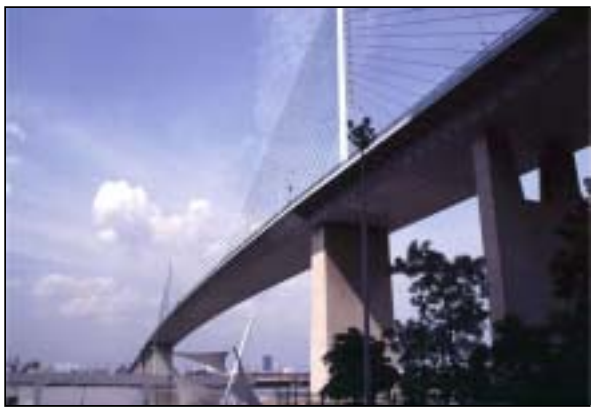
Thailand

Dao Kanong - Klong Toey Port Expressway Project (Stage I) (Construction of bridge section of the Chao Phya River Crossing)

Report Date: October 2002
Field Survey: August 2001

1. Project Profile and Japan's ODA loan

Site Map: Bangkok Metropolitan Region
(*For detail map of project site and Bangkok expressway network, see Figure 2-1, p.8.



Site Photo: The bridge section of the Chao Phya River crossing

1.1. Background

As the political and economic center of Thailand, the metropolitan area around Bangkok showed drastic development in the 1970s. The average rate of population growth from 1975 to 1980 was 3.4%, which exceeded the world average of 2.1%. As of 1980, Bangkok had a population of 5.15 million. The number of registered vehicles in the metropolitan area increased remarkably, at an average yearly rate of 9%, reaching 620,000 in 1980.

Nevertheless, the number of highways and the rate of paving in Bangkok was low. And there were several problems regarding traffic conditions. The Chao Phya River hindered traffic circulation in Bangkok, as drivers had to make detours to the nearest bridge in order to cross the river. Moreover, because of the poor performance of ring roads, through traffic also had to once step inside the center of Bangkok. As a result, traffic in Bangkok was in a chaotic situation.

1.2. Objectives

In order to cope with these conditions, the Transport Master Plan for Greater Bangkok was established in September 1975, which included as one of its main long-term projects the construction of the First Stage Expressway System. The main objectives of the expressway was: 1) to achieve more efficient, faster traffic circulation by connecting Central Bangkok directly to the main arterial roads and 2) to relieve traffic congestion in Central Bangkok by establishing routes exclusively for through traffic.

1.3. Project Scope

This project covers Phase III of the First Stage Expressway System in Bangkok, which was further divided into two parts (Phase III-1 and Phase III-2)[1]. This report evaluates Phase III-1 that covered

[1] The First Stage Expressway System (FSES), links Dao Kanong ramp, a gateway to eastern and southern national highway network network via Route 35, via Klong Toey Port junction in central Bangkok, and two ramps on the separate routes: Din Daeng in the north of city center and Bang Na in the southeast of city center, which are connections to the north- and southeast-bound expressways, respectively. The route of the FSES is Y-shaped, with a hub at Klong Toey Port. The FSES was constructed in three phases: Phase I between Din Daeng and Klong Toey Port; Phase II between Bang Na and Klong Toey Port; Phase III between Klong Toey Port and Dao Kanong (For location of each ramp or junction, please see Figure 2-1, p.8). JBIC loans were provided to all the phases
Phase III was further divided into two parts. The first part (III-1, this project) covered the bridge section of the Chao Phya River crossing. The second part (III-2) covered the remaining sections at the both ends of the bridge.

construction of a bridge linking the inner city and the southwestern outskirts of Bangkok.

The project scope of the JBIC-financed foreign currency portion is construction of 1) the main cable-stayed bridge crossing Chao Phya River; 2) the approach bridge on the Thonburi side; and 3) the approach bridge on the Bangkok side.

Details of the works:

(Cable-Stayed Bridge)

- Main span: 450m
- Number of towers: 2
- Number of Lanes: 6
- Types of cable: rocked coil cable
- Types of girder: box girder

(Approach bridges on Thonburi side)

- Total length: 650m
- Span configuration: 13 approach spans at 50m
- Number of concrete piles: 777
- Number of steel piles: 392

(Approach bridges on Bangkok side)

- Total length: 650m
- Span configuration: 13 approach spans at 50m
- Number of concrete piles: 746
- Number of steel piles: 376

1.4. Borrower/Executing Agency

Borrower: Kingdom of Thailand
Executing Agency: Expressway and Rapid Transit Authority of Thailand (ETA)

1.5. Outline of Loan Agreement

Loan Amount Loan Disbursed Amount	25,900 million yen 11,097 million yen
Exchange of Notes Loan Agreement	June 1982 July 1982
Terms and Conditions Interest Rate Repayment Period (Grace Period) Procurement	 3.0 % p.a. 30 years (10 years) General United
Final Disbursement Date	September 1989

2. Results and Evaluation

2.1. Relevance

The objective of this project at the time of the appraisal was to achieve more efficient, faster traffic circulation by connecting central Bangkok and the arterial roads of the metropolitan region through an expressway. Considering the increase of population and of car traffic, it is deemed that the project was quite relevant at the time of appraisal.

The need to relieve traffic congestion in Central Bangkok still exists, and the existence of the Dao Kanong - Klong Toey Port Expressway Project still contributes to the alleviation of traffic congestion to this day. The Eighth Economic and Social Development Plan (1997-2001) noted, “Development of the

Bangkok Metropolitan Region ("BMR") must shift towards linking the BMR, the Eastern Seaboard, the Upper Central sub-region and the Western sub-region to mutually support their economic basis." It also put emphasis on developing communities in the Upper Central and Western sub-regions, designating separate residential, commercial, industrial and agricultural zones in each province in a way that industrial and other activities would not adversely affect the environment. This project played a significant role in connecting BMR with the Western sub-region.

There remains an ever-growing importance of this bridge that connects the city center of Bangkok and its outskirts, Thonburi and Chom Thomng districts, since there is still room for development within the districts. This project (bridge section) was executed as Phase III-1 of the First Stage Expressway Construction Project in combination with another JBIC loan[2], and the road constructed under it has played quite an important role as one of the main arterial roads in the BMR. With the completion of this project, the First Stage Expressway Network was completed, fulfilling the objective to connect the southern regions to central Bangkok detouring congested roads in the inner city.

2.2. Efficiency

(2.2.1) Schedule

Table 2-1 shows the projected schedule and actual dates of implementation. The detailed design was completed a year behind schedule for improvement of wind control, and the land acquisition ended 2 years behind schedule, which together caused delays in the following procedures of tender and construction.

The contractor pre-qualification was started as scheduled but it ended falling behind the schedule for 5 months. The start of the invitation for tender and evaluation was delayed for 13 months, ending 20 months behind schedule. Construction of the cable-stayed bridge, the Thonburi approach bridge and the Bangkok approach bridge started 21 months late and ended 12 months behind schedule. For the most part, preparation for engineering supervision was completed on schedule. However, actual engineering supervision began 24 months behind schedule and ended 12 months later than scheduled.

As a consequence, the final completion was in December 1987, a year behind schedule.

Table 2-1: Implementation Schedule

		Projected	Actual
1.Detail design		Feb.1980-Dec.1981	Feb.1980-Dec.1982
2.Preparation	(1) Contractor pre-qualification	Aug.1981-Mar.1982	Aug.1981-Aug.1982
	(2) Invitation for tender & evaluation	Apr.1982-Dec.1982	Sep.1983-Aug.1984
3.Preparation for engineering supervision		Mar.1982-Dec.1982	Feb.1982-Nov.1982
4.Engineering supervision		Sep.1982-Dec.1986	Sep.1984-Dec.1987
5.Land acquisition		Apr.1982-Sep.1983	Jun.1982-Sep.1985
6.Construction		Jan.1983-Dec.1986	Oct.1984-Dec.1987

(2.2.2) Cost

The actual project cost of the JBIC-financed foreign currency portion was 11,097 mil yen, merely 43% of 25,900 mil yen of the original estimation at the time of appraisal as a result of heavily competitive bidding. The actual cost of the local currency portion, which was not included in the JBIC-loan scope, was 1,478 mil baht, also less than the estimated 1,891 mil baht.

2.3. Effectiveness

[2] Other than this project (Phase III-1), JBIC has financed Phase I, Phase II and Phase III-2 of the First Stage Expressway project.

(2.3.1) Volume of Traffic

Table 2-2 indicates actual traffic volumes for passenger cars and trucks. As traffic volume of the whole First Stage Expressway System, instead of this particular project section, was estimated in the appraisal, it is not possible to compare the actual traffic volume with the estimation.

However, peak hour traffic on the bridge at present is close to the maximum capacity. In general, maximum capacity of expressways is roughly 2,000 cars per hour per lane[3]. Table 2-3 shows peak hour traffic volume on major bridges that cross the Chao Phya River. The bridge constructed under Phase III-1 of this project, known as the Rama IX Bridge, has the heaviest traffic during the AM peak hour (inbound) and the PM peak hour (outbound), both over 6,000 cars/hour that is the maximum capacity of the three-lane (each direction) expressway bridge. It indicates that this bridge is used to the full capacity during the peak hours, and is of the most importance among the bridges across the Chao Phya River linking central Bangkok and its western and southern outskirts.

Table 2-2: Actual Annual Volume of Traff at the Rama IX Bridge (Unit: million cars)

Year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Passenger Car	10.64	15.71	18.37	20.28	22.95	24.92	24.90	27.73	28.04	29.85	28.95	27.56	29.19
Truck	1.75	3.06	3.34	3.65	3.86	3.94	4.01	3.89	3.69	3.41	2.70	2.71	2.75

Source: ETA

Table 2-3:Traffic Volume by Bridges (1999)

(Unit: cars/hour)

No.	Section	Direction	AM Peak	PM Peak
1.	Sathorn Bridge	INBOUND OUTBOUND	3,397 2,242	1,922 3,271
2.	Krungthep Bridge	INBOUND OUTBOUND	5,673 1,663	2,029 2,070
3.	**Rama IX Bridge (This project)**	**INBOUND OUTBOUND**	**6,412 3,017**	**3,886 6,198**
4.	Pha Namg Klao Bridge	INBOUND OUTBOUND	4,850 2,219	4,609 4,006
5.	Nonthaburi Bridge	INBOUND OUTBOUND	2,244 1,914	1,599 1,862
6.	Pathumthani Bridge	INBOUND OUTBOUND	1,849 1,534	1,273 1,534

Source:ETA

(2.3.2) EIRR and FIRR

The following recalculation of economic and financial internal rates of return (EIRR and FIRR) with the actual data is only for Phase III-1 that this report evaluates. At the time of appraisal, however, EIRR and FIRR were estimated for the entire First Stage Expressway System (FSES). Therefore, a comparison between the estimated and the recalculated EIRR/FIRR shall be provided merely for reference purpose.

In order to recalculate EIRR and FIRR, the following assumptions are applied.

- □ Benefit: VOC (Vehicle Operational Cost) savings
- □ Cost: operation and maintenance cost derived from ETA.
- □ Consumer price index (CPI): the same rate as in 1999/2000.
- □ (FIRR) Toll charge: to be escalated at the CPI after 2001.

[3] Source: Highway Capacity Manual, 1985

The recalculated FIRR was 11.1%, higher than the estimated at the time of appraisal, 8.5%, since the toll has been raised, as shown in Table 2-4, much higher than the estimated 15 baht a compact/passenger car and 25 baht a truck/bus. On the contrary, the recalculated EIRR was 9.3%, lower than the original estimation of 12.3%, because on the one hand the estimation was based on a large beneficiary area along the whole FSES, the other hand the recalculation is based on a small area related to the Chao Phya River bridge section of FSES.

Table 2-4: The toll charge of Dao Kanong – Klong Toey Port section (Unit: Baht)

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1996	1997	1998	1999	2000
Compact Car	10	10	10	10	10	15	30	30	30	30	30	30	40	40	40
Passenger Car	10	10	10	10	10	15	30	30	30	30	30	30	40	40	40
Truck	20	20	20	20	20	30	50	50	50	50	50	50	60	60	60
Bus	20	20	20	20	20	30	50	50	50	50	50	50	60	60	60

Source: ETA

2.4. Impact

(2.4.1) Enhance Developments in Surrounding Area

Table 2-5 and Table 2-6 show changes in the number of houses and population, respectively, in BMR and three districts along the Route 35, which stretches southwest-bound from the Dao Kanong exit of this expressway, namely Thonburi, Chom Thonmg, and Bang Khun Thian District, between 1993 and 1997.

Two out of the three districts, Chom Thonmg and Bang Khun Thian, experienced a rapid growth in the house number and the population as an indication of urbanization for the ten years. This project, the bridge section (Phase III) in particular, is considered to have contributed to an improved access to central Bangkok, and thereby to the urbanization of the districts. The population of Thonburi District, already experienced urbanization to a large extent before this project, has decreased during the period, while other sign of impacts on the area's development are not measurable with this indicator. The total number of houses and the total population of the three districts have increased.

Table 2-5: **Number of Houses in Thonburi, Chom Thonmg and Bang Khum Thian Districts**

Region / Year	1993	1994	1995	1996	1997
Thonburi	48,706	49,186	51,248	43,030	41,624
Chom Thonmg	44,737	46,283	47,867	48,560	49,658
Bang Khum Thian	47,600	55,160	61,075	64,799	70,023
Bangkok Region	1,472,621	1,562,110	1,661,311	1,703,128	1,810,530

Source: Metropolitan Government of Thailand

Table 2-6: **Population in Thonburi, Chom Thonmg and Bang Khum Thian Districts**

Region / Year	1993	1994	1995	1996	1997
Thonburi	220,892	215,778	208,061	203,369	198,377
Chom Thonmg	167,762	170,079	169,382	170,194	169,360
Bang Khum Thian	133,500	134,107	147,646	156,437	164,570
Bangkok Region	5,572,712	5,584,226	5,570,743	5,584,963	5,604,772

Source: Metropolitan Government of Thailand

(2.4.2) Technology Transfer

The objectives of this project include technology transfer, which was implemented in the process of constructing one of the longest suspension bridges in the world. There is a plan to build another suspension bridge over the Chao Phya River. This project contributed to technology transfer in terms of bridge construction through the consulting service.

(2.4.3) Social Impacts

Land acquisition and relocation of residents took place without any friction. This was, according to ETA, because of the following reasons.

- The people understood the importance of the project.
- The law gave enough authority to ETA to execute land acquisition efficiently.
- ETA paid higher compensation fees than other departments[4].

(2.4.4) Environmental Impacts

The level of vibration is within Thai standards. For the noise problem, ETA constructed a noise barrier along the expressway, reducing noise levels to the standards set by the government.

The results of air monitoring conducted near the project, as shown in Table 2-7, indicate data for various air pollutants along the Dao Kanong - Klong Toey Port expressway. The data show that the pollutants other than TSP (total suspended particle) are within the legal range. Although TSP continues to exceed the permitted maximum limit, the value in 1998 decreased from that in 1995.

Table 2-7: Data for various air pollutants along the Dao Kanong – Klong Toey Port section

Place	*Year*	*TSP* ($\mu g/m^3$)*		*SO_2 (mg/m^3)*		*Pb ($\mu g/m^3$)*		*THC** (ppm)*		*NO_2 (ppm)*	
			Average		*Average*		*Average*		*Average*		*Average*
Klong-Toey	***1991***	0.299-0.615	0.433	0.038-0.070	0.056	1.28-1.84	1.530	5.15-6.86	6.13	0.047-0.070	0.061
	1995	0.394-0.499	0.434	0.039-0.066	0.056	0.276-0.313	0.296	4.16-6.04	5.35	0.032-0.049	0.044
	1998	0.265-0.465	0.360	0.046-0.069	0.059	0.0935-0.2905	0.1684	5.46-10.38	6.89	0.050-0.058	0.045
Limit under national regulations		0.33		0.30		10.00		-		0.32	

Source: ETA

* TSP: total suspended particle

** THC: total hydrocarbon

2.5. Sustainability

(2.5.1) Human Resources

The Maintenance Department, which is supervised by the Deputy Governor for Construction and Maintenance, is responsible for maintenance work. The Bridge Maintenance Section of the Expressway Maintenance Division under the Maintenance Department is in charge of maintenance of the Rama IX Bridge. The Maintenance Department has 559 staff members, 188 of which belong to the Expressway Maintenance Division. According to ETA, the staff members of the departments are so young they do not have adequate skills, considering the responsibilities. ETA believes it needs to give workers more technical training in order to provide good maintenance service.

[4] This has allegedly raised the total acquisition cost that was out of ETA budget, but not funded by the JBIC loan.

The Traffic Control Department and the Toll Collection Department, which are supervised by the Deputy Governor for Operation, are responsible for operation of the bridge. The Traffic Control Department has 133 staff members and the Toll Collection Department has 201.

(2.5.2) Financial Condition

The projected cost of annual operation and maintenance for year 2001 and year 2002 are shown in Table 2-8. The maintenance cost, including purchasing cost of necessary equipment and machines, stay higher than 23 million baht per year for 2001 and 2002, estimated at the time of appraisal.

Table 2-8:Operation and maintenance cost for Dao Kanong - Klong Toey Port Section

(Unit: Baht)

	FY 2001	FY 2002
Inspection and maintenance, 2 lifts	240,000	240,000
Inspection, cable of bridge	7,000,000	8,800,000
Inspection, the behavior and movement of bridge	430,000	
Rehabilitation pavement at approaches of bridge	7,700,000	
Road Marking	530,000	1,860,000
Rehabilitation pavement of bridge	13,000,000	19,550,000
Inspection for Ten years of Bridge	15,000,000	14,800,000
Material for inspection and maintain bridge	1,500,000	
Computer	20,000	
Maintenance Gantry		700,000
Repair concrete work at joint		1,650,000
Repair Joint		750,000
Stochastic of Dynamic Behavior		500,000
Inspection cable of bridge		7,400,000
Maintenance inspection equipment		430,000
Total	45,420,000	56,680,000

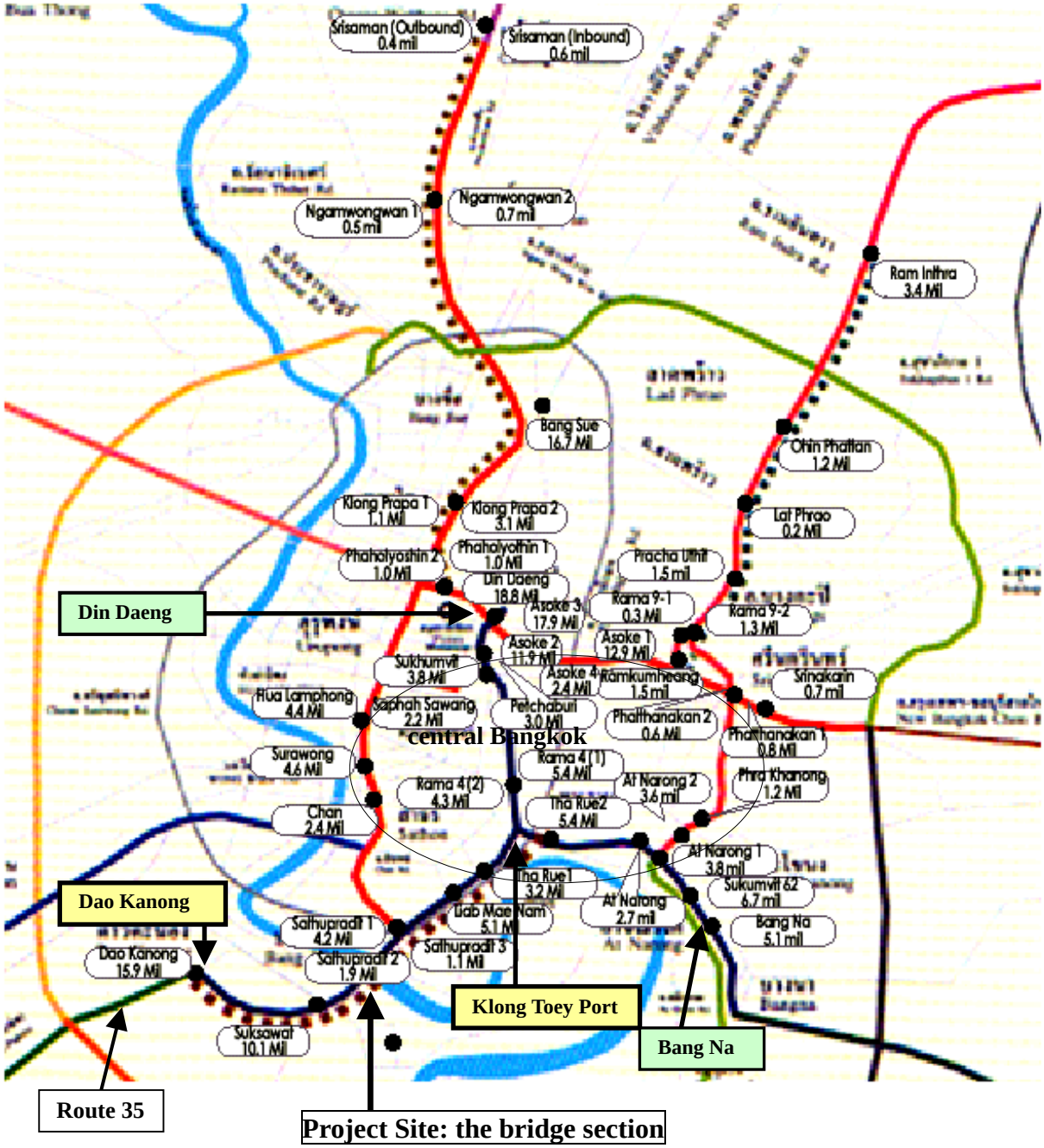
Source: ETA

At the time of the appraisal, even though ETA was running an annual operational deficit, it was thought that the completion of the network would turn around the institution's financial situation. However, the operational deficit was approximately 70 million baht in Fiscal Year 1998. The operational income decreased 5.8% and the operational expense increased 9.9% from the previous year. The financial situation of ETA as a whole has not improved as predicted.

However, the Dao Kanong - Klong Toey Port section (this project) has been performing very well. It is one of the most heavily used sections of the ETA's expressway system, considering that the annual traffic volume of its two ramps west of the bridge, Dao Kanong and Suksawat, both of which are among the busiest in Bangkok, was approximately 16 mil and 10 mil cars (in 2000)[5], respectively, as seen in Figure2-1.

[5] Most of them are expected to be cross-river traffic to and from central Bangkok.

Figure 2-1: The Volume of Annual Traffic by Ramps



Source: Statistical Report 2000, ETA

(2.5.3) Technical Sustainability

The bridge needs special equipment for maintenance. Since the bridge is so high from the ground, existing machines used for inspection and maintenance are insufficient.

There is also a problem regarding maintenance of the bridge's road surface. The pavement on the bridge deteriorates much faster than expected. According to an ETA officer, the abundance of over-weight trucks using the bridge and weathering by the wind, are considered to be among the causal factors. ETA has been trying to improve the situation by applying different paving materials to the road surface.

Comparison of Original and Actual Scope

Item	Plan	Actual
1. Project Scope		
(Cable-Stayed Bridge)		
A) Main span:	450m	450m
B) Number of towers:	2	2
C) Number of Lanes:	6	6
D) Types of cable:	Rocked coil cable	Rocked coil cable
E) Types of girder:	Box girder	Box girder
(Approach Bridges on Thonburi side)		
A) Length of approach spans:	13 approach spans at 50m	13 approach spans at 50m
B) Number of concrete piles:	777	777
C) Number of steel piles:	392	392
(Approach Bridges on Bangkok side)		
A) Length of approach spans:	13 approach spans at 50m	13 approach spans at 50m
B) Number of concrete piles:	746	746
C) Number of steel piles:	376	376
2. Implementation Schedule		
1) Cable-Stayed Bridge (Main Span)	Jan.1983-Dec.1986	Oct.1984-Dec.1987
2) Thonburi Approach Bridge	Jan.1983-Dec.1986	Oct.1984-Dec.1987
3) Bangkok Approach Bridge	Jan.1983-Dec.1986	Oct.1984-Dec.1987
4) Interchange	Jan.1984-Dec.1986	Apr.1985-Dec.1987
5) Toll and Surveillance Equipment	Jul.1985-Dec.1986	Aug.1986-Dec.1987
3. Project Cost		
Foreign Currency	29,370 mil yen	11,097 mil yen
Local Currency	1,891 mil baht	1,478 mil baht
Total	48,280 mil yen	20,618 mil yen *
ODA Loan Portion	25,900 mil yen	11,097 mil yen
Exchange Rate	1 baht = 10 yen	1 baht = 9.27 yen *

* An average exchange rate for 1982-85 is applied, just for reference, to calculate the actual total project cost.

Independent Evaluator's Opinion on "Dao Kanong-Klong Toey Port Expressway Project"

Yongyuth Chalamwong
Research Director, Thailand Development Research Institute Foundation

Relevance

The Project is part of the First Stage Expressway System in Bangkok recommended in the Transport Master Plan for Greater Bangkok Area submitted to Thai government in September 1975. The Government then established a State Enterprise known as the Expressway and Rapid Transit Authority of Thailand (ETA) to especially carry out and operate a star-shaped expressway system in Bangkok. The main aim of the Expressway System is to relieve traffic congestion in Central Bangkok. The Rama IX cable-stayed bridge project linking the inner city and the southwestern suburb of Bangkok is thus relevant and meet with the needs of the Thai government.

Effectiveness and Efficiency

In terms of schedule, the project had gone through various ups and downs. This is particularly true for the project tender and land acquisition processes. The slowdown, however, had positive windfall effect on the project. At the time the project was about to launch there was a slump in steel price. This helped cut back the Project cost by 43% as reported.

For traffic volume, there was no separate forecast for traffic using the Rama IX bridge per se. This was due to the fact that the project, although acquired various sources of funding, its feasibility study considered the whole 3rd link as one system. Therefore, the database available was not in the form readily to be used for the evaluation of the Rama IX bridge project alone. Table 2-3 regarding comparison of traffic volume on various bridge crossing the Chao Phya River should be adequate to see that the Rama IX bridge was fully utilized (based on the Highway Capacity Manual) for the inbound during AM peak and the outbound during PM peak. For the recalculation of EIRR of the project, given the fact that there was a series of change in toll fee, proper evaluation requires knowledge of price elasticity of demand to go with CPI in order to compute the consumer surplus benefits. Moreover, traffic composition and hence VOCs and time cost saving for each categories of traffic must be known prior to compute the associated values of benefits derived from each traffic categories.

Impact and Sustainability

The project, by its very nature, had apparently improved the accessibility of the Thonburi, Chom Thong, and Bang Khun Thian Districts. There were a positive impact to land owner due to price hike and to household consumer due to the availability of cheaper residence yet good accessibility to the CBD of Bangkok. Tables 2-5 and 2-6 shown the change in number of houses and population in the three districts over a period of 1993 to 1997. These Tables should be used with caution that there was a natural rate of growth for both housing and population in each district regardless of the impact rendered by the Rama IX bridge project.

Regarding technology transfer, the construction phase was an exciting experience to Thai engineers. Much attention had been paid on the design, wind tunnel testing and the mounting of bridge superstructure as well as pylons and cabling process. The more important technology transfer and vital one are the maintenance technologies. This is essential to keep the bridge operation save and smooth. Japanese experts supported by JICA in this respect were excellent resources for Thai engineers working for ETA. The system of good bridge maintenance program was established in collaboration with the Japanese experts in the form of on-the-job training. This helped to ensure the technical sustainability of the project.

Lessons Learned

The project could be considered as successful implementation if there was not a problem of pavement failure on the bridge deck. The construction of pavement is relatively a minor matter compared with that of the long span cable-stayed bridge. This could be one of the reasons that the pavement design did not command good attention. The overloading trucks and high temperature on the steel deck were two main factors specific to the site and could create pavement failure if they were not properly accountable for. The failure of pavement on the bridge could in the long run create problem to the structure via the traffic-induced undesired vibration.