A STUDY ON THE JAPANESE CONSTRICTION INDUSTRY REENGINEERING BASED ON THE LOGIC AND PRACTICE OF CONTRACT ADMINISTRATION

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Since industrialization started in the Maiji Era, the people working in Japanese construction industry have been created advanced construction technologies for infrastructure development. And now they keep the top level construction technologies in the world. However, it hardly says that they have enough ability and knowledge about the project management techniques that many people who work in international construction market place have. It is a kind of miracle that the people in Japanese construction industry have successfully been carrying out megaprojects related to infrastructure development without such ability and knowledge. After the babble economy busted way in the beginning of 1990s, the industry environment of Japanese construction industry had drastically changed. Japanese construction industry had been moving and developing on the base of "the principal of cooperation" with the idea of mutual trust. However, the industry has been compelled to change the base and principal from "cooperation" to "competition" by the new industrial envelopment.

Key words : International construction management, civil engineer, project management, engineering education

. Introduction

Asia is the most active area in the world now. Needless to say, without proper development of infrastructures, a country can not be developed. Japan has been acting as the leader of economical development in Asia since middle of the 20th century. In 1950s, she was one of the least developed countries (based on the GDP per capita) in the world but she made remarkable development from 1960s to 1980s. During such period of time, Japanese construction industry had been developed many construction technologies. Those technologies have been expanded and transferred to other Asian countries through commercial activities and ODA (Official Development Assistance) scheme.

It can be said that most of megaprojects in Asia have been carried out with construction technology created by Japanese construction industry. But nowadays other Asian countries such as Korea, Taiwan and China are catching up level of the Japanese construction industry.

What we need to do is how to consider the construction technology that will be required for execution of megaprojects. The execution of megaprojects requires not only advanced pure construction technologies but also advanced project management technologies as well.

In accordance with the size of infrastructure projects is getting to be bigger and content of the projects is getting to be complicate, the risk impact is going to be big. This paper introduces some megaprojects and the movement of project management technology development in Asia.

2.Infrastructure development projects in Asia

2.1.Contemporary situation in Asian countries

It is necessary to go into more details about the economical activities in the region of ASEAN+6. Fig No.1 is showing the history of GDP of countries in the region. Although the now leaders in Asia, such as Korea, China and India are producing big amount of GDP after 1990s, from 1960s and up to the middle of 1990s majority of GDP in this region had been created by Japan.

Actually Japan made remarkable development and also made great contribution for economical development in this region through commercial activities and ODA schemes. After the World War II, like other industries, Japanese construction industry had been spending great effort to create practical and effective construction technologies for Infrastructure development and those technologies have been transferred and expanded into other countries in Asia. The first step of activity for transferring and expanding advanced construction technologies from Japan to Asian courtiers was through implementation of infrastructure

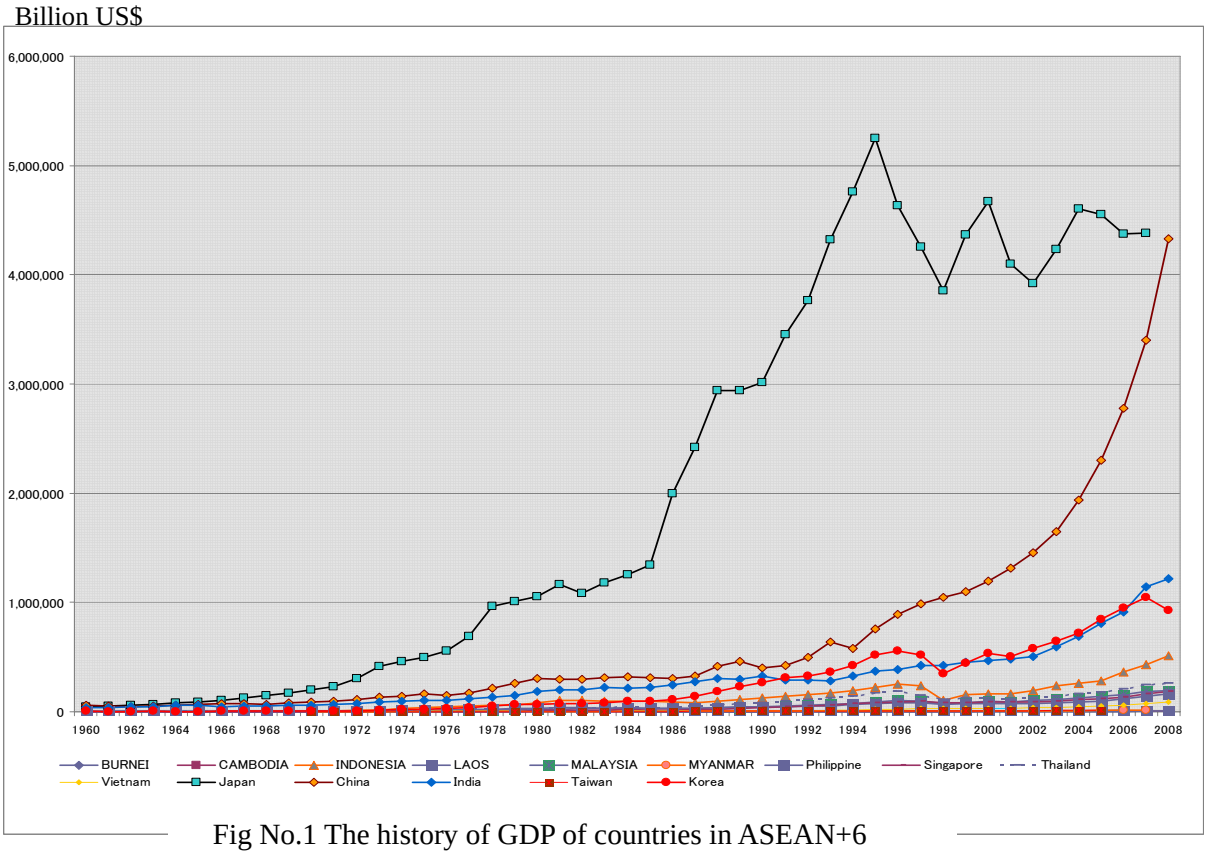

Fig No.1 The history of GDP of countries in ASEAN+6

projects as reparations for war loss. Actually you can see many kinds of advanced construction technologies those were originally coming from Japan and are now applying for big projects in Asian countries.

2.1↜ Mega-projects carried out by using construction technologies.

1) Taiwan High Speed Rail (THSR)

Taiwan High Speed Rail (THSR) is a high speed railway network approximately 340 km long and it connects the capital city Taipei and the second biggest city Kaohsiung in Taiwan. It runs along the west coast of Taiwan with maximal sped 300 km/h. THSR is based on Japan Shinkansen (High speed railway) system which was built in early 1960s. The Ministry of Transportation, Taiwan officially started to study the implementation of this megaproject in 1990 and it was decided to execute under the BOT scheme by the government in1993. The Taiwan High Speed Rail Consortium (THSRC) was selected as the SPC (special purpose company) for this project in September 1997.

The original SPC plan presented to the government was based on the high-speed technology platform of Eurotrain but in December 2000 THSRC finally decided to select Japanese Shinkansen system. In case of Japanese Shinkansen system is applied, most of civil structures such as bridges, viaducts and tunnels will be able to be downsized compare with European systems kike TGV France and ICE Germany because the rolling stock of Japanese Shinkansen system has less gravity that is about 83% of TGV France and 77% of ICE Germany in case of that this a train is composed of ten cars, and it has much higher resistance to the pressure arise when the train is going though tunnels than European systems. However, the civil works had already started in March 2000 before the system was sifted from European system to Japanese Shinkansen system. Another

Taiwan High Speed Rail

The photo and the map of THSR from Wikipedia

problem is Taiwan High Speed Rail is using track maintenance devises manufactured in Germany although it has the rolling stack manufactured based on Japanese Shinkansen system.

The total cost of this project was estimated to be US$ 18 billion and operation started in March 2007. In case of a train composed of ten cars, Shinkansen train can carry passengers about 1.5 times more than ICE and 1.7 times more than TGV. Although the project has this kind of advantages and the construction work was well managed but it is difficult to say whether the operation will be going well or not. The total cumulated loss up to 2009 is approximately 2 billion US$ that is almost 66% of the capital. This project may be one of the cases that a mega-project had a problem of decision making due to a political issues.

2) Honshu Sikoku Link in Japan

Akashi Straits Bridge is the longest suspension bridge in the world. Total length of this bridge is 3,910 m and it has 1991 m central span. The bridge was opened in April 1998 and it carries a part of the Honshu Shikoku Highway. The bridge links Kobe city on the mainland of Honshu to Awaji Island. The total construction cost of this bridge was approximately 5 billion US$. Awaji Island and Shikoku Island are connected by another bridge named Oho-Naruto Bridge. The preliminary planning and investigation of Akashi Straits Bridge was started in 1955 by the National Railways. The Ministry of Construction commenced the planning and investigation for making this bridge in 1959 and those works had been continued for about 10 years up to end of 1960s.

The special organization named Honshu Shikoku Bridge Authority was established in 1970. Many kinds of trial construction works were carried out in laboratories and at the bridge construction sites. The authority was spent almost 20 years period of time for basic design, site investigations and preparation of the construction works. The original design of this bridge was the double decks for vehicles and railway but it was modified from 2 decks to 1 deck only for road use for reducing its cost. Many capable engineers not only working for the public sectors, but also for private entities including big construction companies were hired by the bridge authority. The bridge construction works were started in May 1988 and it required another 10 years period of time to complete the construction works. During construction stage, a big earth quick magnitude of 7.3 occurred in this area in January 1997. The center of the earthquake was located just under the bridge and the bridge span was expanded 1m due to seabed movement. However it was not observed damages and problems. Finally the bridge had been opened in April 1998.

Three bridge connection routes were built in between the mainland of Honshu and Sikoku Island. Akashi Straits Bridge is on the key links named Akashi- Naruto link. There is another bridge named Oho-Naruto Bridge that has 1,629m span on this link. The Construction work of Oho-Naruto Bridge was started in July 1976 and completed and opened in June 1985. This bridge has the double decks for vehicles and railway but only upper duck is being used for vehicles now. The lower deck that must be used for Shinkansen (high speed railways) has not yet been used. It is strange that why the bridge authority did not change the design from 2 decks

to 1deck. The authority says that it will be used when a railway bridge or a tunnel is constructed in between the mainland of Honshu to Awaji Island. Nobody knows when it will be happened. The total cost of this link Akashi- Naruto is about 15 billion US$. Other 2 links like Sakaide-Kojima link that is road and railway used 11.2 billion US$ and Onomichi – Imabaru link that is road link used 6.9 billion US$. The authority had been getting heavy debt since the start of its operation. The government decided to undertake its debt in May 2003.

3) The Tokyo bay link road

The Tokyo bay link road named Tokyo Bay Aqua-Line was constructed in between Kawasaki city in Kanagawa prefecture and Kisarazu city in Chiba prefecture. The link has15.1km total length and consists of an under sea tunnel and bridges as shown on Fig. No 2. This link road was originally planned in 1966 but construction was started only in July 1987.

Before the construction work was started special project execution organization named Trans-Tokyo Bay Highway Corporation was established in October 1986. The project was completed in March 1997. It had taken 9 years 8 months period of time to complete the project.

Although this project created many kinds of new construction technologies, however it spent big amount of construction cost totally US$ 14.4 billion. It is close to 4 times as much as the Sund Link Project that was built between Copenhagen in Denmark and Malmo in Sweden.

The capital city Tokyo has 2 subsidiary cities Yokohama and Chiba. This link was planned to reduce the volume of traffic between these 2 cities through downtown Tokyo, but it has not yet been as great as expected. The reason is the high toll rate. Due to increase the construction cost, the toll rate had been been set up 4,000 Yen (approximately 40 US$) for normal size sedan vehicles. It was reduced from 4,000 Yen to 3,000 Yen but it is still very high.

This project created and developed many kinds of new construction technologies that can

Fig. 2 Tokyo Bay Aqua-Line

be applied to following projects not only in Japan but also in other countries in Asia. However, there are several questions come out if it is evaluated from project management point of view.

The first question is why this link does not have railway. It takes about 1 hour 30 minutes when you take train trip from Kisarazu station to Tokyo station but from Yokohama station to Tokyo station takes about 30 minutes. It takes about 2 hour when you want to go Haneda Airport that is mainly used for domestic airlines from Kisarazu station. However, Yokohama station to Haneda Airport takes only 35 minutes. These circumstances create quite big difference in the assessed residential land value between Yokohama city area and Kisarazu city area. The assessed residential land value in Yokohama city area is about 5 times as much as Kisarazu city area. If the link has railway, it can make a loop line around Tokyo bay area and the time from Kisarazu station to Tokyo station will be roughly 40 minute and to Haneda airport will be only 20 minutes. Moreover when you see going to the international airport, it takes 1 hour 30 minutes from Yokohama station to Narita airport station but it will be possible to take 50 minutes from Kisarazu station to Narita airport station when the loop line is built. Kisarazu city area will be very convenient and will be one of the best areas for the people who want to work in the capital Tokyo.

Although Tokyo Bay Line has a room for expansion from a 2-lane to a 3-lane, but it does not have room for building railway. People say that after the national railway was revitalized, the discussion for the co-development road and railways had been difficult.

The second question is that why these projects Tokyo Bay Line and Honshu – Sikoku link projects could spend such a big amount of money. In order to have better understanding of the project expenditure it is essential to analyze the other circumstances like political economy when these megaprojects were executed., The Japanese government had been facing to a big issue requested by the U.S. government at the time when these projects were started. In 1985, the negotiations on trade imbalance problem started at vice ministerial level in between Japan and U.S. This negotiation had been expanded to the Structural Impediments Initiative (SII) and continued until 1994.

The U.S. asked Japan to allocate 10% of total GDP of the country for the domestic infrastructure development projects. Japanese government responded to the U.S. demand and expressed her willingness to allocate approximately 4,300 billion US$ equivalent Yen to domestic infrastructure development projects in 10 years period of time. The negotiation had been continued until 1994 and finally the amount had been increased up to about 6,000 billion US$ equivalent Yen.

As already mentioned before, Trans-Tokyo Bay Highway Corporation was established in 1986 and construction was started in 1987 and completed in 1997. The Akashi bridge construction works were started in 1988 and completed in 1998. These megaprojects also had been executed under the quite big influence of sociopolitical issues. The Japanese construction industry could create advanced technologies in pure construction method. However, the industry had less awareness about the cost performance. Consequently the industry had a problem for building up the competence in the international market.

4) Seikan Under Sea Tunnel

Tsugaru Channel is located in between Honshu Island and Hokkaido Island. People who wanted to go to and come from Hokkaido needed to get a ferry trip between Hakodate and Aomori for crossing the channel. However it was not a safe trip because of frequent turbulent waters in the channel.

In September 1954, a big typhoon hit the channel and total of 5 big ferries were sunk in the sea and one of them named Toyamaru was carrying more than 1,200 passengers and most of them were killed. The total victims had become totally 1,430 people by this big typhoon. The plan to connect Hokkaido and the main island Honshu by an under sea tunnel was conceived before World War II. This ferry accident occurred just 9 years after the war ended when Japan was still in big chaos. The people’s desire to realize the tunnel was expanded by this disaster. The Japan Railway Construction Corporation was founded in 1964 and the construction work related to the investigation of inclined shaft on the Hokkaido side was started by the corporation.

The Japan Railway Construction Corporation carried out necessary investigation works, construction of inclined shafts and the pilot tunnels by itself. It also had done the preliminary works of the work tunnel before contracting with several groups of contractors for the work tunnel

and the main shaft tunnel. It was needed to overcoming many difficulties and failures until the main shaft tunnel was opened. In March 1985, the main shaft was opened and the service operation was stared in March 1988.

The Seikan Tunnel is railway tunnel and runs beneath the seabed of the Tsugaru Strait. It connects between Aomori City in and Hakodate City. Fig No.3 is showing the tunnel section profile. This tunnel is the longest tunnel in world and the total length of the tunnel is 53.85 km and it's under sea portion is 23.3 km. Incidentally, The total length of Euro Tunnel which opened in 1994 is 50.5 km and the under sea portion is 37.9 km. The tunnel was designed to meet Shinkansen (high speed railway system) specification and the main tunnel gradients are approximately 12‰ (1.2%).

The Author found that the General Conditions of Contract made in early 1960s were used for Seikan Tunnel Project. At the present time Japanese construction industry has just one type of standard conditions of contract that is based on Lump sum contract. However, it was a surprise for the author that the General Conditions of Contract that was used to Seikan Tunnel Project was based on re-measurement contract. The author found that it is quite similar

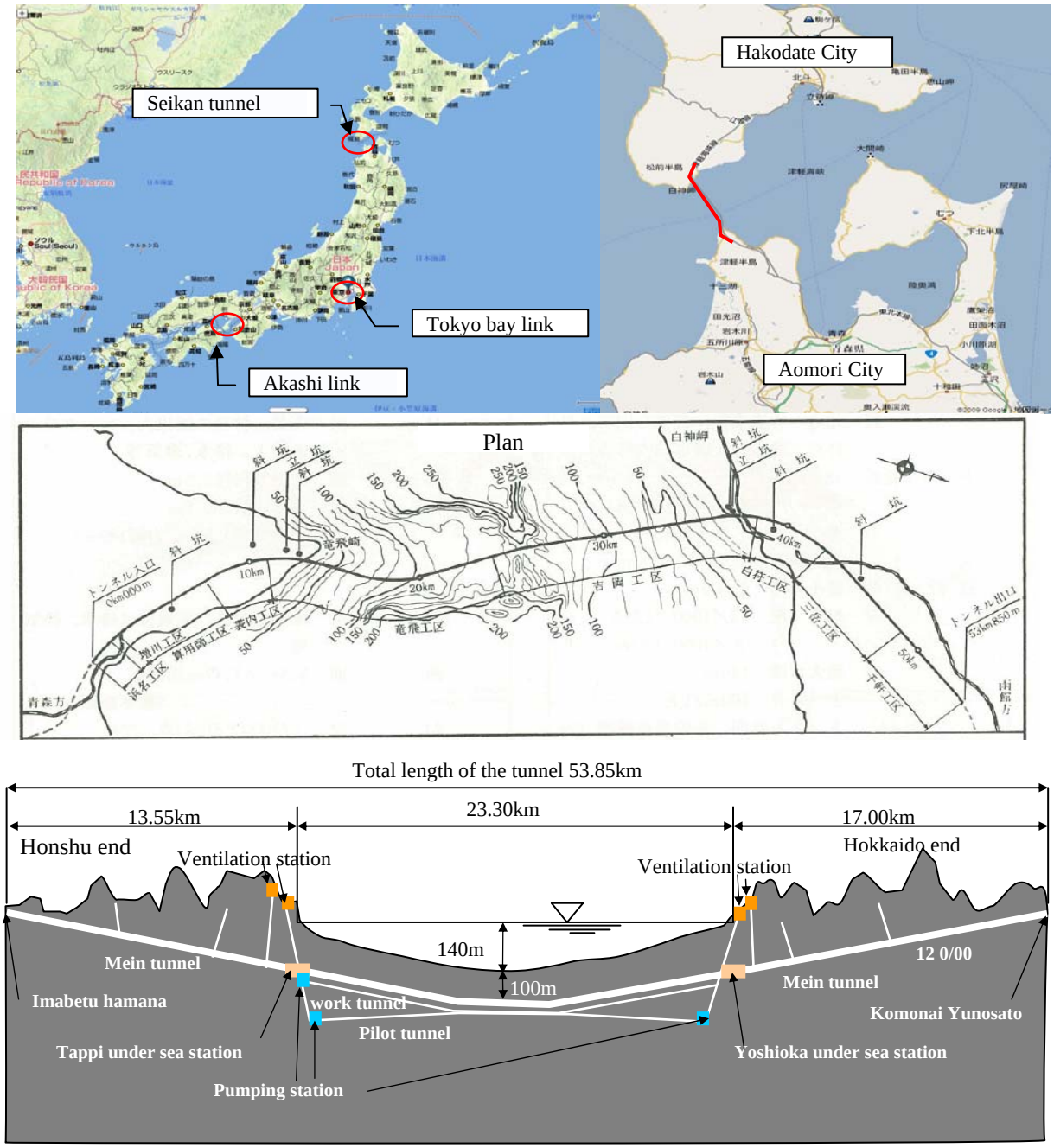

Fig. 3. The Plan and Seikan Tunnel section profile

to FIDIC General Conditions of Contract for civil works so called the Red book and it had incorporated quite reasonable conditions applicable for price adjustments. Although it was needed 6.9 billions US$ equivalent Japanese Yen for construction and Shinkansen has not yet been operated, function of this tunnel is quite big for giving safe journeys to the people.

Authors studied Honshu Sikoku Link, Tokyo Bay link and Seika under sea tunnel as the typical megaprojects in Japan. It can be found a common practice to carry out megaprojects that is to establish a special project execution body like Honshu Shikoku Bridge Authority, Trans-Tokyo Bay Highway Corporation and The Japan Railway Construction Corporation.

These organizations carry out not only preparation works at the starting phase of project like a basic planning, financial arrangement, conceptual design, land acquisition, geological exploration, but also trial construction, to execute initial part of construction works for finding appropriate construction method and scheme. During execution of these activities the organizations try to realize and treat many kinds of unforeseen matters. In other words project execution bodies try to mitigate considerable risks before they hand it over to the contractors. This is the way and reason why megaprojects carrying out smoothly and precisely in Japan. However, it should be evaluated from cost effectiveness point of view.

5) Bosporus crossing Railroad Tunnel

As already mentioned in the introduction, one of the megaprojects named Bosporus Crossing Railroad Tunnel is now being carried out. This project is carrying out under ODA; Official Development Assistance scheme. The Bosporus Strait is located in between Sea of Marmara and the Black Sea. Its total length is approximately 30km and separates Istanbul City from the Asian side and the European side. There are bridges that connect the Asian side and the European side in the city but the city has no railway connection lines. The people in the city only use vehicles as the means of transportation. The city has the chronic traffic jam and heavy air pollution. The construction of this undersea railway tunnel provides the better environment and life for the people in Istanbul city.

The planning and basic design of this project was made by consultant team consist of 3 Japanese consultants and 1 Turkish consultant. Japanese and Turkish contractors' consortium is carrying out the design and construction of the main civil works as the EPC contractor. The main civil works of this project needed to require quite high level of technologies for design and construction especially for under sea portion. The project area is located in an earthquake belt where it will get a seismic intensity of 7.5. The Bosporus Strait is one of the most congested international marine traffic waterways in the world. Approximately 55,000 ships and 260,000 local vessels are passing per year. The main part of this tunnel is immersed tunnel connecting 11 elements of total length 1,387 meters and is sunk under the sea.

This tunnel shall be the world deepest immersed tunnel. The deepest part of this tunnel will be about 60 meters under sea level. Each element of immersed tunnel is made by steel reinforced concrete of 135m length ×15.3m width×8.6m height produced in a dry dock. The elements are towed from the dry dock to the construction place and set out on the designated positions about 60 meters the bottom of the sea and connected each other.

The tunnel elements shall be set under the condition of around 3 knots current speed in general, and in case of adverse weather reaching of highest current speed will be 6 knots. Moreover the flow of the lower-layer is in reverse phase with the upper-layer. It is required complicated security control and risk management of the international navigation and the local traffic. Actually many new technical developments have been made by EPC contractor for carrying out works under the difficult site conditions and all 11 elements were successfully set out in October 2008. The project is still in complicated construction stages such as connection between Immersed Tunnel and TBM Tunnel, but the contractor has already innovated special method and technology for it. However, the EPC contractor has been in difficult situation since the project started even though he has enough technical capacity for caring out the project. The contractor has needed to cope with many difficulties not only pure technical matters but also related to various kinds of social matters. The main civil contract was signed in May 2004 and the contract amount was approximately 10.3 billions U.S.$. The General Conditions of Contract applied to this project is FIDIC EPC/ Turn Key Contract so called Silver Book. The original construction period stipulated in the contract was 56 months that was from August

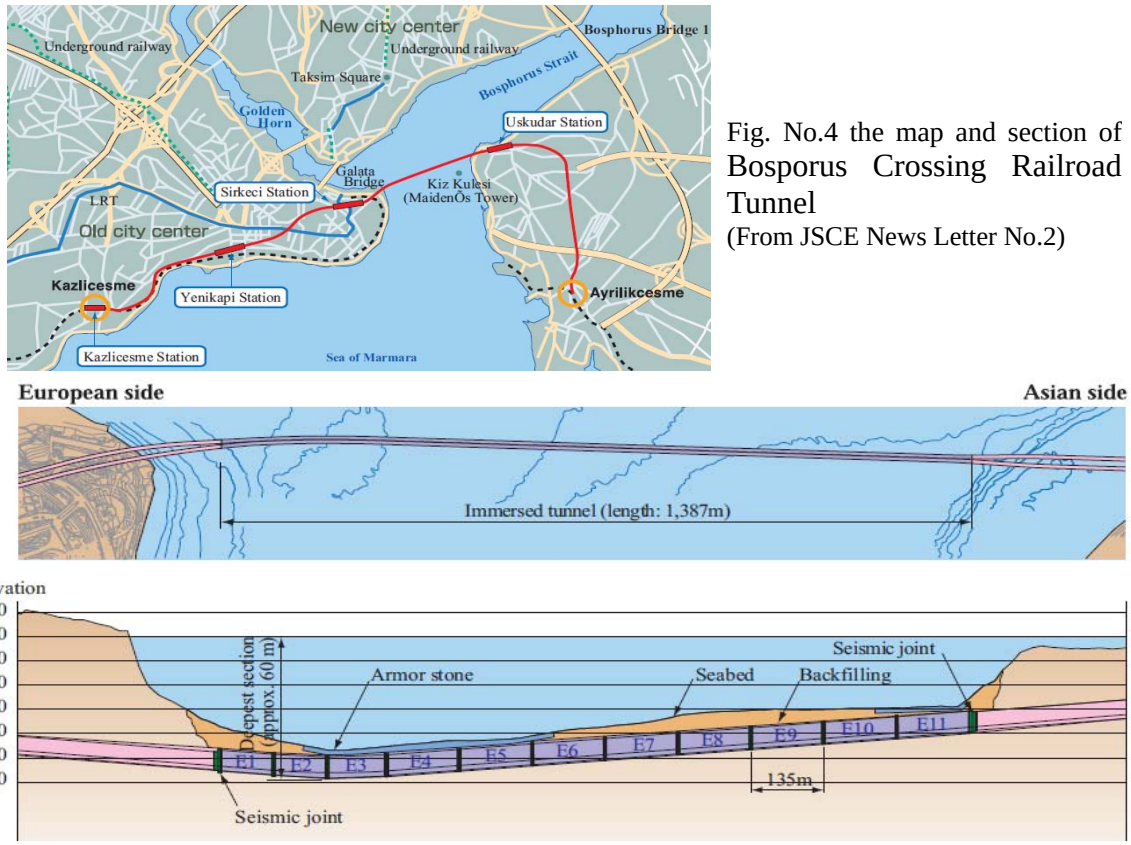

Fig. No.4 the map and section of Bosporus Crossing Railroad Tunnel
(From JSCE News Letter No.2)

2004 to April 2009. However, it was extended from 56 months to 110 months and the contractual completion has been changed to October 2013. The main reason of extension of the construction schedule is funding the cultural heritage of the country. It is essential to set up a steady corroboration in between a project owner and a contactor when a project encountered this kind of situations.

However, it is not well treated this kind of situations in the FIDIC Silver Book. EPC contract is usually applied to power plants and chemical plants. These kinds of projects have considerable risks but those risks shall be in the manageable range by experienced contactors.

It is a quite big question that whether the people planned Bosporus Crossing Railroad Tunnel project had known the EPC contract dose not suit to the project that has considerable uncertainties such as the existence of the cultural heritage of the country.

4. Reconsidering about the base of Megaprojects execution

1) The analysis of the problem that Japanese construction industry has.

Why does the Japanese construction industry not create the competence in the international market place although he has highly advanced construction technologies? The answer is very simple because that the industry does not have appropriate project management technologies required for the international market. Then next question is come out why the industry does not have it. As discussed above, in case of infrastructure development in Japan, the public sector and private sector had been working together. However the problem is that the industry has been keeping a way of “a household industry”.

People say that the construction industry in Japanese is like “an armed convoy”. It is quite good thing for proper execution of the project that the project owner and the contractor work together and help each other. However in case of infrastructure development projects in Japan, the project owner who is the public sector has a mind not only to help the contractor but also strong desire to keep his power for controlling his contractors.

It is just like a father has a mind to help his suns and daughters but also has a strong mind to control them. The problem is that the father does not want to change the present systems because he wants to keep his presence in the family although the structure of the family and the social circumstances has already been changed.

2) Project Management required for carrying out Megaprojects

It is quite usual that with the increase in size of a project the ratio of difficulties coming out from social matters will be higher and the proper execution of the project will be more difficult. That is why the knowledge and techniques related to project management are essential for carrying out megaprojects. Like in case of Bosporus Crossing Railroad Tunnel project, difficulties coming out from social matters are very difficult to manage by a contractor alone. To minimize the effect/impact coming out of this sort of problems, the project must be well planned and needed to evaluate risks related to social matters. For that purpose, the people especially civil engineers who implement megaprojects have to have knowledge of social science and cultural activities. It should be integrated to the role of engineers and the meaning of civil engineering and to make sure these matters for conforming to this requirement. It is also necessary to reconsider the meaning of infrastructure development.

3) Considering the main object of civil engineering

Civil engineering is one complete set of technology using for setting up structure for the public welfare and development own country. It consists of various kinds of technologies such as soil mechanics, hydrodynamics, river & coastal engineering, steel and concrete structure, disaster preventive engineering, traffic engineering etc. When you ask a civil engineer regarding the definition of civil engineering, he may answer you like this. Many people in the present civil engineering field will agree with his answer. However, this understanding is just seeing part of civil engineering shape. It must be understood like a tree showing in Fig.5.

Technologies above mentioned are connected on a trunk and the trunk has become deeply rooted in the social sciences field. This understanding can be applied to other field of engineering but in case of civil engineering field it becomes much more important and realistic because civil engineering is directly related to the society. Judging from this sort of consideration, it is clear that infrastructure development must be done with not only engineering mind but also with the social science mind as well.

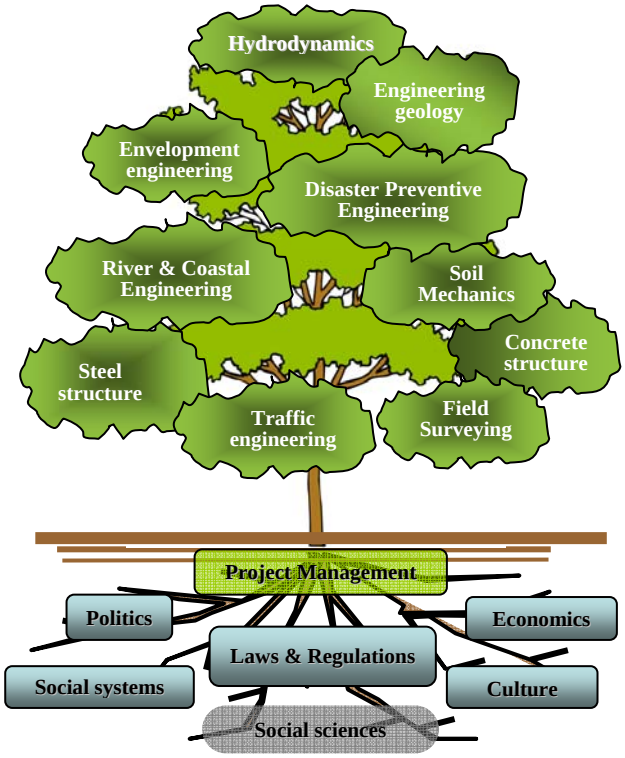

Fig. 5. Real shape of Civil Engineering

However, it is hard to say that the present civil engineering observed in Japan is equipped with above mentioned concept.

3) Social activities and those supporting System

As already mentioned above, infrastructure is something that enhances the public welfare and development of a country, and the welfare shall be to satisfy the public requirement for physical, economical, cultural and environmental aspects. Based on this understanding, the author tried to describe the basic concept of infrastructure as shown on Fig.No.6.

A society will move with several activities such as economical activities, political activities, cultural activities, activities of living things, natural activities, etc. These activities

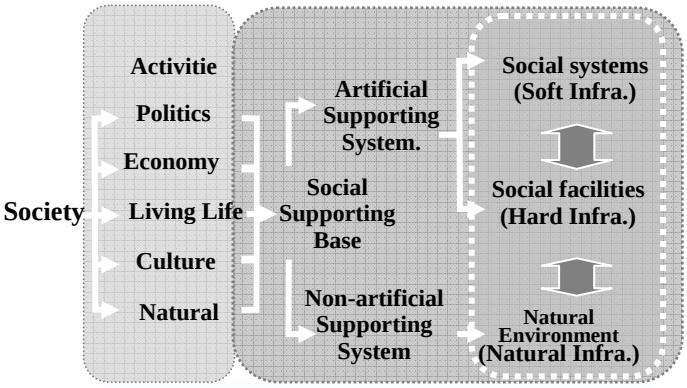

Fig.6. Social Activities Supporting Structure

are interacting with each other on the base that the author calls 'Social Supporting Base'. This base consists of 2 different kinds of basic systems, one is the artificial supporting system and the other is non-artificial supporting system. Furthermore, the artificial supporting system consists of the social systems that may be called "Soft infrastructure", and the social facilities that may be called "Hard infrastructure".

Non-artificial supporting system, on the other hand, can be described as "Natural infrastructures". This concept says that a society is supported by the Social Supporting Base and its base is supported by 3 different kinds of infrastructures.

What described on the Fig.No.6 will be the real meaning and concept of infrastructure that civil engineers need to realize. More over, the important thing that you need to understand is that these 3 different kinds of infrastructures should not be planned, built and operated individually. They must be handled with the idea of correlativity. For example, when you need to build a school, you need to consider the natural environment and also social systems like education systems, security systems, medical care systems, etc. It is considered that this kind of understanding regarding civil engineering and infrastructure will be required for panning and executing megaprojects especially in developing countries.

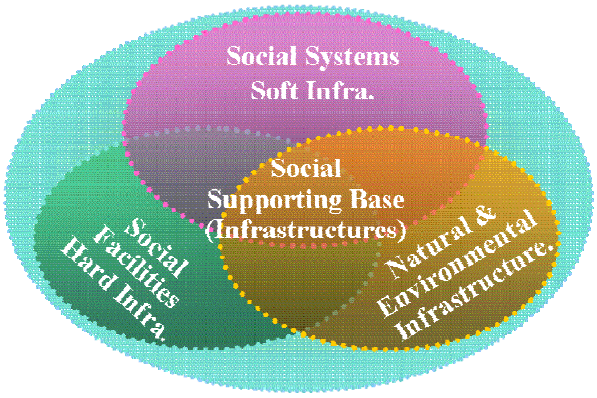

Fig.↕ . The real Shape of Infrastructure

6. Conclusion

As discussed in this paper, it is expected that many infrastructure projects will be carried out in Japan in this decade. The people who are implementing those aprojects are required to manage problems and to overcome various difficulties not only coming out pure technical areas but also related to social matters.

The problem is that how to develop appropriate project management systems and the human resources required for the projects. It is unavoidable tasks for the people, who are in charge of construction projects to manage the field activities where mutual mistrust among stakeholders exists, but at the same time it is desirable to reduce the resources needed to manage such mistrust as much as possible. The authors do not say that the people in charge of infrastructure project need to move into the field where mutual mistrust exists. The authors believe that creating a trust by respecting the professional abilities among the stakeholders is the basic matter for proper project execution especially in the case of implementation of a megaproject. The authors also believe that it is a challenge that civil engineers in Asia need to do.

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