SOCIALIST REPUBLIC OF VIETNAM
QUANG NINH PROVINCE PEOPLE'S COMMITTEE

PREPARATORY SURVEY FOR BACH DANG BRIDGE ON HA LONG – HAI PHONG HIGHWAY DEVELOPMENT PROJECT IN SOCIALIST REPUBLIC OF VIETNAM (PPP INFRASTRUCTURE PROJECT)

INTERIM REPORT

FEBRUARY 2015

JAPAN INTERNATIONAL COOPERATION AGENCY

SE CORPORATION

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LOCATION MAP

SUMMARY

1 Introduction (Chapters 1 and 2)

The Ha Long – Hai Phong Highway (about 25 km long) will be one of the routes connecting the economic north triangle zone in Vietnam (Hanoi, Hai Phong and Quang Ninh), the importance of which is noted in the Prime Minister's Decision, "Adjustment plan of road development by 2020 and the orientation toward 2030" (Decision 356/QD-TTg) issued on February 2013 and other Decisions.

The Bach Dang Bridge Development Project that is the subject of this Survey is a BOT project to build, operate and maintain the Bach Dang Bridge and its approach roads for about 5 km from the Hai Phong City side on the Ha Long – Hai Phong Highway. The construction of a road section about 20 km from the Ha Long City side commenced on September 13, 2014, as a public work implemented and bored by Quang Ninh Province.

As for an initiative involving Japanese companies with this Project, after the Quang Ninh Province People's Committee and SE Corporation concluded a Memorandum of Understanding on cooperation for the Project implementation on April 9, 2012, investigations were conducted with the commencement of the Project in mind and a provisional contract for the Project was concluded between the parties in September 2013.

The objectives of this survey are as follows:

- To investigate the feasibility of this project as a private finance project, by checking the private investment environment, surveying the demand forecast and investigating the scope of the private project, by performing financial and risk analyses, verifying the technical, environmental and social considerations, preparing proposals for government support, market sounding, etc., to propose the optimum project scheme
- To prepare (draft) terms sheets for the main loan agreement conditions and a (draft) term sheet for the government guarantee

2 Existing Circumstances Surrounding the Project (Chapter 3)

Contents of past surveys relevant to the Project, responsibilities and powers of the related Vietnamese agencies, relevant legal systems (legal structures, roads, PPP and taxation), existing circumstances between 20 km from the Ha Long City side on the Ha Long – Hai Phong Highway and recent PPP/BOT project trends were investigated.

Based on 8695/VPCP-KTN issued by the governmental secretariat on December 4, 2009, the authority as the project implementing body of the Ha Long – Hai Phong Highway was transferred to the Quang Ninh Province People's Committee. Accordingly, it was confirmed in interviews with related authorities that the Project was recognized as a national-level project and the project road is an expressway.

Since the procedures for nominating investors as well as a provisional contract were completed in this Project, it was assumed that a new PPP decree, which was under formulation in the survey phase, will not be applied to the Project provided its draft version (as of July 21, 2014) is confirmed.

3 Traffic Demand Forecast (Chapter 4)

As well as utilizing the results of traffic volume surveys and traffic demand forecasts conducted previously, this survey implemented a socioeconomic investigation, traffic volume survey and an interview survey to improve the accuracy of the traffic demand survey.

The traffic demand forecast was carried out under various conditions and obtained the following results (case 1: toll revenue at all interchanges on the Ha Long – Hai Phong Highway). Based on the forecast results, an investigation into the number of lanes required found it was necessary to deal with a decline in service level after 2040.

Unit: vehicle/day

	2020	2025	2030	2035	2040	2045	2050
Cars and taxis	3,756	5,997	9,355	16,513	23,369	29,457	34,120
Trucks (2-axes)	1,453	1,917	3,393	4,763	8,374	9,118	10,928
Tucks (3-axes or more)	300	361	801	1,627	2,185	2,330	2,530
Container	1,944	2,251	2,625	4,187	5,097	8,856	9,247
Bus (25 seats or fewer)	296	421	812	944	1,616	2,202	2,774
Bus (25 seats or more)	1,051	1,312	1,451	2,459	3,452	3,806	4,623
Total	**8,800**	**12,259**	**18,437**	**30,493**	**44,093**	**55,769**	**64,222**

4 Construction Plan (Chapter 5)

Considering that the approval procedures for changes of bridge types, restricted height and other restrictions, substantial changes in road standards, bridge types and other important items should preferably be avoided if at all possible. In this survey, the results of various technical investigations in existing surveys and calculation resuts are reviewed and their optimization is examined to enhance the accuracy of the investigation.

During the survey, a land development plan in Hai Phong City not stated in existing surveys was confirmed. This survey involves adjusting with the land development plan without reviewing the construction plan and Quang Ninh Province takes the initiative to proceed with the adjustment with Hai Phong City, etc.

The estimated construction and project costs are calculated from the rough design of the road and bridge, construction plan and procurement plan as follows:

Category		Amount	
		Mil. VND	1,000 JPY
1	Construction cost	5,735,267	28,674,800
2	Land acquisition cost	181,000	905,000
3	Project management cost	30,225	151,116
4	Consultant fee	286,763	1,433,740
5	Other costs	229,411	1,146,992
6	Cost for establishing project company	130,868	654,000
7	Reserve fund (excluding escalation)	659,353	3,296,565
	Total (project cost)	7,252,887	36,262,213

Individual designs, specific conditions during construction works (construction method, use of surrounding roads, approval of temporary occupation of the sky and airways), etc. must be discussed with the relevant organizations in Vietnam and a consensus formed.

5 Operation and Management Plan (Chapter 6)

Summarizing the characteristics of the Ha Long – Hai Phong Highway, the operation and management scopes are set out as follows. Based on the premise that O&M works are entrusted to a special company, the organizational structure of the project company and division of works by company section were defined.

Category		Contents	Scope
1	Toll Collection	Toll collection, emergency traffic control	Tollbooths at each IC
2	Traffic Control	Patrol, traffic data collection, regulation of traffic violations	Entire 25km length of the Ha Long – Hai Phong Highway
3	Inspection & Repair	Road structure, daily regular inspection of facilities, repairing damage, improvements	5km length of this Project
4	Road Preservation	Cleaning, planting, traffic signage, inspection of special trucks	5km of this Project

Accordingly, the initial and running costs for O&M were calculated.

6 Environmental and Social Consideration (Chapter 7)

The Project is classified as a Category A project under Guidelines for Environmental and Social Considerations. Meanwhile, an environmental impact assessment (EIA) was carried out by the Vietnamese side targeting the entire Ha Long – Hai Phong Highway, the result of which has already been approved by MONRE as of December 12, 2012. In this survey, therefore, the Vietnamese EIA results on the entire Ha Long – Hai Phong Highway, including the project section, were reviewed and new information on survey items that were insufficient in the Vietnamese EIA and required in the Guidelines was gathered.

A tentative environmental impact assessment for the Project implementation was conducted based on impact items selected in scoping and later site survey results and the items requiring investigation are summarized at the end of the chapter.

7 Project Scope and Scheme (Chapter 8)

The project scope and form of the project company to implement the Project were summarized from the survey results, which concluded that a multiple-owner limited liability company was applicable for the form of the company. Moreover, based on the survey results concerning risk analysis, configuration of stakeholders, fund-raising (direct and 2-step loans), the need for foreign exchange swaps by the Vietnamese Ministry of Finance and the project scheme were proposed.

8 Security Package (Chapter 9)

Proposed term sheets for the BOT contract and GGU were prepared. Under circumstances where the term sheet for the BOT contract will be "on behalf of the Government" to appoint the Quang Ninh Province People's Committee the party to the BOT contract, the BOT contract and GGU will be integrated, but this report presents them separately for convenience.

9 Economic Analysis of the Entire Project and Private Sector (Chapter 10)

This chapter comprises two analyses: economic and financial respectively. The economic analysis evaluated the relevance of the Project implementation, not only of this Project but the entire Ha Long – Hai Phong Highway Development Project, including the remaining 20 km section implemented by public works, from socioeconomic aspects. The financial analysis, conversely, evaluated the relevance of investment and other implementation, based on the premise that this project would be implemented as a PPP/BOT project utilizing private funding from a financial aspect including cash flow.

9.1 Economic Analysis

The economic analysis evaluates the Project from socioeconomic perspectives and targets the entire Ha Long – Hai Phong Highway. Following quantitative evaluation of the economic initial cost and economic O&M costs, travel time reduction benefit (TTRB) and fuel consumption reduction benefit (FCRB), the economic internal rate of return (EcIRR) was revealed as 22.08%. Since the figure significantly exceeds the social discount rate (SDR) of 12%, the economic effect of the Project is particularly high. Conversely, the reduction in traffic accidents, promotion of tourism, promotion of FDI and other benefits are deemed positive aspects in the qualitative evaluation.

9.2 Financial Analysis

In the financial analysis, the feasibility of the Project as a private financing project in the BOT format was evaluated from a financial perspective. The investment in the Project, which is the condition of analysis, was calculated as 8,519,320Mil.VND (about 42.6 bil. yen) with the following formula:

Investment amount = (Project cost – Land acquisition cost) x Inflation rate during construction period+ loan handling fee (1.5% of loan amount)

The analysis was made using PIRR, EqIRR, DSCR and other evaluation indicators by setting the ratio of investment to loan as 30 to 70%, as well as assuming conditions for a direct loan (on a JPY basis) and a 2-step loan (on a VND basis) based on interview verdicts.

Where a 2-step loan is adopted, the project company management will be under pressure as the cash flow becomes vulnerable due to interest paid over 10% while the company is free of foreign exchange risk. Financial analysis thus revealed the need to adopt a direct loan with less interest burden from the start.

Among the evaluation indicators, EqIRR, which shows return of sponsors, did not satisfy the hurdle rate set for every case considered. Accordingly, an income mechanism is proposed to shift from toll revenue to the availability fee (A/F system), whereby the project company receives a certain amount from the Vietnamese Government every year.

The annually required A/F is calculated back to the hurdle rate of EqIRR and the amount to be borne by the Vietnamese Government by deducting toll revenue from A/F. By this calculation, the amount paid by the Vietnamese Government represents an increase (income) in direct loan and the annual maximum amount payable is revealed as between 412,003 Bil.VND and 586,073 Bil.VND (2,060 million yen to 2,930 million yen).

As activities to be required for the commencement of the Project in the BOT format, forming a foreign exchange swap with the MOF and adopting an A/F system as well as building a consensus with the Vietnamese Government on the burden are proposed.

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LIST OF ABBREVIATIONS

Abbreviations	Official name
ADB	Asian Development Bank
AIDS	Acquired Immune Deficiency Syndrome
B/C	Cost-Benefit Ratio
BIDV	Bank for Investment and Development of Vietnam
BOT	Build-Operation-Transfer
BT	Build-Transfer
BTO	Build-Transfer-Operate
CAT	Capital Assignment Tax
CEO	Chief executive officer
CIT	Corporate Income Tax
CIENCO	Civil Engineering Construction Corporation
CPI	Consumer Price Index
Cuu Long CIPM	Cuu Long Corporation for Investment, Development and Project Management of Transport Infrastructure
DRVN	Directorate for Roads of Vietnam
EIA	Environmental Impact Assessment
EcIRR	Economic Internal Rate of Return
EqIRR	Equity Internal Rate of Return
EMAC	Environment Monitoring and Analyzing center
EPC	Engineering, Procurement and Construction
EPT	Environment Protection Tax
FCRB	Fuel Consumption Reduction Benefit
FCT	Foreign Contractor Tax
FDI	Foreign Direct Investment
F/S	Feasibility Study
FTA	Free Trade Agreement
GDP	Gross Domestic Product
GSO	General Statistics Office
HIV	Human Immunodeficiency Virus
IC	Interchange
IDR	Indonesia Rupiah
IMF	International Monetary Fund
IUCN	International Union for Conservation of Nature *and* Natural Resources
JICA	Japan International Cooperation Agency
JPY	Japanese Yen
LED	Light Emitting Diode

Abbreviations	Official name
MARD	Ministry of Agriculture and Rural Development
METI	Ministry of Economy, Trade and Industry
MFN	Most Favoured Nation
MOC	Ministry of Construction
MOF	Ministry of Finance
MONRE	Ministry of Natural Resource and Environment
MOT	Ministry of Transport
MOJ	Ministry of Justice
MPI	Ministry of Planning and Investment
MYR	Malaysia Ringgit
NESDB	*National Economic and Social Development Board*
NCEIF	National Center for Socio-Economic Information and Forecast
NEXCO	Nippon Expressway Company Limited
NEXI	Nippon Export and Investment Insurance
NPV	Net Present Value
O&M	Operation and Maintenance
PAJ	Petroleum Association of Japan
PC	Prestressed Concrete
PHP	Philippine peso
PIT	Personal Income Tax
PMU	Project Management Unit
PPP	Public and Private Partnership
PIRR	Project Internal Rate of Return
PVD	Prefabricated Vertical Drain
RC	Reinforce Concrete
SCF	Standard Conversion Factor
SCT	Special Consumption Tax
SDR	Social Discount Rate
SHUI	Social , Health and Unemployment Insurance
SO2	Sulfur Dioxide
SPC	Special Purpose Company
SPT	special preferential treatment
SPSP	Steel Pipe Sheet Pile
TEDI	Transport Engineering Design Incorporated
THB	Thai Baht
TRANCONCEN	Consulting Center for Transport Development
TSP	Total. Suspended Particles

Abbreviations	Official name
TTRB	Travel Time Reduction Benefit
UN	United Nations
USD	United States Dollar
VAT	Value Added Tax
VEC	Vietnam Expressway Company
VIDIFI	Vietnam Infrastructure Development And Finance Investment Joint Stock Company
VND	Vietnam Dong
VOT	Value of time

Chapter 1 Introduction

1.1 Background to the Survey

The rate of dependence on roads for transport within the Socialist Republic of Vietnam (hereafter referred to as "Vietnam") is very high, accounting for 74.3% of freight transport and 92.1% of passenger transport in 2011. In recent years in particular, the amount of traffic on trunk roads in major cities and connecting major cities with provincial cities has been soaring. The GDP growth rate of Vietnam in recent years has been about 6%, high compared with other South-east Asian countries, but inadequate development of the transport infrastructure supporting a sustainable society and the economic growth in future is apparent. In 2010 the total length of roads was 256,000 km, but national routes, which are trunk roads, were affected chronic traffic congestion, since they are as residential as well as industrial roads, thereby causing traffic accidents, etc.

In the Vietnam Government's "Ninth Five-Year Socioeconomic Development Plan (2011 – 2015)", further development of the transport infrastructure is crucial to achieve the objective of sustainable development under a high growth rate. Regarding the development of expressways, in the "Expressway Development Plan (Decision 1734/2008/QD-TTg)" approved by the Prime Minister in December 2008 and the partial amendment to the plan approved by the Prime Minister in February 2013, a plan to develop a total length of 5,873 km was adopted, with the aim of developing 2,018.6 km by 2020. Also, in the "Coastal Road Development Plan (Decision 129/2010/QD-TTg)" approved by the Prime Minister in January 2010, coastal road plans are prioritized from the perspective of contributing to socioeconomic development utilizing the national land along the coasts, the effect of disaster prevention and disaster reduction in the event of natural disasters and forming the national land axis of Vietnam.

The "Ha Long – Hai Phong Highway" is stated as an important route within the plans referred to above and is the top priority infrastructure development project in Quang Ninh Province.

1.2 Project outline, etc.

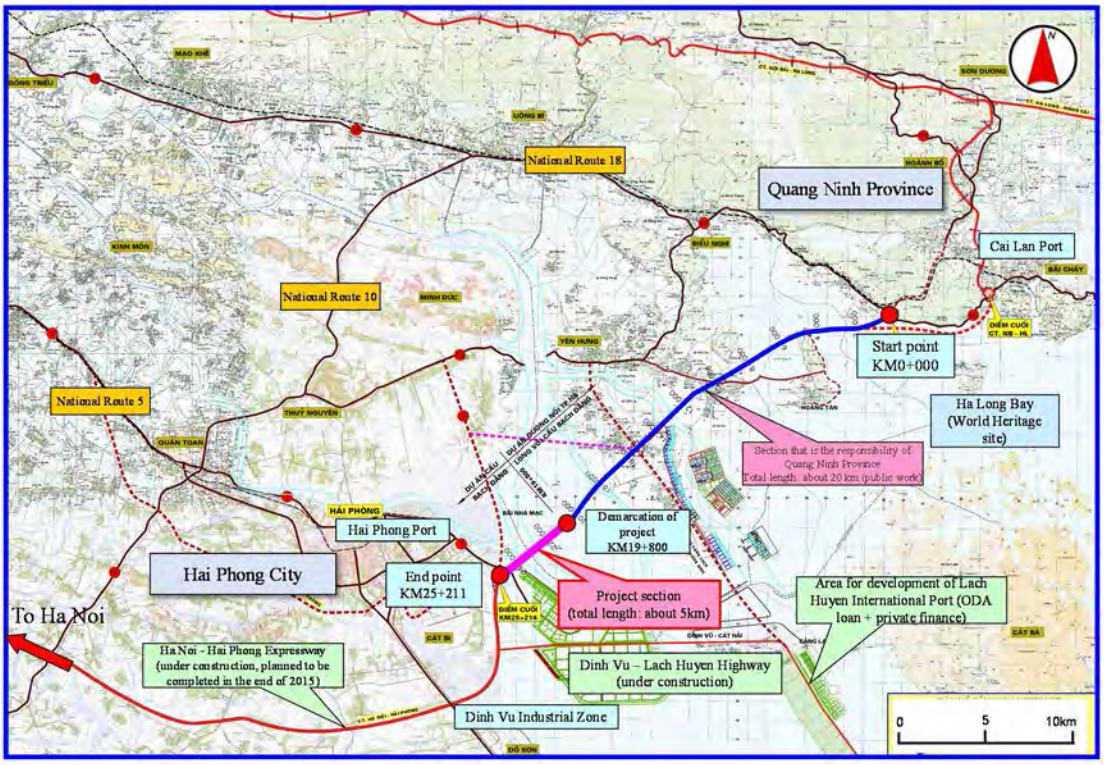
The Ha Long – Hai Phong Highway is a road about 25 km long that connects "Hai Phong City, an international port city" and "Ha Long City, the provincial capital of Quang Ninh Province where Ha Long Bay, the world heritage site, is located" and will be connected to the "Hanoi – Hai Phong Expressway" which is currently under construction and will be completed in the end of 2015. Besides logistics bases such as the Hai Phong port, the Lach Huyen International Port and the Dinh Vu industrial complex, natural tourism resources based on the Ha Long port are scattered around the target area of the Project, where high demands in both sectors can be anticipated. Acknowledging that the Ha Long – Hai Phong Highway is an important route composing one side of the north triangle economic zone (Hanoi, Hai Phong and Quang Ninh), the Government of Vietnam has regarded the Highway as an important expressway under the national development plan forming a part of Ninh Binh – Hai Phong – Quang Ninh Highway (about

160km) in the "Expressway Development Plan (Decision 1734/2008/QD-TTg)" approved by the Prime Minister in December 2008 and the partial amendment to the plan approved by the Prime Minister in February 2013 and in the "Coastal Road Development Plan (Decision 129/2010/QD-TTg)" approved by the Prime Minister in January 2010.

The Bach Dang Bridge Development Project (hereinafter referred to as the "Project") that is the subject of this Survey, involves constructing, managing and maintaining the Bach Dang Bridge and its approach bridges located about 5km from Hai Phong city

The "Bach Dang Bridge Development Project" (hereafter referred to as "the Project") is a BOT project to build, operate and maintain the Bach Dang Bridge and its approach roads for about 5 km from the Hai Phong City side on the "Ha Long – Hai Phong Highway" with the above-mentioned characteristics. This Survey investigated the feasibility of the Project as a private finance project and financing project from a lender's perspective.

Figure 1.1 and Table 1.1 show the location of the Project and the outline of the project plan at the commencement of this Survey.



Source: JICA Study Team

Figure 1.1 Specific Location Map of the Ha Long – Hai Phong Highway and this Project

Table 1.1 Outline of Project Plan (envisaged as of the commencement of the Survey)

Project client	Quang Ninh Province People's Committee
Project type and format	Toll road operated in BOT format (financially independent due to collection of tolls)
Project schedule	Commencement: October 2015, Construction completion: October 2018 (construction period: about 3 years) Commencement of service: January 2019, Project completion: December 2048 (operation period 30 years)
Scope of project	Construction, maintenance and operation of about 5 km of the 25 km Ha Long – Hai Phong Highway
Project cost	About 36.31 billion yen (about 7,262.5 Bil. VND, 1 yen=200 VND) * Including the land cost borne by the Quang Ninh Province
Financing	Investment from sponsors and loan by JICA (overseas investment loans)
Operating revenue	・ Tolls from road users over the entire approximately 25 km of Ha Long – Hai Phong Highway ・ A revenue guarantee of 50% to the SPC provided by the Quang Ninh Province People's Committee
Traffic	9,732 vehicles/day (the year of commencement of operation) to 75,484 vehicles/day (last year of operation)
Government support	・ Interest-free subordinated financing to the SPC of 1,000 Bil. VND (about 5 billion yen) from the Quang Ninh Province People's Committee ・ A revenue guarantee of 50% to the SPC provided by the Quang Ninh Province People's Committee ・ Quang Ninh Province shall bear the additional costs for this project of any delay in the remaining approximately 20 km section
Land be acquired	About ¥710 million (142.7 Bil. VND). To be implemented by Quang Yen Town, Ha Long City and Hai Phong City with the cost to be borne by the Quang Ninh Province

Source: JICA Study Team

1.3 Objectives of the Survey

The survey objectives include (i) investigating the feasibility of this project as a private finance project, by checking the private investment environment, surveying the demand forecast and investigating the scope of the private project, by carrying out financial and risk analyses, verifying the technical, environmental and social considerations, preparing proposals for government support, market sounding, etc., to propose the optimum project scheme, (ii) preparing (draft) terms sheets for the main loan agreement conditions and a (draft) term sheet for the government guarantee and (iii) carrying out a survey necessary to investigate private-sector investment finance.

1.4 Plan of the Survey

1.4.1 Target Area of the Survey

Hai Phong City and Quang Ninh Province, Vietnam

1.4.2 Scope of the Survey

The scope of the Survey involves building, operating and maintaining the Bach Dang Bridge and its approach roads for about 5 km from the Hai Phong City side on the "Ha Long – Hai Phong Highway." On the "Ha Long – Hai Phong Highway," which is an indispensable project, a necessary survey was also carried out in part on a section of about 20 km on the Hai Phong City side.

1.4.3 Survey contents

The major contents of the Survey are described in Table 1.2.

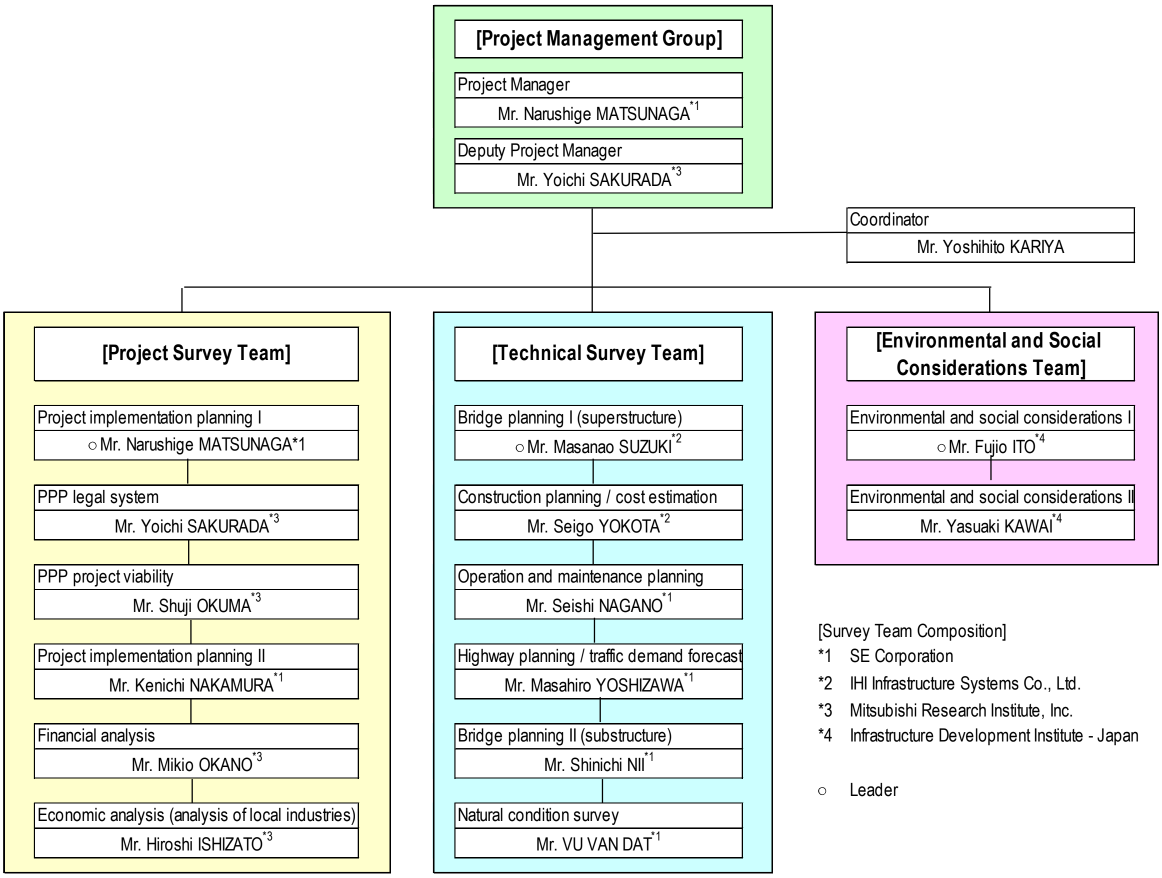
Table 1.2 Major Survey Contents

Item	Contents
Confirmation of project background and necessity	Confirmation of the socioeconomic situations in Vietnam and the target area of the Project
	Confirmation of the current status and issues of the transportation sector
	Confirmation regarding expressway-related project initiatives by companies from other countries, etc., and market trends to date
	Confirmation of relevant policies and plans adopted by the Government of Vietnam and relevant local governments
	Confirmation of transport and traffic-related projects in the area where the project is to be implemented
	Confirmation of the necessity and objectives of the project
Demand forecast	Detailed confirmation of the status of development and use of the road network in the area where the project is to be implemented and collection of fundamental information that will underpin traffic and other demand forecasts
	Analysis of traffic demand forecast and the necessity and timing of expansion in future
Outline design of facilities, cost estimation	Outline design of the bridge and related facilities
	Preparation of construction plan
	Estimation of project (construction) costs
	Calculation of project operation and maintenance costs
Proposal of project scope and scheme	Proposed project scope
	Formulation of a project scheme
	Investigation of means of hedging risks and security package
	Confirmation of relevant toll systems and proposal of an appropriate toll system
	Economic analysis of the overall project and private sectors
	Preparation of project-related contracts and (draft) terms sheets for government guarantee
Environmental and social considerations	The following items corresponding to the environmental impact assessment (EIA) report: a. Environmental and social conditions as a baseline data b. Confirmation of systems and organizations for environmental and social considerations in Vietnam c. Conduct of scoping d. Prediction of impact e. Impact assessment and comparative investigation of alternative proposals f. Investigation of mitigation measures Support for holding EIA Advisory Committee

Source: JICA Study Team

1.4.4 Survey implementation structure

Figure 1.2 shows a survey implementation structure. The survey team is organized by 15 members comprising the Project Survey Team, Technical Survey Team, Environmental and Social Consideration Team under Project management Group. In the implementation structure established, a “Team Leader” is allocated to each team, who manages the survey progress, etc. and, within each team, the Team Leader and Deputy Team Leader gather information, etc. as well as investigating individual issues, etc. in detail.



Source: JICA Study Team

Figure 1.2 Survey Implementation Structure Diagram

Chapter 2 Background of the Project

2.1 Background of the Project

Quang Ninh Province is situated in a geographically important area connecting Vietnam and China, as part of the economic triangle of northern Vietnam-Hanoi, Hai Phong and Quang Ninh. The lack of transport infrastructure development required to attract investment and ensure competitiveness for mid- to long-term economic development has become apparent, despite the remarkable socioeconomic development recently achieved by Vietnam and Quang Ninh Province.

The Ha Long-Hai Phong Highway (officially named the road connecting Ha Long with the Hanoi-Hai Phong Expressway) targeted by the survey is a highway connecting Ha Long City, the capital of Quang Ninh Province, with Hai Phong City, one of the biggest Vietnamese port cities. There are also plans to link it to the Hanoi-Hai Phong Expressway connecting Hanoi with Hai Phong. The realization of the highway development projects is expected to help slash travel times in the economic triangle in northern Vietnam and significantly boost the Vietnamese socioeconomic development plan.

Japanese companies began their involvement in the Project when Quang Ninh Province People's Committee and SE Corporation that represents the survey concluded a memorandum of understanding on cooperation in the Project implementation on April 9, 2012. Later, the Survey on Bach Dang Bridge Construction on the Ha Long-Hai Phong Highway in Vietnam for Infrastructure and System Exportation Promotion Survey Project FY2012 (survey on infrastructure development projects with yen loans and private-sector capital) of the Ministry of Economy, Trade and Industry (hereinafter referred to as "METI F/S") was carried out. The METI F/S included financial analysis to examine its feasibility as a project funded by private-sector capital. However, it emerged that they would become short of cash, given the modest traffic demand forecast in the first few years after opening the road in a project scheme whereby investment is recovered with toll income. Later, discussions between Quang Ninh Province People's Committee and SE Corporation resulted in agreement that the people's committee would help fund the project company that implements it (interest-free subordinated loan explained later and 50% income guarantee). In September 2013, SE Corporation submitted a proposal to the provincial people's committee on the project specifications issued by the committee, was independently nominated as an investor and concluded a provisional contract of the project. However, financing, cash flow and other financial issues that are important in its implementation as a private-sector project have yet to be solved completely and there is a need to examine the physical, technical and environmental aspects comprehensively in the survey.

2.2 Needs for the Project

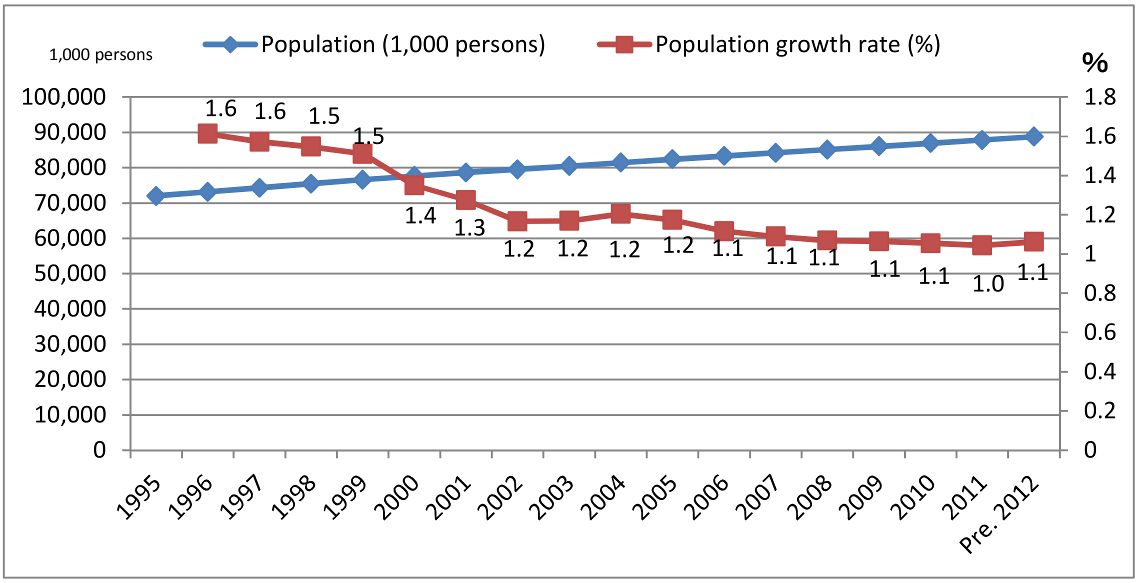
The socioeconomic situations, future highway and expressway development plans and relevant national government policies, including the national budget and financial sources and Quang Ninh Province and Hai Phong City as the project sites were confirmed to reassure the needs for the Project.

2.2.1 Vietnamese socioeconomic overview

The population, GDP, industrial structure, CPI, foreign exchange rate, national finance, international balance and foreign reserve are examined to gain an overview of Vietnamese society and economy.

(1) Population

The population of Vietnam was 88.77 million in 2012 (quick estimation). The growth rate has stabilized at around 1.1% since 2006, increasing at a pace of nine million annually, although it has slowed since 2000.

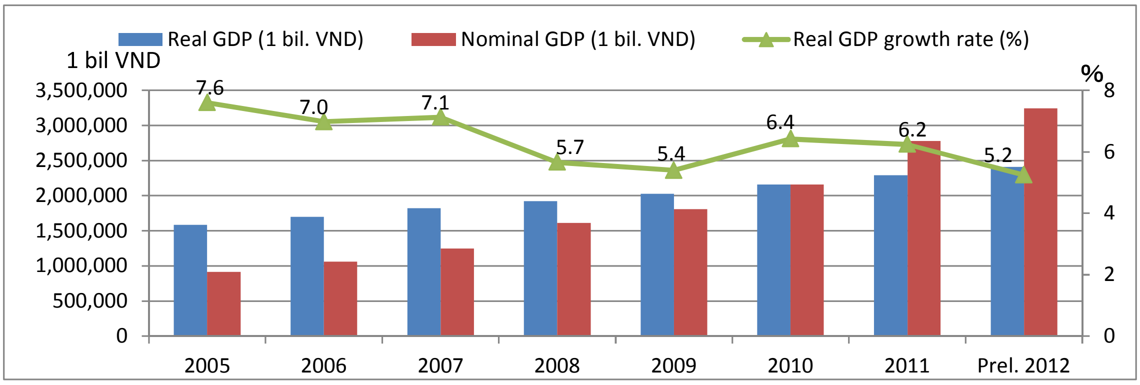


Source: Compiled based on GSO Statistical Data

Figure 2.1 Population and Population Growth Rate of Vietnam

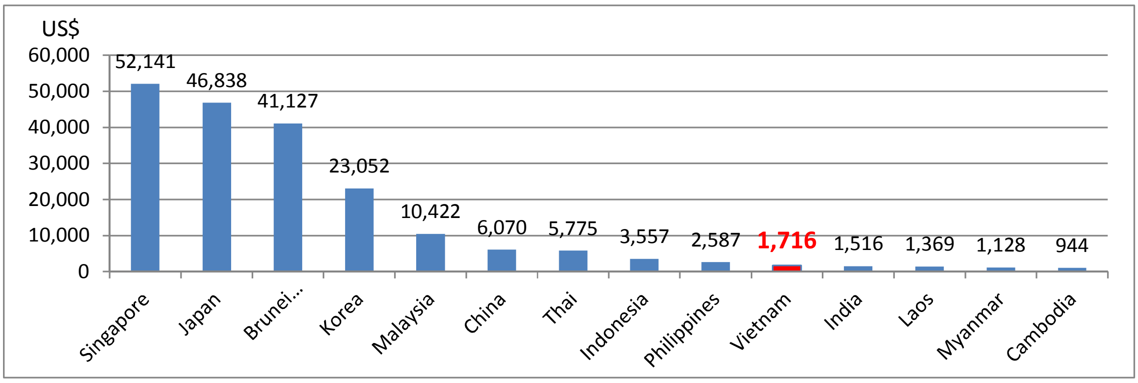
(2) GDP

The Vietnamese nominal GDP was 3,245 trillion VND (approx. 155.8 billion USD) in 2012. Per capita GDP is 1,716 USD, which is approx. one-twenty-seventh that of Japan. Compared with major emerging countries in Asia, it is lower than that of the Philippines at 2,587 USD, although exceeding that of India at 1,516 USD. The GDP growth rate has slowed down due to the sluggish global economy, triggered by the bankruptcy of Lehman Brothers in 2008. It was 5.2% in 2012, which exceeds that of India but is lower than the Philippines, Thailand, Indonesia and Malaysia.



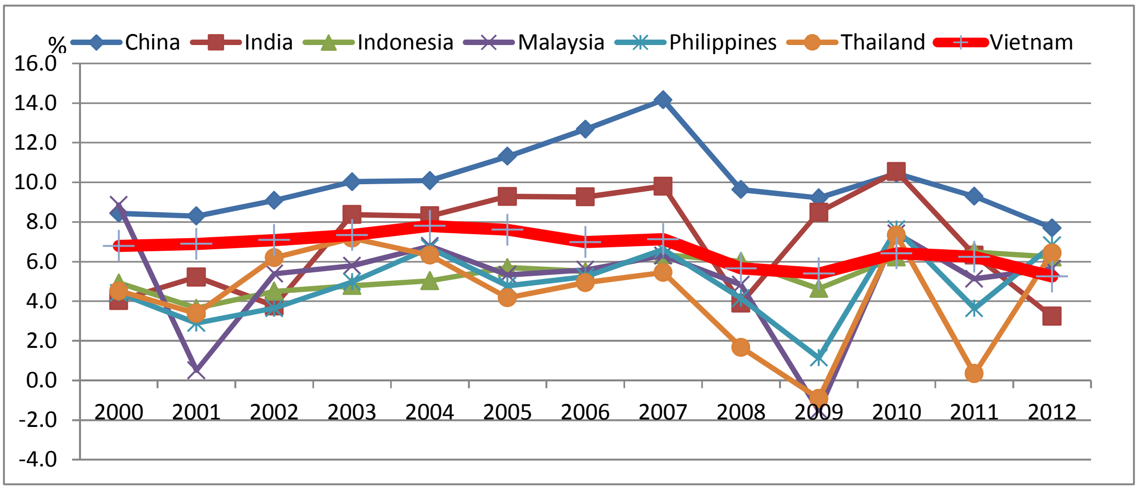
Source: Compiled based on GSO Statistical Data

Figure 2.2 Vietnamese GDP and its Growth Rate



Source: Compiled based on UN National Accounts Main Aggregates Database

Figure 2.3 Per Capita GDP of Major Asian Nations in 2012



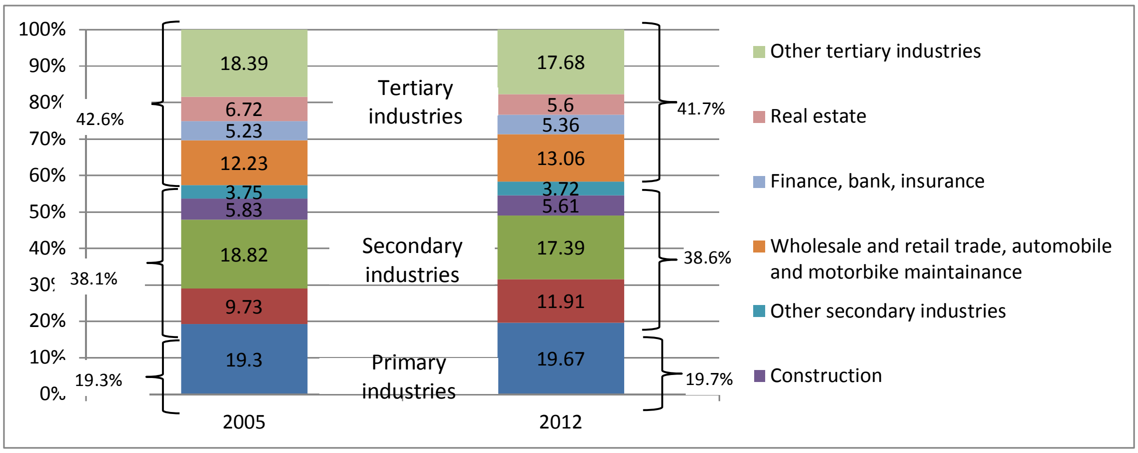
Source: Compiled based on UN National Accounts Main Aggregates Database

Figure 2.4 GDP Growth Rate of Major Asian Nations

(3) Industrial structure

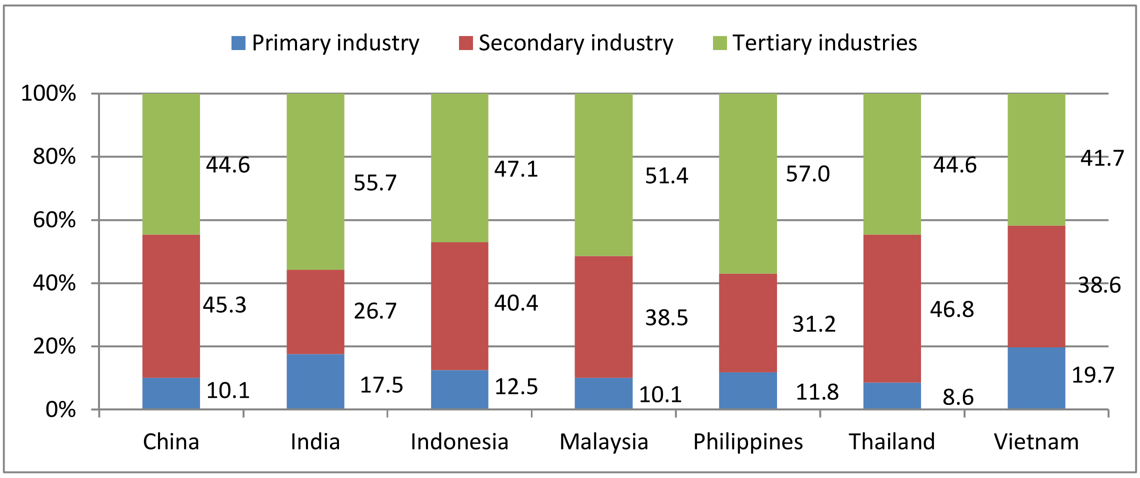
The ratio of primary, secondary and tertiary industry to GDP in 2012 has changed little since 2005. Although the ratio of secondary industry increased from 38.1 to 38.6%, this was mainly due to the sharp increase in the ratio of mining and quarrying and the ratio of manufacturing decreased by 1.43 percentage points, which shows no progress in industrialization.

The ratio of primary industry increased from 19.3 to 19.7%, whereas that of tertiary industry decreased by 0.9 percentage point from 42.6 to 41.7%. The ratio of primary industry is relatively high and that of tertiary industry is low compared to major emerging countries in Asia. The ratio of secondary industry is also lower than those of Thailand, China and Indonesia.



Source: Compiled based on GSO Statistical Data

Figure 2.5 Industrial Structure of Vietnam

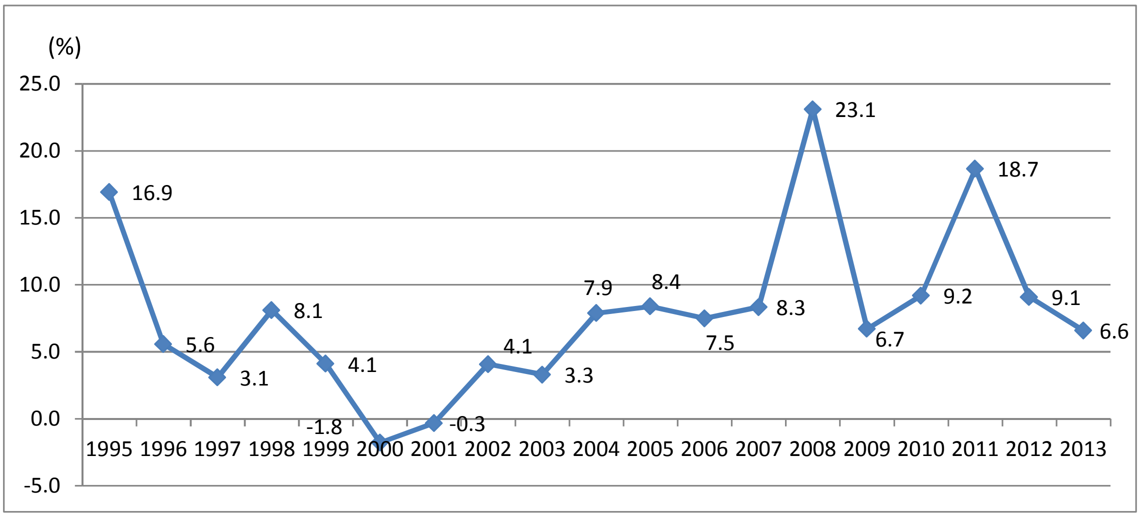


Source: Compiled based on data of China (National Bureau of Statistics), India (Census of India), Indonesia (CEIC), Malaysia (CEIC), the Philippines (NSCB (National Statistical Coordination Board)), Thailand (NESDB (National Economic and Social Development Board), 2011) and Vietnamese GSO Statistical Data

Figure 2.6 Industrial Structure of Major Asian Nations in 2012

(4) CPI Increase Rate

The CPI increase rate of Vietnam has fluctuated drastically over the past two decades or so, in accordance with trends in the global economy and foreign capital. It rose to 16.9% in 1995 in the first foreign capital inflow boom in the 1990s, before dropping to a negative 1.8% by 2000 falling into super deflation, affected by the financial crisis in Asia. It reached 7.9% in 2004 and remains stable at around 8% by 2007. However, it rose to 23.1%; falling into hyperinflation in 2008, affected by the increase in money supply in line with the sharp rise in global resources and grain prices, governmental economic and financial policies that prioritized economic growth and the influx of speculative money (second foreign capital inflow boom). Although it dropped to settle at 6.7% in 2009, it reached 18.7% in 2011 due to another money supply increase affected by the economic stimulus measure implemented by state government in response to the economic slump triggered by the bankruptcy of Lehman Brothers in 2008. In February 2011, the government issued Resolution 11 for inflation control and macroeconomic stabilization, which led to a shifting of priorities from economic growth to austere fiscal and tight money policies (policy interest rate increase and credit balance increase controlled below 20%, etc.). Consequently, the CPI has shown a declining trend at 9.1% in 2012 and 6.6% in 2013, although the economic growth rate dropped to 5 to 6%. Stabilization of the macro-economy, particularly inflation control, is critical for the Vietnamese Government as the nation is easily affected by such external economic factors and their impact on projects needs to be taken into consideration.



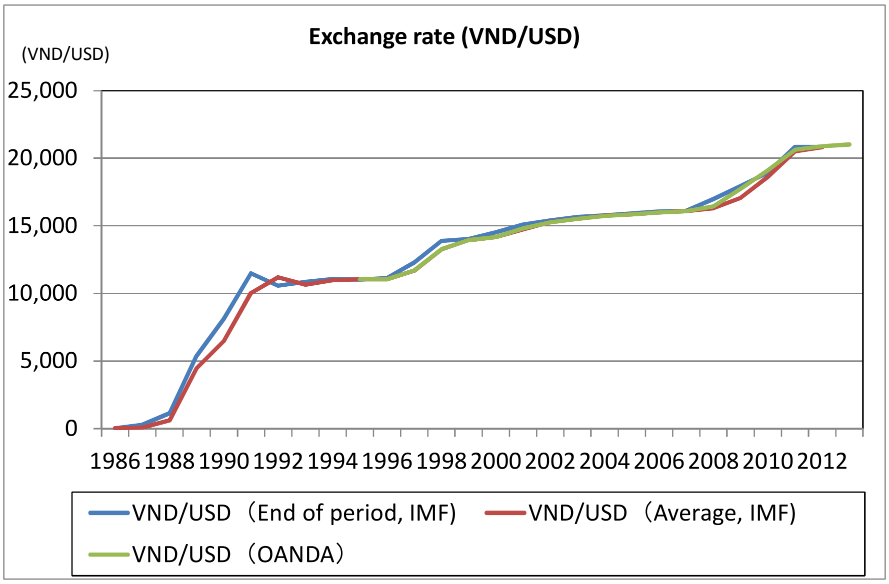
Source: Compiled based on UN National Accounts Main Aggregates Database

Figure 2.7 Trend of CPI Increase Rate of Vietnam

(5) Foreign exchange rate fluctuations

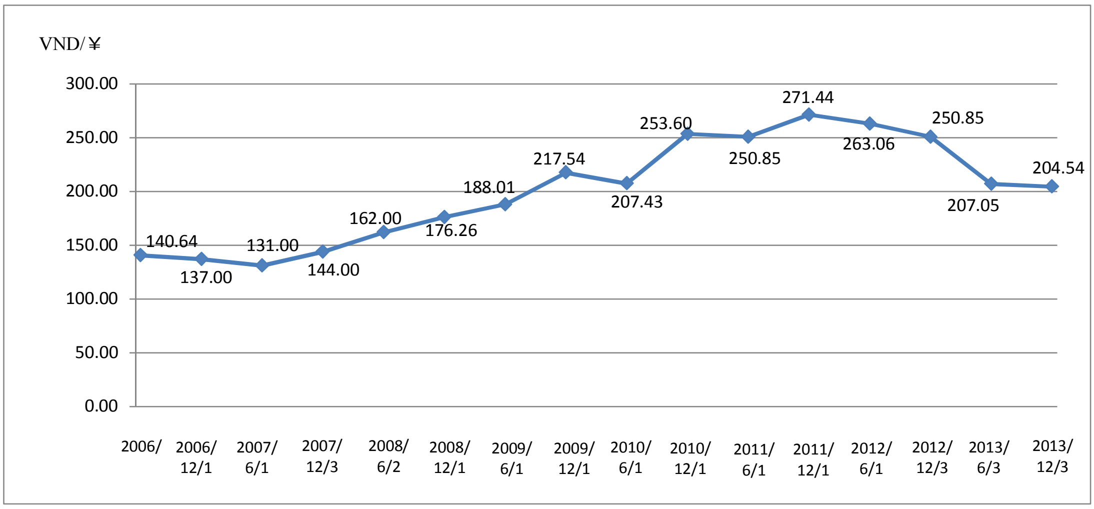
In Vietnam, the Government used to decide the official exchange rate by transaction until 1989, when a system in which the Central Bank of Vietnam decides the official exchange rate was introduced and, in 1999, the managed float system (fix the range of fluctuations of the exchange rate and foreign currencies are traded freely within the range) was officially adopted.

The average annual rate of exchange rate fluctuations from 1995 to 2013 is 3.8% against the USD and 3.4% against the Japanese yen, showing a trend toward depreciation of the VND. From 1997 to 1999, the VND depreciated at an annual rate of more than 5% (against the USD) due to the impact of Asian currency turbulence after the currency crisis. From 2009 to 2011, VND was devalued at an annual rate of more than 5% (against the USD) because of the pressure Conversely depreciation caused by Vietnamese companies and individuals selling the VND and buying USD (emergence of a gap between official and market rates) to avoid reducing the purchasing power of the VND as well as controlling the increasing trade deficit in Vietnam in line with inflation triggered by the economic stimulus measure by the Vietnamese Government, following the global economic slump triggered by the bankruptcy of Lehman Brothers (2008). The exchange rate is prone to devaluation of the VND; affected by changes in the external economic climate, inflation and a chronic trade deficit and there is a need to consider its impact on projects.



Source: International Financial Statistics Yearbook (2002 and 2013), OANDA HP

Figure 2.8 VND Exchange Rate



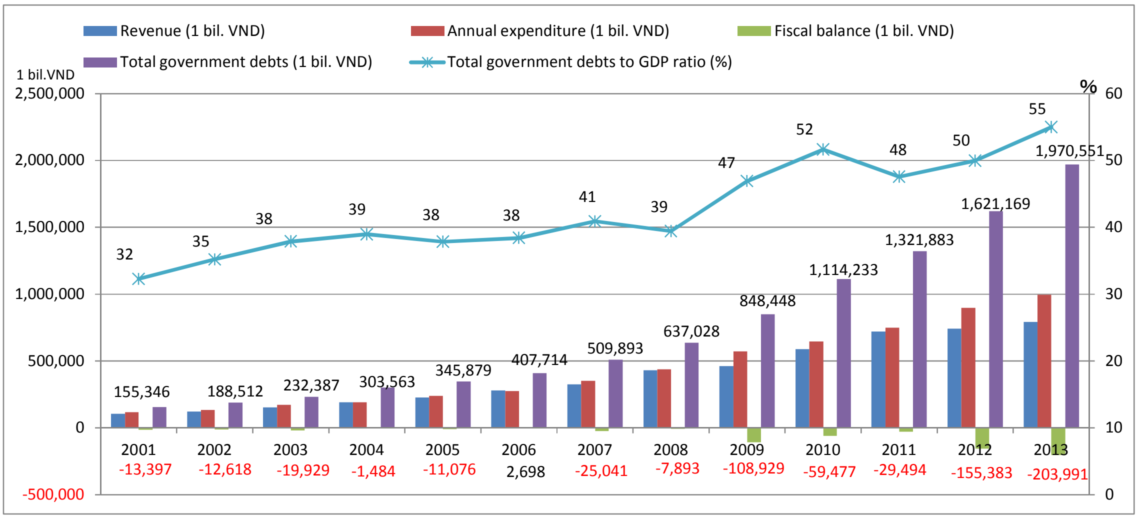
Source: Vietcombank website

Figure 2.9 VND Exchange Rate in Vietnam

(6) National finance

Vietnam has constantly posted revenue shortfalls except in 2006. The amount of excess of expenditures reached 109 trillion VND in 2009 following the global economic slump triggered by the bankruptcy of Lehman Brothers and has continued to increase to 155 trillion VND in 2012 and 204 trillion VND in 2013.

Conversely, total government debts have continued to increase to reach 1,971 trillion VND, which is equivalent to 55% of its GDP, in 2013 and it has become difficult to manage the nation with policies in the past. The use of private-sector capital in PPP and BOT schemes has thus increased in future infrastructure development.



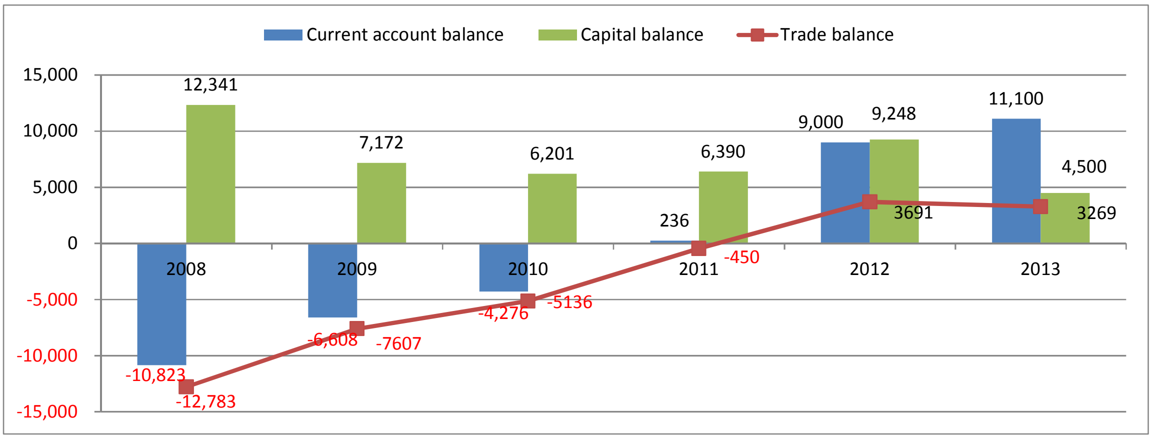
Source: Compiled based on IMF World Economic Overview Database (April 2014)

Figure 2.10 Fiscal revenues and Expenditures and Total Governmental Debts of Vietnam

(7) Balance of payments

The balance of payments of Vietnam has remained in the red due to the huge current account deficit by 2010, despite the consistent surplus of capital balance as a result of sustainable inflow of foreign capital. The main cause of current account deficit is trade deficit. As for FY2008, the trade deficit reached 12.78 billion USD exceeding the current account deficit of 10.82 billion USD.

The deficits of current account and trade balance have been on a declining trend recently and both turned into a surplus in 2011 and 2012, respectively. Whether or not the surplus of current account and trade balance continues depends on the international competitiveness of the Vietnamese manufacturing and service sectors.

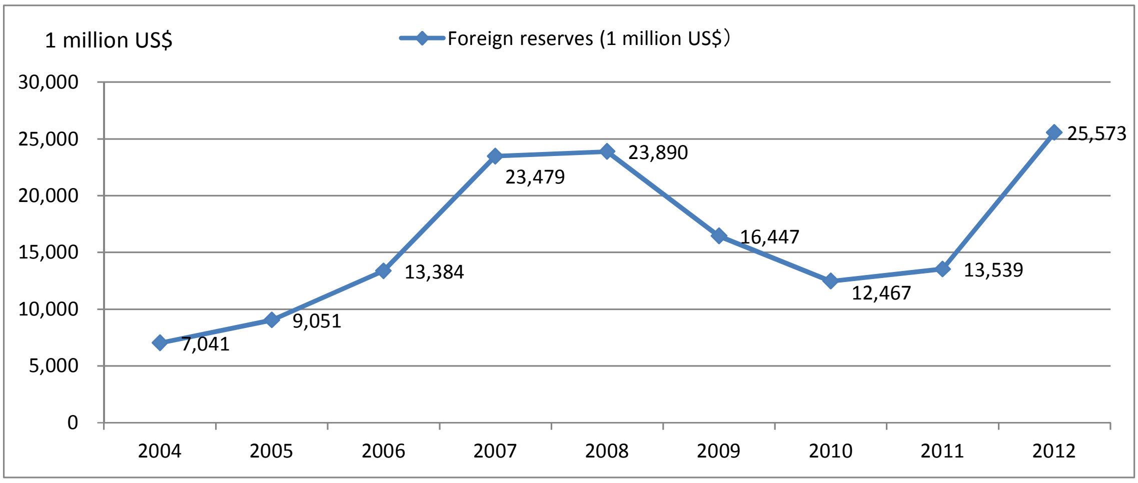


Source: Website, Vietnam Report (original source: JP Morgan)

Figure 2.11 Balance of Payments of Vietnam

(8) Foreign reserve

The foreign reserve of Vietnam increased from 7.04 billion USD in 2004 to 23.89 billion USD in 2008. However, it plummeted to 16.45 billion USD in 2009 and 12.47 billion USD in 2010 due to of outflow of foreign capital and decrease in export volume following the global economic slump triggered by the bankruptcy of Lehman Brothers. It then rocketed from 13.54 billion USD in 2011 to 25.57 billion USD in 2012 because of the recovery in exports and circulation of foreign capital back into Vietnam in line with the global economic recovery.



Source: Information by Country and Area, JETRO website

Figure 2.12 Vietnamese Foreign Reserves

The foreign reserves are needed because of payments to trade activities, securing liquidity in a financial crisis and stabilizing the exchange rate. Although there are many theories concerning what constitutes the appropriate scale of foreign reserves of a country[1], two widely accepted are that it is "equivalent to three months of import value"[2] and "exceeding the amount of short-term foreign debt"[3]. The estimated ratio of foreign reserves to the three-month export value of the previous year and short-term foreign debt[4] of Vietnam and surrounding Asian countries from 2004 to 2013 is shown below.

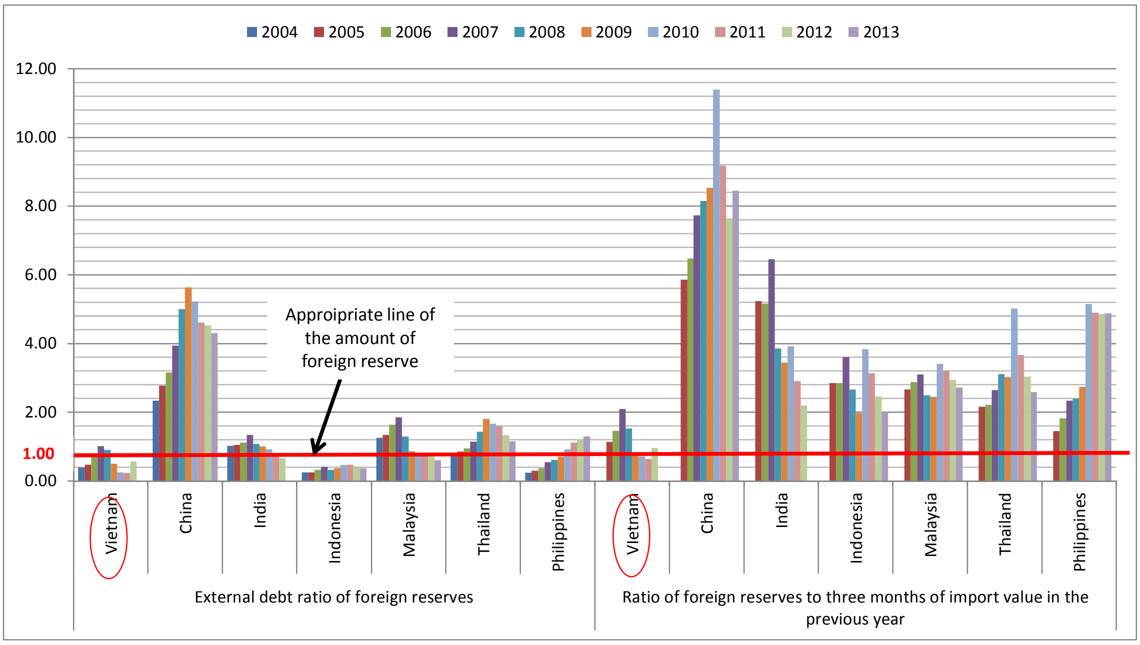
As for the "equivalent to three months of import value," the foreign reserves of almost all other countries exceeded the amount of three-month export value in the previous year throughout the period, whereas Vietnam is the only country where it did not exceed this amount for four years from 2009 to 2012. As for "exceeding the amount of short-term foreign debt," Vietnam did not reach this target in any fiscal year except 2007. However, because the value of short-term foreign debt used for the estimation includes long-term debt because of limited data, the actual situation is not likely to be so serious.

[1] It does not hold that the better the situation, the more foreign reserves a country has, because excessive foreign reserves mean a loss of opportunity cost.

[2] DeBeaufort Wijinholds, J. Onno and Arend Kapteyn, "Reserve Adequacy in Emerging Market Economies", IMF Working Paper, 143, September 2001.

[3] Guidotti, Pablo E., Remarks at the G33 meeting, Bonn, Germany, April 1999.

[4] Because the data used in the estimation is that of foreign debts in Information by Country and Area, JETRO website and includes long-term debts, it is necessary to focus on the issue of overestimating actual short-term debt and underestimating the ratio.



Source: Information by Country and Area, JETRO website

Figure 2.13 Comparison of Ratio of Foreign Reserves to GDP of Major Asian Countries

2.2.2 Socioeconomic overview of Project target areas

The population, GDP, industrial structure, foreign trade and local finance are examined to gain an overview of the society and economy of Quang Ninh Province and Hai Phong City as the target areas of the Project.

(1) Administrative areas and population

Quang Ninh Province comprises four cities, one town and nine districts and the provincial capital is Ha Long City. The populations of the province, cities, town and districts are shown in Table 2.1. The provincial population increased from 1.1 million in 2005 to 1.19 million in 2012 with an average annual growth rate over seven years of 1.15%, which exceeded the national growth rate (1.07%) during the same period.

As for the population growth rate of cities in the province during the same period, that of Mong Cai is the highest at 1.76% and other cities, town and districts whose population growth rate exceeds that of the national average are Co To District (1.73%), Hoanh Bo District (1.51%), Uong Bi City (1.48%), Dam Ha District (1.45%), Ba Che District (1.44%), Hai Ha District (1.39%), Ha Long City (1.36%) and Cam Pha City (1.13%).

Table 2.1 Population in Quang Ninh Province

(Unit: 1,000)

	2005	2010	2011	Prel.2012	Average annual increase rate in 7 years (%)
Total	1,096.10	1,158.80	1,173.00	1,187.70	1.15
Ha Long city	206.5	222.2	224.7	227	1.36
Mong Cai city	81.7	90.1	91	92.3	1.76
Cam Pha city	167.7	176.5	179	181.4	1.13
Uong Bi city	100	107.8	109.4	110.8	1.48
Quang Yen town	129.6	131.5	131.5	132.6	0.33
Binh Lieu district	27.1	28.1	28.6	29.1	1.02
Tien Yen district	43.4	45.2	45.9	46.6	1.02
Dam Ha district	32	34.1	34.8	35.4	1.45
Hai Ha district	50.1	52.9	54	55.2	1.39
Ba Che district	18.1	19.3	19.7	20	1.44
Van Don district	39.3	40.8	41.1	41.1	0.64
Hoanh Bo district	43.5	46.8	47.6	48.3	1.51
Dong Trieu district	152.6	158.5	160.5	162.6	0.91
Co To district	4.7	5.1	5.2	5.3	1.73

Source: Compiled based on Quang Ninh Province Yearbook 2012

Hai Phong City comprises 15 wards, seven of which are in urban zones and eight in rural areas and the city government is situated in the Hong Bang urban zone. The population of Hai Phong and each ward are shown in Table 2.2. The population increased from 1.77 million in 2004 to 1.90 million in 2012 with an average annual increase rate of 0.91%, which is below the national population growth rate.

When the population growth rate of each area is examined, the gap of growth rates among cities, town and districts in the province is relatively small although some gaps do exist and there is no area with negative growth. In comparison, Hai Phong City features both types of areas, namely those in which the population grew significantly and others where it decreased and the gap is huge. In Bach Long vi rural area, where the population was the smallest, the annual average growth rate from 2004 to 2012 was 10.67%. The rates of the Hai An, Do Son and Kien An urban zones and the An Duong rural area, meanwhile, all significantly exceeded the national average at 4.16, 3.97, 2.44 and 2.1%, respectively, whereas the population of the Kien Thuy, Vinh Bao and Tien Lang rural areas and the Hong Bang urban zone decreased with minus growth rates of 4.05, 0.83, 0.68 and 0.65%, respectively.

Table 2.2 Population of Hai Phong City

(Unit: 1,000)

	2004	2005	2010	2011	Prel.2012	Average annual increase rate in 8 years (%)
TOTAL	1,770.8	1,773.5	1,857.8	1,879.8	1,904.1	0.91
Hong Bang urban district	108.6	110.0	100.5	101.8	103.1	-0.65
Ngo Quyen urban district	160.4	160.3	167.1	167.8	169.9	0.72
Le Chan urban district	188.6	194.1	213.7	215.0	217.8	1.82
Hai An urban district	77.5	87.8	103.5	106.0	107.4	4.16
Kien An urban district	85.4	79.3	99.4	102.3	103.6	2.44
Do Son urban district	34.8	36.3	46.2	46.9	47.5	3.97
Duong Kinh urban district	-	-	49.2	50.2	50.9	1.71
Thuy Nguyen rural district	297.7	281.0	308.1	312.3	316.4	0.76
An Duong rural district	141.2	143.4	163.6	164.7	166.8	2.10
An Lao rural district	125.5	126.9	133.9	136.0	137.8	1.18
Kien Thuy rural district	180.7	183.3	127.0	128.1	129.8	-4.05
Tien Lang rural district	153.4	154.4	141.7	143.4	145.3	-0.68
Vinh Bao rural district	188.2	188.2	172.7	173.7	176.0	-0.83
Cat Hai rural district	28.4	28.2	30.3	30.7	31.1	1.14
Bach Long Vi rural district	0.4	0.3	0.9	0.9	0.9	10.67

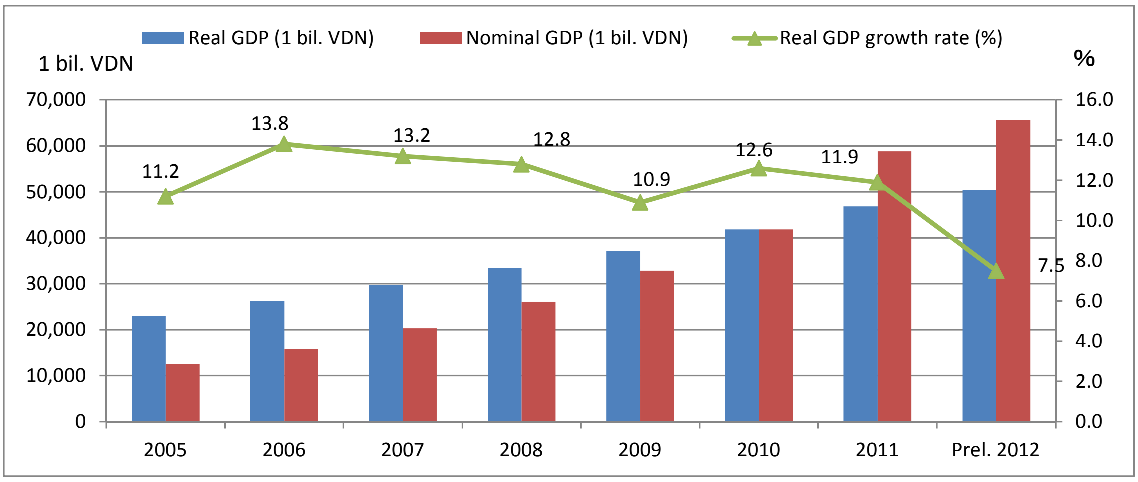
Note: The average annual growth rate of Duong Kinh urban zone is the three-year average from 2010 to 2012.

Source: Compiled based on the Hai Phong City Statistical Yearbook 2012

(2) GDP

1) GDP and its growth rate

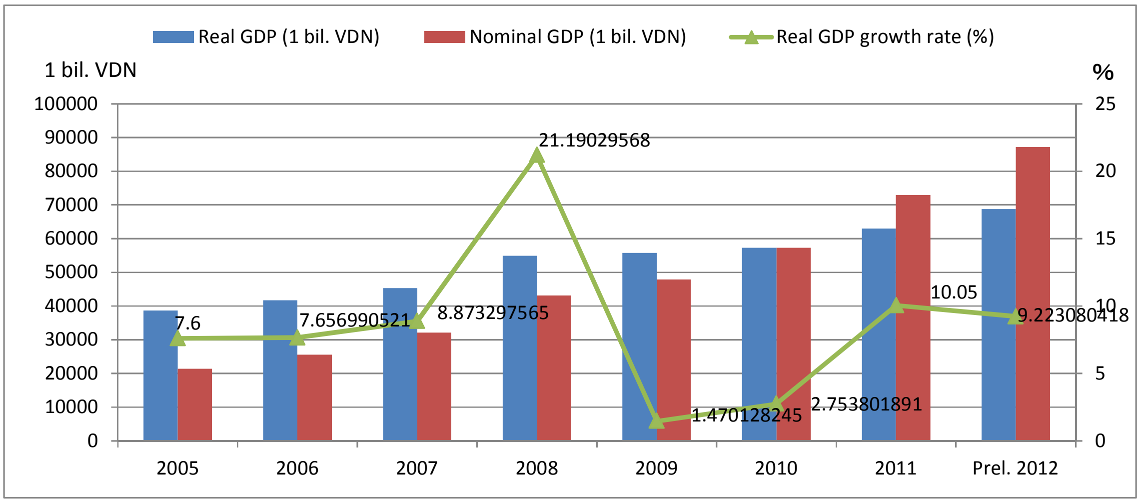
The nominal GDP of Quang Ninh Province and Hai Phong City in 2012 was 65.6 trillion VND (3.2 billion USD or 272.4 billion yen) and 87.2 trillion VND (4.2 billion USD or 362.1 billion yen), respectively and the seven-year average growth rates from 2005 to 2012 were 11.8 and 8.6%, respectively. Although Quang Ninh Province maintained an annual growth rate exceeding 10% by 2011, it dropped to 7.5% in 2012. The growth rate of Hai Phong City, meanwhile, plummeted from 21.2% in 2008 to 1.5% in 2009 and 2.8% in 2010, affected by the global financial crises, which, in turn, were triggered by the bankruptcy of Lehman Brothers in 2008. However, it recovered to 10.1% in 2011 and 9.2% in 2012.



Note: The real GDP is indicated in a single fixed price of 2010.

Source: compiled based on the Quang Ninh Province Statistical Yearbook 2012

Figure 2.14 GDP and GDP Growth Rate of Quang Ninh Province



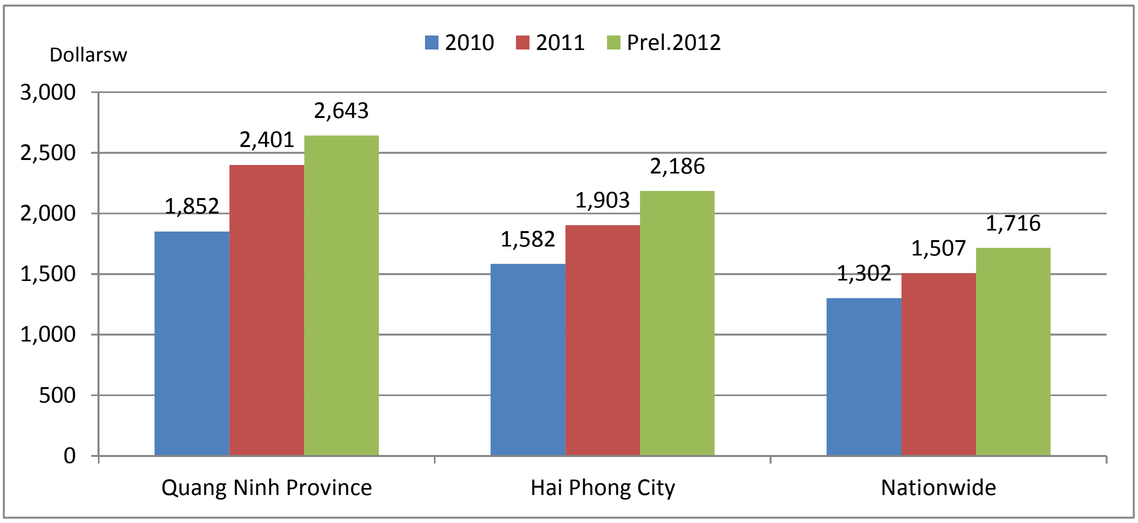
Note: The real GDP is indicated in a single fixed price of 2010.

Source: 1. Nominal GDP: Compiled based on the Hai Phong City Statistical Yearbook 2012
2. Real GDP: Calculated based on GDP deflator announced in UN National Accounts Main Aggregates Database

Figure 2.15 GDP and GDP Growth Rate of Hai Phong City

2) Average per capita GDP

The average per capita GDP of Quang Ninh Province and Hai Phong City in 2012 was 2,643 USD and 2,186 USD, respectively; both far exceeding the national average at 1,716 USD.

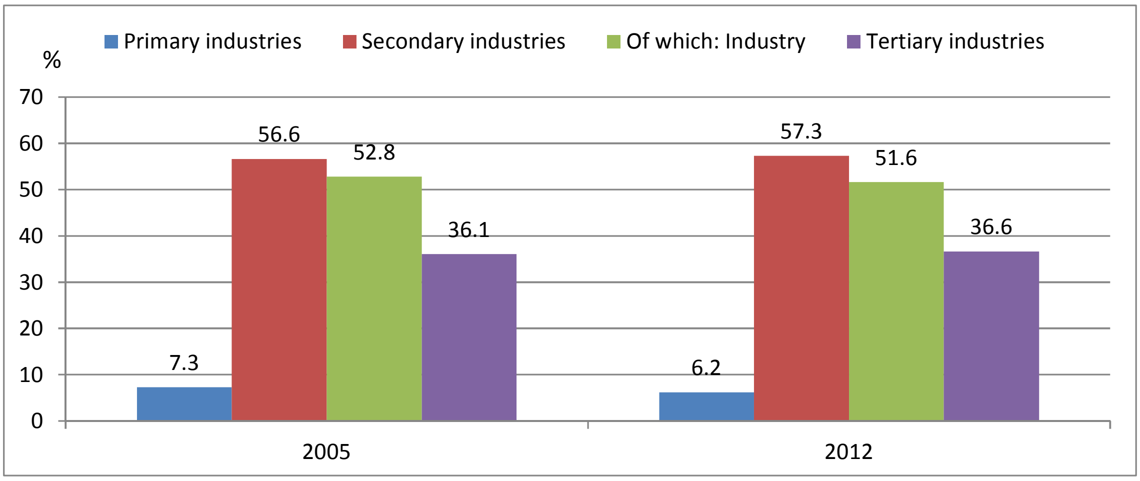


Source: 1. Quang Ninh Province and Hai Phong City Statistical Yearbook 2012
2. UN National Accounts Main Aggregates Database

Figure 2.16 Average Per Capita GDP of Quang Ninh Province and Hai Phong City

(3) Industrial structure

While the ratio of primary industry declined from 7.3 to 6.2% of GDP of Quang Ninh Province in the seven-year period from 2005 to 2012, that of the secondary and tertiary industries increased from 56.6 to 57.3% and from 36.1 to 36.6%, respectively, during the same period. The ratio of industrials in the secondary industry fell from 52.8 to 51.6%, which was mainly due to the decline in mining and quarrying. The ratio of manufacturing to GDP in 2012 increased by 4 percentage points from 11.3% in 2005 to 15.3%. However, it is lower than the ratio of mining and quarrying (26.3%), which shows that Quang Ninh Province remains highly dependent on the latter.

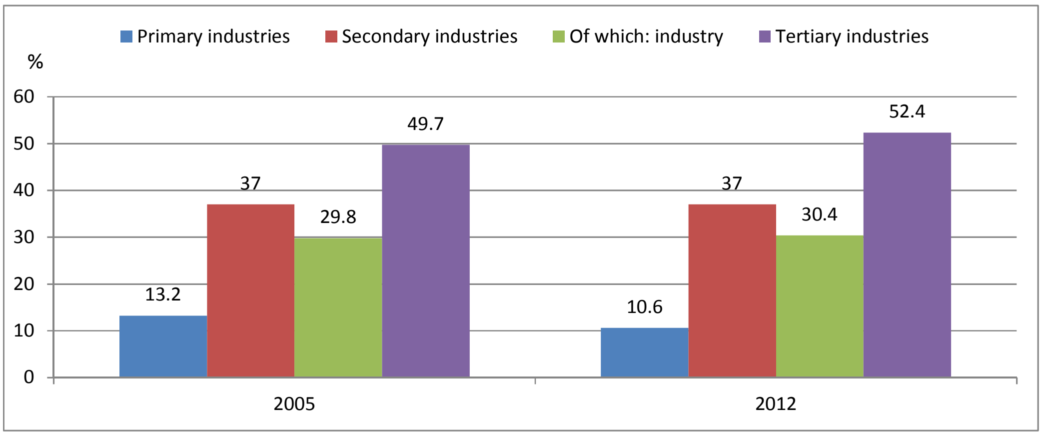


Note: The portion of taxes is excluded.

Source: Compiled based on the Quang Ninh Province Statistical Yearbook 2012

Figure 2.17 Industrial Structure of Quang Ninh Province

Changes to the industrial structure of Hai Phong City over seven years from 2005 to 2012 are examined. The ratio of primary industry declined by 2.6 percentage points from 13.2% in 2005 to 10.6% in 2012, whereas that of the tertiary industry increased at a similar rate from 49.7 to 52.4%, which shows a significant shift from primary to tertiary industries. Although there is little change in secondary industry, the industrial sector increased by 0.6 percentage point from 29.8 to 30.4% and the ratio of manufacturing increased from 27.9 to 28.3%, which is where Hai Phong City differs from Quang Ninh Province.



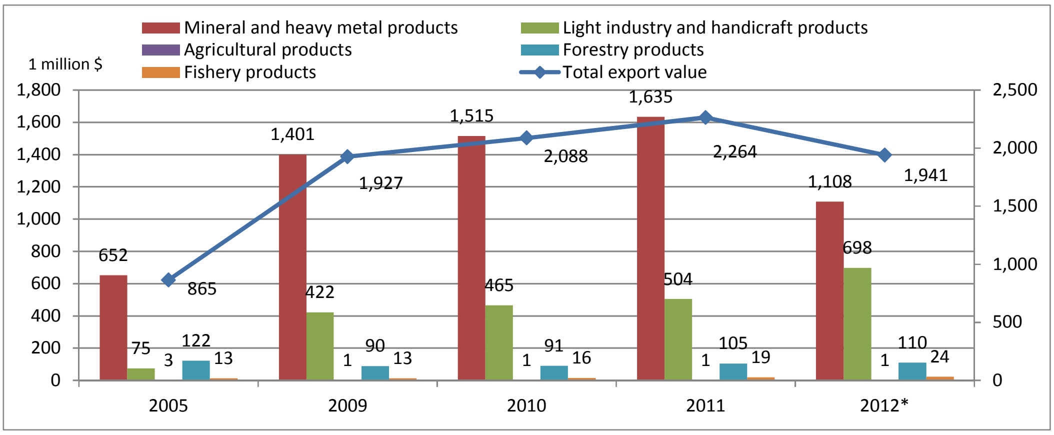
Source: Compiled based on the Hai Phong City Statistical Yearbook 2012

Figure 2.18 Industrial Structure of Hai Phong City

(4) Foreign trade

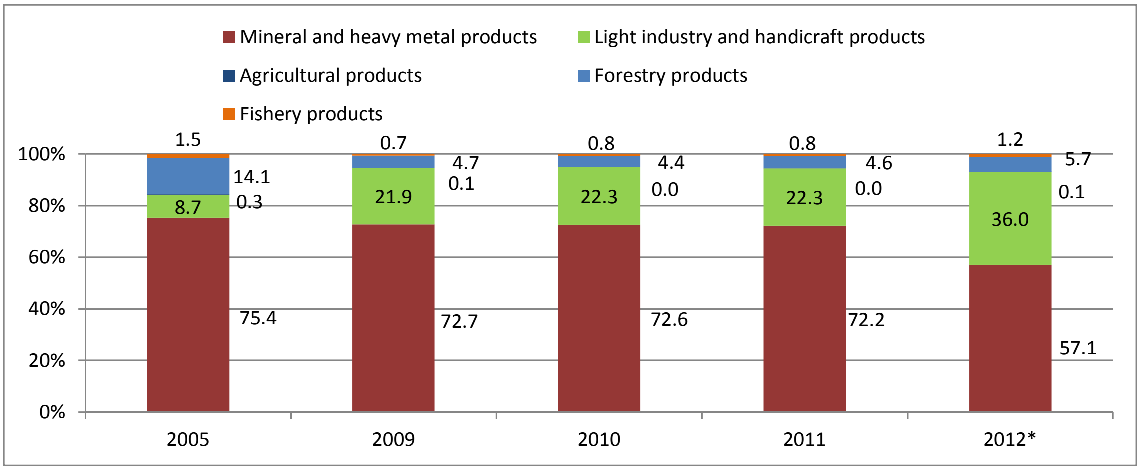
The total export value of Quang Ninh Province tripled in seven years to 1.94 billion USD in 2012 from 650 million USD in 2005, while the average annual growth rate during the period was 12.2%. The 2012 value declined by 14.3% from 2011, which was mainly due to a 32.2% decline from 1.64 billion USD in 2011 to 1.11 billion USD in 2012 of mining and heavy industrial products (mainly petroleum and coal) that are leading export items of Quang Ninh Province.

By product, the ratio of mining and heavy industrial products dropped to below 60% in 2012 although it had been more than 70% by 2011. The ratio of light industry and handicraft products significantly increased from 8.7% in 2005 to 36% in 2012. The structure, led by exports of petroleum and coal and other natural resources, has gradually shifted to one mainly comprising manufacturing products of light industry and handicraft products.



Source: Compiled based on the Quang Ninh Province Statistical Yearbook 2012

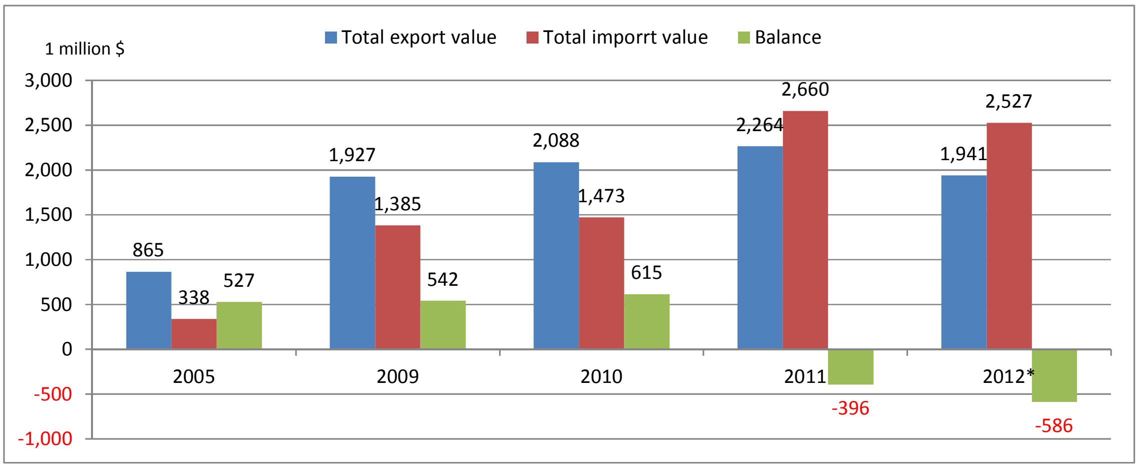
Figure 2.19 Total Export Value and Export Value by Product Group of Quang Ninh Province



Source: Compiled based on the Quang Ninh Province Statistical Yearbook 2012

Figure 2.20 Ratio of Exports Value by Product Group in Total Value of Quang Ninh Province

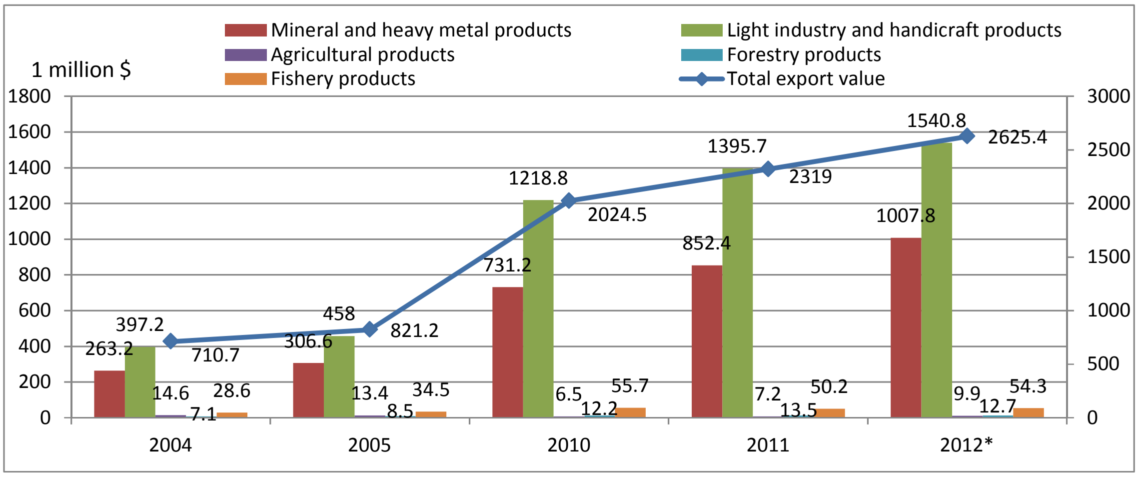
The total export value by 2010 exceeded the total import value and the export-import balance in 2010 was a surplus of 620 million USD. However, it turned into a deficit of 400 million USD in 2011, which increased to 590 million USD in 2012. Although this was mainly due to the significant decline in exports of mining and heavy industrial products as described earlier, it was also due to imports far exceeding exports (annual average growth rate of the former, 33.3% over seven years). It is notable that the average growth rate of machinery and equipment and parts that are leading import items reached 34%.



Source: Compiled based on the Quang Ninh Province Statistical Yearbook 2012

Figure 2.21 Export-Import Balance of Quang Ninh Province

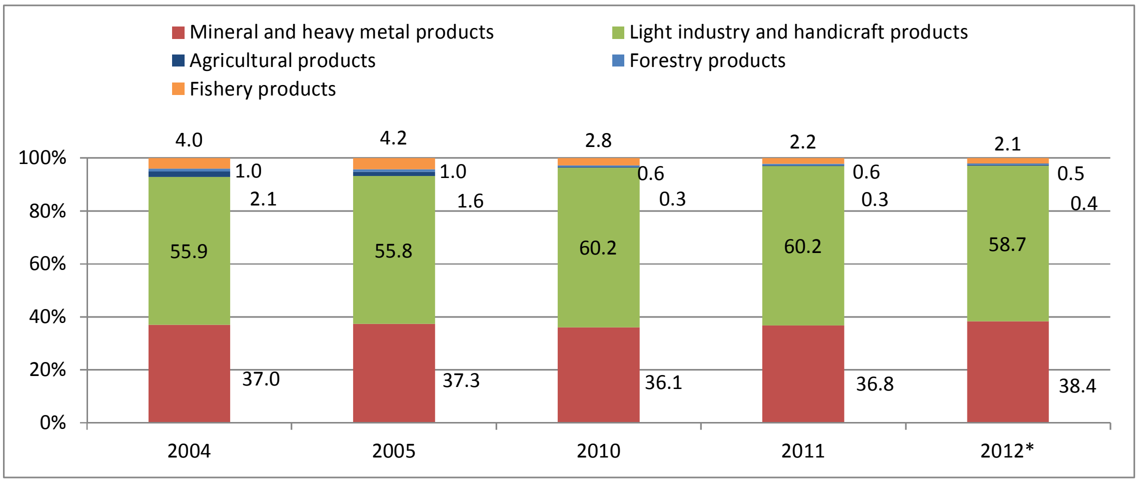
The average annual export growth rate of Hai Phong City during the 8-year period from 2004 to 2012 was 17.7%, exceeding that of Quang Ninh Province. The total export value in 2012 was 2.63 billion USD, which was 40% more than that of Quang Ninh Province.



Source: Compiled based on the Hai Phong City Statistical Yearbook 2012

Figure 2.22 Total Export Value and Export Value by Product Group of Hai Phong City

The leading export products are light industry and handicraft products, unlike Quang Ninh Province and comprise around 60% of the total export value from 2004 to 2012. This is consistent with the way manufacturing is prioritized in the industrial structure described above.



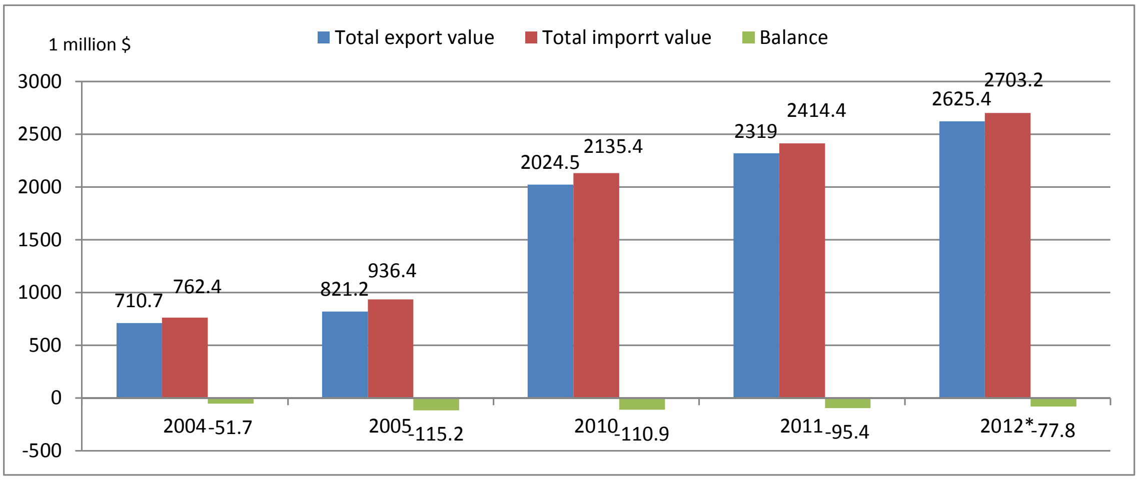
Source: Compiled based on the Hai Phong City Statistical Yearbook 2012

Figure 2.23 Ratio of Exports Value by Product Group to Total Value of Hai Phong City

Although the average annual import growth rate during the 8-year period from 2004 to 2012 was 17.1%, which resembled the export growth rate, the import value consistently exceeded the export value and the export-import balance continues to post a deficit. However, the deficit has been declining and decreased from 110 million USD in 2010 to 78 million USD in 2012.

The leading import products of Hai Phong City are also machinery and equipment and parts, which comprised 46% of the total import value in 2012, showing a heavy dependence on imports.

In general, both Quang Ninh Province and Hai Phong City share problems of a trade deficit and a chronic shortfall in foreign currencies, underlining the importance of promoting industry led by manufacturing and boosting exports.

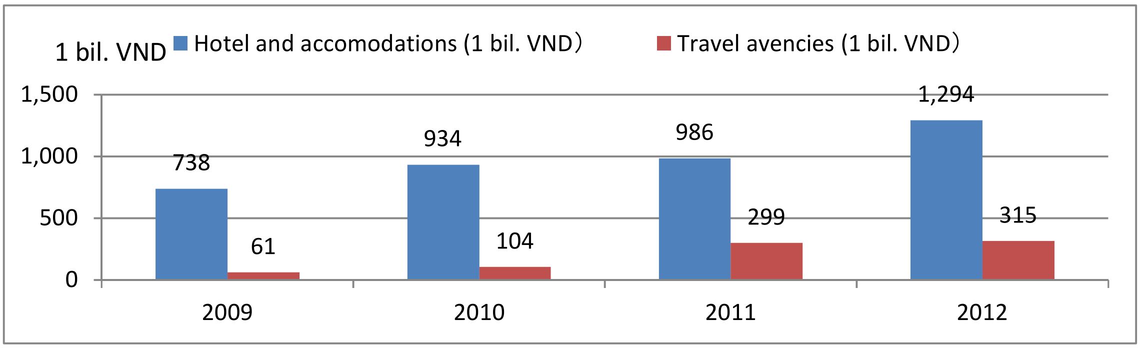


Source: Compiled based on the Hai Phong City Statistical Yearbook 2012

Figure 2.24 Export-Import Balance of Hai Phong City

(5) Tourism

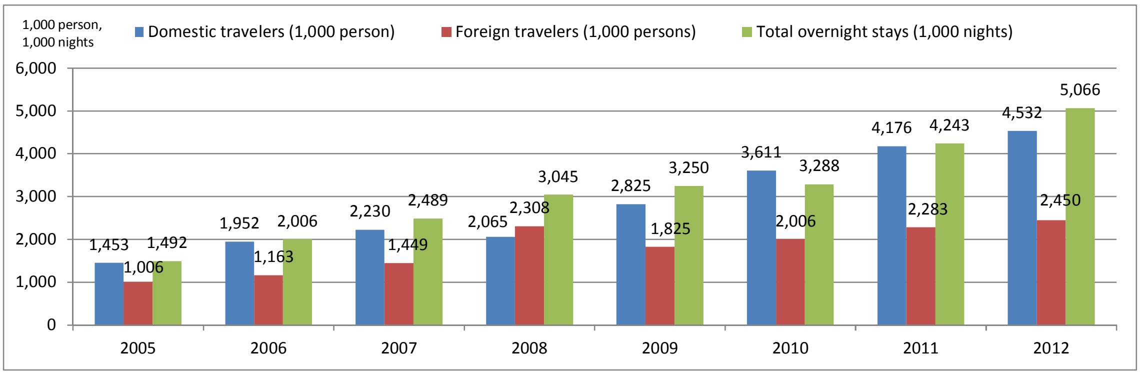
Tourism in Quang Ninh Province, which is home to the Ha Long Bay world heritage site, has not developed as much as expected. Sales of hotels and inns there were 1.2 trillion VND and those of travel agencies were 31.5 billion VND as of 2012, both far below those of Hai Phong City.



Source: Compiled based on the Quang Ninh Province Statistical Yearbook 2012

Figure 2.25 Sales of Hotels and Inns and Travel Agencies in Quang Ninh Province

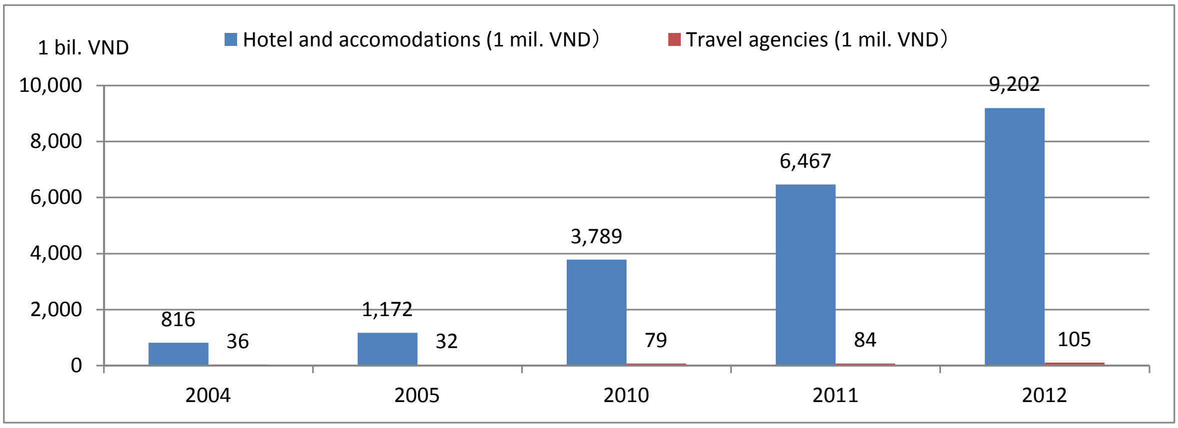
There were 4.53 million and 2.45 million domestic and foreign travelers, respectively, in 2012. However, the total number of overnight stays of all travelers was 5.07 million and the average per traveler was a mere 0.7 night.



Source: Compiled based on the Quang Ninh Province Statistical Yearbook 2012

Figure 2.26 Number of Domestic and Foreign Travelers and Total Overnight Stays in Quang Ninh Province

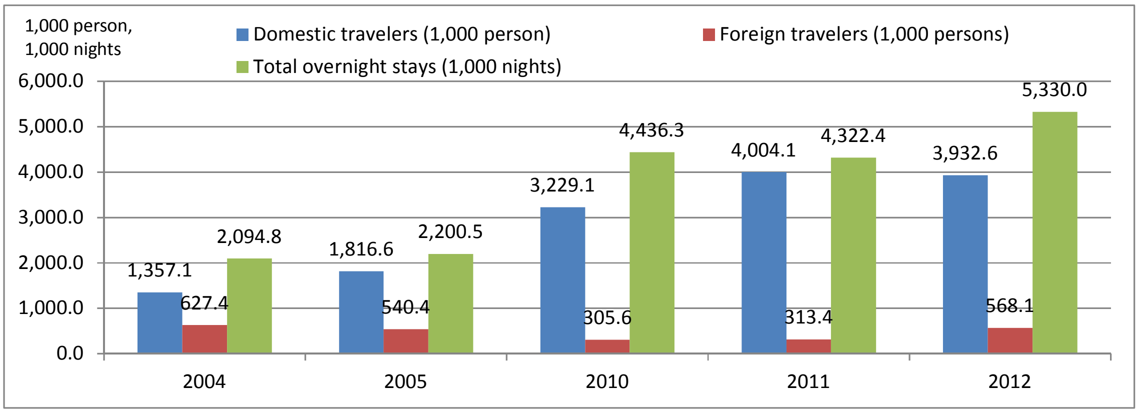
Meanwhile, sales of hotels, inns and travel agencies in Hai Phong City totaled 9.2 and 104.7 billion VND, respectively and sales of hotels and inns were more than seven times higher than those of Quang Ninh Province.



Source: Compiled based on the Hai Phong City Statistical Yearbook 2012

Figure 2.27 Sales of Hotels and Inns and Travel Agencies in Hai Phong City

Domestic and foreign travelers totaled 3.93 million and 570,000, respectively, both less than those of Quang Ninh Province. However, the total number of overnight stays of all travelers was 5.33 million nights and the average per traveler was 1.2 nights, both of which exceeded the figures for Quang Ninh Province. Travelers in Hai Phong City are likely to come for business more than for sightseeing and there are more overnight stays, since they have fewer travelers who do not stay overnight in the city, unlike Quang Ninh Province.



Source: Compiled based on the Hai Phong City Statistical Yearbook 2012

Figure 2.28 Domestic and Foreign Travelers and Total Overnight Stays in Hai Phong City

As the data above shows clearly, it is important to improve the average number of overnight stays and average consumption standard when promoting tourism in Quang Ninh Province. Although the number of travelers is expected to increase upon completion of the Project as it will significantly shorten the travel time from Hanoi, the number of overnight stays may decrease. Challenges include increasing the number of attractions and improving accommodation and services to extend the stay of travelers as well as improving road infrastructure to facilitate trips from Hai Phong and neighboring provinces, including Bac Ninh and Hai Duong Provinces.

(6) Introduction of foreign direct investment (FDI)

According to the FDI data[5] (which differs slightly from data in the above statistical yearbooks) provided by Quang Ninh Province and Hai Phong City, cumulative investments and registered value were 94 and 3.5 billion USD by 2013 in the province and 393 and 9.53 billion USD until June 2014 in the city respectively. This shows that the city received more investment than the province, which reflects the varying appeal for investors, including convenient access to the capital of Hanoi and the degree of development of manufacturing.

The project implementation is expected to facilitate closer economic cooperation between them. If the industry is segregated more rationally between them in a single large area, this will improve the investment environment for the entire area and is expected to change the social structure into one where FID will benefit the entire area, regardless of its destination.

(7) Local finance

The Ministry of Finance (MOF) officials highly evaluate the fiscal conditions of the Quang Ninh Provincial Government that is the implementing body of the Project; mainly for the

[5] Because of the significant gap between data obtained from the province and city in the survey and the figures in their statistical yearbooks, we decided not to use figures in the yearbook.

following reasons[6]:

1) Status as an area where the central budget is particularly coordinated

The State Budget Law of Vietnam stipulates that 13 provinces and cities[7] are assigned the status of "areas where the central budget is particularly coordinated" and the following five taxes are designated as shared taxes between central and local governments:

- Value added Tax (VAT)
- Corporate income tax
- Special consumption tax on domestically produced luxury products (special consumption tax levied on domestically manufactured cars and other domestically produced luxury products)
- Personal income tax
- Environment tax

Another 50 provinces and cities can take 100% of revenues from these taxes as their revenues. However, a certain ratio of them in the 13 provinces and cities above become central government revenues, although the ratio differs in each case. This is because these provinces and cities are economically affluent and not only capable of managing necessary spending with the revenues of the five taxes but also achieving a huge surplus, which allows them to contribute to central government.

Both Quang Ninh Province and Hai Phong City are among the 13 provinces and cities. Fiscal revenues of Quang Ninh Province are mainly supported by coal, tourism, forestry and marine products, and in terms of scale, it is ranked 6th among 62 provinces and cities nationwide. Revenues of the above five taxes of the province are divided in a ratio of 70 to the local government and the remaining 30 to central government. As for other taxes, 100% of export and import tax revenues as well as consumption tax on imported goods are contributed to the central government, which shows that the province remains in good fiscal shape.

2) Fiscal soundness based on debts

The State Budget Law also stipulates the allowable debt limit for Vietnamese local governments. It stipulates that the limit of debts (borrowings from banks and central treasury and issuance of bonds) permitted for 63 provinces and cities, excluding Hanoi and Ho Chi Minh, is 30% of the investment budget of the fiscal budget of the fiscal year. Hanoi and Ho Chi Minh in particular are allowed to have debts exceeding the investment budget as they are in good fiscal shape and capable of repayment.

As Quang Ninh Province has constantly observed the rule of not exceeding the 30% as explained above, its fiscal condition is believed to be highly sound. For example, in the most recent first quarter of 2014, the debt of the province amounted to 23.7% of the investment budget.

The expenditures and revenues of the province in FY2013 are shown in Table 2.3 below. The distribution ratio of central and local treasuries is 70%. Although the ratio of contribution to the central treasury was low compared to the 88% of adjacent Hai Phong City, the provincial fiscal condition is in good shape compared to other provinces.

According to the MOF appendix 09/CKTC-NSNN, its contribution to the central treasury is the fifth biggest among local governments, which also shows its high fiscal strength as a local government.

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[6] The information source of the Section is the interview with MOF' local budget management office manager on July 30, 2014.

[7] Hanoi, Hai Phong, Quang Ninh, Vinh Phuc, bac Ninh, Da Nang, Khanh Hoa, Quang Ngai, Ho Chi Minh, City, Dong Nai, Binh Duong, Ba Ria-Vung Tau and Can Tho

Table 2.3 Local Expenditures and Revenues of Quang Ninh Province in FY2013

	Breakdown	FY 2013 Budget	
		Mil VND	JPY(million yen)[8]
A	Revenues of central treasury	33,833,000	190,073
1	Inland (crude oil excluded)	14,690,000	82,528
2	Exports and imports	18,900,000	106,179
3	Management fees from central treasury	243,000	1,365
4	Grant aid		
B	Revenues of local treasury	12,840,317	72,136
1	Revenues at local level	12,001,940	67,426
	Local treasury 100% receiving	5,279,225	29,658
	Allocated amount	6,479,715	36,402
	Management fees from central treasury	243,000	1,365
2	Supplementary money from central treasury	838,377	4,709
3	Investment acquisition under State Budget Law Article 8.3		
C	Expenditures of local treasury	12,840,317	72,136
1	Investment and development	3,490,130	19,607
2	Repayment at maturity	8,041,557	45,177
3	Land and facilities		
4	Routine spending (labor-, facility-, transportation costs, etc.)	8,041,557	45,177
5	Reserve	617,987	3,471
6	Savings		
D	Balance	0	0

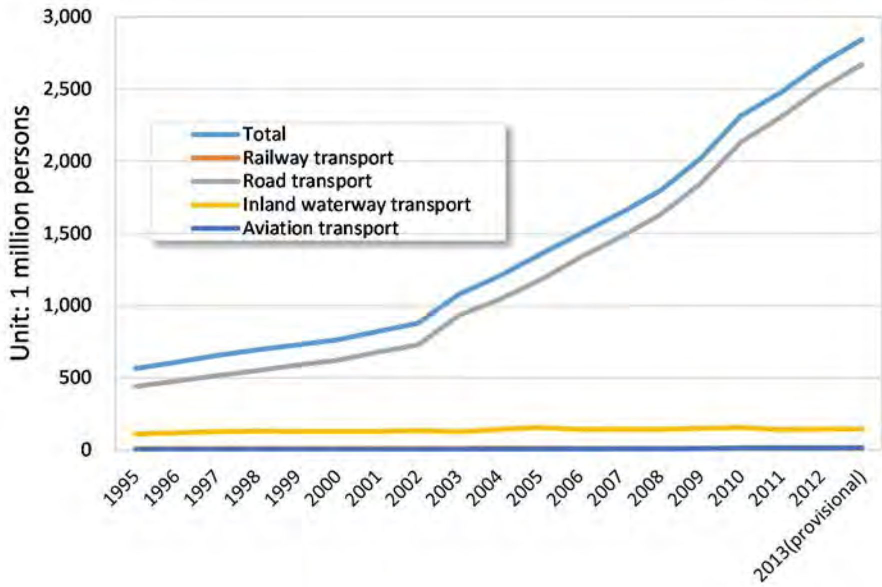
Source: Fiscal data of Quang Ninh Province People's Committee (management number CKTC-NSDP)

[8] 1VND=0.0056JPY

2.3 Transport sector

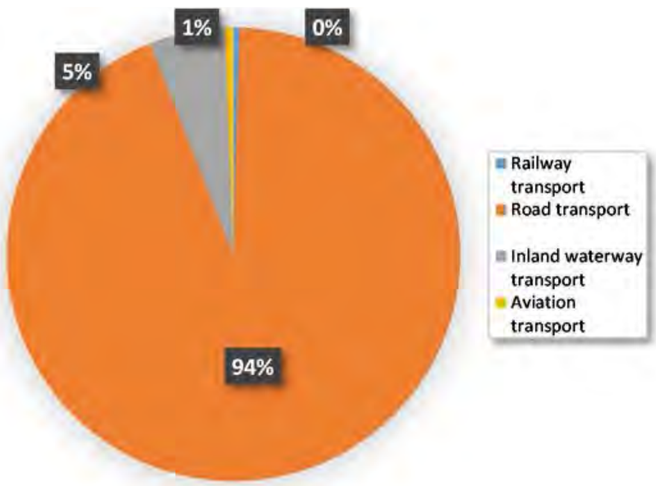
2.3.1 Passenger transport

Figure 2.29 shows the passenger transport by mode (road, inland water, air and railway) in Vietnam. The number of passengers totaled 560 million (78% road transport and 22% other means) in 1995, which increased almost fivefold to 2.68 billion (94% road transport and 6 percent other means) in 2012 and provisionally 2.84 billion (94% road transport and 6 percent other means) in 2013. Over 20 years, the increased passengers mostly depended on road transport, which thus comprised up to 94% of passenger transport in 2012 and 2013.



Source: Compiled by the JICA Study Team based on GSO Statistical Data

Figure 2.29 Passenger Transport by Mode in Vietnam (1995~)



Source: Compiled by the JICA Study Team based on GSO Statistical Data

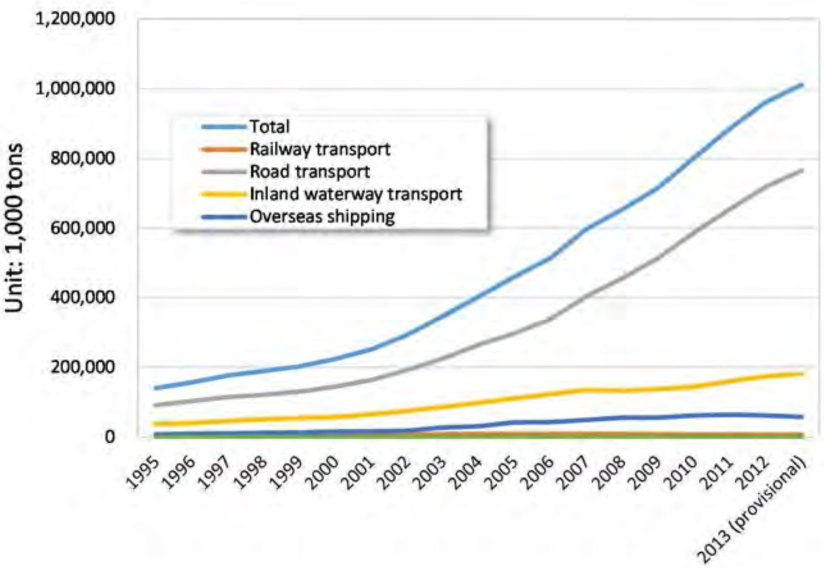
Figure 2.30 Passenger Transport by Mode in Vietnam (2012)

2.3.2 Cargo transport

Figure 2.31 shows the cargo transport by mode (road, inland water, ocean-going shipping, air and railway) in Vietnam. The total cargo transport volume in 1995 was 1.4 million tons (65% road, 27% inland water and 8% other modes). It increased almost sevenfold in 2012 to 9.61 million tons (75% road, 18% inland water and 7% other modes) and provisionally to 10.11 million tons (76% road, 18% inland water and 6% other means), exceeding 10 million tons in 2013.

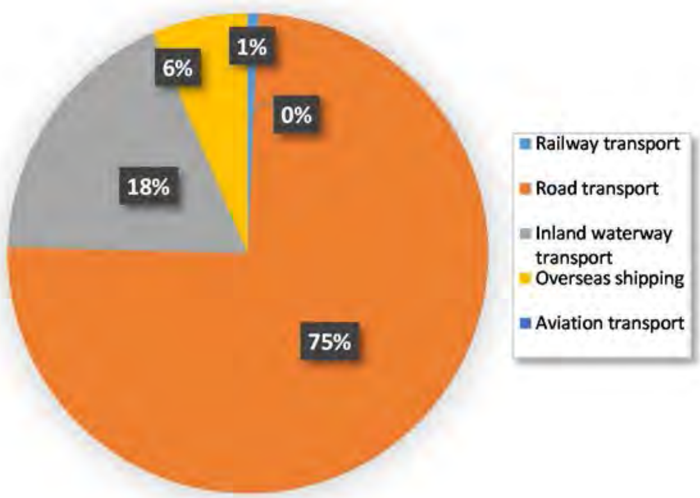
The ratio of road transport increased to 76% in the period and the increased demand was mostly managed by road transport.

Although ocean-going shipments also increased almost eightfold, resembling the increase in road transport, it rose only 1% in 2012 and 2013 because its ratio in 1995 was 5%. When inland water and ocean-going shipping are combined, the ratios in 2012 and 2013 dropped to 24% from 32%, because the inland water that accounted for 27% in 1995 increased only 4.8 times as much as the amount in the period. Accordingly, it cannot be concluded that inland water and ocean-going shipping have played a major role in handling the recent increased transport demand.



Source: Compiled by the JICA Study Team based on GSO Statistical Data

Figure 2.31 Cargo Transport by Mode in Vietnam (1995~)

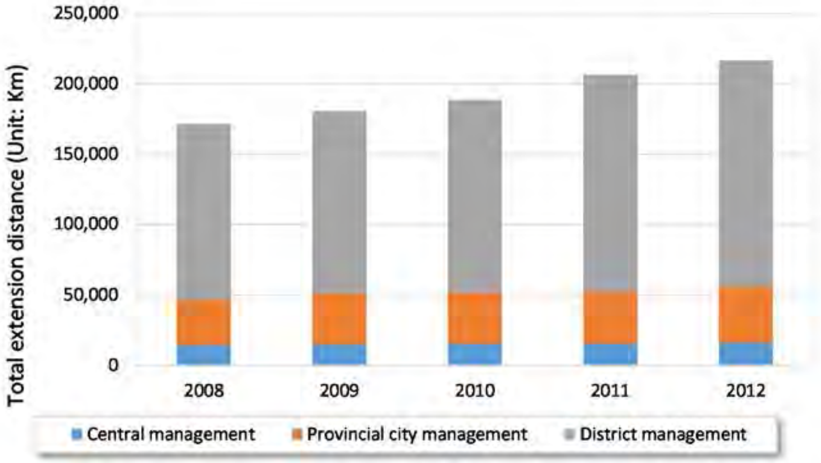


Source: Compiled by the JICA Study Team based on GSO Statistical Data

Figure 2.32 Cargo Transport by Mode in Vietnam (2012)

2.3.3 Road network

The sharp increase in passenger and cargo transport demand since 1995 has been mainly shouldered by road transport. Figure 2.33Figure 2.33 shows the road network development of Vietnam. As for total road length, it increased from 171,392 kilometers in 2008 to 216,557 kilometers in 2012; an increase of 26% or 45,165 kilometers in four years with an annual average increase of 11,000 kilometers.



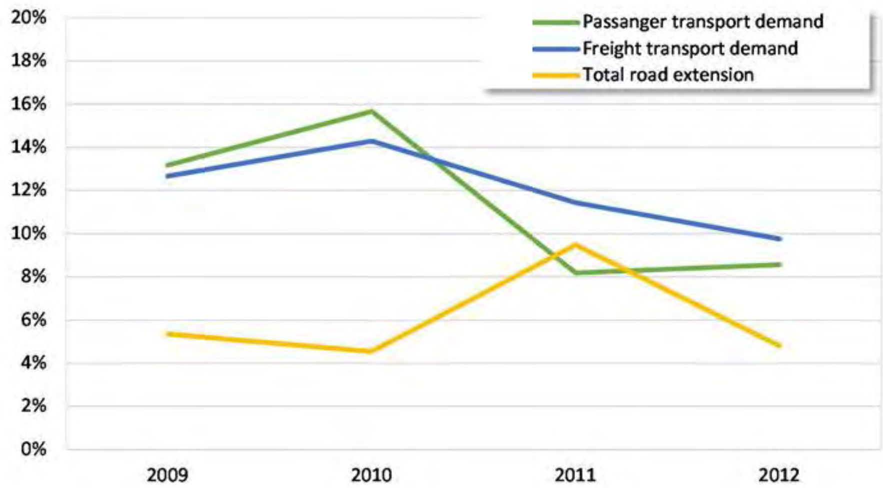
Source: Compiled by the JICA Study Team based on GSO Statistical Data

Figure 2.33 Total Road Length by Management Body

The total length of paved road increased from 80,108 kilometers in 2008 to 112,940 kilometers in 2012, which was an increase of 41% or 32,832 kilometers in the four-year period and 8,200 kilometers per year. The total length of unpaved road also increased from 91,284 kilometers in 2008 to 103,617 kilometers in 2012, which is a 14% increase in the four years.

The ratio of paved road as a proportion of the road network has not improved as much as expected, with only a 5% increase from 47% in 2008 to 52% in 2015. The pavement ratio of roads managed by the national government has exceeded 95% since 2008 from which effective data is available. This is because the pavement ratio of locally managed roads that comprise 74% of the total 216,557 kilometers of roads in Vietnam declined from 66% in 2008 to 60% in 2012, although the pavement ratio of roads of Hanoi and Ho Chi Minh directly controlled by the national government improved from 74% in 2008 to 82% in 2012. The lowered pavement ratio of locally managed roads is probably because paved road development is shelved, given the cost of meeting the transport demand, which reflects the severe fiscal conditions facing local governments.

Is road development in Vietnam meeting demand? Figure 2.34 shows the year-on-year increase ratio of road demand and length. Passenger and cargo transport increased by 54 and 57%, respectively, from 2008 to 2012. As for the year-on-year increase of passenger and cargo transport from 2008 to 2012, the minimum and maximum are 8 and 16% and 10 and 14%, respectively, whereas the total road length increased by only 26% or between 5 and 9% on a year-on-year basis during the period. This shows that the road development has not met the increasing transport demand in terms of road length at least and traffic congestion and accidents are likely to have increased in line with increased traffic demand at various points nationwide. Accordingly, further road development is expected.



Source: Compiled by the JICA Study Team based on GSO Statistical Data

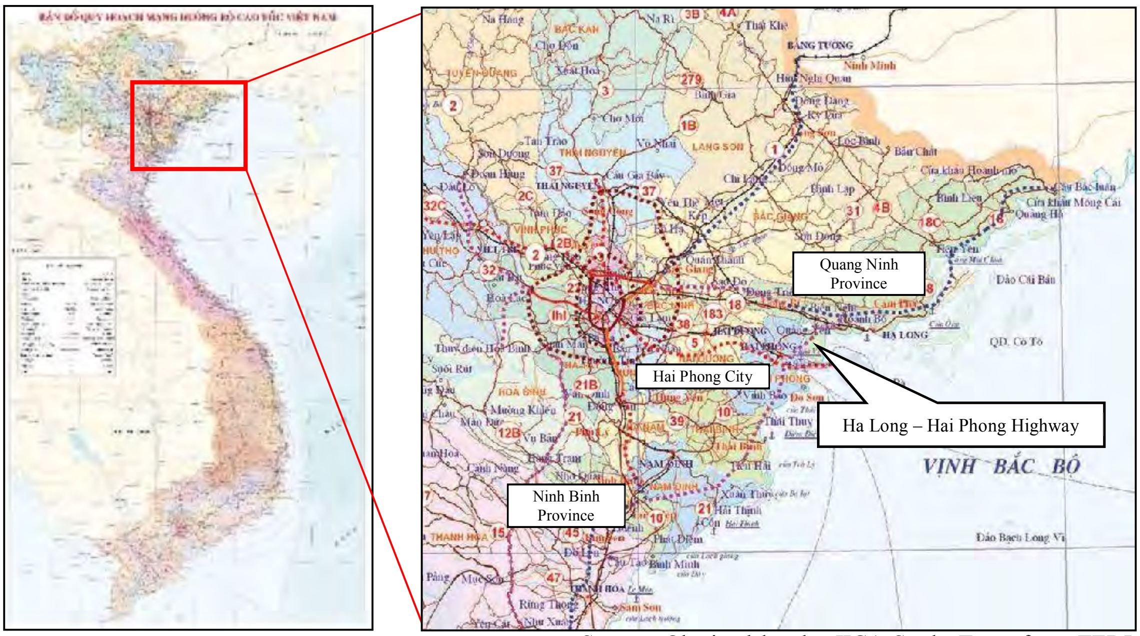
Figure 2.34 Increased Ratio of Road Demand and Length (year-on-year increase)

2.4 Future plans

2.4.1 Expressway development plans

(1) Expressway development plans in Vietnam

The Prime Minister's Decision, master plan on expressways by 2020 and vision after 2020 (Decision 1734/QD-TTg) issued on December 1, 2008, provides plans to develop expressways with total length of 5,873 kilometers and the Ninh Binh-Hai Phong-Quang Ninh expressway development plan, which includes the Ha Long-Hai Phong Highway, with total length of 160 kilometers. The Prime Minister's Decision, adjustment plan of road development by 2020 and the orientation toward 2030 (Decision 356/QD-TTg) issued on February 25, 2013, states that the feasibility of changing the line shape of the Ninh Binh-Hai Phong-Quang Ninh expressway will be examined.



Source: Obtained by the JICA Study Team from TEDI

Figure 2.35 Expressway Development Plan of Vietnam (1734/QD-TTg)

(2) Coastal road development plan of Vietnam

The Prime Minister's Decision, coastal development plan of Vietnam (Decision 129/2010/QD-TTg), issued on January 18, 2010, states the importance of developing coastal roads to boost the socioeconomic development of the country, utilizing the ocean-facing national geography, natural disaster prevention and mitigation and formation of national land axis. The total length is 3,041 kilometers along the coastline and the coastal area from Ninh Binh Province to Quang Ninh Province are targets of the plan in northern Vietnam. Networking with existing roads is expected to promote mutual effects and optimally exploit development.

Source: Obtained by the JICA Study Team from TEDI

Figure 2.36 Coastal Road Development Plan in Northern Vietnam (Decision 129/2010/QD-TTg)

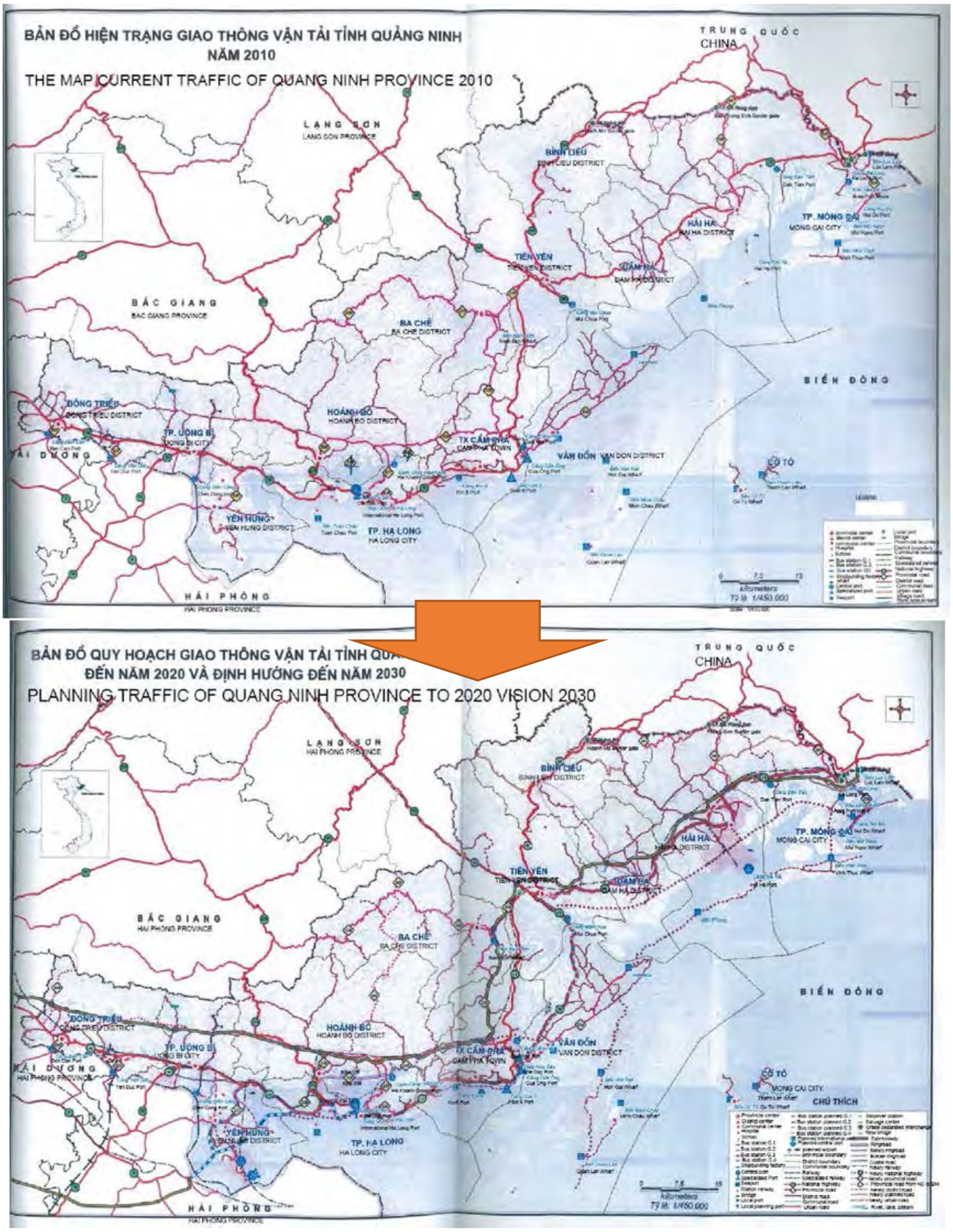
2.4.2 Related plans in the project area

Infrastructure development plans and the progress of related projects around the project site, mainly in Quang Ninh Province and Hai Phong City, are overviewed.

(1) Related projects in Quang Ninh Province

1) Road plans

Quang Ninh Province has formulated a transport plan by 2020 and vision toward 2030. The road development plan of the province is shown in Figure 2.37. It includes the Ha Long-Hai Phong Highway including the Project, Ha Long-Mong Cai Expressway connecting Ha Long with Mong Cai situated on the border with China and a provincial road that leads to the Lach Huyen Port near the Bach Dang Bridge.



Source: Quang Ninh Province Transportation Department

Figure 2.37 Road Development Plans in Quang Ninh Province

2) Development plans of industrial parks and economic zones

Quang Ninh Province plans to develop 11 industrial parks by 2020, approved by the Prime Minister; four of which are already in operation, four under development and a further three under land acquisition. The four industrial parks already in place house 71 companies, including 23 non-Vietnamese companies. A total of 70.80 million USD had been already invested and 8,770 persons employed by the occupant companies by April 2014.

Quang Ninh Province accommodates three border trade economic zones in the border area adjacent to China. The Van Don special economic zone is also planned as one of three special economic zones[9] in the country approved by the Prime Minister. Unlike the 15 economic zones built along the coastal areas in the country, it has special authorities directly managed by state government and provincial and city governments must not be involved. It is also privileged to attract investment in airport construction and casino and other entertainment businesses.

Table 2.4 Overview of Industrial Parks and Economic Zones in Operation or in the Planning Stage (by 2020) in Quang Ninh Province

Type	Current Status	Overview
Industrial parks (11)	Land being acquired	3 locations
	Under development	4 locations
	In operation	4 locations (Cai Lan, Dong Mai, Hai Yen and Viet Hung), 71 occupant companies (23 of which non-Vietnamese companies), 70.80 million USD invested (as of the end of April 2014), 8,770 are employed.
Economic zones (4)	In operation	3 locations (Mong Cai border-gate economic zone, Hoanh Mo – Dong Van border-gate economic zone and Bac Phong Sinh border-gate economic zone)
	In the planning stage	1 location (Van Don special economic zone)

Source: Quang Ninh Province Investment Department

3) Other infrastructure development projects

Infrastructure development projects in the implementation and planning stages in Quang Ninh Province are listed in Table 2.5 and include a wide range of development projects from roads, railways, airports, ports and harbors, resorts and residential areas.

The key projects are six road development projects including this Project and one airport, one port and harbor, one resort and one residential area development project. There are also three long-term railway projects to be implemented by 2030. Among infrastructure development projects, there are many road projects and main expressway construction projects closely related to the Project as they start and end at Ha Long.

9 The other two special economic zones are in Phu Quoc in Kien Giang Province and Van Phong in Khanh Hoa Province.

Table 2.5 Infrastructure Development Projects in the Implementation and Planning Stages in Quang Ninh Province

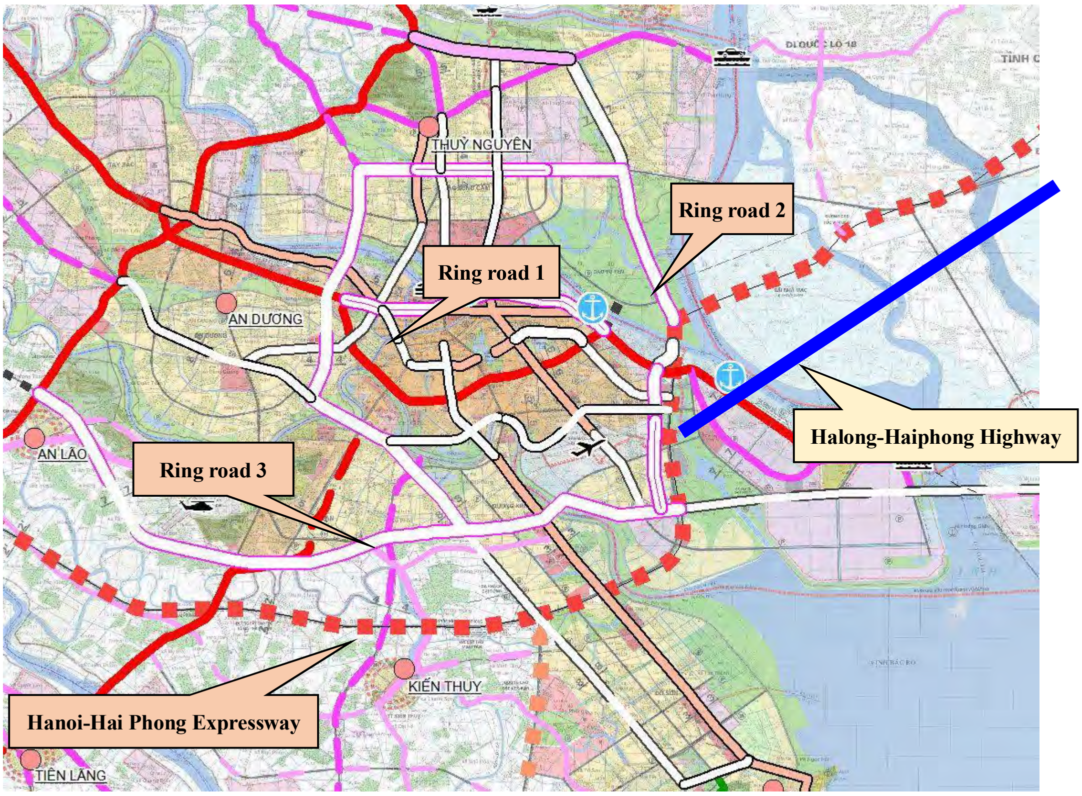
Type	Project	Overview
Road	Hanoi-H Long Expressway Improvement	A key project currently underway
	Ha Long-Hai Phong Expressway	A key project currently underway (this project)
	Minh Chau-Quan Lan Island road	A key project currently underway
	Ban Yen village resettlement zone road development	A key project currently underway, road upgrading from resettlement area to a complex park in the east of Cai Bau Island
	Van Don economic zone road	A key project currently underway, construction of main connecting road in the Van Don economic zone
	Route 334 development phase 3	A key project currently underway
	Ha Long-Van Don-Mong Cai Expressway	To be implemented by 2020
	Noi Bai-Ha Long Highway	To be implemented by 2020
	Ban Tien Bridge	To be implemented by 2020, connecting Van Don and Tien Yen, Lang Son Province, Cao Bang Province and Yunnan Province in China
	National Route 4B upgrading	To be implemented by 2020
Railway	Hanoi-Cai Lan line	To be implemented by 2020
	Ha Long-Mong Cai line	To be implemented by 2030
	Uonn Bi-Lach Huyen line	To be implemented by 2030
	Lang Son-Mui Chua line	To be implemented by 2030
Airport	Quang Ninh Airport construction	A key project currently underway, land being acquired
	Van Don Airport construction	Construction by 2020, extended by 2030.
Ports and harbors	Cai Rong Port construction	A key project currently underway, construction of cruising terminal
	Cai Lan Port development	To be implemented by 2020, promoting port and harbor services
Resort	Ao Tien boutique resort construction	A key project currently underway, construction of golf course, 5-star hotel and luxury resort area, land being acquired
Residential area	Resettlement area construction in Ha Long village, Van Don district	A key project currently underway

Source: Quang Ninh Province Planning and Investment Department

(2) Related plans in Hai Phong City

1) Road plans

Hai Phong City has also formulated a transport plan by 2020 and vision to 2030, like Quang Ninh Province. Road development plans of the city are shown in Figure 2.38, which include ring road Nos. 1 to 3 in the city and the Hanoi-Hai Phong Expressway in addition to the Ha Long-Hai Phong Highway, including the Project. The Ha Long-Hai Phong Highway will play an important role of receiving traffic to Quang Ninh Province via the Hai Phong ring road. Although the line shape of Ha Long-Hai Phong Highway in the Project differs from that supposed to be the precondition in the survey, a consensus is formed on the line shape of the latter as the decision of Vietnam in Decision 1775/TTg-KTN decided by the Prime Minister and issued on November 4, 2013.



Source: JICA Study Team made an addition to THE PLANNING OF ROAD AND RAILROAD OF HAI PHONG CITY TO 2020 WITH THE ORIENTATION TO 2030 by the Hai Phong Transportation Department

Figure 2.38 Hai Phong Road Development Plans

2) Development plans for industrial parks and economic zones

There are 17 industrial parks and 15 industrial clusters, including those in the planning stage in Hai Phong City. Of the 17 industrial parks, eight are already in operation, which includes the Dinh Vu industrial park with an infrastructure which remains partially under development. Industrial clusters are on a smaller scale than industrial parks and can be approved by local governments.

The Dinh Vu industrial park under development is the biggest industrial park in operation, covering a total area of 1,463ha. It is advantageously located 7km from the center of Hai Phong and 15km from Cat Bi Airport, facing the Dinh Vu Port. In addition, phase 3 of infrastructure development is underway and has drawn much attention with future potential. The project owner is Dinh Vu IZ JSC (Dinh Vu Industrial Zone Joint Stock Company) financed by Hong Kong and Belgium companies and Japanese Bridgestone is situated there.

The construction of a special industrial park for Japanese SMEs that has been examined for the last two years is being coordinated with a new policy of attracting companies in other countries. Although the original plan was to construct it in Trang Cat, it partially overlaps with the Dinh Vu economic zone and thus its transfer to a different location is being examined. The industrial park is planned as one of most preferentially treated industrial parks within the allowable scope of Vietnamese laws[10].

Companies within industrial parks in operation highly contribute to the economy of the city, accounting for 36% of industrial production and 50% of exports and imports.

Table 2.6 Overview of Industrial Parks and Clusters in Operation or in the Planning Stage (by 2020) in Hai Phong City

Type	Current Status	Overview
Industrial park (17 locations)	In the planning stage	9 locations
	Under development or in operation	1 location (Dinh Vu, in operation while partially under development)
	In operation	7 locations (Nomura, Do Son, Trang Due, VSIP, Nam Dinh Vu, Nam Cau Kien, Tan Lien) occupancy rate: 53%
Industrial clusters (15 locations)	In operation	15 locations

Source: Hai Phong City Department of Planning and Investment

3) Other infrastructure development projects

There are four other important infrastructure projects in Hai Phong: Hanoi-Hai Phong Expressway construction, Lach Huyen Bridge and Highway construction, Lach Huyen International Port construction and Cat Bi Airport expansion project. They are closely related to the Project and synergy effects are expected.

Table 2.7 Key Infrastructure Projects Underway in Hai Phong City

Type	Project	Overview
Road/bridge	Hanoi-Hai Phong Expressway construction	To be completed by the end of 2015 and open in 2016.
	Lach Huyen Bridge and Highway construction	Yen loan project, construction of access road with total length of 15.6km and bridge, to be completed in 2017 or 2018.
Port	Lach Huyen International Port construction	Yen-loan project, to be completed in 2017.
Airport	Cat Bi Airport expansion project	Extension and internationalization of runway, to be completed by the end of 2015.

Source: Hai Phong City Department of Planning and Investment

It should be particularly noted that the Lach Huyen International Port Construction Project and the Lach Huyen Bridge and Highway construction projects among the above four projects are components of a yen-loan parent project named Lach Huyen International Port Construction Project and they each handle ports, bridges and roads. The project is a major ODA project decided under the leadership of Vietnamese Prime Minister Dung and Japanese Prime Minister Abe under the strategic Japan-Vietnam partnership. A joint venture of Vietnamese and Japanese companies develops piers, etc., for large container vessels and it is very significant as the first major PPP project between the two nations.

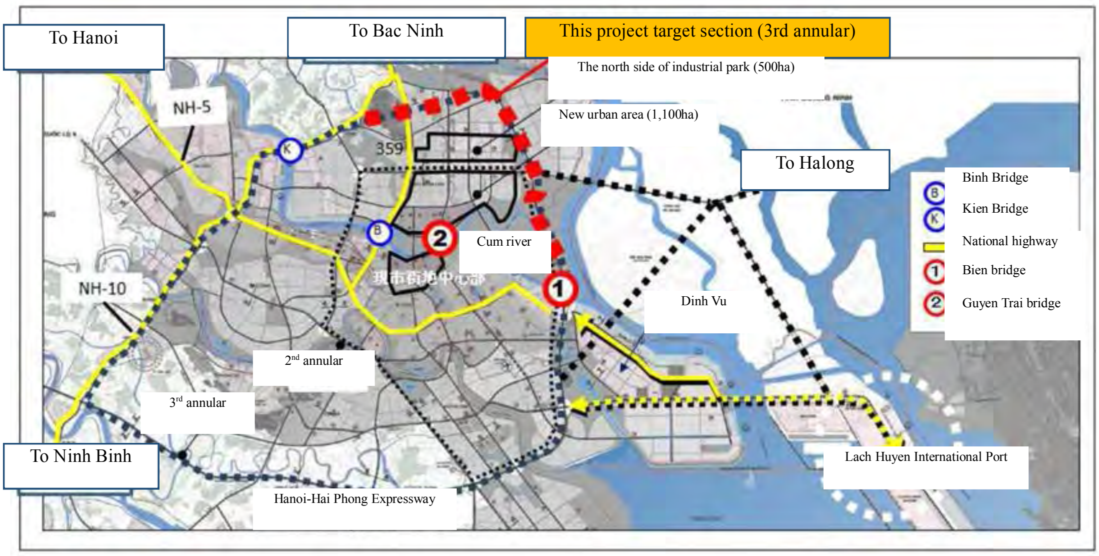
An overview of the Lach Huyen International Port Construction Project is shown in Table 2.8.

[10] Based on an interview with the Vice Director of the Hai Phong Department of Planning and Investment on July 2, 2014

Table 2.8 Yen-Loan Lach Huyen International Port Construction Project

Item		Overview
Basic Info	Project title	Lach Huyen International Port Construction Project
	L/A signing date	November 2, 2011
	Approved yen-loan amount	20,995 million yen (port: 11,924 million yen, road and bridge: 9,071 million yen)
	Borrower	Vietnamese government
Project Overview	Purpose	To construct a deep-water international port and peripheral infrastructure in Lach Huyen to cope with increasing cargo demand and trend of larger vessels in maritime market in Vietnam and thus boost the promotion of economic development and enhance international competitiveness, particularly in northern Vietnam.
	Contents	① Port development component: ・Container terminal construction (water depth: 14.0m, length: 750m, land reclamation and ground improvement work for 2 berths) ・Water route and anchorage dredging (depth of water route: 14.0m, width: 160m, length: approx. 18km) ・Construction of breakwater (3,230m) and groin (7,600m), etc.
		② Access road and bridge construction component: ・Construction of a 15.63m-long access road and bridge connecting the port to be developed and Danh Vi area in Lach Huyen (road length: approx. 10.19km, bridge: approx. 5.44km, 4 lanes with the width of 3.5m per lane)
	Total cost	139,816 million yen
		① Port construction: 92,759 million yen
		② Road and bridge construction: 47,057 million yen
	Period	Scheduled from November 2011 to May 2018 (79 months in total)

Source: Preliminary Evaluation Sheet of the Lach Huyen International Port Construction Project



Source: Hai Phong Master Plan

Figure 2.39 Lach Huyen International Port and Surrounding Area

2.5 Necessity of the Project

The socioeconomic conditions, future expressway development plans, budget and finance and other relevant policies of Vietnam, Quang Ninh Province and Hai Phong City are reviewed to reconfirm the necessity of the Project.

Although the Vietnamese economy has not reached the level of Thailand, Indonesia or the Philippines, the nation has maintained a high level among major new emerging nations in Asia experiencing rapid growth, while its population growth rate also remains steady, hence the country is expected to achieve further socioeconomic development.

Although the Vietnamese government has formulated a plan for the transport sector that supports future socioeconomic development, its fiscal condition is poor, with debts equivalent to 55% of its GDP and it cannot afford the massive infrastructure development within its budget. Accordingly, infrastructure development has failed to keep pace with road use needs in recent years and there is an urgent need to develop infrastructure in PPP/BOT schemes utilizing private funds.

Under these circumstances, the northern economic triangle of the Vietnamese capital of Hanoi, Hai Phong and Quang Ninh Province is mainly connected by existing national highways and there is considerable expectation at new expressway development in Vietnam. This scope includes the Ha Long-Hai Phong Highway and it is fair to conclude that the application of BOT scheme for the construction is crucial.

Chapter 3 Existing Circumstances Surrounding the Project

3.1 Overview

In investigating existing circumstances surrounding the Project, the scope includes past surveys, responsibilities and powers of the related Vietnamese agencies, relevant legal systems, including the taxation system, the condition of the 20-kilometer section on the Ha Long side of the Ha Long – Hai Phong Highway that is inseparable from the Project and Vietnamese PPP/BOT market trends.

3.2 Past survey

3.2.1 Past F/S and its revised F/S in Vietnam

Quang Ninh Province People’s Committee placed the order and a Vietnamese construction consulting firm, TEDI, conducted F/S in two phases (hereinafter referred to as “Vietnamese F/S”).

In the first phase, the F/S was conducted for the Ha Long – Hai Phong Highway with total length of 25 kilometers as a proposed public works project. The study result verifies consistency with the upper-level plan, the effects on Vietnamese society and the economy and contribution to other upper-level plans. Technically, the design speed is 100km/h and it is a four-lane road in principle, to be expanded to a 6-lane road by around 2030. Nine bridges were part of the expressway, the largest of which is the Bach Dang Bridge (a 4.2km-long concrete bridge). Major restrictions on the Bach Dang Bridge are described as follows: the river course limit (48.4m high x 180m wide) has to be secured at two points and the air limit has to be 95m from the datum level (0m above sea level) for planes arriving at and departing from the Cat Bi Airport, which is situated approx. 5 kilometers away; southwest of the bridge. The study result was approved by the MOT in October 11 and by Quang Ninh Province People’s Committee in January 2012.

The F/S in the second phase focused on the project section. The major change from the first phase is that the Bach Dang Bridge, which was originally designed as a 4.two-kilometer-long concrete structure, is planned as a steel bridge.

3.2.2 Environmental impact assessment conducted in Vietnam

Quang Ninh Province People’s Committee placed the order and a local consulting firm in the province, Environmental Monitoring and Analysis Center (EMAC), conducted an environmental impact assessment (hereinafter referred to as “Vietnamese EIA”). The Vietnamese EIA was conducted for the entire 25-kilometer-long Ha Long – Hai Phong Highway and the result was approved by the Vietnamese Ministry of Natural Resources and Environment (MONRE) on December 12, 2011.

The Vietnamese EIA report summarizes the existing social and environmental conditions along the road, the impact assessment of the Project on the surrounding environment, ways to control and reduce negative impacts, the environmental monitoring approach, past public consultations with local organizations and responses to feedback from local communities.

Although local communities expressed their concern over a decline in production due to a reduction in the area they possess, they are mainly outside the Project area. The description of the mangrove states that it supports the local ecosystem and helps prevent soil loss caused by erosion.

3.2.3 METI F/S

The METI F/S for the Project was conducted combined with a land development project in the Dam Nha Mac area as follows, with a PPP project as a precondition: Vietnamese F/S and EIA and relevant materials were gathered and analyzed and traffic demand forecast, project cost estimation and economic and financial analyses were conducted to examine feasibility (study period: August 2012 to February 2013).

The F/S concluded that the EqIRR was 13.2% based on VGE (approx. 6.2 billion yen) secured based on a project cost of 7,999.3 Bil. VND (approx. 30.8 billion yen with the exchange rate at 1 yen = 260VND at the time of the survey) and the EcIRR is 13.3%, only when the benefit of time reduction is taken into consideration. Future challenges of the project realization include securing a security package including revenue guarantees, acquiring VGF as governmental support and building a consensus on proper risk allocation.

3.3 Related agencies

3.3.1 MOT's responsibilities and powers

As an organization representing government, the MOT implements an expressway project. However, because the powers of the Project were transferred from the Prime Minister to Quang Ninh Province, MOT's role is limited to providing comments in the basic design stage and checking whether the Project is in line with the national plan, while all other powers are transferred to Quang Ninh Province. In other words, the province plays the role and is empowered by the MOT in the Project and its decisions are equivalent to those of MOT.[11]

3.3.2 MPI's responsibilities and powers

Article 46 of Decree 108/2009/ND-CP "Investment in BOT, BTO and BT Contract Forms" (Decree "on Investment in the Forms of Build-Operate-Transfer, Build-Transfer-Operate, Build-Transfer Contract") sets out MPI's responsibilities and powers as follows:

a/ It shall elaborate and publicly invest in BOT, BTO and BT contract forms and submit issued documents to the government in accordance with its powers.

b/ It shall instruct rules on project proposals and production and approval of feasibility studies, report to select investors and decide on project contracts, their contents, subsidy rules and procedures, changes and cancellation of investment certificates and other relevant matters within the scope of powers provided under the Decree.

c/ It shall comment on plans and project lists compiled by ministries and their subordinate agencies and provincial people's committee.

d/ Upon coordination with relevant ministries, it shall bear initial responsibility for submitting the examination to the Prime Minister and deciding on the implementation of projects not domestic projects or those under the contract provided in the Decree.

e/ It shall comment on the selection of investors for coordinating project contracts. It shall send representatives as required to the internal working groups of ministries and their subordinate agencies and provincial people's committee.

f/ It shall screen applicable documents and subsidies. It shall change and cancel investment certificates granted to projects within the scope of powers provided in Clause 1 of Article 24 of the Decree.

g/ It shall examine matters related to projects in response to requests from ministries and their subordinate agencies and provincial people's committee within its functions and powers.

h/ It shall coordinate with ministries and their subordinate agencies and provincial people's committee that bear the initial responsibility for reviewing and evaluating the investment project implementation in BOT, BTO and BT contract forms, consult with them on their activities and conduct surveys and screening.

[11] Confirmed in the interview with the MOT on July 30, 2014.

i/ It shall pursue other duties and execute other powers provided under laws.

3.3.3 MOF's responsibilities and powers

Article 47 of Decree 108/2009/ND-CP "Investment in BOT, BTO and BT Contract Forms" (Decree "on Investment in the Forms of Build-Operate-Transfer, Build-Transfer-Operate, Build-Transfer contract") specifies MOF's responsibilities and powers as follows:

a/ It shall pursue responsibilities and execute powers provided in Article 3 (Governmental agencies competent to sign and perform project contracts), Article 5 (Capital sources for project implementation), Article 7 (Internal working groups and Article 46 (Tasks and powers of the MPI) the Decree. (See Table 3.2 Outline of Decree 108/2009/ND-CP)

b/ It shall consult on spending for project preparation, use of operational funds of governmental agencies, financial matters of project contracts, methods and terms of payment to be made to BT project investors and other matters within the scope of powers provided in the Decree in the process of project management.

c/ It shall coordinate with the MPI on the project implementation provided in Clause 8 of Article 46 (Tasks and powers of the MPI) of the Decree.

d/ It shall pursue other duties and execute other powers provided under laws.

3.3.4 MOJ's responsibilities and powers

Article 48 of Decree 108/2009/ND-CP "Investment in BOT, BTO and BT Contract Forms" (Decree "on Investment in the Forms of Build-Operate-Transfer, Build-Transfer-Operate, Build-Transfer Contract") provides MOJ's responsibilities and powers as follows:

a/ It shall help coordinate issues related to applicable laws, conflict settlement, government guarantees and other matters related to project contracts, in response to requests from governmental agencies and as required.

b/ It shall evaluate and comment on the discrepancies between the terms of project contracts and domestic laws.

c/ It shall negotiate the terms of project contracts and express legal opinions as required.

d/ It shall pursue other duties and execute other powers provided under laws.

3.3.5 Responsibilities and powers of the Quang Ninh Province People's Committee

The Project is a project to construct a road connecting Ha Long in Quang Ninh Province with Ha Noi – Hai Phong Expressway, 8695/VPCP-KTN issued by the governmental secretariat on December 4, 2009 and it is approved that the province shall be the project implementing body. Accordingly, all powers of the Project to be executed by the MOT are granted to Quang Ninh Province and the responsibilities and powers of "other ministries" that supervise the project provided in Decree 108/2009/ND-CP "Investment in BOT, BTO and BT Contract Forms" (Decree "on Investment in the Forms of Build-Operate-Transfer, Build-Transfer-Operate, Build-Transfer Contract") are deemed granted to Quang Ninh Province, while those provided in Article 49 are as follows:

a/ It shall pursue responsibilities and execute the powers provided in Clauses 3, 5 and 7 of Article 46 (Tasks and powers of the MPI) of the Decree.

b/ It shall produce and publicize a list of projects of ministries and their subordinate agencies in accordance with the Decree.

c/ It shall comment on project implementation plans and policies in the area it supervises.

d/ It shall accept projects not included in the list that is publicized and prepare a feasibility study report or project proposal based on Article 11 (Projects proposed by investors) and

Article 12 (Evaluation and approval of project proposals and feasibility study reports) of the Decree. (See Table 3.2 Outline of Decree 108/2009/ND-CP)

e/ It shall sign project contracts and execute them independently or empower governmental agencies to do so based on Article 3 (Governmental agencies competent to sign and perform project contracts) of the Decree.

f/ It shall approve the plan and outcome of the tender to select investors to negotiate on project contracts within the scope of its powers.

g/ It shall coordinate with the MPI in pursuing responsibilities provided in Clause of Article 46 (Tasks and powers of the MPI) of the Decree.

h/ It shall pursue other duties and execute other powers provided under laws.

3.4 Legal system

3.4.1 Vietnamese legal system

The Vietnamese legal system comprises the following laws and regulations with the constitution set up by the national assembly as the supreme law:

a/ Constitution/Hiến pháp	set up by the national assembly
b/ Law/Luật	(as above)
c/ Decree/Nghị định	equivalent to Japanese decree
d/ Decision/Quyết định	decided by the Prime Minister

Abbreviation example: Decision 64/2003/QD-TTg

It means Decision No. 64 in 2003. QD refers to “decision” and TTg refers to “Prime Minister”.

e/ National technical standards (QCVN)	
f/ Resolution/Nghị quyết	Issued by a standing committee of the national assembly
g/ Circular (ministerial order) /Thông tư	Issued by ministers

3.4.2 Road-related laws and regulations

(1) Road classification (National Routes)

The road is divided into the following six categories under Article 39 of Law 23/2008/QH12 Law on road traffic set up by the national assembly:

a/ National Routes
b/ Provincial roads
c/ District roads
d/ Commune roads
e/ Urban roads
f/ Special-use roads

The National Route is defined as follows:

- Roads connecting the capital of Ha Noi and provincial capitals
- Roads connecting three or more provincial capitals
- Roads connecting international ports and airports with national borders
- Roads that are particularly important for regional socioeconomic development

The project road is part of a road connecting the capital of Ha Noi, the centrally controlled city of Hai Phong and the capital of Quang Ninh Province, Ha Long, which makes it a National Route. This was confirmed in the interview with the MOT and Quang Ninh Province on July 30, 2014.

The Project is a national-level project; originally to be executed by the MOT but transferred to Quang Ninh Province in the 8695/VPCP-KTN issued by the governmental secretariat on

December 4, 2009.

(2) Expressway

Whether or not the target road is an expressway depends on whether it is designated as such in an upper-level plan decided by the Prime Minister. The project road is an expressway, which was confirmed in the interview with the MOT and Quang Ninh Province on July 30, 2014.

If it is designated as an expressway, it must meet the design standards specified by the MOT. Since the project road meets these technical standards, it is deemed to be an expressway.

3.4.3 Laws and regulations on road tolls

The MOF issued Circular 90/2004/TT-BTC "Guiding the Regime of Road Toll Collection, Payment, Management and Use" in 2004 on road tolls. It was then revised to Circular 159/2013/TT-BTC, "Guiding the Regulations on Collection, Payment, Management and Use of Road Tolls for Payback of Road Construction Investment Capital" in 2013. The revision is summarized below.

The ministerial order applies to both national routes and local roads, but not expressways that are also national routes. Tolls on expressways are agreed on between the governmental agencies that oversee them and their operators and approved by the MOF.

Because expressway tolls are decided separately, they need not comply with the ministerial order. However, if they do comply with the ministerial order, they are automatically approved by the MOF. Otherwise, the relevance needs to be examined and it is desirable to comply with the order to ensure the Project proceeds smoothly.

(1) Toll decision

The toll by auto type, as specified in Circular 159/2013/TT-BTC and that in the former Circular 90/2004/TT-BTC are shown for reference. In the new ministerial order, the toll is raised and further varied to allow recovery of the investment capital.

Although the concept of distance is considered for tolls on certain project roads that involve separate consultation between the governmental agency managing the road and operators, including those of expressways, the ministerial order simply includes the concept of a toll for each use.

Table 3.1 Road Toll Table

Unit: VND/use

Auto Type	Auto Category	Circular 159 (New)	Circular 90 (Former)
1	Passenger cars carrying up to 11 passengers, freight cars with mobile load of up to 2 tons and public buses	15,000~52,000	10,000
2	Passenger cars carrying from 12 to 30 passengers and freight cars with a mobile load of 2 to 4 tons	20,000~70,000	15,000
3	Passenger cars for 30 or more passengers and freight cars with a mobile load of 4 to 10 tons	25,000~87,000	22,000
4	Freight cars with a mobile load of 10 to 18 tons and 20ft container trucks	40,000~120,000	40,000
5	Freight cars with a mobile load exceeding 18 tons and 40ft container trucks	80,000~200,000	80,000

Source: JICA Study Team

(2) Toll revision

Although the toll was not revised in Circular 90/2004/TT-BTC after it was decided in 2004, Article 6 of the new Circular 159/2013/TT-BTC stipulates that the toll applies until 2016 and that the MOF will review it every three years based on actual circumstances, price index and proposal from the MOT.

In the case of the Project, for example, if Quang Ninh Province and the road operator agree to raise the toll by 20 percent every three years in a contract and if the toll is within the scope specified by the MOF, it is automatically approved in principle. However, if the toll exceeds MOF’s rule, it is not approved solely based on the contract between Quang Ninh Province and the road operator.

(3) Distance between tollgates

Article 2 requires a minimum distance between tollgates of 70 kilometers.

3.4.4 Current PPP-related laws and regulations

Vietnamese PPP-related laws and regulations include Decree 108/2009/ND-CP “on investment in the forms of Build-Operate-Transfer, Build-Transfer-Operate, Build-Transfer Contract,” that was issued by the Government in 2009, Circular 03/2011/TT-BKHDT, Guidelines for Investment in the forms of Build-Transfer-Operate, Build-Transfer Contract that provides rules on the application of Decree 108/2009/ND-CP and Decision 71/2010/QD-TTg, Rules on Experimental Investment in the Form of a Public-Private Partnership that was decided by the Prime Minister in 2011.

A provisional contract for the Project was concluded between the Quang Ninh Province People’s Committee and SE Corporation, which stipulates that the Project should be implemented based on Decree 108/2009/ND-CP. Accordingly, Table 3.2 summarizes the contents of Decree 108/2009/ND-CP that constitutes the main rules related to the Project. Decree 24/2011/ND-CP, “Decree on Partial Revision of Decree 108/2009/ND-CP,” was issued on April 5, 2011 and a portion of the clauses of Decree 108/2009/ND-CP are revised as clauses of the revised Decree 24/2011/ND-CP.

Table 3.2 Outline of Decree 108/2009/ND-CP

Chapter 1 General provisions
Article 1 Applicable scope of regulation 1 This Decree provides for investment domains, conditions, order, procedures and incentives and the rights and obligations of parties to BOT, BTO and BT contracts. The MPI shall submit other similar project contracts to the Prime Minister for consideration and decisions as required 2 Omitted
Article 2 Definition of terms Omitted
Article 3 Governmental agencies competent to sign and perform project contracts Omitted
Article 4 Investment domains Omitted
Article 5 Capital sources for project implementation 1 Investors or project companies shall assume responsibility for raising funds for project implementation as agreed in project contracts. 2 For a project capitalized at up to VND 1.5 trillion, the project company's equity must be a minimum of 15% of the project's total investment capital. 3 For a project capitalized at over VND 1.5 trillion, the project company's equity shall be determined as below: a/ For the investment capital portion of up to VND 1.5 trillion, the project company's equity must be a minimum of 15% of this capital portion; b/ For the investment capital portion exceeding VND 1.5 trillion, the project company's equity must be a minimum of 10% of this capital portion. 4 Omitted
Article 6 Use of state capital for project implementation 1 The total state capital used to implement a project must not exceed 49% of the total investment capital of that project. 2 For projects to be implemented to meet urgent needs for infrastructure facilities and other projects, ministries and agencies, their subordinate agencies and provincial People's Committees shall consider and decide on the use of state budget capital for building auxiliary works, organizing compensation, ground clearance and resettlement or performing other jobs to support project implementation. 3 Capital sources for supporting the implementation of a project specified in Clause 2 of this Article will not be included in the total investment amount of that project and shall be managed and used under regulations applicable to state-funded investment projects.
Article 7 Internal working groups Omitted
Article 8 Investment preparation expenses and tasks and legal powers of competent governmental agencies 1 Expenses for making and announcing project lists and selecting investors and other expenses relating to the performance of legal powers and responsibilities of competent governmental agencies shall be allocated from the state budget, based on approved cost estimates. 2 Expenses for formulating and appraising project feasibility study reports and preparing other projects shall be allocated from the state budget and other revenue sources. 3 Depending on the characteristics and scale of a project, the investor selected to implement the project shall pay project preparation expenses specified in Clause 2 of this Article to the competent governmental agency.
Chapter 2 Making and Announcing Lists of Projects
Article 9 Making project lists Omitted
Article 10 Announcement of project lists Omitted
Article 11 Projects proposed by investors Omitted
Article 12 Evaluation and approval of project proposals and feasibility study reports Omitted
Chapter 3 Selection of Investors for Negotiating Project Contracts
Article 13 Bidding for selecting investors Omitted
Article 14 Designation of investors Omitted

Article 15 Negotiation and signing of project contracts and related contracts Omitted
Chapter 4 Project Contracts
Article 16 Contents of a project contract 1 A project contract indicates the objectives, scope and contents of the project (the rights and obligations of the parties to design, build, operate and manage the project work and other projects). 2 The rights and obligations of a project company shall be agreed by either of the following methods: a/ After being established, the project company shall sign the project contract to join the investor as a party to the project contract; b/ The competent governmental agency, investor and project company shall sign a document permitting the project company to receive and exercise the rights and fulfill the obligations of the investor as indicated in the project contract, of which this document is an integral part.
Article 17 Right to receive projects 1 The parties may agree on the lender's receipt of the rights and obligations of the project company (hereinafter referred to as the right to receive projects), in whole or in part, in case the project company or investor fails to fulfill the obligations indicated in the project contract or loan contract. 2 The conditions and procedures for exercise and contents of the lender's right to receive a project must be specified in the loan contract, written loan guarantee or other agreement signed between the project company, investor and lender.
Article 18 Transfer of rights and obligations under project contracts 1 An investor may transfer his/her/its rights and obligations, in whole or in part, under the project contract. 2 The transfer of another project, in whole or in part, must comply with the conditions and procedures prescribed in laws on investment and construction and other relevant laws. 3 The transfer under Clauses 1 and 2 of this Article is subject to the approval of a competent governmental agency and must not affect the objectives, scale, technical standards and implementation procedures of the project and other conditions agreed in the project contract.
Article 19 Modification and supplementation of project contracts 1 A project contract may be modified in case of any change in the agreed scale, technical standards or total investment capital, or due to the occurrence of a force majeure event and under other circumstances as indicated in the project contract. 2 The parties shall agree in the project contract on the conditions for modifying and supplementing the project contract. 3 Actions to modify and supplement a project contract are subject to the approval of the investment certificate-granting agency.
Article 20 Term of a project contract 1 The term of a project contract shall be agreed by the parties to suit the domain, scale and characteristics of the project and may be extended or shortened under the conditions specified in the project contract. 2 Omitted 3 Omitted
Article 21 Termination of project contracts Omitted
Article 22 Project contracts and related contracts 1 The competent governmental agency and a foreign investor may agree to apply foreign laws to: a/ Project contracts b/ Contracts for which the performance obligations are guaranteed by the competent governmental agency under Article 40 of this Decree. 2 The application of foreign laws under Clause 1 of this Article must not contravene Vietnamese law.
Article 23 Security for the project contract performance obligation 1 Measures to secure the project contract performance obligation shall be applied in the form of a bank guarantee or other mandatory guarantee measures under civil law. 2 For projects capitalized at up to VND 1.5 trillion, the amount required to secure the project contract performance obligation must be a minimum of 2% of total investment capital. 3 For projects capitalized at over VND 1.5 trillion, the amount required to secure the project contract performance obligation shall be determined as below: a/ For investment capital portions of up to VND 1.5 trillion, the amount required to secure the project contract performance obligation must be a minimum of 2% of this capital portion; b/ For investment capital portions exceeding VND 1.5 trillion, the amount required to secure the project contract performance obligation must be a minimum of 1% of this capital portion. 4 The security for the project contract performance obligation shall be valid from the date the project contract is officially signed to the date the work is completed.
Chapter 5 Procedures for Granting Investment Certificates and Implementing Projects

Article 24 Investment certificate-granting agencies 1 The MPI grants investment certificates for: a/ National important projects; b/ Projects for which the contracts are overseen by ministries and their subordinate agencies or authorized agencies; c/ Projects to be implemented in multiple provinces and cities 2 Provincial People's Committees grant investment certificates for projects not mentioned in Clause 1 of this Article.
Article 25 Documents, practice and rules and procedures for examining documents and granting investment certificates 1 An investor shall submit ten copies of documents, including at least one original, to the investment certificate-granting agency defined in Article 24 of this Decree for examination and grant of an investment certificate. 2 An application document for an investment certificate comprises: a/ A written application for a certificate; b/ The provisional contract and contracts related to the project implementation; c/ The feasibility study report; d/ The joint venture contract and the project company charter. 3 Contents to be examined include: a/ Rights and obligations of the parties to the project contract; b/ Project implementation schedule; c/ Land-use plan; d/ Environmental solutions; e/ The investor's proposals on investment incentives or government guarantee. 4The investment certificate-granting agency shall examine the document and grant an investment certificate to the investor within 45 working days of receiving a valid document.
Article 26 Details of an investment certificate 1 An investment certificate contains the following principal details: a/ Names and addresses of the investor and project company; b/ Name of the project; c/ Objectives and scale of the project; d/ Project implementation location and land area to be used; e/ Total investment capital of the project; f/ Project implementation schedule; capital raising schedule under the project contract; g/ Investment incentives and support 2 Omitted
Article 27 Company registration, establishment and management of project companies 1 An investor shall register a company to establish a project company or supplement a business line in the registration certificate (of a previously established company). 2 The document, practice and rules and procedures for company registration or supplementation of business lines shall comply with the Enterprise Law. 3 The managerial organization, authority and responsibilities of the project company shall be decided by the investor in accordance with the terms of the project contract, Enterprise Law, Investment Law and other relevant laws.
Article 28 Conditions for project implementation 1 A project shall be implemented after the investor is granted an investment certificate and other conditions are agreed in the project contract. 2 Other projects shall be agreed by the parties in the project contract in accordance with the investment and construction laws.
Article 29 Selection of contractors for project implementation 1 The project company shall select consultancy, procurement and engineering and other contractors to implement the project. The selection of contractors within the regulatory scope of the Bidding Law must comply with the legal bidding provisions. 2 Contractor selection results must be notified to the competent governmental agency within 15 working days of the issuance of the contractor selection decision.
Article 30 Preparation of construction grounds 1 Provincial People's Committees shall clarify the grounds and complete procedures for allocating or leasing land for project implementation under the law and land-use conditions indicated in project contracts. 2 Compensation, ground clearance and resettlement expenses shall be borne by project companies and included in the total investment capital of projects, unless funded with state budget capital under Clause 2, Article 6 of this Decree.
Article 31 Elaboration of technical designs, work construction supervision and management Omitted

Article 32 Management and operation works Omitted
Article 33 Goods prices, service charges and revenues Omitted
Article 34 Support for collecting service charges Project companies shall be given all favorable conditions to properly and fully collect service charges and other lawful revenues from the operation of the project. As required, project companies may request competent governmental agencies to assist in collecting charges and other revenues from the operation of the project.
Chapter 6 Transfer of Project Works
Article 35 General clauses on transfer of project works Omitted
Article 36 Transfer of BOT works Omitted
Article 37 Transfer of BT and BTO works Omitted
Chapter 7 Investment Incentives and Guarantees for Investors and Project Companies
Article 38 Investment incentives and support 1 BOT and BTO enterprises are entitled to enterprise income tax incentives under the law on enterprise income taxes. 2 Goods imported to implement projects of BOT and BTO enterprises and contractors defined in Article 29 of this Decree are eligible for incentives under the law on import and export duties. 3 BOT and BTO enterprises are exempt from a land-use levy for land allocated by Government or from land-use rent throughout the project implementation duration. 4 Omitted
Article 39 Taxes on contractors participating in project implementation Omitted
Article 40 Guarantee for obligations of investors, project companies and other enterprises Omitted
Article 41 Right to mortgage assets 1 Project companies may pledge or mortgage their assets and land use rights in accordance with the law. 2 The pledging or mortgaging of assets of project companies must not affect projects' objectives, progress and operation indicated in project contracts and must comply with law based on the approval of a competent government agency.
Article 42 Right to buy foreign currencies 1 In the course of building and operation, the investor or project company may buy foreign currencies at financial institutions licensed to conduct foreign exchange operations for current, capital and other transactions under the law on foreign exchange management, covering: a/ Payment of rent of equipment and machinery hired from overseas; b/ Import of machinery, equipment and other products and services to implement the project; c/ Payment of foreign debts (both principal and interest) ; d/ Payment of bank loans in foreign currencies (both principal and interest) to import machinery, equipment and other products and services to implement the project; e/ Transfer abroad of capital, profits, investment liquidation amounts and payments to supply techniques, services, intellectual property and other lawful income (applicable to foreign investors). 2 The Government shall balance, or support the balance of, foreign currencies for important projects on energy, transport work construction and waste treatment.
Article 43 Assurance for providing public services Omitted
Article 44 Settlement of disputes 1 Disputes between competent government agencies and investors or project companies and between project companies and other economic entities participating in project implementation must be initially settled through negotiation or conciliation. If such efforts are unsuccessful, the parties may bring such disputes to Vietnamese arbitral bodies or courts for settlement under Vietnamese law, except cases specified in Clauses 2 and 3 of this Article. 2 Disputes between competent government agencies and foreign investors or project companies arising in the performance of project contracts and guarantee contracts under Article 40 of this Decree shall be settled at Vietnamese arbitral bodies or courts or arbitral councils set up by the parties as agreed. 3 Disputes between project companies and foreign organizations or individuals or Vietnamese economic entities and between investors themselves shall be settled under the Investment Law.

Article 45 Capital and asset assurance Omitted
Chapter 8 Government Management of Investment Projects in Forms of BOT, BTO and BT Contracts
Article 46 Tasks and powers of the MPI Omitted
Article 47 Tasks and powers of the MOF Omitted
Article 48 Tasks and powers of the MOJ Omitted
Article 49 Tasks and powers of other ministries and their subordinate agencies Omitted
Article 50 Tasks and powers of provincial People's Committees Omitted
Chapter 9 Implementation Provisions
Article 51 Effect Omitted
Article 52 Transitional provisions Omitted
Article 53 Organization of implementation Omitted

Source: JICA Study Team (Japanese translation of English document of the MOJ)

3.4.5 Trend of PPP-related laws and regulations

Currently, the Vietnamese Government is working to integrate Decree 108/2009/ND-CP and Decision 71/2010/QD-TTg to formulate a new PPP decree.

The draft transitional provisions of the new decree, Public-Private Partnership Investment, (July 21, 2014) are as follows:

Article 76 Transitional provisions 1 Lists of projects produced before the effective date of this Decree need not be reapproved under the Decree. 2 Feasibility study reports approved before the effective date of this Decree need not be reapproved under the Decree. 3 Projects for which the investors were selected before the effective date of this Decree shall proceed under the Decree. 4 Project contracts initialed before the effective date of this Decree need not be renegotiated. 5 Project contracts officially signed before the effective date of this Decree shall proceed in accordance with the contracts and investment certificates. 6 Projects with written approval and pledge from the Prime Minister, ministers, ministries and their subordinate agencies and People's Committees on the state budget for investment incentives or guarantees in relation to their implementation shall proceed in accordance with the approval and pledge.

It is currently uncertain whether the new PPP decree or Decree 108/2009/ND-CP applies to the Project. However, a provisional agreement of the Project is concluded with Quang Ninh Province in response to the Quang Ninh Province People's Committee Decision 2735/UBND-QH3, Nomination of Investors for Bach Dang Bridge, Approach Road and IC Construction Work in BOT Contract," issued on October 10, 2013, which applies to Clause 4 of Article 76, making it unlikely that the agreed contents will have to be renegotiated based on the new decree.

However, investment incentives and government guarantees not mentioned in the provisional contract do not apply to Clause 6, whereupon there will be a need to implement procedures in accordance with the new decree.

As for investment incentives and guarantees, a guarantee of minimum revenues that is not provided in Decree 108/2009/ND-CP shall be supplemented newly in Article 61 of the new decree.

Table 3.3 Investment Incentives and Guarantees in New Decree, Public-Private Partnership Investment (Chapter 9)

Chapter 9 Investment Incentives and Guarantees
Article 58 Investment incentives Same as Article 38 of Decree 108/2009/ND-CP.
Article 59 Taxes applied to contractors participating in project implementation. Same as Clause 1 of Article 39 of Decree 108/2009/ND-CP.
Article 60 Government guarantee Project characteristics are based on the requirement of the article of project implementation and the Prime Minister shall designate a government agency to meet demands of foreign exchange and raw materials, sales of products and other contractual obligations of investors, project companies and other economic entities participating in project implementation and also to meet obligations of sales of raw materials and purchase of products and services from project companies. Article 40 of Decree 108/2009/ND-CP
Article 61 Minimum revenue guarantee 1 The minimum revenue guarantee is granted to projects meeting all the following conditions: a/ Projects included in the list specified in Article 20 of this Decree: b/ Projects that gain operational income and profit, use of project facilities and providing services specified in Clause 4 of Article 4 2 The Prime Minister shall decide the minimum revenue guarantee for applicable projects related to Clause 1.
Article 62 Use of assets and commercial rights of project facilities as mortgage 1 Investors and project companies may mortgage assets and commercial rights of project facilities for lending institutions. 2 Agreements to mortgage assets and commercial rights of project facilities shall be in writing and signed between lending institutions and stakeholders of the project contract. 3 Mortgaging assets and commercial rights to project facilities must not affect a project's objectives, scale, technical standards, implementation schedule or any other matters agreed on in the project contract. Article 41 of Decree 108/2009/ND-CP
Article 63 Security of maintenance of land use objectives The land-use objectives of the projects shall be maintained while the project contract is valid, even when lending institutions intervene based on Article 36 of the Decree.
Article 64 Guarantee of foreign currency balance 1 Investors and project companies may buy foreign currencies at financial institutions licensed to conduct foreign exchange operations for current, capital and other transactions under the law on foreign exchange management and other relevant laws for the overseas transfer of capital, profits and sales amount for asset liquidation. 2 The Prime Minister shall decide the guarantee of foreign currency balance for important projects in investment plans and programs. Article 42 of Decree 108/2009/ND-CP
Article 65 Article 43 of Decree 108/2009/ND-CP
Article 66 Settlement of disputes 1 Efforts to solve disputes arising out of project implementation between competent government agencies and investors or project companies must initially involve negotiation or conciliation. If failing to settle the disputes through negotiation or conciliation, the parties may bring such disputes to Vietnamese arbitral bodies or courts for settlement under Vietnamese law, except cases specified in Clause 2 of this Article. 2 Disputes between competent government agencies and foreign investors arising in the performance of project contracts and government guarantee specified under Article 60 of this Decree may be settled at Vietnamese arbitral bodies or courts or foreign arbitral bodies agreed on by both parties. 3 Disputes shall be settled based on agreement in accordance with project- or other relevant contracts and shall be regarded as commercial disputes. Decisions made by foreign arbitral bodies shall be approved and executed in Vietnam. Article 44 of Decree 108/2009/ND-CP
Article 67 Guarantee of capital and assets Same as Article 44 of Decree 108/2009/ND-CP

Source: Japanese version compiled by JICA Study Team

3.4.6 Tax system

(1) Taxes relevant to the Project

The main Vietnamese taxes and charges imposed on the project company implementing the Project are listed below. All taxes in Vietnam are managed by the Government (MOF), which means there is no tax separately imposed by ministries.

Main taxes and charges imposed on project companies

1. Corporate Income Tax (CIT)
2. Value Added Tax (VAT)
3. Import Duty
4. Non-Agricultural Land-Use Tax
5. Land Rental
6. Business License Tax (BLT)
7. Environment Protection Tax (EPT)
8. Special Consumption Tax (SCT)
9. Registration Fees (applicable to motor vehicles and buildings, etc.)

Other taxes and charges relevant to the Project are those withheld at source and charges to be borne by foreign contractors and individuals as well as taxes on capital assignment gains imposed on project companies in principle and including the following:

Other taxes and charges

1. Foreign Contractor Tax (FCT)
2. Personal Income Tax (PIT)
3. Social, Health and Unemployment Insurance (SHUI) for Local Employees
4. Capital Assignment Tax (CAT)

(2) Corporate Income Tax

1) Supporting law

Vietnamese corporate income tax is specified in Law 14/2008/QH12 (Corporate Income Tax Law), Law 32/2013/QH13 (Revised Corporate Income Tax Law), Decree 218/2013/ND-CP (Decree concerning Execution Guidelines of Corporate Income Tax Law), Circular 78/2014/TT-BTC (Circular concerning Execution Rules of Corporate Income Tax Law) and Resolution 63/NQ-CP (Resolution concerning Solution of Tax-related Problems to Promote Corporate Development).

2) Calculation of Corporate Income Tax

The tax amount is calculated in accordance with the following formula:

Corporate income tax to be imposed ＝taxable income × corporate income tax rate
Taxable income ＝gross income – (tax-exempt income + loss carried forward)
Gross income ＝(gross revenue – loss) + other income

Tax-exempt income is listed in Table 3.4 below. Toll income and income supplementation from the Government are regarded as gross revenue and not tax-exempt.

Table 3.4 Tax-Exempt Income in Corporate Income Tax Calculation

1	Income from agricultural, fisheries and livestock products and their related businesses
2	Income from executing scientific research and technical development contracts. However, sales revenues of products produced based on new technologies in Vietnam during the trial production period shall not exceed one year from the beginning of activities.
3	Income from production and business activities of enterprises with an annual average of 20 or more employees; 30% of whom are physically challenged, drug addicts or infected with HIV.
4	Dividend income from domestic company
5	Receipt of various donations
6	Portion of income that is not dividend of companies in education, training and medical care and other companies engaged in socialization used for business development and reinvestment
7	Income from transfer of technology in a priority sector to companies or individuals in areas with particular socioeconomic difficulties.

Source: Basic Vietnamese (taxes and tariffs) system related to Entry in the Country, JETRO

The loss is determined based on the following three principles:

- Expenses incurred in relation to production and business activities of project companies
- Expenses substantiated with official invoices and receipts meeting legal requirements
- Expenses substantiated with a payment slip of bank money transfer for transactions of 20 million ND (including VAT) or more

Main items not counted as losses are listed in Table 3.5. This excludes any expenses related to the Project operation.

Table 3.5 Main Items not Counted as Losses

1	Expenses for damaged products due to expiration or natural wear
2	Depreciation expenses for fixed assets not approved as such under current laws, that exceed regulations, are unrelated to the Project or already depreciated
3	Expenses for purchasing products and services with no official invoice
4	Electricity and water charges for rental properties (with conditions)
5	Salaries, bonuses and allowances not specified in employment contracts or working regulations, that are unpaid, paid to owners and shareholders not directly involved in the Project, or part of what is to be paid to female employees
6	Allowances for unemployment benefits (excluding companies with nine or fewer employees not obliged to contribute to unemployment insurance)
7	Portion of advertisement expenses, sales promotion expenses and meeting expenses, exceeding the amount approved to be calculated as a loss under current laws (15% of expenses) (cost of purchasing goods is not eligible as a loss for trading companies and included as such for manufacturers)
8	Portion that exceeds 150% of the basic interest rate announced by the Vietnamese central bank on the date of borrowing to repay interest on loans borrowed from companies not financial institutions or economic entities for the production and transaction of goods and services
9	Unpaid statutory capital or equivalent interest on borrowing
10	Exchange rate loss at year-end reassessment or during the period of base establishment
11	Assistance grant outside provisions or without specified document (educational fund, medical fund and housing fund for recovery from disasters or for the poor)
12	Life insurance premiums for employees (with conditions)
13	Expenses for management and operation of foreign companies, not allocated to permanent facilities in accordance with laws
14	Fines for administrative penalty
15	Capital spending that forms fixed assets, fund to local areas, expense to buy golf membership and expenses to play golf

Source: Basic Vietnamese (taxes and tariffs) system related to Entry in the Country, JETRO

3) Tax rate

A） Standard tax rate

Project companies are categorized as Vietnamese domestic companies as they are set up in accordance with Law 60/2005/QH11 (Company Law) based on Clause 1 of Article 27 of Decree 108/2009/ND-CP (Decree on BOT).

The standard corporate income tax rate applied to Vietnamese domestic companies established under its legal system is 22% in 2014 and 2015 and lowered to 20% from January 1, 2016.

B） Preferential treatment

The project companies that implement the Project are eligible to receive preferential treatment based on Circular 78/2014/TT-BTC (Circular concerning Execution Rules on Corporate Tax Law).

- Corporate income tax rate at 10% for 15 years from the first year of operation
- Corporate income tax exemption for four years from the first year where profits are posted
- 50% reduction of corporate income tax for nine years after the period of tax exemption. The corporate income tax rate eligible for the 50% reduction is not the standard rate and the 10% preferential rate is prioritized.

The tax exemption and reduction period begins in the year when taxable income is posted on a single-year basis (losses carried forward are not considered). When there is no taxable income for three years from the generation of sales, the tax exemption and reduction period automatically begins.

The corporate income tax rate applied to the project companies that implement the Project in each year is summarized in Table 3.6 based on scenarios of the first posting of taxable income.

Table 3.6 Corporate Income Tax Rate Applied to Project Implementing Companies

Year		2014	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	2036 ~
i) Standard tax rate		22%		20%																				
ii) Preferential tax rate		–	–	–	–	–	10% (15 years)															–	–	–
Case A	iii) Tax exemption /reduction	–	–	–	–	–	Tax exemption (4 years)				50% tax reduction (9 years)									–	–	–	–	–
	iv) Applied tax rate	–	–	–	–	–	0%	0%	0%	0%	5%	5%	5%	5%	5%	5%	5%	5%	5%	10%	10%	20%	20%	20%
Case B	iii) Tax exemption and reduction	–	–	–	–	–	No. taxable income			Tax exemption (4 years)				50% tax reduction (9 years)									–	–
	iv) Applied tax rate	–	–	–	–	–	–	–	–	0%	0%	0%	0%	5%	5%	5%	5%	5%	5%	5%	5%	10%	20%	20%

The first year of the project is assumed to be 2019.
ii) The preferential tax rate is assumed to be for 15 years.
Case A: when taxable income is posted from the first year of project operation.
Case B: when no taxable income is posted for four years or longer from the first year of project operation.

Source: JICA Study Team

4) Loss carried forward

Losses can be carried forward and offset with taxable income for up to five years. When losses are posted during the tax exemption period, losses posted during the period can be carried forward. Corporate income tax cannot be refunded for carryback of losses.

(3) Depreciation

1) Depreciation period

All fixed assets (including unused) need to be depreciated from the time when they are rendered usable, not when they begin used and the depreciation period needs to be set based on the lifetime of each asset in principle according to Vietnamese accounting standards. However, the depreciation period of the fixed assets of BOT projects can be set from the time when facilities begin used and until the completion of the BOT project as a special measure based on Article 12. 1 of the Circular 45/2013/TT-BTC (Circular concerning Depreciation).

When fixed assets are newly purchased and used for major renovations, etc., during the BOT project period, it needs to be set from the time when facilities begin used after completion of major renovation work, etc. and pending completion of the BOT project based on the abovementioned Article 12.1 of the Circular. For example, when fixed assets with a 20 year service life are purchased when another decade of the BOT project period remains, the service life of the fixed assets needs to be another 10 years from the time of acquisition.

Based on this observation, the depreciation period for the BOT project is set to be for 30 years after the beginning of use based on its project period (assumed to be for 30 years from 2019 to 2048).

2) Calculation method of depreciation cost

The following three methods are approved via Vietnamese accounting standards:

- Straight-line method
- Declining-balance method
- Production output method

3) Major maintenance and renovation costs

Repair and maintenance costs for regular tangible fixed assets for maintaining their capacity to secure benefits equivalent to those at the beginning of operation are deemed expenses for manufacturing and project spending incurred during the project period. Major repair and renovation costs are deemed long-term advance payments and can be depreciated gradually as operational expenses within up to three years.

If maintenance and major renovation costs are to improve the practical function compared to the standard condition at the beginning of operation, as shown below, the expenses are considered to represent an increase in the acquisition price for the fixed assets.

- Replacing portions of tangible fixed assets helps extent the service life or use capacity.
- Renewing portions of tangible fixed assets helps dramatically improve product quality.
- Applying new manufacturing technology helps reduce the operation cost of the assets.

When the renewal of a portion of facilities is regarded to improve the original function and is considered to be an increase in the acquisition price of the fixed assets, the expenses of renewed old facilities must be considered as written off.

(4) Value Added Tax

1) Supporting law

Vietnamese value added tax is provided under Law 13/2008/QH12 (Value Added Tax Law), Law 31/2013/QH13 (Revised Value Added Tax Law), Decree 209/2013/ND-CP (Decree concerning Execution of Value Added Tax Law) and Circular 219/2013/TT-BTC (Circular on Execution of Value Added Tax Law).

2) Tax rate

VAT is imposed not only on products and services supplied and consumed in Vietnam but also on imported goods and services. Business entities must collect it and add it to prices excluding tax.

The VAT is determined at the following time:

- When the ownership or usage right of products is transferred, regardless of whether payment is made or not.
- On the invoice issuance date or before the completion of providing services

The VAT rate is defined as follows:

- 10% : on most products and services
- 5% : on necessities and essential services
- 0% : on exported products and services

3) Calculation of taxable VAT based on credit method

The tax amount is calculated based on the following formula: The deducted purchase VAT is limited to cases when the goods and services purchased and provided by project companies are not for personal consumption but for business and income generation. The project companies may receive a deduction on purchase VAT and refund provided they observe Vietnamese accounting standards for accounting records, ledgers and books in principle.

・Taxable VAT = sales VAT ー purchase VAT

4) VAT refund

Project companies may apply for VAT refunds in the following cases:

- When they bear purchase VAT of 300 million VND or more during the construction period, it can be refunded.
- When the purchase VAT exceeds sales VAT for a consecutive 12 months or during a quarter of operation, the VAT gap can be refunded.

When the project companies apply for a VAT refund, they must submit document to the local tax office. The decision on whether to grant a VAT refund or not is issued by the tax office within 40 days (possibly longer) from the completion of the tax auditing.

Although sales VAT is not incurred by project companies during the construction stage, purchase VAT paid by the companies can be refund within the accounting year.

(5) Import Duty

1) Supporting law

Vietnamese import tax is provided under Decree 87/2010/NĐ-CP (Decree concerning Execution of Export and Import Duty Law), Circular 128/2013/TT-BTC (Circular concerning customs procedures) and Circular 04/2012/TT-BKHDT (Circular concerning a List of Machinery, Equipment, Parts for Replacement, Special Means of Transportation, Raw Materials, Supplies and Semifinished Products that can be Produced Domestically).

2) Overview

Import duties are imposed on products imported to Vietnam in addition to VAT. The import duty rate differs depending on the item and origin of the goods and is largely categorized in three types: regular tax rate, preferential tax rate (MFN) and special preferential tax rate (SPI). Although the MFN rate is sometimes lower than the SPI rate for certain items, project companies may apply for advantageous import duty rates at their own discretion.

- Standard tax rate: The standard tax rate is applied to imported goods to which a preferential tax rate or special preferential tax rate are not applicable. The standard rate is 50% higher than the preferential tax rate (MFN) specified in the list of preferential import duties.

- Preferential tax rate (MFN) : The preferential tax rate is applied to goods imported from countries with which Vietnam has concluded a reciprocal customs agreement. The tax rate is specified by item in accordance with MOF regulations. The preferential tax rate based on Decision 0616/1999/QD-BTM (Decision on Introduction of Japan in the List of Most Favored Nations) issued by the Ministry of Industry and Trade on May 22, 1999, is applied to goods imported from Japan.

- Special preferential tax (SPI) : The special preferential tax rate is applied to imported goods from trading nations or confederation of states with which Vietnam has concluded an agreement on special preferential import duty to enhance collaboration of international trade or when it is subject to other special preferential treatment as part of a free trade zone and common tariff scheme. The Japan-Vietnam Economic Partnership Agreement (JJVEPA) came into effect in October 2009 between both countries and Vietnam is to make items equivalent to 88% of import value duty free within a decade.

Table 3.7 Outline of Agreements on Special Preferential Import Duty

<table>
<tr><th>Agreement</th><th>Outline</th></tr>
<tr><td>Japan-Vietnam Economic Partnership Agreement</td><td>It came into effect in October 2009. Tariffs on electric goods will be removed as follows: flat panel displays and DVD parts in 2 years, digital cameras in 4 years and color TV receivers in 8 years. Tariffs on many agricultural, forestry and fisheries products will be removed instantly or within a decade.
Tariff Concession of Vietnam (examples)
<table>
<tr><td>Item</td><td>Concession</td><td>Tariff Rate (as of 2009)</td></tr>
<tr><td>Hot-rolled steel sheets</td><td>Fixed at existing</td><td>0%</td></tr>
<tr><td>Cold-rolled steel sheets</td><td>Removed in 15 years</td><td>3-7%</td></tr>
<tr><td>Galvanized steel sheets</td><td>Removed in 10 years</td><td>5-12%</td></tr>
</table></td></tr>
<tr><td>Japan-ASEAN Comprehensive Economic Partnership Agreement (AJCEP)</td><td>It came into effect in December 2008. The schedule for tariff removal and reduction is decided in accordance with the economic development of Cambodia, Laos and Myanmar.</td></tr>
<tr><td>ASEAN Trade in Goods Agreement (ATIGA)</td><td>Tariffs on all manufactured products and processed or unprocessed agricultural products imported from ASEAN member nations are reduced to 0 to 5% by 2005. (However, this does not necessarily apply for items to which the rule does not apply permanently or temporarily or those on pending status.) Current tax breaks are provided based on Circular 161/2011/ TT-BTC issued by the MOF on November 7, 2011.
Imported items to which tax breaks apply are those subject to the ATIGA specified in laws and regulations and applicable when the proof of origin (called Form D) is attached and they are directly transported from ASEAN member nations.
Laws and regulations and agreements that offer better tax rate than the ATIGA are applicable.</td></tr>
<tr><td>ASEAN-Korea Free Trade Agreement (AKFTA)</td><td>Circular 163/2011/TT-BTC on the issuance of special preferential import tariff treatment and its revision, Decision 104/QD-BTC, were announced on November 17, 2011 and on January 16, 2012, respectively, in line with the implementation of the AKFTA issued by the MOF. All imported goods meeting all the following conditions are subject to special preferential import tariff treatment:
- Included in the tariff rate table.
- Imported from ASEAN member nations or Korea.
- Shipped out directly from the exporting country to Vietnam.
- With proper proof of origin issued by a foreign supervising agency.</td></tr>
<tr><td>ASEAN-China Free Trade Agreement (ACFTA)</td><td>The MOF announced Circular 162/2011/TT-BTC on the issuance of special preferential import tariff treatment in line with the implementation of the ACFTA on November 17, 2011.
All imported goods meeting all the following conditions are subject to special preferential import tariff treatment:
- Included in the tariff rate table.
- Imported from ASEAN member nations or China.
- Shipped out directly from exporting countries to Vietnam.
- With proper proof of origin issued by a foreign supervising agency.</td></tr>
<tr><td>ASEAN-Australia-</td><td>It came into effect in January 2010.</td></tr>
</table>

Agreement	Outline
New Zealand Free Trade Agreement (AANZFTA)	
ASEAN-India Free Trade Agreement (AIFTA)	It came into effect on June 1, 2010. Tariffs on 7,460 of a total of 9,222 items imported from India to Vietnam are reduced or removed.

Source: JETRO website, Japan-Vietnam Economic Partnership Agreement," Office of economic Partnership, Customs and Tariff Bureau, Ministry of Finance (October 2009)

1） Import duty exemption

Import duties to be levied on imported goods that contribute to fixed asset formation of investment projects in sectors and areas to which preferential import duty treatment in Annex I and investment projects financed by ODA are exempt, based on Clause 6 of Article 12 of Decree 87/2010/NĐ-CP (Decree on Execution of Export and Import Duties Law).

Because the Project meets the conditions (development of bridges and roads) provided in Clause 31 in Section B of Annex I of Decree 87/2010/NĐ-CP, imported materials and equipment are eligible for import duty exemption.

Clause 31 in Section B of Annex I of Decree 87/2010/NĐ-CP (Decree on Execution of Export and Import Duties Law)
IV. Construction and infrastructure development (excerpt)

- Investment projects involving the construction and development of water treatment facilities, electric power generation, water systems, sewage systems, bridges, roads, railways, airport terminals, ports and harbors, river ports, airports and railway stations

Table 3.8 shows the items subject to the import duty exemption provided in Decree 87/2010/NĐ-CP. The project companies or contractors need to register a list of items from which import duties are exempt with the local tax office prior to the import to receive the exemption. It is desirable for the project companies to fully examine details of items to be imported for the Project and include a clause on the import duty exemption in the project contract.

Table 3.8 Items Subject to Import Duty Exemption (in accordance with Clause 6 of Article 12 of Decree 87/2010/ND-CP

(i)	Machinery and equipment
(ii)	Special means of transport of production lines that are yet to be domestically produced, automobiles with a capacity of 24 or more and other vehicles to transport workers and means of water transport
(iii)	Attached parts, members, mounting parts, attachments, assays, molds and auxiliary materials and equipment that are part of machinery and equipment and special means of transport or used as part of them provided in (i) and (ii) in the Clause
(iv)	Raw materials used to manufacture attached parts, members, mounting parts, attachments, assays, molds and auxiliary materials and equipment that are part of machinery and equipment machinery and equipment provided in (i) in the Clause that are yet to be domestically produced or to manufacture machinery and equipment to be installed in technical lines
(v)	Building materials that are yet to be domestically produced

* The project companies may apply for import duty exemptions with the relevant authorities on items that can be procured in Vietnam but do not meet the specifications and required standards of the Project. The duty exemption is decided on a case-by-case basis.

Source: JICA Study Team

(6) Non-Agricultural Land-Use Tax

1) Supporting law

The non-agricultural land-use tax is specified in Law 48/2010/QH12 (Non-Agricultural Land-Use Tax Law), Decree 53/2011/ ND-CP (Decree concerning Execution of Non-Agricultural Land-Use Tax Law) and Circular 153/2011/TT-BTC (Circular concerning Non-Agricultural Land-Use Tax).

2) Overview

The non-agricultural land-use tax is separate from land rental and project companies must bear it, even when land rental is exempted. The land listed below is subject to a non-agricultural land-use tax and the land for the Project is also included in the list.

Land subject to the non-agricultural land-use tax (Article 1 of Circular153/2011/TT-BTC)

- Residential land in cities and rural areas
- Non-agricultural land used for production and business
- When non-agricultural land that was exempt from non-agricultural land-use tax is used for business

The annual tax amount is calculated via the following formula based on the taxable land area and unit price for the acquisition of land-use right allocated on an unlimited basis, as announced by the provincial People's Committee:

Annual tax amount = taxable land area ×unit price of acquisition of land-use right allocated on an unlimited basis (VND/m^2) × tax rate

The taxable land area includes the crossing section area of a bridge.

The unit price to acquire land-use rights allocated on an unlimited basis is supposed to be reviewed every five years. However, in reality, it is announced every year. In Quang Ninh Province, the non-agricultural land price used for production and business is from 210,000 VND to 20.40 million VND in 2014 according to Decision 3566/2013/QD-UBND issued on December 26, 2013.

The tax rate is 0.03% for non-agricultural land for manufacturing and business use under Clause 2 of Article 7 of Circular 153/2011/TT-BTC (Circular on Non-Agricultural Land-Use Tax).

Organizations and existing land users for which land-use rights are granted are obliged to submit tax filing documents to the tax office in the relevant area.

Project companies may receive an exemption on non-agricultural land-use tax if the project is approved as an important investment project by the Prime Minister based on Clause 1 of Article 10 of Circular 153/2011/TT-BTC (Circular on Non-Agricultural Land-Use Tax) and Clause V.19 of Section A of Annex I of Decree 108/2006/ND-CP (Decree concerning Execution of Joint Investment Law).

(7) Land Rental

1) Supporting law

Land rental is specified under Decree 108/2009/ND-CP (Decree on BOT) and Decree 46/2014/ND-CP (Decree on Collection of Land Rental and Surface Rental).

2) Overview

Land rental is calculated based on the following formula: The annual land rental and rental rate are decided by the provincial People's Committee. The rental rate differs by land type and it is around 0.5 to 3% in Quang Ninh Province.

Annual land rental ＝land cost of land rental calculation × rental rate

3) Exemption of land rental

Project companies may receive an exemption on fees to acquire land-use rights allocated by the state government (land-use fees) or rent for leased land (land rental) during the BOT project period in accordance with Clause 3 of Article 38 of Decree 108/2009/ND-CP (Decree on BOT). The exemption on land-use fees or land rental is not automatically applied. The project companies must submit an application form for exemption (exemption application form, application form for land-use fees or land rental, investment certificate, etc.) to the taxation authorities of the provincial government. The provincial taxation authorities shall issue a decision on land-use fees/land rental in statutory form within 30 days of receipt of the exemption application from the project companies.

(8) Business License Tax

1) Supporting law

The business license tax is specified under Circular 42/2003/TT-BTC (Circular concerning Business License Tax).

2) Overview

Business entities are obliged to pay the business license tax annually, which is between 1-3 million VND in accordance with the amount of registered capital.

Table 3.9 Business License Tax

Level	Investment Amount (VND)	Annual Business License Tax (VND)
Level 1	10 billion or more	3,000,000
Level 2	5 billion to 10 billion	2,000,000
Level 3	2 billion to 5 billion	1,500,000
Level 4	2 billion or less	1,000,000

Source: Basic Vietnamese (tax) System related to Entry in the Country, JETRO website

(9) Environment Protection Tax (EPT)

1) Supporting law

The environmental protection tax is specified under Law 57/2010-QH12 (Environment Protection Tax Law), Decree 67/2011/ND-CP (Decree concerning the Execution of Environment Protection Tax) and Circular 159/2012/TT-BTC (Circular concerning Environment Protection Tax).

2) Overview

The Environment Protection Tax is an indirect tax that came into effect on January 1, 2012 and is levied on sales of products (petroleum, coal, etc.) that may harm the environment. Project companies bear the tax indirectly when they purchase taxable products.

Table 3.10 Items subject to Environmental Protection Tax

No.		Goods	Calculation Unit	Tax Tate (VND/unit)
I		Gasoline, oils and oils and fats		
	1	Gasoline (ethanol excluded)	l	1,000-4,000
	2	Aircraft fuel	l	1,000-3,000
	3	Diesel oil	l	500-2,000
	4	Petroleum	l	300-2,000
	5	Fuel oil	l	300-2,000
	6	Lubricant	l	300-2,000
	7	Oils and fats	Kg	300-2,000
II		Coal		
	1	Lignite	t	10,000-30,000
	2	Anthracite	t	20,000-30,000
	3	Fat coal	t	10,000-30,000
	4	Other coal	t	10,000-30,000
III		Liquid hydrogen, HCFC	Kg	1,000-5,000
IV		Plastic bags subject to taxation	Kg	30,000-50,000
V		Herbicides for which usage is regulated	Kg	500-2,000
VI		Pesticides and agricultural chemicals for which usage is regulated	Kg	1,000-3,000

VII	Antiseptic agents for forestry products, for which usage is regulated	Kg	1,000-3,000
VIII	Warehouse disinfectants for which usage is regulated	Kg	1,000-3,000

Source: Q&A on Vietnamese Accounting and Taxation, JETRO

(10) Special Consumption Tax (SCT)

1) Supporting law

The special consumption tax is specified under Law 27/2008-QH12 (Special Consumption Tax Law), Decree 26/2009/ND-CP (Decree concerning the Execution of Special Consumption Tax) and Circular 64/2009/TT-BTC (Circular concerning the Special Consumption Tax).

2) Overview

The special consumption tax is levied on goods and services in Table 3.11 consumed in Vietnam. Although manufacturers, importers and service providers are obliged to file and pay the tax, it is actually paid by end consumers.

Table 3.11 Items subject to Special Consumption Tax

No.	Goods or Services	Tax Rate (%)
I	Goods	
1	Cigar and cigarette	65
2	Wine	25-50
3	Beer	50
4	Automobile (fewer than 24 seats) a/ capacity of nine or fewer b/ capacity of 10 to 15 c/ capacity of 16 to 23 d/ vehicles for freight and passengers	 45-60 30 15 15
5	Motorcycle (125cm^3 or bigger cylinder)	20
6	Gasoline	10
7	Air-conditioner (90,000BTU or less)	10
II	Services	
1	Disco	40
2	Golf	20
3	Lottery	15

Source: JICA Study Team

(11) Registration Fees (applicable to motor vehicles and buildings, etc.)

1) Supporting law

Registration fees are specified under Decree 45/2011/ND-CP (concerning Registration Fees), Circular 124/2011/TT-BTC (concerning Registration Fees) and Circular 34/2013/TT-BTC (concerning Revision of Decree concerning Registration Fees).

2) Overview

Individuals and organizations possessing property such as houses and land and motorcycles and automobiles must pay registration fees when they register the ownership and usage right of properties with the responsible agency. The fees must be paid only once during the initial registration. The entire land for the Project posted in the investment certificate is subject to the calculation of registration fees and the project companies are obliged to pay the fees.

The registration fees are calculated in accordance with the following formula:

Registration fees ＝price for registration fee calculation × registration fee rate

The price for the registration fee calculation of land and houses is decided based on their location and land and house prices announced by the provincial People's Committee. According to Decision 3566/2013/QD-UBND by the Quang Ninh Province People's Committee, the fees differ by region and land prices in 2014 varied between 210,000 and 20,400,000VND/m2. The price for registration fee calculation of other properties, including motorcycles and automobiles, is decided based on the actual transfer price. The registration fee rate is shown in Table 3.12.

Table 3.12 Registration Fee Rate

Item	Tax Rate	Note
Land and house	0.5%	
Motorcycles	2% (generally)	
	5%	Applicable to initial registration of motorbikes of organizations/individuals in provincial cities or towns where
	1%	The provincial People's Committee bases its office. applicable from second registration upon transferred
Automobiles, trailers and semi-trailers	2% 10-20%	Applicable for cars carrying passengers with fewer than ten seats

Source: JICA Study Team

(12) Other taxes and charges

1) Foreign Contractor Tax (FCT)

A） Supporting law

The foreign contract tax is specified in Circular 60/2012/TT-BTC.

B） Overview

The foreign contract tax is levied when Japanese construction companies and other foreign companies and individuals (foreign contractors) gain income from providing services or sales of consideration to project companies and other Vietnamese companies and individuals. It mainly comprises value added tax and corporate income tax (personal income tax) and is imposed regardless of whether the foreign contractors are residents or non-residents of Vietnam or whether they have permanent facility or not in Vietnam. Project companies that are Vietnamese companies are obliged to withhold, file and pay the tax unless they agree with foreign contractors or foreign contractors meeting conditions for tax payment of foreign contractors.

There are three foreign contractor tax payment methods summarized in Table 3.13.

Table 3.13 Foreign Contractor Tax Payment Methods

Payment Method	Outline
(i) Deemed to be withholding tax	Vietnamese contracting parties (project companies) pay value added tax and corporate income tax on behalf of foreign contractors based on the deemed corporate income tax and VAT rates.
(ii) Method based on the Vietnamese accounting system	Foreign contractors pay 22% of corporate income tax (reduced to 20% from January 2016) and value added tax based on the credit method as foreign contractor taxpayers when they keep a proper accounting record based on the Vietnamese accounting system.
(iii) Hybrid method	Foreign contractors pay corporate income tax based on the deemed tax rate and value added tax based on the credit method.

Source: JICA Study Team

Table 3.14 Deemed Tax Rate of Foreign Contractor Tax

No.	Contents	Deemed VAT Rate (%)	Deemed CIT Rate (%)
1	Sales of goods associated with services ※ Including on-the-spot export/import transactions (excluding processing outsourced by foreign countries) and transactions under DDP/DAT/DAP conditions	None	1
2	Services in general, machinery and equipment lease, insurance services	5	5
3	Construction and installation (accompanying supply of materials, machinery and equipment	3	2
4	Construction and installation (not accompanying supply of	5	2

	materials, machinery and equipment)		
5	Transport, manufacturing and other businesses (including marine and air transportation)	3	2
6	Lease of aircraft, aircraft engines and parts, vessels	Exempted	2
7	Reinsurance overseas	Exempted	0.1
8	Transfer of securities	Exempted	0.1
9	Income from interests	Exempted	5
10	Royalties	Exempted	10

Source: JICA Study Team

2) Personal Income Tax (PIT)

A） Supporting law

The personal income tax is specified in Law 04/2007/QH12 (Personal Income Tax Law), Law 26/2012/QH13 (Revised Personal Income Tax Law), Decree 65/2013/ND-CP and Circular 111/2013/TT-BTC.

B） Overview

Personal income tax must be paid; not by the employer but the employees in principle. However, the employer is responsible for withholding and payment.

Vietnamese personal income tax is levied on foreign employees based on their residency.

The applicable tax rate is progressive between 5 and 35% for residents in Vietnam and 20% of income in Vietnam for non-residents.

3) Social, Health and Unemployment Insurance (SHUI) for local employees

A） Supporting law

Social, health and unemployment insurance for local employees is specified in Law 71/2006/QH11 (Social Insurance Law), Law 25/2008/QH12 (Health Insurance Law), Decree 127/2008/ND-CP and Decree 1111/QD-BHXH.

B） Overview

Project companies need to comply with laws and regulations on social, health and unemployment insurance for employees in addition to personal income tax. Employers and employees bear the portions of social, health and unemployment insurance premiums specified by regulations.

4) Capital Assignment Tax (CAT)

A） Supporting law

The capital assignment tax is specified in Law14/2008/QH12 (Corporate Income Tax Law), Law32/2013/QH13 (Revised Corporate Income Tax Law), Law 218/2013/ND-CP, Circular 78/2014/TT-BTC and Law 63/NQ-CP (August 2014) same as the corporate income tax.

B） Overview

When investors have capital gain of the project companies, capital assignment tax is imposed in Vietnam. The tax rate is 22% and is reduced to 20% from January 1, 2016 as in the case of corporate income tax rate. No. preferential treatment is applied to the capital assignment tax. The taxable income is calculated in the following formula:

Taxable income ＝assignment amount －purchase price of assigned capital －spending for assignment (transaction spending)

3.5 20km-long Section of Ha Long – Hai Phong Highway (inseparable project)

The 20-km-long section of Ha Long – Hai Phong Highway on the Ha Long side, which was not included in the Project (hereinafter referred to as "remaining 20km-long section") was originally intended to become a BT project (project cost: 5,825Bil.VND). However, cancellation of the BT project that was yet to be launched was decided by the State Decision 01/NQ-CP issued on January 2, 2014 and cancellation of the BT project for the remaining 20km-long section and its implementation as a public works project financed by Quang Ninh provincial budget were decided by Prime Minister's Decision 699/TTg-KTTH.

According to the letter 166four-CV/TU from the Quang Ninh Provincial Communist Party leader. Mr. Ching, to SE Corporation dated May 22, 2014, the financial source and construction schedule for the remaining 20km-long section as a Quang Ninh provincial project works project are as shown in Table 3.15.

Table 3.15 Quang Ninh Provincial Financial Sources and Construction Schedule of Remaining 20km-Long Section

Financial Source	1.	Contribution from development budget	1,000Bil.VND/year (approx. 5 billion yen/year)
	2.	Cost reduction (for 2013)	600 Bil. VND (approx. 3 billion yen)
	3.	Issuance of local bonds	800 Bil. VND (approx. 4 billion yen)
	4.	Revenue increase (schedule, 2014)	1,000 Bil. VND (approx. 5 billion yen)
	5.	Quang Ninh provincial budget for infrastructure development	1,410 Bil. VND (approx. 7 billion yen)
	6.	Fund from sources not annual Quang Ninh provincial budget (reserve)	500 Bil. VND/year (approx. 2.5 billion yen)
Construction Schedule	July 2014 to December 2015 (18 months)		

Source: composed by JICA study team based on 166four-CV/TU

Quang Ninh Province then swiftly implemented procedures and began to acquire land when the first site survey was conducted (June 10, 2014) as shown in Figure 3.1. The interview results with Quang Ninh Province and Hai Phong City in the survey clarified that Quang Ninh Province completed land acquisition within its administrative zone and that Hai Phong City was producing a land acquisition plan for the administrative zone.

Source: Photos taken by JICA Study Team

Figure 3.1 Land Acquisition for 20km-long Section

An overview of the remaining 20km-long section is shown in Table 3.16 below according to Decision 1292/QD-UBND issued on June 18, 2014, by the Quang Ninh Province People's Committee, which the study team obtained from it in the survey.

Table 3.16 Overview of the 20km-Long Section

Project name	Road to Connect Ha Long with Bach Dang Bridge
Section in charge	Quang Ninh Provincial Department of Transport
Consulting agency	Transport Engineering Design Inc. (TEDI)
Purpose	To connect the economic triangle of Ha Noi, Hai Phong and Quang Ninh to contribute to investment promotion and socioeconomic development of the province and northern Vietnam.
Project section	・Length: approx. 19.8km ・Starting point: KM102+300 of National Route 18 ・Ending point: KM19+800 of Ha Long – Hai Phong Highway (starting point of the Project)
Main specifications	・Design speed: 100km/h ・4 lanes ・Bridge: 7 bridges ─Cai Thanh bridge (length: 111.2m) ─Hot Rever bridge (length: 1,148.5m) ─Binh Huong bridge (length: 64.2m) ─Chanh bridge (length: 1,278.1m) ─Phong Hai bridge (length: 172.2m) ─Rut bridge (length: 750.0m)・ land area: 120.8ha
Project cost and its breakdown	Construction cost 4,13,962 Mil. VND Project management cost 23,927 Mil. VND Consultancy fees 215,272 Mil. VND Other expenses 257,556 Mil. VND Land acquisition expenses 566,622 Mil. VND Reserve fund 1,213,036 Mil. VND Project cost 6,416,034 Mil. VND
Schedule	・Project period: 2014 to 2017 ・Construction period: 24 months from beginning

Source: composed by JICA study team based on 1292/QD-UBND

According to Decision 1628/QĐ-UBND of Quang Ninh Province People's Committee issued on August 1, 2014, the construction is divided into seven packages and contractors are selected in bidding.

The groundbreaking ceremony of the remaining 20km-long section was held on September 13, 2014, attended by Prime Minister Dung, former president Luong, Deputy Prime Minister Minh and other relevant executive officials as shown in Figure 3.2 below.

Source: Hai Phong Newspaper dated September 14, 2014

Figure 3.2 Scene of the groundbreaking ceremony

The groundbreaking ceremony for the remaining 20km-long section highlighted attention at the progress and early completion of the Project.

3.6 Recent Trend of PPP/BOT Projects

Recent trends in PPP/BOT projects are summarized in the Chapter. The information is sorted and introduced herein as a reference. However, it may lack clarity and value for considering the scheme of the Project, since the main scope comprises BOT projects implemented by state corporations, which remain under contemplation or review.

3.6.1 Ha Noi – Hai Phong Expressway[12]

(1) Background and project overview

The Ha Noi – Hai Phong Expressway is a 6-lane Class A expressway with total length of 105.5km, connecting the Vietnamese capital of Ha Noi and Hai Phong, which is one of the biggest port cities in northern Vietnam[13]. The decision was made to implement the construction project in the BOT scheme by the Prime Minister (Decision 1621/QD-TTg dated November 29, 2007) in 2007, whereupon the project was launched in 2008 and is slated for completion in 2015[14].

The Hai Phong Port at the point where the expressway ends is one of the biggest international ports in northern Vietnam with 31 million tons on weight base (2012)[15]. Numerous goods manufactured in industrial parks around Ha Noi are exported from the port as a water gateway of the northern Red River economic zone, including Ha Noi. However, National Route 5 is the only arterial highway connecting Ha Noi and Hai Phong. Its traffic has increased, triggering regular congestion and frequent accidents in accordance with the nation's economic development. Against this backdrop, the expressway construction was decided under Prime Minister Dung's initiative to secure a new distribution route between Ha Noi and Hai Phong in addition to National Route 5. The opening of the expressway is expected to expedite travel time between the two cities from the current four hours to 1.5 hours[16].

The expressway is connected with existing National Routes at seven interchanges. The design speed is 120km/h and the 6-lane highway is to be 33 meters wide with two emergency lanes, center median and greenbelt on both sides, with a service road also built on both sides as required. There are plans to install a comprehensive traffic safety management system and fee collection system as well as service areas (service stations, gas stations, mechanic stations, motels and restaurants, etc.) on the expressway.

(2) Business scheme

The Ha Noi – Hai Phong Expressway Development Project was invested in by the Vietnam Development Bank (VDB), Saigon Invest Group (SGI), Joint Stock Commercial Bank for Foreign Trade of Vietnam (VCB) and Vietnam Construction and Import Export Corporation (VINACONEX) and implemented in the BOT scheme. The project company is to obtain toll collection rights for 35 years after its opening and operate the expressway to redeem the construction cost. The project company formed for its implementation is established with total capital fund of 5 trillion VND and called VIDIFI. The project company is unique in having toll collection rights to National Route 5 that runs in parallel to the expressway and invests in financial, securities, real estate and other projects and participates in other infrastructure construction

[12]Source: Interview results with VIDIFI by the JICA study team and various press releases are summarized. The source is an interview with VIDIFI unless mentioned with a note.

[13] The starting point of the Ha Noi side is on the Ha Noi Loop 3 approx. 1km from the abutment on the ending side of the Thanh Tri Bridge. The ending point of the Hai Phong side is connected to a city road in front of a shipbuilding company near the Dinh Vu bank in Hai An district in Hai Phong.

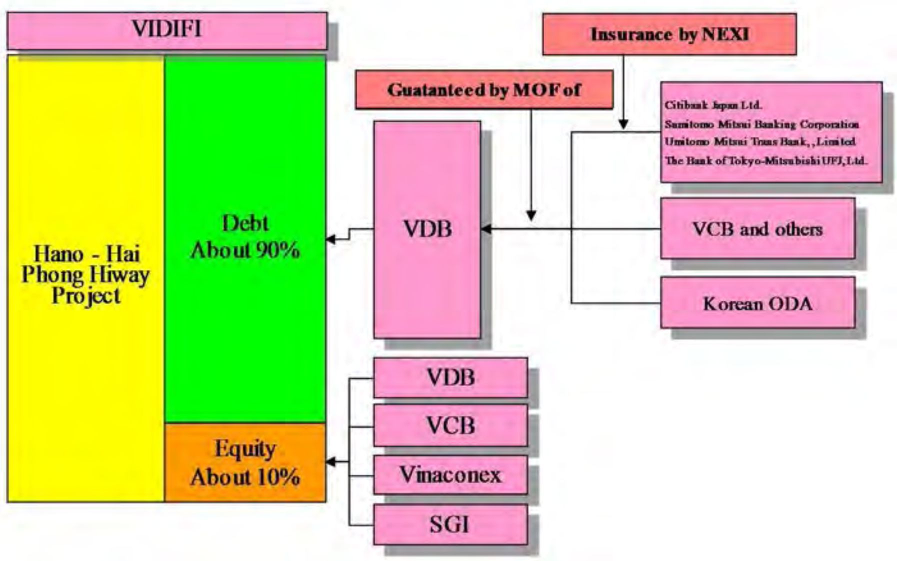
[14]Source: "Korean companies complete Vietnamese expressway next year," Toyo Keizai Nippon dated July 18, 2014, URL: http://www.toyo-keizai.co.jp/news/topics/2014/post_5831.php

[15] Source: Volume of main cargo across sea ports managed by the central level (08:34 23/09/2014)URL: http://www.gso.gov.vn/default.aspx?tabid=503&ItemID=15996, General Statistics Office of Vietnam

[16] Source: "Korean companies complete Vietnamese expressway next year," Toyo Keizai Nippon dated July 18, 2014, URL: http://www.toyo-keizai.co.jp/news/topics/2014/post_5831.php

projects for new cities, industrial parks and distribution services to enhance its financial base.

As for its relation with Japanese companies, Japanese financial institutions fund the project and Citibank Japan Ltd., Sumitomo Mitsui Banking Corp., the Sumitomo Trust and Banking Co., Ltd. and the Bank of Tokyo-Mitsubishi UFJ, Ltd. provided loans via VDB for Sections 3 and 8 of the expressway. Meanwhile, Nippon Export and Investment Insurance (NEXI) is in charge of overseas project loan insurance (loan amount of USD 270 million, 15-year responsibility for insurance)[17].



Source: JICA Study Team

Figure 3.3 Financing of Hanoi-Hai Phong Expressway

(3) Usage fees

The usage fees were yet to be decided at the time of interview by the JICA study team. The decision-making process taken before the interview was as follows:

Provisional fees were provided in the BOT contract (between VIDIFI-MOT) concluded in 2008. VIDIFI then hired consultants to formulate a financial plan. The MOT and MOF engaged in discussions based on the usage fees table in the BOT contract mentioned above and made a new proposal, which was then submitted for approval. (Although unofficial approval is obtained, official approval remains pending.)

Fees for a passenger car carrying 11 or fewer passengers were 1,000VND/km in the provisional fees table in the BOT contract in 2008. However, in the table submitted for approval, the figure was doubled to 2,000VND/km. VIDIFI submitted the fees to the Prime Minister, who will receive comments from governmental agencies (MOT, MOF, MPI, SBV, etc.) and decide the usage fees table.

Although fees revision procedures are provided in the BOT contract in 2008, the details remain unknown because the contract was undisclosed. VIDIFI hopes to negotiate with the government to have a new fees table approved automatically and solely by submission rather than approval to raise them flexibly.

[17] Source: NEXI's press release, "3.4 Overseas project loan insurance for Ha Noi – Hai Phong Expressway Construction Project, Socialist Republic of Vietnam" (November 22, 2011), URL: http://nexi.go.jp/topics/newsrelease/004127.html

(4) Impacts on Japanese companies in Vietnam

There is a cluster of industrial parks where Japanese companies are located along the expressway; the number of which is said to exceed 200. Their distribution currently depends on National Route 5 and constructing the expressway is expected to help logistics in the region and improve their productivity[18].

(5) Current state of the Project

According to media[19], it is decided that 70% of expressway shares will be sold to an Indian company. VIDIFI, as Project contractor, has exchanged a basic agreement to sell 70% of the shares with Indian IL & FS Transportation Networks Limited and, according to its executive officer, the two parties will establish a new project company in the form of a limited company after concluding the basic agreement. The Vietnam Development Bank, which holds 90% of VIDIFI shares as the largest shareholder, will sell the shares to foreign investors to take its funds out of the company.

3.6.2 Phap Van-Cau Gie Expressway

The Phap Van-Cau Gie Expressway is the section in southern Hanoi from the starting point of the North-South expressway Plan (Hanoi-Can Tho) approved by the Prime Minister in January 2010. This is a project to transform the National Route 1 bypass (approx. 29km long, 4 lanes, opened in 2002 and toll-free) that is a regular expressway currently in service into an expressway (phase 1) and expand the width to six lanes (phase 2). The total construction cost, including the design and supervision cost of phases 1 and 2 and sideway construction, reserve fund and VAT, is estimated at 5,481 billion VND (land acquisition cost excluded).[20]

The right to implement the project was granted to VEC that develops and invests in expressways in Vietnam by the Ministry of Transport (MOT) in April 2010. However, VEC has limited remaining investment capacity as it is implementing multiple expressway construction projects and the potential for a project implementation scheme using private funds was examined to implement the Project.[21]

Although Vietnamese and non-Vietnamese private companies proposed these projects to the MOT, it selected, as the investor, Central Nippon Expressway Company Ltd. that was considering participation in the project using JICA's overseas investment program instead of Vietnamese Hai Chau Group in 2013. According to the media, the extended experience of Central Nippon Expressway Company Ltd. in expressway operation in Japan was highly regarded during the selection. Its participation in the Project is also expected to facilitate financing at a low interest rate using JICA's investment loan and promote the participation of foreign investors in PPP road construction projects in Vietnam.

However, the Central Nippon Expressway Company Ltd. examined the conditions of project implementation presented by the MOT after the nomination of the investor and withdrew from the Project, deeming the risk excessive. Central Nippon Expressway Company Ltd. demanded such conditions for participation in the Project after receiving statements that the Vietnamese Government would support land development, which meant before the launch of the Project that

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[18] Source: NEXI's press release, "3.4 Overseas project loan insurance for Ha Noi – Hai Phong Expressway Construction Project, Socialist Republic of Vietnam" (November 22, 2011), URL: http://nexi.go.jp/topics/newsrelease/004127.html

[19] Source: HotNamNews, "70% of shares of Ha Noi – Hai Phong Expressway to be sold to an Indian company" (updated at 03:32 Nov. 7, 2014, URL: http://www.hotnam.com/news/141107033403.html

[20] Preparatory Report on Phap Van-Cau Gie Expressway PPP Project (PPP Infrastructure Project) in Ha Noi, (March 2012, JICA)

[21] Same as above.

the toll would be 1,500 VND/km (3 times as much as the MOF standard) for investment recovery and fees should be revised every three years in accordance with inflation, claiming that it would be difficult to realize the Project without meeting these conditions. However, the MOT responded that there was a huge gap between them and the conditions it originally presented.[22]

After the Central Nippon Expressway Company Ltd. withdrew from the Project, a joint venture formed by Vietnamese companies (Minh Phat Investment and Development Joint Stock Company in Ho Chi Minh and Civil Engineering Construction Corporation No. 1 and Phuong Thanh Transportation Construction & Investment Joint Stock Company both in Hanoi) participated in the Project and the project launching ceremony was held on July 20, 2014. There are plans to implement it in the BOT scheme.[23]

3.6.3 Ho Chi Minh-Trung Luong Expressway

(1) Background and project overview[24]

The Ho Chi Minh-Trung Luong Expressway was expected to help eliminate the chronic traffic congestion on National Route 1A between Ho Chi Minh and Mekong Delta as the first expressway in southern Vietnam. The Government approved the 417 million USD project based on MOT's Decision 1286/QD-TTg 12/06/2004 and it was launched on December 16, 2004.

It opened on February 3, 2010, to enable travel from Ho Chi Minh to Mekong Delta province within 45 to 60 minutes. The total length of the expressway is 39.8km and that of the connecting road is 22.1km. The total length of the side roads on both sides is 61.85km. The minimum and maximum speeds are 50 and 100km/h, respectively. (Motorcycles are prohibited.) It was operated as a toll-free expressway during the defect liability period (for 2 years from February 2010 to February 2012).

(2) Entities that perform development and O&M

PMU My Thuan constructed the Ho Chi Minh-Trung Luong Expressway. It was reorganized and Cuu Long CIPM was newly established as the O&M responsible organization during the period when it was operated as a toll-free expressway (February 2010 to February 2012), while the Expressway Management Center that is the site operating organization of Cuu Long CIPM was responsible for its O&M. Road maintenance and management and rescue work from road accidents were performed by respective professional outsourcees based on outsourcing agreements.

Cuu Long CIPM became responsible for O&M after it began to be operated as a toll road, while Company 715, under its umbrella, performs traffic management and control and toll collection. The Expressway Management Center remains in operation as a site operating organization and rescue work from traffic accidents, etc., continues to be performed by the outsource pursuant to outsourcing agreements. The expressway traffic police remains stationed at the Expressway Management Center full time to help handle traffic accidents.

Meanwhile, responsibilities for maintenance and management work are transferred to DRVN and RRMU7 under its umbrella is responsible for actual operation. As for actual on-site operations, RRMU7 concluded an outsourcing contract with Company 715 and the Expressway Management Center is in charge of on-site work, as is the case of O&M, to perform maintenance work on roads, structures and road facilities.

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22 VENEWS "Japanese investors exit highway deal in Vietnam" on December 11, 2013

23 Source: "Phap Van-Cau Gie to be upgraded into expressway"（2014.7.22）https://www.vcsc.com.vn/Shared/Views/Web/MessagesDetail.aspx?menuid=4&id=149622&catid=1241&tab=&title=&lang=en-us

24 Source: The Saigon Times Daily "Thruway cuts HCMC-Tien Giang travel time by half," February, 4, 2010
The Saigon Times Daily "Work starts on US$417-million expressway," December 17, 2004

(3) Development after opening

The MOT approved the bidding result of toll collection rights for the first phase (5 years from January 1, 2014) of the Ho Chi Minh-Trung Luong Expressway and outsourced the duty to the winning bidder, Yen Khanh Manufacturing Trading Service Co., Ltd., for 2 trillion VND. The winning bidder was authorized to collect tolls at four locations on the expressway (Cho Dem, Tan An, Ben Luc and Than Cuu Nghia). The purchase contract price for the collection right was paid in three installments within 6 months and 40% of it had to be paid immediately after the contract went into effect. The MOT instructed Cuu Long Corporation for Investment, Development and Project Management of Infrastructure (Cuu Long CIMP) to conclude and manage the contract with Yen Khanh.

Although the BIDV Expressway Development Company (BEDC) planned to purchase the toll collection right for 25 years for 9.1 trillion VND when the expressway opened in February 2010, it withdrew this plan at the end of 2011 due to lack of financing prospects. The MOT notified sales of the right by October 2013.[25]

3.6.4 Other projects

(1) Upgrading project of National Route 1A between An Suong and An Lac

This was an upgrading project between An Suong and An Lac on National route 1A (total length of 14km) costing approx. 800 billion VND. The toll fees were between 5,000 to 40,000 VND.[26]

The project implementing body was BOT An Suong-An Lac Co. established by Construction & Natural Gas Co. under the umbrella of the MOC, Civil Engineering Construction Corp. (Cienco6) under the umbrella of the MOT and Cienco 8. It is a BOT project implemented by a Vietnamese state company; completed in mid-August 2004 and opened in December. Toll collection began in January 2005. It was originally a project approved at 312 billion VND, but this figure rose to 831 billion VND when compensation for land development was taken into consideration. Because the project implementing body failed to cover the cost, the land development work was prolonged, so the Ho Chi Minh City Government formulated a plan to take over and accelerate the project. The MOT also hoped to sell the rights pertaining to the project to solve the financial problems facing the project implementing body.[27]

(2) Tan Son Nhat-Binh Loi Outer Ring road Project

The Tan Son Nhat-Binh Loi Outer Ring road Project in H Chi Minh is a project to develop a 1two-lane road with total length of 13.6km connecting Tan Son Nhat International Airport and Thu Duc on National Route 1. It is the first BT project in collaboration with Korean GS E&C. The project cost is approx. 495 million USD (approx. 281 million USD for land acquisition and resettlement). It was launched on June 9, 2008, with 75% completed as of October 2013 and slated for completion in 2014.[28]

(3) Dau Giay-Lien Khuong Expressway Project

The Dau Giay-Lien Khuong Expressway Project with a length of 200km connecting Dong Nai

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[25] Source: Construction Industry Information (recent trend), Japanese consulate general in Ho Chi Minh, Page 2, (December 27, 2013).
http://www.mlit.go.jp/common/001024204.pdf

[26]Source: Saigon Times Weekly “Tolls for An Suong-An Lac road,” October 30, 2004
[27]Source: Saigon Times Daily “City plans to take over An Suong-An Lac road project,” July 22, 2004
[28]Source: Thai News Service “Vietnam Tan Son Nhat - Binh Loi ring road under construction,” June 11, 2008
Vietnam News Summary “US$340 million road opens for traffic in Vietnam’s southern city,“ October 1, 2013

and Lam Dong is planned as a four-lane expressway with total project cost of 30 trillion VND. The first phase involves constructing a two-lane road with a speed limit of 80Km/h. Inchon Urban Development Corporation (IUDC) in Korea concluded an MOU to implement it, with total investment of approx. 1 billion USD with the MOT in 2008 and plans construction and operation in the BOT scheme. As of February 2011, Korean Jinsung Co., Ltd. demanded that the Vietnamese Government approve its participation[29]. Because the MOT and Lam Dong Province were forced to review the project due to the inability to attract investors at the start, they scaled it down, divided it into multiple phases and proposed a two-lane road construction during the first phase.[30]

(4) Trung Luong-My Thuan Expressway Project

This project involves constructing an expressway between Trung Luong and My Thuan with total length of 54km. The project cost was originally estimated at approx. 25 trillion VND. The construction is planned to be launched in 2014. The project company is Cuu Long Corporation for Investment, Development and Project Management of Infrastructure (Cuu Long CIPM) that is responsible for operating the Ho Chi Minh-Trung Luong Expressway. Cuu Long CIPM claims that the project is divided into two phases to facilitate its appeal to investors.

Table 3.17 Overview of the Trung Luong-My Thuan Expressway Development Project in Multiple Phases

Phase 1A	Construction of a two-lane expressway with an emergency stopping section in the BOT scheme There are two capital recovery plans. One involves collecting a toll at both sections between Ho Chi Minh and Trung Luong and between Trung Luong and My Thuan for 15 years from 2019. The other involves collecting a toll only between Trung Luong and My Thuan for 20 years from 2019 and receiving support from the province for toll collection right between Ho Chi Minh and Trung Luong for a certain period.
Phase 1B	Expansion of the road to six lanes with ODA

Source: JICA Study Team

Although the Bank for Investment and Development of Vietnam (BIDV) originally planned to invest in the project, it returned the project right to the MOT two years later due to difficulties in fundraising, whereupon Cuu Long CIPM was selected.[31]

(5) La Son-Tuy Loan Expressway Project

This is a project to construct a four-lane expressway between La Son and Tuy Loan in central Vietnam with total length of 81.7km in the BT scheme. The project cost is approx. 20 trillion VND and the operation is slated to begin in 2017.

It is part of the Ho Chi Minh road and the traffic volume is small. A joint venture of the Vietnamese Government and seven Korean companies, represented by Shinhan E&C, applied for the investment. 17 Japanese banks plan to provide cofinance of 500 million USD, while 14 regional banks, including Yokohama Bank and Chiba Bank, provided loans totaling 300 million USD. It is the biggest overseas infrastructure project for which Japanese regional banks provide syndicated loans.

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[29]Source: "Updates on Vietnamese Expressways," materials for 6th Vietnamese road PP study session, January 28, 2010
Vietnam News Brief Service "Infrastructure: S. Korea Firm Eyes to Build $1B Expressway in Vietnam," February 23, 2011
Vietnam News Summary "Investment of Dau Giay-Lien Khuong expressway project in Vietnam to be ratified before Sep 15," August 21, 2014

[30]"Financial Constraints Force Ministry to Revise Expressway Projects," June 5, 2014
http://english.thesaigontimes.vn/34877/Financial-constraints-force-ministry-to-revise-expressway-projects.html

[31]Source: Vietnam News Summary "Trung Luong-My Thuan expressway to get off ground in Vietnam this year," August 6, 2014

Nippon Export and Investment Insurance (NEXI) also decided to provide loan insurance for cofinancing for Vietnam by Japanese financial institutions.[32]

(6) Long Thanh International Airport

This is a project constructing a passenger terminal for 17 million passengers annually with one runway on 2,565ha of land in Phase 1a, with plans to add another runway on the remaining land in Phase 1b (by 2020). The number of annual passengers is to increase to 50 million by Phase 2 (2030) and to 100 million by Phase 3 (after 2030). The project cost is approx. 7.8 billion USD for Phase 1 and it is slated to open in 2023.

The Economic Internal Rate of Return is 22.1%, which far exceeds the norm for public works projects in Vietnam (10 to 12%). The application of a PPP scheme to construct the basic facility and passenger terminal with a yen loan from Japan and private funds is examined.

However, the Long Thanh International Airport construction has been delayed; partly due to failure to establish a consensus on the division of roles with the existing Tan Son Nhat Airport, with views such that the handling capacity of the existing airport should be increased and that it would be inconvenient if the new Long Thanh Airport were for international flights and the existing Tan Son Nhat Airport for domestic flights.[33]

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[32]Source: New Vietnam Corporate Company Business Registration Incorporation Setup Formation in HCM City "Bidding session for La Son-Tuy Loan highway project" (time unknown)
NEXI "NEXI provides loan insurance for cofinance for Vietnam participated in 14 regional banks for the first time," September 29, 2014
Vietnam News Brief Service, "Infrastructure: Vietnam Firm to Build $547M Expressway in Central Region Next Week," December 18, 2013
Vietnam News Summary, "Vietnam's La Son- Tuy Loan highway not selected BT investor," May 30, 2012
Vietnam News, The Watch, "Korean and domestic companies are aggressive in expressway," (time unknown)

[33]Source: Foreign Press Center, "Long Thanh International Airport Investment Plan, total of 7.8 billion USD," (time unknown)
Vietnam News, "Ministry backs new airport plan" 2013/8/19
Vietnam News Brief Service, "Vietnam Transport Ministry Wants Early Construction of Mega Airport," September 27, 2014
VietnamNet English "Vietnam wasting time on discussing viability of Long Thanh Airport: experts," September 2014
JICA, "Preparatory Study for Long Thanh International Airport Project" (time unknown)
AGS, "Long Thanh International Airport Construction Investment Plan (proposal): To National Assembly Deliberation," September 26, 2014
Vietnam News, The Watch, "5 Major Transport Projects including Expressway and Long Thanh International Airport to be Implemented in PPP," August 16, 2013

Chapter 4 Traffic Demand Forecast

4.1 Background to the Study

4.1.1 Statuses of Related Studies

Table 4.1 shows the results of traffic demand forecasting by the Vietnamese F/S and METI F/S. An interview with TEDI, a Vietnamese consulting firm, revealed the following facts and circumstances concerning traffic demand forecasting in Vietnam:

- There are no set guidelines as to how to forecast traffic demand in Vietnam, where vehicles are classified differently under different standards. For instance, buses under the DRVN system are divided into different groups demarcated by 16 and 25 seats, but divided into two groups of fewer than 30 seats and 30 or more seats for toll collection purposes. Another example is that the PCU equivalent of a large-sized car could be 1.5 or 2 depending on the standards adopted by different government agencies. Under these circumstances, there is a lack of unified guidelines for traffic demand forecasts and surveys.
- For traffic demand modeling, four-step estimation techniques have been used over the last decade or so, before which traffic demand was estimated (by multivariate regression analysis, etc.) based on socioeconomic growth rates in the absence of requirements to use specific models. In recent years, the four-step method has been regarded as a reliable means of estimating traffic demand on roads.
- YOOSHIN[34]-KPT, a consulting consortium, forecasted traffic demand on the Hanoi – Hai Phong Expressway in 2009 and 2013. We were told that they had estimated the demand using only a regression coefficient and without taking the road network into account. In 2013, they revised the 2009 forecast by establishing a road network and adopting the four-step estimation method, which were not used in the 2009 forecast.

The four-step estimation has become the benchmark for forecasting traffic demand in Vietnam in recent years and was also used to review the traffic demand forecast for the Hanoi - Hai Phong Expressway, although the results were not obtainable during the forecasting process of this Study.

Under these circumstances, it proved difficult to simply compare the results of existing traffic demand forecasts conducted in the target area, even for the same route, due to the varying circumstances surrounding each traffic demand survey, as well as the forecasting methods and socioeconomic indices used.

[34] YOOSHIN is a consulting firm headquartered in South Korea.

Table 4.1 Outline of the Traffic Demand Forecasting in Target Area

Item		JICA PPP F/S (this Study)	METI F/S	Ha Long - Hai Phong Highway	Ha Noi - Hai Phong Highway (preparatory study)	Ha Noi - Hai Phong Highway
Year		2015	2013	2010	2013	2009
Report prepared by		JICA Study Team	SE Corporation	TEDI	YOOSHIN-KPT JV	YOOSHIN-KPT JV
Traffic volume survey	Dates of study	July 18 - 22, 2014	June 26 - 28, 2012	Unknown (report suggests 2010)	August 16 - 18, 2013	March 2 - 4, 2008
	Contents of study	By vehicle type, by direction, 24 hours	By vehicle type, by direction, combination of 24/12 hours and weekday/weekend	By vehicle type, by direction, 24 hours	By vehicle type, by direction (inbound/outbound), 24 hours, weekday/weekend	By vehicle type, by direction, combination of 24 and 12 hours
	Survey points	8 points ① Bac Ninh/Hai Duong boundary (road section) ② Hai Duong/Quang Ninh boudary (road segment) ③ Tien Yen T-intersection (NH18･NH4B･Lang Son) ④ Hai Duong/Hai Phong boundary (road segment) ⑤ Thai Binh/Hai Phong boundary ⑥ Thai Binh/Hai Phong boundary ⑦ Bac Giang/Hai Duong boundary ⑧ Hai Duong/Hung Yen boundary (Complementary survey of METI F/S)	7 points ① Intersection of new NH10 / NH18 ② Intersection of old NH10 / NH18 ③ Link between old NH10 and Thai Nguyen (Quang Ninh): river crossing by Pha Rung ferry (screenline survey) ④ Link between PR 333-352 and Thai Nguyen (Quang Ninh): river crossing by Pha Rung ferry (screenline survey) ⑤ Binh Bridge: river-crossing (screenline survey) ⑥ Kien Bridge: river-crossing (screenline survey) ⑦ Intersection connecting to Hai Phong–Dinh Vu port	2 points ① Intersection of new NH10 / NH18 ② Intersection of old NH10 / NH18	6 points ① NH5, Chau Quy district ② NH5 toll both area (Km18+100) ③ NH5, Ghe Bridge - Lai Cach Town (Km 39+831) ④NH5 , Peoples Commitee of Kim Xuyen Commune, Kim Thanh district, Hai Duong district ⑤NH5 two toll booth areas ⑥Intersection of NH5 and Quang Trung - Hai Phong City	10 points ①Intersecton of NH5 and new NH1 ②Intersection of NH5 and NH39 ③Inersection of NH5 and NH38 ④Nguyen Luong Bang Road at gateway to Hai Duong City ⑤Gia Loc 3-way junction ⑥ 3-way junction of NH5 and NH183 ⑦Quan Toan 3-way junction in An Lao district ⑧Intersection of old NH5 and NH10 ⑨Intersection of new NH5 and NH10 ⑩Road leading to Dinh Vu Port
	Vehicle classification	7 vehicle types (Same as METI F/S)	7 vehicle types pursuant to TCVN4054-2005 ①Motorcycles, ② Cars/Taxies, ③ 2-axle trucks, ④ Trucks with 3 or more axles, ⑤Remooks/containers, ⑥ Buses with less than 25 seats)、⑦Buses with more than 25 seats	10 vehicle types ①Passenger cars, ② Passenger cars with 16 or less seats, ③Passenger cars with more than 16 seats, ④Small trucks, ⑤Medium-sized trucks, ⑥3-axle large trucks, ⑦ Large trucks with more than 3 axles, ⑧ Other trucks, ⑨ Motorcycles, ⑩Bicycles	11 vehicle types ①Passenger cars with 7 or less seats (4-seat cars, jeeps, sedans, passenger cars with 7 or less seats), ② Minivans (with 8 - 16 seats) ③ Passenger vans (16 or more seats), ④ Buses (for various public services), ⑤Small trucks (2.5-ton 2-axle small trucks, pickup trucks, 3-axle taxies), ⑥ Medium trucks (2.5 to 8-ton, 2-axle), ⑦Large trucks (8 to 14 ton, 3-axle), ⑧Other truck (cargo trucks, trucks with 4 or more axles), ⑨Semi trailers, ⑩Motorcycles, motorbikes, ⑪Bicycles	8 vehicle types ①Motorcycles, ②Passenger cars (including taxle), ③ Small buses (8 - 24 persons), ④Large buses (25 or more persons), ⑤Small trucks (less than 2.5 tons, 2-axle), ⑥ Medium trucks (2.5 to 8 tons, 2 oe 3 axles),、⑦Large trucks (8 to 14 tons, 3 axles), ⑧Trailers (3 or more axles)
Other surveys and data referenced		･OD interview survey ･Traffic volume data of DRVN	･OD interview survey	･Traffic volume data of DRVN (2002 - 2009) ･OD interview survey ･License plate survey	None	･Interview survey with motorcycle users (income level, wilingnss to switch to cars according to income change)
Forecasting	Socio-economic indices	･Economic indices: GDP of each province/city ･Social indices: population of each protinve/city	･Economic indices: GDP of each province/city ･Social indices: population of each protinve/city	･Economic indices: GDP of each province/city	･Economic indices ･Social indices (Data on relevalt provinces)	･Economic indices: economic growth rates (nationwide, north region) ･Social index: population (nationwide) ･Other indices: cago transport volume (national/north region), no. of passengers (land, national/north region)
	Road network	Improvement of Ha Noi - Hai Phong HW and conencting roads and roads connecting to Ha Long City Improvement of Noi Bai - Ha Long HW Improvement of coastal road Improvement of Ha Long - Mong Cai HW Improvement of Ninh Bin - Hai Phong - Quang Ninh Route	Improvement of Ha Noi - Hai Phong HW and conencting roads and roads connecting to Ha Long City Improvement of Noi Bai - Ha Long HW Improvement of coastal road Improvement of Ha Long - Mong Cai HW Improvement of Ninh Bin - Hai Phong - Quang Ninh Route	･ Ninh Bin - Hai Phong - Uong Ninh Road ･ Hai Phong - Thanh Hoa Coastal NH ･ Ha Noi - Hai Phong Road ･ Noi Bai - Ha Long Road ･ Ha Long - Ha Noi Road (No road network map available)	･Ha Noi - Hai Phong Highway ･Ha Noi - Ha Long Highway ･Ha Noi - Lao Cai Highway ･Ha Noi - Thai Nguyen Highway ･Ha Noi - Lang Son Highway ･Ha Long - Mong Cai Highway ･NH5 ･NH18 ･NH3 ･NH2 ･NH1A	Not clearly provided (current road network + Ha Noi - Hai Phong HN?)
	Other transport hubs, etc. to be taken into account	･Port (present, future) ･Airport (present, future)	None	None	N/A	N/A
	Other development projects, etc. to be taken into account	None	None	･Noi Bai - Ha Long Highway Project ･Ha Noi - Hai Phong Highway Project ･Transport projects associated with development projects	N/A	N/A
	No. of zones	42 zones (Same as METI F/S)	42 zones (divided by city, province, or region. Hai Phong City was divided into 18 zones)	12 zones	Though zones seem to have been defined (possibly by referring to VITTRANSS2), details were not available.	N/A
	Toll rates	Per Circular No.90	Per Circular No.90	N/A	N/A	N/A
	Reproduction of present status	Compared the present conditions preproduced in 2014 with the results of traffic volume survey.	Compared the present conditions preproduced in 2012 with the results of traffic volume survey.	Estimation was compared with actual traffic counts. The difference was within a 10% error margin.	N/A	N/A
	Years forcasted	2015, 2020, 2025, 2030, 2035, 2040, 2045, 2050	2015, 2020, 2025, 2030, 2035, 2040, 2045, 2050	2015, 2020, 2030, 2040	2015, 2020, 2030, 2040	2008, 2012, 2015, 2020, 2025, 2030, 2032
	Software	VISUM	VISUM	Regression estimation based on economic indices and traffic volume data	JICA STRADA	Regression estimation based on social indices and traffic volume data
	Other items to be examined	･Design number of lanes	None	None	None	･Design number of lanes ･Traffic volume at each IC (2032)

Source: JICA Study Team

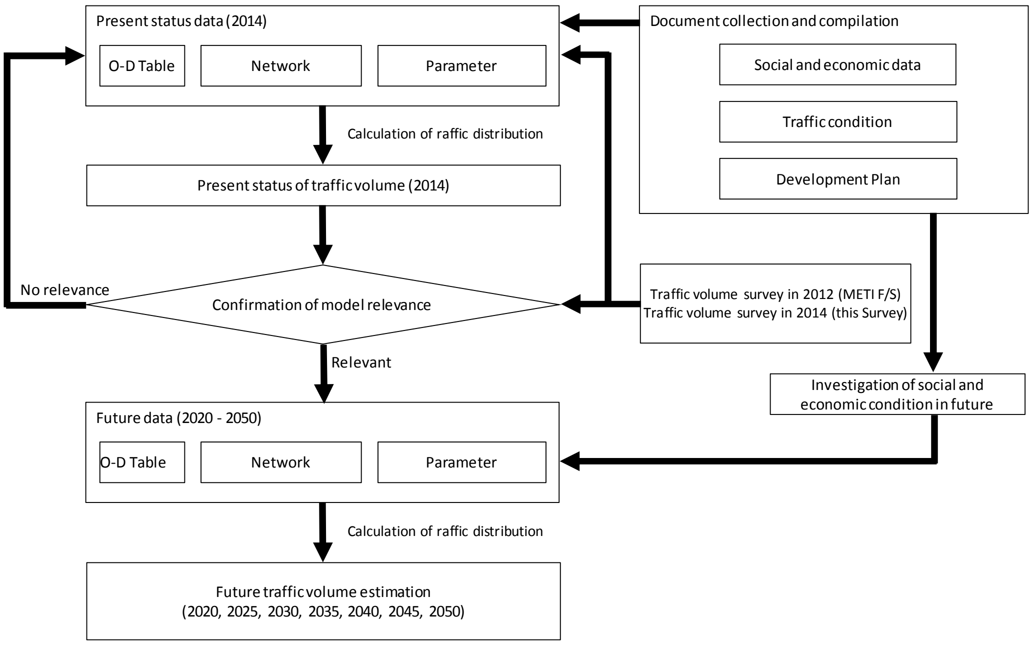
4.1.2 Guidelines for Conducting Traffic Demand Forecasting

Traffic volume surveys and traffic demand forecasting related to this Project have already been conducted in the Vietnamese F/S and METI F/S. Accordingly, the decision was made to perform additional surveys in this Study to gather additional data to complement the results of METI F/S surveys and forecasting to improve accuracy.

As mentioned earlier, the data gathered by METI F/S in 2012 are two years old. Additional surveys are to be conducted as follows to update the METI F/S data and incorporate the results in the traffic demand forecasting of this Study.

- Socioeconomic conditions
- Traffic-volume / interview surveys

The overall image of the traffic demand forecasting work is shown in Figure 4.1.



Source: JICA Study Team

Figure 4.1 Overall Image of Forecasting Work

4.2 Traffic Volume Survey

4.2.1 Organizing Past Survey Results

Traffic volume surveys were conducted to gather base data to determine current traffic conditions and forecast future demand. An interview survey was also conducted to determine the directions of traffic flows, travel time, load types and so on.

(1) Traffic Volume Survey

1) Survey Method

Table 4.2 describes the traffic volume survey conducted at each survey point.

As for the vehicle classification, the survey referred to TCVN405four-2005, a Vietnamese standard for designing highways, which divides vehicles into the following types:

- Motorcycles
- Cars/taxis

- 2-axis trucks
- Trucks with three or more axes
- Remook, containers
- Passenger cars with fewer than 25 seats
- Passenger cars with more than 25 seats

Table 4.2 Description of Survey at Each Survey Point (traffic volume survey of the 2012)

Survey point	Location	Description of survey
1	Intersection of new NH10 – NH18	・24-hour traffic volume survey (6:00am to 6:00am) ・By vehicle type / direction ・Weekday: July 9, 2012 ・Weekend: July 8, 2012
2	Intersection of old NH10 – NH18	・24-hour traffic volume survey (6:00am to 6:00am) ・By vehicle type / direction ・Weekday: July 10, 2012
3	Link between old NH10 and Thai Nguyen (Quang Ninh): river crossing by Pha Rung ferry (screenline survey)	・24-hour traffic volume survey (6:00 to 21:00, during service hours) ・By vehicle type / direction ・Weekday: July 6, 2012
4	Link between PR 333-352 and Thai Nguyen (Quang Ninh): river crossing by Pha Rung ferry (screenline survey)	・24-hour traffic volume survey (6:00am to 6:00am) ・By vehicle type / direction ・Weekday: July 10, 2012
5	Binh Bridge: river-crossing (screenline survey)	・24-hour traffic volume survey (6:00am to 6:00am) ・By vehicle type / direction ・Weekday: June 28, 2012 ・Weekend: July 7, 2012
6	Kien Bridge: river-crossing (screenline survey)	・24-hour traffic volume survey (6:00am to 6:00am) ・By vehicle type / direction ・Weekday: July 6, 2012 ・Weekend: July 7, 2012
7	Intersection connecting to Hai Phong–Dinh Vu port group	・24-hour traffic volume survey (6:00am to 6:00am) ・By vehicle type / direction ・Weekday: July 11, 2012

Source: JICA Study Team

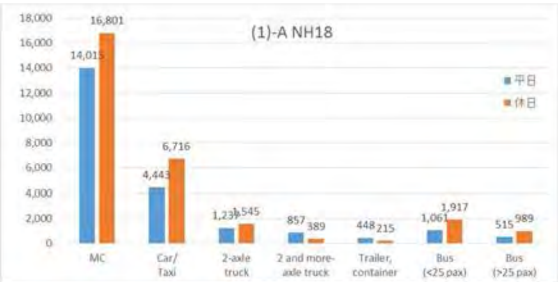
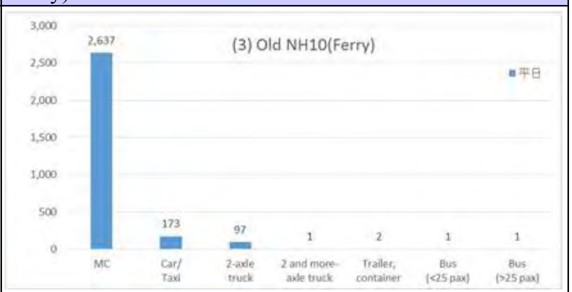
2) Results of the 2012 Traffic Volume Survey

The results of the traffic volume survey in 2012 are as shown inFigure 4.2 and Table 4.3 below.

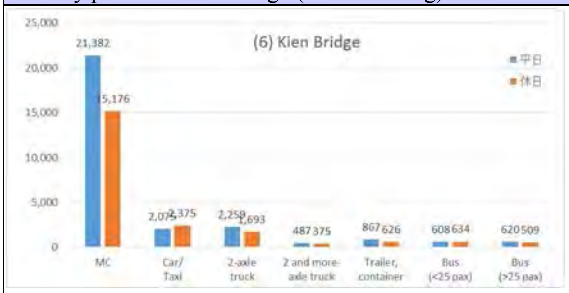
Source: JICA Study Team

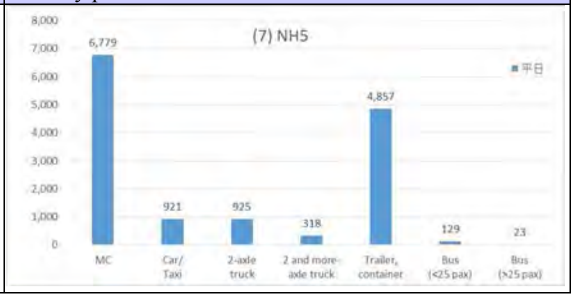
Figure 4.2 Locations/Results of the Traffic Volume Survey (2012)

Table 4.3 Results of the Traffic Volume Survey (2012)

Survey Point 1: National Route 18 (A)	Survey Point 1: National Route 18 (B)
	
Survey Point 1: National Route 10 (C)	Survey Point 2: National Route 18 (A)
	
Survey Point 2: National Route 18 (B)	Survey Point 3: ex-National Route 10 (river-crossing by ferry)
	
Survey Point 4: PR333-352 line (river-crossing by ferry)	Survey Point 5: Binh Bridge (river-crossing)

Survey point 6: Kien Bridge (river-crossing)	Survey point 7: National Route 5





Source: JICA Study Team

(2) Interview Survey

1) Survey Method

The interview survey was conducted as outlined in

Table 4.4. The survey locations were the same as those of the traffic volume survey.

Examiners asked drivers the following questions, to which 3,066 people responded:

- Gender: motorcycle, car
- Vehicle type: all vehicle types
- Purpose: motorcycle, car
- No. of passengers: car, minibus, large-sized bus
- Container type: 2-axis truck, truck with three or more axes, container truck
- Owner type: 2-axis truck, truck with three or more axes, container truck
- Loading capacity: 2-axis truck, truck with three or more axes, container truck
- Origin and destination: all vehicle types

Table 4.4 Description of Survey at Each Survey Point (interview survey in 2012)

Survey point	Location	Survey date
1	Intersection of new NH10 – NH18	・Weekday: July 9, 2012 ・Weekend: July 9, 2012
2	Intersection of old NH10 – NH18	No survey
3	Link between old NH10 and Thai Nguyen (Quang Ninh): river crossing by Pha Rung ferry (screenline survey)	・Weekday: July 6, 2012
4	Link between PR 333-352 and Thai Nguyen (Quang Ninh): river crossing by Pha Rung ferry (screenline survey)	・Weekday: July 7, 2012
5	Binh Bridge: river-crossing (screenline survey)	・Weekday: July 7, 2012
6	Kien Bridge: river-crossing (screenline survey)	・Weekday: July 6, 2012
7	Intersection connecting to Hai Phong–Dinh Vu port group	・Weekday: July 11, 2012

Source: JICA Study Team

2) Survey Results

A total of 3,066 people responded to this interview survey, the results of which are summarized in Table 4.5, Table 4.6, and Table 4.7.

Table 4.5 Interview Survey Results (2012)

Survey Year		2012		
Items surveyed		No. of responses	Total responses	Remarks
No. of total responses		3,066		No. of questionnaires returned
Gender	Male	1,228	1,631	Questions for motorcyclists and car drivers
	Female	298		
	Unknown	105		
Vehicle type	Motorcycle	810	3,066	Questions for all drivers
	Car	821		
	Mini bus (less than 25 seats)	180		
	Large bus (25 or more seats)	206		
	2-axle truck	616		
	Truck w/3 or more axles	150		
	Container, trailer	283		
	Unknown	–		
Purpose of trip	Going home	428	1,631	Questions for motorcyclists and car drivers
	Going to work	363		
	Going to school	54		
	Business	120		
	Other (private)	563		
	Unknown	103		
No. of passengers (including driver)	Less than 5	442	1,207	Questions for car, mini/large bus drivers
	5 - 9	75		
	10 - 14	39		
	15 - 19	72		
	20 - 24	54		
	25 - 29	90		
	30 - 39	64		
	40 - 49	27		
	50 or more	0		
	Unknown	344		
Container type	20 feet	74	1,049	Questions for drivers of trucks and container vehicles with 2, 3, or more axles
	40 feet	260		
	Non-container cargo	667		
	Other	14		
	Unknown	34		
Owner	Public	22	1,049	
	Business	468		
	Private	521		
	Rental	16		
	Unknown	22		
Type of cargo	Agricultural/forestry/fisheries product	67	1,049	
	Chemical product	14		
	Industrial product	75		
	Consumer goods	127		
	Construction material	138		
	Other	266		
	Unknown	362		
Loading ratio	Full	323	1,049	
	Around 75%	138		
	Around 50%	88		
	Around 25%	40		
	25% or less	6		
	Empty	416		
	Unknown	38		

Source: JICA Study Team

Table 4.6 Interview Survey Results in 2012 (Origin points)

Zone code	Name of locality	Origin							
		Motorcycle	Car	Mini bus	Large bus	2-axle truck	Truck with 3 or more axles	Container, trailer	Total
1-18	Hai Phong City	435	315	41	37	314	44	114	1,300
20	Ha Noi City	13	126	38	33	34	16	42	302
21	Lạng Sơn Province	0	0	0	0	0	0	0	0
22	Bắc Giang Province	2	2	2	1	9	3	0	19
23	Bắc Ninh Province	1	4	1	0	5	2	2	15
24	Hải Dương Province	26	27	3	6	27	5	21	115
25	Hưng Yên Province	2	4	2	0	6	1	1	16
26	Thái Bình Province	6	8	5	31	16	2	8	76
27	Đông Bắc (Northeast) Region	8	4	1	1	1	1	2	18
28	Tây Bắc (Northwest) Region	3	1	1	1	2	2	1	11
29	Phía Nam (South) Region	13	13	11	27	16	5	14	99
30-42	Quang Ninh Province	300	317	75	69	183	69	77	1,090
43	Vĩnh Phúc Province	1	0	0	0	3	0	1	5
Total		810	821	180	206	616	150	283	3,066

Source: JICA Study Team

Table 4.7 Interview Survey Results in 2012 (Destination points)

Zone code	Name of locality	Origin							
		Motorcycle	Car	Mini bus	Large bus	2-axle truck	Truck with 3 or more axles	Container, trailer	Total
1-18	Hai Phong City	454	391	32	24	280	40	152	1,373
20	Ha Noi City	39	82	38	13	43	15	33	263
21	Lạng Sơn Province	0	0	0	0	0	1	1	2
22	Bắc Giang Province	2	3	2	3	6	8	2	26
23	Bắc Ninh Province	0	0	0	0	7	4	3	14
24	Hải Dương Province	30	17	9	2	33	12	19	122
25	Hưng Yên Province	2	0	2	0	5	1	1	11
26	Thái Bình Province	3	8	6	19	19	4	4	63
27	Đông Bắc (Northeast) Region	0	1	0	2	1	4	1	9
28	Tây Bắc (Northwest) Region	0	1	0	0	4	6	1	12
29	Phía Nam (South) Region	2	11	5	13	16	4	8	59
30-42	Quang Ninh Province	278	307	86	130	202	50	54	1,107
43	Vĩnh Phúc Province	0	0	0	0	0	1	4	5
Total		810	821	180	206	616	150	283	3,066

Source: JICA Study Team

4.2.2 Outline of This Year's Surveys

(1) Traffic Volume Survey

1) Survey Method

The traffic volume was counted at each of the survey points outlined in Table 4.8 and Figure 4.3 below. The survey points were selected to measure traffic volumes along the outer rim of the target area, as well as to examine changes in traffic counts at some of the METI F/S survey points.

As for vehicle classification for the purpose of this survey, TCVN4054-2005 was referred to, as was the case in METI F/S.

Table 4.8 Description of Survey at Each Survey Point (2014 traffic volume survey)

Survey point	Location	Description
Points 1 – 7 are the same as the METI F/S survey points.		
8	NH18, Bac Ninh / Hai Duong boundary	• 24-hour traffic volume survey (6:00am to 6:00am) • Weekday: July 18, 2014 • Weekend: July 19, 2014
9	NH18, Hai Duong / Quang Ninh boundary	• 24-hour traffic volume survey (6:00am to 6:00am) • Weekday: July 18, 2014 • Weekend: July 19, 2014
10	NH18, T-intersection in Tien Yen (NH18 / NH4B (toward Lang Son) intersection)	• 24-hour traffic volume survey (6:00am to 6:00am) • Weekday: July 18, 2014 • Weekend: July 19, 2014
11	NH5, Hai Duong / Hai Phong boundary	• 24-hour traffic volume survey (6:00am to 6:00am) • Weekday: July 21, 2014 • Weekend: July 20, 2014
12	NH10, Thai Binh / Hai Phong boundary	• 24-hour traffic volume survey (6:00am to 6:00am) • Weekday: July 21, 2014 • Weekend: July 20, 2014
13	NH3, Thai Binh / Hai Phong boundary	• 24-hour traffic volume survey (6:00am to 6:00am) • Weekday: July 21, 2014 • Weekend: July 20, 2014
14	NH37, Bac Giang / Hai Duong boundary	• 24-hour traffic volume survey (6:00am to 6:00am) • Weekday: July 18, 2014 • Weekend: July 19, 2014
15	NH39, Hai Duong / Hung Yen boundary	• 24-hour traffic volume survey (6:00am to 6:00am) • Weekday: July 21, 2014 • Weekend: July 20, 2014
16 (1)	New NH10 / NH18 intersection	• 24-hour traffic volume survey (6:00am to 6:00am) • Weekday: July 22, 2014
17 (6)	Kien Bridge: river crossing	• 24-hour traffic volume survey (6:00am to 6:00am) • Weekday: July 22, 2014
18 (5)	Binh Bridge: river crossing	• 24-hour traffic volume survey (6:00am to 6:00am) • Weekday: July 22, 2014

Note: numbers in ( ) indicate METI F/S survey points.

Source: JICA Study Team

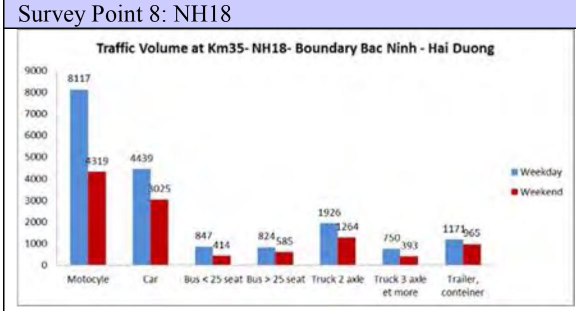
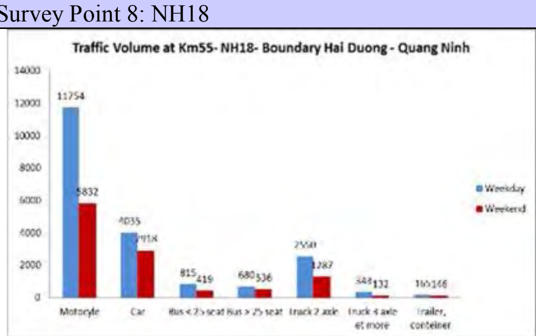
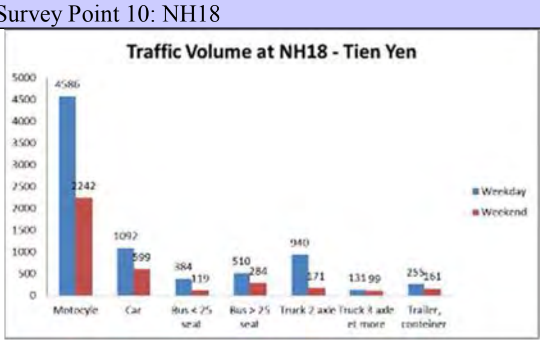
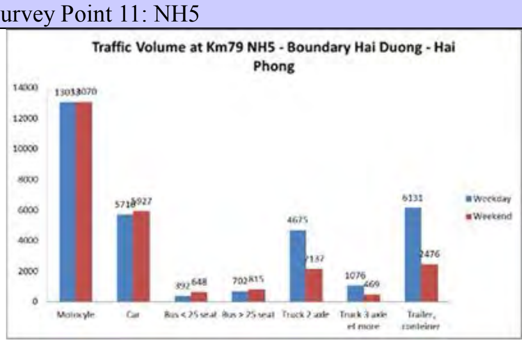
Source: JICA Study Team

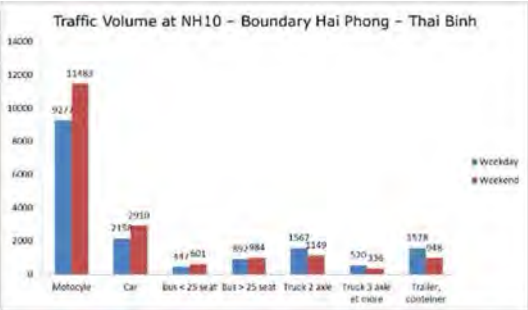
Figure 4.3 Locations of Survey Points (2014 Traffic Volume/Interview Surveys)

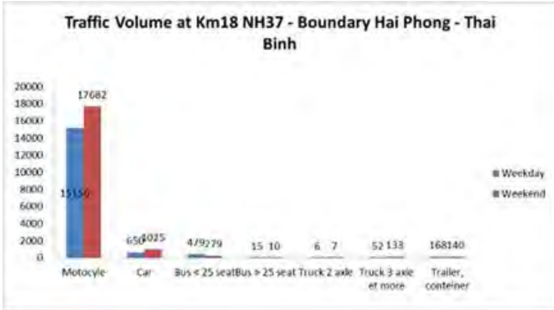
2) Survey Results

The results of the traffic volume survey are shown in Table 4.9 below.

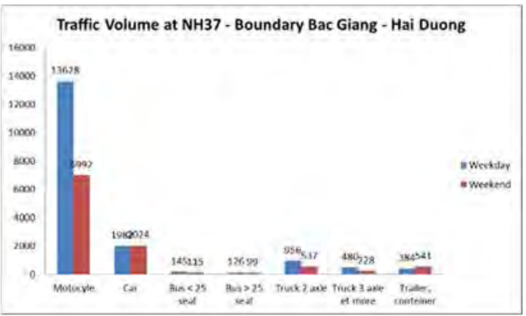
Table 4.9 Results of the Traffic Volume Survey (2014)

Survey Point 8: NH18	Survey Point 8: NH18
	
Survey Point 10: NH18	Survey Point 11: NH5
	
Survey Point 8: NH18	Survey Point 13: NH37

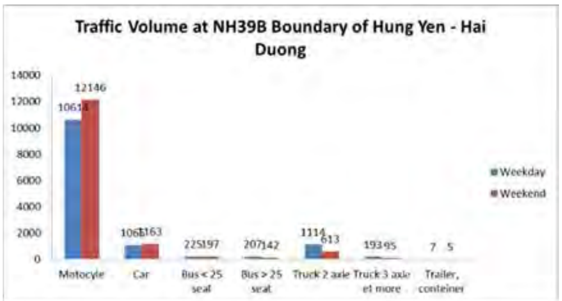




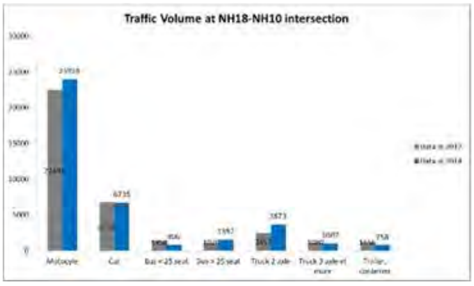
Survey Point 13: NH37



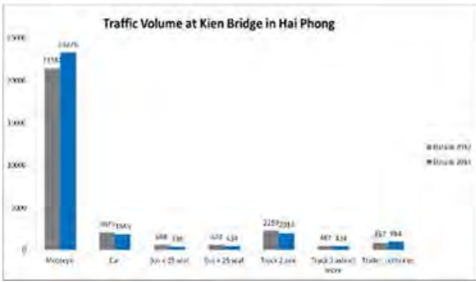
Survey Point 15: NH39



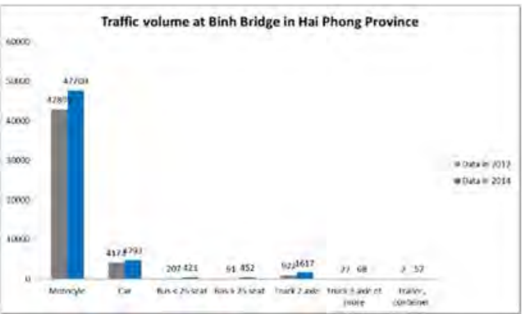
Survey Point 16: NH10/NH18 intersection



Survey Point 17: Kien Bridge



Survey Point 18: Binh Bridge



Source: JICA Study Team

(2) Interview Survey

1) Survey Method

The interview survey was conducted at the same locations as those of the traffic volume survey as outlined in Table 4.10 below.

Examiners asked drivers the same questions as those of METI F/S, to which 3,400 people responded.

- Vehicle type: all vehicle types
- Purpose: motorcycle, car, minibus, large sized bus
- No. of passengers: car, minibus, large-sized bus
- Type of cargo: 2-axis truck, truck with three or more axes, container truck
- Loading capacity: 2-axis truck, truck with three or more axes, container truck
- Origin and destination: all vehicle types

Table 4.10 Description of Survey at Each Survey Point (2014 interview survey)

Survey point	Location	Survey date
Points 1 – 7 are the same as the METI F/S survey points.		
8	NH18, Bac Ninh / Hai Duong boundary	・Weekday: July 25, 2014
9	NH18, Hai Duong / Quang Ninh boundary	・Weekday: July 24, 2014
10	NH18, T-intersection in Tien Yen (NH18 / NH4B (toward Lang Son) intersection)	・Weekday: July 22, 2014
11	NH5, Hai Duong / Hai Phong boundary	・Weekday: July 22 / 23, 2014
12	NH10, Thai Binh / Hai Phong boundary	・Weekday: July 23, 2014
13	NH3, Thai Binh / Hai Phong boundary	・Weekday: July 23, 2014
14	NH37, Bac Giang / Hai Duong boundary	・Weekday: July 24, 2014
15	NH39, Hai Duong / Hung Yen boundary	・Weekday: July 24, 2014

Note: numbers in ( ) indicate METI F/S survey points.

Source: JICA Study Team

(3) Survey Results

3,400 people responded to this interview survey, the results of which are shown in Table 4.11, Table 4.12, and Table 4.14

Table 4.11 Interview Survey Results in 2014

Survey Year		2014		
Items surveyed		No. of responses	Total responses	Remarks
No. of total responses		3,400		No. of questionnaires returned
Vehicle type	Motorcycle	1,001	3,400	Questions for all drivers
	Car	710		
	Mini bus (less than 25 seats)	285		
	Large bus (25 or more seats)	356		
	2-axle truck	332		
	Truck w/3 or more axles	473		
	Container, trailer	240		
	Unknown	3		
Purpose of trip	Going home	273	2,353	Questions for motorcyclists, and cara and mini/large bus drivers
	Going to work	1,165		
	Going to school	77		
	Business	555		
	Other (private)	282		
	Unknown	1		
No. of passengers (including driver)	Less than 5	1,646	2,354	Questions for car, mini/large bus drivers
	5 - 9	118		
	10 - 14	100		
	15 - 19	113		
	20 - 24	167		
	25 - 29	64		
	30 - 39	88		
	40 - 49	58		
	50 or more	0		
	Unknown	0		
Cargo	No cargo	213	1,046	Questions for drivers of trucks and container vehicles with 2, 3, or more axles
	Agricultural product	134		
	Construction material	162		
	Industrial product	130		
	Consumer goods	211		
	Refrigerated/frozen product	79		
	Other	117		
	Unknown	0		
Loading ratio	Empty	238	1,046	
	Around 25%	64		
	Around 50%	183		
	Around 75%	293		
	Full	265		
	Unknown	3		

Source: JICA Study Team

Table 4.12 Interview Survey Results in 2014 (origin points)

Zone code	Name of locality	Origin							
		Motorcycle	Car	Mini bus	Large bus	2-axle truck	Truck with 3 or more axles	Container, trailer	Total
1-18	Hai Phong City	183	122	61	59	83	100	78	686
20	Ha Noi City	37	105	38	60	14	61	21	336
21	Lạng Sơn Province	6	6	5	1	14	7	0	39
22	Bắc Giang Province	64	26	13	14	10	16	12	155
23	Bắc Ninh Province	52	33	4	1	7	15	9	121
24	Hải Dương Province	356	133	28	27	37	67	14	662
25	Hưng Yên Province	25	14	8	9	23	17	1	97
26	Thái Bình Province	60	63	29	21	32	28	37	270
27	Đông Bắc (Northeast) Region	9	22	11	17	3	4	5	71
28	Tây Bắc (Northwest) Region	2	6	2	3	5	4	2	24
29	Phía Nam (South) Region	28	41	10	35	6	21	43	184
30-42	Quang Ninh Province	172	135	74	109	95	129	17	731
43	Vĩnh Phúc Province	7	4	2	0	3	4	1	21
Total		1,001	710	285	356	332	473	240	3,397

Source: JICA Study Team

Table 4.13 Interview Survey Results in 2014 (destination points)

Zone code	Name of locality	Origin							
		Motorcycle	Car	Mini bus	Large bus	2-axle truck	Truck with 3 or more axles	Container, trailer	Total
1-18	Hai Phong City	260	173	62	39	48	57	84	723
20	Ha Noi City	19	47	40	77	26	56	27	292
21	Lạng Sơn Province	8	12	6	2	11	5	0	44
22	Bắc Giang Province	80	42	3	15	17	21	11	189
23	Bắc Ninh Province	49	21	6	6	6	22	3	113
24	Hải Dương Province	285	114	27	30	55	68	12	591
25	Hưng Yên Province	41	15	21	7	22	32	9	147
26	Thái Bình Province	51	49	20	24	35	35	11	225
27	Đông Bắc (Northeast) Region	4	14	3	13	2	5	12	53
28	Tây Bắc (Northwest) Region	1	1	1	0	4	4	3	14
29	Phía Nam (South) Region	19	36	25	25	16	22	28	171
30-42	Quang Ninh Province	182	184	71	117	86	141	37	818
43	Vĩnh Phúc Province	2	2	0	1	4	5	3	17
Total		1,001	710	285	356	332	473	240	3,397

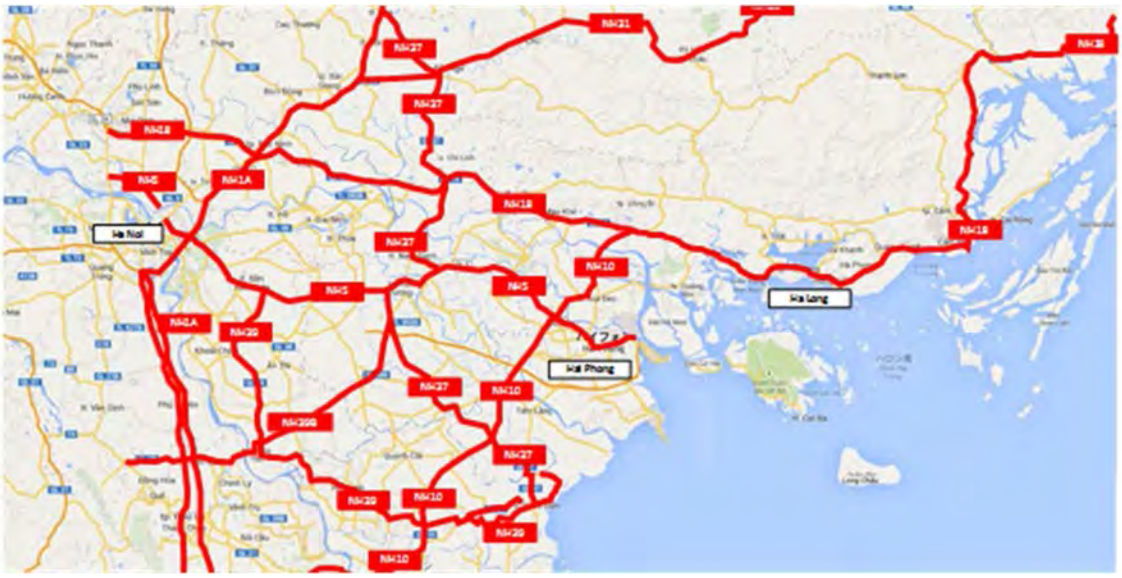
Source: JICA Study Team

4.3 Traffic Conditions of the Target Area

4.3.1 Road Traffic

The core cities of the target area are Hai Phong and Ha Long, the capital of Quang Ninh Province, which are connected to Hanoi, the capital, by NH5 and NH18 in the east-west direction and linked to the southern region by NH10 running north-south.

This section analyzes the characteristics of the traffic conditions on these three routes (NH5, NH18 and NH10) by sorting data gathered by the METI F/S traffic volume survey and those obtained from DRVN.



Source: JICA Study Team

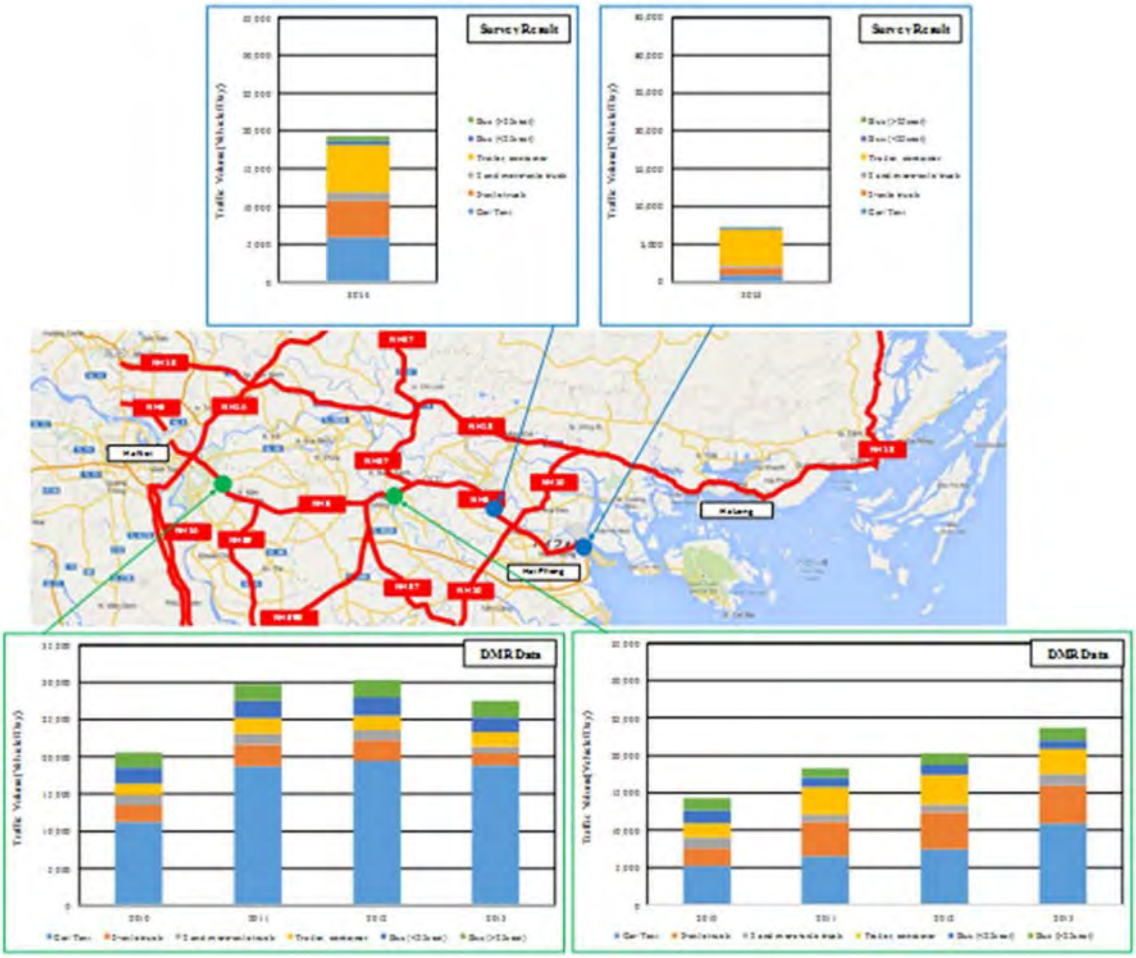
Figure 4.4 Main National Road Network Around the Target Area

(1) Traffic Conditions of NH5

The main characteristics of the traffic conditions of NH5 are as follows:

- The traffic counts in recent years (2012 – 2014) are 25,000 – 30,000 vehicles/day in the suburbs of Hanoi and about 7,000 vehicles/day in Hai Phong.
- Large vehicles comprise about 30% of traffic around Hanoi, as opposed to around 50% and nearly 80% around Hai Phong and in the coastal area of the city, respectively. Trucks and trailers are particularly prevalent on the Hai Phong side.

➢ Traffic volume in recent years has shown a declining trend on the Hanoi side while that on the Hai Phong side is on the increase.



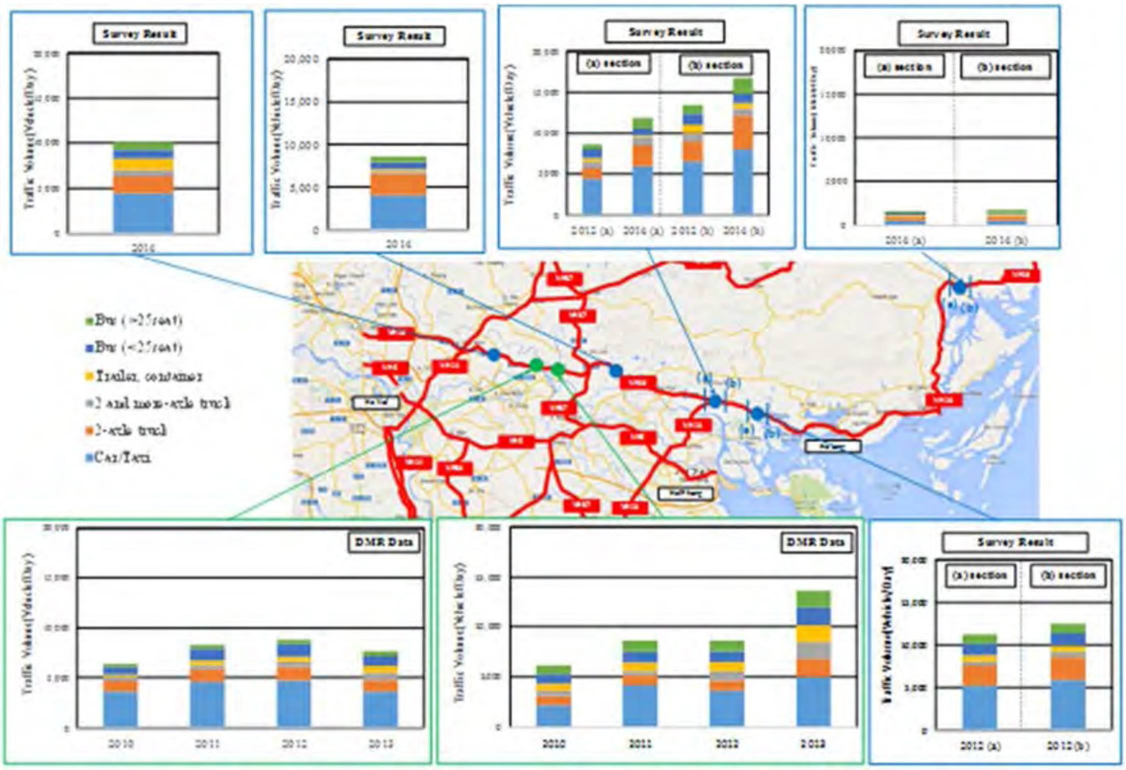
Source: Created based on traffic volume survey results and data provided by DRVN

Figure 4.5 Traffic volume on NH5

(2) Traffic Conditions of NH18

The main characteristics of the NH18 traffic conditions are as follows:

- The traffic counts in recent years (2012 – 2014) are 8,000 – 13,000 vehicles/day between Hanoi and NH10-intersection, around 11,000 – 16,000 vehicles/day in and around Ha Long and about 1,100 – 1,500 vehicles/day near the Chinese border respectively.
- 40 – 50% of traffic on all roads comprises large vehicles, most of which trucks. The closer to Ha Long, the greater the ratio of large buses.
- Traffic volume has been on the increase in all sections of the road.



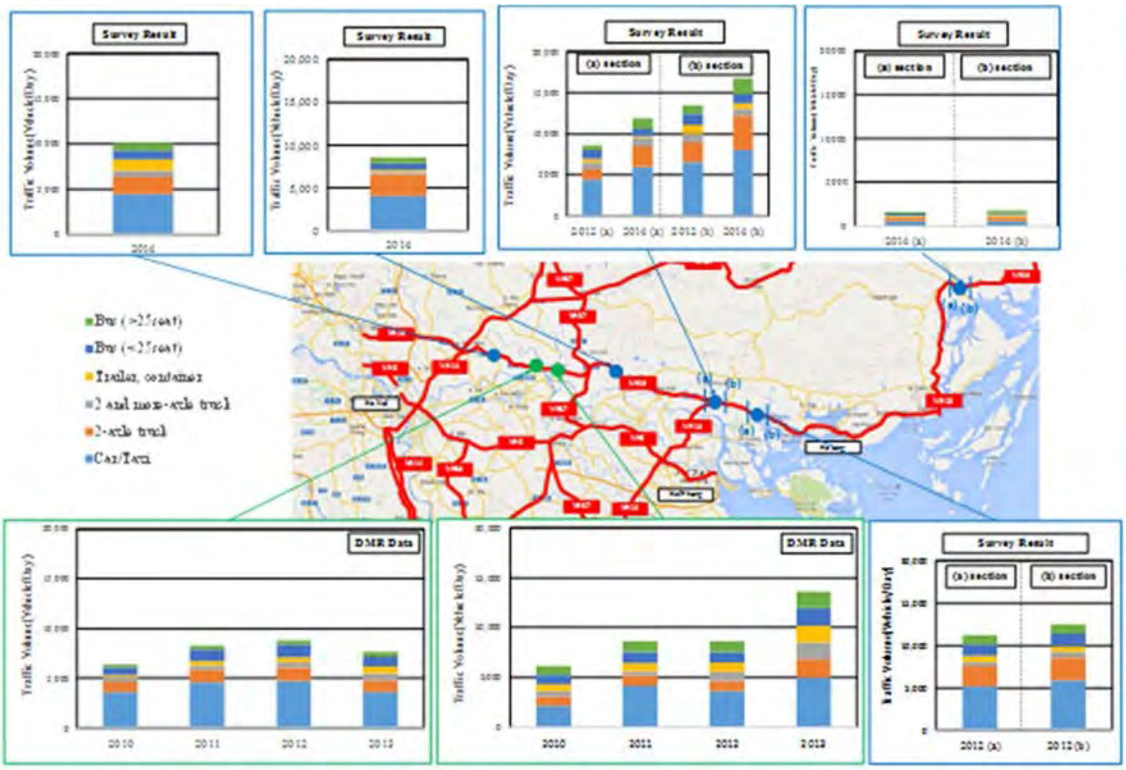
Source: Created based on traffic volume survey results and data provided by DRVN

Figure 4.6 Traffic Volume on the NH18

(3) Traffic Conditions of NH10

The main characteristics of the traffic conditions of NH10 are as follows:

- The traffic counts in recent years (2012 – 2014) are about 4,000 vehicles/day on the south side, 8,000 – 9,000 vehicles/day near NH39 and 6,000 – 7,000 vehicles/day in Hai Phong.
- 50 – 60% of traffic on all roads comprises large vehicles, many of which cargo vehicles (trucks with two or more axes and trailers).
- Traffic volume has been on the increase in all sections of the road.



Source: Created based on traffic volume survey results and data provided by DRVN

Figure 4.7 Traffic Volume on the NH10

4.3.2 Development Status of the Traffic-Related Facilities

Summarized below are the development statuses of traffic-related facilities (roads, railroads, ports, harbors and airports), which are likely to affect the estimation of future traffic volumes.

(1) Northern Vietnam

The traffic infrastructure improvement plan for northern Vietnam is outlined below.

1) Roads

Table 4.14shows a list of road improvement projects for northern Vietnam. Each is based on relevant decisions, based on which the roads shown in Table 4.14 are to be improved by 2030. No other projects are being planned after 2030. The characteristics of these projects are that they are intended not only to rehabilitate and upgrade existing roads but also to construct new arterial roads to increase traffic flows as shown in Figure 4.8In the east-west direction, roads such as Hanoi – Hai Phong and Noi Bai – Hai Phong Highways are to be improved to facilitate traffic flows between the Hanoi Metropolitan Area and the coastal zones. In the north-south direction meanwhile, the coastal road and Ha Long – Mong Cai Highway are to be improved to fortify road communications and transport with China via the coastal areas. However, the Noi Bai – Hai Phong Highway is not included in the list of road improvement projects to be completed by 2030 according to Decision 356/QD-TTg dated February 25, 2013.

Table 4.14 Road Improvement Projects for Northern Vietnam

No.	Route	Length (km)	Start point	End Point	Main contents (widening, adding lanes, etc.)	Scheduled completion	Source (Decision)
1	Ha Noi - Hai Phong Expressway	105.5	1,025km from Ha Noi City Ring Road No.3, Thanh Tri Bridge abudtment in northern Bac Ninh Province, Thuong Hoi village, Thach Ban district, Gia Lam district	Dinh Vu Dam, Hai An District, Hai Phong City	6 main lanes + 2 emergency lanes, clearance width100m, main road width 33m, roadbed width 50m	2015	302/QĐ-BGTVT 22/2/2011
2	Rehabilitation of NH18 Mong Duong - Mon Cai section	124	Mong Duong	Mon Cai	(After rehabilitation) road grade 3, 2 lanes	2015	3763/QĐ-BGTVT; 17/12/2009
3	NH5	95.2	Nhu Quynh (km11+135)	Dinh Vu - Hai Phong (km106+300)	(After rehabilitation) 6 lanes, roadbed width = 22.5 m-32,5m; road width = 15-22,5m	2015	05/2011/QD-TTG
4	NH37	37	Hai Duong	Hai Phong	(After rehabilitation) road grade 3, Roadbed width = 12m, Road width = 11m.	2015	05/2011/QD-TTG
5	Road connecting Ha Noi- Hai Phong and Cau Gie - Ninh Bin Expressways	–	Ha Noi - Hai Phong Highway junction	Liem Tuyen intersection (Cau Gie - Ninh Binh Highway)	Road grade 2. 6 lanes till the end of Phase 1 and 4 more lanes (10m width on each side) will be add thereafter.	2015	05/2011/QD-TTG
6	Ha Long - Mong Cai Expressway	151.5	Road connecting Ha Long City and Ha Noi City (Ha Noi - Hai Phong Highway)	Bac Luan 2 Bridge	6 lanes, roadbed width 35m	2020	1734/2008 of Prime Minister
7	Noi Bai - Ha Long Expressway	148.3	Intersection of Bac Thang Long on NH18 and Noi Bai.	NH18 Km109 (Ha Long City)	6 lanes	2020	1734/2008 of Prime Minister
8	NH10 (Uong Bi - Hoang Hoa)	228	Uong Bi	Hoang Hoa, Thanh Hoa	(After rehabilitation) road grade 2, 4 lanes	2020	05/2011/QĐ-TTg
9	NH18 (widening of Uong Bi - Dong Trieu section)	30	Uong Bi	Dong Trieu	Road grade 2, to be widened to 4 lanes	2020	996/QĐ-BGTVT; 17/5/2011
10	NH18c Tien Bridge at Vietnam/China border)	50	Tien Bridge	Vietnam/China border	Road grade 3, expansion work into 2 lanes completed	2020	3763/QĐ-BGTVT dated 17/12/2009
11	Connection to NH4b	32	Tien Yen	Van Don special economic zone	Road grade 3, expansion work into 2 lanes in Phase 2, and into 6 lanes completed	2020	05/2011/QD-TTG
12	NH279	744	Bai Chay (Quang Ninh)	Tay Trang	Road grade 4, expansion work into 2 lanes completed	2020	05/2011/QD-TTG
13	Coastal Road	3041	Mon Cai	Ha Tinh	Road grade 3, expansion work into 2 lanes completed	2020	05/2011/QD-TTG
14	Coastak Expressway (Ninh Bin, Hai Phong, Quang Ninh)	160	Ninh Bin	Ha Long	4 lanes	2030	129/2010/QĐ-TTg

Source: Summarized by the JICA Study Team Based on each Decision

2) Railroads

The Five Year Socioeconomic Development Plan (2006 – 2010) addresses the major issue of traffic congestion due to underdeveloped traffic infrastructure in large cities, which must be mitigated by constructing ring roads and bypasses in large cities, as well as developing a railway system within Hanoi and Ho Chi Minh Cities. The Plan aims to boost the usage rate of public transport in urban areas to 30%, which means that the railway system will be developed mostly to support urban transportation. Specific railway development plans are shown in the Master Plan on the Development of Vietnam Railway Communications and Transport Sector (Decision 06/2002/QD-TTg), which aims to modernize railway facilities, trains and other components of the railway transport system; thereby expediting and boosting the usage rate of railway transport relative to other modalities.

Table 4.16 lists railway development projects to be implemented in northern Vietnam. The railway lines shown in Figure 4.8 are to be completed by 2030, after which no further railway projects are planned. Highlights of these projects include conversion to double track and change of gage standards in existing lines as shown in Figure 4.8. In the east-west direction, the Hanoi – Hai Phong Line and other lines connecting the Hanoi Metropolitan Area and the coastal region will be improved. In the north-south direction meanwhile, the Coastal Route and Ha Long – Mong Cai Line will be developed to strengthen the movement of cargo and people to/from China via the coastal region.

Table 4.15 Railway Development Projects in Northern Vietnam

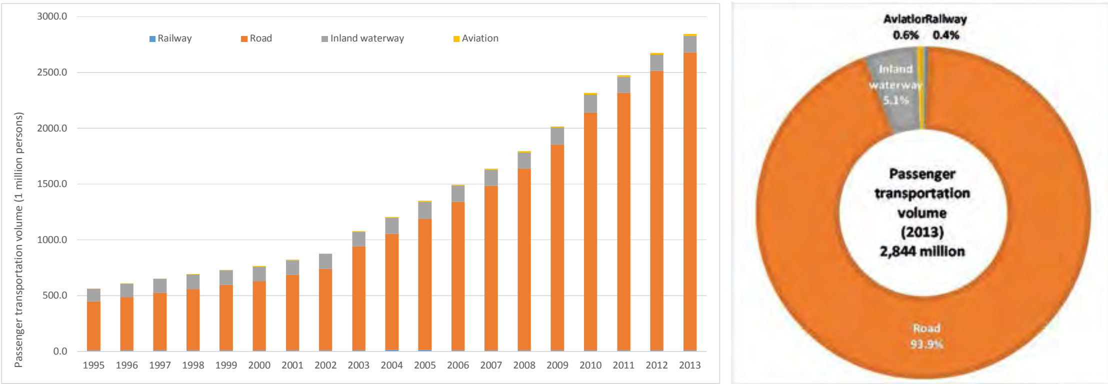
No.	Route	Length (km)	Major Components	Scheduled completion
1	Ha Noi - Hai Phong	106	Electrical system	2020
2	Yen Vien — Pha Lai— Ha Long— Cai Lan	128	Route level 2	2020
3	Lang Son - Quang Ninh	98	Route level 2	2030
4	Coastal Route (Na Dim - Thai Binh - Hai Phong - Quang Ninh)	120	Route level 1	2030
5	Ha Long - Mong Cai	160	Route level 2	2030

Source: JICA Study Team

Source: JICA Study Team

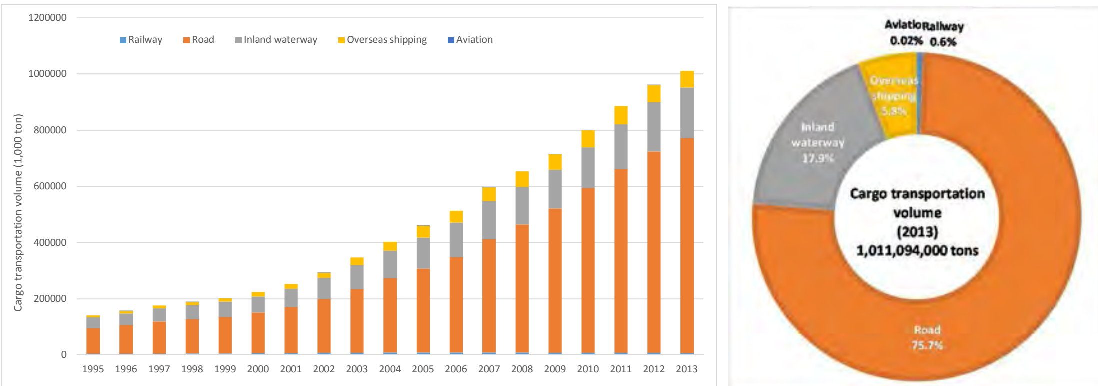
Figure 4.8 Road/Railway Development till 2030

Though road and railway improvement projects share some common characteristics as described above, they differ significantly from each other in terms of transport volume. According to the TEDI personnel interviewed, far greater volumes of goods and people are currently transported by road than rail in the target region and this trend is unlikely to change, even if the railway network is improved in future. This statement is somewhat substantiated by the actual records of passenger movement and cargo transport in Vietnam as shown in Figure 4.9 and Figure 4.11, respectively. In light of the above, it is considered unlikely that land-based cargo transportation will shift from road to railway. Accordingly, the decision was made that this estimation would analyze only the road network without taking into account the allocation of traffic to a railway system.



Source: GENERAL STATISTICS OFFICE OF VIETNAM

Figure 4.9 Trend and Ratio of Passenger Transport Volume in Vietnam by Modality



Source: GENERAL STATISTICS OFFICE OF VIETNAM

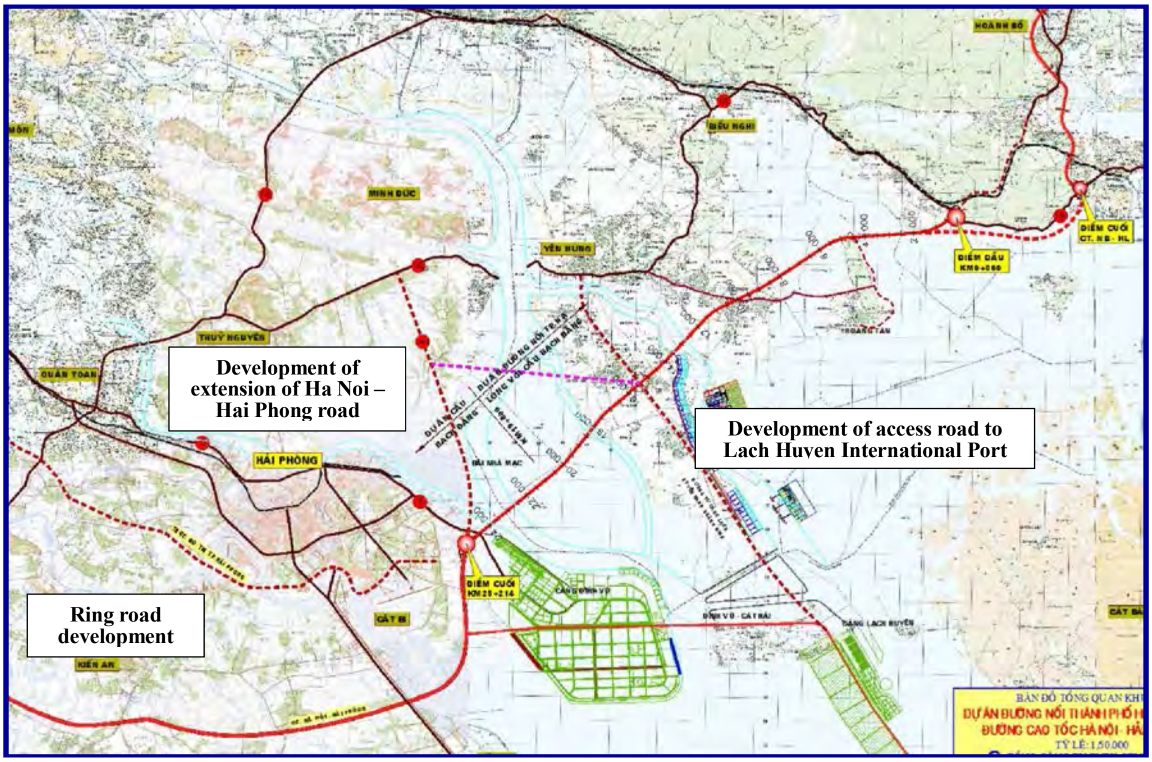
Figure 4.10 Trend and Ratio of Cargo Transport Volume in Vietnam by Modality

(2) Target Area (Hai Phong City, Quang Ninh Province)

Summarized below are the status of traffic infrastructure development in and around the target area, namely, the road network, Cat Bi Airport and Lach Huyen Port.

1) Road Network

Within the target area, the Hanoi –Hai Phong and Ha Long – Hai Phong Highway projects, as well as projects to construct the ring road in Hai Phong City, extend the Hanoi - Hai Phong Highway and construct access roads to Lach Huyen Port are underway as shown in Figure 4.12.



Source: JICA Study Team

Figure 4.11 Road Improvement Projects in and around the Target Area

2) Cat Bi Airport

There are two airports in Hai Phong City, Cat Bi and Kien An. Cat Bi Airport is located 5km from the downtown area and can now accommodate Airbus A320 planes following upgrading work. This airport is currently used as a domestic airport directly connecting Hai Phong City to Ho Chi Minh and Da Nang Cities and also as the reserve airport for Noi Bai International Airport.

Vietnam has announced a new master plan to expand and internationalize Cat Bi Airport by constructing a 3,050-meter second runway. According to the plan, the airport capacity will be increased from about 500,000 passengers per year (2010) to around 2 million passengers and 17,000 tons of cargo by 2015 and approximately 4 million passengers and 82,000 tons by 2025. The total investment is 1,700 billion VND and the upgraded airport is scheduled to open in October 2015.

3) Lach Huyen Port

Numerous foreign enterprises have established bases in the area between Hai Phong and Ha Long Cities along the coast of northern Vietnam; boosting the economic development of the northern region. Major ports supporting the activities of these enterprises include Hai Phong and Cai Lan ports; both of which have been renovated and expanded through yen loans. However, it is said that, even if future expansion plans were taken into account, these ports would only be able to handle containers up to 40 million tons. Demand for container cargo, conversely, is expected to increase to 42 and 59 million tons by 2015 and 2020, respectively, which will exceed the capacity of these two ports alone. In addition, amid recent trends in the international marine freight market, whereby shipping companies are ordering an increasing number of large container ships to meet customers' needs and reduce costs, the development of ports with sufficiently deep channels to accommodate large container ships and elevate the status of the north region as an international logistics hub has become increasingly crucial. As it is deemed technically and socially difficult to expand the capacities of Hai Phong and Cai Lan ports to handle the abovementioned cargo volumes and accept large container ships, the need to develop a new international deep-water port has emerged.

A Japanese assistance project is currently underway to construct a large international deep-water port in the Lach Huyen area of Cat Hai District in the eastern part of Hai Phong City, alongside basic infrastructure facilities in the surrounding areas to cope with increasing demand for cargo shipments and large container vessels in the marine freight market, thus facilitating economic development and enhancing international competitiveness nationwide, particularly northern Vietnam. Details of the project are as shown in Table 4.16Table 4.16 below.

Table 4.16 Contents of Lach Huyen Port Project

Item	Contents
Port	① Land reclamation and soil improvement associated with the construction of a container terminal (water depth: 14.0m, length: 750m, 2 births)
	② Excavation of an access channel and berth (channel depth: 14.0m, width: 160m, length: approx. 18km)
	③ onstruction of a breakwater (3,230m), groins (7,600m), etc.
	④ Other: construction of a container yard and barge berth, procurement of cargo-handling equipment, etc. by JV of Japanese and Vietnamese enterprises (hereinafter referred to as "Private Investment Project")
Access road and bridge	Construction of assess roads and bridges with total length of 15.63km connecting the Port to be constructed in Lach Huyen District to Tan Phu District. (road: approx. 10.19km long, bridge: approx. 5.44km long, four lanes, lane width: 3.5m)
Total project cost	139,816 million yen ① Port: 92,759 million yen ② Road/bridge: 47,057 million yen
Project period	November 2011 – May 2018 (79 months) The project is deemed complete when two berths are put into operation (scheduled for February 2016).

Source: JICA Ex-ante Project Evaluation Form

4.4 Traffic Demand Forecasting

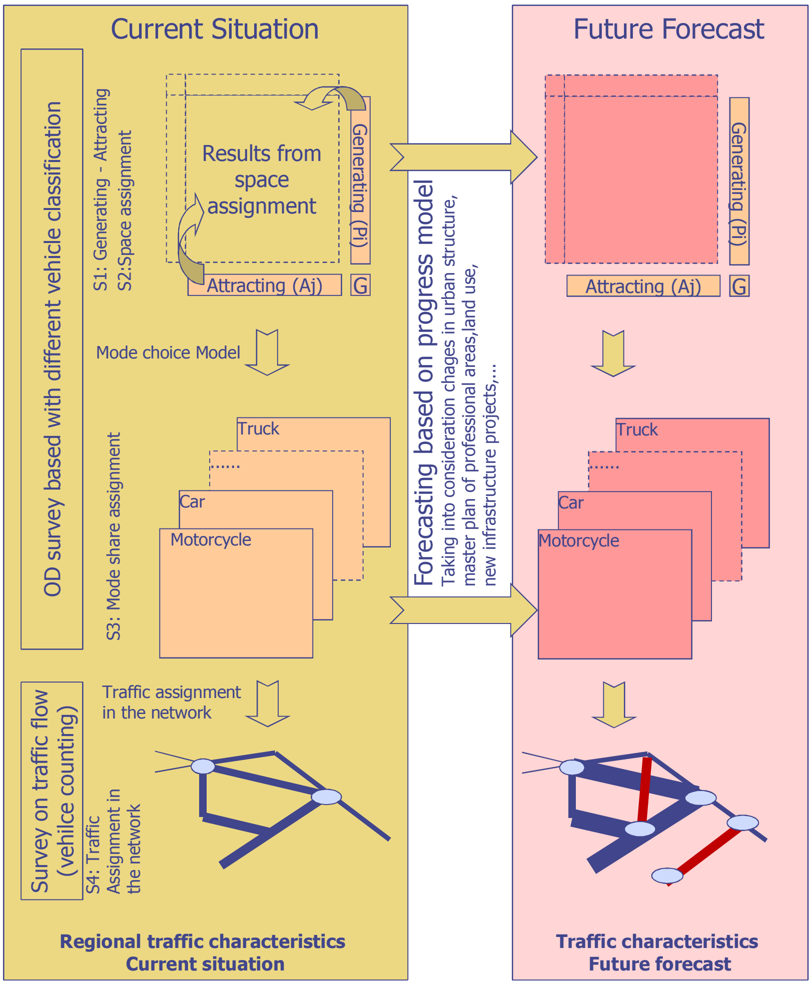
4.4.1 Method and Procedure of Forecasting

The method and procedure of traffic demand forecasting are as follows:

Traffic demand based on traffic volume was forecast by following the five steps below:

Step 1: Preparatory work (defining road network and zones)
Step 2: Analysis of traffic generation and attraction in each zone
Step 3: Distribution of traffic volume in each zone (analysis of traffic volume distribution)
Step 4: Distribution of traffic volume in each road network (analysis of traffic volume allocation)

Steps 2 through 4 were conducted to forecast traffic demand based on the "four-step model" shown in Figure 4.13.



Source: JICA Study Team

Figure 4.12 Traffic Demand Forecasting Method & Procedure Based on Four-Step Model

4.4.2 Preparation

(1) Model Used

VISUM35, a traffic demand forecasting software program, was used in this estimation. VISUM, according to its developer, is a comprehensive traffic simulator, which has been successfully adopted by over 3,000 users in more than 100 countries to forecast traffic demand in various projects, including the "New Urban Transport Project, Public Transport Network/Facilities Development in Dubai" and "Traffic Demand Forecasting in the Park Area of Beijing Olympics." In Vietnam, the software is used by the University of Transport and Communication as one of the traffic forecasting tools. It was also used in METI F/S. Accordingly, the decision was made to use VISUM in this estimation to expedite the forecasting work.

(2) Data used

1) Traffic Volume / OD Data

A） Traffic Volume

The results of the aforementioned traffic volume surveys conducted in 2012 and 2014 were used. The results of the 2012 survey, however, were used to determine the change rate in traffic volume at the same survey point between 2012 and 2014 to compare the estimated traffic volume of 2014, which was calculated based on the change rate, with simulated value.

The increase/decrease rate was then calculated by comparing the traffic counts at the intersection of NH18 and NH10 in 2012 and 2014, which are shown in Table 4.17

Table 4.17 Survey Results at the Intersection of NH18 and NH10 (2012 and 2014)

Unit: vehicles/day

Year surveyed	Car	Bus <25seat	Bus >25seat	Truck 2axle	Truck 3axle	Conteiner Trailer	Total	Rate of change (2014/2012)
2012	6,750	1,358	1,029	2,457	1,080	1,156	13,830	5.1%
2014	6,735	806	1,552	3,673	1,007	758	14,531	

Source: JICA Study Team

Based on the above, the 2012 traffic survey results were used to estimate the traffic volumes in 2014 at a 5% increase rate.

B） OD Data

Based on the results of interview surveys in 2012 and 2014, an OD trip table was drafted for use in estimation as shown below. The zone code in the table refers to the number assigned to each zone as a result of zoning (see Table 4.29).

[35] VISUM is software developed by the PTV GROUP (http://vision-traffic.ptvgroup.com/en-uk/products/ptv-visum/) and distributed in Japan by Kozo Keikaku Engineering Inc. (http://www4.kke.co.jp/ptv-vision/index.html)

Table 4.18 OD Trip Table (Cars)

Zone Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	Total
1	1	1	1	1	1	1	1	1	1	1	1	1	86	1	1	1	1	1	48	0	1	1	1	12	54	1	1	1	1	1	1	1	1	1	1	1	1	0	1	2	1	39	275
2	1	1	1	1	1	1	1	1	1	1	1	1	42	1	1	1	1	1	239	0	1	1	48	12	35	1	1	1	57	1	1	1	1	1	30	1	1	0	1	2	1	39	535
3	1	1	8	69	1	1	9	1	1	1	1	1	444	1	1	12	1	1	89	0	1	1	14	12	125	1	1	43	69	51	6	1	1	1	1	1	16	0	10	50	1	39	1,089
4	1	1	10	1	1	1	1	1	1	1	12	1	130	1	1	1	1	1	48	0	16	1	76	12	52	1	1	1	6	3	1	3	3	0	2	1	0	6	5	42	3	39	489
5	1	1	1	1	1	1	61	8	1	1	7	1	1	1	1	7	1	1	1	0	1	1	48	12	89	1	1	47	7	15	1	0	0	0	0	0	0	0	1	2	0	39	363
6	1	1	8	61	1	1	61	1	1	1	12	1	468	1	1	7	1	8	91	0	10	95	157	12	161	1	1	176	154	1	37	1	1	13	22	1	1	0	15	50	7	39	1,682
7	1	1	1	1	1	1	1	1	1	1	12	1	406	1	1	19	1	1	75	0	2	1	239	12	35	1	1	1	249	92	2	1	1	1	38	1	35	48	100	2	1	39	1,429
8	1	1	1	1	1	1	1	1	1	1	12	1	2	1	1	1	1	1	1	0	2	29	143	12	52	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	386	659
9	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	0	24	1	287	23	106	1	1	115	0	2	0	0	0	0	0	0	0	0	0	0	0	1	581
10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	0	8	1	0	0	0	1	1	1	1	1	1	1	1	1	0	1	1	1	0	40
11	1	1	1	5	1	5	5	1	1	1	1	1	27	1	1	1	1	1	34	0	1	0	0	8	1	0	0	3	1	1	1	1	1	1	1	1	1	0	1	1	1	0	115
12	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	2	1	1	12	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	2	0	1	45
13	104	3	257	135	209	487	538	5	0	2	2	2	1	2	0	44	0	3	4	0	0	9	15	4	5	5	4	0	89	46	46	0	0	8	23	0	1	21	66	49	0	0	2,189
14	1	1	1	1	1	1	1	1	1	1	1	1	0	1	5	1	1	1	1	0	24	1	5	89	160	1	1	71	0	0	0	0	0	0	1	0	0	0	0	0	0	1	376
15	1	1	9	9	1	1	1	1	36	1	9	20	2	54	7	1	1	1	61	1	3	1	23	15	21	12	1	4	0	4	0	0	0	0	0	0	0	0	0	0	0	1	303
16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	0	8	23	0	0	15	1	1	1	1	1	1	1	1	1	0	1	1	1	0	77
17	1	1	1	1	1	1	1	1	1	1	7	1	2	1	1	1	1	1	1	1	2	1	1	12	1	1	1	0	2	1	2	0	0	0	0	0	0	1	3	0	0	1	56
18	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	48	0	2	1	1	12	1	1	1	1	2	2	2	1	1	1	1	1	1	2	1	2	1	1	106
20	1	153	145	206	13	123	170	61	76	1	96	76	18	38	46	1	1	6	1	3	1	1	221	1	1	1	1	1	85	31	12	6	3	3	16	1	2	135	204	2	1	1	1,965
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	1	1	1	1	1	1	1	34	7	1	53	1	1	53	1	1	0	20	1	1	79	264
22	3	38	3	3	3	28	3	3	3	3	3	51	0	3	47	3	3	3	1	1	1	94	666	1	4	1	1	4	0	0	0	1	1	1	1	1	1	0	0	0	0	1	984
23	1	38	1	1	1	38	38	40	76	1	18	1	4	38	1	1	1	1	1	3	94	1	85	1	4	1	1	1	1,571	0	0	0	0	0	0	0	0	0	7	0	0	1	2,071
24	1	114	44	11	1	52	4	23	76	1	1	1	15	69	12	1	1	38	265	1	611	196	174	159	217	123	1	181	21	8	3	0	1	0	3	0	0	222	73	3	1	47	2,775
25	1	1	7	3	1	1	30	30	0	0	0	0	0	1	1	0	1	1	1	1	12	1	262	1	1	1	1	1	3	0	0	0	0	0	0	0	0	1	1	0	0	1	366
26	52	59	52	42	32	46	16	156	56	1	1	11	16	122	37	1	1	32	1	1	2	1	12	1	1	1	1	7	6	2	0	1	0	0	0	0	0	0	1	0	0	1	772
27	1	1	6	1	1	12	1	1	1	1	1	1	0	38	29	1	1	1	1	1	12	1	243	1	1	1	1	1	148	1	1	1	1	1	17	1	1	0	26	0	1	1	561
28	1	1	1	1	1	1	1	1	1	1	1	1	0	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5	0	0	0	0	0	2	0	0	1	1	0	0	1	40
29	1	1	43	23	16	16	12	1	32	1	10	16	15	76	1	16	1	1	1	1	1	1	206	1	1	1	1	1	11	6	0	0	0	0	0	1	0	41	10	2	0	1	569
30	1	1	117	16	7	100	303	1	0	1	1	0	77	1	0	1	1	1	41	96	0	1,939	20	1	3	138	2	11	12	12	24	17	17	1	62	12	17	759	1	12	12	44	3,882
31	11	3	27	2	12	52	111	0	2	1	1	7	17	0	1	1	0	1	21	3	16	35	9	1	2	44	0	2	1	1	1	1	17	17	17	1	1	54	1	1	1	0	496
32	1	1	1	0	0	1	84	0	0	1	1	0	1	0	0	1	0	1	2	1	0	1	3	1	0	1	0	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	115
33	0	7	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	2	14	1	1	0	1	0	14	0	0	17	1	1	1	1	1	7	1	1	1	1	1	1	1	78
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	7	1	1	0	1	0	1	0	0	40	1	1	1	1	1	1	1	1	1	1	1	1	1	66
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	14	1	1	0	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	34
36	0	11	50	7	0	12	8	1	1	0	0	0	15	0	0	0	0	0	21	44	1	11	2	1	0	1	0	2	54	14	1	1	1	1	1	1	1	1	43	1	1	1	310
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	1	0	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	1	0	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21
39	0	0	0	5	0	9	64	4	0	0	0	0	37	0	0	0	0	2	75	0	0	98	216	15	0	1	1	1	940	41	0	1	1	1	20	1	1	1	96	41	1	36	1,709
40	2	0	23	2	2	24	31	0	0	0	0	0	23	2	0	8	0	0	86	1	0	36	198	15	3	1	1	30	296	154	1	38	38	17	38	1	1	1	1	1	12	1	1,088
41	3	91	3	59	3	11	11	0	7	2	2	3	10	0	0	21	0	3	1	1	0	38	20	4	0	1	0	0	1	1	1	1	17	1	1	1	1	50	1	1	1	0	372
42	7	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	31	57
43	1	18	27	1	18	45	27	90	45	1	1	1	4	1	1	1	1	1	1	311	1	1	47	1	1	1	1	1	190	0	0	0	0	0	0	0	0	0	4	0	0	1	845
Total	209	558	855	675	338	1,080	1,601	441	429	35	220	207	1,870	465	205	160	30	120	1,275	511	853	2,608	3,446	500	1,164	369	33	727	4,081	508	155	140	117	80	366	39	93	1,350	703	278	57	919	29,870

Source: JICA Study Team

Table 4.19 OD Trip Table (Buses with 25 seats or fewer)

Zone Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	Total
1	1	1	1	1	1	1	1	1	1	0	0	1	5	1	1	0	1	1	0	0	1	0	0	1	6	0	0	1	0	0	0	0	1	1	1	0	1	1	0	5	0	0	38
2	1	1	1	1	1	1	1	1	1	0	0	1	5	1	1	0	1	1	0	0	4	0	0	4	9	0	0	1	0	0	0	0	1	1	1	0	1	1	0	5	0	0	47
3	1	1	1	1	1	1	1	1	1	0	0	1	5	6	1	0	1	1	4	0	1	0	0	4	1	0	0	9	0	0	0	0	1	1	1	0	1	1	0	5	0	0	53
4	1	1	1	1	1	1	1	1	1	0	0	1	33	1	1	0	1	6	15	0	1	0	0	4	6	0	0	1	1	1	0	0	0	0	6	0	0	1	0	5	0	0	93
5	1	1	1	1	1	1	1	1	1	0	0	1	5	1	1	0	1	1	0	0	1	0	0	1	18	0	0	25	0	0	0	0	0	0	0	0	0	1	0	5	0	0	70
6	1	1	1	1	1	1	1	1	1	0	0	1	5	1	1	0	1	1	0	0	1	0	0	1	54	0	0	32	2	0	0	0	1	17	17	0	1	1	0	0	0	0	146
7	1	1	1	1	1	1	1	1	1	0	0	1	135	1	1	0	1	1	17	0	1	0	0	4	1	0	0	1	0	0	0	0	1	1	2	0	1	5	0	5	0	0	188
8	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	0	1	1	0	0	1	0	0	1	6	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	26
9	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	0	1	1	0	0	1	0	0	1	1	0	0	16	0	0	0	0	0	0	1	0	0	1	0	1	0	0	37
10	0	0	0	0	0	0	0	0	0	1	1	0	3	0	0	1	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	3	0	0	13
11	0	0	0	0	4	0	0	0	0	1	1	0	3	0	4	1	0	0	11	0	0	0	0	3	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	3	0	0	32
12	1	1	1	1	1	1	1	1	1	0	0	1	5	1	1	0	1	1	0	0	1	0	0	1	6	0	0	1	0	0	0	0	0	0	0	0	0	1	0	5	0	0	34
13	2	2	2	30	2	2	87	1	1	1	1	2	1	1	1	1	1	2	0	0	1	0	0	4	1	0	0	1	1	1	1	0	0	0	0	0	0	1	0	0	0	0	151
14	1	1	1	1	1	1	1	1	1	0	0	1	1	1	7	0	1	1	0	0	1	0	7	7	138	0	0	167	0	0	0	0	0	0	0	0	0	1	0	1	0	0	343
15	1	1	1	22	1	1	1	11	11	1	1	11	1	69	1	1	1	1	1	0	1	1	1	2	6	1	1	6	0	0	0	0	0	0	0	0	0	1	0	1	0	1	160
16	0	0	0	0	0	0	0	0	0	1	1	0	3	0	0	1	0	0	0	0	0	0	0	3	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	18
17	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	0	1	1	0	0	1	0	0	4	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	24
18	1	1	1	1	1	1	1	1	1	0	0	1	5	1	1	0	1	1	0	0	1	0	0	4	19	0	0	1	0	0	0	0	1	1	1	0	1	5	0	5	0	0	58
20	0	26	8	0	0	0	0	0	0	0	4	12	5	0	1	0	0	0	8	1	1	1	14	1	1	1	1	1	3	3	0	0	0	0	7	0	0	2	0	0	0	1	102
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	0	1	1	1	1	0	0	1	0	0	12	0	0	0	1	1	1	1	26
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1	1	1	114	1	0	1	0	0	0	1	0	0	0	1	0	1	128
23	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	1	1	1	1	1	1	1	84	8	0	0	1	1	50	0	1	2	0	0	0	1	160
24	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0	0	16	2	2	1	5	38	1	1	1	19	0	0	0	0	0	0	0	0	0	0	0	0	0	1	92
25	1	18	18	18	1	1	18	1	1	12	12	12	17	4	1	12	18	18	1	1	1	1	75	1	1	1	1	1	1	7	1	1	2	2	2	16	2	13	0	17	1	1	333
26	1	1	32	1	1	17	43	33	16	1	1	1	20	258	13	1	1	1	13	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	26	0	1	0	1	491
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	16	1	1	1	1	1	1	1	1	1	8	9	1	1	0	0	5	1	0	0	2	0	1	1	55
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	19
29	1	1	21	1	1	1	5	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1	29	1	1	1	1	1	1	2	0	0	0	3	2	0	0	6	0	1	0	1	99
30	0	19	0	0	0	11	0	0	0	0	0	0	1	0	0	0	0	0	31	1	19	61	5	13	0	32	0	0	1	1	1	1	3	3	3	1	3	220	16	1	1	61	509
31	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	15	1	19	61	1	1	4	1	0	0	1	1	1	1	3	3	3	1	3	110	1	1	1	61	295
32	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	4	0	1	0	1	0	4	1	1	1	1	3	3	3	1	3	10	1	1	1	4	47
33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	0	0	0	1	0	2	0	0	0	1	1	1	1	2	1	0	0	0	0	1	15
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	4	0	1	0	1	0	4	1	1	1	1	1	1	1	1	1	1	1	1	1	4	30
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	4	0	1	0	1	0	2	1	1	1	1	1	1	1	1	1	1	1	1	1	4	27
36	0	0	0	9	0	8	12	0	0	0	0	0	0	0	0	0	0	0	7	13	1	90	2	19	6	1	0	3	4	4	1	1	1	1	1	1	1	1	1	4	1	4	197
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	4	0	1	0	1	0	0	1	1	1	1	3	3	3	1	3	1	8	1	1	4	40
38	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	4	0	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	4	31
39	1	1	1	1	1	9	2	1	1	0	0	1	3	1	1	0	1	2	4	1	1	4	4	9	1	4	4	10	29	29	29	1	3	3	3	1	3	1	1	29	1	4	206
40	1	1	1	5	0	1	1	0	0	0	0	0	0	0	0	0	0	1	6	1	1	192	0	1	0	4	2	3	1	1	1	1	3	3	3	1	3	1	1	1	1	4	246
41	2	2	2	2	2	2	2	1	1	1	1	2	1	1	1	1	1	2	0	1	19	0	0	4	1	0	0	1	1	1	1	1	3	3	3	1	3	10	1	1	1	0	83
42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	4	0	1	0	1	0	0	1	1	1	1	3	3	3	1	3	1	1	1	1	4	34
43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	1	1	1	1	1	1	1	167	8	0	1	1	1	1	0	1	0	0	0	0	1	192
Total	23	86	99	102	26	72	184	62	45	20	24	55	268	360	55	20	37	46	175	34	97	446	149	153	300	61	18	322	427	83	43	18	39	58	139	32	39	430	37	118	15	171	4,988

Source: JICA Study Team

Table 4.20 OD Trip Table (Buses with more than 25 seats)

Zone Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	Total
1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	0	1	1	0	1	1	0	0	1	22	0	0	1	1	1	1	1	1	1	1	1	1	0	0	1	1	0	52
2	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	0	1	1	0	1	1	0	0	9	22	0	0	1	1	1	1	1	1	1	1	1	1	0	0	1	1	0	60
3	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	0	1	1	0	1	1	0	0	9	64	0	0	22	23	1	1	1	1	1	1	1	1	0	0	1	1	6	151
4	1	1	1	1	1	1	1	1	1	0	0	1	0	1	1	0	1	1	63	1	8	0	0	9	1	0	0	1	2	3	0	0	0	0	3	0	0	0	0	1	0	6	112
5	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	0	1	1	0	0	1	16	0	1	22	0	0	22	0	0	0	0	0	0	0	0	0	0	0	1	0	6	84
6	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	0	1	1	49	1	1	0	0	1	42	0	0	64	20	15	20	1	6	1	6	1	1	2	0	12	1	6	265
7	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	0	1	1	0	1	1	0	5	9	3	0	0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	6	53
8	1	1	1	1	1	1	1	1	1	0	0	1	0	1	1	0	1	1	0	0	1	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18
9	1	1	1	1	1	1	1	1	1	0	0	1	0	1	1	0	1	1	2	0	1	0	0	6	1	0	0	42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	66
10	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
11	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
12	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	0	1	1	0	0	1	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	20
13	7	7	7	0	7	7	7	0	0	0	0	7	1	0	1	0	0	7	10	0	0	0	0	7	1	0	0	1	1	1	1	0	0	0	0	0	0	1	0	1	0	0	82
14	1	1	1	1	1	1	1	1	1	0	0	1	0	1	0	0	1	1	0	0	1	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19
15	2	2	2	2	2	2	2	0	2	0	1	2	0	0	1	0	2	2	1	0	3	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	36
16	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
17	1	1	1	1	1	1	1	1	1	0	0	1	0	1	1	0	1	1	0	0	1	0	0	9	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26
18	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	0	1	1	0	1	1	0	0	9	42	0	0	22	1	1	1	1	1	1	1	1	1	1	0	1	1	0	102
20	0	0	0	0	64	0	4	0	0	0	0	0	0	0	6	0	0	0	1	1	1	1	7	1	1	1	1	1	14	20	0	0	0	0	12	0	0	1	0	2	0	1	140
21	1	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	28
22	1	1	1	1	1	1	1	1	1	0	0	1	0	1	2	0	1	1	1	1	1	1	46	1	2	1	1	1	0	0	0	1	1	1	4	1	1	0	0	0	0	1	81
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	1	1	1	1	1	1	1	86	86	1	1	1	1	6	1	1	1	1	0	1	1	199
24	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	9	5	33	1	1	20	9	1	1	20	0	0	0	0	0	0	2	0	0	0	0	0	0	1	107
25	2	110	1	1	2	2	1	2	2	0	0	2	0	3	1	0	1	1	1	1	1	1	31	1	1	1	1	1	0	2	0	1	0	0	1	0	0	0	0	0	0	1	176
26	2	35	0	2	2	2	35	2	2	0	0	19	11	3	6	0	2	2	1	0	3	1	16	1	6	1	1	1	14	15	2	5	0	0	15	0	0	3	1	1	0	1	213
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	1	4	1	1	1	1	1	11	23	1	1	1	1	28	1	1	1	1	1	1	1	87
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	1	0	0	0	1	15
29	2	2	2	35	2	2	2	19	2	0	0	19	0	0	11	0	2	2	1	1	1	1	60	1	1	1	1	1	29	12	1	0	0	0	27	1	1	2	1	1	0	1	247
30	2	2	2	3	0	41	2	0	0	0	0	0	1	0	0	0	0	2	23	1	1	138	1	1	6	59	0	1	1	1	1	1	1	1	1	1	1	66	1	1	1	138	502
31	2	2	2	3	0	2	2	0	0	0	0	0	1	0	0	0	0	2	15	1	1	15	1	1	8	11	0	3	1	1	1	1	1	1	1	1	1	66	1	1	1	15	165
32	2	2	2	0	0	2	2	0	0	0	0	0	1	0	0	0	0	2	1	1	0	0	0	1	0	1	0	3	1	1	1	1	1	1	1	1	1	66	1	1	1	0	98
33	1	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	3	1	1	0	0	1	0	1	0	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	29
34	1	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	1	0	1	0	4	1	1	1	1	1	1	1	1	1	1	1	1	1	0	27
35	1	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	1	6	1	0	1	1	1	1	1	1	3	1	1	1	1	1	1	1	0	32
36	1	1	1	3	0	1	1	0	0	0	0	0	0	0	0	0	0	1	10	2	1	0	1	1	21	4	0	6	1	1	1	1	1	1	1	1	1	1	1	1	1	0	68
37	1	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1	3	1	1	0	25
38	1	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	1	0	1	0	6	1	1	1	1	1	1	1	1	1	1	3	1	1	0	31
39	0	0	0	2	0	4	7	0	0	0	0	0	1	0	1	0	0	7	1	0	0	0	0	0	1	2	0	2	252	63	63	1	2	1	1	1	1	1	1	63	1	0	479
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	16
41	7	7	7	7	7	7	7	0	0	0	0	7	1	0	1	0	0	7	6	1	0	0	0	7	1	0	0	1	1	1	1	1	1	1	1	1	1	66	1	1	1	0	159
42	1	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	23
43	0	6	11	6	6	6	6	0	0	0	0	0	0	0	1	0	0	0	1	1	1	1	1	1	1	1	1	1	86	86	1	1	1	1	1	1	1	1	1	0	1	1	235
Total	50	197	58	78	106	99	99	37	22	3	4	70	25	23	47	3	21	56	204	34	76	182	178	123	295	95	12	246	556	345	108	30	30	26	124	25	25	288	23	102	23	196	4,344

Source: JICA Study Team

Table 4.21 OD Trip Table (2-axis trucks)

Zone Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	Total
1	1	1	6	1	1	1	1	1	1	2	2	1	32	1	1	2	1	1	1	1	1	1	4	2	57	1	1	0	1	1	1	0	0	0	0	0	0	1	0	2	0	1	133
2	1	1	1	1	1	1	1	1	1	2	2	1	24	1	1	2	1	1	1	1	1	1	1	14	29	1	1	0	14	1	1	0	0	0	3	0	0	1	0	2	0	1	117
3	3	3	23	8	6	8	11	6	6	2	2	1	122	3	1	2	8	6	141	1	4	2	61	151	158	1	6	42	15	36	1	1	1	1	20	10	1	14	4	10	1	1	904
4	1	1	24	1	1	1	1	33	1	2	2	1	169	1	1	2	1	1	1	1	72	1	82	14	13	1	1	9	4	8	9	0	0	4	10	4	0	1	0	2	0	1	482
5	1	1	12	1	1	1	1	1	1	2	2	1	34	1	1	2	1	1	1	1	1	1	4	158	87	1	1	19	4	4	0	0	0	0	0	0	0	1	2	2	0	1	353
6	1	1	6	12	1	1	6	1	1	2	2	1	127	1	1	2	1	19	90	1	1	1	1	14	13	1	1	0	1	1	1	0	0	0	4	0	0	1	1	2	0	1	321
7	1	1	6	19	1	1	1	1	1	2	2	1	32	1	1	2	1	1	1	1	1	1	98	14	116	1	1	14	1	15	1	1	7	1	9	1	1	2	4	2	1	1	370
8	1	1	1	1	1	1	1	1	1	2	2	1	53	1	1	2	1	1	1	1	1	82	1	2	1	1	1	13	0	0	0	0	0	0	0	0	0	10	0	1	0	1	189
9	1	1	1	1	1	1	1	1	1	2	2	1	1	1	1	2	1	1	1	1	1	1	51	3	59	1	1	124	0	15	0	0	0	0	0	0	0	1	0	1	0	1	282
10	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	1	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	10
11	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	1	0	0	1	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	11
12	1	1	1	1	1	1	1	1	1	2	2	1	1	1	1	2	1	1	35	1	31	1	35	1	29	1	1	1	0	0	0	0	0	0	0	0	0	1	0	2	0	1	161
13	2	2	139	72	1	103	103	90	17	3	3	1	28	1	1	3	26	153	1	0	5	3	10	10	19	1	1	0	1,065	38	2	0	7	0	15	0	0	40	23	7	0	1	1,996
14	1	1	1	1	1	1	1	1	1	2	2	1	1	1	0	2	1	6	35	1	1	1	0	0	0	17	1	3	4	4	0	0	0	0	0	0	0	1	0	11	0	1	105
15	1	1	1	1	1	1	16	1	1	2	2	1	1	0	1	2	1	1	1	1	1	1	1	3	1	1	1	3	0	8	0	0	0	0	0	0	0	1	1	1	0	1	61
16	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	1	0	0	36	0	0	31	43	5	11	0	0	5	11	11	0	0	0	0	7	0	0	0	3	19	0	0	186
17	1	1	6	1	1	1	1	1	1	2	2	1	1	1	1	2	1	1	1	1	1	1	1	14	1	1	1	0	10	17	5	0	0	4	4	0	0	1	0	1	0	1	91
18	1	1	6	6	1	1	1	1	1	2	2	1	2	1	1	40	1	1	578	1	1	82	168	14	1	1	164	0	29	1	1	1	1	1	72	1	1	2	0	2	1	1	1,194
20	1	1	68	1	1	10	1	1	1	2	2	1	106	1	161	11	1	165	1	1	1	20	104	1	1	1	1	1	56	4	0	11	9	12	37	0	4	68	4	1	0	1	874
21	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	2	6	1	7	7	2	7	1	1	11	1	1	1	1	74
22	28	71	54	1	1	20	0	0	0	0	0	0	29	0	0	0	0	3	1	1	1	1	98	1	0	1	1	1	70	2	2	2	2	1	68	1	1	33	1	48	2	1	547
23	1	1	1	1	1	1	1	1	1	2	2	1	1	1	1	2	1	153	1	1	1	1	1	1	1	1	1	1	486	2	2	68	21	2	2	2	68	68	2	1	2	1	910
24	1	153	39	19	1	167	163	33	1	2	6	38	23	4	1	2	1	5	301	1	21	104	513	285	26	21	1	1	18	4	0	0	4	0	42	0	0	2	4	1	9	1	2,018
25	1	2	22	2	1	1	42	1	27	4	4	22	44	0	1	4	2	11	91	1	21	1	627	1	1	1	1	1	8	1	1	1	1	1	1	1	1	0	3	1	1	1	959
26	1	48	66	1	1	16	16	16	16	2	2	12	49	0	20	2	1	5	1	1	1	1	40	1	1	1	1	1	3	2	3	3	0	0	7	0	0	1	0	1	0	1	344
27	1	14	1	1	1	1	1	1	1	2	2	1	1	42	44	2	1	1	1	1	1	1	44	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	0	1	1	1	185
28	1	1	5	1	1	1	1	1	1	2	2	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	9	0	0	2	0	1	0	1	48
29	1	1	33	1	1	1	1	1	0	2	2	1	40	0	1	2	1	1	1	1	1	1	40	1	1	1	1	14	3	0	11	0	0	0	19	0	0	0	5	1	3	1	195
30	0	0	0	0	0	0	10	0	2	1	1	0	82	5	0	51	0	28	40	1	1	673	29	3	0	1	0	0	1	21	1	11	33	1	11	1	1	119	31	1	1	7	1,168
31	0	0	19	28	2	11	0	0	2	1	1	0	111	0	0	1	12	0	35	23	33	2	24	69	17	31	0	0	1	1	1	11	11	54	1	1	11	4	1	1	1	2	523
32	0	5	5	0	0	0	0	0	0	1	1	0	1	0	0	1	0	5	0	2	31	2	0	3	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	2	73
33	10	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	5	42	2	0	3	0	1	0	0	11	4	1	7	1	11	5	1	1	1	1	1	1	4	116
34	0	0	0	2	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	5	1	2	0	3	0	1	0	0	1	1	1	2	1	1	1	1	1	1	1	1	1	2	33
35	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	183	2	1	2	0	3	0	1	0	0	1	1	1	2	1	1	1	1	1	1	1	1	1	2	211
36	0	0	10	0	0	0	10	0	0	1	1	0	8	0	0	1	0	82	36	7	74	57	11	3	8	1	0	0	1	1	1	1	1	1	1	1	1	31	1	1	1	2	355
37	0	0	0	0	5	0	0	0	0	1	1	0	0	0	0	1	0	0	0	1	1	2	0	3	0	1	0	0	1	1	1	1	11	1	1	1	1	1	1	1	1	2	41
38	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	1	1	2	0	3	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	2	26
39	1	1	1	1	1	1	2	1	1	1	65	31	69	1	1	18	1	2	2	12	1	79	61	24	1	2	79	17	104	3	1	1	1	11	35	1	1	1	103	510	1	2	1,252
40	0	0	0	1	0	0	3	1	0	0	0	0	6	0	0	7	0	5	12	1	40	2	1	1	4	4	1	3	1	1	1	1	1	1	11	1	1	94	1	1	1	2	210
41	2	2	9	2	2	2	2	1	1	3	3	2	65	1	1	3	1	2	1	1	217	1	1	10	1	1	1	0	1	35	1	1	11	1	11	1	1	119	1	1	1	1	524
42	0	0	0	0	0	0	5	0	0	10	1	0	0	0	0	1	0	0	0	1	1	2	0	3	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	2	40
43	1	1	5	1	1	1	1	1	1	2	2	1	1	1	1	2	1	1	1	1	1	1	35	1	1	1	1	1	6	37	2	2	2	2	2	68	2	68	2	23	2	1	288
Total	69	320	573	191	41	358	407	201	92	78	137	127	1,268	74	247	190	72	666	1,636	87	618	1,172	2,192	855	660	109	275	277	1,938	291	58	139	138	118	420	103	104	708	205	671	37	58	17,980

Source: JICA Study Team

Table 4.22 OD Trip Table (trucks with three or more axes)

Zone Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	Total
1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0	0	0	0	1	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22
2	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0	0	0	0	0	11	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29
3	1	1	1	5	1	1	1	1	1	1	1	1	0	1	1	1	5	1	12	0	0	0	5	0	17	1	0	14	0	0	0	0	0	0	0	0	0	0	4	1	0	1	80
4	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0	22	0	4	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	47
5	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	0	0	0	1	20	0	0	8	0	0	0	0	0	0	0	0	0	1	12	0	0	0	60
6	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20
7	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	0	0	0	0	3	0	0	6	1	0	0	0	0	0	0	0	0	0	0	0	0	0	28
8	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	2	0	0	0	1	1	11	0	0	11	0	0	0	0	0	0	0	0	0	1	1	0	0	0	45
9	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0	0	0	0	1	14	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	35
10	2	2	2	2	2	2	2	2	2	1	1	2	0	2	2	1	2	2	0	0	1	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	1	1	0	0	0	38
11	2	2	2	2	2	2	2	2	2	1	1	2	0	2	2	1	2	2	3	0	1	2	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	1	1	0	0	0	43
12	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	0	1	1	1	3	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	27
13	0	0	1	0	0	0	0	3	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	9	2	0	0	0	0	0	0	2	5	69	2	0	0	95
14	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	0	1	4	1	2	0	0	5	0	1	0	0	0	0	0	0	0	6	1	0	0	0	39
15	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	14	1	1	1	0	0	0	0	0	0	1	0	0	1	1	0	0	1	43
16	2	2	2	2	2	2	2	2	2	1	1	2	0	2	2	1	2	2	0	0	1	0	0	0	31	0	0	7	0	2	0	0	0	0	0	0	0	1	1	0	0	0	74
17	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	18	1	0	1	0	39
18	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	4	0	4	2	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	2	2	0	0	0	36
20	36	1	109	1	3	1	36	36	1	2	22	1	1	1	1	28	1	18	1	0	0	1	39	1	1	1	1	1	34	7	0	0	0	0	21	2	0	21	42	1	0	1	474
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22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	202	0	0	0	1	1	0	0	0	0	1	1	1	8	1	1	0	0	0	0	1	221
23	1	1	1	1	36	36	1	1	1	2	2	1	1	1	1	2	1	1	1	0	81	1	1	1	1	1	1	1	7	41	1	1	1	1	20	1	1	3	6	61	1	1	326
24	1	42	1	36	36	5	36	1	1	2	11	48	7	1	22	2	1	6	15	18	121	1	26	1	5	100	1	5	5	3	1	0	0	0	2	0	0	12	19	1	0	1	596
25	1	1	1	1	1	1	1	1	1	2	2	29	2	1	1	2	1	51	7	0	0	1	89	1	1	1	1	1	0	0	0	0	0	0	0	0	0	1	4	0	0	1	208
26	8	1	15	109	8	4	1	1	8	1	1	1	1	3	3	1	1	1	1	0	1	1	33	1	1	1	1	1	0	0	0	0	0	0	1	0	0	1	1	0	0	1	213
27	1	1	10	1	1	1	1	1	1	2	2	1	0	1	1	2	1	1	1	1	1	1	100	1	1	1	1	1	1	2	1	1	1	1	3	1	1	1	5	7	1	1	165
28	1	1	10	1	1	1	1	1	1	2	2	1	0	36	1	2	1	1	1	0	0	1	1	1	1	1	1	1	2	0	0	0	0	0	0	0	0	1	1	0	0	1	77
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39	0	0	0	6	0	0	0	4	0	0	0	0	45	0	1	0	0	0	41	0	0	0	0	0	1	0	0	9	4	4	4	1	1	1	1	1	1	1	1	51	1	0	179
40	0	0	0	6	0	0	0	0	0	0	0	0	23	0	1	0	6	4	30	11	0	0	3	0	24	0	1	2	1	1	1	0	1	1	1	1	1	1	1	1	1	0	123
41	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	1	0	32	0	0	0	1	0	0	1	7	1	1	1	1	1	1	1	302	1	1	1	1	359
42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	15
43	1	1	1	1	1	1	1	1	1	2	2	1	0	1	1	2	1	1	19	0	23	28	1	1	1	1	1	1	25	17	1	1	1	1	3	1	1	12	1	7	1	1	169
Total	74	71	178	194	114	73	107	71	36	33	62	104	81	68	61	67	44	113	182	56	284	300	347	18	178	137	15	91	102	98	22	19	20	19	76	20	21	475	197	144	18	20	4,410

Source: JICA Study Team

Table 4.23 OD Trip Table (containers)

Zone Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	Total
1	1	1	1	1	1	1	1	1	1	2	2	1	0	1	1	2	1	1	42	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	70
2	1	1	1	1	1	1	1	1	1	2	2	1	0	1	1	2	1	1	1	0	0	29	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	55
3	1	1	79	1	1	1	1	1	1	2	2	1	11	1	1	2	1	14	441	0	14	29	94	0	75	1	1	18	1	1	0	0	0	0	3	0	0	0	0	1	0	94	895
4	1	1	57	1	1	1	1	1	1	2	2	1	2	1	1	256	1	1	1	0	0	1	1	0	1	19	1	1	8	0	0	0	0	7	12	0	0	0	1	0	0	1	386
5	1	1	14	1	1	1	1	1	1	2	2	1	0	1	1	2	1	1	1	0	0	1	1	1	1	1	1	15	0	0	0	0	0	0	0	0	0	0	0	0	0	1	56
6	1	1	1	1	1	1	1	1	1	2	2	1	0	1	1	43	1	1	1	0	0	1	1	0	15	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	84
7	1	1	1	1	1	1	1	1	1	2	2	1	2	1	1	43	1	1	88	0	0	1	1	0	46	1	1	31	1	0	0	0	0	0	0	0	0	0	0	0	0	1	234
8	1	1	1	1	1	1	1	1	1	2	2	1	2	1	1	2	1	1	88	0	0	1	1	0	31	1	1	15	0	0	0	0	0	0	0	0	0	0	0	0	0	1	161
9	1	1	1	1	1	1	1	1	1	2	2	1	2	1	1	2	1	1	1	0	0	1	1	1	16	1	1	110	0	10	0	0	0	0	0	0	0	1	0	0	0	1	166
10	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	0	2	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	26
11	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	158	0	22	2	75	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	279
12	1	1	1	1	1	1	1	1	1	2	2	1	0	1	1	2	1	1	1	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	29
13	0	0	15	16	0	0	0	16	16	1	1	0	1	16	16	1	16	0	15	3	0	3	15	0	16	14	15	16	2	1	0	0	0	0	0	0	0	0	1	1	0	15	232
14	1	1	1	1	1	1	8	1	1	2	2	1	2	1	0	43	1	1	1	0	8	1	0	0	20	1	1	60	0	20	0	0	0	0	0	0	0	0	0	0	0	1	182
15	1	1	1	1	1	1	6	1	1	2	2	1	2	2	1	2	1	1	1	0	4	1	1	1	16	1	1	1	0	3	11	0	0	0	0	0	0	2	0	0	0	1	72
16	1	1	45		1	89	1	1	1	1	1	1	0	1	1	1	1	220	989	0	66	2	84	0	45	66	1	151	3	0	0	0	0	0	0	0	0	0	0	0	0	1	1,775
17	1	1	14	1	1	1	1	1	1	2	2	1	52	1	1	2	1	1	1	0	0	1	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	92
18	1	1	14	1	1	1	1	1	1	2	2	1	0	94	1	2	1	1	264	0	0	329	1	3	1	118	88	108	0	1	0	0	0	0	5	0	0	0	0	0	0	1	1,045
20	0	40	118	1	0	0	81	40	121	1	119	9	234	0	1	653	0	188	1	1	1	1	1	1	1	1	1	1	14	0	0	0	0	0	0	0	0	20	1	0	0	1	1,652
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	47	1	1	0	1	1	1	11	1	1	1	1	1	1	1	1	0	1	1	1	1	78
22	0	32	0	0	0	37	0	0	0	1	1	0	0	0	0	1	0	0	20	1	1	1	52	1	0	1	1	1	0	4	0	1	1	1	1	1	1	0	1	0	0	1	163
23	1	1	17	1	77	1	12	77	1	3	3	1	1	1	1	3	1	223	1	59	1	1	1	1	1	1	1	1	46	2	0	0	0	0	0	0	0	4	4	2	0	1	552
24	0	0	9	9	0	58	0	0	40	1	1	0	1	2	1	284	0	62	57	0	17	71	1	1	1	20	1	61	5	4	0	0	0	0	0	0	0	0	0	0	0	1	708
25	1	0	1	0	1	0	0	0	1	0	0	1	0	2	1	0	0	3	1	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	21
26	6	23	75	1	1	29	1	29	31	2	2	1	2	38	1	34	1	34	1	0	0	1	8	1	1	1	1	1	0	0	0	0	0	0	3	0	0	0	0	0	0	1	330
27	0	0	0	0	0	0	0	0	0	1	1	0	1	6	10	53	0	0	1	1	1	1	10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3	3	2	1	1	110
28	0	0	0	0	0	0	0	0	0	1	1	0	4	0	65	1	0	40	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	123
29	1	1	46	11	1	1	6	6	1	2	2	1	17	50	1	282	1	52	1	0	1	1	29	1	1	10	1	1	18	5	0	0	0	5	20	0	0	0	0	0	0	1	577
30	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	1	4	0	28	1	0	4	37	0	0	1	1	30	1	1	1	1	1	1	1	1	1	8	1	1	1	4	142
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	10	0	36	1	0	4	2	0	0	7	0	9	1	1	1	1	1	1	1	1	1	8	1	1	1	4	94
32	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	9	1	1	1	1	1	1	1	1	1	8	1	1	1	0	32
33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	16
34	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	26
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	16
36	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	1	0	5	2	1	7	1	2	0	0	1	0	14	1	1	1	1	1	1	1	1	1	1	1	1	1	0	54
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	16
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	16
39	0	0	0	2	0	0	0	3	0	0	0	0	0	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0	6	6	6	1	1	1	1	1	1	1	1	6	1	0	62
40	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	19
41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	4	0	0	0	8	0	0	1	1	1	1	1	1	1	1	1	8	1	1	1	4	41
42	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	25
43	0	0	0	0	0	0	0	0	0	1	1	0	1	0	1	130	0	0	1	1	1	1	1	1	1	1	1	1	2	2	0	0	0	0	0	0	0	0	0	2	0	1	151
Total	26	114	515	87	97	231	129	198	228	46	163	30	337	226	114	1,853	51	856	2,276	80	152	547	428	19	299	294	131	664	130	73	31	16	16	28	60	16	16	71	25	27	15	148	10,863

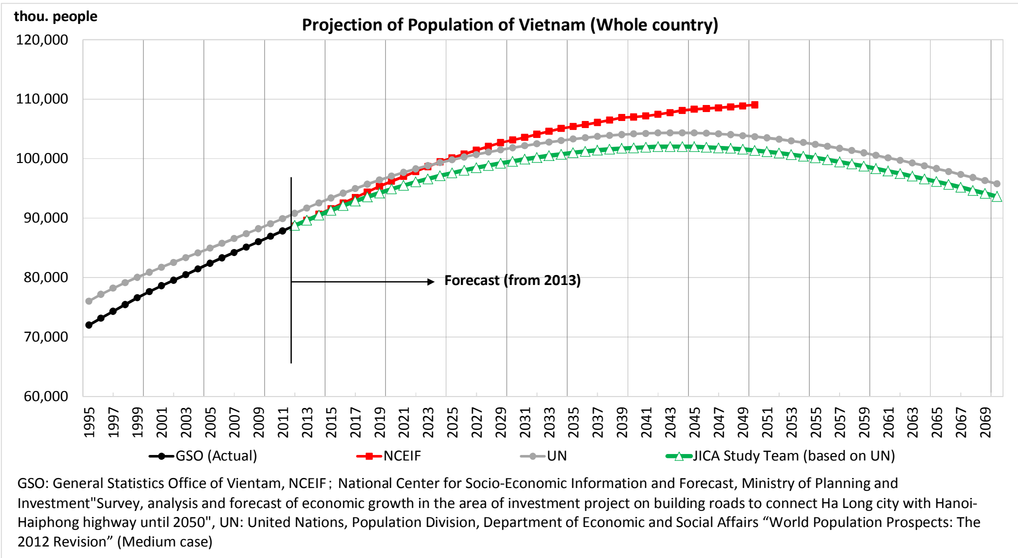
Source: JICA Study Team

2) Social Index

Population growth was used as a social index.

A） National Trend

- According to the latest information on the GSO website, the total population of Vietnam is about 89 million as of 2012 and the population growth rate has hovered around 1.1% in recent years.
- According to the NCEIF[36] estimate, the Vietnamese population will continue to increase, though at a declining rate and is projected to reach 110 million by 2050.
- According to the United Nations' population projection for Vietnam (moderate range), conversely, the country's population has been growing at a rate exceeding that of the General Statistics Office of Vietnam but at a lower rate than that of NCEIF and is expected to begin declining from 2046 onward.

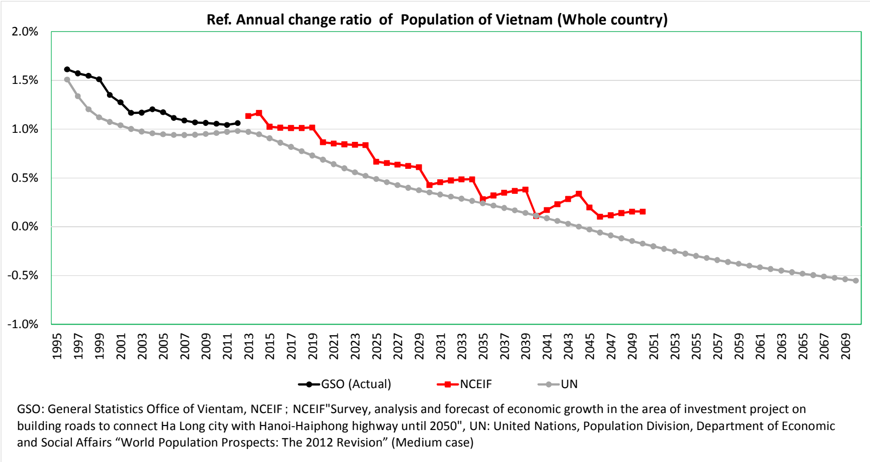


Source: UN statistics, General Statistics Office of Vietnam, METI F/S

Figure 4.13 Population Trend of Vietnam

- The population growth rate (actual record) announced by the General Statistics Office of Vietnam is showing a declining trend year by year.
- While the population growth rate projected by NCEIF is slightly lower than that projected by UN (about 0.2% difference), both show similar declining trends.
- This study estimates future population by applying the UN growth rate to the actual total population of Vietnam in 2012.

[36] NATIONAL CENTER FOR SOCIO-ECONOMIC INFORMATION AND FORECAST, an organization under the jurisdiction of the MINISTRY OF PLANNING AND INVESTMENT that estimated population and economic growth in the METI F/S.



Source: UN statistics, General Statistics Office of Vietnam, METI F/S

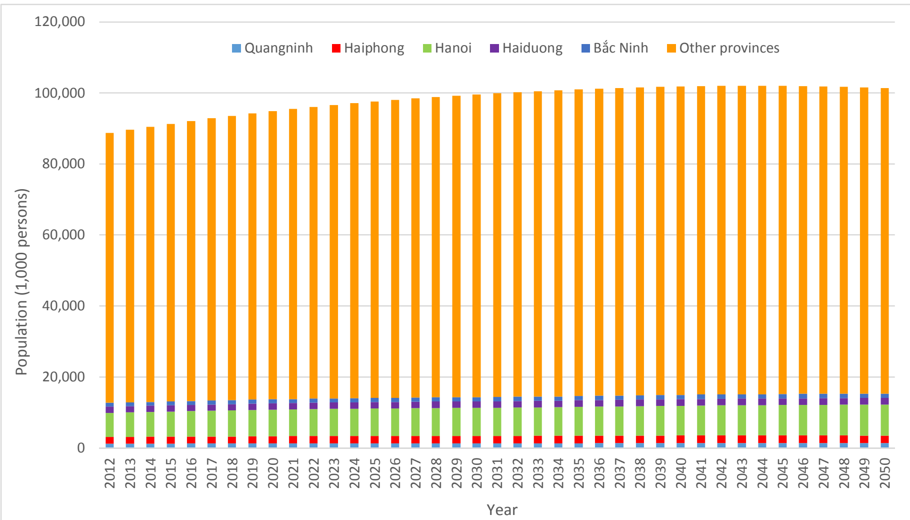
Figure 4.14 Trend of Population Growth Rate

B) Population Trend in Major Cities & Provinces

- The NCEIF's demographic estimation for major provinces and cities in and around the Project Site shows no significant demographic change in Quang Ninh province and Hai Phong City.
- Given the lack of UN data available with regard to the estimated population of each Province, this Study projected the population of each Province and City by applying NCEIF's demographic data to the total population of Vietnam, which was estimated based on the actual population in 2012 and the UN population growth rate estimation.

C) Population Trend Projection

Based on the above, the population trend to be used for this Study was derived as shown in Figure 4.15.



Source: JICA Study Team

Figure 4.15 Population Trend Used in this Study

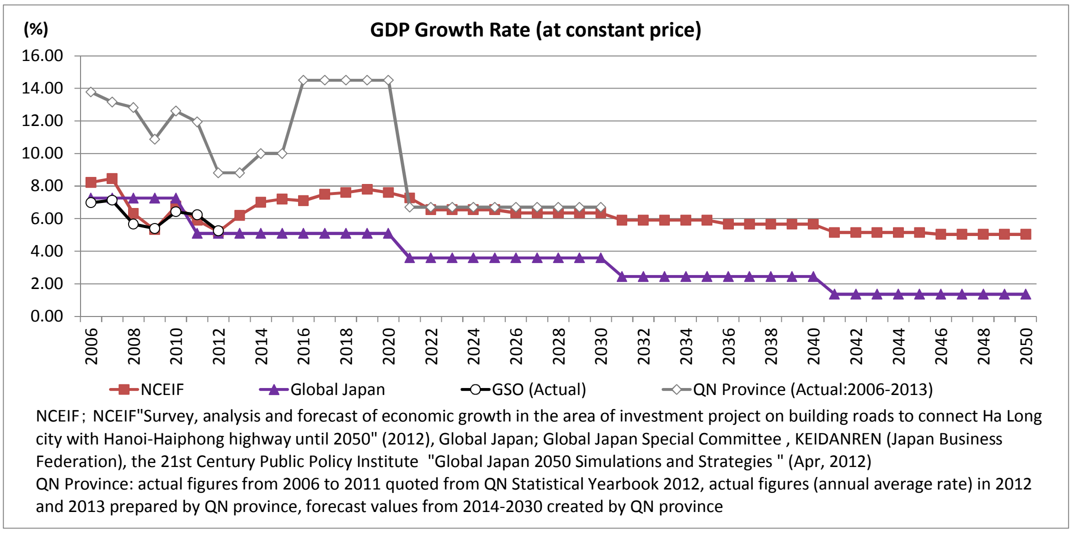
3) Economic Index

The GDP trend was used as an economic benchmark.

A) Analysis of GDP Trend

- According to NCEIF estimation, the GDP growth rate will peak at around 8% in 2018 and gradually decline to about 5% in 2050.
- According to the projection of the Japan Business Federation ("Global Japan"), Vietnamese GDP will grow at a slightly lower rate than NCEIF's estimate.

- In contrast, the 5-Year Master Plan of Quang Ninh Province predicts that the province's GDP from 2016 to 2020 will grow at around 14 – 15%, far exceeding the national average.
- Looking at other Southeast Asian countries for comparison, Japanese GDP grew at an annual rate of around 5% during the 1970s and 1980s and at around 1% during and after the 1990s. South Korea recorded a growth rate of about 10% during the 1970s and 1980s, which declined to 7% during the 1990s and 4% during the 2000s. China's GDP growth rate was around 10% during the 1990s and 2000s and fell to about 8% between 2010 and 2012. The GDP growth rates of Southeast Asian countries have remained stable within the range of 5 – 10% except during the Asia currency crisis.



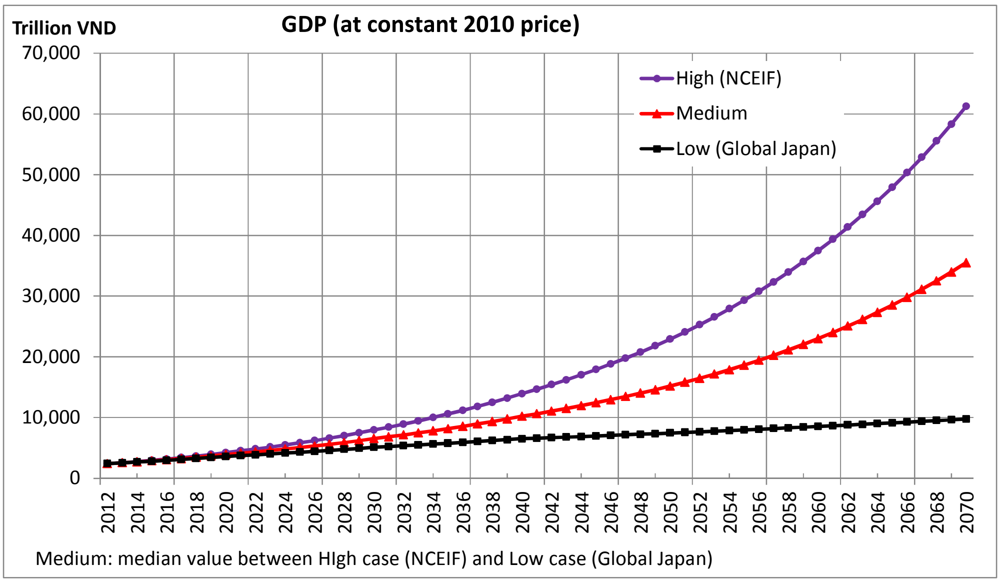
Sources: Japan Business Federation, METI F/S

Figure 4.16 GDP Trend

B） GDP Trend Forecast

Based on the above, the GDP trend used for this estimation was derived as shown in Figure 4.18.

- ➢ Future net GDP was estimated by applying the net GDP growth rate to the actual GDP in 2012. The growth rate was estimated for each of the high, medium and low growth scenarios to be described later.
- ➢ The high growth scenario assumes a growth rate of around 5 – 10%, which was based on the NCEIF projection.
- ➢ The low growth scenario assumes a rate of around 1 – 5% by taking into account the risks that could lead to growth slower than predicted based on the Japan Business Federation's projection ("Global Japan").
- ➢ The medium growth scenario uses mean values between high and low scenarios.
- ➢ The medium growth scenario was used in this estimation.



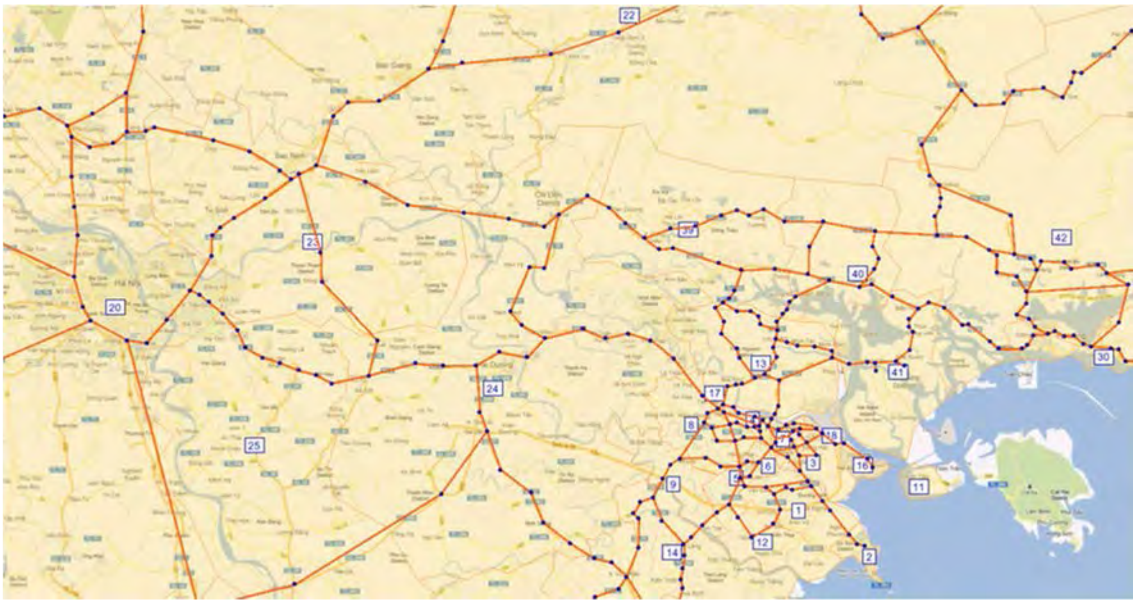
Source: JICA Study Team

Figure 4.17 GDP Growth Scenario Used in this Study

4) Defining a Road Network

A） Present Road Network

The present road network to be used for demand forecasting was defined to mainly comprise roads administered by national government, as well as those administered by municipalities and local governments connecting to national roads.



Source: JICA Study Team

Figure 4.18 Present Road Network

B） Future Road Network

The future status of traffic infrastructure was summarized based on the development statuses of roads and railways described in the above section titled “Traffic Conditions of the Target Area.” Road conditions which newly developed by each analysis years are summarized as follows. In their estimation, analysis is to be conducted by adding new road as summarized below to the present road network.

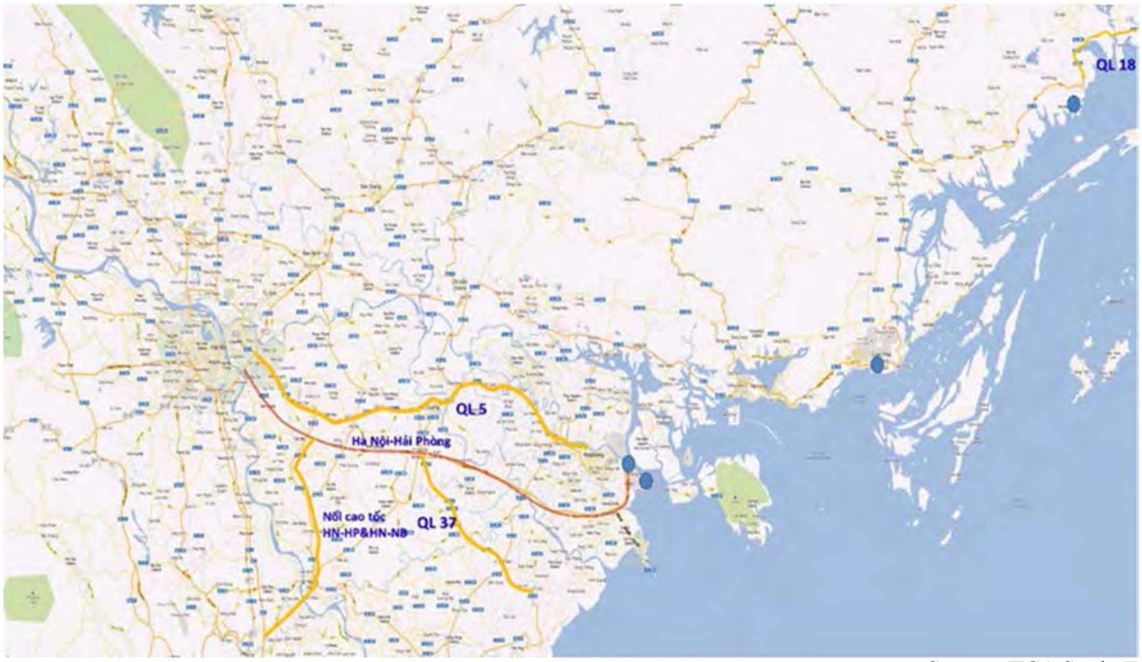
a) Statuses till 2015

The road projects until 2015 outlined in “Traffic Conditions of the Target Area” are as shown in Table 4.24

Table 4.24 Road Development Projects (till 2015)

No.	Highway/Route
1	Hanoi - Hai Phong Expressway
2	NH18 (Mong Duong – Mong Cai)
3	NH5
4	NH37
5	Connecting road between Hanoi – Hai Phong and Cau Gie Highways

Source: JICA Study Team



Source: JICA Study Team

Figure 4.19 Roads in 2015

b) Statuses till 2025

Road projects till 2020 shown in “Traffic Conditions of the Target Area” are listed in Table 4.25. As for the road development status by 2025, the road development in Hai Phong City as shown in the aforementioned “Development Status of the Traffic-Related Facilities” (Figure 4.12) will be completed.

Table 4.25 Road Projects (till 2020)

No.	Highway/Road
1	Ha Long – Mong Cai Expressway
2	Noi Bai – Ha Long Expressway
3	NH10 (Uong Bi－Thanh Hoa)
4	NH 18 (Uong Bi – Tuan Chau)
5	NH 18c (Tien Yen Bridge – Vietnam/China border)
6	NH 4B
7	NH 279
8	Coastal road

Source: JICA Study Team

Table 4.26 Road Project (till 2025)

No.	Highway/Road
1	Roads (ring road, Phu Yen Bridge, etc) in Hai Phong City

Source: JICA Study Team

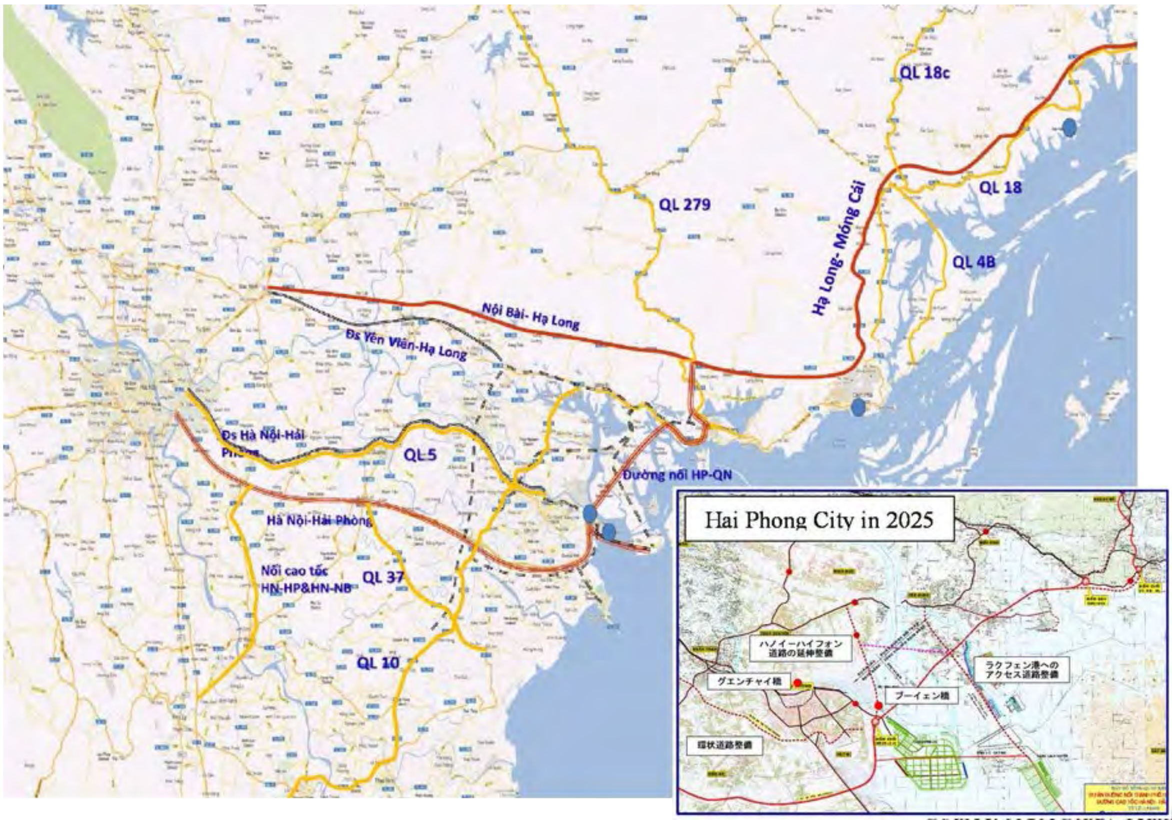


Figure 4.20 Roads in 2020 (till 2025)

c) Status till 2050

The road project till 2030 described in "Traffic Conditions of the Target Area" is shown in Table 4.25. Since no road development projects are being planned after 2030, as mentioned in "Traffic Conditions of the Target Area," the 2030 status is assumed to continue till 2050.

Table 4.27 Road Project (till 2030)

No.	Highway
1	Coastal Expressway (Ninh Bin – Hai Phong – Quang Ninh)

Source: JICA Study Team

Source: JICA Study Team

Figure 4.21 Roads in 2030 (till 2050)

C） Toll Collection on NH18

Tolls on NH18 will be collected from drivers travelling between Pha Lai (30km point) and Dai Yen (97.05km). Toll collection has already begun at Dai Yen in April 2014 and is scheduled to begin at Pha Lai in June 2016. Toll rates at these two points are shown in Table 4.28.

Table 4.28 Toll Rates of NH18 (Dai Yen and Pha Lai)

(Unit: VND)

Year	2014	2016	2019	2022	2025	2028	2031
Passenger cars and taxis	30,000	35,000	42,000	49,000	58,000	68,000	81,000
Buses with fewer than 25 seats	40,000	45,000	54,000	63,000	74,000	88,000	103,000
Buses with more than 25 seats	50,000	55,000	65,000	77,000	91,000	107,000	126,000
2-axis trucks	50,000	55,000	65,000	77,000	91,000	107,000	126,000
Trucks with three or more axes	80,000	90,000	107,000	126,000	148,000	175,000	206,000
Trailers/containers	160,000	180,000	213,000	251,000	296,000	349,000	412,000

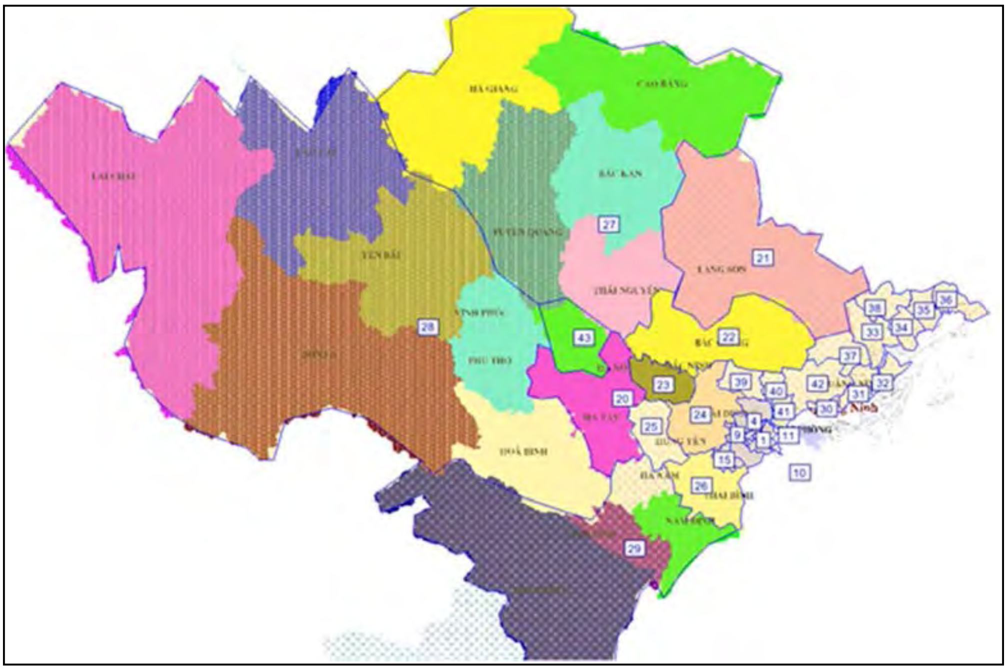
Source: JICA Study Team

(3) Zoning

The study area was divided into zones based on the following principles:

- As Quang Ninh Province and Hai Phong City are within target areas of this Project, their mobility must be scrutinized and they are divided into small zones corresponding to the administrative divisions of the Province.
- Each province adjacent to Quang Ninh Province and Hai Phong City comprises a zone.
- Other special areas and districts, where similar traffic generation and attraction occur, are lumped together as a single zone (e.g. Vinh Phuc Province, industrial areas and port districts)
- Areas other than the above are divided into three regions, each of which forms a zone, namely, the Dong Bac (Northeast) region, the Tay Bac (Northwest) region and the Phai Nam (spell?) region that comprises the southern districts.

The results of zoning are shown in Figure 4.23 and Table 4.29.



Source: JICA Study Team

Figure 4.22 Zoning Map

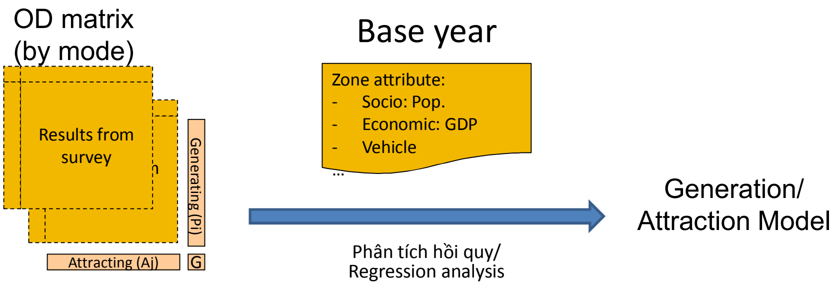
Table 4.29 Result of Zoning

City, Province or Region	Distrit/zone	Zone no.	City, Province or Region	Distrit/zone	Zone no.
Hai Phong City	Quận Dương Kinh	1	Tây Bắc Region (Northwest)	Vĩnh Phúc (Prv.)	28
	Đồ Sơn	2		Phú Thọ Province	
	Hải An	3		Yên Bái Province	
	Hồng Bàng	4		Lào Cai Province	
	Kiến An	5		Lai Châu Province	
	Lê Chân	6		Điện Biên Province	
	Ngô Quyền	7		Sơn La Province	
	An Dương	8		Hòa Bình Province	
	An Lão	9	Phía Nam Region (South)	Hà Nam Province	29
	Bạch Long vĩ	10		Ninh Bình Province	
	Cát Hải	11		Thanh Hóa Province	
	Kiến Thụy	12		Nghệ An Province	
	Thủy Nguyên	13		Hà Tĩnh Province	
	Tiên Lãng	14		Other southern provinces	
	Vĩnh Bảo	15	Quang Ninh Province	Ha Long	30
	KCN Đình Vũ	16		Cam Pha	31
	KCN Q. Toan-Nomura	17		Van Don	32
	Hải phòng port	18		Tien Yen	33
Hà Nội City	Hà Nội City	20		Dam Ha	34
Lạng Sơn Province	Lạng Sơn Province	21		Hải Hà	35
Bắc Giang Province	Bắc Giang Province	22		Móng Cái	36
Bắc Ninh Province	Bắc Ninh Province	23		Ba Chẽ	37
Hải Dương Province	Hải Dương Province	24		Bình Liêu	38
Hưng Yên Province	Hưng Yên Province	25		Đông Triều	39
Thái Bình Procinve	Thái Bình Procinve	26		Uông Bí	40
Đông Bắc Region (Northeast)	Cao Bằng Province	27		Yên Hưng	41
	Bắc Kạn Province			Hoành Bồ	42
	Hà Giang Province		Vinh Phuc Province	Vinh Phuc	42
	Tuyên Quang Prv.				
	Thái Nguyên Prv.				

Source: JICA Study Team

4.4.3 Analysis of the Traffic Generation and Attraction

The traffic generation and attraction of each zone were calculated by creating a present O-D table based on the O-D table generated from traffic counts at the origins and destinations of vehicles obtained through the interview survey. Future traffic volumes were also estimated using a multivariate regression model based on the abovementioned future socioeconomic indices.



Source: JICA Study Team

Figure 4.23 Forecasting Procedure of the Traffic Generation and Attraction

As additional factors that would influence traffic generation and attraction, traffic volumes to be generated as a result of upgrading the Lach Huyen Port and Cat Bi Airport were also analyzed as follows:

(1) Traffic Associated with the Improvement of Lach Huyen Port

1) Cargo-Handling Projection

The following two scenarios were devised to project future cargo-handling volumes at Lach Huyen Port.

A) Development Master Plan of Vietnam Seaport until 2020 and Orientation to 2030 (Prime Minister's Decision 1037 dated 24/6/2014)

This master plan projects the cargo-handling volumes as shown in Table 4.30.

Table 4.30 Forecast of Cargo-Handling Volumes at Lach Huyen Port

Year		2015	2020	2025	2030
Container	1,000 tons	5,500	18,000	50,600	83,200
	1,000 TEU	474	1,552	4,362	72,000
Bulk cargo (1,000 tons)		0	3,700	6,350	9,000
General cargo		500	4,300	6,800	9,300
Total (1,000 tons)		6,474	27,552	68,112	173,500

Source: Decision 1037 dated 24/6/2014

B) Development Master Plan of Đình Vũ – Cát Hải Economic Zone until 2025 (Decision 1438/QĐ-TTG dated 3/10/2012)

This master plan projects the cargo-handling volumes shown in Table 4.31.

Table 4.31 Forecast of Handling Volumes at Lach Huyen Port

Year		2015	2020	2025	2030
Container	1,000 tons	5,500	26,691	63,650	100,650
	1,000 TEU	474	2,299	5,487	8,700
General cargo		500	2,834	4,730	—
Total (1,000 tons)		6,474	31,824	73,867	109,350

Source: Decision 1438/QĐ-TTG dated 3/10/2012

To facilitate forecasting of this Study, the decision was made to use the data of the Development Master Plan of Đình Vũ – Cát Hải Economic Zone, as it is situated in the target area adjacent to Lach Huyen Port, which means the data is likely to present more accurate estimates of cargo volumes linked to the activities of the economic zone. Accordingly, the cargo throughput of Lach Huyen Port was estimated based on the data of this Master Plan.

- The container handling volume is assumed to increase at an annual rate of 10%[37].
- The weight (tons) and number (TEU) of containers in future are calculated by applying the ratios of 2030.

Table 4.32 Estimated Handling Volumes at Lach Huyen Port used for the Demand Forecast

Year		2015	2020	2025	2030	2035	2040	2045	2050
Container	1,000 tons	5,500	26,691	63,650	100,650	162,098	261,060	420,440	677,123
	1,000 TEU	474	2,299	5,487	8,700	14,011	22,566	36,342	58,529
General cargo		500	2,834	4,730	—	—	—	—	—
Total (1,000 tons)		6	29,525	68,380	109,350	162,098	261,060	420,440	677,123

Source: JICA Study Team

2) Conversion to Traffic Volume

There are two types of containers, 20 and 40 feet respectively; both of which are used in ports. The usage ratios of the 20- and 40-foot containers at Lach Huyen Port are unknown and nor was any statistical data found concerning the use of each container type in other existing ports. The Study Team then interviewed customs agency personnel to determine general trends concerning the use of these containers. They responded that the ratios of the 20- and 40-foot containers were about 30 and 70%, respectively. The OD interview survey of 2012 indicated that nearly 80%[38] of containers were 40-feet, which was broadly in line with the accounts of the customs personnel. Accordingly, TEUs were calculated using the 3:7 ratio as shown in Table 4.33.

[37] To gather the required information to forecast the cargo-handling volume at Lach Huyen Port, the Study Team interviewed local consultants, who disclosed that the annual growth rate was projected to be: 1) 8 – 9% in the World Bank report (Efficient Logistics – A key to Vietnam's competitiveness), 2) 8 – 15% between 2016 and 2050 according to the website of Hai Phong City, and 3) 16.8% between 2000 and 2001 according to the statistics of the Vietnam Port Association. While the Study Team is in the process of verifying these data and their sources, this Study used the 10% growth rate, which will need to be adjusted in future according to the capacity expansion of Lach Huyen Port.

[38] The figure was derived from Table 4.5 based on 74 respondents, who were driving 20-foot trucks, and 260 respondents driving 40-foot trucks.

Table 4.33 No. of Containers Handled at Lach Huyen Port

Unit: thousand TEU/year

Container \ Year		2015	2020	2025	2030	2035	2040	2045	2050
20 feet	30%	142	690	1,646	2,610	4,203	6,770	10,903	17,559
40 feet	70%	332	1,609	3,841	6,090	9,808	15,796	25,439	40,970

Source: JICA Study Team

Based on the above total of containers, the number of daily trips per container type can be derived as shown in Table 4.34.

Table 4.34 No. of Container Trips per Day at Lach Huyen Port

Unit: trips/day

Year	2015	2020	2025	2030	2035	2040	2045	2050
20-foot container	390	1,890	4,510	7,151	11,516	18,547	29,870	48,106
40-foot container	455	2,205	5,262	8,342	13,436	21,638	34,849	56,124
Total trips (full)	844	4,094	9,771	15,493	24,952	40,185	64,719	104,230

1 TEU is the equivalent of one 20-foot container or half a 40-foot container.

1 calendar year comprises 356 operating days.

Source: JICA Study Team

Based on published data on the estimated cargo handing volumes between 2015 and 2025, the number of trips involving non-container trucks, which are also used to transport cargo, was calculated. The estimation assumed the use of 5-ton trucks, the results of which are shown in Table 4.35.

Table 4.35 No. of Daily Truck Trips at Lach Huyen Port

Unit: trips/day

Year	2015	2020	2025	2030	2035	2040	2045	2050
Trucks (Average: 5-ton)	274	1,553	2,592	0	0	0	0	0

Source: JICA Study Team

Based on the above, the number of trips per day from Lach Huyen Port is as shown in Table 4.36.

Table 4.36 No. of Daily Trips from Lach Huyen Port

Unit: trips/day

Year	2015	2020	2025	2030	2035	2040	2045	2050
20-foot container	390	1,890	4,510	7,151	11,516	18,547	29,870	48,106
40-foot container	455	2,205	5,262	8,342	13,436	21,638	34,849	56,124
Truck (Average: 5-ton)	274	1,553	2,592	0	0	0	0	0

Source: JICA Study Team

Generally, trucks are not fully loaded both ways. They may be fully loaded one way to/from the port but not so on the other way. According to the World Bank's report (Efficient Logistics – A Key to Vietnam's Competitiveness, 2014), the average loading ratio is around 70%. Accordingly, the decision was made to calculate the number of round trips to/from the port by multiplying the number of trips from the port by 1.7, instead of doubling it, the result of which is summarized in Table 4.37.

Table 4.37 No. of Daily Round Trips to/from Lach Huyen Port

Unit: trips/day

Year	2015	2020	2025	2030	2035	2040	2045	2050
Total trips of container trucks / trailers	1,435	6,960	16,611	26,338	42,418	68,315	110,022	177,191
Total trips of trucks	466	2,640	4,406	0	0	0	0	0

Source: JICA Study Team

According to OD interview surveys in 2012 and 2014, the generation and attraction of container vehicles are 55 and 45%, respectively. Likewise, those of non-container trucks are also 55 and 45%. Based on these figures, the traffic generation and attraction to/from Lach Huyen Port were summarized as shown in Table 4.38.

Table 4.38 Daily Traffic Generation and Attraction to/from Lach Huyen Port

Unit: trips/day

Year	2015	2020	2025	2030	2035	2040	2045	2050
Container vehicles (from Lach Huyen Port to other zones)	789	3,828	9,136	14,486	23,330	37,573	60,512	97,455
Container vehicles (from other zones to Lach Huyen Port)	646	3,132	7,475	11,852	19,088	30,742	49,510	79,736
From Lach Huyen Port to other zones	298	1,690	2,820	0	0	0	0	0
From other zones to Lach Huyen Port	168	950	1,586	0	0	0	0	0

Source: JICA Study Team

Based on Table 4.38, the traffic generation and attraction volumes were allocated to each zone for forecasting purposes; based on the trend by vehicle type and as seen in the OD trip table created in 2014.

Table 4.39 Traffic Generation from Lach Huyen Port (Container Vehicles)

Unit: trips/day

2014	2015	2020	2025	2030	2035	2040	2045	2050	Zone no.	Zone name
1	3	4	9	14	22	36	58	93	1	Quận Dương Kinh
1	3	4	9	14	22	36	58	93	2	Đồ Sơn
14	36	51	123	194	313	504	811	1307	3	Hải An
1	3	4	9	14	22	36	58	93	4	Hồng Bàng
1	3	4	9	14	22	36	58	93	5	Kiến An
1	3	4	9	14	22	36	58	93	6	Lê Chân
1	3	4	9	14	22	36	58	93	7	Ngô Quyền
1	3	4	9	14	22	36	58	93	8	An Dương
1	3	4	9	14	22	36	58	93	9	An Lão
2	5	7	18	28	45	72	116	187	10	Bạch Long vĩ
2	5	7	18	28	45	72	116	187	11	Cát Hải
1	3	4	9	14	22	36	58	93	12	Kiến Thụy
0	0	0	0	0	0	0	0	0	13	Thủy Nguyên
94	241	345	823	1304	2101	3383	5448	8775	14	Tiên Lãng
1	3	4	9	14	22	36	58	93	15	Vĩnh Bảo
2	5	7	18	28	45	72	116	187	16	Đình Vũ
1	3	4	9	14	22	36	58	93	17	Nomura
0	0	0	0	0	0	0	0	0	18	Hải phòng Port
264	676	968	2310	3663	5900	9501	15302	24644	20	Hà Nội
0	0	0	0	0	0	0	0	0	21	Lạng Sơn
0	0	0	0	0	0	0	0	0	22	Bắc Giang
329	842	1206	2879	4565	7352	11841	19069	30711	23	Bắc Ninh
1	3	4	9	14	22	36	58	93	24	Hải Dương
3	8	11	26	42	67	108	174	280	25	Hưng Yên
1	3	4	9	14	22	36	58	93	26	Thái Bình
118	302	433	1033	1637	2637	4247	6839	11015	27	Đông Bắc
88	225	323	770	1221	1967	3167	5101	8215	28	Tây Bắc
108	277	396	945	1499	2413	3887	6260	10082	29	Phía Nam
0	0	0	0	0	0	0	0	0	30	Ha Long
1	3	4	9	14	22	36	58	93	31	Cam Pha
0	0	0	0	0	0	0	0	0	32	Van Don
0	0	0	0	0	0	0	0	0	33	Tien Yen
0	0	0	0	0	0	0	0	0	34	Dam Ha
0	0	0	0	0	0	0	0	0	35	Hải Hà
5	13	18	44	69	112	180	290	467	36	Móng Cái
0	0	0	0	0	0	0	0	0	37	Ba Chẽ
0	0	0	0	0	0	0	0	0	38	Bình Liêu
0	0	0	0	0	0	0	0	0	39	Đông Triều
0	0	0	0	0	0	0	0	0	40	Uông Bí
0	0	0	0	0	0	0	0	0	41	Yên Hưng
0	0	0	0	0	0	0	0	0	42	Hoành Bồ
1	3	4	9	14	22	36	58	93	43	Vĩnh Phúc

Source: JICA Study Team

Table 4.40 Traffic Attraction to Lach Huyen Port (Container Vehicles)

Unit: trips/day

Zone name	Zone no.	2014	2015	2020	2025	2030	2035	2040	2045	2050
Quận Dương Kinh	1	1	3	4	9	14	22	36	58	93
Đồ Sơn	2	1	3	4	9	14	22	36	58	93
Hải An	3	14	36	51	122	194	313	503	811	1306
Hồng Bàng	4	1	3	4	9	14	22	36	58	93
Kiến An	5	1	3	4	9	14	22	36	58	93
Lê Chân	6	1	3	4	9	14	22	36	58	93
Ngô Quyền	7	1	3	4	9	14	22	36	58	93
An Dương	8	1	3	4	9	14	22	36	58	93
An Lão	9	1	3	4	9	14	22	36	58	93
Bạch Long vĩ	10	1	3	4	9	14	22	36	58	93
Cát Hải	11	1	3	4	9	14	22	36	58	93
Kiến Thụy	12	1	3	4	9	14	22	36	58	93
Thủy Nguyên	13	0	0	0	0	0	0	0	0	0
Tiên Lãng	14	1	3	4	9	14	22	36	58	93
Vĩnh Bảo	15	1	3	4	9	14	22	36	58	93
Đình Vũ	16	220	563	806	1923	3050	4912	7910	12739	20517
Nomura	17	1	3	4	9	14	22	36	58	93
Hải phòng Port	18	0	0	0	0	0	0	0	0	0
Hà Nội	20	188	481	689	1644	2606	4197	6760	10886	17533
Lạng Sơn	21	0	0	0	0	0	0	0	0	0
Bắc Giang	22	0	0	0	0	0	0	0	0	0
Bắc Ninh	23	223	570	817	1950	3091	4979	8018	12913	20797
Hải Dương	24	62	159	227	542	859	1384	2229	3590	5782
Hưng Yên	25	3	8	11	26	42	67	108	174	280
Thái Bình	26	34	87	125	297	471	759	1222	1969	3171
Đông Bắc	27	0	0	0	0	0	0	0	0	0
Tây Bắc	28	40	102	147	350	554	893	1438	2316	3730
Phía Nam	29	52	133	190	455	721	1161	1870	3011	4849
Ha Long	30	0	0	0	0	0	0	0	0	0
Cam Pha	31	0	0	0	0	0	0	0	0	0
Van Don	32	0	0	0	0	0	0	0	0	0
Tien Yen	33	0	0	0	0	0	0	0	0	0
Dam Ha	34	0	0	0	0	0	0	0	0	0
Hải Hà	35	0	0	0	0	0	0	0	0	0
Móng Cái	36	5	13	18	44	69	112	180	290	466
Ba Chẽ	37	0	0	0	0	0	0	0	0	0
Bình Liêu	38	0	0	0	0	0	0	0	0	0
Đông Triều	39	0	0	0	0	0	0	0	0	0
Uông Bí	40	0	0	0	0	0	0	0	0	0
Yên Hưng	41	0	0	0	0	0	0	0	0	0
Hoành Bồ	42	0	0	0	0	0	0	0	0	0
Vĩnh Phúc	43	0	0	0	0	0	0	0	0	0

Source: JICA Study Team

Table 4.41 Traffic Generation from Lach Huyen Port (Trucks)

Unit: trips/day

2014	2015	2020	2025	Zone no.	Zone name
1	0	1	2	1	Quận Dương Kinh
1	0	1	2	2	Đồ Sơn
6	1	8	14	3	Hải An
6	1	8	14	4	Hồng Bàng
1	0	1	2	5	Kiến An
1	0	1	2	6	Lê Chân
1	0	1	2	7	Ngô Quyền
1	0	1	2	8	An Dương
1	0	1	2	9	An Lão
2	0	3	5	10	Bạch Long vĩ
2	0	3	5	11	Cát Hải
1	0	1	2	12	Kiến Thụy
2	0	3	5	13	Thủy Nguyên
1	0	1	2	14	Tiên Lãng
1	0	1	2	15	Vĩnh Bảo
40	10	57	94	16	Đình Vũ
1	0	1	2	17	Nomura
1	0	1	2	18	Hải phòng Port
578	144	818	1365	20	Hà Nội
1	0	1	2	21	Lạng Sơn
1	0	1	2	22	Bắc Giang
82	20	116	194	23	Bắc Ninh
168	42	238	397	24	Hải Dương
14	3	20	33	25	Hưng Yên
1	0	1	2	26	Thái Bình
1	0	1	2	27	Đông Bắc
164	41	232	387	28	Tây Bắc
0	0	0	0	29	Phía Nam
29	7	41	68	30	Ha Long
1	0	1	2	31	Cam Pha
1	0	1	2	32	Van Don
1	0	1	2	33	Tien Yen
1	0	1	2	34	Dam Ha
1	0	1	2	35	Hải Hà
72	18	102	170	36	Móng Cái
1	0	1	2	37	Ba Chẽ
1	0	1	2	38	Bình Liêu
2	0	3	5	39	Đông Triều
0	0	0	0	40	Uông Bí
2	0	3	5	41	Yên Hưng
1	0	1	2	42	Hoành Bồ
1	0	1	2	43	Vĩnh Phúc

Source: JICA Study Team

Table 4.42 Traffic Attraction to Lach Huyen Port (Trucks)

Unit: trips/day

Zone name	Zone no.	2014	2015	2020	2025
Quận Dương Kinh	1	1	0	1	2
Đồ Sơn	2	1	0	1	2
Hải An	3	6	2	9	14
Hồng Bàng	4	1	0	1	2
Kiến An	5	1	0	1	2
Lê Chân	6	19	5	27	45
Ngô Quyền	7	1	0	1	2
An Dương	8	1	0	1	2
An Lão	9	1	0	1	2
Bạch Long vĩ	10	0	0	0	0
Cát Hải	11	0	0	0	0
Kiến Thụy	12	1	0	1	2
Thủy Nguyên	13	153	39	218	364
Tiên Lãng	14	6	2	9	14
Vĩnh Bảo	15	1	0	1	2
Đình Vũ	16	0	0	0	0
Nomura	17	1	0	1	2
Hải phòng Port	18	1	0	1	2
Hà Nội	20	165	42	235	393
Lạng Sơn	21	1	0	1	2
Bắc Giang	22	3	1	4	7
Bắc Ninh	23	153	39	218	364
Hải Dương	24	5	1	7	12
Hưng Yên	25	11	3	16	26
Thái Bình	26	5	1	7	12
Đông Bắc	27	1	0	1	2
Tây Bắc	28	1	0	1	2
Phía Nam	29	1	0	1	2
Ha Long	30	28	7	40	67
Cam Pha	31	0	0	0	0
Van Don	32	5	1	7	12
Tien Yen	33	0	0	0	0
Dam Ha	34	0	0	0	0
Hải Hà	35	0	0	0	0
Móng Cái	36	82	21	117	195
Ba Chẽ	37	0	0	0	0
Bình Liêu	38	0	0	0	0
Đông Triều	39	2	1	3	5
Uông Bí	40	5	1	7	12
Yên Hưng	41	2	1	3	5
Hoành Bồ	42	0	0	0	0
Vĩnh Phúc	43	1	0	1	2

Source: JICA Study Team

(2) Traffic Associated with the Upgrading of Cat Bi Airport

1) Passengers and Cargo Volumes

According to the Cat Bi Airport[39] website, annual passenger numbers grew from 185,953 in 2007 to 631,096 in 2011, an increase of around 40% over five years, while the annual cargo-handling volume increased by about 30% from 1,917 tons in 2007 to 4,936 tons in 2011.

Table 4.43 No. of Passengers and Cargo Volume of Cat Bi Airport

Year	No. passengers (people/year)	Cargo volume (tons/year)
2001	55,139	–
2002	65,575	–
2003	76,631	–
2004	79,149	–
2005	94,120	–
2006	112,500	–
2007	185,953	1,917
2008	299,000	–
2009	277,728	–
2010	491,046	–
2011	631,096	–
2012	740,000	4,936
2013	872,800	–

Source: Statistics from Cat Bi Airport

2) Passengers and Cargo Volumes in Future

To forecast passenger numbers and cargo-handling volumes at Cat Bi Airport in coming years, we referred to the following documents:

- The Master Plan on Socioeconomic Development of the Northern Key Economic Region
- Decision 1232/QD-TTg approving the adjustment of the master plan on Cat Bi international airport in Hai Phong City, in period till 2015 and orientations toward 2025
- Statistic data on passengers of Cat Bi Airport

Based on statistics of passenger numbers, the average number of trips per passenger was estimated at 1.5, with each passenger's journey to/from the airport equating to one trip. If someone other than a passenger drives to/from the airport to drop off or pick up a passenger, then each person involved is deemed to make two trips, while the passenger who is dropped off or picked up at the airport makes one trip. In this study, the decision was made to use an average of 1.5 trips/person by assuming passengers are given a ride to/from the airport. We estimated the growth rate in passenger numbers based on regional economic projections and so forth by the Master Plan and the Decision. The estimated future totals for passengers and trips are shown in Table 4.44. It should be noted that the figures remain unchanged after 2030, when passenger numbers are expected to exceed the capacity of Cat Bi Airport.

[39] http://vietnamairport.vn/page/112/cang-hang-khong-san-bay/cang-hang-khong-cat-bi

Table 4.44 Estimated Numbers of Passengers and Trips of Cat Bi Airport

Year	No. of passengers	No. of trips/year	No. of trips/day
2014	960,080	1,440,120	3,946
2015	1,104,092	1,656,138	4,537
2020	2,747,334	4,121,001	11,290
2025	5,525,870	8,288,806	22,709
2030	11,114,499	16,671,749	45,676
2035	11,114,499	16,671,749	45,676

Source: JICA Study Team

According to a survey conducted by a private consultant firm on the types of vehicles used to travel to/from Tan Son Nhat Airport, motorcycles and private cars comprised 63.5 and 29.8%, respectively, while other types of vehicles (city buses, tourist buses, etc.) occupied the rest. In this Study, the number of trips for each vehicle type was estimated by applying these ratios, the results of which are summarized in Table 4.45.

Table 4.45 Estimated No. of Trips to/from Cat Bi Airport by Vehicle Type

Year	No. of vehicles	No. of trips/year	No. of trips/day	Motorcycle	Car/taxi	Other
2014	960,080	1,440,120	3,946	2,505	1,176	264
2015	1,104,092	1,656,138	4,537	2,881	1,352	304
2020	2,747,334	4,121,001	11,290	7,169	3,365	756
2025	5,525,870	8,288,806	22,709	14,420	6,767	1,522
2030	11,114,499	16,671,749	45,676	29,004	13,611	3,060
2035	11,114,499	16,671,749	45,676	29,004	13,611	3,060
2040	11,114,499	16,671,749	45,676	29,004	13,611	3,060
2045	11,114,499	16,671,749	45,676	29,004	13,611	3,060
2050	11,114,499	16,671,749	45,676	29,004	13,611	3,060

Source: JICA Study Team

Based on Table 4.45, the decision was made to allocate the traffic generation/attraction volumes to each zone. Table 4.46 shows the generation/attraction volumes of cars.

Table 4.46 Estimated No. of Trips between Cat Bi Airport and Each Zone

From Cat Bi Airport						To Cat Bi Airport					
2014	2015	2020	2025	2030	Zone	Zone	2014	2015	2020	2025	2030
1	1	2	3	7	1	1	1	1	2	4	8
1	1	2	3	8	2	2	1	1	2	4	8
5	6	12	25	9	3	3	5	6	16	32	64
42	48	107	214	10	4	4	6	7	20	40	80
1	1	2	3	11	5	5	1	1	2	4	8
1	1	2	3	12	6	6	5	6	16	32	64
5	6	14	28	13	7	7	1	1	2	4	8
1	1	2	3	14	8	8	1	1	2	4	8
1	1	2	3	15	9	9	1	1	2	4	8
1	1	2	3	16	10	10	1	1	2	4	8
1	1	2	3	17	11	11	1	1	2	4	8
1	1	2	3	18	12	12	1	1	2	4	8
269	309	686	1380	19	13	13	155	179	506	1017	2046
1	1	2	3	20	14	14	1	1	2	4	8
1	1	2	3	21	15	15	5	6	18	36	72
7	8	19	37	22	16	16	1	1	2	4	8
1	1	2	3	23	17	17	1	1	2	4	8
1	1	2	3	24	18	18	1	1	2	4	8
54	62	137	277	25	20	20	88	101	285	574	1154
0	0	0	0	26	21	21	0	0	0	0	0
1	1	2	3	27	22	22	2	2	6	12	24
1	1	2	3	28	23	23	1	1	2	4	8
8	10	22	43	29	24	24	27	31	87	174	350
7	8	19	37	30	25	25	4	5	14	28	56
76	87	193	388	31	26	26	31	36	102	206	414
1	1	2	3	32	27	27	4	4	12	24	48
1	1	2	3	33	28	28	1	1	2	4	8
26	30	66	134	34	29	29	26	30	85	170	342
42	48	107	214	35	30	30	71	81	230	463	931
31	35	79	158	36	31	31	16	19	53	107	215
4	4	9	19	37	32	32	1	1	2	4	8
1	1	2	3	38	33	33	0	0	0	0	0
1	1	2	3	39	34	34	0	0	0	0	0
1	1	2	3	40	35	35	0	0	0	0	0
1	1	2	3	41	36	36	30	35	98	198	398
1	1	2	3	42	37	37	0	0	0	0	0
10	11	25	50	43	38	38	0	0	0	0	0
0	0	0	0	44	39	39	0	0	0	0	0
6	7	15	31	45	40	40	14	16	45	91	183
30	35	77	155	46	41	41	2	2	6	12	24
1	1	2	3	47	42	42	0	0	0	0	0
24	27	60	121	48	43	43	16	19	53	107	215

Source: JICA Study Team

4.4.4 Examination of Traffic Distribution

Examination of traffic distribution is a process to predict from which zone to which zone the estimated traffic generation/attraction volumes will move. This Study used the following gravity model to determine the number of trips to assign to each O-D zone pair:

$$OD_{ij} = k.\frac{GG_i^{\alpha} A_j^{\beta}}{d_{ij}^{\gamma}}$$

where OD_{ij}: Traffic volume from zone i to zone j
G_i: Traffic generation of zone i
A_{ji}: Traffic generation of zone j
d_{ij}: Spatial distance between zones i and j
k, α, β, γ: coefficients derived by the regression model

The traffic volume between zones i and j was computed based on the results of the OD interview survey by creating an OD matrix organized by survey point and vehicle type as shown in Table 4.47.

Table 4.47 Image of Sorting Out OD Interview Survey Results by Survey Point and Vehicle Type

Survey point / Vehicle type	1	2	3	....	i
Bicycle	$O-D_{XĐ}^{Trạm\ 1}$	$O-D_{XĐ}^{Trạm\ 2}$	$O-D_{XĐ}^{Trạm\ 3}$	...	
Motorcycle	$O-D_{XM}^{Trạm\ 1}$	$O-D_{XM}^{Trạm\ 2}$	$O-D_{XM}^{Trạm\ 3}$	...	
Car	$O-D_{XC}^{Trạm\ 1}$	$O-D_{XC}^{Trạm\ 2}$	$O-D_{XC}^{Trạm\ 3}$	...	
...	...	...	...	...	
j					

Source: JICA Study Team

Based on Table 4.47, expansion coefficients (α, β) were determined using the following equations:

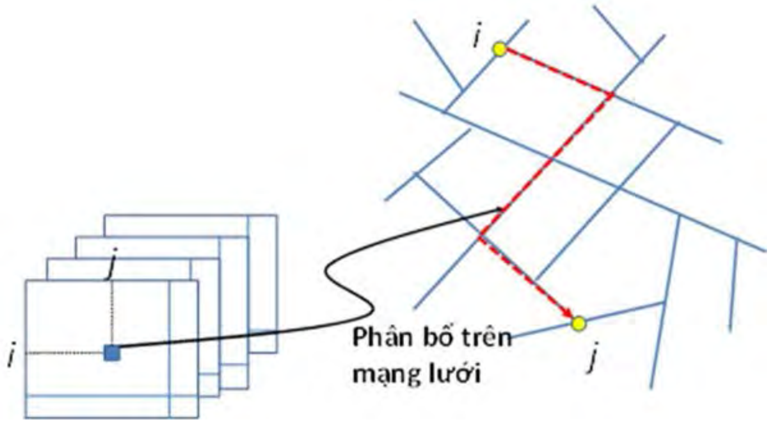
$$Expansion\ coefficiency\ of\ vehicle\ j\ at\ station\ i - \alpha_{PTj}^{Station\ i} = \frac{1}{probability\ of\ vehicle\ j\ at\ station\ i}$$

and

$$Probability\ of\ vehicle\ j\ at\ station\ i - \beta_{PTj}^{station\ i} = \frac{No.of\ survey\ questionnaires\ of\ vehicle\ j\ at\ station\ i}{Volume\ of\ vehicle\ j\ at\ station\ i}$$

4.4.5 Traffic Volume Allocation

Allocation of traffic volumes is a process to allocate the traffic volume of each zone to the road network based on the OD trip table, which is prepared as shown in Figure 4.24.



Source: JICA Study Team

Figure 4.24 Conceptual Image of the Traffic Volume Allocation

Traffic volumes were allocated to the road network by representing the impedance to using each route connecting each O-D zone pair in monetary value, using the travel time (expressed in monetary value), vehicle operating cost and toll (if any) of each route as shown below.

$$\text{Impedance} = \text{Tcur} \times \text{VoT} + \text{Length} \times \text{VoC} + \text{Length} \times \text{Toll}$$

where Tcur: travel time of each route derived from the QV Formula (traffic volume-speed relation within the route).
VoT: value of time defined for each vehicle type based on data on travel time and average income.
Length: distance of each route (km)
VoC: vehicle operating cost determined by the average cost per kilometer, including the costs of fuel and vehicle maintenance.
Toll: charge for using a toll road.

For the VoC and VoT of each vehicle type, the figures shown in Tables 4.48 and 4.49 were used.

Table 4.48 Vehicle Operating Costs Applied

Type of Vehicle	Fuel	UVFC (VND/km)	
		Speed (30km/h)	Speed (40km/h)
Cars	Gasoline	1,902	1,656
Trucks w/ 2 axes	Diesel	18,776	16,540
Trucks w/ 3 axes	Diesel	18,860	16,066
Buses w/ 25 seats or fewer	Diesel	6,287	5,448
Buses w/ more than 25 seats	Diesel	17,602	15,507
Trailers, containers	Diesel	20,368	17,351

Source: JICA Study Team

Table 4.49 Time Values Applied

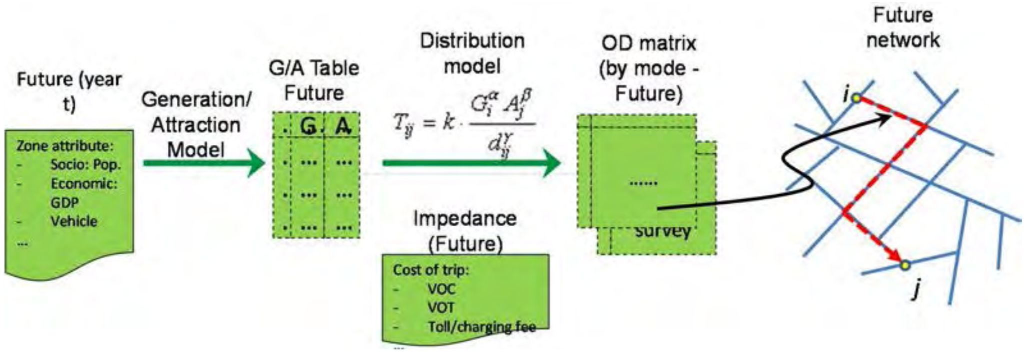
Year	VoT (VND/hr/vehicle)					
	Cars	Small buses	Large buses	Small trucks	Large trucks (2-, 3-axis)	Container trailers
2012	43,149	69,355	110,877	47,071	87,866	154,746
2013	45,145	72,564	116,006	49,249	91,931	161,905
2014	47,427	76,232	121,871	51,738	96,578	170,090
2015	49,896	80,201	128,216	54,432	101,607	178,946
2016	52,497	84,382	134,900	57,270	106,904	188,275
2017	55,370	89,000	142,282	60,404	112,754	198,578
2018	58,462	93,970	150,228	63,777	119,051	209,667
2019	61,824	99,373	158,866	67,444	125,896	221,723
2020	65,352	105,044	167,931	71,293	133,080	234,375
2021	68,558	110,197	176,170	74,790	139,608	245,873
2022	71,705	115,255	184,257	78,223	146,017	257,160
2023	75,042	120,619	192,831	81,864	152,812	269,127
2024	78,577	126,302	201,917	85,721	160,012	281,807
2025	82,322	132,321	211,539	89,806	167,638	295,237
2026	86,194	138,545	221,490	94,030	175,523	309,124
2027	90,291	145,130	232,018	98,500	183,866	323,818
2028	94,625	152,097	243,155	103,228	192,692	339,361
2029	99,209	159,463	254,932	108,228	202,025	355,798
2030	104,054	167,252	267,384	113,514	211,893	373,177
2031	108,438	174,298	278,647	118,296	220,818	388,897
2032	113,059	181,726	290,522	123,337	230,229	405,471
2033	117,933	189,561	303,048	128,655	240,155	422,952
2034	123,078	197,829	316,267	134,267	250,631	441,401
2035	128,509	206,560	330,225	140,192	261,692	460,882
2036	134,039	215,449	344,434	146,225	272,953	480,713
2037	139,870	224,821	359,418	152,586	284,826	501,625
2038	146,022	234,709	375,226	159,297	297,354	523,688
2039	152,516	245,148	391,914	166,382	310,579	546,979
2040	159,376	256,174	409,541	173,865	324,548	571,581
2041	165,518	266,047	425,324	180,565	337,055	593,609
2042	171,994	276,456	441,965	187,630	350,242	616,833
2043	178,825	287,435	459,518	195,082	364,153	641,332
2044	186,034	299,023	478,044	202,947	378,833	667,187
2045	193,646	311,258	497,603	211,250	394,334	694,485
2046	201,532	323,934	517,867	219,853	410,392	722,767
2047	209,855	337,312	539,255	228,933	427,341	752,616
2048	218,640	351,432	561,830	238,517	445,231	784,123

Source: JICA Study Team

4.4.6 Future Projections

Based on the analyses to date, we will reproduce the present status and, on confirming the validity of reproducibility, estimate future traffic demand by creating an O-D trip table using the estimated future socioeconomic indices as described earlier.

Future traffic demand (future O-D) is projected by following the procedure shown in Figure 4.25.



Source: JICA Study Team

Figure 4.25 Procedure of Future Traffic Volume Estimation

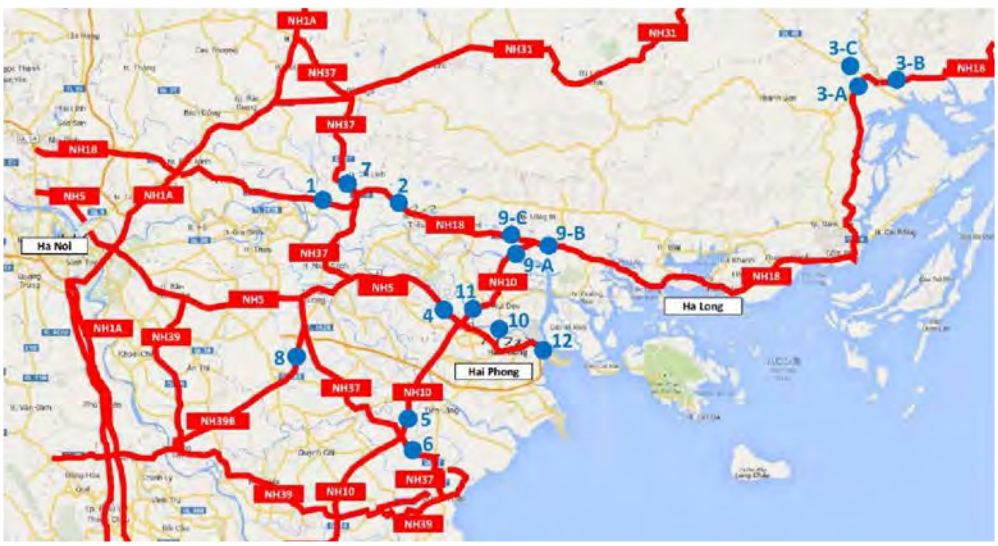
The projected traffic volume will be allocated to the road network of the aforementioned approved master plan.

4.5 Results of Forecasting

4.5.1 Reproduction of Present Status

Before forecasting the future, we reproduced the present status to verify the reproducibility and validity of forecasting the simulation model (software) used. The procedure and results of the reproduction process are shown below.

We checked the results of reproduction against the actual traffic counts at the points shown in Figure 4.26. As Table 4.50 indicates, the differences between the actual and estimated figures remained within the range of around ±10%, underlining the reliability of the model.



Source: JICA Study Team

Figure 4.26 Verification Points of Reproduced Status

Table 4.50 Results of Present Status Reproduction

Survey Point	Route	Survey/ estimation	Traffic volume (no. of vehicles/day)							Comparison between survey and estimation (total value) ②/①	Remarks
			Car	Bus <25	Bus>25	Truck 2axle	Truck 3axle	Container Trailer	Total		
1	National Route 18	①Survey	4,439	847	824	1,926	750	1,171	9,957	92.00%	Traffic volume in weekday
		②Estimation	4,185	663	558	1,925	669	1,160	9,160		
2	National Route 18	①Survey	4,035	815	680	2,550	343	165	8,588	102.06%	Traffic volume in weekday
		②Estimation	4,187	815	680	2,551	367	165	8,765		
3-A	National Route 18	①Survey	1,014	362	501	854	122	253	3,106	96.97%	Traffic volume in weekday
		②Estimation	1,011	254	504	865	124	254	3,012		
3-B	National Route 18	①Survey	1,055	375	503	923	129	252	3,237	95.49%	Traffic volume in weekday
		②Estimation	1,029	273	500	914	122	253	3,091		
3-C	National Route 4B	①Survey	115	31	16	103	11	5	281	109.96%	Traffic volume in weekday
		②Estimation	118	31	17	104	16	23	309		
4	National Route 5	①Survey	5,710	392	702	4,675	1,076	6,131	18,686	100.10%	Traffic volume in weekday
		②Estimation	5,704	394	702	4,675	1,098	6,131	18,704		
5	National Route 10	①Survey	2,158	447	892	1,567	520	1,578	7,162	99.40%	Traffic volume in weekday
		②Estimation	2,158	447	850	1,567	520	1,577	7,119		
6	National Route 37	①Survey	650	479	15	6	52	168	1,370	97.74%	Traffic volume in weekday
		②Estimation	650	479	15	7	20	168	1,339		
7	National Route 37	①Survey	1,982	145	126	956	480	384	4,073	100.37%	Traffic volume in weekday
		②Estimation	1,954	137	134	988	492	383	4,088		
8	National Route 39	①Survey	1,065	225	207	1,114	193	7	2,811	100.32%	Traffic volume in weekday
		②Estimation	1,064	224	207	1,115	200	10	2,820		
9-A	National Route 10	①Survey	2,801	297	638	1,754	638	511	6,639	99.98%	Traffic volume in weekday
		②Estimation	2,801	296	638	1,754	638	511	6,638		
9-B	National Route 18	①Survey	8,045	1,126	1,989	4,100	905	630	16,795	99.98%	Traffic volume in weekday
		②Estimation	8,045	1,125	1,987	4,100	905	630	16,792		
9-C	National Route 18	①Survey	5,916	869	1,363	2,552	1,053	163	11,916	99.96%	Traffic volume in weekday
		②Estimation	5,916	864	1,363	2,552	1,053	163	11,911		
10	Kien Bridge	①Survey	4,793	421	452	1,617	68	984	8,335	100.86%	Traffic volume in weekday
		②Estimation	4,793	391	452	1,717	60	994	8,407		
11	Binh Bridge	①Survey	1,845	336	434	2,014	434	57	5,120	100.06%	Traffic volume in weekday
		②Estimation	1,845	336	434	2,014	434	60	5,123		
12	Dinh Vu Port	①Survey	612	123	20	648	304	3,757	5,464	99.45%	Traffic volume in weekday
		②Estimation	612	124	30	618	293	3757	5,434		

Source: JICA Study Team

4.5.2 Future Projection

(1) Toll Rate

1) Toll Rate of Ha Long – Hai Phong Highway

A） Toll Rates Used in this Study

Based on METI F/S analysis, we reexamined the toll rates by discussing with the relevant organizations and investigating existing standards.

a) Relationship Between Circulars 90/2004/TT-BTC and 159/2013/TT-BTC

After METI F/S, Circular 59/2013/TT-BTC of November 14, 2013 (hereinafter referred to as "Circular 159/2013/TT-BTC") was issued to set forth toll rates.

According to the MOF with jurisdiction over Circular 159/2013/TT-BTC, the rates to date were based on Circular 90/2004/TT-BTC enacted in 2004, which MOT advised the Prime Minister to review to reflect more updated socioeconomic conditions. In response, the Prime Minister instructed MOF to review and revise the toll rates to enable investors to recover their capital. Table 4.51 shows the toll rates published in Circular 159/2013/TT-BTC.

According to the MOF, there are two separate procedures to establish the initial toll rates. One is for setting the rates within the range provided by Circular 159/2013/TT-BTC through discussion between the project operator and owner, whereupon the rates are automatically approved by the MOF upon conclusion of a BOT agreement between the project operator and owner. When setting rates beyond the range set by Circular 159/2013/TT-BTC, the project operator and owner must consult MOF during the discussion process by concluding a BOT agreement, to which all parties must consent prior to filing an application with the MOF.

If the project operator deems it necessary to revise the rates after the operational launch, the operator files a written application with the MOF following consultation and agreement with the owner. If the revision is within the prescribed range, it will be automatically approved. Another approach involves establishing a price revision schedule (e.g. a 30% increase every five years) in the BOT agreement, according to which the rates are revised. In this case, the project owner files an application with the MOF to revise tolls, which will also be automatically approved if the revisions are within the range. If they exceed the range, each revision must be discussed with the MOF, which is unlikely to approve the revision unless there is an alternative route to the road in question, as the MOF must prioritize public benefit over protecting investors.

Table 4.51 Toll Rates Provided in Circular 159/2013/TT-BTC

No.	Vehicle Classification	Toll fare
1	Passenger cars, buses (w/ fewer than 12 seats), trucks (< 2 tons)	15,000 – 52,000
2	Buses (w/ 12 – 30 seats), trucks (2 – 4 tons)	20,000 - 70,000
3	Buses (w/ 31 or more seats), trucks (4 – 10 tons)	25,000 - 87,000
4	Trucks (10 – 18 tons), container trucks (20 feet)	40,000 - 140,000
5	Trucks (≧18 tons), container trucks (40 feet)	80,000 - 200,000

Source: JICA Study Team

b) Toll Rates Used in this Study

It was decided that this Study would set toll rates based on the rates of METI F/S and by taking the inflation rate into account. It is assumed that the initial fares would be kept within the range specified by Circular 159/2013/TT-BTC and that subsequent revisions would be calculated based on the projected inflation rate as assumed in the BOT agreement prior to filing an application. The toll rates are assumed to be revised every three years.

The toll rates used in this Study are shown in Table 4.52.

Table 4.52 Toll Fares of Ha Long – Hai Phong Highway

Vehicle type	Year / Unit	2	7	12	17	22	27	30
		2020	2025	2030	2035	2040	2045	2048
Cars / taxis	VND/car	35,000	51,000	62,000	90,000	130,000	156,000	188,000
2-axis trucks	VND/car	53,000	77,000	93,000	135,000	195,000	234,000	282,000
Trucks w/3 or more axes	VND/car	77,000	113,000	137,000	198,000	286,000	344,000	414,000
Containers	VND/car	200,000	288,000	346,000	500,000	720,000	864,000	1,037,000
Buses w/ 25 seats or fewer	VND/car	53,000	77,000	93,000	135,000	195,000	234,000	282,000
Buses w/ more than 25 seats	VND/car	77,000	113,000	137,000	198,000	286,000	344,000	414,000

Source: JICA Study Team

2) Setting the Toll Rates of Highways Around the Target Area

In addition to the Ha Long – Hai Phong Highway, the following toll roads projects are being planned in and around the target area. While the charges of such roads also need to be established, no specific information related to toll charges was available.

- Hanoi – Hai Phong Highway
- Tan Vu – Lach Huyen Highway
- Noi Bai – Ha Long Highway
- Ha Long – Mong Cai Expressway

To forecast this traffic demand, we set the toll fares per kilometer by referring to the toll rates of the Phap Van – Cau Gie, Ho Chi Minh – Trung Luong and Hanoi – Lao Cai Highways, which were available as shown in Table 4.53. A revision of toll rates every three years, as well as a 20% inflation rate and 25-year collection period, are all assumed.

Table 4.53 Expressway Tolls

Unit: VND/km

Year	2014	2015	2018	2021	2024	2027	2030	2033	2036	2039	2042	2045	2,048
PC	1,500	1,800	2,160	2,592	3,110	3,732	4,479	5,375	6,450	7,740	9,288	11,145	13,374
Bus<25	2,200	2,640	3,168	3,802	4,562	5,474	6,569	7,883	9,460	11,352	13,622	16,346	19,615
Bus>25	4,000	4,800	5,760	6,912	8,294	9,953	11,944	14,333	17,199	20,639	24,767	29,720	35,664
T2	2,200	2,640	3,168	3,802	4,562	5,474	6,569	7,883	9,460	11,352	13,622	16,346	19,615
T3	4,000	4,800	5,760	6,912	8,294	9,953	11,944	14,333	17,199	20,639	24,767	29,720	35,664
Trailer Contain er	8,000	9,600	11,520	13,824	16,589	19,907	23,888	28,665	34,399	41,278	49,534	59,441	71,329

Source: JICA Study Team

Table 4.54 Toll Collection Period

Highway	Toll collection period
Hanoi – Hai Phong	2015-2039
Tan Vu – Lach Huyen	2017-2042
Hanoi – Ha Long	2025 -2050
Ha Long – Mong Cai	2030- 2055

Source: JICA Study Team

(2) Forecasting Scenarios

Based on the aforementioned zoning, O-D table, present/future road network (wide area) and toll rates, the following three scenarios were created to project traffic demand of the Ha Long – Hai Phong Highway:

Scenario 1 assumes the same toll rates will be uniformly applied to all sections of the Ha Long – Hai Phong Highway. This scenario is based on the agreement with Quang Ninh Province that all revenue from highway tolls collected can be passed on to investors.

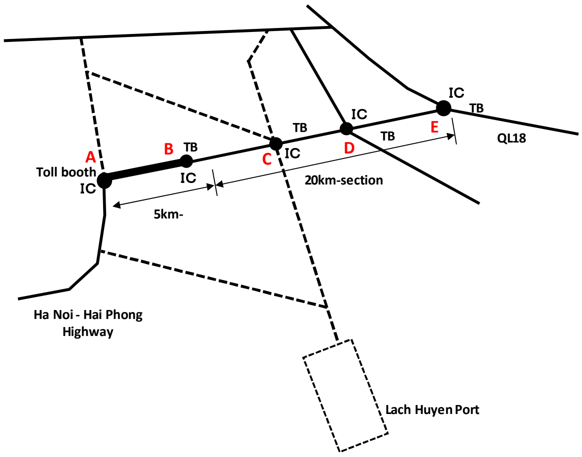
Scenario 2 assumes that tolls will be charged only in the Bach Dang Bridge section, as initially proposed by the People's Committee of Quang Ninh Province during discussions of this Study.

Scenario 3 assumes no toll charge for the purpose of comparison with other scenarios.

The results of analyzing these scenarios are shown in Table 4.55.

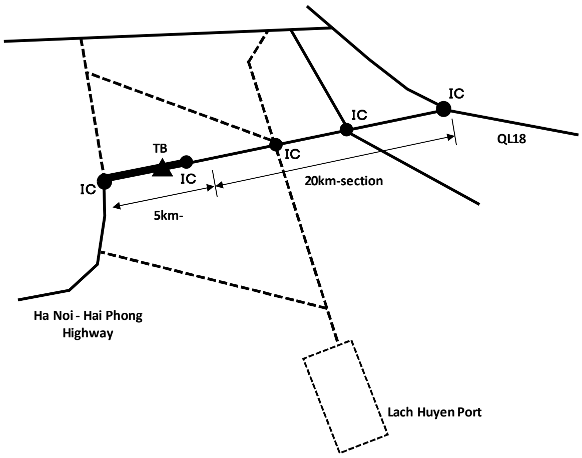
Table 4.55 Examination of Different Scenarios

Case-1: Flat toll rate charged at all ICs



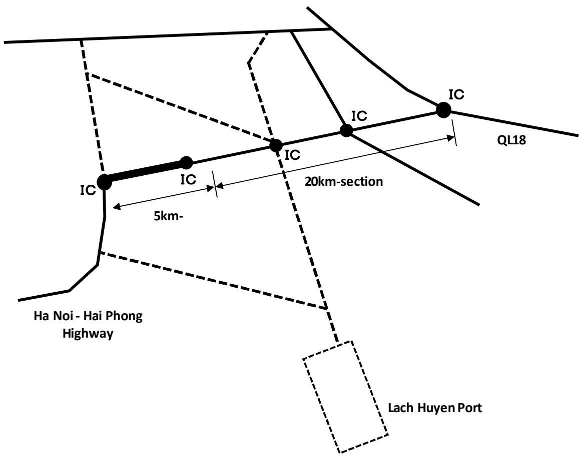
Parameters
(1)Road network: as shown in the left diagram.
(2)No. of Interchanges (IC)
5km-section (Bach Dang Bridge): 1
20km-secton: 2
(3)Toll booth: 5
(4)Toll: collected at all ICs according to new toll table

Case-2: Toll charged only on Bach Dang Bridge



Parameters
(1)Road network: as shown in the left diagram.
(2)No. of Interchanges (IC)
5km-section (Bach Dang Bridge): 1
20km-secton: 2
(3)Toll booth: 1
(4)Toll rate: according to the new toll table

Case-3: No charge



Parameters
(1)Road network: as shown in the left diagram.
(2)No. of Interchanges (IC)
5km-section (Bach Dang Bridge): 1
20km-secton: 2
(3) Toll booth: 0
(4) Toll: not charged

Source: JICA Study Team

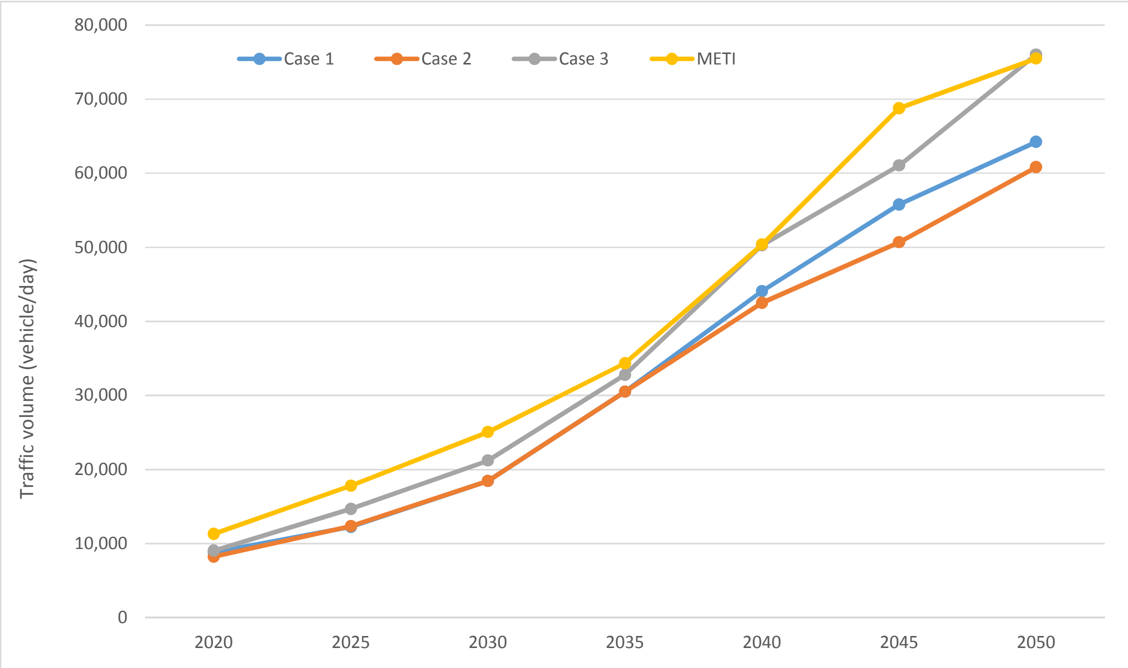
(3) Results of Forecasting

The results of forecasting are shown in Table 4.56 and Figure 4.28, while PCU values were determined based on the Vietnamese standards (TCVN-405four-2005) as follows: 1.0 for car, 2-axis 2.0 for trucks/buses with fewer than 25 seats, 2.5 for trucks with three or more axes and buses with 25 or more seats and 4.0 for trailers/containers.

Table 4.56 Traffic Demand Forecasting and Results

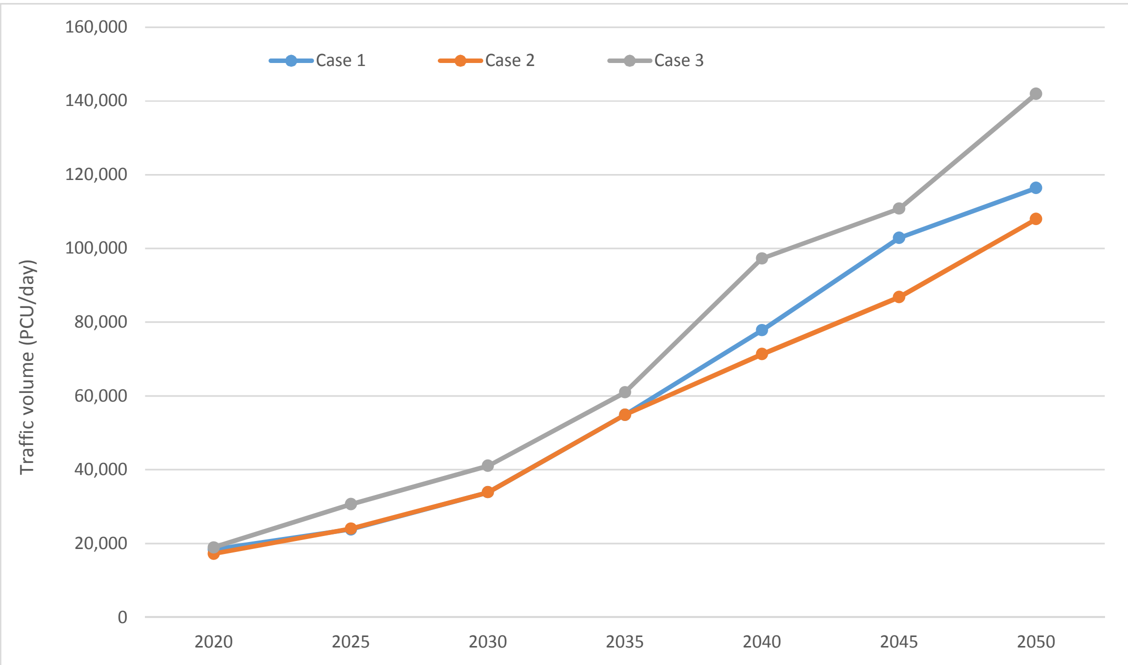
Year	Case	Direction, etc.	Car/Taxi	Truck 2 axle	Truc 3 axle	Container Trailer	Bus<25	Bus>25	Total
2020	Case 1	Hai Phong to Quang Ninh	1,915	661	170	946	131	533	4,356
		Quang Ninh to Hai Phong	1,841	792	130	998	165	518	4,444
		Total	3,756	1,453	300	1,944	296	1,051	**8,800**
		Conversion to PCU	3,756	2,906	750	7,776	592	2,628	**18,408**
	Case 2	Hai Phong to Quang Ninh	1,915	449	132	946	131	533	4,106
		Quang Ninh to Hai Phong	1,841	507	94	998	165	518	4,123
		Total	3,756	956	226	1,944	296	1,051	**8,229**
		Conversion to PCU	3,756	1,912	565	7,776	592	2,628	**17,229**
	Case 3	Hai Phong to Quang Ninh	1,919	662	177	962	272	533	4,525
		Quang Ninh to Hai Phong	1,846	792	136	1,027	197	518	4,516
		Total	3,765	1,454	313	1,989	469	1,051	**9,041**
		Conversion to PCU	3,765	2,908	783	7,956	938	2,628	**18,977**
2025	Case 1	Hai Phong to Quang Ninh	3,032	1,060	204	1,095	185	665	6,241
		Quang Ninh to Hai Phong	2,965	857	157	1,156	236	647	6,018
		Total	5,997	1,917	361	2,251	421	1,312	**12,259**
		Conversion to PCU	5,997	3,834	903	9,004	842	3,280	**23,860**
	Case 2	Hai Phong to Quang Ninh	3,032	1,060	204	1,095	185	665	6,241
		Quang Ninh to Hai Phong	2,965	857	157	1,156	314	647	6,096
		Total	5,997	1,917	361	2,251	499	1,312	**12,337**
		Conversion to PCU	5,997	3,834	903	9,004	998	3,280	**24,016**
	Case 3	Hai Phong to Quang Ninh	3,204	1,358	246	1,596	491	717	7,612
		Quang Ninh to Hai Phong	3,019	1,144	168	1,711	314	704	7,060
		Total	6,223	2,502	414	3,307	805	1,421	**14,672**
		Conversion to PCU	6,223	5,004	1,035	13,228	1,610	3,553	**30,653**
2030	Case 1	Hai Phong to Quang Ninh	4,753	1,649	429	1,271	470	759	9,331
		Quang Ninh to Hai Phong	4,602	1,744	372	1,354	342	692	9,106
		Total	9,355	3,393	801	2,625	812	1,451	**18,437**
		Conversion to PCU	9,355	6,786	2,003	10,500	1,624	3,628	**33,895**
	Case 2	Hai Phong to Quang Ninh	4,753	1,649	429	1,271	470	759	9,331
		Quang Ninh to Hai Phong	4,602	1,744	372	1,354	342	692	9,106
		Total	9,355	3,393	801	2,625	812	1,451	**18,437**
		Conversion to PCU	9,355	6,786	2,003	10,500	1,624	3,628	**33,895**
	Case 3	Hai Phong to Quang Ninh	5,304	1,792	536	2,343	625	846	11,446
		Quang Ninh to Hai Phong	4,755	1,779	436	1,349	518	908	9,745
		Total	10,059	3,571	972	3,692	1,143	1,754	**21,191**
		Conversion to PCU	10,059	7,142	2,430	14,768	2,286	4,385	**41,070**
2035	Case 1	Hai Phong to Quang Ninh	8,014	2,193	927	2,051	448	1,321	14,954
		Quang Ninh to Hai Phong	8,499	2,570	700	2,136	496	1,138	15,539
		Total	16,513	4,763	1,627	4,187	944	2,459	**30,493**
		Conversion to PCU	16,513	9,526	4,068	16,748	1,888	6,148	**54,890**
	Case 2	Hai Phong to Quang Ninh	8,014	2,193	927	2,051	448	1,321	14,954
		Quang Ninh to Hai Phong	8,499	2,570	700	2,136	496	1,138	15,539
		Total	16,513	4,763	1,627	4,187	944	2,459	**30,493**
		Conversion to PCU	16,513	9,526	4,068	16,748	1,888	6,148	**54,890**
	Case 3	Hai Phong to Quang Ninh	8,913	2,653	724	2,914	773	1,144	17,121
		Quang Ninh to Hai Phong	8,268	2,201	949	2,348	566	1,337	15,669
		Total	17,181	4,854	1,673	5,262	1,339	2,481	**32,790**
		Conversion to PCU	17,181	9,708	4,183	21,048	2,678	6,203	**61,000**
2040	Case 1	Hai Phong to Quang Ninh	11,701	4,187	1,070	2,310	803	1,718	21,789
		Quang Ninh to Hai Phong	11,668	4,187	1,115	2,787	813	1,734	22,304
		Total	23,369	8,374	2,185	5,097	1,616	3,452	**44,093**
		Conversion to PCU	23,369	16,748	5,463	20,388	3,232	8,630	**77,830**
	Case 2	Hai Phong to Quang Ninh	11,701	4,187	1,070	1,326	803	1,718	20,805
		Quang Ninh to Hai Phong	11,668	4,187	1,115	2,106	801	1,818	21,695
		Total	23,369	8,374	2,185	3,432	1,604	3,536	**42,500**
		Conversion to PCU	23,369	16,748	5,463	13,728	3,208	8,840	**71,356**
	Case 3	Hai Phong to Quang Ninh	11,760	4,540	1,929	3,689	831	2,313	25,062
		Quang Ninh to Hai Phong	11,758	4,540	1,306	4,475	831	2,313	25,223
		Total	23,518	9,080	3,235	8,164	1,662	4,626	50,285
		Conversion to PCU	23,518	18,160	8,088	32,656	3,324	11,565	**97,311**
2045	Case 1	Hai Phong to Quang Ninh	14,147	4,547	1,161	4,615	1,088	1,897	27,455
		Quang Ninh to Hai Phong	15,310	4,571	1,169	4,241	1,114	1,909	28,314
		Total	29,457	9,118	2,330	8,856	2,202	3,806	**55,769**
		Conversion to PCU	29,457	18,236	5,825	35,424	4,404	9,515	**102,861**
	Case 2	Hai Phong to Quang Ninh	13,170	3,702	1,260	3,347	1,089	2,145	24,713
		Quang Ninh to Hai Phong	15,502	4,666	1,060	2,236	1,094	1,416	25,974
		Total	28,672	8,368	2,320	5,583	2,183	3,561	**50,687**
		Conversion to PCU	28,672	16,736	5,800	22,332	4,366	8,903	**86,809**
	Case 3	Hai Phong to Quang Ninh	15,640	4,591	1,266	4,262	1,224	1,907	28,890
		Quang Ninh to Hai Phong	17,679	4,692	1,534	5,096	1,246	1,917	32,164
		Total	33,319	9,283	2,800	9,358	2,470	3,824	**61,054**
		Conversion to PCU	33,319	18,566	7,000	37,432	4,940	9,560	**110,817**
2050	Case 1	Hai Phong to Quang Ninh	16,448	5,446	1,173	4,582	1,387	2,165	31,201
		Quang Ninh to Hai Phong	17,672	5,482	1,357	4,665	1,387	2,458	33,021
		Total	34,120	10,928	2,530	9,247	2,774	4,623	**64,222**
		Conversion to PCU	34,120	21,856	6,325	36,988	5,548	11,558	**116,395**
	Case 2	Hai Phong to Quang Ninh	16,245	5,967	961	3,756	1,334	2,131	30,394
		Quang Ninh to Hai Phong	16,838	4,237	1,564	4,181	1,155	2,451	30,426
		Total	33,083	10,204	2,525	7,937	2,489	4,582	**60,820**
		Conversion to PCU	33,083	20,408	6,313	31,748	4,978	11,455	**107,985**
	Case 3	Hai Phong to Quang Ninh	18,748	7,864	2,200	5,920	1,564	2,922	39,218
		Quang Ninh to Hai Phong	19,081	5,525	1,791	5,460	2,032	2,922	36,811
		Total	37,829	13,389	3,991	11,380	3,596	5,844	**76,029**
		Conversion to PCU	37,829	26,778	9,978	45,520	7,192	14,610	**141,907**

Source: JICA Study Team



Source: JICA Study Team

Figure 4.27 Traffic Demand Forecasting (not converted to PCU values) and Results



Source: JICA Study Team

Figure 4.28 Traffic Demand Forecasting (converted to PCU values) and Results

4.6 Examining the Required Number of Lanes

4.6.1 No. of Lanes Computed in Vietnamese F/S

In the Vietnamese F/S, the required number of lanes was calculated based on TCVN5729-97, the Vietnamese road design standards, using the following formula:

<Section 4.5 in TCVN5729-97>
Nlk = Nk/Ntk
Where:
Nlk: required number of lanes per direction
Nk : the 30th-50th highest hourly volume of the year (vehicle/hour/heavy direction)
Nk = K x Ntbnam
of which:
Ntbnam : Annual Average Daily Traffic per direction
In case of no anticipation of K,
K = 0.13 for the 50th highest hourly volume
K = 0.15 for the 30th highest hourly volume
Ntk : design traffic capacity (vehicle/hour/lane)
Ntk = Z x Nttmax
of which:
Nttmax : traffic capacity for expressway (2,000 vehicle/hour/lane)
Z: volume to capacity ratio
Z = 0.77 for rolling-mountainous areas
Z = 0.55 for flat areas

From the above formula, the Vietnamese F/S determined the number of lanes as shown in Table 4.57.

Table 4.57 Analysis of the No. of Lanes Calculated by Vietnamese F/S

Year	N_{tbnam}	K	N_k	Z	N_{ttmax}	N_{tk}	N_{lk}	No. of lanes
2015	17,662	0.13	2,296	0.55	2,200	1,210	1.90	4
2020	24,391	0.13	3,171	0.55	2,200	1,210	2.62	4
2025	38,070	0.13	4,949	0.55	2,200	1,210	4.09	4
2030	59,941	0.13	7,792	0.55	2,200	1,210	6.44	4
2030		0.13	7,792	0.55	2,200	1,210	6.44	6
2035	65,169	0.13	8,472	0.55	2,200	1,210	7.00	6
2040	70,853	0.13	9,211	0.55	2,200	1,210	7.61	6

Source: Vietnamese F/S

These numbers of lanes were then evaluated in terms of the service level as defined in the Highway Capacity Manual (HCM) of the United States.

Table 4.58 Evaluation of the No. of Lanes Calculated by Vietnamese F/S

Year	Estimated traffic volume (PUC/day)	No. of lanes	Ave. speed (km/h)	Density (PCU/km/lane)	Level of service
2015	17662	4	82.70	10.97	B
2020	24391	4	92.70	13.33	C
2025	38070	4	90.00	20.65	D
2030	59941	4	85.00	33.51	E
2030		6	90.00	21.10	D
2035	65169	6	94.00	22.47	D-E
2040	70853	6	85.00	27.67	E

Source: Vietnamese F/S

HCM defines each "level of service" as shown in Table 4.59.

Table 4.59 Level of Service

Level of service	A	B	C	D	E	F
Density (PCU/km/lane)	≦7.50	≦12.4	≦18.7	≦26.1	≦41.7	>41.7
Operating condition	Free flow (best)	Reasonably free flow	Stable flow	Approaching unstable flow	Unstable flow	Forced or breakdown flow (worst)

Source: HCM

According to the above table, the service level is projected to decline to Level E in around 2030. To prevent this, there are plans to increase the number of lanes to six by 2030. The plan to have four lanes by 2025 and six by 2030 has been approved by Quang Ninh Province.

4.6.2 Number of Lanes Based on Traffic Volume Forecasting

Based on the results of the traffic demand forecasting of this Study, we examined the number of lanes required, by referring to the computation method provided in TCVN5729-97 so that the results could be compared with those of the Vietnamese F/S.

The numbers of lanes thus calculated are shown in Table 4.60, which indicate that the number of lanes will need to be increased to six by 2035 in all scenarios, as was the case with the Vietnamese F/S, which predicted that four lanes would become insufficient in 2030, whereupon point expansion work to six lanes would start and be completed by 2035. While the traffic demand forecast in this Study is smaller than that estimated by the Vietnamese F/S until 2035, this variation does not translate into a significant difference in terms of the number of lanes required. However, this Study predicts that traffic demand will soar after 2040, whereupon six lanes may no longer prove sufficient under certain circumstances.

Similarly, there is no significant difference in the service level between the Vietnamese F/S and this Study at the assumed driving speed of 80km/h until 2035, as the increases in traffic demand as forecast by the two studies do not affect the required number of lanes until 2035. However, since this Study predicts a faster increase in traffic demand after 2040, the density forecast by this Study after 2040 could exceed that predicted by the Vietnamese F/S if, for instance, six lanes are maintained, indicating that the service level could decline accordingly.

Table 4.60 No. of Lanes Calculated Based on Demand Forecasting

Case 1

Year	Ntbnam	K	N_k	Z	N_{ttmax}	N_{tk}	Nlk	No. of lane
2020	18,408	0.13	2,393	0.55	2,200	1,210	1.98	4
2025	23,860	0.13	3,102	0.55	2,200	1,210	2.56	4
2030	33,895	0.13	4,406	0.55	2,200	1,210	3.64	4
2035	54,890	0.13	7,136	0.55	2,200	1,210	5.90	4
2040	77,830	0.13	10,118	0.55	2,200	1,210	8.36	8
2045	102,861	0.13	13,372	0.55	2,200	1,210	11.05	10
2050	116,395	0.13	15,131	0.55	2,200	1,210	12.51	12

Case 2

Year	Ntbnam	K	N_k	Z	N_{ttmax}	N_{tk}	Nlk	No. of lane
2020	17,229	0.13	2,240	0.55	2,200	1,210	1.85	4
2025	24,016	0.13	3,122	0.55	2,200	1,210	2.58	4
2030	33,895	0.13	4,406	0.55	2,200	1,210	3.64	4
2035	54,890	0.13	7,136	0.55	2,200	1,210	5.90	6
2040	71,356	0.13	9,276	0.55	2,200	1,210	7.67	6
2045	86,809	0.13	11,285	0.55	2,200	1,210	9.33	8
2050	107,985	0.13	14,038	0.55	2,200	1,210	11.60	10

Case 3

Year	Ntbnam	K	N_k	Z	N_{ttmax}	N_{tk}	Nlk	No. of lane
2020	18,977	0.13	2,467	0.55	2,200	1,210	2.04	4
2025	30,653	0.13	3,985	0.55	2,200	1,210	3.29	4
2030	41,070	0.13	5,339	0.55	2,200	1,210	4.41	4
2035	61,000	0.13	7,930	0.55	2,200	1,210	6.55	6
2040	97,311	0.13	12,650	0.55	2,200	1,210	10.45	10
2045	110,817	0.13	14,406	0.55	2,200	1,210	11.91	12
2050	141,907	0.13	18,448	0.55	2,200	1,210	15.25	14

Source: JICA Study Team

Table 4.61 No. of Lanes Calculated Based on Demand Forecasting

Year \ Case	F/S in Vietnam		Case 1		Case 2		Case 3	
	Traffic volume (vehicle/day)	No. of lane	Traffic volume (vehicle/day)	No. of lane	Traffic volume (vehicle/day)	No. of lane	Traffic volume (vehicle/day)	No. of lane
2020	24,391	4	18,408	4	17,229	4	18,977	4
2025	38,070	4	23,860	4	24,016	4	30,653	4
2030	59,941	4 or 6	33,895	4	33,895	4	41,070	4
2035	65,169	6	54,890	4	54,890	6	61,000	6
2040	70,853	6	77,830	8	71,356	6	97,311	10
2045	–	–	102,861	10	86,809	8	110,817	12
2050	–	–	116,395	12	107,985	10	141,907	14

Source: JICA Study Team

Chapter 5 Construction Plan

5.1 Summary of Studies on Construction Planning

5.1.1 History of Technical Studies

(1) Feasibility Study by Vietnam

A feasibility study (F/S) was performed in January 2012 on the Halong-Hai Phong Road (total length 25km). The technical discussions are summarized in Table 5-1 and correspond to Chapters 6 through 11, in which the Bach Dang Bridge was planned as a pre-cast concrete cantilever bridge with a central span of 220 meters.

Subsequently, the above-mentioned F/S was amended in October 2012 for the 5 km section concerning the bridge construction. The review of the Basic Design in Chapter 9 summarizes the planning changes to the 5-km-long Bach Dang Bridge Construction Section, following the revised design conditions of the bridge entailing changes such as the change from a PC cantilever bridge to a cable- bridge. The changes and revisions in this F/S are as shown below:

- The river spanning portion of Bach Dang Bridge is changed from a PC Cantilever to a Cable-stayed Structure.
- The bridge type for the approach section is changed from a Super-T girder to a mixed Super-T / Steel I-Girder type.
- The section traversing the Hanoi-Hai Phong Highway is changed from an overpass to an underpass.
- Following the change to an underpass, the overall profile alignment is changed. (The roadway height is lowered.)

Table 5.1 Summary of Study Contents

	Vietnam F/S (January 2012)	｢ Vietnam F/S (October 2012)
Study Subject	Halong-Hai Phong Highway	Bach Dang Bridge
Technical Analysis and composition of Study Report	Chapter 6 Natural Conditions Chapter 7 Procurement of Construction materials Chapter 8 Road types/standards and main technical standards Chapter 9 Review of Road (Route Review) Chapter 10 Design of Interchange & Highway Chapter 11 Design of Tunnels & Bridges	Chapter 6 Natural Conditions Chapter 7 Procurement of construction materials Chapter 8 Road types/standards and main technical standards Chapter 9 Review of Basic Design Chapter 10 Construction Planning
Main Content	Bach Dang Bridge is planned as a PC bridge	The main span is changed to a cable-stay bridge and part of approach to Steel I Girders

Source: JICA Study Team

(2) METI F/S

The METI F/S was conducted in March 2013, based on the Vietnam F/S and the Schematic Design of Project facilities in the METI F/S was described and compiled as the “Contents of the Project and Technical Analysis”.

The Vietnam F/S was reviewed in the METI F/S and a summary of the changes to the Vietnam F/S was prepared. The main design-related items in the METI F/S are shown in Table 5.2.

Table 5.2 Summary of Related Items in METI F/S

Compliance with Higher-Level Plans	The Halong-Hai Phong Highway was deemed to conform to higher-level plans and could be implemented without changing the latter. It will provide social/financial benefits to Vietnam and boost implementation of such plans.｢
Situation of the Bach Dang Bridge in the Bridge System	The Halong-Hai Phong Highway includes nine bridges (three of which are more than 3km long) which are planned to be built as PC bridges domestically procured in Vietnam. The Bach Dang Bridge (approximately 4.2 km long) is planned as the longest.
Project Route	The present route was selected and the lateral connection with Halong-Hai Phong Highway

	finalized as shown in Figure 5.1 following comparative analysis of alternatives.
Road Specifications	The Road Category is a Highway, Grade A, Design Speed 100km/h, mainly four lanes with plans to increase the capacity to six lanes by 2030.
Soil Investigations	Soil investigations were performed at 18 locations. (three of which within the Project area).
Conditions	The Navigation Limit for the Bach Dang Bridge was set at 48.8m from the sailing dimensions of 20,000DWTvessels (water level: +1.66m (20 year return average)) × width 180m each for two lanes.
	The height limit imposed for landings/takeoffs from Cat Bi Airport situated approximately 5km southwest of the bridge is 95 meters above water level within the Project Area.
Others	The development of the Dam Nha Mac area is not considered.

Source: JICA Study Team

Source: METI F/S

Figure 5.1 Lateral Connection with the Hanoi – Hai Phong Highway

Under the above circumstances, the Bach Dang Bridge, which is part of the Project Facilites, was planned in the METI F/S as described below and summarized in Table 5.3.

Table 5.3 Summary Table of Bridge Facilities

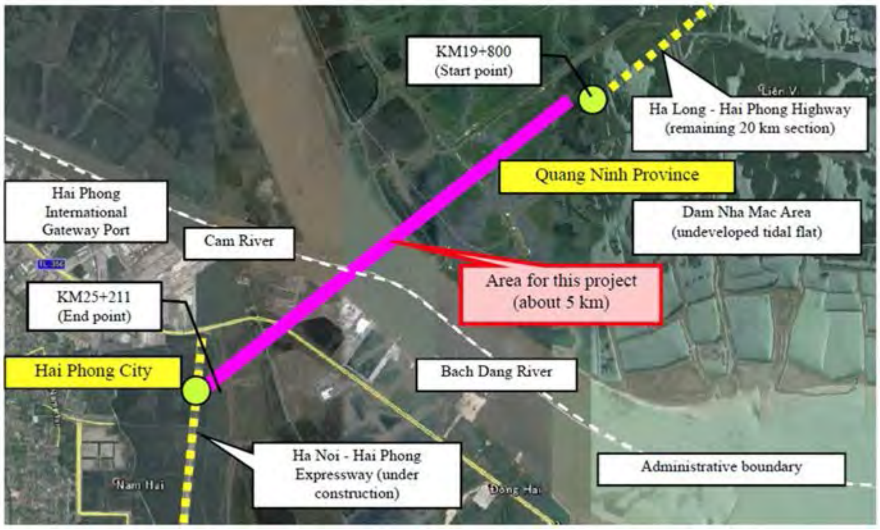
Item		Content
Project Section		· 5km of Halong-Hai Phong Bridge on the Hai Phong side · Start Point: KM19+800 · End Point: KM25+211 · It is noted that the operation area is assumed to be the entire length of the Halong-Hai Phong Highway (approximately 25km long)
Road Standards, etc.		· Road Standard: exclusively for motor vehicles, Grade II · Lanes: four lanes until 2025, planned expansion to six lanes by 2030 · Design Speed: 100km/h (80km/h after expansion to six lanes)
Hai Phong side IC The lateral connection with the Hanoi-Hai Phong Highway)		· Reinforced Concrete Box Culverts: L = 140m · U-type embankment walls: L = 115m + 125m═240m · L-type embankment walls: L = 80m ＋60m═140m · ON and OFF ramps: four locations
Bach Dang Bridge	Main Bridge	· Bridge type: four-span continuous cable-stayed bridge · Span lengths: 100m + 250m + 250m + 100m · Total width: B = 25m · Main Tower Type: Reinforced Concrete H shape main tower (Concrete Strength = 50MpA) · Tower Height: 93.5m · Stay Cable arrangement: cables on two sides, Fan type · Main Span Girder: Steel composite double I girders · Girder Height: 2.5m · Bridge Deck: RC Slab (Concrete Strength = 35MpA, Slab thickness: = 25cm) · Main Tower foundations: cast-in-place piles (Concrete Strength = 35MpA, diameter: = 2.5m)
	Approach Bridge	· Bridge Type: Steel continuous composite double I-girder bridge, Super-T girder Bridge

Item	Content
	· Span: 12x40m + 6x60 + 6x60 = 1,200m (Halong side) · 9x40m + 6x60 + 7x60 = 1,140m (Hai Phong side) · Total width: Up Lane: 12.25m, Down Lane: 12.25m · Main Girder: Steel composite double I-girder · Girder Height: 2.9m · Deck plate: RC slab (Concrete Strength = 35MpA, Slab thickness: = 25cm) · Pier Type: RC Rigid Frame (Concrete Strength = 35MpA) · Bridge Abutments: Reinforced Concrete (Concrete Strength = 30MpA) · Foundation Structure: Cast-in-place Concrete Piles: (Concrete Strength = 35 MpA, diameter: = 1.5m)
Halong side IC & Approach Road (Dan Nha Mac Area)	· KM21+731～KM19+800 · Toll Gates (eight), vicinity should be widened with queuing vehicles in mind
Others	· Toll Collection Stations, Operation Office, Memorial hall

Source: METI F/S

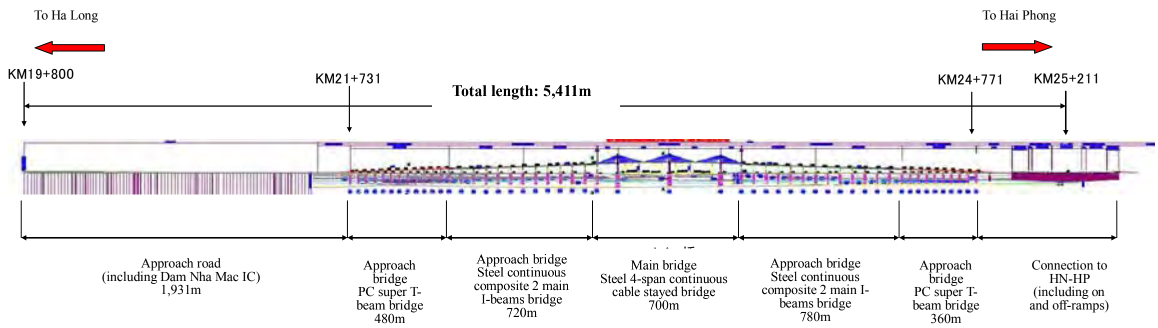
5.1.2 Study Policy for Analysis in This Study

Since the main project components shown in the above Summary of Project Facilities (Table 5.3) are already under procedures for Project approval, based on the Vietnam F/S, major changes to road Standards, Bridge Types, etc. are not advisable unless for compelling reasons. Accordingly, during the schematic design and cost estimation, the results of the various technical analyses and cost estimations in the Vietnam and METI F/S will be reviewed, challenges identified and analysis for additions and optimization performed to confirm the technical appropriateness to further improve projection accuracy. A Detailed Site Drawing and a Schematic Drawing of Facilities are shown in Figure 5.3.



Source: JICA Study Team

Figure 5.2 Detailed Site Drawing



Source: JICA Study Team

Figure 5.3 Diagram of Project Facilities

Based on the previous analytical results, the basic policies for this Study are summarized below.

Study Policy -1: Confirmation and Organizing of Basic Conditions

Basic conditions (applicable standards, laws and regulations, natural conditions, road conditions, etc.) for road planning, bridge design, construction planning and cost estimation and operation and maintenance planning will be verified and organized in consultation with relevant authorities while utilizing the existing design. In particular, the contents of conditions which remain as proposals (position of navigation channels on the Bach Dang River, Construction Yard sites, costs related to customs taxes on import/transport of materials and equipment, planning of ICs and Toll Gates, etc.) shall be re-proposed to the relevant authorities within the scope of this Study and written agreement obtained to prevent design reversals.

In this Report, the confirmed results of discussions with relevant authorities concerning the basic conditions for road design, bridge design, construction planning/cost estimation and operation and miantenance as well as existing design items still only at proposal level are iterated.

Study Policy -2: Road Planning

Road planning in the existing design stipulates the proposed route, road specifications and geometric structure. However, the design of road structures, analysis of soft ground countermeasures and the establishment of speed-change lanes before/after the toll gates are not addressed, while the horizontal/profile coordinates for major points of road alignment and profile drawings and ancillary facilities such as signage/lighting remain as rudimentary schematic drawings or at the proposal level.

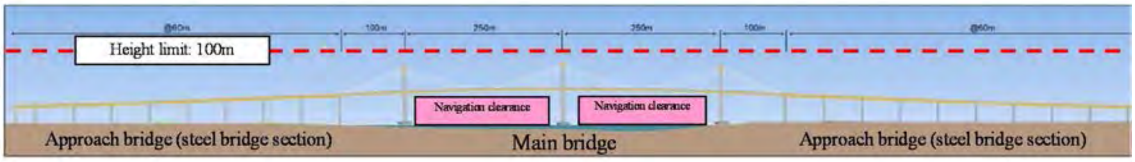
Accordingly, a review and comprehensive analysis of the existing design will be conducted. In particular, a change in Profile Alignment has been proposed in the METI F/S from the Vietnam F/S. Accordingly, longitudinal and transverse sectional drawings for major road alignment points will be prepared to clarify the positional relationship between proposed land aquisition/Project Facilities and obstructions/conflicting objects and provisions for appropriate clearence and the effect on connecting roads will be reflected in the design.

Furthermore, to clarify the demarcation between this Project and the connecting Hanoi-Hai Phong Highway as well as the remaining 20km portion of the Halong-Hai Phong Highway and also clarify the timing and construction method of the expansion to meet growing traffic volume, discussion with relevant authorities (MOT, Quan Ninh Province, Hai Phong City, et al.) and adajacent implementation bodies (VIDIFI, et al.) will be held.

In this Report, the confirmed results of discussions with relevant authorities concerning the basic conditions for road design, bridge design, construction planning/cost estimation and operation and miantenance as well as existing design items still only at proposal level are iterated.

Study Policy -3: Bridge Planning

The Project Facilities of the Bridge are shown in Figure 5.4. The Project comprises the main span over the Bach Dang River (steel 4-span continuous cable-stayed bridge) and the Approach Bridge (steel continuous composite double I-section girder bridge + PC super-T girder bridge). The restrictions in the Main Bridge area include the Navigation Limit for two Navigation Channels (180m wide, 48.4m high) determined by the passage for ships and the Height Limit imposed by the take-off/landing requirements from Cat Bi Airport situated approximately 5km southwest of the bridge. (100m above National Water Level).



Source: JICA Study Team

Figure 5.4 Obstructions and Restrictions in the Site Vicinity

The analysis of the sub- and superstructures of the bridge design are closely related to the contents involving analysis of construction planning/cost estimation and operation and maintenance planning. Accordingly, the Study will be conducted under close cooperation and with sharing of information.

Since the existing substructure designs are only schematic, comprising preparation of schematic drawings of representative substructure elements, the present Study will determine the depth of the bearing stratum at each substructure position and whether or not any temporary diversion is required. In particular, since the main span will be constructed in the river over Navigation Channels, the use of Steel Pipe Sheet Piling (SPSP) will be considered to determine the optimum configuration from economic and safety perspectives. Analysis of the superstructure will focus on its steel and concrete composite construction and the stringent height restrictions imposed on the main towers through the Height Limit and determine the applicability and appropriateness of the existing design.

In this Report, analysis of the depth of the bearing strata, investigations on temporary diversions, considerations for construction activities in the active navigation channels in rivers and optimization to secure economy and safety were performed at each substructure position for the Substriucture. Conversely, the investigations into details of completed works in Vietnam for Steel Pipe Sheet Piles (SPSP) foundations are still underway and the results have been left for the next stage. With regard to the superstructure, investigations into steel/concrete composite structures and structural analysis based on height limits of the towers of the Main Bridge have been performed.

Study Policy -4: CONSTRUCTION PLANNING AND COST ESTIMATION

The construction planning will be determined to optimize the financial and construction period in relation to bridging site restrictions. The construction methods analyzed will then be compared to determine the period where construction is possible (dry/wet season, river levels, typhoon, etc.), feasibility of overnight work and safety measures, surrounding facilities, site topography and production/material yards, (temporary) construction roads, dumping grounds for excess soil will be considered based on existing road conditions. Steel Pipe Sheet Piling (SPSP) will also be considered and the superiority of Japanese construction techniques will be verified.

To determine the feasibility of construction planning, the local labor situation (availability of skilled workers/technicians, both in Vietnam and abroad, transportation methods and costs, labor costs, etc.), material procurement situation (supply of materials, prices, import countries and transportation methods and costs), equipment procurement situation (domestic availability of on-land and over-water construction equipment, unit price, availability of procurement from overseas suppliers, transportation costs and insurance fees, etc.) and various procedures required will be delineated and formulated into a plan that can be feasibily implemented.

The Construction Cost and Project Cost Estimate will be calculated from the quantities derived from the above analysis and road/bridge planning

In this Report, analysis of the optimization of Construction Planning for the economy and construction period have been performed based on the conditions at the bridge site. However, work to investigate and analyze the suitability of overnight construction, safety measures and sites for the disposal of excavated earth have been left for the next stage since the investigations remain underway.

Rough estimates of the Construction Cost and Project Cost in this Report have been prepared based on the Road Design, Bridge Design and Construction Planning described in this Report.

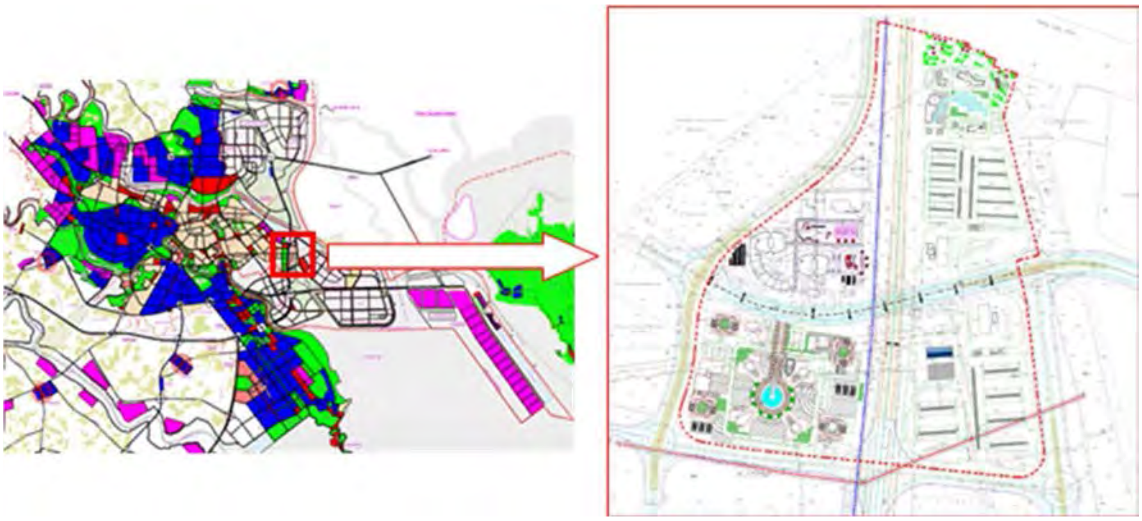
5.2 Site Investigation Results

5.2.1 Results of Investigation

(1) Technical Challenges

1) Influence of Hai Phong Urban Planning on Bridge Design

The existence of an Urban Plan for Hai Phong City (Figure 5.5) on the Hai Phong side that was not identified in the Vietnam F/S was discovered and the position of bridge piers in the Vietnam F/S was confirmed as interfering with a planned road.



Source: Decisions 1448/QĐ-TTg and 113/QD-UBND dated 01/14/2013

Figure 5.5 Urban Planning of Hai Phong City

2) Effect of Dam Nha Mac side Road (embankment construction)

An area in the vicinity of Halong side Bridge is presently used as a shrimp farm. Shrimp farming uses water pumped from nearby seas and road embankments will possibly interfere with water usage and movement of those involved in farming.

3) Requirement for analysis of the Bridge Foundation Type

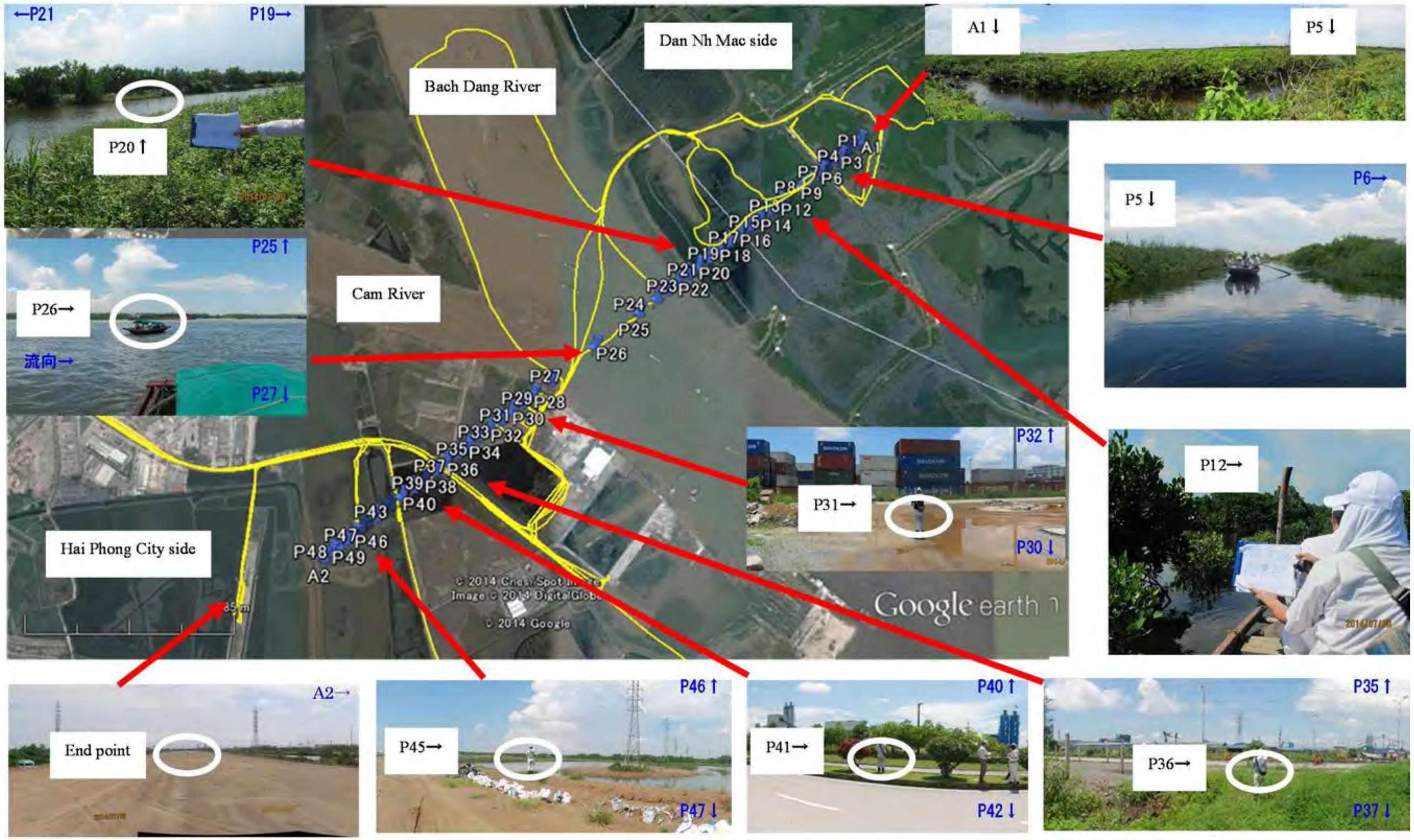
The Vietnam F/S has adopted cast-in-place concrete piles for the Main Bridge foundations. Conversely, it was established that a Vietnamese bridge of similar scope adopting steel pipe sheet piling (SPSP) foundations exists with Japanese technology. The advantages of adopting SPSP foundations are listed below:

- Using large-diameter steel pipes boosts large cross-sectional performance, allowing self-standing retaining walls, which are advantageous for constructions in deep water.
- The flexural rigidity is high and the structure can withstand large horizontal forces.
- It can support large vertical loads if embedded into bearing soil strata.
- Corrosion-resistant and durable structures can be achieved by adopting high-tensile steel or seawater corrosion-resistant steel.

A comparative analysis of the cast-in-place concrete foundations adopted in the Vietnam F/S and the SPSP foundations with a track record in Vietnam should be carried out.

5.2.2 Status of Position of Each Substructure

The results of the investigations into the situation at each substructure position are summarized in Figure 5.6.



Source: JICA Study Team

Figure 5.6 Confirmation of Status at Each Substructure Position

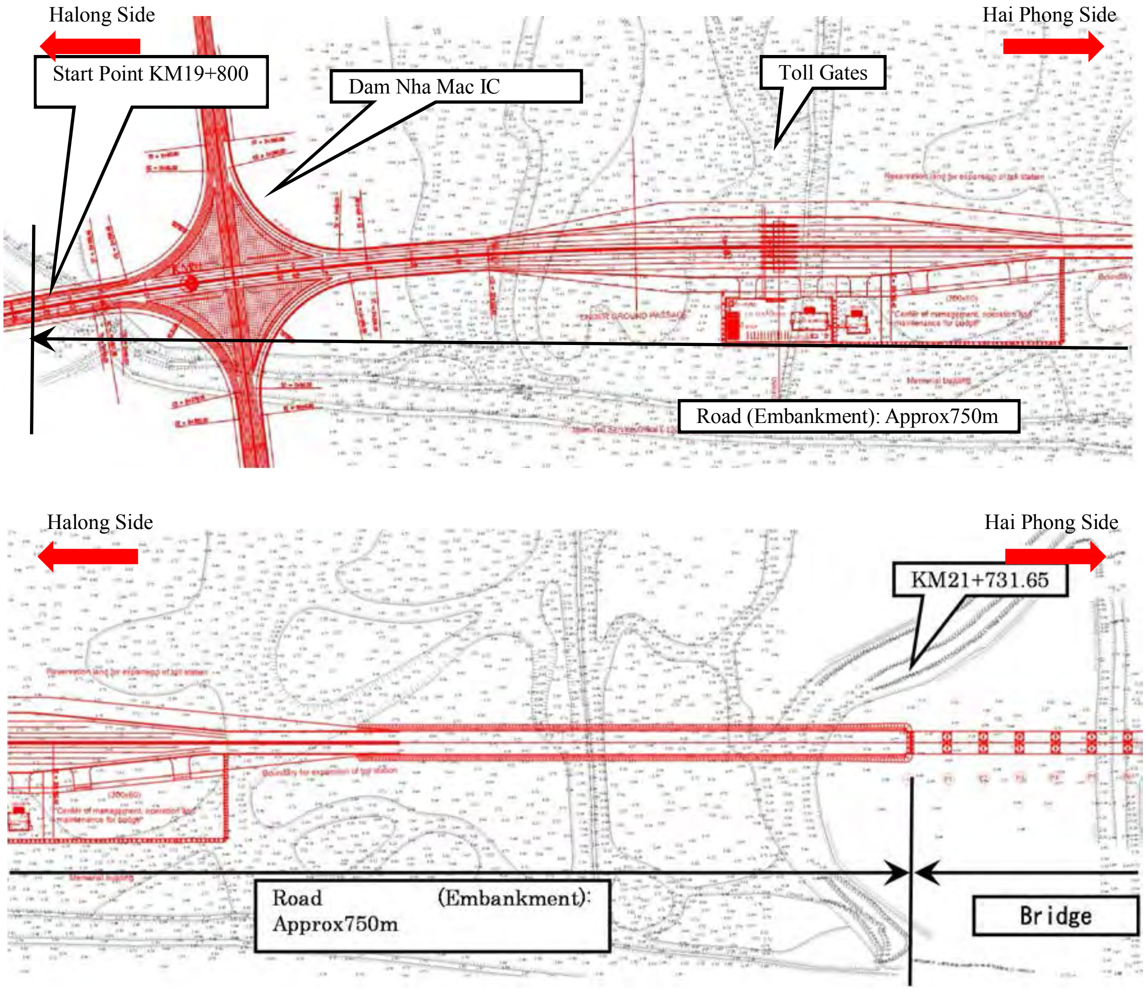
5.3 Design Review

A review of the design analysis in both Vietnam- and METI F/S were conducted. The results will be observed in light of the basic Analysis Policy and optimization will be reflected in the Schematic Design and Construction Planning of this Study.

5.3.1 Summary of the Existing Design

(1) Halong side Road Section

The start point of the subject facilities for review is located at KM19+800 in the Dam Nha Mac area. An IC is located near the starting point and facilitates entry/exit to the Dam Nha Mac area. A Toll Gate will be constructed at approximately 500 meters toward the ending point from this IC and the road will be constructed on embankments until about 750m further toward the ending point. The development within Dam Nha Mac area under this Study currently remains unclear, while the design of the IC structure is not included in this Study, since access to the IC cannot be clarified.



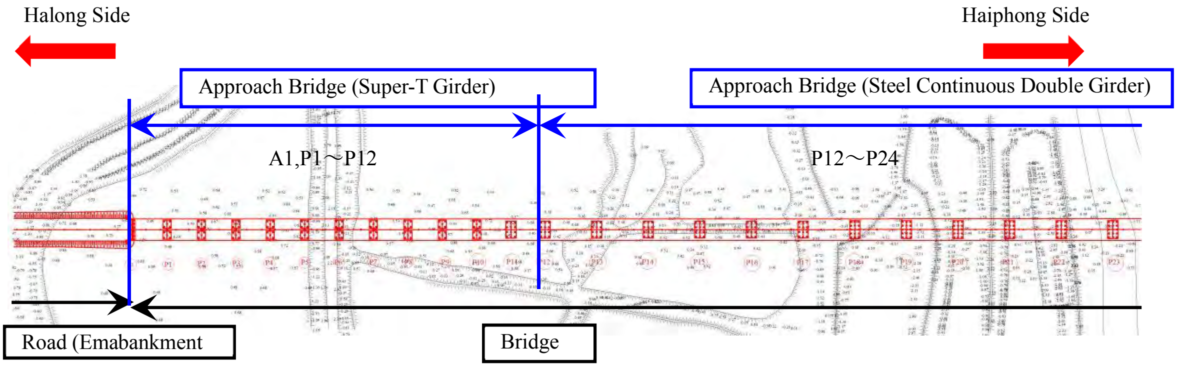
Source: JICA Study Team

Figure 5.7 General Schematic Drawing (Halong side)

(2) Halong side Approach Bridge and Main Bridge Section

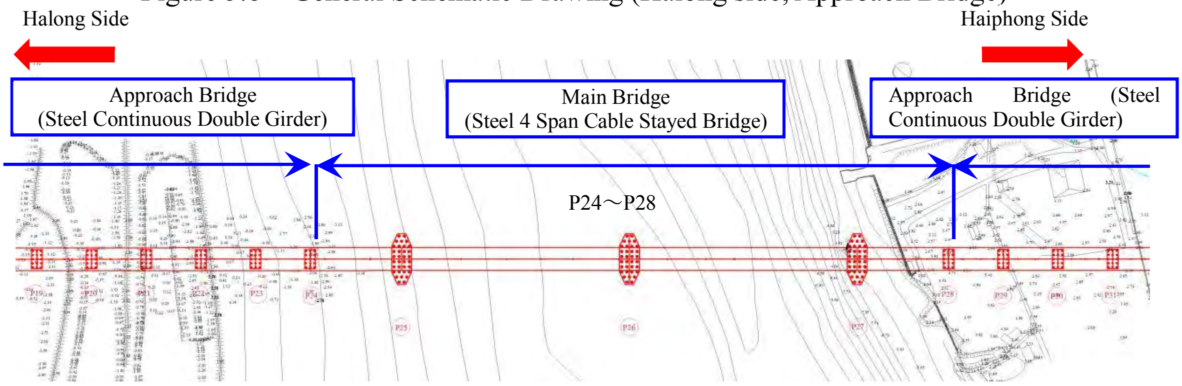
The bridge section starts from KM21+731.65, traversing the Bach Dang River and continuing up to KM24+771.65 on the Hai Phong side.

The bridge section is divided into the Approach Bridge and Main Bridge sections traversing the Bach Dang River. The Approach Bridge section features a Super-T girder bridge (PC Bridge) and Steel Composite Double I-Girder Bridge, both of which are popular in Vietnam. The Main Bridge section is a Steel 4 Span Continuous Cable-Stayed Bridge.



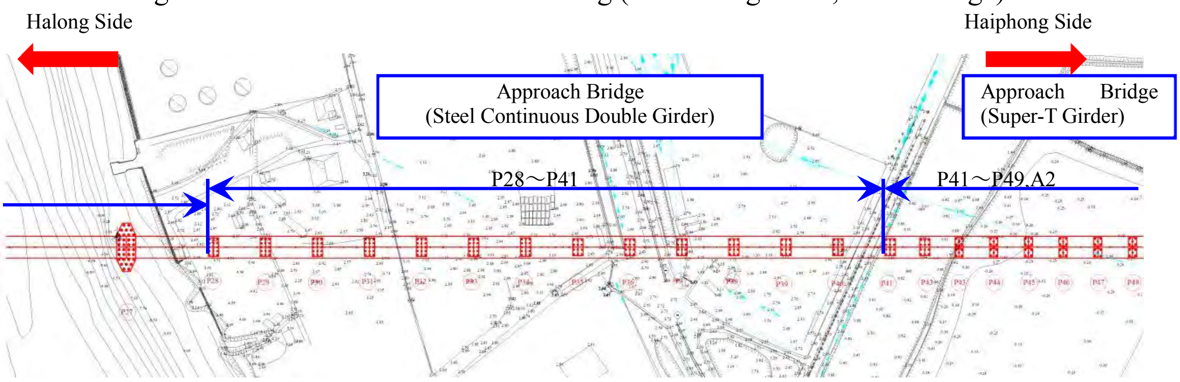
Source: JICA Study Team

Figure 5.8 General Schematic Drawing (Halong side, Approach Bridge)



Source: JICA Study Team

Figure 5.9 General Schematic Drawing (Bach Dang River, Main Bridge)

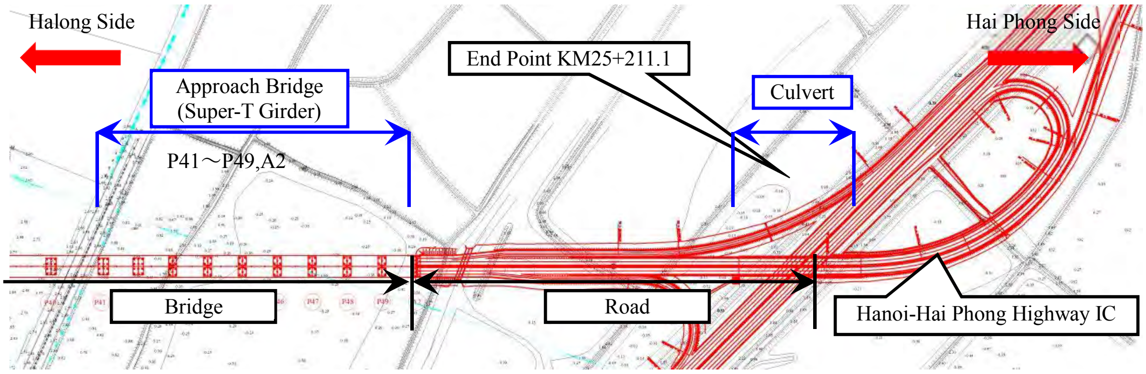


Source: JICA Study Team

Figure 5.10 General Schematic Drawing (Hai Phong side, Approach Bridge)

(3) Hai Phong side Approach Bridge and Road Section

From KM24+771.65 on the Hai Phong side, the road continues as an embankment and culvert that passes under the Hanoi-Hai Phong Highway before connecting to the Hanoi-Hai Phong Highway. The End Point is the connection to the Hanoi-Hai Phong Highway at KM25+211.10.



Source: JICA Study Team

Figure 5.11 General Schematic Drawing (Hai Phong side Facilities)

5.3.2 Review of the Vietnam F/S Schematic Design

(1) Notable Items in Existing F/S

The optimization analysis focused on the following points from the Vietnam- and METI F/S analyses:

- technical analysis of the design change of the Bach Dang Bridge superstructure
- technical analysis of horizontal and Profile Alignment of road structure
- detailed technical analysis of construction of soft soil measures
- analysis of construction plan feasibility
- detailed review of costs estimate for Project structure and temporary roads based on Vietnam F/S and the superstructure construction method.

(2) Notable Items from On-Site Investigations

The optimization analysis focused on the following points on the previously mentioned site. Investigations are summarized as follows:

- The effect of Hai Phong City Urban Planning on the bridge design.
- The effect of the road (embankments) on the Halong side.
- Need for Analysis of the Bridge Foundation Type.

5.3.3 Summary of Review Results

The Vietnam- and METI F/S were reviewed and items for optimization analysis were identified. The items and summary are shown in Table 5.4.

Table 5.4 Summary of Design Review Results (Optimization Analysis Items)

No.	Item	Status and in the Vietnam F/S	Optimization Policy
1	Appropriateness analysis of superstructure	If the bridge is designed as a PC cantilever based on Vietnam F/S, analysis to meet the requirement to secure the position for the two Navigation Limits and Navigation Channels. In addition, the METI F/S has changed the PC cantilever to a cable-stayed design, an analysis of the Height Limit must be considered for such designs.	The appropriateness of steel cable-stayed design is to be shown for navigation limits and Height Limit through design analysis.
2	Analysis of horizontal and profile road alignment	The longitudinal slope for the approach road or Main Bridge on the Halong side is designed as 0% (Level). Discrepancies are observed from the Japanese design standards, which require a minimum 0.3% slope for surface drainage.	A revised Profile Alignment design will be proposed to facilitate surface drainage.
3	Analysis of soft soil	Only standard specifications are described for the soft soil countermeasures of the road section and no detailed proposals are shown.	A schematic design of the road section will be performed and detailed countermeasures prepared to estimate the construction cost. In addition, the following soft soil countermeasures proposed in the Vietnam F/S will be analyzed for appropriateness: ① Vertical drain method ・Sand drain method ・PVD ② Vibration Compaction Method ・Sand Compaction Method
4	Design analysis of culverts on the Halong side	Vietnam F/S has no particular mention. On-site investigations have revealed that they are used in shrimp cultivation and road embankments are in danger of dividing the community.	Analysis will be conducted to secure cross traffic in road embankments situated within shrimp farms by designing with box culverts below.
5	Analysis of bridge design affected by urban planning and city road widening on the Hai Phong side	Urban planning and city road widening plans were discovered on the Hai Phong side that had not been noted in the Vietnam F/S. Some works have been commenced at present and information was obtained during this Study. A review revealed that the present position of the bridge pier interfered with the planned road.	A proposal will be prepared which maintains the position of the bridge pier in the Vietnam F/S and resolves the interference caused by partial improvements to the road.
6	Analysis of the Main Bridge foundation type	The Main Bridge foundations are cast-in-place concrete piles in the Vietnam F/S. It was discovered that similar scale bridges using Japanese technology of Steel Pipe Sheet piles existed in Vietnam.	Cast-in-place piles and steel pipe sheet piling will be compared and design changes will be made if SPSP is found to have more advantages.
7	Construction planning	In the following construction plan, drawings have been prepared in the Vietnam F/S: Plan for temporary construction road ・Schematic construction drawing of open-pit excavation for Approach Bridge pier. ・Schematic construction drawing of steel sheet shoring for Approach Bridge pier. ・Schematic construction drawing of Main Bridge work using gantry and tower crane ・Approach Bridge construction drawing	This review will formulate feasible construction plans, taking the following items into consideration: ・ Size, scope, need for bridges in temporary construction roads ・ Appropriateness of construction cranes ・ Main Bridge pier construction and bridge erection method. These results will be reflected in the cost estimate.

No.	Item	Status and in the Vietnam F/S	Optimization Policy
		for crane construction · Main Bridge construction using LD	
8	Review of Project Costs Estimate	In the METI F/S the construction cost was estimated as 5,213×10^9VND (20,051 million Yen). In addition, the cost of acquiring land, project administration, consultant fees and reserve fees were included, reaching 6,640.7×10^9VND (approx. 25.5 billion Yen) without escalation and 7,999.3×10^9VND (approx. 30.8 billion Yen) with escalation.	The quantities for bridge structures and temporary roads and others will be scrutinized and the erection costs of the superstructure will be adjusted according to the construction method to refine the costs estimates. The quantities for structures will be refined by deriving dimensions from road longitudinal section height, depth of bearing stratum and formation level of bottom slabs. Quantities for temporary roads will be refined by clarifying the use of heavy machinery and adjusting construction planning to reflect the use of erection yards. Bridge erection will also be refined by preparing a realistic construction plan based on completed projects in Vietnam and deriving construction quantities from the same.

Source: JICA Study Team

5.3.4 Analysis Policy and relation to Design Review

The relation between the Analysis Policy of this Study and the previously summarized results of Design Review (Optimization Items) are shown in Table 5.5

Table 5.5 Relation between Analysis Policy and Design Review (Optimization Items)

Analysis Policy		Items for Analysis of Optimization	Analysis of this Study
Analysis Policy-1	Confirmation and review of Basic Conditions	No items applicable	Described in the "Review of Conditions in preparation of Construction Planning"
Analysis Policy -2	Road Planning	Analysis of horizontal and profile road alignment	Described in the "Road Design/ Analysis of Horizontal and Profile Alignment"
		Analysis of soft soil conditions	Described in the "Road Design/ Analysis of Soft Soil
		Analysis of Box Culvert structure on the Halong side	Described in the "Road Design/Design of Box Culvert "
Analysis Policy -3	Bridge Planning	Analysis of appropriateness of superstructure	Described in the "Bridge Design/ Main Bridge-Superstructure"
		Analysis of bridge design affected by urban planning and road widening on the Hai Phong side	Described in the "Bridge Design/ Analysis of Bridge design affected by urban planning and road widening on the Hai Phong side
		Analysis of Main Bridge foundation type	Described in the "Bridge Design/Main Bridge-Substructure"
Analysis Policy -4	Construction Planning and Cost Estimate	Analysis of Construction Planning	Described in the "Construction Planning"
		Review of Cost Estimate	Described in the "Cost Estimate / Project Cost Estimation"

Source: JICA Study Team

5.4 Review of Conditions in Preparation for Construction Planning

5.4.1 Design Standards

The Design Standrads applied in the Vietnam- and METI F/S have been reviewed in this Study and the standards and geometric design standards applied in this Study are shown below. Any content not covered by these standards will be designed to Japanese standards

Whenever Japanese Standards have been employed due to lack of clarification on Vietnam standards and the resulting changes to items in the technical study are significant, the values used in Vietnam approval procedures based on Vietnam F/S have been employed in this Report. These Technical Review Items must be verified to avoid design defects during Detailed Design; following consultations with relevant Vietnam authorities on the technical basis.

(1) Design Standard Documents

The documents in Table 5.6 have been applied in this Study.

Table 5.6 Design Standard Documents

Category	No	Applicable Standards	CODE
Bridge Design	1	Specification for Bridge Design (2007) – Design live load: HL - 93, pedestrian loads: 0,3 MPa ; – Design frequency P= 1%.	22 TCN 272-05
	2	Loads and Actions - Design Code (2nd Ed.)	TCVN 2737:1995
	3	Guidance for determination of dynamic component of the wind loads under TCVN 2737:1995	TCXD 229:1999
	4	Impacts by shrinkage and creeping	CEB-FIP 1990
	5	Seismic design	TCVN 9386:2012
	6	Technical standard on prestressed concrete anchors T13, T15 & D13, D15	22TCN 267-2000
	7	Hot reinforced concrete	TCVN 1651-08
	8	Prestressed cable for concrete	ASTM A416M
	9	Technical standard on structural steel	ASTM A36-00A
	10	Technical standard on welded and casted steel tube	ASTM A53-990
	11	Technical standard on reinforced rubber bearing	22 TCN 217-94
	12	Technical standard on Pot bearing	ASTM D5212-03
	13	Technical standard of expansion joint	AASHTO M297-96
	14		AASHTO M183-96
	15	Prestressed concrete product – Requirements of technical and acceptance	TCVN 9114:2012
	16	Reinforced concrete structure– Design standard	TCVN 5574:2012
	17	Concrete and reinforced concrete structures – Requirementd[sic] of protection from corrosion in marine environment	TCVN 9346:2012
	18	Reinforced concrete - Determining corrosion activity of reinforcing steel - Potential method	TCVN 9348:2012
	19	Process on designing temporary structure for bridge construction	22TCN 200-89
	20	Technical classification of domestic waterway	TCVN 5664-2009
	21	National technical regulation on Vietnam Inland Navigation Aids	QCVN 73:2011/BGTVT
	22	Amending and supplementing rules on signaling of domestic waterway in Vietnam	11/17-01-2005/QĐ-BGTVT
Road Design	23	Freeway / Expressway – Specification for Design	TCVN 5729-1997
	24	Expressway – Specifications for design	TCVN 5729-2012
	25	Highway – Specifications for Design (3rd Ed.)	TCVN 4054-2005
	26	Urban way – Design requirements	TCXDVN 104-2007
	27	Rural road – Design standard	22TCN 210-92
	28	Rigid pavement - Design requirements	22TCN 223-95
	29	Design standard for flexible pavement	22TCN 211-2006
	30	Process on embankment investigation embankment construction	22TCN 262-2000
	31	Process on designing, handling soft soil by vertical artificial drain in embankment construction	22TCN 244-98
	32	Consolidating soft soil – Cement soil pillar method	TCVN 943:2012
	33	National technical norm on signaling road	QCVN 41:2012/BGTVT
	34	Direction signs on highway	22TCN 331-05
	35	Fluorescent reflector screen in signaling road	TCVN 7887-2008
	36	Calculation on characteristics of flood flow	22TCN 220-95
	37	Standard on drainage	TCXD 51-84
	38	Design drainage network outside works	TCVN 7957-2008
	39	Reinforced concrete box culvert	TCVN 9116:2012
	40	Reinforced concrete drain	TCVN 9113:2012
	41	Standard on lightning works	TCXDVN 259-2001

Source: JICA Study Team

(2) Geometric Design Standard

The Geometric Design Standard documents in Table 5.7 have been applied in this Study.

Table 5.7 Geometric Design Standard Document

Design Element				Type / Standard: Until 2025	Type / Standard: Until 2030	Source
Road Category				Grade A (Exclusive motor-vehicle road)		1734/QD-TTg of December 2008
Road Standard				Level II		TCVN 4054-2005
Design Speed	Main Road Section			100km		TCVN 4054-2005
	Bridge Section			100km	80km	
	IC Section			60km		
Lateral Section Composition (Main Road)	Lane number			Four lane	Six lane	TCVN 4054-2005
	Total of Main road/ lateral section			25.50m	33.00m	TCVN 5729-1997
		Median strip width		1.5m	1.5m	TCVN 5729-1997
		Road shoulder width		2×0.75m	2×0.75m	TCVN 5729-1997
		Lane width		2×2×3.75m	2×3×3.75m	TCVN 5729-1997
		Emergency vehicle lane width		2×3.00m	2×3.00m	TCVN 5729-1997
		Planting strip width		2×0.75m	2×0.75m	TCVN 5729-1997
	Bridge section/lateral section total			25.00m	25.00m	METI F/S
	Lateral slope		Motor lane	2.0%		TCVN 5729-1997
			Shoulder	4.0%		TCVN 5729-1997
			Protective shoulder	6.0%		TCVN 5729-1997
	Slope of embankment (embankment)			1:1.5	1:2.0	METI F/S
Horizontal alignment (Main road)	Minimum radius (100km/h)		Standard value	700m		TCVN 5729-1997
			Special case value	400m		TCVN 5729-1997
	Cant (maximum cant)			7%		TCVN 5729-1997
	Minimum easement curve length (100km/h)		Recommended	210m		TCVN 5729-1997
			Standard length	150m		TCVN 5729-1997
Longitudinal Profile Alignment (Main road)	Maximum longitudinal slope (100km/h)			5.0%		TCVN 5729-1997
	Maximum longitudinal slope (Down slope / 100km/h)			5.5%		TCVN 5729-1997
	Longitudinal slope/ limit length (100km/h)		For 4% slope	800m		TCVN 5729-1997
			For 5% slope	600m		TCVN 5729-1997
	Longitudinal curve (100km/h)	Convex	Standard length	10000m		TCVN 5729-1997
			Special case	6000m		TCVN 5729-1997
		Concave	Standard length	5000m		TCVN 5729-1997
			Special case	3000m		TCVN 5729-1997
		Longitudinal curve length		85m		TCVN 5729-1997
Lateral Section Composition (IC section)	One way / single lane type	Total section		8.50m		Road Structure Ordinance (Japan)
			Shoulder	3.50m = 1.00m + 2.50m		(See above)
			Lane width	3.50m		(See above)
			Planting zone width	1.50m = 0.75×2		(See above)
	One way / double lane type	Total section		12.00m		(See above)
			Shoulder	2.0m = 1.0×2		(See above)
			Lane width	8.50m = 4.25×2		(See above)
			Planting zone width	1.5m = 0.75×2		(See above)

Source: JICA Study Team

5.4.2 Natural Conditions

(1) Topographic Survey

The technical standards for topographic surveys in Vietnam are shown in Table 5.8.

Table 5.8 Technical Standards for Topographic Surveys

No.	Technical Standard Number	Description of Technical Standard	Publish Date
1	TCXDVN 364-2006	GPS (Global Positioning System) in topographic survey	2006
2	96 TCN 43-90	Topographic Survey Guideline	1990
3	22TCN 263-2000	Investigation of motorways	2000
4	22TCN 262-2000	Investigation of motorway in soft soil areas	2000
5	83/2000/QD-TTg	Vietnamese Coordinate System (VN2000)	2000

Source: JICA Study Team

1) Vietnam F/S

In the Vietnam F/S, the route was surveyed for the entire 25km length of the Halong-Hai Phong Highway (Start point: KM0+000, End Point: KM25+211), with survey items including centerline / longitudinal section / lateral section surveys. The conditions for each route survey item are shown in Table 5.9.

Table 5.9 Route Survey Conditions for the Halong-Hai Phong Highway

Item	Condition
Scale	1/5000
Scope of survey	Motorway direction: start/end point +50m Lateral direction: Centerline +50m
Centerline survey	1/5000
Longitudinal section	Average 50m interval
Lateral section	Average 50m interval

Source: JICA Study Team

The Halong-Hai Phong Highway connects to National Road No. 18 and the Hanoi-Hai Phong Highway and the topographic survey under the conditions shown in Table 5.10 was conducted in the vicinity of the connections

Table 5.10 Conditions for Topographic Survey in Vicinity of Connections with National Road No. 18 & the Hanoi-Hai Phong Highway

Item	Condition
Scale	1/2000
Scope of survey	Motorway direction: IC area +50m Lateral direction:: Centerline +500m
Centerline survey (ramp)	1/200. Average 20m interval
ongitudinal section (ramp)	1/200. Average 20m interval. Cemterline +30/50m

Source: JICA Study Team

2) METI F/S

In the METI F/S, the topographic surveys limited to Bach Dang Bridge and the Approach Road under the conditions shown in Table 5.11 were conducted for the structural changes to Bach Dang Bridge and the longitudinal profile road alignment. In addition, the obstructions discovered as a result of the survey are shown in Table 5.12.

Table 5.11 Conditions of the Topographic Survey

Item	Condition
Scale	1/2000
Scope of Planner Survey	Load Direction: Bridge Pier +100m Cross Direction: Centerline + 500m (both up/down directions)
Elevation Survey	Altitude: m/200. Average 20m intervals

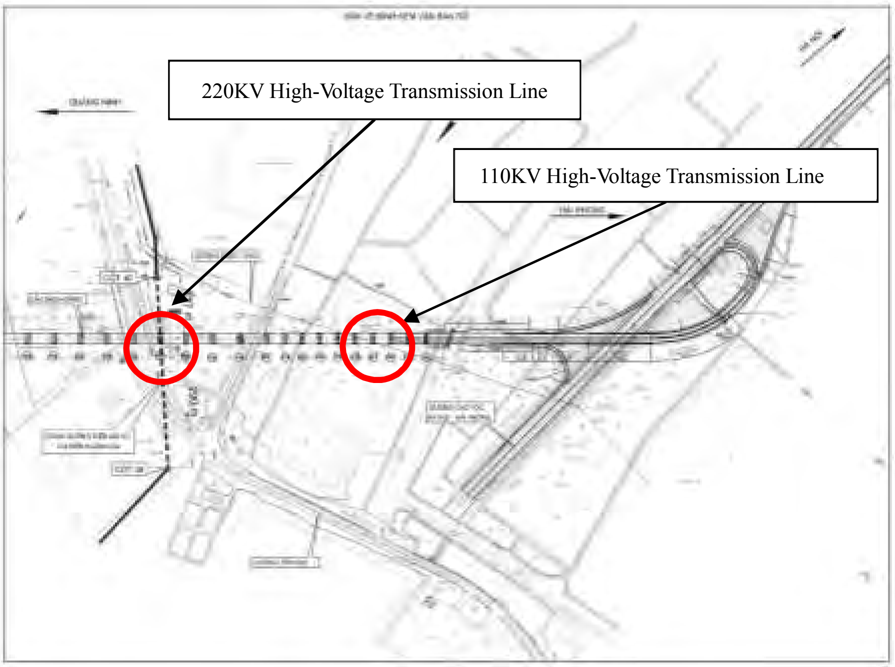
Source: JICA Study Team

Table 5.12 Obstructions with Project Facilities

No	Obstruction	Position	Responsible agency	Countermeasure
1	220 KV Power transmission line (The transmission line from the Hai Phong thermo power plant to Dinh Vu)	Km24+174	National Power Transmission Corporation	Move underground
2	110 KV Power transmission line (The transmission line from the Dinh Vu transformer)	Km24+620	Hai Phong Power Company	Adjust position, height of poles*

* The proposed adjustment will be submitted to the responsible agency after the Study Team analyzes countermeasures with a specialist consultant.

Source: JICA Study Team



Source: JICA Study Team

Figure 5.12 Obstructions with Project Facilities

(2) Hydrology & Watergate Investigations

The approach road will be constructed in the swamps on the Halong side (Quang Yen Town, Dam Nha Mac area). The design high water level for the approach road is based on the Vietnam Highway Design Standard (TCVN 5729-1997) and the Motorway Design Standard (TCVN_4054-2005). The water level for Flooding Probability of 1% will be applied. To calculate the design high water level, the Vietnam F/S has investigated the past high water marks of the three largest historical floods (1990, 2005 and 2008), which are shown alongside the design high water level in Table 5.13. The design high water level also takes into consideration the rise in sea level and wave surges due to climate change in addition to the 1% probability of flood water level.

Table 5.13 Design High Water Level for the Approach Road of this Project

Distance	Water Level of Maximum Historical Floods			Design High Water Level (m)	Notes
	1990	2005	2008		
Km18+820	1.86	2.08	1.95	2.84	Dam Nha Mac area
Km20+700	1.78	2.03	1.92	2.76	
Km22+000	1.86	2.47	2.08	3.11	

Source: JICA Study Team

The Navigation Limit of the Bach Dang Bridge was discussed and agreed between Quang Ninh Province, the project responsible agency, the authority for Ship Navigation and TEDI and the consultant for the Vietnam F/S. The water level for 5% probability of flooding of the Bach Dang River was applied to calculate the height of the Navigation Limit. The clearance for the navigation limit is calculated pursuant to Vietnam Domestic Waterways Regulations (TCVN 5664-2009).

The water level for 5% probability of flooding of the Bach Dang River: H5%=1.66m
Design water Level for 1% probability of flooding of the Bach Dang River: H 1%=3.23m

The river survey was conducted for two randomly selected points at 20-meter intervals within an area of 150m upstream/downstream of the Main Bridge centerline in the Vietnam F/S. Based on measurements at these two points, the Design River Discharge Q was set at 8563 (m3/s). Further, the river width at the bridge position was calculated as approximately 776m, when the average river width at the above two points is considered to be that at the bridge crossing point.

(3) Geological Survey

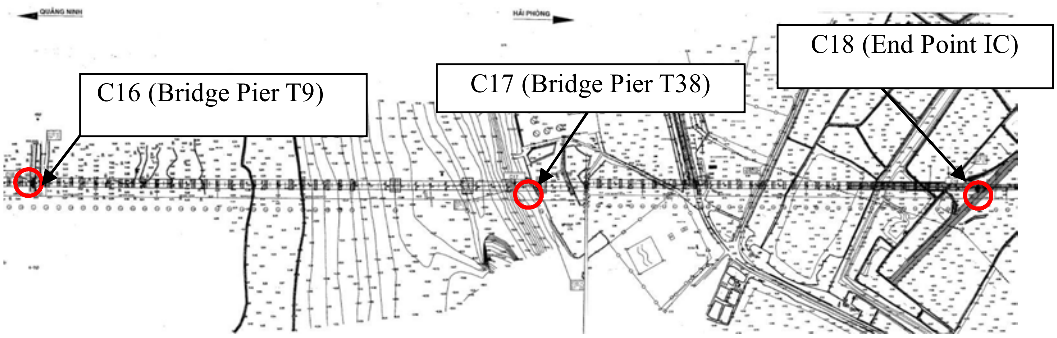
The Vietnam standards for the geological survey are shown in Table 5.14.

Table 5.14 Technical Standards for Geological Surveys

No.	Number of Applicable Standards	Description of Standard	Date published
1	22TCN 259-2000	Geological Investigations	2000
2	22TCN 263-2000	Investigation for Motorways	2000
3	22TCN 262-2000	Investigation for Motorways in Soft Soil Areas	2000
4	TCXDVN 226-1999	Implementation Guideline for site Investigation & SPT	1999
5	TCVN 2683-91	Core Sampling	1991
6	TCVN 4195-1995 ~ 4202-1995	Implementation Guideline for Laboratory Tests	1995

Source: JICA Study Team

Since 22TCN 263-2000 requires more than three geological surveys at bridge position during the feasibility study phase, geological surveys were performed at three locations (C16, C17, C18) related to the Bach Dang Bridge and Approach Road in the Vietnam F/S. The positions and details of the surveys are shown in Figure 5.13 and Tables 5.15 and 5.16.



Source: JICA Study Team

Figure 5.13 Location of Geological Surveys

Table 5.15 Position of Geological Survey for the Bach Dang Bridge conducted by Vietnam F/S

Boreholes		Coordinates		Height (m)	Note
Borehole	Position	X (m)	Y (m)		
C16	Km21+956.44	2307261.720	398363.648	2.12	Halong side Approach Bridge Section
C17	Km23+611.45	2306214.522	397081.868	2.16	Hai Phong side Approach Bridge Section
C18	Km25+183.00	2305232.621	395854.820	0.22	Hai Phong side IC Section

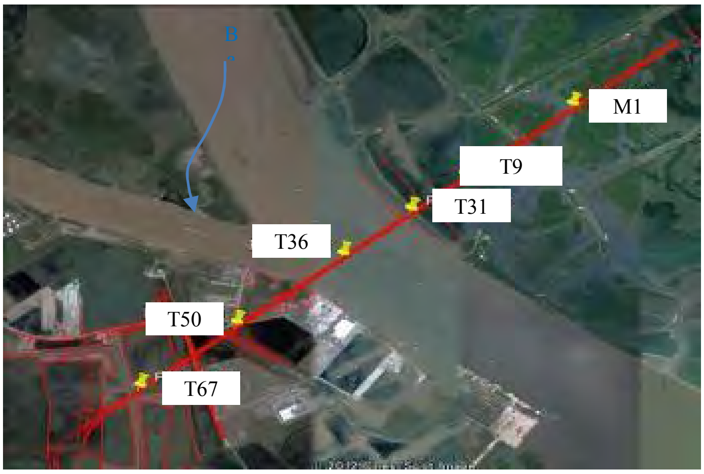
Source: JICA Study Team

Table 5.16 Details of Geological Survey for the Bach Dang Bridge

Borehole	Depth (m)	Soil Material Category		Laboratory Test			SPT	Note
		I-III	IV-VI	UD	D	R		
C16	45.50	39.80	5.70	15	3	3	18	On land
C17	51.00	40.80	10.20	20	0	4	20	On land
C18	56.70	43.50	13.20	17	3	4	20	On land
	153.20	124.10	29.10	52	6	13	58	-

Source: JICA Study Team

In addition to the Vietnam F/S mentioned above, METI F/S conducted additional geological surveys at 6 points as shown in Figure 5.14 and Table 5.17 and Table 5.18, as well as an analysis of the geological survey results from the Vietnam F/S.



Source: JICA Study Team

Figure 5. 14 Geological Survey conducted by METI F/S

Table 5.17 Position of the Geological Survey conducted by METI F/S

No.	Boring		Coordinates (m)		Height (m)	Note
	Borehole	Position	X	Y		
1	M1	Km21+589.58	2307490.180	398650.460	+0.130	Halong side Approach Bridge Section
2	T9	Km21+972.22	2307258.210	398364.140	+2.810	Halong side Approach Bridge Section
3	T31	Km22+824.35	2306712.910	397691.070	-1.600	Halong side Approach Bridge Section
4	T36	Km23+298.28	2306414.580	397322.840	-9.530	Main Bridge Section, In-river
5	T50	Km24+123.90	2305895.220	396681.010	+2.100	Hai Phong side Approach Bridge Section
6	T67	Km24+807.71	2305464.370	396150.010	+0.920	Hai Phong side Embankment Section

Source: JICA Study Team

Table 5.18 Details of the Geological Survey by METI F/S

No.	Borehole	Depth (m)	Laboratory Test				SPT (nos.)	In-hole Ground water observation device	Note
			UD	D	Rock	Water			
1	M1	71.0	10	9	40	-	19	-	38.2m: Sand soil 32.8m: Bedrock
2	T9	60.0	13	7	27	2	20	1	40.8m: Sand soil 19.2m: Bedrock
3	T31	69.4	16	2	62	-	18	-	37.3m: Sand soil 32.1m: Bedrock
4	T36	56.0	10	3	76	-	13	-	26.6m: Sand soil 29.4m: Bedrock
5	T50	60.21	14	3	45	2	17	1	35.4m: Sand soil 24.81m: Bedrock
6	T67	55.0	17	-	12	-	17	-	35.5m: Sand soil 19.5m: Bedrock
Total		371.61	80	24	262	4	104	2	

Source: JICA Study Team

The assumed load-bearing strata is shown in Figure 5.16 Soil Section Drawing, while the results of each borehole drilling having revealed load-bearing strata are shown in Table 5.19.

Based on the Vietnam- and METI F/S, the load-bearing strata is assumed to be as follows: The load-bearing strata is mudstone that emerged at a depth of 26.6m in the boreholes in the river. At the same borehole, the rock was heavily weathered between 26.6 - 34.6m. From a depth of 34.6m onward, the Rock Quality Designation (RQD) was roughly 80%, which was maintained down to 56.0m whereupon drilling was stopped. Strata 9c is confirmed as having compressive strength of 244.00kg/cm² from an unconfined compression test. Strata 9c is good quality bedrock that can be defined as load-bearing strata.

Table 5.19 Load-Bearing Stratum at Each Borehole (9c stratum)

Borehole	Depth of Load-Bearing Stratum (m)	Thickness of load-bearing stratum (m)
M1	-64.870	6.00
T9	-46.590	10.60
T31	-66.00	5.0
T36	-45.330	20.2
C17	-43.84	5.0
C18	-53.48	3.0

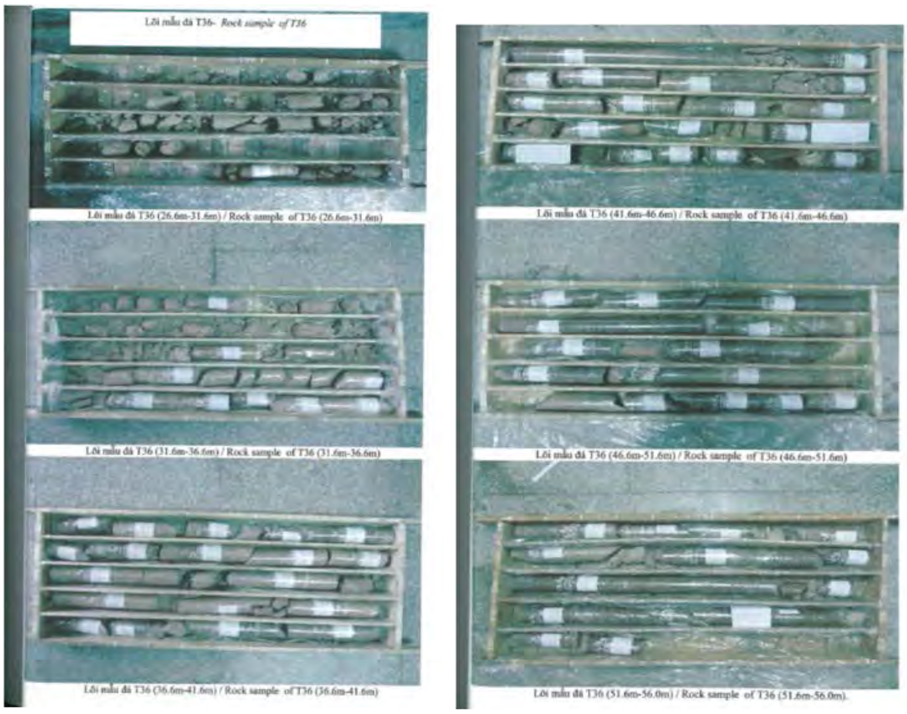
Source: JICA Study Team

Table 5.20 Results of Physical and Mechanical Tests for Load-Bearing Strata at the Bach Dang Bridge

Item	Value
Bulk density, g/cm³	2.44
Specific weight, g/cm³	2.76
Void ratio, %	0.13
Porosity, %	11.77
Saturated absorption factor, %	1.11
Dry, (kG/cm²)	299.9
Wet, (kG/cm²)	207.6
Softening coefficient	0.66

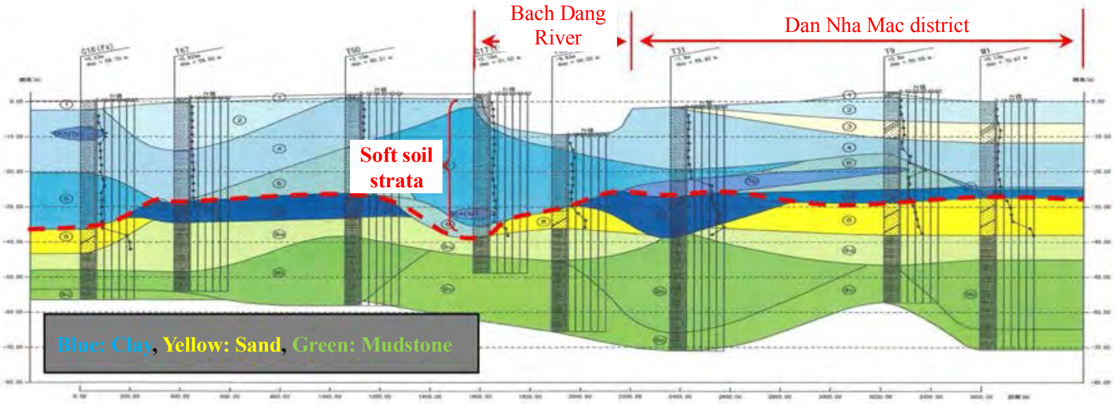
Source: JICA Study Team

The photograph of the core taken at borehole C36 is shown in Figure 5.15 as a representative sample.



Source: JICA Study Team

Figure 5.15 Core Sample from C36



Source: JICA Study Team

Figure 5.16 Soil Strata Sectional Drawing (Composite of Vietnam- & METI F/S)

The geological investigations that should be performed during the Detailed Design stage according to 22TCN 263-2000 are one position for every 50 to 100 meters of embankment roads in soft soil and one position per bridge pier. At present, a total of 9 points have already been performed within the Project site, as shown above, but none of which at bridge pier positions or the embankment section on the Halong side. Accordingly, additional surveys must be performed in the confirmed pier positions (a total of 49 piers) and along the embankment section (approximately 2400m) during the Detailed Design stage for between 75 to 99 positions in total.

(4) Wind Survey

Bach Dang Bridge is located in the southern corner of Northern Vietnam and spans the Bach Dang River near its mouth. The area is exposed to annual typhoons between May and September. The average wind speed in Quang Ninh Province and Hai Phong City is said to be 2 ~ 5 m/s, but the maximum wind velocity observed in typhoons has been 40m/s according to Vietnam F/S.

The main span of the Bach Dang Bridge is a steel cable-stayed bridge of 250 meters. During the detailed design stage, detailed wind analyses, e.g. for factors such as wind stability, must be conducted. In this Study, wind velocity data for the past 20 years (1994 to 2013) were obtained for a meteorological station near the Project Site (Hai Phong City). The relative position of the meteorological station and the Project Site are shown in Figure 5.17.

Source: JICA Study Team

Figure 5.17 Relative Positions of the Phu Lien Meteorological Station and Bridge site

In addition, the observation conditions at the Phu Lien Meteorological Station are shown in Table 5.21.

Table 5.21 Wind Observation Conditions at the Phu Lien Meteorological Station

Item	Value/ Date	Note
Longitude	106°38’	Approximately 20km south west of the bridge location
Latitude	20°48’	
Height of Station	112.409m	
Height of Measurement device	12.0m	
Commencement of Observation	January 8, 1957	

Source: JICA Study Team

The wind speed is recorded for an average of 3 minutes of observed data at the Phu Lien Meteorological Station. Observed wind speeds over 25m/s are shown in Table 5.22.

Table 5.22 Observed Data of Wind Speed over 25km/s at the Phu Lien Meteorological Station

No.	Date	Wind Speed (m/s)	Direction	Note
1	29/8/1994	28	W	
2	4/8/1995	25	NW	
3	24/7/1996	38	SSE	
4	23/8/1996	35	ESE	
5	23/8/1997	33	NW	
6	10/9/1998	30	N	
7	9/5/2001	28	WSW	
8	31/7/2005	28	ESE	Height of 3 maximum historical floods

Source: JICA Study Team

5.4.3 Design Conditions

The Design Conditions were established at the same time as the review of the Vietnam F./S.

(1) Review of Road Conditions

1) Road Category

The category of the Halong-Hai Phong Highway is Grade A: exclusive motor-vehicle way, by Road Categories established in Vietnam Premier Decision 1734/QD-TTg, dated December 2008.

2) Road Specification

The Road Specifications for the Halong-Hai Phong Highway are shown in Table 5.23, according to the Quang Ninh Province Traffic & Transportation Bureau document 1782/TTr-SGTVT, dated May 12, 2012, the specifications of Halong-Hai Phong Highway are Category II (four lanes) as set out in TCVN4054-2005 until 2025 with plans to upgrade (to six lanes) according to traffic demand after 2030.

Table 5.23 Road Specifications

<table>
<tr><th colspan="2"></th><th>Up to 2025</th><th>After 2030</th></tr>
<tr><td colspan="2">Road category</td><td colspan="2">Category II</td></tr>
<tr><td colspan="2">Lane numbers</td><td>4 lane</td><td>six-lane</td></tr>
<tr><td rowspan="3">Design Speed</td><td>Main line</td><td colspan="2">100km/h</td></tr>
<tr><td>Bridge</td><td>100km/h</td><td>80km/h</td></tr>
<tr><td>IC section</td><td colspan="2">60km/h</td></tr>
</table>

Source: 1782/TTr-SGTVT

3) Width Composition

The planned width composition is shown in Table 5.24. Following the change in lane numbers from four to six lanes between 2015 to 2030, the embankment sections will have one additional lane each in an up/down direction, which will increase the total width from 25.5 to 33.0m. Originally, the bridge section was to be widened from its original 25.0m width to 27.0m by extending the deck plate 1.0m on both sides. However, it was considered that this would entail traffic restrictions and cause congestion. Accordingly, it was decided that the total width would remain unchanged and only lane markers would be adjusted. The width composition of the bridge section is shown in Figure 5.18.

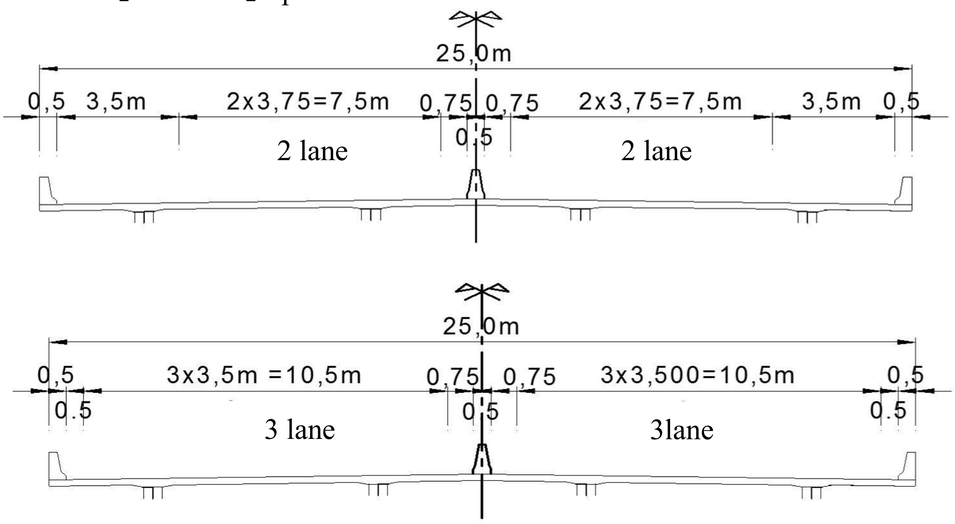
Table 5.24 Width Composition

		Up to 2025	Post-2030
Embankment section	Median Strip width	1.5m	1.5m
	Marginal Strip width	2×0.75m	2×0.75m
	Traffic Lane width	2×2×3.75m	2×3×3.75m
	Emergency Vehicle Lane width	2×3.00m	2×3.00m
	Shoulder width	2×0.75m	2×0.75m
	Total	25.50m	33.00m
Bridge Section	Median Strip width	1.5m	1.5m
	Marginal Strip width	2×0.75m	2×0.50m
	Traffic Lane width	2×2×3.75m	2×2×3.75m
	Emergency Vehicle Lane width	2×3.00m	2×3.75m
	Shoulder width	2×0.50m	2×1.00m
	Total	25.00m	27.00m

Source: JICA Study Team

Originally, the bridge section was to be widened from its original 25.0m width to 27.0m by extending the deck plate 1.0m on both sides. However, it was considered that this would entail traffic restrictions and cause congestion. Accordingly, it was decided that the total width would remain unchanged and only lane markers would be adjusted. The width composition of the bridge section is shown in Figure 5.18.

【 for 4lane】up to 2025: Total width W = 25.0m



Source: JICA Study Team

Figure 5.18 Width Composition of the Bridge Section

4) Lateral Slope

The lateral slope is designed as 2% for traffic lanes, 4% for shoulders and 6% for protective shoulders to ensure rainwater drains properly.

5) Road Alignment

The longitudinal slope for the Project section has been numerized on the horizontal road alignment (coordinates, alignment composition) in this Study as shown in Table 5.25 and in drawing form in Figure 5.19. The Road Longitudinal Foundation Height is at 0.75m on both sides of the road center.

Table 5.25 Main Coordinates (Horizontal)

Bach Dang Bridge	North Latitude (°)	East Longitude (°)	Note
Start Point	2308943.424	400210.734	KP19.4473
IP_1	2308418.018	399795.668	R=4000 C1=450m (A=1341.641)
End Point	2305208.621	395834.330	
Dam Nha Mac IC	North Latitude (°)	East Longitude (°)	Note
Start Point	2308228.147	400089.926	-
End Point	2308746.640	399553.681	-
Center of Central Pier (P26)	North Latitude (°)	East Longitude (°)	Note
Start Point	2306444.821	397316.009	-
End Point	2306401.620	397351.010	-

KP (Km)	North Latitude (°)	East Longitude (°)	Note
19.447300	2308943.424	400210.734	BP
19.447309	2308943.417	400210.729	KA1 (C1tan)
19.800000	2308669.216	399988.936	Project start point
19.897309	2308595.650	399925.245	KE1 (C1circle)
20.047093	2308485.407	399823.858	Dan Nha Mac IC – Intersection
20.332392	2308286.264	399619.645	KE2 (C1circle)
20.782392	2307996.522	399275.418	KA2 (C1tan)
23.281649	2306423.224	397335.507	Central Pier (Highest Point)
25.211102	2305208.621	395834.330	EP

Source: JICA Study Team

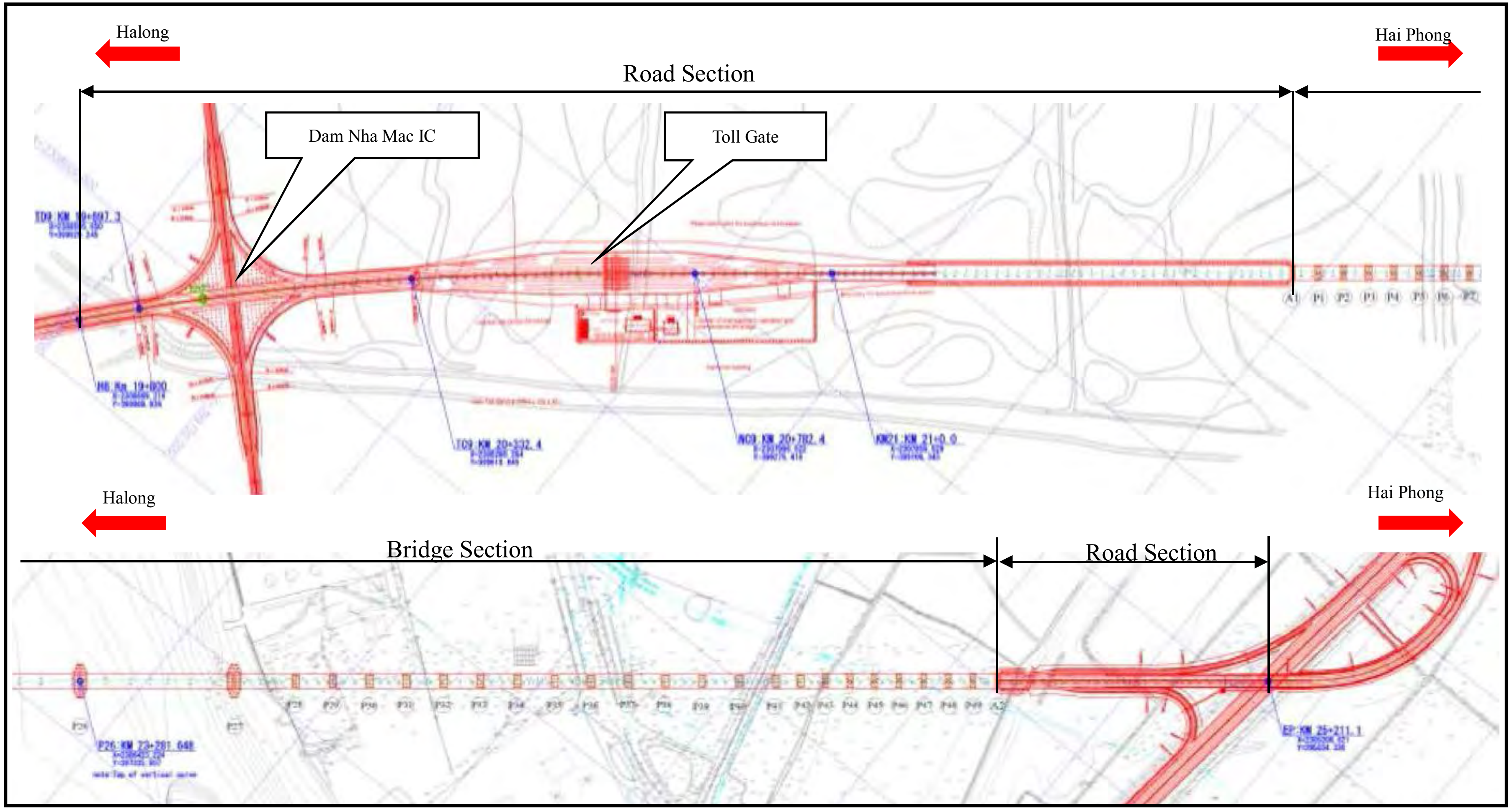
The proposed Profile Alignment for the Project sections in the Vietnam F/S following Japanese Standards are shown as Road Longitudinal Section Alignment Composition in Table 5.26 and as a Longitudinal Sectional Drawing in Figure 5.20.

Table 5.26 Coordinates of Main Points (Profile)

Profile IP data

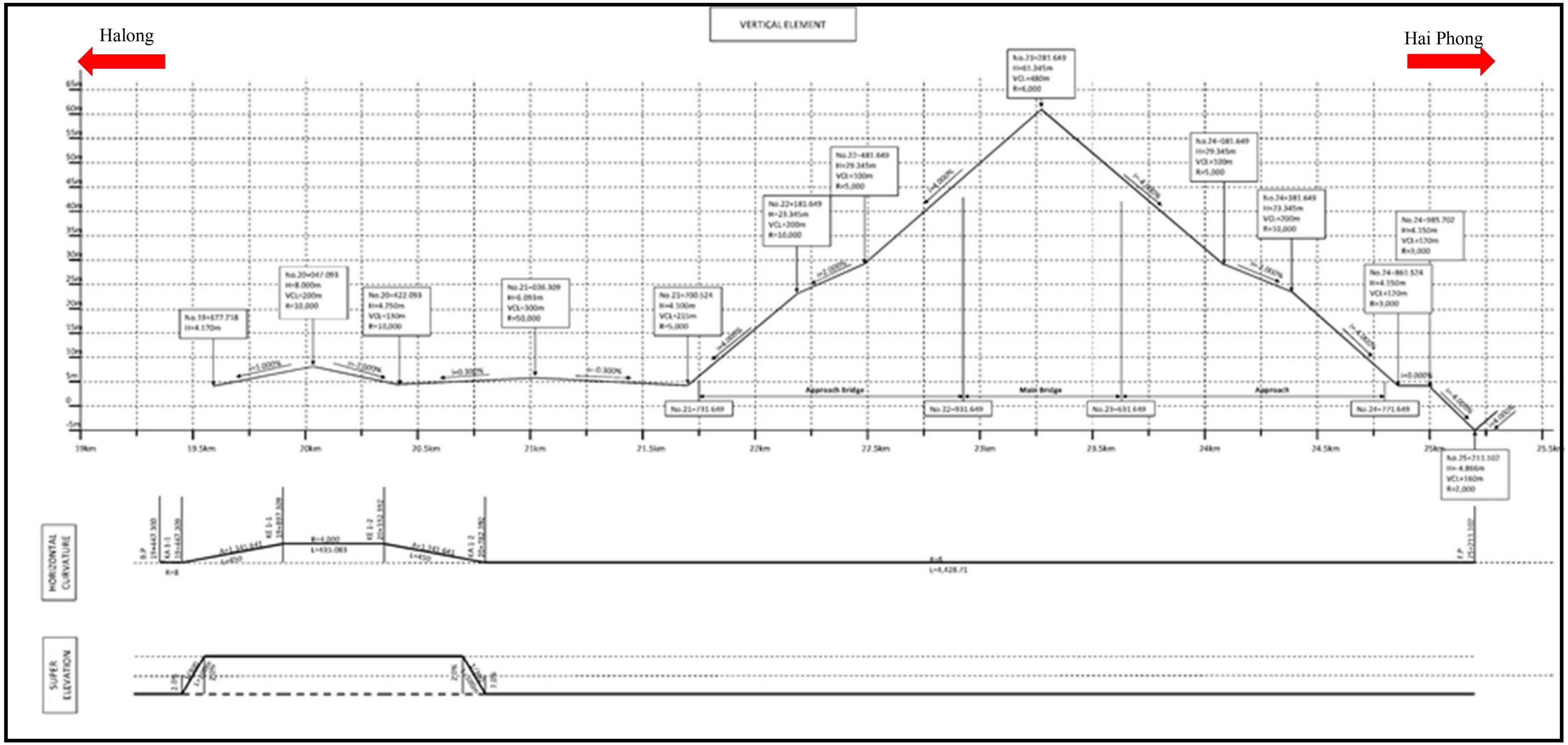
KP (Km)	IP Height (m)	Radius (m)	Slope	Note
19.664093	4.170	-5000	1.0%	-
20.047093	8.000	10000	-1.0%	Dam Nha Mac IC
20.422093	4.250	-10000	0.3%	-
21.036309	6.093	50000	-0.3%	-
21.700524	4.100	-5000	4.0%	-
22.181649	23.345	10000	2.0%	-
22.481649	29.345	-5000	4.0%	-
23.281649	61.345	6000	-4.0%	Central Pier (P26)
24.081649	29.345	-5000	-2.0%	-
24.381649	23.345	10000	-4.0%	-
24.861524	4.150	-3000	0.0%	-
24.985702	4.150	3000	-4.0%	
25.211102	-4.866	-2000	-	End Point (Hanoi-Hai Phong IC)

Source: JICA Study Team



Source: JICA Study Team

Figure 5.19 Horizontal Road Alignment Drawing



Source: JICA Study Team

Figure 5.20 Longitudinal Section Alignment

(2) Review of River Conditions

1) Water Level

The results of statistical analysis of observation data from gaging/hydrometry stations are shown in Table 5.27.

Table 5.27 Results of Statistical Analysis of Observation Data

No.	Item	Return Period	Unit	Investigation Result	Note: Vietnam F/S
1	Design High Water Level	100	m	3.36	3.23
2	Design Discharge	100	m^3/s	8900	8653
3	Ship Lane Water Level	20	M	1.75	1.66
4	National Water Level	—	M	-1.9	—
5	Height of Maximum River Bed Depth	—	M	-11.26	—
6	River Width (at Bach Dang Bridge site)	—	M	760	—

Source: JICA Study Team

The methods for calculating the Design High Water Level and Ship Lane Water Level are shown below.

Design High Water Level = 2.65m+1.42m= 3.36m

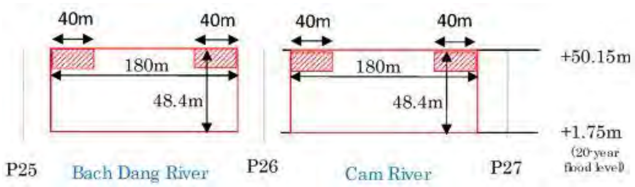
* 100-year probability flood level from data analysis: 2.65m, wave height: 1.42m (± 0.71m)

Ship Lane Water Level = 1.55m+20cm= 1.75m

* 20-year probability water level from data analysis: 1.55m, global warming effect: +20cm

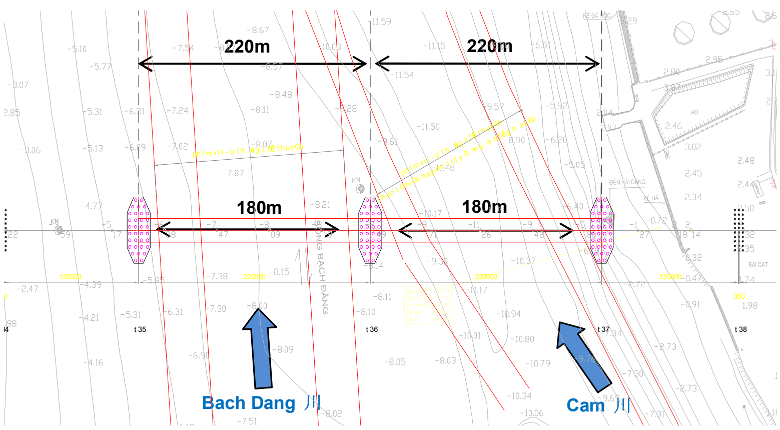
2) Clearance for Navigation Channel

The Ship Lane is shown with coordinates in Figure 5.21 prepared for Vietnam F/S and Figure 5.22. The clearance has been agreed with authorities, but if temporary easement of restrictions is required during construction, the Investor (Contractor) must apply to the authorities and receive approval.



Source: JICA Study Team

Figure 5.21 Elevation of Ship Lane Clearance



Source METI F/S

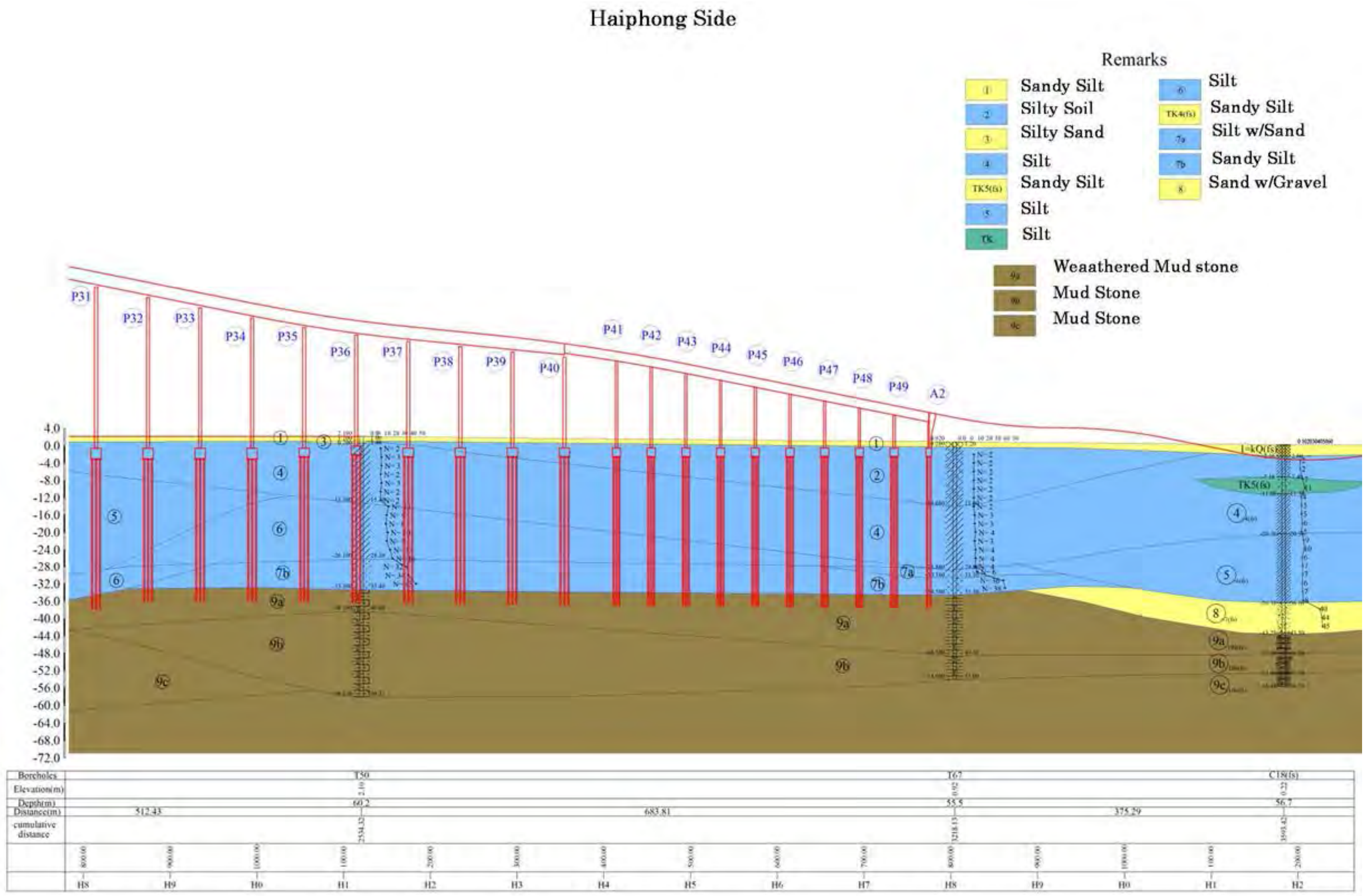
Figure 5.22 Plan of Ship Lane Clearance

(3) Review of Soil Conditions

There are eight sets of drilling data available for the Bach Dang Bridge Project Area. (Borehole Numbers: M1, T9, T31, T36, C17, T50, T67, C18). The Soil Type comprises 9 strata, with profiles summarized below.

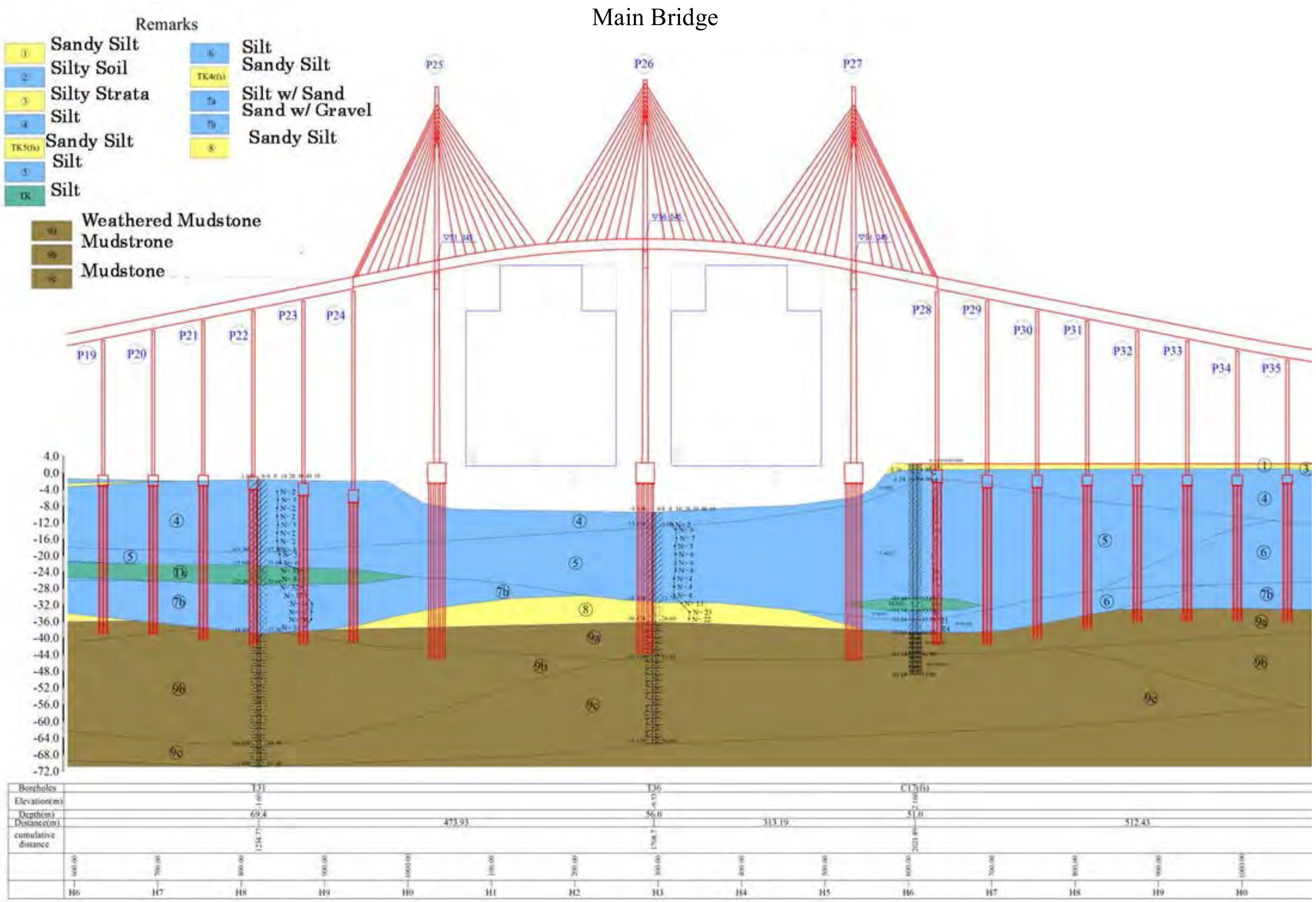
【Strata1】 Sandy Silt, weak ground resistance, significant deformation for this strata
【Strata 2】 Silt, N value is 0~2, weak ground resistance, significant deformation for this strata
【Strata 3】 Silty Sand, N value is 2~5,weak ground resistance for this strata
【Strata 4】 Silt, N value is 1~6 weak ground resistance, significant deformation for this strata
【Strata 5】 Silt, N value is 4~10 weak ground resistance, significant deformation for this strata
【Strata 6】 Silt, N value is 8~24 weak ground resistance, significant deformation for this strata
【Strata 7a】Silt with Sand, N value is 5~13 weak ground resistance, significant deformation
【Strata 7b】Sandy Silt, N value is 16~53 with some ground resistance
【Strata 8】 Sand with Gravel, N value is 13~45 with some ground resistance
【Strata 9a】Weathered Mudstone, high ground resistance, but RQD is below 50%.
【Strata 9b】Mudstone, high ground resistance, but RQD exceeds 50% for load bearing, suitable as load-bearing strata (Load-Bearing Strata)
【Strata 9c】Mudstone, high ground resistance, but RQD exceeds 50% for load bearing, suitable as load-bearing strata (Load-Bearing Strata)

The geological profiles are shown in Figures 5.23 to 5.25.



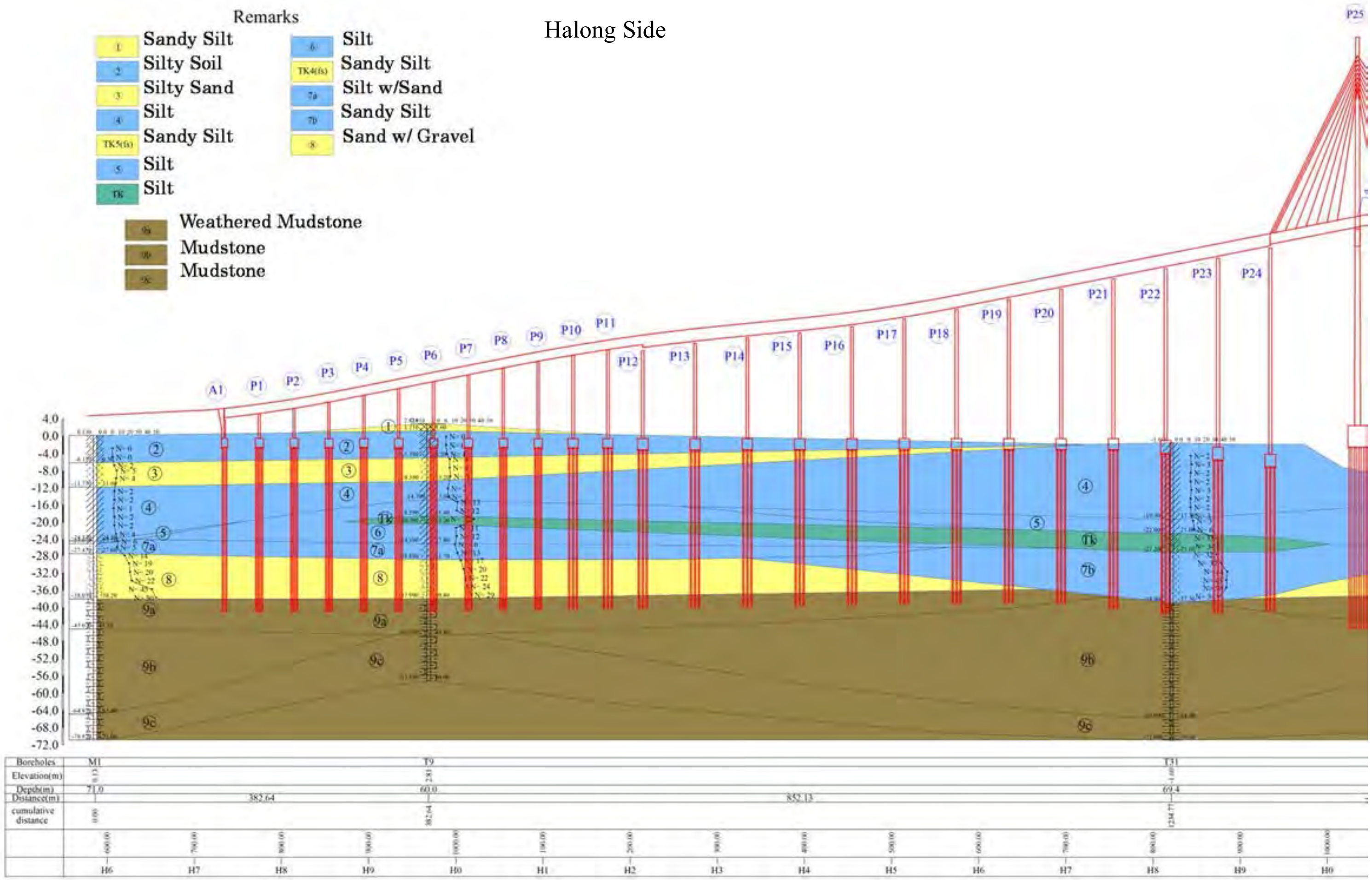
Source: JICA Study Team

Figure 5.23 Geological Profile (Hai Phong side)



Source: JICA Study Team

Figure 5.24 Geological Profile (Main Bridge side)



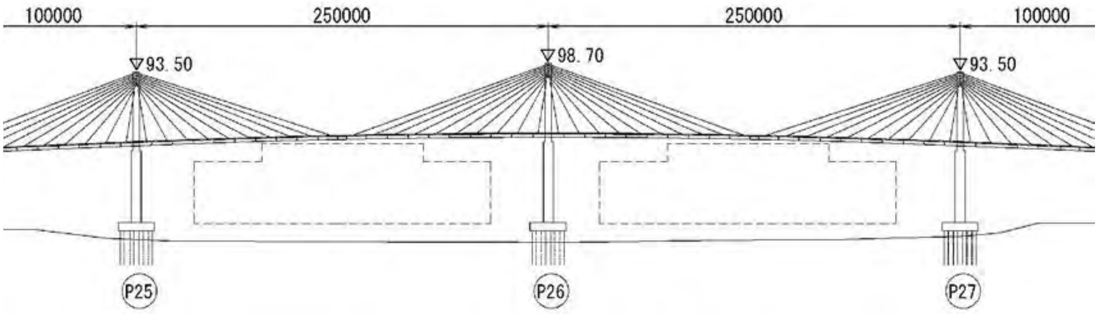
Source: JICA Study Team

Figure 5.25 Geological Profile (Halong side)

(4) Review of Restrictions

1) Height Limit

According to the Ministry of Defense (MOD) document 311/CTC-PQC, dated October 15, 2012, the Height Limit for the top of the main towers is under 95m for the side Main Towers P25 and P27 and under 100m for the Central Main Tower P26. Previously, the height limit was indicated at 95 meters, but the final height of the main towers has been set as shown above. As shown in Figure 5.26, the height of the Main Towers complies with this Height Limit. Furthermore, since the Height Limit agreed with MOD includes that for construction equipment, if the height exceeds the Height Limit, the agreement with MOD must be renewed prior to commencing construction.

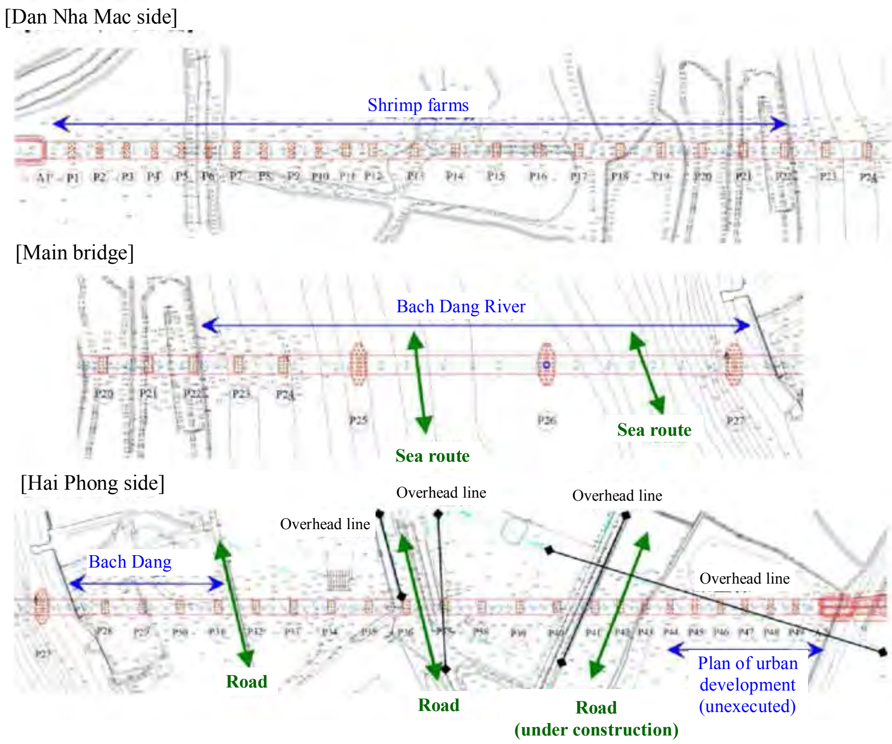


Source: JICA Study Team

Figure 5.26 Height Limit

2) Obstructions

Obstructions are shown in Figure 5.27.



Source: JICA Study Team

Figure 5.27 Obstruction Drawing

(5) Review of Load Conditions

1) Live Loads

The Live Load Category is HL93 based on ASSHTO (American Association of State Highway and Transportation Officials).

2) Dead Loads

Unit weights used in the Design are shown in Table 5.28.

Table 5.28 Unit Weight of Each Material

Material		Unit Weight (kg/m^3)
Aluminum		2800
Asphalt Pavement		2250
Concrete	Low Density	1775
	Low-Density Sand	1925
	Normal	2400
Steel		7850
Water	Fresh water	1000
	Sea Water	1025

Source: Summarized by the JICA Study Team from the Vietnam Standard 22 TCN-272-05

5.5 Road Design

5.5.1 Design Policy

The Road Planning in the Vietnam F/S describes the planned route, Road Standards and geometrical structure, but does not specify the design of road structures, analysis of soft soil countermeasures, or establishment of speed-change lanes before and after Toll Gates. Accordingly, the description is limited to horizontal and vertical coordinates for main points on Road alignment drawings and preparation of schematic drawings of ancillary facilities such as signage and lighting.

Accordingly, it was decided that the following items would be analyzed and designed in the road design based on the results of the review and Policy for Analysis-2.

- Horizontal Road Alignment, Vertical Road Alignment
- Analysis of Soft Soil Countermeasures
- Earthworks Design (Road Embankment)
- Drainage Design
- Box Culvert Design
- Pavement Design
- Traffic Safety Facilities
- Lighting Facilities

5.5.2 Analysis of Road Alignment, Longitudinal Section Alignment, Sectional Composition

As noted in the Study Policy for Analysis, the Vietnamese Government is proceeding with Project Approval for structural dimensions in the Vietnam F/S and no major changes are welcome except for compelling reasons. Accordingly, the Road Alignment, Longitudinal Section Alignment and Sectional Composition will be analyzed after reviewing the design decisions in the Vietnam F/S.

The numbers described in the drawings and reports of the Vietnam F/S are used for analysis, but in some cases where the design value is unclearly described, the numerical values were deduced from the drawings. In addition, compliance with Vietnamese Standards will be the basic benchmark for standards and similar, but for some items the applied standard was unclearly identified, in which case Japanese Standards (Road Structure Ordinance, NEXCO Design

Guideline) were applied. The results for the main Road Alignment Elements are shown in Table 5.29.

Table 5.29 Comparison of Main Road Alignment Elements

Review Item		Trunk Road (Design Speed 100km/h)						IC (Design Speed 60km/h)					
		Values in F/S	※1 Vietnam Road Standard	Road Ordance	Motorway (Former JPHC)	Evaluation	Value Adopted in the Study	Values in F/S	※1 Vietnam Road Standard	Road Ordance	Motorway (Former JPHC)	Evaluation	Value Adopted in the Study
Profile Slope	Minimum	0%	Not Known	※2 0.3~0.5%	※2 0.3~0.5%	Japanese Standard	0.3%	0%	Not Known	※2 0.3~0.5%	※2 0.3~0.5%	Japanese Standard Applied	0.3%
	Maximum	4%	Not Known	3%	3%	OK	4%	4%	Not Known	5%	※3 5% (7%)	OK	4%
Limit Length of Vertical Slope (4%)		799.55m	800m	700m	1,500m	OK	800.00m	—	—	—	—	—	—
Length of Profile Curve		120m	85m	85m	85m	OK	120m	120m	50	50 m	70 m 65 m (w/ Nose)	Japanese Standard Applied	65 m
Profile Curve	Crest Curve	6,000	※3 10,000 (6,000)	6,500	※3 10,000 (6,500)	OK	6,000	3,000	Not Known	1,400	※3 2,000 (1,400)	OK	3,000
	Sag Curve	3,000	※3 5,000 (3,000)	3,000	※3 4,500 (3,000)	OK	3,000	2,000	Not Known	1,000	※3 1,500 (1,000)	OK	2,000
Minimum Curve Radius		4,000	※3 700 (400)	460	700	OK	4,000	51.6	Not Known	140 m	150 m	F/S Values adopted since Japanese Standard not Applicable	51.6
Minimum Curve Length		435.1m	Not Known	170m	170	OK	435.1m	102.738	Not Known	100m	※4 Calculated From Formula	OK	102.738
Speed Reduction/Acceleration Zone Length		450m	Not Known	85m	85m	OK	450m	35.0	Not Known	50m	※5 A=70m	OK	35.0
Cant		2%	Not Known	1.5以上2%以下	2%	OK	2%	2%	Not Known	Over 1.5 Under 2%	2%	OK	2%
Cant Transition		—	Not Known	1/175	1/175	Japanese Standard since Vietnam Standard is not identified	1/175	—	—	—	—	—	—
minimum Cant Transition Ratio		1/300	Not Known	1/285~350	1/250	OK	1/300	—	—	—	—	—	—

※1 Vietnam Road Standard TCVN 5729: 1997, from FS Report
※2 Minimum Profile Slope required for drainage
※3 (Upper): Standard, (Lower) (): Minimum Or special cases
※4

$$R = \frac{V^2}{127(i+f)}$$ (式7-1)

[illegible]

※5 Minimum Parameter

Source: JICA Study Team

The longitudinal slope for the approach road section to the Main Bridge from the Halong side will be reviewed for surface drainage considerations and a revised proposal will be prepared.

(1) Horizontal Alignment

1) Standards applied in this Design

A) Curve Radius and Curve Length

The designated Value (100km/h) and applied values based on the Vietnam National Road Standard TCVN5729-1997 are shown in Table 5.30.

Table 5.30 Minimum Curve Radius

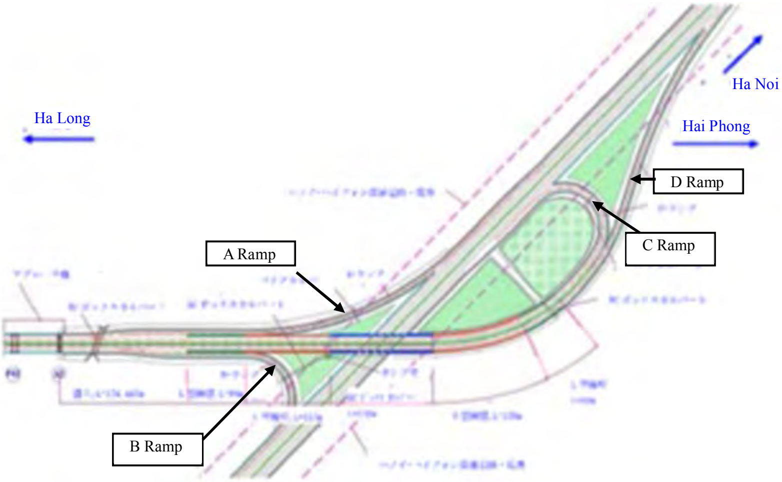
Item	Unit	Designated value	Adopted value in the Vietnam F/S (minimum)
Minimum Curve Radius (normal) Rmingh	m	700	4000
Minimum Curve Radius (special case) Rmintt	m	400	

Source: Vietnam Road Standard TCVN5729-1997

The minimum curve lengths at IC sections were found to be minimum curve radius 51.5m and minimum curve length 102.738m as deduced from drawings in the Vietnam F/S. The appropriateness of applying these values may be ascertained against Japanese standards since the Vietnamese standards are unclearly indicated in the Vietnam F/S, but the application of Japanese standards will trigger major changes to the results and possibly require the acquisition of new land. In this Study, the Vietnam F/S will be honored and the minimum curve radius 51.5m and minimum curve length 102.738m will be applied. However, the shape of the IC, including whether or not the appropriate standard exists, must be confirmed with the Vietnam side during the Detailed Design stage.

B）Widening of Curved Sections

The curved sections will be widened on the ramps of the Hai Phong side IC as shown in Figure 5.28 and Table 5.31. Among the section curves, widening of the curves shall be applied to the tight curves on B and C Ramps. The amount of widening for each ramp is shown in Table 5.30. The Japanese Standard (NEXCO Design Guideline, Book 4) was used as a reference for the applied standard.



Source: JICA Study Team

Figure 5.28 Ramp Position (Hai Phong side IC)

Table 5.31 Widening at Ramp Sections

Ramp Name	Widening Amount (m)
B Ramp	0.25
C Ramp	0.50

Source: NEXCO Design Guideline Book 4

C）Speed Reduction Section

The Vietnam standards for the speed reduction zone are unknown and the Japanese Standard (Road Structure Ordnance) was referenced.

Table 5.32 Length of the Speed Reduction Zone

Location	Stipulated Length (Japanese Standard)	Values in the Vietnam F/S	
Main section (Design Speed 100km/h)	85m	450m	
IC section (Design Speed 60km/h)	50m	Underpass	110m
		A Ramp	65m
		B Ramp	35m
		C Ramp	35m
		D Ramp	130m

Source: Road Structure Ordnance

When the speed reduction zone lengths for the IC sections were confirmed on the drawings of the Vietnam F/S, the lengths on B and C Ramps were found to be 35m, namely less than stipulated. The appropriateness of applying these values may be ascertained against Japanese standards since the Vietnamese standards are unclearly indicated in the Vietnam F/S, but applying Japanese standards will change the results of the F/S. In this Study, the Vietnam F/S will be honored and 35m will be applied for the length of the Speed Reduction zone. However, the IC shape, including whether or not the appropriate standard exists, must be confirmed with the Vietnam side during the Detailed Design stage.

D） Cant

Curved sections requiring a cant are in the curved section of the Hai Phong side and cants will be analyzed for each ramp. Reference will be made to the Japanese Standard (Road Structure Ordnance) shown in Table 5.33, since the Vietnam Standards are not identified.

Table 5.33 Curve Radius and Cant Values (IC Section 60km/h)

Curve Radius (m)	Over 800 Under 2000	Over 560 Under 800	Over 420 Under 560	Over 330 Under 420	Over 270 Under 3300	Over 230 Under 370	Over 190 Under 230	Over 150 Under 190	Over 120 Under 150
Cant (%)	2	3	4	5	6	7	8	9	10

Source: Excerpted from Road Structure Ordnance

Furthermore, the stipulated values for cants have been set out as shown in Table 5.34 from Japanese standards since these values are not indicated in the Vietnam F/S.

Table 5.34 Curve Radius and Cant for Each Ramp

Position	Radius for each curve (m)	Applied Cant (%)
Underpass	250	7.0
A Ramp	390	5.0
B Ramp	68.6	10.0
C Ramp	51.6	10.0
D Ramp	550	4.0

Source: JICA Study Team

E） Cant Transition

Cant Transition was confirmed for IC and Main Line Sections. Reference will be made to the Japanese Standard (Road Structure Ordnance) for cant transition since the Vietnam Standards are not identified.

In the Japanese Standards, the cant transition in the main line sections should be less than 1/175 (m/m) for design speeds of 100km/h. The cant transition zones and values in the main line sections from Vietnam F/S are shown in Table 5.35. Since these values are under 1/175, the cant transition was deemed appropriate.

Table 5.35 Cant Transition Zone and Values (Main Line Section)

Section	Cant Transition
KM19+447.309〜KM19+547.309	1/300
KM20+682.392〜KM20+782.392	1/300

Source: JICA Study Team

The cant Transition in the IC Section should be under 1/125 (m/m) for a Design Seed of 60km/h according to Japanese Standards. The cant transition zones and values in the Trunk Road sections from Vietnam F/S are shown in Table 5.36. Since these values are under 1/125, except for C Ramp, the cant transition was deemed appropriate. As for the C Ramp, while applying Japanese Standards is possible, this will change F/S results. In this Study, the Vietnam F/S will be honored and 1/90 for cant transition will be applied. However, the shape of the IC, including whether or not the appropriate standard exists, must be confirmed with the Vietnam side during the Detailed Design stage.

Table 5.36 Cant Transition Zone and Values (IC section)

Zone	Cant Transition
Underpass	1/195
A Ramp	1/280
B Ramp	1/125
C Ramp	1/90
D Ramp	1/185

Source: JICA Study Team

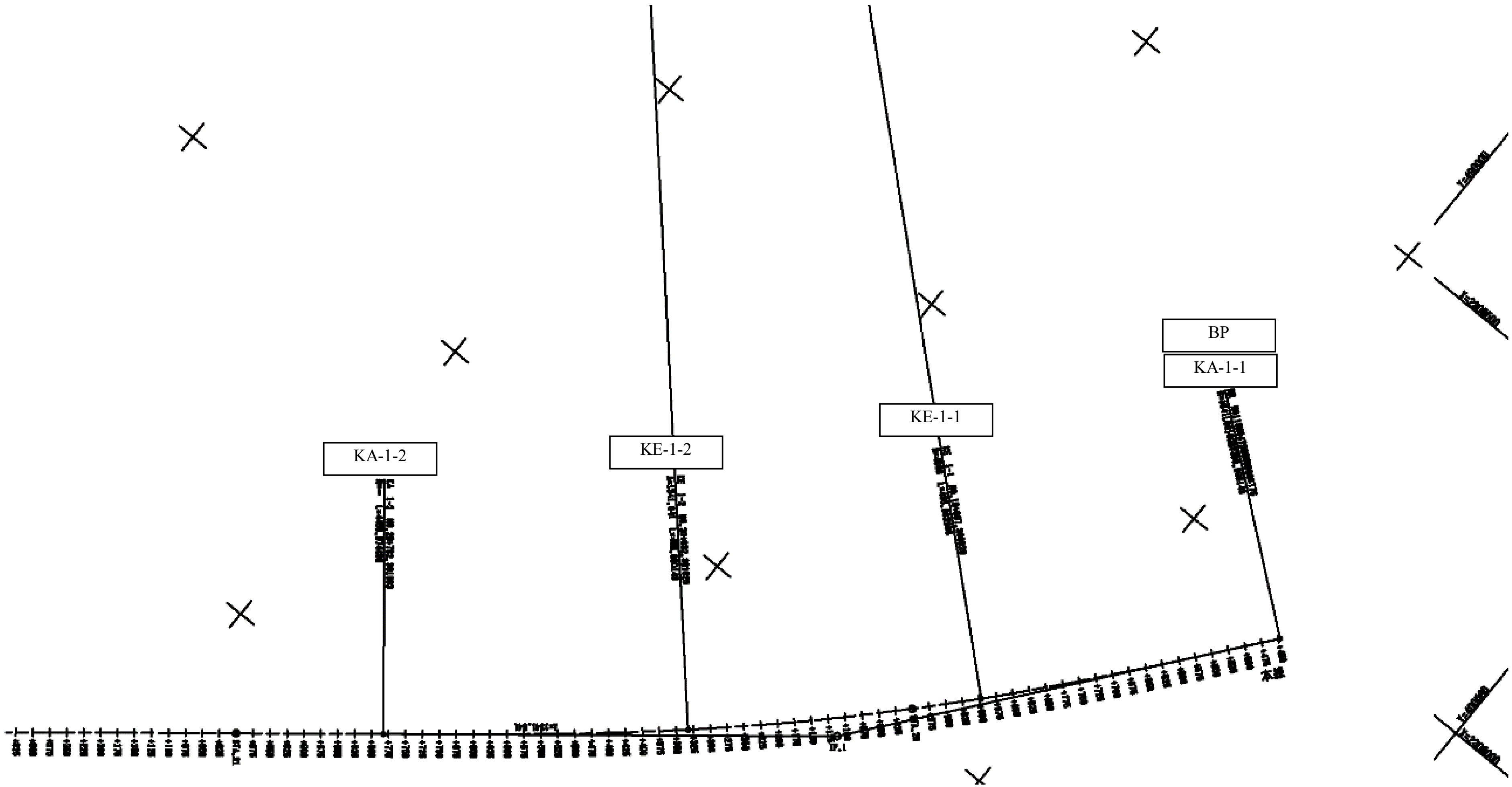
(2) Review of the Horizontal Alignment Components

The results of a review of Vietnam F/S on the above item for the Main Components of Horizontal Alignment are shown in Table 5.37.

Table 5.37 Coordinates and Plan Components of Main Points

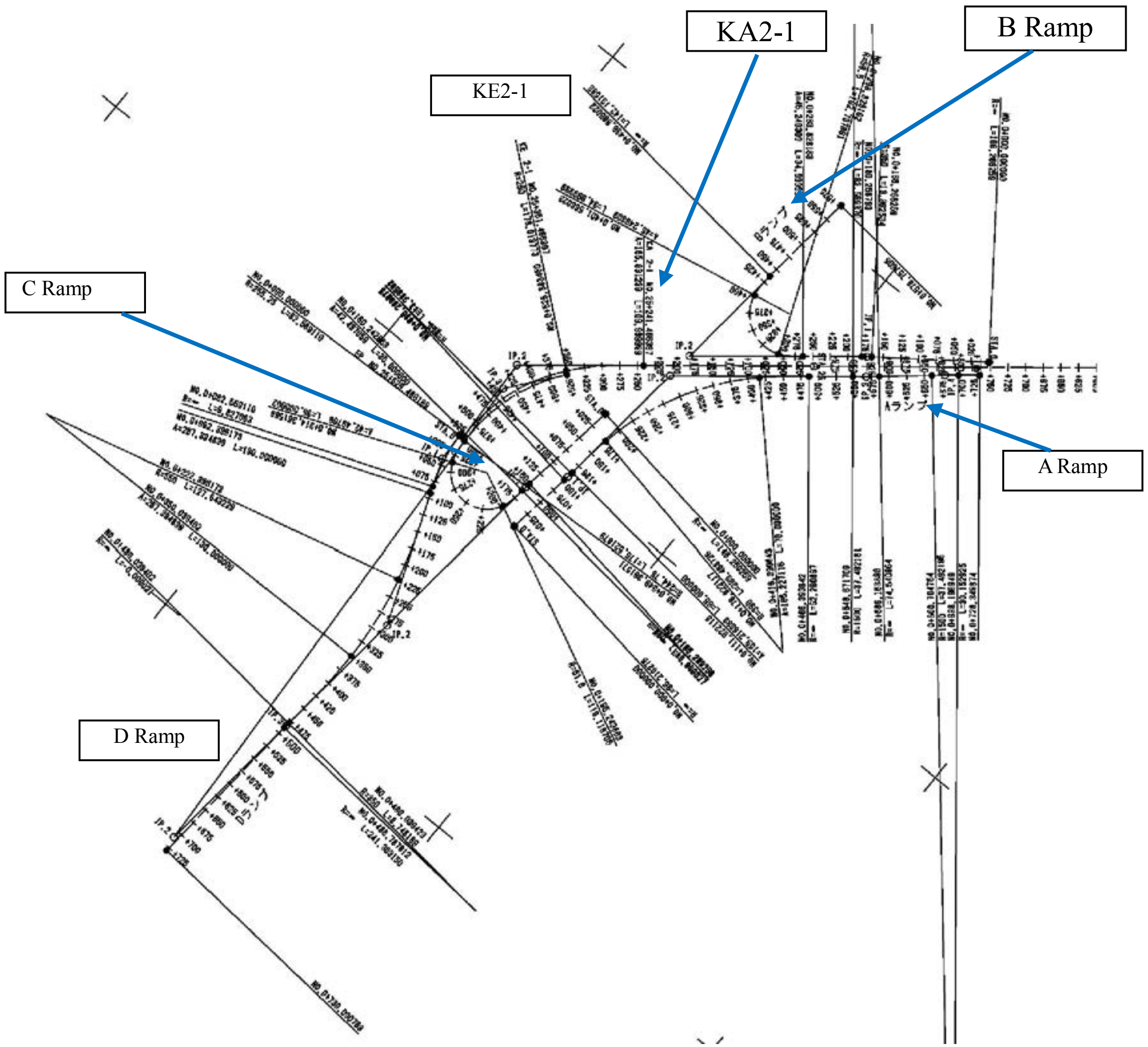
Main Points	Measured Points	X Coordinate	Y Coordinate	Element	Distance
Trunk Road					
BP	19+448.300000	2308943.424000	400210.734000	R = ∞	0.008776
KA 1-1	19+447.308776	2308943.417113	400210.728586	A = 1341.641000	450.000143
KE 1-1	19+897.308920	2308595.649500	399925.244988	R = 4000.000000	435.082900
KE 1-2	20+332.391963	2308286.264323	399619.644950	A = 1341.641000	450.000143
KA 1-2	20+782.391963	2307996.521628	399275.417767	R = ∞	4459.074435
KA 2-1	25+241.466397	2305189.506521	395810.737262	A = 165.831239	109.999999
KE 2-1	25+351.466397	2305114.349108	395730.740999	R = 250.000000	178.013773
EP	25+529.480169	2304948.585414	395676.937556		
Main Points	**Measured Points**	**X Coordinate**	**Y Coordinate**	**Element**	**Distance**
A Ramp					
	0+000.000000	2304897.619195	395813.086275	R = ∞	96.210275
	0+096.210275	2304992.850756	395826.774473	R = 350.000000	13.992542
	0+110.202817	2305006.737057	395828.487894	R = ∞	1.719301
	0+111.922118	2305008.447284	395828.664292	A = 159.216833	65.000000
	0+176.922117	2305072.874227	395837.123709	R = 390.000000	239.468725
	0+416.390843	2305280.514137	395948.710983	165.227116	70.000000
	0+486.390842	2305326.170202	396001.739436	R = ∞	62.280867
	0+548.671709	2305365.376395	396050.131385	R = 1500.000000	37.492181
	0+586.163890	2305389.339545	396078.964663	R = ∞	74.540864
	0+660.704754	2305437.696322	396135.691752	R = 150.000000	37.492195
	0+698.196949	2305461.659480	396164.525041	R = ∞	30.152925
	0+728.349874	2305480.640934	396187.953726		
B Ramp					
	0+000.000000	2305503.205675	396186.615694	R = ∞	166.266259
	0+166.266259	2305403.787057	396053.347516	R = 350.000000	13.992534
	0+180.258793	2305395.198314	396042.302226	R = ∞	83.569370
	0+263.828163	2305342.590877	395977.369207	A = 45.249309	34.999999
	0+298.828162	2305323.448962	395948.233730	R = 58.500000	102.737861
	0+401.566023	2305366.323584	395869.062883	A = 45.249309	34.999999
	0+436.566022	2305401.184406	395869.172349	R = ∞	142.191583
	0+578.757605	2305542.625621	395883.761007		
C Ramp					
	0+000.000000	2305102.321217	395812.334453	R = ∞	146.250259
	0+146.250259	2304957.558711	395791.526878	R = 350.000000	13.992527
	0+160.242786	2304943.672425	395789.813458	R = ∞	0.000077
	0+160.242863	2304943.672349	395789.813450	A = 42.497059	35.000000
	0+195.242863	2304909.658002	395782.359961	R = 51.600000	119.118705
	0+314.361568	2304912.053139	395688.014766	A = 42.497060	35.000002
	0+349.361571	2304946.401871	395682.296807	R = 244.750000	176.521879
	0+525.883450	2305110.963216	395734.756458		
D Ramp					
	0+000.000000	2304948.364062	395671.692794	R = 255.250000	82.569110
	0+082.569110	2304867.857866	395688.341113	R = ∞	9.827063
	0+092.396173	2304858.680499	395691.854959	A = 267.394839	130.000000
	0+222.396173	2304735.615289	395733.496090	R = 550.000000	127.643229
	0+350.039402	2304609.356907	395750.187933	A = 267.394839	130.000000
	0+480.039402	2304479.698528	395741.957831	R = ∞	-0.000021
	0+480.039423	2304479.698549	395741.957834	R = 350.000000	8.748189
	0+488.787612	2304470.986215	395741.169122	R = ∞	241.303150
	0+730.090763	2304230.412694	395722.418354		

Source: JICA Study Team



Source: JICA Study Team

Figure 5.29 Road Horizontal Alignment Drawing (Halong side)



Source: JICA Study Team

Figure 5.30 Road Horizontal Alignment Drawing (Hai Phong side)

(3) Profile Alignment

1) Standards Applied to This Design

A） Profile Alignment and Restricted Length

A length restriction for the Profile Alignment slope is stipulated for each design speed in the Vietnam National Road Standard (TCVN5729-1997). For a design speed of 100km/h and in cases where the Profile Alignment slope exceeds 3%, the length restrictions are as shown in Table 5.38.

In the Vietnam F/S, the maximum Profile Alignment slope is 4% and the slope length is limited to 800 meters based on Vietnam Standards. The Vietnam Standards allow a maximum Profile Alignment slope of up to 5% with length limits of 600 meters, but the Profile Alignment slope is scheduled to be decided following discussions with responsible authorities.

In this Study, the maximum Profile Alignment slope will be kept as 4% following Vietnam F/S and length limits of 800 meters based on the Vietnam Standard to maintain smooth traffic flows.

Table 5.38 Profile Alignment Slope and Length Restrictions

Profile Alignment slope	Length limit (100km/h) (Vietnam Standard TCVN5729-1997)	Length Limit by Japanese Standard (Road Structure Ordnance)
3%	1000m	–
4%	800m	700m
5%	600m	500m

Source: Vietnam Standard TCVN5729-1997 & Road Structure Ordnance

B） Profile Curve

In the Vietnam National Road Standard (TCVN5729-1997), the Profile Curves of main lanes are assigned values according to the design speed as shown in Table 5.39. For roads with design speeds of 100km/h, the values shown in the red square in Table 5.39 apply.

Table 5.39 Profile Curve and Profile Curve Length

Design speed (km/h)		120	100	80	60	40	30	20
Profile Curve (convex type) (m)	Special case value (minimum.)	11000	6000	4000	2500	700	400	200
	Standard value (minimum.)	17000	10000	5000	4000	1000	600	200
Profile Curve (concave type) (m)	Special case value (minimum.)	4000	3000	2000	1000	450	250	100
	Standard value (minimum.)	6000	5000	3000	1500	700	400	200
Profile Curve長(m)		100	85	70	50	35	25	20

Source: Vietnam Standard TCVN5729-1997

The minimum values for the Profile Curve and Profile Curve length on the Trunk Road Section from the Vietnam F/S are shown in Table 5.40.

Table 5.40 Profile Curve and Profile Curve Length (Trunk Road Section)

Item	Utilized Values (minimum)
Profile Curve (Crest Slope)	6000m
Profile Curve (Sag Slope)	3000m
Profile Curve Length	120m

Source: JICA Study Team

The minimum values for the Profile Curve and Profile Curve length on the IC Section from the Vietnam F/S are shown in Table 5.41.

Table 5.41 Profile Curve and Profile Curve Length (IC Section)

Item	Applied Value (Minimum)				
	Underpass	A Ramp	B Ramp	C Ramp	D Ramp
Profile Curve (Crest)	2100	—	—	—	—
Profile Curve (Sag)	2000	6680	4700	4490	1200
Profile Curve Length	90	65	65	65	65

Source: JICA Study Team

The Vietnam Road Standard (TCVN5729-1997) does not stipulate profile curves for IC sections. The design speed for the IC sections is 60km/h and appropriate when compared to the trunk road sections. However, since the existence of regulations concerning IC sections is unclear, these designs, including whether or not the appropriate standard exists, must be confirmed with the Vietnam side during the Detailed Design stage.

C) Vertical Slope

The vertical slope for the trunk road section is stipulated as shown in Table 5.42 in the Vietnam Road Standard (TCVN5729-1997).

Table 5.42 Vertical Slope (Trunk Road Section)

Item	Stipulated Value
Maximum Vertical Slope	5.0%
Maximum Vertical Slope (Down Slope)	5.5%

Source: Vietnam Standard TCVN5729-1997

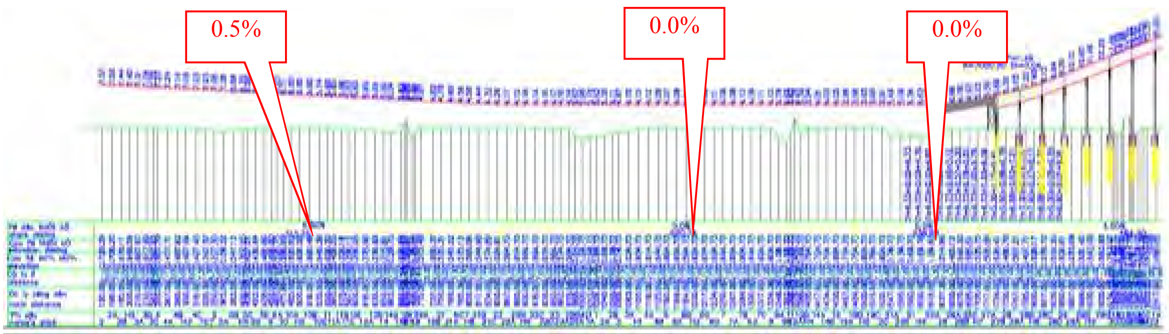
The vertical slope design for the trunk road section in the Vietnam F/S is shown in Table 5.43 and is confirmed compliant with the Vietnam Standard.

Table 5.43 Vertical Slope (Trunk Road Section)

Item	Stipulated Value
Maximum Vertical Slope	4.0%
Maximum Vertical Slope (Down Slope)	4.0%

Source: JICA Study Team

It is known at this time that the approach road section to the Main Bridge on the Halong side has a 0% vertical slope, although the minimum value for the vertical slope in the Vietnam Standard is unknown.



Source: JICA Study Team

Figure 5.31 Vertical Slope in the Vietnam F/S (Approach on the Halong side)

On the one hand, the Japanese Standard (Road Structure Ordnance) includes the following statement on the Minimum vertical slope.

Statement on vertical slope (minimum Vertical Slope) in the Road Structure Ordnance. It is better to have a minimum vertical slope, but problematic to have long completely flat sections. Cant is applied to facilitate surface drainage, but according to rainfall intensity, the vertical slope value, whether or not there are curbstones and the scope of drainage facilities, insufficient surface drainage can occur. Accordingly, it is advisable to provide a small vertical slope to facilitate surface drainage. A slope of 0.3 ~ 0.5% is sufficient for this purpose.

From the above, it is stipulated that a minimum vertical slope of 0.3 to 0.5% should be designed, which creates a condition for discrepancies with the Vietnam F/S.

In this Study, the minimum vertical slope of 0.3% as noted in the Japanese Standard will be applied to maintain adequate surface drainage, whereupon the Vietnam F/S design will be revised.

The Vertical Slope for the IC Section in the Vietnam F/S is shown in Table 5.44.

Table 5.44 Vertical Slope (IC Section)

Item	Applied value				
	Underpass	A Ramp	B Ramp	C Ramp	D Ramp
Maximum Vertical Slope	4.000%	0.929%	0.732%	1.028%	0.278%
Maximum Vertical Slope (Down Slope)	4.000%	0.650%	0.650%	0.419%	0.300%

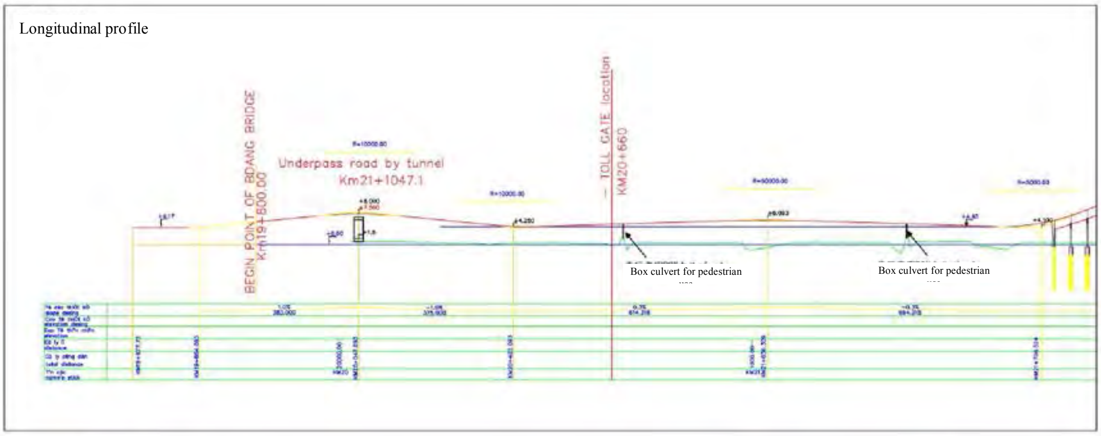
Source: JICA Study Team

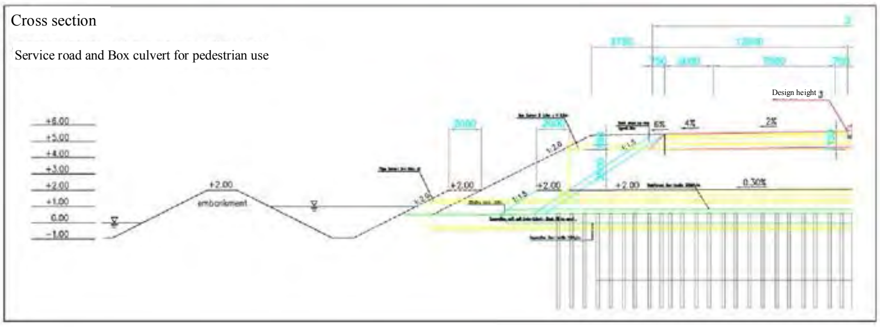
The Vietnam Road Standard (TCVN5729-1997) does not stipulate the vertical slope for the IC section. The present design for the IC section suffices when compared to trunk road section standards, but since the existence of regulations concerning IC sections is unclear, these designs, including whether or not the appropriate standard exists, must be confirmed with the Vietnam side during the Detailed Design stage.

D） Design Height of the Road Surface

When the vertical slope of the Approach Road on the Halong side is revised from 0% (Level) to 0.3%, as noted previously, care must be taken to prevent submersion of the road surface at the Design High Water Level (+3.36m). Accordingly, the decision was made to plan the Profile Alignment to maintain road height above +4.40m.

In addition, shrimp farming is conducted in the section from KM19+800 (Start point) to KM21+37 and there are plans to provide pedestrian paths on the side of the trunk road, box culvert pedestrian underpass (2.0×2.0m) and water pipes (φ1500×2). The heights of these pedestrian service roads and box culverts have been set at +2.0m above the height of the levees in the vicinity (used as pedestrian paths).





Source: JICA Study Team

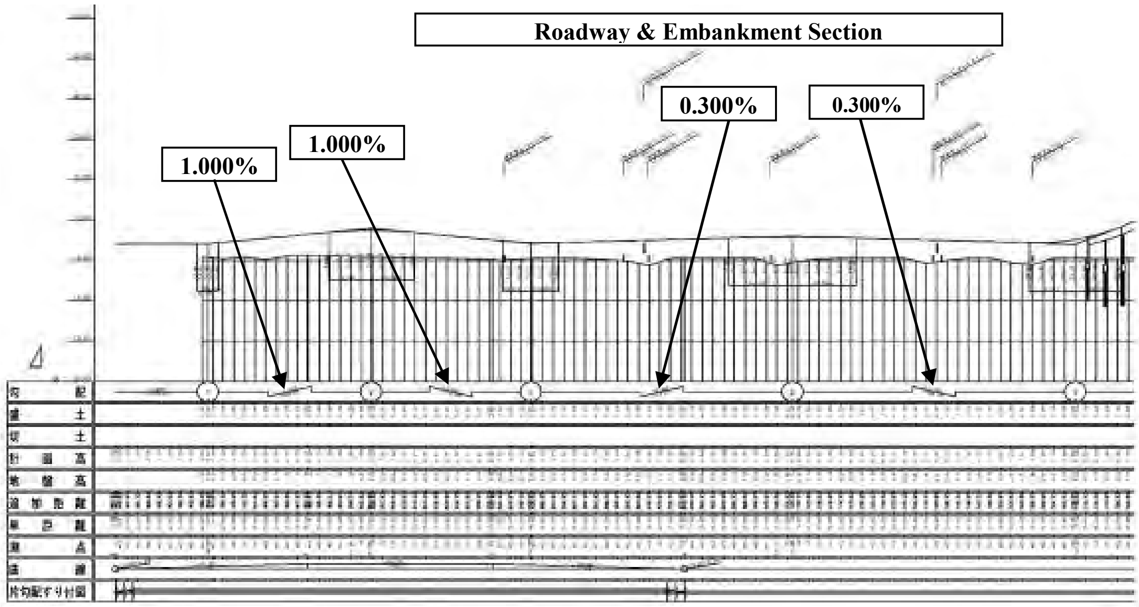
Figure 5.32 Vertical Slope & Cross-Section of Approach Road to Main Bridge on the Halong side

2) Review of Profile Alignment Components

The above review was conducted on the Vietnam F/S and the results are shown below.

A） Halong side

The Longitudinal Section is shown in Figure 5.33.

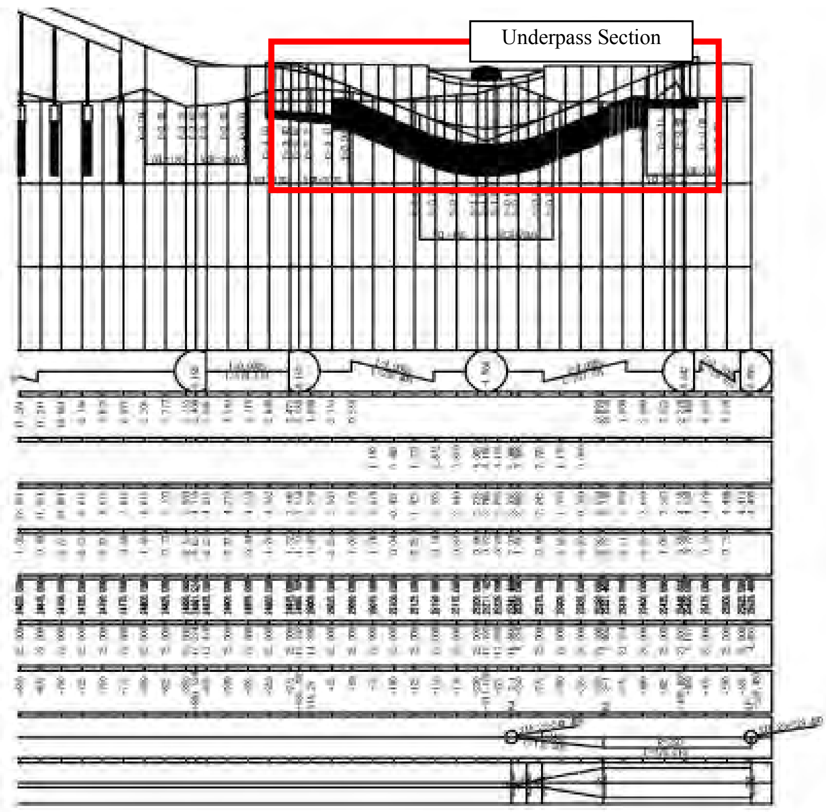


Source: JICA Study Team

Figure 5.33 Road Longitudinal Section (Halong side)

B） Hai Phong side

The Longitudinal Section is shown in Figure 5.34. The Underpass Section will be described later.



Source: JICA Study Team

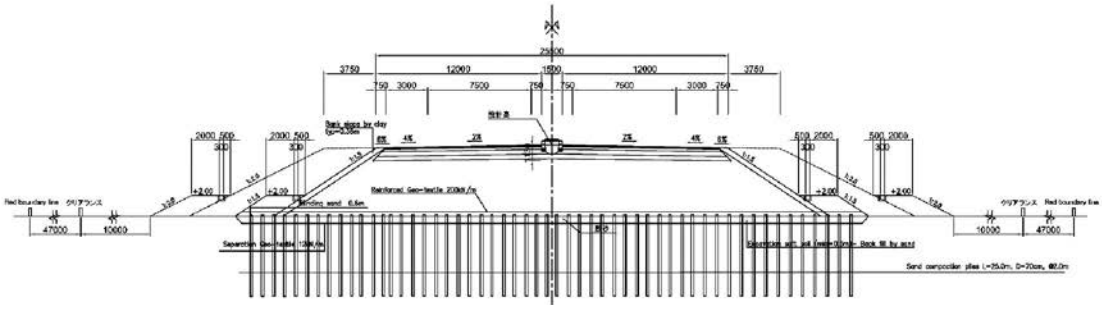
Figure 5.34 Longitudinal Section of Bridge (Hai Phong side)

(4) Composition of Cross-Section

1) Standard Cross-Sectional Composition

A） Road Section

The Vietnam F/S has analyzed the requirements for traffic lane numbers from traffic demand estimates up to 2030 based on Traffic Network Planning for Quang Ninh Province. Based on this analysis, plans for four lanes up to 2025 and six lanes after 2030 have been approved by Quang Ninh Province. The construction of the additional traffic lanes will be decided depending on traffic volume after constructing the four lanes.



Source: JICA Study Team

Figure 5.35 Standard Cross-Sectional Composition (Road Section: four / six lane)

There are plans to add 3.75m in both up/down directions following the change in lane numbers during the period 2025 to 2030, which will widen the road from 25.5 to 30.0m. The planned road width for the embankment sections is shown in Table 5.45.

Table 5.45 Road Section / Cross-Section

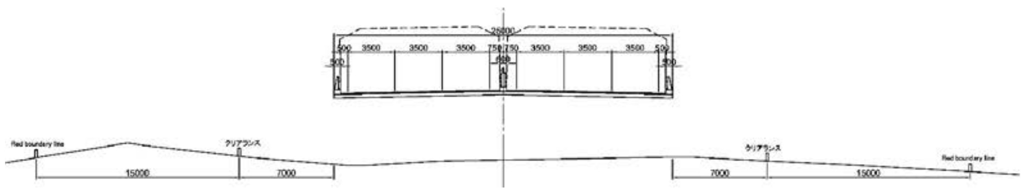
	Up to 2025	After 2030
Central Median Width	1.5 m	1.5 m
Shoulders	2 × 0.75 m	2 × 0.75 m
Traffic Lane Width	2 × 2 × 3.75 m	2 × 3 × 3.75 m
Emergency Lane Width	2 × 3.00 m	2 × 3.00 m
Planting Strip Width	2 × 0.75 m	2 × 0.75 m
Total	25.50 m	33.00 m

Source: JICA Study Team

The cant will be 2.0% for traffic lanes, 4.0% for shoulders and 6% for protective shoulders for surface drainage purposes as will be discussed below. The relation between cant and surface drainage will be discussed in Surface Drainage Works.

B） Bridge Section

The cross-sectional composition of the bridge section is planned to change the number of lanes between 2025 and 2030 in the Vietnam F/S and the embankment section is planned to be widened by adding a 3.75m wide traffic lane in both up/down directions. In the bridge section, the planned response is to retain the total width and acquire the three-lane configuration by revising the lane markings. The Standard Cross-Section for a six-lane configuration is shown in Figure 5.36.



Source: JICA Study Team

Figure 5.36 Standard Cross-Sectional Composition (Bridge Section: for six lanes)

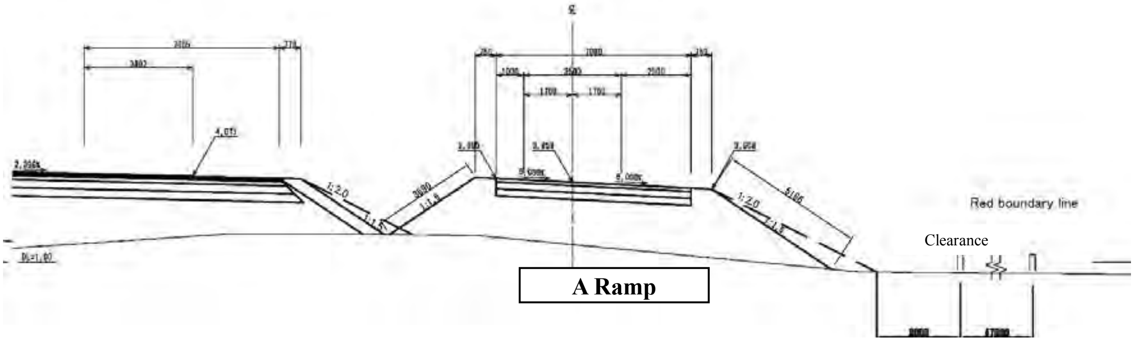
C） IC Section (Hai Phong side)

The cross-section for the IC Section (Hai Phong side) is shown in the Vietnam F/S and a review was conducted in this Study. It emerged that the width of the shoulders in the Vietnam F/S was insufficient, whereupon it was decided that the widths would be revised based on the Japanese Road Standard (Road Structure Ordnance). The width compositions for each ramp secti on are shown in Table 5.46.

Table 5.46 IC Section (Hai Phong side Ramp)/Cross-Sectional Composition

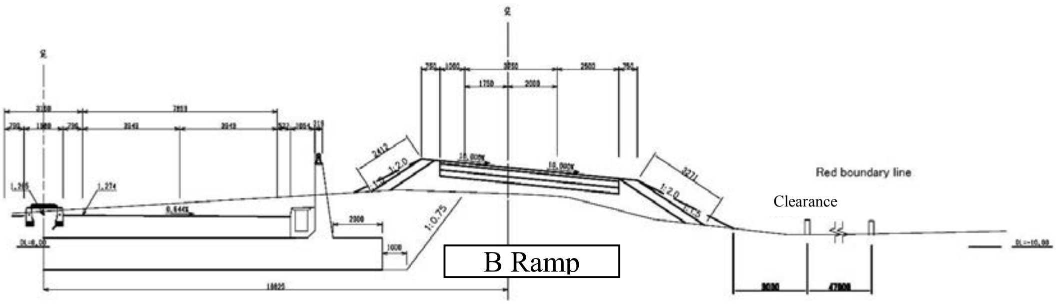
	A Ramp/B Ramp	C Ramp	D Ramp
Lane Composition	Single direction 1lane	Single direction 2lane	Single direction 2lane
Shoulder Width	3.50m = 1.00m + 2.50 m	2.00m = 1.00m × 2	2.00m = 1.00m × 2
Lane Width	3.50 m	8.50m = 4.25m × 2	7.00m = 3.75m × 2
Planting Width	1.50m = 0.75m × 2	1.50m = 0.75m × 2	1.50m = 0.75m × 2
Total	8.50 m	12.00 m	11.00 m

Source: JICA Study Team



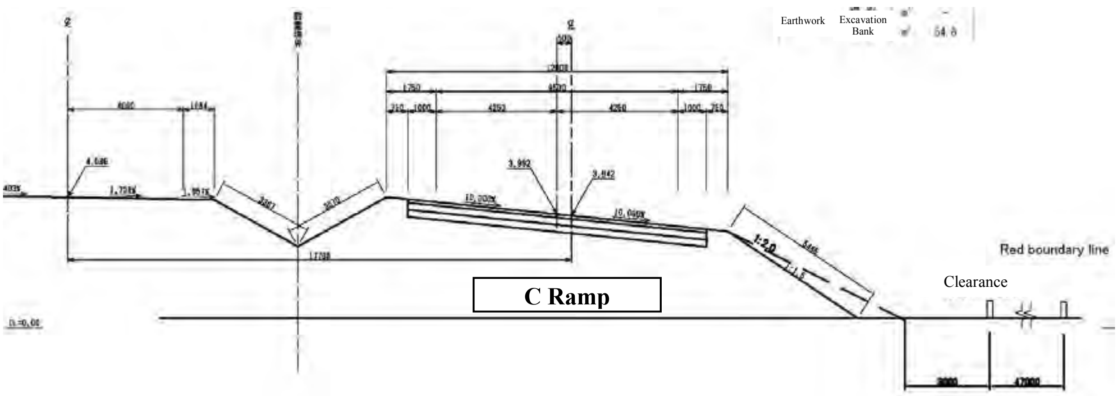
Source: JICA Study Team

Figure 5.37 Representative Cross-Sectional Composition (IC Section/ A Ramp)



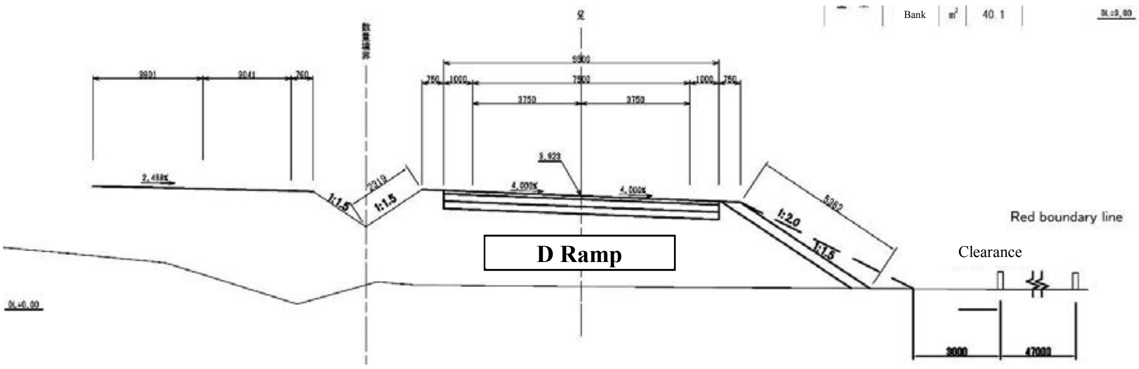
Source: JICA Study Team

Figure 5.38 Representative Cross-Sectional Composition (IC Section/B Ramp)



Source: JICA Study Team

Figure 5.39 Representative Cross-Sectional Composition (IC Section/C Ramp)



Source: JICA Study Team

Figure 5.40 Representative Cross-Sectional Composition (IC Section/D Ramp)

2) Embankment Slope

The Embankment Slope in the Vietnam F/S is shown in Table 5.47.

Table 5.47 Embankment Slope

	Embankment Slope
Four-Lane (up to 2025)	1:1.5
Six-Lane (after 2030)	1:2.0

Source: JICA Study Team

The Vietnam Standards for embankment slopes have not been identified. Accordingly, the Japanese Standards (Road Earth Works, Embankment Work/Slope Stabilization Work Guideline, published by the Japan Road Association) were used as a reference. The statement in the Japanese Standards on Embankment Slopes is as follows:

Statement on the Standard Embankment Slope Section (Standard Embankment Slope) in the Embankment Work/Slope Stabilization Work Guideline
Generally, low embankments can be worked to 1:1.5 slopes if done properly and there will be a large-scale collapse unless there are problems with the soil. However, compaction on 1:1.5 slopes is liable to be insufficient and holds the danger of surface failure or erosion. Accordingly, in the standard embankment, the slope can be set to 1:1.8 as required to allow machine compaction.

Table 5.48 Standard Embankment Slope for Embankment Material & Embankment Height in the Japanese Standard

Embankment Material	Embankment Height (m)	Slope	Application
Well-graded Sand (S), Gravel & Gravel with fine particles (G)	Under 5m	1:1.5〜1:1.8	May be applied to embankments that are supported by load-bearing strata with sufficient strength and no danger of submersion. The uniform categories in ( ) are representative types for reference. When the slope exceeds standard slope limits, stability calculations must be conducted.
	5〜15m	1:1.8〜1:2.0	
Poorly Graded Sand (SG)	Under 10m	1:1.8〜1:2.0	
Rock (including excavated rocks)	Under 10m	1:1.5〜1:1.8	
	10〜20m	1:1.8〜1:2.0	
Sandy Soil (SF), Firm Silty Soil, Firm Mud (firm diluvial Silty Soil, Silt /Kanto Loam and similar)	Under 5m	1:1.5〜1:1.8	
	5〜10m	1:1.8〜1:2.0	
Volcanic Ash Silt (V)	Under 5m	1:1.8〜1:2.0	

Note: the embankment height means the height difference between bank shoulder and toe.

Source: Embankment Work/Slope Stabilization Work Guideline

When the 1:1.5 embankment slope in the Vietnam F/S is compared to Japanese Standards, they are found to be basically applicable, although some slight reservations about difficulty in construction can be pointed out. Accordingly, this Study will apply the embankment slope design in the Vietnam F/S. However, there is the danger of erosion as mentioned in the Japanese Standards and the slope will be changed from 1:1.5 to 1:2.0 following the transition from four to six lanes, Since there is reason to believe that land required for six lanes can be acquired at the initial stage and the embankment constructed to 1:2.0 in the initial construction, this will allow only a 1:2.0 slope to be adopted. Under these considerations, these designs, including whether or not the appropriate standard exists, must be confirmed with the Vietnam side during the Detailed Design stage. Furthermore, if the on-site soil conditions are softer than assumed, there will be a need to review the slope angle for embankments after conducting stability calculations that combine countermeasures (retaining embankments, soil improvements, etc.) implemented in the Detailed Design.

3) Slope Protection Works

Since slope protection works are not described in the Vietnam F/S, the Japanese Standard (Embankment Work/Slope Stabilization Work Guideline) has been referenced.

Planting works to prevent erosion and surface collapse have been selected, since the precondition is to design embankment slopes to angle of stability within the Project Facilities area.

5.5.3 Underpass Structure (Hai Phong side)

The IC section on the Hai Phong side will intersect with the Hanoi-Hai Phong Highway. The shape of this interchange was planned as a bridge-type multilevel interchange in the Vietnam F/S, but switched to an underpass type multilevel interchange structure in the METI F/S due to the considerations shown in Table 5.49.

Table 5.49 Comparison of Overbridge and Underpass Interchange Types

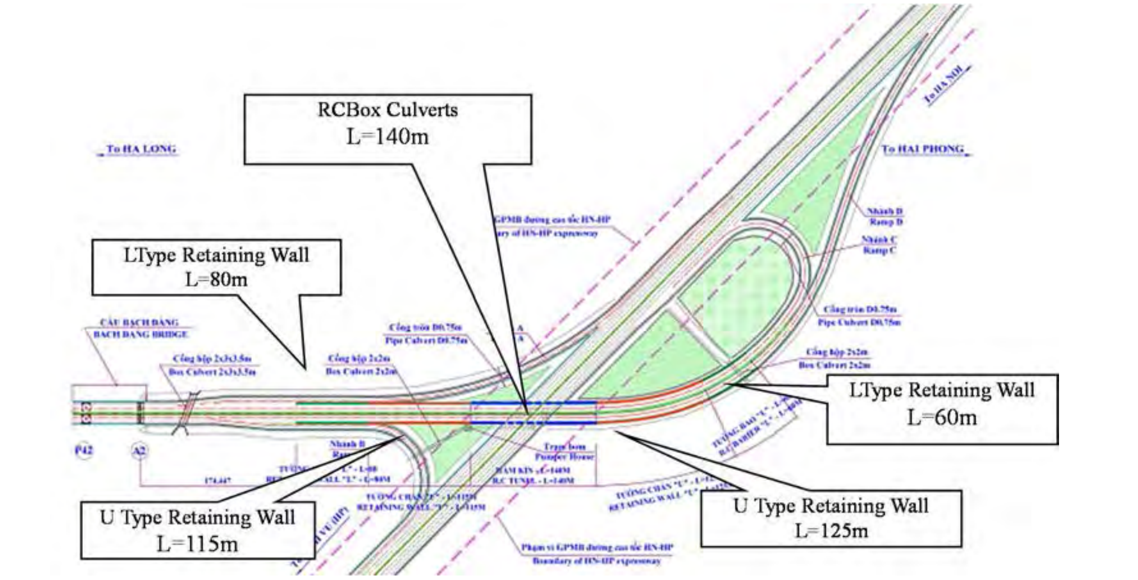
Comparison item	Overbridge (Vietnam F/S)	Underpass
Drivability	Maximum Profile slope is 4%, limiting the visibility of drivers entering the trunk road	Good visibility for drivers since embankment sections are lower
Harmony with surroundings	Disrupts vista from buildings	Vistas are unaffected since structures are underground
Construction Method	Complex curved bridge structure requires extensive temporary support during construction	Simple structure that can be constructed with standard construction technology like box culverts
Construction Period	PC bridges are complex structures, requiring high construction work volume and long construction period	A simple structure, limiting the work volumes required and expediting construction
Operation Cost	Less than Underpass	Construction and renewal of drainage facilities increases operation costs slightly. (small percentage of total cost)
Construction Cost	More than Underpass	Approximately 478×10^9VND

Source: from METI F/S

This Study adopts the Underpass model based on METI F/S. A review of the Underpass structure was conducted as shown below.

(1) Horizontal and Vertical Planning

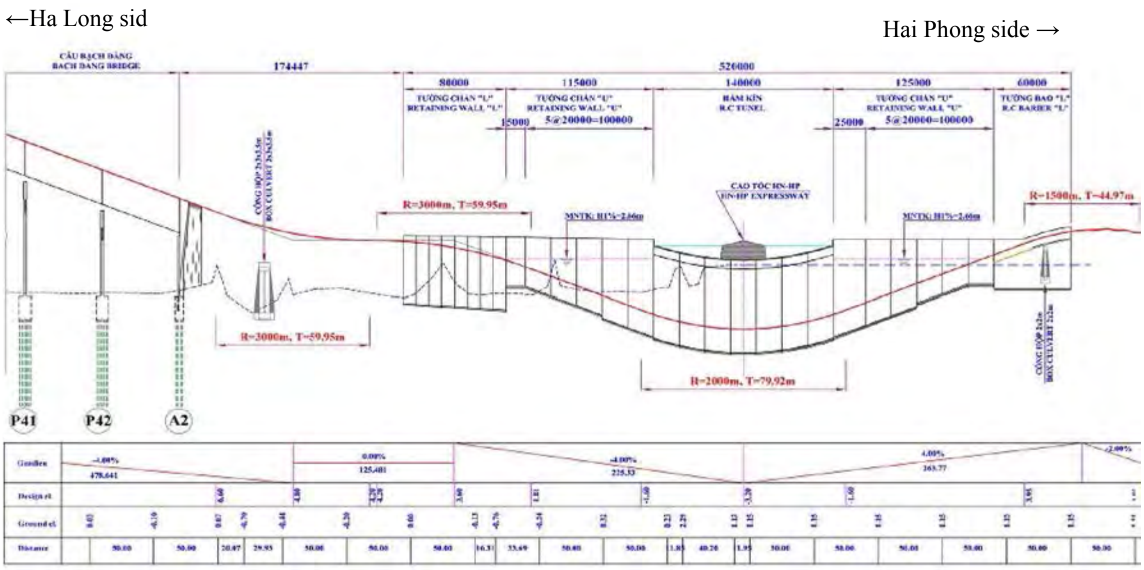
The underpass structure is located on the Hai Phong side Interchange. The Hai Phong side IC was designed as a trumpet shape in the Vietnam F/S and this Study will also adopt the trumpet shape and retain the basic linear alignment of the Vietnam F/S. Since the horizontal and profile alignments are as noted above, the discussion in this section will review the items related to the underpass structure.



Source: JICA Study Team

Figure 5.41 Location of the Underpass Structure

The Profile Curve radius is R=3,000m with a crest shape in the section between the end of the bridge and tunnel. The Profile Curve radius is R=2,000m sag profile within the tunnel and the vertical slope is 4%. The Profile Sectional Drawing of the Underpass Structure is shown in Figure 5.42.



Source: JICA Study Team

Figure 5.42 Profile Sectional Drawing of the Underpass Structure

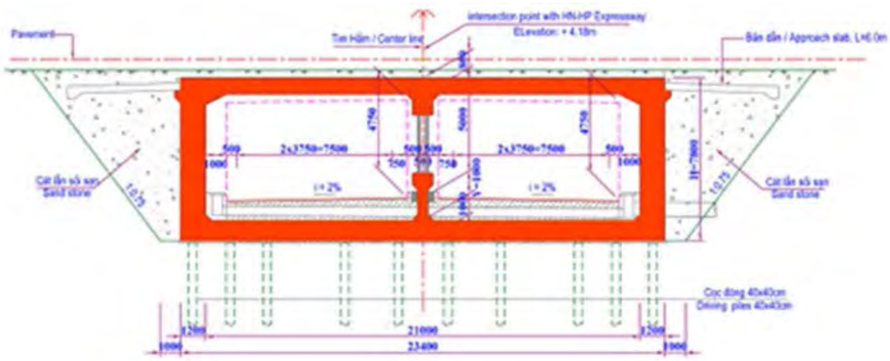
(2) Underpass Structure

As shown in Figure 5.42, the underpass structure has a total length of 520m and can be divided into three structures as shown in Table 5.50. The multilevel section adopts a box culvert type 140m long and will include a waterproof layer on the concrete surface to prevent water infiltrating from cracks in concrete elements, while the joints between segments will have waterproof sealing applied. The start/end point of the box culvert section will both have U-shaped retaining walls 115m and 125m long, with a transition from 2.73 to 6.86m. Sections with low retaining walls will be provided with L-shaped retaining walls 80 and 60m long on the start and end sides respectively. The sections of each structure type are shown in Figures 5.43, 5.44 and 5.45.

Table 5.50 Underpass Structure Type

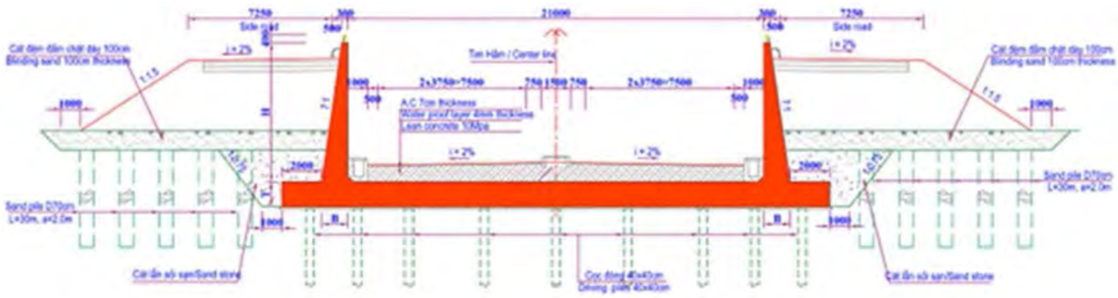
Structure	RC Box Culvert	U-shaped Retaining Wall	L Shape Retaining Wall
Position	Multilevel crossing with the Hanoi-Hai Phong Highway	Adjacent to RC Box Culvert	On embankment adjacent to U-shaped retaining wall
Cross-Section	21m (inner void section) ×7m (total height)	Retaining Wall Height: H= 2.73m ~ 6.86m	Retaining Wall Height: H= 1.26m ~ 2.97m
Total Length	L=140m	L=115m+125m=240m	L=80m+60m=140m
Foundation Structure	RC Piles (40c×40cm), L=35m	RC Piles (40c×40cm), L=35m	Soil Improvement w/ Sand Compaction Piles (D= 0.7m)

Source: JICA Study Team



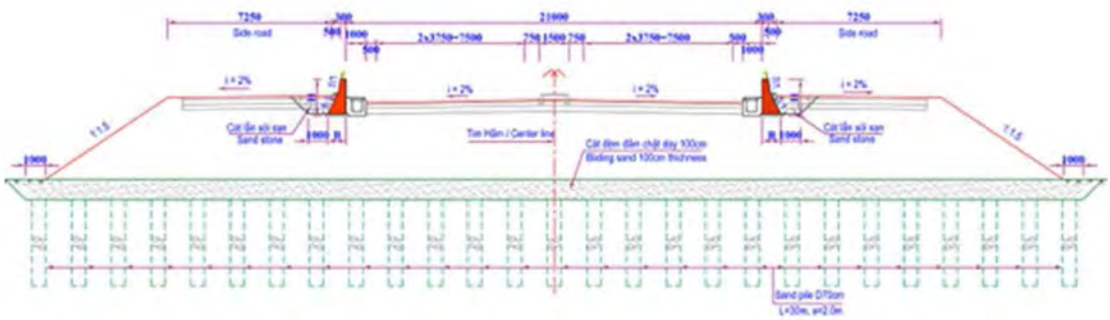
Source: JICA Study Team

Figure 5.43 Reinforced Concrete Box Culvert



Source: JICA Study Team

Figure 5.44 U-Shaped Retaining Wall

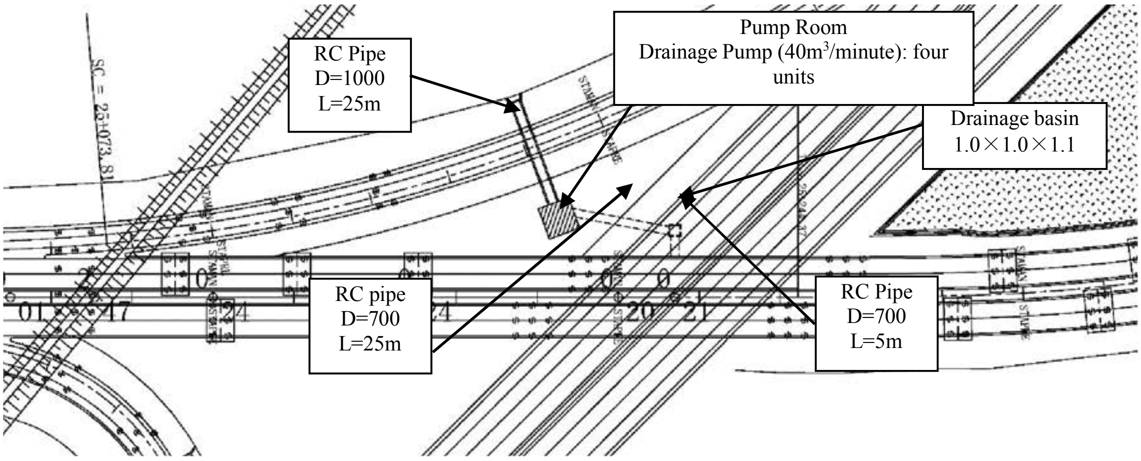


Source: JICA Study Team

Figure 5.45 L-Shaped Retaining Wall

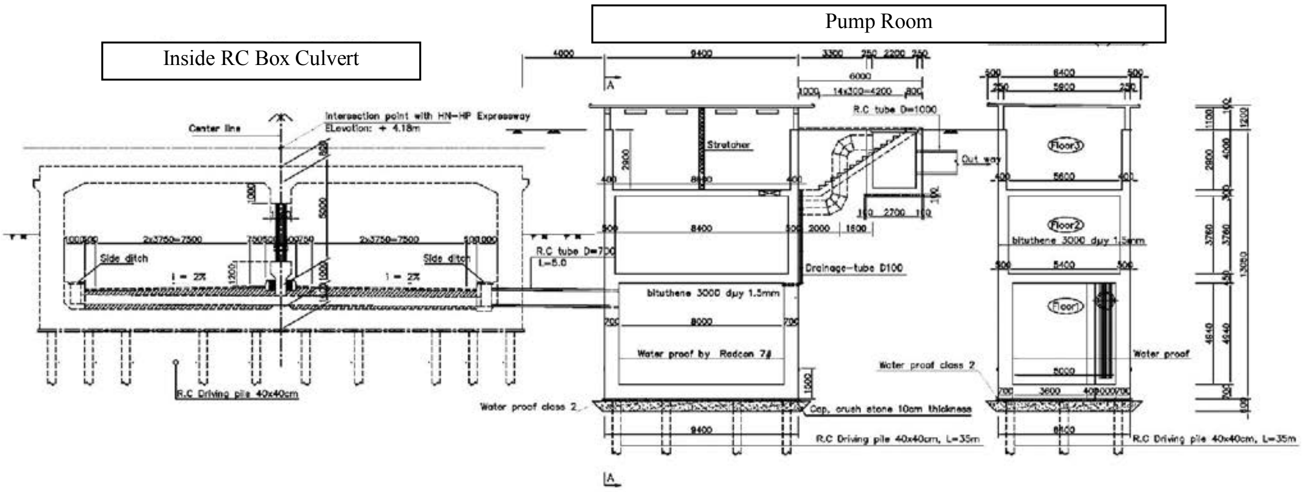
(3) Drainage Facilities

The crest height of the retaining walls as well as the road height between the approach overbridge and underpass are set at +4.5m altitude with 100-year probability High Water Level of +3.36m in mind to prevent flood water from entering the underpass. Furthermore, to prevent surface water drainage from entering the underpass as far as possible, a drain channel across the road is provided at the ends (in the vicinity of the entry) of the RC Box Culvert section. In addition, any water that enters the box culverts will be collected in the adjacent Drainage Pump Room and automatically discharged by four drainage pump units (40m3/ minute).



Source: JICA Study Team

Figure 5.46 Position of Drainage Facilities



Source: JICA Study Team

Figure 5.47 Drainage Facilities

Tunnels will be flooded in emergencies if the pumps stop functioning, which may cause major accidents if vehicles run into the flooded area. Accordingly, there is a need to investigate operations, maintenance and repairs and the corresponding organization for the pumps during the Detailed Design.

5.5.4 Analysis of Soft Soil Measures

The complete scope of the Vietnam F/S is the full 25.21km length connecting Quang Yen Town and Hai Anh ward, Halong City in Quang Ninh Province. The scope of this F/S is a 2.00km road section from the Starting Point 1.56km (Km20+150~Km21+717) to the Ending Point 0.44km (Km20+150 ~Km21+717).

The area is covered in mangrove swamps, which form a natural low-lying flatland. The geology of the vicinity is a thick accumulation of soft clayey soils from the surface to approximately GL-30m. Soft clayey and sandy soils form alternating strata at the Ending Point side, with soft soil from the surface to approximately -30m. When embankment structures are constructed over deep formations of subsidence causing soft soils, such as in the scope area, there is general concern regarding subsidence and slip failure.

The Vietnam F/S has planned for soft soil countermeasures to be applied over the entire length of the Project.

This section will review the soft soil measures in the Vietnam F/S.

(1) Summary of Soft Soil Measures in the Vietnam F/S

1) Design Standards

The Design Conditions described in the Vietnam F/S are the Vietnam National Standards 22TCN262-200 and TCVN5729-1997. The standards shown in Table 5.51 were confirmed as the relevant standards applied during on-site interviews.

Table 5.51 Design Conditions

Standard No.	Name of Standard
22TCN262-2000	Standard Investigation and Design of Embankment on Soft Ground
TCVN5729-1997	Expressway Design Requirement
22TCN211:06	Specification for Flexible Pavement Structure Design

Source: JICA Study Team

2) Design Conditions

The Design Conditions referred to in the Vietnam F/S Report are shown in Table 5.52.

Table 5.52 Design Conditions

Category		Condition
Subsidence	Permissible Residual Subsidence	Sr≤30㎝ Embankment Section Sr≤20㎝ Drainage facility section Sr≤10㎝ In connection with Bridge Structure
	Consolidation	U≥90%
	Others	Annual Residual Subsidence ≤2cm/year
Stability	Safety factor	During Construction Fs≥1.20
		After Construction Fs≥1.40
	Stability analysis	Embankment loading, pavement loading, preventive loading, traffic loading (1.49t/m²)

Source: JICA Study Team

3) Soft Soil Countermeasures Works

The list of countermeasures proposed in the Vietnam F/S is shown in Table 5.53.

The methods proposed (including Sand Drain Method) are part of common construction technology in Vietnam, with sufficient completed examples, including the Hanoi-Hai Phong Highway adjacent to this Project. The Sand Drain Method has been selected for the area of this Study, since it includes a deep accumulation of soft soils.

Table 5.53 Soft Soil Countermeasure Works in the Vietnam F/S

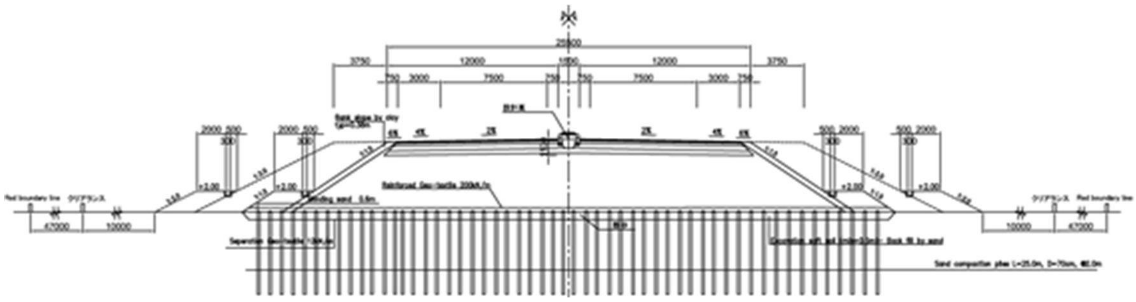
Mane	Replacement Method	Vertical Drain Method	
		PVD*1	Sand Drain Method
Summary	A method whereby surface soft soils are excavated, discarded and replaced with good soil.	Factory manufactured plastic pipe drains are emplaced at regular intervals into the ground to promote draining of clay soils and consolidation	Highly porous sand is emplaced into the ground at regular intervals by specialized equipment to promote draining of clay soils and consolidation
Content	➢Maximum replacement depth is 3.5m for embankments under 3.5m ➢For soft soil less than 5.0m deep, or an embankment height exceeding 4.0m and soft soil depth under 10m, partial application permitted.	➢ Applicable for soft soil depth under 10m for embankment heights of under 6.0m ➢ Placement interval at 1.7m ➢ Depth: to bottom of soft soil strata	➢ Applicable for soft soil depths of 6~30m for embankment heights exceeding 6.0m ➢ Placement interval of 2.0m ➢ Depth: to bottom of soft soil strata, maximum 30m ➢ Speed of embankment: 5-10cm/day
Applicable Scope	Applied outside the scope of this F/S.	Applied outside the scope of this F/S	Applied to scope area

*1 : PVD=Prefabricated Vertical Drain

Source: JICA Study Team

4) Countermeasure Drawings

The Countermeasure Drawings for the area in this Scope are shown in Figure 5.48.



Source: JICA Study Team

Figure 5.48 Typical Cross-Section

(2) Review of Existing Soft Soil Countermeasures

The Vietnam F/S Report describes the types and numbers of Soft Soil Countermeasures, but does not show the results of subsidence and stability analysis. Accordingly, an analysis of consolidation and stability was conducted for typical soil profiles at the Starting and Ending Points of the road section using borehole data and laboratory test results performed in the Vietnam F/S.

The Sand Drain Method was confirmed as effective in meeting the Design Conditions within the Project Area.

There are three types of Permissible Residual Subsidence in the Design Conditions, but the most stringent condition of under 10cm was applied to be on the safe side. In addition, the speed of embankment works was set at 5cm/day.

1) Soil Conditions

The representative Soil Profiles at the Starting and Ending Points are shown in Table 5.54.

Table 5.54 Representative Soil Parameters at the Starting and Ending Points

	Strata	Soil Classification	Natural water content (%)	Unit weight by volume (kN/m^3)	Liquid Limit (%)	Plastic Limit	Adhesive force (kN/m^2)	Angle of Repose (Degree)
Start	1	Clay	49.5	17.2	52.3	24.5	8.30	5.81
	2	Clayey Sand	30.3	18.4	39.5	19.1	12.6	9.20
	3	Clay	39.8	17.9	51.3	23.7	13.2	8.53
	4	Gravel Sand	23.1	18.2	32.7	15.2	12.7	16.65
End Point	1	Clay	50.8	17.1	53.8	25.5	10.0	6.33
	2	Clay	39.9	17.5	48.9	18.1	11.6	8.20
	3	Clayey Sand	28.9	18.9	38.5	17.9	11.6	14.2

Source: JICA Study Team

2) Results of Consolidation and Stability Analysis

Results of Consolidation and Stability Analysis for Soft Soil Countermeasures are shown in Table 5.55.

Table 5.55 Results of Consolidation and Stability Analysis (Sand Drain Method)

	Embankment Height (m)	Thickness of soft soil strata (m)	Final Subsidence Depth (m)	Days for Residual Subsidence of 10 cm	Safety factor in Stability Analysis
Starting Point	5.0	27.6	1.03	211	1.59
	8.0		1.36	257	1.44
Ending Point	5.0	35.5	2.34	373	1.71
	8.0		2.98	342	1.44

Source: JICA Study Team

(3) Concerns on Soft Soil Countermeasures Works

The Vietnam F/S applied the Sand Drain Method out of three possible countermeasure types for the subject area of this Study. As a result of consolidation and stability analyses, it was confirmed that the sand drain method could be expected to promote consolidation and the application is therefore correct. However, given the lack of a sufficient basis to select PVD or the Sand Drain Method in relation to embankment height and soil strata thickness, the selection policy for comparing countermeasures is deemed insufficient.

Accordingly, it is advisable that the PVD method and measures implemented in adjacent construction sections should also be considered in the analysis.

(4) Improved Countermeasure Proposal

Since it is difficult to state that the most appropriate soft soil countermeasures works have been selected after comparing effectiveness and economy in the Vietnam F/S, this section will review to confirm whether PVD and Sand Compaction Methods are applicable for the Project area for which the Sand Drain Method was selected in the Vietnam F/S. The review shall conduct consolidation and stability analyses based on the characteristics of each method as shown in Table 5.56.

Table 5.56 Comparison Table of Countermeasures

Name	Vertical Drain Method		Vibration Compaction Method
	PVD	Sand Drain	Sand Compaction Method
Description	Factory manufactured plastic pipe drains are emplaced at regular intervals into the ground to promote draining of clay soils and consolidation.	Highly porous sand is emplaced into the ground at regular intervals using specialized equipment to promote draining of clay soils and consolidation.	Compacted sand is emplaced using vibration into soft soil strata. This has both a drainage and compaction effect and improves the load-bearing capacity, promotes consolidation and reduces total consolidation of clay soils.
Merits	Drains are factory made, stable quality products. Construction is faster than for sand drains.	Promotion of consolidation is better than PVD for the drain size adopted in the Vietnam F/S.	Emplacing sand piles in clay soils improves the load-bearing capacity of the ground.
Demerits	Removing casing after placement may cause PVD uplifting. Only shallow examples in Vietnam. Depths of up to 40m are possible with proper equipment.	Highly porous sand is unavailable in the vicinity of site, requiring transportation from a distant pit, which will increase the cost.	The construction cost is considered higher than other methods.
Consolidation Time	○	○	◎

Source: JICA Study Team

1) Condition for Analysis

The soil ground conditions resemble the conditions described above.

In the analysis of the PVD and Sand Compaction Methods, the emplacement interval of PVD is that of the Vietnam F/S and the interval for the Sand Compaction Method is 1.5 from the interval used in the adjacent construction section derived from interviews in Vietnam.

The construction period, including resting period, is set at a maximum 470 days (1.35 years).

2) Results of Analysis

The results of the analysis are shown below.

- As a result of the analysis, the PVD and Sand Compaction Methods can both be constructed within the construction period and are deemed applicable in the section assigned to the Sand Drain Method in the Vietnam F/S, as shown in Table 5.57.
- To stabilize the embankment, there is a need to construct slow banking at a rate of 5cm/day or similar and proceed by improving the strength of soft soils through staged banking.
- The plans are for a typical six-lane cross-section with future expansion to six lanes in mind and the countermeasures should be for the full width of the expanded six-lane construction.
- The cost estimate for the PVD Method is found to reduce costs compared to the Sand Drain Method, based on quantity calculation and cost estimation.
- The Sand Compaction Method affords a shear resistance effect from the sand piles and is recommended for the section behind bridge piers.
- The PVD Method is only permitted down to 10m in the Vietnam Standards, but can be applied for deeper construction if appropriate machinery is selected. This method should involve detailed soil investigation and be analyzed in depth at the next step.

Table 5.57 Results of Comparison Analysis

	Planned Embankment Height (m)	Thickness of soft soil strata (m)	Sand Drain Method		PVD Method		Sand Compaction Method	
			Interval (m)	Days for 10cm of Residual Subsidence	Interval (m)	Days for 10cm of Residual Subsidence	Interval (m)	Days for 10cm of Residual Subsidence
Starting Point	5.0	27.6	2.0	211	1.2	211	1.5	119
	8.0			257		306		176
Ending Point	5.0	35.5	2.0	373	1.2	390	1.5	158
	8.0			342		469		229
Applicability			Applicable		Applicable		Applicable	
Recommended Condition			General Embankment		General Embankment		Back of Pier	

Source: JICA Study Team

3) Other Recommendations

Recommendations for further study in subsequent investigations and measures during construction are shown below.

A） Detailed Soil Investigations

Supplementary drilling and laboratory tests for the data in the Vietnam F/S are required since the numbers for the embankment section are particularly scarce. The most urgently required investigations are shown below.

- Boring investigations and Standard Penetration Test in the boreholes
- Unconfined compression test, tri-axial shear test (or direct shear test) for undisturbed samples from each clay strata.
- Natural water content, liquid/plastic limits (Atterberg Limits), particle gradation, sedimentation analysis (hydrometer analysis), specific gravity of soil particles

B） Observation of Movement during Construction

Observation of movement should be conducted during construction to confirm convergence of consolidation settlement and avoid embankment slip failures.

Items of Observation of Movement are shown below.

【General Embankment】

- measure subsidence at surface and each soft soil strata: three points per location
- horizontal movement: place stakes for measuring displacement

【Bridge Pier】

- Implanted Inclinometer: 2 points in front of bridge Pier

C) Other Matters

Other matters that must be investigated during the Detailed Design are shown below.

- Confirmation with test embankment prior to commencing construction
- Pre-loading is effective for some conditions for Box Culvert installation and should be investigated.

5.5.5 Drainage Design

Since the drainage design is unclear in the Vietnam F/S, it was redone for this Study.

The analysis items in the drainage design include calculation of rainfall intensity, calculation of discharge, drainage of shoulders in embankment and bridge sections and longitudinal drainage channels. The detailed calculations are shown in the attached Reference Documents. The results of the analysis of discharge, resulting drainage and longitudinal drainage channels will be shown in this section.

The results of the Analysis are shown below.

(1) Calculation of Discharge Flow

The discharge from the trunk road surface is shown in Table 5.58.

Table 5.58 Discharge from Trunk Road Surface

Position of Discharge Zone, Measurement Point	Discharge Volume	Note
C1 20 + 47.09 ~ 20 + 422.09 L	0.08	
C2 20 + 47.09 ~ 20 + 422.09 L	0.03	
C3 20 + 422.09 ~ 20 + 745.30 L	0.09	
C4 20 + 422.09 ~ 20 + 745.30 L	0.09	
C5 20 + 745.30 ~ 20 + 785.30 L	0.01	
C6 20 + 785.30 ~ 21 + 36.31 L	0.07	
C7 20 + 47.09 ~ 20 + 422.09 R	0.10	
C8 drainage channels at foot of embankment slope 745.30 R	0.09	
C9 36.31 R	0.08	
C10 21 + 36.31 ~ 21 + 734.55 L	0.19	
C11 Permissable Discharge Flow of drainage channels at foot of slope		
C12		Approach Bridge
C13 22 + 185.49 ~ 22 + 485.49 L	0.09	Approach Bridge
C14 22 + 485.49 ~ 22 + 814.55 L	0.09	Approach Bridge
C15 22 + 814.55 ~ 23 + 285.04 L	0.14	Main Bridge
C16 21 + 734.55 ~ 22 + 185.49 R	0.13	Approach Bridge
C17 22 + 185.49 ~ 22 + 485.49 R	0.09	Approach Bridge
C18 22 + 485.49 ~ 22 + 814.55 R	0.09	Approach Bridge
C19 22 + 814.55 ~ 23 + 285.04 R	0.14	Main Bridge
C20 23 + 285.04 ~ 23 + 754.55 L	0.13	Main Bridge
C21 23 + 754.55 ~ 24 + 84.87 L	0.09	Approach Bridge
C22 24 Safety Factor (reduction of discharge area due to sedimentation, etc)		Approach Bridge
C23 24		Approach Bridge
C24 23 + 384.73 ~ 24 + 754.55 R	0.13	Main Bridge
C25 23 754.55 ~ 24 + 84.87 R	0.09	Approach Bridge
C26 24 + 84.87 ~ 24 + 384.73 R	0.09	Approach Bridge
C27 24 + 384.73 ~ 24 + 774.55 R	0.11	Approach Bridge

Source: JICA Study Team

(2) Shoulder Drainage of Embankment and Bridge Sections

The analytical results for placement intervals of vertical channels in each section are shown in Table 5.59. The placement of intervals in the embankment section was set at 200m following the Japanese Standard (NEXCO Design Guideline Book 1 Drainage Chapter).

Table 5.59 Placement Interval of Vertical Channels

Section	Vertical Slope (%)	Permissible Discharge (m^3/sec)	Interval of longitudinal channel (m)	
			Calculated interval	Applied interval
Embankment	1.000	0.166	603.636	200
	0.300	0.091	330.909	200
Opening of Median strip shoulder (No. 20+100~No. 20+746)	1.000	0.002	7.438	7
	0.300	0.001	3.967	4
Interval of Drain basins in Main & Approach Bridge	2.000	0.0008	2.785	3
	4.000	0.0012	4.178	4

Source: JICA Study Team

(3) Design of the Longitudinal Drainage Channel

The surface drainage on the Halong side will be analyzed for longitudinal drainage as the vicinity is used for shrimp farming and no discharge to surrounding areas is possible. However, the development of the Dam Nha Mac area has not been finalized and the terminal point of the drains is unconfirmed. A side drainage channel (0.3×0.3) was planned for the side road in this Study, but its shape may be changed according to the terminal design. Since the width of the side road may be affected when the size of the channel is changed as well as the land acquisition requirements, there is a need to analyze the development planning of the Dam Nah Mac area and drainage terminal planning to finalize the land acquisition width.

The discharge flow and drain flow at the positions shown in Table 5.60 were confirmed in this Study. Consequently, the planned drainage pipes (0.30×0.30) were confirmed as adequate.

Table 5.60 Confirmation of Discharge Flow in the Vertical Drain Channel

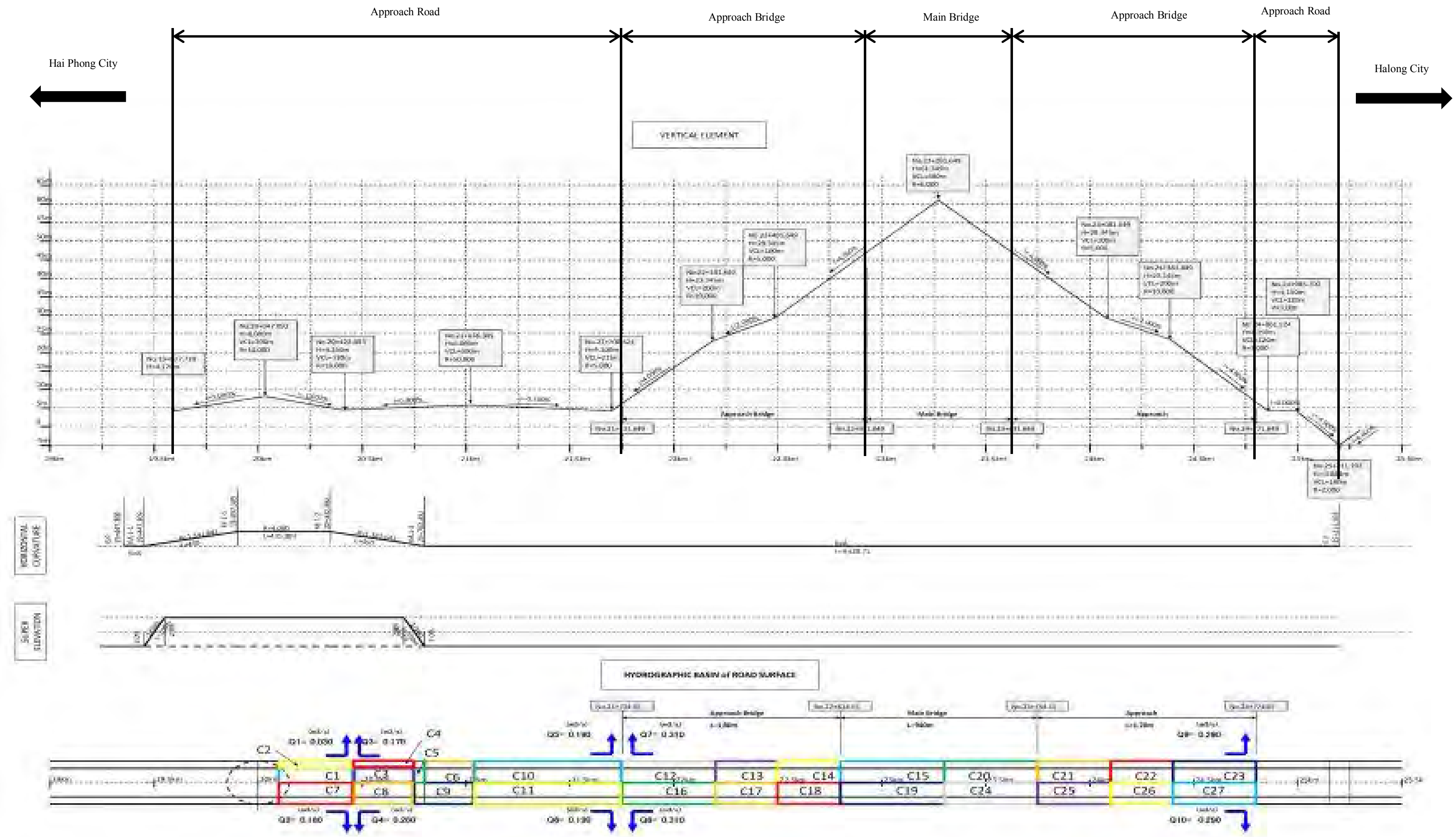
Verification point	Drainage slope	Discharge Volume (m^3/sec)		allowable flow (m^3/sec)	Pipe diameter (m)	Evaluation
		discharge zone	discharge volume			
Q1, No.20+422.093	0.300	C2	0.03	0.07	0.30*0.30	OK
Q2, No.20+422.093	2.200	C1, C7	0.18	0.18	0.30*0.30	OK
Q3, No.20+422.093	2.000	C4～6	0.17	0.17	0.30*0.30	OK
Q4, No.20+422.093	5.000	C3, C8, C9	0.26	0.27	0.30*0.30	OK
Q5, No.21+734.550	0.300	C10	0.19	0.26	0.30*0.30	OK
Q6, No.21+734.550	0.300	C11	0.19	0.26	0.30*0.30	OK

Source: JICA Study Team

As noted above, the discharge point could not be confirmed. Accordingly, the need for proposing discharge to final drainage terminus (rivers) or construction of storm reservoirs and oil-water separator basins is required during the Detailed Design.

(4) Profile Slope/Cant and Surface Drainage

The existing relationship between Vertical Slope/cant and Surface Drainage is shown in Figure 5.49.



Source: JICA Study Team

Figure 5.49 Profile Slope / Cant and Surface Drainage

(5) Box Culvert Design

The main reasons for selecting box culverts differ for each section and are summarized in Table 5.61.

Table 5.61 Reasons for Selection of Box Culverts

Area Name		Reasons for Selection
Starting Point	Dam Nha Mac area, Road Works section	Water flow to shrimp farms Cross passage under trunk road for workers at shrimp farms
Ending Point	Hai Phong Area, Road Works section	Water flow of the existing canal
	Hai Phong area IC	Depressed area in IC

Source: JICA Study Team

The detailed positions of culverts for each section are shown below.

1) Starting Point side/ Dam Nha Mac Area/ Road Works Section

As noted above, the reason to select box culverts for this area is water flow and a pedestrian underpass. Cross pipes (D1500×2) were selected for the water flow, aligned with existing waterways and channels confirmed from site investigations and topological surveys.

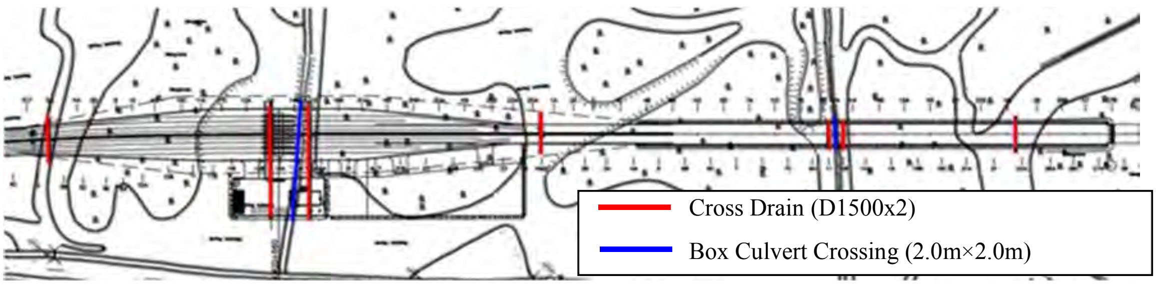
The pedestrian crossings are sized dimensioned to accommodate the passage of a single person using a C-BOX (Culvert-Box, 2.0×2.0m) crossing. The position was selected as above for water pipes to run along existing passages and paddy footpaths, as confirmed from site investigations and topological surveys.

Table 5.62 Culvert Position (Starting Point side/Dam Nha Mac Area/ Road Works Section)

Position		Structure	Shape	Note
Starting Point side Dam Nha Mac area Road Works Section	KM20+360	Pipe crossing	D1500×2	Water flow for shrimp farms
	KM20+650	Pipe crossing	D1500×2	
	KM20+650	C-BOX crossing	2.0mx2.0m	Trunk road crossing for shrimp farm workers on foot
	KM20+700	Pipe crossing	D1500×2	Water flow for shrimp farms
	KM20+980	Pipe crossing	D1500×2	
	KM21+360	Pipe crossing	D1500×2	
	KM21+370	C-BOX crossing	2.0mx2.0m	Trunk road crossing for shrimp farm workers on foot
	KM21+380	Pipe crossing	D1500×2	Water flow for shrimp farms
	KM21+610	Pipe crossing	D1500×2	

Source: JICA Study Team

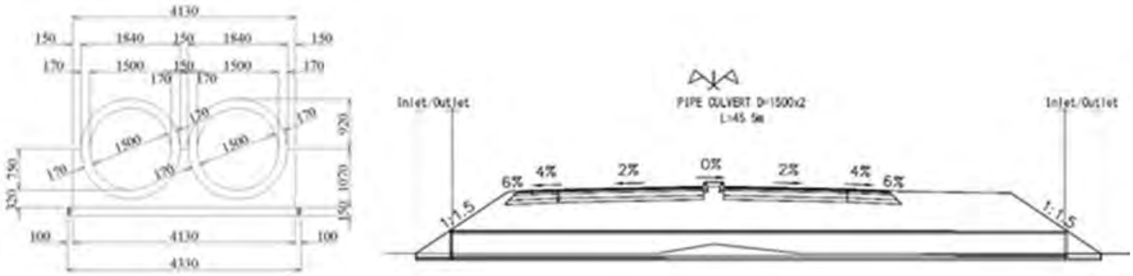
There is the possibility that the trunk road embankment will dam the rising floodwaters during heavy flooding. Accordingly, detailed studies on the size of the culverts and required numbers should be performed to install transverse drainage piping during the Detailed Design stage. Furthermore, when box culverts are to be installed, PC piling may have to be provided, but although the culverts will be supported from settlement by the piling, the embankment may continue to slowly subside after completion, leading to future displacement of surface levels in the vicinity of box culverts due to variable subsidence rates. The requirement for countermeasures (lightweight embankment, pre-loading, etc.) must be investigated.



Source: JICA Study Team

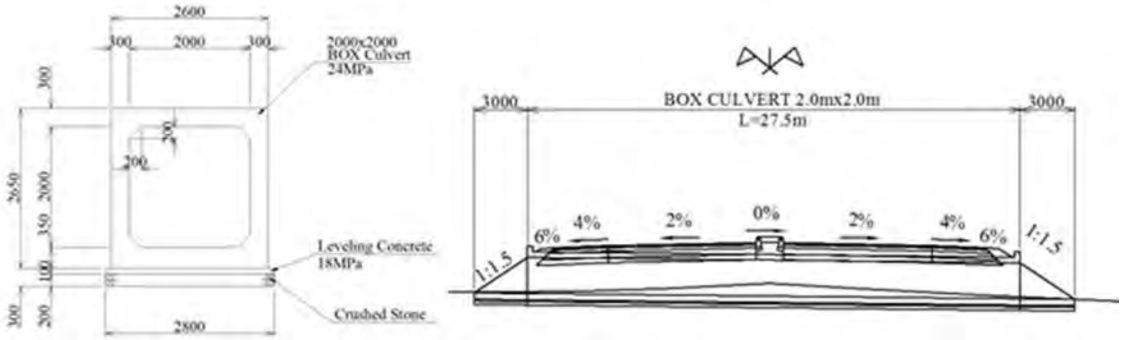
Figure 5.50 Position of Box Culvert (Starting Point side: Dam Nha Mac Area/Earth Works in

Road Section)



Source: JICA Study Team

Figure 5.51 Example of Emplaced Cross Drains (D1500×2)



Source: JICA Study Team

Figure 5.52 Example of Emplaced Box Culvert Crossing (2.0×2.0m)

2) Ending Point side/ Hai Phong Area/Road Works Section

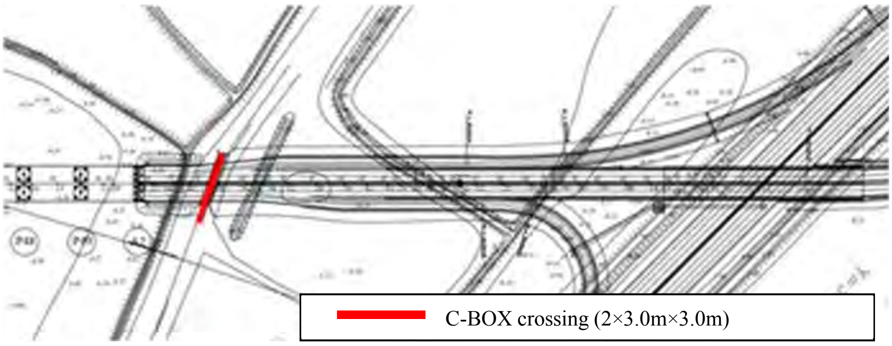
As noted above, the reason for selection in this district is the water flow for the canal, which must exceed the above crossing pipes (D1500×2) and C-BOX crossings (2×3.0×3.0m) selected. The position was selected to run alongside existing canals and water channels as confirmed from site investigations and topological surveys.

As noted above, transverse drainage piping installation, including culverts, must take flood drainage into consideration during the Detailed Design. When box culverts are planned, the need for countermeasures (lightweight embankment, pre-loading, etc.) to prevent future displacement of surface levels in the vicinity of box culverts due to variable subsidence rates should be investigated.

Table 5.63 Culvert Position (Ending Point side/Hai Phong Area/ Road Works Section)

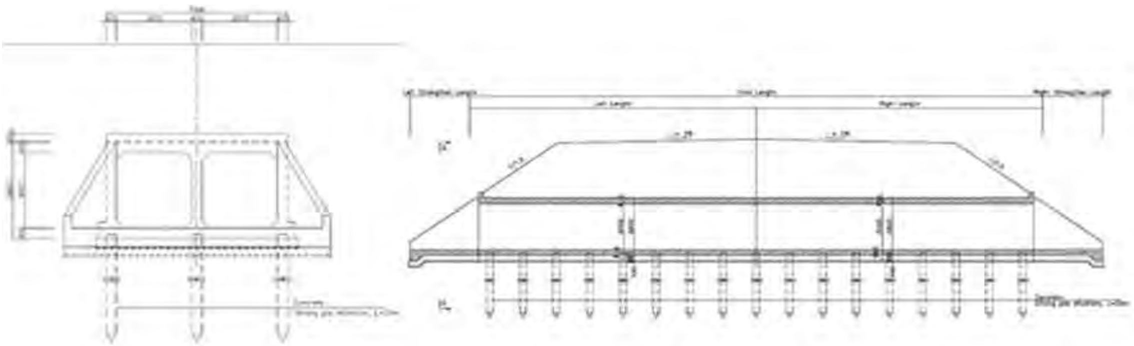
Position		Structure	Shape	Note
Ending Point side Hai Phong Area Road Works Section	KM24+824	C-BOX crossing	2×3.0×3.0	Used as a canal

Source: JICA Study Team



Source: JICA Study Team

Figure 5.53 Position of Culvert (Ending Point side/Hai Phong Area/Road Works Section)



Source: JICA Study Team

Figure 5.54 culvert-Box Crossing (2×3.0×3.0m) Installation Example

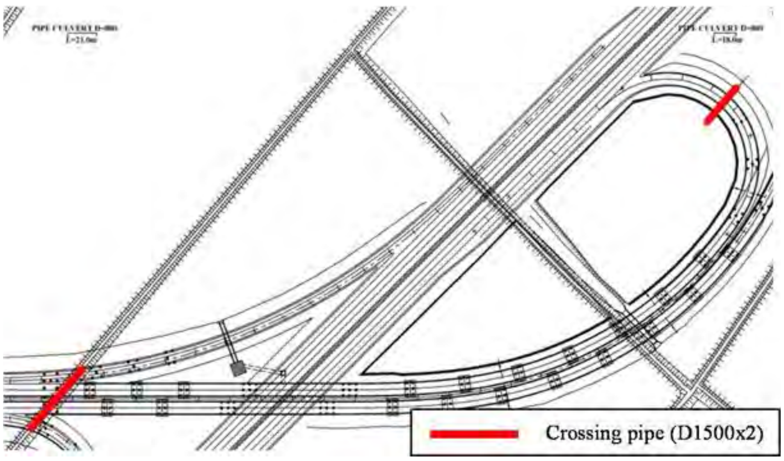
3) Ending Point side/ Hai Phong Area/IC Section

As noted above, the reason for selection in this section is drainage. A crossing pipe (D800) was selected.

Table 5.64 Culvert Position (Ending Point side/ Hai Phong Area/IC Section)

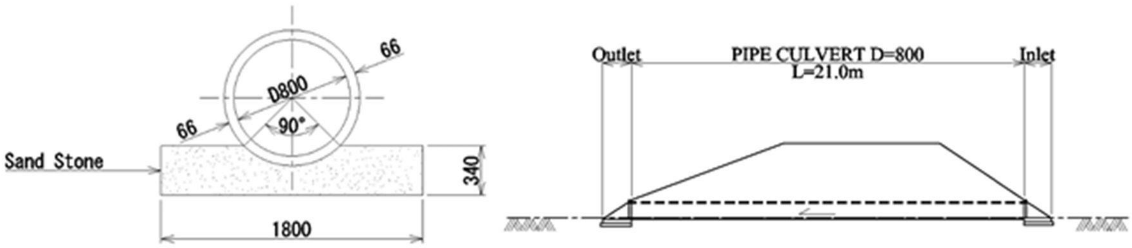
Position		Structure	Shape	Note
Ending Point side Hai Phong Area IC Section	B Ramp	Crossing pipe	D800	Drainage of depressed section in IC
	C Ramp	Crossing pipe	D800	

Source: JICA Study Team



Source: JICA Study Team

Figure 5.55 Culvert Position (Ending Point side/ Hai Phong Area/IC Section)



Source: JICA Study Team

Figure 5.56 Crossing Pipe (D800×2) Installation Example

5.5.6 Pavement Design

When the standards applied for pavement design in Vietnam are reviewed, the pavement type and composition are determined according to the road category and design speed. In addition, traffic conditions that should be considered in the pavement design show no trend toward any major increase from the time of the Vietnam F/S. Therefore this Study will follow the composition of pavement design in the Vietnam F/S.

The Vietnam Standard applied for the pavement design in the Vietnam F/S is shown below.

(1) Asphalt Pavement

According to METI F/S, in Road Standard Grade II (Vietnam Standard TCVN 4054-2005), the plastic deformation resistance coefficient (yc) must exceed yc≧160Mpa.

Since the design speed is 100km/h for trunk roads and 60km/h for IC sections, the pavement must be designed to A1 Standard according to Vietnam Standard 22TCN 211-93.

The requirements for an A1 Standard pavement as stipulated in the Vietnam Standard are shown in Table 5.65.

Table 5.65 Pavement Type

Pavement Standard	Material Composition	Performance Period	Maintenance Period	Application
A1	Cement Concrete Pavement or Fine Asphalt pavement	20	8	Category 60 to 120 Highway (expressway) Major urban roads or roads in industrial areas
A2	Surface treatment with Cold AC Size-Graded Crushed Stone Surface treatment with crushed stone and pavement Surface treatment with Cement or lime stabilized course aggregate or stone	8-12 8-10 8-10	5 5 3-5	Class 40・60・80 (V=40-80km/h) All urban roads including towns & villages
B1	Protective Course of Aggregate of fine crushed stone or composite material	5	2-3	Class 20 (V=20km/h)
B2	Unpaved, local material for pavement are used in some cases (i.e. Slag)	5	0.5-1.0	Village Road

Source: 22TCN 211-93

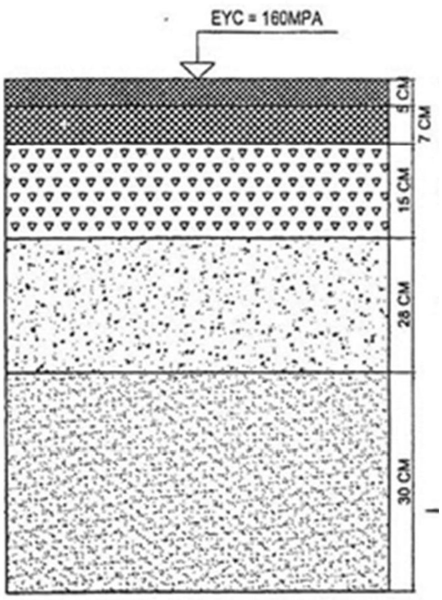
Pavement Composition for A1 Standard in the Vietnam Standard is shown in Table 5.66.

Table 5.66 Pavement Composition of A1 Standard

Layer		Composition Content
Surface Course	D1	Surface Course = Fine AC/Mid. AC (D1 = 4–5cm)
	D2	Base Course = Medium/Coarse AC (D2 = 5–7cm)
Upper base Course	D3	Coarse Aggregate I, Coarse Aggregate I treated with cement mixed with 6~8% Bitumen or black crushed stone (crushed stone or bitumen is mixed on site or in the factory) Minimum thickness D3 = 8cm
Lower Base Course	D4	Coarse Aggregate II, natural gravel or fine aggregate (cement or sand), Lime Laid to thickness determined by calculation or minimum D4 = 10cm
Roadbed	50cm	Necessary Density Kyc ≥ 98% with Vtk ≥ 40 km/h Kyc ≥ 95% with Vtk < 40 km/h

Source: 22TCN 211-93

Under the above circumstances, the pavement composition described in the Vietnam F/S is as in Figure 5.57 and the composition in the Vietnam F/S will be followed in this Study.



Surface Course Asphalt: t = 5 cm
Base Course Asphalt: t = 7cm
Crushed Stone Base Course: t = 18 cm
Crushed Stone Roadbed: t = 35 cm

Roadbed: t = 30 cm

Source: Vietnam F/S

Figure 5.57 Pavement Composition in the Vietnam F/S

(2) Concrete Pavement

In the project design, toll booths are located on the Trunk Road since motor vehicles must stop in the vicinity of the toll gates. The area is generally concrete paved in Japan, but there are no relevant Vietnam Standards. In this Study, pavements in the vicinity of toll gates are paved in concrete, with the effects of stopping in consideration. The area of concrete pavement is also set to 50m before and after toll gates (total 100m) referencing the Japanese Standard (NEXCO Design Guideline).

There are standards for concrete pavements in the Vietnam Standard, which are the same as standard 22TCN 211-93 applying to asphalt pavements. The composition is the same for Expressways, Rural and Urban Highways as shown in Table 5.67.

The Concrete pavement composition of the Vietnam Standard is shown below.

Table 5.67 Composition of Concrete Pavement

Course		Composition Description
Surface Course	D1	CC Slab (Class CC300, 350 or 400) Minimum thickness of slab D1 = 18 cm (highways) and D2 = 24 cm landing strip
Upper Base Course	D2	Coarse Aggregate I, Coarse Aggregate I treated with cement mixed with 6 ~8% Gravel or cement concrete, minimum thickness D2 = 12cm
Base Course	D3	Fine aggregate, sand, or natural gravel treated with cement
Roadbed	50cm	Required density Kyc ≥ 98% (Proctor Compaction Test)

Source: 22TCN 211-93

5.5.7 Traffic Safety Facilities

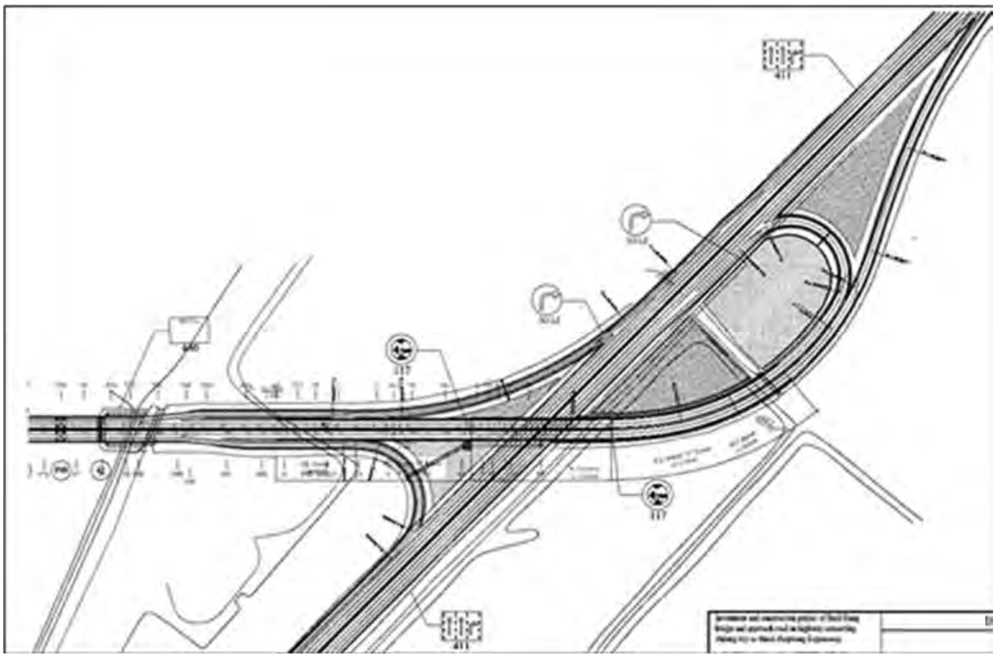
The Traffic Safety Facilities investigated in this Study are the Basic facilities: Signage, protective railing (Guard rail) and Entry Prevention Fencing. The results of the study on each facility are shown below.

Since these facilities must take conformity, continuity and the regulations and installation objectives of the 20km road section into consideration, adjustment with the 20km section must be conducted during the Detailed Design stage.

(1) Signage

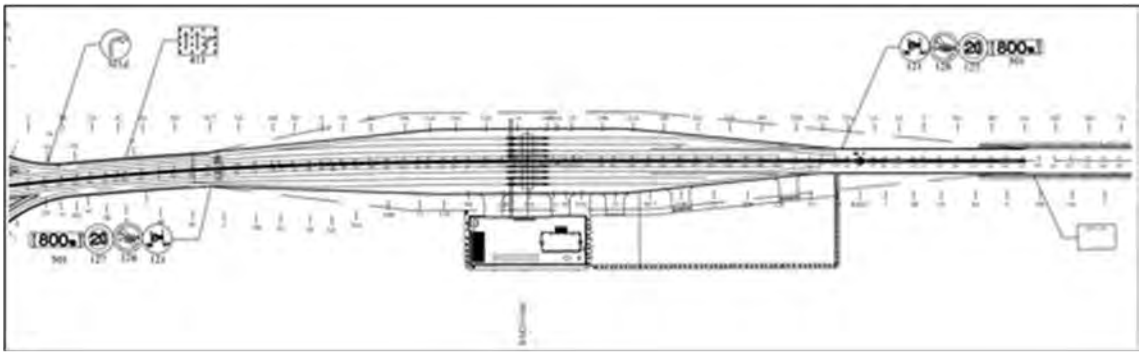
Since Signage facilities are also regulated by Vietnam Traffic Codes, the Vietnam Standards and Design Analysis are followed in principle in this Study.

Signage is analyzed in the Vietnam F/S and the Signage Installation analysis studied in this paragraph is for the convergence and Hai Phong side IC portions requiring traffic regulation and the vicinity of Toll Gates in the Bach Dang Bridge section. Figures 5.58 and 5.59 show the position of the signage installations in the Vietnam F/S.



Source: Vietnam F/S

Figure 5.58 Position of Signage (Hai Phong side)



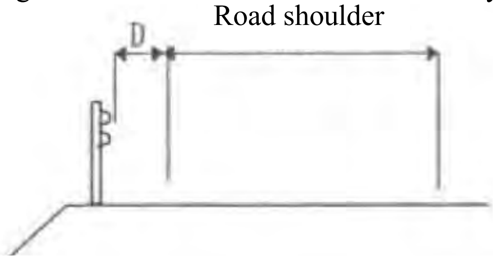
Source: Vietnam F/S

Figure 5.59 Position of Signage (Toll Gate)

(2) Protective Railing (Guardrails)

The Vietnam installation standard for protective railing could not be identified during this Study. Accordingly, the Japanese Standard (NEXCO Design Guideline, Book on Traffic Safety Facilities, Installation of Protective Railing) was referenced.

Guardrails are provided on shoulders as protective railings to prevent vehicles deviating from the roadway. Japanese standards require protective railing to be installed at a distance D = 250mm or more from the shoulder edge as shown in the Figure on the right.



Source: NEXCO Design Guideline

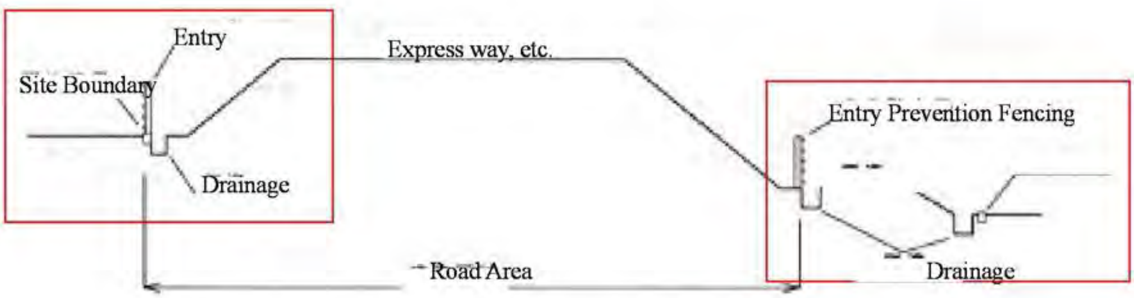
Figure 5.60 Guardrail Installation Diagram

(3) Entry Prevention Fencing

Similar to protective railings, the Vietnam Standards for installing Entry Prevention Fencing could not be identified in this Study. Accordingly, the Japanese Standard (NEXCO Design Guideline, Book on Traffic Safety Facilities, Installation of Entry Prevention Fencing) was referenced.

The purpose of installation of Entry Prevention Fencing is to prevent the entry of things or animals except for personnel related to the Project Road to maintain road safety and proactively prevent unlawful roadway occupation.

The installation is located on the boundary line of the road area and on the land boundaries in the remaining areas as shown in Figure 5.61.



Source: NEXCO Design Guideline

Figure 5.61 Entry Prevention Fencing Diagram

5.5.8 Lighting Facilities

The Vietnam Standards for installing Lighting Facilities could not be identified in this Study. Accordingly, the Japanese Standard (Standard for installation of Road Lighting Facilities and Commentary of same, Japan Road Association, October 2002) is referred.

The purpose of road lighting facilities is to allow road users to obtain good visual information, i.e. road conditions, traffic conditions, identification of obstructions and enjoy safe and pleasant passage at night. It is regarded that the following four conditions must be satisfied to attain this purpose:

Table 5.68 Installation Criteria for Lighting Facilities

Condition to attain purpose of installation	Criteria		Description of Criteria
① Sufficient brightness of road surface	Average road surface brightness (Average brightness of road as seen by the driver. Measured under dry surface conditions.)		The upper values are applied as standard according to the road category and external conditions. However, expressways other than National Highways may use a lower value in Table 5.68 if conditions allow. In addition, Common National Roads may also use lower values of Table 5.68, if light-shielding devices to deflect the headlights of oncoming vehicles are installed in the median strip. Particularly important roads or roads with special conditions may increase the average surface brightness up to 2cd/㎡ regardless of the value in Table 5.68.
② Evenness of lighting is appropriate	Evenness of Brightness (refers to evenness of distribution of brightness)	Toil Evenness (Effects visibility of objects on road)	Over 0.4 in principle
		Evenness in Traffic direction (Negative effects of forward road due to dark/light contrast)	Values in Table 5.70 to be referenced in design as required (recommended values)
③ Incorporates Guiding factor	Guiding Factor		The height, alignment and intervals are determined to attain appropriate guiding factor (refer to Table **5.71**)
④ Glare reduction is considered (Glare: refers to dazzling that reduces visibility and causes discomfort and fatigue.)	Increase in Relative Threshold Value (Criteria for quantitative evaluation of glare that reduces visibility of objects when bright light sources are in the field of vision)		The visibility of objects is affected by visibility reducing glare and is expressed as an increase in the Relative Threshold value. The values for the Increase in Relative Threshold Value for roads are as shown in Table 5.69 in principle.

Source: Standard for Installation of Road Lighting Facilities

Table 5.69 Average Road Surface Brightness

(Unit: cd/m^2)

External Condition / Road Category		External Condition A	External Condition B	External Condition C
High Speed National Road, etc.		1.0	1.0	0.7
		―	0.7	0.5
Common National Roads, etc.	Main Trunk Roads	1.0	0.7	0.5
		0.7	0.5	―
	Trunk roads, supplementary trunk roads	0.7	0.5	0.5
		0.5	―	―

Note: External Conditions refer to the following:
External Condition A: Road vicinity has continuous light affecting road traffic
External Condition B: Road vicinity has intermittent light affecting road traffic
External Condition C: Road vicinity has almost no light affecting road traffic

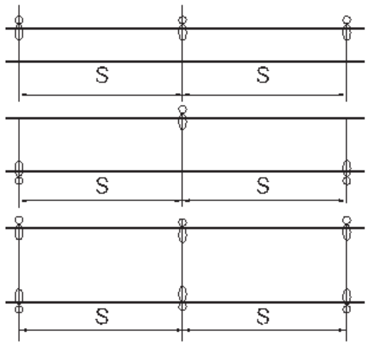
Source: Standard for Installation of Road Lighting Facilities

Table 5.70 Evenness in Traffic Direction & Increase in Relative Threshold Value

Road Category		Evenness in Traffic Direction	Increase in Relative Threshold Value
High Speed National Road, etc.		Over 0.7	Under 10%
Common National Roads, etc.	Main Trunk Roads	Over 0.5	Under 15%
	Trunk roads, supplementary trunk roads	–	

Source: Standard for Installation of Road Lighting Facilities

Table 5.71 Position of Lighting Facilities in Relation to Guiding factor

Lighting Array	Considerations
Height, intervals, overhang, angle of lights	The lighting should be selected for devices meeting the conditions that should be met (i.e. Average Road Surface Brightness, Evenness of Brightness, Visibility reducing Glare and Guiding Factor) and further by considering ease of maintenance and economy. Three heights are presently standardized: 8, 10 and 12m respectively.
Luminaire Arrays	Luminaire Arrays differing from the figure below can be implemented, but they are a combination of the three and wide roads with median strips dividing up-/downstream lanes should be regarded as separate roads: The so-called central arrangement with double light poles in the median can be regarded as two single side arrangements in tandem. The traffic direction evenness of the staggered array is inferior to others and the distribution of surface brightness in a traffic direction as viewed by drivers tends to be uneven. Fixtures should be placed in single side arrays on the outside of curves with radii under 1000m. S: Intervals between Luminaires (m) (a) Single sided Array (b) Staggered Array (c) Double sided Array 

Source: Summary by the JICA Study Team from Iwasaki Electric Co. HP.

Since the lighting facilities in the trunk road will be continuous, design conditions for continuous lighting will also be investigated. The target section is a highway standard road according to Japanese standards and harbors and towns are located along the roadside, the lighting conditions were assumed to be equivalent to intermittent light in the vicinity of the road. Accordingly, the Average Road Surface Brightness (Table 5.5.3.8-2) is set at 1.0cd/m2 (High Speed National Road/ External Condition B).

At this Average Road Surface Brightness (1.0cd/m2), the design condition for the target area of this Study is Type e from Table 5.72.

Table 5.72 Design Condition Type (Continuous Lighting)

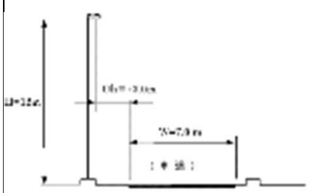
Road category		Common National Road administered by national authority				High Speed National Road administered by national authority
		2 lane road		3 lane road		22 lane road
Pedestrian Walk		Provided	N/A	Provided	N/A	N/A
Design Condition	Average brightness1.0cd/m²	a	b	c	d	e
	Average brightness 0.7cd/m²	f	g	h	i	j
	Average brightness 0.5cd/m²	k	l	-	-	-

Source: Summary from Guideline for the Introduction of LED Road Lighting/ Tunnel Lighting (Draft), J/MOT

The Design Conditions for Type e are described in Table 5.73

From the table, the design array is set as luminaires on poles 12m high and at 42m intervals on the single side of the target road section.

Table 5.73 Contents of Design Condition by Type (Continuous Lighting)

Type	Description of Design Condition	Road Section and Position of Lighting Facilities
e	Average brightness 1.0cd/m² (road with two lanes on each side/ high speed national road) ・Total Evenness: over 0.4 (Drivers sightline traffic lane) ・Evenness in driving direction: Over 0.7 (each lane) ・Increase in relative threshold value: under 10% ・Lane width = 7.0m ・Height of Luminaire = 12m, Overhang = -3.0m (See figure on right) ・Maintenance factor = 0.7 ・Single side array, 42m intervals	

Source: Summary from Guideline for the Introduction of LED Road Lighting/ Tunnel Lighting (Draft), J/MOT

5.5.9 Toll Gate and Administration

The investigation into Toll Gates, Administration Office and operation and maintenance will be described in Chapter 6.

5.5.10 Speed-Change Lane Length

A speed-change lane is to be provided where the trunk road and ramp converge in the IC. The Vietnam standard has not been identified and the design was confirmed while referencing the Japanese Standard (NEXCO Design Guideline Book 4 Geometric Structure, Guide for Design of Geometric Structure).

According to the Japanese Standard, the speed-change lane length and taper length should be more than the values shown in Table 5.74 based on the design speed of the trunk road. The standard lengths for direct connection type should also be the same as for Table 5.74.

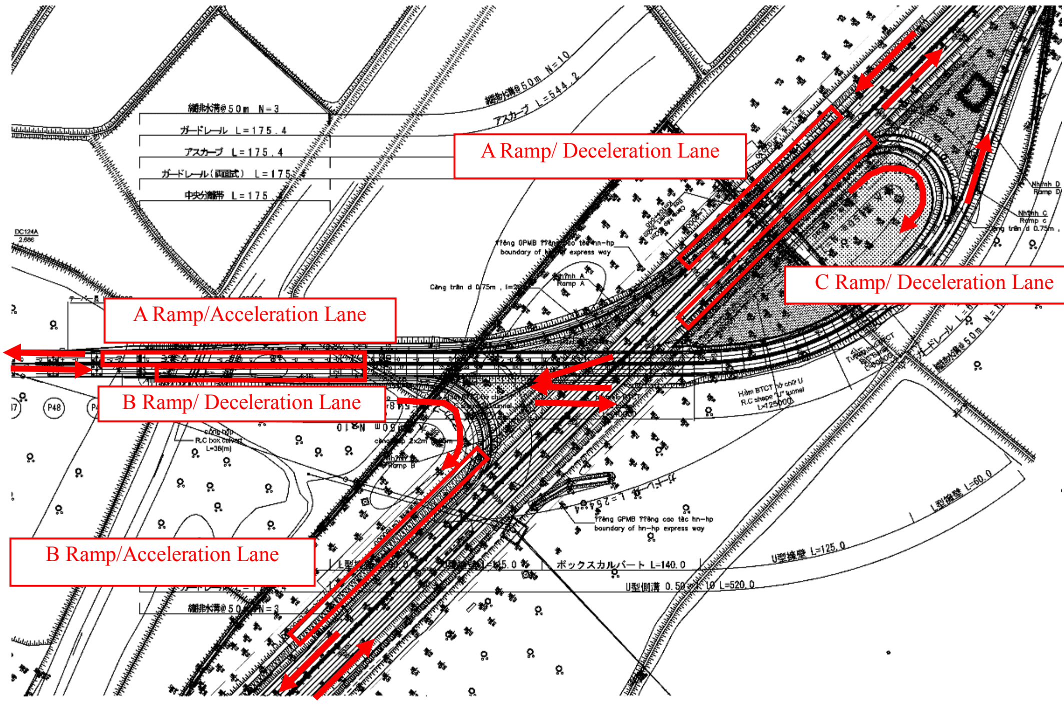
The Project Road Design Speed is 100km/h and the values for the red frame in Table 5.74 are the applied lengths.

Table 5.74 Speed-Change Lane Length/Angle of entry/exit

Design Speed of trunk road (km/h)		120	100	80	60	50	40
Deceleration lane excluding taper zone (m)	1 lane	100	90	80	70	50	30
	2 lane	150	130	110	90	—	—
Acceleration lane excluding taper zone (m)	1 lane	200	180	160	120	90	50
	2 lane	300	260	220	160	—	—
Taper length (m)	1 lane	70	60	50	45	40	40
Angle of exit	1 lane	1/25		1/20	1/15		
	2 lane						
Angle of entry	1 lane	1/40		1/30	1/20		
	2 lane						

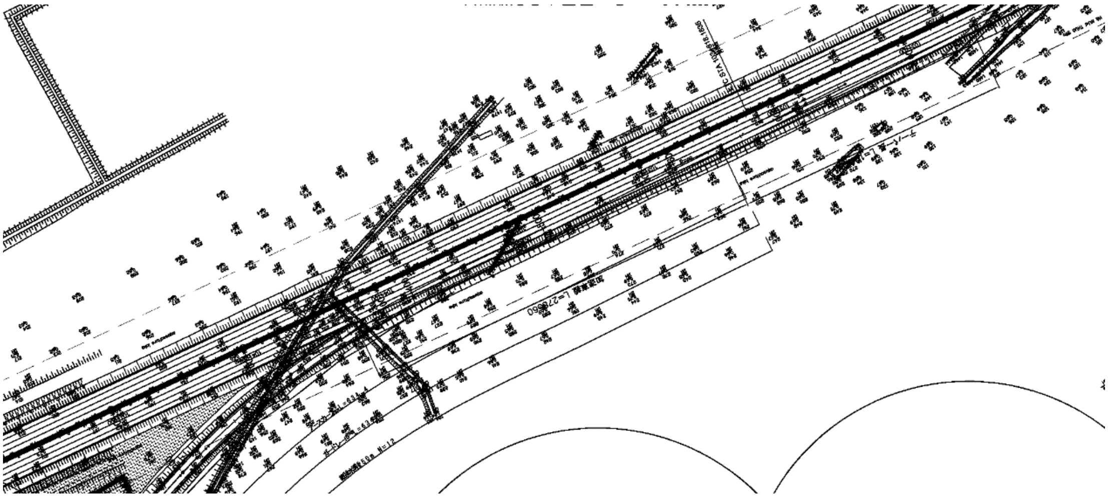
Source: NEXCO Design Guideline, Book 4 Geometric Structure, Guide for Geometric Design of IC Structure

As a result of the confirmation conducted by this Study, the Vietnam F/S has set out deceleration/acceleration lanes and taper lengths, but some sections have shorter lengths than the Japanese Standard. Accordingly, the shorter sections will be lengthened to Japanese Standard lengths and where the lengths exceed Japanese standards, the Vietnam F/S will be followed. The analytical results are shown in Figures 5.62 and 5.63 and Table 5.75.



Source: JICA Study Team

Figure 5.62 Length of Speed-Change Section/Taper Installation Position (Hai Phong side IC)-1



Source: JICA Study Team

Figure 5.63 Length of Speed-Change Section/Taper Installation Position (Hai Phong side IC) -2

Table 5.75 Speed-Change Length/Taper Length

Position		Lanes	Speed adjustment	Taper length
A Ramp	Deceleration lane	Single direction 1 lane	90.000m	107.030m
	Acceleration lane		180.000m	60.000m
B Ramp	Deceleration lane		90.010m	100.070m
	Acceleration lane		180.000m	60.000m
C Ramp	Deceleration lane	Single direction 2 lane	140.090m	106.320m
D Ramp	Acceleration lane		278.560m	190.460m

Source: JICA Study Team

5.6 Bridge Design

5.6.1 Items for Investigations for Bridge Design

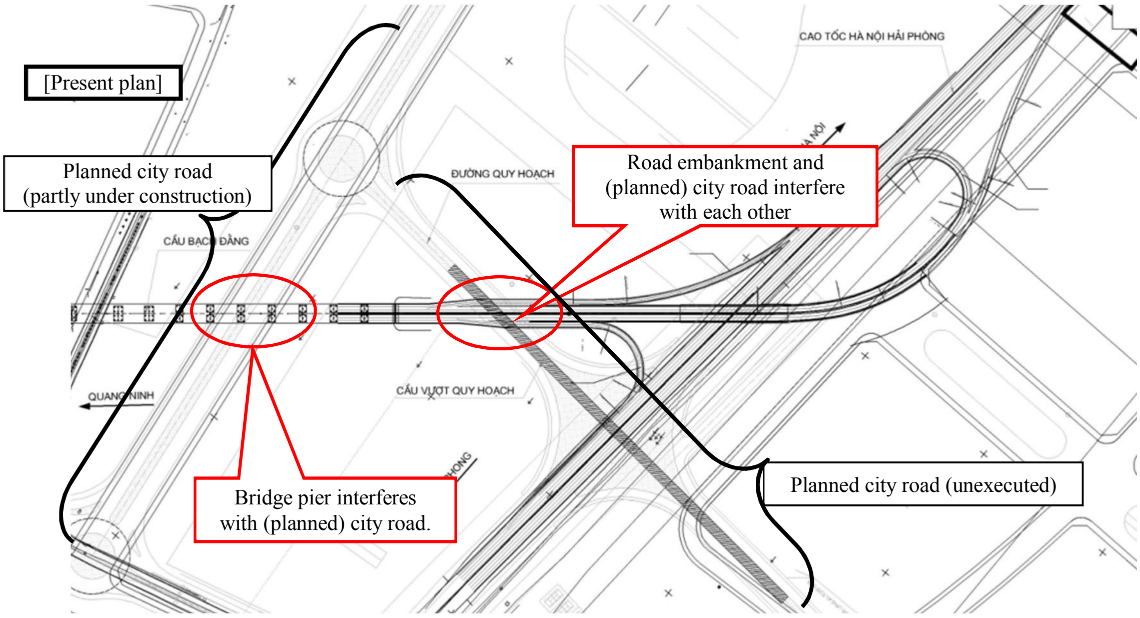
Like the road design, the following aspects of the Bridge Design were reviewed following the Design Review results and Analysis Policy-3. Conformity with Urban Planning on the Hai Phong City side identified during the Studies in Vietnam is discussed in the Bridge section since the effects on bridge design are more significant.

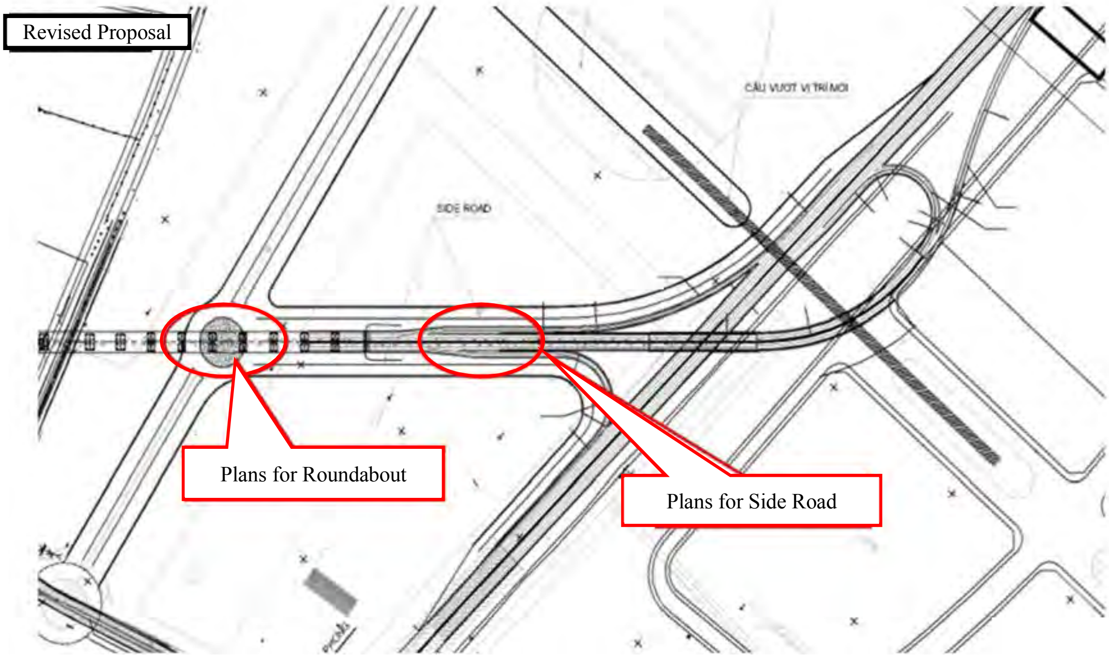
- The Bridge Planning in relation to the Hai Phong side Urban Planning
- Main Bridge/Superstructure (proposal to optimize Superstructure)
- Main Bridge/Substructure
- Approach Bridge/Superstructure: Steel Bridge and Super-T girder bridge
- Approach Bridge/Substructure:

5.6.2 Hai Phong side Urban Planning & Bridge Planning in Relation to Urban Planning

According to Vietnam F/S, swamps dominate in the vicinity of the Hai Phong City side IC and there are no roads other than the connecting Hanoi-Hai Phong Highway. However, during the on-site Study, a new road under construction was identified and the existence of urban planning for the vicinity of the Hai Phong side IC was confirmed. After the confirmation, Urban Planning Drawings were obtained and conflicts with the Project Facilities were checked, whereupon a land development project was identified in the vicinity of the connection point between the Project facilities and the Hanoi-Haiphong Highway. Therefore, further investigations were carried out and revealed that three piers and a section of the embankment road were found to be in conflict. A revision to the urban plan drawings entailing adoption of a roundabout design and revisions to road alignment to relieve the conflicted portion without revising the position of the bridge piers in the present design as shown in Figure 5.64 was presented to Quang Ninh Province and Quang Ninh Province has agreed to discuss the proposal with Hai Phong City.

The results of the discussions between Quang Ninh Province and Haiphong City were unable to be confirmed during this Study, and it should be noted that based on the results of the discussions, changes to the Bridge design may be required in the future.





Source: Partial revision of reference documents (upper drawing), JICA Study Team (lower drawing)

Figure 5.64 Hai Phong side Urban Planning and Project facilities

5.6.3 Main Bridge/Superstructure

The appropriateness of the steel cable-stay structure selected for the Main Bridge superstructure will be verified and conditions imposed on the design and construction of a steel cable-stayed structure will be reviewed. Finally, measures to counter the challenges will be analyzed.

(1) Verification of Appropriateness of Superstructure

The Main Bridge was designed as a PC girder (cantilever) bridge in the Vietnam F/S. If the original design for the PC girder bridge had been followed, the girder height would have become excessive to accommodate the requirements for two Navigation Limits (180m wide, 48.4m high) and the position of the navigation channel. Increasing the girder height entails raising the road surface level, which, in turn, increases the bridge length and makes the construction uneconomical. In addition, the number of girders will also be increased, which will hamper efforts to accommodate the challenges posed by the Navigation Limits difficult.

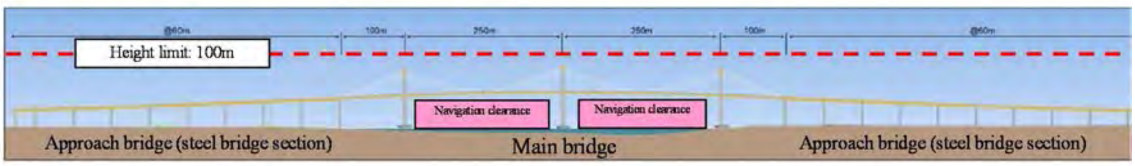
Conversely, the METI F/S investigates the cable-stayed bridge scheme, which has a lower girder height. The steel cable-stayed bridge was shown to have girder heights four meters lower compared to the PC girder bridge in the METI F/S. The largest difference between the steel cable-stayed and PC girder bridges identified in the analysis was that the total length for the PC girder bridge, including the Approach Bridge, would be 4,201m compared to a total length for the steel cable-stayed bridge of 3,054m. In other words, adopting the cable-stayed bridge would allow the structure to be shortened by approximately 1,150m. The F/S states that a cable-stayed bridge is more expensive than a PC girder bridge if only the Main Bridge section is considered, but significantly reducing the bridge length would elicit larger construction cost savings.

Based on the above review of both design and construction cost reductions, the selection of a steel cable-stayed structure for the Main Bridge superstructure is deemed appropriate.

However, the height limit poses a new restriction when the steel cable-stayed design is selected in addition to the problems associated with the navigation limits. Measures and design policy regarding these challenges are discussed below.

(2) Challenges for Steel Cable-stayed Bridge Design

The decision to select a steel cable-stayed bridge added the restricting condition on the height of the towers (under 95m for the side Towers P25, P27 and under 100m for the Central Tower) due to height limits (100m over National Water Level) imposed for take-off/landing flights from Cat Bi Airport located approximately 5km southwest of the bridge. Due to these limiting conditions, the height limit for construction will be taken as 100m at top of towers for planning purposes.



Source: JICA Study Team

Figure 5.65 restricting Conditions In Main Bridge Vicinity

Furthermore, shipping traffic in the river proved heavy and the passage of large vessels was confirmed; underlining the requirement for the following considerations in construction planning:

- Reduced navigation restrictions due to moored barges
- Long-term temporary works cannot be erected within the navigation channel.

The detailed appropriateness of the steel cable-stayed bridge will be demonstrated by analyzing these challenges.

(3) Analysis for Countermeasures for Restrictions

The restrictions that have been identified from the above include tower height restrictions and restrictions on the usage of navigation channels. Countermeasures for each are described below.

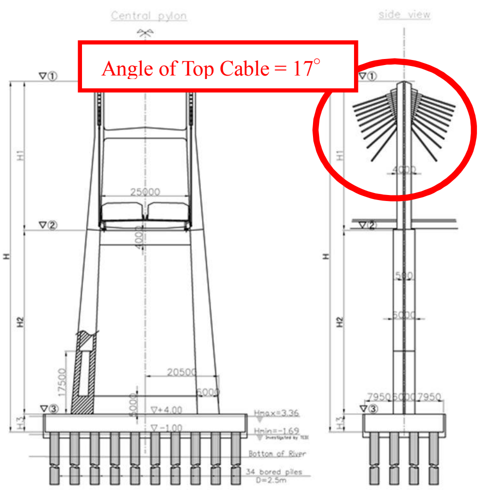
1) Studies on Tower Height Restriction

The need to keep the tower height lower than 100m due to height restrictions imposed by take-off/landing flights from Cat Bi Airport was confirmed during discussions with Quang Ninh Province and replies to the questionnaire.

The height of the cable-stayed bridge is the total for [navigation channel height + longitudinal slope + girder height+ length of span/2×tan (angle of top cable)+height of tower above top cable].

Here, if the height limit of 100m, navigation height of 48m, girder height of 3m, span length of 250m, longitudinal slope of 2% and height of tower above top cable of 3m is employed, the angle of the top cable becomes 17°.

This cable angle affects the tension on the cables and cable-stayed bridges usually have cable angles of 20°. The present design requires 17° and when the tensions exerted on the cables are compared, sin (20°)/sin (17°) =1.17 and the 17° case has 17% higher tension. This is within both tolerable design and construction limits and it was concluded that the effect on total construction cost would be negligible.



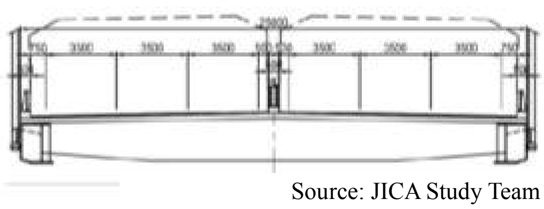
Source: JICA Study Team

Figure 5.66 Angle of Top Cable

Accordingly, the cable-stayed design is deemed appropriate in relation to the height limit.

2) Appropriateness in Relation to Restrictions on Navigation Conditions

When constructing cable-stayed bridges, it is normal to erect girders by overhanging navigation channels. The selection of a construction method to take in girder members (steel girder & pre-cast deck plate) at the tower position and erect them into position after moving the girder end will allow a reduction in use of the navigation channels as well as virtually eliminating the need for temporary erection structures in the navigation channels. The girder type will be kept as simple as possible and double main girder + pre-cast deck plate is deemed appropriate.



Source: JICA Study Team

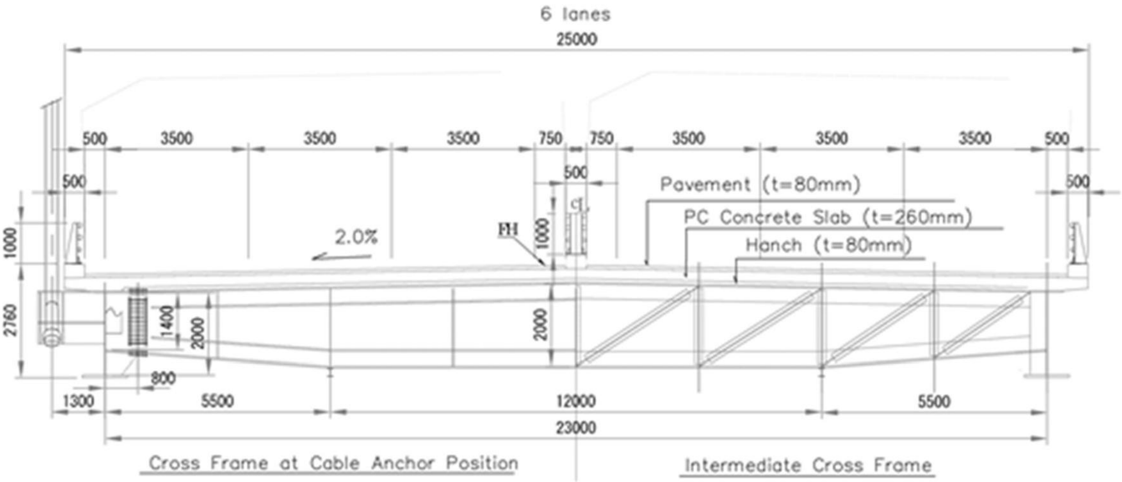
Figure 5.67 Double Main Girder + Precast Deck

(4) Study of the Steel Cable-Stayed Bridge Design

In addition to the above restrictions, the following design items for the cable-stayed bridge design are also to be confirmed:

1) Layout of the Main Girder and Section Shape

For double main girder cable-stayed bridges, there is a need to smoothly transfer tension from cables to girders. Accordingly, the girder layout is determined from cable intervals and the cable anchor structure. Furthermore, the cables should be placed on the outer edges to ensure the efficiency of cross-sectional composition in most cases. In the Project Bridge, the girder layout is of a type with a cable anchor structure laid out for the cable intervals that have been designed to accommodate a six-lane width. The girder section is a simple I-section and the flange width will be designed to the normal rule not to exceed 1/3 of the girder web height. The main girder layout and section shape are shown in Figure 5.68.



Source: JICA Study Team

Figure 5.68 Main Girder Layout and Section Shape

2) Cross Beam Interval and Section Shape

The direction of the main reinforcement bars in the deck plates will be in the direction of the bridge axis, given the wide intervals between the main girders. Accordingly, the spacing of the deck plates will be determined by the cross beams, which are normally at a 2.5~4.0m pitch.

It is also rational to design the crossbeam sections as simple I sections like the main girders. Since the main girder intervals are wide, it will be necessary to ensure sufficient crossbeam stiffness. The beam height and others will be optimized.

3) Cable Layout (Permissible Stress)

Cables will be laid out according to the loading size, cable angle and others. The normal pitch is 10~15m and the Project Bridge has the same pitch.

4) Deck plate

As noted above, the RC deck plate is reinforced in the direction of the bridge axis. Locally procurable RC deck plates were selected, since steel deck plates have not been constructed in Vietnam due to the difficulty and cost of construction. Accordingly, the selection of steel deck structures will require procurement from Japan, which may increase costs. The deck plate is secured to the girder by studs on the upper flange to form a composite structure, capable of withstanding both dead and live loads. The thickness of the slab is 260~340mm from the intervals of slab supports.

5) Support Condition

A） Terminal Support Point

The end of the girder supports vertical force and the horizontal reaction force perpendicular to the bridge axis. The reactive force is normally negligible since the vertical reaction force is mostly canceled out by the cable tension force and supports allowing sufficient movement. It is normally more economical to respond to negative reactive force separately in the structural design, as has been followed in this design.

Horizontal support can be provided via horizontal stoppers or bearing structures. The Project design selects horizontal bearings, which allows a simplified terminal cross beam structure.

B） Interim (Tower) Support Point

The Tower requires a structure to support the horizontal forces perpendicular to the bridge axis. Horizontal supports will be placed alongside the Tower sides or on horizontal members.

C） Movement in the Bridge Axis Direction

Limiting movement from earthquakes, etc., in the bridge axis direction will be determined based on flexible restraint structures provided in the Towers or Bridge Terminal Points following comprehensive structural analysis.

6) Expansion Joints

Expansion Joints will be provided for the terminal points. The permissible movement will be derived from structural analysis, but the structure must be able to respond to temperature and earthquake deformations. A finger-type device is assumed.

7) Corrosion Prevention

Coatings with high corrosion-resistance performance will be selected, since the bridge is located in the vicinity of the river mouth and also to reduce the frequency of future repainting. The actual selection will be made from Type C-5 Coatings (Fluoride paints for General Exterior Surface) and Type D-5 Coatings (Modified Epoxy Resin based coatings for interior surfaces), described in “Steel Road Bridges Coatings and Corrosion Prevention Guidebook” (December 2005). As a further note, the river mouth area is exposed to more salt wind blown by prevalent strong coastal winds, hindering the selection of weathering steel.

5.6.4 Main Bridge/ Substructure

(1) Selection of Load-Bearing Strata

The substructure for the Main Bridge section comprises the three piers P25, P26, P27; all of which lying within the Bach Dang River. The bearing strata for all three piers is the mudstone strata 9b, 9c (RQD= over 50%), lying at over 40m deep and selected based on soil investigations.

(2) Design Of Piles

Based on the Vietnam Load-Bearing Evaluation Method (22-TCN-272-05), the strata overlying the load-bearing stratum are soft soil strata with N values of 0～20 and cannot be expected to provide friction resistance. Accordingly, the piles are designed as bearing piles. The pile length for all three piers exceeds 40m after including the footing penetration to comply with the Vietnam Standard (22-TCN-272-05).

The piles will be cast-in-place construction (Reverse Circulation Method); taking the soil strata composition and construction depth into consideration. Pile diameters are to be 2.5m based on interviews with the Vietnamese design consultant TEDI and confirmation of executed examples. The pile layout was designed to comply with the Vietnam Standard (22-TCN-272-05) for minimum peripheral and axial separation distance.

The number of piles is determined based on the reactive force of structure and the required support against external forces and load-bearing capacity of the piles. In the Main Bridge design, the combined force exerted by the ship collision with the pile caps was decisive.

The foundation structure includes pile caps designed as exposed piles on the water surface. Although this design must consider increased flow speed and scouring from eddy currents in the vicinity, after consideration of Vietnamese rivers' characteristics and the speed of the river in the vicinity of the bridge near the river mouth, it is considered unlikely that scouring will occur, but a simple protective structures comprising block revetments have been provided for safety.

Although the Nha Tang Bridge is a completed example of Steel Pipe Sheet Piling (SPSP) piling in Vietnam, sufficient data to determine concrete details of technical specifications and costs has not been obtained at present. Further investigations must be performed to determine the selection feasibility from construction and financial perspectives.

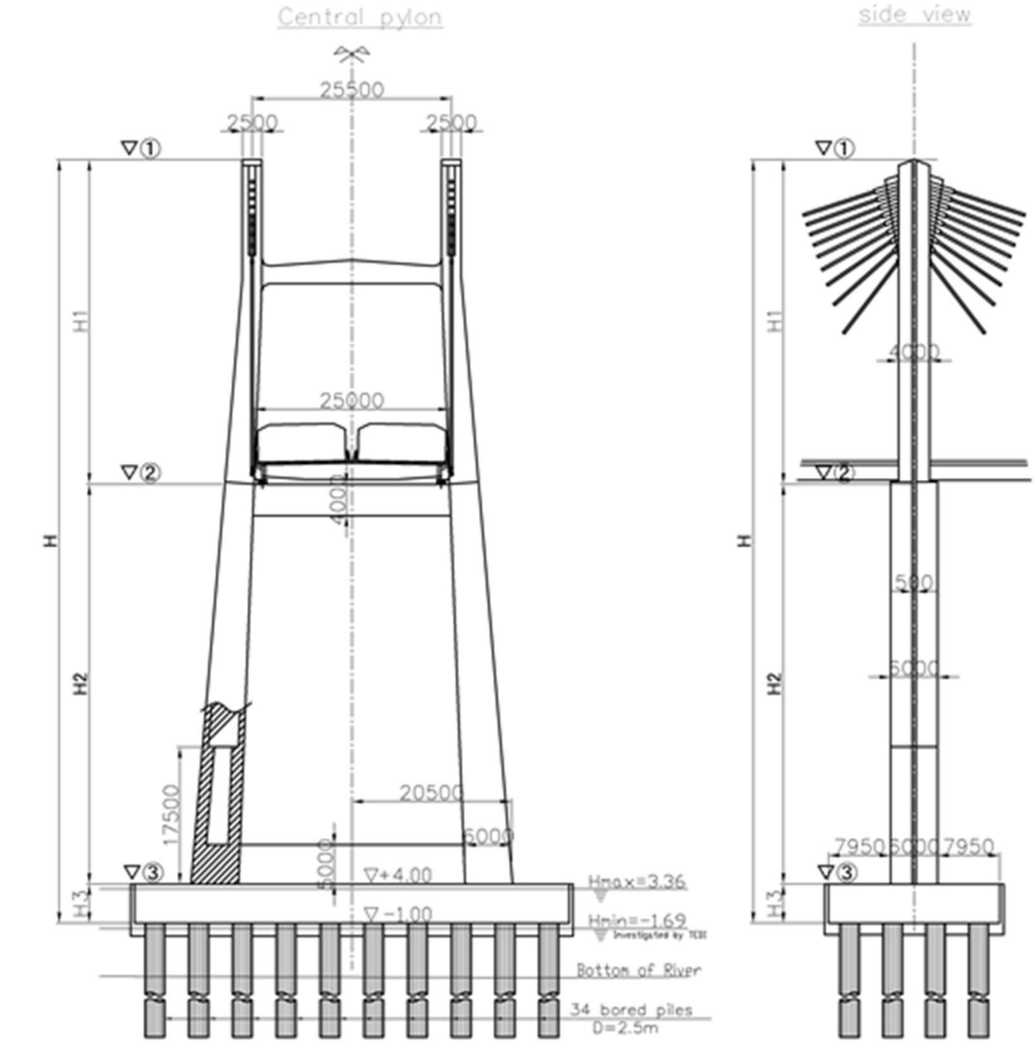
(3) Pile Cap

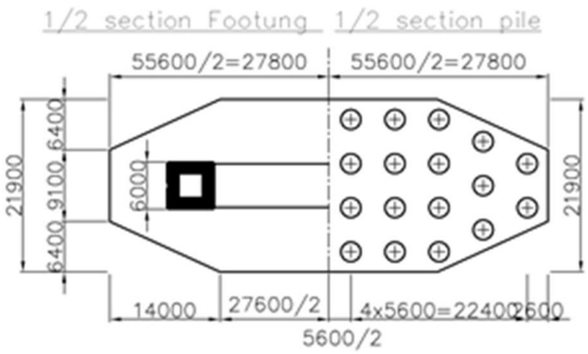
Since the pile caps are arranged on the water surface, the shape in plan and placement level are important. It is octagonal in shape with reduced faces perpendicular to the river flow to minimize the effects on the river and reduce the concrete volume. The pile cap top height is designed to remain slightly above the Design High Water Level (100-year probability) to enhance visibility to passing ships.

(4) Tower

The bridge is located within the height restriction area of Cat Bi Airport and the Tower is limited to under 100m. Accordingly, the central main tower and towers on both sides are designed to be 98.7m high, 93.5m above the national Water Level, respectively, after allowing for the road surface and main girder profiles.

Seismic loads are decisive in determining the tower section, which has been designed as a hollow structure for both sectional rigidity and lightness. It has also been designed to increase overall rigidity by providing cross beams at three point of cable securing members, directly under the Main Girder and at the foot of the bridge pier of the Main Tower. Detailed shapes are shown in Figure 5.69.





Item	Main Bridge		
	P25	P26	P27
①Height of Top of Tower (From Center of Footing)	93.500	98.700	93.500
②Height of Top of Horizontal Spread (From Center of Footing)	48.300	53.500	48.300
③Footing Top Level (From Center of Footing)	4.000	4.000	4.000
H : Total Height (H1+H2+H3)	94.500	99.700	94.500
H1 : (①−②)	45.200	45.200	45.200
H2 : (②−③)	44.300	49.500	44.300
H3 : Footing Height	5.000	5.000	5.000
Pile Numbers n=	34	34	34
Pile Length	46.000	46.000	46.000

Source: JICA Study Team

Figure 5.69 Main Bridge Substructure

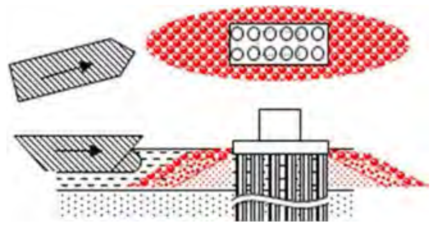
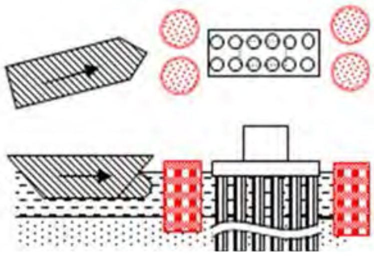
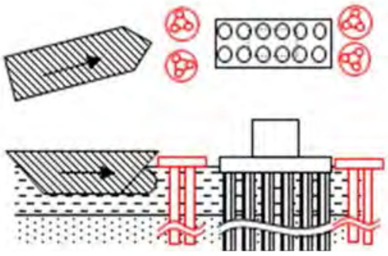
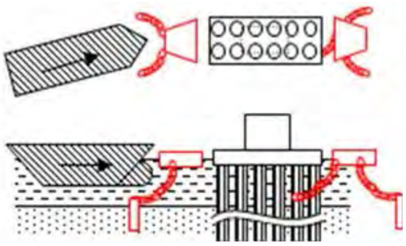
(5) Buffer Structures

The bridge is located near Hai Phong Harbor, the largest port in Vietnam and large vessels frequently traverse the site. Accordingly, it is commendable to minimize damage to the bridge structure and vessels which would be incurred by vessels colliding with the Main Bridge (Pile caps) by providing buffer structures.

The main structural elements of the Main Bridge foundation are determined, in the design, by the combined forces of vessel collision with pile caps. When ships collide directly with the pile caps and large-scale repairs are necessary, the damage to the BOT enterprise (reduced revenue due to traffic stoppages, etc.) as well as temporary effects on shipping are feared.

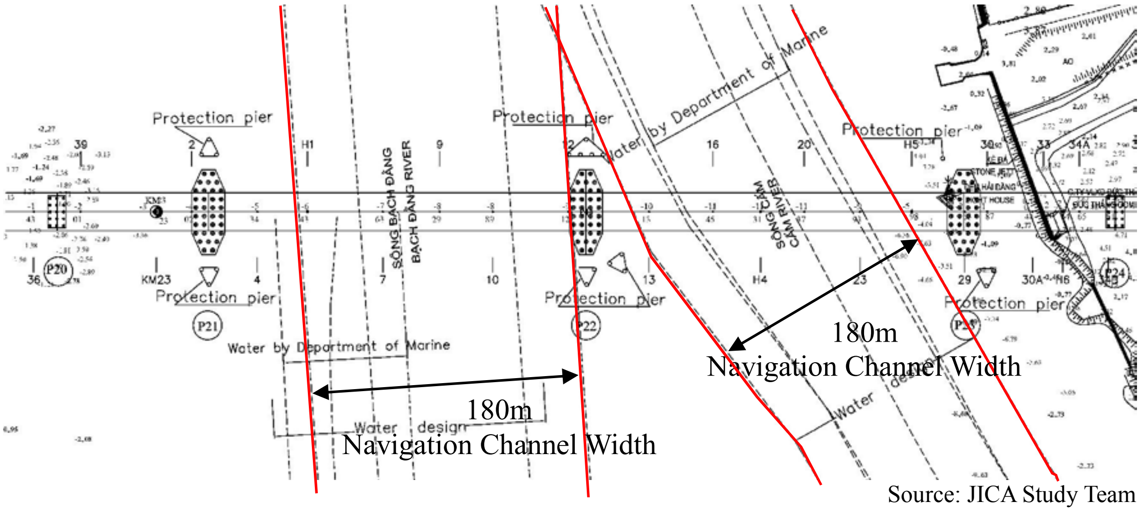
Buffer Structures will be provided around the pile caps to alleviate these fears. The results of investigations into concrete examples of buffer structures are shown in Table 5.76

Table 5.76 Examples of Buffer Structures

Type	Schematic Drawing	Example
Levee Type		 Arthur Ravenel Jr. Bridge (USA)
Sheet Piling Type		 Incheon Bridge (South Korea)
Pile Type		 Rosario Victoria Bridge (Argentina)
Floating Structure Type		 Zarate B. L. Bridge (Argentina)

Source: JICA Study Team

Pile type buffers were selected since navigation channels 180m wide must be provided between the piers in this Project and sufficient space for buffer structures cannot be secured. The buffer structure layout and structure are shown in Figure 5.70. It is possible to design stronger structures for the buffers if preventing collision forces from reaching the bridge structure was the concept, but this will require more detailed analysis and the structures proposed here are strictly a safety feature.



Source: JICA Study Team

Figure 5.70 Buffer Structure Layout Plan

5.6.5 Approach Bridges / Superstructure

(1) Super-T Girder Section

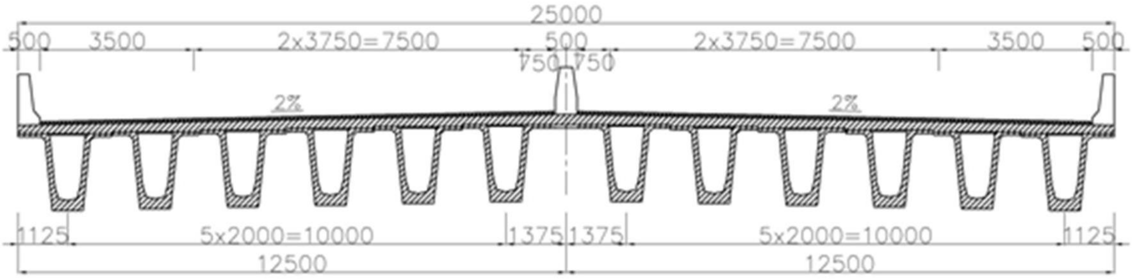
The Super-T girder bridges on Piers A1 ~ P12 on the Halong side and P40 ~ A2 on the Hai Phong side are a common bridge type in Vietnam. They are cheaper than steel bridges, but the increased weight of the concrete superstructure compared to a steel structure is a disadvantage for a bridge built on soft soil and the structure is restricted to areas where the pier height is comparatively low.

The girder length is set at 38.3m based on the applicable span length in Vietnam. There are 12 main girders for each span arranged to support the 25m total width and cant (2% raised middle slope). The deck plate is a cast-in-place RC structure, formed using embedded formwork placed between the main girder webbing and the top of the girder as the lower formwork. Cutouts are placed at the girder end points and the girders are concealed by placing the main girders directly on protrusions on the bridge piers.

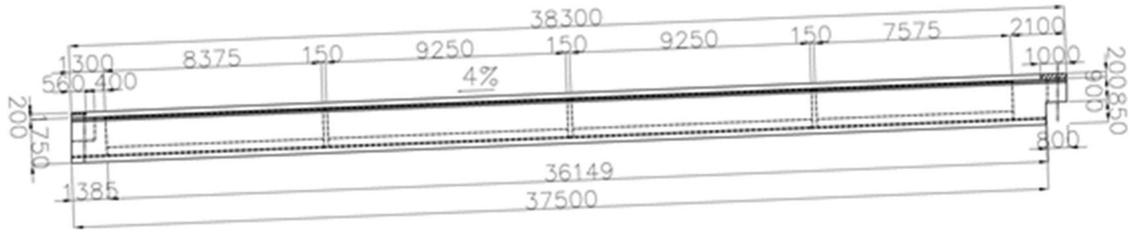
The sections of the main girders are U-shaped and prestress tension is introduced through PC steel members in the lower deck plate by the pre-tension method. The thickness of the lower deck plate is increased to provide the required bending resistance.

The girder assembly will be conducted in the Construction Yard on site and two crawler cranes in tandem will lift the girders into place.

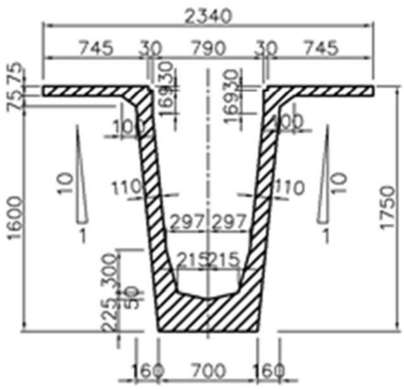
【 Sectional Drawing of Superstructure】

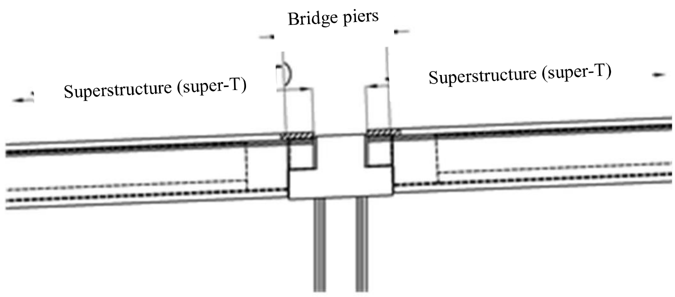


【 Elevation Drawing of Superstructure】



【 Sectional Drawing of the Main Girder】【 Cut out at Girder End】





Source: Vietnam F/S Reference document

Figure 5.71 Approach Bridge Superstructure (Super-T Girder)

(2) Steel Continuous Double Main I-Girder Section

Approach Bridge sections other than Super-T girders are to be Steel Continuous Double Main I-Girder bridges.

1) Challenges

The Urban Planning on the Hai Phong side and the vehicle traffic situation observed during site inspections confirmed the requirement that P36~P37and P40~P41 in the steel girder section of the Approach Bridge must be designed to pass over the existing road. Confirmation of span length requirements and construction of an overpass under road in-operation conditions requires the exploration of viable options.

Source: JICA Study Team

Figure 5.72 Situation at Crossing of Approach Bridge and Roads

Other construction restrictions include the need for an access road for construction and landing piers to take in construction material on the Halong side and the fact that although P. 29~31 are outside navigation channels, they will most likely require in-river construction.

2) Studies on Countermeasures to Challenges

The results of investigations into countermeasures for the challenges described above are shown below.

A) Span Length and Types

The span of the overpass section on the Hai Phong side is set at 60m. The width of the existing road is approximately 40m and can be spanned using the present plans with a limited number of main girders. In the Japanese Standard (Japan Bridge Association: Birth of the New Bridge II), the economical span is stated to be approximately 60m or so and the financial aspects for the 60m span are also good. Accordingly, the 60m span is deemed appropriate. Furthermore, from an economic perspective, a steel-concrete composite continuous I-girder was selected.

B) Numbers of the Main Girder and Main Girder Span

The number of main girders was set at double the main girder by applying the maximum deck plate span since the width in one direction is about 12m. The distance between the main girders is overhang: center portion (main girder interval): overhang, or roughly 0.2:0.6:0.2 or 0.25:0.5:0.25, since the overall width is 12.5m. The center portion is found to be 7m from this ratio.

C) Span Numbers

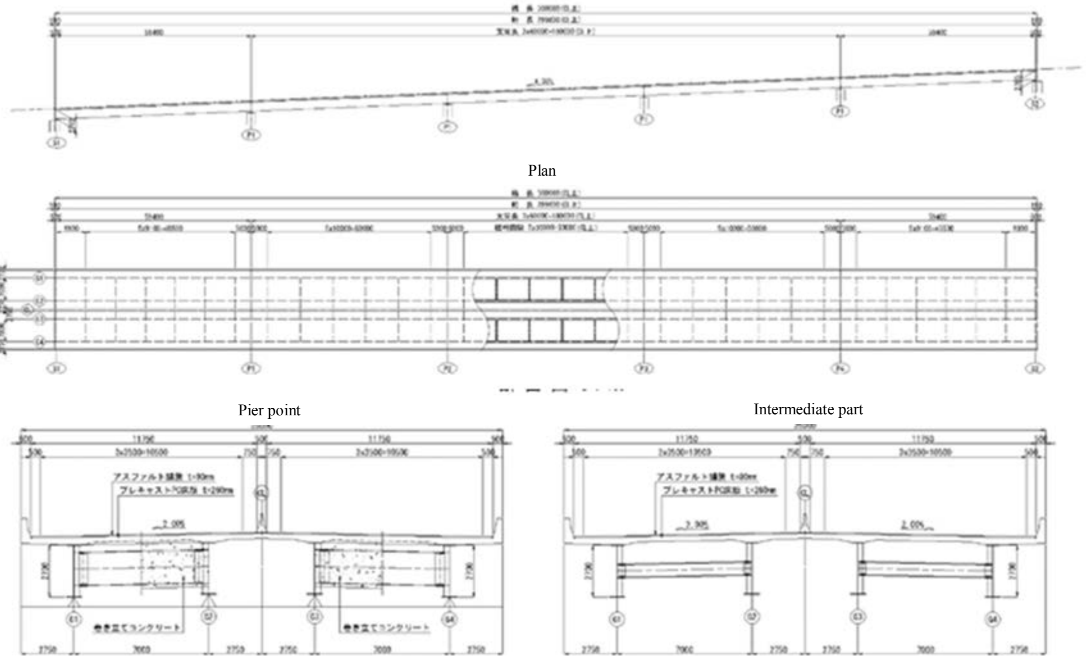
The number of spans in the steel girder section is 12 on the Dam Nha Mac side and 13 on the Hai Phong side. Since the vertical slope is 3% and requires a Fixed Point, it will be uneconomical to design it completely as a continuous structure. Accordingly, roughly six spans each were designed as a continuous structure.

D） Deck Plate

The deck plate was designed as a live load composite girder. Since the plate is divided laterally to reduce the weight of on-site erection work, the deck is a RC deck plate structure not a PC deck plate.

E） Applicability for Erection

To eliminate traffic restrictions as far as possible on existing roads, it is recommended that erection machinery be erected outside the road area. If it is assumed that the erection is erected in the central median strip of the road and two blocks are assembled on the ground prior to erection by cranes placed off-road to reduce the construction time, it will be possible to proceed with a 650t crane. Accordingly, the works can be performed with the present design.



Source: JICA Study Team

Figure 5.73 Steel Continuous Double Main I-Girder Bridge/General Drawing

3) Other Design Considerations

The following design considerations on steel continuous double main I-girder type, separate from the above concerns, will also be investigated:

A） Shape of Traverse Beam

With limited main girder designs, the Traverse beams are either H or I steel sections or built-up members of a similar section. Since the perpendicular distribution is shared with the deck plate, a minimum section member will be placed in the vicinity of the middle of the girder.

The intervals of the Traverse beam will be about 10m in pitch for economic reasons and the results of optimization analysis previously performed.

B） Bearings

Since the vertical slope is relatively steep, the lower ends are fixed and the rest made movable. Pot Bearings will be selected for economic reasons.

C） Expansion Joints

The Expansion Joints on the Approach Bridges are selected from types that are able to follow movement caused by temperature and seismic forces. Rubber or finger-type devices are envisaged.

D） Corrosion Prevention

Coatings with high corrosion-resistance performance will be selected, since the bridge is located in the vicinity of the river mouth and also to reduce the frequency of repainting in future. The actual selection will be made from Type C-5 Coatings (Fluoride paints for General Exterior Surface) and Type D-5 Coatings (Modified Epoxy Resin based coating for interior surfaces), described in "Steel Road Bridges Coatings and Corrosion Prevention Guidebook" (December 2005). As a further note, the river mouth area is exposed to increased salt blown by the prevalent strong coastal winds, hindering selection of the weathering steel.

4) Items for Consideration in the Detailed Design

The following items must be investigated in the Detailed Design:

A） Continuity of Cable-stayed Bridge Spans

As was shown in the previous section, the design for continuity of the terminal point of the cable-stayed bridge with the Approach Bridge girder will be investigated to facilitate the design of countermeasures to negative reaction forces. However, the change in main girder interval at points where continuity is planned and significant differences in deflection between inside/outside the approach girders must be carefully investigated.

B） Span Numbers

The most appropriate design will have the main cable-stayed bridge at the center of a symmetrical structure design on the Hai Phong /Halong sides, in principle. However, in the original design, girder heights over 25m were designed for steel girders with the over road section in the Hai Phong side and in terms of steel girders, the number of spans is 12 and 13 on the Halong and Hai Phong sides respectively. Investigations will be conducted to determine whether designing the Halong side to also have 13 spans will have economic benefit.

5.6.6 Approach Bridge/Substructure

(1) Super-T Girder Section

1) Approach Bridge/Substructure

Since P12 ~ P24 piers on the Halong side and P28 ~ P41 piers on the Hai Phong side are tall pier sections over 20m high, reducing the weight of the superstructure allows a more compact substructure which, in turn, will reduce the construction cost. Accordingly, the steel continuous I-girder bridge design was selected for the superstructure of this section.

Conversely, A1 abutment ~ P12 pier on the Halong side and P40 pier~ A2 abutment on the Hai Phong side are extremely similar in geological formation to the above steel continuous I-girder bridge sections, but since the pier heights in these sections are under 20m and the weight of the superstructure is thought to have less of an effect on the size of the substructure, Super-T girder designs, a type popular in Vietnam, have been selected for the superstructure of this section.

2) Determination of Load-Bearing Strata

As with the Main Bridge, the load-bearing strata for A1 Abutment ~ P24 Piers on the Halong side is the mudstone stratum 9b, 9c (RQ= over 50%) at a depth of approximately 38m and P28 pier ~ A2 Abutment on the Hai Phong side is the mudstone stratum 9b,9c (RQ= over 50%) at a depth of approximately 36m, based on geological surveys.

3) Design of Piles

Based on the Vietnam Load-Bearing Evaluation Method (22-TCN-272-05), the strata overlying the load-bearing stratum are soft soil strata with N values of 0〜20 and cannot be expected to provide friction resistance. Accordingly, the piles are designed as bearing piles. The pile length for each pier will be from 38 to 43m after including the footing penetration to comply with the Vietnam Standard (22-TCN-272-05).

The piles will be a cast-in-place construction (Reverse Circulation Method) in consideration of the soil strata composition and depth of construction. Pile diameters are to be 1.5m, which are normal for Vietnam and the pile layout was designed to comply with the Vietnam Standard (22-TCN-272-05) for minimum peripheral and axial separation distance.

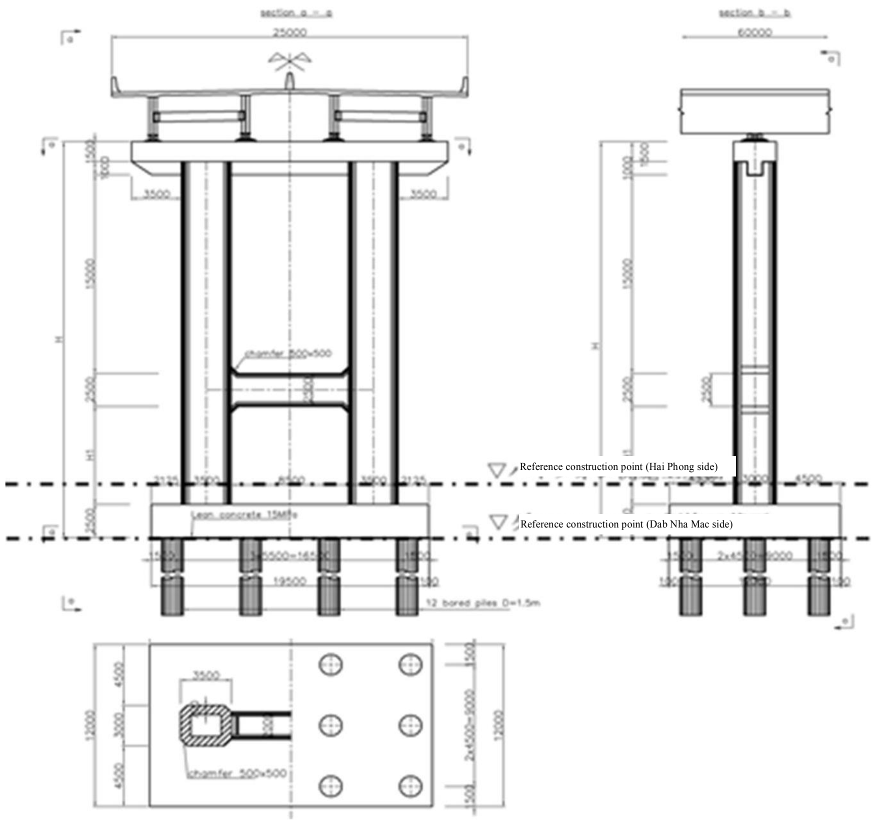
The number of piles is determined from the reactive force of structure, the required support against external forces and the load-bearing capacity of the piles. In the Approach Bridge design, the combined force in a seismic event was decisive.

4) Footings

The positional relation (Reference Construction Level) between the existing ground level and footings differ on the Halong and Hai Phong sides. On the Hai Phong side, open excavations or excavations after sheet piles are placed will be needed prior to footing construction. On the Halong side, the existing ground level forms the base for the footings and the extra work involved in excavating the ground is eliminated. This is due to the fact that the bridge location in the existing Dam Nha Mac area largely comprises swamplands with high water tables and also to the fact that future land development is planned and land reclamation is expected. Accordingly, footing construction coinciding with reclamation work was concluded as the most logical plan.

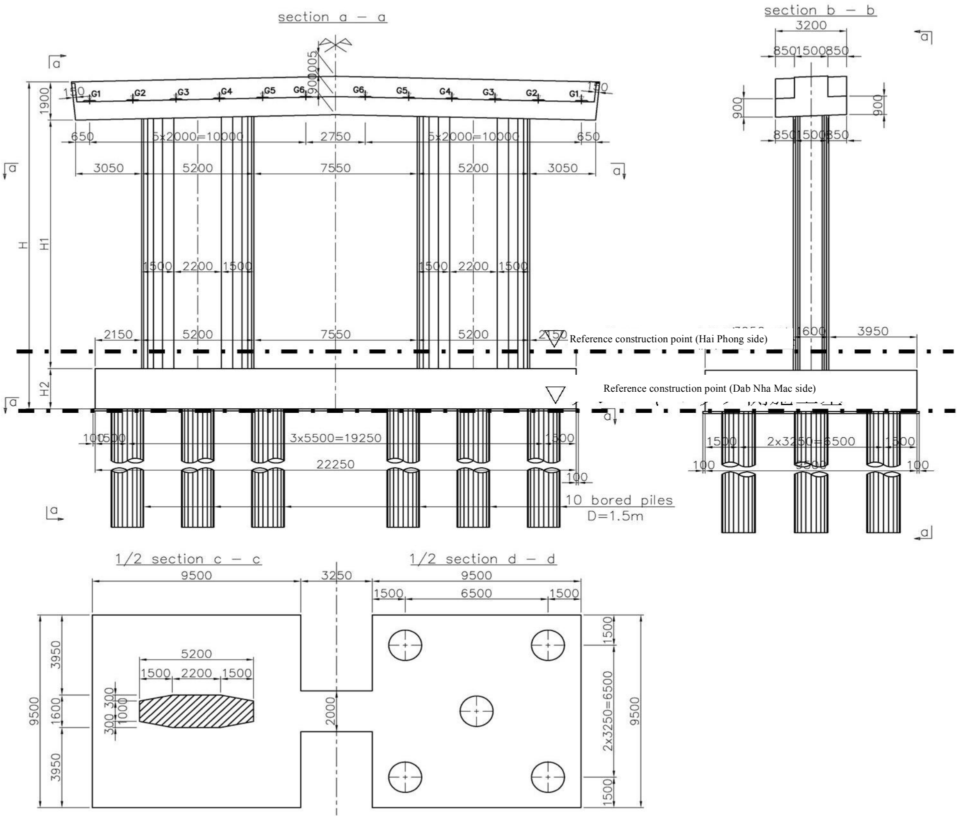
5) Piers

The piers are designed as rigid frame structures with the top of two columns rigidly connected by transverse beams to ensure improved seismic resistance, ease of construction and visual acceptability. The height per section, designed as steel continuous double main I-girder bridge, will be provided with transverse beams to withstand horizontal seismic forces but not the Super-T girder bridge sections.



Source: JICA Study Team

Figure 5.74 Substructure for Steel Continuous 2 Main I-Girder Bridge Section

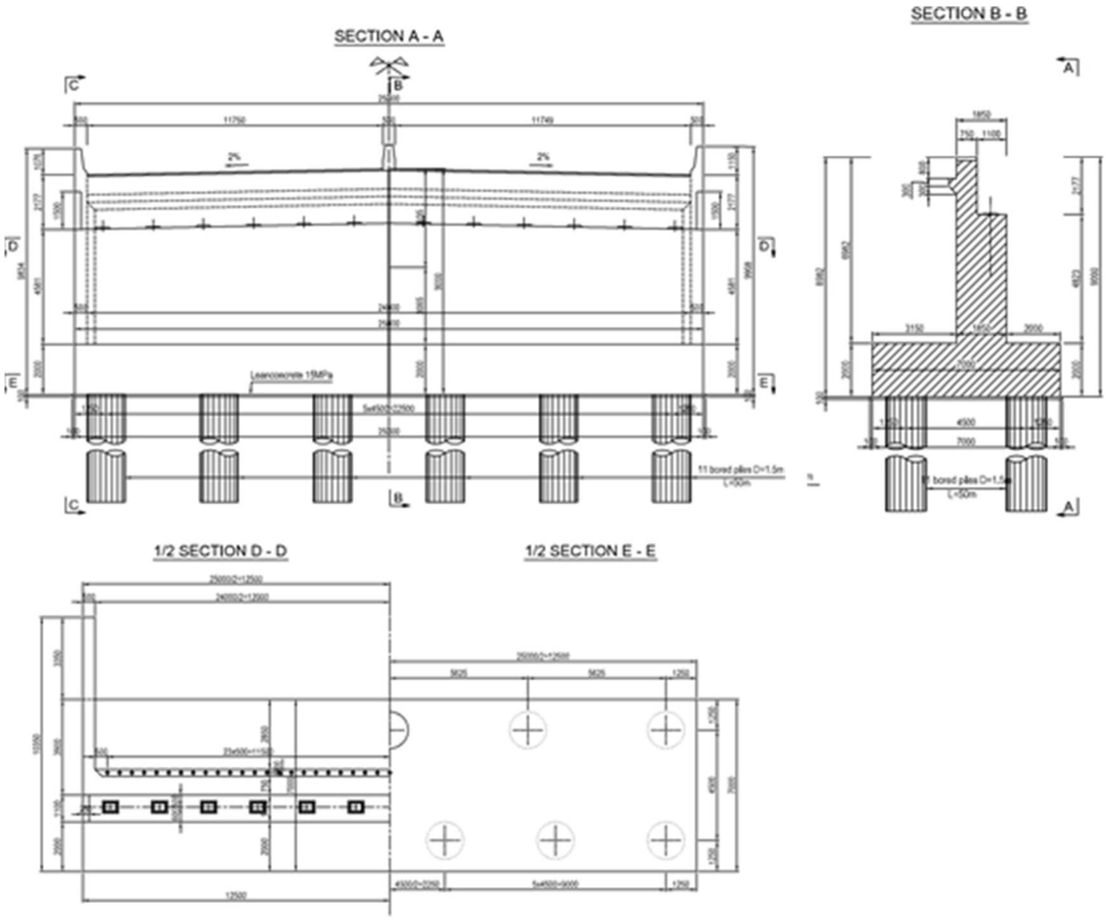


Source: JICA Study Team

Figure 5.75 Substructure for the Super-T Girder Bridge Section

6) Bridge Pier

The Bridge Pier Type is the most economical Reverse T Pier Type. Here, the pier position is determined from the most economical comprehensive arrangement; based on the relation between the cost of constructing the road section and embankment section, including piers, embankment of the abutment side and soft soil improvement measures, since no obstructions exist in the vicinity of the bridge that would be a controlling factor.



Source: JICA Study Team

Figure 5.76 Bridge Pier Structure