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A STUDY ON GOTTHARD BASE TUNNEL

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ABSTRACT

The Gotthard Base Tunnel in Switzerland, with a total length of 57 km, will be the longest railway tunnel in the world when it is finished. The total length of the system's access tunnels, railway tunnels, connecting galleries, and ancillary structures totals 153.3 km. The primary system's excavation got under way in 2002. By the end of March 2008, more than 108 km, or more than 70% of the entire 153.3 km of tunnel system, had been finished. Both traditional tunnelling and TBM excavation have been used.

Keywords: Gotthard base tunnel, Tunnel system, Traditional tunneling and excavation methods.

I. INTRODUCTION

The major goal of the Gotthard Base Tunnel is to boost local transportation via the Alpine barrier, particularly for cargo travelling along the Rotterdam-Basel-Genoa corridor, and more specifically to switch more freight from trucks to freight trains. This greatly lessens the risk of deadly truck-related traffic accidents as well as the harm that large trucks do to the environment. The tunnel shortens travel times by an hour for passenger trains travelling from Basel/Zürich to Lugano and Milan, as well as between northern and southern Europe, and the canton of Ticino (and from Lucerne to Bellin zona by 45 minutes). Basically, it is located in Switzerland.

Switzerland, like every other nation in central Europe, must contend with an increase in traffic, the majority of which is brought on by trucks travelling from Germany to Italy and back. Today's roadways and the 130-year-old Gotthard railways, which both handle considerable traffic, have reached their capacity. Nowadays, the Gotthard line sees more than 150 trains every day. Estimates state that within the next 20 years, the amount will increase from 20 million tons annually to above 40 million tons.

The Swiss government suggested the creation of a special fund to finance four significant projects to upgrade and expand the current railway network in order to address the impending issues to the Swiss electorate:

- Alp Transit, which includes the brand-new Gotthard and Lötschberg base tunnels.
- Rail 2000, a proposal to update the current rail network.
- Noise reduction on the current lines and rolling stock.
- Connectivity to the European High-Speed Network.

The climate of Europe, and particularly that of Switzerland, is significantly influenced by the Alps, and the Ticinese architect Mario Botta noted that "the light changes at the Gotthard: that of the Mediterranean Sea is not the same as that of the continent, that of the central lands, that of Europe far from the sea." On average, the south side has a temperature that is 3 °C (5 °F) warmer than the north side, however there are certain days when the difference is well over 10 °C (18 °F).

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Fig-1: Gotthard Base tunnel system

II. FEATURES OF GBT

- Distance: 57 kilometers (the longest rail tunnel in the world)
- Two single-track tubes that are joined every 325 meters by crosscuts
- Total distance between all tunnels: 152 km
- Erstfeld (UR) is the northern gateway, and Bodio is the southern portal (TI)
- The tunnel's highest point is 550 meters above sea level.
- Maximum rock cover is 2,300 meters.
- Construction time (17 years, excluding exploratory work)
- Tunnel boring equipment were used to drill the main tunnels (80%) and blasting (20%)
- Material excavation: 28.2 million tons
- The total cost of the NRLA, comprising the Lötschberg, Gotthard, and Ceneri Base Tunnels, is CHF 18.2 billion (cost as of 1998, excluding VAT increases and construction interest; current Total price: around CHF 23 billion.
- Up to 260 freight trains and 65 passenger trains can run through the tunnel each day.
- 100 km/h for freight trains and 200 km/h for passenger trains are the scheduled speeds.
- Maximum speed for passenger trains is 250 km/h, and 160 km/h for freight trains.
- mechanism to safeguard trains and signal cabs (ETCS Level 2)
- After the axis is complete, the trip from Zurich to Lugano will take about 45 minutes less time (starting in 2019 or 2020).
- 11 December 2016 marks the Gotthard Base Tunnel's formal opening.

III. CONSTRUCTIONAL PROCEDURE FOR GBT

The Gotthard Base Tunnel was built using both conventional tunnelling techniques and tunnel boring machines (TBM). In the section that follows, these techniques are explained in more detail. They are:

1. **Conventional tunneling method:**

The following steps are involved in creating an underground entrance using conventional tunnelling:

- Initially, the tunnel profile is dug out using drilling and blasting.
- After that, a mechanical discharging mechanism is used to remove the muck.
- The application of tunnel lining materials depends on the state of the ground.

Each of the processes is completed in a cycle. The tunnel is separated into manageable sections, with the identical steps being taken for each piece. Each phase of tunnel building is carried out by a skilled group of workers with the use of common or specialized equipment.

The conventional tunnelling method has the advantage over other tunnelling methods in that it can quickly adjust the tunnel's architecture in the event of a bad situation. So, in extremely varied ground conditions with existing infrastructure, the classic tunnelling method is chosen.

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Fig-2: Conventional tunneling of GBT

Equipment:

Typical equipment needed for conventional tunnelling includes the following:

- ✓ Blasting holes, rock bolt holes, and air pressure release are all accomplished with the use of drilling jumbo.
- ✓ In situations when blasting is prohibited, road header is used.
- ✓ The workers can access the tunnel's side faces and crown thanks to a lifting platform.
- ✓ For the placement of the steel sets, lifting equipment is needed.
- ✓ Excavated muck is loaded into dump trucks using an excavator or loader machine.
- ✓ For moving excavated stones outside the tunnel, dump trucks are needed.
- ✓ Shotcrete manipulators are necessary whether wet or dry shotcrete is being applied.

Fig-3: By using road header to excavate the tunnel

2. Tunnel boring machine(TBM)

TBMs are typically used to excavate circular tunnel profiles. A TBM may operate on a variety of ground surfaces, including extremely soft rock and very hard rock.

This is a description of the most typical TBM tunnel construction techniques:

- ✓ The tunnel profile is dug using a spinning cutter wheel.
- ✓ After excavation, a mechanical discharging device is used to remove the excavated mud.
- ✓ Finally, the support structures are positioned to lessen ground convergence. Steel arches, shotcrete, concrete lining segments, rock bolts, and steel meshes make up the support system.

IV. CRITERIA FOR SELECTION OF THE EXCAVATION METHOD

Excavation methods for tunneling are selected based on the type of project depending on the following points:

- ✓ Requirements for workers handling the tunnelling activity in terms of safety and health.
- ✓ Ecological factors.
- ✓ Future extension is required.
- ✓ Criterion used in the tunnel's design.

- ✓ Cost of construction.
- ✓ Timetable for the project.
- ✓ Participation of outside parties.
- ✓ Obstruction caused by already-built infrastructure, including highways, buildings, bridges, pavements, and railroad crossings.
- ✓ Influence zone of the current structures' foundations.

The Gotthard Base Tunnel was divided into five sections for construction, and different excavation techniques were chosen for each portion. Each section varied in length from 6 to 15 kilometers.

The Gotthard Base Tunnel's Sedrun portion, which is 6 km long, is located in the middle of the tunnel system. With the aid of an 800 m deep shaft, the excavation had to be started from the Sedrun portion in both the northern and southern directions. The Sedrun section's rock quality ranged from extremely good rock to very poor rock.

Moreover, the overburden pressure exceeded 1 km and had a strong potential for compression. The southern tunnelling drive was also obstructed by the concrete arch dam's effect zone. For the Sedrun segment, the engineers made the decision to use the traditional tunnelling excavation technique.

The remaining four portions were Amsteg (11.4 kilometers), Erstfeld (7.1 kilometers), Bodio (14.8 kilometers), and Faido (12.2 km). For these four portions, the rock quality and other boundary conditions were favorable. So, based on the construction duration and cost, the excavation method was chosen. These four sections were dug out using tunnel boring machines (TBMs). To speed up construction, TBM was chosen primarily for this reason.

V. CONCLUSION

As a result, freight trains will not require as many locomotives and passenger trains will be able to cross the Alps more swiftly. Moreover, the Gotthard Base Tunnel will cut the travel time between Bellin zona (TI) and Altdorf (UR) by 30 kilometers. In October 2010, the Gotthard Base Tunnel's east tube had its ultimate breakthrough. The tunnel's two ends were joined by 2,500 employees over the course of roughly 14 years. In March 2011, the west tube's final development was finished.

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