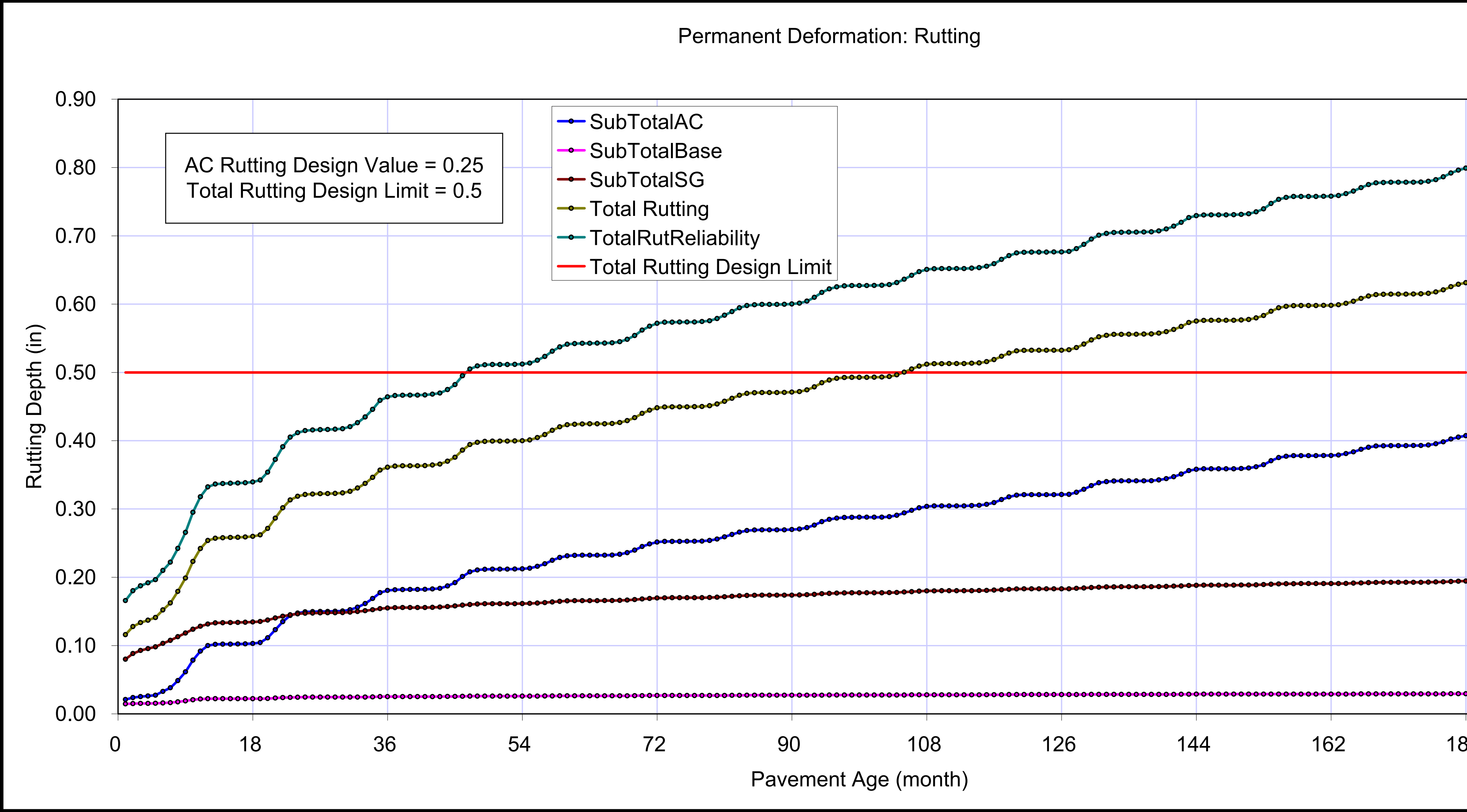



| | Season | Veh. Class | Total | 3000 | 4000 | 5000 | 6000 | 700 |
|---|---|---|---|---|---|---|---|---|
| | January | 4 | 100.00 | 1.8 | 0.96 | 2.91 | 3.99 | 6.8 |
| | January | 5 | 100.00 | 10.05 | 13.21 | 16.42 | 10.61 | 9.22 |
| | January | 6 | 100.00 | 2.47 | 1.78 | 3.45 | 3.95 | 6.7 |
| | January | 7 | 100.00 | 2.14 | 0.55 | 2.42 | 2.7 | 3.21 |
| | January | 8 | 100.00 | 11.65 | 5.37 | 7.84 | 6.99 | 7.99 |
| | January | 9 | 100.00 | 1.74 | 1.37 | 2.84 | 3.53 | 4.93 |
| | January | 10 | 100.00 | 3.64 | 1.24 | 2.36 | 3.38 | 5.18 |
| | January | 11 | 100.00 | 3.55 | 2.91 | 5.19 | 5.27 | 6.32 |
| | January | 12 | 100.00 | 6.68 | 2.29 | 4.87 | 5.86 | 5.97 |
| | January | 13 | 100.00 | 8.88 | 2.67 | 3.81 | 5.23 | 6.03 |

# PerRoad Output



# MEPDG Output

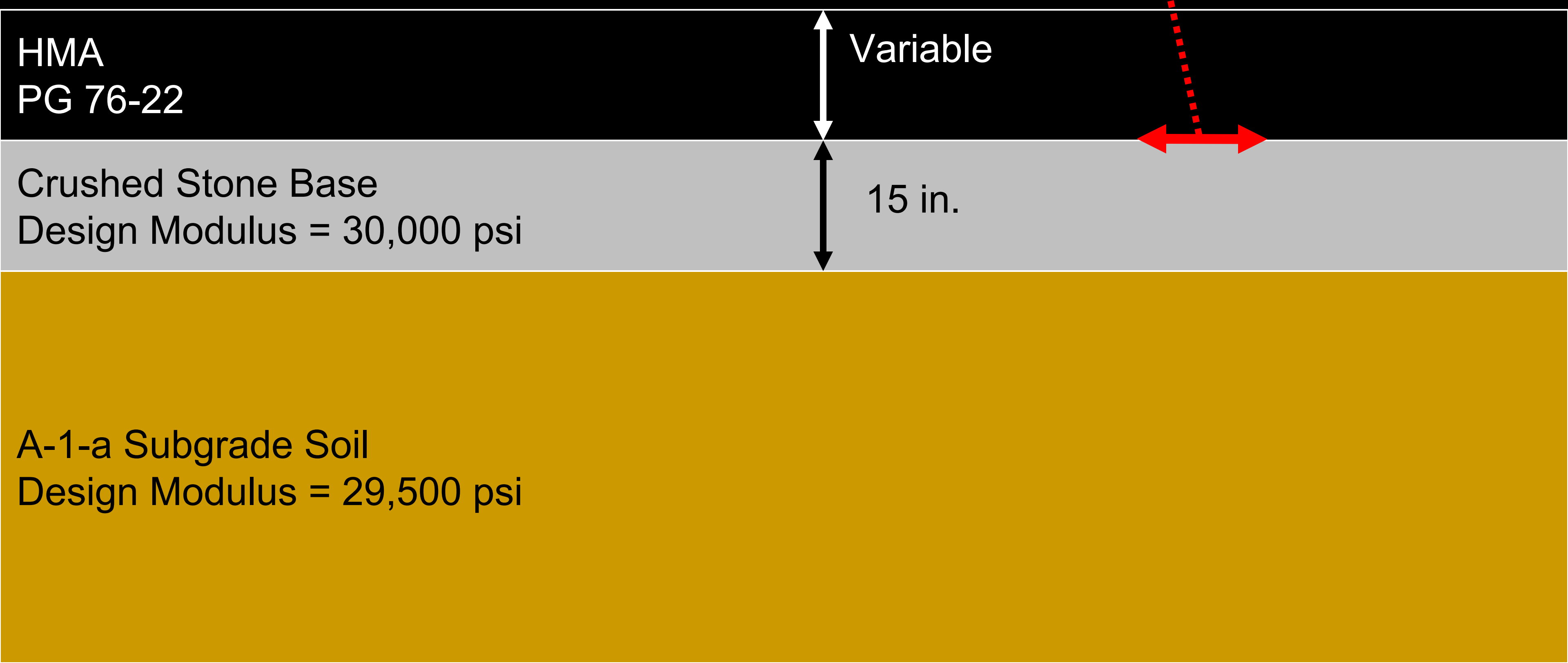


# Design Comparison

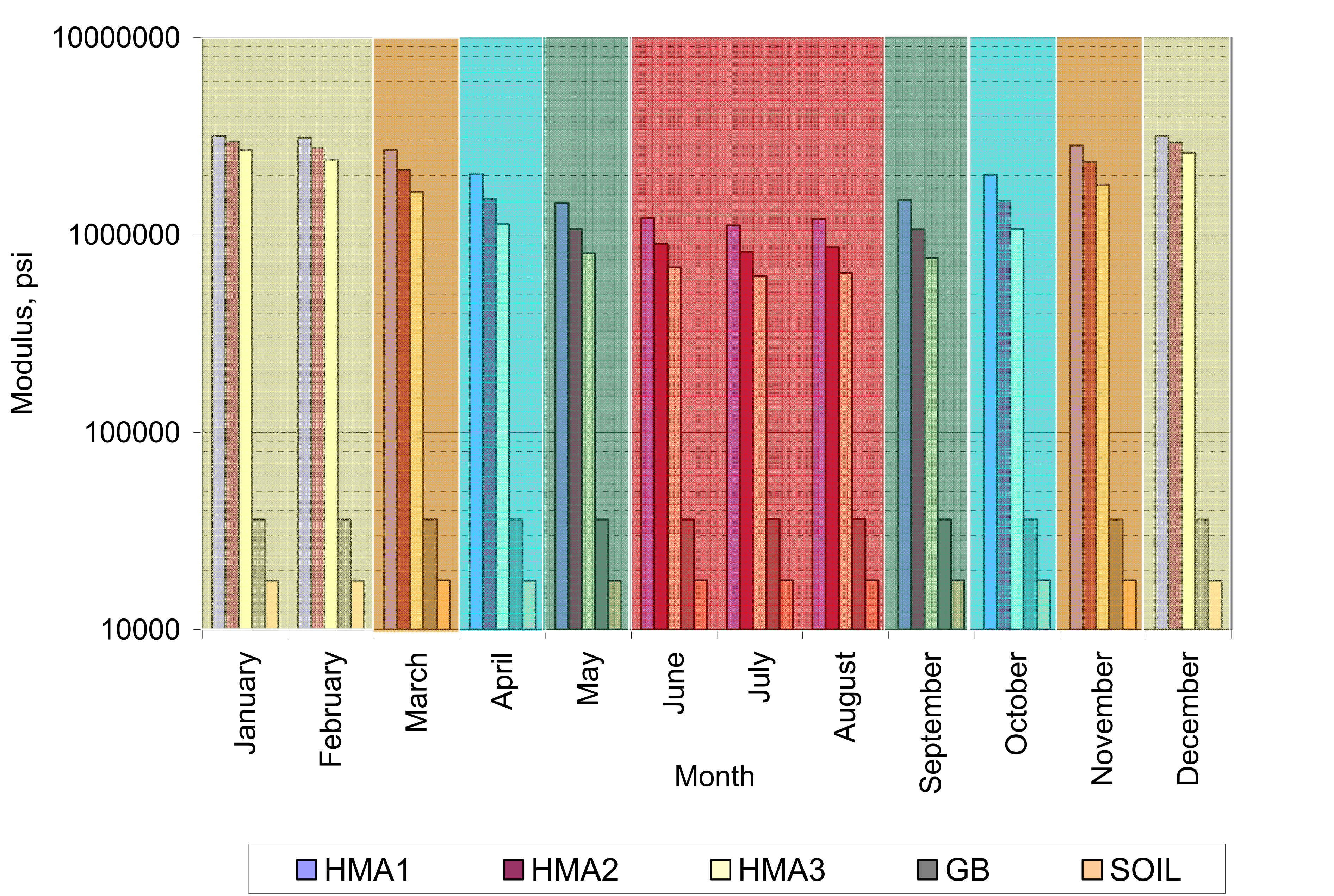
- 40 yr. design period
- Fatigue analysis only
- 4500 AADTT
- 4% Growth
- Load Spectra = MEPDG Default
- Alabama Climate
- Level 3 input parameters
- Alabama Climate

**4 Thresholds**

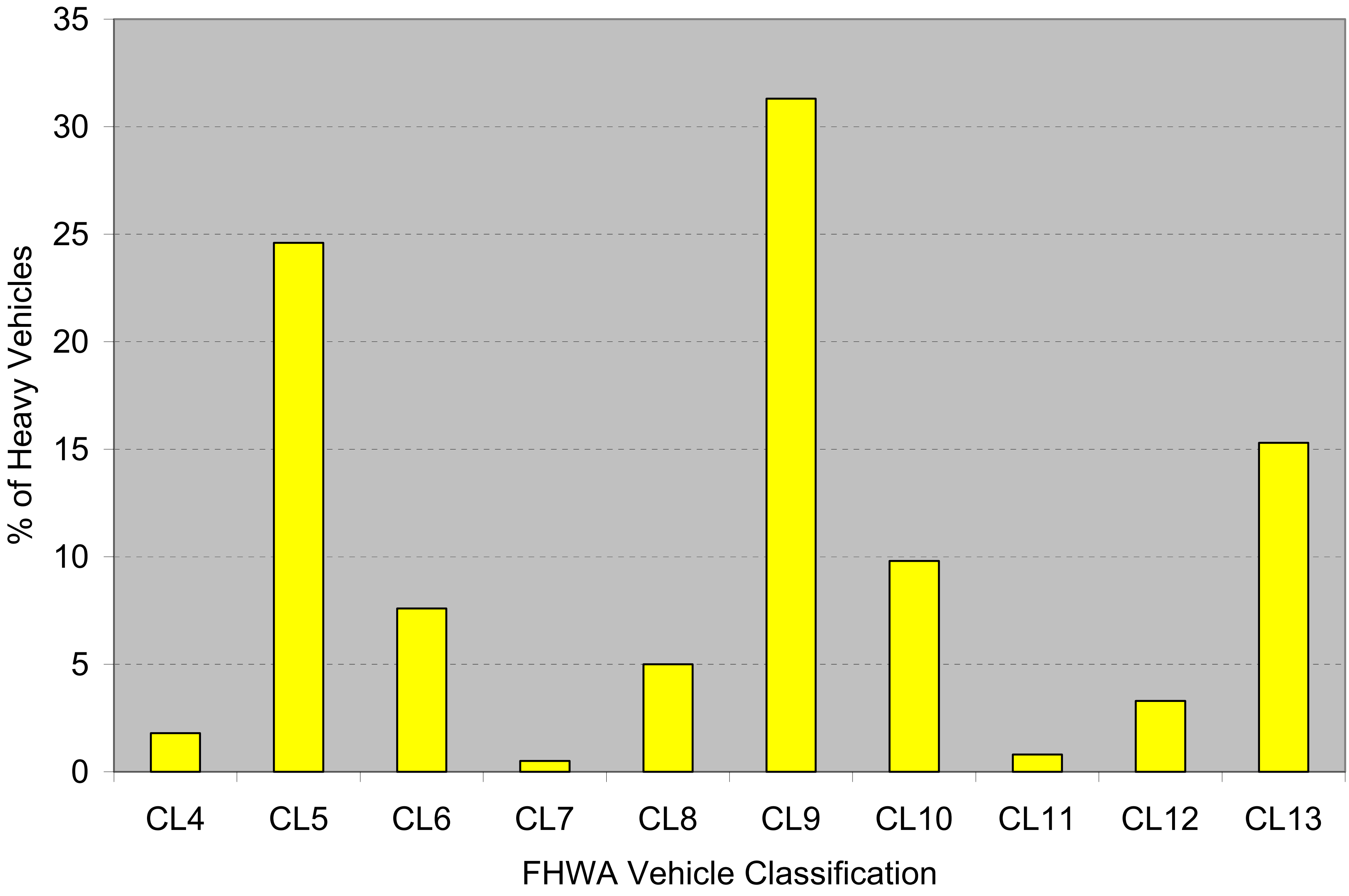
**0** με
70 με
100 με
200 με



# Seasonal Layer Moduli



# Traffic



35
30
25
20
15
10
5
0
% of Heavy Vehicles
CL4
CL5
CL6
CL7
CL8
CL9
CL10
CL11
CL12
CL13
FHWA Vehicle Classification

# MEPDG Transfer Function

- Calibrated to specific level of pavement damage

$$N_f = 0.00432 * C * 0.007566 * \left(\frac{1}{\varepsilon_t}\right)^{3.9492} \left(\frac{1}{E}\right)^{1.281}$$

$$C = 10^M$$

$$M = 4.84\left[\frac{Vb}{Va + Vb} - 0.69\right]$$

$$FC = \left(\frac{1}{60}\right)\left[\frac{6000}{1 + e^{C_1 * C_1' + C_2 * C_2' \log(D)}}\right]$$

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

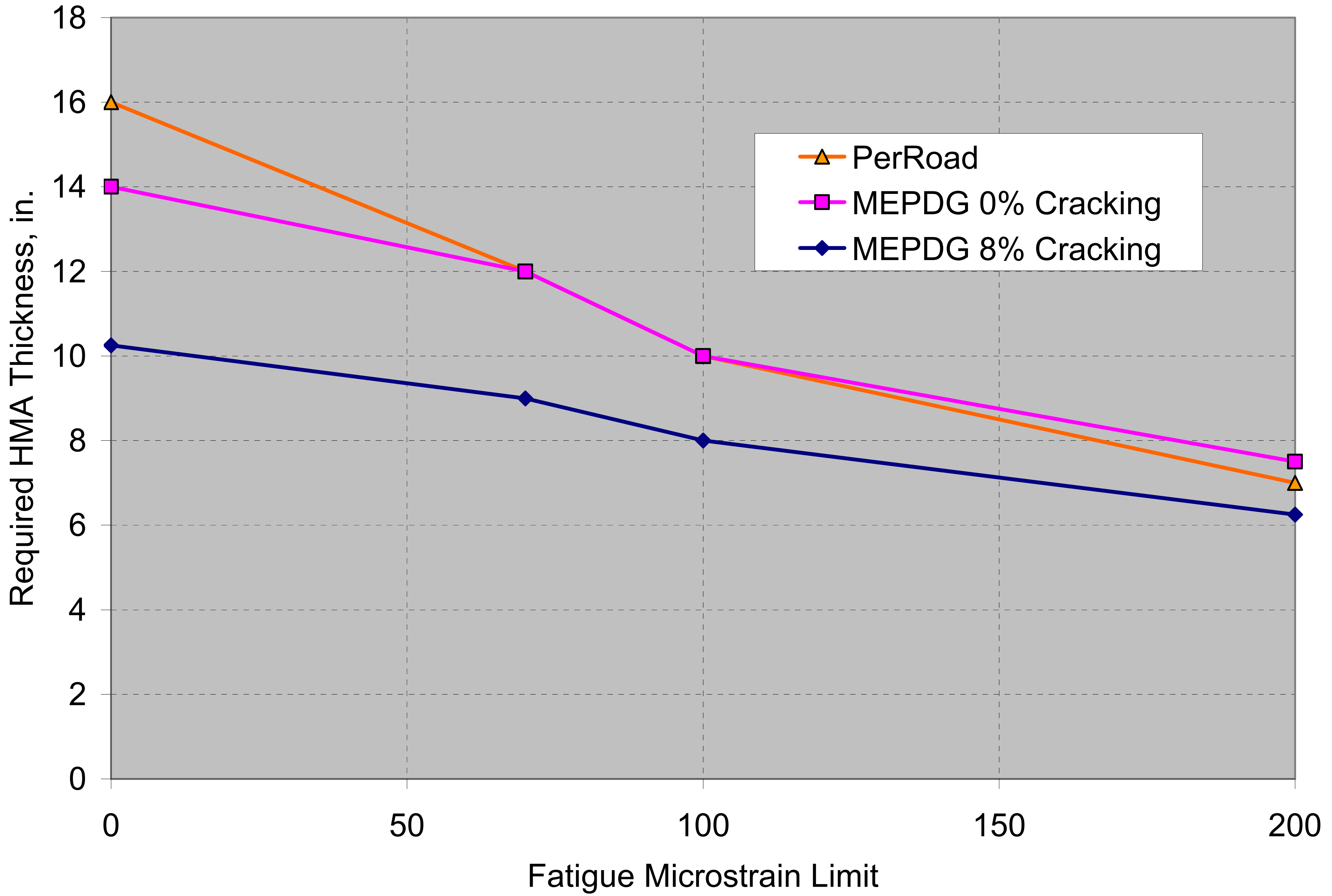
***Designed to two levels of fatigue damage***
***8%***
***0%***

# PerRoad Transfer Function

- Calibrated to crack initiation
- Pavement Designed to D = 0.1 (0% Cracking)

$$N_f = 2.83 * 10^{-6} \left( \frac{1}{\varepsilon_t} \right)^{3.148}$$

# Results



PerRoad
MEPDG 0% Cracking
MEPDG 8% Cracking
Required HMA Thickness, in.
18
16
14
12
10
8
6
4
2
0
0
50
100
150
200
Fatigue Microstrain Limit

# Summary and Conclusions

- MEPDG and PerRoad share common design philosophy
  - Differences lie in…
    - Level of complexity
    - Handling of reliability
    - Calibration data set
- MEPDG can handle flexible and rigid M-E design
- PerRoad intended for long-life flexible M-E design
- Despite differences, both programs can arrive at similar design thicknesses


Thank You!