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Plug & play relighting in Vierarmen Tunnel

Application story

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Today LED lighting is established everywhere and a complete switch is in progress to this sustainable and maintenance-friendly technology in tunnels too. On the R0 near Brussels, it was recently the turn of the Vierarmen Tunnel for a relighting project. You have probably not noticed much of the work itself and that is not by accident. Both installers and component suppliers do all they can to thoroughly prepare the work and to deliver a reliable solution.

The renewal of the lighting in a tunnel is an enormous project. In the Vierarmen Tunnel, which is 540 metres long, it was all about the installation of somewhat more than 1,400 light modules. In addition, advanced automation was implemented so as to permit remote operation and monitoring of the lighting. The management of all this has been handled by the Flemish Traffic Centre.

The Agentschap Wegen en Verkeer (Agency for Roads and Traffic) was the client for this project. By replacing the old fluorescent and sodium lights with LED lighting, the government does not only want to achieve energy savings. LED lights also have a longer life, so less maintenance is required. Less frequent maintenance work also means less holdups for road users.

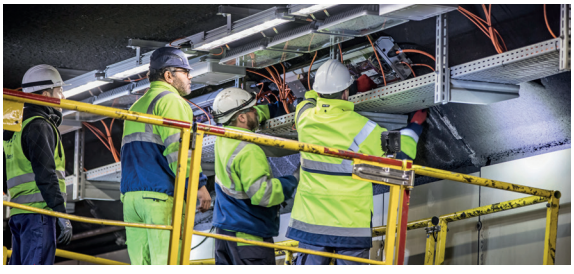
And with the replacement of the lighting itself, moreover, every effort was made to cause as little inconvenience as possible. All the modification work in the tunnel itself was done at night. Thanks to good preparation and the implementation of a plug & play concept, the whole job was completed in 45 nights per tunnel shaft. The tunnel usually remained available during the daytime.

Good collaboration

The replacement of the lighting in the Vierarmen Tunnel was carried out by the VSE - ENGIE Fabricom joint venture. Lighting systems from the Belgian manufacturer Schréder were selected. Phoenix Contact supplied the Tunnel Control System and dealt with the implementation of the plug & play concept. Lastly, Tein Technology is the supplier of the central operating and monitoring system of the Flemish tunnels in the control room.

Good collaboration between all these partners is crucial to a project of this scale. Every aspect of the installation has to be optimally coordinated so as to finally arrive at a reliable solution and to permit the installation of the system to occur smoothly and efficiently. Each step in the installation is in fact prepared in minute detail.

The Vierarmen Tunnel is one of the many relighting projects that the Agency for Roads and Traffic is undertaking. But they are all unique projects because every tunnel is different with its own characteristics and restrictions. Typical of the Vierarmen Tunnel is the low ceiling, as a result of which the lighting had to be positioned on the side wall, above the service walk. That presented an additional challenge during installation and also with the selection of the lighting modules.



Minimum energy and maintenance

"Every project starts with a light study," says Steven Hulpiau, Key Account Manager of Uitrusting Schréder. *"The brightness of the lighting is specified in European standards for both the lighting of the road surface and the walls of the tunnel. At the start of the tunnel you also need additional lighting to reduce the contrast with the sunlight outside."*

At the entrance to the tunnel, 300 candela per square metre is required. This entrance luminance is achieved by means of TAG lighting equipment. These LED lights are light in weight for easy installation and thanks to their compact form they can be used in most tunnel configurations. After the entrance to the tunnel, the luminance drops gradually to the base level of 12 cd/m^2. At night, the lighting is reduced to 3 cd/m^2. For the basic lighting that runs through the whole tunnel, for this project the ContiLED was chosen, a light specially developed for suspended cable lighting in tunnels.

Steven Hulpiau: *"Because the light fittings can only be positioned on the side wall of the tunnel in this case, we are using special lenses that scatter the light beams to the side. In this way we can guarantee the required brightness everywhere in the tunnel with a minimum of energy. An additional saving arises from the fact that the lights can be dimmed."*

For this project, the electronics that control the lighting and that are normally located in the light fittings were located in separate "driver boxes" installed right next to the light fittings. The advantage of this is that the light fittings do not have to be opened if maintenance needs to be performed on the electronics at a later date. This also ensures that the LEDs are not affected by the heat generated by the electronics.

Tunnel Control System

The electronic control of the lighting makes a whole range of options and scenarios possible. To start with, there is the difference between daytime and night-time mode with lights that can be dimmed or switched off at night. Here a safe distribution is used so that the life of the LEDs can be maximised.

The control of the brightness also takes into account the sensors for measuring the luminance at both entrances to the tunnel. In future it should also be possible to incorporate traffic speed measurement. If there is congestion and cars are driving slower, the zone with extra lighting at the entrance to a tunnel may in fact be a little shorter. This entails being able to dim the extra lighting further in that zone. The aim of this is always the same: to guarantee sufficiently bright lighting with as little energy consumption as possible.

The beating heart in this case is the Tunnel Control System from Phoenix Contact. This is a box with a controller, I/Os and communication modules that are used worldwide in tunnel projects. But even more important than the hardware is the software that was developed by the company so that all aspects of the lighting and also other systems such as ventilation, pumps and the like can easily be configured.

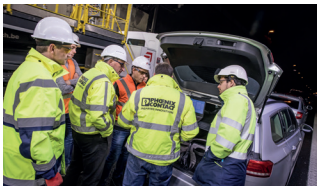
RS422 closed loop network DMV Lumgates

"The tunnel layout with its various light points can easily be entered into the Tunnel Control System", says Denis Verhoeven, the Infrastructure Manager of Phoenix Contact. *"There is an RS422 closed loop network running through the tunnel that connects all the driver boxes to the controller. The system controls the lighting levels in the tunnel based on pre-configured scenarios."*

Specifically, the Tunnel Control System gives each driver box a setpoint with the desired brightness of the lighting. The Lumgate in the driver box translates this setpoint into a specific DC voltage which is supplied to the light fittings. There are twelve light fittings per driver box for the suspended cable lighting in the tunnel. The additional lighting at the entrances uses one driver box per three light fittings. In the other direction, the controller also receives feedback from the driver boxes with status reports and alerts.

When the lighting may be heavily dimmed, for example at night, the control system switches over to turning off specific modules, which is more energy-efficient than deep dimming and this is also better for the life of the electronics and lighting.

One benefit of the RS422 closed loop network is that it can bridge big gaps of up to 400 metres between the modules.



Control room

On the other side, the Tunnel Control System consists of an interface with the Flemish government's glass fibre network with which the entire road network is managed. So the lighting in the Vierarmen Tunnel can be monitored and operated from the control room via that telematic network.

This overarching system in the tunnel control room of the Flemish Traffic Centre is called the IRIS platform and it was implemented in 2016 by Tein Technology. *"All the technology in the tunnel road network can be monitored and operated centrally via the platform,"* says Christophe Vandenbossche, the Solutions Architect of Tein Technology. *"In this case, operators at their desks have access via the IRIS platform to all status and diagnostic data. The lighting can also be operated from here. This is done by means of predefined scenarios which are then translated in the local controller into specific commands to the lighting modules. Some scenarios are even automatically controlled. If, for example, an accident occurs in the tunnel, all the lighting is automatically set to 100% when the emergency button is pressed by the emergency services in situ. Whilst this emergency button is active, the tunnel lighting can no longer be controlled by the operators. In fact, the emergency button has precedence over the remote control system. Every shaft has its own emergency button. So in the event of an accident, it is possible to choose to switch to very bright for only one shaft."*

Hundred percent, in the Vierarmen Tunnel that equates to power consumption of 170,000 Watts, which gives an idea of the scale of the project. In normal mode the lighting in the tunnel consumes about 113,000 Watts. That power level is then further reduced by using various scenarios to further dim the lighting depending on the input from the luminance measurements at the tunnel entrances.

Plug & play

To permit the installation of the new lighting to be carried out smoothly, the various parties on the project collaborated on a plug & play concept. Here Phoenix Contact's QPD connectors were selected for the data network and the supply to the driver boxes and light fittings. The connectors are also used on the rapid boxes that are provided in the installation so as to ensure maintenance of the electricity supply in the event of an accident. The whole supply network can withstand high temperatures for at least one hour so the lighting will continue to work even in the event of a fire.

The use of the connectors is to a large extent customised since all the components in the installation had to be preadapted. Phoenix Contact was also responsible for prefabricating the cabling. Every cable in the tunnel project was custom cut in advance, equipped with the required connectors and labelled.

The aim of this is not only to save time but also to increase the success rate during installation, which is intrinsically once more a matter of saving time. Compared with the traditional connection method, thanks to the use of the QPD connectors a time saving of 75% was recorded during installation. This greatly reduced connection time ensures that the time saving can amount to 15% of the total installation time in the tunnel.

The Tunnel Control System also contributes in its way to the plug & play concept because ease of use is an essential aspect of the software. *"There is a special mode for commissioning in which the system itself seeks the driver boxes in the network and allocates addresses,"* says Bjorn Dotremont of Phoenix Contact. *"In that phase, automatic tests are also run and power measurements are taken that are used later as references for diagnoses."*

More information?

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Convenience and safety

But before things reach that stage, a lot more needs to happen: the installation in the tunnel itself. That is a task which, because of its scale and the special working conditions, is particularly impressive.

"The Vierarmen Tunnel on the R0 forms part of the Trans European Road Network", explains Sam Pintjens, Project Manager at ENGIE Fabricom. *"So it was decided to work at night and to keep the tunnel open during the day. This also means that in the period of night-time working, a certain safety level must be guaranteed during the daytime. So during the work we have to install additional temporary lighting."*

"We of course want to keep the number of nights when the tunnel has to be closed as small as possible," says Hans Smits, VSE's Project Manager. Here it's not just about limiting traffic holdups but also the cost associated with every closure. 45 nights per shaft were envisaged in this project. *"A comprehensive work schedule which must be strictly adhered to is being produced with the tunnel operator. Every morning there is an inspection to check whether the tunnel is safe to be opened again. A penalty is imposed for every quarter of an hour's delay."*

The time pressure leads to a whole series of consequences for all the parties involved. Thus for instance the installers have special maintenance contracts with their suppliers so that any faults with the machines used can be quickly corrected. In this connection, a comprehensive risk analysis is conducted in advance to consider all the faults that might occur. A solution is sought for all of these possible risks before the roadworks are even started. And then of course comes the actual preparation of the work itself, with all the components, down to the last screw, that are going to be used during the night being set out ready.

Thanks to the good cooperation between the various parties and the consistent application of plug & play principles, the relighting project for the Vierarmen Tunnel was completed in a smooth and efficient manner. A sustainable, technologically high-quality solution was implemented with a minimum of inconvenience. Good lighting in tunnels is an essential aspect in guaranteeing the convenience and safety of road users.

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