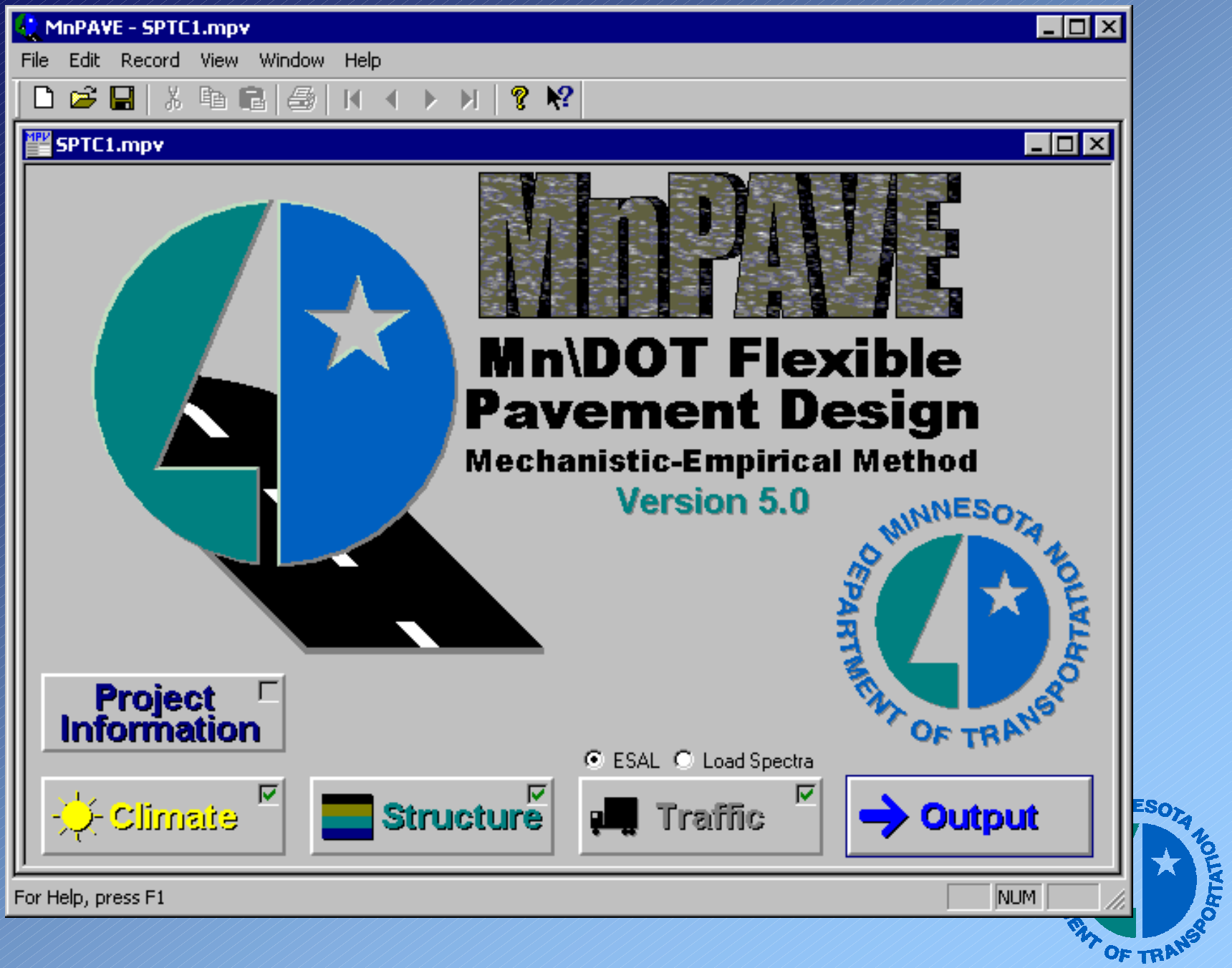
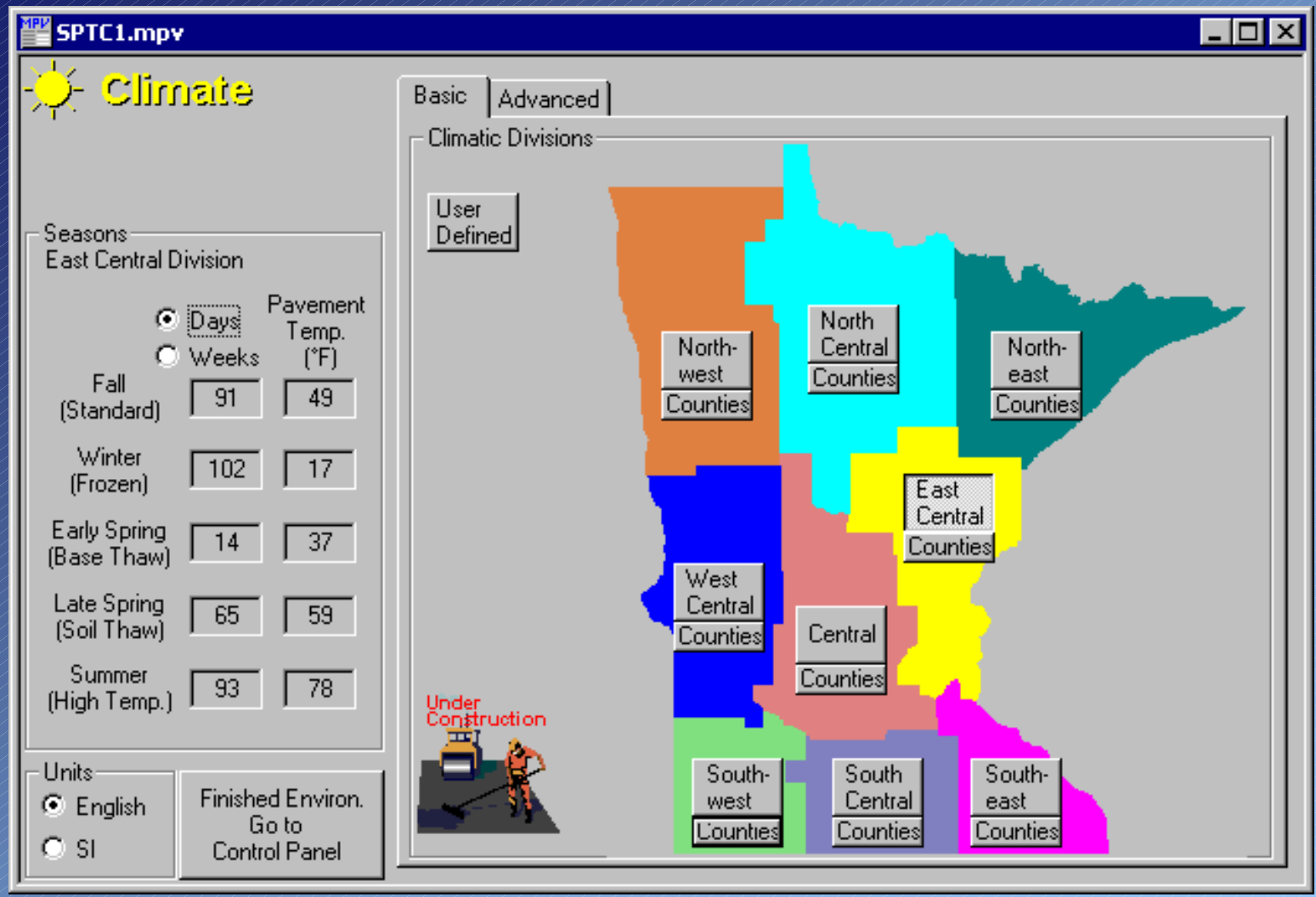
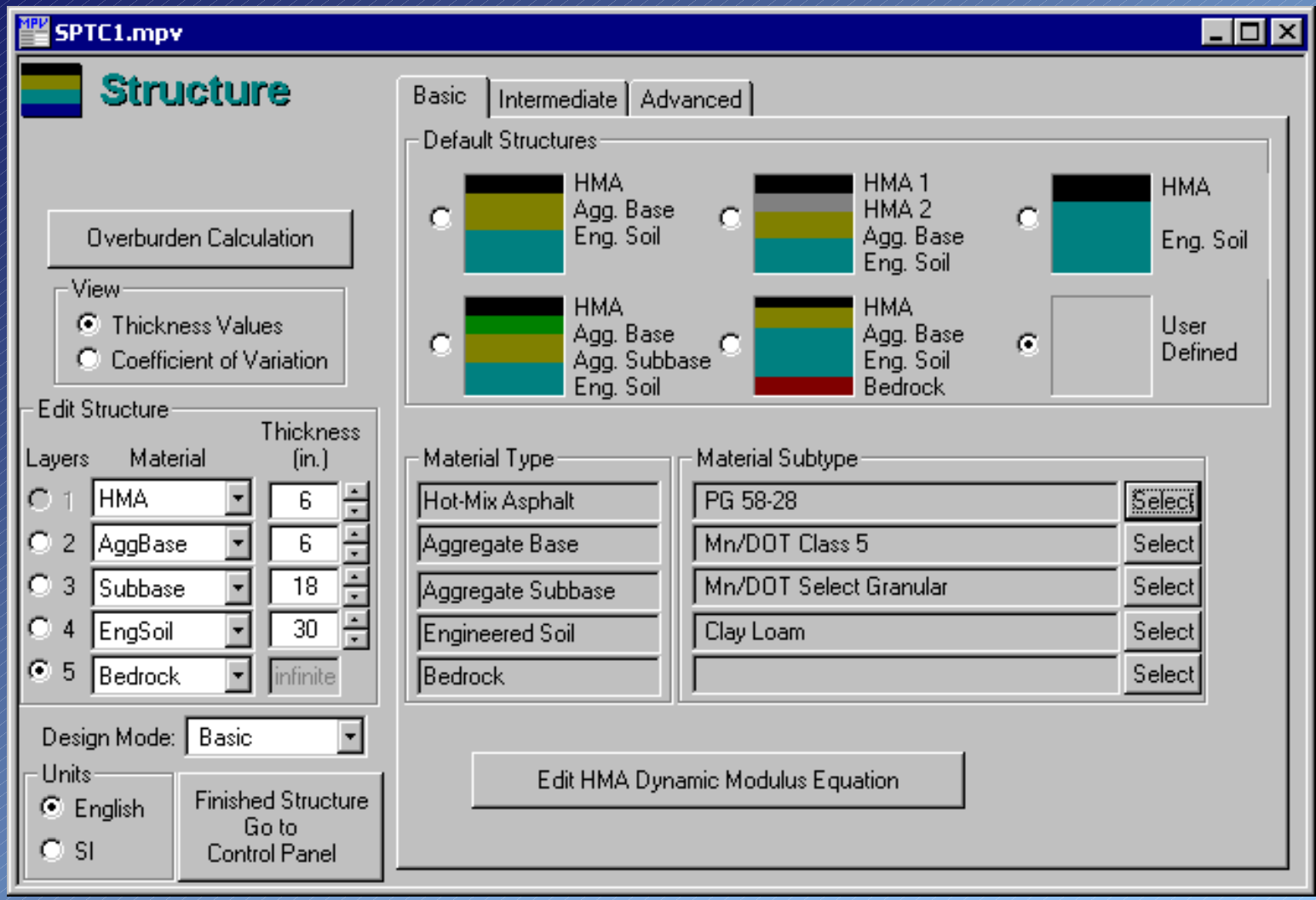

MnPAVE - SPTC1.mpv
File Edit Record View Window Help
SPTC1.mpv
MnPAVE
Mn\DOT Flexible Pavement Design
Mechanistic-Empirical Method
Version 5.0
MINNESOTA DEPARTMENT OF TRANSPORTATION
Project Information
ESAL
Load Spectra
Climate
Structure
Traffic
Output
For Help, press F1
NUM



MINNESOTA DEPARTMENT OF TRANSPORTATION



MINNESOTA DEPARTMENT OF TRANSPORTATION

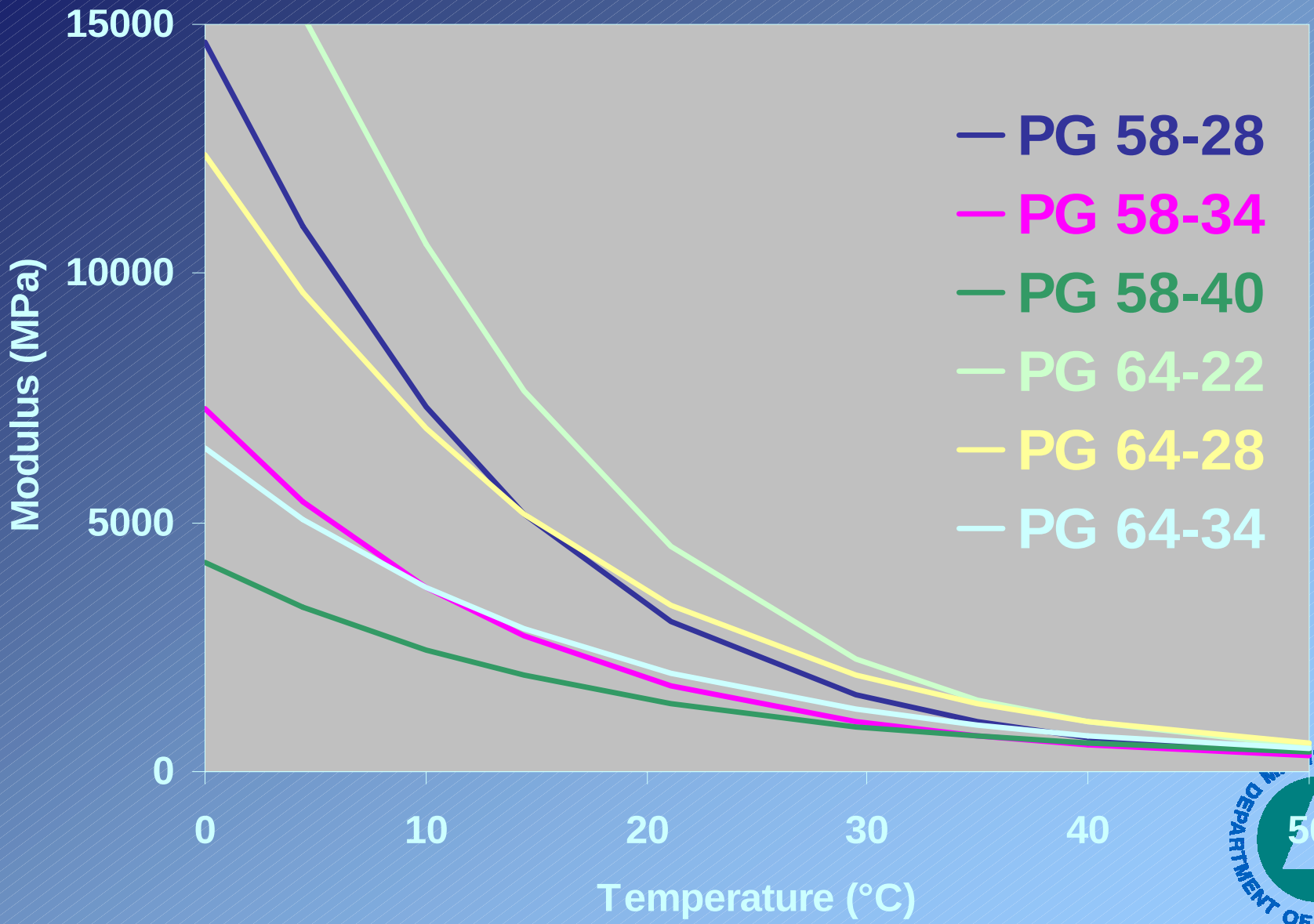
Witczak's Dynamic Modulus Equation

- Binder viscosity
- Effective binder content
- Aggregate gradation
- Loading frequency

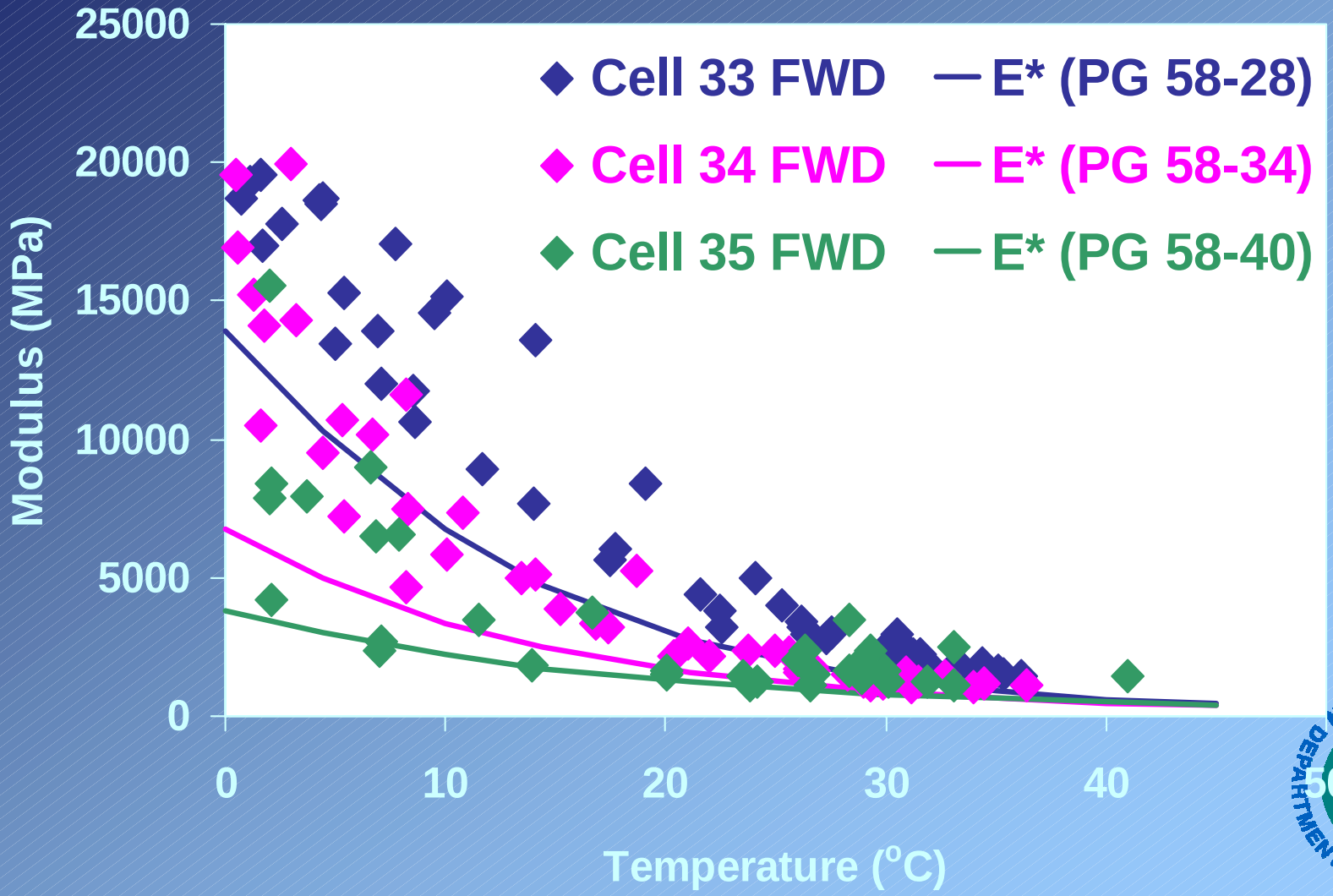
$$\log E = a_0 + a_1 p_{200} + a_2 \left(p_{200}\right)^2 + a_3 p_4 + a_4 V_a + a_5 \frac{V_{beff}}{V_{beff} + V_a}$$

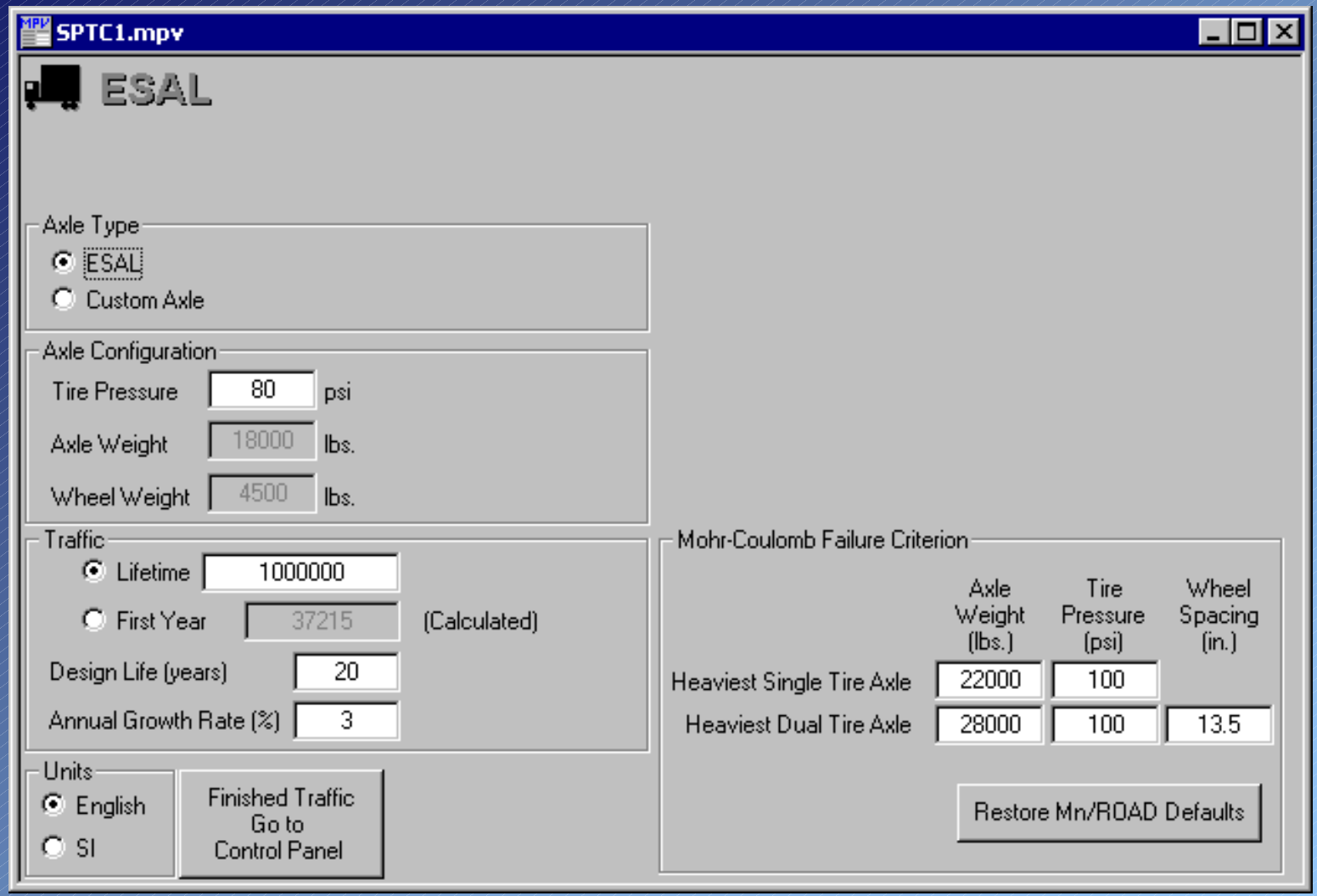
$$+ \frac{a_6 + a_7 p_4 + a_8 p_{3/8} + a_9 \left(p_{3/8}\right)^2 + a_{10} p_{3/4}}{1 + e^{\left(a_{11} + a_{12} \log f + a_{13} 2 \log \eta\right)}}$$

Calculated HMA Dynamic Modulus

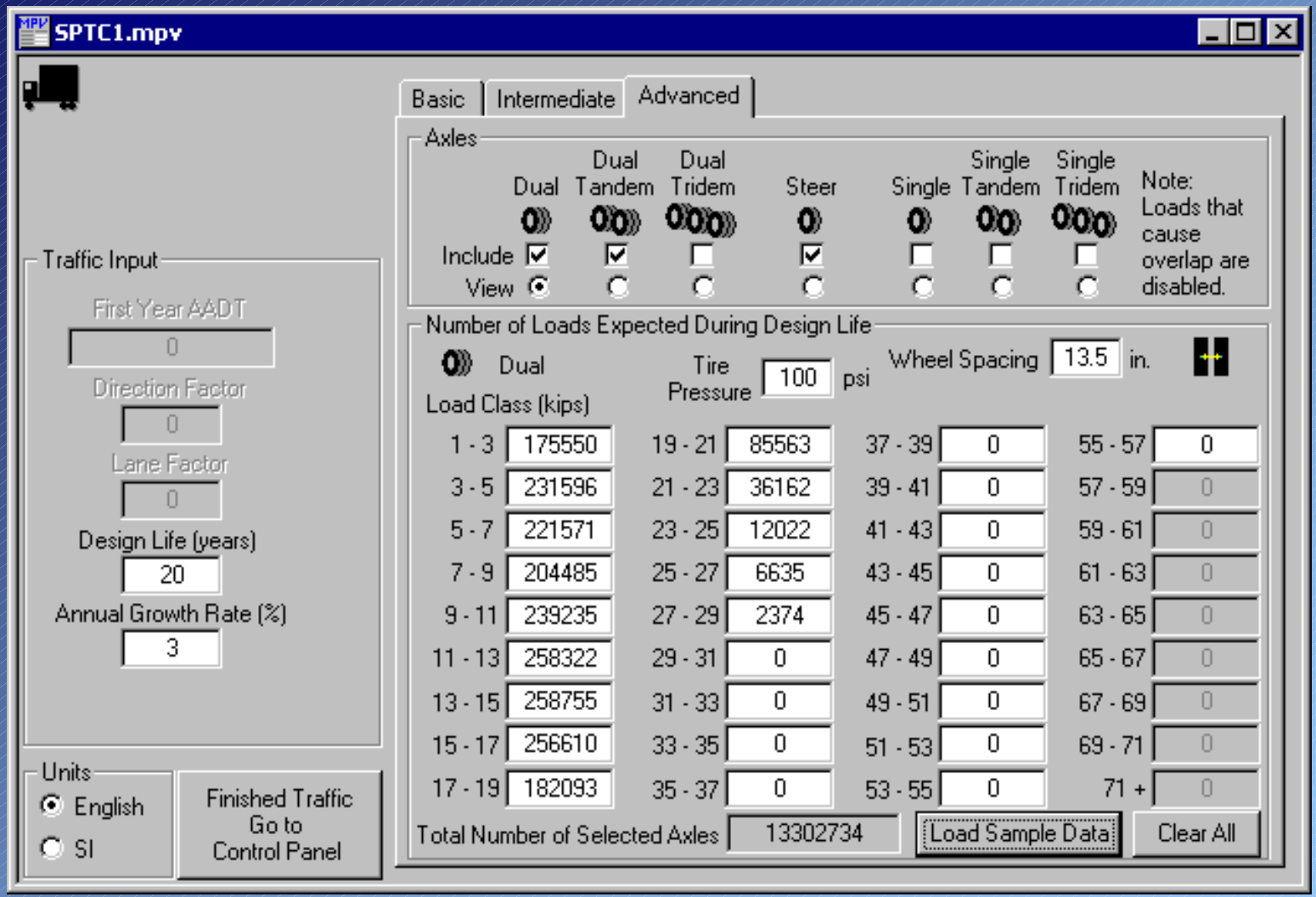


Backcalculated Modulus vs. Witczak Dynamic Modulus

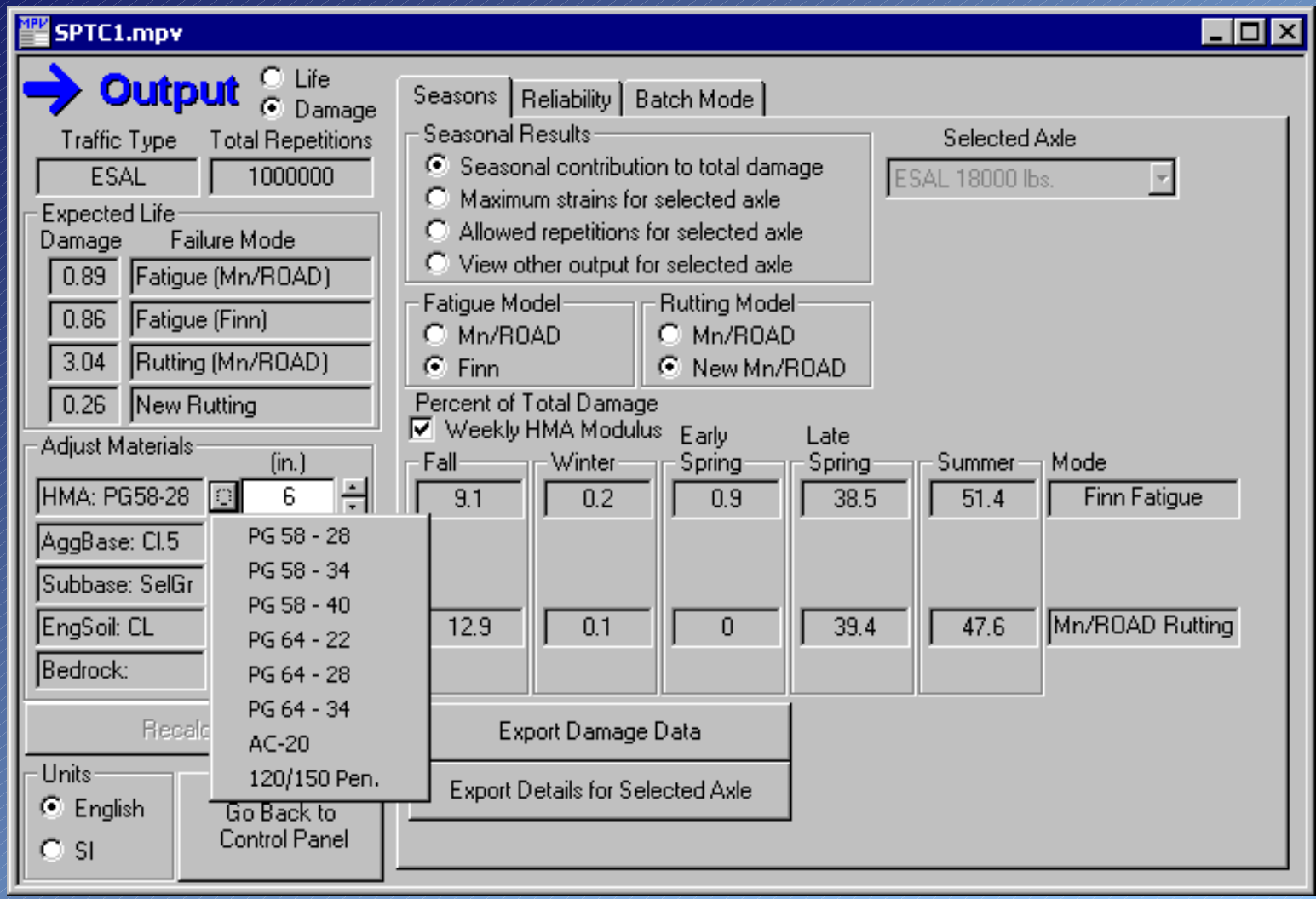


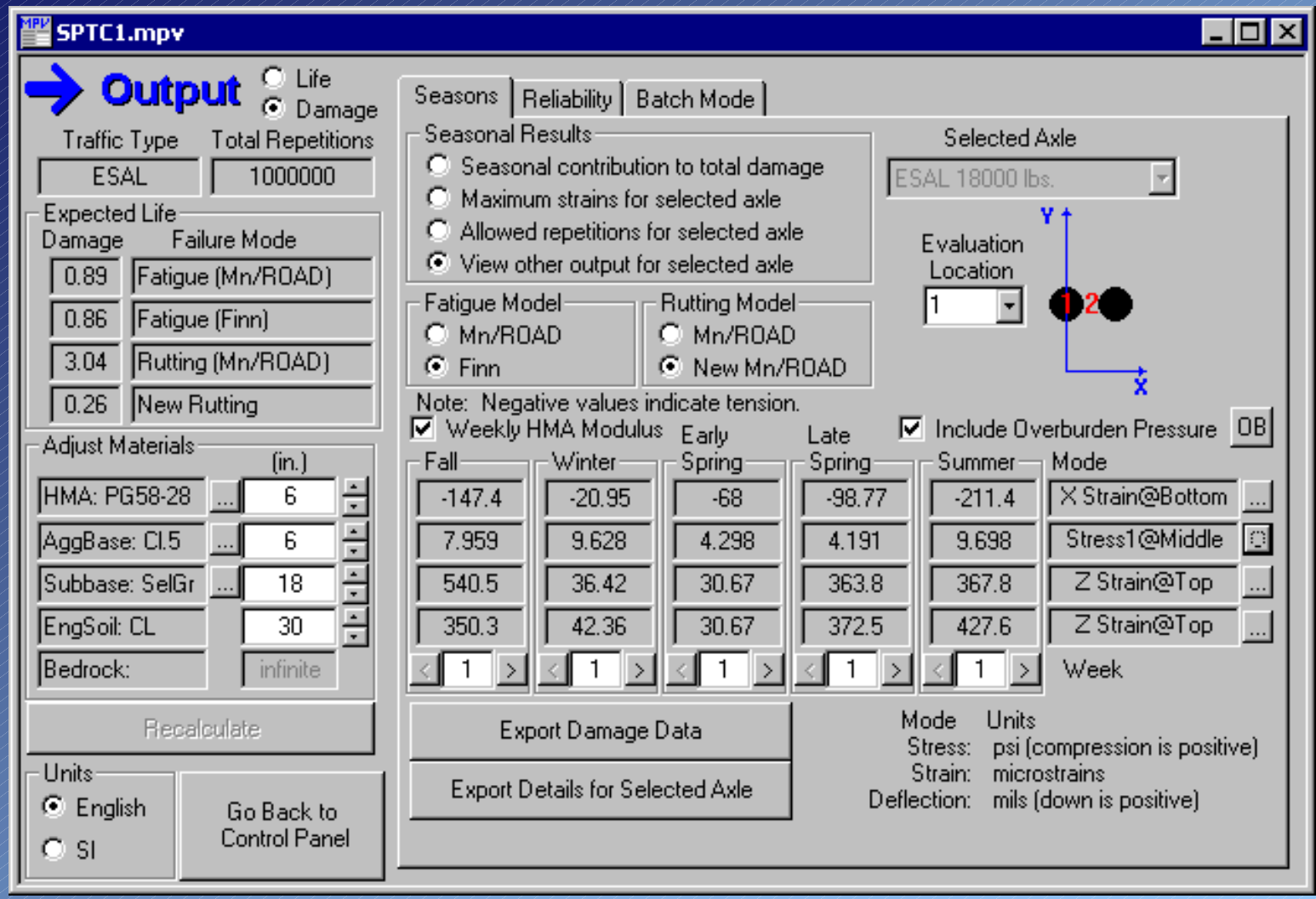


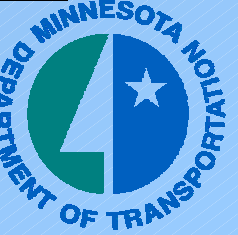
MINNESOTA DEPARTMENT OF TRANSPORTATION



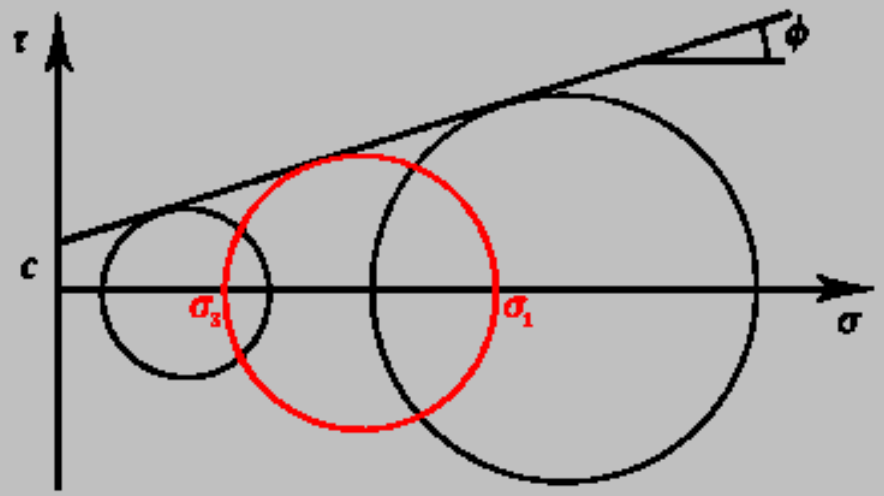
MINNESOTA DEPARTMENT OF TRANSPORTATION


SPTC1.mpv
Output
Life
Damage
Traffic Type
ESAL
Total Repetitions
1000000
Expected Life
Damage
Failure Mode
0.89
Fatigue (Mn/ROAD)
0.86
Fatigue (Finn)
3.04
Rutting (Mn/ROAD)
0.26
New Rutting
Adjust Materials
(in.)
HMA: PG58-28
6
AggBase: Cl.5
Subbase: SelGr
EngSoil: CL
Bedrock:
PG 58 - 28
PG 58 - 34
PG 58 - 40
PG 64 - 22
PG 64 - 28
PG 64 - 34
AC-20
120/150 Pen.
Units
English
SI
Go Back to Control Panel
Seasons
Reliability
Batch Mode
Seasonal Results
Seasonal contribution to total damage
Maximum strains for selected axle
Allowed repetitions for selected axle
View other output for selected axle
Selected Axle
ESAL 18000 lbs.
Fatigue Model
Mn/ROAD
Finn
Rutting Model
Mn/ROAD
New Mn/ROAD
Percent of Total Damage
Weekly HMA Modulus
Fall
Winter
Early Spring
Late Spring
Summer
Mode
9.1
0.2
0.9
38.5
51.4
Finn Fatigue
12.9
0.1
0
39.4
47.6
Mn/ROAD Rutting
Export Damage Data
Export Details for Selected Axle


SPTC1.mpv
Output
Life
Damage
Traffic Type
ESAL
Total Repetitions
1000000
Expected Life
Damage
Failure Mode
0.89
Fatigue (Mn/ROAD)
0.86
Fatigue (Finn)
3.04
Rutting (Mn/ROAD)
0.26
New Rutting
Adjust Materials
(in.)
HMA: PG58-28
6
AggBase: CL5
6
Subbase: SelGr
18
EngSoil: CL
30
Bedrock:
infinite
Recalculate
Units
English
SI
Go Back to Control Panel
Seasons
Reliability
Batch Mode
Seasonal Results
Seasonal contribution to total damage
Maximum strains for selected axle
Allowed repetitions for selected axle
View other output for selected axle
Fatigue Model
Mn/ROAD
Finn
Rutting Model
Mn/ROAD
New Mn/ROAD
Selected Axle
ESAL 18000 lbs.
Evaluation Location
1
Y
X
1
2
Note: Negative values indicate tension.
Weekly HMA Modulus
Early
Late
Include Overburden Pressure
OB
Fall
Winter
Spring
Spring
Summer
Mode
-147.4
-20.95
-68
-98.77
-211.4
X Strain@Bottom
7.959
9.628
4.298
4.191
9.698
Stress1@Middle
540.5
36.42
30.67
363.8
367.8
Z Strain@Top
350.3
42.36
30.67
372.5
427.6
Z Strain@Top
1
1
1
1
1
Week
Export Damage Data
Export Details for Selected Axle
Mode
Units
Stress:
psi (compression is positive)
Strain:
microstrains
Deflection:
mils (down is positive)


MINNESOTA DEPARTMENT OF TRANSPORTATION

Mohr-Coulomb Criterion



OK

Cancel

Material: Mn/DOT Class 5

c 3.5 psi

ϕ 51 °

Restore Default Values

$$\sigma_1 < \sigma_{1\,critical} = \sigma_3 \times \tan^2\left(45 + \frac{\phi}{2}\right) + 2c \times \tan\left(45 + \frac{\phi}{2}\right)$$

Where:

$\sigma_{1\,critical}$ = Maximum allowed stress at middle of aggregate base

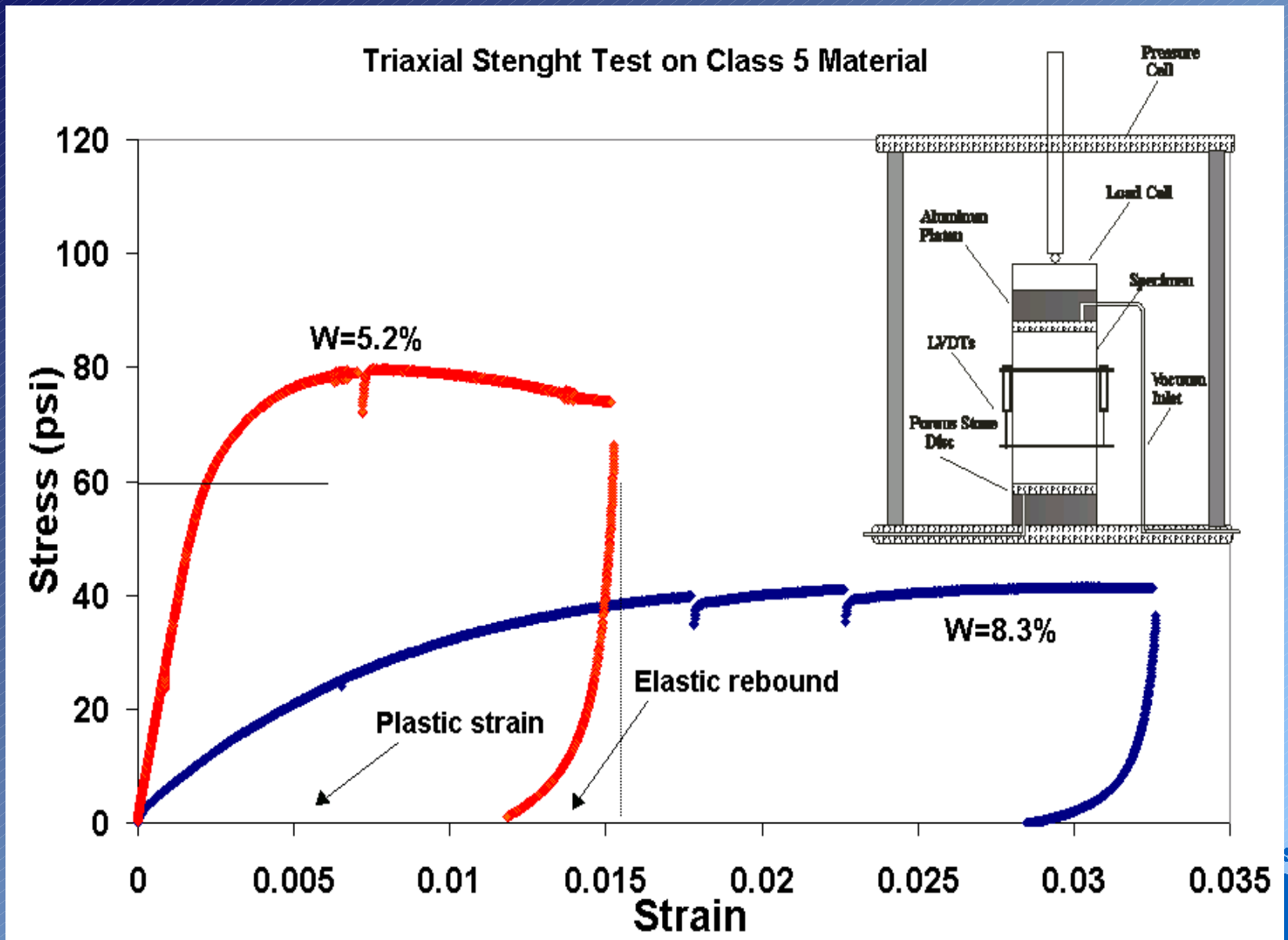
σ_1, σ_3 = Principal stresses due to maximum axle load

ϕ = Friction angle of granular material (from triaxial test)

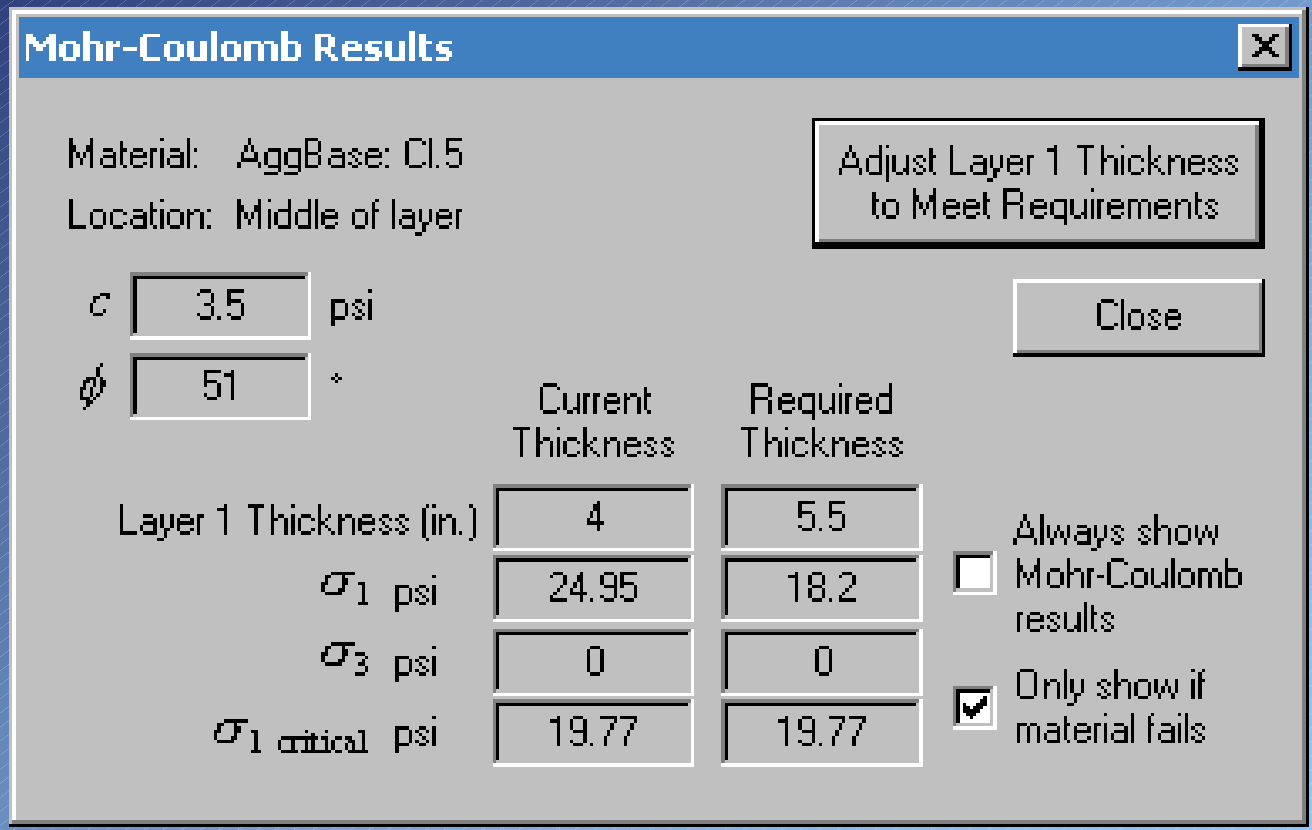
c = Cohesion of granular material (from triaxial test)

Note:
Currently all default values are derived from tests performed on Class 5 aggregate. Values for other materials will be added when testing is complete.

MINNESOTA DEPARTMENT OF TRANSPORTATION


Triaxial Stenght Test on Class 5 Material
Stress (psi)
120
100
80
60
40
20
0
0
0.005
0.01
0.015
0.02
0.025
0.03
0.035
Strain
W=5.2%
W=8.3%
Plastic strain
Elastic rebound
Pressure Cell
Load Cell
Aluminum Platen
Specimen
LVDTs
Vacuum Inlet
Porous Stone Disc

MnPAVE Mohr-Coulomb Results



- **Transfer Function Calibration**
  - **Compared MnPAVE with R-value design and Soil factor design methods: Current MnPAVE is conservative.**
  - **Simple calibration for rutting using MnROAD**

- **User Manual: Draft**

Future Work

- Continue calibration of transfer functions.
  - Should use Witczak's equation to calculate E* of bituminous mixture: binder effects

- **Improve the base and subgrade Mr table**
  - **MnROAD Cl5, Cl3, taconite tailings, MnROAD Subgrade soils.**
  - **Convert R-value to Mr using laboratory data.**

- **Implement Mohr-Coulomb failure criteria: prevent catastrophic failure**
  - **Obtain a minimum HMA thickness**

Timeframe

- User training — Oct. 2001
- Incorporate user feedback, calibrated MnPAVE — Feb 2002
- M-E design adopted as Mn/DOT's procedure — Dec 2002
- Evaluate AASHTO 2002, incorporate features as needed http://www.2002designguide.com/ — Dec 2003

Thank you.

- Questions?