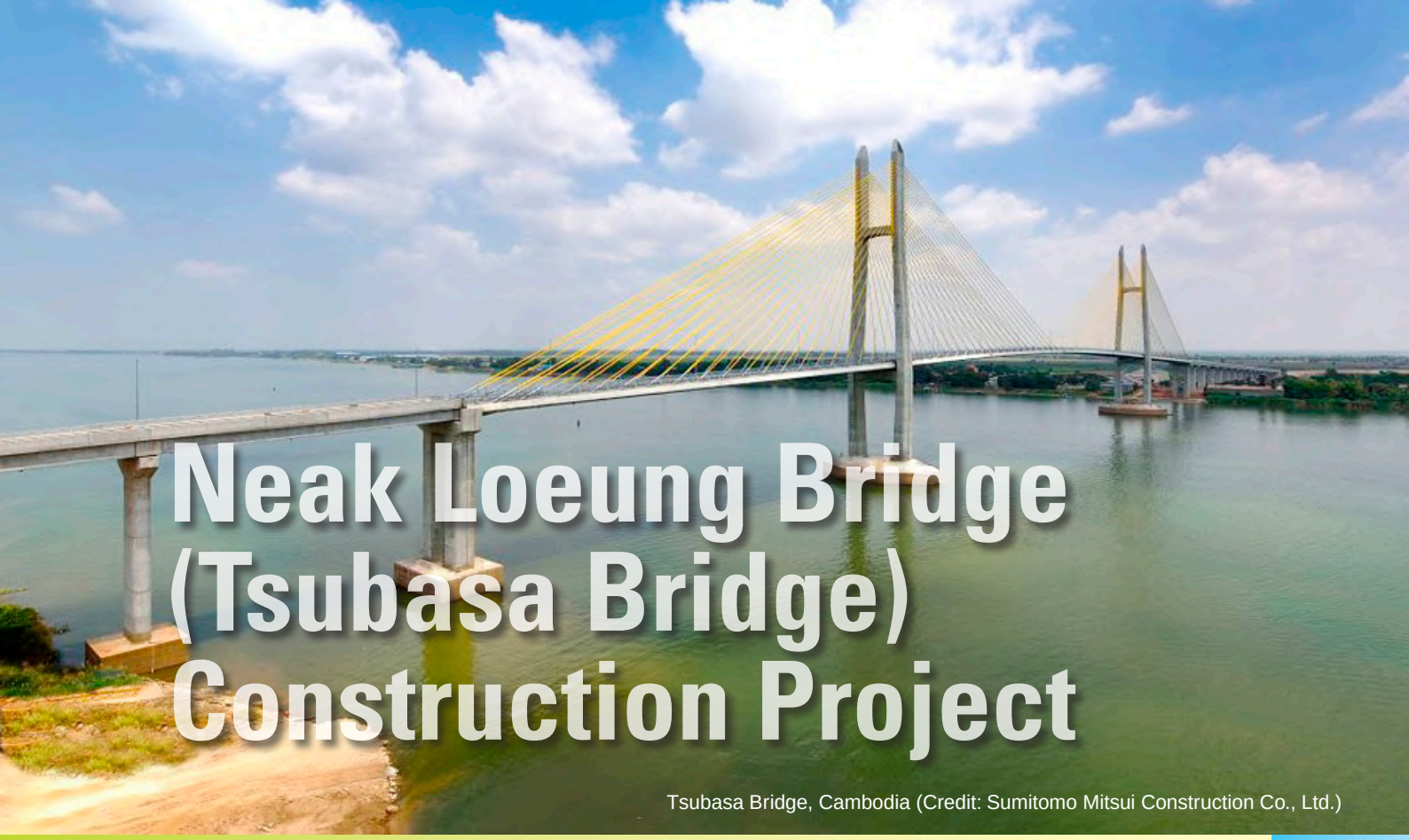

Neak Loeung Bridge (Tsubasa Bridge) Construction Project

Tsubasa Bridge, Cambodia (Credit: Sumitomo Mitsui Construction Co., Ltd.)

Reasons for taking up this project

The Tsubasa Bridge in Cambodia is a bridge spanning 2,215 meters that opened to the public in April 2015. As well as resolving the bottleneck of the Southern Economic Corridor connecting Vietnam, Cambodia, Thailand, and Myanmar and contributing to improved regional connectivity, the Tsubasa Bridge continues to have a significant impact from the viewpoint of securing basic human needs, such as improving the reliability of medical access for local residents, with it now being possible to cross the Mekong River 24 hours a day, 365 days a year.

The Japan Society of Civil Engineers decided to feature this project in its archive for the following reasons.

1) This project saw the development of economic corridors connecting the six countries and regions that make up the Greater Mekong Subregion (GMS). This project can be said to be the flagship of the Southern Economic Corridor connecting Vietnam, Cambodia, Thailand, and Myanmar, which are countries that Japan has continued to support under the framework of the Greater Mekong Subregion, and that it embodies the “high-quality infrastructure” promoted by the Japanese government.
2) In Neak Loeung, the fluctuation of water levels between the rainy season and dry season is 7.5 meters, and the difference in water volume is 11 times. It is also a large-scale project to build a bridge across the Mekong River, a huge river with harsh natural conditions that are unprecedented in Japan, such as the 40 meters of riverbank erosion witnessed just 5 years.
3) It is a project that took more than 10 years from the start of the initial study to the completion of the construction, and it was completed by carefully conducting the decision-making process from the viewpoints of the environmental and social considerations.
4) After overcoming the impact of land mines and unexploded ordinances (UXO), which are still the negative legacies of Cambodia, figuring out how to successfully construct the bridge, and approximately 8 million man-hours of no casualties, the project was completed within the scheduled construction period.

1 Project Background

April 6, 2015. This was the day the inauguration ceremony of the Tsubasa Bridge was held in the presence of the prime minister of Cambodia, Hun Sen, and then Deputy Minister for Land, Infrastructure, Transport and Tourism, Nishimura Akihiro. At the ceremony, Prime Minister Hun Sen said, “In December 2001, the first bridge (the Kizuna Bridge) over the Mekong River was completed with the assistance of Japan, and at that time I mentioned that we would like to build another bridge. I am very grateful that the Tsubasa Bridge was completed with the support of Japan.” At the Seventh Mekong-Japan Summit held in Japan in July 2015, the then Japanese Prime Minister Abe Shinzo announced that Japan would ‘strengthen connectivity as a pillar of cooperation between Japan and Mekong region countries and that Japan would support the development of “high-quality infrastructure” such as the Tsubasa Bridge in Cambodia’, with this project embodying Japan’s high-quality infrastructure support (Figure 1).

Until then, those using National Road No.1 in Cambodia had to cross the Mekong River by ferry, and there were even times where one could have to wait up to 7 hours during peak seasons such as Cambodia’s New Year in April and Puchungbang (Obon holiday) in September. This is why building a bridge over the Mekong River so that it is possible to cross the river 24 hours a day has long been a dream not only for the locals but also the Cambodian people and those of neighboring countries. Thanks to the building of a 2,215 meter-long bridge, which includes a cable-stayed bridge of 640 meters. It is now possible to cross the Mekong River 24 hours a day, 365 days a year in just 5 minutes. The bridge has contributed immensely to the country’s economic development by improving the reliability of the local residents’ access to the likes of medical care, education, and workplaces, and has improved the connectivity not only in Cambodia but also in the entire Mekong region. The Economic Research Institute for ASEAN and East Asia (ERIA) predicts that Cambodia’s GDP will increase by 70% in 10 years due to the development of the Southern Economic Corridor.

This bridge is still widely known as a symbol of Japan’s collaboration with Cambodia, such as being used in the design of the 500 riel bill (equivalent to USD 0.12), which is the bill most often used in Cambodia (Photo 1).

Figure 1: Southern Economic Corridor, Tsubasa Bridge and Kizuna Bridge

Photo 1: 500 Riel Bill (Tsubasa Bridge on the left, Kizuna Bridge in the center)

❷ Project Chronology

More than 13 years passed between Prime Minister Hun Sen requesting the help of Japan in December 2001 up to the opening of the bridge in April 2015, meaning the construction took longer than a typical project backed by Japan. While it was required to open the bridge to the public as soon as possible, it took time for the Japanese government to make a decision on donating the grant aid as it was done so based on the process of a lot of dialogue from the perspective of environmental and social considerations with local residents that would be affected by the project, design policies that gave maximum consideration to mitigating the environmental impact, as well as the political and diplomatic perspectives of both Japan and Cambodia. I will introduce the backstories to these factors separately by dividing the project into the project formulation stage (highlighted green in Table 1), study implementation stage (highlighted yellow in Table 1), and construction stage (highlighted orange in Table 1). In the project formulation stage, I will also discuss the situation surrounding consideration given to the project prior to the request made by Prime Minister Hun Sen in December 2001 (Table 1).

Table 1: Chronology up to the Inauguration Ceremony of the Tsubasa Bridge

	Month/Year	Contents
-	4/1995-6/1996	Alternative Analysis at Neak Loeung (Feasibility Study for 1st Mekong Bridge (Kizuna Br.))
-	11/1998-12/1998	Project Formulation Survey by IDI
1	12/2001	Request by PM Hun Sen (at the Inauguration Ceremony of the Kizuna Bridge)
3-6	11/2003-3/2006	Feasibility Study (F/S) include Preliminary Study
6-7	11/2006-11/2007	Follow-Up Study (F/U study)
8-10	8/2008-3/2010	Preparatory Study include Preliminary Study
10	6/2010	Signing on Exchange of Notes (E/N), and Grant Agreement (G/A)
10	12/2010	Start Construction
15	4/2015	Inauguration Ceremony of the Tsubasa Bridge

2.1 First phase (project formulation stage)

From April 1995 to June 1996, JICA conducted a feasibility study for Cambodia's first bridge construction over the Mekong River. The study compared and examined the following three points as crossing points of the Mekong River: the A-1 route: Neak Loeung, the B-1 route: Prek Tamak, and the C-1 route: Kampong Cham. (https://libopac.jica.go.jp/images/report/11297223_02.pdf). Of these three points, the positives of Neak Loeung, which is the A-1 route, was that it had the largest number of potential users, was located on the Asian Highway (Southern Economic Corridor), and was easy to access because the surrounding area is not very built up. Meanwhile, the downside was that Vietnam, which is located downstream from Neak Loeung, demanded a clearance height of 37.5 meters be guaranteed so that 5,000 DWT vessels could navigate passed the bridge, and so this meant the total length of the bridge would become longer, therefore

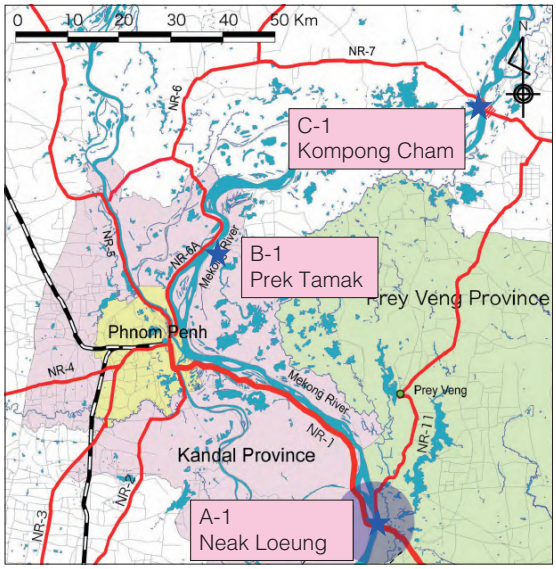

Figure 2: Alternative Bridge Sites Described in the Feasibility Study Report (the A-1 route is almost the position of where the Tsubasa bridge is now)

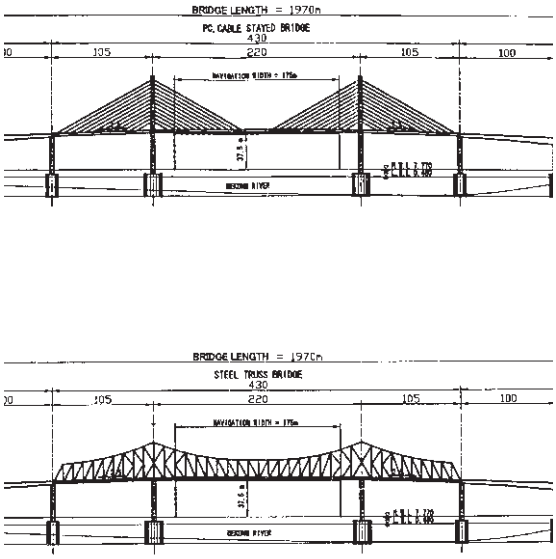

Figure 3: Alternative Bridge Types (from Infrastructure Development Institute report)

increasing the cost of the project. As a result, Kampong Cham was identified as the main candidate (Figure 2).

In 1998, the Infrastructure Development Institute (IDI) carried out the 'Mekong River Bridge Project for National Road No. 1 in Cambodia' as a project formulation study for constructing a bridge in Neak Loeung. This study looked at the economic situation and aid trends in Cambodia at that time, ascertained the status of infrastructure development, conducted a demand forecast and hydrological analysis, and ascertained the geological features of the area, etc. The position of the bridge was then selected and the bridge type was examined. For the bridge type, proposals were made for a cable-stayed bridge, an extradosed bridge, a truss bridge, and an arch bridge (Figure 3).

In December 2001, at Kampong Cham, which was proposed in the aforementioned feasibility study, the first bridge in Cambodia to cross the Mekong River, the Mekong Bridge (Kizuna Bridge), was opened to the public with help of Japan's grant aid. At the ceremony to commemorate the opening of the Kizuna Bridge, Prime Minister Hun Sen expressed his gratitude to Japan, saying, "This is the first time in history Cambodia has been united as one country," before requesting the construction of a bridge in Neak Loeung by declaring, "A second bridge is needed across the Mekong River."

2.2 Second phase (study implementation stage)

In the case of a typical grant aid project, the validity of the project is confirmed through a single preparatory study after determining the approximate project cost and the outline design (Figure 4). Then, after an Exchange of Notes (E/N) is signed between both countries, construction starts.

However, in addition to the fact that this project was particularly large in terms of scale, the heightened awareness of environmental and social considerations and the response of practical measures had a significant impact, and so multiple studies were undertaken to get the project

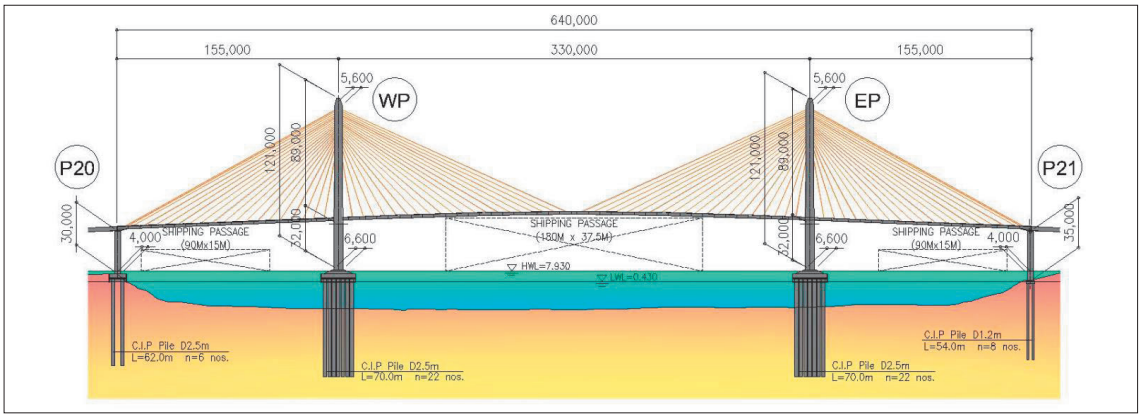

Figure 4: Final Drawing

Photo 2: Interview to Local Seller at the Ferry Terminal

Photo 3: Explanation to the Project Affected Peoples

closer to being good to go while at the same time trying to reach a consensus between stakeholders on the Japanese side as well as a consensus between stakeholders on the Cambodian side. Although an agreement was reached from an early stage on the economic effects of this project on a local, national, and neighboring country level, care was particularly paid to verifying the results of the demand forecast, the validity of the process for building a consensus among local residents and compensation for affected residents, and understanding the impact on the creatures that inhabit the Mekong River (Photos 2 and 3).

As a result, from June 2003, in which the then Foreign Minister, Kawaguchi Yoriko, declared the start of the study in her Phnom Penh policy speech 'Building Bridges toward Our Future' at the ASEAN+3 Meeting, it would take seven years until the signing of the Exchange of Notes and Grant Agreement, which would act as the official go-ahead for project implementation between the Japanese and Cambodian governments in June 2010. Initially, the aim was to complete the project by the end of 2012, but as will be described later, it was completed in 2015 (Photo 4).

Photo 4: Signing of Grant Agreement

2.3 Third phase (construction stage)

In December 2010, the Cambodian government entered into a contract with construction company Sumitomo Mitsui Construction Co., Ltd. The deadline for fulfillment of the contract was March 2015, which is before the Cambodian New Year that occurs during mid-April every year.

Sumitomo Mitsui Construction carried out the construction by way of a direct management approach with a total of 17 Japanese members (a director, a deputy director, 13 technical staff, a safety specialist, and a clerical worker), 32 engineers from countries other than Japan and Cambodia, and 107 Cambodian staff when everyone was present. The number of construction workers, including local residents, was increased to a draw-dropping 1,000 people, with the implementation of this project over the four years also making a significant impact in terms of the jobs it created.

Furthermore, at the joint venture of Chodai and Oriental Consultants Global, which was in charge of supervising the construction, Japanese engineers from the six different fields of resident supervisors, safety management specialists, bridge engineers (in charge of the cable-stayed bridge), cable-stayed bridge engineers, road pavement engineers, and electrical engineers supervised the progress of the construction work and liaised with the Ministry of Public Works and JICA.

The construction company put particular effort into safety measures for construction work. Examples include: (1) Thoroughly implementing '5.5.5' activities (the practice of safety meetings for 5 minutes before the start of work, safety inspections for 5 minutes before the start of work in the morning, afternoon, and night, and organizing, tidying, and cleaning for 5 minutes before the end of work) among all workers; (2) Improving the safety awareness of workers by incorporating a way to assess the safety and hygiene management behavior of workers every three months through introducing a worker safety point system that gives minus points for inappropriate behavior in terms of safety and hygiene management, and positive points for excellent performance and behavior; (3) Soliciting quarterly safety slogans from all workers and staff, and commending those who propose excellent slogans by giving them a monetary prize at a special safety event. Furthermore, by producing a banner with the chosen safety slogan and the name of the person who proposed it and presenting the banner throughout the construction site during the quarter, it helped to achieve 8 million man-hours without accidents and disasters as a result of improving the safety awareness of workers (Photos 5 and 6).

Photo 5: Safety Meeting (Credit: Sumitomo Mitsui Construction Co., Ltd.)

Photo 6: Awards for Excellent Safety Slogans at Safety Event (Credit: Sumitomo Mitsui Construction Co., Ltd.)

Photo 7: View of the West Side from the East Main Tower

Photo 8: Monument Installed on the West Side to Commemorate the Opening of the Bridge (Naga Statue)

Meanwhile, although a ceremony to commemorate the start of the construction was held in February 2011 and the construction had gone smoothly since then, a slight blip occurred when an unexploded ordinance exploded during the reverse pile excavation in the foundation work of the eastern main tower in July 2012. The construction was forced to be suspended for four months to investigate the cause of the incident and double-check that everything was safe. The construction period was, however, shortened with an additional budget allocation, and the inauguration ceremony would ultimately be held on April 6, 2015. In commemoration of the completion of this project, a monument made to look like paper crane was placed at the starting point on the east bank of the Tsubasa Bridge and a monument reminiscent of Naga statue was installed at the starting point on the west bank (Photos 7 and 8).

3 Project Characteristics

3.1 Support by Japan for strengthening connectivity in the Greater Mekong Subregion (GMS)

Japan has been working with the Asian Development Bank since the latter half of the 1990s to strengthen connectivity in the Greater Mekong Subregion. Examples of infrastructure projects include the Cai Mep-Thi Vai Port and Saigon East-West Corridor in Vietnam, the Second Bangkok International Airport (Suvarnabhumi Airport) and Eastern Seaboard Development Project, which had been carried out since the 1970s prior to the airport, in Thailand, and the development of National Road No.1 and National Road No.5 in Cambodia. As an example, through this series of projects, the travel time of roughly 250 km from Phnom Penh, the capital of Cambodia, to Ho Chi Minh City, Vietnam, has been reduced from 12 hours in 2001 to 6 hours in 2008 due to the development of road infrastructure. Also, border customs clearance procedures have also been made simpler under the leadership of ADB, at least 10 direct buses now operate between the two cities daily, and logistics efforts have been given a new lease of life. As a result, factories are now gathering along the Southern Economic

Corridor, giving birth to the 'Mekong Industrial Belt'. Among other things, in Cambodia, the number of members of the Japanese Business Association of Cambodia (JBAC) increased from 35 in 2008 to 264 in 2019, and investment from Japan is rapidly increasing due to the development of the Southern Economic Corridor and the economic growth of the country. As such, while the ferry crossing of the Mekong River was the last bottleneck, the opening of the Tsubasa Bridge has made it possible to drive across the Mekong River 24 hours a day, 365 days a year, making the movement of people and goods significantly smoother. This project can be said to be Japan's flagship project in its support of Cambodia, and has been featured on various occasions as an embodiment of Japan's high-quality infrastructure.

3.2 Overcoming the severe natural conditions

The Mekong River, which originates in the Tibetan Plateau of China and flows through six countries including Myanmar, Laos, Thailand, Cambodia, and Vietnam, stretches 4,763 km. The altitude difference is about 100 meters at the point 1,000 km upstream from the estuary, which means very low.

In Neak Loeung, the crossing point of the bridge over the Mekong River, the water depth is 25 meters and the river's maximum flow velocity is 1.6 m/sec. The maximum discharge during the flood season is 33,000 m^3 per second, while the minimum discharge during the dry season is 11 times higher at 3,000 m^3 per second. The fluctuation in water level also reaches 7.5 meters. The Mekong River was flooded in 1996, 2000, 2001, and 2002, and at the time of the flood in 2000, the maximum water level in Neak Loeung reached 7.79 meters (Figure 5). Based on this set of circumstances, particularly in the design of foundation work, a multi-column foundation was used due to being excellent in terms of its economic efficiency and workability because the seismic forces are small, and ship-shaped pile caps were used to design it in consideration of streamflow and vessel navigation.

Meanwhile, on-site surveys and interviews conducted in the local area brought to light that the right bank of the Mekong River was significantly eroded. Given that it had been

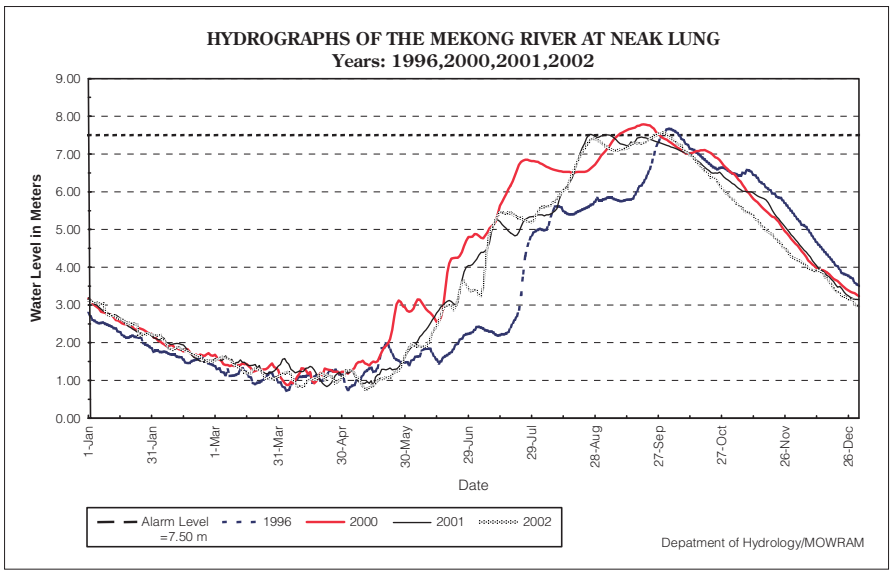

Figure 5: Fluctuations in the Mekong River Water Level in Neak Loeung

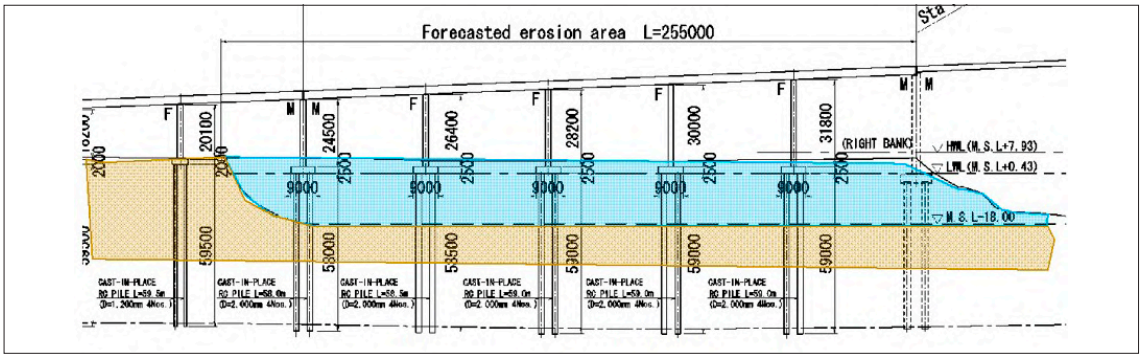

Figure 6: Structure to Support the Erosion of the Sandbank

confirmed that 40 meters of erosion had occurred from the time of the 2004 feasibility study to the time of the basic design study in 2009, it was decided that the riverbank erosion rate would be estimated using satellite Photographs and this information would be reflected in the pier design. Consequently, the pile length was set to 70 meters because of the fact that the water level difference was 7.5 meters, the work to prevent scouring was carried out up to 12 meters from the riverbed, and the support layer was located 37 meters from the riverbed (Photo 9, Figure 6).

Hence, it is a huge river, the likes of which do not exist in Japan, and although worst-case scenarios were incorporated in the study and design stages, there were many requests to implement measures during construction, with riverbank erosion even higher than expected.

Photo 9: The State of Erosion at the Right Bank of the Mekong River

The project received the 2015 Tanaka Award of the Japan Society of Civil Engineers for being completed within the scheduled construction period using Japan's renowned engineering while at the same time answering the questions raised by these tough natural conditions.

3.3 Process up to giving the project the green light

The Japanese government decided to provide grant aid funds for this project, and signed and exchanged the official documents (Exchange of Notes) with the Cambodian government in June 2010, seven years on from June 2003 when it was declared that a feasibility study would get underway. As mentioned above, during this period, multiple studies had been conducted, but this was a period in which the awareness of environmental and social considerations and the practical aspects of granting aid had moved forward significantly. JICA formulated the 'JICA Guidelines for Environmental and Social Considerations' on April 1, 2004, and in the report of the Environmental and Social Considerations Review Board in May 2006, in reference to this project, it was stated that "it is necessary to monitor the amount of traffic over the next few years and examine the appropriate timing in which to start the project based on these results." In response to

this, JICA conducted a follow-up study from November 2006 and a preparatory study from August 2008 to check the validity of the demand forecasts, examine measures to mitigate the impact on the environment, confirm the building of a consensus among residents, and check the validity of the process leading to the acquisition of payments and land. Ultimately, the preparatory study began in February 2009, the validity of the grant aid project was confirmed, the outline design was drawn up and the project cost was estimated, and based on the preparatory study, the Exchange of Notes was signed in June 2010, and the Grant Agreement (G/A) was signed between JICA and the Ministry of Economy and Finance of Cambodia. I would like to mention that during this time, JICA, with the cooperation of the Hanshin Expressway Company and the Japanese consultants, had also worked to strengthen the ability of land acquisition by way of the Cambodian government's implementing agency. In addition to Japan, the Asian Development Bank, and the World Bank, the Cambodian government began to receive support from new donor countries such as China, South Korea, Thailand, and Vietnam at the start of the millennium, but it appears that problems may become apparent in the future with some of these countries from the perspectives of project construction supervision, safety management, and environmental and social considerations.

3.4 Measures against land mines and unexploded ordinances (UXO)

The number of land mine and unexploded ordinance casualties in Cambodia exceeded 4,300 in 1996. Although the number of casualties in 2018 decreased significantly to 58 with the support of the Cambodian Mine Action Centre (CMAC) and Japan and other countries' aid agencies and NGOs, many landmines and unexploded ordinances remain. Thus, the clearance of landmines and unexploded ordinances in the area was indispensable prior to the implementation of the project. From May to August 2005 during this project, multiple unexploded ordinances were found during the topographical survey of the area scheduled to be used for the bridge construction. In addition, 12 UXOs were discovered during the preparatory study conducted in 2009. For this reason, it was arranged with the Cambodian government that "ensuring the safety of the project (detecting and clearing unexploded ordinances and land mines, etc.) is the responsibility of the Cambodian government."

In response to this, from September 15 to November 30, 2010, the Cambodian government detected and cleared unexploded ordinances and land mines in about 38 hectares of the construction area, and found and cleared 4,216 unexploded ordinances and 12,127 pieces of debris. Furthermore, even after the start of construction in February 2011, the Cambodian government stationed the Cambodian Mine Action Centre (CMAC) and members of the military at the construction site, and took measures such as holding regular discussions and detecting and clearing unexploded ordinances and land mines.

In July 2012, however, an incident occurred in which an unexploded ordinance exploded during the pile foundation work of the eastern main tower (Photos 10 and 11). Fortunately, nobody was injured, although the incident forced the construction to be suspended for four months to investigate the cause and take measures against a similar incident happening again. The weather in Cambodia is broadly divided into the rainy season from April to October and the dry season from November to March, and the

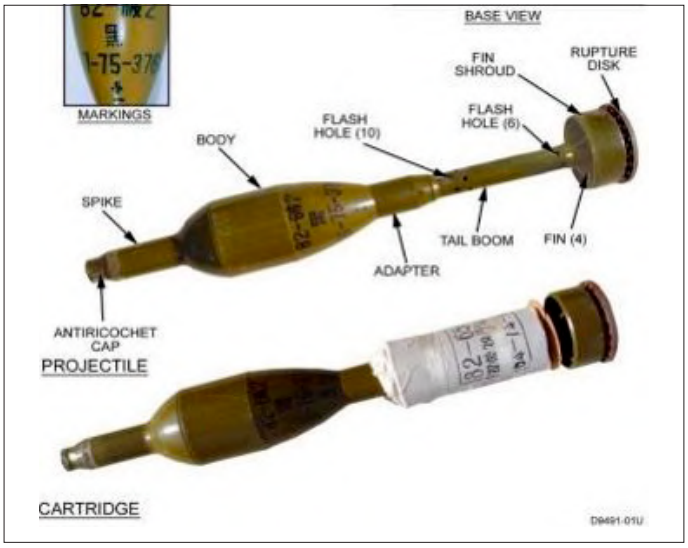

Photo 10: The UXO that Exploded

Photo 11: Damaged Foundation Pile

fluctuation in water levels reaches a maximum of 7.5 meters near Neak Loeung. Therefore there was concern that the substructure work, which was scheduled to be carried out during the dry season, would drag on into flooding season, thereby extending the construction period by up to nearly a year. However, because the Cambodian government strongly requested that the bridge be opened before the Cambodian New Year in mid of April 2015, the Cambodian government's Ministry of Public Works and Transport and the project consultant and construction company examined what action to take and the following efforts were taken to shorten the project schedule: (1) An 8-meter large block cantilever construction that relied on work vehicles was adopted to support the main girder construction and chipping construction was carried out day and night; (2) The stirrup rebar of the east side main tower pile cap frame was changed to a plate fixing type and a rebar assembly stand was added, (3) The main tower lifting allocation was changed and a rebar prefabricated construction was implemented. Implementing the aforementioned measures meant the bridge was completed per the original schedule.

4 Conclusion

Over 13 years passed from the initial request to the opening of the bridge, with it taking 7 years from the declaration of the start of the study in June 2003 to the signing of the bilateral agreement (signing the Exchange of Notes) of the grant aid project in June 2010. It is no exaggeration to suggest that during this period Japan has fallen from the position of the top donar to Cambodia to being just one of countries that donates to Cambodia (Figure 7). While the transparency of procedures and the importance of consensus-building with various stakeholders are a given, there were many lessons learned and issues taken away from the project such as the importance of decision-making timing to maximize the effect of the development, the authority of stakeholders, and the responsibilities to be fulfilled as a donor (Photos 12-14).

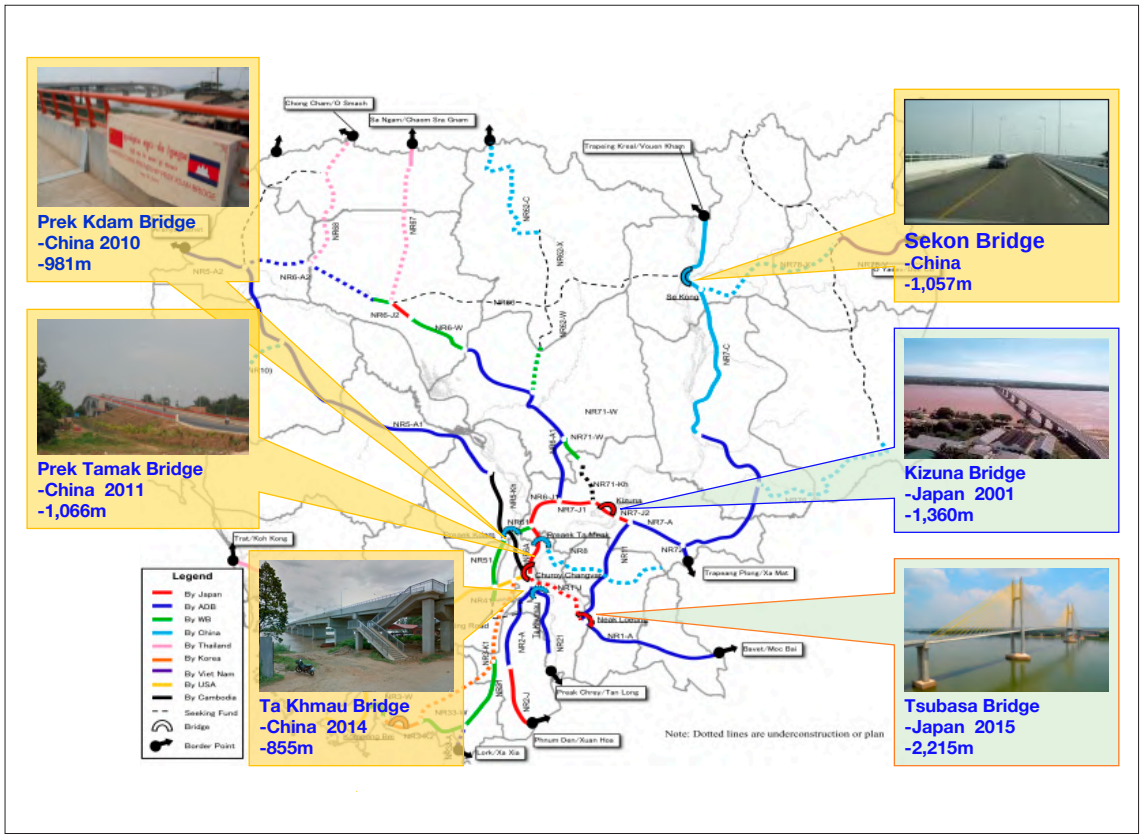

Figure 7: Main Bridges in Cambodia (Green: Construction supported by Japan, Yellow: Construction supported by China)

Photo 12: Brochure of the Inauguration Ceremony

Photos 13 and 14: The Completed Tsubasa Bridge and the Inauguration Ceremony

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