The Feasibility Study
on The Can Tho Bridge Construction in
Socialist Republic of Viet Nam

ANNEXURE 5

INITIAL ENVIRONMENTAL EXAMINATION

5.1 Special Forest Areas Environmentally Preserved

T.T	Forest Name	Location	Area(ha)	Purpose
1	2	3	4	5
	ENTIRE COUNTRY		924,294	
I.	NATIONAL PARKS:		188,500	
1	Cúc Phương	Ninh Bình, Hòa Bình, Thanh Hóa	22,500	To preserve nature and cultural heritages, to conduct scientific research, to observe, visit, and travel
2	Ba Bể	Cao Bằng	8,000	
3	Ba Vì	Hà Tây	8,500	
4	Đảo Cát Bà	Hải Phòng	15,000	
5	Bến En	Thanh Hóa	12,000	
6	Bạch Mã	Thừa Thiên - Huế	22,500	
7	Yokdon	Đắc Lắc	58,000	
8	Nam Cát Tiên	Đồng Nai	36,000	
9	Côn Đảo	Ba Rịa-Vũng Tàu	6,000	
II.	NATURE RESERVES:		616,000	
1	Mường Nhé-Mường Chà	Lai Châu	182,000	To protect wildlife plants and animal gene resources, and to conduct scientific research
2	Sốp Cộp	Sơn La	5,000	
3	Xuân Nha	Sơn La	60,000	
4	Nậm Dôn	Sơn La	18,000	
5	Pà Cò- Hang Kia	Hòa Bình	1,000	
6	Thường Tiến	Hòa Bình	1,500	
7	Trùng Khánh	Cao Bằng	3,000	
8	Núi Pia Hoắc	Cao Bằng	10,000	
9	Hữu Liên	Lạng Sơn	10,000	
10	Ba Mùn	Quảng Ninh	1,800	
11	Núi Yên Tử	Quảng Ninh	5,000	
12	Phong Quang	Hà Giang	2,000	
13	Núi Hoàng Liên	Lào Cai, Yên Bái	5,000	
14	Xuân Sơn	Vĩnh Phú	4,600	
15	Tam Đảo	Bắc Thái- Tuyên Quang, Vĩnh Phú	19,000	
16	Tam Quy	Thanh Hóa	350	
17	Hòn Mê	Thanh Hoá	500	
18	Anh Sơn	Nghệ An	1,500	
19	Thanh Thủy	Nghệ An	7,000	
20	Bù Huống	Nghệ An	5,000	
21	Vụ Quang	Hà Tĩnh	16,000	
22	Phong Nha	Quảng Bình	5,000	
23	Cù Lao Tràm	QN Đà Nẵng	1,535	
24	Ba Ná-Núi Chúa	Qn Đà Nẵng	5,215	
25	Suối Trai	Phú Yên	19,000	

List of Special Forest Areas Environmentally Preserved
(comtinued)

T.T	Forest Name	Location	Area(ha)	Purpose
1	2	3	4	5
26	Đảo Cà-Hòn Rồn	Phú Yên	10,000	
27	Rừng khô Phan Rong	Ninh Thuận	1,000	
28	Biển Lạc	Bình Thuận	20,000	
29	Tánh Linh	Bình Thuận	2,000	
30	Kông Cha Răng	Gia Lai	11,000	
31	Kon Ka Kinh	Gia Lai	20,000	
32	Monrây-Ngọc Vin	Kon Tum	20,000	
33	Ngọc Lĩnh	Kon Tum	20,000	
34	Chư Giang Sinh	Đắc Lắc	20,000	
35	Quảng Xuyên	Đắc Lắc	20,000	
36	Nam Lung	Đắc Lắc	20,000	
37	Đèo Ngoạn Muc	Lâm Đồng	2,000	
38	Núi Bà	Lâm Đồng	6,000	
39	Thượng Đa Nhim	Lâm Đồng	7,000	
40	Núi Đại Bình	Lâm Đồng	5,000	
41	Huỳnh Châu-Phước Bửu	Đồng Nai	5,500	
42	Bu Gia Mập	Sông Bé	16,000	
43	Tay Bãi Cát Tiên	Sông Bé	10,000	
44	Lò Gò-Sa Mát	Tây Ninh	10,000	
45	Phú Quốc	Kiên Giang	5,000	
46	U Minh	Minh Hải	2,000	
47	Cà Mau	Minh Hải	4,000	
48	Các Sân Chin	Minh Hải	500	
III	CULTURAL, HISTORIC, SCENIC AND ENVIRONMENTAL FORESTS			
1	Mường Phăng	Lại Châu	1,000	These forests contain historical and cultural heritages, and the scenery has artistic value which is an impetus for protecting the environment. The forests also serve travel, recreational and rest purposes.
2	Đảo Hồ Sông Đà	Hoa Bình	3,000	
3	Hương Tích	Hà Tây	500	
4	Pắc Pó	Cao Bằng	3,000	
5	Bắc Sơn	Lạng Sơn	4,000	
6	ái Chi Lăng	Lạng Sơn	1,000	
7	Hồ Núi Cốc	Bắc Thai	6,000	
8	Bãi Cháy	Quảng Ninh	560	
9	Vịnh Hạ Long	Quảng Ninh	1,000	
10	Hồ Cấm Sơn	Hà Bắc	15,000	
11	Tên Trào	Hà Giang	1,100	
12	Đảo Hồ Thác Bà	Yên Bái	5,000	
13	Đền Hùng	Vĩnh Phú	285	
14	Đồ Sơn	Hải Phòng	267	
15	Côn Sơn	Hải Hưng	282	
16	Ngọc Trạo	Thanh Hoá	300	
17	Lam Sơn	Thanh Hoá	300	
18	Đền Bà Triệu	Thanh Hoá	300	
19	Núi Thành	QN Đà Nẵng	1,000	
20	Ngũ Hành Sơn	QN Đà Nẵng	400	
21	Bán Đảo Sơn Trà	QN Đà Nẵng	4,000	
22	Ba Tơ	Bình Định	6,000	
23	Hồ Lắc	Đắc Lắc	10,000	
24	Rừng thông Đà Lạt	Lâm Đồng	42,500	
25	Núi Bà Ré	Sông Bé	1,000	
26	Dương Minh Châu	Tây Ninh	5,000	
27	Núi Bà Đen	Tây Ninh	2,000	
28	Bời Lời	Tây Ninh	2,000	
29	Hòn Thông	Kiên Giang	3,000	

5.2 Classification of Structures

CLASSIFICATION OF STRUCTURES
(circular No 05/BXD/TT - Ministry of Construction).

CLASSIFICATION OF STRUSTURES ACCORDING TO CIRCULAR 05/BXDTT

Criteria used for classification of structures

	Category 1	Category 2	Catergory 3	Catergory 4
Level of comfort	High comfort level: bedrooms, kitchen, private toilet on the same floor	Medium comfort level kitchen and private toilet on the same floor	Average level of comfort, toilet could be shared and on different floor	Low comfort level, 1 or 2 room, toilet and kitchen shared
Quality of materials	High quality of materials, decoration	Medium quality, materials, some decoration	Average quality of materials	Low quality materials
Utilities	High level of utilities (electricity, water supply)	Medium level of utilities	Average quality of equipment for electricity and water supply	Low quality of equipment water supply is shared

Below these categories are temporary structures. These structures do not meet the minimum requirements for comfort level, quality of materials and utilities. Kitchen and toilets are built by temporary and inflammable materials.

5.3 Contents of Environmental Impact Assessment Report

Contents of Environmental Impact Assessment Report

I. Opening

1.The purpose of the report
2.Data information of the report
3.The selection of evaluation method
4.Agencies and members in charge, methods and processes of making the report

II. Project general description

1. Project title.
2. Name of project owner, name of organization which prepared the economic-technical report or equivalent project documents.
3. Main contents of project. Possible socio-economic benefits of the project.
4. Progress of project implementation.
5. Cost of the project. Estimated progress of investment during progress of project implementation.

III. Actual environmental situation of the location where the project is supposed to take place

1. General description of geographical and socio-economic conditions of the project location.
2. Actual degree of pollution in the project location, and the estimation of the future environmental condition in case that project is not implemented.

IV. Impacts resulting from project implementation on natural resources and environment

1. Impacts resulting from project implementation on natural resources and environmental factors at project location.

Explain features, scope, degree and progress of each impact, and compare with the environmental condition in case that the project is not implemented.

A. Impact on environmental factors: lithosphere, atmosphere, hydrosphere, soil, etc.
B. Impact on biological resources and the biological system:
(1) biological resources under the water and
(2) biological resources on the earth's surface.
C. Impact on economic activities and material-technical foundation:
(1)water supply, (2) transportation,
(3) agriculture, (4) irrigation,
(5) energy, (6) mineral exploitation,
(7) industry, (8) handicrafts,
(9) soil usage for various purposes, (10) recreation and health protection.
D. Impact related to quality of life:
(1) Socio economic activities
(2) Cultural activities and historical, cultural remains.
(3) Artful conditions

2. General changes in the environment if the project is to be implemented. Analyzing changes in the environment caused by each project approach.
The damages on natural resources and environment of each project approach. Possible measures to overcome these adversities.
Carrying out brief cost-benefit analysis for each project approach.
Making clear the following matters in this part:
- Materials used in production,
- Wastes originated from production,
- Final products,
- Estimate the impacts of these said materials to environment.

3. Measures to overcome negative impact of the project on the environment. Explaining technical or managerial measures to overcome the negative impact of the project on environment.
Making the comparison between the proposed benefits and the costs for each said measures.

4. General assessment
Assessing the reliability of forecasts on the environment impact assessment. Suggesting studies, research and surveys necessary to be carried out to obtain reliable conclusions and to adjust forecast on the environmental impact assessment in the future.

V. Proposing approach to protect the environment

1. Proposing to select project implementation approach from the view point of environmental protection.
2. Proposing measures to protect the environment accompanied with the approved implementation approach.

The Feasibility Study
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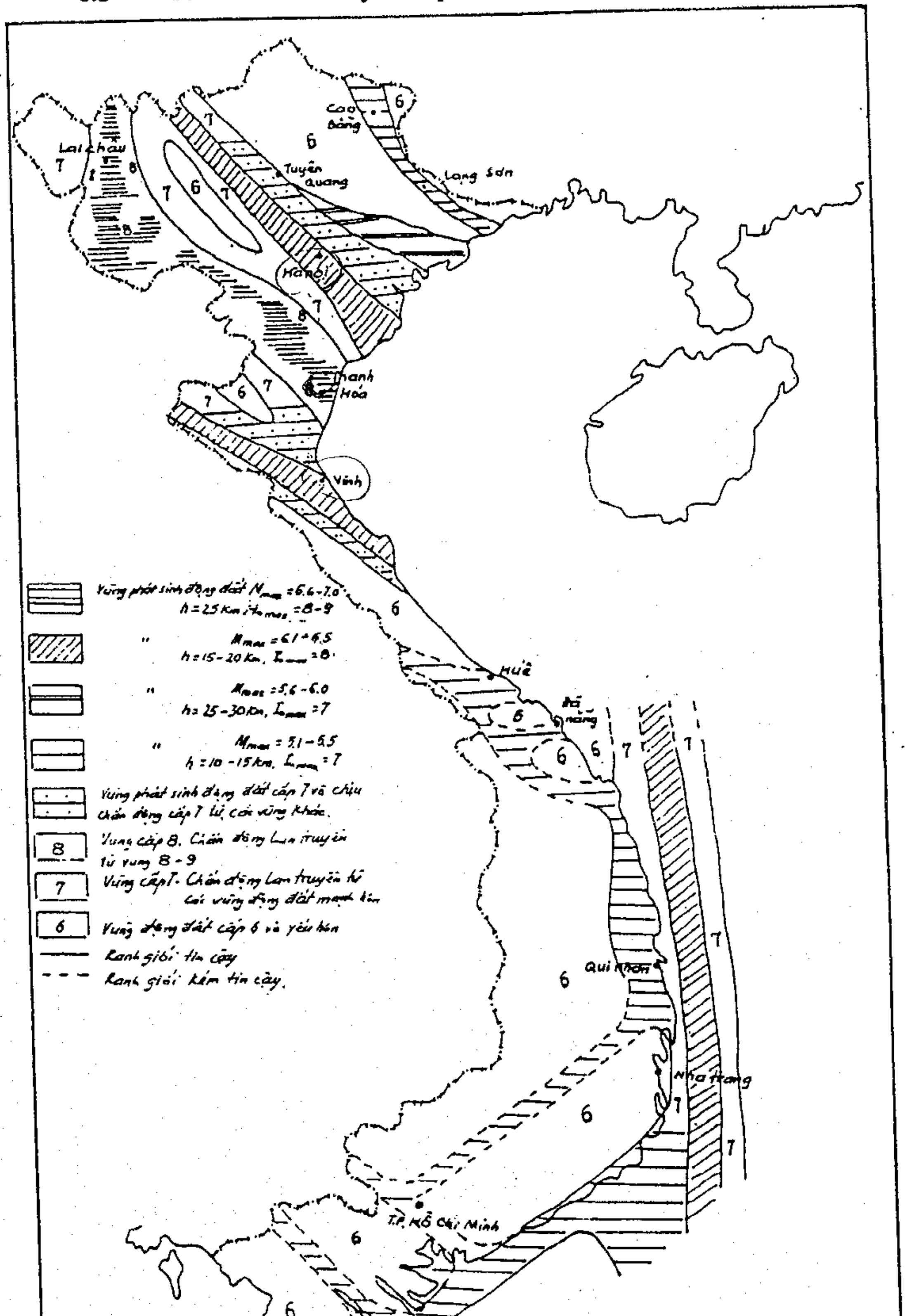
ANNEXURE 6

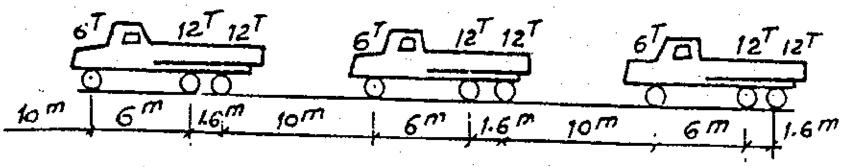
DESIGN CRITERIA AND STANDARD

6.1 Seismic Intensity Map of Viet Nam

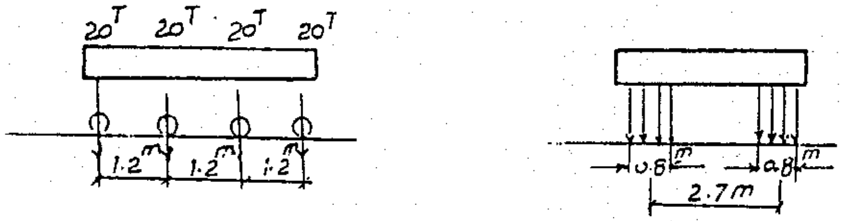


HIGHWAY STANDARD LOAD OF VIETNAMESE BRIDGE DESIGN CODE

1- The H-30 loading consists of trucks with unlimited number, the weight of each truck is 30 tons and they are arranged as illustrated in figure below:



2- The XB-80 loading consists a special heavy truck - 80 tons in weight as illustrated in figure below:



3- Whenever a special heavy truck is placed, no other normal trucks and pedestrians are allowed to be placed simultaneously.

4- Main technical characteristics of the H-30 standard truck lane:

Weight of a truck (T)	30
Number of truck	not limited
Load on rear axle (T)	2 x 12
Load on front axle (T)	6
Width of rear wheel (m)	0.6
Width of front wheel (m)	0.3
Width of truck body (m)	2.9
Distance between center to center of rear wheel (m)	1.9

5- On the roadway width, the truck lanes may be arranged freely so that it produces maximum stresses with following conditions:

- The spacing between the two truck bodies that are placed side by side is not less than 0.1 m.
- The truck clearance is not greater than the horizontal clearance of roadway width.

When the loaded length is greater than 25 m, the vertical live load of highway bridge should be multiplied by coefficient 0.9 with 2 lanes and 0.8 with 3 lanes.

6- For. reinforced concrete structure and frame structure, the impact coefficient is given by following values:

- With the loaded length λ <= 5m is 1.3
- With the loaded length λ >= 45m is 1.0
- With 25< λ <45m it should be calculated by interpolation.

7- The horizontal brake force of each lane in one direction is a concentrated force that is put on the top of roadway and equals to 0.3P, 0.6P, 0.9P with loaded length less than 25m, from 25m to 45m and greater than 45m respectively. In which P is maximum truck weight in the lane.

8- The overloading coefficient of live load n_1:

8.1. In main loading combination:

For truck lane:	n_1 = 1.4
For Special heavy truck:	n_1 = 1.1
For pedestrian load and pedestrian bridge:	n_1 = 1.4
For railing	n_1 = 1.1

8.2. In supplementary loading combination:

The overloading coefficient equal to 0.8 n_1

8.3. In special loading combination: it equal to 0.7 n_1

9- Loading coefficient of dead load n_2

- For all loads except following loads below: n_2 = 1.1 and 0.9
- For weight of levelling layers, waterproofing, protection, roadway, sidewalk: n_2 = 1.5 and 0.9
- For creep and shrinkage effect of concrete n_2 = 1.0 and 0.9. The amount of n_2 , greater than (or less than) unit is to be used in case when the load makes the total of calculated effect increase (or reduce) so that the structure has the most unfavourable loaded condition.

10- Pedestrian load of all bridge types: 300 kg/m2.

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ANNEXURE 7

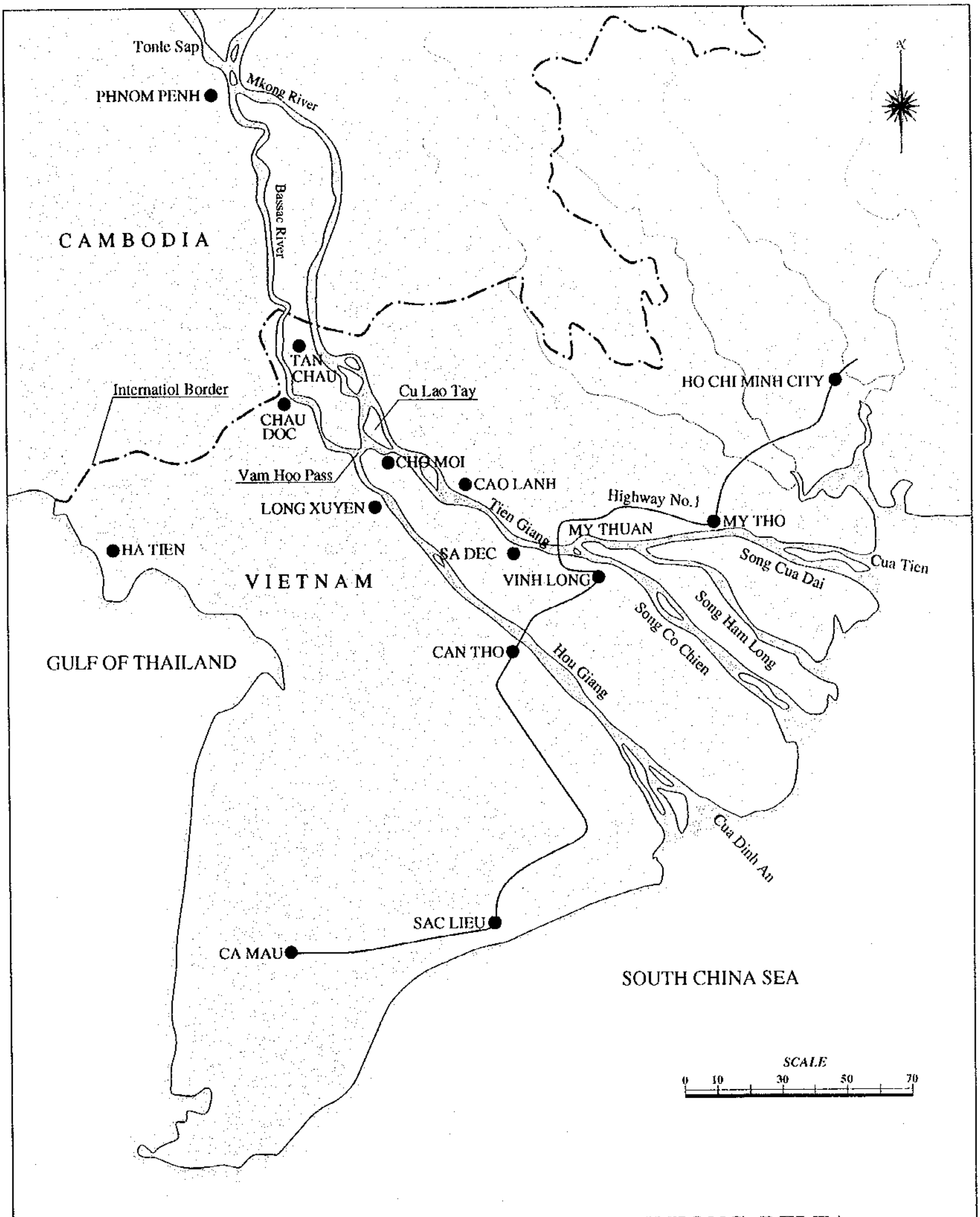
PLANNING CONDITIONS FOR BRIDGE DESIGN

7.1 Navigational Conditions for the Can Tho Bridge Construction in Socialist Republic of Viet Nam

NAVIGATIONAL CONDITIONS
FOR
THE CAN THO BRIDGE CONSTRUCTION
IN
SOCIALIST REPUBLIC OF VIET NAM

NOVEMBER 1997

NIPPON KOEI CO., LTD. and PADECO CO., LTD.



MAIN NAVIGATION ROUTES IN THE MEKONG DELTA

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Appendices:

1. Review of the Existing Data and Previous Surveys

1.1 General

The review of the data and studies on navigational clearance required for the Can Tho Bridge are based on the following existing data and previous surveys, especially, those which studied during the period of the feasibility study and the detailed design of the My Thuan Bridge.

- International shipping survey
- Study for improvement of the access channel to the Hau (Bassac) River
- Hydraulic and morphological conditions at Vam Nao Pass
- Existing utilities such as electricity lines and telephone cables
- An update of important subjects of the Mekong Navigation Strategy Review
- Study of the international aspects of the My Thuan Bridge
- Existing and planned ports along the Hau (Bassac) and Mekong rivers
- The decision on the navigational clearance of the My Thuan Bridge

1.2 International Shipping survey

The International Shipping survey included the movement of international shipping between the South China Sea and Phnom Penh over a 5 month survey period from 1/5/94 to 30/9/94. The shipping survey also included the detailed information and physical data on past international shipping using the Tien (Mekong) and Hau (Bassac) Rivers. The vessels surveyed included all international vessels traveling to Phnom Penh, irrespective of whether they currently use the Tien (Mekong) or Hau (Bassac) Rivers, and all piloted vessels that use the Tien (Mekong) River found for Vietnam Ports.

The table below shows the profile of ships traveling to Phnom Penh. Approx. 20 to 25 international vessels travel via one of the available channels each mouth. This international shipping survey provided that 95th percentile analyses of shipping transit to Phnom Penh for the Tien (Mekong) and Hau (Bassac) Rivers. The results are summarized as below:

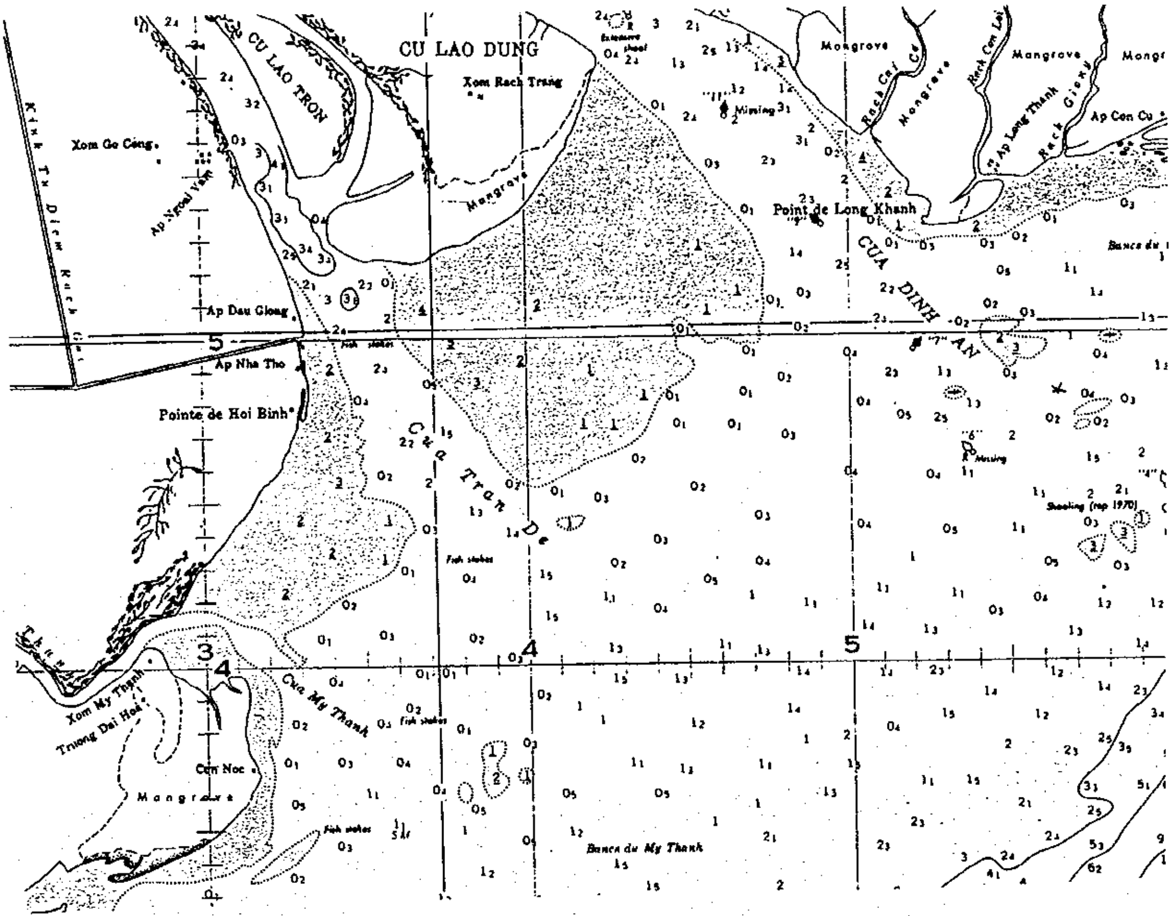
Attribute Analysis of Shipping Transits to Phnom Penh

International Shipping Transits to Phnom Penh			
Shipping Transits to Phnom Penh	Commonly Recorded Attributes	Maximum Recorded Attributes	
		Tien River	Hau River
Dead Weight tonnage (T)	< 2,000	4,305	approx. 11,335
Fully Loaded Draft (m)	3.4 - 4.5	6.8	7.8
Air Draft (Ballasted) (m)	< 25	29	approx. 45
Length Overall (LOA, m)	60 - 70	92	121

The distribution of main vessel characteristics to travel to Phnom Penh are shown in the Appendices.

1.3 Study for Improvement of the Access Channel to the Hau (Bassac) River, Belgium

The study started from mid. 1995 and will be accomplished by September 1998. The study includes the comparison of dredging work at entrance/estuary of the Hau (Bassac) River corresponding to vessel sizes, such as 5,000, 7,000, 10,000 DWT. The technical feasibility and economic viability of achieving and maintaining a safe navigable entrance/estuary all year round for the large sized vessels are under study. It is supposed that the behavior of the sea/river-bed at the estuary of the Cua Tran De to the Hau (Bassac) River must be complicated to estimate the dredging works required due to the highly complex hydrodynamic processes and sedimentation behavior. Below is water depth from Low Water Sea Level in fathoms unit.



Unit: Fathoms (1 Fathom = 1.8 m)

1.4 Hydraulic and Morphological Conditions at Van Nao Pass

1) General

The only hydrographic data available for the Vam Nao Pass study was that from the 1992 Hydrographic Atlas, and the hydrographic survey undertaken by the consultant for the feasibility study of the My Thuan Bridge in December 1994, making it difficult to assess in detail of the bed morphology. Planform data was obtained for the time frame 1958 to 1994 covering a period of approximately 35 years using aerial photography.

A comparison of the available planform data indicates a mostly stable river planform over the intervening 35 years. Major planform changes have only occurred to the north-western section of Cu Lao Tay at the Vam Nao River confluence and the Cho Moi channel, which was formerly part of the navigation channel between the Tien (Mekong) River and the Hau (Bassac) River. The Cho Moi channel has reduced in size and flood flow carrying capacity and this trend is anticipated to continue.

For the Vam Nao Pass and the extended Vam Nao River passing along the western site of Cu Lao Tay, a generally deep and navigable channel exists with only one or two areas of shoaling along the western side of Cu Lao Tay and at the northern junction with the Tien (Mekong) River. It is not anticipated that morphological processes. The river is in a state of dynamic stability and minor variations are to be expected and ongoing, its character should remain essentially the same as it is at present.

2) Existing Morphological Conditions

The only existing data available relating to the Vam Nao Pass was the 1992 Hydrographic Atlas. To supplement this, a further hydrographic survey of the Vam Nao River was undertaken in 1994 as part of the Feasibility Study of My Thuan Bridge.

The 1994 hydrographic survey showed that at the northern entrance to the Vam Nao River, shoaling occurs with water depths reducing to approximately 6 m below MSL. A deep channel has developed on the right side of the river along the western side of Cu Lao Tay with depths more than 10 m and up to 27 m in places. Shoaling at the entrance to the Cho Moi channel appears to be continuing with minimum water depths in the range of 4 m to 6 m below MSL.

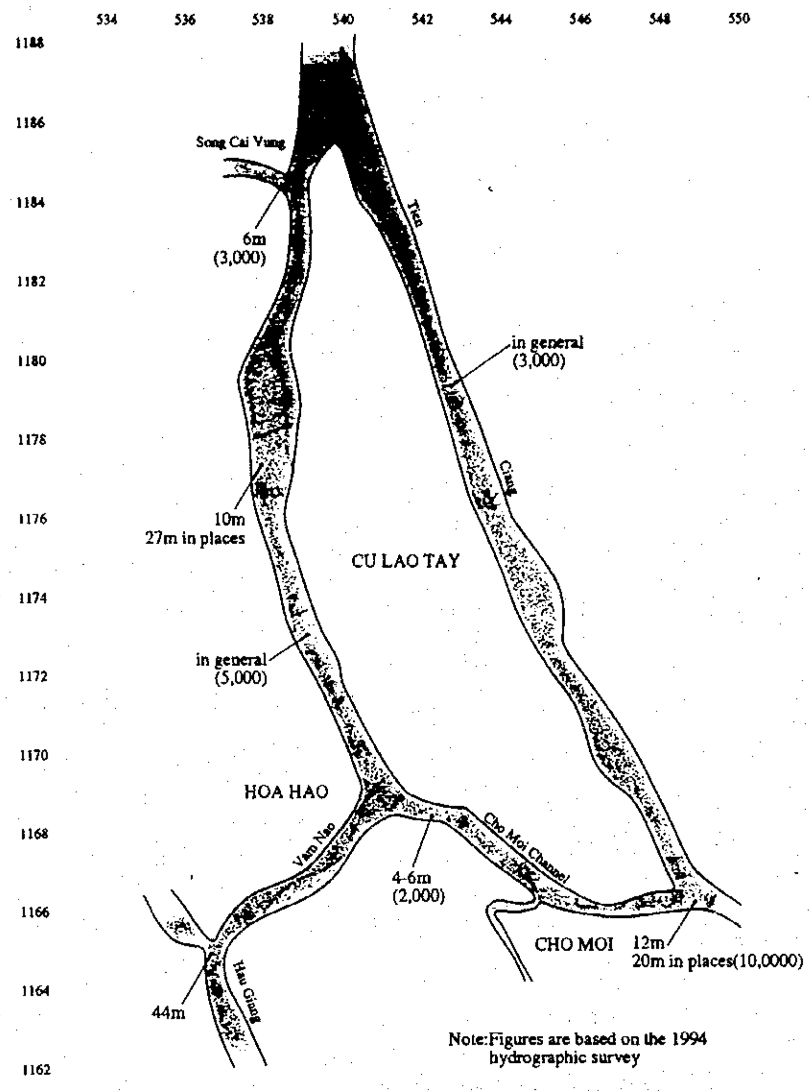
In the Vam Nao Pass itself downstream of the Cho Moi channel confluence, the deeper section of the channel aligns along the southern bank with water depth more than 12 m below MSL throughout, and reaching to 20 m below MSL in one location. Immediately downstream of the confluence with the Hau (Bassac) River, the deep scour hole associated with the convergent flows is to a depth of more than 44 m below MSL.

3) Morphological Assessment of Vam Nao Pass

An assessment of the historical morphological changes was undertaken based upon available maps, survey, navigation charts, hydrographic data and aerial photography. The information obtained provides coverage of morphological changes over a period back to 1958.

The 1967 Pilot Guide indicated that the navigation route from the Hau (Bassac) River to the Tien (Mekong) River was through Vam Nao Pass and the Cho Moi channel. Subsequent data indicates that shoaling of the Cho Moi channel entrance has closed this channel to large ships. The shipping channel now follows the Vam Nao Pass and Vam Nao River along the western side of Cu Lao Tay, which is the predominant path for flow diverted from the Tien (Mekong) River into the Hau (Bassac) River.

The planform information, extracted from aerial photography of the area carried out in 1958, 1969 and 1979 and plotted to the UTM grid coordinate system allowed a direct comparison with the aerial photographic surveys made in conjunction with the 1992 Hydrographic Atlas and which were plotted to the same grid system. This comparison indicates a close similarity between the data sets with the western bank planform of the Vam Nao River in a very similar location now, as for 35 years ago. Major changes have occurred to the north-western section of Cu Lao Tay at the Vam Nao River confluence with the Tien (Mekong) River.



MORPHO LOGICAL CONDITION OF VAM NAO PASS

1.5 Existing Utilities such as Electricity Lines and Telephone Cable

The utilities, such as electricity line and telephone cable crossing the Tien (Mekong) and Hau (Bassac) Rivers over the river and under the river-bed, are shown in the map of the Navigable Condition of the rivers.

1.6 An Update of Important Subjects of the Mekong Navigation Strategy Review

The Mekong Navigation Strategy Review includes the important and relevant findings of the My Thuan Bridge feasibility study. The My Thuan feasibility study, October 1995, included the following components that are important to international navigation development of the lower Mekong river system: (i) the Navigation Access and Dredging Report completed in October 1994, (ii) Mekong River; International Shipping Survey completed in November 1994, (iii) River Studies, Interim Report in January 1995, (iv) Transport Survey and Economic/Financial Evaluation - Interim Report in January 1995, and (v) Interim Report in April 1995.

The important and relevant conclusions to the Can Tho Bridge in the summary of the report are:

1) The magnitude of capital dredging volumes for the nine options considered (three options for each of the three vessels sizes) varies from 2.1 to 6.9 times higher for the Tien (Mekong) River that the Hau (Bassac) River for the entire routes between the entrances and the Cambodian border. As the Government of Viet Nam will invest in improving the Bassac entrance up to Can Tho, the magnitude of capital dredging volumes for the nine options considered varies from 6.8 to 22.2 times higher for the Tien (Mekong) River than the Hau (Bassac) River route. These differences confirm that the Hau (Bassac) River route as the most economical route to dredge, maintain and develop. The study therefore recommended to adopt the Hau (Bassac) River route for maritime shipping of 3,000, 5,000 and 7,000 DWT vessels.

2) The shipping survey analyses, based on data collected and records of the period from 1990 to September 1994, indicated that most of the ships using the two rivers are small with 65 - 80% less than 1,500 DWT. Occasional larger ships of up to 6,500 GRT (approximately 7,500 DWT) are recorded. These larger ships predominantly use the Bassac channel due to its superior navigation qualities. The analyses also indicated that about 20% of vessels have air draft exceeding 25 m, 50% exceeding 20 m and no vessel exceeding 31 m was recorded. In terms of 5% probability of exceedance, the corresponding DWT and air draft were found to be 3,245 tons and 28.5 m respectively.

3) Although all the technical studies conducted for the My Thuan Bridge feasibility study recommended common resources of the Governments of Cambodia and Viet Nam be devoted to developing the Bassac route into an international shipping route, the Interim Report proposed to adopt a minimum vertical clearance of 30 m for the design of the My Thuan Bridge.

1.7 Study of the International Aspects of the My Thuan Bridge

The study, prepared by MAUNSELL-SINCLAIR KNIGHT JOINT VENTURE in association with SEATECH CONSULTANTS MIDDLETONS SOLICITORS in October

1991, shows the relationship of the dead weight tones and required clearances for ships with a given draft.

MTC Nominal Ships and Adopted Design Ships

	Draft Laden (m)	Masthead Height (Unladen) (m)	Clearance Required (m)	Length (m)	Breadth (m)	Tonnage DWT (t)	Tonnage Displacement (t)
MTC Nominal Ships	5		23	70	12	2,500	
	6		25	85	14	3,000	
	6.5		30	100/105	15/16	5,000	
	7.5		32	100/100	-	7,000	
	8.5		37.5	145/155	18/21	10,000	
Adopted Design Ships	5	27	28	80	13	3,000	4,200
	6	29	30	95	16	4,800	6,700
	7	32	33	110	18	7,200	10,000
Canal Traffic (Est)	3.2	17	18	42	6.5	360	500
	4	20	21	52	8	720	1000

1.8 Existing and Planned Ports along the Hau (Bassac) and Mekong River

1) Phnom Penh Port

The existing Phnom Penh Port is located on the right bank of the Tonle Sap River immediately upstream of the confluence with the Mekong River. the port was rehabilitated and works completed in December 1996 under Grant Aid of Japan. The port was rehabilitate including extension of the berth in a capacity of design ship size of 2,000 DWT at LWL and 6,000 DWT at HWL.

2) Existing Can Tho Port

The existing Can Tho Port, located on the right bank of the Hau (Bassac) River, is 8 km north from the central part of Can Tho City near Tranoc Exporting Processing Zone (EPZ). The port was established in 1983. To transport exported/imported commodities from and to Can Tho, the Dinh An estuary in the Hau (Bassac) River has been dredged to allow 5,000 DWT ships to the Can Tho Port, however thanks to the high tide vessels more than 5,000 DWT are able to navigate to the Can Tho Port.

3) Future Port Plans

A port beside the Exporting Processing Zone (EPZ) located on the upstream of the existing Can Tho Port, is planned with the capacity of 10,000 DWT vessels size. The new Can Tho Port, located at 16 km downstream from the existing one, is planned with the capacity of 20,000 to 30,000 DWT vessel size.

1.9 The Decision on the Navigational Clearance of the My Thuan Bridge

The decision on the navigational clearance of the My Thuan Bridge was finally concluded in accordance with the Agreement on the Establishment of the Join Commission on Economic, Cultural, Scientific and Technical Cooperation, and the agreement between the Government of the Kingdom of Cambodia and the Government of the Socialist Republic of Viet Nam, the First Meeting of the Joint Commission was held in Hanoi on 8 - 10 September 1995. In the Agreement, Article 6 Communication and Transport describes that:

In line with the Agreement on Cooperation for the Sustainable Development of the Mekong River Basin signed on 5 April 1995 which provides for freedom of navigation on the mainstream of the Tien (Mekong) River. The two sides agreed that the vertical air clearance of the My Thuan Bridge over the Tien (Mekong) River shall be 37.5 metres.

And the Agreement on Cooperation for the Sustainable Development of the Mekong river Basin, signed on 5 April 1995 by the parties of the Government of; the Kingdom of Cambodia; the Lao People's Domestic Republic; the Kingdom of Thailand; and the Socialist Republic of Viet Name (Mekong River Commission), describes in Article 9 Freedom of Navigation that:

On the basis of equality of right, freedom of navigation shall be accorded throughout the mainstream of the Mekong river without regard to the territorial boundaries, for transportation and communication to promote regional cooperation and to satisfactorily implement projects under this Agreement. The Mekong River shall be kept free from obstructions, measures, conduct and actions that might directly or indirectly impair navigability, interfere with this right or permanently make it more difficult. Navigational uses are not assured any priority over other uses, but will be incorporated into any mainstream project. Riparians may issue regulations for the portions of the Mekong River within their territories, particularly in sanitary, customs and immigration matters, police and general security.

2. Navigable Condition of the Hau (Bassac) River

Based on the review of the existing data, the previous surveys and the information obtained in this study, the findings in relation to the navigable conditions on the Hau (Bassac) River are summarized as follows:

- According to the Attribute Analysis of Shipping Transits to Phnom Penh based on the International Shipping Survey from 1/5/94 to 30/9/94, the Dead Weight tonnage (DWT) of the ships using the Hau (Bassac) is commonly recorded less 2,000 DWT and maximum recorded is approx. 11,335 DWT with air draft approx. 45 m. However, the vessel attribute frequency analysis shows that the 95 percentile to travel to Phnom Penh 3,246 DWT on the Hau (Bassac) River. Its air draft can be calculated at 25.5 m.

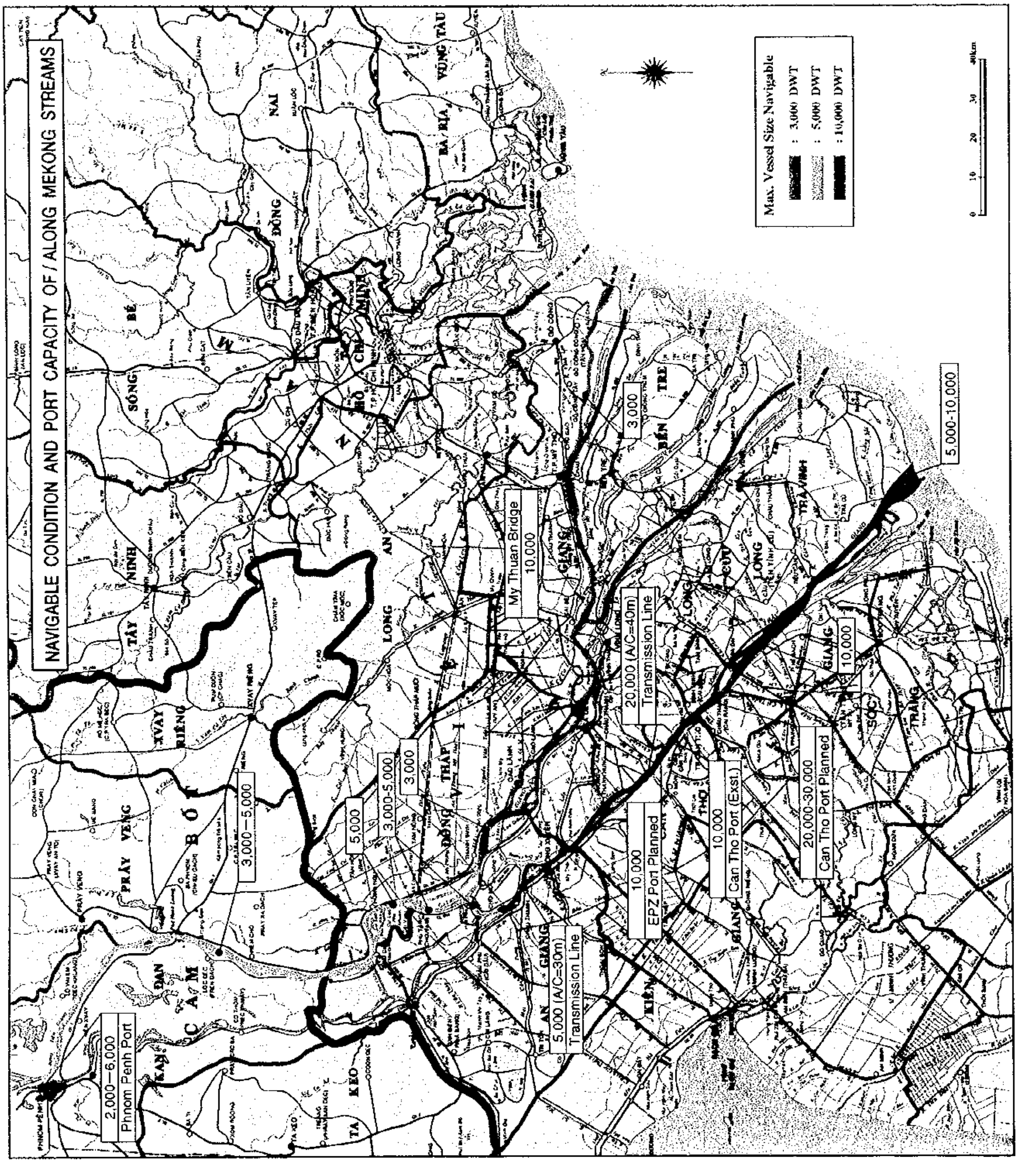
- The study that covers the dredging work at the entrance/estuary of the Hau (Bassac) River in relation to the vessel sizes such as 5,000, 7,000 and 10,000 DWT from the economic and technical viewpoints. It is supposed that due to the highly complex hydrodynamic processes and sedimentation behavior, the appropriate vessel size feasibly to pass the entrance/estuary of the Hau (Bassac) River will be max. 7,000 DWT.

- According the hydrographic data from 1992 and the planform data for the period 1958 (35 years) for the Vam Nao Pass, collected and analyzed during the feasibility study stage of the My Thuan Bridge, in general the character of the Vam Nao Pass is that the foreseeable future major changes will not occur and the river is in a state of dynamic stability and minor variations are to be expected. The existing morphological condition in relation to the navigable condition of water depth and ship sizes are that the Cho Moi channel has reduced in size and has the shoaling at the Cho Moi Channel entrance and has closed to large ships. For the Vam Nao Pass, the western side of Cu Lao Toy is a generally deep and navigable channel which allows ship size of 3,000 to 5,000 DWT, however, at the northern entrance to the Vam Nao River, shoaling occurs with water depth approx. 6 m below MSL (approx. 3,000 DWL draft), surveyed in 1994. It is roughly expected passing 3,000 to 5,000 DWT subject to further surveys.

- The electricity lines crossing the Hau (Bassac) River are two locations at the upstream of the Can Tho ferry line. One with 40 m air clearance is immediately upstream of the ferry line and another with 30 m air clearance is situated at Long Xuen, resulted in a limit passing vessel to approx. 5,000 DWT in size, if without any improvement.

- The shipping survey analyses based on the data collected and records of the period from 1990 to September 1994, including the International Shipping Survey, indicated that for both Tien (Mekong) and Hau (Bassac) River are small with 65 - 80% less than 1,500 DWT, occasionally recorded approx. 7,500 DWT. The larger ships normally use the Hau (Bassac) River by reason of its superior navigable condition. About 20% of vessels have air draft exceeding 25 m, 50% exceeding 20 m and no vessels exceeding 31 m were recorded. In case of 5% probability of exceedance, the corresponding DWT and air draft were 3,246 tonnes and 25.5 m to 31 m respectively.

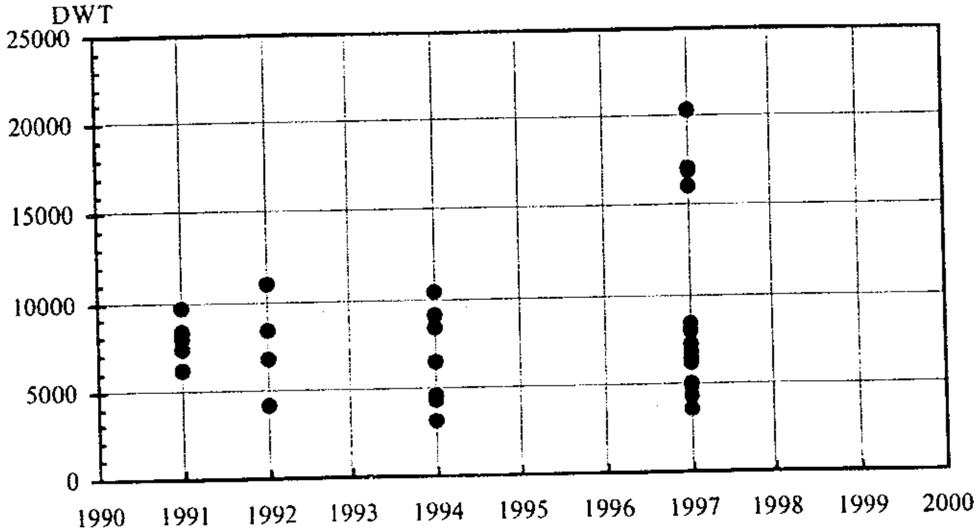
Consequently, the larger ships/vessels used the Hau (Bassac) River are from less 2,000 DWT to approx. 11,335 with air draft approx. 45 m, in case of 95% percentile 3,246 DWT with air draft 25.5 m to 31 m. If without any improvement such a dredging work, the vessel size might be restricted upto 7,000 DWT at the entrance/estuary. The MTC Nominal Ships are listed upto 10,000 DWT with air clearance 37.5 m in maximum. Meanwhile, the maximum vessel capacity for the existing and planned ports along the Hau (Bassac) and Mekong Rivers are 6,000 DWT for Phnom Penh Port, 10,000 DWT for both EPZ port and the existing Can Tho Port, and 20,000 to 30,000 DWT for the future Can Tho Port which will be constructed on the downstream of the Can Tho Bridge. In any case, navigational clearance for the Can Tho Bridge must be accommodated with the freedom of navigation described as the principles of cooperation of the Agreement of the Mekong River Basin, 5 April 1995, Mekong River Commission, and technical and economic feasibility for the dredging works.



NAVIGABLE CONDITION AND PORT CAPACITY OF / ALONG MEKONG STREAMS
Max. Vessel Size Navigable
: 3,000 DWT
: 5,000 DWT
: 10,000 DWT
0 10 20 30 40Km
2,000—6,000
Phnom Penh Port
3,000—5,000
5,000
3,000-5,000
3,000
5,000 (A/C=30m)
Transmission Line
My Thuan Bridge
10,000
3,000
20,000 (A/C=40m)
Transmission Line
10,000
EPZ Port Planned
10,000
Can Tho Port (Exst.)
20,000-30,000
Can Tho Port Planned
10,000
5,000-10,000

3. Records of Arrival Ships and Forecast of Vessel Size

The records of vessel sizes are based on the declaration of arrival ship sheet to travel to Can Tho Port and Phnom Penh Port from the South China Sea. These data were available for the Can Tho Port Authority for the ships using the Hau (Bassac) River and Vung Tau Port Authority using the Tien (Mekong) River. The records are summarized based on the large size vessels, covering 1991/2, 1994 and 1997. The records for Vung Tau Port Authority is not yet accomplished because the large size vessels, greater than 3,000 DWT, were very unusual due to the shallow estuary of the Tien (Mekong) River. The condition of vessels traveling upto Phnom Penh Port after arriving Can Tho Port are restricted by the utilities such as electricity lines.



The vessels, above 10,000 DWT size recorded in 1997, are supposed that due to the shallow water depth or shoaling at the estuary of the Hau (Bassac) River, the ships are necessitated waiting high tide or reduce the loading to keep its shallow draughts to travel to the port.

4. Dredging Calculation corresponding to Vessel Sizes

The dredging volumes corresponding to vessel sizes for safe navigation are calculated for the Tien (Mekong) and Hau (Bassac) Rivers. The vessels sizes are 3,000, 5,000, 7,000, 10,000 and 20,000 DWT. The most recent hydrographic survey data, i.e., the Hydrographic Atlas 1990 - 1992 for the river sections and the Service of Maritime Safety 1994 Charts for the estuaries are used. The calculation of dredging volumes are carried out under the following conditions:

1) The segmental distances from Viet Nam Cambodia Border to the Cua Tieu Estuary on the Mekong River:

Segment A: Vam Nao Pass - Border (From MK200 to MK235)
Segment B: My Thuan - Vam Nao Pass (From MK112 to MK200)
Segment C: Tieu Estuary - My Thuan (From MK10 + 900 to MK112)
Segment D: Tieu Estuary Entrance (From Sea to Tieu Estuary)

Unit: KM

Segment A	Segment B	Segment C	Segment D	Total
35	88	101	25	249

2) The segmental distances from Vietnam Cambodia Border to the Dinh An Estuary on the Bassac River:

Segment A: Vam Nao Pass - Border (From MK200 to MK235)
Segment I Vam Nao Pass (From BS180 to BS206 + 700 # MK200)
Segment II: Can Tho - Vam Nao Pass (From BS102 to BS180)
Segment III: Dinh An Estuary - Can Tho (From BS22+400 to BS102)
Segment IV: Dinh An Estuary Entrance (From Sea to Dinh An Estuary)

Unit: KM

Segment A	Segment I	Segment II	Segment III	Segment IV	Total
35	27	78	80	30	250

3) Vessel and channel parameters for each case:

	3,000 DWT	5,000 DWT	7,000 DWT	10,000 DWT	20,000 DWT
Length vessel (m)	85	100	130	145	177
Beam vessel (m)	14	16	17	20	24
Laden Draft (m)	5.5	6.5	7.5	8.3	10
Underkeel Clearance at Seaward Entrances (m)	1.0	1.2	1.4	1.6	1.8
Underkeel Clearance in River (m)	0.5	0.6	0.7	0.8	0.9

Notes: (i) Volumes for river waterway sections shall be based on soundings reduced to chart datum (LLW)

(ii) Volumes for the seaward river entrances and estuaries shall be calculated for two alternatives namely

- On basis of laden ships crossing at high tide conservatively based on water level of +2.0 and +3.0 metres of LLW datum.
- On basis of laden ships crossing at LLW i.e. with water level of zero metres.

4) Dredging Volumes for safe navigation on the Tien (Mekong) River from Viet Nam Cambodia border to the entrance of Cua Tieu Estuary.

Unit: m^3

	3,000 DWT	5,000 DWT	7,000 DWT	10,000 DWT
Segment A	0	8,340	119,944	309,019
Segment B	39,704	42,608	1,411,835	3,283,115
Segment C	2,556,952	11,947,278	15,741,195	27,296,197
Segment D	8,223,872	14,285,901	22,021,877	29,988,815
Total (A+B+C+D)	**10,820,528**	**26,284,127**	**39,294,851**	**60,877,146**
Option 1 (LLW) (Segment D)	8,223,872	14,285,901	22,021,877	29,988,815
Option 2 (+2 m) (Segment D)	2,330,478	5,981,534	11,370,725	17,360,533
Option 3 (+3 m) (Segment D)	643,719	3,070,974	7,220,708	12,161,372

5) Dredging Volumes for safe navigation on the Haü (Bassac) River from Viet Nam Cambodia Border to the Entrance of Dinh An Estuary:

Unit: m^3

	3,000 DWT	5,000 DWT	7,000 DWT	10,000 DWT	20,000 DWT
Segment A	0	8,340	119,944	309,019	N.A.
Segment I	58,111	285,883	817,527	1,676,345	N.A.
Segment II	487,881	1,088,940	2,452,104	4,624,980	N.A.
Segment III	46,505	615,071	2,621,665	5,616,226	16,320,342
Segment IV	2,586,772	6,891,625	13,451,226	20,~~1~~658,616	38,65~~0~~,040 (3)
Total (A+I+II+III+IV)	**3,179,259**	**8,889,859**	**19,462,4~~5~~66**	~~**20,658,616**~~ 32,885,186	~~**54,973,382**~~ 54,979,382
Option 1 (LLW) (Segment IV)	2,586,772	6,891,625	13,451,226	20,658,616	38,653,040
Option 2 (+2 m) (Segment IV)	182,381	1,252,437	4,387,675	9,017,914	22,401,560
Option 3 (+3 m) (Segment IV)	0	297,759	1,731,541	4,750,350	15,623,570

5. Navigational Conditions to be considered for the Bridge Construction

5.1 Vertical Navigational Condition

The level of the girder soffit can be determined with the following navigational and hydrological conditions and requirements

1) River Navigational Clearance corresponding vessel sizes are:

Vessel Size (DWT)	Ballast Air Draught (in meter)
3,000	25
5,000	30
7,000	32
10,000	36 (37.5 m for My Thuan)
15,000	39

Source: Honshu-Shikoku Bridge Project, Japan based on the international ship data

2) The river navigational clearances for the bridge crossing the Mekong River in the previous studies or construction are as follows:

- Nong Khai/Thanaleng : 10 m above 20 year flood height for 60 m
- Mukdahan/Savanaket : 10 m above 15 year flood height for 60 m width
- Pakse : 10 m above annual average high water level

5.2 Horizontal Navigational Clearance

1) According to Permanent International Association of Navigation Congress, Belgium, the total width consists of the basic maneuvering lane width plus additional widths to all for the effects of wind, current, etc. further, the additional width for passing distance and bank clearance are considered.

-	Maneuverability	2 x 1.8	=	3.6
-	Speed	2 x 0	=	0
-	Cross wind	2 x 0.4	=	0.8
-	Cross current	2 x 0	=	0
-	Longitudinal current	2 x 0.2	=	0.4
-	Waves	2 x 0	=	0
-	Aids to navigation	2 x 0.1	=	0.2
-	Bottom surface	2 x 0.1	=	0.2
-	Depth	2 x 0.2	=	0.4
-	Cargo hazard	2 x 0.4	=	0.8
-	Passing distance	1.0	=	1.0
-	Bank clearance	2 x 0.5	=	1.0
	Total			8.4 B
			=	8.4 x 20 m
			=	168 m

2) According to Japanese Design Specification for harbor design, 1988, on relative long reaches and moderate traffic, the width is a one-a-half times the length overall of vessel.

Width = 1.5 x 133 = 200 m

3) According to a handbook by UNCTAD, 1985, the opening space under the main span of bridge can be determined with the following conditions:

- As the channel width, a major consideration will be whether the channel should be wide enough to allow ship to pas in opposite directions. Unless there are severe economic restraints, a two-way channel should be made in order to offer unrestricted access to the port. A secondary consideration is that if there is an accident in one lane of the channel, access to the port will still be possible and so there will be less disruption of traffic to and from the port.

- The total width of full-depth channel required for two-lane traffic comprises, on straight reaches, maneuvering lane of about twice the vessel beam for each direction, plus about 30 m between vessels and up to one-a-half times the beam for bank clearance each side. If in case of 10,000 DWT cargo vessel with beam 19.8 m say 20 m and length overall 133 m, the required width is estimated as follows:

  $2 \times 2B + 2 \times 1.5B + 30 = 80 + 60 + 30 = 170$ m

  Therefore, the total opening under the bridge shall be two maneuvering lanes and not less than 168 m to 200 m. furthermore, the protection of the piers of bridge shall be considered in addition to the above figures. It is finally recommended for the total opening under the bridge that 200 m plus two times of 50 m for protecting the pier should be considered and in total 300 meters is reasonable.

APPENDICES

- Attribute Analysis from the International Shipping Survey, Sept 1994
- Morphological Condition of Vam Nao Pass, 1992 Hydrographic Atlas, Planform data from 1958 to 1994
- Vessels Transport on the Tien (Mekong) and Hau (Bassac) River
- Navigational Clearance in Viet Nam (Technical Classification of Inland Waterways: TCVN-5664-1992)
- Relationship between Typical Ship tonnage and Top Level of Ship Mast (Air Draft)
- Typical Ship Dimensions, Permanent International Association of Navigation Congresses, BELGIUM
- REPORT ON ARRIVAL SHIP (1991, 1992, 1994 and 1997)
- New MRCS (Mekong River Commission Secretariat) Organization Structure

Attribute Analysis from the International Shipping Survey, Sept.1994

Figure C1 :VESSEL ATTRIBUTE FREQUENCY ANALYSIS - RIVER TRANSITS FOR STUDY PERIOD
ATTRIBUTE : DEADWEIGHT TONNAGE

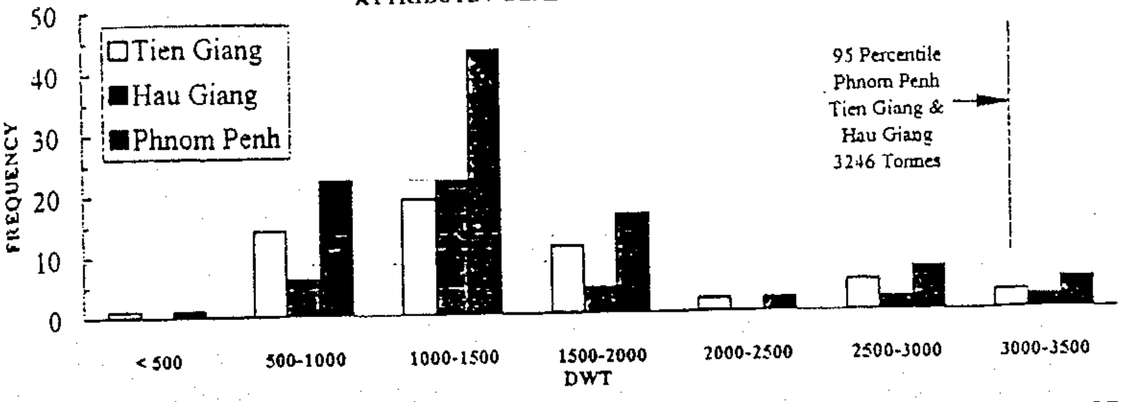


Figure C2 :VESSEL ATTRIBUTE FREQUENCY ANALYSIS - RIVER TRANSITS FOR STUDY PERIOD
ATTRIBUTE : FULL LOAD DRAFT

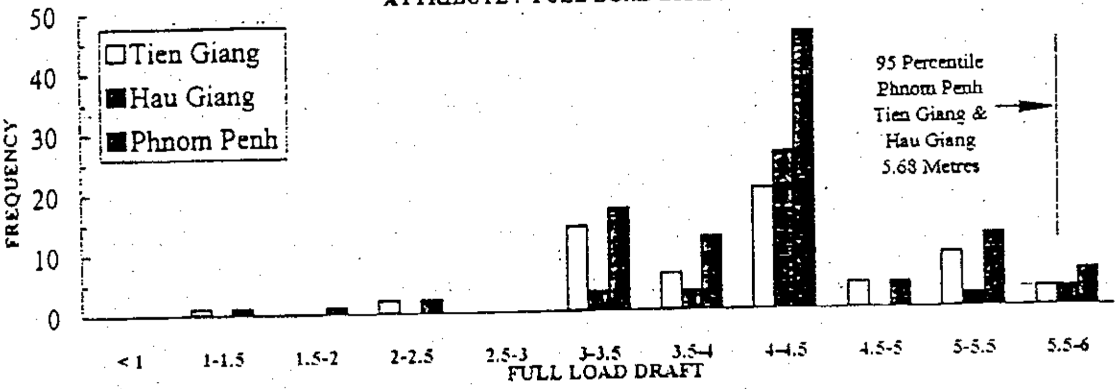


Figure C3 :VESSEL ATTRIBUTE FREQUENCY ANALYSIS - RIVER TRANSITS FOR STUDY PERIOD
ATTRIBUTE : AIR DRAFT

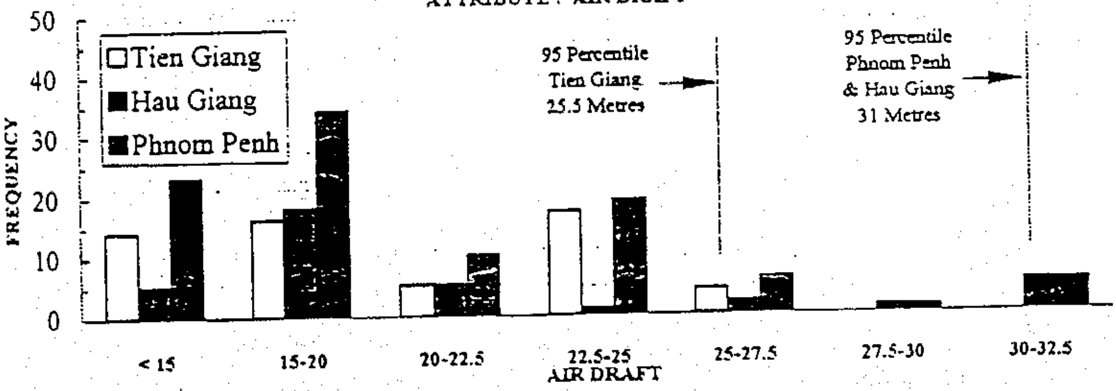
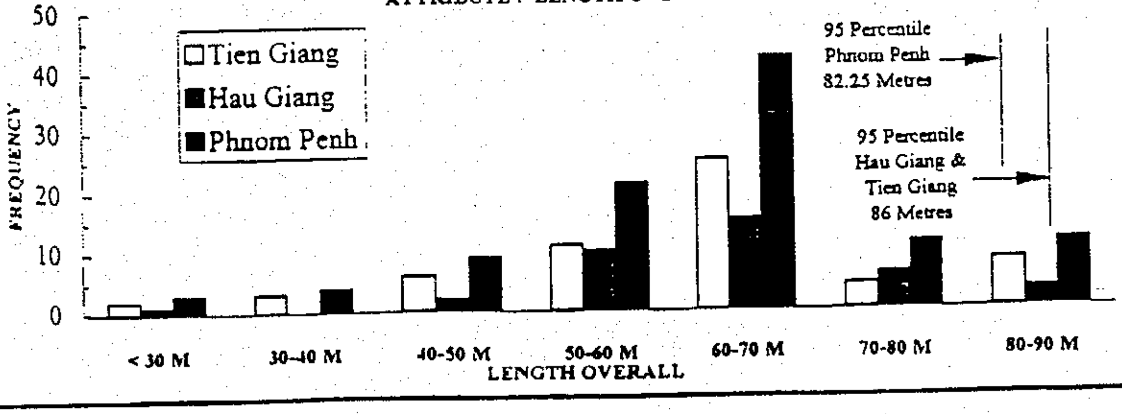
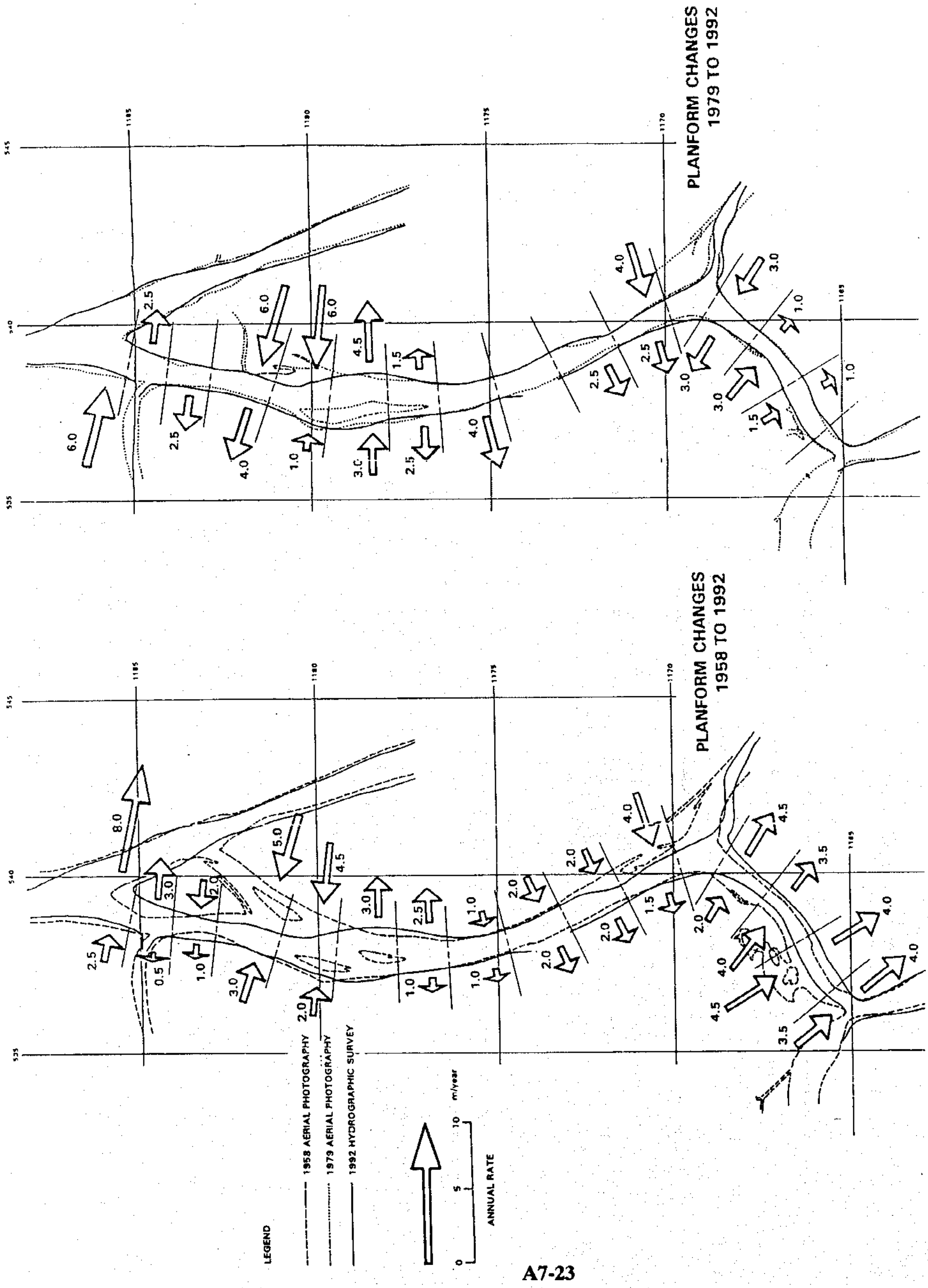


Figure C4 :VESSEL ATTRIBUTE FREQUENCY ANALYSIS - RIVER TRANSITS FOR STUDY PERIOD
ATTRIBUTE : LENGTH OVERALL




PLANFORM CHANGES
1979 TO 1992
PLANFORM CHANGES
1958 TO 1992
LEGEND
1958 AERIAL PHOTOGRAPHY
1979 AERIAL PHOTOGRAPHY
1992 HYDROGRAPHIC SURVEY
ANNUAL RATE
m/year

Report on information regarding vessels and decisions on river navigation on Tien and Hau Rivers.

1- Control International vessels (Size of Vessels that come Can tho and Phnom -Penh)

+ The Level of sinking water of vessels is 8 m.
+ Capacity of vessels is 10,000 tons.

- The size of vessels that come and leave at Can Tho Port as follows:

+ Capacity: 20,330 tons.
+ The length of vessels: 164 m'
+ The width of vessels: 22 m

2- The list of vessels that come and leave on Tien and Hau Rivers

a- In 1995 there were 63 vessels

+ Oversea vessels: 20
+Domestic vessels: 39
+ Junk, Barge: 4
+The yield of goods in 1995 : 55,903 tons.

b- In 1994 there were 92 vessels

+ Oversea ships: 39
+ Domestic ships: 29
+ Junk and Barge: 6
+ The yield of Cargoes: 65,870 tons.

c- In 1995 there were 85 vessels.

+ Oversea ships: 32
+ Domestic ship: 48
+Junk and Barge: 5
+The yield of cargoes: 125,919 tons

d- In 1996 there were 125 vessels.

+ Oversea ships: 19
+ Domestic ships: 96
+ Junk and barge: 10
+The yield of cargoes: 183,158 tons

- From early year to August of 1997, there were 74 vessels

+ Oversea ships 30
+ Domestic ships: 20
+ Junk and barge: 24
+ The yield of cargoes: 133,503 tons

Dredge's programme on Tien and Hau Rivers will be carried out at Vam Nao current and estuaries of Hau and Tien Rivers.

NAVIGATIONAL CLEARANCE
(Technical Classification of Inland Waterways : TCVN-5664-1992)

(1) Classification of Waterway
Waterways (river and canal) are classified in accordance with Table 2-7
Water depth and width of water surface shown on Table 2-7 are based on low water level of waterway with a frequency of 95 % in dry season.

(2) Clearance required
Clearance required for bridge construction are :
1) Horizontal clearance : span length, and
2) Vertical clearance : height between water level and bottom of girder.
these are provided as shown in Table 2-7 for each class of waterway, depending on water level with a frequency of 5 %.

Notes : following classification of inland waterway TCVN-5664-1992 for DoanVy Bridge is III class waterway river, for Do Len Bridge is IV class waterway river. But in project, the applicable class is based on the existing structure, subject to the approval of the official authority.

Table 2-7 : Classification of Waterway and Navigational Clearance

unit : meters

Class	Waterway size					Navigational Clearance		
	Natural River		Canal		Curvature	Horizontal		Vertical
	Water Depth	Width of Water Surface	Water Depth	Width of Water Surface		River	Canal	
I	> 3.0	> 90	> 4.0	> 50	> 700	80	50	10
II	2.0 - 3.0	70 - 90	3.0 - 4.0	40 - 50	500 - 700	60	40	9
III	1.5 - 2.0	50 - 70	2.5 - 3.0	30 - 50	300 - 500	50	30	7
IV	1.2 - 1.5	30 - 50	2.0 - 2.5	20 - 30	200 - 300	40	25	6 (5)
V	1.0 - 1.2	20 - 30	1.2 - 2.0	10 - 20	100 - 200	25	20	3.5
VI	< 1.0	10 - 20	< 1.2	10	60 - 150	15	10	2.5

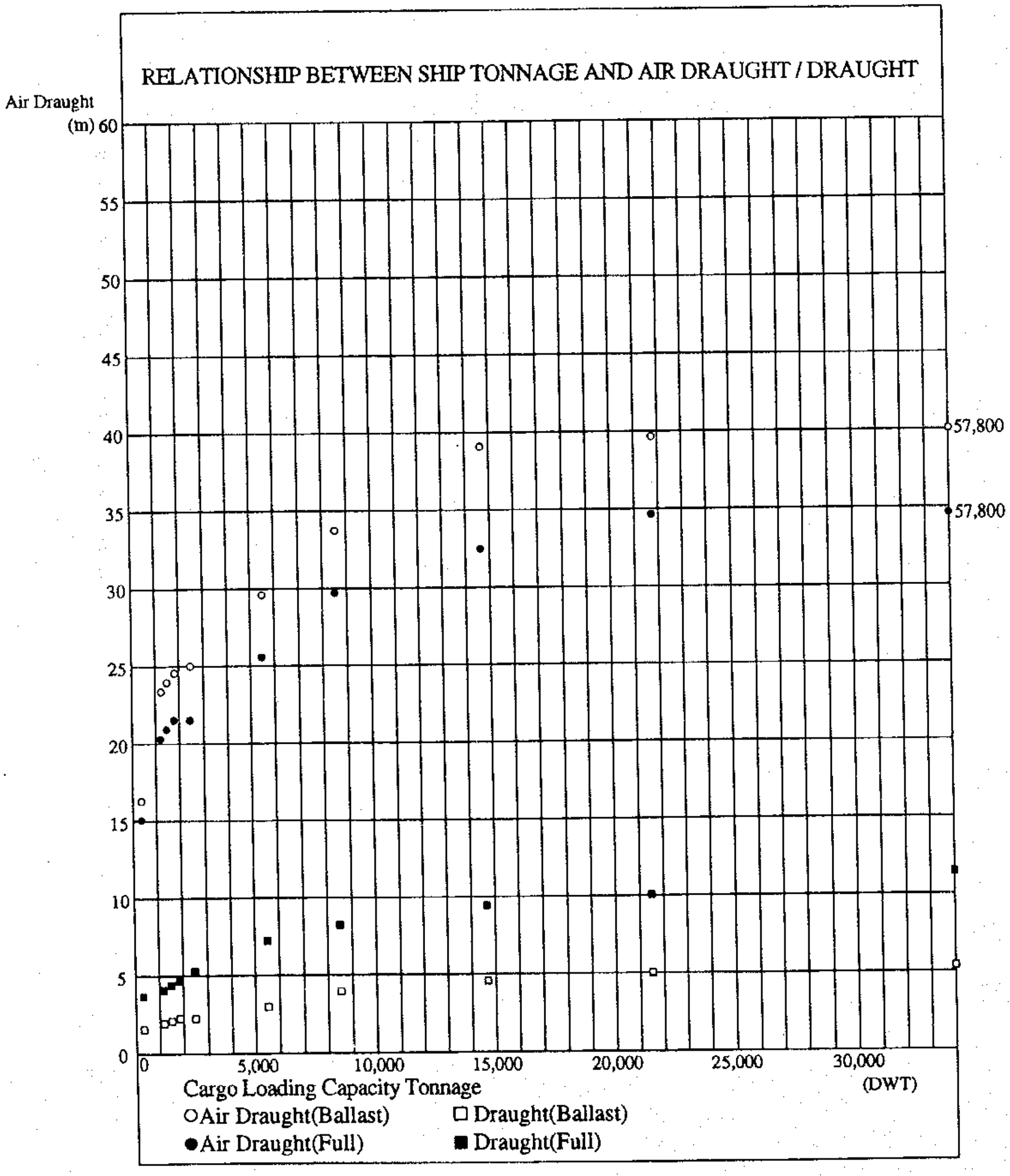
Note : Figure with ( ) can be applied with approval of official agencies.

RELATIONSHIP BETWEEN TYPICAL SHIP TONNAGE AND TOP LEVEL OF SHIP-MAST

Gross Regis-tered Tonnage	Cargo Loading Cap. Tonnage	Ship	Draft Full	Draft Balast	Depth	Main Deck Level (m)	Top Level of Mast Above Sea Level (m) Full	Top Level of Mast Above Sea Level (m) Balast
200	300	Cargo Ship	3.2	1.0	3.3	14.9	15.0	17.2
500	1,100	-do-	3.9	1.8	4.2	20.6	20.9	23.0
700	1,700	-do-	4.2	1.8	5.2	20.0	21.2	23.6
1,000	1,800	-do-	4.6	2.0	5.5	20.7	21.6	24.2
1,500	2,600	-do-	5.1	2.2	6.5	20.2	21.6	24.4
3,000	5,400	-do-	6.3	2.8	7.5	24.5	25.7	29.2
5,500	8,500	-do-	7.6	3.3	9.7	27.3	29.4	33.7
9,000	12,200	-do-	9.0	4.0	12.1	39.2	42.3	47.5
10,000	14,600	-do-	9.1	4.0	12.4	29.4	32.7	37.8
15,000	21,800	-do-	10.1	5.0	14.0	30.0	33.9	39.0
35,000	57,800	-do-	12.0	5.8	17.8	28.0	33.8	40.0
60,000	108,700	-do-	14.4	5.6	20.4	27.6	33.6	42.4
110,000	238,200	-do-	17.3	7.9	25.7	32.2	40.7	50.1
129,300	252,000	-do-	19.6	9.7	26.0	36.0	42.5	52.3
184,900	372,700	-do-	27.0	10.4	35.0	39.0	47.0	63.6
235,000	477,000	-do-	28.0	12.3	36.0	40.0	48.0	63.7

Source: Honshu-Shikoku Bridge Project, Japan

Above the tonnages (GRT) of 60,000 are the size of tank vessel.



RELATIONSHIP BETWEEN SHIP TONNAGE AND AIR DRAUGHT / DRAUGHT
Air Draught
(m) 60
55
50
45
40
35
30
25
20
15
10
5
0
57,800
57,800
0
5,000
10,000
15,000
20,000
25,000
30,000
(DWT)
Cargo Loading Capacity Tonnage
○Air Draught(Ballast)
□ Draught(Ballast)
●Air Draught(Full)
■ Draught(Full)

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BELGIUM

APPENDIX B

TYPICAL SHIP DIMENSIONS

Dead-weight tonnes	Displacement tonnes	Length$_{OA}$ m	Length$_{pp}$ m	Beam m	Draught m	Block Coefficient
Tankers (ULCC)						
500,000	590,000	415.0	392.0	73.0	24.0	0.86
400,000	475,000	380.0	358.0	68.0	23.0	0.85
350,000	420,000	365.0	345.0	65.5	22.0	0.85
Tankers (VLCC)						
300,000	365,000	350.0	330.0	63.0	21.0	0.84
275,000	335,000	340.0	321.0	61.0	20.5	0.84
250,000	305,000	330.0	312.0	59.0	19.9	0.83
225,000	277,000	320.0	303.0	57.	19.3	0.83
200,000	246,000	310.0	294.0	55.0	18.5	0.82
Tankers						
175,000	217,000	300.0	285.0	52.5	17.7	0.82
150,000	186,000	285.0	270.0	49.5	16.9	0.82
125,000	156,000	270.0	255.0	46.5	16.0	0.82
100,000	125,000	250.0	236.0	43.0	15.1	0.82
80,000	102,000	235.0	223.0	40.0	14.0	0.82
70,000	90,000	225.0	213.0	38.0	13.5	0.82
60,000	78,000	217.0	206.0	36.0	13.0	0.81
Product and Chemical Tankers						
50,000	66,000	210.0	200.0	32.2	12.6	0.81
40,000	54,000	200.0	190.0	30.0	11.8	0.80
30,000	42,000	188.0	178.0	28.0	10.8	0.78
20,000	29,000	174.0	165.0	24.5	9.8	0.73
10,000	15,000	145.0	137.0	19.0	7.8	0.74
5,000	8,000	110.0	104.0	15.0	7.0	0.73
3,000	4,900	90.0	85.0	13.0	6.0	0.74
Bulk Carriers/OBO's						
400,000	464,000	375.0	356.0	62.5	24.0	0.87
350,000	406,000	362.0	344.0	59.0	23.0	0.87
300,000	350,000	350.0	333.0	56.0	21.8	0.86
250,000	292,000	335.0	318.0	52.5	20.5	0.85
200,000	236,000	315.0	300.0	48.5	19.0	0.85
150,000	179,000	290.0	276.0	44.0	17.5	0.84
125,000	150,000	275.0	262.0	41.5	16.5	0.84
100,000	121,000	255.0	242.0	39.0	15.3	0.84
80,000	98,000	240.0	228.0	36.5	14.0	0.84
60,000	74,000	220.0	210.0	33.5	12.8	0.82
40,000	50,000	195.0	185.0	29.0	11.5	0.80
20,000	26,000	160.0	152.0	23.5	9.3	0.78
10,000	13,000	130.0	124.0	18.0	7.5	0.78
Container Ships (Post Panamax)						
70,000	100,000	280.0	266.0	41.8	13.8	0.65
65,000	92,000	274.0	260.0	41.2	13.5	0.64
60,000	84,000	268.0	255.0	39.8	13.2	0.63
55,000	76,500	261.0	248.0	38.3	12.8	0.63

Note: The dimensions of the ships given in the tables may vary up to + 10% depending on construction and country of origin.

Dead-weight tonnes	Displacement tonnes	Length_{OA} m	Length_{pp} m	Beam m	Draught m	Block Coefficient
Container Ships (Panamax)						
60,000	83,000	290.0	275.0	32.2	13.2	0.71
55,000	75,500	278.0	264.0	32.2	12.8	0.69
50,000	68,000	267.0	253.0	32.2	12.5	0.67
45,000	61,000	255.0	242.0	32.2	12.2	0.64
40,000	54,000	237.0	225.0	32.2	11.7	0.64
35,000	47,500	222.0	211.0	32.2	11.1	0.63
30,000	40,500	210.0	200.0	30.0	10.7	0.63
25,000	33,500	195.0	185.0	28.5	10.1	0.63
20,000	27,000	174.0	165.0	26.2	9.2	0.68
15,000	20,000	152.0	144.0	23.7	8.5	0.69
10,000	13,500	130.0	124.0	21.2	7.3	0.70
Freight Ro-Ro Ships						
50,000	87,500	287.0	273.0	32.2	12.4	0.80
45,000	81,000	275.0	261.0	32.2	12.0	0.80
40,000	72,000	260.0	247.0	32.2	11.4	0.79
35,000	63,000	245.0	233.0	32.2	10.8	0.78
30,000	54,000	231.0	219.0	32.0	10.2	0.75
25,000	45,000	216.0	205.0	31.0	9.6	0.75
20,000	36,000	197.0	187.0	28.6	9.1	0.75
15,000	27,500	177.0	168.0	26.2	8.4	0.74
10,000	18,400	153.0	145.0	23.4	7.4	0.73
5,000	9,500	121.0	115.0	19.3	6.0	0.71
Cargo Vessels						
40,000	54,500	209.0	199.0	30.0	12.5	0.73
35,000	48,000	199.0	189.0	28.9	12.0	0.73
30,000	41,000	188.0	179.0	27.7	11.3	0.73
25,000	34,500	178.0	169.0	26.4	10.7	0.72
20,000	28,000	166.0	158.0	24.8	10.0	0.71
15,000	21,500	152.0	145.0	22.6	9.2	0.71
10,000	14,500	133.0	127.0	19.8	8.0	0.72
5,000	7,500	105.0	100.0	15.8	6.4	0.74
2,500	4,000	85.0	80.0	13.0	5.0	0.77
Vehicle Carriers						
30,000	48,000	210.0	193.0	32.2	11.7	0.66
25,000	42,000	205.0	189.0	32.2	10.9	0.63
20,000	35,500	198.0	182.0	32.2	10.0	0.61
15,000	28,500	190.0	175.0	32.2	9.0	0.56

Gross Tonnage	Displacement tonnes	Length_{oa} m	Length_{pp} m	Beam m	Draught m	Block Coefficient
Ferries						
50,000	25,000	197.0	183.0	30.6	7.1	0.63
40,000	21,000	187.0	174.0	28.7	6.7	0.63
35,000	19,000	182.0	169.0	27.6	6.5	0.63
30,000	17,000	175.0	163.0	26.5	6.3	0.62
25,000	15,000	170.0	158.0	25.3	6.1	0.62
20,000	13,000	164.0	152.0	24.1	5.9	0.60
15,000	10,500	155.0	144.0	22.7	5.6	0.57
Cruise Liners						
80,000	44,000	272.0	231.0	35.0	8.0	0.68
70,000	38,000	265.0	225.0	32.2	7.8	0.67
60,000	34,000	252.0	214.0	32.2	7.6	0.65
50,000	29,000	234.0	199.0	32.2	7.1	0.64
40,000	24,000	212.0	180.0	32.2	6.5	0.64
35,000	21,000	192.0	164.0	32.2	6.3	0.63

REPORT ON ARRIVAL SHIP (>3000DWT)IN 1991 OF CAN THO PORT

No	Name of ship	Nationality	Arrival	Departure	GRT	DWT	Length (m)	Breadth (m)	Full draft (m)
1	UNI WISE	PANAMA	8/5/91	19/5/91	6254	8130	105.70	18.00	7.61
2	NEW OCEAN	PANAMA	23/8/91	29/8/91	4679	7854	114.26	17.60	7,20
3	RICHER	PANAMA	26/6/91	1/7/91	4022	6076	111.96	16.15	7.16
4	LONG HAI	VIETNAM	6/10/91	14/10/91	4619	8332	117.90	18.00	7.20
5	DONG NAI	VIETNAM	7/11/91	22/11/91	7113	9632	134.15	18.00	9.00
6	UNI WISE	PANAMA	16/11/91	22/11/91	6254	8130	105.70	18.00	7.61
7	AMRTA 2	INDONESIA	20/13/91	26/12/91	4625	7300	109.90	17.50	7.04

REPORT ON ARRIVAL SHIP (>3000DWT) IN 1992 OF CAN THO PORT

No	Name of ship	Nationality	Arrival	Departure	GRT	DWT	Length (m)	Breadth (m)	Full draft (m)
1	DIEN BIEN 01	VIETNAM	11/5/92	16/5/92	5109	8297	118.00	18.00	7.00
2	SONG DAY	VIETNAM	26/7/92	29/7/92	6051	10924	127.97	18.30	7.80
3	TENYOSHI MARU	SINGAPORE	13/10/92	17/10/92	3738	6702	110.79	15.50	6.49
4	TRI AN	VIETNAM	28/10/92	10/11/92	3224	4150	105.85	14.63	6.55

REPORT ON ARRIVAL SHIP (>3000DWT) IN 1994 OF CAN THO PORT

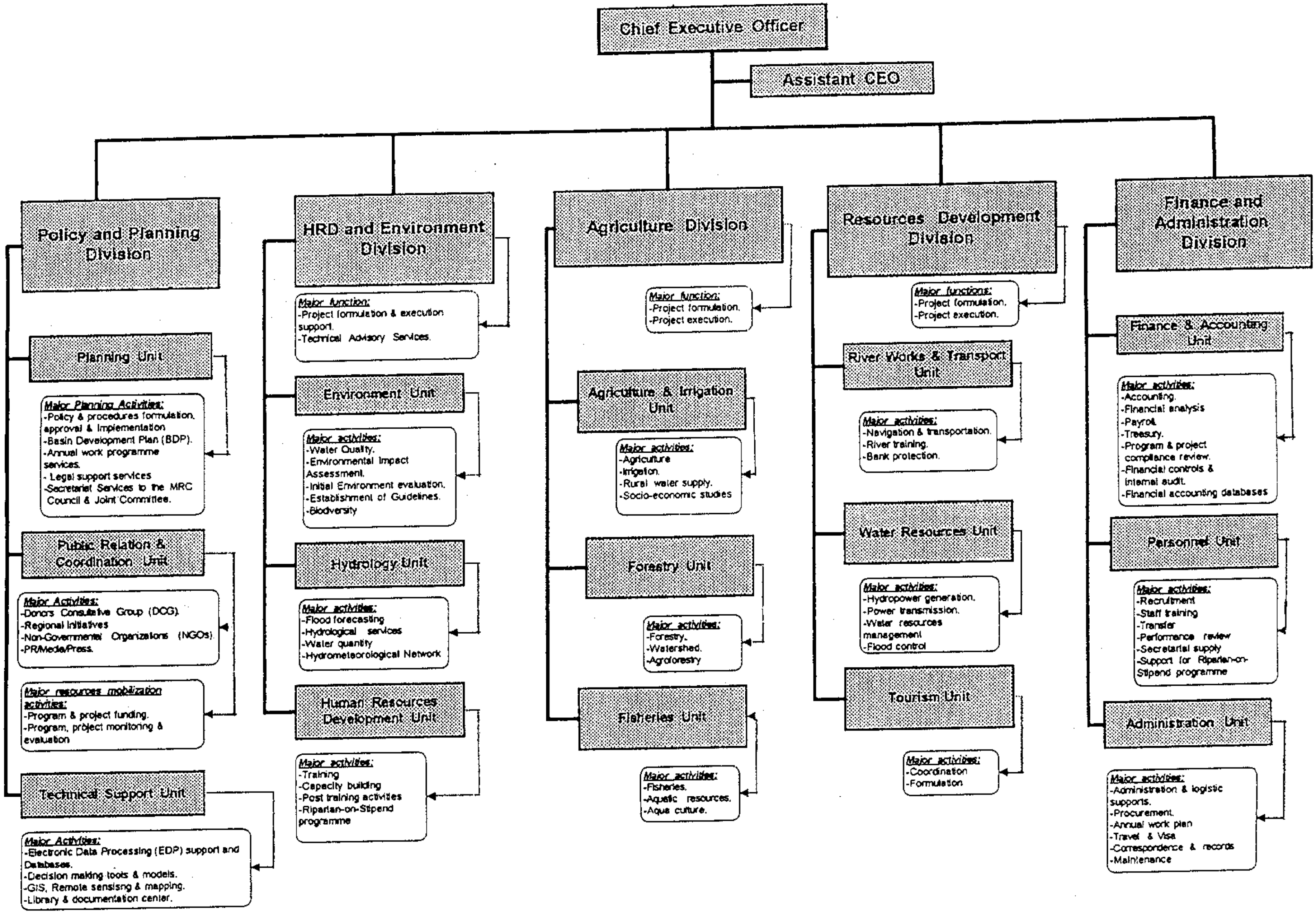
No	Name of ship	Nationality	Arrival	Departure	GRT	DWT	Length (m)	Breadth (m)	Full draft (m)
1	HAI AU 1	VIETNAM	19/1/94	22/1/94	3811	6479	105.57	16.33	6.81
2	OXALIS SAKURA	PANAMA	12/2/94	13/2/94	2487	4232	86 70	13.80	
3	DIEN BIEN 03	VIETNAM	8/5/94	15/5/94	5051	8342	118.00	18.00	7.21
4	LONG BINH	BAHAMAS	24/6/94	30/6/94	5717	9060	120.00	18.50	7.85
5	MEKONG HARMONY	DENMARK	24/11/94	25/11/94	2762	3061	91.50	16.20	4.25
6	MEKONG HARMONY	DENMARK	15/12/94	16/12/94	2762	3061	91.50	16.20	4.25
7	ASIAN WISE	MALAYSIA	10/12/94	16/12/94	2636	4531	90.50	14.50	6.17
8	YU HUA	CHINA	11/12/94	22/12/94	9787	10400	153.90	19.44	8.31

REPORT ON ARRIVAL SHIP (>3000 DWT) IN 1997 OF CAN THO PORT

(From January to September only)

No	Name of ship	Nationality	Arrival	Departure	GRT	DWT	Length (m)	Breadth (m)	Full draft (m)
1	HONG LONG	VIETNAM	30/12/96	5/1/97	2574	3470	102.00	14.00	6.00
2	WANFA	CHINA	22/1/97	29/1/97	4942	7825	115.70	17.45	7.80
3	TAN TRAO	VIETNAM	6/2/97	1/3/97	3354	4303	105.85	14.60	6.55
4	PLOYPALIN NAREE	THAI	26/3/97	15/4/97	10704	17137	146.68	22.90	9.00
5	BUDI AIN	MALAYSIA	11/5/97	17/5/97	3147	4914	97.17	15.33	6.30
6	BUDI AINNA	MALAYSIA	18/5/97	24/5/97	3051	5030	96.25	15.50	6.13
7	YUE LU SHAN	CHINA	11/6/97	12/6/97	5795	7214	118.30	18.00	7.10
8	KANOK NAREE	SINGAPORE	12/6/97	17/6/97	9865	16076	141.93	21.80	9.10
9	BONSOON	PANAMA	12/6/97	26/6/97	4012	6754	107.33	16.50	7.55
10	TERACHA SAMUT	THAI	29/6/97	6/7/97	2500	4234	89.60	14.40	6.02
11	MELATI MAS	MALAYSIA	29/6/97	9/7/97	3960	6414	96.00	20.00	5.90
12	DIEN BIEN 01	VIETNAM	12/7/97	20/7/97	5051	8297	118.00	18.00	7.21
13	BANGKHUNGSRI	THAI	18/7/97	25/7/97	4032	6151	108.92	16.40	6.78
14	XINPING	CHINA	30/7/97	12/8/97	4967	6700	106.90	17.60	7.00
15	TONSHUN	PANAMA	8/8/97	25/8/97	11630	17029	164.40	21.38	9.30
16	ANASTASIA	CYPRUS	9/8/97	1/9/97	12683	20330	164.00	22.00	9.82
17	OCEAN TRADE	PANAMA	30/8/97	2/9/97	4010	6266	106.67	16.40	
18	YON BONG	D.P.R.KOREA	29/8/97	6/9/97	2658	4823	94.00	15.00	6.28
19	DIBENA EXPRESS	THAI	10/9/97	19/9/97	4792	7892	115.65	17.40	6.65
20	BUDIAINNA	MALAYSIA	23/9/97	29/9/97	3050	5030	96.25	15.50	6.13

New MRCS Organization Structure*



*Approved by MRC Council & Joint Committee

7.2 Assessment of Navigational (Vertical) Clearance for the Cases of 37.5 m and 41.0 m

ASSESSMENT OF NAVIGATIONAL (VERTICAL) CLEARANCE FOR THE CASES OF 37.5M AND 41.0M

January 1998

ASSESSMENT OF NAVIGATIONAL (VERTICAL) CLEARANCE

A. Summary of Assessment on the Navigational Clearance

- According to the attributed analysis, frequency analysis and declaration of arrival to the existing Can Tho port, the maximum vessel size to travel to the Can Tho port is 20,330 DWT referring to the declaration of arrival with air draft (ballast). Meanwhile, the ship travel is restricted by navigable condition at the estuary of the Hau River to less 10,000 DWT vessel. Because the 10,000 DWT vessel requires the draft depth (full loaded) 8.0m. However, the water depth at the estuary is 4.0m only below LLW and thanks to high tide 7.0m (+3m LLW)

- The part of the Hau River from the estuary to Vam Nao Pass is able to allow the travel of the vessel size approx. 10,000 DWT except the point in An Giang where the transmission line restricts the air clearance 30m only, equivalent to 5,000 DWT vessel.

- At the Vam Nao Pass, the vessel size is limited to 3,000 DWT to travel due to shallow portion of channel, otherwise the dredging required approx. 1,680,000 cu m for 10,000 DWT vessel

- The maximum vessel capacity for the port of Phnom Penh, the existing Can Tho Port and the future Can Tho Port (to be located on the downstream side of the Can Tho Bridge) are 6,000 DWT, 10,000 DWT and 20,000 to 30,000 DWT respectively.

- The vessel sizes of 10,000 DWT and 20,000 DWT, which may travel under the Can Tho Bridge, necessitate the dredging works of the riverbed of the Hau River and the seabed at the estuary. From the Dinh An Estuary to Can Tho (the existing Can Tho Port), the dredging volumes based on hydrographic atlas 1990-1992 and the Service of Maritime Safety 1994 chart, are calculated as below:

Description	Dredging Volume (cu m)	
	10,000 DWT	20,000 DWT
a) Can Tho ~ Dinh An Estuary (for LLW datum)	26,274,842	54,970,382
b) Can Tho ~ Dinh An Estuary (for +2m LLW at the estuary)	14,634,140	38,721,902
c) Can Tho ~ Dinh An Estuary (for +3m LLW at the estuary)	10,366,576	31,943,912

Note: For reference, actual dredged records at the estuary are 200,000 cu m per each year in 1990 and 1997.

Therefore, the dredging volume to maintain the navigable condition for 20,000 DWT to the existing Can Tho Port is two or threefold of that of 10,000 DWT, and extremely costly.

B. Detailed Navigational Conditions of the Hau River

Descriptions	DWT (ton)	Air Draft with Ballast (m)
1. Actual Shipping Condition base on Surveys		
1)Attribute analysis based on International Shipping Survey between South China and Phnom Penh (1/5/1995-30/9/1994)	approx.11,335	45.0 [1] (36.0)
2)Frequency Analysis based on the above shipping survey (95% percentile to travel to Phnom Penh)	3,246	25.5
3)Declaration of arrival to the existing Can Tho port		
- Max. vessel size in 1994 - Max. vessel size in 1997	10,400 [2)] 20,330 [2)]	37.5 41.0
2. Navigable Condition of the Hau River		
1)Vam Nao Pass based on:		
- Historical morphological changes, 1958 - 1967 Pilot Guide - Platform information in 1958, 1969 and 1979 - Hydrographic atlas		
The water depths vary from 6m to 10m, partially deeper than 10m	3,000 to 5,000	25.0 30.0
2) Hau River		
- Estuary to Vam Nao Pass	approx. 10,000[2)]	37.5
3)Restriction by electricity transmission line crossing the Hau River at An Giang	5,000	30.0

Descriptions	DWT (ton)	Air Draft with Ballast (m)
3. Vessel capacity of the ports		
- Phnom Penh (Cambodia) port	Max. 6,000	31.0
- Existing Can Tho port	Max.10,000 2)	37.5
- Future Can Tho port (to be located on the downstream of the Can Tho Bridge)	20,000 3) to 30,000 3)	41.0 41.0
4. Dredging works		
1)Dredging volume based on the hydrographic atlas 1990-1992 for the Hau River and the Service of Maritime Safety 1994 chart for the estuary		
	(for 10,000 DWT)	(for 20,000 DWT)
- Cambodia Border-Vam Nao Pass	309,019	N.A
- Vam Nao Pass	1,676,345	N.A
- Vam Nao Pass-Can Tho	4,624,980	N.A
- Can Tho-Dinh An Estuary	5,616,226	16,320,342
- Dinh An Estuary	20,658,616	38,650,040
Total	32,885,186	54,973,382
2)The report on the study for improvement of the access channel to the Bassac River, Belgium, is not available so far.		

Note:

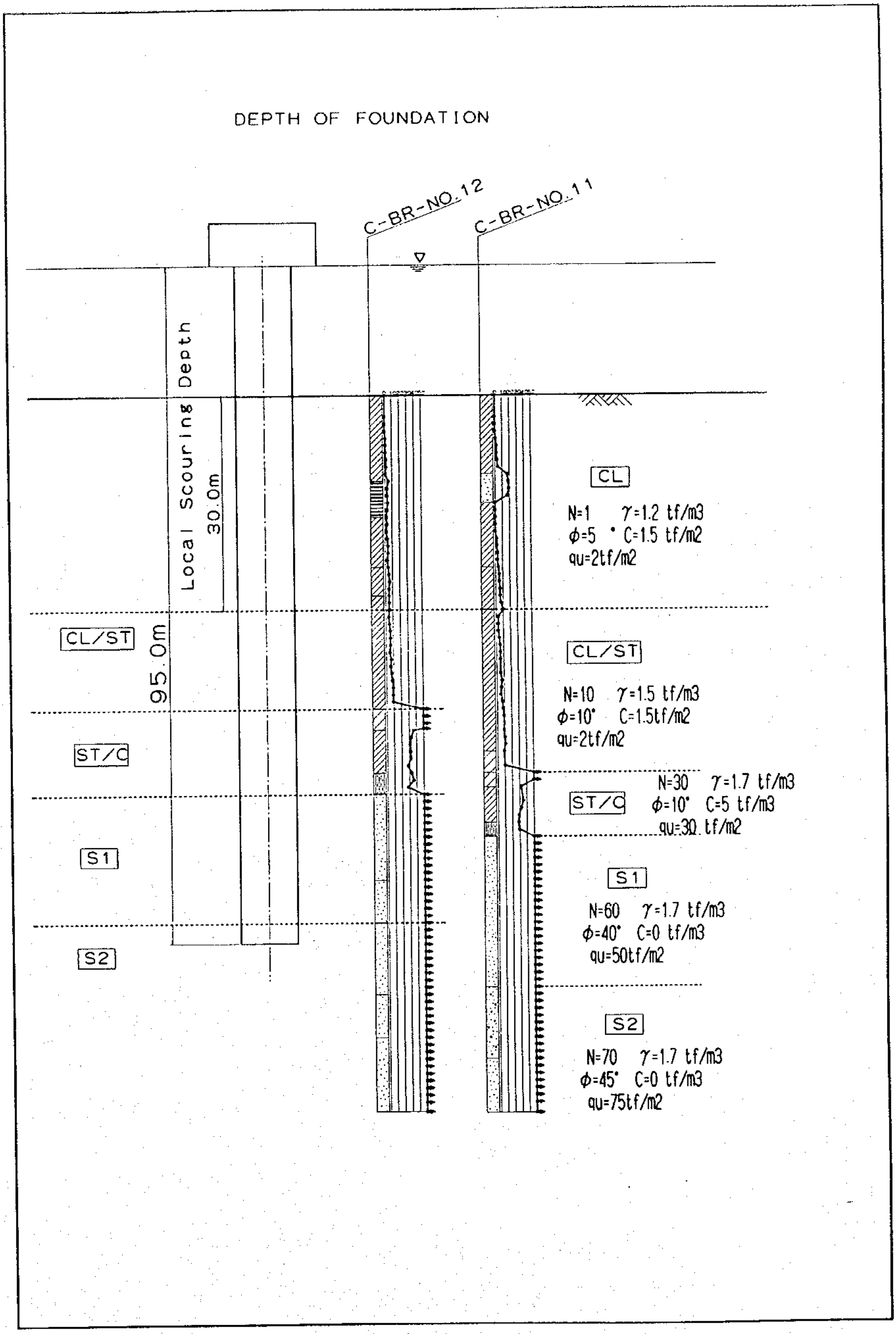
1) According to the source of international data, the air draft (ballast) is 36.0m

2) The vessel may reach to the existing Can Tho Port only with the half loading condition, which is controlled by the water depth at the estuary.

3) The vessel will not underpass the Can Tho Bridge.

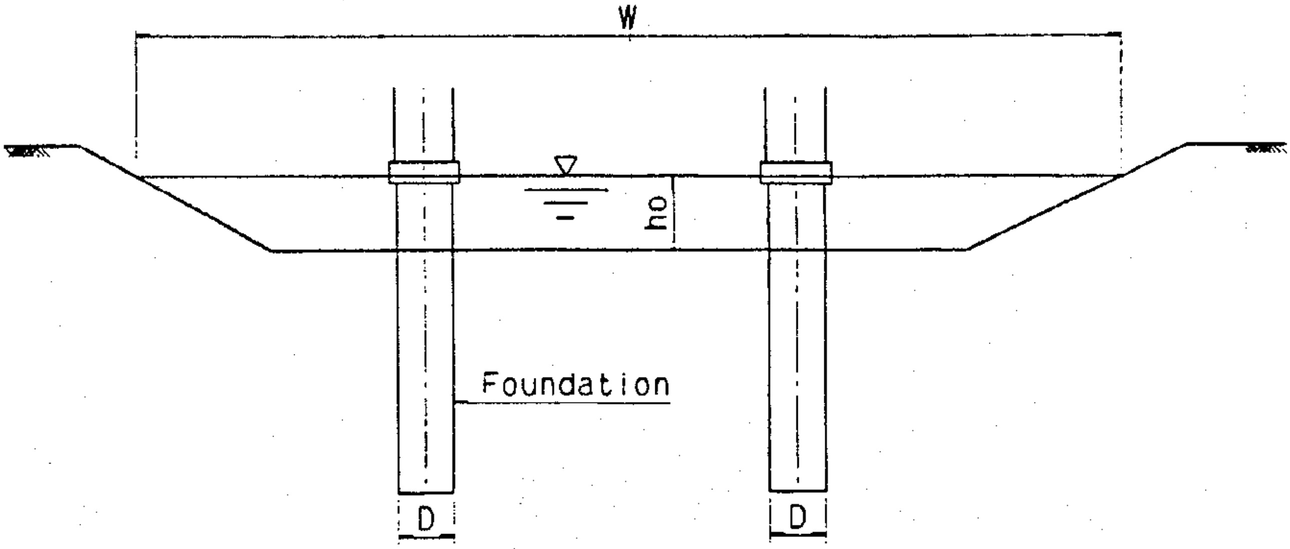
- Navigable Condition and Port Capacity of/along the Mekong Stream

- Relationship between Tonnage (DWT) and Air Draught

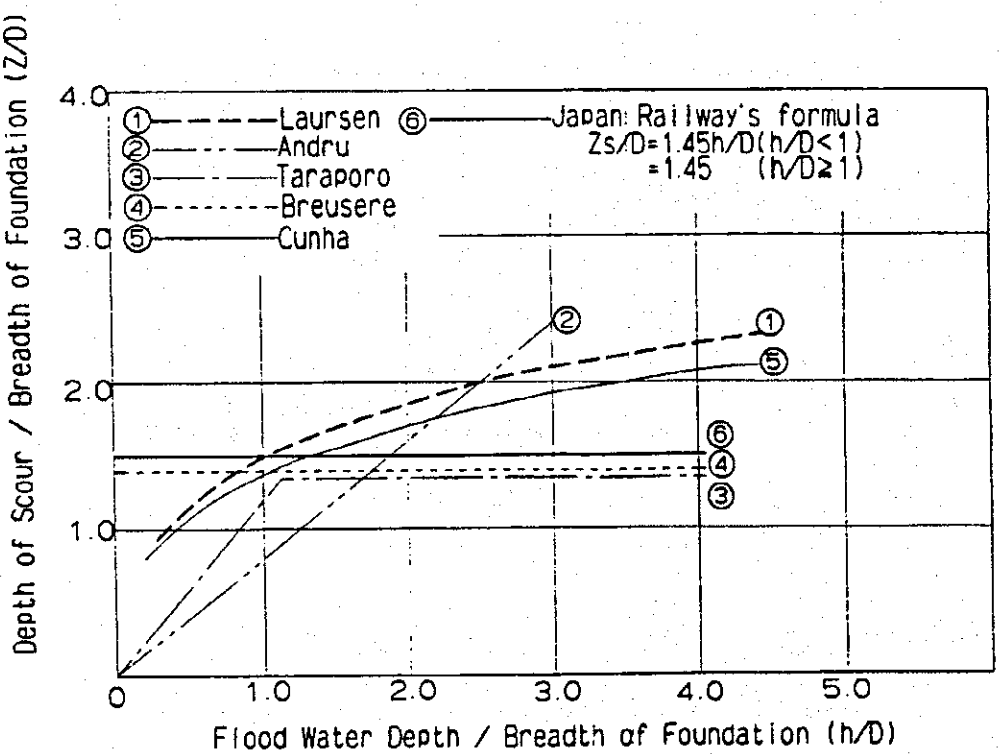


DEPTH OF FOUNDATION
C-BR-NO.12
C-BR-NO.11
Local Scouring Depth
30.0m
95.0m
CL/ST
ST/C
S1
S2
CL
N=1 γ=1.2 tf/m3
φ=5 ° C=1.5 tf/m2
qu=2tf/m2
CL/ST
N=10 γ=1.5 tf/m3
φ=10° C=1.5tf/m2
qu=2tf/m2
ST/C
N=30 γ=1.7 tf/m3
φ=10° C=5 tf/m3
qu=30 tf/m2
S1
N=60 γ=1.7 tf/m3
φ=40° C=0 tf/m3
qu=50tf/m2
S2
N=70 γ=1.7 tf/m3
φ=45° C=0 tf/m3
qu=75tf/m2

- Cross Sectional area of River and Breadth of Foundation.



- Flood Discharge :Q=31000 m3/sec
- Breadth of Water Surface : W=900m
- Water depth :ho=15m
- Breadth of Foundation : D=15m(assumptive)
- Bed Material : Fine Sand



Reference : Relation of Depth of Scour.Water Depth.Breadth of Foundation.

Studey on Scour

CASE-1

THE INDIAN ROAD CONGRESS

Mean Depth of Scour

dsm = 1.34(Db^2/ksf)^0.333

Where Db: the dischage in cubics per meter width

The value of 'Db'shall be the maximum of the following.

Type of bed material	dm : Weighted mean diameter of particle in mm	Value of 'Ksf' Silt Factor
fine silt	0.081	0.500
fine silt	0.120	0.600
fine silt	0.158	0.700
medium silt	0.233	0.850
standard silt	0.323	1.000
medium sand	0.505	1.250
course sand	0.725	1.500
fine bajri and sand	0.988	1.750
heavy sand	1.290	2.000

Maximum depth of scour for design of foundation
In the vicinity of pier (Foundation) 2.00 dm

Db: 31000m3/900m= 34.44 m3
Ksf: 0.500 (fine silt)

dsm= 15.97 m
design scour = 31.95 m

CASE-2

Laursen's formula

D/ho=5.5Zs/ho[(Zs/11.5ho+1)^0.875/(τ / τ c)^0.5-1]

Zs: Maximum Dipth of Scour for Foundation
D: Width of Foundation =15.0m
ho: Mean Water Depth =15.0m

Zs/D = 1.46
Zs = 1.46*15 = 21.9m

CASE-3

Japan Rail Way's formula

According to The Japan Railway's formula, the depth of scour is given as

Z/D= 1.45 * hm/D (hm / D < 1.0)
Z/D= 1.45 (hm / D < 2.0)
hm : Mean Water Depth =15.0m
D: Width of Pier =15.0m

Z/D = 1.45
Zs = 1.45*15 = 21.8m

The Feasibility Study on The Can Tho Bridge Construction in Socialist Republic of Viet Nam

ANNEXURE 8

PRELIMINARY DESIGN

8.1 Geometric Design Standard for Bridge Rehabilitation of N.H. No.1

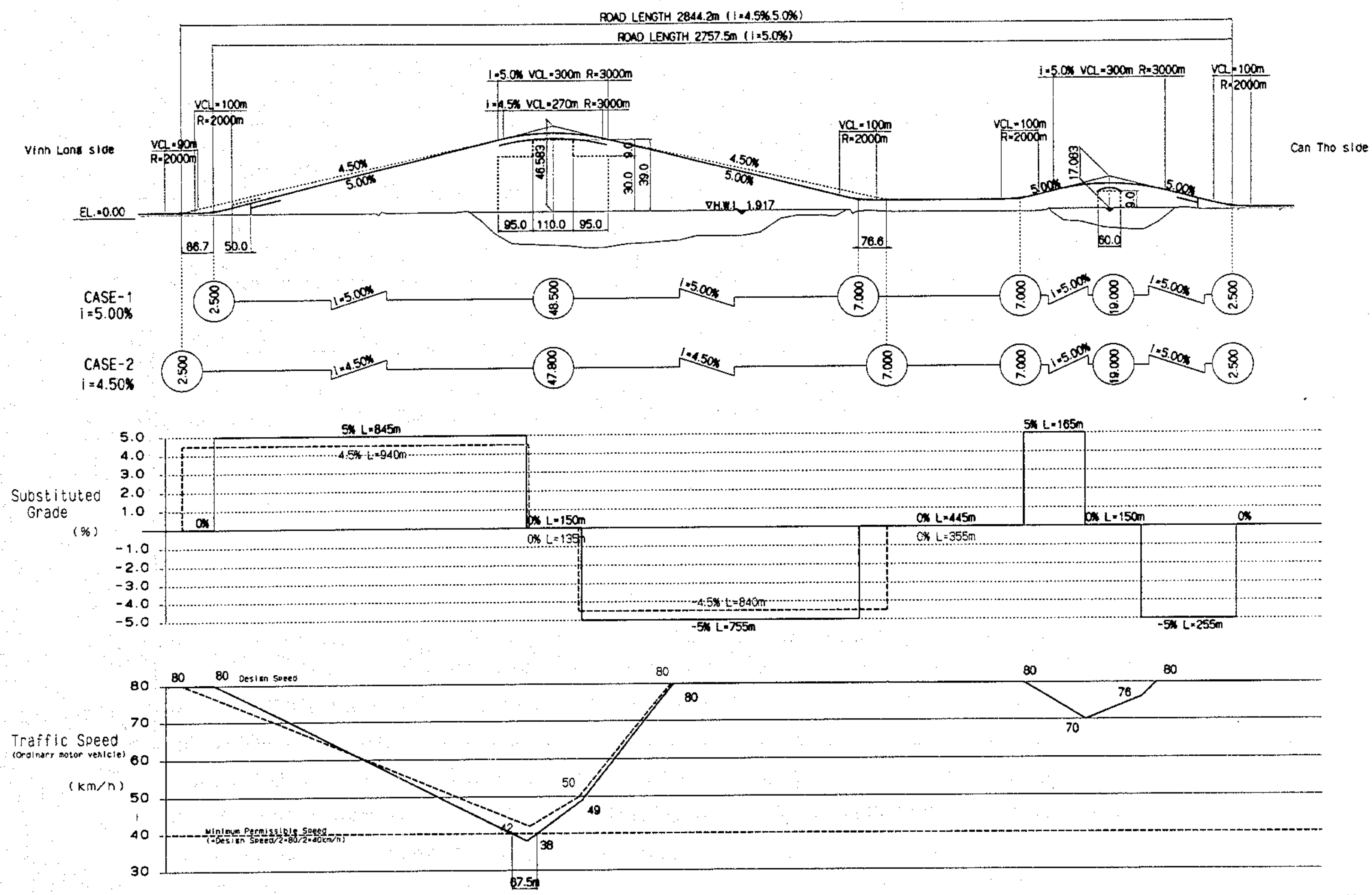
GEOMETRIC DESIGN STANDARDS

Section from ... To	HANOI - HA NAM		HA NAM - VINH		NHA TRANG - HO CHI MINH CITY		HO CHI MINH CITY - CAN THO	
	HANOI - GIE Bridge	GIE Bridge HA NAM						
	NTSR 1990	VNRA 1993	NTSR 1990	VNRA 1993	NTSR 1990	VNRA 1993	NTSR 1990	VNRA 1993
Traffic Volume ADT	2,729	9,053	2,464	5,154	7,733	6,189	9,529	-
Design speed (Km / hr)	80	80	80		80		80	
Number of Lane	4	2	2		2		2	
Minimum Horizontal Curve Radius (m)	250	250	250		250		250	
Longitudinal Profile: - Maximum Gradient % - Convex curve minimum Radius (m) - Concave curve minimum Radius (m)	6 5000 (3000) 2000 (1000)	6 5000 (3000) 2000 (1000)	6 5000 (3000) 2000 (1000)		6 5000 (3000) 2000 (1000)		6 5000 (3000) 2000 (1000)	
The Minimum Length of the Transition curve	80	80	80		80		80	
Max. Superelevation %	6	6	6		6		6	
Bridge Cross - Section Type and Width (m)	(C) 24.0	(A) or (D) 12.5 or 14.0	(A) or (D) 12.5 or 14.0		(A) or (D) 12.5 or 14.0		(A) , (B) or (D) 12.5 , 7.8 or 14.0	

Source: - Highway Design Standards (TCVN 4054 - 85)
- Vietnam Road Administration.
- UNDP - NTSR Final Report Transport Demand and Traffic Forecasts.
- National Highway No . 1A Improvement Project.

Notes:
- Traffic volume in the table without Motorcycle and Bicycle.
- NTSR: National Transportation Section Review.
- VNRA: Vietnam Road Administration.
- Shows absolute mimimpm value

COMPARISON OF GRADIENT FOR APPROACH PORTIONS



8.2 Optimum Span Length of Main Bridge

NIPPON KOEI CO., LTD AND PADECO CO., LTD.
The Feasibility Study on the Can Tho Bridge Construction Project in Socialist Republic of Vietnam entrusted by JICA (Japan International Co-operation Agency).
Project Office.
c/o My Thuan Projects Management Unit (MOTAC)
127B Dinh Tien Hoang St., Binh Thanh Dist., HCM City
Tel: 84-8-8413546 Fax: 84-8-8413547

To : PMU- My Thuan

Attention : Mr. Le Long DINH.
General Director
PMU-My Thuan

Ref. : CTB-8/98/HCMC
Date : January 22th, 1998

Subject : Optimum Span Length of Main Bridge

Dear Sir,

Based on the Meeting in Hanoi on 8th January and the Discussion at PMU-My Thuan on 14 th January, we would like to submit herewith the result of the optimized span length coupled with bridge type study. It is recommended that the optimized span length to straddle the main stream of the Hau River should be 500^{m} and the bridge type Hybrid Cable-Stayed Bridge, i.e. steel structure for the central span and prestressed concrete structure for the side span. The reasons are:

1) The required span length for the mainstream should be greater than 500^{m} due to the hydrodynamics tendency (general scouring) of the riverbed during the period from 1963 to 1997. (see attached sheet)

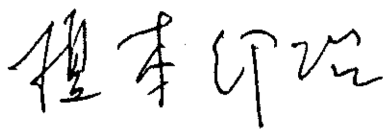
2) The difference of cost between Hybrid Cable-Stayed to span 500m and PC Cable-Stayed is very narrow (1%~4%).

3) The 350^{m} PC Cable-Stayed is not recommendable because the towers of bridge will be situated in the deep water area (20^{m}~25^{m}) which may be involved in the hydrodynamics issues and the bridge structure might be unsafe.

4) Even though PC Cable-Stayed is economical with narrow cost difference with Hybrid Cable-Stayed, the 400^{m} central span length of PC Cable-Stayed is maximum from the technical reason, and not able to clear the required span length 500^{m}.

Your kind review on the above recommendations will be highly appreciated.

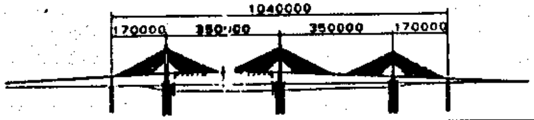
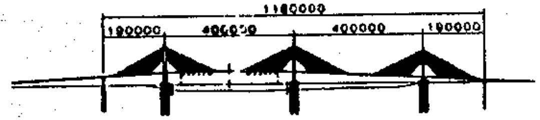
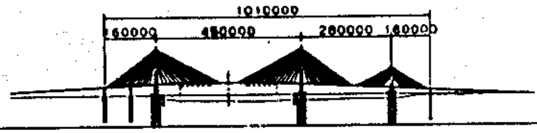
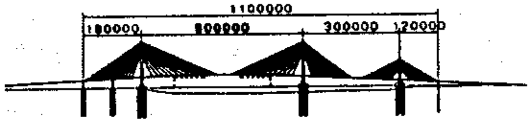
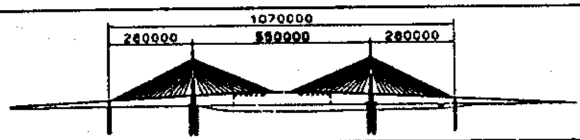
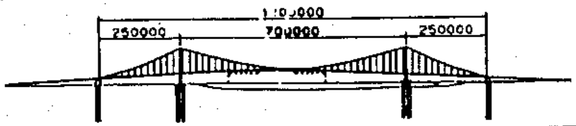
Sincerely yours,



KOJI ENOMOTO
Team Leader
F/S on Can Tho Bridge
JICA

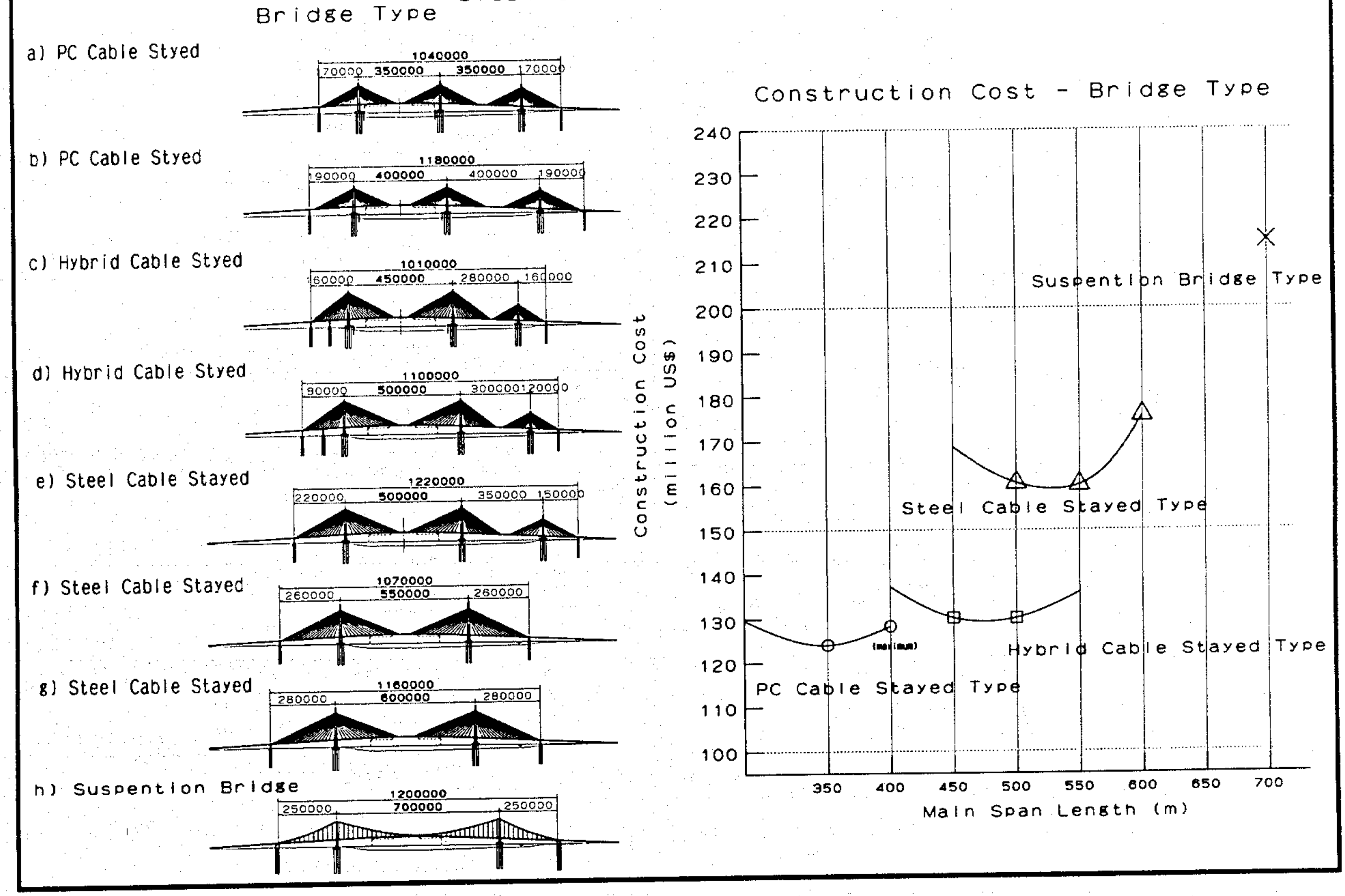
Attachments: - Comparison Study for Main Bridge
- Riverbed Condition of Route-C

STUDY ON MAIN SPAN LENGTH

Bridge Type		Main Span Length (m)	Construction Cost (million US$)	Hydrodynamics Problem	Remarks
a) PC Cable Styed		350	(※) 124.05 (0.953)	Serious Problem	
b) PC Cable Styed		400	(※) 128.28 (0.986)	Problem	
c) Hybrid Cable Styed		450	(※) 130.17 (1.000)	Problem	
d) Hybrid Cable Styed		500	130.13 (1.000)	No Problem	to be recommended
e) Steel Cable Stayed		500	160.57 (1.234)	-do.-	
f) Steel Cable Stayed		550	160.10 (1.230)	-do.-	
g) Steel Cable Stayed		600	175.58 (1.349)	-do.-	
h) Suspention Bridge		700	214.79 (1.651)	-do.-	

note (※) :Construction Cost is inclusive of Pier Protection.

STUDY ON MAIN BRIDGE TYPE



8.3 Limitation of Approach Bridge End

NIPPON KOEI CO., LTD AND PADECO CO., LTD.
The Feasibility Study on the Can Tho Bridge Construction Project in Socialist Republic of Vietnam entrusted by JICA (Japan International Co-operation Agency).
Project Office.

c/o My Thuan Projects Management Unit (MOTAC)
127B Dinh Tien Hoang St., Binh Thanh Dist., HCM City
Tel: 84-8-8413546 Fax: 84-8-8413547

To : PMU- My Thuan

Attention : Mr. Le Long DINH.
General Director
PMU-My Thuan

Ref. : CTB-9/98/HCMC
Date : January 22^{th}, 1998

Subject : Optimization on the Limitation of Approach Bridge End or Beginning of Approach Road Embankment

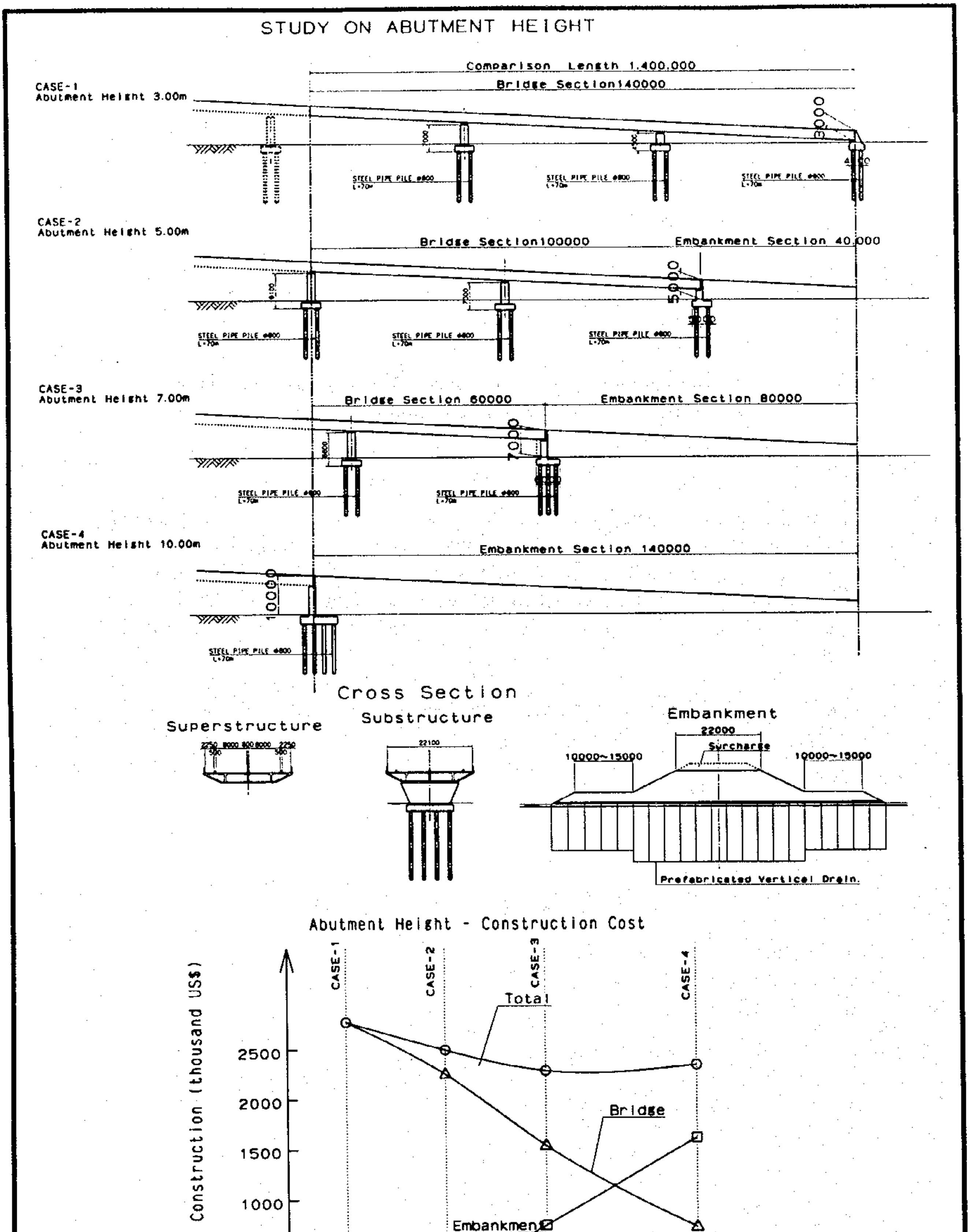
Dear Sir,

Regarding the optimum limitation of the end of the approach bridge, we would like to offer the conclusion from technical and economical study. The limitation, i.e. location of the abutment (bridge end) or beginning of embankment (highest point of approach road embankment), is at the point where the height of approach road embankment become 7^{m} high from the ground as the economically optimum curve line of the attached sheet.

Your kind review on the above conclusion will be highly appreciated.

Sincerely yours,

KOJI ENOMOTO
Team Leader
F/S on Can Tho Bridge
JICA


STUDY ON ABUTMENT HEIGHT
Comparison Length 1,400,000
CASE-1
Abutment Height 3.00m
Bridge Section140000
3000
STEEL PIPE PILE ø800
L=70m
CASE-2
Abutment Height 5.00m
Bridge Section100000
Embankment Section 40,000
5000
CASE-3
Abutment Height 7.00m
Bridge Section 60000
Embankment Section 80000
7000
CASE-4
Abutment Height 10.00m
Embankment Section 140000
10000
Cross Section
Superstructure
Substructure
Embankment
22000
Surcharge
10000~15000
10000~15000
22100
Prefabricated Vertical Drain.
Abutment Height - Construction Cost
Cost of Construction (thousand US$)
CASE-1
CASE-2
CASE-3
CASE-4
Total
Bridge
Embankment
2500
2000
1500
1000
500
3.0
5.0
7.0
10.0
Abutment Height(m)
note:Exchange late(1US$=12,000Dong)

8.4 Preliminary Design Calculation of the Main Bridge

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
MINISTRY OF TRANSPORT OF SOCIALIST REPUBLIC OF VIET NAM

FINAL REPORT
ON
THE CAN THO BRIDGE CONSTRUCTION

PRELIMINARY DESIGN
OF
MAIN BRIDGE

NIPPON KOEI CO., LTD and PADECO CO., LTD

General

Preliminary design has to involve design concept, basic in formation for cost estimation and further detail design. And some recommendation for construction method must be included. That is why project costs depend on methods of construction and construction procedure.

Preliminary design has minimum information contract items for cost estimation.

Stress check has done for critical section under major loads combinations.

For live load Vietnam Standard, 125% AASHTO, AUSTRO, and JAPANESE B (currently used) are compared for maximum influence for structural members.

High strength concrete 500 kgf/cm^2 is intended to use for precast concrete members to reduce construction period.

Reduce construction period contribute cost saving for construction.

OUTLINE OF PRELIMINARY DESIGN

Basic information for cost estimate and further detail design must be included on preliminary design of bridge construction and approach roads.
Cost estimation is basically based on quantities of major material, manpower, machinery exemption, overhead, tax, compensation and so on.

1. Superstructure.

1.1 Superstructure Design

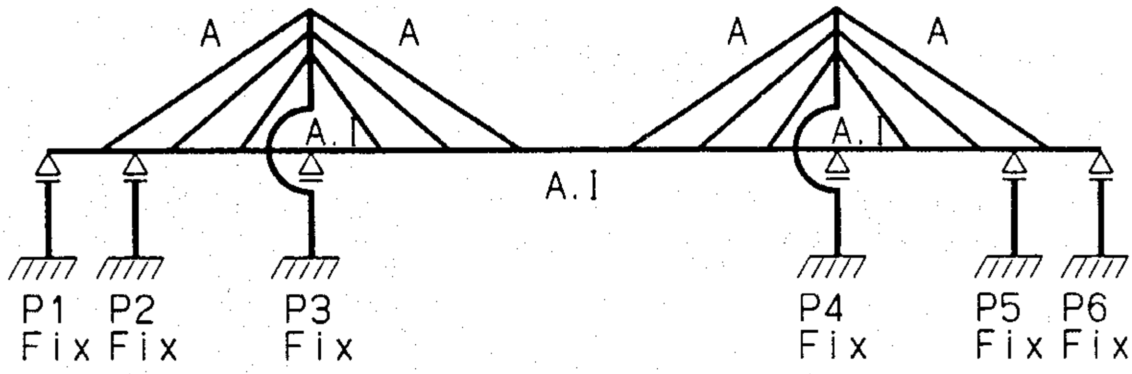
Major loads for checking the stress are as follows:

- Dead load
- Superimposed dead load
- Live load (Vietnamese standard including XB80, Australian Standard and AASHTO)
- Impact
- Thermal effect
- Shrinkage
- Wind load
- Prestress

Under serviceability, stress of materials must be ascertained under allowable stress and deformation of members especially girders must be limited.

1.2 Model for main Bridge Analysis

Frame analysis shall be done for sectional forces, deformation due to loading: Members of girder and towers have A (area), I (moment inertia) and Stays have area A (truss member) shown as the following figure.



A: Sectional area
I: Moment inertia

For moving load like live load, influence lines are used to obtain maximum influence of sectional forces.
Nodal point number is about 400.
Section forces at fixed end of piers are used for calculation of foundation. (N,S,M)
Where N: Normal Force S: Shear M: Bending Moment

1.3 Design Loads

Vietnamese Bridge Design Code (Specifications 2057/QD-KT4-1979) will be followed together with AASHTO specifications and also Japanese standard.

(1) Dead load

Dead loads are calculated using following density of each material

RC; 2.5 tf/m^3
Plain concrete; 2.3 tf/m^3
Asphalt; 2.3 tf/ m^3
Steel; 7.85 tf/ m^3

(2) Live load

- Loading Classification

In conformity with design traffic loads H30 an XB80 in Vietnamese

Standard are applied and also 125% of HS20-44 (Track loading) or 125% of HS20-44 (Lane loading) whichever produces the maximum stress as well B Live loading currently used in Japan.

- Application of Live Loading

Application of live loading and reduction in loading intensity for multiple lanes shall conform to Article 3.11 and 3.12 of AASHTO standard, respectively.

- Impact

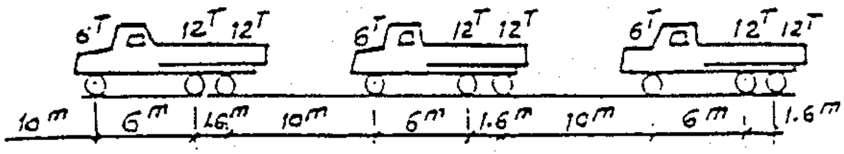
To provide for the dynamic and vibration effects live loading to be applied shall be increased in accordance with Article 3.8 of AASHTO standard.

- Load Distribution

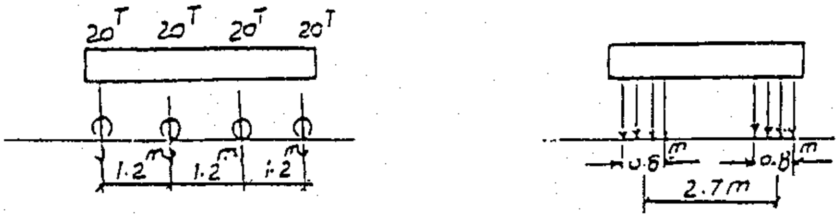
The load distribution shall be calculated based on Part C-Section 3 of AASHTO Standard.

Design Loads for Bridge Design, Viet Nam

The H-30 loading consists of trucks with unlimited number, the weight of each truck is 30 tons and they are arrange as illustrated in figure below:



The XB-80 loading consists especial heavy truck-80 tons in weight as illustrated in figure below:



Whenever a special heavy truck is placed, no other normal trucks and pedestrians are allowed to be placed simultaneously.

Main technical characteristic of the H-30 standard truck lane:

Weight of a truck (T)	30
Number of truck	not limited
Load on rear axle (T)	2x12
Load on front axle (T)	6
Width of rear wheel (m)	0.6
Width of front wheel (m)	0.3
Distance between center To center of rear wheel (m)	1.9

On the roadway width, the truck lanes may be arranged freely so that it produces maximum stresses with following conditions:

- The spacing between the two truck bodies that are placed side by side is not less than 0.1 m

- The truck clearance is not greater than the horizontal clearance of roadway width

1.4 Input Data for Computer Calculation

(1) Dead Load

a. PC Girder

W_c = 2.5 x (58.658 - 13.391 x 2 - 7.358 x 2) = 42.9tf / m

42.9x1.1

48.0tf / m

b. Steel Girder

Unit weight/m^3 is assumed 600 kgf/m^2

Ws = 0.6 x 24.6 = 14.76 tf/m = 15.0 tf/m

c. Tower

W_t = 2.5 x (6.00 x 9.00 - 3.00 x 6.00) x 2 = 180 tf/m

d. Stay Cable

Neglect

(2) Superimposed Dead Load

Pavement

Wa = 2.3 x 0.08 x 20.0 = 3.680 tf/m

Curb, Guard Wall

Wb = 4.00 tf/m

7.680 → 8.0 tf/m

(3) Live Load

(4) Shrinkage

(5) Thermal Effect

1.5 Sectional Constants

1) PC Girder

Section Area	;	$A_c = 16.341\ m^2$
Moment Inertia	;	$I_c\ = 19.446\ m^4$
Center of Gravity	;	$y_o\ = 1102\ \ m$
		$y_u\ =\ -1.898\ m$
Section Modules	;	$Z_o = I/y_o =\ 17.64\ m^3$
		$Z_u = I/y_u = -10.24\ m^3$

2) Steel Girder

Section Area	;	$A_s\ =\ 1.102\ m^2$
Moment Inertia	;	$I_s\ =\ 1.502\ m^4$
Center of Gravity	;	$y_o\ =\ 1.368\ m$
		$y_u\ =\ -1.632\ m$
Section Modules	;	$Z_o = I/y_o =\ 1.09\ m^3$
		$Z_u = I/y_u = -0.92\ m^3$
Effective Buckling Length	;	$l\ = 2 \times 12.0 = 24.0m$
	;	$r = \sqrt{I / A} = 1.167m$
	;	$l/r\ = 20.6$

1.6 Load Combinations and Stress Check

Load combination to be considered at this stage are as follows:

1) Dead Load + Prestress 1(stay) + Prestress 2 (Inner Cable)
   : D + PS1 + PS2
2) 1) + Live Load + Impact
   : D + L + I + PS1 + PS2
3) 2) + Thermal Effect (Shrinkage)
   : D + L + I + PS1 + TH(SH)

In case of using concrete strength 500 kg/cm^2, stresses of member sections must be ascertained under the following allowable stresses.
For flexural stress of the girder and diagonal tensile stresses of PC portion are limited below (allowable stress) of PC.

$0<\sigma_{1)o}, \sigma_{2)o}<200$ kgf/cm2

$0<\sigma_{2)o}, \sigma_{2)o}<200$ kgf/cm2

$0<\sigma_{3)o}, \sigma_{2)o}<200\text{x}1.15$ kgf/cm2

$$\sigma_o, \sigma_u = \frac{N}{A} \pm \frac{M}{Z_u, Z_u}$$

σ_o: Flexural stress of upper edge of girder
σ_u: Flexural stress of lower of girder
N : Normal force Z_o, Z_u
A : Section area
M : Bending moment

*)Suffix
1), 2), 3): Load Combination
o,u: Edge of Girder
Resisting bending moment distribution due to allowable stress of each material under serviceability should be compared with acting bending moment.
Diagonal tensile stress must be checked under allowable stress.

$$\sigma_I = \frac{1}{2}\left\{\sigma_x - \sqrt{\sigma_x^2 + 4\tau^2}\right\} \langle 12\text{kgf} / cm^2$$

$$\tau = \frac{SQ}{BI}$$

σ_I: Diagonal tensile stress of concrete
τ : Shear stress
S: Shear force
I : Moment Inertia
B: B readth of section
Q: Geometrical moment of area

1.6.1 Allowable stress of material

1) Prestressed Concrete

Allowable Stress of Concrete

Specified Concrete Strength for Design Fc'		400 (kgf/cm^2)	500 (kgf/cm^2)
Flexural tensile stress	During Erection	0	0
	Serviceability condition	0	0
	Over loading condition	25	30
Flexural compressive stress	After prestressing	0.55 Fc' 220	" 275
	Serviceability	0.4 Fc' 160	" 200

Allowable Diagonal Tensile Stress

Specified Concrete Strength for Design Fc'	400 (kgf/cm^2)	500 (kgf/cm^2)
Diagonal Tensile Sress of Concrete	10	12

2) Mild reinforcement steel SD 345 & SD 295 B

Tensile stress of Mild Reinforcement Bar

	Tensile Stress	
Specified tensile stress	SD 295 B	SD 345
Yield point stress	295≈390 N/mm^2	345≈400 N/mm^2
Breaking stress	>440	>490

3) Steel (SM 490 Y)

Tensile Strength of Steel(SM490Y)

Thickness of Steel	~ 16 mm	16 ~ 40mm	40 ~ 70mm	70mm ~
Yield Point Strength	365N/mm^2	355N/mm^2	335N/mm^2	325N/mm^2
Breaking Strength	490 ~ 610 N/mm^2			

4) Prestressing Tendons

a) Inner cable

SWPR7B (12S 12.4)

Stress at transfer : 0.7 *f*puk or 0.85 *f*pyk

Stress during prestressing : 0.8 *f*puk or 0.9 *f*pyk

Stress under serviceability : 0.7 *f*puk

*) *f*pyk: yield point stress of prestressing cable

*f*puk: ultimate stress of prestressing cable

b) Extra-dosed cable.

Extra-dosed cable is one of out cable with large eccentricity. Changeable stress range is less than stay cable. Therefore, stress reduction due to fatigue is less than stay cable. Then, allowable stress of PC cable is 0.6 *f*puk.

c) Stay cable (H systems)

Changeable stress range is bigger than inner cable of PC girder, therefore reduction of stress due to fatigue bigger than the above PC girder. Then, allowable stress of stay cable is limited 0.4 *f*puk.

Where, *f*puk: ultimate stress prestressing cable

Stay cable- H system

	Number of PC Strand (T15.2)	Diameter PE Pipe (mm)	Section Area (PC Strand) (mm^2)	Ultimate tensile Strength (Ton)	Unit Weight (kg/m)		
					PC Strand	After grouting	
19H15	19	114	2,635	50.4 (483.9)	20.9	34.0	• SWPR7B • ( ): Grade A
27H15	27	140	3,745	718 (624)	29.7	49.7	
37H15	37	165	5,132	984 (855)	40.7	68.9	
48H15	48	190	6,658	1,277 (1,109)	52.8	90.5	
61H15	61	216	8.461	1,623 (1,409)	67.2	116.3	
91h15	91	267	12,622	2,421 (2,1020)	100.2	173.4	

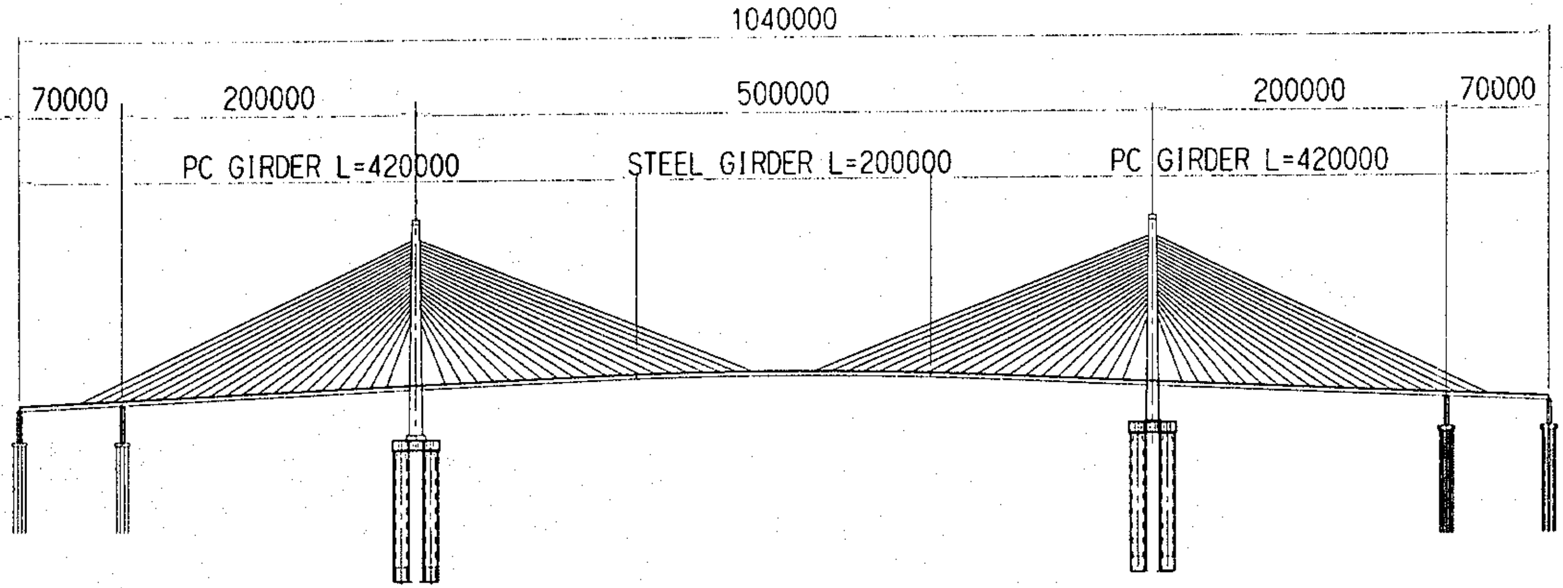
1.7 Results of Calculation

1.7.1 Sectional Forces for Stress Check

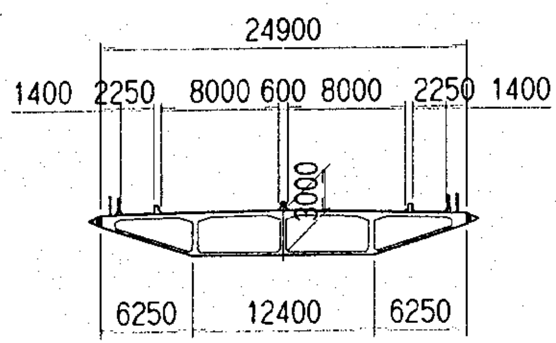
Results of sectional forces under dead loads and live loads are shown in the following diagram.

SUPERSTRCTURE OF MAIN BRIDGE

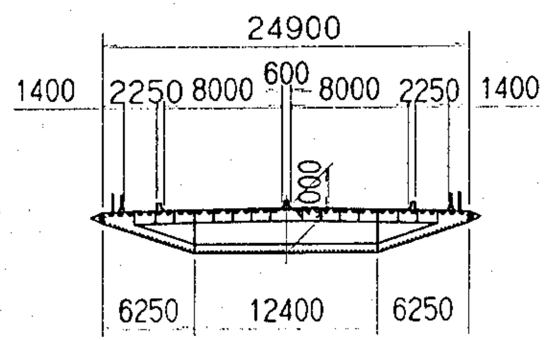
SIDE ELEVATION

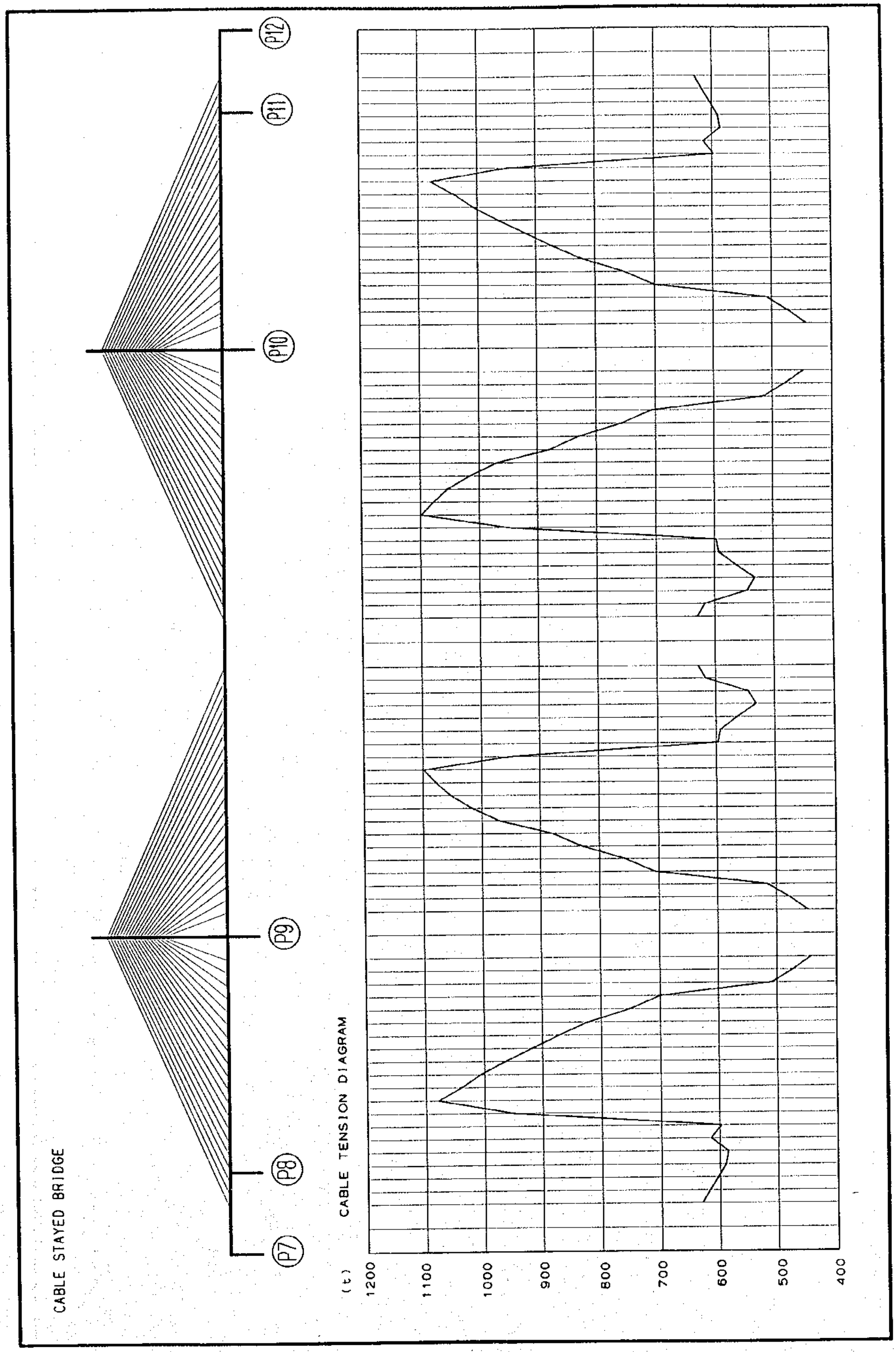


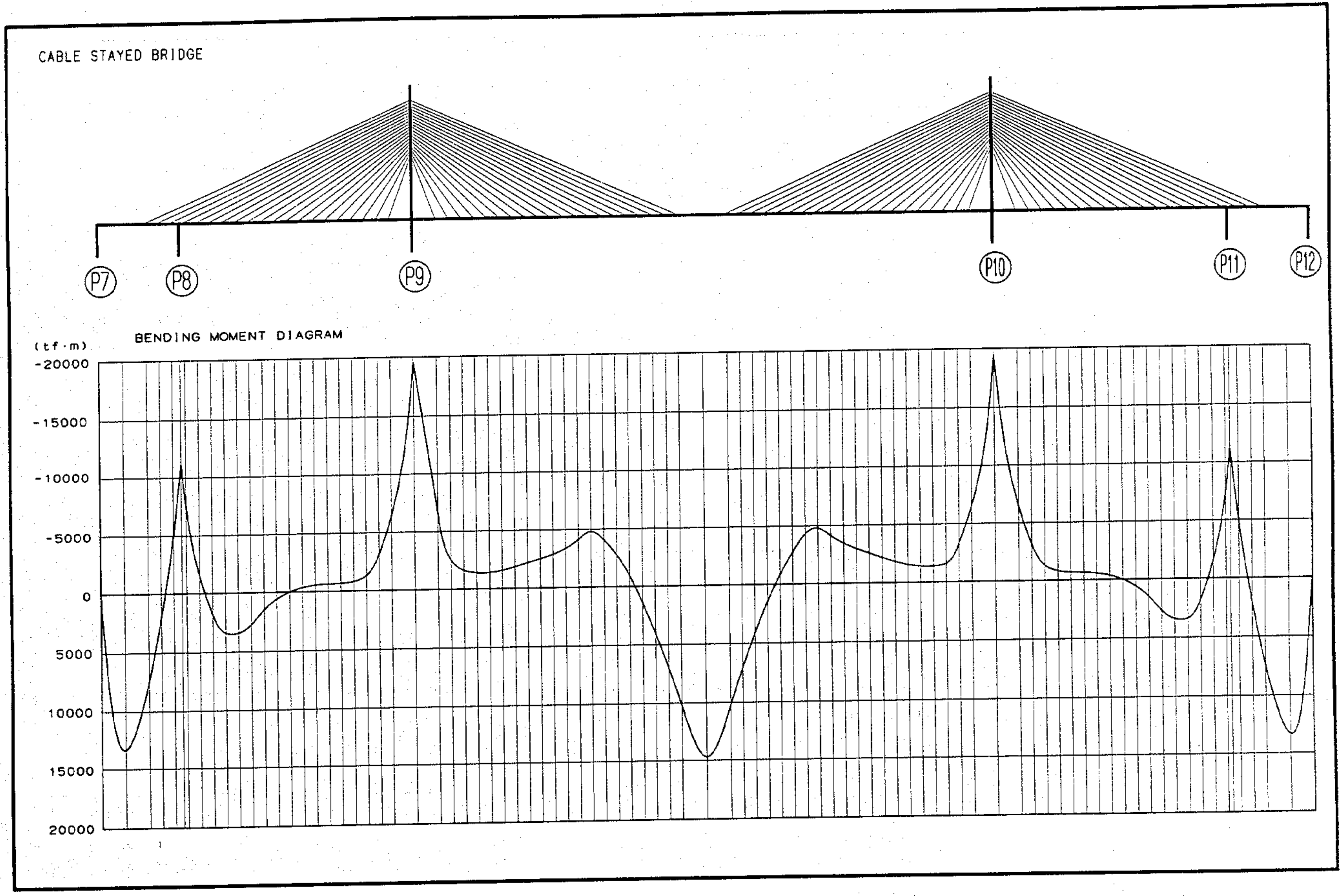
PC GIRDER

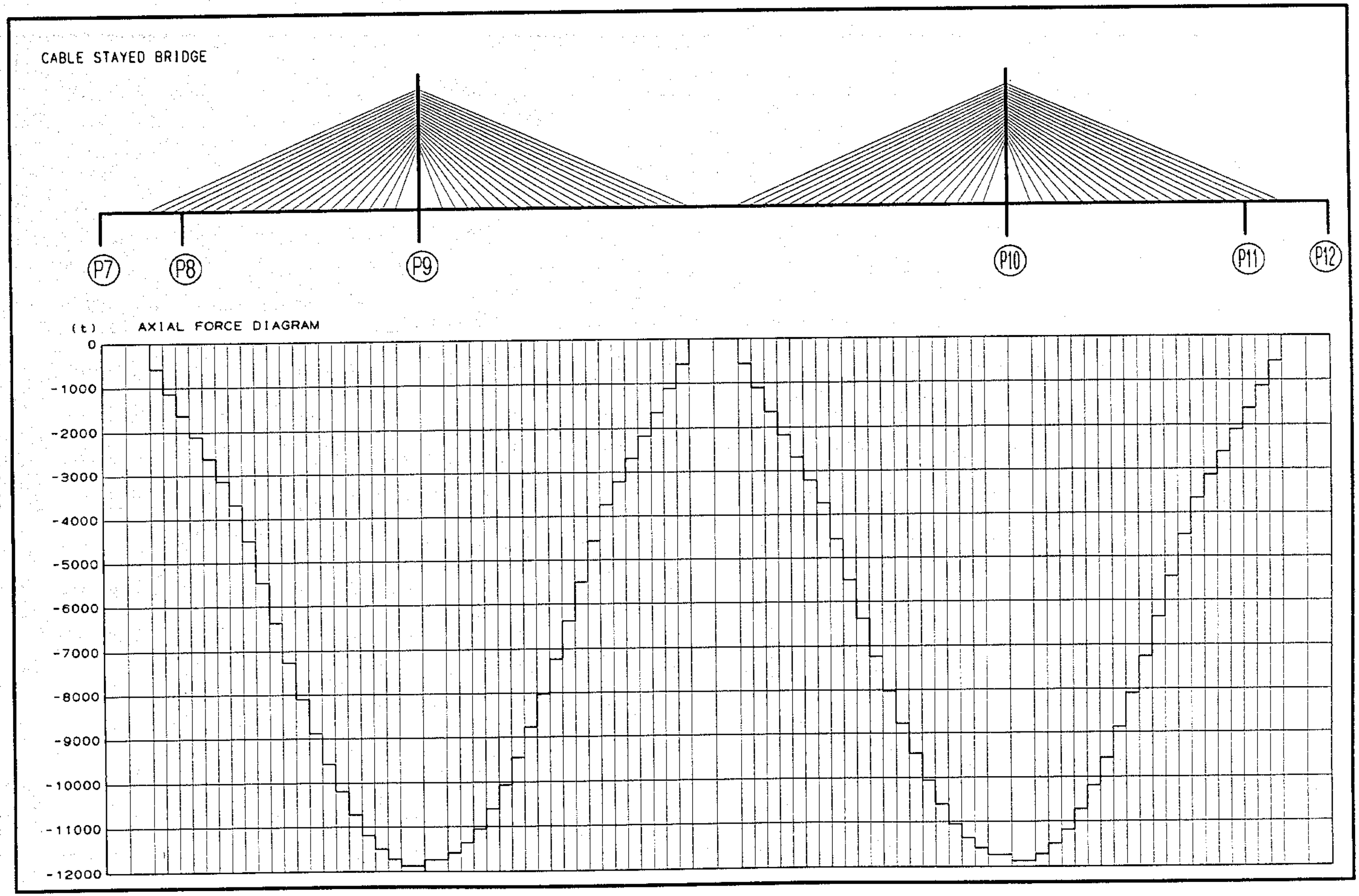


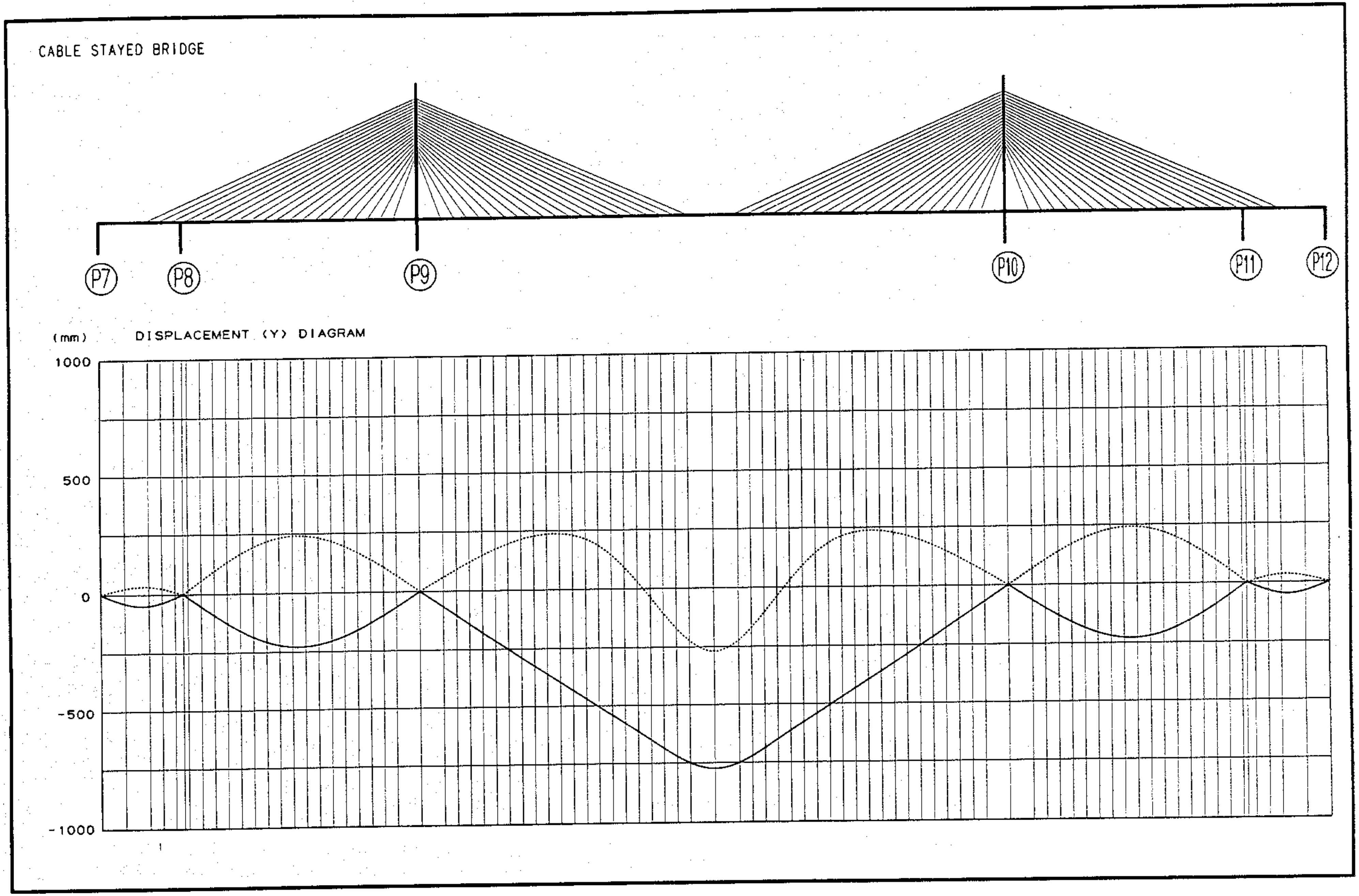
STEEL GIRDER




CABLE STAYED BRIDGE
P7
P8
P9
P10
P11
P12
CABLE TENSION DIAGRAM
(t)
1200
1100
1000
900
800
700
600
500
400

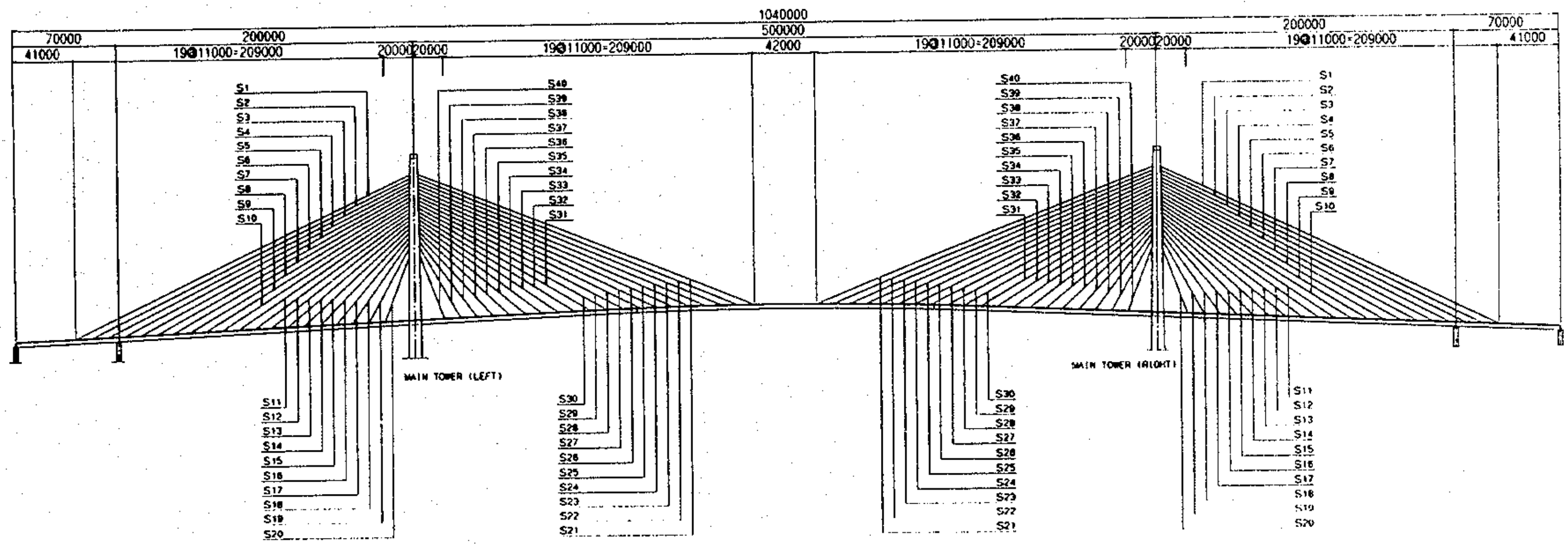

CABLE STAYED BRIDGE
P7
P8
P9
P10
P11
P12
BENDING MOMENT DIAGRAM
(tf·m)
-20000
-15000
-10000
-5000
0
5000
10000
15000
20000


CABLE STAYED BRIDGE
P7
P8
P9
P10
P11
P12
AXIAL FORCE DIAGRAM
(t)
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
-8000
-9000
-10000
-11000
-12000


CABLE STAYED BRIDGE
P7
P8
P9
P10
P11
P12
(mm)
DISPLACEMENT (Y) DIAGRAM
1000
500
0
-500
-1000

SUPERSTRCTURE OF MAIN BRIDGE

STAY CABLE ARRANGEMENT



STAY CABLE

MAIN TOWER							
No.	LENGTH (m)	Nos	REMARK	No.	LENGTH (m)	Nos	REMARK
S1	254.2	4	PC GIRDER	S21	246.7	4	STEEL GIRDER
S2	243.0	4	〃	S22	235.6	4	〃
S3	231.8	4	〃	S23	224.6	4	〃
S4	220.6	4	〃	S24	213.5	4	〃
S5	209.5	4	〃	S25	202.6	4	〃
S6	198.4	4	〃	S26	191.6	4	〃
S7	187.3	4	〃	S27	180.7	4	〃
S8	176.3	4	〃	S28	169.9	4	〃
S9	165.3	4	〃	S29	159.1	4	PC GIRDER
S10	154.4	4	〃	S30	148.5	4	〃
S11	143.6	4	〃	S31	138.0	4	〃
S12	132.8	4	〃	S32	127.4	4	〃
S13	122.2	4	〃	S33	117.1	4	〃
S14	111.8	4	〃	S34	107.0	4	〃
S15	101.5	4	〃	S35	97.1	4	〃
S16	91.5	4	〃	S36	87.5	4	〃
S17	81.9	4	〃	S37	78.3	4	〃
S18	72.7	4	〃	S38	69.7	4	〃
S19	64.4	4	〃	S39	61.9	4	〃
S20	57.0	4	〃	S40	55.3	4	〃

1.9 Stress Check of Members

1.9.1 PC Girder

1.Checking at the section occurring minimum bending moment

Sectional force {
$M = -19{,}500 * (1 + 0.05) = -20{,}475$ tf*m
$N = 11{,}800 * (1 + 0.05) = 12{,}390$ tf

Sectional coefficient {
A = 64.368 m^2
ZU= 36.258 m^3
ZL= -28.693 m^3

1) Bending stress is calculated by the following formula.

$$\text{Upper edge } \sigma u = \frac{N}{A} + \frac{M}{ZU} \qquad \text{Lower edge } \sigma L = \frac{N}{A} + \frac{M}{ZL}$$

2) Calculate bending stress due to sectional force

$$\sigma u = \frac{12{,}390}{64.368} + \frac{-20{,}475}{36.258} = -372.2 \text{ tf/m}^2 = -37.2 \text{ kgf/cm}^2$$

$$\sigma L = \frac{12{,}390}{64.368} + \frac{-20{,}475}{-28.693} = 906.1 \text{ tf/m}^2 = 90.6 \text{ kgf/cm}^2$$

3) Arrangement of PC steel

PC steel type		12S12.7B
Sectional area	A =	1184.5 mm^2
Nos.	N =	70 each
Height of PC steel group from upper edge	d =	0.150 m ep= 1.264 m
Imagined effective stress of PC steel	σpe =	104.5 kgf/mm^2 (0.55σpu)

4) Calculate prestress

$$\text{Upper edge } \sigma ce = \frac{Pe}{A} + \frac{Pe*ep}{ZU}$$

$$\text{Lower edge } \sigma ce' = \frac{Pe}{A} + \frac{Pe*ep}{ZL}$$

$$Pe = 1184.5 * 104.5 * 70 = 8{,}665 \text{ tf}$$

$$\sigma ce = \frac{8{,}665}{64.368} + \frac{8{,}665 * 1.264}{36.258} = 436.6 \text{ tf/m}^2 = 43.7 \text{ kgf/cm}^2$$

$$\sigma ce' = \frac{8{,}665}{64.368} + \frac{8{,}665 * 1.264}{-28.693} = -247.0 \text{ tf/m}^2 = -24.7 \text{ kgf/cm}^2$$

5) Compose bending stress

$$\text{Upper edge } \sigma u = -37.2 + 43.7 = 6.4 \text{ kgf/cm}^2 > 0 \text{ kgf/cm}^2$$

$$\text{Upper edge } \sigma u = 90.6 + -24.7 = 65.9 \text{ kgf/cm}^2 < 200 \text{ kgf/cm}^2$$

2.Checking at the section occurring maximum bending moment

Sectional force { M = 14,000 * (1 + 0.05) = 14,700 tf*m
N = 0 * (1 + 0.05) = 0 tf

Sectional coefficient {
A = 16.341 m^2
ZU= 17.640 m^3
ZL= -10.240 m^3

1) Bending stress is calculated by the following formula.

$$\text{Upper edge } \sigma u = \frac{N}{A} + \frac{M}{ZU} \qquad \text{Lower edge } \sigma L = \frac{N}{A} + \frac{M}{ZL}$$

2) Calculate bending stress due to sectional force

$$\sigma u = \frac{0}{16.341} + \frac{14,700}{17.640} = 833.3 \text{ tf/m}^2 = 83.3 \text{ kgf/cm}^2$$

$$\sigma L = \frac{0}{16.341} + \frac{14,700}{-10.240} = -1435.5 \text{ tf/m}^2 = -143.6 \text{ kgf/cm}^2$$

3) Arrangement of PC steel

PC steel type		12S12.7B
Sectional area	A =	1184.5 mm^2
Nos.	N =	55 each
Height of PC steel group from lower edge	d =	0.150 m ep= -1.748 m
Imagined effective stress of PC steel	σpe =	104.5 kgf/mm^2 ($0.55\sigma pu$)

4) Calculate prestress

$$\text{Upper edge } \sigma ce = \frac{Pe}{A} + \frac{Pe*ep}{ZU}$$

$$\text{Lower edge } \sigma ce' = \frac{Pe}{A} + \frac{Pe*ep}{ZL}$$

$$Pe = 1184.5 * 104.5 * 55 = 6{,}808 \text{ tf}$$

$$\sigma ce = \frac{6{,}808}{16.341} + \frac{6{,}808 \text{ -* } 1.748}{17.640} = -258.0 \text{ tf/m}^2 = -25.8 \text{ kgf/cm}^2$$

$$\sigma ce' = \frac{6{,}808}{16.341} + \frac{6{,}808 \text{ -* } 1.748}{-10.240} = 1578.8 \text{ tf/m}^2 = 157.9 \text{ kgf/cm}^2$$

5) Compose bending stress

$$\text{Upper edge } \sigma u = 83.3 + -25.8 = 57.5 \text{ kgf/cm}^2 < 200 \text{ kgf/cm}^2$$

$$\text{Upper edge } \sigma u = -143.6 + 157.9 = 14.3 \text{ kgf/cm}^2 > 0 \text{ kgf/cm}^2$$

1.9.2 Steel Girder

(1) Allowable stress of members

Material of steel members SM490Y

Allowable tensile stress $\sigma ta =$ 2,100 kgf/cm^2

Allowable compressive stress $\sigma caz =$ 2,100 - 15 * (l/r -14)

$=$ 2,001 kgf/cm^2

Allowable flexural compressive stress (local bucking not considered) upper limit

$\sigma bao =$ 2,100 kgf/cm^2

Local bucking for stiffer (Deck, Bottom Plate)

$$\sigma cal = 2100 - 45 * \left(\frac{b}{n*\phi*t} \right) - 22 = 1,927 \ kgf/cm^2$$

Where, b : Breadth of stiffner
ϕ : Stress gradientt (ϕ = 1.0)
n : Number of divided stiffner (n = 20)
t : Thickness of stiffner

Allowable bucking stress by Euler

$$\sigma caz = 12 * 10^6 / (l/r)^2 = 12 * 10^6 / 20.6^2 = 28,277 \ kgf/cm^2$$

(2) Stress check of section

Normal force is compressive with minimum moment.

M = -5000 * (1 + 0.05) = -5250 tf*m
N = 3700 * (1 + 0.05) = 3885 tf

Compressive stress due to normal force

$$\sigma c = \frac{N}{A} = \frac{3885}{1.102} = 3525.4 \ tf/m^2 = 352.5 \ kgf/cm^2$$

Flexural compressive stress due to bending moment

$$\sigma bcz = \frac{M}{Zu} = \frac{5250}{0.92} = 5706.5 \ tf/m^2 = 570.7 \ kgf/cm^2$$

Check of safty

$$\frac{\sigma_c}{\sigma_{caz}}+\frac{\sigma_{bcz}}{\sigma_{bao}\left(1-\frac{\sigma_c}{\sigma_{eaz}}\right)}=\frac{356.6}{2001}+\frac{1006.3}{2100\times\left(1-\frac{356.6}{28277}\right)} = 0.45 < 1.0$$

$$\sigma_c+\frac{\sigma_{bcz}}{\left(1-\frac{\sigma_c}{\sigma_{eaz}}\right)}=356.6+\frac{1006.3}{\left(1-\frac{356.6}{28277}\right)} = 930.4 \text{ kgf/cm}^2 < \sigma cal = 1,927 \text{ kgf/cm}^2$$

In case of tensile normal force

Sectional force

M = 14500 * (1 + 0.05) = 15225 tf*m
N = 0 * (1 + 0.05) = 0 tf

Tensile stress due to normal force

$$\sigma t = \frac{N}{A} = \frac{0}{1.102} = 0.0 \text{ tf/m}^2 = 0.0 \text{ kgf/cm}^2$$

Compressive stress due to bending moment

$$\sigma bcz = \frac{M}{Zo} = \frac{15225}{1.09} = 13967.9 \text{ tf/m}^2 = 1396.8 \text{ kgf/cm}^2$$

Tensile stress due to bending moment

$$\sigma btz = \frac{M}{Zu} = \frac{15225}{0.92} = 16548.9 \text{ tf/m}^2 = 1654.9 \text{ kgf/cm}^2$$

Check of safty

$\sigma t + \sigma btz =$ 0.0 + 1654.9 = 1654.9 kgf/cm² < $\sigma ta =$ 2,100 kgf/cm²

$$\frac{\sigma t}{\sigma ta}+\frac{\sigma bcz}{\sigma bao}=\frac{0.0}{2,100}+\frac{1396.8}{2,100} = 0.67 < 1.0$$

$\sigma t + \sigma bcz =$ 0.0 + 1396.8 = 1396.8 kgf/cm² < $\sigma ta =$ 1,927 kgf/cm²

2.Substructure

Design criteria is based on"Specification for Highway Bridge part Ⅰ,Ⅱ,Ⅲ,Ⅳ
(Japan Road Association)

2.1 Material and allowable stress

(1) Reinforced concreet

Specified design strength	σ ck =	240 kgf/cm²
Allowable compressive stress	σ ca =	80 kgf/cm²
Allowable shearing stress	τ a =	2.3 kgf/cm²

(2) Rienforced bar (Equivalent "JIS G3112 SD295B,SD345")

Allowable tensile stress	σ sa =	1800 kgf/cm²

2.2 Tower Reaction at Fix end for Substructure Design

Longitudinal direction

Load Case	M (tf·m)	H (tf)	V (tf)
Dead Load	3320.0	57.0	39370.8
Shrinkage	11650.5	-91.5	12.0
Effect of tenperature (+)	-8095.7	67.5	31.9
Effect of tenperature (-)	8095.7	67.5	-31.5
Live Load(Vmax)	18433.6	-146.4	2755.0
Live Load(Vmin)	32077.9	-257.4	-62.9
Live Load(Hmax)	-33381.0	413.9	685.1
Live Load(Mmax)	78660.2	-736.4	1988.5
Live Load(Mmin)	-36260.3	411.9	603.1
Wind Load:100%(Perpendicular)	5171.5	508.6	753.8
Wind Load:30%(Perpendicular)	1551.5	152.6	226.1