- 2-lane per direction could serve sufficient traffic capacity until 2027.
- Construction cost: Alternative SC-2 has 20% higher construction cost (around USD 10 million) than Alternative SC-1.
- Construction period: Construction period of Alternative SC-2 could be two months longer than that of Alternative SC-1. However, overall construction period is controlled by the bridge works so difference of the construction period between alternatives is negligible.
- Easiness of future widening works: Construction site is soft-ground area. It is technically a little difficult to widen the embankment (said levy widening) from 4-lane to 6-lane in the future because of unequal consolidation status in the ground at that time.

Recommended Stage Construction Option

Considering the above results of the comparison, the following is the recommended stage construction option.

Table 2.4-6 Recommended Stage Construction Program

Stage	Tan Vu IS	Hai An Side		Bridge	Cat Hai Side	
		Embankment	Pavement		Embankment	Pavement
1st	At-grade	6-lane	4-lane	4-lane	6-lane	4-lane
2nd	Grade-separated	No work	6-lane	6-lane	No work	6-lane
		Flyover in Dinh Vu IZ				

1st Stage

- Tan Vu intersection is built as at-grade type.
- Embankment of highway is built as 6-lane.
- Pavement is 4-lane.
- Bridge is 4-lane.

2nd Stage

- Tan Vu intersection will be grade-separated when Ring Road No. 3 is connected.
- No highway embankment works.
- Pavement will be widened to 6-lane.
- Bridge will be widened to 6-lane.
- Flyover in Dinh Vu IZ will be built.

2.4.4. Alternative Study on Bridge Length

In accordance with the recommended stage construction, the following alternative studies were carried out.

(1) Main Bridge

1) Design Conditions

Length of the main bridge is controlled by the following design conditions:

- Required navigation clearance
- Bridge superstructure type

Navigation Clearance

In accordance with VINAMARINE Letter No. 192/TB-BGTVT dated May 14, 2009, it was confirmed that the following navigation clearance is required:

Table 2.4-7 Required Navigation Clearance

2 channels of 100 m wide for the vessels under 1,000 DWT

Bridge Structure Type

Concrete PC-box girder is selected in the F/S and it is reasonable because of the following reasons:

- Materials can be procured locally,
- Popular structure which local contractor can build,
- Initial construction cost is least cost,
- No influence to on-going traffic during 2nd stage construction in the future, and
- Maintenance-free; it is suitable as an offshore structure.

Ratio between Main Spans and Side Spans

Standard ratio between main spans and side spans of the PC-box girder bridge is as follows:

Table 2.4-8 Ratio between Main Span and Side Spans (Four Spans Bridge)

Side Span : Main Span : Main Span : Side Span = 0.63 : 1.00 : 1.00 : 0.63

2) Selection of Optimum Bridge Length

Considering the above design conditions, the following bridge length is selected as the optimum bridge length for the main bridge.

Table 2.4-9 Selection of Optimum Length of Main Bridge

Side Span : Main Span : Main Span : Side Span = 95m : 150m : 150m : 95m = 490m

(2) Approach Bridge (1) Hai An Side

1) Design Conditions

Length of the approach bridge is controlled by the following design conditions:

- Position of the east abutment and edge of the Main Bridge

Alternative Positions of Abutment of Approach Bridge (Hai An Side):

The east abutment should be located on the land area because approaching embankment to the abutment should be on the land. Otherwise, the embankment work would be very costly.

Abutment height should be determined by slope stability analysis of approach embankment. The critical height of the embankment was determined to be 5.5 m. The bridge structure should be higher than this value.

Table 2.4-10 Critical Height of Embankment (Hai An Side)

Critical Height of Embankment H_{max} = 5.5 m

Considering the above, the following are the two alternative positions of the abutment of the approach bridge at Hai An side.

Table 2.4-11 Alternative Abutment Positions of Approach Bridge (Hai An Side)

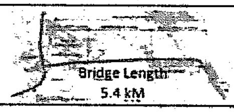
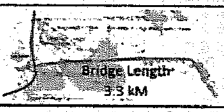
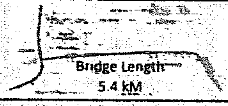
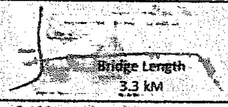
Alternative No.	Abutment Position
AB-HA-1	Edge of Existing Land
AB-HA-2	Edge of Land in Future (After development of South Dinh Vu IZ)

2) Alternative Study and Selection of Optimum Bridge Length of Approach Bridge (Hai An Side)

Considering the above design conditions, the comparison study was carried out and summarized in Table 2.4-12.

"Delay risk" was considered because it will have a very strong adverse effect to the project implementation.

Table 2.4-12 Comparison of Abutment Position of Approach Bridge (Hai An Side)

Schedule of Dinh Vu Improvement Project	On Schedule		Delay	
Alternatives	Alternative 3A	Alternative 3B	Alternative 3A	Alternative 3B
Layout				
1. Construction Cost (Million VND)	Bridge L=2,100m: 1,170,000 · Temporary road and cofferdam are not required. · Access to bridge construction works become easy.	Road L= 2,100m : 444,000 Soft ground countermeasure: 325,000 Total: 769,000 · Soft ground countermeasure is required.	Bridge L=2,100m: 1,419,000 · Temporary road and cofferdam are required.	Road L= 2,100m : 616,000 Soft ground countermeasure: 325,000 Dyke: 52,000 Total: 993,000 · Soft ground countermeasure and dyke works are required
2. Construction Period	19.5 months	17.5 months	19.5 months	17.5 months
3. Workability	· Reclamation, bridge and road construction works will be done simultaneously, so construction management and schedule control by mutual executing organization is quite difficult.		· Bridge construction will be individually done, so construction management and schedule control can be correctly done on schedule.	· Even though road construction will be individually done, construction management and schedule control for not only soft ground countermeasure but also dike works are required longer period in the sea.
4. Maintenance	· Bigger range of bridge maintenance, on the other hand smaller range of road maintenance.	· Smaller range of bridge maintenance, on the other hand bigger range of road maintenance, especially maintenance for consolidation settlement.	· Bigger range of bridge maintenance, on the other hand smaller range of road maintenance.	· Smaller range of bridge maintenance, on the other hand bigger range of road maintenance, especially maintenance for consolidation settlement and dyke.
5. Convenience	· It can be served all year because a viaduct on the Dinh Vu IZ improvement area is not affected by wind waves and others. · It connects to Dinh Vu IZ at 1 location.	· It can be served all year because a road on the Dinh Vu IZ improvement area is not affected by wind waves and others. · It connects to Dinh Vu IZ at 2 location.	· It can be served all year because a viaduct in the sea is not affected by wind waves and others. · It connects to Dinh Vu IZ at 1 location.	· Until completion of Dinh Vu IZ, a marine road could be affected by wind waves arising from typhoon and others. · It connects to Dinh Vu IZ at 2 locations.
6.Environmental Impact	· Environmental impact is controlled by Dinh Vu IZ improvement project, therefore both construction of bridge and road is under same conditions.		· Works affecting environmental impact until completion of Dinh Vu IZ improvement project are temporary roads for pier and foundation of bridge construction in case of delay of Dinh Vu IZ improvement project. · The environmental impact is smaller that of Alternative 3B.	· Works affecting environmental impact until completion of Dinh Vu IZ improvement project are road embankment for stopping ocean current, soft ground countermeasure and dyke in case of delay of Dinh Vu IZ improvement project. · The environmental impact is larger that of Alternative 3A.
7. Issues to be resolved	· Completion of road and bridge construction before open of Luch Huyen Port · Mutual deep coordination between different two Projects.	· Completion of road and bridge construction before open of Luch Huyen Port. · Mutual deep coordination between different two Projects. · Road construction in the sea. · Selection of construction methods for soft ground countermeasure. · Monitoring and maintenance of road on soft ground.	· Completion of road and bridge construction before open of Luch Huyen Port	· Completion of road and bridge construction before open of Luch Huyen Port. · Mutual deep coordination between different two Projects. · Road construction in the sea. · Selection of construction methods for soft ground countermeasure. · Monitoring and maintenance of road on soft ground.
8. Conclusion	Recommendation	· No recommendation according to evaluation of Maintenance and Issued to be resolved.	Recommendation	· No recommendation according to evaluation of Maintenance, Covienience, Environmental impact and Issued to be resolved.
	· **Recommendation of bridge construction alternatives in the existing sea**			[ ] is described as disadvantages.

(3) ***Approach Bridge (2) Cat Hai Side***

Abutment height should be determined by slope stability analysis of approach embankment. The critical height of the embankment was determined to be 5.5 m. The bridge structure should be higher than this value.

(4) ***Recommended Length of Approach Bridges***

Approach Bridge at Hai An Side:

B Bridge length is controlled by the location of abutment and it is selected to be located at the existing land area (Alternative-3A in the F/S). Alternative 3B (abutment in the future reclaimed area) would take a very long construction period which could not meet the port opening in early 2015.

Table 2.4-13 Selection of Optimum Length of Approach Bridge (Hai An Side)

Approach Bridge at Hai An Side = 4,433.7 m (Abutment at edge of existing land area)

Approach Bridge at Cat Hai Side:

Bridge length is controlled by the location of abutment and it is selected to be located just behind the dyke. This position would not be shortened.

Table 2.4-14 Selection of Optimum Length of Approach Bridge (Cat Hai Side)

Approach Bridge at Cat Hai Side = 519.2 m (Abutment behind of the dyke)

2.4.5. Alternative Study on Bridge Type (1) Main Bridge

(1) Structural Alternatives

Structural alternatives are prepared for superstructure and pile foundation.

1) Superstructure

Considering the application of stage construction and the required 30 month construction period, the following three types of superstructure were selected for the alternative study.

1) MSB-2: PC Box Girder Separated Type
   - 3 lanes/4 lanes to 6 lanes, 2 stages construction
2) MUBR: PC Box Girder with Rib
   - 4 lanes to 6 lanes, 2 stages construction
3) MUBS: PC Box Girder with Strut Unified
   - 4 lanes to 6 lanes, 2 stages construction

Table 2.4-15 Alternative types of Superstructure for Main Bridge

Type		MSB-2 PC Box Girder Separated type	MUBR PC Box Girder with Rib Unified type	MUBS PC Box Girder with Strut Unified type
Span Arrangement		95m+150m+150m+95m		
Width	1st Stage	13.5m	19.0m	
	2nd Stage	13.0m	7.5m	
	Total	26.5m	26.5m	
Girder Depth		H= 3.0m-8.0m		

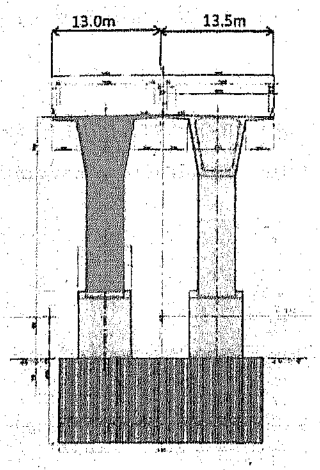
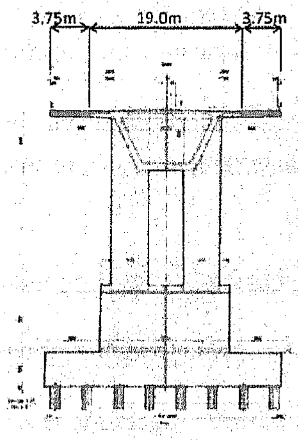
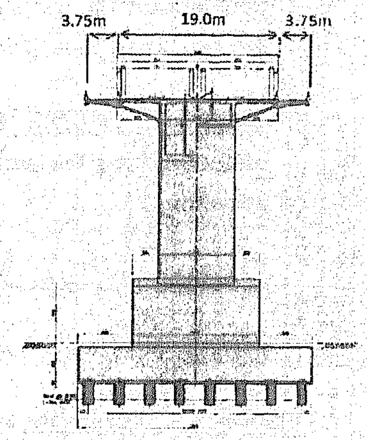
2) Pier

- V-shaped pier is selected similar to the recommendation in the F/S.

3) Foundation

- Bored Pile ϕ 1.2m based on the F/S
- Steel Pipe Well Foundation

Table 2.4-16 Alternative Types of Superstructure for Main Bridge

MSB-2: PC Box Girder Separated Type	MUBR: PC Box Girder with Rib Unified Type	MUBS: PC Box Girder with Strut Unified Type
		
: First Stage Construction	Second Stage Construction	

(2) ***Evaluation Criteria***

In order to select the optimum bridge type, the following evaluation criteria were established:

- 1st stage initial construction cost and 2nd stage cost
- 1st stage construction period and 2nd stage period
- Maintenance aspect
- Consideration of 2nd stage constructability
- Required traffic control in 2nd stage widening

1st Stage Initial Construction Cost and 2nd Stage Construction Cost

Construction cost should be quantitatively evaluated based on the updated project cost.

1st Stage Initial Construction Period and 2nd Stage Construction Period

Construction period should be quantitatively evaluated based on the updated construction planning.

Maintenance Aspect

Maintenance aspect will be evaluated considering the difference between bridge types with respect to salt damage. It is possible to evaluate durability of structural members according to exposed surface area. It is also possible to evaluate durability of bridge accessories such as bearing shoe and expansion joint according to number and quality.

No remarkable difference was found among the alternative types of superstructure for the main bridge with regard to maintenance.

Consideration of 2nd Stage Constructability

MSB-2: Both abutments of the approach bridge and substructure of the main bridge should be built during the 1st stage. During the 2nd stage, all bridge structural entities shall be built including pile foundation, substructure and superstructure.

MUBR and MUBS: Only additional cantilever slab with rib and cantilever slab with strut shall be built during the 2nd stage. However, these works require high construction technology and know-how.

Required Traffic Control in 2nd Stage Widening

MSB-2: No special traffic control is required when the 2nd stage works are carried out.

MUBR and MUBS: Strict traffic regulation is required for the widening works during the 2nd stage.

(3) Comparative Study

Considering the above evaluation criteria, the comparative study was carried out and summarized in Tables 2.4-17 and 2.4-18.

Table 2.4-17 Comparison of Superstructure Type for Main Bridge

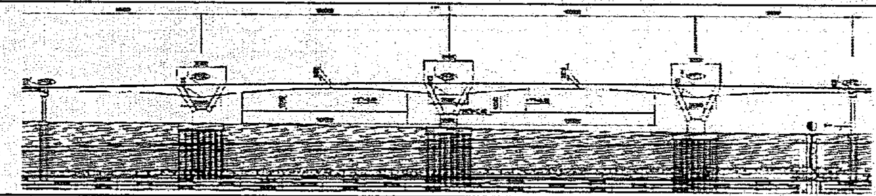
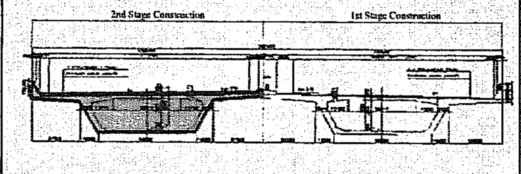
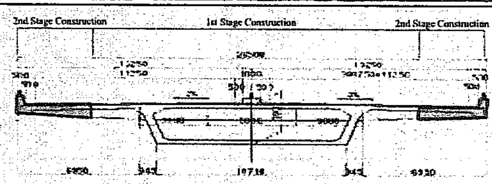
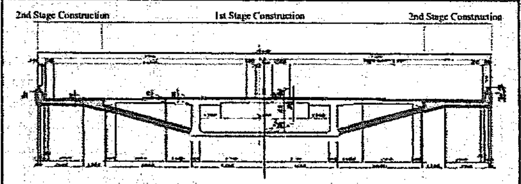
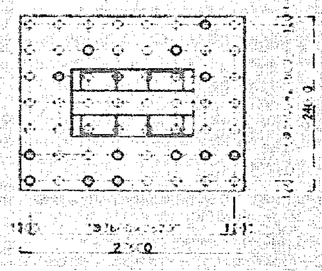
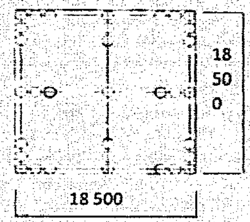
Alternatives		MSB-2: PC Box Girder Separated Type			MUBR: PC Box Girder with Rib, Unified Type			MUBS: PC Box Girder with Strut, Unified Type		
Span Component		95m + 150m + 150m + 95m = 490m								
Side View										
Cross Section		 3 Lanes/4 lanes to 6 lanes			 4 Lanes to 6 lanes			 4 Lanes to 6 lanes		
Construction Cost (MVND)		1 st Stage	2nd Stage	Total	1 st Stage	2nd Stage	Total	1 st Stage	2nd Stage	Total
	Superstructure	171,621	168,687	340,308	281,499	48,354	329,853	241,055	79,085	320,140
	Substructure	274,548	14,391	288,939	289,658	—	289,658	278,385	—	278,385
	Total	446,169	183,078	629,247	571,157	48,354	619,511	519,440	79,085	598,525
	Cost Ratio	1.00	1.00	1.00	1.28	0.26	0.98	1.16	0.43	0.95
		(MSB-2 : MUBR : MUBS); **1st Stage Initial Cost = 1.00 : 1.28 : 1.16** and 2nd Stage Widening Cost = 1.00 : 0.26: 0.43 and **Overall Final Cost = 1.00 : 0.98 : 0.95**								
Construction Period		20 months	18 months	38 months	24 months	12 months	36 months	24 months	15 months	39 months
Maintenance		To give attention against salt damages on strucural members and bridge accessories No remarkable difference between each alternative			To give attention against salt damages on strucural members and bridge accessories No remarkable difference between each alternative			To give attention against salt damages on strucural members and bridge accessories No remarkable difference between each alternative		
Project Merit		Possession of project scale merit for 2nd stage construction in the future			No Possession of project scale merit for 2nd stage construction in the future To require high construction technology and know-how			No Possession of project scale merit for 2nd stage construction in the future To require high construction technology and know-how		
Workability		No influence to opened traffic during 2nd stage construction in the future			Big influence to opened traffic during 2nd stage construction in the future To design considering unbalance loads during 2nd stage construction			Big influence to opened traffic during 2nd stage construction in the future To design considering unbalance loads during 2nd stage construction		
Conclusion		Recommendable for 4-lanes bridge (can be opearted as 4-lanes bridge)			Not Recommendable			Recommendable for full 6-lanes bridge		
		※ Initial construction cost is least cost. ※ No influence to opened traffic.						※ MUBR and MUBS don't have project scale merit in the 2nd Stage. ※ Big influence to opened traffic in case of 2 stage construction. ※ Overall construction cost is least cost.		

Table 2.4-18 Comparison of Foundation Type for Main Bridge

	Main Bridge	
Alternative Pile Type	Alrenative-1 Cast-in-place pile D=1.2m	Alrenative-2 Steel pipe well D=1.2m
Plan of Pile Cap	 L=29.0m , n=56nos	 L=29.0m , n=69nos
Amount	70,076 Million VND	104,167 Million VND
Cost ratio	1.000	1.486
Construction Period	4.0 months ・Longer period	2.5 months ・Shorter period
Workability	・Very common in Vietnam ・Machines and equipments is available ・Double temporary cofferdam is requred in case of 10m or more sea water depth.	・A little rare adoption in Vietnam ・Steel pipe well is used both for foundation of bridge and temporary cofferdam ・Steel pipe well can be safely constructed in deep sea water depth.
Environmental impact	・Much turbid water ・Much discharged soils	・Even though larger noise and vibration is generated, residential area is far from the construction site.
STEP requirement	・Japanese products are not much used.	・Japanese products are much used.
Conclusion	Not Recommendable	**Recomendable** ※ Shorter construction period ※ More safety construction ※ Smaller environmental impact ※ Japanese products are much used.

(4) Selection of Optimum Bridge Type of Main Bridge

According to the result of the comparative study above, the following bridge type is selected as the optimum bridge type for the main bridge:

1) Superstructure

In case of adoption of stage construction, PC box girder, separated type is selected due to the following reasons:

- Materials can be produced locally,
- Popular structure which local contractors can build,
- Initial construction cost is least costly,
- No influence to present traffic during 2nd stage construction in the future, and
- Maintenance-free; it is suitable as an offshore structure.

In case of adoption of full scale 6-lane construction, PC box girder with strut, unified type is selected due to the following reasons:

- Materials can be produced locally,
- Overall construction cost is least costly,
- New technology can be introduced in Vietnam as a STEP loan project, and
- Maintenance free; it is suitable as an offshore structure.

Reference: PC Box Girder with Strut, Unified type

This strut-type superstructure has been adopted in the two-stage construction of one project without any open traffic in Japan. It consists of one core box segment and additional strut wing slab. This type is also planned in the two-stage construction of two different projects. Firstly, the required bridge width according to future traffic volume will be constructed. Next, it will be opened to traffic. Finally, only additional strut wing slab will be constructed in the future while there is ongoing traffic. The latter stage construction type has no practical construction records while traffic is open; therefore, it is required to improve construction technology and know-how in order to secure the structural safety of connection parts between the constructed PC box and additional strut wing slab.

Table 2.4-19 Selection of Optimum Superstructure Type for Main Bridge

In case of adoption of stage construction	: PC Box Girder, separated type
In case of adoption of full scale 6-lane construction:	PC Box Girder with strut, unified type

2) Substructure (1), Pier

Double V-shaped Pier was selected from landscaping view point, the Study Team has no objection to the selected pier type in the F/S.

Table 2.4-20 Selection of Optimum Pier Type of Main Bridge

Double V-shaped Pier

3) Substructure (2), Foundation

Steel Pipe Well Foundation is selected due to the following reasons (refer to Table 2.4-18):

- Even if construction cost is a little higher, it is the best and safest construction option against deep sea, high wave and strong winds during typhoon seasons,
- Construction period is shortest because the steel pipe functions both as temporary cofferdam and permanent foundation,
- Environmental influence of turbid water and discharged soil is smaller, and
- Amount of Japanese products would increase, making the project eligible to apply for STEP loan.

Table 2.4-21 Selection of Optimum Foundation Type of Main Bridge

Steel Pipe Well Foundation

2.4.6. Alternative Study on Bridge Type (2), Approach Bridge

(1) Structural Alternatives

Structural alternatives are prepared for the superstructure and pile foundation.

1) Superstructure

According to the F/S, the Super-T girder, out of six superstructure types, was selected as the optimum bridge type in consideration of economical predominance. Even though construction cost varies significantly between Super-T and PC-I girder, the cost between Super-T and PC box is slightly different. Therefore, four types of superstructure, excluding the PC-I girder, are considered for the comparative study in this Survey.

AST: Super-T Girder and ASB-2: PC Box Girder, Separated type

- 3 lanes/4 lanes to 6 lanes, 2 stages construction

AUBR: PC Box Girder with Rib and AUBS: PC Box Girder with Strut, Unified type

- 4 lanes to 6 lanes, 2 stages construction

Table 2.4-22 Alternative Types of Superstructure for Approach Bridge

Type		AST Super-T Girder Separated type	ASB-2 PC Box Girder Separated type	AUBR PC Box Girder with Rib Unified type	AUBS PC Box Girder with Strut Unified type
Span Arrangement		40m	60m	60m	
Width	1st Stage	13.5m		19.0m	
	2nd Stage	13.0m		7.5m	
	Total	26.5m		26.5m	
Girder Depth		H=1.75m	H= 3.0m (1/20)	H=3.0m (1/20)	

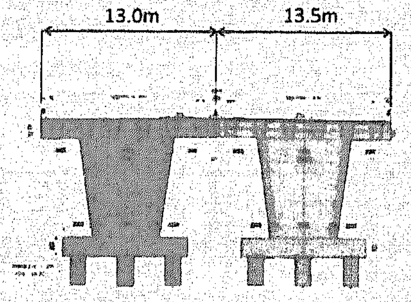
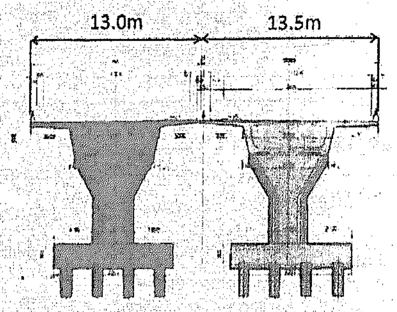
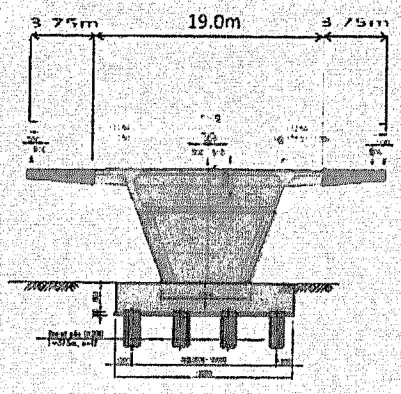
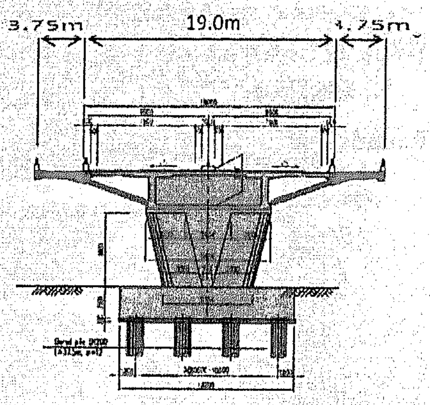
2) Pier

- Wall Pier based on the F/S

3) Foundation

- Bored Pile ϕ 1.2m based on the F/S
- Steel Pile Foundation

Table 2.4-23 Alternative Types of Superstructure for Approach Bridge

AST: Super-T Girder Separated Type	ASH-2: PC Box Girder Separated Type
	
AUBR: PC Box Girder with Rib Unified Type	**AUBS: PC Box Girder with Strut Unified Type**
	
: First Stage Construction	: Second Stage Construction

(2) *Evaluation Criteria*

Considering the above design conditions, the type of the approach bridge will be selected through comparative study based on the following evaluation criteria, which are same as those for the main bridge.

- 1st stage initial construction cost and 2nd stage cost
- 1st stage construction period and 2nd stage period
- Maintenance aspect
- Consideration of 2nd stage constructability
- Required traffic control during 2nd stage widening

(3) *Comparative Study*

Considering the above design conditions and evaluation criteria, the comparative study was carried out and summarized in Tables 2.4-24 and 2.4-25.

Table 2.4-24 Comparison of Superstructure Type for Approach Bridge

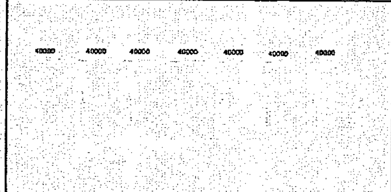
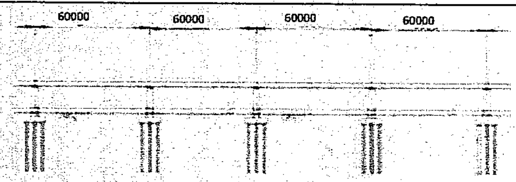
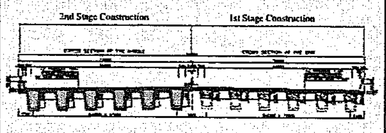
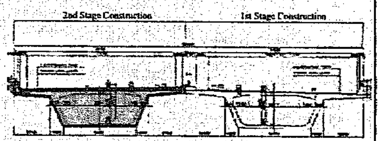
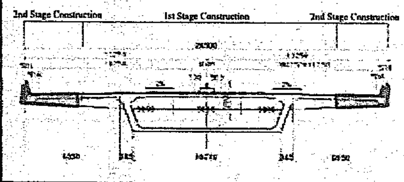
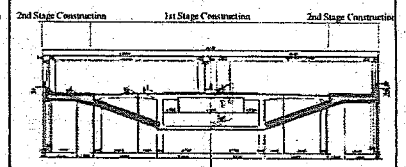
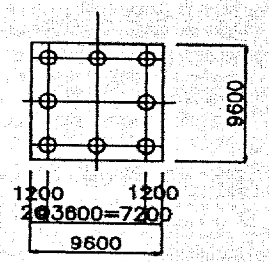
Alternatives		AST: Super-T Girder			ASB-2: PC Box Girder Separated Type			AUBR: PC Box Girder Separated Type			AUBS: PC Box Girder Separated Type		
Span Component		1 Span Length = 40m, Total objective length = 4748.4 m			1 Span Length = 60m, Total objective length = 4748.4 m								
Side View													
Cross Section		3 Lanes/4 lanes to 6 lanes 			3 Lanes/4 lanes to 6 lanes 			4 Lanes to 6 lanes 			4 Lanes to 6 lanes 		
Construction Cost (MVND)		1 st Stage	2nd Stage	Total	1 st Stage	2nd Stage	Total	1 st Stage	2nd Stage	Total	1 st Stage	2nd Stage	Total
	Superstructure	604,446	596,906	1,201,352	1,006,271	988,529	1,994,800	1,851,380	475,169	2,326,549	1,572,815	667,147	2,239,962
	Substructure	1,040,964	965,129	2,006,093	775,298	747,139	1,522,437	1,314,933	——	1,314,933	1,219,081	——	1,219,081
	Total	1,645,410	1,562,035	3,207,445	1,781,569	1,735,668	3,517,237	3,166,313	475,169	3,641,482	2,791,896	667,147	3,459,043
	Cost Ratio	1.00	1.00	1.00	1.08	1.11	1.10	1.92	0.30	1.14	1.70	0.43	1.08
		(AST : ASB-2 : AUBR : AUBS): 1st Stage Initial Cost = 1.00 : 1.08 : 1.92 : 1.70 and 2nd Stage Widening Cost = 1.00 : 1.11 : 0.30 : 0.43 and Overall Final Cost = 1.00 : 1.10 : 1.14 : 1.08											
Construction Period		28 months	24 months	52 months	26 months	22 months	48 months	28 months	12 months	40 months	28 months	15 months	43 months
Maintenance		Exposed surface area of Super-T is larger than PC Box types, so it will be severely affected by salty conditions. Number of Bearing Shoe is so many rather than PC Box types, so maintenance activities are required much more.			To give countermeasure against salt damages on strucural members and bridge accessories No remarkable difference between each alternative between PC Box types			To give countermeasure against salt damages on strucural members and bridge accessories No remarkable difference between each alternative between PC Box types			To give countermeasure against salt damages on strucural members and bridge accessories No remarkable difference between each alternative between PC Box types		
Project Merit		Possession of project scale merit for 2nd stage construction in the future			Possession of project scale merit for 2nd stage construction in the future			No Possession of project scale merit for 2nd stage construction in the future To require high construction technology and know-how			No Possession of project scale merit for 2nd stage construction in the future To require high construction technology and know-how		
Workability		Local resourse can be effectively applied. Construction of Girder is easier because of light weight girder. No influence to opened traffic during 2nd stage construction in the future			No influence to opened traffic during 2nd stage construction in the future			Big influence to opened traffic during 2nd stage construction in the future To design considering unbalance loads during 2nd stage construction			Big influence to opened traffic during 2nd stage construction in the future To design considering unbalance loads during 2nd stage construction		
Conclusion		No Recommendable			Recommendable for 4-lanes bridge (can be opearted as 4-lanes bridge)			No Recommendable			Recommendable for full 6-lanes bridge		
		Even if Initial construction cost is least cost (8 % less). ※ Maintenance activities are required much more ※ Construction Period is longest alternative because of large number of piers and piles.			Even if Initial construction cost is a little higher cost (8 % more). ※ Maintenance activities are not required much. ※ Construction Period is not longer alternative because of not so large number of piers and piles.						※ AUBR and AUBS don't have project scale merit in the 2nd Stage. ※ Big influence to opened traffic in case of 2 stage construction. ※ Overall construction cost is least cost as Box type. ※ Approach bridge should be harmonized with Main bridge. ※ Construction Period is a same as full scale construction.		

Table 2.4-25 Comparison of Foundation Type for Approach Bridge

	Approach Bridge	
Alternative Pile Type	Alrenative-1 Cast-in-place pile D=1.2m	Alrenative-2 Steel pipe pile D=0.8m
Plan of Pile Cap	 L=37.5m , n=8nos	L=37.5m , n=14nos
Amount	352 Million VND	447 Million VND
Cost ratio	1.000	1.270
Construction Period	16 days ・Longer period	8 days ・Shorter period
Workability	・Very common in Vietnam ・Machines and equipments is available ・Double temporary cofferdam is required in case of 10m or more sea water depth.	・A little rare adoption in Vietnam ・Machines and equipments is available ・Double temporary cofferdam is required in case of 10m or more sea water depth.
Environmental impact	・Much turbit water ・Much discharged soils	・Even though larger noise and vibration is generated, residential area is far from the construction site.
STEP requirement	・Japanese products are not much used.	・Japanese products are much used.
Conclusion	Not Recommendable	**Recomendable** ※ Shorter construction period ※ Smaller environmental impact ※ Japanese products are much used.

(4) ***Selection of Optimum Bridge Type of Approach Bridge***

According to the comparative study result, the following bridge type is selected as the optimum bridge type for the approach bridge:

1) Superstructure

In case of adoption of stage construction, PC box girder, separated type is selected due to the following reasons:

- Materials can be produced locally,
- No influence to ongoing traffic during 2nd stage construction in the future

Even if initial construction cost is a little higher than that of the Super-T girder,

- Maintenance activities are not required much based on the number of bearing, length of expansion joint, exposed area of structure and so on, and
- Construction period is shorter based on the quantity of pier and piles.

In case of adoption of full scale 6-lane construction, PC box girder with strut, unified type is selected due to the following reasons:

- Materials can be produced locally,
- Overall construction cost is less costly than the PC box type, and
- New technology can be introduced in Vietnam as a STEP loan project.

Even if initial construction cost is a little higher than that of the Super-T girder,

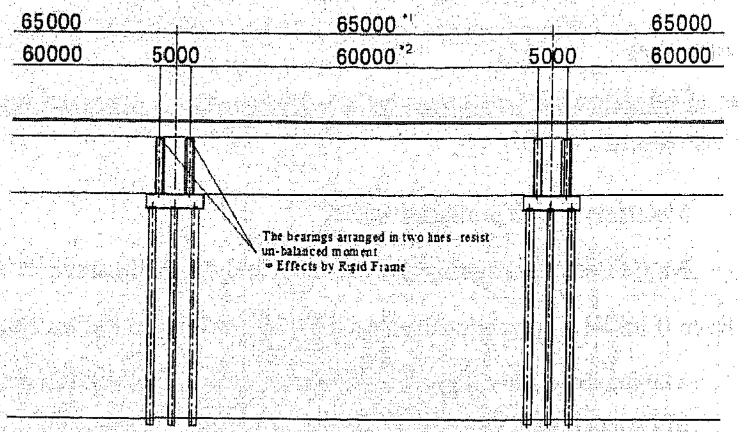
- Maintenance activities are not required much based on the number of bearing, length of expansion joint, exposed area of structure and so on, and
- Construction period is shorter based on the quantity of pier and piles.

Table 2.4-26 Selection of Optimum Superstructure Type of Approach Bridge

In case of adoption of Stage Construction	: PC Box Girder, separated type
In case of adoption of Full scale 6-lanes Construction:	PC Box Girder with strut, unified type

2) Substructure (1), Pier

Wall pier was selected for supporting the Super-T girder and PC box girder superstructures. Furthermore, as mentioned in the F/S, the pier shall be a double wall type in order to achieve cost savings through applying longer span as much as possible to reduce the numbers of piers as shown in Figure 2.4-4. In addition, the bearings are arranged on each double wall to make an equivalent short-period structure, which is similar to a rigid frame, in order to avoid the resonance between the bridge structure and soft soil ground during an earthquake.



*1 The pier shall be arranged in 65 m intervals = numbers of piers can be reduced by approx. 10%.

*2 The girder depth is determined considering a clear span of 60 m.

Figure 2.4-5 Effectiveness of Double Wall Pier

The Study Team has no objection to the selected pier type in the F/S.

Table 2.4-27 Selection of Optimum Pier Type of Approach Bridge

Double Wall Pier

3) Substructure (2), Foundation

Steel pile foundation is selected due to the following reasons:

- Even if construction cost is a little higher, its **construction period is shortest**,
- Environmental influence of turbid water and discharged soil is smaller, and
- Utilization of more Japanese products qualifies the project as a STEP loan scheme