# Construction of a second tube for the Karawanks motorway tunnel

## General information

This project regards the **construction of a second tube for the Karawanks motorway tunnel** on the cross-border section between Austria and Slovenia.

The Karawanks motorway tunnel connects the A2 motorway in Slovenia and the A11 motorway in Austria[1] and is part of the TEN-T comprehensive network, connecting the Baltic-Adriatic and the Mediterranean CNCs (see Figure 2-1). It also connects hubs of the comprehensive and core transport networks (i.e., Villach-Klagenfurt, Ljubljana).

**Figure 2-1: Localisation of the Karawanks motorway tunnel with respect to the TEN-T CNCs**


Source: EC (2016)

The Karawanks motorway tunnel is currently single-tube and two-lane of approximately 8 km (see Figure 2-2). It was opened on 1 June 1991. In the initial planning activities, the construction of a double-tube tunnel was envisaged, but only one tube was eventually built between 1987-1991.

Until 1991, the Karawanks mountain was an obstacle between western and southern Europe. Traffic had to pass through the Karawanks railway tunnel or on roads across the passes of Podkoren, Jezersko and Ljubelj. Traffic flows of foreign vehicles (i.e., tourist and workers) were also quite relevant in this direction (Ljubelj border crossing and Korensko sedlo pass together) accounting for 4.500 vehicles per day on average. Moreover, prior to the opening of the tunnel, there was almost **no cargo transportation** on that route, due to poor road network conditions[2].

The Karawanks motorway tunnel opened an **important transport connection** for private cars and freight transport amongst major economic areas. The Karawanks motorway tunnel is an important transport link especially in summer months. Observed traffic flows of the weekends can reach three times the average daily traffic. This generates long queuing on both sides[3] and traffic diversion, which

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1 Between the toll stations of Rosenbach (Austria) and Hrušica (Slovenia).

2 Cargo transport was even prohibited at the Korensko sedlo pass and only a few drivers chose to use the road across the Ljubelj pass.

3 Due to the high traffic density in summer, an HGV ban has been introduced in recent years on summer weekends.

also have consequences for the subordinate road network and are often the cause of serious traffic accidents.

The tunnel does not have escape routes or protective spaces for emergency situations. This is particularly relevant for HGVs. Moreover, the insufficient ventilation and the two-lanes section pose enormous hazard potential in the event of fires. Thus, the Karawanks motorway tunnel is a **bottleneck and poses high risks** to users.

Therefore, the main goals are (i) to improve capacity and traffic **safety levels** and (ii) to reduce the environmental impacts on the adjacent areas.

**Figure 2-2: Detail of the localisation of the Karawanks motorway tunnel**


Source: EC (2016)

Regarding the **relevance of the project**, the construction of a second tube is (i) in line with the requirements of Directive 2004/54/EC on minimum safety requirements for tunnels in the TEN-T[4], (ii) it is object of a Memorandum of Understanding signed by Slovenia and Austria in 2015, (iii) it is envisaged in the Transport Development Strategy in the Republic of Slovenia (adopted in 2015), (iv) listed in the annex to the Austrian Federal Roads Act and (v) a letter of intent was signed by Slovenia and the Region of Carinthia in 2001 on the join implementation.

The Karawanks motorway tunnel is a tolled infrastructure. It is excluded from toll payment with regards to the EURO emission class[5].

[4] All tunnels must be harmonised with the safety requirements of this Directive by 2014. Since Karawanks tunnel is an international tunnel and because of the large number of tunnels in Austria, the deadline for the implementation of provisions under the Directive has been extended to April 2019.

[5] On the Austrian side, a time-based tolling system (i.e., vignette) is applied for vehicles up to 3,5 tonnes. A distance-based tolling system is applied for trucks and buses, with surcharges calculated depending on the

The Austrian Federal Ministry of Transport, Innovation and Technology and the Slovenian Ministry of Infrastructure are the promoters. ASFINAG and DARS are the implementing bodies.

## Technical description

The Karawanks motorway tunnel is currently **single-tube two-lane.** The **length** of the existing tunnel is 7.998,53 meters, of which 44% in Slovenia and 56% in Austria (see Figure 2-3). It has a total of 16 breakdown bays at intervals varying between 749 and 1.060 metres. There are no escape routes or emergency exits.

By upgrading from a single to a double-tube tunnel, a two-lane unidirectional traffic will be established[6]. The existing tube will be subject to thorough refurbishment works. The design speed will be 100 km/h. Emergency turn-offs will be arranged and transversal passages will be regulated for the passage of users and ventilation. The construction works are summarised below.

- Tunnelling and related works in **Austria**:
  - → excavation of the new tunnel tube and the cross cuts between the existing and new tube, including the landfilling of the excavated material;
  - → interior construction works for tunnel sealing, the drainage system and internal suspended ceiling;
  - → road pavement, coating of side walls and construction of shoulder with a cable duct;
  - → upgrading of the operations building for additional machines and control devices needed once the second tunnel tube will be operational.
- Tunnelling and related works in **Slovenia**:
  - → excavation and sub-construction of the new tunnel tube and the cross cuts between the existing and new tube including the landfilling of the excavated material;
  - → construction of three bridges: M1 (over Sava Dolinka, 165 m), M2 (over river Sava Dolinka, 30,7 m) and M3 (33 m long, meant only for the transport of excavated materials);
  - → execution of protection and relocation of public utilities in the area of tunnel portal and other systems outside and organization of connections and access roads to the landfill.

**Technical alternatives** have been analysed for compliancy of the Karawanks motorway tunnel with Directive 2004/54/EC, Austrian legislation on road tunnel safety and technical standards and requirements for road tunnel design in Slovenia. Alternatives were taken into consideration and risk assessments carried out. The analysis of alternatives was completed in 2014 and the decision was confirmed by an interstate commission. Other alternatives were not further analysed.

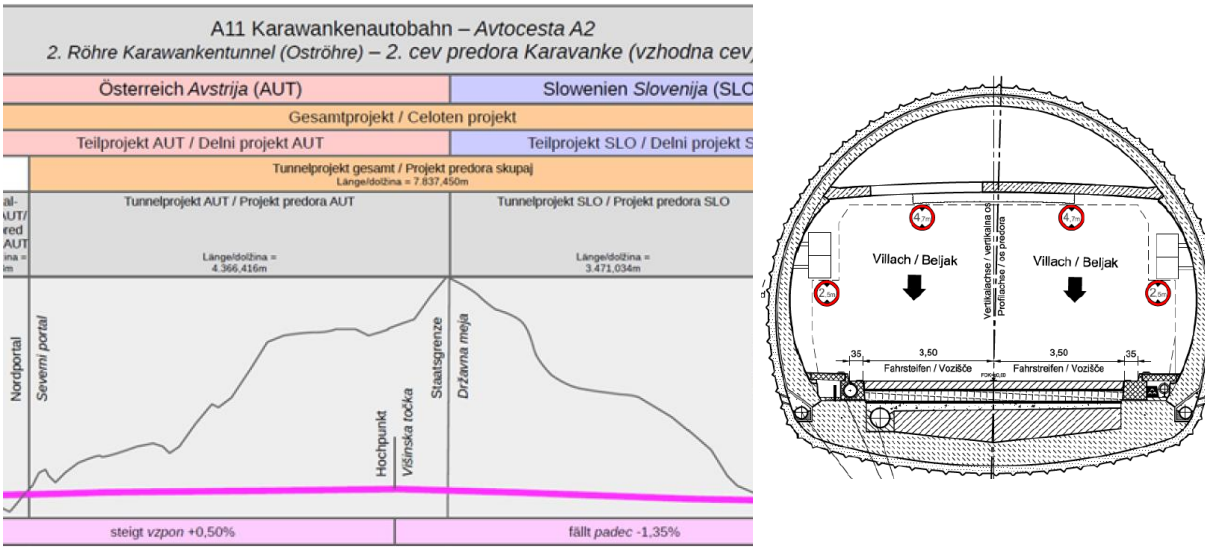
The total **estimated cost** of the investment alternative is € 317,1 million. Maintenance costs for double-tube tunnel have been estimated at € 1,8 million year (Snizek + Partner, 2017). Information on cost breakdown per category of cost and country is not available[7].

pollutant emissions and noise. On the Slovenian side, a time-based tolling system (i.e., vignette) is applied for vehicles up to 3,5 tonnes. Open and closed tolling system is applied for vehicles weighing over 3,5 tonnes.

6 According to project design, the tubes will be connected through cross cuts.

7 There is not information available to break out the amount of contingency included. This cost component could be high to address cost overruns expected for a tunnel project.

**Figure 2-3: Longitudinal and transversal sections of the Karawanks motorway tunnel**




Source: EC (2016)

According to the extensive geological and hydrogeological surveys carried out, the tunnel will be excavated through a massif of extreme geological complexity. The underground conditions are inhomogeneous and the expectable amount of mountain water is massive. Those factors would influence construction costs[8] and could end in a cost per kilometre 50-70% higher than other tunnels in the Alps. Therefore, the excavation of the second tube might require **higher financial resources**.

## Project implementation

With respect to the **maturity** and approval of the project, in Austria all prerequisites and authorisations to start are already in place. For Slovenia, the governmental Decree on National Spatial plan has been adopted and the preparation of detailed designs is in the final stage. The conclusion of the building permit is foreseen in June 2017. During the months to come investment and tender documentation will be elaborated. The duration of construction works is expected to lasts 3 years (i.e., from 01/01/18 to 31/12/20). Excavation works will start simultaneously on both sides.

Table 2-1 summarises on the schedule of the preparatory activities and procedures before the start of the construction works.

[8] Concerning cost risks, ASFINAG and DARS apply a margin of error of ± 10% for the period after the tendering of the construction services. As the level of uncertainty of tunnel implementation is higher, this margin of error can differ from the average percentage.

**Table 2-1: Planning of the preparatory activities of the Karawanks motorway tunnel**

| Item | Procedure | Planned publication |
|---|---|---|
| Tunnelling and related works in Austria | Open | 08/2017 |
| Project control and local supervision in Austria | Open | 02/2017 |
| Waste disposal supervision, including soil chemical supervision | Direct award | 09/2017 |
| Water law supervision | Direct award | 09/2017 |
| Environmental construction supervision | Direct award | 09/2017 |
| Health and safety coordinator | Open | 09/2017 |
| Tunnelling and related works in Slovenia | Open | 08/2017 |
| External quality control | Open | 08/2017 |
| Geological, hydrological and geomechanical monitoring | Open | 10/2017 |
| Health and safety coordinator | Open | 04/2017 |
| Consultant for verification of additional design measures | Open | 10/2017 |

Source: Elaboration from EC (2016)

## Transport demand

The A11 on the Austrian side and the A2 on the Slovenian side are important connections between central Carinthia (i.e., Villach and Klagenfurt) and Slovenia – especially the Ljubljana area. For Slovenia, the tunnel is a gateway to other EU Member States in Central and Eastern Europe.

Through documents made available, limited information exists regarding demand volumes crossing the Karawanks motorway tunnel (EC, 2016; Snizek + Partner, 2017).

The **average daily volume** through the Karawanks tunnel is reported around 10.000 vehicles per day, of which around 15% are heavy goods vehicles (i.e., HGVs). On summer weekends, especially during the peak tourism season (i.e., June-September), the traffic increases up to 34.000 vehicles per day. According to estimations, the double-tube tunnel is necessary if the average daily rate becomes higher than 20.000 vehicles per day.

To address vehicles queuing at the portals and safety issues, an HGVs ban has been introduced in recent years. Since 2011, HGVs over 7,5 tonnes cannot enter the tunnel on Saturdays in the summer peak season.

Other information is not available with respect to specific counts of the current traffic, forecasted trends and evolution of demand components (i.e., diverted from alternative paths and modes or induced).

## Financial analysis

The financial performance of the project has been carried out in terms of financial profitability. The documents made available do not report on financial sustainability analysis.

Concerning **profitability performance**, the following assumptions have been introduced:

- the appraisal period extends over 95 years, from 2021 to 2115. This to reflect the amortisation period of the tunnel;
- the overall investment costs of the second tunnel tube is € 317,1 million, which includes the construction of foreland bridges and portal facilities on both sides and the installation of electromechanical operation and safety equipment;
- costs for refurbishment and the operation of the tunnel within the amortization period are considered in the calculation;

- a discount rate of 4% was applied according to analyses of DARS;
- concerning the revenues, tolls charged at Karawanks motorway tunnel are expected to remain unchanged. However, even if the tolls were increased, this would only be possible to a minor extent and the results of the financial analysis would not change significantly.

According to the above, **FNPV obtained is equal to € -196,4 million** (see also Figure 2-4). The FIRR cannot be determined. The elaborations do not present additional information on sensitivity and risks analyses carried out.

With respect to the funding mechanism foreseen, ASFINAG and DARS will provide own resources for 90% of the investment costs from tolls, commercial loans and other sources. **The possibility of EIB loans is envisaged**. A CEF grant of € 24,97 million has been requested through application to the annual programme of 2016 (EC, 2016)[9] (i.e., 8% of the estimated investment cost).

## Economic analysis

In terms of appraisal period, the economic analysis relied on the same assumptions of the financial one. With regards to the reference and investment scenarios, the single-tube tunnel served as the reference scenario, but incorporated also the construction of a new escape tunnel. This according to the minimum safety requirements of Directive 2004/54/EC. The investment scenario added the second tunnel tube.

Investment costs are summarised in Table 2-2. Values are reported net of VAT. There are not additional indications of the conversion factors applied to the financial values. The documents available do not report on more detailed breakdown either by cost item or construction period.

**Table 2-2: Summary of estimated investment costs of the Karawanks motorway tunnel**

| Item | Value [€] |
|---|---|
| Access to tunnel portals | 10.831.143 |
| New second tunnel tube | 123.289.420 |
| Planning and project management | 24.988.385 |
| **Total** | **162.108.948** |

Source: Elaboration from Snizek + Partner (2017)

Operating costs have been estimated equal to € 1,22 million in the reference scenario and € 1,81 million in the projects scenario, respectively. Maintenance costs are assumed for refurbishment works every 30 years for (i) road concrete pavement and (ii) electromechanical equipment. These have been identified at three key points in time (i.e., 2050, 2080 and 2110). Table 2-3 summarises. The documents provided do not specify whether the values are net of VAT and on the conversion factors applied to the financial inputs.

**Table 2-3: Summary of estimated maintenance costs of the Karawanks motorway tunnel**

| Year | Concrete pavement [€] | Electromechanical equipment [€] |
|---|---|---|
| 2050 | 14,7 | 32,9 |
| 2080 | 30,8 | 44,3 |
| 2110 | 64,5 | 59,7 |

Source: Elaboration from Snizek + Partner (2017)

[9] Also the studies in preparation of these works received CEF grants. The application was submitted in 2014. The amount granted were € 3,5 million for Austria and € 3,7 million for Slovenia, respectively.

The benefit obtained considered costs variations of vehicle operating costs, travel time, accidents and emissions (see Table 2-4). The estimation of the benefits assessed the occurrence of traffic congestion at portals (i.e., waiting times)[10] and detour routes resulting from tunnel closures. Time savings for higher travel speed with a double-tube tunnel (i.e., 100 instead of 80 km/h) were also assessed.

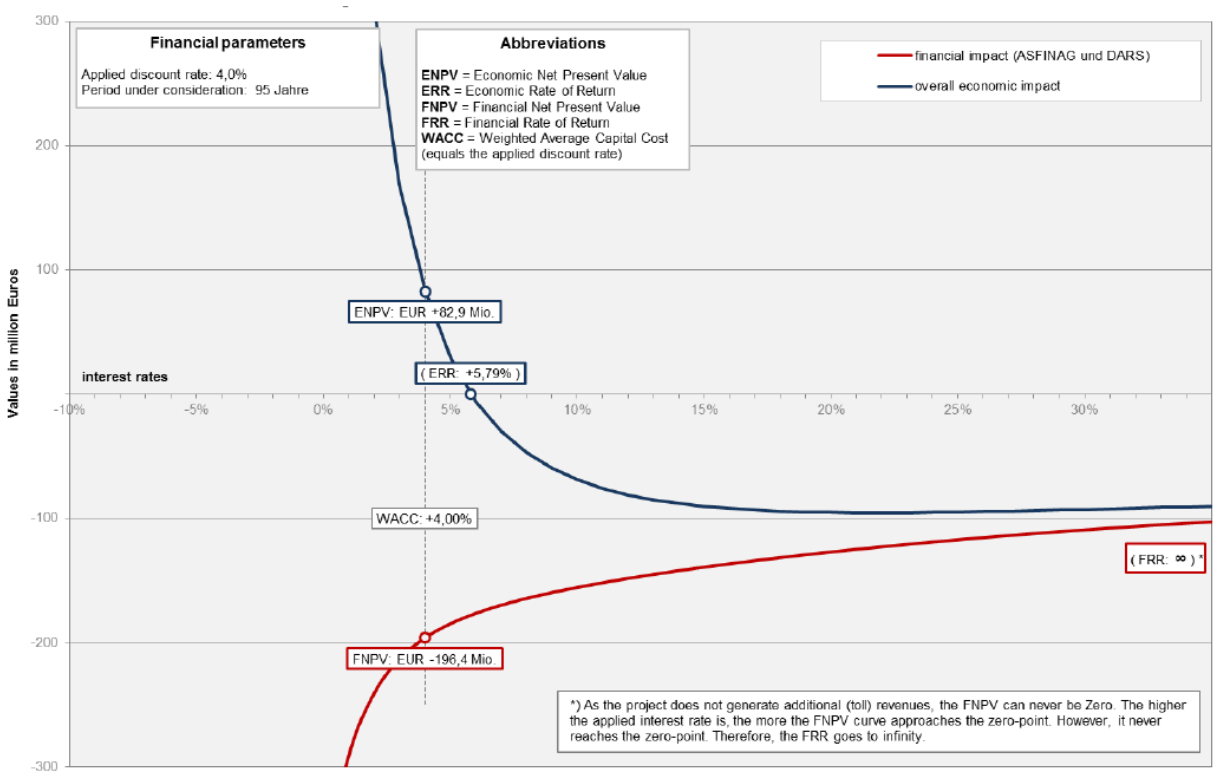
The economic analysis comes to the following performance indicators. Assuming a discount rate equal to 4%, **the ENPV is € 82,9 million and the EIRR is 5,79%** (see Figure 2-4). The elaborations do not present additional information on sensitivity and risks analyses carried out.

**Table 2-4: Summary of estimated costs and benefits (not actualised) of the Karawanks motorway tunnel**

| Item | | Value [€/year] |
|---|---|---|
| **Costs** | Investment | -581.586 |
| | Maintenance | -6.779.811 |
| | **Total** | **-7.361.397** |
| **Benefits** | Vehicles operating costs | 2.122.451 |
| | Time | 6.233.997 |
| | Accidents | 221.541 |
| | Noise | 0 |
| | Pollution | 7.498 |
| | Other environmental | 50.180 |
| | **Total** | **8.635.667** |

Source: Elaboration from Snizek + Partner (2017)

**Figure 2-4: Financial and economic performances of the second tube of the Karawanks motorway tunnel**




[10] Specific traffic surveys were not available. The analysis relied on the length of the queue at toll stations on the Austrian and Slovenian side. If a tunnel closure lasts up to two hours in both directions, drivers are being assumed waiting. If the closure lasts more than two hours, drivers' detours were assumed. Detours assumed are Wurzen pass for vehicles < 3.5 t and Spielfeld for vehicles > 3.5 t. Long-term tunnel closure (i.e. due to fire) was assumed ending in six-week closure.

Source: Snizek + Partner (2017)

## Environmental analysis

With respect to the EIA procedure, (i) in Austria it is reported that this is not necessary[11] and (ii) in Slovenia the EIA procedure was carried out and consent was issued on 16 May 2016[12]. In order to keep the environmental impact as minimal as possible, extensive geological and hydrogeological investigations have been carried out.

During excavation works, the protection and relocation of the sewage will be carried out to limit environmental impact. Regarding the reduction impacts during the operation of a second tunnel tube, it will prevent congestion at portals and additional travels, thus reducing the emission of environmentally harmful substances (i.e., $CO_2$, $CO_x$, $NO_x$, $PM_2$, and $PM_{10}$) and noise emission will drop. Reduction of energy consumption is also expected for improvements of the ventilation system.

The preparation of the project design (for the acquisition of a building permit and the executive design for the construction of the second tube) includes civil engineering services and minor physical interventions within the scope of geological research. These have no impact on the environment.

## Safety levels

The documents made available do not report on current safety levels of the road networks accessing to the tunnel on both sides. Besides, there is not specific information referring to reported incidents or accidents occurred inside the tunnel.

Several **safety measures** have recently been implemented by the national road infrastructure managers. These include thermo-scanning system for detection of over-heating HGVs, a metering system, a distance control system for HGVs – to preliminarily mitigate the risk of frequently recurring tunnel fires and collision accidents. In addition, there is an ASFINAG fire-fighting team on standby on the Austrian side.

Basically, the implementation of the second tube is expected to have a beneficial effect on the users. In case of accident in one tube, the other will safely be used for evacuation and access for intervention. In emergency situations, effective clearing of the area in front of the portal will be enabled and by-passes along the parallel traffic infrastructure will be arranged. Maintenance and action in extraordinary conditions will be easier and access for maintenance and intervention services will be facilitated.

[11] According to section 4 of the Federal Roads Act.

[12] The non-technical summary of the environmental report is part of the CEF application (Annex 11).