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IDA Credit No. / IDA tín dụng số : 4779-VN

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**Consulting Services for / Dịch vụ tư vấn
Detailed Design for Da Nang - Quang Ngai Expressway Development Project
/ Thiết kế kỹ thuật dự án Đường cao tốc Đà Nẵng – Quảng Ngãi**

Detailed Engineering Design Report (Final)

Volume 2: Main Report (PKG5)

Volume 2.1: Main Report (PKG5, Road)

July 5, 2013

The Joint Venture of / Liên danh Tư vấn:



NIPPON KOEI CO.,LTD.



NIPPON ENGINEERING CONSULTANTS CO.,LTD.



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THAI ENGINEERING CONSULTANTS CO., LTD.

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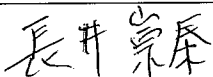
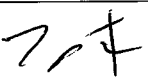

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Volume 2: Main Report (PKG5)

(Tập 2: Thuyết minh chính (Gói thầu 5))

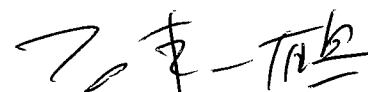
Volume 2.1: Main Report (PKG5, Road)

(Tập 2.1: Thuyết minh chính (Gói thầu 5, Đường))

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THE JOINT VENTURE OF NK-NE-CHODAI-TEC/LIÊN DANH TƯ VẤN

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List of Abbreviations

D/D	: Detailed Engineering Design
DHWL	: Design High Water Level
DQE	: Da Nang - Quang Ngai Expressway
F/S	: Feasibility Study
GOVN	: Government of Vietnam
IBRD	: The International Bank for Reconstruction and Development
MOT	: Ministry of Transport
NH	: National Highway
PC	: Pre-stressed Concrete
PKG	: Package
PMU	: Project Management Unit
QCVN	: Vietnamese National Standards
RNIP	: Road Network Improvement Project
TCN	: National Technical Regulations
TEDI	: Transport Engineering Design. Incorporated
TOR	: Terms of Reference
VEC	: Vietnam Expressway Corporation
WB	: The World Bank

1 GENERAL

1.1 Composition of Detailed Engineering Design Report

The design report consists of the following volumes;

Basic Design Report

Volume 1 : Basic Design Report

Volume 1.1 : Basic Design Report for Civil Works (Final) (Whole Section of Expressway)

Detailed Engineering Design Report

Volume 2 : Main Report (PKG5)

Volume 2.1 : Main Report (PKG5, Road) – This Report

Volume 2.2 : Main Report (PKG5, Bridge)

Volume 3 : Drawings (PKG5)

Volume 3.1 : Road Works (PKG5)

Volume 3.2 : Bridge Works (PKG5)

Volume 4 : Structural Calculation Report (PKG5)

Volume 4.1 : Road Works (PKG5) (4.1.1 Box Culvert, 4.1.2 MSE Wall)

Volume 4.2 : Bridge Works (PKG5)

Volume 5 : Quantity Report (PKG5)

Volume 5.1 : Road Works (PKG5)

Volume 5.2 : Bridge Works (PKG5)

Volume 6 : Hydrological and Hydraulic Calculation Report (PKG5)

1.2 Objective

The objective of this report is to present the results of the detailed engineering design of roadworks for the construction of Package 5.

1.3 Scope of Works and Work Demarcation

The scope of works in the Contract Package 5 (Road Works) include the construction of the expressway from Km32+600 to Km42+000 of Da Nang – Quang Ngai Expressway, except Bridge Works. The work items related to the traffic safety, operation and maintenance, lighting and power supply and ITS are included in separate construction packages. The work demarcation is indicated in Table 1.1.

Table 1.1 Work Demarcation of Construction Package 5 (Road Works)

S.N.	Item	PKG5 (Road Works)	PKG13 (O&M/ITS)	PKG14A (Traffic Safety/Lighting)
1	Road Works	✓		
2	Traffic Safety on Expressway (guard rail, fence, road signs and markings, others)			✓
3	Lighting and Power Supply			✓
4	Communication System	*)		
5	ITS		✓	

Note: *) The communication cable and conduits and pullbox for the communication cable are scheduled to invest by VNPT and those will be re-designed in the construction phase

2 LEGAL BASIS

- Decree 12/2009/NĐ - CP dated 12th February 2009 by Government on Management of Works Investment and Decree 83/2009/NĐ-CP dated 15th October 2009 of Government on revision and adjustment of some articles in Decree 12/2009/NĐ-CP;
- Decree 112/2009/NĐ-CP dated 14th December 2009 by Government on management of Works Investment;
- Decree 209/2004/NĐ-CP dated 16th December 2004 by Government regarding Construction quality management; and Decree No.49/2008/NĐ-CP dated 18th April 2008 regarding revision and addition of several articles of Decree No.209/2004/NĐ-CP;
- Decision No.362/QĐ-BGTVT dated 20th February 2009 and Decision No.727/QĐ-BGTVT dated 6th April 2012 by MOT regarding approval for Technical standard list applied for DQEP;
- Decision 2656/QĐ-BGTVT dated 10th September 2010 of MOT on approval on Investment of Da Nang- Quang Ngai Expressway Project.
- Decision No. 278/QĐ-VEC dated 14th June 2013 with No. 192/BC-KTCNMT dated 11th June 2013 regarding Approval on Detailed Design of package 5 : Km32+600-Km42+000 under DQEP (phase 1) by VEC.
- Decision No. 1534/QĐ-BGTVT dated 5th June 2013 regarding Approving on Modification of Basic Design – Danang – Quang Ngai Expressway Project by Minister of MOT.

3 NATURAL CONDITION SURVEYS

3.1 Topographic Surveys

- See Topographic Surveys Report

3.2 Geotechnical and Geological Survey

- See Geotechnical and Geological Survey Report

3.3 Hydrological and Inundation Analysis

- See Hydrological and Inundation Analysis Report

4 GEOMETRIC DESIGN STANDARDS

According to the Decision No.362/QĐ-BGTVT regarding “Standard frame applied for Da Nang – Quang Ngai expressway” dated 20 February 2009, the Vietnamese geometric design standards to be applied for the project are as follows:

- Expressway design standards TCVN 5729-97;
- Highway design standards TCVN 4054-05;
- Standard for designing highway 22TCN 273-2001;

Where no provisions exist in those standards, the relevant standards of AASHTO (A Policy on Geometric Design of Highways and Streets, 2011) or JRSO (Japan Road Structure Ordinance, 2004) to be referred.

Decision 315/QD-BGTVT dated on 23 February 2011 is applied to local roads which are classified A, B, and C.

4.1 Design Vehicles

Design vehicle is not clearly mentioned in the F/S. Dimension of Semi-trailer stipulated in TCVN4054 as shown in Table 4.1 shall be applied to the design.

Table 4.1 Design Vehicles

Type	Length (m)	Width (m)	Height (m)	Front Overhang (m)	Rear Overhang (m)	Wheel base (m)
Car	6.00	1.80	2.00	0.80	1.40	3.80
Truck	12.00	2.50	4.00	1.50	4.00	6.50
Semi-trailer	16.50	2.50	4.00	1.20	2.00	4.00 – 8.80

Source: TCVN4054-2005

4.2 Road Classification and Design Speed

Topographic features of the Da Nang – Quang Ngai expressway is generally flat with partial rolling sections. Design speed of 120km/h is applied to the expressway mainline.

4.3 Required Lateral and Vertical Clearances

TCVN5729-1997 is applied to lateral and vertical clearances on thruway and TCVN 4054-2005 is applied to lateral and vertical clearances on crossing roads and frontage roads which are given class I to VI.

(1) TCVN5729-1997

The lateral and vertical clearances for mound type median stipulated in TCVN5729-1997 are given in Figure 4.1. A 1.5m width is shown as hunch width at the top of envelop of corridor in the figure. However, dimension of hunch should be flexible because that the hunch is outside of travelled way space.

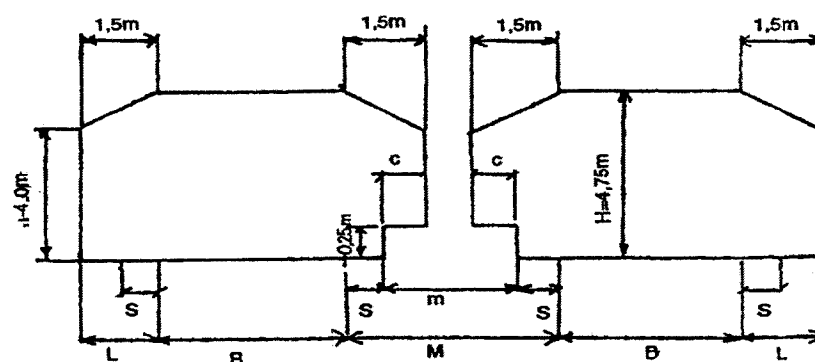


Figure 4.1 Lateral and Vertical Clearances in TCVN5729-1997

Where, (applied values)

m – median width (1.5m)

S – median marginal strip width (0.75m)

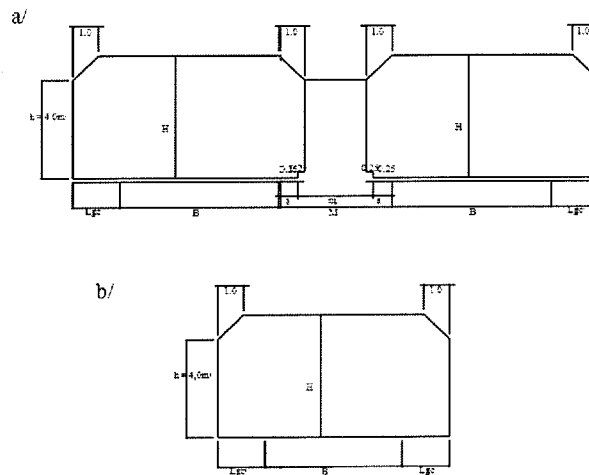
B – traveled way width (7.5m (initial stage), 11.25 (ultimate stage))

L – paved shoulder width (3.0m, the hunch width should be same as this value)

C – 0.3 m for Grade 120

(2) TCVN4054-2005

The lateral and vertical clearances stipulated in TCVN4054-2005 are given in Figure 4.2. A 1.0m width is shown as hunch width at the top of envelop of corridor in the figure. However, dimension of hunch should be flexible because that the hunch is outside of travelled way space.



Note: a- Highways of $V_{tk} \geq 80$ km/h with median, b- All types of highway without median;

Figure 4.2 Lateral and Vertical Clearances in TCVN4054-2005

Where,

B – Width of traveled way;

Lgc – Width of stabilized shoulder part;

m – Separated part;

s – Safety part (stabilized);

M – Width of separator;

M, m, s – Minimum values

H – Clearance height from the highest point of traveled lane (the height does not take into account of the reserved height for pavement raising when repairing or improvement);

h – Clearance height at the edge of stabilized shoulder

H = 4.75 m, h = 4.00 m for highway class I, II, III

H = 4.50 m, h = 4.00 m for remaining highway classes

4.4 Decision 315/QD-BGTVT

In consideration of clearance height specified in Decision 315/QD-BGTVT for each classification, lateral and vertical clearance of AH class follows criteria in TCVN4054-2005.

As for road classifications of A to C, lateral and vertical clearance is not specified in Decision 315/QD-BGTVT.

4.5 Setting of Lateral and Vertical Clearance

Setting of lateral and vertical clearance are developed as follows;

Ceiling line of the envelope is parallel with road surface.

Vertical edge lines are perpendicular to road surface. In case (a) normal cross fall, the vertical edge lines are plumb line, in case (b) super-elevated cross fall, the vertical edge lines are perpendicular to road surface shown in Figure 4.3. In case, the super-elevated value is smaller than the normal crossfall, which is 2%, plumb line is applied.

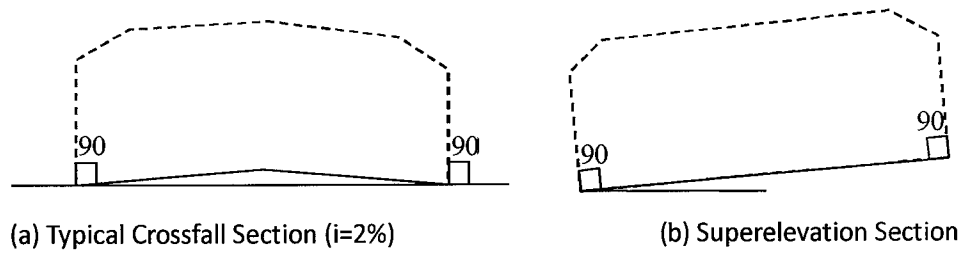


Figure 4.3 Setting of Lateral and Vertical Clearances Lines

4.6 Geometric Design Criteria for Thruway

Summary of geometric design criteria to be applied for the PKG5 for thruway with design speed of 120km/h is given in Table 4.2.

Table 4.2 Geometric Design Criteria for Thruway (Initial Stage)

Design Elements		Type/Value	Remarks	Reference
1	Expressway Classification	Grade 120	Type A	TCVN5729
2	Terrain	Flat		TCVN5729
3	Design Speed (km/h)	120		TCVN5729
4	Cross-Sectional Elements	Basic Lane Width (m)	3.75	TCVN5729
		Number of Lanes in each Traveled Way	2	F/S
		Number of Traveled Way	2	F/S
		Formation Width (m)	25.5	F/S
		Traveled Way Width(m)	2 x 7.5	TCVN5729
		Outer Shoulder Paved Width (m)	2 x 3.0	TCVN5729
		Outer Shoulder Earthen Width (m)	2 x 0.75	F/S
		Median Width (m)	1.5	F/S
		Median Marginal Strip (m)	2 x 0.75	TCVN5729
		Crossfall of Roadway (%)	2.0	TCVN5729
		Slope of Earthworks		
		Fill	V : H = 1:2.0	F/S
		Cut (soil)	V : H = 1:1.0	F/S
		Cut (stone Class 4)	V : H = 1:0.75	F/S
5	Sight Dist.	Stopping Sight Distance (m)	230	TCVN5729
		Driver's Eye Height (m)	1.2	TCVN5729
		Height of Object (m)	0.3	TCVN5729
6	Horizontal Alignment	Horizontal Curve		
		Absolute Minimum Radius of Horizontal Curve (m)	650	TCVN5729
		Desirable Minimum Radius of Horizontal Curve (m)	1000	TCVN5729
		Minimum Radius without Superelevation (m)	4000	TCVN5729
		Superelevation (Se)		TCVN5729
		Maximum Se for Absolute Minimum Radius (%)	7.0	TCVN5729
		Maximum Se for Desirable Minimum Radius (%)	5.0	TCVN5729
		Transition Curve		
		Minimum Length for Absolute Minimum Radius (m)	210	TCVN5729
7	Vertical Alignment	Minimum Length for Desirable Minimum Radius (m)	150	TCVN5729
		Minimum Length for Radius of 1125 m (m)	125	TCVN5729
		Minimum Length for Radius larger than 1125 m (m)	R/9	TCVN5729
		Vertical Gradient		
		Maximum Gradient		
		Maximum Grade-Up (%)	4.0	TCVN5729
		Maximum Grade-Down (%)	5.5	TCVN5729
		Critical Length for Maximum Grade of 4% (m)	600	
		Minimum Gradient		
		Minimum Grade for Cut Section (%)	0.5	TCVN5729
		Minimum Grade for Transition Section with Se<1% (%)	1.0	TCVN5729
		Minimum Grade for Tunnel Section (%)	0.3	TCVN5729
		Minimum Length of Grade (m)	300	TCVN5729
		Vertical Curve		
		Minimum Length of Vertical Curve (m)	100	TCVN5729
		Minimum Radius of Crest Curve (m)		
		Absolute Minimum Radius (m)	12000	TCVN5729
		Desirable Minimum Radius (m)	17000	TCVN5729
		Desirable Radius (m)	20000	TCVN5729
		Minimum Radius of Sag Curve (m)		
		Absolute Minimum Radius (m)	5000	TCVN5729
		Desirable Minimum Radius (m)	6000	TCVN5729
		Desirable Radius (m)	12000	TCVN5729
8	Lateral Clearance (m)	Traveled width		TCVN5729
	Vertical Clearance (m)	4.75		TCVN5729

5 TYPICAL CROSS SECTIONS

The cross sectional elements for PKG5 are proposed as shown in Table 5.1.

The expressway is designed with a staged construction approach by widening the road on both sides, maintaining the centerline in initial stage (Phase 1) as well as ultimate stage (Phase 2). However, for large scale bridge where PC Box girder is designed, the total width in the initial and ultimate stage is 26m as shown in the table.

Table 5.1 Proposed Cross Sectional Elements

Cross Section Elements	D/D (Proposal)											
	Initial Stage						Ultimate Stage					
	Earthwork Section			Bridge Section			Earthwork Section			Bridge Section		
	Q'ty	Width (m)	Total (m)	Q'ty	Width (m)	Total (m)	Q'ty	Width (m)	Total (m)	Q'ty	Width (m)	Total (m)
Median	1	<u>1.50</u>	1.50	1	1.50	1.50	1	<u>1.50</u>	1.50	1	1.50	1.50
Marginal Strip (Inner)	2	0.75	1.50	2	0.75	1.50	2	0.75	1.50	2	0.75	1.50
Marginal Strip (Inner) Long Bridge (PC-Box)										2	0.50	1.00
Traveled Way	4	3.75	15.00	4	3.75	15.00	6	3.75	22.50	6	3.75	22.50
Traveled Way Long Bridge (PC-Box)										6	3.50	21.00
Paved Shoulder include Marginal Strip (Outer)	2	3.00	6.00	2	3.00	6.00	2	3.00	6.00	2	3.00	6.00
Paved Shoulder include Marginal Strip (Outer) Long Bridge (PC-Box)										2	<u>0.50</u>	1.00
Earthen Shoulder	2	0.75	1.50				2	0.75	1.50			
Parapet, Service Space				2	0.75	1.50				2	0.75	1.50
Parapet, Service Space Long Bridge (PC-Box)				2	1.00	2.00				2	0.75	1.50
Pedestrian way												
Total			25.50			25.50			33.00			33.00
				PC-Box		26.00				PC-Box		26.00

Note: Underlined values are proposed values by the Consultant

Total width of 25.5m for general section and 26.0m for PC-Box Bridge section are proposed in initial stage and the boundaries for land acquisition are 10m outer side from edge of embankment slopes on the general section of the expressway.

5.1 Typical Cross Section at Normal Embankment

Proposed typical cross section of the road on normal embankment is shown in Figure 5.1. When the embankment height is more than 10m, a berm is designed at a height of 6m having 2m width.

When the expressway passes through flat inundation sections, the embankment slopes are protected by mortared stonework to a height determined by the design high water level and a freeboard of 0.5m.

5.2 Typical Cross Section at Common Excavation

Proposed typical cross section of the road at common excavation is shown in Figure 5.2. Berms are designed at every excavation depth of 6m having width of 2m.

5.3 Typical Cross Section at Rock Excavation

Proposed typical cross section of the road at road excavation is shown in Figure 5.3. Berm ditches are designed with triangular shape in the rock area.

5.4 Typical Cross Section at Partial Excavation and Embankment

Proposed typical cross section of the road at partial excavation and embankment is shown in Figure 5.4. When the natural slope at embankment side is more than 20%, bench cutting at the slopes is required before the construction of embankment.

5.5 Typical Cross Section at Superelevated Sections

Proposed typical cross section of the road at superelevated section is shown in Figure 5.5. Median drains are designed and are discharged by cross drainage.

5.6 Typical Cross Section at Deep Excavation

Based on the Vietnamese Standard TCVN4054, when the depth of excavation exceeds 12m, it is defined as deep excavation. Along these sections, it will be difficult to widen the road in future for ultimate stage and hence the excavation is extended to a width required by the ultimate stage (6 traffic lanes). However, the pavement is constructed only to the width required for the initial stage, as shown in Figure 5.6. Along the deep excavation area with hard rock, the berms are designed at every 8m height. The slope of excavation depends on the type of material determined from the boring data.

5.7 Typical Cross Section of Expressway at Bridge Approach

The concrete median barrier at the bridge has a total base width of 1m whereas, the concrete median barrier (New Jersey type) at the normal embankment section has a total base width of 0.82m. The median barrier is transitioned from 0.82m to 1.0m with a taper slope of 1:70. The typical cross section is shown in Figure 5.8.

5.8 Typical Cross Section of Expressway at Flyover Location

Typically, the expressway is designed with a median width of 1.5m and a New Jersey type concrete median barrier is installed. When a flyover is designed for the crossing road, a median width of 3.5m is required in order to accommodate the center pier of the flyover at the expressway median. The typical cross section is shown in Figure 5.9.

The median is transitioned from 1.5m to 3.5m within a length of 70m with taper (taper slope of 1:70 for 1m shift on each side).

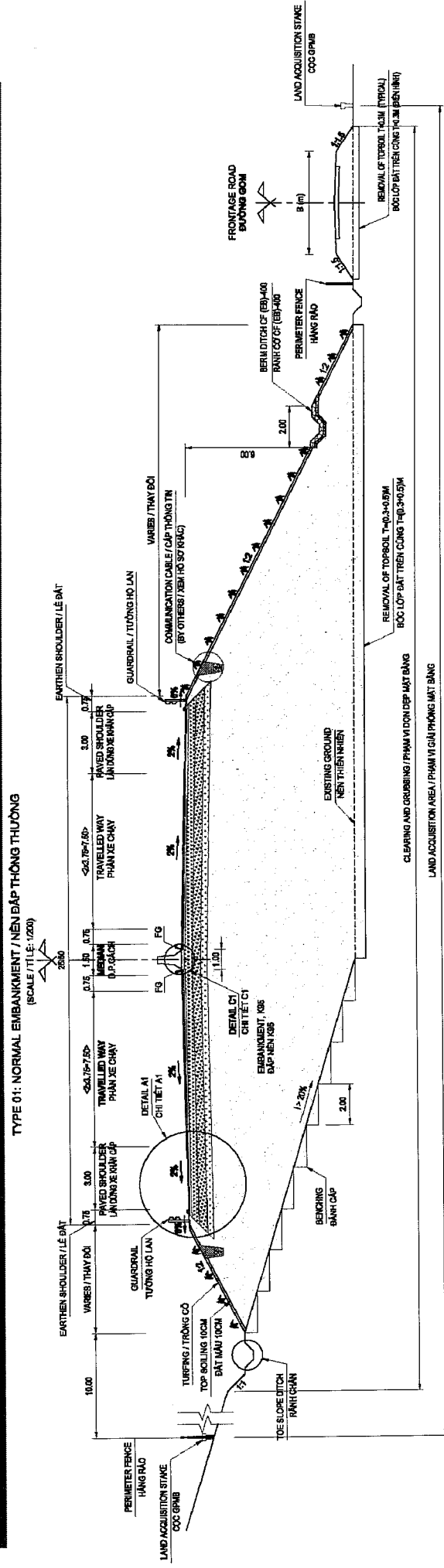


Figure 5.1 Typical Cross Section of Expressway on Normal Embankment

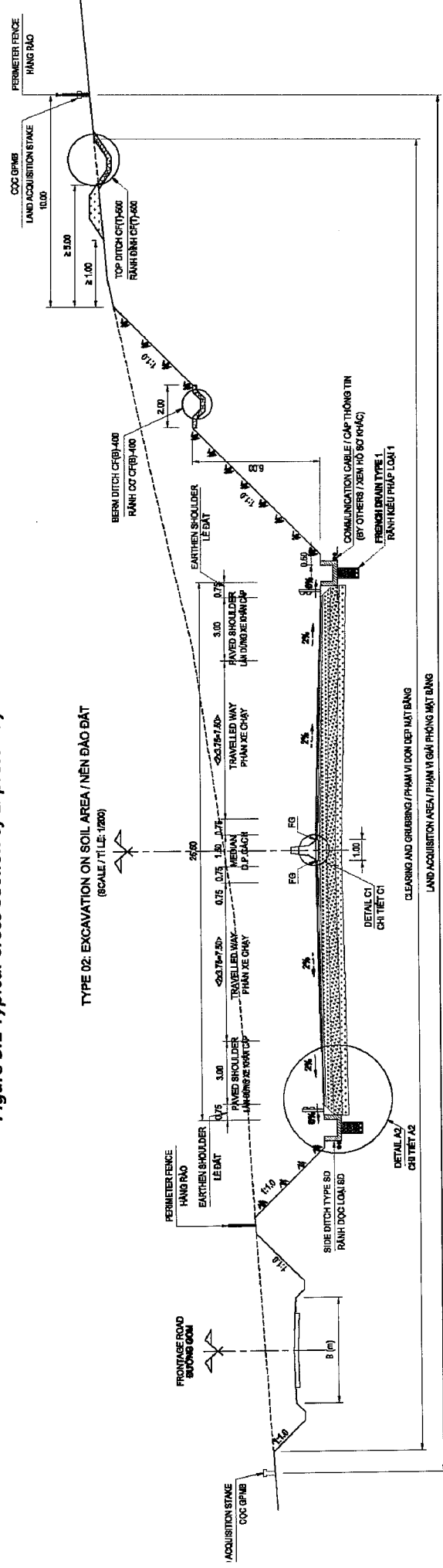


Figure 5.2 Typical Cross Section of Expressway on Common Excavation

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TYPE 05: EMBANKMENT WITH SUPERELEVATION / NỀN ĐẬP CÓ SIÊU CAO
(SCALE / TỈ LỆ: 1/200)

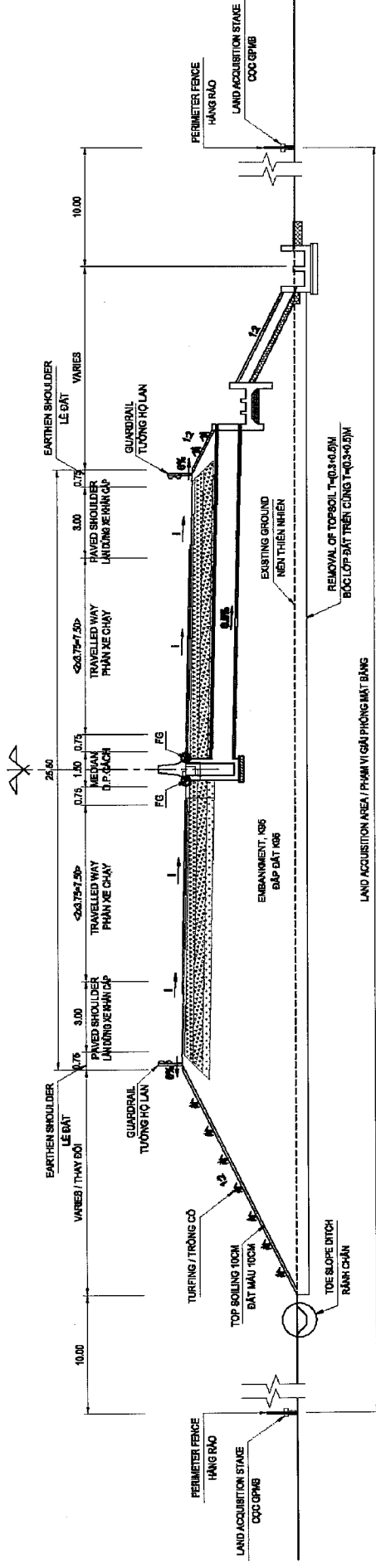


Figure 5.5 Typical Cross Section of Expressway at Superelevated Section

TYPE 06: DEEP EXCAVATION WITH 8 LANES AREA / NỀN ĐÀO SÂU 8 LÀN XE
KM111+080.00-KM113+113.01, L = 2,033.01M
(SCALE / TỈ LỆ: 1/200)

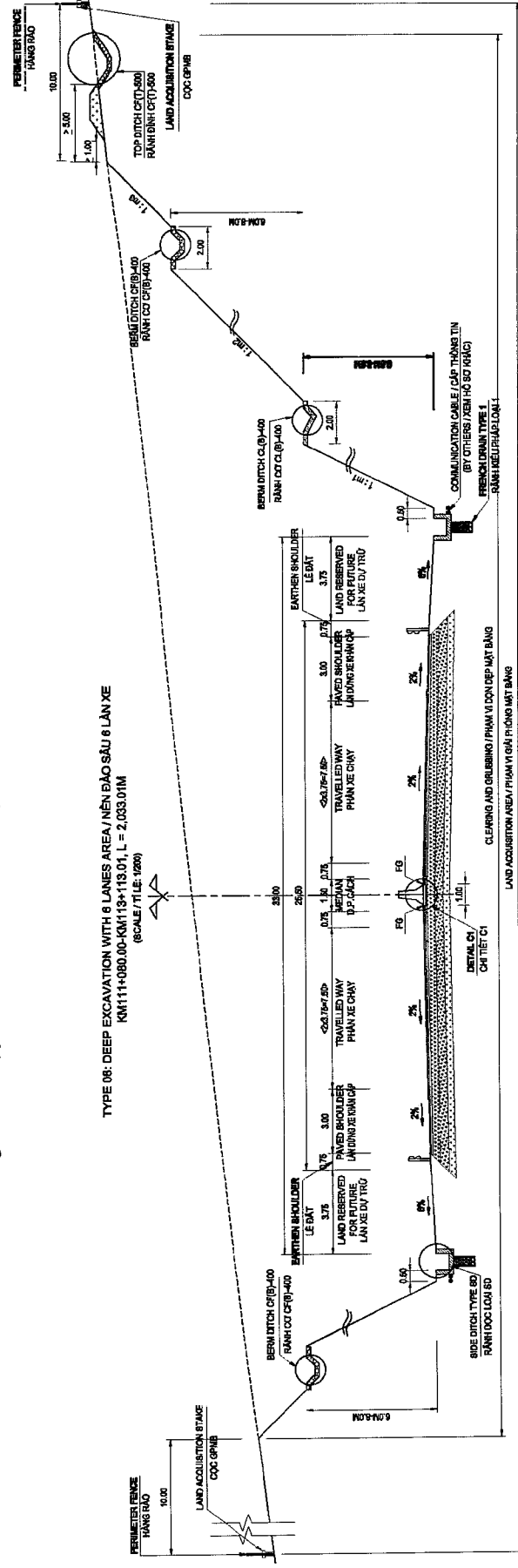


Figure 5.6 Typical Cross Section of Expressway at Deep Excavation

TYPE 08: AT BRIDGE APPROACH / ĐƯỜNG ĐẦU CẦU
(SCALE 1:200)

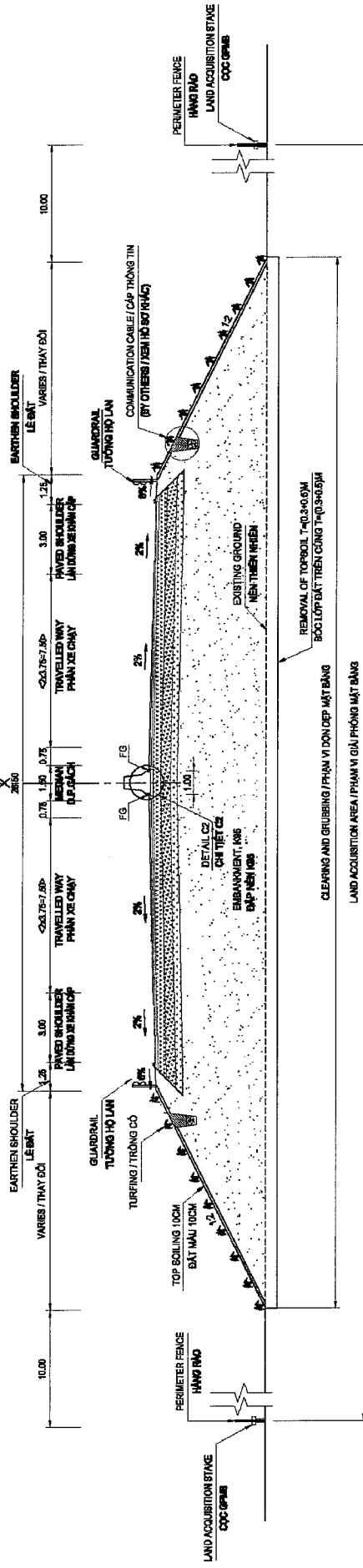


Figure 5.7 Typical Cross Section of Expressway at Bridge Approach

TYPE 8: AT FLYOVER / TÀI CẦU VƯỢT TRÊN ĐƯỜNG NGANG
(SCALE 1:100)

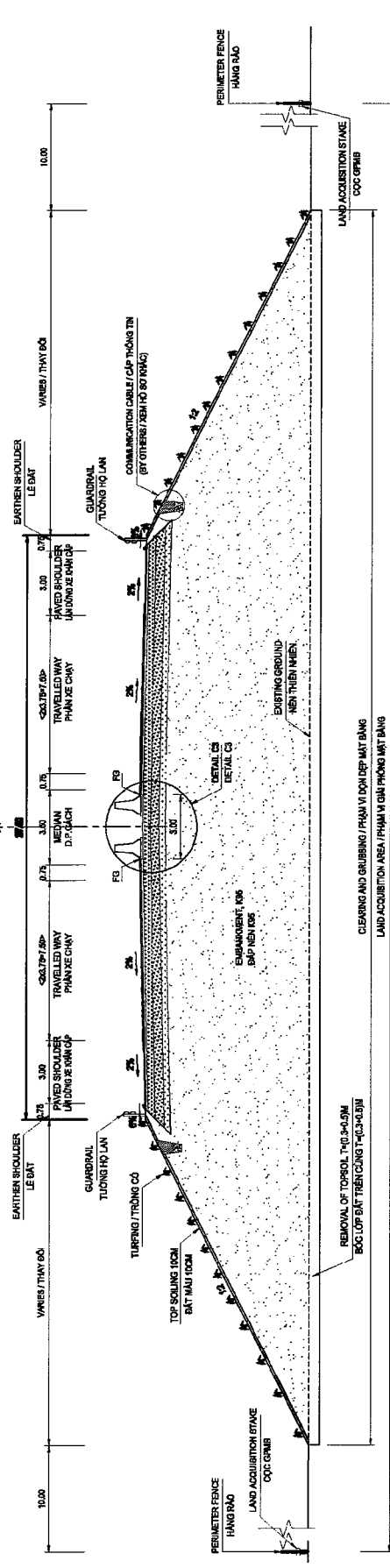


Figure 5.8 Typical Cross Section of Expressway at Flyover Location

6 DESIGNED ALIGNMENT

6.1 Horizontal Alignment

The alignment in Package 5 starts at Que Xuan commune, Que Son District in Quang Ngai Province at Km32+600 of the expressway alignment.

The alignment in Package 5 ends at Binh Quý commune, Thăng Bình district in Quang Ngai Province at Km42+000.

The horizontal alignment for Package 5 is shown in Table 6.1.

Table 6.1 Horizontal Alignment

No.	Station	Northing	Easting	Distance	Direction					Circular Curve		Spiral Length	
						D	M	S		L/R	Radius	In	Out
	29+018.343	1746639.840	527597.568	5169.358	S	40	39	3	E	Right	10500		
1	34+103.367	1742717.880	530965.133	613.710	S	54	10	21	E		1500	240	240
2	34+715.097	1742358.648	531462.720	2078.719	S	36	41	33	E		1500	170	170
3	36+790.005	1740691.820	532704.797	6601.057	S	40	39	3	E		12000		
	43+385.827	1735683.639	537005.039	3970.258	S	39	16	13	E	Right	45000		

Note: Package 5 is from Km32+600 to Km42+000

6.2 Vertical Alignment

6.2.1 Major Vertical Controls in Package 5

Major vertical controls for the design of profile in Package 5 are generally,

1. Design High Water Level (DHWL)
2. Water crossing structures
 - i) Bridges
 - ii) Culverts (box and pipe)
3. Road crossing structures
 - i) Box for existing roads across expressway (box for road for expressway overpass)
 - ii) Bridges for existing roads across expressway (flyover for expressway underpass)
 - iii) Bridges on expressway across existing roads (bridge for road for expressway overpass)

6.2.2 Consideration to Phase 2 (Ultimate Stage)

At the initial stage (current stage Phase 1), the expressway is designed with a total of four lanes. At the ultimate stage (Phase 2) in future, the expressway is planned to be designed with six lanes by widening on both sides and adding one lane to each direction of traffic.

Design of vertical alignment considers the total width of expressway at the ultimate stage in the calculation of margins for vertical controls because the widened widths in future, otherwise, will be lower than the elevations from hydrological requirements.

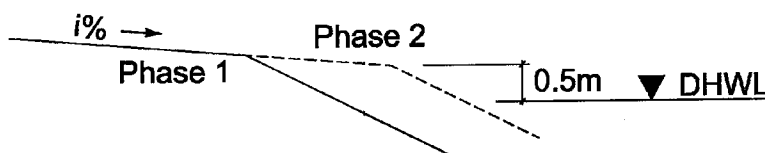


Figure 6.1 Required Margin for DHWL for Phase 2 Width

6.2.3 Designed Vertical Alignment

The details of the designed vertical alignment in Package 5 is give in Table 6.2

Table 6.2 Vertical Alignment in Package 5

PVI	Station	PVI Distance (m)	Elevation (m)	Grade-in (%)	Grade-out (%)	Curve Length (m)	Radius (m)	Remarks
	32+600.000		20.606		-1.500			Continue from PKG4
1	32+742.000		18.476	-1.500	2.330	230	6005	
2	33+520.000	778.000	36.603	2.330	-1.780	700	17032	
3	34+120.000	600.000	25.923	-1.780	2.000	230	6085	
4	34+720.000	600.000	37.923	2.000	-0.360	410	17373	
5	35+425.581	705.581	35.383	-0.360	-1.220	200	23256	
6	36+772.181	1346.600	18.954	-1.220	0.500	210	12209	
7	37+416.680	644.499	22.201	0.500	-0.700	280	23333	
8	38+044.167	627.487	17.809	-0.700	0.600	160	12308	
9	38+900.000	855.833	22.944	0.600	-0.441	180	17287	
10	39+380.000	480.000	20.826	-0.441	0.300	110	14840	
11	40+960.000	1580.000	25.566	0.300	-0.800	260	23637	
	42+030.000	1070.000	17.006	-0.800				PKG6

7 GEOTECHNICAL DESIGN

7.1 General

Alignment of PKG5 passes plane and mountainous sections. thus from the geotechnical aspects the section are divided into following sections.

1) Normal Embankment Section

The section in which embankment height is under than 12m, and the total length of this section is about 8.2km.

2) Normal Excavation Section

The section in which slope height of the excavation is not deeper than 12m, and the total length of the section is about 0.3km.

3) Deep Excavation Section

The section in which slope height of the excavation is deeper than 12m, and the total length of this section is about 0.9km.

At the deep excavation sections, the excavation width is extended up to a width required by Phase 2. However, the pavement is applied only for Phase 1 width. Moreover, when the excavation depth exceeds 12m only marginally for short length and when there is no hard rock (requiring blasting for excavation), excavation for Phase 2 width is not considered.

4) Mechanically Stabilized Earth (MSE) Wall Section

The section in which Mechanically Stabilized Earth (MSE) wall is designed at embankment section on the side where the expressway passes close to the existing railway line to limit the construction width.

The study for each sections were conducted and are described below.

7.2 Normal Embankment Section

Embankment slope is designed with a value of 1:2 (1 vertical to 2 horizontal) when height of embankment is less than 10m. **When the height of embankment is greater than 10m, a berm of 2m width is applied at a height of 6m.**

In normal embankment, the embankment slopes are protected only by turfing. However, in the bridge approaches, 10m of approach road from the end of the bridge are protected with mortared stonework from top to the toe of embankment slope. Beyond the 10m of approach road, the embankment slopes are protected with mortared stonework to a height determined by the design high water level of 1% with additional marginal of 0.5m. The slope protection of embankment slope by mortared stonework is applied along inundation area only.

In this package, there is a section where the embankment height is around 12m height. The stability of the embankment at this section (KM35+000) with maximum embankment heights were checked. The conditions for slope stability analysis are given in Table 7.1.

Table 7.1 Conditions for Embankment Slope Stability Analysis at Km35+000

Layer Name	Soil	SPT	Unit Weight (kN/m ³)	Cohesion (kN/m ²)	Angle (deg.)
Layer4	Very stiff clay	27	19.0	32.0	20
Layer4c	Dense clayey sand	34	19.5	35.0	22
Layer5a	weathered hard rock	> 50	27.0	40(Mpa)	-
Fill Material	Borrow material		21.0	20.0	21

The result of the analysis is shown in Figure 7.1. Based on the analysis results it was concluded that there is no need for any treatment or countermeasure required in this section. Meanwhile, geotechnical analysis was carried out for whole section and countermeasures was applied to ensure stability as mentioned in Volume 4.1.2 "Geotechnical Analysis".

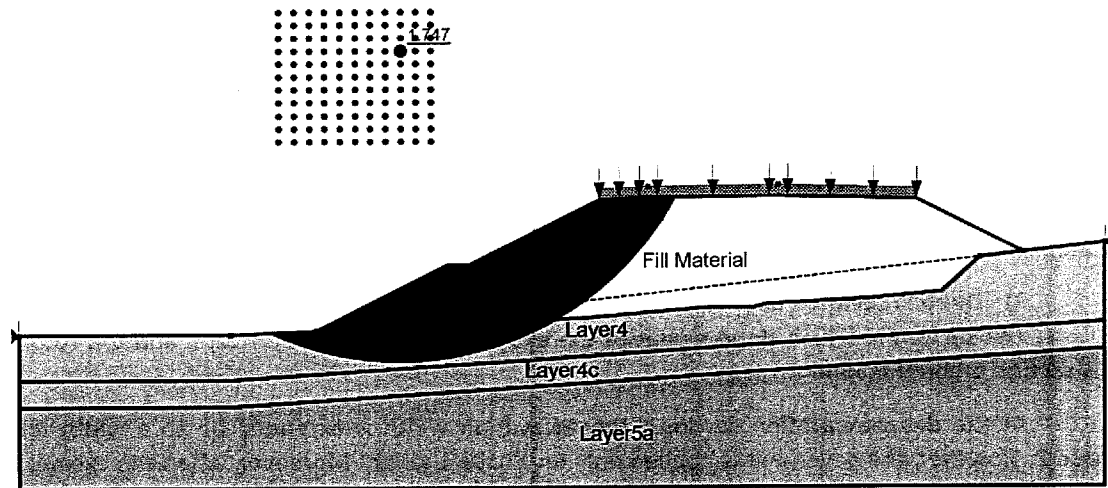


Figure 7.1 Results of Embankment Slope Stability Analysis at KM35+000

7.3 Normal Excavation Section

Normal excavation slope is designed with a value of 1:1 (1 vertical to 1 horizontal) when slope height is less than 12m. When the slope height is greater than 6m, a berm of 2m width is applied at a height of 6m. Generally, there are no rock section at normal excavation and hence slope gradient of 1:1 is generally applied. The cut slopes are protected by sodding.

7.4 Deep Excavation (Cut) Section

7.4.1 Deep Excavation (Cut) Sections in the Package

PKG 5 includes cut and embankment slopes. In the PKG, deep cut sections have slopes of higher than 12m as listed below;

KM33+260 – KM33+740 (Left Side)

KM33+260 – KM33+805.377 (Right Side)

Not only the ordinary slope works complying with the Vietnamese technical design standards, the slope protection works which can address a large-scale cut slope shall be designed in these sections.

7.4.2 Topographical and Geological Features in the Package

In the section of KM33 – KM34, where the large-scale cut slopes are planned, the Expressway passes north to south through the edges of rocky mountain. Geological features in the project area consists of five basic stratum as follows;

- Chu Lai Complex ($\gamma PR_3 c/$): These are composed of granitogneiss, migmatit granite, mica granite and pegmatite.
- Hai Van Complex Phase 1 ($\gamma aT_3 hv_1$) : These are the main component of the complex, consisting of biotite granite, two - mica granite, bionite granodiorite bearing muscovite. These rocks are white- grey with black spots, of oriented structure and medium-grained hypidiomorphic texture.
- Lower Pleistocene fluvial (aQ_1): These consist mainly of sand, pebble, granule, silty clay in some places mixed with few boulders. Total thickness is 2-5m.
- Fluvio-marine deposits (amQ_{II-III}): These are composed mainly of sand, silt, clay, some pebble, granule and a little grit, light-grey, yellow-grey colored and well cemented. The thickness is 10-15m.

- Fluvial deposits (aQ_{IV}³): These are composed of sand, pebble, granule and minor silt in the upper part. Pebble and granule have heterogeneous composition; 1.5-10m thick.
- Undifferentiated Quaternary (Q): This formation is composed of boulders, pebble, grit, in some places, lateralized clay of motley color; 3-10m thick.

This is a detailed topographic map of a mountainous region in Vietnam. The map features a prominent road running diagonally from the upper left towards the lower right. Key geographical features include:

- Mountains and Hills:** Labeled with names such as 'N. Dương Bà Chấm', 'N. Hòn Mỏ', 'N. Hòn Hiến', and 'Đ. bích đàn'. Elevation points are marked with numbers like 101.8, 142.1, 188.6, and 167.1.
- Rivers and Waterways:** A river labeled 'Sông T. L. H.' flows through the lower left portion of the map.
- Infrastructure:** A road is shown with distance markers: 'KM 33+260 - 33+740 (Left Side)' and 'KM 33+260 - 33+805.377 (Right Side)'. There are also smaller roads and paths indicated by dashed lines.
- Settlements and Landmarks:** Several small settlements or landmarks are marked with dots and labels, including 'Đ. bích đàn', 'Đ. 7 bích đàn', and 'Đ. 7'. A small area is labeled 'mía' (sugarcane).
- Topographic Details:** The map includes contour lines, spot elevations, and various symbols for terrain features like cliffs and depressions.

Package 5

Legend:

Al	Alkaline	Al	Alkaline
As	Asbestos	As	Asbestos
Ca	Calcium	Ca	Calcium
Co	Copper	Co	Copper
Cr	Chromite	Cr	Chromite
Cl	Clay	Cl	Clay
Fl	Flint	Fl	Flint
G	Gneiss	G	Gneiss
H	Hornblende	H	Hornblende
I	Iron	I	Iron
L	Limestone	L	Limestone
M	Mica	M	Mica
N	Nickel	N	Nickel
O	Ore	O	Ore
P	Pyrite	P	Pyrite
Q	Quartz	Q	Quartz
R	Rhyolite	R	Rhyolite
S	Sandstone	S	Sandstone
T	Tuff	T	Tuff
U	Uranium	U	Uranium
V	Volcanic	V	Volcanic
W	Woolfite	W	Woolfite
X	Xenite	X	Xenite
Y	Yenite	Y	Yenite
Z	Zinc	Z	Zinc

Figure 7.3 Geological Map of PKG 5

7.4.3 Design Policy

- Apply proper slope protection works which are suitable for the specific situations of the sites in consideration of the slope protection works widely used in Vietnam
 - Place emphasis on ensuring the stability in view of importance of the Expressway
- 1) Slope Protection Works Widely Applied in Vietnam

In order to grasp a general situation of slope protection in Vietnam, the slope protection works applied in national highways and provincial roads in the vicinity of the project site were studied.

- 2) For normal excavation section, where excavation depth is less than 12m, excavation slope of 1:1 is applied and the slopes are protected by sodding.

- 3) For deep cut sections, slope design is conducted based on geological investigation results.

- 4) Measures for Ensuring Stability

In view of importance of the Expressway, the structural countermeasures at the lowest slope and the wide berms (w=2.0m) are applied.

Furthermore, phenomena to occur during and after construction were envisaged based on the site conditions and the plural countermeasure options were proposed.

7.4.4 Slope Design

- 1) Gradient and Height

It is assumed that sand rocks, alternate layers of sand rock and mud rock, granitic rocks would appear and they are evaluated based on the results of site survey and geological boring, as hard rocks under less weathered condition. Since land slide and rock slope failure are not confirmed at site, the slope gradients as recommended in Table 7.2 are applied in comparison to TCVN4054.

Table 7.2 Slope of Cut Sections

Type and Condition of Soil/Rock	Cut Slope Gradient TCVN4054		Cut Slope Gradient Recommended	
	<12m	>12m	<12m	>12m
Cohesive soil or incohesive soil with medium to high density	1:1.00	1:1.25	1:1.00	1:1.00
Granular soil	1:1.50	1:1.75	1:1.00	1:1.00
Lightly weathered rock	1:0.30	1:0.50	1:0.30	1:0.50/ 1:0.30
Heavily weathered rock	1:1.00	1:1.25	1:1.00	1:1.00
Lightly weathered soft rock	1:0.75	1:1.00	1:0.75	1:1.00
Heavily weathered soft rock	1:1.00	1:1.25	1:1.00	1:1.00
Note from TCVN4054: As for soil excavation, height of the slope should not be over 20m. As for soft rock excavation, if the surface of the rock layer slopes outward with the slope angle above 25°, the design slope should be as steep as the rock layer surface and the height of the slope should be limited less than 30m.				

- When the cut height is less than 12m, slope gradient of 1:1.0 is recommended except for lightly weathered rock and are protected by sodding.
- When the cut height is more than 12m, slope gradient of 1:1.0 is recommended except for lightly weathered rock but are protected by other methods described below. Additionally, slope stability analysis is performed for the recommended slope gradient and height.

Type and condition of soil/rock in the above table and corresponding rock class and soil type determined by the geological survey conducted are shown in Table 7.3.

Table 7.3 Type and Condition of Soil/Rock and Corresponding Rock Class and Soil Type

Category of Rock/Soil Layer (PKG 5)			Rock and Soil Type	Class	Type and Condition of Soil/Rock
Layer f	Fill material	Rock, soil, organics		S	Cohesive soil or incohesive soil with medium to high density
Layer b	Boulder			S	
Layer 1	Cover soil	Mud, clay, sandy clay with organics		S	
Layer 2	Fine sand		sp	S	
Layer 3	Clayish sand		sc	S	
Layer 4	Low-plasticity clay		cl	C	Granular soil
Layer 5	Low-plasticity clay		cl	C	
Layer 6	Clayish sand		sc	S	
Layer 7	Poorly sorted sand		sp	S	
Layer 8	Clayish sand		sc	S	
Layer 9	Low-plasticity clay		cl	C	Heavily weathered soft rock
Layer 10	Silty - Clayish sand		sc-sm	S	
Layer 11	Silt rock, sand rock, heavily weathered soft rock		iv-2		
Layer 12	Silt rock, sand rock, lightly weathered soft rock		iv-1		
Layer 13	Granitic rock, heavily weathered hard rock		v-2		
Layer 14	Granitic rock, lightly weathered hard rock		v-1		Lightly weathered rock

Although the result of geological boring does not indicate the existence of soft rock or rock with well-developed discontinuous surface, in case where they appear on the surface of cut slope, the gradient shall be changed in consideration of the following note *1).

*1) As for soft rock excavation, if the surface of the rock layer slopes outward with the slope angle above 25°, the design slope should be as steep as the rock layer surface and the height should be limited less than 30m.

2) Berm Width

The width of berm shall be 2.0m in the standard section and drainage shall be equipped.

7.4.5 Slope Protection Design

Slope protection works shall be selected in consideration of protection works widely applied in Vietnam. Table 7.3 shows selected slope protection works for the project.

Although many slopes are left untreated in Vietnam, a common issue found in the site is that the weathering of rocks exposed on the slope surface may cause rock fall, collapse, sediment discharge or functional deterioration of structures caused by them.

Therefore, the countermeasures against weathering of slopes are selected in principle. Furthermore, considering a huge amount of rainfall of over 700mm in a month in the rainy season, drainage shall be installed on the berm and every effort shall be made to decrease the flow speed of rain water on the slope surface. The basic patterns for specific slopes are shown in Table 7.4.

7.4.6 Stability Analysis

Slope stability analysis for the deep excavation sections were conducted for the critical sections. Work procedure of the slope stability analysis is proposed as shown in Figure 7.4. The results of the analysis are given in given in Figure 7.5 to Figure 7.7. The results of the analysis show that all the designed slopes are stable. The stability at Section 32+880 was checked although slope protection was not designed at this section since the excavation height exceeds 12m for a short length only.

Table 7.4 Basic Patterns of Slope Shape and Protection Works

Type of Soil/Rock	Weathering Condition	Rock Grade	Recommended Slope Gradient		Condition of Cut Slope and Slope Protection Measure					
			h<12m	h>=12m	Symbol	a	b	c	d/e	*
Cohesive Soil			1:1.0	1:1.0	CS	Turfing	Turfing			UD,DS
			CS-h		Bl+PB	SF+SD			UD,DS	
Granular (Sandy) Soil			1:1.0	1:1.0	GS	Turfing	Turfing			UD,DS
					GS-h	PB	SF+SD			UD,DS
Hard Rock (Granit)	Extremely (N>30)	V-3	1:1.0	1:1.0	RWg	Turfing	Turfing	--	--	UD,DP
					RWg-h	SF+PB	SF	Bl	An-a,b	UD
Soft Rock / Hard Rock	Moderately to Highly	IV-3, IV-2/ V-3, V-2	1:1.0	1:1.0	RW	Turfing	Turfing	--	--	UD,DP
					RW-h	SF+SC	SF	Bl	An-a,b	UD
Soft Rock	Fresh to Lightly	IV-1	1:0.75	1:1.0	SR	--	--	--	--	DP
					SR-h	SM	SF	Bl	An-a,b	UD,DP
Hard Rock	Fresh to Lightly	V-1	1:0.3	1:0.5/1:0.3	HR	--	--	--	--	DP
					HR-h	SF+SC	SC	Bl	An-a,b	UD,DS+DP
Item		Symbol	Description							
Symbol		CS	Cohesive Soil							
		GS	Granular Soil							
		RWg	Weathered Granitic Rock							
		RW	Weathered Rock							
		HR	Hard Rock							
		SR	Soft Rock							
Condition of Cut Slope		a	First Slope							
		b	No Joint is expected/observed							
		c	Small scale of slope failure along with joint (spacing <1.0m) is expected -> The final decision shall be made on actual geological condition of excavated cut slope.							
		d/e	The slope where more failure is expected than the above. -> The final decision shall be made on actual geological condition of excavated cut slope.							
		*	If much seepage water is expected/observed (surface, layer, piping hole, etc.)							
Structure of Slope Protection		SF	Cribwork with Shotcrete (B=200mm, 1500*1500 with anchor pin)							
		Bl	Anchor Rod + Cribwork with Shotcrete (B=200mm, 1500*1500, with steel bar L=2000)							
		An-a	Anchor Rod + Cribwork with Shotcrete (B=400mm, 2000*2000, with anchor bar L=100,000mm)							
		An-b	Anchor Rod + Cribwork with Shotcrete (B=500mm, 3000*3000, with anchor bar L=200,000mm)							
Structure of Surface Protection		PB	Precaset block facing							
		MS	Mortared Stone Works							
		SC	Shotcrete (t=10cm)							
		SD	Sodding							
Drainage Works		UD	French Drain (Wire Cylinder (Gabion), Perforated Drain Pipe, etc.)							
		DS	Geotextile Sheet							
		DP	Drain Pipe							

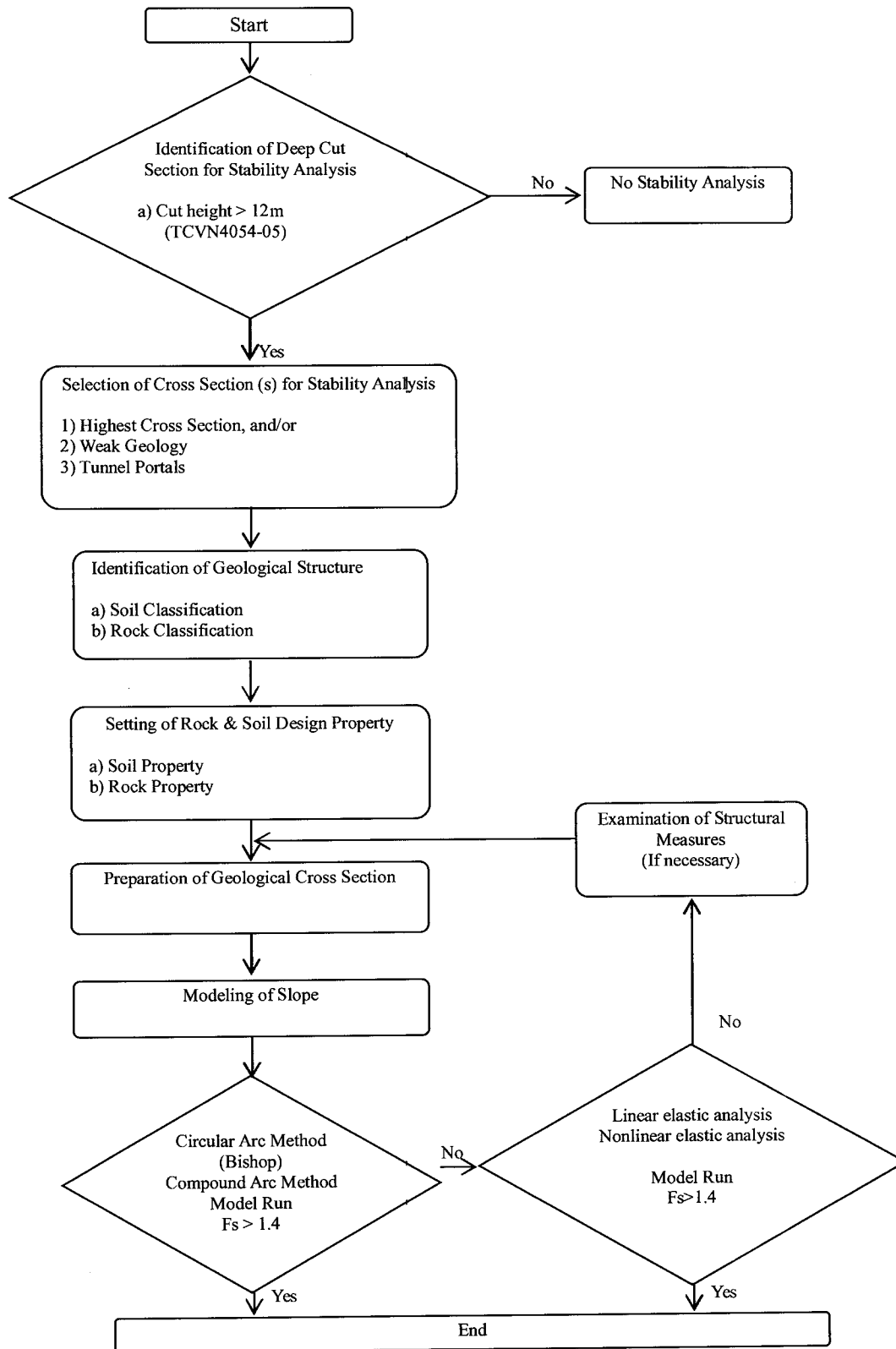


Figure 7.4 Work Flow of Stability Analysis (Deep Cut)

DA NANG - QUANG NGAI EXPRESSWAY PROJECT
PACKAGE 5
STAGE: DETAIL DESIGN

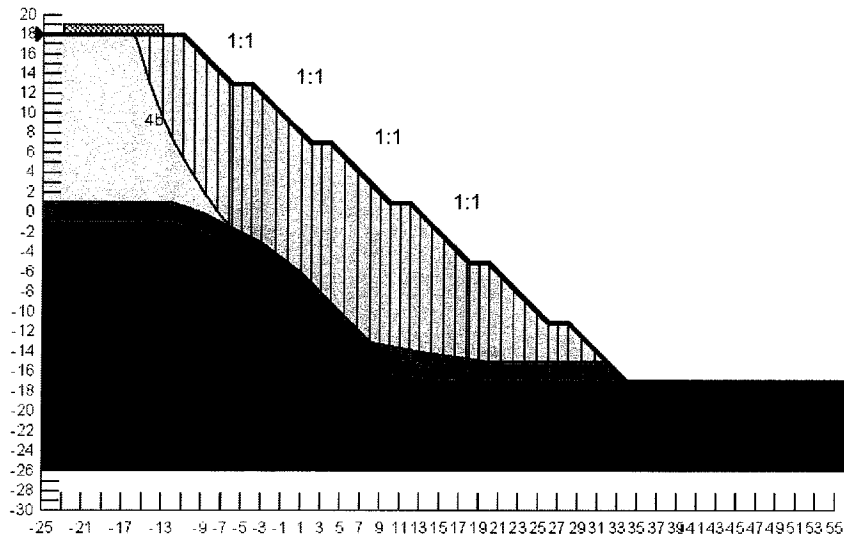
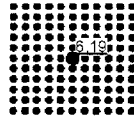
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Analysis Method: Bishop

STABILIZATION TEST OF CUTTING SLOPE
KM 33+400

- Height of Excavation: $H=35.5\text{m}$
- Load: $q=13.0\text{ kN/m}^2$

- $F_s > 1.4$ ----> OK

None Treatment



4b
Model: MohrCoulomb
UnitWeight: 20 kN/m3
C: 0 kPa
Phi: 30°

5a
Model: MohrCoulomb
UnitWeight: 25 kN/m3
C: 100 kPa
Phi: 30°

5c
Model: MohrCoulomb
UnitWeight: 27 kN/m3
C: 1000 kPa
Phi: 40°

Figure 7.5 Slope Stability Analysis at Deep Cut KM33+400

DA NANG - QUANG NGAI EXPRESSWAY PROJECT
PACKAGE 5
STAGE: DETAIL DESIGN

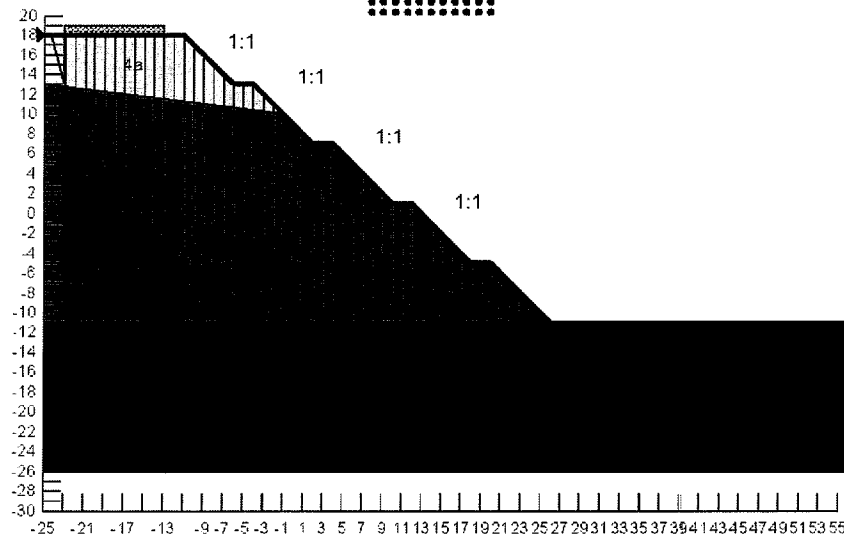
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Analysis Method: Bishop

STABILIZATION TEST OF CUTTING SLOPE
KM 33+720

- Height of Excavation: $H=29.5\text{m}$
- Load: $q=13.0\text{ kN/m}^2$

- $F_s > 1.4$ ----> OK

None Treatment



4a
Model: MohrCoulomb
UnitWeight: 25 kN/m3
C: 0 kPa
Phi: 18°

4b
Model: MohrCoulomb
UnitWeight: 20 kN/m3
C: 0 kPa
Phi: 30°

5c
Model: MohrCoulomb
UnitWeight: 27 kN/m3
C: 1000 kPa
Phi: 40°

Figure 7.6 Slope Stability Analysis at Deep Cut KM33+720

DA NANG - QUANG NGAI EXPRESSWAY PROJECT
PACKAGE 5
STAGE: DETAIL DESIGN

File Name: 649km33+880j.gsz
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Last saved time: 4:37:45 PM
Analysis Method: Bishop

STABILIZATION TEST OF CUTTING SLOPE

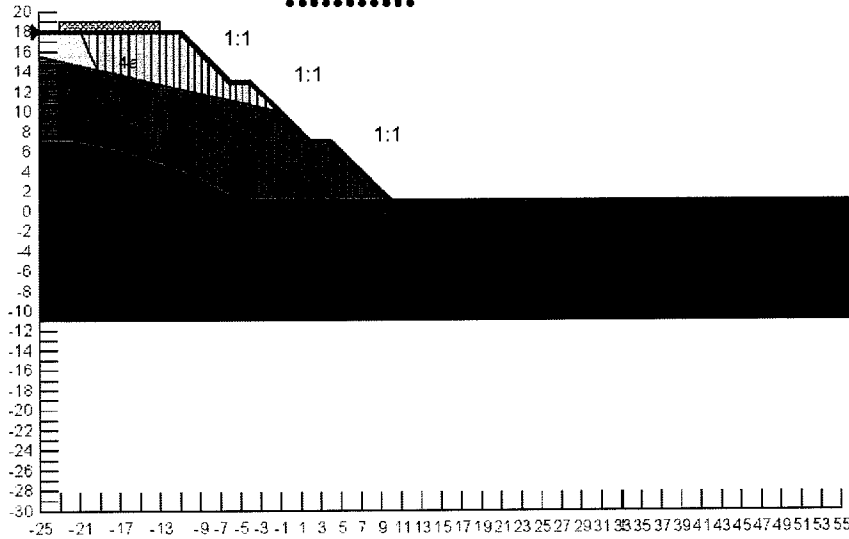
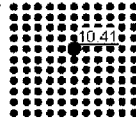
KM 33+880

- Height of Excavation: H=17.0m

- Load: q=13.0 kN/m²

- $F_s > 1.4$ ----> OK

None Treatment



4a
Model: MohrCoulomb
UnitWeight: 25 kN/m³
C: 0 kPa
Phi: 18°

4b
Model: MohrCoulomb
UnitWeight: 20 kN/m³
C: 0 kPa
Phi: 30°

5c
Model: MohrCoulomb
UnitWeight: 27 kN/m³
C: 1000 kPa
Phi: 40°

Figure 7.7 Slope Stability Analysis at Deep Cut KM33+880

7.4.7 Detailed Design

1) Typical Cross Section

Typical cross sections were prepared setting combination of slope gradient and protection works as shown in Figure 7.8.

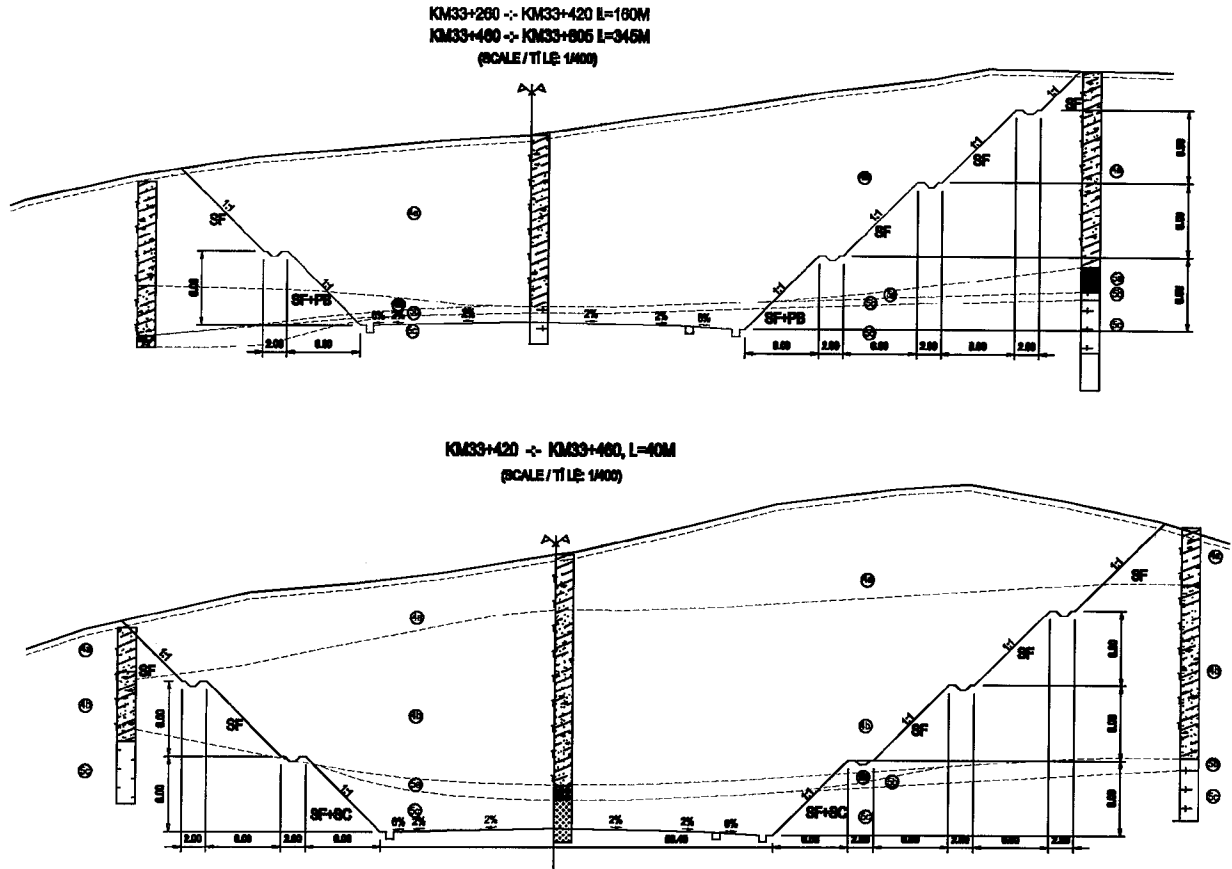


Figure 7.8 Typical Cross sections

2) Arrangement of Protection Works for Each Cross Section

Based on the typical cross sections, slope gradient and protection works were arranged for each cross section. Arrangement plan with pitch of 75m is shown in Figure 7.9. Where the applied gradients significantly differ in consecutive two slopes, transition sections of slope gradient were arranged.

[Section A]

KM/	Slope	L5		L4		L3		L2		L1		R1		R2		R3		R4		R5		R6
	Berm		S4		S3		S2		S1				S1		S2		S3		S4		S5	
33+500	Slope condition									RWg-h		RWg-h		RWg								
	Gradient									1:1.0		1:1.0		1:1.0								
	Protection									SF+PB		SF+PB		SF								
33+460	Slope condition					RWg		RWg		HR-h		HR-h		RWg		RWg		RWg				
	Gradient					1:1.0		1:1.0		1:1.0		1:1.0		1:1.0		1:1.0		1:1.0				
	Protection					SF		SF		SF+SC		SF+SC		SF		SF		SF				
33+420	Slope condition							RWg		HR-h		HR-h		RWg		RWg		RWg		RWg		
	Gradient							1:1.0		1:1.0		1:1.0		1:1.0		1:1.0		1:1.0		1:1.0		
	Protection							SF		SF+SC		SF+SC		SF		SF		SF		SF		
33+380	Slope condition									RWg-h		RWg-h		RWg		RWg		RWg		RWg		
	Gradient									1:1.0		1:1.0		1:1.0		1:1.0		1:1.0		1:1.0		
	Protection									SF+PB		SF+PB		SF		SF		SF		SF		
33+340	Slope condition							RWg		RWg-h		RWg-h		RWg		RWg		RWg				
	Gradient							1:1.0		1:1.0		1:1.0		1:1.0		1:1.0		1:1.0				
	Protection							SF		SF+PB		SF+PB		SF		SF		SF				
33+300	Slope condition							RWg		RWg-h		RWg-h		RWg		RWg		RWg				
	Gradient							1:1.0		1:1.0		1:1.0		1:1.0		1:1.0		1:1.0				
	Protection							SF		SF+PB		SF+PB		SF		SF		SF				

[Section B]

KM/	Slope	L5		L4		L3		L2		L1		R1		R2		R3		R4		R5		R6
	Berm		S4		S3		S2		S1				S1		S2		S3		S4		S5	
33+800	Slope condition											RWg-h										
	Gradient											1:1.0										
	Protection											SF+PB										
33+760	Slope condition											RWg-h		RWg		RWg		RWg				
	Gradient											1:1.0		1:1.0		1:1.0		1:1.0				
	Protection											SF+PB		SF		SF		SF				
33+720	Slope condition									RWg-h		RWg-h		RWg		RWg		RWg		RWg		
	Gradient									1:1.0		1:1.0		1:1.0		1:1.0		1:1.0		1:1.0		
	Protection									SF+PB		SF+PB		SF		SF		SF		SF		
33+680	Slope condition									RWg-h		RWg-h		RWg								
	Gradient									1:1.0		1:1.0		1:1.0								
	Protection									SF+PB		SF+PB		SF								
33+640	Slope condition					RWg		RWg		RWg-h		RWg-h		RWg								
	Gradient					1:1.0		1:1.0		1:1.0		1:1.0		1:1.0								
	Protection					SF		SF		SF+PB		SF+PB		SF								
33+600	Slope condition					RWg		RWg		RWg-h		RWg-h		RWg		RWg						
	Gradient					1:1.0		1:1.0		1:1.0		1:1.0		1:1.0		1:1.0						
	Protection					SF		SF		SF+PB		SF+PB		SF		SF						
33+560	Slope condition							RWg		RWg-h		RWg-h										
	Gradient							1:1.0		1:1.0		1:1.0										
	Protection							SF		SF+PB		SF+PB										

- * In case where more than one slope conditions are expected in a single step, the mildest gradient shall be applied.
- * Hatching means that the cell applies exceptional value to avoid sharp changes in gradient.
- * s1, s2, s3, s4 mean the wide berm (w=2.0m).
- * The slopes are revised for better transitioning for each section in the design.

Figure 7.9 Arrangement plan of Slope Protection Works

7.5 Mechanically Stabilized Earth (MSE) Wall Section

The design of reinforced earth structure is based upon the principles published by the American Association of State Highway and Transportation Officials (AASHTO LRFD Bridge Design Specifications 2007 & 2010). In common with other codes for the design of civil engineering structures, this code of practice adopts *limit state* principles. These principles involve the application of resistance factors and load factors for various structure types; design lives and load combinations to ensure sufficient safety margins.

The design of reinforced soil structures is considered in two parts. The first part is the *external stability*. First, the lateral earth pressure acting on the back of the reinforced soil structure is derived using the *active earth pressure coefficient*, k_a . Passive earth pressures on the foot of the wall are always ignored when considering any stabilizing forces. The reinforced soil structure is considered to behave as a mass gravity structure and is designed to prevent the following external failure modes from occurring:

Overturning of the reinforced soil block

Forward sliding of the structure on the foundation soil

Bearing Failure

Loss of overall stability

The external stability of the MSE or Reinforced Earth walls is governed by the size of the Reinforced Earths Block. The wall is checked whether both overturning and sliding stabilities are satisfied as well as determining the number of reinforcing strips to satisfy the internal stability.

The second part of the design is the *internal stability*. This aspect of the design is used to determine the amount of soil reinforcement required to maintain the structural integrity of the reinforced soil mass. Sufficient reinforcement is provided to ensure the following internal failure modes do not occur:

Tensile rupture at any point along the length of the reinforcement

Loss of frictional bond (adherence) between the reinforcement and the soil fill.

The design of the MSE wall in Package 5 is as shown in Table 7.5.

Table 7.5 MSE Wall in Package 5

S.N.	Type of Block	Max. Wall Height	Strip Length	Min. Embedment	Total Wall Length
		(m)	(m)	(m)	(m)
1	A	6	4.5	1.0	760
2	B	8	5.8	1.0	
3	C	10	7	1.0	
4	D	12	8.5	1.0	
5	E	15	13	1.0	

8 PAVEMENT DESIGN

8.1 Pavement Thickness in Normal Embankment of Expressway

The designed pavement thickness in Package 5 of expressway mainline is given as;

1) Normal Section

Asphalt Concrete Anti-Skid	:	3cm (not applied in emergency shoulder lane)
Asphalt Concrete Surface	:	5cm
Asphalt Concrete Binder	:	8cm
Cement Treated Base	:	15cm
Aggregate Base Type-I	:	30cm
Aggregate Subbase Type-II	:	30cm
TOTAL	:	91cm

2) Deep Cut (Rock) and soft ground Sections

Asphalt Concrete Anti-Skid	:	3cm (not applied in emergency shoulder lane)
Asphalt Concrete Surface	:	5cm
Asphalt Concrete Binder	:	8cm
Asphalt Treated Base	:	10cm
Aggregate Base Type-I	:	30cm (total 25cm for deep cut rock sections)
Aggregate Subbase Type-II	:	35cm (not required for deep cut rock sections)
TOTAL	:	91cm

The pavement is designed for $E_{yc} \geq 200 \text{MPa}$ and the total thickness of the pavement is 91cm. The anti-skid asphalt concrete layer is not applied in the emergency shoulder lane. A minimum of 30cm of subgrade is designed with a compaction degree of 98%. The design CBR value of the subgrade is $\geq 9\%$.

8.2 Pavement Thickness in Excavation on Hard Rock

The designed pavement thickness in excavation on hard rock, a minimum of 25cm (along the cross section) of base course (Type-I) is recommended. Asphalt concrete layers and treated base are applied same as in the normal embankment section. The construction of subgrade and subbase layers are not required at such locations, but shall be confirmed by the Engineer.

8.3 Pavement Thickness in Common Excavation

In general, when the finished grade requires common excavation on hill, all the pavement layers from the 30cm of subgrade layers are recommended to be constructed. If the compaction requirement and CBR value of the existing road bed are confirmed to satisfy the design requirements, the construction of subgrade layer may be omitted, as directed by the Engineer.

8.4 Pavement Thickness at Interchange Rampways and Parking Area

The designed pavement thickness for the interchange rampways and parking area (rampways and inside of parking area) is given as;

Asphalt Concrete Surface	:	5cm
Asphalt Concrete Binder	:	7cm
Aggregate Base (Type-I)	:	18cm
Aggregate Subbase (Type-II)	:	20cm
TOTAL	:	50cm

The pavement is designed for $E_{yc} \geq 144 \text{MPa}$ and the total thickness of the pavement is 50cm, which includes 20cm of aggregate subbase (Type-II), 18cm of aggregate base (Type-I), 7cm of asphalt concrete binder and 5cm of asphalt concrete surface layers. The anti-skid asphalt concrete layer is not applied for the interchange rampways. A minimum of 50cm of subgrade is designed with a design CBR

value of $\geq 6\%$.

8.5 Pavement Thickness at Toll Plaza

The pavement structure at the toll plaza is designed with concrete pavement of 28cm thickness and class C40 is applied. 15cm thickness of concrete C10 is provided beneath and aggregate subbase course (Type-II) of 20cm with $\text{CBR} \geq 30\%$ has been applied, separated by oil paper. Standard wire mesh of 6mm diameter at spacing of 200mm on both directions has been designed. Longitudinal joints are placed at each lane width required in the toll plaza. Contraction (saw cut) joints are used at every 4.5m interval as required by the Vietnamese Standard.

8.6 Pavement Structure for Crossing Roads and Frontage Roads

For rural Class A, B and C, bituminous surface treatment of 3kg/m^2 is applied with 18cm of aggregate base (Type-I) or cement concrete (C20) pavement of 18cm thick over 12cm of compacted sand is applied.

9 DRAINAGE DESIGN

9.1 General

Storm drainage design is an integral component in the design of expressway. Drainage design for expressway must strive to maintain compatibility and minimize interference with existing drainage patterns, control flooding of the roadway surface for design flood events, and minimize potential environmental impacts from expressway related storm water runoff.

Effective drainage of expressway pavements is essential to the maintenance of expressway service level and to traffic safety. Water on the pavement can interrupt traffic, reduce skid resistance, increase potential for hydroplaning, and limit visibility due to splash and spray, and cause difficulty in steering a vehicle when the front wheels encounter puddles. Pavement drainage requires consideration of surface drainage, gutter flow, and inlet capacity. The design of these elements is dependent on storm frequency and the allowable spread of storm water on the pavement surface.

For this Project, most of the drainage works shall be planned and designed in accordance with the following Standards and Specifications:

- TCVN 5729-1997 : Vietnamese Design Standards for Expressway;
- TCVN 4054-2005 : Vietnamese Design Standards for Highway;
- 22 TCN 273-2001 : Vietnamese Standard for Designing Highway;
- 22 TCN 272-2005 : Vietnamese Specification for Bridge Design (based on AASHTO LRFD Bridge Design Specifications, Second Edition, 1998);
- Other relevant Standards, design requirement and guidelines for highway drainage works.

The main river system in Package 5 is Tra Khuc river. Detailed of Tra Khuc river system is described in Hydrological and Inundation Reports.

9.2 Design Frequency and Design Spread

Two of the more significant variables considered in the design of expressway pavement drainage are the frequency of the design rainfall and runoff event and the allowable spread of water on the pavement. A related consideration is the use of an event of lesser frequency to check the drainage design.

The objective of highway storm drainage design is to provide for safe passage of vehicles during the design storm event. The design of a drainage system for a curbed highway pavement section is to collect runoff in the gutter near the asphalt curb and convey it to pavement drainage inlets, provided at interval along the asphalt curb, and then discharge it through the connecting inclined drains (or vertical drain) into the longitudinal side ditch, generally located at or near the toe slope of the highway embankment (called a toe slope ditch) in a manner that will provide reasonable safety for traffic.

According to the Vietnamese Standards mentioned above, the longitudinal side ditch is not necessary to be provided at all sections. It shall be provided only on the cut section, the embankment fill with the height of 0.6 m or less, the residential section, the collector road section, the section closed to the existing stream (or river). Besides these sections, it is not necessary to provide the side ditch. And it should be noted that as spread from the curb increases, the risks of traffic accidents and delays also increase.

For this project, Design Frequency and Design Spread are as follows:

- Design frequency of pavement drainage is 4% (25 years return period);
- Design spread of pavement drainage is 3m (width of an emergency lane).

9.3 Storm Drainage System

Storm drainage system shall include the following structures:

- i) Asphalt curb
- ii) Vertical drainage structure
- iii) Side ditch

9.3.1 Asphalt Curb

located along the lower edge of an emergency lane of the expressway. Height of the asphalt curb is 12 cm to prevent storm water on the pavement surface from discharging directly over the side slope. This structure is generally installed in all embankment sections, except for the elevated edge of a super elevation section (where the drainage system is provided at the median to collect and drain the storm water).

Spacing of the drainage inlets (L) along the asphalt curb is designed based on the design rainfall and the allowable spread of water on the pavement as previously mentioned. However, the maximum height of the surface water flowing along the gutter contacting with the asphalt curb on each side of the expressway is limited to 9 cm for calculation of the gutter flow rate and the spacing of the inlets to the vertical drains.

The Rational formula and the Manning equation are adopted to compute the flow rate of surface runoff and its cross-sectional area and flow rate of gutter flow for each trial value of distance between the drainage inlets (L) for a required discharge through each vertical drains. The data provided from the road design team included the longitudinal slope or the vertical profile slope (J) and the cross slope in different sections of the expressway are also adopted in the computation.

The designed spacing of the drainage inlets (L) for different ranges of the longitudinal slope (J) of portions of the expressway can be summarized as follows:

- If $J \leq 0.4\%$ $L = 100\text{m}$;
- If $0.4\% < J < 0.6\%$ $L = 125\text{m}$;
- If $0.6\% \leq J < 0.8\%$ $L = 150\text{m}$;
- If $0.8\% \leq J < 1.0\%$ $L = 175\text{m}$;
- If $1.0\% \leq J$ $L = 200\text{m}$.

9.3.2 Vertical Drainage Structure

located on the slope of the roadway embankment and deep cut section. It is functioned to collect water from the outlet of asphalt curb or outlet of berm ditch in deep cut section and discharge to the side ditch or to the existing ground. This structure is made of mortared stone masonry and is an open channel with inclined bed or, in some special cases, with a step-type bed; connecting to catch basins without or with gabion at the end.

9.3.3 Side Ditch

located at the end of talus. It is functioned to collect water and discharge to proper locations and many types are designed according to the conditions as follows:

- Cut section: concrete type
- Embankment fill with height (H) = 0.6 m or less: concrete type
- Scouring/seepage protection section: mortared stone or concrete type
- Residential section: earth type

- Collector road section: earth type
- Nearby the rivers or streams: earth type (except where the irrigation canal joins to the side ditch, a concrete paved type shall be used)

In general, the side ditch will discharge the collected water to the existing stream, river, or to the existing ground. In case of discharging water to the existing ground, the catch basin with gabions shall be installed at the end or discharge location of the side ditch to protect the existing ground from scouring or erosion.

For high embankment (normally more than 3 m), an embankment berm ditch may be used to intercept and drain the excess water from embankment slopes in the same way like the side ditch. For high cut sections (normally more than 3 m), a top ditch and a cut berm ditch may also be used to intercept and drain the excess water from cut slopes in the same way like the side ditch and the embankment berm ditch. The water from these ditches mentioned above will be diverted and discharged directly to the existing streams, rivers and other receiving water sources (if it is possible).

9.3.4 Surface drainage at super-elevated sections

In super-elevated sections, the asphalt curb shall be installed only in the lower shoulder side. The surface water from the elevated side is collected by a ditch of BxH = 0.35x0.40 m under the New Jersey medial. At the end of the medial ditch, a pipe culvert of D0.80 m shall be used to drain collected water out.

9.4 Runoff Discharge Calculation

One of the most commonly used equations for the calculation of peak flow from small areas (not more than 20 sq.km) is the Rational formula, given as:

$$Q = (CIA)/K_u$$

where:

- Q = Peak flow rate in cu.m/sec
- C = Dimensionless runoff coefficient
- I = Rainfall intensity (for a short period duration) in mm/hr
- A = Drainage area in hectares (ha)
- K_u = Unit conversion factor equals to 360

The runoff coefficient C is a function of the ground cover and a host of other hydrologic abstractions. It relates the estimated peak discharge to a theoretical maximum of 100% runoff. Typical values for C are given in Table below. If the basin contains varying amounts of different land cover or other abstractions, a composite coefficient can be calculated through areal weighing.

Table 9.1 Runoff Coefficients for Rational Formula

Type of Drainage Area	Runoff Coefficient, C*
Residential:	
Single-family areas	0.30 - 0.50
Multi-units, detached	0.40 - 0.60
Multi-units, attached	0.60 - 0.75
Suburban	0.25 - 0.40
Apartment dwelling areas	0.50 - 0.70
Industrial:	
Light areas	0.50 - 0.80
Heavy areas	0.60 - 0.90
Parks, cemeteries	0.10 - 0.25
Playgrounds	0.20 - 0.40
Railroad yard areas	0.20 - 0.40
Unimproved areas	0.10 - 0.30

Lawns:	
Sandy soil, flat, 2%	0.05 - 0.10
Sandy soil, average, 2 - 7%	0.10 - 0.15
Sandy soil, steep, 7%	0.15 - 0.20
Heavy soil, flat, 2%	0.13 - 0.17
Heavy soil, average, 2 - 7%	0.18 - 0.22
Heavy soil, steep, 7%	0.25 - 0.35
Streets:	
Asphaltic	0.70 - 0.95
Concrete	0.80 - 0.95
Brick	0.70 - 0.85

Rainfall intensity, duration, and frequency curves are needed data for the Rational method calculation. Rainfall IDF (Intensity-Duration-Frequency) curves at Danang previously prepared by our Hydrology study team are adopted in the calculation of the peak flows from small drainage areas. The result of rainfall IDF curve analysis and its values estimated for further uses are shown in the Tables and Figure below.

Table 9.2 Rainfall IDF-Curve Constants

Recurrence Probability		Constants		
% P	Year	n	a	b
50	2	0.8333	2667.313	14.992
33.3	3	0.8333	3068.609	15.497
20	5	0.9091	4804.695	23.028
10	10	0.9174	5684.649	24.372
5	20	0.9434	7097.925	28.096
4	25	0.9434	7325.981	28.200
2	50	0.9709	9050.138	32.677
1	100	0.9709	9812.921	32.926

Table 9.3 Rainfall Intensity for Short Duration at Danang

Duration	Rainfall Intensity (mm/hr)							
	50% P	33.3% P	20% P	10% P	5% P	4% P	2% P	1% P
5	142	159	176	198	217	224	242	260
10	122	138	154	174	192	198	215	232
15	109	123	138	156	173	178	194	210
30	83	94	107	121	134	138	151	163
45	69	78	88	99	110	114	124	134
60	59	67	75	85	94	97	105	114

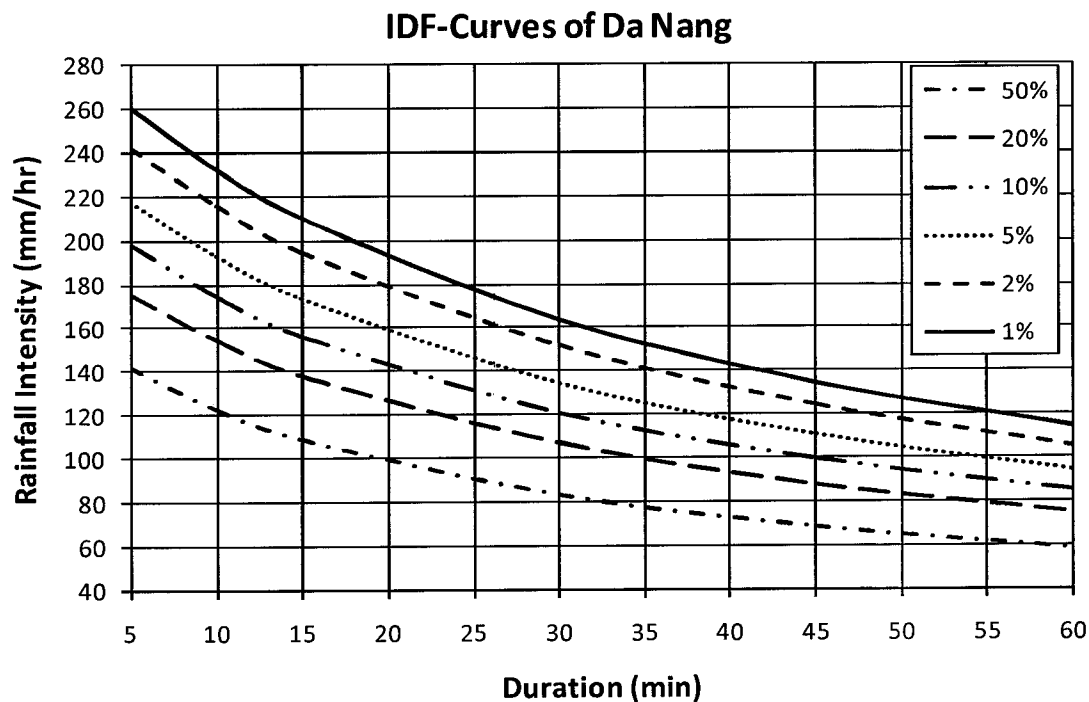


Figure 9.1 Rainfall IDF-Curves of Danang

Based on the Tables and Figure shown above, short duration rainfall intensities of 5, 10, 15, 30, 45 and 60 min can be estimated for 1%, 2%, 4% and 5% probability levels from the IDF relations. For instance, 5-min design rainfall intensities are: 260 mm/hr (1%P), 242 mm/hr (2%P), 224 mm/hr (4%P) and 217 mm/hr (5%P). Similarly, 60-min design rainfall intensities are: 114 mm/hr (1%P), 105 mm/hr (2%P), 97 mm/hr (4%P) and 94 mm/hr (5%P).

In case the drainage area is larger than 20 sq.km, the Rational method should not be adopted because there will be higher errors in the calculation result. Most hydrologists are likely to use the other methods, for instance, Unit Hydrograph, Regional Flood Curves, etc., for the estimation of the peak flow rate for a specific region or drainage area.

More details on the hydrological analysis and the hydraulic calculation for the required opening areas and proposed sizes of all relevant drainage structures of the Project are presented in the Hydrological Report and Inundation Study Report of the Project prepared by the related study teams.

9.5 Calculation and Design of Drainage Channel and Structure

The required opening area for a design discharge of the drainage structure can be calculated by using a hydraulic formula as shown below:

$$A = Q/V$$

Where,

A = Minimum opening area of the structure in sq.m

Q = Design discharge or flow rate in cu.m

V = Allowable velocity of flow in m/sec

To obtain the required opening area for a known design discharge of the drainage structure or channel by this formula, it needs to assume the allowable velocity of flow to be not more than 2.5 m/sec for the concrete or mortared stone ditch or culvert. For the earth ditch or channel which may be eroded easily from the flow, the design velocity of flow should not be more than the maximum permissible velocity for each type of its soil texture in the channel bed and side slopes as recommended in the

following section

The alternative approach to determine the flow velocity of an open channel or structure can be carried out by using the Manning equation as follows:

$$V = \frac{1}{n} R^{2/3} S^{1/2}$$

Where,

V = Velocity of flow in m/sec

n = Manning roughness coefficient

R = Hydraulic radius in m (where $R = A/P$, and P = Wetted Perimeter in m)

S = Slope of the channel

The Manning Roughness Coefficient (n) varies with the type of materials used for the drainage structure or ditch or channel. The values shown in the following Table are recommended to be adopted for calculation of its flow capacity.

Type of Material	Manning Roughness Coefficient (n)
Concrete Pipe or Box Culvert (pre-fab.)	0.013
Concrete Pipe or Box Culvert or Ditch	0.015
Rock-cut Ditch (smooth /uniform)	0.033
Mortared Stone Ditch	0.040
Earth Ditch (straight /uniform)	0.035

Besides the formulae mentioned above, the following factors should also be considered in designing of appropriate sizes of the drainage channel, ditch or structure:

(i) **Tractive Force:** To check the possibility of erosion (scouring) and sedimentation on the designed open channel, particularly the earth channel or ditch, it is also necessary to determine the unit tractive force generated in the channel which can be calculated from the following formula:

$$T = WRS$$

Where

T = Unit tractive force in kg/sq.m

W = Unit weight of water = 1,000 kg/cu.m

R = Hydraulic radius in m

S = Slope of energy gradient = Slope of channel bed

The unit tractive force should be between 0.30 and 0.50 kg/sq.m which is the safe value that erosion and sedimentation will not occur in the designed open channel or drainage ditch (based on "Open Channel Hydraulics" by Ven Te Chow, 1959).

(ii) **Maximum Permissible Velocity:** Because the possibility of erosion (or scouring) on the designed open channel, particularly the earth channel or ditch, increases with the increased flow velocity, the design velocity should not be more than the maximum permissible velocity recommended by the U.S. Bureau of Reclamation. The maximum permissible velocity depends on the soil texture at the bed and side slopes of the earth channel as follows:

Soil Texture	Maximum Permissible Velocity (m/sec)
Stiff Clay	1.22
Sandy Loam	0.76
Fine Sand	0.46

To adopt the values shown above, the side slopes of the channel should be designed not to be so steep and they should be stable enough for slope stability. For instance, a side slope of 1 : 1.5 will be suitable for the cohesive sandy soil and sandy clay soil, while a side slope of 1 : 1 will be suitable for the stiff clay soil.

(iii) Minimum Permissible Velocity: Besides possibility of erosion (or scouring), sedimentation on the designed open channel should also be taken into account. Because the possibility of sedimentation increases with the decreased flow velocity, the design velocity should be more than the minimum permissible velocity recommended by the U.S. Bureau of Reclamation which is 0.30 m/sec to prevent sedimentation of silt and sand carried along the channel by the water.

(iv) Freeboard: In general, the freeboard for a drainage channel or ditch is the difference in elevations between the existing ground and the maximum designed water level. It is recommended that a minimum freeboard of 0.10 m should be provided. The maximum water level in the upstream branch should also be designed in such a way that the water can flow by gravity through its outlet to a downstream main drainage channel, stream, river or receiving water retention area.

9.6 Calculation and Design of Drainage Road Culvert

The required opening area for the drainage road culvert (box and pipe culverts), particularly the cross-drainage structure) is calculated based on the maximum peak flow that can pass through the expressway for the adopted design frequency without overtopping the traffic road surface. The detailed results are presented in the Hydrological Report and Inundation Study Report previously prepared by the Hydrological Study Team and the Inundation Study Team of this Project respectively.

Design of the road culvert for drainage purposes is carried out based mostly on the results of Hydrological study and Hydraulic calculation presented in the Reports referred above. Only some additional calculations are made for the other additional structures required for drainage works, such as the longitudinal drainage culvert along the road median, or are supplemental to the previously calculated results.

The following requirements are adopted in the structural design of the culverts for drainage purposes:

- 1) The calculation should be made for the condition: without water in the culvert.
- 2) The minimum depth of fill above the top of culvert should be 0.60 m for the farm road and 0.90 m for the traffic road.
- 3) The guidelines for application of traffic loads on the culvert should be adopted in the structural analysis. The recommended guidelines are the 22 TCN 272-2005 Specification.
- 4) In case that the fill above the top of culvert is less than 0.60 m, the wheel load should be applied directly on the culvert (not a distributed load).
- 5) In case that the fill above the top of culvert is more than 0.60 m, application of the wheel load on the culvert can be neglected.
- 6) In case that the fill above the top of culvert is more than 0.90 m but less than 3.00 m, the wheel load on the culvert should be applied according to the 22 TCN 272-2005 Specification.
- 7) In case that the fill above the top of culvert is less than 0.90 m, the impact load due to the vehicle (truck) weight should also be applied on the culvert. The following values are recommended for different thicknesses of the fill.

Thickness of Fill above Culvert (m)	Impact Load (% of Vehicle Weight)
Less than 0.30	30
Less than 0.60	20
Less than 0.90	10
0.90 or more	0

9.7 Drainage Design for Bridge, Overpass and Flyover

9.7.1 Introduction

Deck drain gutter and grate inlet type of catch pit will be used to capture pavement surface runoff occurred during a storm runoff event and divert it down via grate inlets installed at interval along the gutter on both edges of the bridge (or overpass) or flyover deck. From the inlet, the runoff will be discharged into a short vertical connecting pipe or directly discharged into a vertical leg of a T-shape pipe fitting and further drained into the collecting pipeline which is normally laid longitudinally under the bridge or flyover deck at the same designed slope as the bridge deck slope. Many inlets can be connected to the same collecting pipeline depending on the inlet spacing and inlet numbers required to drain the pavement surface runoff effectively. The end of the longitudinal pipeline will be connected with the vertical pipe laid along the exposed vertical wall of the bridge or flyover abutment (or in some cases, along the vertical wall of the bridge or flyover pier) before all of the collected runoff is drained through the inclined or vertical pipe outlet or down spout to the at-grade drain, ditch and/or catch basin which will further discharge the water to the nearby drainage system (or in some cases, drained directly into the existing swamp, stream or river under the bridge). The at-grade drain which is crossing under the bridge or flyover will further convey the runoff to the public waterways or the existing streams or rivers.

Besides, there is a suggestion that the proposed drainage outlet should be avoided to drain directly on the cross roads passing under the bridge or flyover. As for the canal or the main channel of river, the proposed drainage outlet should also be avoided to drain directly on it as much as applicable. And in some conditions for the bridge or flyover other than the major river bridge, installation of the inlets or catch pits on the bridge deck surface is not required. For example in the case that it is planned to install the expansion joint on the bridge or flyover, the catch pits may be installed at least in front of it only. But in the case that the portal rigid frame is planned to be used as the bridge or flyover structure, the catch pit is not required on the bridge deck surface, the deck drain will be joined to the road side ditches behind the abutments.

For all bridges and flyovers in this Project, except the Major River bridges, the catch pit with grating at the inlet shall be a pre-fabricated Cast Iron type in accordance with AASHTO M105/ASTM A48M Standard. Such catch pit with grate inlet shall be strong enough to bear the design loads specified for the bridge or flyover (22 TCN 272-2005: Specification for Bridge Design). The round-shaped grate inlet is common in Vietnam. However, in consideration of the characteristics of heavy rain in the Project area, the rectangular-shaped type will be adopted to catch the surface water effectively. From the calculation, a 400 x 300 mm grate inlet for the catch pit is selected to be used for the other bridge and flyover in this Project.

The type of pipes to be used for such deck drainage purpose shall be a Polyvinyl Chloride (PVC) pipe in accordance with TCVN 6151-1996 or ASTM A53 Standards. The vertical pipe or T-shape fitting shall be fitted to the circular-shape outlet of the catch pit. The minimum diameter of the collecting pipe and down spout is calculated based on the pipe slope and the accumulated amount of runoff in the pipe from upstream to downstream sides. A nominal diameter of the collecting pipe and its vertical or inclined down-spout is determined to be 225 mm or 200 mm (minimum size) with the minimum inlet spacing (or interval) required varies from about 5 to 30 m, depending on the calculation for different sizes. However, a general minimum spacing of 15 m can be adopted for most of the bridge and flyover proposed for this Package.

In summary, for the drainage design of the bridge, overpass and flyover in this Package, a 400 x 300 mm grate inlet for the Cast Iron catch pit (470 mm total depth) shall be used to capture the pavement surface runoff. For the vertical or inclined down-spout pipe, and the longitudinal collecting pipe (if

needed), a PVC pipe of 200 or 225 mm Nominal Diameter (DN) with allowable Nominal Pressure (PN) of 6.6 bar (or 0.66 Mpa) or PN6 class shall be used.

9.7.2 Design Criteria and Concepts

(1) Frequency of Rainfall and Rainfall Duration:

The maximum rainfall intensity of frequency 25 years (probability = 4%) at a rainfall duration of 5 minute is adopted for design of the bridge deck drainage for the bridge and flyover in this Package. It is 224 mm/hr from the Danang Rainfall Intensity-Duration-Frequency (IDF) curves.

(2) Peak Flow Calculation:

One of the most commonly used equations for the calculation of peak flow from small areas (not more than 20 sq.km) is the Rational formula as given above.

A value of 'C' of 0.86 is adopted for the calculation of the deck drainage based on the type of the pavement and the deck surface.

As for the drainage area, 'A', in this formula, it is the result of different inundated widths on the sloped pavement surface multiplied by the trial value of inlet interval (or spacing). The inundated width is the allowable spread of water on the pavement. The design speed is important to the selection of the design criteria on this matter. At speeds greater than 75 km/hr, it has been shown that water on the pavement can cause hydroplaning which a risk of accident from uncontrollable driving will be higher.

Therefore, the spread of water is not allowed on the traffic lanes of the main road (thru-way) of expressway on which the maximum allowable speed is 120 km/hr, the spread will be allowed only on the emergency lane closing to the parapet, i.e. the maximum spread (inundated width) is 3.25 m for the main road (thru-way) of expressway and sometimes 2.75 m for one side of the overpass depending on the overpass design.

For the flyover and the bridge in the Interchange, the maximum allowable speed is generally less than 75 km/hr. The spread on traffic lanes can be tolerated to greater widths where traffic volumes and speeds are low. Spreads of one-half of a traffic lane or more are usually considered a minimum type design for low-volume local roads. This is also specified in a Vietnamese Standard: 22 TCN 273-2001, "Standard for Designing Highway (junctions)". Therefore, in this Project, the allowable spread of water will be extended from the inside edge of parapet to one-half of the traffic lane (normally without an emergency lane), i.e. the maximum spread (inundated width) is ranged from 1.00 - 3.25 m for the flyover in this Package depending on the flyover design.

(3) Calculation and Design of Drainage Pipe and Inlet Spacing:

The required opening area for a design discharge of the drainage structure/pipe can be calculated by using a hydraulic formula as shown below:

$$A = Q/V$$

Where A = Minimum opening area of the structure/pipe in sq.m

Q = Design discharge or flow rate in cu.m

V = Allowable velocity of flow in m/sec

To obtain the required opening area for a known design discharge of the drainage structure/pipe or channel by this formula, it needs to assume the allowable velocity of flow to be not more than some values, e.g. a value of 2.5 m/sec for the concrete or asphaltic surface of the pavement on the bridge deck or a value of 3.0 m/sec for the PVC drainage pipe. For safety purposes, the maximum design flow in the longitudinal pipe shall be a value which is not more than 90% of the full-pipe capacity. In that case, the pipe flow will be likely an open-channel flow.

The alternative approach to determine the flow velocity of an open channel or structure can be carried out by using the Manning equation as provided before.

The Manning 'n' adopted for calculation of the surface runoff in this case is 0.013 which is suitable for the smooth surfaces of the surface water open channel flow or gutter flow closed to the parapet.

9.7.3 Drainage Calculation method

(1) Deck Drainage

(a) On-Deck drainage

The bridge, overpass and flyover in this Package: use rainfall intensity of frequency 25 years (probability = 4%) and rainfall duration equal to 5 minutes, which can obtain the rainfall intensity from the Danang IDF to be 224 mm/hr.

Determining the inlet overflow capacity by using overflow velocity equaled to the Critical Velocity (V_c) which can be determined by this expression:

$$V_c = \sqrt{2gh}$$

Where g = acceleration due to gravity

h = average height of water when the width of ponding is equaled to the maximum allowable spread of water from the inside edge of the parapet as mentioned above

Then calculate inlet capacity by this expression

$$Q = VA$$

Where Q = Inlet capacity

$V = V_c$ = Critical Velocity

$A = L.Y_c$ = Overflow area, where

L = overflow length, Y_c = Critical overflow depth, simplified to be $2/3 h$

The applied size of catch pit (with grate inlet) shall have the capacity twice of the calculated size due to clogging. Therefore, the catch pit size for the bridge and flyover is 400 x 300 x 470 (depth) mm, spacing at a minimum acceptable value of 15 m. interval (in general case).

(b) Collecting pipeline

Collecting Pipe (including connecting pipe): use PVC pipe in accordance with TCVN 6151-1996 or ASTM A53 Standards. The following requirements are also adopted:

the minimum pipe nominal diameter (DN) is 225 mm. (except for some vertical pipes, 200 mm is allowed).

The minimum longitudinal slope of pipe is 2% (preferable).

Full pipe flow velocity is calculated by using Manning formula from the pipe slope and pipe size selected by trial. The designed pipe size and slope shall be able to accommodate the accumulated runoff at all locations along the pipeline. However, such accumulated runoff at each location should not be larger than 90% of the pipe full flow capacity at the location.

Summary of Designed Collecting Pipe (including connecting pipe):

Pipe material: PVC (conforming to TCVN 6151-1996, ASTM A53 Standards)

Nominal Pressure: PN6 (= 0.66 MPa)

Nominal Diameter: DN 200 and DN 225 (outside diameters = 200.0 and 225.3 mm, respectively)

(c) Summary of the calculation

Summary of the calculation includes surface runoff, spacing of inlets (inlet interval), sizes of pipe,

etc. are shown in Volume 6.3

9.8 Designed Cross Drainage Structures

Cross drainage structures comprise culverts and approached canals, streams or rivers. For the expressway, the minimum size of pipe culvert adopted is D1.50 m. In case the approached canal, stream or river needs to be relocated, its minimum size will be designed to be equaled or larger than the existing one and should follow requirements of the managing agencies.

The designed cross drainage pipe culverts and box culverts in this Package (in Mainline and IC of the expressway) are given in Table 9.4 and Table 9.5 respectively.

Table 9.4 Designed Cross Drainage Pipe Culverts in Package 5

SN	Station	Pipe Dia. (m)	Angle (degree)	Length (m)	Flow Direction	Function	Remarks
1	32+637.00	1-D1.50	90	43.71	R->L	Irrig. & Drain.	
2	33+230.00	1-D1.50	R70	53.35	R->L	Basin	
3	33+525.00	1-D1.50	90	47.86	R->L	Basin	
4	33+834.00	1-D1.50	90	32.66	R->L	Topo.	
5	33+923.00	1-D1.50	90	31.53	R->L	Topo.	
6	34+360.00	1-D1.50	L70	50.31	R->L	Basin	
7	34+510.00	1-D1.50	90	43.72	R->L	Topo.	
8	34+720.00	1-D1.50	90	33.69	R->L	Basin	
9	35+090.00	1-D1.50	90	76.26	R->L	Basin	
10	37+420.00	1-D1.50	90	45.74	R->L	Basin	
11	37+645.00	1-D1.50	90	43.71	R->L	Basin	
12	37+945.00	1-D1.50	90	35.58	R->L	Basin	
13	38+230.00	1-D1.50	90	36.59	R->L	Irrig. Canal	
14	39+380.00	1-D1.50	90	42.69	R->L	Topo.	
15	39+968.00	1-D1.50	90	49.81	R->L	Irrig. & Drain.	
16	40+598.00	1-D1.50	L70	68	R->L	Irrig. Canal	Adj.fr. Sta. 40+600.00 (Thruway-Ha Lam IC)
17	0+150.00	1-D1.50	90	18	R->L	Basin	Adj.fr. Sta. 0+139.00 (Ramp A-Ha Lam IC)
18	0+490.00	1-D1.50	90	16	R->L	Basin	Adj.fr. Sta. 0+522.00 (Ramp B-Ha Lam IC)
19	0+100.00	1-D1.00	90	29	R->L	Basin	Ramp C-Ha Lam IC
20	0+072.88	2-D1.50	90	32	R->L	Basin	Adj.fr. Sta. 0+079.00 (Ramp C1-Ha Lam IC)
21	0+442.79	1-D1.50	90	20	R->L	Basin	Ramp C1-Ha Lam IC

Table 9.5 Designed Cross Drainage Box Culverts in Package 5

SN	Station	Size (m)	Angle (degree)	Covering (m)	Length (m)	Flow Direction	Function	Remarks
1	32+860.00	1-(2.5x2.5)	90	3.46	38.14	R->L	Basin	Adj.fr. Sta. 32+856.00
2	36+894.00	2-(3.0x3.0)	90	2.92	35.98	R->L	Basin	Adj.fr. Sta. 36+877.30
3	39+150.00	1-(2.0x2.0)	90	5.77	47.36	R->L	Basin	Adj.fr. Sta. 39+145.00
4	41+107.26	1-(2.0x2.0)	90	7.70	69.09	R->L	Basin	Adj.fr. Sta. 41+114.00 (Thruway-Ha Lam IC)
5	0+196.00	2-(2.0x2.0)	90	0.67	18.59	R->L	Basin	Canal on NH14E (in Ha Lam IC)
6	41+460.00	1-(2.0x2.0)	90	4.68	43.82	R->L	Basin	
7	41+845.00	1-(2.0x2.0)	90	4.89	31.98	R->L	Basin	Adj.fr. Sta. 41+871.00

10 DESIGN OF CROSSING ROADS AND FRONTAGE ROADS

10.1 Design of Crossing Roads

The locations, where crossing facilities are designed for the existing local roads crossing the expressway, are given in Table 10.1. The approach roads are also included in the design of crossing roads.

Table 10.1 List of Crossing Roads in Package 5

Proposed Road Crossing Structures					Horizontal/Vertical Clearance for Structure		Pavement Type	Remarks
SN	Station	Class	Type	Angle	Horizontal	Vertical		
1	34+160.250	Rural B	Under Bridge	90	4.0	3.0	Bituminous surface treatment and concrete	Relocated from Km34+435
2	35+105.438	Rural C	Underpass Box	90	3.0	3.0	Concrete	
3	36+442.259	Rural A	Under Bridge	L70	5.0	3.5	Bituminous surface treatment and concrete	Relocated from Km36+606
4	37+628.210	Rural A	Underpass Box	L80	6.5	4.5	Bituminous surface treatment	Underpass size for future class AH
5	38+344.223	Rural C	Under Bridge	R70	3.0	3.0	Concrete	
6	38+919.856	Rural A	Underpass Box	R80	6.5	4.5	Bituminous surface treatment	Underpass size for future class AH
7	39+744.498	Rural C	Under Bridge	90	3.0	3.0	Concrete	Relocated from Km39+864
8	40+468.400	Rural C	Underpass Box	L70	3.0	3.0	Bituminous surface treatment	Ha Lam IC area

Note: The list does not include expressway crossings for interchange rampways

10.2 Design of Frontage Roads

Frontage roads are designed at locations where the crossing facilities are not designed for the crossing roads and are diverted to nearest crossing facility.

The frontage roads are designed with the same road classification as the respective road of concern. The list of frontage roads designed in Package 5 is given in Table 10.2.

Table 10.2 List of Frontage Roads in Package 5

SN	Station	Side	Class	Length	Pavement Type
1	41+400.000	Right	Rural B	136.317m	Concrete pavement
2	41+483.401	Left	Rural B	238.195m	Bituminous surface treatment

11 INTERCHANGE DESIGN

11.1 Design Standard and Design Criteria

11.1.1 Design Speed of Rampway

Design speed of junction and rampway are specified in TCVN5729 considering design speed of expressway and connecting road. Design speed of junction and rampway in case of thruway design speed of 120km/h are shown in Table 11.1.

Table 11.1 Design speed of Rampway

No.	Type of Connection	Design Speed of Junction and Rampway (Expressway 120km/h)
1	Connect between expressway class A and class A	80~50km/h
2	Connect between expressway class A and class B	70~40km/h
3	Connect between expressway class A and other road	60~35km/h

Class A and Class B are described in TCVN5729 as follows:

(a) Class A (Freeway)

Locating elevated interchange at the in/out-going point on the freeway/expressway, at the intersection of freeway/expressway and railway, pipeline and other road (including public road).

➤ Applied Design Speed

- 120km/h for plain topography
- 100km/h for hilly topography
- 80km/h for mountainous and rough topography

(b) Class B (Expressway)

Locating on plane intersection at the same place as class A (except for the intersection of freeway/expressway and railway, pipeline) if the traffic at the intersection is not much and budget is limited. However, this location of intersection requires measure to ensure the priority of traffic on freeway/expressway and safe transport at the intersection.

➤ Applied Design Speed

- 100km/h for the complicated topography (mountainous, rough area)
- 80km/h for hilly topographic area
- 60km/h for mountainous and rough topography

Design Speed of rampway was decided 40km/h based on design speed of expressway and classification of connecting road. Classification of connecting roads is shown in the Table 11.2.

Table 11.2 Outline of Connecting Road to ICs

Name of IC	IC Station	Station (Crossing with Connecting Road)	Outline of Connecting Road							Remark	Note
			Name	Station (Connecting Road)	Road Class		Width (m)		Pavement		
					Existing	Planning	Existing (pavement)	Planning (pavement)			
Ha Lam IC	Km40+880	Km41+235.45	NH14E	KM17+500 (NH14E)	Class V (Flat rolling terrain)	Class III (Flat rolling terrain)	6.5 (3.5)	12.0 (7.0)	Asphalt	-	Decision No. 07/2011/QĐ-TTg dated 25/1/2011 of the Prime Minister

11.1.2 Geometric Design Standard for Thruway at Interchange Section

Geometric design standards for expressway at interchange section for design speed of 120km/h and 100km/h are specified as shown in Table 11.3. A limited value is applied for vertical curve radius in some interchanges.

Table 11.3 Geometric Design Standard for Expressway at Interchange Section

No.	Geometrical Element			Expressway	
				120km/h	100km/h
1	Minimum radius of horizontal curve		Desirable	2000	1500
			Absolute	1500	1000
2	Minimum radius of vertical curve	Crest	Desirable	45000	25000
			Absolute	23000	15000
		Sag	Desirable	16000	12000
			Absolute	12000	8000
3	Maximum longitudinal gradient		Desirable	2	2
			Absolute	2	3

Source: TCVN 5729-1997

11.1.3 Geometric Design Standard for Rampway

Geometric design criteria for interchange rampway are established with reference to practical standards in developed country as shown in Table 11.4.

Table 11.4 Design Criteria for Interchange Rampway

Design Elements			1 direction		2 direction		Reference
			1 lane	2 lane	2 x 1 lane	2 x 2 lane	
1	Expressway Classification Type A		Grade 120				TCVN5729
2	Rampway Classification		Other Roads				TCVN5729
3	Design Speed of Rampway (km/h)		40				TCVN5729
4	Cross-Sectional Elements	Basic Lane Width (m)	3.5*1	3.5	3.5*1	3.5	*1:JRSO, TCVN5729
		Total Number of Lanes	1	2	2	4	Traffic Forecast
		Widening (for R<100 m) of Basic Lane (m)	1 x 50/R	1 x 50/R	2 x 50/R	2 x 50/R	TCVN5729
		Number of Traveled Way	1	1	2	2	Traffic Forecast
		Formation Width (m)	8.5	10.5	15.5	19.5	TCVN5729
		Traveled Way Width(m)	3.5*1	7.0	2 x 3.5*1	2 x 7.0	*1:JRSO, TCVN5729
		Outer Shoulder Paved Width (m)	2.5*1	1.0	2 x 2.5*1	2 x 1.0	*1:JRSO, TCVN5729
		Inner Shoulder Paved Width (m)	1.0*1	1.0	-	-	*1:JRSO, TCVN5729
		Shoulder Earthen Width (m)	2 x 0.75*1	2 x 0.75*1	2 x 0.75	2 x 0.75	*1:JRSO, TCVN5729
		Median Width (m)	-	-	1.0	1.0	JRSO
		Median Marginal Strip (m)	-	-	2 x 0.5	2x 0.5	JRSO
		Cross fall of Roadway (%)	2.0				TCVN5729
Slope of Earthworks					TCVN5729		
	Fill				V : H = 1:2.0 TCVN5729		
	Cut				V : H = 1:1.0 (0.75) TCVN5729		
5	Sight Dist.	Driver's Eye Height (m)	1.20				TCVN5729
		Height of Object for Stopping Distance (m)	0.30				TCVN5729
		Stopping Sight Distance (m)	40				TCVN4054
6	Horizontal Alignment	Minimum Radius of Horizontal Curve (m)	60				TCVN4054
		Superelevation (Se)					
		Maximum Se for Absolute Min. Radius (%)	6.0				TCVN4054
		Minimum Radii w/o Superelevation (m)	600				TCVN4054
		Maximum Slope of Superelevation Runoff	1/100				JRSO
7	Vertical Alignment	Minimum Length of Transition Curve (m)	35				TCVN4054
		Maximum Grade (%)	7.0				TCVN4054
		Minimum Length of Vertical Curve (m)	35				TCVN4054
		Minimum Radius of Crest Curve (m)					
		Desirable Minimum Radius (m)	1000				TCVN4054
		Absolute Minimum Radius (m)	700				TCVN4054
		Minimum Radius of Sag Curve (m)					
		Desirable Minimum Radius (m)	700				TCVN4054
8	Lateral Clearance	Traveled Way Width				TCVN5729	
		4.75				TCVN5729	

Superelevation value of rampway in design speed 40km/h are specified in TCVN 4054 as shown in Table 11.5.

Table 11.5 Superelevation Values corresponding with Horizontal Curve Radius (V=40km/h)

Radius	Super-elevation
60~69	6%
70~74	5%
75~84	4%
85~99	3%
≥100	2%

Maximum grade of 2% on toll gate section of rampway is applied in consideration of repetition of

stop and go at toll gate.

11.1.4 Geometric Design Standard for Ramp Terminal

Direct type ramp terminal on deceleration lane and parallel type ramp terminal on acceleration lane are adopted in case of one lane rampway.

Position of nose is set at the outside of 6 lanes of expressway ultimate stage in order to avoid relocation of the nose in ultimate stage. Deceleration lane is consequently extended to outside lane of 4 lane of expressway with the taper ratio of 1/15~1/20 and acceleration lane is also extended to outside lane of 4 lane of expressway with S-curve.

Geometric design standard for ramp terminal is shown in Table 11.6.

Table 11.6 Applied Geometric Design Standard for Ramp Terminal

No.	Geometrical Element		Expressway: 120km/h	Expressway: 100km/h	Reference
			1 lane	1 lane	
1	Deceleration lane		100m	90m	TCVN5729
2	Acceleration lane		200m	180m	TCVN5729
3	Taper	Deceleration	1/15-1/20 ($\geq 75\text{m}$) *Direct Type	1/15-1/20 ($\geq 60\text{m}$) *Direct Type	JRSO (TCVN5729)
		Acceleration	75m *Parallel type	60m *Parallel type	TCVN5729

Adjustment factor for speed change lane by grade is shown in Table 11.7.

Table 11.7 Applied Adjustment Factor of Speed Change Lane

No.	Average grade of speed change lane	$0 < \lambda \leq 2$	$2 < \lambda \leq 3$	$3 < \lambda \leq 4$	$4 < \lambda \leq 5$	Reference
1	Factor of deceleration lane Down grade	1.0	1.1	1.2	1.3	TCVN5729
2	Factor of acceleration lane Up grade	1.0	1.2	1.3	1.4	TCVN5729

11.2 Typical Cross Section

11.2.1 Rampway

Typical cross sections of rampway are established based on the proposed geometric design criteria as shown in Figure11.1 to Figure 11.5.

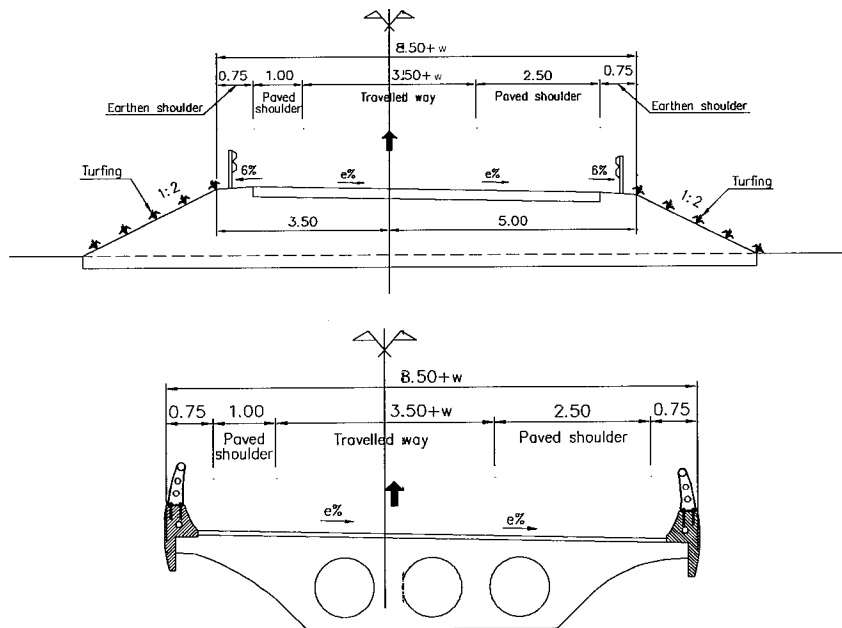


Figure 11.1 Typical Cross Sections of Interchange Ramp Way (1 Direction 1 Lane)

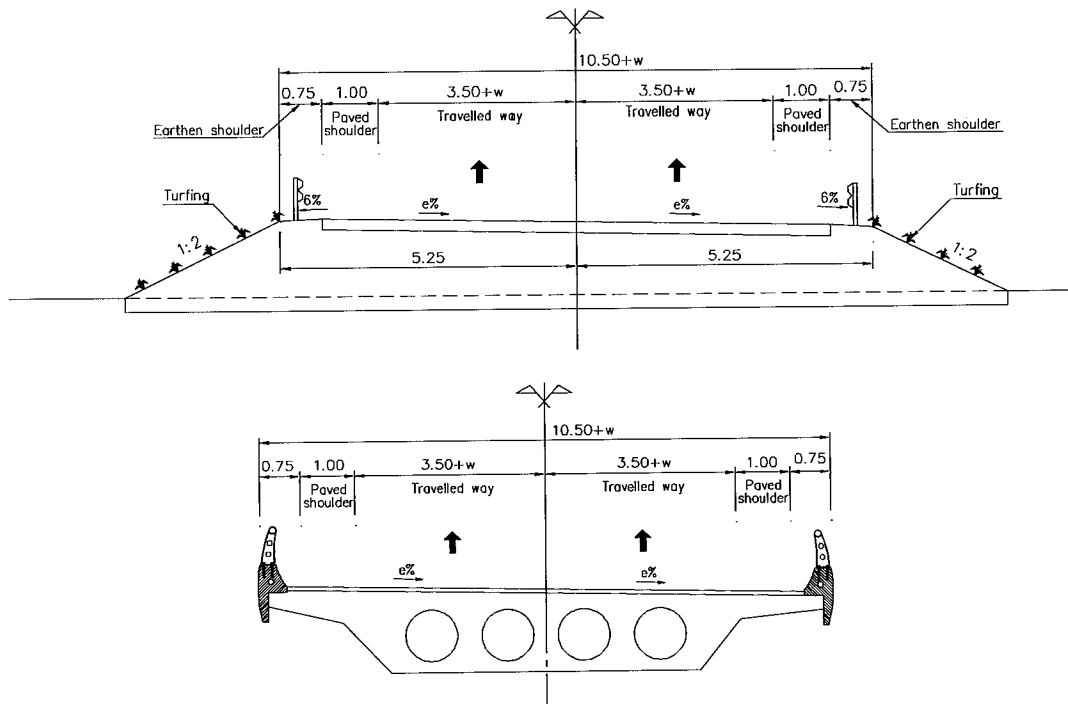


Figure 11.2 Typical Cross Sections of Interchange Ramp Way (1 Direction 2 Lane)

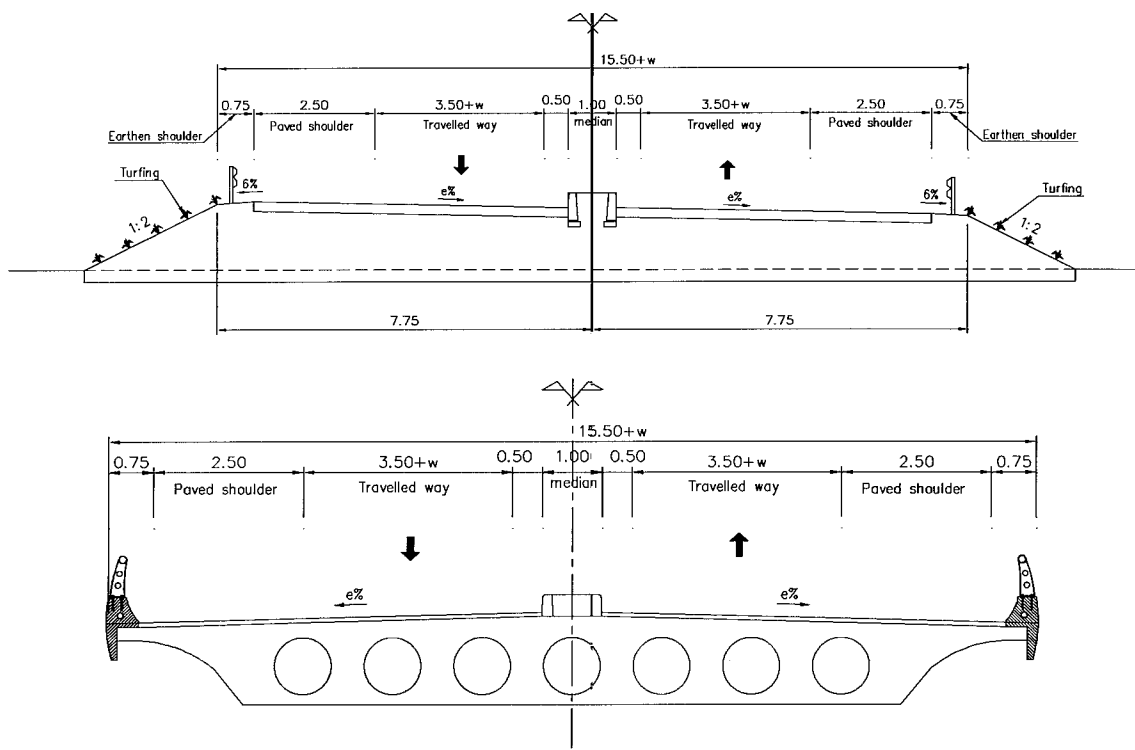


Figure 11.3 Typical Cross Sections of Interchange Ramp Way (2 Direction 1 Lane)

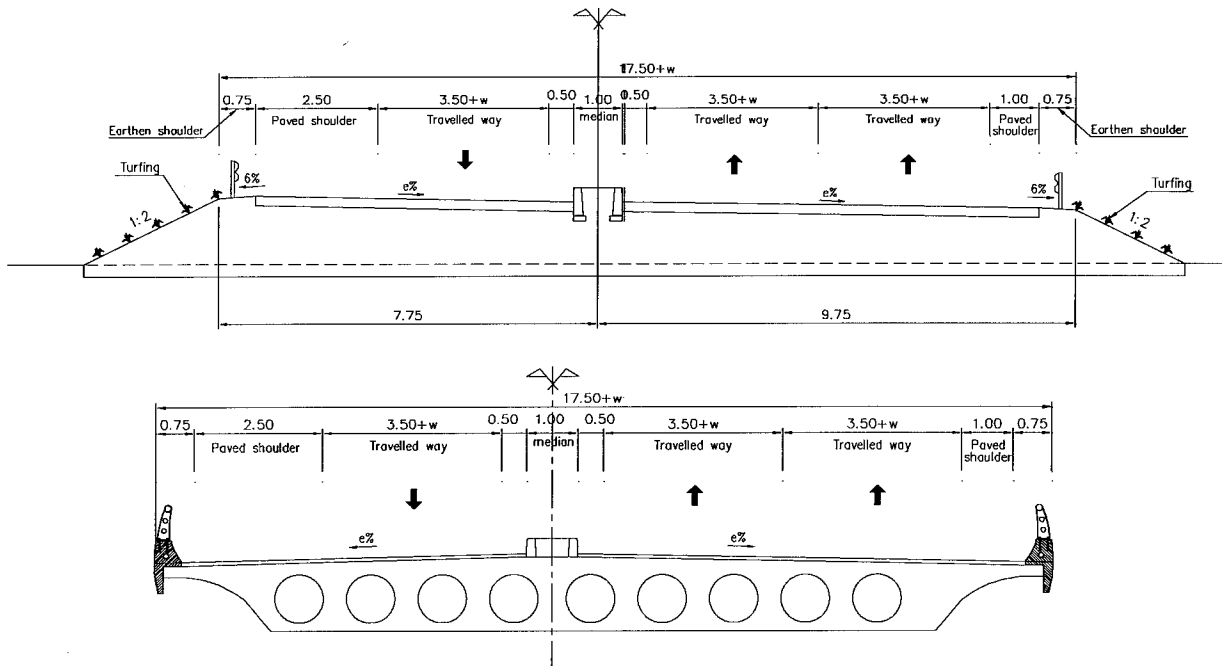


Figure 11.4 Typical Cross Sections of Interchange Ramp Way (2 Direction 1-2 Lane)

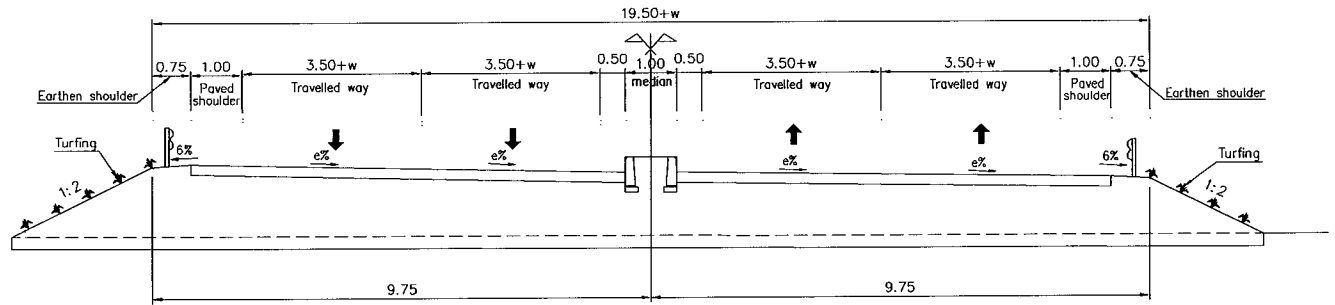


Figure 11.5 Typical Cross Sections of Interchange Ramp Way (2 Direction 2 Lane)

11.2.2 Connecting Road

Cross sections of connecting road are confirmed based on data collection and discussion about the connecting road as shown in Figure 11.6 to Figure 11.7.

(i) Ha Lam IC

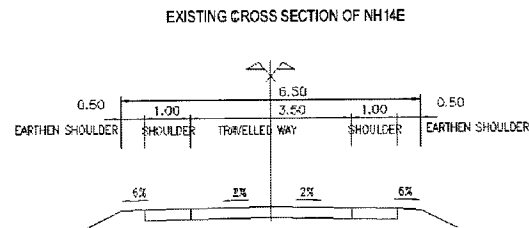


Figure 11.6 Cross Section of Connecting Road (NH14E)

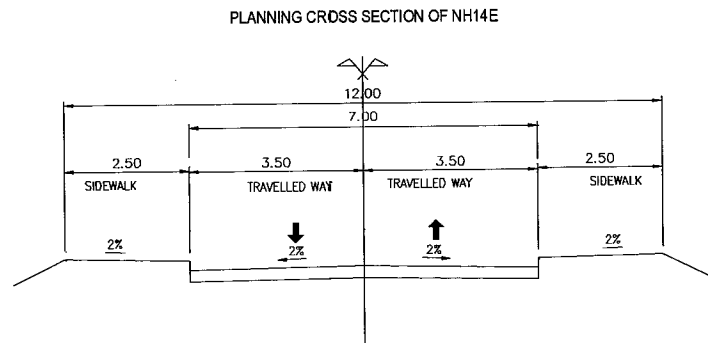


Figure 11.7 Cross Section of Connecting Road (NH14E)

11.2.3 Ramp Terminal

Layouts of ramp terminal are established based on the consideration of stage construction as shown in Figure 11.8 to Figure 11.11.

(i) Ha Lam Interchange

a) One Lane Ramp for Expressway (Exit) – Phase 1

In ultimate stage, number of thruway lane is planned to increase from 4 lanes to 6 lanes. This increment will make shifting of rampway and ramp nose position. Therefore, position of ramp nose is set at position of ultimate stage as shown in Figure 11.8.

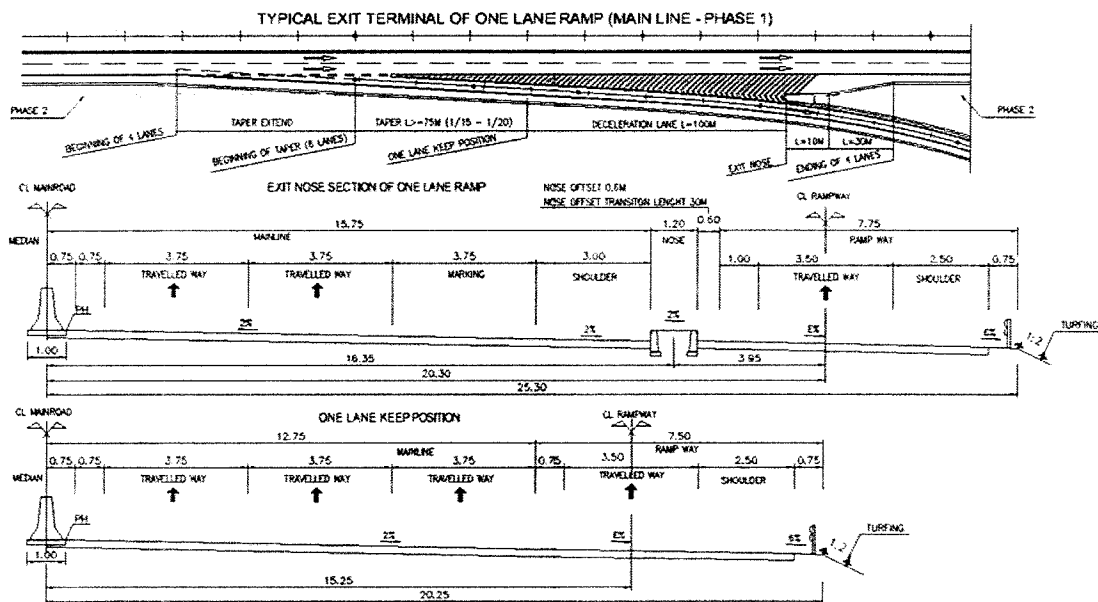


Figure 11.8 One Lane Ramp for Expressway (Exit) – Phase 1

b) One Lane Ramp for Expressway (Entrance) – Phase 1

In ultimate stage, number of thruway lane is planned to increase from 4 lanes to 6 lanes. This increment will make shifting of rampway and ramp nose position. Therefore, position of ramp nose is set at position of ultimate stage as shown in Figure 11.9.

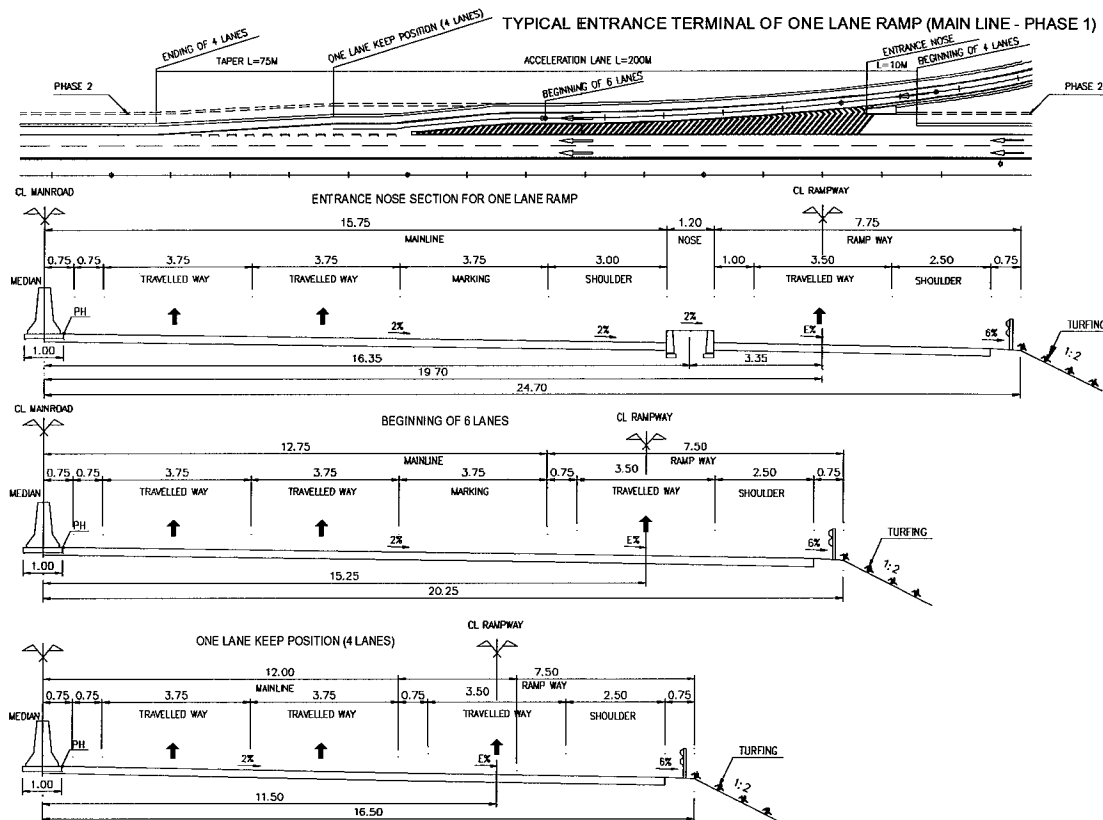


Figure 11.9 One Lane Ramp for Expressway (Entrance) – Phase 1

c) One Lane Ramp for Expressway (Exit) – Phase 2

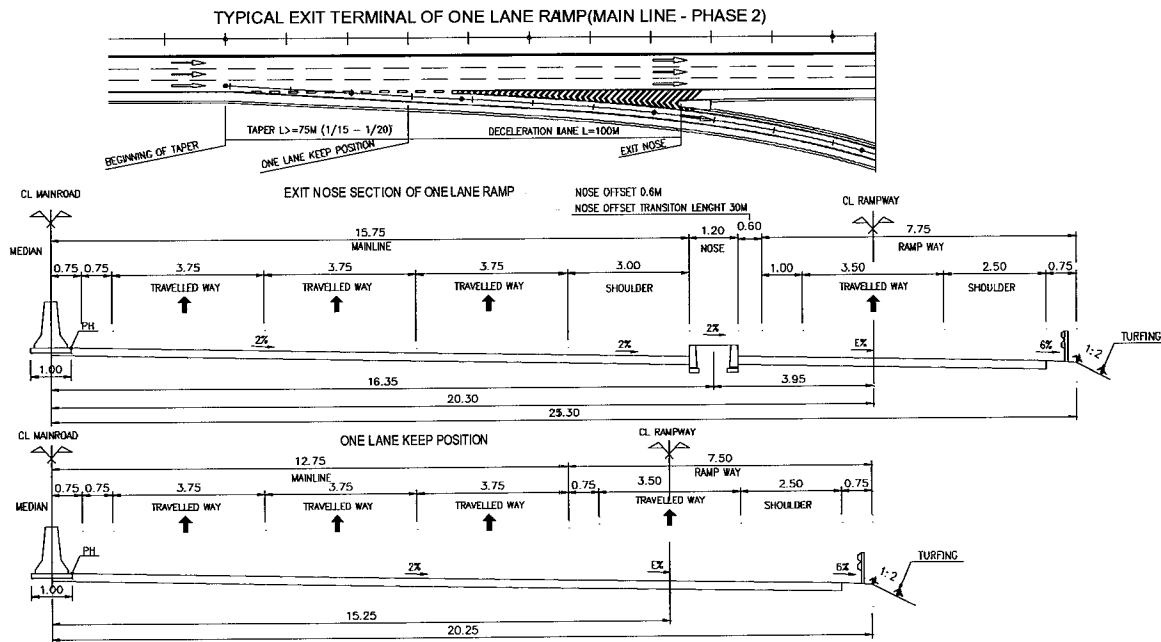


Figure 11.10 One Lane Ramp for Expressway (Exit) – Phase 2

(ii) One Lane Ramp for Expressway (Entrance) – Phase 2

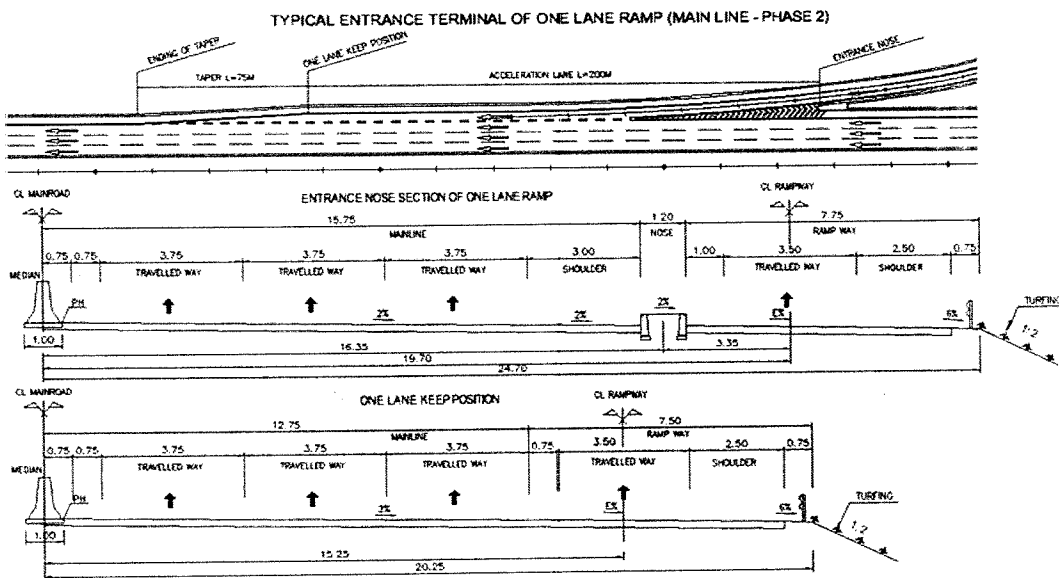


Figure 11.11 One Lane Ramp for Expressway (Entrance) – Phase 2

11.3 General Layout

11.3.1 General Layout of Ha Lam Interchange

The general layout of Ha Lam Interchange is given in Figure 11.12.

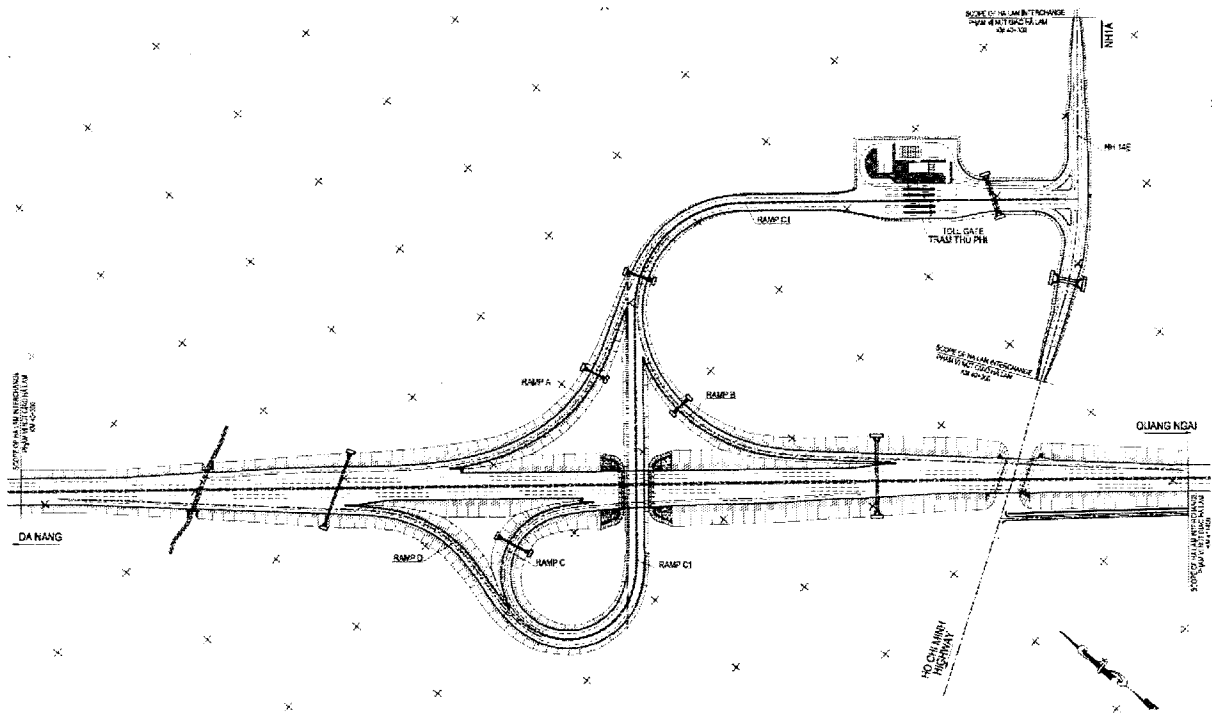


Figure 11.12 General Layout of Ha Lam Interchange

11.4 Operation and Maintenance Buildings at Interchange

11.4.1 Type of Buildings

Type of buildings installed at Interchange is

- TO : Toll Office
- TG : Toll Gate
- Ancillary Facilities

11.4.2 Existing Standards in Vietnam

Vietnamese Highway Design Standard for the project is applied in accordance with the Decision No.362/QD-BGTVT dated 20 February, 2006 and the Decision No.727/QD-BGTVT dated 6 April, 2012. The following standards of them should be applied as planning criteria of buildings.

- Expressway design standards TCVN 5729-97
- Office design standards TCVN 4601-98
- Toll Station design standards TCCS01-08/VRA

The above standards are summarized in **Table 11.8**.

Table 11.8 Summary of Existing Standard

No.	Type	Item	Type/Value		Remarks
1	TO	Working Area	---		TCVN 4601-98 TCCS01-08/VRA
2	TG	Width of lane (general)	3.0-3.2m	3.5-3.8m	L) TCVN 5729-97 R) TCCS01-08/VRA
		Width of lane (over-sized)	3.5-4.0m	4.0-4.5m	
		Width of island	1.5-2.2m	2.0m	
		Length of island (branch road)	25-30m	30m	
		Length of island (expressway)	30-45m	30m	
		Overhead space limit	Shown in Figure 11.1	Height 5m	

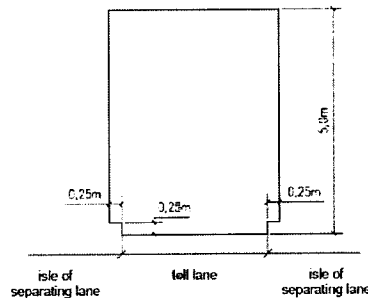


Figure 11.13 Overhead Space Limit for TG

11.4.3 Applied technical Standards

Basically the above standards are applied with planning O&M Building. However, those standards is not enough especially to calculate size of office space. Therefore, where no provisions exist in those standards, the relevant standards of NEXCO Design Standard will be referred. Regarding size of TG, basically TCCS 01-08/VRA is applied in this report because TCCS 01-08/VRA is newer than TCVN 5729-97 and also applied in current other projects in Vietnam.

11.4.4 Toll Office

TO is installed at every Interchange and Toll Barrier (Tuy Loan and Quang Ngai). TO consists of office of toll collection unit, common space, facilities room and relevant organization room. Size of building is calculated based on number of staff. The classification and size of required room are shown in the following Table 11.9.

Table 11.9 Classification and Size of TO

No.	Classification		Area		Remarks
1	Office of Toll Collection Unit	Office Room	60	m2	
		Account Room	30	m2	
		Ticket Selling	20	m2	
		Storage for Ticket	20	m2	
		Subtotal	130	m2	
2	Common Space	Sleeping Room	30	m2	
		Locker Room	20	m2	
		Toilet	20	m2	2 stories
		Corridor	150	m2	2 stories
		Subtotal	220	m2	
3	Facilities Room	Machine Room	20	m2	
		Generator Room	60	m2	
		Subtotal	80	m2	
4	Relevant Organization Room	Police Room	30	m2	
		Room for Staff	20	m2	
		Subtotal	50	m2	
Total			480	m2	

Also the required conditions for Toll Office are described as follows:

- The distance between TO and TG should be secured around 10m because of increasing number of lane in the future.
- Ancillary facilities such as canteen for staff, living building for staff, motorbike and car garages, pumping well, waste water treatment station, etc. should be prepared in TO area.

As the result of the above mentioned, general layout of TO is planned as shown in **Figure 11.14** below.

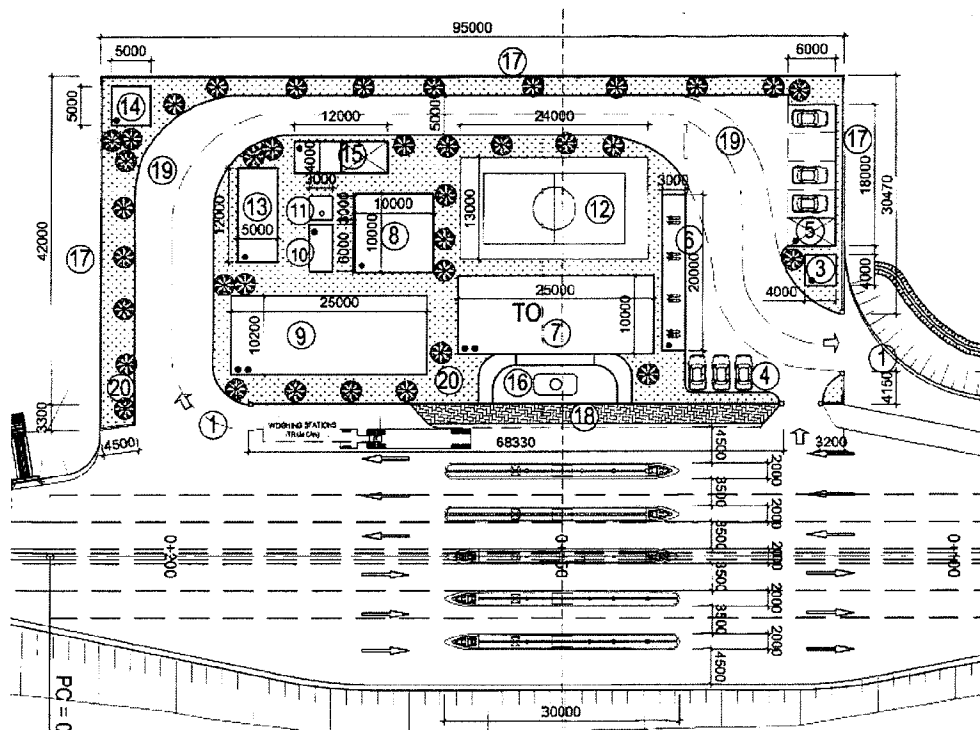


Figure 11.14 General layout of TO

11.4.5 Toll Gate

Regarding the width of lane, all general lanes are adapted 3.5m and the over-sized lane is adapted 4.5m in accordance with TCCS 01-08/VRA. The width and length of island is planned 2.0m x 30m considering installation of toll collection equipments.

As the result of the above mentioned, the typical layout is planned as shown in Figure 11.15.

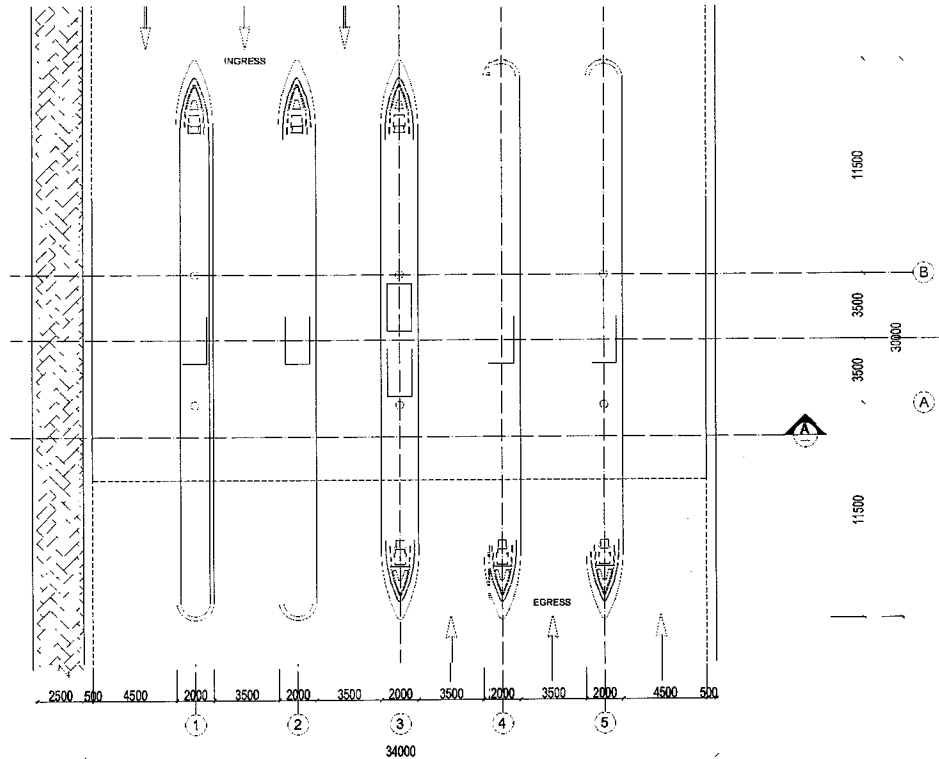


Figure 11.15 Typical Layout of TG

12 Parking Area Design

12.1 Existing Standards in Vietnam

The design standard, TCVN5729-97 is applied as planning criteria of Service Area/Parking Area (SA/PA) in Vietnam. The standard describes a guideline for Service works on Freeway and Expressway as follows:

Distance	Requirement
Every 15-25km	One parking lot of outside of expressway
Every 50-60km	Technical service center with petrol station and repair shop Restaurant, toilet, hotel
Every 120-200km	A big Service center Restaurant, hotel, can be arranged at one side and via duct or tunnel is required for passenger

12.2 Applied Technical Standards

Basically the above standard is applied with planning PA, PA is installed every 15-25Km and SA is installed 50-60Km. However, the standard describes only location and is not enough especially to calculate area of PA and building. Therefore, where no provisions exist in the standard, the relevant standards of NEXCO Design Standard will be referred.

12.3 Geometric Design of Rampway and Parking Lots

The schematic layout of parking area is given in Figure 12.1.

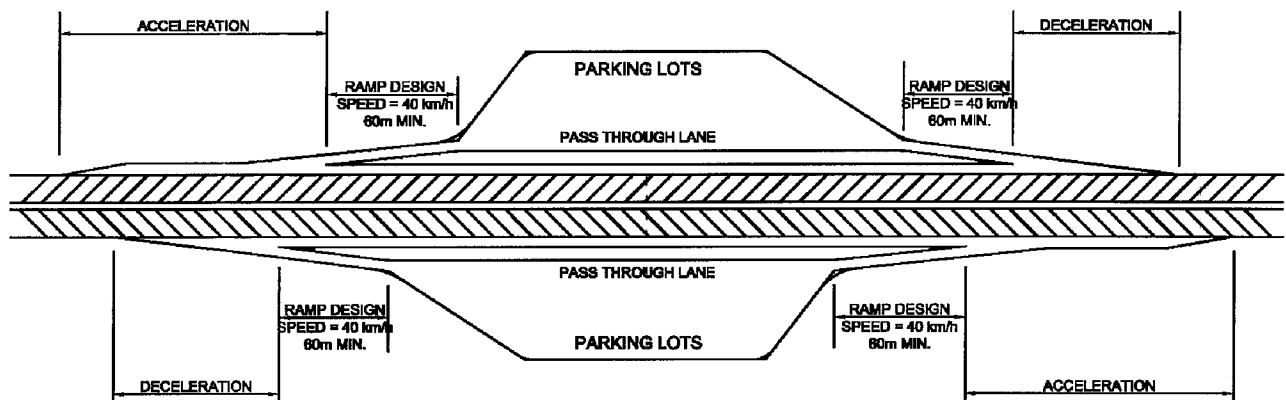


Figure 12.1 Schematic Layout of Service/Parking Area

12.3.1 Geometric Design of Ramp Terminals

The ramp terminals of service/parking areas are designed with the same concept and design standards as that of the interchange in the Project.

(1) Design Speed

The design speed of the expressway at the ramp terminal is 120 km/h, which is the design speed of the expressway at normal sections.

(2) Horizontal Alignment

The minimum radius of horizontal curve at the expressway in the ramp terminals is 2000m, with the absolute minimum of 1500m at unavoidable situations, based on TCVN5729.

(3) Vertical Alignment

The minimum vertical gradient at the ramp terminals is 2.0% based on TCVN5729. The absolute minimum radius of vertical crest and sag curves at the ramp terminals are 23,000m and 12,000m respectively based on TCVN5729.

(4) Lengths of Speed Change Lanes

The minimum lengths of deceleration and acceleration lanes are 100m and 200m respectively, excluding the tapers. The minimum length of the taper is 75m as stipulated in TCVN5729.

12.3.2 Geometric Design of Rampway

(1) Design Speed

The design speed of rampway is proposed to be a minimum of 40 km/h based on the NEXCO Design Standard for Rest Areas, as shown in Figure 12.1.

(2) Horizontal Alignment

The horizontal alignment in the rampway shall follow the minimum radius based on a design speed of 40 km/h.

Since the traffic at rampway after the exit ramp terminal may still have higher speed, it is desirable to design the curves in the rampway with spiral transition curves. Based on the NEXCO Design Standard, the minimum length of rampway from the exit/entry nose shall be 60m, beyond which it will be considered as the parking lot.

The design graph recommended by NEXCO Design Standard for determination of minimum radius at a distance travelled from the nose of exit ramp is given in Figure 12.2 for reference. As an example, the radius of 60m can be applied in the rampway alignment after travelling a distance of 87m from the nose at exit ramp. The minimum radius at the nose of exit ramp is recommended to be 250m. In addition, the minimum length of spiral is recommended to be 70m (absolute) and 90m (desirable) for the curve at nose of the exit ramp.

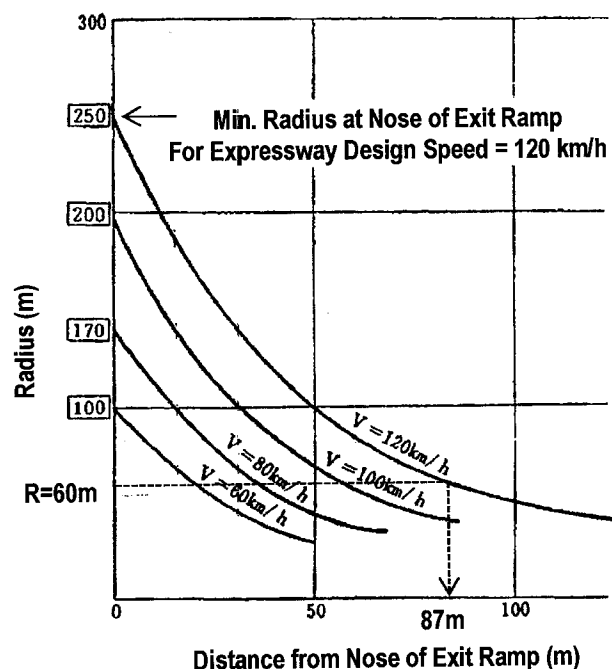


Figure 12.2 Design Graph for Minimum Radius in Rampway

(3) Vertical Alignment

The maximum permissible vertical grade for a design speed of 40 km/h from TCVN4054 is 7%. When the design grade exceeds 4%, the maximum permissible lengths shall be considered based on TCVN4054, which are 1100m, 900m, 700m and 600m for grades of 4%, 5%, 6% and 7% respectively for design speed of 40 km/h. The minimum radius of vertical curve at rampway for design speed of 40 km/h is given in Table 12.1, based on TCVN4054.

Table 12.1 Minimum Radius of Vertical Curve at Rampway

Design Speed	40 km/h
Radius of Crest Vertical Curve	
Desirable Minimum	1000
Limited Minimum	700
Radius of Sag Vertical Curve	
Desirable Minimum	700
Limited Minimum	450
Minimum Length of Vertical Curve	35

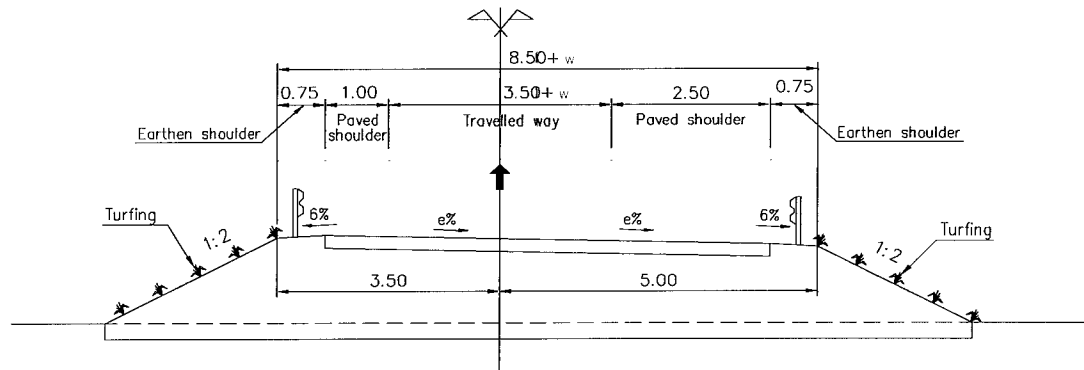
The minimum radius of vertical curve near the nose of the rampway is given in Table 12.2 as stipulated in the NEXCO Design Standard.

Table 12.2 Minimum Radius of Vertical Curve at near Nose

Expressway Design Speed	120 km/h
Radius of Crest Vertical Curve	
Desirable Minimum	2000
Limited Minimum	1400
Radius of Sag Vertical Curve	
Desirable Minimum	1500
Limited Minimum	1000
Minimum Length of Vertical Curve	50

(4) Typical Cross Section

The typical cross section at the rampway is proposed to be the same as the one lane rampway of the interchange, as given in Figure 12.3.

**Figure 12.3 Typical Cross Section at Rampway**

12.3.3 Geometric Design of Parking Lots

(1) Design Speed

The design speed at the parking lots is not considered, although a design speed, which is slightly lower than that of rampway, is desirable.

(2) Horizontal Alignment

Therefore, the minimum radius of horizontal curve inside the parking lots is proposed to be 40m for ease in turning movements.

(3) Vertical Alignment

The maximum vertical grade in the longitudinal direction of the parking lot is recommended to be less than 3% based on the NEXCO Design Standard. In the direction of the cross section, it is recommended to be 2%, which is the slope of normal cross-fall.

(4) Typical Cross Sections

The typical cross section of the rampway is continued along the Pass Through lane and the alignment inside parking area. The offset for marking the parking lots are required separately and will be discussed later.

12.3.4 Design Vehicles

(1) Design Vehicle Types

The design vehicles used for road design in Vietnam are given in TCXDVN 104-2007 and 22TCN273-01 and are given in Figure 12.4.

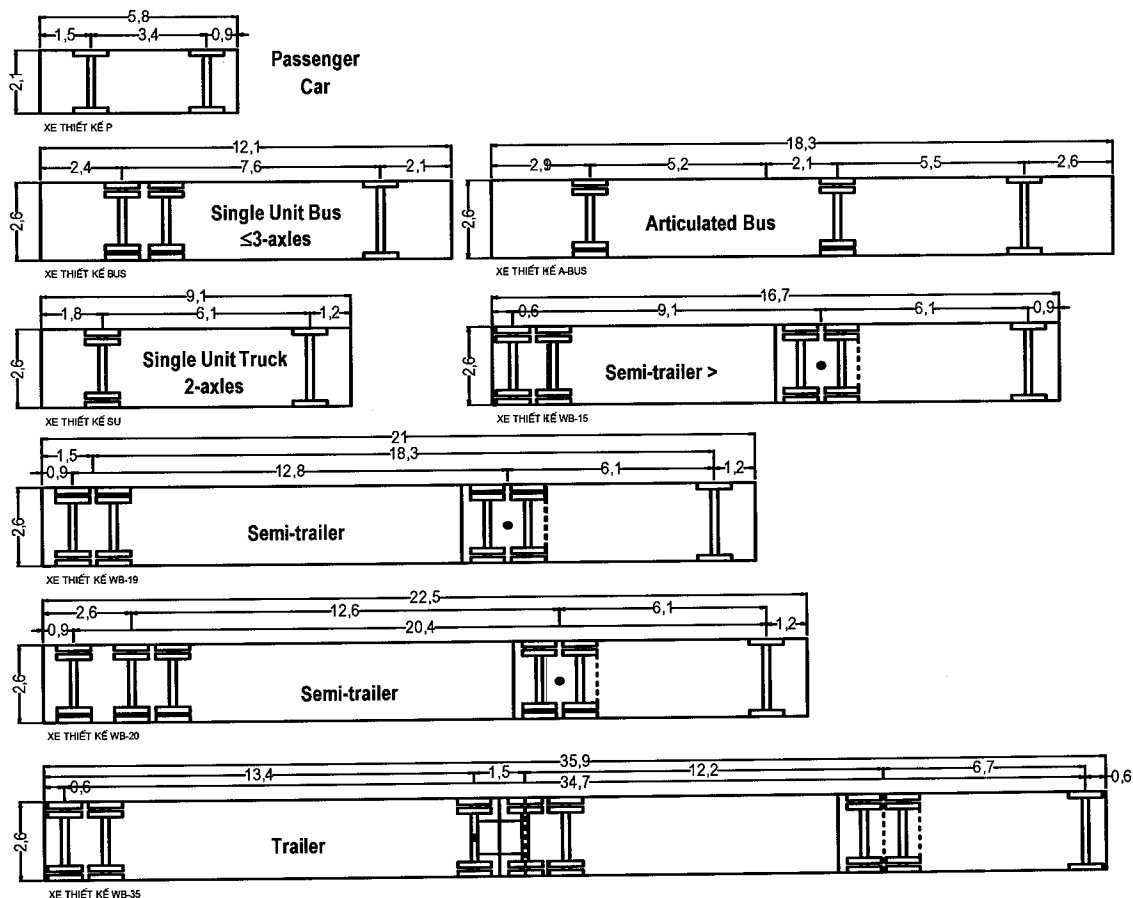


Figure 12.4 Design Vehicles used in Vietnam

Based on the normal practice in Japan and from NEXCO Design Standards, generally following types of vehicles are considered for the design of parking lots in the service area and parking area;

- i) Passenger cars
- ii) Heavy vehicles
- iii) Oversized heavy vehicles

Selection of total number of vehicle types for consideration in design of parking lot dimensions is crucial for efficient use of the area. Selecting a large number of vehicle types will be difficult in management, whereas, too little number may result in in-efficient use of the area. Based on the results of the traffic volume survey, vehicle types, as shown in Table 12.3, are considered in the project;

Table 12.3 Design Vehicle Types for Parking Lots

S.N.	Vehicle Types	Design Types for Parking Lots
1	Passenger Car	Small Vehicle
2	Minibus (<16 seats)	Medium Vehicle (Bus)
3	Bus (>16 seats)	Heavy Vehicle (Bus)
4	Light Truck (SU 2-axles)	Medium Vehicle (Truck)
5	Medium Truck (SU 2-axles)	Medium Vehicle (Truck)
6	3-axles Truck (SU 3-axles)	Heavy Vehicle (Truck)
7	>3-axles Truck (Semi-trailer WB-15)	Oversized Heavy Vehicles
8	>3-axles Truck (Trailer)	Basically, not considered

From Table 12.3, medium vehicle type is added in the recommended design vehicle types from NEXCO Design Standards and therefore, following four design vehicle types are considered;

- i) Passenger cars
- ii) Medium vehicles
- iii) Heavy vehicles
- iv) Oversized heavy vehicles

The trailer trucks with a maximum length of 35.9m in Figure 12.4 are basically not considered in the design of parking lots. However, it may be accommodated in two parking areas of oversized heavy vehicles, if required, as will be explained later.

(2) Design Vehicle Dimensions

Based on Figure 12.4, the dimensions of design vehicle types are given in Table 12.4.

Table 12.4 Design Vehicle Types for Parking Lots from TCVN

S.N.	Design Vehicle Types	Vehicle Dimension		Remarks
		Width	Length	
1	Small Vehicle	2.1	(5.8)	
2	Medium Vehicle (Bus)	--	--	Not specified in TCVN
3	Heavy Vehicle (Bus)	2.6	12.1	Single Unit Bus ≤ 3 -axles
4	Light Vehicle (Truck)	2.6	9.1	Single Unit Truck 2-axles
5	Medium Vehicle (Truck)	2.6	9.1	Single Unit Truck 2-axles
6	Heavy Vehicle (Truck)	--	--	Not specified for SU 3-axles in TCVN
7	Oversized Heavy Vehicles	2.6	16.7	Semi-trailer WB-15

Note: () NEXCO Standard for small vehicle is 4.7m length and is more reasonable from the parking area dimension of 5m recommended in TCVN4054.

As shown in Table 12.4, vehicle dimensions of Medium Vehicle (Bus) and Heavy Vehicle (Truck) are not definitive in the Vietnamese Standards. Therefore, the catalog from Hyundai is referred in order to check the vehicle dimensions.

Dimensions as shown in Table 12.5 are given for two types of minibus;

Table 12.5 Recommended Dimensions of Medium Vehicle (Bus)

S.N.	Design Vehicle Types	Width	Length	Remarks
1	Minibus (Hyundai Standard)	2.035	6.350	
2	Minibus (Hyundai Long type)	2.035	7.085	
Recommended for Medium Vehicle (Bus)		2.6	9.1	Same dimension as Medium Vehicle (Truck)

In order to standardize the parking lot dimensions, the same dimensions of Medium Vehicle (Truck) are applied for the Medium Vehicle (Bus), which also satisfy the dimensions from the catalog of Hyundai.

Similarly, dimensions as shown in Table 12.6 are given for Heavy Vehicle (SU Truck 3-axes) by Hyundai;

Table 12.6 Recommended Dimensions of Heavy Vehicle (Truck)

S.N.	Design Vehicle Types	Width	Length	Remarks
1	Tractor 3-axes	2.495	6.885	The indicated dimensions are for maximum size in each category
2	Dump 3-axes	2.495	8.465	
3	Mixer 3-axes	2.495	8.555	
4	Cargo 3-axes	2.495	9.635	
5	Cargo 3-axes	2.495	11.610	
Recommended for Heavy Vehicle (Truck)		2.6	12.1	Same dimension as Heavy Vehicle (Bus)

In order to standardize the parking lot dimensions, the same dimensions of Heavy Vehicle (Bus) are applied for the Heavy Vehicle (Truck), which also satisfy the dimensions from the catalog of Hyundai for different types of heavy trucks.

Therefore, the recommended dimensions for design vehicle types are given in Table 12.7

Table 12.7 Recommended Dimensions for Design Vehicle Types

S.N.	Design Vehicle Types	Vehicle Dimension		Remarks
		Width	Length	
1	Small Vehicle	2.1	(5.8)	
2	Medium Vehicle (Bus)	2.6	9.1	Same as Medium Vehicle (Truck)
3	Heavy Vehicle (Bus)	2.6	12.1	Single Unit Bus ≤ 3 -axes
4	Light Vehicle (Truck)	2.6	9.1	Single Unit Truck 2-axes
5	Medium Vehicle (Truck)	2.6	9.1	Single Unit Truck 2-axes
6	Heavy Vehicle (Truck)	2.6	12.1	Same as Heavy Vehicle (Bus)
7	Oversized Heavy Vehicles	2.6	16.7	Semi-trailer WB-15

12.3.5 Design Number of Parking Lots

(1) Traffic Volume along the Expressway

The forecasted traffic volumes for the year 2035 along the expressway at the parking area location in Package 5 are given in Table 12.8. The traffic volume forecast considers only four different types of vehicles as shown in the Table.

Table 12.8 Forecasted Traffic Volume for Parking Area in PKG5 for Year 2035

Type	Location	Direction	Car	Bus	Truck	
					Light	Heavy
Parking Area	Km 35+960	My Son - Ha Lam	12,289	4,152	2,448	4,525
		Ha Lam - My Son	11,163	3,771	2,223	4,111

(2) Dropping Traffic Volume at Service/Parking Area

The Dropping Ratio of traffic volume at service/parking area for different vehicle type is given in Table 12.9, as recommended by NEXCO Standard. The ratio for parking area is applied for the parking area in Package 5.

Table 12.9 Dropping Ratio at Service/Parking Area

Ratio	Type	Car	Bus	Truck	
				Light	Heavy
Dropping Ratio	Service Area	0.1750	0.2500	0.1750	0.1250
	Parking Area	0.1000	0.1000	0.1000	0.1250

The dropping traffic volume at service/parking area is then determined by multiplying the dropping ratio in Table 12.9 to the traffic volume in Table 12.8. The dropping traffic volumes are given in Table 12.10.

Table 12.10 Dropping Traffic Volume at Parking Area in PKG5

Type	Location	Direction	Car	Bus	Truck	
					Light	Heavy
Parking Area	Km 35+960	My Son - Ha Lam	1,229	415	245	566
		Ha Lam - My Son	1,116	377	222	514

(3) Design Number of Parking Lots at Parking Area

The design number of parking lots for each vehicle type at the service/parking area is determined by the Parking Ratio for the dropping traffic volume and is given in Table 12.11, as recommended by NEXCO Standard.

Table 12.11 Parking Ratio for the Dropping Traffic Volume at Service/Parking Area

Ratio	Type	Car	Bus	Truck	
				Light	Heavy
Parking Ratio	Service Area	0.0417	0.0833	0.0417	0.0375
	Parking Area	0.0250	0.0625	0.0250	0.0333

The design number of parking lots for each vehicle type in the parking area of PKG5 is then determined by applying the Parking Ratio to the dropping traffic volume and is given in Table 12.12.

Table 12.12 Design Number of Parking Lots for Parking Area in PKG5

Type	Location	Direction	Car	Bus	Truck		
					Light	Heavy	Total Truck
Parking Area	Km 35+960	My Son - Ha Lam	31	26	6	19	25
		Ha Lam - My Son	28	24	6	17	23

As mentioned earlier, the results of the traffic volume forecasts include only four types of vehicles whereas, seven different vehicle types are considered in the design vehicle types, as given in Table 12.7. Therefore,

- The traffic volume for bus is required to be divided into two categories of (i) Medium Vehicle (Bus) and (ii) Heavy Vehicle (Bus).
- The traffic volume for truck is required to be divided into four categories of (i) Light Vehicle (Truck), (ii) Medium Vehicle (Truck), (iii) Heavy Vehicle (Truck) and (iv) Oversized Vehicles.
- The percentage distribution is considered from the results in Pavement Design Report, submitted separately and is given in Table 12.13.

Table 12.13 Percentage Distribution of Different Vehicle Types

SN	Section	% Distribution in Bus			% Distribution in Truck				
		Bus<16	Bus>16	Total Bus	Light	Medium	3axle	>3axle	Total Truck
1	Da Nang - Tam Ky	51.00	49.00	100.00	19.52	45.88	17.70	16.90	100.00
2	Tam Ky - Quang Ngai	46.88	53.12	100.00	26.33	45.63	15.43	12.61	100.00

From these percentage distributions of different vehicle types, the design numbers of parking lots for each design vehicle type at the parking area in PKG5 are determined as given in Table 12.14.

Table 12.14 Design Number of Parking Lots

Type	Location	Direction	Car	Bus		Truck			
				Bus<16	Bus>16	Light	Medium	3axle	>3axle
Parking Area	Km 35+960	My Son - Ha Lam	31	13	13	5	12	4	4
		Ha Lam - My Son	28	12	12	4	11	4	4

12.3.6 Layout of Parking Lots

(1) Dimensions of Parking Lots

The dimensions of parking lots for different vehicle types stipulated in TCVN4054 are given in Table 12.15. Comparison of the recommended dimensions from NEXCO Standard is also shown in the table.

It is presumed that the wider width for the bus in TCVN4054 compared to NEXCO Standard may be in consideration to the width required for loading and unloading of the passengers.

Table 12.15 Comparison of Dimensions for Parking Lots in TCVN4054 and NEXCO Standard

S.N.	Vehicle Types	TCVN4054		NEXCO Standard		Remarks
		Width	Length	Width	Length	
1	Car	2.5	5.0	2.50	5.0	
2	Bus	5.0	15.0	3.25	13.0	NEXCO dimensions are for heavy vehicles
3	Truck	4.0	20.0	3.50	17.0	NEXCO dimensions are for oversized heavy vehicles

The parking lots dimensions for all design vehicle types in Table 12.7 are not defined in TCVN4054. The comparison of parking lots dimensions with NEXCO Standard shows a wide variance from TCVN4054. Therefore, the parking lots dimensions for different vehicle types are determined from the following method;

1. In the parking lots dimensions of Bus (Heavy) in TCVN4054 shows that the length of the parking lot (15m) is 2.9m longer than the design vehicle length (12.1m). Therefore, the parking lot length for Medium Vehicle (Bus) is determined as 12m, which is 2.9m longer than its design vehicle length of 9.1m. The same length of 12m is also applied for the parking lot length for Light and Medium Vehicle (Truck) since the design vehicle lengths are similar.
2. In the Medium Vehicle (Bus), the width of parking lot dimensions is decided as 3.5m, which is the lane width at normal roads and is the largest width given in NEXCO Standards.
3. In the parking lots dimensions of Light and Medium Vehicle (Truck), the length is determined as 12m, which is the same length of Medium Vehicle (Truck).
4. In the parking lots dimensions of Light and Medium Vehicle (Truck), the width is determined as 4m, which is the same width recommended in TCVN4054 for Heavy Vehicle (Truck).

The recommended parking lots dimensions for different vehicle types are given in Table 12.16 after consideration to the dimensions specified in TCVN4054.

Table 12.16 Recommended Dimensions for Parking Lots for Different Vehicle Types

S.N.	Design Vehicle Types	Parking Lot Dimension		Remarks	
		Width	Length	Width	Length
1	Small Vehicle	2.5	5.0	TCVN4054	
2	Medium Vehicle (Bus)	3.5	12.0	Same as normal lane width	Same as SU Medium Truck
3	Heavy Vehicle (Bus)	5.0	15.0	TCVN4054	
4	Light Vehicle (Truck)	4.0	12.0	Same as Truck in TCVN4054	Design Vehicle Length + 2.9m
5	Medium Vehicle (Truck)	4.0	12.0	Same as Truck in TCVN4054	Design Vehicle Length + 2.9m
6	Heavy Vehicle (Truck)	4.0	15.0	Same as Truck in TCVN4054	Same as Heavy Vehicle (Bus)
7	Oversized Heavy Vehicle	4.0	20.0	TCVN4054 applicable for Semi-trailer	

(2) Parking Lot Angle and Offset

The angle of parking lot is selected as 60 degrees to optimize the space as well as ease in the turning movements. The minimum offset between two parking lots in the cross section direction of the parking area is selected from the recommended values from the NEXCO Standard as given below and as shown in Figure 6.1.

i) Minimum offset for passenger car for 60 degree parking is 5m

ii) Minimum offset for heavy vehicle for 60 degree parking is 11m

Similarly, the minimum offset for the medium vehicle is proposed to be 9m for 60 degree parking. Although, the minimum offset for passenger car is 5m, when the typical cross section width of the ramp is continued, the minimum width is 7m as shown in Figure 12.5. When two different types of vehicles are parked in the same row, the minimum offset of larger vehicle should be applied.

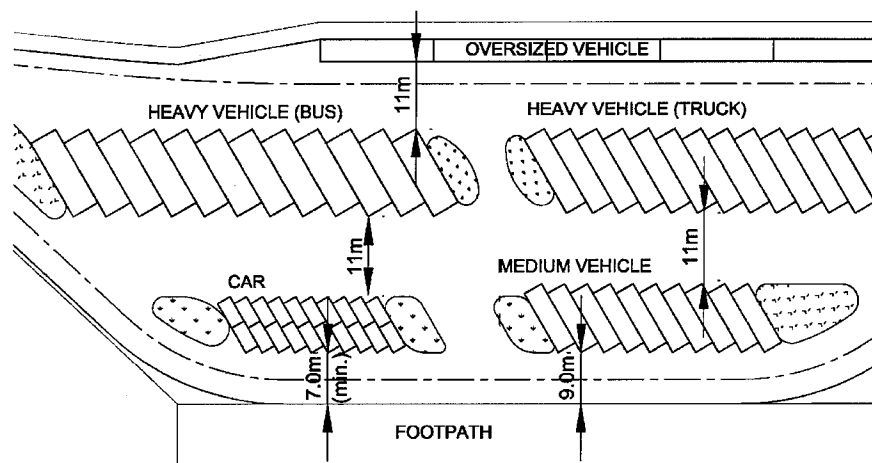


Figure 12.5 Minimum Offset for Parking Lots

12.3.7 Access Roads

Access roads are required for service/parking areas on both sides of the expressway for the daily use by the staff as well as by the delivery vehicles. The access roads are recommended to be linked with the nearest crossing roads or frontage roads. Since medium sized heavy vehicles may travel for the delivery of goods, the road shall be of minimum Rural Road Class A. Access roads with a total of 468.522m on left side and 380.334m on the right side have been designed.

12.4 Design of Building and Service Facilities

12.4.1 Unit Area for Vehicle Type

Based on NEXCO Design Standard, it is calculated considering size of design vehicle type. Unit area for vehicle type is shown in following Table 12.17.

Table 12.17 Required Unit Area for Vehicle Type

Area	Car	Medium	Heavy (Truck)	Heavy (Bus)	Oversized
Required Area (m2)	23.5	104.3	120.7	151.9	196.0

Source: NEXCO Design Standard

12.4.2 Construction Area

Parking Space is calculated by the above unit area multiplying number of parking lots. PA has Passage Space, Pedestrian Space, Building Space, Backyard Space and Open Space except Parking Space. Construction area including whole required space is shown in following Table 12.18.

Table 12.18 Construction Area of PA

Type	Classification			Total Size (m2)
PA	Parking Space	Unit Area x No. of Parkig Lots	8,000	27,000
	Passage Space	6m x 500m	6,000	
	Pedestrian Space	10m x 100m	2,200	
	Building Space	Same as Pedestrian Space	1,200	
	Backyard Space	Same as Pedestrian Space	2,300	
	Open Space	Same as Parking Space	7,300	

12.4.3 Building Area

Size of Toilet is desirable to design widely because number of parking lot of bus is high and there are many cases of expanding toilet with increasing to traffic volume in Japan. Actually management of commercial buildings except Toilet is not decided. Also the kind and size of commercial buildings would be determined by the management company. Therefore, building area based on NEXCO Design Standard is shown in Table 12.19.

Table 12.19 Building Area of PA

Type	Classification		Total Size (m2)
PA	Toilet	300	300

12.5 General Layout

It is necessary to take a moderate rest in order to drive on expressway safely. PA requires minimal function of rest of driver. It has Parking Space, Toilet, Rest House, Food Shop, Open Space and so on. As for planning layout of PA, there are several conditions as follows:

- It is desirable to install toilet in front of parking lot of bus.

The reason is that many customers use toilet first when a bus arrives at PA.

- It is desirable to secure enough space in front of toilet and commercial buildings. (PA : 10m)

The reason is that space of car and people should be separated in order to provide rest of driver.

- It is needed to secure enough space of backyard and connect to local road.

The reason is that the staff can commute and the delivery vehicle can carry materials and something.

As the result of the above mentioned, general layout of PA is planned as shown in the following Figure 12.6.

FT SIDE]-TYPE A / ĐƯỜNG VÀO BÀI ĐỖ XE (BÊN TRÁI)-LOẠI A
 45 - Km35+924.116, L= 468.522 m

-TYPE A / ĐƯỜNG VÀO BÀI ĐỖ XE (BÊN PHẢI)-LOẠI A
 35+868.914, L= 380.334 m

Figure 12.6 General Layout of Parking Area in Package 5

13 MISCELLANEOUS DESIGN

13.1 Provision for Emergency Opening of Median

Each unit of the median concrete barrier is normally designed with a length of 4m. Based on the Vietnamese Standard TCVN5729-1997, the expressway is required to be designed with a provision of emergency opening of median at every 2km to 4km and near the tunnel and major bridges. Based on the same standard, the length of the opening provision shall be 25m to 30m. Therefore, the unit of median concrete barrier is designed with a length of 1m at every 4km for this project, so that the median can be easily moved during emergency. The length of the opening provision is designed for a length of 28m, which is 7 units of normal median concrete barrier.

13.2 Traffic Safety Design

13.2.1 Traffic Sign

Basically there are 4 types of traffic signs as given below;

- Kilometer Station
- Bridge Name
- Traffic signs at interchange
- Traffic signs at parking area

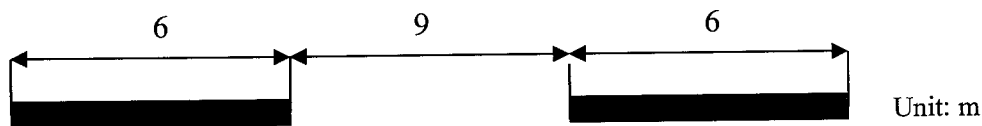
The design of traffic sign is based on Vietnamese Standards 22TCN 237-01 and TCVN5729-97.

Kilometer stations are provided at an interval of 1km, on both sides of the expressway. The sign posts of bridge names, interchange and parking are installed at the respective locations.

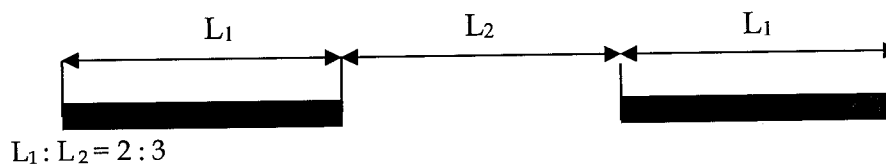
13.2.2 Road Markings

In general, two types of road markings are applied. One is white interruptive lane marking (Type 2) and the other is yellow continuous lane marking (Type 4). Both of these markings are also based on the Vietnamese Standards 22TCN237-01 (QCVN41-2012). Additionally, there are road markings at merging and diverging noses of the interchange rampways and directional arrow markings etc.

The white interruptive lane markings stipulated in the Vietnamese Standard 22TCN 237-01 (QCVN41-2012), as shown below,



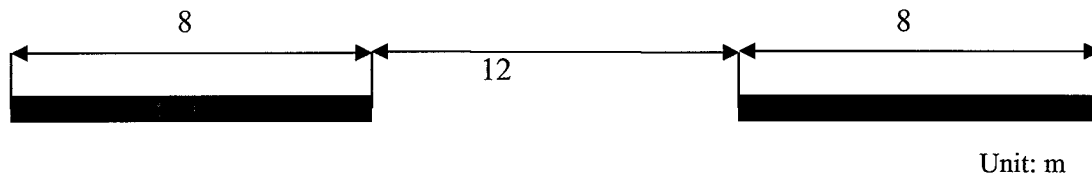
has shorter interval compared to the Expressway Standards in Japan. Shorter lengths as shown above are suitable only for national highways with lower design speeds such as 50-60km/h. In case of expressway, with design speed as high as 120km/h, shorter lane marking may cause flickering effect to drivers. Japanese standards recommend the following lengths;



The length of L_1 is decided based on the design speed, as follows;

Design Speed (km/h)	Below 40	50 ~ 60	Above 80
Length (m)	4	6	8

Applying the above recommended values, the lengths for lane markings in this project can be drawn as follows;



From the driver's visual point of view, the latter values for lane markings will provide more comfortable driving and will reduce driver's stress from flickering effect. In this context, the Consultant would like to recommend the values recommended by Japanese standard regarding lane marking in order to enhance traffic safety, which is the same applied in Ho Chi Minh – Long Thanh – Dau Giay Expressway.

13.3 Electrical / Lighting / Communication Design

13.3.1 Power Supply System

(1) Power Receiving Point

Power supply system will be fed from medium voltage distribution line of 22 kV. Voltage of received power will be stepped down to low voltage by transformer and distributed to each facility and/or equipment. The power supply facility in PKG 5 section will be placed at following place.

- Parking Area (KM 35+950)
- Ha Lam Toll Office

(2) Design Standards

Followings are reference standards for the electrical facility.

- Vietnamese sectorial standard 11TCN 18,19,20:2006: Norm of electrical equipment part I, II, III.
- Vietnamese construction standard TCXD 4756-89: Specification on grounding for electrical equipment
- Technical Regulation on Rural Electric Power Grid by Ministry of Industry 57/2000/QĐ-BCN
- IEC-62271-1: High voltage switchgear and control gear, common specifications
- IEC-62271-200: AC metal-enclosed switchgear and control gear
- IEC-62271-201: Insulation -enclosed switchgear and control gear
- IEC-60076: Power transformers
- IEC-61439 Standard: Low voltage switchgear and control gear
- Other relevant standards

(3) Power Demand Load

The power supply system shall feed power to various facilities and equipment such as road lighting, building facilities and ITS equipment. The power supply system must have enough capacity to supply power all electrical equipment. The table below shows the estimated power demand load at each power receiving point.

Table 13.1 Estimated Power Demand Load

No.	Station No.	Location	Estimated Demand Load
1	KM 35+950	Parking Area (KM 35+950)	155.53 kVA
2	KM 40+800	Ha Lam Toll Office	123.87 kVA

Source: Consultant

(4) Power Receiving System Configuration

Three types of candidate are considered as power receiving system as shown in the table below.

Table 13.2 Comparison of Power Receiving System

Type	Pole Mounted	Outdoor Cubicle	House Building (Compact Type)
Item			
Features	Simple composition but low reliability	Maintenance problem during rain	Higher cost but longer life and higher reliability
Installation	Outdoor	Outdoor	Indoor
Relative cost	100	130	160
Expected life	15~20 years	15~20 years	20~30 years
Reliability	Average	Good	Excellent
Construction Period	Short	Short	Long
Evaluation	Average	Average	Recommended

Source: Consultant

According to the comparison of initial construction cost above, the pole mounted type costs are lowest. However, the Consultant proposes the house building type (compact type) for power receiving system in the Project from view points of ease of maintenance, higher reliability, longer equipment lifetime and lowest life cycle costs.

Following photo shows an example of house building type power receiving system. It requires installation space of 3.0 m length and 2.0m width.

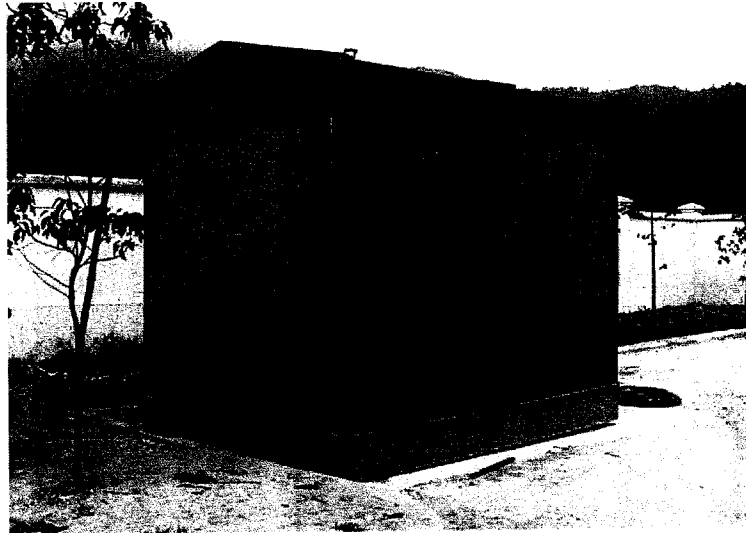


Figure 13.1 Sample Photo of House Building Type Power Receiving System

1) Transformer

Rated capacity of transformer is determined by the estimated power demand load shown in Table 13.1 above and rounded up to the nearest rated capacity used in Vietnam.

Following are technical requirements of transformer installed in the house building.

[Ha Lam Toll Office/ Parking Area (KM 35+900)]

Type	Outdoor, Oil immersed, ONAN
Rated Capacity	160 kVA
Number of Phase	3
Rated primary voltage	24 kV
Rated secondary voltage	400 V
Frequency	50 Hz
Connection	Dyn or Yzn, depending on power system
Off-loaded Tap Changer	22kV+-2x2.5%/0.4

2) Diesel Engine Generator (DEG)

The power supply system must operate even during commercial power interruption or maintenance works for power supply system to continuously feed power to ITS equipment or other vital equipment. Therefore, stand-by Diesel Engine Generator (DEG) shall be introduced at toll office in this Project. It is costly if the generator covers all loads of the system. Thus, loads for the DEG must be selected to reduce the required capacity of the generator. The conditions to calculate loads for power supply by engine generator are as follows;

- Traffic management, toll collection and communication equipment: 100 %
- Air conditioner for equipment room : 100 %
- Lighting for toll booth and island: 100 %
- Lighting and outlet for buildings: 50 %
- Water supply and sewerage: 100 %
- Auxiliary power for engine generator: 100 %

Followings are technical requirements of DEG installed in Ha Lam Toll Office.

Type	Indoor, 4 cycle engine, Electrical governor, Brushless exciter
Rated Capacity	75 kVA
Number of Phase	3
Rated Voltage	400 V
Frequency	50 Hz
Operational Duration	24 hours
Fuel Tank Capacity	depends on operational duration

Table below shows generator capacity and engine power required.

Table 13.3 Generator Capacity and Engine Power

Location	Estimated Capacity	Selected Engine Generator	Converted Engine Power
Ha Lam Toll Office	71.75 kVA	75 kVA	101 PS

Source: Consultant

Fuel tank capacity is calculated based on the following parameters:

- Generator operation duration: 24 hours
- Required oil tank capacity calculation formula:

$$Q = b \times Le / \phi$$

Where: Q: Hourly fuel consumption (litter/h)
b: Fuel consumption rate per horsepower (0.173-0.178kg/psh)
Le: Engine power (PS)
 ϕ : Fuel oil specific gravity
(Heavy oil: 0.84kg/litter, light diesel oil: 0.83kg/litter)

Required fuel tank capacity is summarized as table below.

Table 13.4 Fuel Tank Capacity

Location	Selected Engine Generator	Required Fuel Capacity	Selected Fuel Tank
Ha Lam Toll Office	75 kVA	519.8 litter	600 litter

Source: Consultant

The DEG and power receiving system composed of transformer and distribution panel shall be procured in same package because the Automatic Transfer Switch (ATS) to change over commercial power and DEG must be put in the distribution panel and synchronize with each power source.

3) **Uninterruptible Power Supply (UPS)**

To compensate for a short time power cut off during power changeover duration from commercial power to emergency generator power, Uninterruptible Power Supply (UPS) must be provided in the Project.

Compensation time of UPS is decided by expected power interruption period. Generally, it will take around 30 seconds until the DEG generates normal voltage after commercial power interruption. However, considering possible starting trouble of the DEG, the power interruption period is selected as 10 minutes.

Followings are requirements of UPS procured in Ha Lam Toll Office.

Type	
- Capacity	50 kVA
- Compensation period	10 minutes
- Rating	Continuous duty
- Cooling system	Forced air-cooling
- System	Synchronized AC line (By-pass)
- Rectifier/Charger	Full wave rectifier
- Inverter	Transistor bridge
AC Input	
-Phase & Wiring	3 phase 3 wires
- Rated voltage	400V
- Voltage variation range	Within $\pm 10\%$
- Rated frequency	50 Hz
- Frequency variation range	Within $\pm 5\%$

The UPS shall be procured in PKG 13: O&M/ITS package, since almost all UPS loads are ITS equipment and demand load capacity of ITS equipment will be varied by the manufacturer and fixed later stage after the contractor carry out detailed design of ITS equipment.

13.3.2 Lighting Facility

(1) **Required Lighting Area**

Road lighting system improves a capacity of traffic volume of expressway. Requirements to the road lighting are ensured the smooth traffic flow with safely in the conditions of night time or bad weather situations. The lighting system should be a high quality of lighting and low running cost in operation stage. Major principles of the design should be:

- To keep driver's visibility guiding continuously by a lines of lighting at tollgate areas, interchanges, etc.,
- To install sufficient lighting level for finding out disabled car, stack-up, or obstructions, and
- To provide sufficient light for identification of roadside facilities

The road lightings in PKG 5 will be placed at the following sections:

- Toll plaza
- Interchange (main carriageway and ramp)
- Parking Area (including main carriageway and ramp)

(2) Design Standards

Followings are reference standards for the road lighting.

- TCXDVN 333: 2005 Design Standard of Artificial Outdoor Lighting for Public Buildings and Urban Infrastructure
- TCXDVN 259: 2001 Standard for Design of Urban Streets and Square Lighting
- TCVN 5729: 2007 Expressway Standard for Design
- Other relevant standards

(3) Design Conditions and Calculation Results

1) Lighting Source

The road lighting is recently being developed high efficiency lighting source with more efficient lighting distribution characteristics in the world. One of famous technical revolution in this sector is an application of LED (light-emitting diode). The LED lighting source has various advantages such as low power consumption, high color rendering properties, long lifecycle, less CO₂ emission, etc. Table below shows lighting source comparison between LED and high-pressured sodium lamp which has been generally used for road lighting in Vietnam.

Table 13.5 Comparison of Lighting Source

Item \ Lighting	High-Pressure Sodium (HPS) Lamp	LED Lamp	Remarks
Output Power	150W, 250W, 400W, 1000W, etc.	Up to 160W	
Color Rendering Properties	Average (Ra25)	Excellent (Ra65)	Ra100: natural sunlight
Lamp Lifetime	6 years	15 years	
Power Consumption (Relative, HPS Lamp = 100)	100	70	
Initial Cost (Relative, HPS Lamp = 100)	100	160	
Running Cost (Relative, HPS Lamp = 100)	100	45	
Lifecycle Cost (Relative, HPS Lamp = 100)	100	98	15 years

Source: Consultant

In this project, LED lamp instead of HPS lamp is proposed as a road lighting source for interchange, bridge and intersection due to lower lifecycle cost and other various advantages. On the other hand, metal halide (MH) lamp having similar color rendering properties with LED lamp will be used as a road lighting source for tollgate area and parking area where

require high luminance level and high output power lighting.

2) Required Luminance and Illuminance Levels

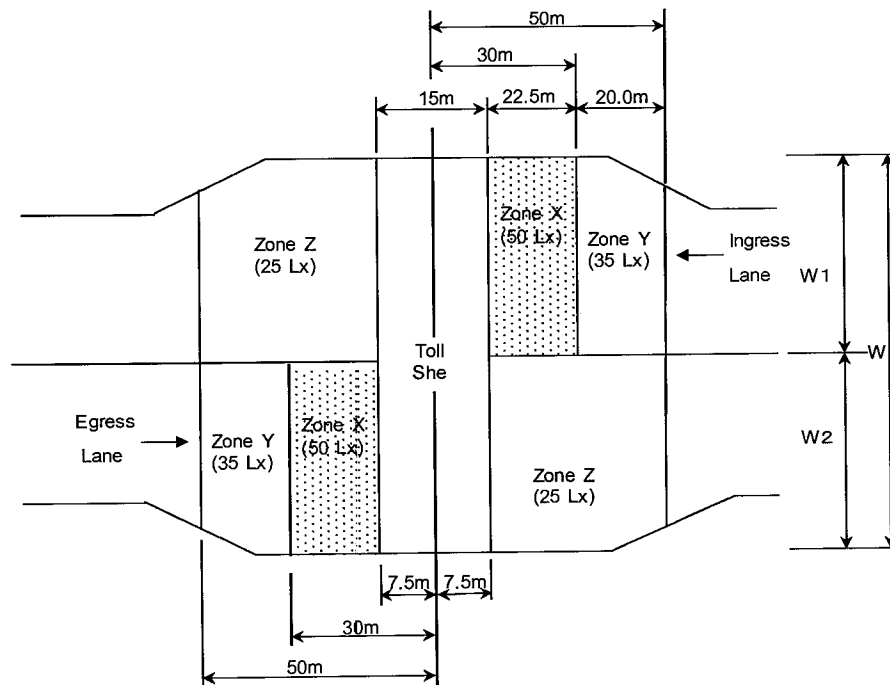
Required luminance and illuminance levels at each lighting area are set as follows by referring to relevant standards.

i) Tollgate Area

Table 13.6 Required Luminance and Illuminance Levels

Lighting Area	Average Luminance/ Illuminance Level	Remarks
Main Carriageway	2.0 cd/m ² = 35 lux	
Rampway	1.2 cd/m ² = 20 lux	
Toll Plaza	25 - 50 Lux	See Figure 13.2 below

Source: Consultant



Source: Consultant

Figure 13.2 Required Illuminance at Toll Plaza

ii) Parking Area

Table 13.7 Required Illuminance Levels of Parking Area

Lighting Area	Horizontal Illuminance Level	
	Average	Minimum
Parking Area	10 lux	3 lux
Approach Road to/from Parking Area	1.2 cd/m ²	

Source: Consultant

3) Calculation results

The lighting calculation using program software was carried out in this design. The selected lamp, height of lighting pole, etc. based on the calculation is summarized as follows.

Table 13.8 Lighting Calculation Results

Lighting Area Items	Main Carriageway (Including Bridge)	Interchange/ Parking Area Rampway	Toll Plaza/ Parking Area
Adopted Lamp	LED Lamp 180W	LED Lamp 180W	MH Lamp 400W x 8
Height of Lighting Pole	12m	12m	25m
Arrangement of Pole	Both sided	One sided	-
Calculated Pole Distance	40m	40m	-
Size of Lighting Pole Foundation	1,000mm(W) x 1,000mm(D) x 1,200mm(H)	1,000mm(W) x 1,000mm(D) x 1,200mm(H)	3,000mm(W) x 3,000mm(D) x 3,100mm(H)

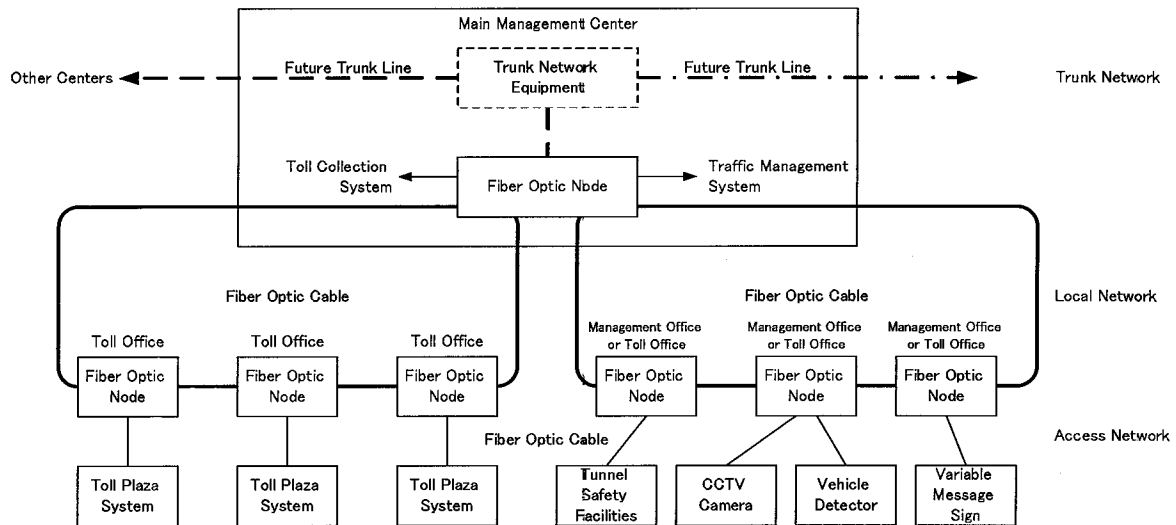
Source: Consultant

13.3.3 Communication Facility

(1) Network Configuration

ITS consists of various facilities such as vehicle detector, CCTV camera, variable message sign and toll collection facilities installed along roadside. These roadside facilities are connected with the center equipment installed at a main management center through fiber optic network.

A network structure of the communication system will be separated by three (3) hierarchies, that is, trunk network, local network and access network. Communication nodes (FON: Fiber Optic Node) will be placed to link between the main management center and management office or toll office. The network topology shall be configured a flattened ring structure to guarantee connectivity even if one node or communication cable fail to operate. The concept of the network structure and hierarchy is shown in figure below.



Source: Consultant

Figure 13.3 Network Structure and Hierarchy

(2) Location of Communication Node

All communication cable shall be fiber optic cable having enough number of cores. The location of FON in PKG 5 section is listed as table below.

Table 13.9 Location of Fibre Optic Node (FON)

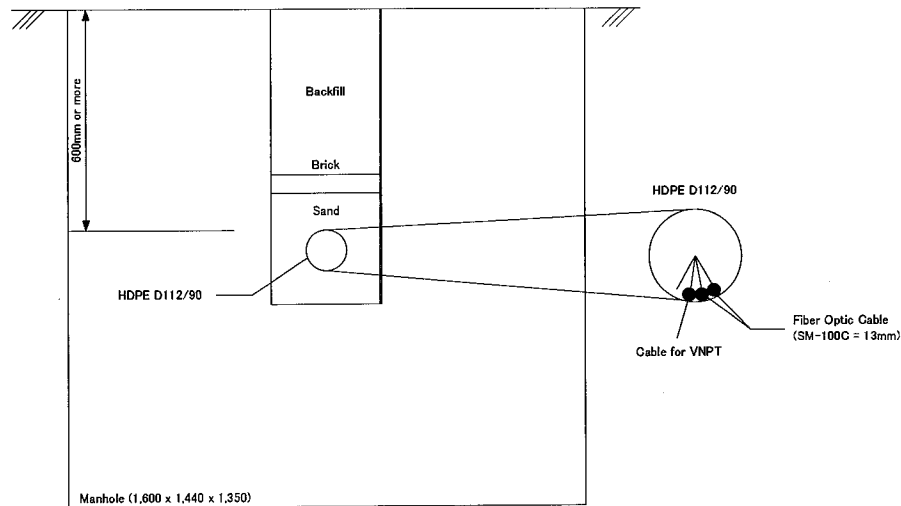
No.	Location	Quantity	Remarks
1	Ha Lam Toll Office	1	KM 40+800

Source: Consultant

The FON will be installed in the building of toll office and procured in other package.

(3) Conduit for Communication Cable

Typical section of conduit for communication cable at grade-section is illustrated as figure below.



Source: Consultant

Figure 13.4 Typical Section of Conduit Installation

One (1) HDPE pipe of which diameter is 112/90mm will be laid along left side of expressway. The pipe must be buried at least 600 mm from surface. Manhole with the size of 1,600 mm length x 1,440 mm width x 1,350 mm height shall be installed for pulling and connecting/diverging the cable. Interval of manhole must be less than 250m to reduce cable laying tension.

13.3.4 Conduit Plan

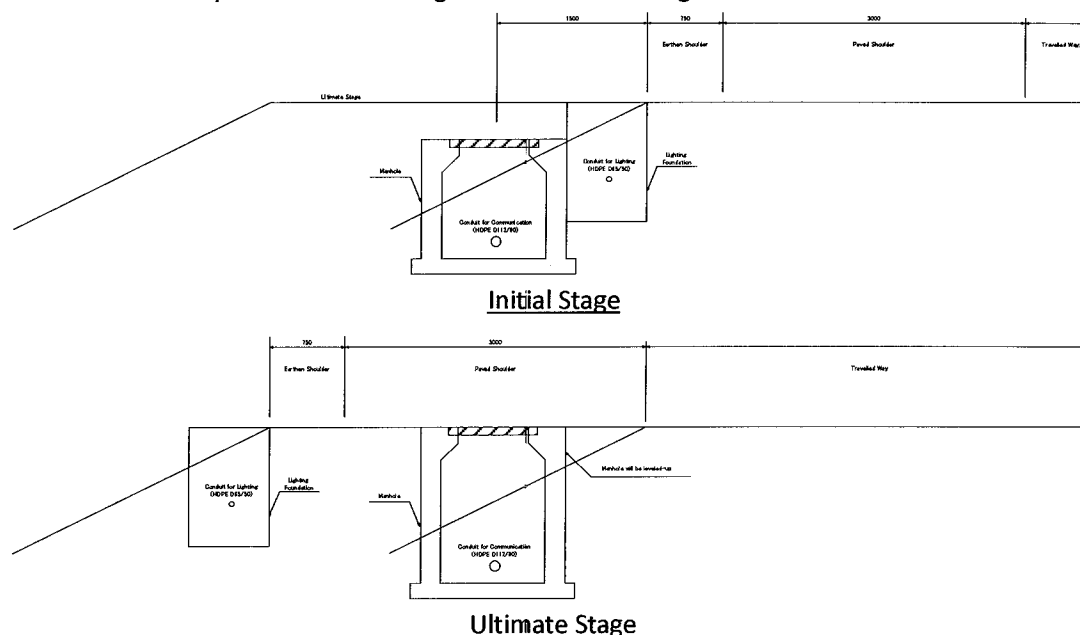
The cable conduit system for the electrical, lighting and communication system includes pipe buried underground or inserted in bridge barrier, manhole, pull box and other associated accessories necessary for cable installation. The basic requirements of conduit system are shown in table below.

Table 13.10 Basic Requirements of Conduit System

Item		Requirements
Location	Road Section	Under side slopes, 600mm depth from the surface
	Bridge Section	In concrete barriers
Conduit	Nos.	For Communication: 1 nos. (left side) For Power for ITS facility: 1 nos. For Power for Lighting: 1 nos.
	Type and Size	HDPE ϕ 112/90mm x 1 : Communication HDPE ϕ 65/50mm x 1 : Power for ITS facility HDPE ϕ 65/50mm x 1 : Power for Lighting
	Min. Curve Radius	Communication Cable: $R \geq 300$ mm ($R \geq 20D$, D: expected 15mm) Electric Cable: $R \geq 600$ mm ($R \geq 20D$, D: expected 30mm)
Manhole: MH-C	Size	L: 1,600mm x W: 1,440 mm x D: 1,350 mm
	Interval	Communication Cable: 250m pitch Power Cable: 50m pitch
Pull Box : PB-E	Size	L: 1,200 mm x W: 350mm x D: 200mm
	Interval	Communication Cable: 250m pitch Power Cable: 50m pitch
Pull Box : PB-B	Size	L: 1,200 mm x W: 339mm x D: 185mm (min)
	Interval	Communication Cable: 250m pitch Power Cable: 50m pitch
Reinforced Concrete Culvert	Size	ϕ 400 x 1 : at Toll gate

Source: Consultant

Conduit transition plan to ultimate stage is summarized in figure below.



Source: Consultant

Figure 13.5 Conduit Transition Plan

In the ultimate stage, the number of lanes will be expanded to 6 lanes. Conduit plan is proposed taking into consideration the following conditions for future road widening.

- Communication conduit is proposed at location where 1.5 m away from edge of earthen shoulder of initial stage. Even in ultimate stage, the conduit is not necessary to be relocated since communication cable is still under the paved shoulder and maintenance work of the cable can be carried out without interruption to traffic flow in case of cable trouble. Manhole height will be leveled up to meet the surface of pavement at the time of road widening. This location can also minimize the interference of flooding.

- Lighting system including lighting foundation, cable and conduit must be replaced or relocated at ultimate stage since the required lighting output is varied depending on road width to keep luminance level required. An implementation of lighting arrangement considering future widening at initial stage is not economical in both implementation cost and running cost. Thus, the Consultant recommends to install lighting pole at outer edge of earthen shoulder.

13.3.5 Work Demarcation with other Package

Work demarcation with other package is proposed as table below.

Table 13.11 Proposed Work Demarcation with Other Package

Item		PKG	PKG 5 (KM32+600-42+000)	PKG 13 (O&M/ITS)	PKG 14 (Traffic Safety / Lighting)
Electrical System	Power Receiving System (Transformer)				X
	Diesel Engine Generator				X
	UPS			X	
	Power Cable			X (For ITS equipment)	X (For lighting)
Road Lighting System	Lamp				X
	Lighting Pole				X
	Foundation for Lighting Pole		X		
	Control Panel				X
Communication System	Communication Node			X	
	Fibre Optic Cable			X	
	Fibre Optic Connection & Terminal Box			X	
Conduit System	HDPE Pipe for Electrical and Lighting Systems		X		
	HDPE Pipe for Communication System		X		
	Manhole		X		
	Pull Box		X		
ITS Equipment	ITS Roadside Equipment			X	
	Structure and Foundation supporting ITS Equipment			X	
	Block out or other necessary civil works for ITS installation			X	

Source: Consultant

The proposed work demarcation is set up based on the following considerations.

- To avoid the double construction works such as excavation, backfill and pavement, the installation works of conduit system for power and communication cables shall be included in scope of PKG 5.
- The foundation for lighting pole must be constructed at a same timing with power cable conduit installation, because the PVC pipe protecting the power cable to feed the power to lamp must be buried in the concrete foundation for lighting pole. Thus, the construction work of foundation for lighting pole shall be also included in PKG 5.
- Dimension and weight of ITS equipment will be determined and fixed in detail after the contractor complete their detailed equipment design. Therefore, structure and foundation supporting ITS equipment shall be basically procured in the scope of PKG 13. However, necessary civil works for ITS installation such as blockout for axle load scale on concrete pavement at tollgate shall be properly arranged in the PKG 5.

14 CONSTRUCTION PLAN

- See Method Statement Report for Package 5

15 STATUS OF AGREEMENT WITH LOCAL AUTHORITIES

15.1 Basic Policy for Cross Structure Plan

The expressway is crossing many local roads. In principle, cross road shall be reinstalled and possess the existing function by providing appropriate cross structures (i.e. underpass, overpass or flyover).

Following planning policies are applied to culvert box (cross road) plan:

- Dimension of inner space of the culvert box (cross road) shall be maintained those of existing road, as well as complying with the standard value in TCVN4054-05 and 315/QD-BGTVT
- Location and classification of planned / ongoing road projects crossing the expressway shall be confirmed, and be incorporated into the cross structure plan
- To ensure efficiency of the design and construction of the culvert box, standardization of structure type is applied. Crossing angle of the culvert box for the expressway are categorized 90 degrees, 80 degrees, and 70 degrees

15.2 Status of Agreement with Local Authorities

During basic design and detailed design of PKG-5, the Consultant has discussed with local authorities and irrigation management agencies, as followings:

(1) Cross Structure Plan (Roadway)

- On 05/04/2012, the Consultant, PMU85, and PMU 1 had a meeting with the People's Committee of Thang Binh District. Proposed cross structure plan including location, cross structure type, road classification, and dimensions, and frontage road plan are basically agreed by the People's Committee of Thang Binh District and the minutes of agreement was signed by participated parties on 05/04/2012.
- On 11/04/2012, the Consultant, PMU85, and PMU 1 had a meeting with the People's Committee of Que Son District. Proposed cross structure plan including location, cross structure type, road classification, and dimensions, and frontage road plan are basically agreed by the People's Committee of Que Son District and the minutes of agreement was signed by participated parties on 11/04/2012.

(2) Cross Structure Plan (Waterway)

- On 11/04/2012, Consultant and PMU85 had a meeting with the People's Committee of Que Son district and communes. The two parties have confirmed on number, location and dimension of cross structures for waterways.
- On 05/04/2012, Consultant and PMU85 had a meeting with the People's Committee of Thang Binh district and communes. After site checking, the two parties have confirmed on number, location and dimension of cross structures for waterways.

The main conclusions of those meetings are as follows (detailed are shown in appendices):

- Cross drainage structures are culverts and approached canal, river, stream.

**APPENDIX 1: AGREEMENTS ON CROSS STRUCTURE PLAN WITH LOCAL AUTHORITIES (QUE SON
DISTRICT, THANG BINH – QUANG NGAI PROVINCE)**

**APPENDIX 1: AGREEMENTS ON CROSS STRUCTURE PLAN WITH LOCAL AUTHORITIES (QUE SON
DISTRICT, THANG BINH – QUANG NGAI PROVINCE)**

Thang Binh, April 5, 2012

MINUTES OF MEETING
DA NANG – QUANG NGAI EXPRESSWAY DEVELOPMENT PROJECT
Stage: Detailed design
Thang Binh District (Km38+650 – Km52+350)

TIME AND PLACE:

1. **Time:** 08h30 – 11h30, 5 April 2012;
2. **Place:** Meeting room – Thang Binh District People's Committee;
3. **Meeting Chairman:** Ms. Le Thi Thanh Mai– Vice Chairperson of Thang Binh DPC.

PARTICIPANTS:

1. Representative of Project Owner – PMU 85

- 1.1. Mr. Nguyen Khac Son – Deputy Project Manager;

2. Representatives of Thang Binh District

- 2.1. Ms. Le Thi Thanh Mai– Vice Chairman of Thang Binh DPC;
- 2.2. Mr. Do Vo Ban – Head of Economy – Infrastructure Division;
- 2.3. Mr. Nguyen Van Huy – Head of Finance and Planning Division;
- 2.4. Mr. Vo Van Tuong – Head of Natural Resources and Environment Division;
- 2.5. Mr. Pham Phu Hai – Director of Thang Binh irrigation branch;
- 2.6. Mr. Nguyen Quang – Specialist of Agriculture and Rural Development Division;
- 2.7. Mr. Phan Van Sau – Chairman of Binh Quy CPC;
- 2.8. Mr. Nguyen Duc Quang –Land Survey Officer of Binh Quy Commune;
- 2.9. Mr. Huynh Van Hoang – Chairman of Binh Chanh CPC;
- 2.10. Mr. Nguyen Van Nhien – Land Survey Officer of Binh Chanh Commune;
- 2.11. Mr. Le Thanh Hai– Chairman of Binh Que CPC;
- 2.12. Mr. Phan Duy Nhut – Land Survey Office of Binh Que Commune
- 2.13. Mr. Ngo Huong – Chaiman of Binh An CPC;
- 2.14. Mr. Nguyen Thanh Hung – Land Survey Officer of Binh An Commune;

3. Representatives of Design Consultant

- 3.1. Mr. Takayasu Nagai – Deputy Project Manager /Road Design Team Leader;
- 3.2. Mr. Doan Van Thang – Co-Project Manager /Highway Engineer;

DISCUSSION CONTENTS:

1. Alignment of the Expressway

- Alignment of the Expressway passing Thang Binh District follows basically the alignment approved by MOT in Decision No. 2656/QD-BGTVT dated 10 September 2010 and Document No. 1619/BGTVT-CQLXD dated 9 March 2012. The total length of expressway section passing Thang Binh District is 12.70 km.

- Crossing structures: Basically, appropriate cross structures (i.e. underpass, overpass or flyover) shall be provided with consideration of local planning at positions where the Expressway crosses local roads. Some locations shall be provided with frontage road.

- Drainage structures: including bridges, irrigation/drainage culverts relocation canals located along the expressway, side ditches, etc. Dimension of structures is designed in accordance with hydrological calculation results and existing conditions of local irrigation system;

The design results of the structures are presented from appendixes 1-5.

CONCLUSION

In the meeting, the followings are discussed and agreed among the parties:

- Basically, it is agreed with the design of the Consultant regarding location and dimension of structures presented from appendixes 1-5;
- During construction, the Owner is requested to direct involved agencies to provide temporary instatement methods and to agree with the local authority to ensure the continuity of local drainage/irrigation structures.

RECOMMENDATIONS OF THE LOCAL AUTHORITY

- For Binh Quy section:

+ It is to study additional canal in the west of expressway connecting with the bridges and culverts in order to increase the capacity of flood sewage in the rainy season;

+ It is considered the additional frontages in both side of the expressway from Km40+020 to Km40+380, the dimension of local frontage is followed the dimension of rural roads;

- For Binh Que section: It is to study additional C-typed underpass for the section of Km48+393-Km49+040;

- For Binh An section: It is to design the reinstatement of D25cm plastic pipe canal for the locality. The Consultant is requested to cooperate with Binh An commune, Binh Que commune and District Division of Agriculture and Rural Development during design and construction of pipeline;

- For irrigation system: It is basically agreed with the proposals of the Consultant. However, the Consultant is requested to coordinate with Quang Nam Irrigation Works Exploitation Single Member Limited Company and District Division of Agriculture and Rural Development on detail design.

The minutes is set into 10 copies with equal legal value. Each involved party keeps 1 copy.

Representative of PMU85 (signed & sealed) Mr. Nguyen Khac Son	Representative of Thang Binh DPC (signed & sealed) Ms. Le Thi Thanh Mai
Representative of Binh Quy CPC (signed) Mr. Phan Van Sau	Representative of Binh Chanh CPC (signed) Mr. Huynh Van Hoang
Representative of Binh Que CPC (signed) Mr. Le Thanh Hai	Representative of Binh An CPC (signed) Mr. Ngo Huong
Representative of Consultant (signed) Mr. Takayasu Nagai	

Appendix 1 : List of Cross Structure of roadway

No.	Station	Commune	Existing Width (m)	Assumed Class.	Type of Cross Structure	Dimensions (m)	Remarks
1	Km39+864.00	Binh Quý	2.3	C	Underpass	BxH=3.0x3.0	Internal hamlet 5
2	Km41+110.50		2-5	A	Combination with bridge	L=29	OP/FO with canal N22
3	Km41+234.00		7	III _{MN}	OP/FO	LxH=15x4.75	QL14E
4	Km42+189.00			C	Combination with bridge	L=24	OP/FO with canal N20
5	Km42+400.00		2	B	Underpass	BxH=4.0x3.0	
6	Km42+723.50		3.5	IV	OP/FO	LxH=35x4.5	DR08
7	Km43+312.00		2.5	C	Underpass	BxH=3.0x3.0	
8	Km43+656.00			B	Combination with bridge	L=24	OP/FO with canal N18
9	Km44+175.00		2	C	Underpass	BxH=3.0x3.0	
10	Km44+740.00		2	C	Underpass	BxH=4.0x3.5	combination with irrigation canal
11	Km45+260.00		4	B	Underpass	BxH=4.0x3.0	
12	Km45+540.00	Binh Chánh		A	Combination with bridge	L=24	OP/FO with canal N16
13	Km46+174.00			IV	OP/FO	LxH=12x4.5	DR10
14	Km46+440.00		3	C	Underpass	BxH=4.0x3.5	combination with irrigation canal
15	Km47+135.50			IV	OP/FO	LxH=12x4.5	DR06
16	Km47+586.00		2	B	Underpass	BxH=4.0x3.0	
17	Km48+393.5			V	Combination with bridge	L=24	DR13 + canal TL
18	Km49+040.00	Binh Quế	2	A	Underpass	BxH=5.0x3.5	
19	Km49+398.50		2	A	Underpass	BxH=5.0x3.5	
20	Km50+413.00	Binh An	4	A	Underpass	BxH=5.0x3.5	
21	Km50+718.00		3	B	Underpass	BxH=4.0x3.0	
22	Km51+121.00	Binh Quế	2	B	Underpass	BxH=4.0x3.0	
23	Km51+271.00		3.5	IV	OP/FO	LxH=12x4.5	DR04
24	Km51+577.00		3.5	C	Underpass	BxH=4.0x3.5	combination with irrigation canal
25	Km52+066.00	Binh An	3	A	Underpass	BxH=5.0x3.5	

Appendix-2

List of Culverts (Drainage)

No.	Station	Commune	Type	Dimension (m)	Remarks
1	Km40+600.00	Bình Quý	Pipe culvert	D1.5	
2	Km40+714.00		Pipe culvert	D1.5	
3	Km40+900.00		Pipe culvert	D1.5	
4	Km41+110.00		Pipe culvert	D1.5	
5	Km43+916.00		Pipe culvert	D1.5	
6	Km44+224.00		Pipe culvert	D1.5	
7	Km45+005.00		Pipe culvert	D1.5	
8	Km45+746.00	Bình Chánh	Box culvert	2.0x2.0	
9	Km46+832.00		Box culvert	2.0x2.0	
10	Km46+872.00		Box culvert	2.0x2.0	
11	Km47+685.00		Pipe culvert	D1.5	
12	Km48+145.00		Pipe culvert	D1.5	
13	Km48+417.00	Bình Quế	Pipe culvert	D1.5	
14	Km48+767.00		Box culvert	3.0x2.0	
15	Km49+035.00		Pipe culvert	D1.5	
16	Km49+490.00		Box culvert	2.0x2.0	
17	Km49+700.00	Bình An	Pipe culvert	D1.5	
18	Km50+342.00		Pipe culvert	D1.5	
19	Km50+483.00		Pipe culvert	D1.5	
20	Km50+780.00		Pipe culvert	D1.5	
21	Km51+134.00	Bình Quế	Box culvert	2.0x2.0	
22	Km51+330.00		Box culvert	2x(2.5x2.5)	
23	Km52+030.00	Bình An	Pipe culvert	D1.5	
Total			Pipe culvert	16	Location
			Box culvert	7	Location

Appendix-3 List of Frontage Road

No.	Commune	Station (left side)		Length	Station (right side)		Length
		From	To	(m)	From	To	(m)
1	Bình Quý	Km39+817.00	Km40+095.00	278.00	Km41+211.00	Km41+536.00	325.00
2		Km41+484.00	Km41+700.00	216.00			
3		Km42+480.50	Km42+941.50	461.00	Km42+685.00	Km42+767.00	82.00
4		Km43+111.00	Km43+321.00	210.00	Km43+140.00	Km43+642.00	502.00
5		Km43+510.00	Km43+650.00	140.00	Km43+661.50	Km44+167.50	506.00
6		Km43+860.00	Km44+176.00	316.00	Km44+739.50	Km44+784.00	44.50
7		Km44+930.00	Km45+287.00	357.00	Km45+080.00	Km45+287.00	207.00
	Total length			3644.50			
8	Bình Chánh	Km46+077.50	Km46+238.50	161.00	Km46+170.00	Km46+290.00	120.00
9		Km46+397.50	Km46+695.00	297.50	Km46+395.00	Km46+647.00	252.00
10		Km46+967.00	Km47+140.00	173.00	Km46+866.00	Km47+208.00	342.00
11		Km47+460.00	Km47+728.00	268.00	Km47+498.00	Km47+604.00	106.00
12					Km48+269.00	Km48+382.50	113.50
13					Km48+385.00	Km48+416.00	31.00
	Total length			1864.00			
14	Bình Quế	Km48+545.00	Km48+844.00	299.00	Km48+416.00	Km48+455.00	39.00
15					Km48+580.00	Km48+773.00	193.00
16		Km49+313.00	Km49+400.00	87.00	Km49+028.00	Km49+174.00	146.00
	Total length			764.00			
17	Bình An	Km50+347.50	Km50+417.00	69.50	Km50+716.50	Km50+818.00	101.50
18		Km50+704.00	Km50+819.50	115.50			0.00
	Total length			286.50			
19	Bình Quế	Km51+052.00	Km51+123.50	71.50	Km51+530.00	Km51+641.00	111.00
	Total length			182.50			
20	Bình An	Km52+018.00	Km52+080.00	62.00			
	Total length			62.00			
Total							6803.50 m

**Consulting Services for
Detailed Design for Danang - Quang Ngai Expressway Development Project
IDA Credit No. 3843-VN**

Appendix-4 List of Relocation Canal

No.	Commune	Station		Side	Length	Width	Remarks
		From	To		(m)	(m)	
1	Bình Quý	Km40+585.00	Km40+600.00	Right	15		Concrete
2		Km40+600.00	Km40+636.00	Left	36		Concrete
3		Km42+460.50	Km42+560.00	Right	99.5	6	Soil
4		Km44+738.00	Km44+784.00	Right	46	2	Soil
5	Bình Chánh	Km45+897.00	Km45+935.00	Right	38	2	Soil
6		Km46+791.50	Km46+833.50	Right	42	2	Soil
7		Km47+979.50	Km48+068.00	Right	88.5	2	Soil
8	Bình Quế	Km48+570.00	Km48+768.50	Left	198.5	2.5	Soil
9		Km50+780.00	Km50+819.50	Right	39.5	1	Soil
10		Km50+780.00	Km50+818.00	Left	38	1	Soil
11		Km51+057.00	Km51+146.00	Left	89	2	Soil
Total length					730.00m		

Appendix-5 List of Bridges

No	Commune	Bridge code	Station	Length (m)	Span layout
1	Bình Quý	LRB08	KM039+645	165	
2		CB09	KM040+111	57.9	1@40
3		OP10	KM041+234	37.8	1@22
4		CB10	KM042+189	43.6	1@27
5	Bình Chánh	ORB10	KM042+463	30.8	1@14
6		OP11	KM042+723	52.2	1@40
7		CB11	KM043+656	46	1@30
8		ORB11	KM044+435	88.4	3@27
9		ORB12	KM045+434	92.4	3@27
10		CB12	KM045+584	82.55	2@33
11		ORB13	KM045+889	96.2	3@27
12		LRB09	KM047+920	164.3	5@30
13		CB13	KM048+393	37.8	1@22
14	Bình Quế	OP12	KM048+834	29.6	1@14
15		OP13	KM049+037	32.8	1@17
16		OP14	KM051+268	38.1	1@24

Thăng Bình, ngày 5 tháng 4 năm 2012

BIÊN BẢN THỎA THUẬN
DỰ ÁN ĐƯỜNG CAO TỐC ĐÀ NẴNG - QUẢNG NGÃI
Giai đoạn: Thiết kế kỹ thuật
Đoạn qua huyện Thăng Bình (Km38+650 – Km52+350)

THỜI GIAN, ĐỊA ĐIỂM:

1. Thời gian họp: 8h30 – 11h30, ngày 5/4/2012;
2. Địa điểm họp: Phòng họp – UBND huyện Thăng Bình;
3. Chủ trì cuộc họp: Bà Lê Thị Thanh Mai – Phó Chủ tịch huyện.

THÀNH PHẦN THAM DỰ:

1. Đại diện Chủ đầu tư – Ban QLDA 85

- 1.1. Ông: Nguyễn Khắc Sơn – Phó Giám đốc Ban điều hành;

2. Đại diện UBND huyện Thăng Bình

- | | |
|------------------------------|---|
| 2.1. Bà: Lê Thị Thanh Mai | – Phó Chủ tịch UBND huyện; |
| 2.2. Ông: Đỗ Võ Bán | – Trưởng Phòng Kinh tế - Hạ Tầng; |
| 2.3. Ông: Nguyễn Văn Húy | – Trưởng Phòng TC - KH; |
| 2.4. Ông: Võ Văn Tường | – Trưởng Phòng tài nguyên và môi trường; |
| 2.5. Ông: Phạm Phú Hải | – Giám đốc chi nhánh thủy lợi Thăng Bình; |
| 2.6. Ông: Nguyễn Quang | – Chuyên viên Phòng NN&PTNT; |
| 2.7. Ông: Phan Văn Sau | – Chủ tịch UBND xã Bình Quý; |
| 2.8. Ông: Nguyễn Đức Quang | – Cán bộ địa chính xã Bình Quý; |
| 2.9. Ông: Huỳnh Văn Hoàng | – Chủ tịch UBND xã Bình Chánh; |
| 2.10. Ông: Nguyễn Văn Nhiên | – Cán bộ địa chính xã Bình Chánh; |
| 2.11. Ông: Lê Thanh Hải | – Chủ tịch UBND xã Bình Quế; |
| 2.12. Ông: Phan Duy Nhựt | – Cán bộ địa chính xã Bình Quế; |
| 2.13. Ông: Ngô Hường | – Chủ tịch UBND xã Bình An; |
| 2.14. Ông: Nguyễn Thành Hưng | – Cán bộ địa chính xã Bình An; |

3. Đại diện Tư vấn thiết kế

- 3.1. Ông: Takayasu Nagai – Phó Giám đốc dự án/Trưởng nhóm thiết kế đường;
- 3.2. Ông: Đoàn Văn Thắng – Đồng Giám đốc dự án/Kỹ sư đường cao tốc;

NỘI DUNG THẢO LUẬN:

- Hướng tuyến đường cao tốc trong phạm vi huyện Thăng Bình tuân theo hướng tuyến đã được Bộ GTVT phê duyệt tại Quyết định số 2656/QĐ-BGTVT ngày 10/9/2010 và văn bản số 1619/BGTVT-CQLXD ngày 9/3/2012. Tổng chiều dài đoạn tuyến qua địa phận huyện Thăng Bình khoảng 12.70km;
- Các công trình dân sinh: về cơ bản các vị trí đường cao tốc cắt đường hiện tại sẽ bố trí các công trình cống chui (hoặc cầu vượt). Một số vị trí không bố trí cống chui (hoặc cầu vượt) sẽ thiết kế đường gom hai bên đường cao tốc để thu gom về các vị trí chui/vượt phù hợp;
- Các công trình thoát nước: gồm cầu, cống tưới/tiêu, hệ thống mương cải dọc theo đường cao tốc, các tuyến rãnh dọc... Kích thước các công trình được thiết kế theo kết quả tính toán thủy văn và các điều kiện hiện trạng của hệ thống thủy lợi địa phương;
Kết quả thiết kế các công trình trong phạm vi huyện Thăng Bình được thống kê theo các phụ lục từ 1 – 5 (kèm theo biên bản);

KẾT QUẢ THỐNG NHẤT:

Sau khi các thành viên dự họp thảo luận nội dung liên quan, Hội nghị đi đến thống nhất một số nội dung như sau:

- Cơ bản thống nhất với những đề xuất của Tư vấn thiết kế về vị trí, khẩu độ các công trình theo các phụ lục từ 1 – 5 (kèm theo biên bản);
- Trong quá trình thi công đề nghị Chủ đầu tư chỉ đạo các đơn vị liên quan đưa ra các biện pháp hoàn trả tạm thời và thống nhất với địa phương để đảm bảo các công trình phục vụ tưới tiêu của địa phương không bị gián đoạn;

ĐỀ XUẤT CỦA ĐỊA PHƯƠNG:

- Trong phạm vi xã Bình Quý:
 - + Nghiên cứu bổ sung mương phía Tây dọc đường cao tốc nối về các cầu, cống để tăng khả năng thoát lũ về mùa mưa;
 - + Xem xét bổ sung đường gom 2 bên từ Km40+020 – Km40+380, quy mô của đường gom dân sinh theo quy mô đường giao thông nông thôn;
- Xã Bình Quế: Nghiên cứu bổ sung cống chui loại C đoạn từ Km48+393 – Km49+040;
- Xã Bình An: Đoạn khoảng Km51+120-51+280 thiết kế hoàn trả tuyến kênh ống nhựa tưới D25cm cho địa phương. Đề nghị phối hợp với xã Bình An, Bình Quế và phòng Nông Nghiệp phát triển nông thôn trong quá trình thiết kế, thi công tuyến ống;
- Hệ thống kênh thủy lợi: cơ bản thống nhất với đề xuất của Tư vấn. Tuy nhiên, đề nghị Đơn vị Tư vấn phối hợp với Công ty TNHH một thành viên khai thác thủy lợi Quảng Nam và Phòng Nông nghiệp phát triển nông thôn Huyện trong quá trình thiết kế chi tiết;

Biên bản được lập thành 10 bản có giá trị pháp lý như nhau. Mỗi bên liên quan giữ 01 bản.

<p>Đại diện Ban QLDA 85</p>  <p>Nguyễn Khắc Sơn</p>	<p>Đại diện UBND huyện Thăng Bình</p>  <p>PHÓ CHỦ TỊCH</p>  <p>Lê Thị Thanh Mai</p>
<p>Đại diện xã Bình Quý</p>  <p>Phan Văn Sang</p>	<p>Đại diện xã Bình Chánh</p>  <p>Huỳnh Văn Hoàng</p>
<p>Đại diện xã Bình Quế</p>  <p>Lê Thanh Hải</p>	<p>Đại diện xã Bình An</p>  <p>Ngô Hường</p>
<p>Đại diện Tư vấn thiết kế <i>Phimail</i></p>  <p>Takayasu Nagai</p>	

Phụ lục 1 Danh sách các kết cấu ngang đường

STT	Lý trình	Xã	Betông Hiện tại (m)	Phương đường để xuất	Loại kết cấu ngang	Kích thước (m)	Ghi chú
1	Km39+864.00	Bình Quỷ	2.3	C	Cống chui	BxH=3.0x3.0	Đường nội bộ thôn 4
2	Km41+110.50		2-5	A	K/h cầu	L =29	Cầu vượt kênh chính Bắc Phú Ninh
3	Km41+234.00		7	III _{MN}	Cầu vượt	LxH=15x4.75	QL14E
4	Km42+189.00			C	K/h cầu	L =24	Cầu vượt kênh N20
5	Km42+400.00		2	B	Cống chui	BxH=4.0x3.0	
6	Km42+723.50		3.5	IV	Cầu vượt	LxH =35x4.5	ĐH08
7	Km43+312.00		2.5	C	Cống chui	BxH=3.0x3.0	Đường nội bộ thôn 3
8	Km43+656.00			B	K/h cầu	L =24	Cầu vượt kênh N18
9	Km44+175.00		2	C	Cống chui	BxH=3.0x3.0	
10	Km44+740.00		2	C	Cống chui	BxH=4.0x3.5	Kết hợp mương tưới
11	Km45+260.00		4	B	Cống chui	BxH=4.0x3.0	
12	Km45+540.00	Bình Chánh		A	K/h cầu	L =24	Cầu vượt kênh N1c
13	Km46+174.00			IV	Cầu vượt	LxH =12x4.5	ĐH10
14	Km46+440.00		3	C	Cống chui	BxH=4.0x3.5	Kết hợp mương tưới
15	Km47+135.50			IV	Cầu vượt	LxH =12x4.5	ĐH06
16	Km47+586.00		2	B	Cống chui	BxH=4.0x3.0	
17	Km48+393.5			V	K/h cầu	L =24	ĐH13 + kênh N14
18	Km49+040.00	Bình	2	A	Cống chui	BxH=5.0x3.5	
19	Km49+398.50	Quế	2	A	Cống chui	BxH=5.0x3.5	
20	Km50+413.00	Bình An	4	A	Cống chui	BxH=5.0x3.5	
21	Km50+718.00		3	B	Cống chui	BxH=4.0x3.0	
22	Km51+121.00	Bình Quế	2	B	Cống chui	BxH=4.0x3.0	
23	Km51+271.00		3.5	IV	Cầu vượt	LxH =12x4.5	ĐH04
24	Km51+577.00		3.5	C	Cống chui	BxH=4.0x3.5	Kết hợp mương tưới
25	Km52+018.00	Bình An	3	A	Cống chui	BxH=5.0x3.5	

Phụ lục 2 Danh sách cống thoát nước

SSTT	Lý trình	Xã	Loại cống	Kích thước (m)	Chiều dài
1	Km40+600.00	Bình Quý	Cống tròn	D1.5	
2	Km40+714.00		Cống tròn	D1.5	
3	Km40+900.00		Cống tròn	D1.5	
4	Km41+110.00		Cống tròn	D1.5	
5	Km43+916.00		Cống tròn	D1.5	
6	Km44+224.00		Cống tròn	D1.5	
7	Km45+005.00		Cống tròn	D1.5	
8	Km45+746.00	Bình Chánh	Cống hộp	2.0x2.0	
9	Km46+832.00		Cống hộp	2.0x2.0	
10	Km46+872.00		Cống hộp	2.0x2.0	
11	Km47+685.00		Cống tròn	D1.5	
12	Km48+145.00		Cống tròn	D1.5	
13	Km48+417.00	Bình Quế	Cống tròn	D1.5	
14	Km48+767.00		Cống hộp	3.0x2.0	
15	Km49+035.00		Cống tròn	D1.5	
16	Km49+490.00		Cống hộp	2.0x2.0	
17	Km49+700.00	Bình An	Cống tròn	D1.5	
18	Km50+342.00		Cống tròn	D1.5	
19	Km50+483.00		Cống tròn	D1.5	
20	Km50+780.00		Cống tròn	D1.5	
21	Km51+134.00	Bình Quế	Cống hộp	2.0x2.0	
22	Km51+330.00		Cống hộp	2x(2.5x2.5)	
23	Km52+030.00	Bình An	Cống tròn	D1.5	
Tổng cộng			Tròn	16	Vị trí
			Hộp	7	Vị trí

(Ghi chú: Vị trí và khẩu độ các cống tiêu nước có thể thay đổi theo kết quả tính toán thủy văn)

Phụ lục 3 Danh sách đường gom

Stt	Xã	Lý trình theo hướng đi		Chiều dài (m)	Lý trình theo phương tiện		Chiều dài (m)
		Từ	Đến		Từ	Đến	
1	Bình Quý	Km39+817.00	Km40+095.00	278.00	Km41+211.00	Km41+536.00	325.00
2		Km41+484.00	Km41+700.00	216.00			
3		Km42+480.50	Km42+941.50	461.00	Km42+685.00	Km42+767.00	82.00
4		Km43+111.00	Km43+321.00	210.00	Km43+140.00	Km43+642.00	502.00
5		Km43+510.00	Km43+650.00	140.00	Km43+661.50	Km44+167.50	506.00
6		Km43+860.00	Km44+176.00	316.00	Km44+739.50	Km44+784.00	44.50
7		Km44+930.00	Km45+287.00	357.00	Km45+080.00	Km45+287.00	207.00
	Tổng chiều dài			3644.50			
8	Bình Chánh	Km46+077.50	Km46+238.50	161.00	Km46+170.00	Km46+290.00	120.00
9		Km46+397.50	Km46+695.00	297.50	Km46+395.00	Km46+647.00	252.00
10		Km46+967.00	Km47+140.00	173.00	Km46+866.00	Km47+208.00	342.00
11		Km47+460.00	Km47+728.00	268.00	Km47+498.00	Km47+604.00	106.00
12					Km48+269.00	Km48+382.50	113.50
13					Km48+385.00	Km48+416.00	31.00
	Tổng chiều dài			1864.00			
14	Bình Quế	Km48+545.00	Km48+844.00	299.00	Km48+416.00	Km48+455.00	39.00
15					Km48+580.00	Km48+773.00	193.00
16		Km49+313.00	Km49+400.00	87.00	Km49+028.00	Km49+174.00	146.00
	Tổng chiều dài			764.00			
17	Bình An	Km50+347.50	Km50+417.00	69.50	Km50+716.50	Km50+818.00	101.50
18		Km50+704.00	Km50+819.50	115.50			0.00
	Tổng chiều dài			286.50			
19	Bình Quế	Km51+052.00	Km51+123.50	71.50	Km51+530.00	Km51+641.00	111.00
	Tổng chiều dài			182.50			
20	Bình An	Km52+018.00	Km52+080.00	62.00			
	Tổng chiều dài			62.00			

Phụ lục 4 Danh sách cải mương

Phụ lục 4

Danh sách các đường

STT	Xã	Điểm		Bên	Chiều dài	Rộng	Ghi chú
		Trái	Phải		(m)	(m)	
1	Bình Quý	Km40+585.00	Km40+600.00	Phải	15		Bê tông
2		Km40+600.00	Km40+636.00	Trái	36		Bê tông
3		Km42+460.50	Km42+560.00	Phải	99.5	6	Đất
4		Km44+738.00	Km44+784.00	Phải	46	2	Đất
5	Bình Chánh	Km45+897.00	Km45+935.00	Phải	38	2	Đất
6		Km46+791.50	Km46+833.50	Phải	42	2	Đất
7		Km47+979.50	Km48+068.00	Phải	88.5	2	Đất
8	Bình Quế	Km48+570.00	Km48+768.50	Trái	198.5	2.5	Đất
9		Km50+780.00	Km50+819.50	Phải	39.5	1	Đất
10		Km50+780.00	Km50+818.00	Trái	38	1	Đất
11		Km51+057.00	Km51+146.00	Trái	89	2	Đất
Tổng					730.00m		

Phụ lục 5 Danh mục công trình cầu

STT	Xã	Mã cầu	Lý trình	Chiều dài	Số dầm
1	Bình Quý	LRB08	KM039+645	165	
2		CB09	KM040+111	57.9	1@40
3		OP10	KM041+234	37.8	1@22
4		CB10	KM042+189	43.6	1@27
5	Bình Chánh	ORB10	KM042+463	30.8	1@14
6		OP11	KM042+723	52.2	1@40
7		CB11	KM043+656	46	1@30
8		ORB11	KM044+435	88.4	3@27
9		ORB12	KM045+434	92.4	3@27
10		CB12	KM045+584	82.55	2@33
11		ORB13	KM045+889	96.2	3@27
12		LRB09	KM047+920	164.3	5@30
13		CB13	KM048+393	37.8	1@22
14		OP14	KM051+268	38.1	1@24

(Ghi chú: Chiều dài cầu tính đến đuôi móng)

Que Son, 11 April 2012

MINUTES OF MEETING
DA NANG – QUANG NGAI EXPRESSWAY PROJECT
Stage: Detailed design
Que Son District (Km29+465 – Km39+650)

TIME AND PLACE:

1. **Time:** 8h30 – 11h30, 11 April 2012;
2. **Place:** Meeting room – Que Son District People's Committee;
3. **Meeting Chairman:** Mr. Tran Dai Nghia – Vice Chairman of Que Son DPC.

PARTICIPANTS:

1. Representatives of Project Owner – PMU 85

- 1.1. Mr. Le Trong Do – Deputy Project Manager;

2. Representatives of Que Son DPC

- 2.1. Mr. Tran Dai Nghia – Vice Chairman of DPC;
- 2.2. Mr. Doan Hao – Chief of the District People's Committee and People's Council Secretariat;
- 2.3. Mr. Tran Ngoc Kinh – Head of Natural Resources and Environment Division;
- 2.4. Mr. Duong Ngoc Hoang – Deputy Head of Economy - Infrastructure Division;
- 2.5. Mr. Trieu Ngoc Chi – Director of Land Source Development Center;
- 2.6. Mr. Nguyen Truong Sang – Chairman of Phu Tho CPC;
- 2.7. Mr. Bui Quang Huan – Chairman of Que Xuan 2 CPC;
- 2.8. Mr. Le Thanh Chung – Land officer of Que Xuan 2 Commune;
- 2.9. Mr. Nguyen Nhut – Director of Que Son Irrigation Branch;

3. Representatives of Design Consultant

- 3.1. Mr. Takayasu Nagai – Deputy Project Manager /Road Design Team Leader;
- 3.2. Mr. Doan Van Thang – Co-Project Manager /Highway Engineer;

DISCUSSION CONTENT:

- Alignment of the Expressway in Que Son section follows the alignment approved by MOT in Decision No. 2656/QĐ-BGTVT dated 10 September 2010 and Document No. 1619/BGTVT-CQLXD dated 9 March 2012. The total length of Que Son section is approximately 10.20km;

- Residential structures: Underpass (or overpass) shall be basically provided at the positions where the Expressway crosses existing roads. Some locations shall be provided frontage roads;
- Drainage structures include bridges, drainage/irrigation culverts, relocation canals along the expressway and side ditches, etc... Dimension of these structures are determined in accordance with hydrological calculation results and current situation of local irrigation system;

Results of structures in Que Son section are shown in Appendix 1~4 (see attachments);

MEETING CONCLUSION:

After discussion, the followings are agreed among the parties:

- The location and openings of structures as shown in Appendix 1~4 (see attachments) proposed by Consultant are basically agreed;
- During construction, the Project Owner is requested to direct involved agencies to provide temporary reinstatement methods and to agree with the local authority to ensure the continuity of local drainage/irrigation structures;

The Project Owner and Consultant are requested to consider and update recommendations of local authority to the Project as below:

RECOMMENDATIONS OF LOCAL AUTHORITY:

- Que Xuan 2 commune:
 - + At Km30+040: position of District Road 14. It is requested to apply AH-class and further consideration for appropriate location in correlation with the design is required;
 - + At Km32+070: sub-section of District Road 01: It is requested to consider the vertical clearance to be increased to $H=4m$ to ensure navigation of vehicles;
 - + Km32+430: position of District Road 01 section which is under construction with $B_{formation}=6.5m$, $B_{pavement}=3.5m$. It is requested to apply AH-class;
 - + From Km32+500 to Km34+149: It is requested to consider to provide an additional underpass that serves for agriculture and forestry production of local people (C-class);
 - + Road leading to Huong Mao Lake (Km34+149): Clearance is requested to be at least $H=4.5m$ to serve for maintenance works of Huong Mao dam;
- Phu Tho Commune:
 - + At Km36+416: It is proposed to adjust vertical clearance to be correlated with A-class ($H=3.5m$);
 - + At Km37+619: District Road 23. It is requested to adjust to AH class;
 - + At Km38+920: District Road 06. It is requested to adjust to AH class;
- Regarding Provincial Roads. Consultant is requested to work with Quang Nam DOT;
- It is requested to cooperate with DPC in terms of survey for material sources, positions of waste sites;

The Minutes is prepared in 10 copies with equally legal value. Each involved party keeps 1 copy.

<p>Representative of PMU85</p> <p>Le Trong Do</p>	<p>Representative of Que Son DPC</p> <p>Tran Dai Nghia</p>
<p>Representative of Que Xuan 2 Commune</p> <p>Bui Quang Huan</p>	<p>Representative of Phu Tho Commune</p> <p>Nguyen Truong Sang</p>
<p>Representative of Que Son Irrigation Branch</p> <p>Nguyen Nhut</p>	<p>Representative of Design Consultant</p> <p>Takayasu Nagai</p>

Appendix 1 List of Cross Structures (Roadway)

No.	Station	Commune	Existing width (m)	Assumed road classification	Assumed crossing type	Dimension (m)	Remark
1	Km030+296.00	Que Xuan 2	2.50	B	Underpass	[BxH] = [4.0 x 3.0]	
2	Km031+278.00		3.00	C	Underpass	[BxH] = [3.0 x 3.0]	
3	Km032+070.00		3.00	B	Underpass	[BxH] = [4.0 x 3.0]	
4	Km032+510.50			A	Overpass	[LxH] = [37.50 x 3.5]	Canal bridge + Frontage road
5	Km034+149.00			C	Overpass	[LxH] = [48.10 x 3.0]	Stream bridge + Frontage road
6	Km035+094.00	Phu Tho	3.00	C	Underpass	[BxH] = [3.0 x 3.0]	Hamlet 3. Phu Tho Commune
7	Km035+487.00		11.00	IV_{DB}	Overpass	[LxH] = [33.80 x 4.5]	PR611
8	Km036+416.00			C	Overpass	[LxH] = [85.20 x 3.0]	Stream bridge + Frontage road
9	Km037+619.00		3.00	B	Underpass	[BxH] = [4.0 x 3.0]	Group 4. Phuoc Phu Dong Hamlet. Phu Tho Commune
10	Km038+356.50		2.80	C	Overpass	[LxH] = [170.10 x 3.0]	River bridge + Cross road
11	Km038+920.00		5.00	A	Underpass	[BxH] = [5.0 x 3.5]	Group 3. Hamlet 5. Phu Tho Commune

Appendix 2 List of Drainage Culverts

No.	Commune	Station	Type	Dimension (m)	Remark
1	Que Xuan 2	Km029+145.5	Box culvert	2.0*2.0	
2		Km030+520.0	Pipe culvert	D1.5	
3		Km030+640.0	Pipe culvert	D1.5	
4		Km030+981.0	Pipe culvert	D1.5	
5		Km031+123.0	Box culvert	2.0*2.0	
6		Km031+290.0	Box culvert	2.5*2.5	
7		Km031+675.0	Pipe culvert	D1.5	
8		Km032+380.0	Box culvert	2*2	
9		Km032+660.0	Pipe culvert	D1.5	Soil canal
10		Km032+856.0	Box culvert	2*(2.5*2.5)	Soil canal
11		Km033+230.0	Pipe culvert	D1.5	
12		Km033+525.0	Pipe culvert	D1.5	
13		Km033+834.0	Pipe culvert	D1.5	
14		Km033+923.0	Pipe culvert	D1.5	
15	Phu Tho	Km035+100.0	Pipe culvert	D1.5	
16		Km035+700.0	Pipe culvert	D1.5	
17		Km037+420.0	Pipe culvert	D1.5	
18		Km037+600.0	Box culvert	2.5*2.5	
19		Km037+690.0	Pipe culvert	D1.5	
20		Km037+975.0	Pipe culvert	D1.5	
21		Km038+230.0	Pipe culvert	D1.5	Masonry canal
22		Km039+145.0	Pipe culvert	D1.5	
23		Km039+380.0	Pipe culvert	D1.5	
	Total	Pipe culvert		17 locations	
		Box culvert		06 locations	

Appendix 3 List of Frontage Roads

Appendix 2 List of Frontage Roads						
No.	Commune	Station		Length (m)	Side	Remark
		From	To			
1	Que Xuan 2	Km29+642	Km30+300	658.00	Left	
2		Km29+642	Km30+293	651.00	Right	
3		Km31+278	Km31+480	202.00	Left	
4		Km32+020	Km32+120	100.00	Left	
5		Km32+040	Km32+180	140.00	Right	
6		Km32+380	Km32+520	140.00	Right	
	Length (Que Xuan 2)			1,891.00		
9	Phu Tho	Km34+185	Km34+502	317.00	Left	
10		Km34+869	Km35+259	390.00	Left	
11		Km36+439	Km36+628	189.00	Left	
12		Km36+439	Km36+590	151.00	Left	
	Length (Phu Tho)			1,047.00		
	Total length of frontage road			2,938.00		

Appendix 4 List of Relocation Canals

No.	Commune	Station		Length (m)	Side	Remark
		From	To			
1	Que Xuan 2	Km31+123	Km31+160	37.00	Left	Soil
2		Km32+606	Km32+660	54.00	Right	Soil
3		Km32+856	Km33+006	150.00	Right	Soil
	Total length (Que Xuan 2)			241.00		
4	Phu Tho	Km38+090	Km38+288	198.00	Right	Soil
5		Km38+165	Km38+230	65.00	Right	Concrete
6		Km38+208	Km38+288	80.00	Left	Soil
	Total Length (Phu Tho)			343.00		
	Total length of relocation canall			584.00		

Quế Sơn, ngày 11 tháng 4 năm 2012

BIÊN BẢN THỎA THUẬN
DỰ ÁN ĐƯỜNG CAO TỐC ĐÀ NẴNG - QUẢNG NGÃI
Giai đoạn: Thiết kế kỹ thuật
Đoạn qua huyện Quế Sơn (Km29+465 – Km39+650)

THỜI GIAN, ĐỊA ĐIỂM:

1. Thời gian họp: 8h30 – 11h30, ngày 11/4/2012;
2. Địa điểm họp: Phòng họp – UBND huyện Quế Sơn;
3. Chủ trì cuộc họp: Ông Trần Đại Nghĩa – Phó Chủ tịch huyện.

THÀNH PHẦN THAM DỰ:

1. Đại diện Chủ đầu tư – Ban QLDA 85
 - 1.1. Ông: Lê Trọng Độ – Phó Giám đốc Ban điều hành;
2. Đại diện UBND huyện Quế Sơn
 - 2.1. Ông: Trần Đại Nghĩa – Phó Chủ tịch UBND huyện;
 - 2.2. Ông: Doãn Hào – Chánh văn phòng HĐND & UBND huyện;
 - 2.3. Ông: Trần Ngọc Kính – Trưởng Phòng TN - MT;
 - 2.4. Ông: Dương Ngọc Hoàng – Phó Trưởng Phòng KT-IT;
 - 2.5. Ông: Triệu Ngọc Chí – Giám đốc Trung Tâm phát triển Quỹ đất;
 - 2.6. Ông: Nguyễn Trường Sang – Chủ tịch UBND xã Phú Thọ;
 - 2.7. Ông: Bùi Quang Huân – Chủ tịch UBND xã Quế Xuân 2;
 - 2.8. Ông: Lê Thanh Chung – Cán bộ địa chính xây dựng xã Quế Xuân 2;
 - 2.9. Ông: Nguyễn Nhựt – Giám đốc Chi nhánh Thủy Lợi Quế Sơn;
3. Đại diện Tư vấn thiết kế
 - 3.1. Ông: Takayasu Nagai – Phó Giám đốc dự án/Trưởng nhóm thiết kế đường;
 - 3.2. Ông: Đoàn Văn Thắng – Đồng Giám đốc dự án/Kỹ sư đường cao tốc;

NỘI DUNG THẢO LUẬN:

- Hướng tuyến đường cao tốc trong phạm vi huyện Quế Sơn tuân theo hướng tuyến đã được Bộ GTVT phê duyệt tại Quyết định số 2656/QĐ-BGTVT ngày 10/9/2010 và văn bản số 1619/BGTVT-CQLXD ngày 9/3/2012. Tổng chiều dài đoạn tuyến qua địa phận huyện Quế Sơn khoảng 10.20km;
- Các công trình dân sinh: về cơ bản các vị trí đường cao tốc cắt đường hiện tại sẽ bố trí

các công trình cống chui (hoặc cầu vượt). Một số vị trí không bố trí cống chui (hoặc cầu vượt) sẽ thiết kế đường gom hai bên đường cao tốc để thu gom về các vị trí chui/vượt phù hợp;

- Các công trình thoát nước: gồm cầu, cống tưới/tiêu, hệ thống mương cải dọc theo đường cao tốc, các tuyến rãnh dọc... Kích thước các công trình được thiết kế theo kết quả tính toán thủy văn và các điều kiện hiện trạng của hệ thống thủy lợi địa phương;

Kết quả thiết kế các công trình trong phạm vi huyện Quế Sơn được thống kê theo các phụ lục từ 1 -- 4 (kèm theo biên bản);

KẾT QUẢ THÔNG NIẾT:

Sau khi các thành viên dự họp thảo luận nội dung liên quan, Hội nghị đi đến thống nhất một số nội dung như sau:

- Cơ bản thống nhất với những đề xuất của Tư vấn thiết kế về vị trí, khẩu độ các công trình theo các phụ lục từ 1 -- 4 (kèm theo biên bản);
- Trong quá trình thi công đề nghị Chủ đầu tư chỉ đạo các đơn vị liên quan đưa ra các biện pháp hoàn trả tạm thời và thống nhất với địa phương để đảm bảo các công trình phục vụ tưới tiêu của địa phương không bị gián đoạn;

Đề nghị Chủ đầu tư, đơn vị tư vấn xem xét cập nhật vào dự án đường cao tốc một số các đề xuất của địa phương bao gồm:

ĐỀ XUẤT CỦA ĐỊA PHƯƠNG:

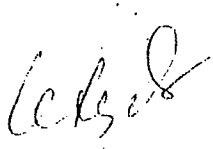

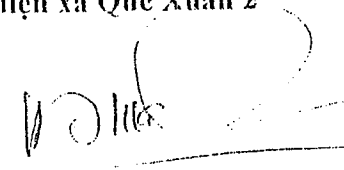
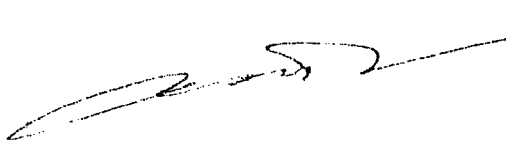
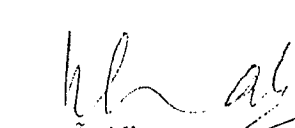
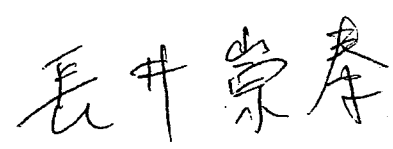
- Xã Quế Xuân 2:

- + Tại Km30+040: trùng với vị trí đường ĐH14. Đề nghị áp dụng loại AH và cân nhắc vị trí phù hợp với phương án thiết kế đường cao tốc;
- + Km32+070: là một nhánh phụ của ĐH01: đề nghị xem xét tăng chiều cao tính không đứng $H=4m$ để đảm bảo lưu thông qua lại của phương tiện;
- + Khoảng Km32+430 trùng với vị trí đường huyện ĐH01 đang triển khai thi công với quy mô B nền = 6.5m, B mặt = 3.5m. Đề nghị áp dụng theo quy mô đường AH;
- + Đoạn tuyến từ Km32+500 -- Km34+149: xem xét bổ sung vị trí cống chui dân sinh phục vụ cho người dân đi sản xuất nông, lâm nghiệp (loại C);
- + Vị trí đường vào hồ Hương Mao (Km34+149): kết hợp với việc cứu hộ cứu nạn đập Hương Mao nên đề nghị tính không đảm bảo tối thiểu $H=4.5m$;

- Xã Phú Thọ:

- + Tại Km36+416: kiến nghị điều chỉnh chiều cao tính không đứng lên tương ứng với quy mô đường cấp A (H=3.5m);
- + Tại Km37+619: vị trí trùng đường DH23 đề nghị điều chỉnh lên loại AII;
- + Tại Km38+920: vị trí trùng đường DH06 đề nghị điều chỉnh lên loại AII;
- Các nội dung liên quan đến đường tỉnh đề nghị làm việc với Sở Giao thông vận tải Quảng Nam;
- Đề nghị phối hợp với UBND huyện trong công tác điều tra nguồn cung cấp vật liệu, vị trí đổ vật liệu thải;

Biên bản được lập thành 10 bản có giá trị pháp lý như nhau. Mỗi bên liên quan giữ 01 bản.

<p>Đại diện Ban QLDA 85</p>  <p>Lê Trọng Độ</p>	<p>Đại diện UBND huyện Quế Sơn</p>  <p>Trần Đại Nghĩa</p>
<p>Đại diện xã Quế Xuân 2</p>  <p>Bùi Quang Huân</p>	<p>Đại diện xã Phú Thọ</p>  <p>Nguyễn Trường Sang</p>
<p>Đại diện Chi nhánh TL Quế Sơn</p>  <p>Nguyễn Nhật</p>	<p>Đại diện Tư vấn thiết kế</p>  <p>Takayasu Nagai</p>

Phụ lục 1 Danh sách các kết cấu ngang đường

STT	Lý trình	Xã	Đề rộng hiện tại (m)	Cấp đường đự kiến	Hình thức giao cắt đự kiến	Kích thước (m)	Ghi chú
1	Km030+296.00	Quê Xuân 2	2.50	B	Cống chui	[BxH] = [4.0 x 3.0]	
2	Km031+278.00		3.00	C	Cống chui	[BxH] = [3.0 x 3.0]	
3	Km032+070.00		3.00	B	Cống chui	[BxH] = [4.0 x 3.0]	
4	Km032+510.50			A	Cầu vượt	[LxH] = [37.50 x 3.5]	Cầu vượt kênh + đường gom
5	Km034+149.00			C	Cầu vượt	[LxH] = [48.10 x 3.0]	Cầu vượt suối + đường gom
6	Km035+094.00		3.00	C	Cống chui	[BxH] = [3.0 x 3.0]	Thôn 3, xã Phú Thọ
7	Km035+487.00		11.00	IV _{pm}	Cầu vượt	[LxH] = [33.80 x 4.5]	DT611
8	Km036+416.00			C	Cầu vượt	[LxH] = [85.20 x 3.0]	Cầu vượt suối + đường gom
9	Km037+619.00	Phú Thọ	3.00	B	Cống chui	[BxH] = [4.0 x 3.0]	Tổ 4, Thôn Phước Phú Đông, xã Phú Thọ
10	Km038+356.50		2.80	C	Cầu vượt	[LxH] = [170.10 x 3.0]	Cầu vượt sông + đường ngang
11	Km038+920.00		5.00	A	Cống chui	[BxH] = [5.0 x 3.5]	Tổ 3, Thôn 5, xã Phú Thọ

Phụ lục 2 Danh sách cống thoát nước

STT	Xã	Lý trình	Loại	Kích thước (m)	Ghi chú
1	Quê Xuân 2	Km029+145.5	Cống hộp	2.0*2.0	
2		Km030+520.0	Cống tròn	D1.5	
3		Km030+640.0	Cống tròn	D1.5	
4		Km030+981.0	Cống tròn	D1.5	
5		Km031+123.0	Cống hộp	2.0*2.0	
6		Km031+290.0	Cống hộp	2.5*2.5	
7		Km031+675.0	Cống tròn	D1.5	
8		Km032+380.0	Cống hộp	2*2	
9		Km032+660.0	Cống tròn	D1.5	Mương đất
10		Km032+856.0	Cống hộp	2*(2.5*2.5)	Mương đất
11		Km033+230.0	Cống tròn	D1.5	
12		Km033+525.0	Cống tròn	D1.5	
13		Km033+834.0	Cống tròn	D1.5	
14		Km033+923.0	Cống tròn	D1.5	
15	Phú Thọ	Km035+100.0	Cống tròn	D1.5	
16		Km035+700.0	Cống tròn	D1.5	
17		Km037+420.0	Cống tròn	D1.5	
18		Km037+600.0	Cống hộp	2.5*2.5	
19		Km037+690.0	Cống tròn	D1.5	
20		Km037+975.0	Cống tròn	D1.5	
21		Km038+230.0	Cống tròn	D1.5	Mương xây
22		Km039+145.0	Cống tròn	D1.5	
23		Km039+380.0	Cống tròn	D1.5	
	Tổng cộng	Cống tròn		17 vị trí	
		Cống hộp		06 vị trí	

Phụ lục 3 Danh sách đường gom

STT	Xã	Ly trình		Chiều dài (m)	Đến	Ghi chú
		Từ	Đến			
1	Quê Xuân 2	Km29+642	Km30+300	658.00	Trái	
2		Km29+642	Km30+293	651.00	Phải	
3		Km31+278	Km31+480	202.00	Trái	
4		Km32+020	Km32+120	100.00	Trái	
5		Km32+040	Km32+180	140.00	Phải	
6		Km32+380	Km32+520	140.00	Phải	
	Chiều dài (Quê Xuân 2)			1,891.00		
9	Phú Thọ	Km34+185	Km34+502	317.00	Trái	
10		Km34+869	Km35+259	390.00	Trái	
11		Km36+439	Km36+628	189.00	Trái	
12		Km36+439	Km36+590	151.00	Trái	
	Chiều dài (Phú Thọ)			1,047.00		
	Tổng chiều dài đường gom			2,938.00		

Phụ lục 4 Danh sách cải mương

STT	Xã	Lý trình		Chiều dài (m)	Phía	Ghi chú
		Từ	Đến			
1	Quế Xuân 2	Km31+123	Km31+160	37.00	Trái	Đất
2		Km32+606	Km32+660	54.00	Phải	Đất
3		Km32+856	Km33+006	150.00	Phải	Đất
		Tổng chiều dài (Quế Xuân 2)		241.00		
4	Phú Thọ	Km38+090	Km38+288	198.00	Phải	Đất
5		Km38+165	Km38+230	65.00	Phải	Bê tông
6		Km38+208	Km38+288	80.00	Trái	Đất
		Tổng chiều dài (Phú Thọ)		343.00		
		Tổng chiều dài cải mương		584.00		

APPENDIX 2: RESULT OF STABILITY ANALYSIS AT EMBANKMENT SECTION

SLOPE/W Analysis

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Project Settings

Length(L) Units: meters
Time(t) Units: Seconds
Force(F) Units: kN
Pressure(p) Units: kPa
Strength Units: kPa
Unit Weight of Water: 9.807 kN/m³
View: 2D

Analysis Settings

SLOPE/W Analysis

Kind: SLOPE/W
Method: Bishop

Settings

PWP Conditions Source: Piezometric Line
Apply Phreatic Correction: No
Use Staged Rapid Drawdown: No

Slip Surface

Direction of movement: Right to Left
Use Passive Mode: No
Slip Surface Option: Grid and Radius
Critical slip surfaces saved: 1
Optimize Critical Slip Surface Location: No
Tension Crack
Tension Crack Option: (none)

F of S Distribution

F of S Calculation Option: Constant

Advanced

Number of Slices: 30
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 0.1 m
Optimization Maximum Iterations: 2,000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Fill Material

Model: Mohr-Coulomb
Unit Weight: 21 kN/m³

Cohesion': 20 kPa
Phi': 21 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Layer4

Model: Mohr-Coulomb
Unit Weight: 19 kN/m³
Cohesion': 32 kPa
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Layer4c

Model: Mohr-Coulomb
Unit Weight: 19.5 kN/m³
Cohesion': 35 kPa
Phi': 22 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Layer5a

Model: Mohr-Coulomb
Unit Weight: 27 kN/m³
Cohesion': 40,000 kPa
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Grid

Upper Left: (-36, 44) m
Lower Left: (-22, 44) m
Lower Right: (-22, 32) m
Grid Horizontal Increment: 10
Grid Vertical Increment: 10
Left Projection Angle: 0 °
Right Projection Angle: 0 °

Slip Surface Radius

Upper Left Coordinate: (-59.990752, 14.039046) m
Upper Right Coordinate: (0.00354, 14.039046) m
Lower Left Coordinate: (-59.990752, 2.017102) m
Lower Right Coordinate: (0.00354, 2.017102) m
Number of Increments: 20
Left Projection: No
Left Projection Angle: 135 °
Right Projection: No

Right Projection Angle: 45 °

Slip Surface Limits

Left Coordinate: (-60, 14.2) m

Right Coordinate: (40, 22.5) m

Piezometric Lines

Piezometric Line 1

Coordinates

	X (m)	Y (m)
Coordinate 1	-60	14.2
Coordinate 2	-40.5	14.2
Coordinate 3	-32.6	14.5
Coordinate 4	28.5	21.2
Coordinate 5	32.5	21.7
Coordinate 6	40	22.5

Surcharge Loads

Surcharge Load 1

Surcharge (Unit Weight): 15.7 kN/m³

Direction: Vertical

Coordinates

	X (m)	Y (m)
	-6.5	27.6
	-2	27.8
	10	27.9
	22.7	27.6

Points

	X (m)	Y (m)
Point 1	-60	14.2
Point 2	-40.5	14.2
Point 3	-32.6	14.5
Point 4	-20.5	20.6
Point 5	-18.5	20.6
Point 6	-6.5	26.6
Point 7	-2	26.8
Point 8	10	26.9
Point 9	22.7	26.6
Point 10	32.5	21.7

Point 11	40	22.5
Point 12	-7.4	15.7
Point 13	3.5	16.6
Point 14	7.7	16.6
Point 15	8.9	16.9
Point 16	18.2	17.4
Point 17	25	18
Point 18	28.5	21.2
Point 19	-60	10
Point 20	-40.5	10
Point 21	40	15.2
Point 22	-60	7.5
Point 23	-40.5	7.5
Point 24	40	12.7
Point 25	-60	0
Point 26	40	0

Regions

	Material	Points	Area (m ²)
Region 1	Layer5a	22,23,24,26,25	959.3
Region 2	Layer4c	19,20,21,24,23,22	250
Region 3	Layer4	1,2,3,12,13,14,15,16,17,18,10,11,21,20,19	427.34
Region 4	Fill Material	3,4,5,6,7,8,9,10,18,17,16,15,14,13,12	474.87

Current Slip Surface

Slip Surface: 530

F of S: 1.747

Volume: 230.03744 m³

Weight: 4,713.5604 kN

Resisting Moment: 78,625.691 kN-m

Activating Moment: 45,003.659 kN-m

F of S Rank: 1

Exit: (-36.966289, 14.334192) m

Entry: (0.55871581, 26.821323) m

Radius: 28.765343 m

Center: (-24.8, 40.4) m

Slip Slices

	X (m)	Y (m)	PWP (kPa)	Base Normal Stress (kPa)	Frictional Strength (kPa)	Cohesive Strength (kPa)
Slice 1	-36.238574	14.018665	3.3653855	15.560512	4.438663	32
Slice 2	-34.783144	13.433732	9.643852	26.784205	6.2385781	32
Slice 3	-33.327715	12.938347	15.044118	36.200623	7.7003381	32
Slice 4	-31.995	12.556034	19.715094	49.623866	10.885903	32
Slice 5	-30.785	12.270974	23.811912	67.212785	15.796626	32
Slice 6	-29.575	12.040382	27.374554	83.521524	20.435826	32
Slice 7	-28.365	11.862937	30.415996	98.59724	24.815943	32
Slice 8	-27.155	11.737648	32.945936	112.4765	28.946756	32
Slice 9	-25.945	11.663833	34.971076	125.18661	32.835767	32
Slice 10	-24.735	11.641094	36.49531	136.7466	36.488485	32
Slice 11	-23.525	11.66931	37.519831	147.16785	39.908615	32
Slice 12	-22.315	11.748631	38.043158	156.45446	43.098189	32
Slice 13	-21.105	11.879485	38.061102	164.6034	46.05763	32
Slice 14	-20	12.0425	37.65073	165.96953	46.704225	32
Slice 15	-19	12.230081	36.886529	160.84768	45.118168	32
Slice 16	-17.913578	12.477655	35.626903	160.36054	45.399333	32
Slice 17	-16.740734	12.793479	33.790892	164.21081	47.468967	32
Slice 18	-15.56789	13.163449	31.423873	166.88988	49.305596	32
Slice 19	-14.395046	13.589812	28.503812	168.35195	50.90056	32
Slice 20	-13.222203	14.075313	25.003775	168.53983	52.242852	32
Slice 21	-12.049359	14.623304	20.890904	167.38266	53.318639	32
	-10.876515	15.237879	16.125039	164.79273	54.110615	32

Slice 22						
Slice 23	-9.6580007	15.953897	10.413448	162.6136	58.424163	20
Slice 24	-8.3938166	16.784545	3.6267815	155.165	58.170072	20
Slice 25	-7.1308622	17.715047	-4.1404742	146.05815	56.066469	20
Slice 26	-5.9375	18.695262	-12.470096	144.66455	55.531519	20
Slice 27	-4.8125	19.727976	-21.388099	124.15486	47.658587	20
Slice 28	-3.6875	20.880248	-31.478604	101.86228	39.101266	20
Slice 29	-2.5625	22.174988	-42.966298	77.552008	29.769427	20
Slice 30	-1.360321	23.762541	-57.242614	48.474862	18.607756	20
Slice 31	-0.080963146	25.742538	-75.284617	13.822443	5.3059386	20

APPENDIX 3: TECHNICAL STANDARD LIST APPLIED IN DQEP

Appendix 3: Technical Standards to be applied to the Project

Update: 25 April 2013

According to the Decision No. 362/QD-BGTVT dated on 20 February 2009, Decision No. 727/QD-BGTVT dated 6/4/2012, Decision No.270/QD-BGTVT dated 29 January 2013, Decision No. 994/QD-BGTVT dated 16 April 2013, the following technical standards are to be applied to the Project. .

Decision No. 362/QD-BGTVT dated 20 February 2009

No.	Standards to be applied	Code
I.	TO BE APPLIED FOR SURVEY	
1	Specification for measuring and drawing topography	96TCN43-1990
2	Specification for drawing topographical maps with scale 1:500 1:1000 1:2000 1:5000 1:10000 1:25000	96TCN42-1990
3	Geodesy works in engineering - general requirements	TCXDVN309-2004
4	Specification for measuring and analyzing GPS data	TCXDVN364-2006
5	Specification for boring survey	22TCN259-2000
6	Specification for geotechnical investigation of marine works	22TCN260-2000
7	Specification for surveying and designing the highway embankment on the soft ground	22TCN262-2000
8	Specification for surveying highway	22TCN263-2000
9	Specification for geotechnical investigation and design solution for roads in land sliding areas	22TCN171-1987
10	Specification for Static Penetration Test (CPT and CPTU)	22TCN317-2004
11	Specification for site shearing test	22TCN355-2000
12	Construction soil site testing method SPT	TCXD226-1999
13	Construction soil-physic-mechanical test	TCVN4195-4202-1995
14	Surveying works for design and construction of pile foundation	20TCN160-1987
15	Construction soil exploiting packing transporting and maintaining samples	TCXD2683-1991
16	Specification for checking bridge on highway technical requirements	22TCN243-1998
17	Specification for testing elastic modulus of the pavement by deflection measurement Benkelman beam	22TCN251-1998
18	Specification for testing and evaluating pavement strength and flexible pavement of highway by FWD	22TCN335-2006
19	Specification for analyzing water used in transport constructions	22TCN61-1984
20	Specification for geotechnical investigation for constructions in Karst area	TCXDVN366-2006
II.	TO BE APPLIED FOR DESIGN	
1	Expressway highway design requirements	TCVN5729-1997
2	Highway Design Requirements	TCVN4054-2005

No.	Standards to be applied	Code
3	Standard for designing highway (junctions)	22 TCN273-2001
4	Soft soil treatment with wick drains	22TCN244-1998
5	Geotextile applying for embankment of soft soil ground	22TCN248-1998*
6	Specification for designing of flexible pavement	22TCN211-2006
7	Specification for rigid pavement design	22TCN223-1995
8	Standard of bridge design	22TCN272-2005
9	Standard for design culverts with limit state (applying for culvert design and auxiliaries)	22TCN18-1979
10	Pile foundation design standard	TCXDVN205-1998
11	PC concrete nail T13 T15 & D13 D15	22TCN267-2000
12	Rubber bearings	AASHTO M251-06-UL, ASTM D4014-03(2007)
13	Standard for expansion joints	AASHTO M297-96, AASHTO M183-96
14	Specification for design of bridges and auxiliaries for bridges	22TCN200-1989
15	Calculation of flood flow features	22TCN220-1995
16	Transport works in earthquake zone design standard	22TCN221-1995
17	Regulations of traffic signals on highway	22TCN237-2001*
18	Guiding board on expressway	22TCN331-2005*
19	Drainage design standard	22TCN51-1984
20	Standard for design lighting of roads and squares in urban	TCXDVN259-2001
21	Lighting outdoor of public works and infrastructure in urban construction design standards	TCXDVN333-2005
22	Specification for environment impact assessment in preparing FS and design for transport works	22TCN242-1998
23	Design earthquake bearing facilities	TCXDVN375-2006
24	Concrete and reinforced concrete	TCXDVN356-2005
III.	TO BE APPLIED FOR CONSTRUCTION AND ACCEPTANCE	
1	Block bricks, construction and acceptance	TCVN 4085-1985
2	Specification for construction and acceptance of culverts and bridges	22TCN 266-2000
3	Specification for testing CBR for crush stones and sand in lab	22 TCN 332-2006
4	Specification for compaction of crushed stone and soil in lab	22 TCN 333-2006
5	Specification construction and acceptance of crushed stone layers in highway pavement	22 TCN 334-2006
6	Specification for checking compaction of embankment by priming funnel	22 TCN 346-2006
7	Specification for measuring the smoothness of pavement by 3m ruler	22 TCN 16-1979

No.	Standards to be applied	Code
8	Specification for checking and evaluating roughness by IRI	22 TCN 277-2001
9	Specification for testing roughness of pavement by sand sprinkling	22 TCN 278-2001
10	Painting traffic signals in liquidity on concrete cement pavement and asphalt pavement	22 TCN 282-285
11	Specification for checking compaction of embankment in transport works	22 TCN 02-1971 and Decision 4313/2001/QĐ-BGTVT
12	Construction soil - construction and acceptance specification	TCVN 4447-1987
13	Specification for construction and acceptance of AC pavement	22 TCN 249-1998
14	Standard for construction and acceptance of bituminous surface pavement	22 TCN 271-2001
15	Concrete drainage pipe	TCXD VN 372:2006
16	Aggregates used for concrete and mortar	TCVN 7572:2006
17	Specification for taking samples of asphalt applying for road, airport	22 TCN 321-2006
18	Specification for testing AC	22 TCN 62-1984
19	Dense asphalt - technical requirements and testing method	22 TCN 279-2001
20	Specification for testing mineral powder used for ETN	22 TCN 58-1984
21	Bored piles - specification for construction and acceptance	TCXDVN 326-2004
22	Bored piles - sonic logging method to test the homogene of concrete	TCXDVN 358-2005
23	Portland cement - methods of determining physio-mechanical criteria	TCVN -4029-1985 TCVN-4030-2003
24	Portland cement - technical requirements	TCVN-2682-1999
25	Mixed Portland cement - technical requirements	TCVN-6260-1997
26	Aggregates for concrete and mortar - technical requirements	TCVN-7570-2006
27	Water for concrete and mortar - technical requirements	TCVN 4506 - 1987
28	Heavy concrete - method testing physio-mechanical criteria	TCVN 3105-3120:1993
29	Heavy concrete - Method of testing cylinder strength and elastic modulus of static compression	TCXD 171-1989
30	Heavy concrete - method of nondestructive sonic logging and rebound hammer to check the compressive strength	TCVN 2576-1993
31	Specification for construction and acceptance of PC beam	22 TCN 247-1998
32	Specification for construction and acceptance asphalt pavement using polime asphalt.	22 TCN 356-2006
33	Specification for construction and acceptance asphalt pavement with high roughness cover layer	22 TCN 345-2006
34	Temporary specification for construction and acceptance of super thin cover layer for roughness n highway	QĐ 3287/QĐ-BGTVT of 29 Oct 2008
35	Finishing works - construction and acceptance	TCXD 305-2004
36	Mass concrete, specification of construction and acceptance	TCXDVN 305-2004
37		

No.	Standards to be applied	Code
38	Specification of construction and acceptance of wick drain in soft soil pavement	22TCN 236-1997
39	Specification for testing bridges	22TCN 170-1987
40	Specification of testing density by sand pouring	22TCN 13-1979
41	Specification of construction and acceptance of crushed stone layers	22TCN 252-1998
42	Technical requirements and testing method for polime asphalt	22TCN 319-2004
43	Acceptance of construction quality	TCXDVN 371-2006

Decision No. 727/QD-BGTVT dated 6 April 2012

No.	Standards to be applied	Code
I.	TO BE APPLIED FOR SURVEY	
1	British Practical standard of soil and other reinforced materials	BS8006-1995
2	Paint traffic signals: Solvent road marking paint – Specification and testing method	22TCN 283-2002
II.	TO BE APPLIED FOR DESIGN	
3	Hazardous solid waste landfills – Design standard	TCXDVN320-2004
4	Load and Effect	TCVN 2737-1995
5	Steel bridges and steel structures	TCXDVN 338-2005
6	Guidance for determination of dynamic component of the wind load under TCVN 2737-1995	TCXD 229-1999
7	Standard for railway tunnel and highway tunnel	TCVN4527-1988
8	Tunnel Design Standard: Mountain Tunnel	JSC 2007
9	Navigation clearance requirements of rivers	TCVN 5664-2009
10	Regulation on navigation aids of Vietnam inland waterways	22TCN 269-2000
11	Drainage & Sewerage – External Network & Facilities – Design Standard	TCVN7957-2008
12	Standard for design of rural roads	22TCN 210-1992
13	Office buildings – Design standard	TCVN 4601-1988
14	Dwellings – Design standard	TCVN 353-2004
IV.	TO BE APPLIED FOR CONSTRUCTION AND ACCEPTANCE	
15	Specification for High-Strength Bolts for Structural Steel Joints	AASHTO M164
16	Standard for construction and acceptance of cement consolidated stones sub- grade in highway pavement structure	22TCN 245-1998
17	Cement - Classification	TCVN 5439-2004
18	Mortar – Technical specifications	TCVN 4314-2003
19	Concrete - Requirement for natural moist curing	TCXDVN 391-2007
20	Chemical admixtures for concrete	TCXDVN 325-2004
21	Steel scaffolding	TCVN 6052-1995
22	Scaffolding-Safety Requirements	TCXDVN 296-2004
23	Pre-cast reinforced concrete box culvert technical requirements and testing method	TCXDVN 392-2007
24	Monolithic concrete and reinforced concrete structures – Codes for construction, check and acceptance	TCVN 4453-1995

No.	Standards to be applied	Code
25	Specification for underwater concrete construction by cavity-fill method	22TCN 209-1992
26	Precast pre-stressed concrete products - Technical requirements and acceptance	TCXDVN 389-2007
27	Assembled Concrete and reinforced Concrete Structures - Code of Practice for construction and acceptance	TCXDVN 390-2007
28	Concrete and Reinforced concrete structures-Guide on technical measures for prevention of cracks occurred under the action of local hot humid climate	TCXDVN 313-2004
29	Welding specifications for steel bridge and steel structure	22TCN 280-01
30	Pile driving and static jacking works - Standard for construction, check and acceptance	TCVN 286-2003
31	Protection against corrosion in construction. Concrete and reinforced concrete structures. Classification of corrosive medium	TCVN 3994-1985
32	Specification for construction and acceptance of paint used for steel bridge and steel structures	22TC 253-98
33	Piles - Standard test method for piles under axial compressive load	TCXDVN 269-2002
34	Foundation Piles - Method of detection of defects by dynamic low-strain testing	TCXDVN 359-2005
35	Standard Test Method for High-Strain Dynamic Testing of Deep Foundations	ASTM D4945
36	Standard Specification for Steel Strand Uncoated Seven-Wire for Pre-stressed Concrete	ASTM A416
37	Standard Specification for Uncoated High-Strength Steel Bars for Pre-stressing Concrete	ASTM A722
38	Steel for reinforcement of concrete	TCVN 1651-2008
39	Paint for construction – Classification	TCXDVN 321-2004
40	Paint used for steel bridges and steel structures - Technical requirements and testing method	22TCN 235-97
41	Paint and metal protective coating	22TCN 300-02
42	Bridge construction specification	TCCS 02:2010/TCDBVN
43	Specification for construction and acceptance of pavement structure by natural grading	22TCN 304-2003
III.	TO BE APPLIED FOR ELECTRICAL SURVEY and DESIGN	
44	Standard for electric system- electric line system	11TCN 19-2006
45	Specification for lighting	TCXDVN 259-2001
V.	TO BE APPLIED FOR BUILDING SURVEY and DESIGN	
46	Toll station	TCCS 01-2008/VRA
47	Electric distribution network in dwellings and public building – Design standard	TCXD 27-1991
48	Installation of electric wire in dwellings and public buildings – Design standard	TCXD 25-1991
49	Protection of Structures Against Lightning - Guidance for design, inspection and maintenance	TCXDVN 46-2007
VI.	TO BE APPLIED FOR OPERATION and MAINTENANCE (O&M) of ROADS	
50	Concrete and Reinforced concrete Structures - Guide on Maintenance	TCXDVN 318-2004

Decision No. 270/QD-BGTVT dated 29 January 2013

No.	Standards to be applied	Reference
I	TO BE APPLIED FOR TRAFFICE MANAGEMENT SYSTEM	
1	Reference model architecture for the ITS sector	ISO 14813

No.	Standards to be applied	Reference
2	Transport information and control systems – Requirements for ITS/TICS central data registry and ITS/TICS data dictionaries	ISO 14817:2002
3	Transport information and control systems – Data interfaces between centers for transport information and control system – Part1: message definition requirements	ISO 14827-1:2005
4	Transport information and control systems – Data interfaces between centers for transport information and control systems – Part 2: DATEX-ASN	ISO 14827-2:2005
5	Intelligent transport systems (ITS) – Data exchange involving roadside modules communication Part1: General principles and documentation framework of application profiles	ISO 15784-1:2008
6	Intelligent transport systems (ITS) – Data exchange involving roadside modules communication Part2:Application Profile-SNMP	ISO 15784-2:2008
7	Intelligent transport systems (ITS) – Data exchange involving roadside modules communication --- Part3: Application profile-data exchange (AP-DATEX)	ISO 15784-3:2008
II	TO BE APPLIED FOR TOLL COLLECTION SYSTEM	
1	Information technology – specification and standardization of data elements	ISO/IEC 11179
2	ITS – Dedicated Short Range Communication (DSRC) at 5.8GHz	ITU-R M.1453-2
3	Road transport and traffic telematics – Dedicated Short Range Communication (DSRC) – Application Layer	ISO 15628
4	DSRC System	ARIB STD-T75
5	Road transport and traffic telematics – Electronic fee collection Application	ISO 14906
6	Electronic fee collection -- Interface Definition for on-board account using	ISO/TS 25110
7	Road transport and traffic telematics – Electronic fee collection (EFC) – systems	ISO 17573
8	Identification cards – Contactless integrated circuit cards – Proximity cards –	ISO/IEC 14443-1
9	Identification cards – Contactless integrated circuit cards – Proximity cards – Part 2: Radio frequency power and signal interface	ISO/IEC 14443-2
10	Identification cards – Contactless integrated circuit cards – Proximity cards – Part 3: Initialization and anticollision	ISO/IEC 14443-3
11	Identification cards – Contactless integrated circuit cards – Proximity cards – Part 4: Transmission protocol	ISO/IEC 14443-4
12	Identification cards – Integrated circuit cards – Part 4: Organization, security and commands for interchange	ISO/IEC 7816-4
13	Information technology – Telecommunication and information exchange between systems – Near Field Communication – Interface and Protocol (NFCIP-1)	ISO/IEC 18092
14	Classification of environment conditions – Part 3 : Classification of groups of environmental parameters and their severities – Section 4: Stationary use at non-weatherprotected locations	IEC 60721-3-4

No.	Standards to be applied	Reference
15	Classification of environment conditions – Part 3 : Classification of groups of environmental parameters and their severities – Section 5: Ground vehicle installations	IEC 60721-3-5
16	Road transport and traffic telematics – Automatic vehicle and equipment identification –System specifications	ISO 14815
17	Environmental testing. Part 1: General and guidance	IEC 60068-1
18	Road transport and traffic telematics – Electronic fee collection – Test procedures for user and fixed equipment – Part 1: Description of test	ISO/TS 14907-1
19	Road transport and traffic telematics – Electronic fee collection – Test procedures for user and fixed equipment – Part 2: Conformance test for the onboard unit application interface	ISO/TS 14907-2
III	TO BE APPLIED FOR COMMUNICATION SYSTEM	
1	<ul style="list-style-type: none"> 8802-3: 2000 (ISO/IEC) (ANSI/IEEE Std 802.3 2000 Edition): Information Technology – Telecommunications and information exchange between systems – Local and Metropolitan area networks – Specific equipment -- Part3: Carrier sense multiple access with collision detection (CAMA/CD) access method and physical layer specifications. 	Ethernet
2	<ul style="list-style-type: none"> IEEE 802.3u-1995 IEEE Standards for Local and metropolitan area networks: Supplement to Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications: Media access control (MAC) Parameters, Physical Layer, Medium Attachment Units, and Repeater for 100Mb/s Operation, Type 100BaseT (Clauses 21-30) (ANSI) EIA/TIA568B (AT and T-258A) Commercial Building Telecommunications Wiring Standard, 1991 	Fast Ethernet
3	<ul style="list-style-type: none"> IEEE 802.3ab : Physical coding sublayer (PCS), physical medium attachment (PMA) sublayer and baseband medium, type 1000BASE-T IEEE 802.3z : Media Access Control(MAC) Parameters, Physical Layer, Repeater and Management Parameters for 1000 Mb/s Operation 	Gigabit Ethernet
4	<ul style="list-style-type: none"> RFC 959 File Transfer Protocol, J. Postel, J.K. Reynolds, Oct-01-1985 RFC 1350 The TFTP Protocol (Revision 2), K. Sollins, July 1992 (TFTP) 	FTP
5	<ul style="list-style-type: none"> RFC 1945 Hypertext Transfer Protocol -- HTTP/1.0. R. Fielding, H. Frystyk, T. Berners-Lee RFC 2068 Hypertext Transfer Protocol -- HTTP/1.1. R. Fielding, J. Gettys, J. Mogul, H. Frystyk, T. Berners-Lee, January 1997 (Status: PROPOSED STANDARD) RFC 2616 Hypertext Transfer Protocol /1.1 June 1999 RFC 2617 HTTP Authentication: Basic and Digest Access Authentication, June 1999 	HTTP
6	<ul style="list-style-type: none"> RFC 791 Internet Protocol. J. Postel. Sep-01-1981 	IP
7	<ul style="list-style-type: none"> RFC 1661 The Point-to-Point Protocol (PPP), W. Simpson, July 1994 	PPP

No.	Standards to be applied	Reference
8	<ul style="list-style-type: none"> RFC 1157 Simple Network Management Protocol (SNMP), J.D. Case, M. Fedor, M.L.Schoffstall, C. Davin, May-01-1990 	SNMP
9	<ul style="list-style-type: none"> RFC 793 Transmission Control Protocol. J. Postel. Sep-01-1981 	TCP
10	<ul style="list-style-type: none"> RFC 768 User Datagram Protocol. J. Postel. Aug-28-1980 	UDP
11	<ul style="list-style-type: none"> ISO/IEC 144916-1:1999 Information technology -- Coding of audio visual objects -- Part 1: Systems ISO/IEC 144916-2:1999 Information technology -- Coding of audio-visual objects -- Part 2: Visual ISO/IEC 144916-2:1999 Information technology -- Coding of audio-visual objects -- Part 3: Audio ISO/IEC 14496-10:2003: Information technology -- Coding of audio-visual objects -- Part 10: Advanced Video Coding 	MPEG4
12	<ul style="list-style-type: none"> ITU-T G 652: Characteristics of a single-mode optical fiber and cable ITU-T G 655: Characteristic of a non-zero dispersion-shifted single-mode optical fiber and cable 	FOC
13	Telecom Peripheral Construction – Technical regulations	TCN 68-254:2006
14	Cable duct and cable connected box - Technical requirements	TCN 68-153:1995
15	Rigid PVC pipes for underground cables - Technical standards	TCN 68-144:1995
16	Rigid PVC pipes for underground cables - Technical standards	TC.VNPT-06:2003
17	Code of practice for the construction for optical fiber communication system	TCN 68-178:1999

Decisions No. 994/QD-BGTVT dated 16 April 2013

List of Additional / Updated Technical Standards Applied to DQEP

A. UPDATED STANDARDS

No	Technical Standard	Standards approved in Decision No.362/QD-BGTVT dated 20/2/2009 and No. 727/QD-BGTVT dated 6/4/2013 by MOT	Updated/Approved Standards
1	Asphalt Concrete Pavement – Specification for Construction and Acceptance	22TCN 249-1998	TCVN 8819:2011

No	Technical Standard	Standards approved in Decision No.362/QĐ-BGTVT dated 20/2/2009 and No. 727/QĐ-BGTVT dated 6/4/2013 by MOT	Updated/Approved Standards
2	Graded Aggregate Base and Subbase Pavement - Specification for Construction and Acceptance	22TCN 334-2006	TCVN 8859:2011
3	Bituminous Surface Treatment – Specification for Construction and Acceptance	22TCN 271-2001	TCVN 8863:2011
4	Standard Test Method for Measuring Road Pavement Surface Roughness Using a 3m Straight Edge	22TCN 16-1979	TCVN 8864:2011
5	Method for Measuring and Assessment Roughness by International Roughness Index (IRI)	22TCN 277-2001	TCVN 8865:2011
6	Standard Test Method for Measuring Pavement Macrottexture Depth Using a Volumetric Technique	22TCN 278-2001	TCVN 8866:2011
7	Flexible Pavement – Standard Test Method for Determination of Elastic Modulus of Pavement Structure Using Benkelman beam	22TCN 251-1998	TCVN 8867:2011
8	National Technical Regulation on Road Signs and Signals	22TCN 237-2001	QCVN 41:2012/BGTVT
9	Soil - Methods laboratory of determination of specific weight	TCVN4195:1995	TCVN4195:2012
10	Soil - Methods laboratory of determination of volume weight	TCVN4202:1995	TCVN4202:2012
11	Soils - Sampling, packing, transportation and curing of samples	TCVN2683:1991	TCVN2683:2012
12	Bored Piles- Construction, check and acceptance	TCXDVN 326:2004	TCVN 9395:2012
13	Bored piles – Determination of homogeneity of concrete - sonic pulse method	TCXDVN 358:2005	TCVN 9396:2012
14	Piles - standard test method in situ for piles under axial compressive load	TCXDVN 269:2002	TCVN 9393:2012
15	Cement Treated Aggregate Base for Road Pavement – Specification for Construction and Acceptance	22TCN 245-1998	TCVN 8858:2011
16	Painting Traffic signal – Road marking by thermoplastic reflective material – Specification, testing method, construction and acceptance.	22TCN 283-2002	TCVN 8791:2011
17	Painting for protection of steel structure – Specification and testing method	22TCN 235-97	TCVN8789:2011
18	Painting for protection of steel structure – Construction and acceptance	22TCN 253-98	TCVN8790:2011
19	Paint and metal covering – Testing method in natural conditions	22TCN 300-02	TCVN8785-1:2011 TCVN8785-14:2011
20	Concrete structure and precast reinforced concrete	TCXDVN 390:2007	TCVN 9115:2012

No	Technical Standard	Standards approved in Decision No.362/QĐ-BGTVT dated 20/2/2009 and No. 727/QĐ-BGTVT dated 6/4/2013 by MOT	Updated/Approved Standards
21	Drainage reinforced concrete culvert pipe	TCXDVN 372:2006	TCVN 9113:2012
22	Reinforced concrete box culvert	TCXDVN 392:2007	TCVN 9116:2012
23	Product of pre-prestressed concrete – Technical specification and acceptance	TCXDVN 389:2007	TCVN 9114:2012
24	Bored pile – Specification for construction and acceptance	TCXDVN 326:2004	TCVN 9395:2012
25	Bored pile – Ultrasonic impulse method for determining the uniform of concrete	TCXDVN 358:2005	TCVN 9396:2012
26	Cement – Testing method – Determination of durability	TCVN 6016:1995	TCVN 6016:2001
27	Portland cements – Specifications	TCVN 2682 – 1999	TCVN 2682 - 2009
28	Portland blended cements – Specifications.	TCVN 2660 – 1987	TCVN 6260 - 2009
29	Water for mixing concrete and mortar – Technical Specification	TCVN 4506:1987	TCXDVN 4506:2012
30	Heavy concrete – Nondestructive method by using both ultrasonic counter and rebound hammer for determining compressive strength	TCXD 171-1989	TCVN 9335:2012
31	The finalization works in construction – Construction and acceptance	TCXD 303-2006	TCVN 9397-2:2012 TCVN 9397-3:2012
32	Mass concrete – Specification for construction and acceptance	TCXDVN 305-2004	TCVN 9395-2012
33	Bitumen – Testing method for physico-mechanical characteristic	22TCN 279-01	TCVN 7493:2005 ÷TCVN 7405:2005
34	Bitumen –Method for sampling	22TCN 231-96	TCVN 7494:2005
35	Installation of conduct line in house and public works – Design specification	TCXD25:1991	TCVN 9207:2012
36	Installation of electric facilities in house and public works – Design specification	TCXD27:1991	TCVN 9206:2012
37	Anti-lightning for civil works – Instruction of design, inspection and maintenance for its system	TCXDVN 46:2007	TCVN 9385:2012
38	Chemical admixture for concrete	TCXDVN 325-2004	TCVN 8826:2011
39	Concrete – Requirements on natural moisture curing	TCXDVN 391:2007	TCVN 8828:2011
40	Structure of concrete and reinforced concrete – Technical instruction on preventing cracks under impact of hot- moist climate	TCXDVN 313:2004	TCVN 9345:2012

No	Technical Standard	Standards approved in Decision No.362/QD-BGTVT dated 20/2/2009 and No. 727/QD-BGTVT dated 6/4/2013 by MOT	Updated/Approved Standards
41	Structure of concrete and reinforced concrete – Instruction on maintenance works.	TCXDVN 318:2004	TCVN 9343

B. ADDITIONAL STANDARDS

No	Technical Standard	Code
1	Standard test method for CBR (California Bearing Ratio) of soils and unbound roadbase in place	TCVN 8821-2011
2	Steel for the reinforcement of concrete – Threaded coupler splice	TCVN 8163:2009
3	Water-stop membrane used in construction joints - Requires in using	TCXDVN 290:2002
4	Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)	ASTM C1107
5	Materials, Equipment, and Procedures for Mixing Standard Compounds and Preparing Standard Vulcanized Sheets - Evaluation of Rubber for Bridge bearing.	ASTM D3182÷D3190; D3192
6	Reflective membrane for road signalling	TCVN 7887:2008
7	Temporary regulation on normal cement concrete formation with joint in construction of traffic works.	Decision No.3230/QD-BGTVT dated 14/12/2012.
8	Temporary regulation on construction engineering and acceptance for cement concrete pavement in construction of traffic works.	Decision No.1951/QD-BGTVT dated 17/08/2012.
9	Flexible pavement – Determination of elastic modul of ground base and pavement structure courses by using hard steel plates	TCVN 8861:2001
10	Water supply – Network of pipe and structures – Specification for design	TCXDVN 33:2006
11	National technical codes on safety for fire for house and structures	QCVN 06:2010/BXD
12	Regulations on earthing connection and neutral connection for electric facilities	TCVN 4756:1989
13	Geotextile fabric – Testing method	TCVN 8871-1:2011-TCVN 8871-6:2011
14	Painting for traffic signal	TCVN 8786:2011 TCVN 8788:2011
15	Structure of stone brick – Regulations on construction and acceptance	TCVN 4085:2011
16	Asphalt concrete – Testing method	TCVN 8860-1:2011-TCVN 8860-12:2011
17	Hot asphalt concrete mixing plant – Specification and checking method	22TCN 255-99
18	Pavement for highway – Construction and acceptance	TCVN 9436-2012

No	Technical Standard	Code
19	Polymer Modified Cationic Emulsified Asphalt	TCVN 8816:2011
20	Cationic Emulsified Asphalt	TCVN 8817-1:2011 - TCVN 8817-15:2011
21	Cut-back asphalt	TCVN 8818-1:2011 - TCVN 8818-5:2011