



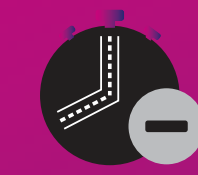
# TUNNEL LIGHTING SOLUTIONS

*Concept to Care*

# Importance of Tunnels



Tunnels optimize traffic efficiency



Reduces travel time



Decrease air pollution



Unburdens Roads



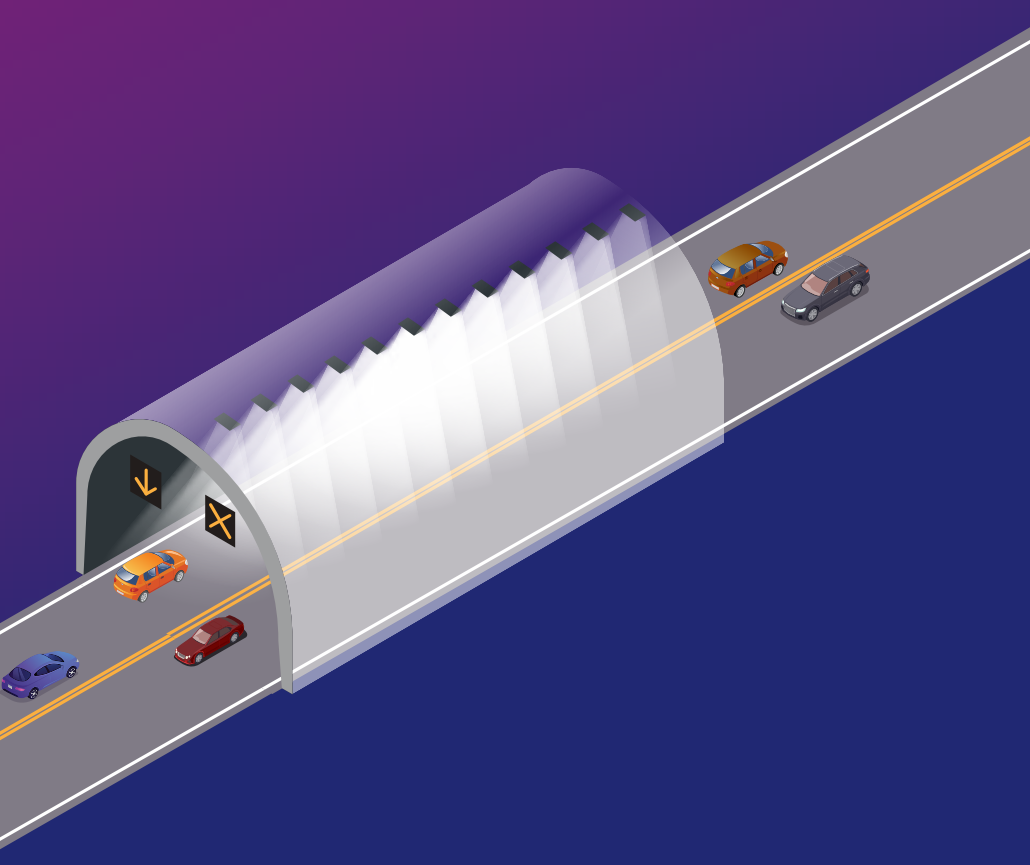
Reduces Noise

## Tunnels

A new trend

## Objective of Tunnel lighting

- To allow traffic to enter, move through and exit the tunnel safely.
- Enable smooth traffic flow.



# Our Strengths

**Application Design**  
(Illumination-Structural-Electrical)  
Application design and engineering services



**Complete Offerings for Lighting**  
Product & Technology Development (R&D)



**Operations & Maintenance**  
Highly effective O&M capability



**In-house Tunnel Luminaires**  
Manufacturing Facilities



**Installation Testing & Commissioning**  
Skilled pool of engineers



**Efficiency**  
is the key



# Requirements in tunnel lighting

## The 5 zones of a tunnel

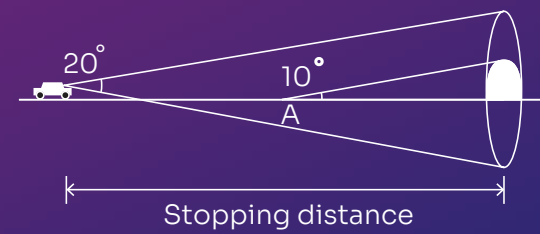
According to CIE guidance (CIE 88-2004), the amount of light needed inside a tunnel depends on the amount of light outside and the location inside the tunnel at which the user's vision must adjust.

## Visual adjustment

The process of driving requires an adjustment period for the eyes to transition between high and low luminance, giving rise to two phenomena related to visibility.

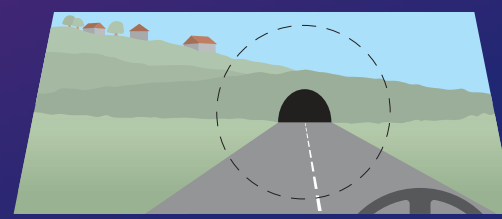
### 1. Spatial adaptation:

The stark contrast in luminance between the tunnel's exterior and interior poses a significant challenge for drivers as they approach the adaptation point. This stark shift can create a sense of unease and diminished visibility, impacting their comfort and confidence while driving.



### 2. Temporal adaptation:

Refers to the prolonged duration required for human eyes to adjust from brightness to darkness. The distance covered during this adaptation phase is a pivotal factor influencing this process.



### 1. Access Zone

This refers to the section of the road leading to the entrance of the tunnel, not inside it. Drivers must have visibility into the tunnel from this area to identify potential obstacles and enter at a consistent speed. The level of lighting in the subsequent tunnel section is determined by the driver's adaptability in the access zone.

### 2. Threshold Zone

The length of this zone equals the stopping distance. The required luminance in the initial section must remain constant and is linked to outside luminance and traffic flow. At the edge of the zone, the luminance level can quickly decrease to 40% of its initial value.

### 3. Transition Zone

Luminance gradually decreases over the length of the transition zone to reach the level required in the interior zone. The reduction stages are time-related and depend on how well the human eye can adapt to its surroundings, with a crucial constraint: the ratio must not exceed 1:3. Once the luminance equals three times the interior level, the transition zone concludes.

### 4. Interior Zone

This segment of the tunnel, often the longest, sits between the transition and exit zones. Lighting levels are directly tied to speed and traffic density.

### 5. Exit Zone

The portion of the tunnel situated between the interior zone and the portal is known as the exit zone. In this zone, the brightness outside the tunnel can significantly impact a driver's vision as they approach the exit during the day.



1) Access zone

$L_{20}$   
(outside luminance)

2) Threshold zone

$L_{th}$   
(threshold luminance)

3) Transition zone

$L_{tr}$   
(transition luminance)

4) Interior zone

$L_{in}$   
(interior luminance)

5) Exit zone

$L_{ex}$   
(exit luminance)

Adaptation point

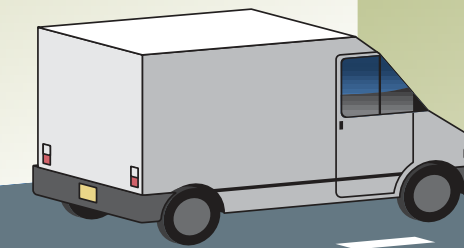
Stopping point

Stopping distance (SD)

Portal

Parting zone  
 $2 \times SD$

Portal



**Our Offering**  
 Maximum Safety.  
 Maximum Comfort.



### Typical tunnel lighting arrangements

Available mounting with their respective advantages/disadvantages

	Ceiling Mounting		Wall Mounting	
Mounting Constraint	Enough spacing above legal and protection minimum height		Not enough spacing above legal and protection minimum height	
Arrangement Type	Above road on several rows 	1 row above road 	Twin opposite 	Single sided 
Advantages	<ul style="list-style-type: none"> <li>Best utilisation factor for luminaires</li> <li>Low glare</li> </ul>	<ul style="list-style-type: none"> <li>Less investment and maintenance</li> </ul>	<ul style="list-style-type: none"> <li>Easier access to luminaires</li> <li>1 lane only need be closed</li> </ul>	<ul style="list-style-type: none"> <li>Less investment and maintenance</li> </ul>
Disadvantages	<ul style="list-style-type: none"> <li>Luminaires concealed by signs </li> <li>Heavy fixings</li> </ul>	<ul style="list-style-type: none"> <li>Closure of carriage way required</li> </ul>	<ul style="list-style-type: none"> <li>Utilisation factor downgraded</li> <li>High glare</li> </ul>	<ul style="list-style-type: none"> <li>Beware of trucks blocking the light </li> </ul>
Tunnel Profile	<ul style="list-style-type: none"> <li>Arched type with or without fan tubes</li> <li>Framed type with or without fan tubes</li> </ul>		<ul style="list-style-type: none"> <li>Arched type with or without fan tubes</li> <li>Framed type with or without fan tubes</li> </ul>	

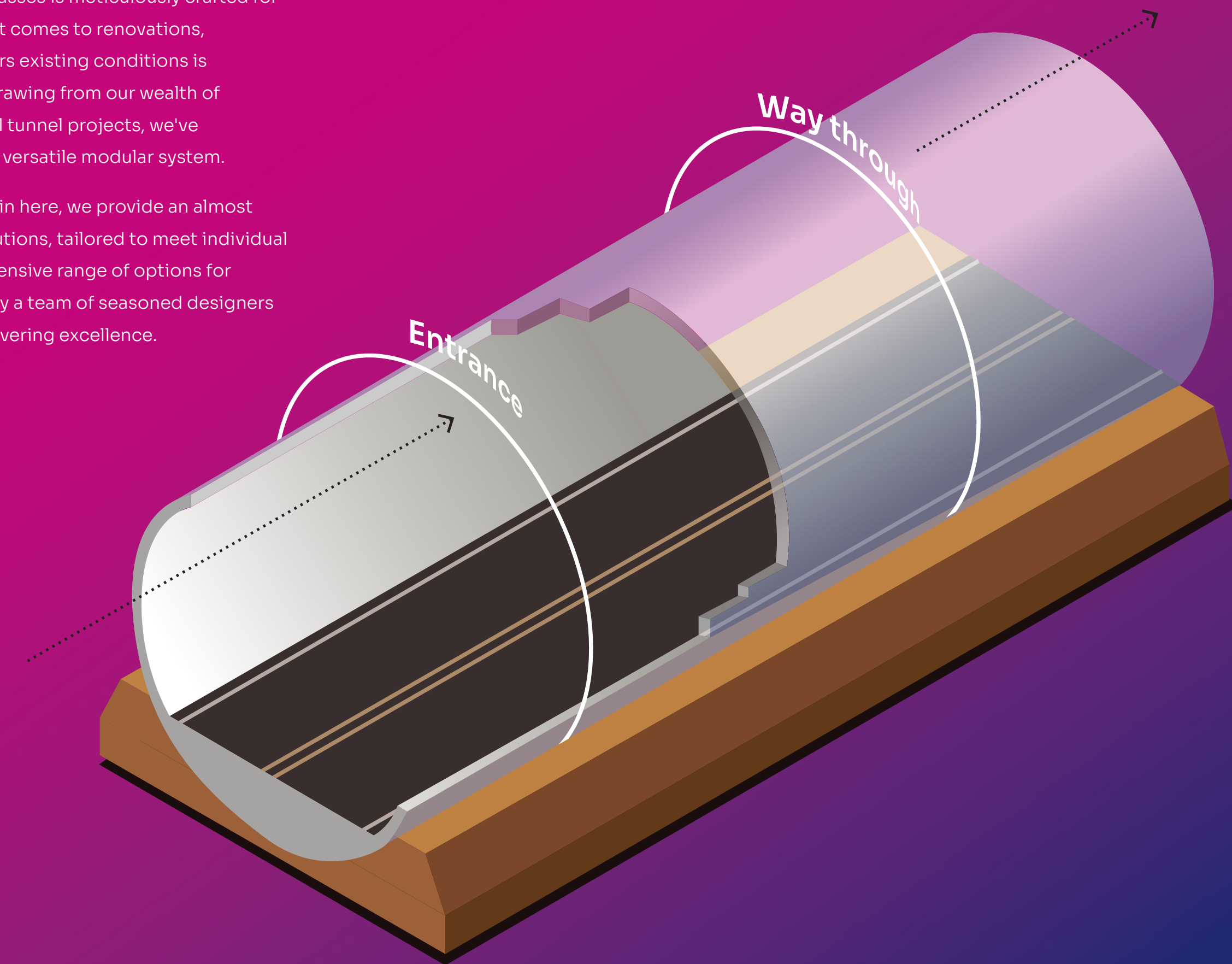
## Right Balance

between visibility,  
safety and cost



Recognizing the unique nature of each tunnel, our array of lighting solutions for tunnels and underpasses is meticulously crafted for unparalleled adaptability. When it comes to renovations, selecting a solution that considers existing conditions is paramount for optimal results. Drawing from our wealth of knowledge amassed from several tunnel projects, we've integrated this experience into a versatile modular system.

Beyond the diversity showcased in here, we provide an almost limitless array of customized solutions, tailored to meet individual needs. Bajaj presents a comprehensive range of options for personalized solutions, backed by a team of seasoned designers and engineers committed to delivering excellence.



# 24x7 Operation

## Well Thought-out Design

Ensuring traffic safety across all zones of tunnel.

## Simple & Compact

The compact luminaire with great flexibility ensures easy installation and maintenance.

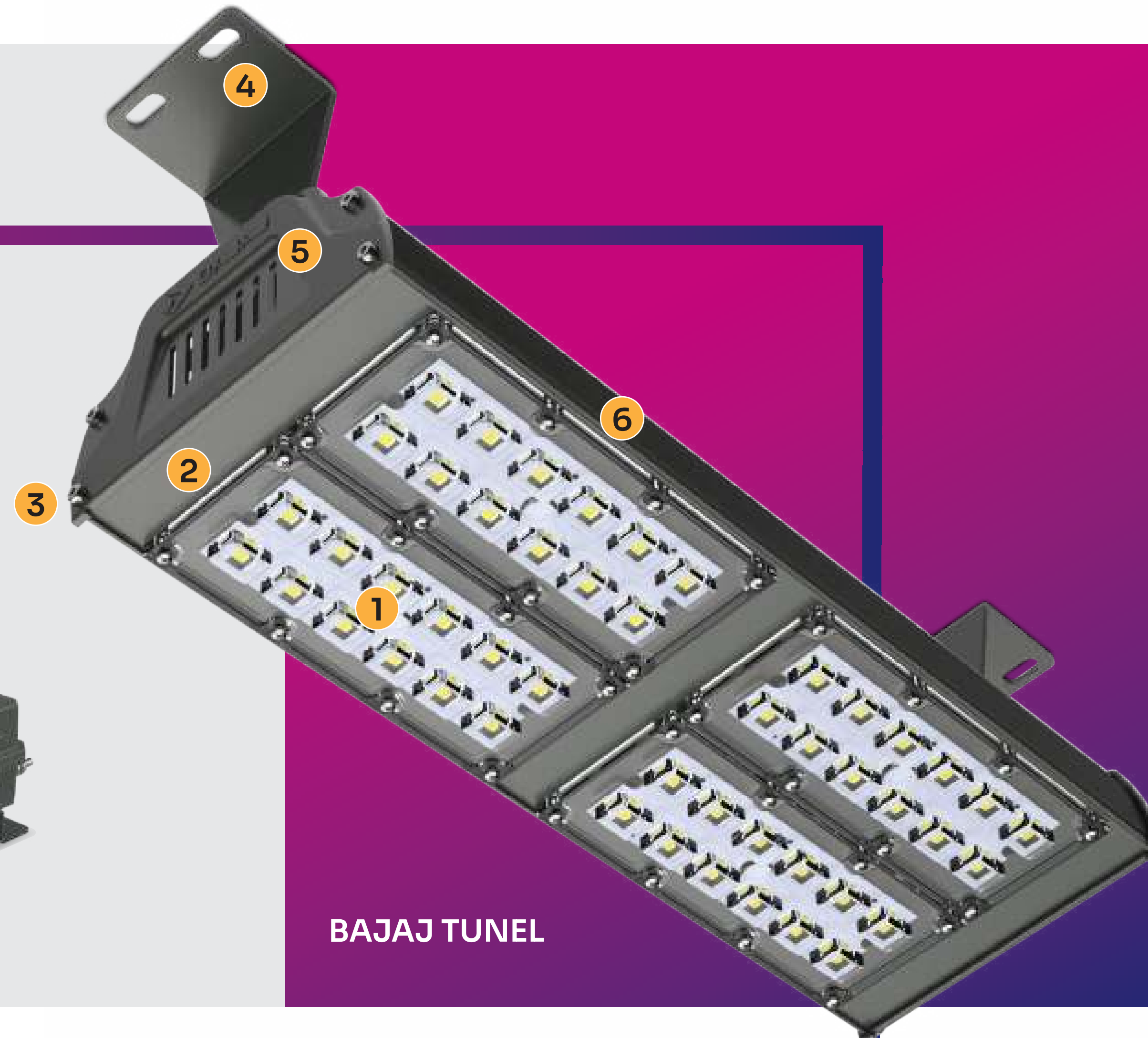
## Efficiency is Priority

Uniform illumination ensuring good visual guidance.

## Absolute Best Model to light up Tunnels

A well thought innovative design for seamless continuous rows and with best lighting values. Bajaj **Tunel** is the optimum solution for traffic safety and maximum visual comfort in tunnels.

- 1 High quality polycarbonate LED lens
- 2 Extruded aluminium housing with high thermal conductivity
- 3 High quality anti corrosion materials for all load bearing parts, all hardware used is stainless steel SS316
- 4 Well thought out intelligent features easy and simple mounting brackets for easy and simple mounting
- 5 Construction and mechanical protection
- 6 Modular design for easy maintenance
- 7 Constant current driver used is specially designed to have built in surge protection, open/short circuit protections. External surge protection provided for additional safety.



BAJAJ TUNEL

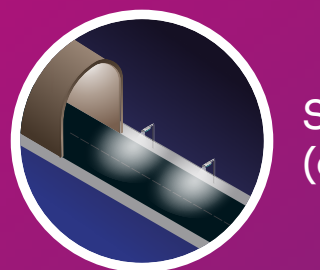




# One-stop Solution



Tunnel Lighting



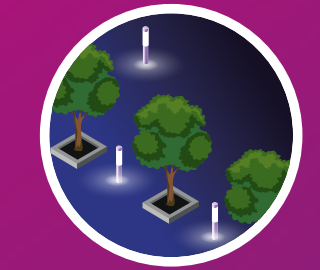
Street Lights (outside the tunnel)



Controls - CITISOL®



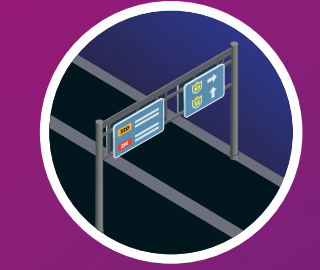
Area Lighting



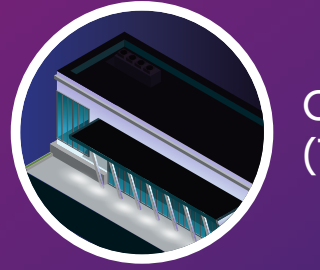
Landscape & City Beautification



Emergency Signaling



Poles & Gantries at Entry and Exit



Office Lighting (Tunnel control center)



Fire Alarm LHS

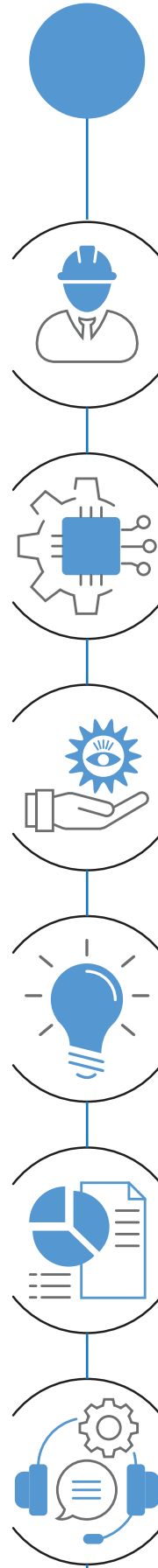


CCTV & BMS

# Partner for your lighting solution

## Making it "SMART" & "CONNECTED"

Communication Architecture and feasibility check



## Requirement Assessment

The assessment process will be conducted by seasoned engineers from Bajaj, ensuring thorough and expert evaluation.

## Hyper Support

Supply and supervision (on request)

## Lighting & Electrical Design

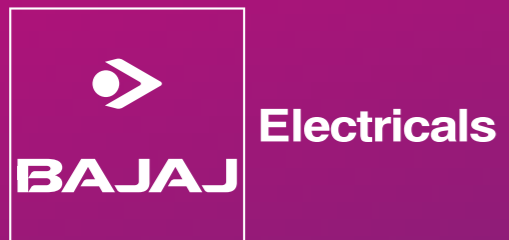
Synergic solution architecture

## BOQ Creation

With technical datasheets and maintenance guides

## After Sales Support & service





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