Cours E314
Principe d'éclairagisme

ÉCOLE POLYTECHNIQUE MONTRÉAL

Module 10

Éclairage routier et tunnels

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Module 9:

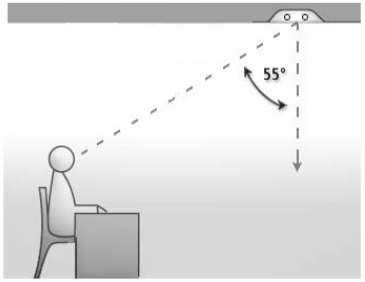
Éclairage routier et tunnels

- Luminances
- Luminance de voile (veiling luminances)
- STV
- Calculs, normes et recommandations

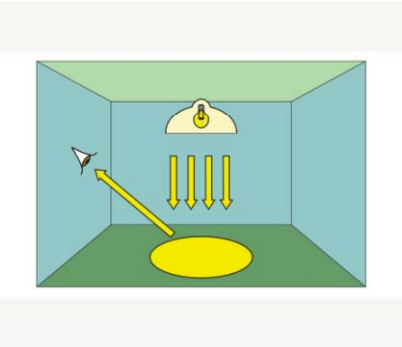
Luminance

Luminances primaires
et luminances secondaires

Les luminances primaires sont causées par des sources lumineuses. Soleil, ampoules, luminaire, écran d'ordi, …



Les luminances secondaires sont causées par des réflexions de la lumière sur une surface (sur un bureau...) ou transmission (à travers un vitrage ...).

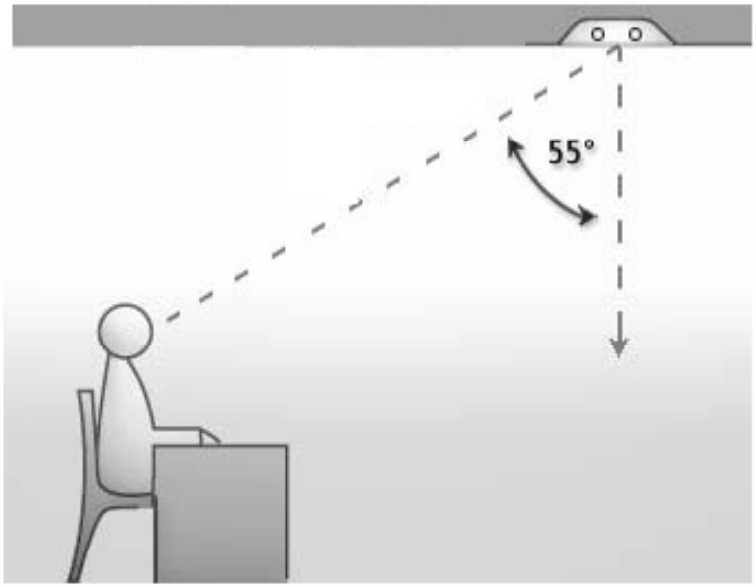


Luminance

La luminance permet de quantifier l'impression lumineuse perçue par un observateur qui regarde une source. Elle s'exprime comme le rapport entre l'intensité émise en direction de l'œil et la surface apparente qui émet cette intensité. La luminance s'exprime en cd / m2.

$$L = \frac{I}{S \cos\alpha} \quad \text{en cd / m2}$$

Où
I : intensité lumineuse de la source
S : surface réelle de la source
α : angle sous lequel est vue cette source



Luminance

Ordres de grandeur

Sources primaires	L (cd/m^2)
Soleil	1,6 10^9
Lampe incandescence 100W	6; 10^6
Tube fluorescent 36 W	10 000
Bougie de ménage	5000

Sources secondaires	L (cd/m^2)
Lune	2500
Papier éclairé à 400 lx - blanc - gris	 100 50
Mur ou plafond d'un local	50 à 150
Chaussée normalement éclairée	1 à 2

Cas particulier

Relation entre E et L dans le cas des surfaces diffusantes

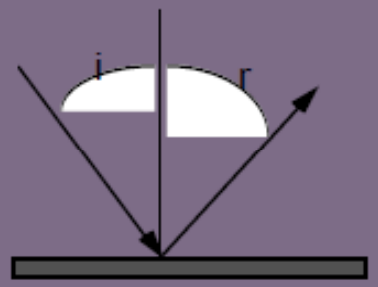
Dans le cas des matériaux diffusants, il existe une relation simple entre éclairement et luminance :

$$L = (\rho \pi) \times E \quad \text{en cd / m2}$$

où ρ : facteur de réflexion de la surface diffusante

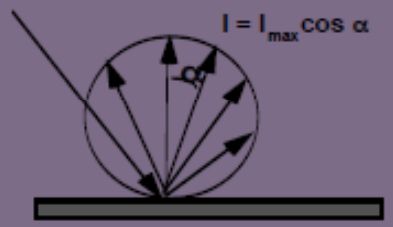
π : 3,1416

Comportement d'un matériau en réflexion



Loi de DESCARTES

angle d'incidence =angle de réflexion
Réflexion régulière



Loi de LAMBERT

quelque soit l'angle d'incidence, la réflexion se fait dans toutes les directions, de façon à ce que l'extrémité des rayons réfléchis soit sur la sphère tangente au point de contact.
Réflexion diffuse

Comportement d'un matériau quelconque, plus proche de la loi de Lambert que de celle de Descartes

Matériaux	
Béton clair	0,35
Béton sombre	0,15
brique	0,2
Bois sapin	0,35
vitrage	0,08

Peintures	claire	Moy.	Foncée
blanc	0,8	0,7	
jaune	0,7	0,5	0,3
gris	0,5	0,2	0,05
bleu	0,5	0,2	0,1
rouge	0,35	0,2	0,1

Éclairage Routier

Classification des surfaces routières

Class	Q_o	Description	Mode of Reflectance
R1	0.10	Portland cement, concrete road surface. Asphalt road surface with a minimum of 15 percent of the aggregates composed of artificial brightener and aggregates	Mostly diffuse
R2	0.07	Asphalt road surface with an aggregate composed of a minimum 60 percent gravel (size greater than 10 milimeters). Asphalt road surface with 10 to 15 percent artificial brightener in aggregate mix. (Not normally used in North America).	Mixed (diffuse and specular)
R3	0.07	Asphalt road surface (regular and carpet seal) with dark aggregates (*e.g.*, trap rock, blast furnace slag); rough texture after some months of use (typical highways).	Slightly specular
R4	0.08	Asphalt road surface with very smooth texture.	Mostly specular

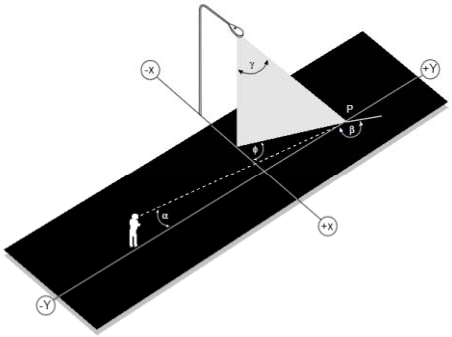
Note: Q_0 = representative mean luminance coefficient.

Luminance

Table R1

tan γ \ β	0	2	5	10	15	20	25	30	35	40	45	60	75	90	105	120	135	150	165	180
0	655	655	655	655	655	655	655	655	655	655	655	655	655	655	655	655	655	655	655	655
0.25	619	619	619	619	610	610	610	610	610	610	610	610	610	601	601	601	601	601	601	601
0.5	539	539	539	539	539	539	521	521	521	521	521	503	503	503	503	503	503	503	503	503
0.75	431	431	431	431	431	431	431	431	431	431	395	386	371	371	371	371	371	386	395	395
1	341	341	341	341	323	323	305	296	287	287	278	269	269	269	269	269	269	278	278	278
1.25	269	269	269	260	251	242	224	207	198	189	189	180	180	180	180	180	189	198	207	224
1.5	224	224	224	215	198	180	171	162	153	148	144	144	139	139	139	144	148	153	162	180
1.75	189	189	189	171	153	139	130	121	117	112	108	103	99	99	103	108	112	121	130	139
2	162	162	157	135	117	108	99	94	90	85	85	83	84	84	86	90	94	99	103	111
2.5	121	121	117	95	79	66	60	57	54	52	51	50	51	52	54	58	61	65	69	75
3	94	94	86	66	49	41	38	36	34	33	32	31	31	33	35	38	40	43	47	51
3.5	81	80	66	46	33	28	25	23	22	22	21	21	22	22	24	27	29	31	34	38
4	71	69	55	32	23	20	18	16	15	14	14	14	15	17	19	20	22	23	25	27
4.5	63	59	43	24	17	14	13	12	12	11	11	11	12	13	14	14	16	17	19	21
5	57	52	36	19	14	12	10	9.0	9.0	8.8	8.7	8.7	9.0	10	11	13	14	15	16	16
5.5	51	47	31	15	11	9.0	8.1	7.8	7.7	7.7										
6	47	42	25	12	8.5	7.2	6.5	6.3	6.2											
6.5	43	38	22	10	6.7	5.8	5.2	5.0												
7	40	34	18	8.1	5.6	4.8	4.4	4.2												
7.5	37	31	15	6.9	4.7	4.0	3.8													
8	35	28	14	5.7	4.0	3.6	3.2													
8.5	33	25	12	4.8	3.6	3.1	2.9													
9	31	23	10	4.1	3.2	2.8														
9.5	30	22	9.0	3.7	2.8	2.5														
10	29	20	8.2	3.2	2.4	2.2														
10.5	28	18	7.3	3.0	2.2	1.9														
11	27	16	6.6	2.7	1.9	1.7														
11.5	26	15	6.1	2.4	1.7															
12	25	14	5.6	2.2	1.6															

$Q_0 = 0.10$; S1 = 0.25; S2 = 1.53

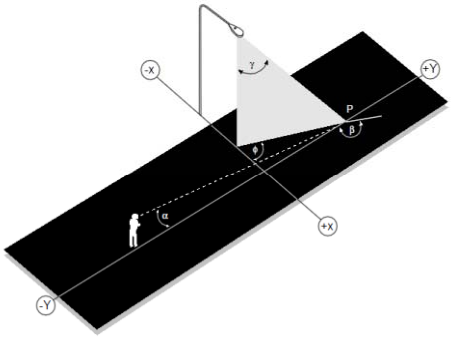


Luminance

Table R2

tan γ \ β	0	2	5	10	15	20	25	30	35	40	45	60	75	90	105	120	135	150	165	180
0	655	655	655	655	655	655	655	655	655	655	655	655	655	655	655	655	655	655	655	655
0.25	619	619	619	619	610	610	610	610	610	610	610	610	610	601	601	601	601	601	601	601
0.5	539	539	539	539	539	539	521	521	521	521	521	503	503	503	503	503	503	503	503	503
0.75	431	431	431	431	431	431	431	431	431	431	395	386	371	371	371	371	371	386	395	395
1	341	341	341	341	323	323	305	296	287	287	278	269	269	269	269	269	269	278	278	278
1.25	269	269	269	260	251	242	224	207	198	189	189	180	180	180	180	180	189	198	207	224
1.5	224	224	224	215	198	180	171	162	153	148	144	144	139	139	139	144	148	153	162	180
1.75	189	189	189	171	153	139	130	121	117	112	108	103	99	99	103	108	112	121	130	139
2	162	162	157	135	117	108	99	94	90	85	85	83	84	84	86	90	94	99	103	111
2.5	121	121	117	95	79	66	60	57	54	52	51	50	51	52	54	58	61	65	69	75
3	94	94	86	66	49	41	38	36	34	33	32	31	31	33	35	38	40	43	47	51
3.5	81	80	66	46	33	28	25	23	22	22	21	21	22	22	24	27	29	31	34	38
4	71	69	55	32	23	20	18	16	15	14	14	14	15	17	19	20	22	23	25	27
4.5	63	59	43	24	17	14	13	12	12	11	11	11	12	13	14	14	16	17	19	21
5	57	52	36	19	14	12	10	9.0	9.0	8.8	8.7	8.7	9.0	10	11	13	14	15	16	16
5.5	51	47	31	15	11	9.0	8.1	7.8	7.7	7.7										
6	47	42	25	12	8.5	7.2	6.5	6.3	6.2											
6.5	43	38	22	10	6.7	5.8	5.2	5.0												
7	40	34	18	8.1	5.6	4.8	4.4	4.2												
7.5	37	31	15	6.9	4.7	4.0	3.8													
8	35	28	14	5.7	4.0	3.6	3.2													
8.5	33	25	12	4.8	3.6	3.1	2.9													
9	31	23	10	4.1	3.2	2.8														
9.5	30	22	9.0	3.7	2.8	2.5														
10	29	20	8.2	3.2	2.4	2.2														
10.5	28	18	7.3	3.0	2.2	1.9														
11	27	16	6.6	2.7	1.9	1.7														
11.5	26	15	6.1	2.4	1.7															
12	25	14	5.6	2.2	1.6															

$Q_0 = 0.10$; S1 = 0.25; S2 = 1.53

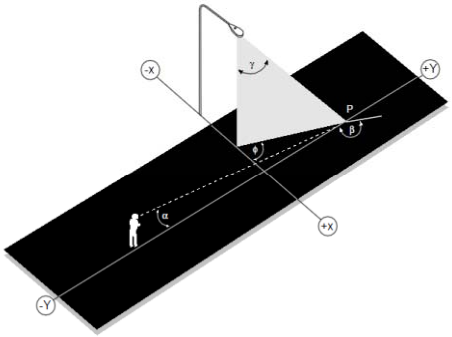


Luminance

Table R3

tan γ \ β	0	2	5	10	15	20	25	30	35	40	45	60	75	90	105	120	135	150	165	180
0	294	294	294	294	294	294	294	294	294	294	294	294	294	294	294	294	294	294	294	294
0.25	326	326	321	321	317	312	308	308	303	298	294	280	271	262	258	253	249	244	240	240
0.5	344	344	339	339	326	317	308	298	289	276	262	235	217	204	199	199	199	199	194	194
0.75	357	353	353	339	321	303	285	267	244	222	204	176	158	149	149	149	145	136	136	140
1	362	362	352	326	276	249	226	204	181	158	140	118	104	100	100	100	100	100	100	100
1.25	357	357	348	298	244	208	176	154	136	118	104	83	73	70	71	74	77	77	77	78
1.5	353	348	326	267	217	176	145	117	100	86	78	72	60	57	58	60	60	60	61	62
1.75	339	335	303	231	172	127	104	89	79	70	62	51	45	44	45	46	45	45	46	47
2	326	321	280	190	136	100	82	71	62	54	48	39	34	34	34	35	36	36	37	38
2.5	289	280	222	127	86	65	54	44	38	34	25	23	22	23	24	24	24	24	24	25
3	253	235	163	85	53	38	31	25	23	20	18	15	15	14	15	15	16	16	17	17
3.5	217	194	122	60	35	25	22	19	16	15	13	9.9	9.0	9.0	9.9	11	11	12	12	13
4	190	163	90	43	26	20	16	14	12	9.9	9.0	7.4	7.0	7.1	7.5	8.3	8.7	9.0	9.0	9.9
4.5	163	136	73	31	20	15	12	9.9	9.0	8.3	7.7	5.4	4.8	4.9	5.4	6.1	7.0	7.7	8.3	8.5
5	145	109	60	24	16	12	9.0	8.2	7.7	6.8	6.1	4.3	3.2	3.3	3.7	4.3	5.2	6.5	6.9	7.1
5.5	127	94	47	18	14	9.9	7.7	6.9	6.1	5.7										
6	113	77	36	15	11	9.0	8.0	6.5	5.1											
6.5	104	68	30	11	8.3	6.4	5.1	4.3												
7	95	60	24	8.5	6.4	5.1	4.3	3.4												
7.5	87	53	21	7.1	5.3	4.4	3.6													
8	83	47	17	6.1	4.4	3.6	3.1													
8.5	78	42	15	5.2	3.7	3.1	2.6													
9	73	38	12	4.3	3.2	2.4														
9.5	69	34	9.9	3.8	3.5	2.2														
10	65	32	9.0	3.3	2.4	2.0														
10.5	62	29	8.0	3.0	2.1	1.9														
11	59	26	7.1	2.6	1.9	1.8														
11.5	56	24	6.3	2.4	1.8															
12	53	22	5.6	2.1	1.8															

$Q_0 = 0.07$; S1 = 1.11; S2 = 2.38

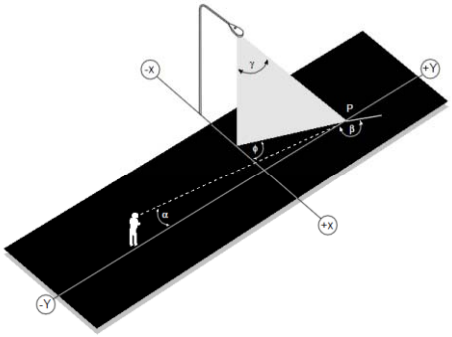


Luminance

Table R4

tan γ \ β	0	2	5	10	15	20	25	30	35	40	45	60	75	90	105	120	135	150	165	180
0	264	264	264	264	264	264	264	264	264	264	264	264	264	264	264	264	264	264	264	264
0.25	297	317	317	317	317	310	304	290	284	277	271	244	231	224	224	218	218	211	211	211
0.5	330	343	343	343	330	310	297	284	277	264	251	218	198	185	178	172	172	165	165	165
0.75	376	383	370	350	330	304	277	251	231	211	198	165	139	132	132	125	125	125	119	119
1	396	396	396	330	290	251	218	198	185	165	145	112	86	86	86	86	86	87	87	87
1.25	403	409	370	310	251	211	178	152	132	115	103	77	66	65	65	63	65	66	67	68
1.5	409	396	356	284	218	172	139	115	100	88	79	61	50	50	50	50	52	55	55	55
1.75	409	396	343	251	178	139	108	88	75	66	59	44	37	37	37	38	40	41	42	45
2	409	383	317	224	145	106	86	71	59	53	45	33	29	29	29	30	32	33	34	37
2.5	396	356	264	152	100	73	55	45	37	32	28	21	20	20	20	21	22	24	25	26
3	370	304	211	95	63	44	30	25	21	17	16	13	12	12	13	13	15	16	17	19
3.5	343	271	165	63	40	26	19	15	13	12	11	9.8	9.1	8.8	8.8	9.4	11	12	13	15
4	317	238	132	45	24	16	13	11	9.6	9.0	8.4	7.5	7.4	7.4	7.5	7.9	8.6	9.4	11	12
4.5	297	211	106	33	17	11	9.2	7.9	7.3	6.6	6.3	6.1	6.1	6.2	6.5	6.7	7.1	7.7	8.7	9.6
5	277	185	79	24	13	8.3	7.0	6.3	5.7	5.1	5.0	5.0	5.1	5.4	5.5	5.8	6.1	6.3	6.9	7.7
5.5	257	161	59	19	9.9	7.1	5.7	5.0	4.6	4.2										
6	244	140	46	13	7.7	5.7	4.8	4.1	3.8											
6.5	231	122	37	11	5.9	4.6	3.7	3.2												
7	218	106	32	9.0	5.0	3.8	3.2	2.6												
7.5	205	94	26	7.5	4.4	3.3	2.8													
8	193	82	22	6.3	3.7	2.9	2.4													
8.5	184	74	19	5.3	3.2	2.5	2.1													
9	174	66	16	4.6	2.8	2.1														
9.5	169	59	13	4.1	2.5	2.0														
10	164	53	12	3.7	2.2	1.7														
10.5	158	49	11	3.3	2.1	1.7														
11	153	45	9.5	3.0	2.0	1.7														
11.5	149	41	8.4	2.6	1.7															
12	145	37	7.7	2.5	1.7															

$Q_0 = 0.08$; S1 = 1.55; S2 = 3.03



Luminance

European roadways are lit to levels more than twice as high as those in the United States, and with better uniformity. Belgian experts expressed the opinion that a high degree of pavement uniformity yields good driver comfort. They are confident that driver comfort equates to driver safety. They were not, however, aware of any formal studies linking driver comfort to safety.

Based on the Belgian experience, experts suggest that roadways lit to levels between 1 and 2 cd/m^2 produce good visibility, while lighting the roadway to less than 1 cd/m^2 does not yield good visibility. In addition to light level, good visibility in wet conditions also depends on the locations of luminaires. For example, in Finland, the team observed lighting over the roadway.

Pavement Reflection Factors and R-Tables

Because the luminance design method depends on road surfaces being made visible by light reflected from roads and entering the eye of the observer, the reflection properties of pavement become an integral part of the lighting-design process. The existing pavement reflection tables, the R-tables, were published in 1976 and have been used in luminance design worldwide ever since. The R-tables refer to pavement reflection characteristics under dry road-surface conditions only.

The R-tables are based on two pavement properties: S1, the specularity or pavement shininess; and Qo, the lightness or degree of grayness, from white to black, of a road's surface.

The range of the S1 value determines the class in which pavement is assigned, R1 through R4, as shown in table 3.

Table 3. R-Table Values, by Pavement Class.

Pavement Class	Standard S1	S1 Range
R1	0.25	< 0.42
R2	0.58	>0.42 but < 0.85
R3	1.11	>0.85 but <1.35
R4	1.55	>1.35

For accuracy, the average luminance coefficient, Qo, must be determined for the particular pavement under consideration. Typically, the values for Qo are R1 = 0.1, R2 and R3 = 0.7, and R4 = 0.8. However, these typical numbers do vary.

In Belgium, the most commonly encountered road pavements were bituminous asphalts (R3, with Qo from 0.07 to 0.10 cd/m^2/lux) and porous asphalts (R2, with Qo from 0.05 to 0.08 cd/ m^2/lux). French experts use the real R-value of the roadway, if possible. For quick estimating purposes, however, the following luminance/illuminance conversions for roadway lighting are used in France:

1 cd/m^2 is produced by 8 lux on light-colored pavement.

1 cd/m^2 is produced by 18 lux on dark-colored pavement.

1 cd/m^2 is produced by 14 lux on average-colored pavement.

Swiss, French, and Belgian experts mentioned that a refined analysis of pavement properties is conducted for major projects. The analysis requires that a sample of the future road pavement be measured in the laboratory and the matrix of the reduced reflection coefficient be incorporated into the specifications, along with the minimum required lighting levels and uniformities for the project.

To obtain realistic R-values when evaluating an actual road surface, the Belgians evaluate several core samples and average the results. Outliers are discarded. Furthermore, results of studies have shown that, in the case of porous asphalts, it typically takes between 6 months and a year for the pavement to stabilize in order to obtain reliable R-values.

Luminance

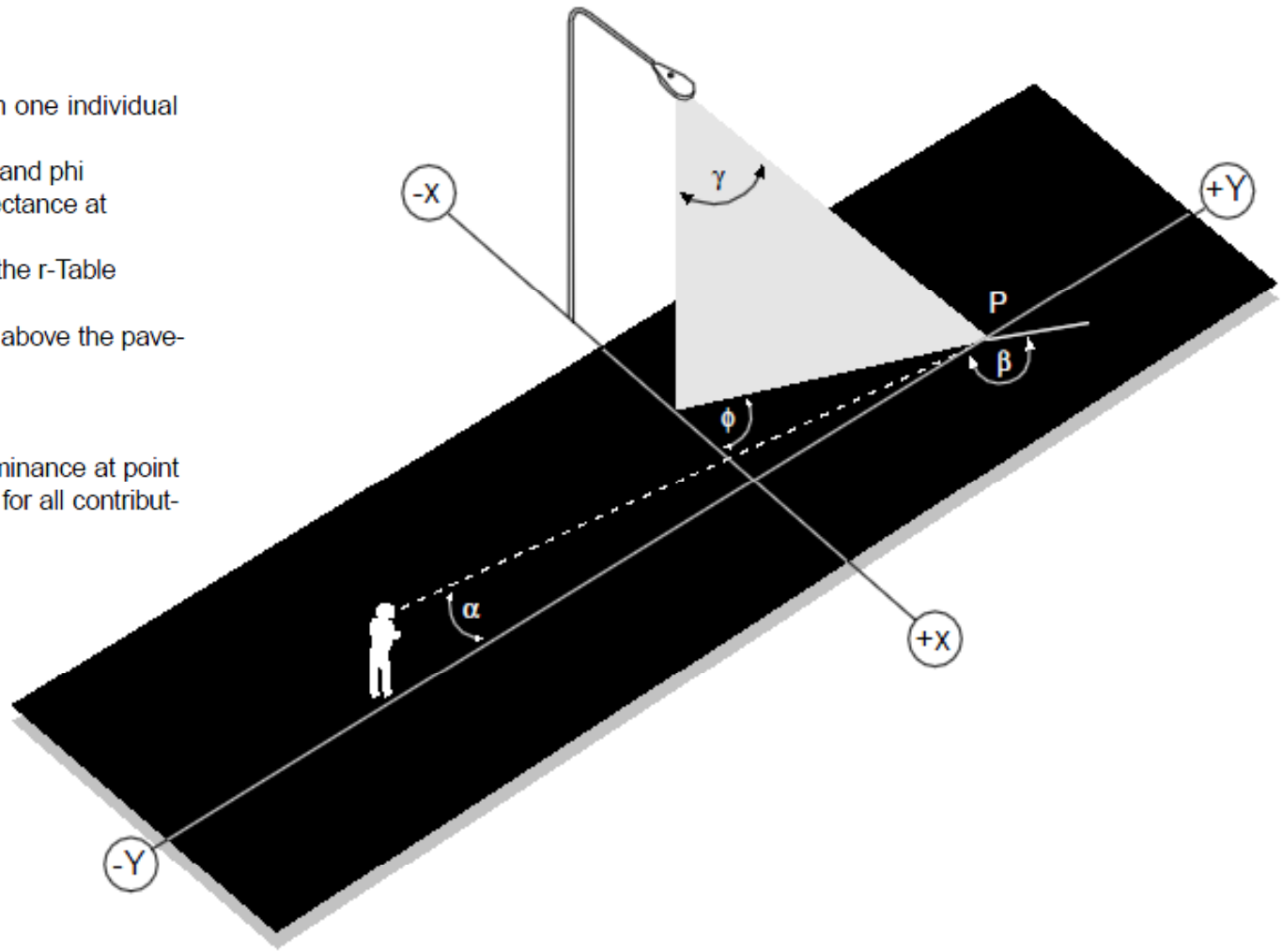
Luminance

$$L = \frac{I(\phi,\gamma) \times r(\beta,\gamma) \times LLF}{MF \times H^2}$$

Luminance du pavé

L = Pavement Luminance from one individual luminaire at point P
I = Intensity at angles gamma and phi
r = Reduced coefficient of reflectance at angles gamma and beta
MF = Multiplying Factor used by the r-Table (often 10,000)
H = Luminaire mounting height above the pavement surface (meters)
LLF = Light Loss Factor

The total horizontal illuminance or luminance at point P is the sum of the values calculated for all contributing luminaires.



Luminance

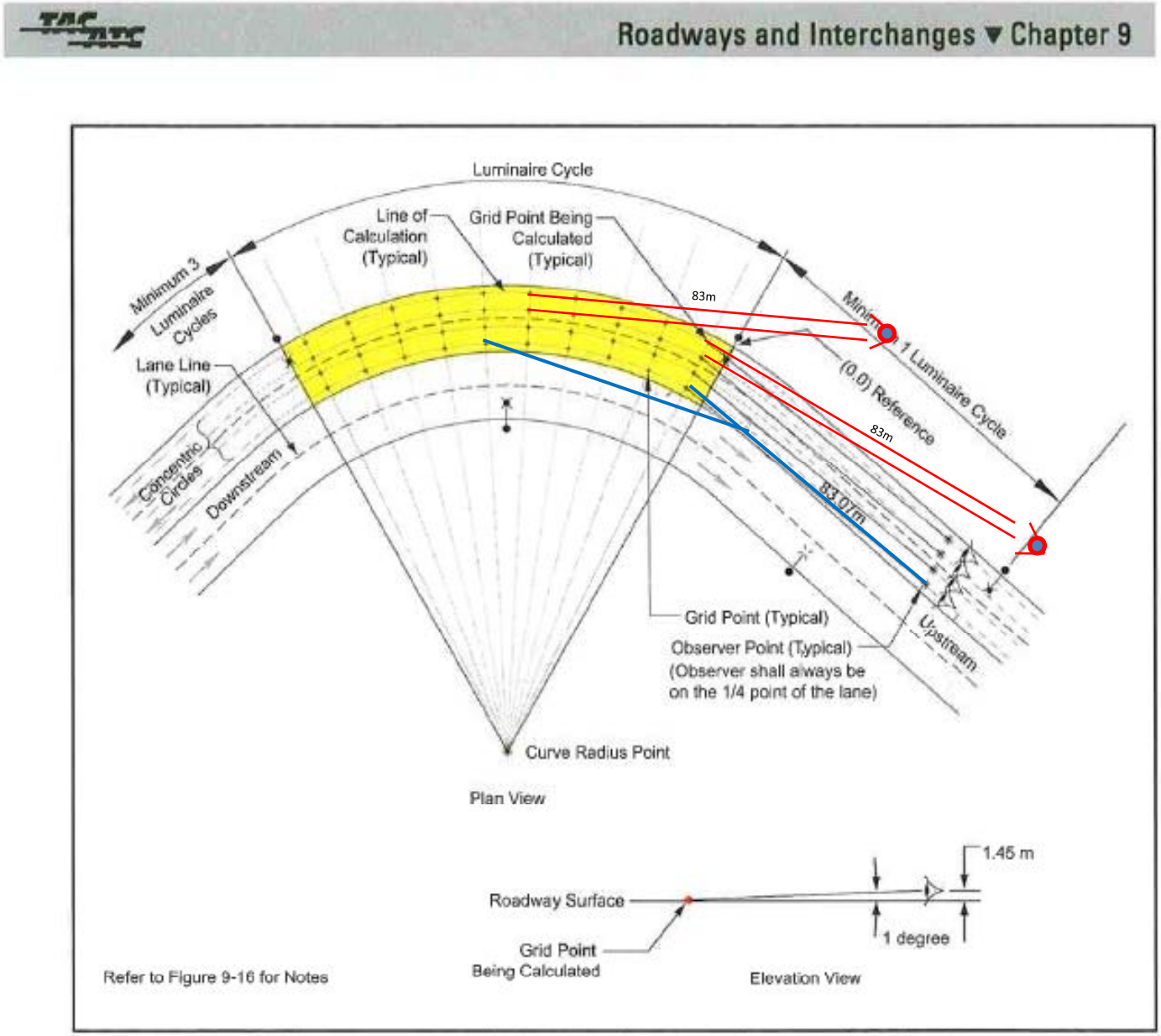


Figure 9-17 – Luminance Calculation Grid Geometry for Curved Roadway Sections

Pourquoi on ne calculs pas la luminance dans une courbe ?

La grille RP8 d'IES positionne l'observateur dans la sens du trafic à 83m d'un point , ce qui positionnerait l'observateur à l'extérieur de la route basé sur la tangente de la courbe. Voilà pourquoi IES recommande de calculé en éclairement seulement dans le courbes.

Pourquoi AGI ne calculs pas la luminance dans les courbes? Complexité géométrique, les angles changent trop entre chaque points et aucun standard n'as été établi ou est reconnu.

Les standards sont établis par de la recherche avec groupe témoin qui détermine les niveaux de conforts à être respectés.

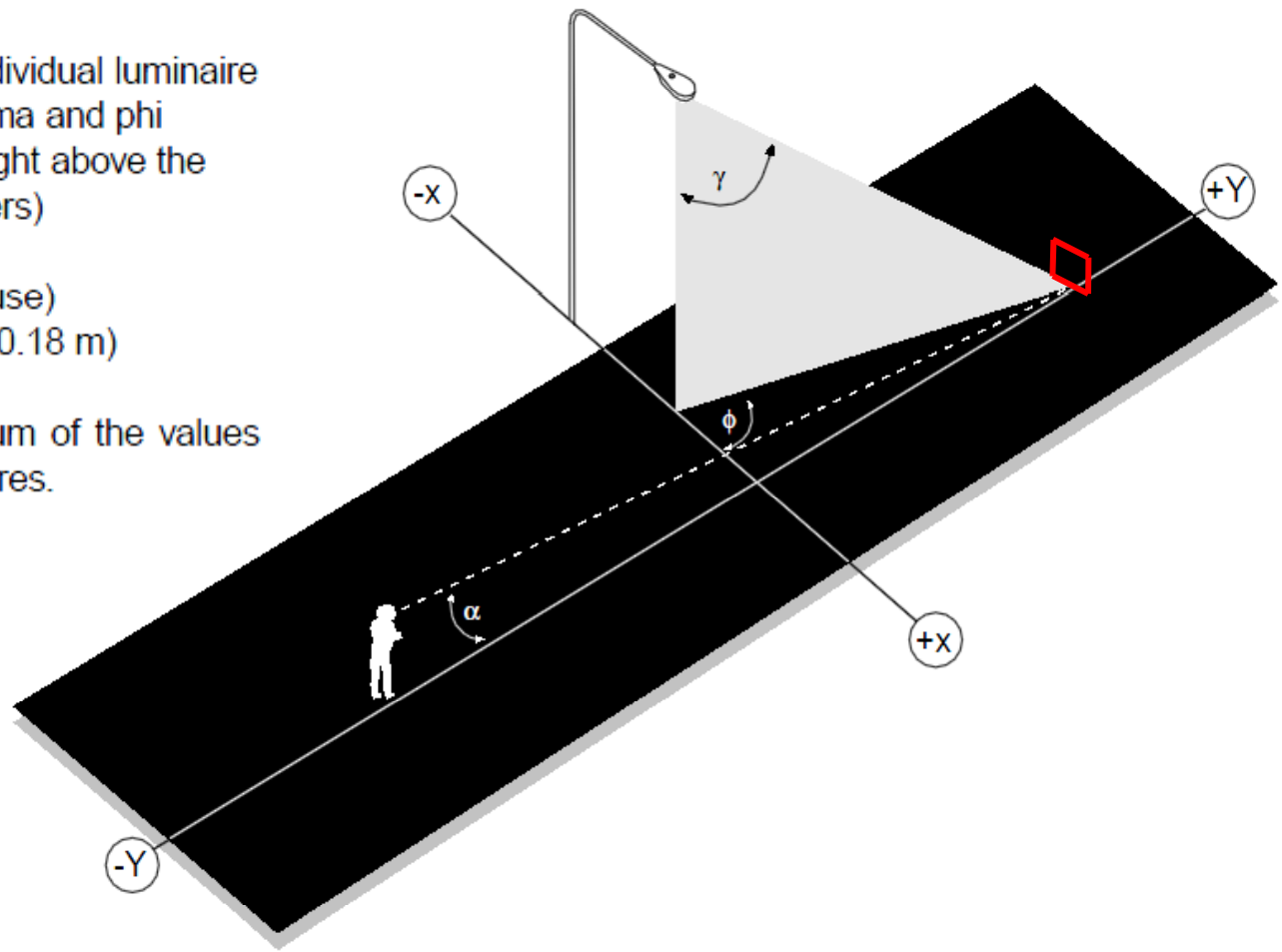
Luminance

Luminance d'une cible à surface vertical

$$L_t = \frac{I(\phi,\gamma) \times (\cos\gamma)^2 \times \sin(\gamma) \times [\cos(90-\phi)] \times 0.5 \times LLF}{[H - (0.5 \times TH)]^2 \times \pi}$$

L_t = Luminance from one individual luminaire
I = intensity at angles gamma and phi
H = Luminaire mounting height above the pavement surface (meters)
LLF = Light Loss Factor
0.5 = Reflectance Factor (diffuse)
TH = Target Height (typically, 0.18 m)

The total target luminance is the sum of the values calculated for all contributing luminaires.



Luminance de voile

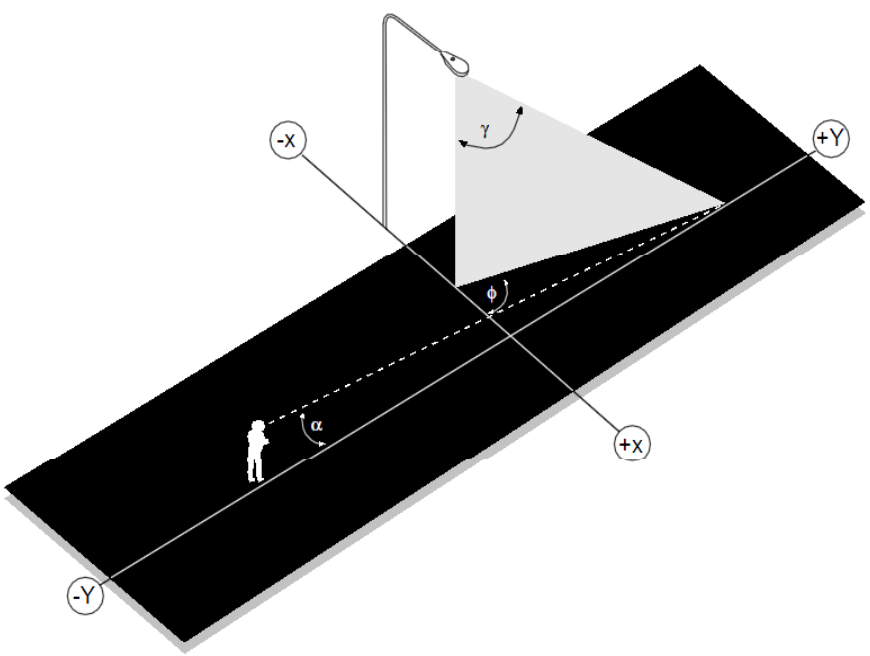
Luminance de voile (Veiling luminance)

$L_v = K/\theta^n$, $n = 2.3 - 0.7 \times \log_{10}(\theta)$ for $\theta < 2$, $n = 2$ for $2 \leq \theta$

where:

L_v	=	Veiling Luminance from one individual luminaire
K	=	10 × (Vertical illuminance at the plane of a 25-year-old observer's eye)
θ	=	Angle in degrees

The veiling luminance due to all light sources (Lv) is the sum of the veiling luminance of all of the individual contributing sources.



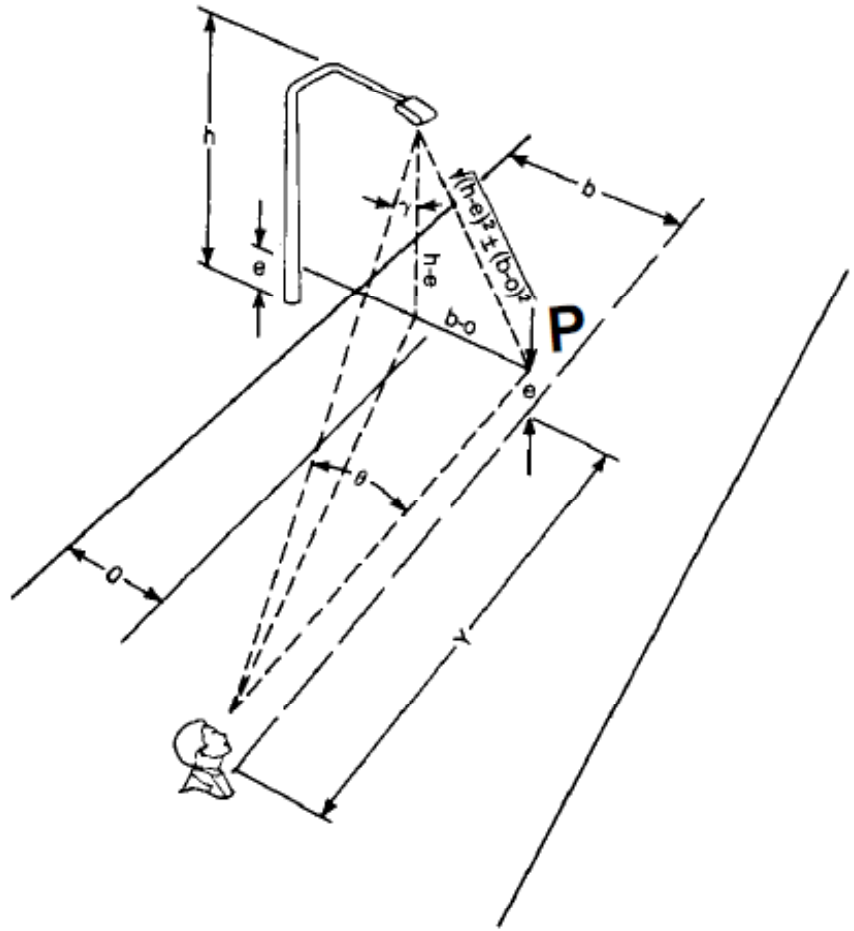


Figure A3. Orientation for veiling luminance. Downward viewing direction (α in Figure A2) is 1°.

Luminance de voile

On calcul la luminance de voile pour figurer les risques d'éblouissement en établissant un ratio entre la luminance de voile maximum sur la luminance moyenne.

Maximum Veiling Luminance Ratio

L_{Vmax}/L_{avg}

$$\frac{\text{La luminance de voile Maximum}}{\text{Luminance moyenne}}$$

≤ 0.3 ou ≤ 0.4

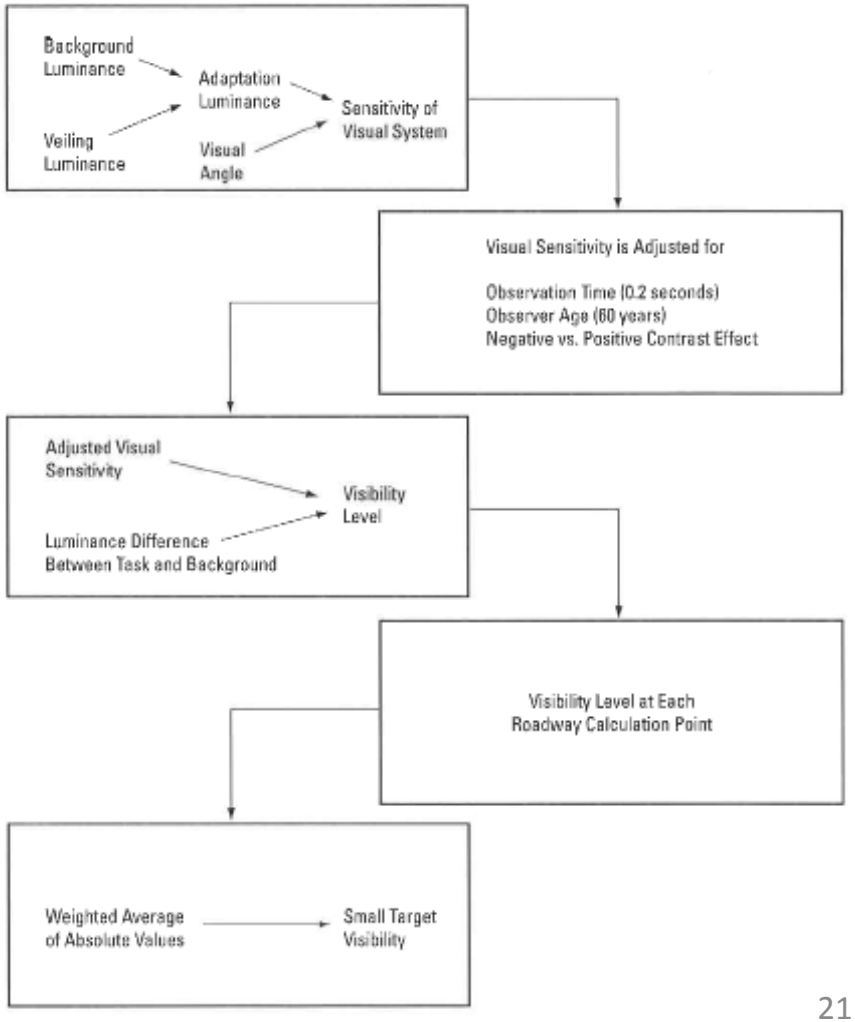
Selon le type d'application routière

STV (small target visibility)

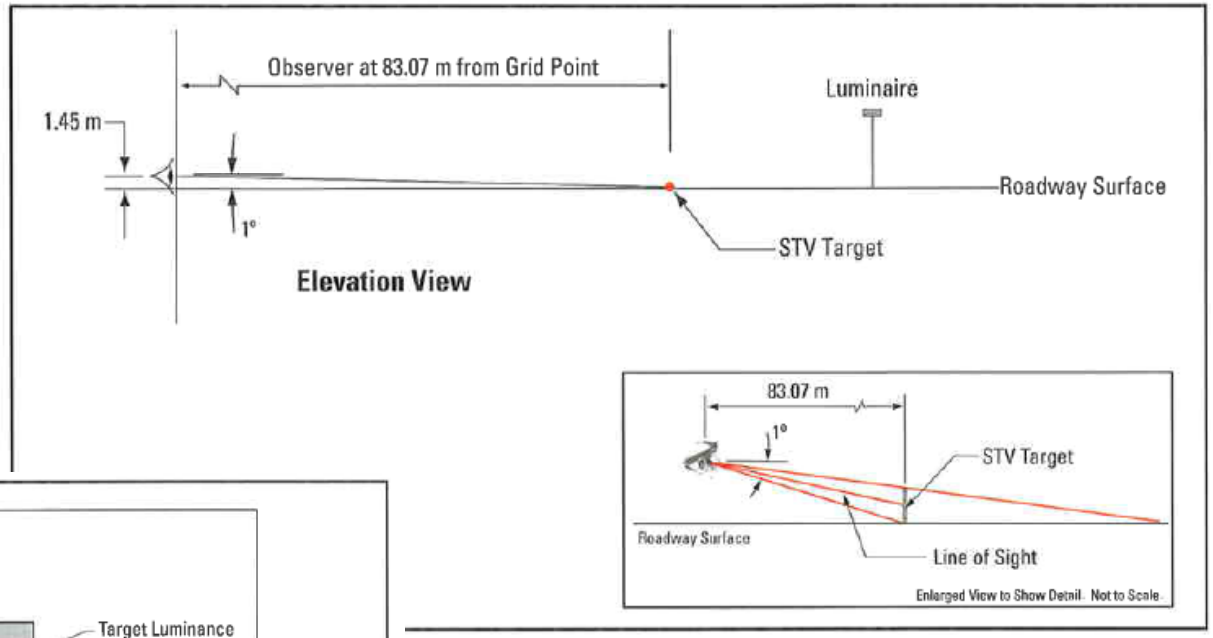
Le STV est une moyenne pondéré des niveaux de visibilités ciblé sur le grille de point routière. C'est un ratio donc, il n'y a pas d'unité à cette valeur. Plus le STV sera grand , plus la perception d'un petit objet sera faite dans un cours lapse de temps.

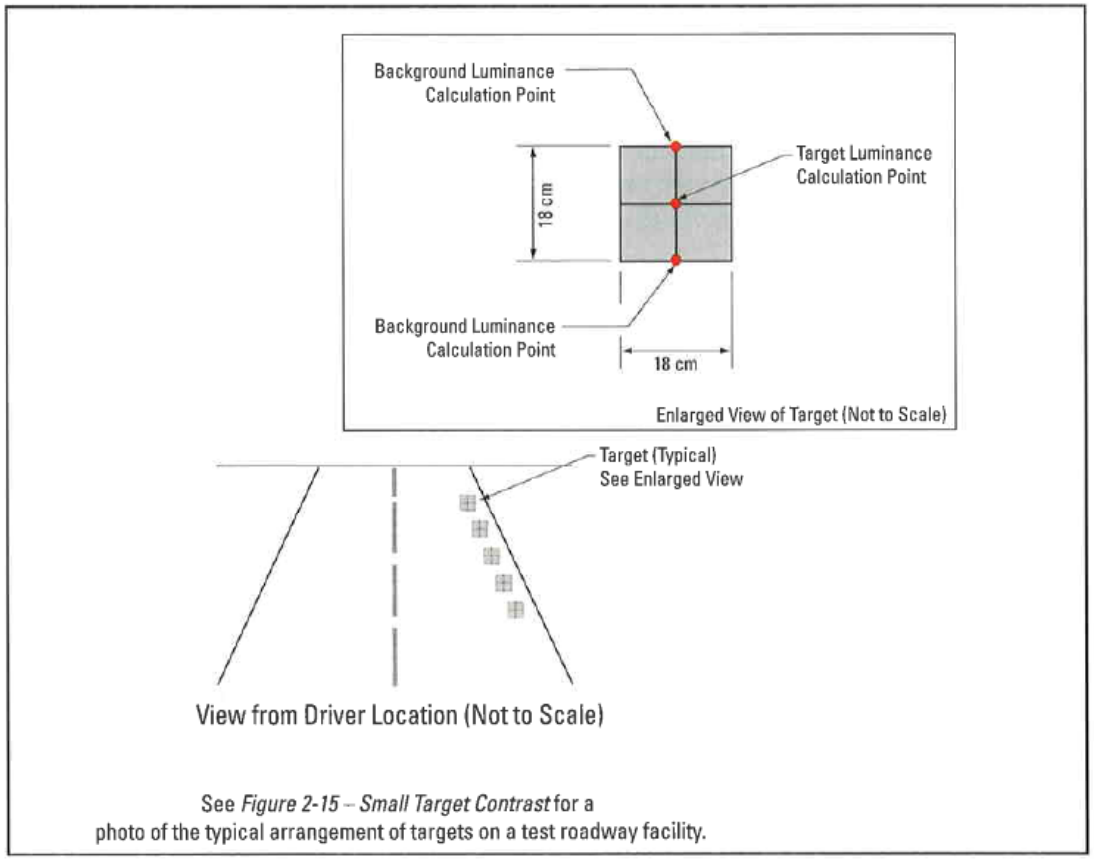
Ce calcul nécessite une dizaine d'étapes mathématiques. Il faut calculer les niveaux de visibilité en chaque point VL (Visibility level) en comparant la luminances vertical d'un objet et l'arrière plan, soit un point non loin sur l'asphalte. Tous ces calculs sont basé sur un point de vue de l'observateur dans le sens du trafique. Je vais vous épargnez les explications mathématique, mais si vous désirez plus d'informations, je vous invité à allez consulter le document RP8

L'observateur a 64ans et le temps de perception est de 0.2 sec.



STV (small target visibility)





See *Figure 2-15 – Small Target Contrast* for a photo of the typical arrangement of targets on a test roadway facility.

STV (small target visibility)

La perception n’est pas relié qu’aux niveaux d’éclairement et de luminance, elle est aussi sujet à une question de contraste.

(TI) Relative treshold increment

Treshold increment (TI) - Une mesure de l'effet d'éblouissement produit par l'incapacité du système d'éclairage. Seuil Increment est destiné à donner le pourcentage d'augmentation de la luminance de la surface de la route qui est nécessaire pour rendre un objet à peine visible (seuil de visibilité) dans le cadre du système d'éclairage proposé (présent l'éblouissement) par rapport à la luminance nécessaire pour rendre l'objet à peine visible dans l'absence d'éblouissement.

Threshold Increment (TI) is an alternative method of expressing and limiting disability glare. It is used chiefly with the CIE form of roadway lighting specifications.

When the contrast of an object to its background is said to be at threshold, the detection probability is 50 percent. If a glare source is then introduced, visibility will fall below threshold. To return to the threshold, or 50 percent probability condition, contrast must be increased. The amount of the contrast increase is a measure of the level of disability glare. Threshold contrast is this contrast increase expressed as a percentage of the zero glare threshold contrast.

TI is not used in North American lighting practice, however, it has been shown to correlate well with the veiling luminance ratio.

Grille de calcul RP8

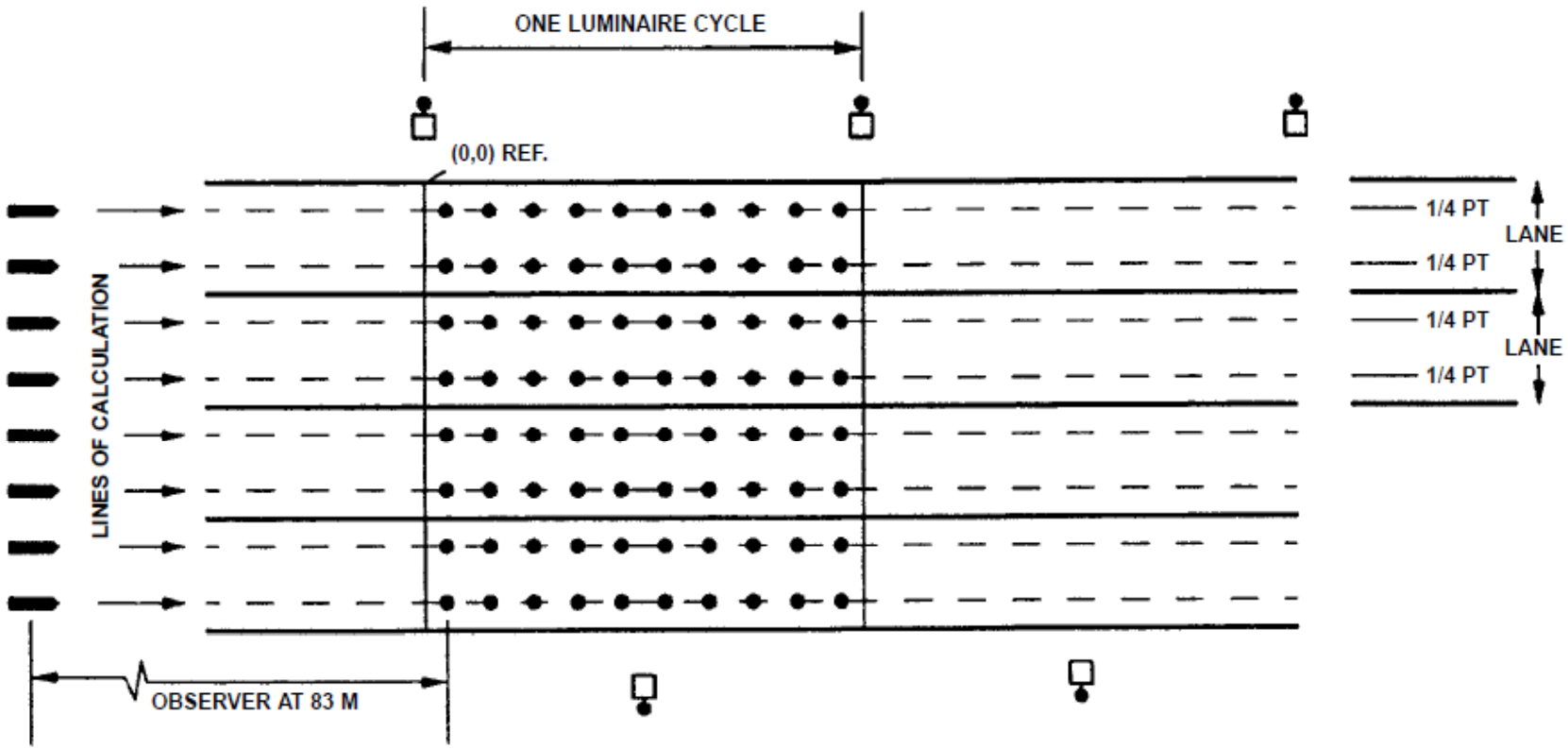


Figure A4. Location of test points for illuminance and luminance measurements on roadways. (a) Area and points are typical as shown: two transverse points per lane at each longitudinal point along one luminaire cycle. Maximum 5 meters between longitudinal points. (b) For illuminance measurements, the installation should include the contributions of at least three luminaire cycles: the cycle under test and one cycle on either side. (c) For luminance measurements: the observer moves with points parallel to the roadway [detector height = 1.45 meters; line of sight = 1 degree down over a longitudinal distance of 83 meters]. The installation should include a minimum of three luminaire cycles beyond the test area and one cycle in front of the test area.

Grille de calcul RP8

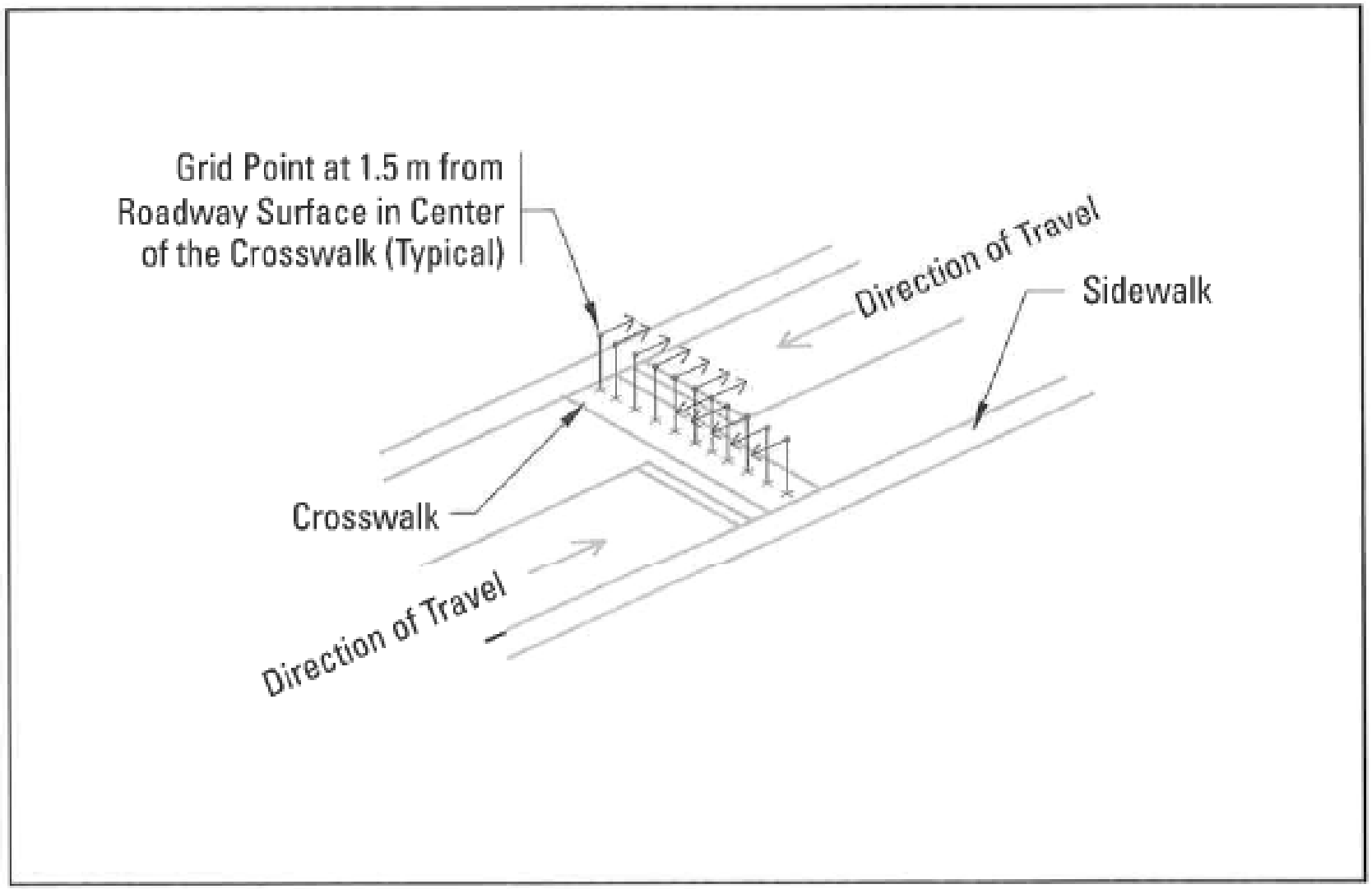


Figure 12-3 – Typical Calculation Grid for Mid-Block Crosswalks

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Luminance cd/ m²

Table 3: Luminance Method - Recommended Values

Road and Pedestrian Conflict Area		Average Luminance	Uniformity Ratio	Uniformity Ratio	Veiling Luminance Ratio
Road	Pedestrian Conflict Area	L_{avg} (cd/m²)	L_{avg}/L_{min} (Maximum Allowed)	L_{max}/L_{min} (Maximum Allowed)	L_{Vmax}/L_{avg} (Maximum Allowed)
Freeway Class A		0.6	3.5	6.0	0.3
Freeway Class B		0.4	3.5	6.0	0.3
Expressway	High	1.0	3.0	5.0	0.3
	Medium	0.8	3.0	5.0	0.3
	Low	0.6	3.5	6.0	0.3
Major	High	1.2	3.0	5.0	0.3
	Medium	0.9	3.0	5.0	0.3
	Low	0.6	3.5	6.0	0.3
Collector	High	0.8	3.0	5.0	0.4
	Medium	0.6	3.5	6.0	0.4
	Low	0.4	4.0	8.0	0.4
Local	High	0.6	6.0	10.0	0.4
	Medium	0.5	6.0	10.0	0.4
	Low	0.3	6.0	10.0	0.4

(*Refer to* ***Section 3.6*** *for Intersection Lighting*)

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Illuminance
Eclairament lux /fc

Table 2: Illuminance Method - Recommended Values

Road and Pedestrian Conflict Area		Pavement Classification (Minimum Manintained Average Values)			Uniformity Ratio	Veiling Luminance Ratio
Road	Pedestrian Conflict Area	R1 lux/fc	R2 & R3 lux/fc	R4 lux/fc	E_{avg}/E_{min}	L_{vmax}/L_{avg}
Freeway Class A		6.0/0.6	9.0/0.9	8.0/0.8	3.0	0.3
Freeway Class B		4.0/0.4	6.0/0.6	5.0/0.5	3.0	0.3
Expressway	High	10.0/1.0	14.0/1.4	13.0/1.3	3.0	0.3
	Medium	8.0/0.8	12.0/1.2	10.0/1.0	3.0	0.3
	Low	6.0/0.6	9.0/0.9	8.0/0.8	3.0	0.3
Major	High	12.0/1.2	17.0/1.7	15.0/1.5	3.0	0.3
	Medium	9.0/0.9	13.0/1.3	11.0/1.1	3.0	0.3
	Low	6.0/0.6	9.0/0.9	8.0/0.8	3.0	0.3
Collector	High	8.0/0.8	12.0/1.2	10.0/1.0	4.0	0.4
	Medium	6.0/0.6	9.0/0.9	8.0/0.8	4.0	0.4
	Low	4.0/0.4	6.0/0.6	5.0/0.5	4.0	0.4
Local	High	6.0/0.6	9.0/0.9	8.0/0.8	6.0	0.4
	Medium	5.0/0.5	7.0/0.7	6.0/0.6	6.0	0.4
	Low	3.0/0.3	4.0/0.4	4.0/0.4	6.0	0.4

(*Refer to Section 3.6 for Intersection Lighting*)

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STV

Table 4: Small Target Visibility - Recommended Values

Road and Pedestrian Conflict Area		STV Criteria	Luminance Criteria		
Road	Pedestrian Conflict Area	Weighting Average VL	L_{avg} cd/m² Median <7.3 m	L_{avg}* cd/m² Median ≥7.3 m	Uniformity Ratio L_{max}/L_{min} (Maximum Allowed)
Freeway "A"		3.2	0.5	0.4	6.0
Freeway "B"		2.6	0.4	0.3	6.0
Expressway		3.8	0.5	0.4	6.0
Major	High	4.9	1.0	0.8	6.0
	Medium	4.0	0.8	0.7	6.0
	Low	3.2	0.6	0.6	6.0
Collector	High	3.8	0.6	0.5	6.0
	Medium	3.2	0.5	0.4	6.0
	Low	2.7	0.4	0.4	6.0
Local	High	2.7	0.5	0.4	10.0
	Medium	2.2	0.4	0.3	10.0
	Low	1.6	0.3	0.3	10.0

Table based on a 60 year old driver with normal vision, an 18 cm x 18 cm (7.1 in. x 7.1 in.) 50 percent reflective target, and a 0.2 second fixation time.

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Conflits piétonniers

Table 5: Recommended Values for High Pedestrian Conflict Areas

Maintained Illuminance Values for Walkways/Bikeways			
	E_H lux/fc	E_{Vmin} lux/fc	E_{avg}/E_{min}*
Mixed Vehicle and Pedestrian**	20.0/2.0	10.0/1.0	4.0
Pedestrian Only	10.0/1.0	5.0/0.5	4.0

* Horizontal only

Mixed vehicle and pedestrian refers to those areas where the pedestrians are immediately adjacent to vehicular traffic without barriers or separation. Does not apply to mid-block crossings. (See **Section 3.5.1.4.)

E_H = average horizontal illuminance at walkway/bikeway

E_{Vmin} = minimum vertical illuminance at 1.5 m (4.9 ft.) above walkway/bikeway measured in both directions parallel to the main pedestrian flow

Table 6: Recommended Values for Medium Pedestrian Conflict Areas

Maintained Illuminance Values for Walkways/Bikeways			
	E_H lux/fc	E_{Vmin} lux/fc	E_{avg}/E_{min}*
Pedestrian Areas	5.0/0.5	2.0/0.2	4.0

* Horizontal only

E_H = average horizontal illuminance at walkway/bikeway

E_{Vmin} = minimum vertical illuminance at 1.5 m (4.9 ft.) above walkway/bikeway measured in both directions parallel to the main pedestrian flow

Niveaux standards RP8

Conflits piétonniers

Table 7: Recommended Values for Low Pedestrian Conflict Areas

Maintained Illuminance Values for Walkways/Bikeways			
	E_H lux/fc	E_{Vmin} lux/fc	E_{avg}/E_{min}*
Rural/Semi-Rural Areas	2.0/0.2	0.6/0.06	10.0
Low Density Residential	3.0/0.3	0.8/0.08	6.0
Medium Density Residential	4.0/0.4	1.0/0.1	4.0

* Horizontal only

E_H = average horizontal illuminance at walkway/bikeway
E_{Vmin} = minimum vertical illuminance at 1.5 m (4.9 ft.) above walkway/bikeway measured in both directions parallel to the main pedestrian flow

Table 8: Recommended Values for the Pedestrian Portion of Pedestrian Vehicular Underpasses and Exclusive Pedestrian Underpasses

Maintained Illuminance Values for Walkways/Bikeways			
	E_H lux/fc	E_{Vmin} lux/fc	E_{avg}/E_{min}*
Day	100.0/10.0	50.0/5.0	3.0
Night	40.0/4.0	20.0/2.0	3.0

* Horizontal only

E_H = average horizontal illumination at walkway/bikeway
E_{Vmin} = minimum vertical illumination at 1.5 m (4.9 ft.) above walkway/bikeway measured in both directions parallel to the main pedestrian flow

Niveaux standards RP8

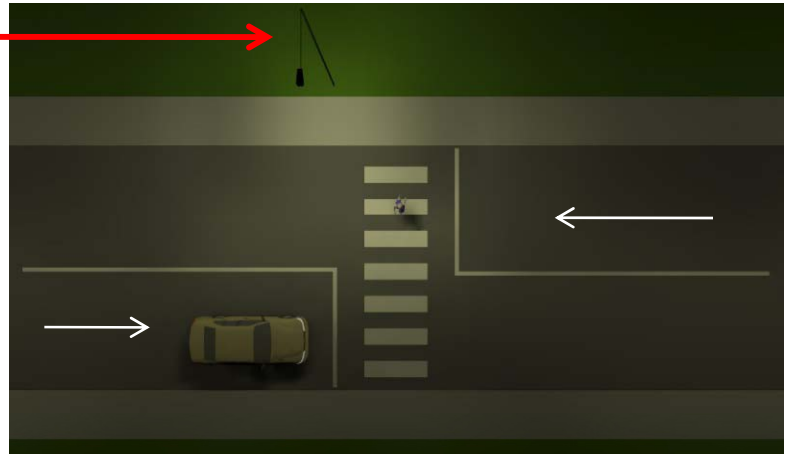
Intersection Urbaine

Table 9. Recommended Illuminance for the Intersection of Continuously Lighted Urban Streets
(Based on the values in Table 2 for R2 and R3 pavement classifications)

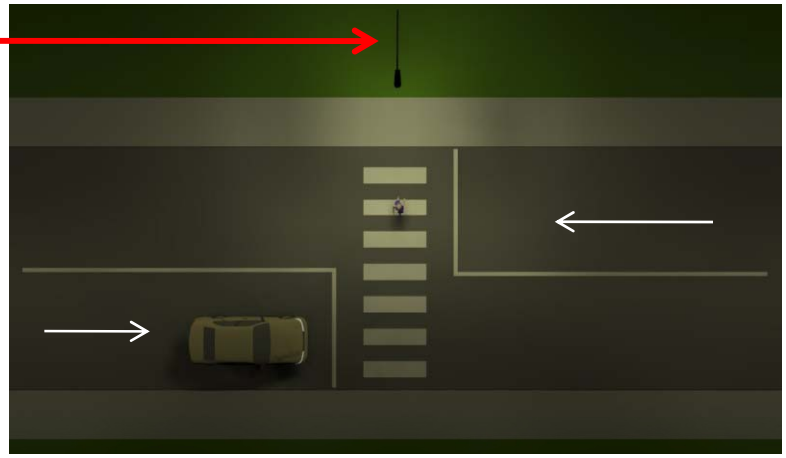
Illuminance for Intersections				
Functional Classification	**Average Maintained Illumination at Pavement by Pedestrian Area Classification** lux/fc			E_{avg}/E_{min}
	High	Medium	Low	
Major/Major	34.0/3.4	26.0/2.6	18.0/1.8	3.0
Major/Collector	29.0/2.9	22.0/2.2	15.0/1.5	3.0
Major/Local	26.0/2.6	20.0/2.0	13.0/1.3	3.0
Collector/Collector	24.0/2.4	18.0/1.8	12.0/1.2	4.0
Collector/Local	21.0/2.1	16.0/1.6	10.0/1.0	4.0
Local/Local	18.0/1.8	14.0/1.4	8.0/0.8	6.0

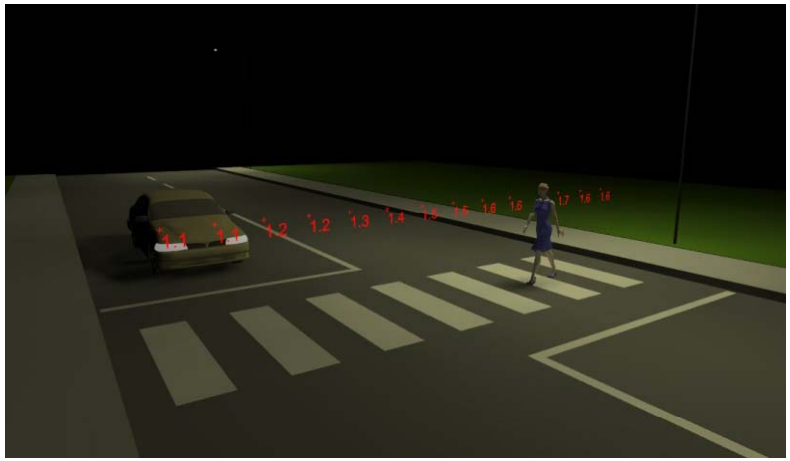
Pour des rue non éclairés en continue, utiliser 50% de plus que les niveaux recommandés selon la classification de la rue de la table 2.

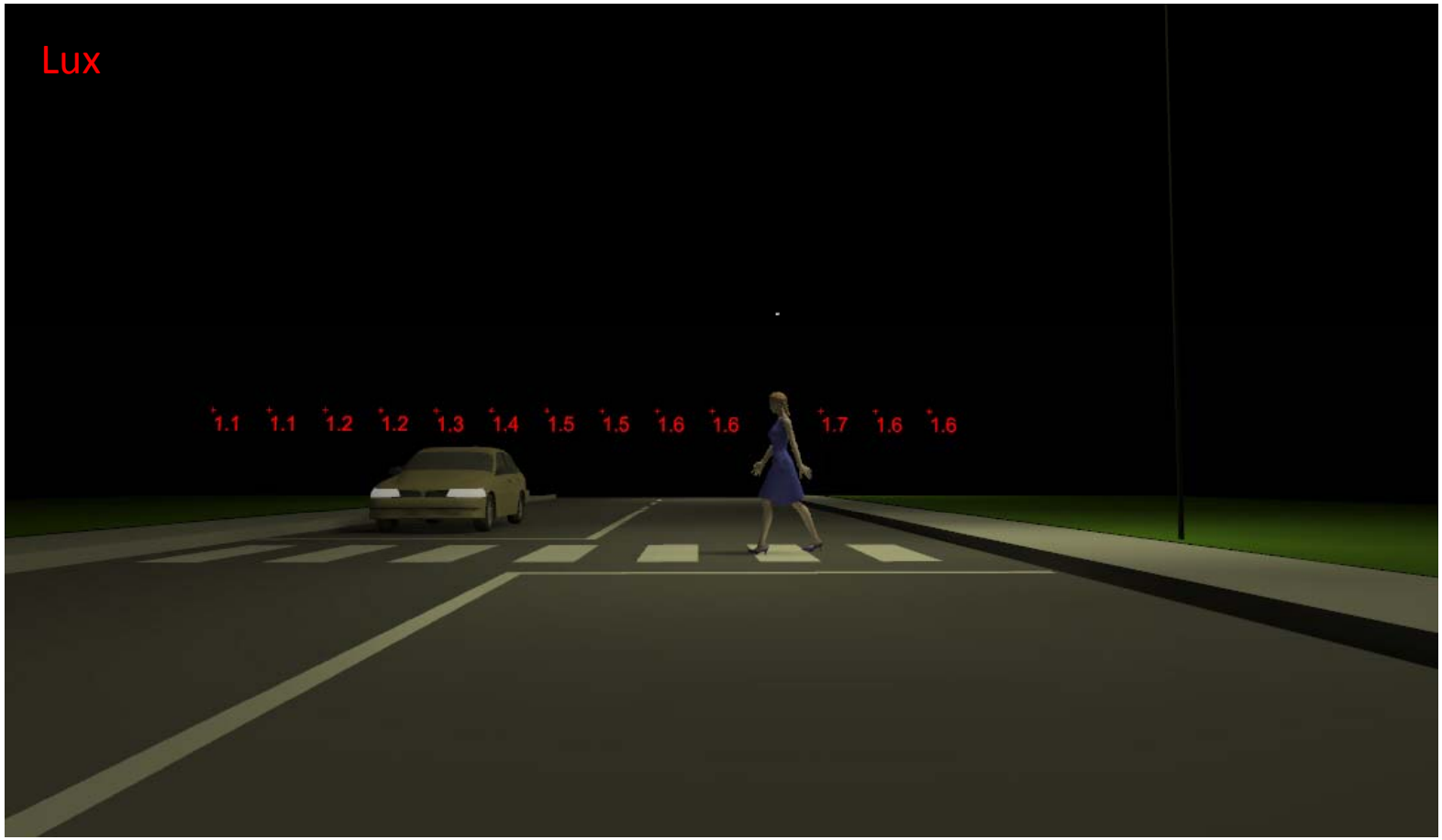
Éclairage Routier



Éclairage Routier







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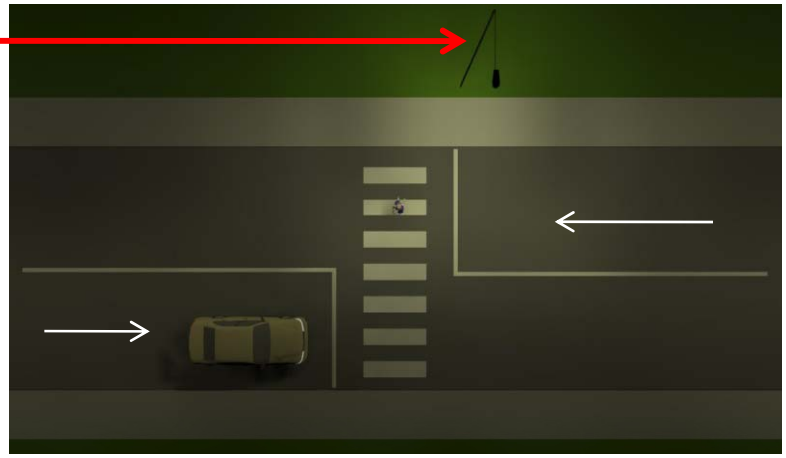
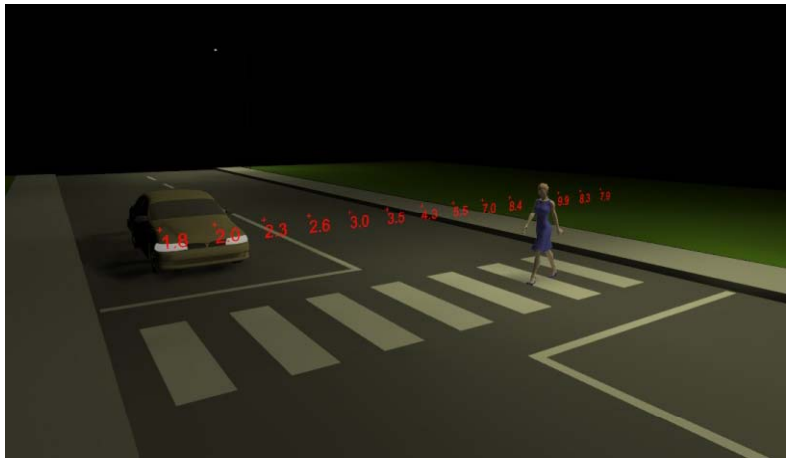
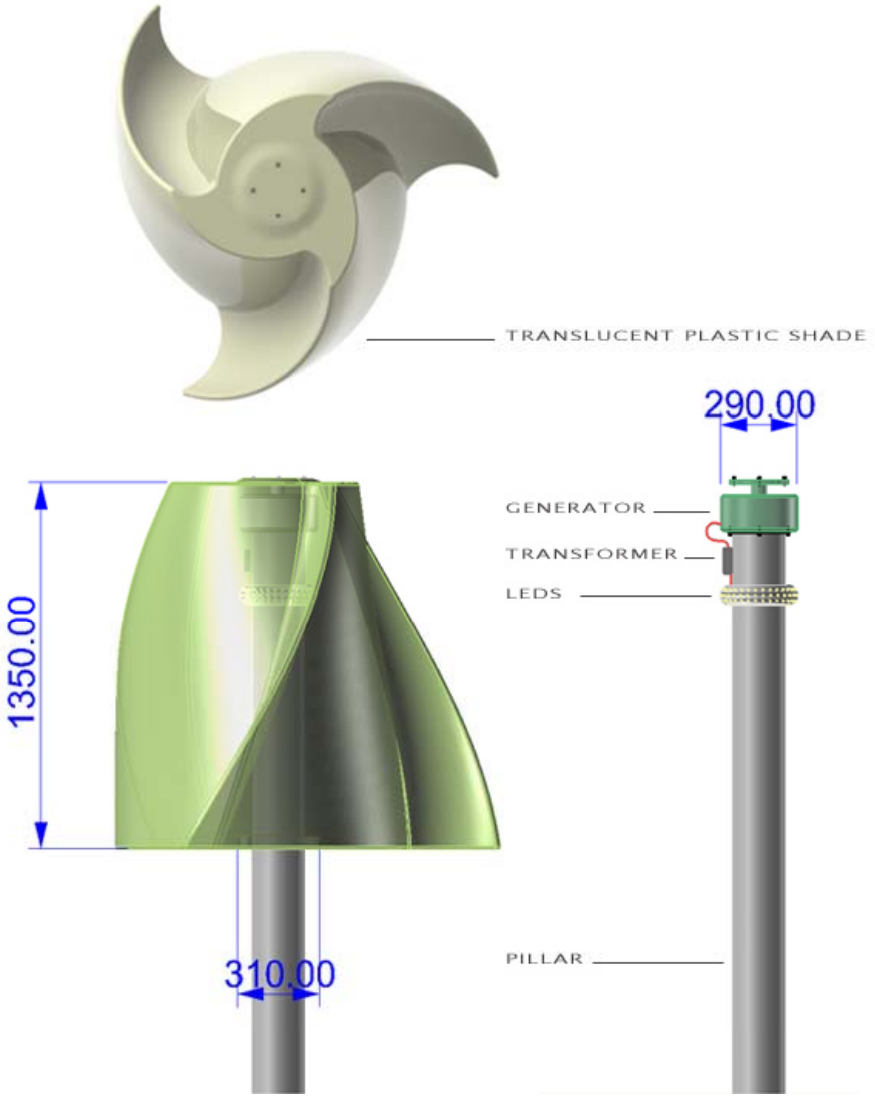




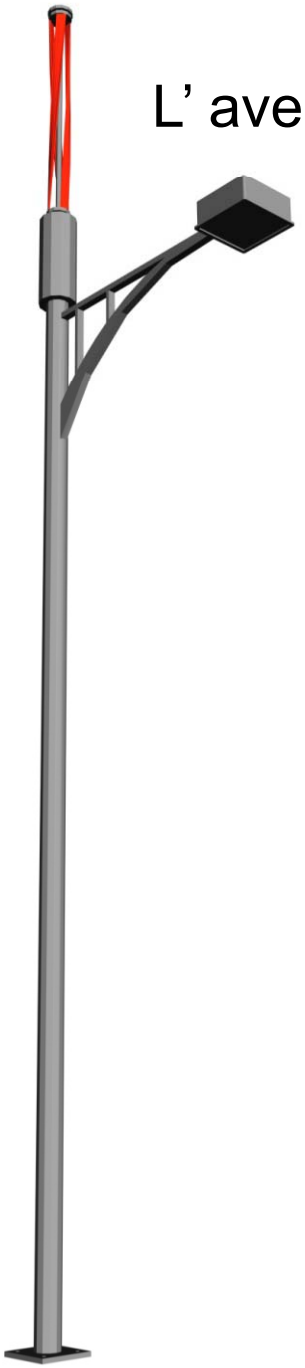
L’ avenir de l’éclairage routier

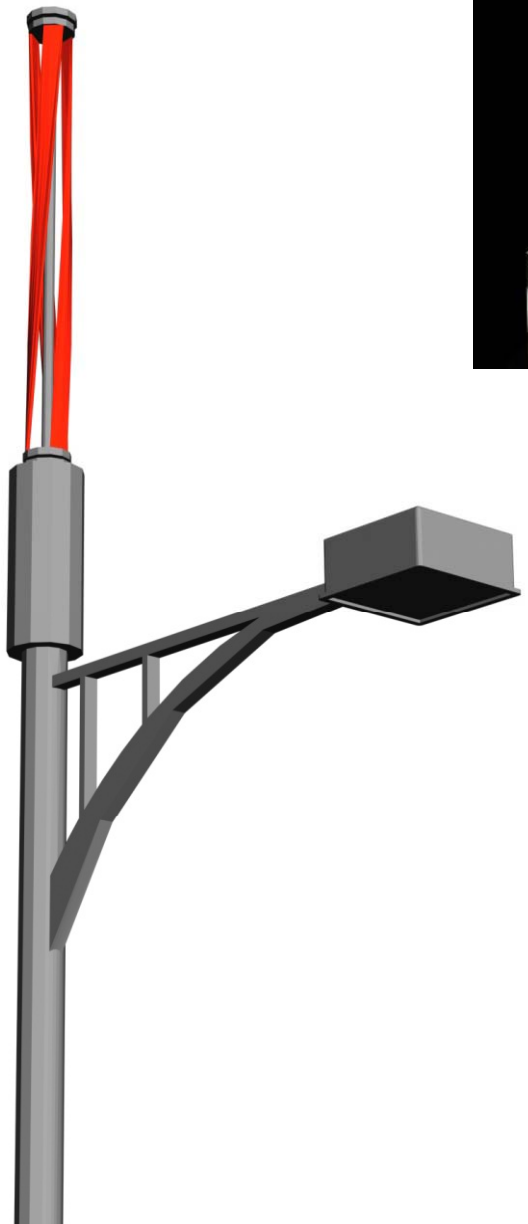
L' avenir de l'éclairage routier

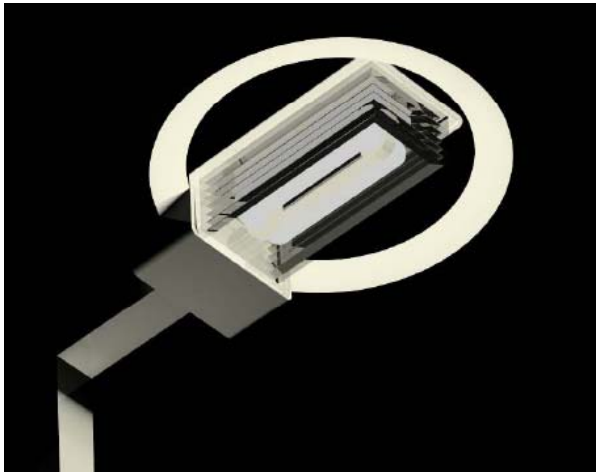


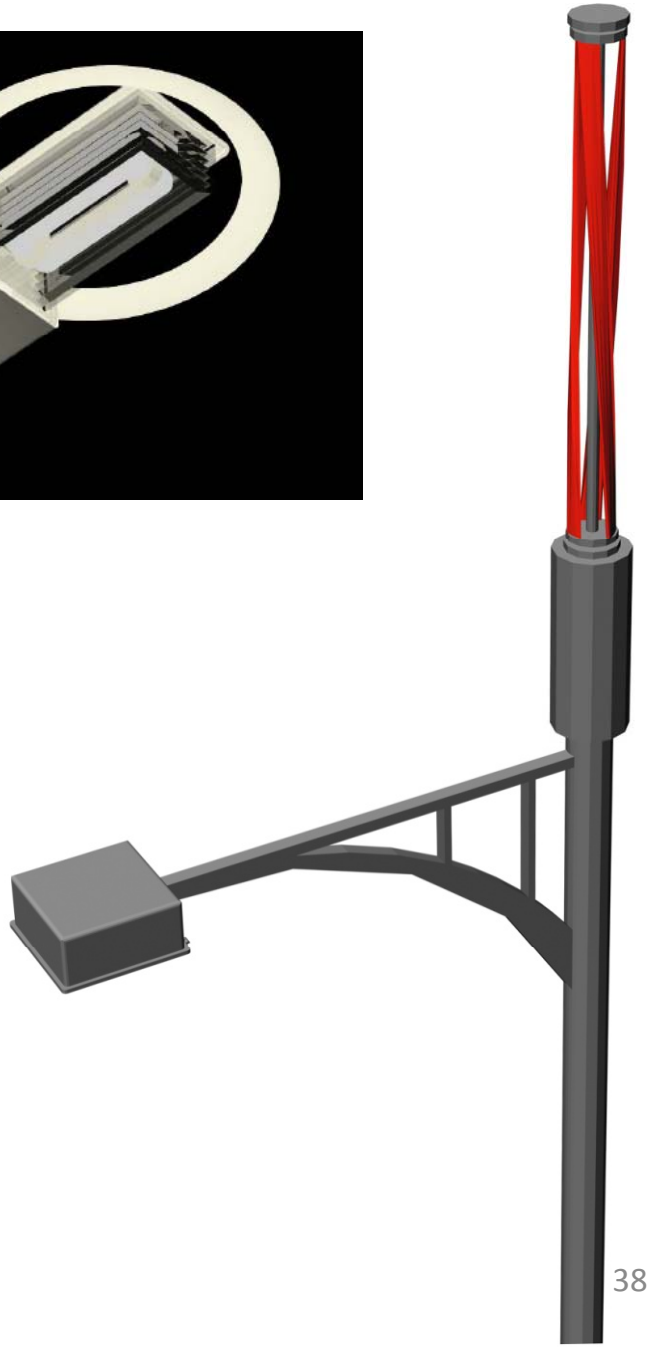
Éclairage Routier

L’ avenir de l’éclairage routier







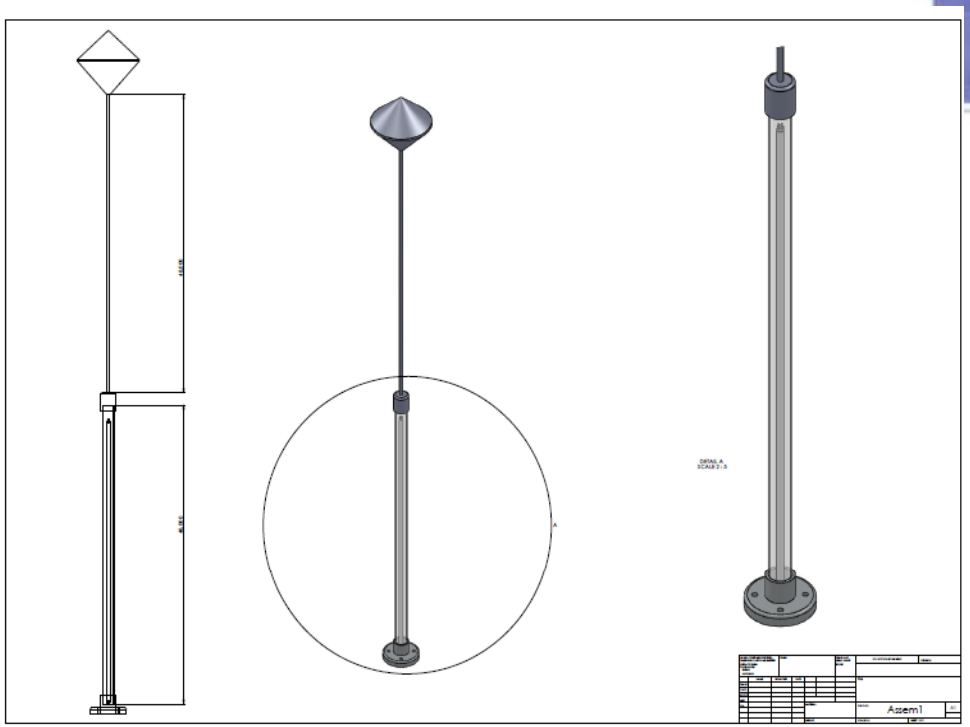


L’ avenir de l’éclairage routier

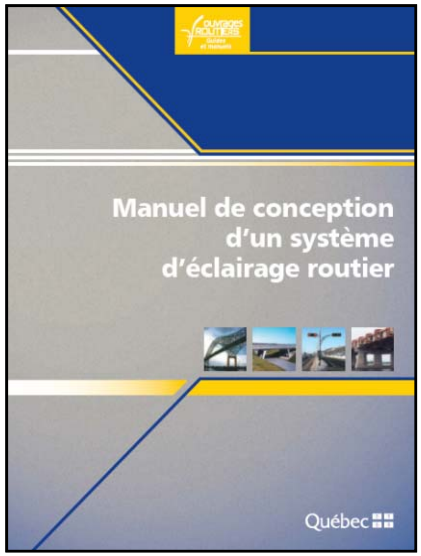
L’ avenir de l’éclairage routier

Éclairage Routier

L’ avenir de l’éclairage routier



Éclairage routier



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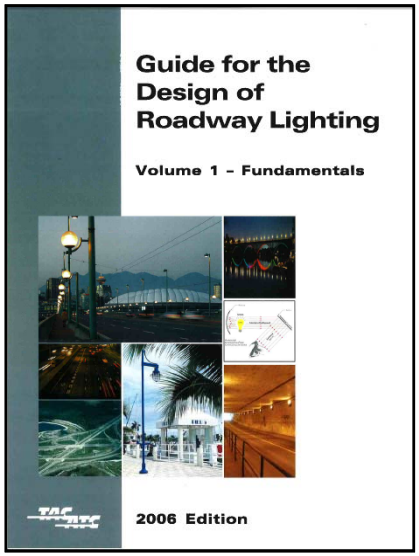

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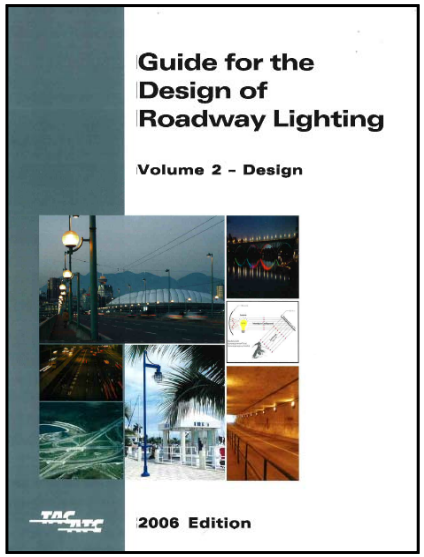

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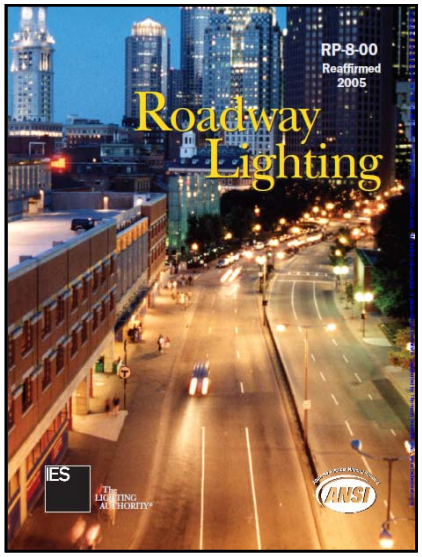
Comment utiliser AGI32 afin de valider les résultats qui répondent aux différentes normes en éclairage routier.



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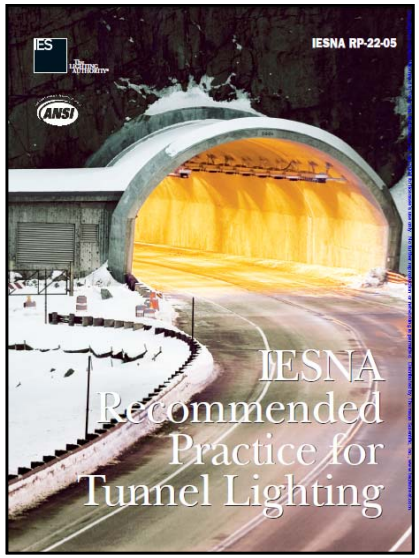

Guide de 50 pages

Normes du MTQ

Le contenu de cette publication a été préparé par le ministère des Transports.
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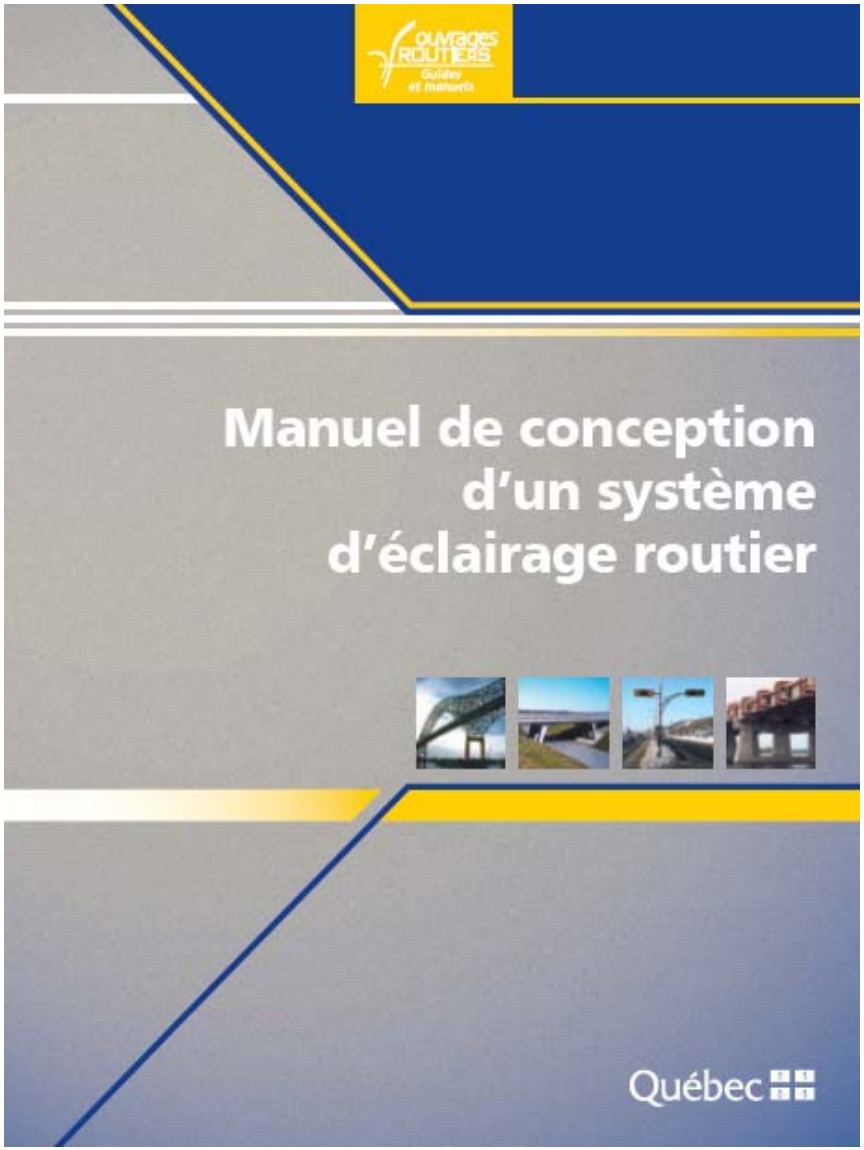

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http://www3.publicationsduquebec.gouv.qc.ca/produits/ouvrage_routier.fr.html

Étapes à suivre pour la conception d'un éclairage routier.

1- Rassemblez les données disponibles

2- Classifiez le projet.

3- Définir les différentes zones si applicable

4- Remplir la grille d'évaluation appropriée pour la justification ou non de l'éclairage
Voir: Manuel de conception d'un système d'éclairage routier (MTQ)

5- Établir la liste des normes à respecter.
Voir: le guide de TAC/ATC et/ou IES RP8

6- Effectuez l'analyse avec AGI32

7- Montez un rapport

Étapes à suivre pour la conception d'un éclairage routier.

1- Rassemblez les données disponibles

- **Plan CAD en .dwg des lieux**
  (Nombre de voies, largeur, distance de recul des fûts ,…)
- **Type de surface (R1-R2-R3-R4)**
- **Établir la liste des luminaires disponibles et leurs fichier IES**
- **Dimension des fûts et bras pouvant être utilisés.**
- **Vitesse de circulation**
- **Distance d'arrêt sécuritaire SSSD (Security Stopping Sight Distance)**
- **Débit journalier moyen annuel DJMA « AADT »**
- **Niveau d'activité piétons/cyclistes** **Faible (≤ 10/ hr) Moyenne(11-99/hr) Élevée(≥ 100/hr)**
- **Rapport des accidents Nuit/jour (RNJ)**
- **Et autres …**

Étapes à suivre pour la conception d'un éclairage routier.

2- Classifiez le projet.

Milieu

- Rural
- Industriel
- Résidentiel
- Commercial
- Centre-ville

Types de routes

- une autoroute
- une autoroute avec carrefours à niveau
- une route nationale
- une route régionale;
- une route collectrice
- une route locale.

3- Définir les différentes zones si applicable

Les sections de routes

- un tronçon
- un échangeur
- un carrefour
- une rampe d'accès
- un viaduc
- une zone d'approche de transition
- une voie de service
- une intersection
- un trottoir
- une voie pédestre/cyclable
- une traverse piétonnière
- ou autre.

Éclairage routier

Étapes à suivre pour la conception d'un éclairage routier.

4- Remplir la grille d'évaluation appropriée pour la justification ou non de l'éclairage. **Voir:** Manuel de conception d'un système d'éclairage routier (MTQ)

2.2 GRILLES D'ÉVALUATION

Les grilles sont formées de plusieurs critères qui aident à évaluer le besoin d'éclairage. Un pointage de classement et une pondération sont associés à chaque critère.

Il existe cinq grilles d'évaluation, soit : G1, G2, G3, G4 et G5.

G1 :Autoroutes
G2 :Autoroutes avec carrefours à niveau
G3: Route nationale, régionale, collectrice ou locale.
G4: Échangeurs d'autoroutes et des échangeurs d'autoroutes avec carrefours à niveau.
G5: Tous les types de carrefours

Les critères contenus dans chaque grille sont rassemblés en quatre groupes :
•Géométrie
•Opération
•Environnement
•Sécurité

Pour plus d'informations , voir chapitre 2.2 du guide et annexe B

Grille d'évaluation « G1 » (voir note 2)

Élément évalué:
Longueur du tronçon: Niveau (1, 2 ou 3):

	Description des critères analysés	Valeurs réelles	Pointage de classement «PT» 1	2	3	4	5	Pondération «PD»	Valeur pondérée «PD x PT»
Groupe 1 : Géométrie (voir note 4)									
1	Nombre total de voies		≤ 4	5	6	7	≥ 8	0,15	
2	Largeur des voies (m)		>3,6	3,4 à 3,6	3,2 à 3,4	3,0 à 3,2	<3,0	0,30	
3	Largeur du terre-plein central (m)		>12	7,5 à 12	3,5 à 7,5	1,2 à 3,5	<1,2	0,30	
4	Largeur de l'accotement (m)		>3,0	2,5 à 3,0	1,8 à 2,5	1,2 à 1,8	<1,2	0,30	
5	Pente du talus de bas-côté (0 à 7)		> 6:1	6:1	4:1	3:1	< 3:1	0,30	
6	Rayon de courbure horizontal (m)		>3500	1750 à 3500	1750 à 875	575 à 875	<575	4,90	
7	Gradient vertical (pente en %)		<3,0	3,0 à 4,0	4,0 à 5,0	5,0 à 7,0	>7,0	0,25	
8	Distance entre les échangeurs (km)		>6,5	5,0 à 6,5	3,5 à 5,0	1,5 à 3,5	<1,5	1,85	
								Sous-total géométrie:	0
Groupe 2 : Opération									
9	Niveau de service nocturne (heure de pointe de noirceur)		A	B	C	D	≥ E	3,05	
									0
Groupe 3: Environnement									
10	% de développement		0	0 à 24	25 à 50	50 à 75	>75	1,85	
11	Distance des développements à partir de la route (m) (voir note 3)		>60	45 à 60	30 à 45	15 à 30	<15	1,85	
									0
Groupe 4 : Sécurité (accidents)									
12	Rapport des accidents Nuit/jour		<1,0	1,0 à 1,2	1,2 à 1,5	1,5 à 2,0	>2,0 (voir note 1)	4,90	
									0
								Grand total:	0
								Pointage requis pour éclairer	60
								Écart	

Notes:
1- Éclairage justifié
2- Vitesse courante: 80 km/h (la vitesse de nuit au 95e centile si on la connaît, sinon, la vitesse affichée)
3- Développement défini comme englobant les bâtiments commerciaux, industriels ou résidentiels.
4- Utiliser les facteurs géométriques les plus défavorables pour le tronçon de route.

Étapes à suivre pour la conception d'un éclairage routier.

5- Établir la liste des normes à respecter.

Voir: le guide de TAC/ATC et/ou IES RP8

Positionnement de la grille de point de calculs selon les normes dans les différentes zone

- **Voir: le guide de TAC/ATC et/ou IES RP8**

Luminance

- **Luminance moyenne (cd/m^2)**
- **Ratio d'uniformité de luminance L moy/ L min et Lmax/ L min**

Luminance de voile (veiling luminance)

- **Luminance de voile (veiling luminance) Lvmax/ Lmoy**

Éclairement

- **Éclairement moyen (lux ou fc)**
- **Ratio d'uniformité de l'éclairement E moy/ E min**
- **Éclairement vertical minimum (lux ou fc) lorsque requis avec conflit piétonnier**

Cibles visibles de petites dimensions Small Target visibilité STV

- **Weighting average VL**

Éclairage routier

Étapes à suivre pour la conception d'un éclairage routier.

5- Établir la liste des normes à respecter.

Voir: le guide de TAC/ATC et/ou IES RP8

Luminance cd/ m²

Table 3: Luminance Method - Recommended Values

Road and Pedestrian Conflict Area		Average Luminance	Uniformity Ratio	Uniformity Ratio	Veiling Luminance Ratio
Road	Pedestrian Conflict Area	L_{avg} (cd/m²)	L_{avg}/L_{min} (Maximum Allowed)	L_{max}/L_{min} (Maximum Allowed)	L_{Vmax}/L_{avg} (Maximum Allowed)
Freeway Class A		0.6	3.5	6.0	0.3
Freeway Class B		0.4	3.5	6.0	0.3
Expressway	High	1.0	3.0	5.0	0.3
	Medium	0.8	3.0	5.0	0.3
	Low	0.6	3.5	6.0	0.3
Major	High	1.2	3.0	5.0	0.3
	Medium	0.9	3.0	5.0	0.3
	Low	0.6	3.5	6.0	0.3
Collector	High	0.8	3.0	5.0	0.4
	Medium	0.6	3.5	6.0	0.4
	Low	0.4	4.0	8.0	0.4
Local	High	0.6	6.0	10.0	0.4
	Medium	0.5	6.0	10.0	0.4
	Low	0.3	6.0	10.0	0.4

(*Refer to* **Section 3.6** *for Intersection Lighting*)

Illuminance Eclairament lux /fc

Table 2: Illuminance Method - Recommended Values

Road and Pedestrian Conflict Area		Pavement Classification (Minimum Manirtained Average Values)			Uniformity Ratio	Veiling Luminance Ratio
Road	Pedestrian Conflict Area	R1 lux/fc	R2 & R3 lux/fc	R4 lux/fc	E_{avg}/E_{min}	L_{vmax}/L_{avg}
Freeway Class A		6.0/0.6	9.0/0.9	8.0/0.8	3.0	0.3
Freeway Class B		4.0/0.4	6.0/0.6	5.0/0.5	3.0	0.3
Expressway	High	10.0/1.0	14.0/1.4	13.0/1.3	3.0	0.3
	Medium	8.0/0.8	12.0/1.2	10.0/1.0	3.0	0.3
	Low	6.0/0.6	9.0/0.9	8.0/0.8	3.0	0.3
Major	High	12.0/1.2	17.0/1.7	15.0/1.5	3.0	0.3
	Medium	9.0/0.9	13.0/1.3	11.0/1.1	3.0	0.3
	Low	6.0/0.6	9.0/0.9	8.0/0.8	3.0	0.3
Collector	High	8.0/0.8	12.0/1.2	10.0/1.0	4.0	0.4
	Medium	6.0/0.6	9.0/0.9	8.0/0.8	4.0	0.4
	Low	4.0/0.4	6.0/0.6	5.0/0.5	4.0	0.4
Local	High	6.0/0.6	9.0/0.9	8.0/0.8	6.0	0.4
	Medium	5.0/0.5	7.0/0.7	6.0/0.6	6.0	0.4
	Low	3.0/0.3	4.0/0.4	4.0/0.4	6.0	0.4

(*Refer to* **Section 3.6** *for Intersection Lighting*)

STV

Table 4: Small Target Visibility - Recommended Values

Road and Pedestrian Conflict Area		STV Criteria	Luminance Criteria		
Road	Pedestrian Conflict Area	Weighting Average VL	L_{avg} cd/m² Median <7.3 m	L_{avg}* cd/m² Median >7.3 m	Uniformity Ratio L_{max}/L_{min} (Maximum Allowed)
Freeway "A"		3.2	0.5	0.4	6.0
Freeway "B"		2.6	0.4	0.3	6.0
Expressway		3.8	0.5	0.4	6.0
Major	High	4.9	1.0	0.8	6.0
	Medium	4.0	0.8	0.7	6.0
	Low	3.2	0.6	0.6	6.0
Collector	High	3.8	0.6	0.5	6.0
	Medium	3.2	0.5	0.4	6.0
	Low	2.7	0.4	0.4	6.0
Local	High	2.7	0.5	0.4	10.0
	Medium	2.2	0.4	0.3	10.0
	Low	1.6	0.3	0.3	10.0

Table based on a 60 year old driver with normal vision, an 18 cm x 18 cm (7.1 in. x 7.1 in.) 50 percent reflective target, and a 0.2 second fixation time.

Conflits piétonniers

Table 5: Recommended Values for High Pedestrian Conflict Areas

Maintained Illuminance Values for Walkways/Bikeways			
	E_H lux/fc	E_{Vmin} lux/fc	E_{avg}/E_{min}*
Mixed Vehicle and Pedestrian**	20.0/2.0	10.0/1.0	4.0
Pedestrian Only	10.0/1.0	5.0/0.5	4.0

* Horizontal only
**Mixed vehicle and pedestrian refers to those areas where the pedestrians are immediately adjacent to vehicular traffic without barriers or separation. Does not apply to mid-block crossings. (See Section 3.5.1.4.)

E_H = average horizontal illuminance at walkway/bikeway
E_{Vmin} = minimum vertical illuminance at 1.5 m (4.9 ft.) above walkway/bikeway measured in both directions parallel to the main pedestrian flow

Table 6: Recommended Values for Medium Pedestrian Conflict Areas

Maintained Illuminance Values for Walkways/Bikeways			
	E_H lux/fc	E_{Vmin} lux/fc	E_{avg}/E_{min}*
Pedestrian Areas	5.0/0.5	2.0/0.2	4.0

* Horizontal only

E_H = average horizontal illuminance at walkway/bikeway
E_{Vmin} = minimum vertical illuminance at 1.5 m (4.9 ft.) above walkway/bikeway measured in both directions parallel to the main pedestrian flow

Table 7: Recommended Values for Low Pedestrian Conflict Areas

Maintained Illuminance Values for Walkways/Bikeways			
	E_H lux/fc	E_{Vmin} lux/fc	E_{avg}/E_{min}*
Rural/Semi-Rural Areas	2.0/0.2	0.6/0.06	10.0
Low Density Residential	3.0/0.3	0.8/0.08	6.0
Medium Density Residential	4.0/0.4	1.0/0.1	4.0

* Horizontal only

E_H = average horizontal illuminance at walkway/bikeway
E_{Vmin} = minimum vertical illuminance at 1.5 m (4.9 ft.) above walkway/bikeway measured in both directions parallel to the main pedestrian flow

Table 8: Recommended Values for the Pedestrian Portion of Pedestrian Vehicular Underpasses and Exclusive Pedestrian Underpasses

Maintained Illuminance Values for Walkways/Bikeways			
	E_H lux/fc	E_{Vmin} lux/fc	E_{avg}/E_{min}*
Day	100.0/10.0	50.0/5.0	3.0
Night	40.0/4.0	20.0/2.0	3.0

* Horizontal only

E_H = average horizontal illumination at walkway/bikeway
E_{Vmin} = minimum vertical illumination at 1.5 m (4.9 ft.) above walkway/bikeway measured in both directions parallel to the main pedestrian flow

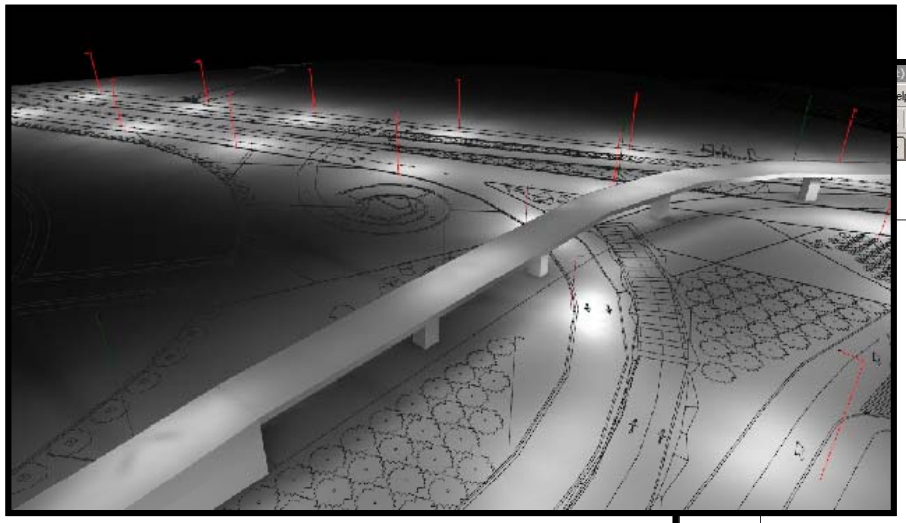
Intersection Urbaine

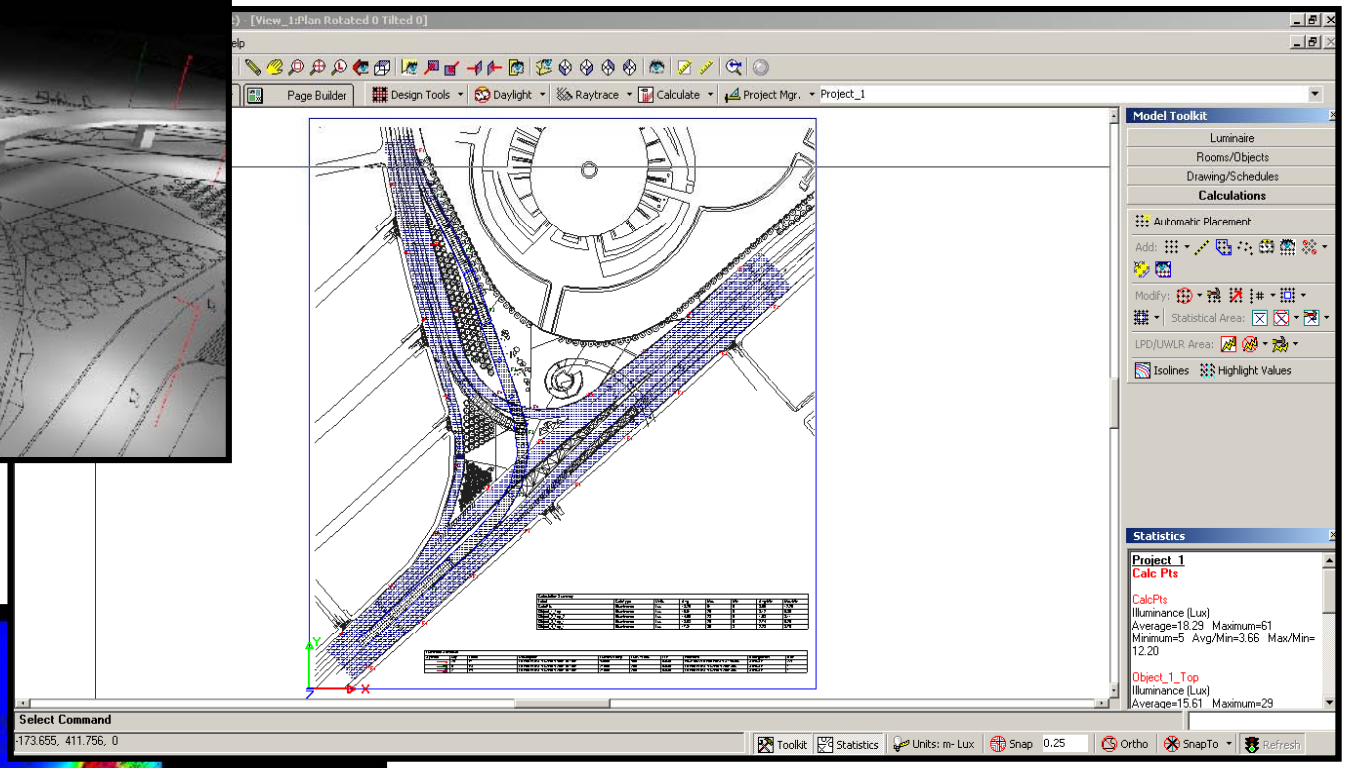
Table 9. Recommended Illuminance for the Intersection of Continuously Lighted Urban Streets
(Based on the values in Table 2 for R2 and R3 pavement classifications)

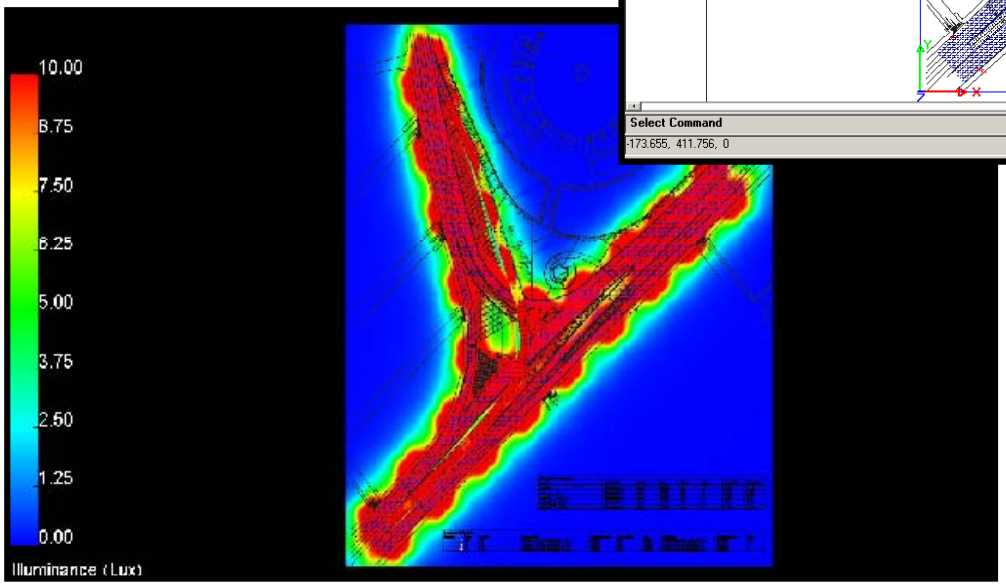
Illuminance for Intersections				
Functional Classification	Average Maintained Illumination at Pavement by Pedestrian Area Classification lux/fc			E_{avg}/E_{min}
	High	Medium	Low	
Major/Major	34.0/3.4	26.0/2.6	18.0/1.8	3.0
Major/Collector	29.0/2.9	22.0/2.2	15.0/1.5	3.0
Major/Local	26.0/2.6	20.0/2.0	13.0/1.3	3.0
Collector/Collector	24.0/2.4	18.0/1.8	12.0/1.2	4.0
Collector/Local	21.0/2.1	16.0/1.6	10.0/1.0	4.0
Local/Local	18.0/1.8	14.0/1.4	8.0/0.8	6.0

Éclairage routier

6- Effectuez l'analyse avec AGI32



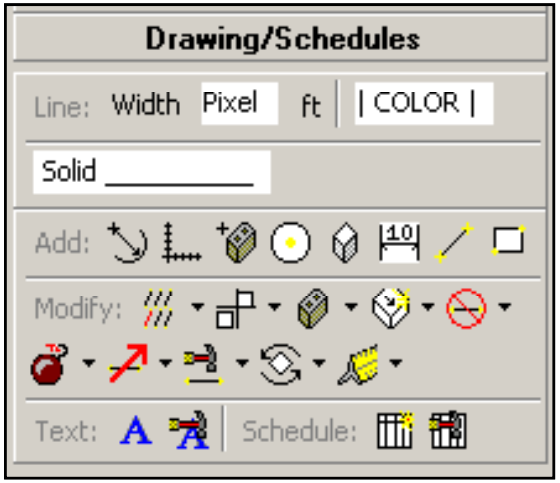


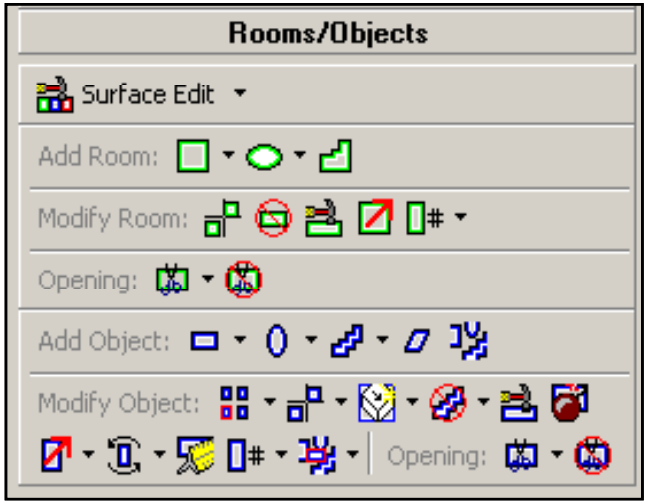


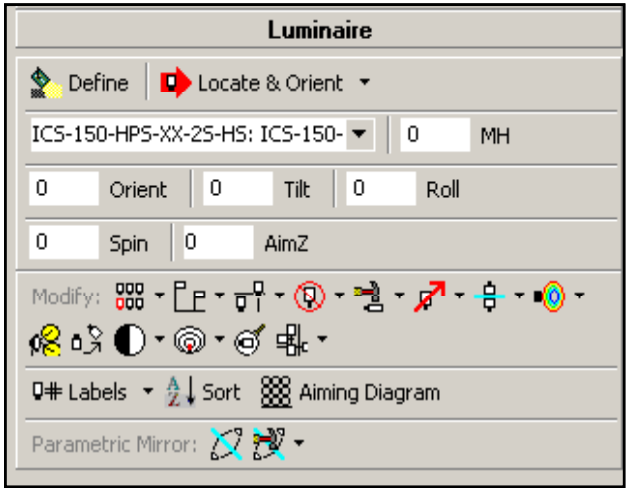
Éclairage routier

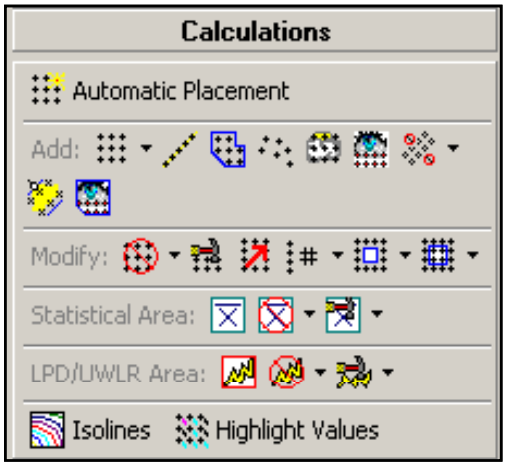
6- Effectuez l'analyse avec AGI32

Établir les marches à suivre pour l'analyse informatique.

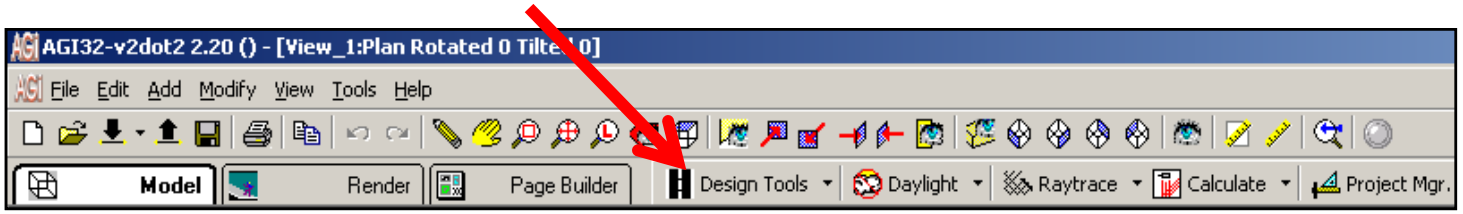




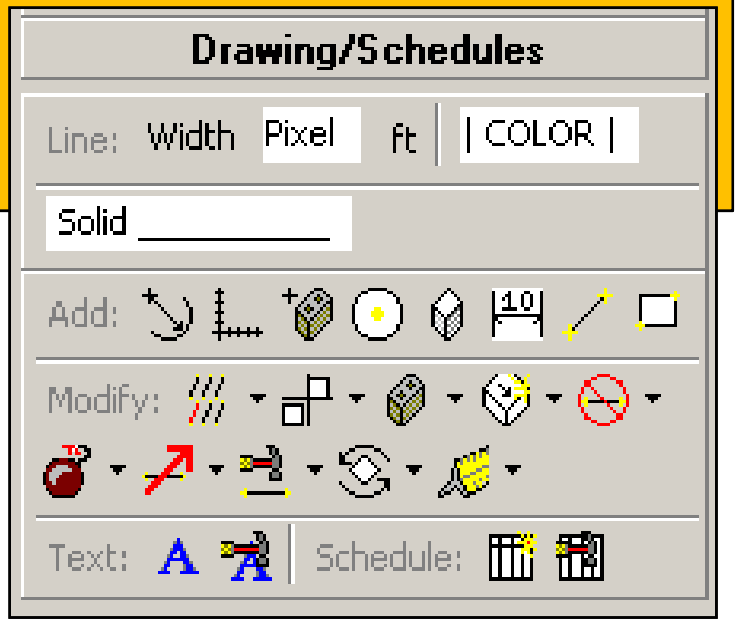




4 boites à outils et un Roadway Optimizer



6.1- Dessinez un espace ou importez un plan qui délimite la zone de l'étude



Éclairage routier

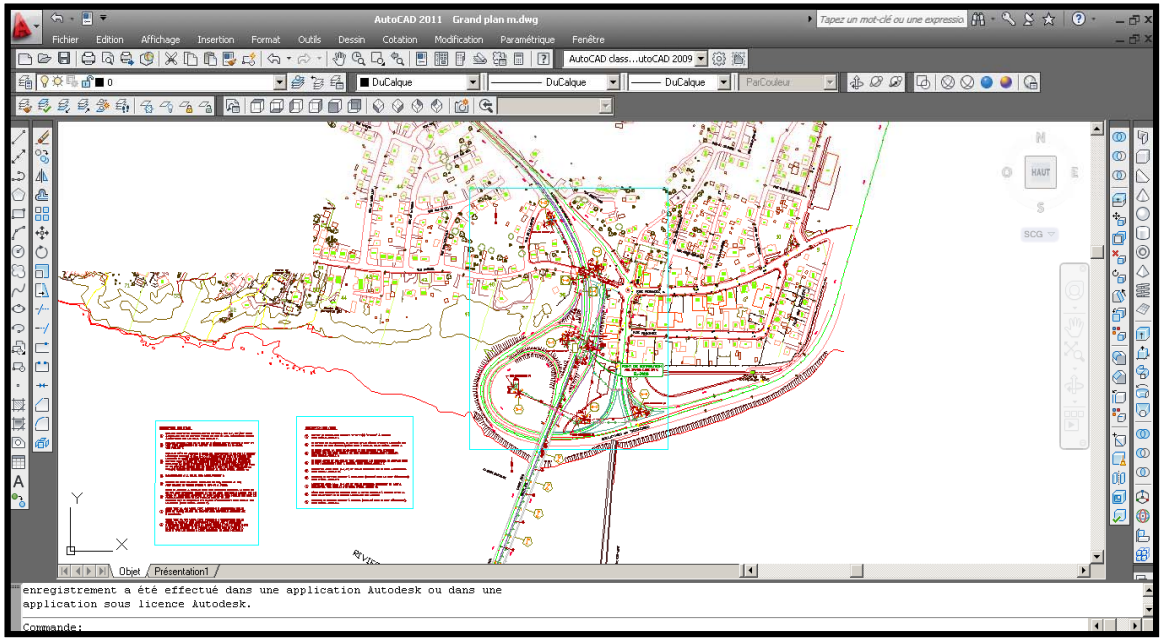
Notes importantes:
Si vous importez un plan CAD .dwg

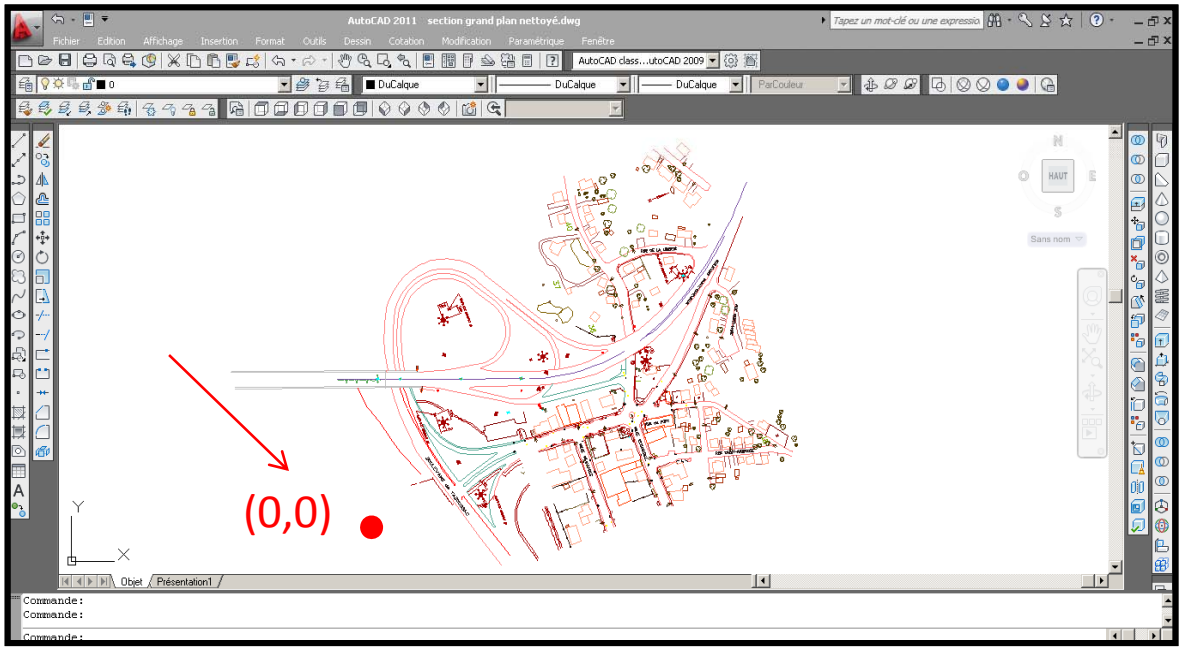
1-Nettoyez vos plans à sa plus simple expression, idéalement avec Autocad si non AGI.

2-Orientez le dessin afin d'avoir l'axe principal de gauche à droite pour des raisons de présentation et il sera plus facile de positionner les grilles.

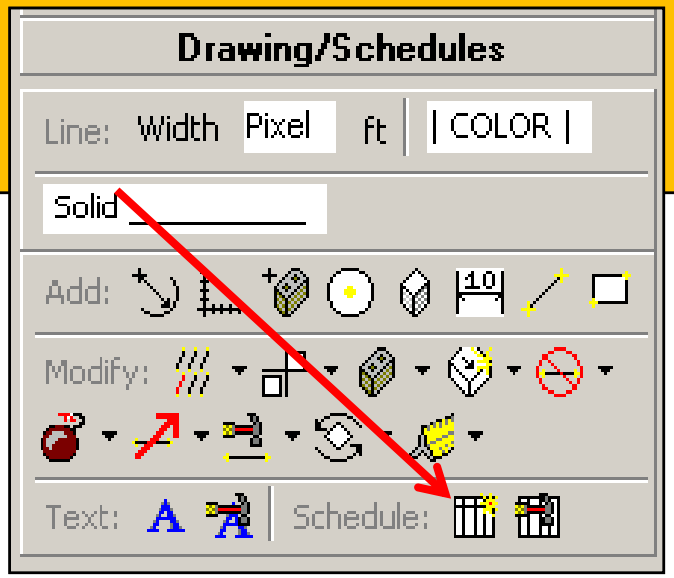
3-Assurez vous que l'origine soit à proximité de la zone ou vous travaillé. Le logiciel devient peut devenir lent et instable lorsque l'origine est situé trop loin de la zone de calcul.

4- Importez le plan sur un même niveau de Z

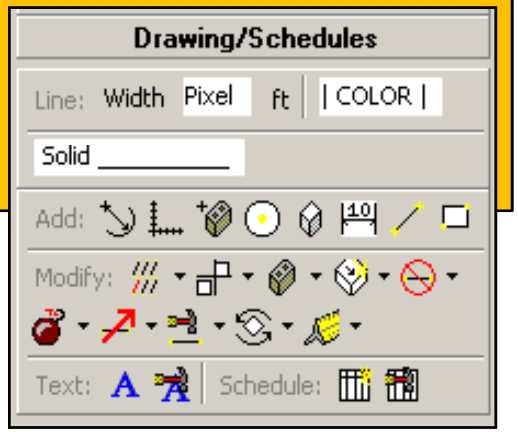




6.2- Positionnez les tableaux de données et de résultats.



6.2- Positionnez les tableaux de données et de résultats.



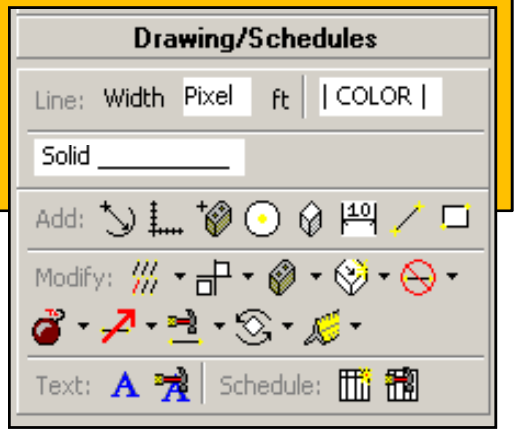
Créez et enregistrez vos tableaux selon les standards du MTQ

Tableau 4.1-2

Exemple d'un tableau de la description des luminaires

Luminaire Schedule												
Symbol	Qty	Label	Arrangement	Lumens	LLF	Description	Filename	Arm	Total Watts	IES Class	Long. Class	Cutoff Class
—▪	28	OVY15SXX2D	SINGLE	16000	0.729	OVY15SXX2D	OVY15SXX2D.ies	3.6	150	Type II	Medium	Cutoff

6.2- Positionnez les tableaux de données et de résultats.



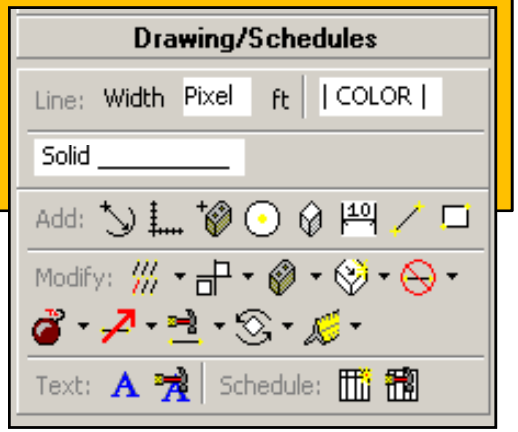
Créez et enregistrez vos tableaux selon les standards du MTQ

Tableau 4.1-3

Exemple d'un tableau du résumé de la localisation des luminaires

Luminaire Location Summary							
LumNo	Label	X	Y	Z	Orient	Tilt	Status
38	OVY15SXX2D	280	38	6	270	0	On
40	OVY15SXX2D	320	38	6	270	0	On
42	OVY15SXX2D	360	38	6	270	0	On
29	OVY15SXX2D	120	29	6	90	0	On
31	OVY15SXX2D	160	29	6	90	0	On
33	OVY15SXX2D	200	29	6	90	0	On
35	OVY15SXX2D	240	29	6	90	0	On
37	OVY15SXX2D	280	29	6	90	0	On
39	OVY15SXX2D	320	29	6	90	0	On
41	OVY15SXX2D	360	29	6	90	0	On
16	OVY15SXX2D	-160	38	6	270	0	On

6.2- Positionnez les tableaux de données et de résultats.



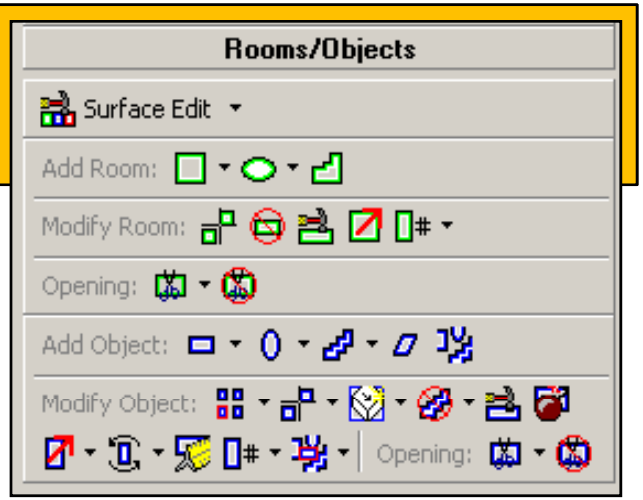
Créez et enregistrez vos tableaux selon les standards du MTQ

Tableau 4.1-4

Exemple d'un tableau du résumé des grilles de calcul

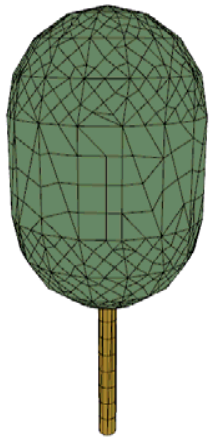
Calculation Summary								
Label	CalcType	Units	Avg	Avg/Min	Max/Min	LVRatio	Max	Min
Direction_Est_Lum	L_Roadway	Cd/Sq.M.	0.00	N.A.	N.A.	0.00	0.0	0.0
Direction_Est_Ill	Illuminance	Lux	0.00	N.A.	N.A.	0.00	0.0	0.0
Direction_Est_Lv	L_Veiling	Cd/Sq.M.	0.00	N.A.	N.A.	0.00	0.00	0.00
Direction_Ouest_Lum	L_Roadway	Cd/Sq.M.	0.00	N.A.	N.A.	0.00	0.0	0.0
Direction_Ouest_Ill	Illuminance	Lux	0.00	N.A.	N.A.	0.00	0.0	0.0
Direction_Ouest_Lv	L_Veiling	Cd/Sq.M.	0.00	N.A.	N.A.	0.00	0.00	0.00

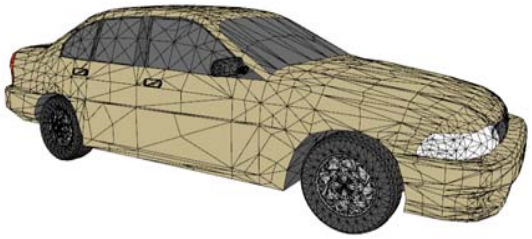
6.3- Importez ou dessinez vos objets ou surfaces.



Notes importantes:
Assurez vous de bien définir vos surfaces selon le type d'étude.

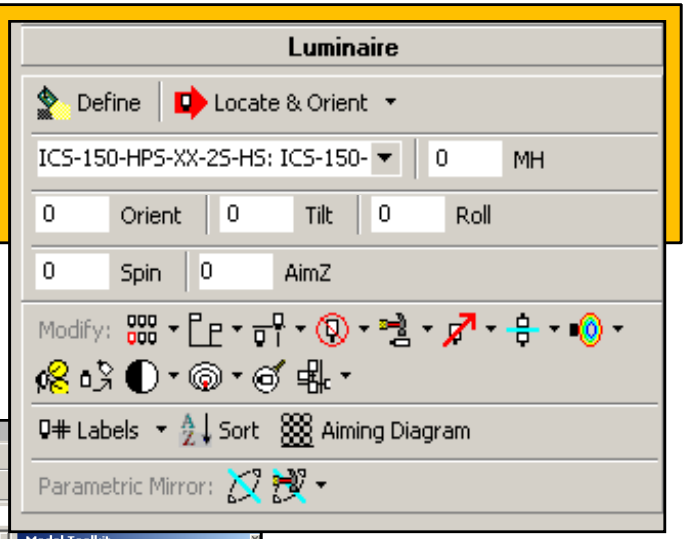
Surface Type
10- Single Sided
11- Double Sided
14- Glass
20- Daylight Transition Glass (transparent)
21- Daylight Transition Glass (diffuse)
22- Daylight Transition Opening
40- Roadway Pavement Single Sided (Direct Flux Only)
41- Roadway Contributor Single Sided

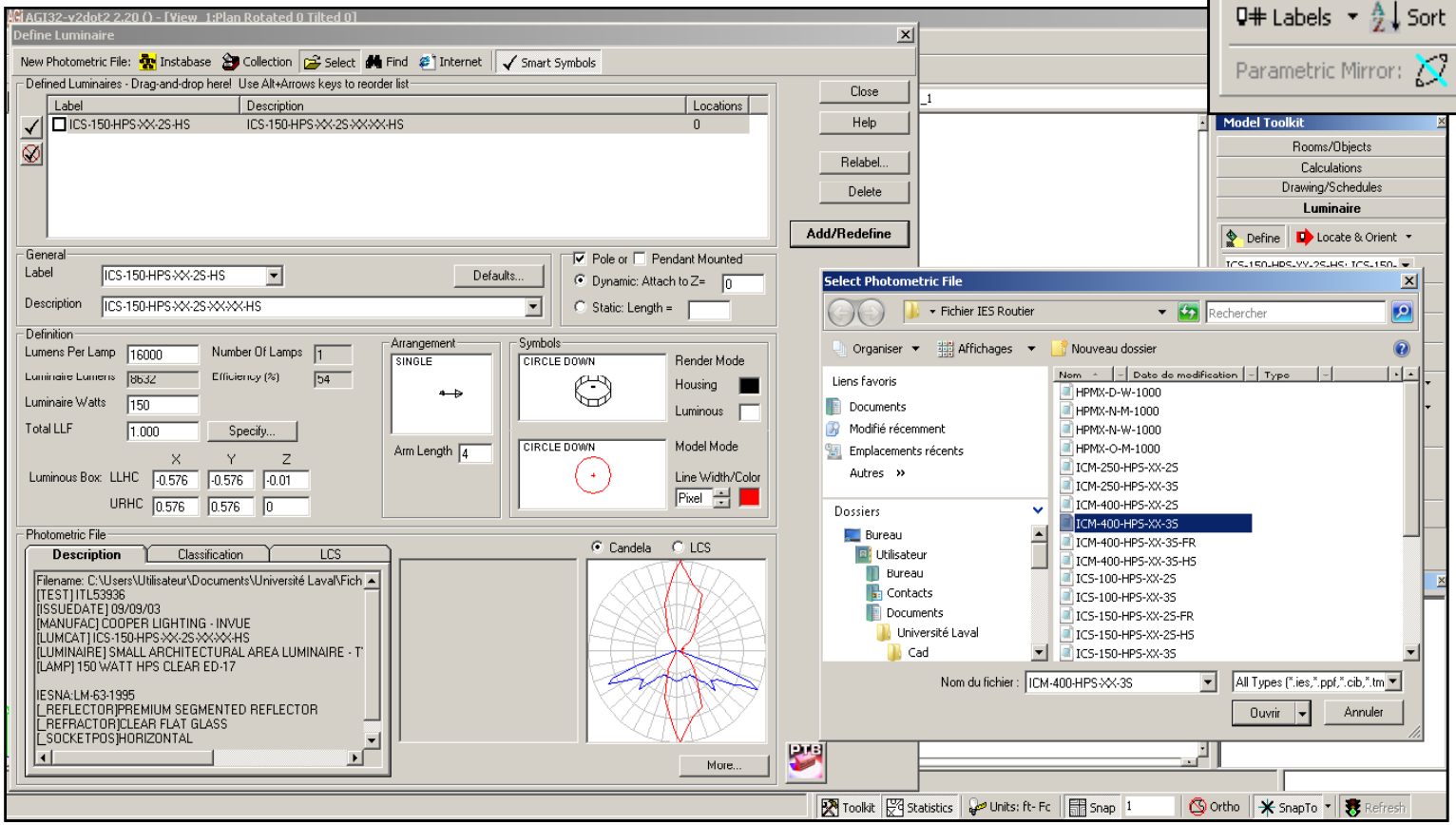




Éclairage routier

6.4- Importez et définissez vos luminaires.





Normes du MTQ

Lampadaire :

Le lampadaire comporte un fût d'une longueur maximale de 15 m, avec lequel on peut utiliser indifféremment cinq longueurs de potence, soit 0,6 m, 1,2 m, 2 m, 3 m et 4 m. L'ensemble fût et potence doit s'agencer.

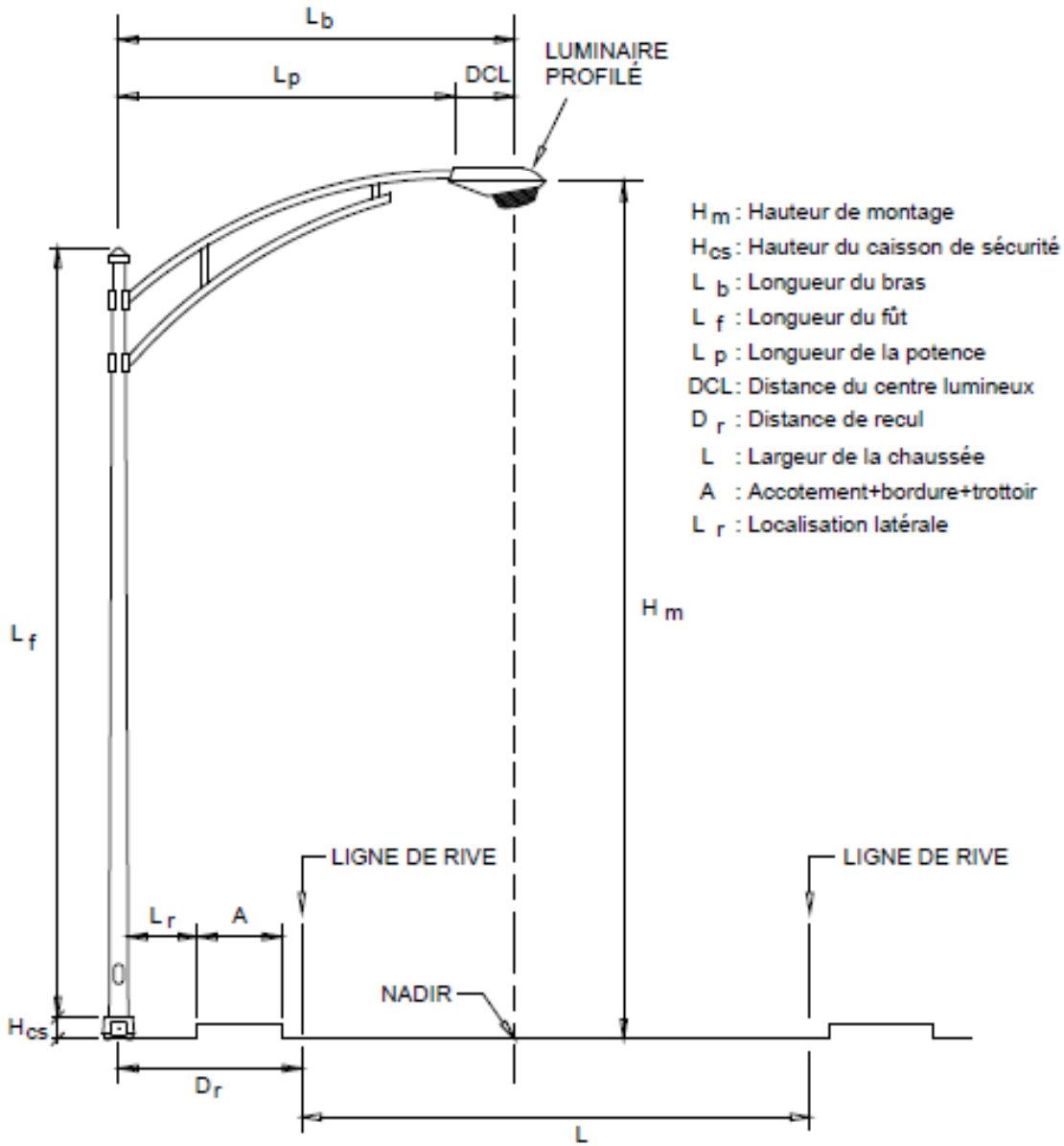
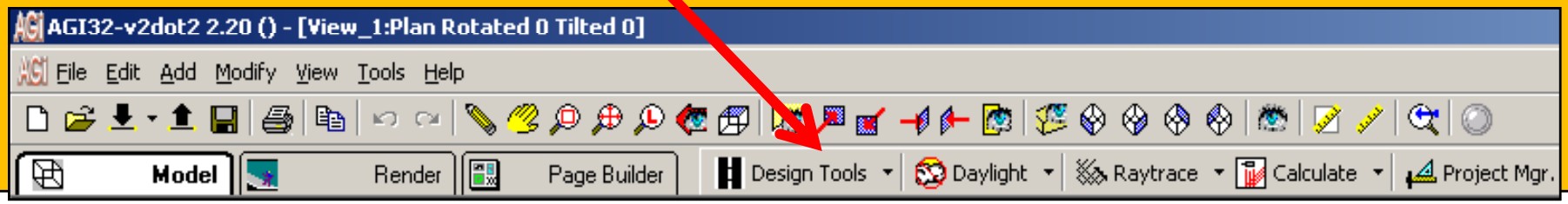


Figure 4.1-1
Géométrie de l'installation d'éclairage

6.5- Estimez avec le Roadway Optimizer

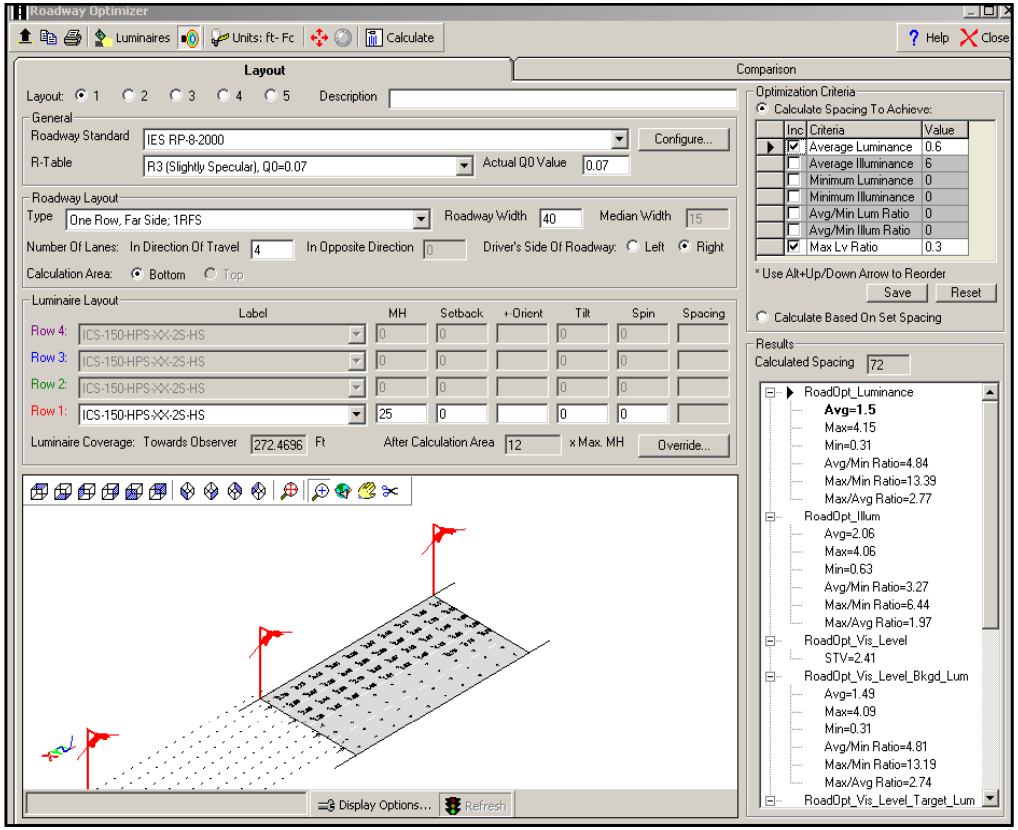


Notes:

Une fois que vous avez vos données et critères à respecter, utilisez le roadway optimizer.

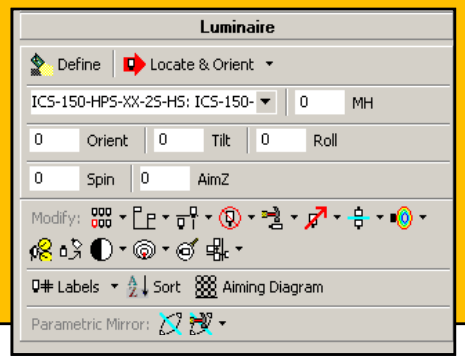
Vous pourrez estimer l'espacement selon vos critères ou les résultats selon votre espacement.

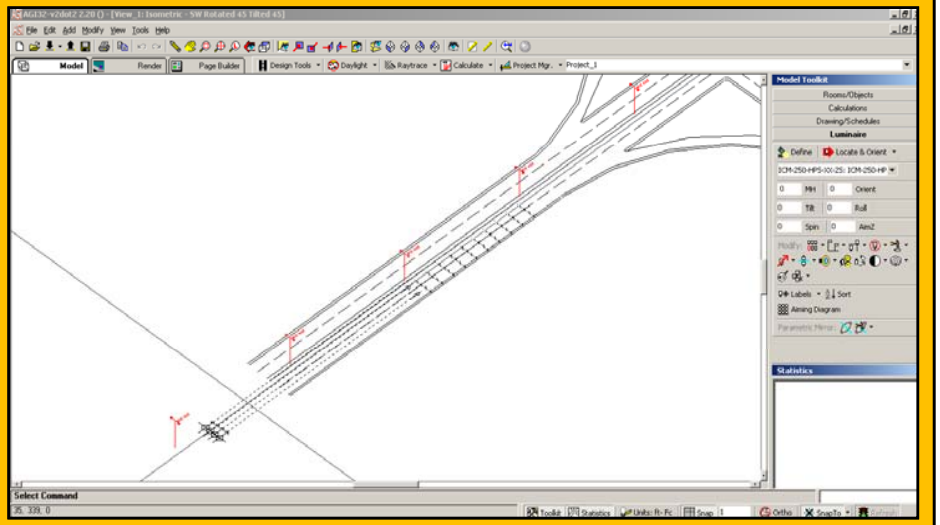
Il sera aussi possible d'exporter les luminaires et la grille sur votre plan.



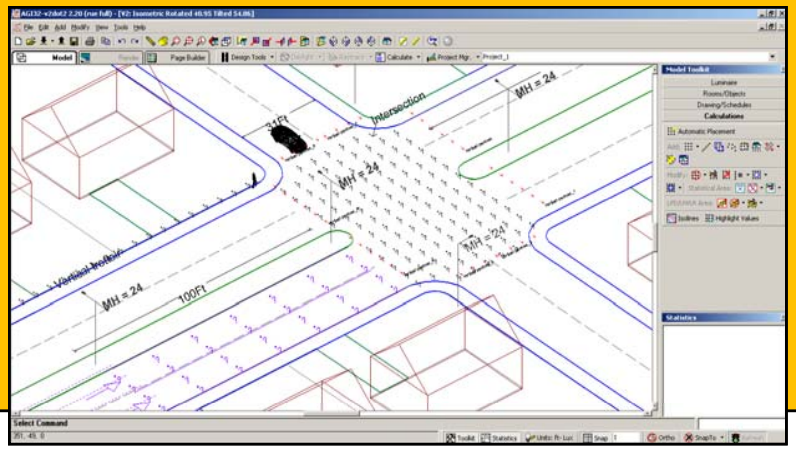
Éclairage routier

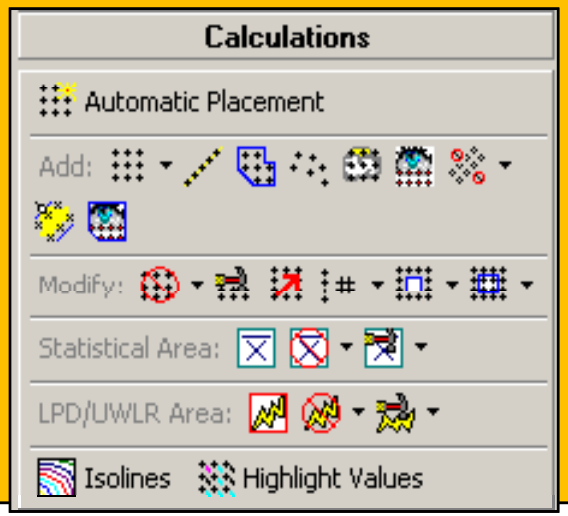
6.6-Exportez le Roadway Optimizer sur vos plans ou placez manuellement vos luminaires sur le plan.



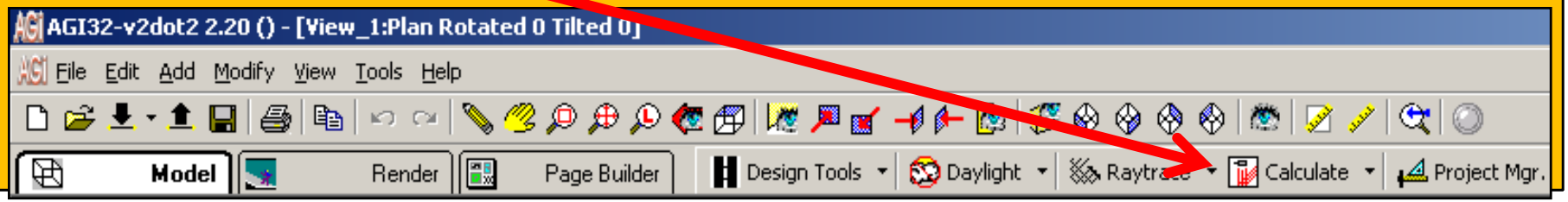


6.7-Positionnez vos grilles de calculs.



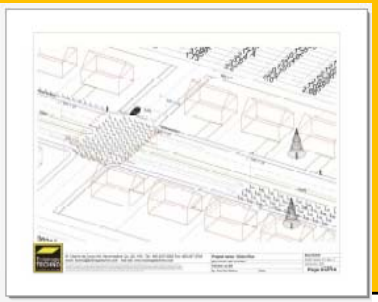


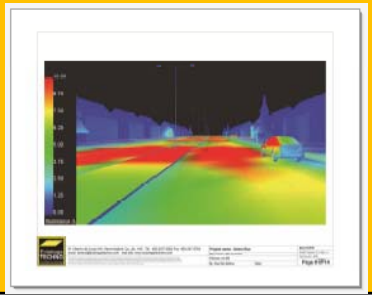
6.8- Exécutez le calcul



6.9- Analyser les résultats , si les résultats ne sont pas satisfaisants, déplacés ou changés de luminaires et recommencer jusqu'à vous soyer satisfait.

7- Exportez vos résultats en CAD et ou monter un rapport avec le Page Builder.





Éclairage Routier

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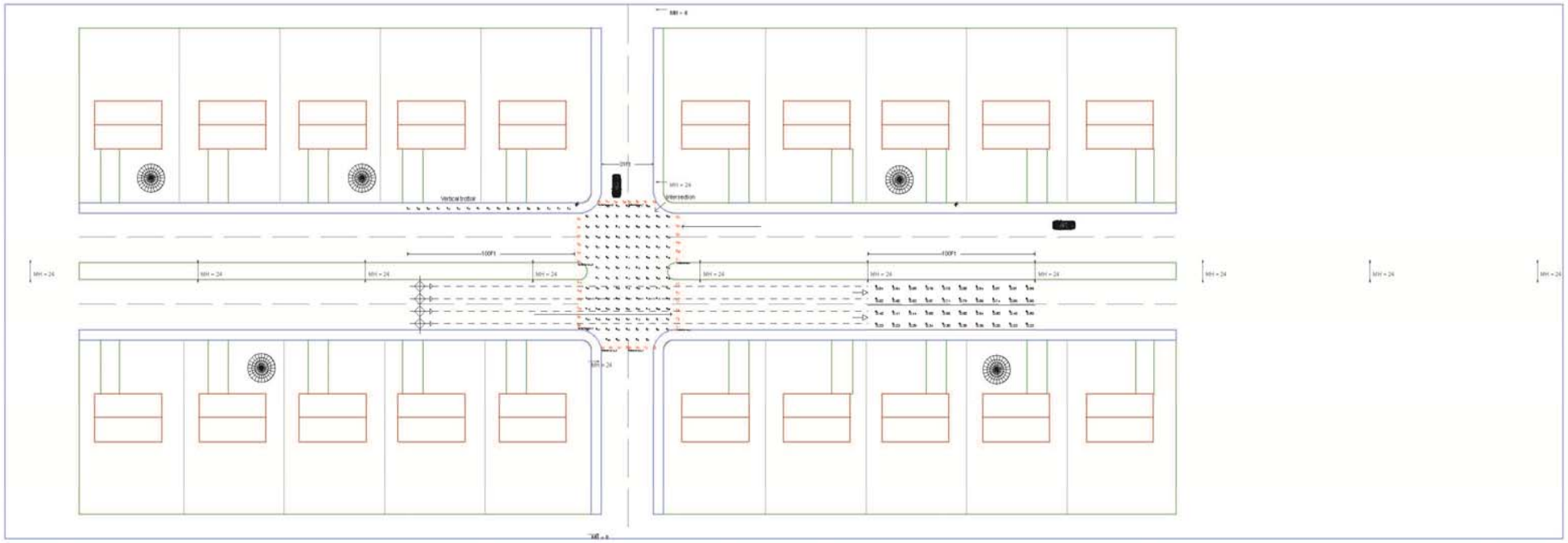
Prepared for: Ville de Québec		AGi32 Version 2.14 Rev. 4
Filename: rue.AGI		Total Time (Hrs.): 28.83
By : Peer Eric Moldvar	**Units:**	**Page 1 of 14**

Calculation Summary											
Label	CalcType	Roadway Standard	Units	Avg	Max	Min	Avg/Min	Max/Min	LVRatio	STV	RTable
Intersection	Illuminance	N.A.	Lux	11.24	19.4	4.7	2.39	4.13	N.A.	N.A.	N.A.
RoadOpt_Illum	Illuminance	IES RP-8-2000	Lux	10.64	26.82	4.69	2.27	5.72	N.A.	N.A.	N.A.
RoadOpt_Luminance	Luminance	IES RP-8-2000	Cd/SqM	0.60	0.97	0.22	2.73	4.41	N.A.	N.A.	R3
RoadOpt_Veil_Lum	Veiling Luminanc	IES RP-8-2000	Cd/SqM	0.09	0.19	0.04	2.25	4.75	0.32	N.A.	R3
RoadOpt_Vis_Level	Visibility Level	IES RP-8-2000	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2.51	R3
RoadOpt_Vis_Level_Bkgd_L	Background Lumin	IES RP-8-2000	Cd/SqM	0.60	1.09	0.22	2.73	4.95	N.A.	2.51	R3
RoadOpt_Vis_Level_Target	Target Luminance	IES RP-8-2000	Cd/SqM	0.82	1.79	0.09	9.11	19.89	N.A.	2.51	R3
Vertical traverse	Illuminance	N.A.	Lux	10.32	17.1	2.6	3.97	6.58	N.A.	N.A.	N.A.
Vertical traverse_1	Illuminance	N.A.	Lux	1.43	1.7	1.2	1.19	1.42	N.A.	N.A.	N.A.
Vertical traverse_2	Illuminance	N.A.	Lux	2.08	4.0	0.8	2.60	5.00	N.A.	N.A.	N.A.
Vertical traverse_3	Illuminance	N.A.	Lux	2.50	2.6	2.4	1.04	1.08	N.A.	N.A.	N.A.
Vertical traverse_4	Illuminance	N.A.	Lux	11.48	17.4	5.0	2.30	3.48	N.A.	N.A.	N.A.
Vertical traverse_5	Illuminance	N.A.	Lux	2.02	2.4	1.5	1.35	1.60	N.A.	N.A.	N.A.
Vertical traverse_6	Illuminance	N.A.	Lux	1.88	3.6	0.7	2.69	5.14	N.A.	N.A.	N.A.
Vertical traverse_7	Illuminance	N.A.	Lux	3.05	3.2	2.9	1.05	1.10	N.A.	N.A.	N.A.
Vertical trottoir	Illuminance	N.A.	Lux	1.73	3.2	0.6	2.88	5.33	N.A.	N.A.	N.A.



Luminaire Schedule								
Symbol	Qty	Label	Description	Lumens/Lamp	Lum. Watts	LLF	Filename	Arrangement
	24	Cobra 100HPS	CHS-S0100-X-2SC	9500	111	0.620	CHS-S0100-X-2SC b3.ies	SINGLE

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By : Peer Eric Moldvar | **Units:**

Date:7/2/2010

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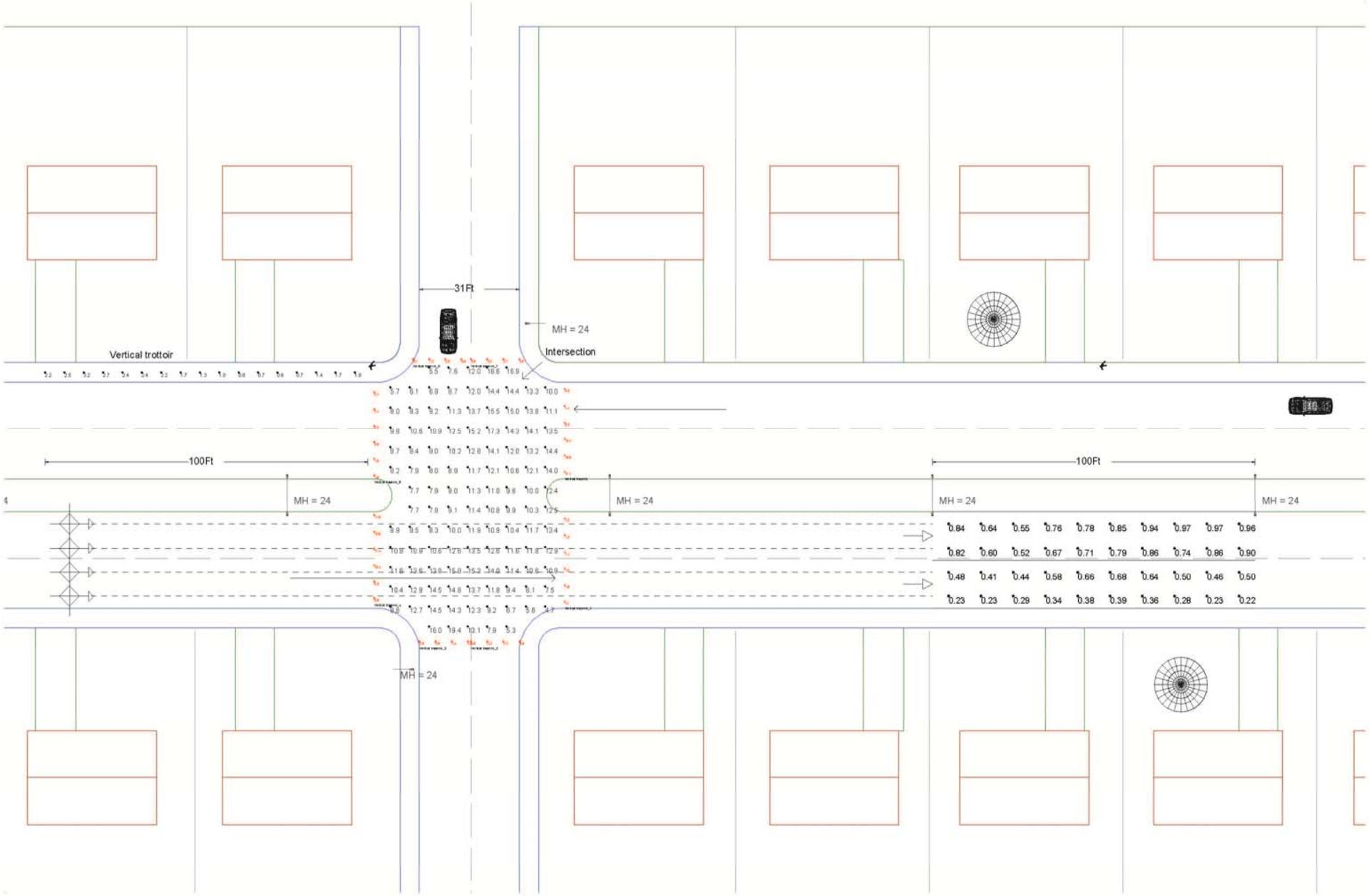

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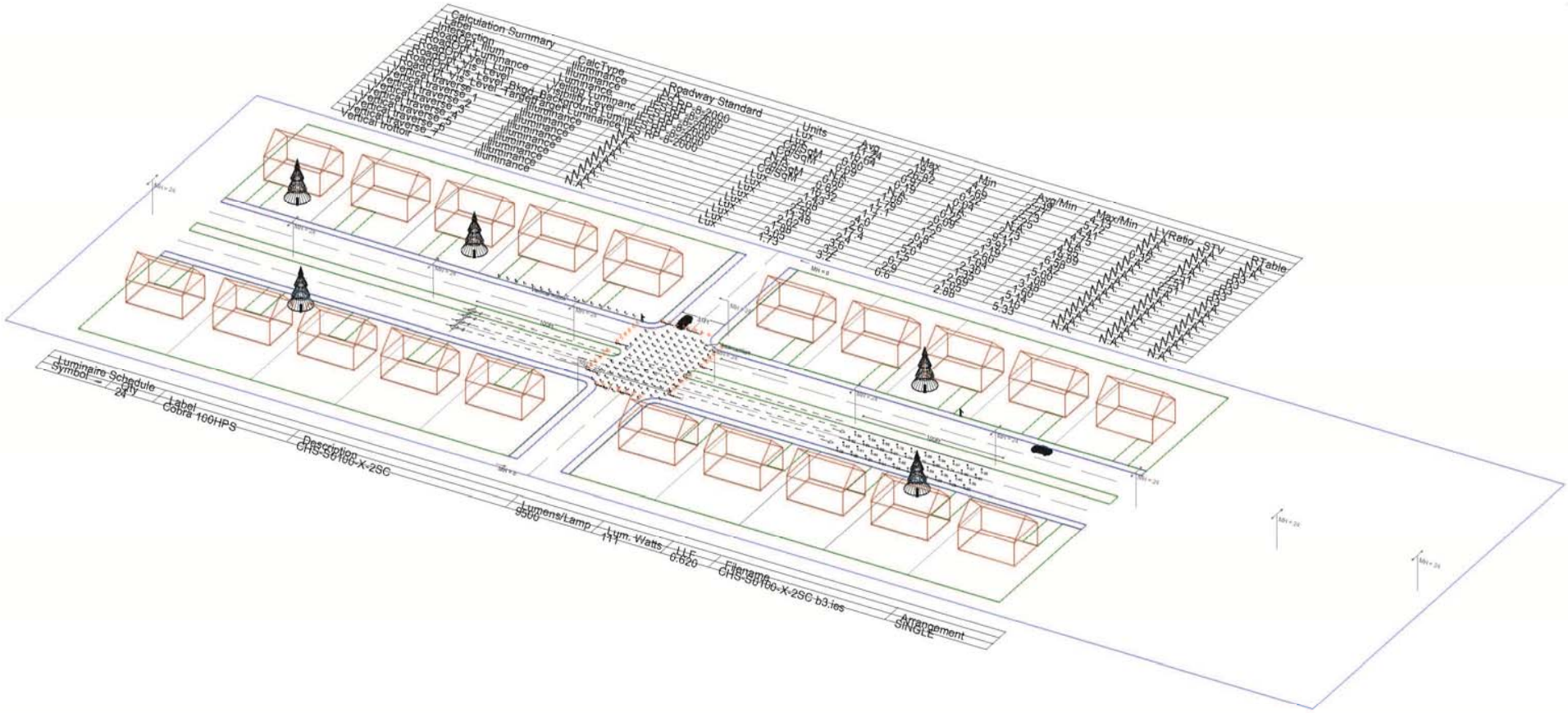

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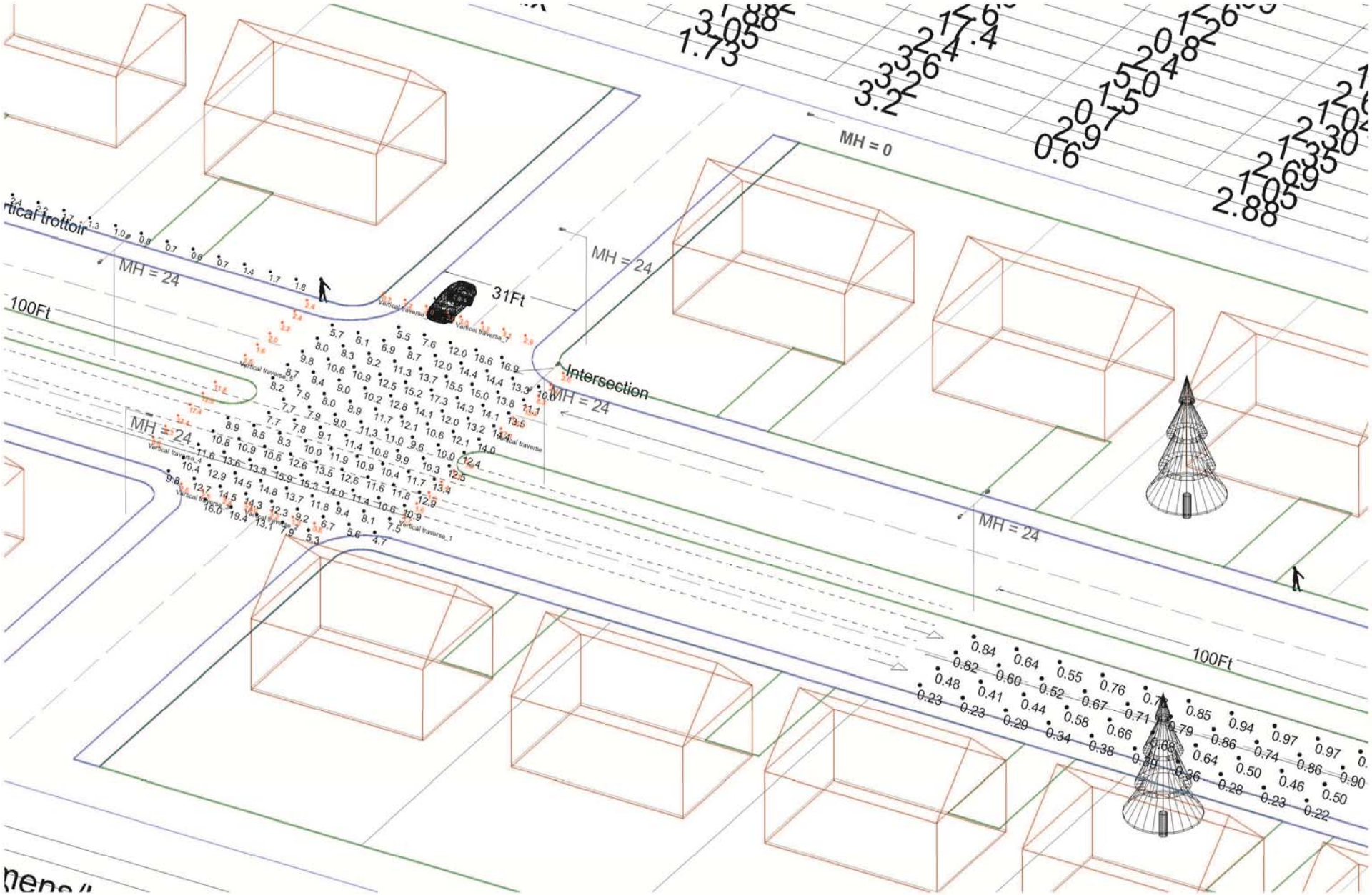

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Luminaire Schedule						
Symbol	Qty	Label	Description	Lumens	LLF	Filename
	24	Cobra 100HPS	CHS-S0100-X-2SC	9500	0.620	CHS-S0100-X-2SC b3.ies

Calculation Summary										
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min	Roadway Standard	LVRatio	STV
Intersection	Illuminance	Lux	11.24	19.4	4.7	2.39	4.13	N.A.	N.A.	N.A.
RoadOpt_Illum	Illuminance	Lux	10.64	26.82	4.69	2.27	5.72	IES RP-8-2000	N.A.	N.A.
RoadOpt_Luminance	Luminance	Cd/SqM	0.60	0.97	0.22	2.73	4.41	IES RP-8-2000	N.A.	N.A.
RoadOpt_Veil_Lum	Veiling Luminanc	Cd/SqM	0.09	0.19	0.04	2.25	4.75	IES RP-8-2000	0.32	N.A.
RoadOpt_Vis_Level	Visibility Level	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	IES RP-8-2000	N.A.	2.51
RoadOpt_Vis_Level_Bkgd_Lum	Background Lumin	Cd/SqM	0.60	1.09	0.22	2.73	4.95	IES RP-8-2000	N.A.	2.51
RoadOpt_Vis_Level_Target_Lum	Target Luminance	Cd/SqM	0.82	1.79	0.09	9.11	19.89	IES RP-8-2000	N.A.	2.51
Vertical traverse	Illuminance	Lux	10.32	17.1	2.6	3.97	6.58	N.A.	N.A.	N.A.
Vertical traverse_1	Illuminance	Lux	1.43	1.7	1.2	1.19	1.42	N.A.	N.A.	N.A.
Vertical traverse_2	Illuminance	Lux	2.08	4.0	0.8	2.60	5.00	N.A.	N.A.	N.A.
Vertical traverse_3	Illuminance	Lux	2.50	2.6	2.4	1.04	1.08	N.A.	N.A.	N.A.
Vertical traverse_4	Illuminance	Lux	11.48	17.4	5.0	2.30	3.48	N.A.	N.A.	N.A.
Vertical traverse_5	Illuminance	Lux	2.02	2.4	1.5	1.35	1.60	N.A.	N.A.	N.A.
Vertical traverse_6	Illuminance	Lux	1.88	3.6	0.7	2.69	5.14	N.A.	N.A.	N.A.
Vertical traverse_7	Illuminance	Lux	3.05	3.2	2.9	1.05	1.10	N.A.	N.A.	N.A.
Vertical trottoir	Illuminance	Lux	1.73	3.2	0.6	2.88	5.33	N.A.	N.A.	N.A.

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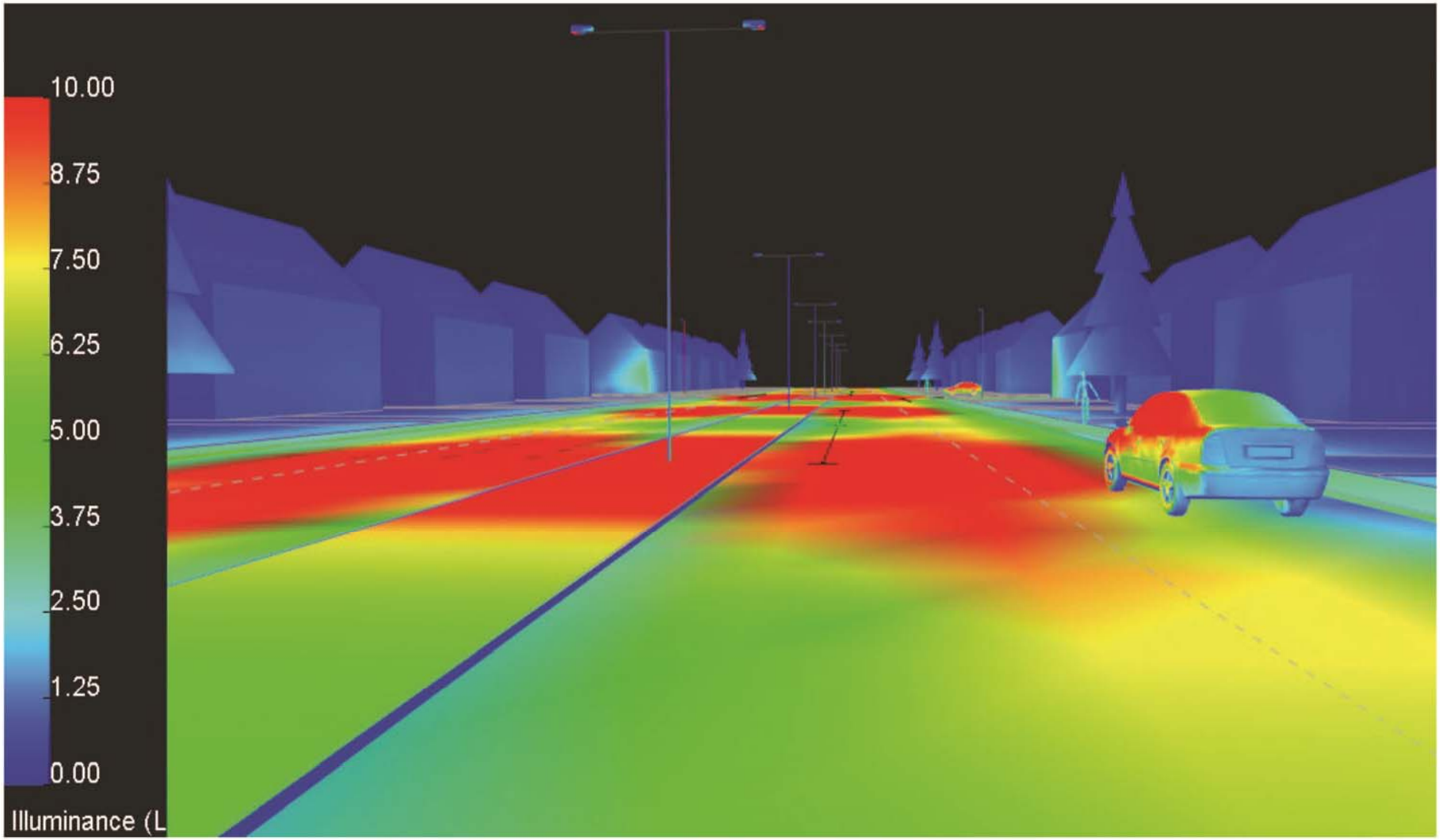

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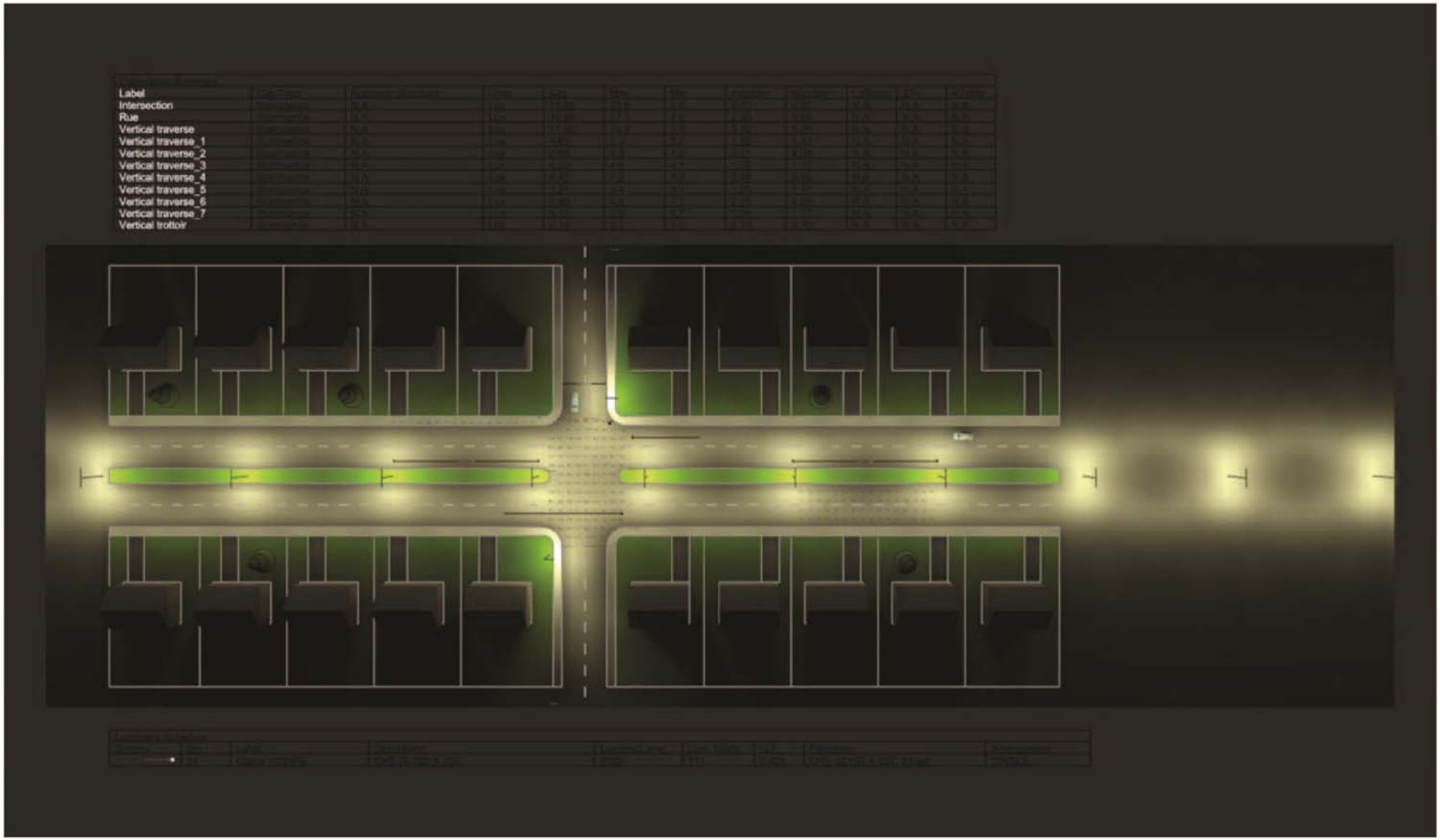
Filename: rue.AGI		Total Time (Hrs.): 28.83
By : Peer Eric Moldvar	**Units:**	**Page 8 of 14**



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Project name : Démo Rue

Prepared for: Ville de Québec

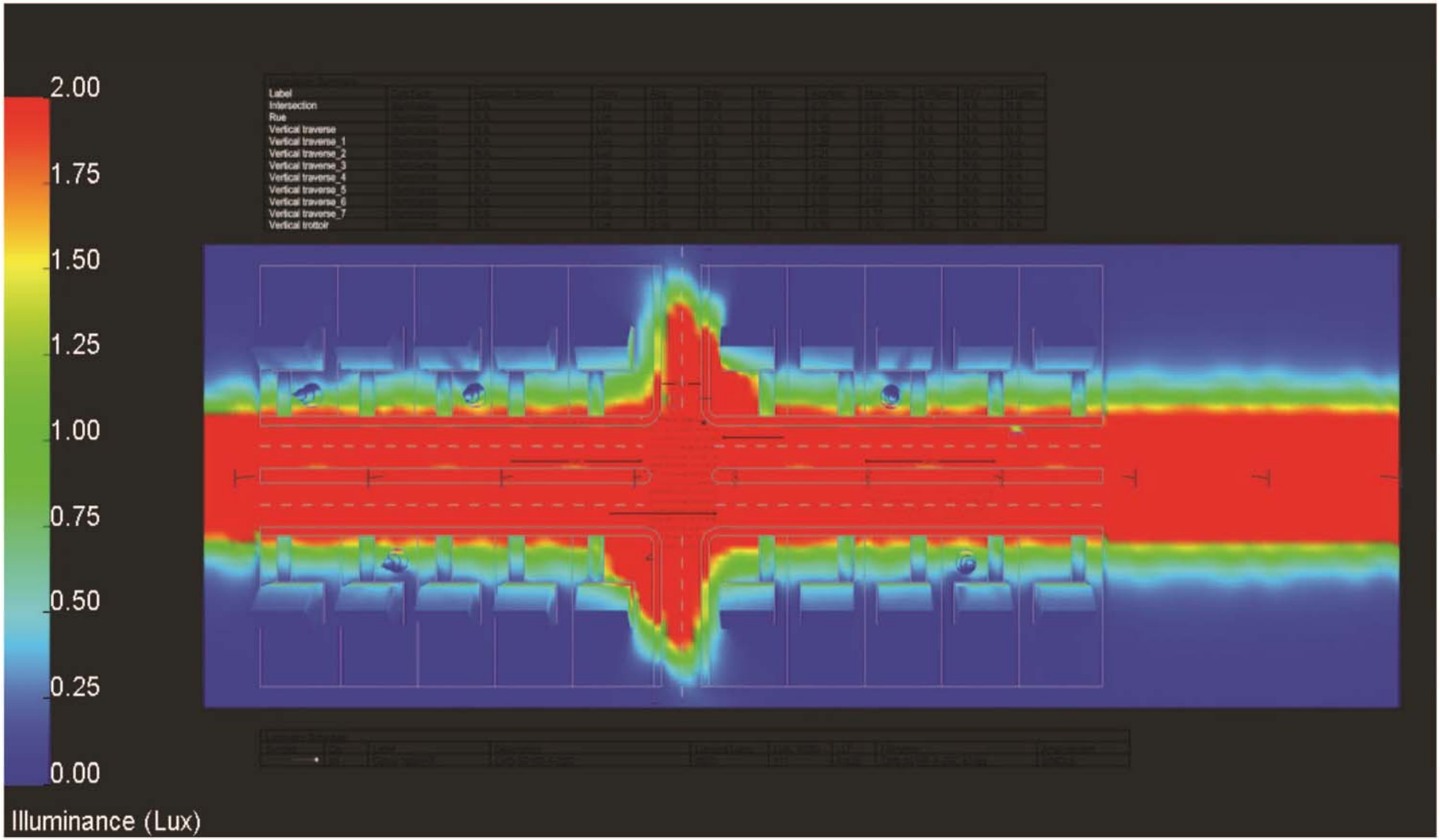
Filename: rue.AGI

By : Peer Eric Moldvar | **Units:**

Date:7/2/2010

AGi32 Version 2.14 Rev. 4

Total Time (Hrs.): 28.83



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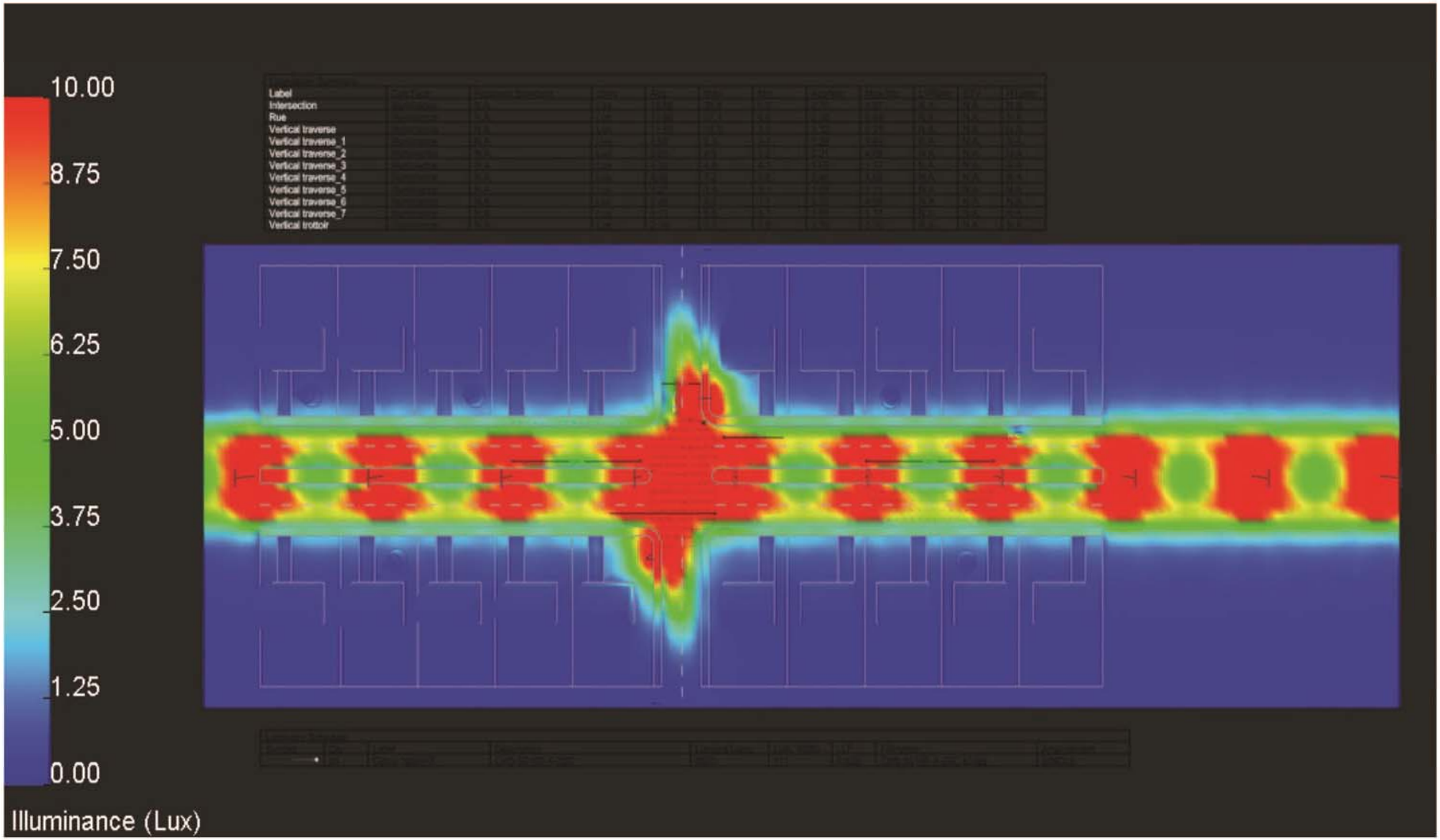
Filename: rue.AGI		Total Time (Hrs.): 28.83
By : Peer Eric Moldvar	**Units:**	**Page 10 of 14**



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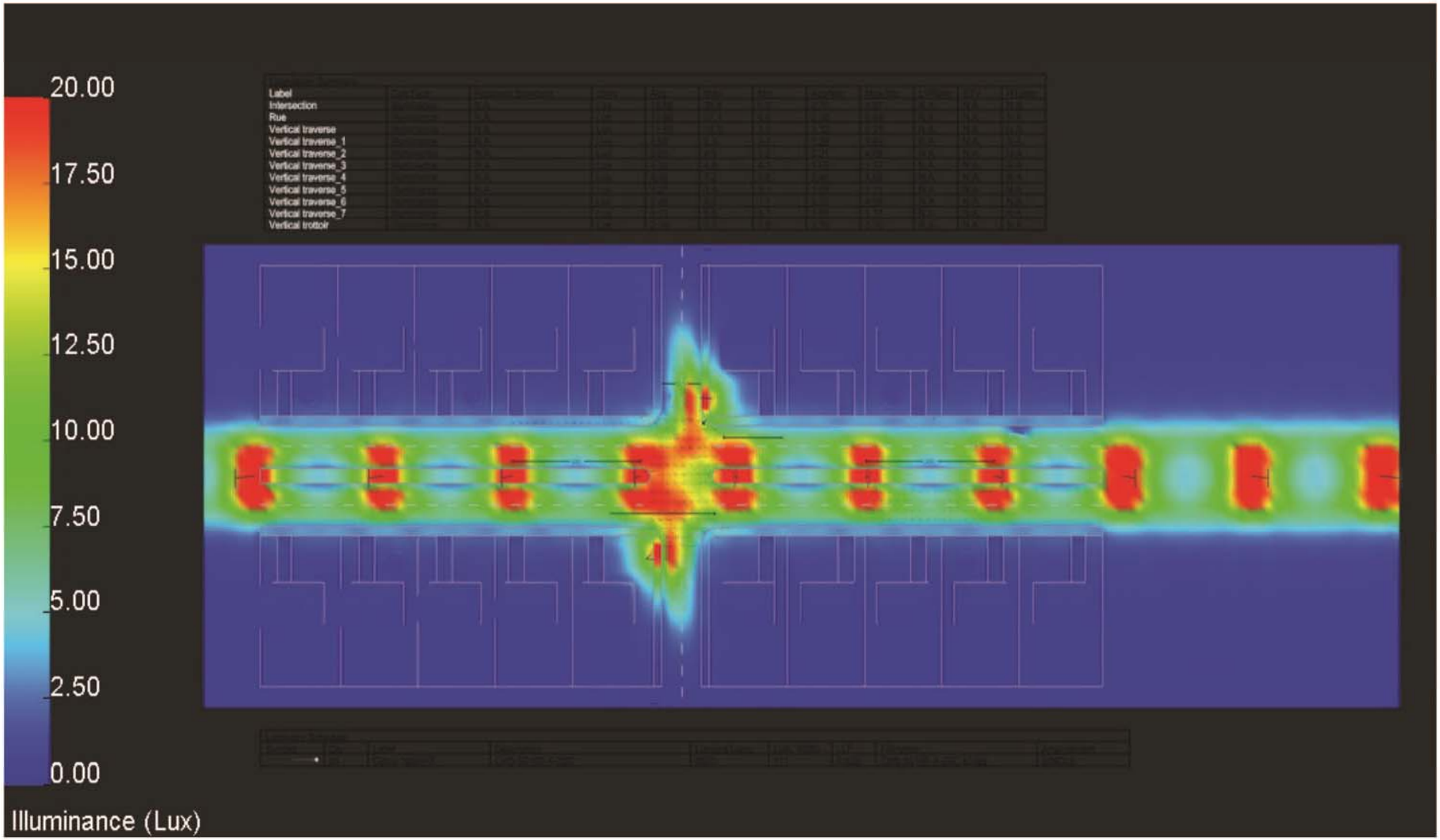
By : Peer Eric Moldvar	**Units:**	**Page 11 of 14**



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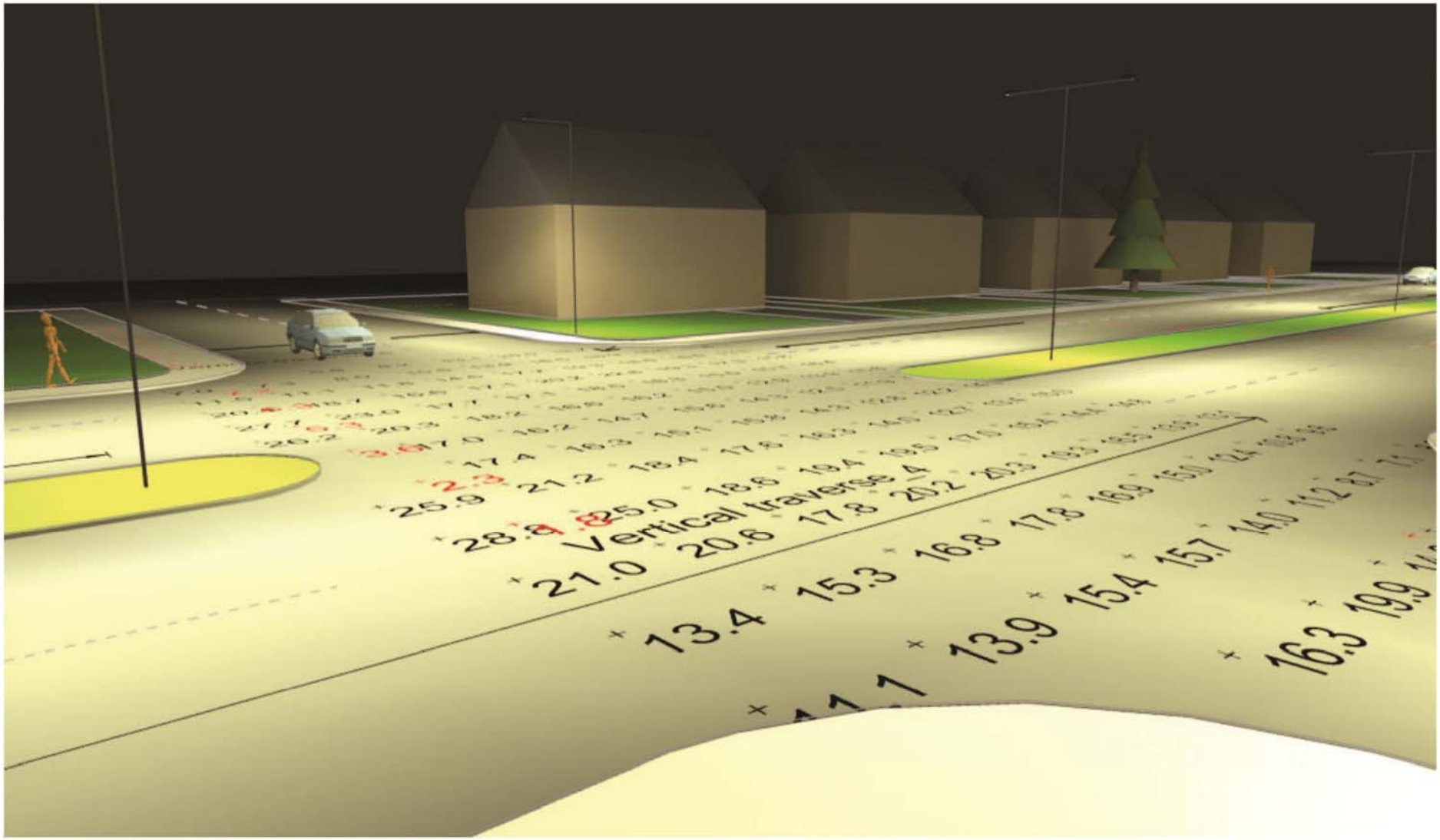
By : Peer Eric Moldvar	**Units:**	**Page 12 of 14**



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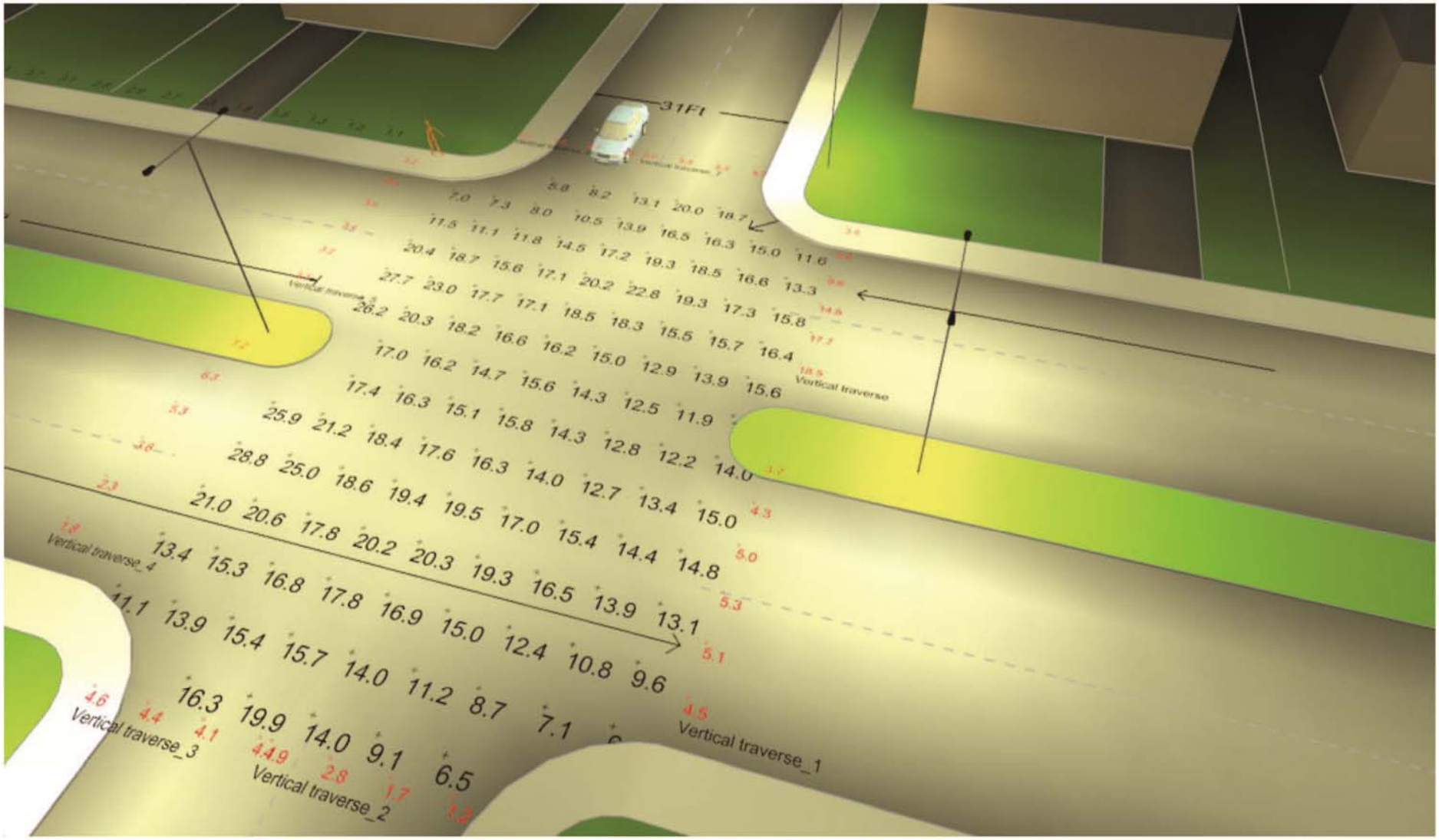

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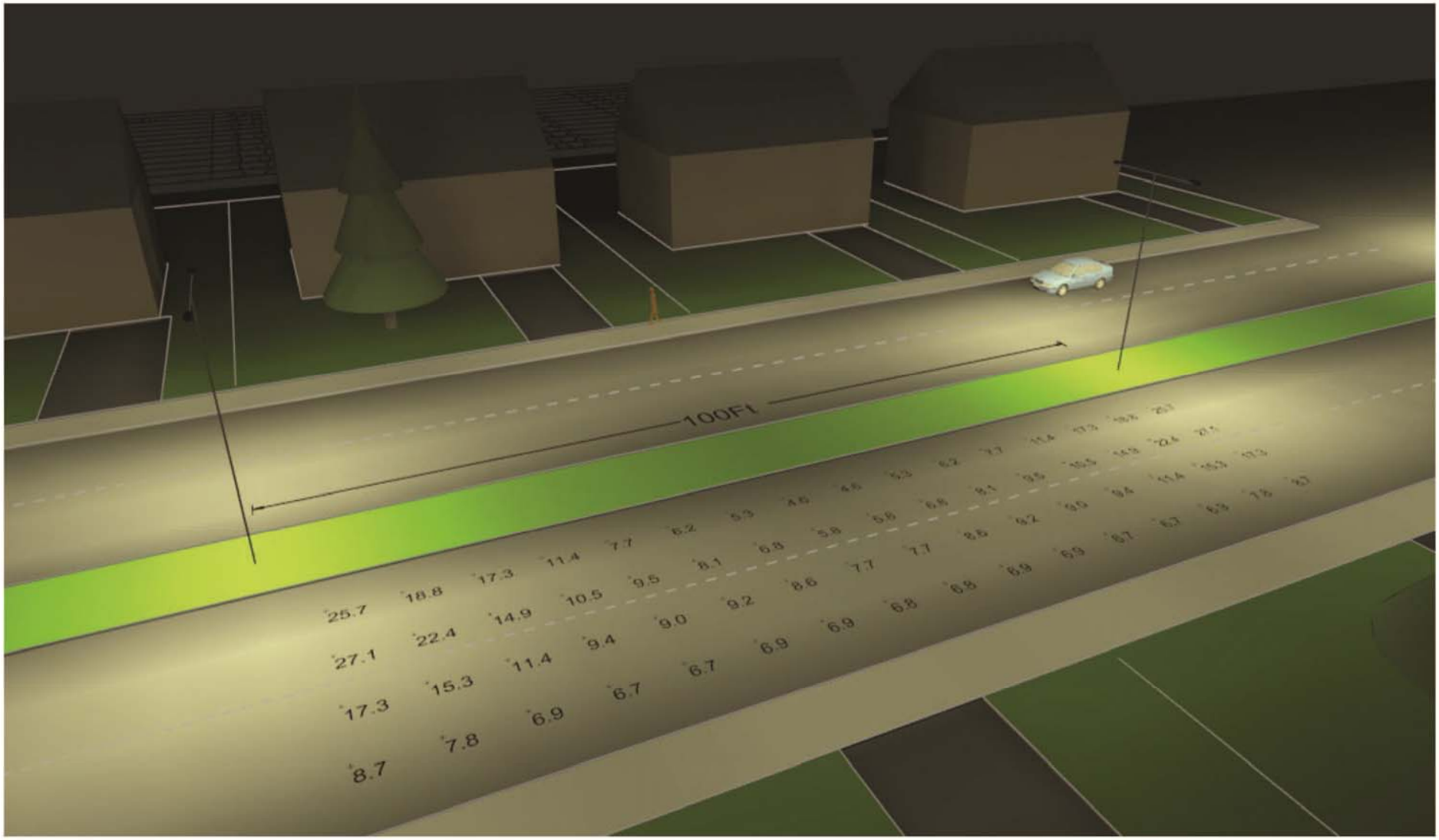
By : Peer Eric Moldvar	**Units:**	**Page 14 of 14**



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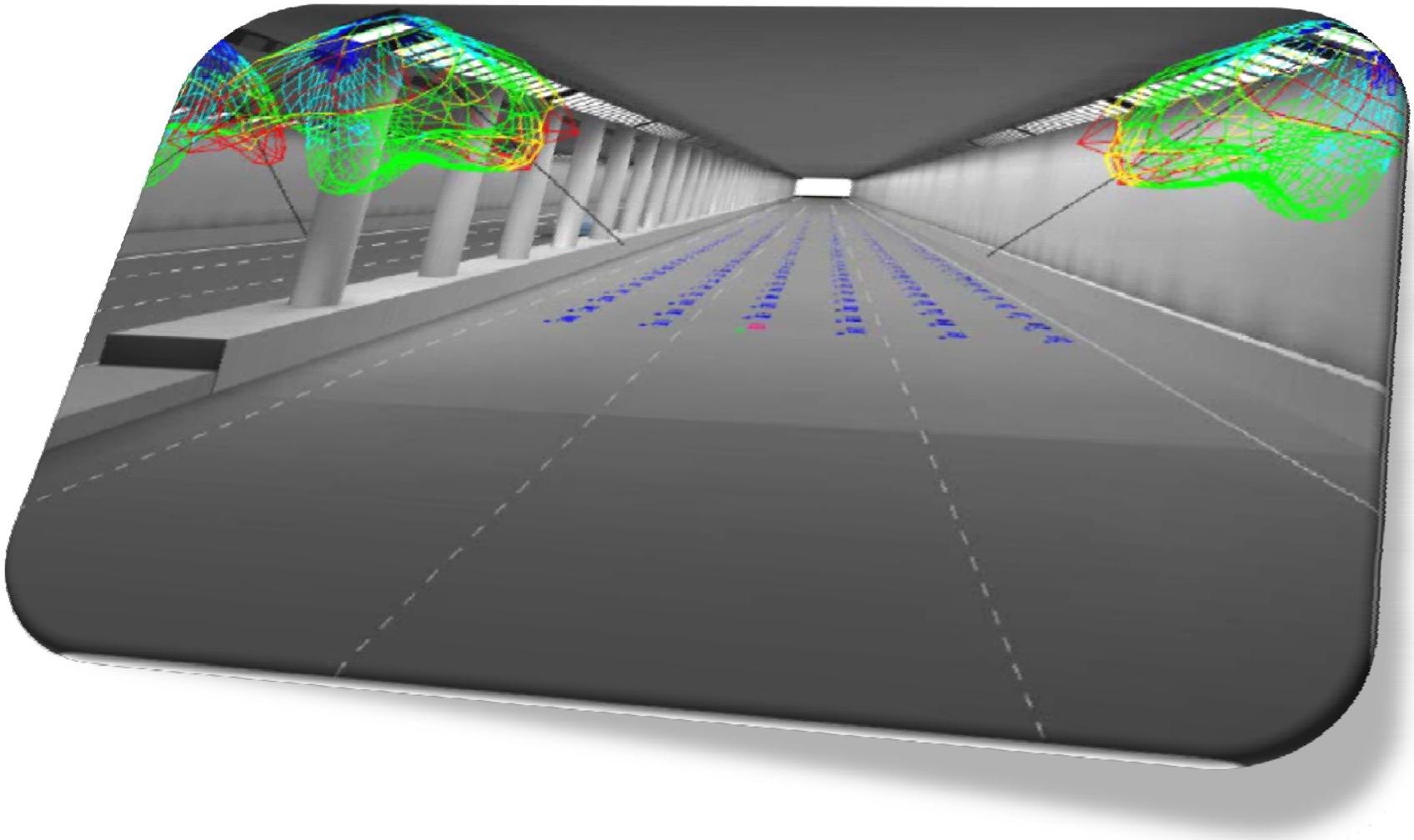
Project name : Démo Rue		**Date:7/4/2010**
Prepared for: Ville de Québec		AGi32 Version 2.14 Rev. 4
Filename: rue.AGI		Total Time (Hrs.): 28.87
By : Peer Eric Moldvar	**Units:**	**Page 15 of 15**

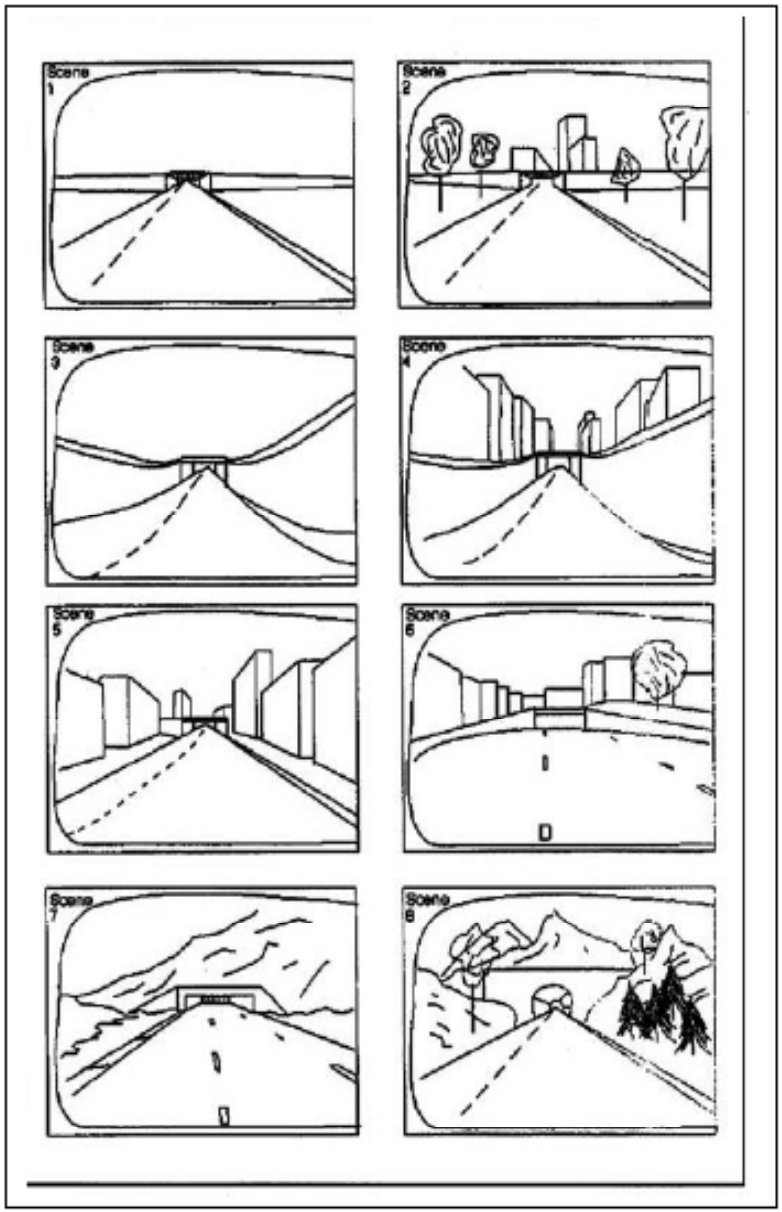
Tunnels

Tunnels

Référence : IES RP22



Tunnels



Le type de tunnels, son orientation, sa distance, la vitesse des voitures, la quantité de trafique sont des facteurs importants à analyser avant d'entreprendre le concept d'éclairage d'un tunnel.

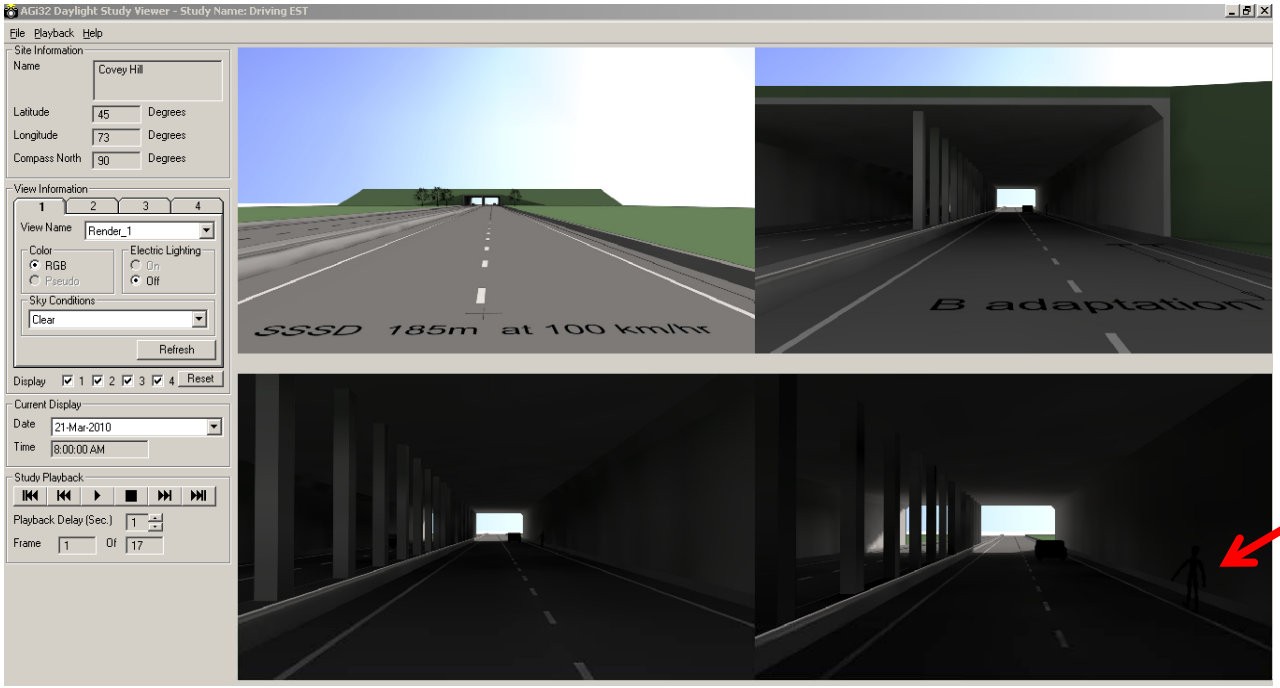
Figure 3:
Open Road Tunnel – Scene 1, 2, 3
Urban Tunnel – Scene 4, 5, 6
Mountain Tunnel – Scene 7, 8
6.3 Assessment of Major Factors Influencing Lighting Design Criteria

Tunnels

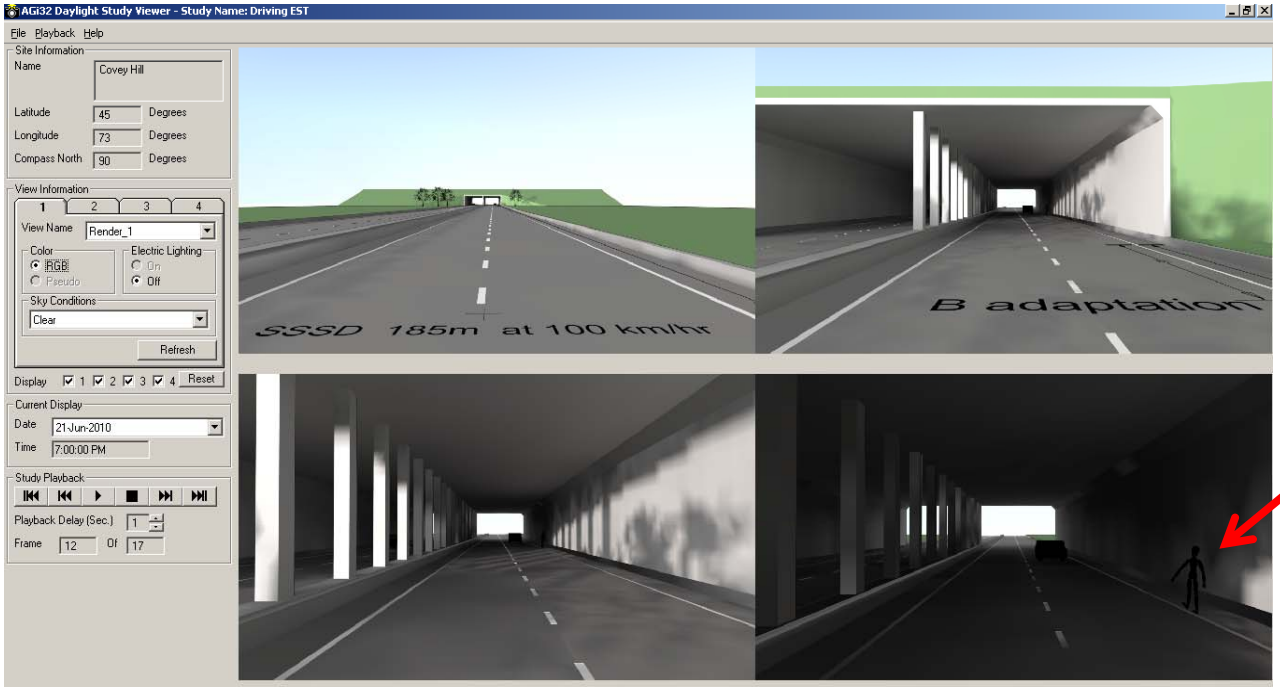
Petit tunnel de 75m sans système d'éclairage.

Trafique direction EST

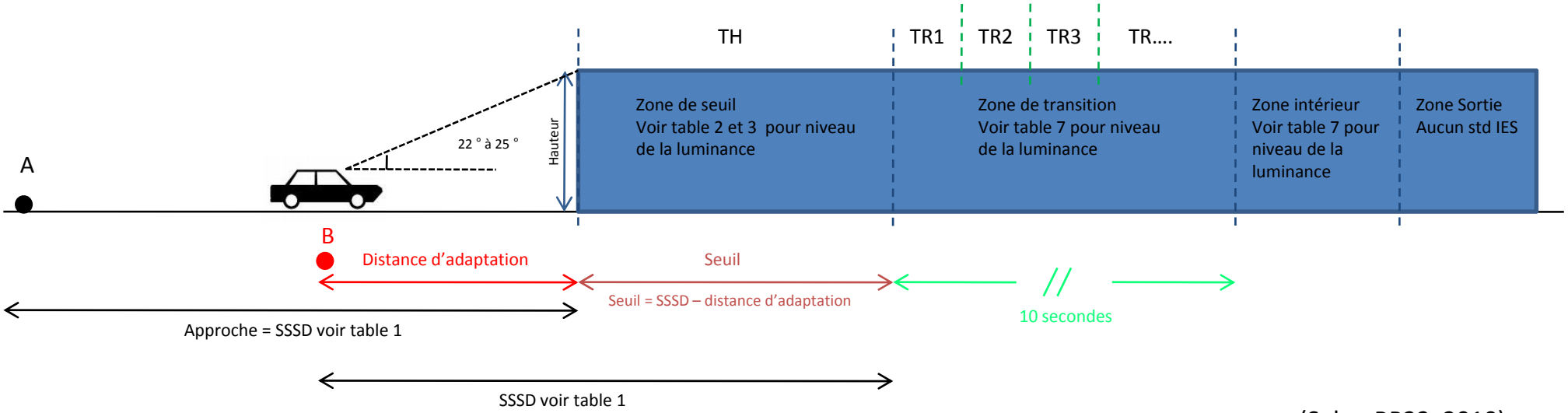
21 mars 8:00 AM



21 juin 7:00PM



Tunnels



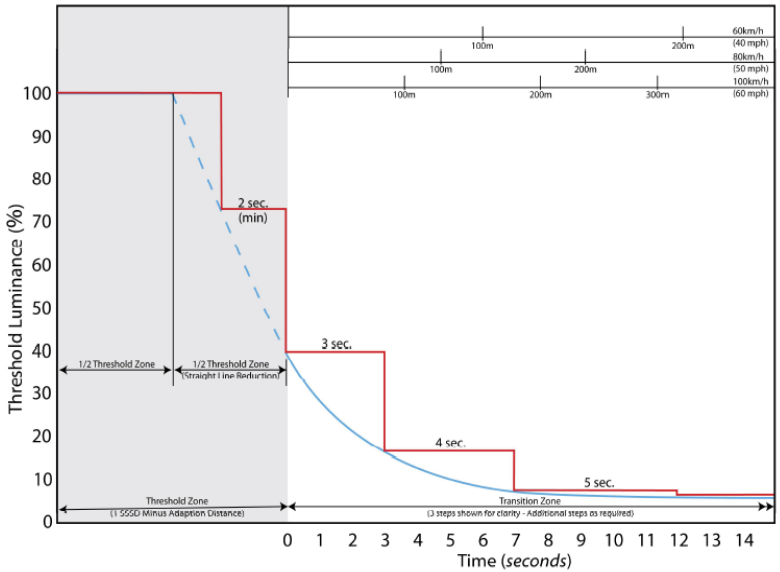
(Selon RP22 2010)

Niveaux de luminance

Zone TH : voir table 2 et 3 pour déterminer

Les différente zones de transitions doivent êtres équidistante. (Selon RP22 05)
Zone TR1 = TH x 75%
Zone TR2 = TR1 x 66%
Zone TR3 = TR2 x 66%
Zone TR4 = TR3 x 66%
Zone TR …
La dernière Zone de transition doit être au plus 2 fois la Zone intérieur

Zone intérieur = voir table 7

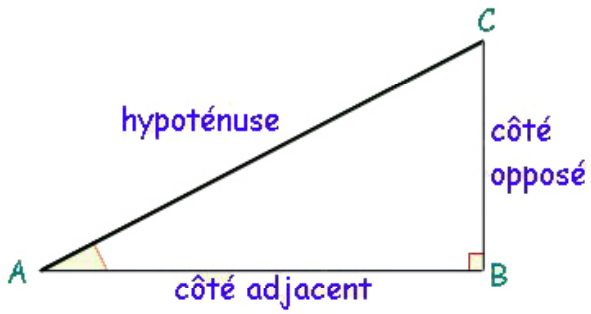


Tunnels

B= distance d'adaptation

B = (La hauteur du tunnel - 1.45m) / tan de 22 ° à 25 ° (0.4663)

Relativement à l'angle au sommet A, nous avons :



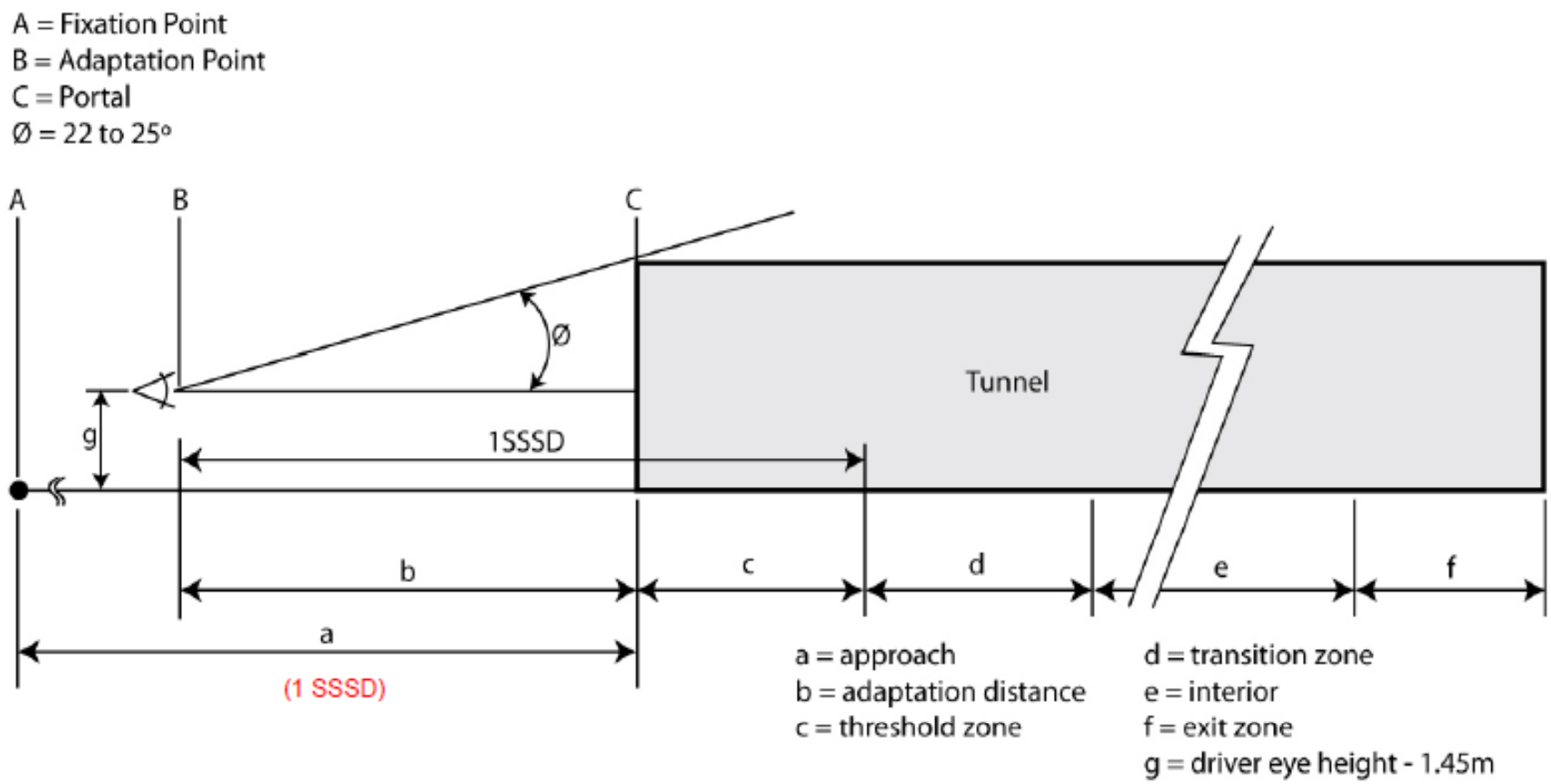
$$\cos(\hat{A}) = \frac{\text{côté adjacent}}{\text{hypoténuse}} = \frac{AB}{AC}$$

$$\sin(\hat{A}) = \frac{\text{côté opposé}}{\text{hypoténuse}} = \frac{BC}{AC}$$

$$\tan(\hat{A}) = \frac{\text{côté opposé}}{\text{côté adjacent}} = \frac{BC}{AB}$$

Tunnels

Terms used to describe tunnel topology are as follows, **see Figure 1**.



Tunnels

Table 1 : AASHTO Stopping Sight Distance (Wet Pavement)							
Stopping Sight Distance Meters (feet) by Percent Grade (%)							
		Downgrade			Upgrade		
Design Speed km/h (mph)	0	3	6	9	3	6	9
35 (20)	35 (115)	35 (116)	40 (120)	40 (126)	35 (109)	35 (107)	35 (104)
40 (25)	50 (155)	50 (158)	50 (165)	55 (173)	45 (147)	45 (143)	45 (140)
50 (30)	60 (200)	65 (205)	65 (215)	70 (227)	60 (200)	60 (184)	55 (179)
60 (35)	80 (250)	80 (257)	85 (271)	90 (287)	75 (237)	70 (229)	70 (222)
65 (40)	95 (305)	95 (315)	100 (333)	110 (354)	90 (289)	85 (278)	80 (269)
75 (45)	110 (360)	115 (378)	120 (400)	130 (427)	105 (344)	100 (331)	100 (320)
80 (50)	130 (425)	135 (446)	145 (474)	155 (507)	125 (405)	120 (388)	115 (375)
90 (55)	150 (495)	160 (520)	170 (553)	180 (593)	145 (469)	140 (450)	135 (433)
100 (60)	175 (570)	185 (598)	195 (638)	210 (686)	165 (538)	160 (515)	150 (495)
105 (65)	200 (645)	210 (682)	220 (728)	240 (785)	190 (612)	180 (584)	170 (561)
115 (70)	225 (730)	235 (771)	250 (825)	275 (891)	210 (690)	200 (658)	195 (631)
120 (75)	250 (920)	265 (866)	285 (927)	305 (1003)	235 (772)	225 (736)	215 (704)

Source: A Policy on Geometric Design of Streets & Highways, AASHTO, Washington DC, 2004. Chapter 3 Elements of Design

The speed and distance columns only correspond to their metric or English equivalent i.e., if determining the SSSD for a posted speed in kilometers per hour, use the value shown in meters,(if using miles per hour, use the value shown for feet).

Tunnels

Table 3 Recommended Daytime Maintained Average Pavement Luminance Levels in the Threshold Zone of Vehicular Tunnels (L_{th})					
Approach Characteristics	Traffic Speed		Driver Direction		
	km/h	mph	North	East-West	South
			cd/m²		
Open Road Scene 1,2,3	100 80 60	60 50 40	250 220 180	310 260 220	370 320 270
Urban Tunnel Scene 4,5,6	100 80 60	60 50 40	320 280 230	280 240 200	310 270 220
Mountain Tunnel Scene 7,8	100 80 60	60 50 40	230 200 170	200 170 140	200 170 140

Linear interpolation is acceptable

Tunnels

Table 2
Adjustment Factors for Pavement Luminance in Threshold (L_{th})
(Adapted from CIE 88 2004, Figure 4.1)

Tunnel Category	Traffic Volume (AADT)	Cyclist	Exit Visible (from 1 SSSD)				Exit Not Visible (from 1 SSSD)			
			Daylight Penetration				Daylight Penetration			
			Good		Poor		Good		Poor	
			Wall Reflectance[1]				Wall Reflectance[1]			
			High	Low	High	Low	High	Low	High	Low
<25M <80FT	All	All	0% (No Threshold Lighting Required)				0% (No Threshold Lighting Required)			
25 – 75M 80 – 250FT	< 15,000	No	0%	50%	50%	50%	50%	50%	100%	100%
		Yes	0%	50%	50%	100%	100%	100%	100%	100%
	> 15,000	No	50%	50%	50%	50%	100%	100%	100%	100%
		Yes	50%	50%	50%	100%	100%	100%	100%	100%
76 – 125M 251 – 410FT	< 15,000	No	50%	50%	50%	50%	50%	100%	100%	100%
		Yes	50%	50%	50%	100%	100%	100%	100%	100%
	> 15,000	No	50%	50%	100%	100%	100%	100%	100%	100%
		Yes	100%	100%	100%	100%	100%	100%	100%	100%
>125M >410FT	All	All	100%				100%			

[1]Low Wall Reflectance < 30%
High Wall Reflectance > 30%

Daylight:

Single direction tunnel: supplemental daytime lighting not needed within 7 meters of the entry portal and 15 meters of the exit portal. Night time lighting is required for the complete length of the tunnel.

Bi-directional tunnel: supplemental daytime lighting is not needed within 7 meters of both the entry and exit portals. Night time lighting is required for the complete length of the tunnel.

Tunnels

Table 7: Recommended Daytime Interior Zone Average Pavement Luminance (in cd/m^2)			
Traffic Speed	Traffic Flow		
	≤ 2,400 AADT	> 2,400 AADT < 24,000 AADT	Heavy ≥ 24000 AADT
100 km/h (60 mph)	6	8	10
80 km/h (50 mph)	4	6	8
60 km/h (40 mph)	3	4	6

"AADT" – Annual Average Daily Traffic

Tunnels

Nighttime Luminance. During nighttime the motorist's eyes are adapted to the low exterior luminance; therefore, a nighttime pavement luminance of 2.5 cd/m^2 minimum average is recommended for the entire length of a divided tunnel (this luminance value has been derived by consensus among experts). However, if the tunnel is undivided with bi-directional traffic, the lighting level should remain at daytime interior levels The approach and exit roadways should have a luminance level of no less than one-third the tunnel interior level for one safe-stopping-sight-distance (SSSD).

Tunnels

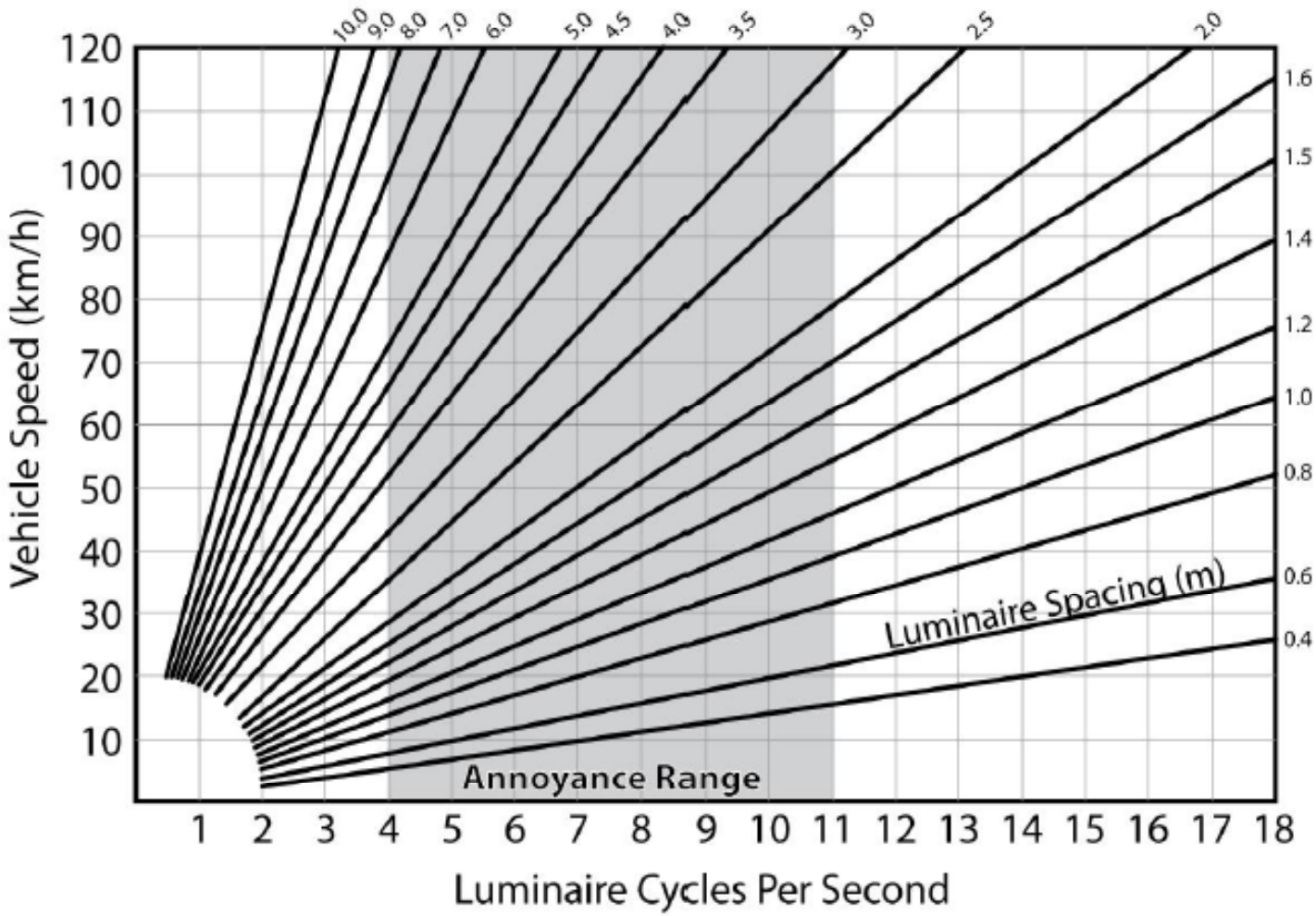


Figure 9. Illustration of the core annoyance zone for Flicker.

Tunnels

Table 8 – Conversion of Average Illuminance to Average Luminance for the Tunnel Wall WE_A X Conversion Factor = WL_A		
WE_A = Illuminance Average Wall (lux)	10% (0.10) Wall Reflectance Conversion Factor = 0.032	WL_A = Luminance Average Wall (cd/m^2)
	20% (0.20) Wall Reflectance Conversion Factor = 0.064	
	30% (0.30) Wall Reflectance Conversion Factor = 0.095	
	40% (0.40) Wall Reflectance Conversion Factor = 0.127	
	50% (0.50) Wall Reflectance Conversion Factor = 0.159	
	60% (0.60) Wall Reflectance Conversion Factor = 0.190	

Some wall Illumination, however, is always necessary. The lower part of the tunnel walls, up 2 meters (6.6 feet) above the roadway shoulder, should have a maximum ratio of 2.5 between the average road luminance and average wall luminance. Due to the limited availability of software to calculate tunnel wall luminance, the average wall illuminance can be calculated and converted to luminance using the formula shown below. The designer can then use the converted value to validate the ratio required. It should be noted, however, that at this period in time, this formula is only effective on diffuse wall surfaces. Materials having a high gloss or specular finishes will exhibit higher luminance than those provided by the formula. Table 8 above provides a breakdown of the conversation factors for known diffuse wall reflectances.

Conversion Formula;

The conversion factor is based on: $\frac{WE_A \cdot \rho}{\pi}$

Where: WE_A = Illuminance Average Wall (lux)

ρ = Wall diffuse reflectance factor (as decimal, not percentage)

Tunnels

Maintenance Considerations	Range of Possible Values
Lamp Lumen Maintenance	0.50 to 0.95
Lamp Burnouts	0.30 to 0.99
Luminaire Dirt Depreciation (LDD)	0.10 to 0.95
Equipment Factors (EF)	0.50 to 0.95
Ambient Temperature	0.20 to 0.99
Voltage	0.87 to 1.13
Ballast & Lamp Factor	0.85 to 0.90
Tunnel Surface Reflectance	0.20 to 0.90
Luminaire Cleaning	0.10 to 0.90
Total Typical Maintenance Factor (TMF)	0.30 to 0.65

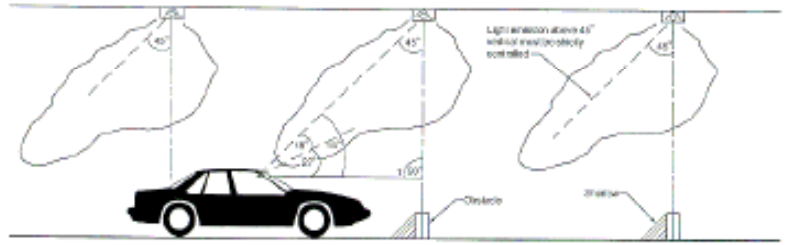
Tunnels

7.1 Symmetrical Light Distribution

Tunnel lighting luminaires are available in many distributions. Typically symmetrical luminaires provide a distribution pattern that is similar in all directions. Symmetrical luminaires also produces a uniform luminance throughout the tunnel

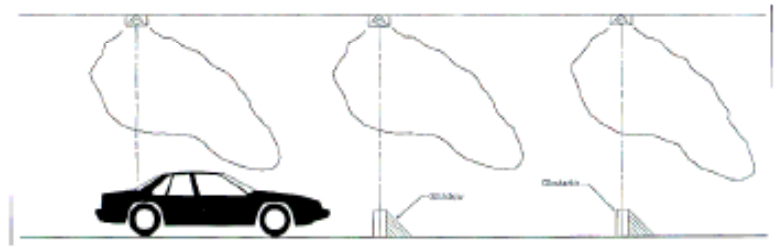
7.2 Asymmetrical Light Distribution - Negative Contrast

The ALD-NC system is also known as Counterbeam Lighting (CBL). The luminaires flux is predominantly distributed toward the driver in a controlled manner reducing glare and providing high pavement luminance and minimized in the direction of travel to create low object luminance and enhance negative contrast.



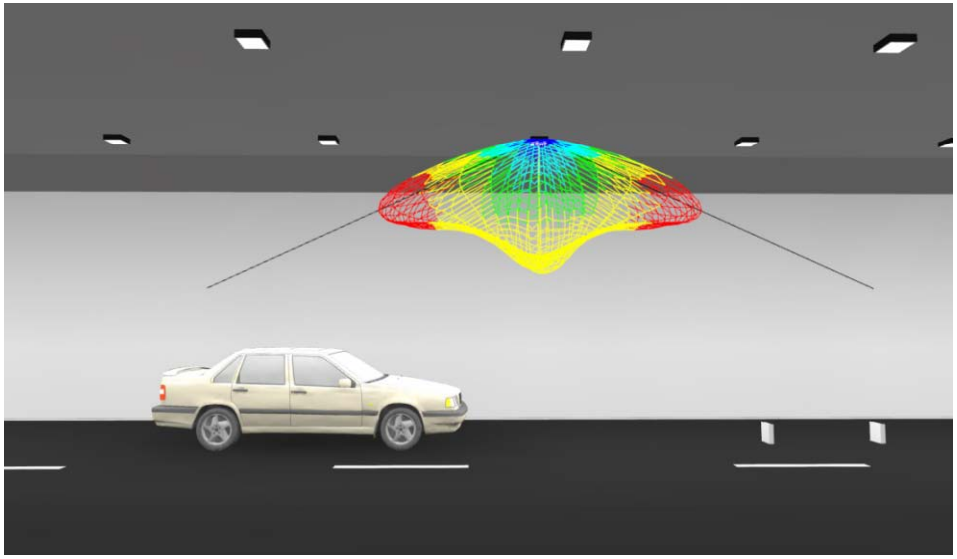
7.3 Asymmetrical Light Distribution - Positive Contrast

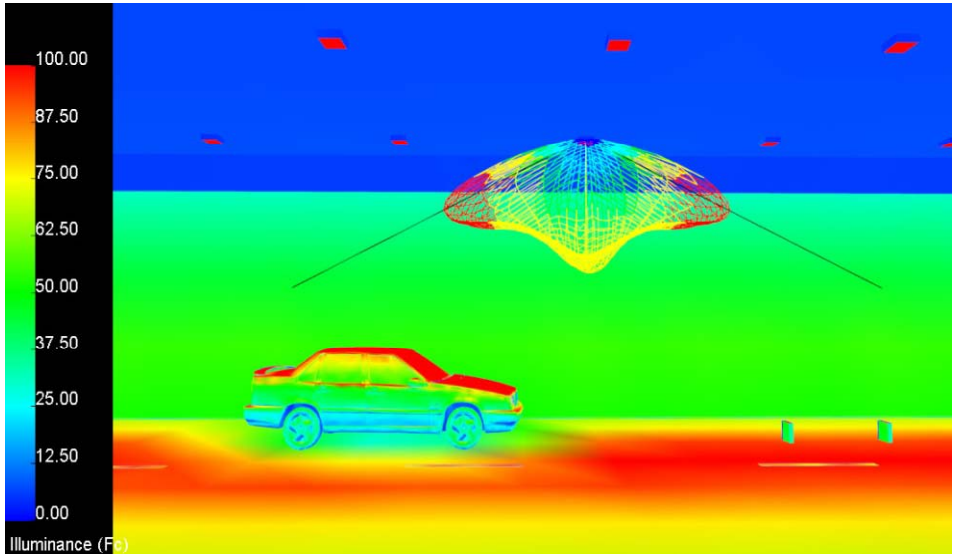
The ALD-PC system, also known as Pro-beam Lighting (PBL), is similar to that of the Counterbeam light application technique except the direction of the main beam of light is in the direction of the traffic flow. This method provides high object luminance and low pavement luminance creating positive contrast.

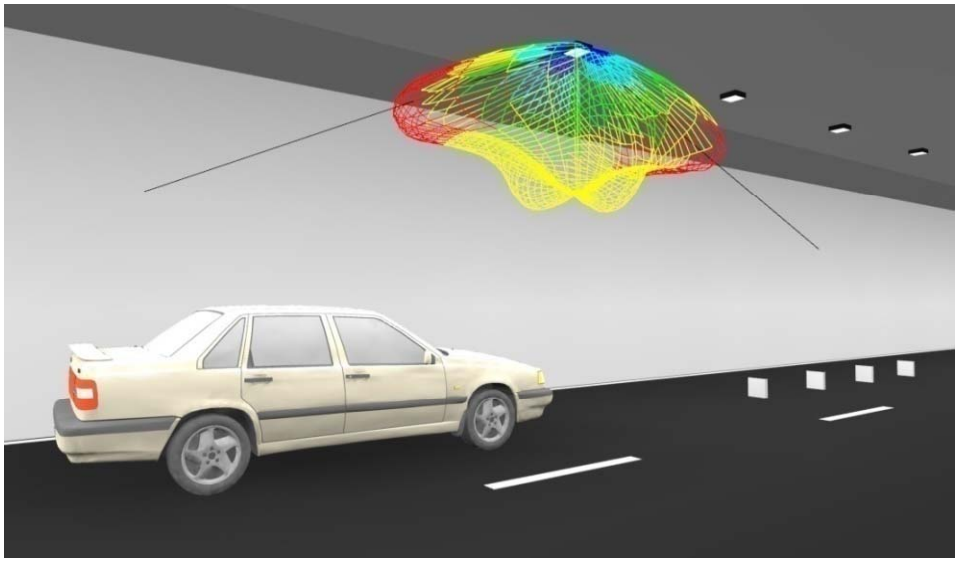


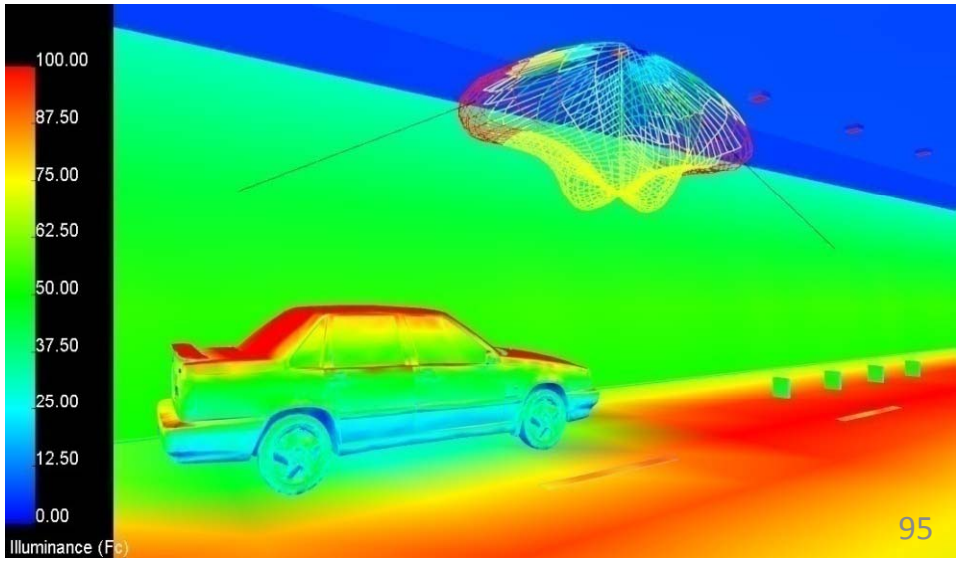
Tunnels

Éclairage symétrique



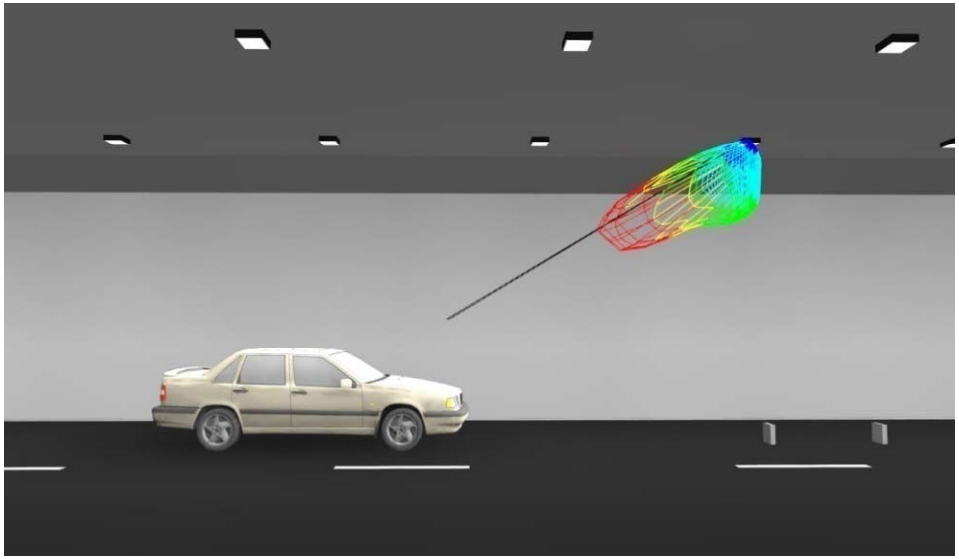


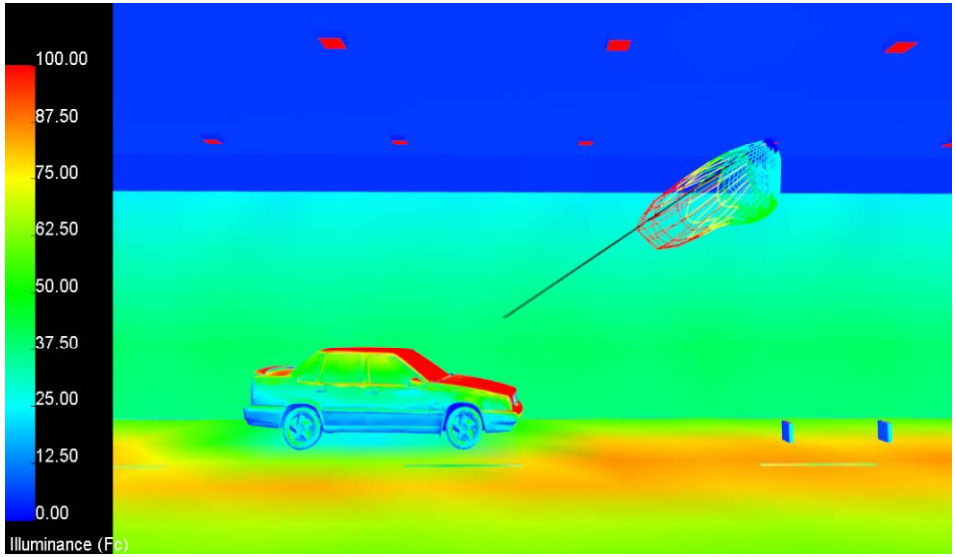


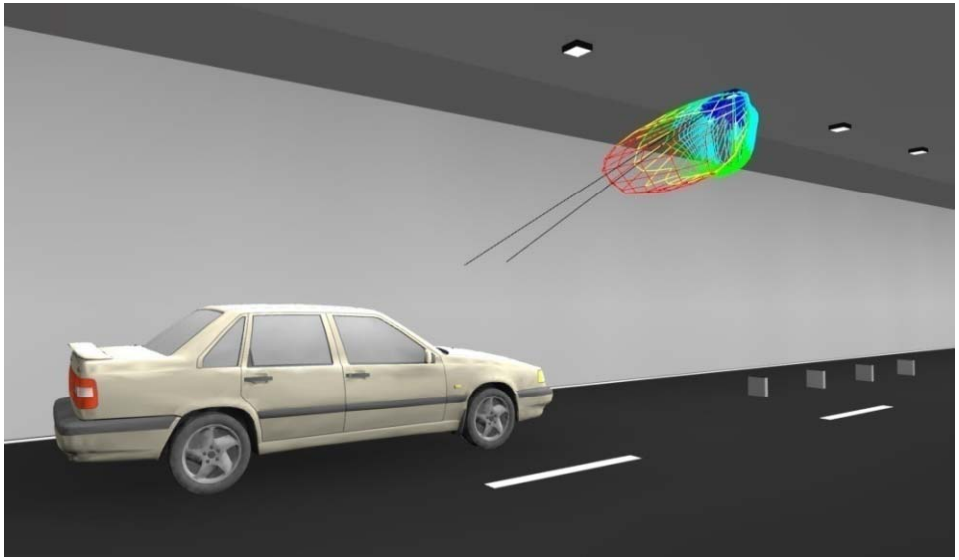


Tunnels

Éclairage asymétrique conterbeam contraste négatif

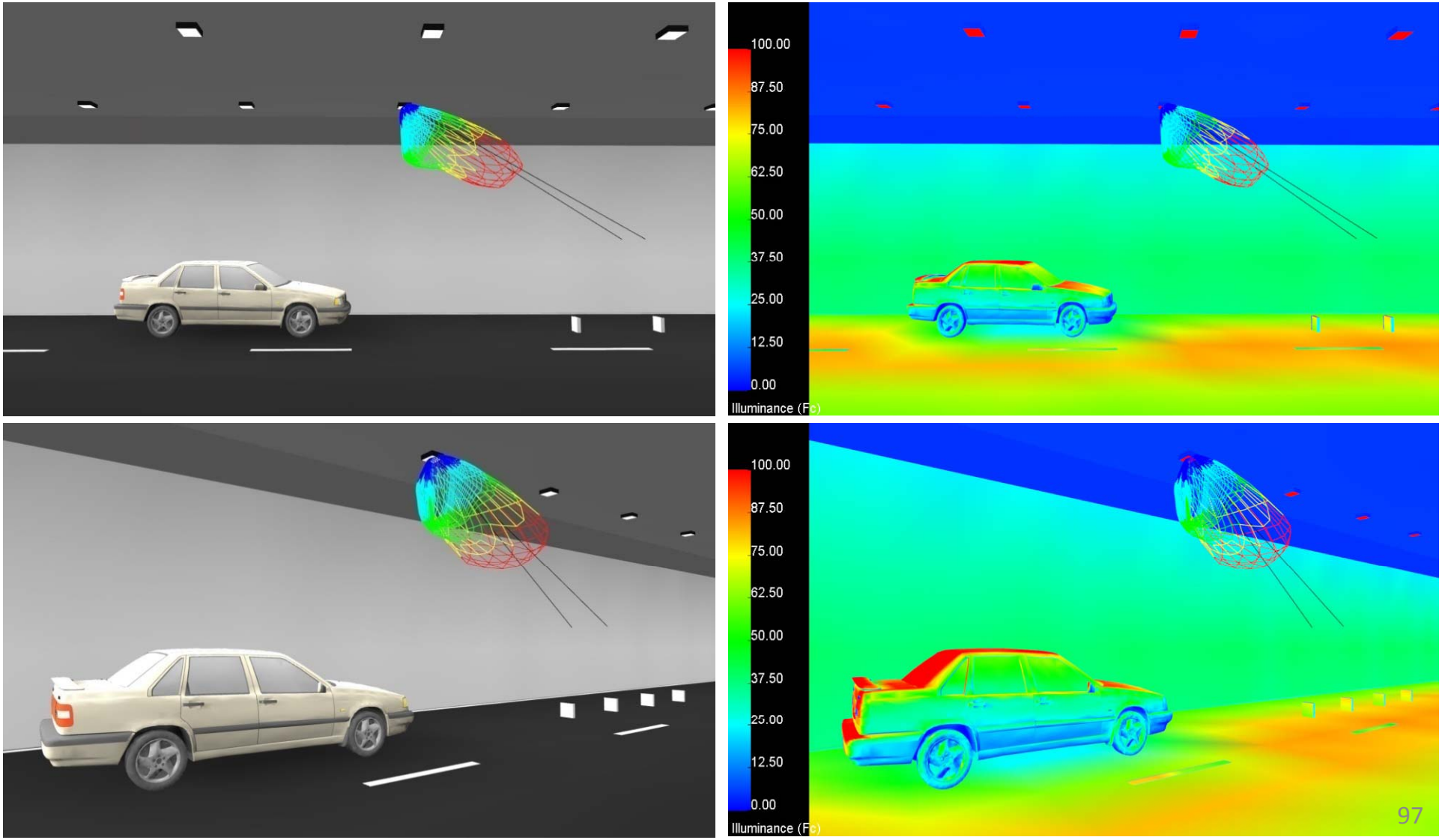




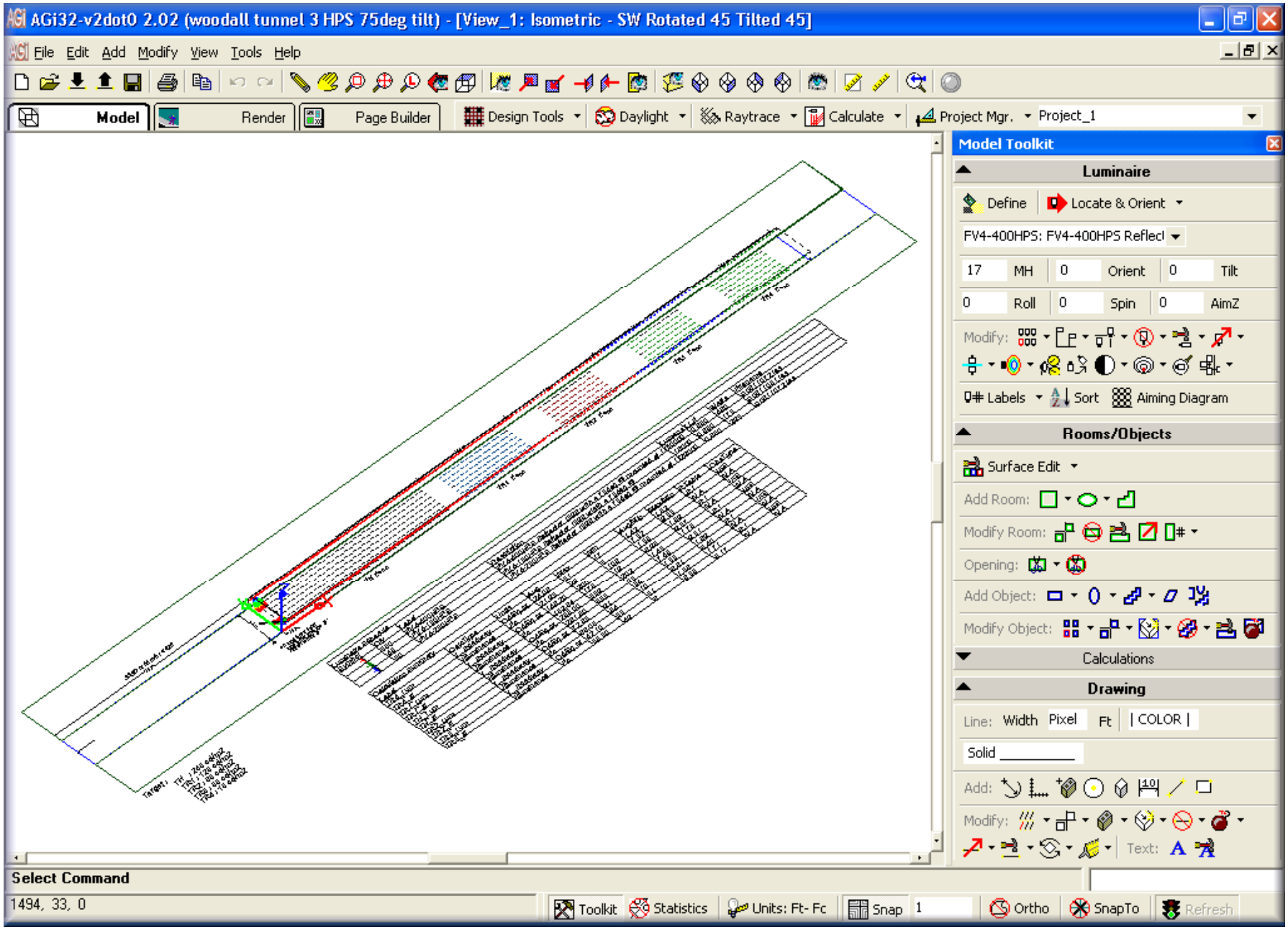


Tunnels

Éclairage asymétrique pro-beam contraste positif



Tunnels


AGi32-v2dot0 2.02 (woodall tunnel 3 HPS 75deg tilt) - [View_1: Isometric - SW Rotated 45 Tilted 45]
File Edit Add Modify View Tools Help
Model
Render
Page Builder
Design Tools
Daylight
Raytrace
Calculate
Project Mgr.
Project_1
Model Toolkit
Luminaire
Define
Locate & Orient
FV4-400HPS: FV4-400HPS Reflect
17 MH 0 Orient 0 Tilt
0 Roll 0 Spin 0 AimZ
Modify:
Labels
Sort
Aiming Diagram
Rooms/Objects
Surface Edit
Add Room:
Modify Room:
Opening:
Add Object:
Modify Object:
Calculations
Drawing
Line: Width Pixel Ft | COLOR |
Solid
Add:
Modify:
Text:
Select Command
1494, 33, 0
Toolkit
Statistics
Units: Ft- Fc
Snap 1
Ortho
SnapTo
Refresh

Tunnels

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