

# TUNNEL



APLYLED

arianna light  
looking  
forward



APLYLED

## VISUAL COMFORT AND SAFETY

Arianna-Aplyled luminaires are designed to allow the human eye to make out all visible objects without being blinded.

Uniform lighting is synonymous with visual comfort and attractively lit spaces. Restoring light to roads and squares without creating dark spots is how we make cities welcoming even at night through the experience of our vision.

## MADE IN ITALY AND CUSTOM DESIGN

We closely monitor every stage of our luminaires' production process: from design to manufacture all the way through to their final sale. This is the only way to ensure high standards of quality.

We have a dedicated structure to handle lighting engineering calculations, while attention to the tiniest detail ensures that the resulting installation delivers in terms of performance. Any changes to the lighting systems are assessed on a case-by-case basis to provide effective solutions to concrete needs.

## ENERGY SAVING

Here at Arianna-Aplyled, energy saving is not just a buzzword: for us, it means reducing consumption and optimizing product performance. This is why we fit systems with dimmer features so that lumen output can be reduced to suit traffic conditions, resulting in a proportional reduction in energy consumption and light pollution levels.

# QUALITY AND CERTIFICATIONS

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## CERTIFICATIONS

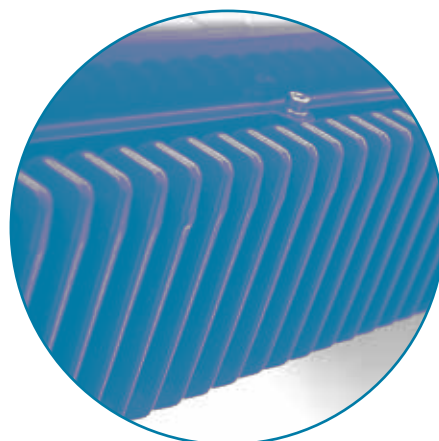
Arianna luminaires have received the ENEC\* mark (European Norms Electrical Certification) by an accredited external body to certify the compliance of products with harmonised European standards. All Arianna products also comply with European regulations governing the lighting industry.

\* visit the website [www.ariannaled.com](http://www.ariannaled.com) for a complete list of certified products

## RELIABILITY

The reliability of products is measured in terms of duration. That is why Arianna pays special attention to the thermal analysis of products to control operating temperature. Heatsinks have been designed to boost thermal transfer to the outside and ensure lasting light output.

All Arianna street lighting fixtures mount internal electronic devices which protect from electrical over stresses, both in differential mode and in common mode, up to 6kV.



## PRODUCTION

The heart of Arianna products is manufactured at the production facilities of Carel Industries, an Italian multinational company and shareholder of Arianna. The internal SMD process makes it possible to check the quality of the LED welding process and speed up delivery times.

The quality of production processes is guaranteed by a number of certifications that ensure a safe and reliable end product.



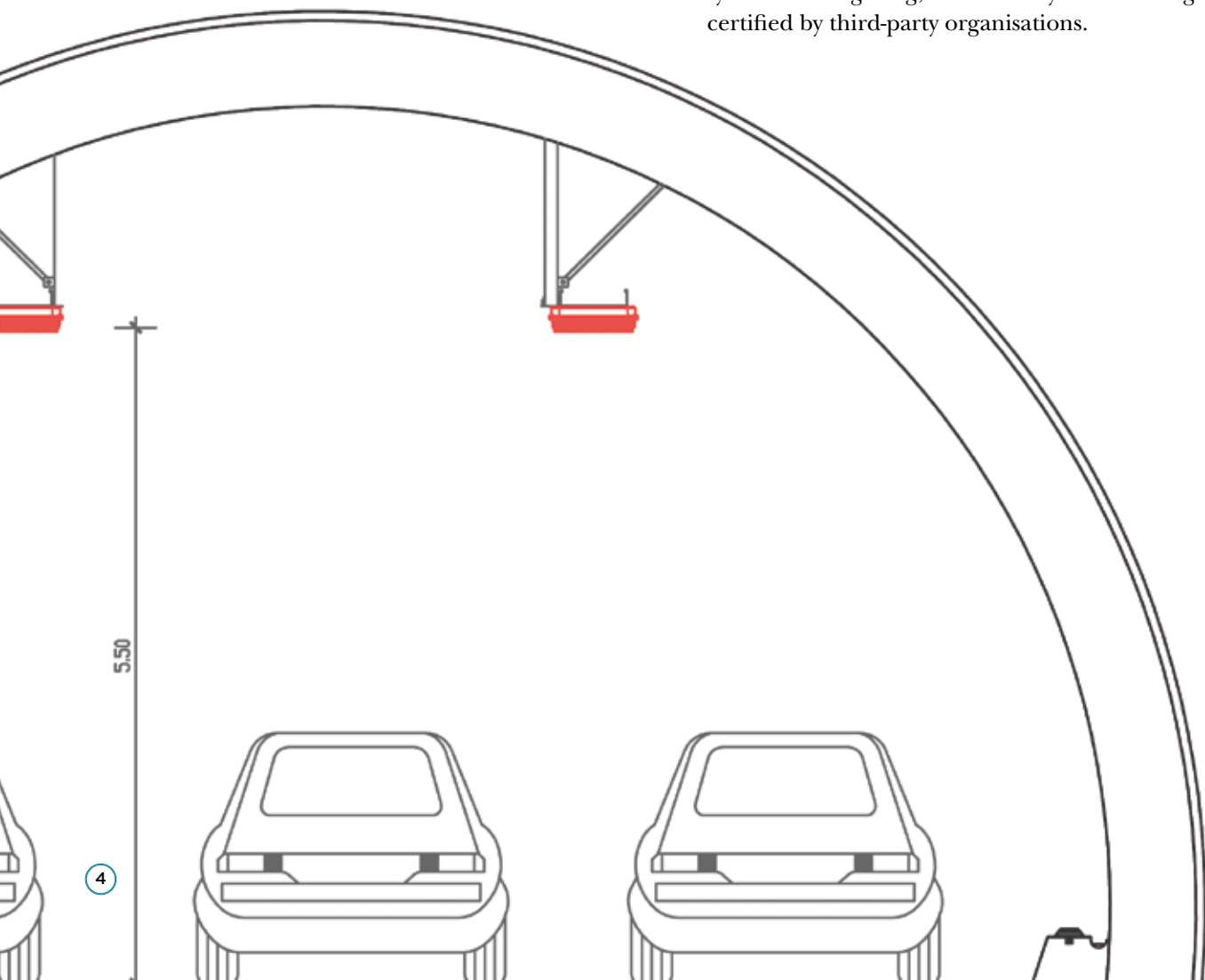
# UNIQUE VALUE PROPOSITION



Arianna's technological know-how has led to the development of a tunnel lighting solution that combines efficiency, visual comfort and energy saving, with the aim of reducing the total cost of system ownership without compromising on driver safety.

The optics represent the heart of the luminaires, designed in-house at the Arianna design centre, and are completed by premium components to create high-quality, robust and reliable products, and therefore suitable for critical environments such as tunnels, where safety and maintenance complexities are delicate matters that require a response using materials that are up to the task.

The use of its total reflection patent in tunnel lighting applications makes Arianna luminaires instantly recognisable, standing out from all other competing solutions. Performance, for both counterbeam and symmetrical lighting, is assured by careful design and certified by third-party organisations.



# TUNNEL LIGHTING



The purpose of tunnel lighting is to guarantee drivers the same visual perception both inside and outside of the tunnel. The difference in brightness between these two areas is too high for the human eye to distinguish obstacles inside the tunnel, and travel speeds mean there is too little time for the eye to adapt to the different luminance levels on entering the tunnel.

For this reason, tunnels are divided into different zones, each with their own specific lighting requirements. In the entrance zone, luminance values on the road must be very high, in order to minimise the difference between the outside and the inside; these values are proportional to the situation outside of the tunnel, and depend on atmospheric luminance, the positioning and layout of the tunnel portal. Subsequently, in the transition zone, luminance levels are gradually reduced, until reaching the interior zone, where the drivers' eyes have now had time to adapt to the artificial lighting. At the end of the tunnel, in the exit zone, luminance is increased once again so as to allow the drivers' eyes to adapt to outside conditions.

## ACCESS ZONE

Stretch of road prior to the tunnel entrance. Here drivers must be able to see any obstacle inside the tunnel within the reference distance, defined as the distance within which a reference obstacle located in the lane must be able to be perceived by the driver of a vehicle travelling at the design speed, allowing for the driver to brake safely and avoid colliding with the obstacle.

## ENTRANCE ZONE

Initial stretch of road inside the tunnel, along which the lighting system must ensure a sufficient average luminance value that will allow the driver of an approaching vehicle to identify the reference obstacle from the reference distance. The lighting in this zone depends on the luminance in the access zone, and its length is equal to the reference distance.

## TRANSITION ZONE

Stretch of road inside the tunnel following the entrance zone, along which the average luminance value of the roadway is gradually reduced to allow the eyes of drivers to adapt to the luminance levels inside the tunnel.

## INTERIOR ZONE

Stretch of road inside the tunnel, following the transition zone, along which lighting conditions must ensure that drivers will spot the reference obstacle and drive safely through the tunnel.

## EXIT ZONE

Stretch of road inside the tunnel where the sight of drivers exiting the tunnel during daylight hours is affected by outside light.

## PARTING ZONE

Stretch of open road immediately after the tunnel exit.





# REINFORCED LIGHTING

Reinforced lighting refers to the lighting in the initial stretch of road inside the tunnel that is designed to prevent the so-called ‘black hole’ effect, in other words, a sudden change from the outside approach luminance to the darkness inside the tunnel. This transition is undoubtedly the most critical stage in tunnel driving and represents one of the main causes of most traffic accidents that occur inside tunnels.

The purpose of reinforced lighting is to guarantee users safe entrance into the tunnel and a sufficiently clear perception of obstacles as to prevent accidents. By nature, reinforced lighting is only used during the daytime, when outside luminance is very high, and consequently the permanent inside lighting needs to feature a dedicated system. To correctly size this system, all the surrounding conditions need to be analysed very carefully, from the type of road to the atmospheric conditions and the specific tunnel layout. A city underpass is very different from a motorway tunnel and therefore needs to be designed with a different approach. For this reason, detailed knowledge of lighting systems and a custom design of each individual tunnel threshold are essential: lighting quality and user safety are more closely linked in this area than any other

## COUNTERBEAM OPTICS

Arianna has chosen counterbeam optics for its reinforced lighting solutions, meaning the maximum intensity of light emissions is aimed against the direction of traffic. Obstacles therefore appear as dark objects on a bright road surface and are highly visible, with very high negative contrast values.

By eliminating the vertical and symmetrical components from the light emissions, the beam generates much higher luminance levels, for the same power, than different types of optics; in other words, the design lighting specifications can be achieved with much lower power consumption. This translates directly into lower investment costs for materials and significant energy savings, and consequently an even faster return on investment.

The Arianna-Aplyled luminaires perform this task with very high efficiency: the counterbeam optics are designed to guarantee the exact luminance levels required by the standard, thus minimising energy consumption; careful design means light is provided only where needed, eliminating waste and drastically reducing glare. The total-reflection optics stand out immediately for their unique technological features and unrivalled visual comfort.



# PRODUCTS/TUNNELLED TESEO



## ELECTRICAL FEATURES

Voltage	220÷240 V ac
Frequency	50 - 60 Hz
Electrical safety class	II
Driver input	1-10 V o DALI for external control
Flux control system	Power line comunication
Certifications	CE – RoHS -ENEC

## MECHANICAL FEATURES

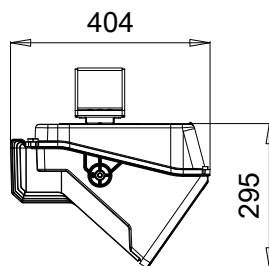
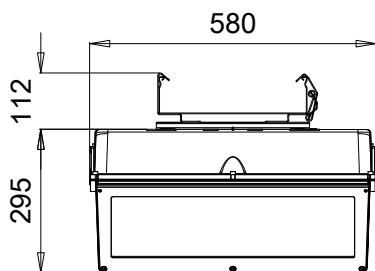
Body	Die-cast aluminium EN 46100
Total weight	19 kg
Ingress protection	IP 66
Paint	Resistent to 1000 hours in salt spray
Glass	Tempered extra clear, 4 mm thick
External screws	A2 Stainless Steel
Impact resistance	IK07 – 2J
Cable type	FG7OM1 - 2x1,5 mm²
Gasket	Silicone based gasket
Cable gland	m20 EPDM cable gland

## OPTICAL FEATURES

LED	LUMILEDS LUXEON M
Photobiological Safety	Exempt group
Color temperature	5700 K
Color rendering index	>70
Total reflection patent	1395290

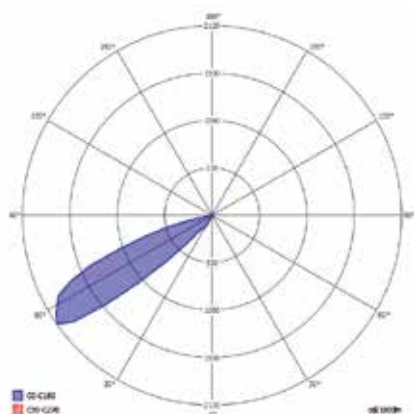
## POWER SUPPLY FEATURES

Maximum efficacy (full-load)	92,5%
Power factor	> 0,9
Lifetime	120.000 hours



IP66  

## PHOTOMETRIC DATA



Model	n. LED	flux @6000K [lm]	Power [W]	Efficacy [lm/W]
45 watt	20	4692	44	107
75 watt	35	8181	77	106
105 watt	50	11646	110	106
135 watt	16	14076	139	101
170 watt	20	17594	174	101
205 watt	24	21114	205	103
285 watt	24	27160	280	97
305 watt	24	28713	306	94

# PERMANENT LIGHTING

Permanent lighting is intended to illuminate the road for drivers whose eyes have already adapted to the change in brightness when entering the tunnel. It is installed along the entire length of the tunnel and, during the daytime, in the initial stretch corresponding to the entrance and transition zones, includes reinforced lighting to ensure correct perception of obstacles.

Drivers reaching the interior zone will have had time to adapt to brightness levels similar to night-time, and consequently the lighting needs to be constant, uniform and comfortable, without changes until reaching the exit zone. At night, on the other hand, this system is fully responsible for illuminating the tunnel.

As there is no discontinuity in brightness at the entrance, there is less need for adaptation and the situation can be considered similar, with the due proportions, to normal road lighting.

Arianna's approach, in this case too, is to apply its technology to ensure visual comfort and energy efficiency. Symmetrical optics guarantee the highest uniformity and lowest glare values, even in stretches of road with two-way traffic, together with its established levels of quality, reliability and care for the environment.







## ELECTRICAL FEATURES

Voltage	220÷240 V ac
Frequency	50 - 60 Hz
Electrical safety class	II
Driver input	1-10 V o DALI for external control
Flux control system	Power line communication
Certifications	CE – RoHS -ENEC

## MECHANICAL FEATURES

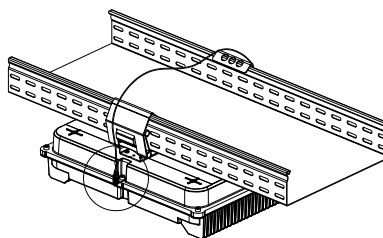
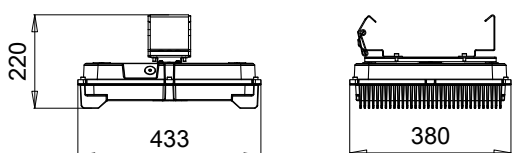
Body	Die cast aluminium EN 46100
Total weight	9,5 kg
Ingress protection	IP 66
Paint	Resistent to 1000 hours in salt spray
Glass	Tempered extra clear, 4 mm thick
External screws	A2 stainless steel
Impact resistance	IK08 – 5J
Cable type	FG7OM1 - 2x1,5 mm <sup>2</sup>
Gasket	Silicone based gasket
Cable gland	m20 EPDM cable gland

## OPTICAL FEATURES

LED	LUMILEDS LUXEON M
Photobiological Safety	Exempt group
Color temperature	5700 K
Color rendering index	>70
Total reflection patent	1395290

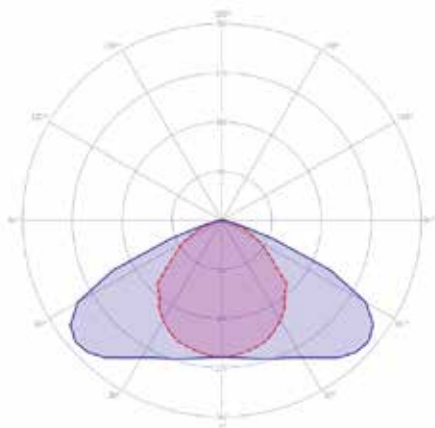
## POWER SUPPLY FEATURES

Maximum efficacy (full-load)	92,5%
Power factor	> 0,9
Lifetime	120.000 hours



IP66 CE □

## PHOTOMETRIC DATA



Model	n. LED	flux @6000K [lm]	Power [W]	Efficacy [lm/W]
45 watt	20	4510	45	100
65 watt	30	6749	67	101
85 watt	40	8976	88	102
105 watt	50	11193	110	102



## ELECTRICAL FEATURES

Voltage	220÷240 V ac
Frequency	50 - 60 Hz
Electrical safety class	II
Driver input	1-10 V o DALI for external control
Flux control system	Power line communication
Certifications	CE – RoHS

## MECHANICAL FEATURES

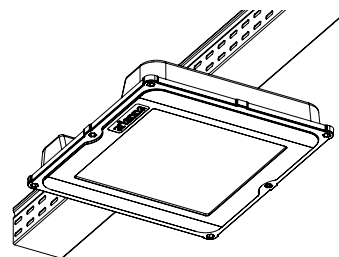
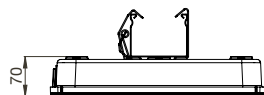
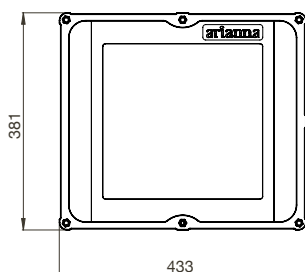
Body	Die cast aluminium EN 46100
Total weight	6,5 kg
Ingress protection	IP 66
Paint	Resistent to 1000 hours in salt spray
Glass	Tempered extra clear, 4 mm thick
External screws	A2 Stainless Steel
Impact resistance	IK08 – 5J
Cable type	FG7OM1 - 2x1,5 mm <sup>2</sup>
Gasket	Silicone based gasket
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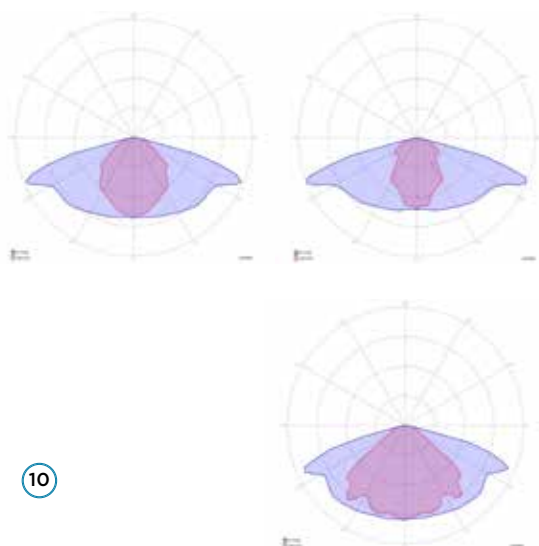
## POWER SUPPLY FEATURES

Maximum efficacy (full-load)	92,5%
Power factor	> 0,9
Lifetime	120.000 hours



IP66 CE □

## PHOTOMETRIC DATA



Model	n. LED	flux @6000K [lm]	Power [W]	Efficacy [lm/W]
30 watt	4	2937	28	105
45 watt	8	4865	44	111
60 watt	10	6388	58	110
75 watt	14	8187	73	111
90 watt	16	9645	88	110
105 watt	18	11158	104	107
120 watt	18	12454	118	106
140 watt	18	14213	138	103

## VAL DI SAMBRO TUNNEL



INNOVATION

VISUAL COMFORT

HIGH COST-EFFICIENCY

# CASE HISTORY/VAL DI SAMBRO



The signing of the new agreement between Autostrade S.p.a. and ANAS to extend the motorway operating license also includes the commitment to improve motorway traffic between Florence and Bologna by constructing a new more modern and efficient section of motorway, called the Variante di Valico.

The planning work on the Val di Sambro tunnel, in the new section of the A1 motorway between Bologna and Florence, represents an important project in the field of LED tunnel lighting.

Counterbeam lighting has been chosen for the tunnel entrance, using the total reflection patent: this ensures that drivers' eyes adapt gradually to the changeover from outside light to the darkness inside.

This system improves the visibility of obstacles, preventing what is known as the black hole effect.

Arianna's technological innovations mean the lighting in the Val di Sambro tunnel will be totally green, with energy savings of over 60% compared to traditional lighting systems.

This lighting system has been designed to achieve the highest results in terms of efficiency and uniformity, without compromising on safety in terms of visibility.



# CASE HISTORY/VAL DI SAMBRO



## PROJECT

The Val di Sambro tunnel is 3.8 km long and comprises two one-way tubes, each with two lanes and one emergency lane.

As regards the southern side of the Val di Sambro tunnel, reinforced lighting covers a length of 750 metres. Luminance values at the entrance are 136 cd/m<sup>2</sup>, while inside luminance is 1.5 cd/m<sup>2</sup>. Reinforced lighting is provided by a total of 252 luminaires with different power ratings, Teseo and Titlis models.

In the northern side of the tunnel, reinforced lighting covers a length of 680 metres, with luminance values at the entrance of 117 cd/m<sup>2</sup>, and inside luminance of 1.5 cd/m<sup>2</sup>. Reinforced lighting is provided by a total of 214 luminaires with different power ratings, Teseo and Titlis models.

## RESULT

Quality of light and energy savings are surprising: following installation of the luminaires, thanks to Arianna's technological innovations lighting in the Val di Sambro tunnel is totally green, with energy savings of over 60% compared to traditional lighting systems. This lighting system has been designed to achieve the highest results in terms of efficiency and uniformity, without compromising on safety in terms of visibility.

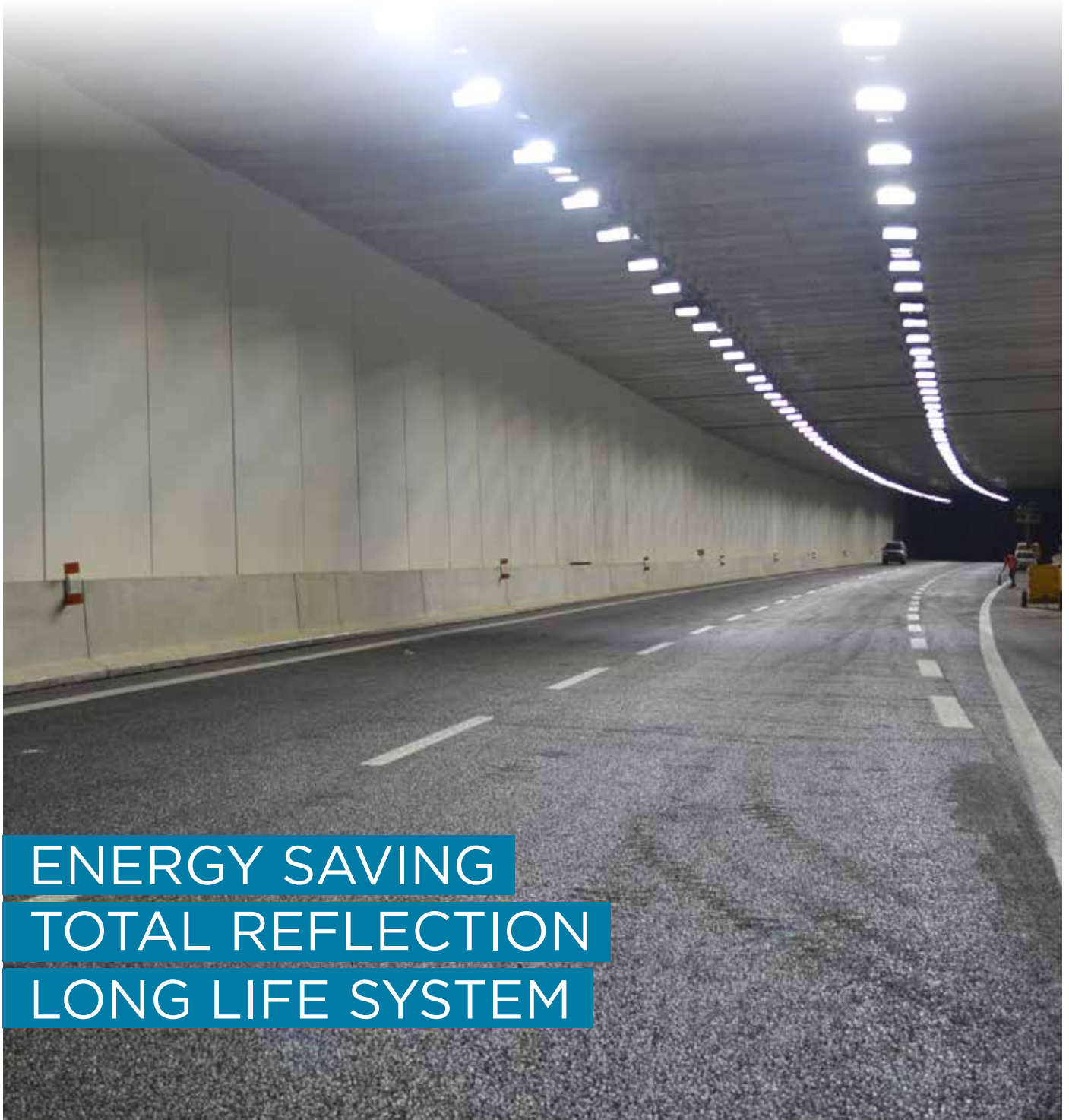
PROJECT DATA	VAL DI SAMBRO SOUTH	VAL DI SAMBRO NORTH
Tunnel type	Natural	
Uni/bidirectional	2 unidirectional tube	
Number of lanes	2 driving lane + 1 emergency lane	
Number of lighting fixtures	252 only reinforc.	214 only reinforc.
Street type	A1 var - Variante di Valico	
Reinforcement length	750m	680m
Standard	UNI 11095:2011	
Street coating	C2, Q0 = 0.07	
Tunnel lenght	3.8 km	
Entrance zone luminance	136 cd/m <sup>2</sup>	117 cd/m <sup>2</sup>
Interior zone luminance	1.5 cd/m <sup>2</sup>	1.5 cd/m <sup>2</sup>
Reinforcement lighting	Teseo 205W 94 Teseo 135W 28 Teseo 75W 28 Titlis 105W 66 Titlis 45W 36 TOTAL 252	Teseo 205W 76 Teseo 135W 30 Teseo 75W 30 Titlis 105W 46 Titlis 45W 32 TOTAL 214
Reinforcement lighting power consumption	33 kW	27 kW
Permanent lighting	-	
Permanent lighting power consumption	-	





## COPRENO TUNNEL

THE MOST IMPORTANT TUNNEL PROJECT IN EUROPE



ENERGY SAVING  
TOTAL REFLECTION  
LONG LIFE SYSTEM

Major infrastructure projects are often not simply civil or specialist engineering works, but can also help create a different awareness of the local territory and landscape from an architectural and urban planning point of view. Expanding on this concept, the recently established Pedemontana Lombarda motorway has started working on defining a number of recurring themes and elements with Aurelio Galfetti – architect and lecturer at the Lausanne and Paris Polytechnics and the Mendrisio Academy of Architecture - and assisted by Fabio Nocentini, architect and lecturer at the Milan Polytechnic.

The motorway has been designed as a unitary and recognisable work that both adapts to the different landscapes it passes through and contributes to redefining and reorganising them. With the exception of certain parts of the route that are defined as special sites - for example, the Adda river crossing - this infrastructure is a set of precise and discrete adjoining elements, aimed at strongly characterising both the space reserved for drivers and the image of the work itself within its context. The most important experiences from around the world in fact show that by placing the focus on quality, infrastructure can become an element that makes up the landscape, one that is variable and not monotonous, and that at the same time helps ensure driver safety.

Uniformity, light and shadow, lightness and elegance are the key design guidelines, together with the choice of just one construction material - reinforced concrete: pursuing material uniformity means defining a recognisable characteristic of the work, building it with harmonious relationships and raising it to the status of architecture.

All these elements were kept in consideration when constructing the tunnels along the motorway.



# CASE HISTORY/COPRENO

## PROJECT

The Copreno tunnel project was developed in collaboration with Costruzioni & Ingegneria Elef, and includes the use of LED technology: a prestigious project that recognises innovative patented Arianna technology. The entire lighting project was designed with the aim of achieving energy efficiency. The tunnel is around 170 metres long and features two lanes of traffic and a deceleration lane. Luminance values at the tunnel entrance are 110 cd/m<sup>2</sup>.

Reinforced lighting is provided by 110 265-watt Tesco luminaires and 16 205-watt Tesco luminaires, while 22 85-watt Titlis luminaires provide permanent lighting. Installed permanent lighting power is therefore 2 kW, with 34 kW for reinforced lighting, giving a total of 36 kW.

One unique aspect of the Pedemontana motorway is the system that uses dual luminaires, operating alternately. This solution doubles the lifespan of the luminaires, which need to stay on 24 hours a day, 7 days a week.

## RESULT

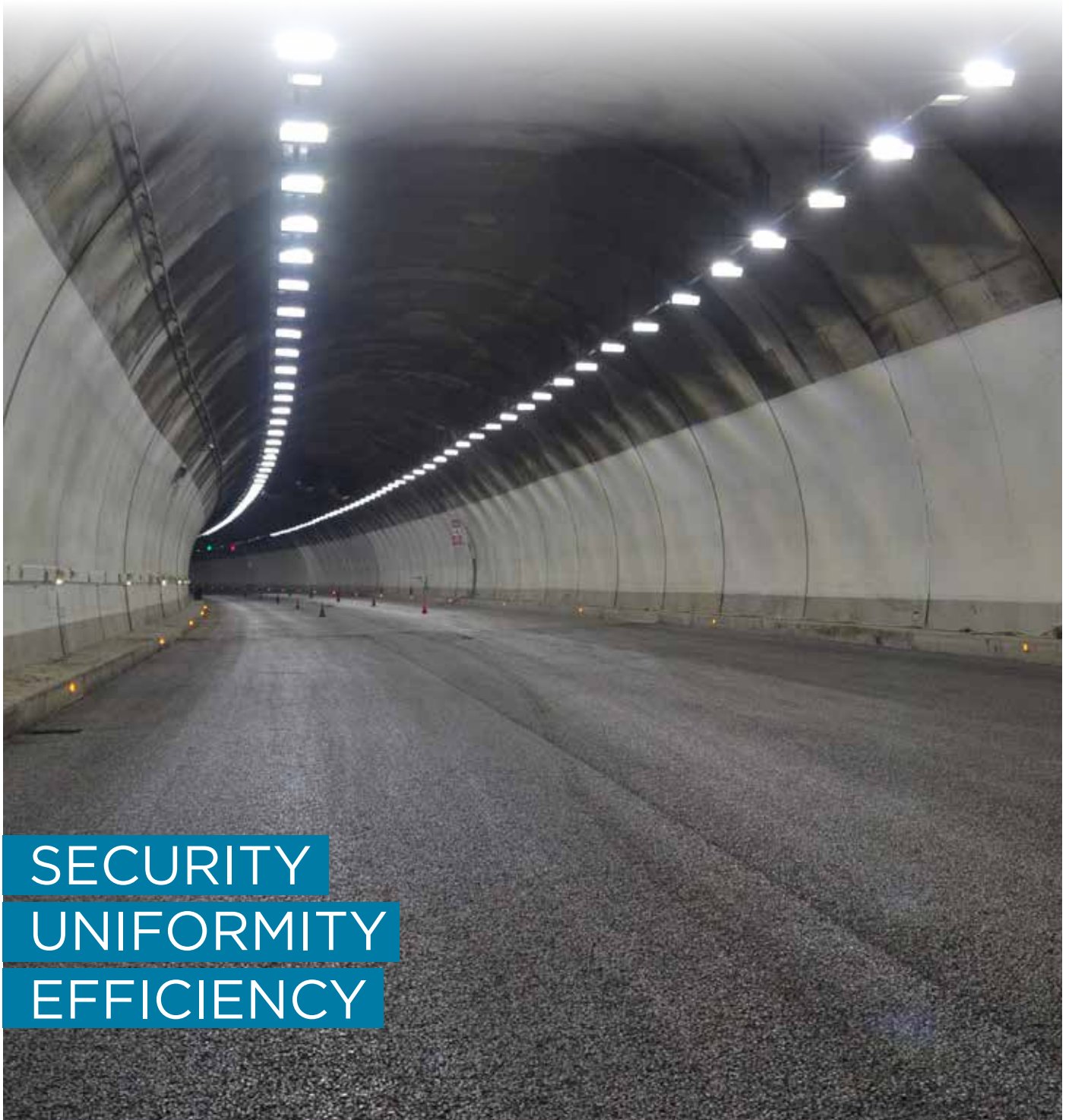
Following installation of the luminaires, uniformity measured during technical inspections is very high as regards the permanent lighting, guaranteeing driver safety. At the same time, glare is below 3%, less than one third of the value required by the standard on tunnel lighting levels. Reliability, visual comfort and energy savings are thus the key points of this tunnel, which stands out for the use of total reflection patent luminaires.

PROJECT DATA	
Tunnel type	Artificial
Uni/bidirectional	2 unidirectional tube
Number of lanes	2 driving lane + 1 deceleration lane
Number of lighting fixtures	22 permanent + 126 reinforcement
Street type	A36 Pedemontana Lombarda Motorway
Reinforcement length	170 m
Standard	UNI 11095:2011
Street coating	C2, Q0 = 0.056
Tunnel length	170 m
Entrance zone luminance	110 cd/m <sup>2</sup>
Interior zone luminance	2.25 cd/m <sup>2</sup>
Reinforcement lighting	Tesco 265W 110 Tesco 205W 16 TOTAL 126
Reinforcement lighting power consumption	34 kW
Permanent lighting	22 Titlis 2x85 W (double, switched on alternately)
Permanent lighting power consumption	2 kW





## SERRA SPIGA TUNNEL



SECURITY  
UNIFORMITY  
EFFICIENCY

# CASE HISTORY/SERRA SPIGA



The A3 Salerno - Reggio Calabria motorway represents the main road link connecting Sicily and Italy's southern regions on the Tyrrhenian sea to the bulk of the European motorway network. In the second half of the nineties work began on upgrading this motorway, originally designed and built in the sixties and seventies yet no longer able to deal with the considerable increase in road traffic and not compliant with updated standards.

ANAS, the national road authority, has completed the new system of access to the city of Cosenza, which also includes the motorway section. This has brought enormous strategic advantages: smoother and safer traffic, driver

comfort - above all in the peak summer period, and faster access for both vehicles entering the city and accessing the motorway.

This project also included work on the Serra Spiga tunnel, involving widening the lanes and adding an emergency lane, and upgrading the safety and lighting systems.

The lighting was designed from a viewpoint of energy efficiency and safety, thanks to the use of innovative patented LED technology from Arianna.

The luminaires with counterbeam optics installed minimise glare and ensure high performance in terms of safety.





# CASE HISTORY/SERRA SPIGA



## PROJECT

The tunnel is 600 metres long and comprises two one-way tubes, each with two lanes and one emergency lane. Luminance values at the entrance are 185 cd/m<sup>2</sup>, while inside luminance is 2.25 cd/m<sup>2</sup>.

Reinforced lighting is provided by 552 luminaires with different power ratings, Teseo and Snell models, while 152 60-W Snell luminaires were installed to provide permanent lighting. Total installed reinforced lighting power is therefore 120 kW, and 9 kW for permanent lighting.

## RESULT

The installation of Teseo and Snell luminaires has created perfect lighting inside the tunnel. The smooth transition from natural outside light to artificial inside light ensures safe access to the tunnel. The patented counterbeam optics provide the right light, without glare nor wasted energy. Maximum efficiency, environmentally-friendly and effective lighting. Inside the tunnel, the highly uniform lighting ensures complete safety for the vehicles in transit.

DATI PROGETTO	
Tunnel type	Natural
Uni/bidirectional	2 unidirectional tube
Number of lanes	2 driving lane + 1 emergency lane
Number of lighting fixtures	152 permanent + 552 reinforcement
Street type	A3 Autostrada SA-RC
Reinforcement length	600m
Standard	UNI 11095:2011
Street coating	C2, Q0 = 0.07
Tunnel length	600m
Entrance zone luminance	185 cd/m <sup>2</sup>
Interior zone luminance	2.25 cd/m <sup>2</sup>
Reinforcement lighting	Teseo265W 336 Teseo205W 36 Teseo105W 26 Teseo75W 40 Teseo45W 28 Snell135W 44 Snell120W 40  TOTAL 552
Reinforcement lighting power consumption	120 kW
Permanent lighting	152 Snell 60W
Permanent lighting power consumption	9 kW



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forward



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