

## Appendix 2.17 - SPAIN – Madrid – M30-Río-TUNNEL

### 1. INTRODUCTION

The M30-Río Tunnel is located in Madrid (Spain), a city of about 3,200,000 inhabitants. The M30 is the main ring road, linking all the neighbourhoods of the city (**Figure 1**).

The M30-Río Tunnel is in the South of the M30 and it runs along the River Manzanares, under the former ring, which is to be rezoned as a green area near the River. There are 21 entrances and 25 exits in the entire tunnel (**Figure 2**).

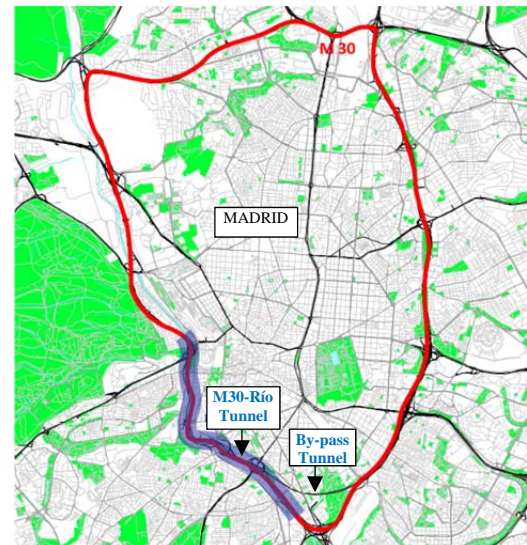


Figure 1 – M30 Ring Road in Madrid

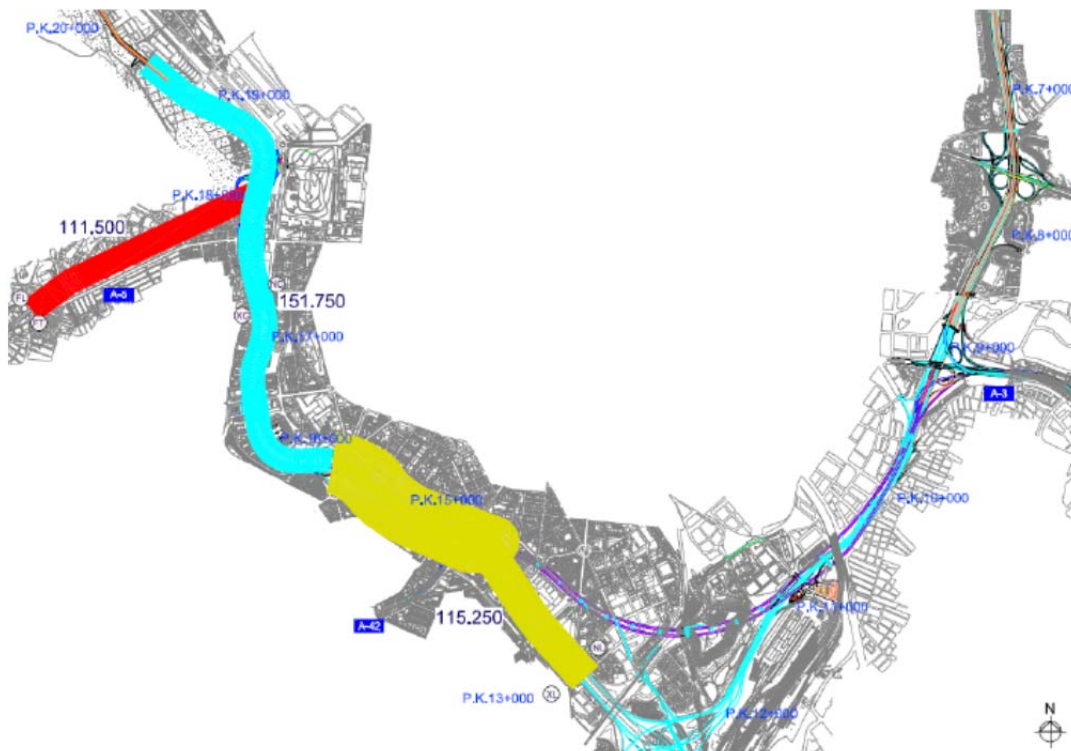


Figure 2 – M30-Río Tunnel location

There are 3 main sections in the tunnel:

- The green colour section goes from PK 13 to PK 16;
- The blue colour section goes from PK 16 to PK19.5;
- The red colour section is one of the main branches named Avenida de Portugal, with a length of 1,700 m per each direction, which connects the tunnel to the Highway A-5 direction to the city of Badajoz. It has direct access to the transport interchange Principe Pio, which is used exclusively for a bus connection with the docks.

The M30-Río tunnel, in service since 2007, is owned and operated by “Madrid Calle 30”.

The construction method was "cut & cover". It has two unidirectional tubes with a length of 16.4 km each including the main branch (Avenida de Portugal) (**Figures 3 and 4**).

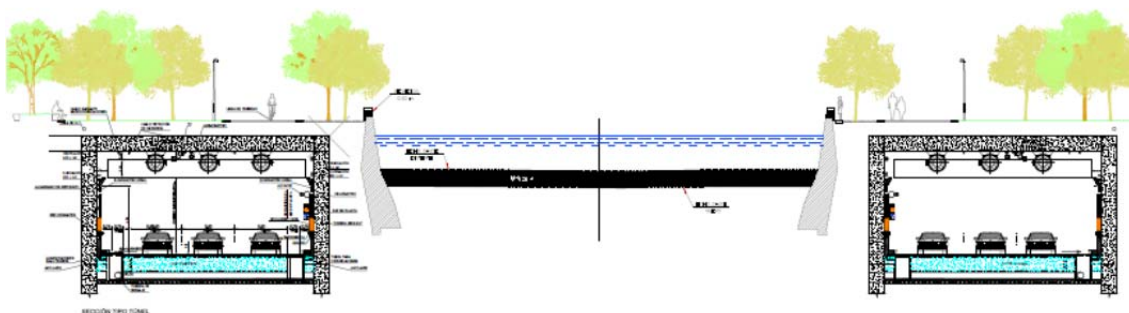


Figure 3 – M30-Río Tunnel. Cross section near the river, with 3 lanes

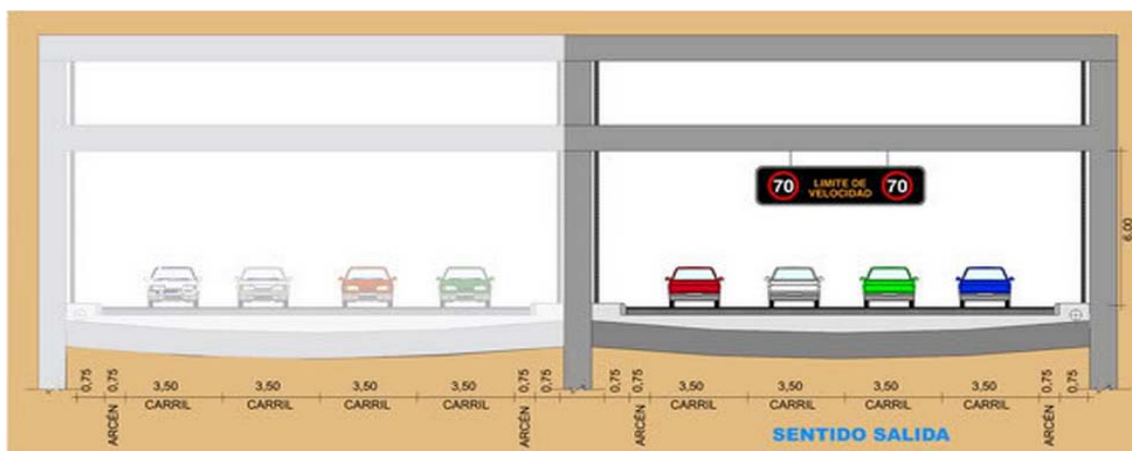


Figure 4 – Avenida de Portugal tunnel. Cross section under the Green area, with 4 lanes.

## 2. MAIN CHARACTERISTICS

### 2.1 GEOMETRY

- Tunnel length: 16.4 km including main branches,
- Horizontal alignment: minimum radius of curvature (internal road): 240 m,
- Vertical alignment: average slope 1%.

### 2.2 CROSS SECTION

#### 2.2.1 Main Tunnel M30-Río (Figure 5)

- 3 lanes of width 3.5 m each;
- 2 walkways at each side of width 0.75 m each;
- 2 shoulders at each side of width 0.75 m each;
- Vertical Clearance 4.5 m;
- Total vertical height: 5.5 m.

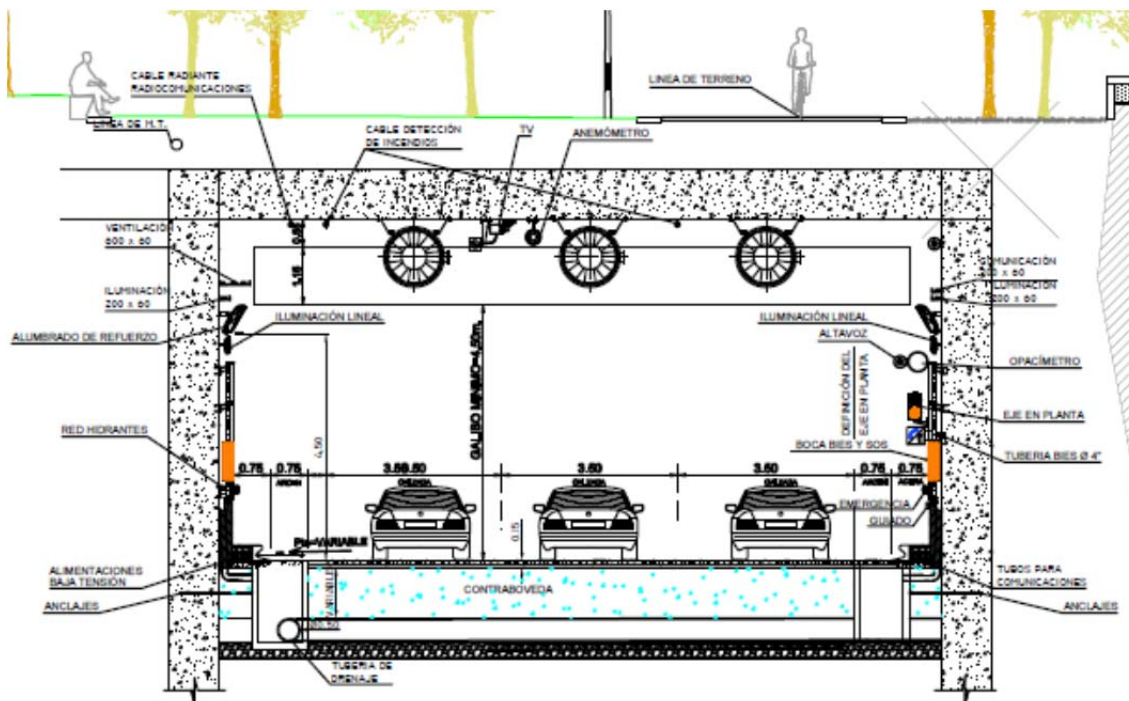


Figure 5 – M30-Río Tunnel. Cross section.

## 2.2.2 Main branch - Avenida de Portugal (Figure 6)

- 4 lanes of 3.50 m each;
- 2 walkways at each side of 0.85 m width each;
- 2 shoulders at each side of 0.60 m width each;
- Vertical Clearance: 4.5 m;
- Total vertical Height: 5.5 m.

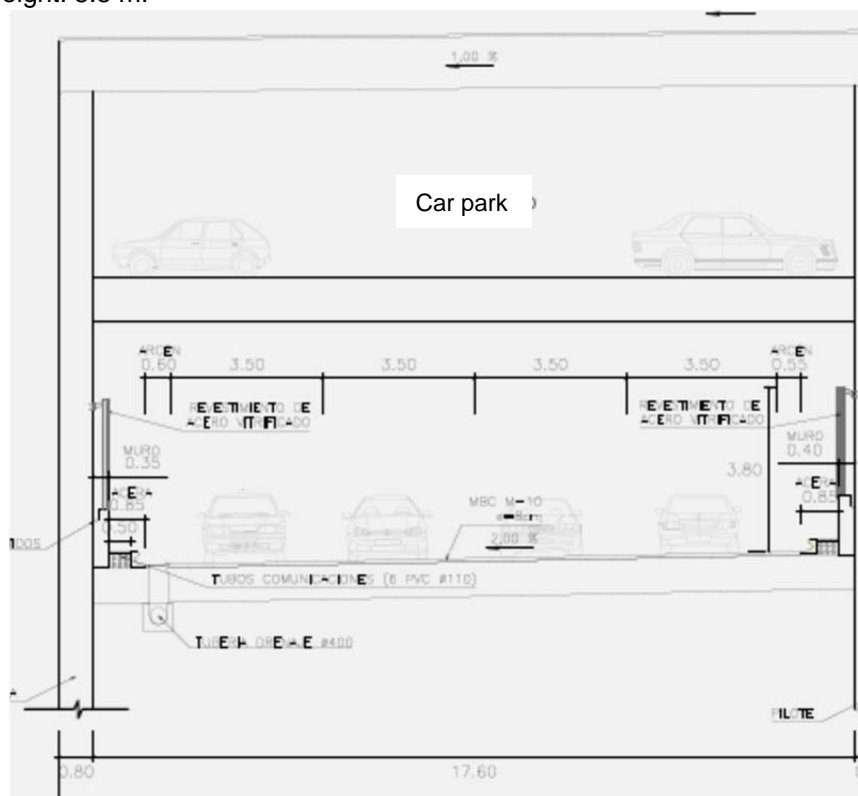


Figure 6 – Avenida Portugal Tunnel. Cross section

## 2.2.3 Escape route

- Emergency exits with spacing of 150 m in the area of the river, and 250 m in other areas, with direct access to the surface for pedestrians through stairs and automatic doors;
- Emergency exits are closed off by doors and pressurised.

## 2.3 TRAFFIC CONDITIONS, BREAKDOWNS AND ACCIDENTS

### 2.3.1 Traffic conditions

- AADT (Annual average daily traffic) for MAIN TUNNEL 150,000 veh/day in 2012;
- AADT for Avenida de Portugal 111,000 veh/day in 2012;
- Heavy vehicles: 0.05% inside the main tunnel and 5.26% in area near the transport interchange owing to bus transit;
- Dangerous HGV traffic is forbidden;
- Vehicles over 7.5 tons are forbidden;
- Speed limit: 70 km/h for the main road and 50 km/h or 30 km/h for branches in access and exits;
- No regular traffic queuing inside the tunnel;
- Hourly traffic distribution during the day for working days in the main tunnel: **(Figure 7: westbound) – (Figure 8: eastbound)**.

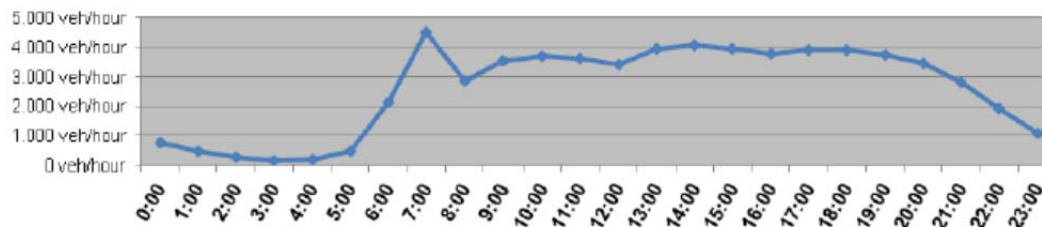


Figure 7 – Hourly traffic distribution main tunnel – weekday - westbound

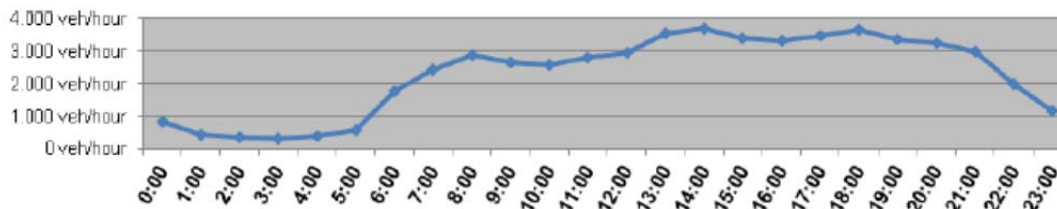


Figure 8 – Hourly traffic distribution main Tunnel – weekday- eastbound

- Hourly traffic distribution during the day for working days in the main branch: **(Figure 9: direction to Badajoz) – (Figure 10: direction to Madrid)**.

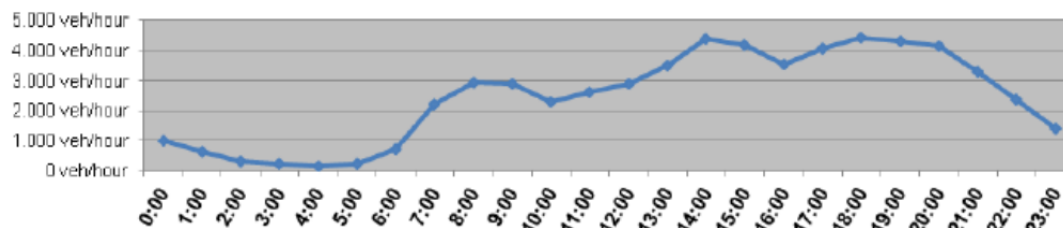


Figure 9 – Hourly traffic distribution. Main Branch – weekday- towards Badajoz

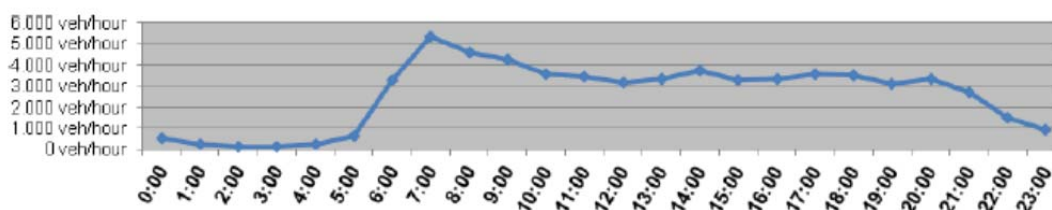


Figure 10 – Hourly traffic distribution. Main Branch – weekday- towards Madrid

## 2.3.2 Breakdowns and accidents

- Average of 331 accidents per year for the entire M30 tunnel system (40 km tubes, including M30-Río Tunnel and Bypass Tunnel);
- 2,697 breakdowns per year for the entire M30 tunnels;
- No fires;
- Analysis of the events shows that most accidents occur due to inappropriate speed or driver distraction.

## 2.4 VENTILATION

### 2.4.1 Ventilation system

- Longitudinal ventilation type with local massive air extraction stations. the objectives are: (1) regular ventilation - (2) control of air flow in case of fire and containment of smoke spread;
- Jet fans are placed along the tunnel approximately every 100 m;
- 600 m long ventilation sections, bounded by supply and exhaust shafts containing axial flow fans (**Figure 11**).

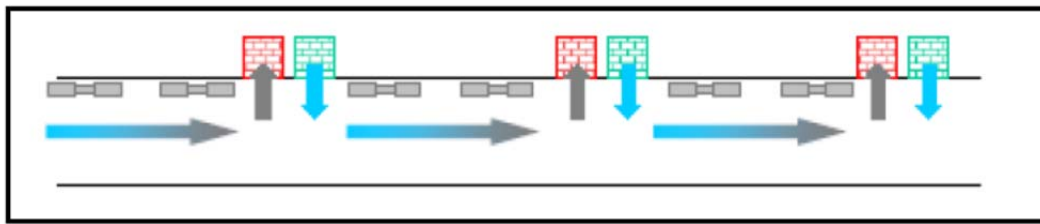


Figure 11 – Longitudinal ventilation

- Shafts with axial fans are designed for ramps and branches longer than 300 m. For the branches shorter than 300 m the ventilation is longitudinal,
- Overpressure of 50 Pa in emergency exit routes and cross passages permitting swing doors to be opened manually.

### 2.4.2 Main parameters of design

Design fire power of 30 MW.

Regular ventilation. Air flows are those required to maintain the contaminants under these figures:

- CO 40 ppm
- NO 2 ppm
- Opacity 4.

### 2.4.3 Strategy for regular ventilation system

Axial fans and jet fans are activated when tunnel sensors indicate that pollution limits have been exceeded.

### 2.4.4 Strategy for the fire ventilation system

- The ventilation section in which a fire is located is determined by the linear heat detector or the Automatic Incident Detection System;
- During the evacuation phase, smoke is extracted by the exhaust fans located in that ventilation section. The jet fans are deactivated to reduce undesirable disruption of smoke;
- Once people have been evacuated from the tunnel, the control centre staff can change the ventilation strategy so that smoke is drawn through the tunnel in the direction of the traffic, using jet fans and axial fans. This strategy enables fire fighters to approach the fire from one side;
- If the fire is located inside a branch or ramp, it will be ventilated longitudinally. Smoke will be exhausted in the direction of traffic, and people will be evacuated in the opposite direction.

## 2.4.5 Ventilation management

In normal operation, the ventilation system is controlled automatically, with input from tunnel sensors and traffic monitors. The emergency ventilation system is activated and operated manually, based on established procedures prepared for each situation. There are 149 protocol emergency sheets covering incidents in each section of the entire M30 tunnel system.

## 2.5 ENVIRONMENTAL ISSUES

### 2.5.1 Air quality

An air-cleaning system is installed inside the ventilation shafts. It includes electrostatic filters to reduce particulate emissions. These cleaning systems operate at the same time as the axial fans.

### 2.5.2 Noise

Sound attenuators are installed inside the ventilation shafts for the following purposes:

- At the top of the shaft, near the street to mitigate the noise of the axial fans to the external area;
- At the bottom of the shaft, to mitigate the noise of the axial fans inside the tunnel.

## 2.6 OPERATION AND SAFETY EQUIPMENT

The tunnel is equipped with all the usual operation and safety equipment:

- Fire hoses, fire extinguishers and hose connections for Fire Brigade uses;
- Water mist for the protection of the structures in areas that are below the River Manzanares and in roadways that are one over the other;
- Linear heat detector;
- Control Lighting with a system named DALI which permits to vary the intensity of the light ranging from 30% in low traffic hours, 70% during peak hours and 100% during breakdowns, accidents or maintenance works;
- CCTV with cameras connected to the AID (Automatic Incident Detection System);
- SCADA;
- Traffic loops;
- Signalling of the Emergency Exits and the location inside the tunnel.

## 2.7 OPERATION

M30-Río Tunnel is operated by two independent Management Control Centres (one for the regular operation and the other in stand-by) which are staffed at all times.

First line intervention teams and Maintenance Support are located at four points outside the tunnel, with the ability to reach any incident in the tunnel within 6-8 minutes of the first call. The team comprises one fire truck, one incident signalling lorry and one crane lorry to remove broken-down cars.