JSCE Study Tour Grant 2000
Study Tour Report
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1.0 INTRODUCTION

In February 2000, I was invited as a representative of the Institution of Engineers, Singapore to visit Japan on a Study Tour Grant provided by the Japan Society of Civil Engineers (JSCE).

The visit took place between 25 September 2000 to 3 October 2000 and centred mainly in Tokyo and Yokohama cities.

This report details the interesting sites and technologically advanced know-how experienced along the way. For ease of writing, a chronological format was adopted.

I am a practicing Civil & Structural Engineering Professional Engineer, Principal Partner of LBW Consultants. It is indeed a great honour to be chosen as this year's recipient of the Study Tour Grant. It is with great excitement and enthusiasm that I look forward to the Japan visit.

2.0 STUDY TOUR

I was asked to name the places I would like to visit and any pertinent engineering practices in Japan which I wish to discuss. As this is my first visit to Japan, the lists include a wide spectrum of the engineering construction industries from planning to design and to construction.

The final agenda, granted by JSCE included Government agencies, engineering design firms, construction companies, research institutes and various construction sites.

The agenda was indeed comprehensive for the limited time I had in Japan (See Appendix).

3.0 JAPAN SOCIETY OF CIVIL ENGINEERS (JSCE)
25 SEPTEMBER 2000

The Study Tour began with a trip to the office of JSCE at Shinjuku, Tokyo. I was met by Mr. Itsuji Miyoshi, Executive Director, and Mr. Masashi Matsuo. The society was founded in 1914 and member strength grew from 43 to more than 40,000 today. It's main objective was "to contribute to academic culture through the promotion of civil engineering and development of civil engineering services". JSCE has expended great efforts to provide opportunities for exchanges among the members, promoting activities related to civil engineering where both academic, government and private sectors can exchange ideas and technologies to help build and maintain Japan's infrastructure.

The organisation of JSCE includes a Civil Engineering Library and eleven divisions. The organisation chart shown gives a brief detail of the set-up. The main activities of JSCE include :

Ⅰ. Providing Information through Bulletin

a. JSCE Bulletin, Journal of the Japan Society of Civil Engineers
   This is published monthly since its founding.
b. JSCE Theses
   A report of theses submitted by its members.
c. Civil Engineering, JSCE
   Published annually to provide information on civil engineering in Japan to related organisations abroad.
d. JSCE, International News
   Published periodically to cater to cosmopolitan readers abroad.

II. Opportunities for Academic Exchange:

a. Annual Conference
   This is held annually to conduct general businesses of the society and also to allow civil engineers throughout Japan to share ideas and new technologies during the lecture sessions.

b. Annual Symposiums

This is organised annually where critical issues involving the industry are discussed and debated.

There are 30 committees on Studies and Researches from which 300 sub-committees are organised to study and conduct researches on various engineering issues.

III. Promotion of Civil Engineering

Workshops, seminars, field tours and film showings are organised to promote the study of civil engineering. The JSCE Civil Engineering Library stores approximately 30,000 publications and a number of films related to civil engineering. The library is not only open to members but also to the general public.

IV. Evaluating and Awarding Academic and Technical Efforts

One of the duties of JSCE is to give impartial and objective evaluation of contributions made to the industry. The annual awards given include the Achievement Award, Technical Award, Publication Award and International Contribution Award.

V. Building and Maintaining Social Infrastructure

JSCE co-operates with public institutions to build and maintain social infrastructure through dialogues where objective opinions are voiced. JSCE provides solutions by conducting research and studies through its committees.

VI. Academic Exchange

JSCE has been active in promoting exchange programs with other organisations both within and outside Japan. These include inviting experts from abroad for lectures and debate sessions and the exchange of information and co-operation with societies abroad. Tours to observe and study projects locally and abroad have been organised to give members the opportunity to expand their knowledge.

VII. Public Relations

To promote the understanding and knowledge of Civil Engineering among the general public, JSCE has held civil engineering courses and field tours. To encourage the younger generation to pursue civil engineering as a career, November 18th is designated as 'The Civil Engineering Day' and the following 6 days dubbed as 'The Week To Think About Livelihood And Civil Engineering'.

JSCE's members comprise of :

Regular Members	-	34,216
Student Members	-	6,127
Corporate Members and Fellow Members	-	1,200

Main bulk of the Regular Members is either working with the Contractors (30.5%) or the Consultants (23.8%). Private organisations make up 66.6% while Government offices 21.7%.

4.0 KUMAGAI GUMI CO., LTD.

The first private organisation visited was Kumagai Gumi Co.,Ltd. At the office in Shinjuku, I met Mr. Watanabe, Mr. Kozo Katayama, Mr. Koji Takehisa and Mr. Toru Fujita. I was informed that at present, Design and Build projects are popular in the private sector in Japan. Government projects are still based on conventional design-bid-build. It is interesting to note the project may not necessarily be awarded to the lowest tenderer (more elaboration in item 10). The close relationship between the client and contractors is built on trust, satisfaction of product and on-time delivery.

Kumagai Gumi Co., Ltd like many established contractors in Japan is a multi-disciplinary firm with Architects, Civil and Structural Engineers, Mechanical and Electrical Engineers and Quantity Surveyors in their employment.

The first site visited was the Shield Tunnels at the Rinkai Railway construction site. The two number of parallel tunnels, one above the other were bored using shield tunneling machines operating simultaneously. Each machine is 7 metres in diameter and approximately 10 metres long. The machines are able to accommodate sharp curves required in the design. We walked through the completed tunnel and was struck by the cleanliness and efficient

co-ordination of work. The tunnel segments were fabricated offsite and brought to site for assembly. It took 7 months to complete the present tunnel, a speed of approximately 200 metres per month.

5.0 PORT AND HARBOURS RESEARCH INSTITUTE (PHRI) -MINISTRY OF TRANSPORT-

In the morning of my second visit, we travelled to Yokosuka, the office of the PHRI. I was met by Mr. Hisao Ohuchi, the Deputy Director-General. We had discussions on the recent developments in the Ministry. The Overseas Coastal Development Institute was set up by PHRI on a land of 6 to 7 hectares in area. Research are carried out mainly on concerns in Japan but results are also used by JICA which does research in other countries.

PHRI have developed 3 main standards. All port, harbour and airport facilities are designed in accordance to these standards. The English version of the Technical Standards is targeted to be published in December 2000. The present interest is to internationalise the Japanese Standards. The other point of interest is the introduction of performance-based design, where the design methods will consider the probability or risk of failure, reliability factor and partial safety factor. By using reliability-based design, it is possible to reduce the number of structures which are excessively safe or dangerous. This will result in reducing the average construction cost while ensuring a reasonably low failure probability.

PHRI has presently a total of 195 staff of which 133 are researchers. It was established as a testing research agency of the Ministry of Transport. It began as a Harbour Laboratory in 1946 which gradually grew and reorganised into 10 divisions :

- General Affairs Division
- Administration Planning Division
- Director of Special Research
- Hydraulic Engineering Research
- Marine Environment Division
- Geotechnical Engineering Division
- Structural Engineering Division
- Planning and Design Standard Division
- Machinery Division
- Information Processing Centre

At the Structural Mechanics Laboratory, we witnessed the testing of a beam constructed

using fire-ash. It has a high compressive strength of approximate 80 N/mm2 but with a relatively low tensile strength.

At the Environment Testing Facility is a wave generator laboratory equipped with 5 sea-wave generators in 2 modeling basics. The generators are capable of generating multi-directional irregular waves.

Next, we visited the Inter Tidal Flat Experimental facility which was started in 1995 to conduct research studies on natural shallow water ecosystems and the impact of coastal development on water quality, sediment characteristics and the living organisms. At present, the tidal Flat ecosystems have been reproduced in 3 experimental pools in which different physical and chemical conditions are being studied. The results will eventually be used as guidelines for the restoration and creation of tidal flats. The pools were created using natural tidal flats and dried for 2 weeks to kill the organisms. The seawater is obtained is created with wave generators while the other 2 pools have only current generators. The experiments began 6 years ago and the results have been promising, with moving plants and organisms developed in the tidal pool.

The large Hydro-geotechnic cronics of dimensions 184 (L) x 3.5 (W) x 8 – 11 metres high is the largest flume in the world. It has a sand bed basin with a large wave generator capable of generating waves of upto 3.5 m in height and a current generator with speeds of maximum 2 m/s. This flume enables the study of the stability of seabed against wave and current forces. At the base of the flume are 240 perforated pipes through which fresh air is pumped to model liquefied sand bed. Studies have shown that the weight, height or energy can be reduced by liquefied sand bed, from a ware height of 1.5 metres to 10 or 20 cm.

6.0 OBAYASHI CORPORATION

My third visit was to one of Japan's most established contractor, Obayashi Corporation's head office at Shinagawa Intercity Tower B. I was met by Mr. Hideki Kawamura and Ms. Shoko Sato. The Shinagawa Intercity is a new major development in Tokyo, selected as the new urban case in the 21st century. The office is an impressive 31 storey central tower of the complex. The use of architecture and art display feature strongly in all areas of the building, including the floors, walls, ceilings, furniture, lighting, painting and sculpture. All of these create an innovative, pleasure and exciting office environment.

Obayashi Corporation also has a large Design Department consists of Architects, Engineers and Planners. They have the capability of offering design and build. Even for conventional design-bid-build projects, their in-house engineers and architects normally carry out another round of checking on Consultant's design. I was told that in Japan, the owners

normally hold contractors responsible for both design adequacy and workmanship as contractors have stronger financial muscles.

Under construction just in front of the office, on the East Side of existing Shinagawa Railing Station is a development of 7 office buildings which will have the head offices of major corporations. Obayashi is constructing the Canon Building on this site. The building is 28 storey high with 4 basements. The lowest basement is 21m below ground and excavation of the basements are currently in progress. The entire basement is retained using the SMW system, a system of sheet piles with ground anchors. The superstructure is of steel construction to reduce overall building weight.

The second site visited was the Morunochi Building located at the centre of the Morunochi area, one of the few main business centres in the world. The new 37 storey building, 2 storey penthouse and 4 basements is sited on the former Morunochi Building built in 1923. The site is located between the Tokyo Station and the Imperial Palace. The building is 178 metres high with a basement of 27.8 metres below ground. The superstructure is constructed of steel frames while the substructure is of steel framed surfaced concrete. The top-down construction method was adopted with the first storey as a working platform. A 700 to 800 mm diaphragm wall is used as a temporary retaining wall for the construction of the permanent 400 thick basement wall. No significant displacement of the wall is allowed due to the proximity of major buildings. A new earthquake (shaking) control system is adopted in this project. Located at 4 corners of the tower, each system consists of a central column with 4 corner columns connected to steel beams, using pinned connection. Damper in the form of thin steel sheet placed in the vertical and horizontal planes absorb the acceleration energy of earthquakes. This system is incorporated on every storey starting from the first storey. The rest of the columns are fixed to the structure at first storey. Construction of the superstructure was well underway. The first impression was a remarkable and efficient work site with a relatively small workforce.

7.0 ORIENTAL CONSULTANTS CO. LTD

My fourth visit is to Oriental Consultants Co. Ltd., a civil consulting engineering firm, located in Shibuya, Tokyo. I was met by Mr. Akihiko Hirotani, Mr. Tadao Ohno, Mr. Jiro Kajima, Mr. Mosotada Tokahasi and Mr. Masotaka Fujikuma. The company was founded in 1937, providing engineering consultancy services such as surveys, research, planning, feasibility studies, conceptual and detailed design, and supervision of construction and overall project management. It presently employs 644 full time staff of which 483 are professional engineering personnel, including more than 120 registered consulting engineers. The

company's strength and reputation are in planning, design and construction of bridges, roads, highways, tunnels, parks, recreation facilities, coastal development and traffic engineering.

I was also given a brief introduction to the procedure of obtaining registration as a Professional Engineer in Japan. There are about 300,000 civil engineers in Japan, working in both the public and private sectors, of which less than 40,000 are Registered Engineers or Giyutushi. To be qualified as a Registered Engineer, all applicants require seven or more years of working experience in professional practice, or four or more years working experience under the supervision of a Registered Engineer as a registered associate engineer, pass a written and an oral examination.

The Giyutushi Act, which come into force in 1957, regulates the qualification and is controlled by the Japanese Science and Technology Agency (JSTA). There are altogether 19 engineering fields in which qualified engineers can register. The Japan Consulting Engineers Association, JCEA, a non-governmental institution was commissioned by JSTA to manage examinations and registration of professional engineers. Examinations are conducted once a year and the final examinations are tough with a success rate of only 15%.

The current concern is to establish a new accreditation system for engineering education and engineering qualification system so that Japanese Engineers are mobile to compete and practice globally.

I was told that in Japan, the consultants quote their consultant fee based on the estimated number of houses at a fixed rate given by Government, and then multiply by a multiplying factor (2.4 is commonly used).

I was also told that in Japan, the supervision of construction works are left to the contractors with periodic inspection by Inspector Engineers accredited by the Government.

In the afternoon, I was given a tour of the Tokyo Wan Aqua-line, a 15 km toll highway that runs across the central portion of Tokyo Bay from Kisarazu in the east to Kawasaki in the West. The completion of this highway has greatly reduced the driving distance from the densely populated Keihin and the Boso area. In Kisaruzu, the start of the Aqua-line is 4.4 km long bridge at the end of which is the Umihotaru (Marine Fire Fly), a man-made island built for transition between the bridge and the 9.5 km long tunnel. This rest area has parking facilities for 480 vehicles with restaurants, shops and amusement facilities. It is a popular leisure place during the holidays. The undersea twin tunnels of 13.9 meters in diameter were bored simultaneously using shield machines from both ends, meeting in the middle. The deepest section is 60 metres below the sea. In the middle of the tunnel, a ventilation tower built on a man-made island, called the Kazenotou (Towers of Wind), the structure is modeled like the sails of a ship. At the end of the tunnels on the Kawasaki side, is a visually eye-catching pyramid-shaped ventilation station called the Ukishirma Ventilation Station.

We also make a visit to the Tamagawa Centre Facilities Control Station which monitor and control the various facilities on the Bay-Shore Route Karagawa Area. The station adopts highly advanced real-time monitoring system and tunnel disaster prevention equipment are in place to detect disaster like fire. In the event of a fire, sensors send alarms to the control station which will oversee the evacuation and extinguishing of fires. Located within the same building is the ventilation station, where ventilators are automatically controlled according to real-time monitoring of tunnel conditions. In the event of a fire, the ventilators perform a smoke exhaust function, assisting the evacuation of those in the tunnel.

8.0 KAJIMA TECHNICAL RESEARCH INSTITUTE (KaTRI)

My fifth day was a visit to the KaTRI at Tobitokyu Complex. The institute was established in 1949, the country's first research institute then. The KaTRI is the core of Kajima Corporations research and development establishment. Besides providing solutions for problem encountered on site, the Institute also conduct cooperative research and development activities with local and foreign companies, universities, etc. It also carry out independent research into developing new technologies materials and advanced construction methods.

The institute presently employs 300 personnel at its over 16 laboratories with fields of study in dam construction technology, large underground storage tanks for liquefied natural gas, earthquake and microtremor isolation systems, high-strength, high-fluidity and high performances concrete, advanced shield excavation techniques, building construction control system among others.

The facilities available at the various laboratories are truly impressive, which explains Kajima's ability to make a significant contribution to the construction in Japan as well as the overseas projects it undertook.

9.0 SHIMIZU CORPORATION

On the sixth visit of the tour, was a visit to Shimizu Corporation MM, Takashiwa Station in Yokohama. The station is one of 4 new stations of the new Minato Mirai 21 District Line joining Yokohama station to Motomachi station. This new 4.1 km long subway line will connect with the Tokyo-Tohoku line at Yokohama station, resulting in a shorter trip between Shibuya Tokyo and the central Yokohama by 40 minutes.

The station is constructed by the cut and cover method. The retaining wall is a special

type of diaphragm wall, using reinforcing steel sections called NSBox instead of steel bar cages. The diaphragm wall thickness are of 800 – 1000 mm thickness with depths of 60m. The NSBoxes (special I sections) are of sizes 800 ~600 (W) x 750 (H). The station is 5 storey high constructed of 3 spans reinforced concrete. The length of the station is 180m, with widths of 18.7 ~ 24.4m and 34.4 maximum in depth. A steel road deck is erected above the site to allow the road to be used as construction proceed below with the excavation of the station.

The dual platform is 170m long, 6.7 ~ 4.0m wide. The diaphragm wall is cured around the tunnel opening to receive the shield tunnelling machine from Minatomira Chao station. The diaphragm wall needs to be strengthened from the 12^{th} strut (lowest) to the 8^{th} strut, about 15m high. The struts from the 12^{th} to 8^{th} struts had to be removed to receive the shield machine. To ensure workers safety, Shimizu has employed the unique system of flooding the station with water, and utilising a floating raft to remove the 8^{th} strut. The shield tunnelling machine of 10m diameter arrive from Minatomirai Chuo station and moved within the excavated Takushima station and then proceed to bore the tunnel towards Yokohama station.

I also visited another Shimizu's construction site, the Imai River Underground Retarding Basin Project in Yokohama. The Imai River, 4.74 km in length joins the Katabira River. With a 7.6 square km catchment basin which has gradually and expected to be fully urbanised in the coming years, the runoff storage capacity has greatly decreased resulting in frequent floods. In order to arrest this problem immediately, an underground retarding basin was selected.

The development consist of a tunnel-type underground retarding basin of 10.8m in diameter, 2,410,m long with a storage capacity of 214,000 m3 constructed 45 to 85m below the National Highway Route 1 (to minimise disruption and obstacles). The provisional design rainfall of 50mm per hour was set with a future design rainfall of 82mm per hour expected. The intake facilities consist of side-overflow intake of 80m length, a headrace tunnel, setting basin and intake shafts.

The 2,410m tunnel was excavated using the slurry shield machine of outer diameter 12.14m. Before launching the shield machine, a launching shaft was constructed. The shaft has an inner diameter of 26.2m, wall thickness of 1.2m and reaching a depth of 61.9m. To protect the cutting face against the high water pressure, a combined freezing and chemical grouting method was utilized to create a bearing wall to cut off the water.

10.0 The Public Works Research Institute (PWRI)

The PWRI is the largest national institute in the field of civil engineering in Japan. It originated as a civil engineering laboratory in 1922 and renamed as PWRI in 1948 under the

Ministry of Construction.

A presentation was given by Mr. Akira Fujimoto on the 'Tender Process and Quality Control'. For Government projects, the contracts for design and construction are separated. The concept of design and build is being studied but no project has been awarded under design and build so far. I was told that one of the reasons being the Government also would like the Consultants to have enough works. Lump sum contracts is most popular with contracts normally awarded to the lowest bidder within the ceiling price preset by client. For local Government projects, those bids below the lower bound are normally rejected automatically. The type of bidding are as follows:

Ceiling Price (million yen)	**Type of Bidding**
Above 720	Open competitive bidding
200-720	Public-invitation type designated competitive bidding
100-200	Willingness confirmation type designated competitive bidding
Up to 100 million	Designated competitive bidding

The Qualification of Contractors and Consultants are as follows:

Category	**Frequency**	**Screening Items**
Category Industry Registration	Every 5 years	-past business management -experience of manager
Screening for qualification	Every 2 years	-objective appraisal (work experience, etc) -subjective appraisal (quality of works, etc)
Pre-qualification	Before works	-experience of works -implementation planning

The contractor must, at his own responsibility, establish a works execution management system that ensures that the works is done in accordance with the contract document. Wherever necessary for the sake of checking whether or not the works is being done according to the contract documents and drawings, supervisory personnel can have access to the construction site or production plant, witness the works and demand submittal of information materials, and the

contractor must cooperate in that.

The institute performs research and development covering a wide field of civil engineering.

I toured the PWRI in Tsukuba City and paid a courtesy call on Mr. Tsunoo Chesaka, the Deputy Director-General. The institute is a large facility of 1,255,815 m2 with over 50 laboratories. There are over 400 staff in PWRI of which 300 are researchers.

The institute is developing the Intelligent Transport Systems (ITS), that uses intelligent communications portals to establish an integrated system for users, roads and vehicles. This system was developed to arrest traffic problems that arise out of economic and industrial prosperity, namely accidents, congestion and pollution. In Japan, the number of traffic accidents has grown to more than 800,000 in 1998. With the introduction of the Vehicle Information and Communication System (VICS), the Electronic Toll Collection System (ETC) and the Advanced Cruise-Assist Highway System (AHS), accidents and congestion can be reduced by 80% and 70% respectively. The AHS system is expected to be introduced in 2003. An experiment will be conducted in late November to test the systems. It is envisaged that the ITS will lead to a safe, smooth and comfortable travel in the 21st century.

11.0 Acknowledgement

I am very grateful to JSCE for giving me this study tour grant and their tireless effort in making all the necessary arrangement and in accommodating to my needs. The trip was superbly arranged and it maximised the limited time that I had in Japan.

Appendix

Ms. Lee Bee Wah Itinerary (9/20 – 10/5)

Date	Day	Place	Hotel
09/20	Wed.	Arrive at Sendai NH112 Singapore – Osaka E129 Osk-Scn 09:35	Sendai Tokyu Hotel 2-9-5 Aobaku, Sendai 980-0811 Japan Phone: +81-22-262-2411 Fax: +81-22-262-4109
09/21	Thurs.	10:30 Annnual Conference	“
09/22	Fri.	10:00 JSCE Annual Conference	“
09/23	Sat.	JSCE Annual Conference 12:30-13:00 Briefing on Study Tour Grant at Sendai Tokyu Hotel Prof. Aoki	Hotel Edmont 3-10-8 Iidabashi Chiyoda-ku, Tokyo 102-8130 Japan Phone: +81-3-3237-1111

		(Chief Secretary of Int'l Exchange Fund Committee) 14:37 Leave for Tokyo by JR Shinkansen	Fax: +81-3-3234-4371
09/24	Sun.	Free day	"
09/25	Mon.	10:30 – 11:30 JSCE Briefing of the Tour and JSCE Mr. Miyoshi (Executive Director) Mr. Matsuo (Secretary General) Mr. Yoshikawa (Manager of Int'l Affairs Division) 13:30 – 17:00 Kumagai Gumi Co. Ltd. Meeting with Mr. Watanabe (Chair of Int'l Exchange Fund Committee) Visit construction site (Shield Tunnel at Rinkai Railway construction site)	"
09/26	Tues.	10:30 – 16:00 Harbour and Port Research Institution, Ministry of Transport (Yokosuka) Discussion and visit laboratories and facilities	"
9/27	Wed.	09:30 – 17:00 Obayashi Corporation Construction site (Tokyo Intercity Development Project – Shinagawa) High Rise Building, etc.	"
9/28	Thurs.	09:30 – 16:00 Oriental Consultants Co. Ltd. Discussion on Engineers in Japan and visit Tokyo Harbour Tunnel - Aqualine	"
9/29	Fri.	10:00 – 16:00 Kajima Technical Research Institute, Kajima Corporation Discussion and visit experimental facilities	"
9/30	Sat.	Free day	"
10/1	Sun.	Free day	"
10/2	Mon.	10:00 – 20:00 Shimizu Corporation MM21, Imai River (Shield Tunnel at deep basement)	"
10/3	Tues.	13:15-20:00 Lunch at Tsukuba Center Public Works Research Institute, Ministry of Construction (Tsukuba) Discussion on Tender Process and Quality Control	"
10/4	Wed.	Free day	"
10/5	Thurs.	Leave for Singapore NH901 Tokyo 16:20	