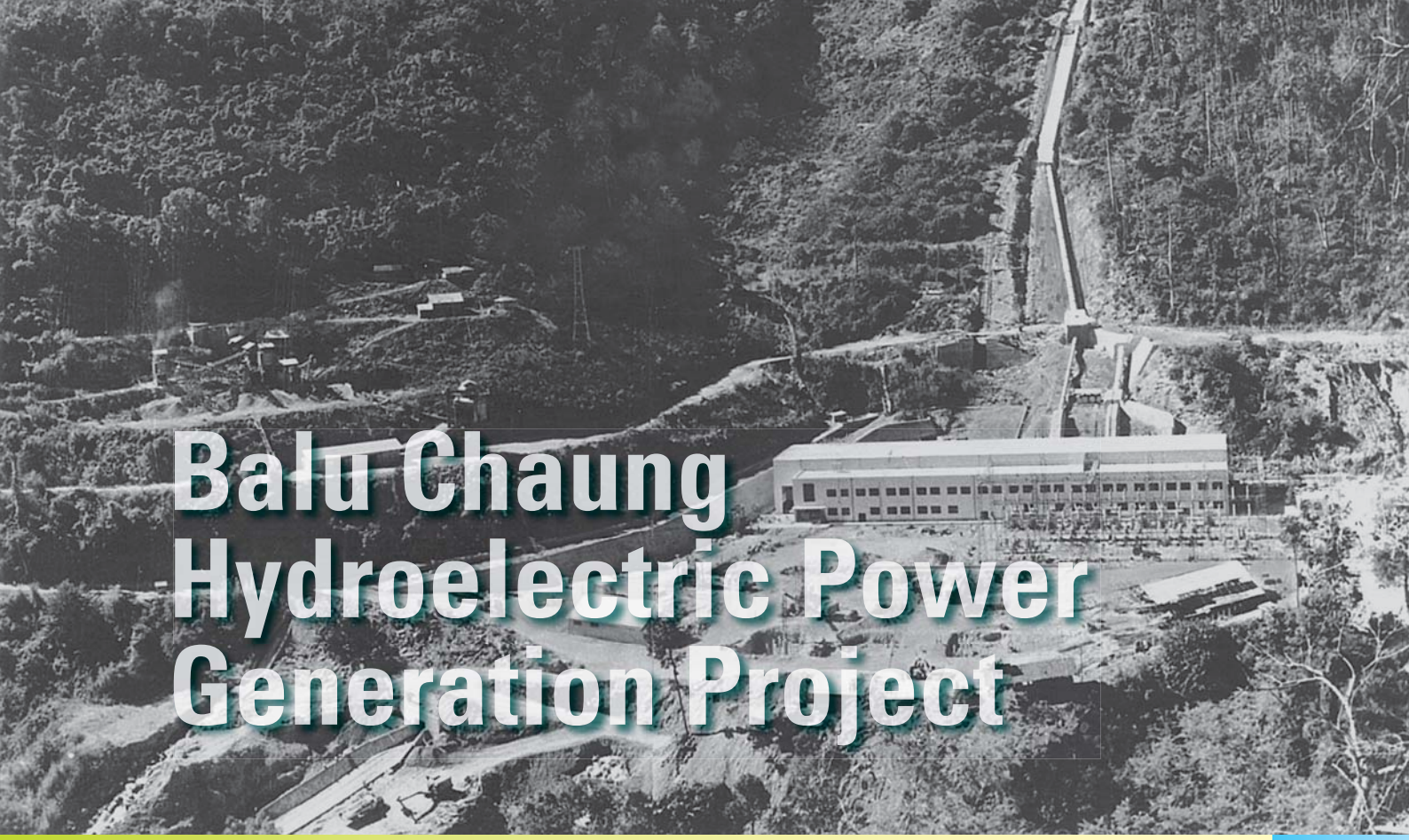

Balu Chaung Hydroelectric Power Generation Project

Reasons for taking up this project

The Balu Chaung Hydroelectric Power Generation Project was a grand project of infrastructure development to install a run-of-river type power station in the mountain recesses of the Union of Burma (currently: Republic of the Union of Myanmar; hereinafter: Myanmar) in 1954 aiming to generate a total of 256,000kW. It was known not only for the severe natural conditions and social circumstances in which the surveying, planning, design, and construction were undertaken, but also for the project being the foundation of Japan's Official Development Assistance (hereinafter: ODA). Although the primary concept of the Balu Chaung Hydroelectric Power Generation Project was to construct power stations No. 1 through No. 3, here we will take up the No. 2 power station, the one which was actually constructed (hereinafter: the works on the No. 2 power station are referred to as the Balu Chaung Hydroelectric Power Generation Project).

The Japan Society of Civil Engineers takes up the Balu Chaung Hydroelectric Power Generation Project, because

1) It is a large-scale infrastructure development project which Japan implemented overseas for the first time in the post war period.
2) The construction of the Balu Chaung hydroelectric power station enabled the supply of electricity at a much lower cost than the prior period, and it has remained the major source of power for Myanmar for more than 50 years after its implementation, up through today.
3) There being no mid-level engineers in Myanmar at the time, Japanese engineers spent time to convey/transfer technology. As a result, the construction of a run-of-river type power station and the operation, maintenance and management of it were carried out by Myanmar engineers for themselves.
4) Despite the severe natural conditions and chaotic circumstances, the project was achieved with the support of the local communities.

1 Project Background

The Balu Chaung hydroelectric power station is located along the Balu Chaung River, which is a tributary to the Salween River in eastern Myanmar (see Figure 1).

At the time, Myanmar's overall domestic power generation output was approximately 75,000kW. The majority was thermally generated, and there was almost no hydroelectric power generation. The Myanmar government needed new sources of energy accompanied by the expansion of industry and industrialization which was anticipated in the near future. In 1953, the government commissioned the American technical consultant company KTAM (Knappen Tippetts Abett McCarthy) to investigate suitable places for hydroelectric power generation and KTAM suggested 3 alternative locations; Akyab, Pegu, and Balu Chaung. In Myanmar at the time, hydroelectric power generation was considered to play a major role in economic development, and the Myanmar government hadn't yet narrowed down the 3 alternative locations to the most suitable one.

Figure 1: Location of Balu Chaung

2 Project Chronology

2.1 Project Formation Phase

Formation Phase

October 1953	Nippon Koei President Kubota was commissioned by the Vice-Minister of Industry of Myanmar to select the most suitable location for hydroelectric power generation from the 3 candidate locations.
November 1953	Mr. Kubota submitted an opinion in a document to the government of Myanmar selecting Balu Chaung as the most suitable location for hydroelectric power generation.
January 1954	From the end of 1953 to the start of the next year, talks between the Vice-Minister of Industry and Mr. Kubota were concluded, and the commission of the foundation survey was decided. Before the agreement, the field survey was started.
April 1954	Agreements to offer technical expertise on regarding survey planning were exchanged.
December 1954	Construction work was started.

The project began as a result of coincidence. On September 28, 1953, Mr. Yutaka Kubota, President of Nippon Koei Co., Ltd. (hereinafter: Mr. Kubota) was travelling around the world to conduct market research into the overseas consultant

market. When he stopped in Myanmar for a transit, he coincidentally had the chance to meet with the Vice-Minister of Public Works and Industry of Myanmar. At this time, he was asked by the Vice-Minister which of the 3 candidate locations proposed by KTAM was the most suitable for power station, and promised to reply at a later date. Mr. Kubota compiled opinions in a document during his travel (predominance, development scale, execution procedures, construction costs, electricity consumption plans) that proposed Balu Chaung was the most suitable location, and submitted it by mail to the Myanmar government from Paris in November 1953.

This document attracted great interest by the Myanmar government, and Mr. Kubota, who was on a trip, rushed back to Japan before visiting Myanmar again on December 31, 1953 to conclude talks with the Vice-Minister of Industry of Myanmar at the start of 1954. The data collection survey for the project was decided to be commissioned to Nippon Koei Co., Ltd. In January 1954. A field survey was implemented without a formal agreement, and after some confusion caused by intervention from the United Kingdom, in April 1954 formal agreements to offer technical expertise through the Myanmar government's own funds regarding survey planning were exchanged with the Myanmar government.

The Balu Chaung Hydroelectric Power Generation Project was a plan to generate a total of 256,000kW at 3 power stations (see Figure 2). Considering the current

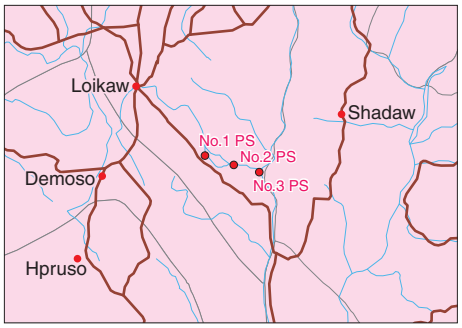

Figure 2: Locations of the 3 Balu Chaung Hydroelectric Power Stations

domestic power demands, Nippon Koei Co., Ltd. proposed making the first stage development of 84,000kW, which is half the scale of the No. 2 power station (gross head: 444m; volume of water usage: 47.5m^3/s; output: 168,000kW). The company conducted a preliminary design of this and submitted it. Based on this preliminary design, the Myanmar government formally decided to start on construction.

From the second half of 1954, Nippon Koei Co., Ltd. conducted the detailed design, and from February 1955 construction was started with the labor service of Nippon Koei Co., Ltd. (design, supervision capacity building) and Kajima Corporation (construction, planning, guidance, and education of execution), with construction equipment and laborers supplied by the Electricity Supply Bureau (hereinafter: ESB) as construction work directly controlled by the ESB. The conclusion of the formal contract between the government and Nippon Koei Co., Ltd. and Kajima Corporation was

Column

At the field survey, which started from January 1954, after Mr. Kubota returned to Japan, the preliminary measurement survey was started. The planned construction location of the No. 2 power station, which was the core of the Balu Chaung hydroelectric power station, was at the basin under the Ropita Waterfall, which had a head of 300m from the plateau, and it was necessary to walk through a jungle where tigers were said to dwell to get to the basin. Thinking it hopeless with only 3 surveyors, I was conducting measurement around the No. 1 power station when Mr. Kubota arrived at the site suddenly and got severely angry, saying "Move to the No. 2 power station site immediately".

Mr. Kubota taught me that "there is a key to anything, and once you know what it is you must proceed straight forward as much as possible". This was the first of many lessons I learned from him. [from interview]

delayed until September 1955, and Japan's war reparations funds were assigned for the costs.

2.2 Project Execution Phase

Execution Phase

From February 1955-End of 1963	1st stage construction (majority of public works construction work of the No. 2 power station, installation of 84,000kW hydraulic iron pipes and power generation equipment, construction of mountain roads for transmission line construction, laying of 2 long-distance transmission lines)
From December 1969-End of 1974	2nd stage construction (construction of Mobie reservoir, expansion of 84,000kW hydraulic iron pipes and power generation equipment)

1st stage construction started from February 1955, and it was completed in March 1960 including the transmission lines from Balu Chaung No. 2 power station to Rangoon, after which it began operating at 84,000kW. Subsequently the remaining construction of transmission lines from the Balu Chaung No. 2 power station to northern Mandalay was completed in the end of 1963. The laying of the approximately 400km transmission lines to Rangoon also included the construction of approximately 223km of mountain roads for construction from Loi-Kaw to Toungoo (the so-called "Toungoo Road").

The majority of the 1st stage construction funds (approximately 1.89 billion yen) were allotted from the funds (approximately 12.5 billion yen) of the agreement of Japan to provide war reparations to Burma, executed in November 1954.

The 2nd stage construction was mainly the construction of the Mobie reservoir and construction to expand iron pipes and power generation equipment to increase the 84,000kW. As the planning of the 2nd stage construction was completed, guidance management of execution was conducted by Kajima Corporation under the construction management of ESB.

2.3 Maintenance and Management after the Construction of the Balu Chaung Hydroelectric Power Station

After Construction

End of 1974	Completion of 2nd stage construction of Balu Chaung No. 2 power station, start of operation at 168,000kW
1992-1994	Repair of No. 1-3 water wheels and generator of the Balu Chaung No. 2 power station
2001-2003	Repair of transmission lines and substations, repairs of No. 4-6 postponed

Regarding the maintenance and management of the power station, training of core personnel for operation was conducted at fixed periods, and subsequently all operation, maintenance, and management of the power station was conducted by locals. However, regarding repairs to the power generation and power supply equipment, the work was conducted with assistance of Japan on 2 subsequent occasions.

The 1st repairs were conducted from 1992 to 1994 using the 1986 ODA from Japan (loan assistance of approximately 3.6 billion yen), and consisted of repairs on No. 1-3 water wheels and generator of No. 2 power station, which had been operating since 1960.

For the 2nd repairs, a survey was conducted in 2001 with technical cooperation of Japan and repair work to transmission lines, and transformer substations was conducted from 2002 to 2003 with Japan's grant aid program. However, repairs to the power generation equipment were postponed.

3 Project Features

3.1 High Head Hydroelectric Power Generation

The Balu Chaung No. 2 power station is a hydroelectric power generation development with high head exceeding 400m. At that time there were no such high head hydroelectric power stations in Japan. The project would not have been realized without Mr. Kubota's abundant experience before the war in the construction of high head power stations such as the Pujŏn gang No. 1 power station (head: approximately 700m; output: 130,000kW) and the Changjin Bay No. 1 power station (head: approximately 400m; output: 144,000kW) in North Korea. His experience is considered to be very helpful to the development of the Balu Chaung power station, which was surrounded by similar conditions.

3.2 Nationwide Power Grid

In Myanmar at the time, although there were local power grids centered around major urban areas such as Rangoon, Mandalay and Pyinmana, there was no transmission network system connecting these cities. With the completion of the Balu Chaung power station and the long-distance transmission lines connecting it to these cities, a nationwide power grid was finally accomplished.

3.3 Far Cheaper Power Supply

In Myanmar at the time, the cost of electricity for household consumers was approximately 40 yen per kWh, but with the 1st stage completion of the Balu Chaung No. 2 power station, supply of far cheaper electricity became possible. If the entire generated power volume of 560 GWh of the Balu Chaung No. 2 power station's 1st stage were consumed, the electricity cost on the end user would be 3 yen or less per kWh. Even assuming that consumer demand at the time of completion was only approximately 30% of that, it seems that the cost of electricity was 10 yen or less per kWh, enabling the provision of far cheaper electricity.

3.4 Severe Natural Conditions and Chaotic Social Circumstances

The Balu Chaung No. 2 power station was located on a spot directly under the unexplored "Ropita Waterfall" where it is said that beasts such as tigers dwelled and it was difficult to approach. Under the command of Mr. Kubota, the surveyors lived lives in crude lodgings that was almost camping sites, cleared the jungle on approximately 300m cliffs, and conducted such works as measuring and geological survey which took less than a year to complete (see Figure 3).

Figure 3: On-Site Lodging for Surveying

The living environment was also severe from the start of construction. Although on-site lodging was constructed, the roofs were made of teakwood leaves and rain water often leaked in.

The construction of the Toungoo Road was also undertaken under severe natural conditions which goes through the mountain side of a mountain region of 2,000m in elevation. Despite the appearances of tigers and antigovernment guerillas, it was completed in May 1959 with the cooperation of local heads of communities.

At the time, in areas such as the Kachin State, Shan State, and Kayah State, antigovernment forces with aspirations for independence, including the communist party, were active. So there were great difficulties in countering the antigovernment activities during the construction of transmission lines, etc.

3.5 Capacity Building

Because there were no private companies in Myanmar which could undertake such large-scale construction at the time, the construction was under the direct control of ESB. While ESB was in charge of supplying construction equipment, raw materials, and laborers, Nippon Koei Co., Ltd. was in charge of planning, design, and supervision on the technological side, and Kajima Corporation was in charge of planning, guidance (including dispatch of specialised skilled workers) and education of construction. In the peak of construction, approximately 20 engineers from Nippon Koei Co., Ltd. and a total of approximately 150 engineers and skilled workers from Kajima Corporation participated.

As stated above, there were only managers at ESB and no mid-level engineers who could actually conduct the measurement, calculations, and drawing. But from March 1956, young graduate engineers from University of Rangoon joined and Nippon Koei's engineers conducted educational guidance on designing. Through this education, after the completion of the Balu Chaung hydroelectric power station, many run-of-river type power stations have been constructed in Myanmar, which would indicate that the technical experience of the Balu Chaung hydroelectric power station (overall knowledge, technology, and actual on-site experience on surveying, planning, design, implementation (construction))

contributed to further development.

4 Learned Lessons

It is admirable that the Balu Chaung hydroelectric power generation project, the first project in the post war period, which Japan's public works technology advanced overseas, has served as the major power source for Myanmar for more than half a century since its completion and continues operation to this day. This project started in a period shortly after the war and is all the more impressive considering that it overcame severe natural conditions and chaotic social circumstances.

There are things in this project which deserve attention from the viewpoint of technology transfer, which is still an issue to this day. As stated above, at the start of the project there were no counterpart engineers with experience to be the partners of technology transfer in Myanmar. Starting from such conditions, young local engineers gradually participated on the site and received educational guidance from Japanese engineers, and they finally became capable of conducting the operation, maintenance and management of the power station, for themselves. On this basis, it seems that the spirit of independent self-respect, which is a national trait of the Myanmar people, was aptly worked. It suggests that this spirit will be essential in future technology transfer and that it is important to find this kind of national trait in such partner countries.

Furthermore, from the viewpoint of country risk, when the target regions are politically divided or in disorder, what position the companies should take is a controversial issue. In order to proceed smoothly with projects, it is necessary to cooperate with local communities. But considering the fact that the government at the time raised suspicion over Nippon Koei Co., Ltd. of communicating with the local antigovernment forces, responding to this issue can be said to be extremely difficult. Even today, since there exist various strifes and political opposition around the world, it is essential to always exercise caution when conducting operations overseas.

Whether capacity building or country risks, the difficulty of the issues is indicated by the fact that they are still issues today after existing for more than half a century. Precisely because they are not issues that can be solved overnight, we must continue learning from the examples of the past and handle more carefully in the future.

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Interview was conducted for this paper with the following person, and it was drafted by the Infrastructure International Cooperation and Contribution Archives WG of Japan Society of Civil Engineers. We wish to thank Mr. Yamaguchi here.

Biography

Masashi Yamaguchi

Nippon Koei Co., Ltd. colleague (at the time of the interview)
Joined Nippon Koei in 1951, built a long career as general manager of mostly overseas projects, and was appointed managing director of Nippon Koei in 1983 and executive vice-president of the same company in 1989 before being appointed as vice-chairman in 1993. He was in charge of the Balu Chaung Hydroelectric Power Generation Project from its start in 1954, and contributed to the project until its completion, including providing support at the headquarters.