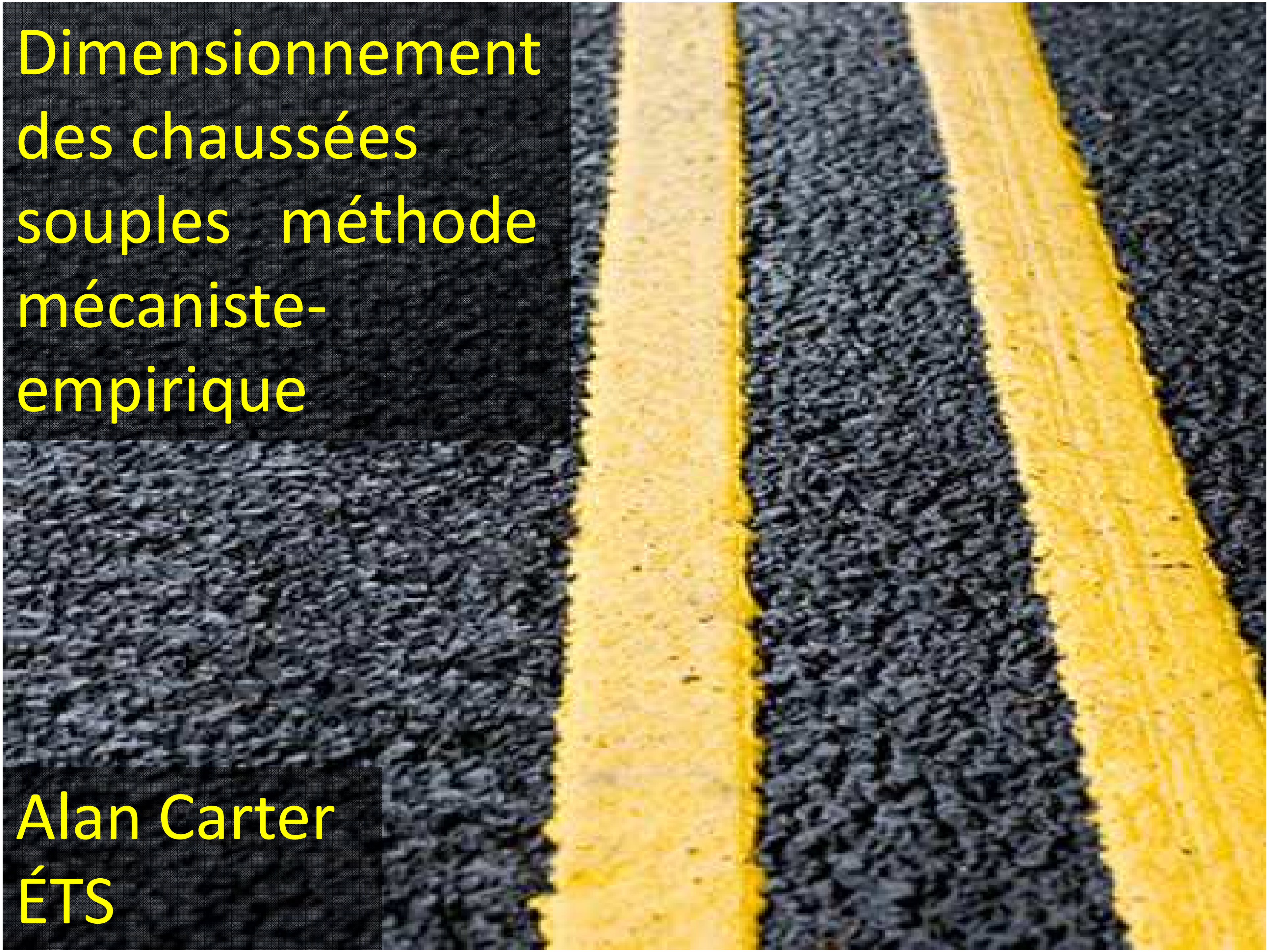
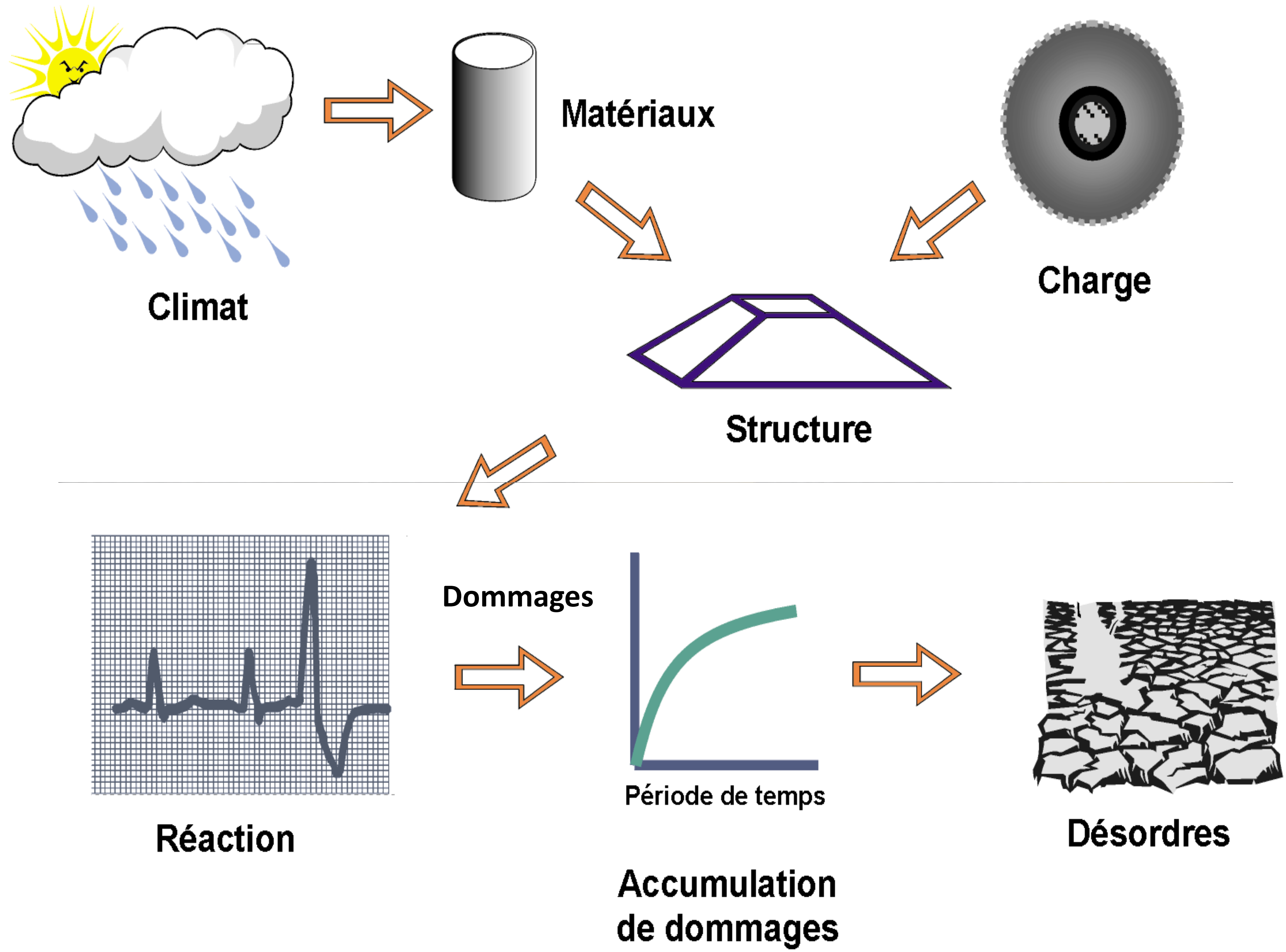


Dimensionnement des chaussées souples méthode mécaniste-empirique

Alan Carter
ÉTS

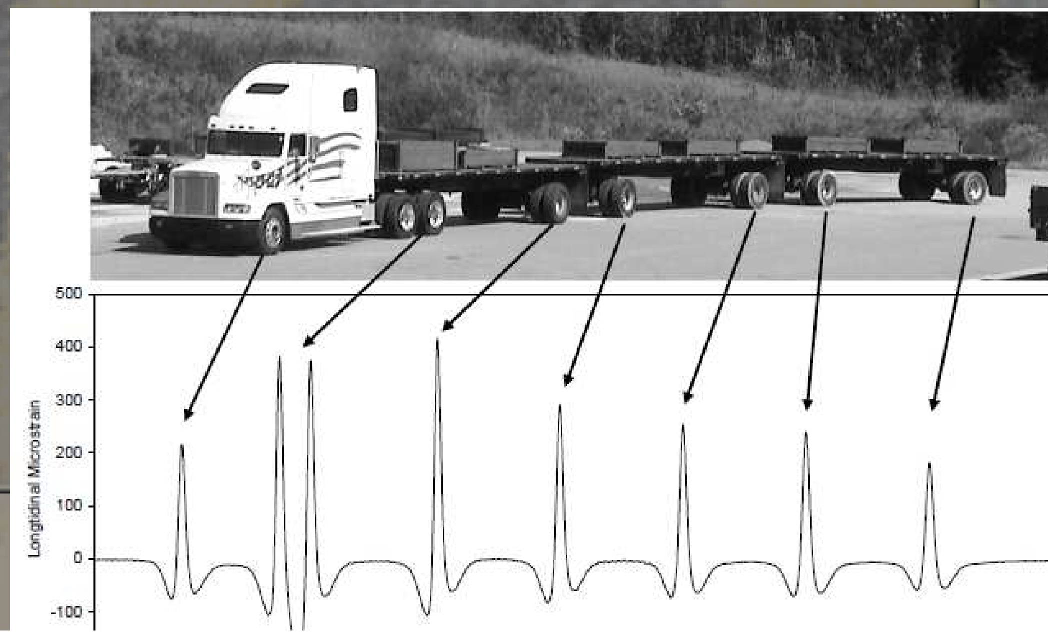
Plan de la présentation

- Qu’est qu’une méthode M-E
  - Définition
  - Justification
- MEPDG
  - Historique
  - Principaux points à considérer
- Exemple avec nos données
- Conclusion


Matériaux
Climat
Charge
Structure
Dommages
Période de temps
Réaction
Désordres
Accumulation de dommages

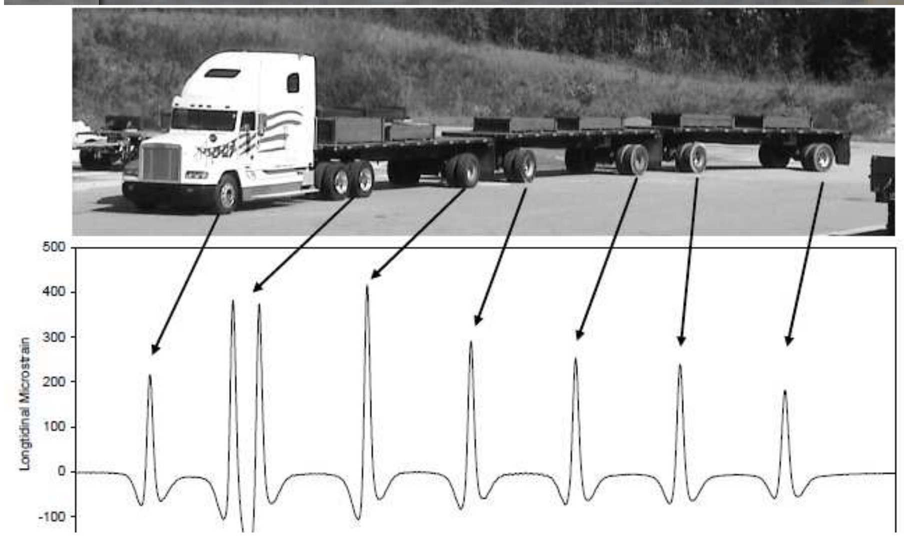
M-E?

- Méthode mécanistique-empirique
  - Partie mécanique
    - Calcul les contraintes et déformations dans un système multi-couche soumis à des charges extérieures, aux effets de la températures et de l'humidité
    - Modélisation du comportement des matériaux inclut dans la chaussée



M-E?

- Méthode mécanistique-empirique
  - Partie empirique
    - Lien entre les caractéristiques mécaniques et les dégradations de la chaussée
    - corrélations

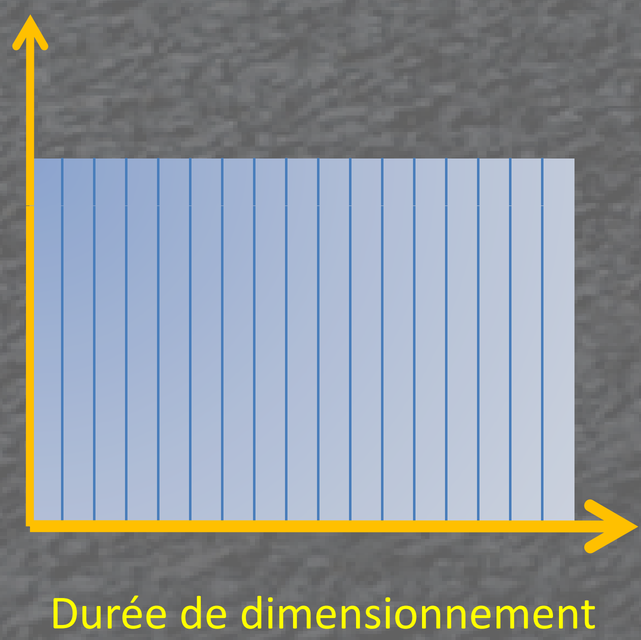


?

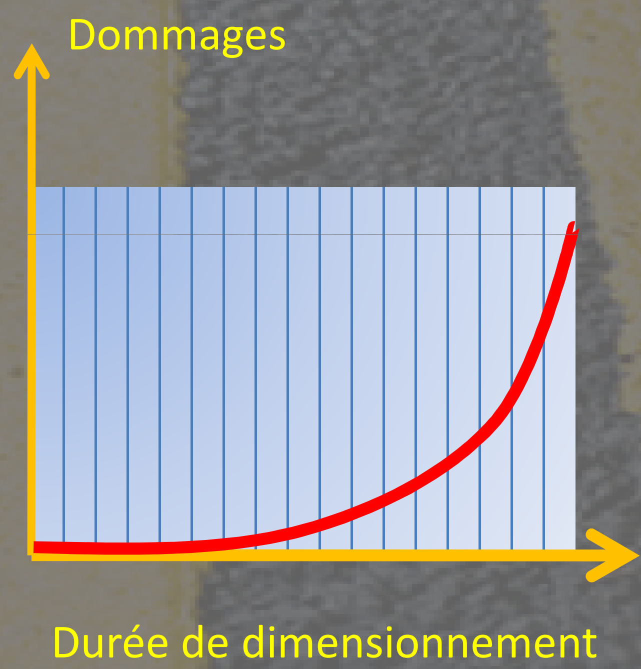
=

M-E?

- principe



Durée de dimensionnement



Dommages
Durée de dimensionnement

M-E?

- Hypothèse de Miner

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

Pourquoi pas juste mécanique?

- Manque de connaissances
- Manque de données
- Pas nécessairement utile…

Historique

- Chaussées rigides
  - 1938 Bradbury
  - Dalle structurale
  - Travaux toujours en cours
- Chaussées souples
  - 1940 Burminster
  - Hypothèse
    - La chaussée peut être modélisé comme une structure multi-couche élastique ou visco-élastique sur une fondation élastique ou visco-élastique
  - Premier développement méthode mécaniste: Ivanov (URSS) et McLeod (Canada)

M-E utilisable

- Chaussées rigides
  - Méthode PCA
- Chaussées souples
  - Kentucky DOT
  - Asphalt Institute
  - Shell International
  - Minnesota DOT

Pourquoi une méthode M-E?

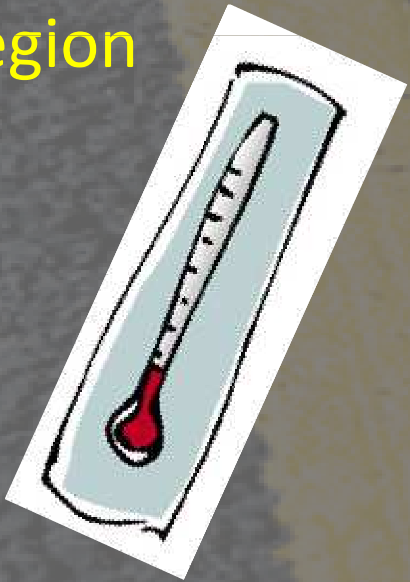
- Nos chaussées sont en bons états…

Pourquoi une méthode M-E?

- Trafic
  - Augmentation du nombre
    - De 5 à $15x10^6$ en 1960 à 50 à $200x10^6$ aujourd'hui
  - Augmentation de la période de conception
    - 20 ans en 1960 à 30-40 ans maintenant
  - Changement de la configurations des essieux
  - Pression des pneus
    - 80 vs 120 psi

Pourquoi une méthode M-E?

- Environnement
  - Méthode AASHTO basé sur le test track
    - Basé sur climat local
  - Utilisation d’une moyenne dans la région



Pourquoi une méthode M-E?

- Matériaux
  - Surface
    - Modèle non complet
  - Base
    - Modèle sur 2 types de base seulement
  - Infra
    - Caractérisation incomplète

Pourquoi une méthode M-E?

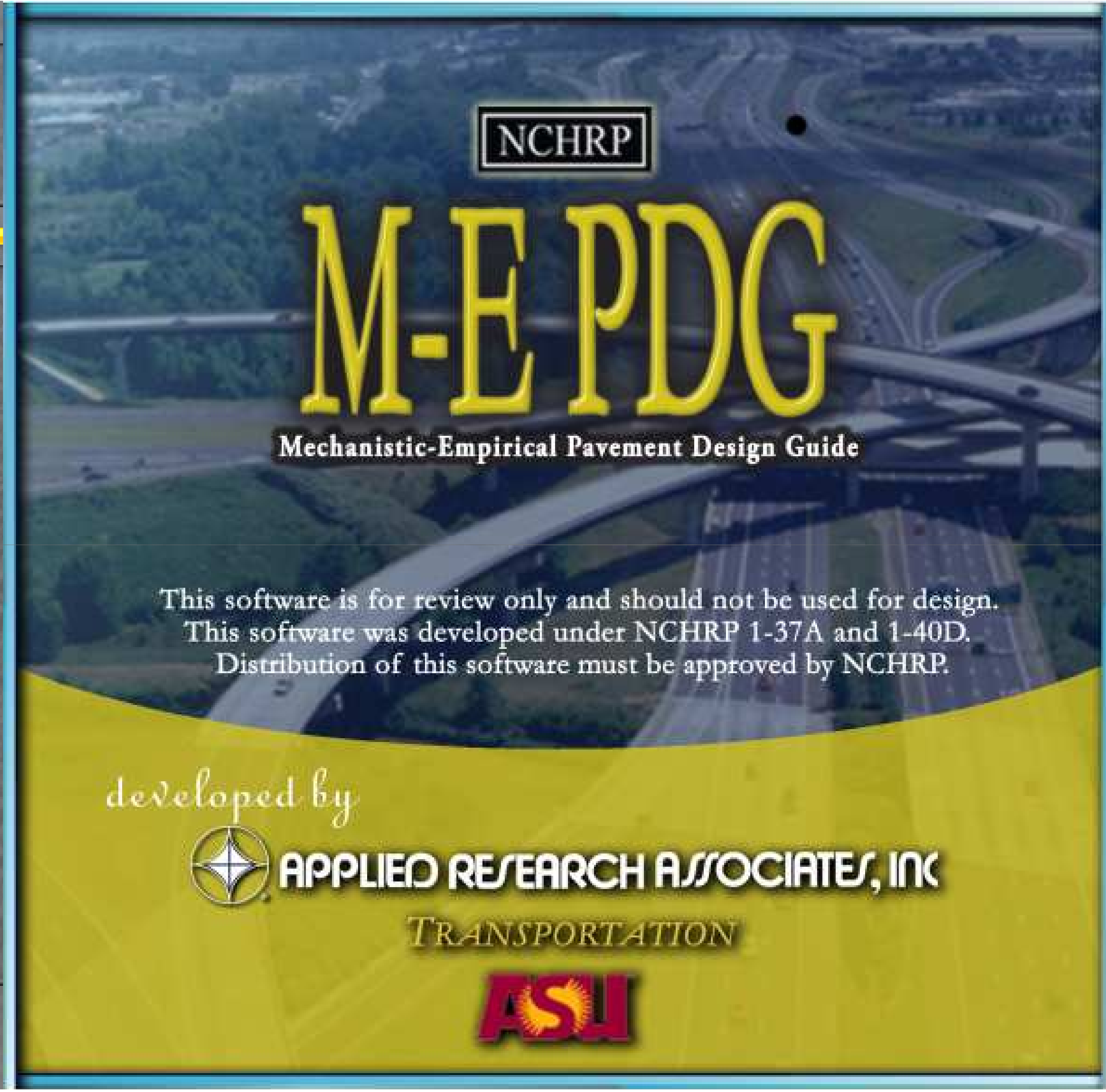
- Lien avec performance
  - Méthode empirique basé sur PSI
  - Besoin d'une méthode qui prédit la fissuration par fatigue, fissuration thermique, orniérage, écaillage, arrachement, etc…

Problèmes avec méthode M-E

- Énormément de facteur à prendre en considération
- Nécessite un ordinateur
- Besoin de données pas nécessairement disponible!

Méthode M-E AASHTO

- Commencé en 1996
- AASHTO abandonne
- Devient MEPDG
  - **M**echanical **E**mpirical **P**avement **D**esign **G**uide
- Chaussées souples et rigides
- 2009 groupe de travail pour DARWIN-ME

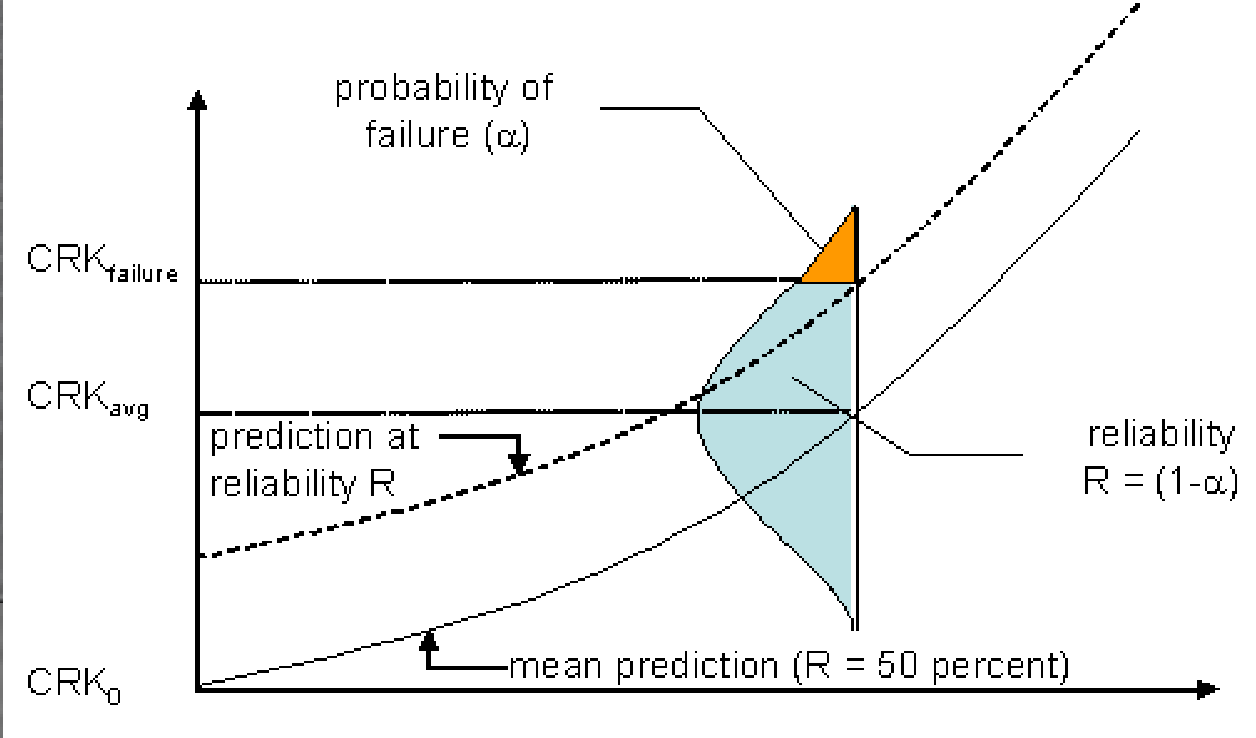

NCHRP
M-E PDG
Mechanistic-Empirical Pavement Design Guide
This software is for review only and should not be used for design.
This software was developed under NCHRP 1-37A and 1-40D.
Distribution of this software must be approved by NCHRP.
developed by
APPLIED RESEARCH ASSOCIATES, INC
TRANSPORTATION
ASU

Critères de conception

	Limit	Reliability
☑ Terminal IRI (in/mile)	482	90
☑ AC Surface Down Cracking Long. Cracking (ft/mi)	2000	90
☑ AC Bottom Up Cracking Alligator Cracking (%)	25	90
☑ AC Thermal Fracture (ft/mi)	1000	90
☑ Chemically Stabilized Layer Fatigue Fracture(%)	25	90
☑ Permanent Deformation - Total Pavement (in)	0.75	90
☑ Permanent Deformation - AC Only (in)	0.25	90

Confiance - Reliability

- Probabilité qu'une structure de chaussée donnée «survive» le temps prévue lors de la conception



MEPDG

- Étapes de conceptions

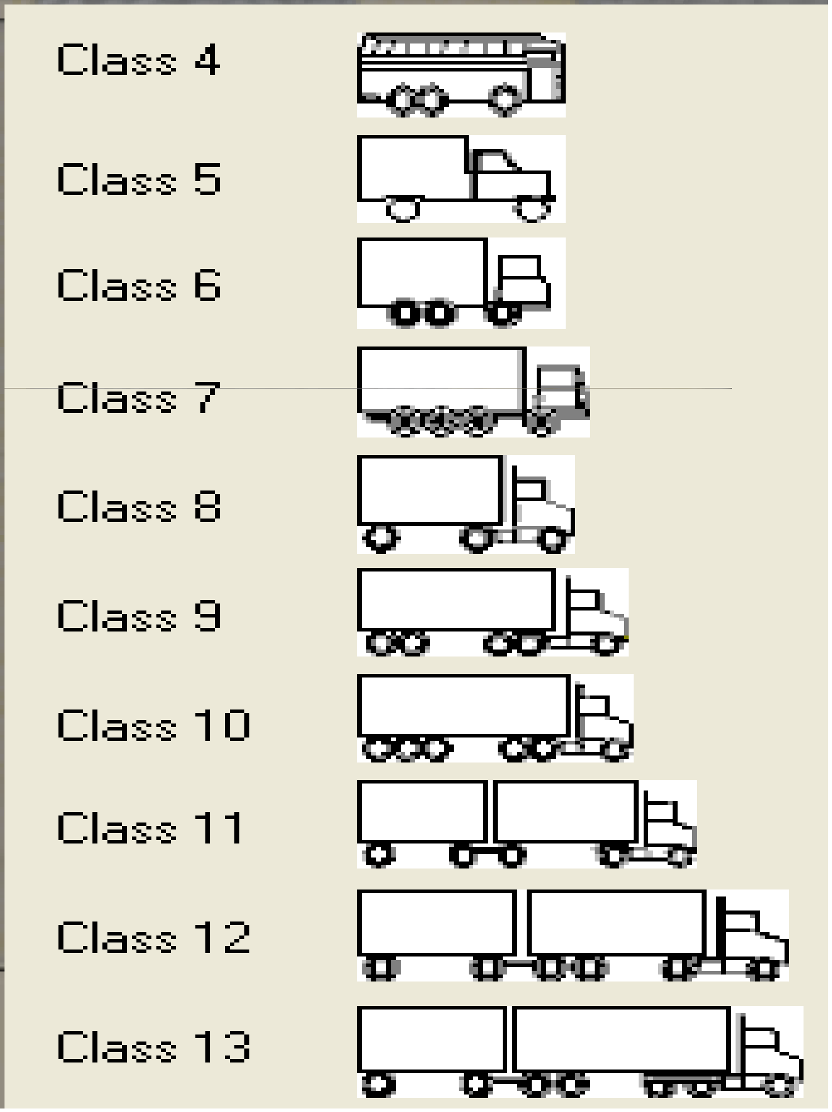
1. Le concepteur entre une conception initiale
2. Le logiciel estime le domage et les principales dégradations durant la durée de vie
3. La conception est vérifiée en fonction des critères de performances et est modifiée au besoin

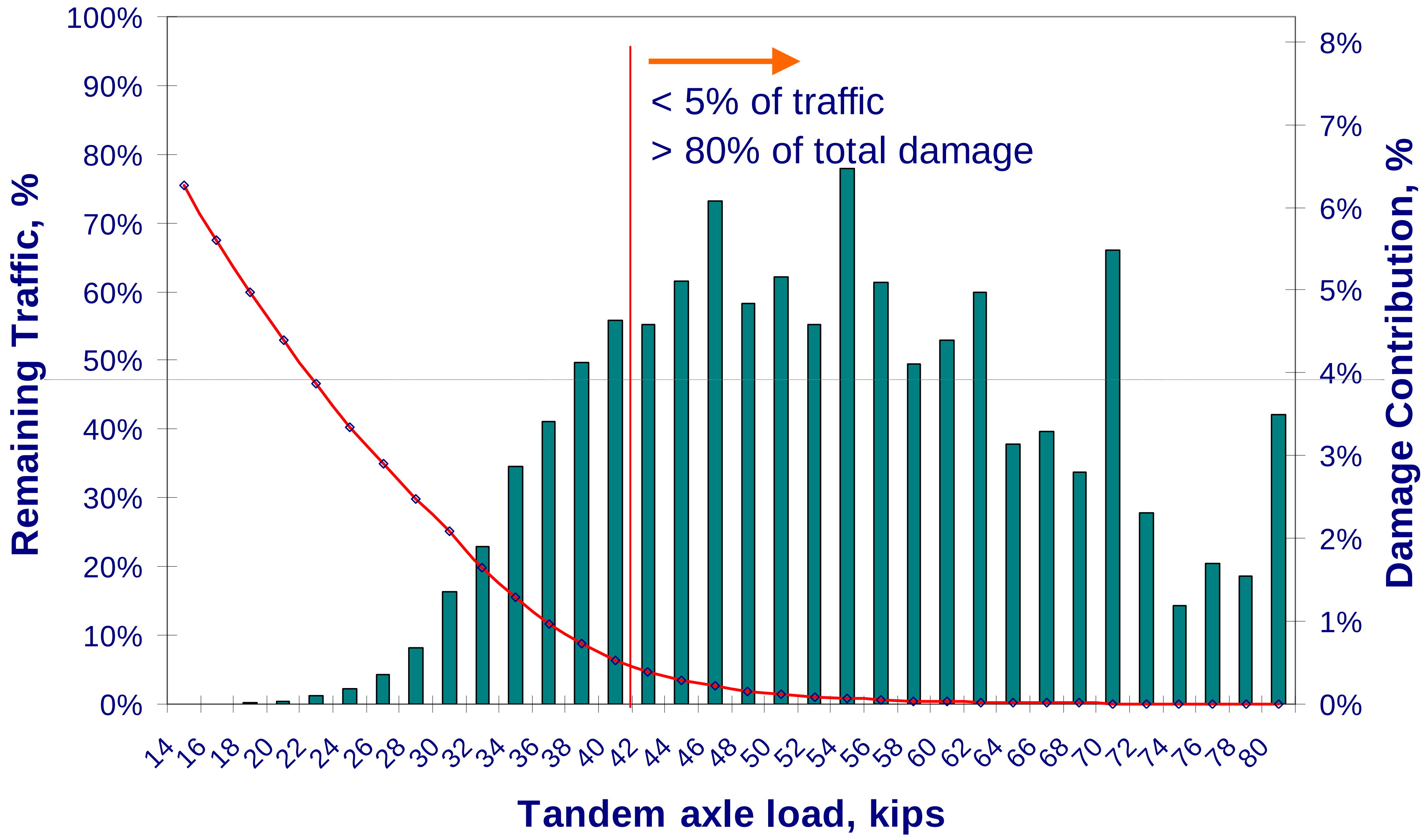
Les intrants

- Trafic
- Environnement
- structure

Trafic

- DJMA-camion
  - Dans les deux directions
  - Classe 4 et plus

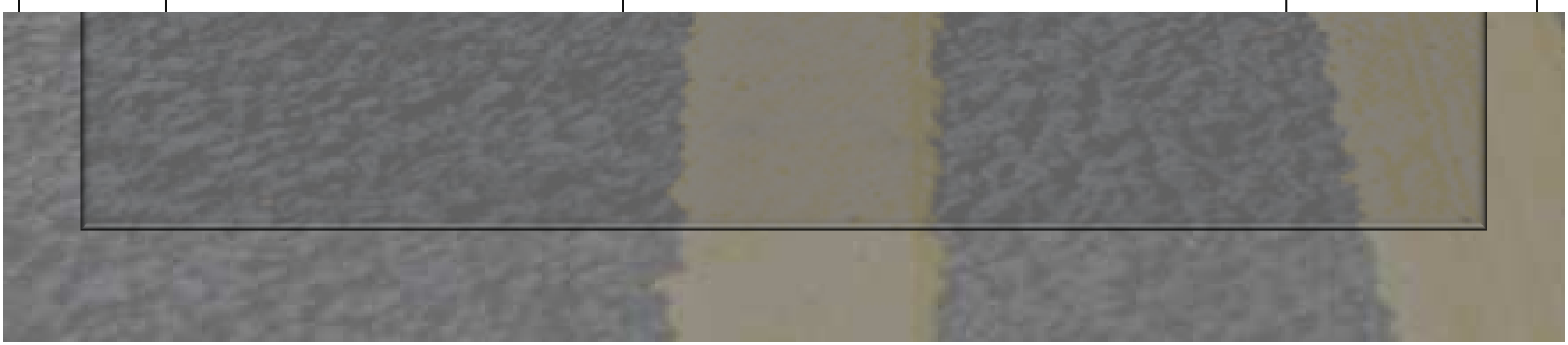




< 5% of traffic
> 80% of total damage
Remaining Traffic, %
Damage Contribution, %
Tandem axle load, kips
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
8%
7%
6%
5%
4%
3%
2%
1%
0%
14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80

Table 2: FHWA Vehicle Classification (from FHWA, 2001)[1]

Class	Type	Description	Typical ESALs per Vehicle[2]
1	Motorcycles	All two- or three-wheeled motorized vehicles. Typical vehicles in this category have saddle type seats and are steered by handle bars rather than wheels. This category includes motorcycles, motor scooters, mopeds, motor-powered bicycles, and three-wheel motorcycles. This vehicle type may be reported at the option of the State.	negligible
2	Passenger Cars	All sedans, coupes, and station wagons manufactured primarily for the purpose of carrying passengers and including those passenger cars pulling recreational or other light trailers.	negligible
3	Other Two-Axle, Four-Tire Single Unit Vehicles	All two-axle, four tire, vehicles, other than passenger cars. Included in this classification are pickups, panels, vans, and other vehicles such as campers, motor homes, ambulances, hearses, and carryalls. Other two-axle, four-tire single unit vehicles pulling recreational or other light trailers are included in this classification.	negligible

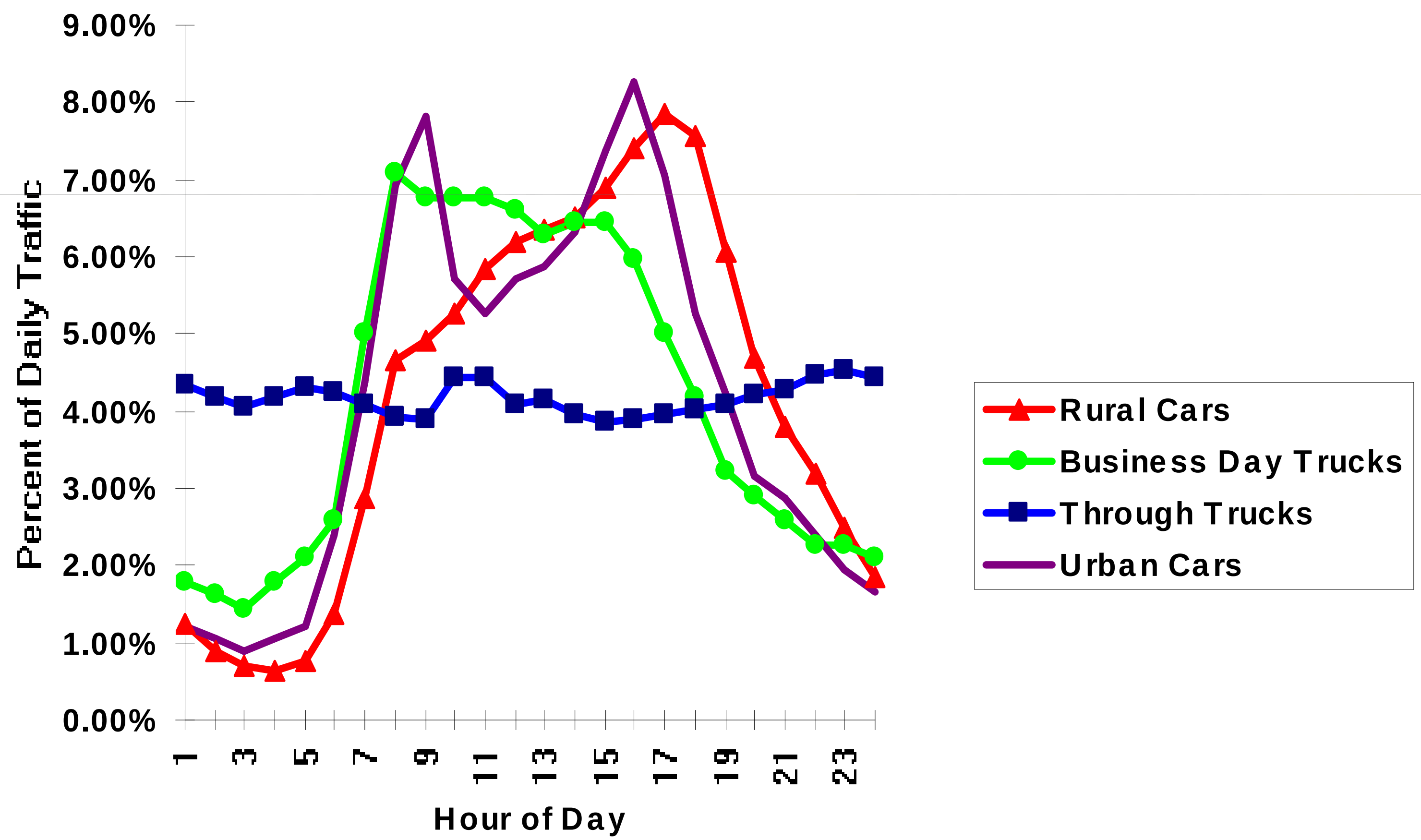


4	Buses	All vehicles manufactured as traditional passenger-carrying buses with two axles and six tires or three or more axles. This category includes only traditional buses (including school buses) functioning as passenger-carrying vehicles. All two-axle, four-tire single unit vehicles. Modified buses should be considered to be a truck and be appropriately classified.	0.57
5	Two-Axle, Six-Tire, Single Unit Trucks	All vehicles on a single frame including trucks, camping and recreational vehicles, motor homes, etc., having two axles and dual rear wheels.	0.26
6	Three-Axle Single Unit Trucks	All vehicles on a single frame including trucks, camping and recreational vehicles, motor homes, etc., having three axles.	0.42
7	Four or More Axle Single Unit Trucks	All trucks on a single frame with four or more axles.	0.42
8	Four or Less Axle Single Trailer Trucks	All vehicles with four or less axles consisting of two units, one of which is a tractor or straight truck power unit.	0.30
9	Five-Axle Single Trailer Trucks	All five-axle vehicles consisting of two units, one of which is a tractor or straight truck power unit.	1.20
10	Six or More Axle Single Trailer Trucks	All vehicles with six or more axles consisting of two units, one of which is a tractor or straight truck power unit.	0.93
11	Five or Less Axle Multi-Trailer Trucks	All vehicles with five or less axles consisting of three or more units, one of which is a tractor or straight truck power unit.	0.82
12	Six-Axle Multi-Trailer Trucks	All six-axle vehicles consisting of three or more units, one of which is a tractor or straight truck power unit.	1.06
13	Seven or More Axle Multi-Trailer Trucks	All vehicles with seven or more axles consisting of three or more units, one of which is a tractor or straight truck power unit.	1.39

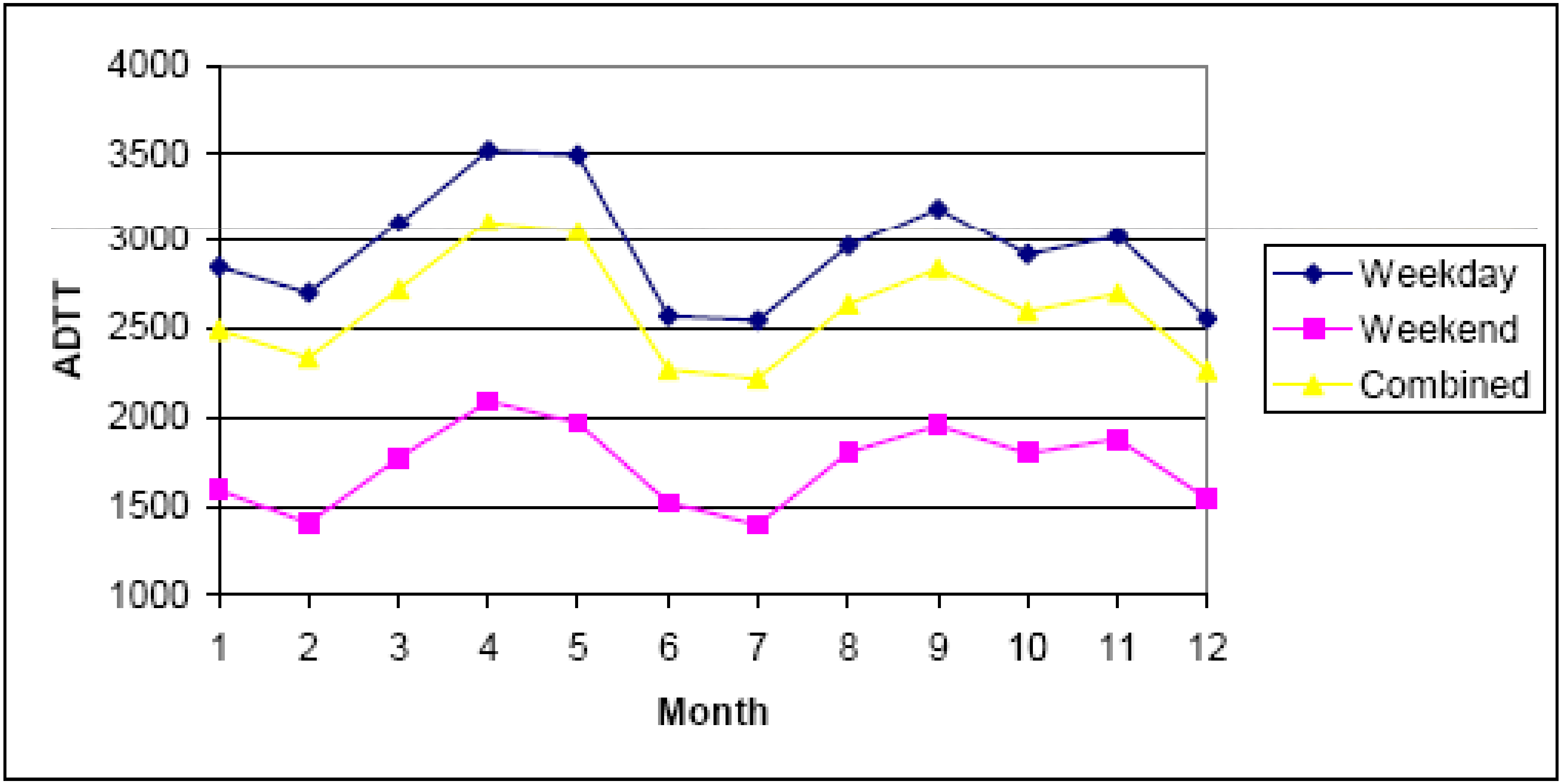
Trafic

- Ajustement
  - Mensuel
    - Trafic annuel ajusté à chaque mois
  - Classe de véhicule
    - Ajustement en fonction des classes
  - Horaire
    - Trafic annuel ajusté à chaque heure
  - Accroissement du trafic
    - Pas d’accroissement, linéaire, composé

Trafic


9.00%
8.00%
7.00%
6.00%
5.00%
4.00%
3.00%
2.00%
1.00%
0.00%
Percent of Daily Traffic
1
3
5
7
9
11
13
15
17
19
21
23
Hour of Day
Rural Cars
Business Day Trucks
Through Trucks
Urban Cars

Trafic

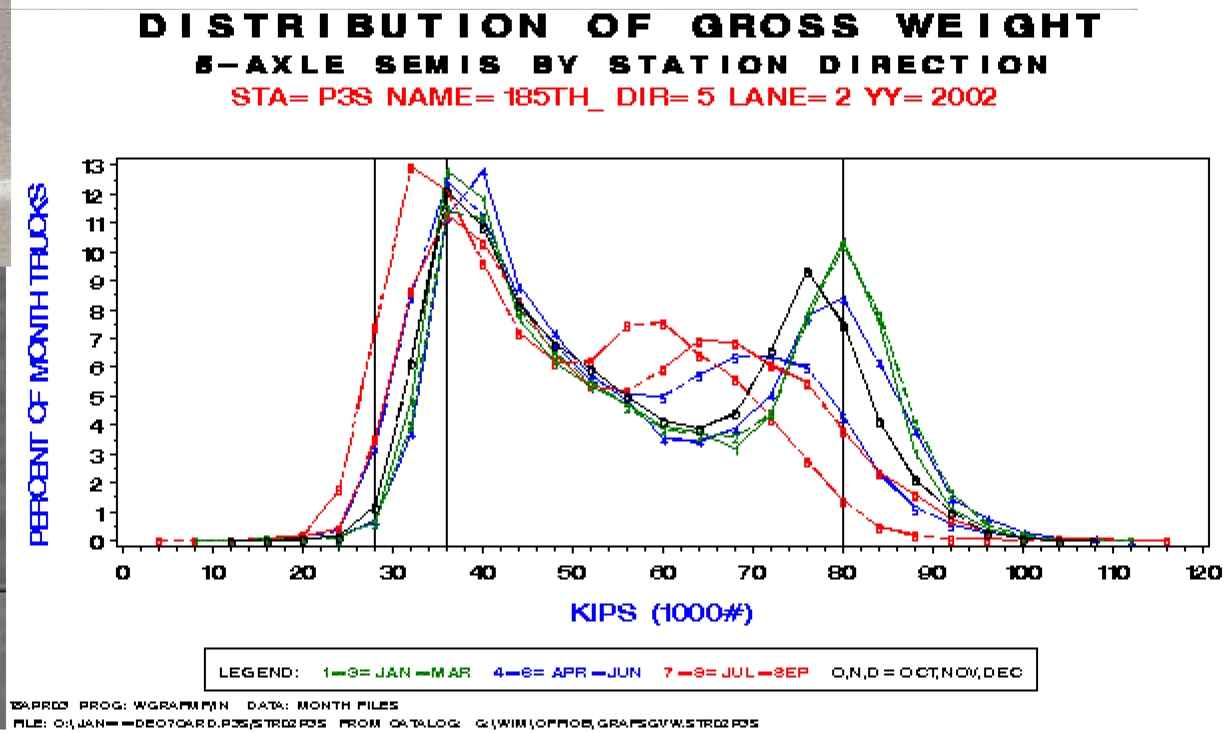


4000
3500
3000
2500
2000
1500
1000
ADTT
1
2
3
4
5
6
7
8
9
10
11
12
Month
Weekday
Weekend
Combined

Charge sur essieux

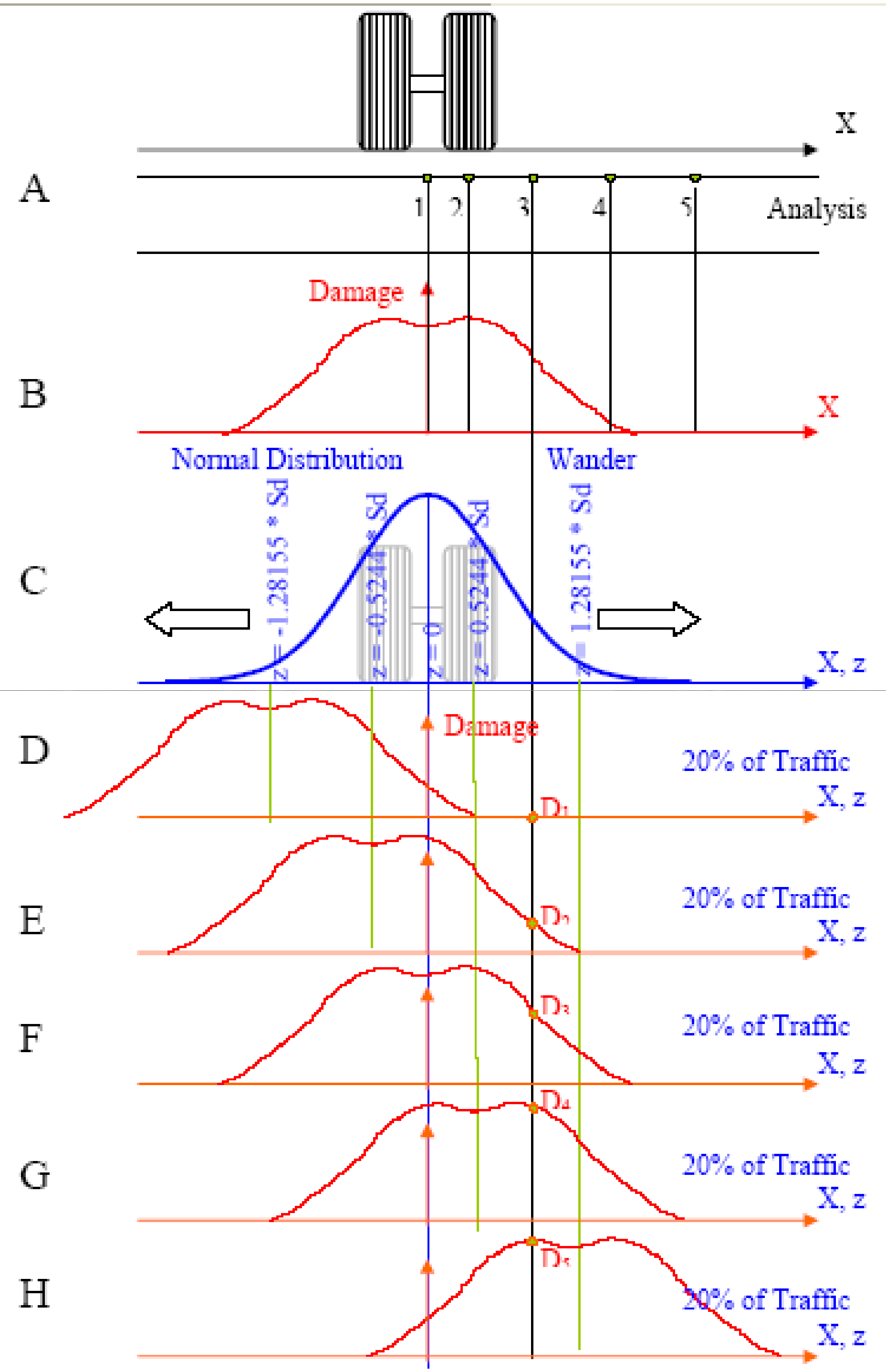
- Doit définir charge sur chaque essieux pour chaque catégorie de véhicules à chaque mois
- Calculer avec WIM

WIM


DISTRIBUTION OF GROSS WEIGHT
5-AXLE SEMIS BY STATION DIRECTION
STA= P3S NAME= 185TH_ DIR= 5 LANE= 2 YY= 2002
PERCENT OF MONTH TRUCKS
0 1 2 3 4 5 6 7 8 9 10 11 12 13
0 10 20 30 40 50 60 70 80 90 100 110 120
KIPS (1000#)
LEGEND: 1—3= JAN —MAR 4—6= APR —JUN 7 —9= JUL —SEP O,N,D = OCT,NOV,DEC
DATA: MONTH FILES

Trafic

- Configurations des essieux
- Position des charges sur la chaussée

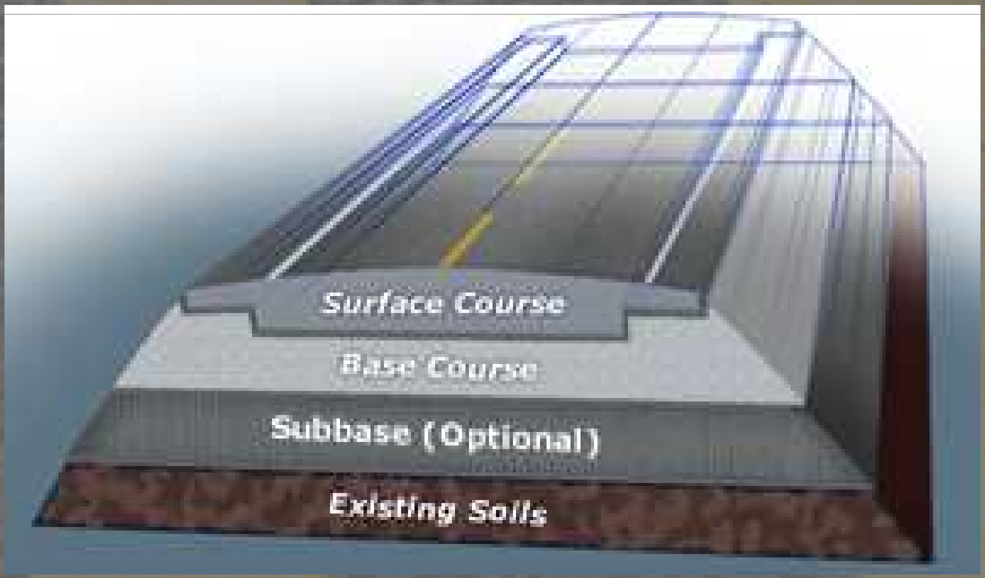

A
B
C
D
E
F
G
H
X
1
2
3
4
5
Analysis
Damage
X
Normal Distribution
Wander
z = -1.28155 * Sd
z = -0.5244 * Sd
z = 0
z = 0.5244 * Sd
z = 1.28155 * Sd
X, z
Damage
20% of Traffic
X, z
20% of Traffic
X, z
20% of Traffic
X, z
20% of Traffic
X, z
20% of Traffic
X, z

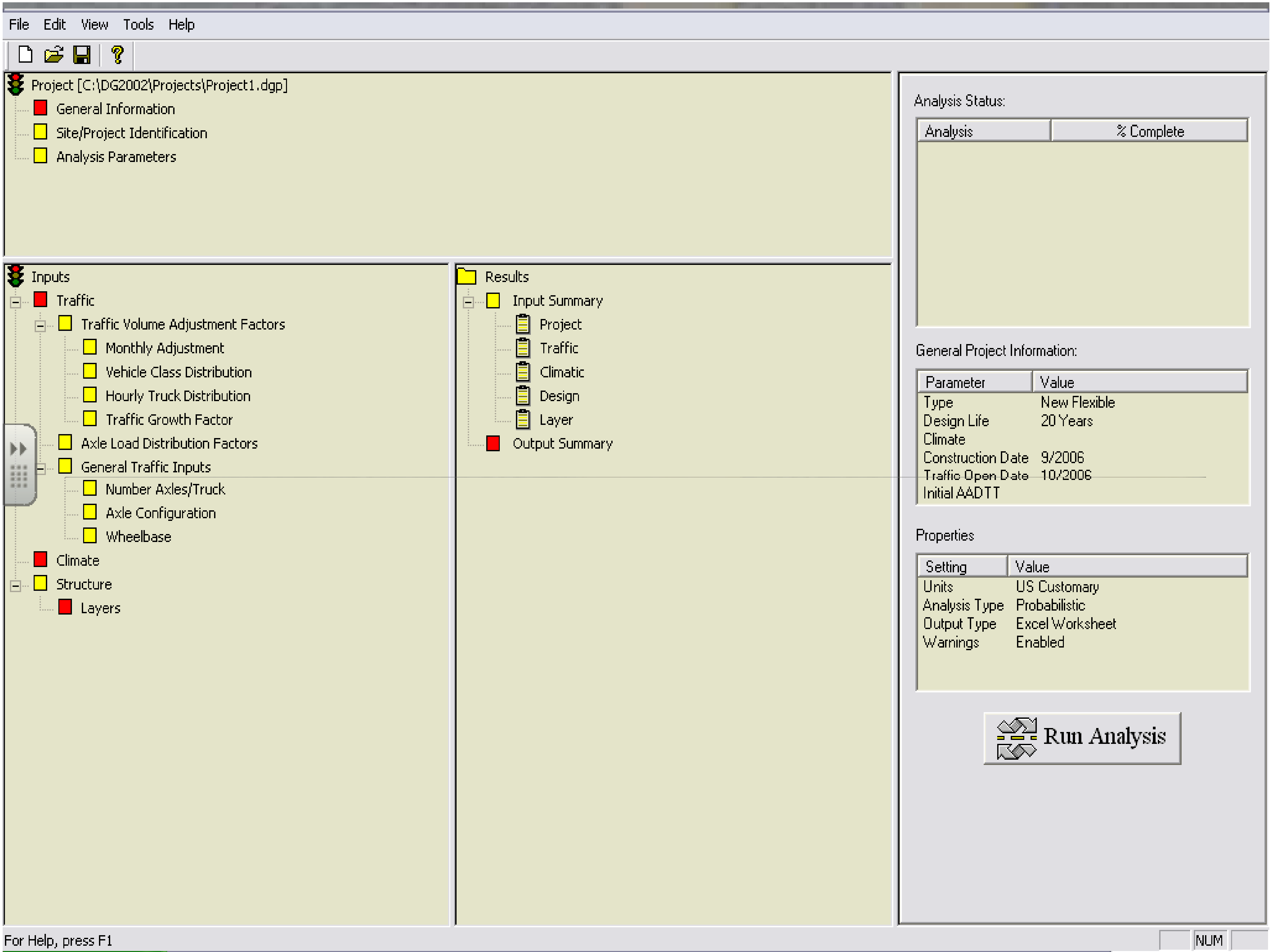
Climat

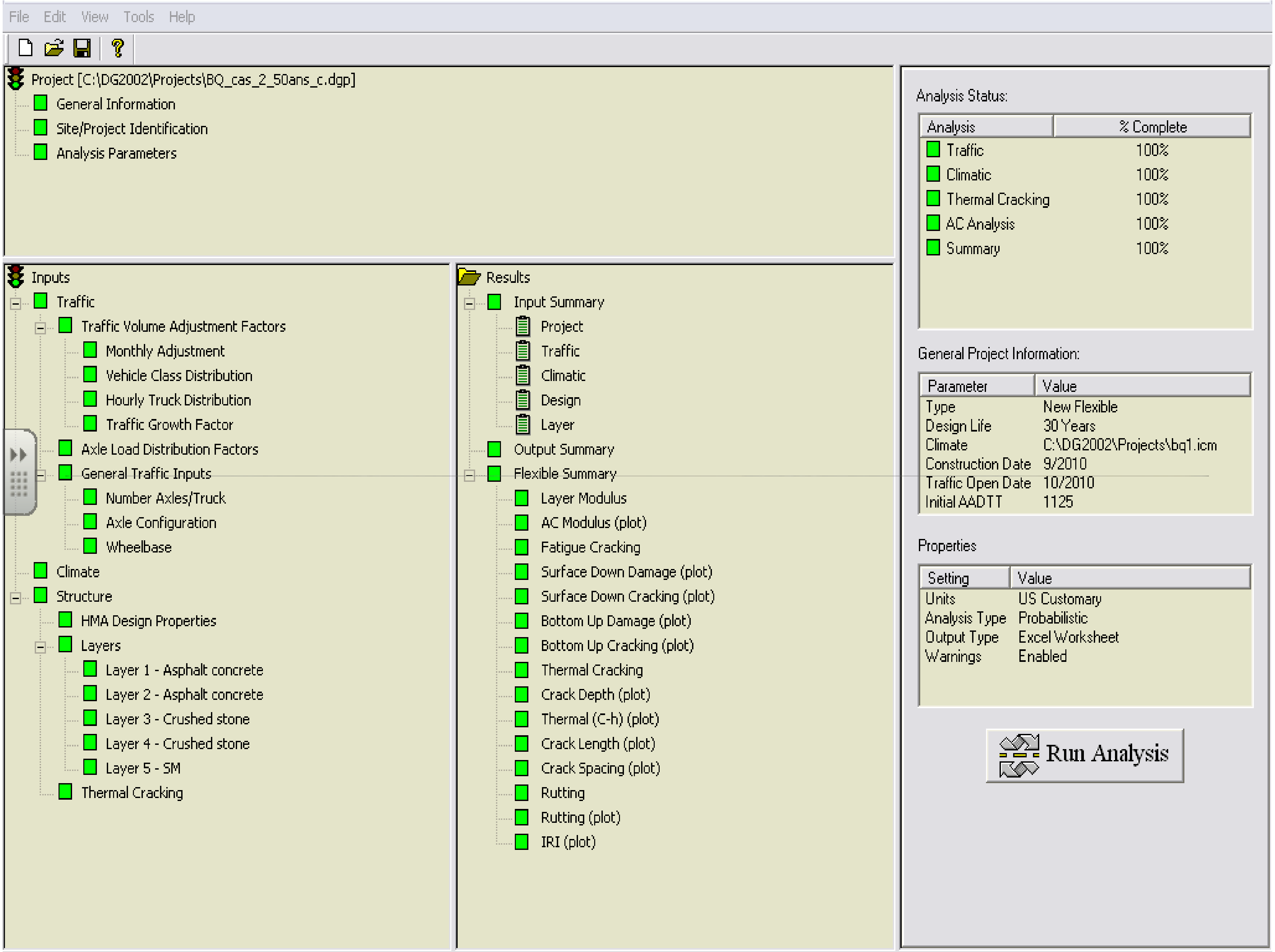
- Température
- Humidité
- Profondeur de la nappe phréatique

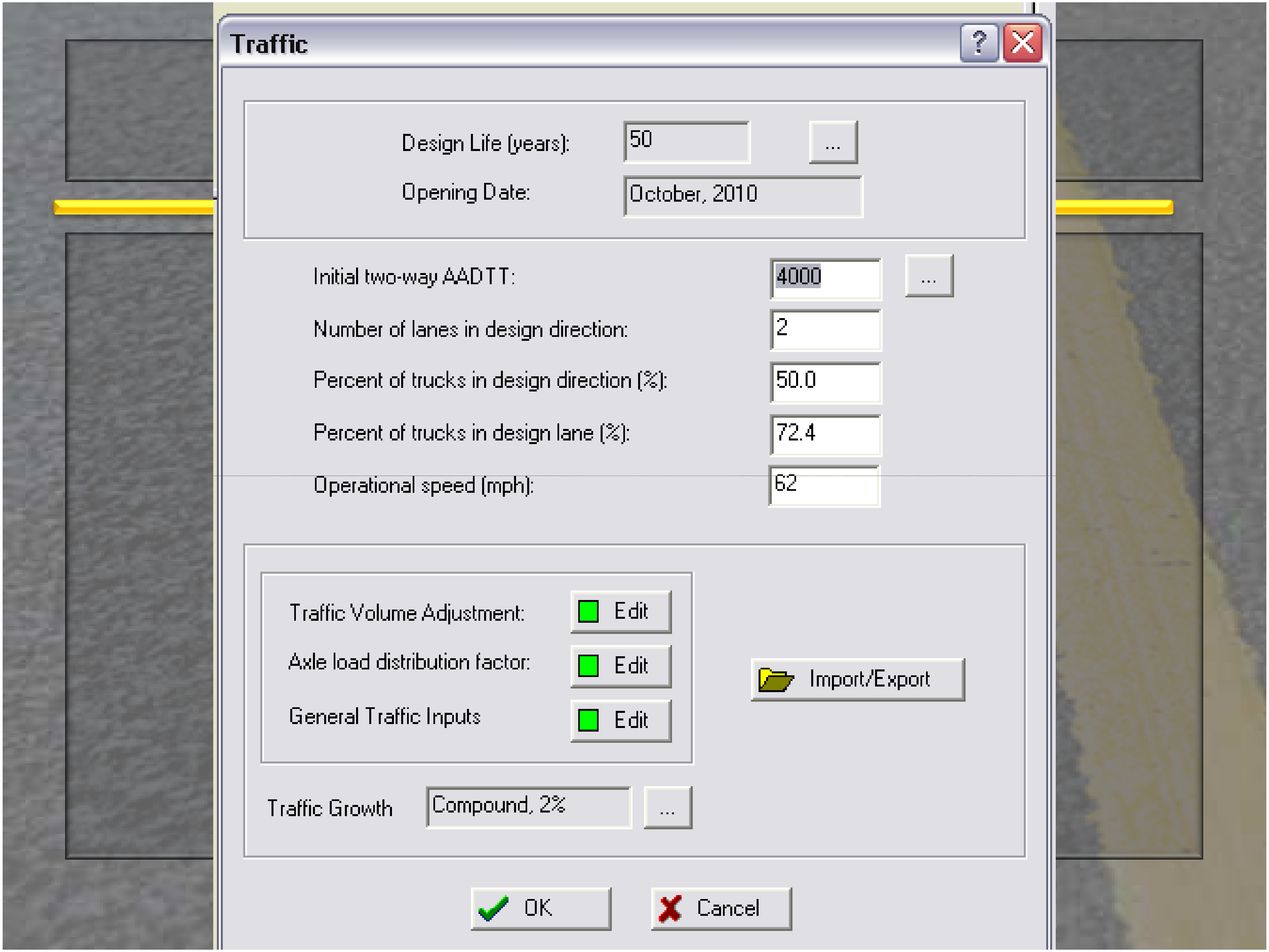
Structure

- Utilisation de modèle mathématique pour
  - Évaluation des contraintes
  - Évaluation des modules
  - …




File Edit View Tools Help
Project [C:\DG2002\Projects\Project1.dgp]
General Information
Site/Project Identification
Analysis Parameters
Inputs
Traffic
Traffic Volume Adjustment Factors
Monthly Adjustment
Vehicle Class Distribution
Hourly Truck Distribution
Traffic Growth Factor
Axle Load Distribution Factors
General Traffic Inputs
Number Axles/Truck
Axle Configuration
Wheelbase
Climate
Structure
Layers
Results
Input Summary
Project
Traffic
Climatic
Design
Layer
Output Summary
Analysis Status:
Analysis
% Complete
General Project Information:
Parameter
Value
Type
New Flexible
Design Life
20 Years
Climate
Construction Date
9/2006
Traffic Open Date
10/2006
Initial AADTT
Properties
Setting
Value
Units
US Customary
Analysis Type
Probabilistic
Output Type
Excel Worksheet
Warnings
Enabled
Run Analysis
For Help, press F1
NUM


File Edit View Tools Help
Project [C:\DG2002\Projects\BQ_cas_2_50ans_c.dgp]
General Information
Site/Project Identification
Analysis Parameters
Inputs
Traffic
Traffic Volume Adjustment Factors
Monthly Adjustment
Vehicle Class Distribution
Hourly Truck Distribution
Traffic Growth Factor
Axle Load Distribution Factors
General Traffic Inputs
Number Axles/Truck
Axle Configuration
Wheelbase
Climate
Structure
HMA Design Properties
Layers
Layer 1 - Asphalt concrete
Layer 2 - Asphalt concrete
Layer 3 - Crushed stone
Layer 4 - Crushed stone
Layer 5 - SM
Thermal Cracking
Results
Input Summary
Project
Traffic
Climatic
Design
Layer
Output Summary
Flexible Summary
Layer Modulus
AC Modulus (plot)
Fatigue Cracking
Surface Down Damage (plot)
Surface Down Cracking (plot)
Bottom Up Damage (plot)
Bottom Up Cracking (plot)
Thermal Cracking
Crack Depth (plot)
Thermal (C-h) (plot)
Crack Length (plot)
Crack Spacing (plot)
Rutting
Rutting (plot)
IRI (plot)
Analysis Status:
Analysis
% Complete
Traffic 100%
Climatic 100%
Thermal Cracking 100%
AC Analysis 100%
Summary 100%
General Project Information:
Parameter
Value
Type New Flexible
Design Life 30 Years
Climate C:\DG2002\Projects\bq1.icm
Construction Date 9/2010
Traffic Open Date 10/2010
Initial AADTT 1125
Properties
Setting
Value
Units US Customary
Analysis Type Probabilistic
Output Type Excel Worksheet
Warnings Enabled
Run Analysis


Traffic
Design Life (years):
50
...
Opening Date:
October, 2010
Initial two-way AADTT:
4000
...
Number of lanes in design direction:
2
Percent of trucks in design direction (%):
50.0
Percent of trucks in design lane (%):
72.4
Operational speed (mph):
62
Traffic Volume Adjustment:
Edit
Axle load distribution factor:
Edit
General Traffic Inputs
Edit
Import/Export
Traffic Growth
Compound, 2%
...
OK
Cancel

Traffic Volume Adjustment Factors

Monthly Adjustment | Vehicle Class Distribution | Hourly Distribution | Traffic Growth Factors

Load Monthly Adjustment Factors (MAF)

- Level 1: Site Specific - MAF
- Level 3: Default MAF

Load MAF From File

Export MAF to File

Monthly Adjustment Factors

Month	Class 4	Class 5	Class 6	Class 7	Class 8	Class 9	Class 10	Class 11	Class 12	Class 13
January	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
February	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
March	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
April	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
May	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
June	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
July	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
August	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
September	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
October	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
November	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
December	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

OK | Cancel

Traffic Volume Adjustment Factors

Monthly Adjustment | Vehicle Class Distribution | Hourly Distribution | Traffic Growth Factors

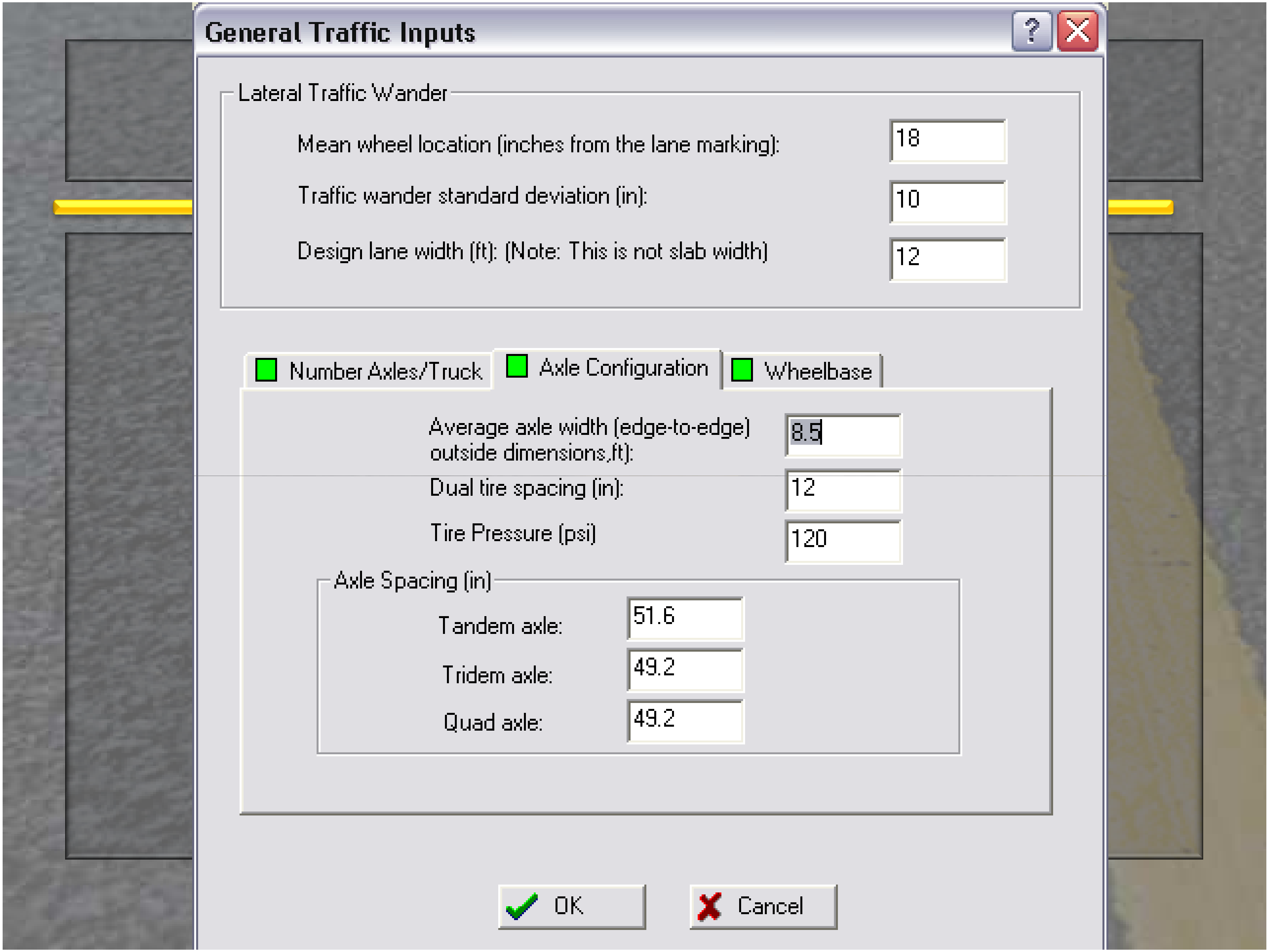
Hourly truck traffic distribution by period beginning:

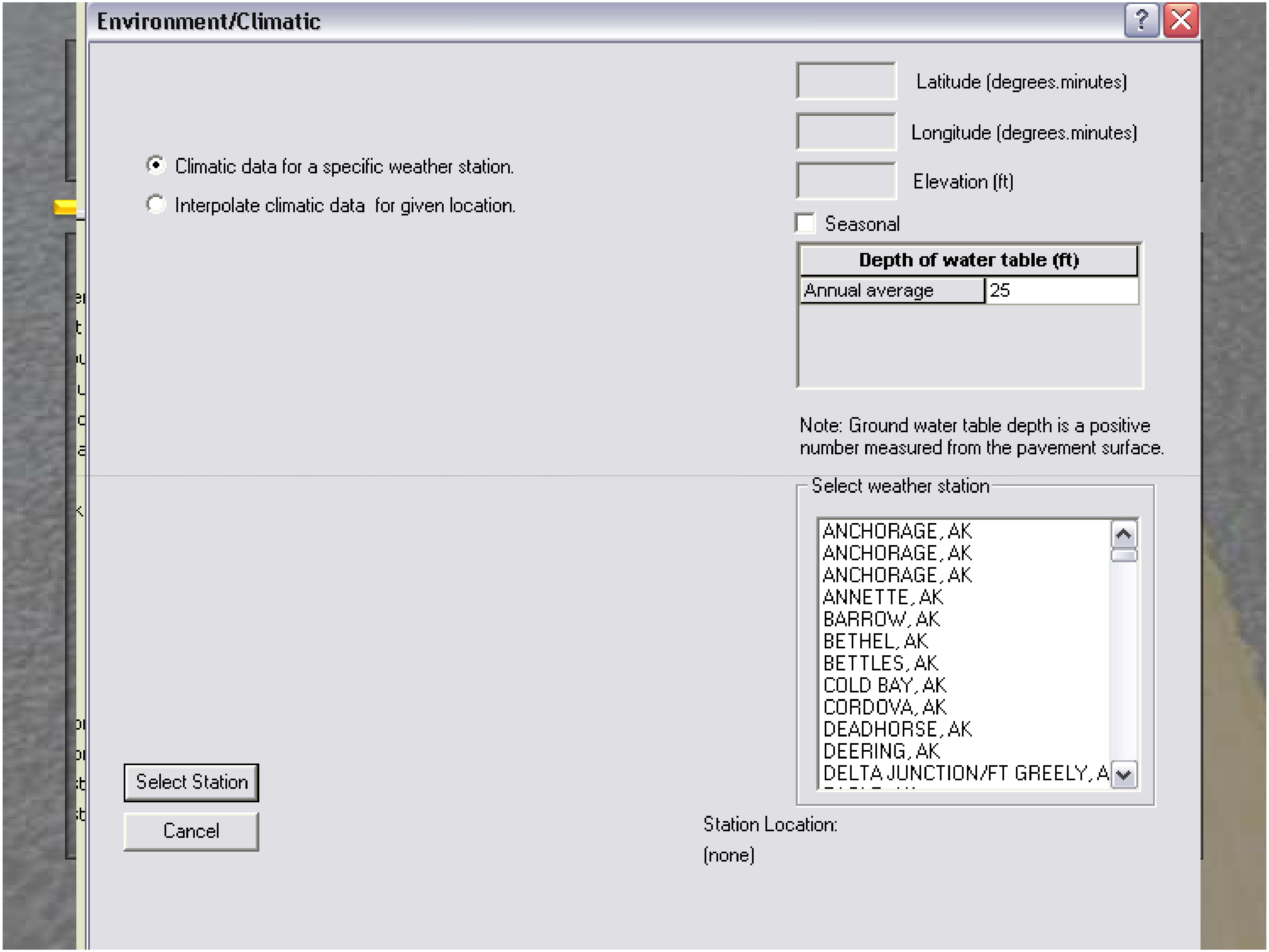
Midnight	2.3	Noon	5.9
1:00 am	2.3	1:00 pm	5.9
2:00 am	2.3	2:00 pm	5.9
3:00 am	2.3	3:00 pm	5.9
4:00 am	2.3	4:00 pm	4.6
5:00 am	2.3	5:00 pm	4.6
6:00 am	5.0	6:00 pm	4.6
7:00 am	5.0	7:00 pm	4.6
8:00 am	5.0	8:00 pm	3.1
9:00 am	5.0	9:00 pm	3.1
10:00 am	5.9	10:00 pm	3.1
11:00 am	5.9	11:00 pm	3.1

Note: The hourly distribution must total 100%

Total: 100

OK   Cancel


General Traffic Inputs
Lateral Traffic Wander
Mean wheel location (inches from the lane marking):
18
Traffic wander standard deviation (in):
10
Design lane width (ft): (Note: This is not slab width)
12
Number Axles/Truck
Axle Configuration
Wheelbase
Average axle width (edge-to-edge) outside dimensions,ft):
8.5
Dual tire spacing (in):
12
Tire Pressure (psi)
120
Axle Spacing (in)
Tandem axle:
51.6
Tridem axle:
49.2
Quad axle:
49.2
OK
Cancel


Environment/Climatic
Latitude (degrees.minutes)
Longitude (degrees.minutes)
Elevation (ft)
Climatic data for a specific weather station.
Interpolate climatic data for given location.
Seasonal
Depth of water table (ft)
Annual average
25
Note: Ground water table depth is a positive number measured from the pavement surface.
Select weather station
ANCHORAGE, AK
ANCHORAGE, AK
ANCHORAGE, AK
ANNETTE, AK
BARROW, AK
BETHEL, AK
BETTLES, AK
COLD BAY, AK
CORDOVA, AK
DEADHORSE, AK
DEERING, AK
DELTA JUNCTION/FT GREELY, A
Select Station
Cancel
Station Location:
(none)

Structure

Surface short-wave absorptivity: 0.85

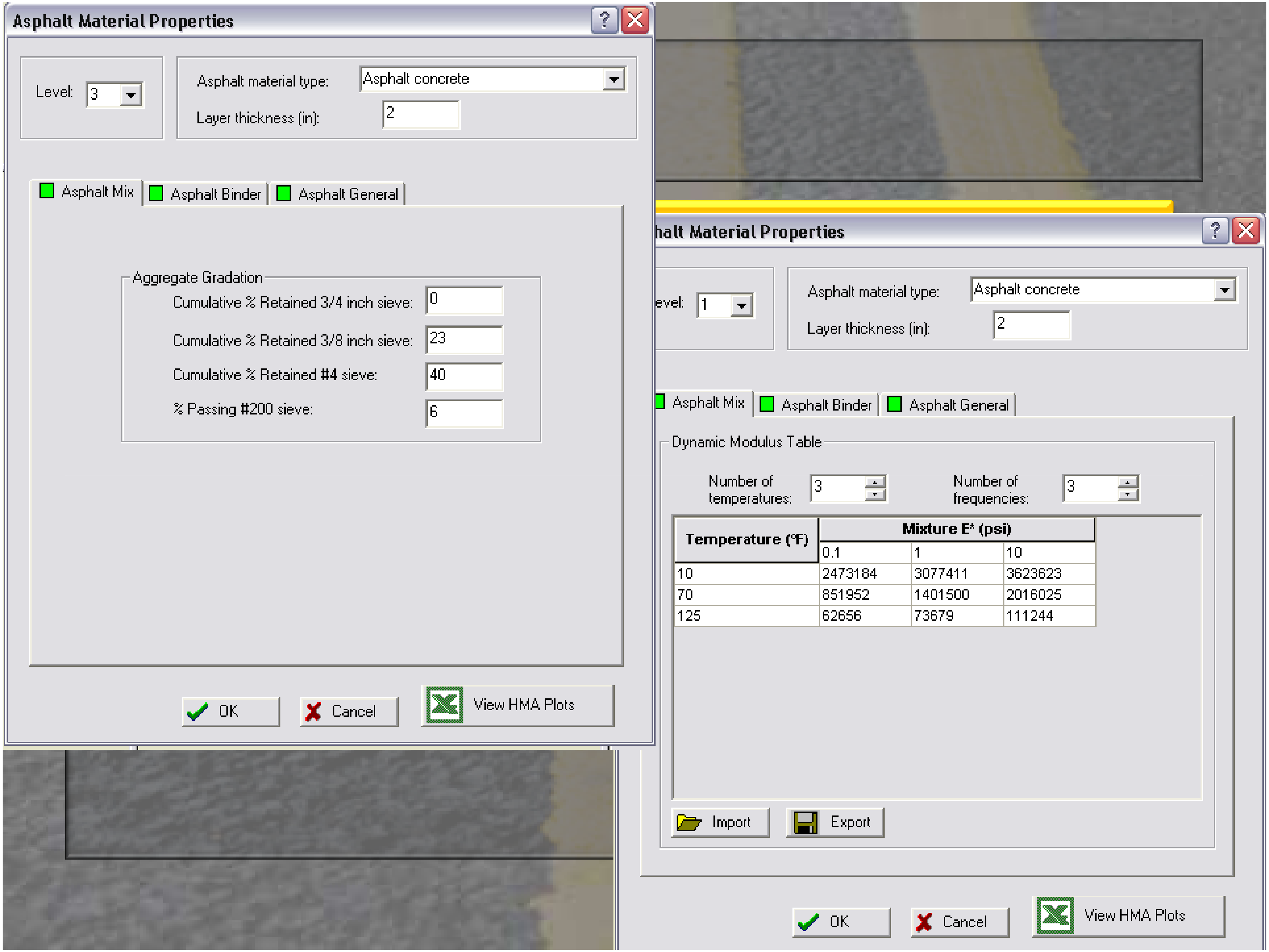
Layers

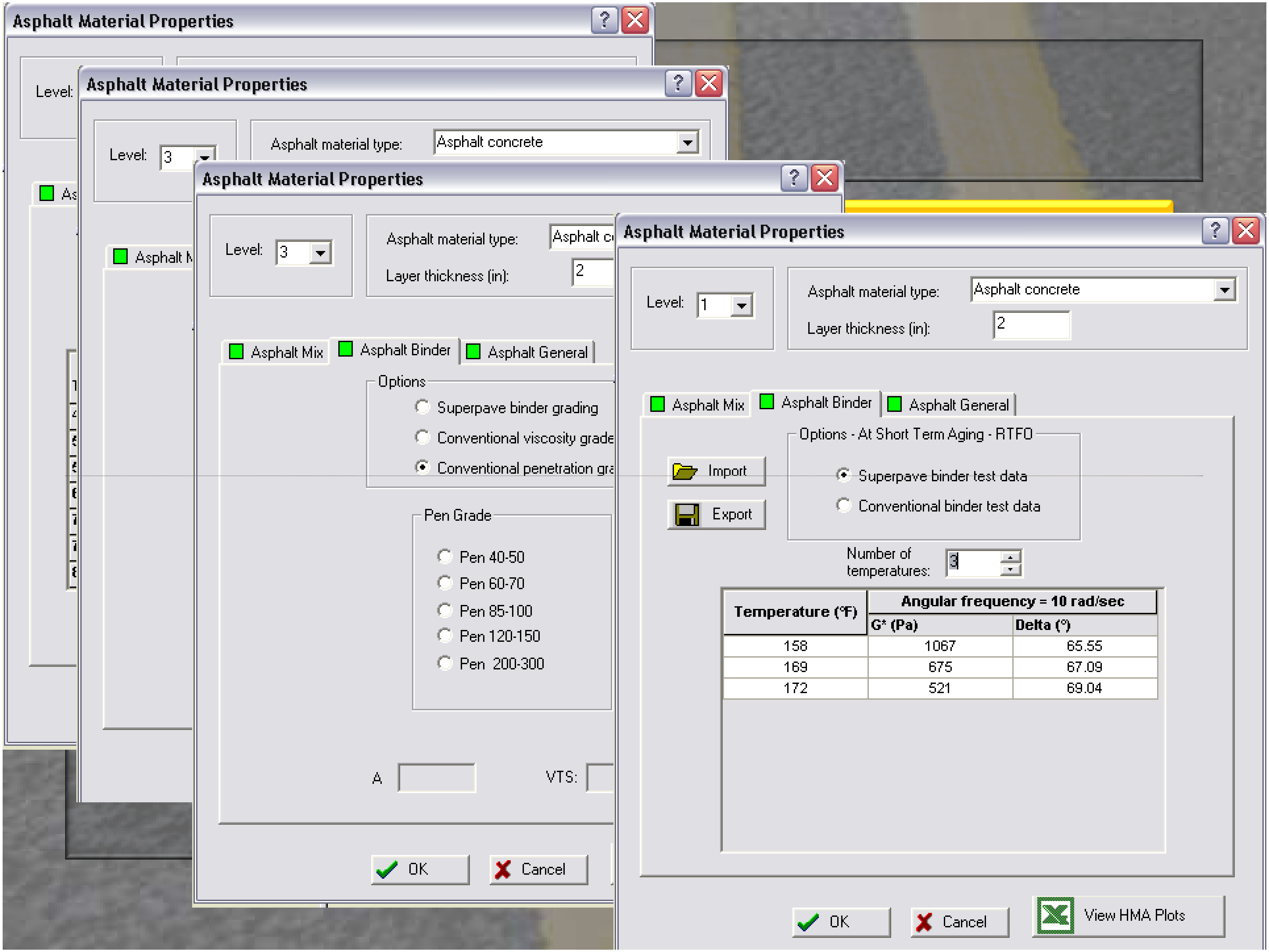
Layer	Type	Material	Thicknes	Interface
1	Asphalt	Asphalt concrete	2.0	1
2	Asphalt	Asphalt concrete	7.0	1
3	Granular Base	Crushed stone	8.0	1
4	Granular Base	Crushed stone	30.0	1
5	Subgrade	CL	Semi-infinit	n/a

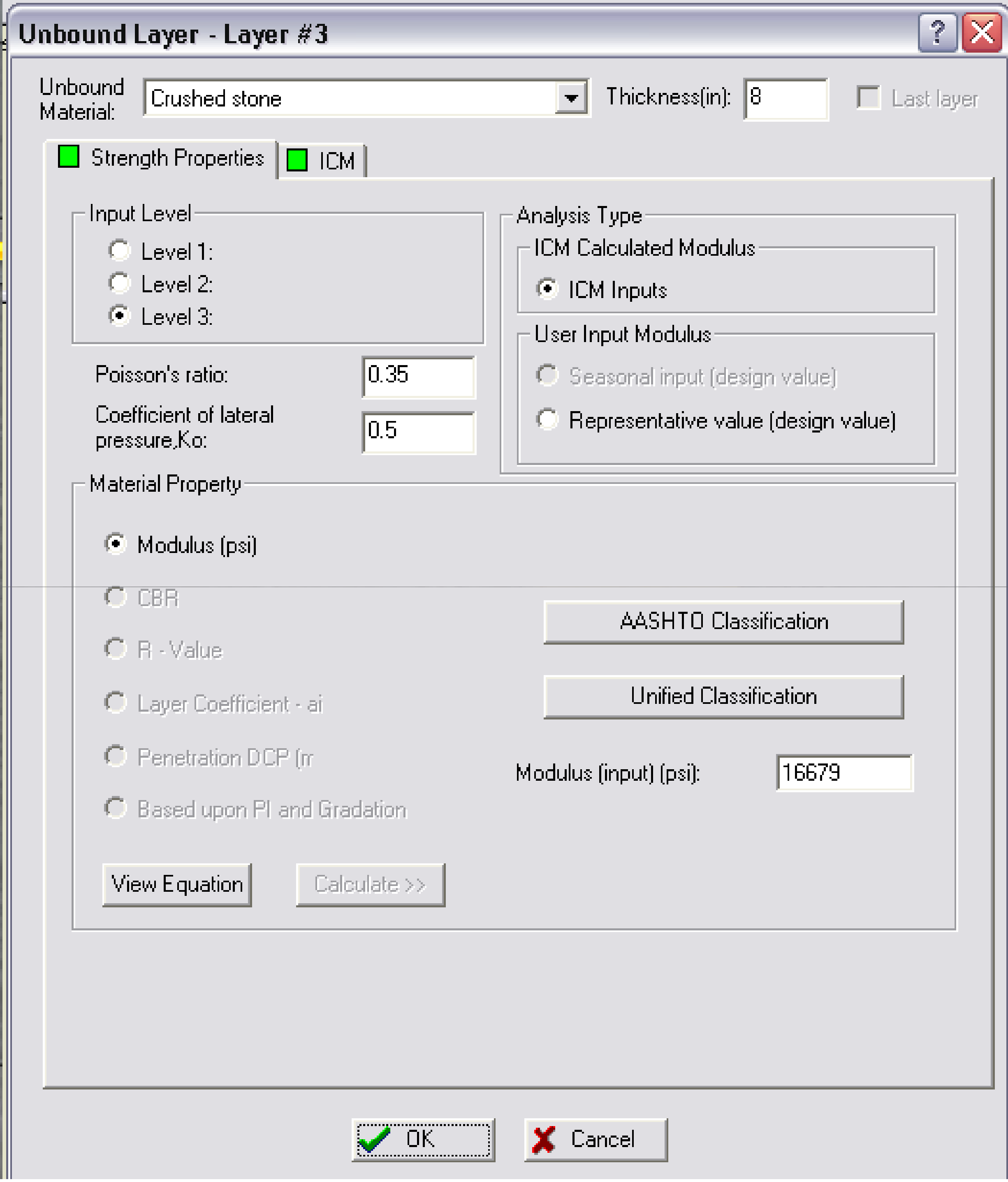
Insert Delete Edit

Opening Date: October, 2010 Design Life (years): 50 ...

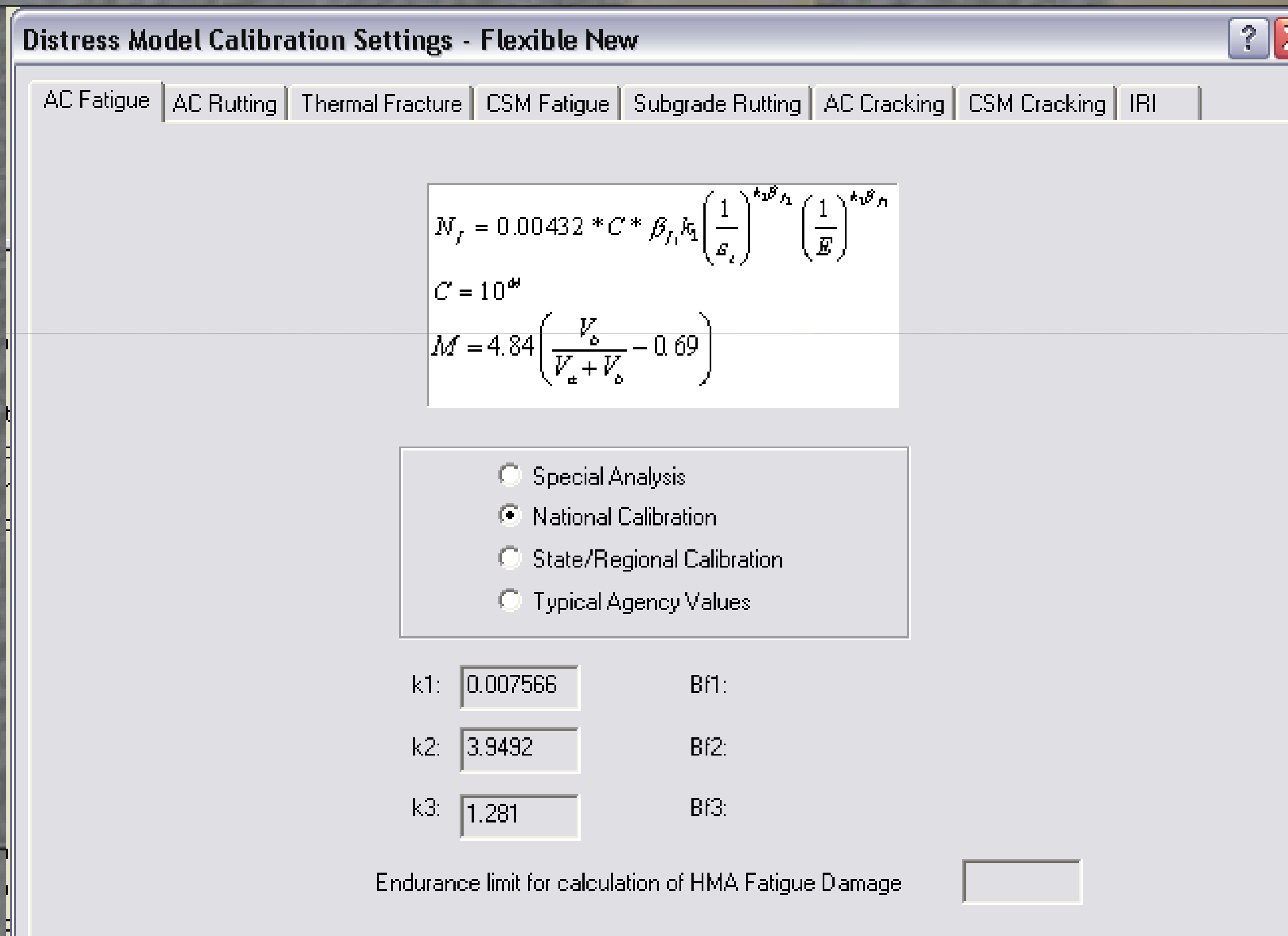
OK Cancel


Asphalt Material Properties
Level: 3
Asphalt material type: Asphalt concrete
Layer thickness (in): 2
Asphalt Mix
Asphalt Binder
Asphalt General
Aggregate Gradation
Cumulative % Retained 3/4 inch sieve: 0
Cumulative % Retained 3/8 inch sieve: 23
Cumulative % Retained #4 sieve: 40
% Passing #200 sieve: 6
OK
Cancel
View HMA Plots
halt Material Properties
evel: 1
Asphalt material type: Asphalt concrete
Layer thickness (in): 2
Asphalt Mix
Asphalt Binder
Asphalt General
Dynamic Modulus Table
Number of temperatures: 3
Number of frequencies: 3
Temperature (°F)
Mixture E* (psi)
0.1 1 10
10 2473184 3077411 3623623
70 851952 1401500 2016025
125 62656 73679 111244
Import
Export
OK
Cancel
View HMA Plots


Asphalt Material Properties
Level: 3
Asphalt material type: Asphalt concrete
Layer thickness (in): 2
Asphalt Mix
Asphalt Binder
Asphalt General
Options
Superpave binder grading
Conventional viscosity grade
Conventional penetration gra
Pen Grade
Pen 40-50
Pen 60-70
Pen 85-100
Pen 120-150
Pen 200-300
A
VTS:
OK
Cancel
Asphalt Material Properties
Level: 1
Asphalt material type: Asphalt concrete
Layer thickness (in): 2
Asphalt Mix
Asphalt Binder
Asphalt General
Import
Export
Options - At Short Term Aging - RTFO
Superpave binder test data
Conventional binder test data
Number of temperatures: 3
Temperature (°F)
Angular frequency = 10 rad/sec
G* (Pa)
Delta (°)
158 1067 65.55
169 675 67.09
172 521 69.04
OK
Cancel
View HMA Plots


Unbound Layer - Layer #3
Unbound Material:
Crushed stone
Thickness(in):
8
Last layer
Strength Properties
ICM
Input Level
Level 1:
Level 2:
Level 3:
Poisson's ratio:
0.35
Coefficient of lateral pressure,Ko:
0.5
Analysis Type
ICM Calculated Modulus
ICM Inputs
User Input Modulus
Seasonal input (design value)
Representative value (design value)
Material Property
Modulus (psi)
CBR
R - Value
Layer Coefficient - ai
Penetration DCP (in
Based upon PI and Gradation
AASHTO Classification
Unified Classification
Modulus (input) (psi):
16679
View Equation
Calculate >>
OK
Cancel

Avant de voir les résultats: Les équations



Avant de voir les résultats: Les équations

Unbound Aggregate Bases and Subbases

$$IRI = IRI_O + 0.0463\left[SF\left(e^{\frac{age}{20}} - 1\right)\right] + 0.00119(TC_L)_T + 0.1834(COV_{RD}) + 0.00384(FC)_T$$
$$+ 0.00736(BC)_T + 0.00115(LC_{SNWP})_{MH} \tag{3.3.74a}$$

where:

IRI	=	IRI at any given time, m/km.
IRI_O	=	Initial IRI, m/km.
SF	=	Site factor (see equation 3.3.74b).
$e^{age/20} - 1$	=	Age term (where *age* is expressed in years).
COV_{RD}	=	Coefficient of variation of the rut depths, percent (assumed to be 20 percent).
$(TC_L)_T$	=	Total length of transverse cracks (low, medium, and high severity levels), m/km).
$(FC)_T$	=	Fatigue cracking in wheel path, percent total lane area
$(BC)_T$	=	Area of block cracking as a percent of total lane area (user input).
$(LC_{SNWP})_{MH}$	=	Length of moderate and high severity sealed longitudinal cracks outside wheel path, m/km (user input).

$$SF = \left(\frac{(R_{SD})(P_{.075}+1)(PI)}{2*10^4}\right) + \left(\frac{\ln(FI+1)(P_{02}+1)[\ln(R_m+1)]}{10}\right) \tag{3.3.74b}$$

where:

R_{sd}	=	Standard deviation of the monthly rainfall, mm.
P_{075}	=	Percent passing the 0.075 mm sieve.
PI	=	Percent plasticity index of the soil.
FI	=	Average annual freezing index, °C-days.
P_{02}	=	Percent passing the 0.02 mm sieve.
R_m	=	Average annual rainfall, mm.

Résultats

Project:

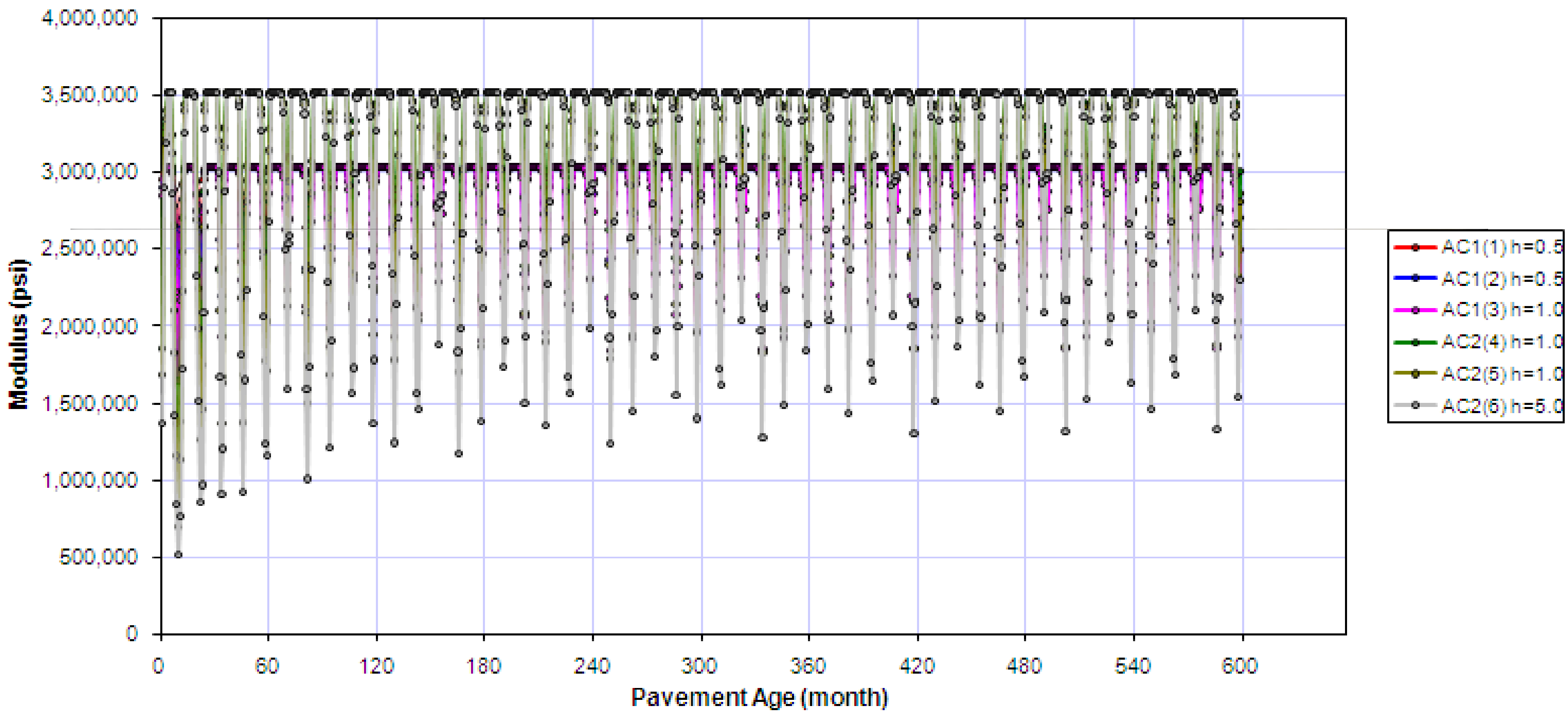
BQ_cas_1c_50ans_3

Reliability Summary

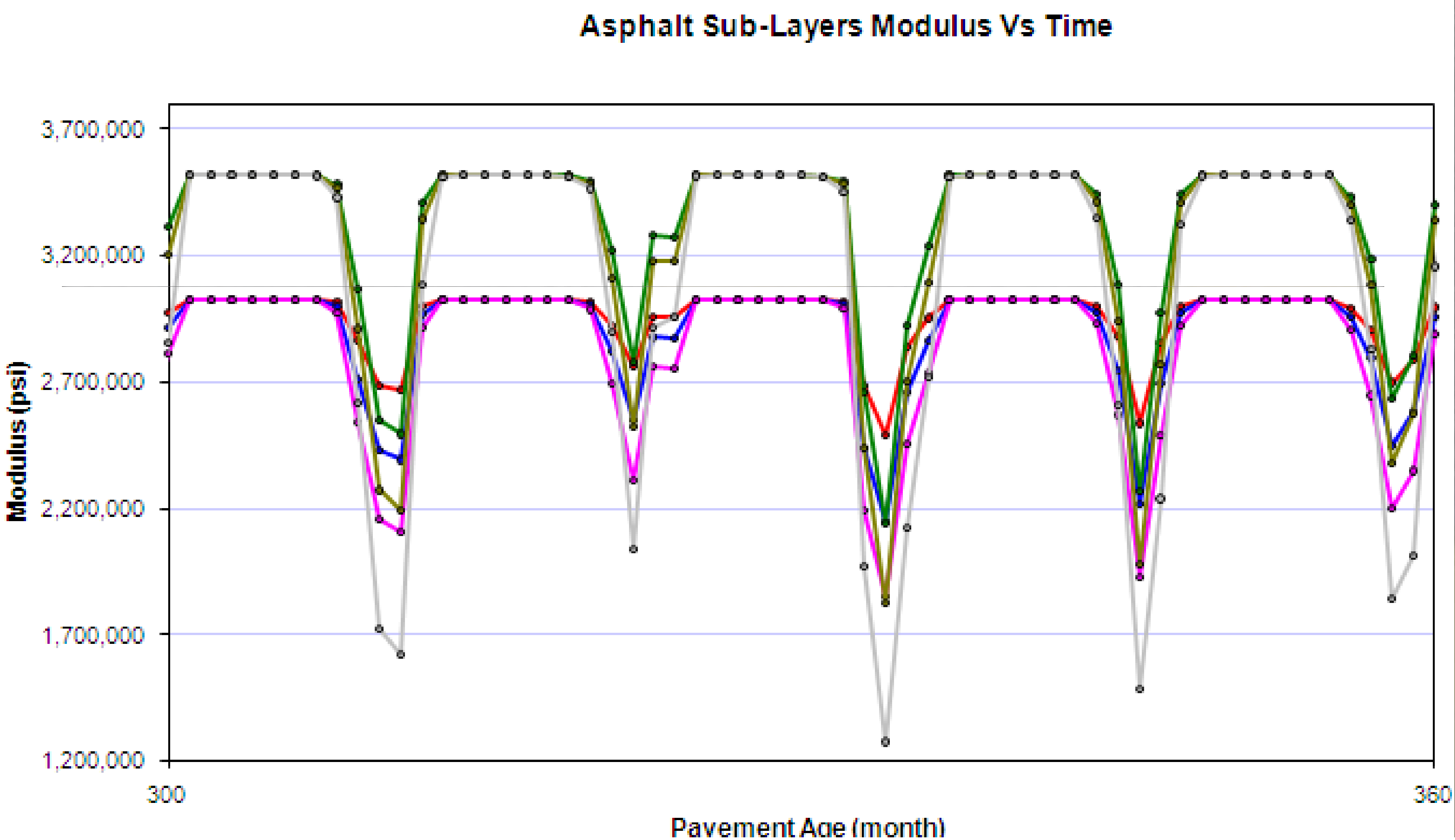
Performance Criteria	Distress Target	Reliability Target	Distress Predicted	Reliability Predicted	Acceptable
Terminal IRI (in/mi)	241	90	205	78.52	Fail
AC Surface Down Cracking (Long. Cracking) (ft/mile):	2000	90	0.1	99.999	Pass
AC Bottom Up Cracking (Alligator Cracking) (%):	25	90	1.3	99.999	Pass
AC Thermal Fracture (Transverse Cracking) (ft/mi):	1000	90	0	99.999	Pass
Chemically Stabilized Layer (Fatigue Fracture)	25	90			N/A
Permanent Deformation (AC Only) (in):	0.25	90	0.12	99.86	Pass
Permanent Deformation (Total Pavement) (in):	0.75	90	0.67	77.34	Fail

Résultats

Asphalt Sub-Layers Modulus Vs Time

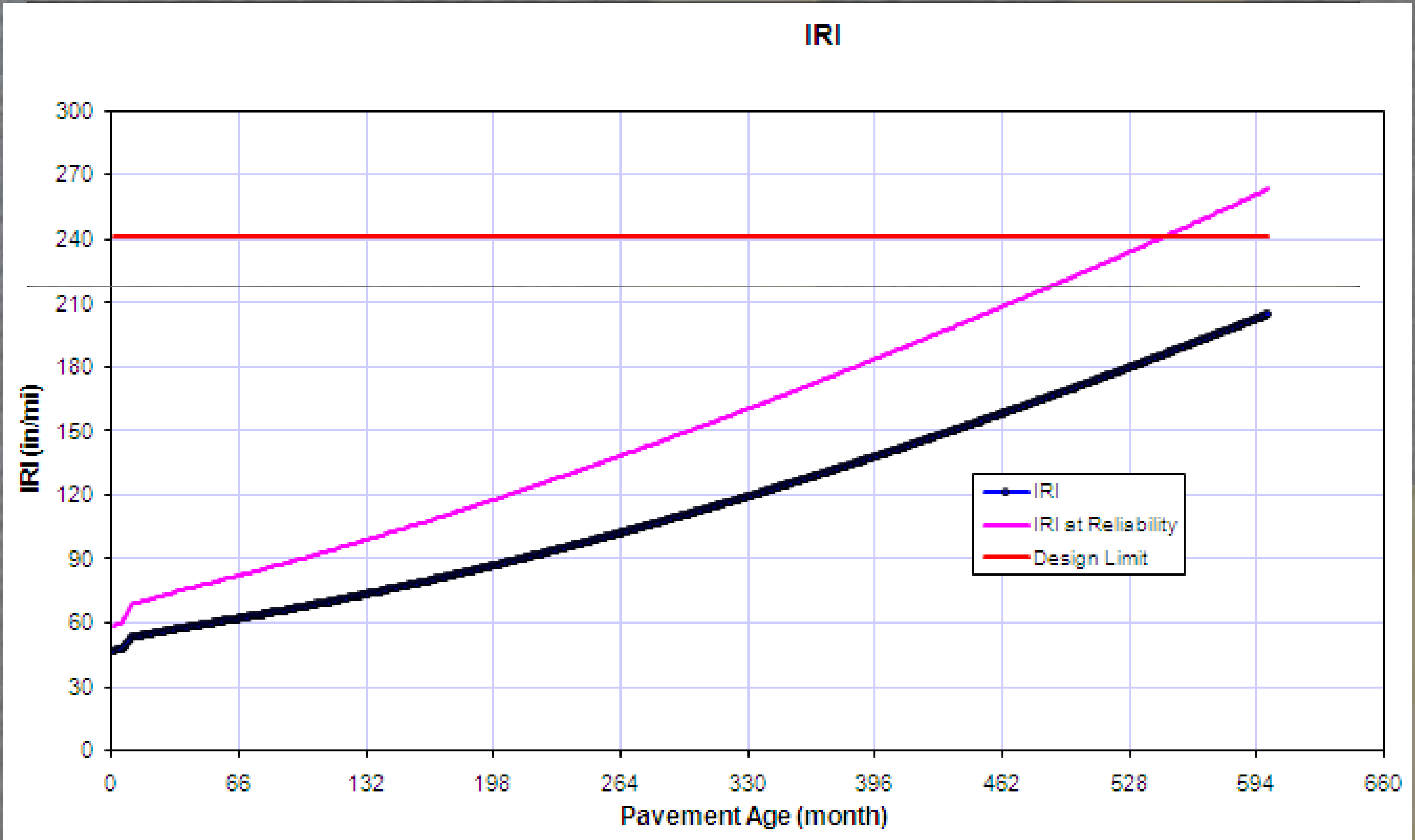


Résultats



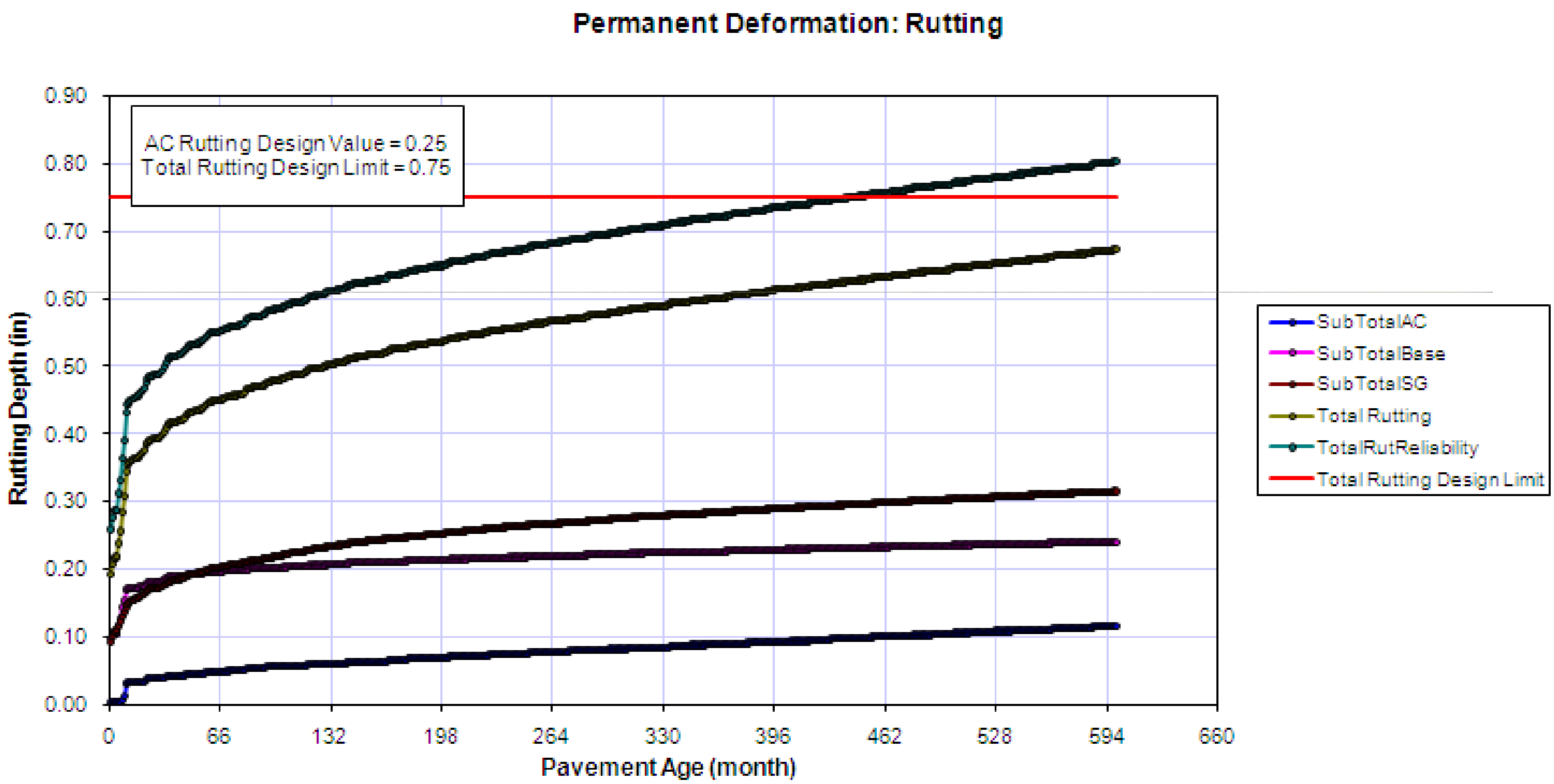
Asphalt Sub-Layers Modulus Vs Time
Modulus (psi)
3,700,000
3,200,000
2,700,000
2,200,000
1,700,000
1,200,000
300
360
Pavement Age (month)

Résultats



IRI
300
270
240
210
180
150
120
90
60
30
0
IRI (in/mi)
0
66
132
198
264
330
396
462
528
594
660
Pavement Age (month)
IRI
IRI at Reliability
Design Limit

Résultats



Permanent Deformation: Rutting
AC Rutting Design Value = 0.25
Total Rutting Design Limit = 0.75
Rutting Depth (in)
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
66
132
198
264
330
396
462
528
594
660
Pavement Age (month)
SubTotalAC
SubTotalBase
SubTotalSG
Total Rutting
TotalRutReliability
Total Rutting Design Limit

Résultats - autoroute

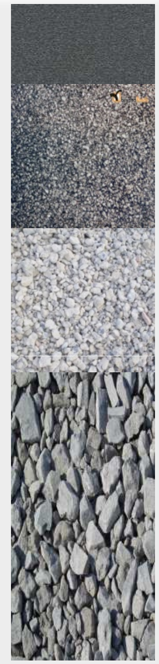
ESG-10 50mm

GB-20 175mm

MG-20 200mm

MG-112 750mm

IRI	45 ans
Fiss. (haut-bas)	> 50 ans
Fiss. (bas-haut)	>50 ans
Fiss. thermique	>50ans
Orni. enrobés	>50 ans
Orni. total	36 ans



ESG-10 100mm

MR-5 150mm

MG-20 200mm

MG-112 750mm

IRI	44 ans
Fiss. (haut-bas)	> 50 ans
Fiss. (bas-haut)	>50 ans
Fiss. thermique	>50ans
Orni. enrobés	>50 ans
Orni. total	25 ans

Résultats - urbain

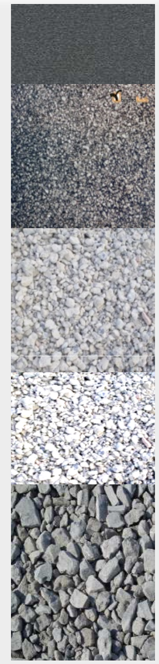
ESG-10 60mm

GB-20 110mm

MG-20 213mm

MG-112 575mm

IRI	>30 ans
Fiss. (haut-bas)	27 ans
Fiss. (bas-haut)	>30 ans
Fiss. thermique	>30ans
Orni. enrobés	>30 ans
Orni. total	25 ans



ESG-10 30mm

MR-5 traité 150mm

MR-5 150mm

MG-20 100mm

MG-112 450mm

IRI	44 ans
Fiss. (haut-bas)	> 50 ans
Fiss. (bas-haut)	>50 ans
Fiss. thermique	>50ans
Orni. enrobés	>50 ans
Orni. total	25 ans


WE'RE
WORKING
ON IT

Conclusions

- Méthode complète et complexe
- Besoin d'intrants non disponible
- Modèle de dégradation à revoir
- Pas de dimensionnement au gel

- Il reste beaucoup de travail à faire

Merci de votre attention