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Second Stage Expressway System in Bangko:

Deuxième phase du système de voies express à Bangkok

Zweite Ausbaustufe von Bangkoks Expressstrassennetz

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SUMMARY

Second Stage Expressway System in Bangkok (SES) is one of the most outstanding projects in the urban transportation system. The project has studied and planned, for more than two decades, the master plan has been implemented for the first stage and now for the second stage, while the third and fourth stages are in the process of design and study, respectively. Project development of the SES in cooperation with the management to privatization at a great success will be introduced. Project execution has carefully been pursued to obtain the most reliable project of effective productivity, high quality and accurate performance. The structural systems of segmental box girder and U-beam section will be presented with their appropriate construction techniques. The operation system for the SES will also be discussed concerning toll collection, revenue, traffic regulation, inspection, repair and maintenance.

RÉSUMÉ

La deuxième phase du système de voies express à Bangkok (SES) est l'un des plus remarquables projets dans le domaine des transports urbains. Cette réalisation a été étudiée et planifiée durant plus de deux décennies; elle comporte le projet principal ayant déjà été exécuté au cours de la première étape, puis la seconde étape actuelle, enfin les troisième et quatrième phases qui sont en cours d'étude. L'article présente le développment du projet de la deuxième phase du SES avec le concours d'une gestion privatisée de grande ampleur. L'exécution de ce projet a été poursuivie avec soin, en vue d'obtenir un ouvrage à fiabilité maximale, de haute qualité et offrant les performances ciblées. En outre, cet article expose les systèmes structuraux comportant les poutres-caissons en segments et les poutres à section en U, ainsi que les techniques de construction adéquates. Il analyse l'ensemble opérationnel du système de voie express SES, quant à la perception des droits de péage, la régulation du trafic, les inspections de contrôle, les réparations et l'entretien.

ZUSAMMENFASSUNG

Der Ausbau von Bangkoks Expressstrassennetz ist ein sehr ambitiöses Vorhaben, dessen Projektierung bereits über zwei Jahrzehnte währt. Zur Zeit wird die zweite Stufe des Masterplans umgesetzt, die dritte und vierte sind in Projektierung bzw. Studienphase. Mit grossem Erfolg wird die Privatisierung des Projekts vorangetrieben, wobei Landerwerb, Vergabe, Managementauswahl und Finanzierung besonderen Anforderungen hinsichtlich Effizienz, Qualität und Zielerfüllung unterlagen. Als Tragsystem wurden segmentierte Hohlkästen und U-Querschnitte gewählt. Der Beitrag bespricht auch das Betriebssystem hinsichtlich Strassenbenützungsgebühr und Amortisation, Verkehrsregelung, Inspektion und Unterhaltung.

1. INTRODUCTION

Bangkok is a wellknown beautiful city in the East, it is named as Vanice of Asia since water transportation had been used for long period in the past. But now Bangkok becomes a big city of the most serious traffic congestion. Bangkok has developed to so much in the last two decade, canels had been converted to road ways or drainage system instead of serving transportation system as usual. The population in Bangkok now is about 5 million in the metropolis or 8 million in the Greater Bangkok Area (GBA) including surrounding suburban. The population as expected to grow and may become 10 million within a decade.

Traffic congestion in the metropolis are very serious and become one of the nation critical problem. Vehicle speed on various main road are lower than 10 kilometer per hour in the rush hour and the people are suffered from travelling times in the city. The major cause may consider from poor town planning, too many vehicle on the road, and lack of efficient public transportation.

In solving the traffic problem, various means have been introduced such as expressway system, mass transit system, eleveted highway, improvement of train services, and implement of water transportation. The Second Stage Expressway System (SES) is a continuation project of the First Stage Expressway System (FES) with an approximate 40 kilometer has been estabished and implemented to link with the FES at Makhasan, central interchange. Total cost of the project will be Baht 27.5 billion (US $ 1.10 million) within 5 years of construction. The first phase of 27 kilometers is supposed to open for traffic in March 1992.

This paper will present development of the project, project execution, operation and maintenance of the whole system. The Structural system for the expressway, and construction techniques will also be introduced as the most effective planning and scheduling to accommodate the execution period of 6 years including land acquisition, design, and construction.

2. PROJECT DEVELOPMENT

The study on long term improvement of Bangkok transportation system had been conducted between 1971-1975 by expert team arranged under bilateral assistance from Repubic of Germany. In accordance with such report, the Expressway and Mass Transit Authority (ETA) has been established since 1972 to responsible for implementation the long term project. The First Stage Expressway System (FES) had started by then and opened for operation since 1982. of first phase and followed by the success of a longest single plane cable stayed bridge in 1987 of the second phase. The Master plan of multi-projects for solving traffic congestion in Grater Bangkok have been summeried in Fig 1 including rapid transit project, and expressway systems; stage 1, 2 and 3, respectively.

The Second Stage Expressway System (SES) had been joinly studied by Japanese International Cooperation Agency (JICA) and ETA to recommend the route as shown in Fig 2, consists of two routes North-South from Chang Wattana to Bangklo (25 km) and East West route from Makkasan to Srinakarin Road (13.5 km). In detail design, East route of 2 km along San Saeb Canal had been included for purpose of combining and dispursing the traffic.

The development of SES will improve the traffic congestion in the Greater Bangkok Area (GBA), especially in the central Bangkok Metropolis as a result of a network formed between the SES and the FES. The new expressway to the North and East will help ease the traffic density in the city center. Travel time can be saved by 20% of normal travelling period and travelling speed can be increased by 24% so it will result in the reduction of traffic expense by Baht 14.0 million (US$ 0.70 million) per day. The SES will encourage commercial and residential development along its route. This will have the additinal benefit of spreading economic development through-out the Greater Bangkok Area. Better roads and reduce traffic congestion has improved psychologically effect on motorist which can not be measured in term of money.

The feasibility study of the SES was also considered by the office of the National Environment Board and the subcommittee controlling and co-ordinating the project relating to the serveys, designs and studies of the environmental impact. The subcommittee are considered representatives of various concerned offices.

3. PROJECT PRIVATIZATION

The cabinet passed a resolution for the ETA to consider a private investment in the SES project by mean of the grant a concession to the private sector to build and manage the project in accordance with conditions and procedures prescribed by the ETA.

The project privatization is a joint success between the government and the private sector for the development of the country. The investment value of the SES makes it the world's second largest public utilities concession project. This project is aimed at the spread and coordination of profit, rather than at a party's benefit or loss. The Bangkok Expressway Company Limited (BECL) has been awarded in this SES project with the term and conditions of the concessions as follows:

The investor must have a registered capital of approximately 20 percent of the project value which must not be less than Baht 1,800 Million Baht (US.$ 702 million).

BECL will bear the total costs of the construction and accessories and the investment risks without the goverment's guarantee to any loans.

The expressway must be constructed according to the required standards of the ETA and the construction must commence by 1990 and be completed by 1995 in respect of the first stage covering 39 kilometers.

BECL will refund the cost of land acquisition arrangement with interest at total of Baht 16,815 million (US.$ 673 million) in the last 15 years.

The toll rate for the urban and the suburban area must be Bath 30 (US.$1.20) and Bath 15 (US.$0.60), respectively with the discount of Bath 5 (US.$0.20) for the use of a combined area. The rates must be adjusted in accordance with the inflation rate at every 5 year

The toll revenue collected in the urban area will be shared between the ETA and BECL at the rate of 40/60, 50/50 and 60/40 in respect of the first, second, and third nine year periods, respectively.

The Expressway system and its accessories will belong to the ETA after the expiration of the 30 year period.

4. PROJECT EXECUTION

ETA put all of its effort to achieve the success of projects under its responsibility. The increasing number of the FES users has shown the demand and favor of using the expressway. Besides ETA successfully invited private sectors to invest in the SES and the Mass Transit System, of which a huge sum of investment is needed, so the implementation of project on privatization basis has lessened the financial burden of the government. In addition, ETA has also implement the Third Stage and the Fourth Stage Expressway System Project and the Ekamai-Ramindra Project to cope with the ever increasing traffic volume.

The Bangkok Expressway Co.,Ltd. (BECL) as awarded by the government, through the ETA for a 30 year contract to build and operate the SES has proposed the management team as shown in Fig. 3; comprising project manager, contractors under the supervision of ETA'S engineers; independent design checker and independent certification engineer. The construction of the 39 kilometers expressway is scheduled to commence on the March 1, 1990 (Fig. 4), with an estimated amount of investment of Bath 25,000 million (US.$ 1,000 million)

The financial package of the SES project is recognized as an outstanding example of innovation and co-operation between local and forign financial institutions. Shareholder of BECL authorized an increase in capital up to Bath 5,500 million (US $ 220 million) with an initial capital as already been registered. Onshore credit facilities with a syndicate of 11 major local banks are structured to provide loan, garantee, note, aval and acceptance financing of up to Baht 22,000 million (US $ 880 million). The on-shore credit facilities are

further supported by an off-shore credit facility which was executed between 30 major international banks to provide gaurantees to barrowings of an amount up to the lower of US.$ 275 million.

Land acquisition to construct the SES has been carried out by ETA. The land and the building to be expropriated for the construction at total of 5,567 plots of land and 8,476 buildings. The Royal Decree issued in 1987 has been enforced so that ETA can gradually commence to appropriate the immovable property located in the right of way. A committee responsible for the initial price of immovable property, will consider the compasation under the criteria as

Land based on the higher appraised value will be in accordance with the cost of land as listed on the dated of enforcement of the Royal Decree

Building indemnity payment for buildings consists of removing cost, labor cost for reconstruction, design fee, and other compensation costs.

5. STRUCTURAL SYSTEM

The structural design of the SES uses the latest internationally proven technology and is intended to facilitate construction work with the minimum of discruption to traffic flow and the surrounding areas. A combination of segmental box and U-beam construction will be used. Both methods employ precast concrete components to create road deck, allowing precise quality control and as the components are cast off site, this again helps to minimize disruption to the traffic.

5.1 Substructures

Since soil condition in various parts of Bangkok are somehow difference from one places to the others, and due to soft soil condition then long piles of various length are used in this project. The average length of 40.00 meters are constructed by bored piles technique, except the location of pilecaps on swamp are where precast driven piles are used instead. Pile-caps are cast on pile groups with a typical of 5 piles per peir. The peirs are box section with an average height of 10.00 meters and the caps are designed to accommodate the differential settlement of 50 mm. Structural portions of ramps or transition zones between ground and elevated section, the structures are designed and constructed by precast piles of diffrent lengths, flat plate mate, retaining structures and back-fill to support the pavement. The structures will accommodate long term differential settlement and will obtain smooth ride.

5.2 Segmental Box

A single box girder is designed to accommodate 3 lanes traffic. The system consist of 14 segments per span, are assembled span by span and then stressing by dry joint external post-tensioned system as shown in Fig 5. Reinforced concrete continuous deck will joint each span together with special details to obtain smooth connection as which the expansion joint will be provided at every four spans. Fix and slide bearing units are used for each span to accommodate diffrential settlement, thermal elongation, creep, strinkage and prestressing losses.

5.3 U-Beam

Only some section of the project that required multi-box girder due to some limitation of site congestion and peir location. The cross section as shown in Fig. 6 will be precast member of a U-shape. Top deck is cast in-situ to complete the whole section with provision of shear connectors at the interface between web of U-beam and the top deck. Ends of each span will link together as a diaphram action for lateral stability and as for a continuous deck between span to obtain smooth connection. The span length of U-beam varies from 22.00 meter to 35.00 meter depends on the geometric configuration and peir location. The expansion joint will also be provided at every 4-6 consecutive spans in the same manner as the segmental box.

6. CONSTRUCTION

The SES currently under construction carried out by the Bangkok Expressway Company limited (BECL). The BECL in turn appointed Kumagai Gumi Company Limited as a Project Manager and five construction companies group have been awarded the six civil works contracts for the first phase. These include contracts for the substructure work at ground level, including construction of the main supporting columns for the elevated roadway and for the superstructure work, to erect and finish the road deck. The construction of the first phase currently underway includes the North-South route from Changwatana to Phayathai and the East-West route form Phayathai to Rama IX. It is due to be completed and fully operational during 1993. The second phase which is in the process of land acquisition will see the start of construction in 1992. It comprises 12 kilometer North-South connection between Phayathai to Bangklo at the Cable Stayed Bridge and East-West from Urupong to Rachadamri. This will be completed in 1995.

The construction techniques for segmental decks with total length of 20 kilometers, the box girder segments have been prefabricated at the world largest precast yard in Bang Pa-in, 60 kilometer away from Bangkok, are loaded onto the several vehicles of the groups fleet to deliver at the construction site where peirs are ready for erection. Luanching gantries with total length of 96 meter are used to support and erect the segments prior to post-tensioning of external prestressing. Bearing units as elastomeric pad are installed after stressing and then top decks are simultaneously cast to meet the requirement as well as the parapet.

The construction of the expressway on North-South route along water supply canel, with some difficulties including narrow work spaces, time restriction, heavy traffic and noise problem with neighbourhood, then U-beam construction are used for this portion. The U-beams of average span length 30.00 meter and weight of 80 ton are cast in the precast yard at distance about 4 kilometers from the site, they are carried on a special transporter, to the site and then are hoisted from the transporter using 58 meters launching gantry which following the completion of each span as self-driven to the next section. Once U-beam installation is completed, reinforced concrete slab which make up the actual road deck are cast over precast formwork. The parapet wall then are constructed ulilising travelling formwork systems to complete the whole roadway section.

7. OPERATION AND MAINTENANCE

The FES and SES will be operated adopting the flat tariff and on-ramp toll collection system. The location of the on and off ramp have been determined as shown in Fig 7. Toll gate structures, refuge island, toll booths, toll buildings and equipment installation are included in the cost.

Expressway lighting and other electrical system will be provided on throughway, interchange, rampways, at grade intersection, toll plaza, and toll buildings. Subsystem such as closed circuit TV system, sign, control system and emergency power unit will be istalled and operated in the regular basis.

The operation system will be controlled by the ETA under the management of the BECL. For the structures and operating equipments will be subjected to general inspection on routine basis, daily, monthly or anually. According to this inspection, conditions of structures are evaluated and classified for the maintenance. Some items may be subjected to a detailed or special inspection and then repair or retrofitting may required as necessity. The ETA is forming a specific program to solve some problems of the traffic at the interface between the expressway system and the local roads of GBA, so that the stable transit system in the SES and traffic congestion will be relieved.

8. CONCLUSION

The Second Staye Expressway System in Bangkok has been well studied, planned and developed considering various aspects such as traffic valume, travel time, financial effects, social factor and environment impact. The concept of project privatization in co-operative between the government and private sector to reduce burden of investment, minimize construction duration and obtain excellent management. The structural system related to the construction techniques as employed in this project has proved to most the efficient and advanced technology to achieve high quality structures of better performance and to sastisfy the project objectives in reduce traffic congestion in Bangkok at remarkable saves on travelling times and reduction of traffic expense.

9. REFERENCE

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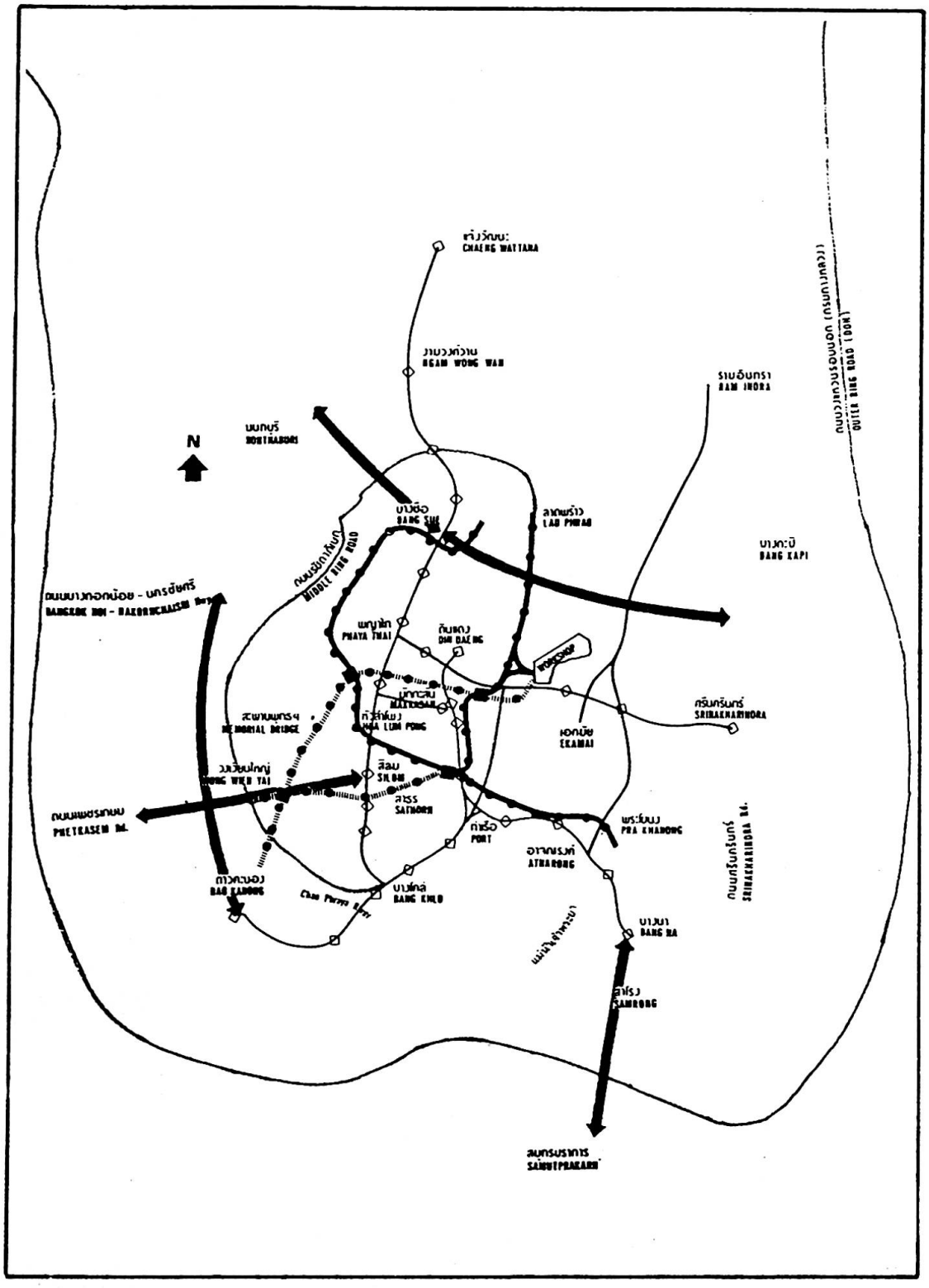

Fig.1 Expressway and Mass Transit System in Bangkok

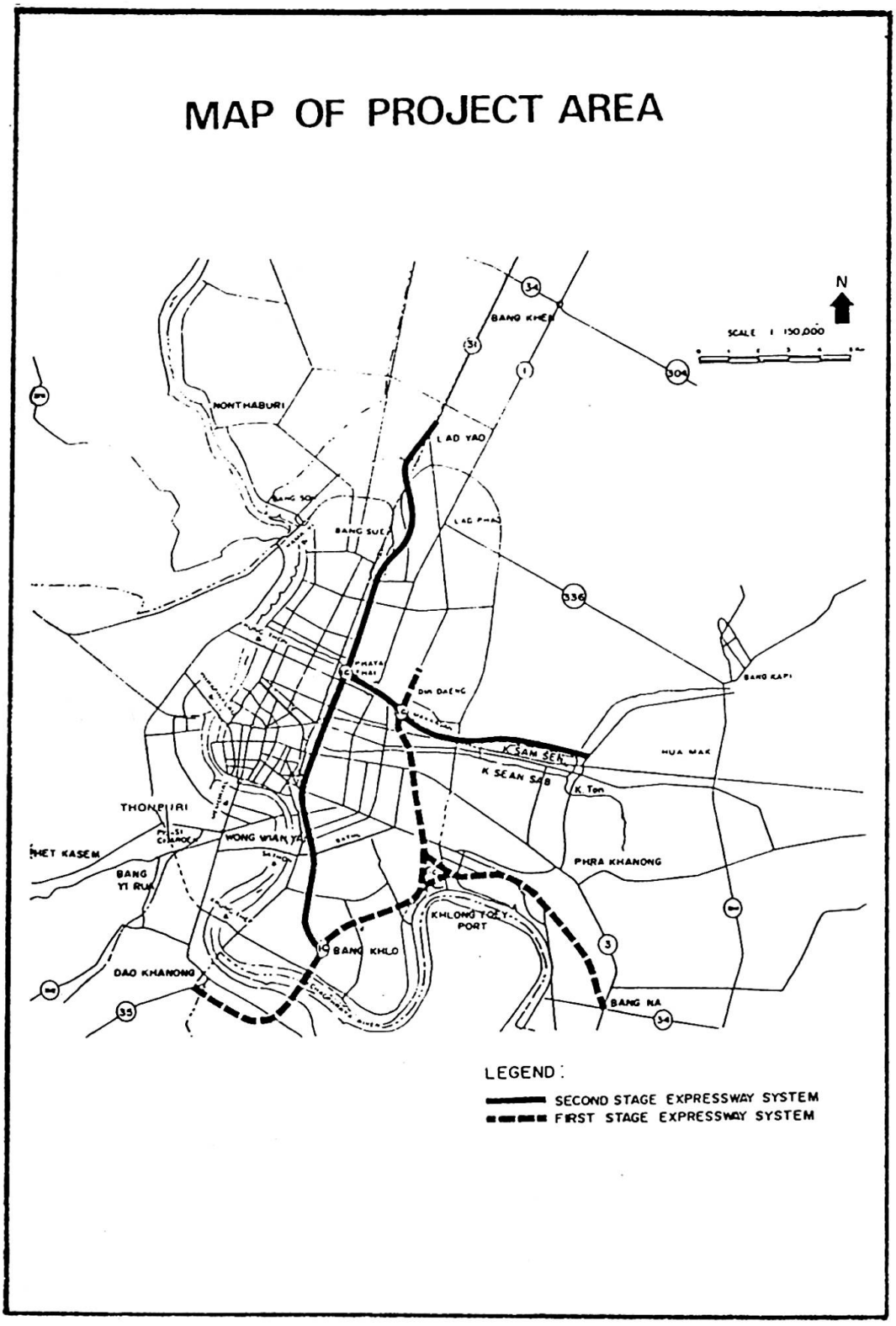

Fig.2 The Second Stage Expressway (SES)

MANAGEMENT TEAM

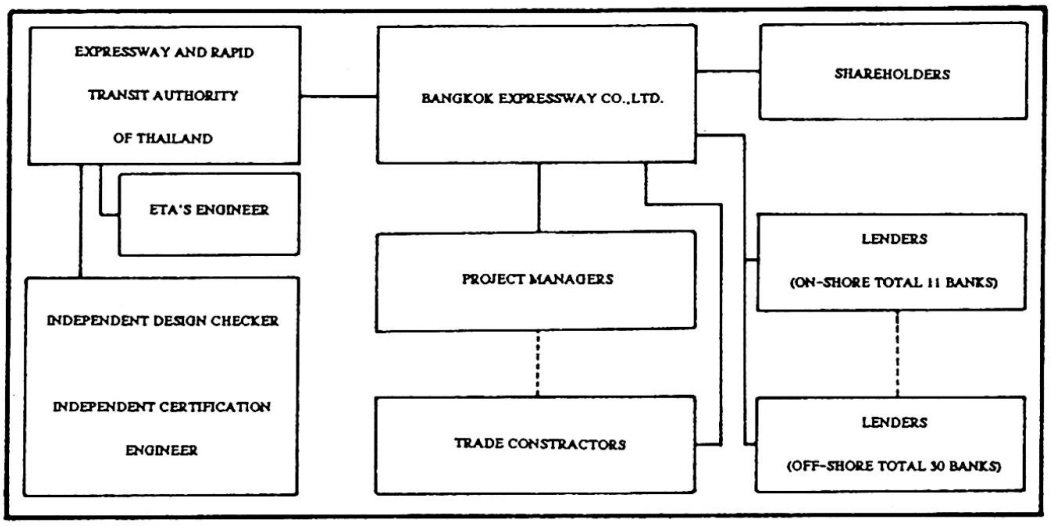

Fig.3 SES Management Team

MASTER PROGRAMME

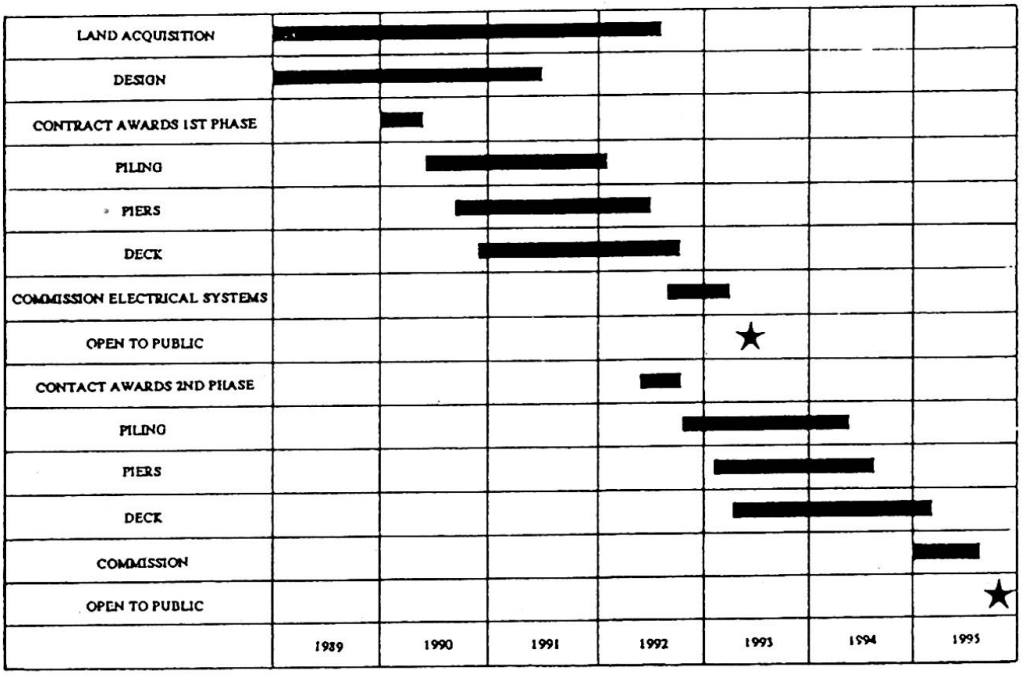

Fig.4 Master Schedule for the SES

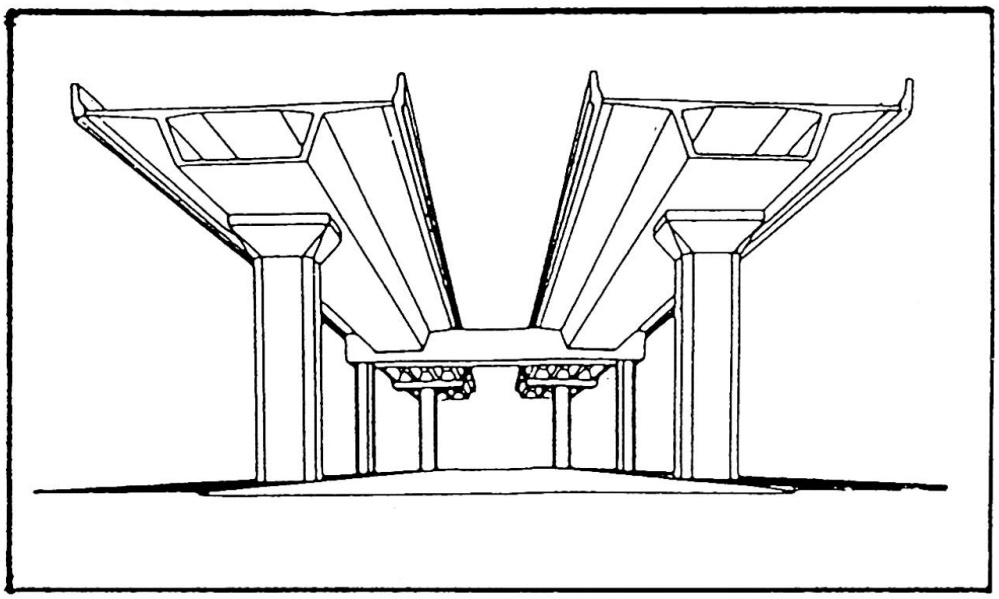

Fig.5 Segmental Box Girder

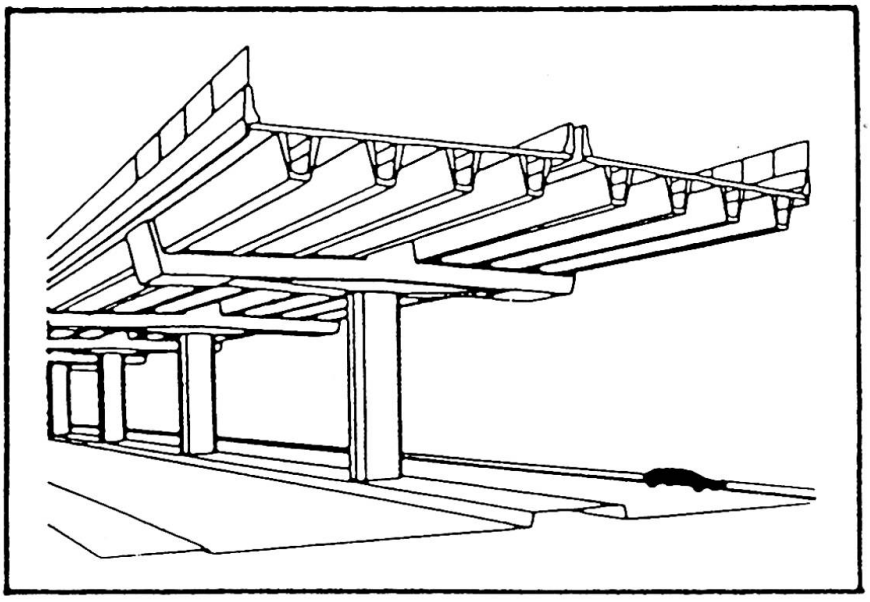

Fig.6 U-Beam Section

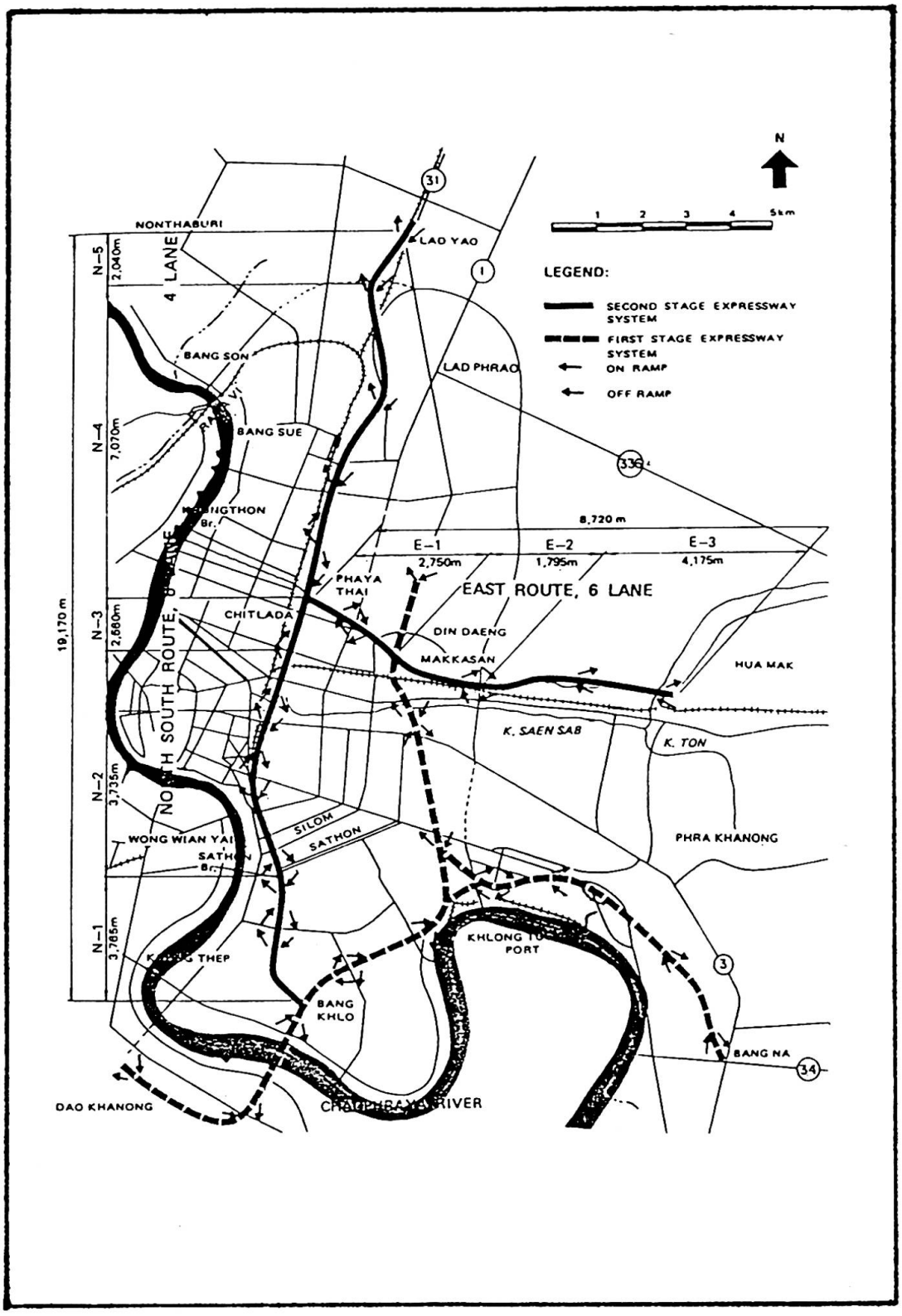

Fig.7 Ramps and Toll-Booth Locations

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