JAPAN SOCIETY OF CIVIL ENGINEERS- 1993 STUDY TOUR REPORT

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Introduction

The Japan Society of Civil Engineers (JSCE) offered a study tour grant to members of the American Society of Civil Engineers in the fall of 1993. The opportunity to travel to Japan and study civil engineering and construction was offered to the winning paper on the subject of relations between Japan and the United States in these fields. My paper titled "Japan and the United States, working together in Engineering and Construction" was selected as the winning paper and I was given the privilege of receiving the 1993 JSCE Study Tour Grant.

The theme of the study tour was to promote a mutual understanding between Japan and the United States in engineering and construction. Insights into the relationship between these two world leaders can also help promote a mutual understanding of engineering and construction around the world. JSCE has previously sponsored study tours with engineers from Sweden and Australia.

This report gives the details of my experience traveling to Japan between August 19 and September 5, 1993. Although I received enough information to write an entire book, I can only present the highlights of each visit. The content of my original paper was based on research of material available in the United States without previous experience visiting Japan. The study tour has given me new insight and first hand experience of the engineering and construction industries in Japan.

The Study Tour

Over three months of planning went into the organization of the study tour. Originally, I was asked as to what places would I like to visit. As this was to be my first trip to Japan, I relied heavily upon JSCE to guide my decisions. In keeping with the theme of the study tour, I suggested a list of places to visit that would cover the entire spectrum of the construction process in Japan from planning to design to actual construction. My list included the following: professional organizations, engineering design firms, construction companies, government agencies, university programs, research institutes, and various construction sites. From my original list, JSCE was able to schedule an agenda and make all of the necessary appointments. The final schedule was impressive as it made excellent use of the limited time I was to be in Japan. The only things that altered the schedule were two typhoons! I was also able to enjoy sightseeing throughout Tokyo, Yokohama, Kamakura, Kyoto, Nara, and Osaka. The overall tours and presentations from each visit were excellent without exception.

The Japan Society of Civil Engineers

The Japan Society of Civil Engineers (JSCE) is an impressive organization with over 35,000 members. Founded in 1914, JSCE has contributed greatly to the development of civil engineering in Japan and the improvement of its quality of life. JSCE has been active to develop the idea that civil engineering promotes the cultural development of citizens and improves every process of human society. In addition, the activities of SCE spread internationally to promote the exchange of technical information and academic products with academic institutions and research institutes of various countries. JSCE welcomes the membership of all citizens, besides civil engineers, who are interested in civil engineering to produce a better social capital.

JSCE also holds an annual convention to conduct general business of the society and allow civil engineers throughout Japan to share ideas and new technologies. My visit to the headquarters revealed a well organized office with accommodations for committee meetings and other gatherings in addition to a substantial library.

The organization of JSCE includes seven branch offices, a civil engineering library, members and branches divisions, a research division, an editing and publishing division, an accounting division, a planning and public relations division, and a general affairs division. The works of JSCE include the following: 1) Publication of monthly and yearly periodicals as well as "Civil Engineering in Japan" and other publications in English which contribute to the international communication in civil engineering technology. 2) Editing and publication of books on civil engineering which include the summaries of studies and research activities. 3) Presentation of research studies through lecture assemblies, training sessions, symposiums, conferences, and panel discussions as well as promotion of civil engineering technologies through field study trips, construction site visits, film exhibitions, and other events. 4) Institution of awards to promote the development of civil engineering and to encourage excellent research. 5) Providing a civil engineering library open to the public which possesses approximately 30,000 items such as historical materials, cultural artifacts, contemporary documents, and a film library. 6) International and domestic communication with relative academic societies and associations which includes international conferences, mutual visits of JSCE and overseas engineers, and cross-disciplinary communications with overseas academic societies. 7) Cooperation in the construction of social capitals by having JSCE research committees play a central role in such projects as the Honshu-Shikoku Bridges, Seikan Tunnel and Narita International Airport.

The American Society of Civil Engineers (ASCE)- Japan Section

The fact that an ASCE section exists in Japan is an indication of the efforts Japanese

engineers have made to establish relations with American engineers. The Japan section gives Japanese engineers and American engineers in Japan the opportunity to discuss American engineering practices and their influence on Japan as well as the chance to exchange information. Many engineers I met during the study tour have spent time working or attending universities in the United States and share common experiences through the Japan section of ASCE.

I attended a dinner/lecture presented by the ASCE Japan section in which the topic "Construction Disputes, Avoidance and Resolution" was presented. The Japanese construction industry has predominately operated on the basis of trust and established relationships. However, Japan will have more court cases as the United States gets more involved in the Japanese construction industry. With nearly a million attorneys in the United States as compared to approximately 15,000 in Japan, maybe Japan can avoid some of the pitfalls of the American system as the use of more formal contracts becomes more prevalent. In the Japanese system, each clause of the contract is not carefully examined as in the American system. The contract as a whole is important which avoids the process of dealing with everything by legal proceedings.

Education

I was given the opportunity to visit the University of Tokyo and to discuss issues with representatives from other university programs during my visit. Japan's educational system is world renown and the civil engineering programs at the university level are quite extensive. I met a number of engineers and professors who have attended university programs in the United States and are familiar with both systems. Japanese professors are often frustrated hearing about grants given to American Universities by private corporations. This is certainly not the case in Japan. In addition, Japanese universities appear to have the problem of young Phd's leaving the universities for more lucrative positions with private business or government.

A good example of the civil engineering programs offered in Japan is the graduate school program for the Department of Civil Engineering at the University of Tokyo. The program offers such fields of study as Infrastructure Development and Management, Regional planning and surveying, Transportation Engineering and planning, Environmental Engineering, Coastal and Ocean Engineering, Hydraulic and Water Resources Engineering, Geotechnical Engineering, Concrete Engineering, Earthquake Engineering, and Mechanics and Structures. With approximately one hundred foreign students from more than twenty different countries, the accommodation to foreign students is excellent. Class instruction and research supervision are given in both English and/or Japanese. Master's thesis and doctoral dissertations are accepted in English while Japanese courses are also offered to foreign students and their spouses.

Of particular interest was the Construction Management/Infrastructure Systems Laboratory at the University of Tokyo. Originally established in 1989, the program's main fields of study are 1) construction management with emphasis on the public procurement system and structural improvement of the construction industry and 2) general studies on infrastructure development and management. The members of the laboratory are challenged with the problem of developing and managing infrastructure on a global basis under the ever-changing social and economic conditions. This program is especially relevant in Japan where they have been continuously improving the vast network of infrastructure within such a densely populated country.

JAPANESE GOVERNMENT AGENCIES

The Japanese government consists of the Cabinet, the Prime Minister's Office, twelve ministries and various gencies. The Prime Minister appoints other ministers to run each ministry, which is constituted as an office to serve its minister. The various ministries of the Japanese government include the Ministries of Justice; Foreign Affairs; Finance; Education; Welfare; Agriculture, Forestry and Fisheries; International Trade and Industry; Transport; Post and Telecommunications; Labor; and Home Affairs.

The Ministry of Construction

I was given the opportunity to visit the International Affairs Division, Economic Affairs Bureau, at the main office of the Ministry of Construction. The main function of the Ministry of Construction is to provide construction and maintenance of private and public works. The ministry has approximately 23,000 employees, 2,000 in the main office alone, and receives 70% of the national public works budget. Employees of the ministry are well respected as candidates are chosen among the best in their fields.

In general, planning and budgeting functions are handled by the ministry and implemented at local levels of government, such as the ministry's regional construction bureaus, prefectural governments and municipal governments. The ministry consists of the Ministry Proper, eight branch offices, regional construction bureaus, four auxiliary institutes, three research institutes, and a construction college to provide training to staff members of the ministry, local public bodies and public corporations. The Ministry Proper is divided into six bureaus which include the Minister's Secretariat, Economic Affairs, City, Road, River, and Housing. Specific functions of the ministry include licensing for businesses and professionals (architects, engineers, and surveyors), research and development activities, natural disaster prevention and assistance, housing development and supply, urban planning, construction and maintenance of infrastructure, and promotion of international cooperation to name a few. The ministry is also responsible for the design and construction of all government ministry buildings except for the

Ministry of Post and Telecommunications.

With cooperation from local governments, the ministry is improving the quality of life throughout Japan with improvements to infrastructure and public housing. The Ministry feels that the level of infrastructure is lower in Japan than in the United States or Europe; however, that will change in the next ten years. Also, the Housing Bureau is trying to raise the quality of public housing as quantity over quality was emphasized in the past.

The Public Works Research Institute

The Public Works Civil Engineering Research Institute (PWRI) is the largest national institute in the field of Civil Engineering in Japan. The PWRI originated as the Civil Engineering Laboratory under the Ministry of Internal Affairs in 1922. Given its new name under the Ministry of Construction in 1948, the PWRI fulfills the role within the Ministry of Construction to perform research and development activities in the field of civil engineering technologies. Such technologies contribute to the development of construction technologies in Japan and throughout the world. More specifically, the PWRI conducts fundamental and applied research in such fields as highway engineering, river engineering, erosion control, dam construction, waste water treatment, and construction machinery.

I met with the Coordinator for International Research Cooperation and toured the site at the PWRI in Tsukuba City, approximately one hour north of Tokyo. The PWRI is a large facility which has 51 large-scale facilities in an area of 126 hectares. There are research facilities for geotechnical, soil and foundation engineering; structural engineering which include earthquake laboratories, wind tunnels, and the gigantic 30 mega-newton universal testing machine; hydraulic and water quality engineering which include river, darn, and coastal hydraulics laboratories; and finally road and traffic engineering which consists of a traffic collision test field, a full-scale test tunnel, a pavement test field, and a 6,152 m test track. The ride along the south loop at 120 km/hr balanced gravity and centrifugal force perfectly.

The number of facilities and research projects at the PWRI are too numerous to mention. The following give an example of the types of activities currently under way: sediment-related disaster prevention systems, advanced road and intelligent traffic systems, climate change induced by the Greenhouse Effect, high-tech construction materials, application of new materials and methods on concrete production, flood prediction models and applications, alternative sewer systems, water resources development, investigation of avalanches, diffusion of air pollutants from vehicles, seismic resistance of earth structures, and studies of long span bridges to name just a few. In addition, the amount international research collaborations is tremendous as the PWRI is cooperating with 12 foreign countries by holding conferences, exchanging researchers and information, and performing joint research. The PWRI also

provides technical cooperation for developing countries, collaborates with private organizations, and publishes civil engineering research information. The Public Works Research Institute is just one example of how Japan is committed to improving civil engineering technology throughout the world.

The Ministry of Transport

My visit to the Office for Airport Construction Market Access, Civil Aviation Bureau, at the Ministry of Transport provided information as to the funding, planning, design, construction, and maintenance of airports throughout Japan. In these regards, the Ministry of Transport is similar to the Federal Aviation Administration in the United States. Air transport in Japan has developed rapidly over the last two decades through laws, institutions, planning guidelines, and technical standards. In particular, three laws have guided Japan's air transport system to its current level.

The "Civil Aeronautics Law" was established in 1952 and is the basic law regarding Japan's air transport in accordance with regulations set forth in the International Civil Aviation Treaty. This law sets standards for safety, aircraft operations, certifications for aircraft and pilots as well as procedures, regulations, and standards for airport design.

Since the end of World War II, the development of airports in Japan has progressed through the establishment of the "Airport Development Law" of 1956, responsible for the establishment and administration of airports and cost sharing between the government and airport authorities. By this law, the airports are classified as Class l (mainly international air transport), Class 2 (major airports with domestic air transport), and Class 3 (local airports with domestic air transport). According to this law, the costs for development of Class l airports is 1005 born by the state, while local governments share 255 of the costs for Class 2 airports and 505 for Class 3 airports.

In 1970, the "Law for Special Account for Airport Development" was established to secure the necessary budget for the development, operations and maintenance of airports. The basic principle behind this law is that the benefactors from using the airport will generate revenue through landing fees, facility charges, and fuel taxes.

To systematically develop airports, secure air transport safety, and preserve the environment surrounding airports, the Japanese government established the Five Year Airport Development Plan in 1967. Japan is currently is its Sixth Five Year Airport Development Plan which includes the off-shore development of Tokyo International Airport (Haneda), the expansion of the New Tokyo International Airport (Narita), and the construction of the new Kansai International Airport in Osaka Bay.

The Ministry of Transport has established planning guidelines to standardize the level of airport development. The guidelines include the requirements for layout of airport facilities and methods for calculating the facility requirements. Design, construction, operations and maintenance are monitored by the Standard for Airport Civil Engineering Facilities. The design phase includes design standards, design manuals, and design guidelines. Next, the construction phase includes cost estimation standards, general specifications, and construction manuals. Finally, the maintenance phase consists of maintenance regulations, repair manuals, and inspection manuals. These standards promote efficient design and construction between the various site conditions at airport facilities throughout Japan. Poor topographical and limited site conditions have developed a high quality of airport engineering technology in Japan.

CIVIL ENGINEERING CONSULTANTS

Consulting engineering in Japan essentially started after World War II, when engineers who had been involved in the construction of railways, dams and other facilities prior to the war began to put their expertise to work during the post-war period. A civil engineering consultant is Japan is defined as "one who is contracted or commissioned to be engaged in construction design, surveys and studies, planning, establishment of proposals and provision of advice with regard to construction of civil engineering structures." The Japan Civil Engineering Consultants Association (JCCA), the largest organization of its type in Japan, has contributed to the development of this industry and the volume of services for this industry has continued to increase at a rapid rate throughout recent years.

The Japanese system seems to use more in-house engineers whereas the American system seems to use more consultants. However, the Japanese government is aiming to reduce the size of government; therefore, the Ministry of Construction is under pressure to use consulting engineers more.

Professional registration through JCCA as a consulting engineer in Japan is a long and difficult process for applicants which assures that only qualified professionals are allowed to practice as consulting engineers. Consulting engineers in Japan appear to have a good relationship with contractors as well. Japanese firms take advantage of the fact that contractors have more knowledge of cost estimates and use them to refine and reduce construction cost estimates.

I was able to visit a general civil engineering firm, an airport consultant, and a Japanese-American joint venture, which was a small representation of a field which has over 2,000 consulting firms.

Oriental Consultants is an independent firm of consulting engineers providing services

such as research, planning, investigation, feasibility studies, concept and detailed design, tender assistance, supervision of construction and overall project management. The scope of their work covers the field of civil engineering with regional and urban planning, traffic engineering, road and highway construction, railways, structural works, maritime works, onshore and offshore structures and other related fields.

Oriental Consultants holds memberships in seventeen professional societies and supports several branch offices in Japan as well as an international headquarters with representative offices in Jakarta and Chile. Established in 1957, Oriental Consultants has an excellent reputation and has been influential in the consulting engineering industry as the l5th largest such firm in Japan.

I attended presentations of design capabilities from several departments within Oriental Consultants, which relayed their high quality of work and expertise with computers. Some of their specialties include: use of traffic models to assist in forecasting and road maintenance; sophisticated earthquake engineering for Japan's high earthquake frequency, soft soils, and prevention of liquefaction; coordinating landscaping into engineering design; and preliminary and detailed bridge design which includes aesthetics, materials, and maintenance design.

Japan Airport Consultants (JAC) is a full-service airport consultant established in 1970. Their work encompasses the planning, design, construction, maintenance, supervision, and other services for total aviation facilities across Japan and throughout the world. I was given the opportunity to visit the headquarters office in Tokyo, but there are also four branch offices in Japan and another six branch offices located in other countries. JAC has an impressive resume of airport projects which include developing new airports, reconstructing and expanding existing airport facilities, assisting in the enhancement of the air traffic safety system in Japan, and even the development of a 15-year modernization program for the nationwide air navigation facilities in the Philippines. Their reputation and quality of work have established them as a leader in aviation design.

JAC serves approximately 90 percent of all Japanese airports, which totals over one hundred facilities.

In Japan, almost all airport work is extension or reconstruction as land availability is limited for the development of airport sites. Such JAC projects as the world's first offshore airport, Kansai International, or the land reclamation taking place for the extension of Tokyo International Airport (Haneda) are just two examples of the innovative ideas to deal with the extinction of land resources.

Mountain sites are also popular for new airports as they are generally isolated from population centers which eliminates noise problems. However, these site locations introduce long access problems and have incredibly high earthwork construction costs. With such a

limited amount of land available for development, most airport designs have similar layouts which consist of a main runway with a full parallel taxiway system. Having such a substantial involvement in the Japanese aviation industry, JAC presented a thorough background on the major airport construction projects prior to my airport construction site visits.

Parsons Polytech Inc. (P&P) was established five years ago as a Japanese subsidiary of the Parsons Corporation, Pasadena, California. The Parsons Corporation is one of the world's largest engineering organizations and comprises a wide range of specialized engineering companies.

P&P provides planning, survey, design, construction management, and other engineering services in urban and community development, space and defense facilities, industrial and commercial facilities, institutional facilities, traffic planning and highway facilities, power and energy facilities, environmental projects, and aviation facilities. As a member of the Parsons Corporation network around the world, Parsons Polytech has a strong foundation and ability to provide quality engineering services.

The Ralph M. Parsons company is just one of the nearly twenty international members of the Japan Federation of Construction Contractors.

P&P has discovered that starting a new business in Japan is very difficult. However, they have no illusions about developing the company without sacrifice. They have adjusted their business practice to the standards of Japanese business practice, learned to understand Japanese culture, and realize that developing a business reputation in Japan takes time just as it has for all other Japanese businesses.

My visit to P&P gave me the opportunity to discuss these issues with them and the chance to witness a project meeting to decode Japanese design standards established years ago.

CONSTRUCTION PROJECTS

At my request to visit some typical Japanese construction sites, I was overwhelmed by the chance to visit some of the largest construction projects in the world. One the first things I noticed at these projects was the superior level of safety standards. The Japanese construction industry boasts a low number of construction accidents. They have learned that implementation of effective safety programs protects construction workers and the public and that high safety standards reap the benefits of higher profit margins on construction projects. In terms of construction materials for infrastructure, I noticed the prevalent use of asphalt on roadways and runways. In America, there is much competition between the asphalt and concrete industries in all areas of paving construction.

However, in Japan, asphalt is used in high traffic areas due to the short time frame of maintenance and reconstruction that it affords.

Tokyo International Airport (Haneda)

Tokyo International Airport (Haneda) is vital to air travel in Japan as it handles approximately 42 million passengers per year and 60 percent of Japan's domestic air travel. Under present conditions with limited space and no adjacent land available to develop, the airport is not able to cope with increasing demands to handle more air traffic. In order to solve this problem, the Ministry of Transport has implemented the "Tokyo International Airport Offshore Development Project." The expansion at Haneda is a remarkable project aimed at expanding the air and ground transportation network, solving problems with aircraft noise, and effectively using waste disposal material from the Tokyo area. The 611 development of the airport site increases from an existing 580 hectares to 1,100 hectares in the fixture by expanding the airport site into Tokyo Bay.

Special soil conditions have created the need for innovative solutions to the site as it was originally filled with sludge from Tokyo Port and then covered with surplus soil from construction sites. The methods used to stabilize the soil include the paper drain method which has permeable strips of geotextile material, the sand and/ or pack drain method which penetrates deep into the ground to drain large quantities of water, the deep mixing method in which chemical stabilizers such as cement are injected into the ground to solidify the soft clay, the quicklime pile method to consolidate the ground with dehydration and expansion properties, and the high pressure jet mixing method in which solid piles are created from a revolving nozzle which shoots out streams of stabilizers. Such adverse soil conditions have created interesting problems to handle soil consolidation beneath the pavement as well.

For example, the aircraft parking apron consists of prestressed concrete with a computerized jacking system. As differential settling occurs, sensors detect voids beneath the pre-stressed concrete which are then injected with high-flow concrete.

The offshore development is just the beginning of the expansion project as it will support a terminal building complex, an aircraft parking apron, seven bridges (including the world's first cable stayed bridges suspended from an archway), underground structures, fixture runways, an administrative building complex, a utility center, a cargo area, jumbo jet hangars (the world's largest), Gel facilities, underground railway access (by the Keihin Kyuko Line and the Tokyo Monorail), and surface access to the Tokyo Bay Coastal Highway (to be completed in 1997). As with all new land development projects in Japan, land acquisition consumes a large part of the total budget. Of the total budget for the extension project, 40 percent of the total budget went to land acquisition and 60 percent went to actual construction. I witnessed the large amount of aircraft traffic during my visit to the existing control tower. I also visited the new terminal building complex which will serve as an excellent international gateway to Japan.

Akashi Kaikyo Bridge

The Akashi Kaikyo Bridge is a 3-span truss suspension bridge which will link the main island of Kobe with the island of Awaji. The project, which will be completed inl998 after ten years or construction, also includes highway and tunnel construction to the junction of a new highway approximately 10 km away. I was received at the Honshu-Shikoku Bridge Authority Construction Affairs Department for a boat-tour of the main project towers in the Akashi Straits and a full tour of the inland tunneling project.

The Maiko Tunnel consists of two parallel tunnels, each with three lanes, and is primarily constructed using the New Austrian Tunneling method which uses radially placed rock bolts and shot-crete to make use of the existing force in the ground. The Side Drift and Center Diaphram Methods as well as large Tunnel Boring Machines (Used against granite) are other tunneling methods to bore beneath this portion of the city, mostly a cemetery and golf course. This large-scale project is occurring practically unnoticed at the surface of the city.

The Akashi Kaikyo Bridge will be the longest suspension bridge in the world upon completion with a total length of 3,910 m and a center span of l,990 m. The bridge spans the Akashi Straits which sees l,400 ships a day in typically rough waters, making construction very difficult. Special features of the bridge design include a wind-proof design to withstand winds with a velocity of 46 m/s at a 150 year frequency and earthquake resistance of up diameter cables its size and will to 8.5 on the Richter scale. The two main towers holding the 1.1m diameter cables rise about 300m above the sea level.

The bridge will set new records in its size and will be of unprecedented scale as 200,000 tons of steel will be used for the cubic meters of concrete will be used for the substructure.

Kansai International Airport

One of the being highlights of the study tour was a visit to the new Kansai International Airport being built in Osaka Bay. The Kansai Airport is the world’s first offshore airport and has received much international attention, especially in the area of foreign access to Japan’s construction market. The Kansai International Airport Company, Ltd. (KIAC), owned by national and local government as well as the private sector, was incorporated in 1984 to build and manage Japan’s first 24-hour airport (although there have seen court suits to limit airport operations according to curfews).

The Kansai International Airport was conceived to relieve some of the over-burden from two of Japan's main international airports, the New Tokyo International Airport (Narita) and Osaka International Airport. By building the airport five kilometers offshore to avoid noise restrictions, the land reclamation costs are still less than the cost of purchasing the property

inland. Construction began in 1987 and the airport is now scheduled to open in 1994 at a cost of approximately $10 billion (U.S.). QC has over 500 employees and approximately 10,000 people commute to the island by boat to work each day.

The foundation of the project is the man-made island consisting of over 180 million cubic meters in reclamation. Although the project was faced with formidable ocean depths and a soft sea-bottom foundation, QC has successfully overcome engineering obstacles never before experienced in reclamation work. Settlement of the island is expected and all structural foundations have been designed to accommodate this problem. Differential settlement is expected where building foundations were excavated for basement level construction, and for this reason, iron ore was spread under the building foundations. In order to prepare for future differential settlement, a jacking system has been installed in all 900 foundation pillars which allow the heights of the pillars to be adjusted between 30 and 60 centimeters up or down. The aircraft parking apron has been constructed with prestressed concrete and a jacking system to accommodate settlement as well.

To develop a truly international airport, QC adopted a fair and nondiscriminatory opportunity for foreign companies to participate in the airport project. The cornerstone of the project is the passenger Terminal Building, developed from a proposal by the Aeroports de Paris of France, and the basic concept carried out by KIAC. The concept was then given final form by Renzo Piano, whose design was selected through an international design competition. As for construction services, a large number of foreign-affiliated companies submitted bids on 24 of the 81 international tenders for airport construction projects, of which, thirteen were successful. Foreign participation includes Overseas Bechtel, Fluor Daniel, the Austin Company, and Schal Associates among others.

Besides the passenger terminal building, the facilities on the airport island include a 3,500 m asphalt runway, a 3.75 km access bridge, a domestic cargo terminal, an international cargo terminal, a control tower, a railway station, a hotel and shopping zone, an oil tanker berth, and a sea access port. The new airport is also a catalyst for other projects in the area such as Rinku Town, the airport's landward gateway, which will be a center for financial and commercial districts as well as international communications. The new Kansai International Airport will be the gateway to the Kansai region, second only to Tokyo as Japan's leading industrial and economic center.

Tokyo Subway Line #7

The Tokyo Subway Line #7 project next to Tokyo Dome is a good example of the construction methods necessary to work in Japan's dense population conditions. I was given the chance to literally crawl around beneath the surface to witness this vast network of subsurface

construction.

The subway station is being constructed in two sections, one by Shimizu and the other by Obayashi. The structure consists of six levels beneath the surface using a top-down style of construction. This method is more stable than completing the full excavation first, which allows inner walls to be constructed in advance, thereby allowing for a faster schedule of completion. Because the construction space is so limited, steel retaining walls consisting of "H" beams and sheet piles filled with concrete were used instead of conventional and thicker concrete walls.

In Japan's condensed population area, every measure possible is taken to not disturb the environment surrounding the construction site. In addition, the "spaghetti-like" network of underground utilities presents difficulties. As with all subsurface construction projects in the Tokyo area, utilities are protected and are not moved, making construction around existing lines very difficult. Also, no previous project in the Tokyo area has excavated this deep. Therefore, soil conditions are uncertain and lowering the water table is much more difficult. Once excavation is completed, all waste material must be hauled 80 km away to a landfill project at a riverside site. With all of these construction difficulties to contend with, the project is moving along on schedule and with excellent coordination.

Trans-Tokyo Bay Highway Project

The Trans-Tokyo Bay Highway is the first highway to be built across Tokyo Bay and will be a 15.1 km toll highway connecting the cities of Kawasaki and Kisarazu. The massive project consists of an undersea tunnel section, two man-made islands, and a bridge section. The first 10 6 section from the Kawasaki side, adjacent to the Tokyo metropolitan area, is being constructed as a dual tunnel to allow for the heavy shipping traffic to continue in Tokyo Bay. The remaining 5 km section to the Kisaruza side is being constructed as a bridge because shipping traffic is less frequent on this side. Construction began in 1989 and is being administered by the Trans-Tokyo Bay Highway Corporation and the Japan Highway Public Corporation at a total project cost of 1,440 billion yen. The highway is expected to reduce traffic congestion in the area and vitalize the industrial activities in the Tokyo Metropolitan Region. The highway will also contribute to the formation of new urban areas which will alleviate the over-concentration of facilities and activities in central Tokyo.

Each component of the project represents advanced technologies for both design and construction. The Ukishima Access Ramps which connect the land section and undersea section on the Kawasaki side consists of an access/ventilation shaft with a tunnel workyard area and a man-made underwater embankment. This embankment will provide overburden and stability for tunnel boring and protection against buoyancy for the ground through which the tunnels are driven. The Kawasaki man-made island will provide a work base during tunneling and act as a

ventilator shaft after construction.

The water is approximately 28 m deep at this location and the seabed was stabilized to a depth of 30 m before the diaphram wall was constructed. The Kisarazu man-made island links the bridge and the undersea tunnels. This island is being reclaimed by constructing a structure prior to the placement of embankment. The shield tunnel is being constructed about 15 meters below the sea bottom in approximately 25 m deep water. The slurry shield tunneling method is being used in which eight shields will start their advance: two from the Ukishima access, four from the Kawasaki man-made island and two from the Kisarazu island to meet at the same time under the bay at points midway between the shafts. As for the bridge, its superstructure is a steel box girder with a steel deck supported by steel piers on steel pipe pile foundations. Finally, the highway itself will consist of four 3.5 m wide lanes which can handle 33,000 vehicles per day at a design speed of 80 km/hr. Two additional lanes are planned for the future which will increase capacity to 64,000 vehicles per day.

My tour of the project included the man-made island and bridge section to witness the difficulties of construction at sea. Sortie of the most advanced technologies today are being used to design and construct the Trans-Tokyo Bay Highway. With such requirements as a 100 year working life, construction at great water depths and a soft seabed, Japan can be proud of a project from the fruits of knowledge and extensive experience.

CONSTRUCTION COMPANIES AND RESEARCH INSTITUTES

At my request to visit a Japanese construction company, JSCE arranged visits with two of Japan's largest and oldest construction companies, Kajima and Shimizu. Both companies and international offer the full spectrum of design and construction services on a nationwide and international basis.

Of particular interest are the research and development institutes of these companies. There are over 510,000 contractors in Japan, of which 650 have research facilities. Japan initiated construction R & D after World War II in an effort to advance the nation's technology and rebuild its building network and shattered infrastructure. Since then, the research laboratories have become a standard feature of the large Japanese construction companies. In Japan, a construction company's reputation is not only dependent on the quality of work, but also its research capabilities. These research capabilities also play a central role in a company's marketing strategies and allow a channel for research to be easily transferred into practice. In the United States, none of the major contractors have R & D laboratories, and formal R & D does not play a role in marketing strategies.

Kajima Research Institute

Kajima Corporation was founded in 1840 and has been a leader in the long history and tradition of the Japanese construction industry through superior work in civil engineering, architecture and development. Kajima also makes great contributions to society through the Kajima Foundation for scientific research and international exchange, the Kajima Institute publishing CO., the Kajimavision Productions CO., the Kajima Institute for International Peace, the Kajima Foundation for the Arts, and the Yaesu Book Center.

Kajima has operations around the world with vast research capabilities contributing to its global reputation. The Kajima Technical Research Institute (KaTRI) is the core of Kajima Corporation's research and development establishment. My visit to the KaTRI included the Tobitaky-u, complex and the Nishichofu complex outside of Tokyo. Fields of study at the various laboratories of KaTRI include materials and methods of execution, disaster prevention and safety technology, soil mechanics and foundations, geology and rock mechanics, structures and construction methods, environmental control technology, equipment, the ocean and hydraulics, and biotechnology. Some of the innovative designs in new technology from KaTRI include a unique Sol-air heat pump system which absorbs the thermal content and solar energy of air and dissipates heat in the form of natural convection and radiation, an isolation floor system which protects precision instrument equipment such as computers from earthquake damage, and a sound field simulation to provide simulated acoustic conditions to accompany various images of actual environments, to name just a few. Kajima was the first to develop a research institute in 1949. Other firsts for Kajima include the industry's first radio isotope laboratory and acoustic laboratory in addition to Japan's first high-rise building in 1968.
The facilities at the Kajima Technical Research Institute were amazing and explain how Kajima's innovations have made significant contributions to the construction industry in Japan and around the world.

Shimizu Institute of Technology

The Shimizu Corporation was established in 1804 and is another leading engineering/construction company in Japan with extensive international operations. With over 15,000 employees, Shirnizu's activities include architecture, civil engineering, planning, project management, development, real estate management, manufacturing of construction materials and equipment, and research and development.

Shirnizu has been influential in society through information-related services, globalization, the improvement of cities, development of leisure facilities, and the need for an overall quality of life in Japan.

The Shimizu Institute of Technology is the core of the corporation's technology related research program. The institute has nine divisions which concentrate on the following areas of research: Construction Engineering, which includes research on construction methods, architectural performance, material properties, concrete, and construction management; Structural Engineering, which focuses on steel structures, earthquake engineering, building structural engineering, and civil structural engineering; underground Engineering, which explores rock mechanics, groundwater hydrology, soil dynamics and aseismic engineering, foundation engineering, soil engineering, soil dynamics, and cold regions engineering; Environmental Engineering, which researches acoustics, air technology, fluid dynamics, ocean environment engineering, water environment, human science, and social science; Facility Engineering, which looks at facility systems, HVAC, electronic facilities, and information facilities; planning Engineering, which includes fire safety, information systems, and architectural design methods; Advanced Technology which consists of research on advanced materials, applied biology, and applied physics and radiation; and finally Technology Development Engineering which researches applied technology, large-scale testing, vibration testing, and material testing

The institute began with 3 researchers and has grown to over 350 today. Research and development is conducted for Shimizu projects and joint projects for other organizations while Shimizu’s consulting practice offers appropriate advice and technical assistance. The institute shares the results of its work by participating in academic societies, presenting technical papers at domestic and international conferences and publishing its findings in various journals.

In addition to the visit to the Shimizu Institute of Technology, I was able to see the Shimizu offices at Seavans South in Tokyo. This was a perfect example of the Japanese style of management in terms of office layout. As opposed to the American style of office layout in which employees are often isolated from each other in separate offices or cubicles to ensure privacy, the Japanese office layout consists of a large open room with managers seated at the end of the rows of their employees.

This allows for the managers to be interactive with their subordinates while also giving an environment conducive to teamwork.

JAPANESE CULTURE AND ITS EFFECTS ON BUSINESS PRACTICES

Throughout the history of Japan, almost all construction work has been carried out solely by Japanese contractors. Therefore, opening the Japanese construction market to foreign companies will have an enormous impact on the owners and contractors in Japan. The Japanese construction management system comes from the traditions of trade and from government regulations, and it will have difficulties adopting the international system quickly. The official

position of the Ministry of Construction is that the Japanese construction market is open to all firms, with its system in no way discriminating between foreign firms and domestic companies. Japan has instigated Major Project Arrangements (with pressure from the United States) to facilitate the participation of foreign companies and had developed a guide for foreign companies to conduct construction business in Japan.

The business practices of Japan are a kind of heritage rooted in Japanese history and culture. This is the reason why it has been so difficult for American companies to break into the Japanese construction industry. There are obvious differences in the business practices of Japan and the United States.

For example, business viewpoints in Japan seem to focus on the long term scenario while Americans often focus on the short term viewpoint. The costs of marketing the United States often seem to limited by strict budgets whereas marketing costs are more flexible in Japan. In terms of the client’s needs, extra services are usually charged in the United States while they are free in Japan, As for business proposals, resume experience and the description of services are important in the United State while the description of what to do and how to do it from the client’s viewpoint is emphasized in Japan.

In Japan, winners and losers are not distinguished as in the United States. The Japanese system allows the work to be spread out between all companies. Reputation is essential for a company to succeed which comes from providing superior quality. Superior quality comes from employee dedication at all levels. Lifetime employment is still prevalent in Japan as both the employee and employer are dedicated to each other. Many engineers explained their rituals of working long hours for their employer at their own free will. Also, many engineers are expected to spend time contributing to the industry through involvement with professional organizations.

The key to working within the Japanese culture is to first understand it. American firms are learning that it takes time to establish relationships and reputations within Japan. There are characteristics of Japanese projects that American firms must learn about before considering involvement in the Japanese construction industry. The first priority is the client's budget. Propose what can be done within the client's budget, then propose what is the best approach and the cost associated.

Next is overcoming the language barrier. Be prepared to conduct business activities in Japanese. This includes meetings and reports. Once a foreigner can be accepted by Japanese society, his future is secure. American companies need to understand that Japan's business policy is "everyone gets a fair share of the work" in contrast to the American policy that "everyone gets a fair opportunity to go after the -work." Japan is a country with a well rooted culture but at the same time very internationalized. Foreign countries can take advantage of this fact. This knowledge can be advantageous for business opportunities in other countries as well.

For example, Thailand, the Philippines, and Indonesia are developing as rapidly as Japan was thirty years ago.

SUMMARY

Japan has excellent standards of civil engineering and construction technology. Such conditions as heavy seismic activity, poor topography, difficult soil conditions, and high population density have forced Japan to develop advanced civil engineering and construction technologies to overcome such conditions. Techniques in land reclamation, tunneling methods, innovative bridge structures, and methods for improving soils conditions are just a few examples of the high level of civil engineering and construction in Japan.

Japan has many American influences and has studied the American civil engineering and construction industries well. Hopefully, Japan can continue to improve market access to its construction industry and understand the frustrations of foreign companies. Exchanges such as this study tour will continue to facilitate the learning process between Japan and the United States.

Small reception for Mr. Thompson with JSCE members at JSCE Library Bldg.

Although Japan is a beautiful country and has a fascinating culture, the people left the biggest impression on me. It was a pleasure to meet so many kind and interesting people who have a genuine mutual respect for each other. As for my travels, I was given the opportunity to see anything of my choice under a complete "open-door" policy. I am grateful to all the participants of the tour as they were extremely accommodating without exception. Finally I would like to thank the Japan Society of Civil Engineers. Their cooperation and capable staff made the study tour a success. My personal guide for most of the tour made it comfortable and enjoyable. Not only was this study tour an incredible opportunity for myself to learn about civil engineering and construction in Japan, it was an excellent example of Japan's efforts to promote the exchange of information between the two countries.