



# NIGERIAN BUILDING AND ROAD RESEARCH INSTITUTE

FEDERAL MINISTRY OF INNOVATION, SCIENCE AND TECHNOLOGY



## 2nd International Workshop on GLOBAL TRENDS IN DESIGNS & CONSTRUCTION OF DURABLE ROAD PAVEMENTS



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**IR. KASBERGEN COR**  
Delft University of Technology

**DATE: 24TH - 28TH NOVEMBER, 2025 | TIME: 8AM PROMPT**

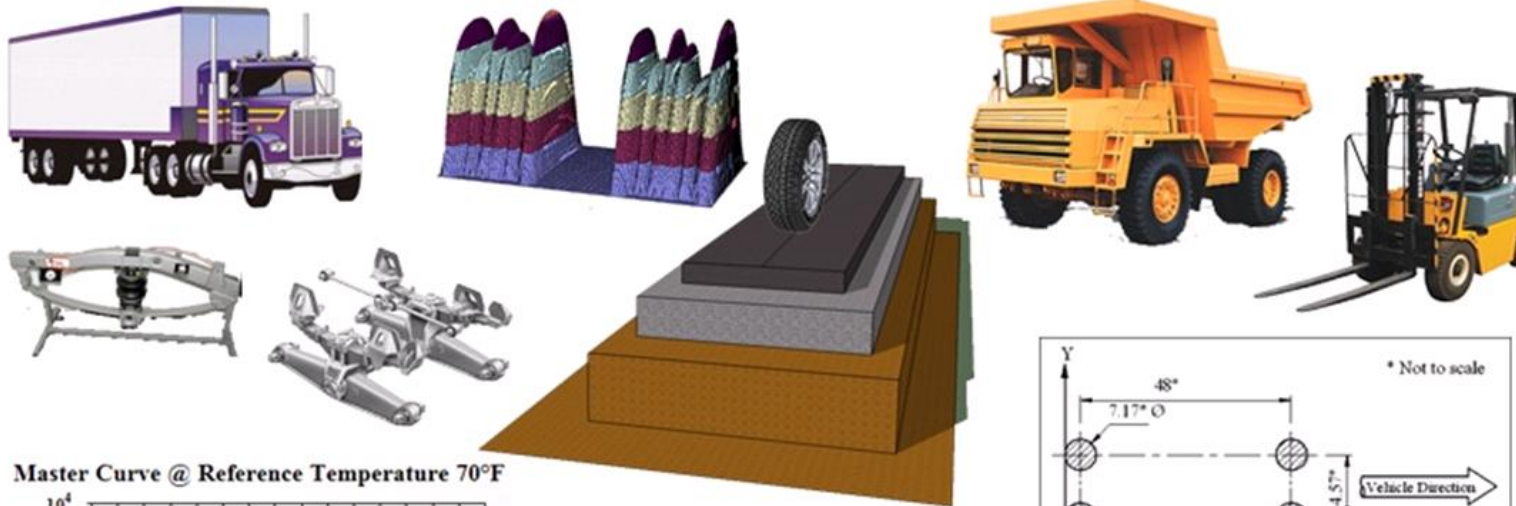
**SUPPORTED BY:**



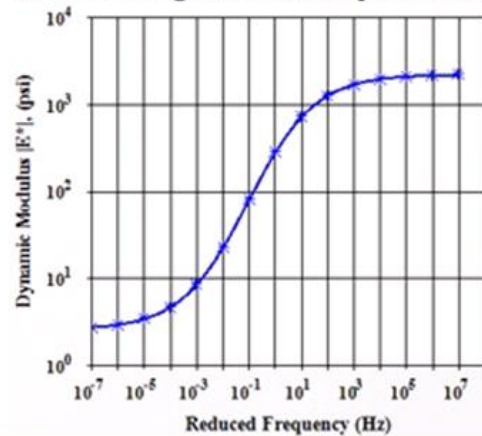
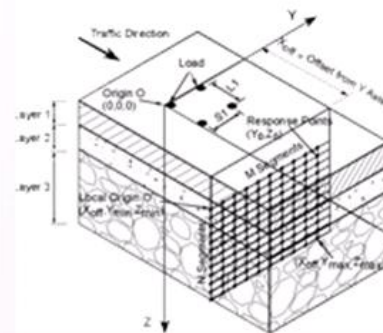


University of Nevada  
Reno

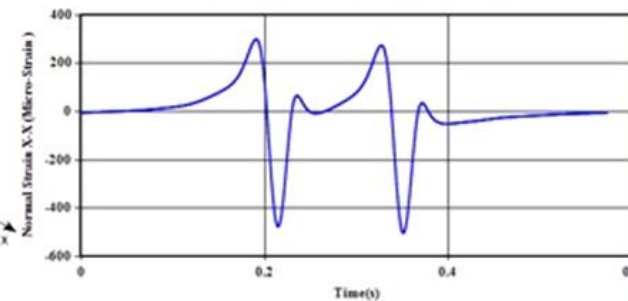
# 3D-Move Analysis (Ver 2.1)



Master Curve @ Reference Temperature 70°F

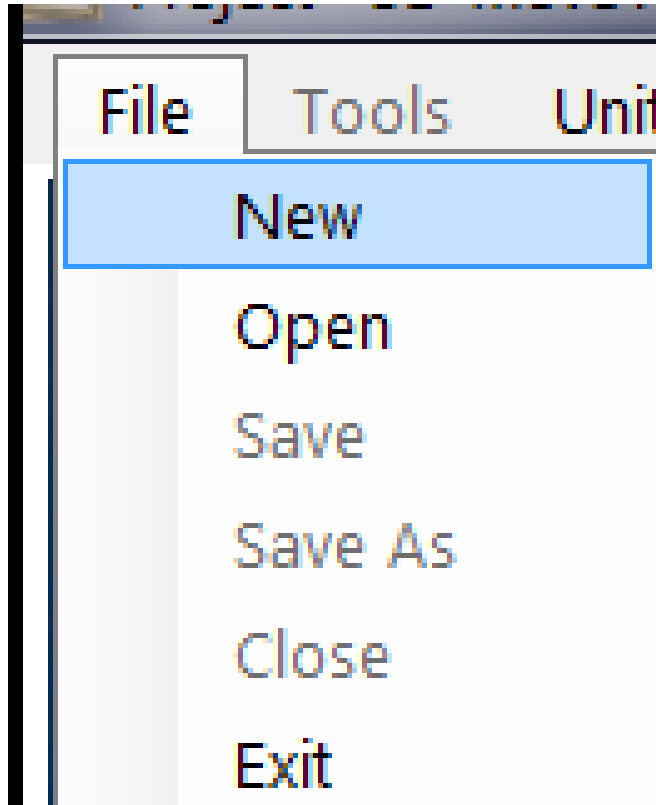


Normal Strain in X Direction Vs Time



<http://www.arc.unr.edu/Software.html>

Step 1: Click on **File**

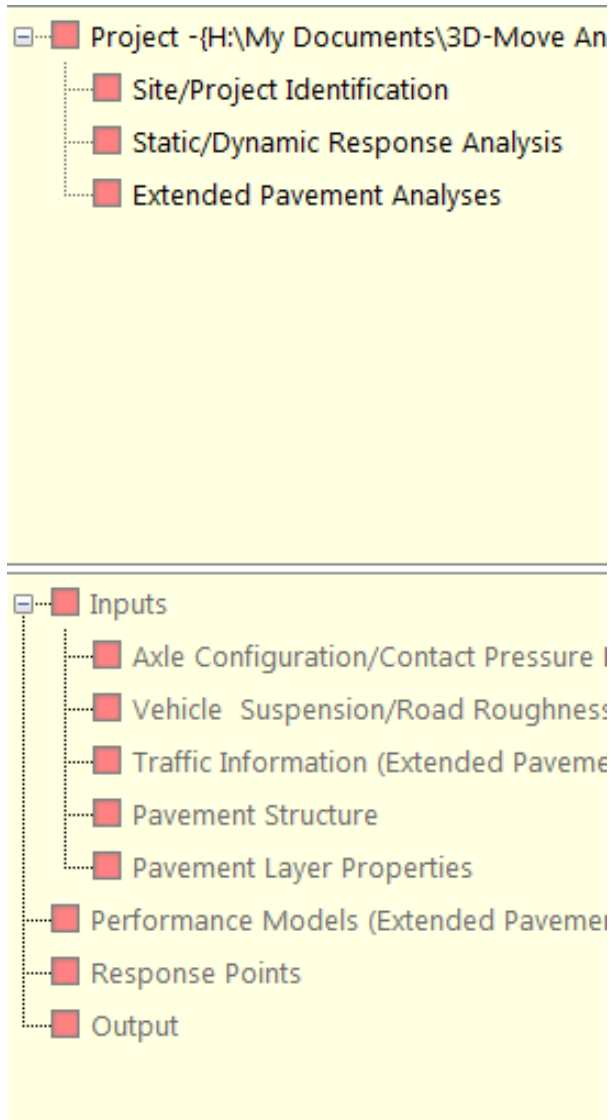


Step 2: Click on **New**

Project name

Project Folder: Choose local drive to save your files

These red dots should turn green!



Step 3: Click on **Site/Project Identification**

Site/ Project Identification

|                      |                                                                       |
|----------------------|-----------------------------------------------------------------------|
| Location             | <input type="text"/>                                                  |
| Project ID           | <input type="text"/>                                                  |
| Section ID           | <input type="text"/>                                                  |
| Date of Construction | Thursday , September 29, 2016 <input type="button" value="Calendar"/> |

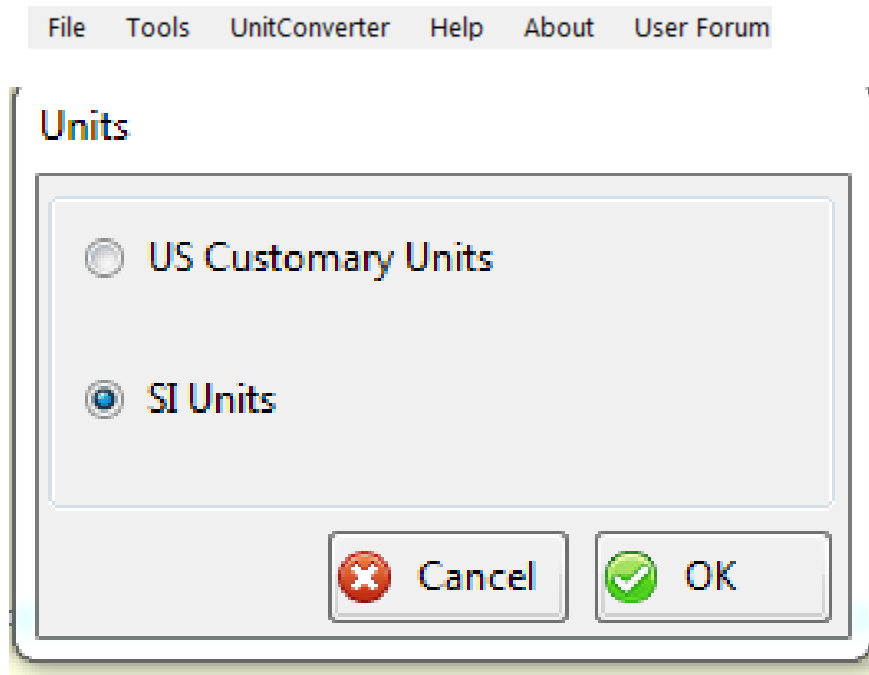
|                           |                      |
|---------------------------|----------------------|
| Station / Milepost Format | <input type="text"/> |
| Station / Milepost Begin  | <input type="text"/> |
| Station / Milepost End    | <input type="text"/> |
| Traffic Direction         | <input type="text"/> |

Project Description

asghe

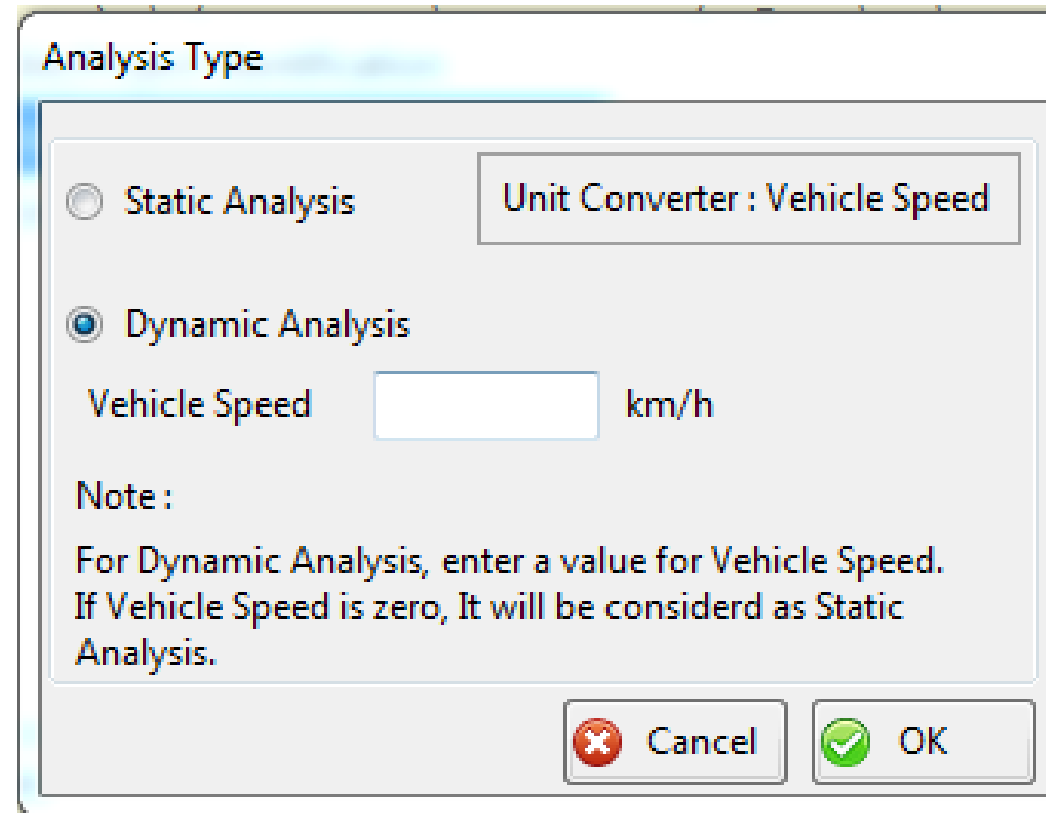
Enter “**Global trend workshop**” at Project Description  
Click ok

## Step 4: Click on Tools



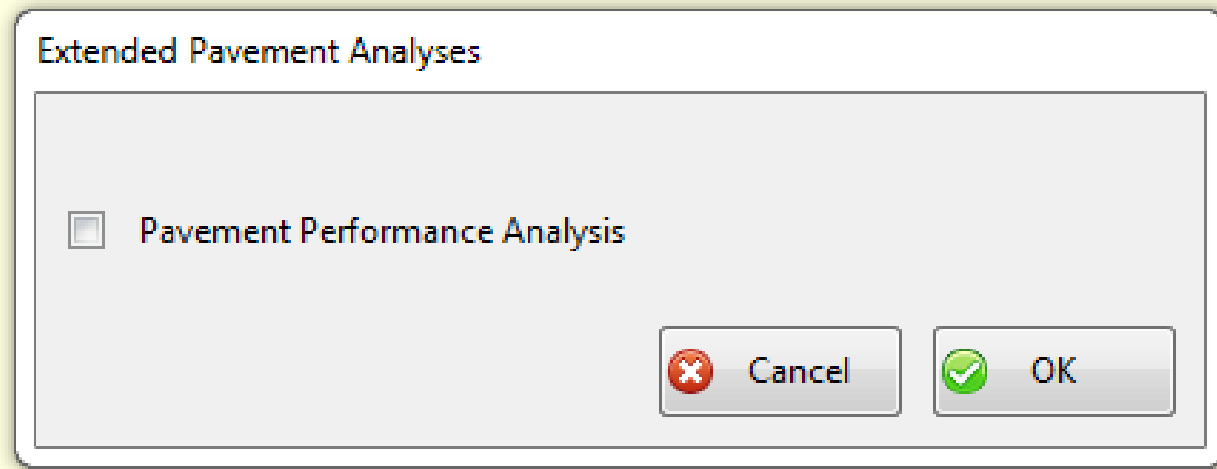
Choose SI units  
and click ok

## ➤ Step 5: Click on Static/Dynamic Response Analysis



5a. Choose  
Dynamic  
Analysis  
5b. Put 10  
km/h as  
Vehicle Speed  
Then press ok

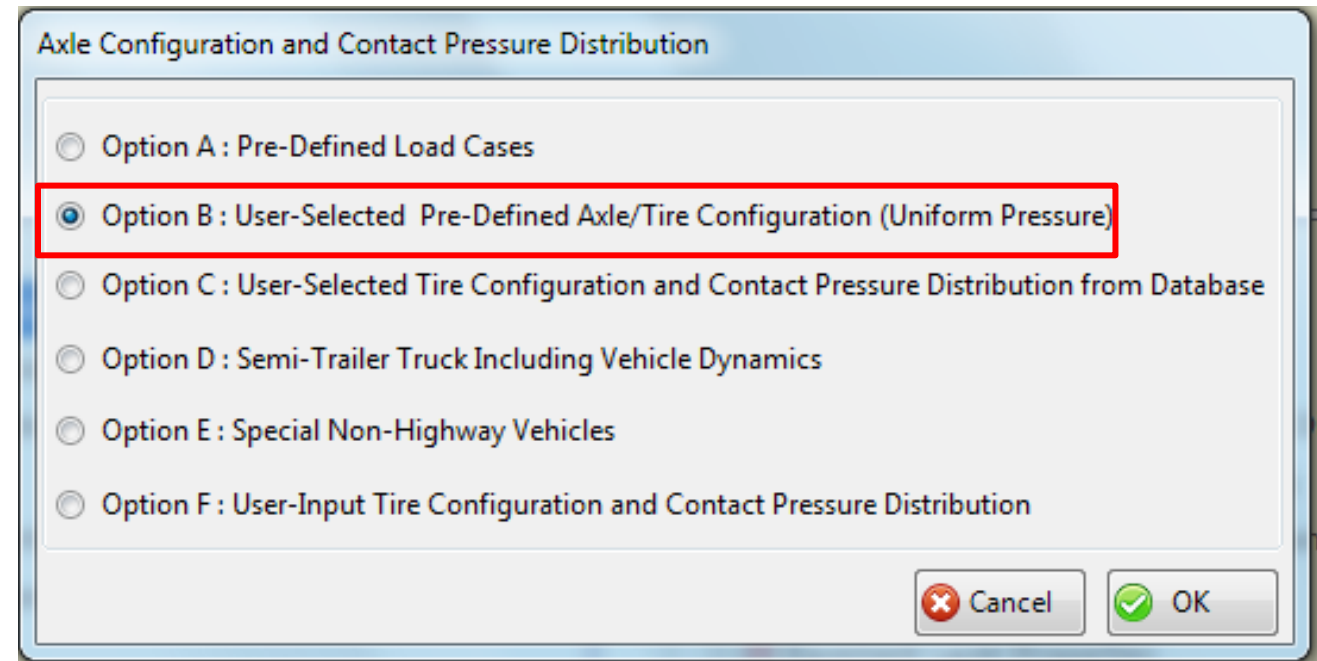
## Step 6: Extended Pavement Analyses



➤ Step 7: Click on **Axle Configuration/Contact Pressure Distribution**

✓ Please tick the box

Choose option B and press OK



# Step 8: Axle Configuration / Contact Pressure distribution

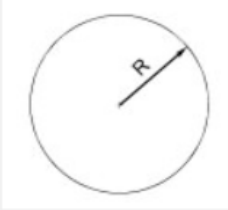
Option B : User-Selected Pre-Defined Axle/Tire Configuration (Uniform Pressure)

Reference Title for Axle SINGLE AXLE LOAD

Tire Pressure  kPa      Tire Load  kN

Geometry of Loaded Area

☒ Circle  
☐ Ellipse  
☐ Rectangle



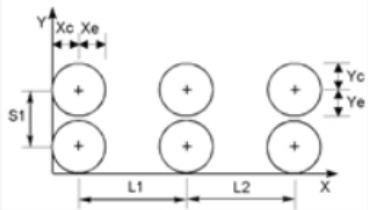
Note :

$$R = \sqrt{\frac{\text{Tire Load}}{\pi \times \text{Tire Pressure}}}$$

Calculated R  m

Axle Spacing

L1  m  
L2  m  
S1  m



Xc = 0.112 m      Yc = 0.112 m  
Xe = 0.112 m      Ye = 0.112 m

Friction Coefficient

☐ Rolling Friction Coefficient   
☐ Braking Friction Coefficient

Note :  
Default for Friction Coefficient is zero.

Note :

1. As many as , six Single Loaded Areas can be specified
2. A Single Tire can be represented by using S1 = L1 = L2 = 0
3. A Single Axle Dual Tire can be represented by L1 = L2 = 0 and S1 ≠ 0
4. A Tandem Axle Dual Tire can be represented by L2 = 0 and S1 ≠ 0 , L1 ≠ 0
5. L1 > Xc+Xe, L2 > Xc+Xe, and S1 > Yc+Ye.

Tire pressure:

512 kPa

Tire load: 20 kN

L1=0

L2=0

S1=0

# DLC

- ☒ No DLC
- ☐ DLC from Database
- ☐ DLC from Regression

# Traffic Information

Traffic Information

|                                                                                   |        |  |  |  |
|-----------------------------------------------------------------------------------|--------|--|--|--|
| Number of Seasons/Periods                                                         | 1      |  |  |  |
| Name of the Seasons/Periods                                                       | Spring |  |  |  |
| Duration of the Seasons/Periods (Months)<br>(computed in twelve month increments) | 12     |  |  |  |
| One-way average daily repetitions of design axle                                  | 200    |  |  |  |
| Percentage of design axles in design lane (%)                                     | 90     |  |  |  |
| Design axle growth rate (%)                                                       | 0      |  |  |  |

☒ Linear growth  
☐ Compound growth

Design Life (Years) 15

Design axle repetitions per Season/Period 972,000

Total design axle repetitions 972,000

Cancel OK

Response Points

Text Mode - (Note

Design Life: 15

## Step 9: Click at Pavement Structure

Pavement Structure

Unit Converter : Length

| Layer No | Layer Type | Material Charaterization | Thickness (m) |
|----------|------------|--------------------------|---------------|
|----------|------------|--------------------------|---------------|

Note :  
-Layer No.1 represents the top/surface layer  
-For semi infinite depth, enter zero for last layer.

 Add  Delete  Cancel  OK

Click at +Add

## Step 9: Click at Layer Type and fill Thickness

Pavement Structure

Unit Converter : Length

| Layer No | Layer Type                                           | Material Charaterization | Thickness (m) |
|----------|------------------------------------------------------|--------------------------|---------------|
| 1        | <div>Asphalt<br/>Base<br/>Subbase<br/>Subgrade</div> |                          |               |

Note :  
-Layer No.1 represents the top/surface layer  
-For semi infinite depth, enter zero for last layer.

 Add  Delete  Cancel  OK

Choose Asphalt

## Step 9: Fill details for all Layers

### Pavement Structure

Unit Converter : Length

| Layer No | Layer Type | Material Charaterization    | Thickness (m) |
|----------|------------|-----------------------------|---------------|
| 1        | Asphalt ▼  | Linear Elastic/Viscoelastic | 0.1           |
| 2        | Base ▼     | Linear Elastic              | 0.2           |
| 3        | Subbase ▼  | Linear Elastic              | 0.2           |
| 4        | Subgrade ▼ | Linear Elastic              | 1             |

Note :

- Layer No.1 represents the top/surface layer
- For semi infinite depth, enter zero for last layer.

 Add

 Delete

 Cancel

 OK

# Step 10: Click at "Layer1 – Asphalt"

Click on Asphalt Binder Properties

Pavement Layer Properties - Layer 1

Material Type

- Linear Elastic Materials
- Viscoelastic Materials
  - Laboratory Data
    - Symmetrical Sigmoidal Function
    - Non-Symmetrical Sigmoidal Function
    - Symmetrical Sigmoidal Function (AMPT)
    - User Input (Interpolation)
  - Model Equation

Choose No of Temperature = 3  
Frequencies = 6  
Reference Temperature = 50

Asphalt Mixture Properties | Asphalt Binder Properties | [E\*] Master Curve | Asphalt General

Dynamic Modulus, [E\*] | Damping Ratio and Poisson's Ratio

No of Temperatures 3 | No of Frequencies 6 | Reference Temperature 50 °C

| Temperature (°C) | Dynamic Modulus [E*], ( kPa ) |             |             |             |             |             |
|------------------|-------------------------------|-------------|-------------|-------------|-------------|-------------|
|                  | 0.1 Hz                        | 0.5 Hz      | 1 Hz        | 5 Hz        | 10 Hz       | 25 Hz       |
| 25               | 65000                         | 152240.5081 | 286408.5265 | 1306961.92  | 2196936.795 | 3144961.584 |
| 50               | 55459.92                      | 129896.1    | 244372.22   | 1115138.55  | 1874491.43  | 2683374.2   |
| 75               | 40000                         | 93686.46651 | 176251.401  | 804284.2582 | 1351961.105 | 1935360.975 |

Damping Ratio and Poisson's Ratio

Constant Damping Ratio = 0  
Constant Poisson's ratio = 0.35

Cancel OK

Pavement Layer Properties - Layer 1

Material Type

- Linear Elastic Materials
- Viscoelastic Materials
  - Laboratory Data
    - Symmetrical Sigmoidal Function
    - Non-Symmetrical Sigmoidal Function
    - Symmetrical Sigmoidal Function (AMPT)
    - User Input (Interpolation)
  - Model Equation

Layer Thickness 0.12 m

Symmetrical Sigmoidal Function (MEPDG)

$$\log E^* = \delta + \frac{\alpha}{1 + e^{\beta + \gamma [\log(t) - c(\log(\eta) - \log(\eta_{Tr}))]}}$$

Asphalt Mixture Properties | Asphalt Binder Properties | [E\*] Master Curve | Asphalt General

Asphalt Binder Properties Used in the Development of the mixture's Dynamic Modulus Master Curve

Input Level 2

Binder Properties

- ☐ Superpave Binder Grade
- ☐ Conventional AC Grade
- ☒ Conventional Penetration Grade

Conventional Penetration Grading

- ☒ Pen 40 - 50
- ☐ Pen 60 - 70
- ☐ Pen 85 - 100
- ☐ Pen 120 - 150
- ☐ Pen 200 - 300

Note:  
For Level 2, Only the A - VTS for the short-term aged asphalt binder (RTFO-aged) is Provided.

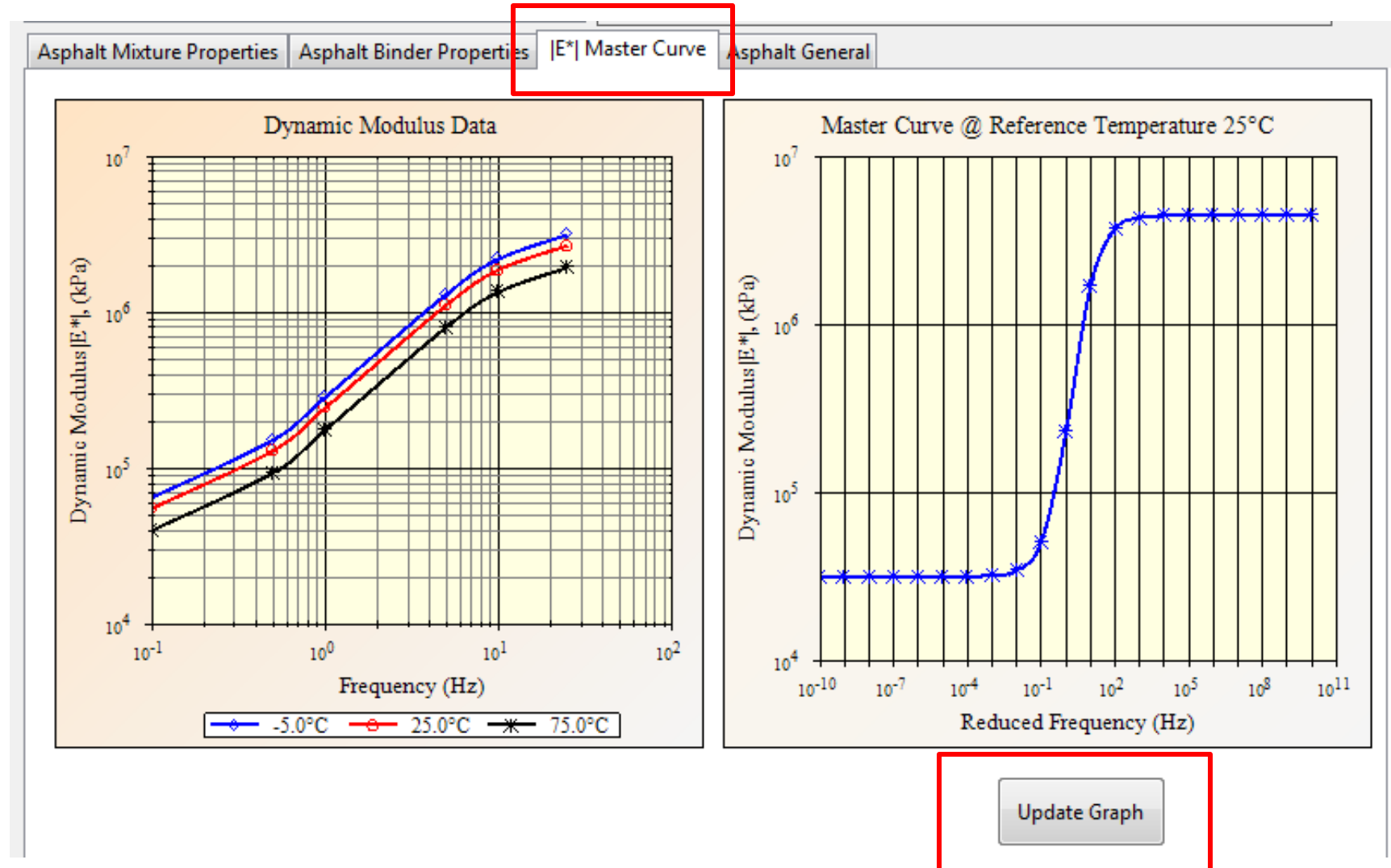
VTS -3.901

Input Level: 2

Conventional Penetration Grade  
then  
Pen 60-70

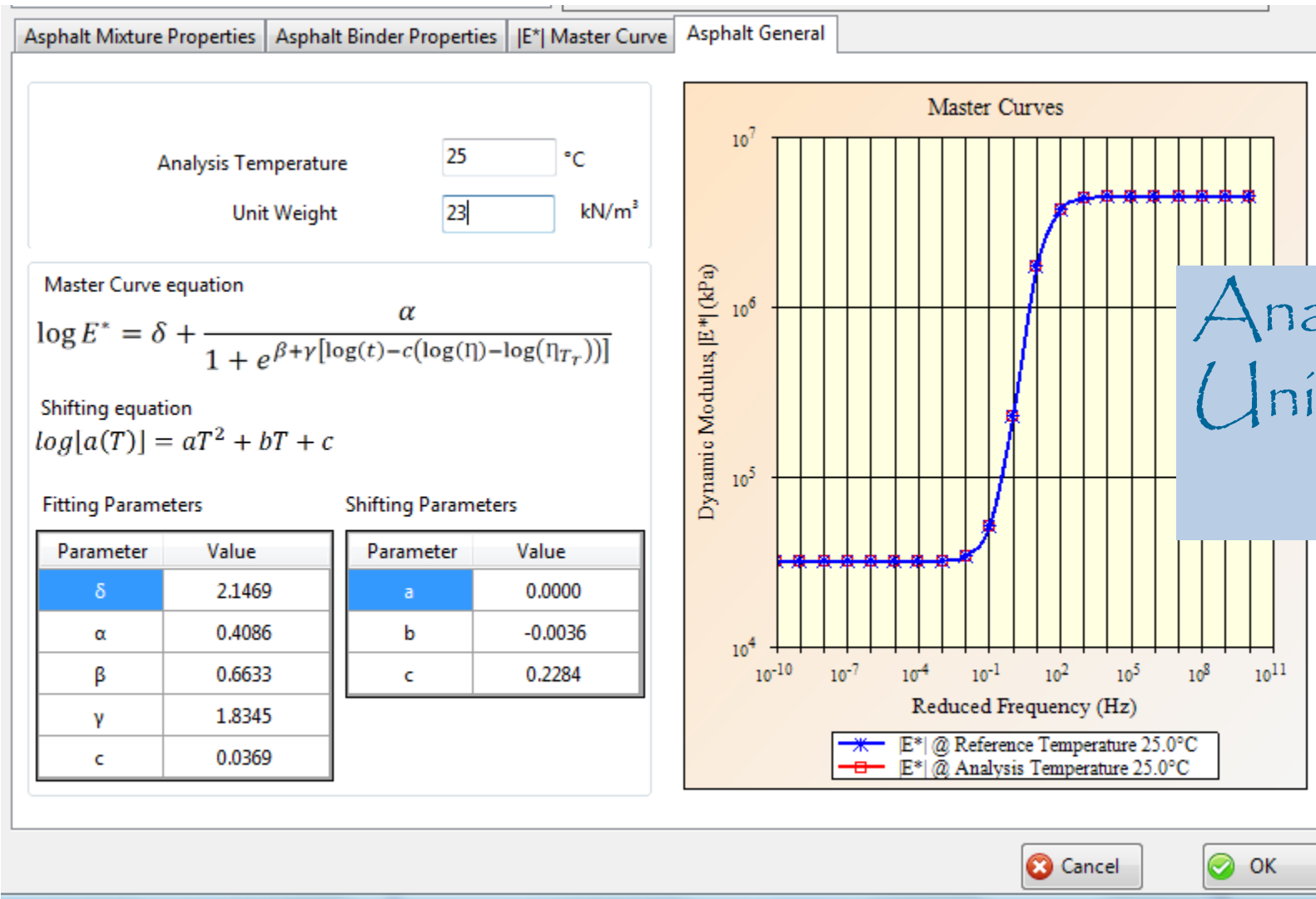
## Step 10: Click at “Layer1 – Asphalt”

➤ Click on “E\* Master Curve tab”



# Step 10: Click at “Layer1 – Asphalt”

➤ Click at “Asphalt General tab”



Analysis temp = 50  
Unit Weight = 23  
press ok

## Step 11: Click at “Layer2 –Base”

Pavement Layer Properties - Layer 2

Layer 2      Thickness    0.2    m

Material

Standard Material Type    A-1-a    ▼

Range of E value is between 265448 - 289580.  
Typical Value of E is 275790

☒ Elastic Modulus, E    172000    kPa

☐ CBR   

☐ R Value   

Poisson's Ratio    0.35

Damping Ratio    0    %

Unit Weight    21    kN/m<sup>3</sup>

Depth to Ground Water Table        m  
(Measured from the pavement surface)

Depth to Bed Rock        m  
(Measured from the last layer surface)

Standard Material A-1-a  
Elastic Modulus E=172000  
Poisson's ratio = 0.35  
Damping ratio=0  
Unit weight= 21

Press ok

## Step 12: Click at “Layer3 –Subbase”

Pavement Layer Properties - Layer 3

Layer 3      Thickness    0.2    m

Material

Standard Material Type    A-1-a    ▼

Range of E value is between 265448 - 289580.  
Typical Value of E is 275790

☒ Elastic Modulus, E    100000    kPa

☐ CBR   

☐ R Value   

Poisson's Ratio    0.35

Damping Ratio    0    %

Unit Weight    21    kN/m<sup>3</sup>

Depth to Ground Water Table        m  
(Measured from the pavement surface)

Depth to Bed Rock        m  
(Measured from the last layer surface)

Standard Material A-1-a  
Elastic Modulus E=100000  
Poisson's ratio = 0.35  
Damping ratio=0  
Unit weight= 21

Press ok

## Step 13: Click at “Layer4 –Subgrade”

Pavement Layer Properties - Layer 4

Layer 4      Thickness    1    m

Material

Standard Material Type    A-1-a    ▾

Range of E value is between 265448 - 289580.  
Typical Value of E is 275790

☒ Elastic Modulus, E    50000    kPa

☐ CBR   

☐ R Value   

Poisson's Ratio    0.35

Damping Ratio    0    %

Unit Weight    21    kN/m<sup>3</sup>

Depth to Ground Water Table        m  
(Measured from the pavement surface)

Depth to Bed Rock        m  
(Measured from the last layer surface)

Standard Material A-1-a  
Elastic Modulus E=50000  
Poisson's ration = 0.35  
Unit weight= 21

Press ok

## Step 14: Click on performance models

Performance Models

☒ NCHRP (1-37A) Models [Info](#)

|                                                                 | Limiting Values | Reliability |
|-----------------------------------------------------------------|-----------------|-------------|
| <input checked="" type="checkbox"/> AC Top Down Cracking (m/km) | 379             | 90          |
| <input checked="" type="checkbox"/> AC Bottom Up Cracking (%)   | 25              | 90          |
| <input checked="" type="checkbox"/> AC Rutting (mm)             | 6.35            | 90          |
| <input checked="" type="checkbox"/> Base Rutting (mm)           | 7.62            | 90          |
| <input checked="" type="checkbox"/> Subbase Rutting (mm)        | 6.35            | 90          |
| <input checked="" type="checkbox"/> Subgrade Rutting (mm)       | 5.08            | 90          |

☐ VESYS Models [Info](#)

|                                                     |  |  |
|-----------------------------------------------------|--|--|
| <input type="checkbox"/> Fatigue Cracking (%)       |  |  |
| <input type="checkbox"/> Layer Rutting (mm)         |  |  |
| <input type="checkbox"/> System Rutting (mm)        |  |  |
| <input type="checkbox"/> Roughness (Slope Variance) |  |  |

Click VESYS models

Click ok

Click Next – Next – Next – Next – ok

## ➤ Step 15: Click at “Output”

The screenshot displays the software's hierarchical tree on the left and the 'Output' dialog box in the center. In the tree, the 'Output' item is highlighted with a red box. The 'Output' dialog box is open, showing various output categories. A red rectangle highlights the 'Principal Stresses' and 'Principal Strains' checkboxes, which are both checked. A red arrow points from this area towards the 'Run Analysis' button on the right.

**Inputs**

- Axle Configuration/Contact Pressure
- Vehicle Suspension/Road Roughness
- Traffic Information (Extended Pavement)
- Pavement Structure
- Pavement Layer Properties
  - Layer 1- Asphalt
  - Layer 2- Base
  - Layer 3- Subgrade
- Performance Models (Extended Pavement)
- Response Points
- **Output**

**Output**

**Stresses**

- $\sigma_{xx}$  Normal Stress in X direction
- $\sigma_{yy}$  Normal Stress in Y direction
- $\sigma_{zz}$  Normal Stress in Z direction
- $\tau_{xy}$  Shear Stress in XY direction
- $\tau_{xz}$  Shear Stress in XZ direction
- $\tau_{yz}$  Shear Stress in YZ direction
- ☒ Principal Stresses

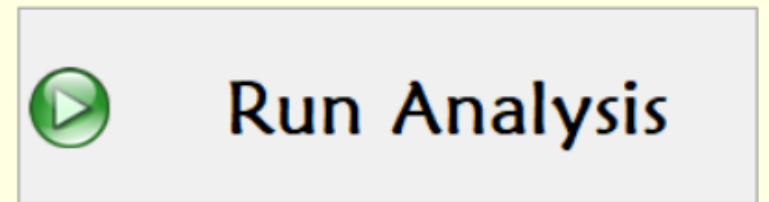
**Strains**

- $\epsilon_{xx}$  Normal Strain in X direction
- $\epsilon_{yy}$  Normal Strain in Y direction
- $\epsilon_{zz}$  Normal Strain in Z direction
- $\gamma_{xy}$  Shear Strain in XY direction
- $\gamma_{xz}$  Shear Strain in XZ direction
- $\gamma_{yz}$  Shear Strain in YZ direction
- ☒ Principal Strains

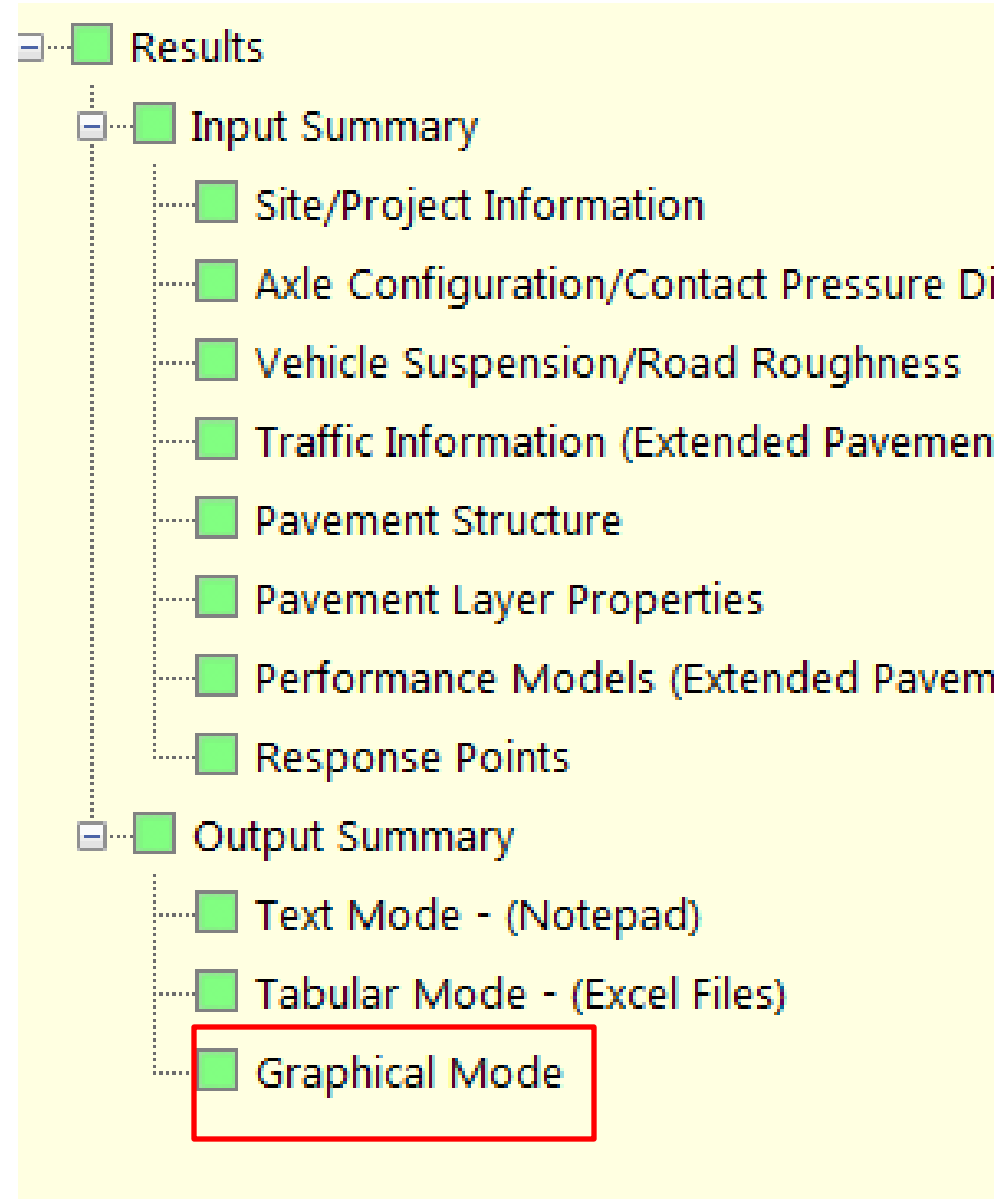
**Displacements**

- u - Displacement in X direction
- v - Displacement in Y direction
- w - Displacement in Z direction

Cancel OK



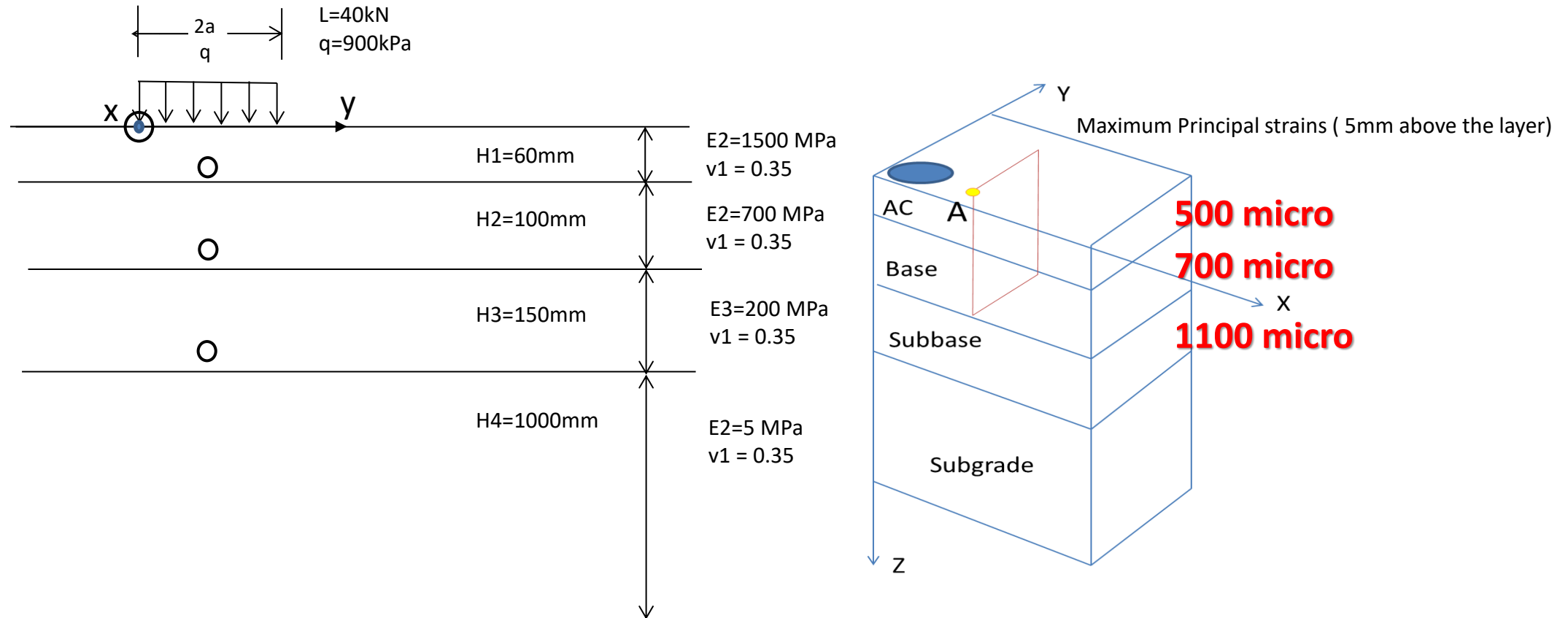
➤ Step 16: Click at Graphical mode to check



## Practice

You asked a contractor to design an asphalt pavement considering linear elastic properties (see figure below). The contractor came up with a thickness design as shown in the figure below.

Your first task is to evaluate the contractor's proposed thickness design against the maximum strain that your chose of materials can take.(see in bold the in right side of the figure below). If the proposed design criterial fails, please propose a new thickness for the layer(s) that does not meet your requirement for the layer thickness



**Thank you**