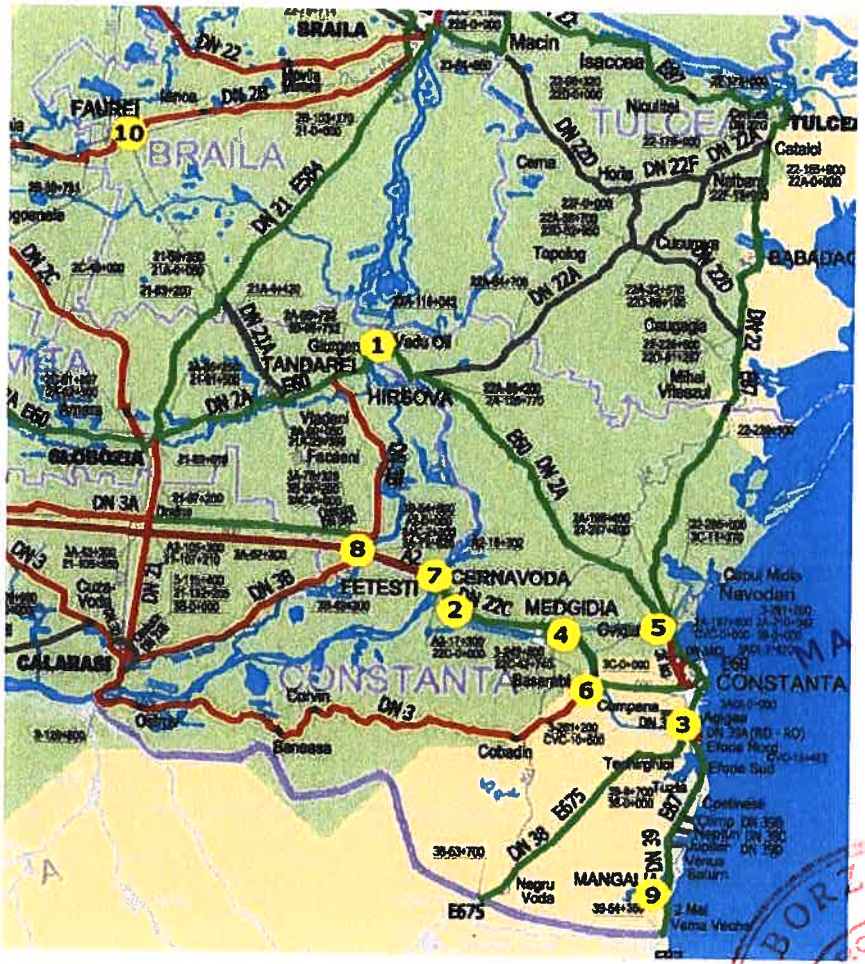
RNCMNR – ROMANIAN NATIONAL COMPANY OF MOTORWAYS AND NATIONAL ROADS

CONSULTING SERVICES FOR DESIGN AND WORKS SUPERVISION OF 10 BRIDGES IN DOBROGEA AREA



Detailed Design

Volumes series 3 – Electrical works

Volume 3.1 – Illumination Technical Report

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Louis Berger Group, Inc.

DESIGNER/ PROIECTANT
LOUIS BERGER Group Inc.

DESIGN TEAM LEADER
Vittorio Ascoli Marchetti

CONSULTANTS
SOLIDUS srl
Francesco Del Tosto
Romano Tucci

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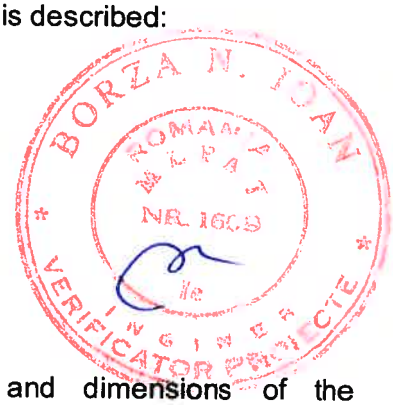
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1 ROADWAY ILLUMINATION SYSTEM

In the present report included in Detailed Design, related to intervention A4 - Electrical Equipment Replacement, the new roadway illumination system concerning the following bridges (located in Romania) is described:

- Bridge B01 – Bridge DN 2A Giurgeni;
- Bridge B02 – Bridge DN 22C Cernavoda;
- Bridge B03 – Bridge DN39 Agiega;
- Bridge B04 – Bridge DN22C Porta Alba;
- Bridge B05 – Bridge DN2A Ovidiu;
- Bridge B06 – Bridge DN3 Basarabi;
- Bridge B07 – Bridge A2 Cernavoda;
- Bridge B08 – Bridge A2 Borcea;
- Bridge B09 – Bridge DN39 Mangalia.



In the following paragraphs the characteristics and dimensions of the components will be indicated as well as the required equipments for the illumination system design.
The rules list and product specifics according to which the design has been developed are mentioned in the present report.

1.1 Performance Basic Characteristics

The main characteristics of this roadway illumination system project can be summarized as follows:

Illuminotechnics Characteristics:

- design velocity: 70km/h;
- stop distance: 80m;
- roadway pavement: ..... C2 (Q0=0.07);
- average luminance with luminaries on the pole:2cd /m² (min);
- maintenance coefficient: ..... 0.8.

General Characteristics:

- colour tonality (UNI EN 13201) external areas: W;
- colour rendering index (UNI EN 13201) external areas: 4;
- bright flux of lamp SAP 250W: 33000lm.
- protection level (IEC 364-1/7) ≥IP55.
- cables type
  main distribution circuit: ..... cables FG7(O)R type 0.6/1kV no fire spread;
  secondary distribution circuit: cables FG7(O)R type 0.6/1kV no fire spread;

1.2 Reference Rules

- **CEI 11-17** Equipment of production, transmission and distribution of electric power – lines in cable;

- **IEC 364-1/7 (CEI 64-8)** "User electrical installations having nominal voltage not in of 1000V alternating current and 1500V direct current";
- **CEI 81-10 (CEI EN 62305-1) (IEC 1024-1)** Protection of the structures against the lightning;
- **UNI EN 13201-1/4** Road illumination;
- **I7-2002** Normative regarding the design and performance of electrical equipments at voltages to 1.000 V a.c. and 1500 V d.c.;
- **I20- 2000** Normative regarding the protection of buildings against lightning bolts;
- **GP-052-2000** Guide for electrical equipments having voltage to 1000 V a.c. and 1500 d.c.
- **I18/1-2001** Normative for the design and the performance of electrical equipments of weak currents adequate to civil and protection buildings
- **NP 061-2002** Normative for the design and the performance of the artificial lighting system;
- **PE 103/92** Instructions for the dimensioning and testing of electro-energetical equipments at mechanical and thermal stress under short-circuit conditions;
- **P 118/99** Normative for fire safety;
- **PE 107/2008** Normative for the design and the performance of electric cable networks;
- **PE 116/94** Normative for tests and measurements of electrical equipments and plants;
- **PE 120/94** Instructions regarding the compensation of reactive power in electric distribution networks and for industrial and similar consumers installations;
- **PE 100/98** Normative for the anti-seism design;
- **SR EN 60617-11-2001** Graphic symbols for circuit diagrams;
- **SR EN 60529-95** Normal protection degrees assured in cases. Classification and methods of tests;
- **SR EN 60439-1** Assemblies of low voltage apparatus;
- **SR CEI 60598-2-22-1992** - Lighting units. Lighting safety units. Special technical conditions;

- **C 56-2002** Normative for the work quality check in buildings and adequate installations
- National Electrical Norms for MV and LV systems
- International Electro technical Standards conforming to Romanian Standards (SR CEI, SR ISO)
- European Standards conforming to Romanian Standards (SR EN)
- Romanian Law No.10/1995 regarding Quality of Construction
- Romanian Law No.9/1996 regarding fire fighting

Other Standards BS, EN.

1.3 General principles of the road illumination vision

Roadway illumination must allow drivers to night circulation with maximum safety and comfort; the purpose is to perceive clearly and precisely locating on time the particular roadway points and possible impediments, if possible without car lamps.
In fact, when roadway illumination is obtained only by car lamps light, the *orientation view* prevails on the *identification view*, which induces the driver to a safety travel false impression. Actually, the vision is reduced and there is a high accident risk.
The safety and fast perception is given by the contrasting objects in the background; this allows the driver to get perception of the following elements (mentioned according to their relevance order):

1) Carriageway and edges limits;
2) sky, including lighting points obtained from visible surface of luminaries and lamps.

The perception of the obstacles is frequently got with by the "silhouette" effect: the obstacle appears as detached as a dark shade on a clear background; since the nature of the obstacle is not previously known, it is desirable to take all the useful provisions so that the contrast is enough. The possibility to perceive this contrast is influenced by:

- average level of the luminance of the road surface;
- uniformity of the luminance;
- illumination of the edges and the outskirts of the road;
- limitation of the dazzle caused by the installation..

The illumination level is an indication of the quantity of light received by the roadway; it is a useful information, but without practical importance for the appreciation of the visual quality of the illumination system. The aspect of the illuminated roadway is more relevant, perceived by the driver on the road; this aspect depends on the quantity of light reflected toward the driver from the different parts of the roadway, or rather from the luminance of his "covering."

1.3.1 Iluminotechnics Requirements of the lighting system

Quantity and quality requirements of this roadway illumination design are indicated in rules UNI EN 13201-1 and UNI EN 13201-2; expressed in terms of level and uniformity of luminance of the roadway surface, illumination of the roadway edges, limitation of the dazzle, optic driving.
Mentioned prescriptions ed represent minimums for dry surfaces; nevertheless, if the system installation satisfies requirements, the circulation safety results reasonably satisfactory also in rain conditions.
The required performances, are the following:

Table 1: Lighting system minimal requirements:

Requisite	Value
Average Luminance (L_m)	1.5÷2 cd/m^2
Uniformity Relationships:	
$U_0 = L_{min}/L_m$ (relationship between minimum luminance e average luminance on the whole roadway)	≥ 0.4
$U_l = L_{min}/L_{max}$ (relationship between minimum luminance e maximum luminance long a lane axis)	≥ 0.5÷0.7
Dazzle limitation:	
G (dazzle index)	≥ 5
TI (debilitating dazzle index)	≤ 10

The roadway illumination system has to satisfy, besides, the visual driving demands, widely determined by the disposition of the bright centers, from their geometric succession, from their bright intensity and from the colour of the issued light; so that such demands are satisfied, every discontinuity of the system that is not the consequence of singular points will be avoided, for which it will be necessary to recall the drivers' attention.
Finally, in the calculation it has been considered a maintenance factor equal to 0.8, for taking into account the reduction of the lamps emitted flux and the dirt on the luminaries, that reduces it performances.

1.3.2 Bridge n.01- Roadway Characteristics

The road is bidirectional and it consists on a roadway with double sense of traffic, with two lanes for each direction, each one 3.45m wide and with two sidewalks 1.60m wide on bridge and 1,45m wide on viaducts.
Road-decks are usually divided into two classes, named C1 and C2; in lack of the knowledge of the global parameters, a typical indication of the distribution of the luminance coefficients can be gotten associating the class C1 to the concrete surfaces and the class C2 to those in asphalt; in our case, having asphalt surfaces, will be considered a road deck of C2 class, characterized by an average coefficient of luminance Q_0 equal to 0.07.

1.3.3 *Bridge n.02- Roadway Characteristics*

The road is bidirectional and it consists on a roadway with double sense of traffic, with one 3.90m wide lane for each direction and with two 1.90m wide sidewalks.
Road-decks are usually divided into two classes, named C1 and C2; in lack of the knowledge of the global parameters, a typical indication of the distribution of the luminance coefficients can be gotten associating the class C1 to the concrete surfaces and the class C2 to those in asphalt; in our case, having asphalt surfaces, will be considered a road deck of C2 class, characterized by an average coefficient of luminance Q_0 equal to 0.07.

1.3.4 *Bridge n.03- Roadway Characteristics*

The road is bidirectional and it consists on a roadway with double sense of traffic, with two lanes for each direction, each one 3.70m wide and with two 1.50m wide sidewalks.
Road-decks are usually divided into two classes, named C1 and C2; in lack of the knowledge of the global parameters, a typical indication of the distribution of the luminance coefficients can be gotten associating the class C1 to the concrete surfaces and the class C2 to those in asphalt; in our case, having asphalt surfaces, will be considered a road deck of C2 class, characterized by an average coefficient of luminance Q_0 equal to 0.07.

1.3.5 *Bridge n.04- Roadway Characteristics*

The road is bidirectional and it consists on a roadway with double sense of traffic, with two lanes for each direction, each one 3.50m wide and with two sidewalks 3.90m wide on bridge and 1,90m wide on viaducts.
Road decks are usually divided into two classes, named C1 and C2; in lack of the knowledge of the global parameters, a typical indication of the distribution of the luminance coefficients can be gotten associating the class C1 to the concrete surfaces and the class C2 to those in asphalt; in our case, having asphalt surfaces, will be considered a road deck of C2 class, characterized by an average coefficient of luminance Q_0 equal to 0.07.

1.3.6 *Bridge n.05- Roadway Characteristics*

The road is bidirectional and it consists on a roadway with double sense of traffic, with two lanes for each direction, each one 3.50m wide and with two sidewalks 3.90m wide on bridge and 1,90m wide on viaducts.
Road decks are usually divided into two classes, named C1 and C2; in lack of the knowledge of the global parameters, a typical indication of the distribution of the luminance coefficients can be gotten associating the class C1 to the concrete surfaces and the class C2 to those in asphalt; in our case, having asphalt surfaces, will be considered a road deck of C2 class, characterized by an average coefficient of luminance Q_0 equal to 0.07.

1.3.7 *Bridge n.06- Roadway Characteristics*

The road is bidirectional and it consists on a roadway with double sense of traffic, with one lane 3.90m wide for each direction and with two sidewalks 2.90m wide on bridge and 1,50m wide on viaducts.
Road decks are usually divided into two classes, named C1 and C2; in lack of the knowledge of the global parameters, a typical indication of the distribution of the luminance coefficients can be gotten associating the class C1 to the concrete surfaces and the class C2 to those in asphalt; in our case, having asphalt surfaces, will be considered a road deck of C2 class, characterized by an average coefficient of luminance Q_0 equal to 0.07.

1.3.8 *Bridge n.07- Roadway Characteristics*

The road is bidirectional and it consists on two roadways each one with one sense of traffic, with two lanes for each direction, each one 4.25m wide and with two sidewalks 1.50m wide.
Road decks are usually divided into two classes, named C1 and C2; in lack of the knowledge of the global parameters, a typical indication of the distribution of the luminance coefficients can be gotten associating the class C1 to the concrete surfaces and the class C2 to those in asphalt; in our case, having asphalt surfaces, will be considered a road deck of C2 class, characterized by an average coefficient of luminance Q_0 equal to 0.07.

1.3.9 *Bridge n.08- Roadway Characteristics*

The road is bidirectional and it consists on two roadways each one with one sense of traffic, with two lanes for each direction, each one 4.25m wide and with two sidewalks 1.50m wide.
Road decks are usually divided into two classes, named C1 and C2; in lack of the knowledge of the global parameters, a typical indication of the distribution of the luminance coefficients can be gotten associating the class C1 to the concrete surfaces and the class C2 to those in asphalt; in our case, having asphalt surfaces, will be considered a road deck of C2 class, characterized by an average coefficient of luminance Q_0 equal to 0.07.

1.3.10 *Bridge n.09- Roadway Characteristics*

The road is bidirectional and it consist on a roadway with double sense of traffic, with two lanes for each direction, each one 3.70m wide and with two sidewalks 2.00m wide.
Road decks are usually divided into two classes, named C1 and C2; in lack of the knowledge of the global parameters, a typical indication of the distribution of the luminance coefficients can be gotten associating the class C1 to the concrete surfaces and the class C2 to those in asphalt; in our case, having asphalt surfaces, will be considered a road deck of C2 class, characterized by an average coefficient of luminance Q_0 equal to 0.07.

1.4 Bridge n.1 – Roadway Illumination System

1.4.1 Roadway Illumination

The developed design includes the installation of roadway luminaries with lamps SAP with 250W power fixed on lighting pole at 14 m height above ground level with a 2m bracket, on right and left sides of the roadway, in correspondence of the edge of the bridge.
The lighting system has been designed in order to furnish a average luminance of 2cd/m² on the roadway plan. The installation, will be controlled by a crepuscular switch appropriately placed.
The roadway illumination system of the Bridge n.1 includes the installation of:

- # 74 luminaries installed on poles of height h=14m a.g.l. with a simple bracket of two meters and with high pressure sodium vapour lamps of 250W power, located as illustrated in design drawings.

The electric distribution circuit will be derived from the electric panels Q1.B01 and Q2.B01, as indicated in design drawings.
Following are indicated:

- Input data for design calculation;
- criterions that have conduct to the effected choices;
- system and components description.

1.4.2 Input Data

The power of the circuits supplied has been obtained on the base of the illuminotechnics calculation indications;
The necessary total power is equal to: 11kW (cosφ=0,9) as it is deduced by Table 2.

Table 2: Summary of assorb power

Bridge number	Lamps Power [W] / *Overall Power [kW]*	Interdistance [m]	Lamps Number	Optic
Bridge n.1	250 / 11	46.00	74	STR

1.5 Bridge n.2 – Roadway Illumination System

1.5.1 Roadway Illumination

The developed design includes the installation of roadway luminaries with lamps SAP with 250W power fixed on lighting pole at 12 m height above ground level with a 2m bracket, on right and left sides of the roadway, in correspondence of the edge of the bridge.
The lighting system has been designed in order to furnish a average luminance of 2cd/m² on the roadway plan. The installation, will be controlled by a crepuscular switch appropriately placed.
The roadway illumination system of the Bridge n.2 contain the installation of:

- # 32 luminaries installed on poles of height h=12m a.g.l. with a simple bracket of two meters and with high pressure sodium vapour lamps of 250W power, located as illustrated in design drawings.

The electric distribution circuit will be derived from the electric panel Q1.B02, as indicated in design drawings.
Please find below:

- Input data for design calculation;
- criterions that have conduct to the effected choices;
- system and components description.

1.5.2 Input Data

The power of the circuits supplied has been obtained on the basis of the illuminotechnics calculation indications;
The necessary total power is equal to: 9.2kW (cosφ=0,9) as it is deduced by Table 3.

Table 3: Summary of assorb power

Bridge number	Lamps Power [W] / *Overall Power [kW]*	Interdistance [m]	Lamps Number	Optic
Bridge n.2	250 / *9.2*	41.00	32	STR

1.6 Bridge n.3 – Roadway Illumination System

1.6.1 Roadway Illumination

The developed design includes the installation of roadway luminaries with lamps SAP with 250W power fixed on lighting pole at 12 m height above ground level with a 2m bracket, on right and left sides of the roadway, in correspondence of the edge of the bridge.
The lighting system has been designed in order to furnish an average luminance of 2cd/m² on the roadway plan. The installation, will be controlled by a crepuscular switch appropriately placed.
The roadway illumination system of the Bridge n.3 includes the installation of:

- # 16 luminaries installed on poles of height h=12m a.g.l. with a simple bracket of two meters and with high pressure sodium vapour lamps of 250W power, located as illustrated in design drawings.

The electric distribution circuit will be derived from the electric panel Q1.B03, as indicated in design drawings.
Please find below:

- Input data for design calculation;
- criterions that have conduct to the effected choices;
- system and components description.

1.6.2 Input Data

The power of the circuits supplied has been obtained on the basis of illuminotechnics calculation indications;
The necessary total power is equal to: 4.6kW (cosφ=0,9) as it is deduced by Table 4.

Table 4: Summary of assorb power

Bridge number	Lamps Power [W] / *Overall Power [kW]*	Interdistance [m]	Lamps Number	Optic
Bridge n.3	250 / *4.6*	40.00	16	STR

1.7 Bridge n.4 – Roadway Illumination System

1.7.1 Roadway Illumination

The developed design includes the installation of roadway luminaries with lamps SAP with 250W power fixed on lighting pole at 12 m height above ground level with a 2m bracket, on right and left sides of the roadway, in correspondence of the edge of the bridge.
The lighting system has been designed in order to furnish an average luminance of 2cd/m² on the roadway plan. The installation, will be controlled by a crepuscular switch appropriately placed.
The roadway illumination system of the Bridge n.4 includes the installation of:

- # 16 luminaries installed on poles of height h=12m a.g.l. with a simple bracket of two meters and with high pressure sodium vapour lamps of 250W power, located as illustrated in design drawings.

The electric distribution circuit will be derived from the electric panel Q1.B04, as indicated in design drawings.
Please find below:

- Input data for design calculation;
- criterions that have conduct to the effected choices;
- system and components description.

1.7.2 Input Data

The power of the circuits supplied has been obtained on the basis of the illuminotechnics calculation indications;
The necessary total power is equal to: 4.6kW (cosφ=0,9) as it is deduced by Table 5.

Table 5: Summary of assorb power

Bridge number	Lamps Power [W] / *Overall Power [kW]*	Interdistance [m]	Lamps Number	Optic
Bridge n.4	250 / *4.6*	37.00	16	STR

1.8 Bridge n.5 – Roadway Illumination System

1.8.1 Roadway Illumination

The developed design includes the installation of roadway luminaries with lamps SAP with 250W power fixed on lighting pole at 12 m height above ground level

with a 2m bracket, on right and left sides of the roadway, in correspondence of the edge of the bridge.
The lighting system has been designed in order to furnish an average luminance of 2cd/m² on the roadway plan. The installation, will be controlled by a crepuscular switch appropriately placed.
The roadway illumination system of Bridge n.5 includes the installation of:

- # 18 luminaries installed on poles of height h=12m a.g.l. with a simple bracket of two meters and with high pressure sodium vapour lamps of 250W power, located as illustrated in design drawings.

The electric distribution circuit will be derived from the electric panel Q1.B05, as indicated in design drawings.
Please find below:

- Input data for design calculation;
- criterions that have conduct to the effected choices;
- system and components description.

1.8.2 *Input Data*

The power of the circuits supplied has been obtained on the base of the illuminotechnics calculation indications;
The necessary total power is equal to: 5.2kW (cosφ=0,9) as it is deduced by Table 6.

Table 6: Summary of assorb power

Bridge number	Lamps Power [W] / *Overall Power [kW]*	Interdistance [m]	Lamps Number	Optic
Bridge n.5	250 / *5.2*	37.00	18	STR

1.9 Bridge n.6 – Roadway Illumination System

1.9.1 *Roadway Illumination*

The developed design includes the installation of roadway luminaries with lamps SAP with 250W power fixed on lighting pole at 12 m height above ground level with a 2m bracket, on right and left sides of the roadway, in correspondence of the edge of the bridge.
The lighting system has been designed in order to furnish an average luminance of 2cd/m² on the roadway plan. The installation, will be controlled by a crepuscular switch appropriately placed.
The roadway illumination system of the Bridge n.6 contain the installation of:

- # 18 luminaries installed on poles of height h=12m a.g.l. with a simple bracket of two meters and with high pressure sodium vapour lamps of 250W power, located as illustrated in design drawings.

The electric distribution circuit will be derived from the electric panel Q1.B06, as indicated in design drawings.
Following are indicated:

- Input data for design calculation;

- criterions that have conduct to the effected choices;
- system and components description.

1.9.2 Input Data

The power of the circuits supplied has been obtained on the basis of the illuminotechnics calculation indications;
The necessary total power is equal to: 5.2kW (cosφ=0,9) as it is deduced by Table 7.

Table 7: Summary of assorb power

Bridge number	Lamps Power [W] / *Overall Power [kW]*	Interdistance [m]	Lamps Number	Optic
Bridge n.6	250 / *5.2*	30.00	18	STR

1.10 Bridge n.7 – Roadway Illumination System

1.10.1 Roadway Illumination

The developed design includes the installation of roadway luminaries with lamps SAP with 250W power fixed on lighting pole at 12 m height above ground level with a 2m bracket, on right and left sides of the roadway, in correspondence of the edge of the bridge.
The lighting system has been designed in order to furnish an average luminance of 2cd/m² on the roadway plan. The installation, will be controlled by a crepuscular switch appropriately placed.
The roadway illumination system of the Bridge n.7 contain the installation of:

- # 104 luminaries installed on poles of height h=12m a.g.l. with a simple bracket of two meters and with high pressure sodium vapour lamps of 250W power, located as illustrated in design drawings.

The electric distribution circuit will be derived from the electric panels Q1.B07, Q2.B07 and Q3.B07, as indicated in design drawings.
Please find below:

- Input data for design calculation;
- criterions that have conduct to the effected choices;
- system and components description.

1.10.2 Input Data

The power of the circuits supplied has been obtained on the basis of the illuminotechnics calculation indications;
The necessary total power is equal to: 30 kW (cosφ=0,9) as it is deduced by Table 8.

Table 8: Summary of assorb power

Bridge number	Lamps Power [W] / *Overall Power [kW]*	Interdistance [m]	Lamps Number	Optic
Bridge n.7	250 / *30*	32.00	104	STR

1.11 Bridge n.8 – Roadway Illumination System

1.11.1 Roadway Illumination

The developed design includes the installation of roadway luminaries with lamps SAP with 250W power fixed on lighting pole at 12 m height above ground level with a 2m bracket, on right and left sides of the roadway, in correspondence of the edge of the bridge.
The lighting system has been designed in order to furnish an average luminance of 2cd/m² on the roadway plan. The installation, will be controlled by a crepuscular switch appropriately placed.
The roadway illumination system of the Bridge n.8 contain the installation of:

- # 68 luminaries installed on poles of height h=12m a.g.l. with a simple bracket of two meters and with high pressure sodium vapour lamps of 250W power, located as illustrated in design drawings.

The electric distribution circuit will be derived from the electric panels Q1.B08, Q2.B08, Q3.B08 and Q4.B08, as indicated in design drawings.
Please find below:

- Input data for design calculation;
- criterions that have conduct to the effected choices;
- system and components description.

1.11.2 Input Data

The power of the circuits supplied has been obtained on the basis of the illuminotechnics calculation indications;
The necessary total power is equal to: 19.2 kW (cosφ=0,9) as it is deduced by Table 9.

Table 9: Summary of assorb power

Bridge number	Lamps Power [W] / *Overall Power [kW]*	Interdistance [m]	Lamps Number	Optic
Bridge n.8	250 / *19.2*	30.00	68	STR

1.12 Bridge n.9 – Roadway Illumination System

1.12.1 Roadway Illumination

The developed design includes the installation of roadway luminaries with lamps SAP with 250W power fixed on lighting pole at 12 m height above ground level with a 2m bracket, on right and left sides of the roadway, in correspondence of the edge of the bridge.

The lighting system has been designed in order to furnish an average luminance of 2cd/m² on the roadway plan. The installation, will be controlled by a crepuscular switch appropriately placed.
The roadway illumination system of the Bridge n.9 contain the installation of:

- # 26 luminaries installed on poles of height h=12m a.g.l. with a simple bracket of two meters and with high pressure sodium vapour lamps of 250W power, located as illustrated in design drawings.

The electric distribution circuit will be derived from the electric panels Q1.B09, as indicated in design drawings.
Please fimd below:

- Input data for design calculation;
- criterions that have conduct to the effected choices;
- system and components description.

1.12.2 Input data

The power of the circuits supplied has been obtained on the basis of the illuminotechnics calculation indications;
The necessary total power is equal to: 7.6 kW (cosφ=0,9) as it is deduced by Table 10.

Table 10: Summary of assorb power

Bridge number	Lamps Power [W] / *Overall Power [kW]*	Interdistance [m]	Lamps Number	Optic
Bridge n.9	250 / *7.6*	35.00	26	STR

1.13 Electric Power Supply System

The necessary electric power to the operation of the system to supply the road lines in project will be derived from the local net and it will be set avaible from the Arrival Electric Agency with tension of 400V and frequency of 50Hz.
It will be provided the realization of a LT net for supply the illuminating equipments positioned on each one of the nine bridges in project, with different typologies of installation, according to the works related to every intervention.

2 EXTERIOR ARCHITECTONIC ILLUMINATION

The exterior architectonic illumination system design is referred to bridges 3, 4, 5 and 6 and is inserted in a wide program of maintenance and replacement of the existing electrical equipment.
The adopted solution synthesizes a series of design decisions contemplated to:
. reduce or cancel the diurnal visual impact;
. allow an energetic saving, measured on the efficiency of the bright sources and on the performance of the illuminating elements;
. allow an analogous energetic saving based on the cost of using the general system;
. allow a correct and precise vision of the tonalities of color adjusted to the chromatic characteristics of the structures and the particular architectural and environmental context;
. guarantee the balancing of the contrasts of luminance for the achievement of the visual comfort;
. don't produce bright pollution.

Such solution, has been conceived for allowing a best night vision of the bridges the outside guaranteeing a renewed visual perception and availability of the immediately adjacent spaces.

2.1 Methodology

The adopted operational procedure has been characterized by a first phase of analysis, during which the following activities have been affected:
. survey of the actual state;
. individualization of some particular aspects of the site;
. creation of a model calculator by means of a software that contemplates the photometric characteristics of the illuminating elements.

2.2 Priority

Individualizing and recognizing, in the bridges structure, a value of architectural emergency may turn the light into an instrument to reach the following goals:
. maintain the historical memory of these important structures;
. highlight in an appropriate way the remarkable importance that they have, also related to the surrounding environment that doesn't have the same importance;
. highlight the presence of the structures, underlining main architectural aspects, as a didactic reference.

The exterior architectonical illumination system coexists with the roadway illumination system to which is submitted to guarantee the correct visual perception and the safety on the roadway axis, assuming however a role functional in comparison to the illumination of the architecture.

The common characteristic of all interventions is the use of elements of small dimensions that, exploiting the Led technology, make both the advantage of a void diurnal visual impact and the advantage of a reduced or in existing maintenance coexist.
Particularly these are used for an illumination located where the maintenance results more difficult.
In addition, is expected the use of illuminating elements that exploit high colour rendering bright sources, with the new ceramic technology of metallic halogen lamps (colour rendering index CRI of 80 and colour temperature of 3000°K), to get, also because of the reduced dimensions of the burners, an elevated control of the light from the optics. This type of illuminated elements is used for the illumination of the structures of large dimensions and it is prepared in the points of easiest accessibility.

The definition of the elements typology used, the position and the employed powers is indicated on design drawings.

2.3 Architectural Lighting Systems:

2.3.1 Bridge n.3



Figure 1: Bridge n.3

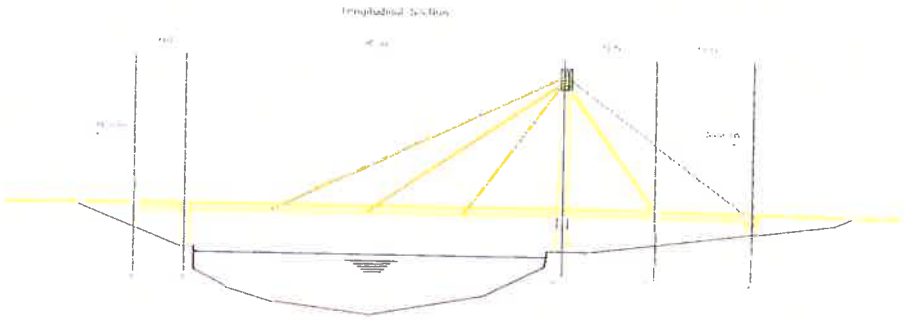


Figure 2: Longitudinal section of Bridge n.3

Particular Aspects

First of all it is necessary to highlight that the stay-cable bridge is characterized by a strong dimensional contrast with the neighbouring environment. The head of the pier apart from being the most important structural point is also the tallest part and of large visibility.

Finishings and Materials Analysis

The tower leg structure is entirely in concrete and has very large dimensions, introducing therefore a strong visual impact, especially for what concerns the gantries set on the head and the stay-cables. The diurnal light, on the other way, doesn't stress the vision because of the effect of great diffusion. The proposed illumination allows to underline the structure at least at night.
These elements have surely been considered and they are a valid starting point to conceive the illumination of this bridge.

2.3.2 *Bridge n.4 e n.5*



Figure 3: Bridge n.4

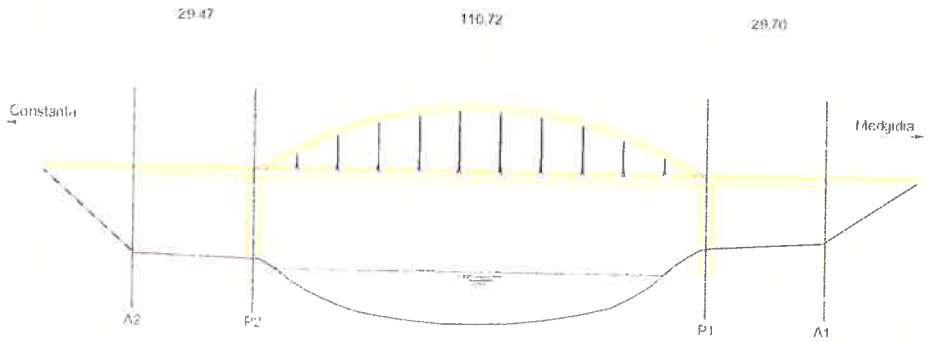


Figure 4: Longitudinal Section of Bridge n.4

Particular Aspects

The prosecution of the intervention regards bridges n.4 and n.5; the illumination project aims at putting in evidence the architectural characteristic of the bridges exalting their structural elements.
Unlike the bridge n.3, the architectural structures are represented by arch bridges with separate archs.

Finishings and Materials Analysis

The typology of the structure is completely different from the previous, the bright scenography aims at exalting the steel archs and the steel connecting rods.
The first are illuminated for projection from the outside of the bridge whereas, for every connecting rod, the use of two micro projectors Led is required, longitudinally placed, as illustrated by the design drawings.
Also in this case, a particular evidence is to be given to the deck.

2.3.3 *Bridge n.6*



Figure 5: Bridge n.6

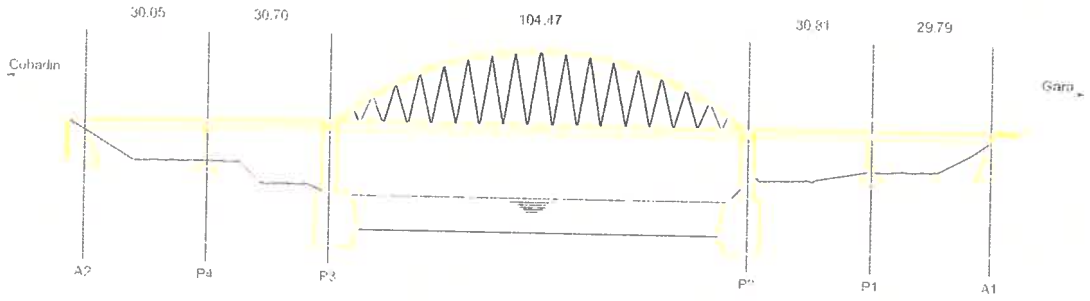


Figure 6: Longitudinal Section of Bridge n.6

Particular Aspects

The intervention is closed by the illumination of bridge n.6. The structure is similar to that of bridges n.4 and n.5 but archs introduce a point of tangency to the height and the connecting rods are crossed.

Finishings and Materials Analysis

Also for this bridge the structure and the connecting rods are made of steel; as for other bridges, the arch is underlined by the use of projectors positioned towards the outside whereas the use of a projector Led toward the outside of the bridge is required for every connecting rod on the arch in order to exalt the inclination of the connecting rod.

2.4 Proposed Illuminotechnics Solutions

2.4.1 *Bridge # 3 – Exterior Architectonic Lighting System*



The exterior architectonic illumination system design of bridge n.3, develops from the tower leg head and is meant to underline the deck suspension through the stay-cables. Particular prominence is also given to the longitudinal profile of the same deck.
The bright scenography underlines the suspension of the bridge against the underlying context.
What emerged from the above described analysis is that the direction bright for this important architectural episode can be performed employing a technique of projection devoted to illuminate the tower legs downward around four sides, conferring to the structure a good level of uniformity and containing the luminance

levels, especially in the lower part, avoiding problems related to the bright pollution. The deck is evidenced by projectors put among the support piers returning dynamism to the profile in a longitudinal sense. The stay-cables are illuminated downward from the tower legs head, getting the double effect to evidence the head of the tower legs and show the dynamism of the stay-cables.
The intervention of illumination proposed wants to underline the forms and the volumes of the bridge, whereas they change direction or where live edges exist; this highlighting is profit to produce clear and marked shades that emphasize the structure and give thickness and depth to the complex.
The non-uniformity, in some zones, is intentionally realized in order to increase *pathos* and not to incur into the visual levelling; the uniformity on the plain surfaces is instead a way to underline the big structural mass that is risen as a compact vertical barrier.

2.4.2 *Bridge # 4-5 – Exterior Architectonic Lighting System*



The light, that comes down from the archs and highlight the connecting rods, has the purpose to redefine, in depth, the architectural plot, creating thin shades that exalt the structural elements.
The illumination by projecting the archs themselves has the assignment to exalt them and to underline them against the context.
The inferior level of the bridges is not illuminated in a direct way, exalting the only deck in order to allow the inquiring and curious eye of a simple passer-by to be attracted to explore the space.

2.4.3 *Bridge # 6 – Exterior Architectonic Lighting System*

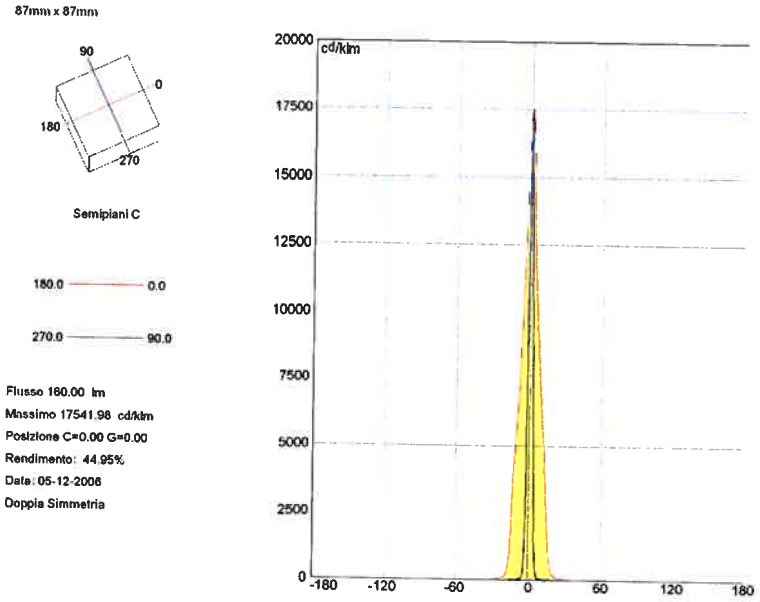


The study of the light for this structure repeats the ideology used for the bridges #4 and #5. In this case, the light that comes down from the archs and highlights the connecting rods has the further purpose to underline the structural elements junction in correspondence of the arch.
Also in this case the illumination by projecting the archs themselves has the assignment to exalt them and to underline them against the context.
The inferior level of the bridges is not illuminated in a direct way, exalting the only deck to allow the inquiring and curious eye of a simple passer-by to be attracted to explore the space.

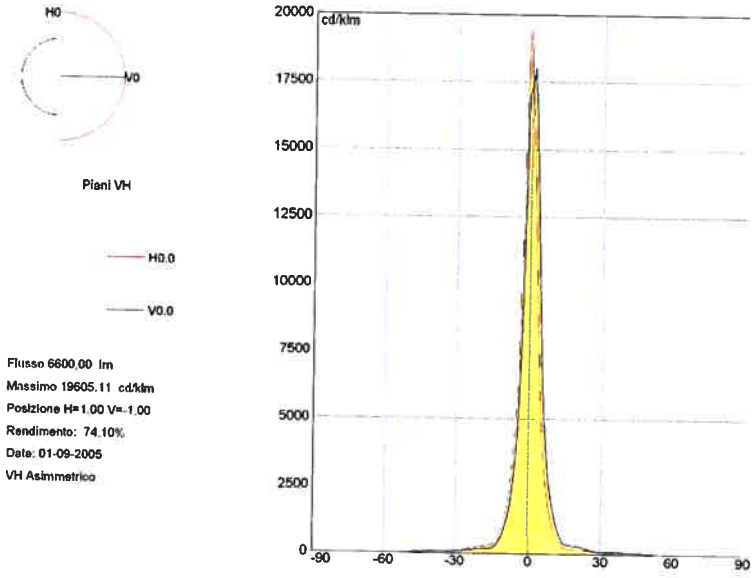
2.5 Illuminating Elements Photometric Characteristics

The illuminotechnic study has been based on optic elements in commerce. This doesn't impose the contractor to the employment of elements specified by builders, the main point is that the luminance, illuminating and uniformity distributions are those indicated in the illuminotechnic study.
The use of elements in conformity with technical specifications and with optics with different characteristics, even if with the same results, impose the contractor to the execution of the illuminotechnic study as the present.
Please find below the illuminating elements photometrics used both for the illumination of highlight the connecting rods and for the general illumination of the structures.

2.5.1 *Connecting Rod Illumination Photometric*



2.5.2 *Archs and Deck Illumination Photometric*



3 ELECTRICAL SYSTEM

The electrical distribution will be derived, for every infrastructure, from one or more points of access, as pointed in the design drawings. The supply of the electrical panel of every illumination system, will be made available by the Arrival Electrical Agency.
From the electric panel all necessary distribution lines will depart for the supply of the illuminating elements, installed according to the schemes in the design drawings.

3.1 General Considerations

The work director, for the installation of the lighting systems, besides the coordination of all necessary works, will have to pay particular attention to the verification of the completeness of the whole documentation, to the temporal program of the realization and to possible interferences with other works.
He will have to verify, in addition, that the used materials and their relating work are conforming to that established by the project.
At the end of the works he will formulate a report of verification of the electric system and the necessary documentation, that will attest that the works have been performed to rule of art. it will
All the materials will have to be exempt from qualitative and workmanship defects.

3.1.1 Criterions for predisposition of the electric system

In these installations, the electric systems include: separated supply points for every infrastructure; circuits with derivation of the distributed load.

The circuit sections calculation has been established considering a concentrated load in the appropriate point of the total circuit; the electric panel will contain all the necessary equipments for the correct operation and protection of the system.

3.1.2 *Criterions for components choice.*

The components have to be conforming to the safety prescriptions of the respective rules and select and place in work considering the characteristics of every infrastructure.
The pipes circuit, the position of derivation boxes, the position of the single supports of the illuminating elements, are presented in design drawings.
The illumination system design include the use of equipments with characteristic of double isolation (class II), cables of class II, FG7R 0,6/1kV type and terminal board, situated at every pole base, also of class II.
The instruments of class II don't need the realization of electrical connection to earth. In fact, the current rules forbid the realization of electrical connection to earth in the case of illumination systems of class II type.
Experience has, in fact, shown that the probability that on the metallic wrap, dangerous tensions are brought for the inefficient electrical connection to earth is greater than the probability that the electrical connection to earth is useful in

case of yelding of the double isolation. This, besides, doesn't make the installation of differential devices necessary, avoiding consequently inconvenient releases.
The lighting poles for road illumination are never to consider of notable dimensions, therefore it is not necessary any protection against the atmospheric discharges. Such conditions are enough to avoid the electrical connection to earth.

3.2 Power Distribution

3.2.1 *Supply and Distribution System*

The reference characteristics of the supply and distribution system in project, are the followings:

- Trifase normal LT supply + neutral system TT

3.2.2 *Circuit*

Dimensioning the circuit cables sections have been considered:

- distribution, from the electric panel, of the 400V lines and 50Hz frequency, effected using pipes inside the sidewalks, whereas such installation didn't result possible, inside of a steel box fixed on the bridge edge of the same infrastructure.

3.2.3 *Cables*

For the distribution system monopole cables have been designed, not fire spreading and with low emission of toxic smoke, of the FG7R 0,6/1kV type.
In the case of presence of more cables, inside the same pipe, related to different circuits, it has been considered a coefficient reduction of the range dependent of the number of circuits. The reference environment temperature has been considered equal to 30°C.
The tension reduction, for operational system, has been contained within the 3% of the nominal tension.
The calculation of tension reduction, for single lines and total circuit, has been conducted hypothesizing to concentrate the whole load in 60% of its length.

3.2.4 *Electric Panels*

The LT electric panel is constituted by structure in SMC and color RAL 7035.
The dimensions and positioning of the electric panels, are brought on the design drawings.
The electric panels that will be installed are the following:

- Bridge # 01 – Electric Panels Q1.B01 / Q2.B01
- Bridge # 02 – Electric Panel Q1.B02
- Bridge # 03 – Electric Panel Q1.B03
- Bridge # 04 – Electric Panel Q1.B04
- Bridge # 05 – Electric Panel Q1.B05
- Bridge # 06 – Electric Panel Q1.B06
- Bridge # 07 – Electric Panels Q1.B07 / Q2.B07 / Q3.B07
- Bridge # 08 – Electric Panels Q1.B08 / Q2.B08 / Q3.B08 / Q4.B08
- Bridge # 09 – Electric Panel Q1.B09

The above said electric panels, will be placed as far as possible in accessible position.

Before the new installation the old circuit will be dismantled as well as the supports and the existing illuminating elements. This dismantling process will be made upon certification to the customer.