Installations in tunnels

The significance of installations in tunnels can be easily illustrated when looking at the cost. For the 9.2 km long Plabutsch western tube (road tunnel) in Austria, the following sums have been spent:

<table>
<thead>
<tr>
<th>Installation</th>
<th>Costs in m €</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning, controlling</td>
<td>11.0</td>
</tr>
<tr>
<td>Main construction</td>
<td>91.0</td>
</tr>
<tr>
<td>Geotechnical measurements</td>
<td>2.3</td>
</tr>
<tr>
<td>Electrical equipment</td>
<td>18.0</td>
</tr>
<tr>
<td>Ventilation</td>
<td>5.8</td>
</tr>
<tr>
<td>Water supply for fire fighting</td>
<td>1.0</td>
</tr>
</tbody>
</table>

2.1 Installations for traffic control

Installations for traffic control comprise:

- Road signs
- Traffic lights at tunnels with emergency call provisions (to be placed at the portals, U-turn (turn-around) niches and at trafficable cross-overs).
- Traffic guide equipment (floor labelling, side reflectors)
- Traffic census. Peak of maximum allowable traffic (with respect to ventilation capacity) is indicated in the tunnel control-room.
- Height control to catch oversized vehicles before they enter the tunnel (measured e.g. with photo-sensors)
- Video-monitoring of those tunnels longer than 1,500 m or with a high traffic density. The entire tunnel length as well as the areas in front of the portals should be monitored.
- Modern sensors provide warning of traffic slow down (e.g. due to a fire).
The frequency of accidents in road tunnels is reduced by ca. 50% compared with open roads.\textsuperscript{1} The reasons are:

- Speed limits in tunnels are, in general, accepted by the users.
- Snow, ice, wind, rain and fog are rarely encountered in tunnels.

One should, however, take into account the consequences of accidents in tunnels which are much more severe than on open roads.

### 2.2 Installations for telecommunication

**Equipment for emergency calls:** These have to be provided in tunnels of more than 500 m length with a spacing of 150 m. Portals and U-turn-niches should also be equipped with emergency call facilities. Telephone boxes should be provided with glass doors that can be opened toward the tunnel.

**Service telephones:** These telephones have to be provided in tunnels of more than 1,000 m length at every service station and also in every control room. They are dispensable if radio communication facilities are provided.

**Radio communication:** In those tunnels longer than 1,000 m or with a high traffic density radio communication should be provided for fire brigade, police and road administration as well as for traffic announcements via radio. Radio re-broadcasting equipment and loudspeakers serve the information of the public.

### 2.3 Ventilation

With reference to tunnel ventilation, two different systems of ventilation have to be distinguished: ventilation during construction (i.e. during the heading of the tunnel) and service ventilation (i.e. during the operation of the tunnel). Expenditures on the latter amount up to ca 30\% of the total construction costs.

#### 2.3.1 Ventilation during construction

Ventilation during construction has the following aims:

**Supply with oxygen:** The O\textsubscript{2}-content of air should not fall below 20 vol.\%.

Below 18 vol.\%\textsuperscript{2} breathing is not possible and protection masks should be used. The lack of oxygen is due to:

- Combustion motors

\textsuperscript{1}According to G. Brux, Safety in road tunnels, *Tunnel*, 6/2001, 52-61, in the year 2000 up to 10 accidents per km tunnel.

\textsuperscript{2}This can be checked by the fact that a match cannot be lit.