Tunnel construction

Special applications require special solutions
Security for man and appliances

Specially adapted for rough conditions or hazardous atmosphere, all housings IP65

The baseplates of the Woertz Lithos boxes afford fastening possibilities - M4 or M6, depending on the size of the box. These galvanized brass bushings are sealed in a bar within the baseplate edgeways and can receive mounting plates, mounting rails, printed circuit boards etc.

Both captive screws of the cover and bushings for fastening it are made up with stainless steel. Ex factory the standard box is fitted with a joint seal to ensure the degree of protection. By default, the polyester housings are available in grey (RAL 7000).
Woertz Lithos boxes have not been shortened compared to the boxes of cast-iron. In terms of resistance they are even unbeatable. A plastic housing for rough applications.

<table>
<thead>
<tr>
<th>Properties of the material</th>
<th>Unit</th>
<th>ABS</th>
<th>Polyester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>g/cm³</td>
<td>1.05</td>
<td>1.8</td>
</tr>
<tr>
<td>Resistance to impact</td>
<td>mJ/mm²</td>
<td>60</td>
<td>80</td>
</tr>
<tr>
<td>Impact strength</td>
<td>mJ/mm²</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Tensile strength</td>
<td>N/mm²</td>
<td>43</td>
<td>45</td>
</tr>
<tr>
<td>Elongation at rupture</td>
<td>%</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>E-module (bending test)</td>
<td>N/mm²</td>
<td>2100</td>
<td>6500</td>
</tr>
<tr>
<td>Limiting flexural stress</td>
<td>N/mm²</td>
<td>90</td>
<td>100</td>
</tr>
<tr>
<td>Burning behaviour</td>
<td>Class</td>
<td>HB</td>
<td>V 0</td>
</tr>
<tr>
<td>Spec. contact resistance</td>
<td>Ω x cm</td>
<td>10^{13}</td>
<td>&gt; 10^{12}</td>
</tr>
<tr>
<td>Surface resistance</td>
<td>Ω</td>
<td>4 x 10^{14}</td>
<td>3 x 10^{14}</td>
</tr>
<tr>
<td>Dielectric strength</td>
<td>kV/mm</td>
<td>24</td>
<td>25 – 40</td>
</tr>
<tr>
<td>Heat conductivity (20 °C)</td>
<td>W/mK</td>
<td>0.18</td>
<td>0.25</td>
</tr>
</tbody>
</table>

How the different housing materials resist to mechanical load and under corrosion-promoting conditions is shown in this diagram.
Quality, strength and safety

Tunnel construction is related to stringent requirements and strains. A high availability of the tunnel is however expected. Cleaning and maintenance services are rarely possible.

All promising options of the Woertz flat cable system - in terms of flexibility, rapidity and safety - may be exploited by constructing a tunnel. Using the different cross-sections and degrees of protection allows to perform a temporary infrastructure for the construction phase and a definitive one once the tunnel is operational.

Construction phase
During construction the flat cable system may easily be extended. The system can „grow” together with the tunnel. The outlets have been designed so they can easily be connected even under rough conditions (darkness, wetness, time pressure) and without the cable having to be severed!

Installation phase
Towards the end of the project the schedule is often very tight. Using a rapid but secure type of installation allows to save twice as much time and thus also money. First the flat cable enables to save time at installation, because there is no use of stripping off the sheath or the insulation to connect the end receivers (lights, engines, etc.). Secondly the branching boxes have been designed so as to avoid any wrong mounting. Later troubleshooting is almost excluded. If installations are complex searching and eliminating trouble may need more time than the installation itself.

Operation phase
The system can be extended quickly even under operation, in order not to disturb the use of the tunnel too much.
Easy, flexible and cost-effective

The flat cable system shows its strengths not only during installation but also during operation.

<table>
<thead>
<tr>
<th>Type of flat cable</th>
<th>Number of conductors</th>
<th>Section</th>
<th>Sheath material</th>
<th>Contact</th>
<th>Type of connection</th>
<th>Degree of protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>ecobus power 5G2.5</td>
<td>5</td>
<td>2.5 mm²</td>
<td>PVC / FR/LS0H (HF)</td>
<td>screw-type/ plug-type</td>
<td>IP 20</td>
<td></td>
</tr>
<tr>
<td>ecobus power 5G10</td>
<td>5</td>
<td>10 mm²</td>
<td>PVC / FR/LS0H (HF)</td>
<td>screw-type/ plug-type</td>
<td>IP 20</td>
<td></td>
</tr>
<tr>
<td>ecobus power 5G16</td>
<td>5</td>
<td>16 mm²</td>
<td>PVC / FR/LS0H (HF)</td>
<td>screw-type/ plug-type</td>
<td>IP 20</td>
<td></td>
</tr>
<tr>
<td>ecobus power 5G18</td>
<td>5</td>
<td>20 mm²</td>
<td>PVC / FR/LS0H (HF)</td>
<td>screw-type/ plug-type</td>
<td>IP 20</td>
<td></td>
</tr>
<tr>
<td>ecofil 5G16</td>
<td>5</td>
<td>16 mm²</td>
<td>PVC / FR/LS0H (HF)</td>
<td>screw-type</td>
<td>IP 65</td>
<td></td>
</tr>
<tr>
<td>ecofil 7G2.5</td>
<td>7</td>
<td>2.5 mm²</td>
<td>PVC / FR/LS0H (HF)</td>
<td>screw-type</td>
<td>IP 65</td>
<td></td>
</tr>
<tr>
<td>ecofil i 5G2.5</td>
<td>5</td>
<td>4 mm²</td>
<td>PVC / FR/LS0H (HF)</td>
<td>screw-type</td>
<td>IP 20</td>
<td></td>
</tr>
<tr>
<td>ecofil i 5G10</td>
<td>5</td>
<td>8 mm²</td>
<td>PVC / FR/LS0H (HF)</td>
<td>screw-type</td>
<td>IP 20</td>
<td></td>
</tr>
<tr>
<td>ecofil i 5G16</td>
<td>5</td>
<td>16 mm²</td>
<td>PVC / FR/LS0H (HF)</td>
<td>screw-type</td>
<td>IP 65</td>
<td></td>
</tr>
</tbody>
</table>

Properties

Flat cable systems

- Halogen-free (0H), no corrosive combustion gases
  - IEC 60754-2
  - EN 50267
- Self-extinguishing (FR) according to
  - IEC 60332-1
  - EN 60332-1
- Low fire propagation
  - IEC 60332-3 CAT.C
  - EN 50266-2-4
- Low smoke development (LS)
  - IEC 61034
  - EN 50268
- Cable design in dependence on
  - DIN VDE 250-214
  - and DIN VDE 0281

ecobus power 5G2.5 temporary installation on the right side of the tunnel used for lighting of works during construction.
In practice

„The costs related to connectors and couplers would be too high for us. And to introduce a cable and lay spur lines would be difficult. This is the reason why we have opted for the Woertz flat cable system.”

South entrance of the Katzenberg tunnel with two pipes

This statement originates from Roberto Piacentini from the machine technology department of the construction supervision. He is electrical engineering technician, at Wayss und Freytag, one of the four partners of the ARGE including Züblin, Marti and Jäger Bau. The tunnel drives from Efringen-Kirchen through the mountain. This phase of the project started in June 2005 and is part of the new high-speed railway line project from Karlsruhe to Basel. Once the tunnel has been completed in 2010, this railway line will serve as feeder for the new NEAT.
Efficient, cost-effective

Major project with 15 MW power input
80 percent less man hours
18 km flat cable

„Ducts and conduits are laid along the walls to carry power, wastewater, cooling water and so on. They seem to be endless. The total electrical connection power amounts to 15 MW, whereas our current consumption varies between 3 and 3.5 millions kWh per month“, according to Piacentini.

Supply sections
Within the tunnel electricians have installed transformers at intervals of one kilometer. Each transformer supplies 1000 m flat cable in one direction with a voltage of 400 V. The cable is made up with 5 conductors of 2.5 mm² cross-section. One section feeds about 80 lights.

Cost savings
„This solution involves higher material costs, but lower manpower requirements as compared to a conventional installation. To connect a lamp the electrician needs about five minutes. A total of 1500 lamps will be installed until the end of the construction works. Conventionally i.e. with cut-offs and branching boxes about 625 man hours would be necessary. With the Woertz flat cable system the lamps can be installed in about 125 hours. 80 percent less!“, plans Piacentini.

Security
About 90 workers operate in the tunnel in 3-shift. To ensure good working conditions, the worksite has to be lighted efficiently. The lighting installation provides not only illumination for the drives and intervention ways but also for the convergence measurements which allow a permanent control to see if the pipes move.
Lamps hang on the wall of each tunnel tube at intervals of 12 m. In addition, red lights indicate fire water stations and green lights special, fire-safe protection rooms.
The 385 meter long two-way traffic road tunnel „Rinderweid“ on the A1.1 acts as a feeder to the A-road A1 at Arbon. To achieve the regular maintenance works of the tunnel a traffic guidance facility is installed over the cantonal roads to deviate the traffic. A drive lighting is simultaneously installed. The electrical installations are connected to the control system of the canton Thurgau.

Flexibility and security
Installing the traffic guidance facility and connecting the installations to the main control system posed a more important challenge than installing light in the tunnel. As the tunnel could only be barred to traffic during short time frames, the installation of the new lights had to be performed quickly, easily and in a secure way.

During the day the tunnel was open to traffic. By night works had to be performed step by step so as to allow the tunnel traffic the next day. The Woertz flat cable was laid into cable trays and supplied. By night the lights could be mounted and connected to the cable. The Woertz flat cable system ensures a trouble-free mounting thanks to a special form-fitted connection technique. Time-consuming trouble shooting is thus avoided.

Facts & Figures
• Builder: federal office for roads ASTRA
• Planner: LBP AG
• Installer: Letech AG
• 800 m ecofill i 7G2.5mm2 FR/LS0H
• 220 supply and branching boxes
• Drive lighting
Cassanawald
Drive lighting in tunnels

Maintenance works on roads have to be well planned and quickly performed.

The 2.9 km long Cassanawald tunnel is located at an altitude of 1600m near Nufenen on the busy North-South road A13. Winter salting and heavy traffic have lead to serious damage and repairing may be difficult and costly.

Pre-wiring
To achieve real time savings lamps may be wired in advance to the flat cable connecting boxes. On the building site in the tunnel the lamps have only to be fastened and the boxes to be placed on the flat cable – electrical contact is made by tightening the screws and the installation is ready.

Facts & Figures
• Builder: public works service Graubünden
• Planer: Nay+Partner AG
• Installer: Kummler+Matter AG
• 3 km ecofil i 5G16mm² FR/LS0H
• 300 supply and branching boxes
• Drive lighting
Gotthard base tunnel
Lighting during construction of railway tunnel

Installation of temporary lighting on the building site has to be quick, safe and easy.

With her NRLA project (New Rail Link through the Alps – called NEAT project on German), Switzerland, the tiny country writes a remarkable new railway story. The Gotthard base tunnel is at the heart of this ambitious project: with a planned length of 57 km, it will be the longest tunnel in the world. The biggest construction job of this century promotes modern machines and new technologies. Both human and technical resources have to combine a lot of high requirements. All that has led to the development of a new connection box with high degree of protection. Thanks to the piercing technology substantial time savings will be performed.

No need for tools
To achieve real time savings lamps may be wired in advance to the flat cable connecting boxes. On the building site in the tunnel the lamps have only to be fastened and the boxes to be placed on the flat cable. The electrical contact is made by folding back the lever; thanks to the piercing technology the installation is performed in a matter of seconds without using any tool. With the boxes rated IP68, the connection points remain save even under the hard conditions inside the tunnel. Just click to light.

Facts & Figures
• Builder: ABAG – Alpiq-Burkhalter AG
• Planner: Hefti, Hess & Martignoni
• Installer: Alpiq AG
• 140 km ecoline P3 3G4mm² FR/LS0H
• >6000 flat cable boxes IP68
• Temporary lighting during construction
Safety first even in the longest tunnel in the world. Great attention is paid to workers safety and not only through the building phase. In the Gotthard base tunnel everybody has to get ready in the eventuality something unforeseen happens. Even after several years of operation a visible and good working emergency lighting is essential. The Woertz flat cable has to meet new requirements thus. Thanks to the recently designed flat cable with insulation integrity up to 180 minutes, the emergency lighting will be fed during three hours in case of fire and so the tunnel may be evacuated simply and safely.

Development
Innovative products combined with a long experience with flat cable technology are a good basis for developing new safety flat cables which will meet all stringent European requirements and give guarantee for the whole system. Corresponding tests and verifications may be performed by external independent testing laboratories. The interesting concept of the flame-resistant flat cable and its components is at the moment cheaper and safer than the usual ones – no compromise when it comes to safety!

Facts & Figures
- Builder: ABAG – Alpiq-Burkhalter AG
- Planer: Hefli, Hess & Martignoni
- Installer: Alpiq AG
- 230 km ecoline P3 FE180 FR/LS0H
- >10’000 flat cable boxes IP68
- Emergency lighting