

NEW RAILWAY DIVACA-KOPER: PROJECT DEVELOPMENT

D.Kolic

Neuron⁴ Consult, Linz/Pasching, Austria

ABSTRACT: The main design of the new railway line Divaca - Koper for a single-track solution was finished for construction permission in 2016 and a new version of main design for a double-tube single track long tunnels was finished in 2018 with the pertinent construction permission that is already issued. Altogether 27 km of the second rail line with single track consists of 20+15 km of tunnels and 2 viaducts, passing through limestone and breccia formations in the north expecting karstic phenomena on the route. The southern half of the route is located predominantly in flysch. Main design has been prepared for conventional tunnelling along the route with no possibility to offer mechanized tunnelling. Financing has been principally agreed as well as resources providing required money. The project is at the moment in the procedure of detailed design that will enable the start of construction works on tunnels in 4th quarter of 2019. Approaching roads to tunnel portals have already been tendered and contracts for construction signed enabling the start of construction works in 2019. The construction time is estimated with the period of 5 years.

1. INTRODUCTION

The port of Koper as a distinct source of freight transport in Slovenia is connected to the rail network through the Prešnica-Koper single-track railway line built in 1967. This line is situated on particularly unfavorable terrain and presents a bottleneck in the Slovenian railway infrastructure due to steep gradients. Previous studies have shown that in the near future, the single-track electrified Divača-Prešnica-Koper line will no longer suffice for the increasing freight transport of the port of Koper. With the decision of the Government of the Republic of Slovenia, the Ministry of Infrastructure, the Ministry of Finance and the Ministry of Economic Development and Technology were instructed to propose as soon as possible to the Government the possible forms of financing and development of the project including public and private ways of financing. For the successful completion of the search of possible development of the project OECD/ITF proposed the publication of a public tender for a review of the investment value and the optimization and rationalization of the project that was finished until March 2017. Afterwards further check on project including public referendum for general acceptance and new government elections passed during 2017 and 2018 and project started under then new government from June 2018 and with the new construction permission end of 2018.

2. PROJECT PRINCIPLES

2.1 PROJECT DESCRIPTION

The development of the new second track of the Divača-Koper railway line began more than 20 years ago. The project had many supporters at all the time and designing performed until today for the largest project in Slovenia is an example of multi-professional good practice. The first variant of the line was issued 1996 and further 17 variants were developed in the time of 10 governments. The current tunnel route has been confirmed as the most appropriate, also due to consideration of environmental aspects. Principle project characteristics are:

Type of track:	single-track with preparation for double track
Length:	27,1 km
Estimated value of construction works:	EUR 1,047 million (with no VAT, prices on Dec.31, 2017)
Source of financing:	capital contribution from Slovenia and the rest of the country, European grant and loan, Estimated share of non-refundable EU funds: 21%
Traffic capacity:	231 trains per day (existing old and new track)
Transport capacity:	43.4 million tonnes per year (existing and new track)
Maximum slope:	17 ‰ (existing track 26 ‰)
Number of tunnels:	8 (longest: 6.714 m)
Total length of tunnels, service and exit pipes:	37.4 km
Total length of viaducts:	1.1 km
Total length of access and maintenance roads:	20.6 km

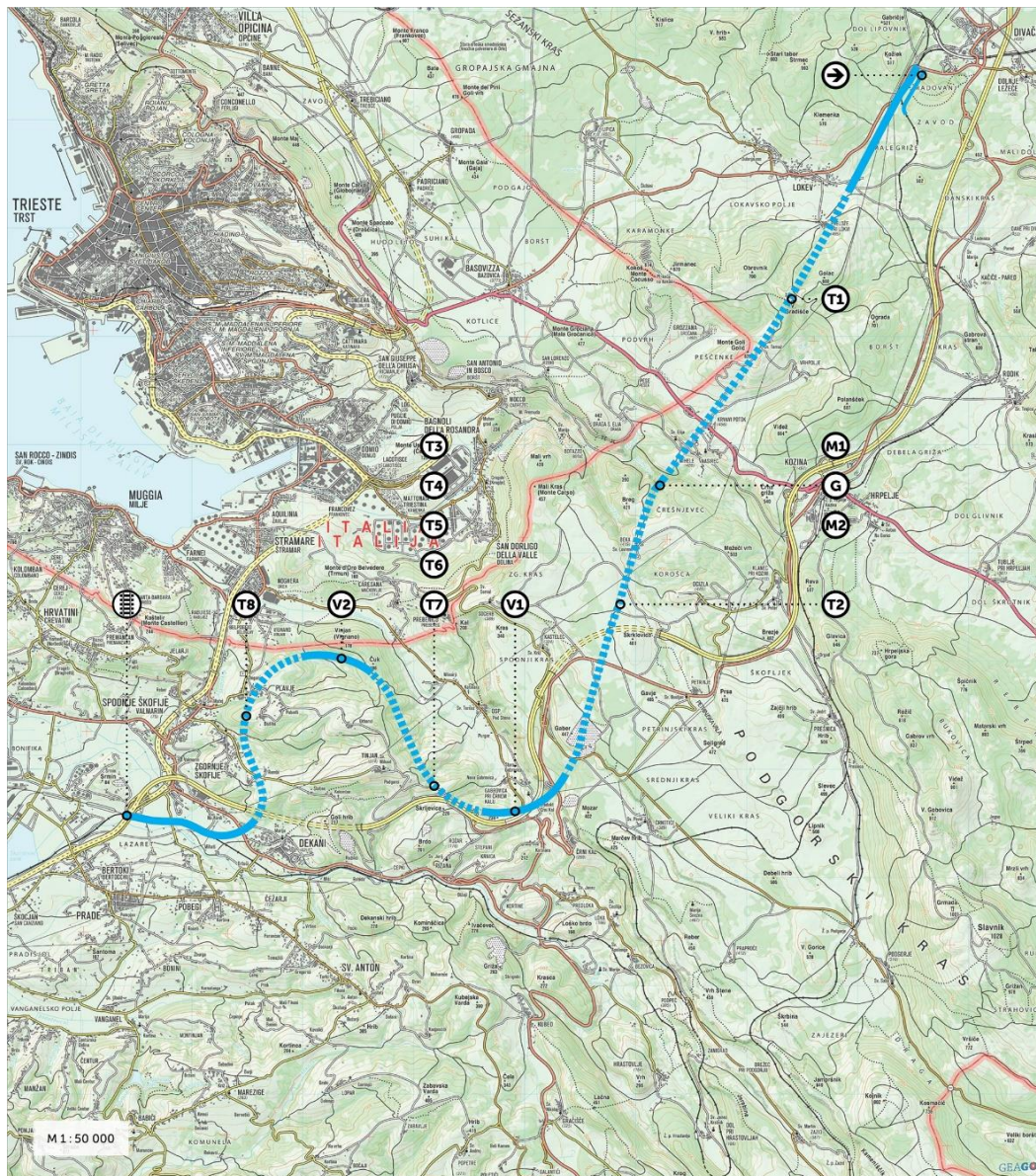




Figure 1: Layout of the 2nd track of the new railway line Divaca-Koper, final variant I/3, main project (blue line), with 8 tunnels of 20.5 km length (T1-T8), 2 viaducts (V1 and V2) of 1.1 km length, 2 bridges (M1 and M2), 1 gallery (G1)

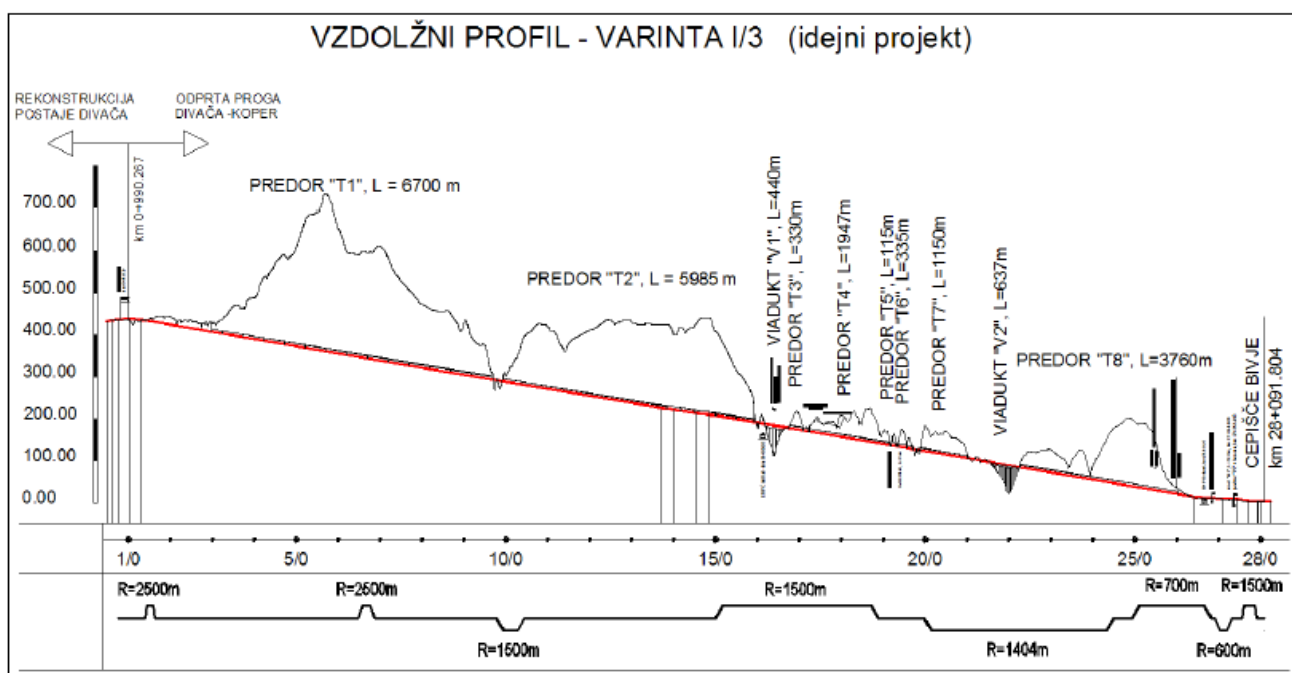


Figure 2: Longitudinal section of the 2nd track of the new railway line Divaca-Koper, final variant I/3, main project (red line).

2.2 THE PURPOSE OF THE SECOND RAILWAY TRACK DIVACA-KOPER

The new Divača-Koper line is part of trans-European transport corridor 5 which connects the cities of Venice, Trieste/Koper, Ljubljana, Maribor, Budapest, Uzhhorod, Lviv and Kiev, and includes road, rail and combined transport, ports and other required infrastructure. With the construction of this new railway line following targets will be achieved:

- ensuring the modern and efficient railway connection of the cargo port of Koper to the railway network in Slovenia and consequently also to the wider European rail network;
- the definitive elimination of all restrictions on permeable and transport capacity of the railway line from Koper to the Divača site;
- increasing the reliability of the operation of the railway line from Koper to Divača;
- increasing the level of traffic safety;
- reduction of driving times;

- reducing environmental impacts and reducing risks to the environment;
- additional increase in the share of freight carried by rail;
- facilitating and increasing the use of a more environmentally friendly type of transport.

2.3 IMPROVEMENT OF THE CAPACITY OF THE DIVACA-KOPER RAILWAY LINE

After completing the construction of the second track, due to the changed traffic organization, the capacity of the modernized old existing rail line route should be increased from 90 to 102 trains per day and the transport from 14 to 17.7 million net tons per year. Taking into account that freight trains are running exclusively in the direction from Koper to Divača along the new route the expected load of freight trains on the basis of the calculated tracking intervals, the capacity of the new line or second track 120 trains per day or 25.7 million net tons per year, while the capacity of both lines old existing refurbished line and the second newly constructed track should be is 231 trains per day with the volume capacity of 43.4 million tons per year.

3. PROJECT ELEMENTS

The route of the new line is envisaged to connect to the modernized existing line after the Divača station. After the Divaca station the route enters the first tunnel, T1, in which it runs in a straight line, with the exception of a slight arch approximately halfway through the tunnel. The route of the second track surfaces south of the Mihele settlement in the upper section of the Glinščica valley. The second track crosses the Glinščica valley with two longer bridges in the form of a closed box-shaped cross-section and closed galleries between bridges and bridges and tunnels. Platforms for maintenance access and safety and rescue are anticipated in front of both portals.

The implementation of a ventilation station for ventilating tunnels T1 and T2, which are connected with galleries into one tube is anticipated, within the portal of the second tunnel. In the first part of Tunnel T2, the route runs in a curve with a radius of 1,500 m and then in a straight line for most of the tunnel. A siding in the length of 750 m is planned in the last part of the straight line. At this point, the tunnel profile widens accordingly. A passing track will be placed right from the main one with the distance between the two axes being 4.75 m.

In the last part of the tunnel, where the route passes from the area of the Karst plateau to the surface, the route of the new line runs in a right curve. The implementation of the service platform is anticipated behind the portal of the tunnel for maintenance access and safety and rescue. In the immediate vicinity of the platform, the Črni Kal electric power sub-station will be constructed for the purpose of powering electric catenary.

3.1 CHARACTERISTICS OF THE NEW TRACK

- Length: 27.1 km
- Max. longitudinal gradient: 17 ‰
- Max. speed: 160 km/h
- Clearance: GC
- Axle load: 255 KN or 80 KN/m, (category D4)
- Tracks: 60 E1, mostly slab track
- Electrification : direct current 3kV
- Telecommunication system: ERTMS/ETCS level 2

Tunnel T1:	6,714 m + parallel service tunnel in full size cross section
Glinščica I Bridge:	74 m
Glinščica Gallery:	41 m
Glinščica II Bridge:	104 m
Tunnel T2:	6,017m + parallel service tunnel in full size cross section
Tunnel T3:	330 m
Tunnel T4:	1,954 m
Tunnel T5:	128 m
Tunnel T6:	358 m
Tunnel T7:	1,163 m
Viaduct V1 Gabrovica:	452 m
Viaduct V2 Vinjan:	647 m
Tunnel T8:	3,808 m + parallel service tunnel in full size cross section
Train formatting track:	approx. 1.2

Immediately after the platform, the route continues over the first viaduct, V1 - Gabrovica, and bypasses the village of Gabrovica under Črni Kal in a long curve. On the viaduct, the track runs below the Črni Kal motorway viaduct.

The route then continues almost entirely through tunnels, T3, T4, T5 and T6 along the southwestern slope of the Osp Valley. Access and service roads lead to platforms before the tunnels which enable access to construction sites during construction, while during operation they will serve as service and intervention paths in rescue operations. Access service roads in this area are linked to access service road T4-T7, which runs above the south-western slope of the Osp Valley.

At the end of its route on the Tinjan slope above the Osp Valley, the route of the second track turns south in the penultimate tunnel, T7. After exiting the tunnel, the line runs in dug-in and cut sections to viaduct V2, Vinjan, where the line crosses the valley of the Vinjan Stream and approaches the state border with the Republic of Italy.

After the viaduct, the line continues into the final tunnel T8. The route runs in a long left curve under Plavje and the hinterland of Zgornje Škofije and Spodnje Škofije. In the last part of the tunnel, the line continues in a sharper right curve, which will enable a maximum speed of 120 km/h. In the hinterland of Dekani, the line passes to a widened pre-cut behind the main road. Two service roads will lead to both platforms at the beginning and end of tunnel T8. The route continues down the valley of the Rižana River where the 17‰ incline reduces. The line continues on the embankment; it approaches the existing line and runs along it until the Bivje junction. At the area where both tracks connect, a new electric power sub-station Dekani is planned (it will be implemented in the context of the modernization of the existing line).

The speed on the section of the second track between Dekani and the Bivje junction gradually reduces from 120 km/h to 100 km/h and then to the final 80 km/h, which represents the maximum allowed speed in the deviation at the existing junction point for the Koper passenger station (R=760 m). In the final section, the line crosses a local road and a bicycle path. The line bridges the Rižana River with a new bridge which will be built next to the existing one. The installation of a point connection with the existing track is anticipated on the final section of the joint route. The route of the new second track ends at the Bivje junction.



Figure 3: View to the North portal of the tunnel T8 with single track active and service tunnel without track structure.

3.2 UPGRADE TO THE TWO TRACK LINE

The second rail track project envisages a single track with service lines along the longest tunnels. In order to enable the upgrade of the second track to the two-track route in the future, the Government of the Republic of Slovenia in June 2017 adopted a decision to provide in the first phase the necessary bases and projects for increasing the profile of the service pipes in the T1, T2 and T8 tunnels and to carry out a change in the construction permit.

In February 2018, the Ministry of Infrastructure, DRSI, obtained changes to the project building documentation, on the basis of which the ARSO decided in August 2018 that due to the increase in the profiles of the service pipes, it is not necessary to carry out a new environmental impact assessment and acquire a new environmental consent. Based on these decisions, 2TDK has reached the issue of a modified construction permit.

When the second track will be constructed approximately 60 percent of the parallel line will be already constructed as well.

4. CONVENTIONAL TUNNELLING

The entire tunneling sections have been designed as conventionally driven tunnels in formations of limestone. Typical cross section has been following requirements of the EU design guidelines for rail underground tunnels and recent practice in rail tunneling. Beside regular requirements for traffic rail tunnels additional profiles and structures have been designed following the concept of safety and ventilation on the rail line like cross over chamber in tunnel T2, additional service tunnel parallel with tubes of T1, T2 and T8 and side tunnels as escape routes with emergency exists. All mentioned

5. SAFETY CONCEPT AND VENTILATION

Safetyconcept and ventilation requirements made a serious influence on the concept of structures of the tunnelling part. Entire length of new railway line is 27 km with the constant longitudinal slope of 1,7% and with the height difference of 434.6 m. Tunnel length is 20 km that makes 75% of the entire new railway length. In addition due to the additional service tunnel structures that are planned to be constructed as parallel tubes with main tunnels T1, T2 and T8 the total length of tunnel structures is coming to the 36 km. Table 1 is showing additional tunnelling structures that are to be constructed because of safety reasons and required evacuation routes.

Table 1: Overview of tunnel structures and safety tunnels on the section Divača-Koper.example

Nr.	Tunnel length	System	Evacuation routes
T1	6'700 m	1 single tube , single track	Parallel service tunnel, <u>In full cross section size</u>
T2	5'994 m	1 single tube , single track	Parallel service tunnel, <u>In full cross section size</u>
T3	330 m	1 single tube , single track	Over tunnel portal
T4	1'947 m	1 single tube , single track	Evacuation side tunnels with emergency exists
T5	115 m	1 single tube , single track	Over tunnel portal
T6	335 m	1 single tube , single track	Over tunnel portal
T7	1'150 m	1 single tube , single track	Evacuation side tunnels with emergency exists
T8	3'760 m	1 single tube , single track	Parallel service tunnel, <u>In full cross-section size</u>

Tunnels T1 and T2 are connected with one bridge structure in a form of a closed setion, like a tunnel as well. The distance between tunnels T1 and T2 is about 500 m and this way both long tunnels and closed bridge are making one tunnel structure TK_1 of about 12.935 m length.

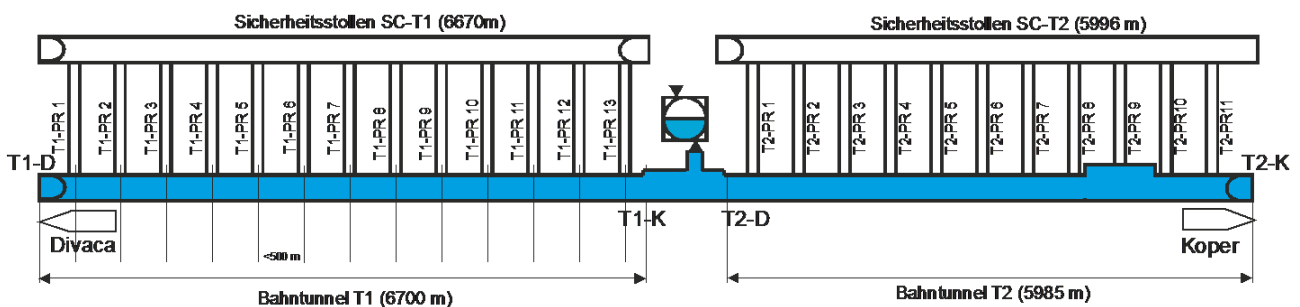


Figure 6: Ventilation concept for tunnels T1 and T2 of the 2nd track of the new rail line Divaca-Kop.

6. PROJECT FEASIBILITY AND FINANCING

6.1 PROJECT FEASIBILITY

In addition to the financial analysis, the economic analysis was carried out with a view to calculating the eligibility of the project from a social point of view. In calculating the economic performance of the project (economic net present value - ENSV, economic rate of return - ESD), measurable economic benefits and costs in the table on the next page were taken into account. In addition to measurable benefits taken into account in the calculation of economic performance, as a result of the project, the realization of the below mentioned non-identified or qualitative benefits is also expected. These benefits are not taken into account in the calculation of economic performance but have a positive impact on society.

Key economic benefits and costs of the project are:

Type	Description
Costs	Initial cost of investment / investment in fixed assets (CAPEX) Additional operating costs, replacement costs and savings in the renovation of an existing line
Benefits (quantified)	Increased revenues from railway users' charges (regular usage) and increased user charges Saving operating costs for cargo carriers and passengers Time saving for cargo carriers and passengers due to shorter and faster routes Reduced specific risks of existing lines that cause traffic disruption and closure of the line External savings due to increased use of rail transport
Benefits (non-identified)	Increase productivity Positive impact on the spread of port Koper Job creation and economic growth (contribution of the project to the economy) Increased reliability of transport of passengers and cargo Better access to other markets Improved transport links for travellers and better opportunities for tourism development for the coastal region

The results of the economic analysis of the CBA show that the project is economically justified, as it contributes to a general increase in social welfare. This is confirmed by the economic net present value (ENSV) in the amount of EUR 183 million, the economic rate of return (ESD) is 6.60% and the ratio of benefits and costs (K / S ratio) to 1.46.

6.2 PROJECT FINANCING

In addition to the initial investment costs, 2TDK will have to provide financing for other costs that will be incurred during the construction period. These consist of EUR 12 million of operational costs of the 2TDK and EUR 32 million of costs of interest, compensation and other needs. The total amount of financing at current prices excluding VAT is thus EUR 1,194 million.

The investment will be financed by various sources. The largest part is supposed to be the capital contribution of Slovenia, the amount of which will depend on the possible participation of the second back country. The total amount of capital is estimated at EUR 522 million, of which EUR 122 million

will be invested by Slovenia from the collected toll on freight vehicles (a dedicated vehicle premium weighting of 3,500 kg on a certain motorway corridor) ("Toll toll") and 200 EUR million from the state budget. In the event of the cooperation of the back country, it will contribute an additional EUR 200 million of capital, while in the opposite scenario this will be covered by Slovenia from the state budget. Additional funds are expected in the form of EU grants (EUR 250 million), loans from international financial institutions (MFIs) and SID Bank (total of EUR 250 million) and loans from commercial banks (EUR 167 million). In addition, EUR 6 million will be generated through increased user charges for users of railway lines in the Slovenian core network ("Increased user charges") collected during construction.

Table 2: Investment value and sources of financing during construction period excluding VAT.(in €mill.)

Investment	Value (mill.€)	Sources	Value (mill.€)
Costs of construction	1.150	Increased charges for railways	6
Operating costs of the 2TDK at the time of construction	12	EU grants 250 (May 17,2019 confirmed)	250
Interest, fees and other charges	32	Loan of MFI / SID Bank	250
		Loan of Commercial Bank	167
		Capital of Slovenia - Toll Collection	122
		Slovenia's capital and loan of EIB	400
Total	1.194		1.194

During the period of operation, 2TDK will cover its activities with the use of the second-tier, Increased User's and Pay-Per-Action Payments. The latter represents the payment of the Republic of Slovenia to 2TDK throughout the operational phase for the provision of a second rail accessibility for the smooth operation of rail transport, in accordance with the "no service, no payment" principle and in accordance with the concession contract. This payment should amount to EUR 35 million per year at current prices (prices in 2026) and will be financed from a newly introduced tax on transshipment at the Koper freight port (Transaction Tax) and a toll on heavy goods vehicles in certain parts of the Slovenian motorway network ("win from toll"). The project will be fully financed by infrastructure users, i.e. carriers of goods by road, railway and through the Port of Koper. The project is also eligible for EU support, while at the same time it is financially sustainable.

6.3 INVESTMENT VOLUME

The basic cost of investing the project in the second track at constant prices is estimated at EUR 968 million, and with specific reserves for unforeseen work at EUR 1,011 million. It consists of implementation works (EUR 879 million), purchases (EUR 10 million) and services (EUR 121 million). Additional contingency reserves (EUR 91 million), mainly due to the complexity of the site, are included in the investment appraisal amounting to EUR 1,102 million. Costs incurred before 2018 amount to EUR 55 million and are not taken into account in the final investment cost. The latter is estimated at EUR 1,047 million at constant prices excluding VAT.

Table 3: Summary of investment costs excluding VAT (EUR million)

Investment costs excluding VAT	Current prices ⁽¹⁾	Constant prices ⁽¹⁾
Basic investment costs	1058	968
Specific contingency reserves	47	43
Investment costs with specific reserves	1105	1011
- of which: Performing works	966	879
- of which: Purchases and other costs	11	10
- of which: Services	128	121
General contingency reserves	100	91
Total investment costs with reserves	1205	1102
Already used costs of services (before 2018)	-55	-55
Total future investment costs	1150	1047

[1] Constant prices are used in the assessment of the final value of the investment, in calculating the financial return on investment and in the economic analysis. Current prices are used to calculate the required sources and use of financing, analyse the financial sustainability of 2TDK and calculate the return on the national contribution.

7. CONCLUSION

The new railway line Divaca-Koper is a technical and financial challenge that may make a milestone in the development of modern railway structures nowadays. The project is predominantly situated in the underground with 36 km of tunnels on 27 km of the length. From the financial point of view it will be financed for different sources but in a public way of procurement, however some private investors would be welcome. The development of the port of Koper and intensive need to use this port as the export port for mainly car industry opens a possibility to construct this serious civil engineering project and at the same time provides the way how to develop other similar transportation rail infrastructure in the future. The start of the tunnel construction is foreseen for 4th quarter of 2019.

REFERENCES

- [1] Gradbeni inštitut ZRMK: "Geological and geotechnical study for the phase of the project design for a building permit for the second track of the Divača-Koper railway line, Črni Kal-Koper section", prepared for construction permit as the project no. 3610/T for the route on Črni Kal-Koper section, Ljubljana, in September 2010, *(In Slovenian)*
- [2] Gradbeni inštitut ZRMK: "Geological and geotechnical study for the phase of the project design for a building permit for the second track of the Divača-Koper railway line, Črni Kal-Koper section", prepared for construction permit as the project no. 3353 for the route on Divaca-Črni Kal section, Ljubljana, in September 2012, *(In Slovenian)*
- [3] SŽ - projektivno podjetje Ljubljana, d.o.o. : "Project design for a building permit for the route of the second track of the line, project No. 3610/T", prepared in July 2010, *(In Slovenian)*
- [4] SŽ - projektivno podjetje Ljubljana, d.o.o. : "Project design for a building permit for the route of the second track of the line, project No. 3623/T", prepared in July 2011, *(In Slovenian)*.
- [5] KOLIC, D.: „Tunnelling on New Railway Line Divaca -Koper”, *Underground Construction 2016*, Prague, May 23-25, 2016, pp.8
- [6] <http://www.drugitir.si/2tdk/javna-narocila/dokumentacija>, 02.2019

Dipl.-Ing.Dr.sc. Davorin KOLIC, M.Sc.

Neuron 4 Consult ZT

office@neuronconsult.eu