

**STATE OF OHIO
DEPARTMENT OF TRANSPORTATION
SUPPLEMENT 1033
HIPERPAV REQUIREMENTS FOR CONCRETE PAVEMENT**

July 15, 2011

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1033.01 Scope.

This supplement provides guidelines for the use of HIPERPAV software. Use HIPERPAV III (3.0) or later version to determine the risk of early age cracking of Portland Cement Concrete Pavement.

HIPERPAV III (3.0) cannot be used with slag aggregate. Refer questions to the Office of Materials Management if using slag aggregate.

1033.02 Acquiring Software.

HIPERPAV software is a computer program initially developed by FHWA research. The software determines the risk of early age cracking in Portland Cement Concrete Pavement within the first 72 hours of construction. The software uses environmental, material, design, and construction condition inputs in its evaluation.

Acquire a copy of the software from

The Transtec Group, Inc.
1012 East 38 ½ Street
Austin, Texas 78751
Web Page: <http://www.transtecinc.com/>

Any costs associated with this software are incidental to 451.

1033.03 Contractor Submittal Requirements for HIPERPAV.

Conforming to the requirements of 451.08, HIPERPAV will be used on all concrete pavement projects to evaluate early age cracking of concrete pavement.

An individual HIPERPAV file will be provided for each scheduled concrete pavement operation. Develop the HIPERPAV file to include all inputs to properly run the file and document the probability of early age cracking is eliminated. Each HIPERPAV file will include contractor-determined strategies for variables (i.e. weather, change in concrete temperature, construction time) that could influence early age cracking of the pavement.

Provide the completed HIPERPAV file and reports to the Engineer at least 24-hours before the actual concrete placement.

Upload the file into the Engineer's HIPERPAV software and review the inputs used and the analyses. Agree on the inputs and the strategy runs to validate that the scheduled paving time, materials, processes, and environmental factors will not create early age cracking in the pavement to be placed. If the Engineer does not agree, make modifications to the strategies to show either the concrete pavement can be placed without cracking or a delay of the operation is required.

HIPERPAV software guidelines with screen examples are provided in this Supplement.

1033.04 ODOT Standard Input Requirements for HIPERPAV.

A completed HIPERPAV software file will require inputs specified by the Department and Contractor selected inputs.

1033.05 provides an initial example for creating a HIPERPAV file. It includes required inputs and examples, and details on inputting the information into the software. While the 1033.05 example has all ODOT standard inputs incorporated, a separate list is provided below. The list includes the HIPERPAV screen name, the input requirement, and the 1033.05 section where the screen and input can be seen.

| Supplement Section | HIPERPAV Screen Name | ODOT Required Input |
|---------------------------|-----------------------------|---|
| 1033.05.A | New Project Screen | Select: "Early Age JPCP option" |
| 1033.05.B | Project Information Screen | Project Name = project number and date Project ID = Route and county Begin Sta. = Beginning pavement station for the file run. End Sta. = Ending pavement station for this file run. |
| 1033.05.C | Geography | Find and select the location of the project on the geography map |
| 1033.05.D | Monthly Weather Data | Select the option: "Estimate Monthly Data from Location" |
| 1033.05.E | Strategy Information | Input User Name: Contractor or Sub-contractor. |

| Supplement Section | HIPERPAV Screen Name | ODOT Required Input |
|---------------------------|--|---|
| 1033.05.F | Design: General, Geometry | “Reliability Level”: Input 95% Input the slab thickness, the slab width and the transverse joint spacing |
| 1033.05.G | Design: Dowels | No input (screen not used) |
| 1033.05.H | Design: Slab Support | “Base Material”: From the pull down menu select the base material type being used. “Base Properties”: Input the thickness of the base material. Select “User-Defined Modulus” and input the modulus from the list in 1033.05 H. “Subgrade Stiffness Type”: Select “Use Subgrade Modulus” and input a value of 7200 psi. “Axial Restraint”: Select “Estimate from Material Type”. |
| 1033.05.I | Materials and Mix Design: Cement | Select “ASTM Cement Type Classification” and input the type of ASTM cement being used. For “Blaine Fineness Index” select “Estimate from Cement Type”. |
| 1033.05.J | Materials and Mix Design: PCC Mix | Input the coarse aggregate to be used in the concrete mix. Input the admixtures to be used. Select fly ash type. Input the concrete mix design’s batch proportions. |
| 1033.05.K | Materials and Mix Design: PCC Properties | Select “compressive strength” for Strength Type and input the 28 Day Strength (STR) in psi. For Strength Coefficients select “Estimate from Strength Type”. For PCC 28 Day Modulus select “Estimate from Strength”. For PCC Ultimate Shrinkage select “Estimate from Mix”. For Coefficient of Thermal Expansion select “Estimate from Aggregate type”. |
| 1033.05.L | Materials and Mix Design Maturity Data | <u>Minimum</u> requirement - select “Default Strength Gain”. |
| 1033.05.M | Construction | Strength for opening to traffic – Use 2500 psi. Complete all inputs on this screen with contractor selected information. |

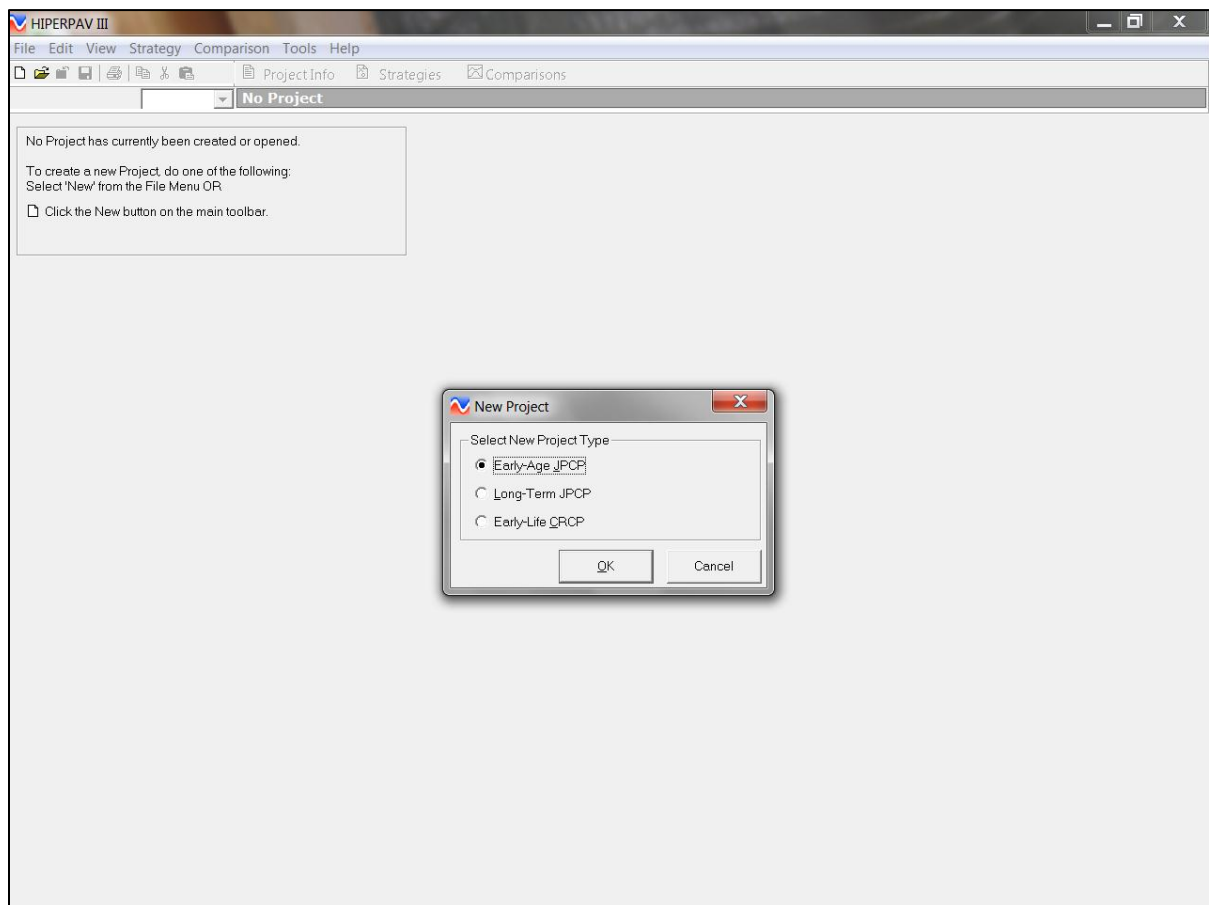
| Supplement Section | HIPERPAV Screen Name | ODOT Required Input |
|--------------------|----------------------|--|
| 1033.05.N | Environment | This is a unique input. The screen provides estimate of environmental conditions for the actual paving date and the next 72 hours. ODOT requires use of validated temperature, humidity and wind speed data. S1033.05.N provides a method to validate expected environmental conditions. |
| 1033.05.O | Analysis | No inputs required. This is HIPERPAV's output screen. |

1033.05 Input example for HIPERPAV including standard inputs

A standard HIPERPAV file will require both Contractor driven inputs and standard inputs.

A. New Project.

This screen has three project options. The standard option will be “Early Age JPCP”.



The Long Term JPCP option is not applicable to a construction project. “Early-life CRCP” will also not be applicable as ODOT pavement design is not continuously reinforced.

Select “Early-life JPCP”. Next the project information screen shown in 1033.04 B will be displayed.

B. Project Information Screen.

The HIPERPAV project information screen will be displayed as shown:

The screenshot shows the HIPERPAV III software interface. The title bar reads "435(05).hpb3 * - HIPERPAV III". The menu bar includes File, Edit, View, Strategy, Comparison, Tools, and Help. Below the menu bar is a toolbar with icons for Project Info, Strategies, and Comparisons. The main window is titled "Project Information" and contains the following fields:

| | |
|----------------|--------------------------------|
| Project Name: | 435(05) |
| Project ID: | MEG-33 |
| Section Name: | First section of this project. |
| Begin Station: | 1000+00 |
| End Station: | 1003+50 |
| Comments: | Initial Run |

On the left side of the screen, there is a tree view with the following items:

- Project Information (highlighted with a blue arrow)
- Geography
- Monthly Weather Data

Complete the required input information for the project design file. Fill in the “Project Name” (project number and date), “Project ID” (Route and county), “Section Name” and beginning and ending pavement section for this file run.

USER NOTE: The left portion of the screen is similar to sub-directory areas or drives in windows. Note the blue arrow and the highlighted area over “project information”. At the top of the screen, note the button for project info. These are shortcuts to HIPERPAV screens that you can use as you become more familiar with the program.

Save the file using the Project Name [project number and date of placement]. Go to “File”; pull down the menu and select “Save As”. Saving the file will return you to the same screen shown above.

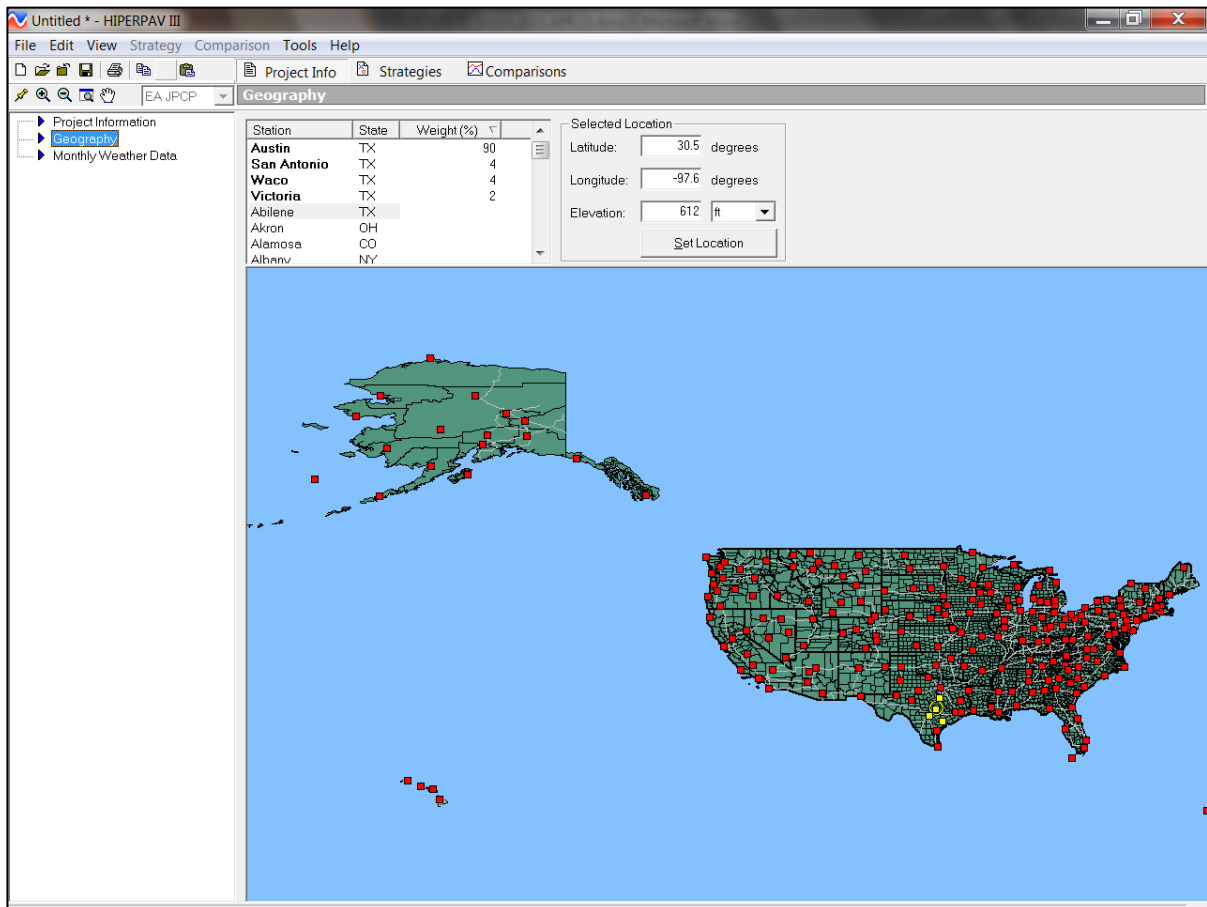
Now move your mouse arrow to the left menu and select “Geography”. The following screen shown in 1033.03C will be displayed.

C. Geography.

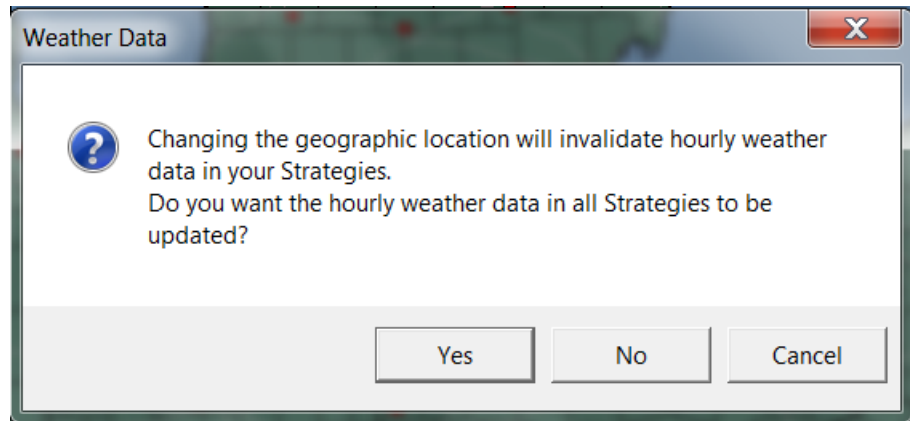
The geography screen provides historic temperatures for the project location. While initially it is a big map you can expand the map to find the actual project location. To select a location move the mouse arrow to the top menu and select the magnifying glass icon.

Move the magnifying glass over the map: major city names will be displayed when the magnifying glass is over a small red square. Use the left mouse button to zoom in on the map. Select the “hand button” if you need to move the map or the magnifying glass with the minus sign to zoom out.

Now move the magnifying glass back to the menu and select the “yellow pin” icon.



Move the pin to your location and click the left mouse button. The following message should come up.

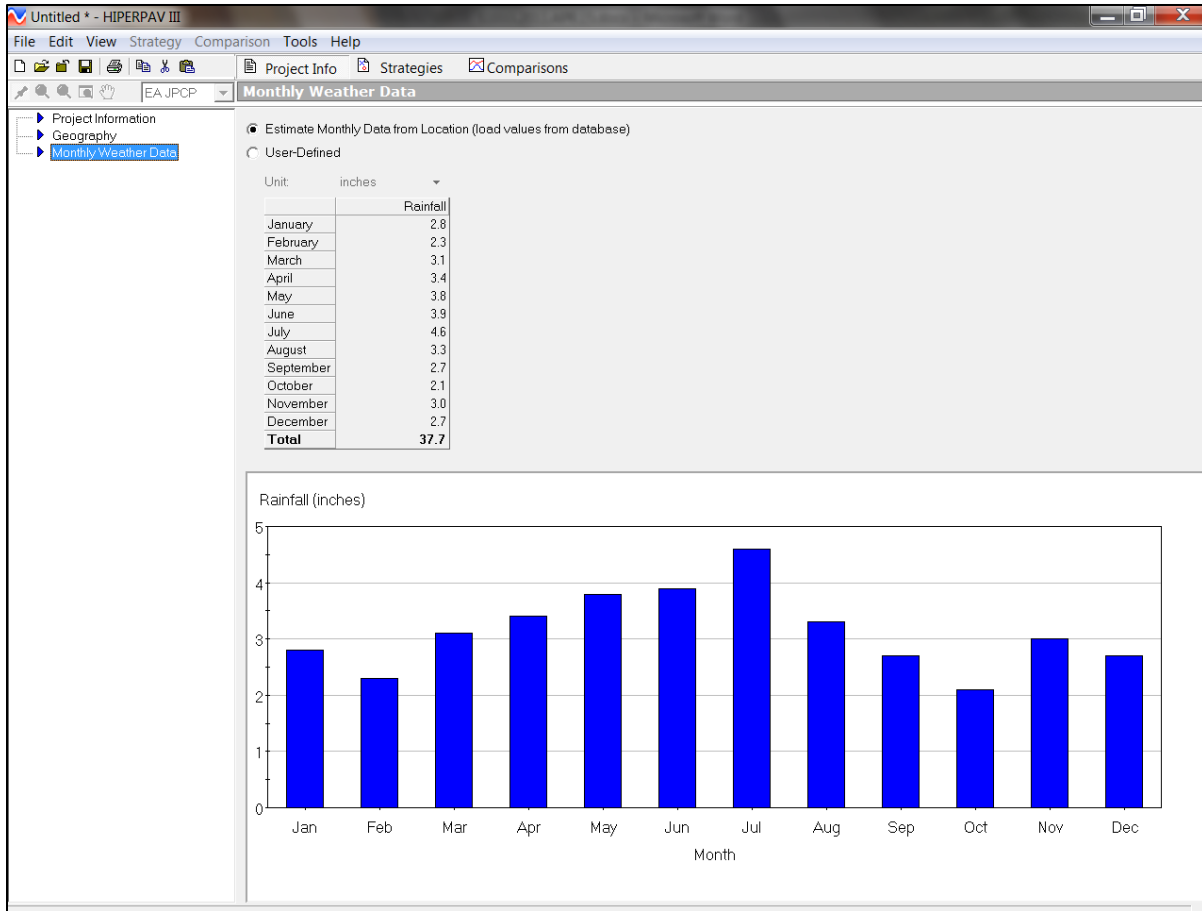


Select the "Yes" button.

The local average temperature data for your location has now been selected. If your location does not have specific weather information HIPERPAV will determine average weather data from the nearest weather reporting locations.

D. Monthly Weather Data.

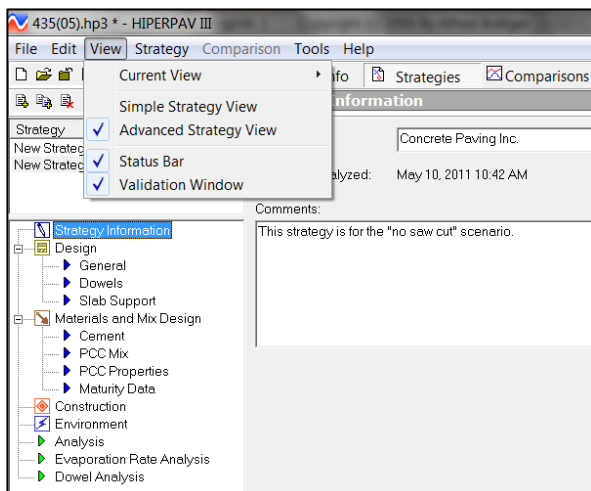
Go back to the left menu and select "Monthly Weather Data". The following screen will be displayed.

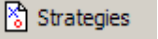


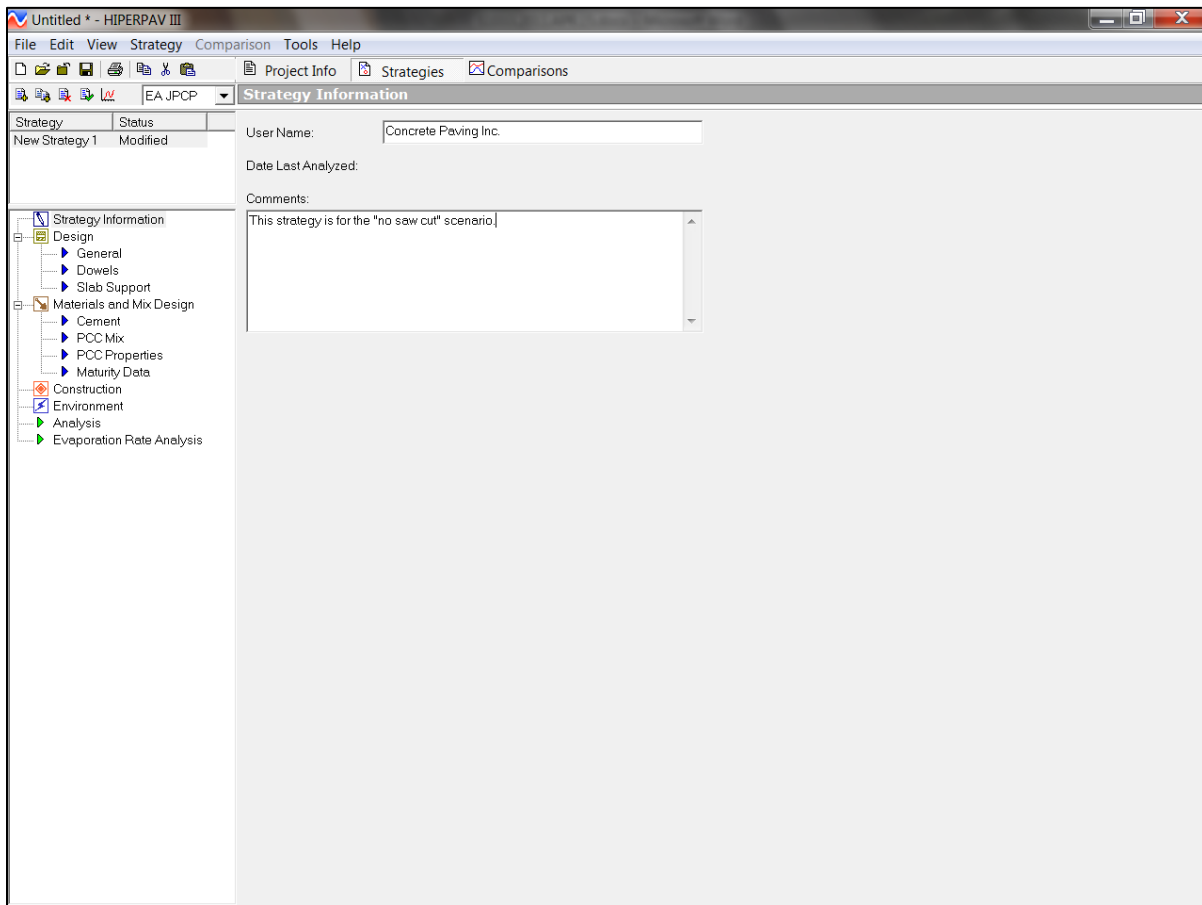
Select the “Estimate Monthly Data from Location” button on this screen.

E. Strategy Information.

Make sure the “Advanced Strategy View” is checked under the “View” option on the top menu as shown below.



Move the mouse arrow to the top center of the menu and select “Strategies”, . Click the left mouse button and the screen below will be displayed.



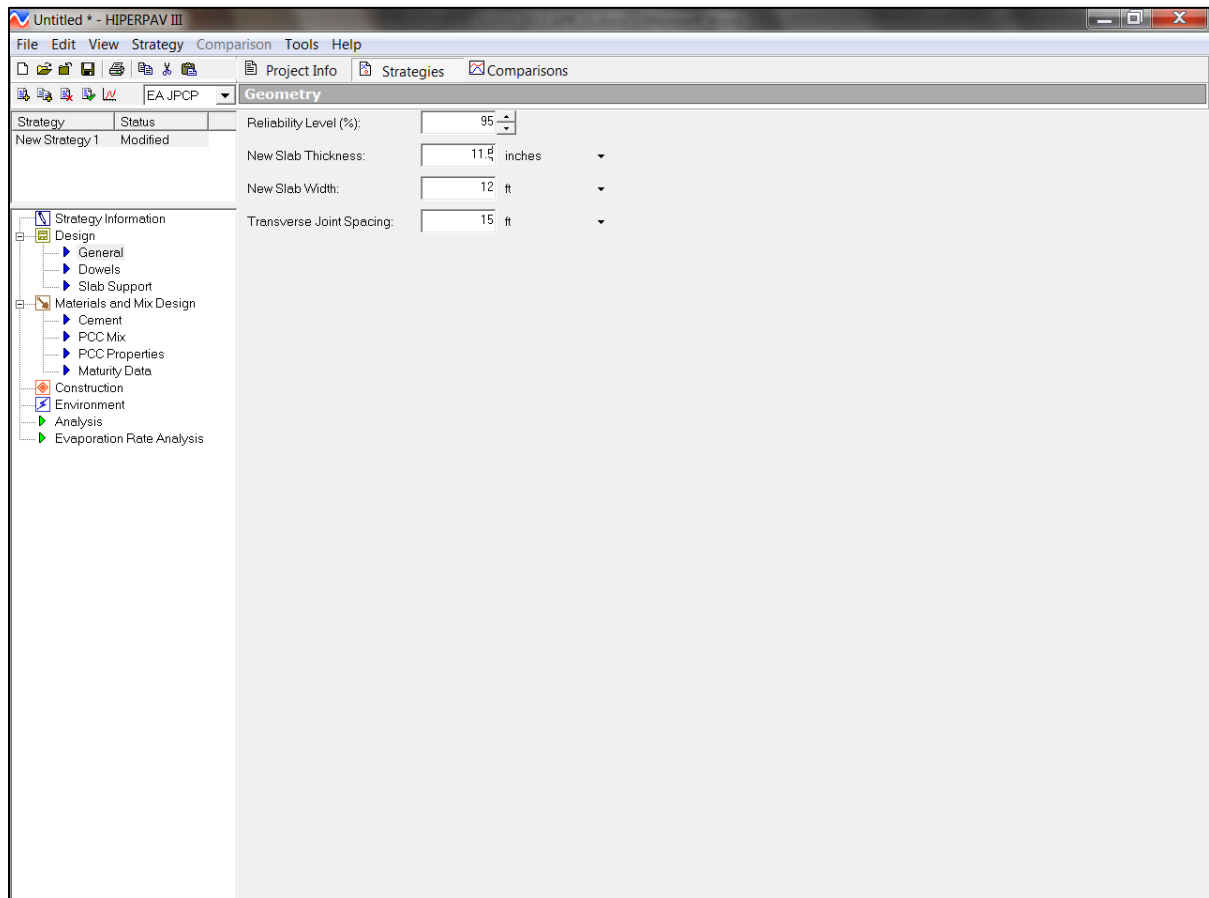
Input “User Name” – Contractor or sub-contractor.

Add any comments about the strategy.

Save the file.

F. Design - Geometry.

Move the mouse arrow to the left menu and select “General” under “Design”. The “Geometry” screen will be displayed as shown below.



Input “Reliability Level (%)”: = 95.


Input the “Slab Thickness”, “New Slab Width”, and “Transverse Joint Spacing” based on the project-specific requirements.






USER NOTE: When paving wider than 12 feet use the actual pavement paving width, e.g. 24 feet.


In the specific case where a contractor is paving two 12 feet lanes with a center longitudinal joint run two HIPERPAV analyses; one at 24 feet wide and one at 12 feet wide. Early age cracking will be controlled by the original geometry until the longitudinal joint is saw cut. After the longitudinal joint is cut the pavement will act as two separate 12 feet lanes.

In this case when HIPERPAV validates the input data the strategy status will be “Invalid”; this can be disregarded. See the screen below.

| Strategy | Status |
|----------------|----------|
| New Strategy 1 | Invalid |
| New Strategy 2 | Modified |

 Strategy Information

-  Design
 - ▶ General
 - ▶ Dowels
 - ▶ Slab Support
-  Materials and Mix Design
 - ▶ Cement
 - ▶ PCC Mix
 - ▶ PCC Properties
 - ▶ Maturity Data
-  Construction
-  Environment
-  Analysis
- ▶ Evaporation Rate Analysis
- ▶ Dowel Analysis

Validated - 11:50:19 AM 

Geometry - Slab Width

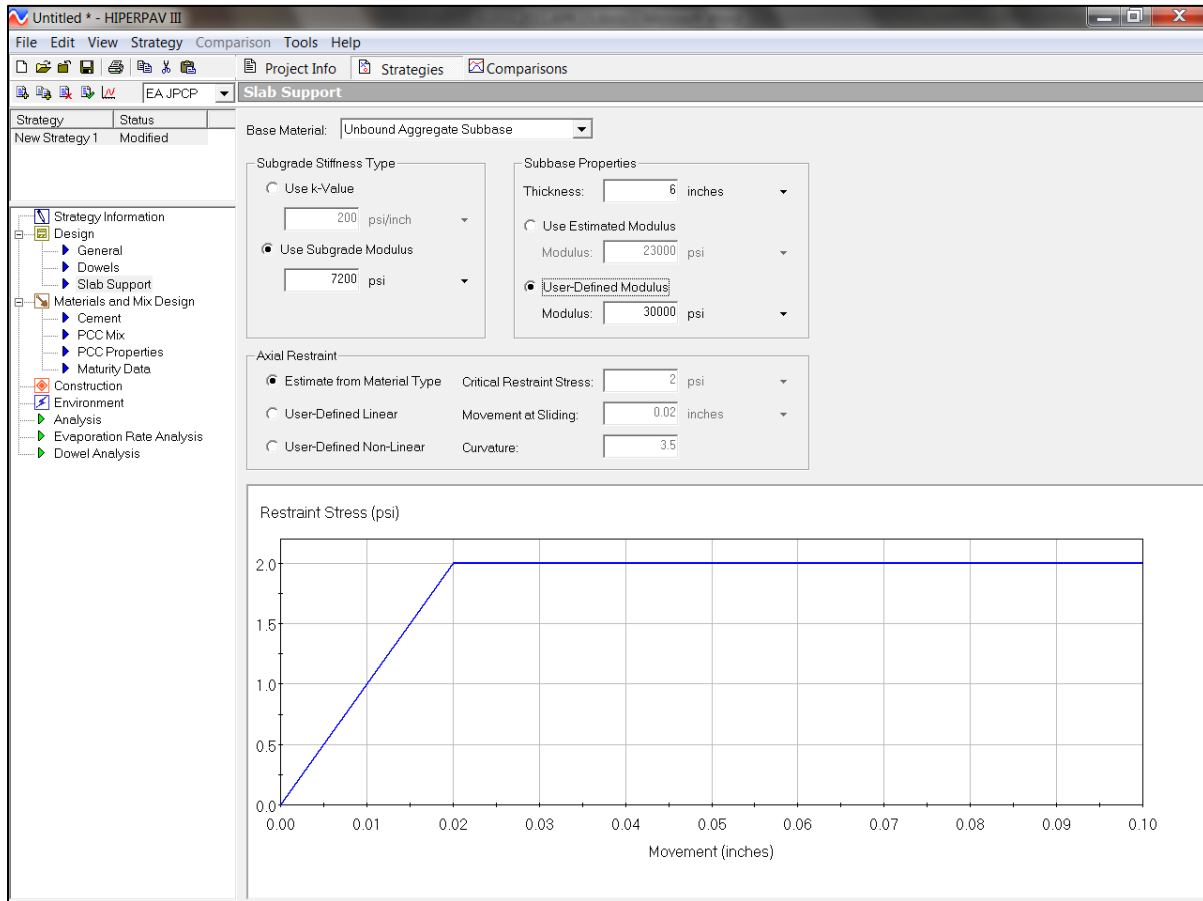
Save the file. If the information on the screen has been not changed saving is not required.

G. Design - Dowels.

Do not include dowels in the Early Age analysis. No input required.

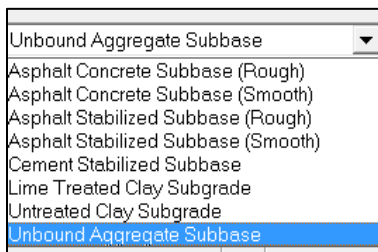
H. Design Slab Support

Select “Slab Support” under “Design” from the left menu. The “Slab Support” screen will be displayed as shown below.



“Base Material”:

Select “Base Material” type from the pull down menu on the screen.



USER NOTE: HIPERPAV uses the term “subbase” to represent the layer of material directly below the pavement and above the subgrade; ODOT also calls this “base”. In most cases ODOT uses Item 304 as the base material for new concrete pavement.

Where new concrete pavement is placed directly on a subgrade with no intermediate base or subbase layer, the input would be “subgrade”.

“Subbase Properties”:

Subbase Properties

Thickness: inches ▼

☐ Use Estimated Modulus
Modulus: psi ▼

☒ User-Defined Modulus
Modulus: psi ▼

- Input “Subbase Thickness”.
- Select “User-Defined Modulus” and input modulus value selected from the list below. ODOT Item 304 is “Unbound Aggregate Subbase”.

List of Modulus Values:

| | |
|-------------------------------------|-------------------------|
| Asphalt Concrete Subbase (Rough) | Modulus = 300,000 psi |
| Asphalt Concrete Subbase (Smooth) | Modulus = 300,000 psi |
| Asphalt Stabilized Subbase (Rough) | Modulus = 200,000 psi |
| Asphalt Stabilized Subbase (Smooth) | Modulus = 200,000 psi |
| Cement Stabilized Subbase | Modulus = 1,200,000 psi |
| Lime Treated Clay Subgrade | Not used by ODOT |
| Untreated Clay Subgrade | Not used by ODOT |
| Unbound Aggregate Subbase | Modulus = 30,000 psi |

“Subgrade Stiffness Type”:

Subgrade Stiffness Type

☐ Use k-Value
 psi/inch ▼

☒ Use Subgrade Modulus
 psi ▼

- Select “Subgrade Modulus” and input a modulus of 7200 psi..

“Axial Restraint”

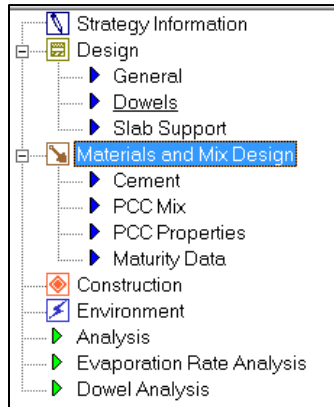
| Axial Restraint | | | |
|--|----------------------------|-----------------------------------|----------|
| <input checked="" type="radio"/> Estimate from Material Type | Critical Restraint Stress: | <input type="text" value="2"/> | psi ▼ |
| <input type="radio"/> User-Defined Linear | Movement at Sliding: | <input type="text" value="0.02"/> | inches ▼ |
| <input type="radio"/> User-Defined Non-Linear | Curvature: | <input type="text" value="3.5"/> | |

- Select “Estimate from Material Type”

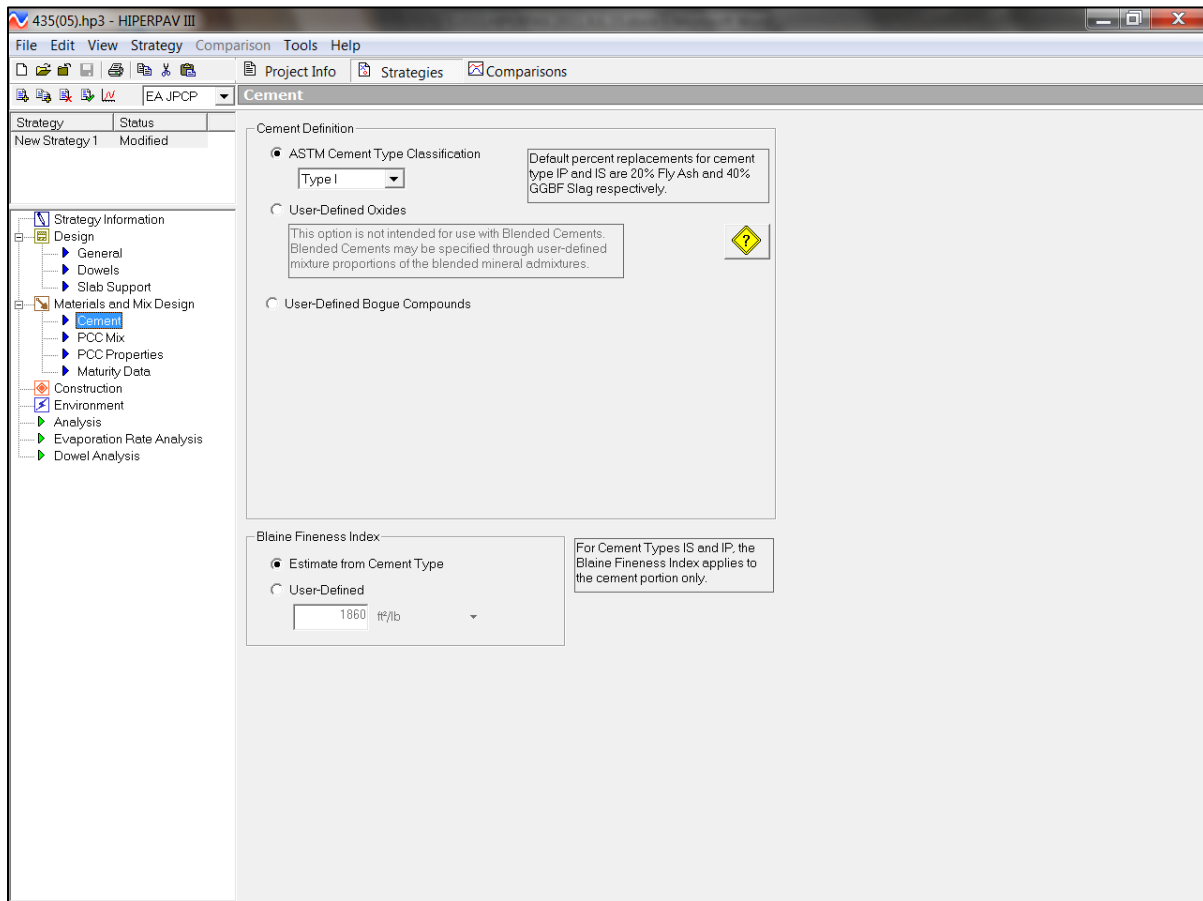
USER NOTE: Axial restraint is due to the slab-base friction. The graph will change with material type. Get a feel for the software by selecting other material types.

I. Materials and Mix Design - Cement.

Select “Materials and Mix Design” and “Cement” from the left menu.



The following screen will be displayed:



Standard ODOT mixes:

Select “ASTM Cement Type Classification”. From the pull down menu select “Type I for Class C concrete and all options. Do not select “Type 1P or 1S” even if using pozzolans in the concrete; Type 1P and 1S are cement factory blended.

Confirm cement type with the supplier.

ODOT Type MS or FS mixes:

Select the type of cement being supplied. Type 1 is normally used but Type III cement is high early strength cement and may sometimes be supplied. Confirm cement type with the supplier.

QC-QA Specifications:

Option 1

Select the cement type being used from the pull down menu as shown in the approved mix design. Do not select “Type 1P or 1S” even if using pozzolans in the concrete; Type 1P and 1S are cement factory blended.

Option 2

Select either “User-Defined Oxides” or “User-Defined Bogue Compounds” and input the percent content based on cement manufacturer certified data as shown below. Provide certified cement data to the Engineer.

Cement

Cement Definition

☐ ASTM Cement Type Classification
 Type I

☐ User-Defined Oxides
 This option is not intended for use with Blended Cements. Blended Cements may be specified through user-defined mixture proportions of the blended mineral admixtures.

☒ User-Defined Bogue Compounds

| Compound | Content (%) |
|---|-------------|
| <input type="checkbox"/> Alite (C3S) | 48.7 |
| <input type="checkbox"/> Belite (C2S) | 24.8 |
| <input type="checkbox"/> Aluminate (C3A) | 11.9 |
| <input type="checkbox"/> Ferrite (C4AF) | 8 |
| <input type="checkbox"/> Magnesia (MgO) | 2.4 |
| <input type="checkbox"/> (SO4) | 2.9 |
| <input type="checkbox"/> Free Lime (Free CaO) | 0.8 |
| <input type="checkbox"/> Other | 0.5 |
| Total | 100 |

Default percent replacements for cement type IP and IS are 20% Fly Ash and 40% GGBF Slag respectively.

?

All Concrete Mixes:

For “Blaine Fineness Index” select “Estimate from Cement Type” as shown below.

Blaine Fineness Index

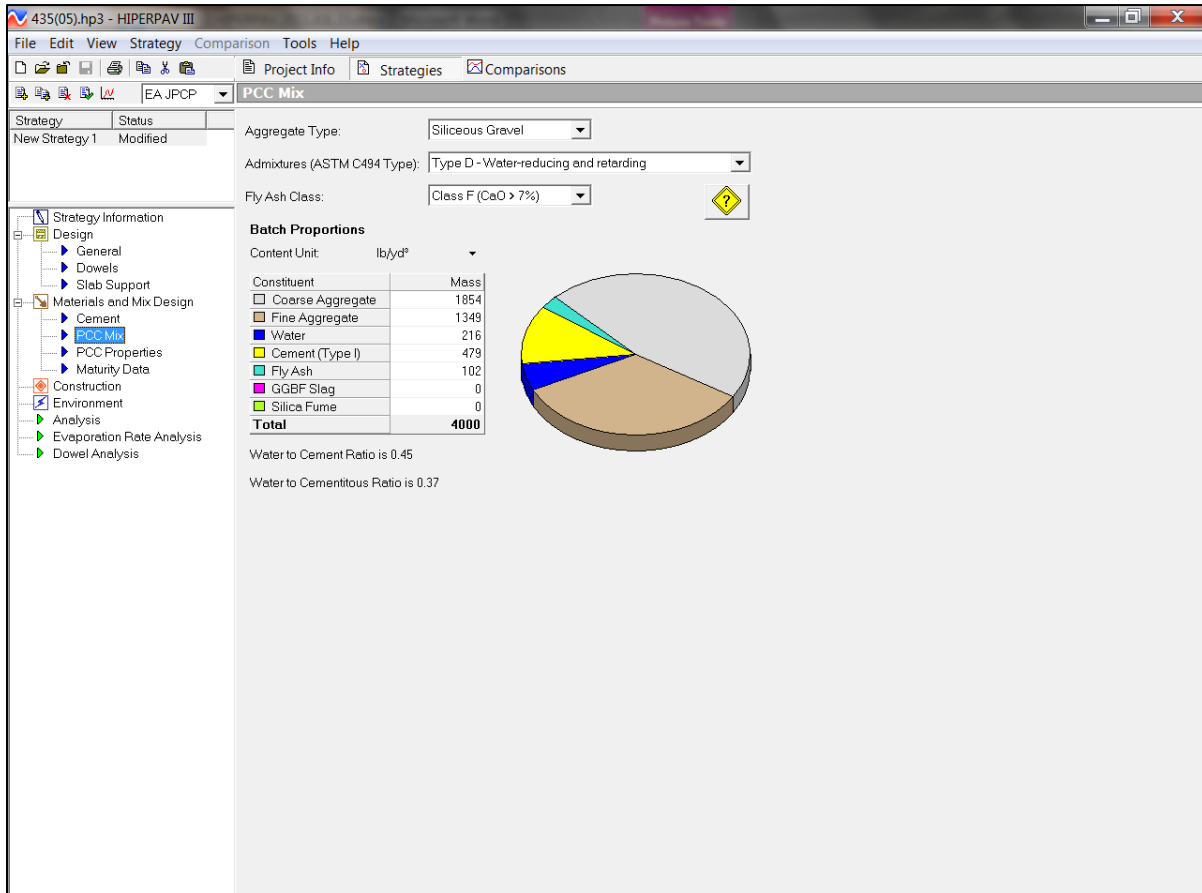
☒ Estimate from Cement Type
☐ User-Defined

1860 ft²/lb

For Cement Types IS and IP, the Blaine Fineness Index applies to the cement portion only.

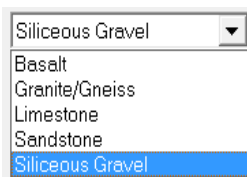
J. Materials and Mix Design – PCC Mix.

Select “PCC Mix” from the left menu. The following screen will be displayed.



“Aggregate Type”

Select “Aggregate Type” from the pull down menu.



“Admixtures”

Select “Admixtures” from the pull down menu.

Type D - Water-reducing and retarding

None

Type B - Retarding

Type C - Accelerating

Type D - Water-reducing and retarding

Type E - Water-reducing and accelerating

Type G - Water-reducing, high range, and retarding

Air entrainment is not considered an admixture in the HIPERPAV analysis.

“Fly Ash Class”

Select Fly Ash Class, either Type F or Type C from the pull down menu.

Fly Ash Class:

Class F (CaO ≤ 7%)

None

Class C

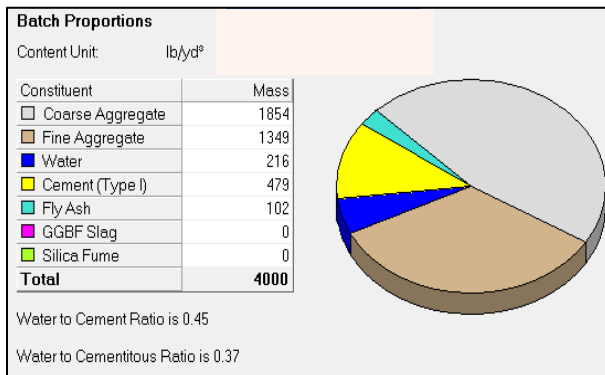
Class F (CaO ≤ 7%)

Class F (CaO > 7%)

Determine fly ash class from the “Certified Producers and Suppliers” list on the Office of Materials Management website. For Type F fly ash use CaO < 7%.

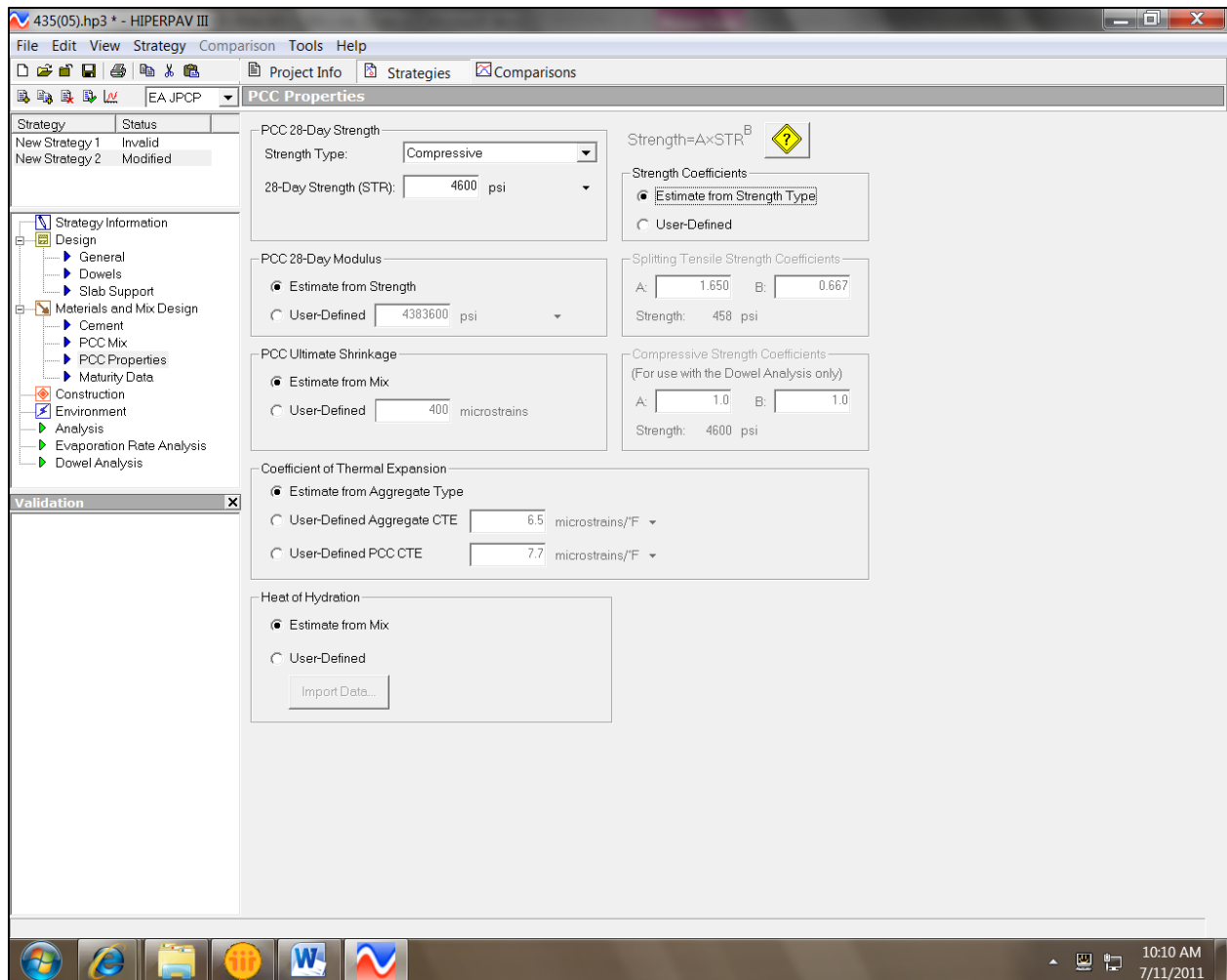
“Batch Proportions”

Input the batch proportions from the approved mix design. Use SSD weights corrected for specific gravity.



K. Materials and Mix Design – PCC Properties.

Select “PCC Properties” from the left menu. The following screen will be displayed.



“PCC 28-Day Strength”

Select “Strength Type” = “Compressive” from the pull down menu. Input 28-day compressive strength selected from the following list.

Gravel mixes (not crushed) = 4600 psi

Limestone mixes = 5200 psi

QC/QA mixes contact the laboratory

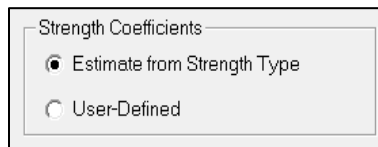
PCC 28-Day Strength

Strength Type: Compressive

28-Day Strength (STR): 4600 psi

“Strength Coefficients”

Select “Estimate from Strength Type”.

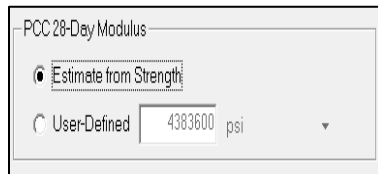


The screenshot shows a dialog box titled "Strength Coefficients". It contains two radio button options: "Estimate from Strength Type" which is selected, and "User-Defined".

“User-Defined” strength coefficients must be laboratory-measured values.

“PCC 28-Day modulus”

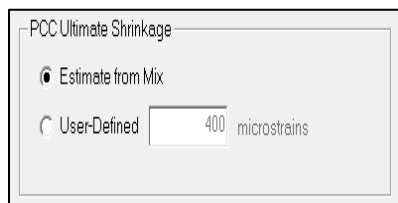
Select “Estimate from Strength”.



The screenshot shows a dialog box titled "PCC 28-Day Modulus". It contains two radio button options: "Estimate from Strength" which is selected, and "User-Defined". The "User-Defined" option has a text input field containing the value "4383600" and a unit dropdown menu set to "psi".

“PCC Ultimate Shrinkage”

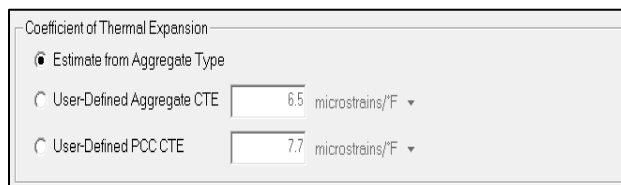
Select “Estimate from Mix”.



The screenshot shows a dialog box titled "PCC Ultimate Shrinkage". It contains two radio button options: "Estimate from Mix" which is selected, and "User-Defined". The "User-Defined" option has a text input field containing the value "400" and a unit dropdown menu set to "microstrains".

“Coefficient of Thermal Expansion”

Select “Estimate from Aggregate Type”.



The screenshot shows a dialog box titled "Coefficient of Thermal Expansion". It contains three radio button options: "Estimate from Aggregate Type" which is selected, "User-Defined Aggregate CTE", and "User-Defined PCC CTE". The "User-Defined Aggregate CTE" option has a text input field containing the value "6.5" and a unit dropdown menu set to "microstrains/F". The "User-Defined PCC CTE" option has a text input field containing the value "7.7" and a unit dropdown menu set to "microstrains/F".

“Heat of Hydration”

Select “Estimate from Mix”.

Heat of Hydration


☒ Estimate from Mix

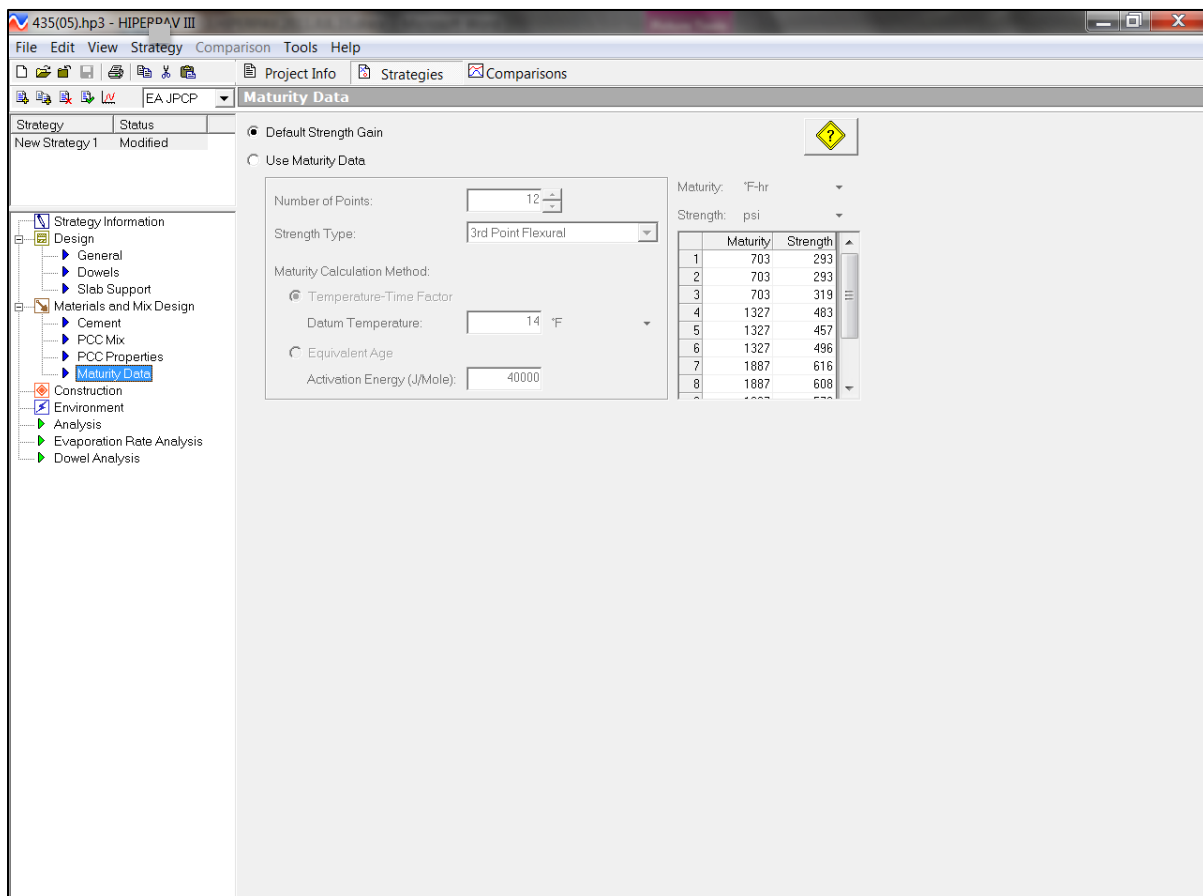
☐ User-Defined

Import Data...

The “User-Defined” option requires calorimetry test data. If these data are available contact the Office of Materials Management, Concrete Section for guidance.

L. Materials and Mix Design Maturity Data.

Select “Maturity Data” from the left menu.  The following screen will be displayed.





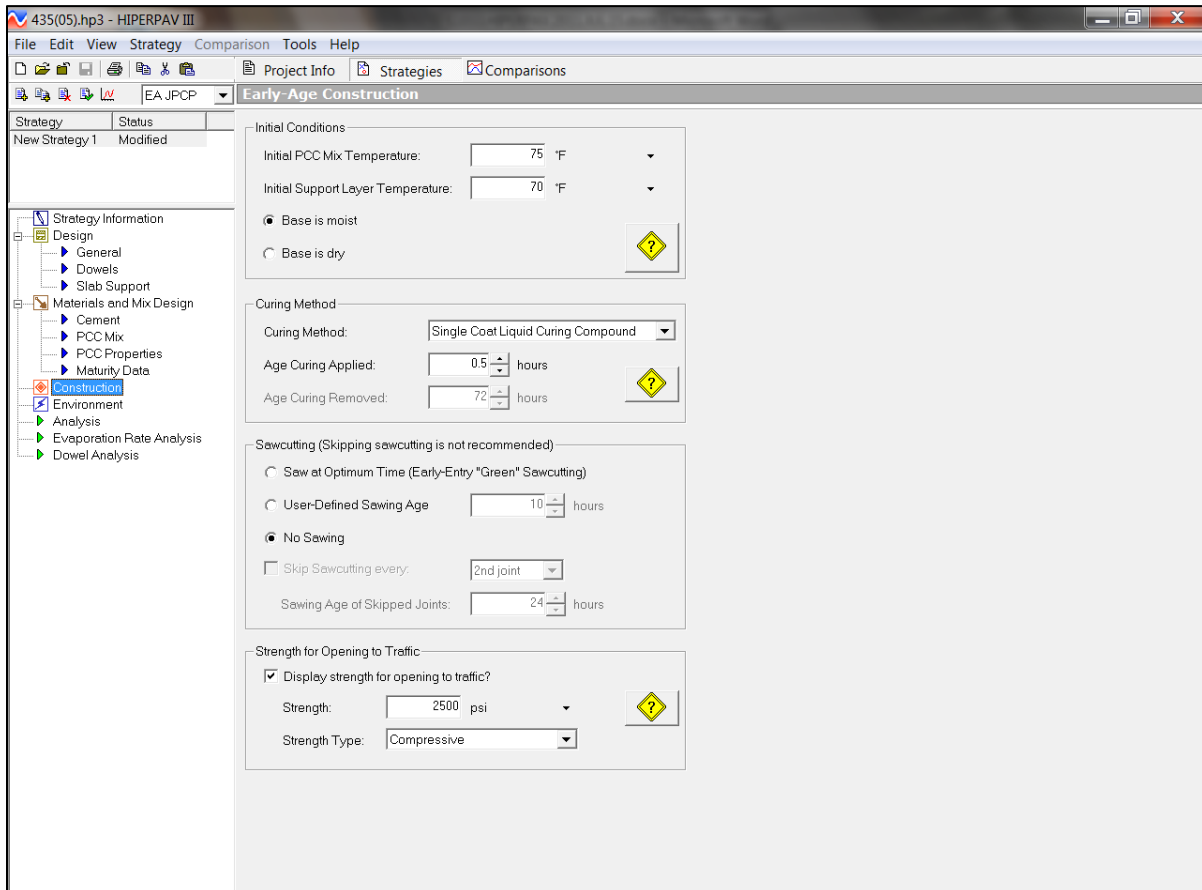
| | Maturity | Strength |
|---|----------|----------|
| 1 | 703 | 293 |
| 2 | 703 | 293 |
| 3 | 703 | 319 |
| 4 | 1327 | 483 |
| 5 | 1327 | 457 |
| 6 | 1327 | 496 |
| 7 | 1887 | 616 |
| 8 | 1887 | 608 |

Select “Default Strength Gain” on this screen.

USER NOTE: If an actual maturity curve has been developed for the mix, select “Use Maturity Data: and input the actual maturity data.

M. Construction.

Move the mouse arrow to the left menu and select “Construction”  . The following screen will be displayed.



The screenshot shows the HIPERPAV III software interface. The title bar indicates the file is 435(05).hp3. The menu bar includes File, Edit, View, Strategy, Comparison, Tools, and Help. The toolbar contains icons for file operations and analysis. The left sidebar shows a tree view with the following structure:

- Strategy Information
 - Design
 - General
 - Dowels
 - Slab Support
 - Materials and Mix Design
 - Cement
 - PCC Mix
 - PCC Properties
 - Maturity Data
 - Construction**
 - Environment
 - Analysis
 - Evaporation Rate Analysis
 - Dowel Analysis

The main window displays the 'Early-Age Construction' tab. The inputs are as follows:

- Initial Conditions**
 - Initial PCC Mix Temperature: 75 °F
 - Initial Support Layer Temperature: 70 °F
 - Base is moist (selected)
 - Base is dry
- Curing Method**
 - Curing Method: Single Coat Liquid Curing Compound
 - Age Curing Applied: 0.5 hours
 - Age Curing Removed: 72 hours
- Sawcutting (Skipping sawcutting is not recommended)**
 - Saw at Optimum Time (Early-Entry "Green" Sawcutting)
 - User-Defined Sawing Age: 10 hours
 - No Sawing (selected)
 - Skip Sawcutting every: 2nd joint
 - Sawing Age of Skipped Joints: 24 hours
- Strength for Opening to Traffic**
 - Display strength for opening to traffic? (checked)
 - Strength: 2500 psi
 - Strength Type: Compressive

Use project inputs to complete this screen.

“Initial PCC Mix Temperature” - input in degrees Fahrenheit (F). Estimate based on experience and weather temperature.

USER NOTE: As Initial temperature of the concrete is an estimate, adjust the initial temperature and perform multiple runs of HIPERPAV to assure covering the expected range of concrete temperatures will be performed.

“Initial Support Layer Temperature” - input in degrees Fahrenheit (F). Use a surface thermometer to measure the base temperature. Do not use air temperature.

USER NOTE: As surface temperature will vary, use different surface temperatures and perform additional runs of HIPERPAV to assure covering the expected range of the base’s surface temperature.

Select either “Base is Moist” or “Base is Dry”. Note that C&MS Item 451.06 requires granular base material to be in a moist condition prior to placing concrete.

Asphalt base material requires the application of curing membrane at least one day prior to concrete placement (C&MS 451.06); in this case select “Base is Dry”.

“Curing Method” - Select curing method from the pull down menu.

USER NOTE: Curing method may be a modification if HIPERPAV runs show that early age cracking of the pavement will happen.

“Sawcutting” – Select the “No Sawing” option from the “Sawcutting” menu for the first strategy to evaluate the risk of early age cracking.

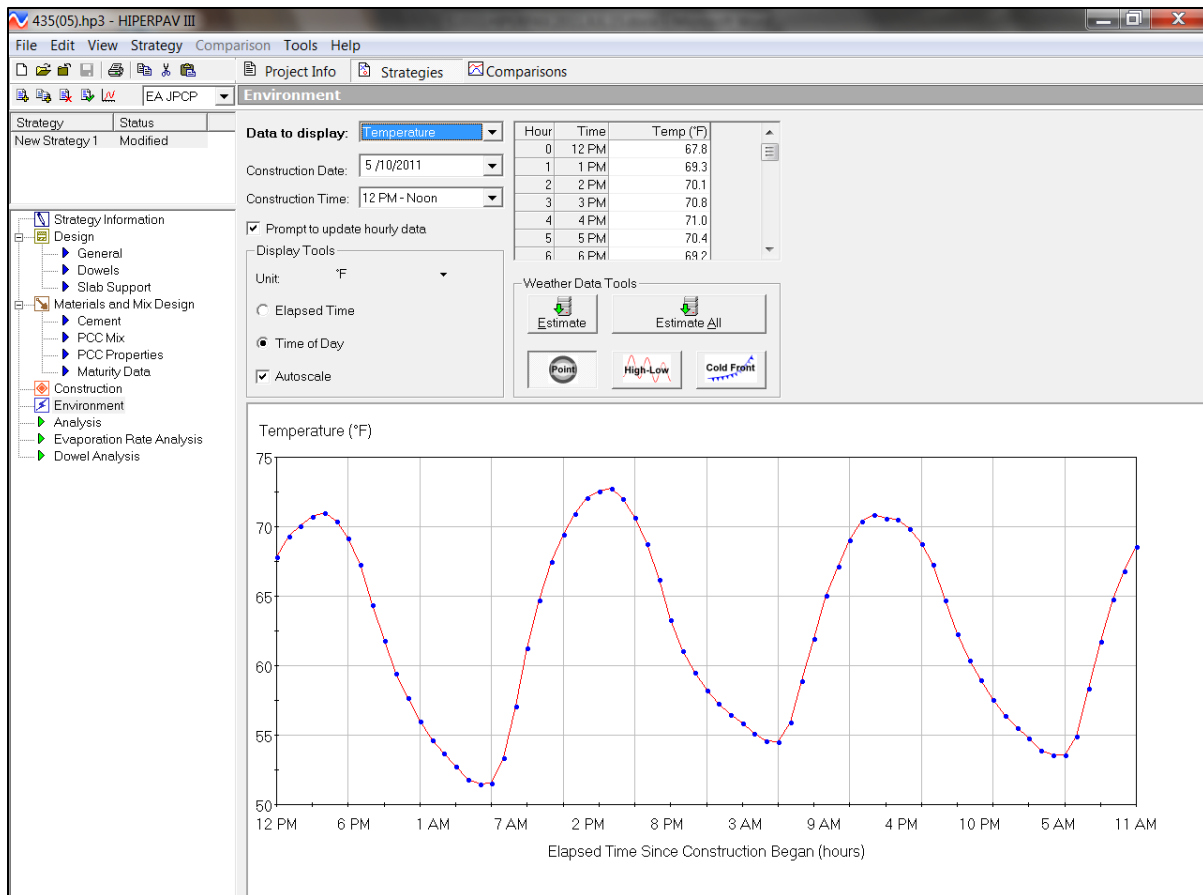
USER NOTE: The initial strategy should be evaluated using the “No Sawing” option to provide a baseline for the pavement operation. Upon completing the initial strategy create additional strategies and input the actual sawcutting operations to be used.

“Strength for Opening to Traffic” - Select “Display Strength for opening to traffic?”.

From the “Strength Type” pull down menus select “Compressive”. Use 2500 psi for “Strength”.

N. Environment.

Select “Environment” from the left menu. You will see the below screen.



This screen pulls historic temperature data from a local environmental conditions database. This information is based on the selection made for a specific county location under 1033.C Geography.

USER NOTE: The temperature information can also be self-generated by inputting data from local sources.

Step 1: input the date of placement, “Construction Date”

Step 2: Input “Construction Time”.

USER NOTE: Changing “Construction Time” will change the temperature graph as it changes the Time of Day baseline to match.

Step 3a: Go to “Data to display” -Select “Temperature” from the pull down menu. Note, in the graph that the temperature for 72 hours is shown.

Step 3b: Go to “Data to display” - Select “Wind Speed” from the pull down menu. Note, in the graph that the wind speed for 72 hours is shown.

Step 3c: Go to “Data to display” - Select “Humidity” in the pull down menu. Note, in the graph that the humidity for 72 hours is shown

Step 3d: Go to “Data to display” - Select “Cloud Cover” in the pull down menu. Note, in the graph that the cloud cover for 72 hours is shown

USER NOTE: Steps 3a thru 3d show the four different data types that “Data to display” includes. All four (4) types are estimated from historical data. All data can and should be changed to show the actual conditions expected on the day of placement and for the following 72 hours (3 days).

To minimize the risk of early age cracking the estimated temperatures will need to be verified and changed if they don't match the historical predictions for the project location. This is critical!

Step 4: Evaluation of temperature, wind speed, humidity and cloud cover predictions.

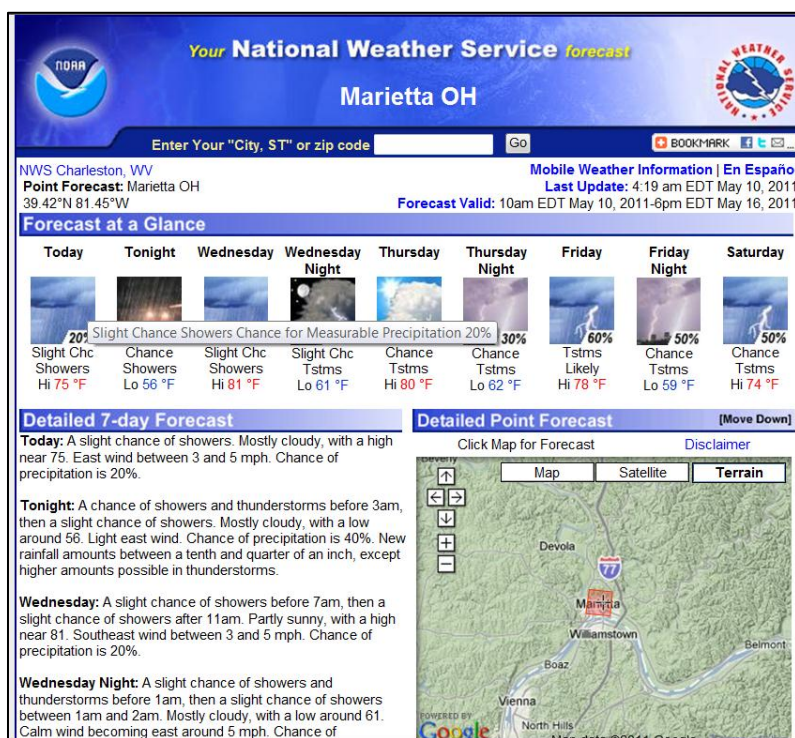
Look at the temperature graph and the projections for high and low temperatures for the first 72 hours. The estimated temperatures need to be verified and changed if they don't match the predictions for the project location. This is critical!

Verify the HIPERPAV generated temperatures, wind speed, against local weather predictions as follows:

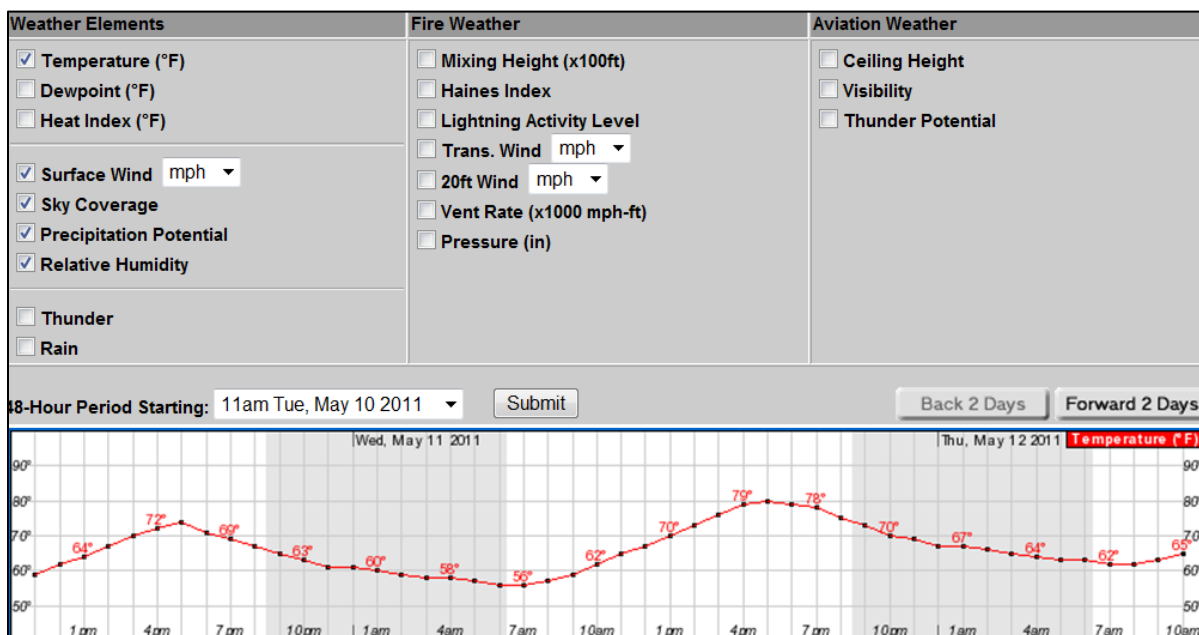
- a Use the National Oceanic and Atmospheric Administration weather website, www.noaa.gov/wx.html.

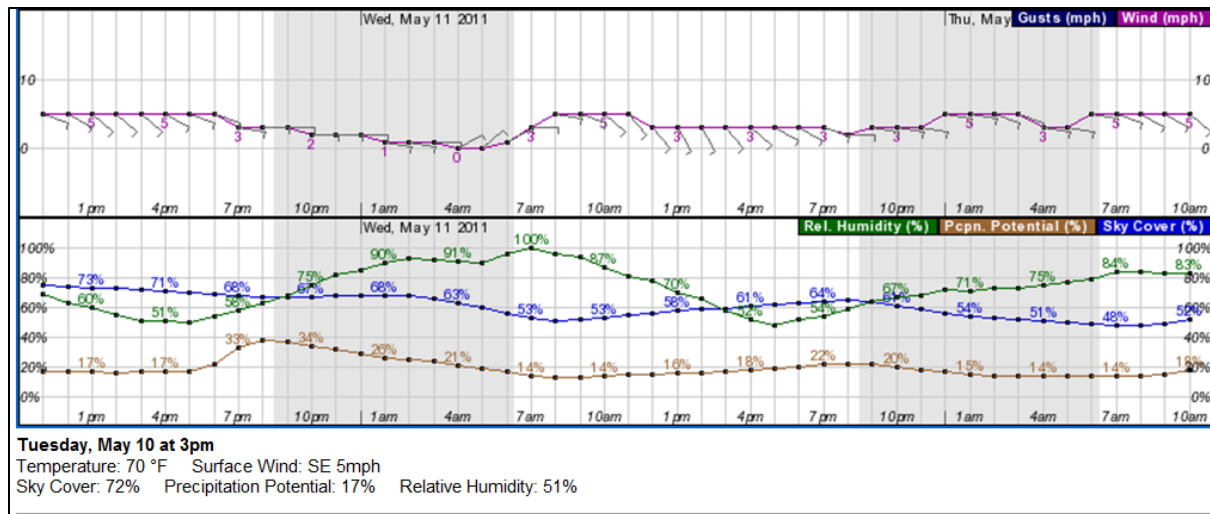


- b Enter the zip code for the project location. Entering the zip code will bring up the following screen.



USER NOTE: NOAA local forecast site page – Right hand side- lower portion has a list of information including “Hourly Weather Graph”. Selecting that page will provide graphs of wind, humidity, etc. that will provide data in 48 hour increments. This source provides the most detailed hourly weather predictions. An example of an Hourly Weather Graph is shown below.



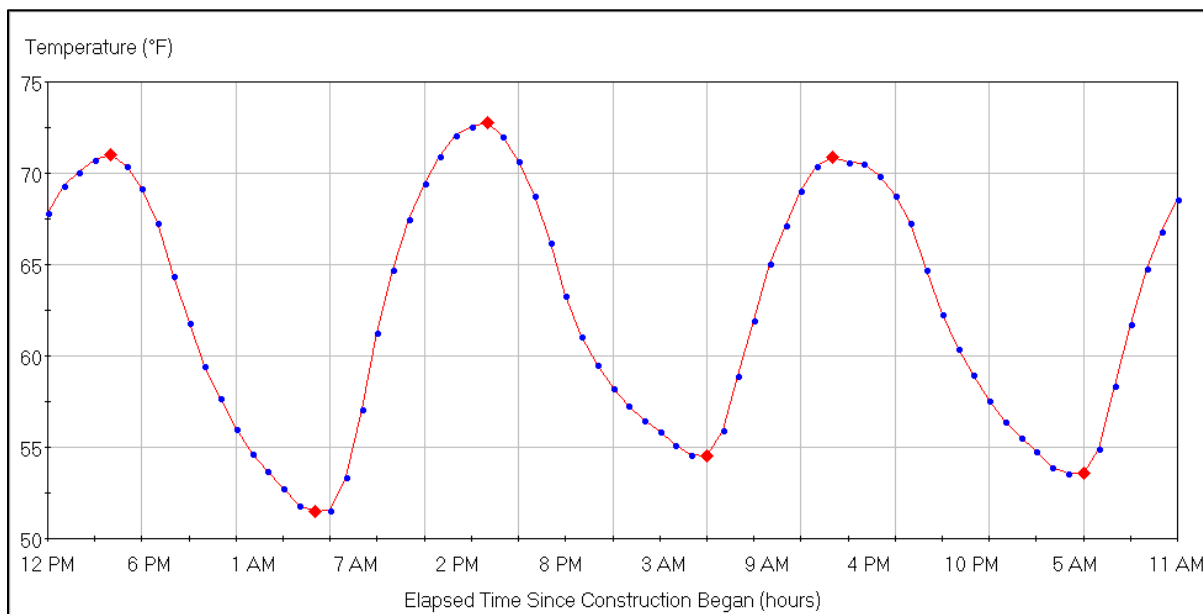


c Check the HIPERPAV graph high and low temperatures versus the NOAA weather forecast.

- 1) **Temperature** - If the temperature predicted by HIPERPAV is not within 2 degrees change the temperatures to reflect the NOAA weather predictions. Since the temperatures in this example are NOT THE SAME the temperatures need to be changed. To change the temperature data perform the following.



Select the “High Low” button. The environment screen temperature will change by adding red dots to the high low temperatures as shown below.




Uncheck the “Autoscale” box, . Then the high and low temperatures can be changed either by moving the red diamonds up or down on the graph or by directly inputting the information in the Hour/Time/Temp./Type box.

| Hour | Time | Temp (°F) | Type |
|------|------|-----------|------|
| 4 | 4 PM | 71.0 | High |
| 17 | 5 AM | 51.5 | Low |
| 28 | 4 PM | 72.8 | High |
| 42 | 6 AM | 54.5 | Low |
| 50 | 2 PM | 70.9 | High |
| 66 | 6 AM | 53.6 | Low |

To change highs and lows directly on the graph use the left mouse button to click on a red diamond to move it up or down to change the temperature for that time of day. Changing the highs or lows on the graph also changes the Hour/Time/Temp./Type chart.

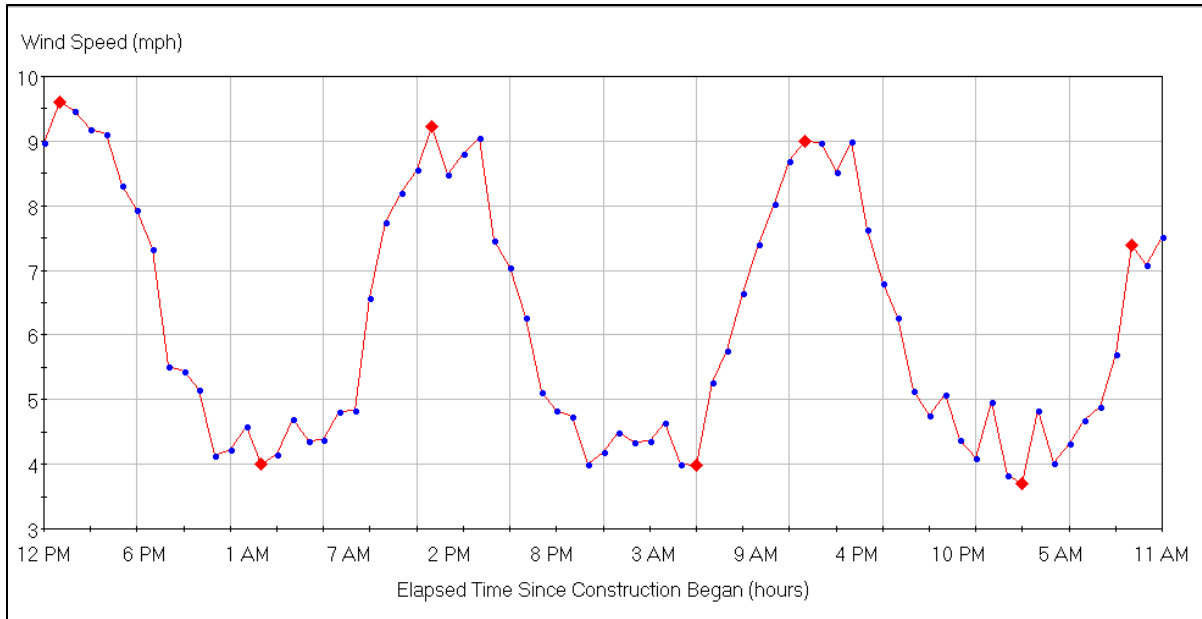
Go back and check the “Autoscale” box and the graph will be readjusted.

USER NOTE: Individual temperature points on chart the can also be moved by using the “Point” button, . Adjust individual temperature points with the mouse to reflect expected temperatures.

Save the file.

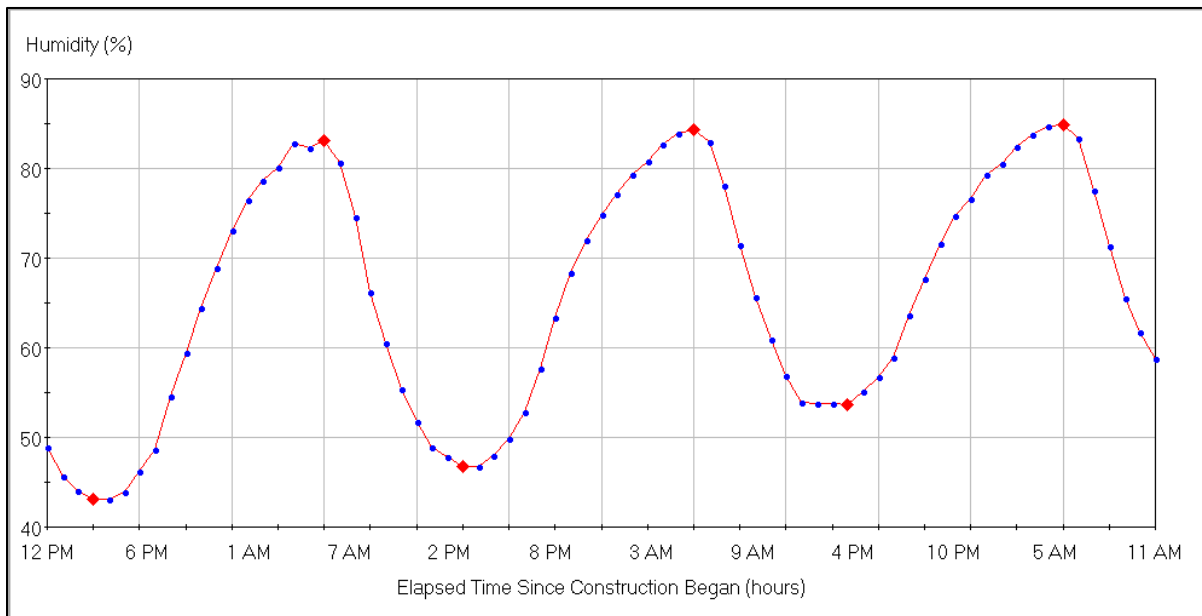
- 2) **Wind Speed** - Select “Wind Speed” from the pull down menu. The graph will show wind speed. If the highs and lows (red diamonds) are not shown on the graph click the “High Low” button.

Compare the high and low wind speed values to the NOAA predictions for each day. Change wind speed to match NOAA predictions by moving the high-and low values on the chart or directly inputting into the Hour/Time/Humidity/Type chart.



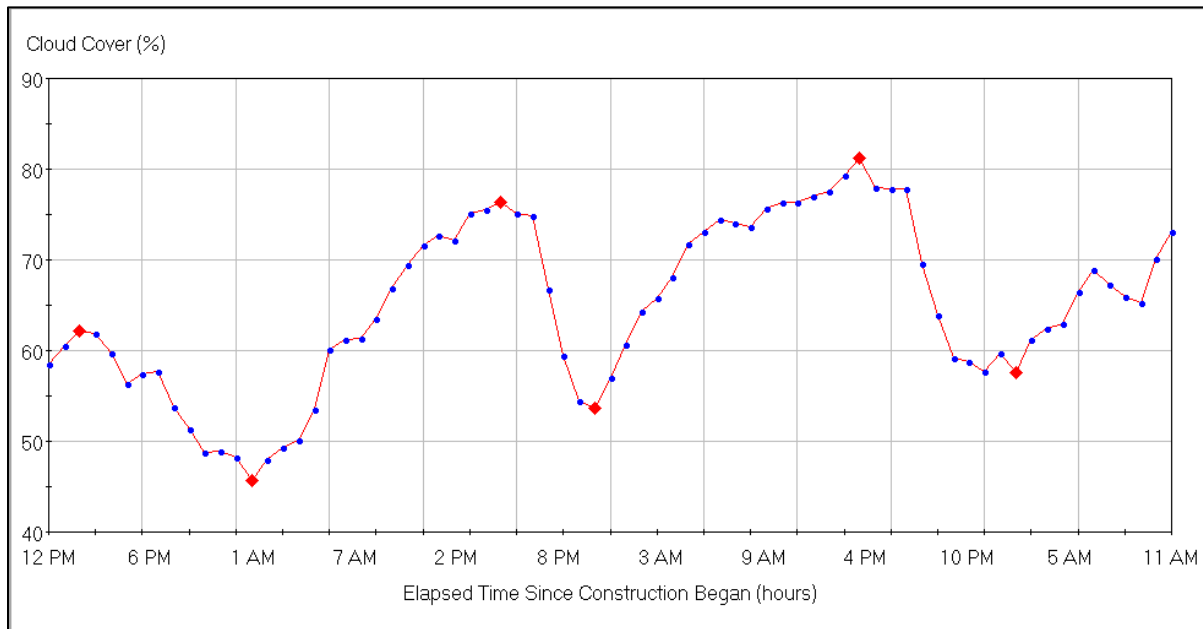
- 3) **Humidity** - Select “Humidity” from the pull down menu. The graph will now exhibit percent humidity. If the highs and lows (red diamonds) are not shown on the graph click the “High Low” button.

Compare the high and low humidity values to the NOAA predictions for each day. Change percent humidity to match NOAA predictions by moving high-low values on the chart or directly inputting into the Hour/Time/Humidity/Type chart.



- 4) **Cloud Cover** - Select “Cloud Cover” from the pull down menu. The graph will exhibit percent cloud cover. If the highs and lows (red diamonds) are not shown on the graph click the “High Low” button.

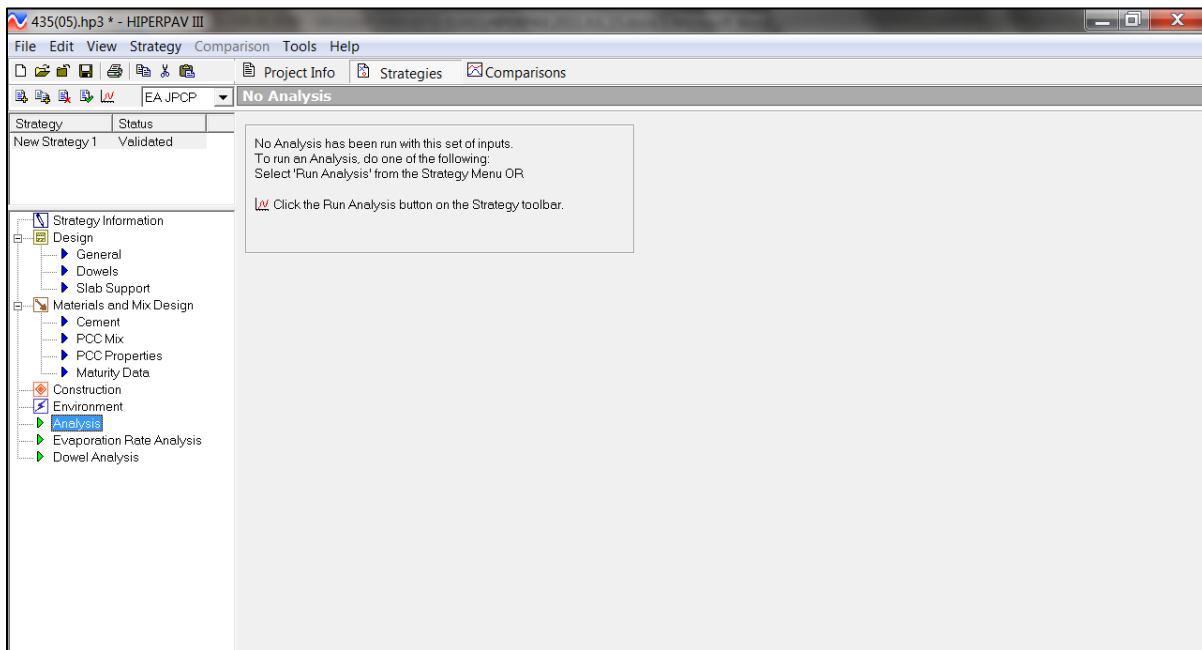
Compare the high and low cloud cover values to the NOAA predictions for each day. Change cloud cover to match NOAA predictions by moving high low values on the chart or directly inputting into the Hour/Time/Cloud Cover/Type chart.




O. Analysis.

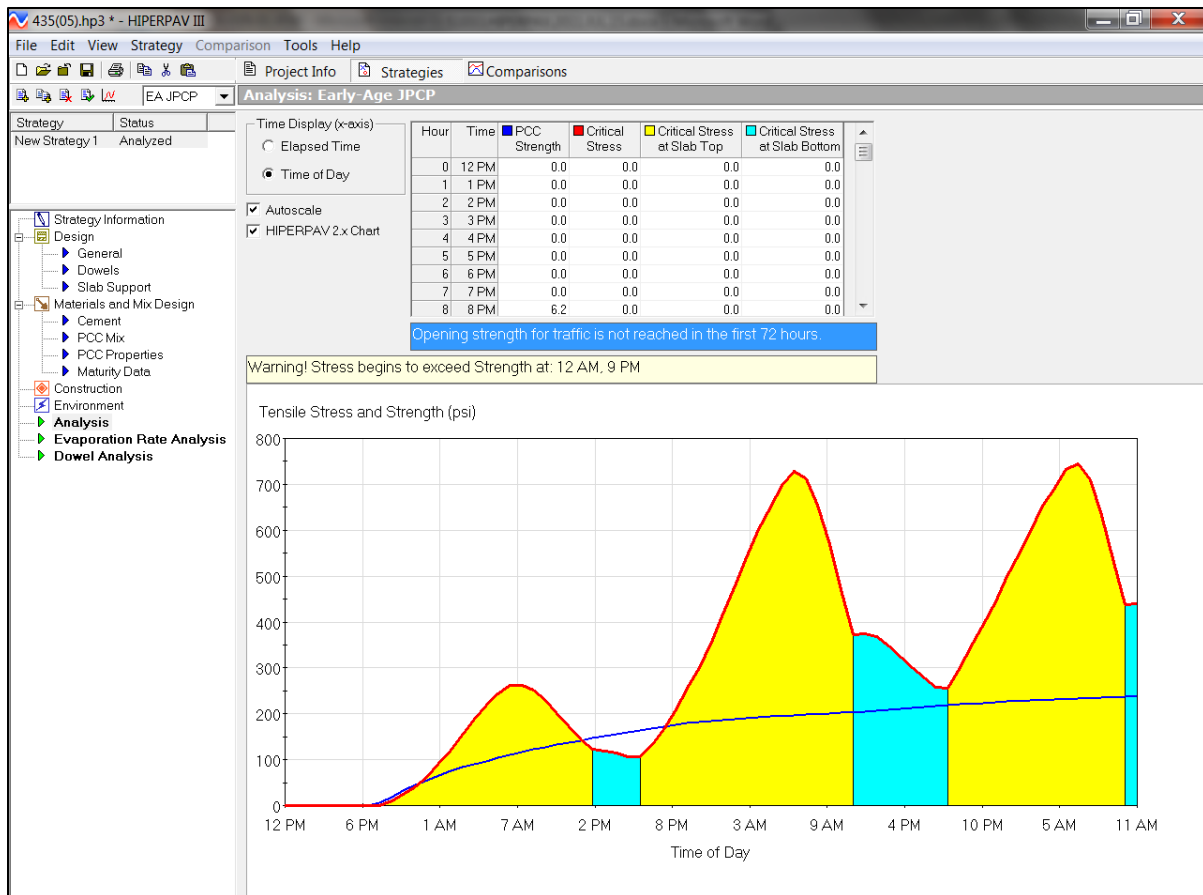
Select “Analysis” from the left menu, then “Strategy” from the top menu. A pull down menu will appear. From the pull down menu select “Validate”.

The “Strategy Status” box will show the strategy as “Validated” as displayed below.



Click on the analysis icon .

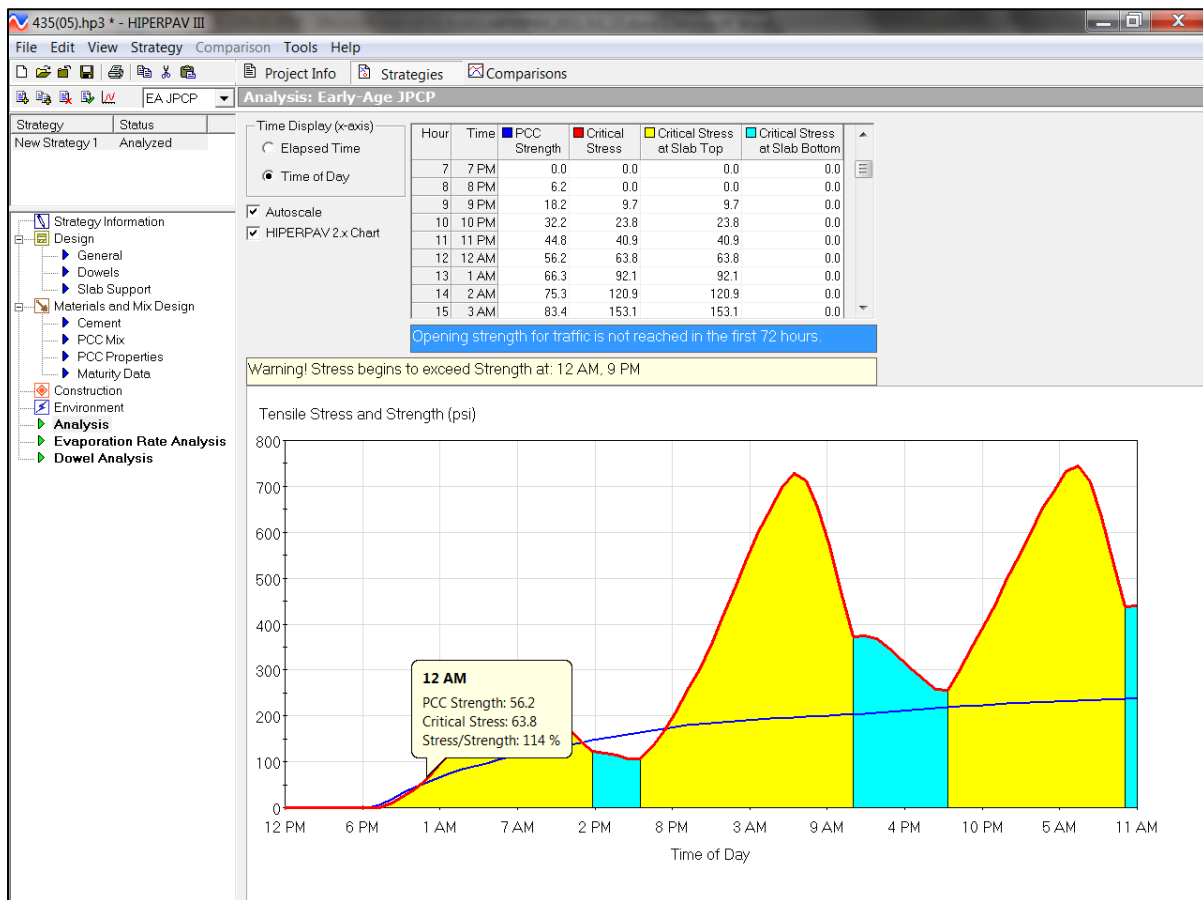
When the analysis is complete the following screen will be displayed showing the stress and strength relationship for the pavement for the first 72 hours.



Yellow highlighted areas indicate stress at the top of the slab and blue highlighted areas indicate stress at the bottom of the slab. The blue line indicates the predicted slab strength gain. When the predicted stress exceeds the strength there is a risk for early age cracking.

P. Reading Analyses.

The completed analysis screen values can be read for each hour of the operation and time. The scroll bar on the right side of the data screen provides the complete data for the first 72 hours including “PCC Strength”, “Critical Stress”, “Critical Stress of Slab Top”, and “Critical Stress at Slab Bottom”.



USER NOTE: By moving the mouse arrow over the blue concrete strength line the PCC concrete strength, stress (either top or bottom of concrete slab), and Stress-to-Strength percentage is displayed.

WHEN THE CRITICAL STRESS-TO-STRENGTH PERCENTAGE IS 98% OR HIGHER MODIFICATIONS TO THE STRATEGY ARE REQUIRED.

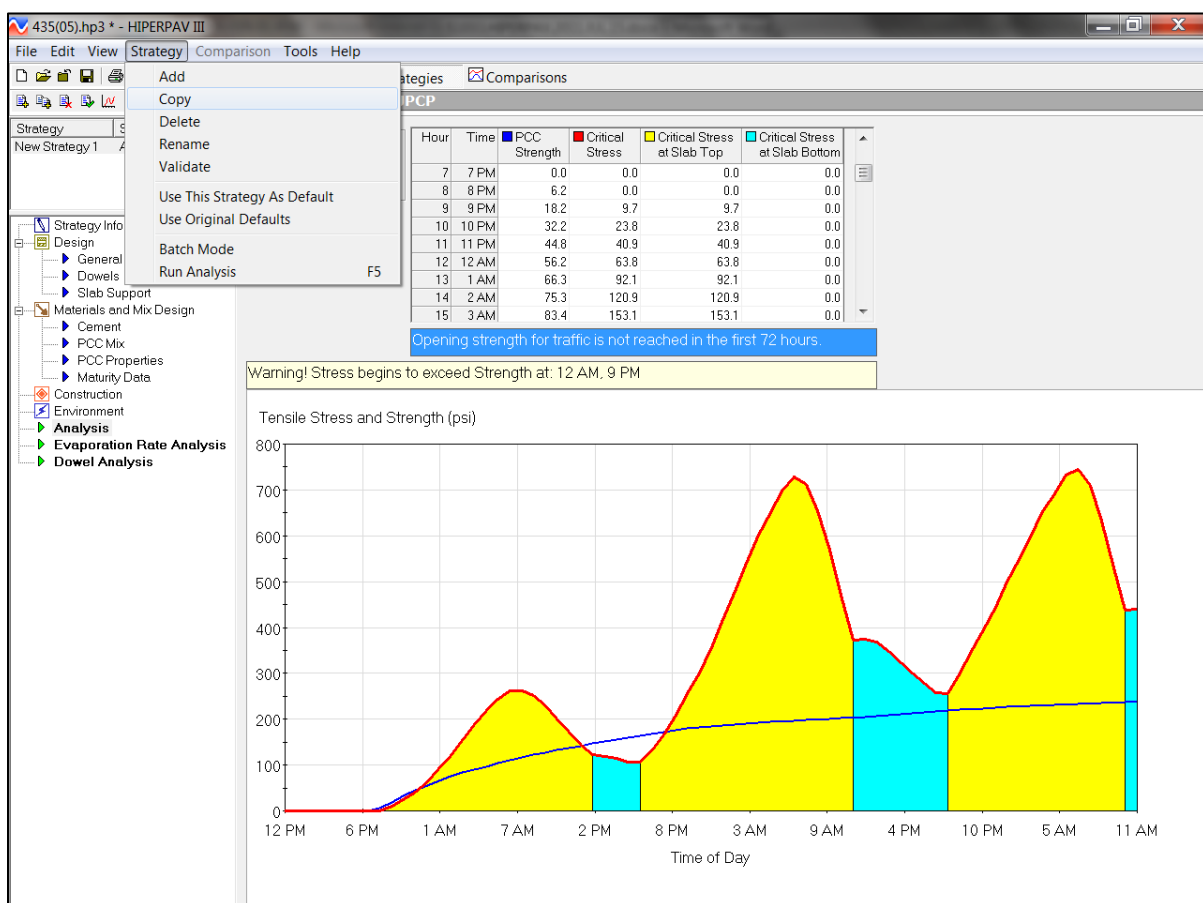
1033.06 Analyses of Additional Strategies and Modifications.

To minimize the risk of early age cracking, run additional strategies of HIPERPAV by changing variables that can be modified for the paving operation.

The first strategy was the “No Sawcutting” strategy. This will always be the baseline and will be revised to include the contractor’s saw cutting scenario and may require further revisions for curing method, time of construction, etc. in order to ensure the stress-to-strength percentage is less than 98%. In the following example sawcutting is specified at 10 hours and the time of construction was changed to 7 am. The estimated weather data was used in this example; however, weather should always be modified for the specific location and local weather predictions as discussed previously.

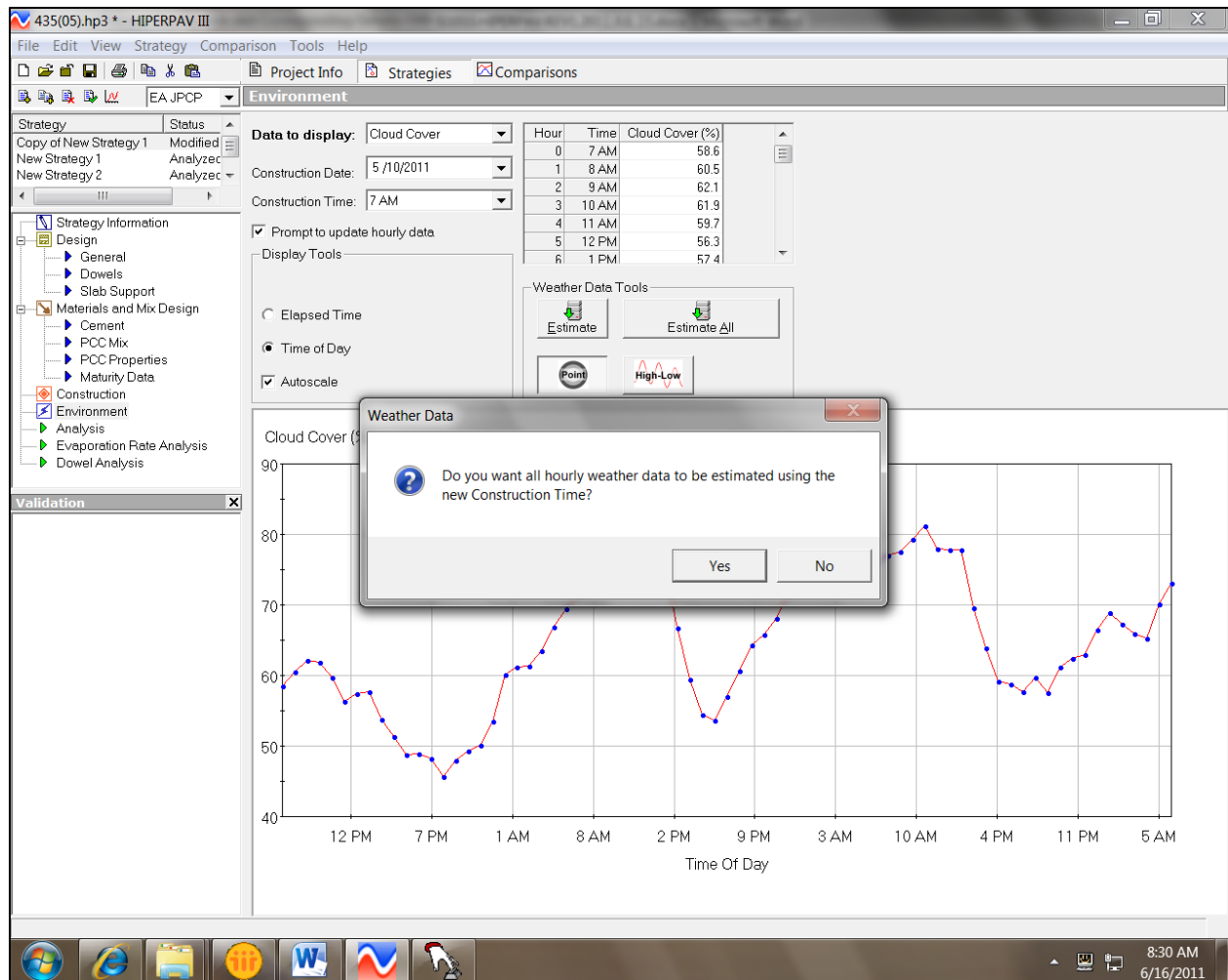
To run additional strategies perform the following steps.

Step 1: Copy Strategy 1 and rename by moving the mouse arrow up to **Strategy** in the top menu. Select “Copy”. In the “Status” the text “Copy of New Strategy 1” will appear.




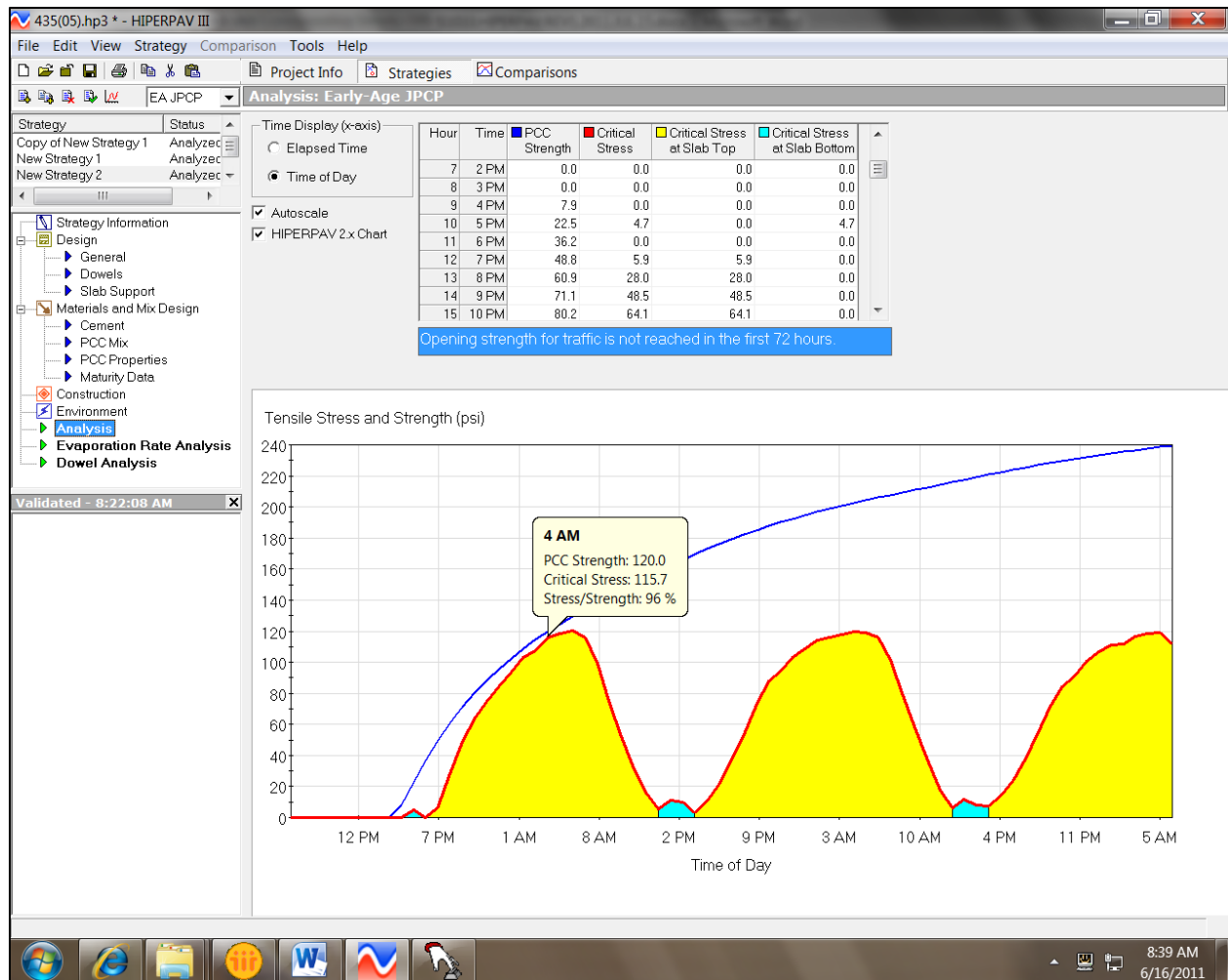
Step 2: In the “Status” box the text “Copy of New Strategy 1” will be displayed. Select “Copy of New Strategy 1” and change the file name to “New Strategy 2”.

Note, if “Construction Time” is changed as part of this new strategy, the user is asked if the weather data should be estimated using the new construction time. If the weather data previously input is still valid select “No”. Selecting “Yes” will restore all of the default weather data.



Step 4: For this example of revising and creating different strategies select “Construction” from the left menu. In the construction screen select “User-Defined Sawing Age”. Input 10 hours. Save the file.

Step 5: On the “Strategy” pull down menu select “Validate” and then the “Analyze Strategy” icon, . The following screen will be displayed.



In this case changing the time of sawing to 10 hours and the construction time to 7 am, the risk of early age cracking is minimized as shown above. The blue concrete strength line does not cross areas of critical stress and the stress-strength ratio is less than 98%.

The user will create as many different strategies as required to ensure the stress-to-strength ratio is less than 98%.

USER NOTE: Other possible strategies include changing the construction start time, curing method, base temperature, etc. Copying Strategy 1 will preserve the original input weather data.

It is the intent of this Supplement that the user creates and analyzes as many scenarios as needed to demonstrate the stress-to-strength ratio remains below 98%. This requires the user to completely and accurately represent the construction operation and use actual weather data. It is expected that the user will modify curing methods, mix designs, sawcutting times, and construction start times, at a minimum.

1033.07 Required Submittal of Outputs.

Provide the Engineer with the “No Sawcutting” strategy and all other strategies using actual weather conditions and construction operations for the day of placement in electronic format. Additionally provide a complete paper copy of all inputs and analyses for the day of placement using the HIPERPAV report capability.

Discuss with the Engineer the analyses and the construction variables considered and used in the HIPERPAV strategies to keep the stress-to-strength ratio to less than 98%. Run any additional strategies that the Engineer determines is necessary to minimize the risk of early age cracking.