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ASEAN OUTSTANDING ENGINEERING ACHIEVEMENT AWARD YEAR 2014

Thaukyegat (2) Hydropower Station (3 x 40 MW, 605 GWh)

Wan Kyi

(A) Introduction. A complementary site visit was conducted for **CAFEO-32** delegates to Thaukyegat (2) Hydropower Station, **TYG(2)** in short, located on Thaukyegat Chaung, some 10 km to the East of Taungoo city, Bago Region, The Republic of the Union of Myanmar. The visit initiates me to prepare this manuscript to give some information and knowledge to fellow engineers in other field of specialization. The power station consists of a 93 m high Concrete Face Rock-filled Dam (CFRD), 540 m long diversion tunnel (10 m x 12 m), 530 m long headrace tunnel (Ø 8.5 m), service spillway with five gates (10 m x 12 m) and a power house (**3 x 40 MW** capacity and **605 GWh** annual generation) and **230 KV** switchyard. The project construction was started in February **2008**, completed after 5 years in February **2013**, and continuously and actively participated in Myanmar electricity generation business since completion.

B) Background. In **1964**, a UN survey team suggested a number of promising hydropower projects in his report entitled "Sittong Valley Water Resources Development" to enhance Myanmar economic development, **Fig. 1**.

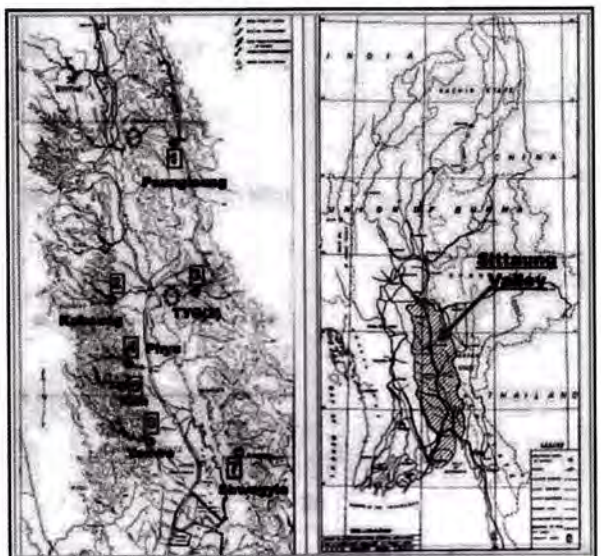


Fig 1. Sittaung Valley and its projects

In **2003**, **DHPI** (Dept of Hydropower Implementation, Ministry of Electric Power) started investigation, planning and design of **TYG(2)** in cooperation with **Kansai** (Kansai Electric Power Co., Ltd of Japan) relocating the dam site downstream as shown. In **2007**, the project with preliminary design report was handed over to a private Myanmar company **GEC** (Gold Energy Co., Ltd) for implementation on **BOT** (Built, Own, and Transfer) basis.

(C) Implementation Style. Since it was the first ever BOT project with high & intensive investment, GEC recruited some personnel with similar experience to start construction work in ahead of project handing over in November 2007. Then, a consulting firm with international reputation was engaged in February 2008 for final design, preparation of construction drawings and construction supervision & quality control works. At the same time, construction preliminaries including residential, access, temporary bridge, air, water, electricity were undertaken to suit into various construction needs. International construction contractors were engaged for every major work such as waterway, main dam, spillway and power house with a precondition of importing minimum number of technicians and skill persons and provision of semi-skill and un-skill persons as needed by GEC at contractors' cost.

(D) Natural Conditions. As shown in **Fig. 1**, the project utilizes water resources potential of Thaukyegat Chaung with an elevation of nearly 1,000 m at origin and 35 m at site. It was an East bank tributary of Sittaung River. The catchment area, annual rainfall and average discharge are 2,175 Km^2, 1960 mm and 133 m^3/s respectively. Meta-sandstone predominate the area with spot granitic rock intrusion. In general, the project area possesses a weak to poor foundation condition.

(E) Project Layout. Major components of the project/power station are; main dam, diversion facility, waterway, spillway, power house and switchyard. It is best illustrated by a drawing and corresponding picture as follow;

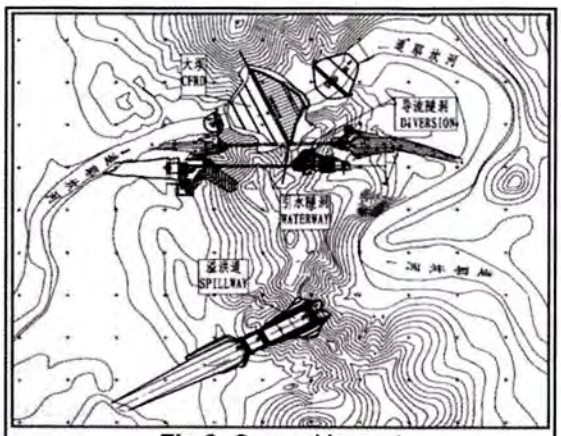


Fig 2. General Layout

Plate 1. Photo of General Layout

(F) Construction Schedule. Simplified construction schedule was presented for easy reference as shown although actual conditions are more complicate. Every major work had a number of sub-works which should be completed in specified period keeping a strict and regular watch on critical items. Critical path method (**CPM**) of control was constantly applied.

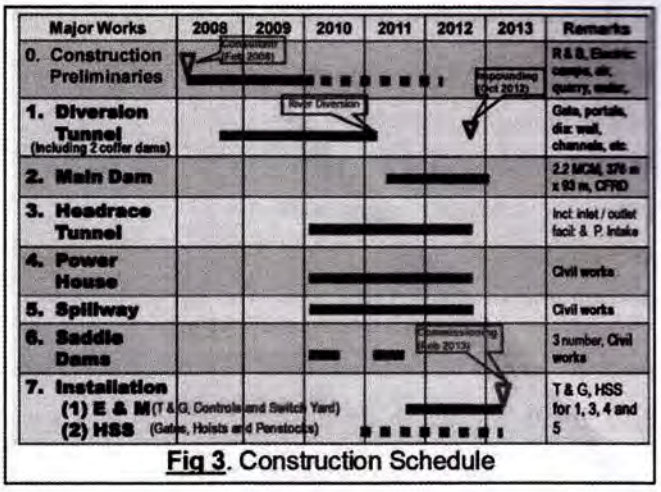


Fig 3. Construction Schedule

(G) Major Project Components. Major project components are described in following paragraphs and refer to **Fig 2** for layout.

1) Main dam including diversion facilities;

Two coffer dams and one diversion tunnel (540m x 10m x 12m) were undertaken to facilitate construction of main dam (**CFRD** = Concrete Face Rock-filled Dam), **Fig 4**. Tunnel works in weak rock area was really challenging.

CFRD of TYG(2) had a measurement of 375 m x 93 m x 2,150,000 m^3 and it must be filled in 18 months to meet the completion target. Typical cross section and specifications of filling material are shown in **Fig 5**. It is the **first CFRD** in Myanmar. To maintain daily average fill e" 5,000 m^3, round the clock working system had to be applied for 10 months in parallel with giant filling and transportation fleet of DT (rock type).

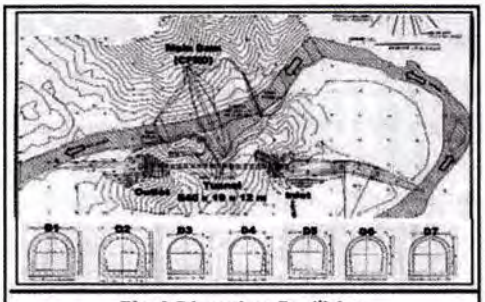
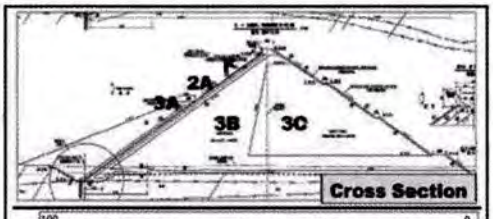
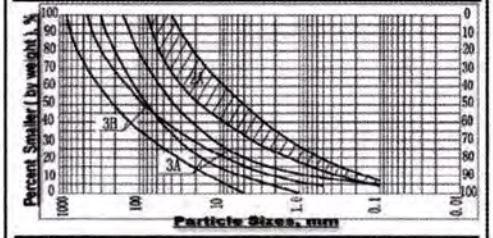


Fig 4 Diversion Facilities





Required Gradation + Quantities

Particulars	2B	2A	3A	3B	3C
1. Dry density, g/cm³	2.25	2.25	2.2	2.14	2.11
2. $d_{max.}$ mm	40	80	300	800	800
3. < 5 mm, %	35 -60	35-50	8 - 20	-	-
4. < 0.075, mm, %	5 - 10	4 - 7	< 5	< 5	≤ 5
5. k, Coefficient of Permeability, cm / s	-	10^{-3} to 10^{-4}	10^{-5} to 10^{-2}	$>10^{0}$	$>10^{0}$
6. Volume, 10^3 m³ (" , 10^3 Sud:)	3.7 (1.3)	77.3 (27.3)	149.9 (53)	758.9 (268.2)	889.5 (314.3)

Fig 5 Spec: for Filling Materials of CFRD

2) Waterway (Concrete and steel lined)

Reservoir water was conveyed to power house through Ø 8.5m tunnel with gate shaft for power generation. The tunnel is concrete lined in upper portion and steel lined in lower portion under a hydrostatic pressure of 48 – 80 m. Inclined alignment and poor geology were the major problems.

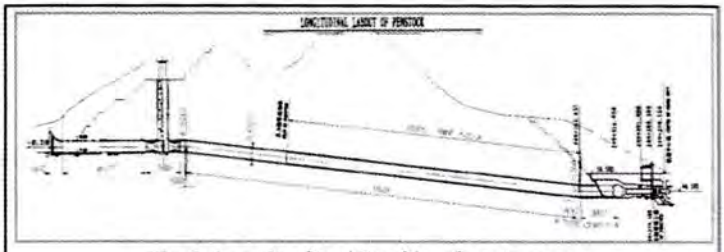


Fig 6. Longitudinal Profile of waterway

Fig 7. Tunnel (Ø8.5m) and Linings (Conc: & Steel)

3) Service Spillway (5 gates, 3,500 m³/s)

Due to very weak foundation and deeper bed rock position, a huge excavation (3,360,000 m3 = nearly 150 % of main dam volume) was done to meet the target. Overall dimension of spillway was L 250 m x W 60m with flip bucket. Concrete volume was estimated to be 100,000 m³ and it had been a critical work for the project, Fig 8.

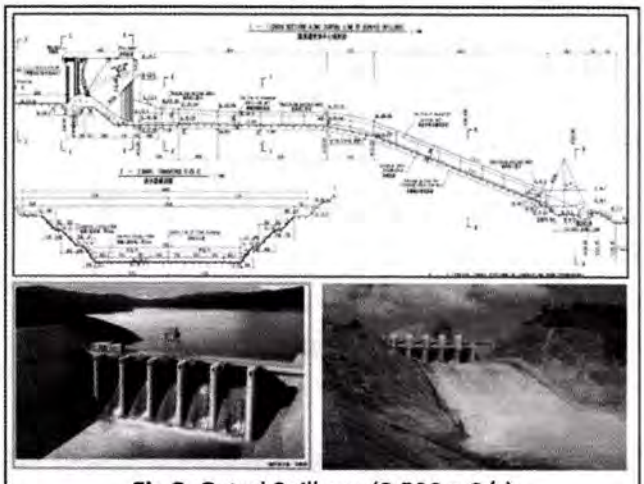


Fig 8. Gated Spillway (3,500 m3/s)

4) Power House (3 x 40 MW)

Construction method of power house was rather complicate due to involvement of electrical & mechanical installation although it was simple structurally, Fig 9. Timely completion of power house was greatly dependant on timing of erection bay which had been so much critical for construction of TYG(2) project.

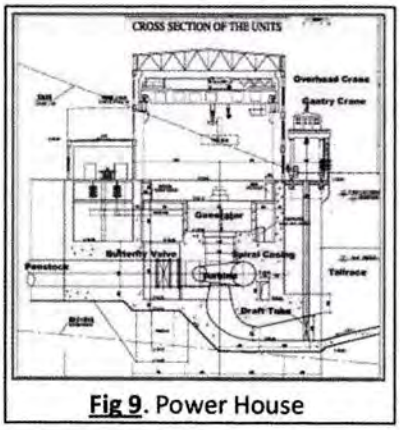


Fig 9. Power House

5) Electrical & Mechanical and Hydraulic steel structures (E & M and HSS)

Electrical equipments include generator, transformer, control- gears in switchyard and power house, whereas mechanical equipment includes turbine, gate, valves, pipes, etc (**E & M**). Penstock, Radial gate, Bulkhead gate and steel liner of waterway are grouped as hydraulic steel structure (**HSS**). They were supplied and installed by respective contractor.

Fig 10. Turbine and Generator

Fig 11. Controls and Switchyard

(H) Corporate Social Responsibility (CSR)

In the course of project implementation and reservoir impounding, environment and some people in the project area are affected. In order to make people feel back to normal, **GEC** undertook many countermeasures some of which were shown in **Fig 12**.

Fig 12. Roads, Suspension Bridges, Churches, Schools, etc

Corresponding countermeasures were also taken to the environment some of which are presented below in **Fig 13**.

Fig 13. Rubber Plantation, Teak Plantation and Environment Conservation of PH area