Roadway Calculations in AGi32

Introduction

There are two techniques used to perform roadway specific calculations in AGi32: the *Roadway Optimizer* and the *Calculation Points – Roadway* command[1]. The calculation methodology employed is similar, but usage patterns for each function may be completely different. *Roadway Optimizer* can predict pole spacing for a variety of typical roadway configurations with a few clicks and produce instant presentation quality output. The *Calculation Points – Roadway* command on the other hand is used to place roadway calculation grids in AGi32's Model Mode to be integrated with CAD backgrounds and possibly luminaire locations covering a project boundary of larger scope.

AGi32's roadway capabilities are easily elevated to a level beyond the expectations of published standards. A discussion of the use of reflective surfaces (objects) expands analysis techniques to consider shadow casting and reflecting environments and opens the world of visualization to roadway lighting professionals.

Finally, a brief description of the new research oriented *Roadway Standard Configuration Tool* is included. The configuration tool allows the assumptions inherent in a roadway standard to be adjusted and customized in order that our industry may develop a deeper understanding of the calculations being employed and their correlation to roadway design practice.

AGi32 supports all popular international standards: North American IES-RP-8-2000, British BSEN 13201-3.2003, European CIE-140-2000, Australian AS1158.2-2005 and New Zealand NZ1158.2-2005.

---

[1] Roadway specific calculations refers to the calculation of pavement luminance and related quantities

Roadway Optimizer

The Roadway Optimizer is essentially a complete roadway design program in its own right. The Roadway Optimizer has the ability to predict pole spacing for a variety of road configurations while optimizing on multiple calculation criteria simultaneously. Each calculation iterates until all requested criteria are either met or, if not possible, program tolerances are reached. Detailed output of all calculated metrics is displayed immediately, bypassing AGi32's main program area.

Steps to use AGi32's Roadway Optimizer
Each step references Figure 1 below

1. Select a Roadway Standard (Ex: IES RP-8-2000)
2. Select roadway pavement characteristics, i.e. an R-table. AGi32 supports many international R-tables and you can add additional tables easily if available
3. Select Roadway Layout specifics:
    a. Layouts include: 1-row, 2-rows, 4-rows, opposite, staggered, near side, far side, with or without median
    b. Number of lanes: 2-direction calculations such as CIE can specify number of lanes in both directions
    c. Roadway width in direction of travel
    d. Median width
    e. Drivers side of roadway (left or right)
    f. Calculation area (top or bottom)
4. Specify Luminaire Layout: different luminaires, setbacks, mounting heights, aiming angles can be used for each row.
5. Select Optimization Criteria (as many as needed):
    a. Max Lv Ratio
    b. Avg/Min Illuminance ratio
    c. Avg/Min Luminance ratio
    d. Minimum Illuminance
    e. Minimum Luminance
    f. Average Illuminance
    g. Average Luminance
6. Click the Calculate button
7. All calculations required by the selected standard are performed and statistics shown. If the selected Optimization Criteria have been met or exceeded, the headings are shown in Bold in the statistical window. If they were not achieved, the results are shown in red
8. Each point-by-point grid can be reviewed in the graphics window by selecting it in the statistical list (arrow is shown for currently viewed metric)
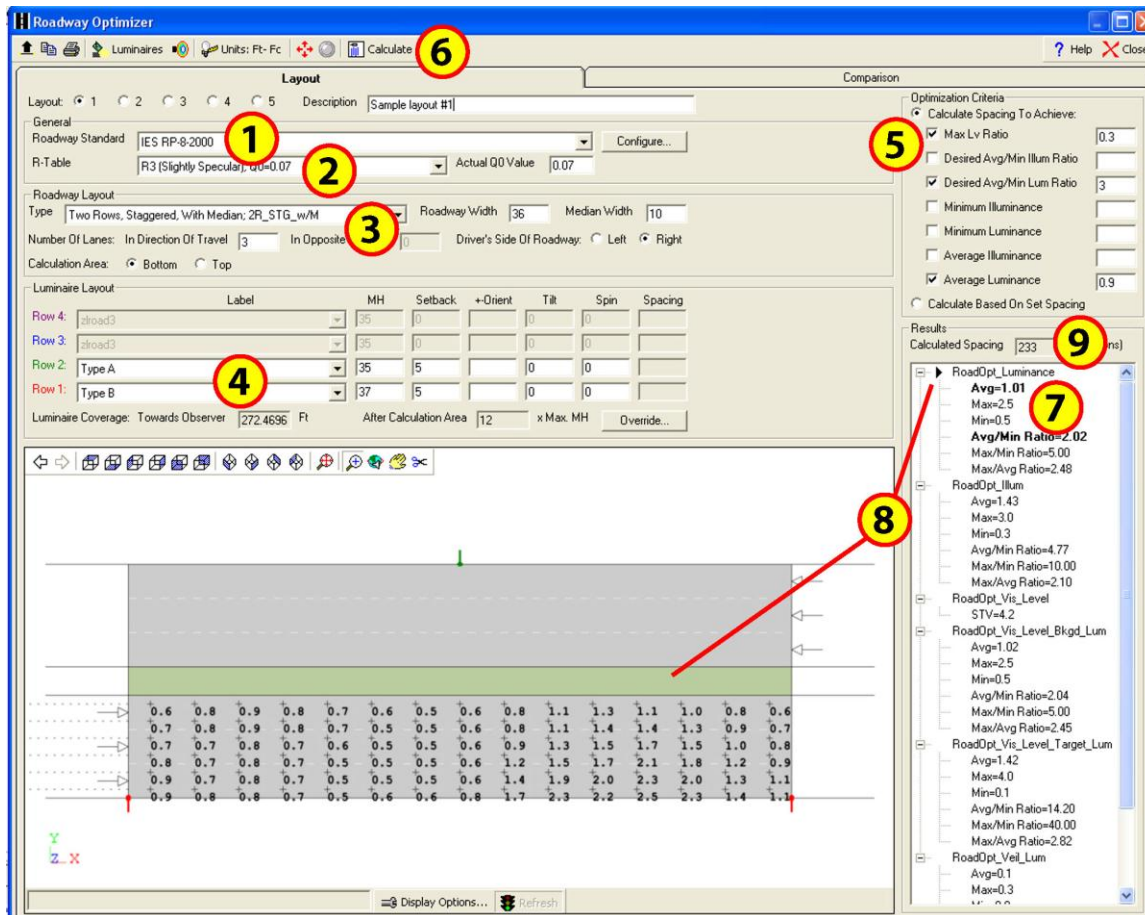9. Pole spacing is computed to meet the selected Optimization Criteria

Figure 1 – The Roadway Optimizer

Refine the pole spacing manually if desired (Figure 2):

10. Select the "Calculate Based on Set Spacing" setting
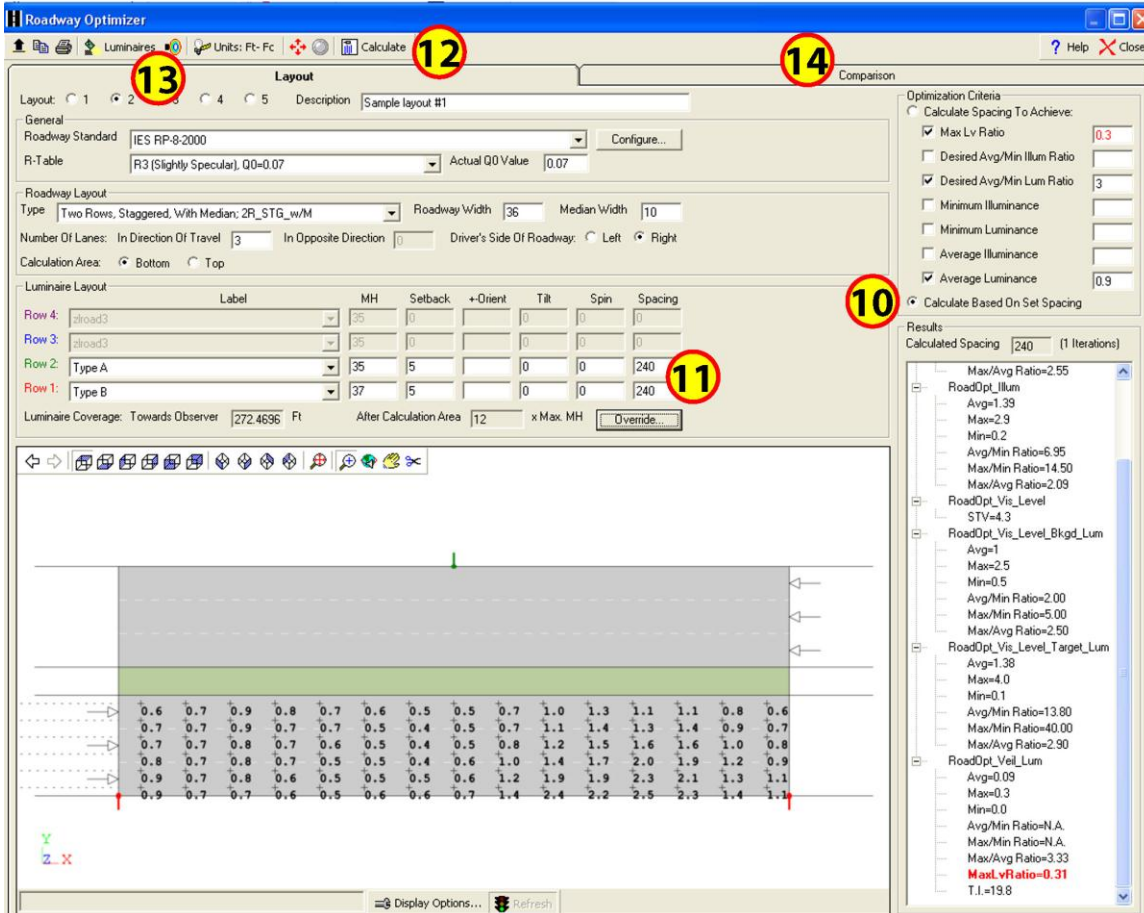11. Manually enter pole spacing for each row
12. Click the Calculate button

Figure 2 – Calculate Set Spacing in Roadway Optimizer

Create additional layouts and compare (Figures 2 & 3):

13. Click on the radio button for Layout 2 at the top of the form. All specifics from Layout 1 will be copied to Layout 2. Make any adjustments to Layout 2 and re-calculate

14. Provided the Roadway configuration and Standard remain the same, the layouts can be compared side by side by selecting the Comparison tab. This is particularly useful when comparing results for different luminaires using the same criteria, or slightly different pole spacings.
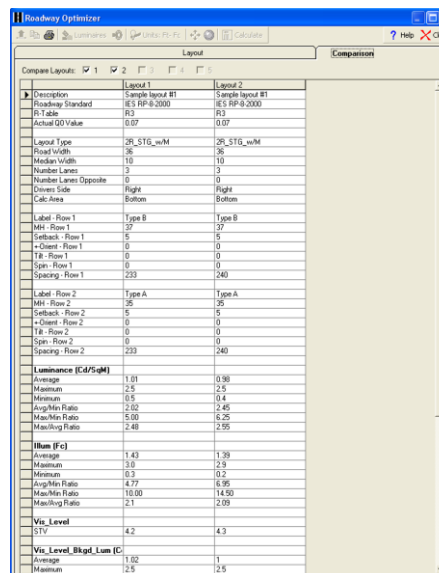

Figure 3 – Optimizer's Compare Tab

Output Options for Roadway Optimizer

Any calculation can be printed with results for each computed metric (i.e. Luminance, Illuminance, etc.) shown on an individual page. The cover page contains details on the photometric files used and luminaire/pole layout. A company logo can be used across the cover page. This output is also easily printed to PDF using any PDF capable printer driver.

Exporting the results from *Roadway Optimizer* into AGi32's Model Mode can be especially useful when the specific calculation should consider additional pole placements aside from the standard roadway. In this case it is easy to drop the output from Roadway Optimizer directly on top of an imported CAD background. Pole placements can be adjusted and amended as required. This is a quick substitute for using the more involved *Calculation Points – Roadway* command discussed in the next section.

Calculation Points – Roadway command

The *Calculation Points – Roadway* command is available from within the main Model Mode environment of AGi32. Similar to the *Roadway Optimizer*, it performs calculations based on any of the supported international standards. However, in the model environment, the command can be used to place composite roadway calculations[2] in position on top of 2-dimensional CAD created backgrounds considering all luminaires placed within the environment. This provides designers the flexibility to consider any luminaire type and position in the various roadway specific calculations. For example: luminaires can be considered not only along the roadway, but from intersecting roadways, adjacent site lighting, pedestrian lighting or any off-roadway source. Roadway specific calculation point grids can also be stretched across more than one pole cycle to encompass any distance. AGi32 makes every attempt to adhere to the various international standards when grid size exceeds that specified in the standard.

Steps to use AGi32's Calculation Points – Roadway command
Each step references Figure 4 below

1. Enter a Label and Description for this calculation
2. Select the Roadway Standard to be used as the calculation basis
3. Enter the number of lanes in the direction of travel
4. Select the R-Table to describe the pavement surface characteristics
5. Standard calculation metrics for the selected standard are shown on the left. They can be deselected. Specifics associated with each metric will appear in the area on the right.
6. Various aesthetic settings can be adjusted if necessary

---

[2] Composite roadway calculations refers to the command capability to place all of the various calculation grids with a single operation: Luminance, Illuminance, Veiling Luminance, Visibility, and more depending on the international standard selected.
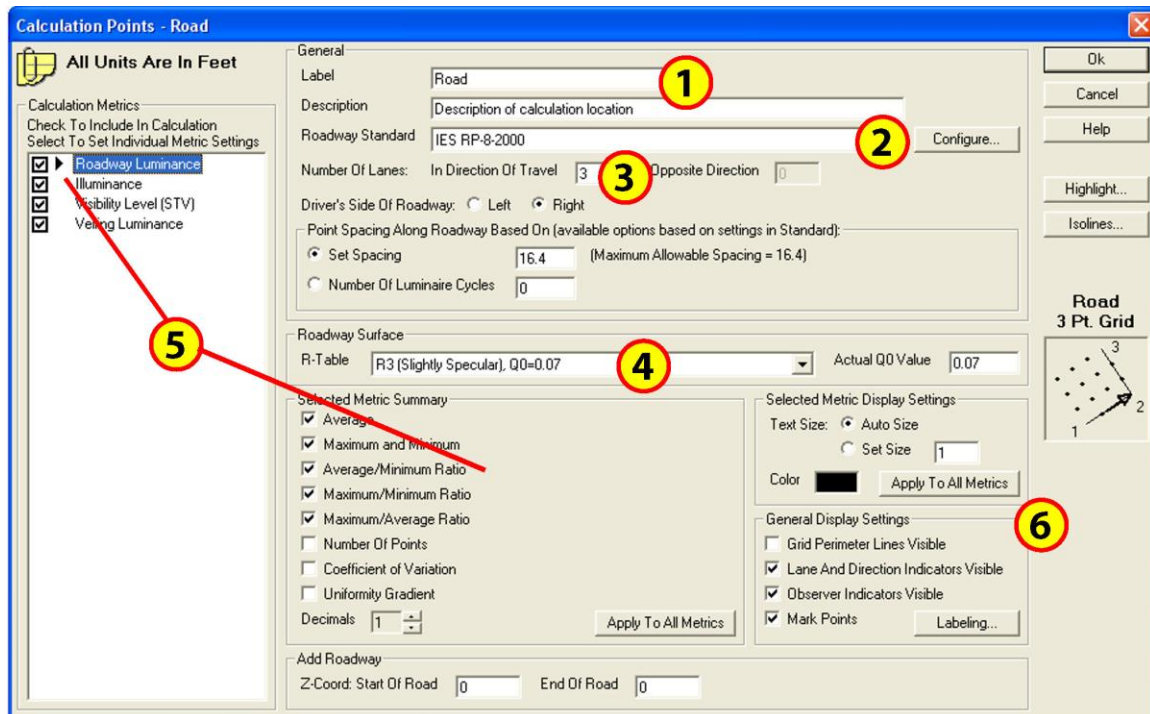
Figure 4 – The Calculation Points – Roadway dialog

7. By clicking OK in the dialog, control is transferred back to the graphics cursor in the Model view. Locate the grid using three points as shown below.
    a. Point number one (pt1) is on the curb line at the beginning of the analysis zone.
    b. Point number two (pt2) is on the same curb line at the end of the analysis zone.
    c. Point number three (pt3) is directly across the roadway from point 2 defining the width of the road in the direction of travel.
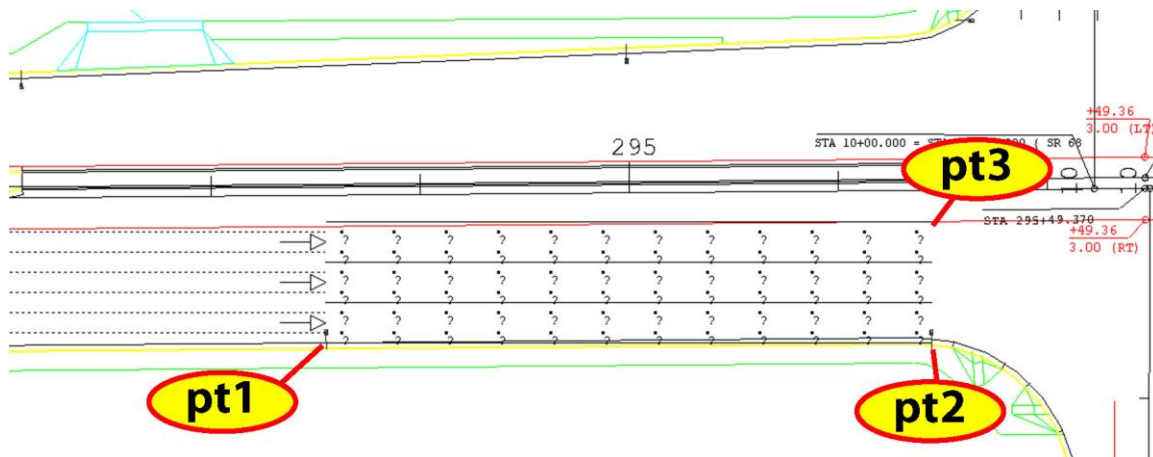

Figure 5 – Placing points in Model Mode

The end result can be a series of calculation areas within the project, each in position to analyze the specifics at that location. All luminaires in the project are considered in the final calculation.
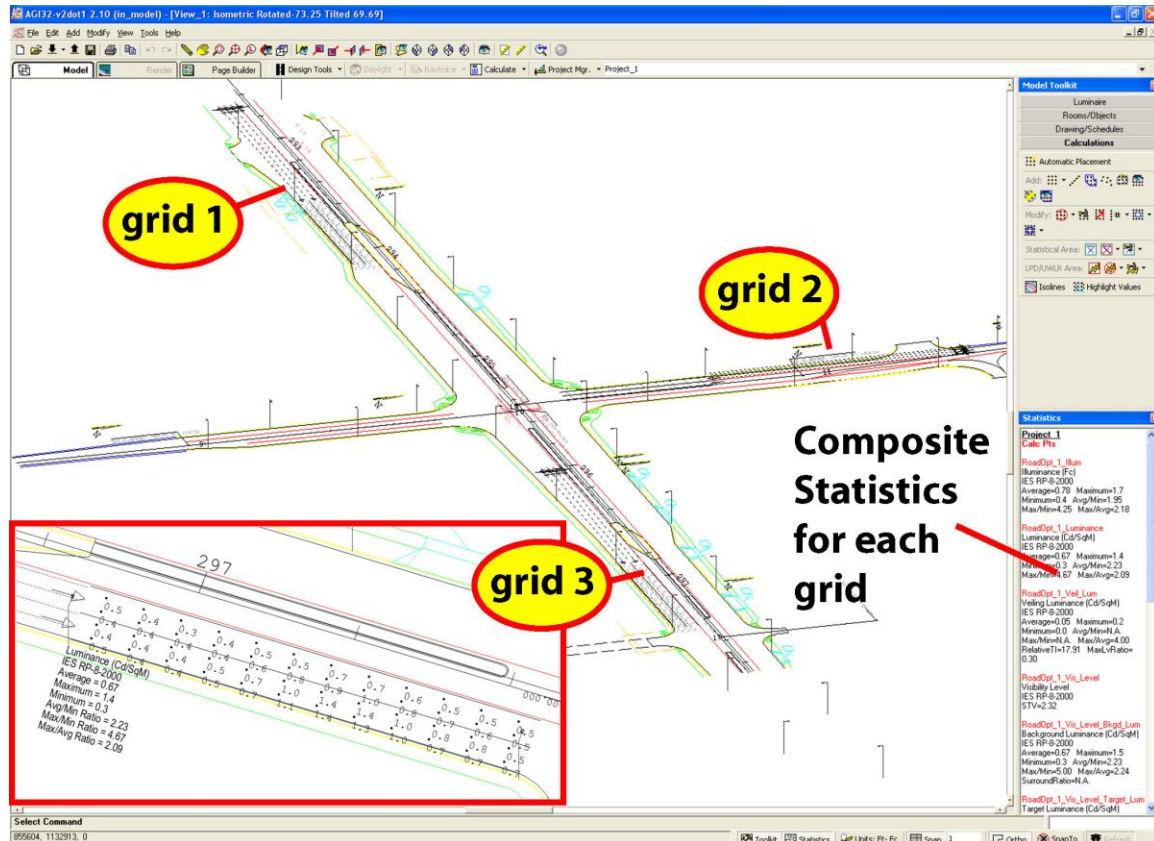

Figure 6 – Model Mode with multiple grids

Roadway Calculations in 3-dimensional environments

AGi32 allows 3-dimensional obstructions or reflecting surfaces to be considered in roadway calculations. This is not simply illuminance, but all roadway metrics will consider the shadowing and reflecting properties of objects in the environment. This allows realistic luminance calculations in applications where reflected or obstructed light is a factor such as over/under-passes and tunnels. AGi32 is the only program with this capability.

Starting with the most basic scenario, it is a simple operation to add a roadway surface to a 2-dimensional model to enable AGi32's visualization capability. In the image below we have placed a single polygon object at Z=0 with asphalt reflectance of 10%. The reflectance is actually immaterial at this point as all reflected light is lost without additional surfaces to redirect it back down toward the pavement. It does however, allow a rendered view of the roadway as we now know the diffuse luminance of the pavement surface due to direct light. In terms of the relationship to the actual roadway calculations,

it is set as surface type: "Pavement Surface- Direct Flux Only" using the Surface Edit command and has no impact on the results of this calculation.
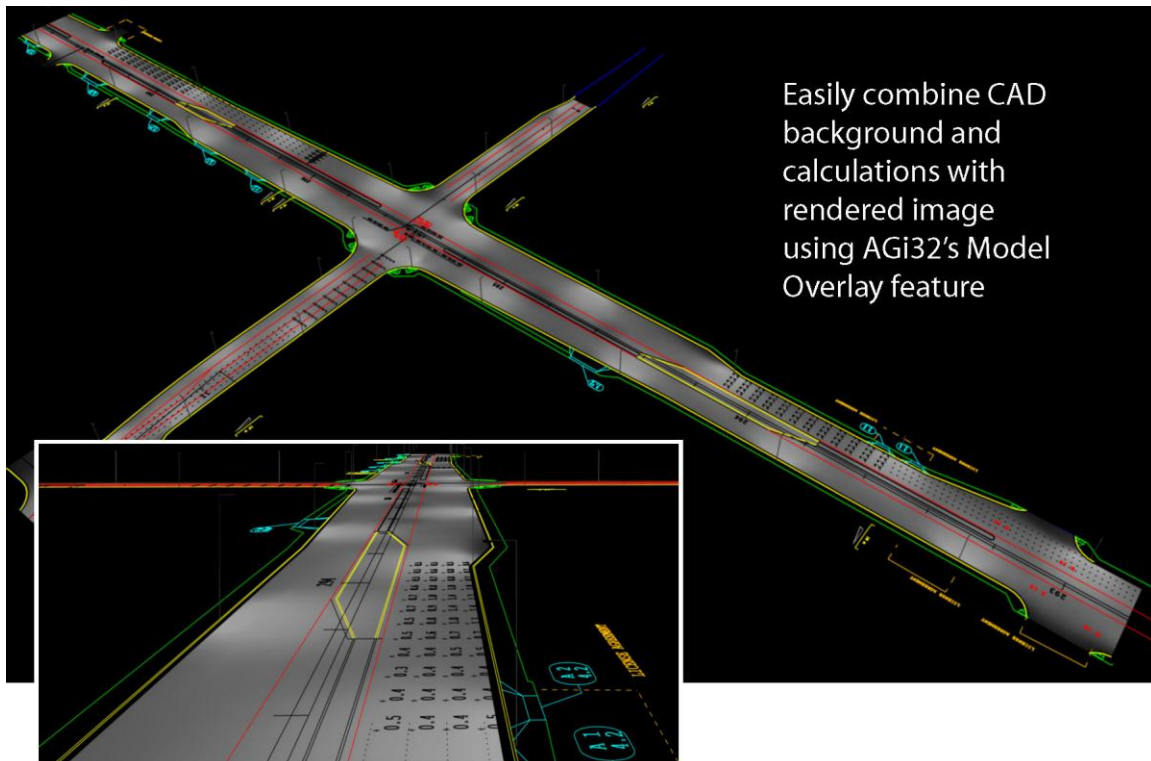

Figure 7 – Object added for pavement to facilitate rendering

In a more detailed analysis, an overpass and its obstructive and reflective properties can be considered in the computation of all roadway grids placed in the environment. The critical procedural element within the software is to define all object surfaces as "Roadway Contributors."

Using AGi32's visualization capability it is easy to assess the need for supplemental lighting under the overpass (Figure 8).
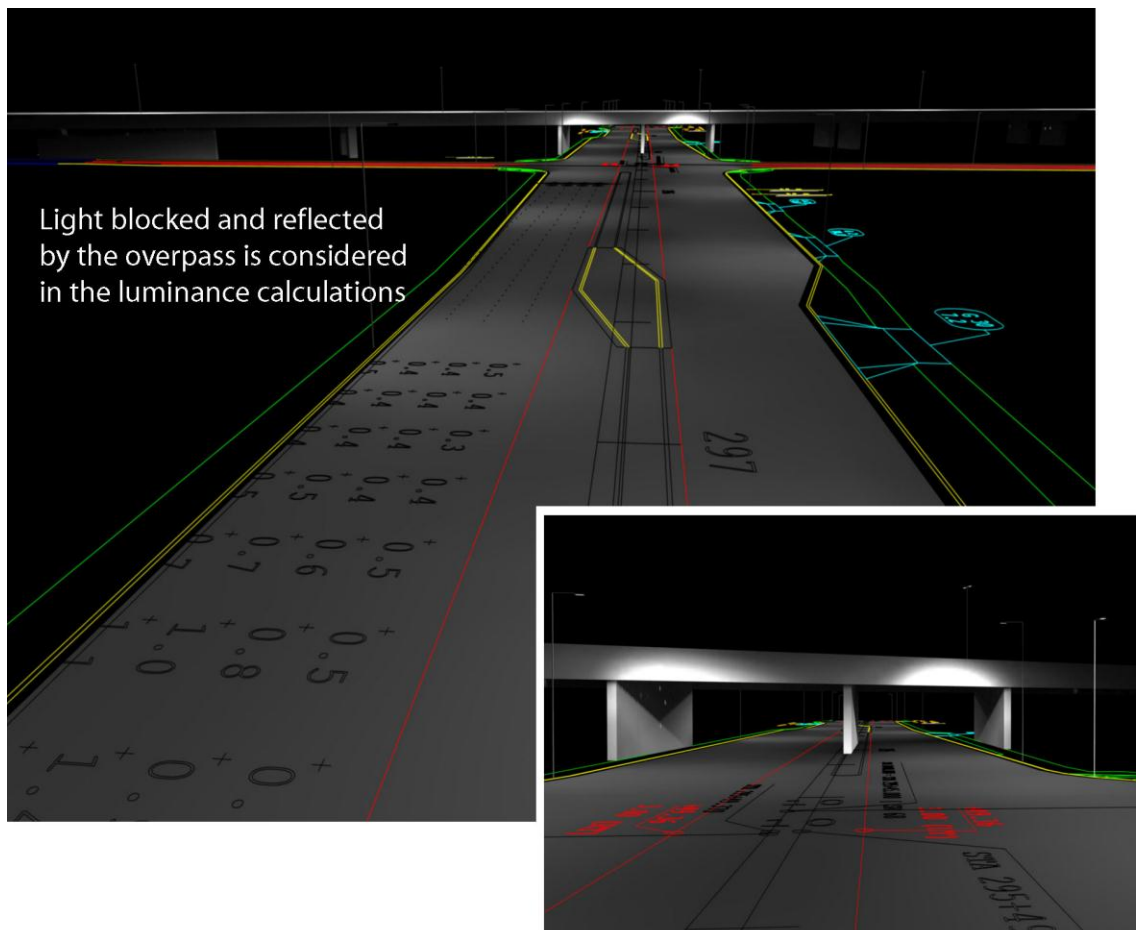
Light blocked and reflected by the overpass is considered in the luminance calculations

Figure 8 – Reflective surfaces (objects) considered in the roadway calculations

Roadway Standard Configuration Tool

There are a number of unique calculations associated with each international roadway standard (North American IES-RP-8-2000, British BSEN 13201-3.2003, European CIE-140-2000, Australian AS1158.2-2005 and New Zealand NZ1158.2-2005). Consider that any software tool must compute a multitude of metrics such as: Illuminance, Pavement Luminance, Veiling Luminance, Visibility Level, Surround Illuminance, Background Luminance, and more for each specific roadway section to be analyzed. Each international standard stipulates similar but different calculations and parameters can vary dramatically.

At Lighting Analysts, we believe we may be the only people that have ever tried to support all of the popular international roadway standards giving us a unique perspective when constructing our new roadway calculation engine. Placing all of the standard calculations in a single software tool begged for underlying code that could handle variations in calculation specifics such that each standard could simply modify a few variables and utilize the same engine. We are proud to have achieved this goal, but perhaps more importantly, we arrived at a landmark decision in the process: Why not

allow individual calculation choices and parameters to be modified on the user level such that an educated party could feasibly construct a completely new standard by mixing calculations from all standards and adjusting specifics? Imagine including the British Semi-cylindrical Illuminance calculation with pavement Luminance calculations from the IES method! How about adjusting the observer position or the grid of calculation points? It can all be done. User modifications can be saved as a custom standard and reused as required in place of published standards.

Steps to define a custom standard
Steps refer to Figure 9 below

1. Select the Create button and provide a name for the standard
2. Click the Configure button and select Calculation Metrics to include in the custom standard
3. Adjust each metric specifics as necessary by selecting the metric on the left side and editing specifics on the right
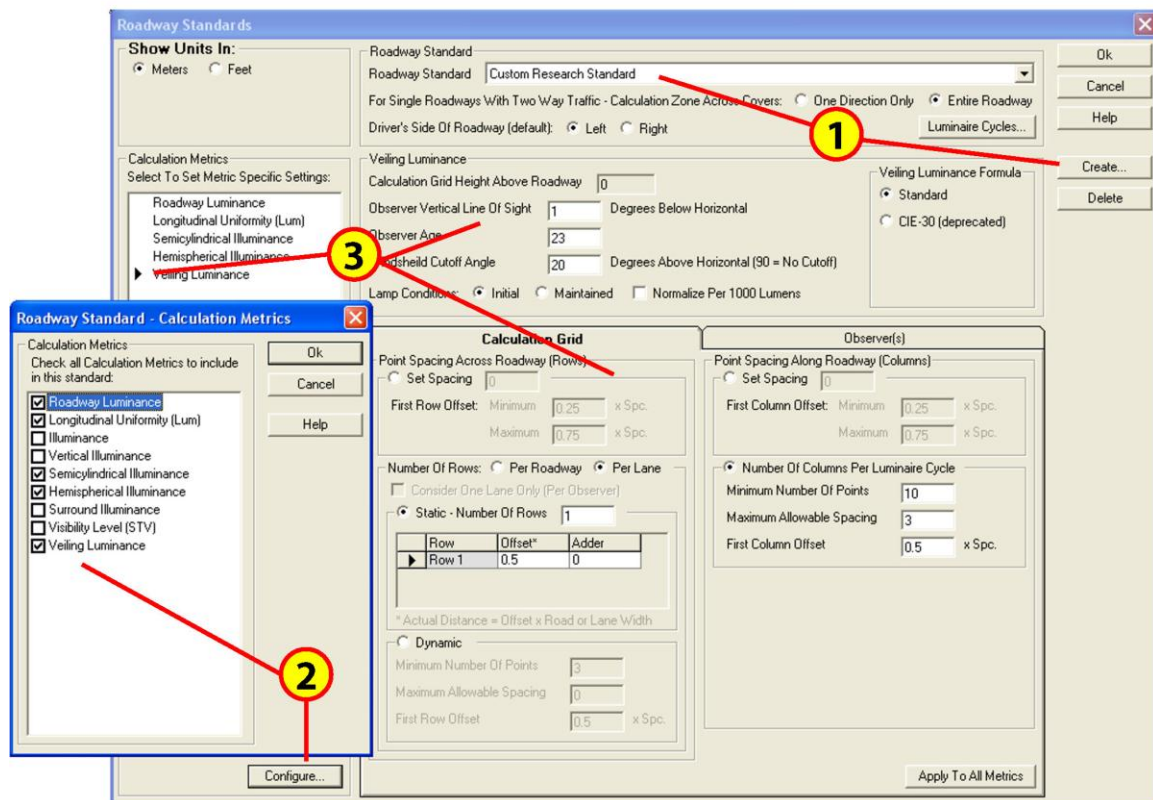

Figure 9 – The Roadway Standard Configuration Tool

This is the birth of the **Roadway Standard Configuration Tool** - what we hope will become an indispensable research aid for roadway specialists everywhere!