

BRIGHT LINES FOR UNDERGROUND

Advances in LED strip lighting can help improve construction safety in tunnels and so productivity and efficiency, says industrial strip lighting specialist MineGlow's founder and general manager, **Carinne Pater**

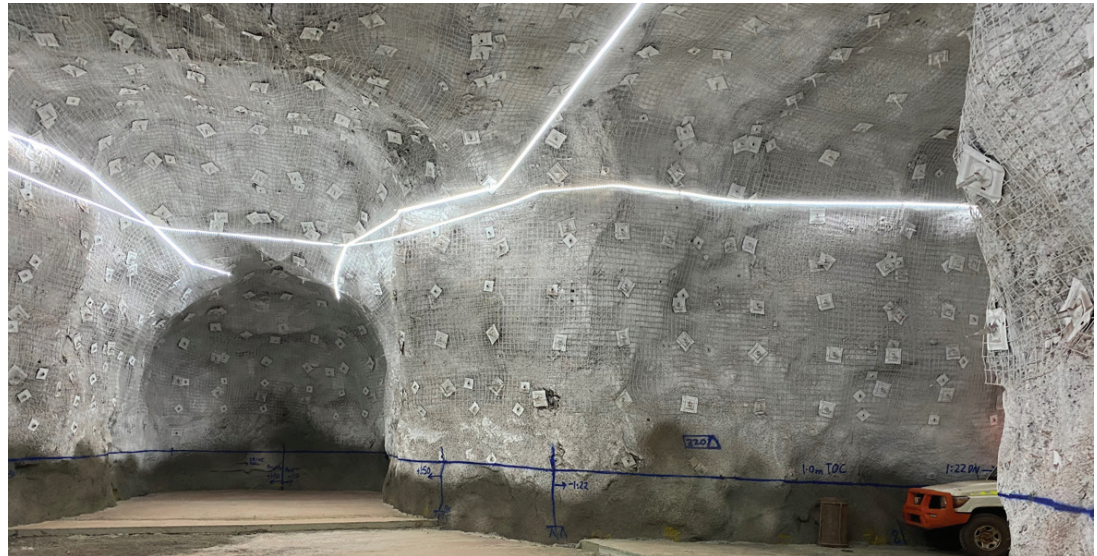
With governments investing more in infrastructure, the number of tunnel projects is on the rise! This growth in tunnel construction, and the increasing government policies to adopt clean, sustainable lighting technology are fuelling the demand for high-quality light-emitting diode (LED) tunnel lighting.

Tunnelling projects are often subject to harsh environmental challenges such as high vibration, large debris and extreme temperatures – all with little to no natural light. To ensure the highest standard of safety, and the productivity and efficiency of equipment and operations, high quality, reliable and certified LED lighting can help. The lighting solution can, when correctly selected, provide benefits such as: better

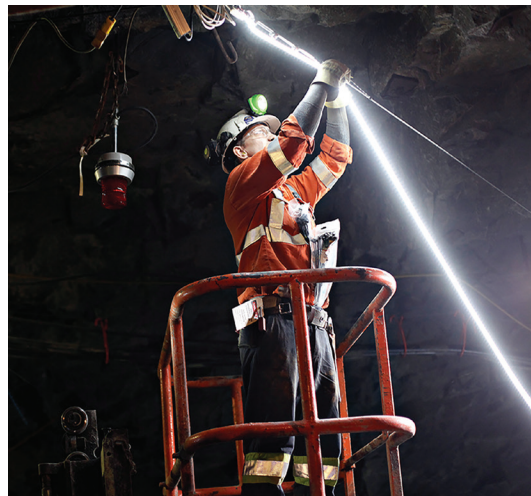


Above: Cross River Rail using red LED Strip lighting ALL IMAGES COURTESY: MINEGLOW

Right:
LED strips lights are growing in use underground



Right:
LED strip lights for continuous, constant lighting underground



Far right:
Low energy consumption benefits from offered by extensive LED strip lights



lighting quality and output; reduced maintenance costs and energy consumption; and, increased safety due to the greater performance and long life.

EVOLUTION OF TUNNEL LIGHTING

Over the last five years, there has been accelerated development of LED technology, making it economically and technologically justifiable to start phasing out traditional lighting technology, such as fluorescent lamps, high-pressure sodium (HPS) and high-intensity discharge (HID) lighting sources.

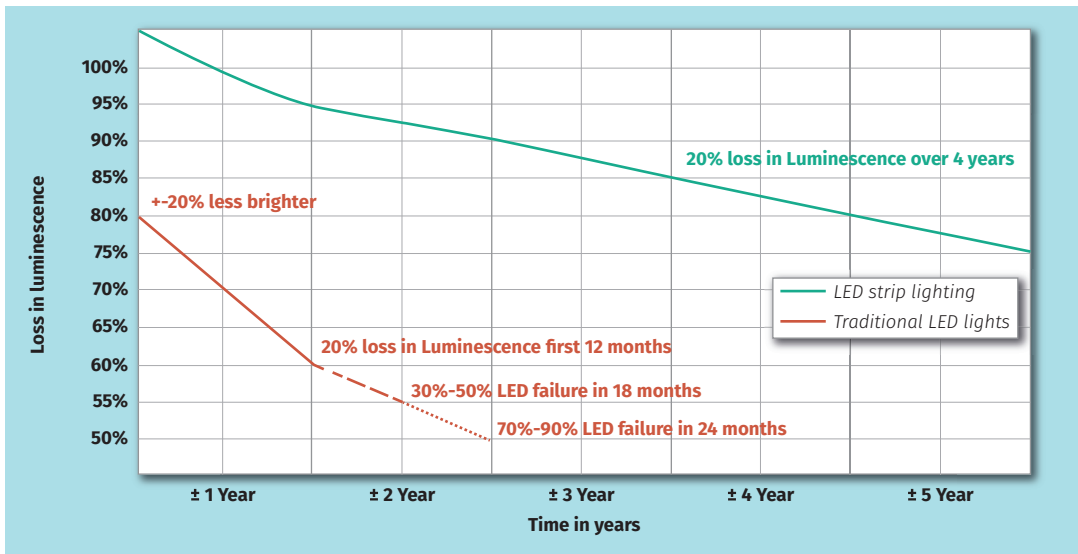
Before the advancements in LEDs, traditional lighting systems offered an attractive combination of low unit cost and were proven across tunnelling applications. However, the drawbacks are also significant.

HPS lighting, for example, has a low colour temperature and light output, and uses a substantial amount of energy with a lifespan of only 14,000 hours. Traditional lights are easily knocked and broken. So common concerns include their need for regular replacement as well as their overall reliability, lack of longevity and efficiency.

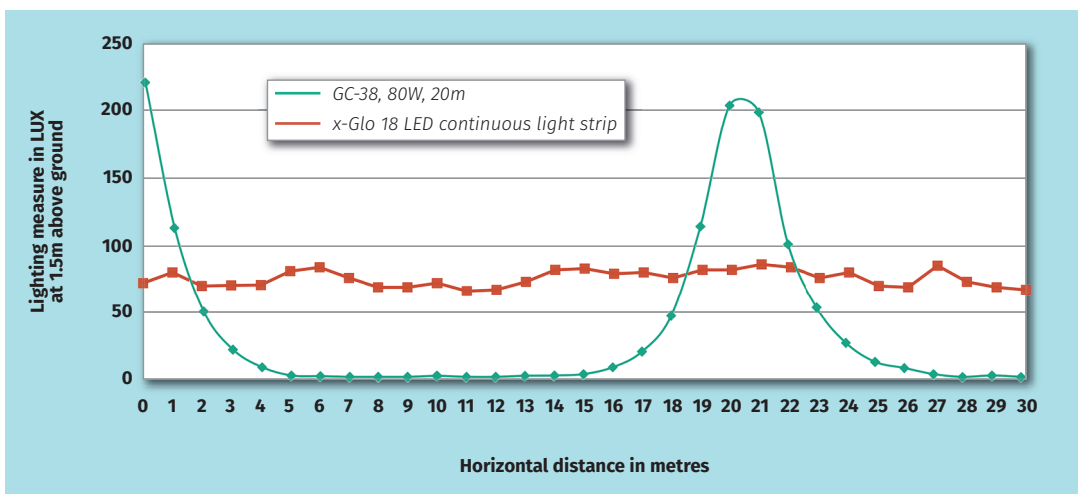
The use of the latest generation of LED light sources, particularly LED strip lighting, is now a more practical option in tunnel lighting. Long service life (6-10years), shock and vibration resistance properties, excellent light output and colour temperature (6500K), and continuous lengths are just some of the characteristics of LED strip lighting.

But while LED strip lighting has a solid foothold in industrial and mining applications, only in recent years has the technology started to make its mark in tunnelling, and mainly for reasons of flexible continuous lighting distribution and rugged properties. The strips provide a continuous and constant light lux in comparison to other LED lighting systems, and lux fading with distance from bright single point sources, such as traditional lights.

When working in demanding underground environments with little or no natural light, and limited access to power, the design and quality of the lighting system is, therefore, vital. Improved illumination can help counter poor lighting affecting fatigue, attention, reaction ability and hand-eye coordination² in mining,



Left, figure 1: Light depreciation and lifespan of traditional lighting versus LED strip



Left, figure 2: Lighting distribution comparison between x-Glo LED strip and spaced traditional bulbs

studies have shown it can also affect productivity and increase physical hazards, such as tripping, and mental exhaustion that can lead to safety incidents.

By offering 180-degree, floor-to-ceiling illumination, LED strips help to eliminate shadows, glare and hazardous dark spots to help workers operate more safely while identifying risks and mitigating hazards early. Compared to conventional light sources, LEDs' superior colour rendering improves workplace illumination, operator comfort and lighting quality, especially for tasks in industrial environments..

For example, MineGlow's x-Glo strip lighting produces 65000k white light emissions for precise colour recognition and have a colour rendering index (CRI) of > 80. As a result, the vibrant white output reduces eye strain and improves visual safety.

Further, LED strip lighting solutions provide continuous illumination potentially along the entire tunnel, so improving site safety and visibility while reducing the risk of equipment damage.

To be effective in underground construction environments often with extreme temperatures,

corrosive conditions, debris and vibration, the lighting system needs to be robust.

High-quality industrial LED strip lighting systems should undergo stringent tests to verify the operating temperature, integrity, electrical safety, and photobiological and photometric efficiency. Moisture, dust, impact, shock and acid resistance and ability to withstand vibration and keep out fine particles are all important.

The strips must also comply with international and local standards. When working in areas where flammable gases and dust are present, the IEC and IECEX certifications are required.

PROJECT: CROSS RIVER RAIL

The Cross River Rail tunnel project in Brisbane, Australia, is a 10.2km long new link that includes 5.9km of twin tunnels under the Brisbane River. The large tunnel project is required to unblock a bottleneck in the city's transport system and the investment will have consequent economic benefits out to the rest of southeast Queensland. 📍

TIME, COST AND PERFORMANCE

Due to the flexible and low-profile design, LED strip lights are easy and quick to install and adaptable to position on varied surfaces and corners. At the same time, the low-profile design reduces the risk of damage resulting in next to zero maintenance.

LED strip lighting is provided in continuous lengths of up to almost 170m between power sources. As a result of the low power intake, new installations require significantly less cabling and switchgear with no extra electrical wiring, further simplifying the installation process. Lifespan of LED strip lights are up to 10 years, resulting in less downtime, but they also can be easily and quickly replaced.

The quality of power supplies is of critical importance to the performance of LED strip lights. Built-in power redundancy is a unique feature that enables a power supply to be connected at both ends of the strip lighting. This essentially doubles the rated length and ensures that the lighting will continue to operate even if entirely severed, or if one of the power supplies fails.

For MineGlow products, for example, LED strip lighting can be manufactured to suit power specifications using AC or DC power. LED power controllers convert the input voltage into a lower voltage

to energise the LEDs and with a variable input feature they can be used worldwide.

Typically, most of the LED lighting solutions from MineGlow range between only 2W to 9W per metre, depending on the brightness required of the strip, and reduced power consumption.

Typically, lighting installations in tunnels are evenly spaced. Unfortunately, this design can give an uneven light distribution with high and low spots of luminescence, causing glare and dark spots. In turn, this creates unsafe working conditions, which are further exaggerated when lighting failure occurs. LED strip lights can emit more than double the light as their traditional counterpart.

Toward reducing environmental impact during construction, ensuring long-term, sustainable lighting system in underground infrastructure and also during construction phases, can help achieve cost saving and reduce a project's carbon footprint.

Compared to halogen and other filament-based light sources, LED strip lights do not emit UV or infra-RED radiation, producing little to no heat. LED strip lighting also doesn't contain any filaments, electrodes or mercury, such as inside fluorescent light sources. As a result, LED strip

Construction sites for the extensive project include Woolloongabba, Boggo Road, Albert Street, Roma Street and the Northern Tunnel Portal in Spring Hill.

The Woolloongabba site was the staging area for the TBMs and roadheaders used to excavate the twin tunnels. For the site, MineGlow was contracted to illuminate more than 500m of walkways under Doka formwork structures.

The x-Glo Long-Range LED strip lights were installed in October 2021 and have continued to illuminate the walkways.

Installation time was an important consideration for the site when selecting their lighting, making the Long-Range solution a natural choice. The product was originally developed in response to customer feedback and is now commonly used in tunnelling due to the long run lengths between power supplies.

MineGlow's x-Glo range offers the world's longest continuous LED strip with single run lengths of up to 168m between power sources due to its extra thick copper backbone.

The long distances simplify installation by reducing the base infrastructure needed to power the lights. This results in fewer parts that can fail or get damaged, meaning minimal maintenance is required. X-Glo also has high water ingress protection of IP68 and dust and dirt retardant properties.

Five 108m long rolls of MineGlow's x-Glo LED strip lights were installed in the tunnel, totalling 540m across the Doka formwork walkways.

The lights, purpose-built for industrial environments, have supported previous road and infrastructure tunnelling projects throughout Australia and New Zealand, such as the Sydney motorway project, Victorian road tunnel project, Perth airport rail project and New Zealand wastewater project where emergency lighting alert the crew of overhead crane movement.

The latter use of emergency lighting solutions is growing. Products can be multi-coloured, multi-directional pulsating lights to support emergency evacuations and zone identification as well as traffic or equipment awareness. There is also a world-first IECEx-rated explosion-proof LED strip product that has been adopted in industrial sectors such as mines, chemicals (paint manufacturing), granaries and distilleries.

After it installed its first LED strip lighting in an underground coal mine in 2014, MineGlow is the world's largest distributor of x-Glo lighting and focuses on Asia Pacific markets, but projects are also supported in Mongolia and West Africa.

While the focus is on construction phase of projects, the LED strip lighting, with a 5-year warranty, can be used afterward for ongoing operational needs in underground infrastructure. ■

REFERENCES

- 1 <https://www2.deloitte.com/content/dam/Deloitte/au/Documents/infrastructure-capital-projects/deloitte-au-icp-future-of-infrastructure-unlocked-050422.pdf>
- 2 https://www.researchgate.net/publication/342363194_Study_on_the_Influence_of_Underground_Low-light_Environment_on_Human_Safety_Behavior