INTRODUCTION OF HAI VAN PASS TUNNEL CONSTRUCTION PROJECT IN VIETNAM
- Longest Highway Tunnel in South-East Asia -

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Abstract: The Hai Van Pass Tunnel construction, a 6.3km long highway tunnel, is being implemented to improve the main north-south road corridor in Central Vietnam, named National Highway No.1. The existing Hai Van Pass is approximately 20km long, with 475m elevation change, of low standard highway with numerous tight bends and a steep gradient. The tunnel project is the first application of the New Austrian Tunneling Method (NATM), longitudinal ventilation system with the Electrostatic Precipitator (EP), Supervisory Control And Data Acquisition (SCADA) for a highway tunnel in Vietnam. The construction started 1st October 2000, the tunnel breakthrough was celebrated on 7th November 2003, and the traffic opening will be early 2005. This paper introduces the general view of the project, as a record of turning point project of civil engineering field in Vietnam.

Key words: Highway, Tunnel, NATM, Longitudinal Ventilation System, Vietnam

1 BACKGROUND
The Hai Van Pass located in coastal Central Vietnam, is the biggest traffic bottleneck on the National Highway No.1, which is the most important North-south longitudinal arterial linking the capital Hanoi with Ho Chi Minh. The Pass rises to an elevation of 475 m for approximately 20 km with continuous small curves and steep grade. From the late 1990’s, the rapid development of national economy has increased the logistic volume through the Pass, however, the heavy tracks have been forced to run slowly and fatal traffic accidents increased year by year. In addition, the road is often blocked due to the landslide and slope failure during the rainy seasons. Under such circumstances, the Government of Vietnam decided to construct a new highway segment with a tunnel under the Hai Van Pass by the Prime Minister’s Decree in March 1994.

2 TUNNEL OUTLINE
1) Length: 12,182m
2) Traffic Lane: 2 Lanes
   3.75 + 1.25 shoulder. Total 10.0m
3) Tunnel Length: 6,274m (Main Tunnel, MT), 6,286m (Evacuation Tunnel, ET)
   1,888m (Ventilation Adit, VA)
4) Tunneling Method: NATM
5) Cross-section: 89m²(MT), 15.5(ET), 36.2(VA)
6) Cross-Passage: 400m interval
7) Ventilation System: Longitudinal System, 23 Jet Fans, 3 EPs, 1 VA

Fig. 1 Project Layout

Fig. 2 Tunnel Ventilation System
2.1 Traffic demand forecast

In 2002, the supplemental traffic survey was carried out in order to confirm the proper timing of the 2nd tunnel opening. The study reconfirmed the importance of the project for the development of the national economy: 20% of the traffic passing the Pass was between Hanoi and Ho Chi Minh; annual traffic growth rate was approximately 18% and the traffic volume was forecasted to reach the capacity of the tunnel in 2016. Means the 2nd tunnel should be built and opened timely.

2.2 Distinct characteristics of the project

Distinct characteristics of the project can be summarized as the following items:
1) 6.3km long highway tunnel
2) 1st NATM tunnel in Vietnam
3) Longitudinal Ventilation System
4) SCADA for Overall System Control
5) O&M Company

2.3 Implementation Program

The construction was started on 1st October 2000 and, as of December 2003; the project implementation is scheduled as follows:

- Completion of civil works: December 2004
- Completion of mechanical works: April 2005
- Completion of electrical works: April 2005
- Operation Training: May 2005
- Traffic Open: June 2005

Considering the land acquisition and compensation cost and some additional scope of works, the project scale is some Two Hundred Million US Dollars.

3 PROJECT ORGANIZATIONS

3.1 Bank

The project is implemented by Japanese ODA Loan through Japan Bank of International Cooperation (JBIC). The first Loan Agreement (L/A) was concluded on March 26, 1997, subsequently the second and the third was concluded March 30,1999 and March 29, 2002, respectively. Total L/A amount is 18.859 Billion JPY.

3.2 Executing Agency

The executing agency of the project is the Project Management Unit No.85 (PMU85) under the Ministry of Transport (MOT) of the Government of the Socialist Republic of Vietnam.

3.3 Consultant

The design and supervision services have been carried out by the Consultant Team, Joint Venture of Nippon Koei Co., Ltd., Japan and Louis Berger International Inc., USA in association with Transport Engineering Design Incorporation (TEDI), Vietnam. The Service consists of 1) Special Survey, 2) Detailed Design, 3) Contract Tendering Assistance, 4) Construction Supervision, and 5) Training and Technology Transfer. Consultant Team consists of the following teams as of December 2003:

1) 1: Core Team
2) 4: Resident Teams
3) 1: QS Team
4) 1: Geotechnical Team
5) 1: Supporting Staff Team

3.4 Contractors

All the contract packages were already commenced except Package VI: Procurement of Maintenance Vehicles. Awarded contractors are tabulated below:
4 TUNNELING PROGRESS

4.1 Portal Location
The locations of the tunnel portal were selected to optimize the tunnel alignment against construction costs including minimizing the soft soil excavation at the portals. Another consideration for the south portal was to drive the main tunnel directly beneath a sacred Banyan tree at the portal.

4.2 Waterproofing Membrane and Drain
The main tunnel is designed as a waterproofed drained single tube with a 2mm thick PVC waterproof membrane or a 0.8mm thick EVA membrane. North contractor applied EVA and the south applied PVC, and both systems have proved equally successful in sealing the tunnel lining. Any water is collected in the fabric installed beneath the water proof membrane to be channeled into the side collector drains and the main center drain.

4.3 Geology
The NATM support type has been determined by the RMR value, Hai Van rock mass has averages at around 70, therefore the support is mostly Type I, which is 50mm of shotcrete and bolting determined locally by the rock jointing. However, for the first 100m at each portal, highly weathered to completely decomposed granite exists and both contractors experienced hard time.

Table 3 Support Type

<table>
<thead>
<tr>
<th></th>
<th>PK1A</th>
<th>PK1B</th>
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<tbody>
<tr>
<td>TYPE VI</td>
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<td>79.4</td>
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<tr>
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<td>TYPE III</td>
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<tr>
<td>Cut &amp; Cover</td>
<td>10</td>
<td>25.585</td>
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<tr>
<td>TOTAL</td>
<td>3855.8</td>
<td>2397.825</td>
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</tbody>
</table>

4.4 Tunnel Excavation Progress
Average excavation rate is 150m per month for the main tunnel for both sections except the first softground sections.

4.5 Concrete Lining Progress
Both contractors mobilized two sliding forms for the standard section and one for the lay-by section. Potentially, over 200m per month can be achievable, but this works was not on the critical path for the overall tunneling progress.

5 LONGITUDINAL VENTILATION SYSTEM
Longitudinal ventilation system with the Electrostatic Precipitator (EP) was invented and developed in Japan. The EP is a device to remove smoke dust by electrical discharge. After the development of the EP, the longitudinal ventilation system with the EP became the standard method of the long highway tunnel in Japan, because it reduces the number of the ventilation shafts, reduces cross-section area of the main tunnel and therefore the requirement electricity. Consequently, the construction and operation costs are lowered. In the Hai Van Pass Tunnel, one ventilation adit, 3 EPs and 23 Jet Fans are required.
“Micro-SCADA” is a microcomputer-based, programmable and distributed Supervisory Control And Data Acquisition (SCADA) system, and applied to the project for overall system control. Following individual system is integrated by SCADA in the project:
1) Power Distribution System
2) Tunnel Lighting System
3) Traffic Management System
4) Telecommunication System
5) Fire Detection System
6) Fire Protection System
7) CCTV System
8) Radio Rebroadcast System
9) Ventilation System

Establishment of the organization for operation and maintenance and training has also been an important part of the Project because such long road tunnel is the 1st introduction in the country. The O&M Company, namely HAMADECO, was established by referring the Japanese practice of highway tunnel operation, which was introduced and guided by specialists from Japan.

New concepts of motorization society has been introduced by several teams such as “relation between road-user and road-administrator”, “high-speed society and required traffic manner”, “traffic safety education”.

Transfer of technology were carried out through three approaches, 1) through On the Job Training (OJT) of both the Consultant and Contractors, 2) Special training under the Consulting Services contract, NATM training program for design method course and the construction method course, and 3) Contractor’s trainings.

Just before the traffic open, overall operation training shall be carried out for O&M Company.

In addition to the standard duty stipulated in FIDIC, the Consultant has been taking proactive initiative for work coordination among the contractors because all contractors are required to work simultaneously inside the tunnel in order to shorten the overall construction period. Weekly basis work coordination meeting has been held. Primavera P3 was used as scheduling tool. PMBOK was referred to for the project management.

This report summarized a historical civil engineering project in Vietnam. Introducing new technology to a country requires much effort of all the concerned agencies and people, from planning phase to maintenance phase. Long tunnel project in Vietnam is really timely project to support the rapid growth of the national economy and as an event at the beginning of the motorization era of the society.

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REFERENCES