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CHOOSING CROSS SECTION OF TUNNEL

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Abstract: *The development in recent decades of the underground transport led to the need for large sections in all sectors of transport: road, railway, subway. This paper presents timing and rational choice of parameters required for choosing the cross-section of tunnel. The rationality refers to both technical and economic conditions or simply to the investor wishes.*

Key words: *tunnel, cross section, rational choice.*

1. Introduction

Transport development in the last decade, including the underground transport, led to the need for greater cross sections of the transport ways in all sectors: road, rail, subway and hydraulics. It is believed that the problems arising in the execution of underground works are proportional to the squared of opening.

The parameters that require a certain cross section, beginning with construction gauge and free way gauge and continue with tunnel length, litostatic pressure, ventilation, lighting, safety, traffic speed, and psychological factors, and not at least the requirements of the operator. To achieve such works all these parameters must be linked to the economic side too.

Currently the performance in tunnel construction compete the most optimistic expectations.

We are already used with the achievements of the last century (XX century) such as: the double railway tunnel between the Japanese islands of Honshu and Hokkaido, Tsugaru Strait under length 53.85 km (put into operation in1988) or the two simple way parallel tunnels, between France and the United Kingdom with a length of 53.3km (put into operation in1994).

Nowadays, (XXI century), has already been accomplished 57.00 km of tunnel of Saint-Gothard (which will be put into operation in 2013).

We recommend to have into consideration some of these parameters that we presented.

2. The construction gauge and the free passage gauge

2.1. For railways tunnel

The construction and free passage gauge for normal railway (single path) is well regulated by Romanian standards in accordance with the regulations related to the UIC railways and OCCT and after those was achieved the standards and tolerances from Instruction no. 314. There are no rules for normal or double railway and for speeds from 200 km / h upwards. Of course to the free passage gauge in alignment we have to add the needs for expanded, extra built and the tunnel axis movement in curve.

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For the construction gauge we adds, as appropriate, the gauge limit for works of art, electrification gauge, SCB installations, the limits of the ballast riddled machine, having allso effects of pressure and suction.

At speeds above 200km/h we should take into account the constructive additional because we can say that the train is the piston from a cylinder of a mechanism.

Also safety measures must be provided to maintenance the works especially in tunnels without risk (the tunnels without niche), because it is known that a train traveling at 120 km / h creates an attractive force, a vacuum, to which at 1 m distance from the train a man can not resist, standing on a platform. The phenomenon is similar to the so-called vacuum pump.

In the special literature we did dot found data about the action of a high-speed train passing through a tunnel (not even a wind tunnel study).

2.2. For road tunnels

Currently in Romania there are not special standards to regulate the construction gauge of a tunnel.

Now we used the gauge for metal bridges with down path that to wich we added the necessary and specific areas, such as psychological (ex. The driver tends to get away from the walls, heading for the track that is opposite to the wall) especially in the tunnels with vault.

With the observation that the height for free passage gauge is now 5m (not 4.5 m as shown in figure 1), we present the three cross sections of the highway [2].

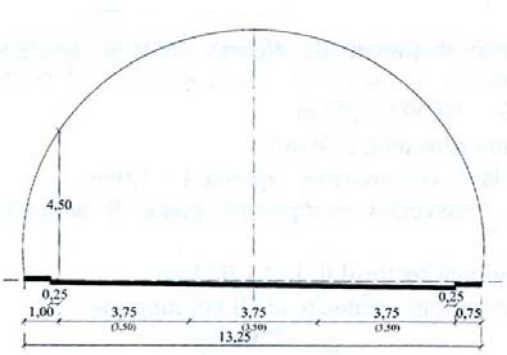

Fig. 1a. *Unidirectional tunnel profile.*

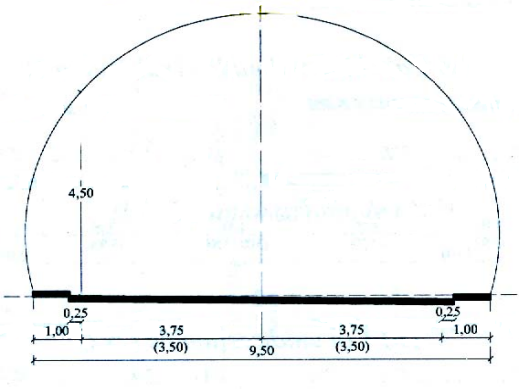

Fig. 1b. *Unidirectional tunnel profile without stationary place*

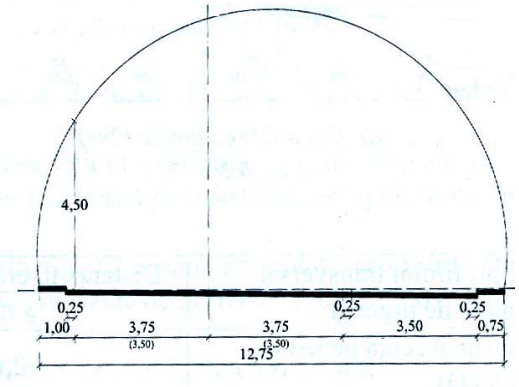

Fig. 1c. *Unidirectional tunnel profile with stationary place*

In 1968, in our country, there were realized tunnels with 4.5m height gauge approved by CSCAS (State Committee for

Construction, Architecture and Planning), without taking into account the inaccuracies of the building spaces or psychological space.

All tunnels were made on a national and european roads.

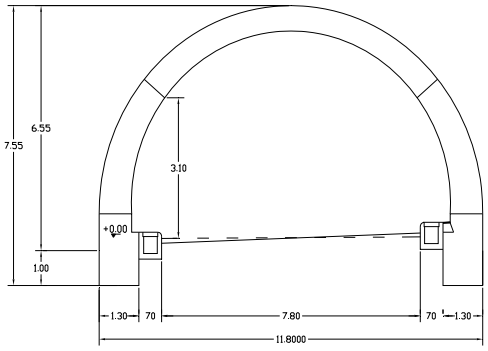

Fig. 2. *Road tunnel profile, Bahna 1968*

According to the technical rules of TEM, for the tunnels that are longer that 1.00 km, parking areas are provided (stationary) of 40mx 2,5m, for the damaged cars, with a distance between in according to the regulation of each country.

In our country it is expected that the tunnels over 2km to have platforms (30mx3m) with a distance between of 1.00km.

This directive requires that on these areas we must use a different cross section for tunnels. But neither for this profile the road tunnels on national highways, have the profile regulated by national or special standards.

2.3. Underground tunnels

The metro, is built mostly, inhabited area and is not fully assimilated with the railroad. For this category of tunnels the company Metroul of Bucharest, has its own rules.

Generally the section is circular on the each way, because the most comfortable technology is with the shield.

In case of a suitable rock, NATM technology can be applied and then the cross section can take different forms, including the parabolic one, depending on the available space. Usually the big underground spaces run between diaphragm walls with storied frame structure, but it can run with vault profile too, that is mainly subjected to compression.

3. The cross section through both lines of traffic

3.1. Railway tunnels

The two wires of movement can be organized either double-track tunnels (see Fig. 3) or with simple way using separate tunnels (see Fig. 4a, 4b).

We can affirm that an important role play the distance between tunnels, so called pillar.

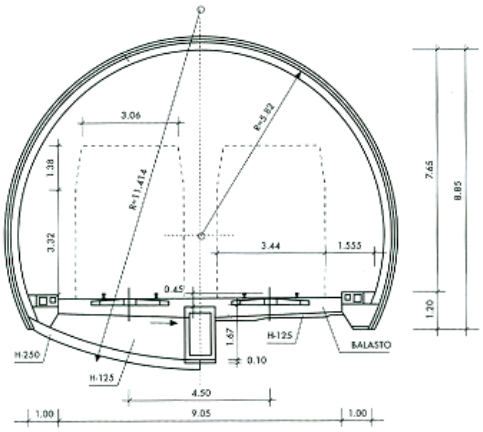

Fig. 3. *Double-track rail tunnel*

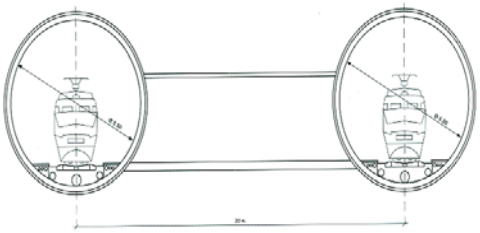

Fig. 4a. *Railway tunnels with simple parallel way, spaced and connected by galleries*

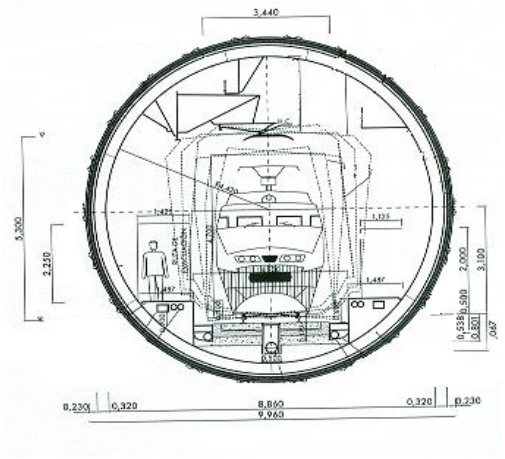

Fig. 4b. *Railway tunnel with simple track*

Depending on the nature of rock the distance between tunnels (pillar width) left as floor varies from P = 15 to 30 m (In figure 4 we present the case of Guadarrama tunnel, Spain).

Joints tunnel are not recommended because the central point can becomes critical in case of fire or geology accidents.

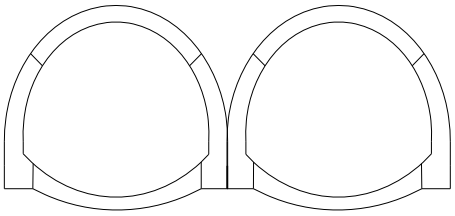

Fig. 5. *Simple joints railway tunnels*

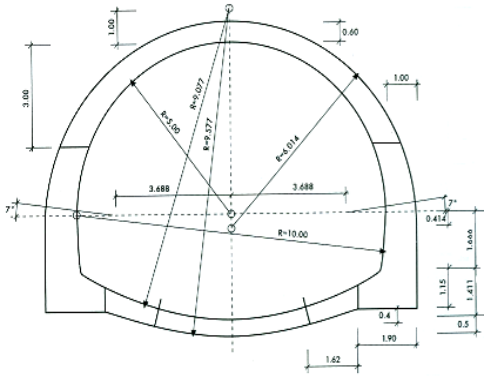

Fig. 5a. *Detail simple joints railway tunnels.*

3.2. Road tunnels

For the tunnels with one way track for each direction it is ok to build only one tunnel. But if the road has two or more tracks separate tunnels are necessary for each way. If:

D = distance between the underside of the straight legs of a tunnel;

P = the landing width measured at the underside of the straight legs;

K = varies with rock and site conditions between 1.25 and 2.5.

Than : $P = K \times D$ (1)

Fig. 6. *Road tunnel spacing for each direction*

Regarding to the choice of cross-section an good example is the comparison between Japanese tunnel under the Tsugaru and the tunnel made under the English Channel. The japanese chose one tunnel with double section. Costs have gone up from the original estimate and the execution time was increased to 10 years.

Europeans chose two single track tunnel with a service tunnel between them. They ranged in cost and execution time was short. They worked with four shields at the base of the tunnels and at the same time at the prospecting gallery and rescue service gallery.

The reason of such section was relevant when, with all the security measures PSI, a train caught fire in one of the galleries and circulation was interrupted for one year for structure reconstruction. This system of tunnels still allowed traffic between France and Britain.

In case of undercrossing other communication ways, or in towns, where coverage is low and lithostatic pressures are low the structural strength can be joints in the form of frames but without pillar, the straight joints legs will be treated like a special case.

3.3. Underground tunnels

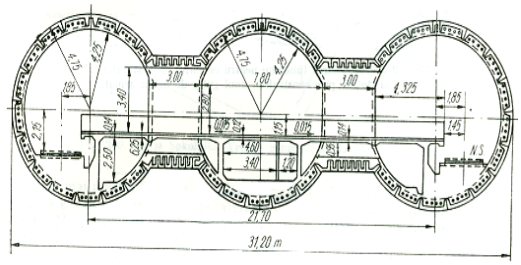

Fig. 7. *Metro Station performed with three vaults of metal tubing*

As we show in section 2.3., space is often reduced between monumental building with a very small coverage the tunnels are realized joints or with a very short pillar. (see fig.7) [1].

3.4. Hydraulic caves

In case of large cavern there are recommended higher floor (see fig. 8). Generally the galleries section are not exceeding 5 m in diameter and sometime can be single. From case to case also can become joints.

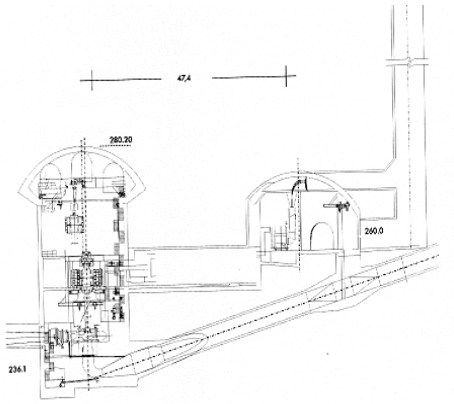

Fig. 8. *Pillars between hydraulic caverns*

4. Conclusions

- Because a lifetime of a tunnel is running for least 100 years to establish cross-section we must be considered further realization of attachments;
- We must considered the consolidation works;
- In our country we have no standards for tunnels execution with different cross sections;
- For speeds above 200km / h we have no regulation;
- It is recommended that whenever economically is justified, to provide separate tunnels for both directions of travel;
- In case parallel tunnels and especially when there are tunnels

with technical gallery or rescue gallery between we recommend the use of pillars.

5. Acknowledgements

- It is necessary to develop some regulations for cross sections of communication tunnels and including highway too;
- In a big investment, like the construction of a tunnel, with the choice of execution technology, establishing the cross section, has a special significance.
- Expensive or cheap, this work can reduce the execution period, and this is essentials for entier project.
- On the Romanian network of roads there are tunnels with a gauge height equal to 4.5m and that do not meet the height of 5m. To eliminated the transport oversized procedures, we must have endorsed a new indicator of movement that is coupled with automatic traffic lights (height reader) and let pass the vehicles greater than 5 m, on a the traffic with one central thread.

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