Natural draught cooling towers at Panipat (India)

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4. Natural Draught Cooling Towers at Panipat (India)

Owner: Haryana State Electricity Board, Chandigarh

Consultant: Tata Consulting Engineers, Bangalore

Engineer: Gammon India Limited, Bombay, in collaboration with Hamon-Sobelco S.A., Brussels

Contractor: Gammon India Limited, Bombay

Construction: 1976-1980

The Panipat Thermal Power Station, with an installed capacity of 220 MW in its first stage, is located about 100 km northward from New Delhi. The non-availability of adequate perennial water resources near the project site, and the results of techno-economic studies led the Consultant to recommend a recirculatory cooling-water system incorporating two natural draught-cooling towers – one each for a 110 MW unit. The thermic design, detailed engineering and the construction of these two cooling towers was entrusted to Gammon India Limited, assisted by Hamon-Sobelco who carried out the thermic design and the computerised structural analysis of the tower shell.

Each of the two hyperbolic cooling towers is designed to cool 17,000 cubic metres of circulating water per hour from 42.5° C to 32.5° C at an inlet wet bulb temperature of 26.5° C and a relative humidity of 45 percent. The salient tower dimensions are:

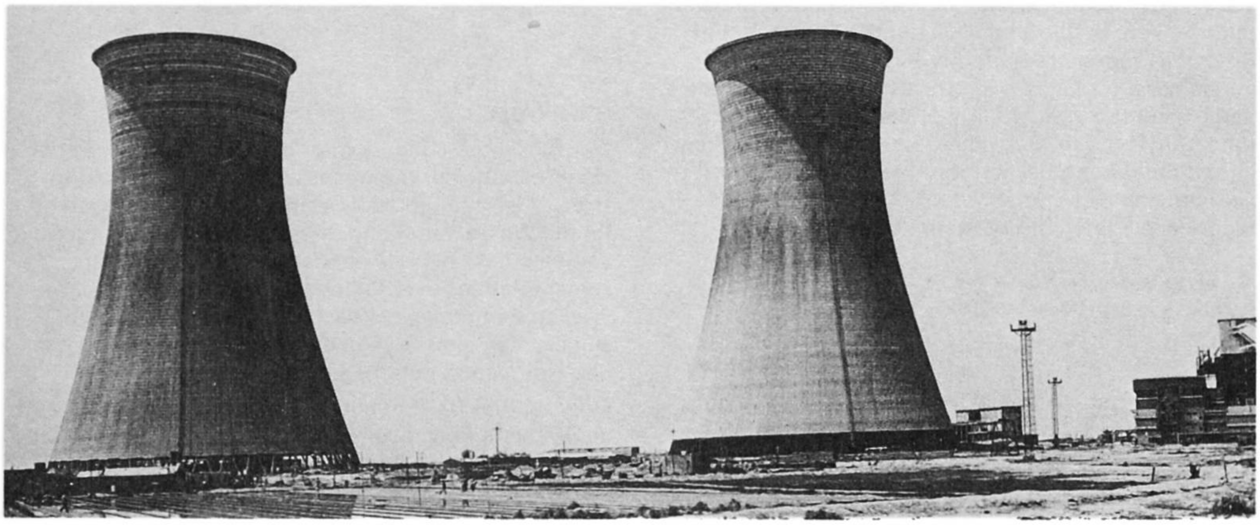
a) Total height: 123.6 m above basin top at 0.0 m level.
b) Base diameter: 87.7 m at 0.0 m level.
c) Throat diameter: 47.3 m at 92.7 m level.
d) Top diameter: 53.6 m at 123.6 m level.

The soil stratum at the site is quite heterogeneous and consists of loose sandy silt and occasional clay pockets. Based on the extensive pre-bid soil investigations, the specifications called for pile foundations to support the shell structure of each tower and the use of sulphate resistant cement for all concrete work below ground level. Furthermore, initial pile-load tests conducted after the commencement of work revealed that the internal fill structure of the first tower (seen on the right in photograph 1) also required pile foundations. For the second tower (seen on the left in photograph 1), replacement of the loose soil stratum below the basin floor by mass concrete, sufficed to support the internal fill structure directly on the basin floor.

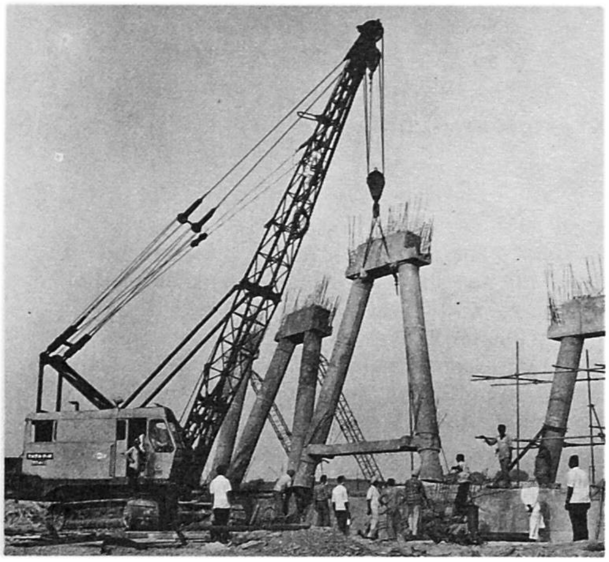
Each tower shell, together with its inclined supports and the basin wall, is supported on RC raker piles alone, all raked outwards at one horizontal in six vertical. 600 raker piles, distributed uniformly along three concentric rows of 200 piles each and topped by a 3.2 m wide combined continuous annular RC cap, are provided for the first tower; and 440 raker 220 piles each topped by a similar 2.6 m wide RC pile cap, for the second tower. The pile layouts are optimised through computer analysis.

The internal fill of the first tower is supported on 866 RC vertical piles. All the piles, which are driven cast-in-situ, are 40 cm diameter, and for the first tower are about 20 m long with a derated load capacity of 400 kN each, whereas for the second tower are about 17 m long with a normal load capacity of 550 kN each.

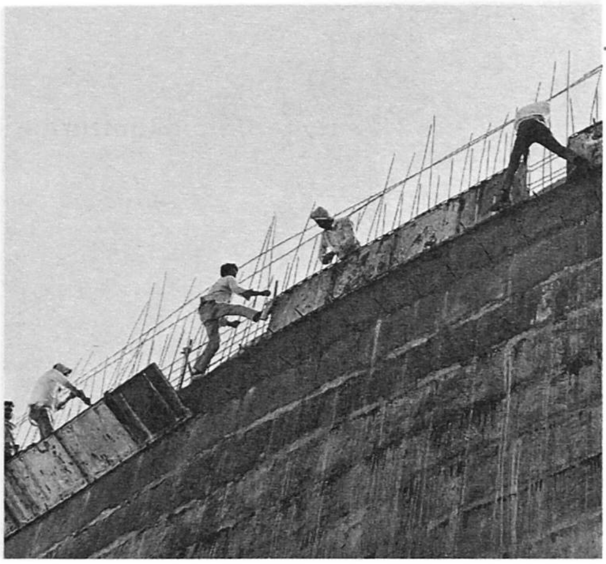
Both the tower shells have a minimum thickness of 14 cm and are stiffened near their upper and lower edges by a gradual increase in their thickness to 75 cm and 70 cm respectively. Each shell is supported by 40 pairs of precast inclined oval columns (55 cm × 60 cm) which traverse a 5.1 m high air-inlet space below the shell and merge at their lower ends through a specially designed RC joint, with 40 pedestals cast integral with the basin wall. The shell and the inclined columns are designed to withstand a wind pressure varying from 1.5 kN/m² to 2.0 kN/m², and a seismic acceleration of 0.09 g.



Photograph 1 View of the completed towers with the precasting yard in the left foreground



Photograph 2 Placing precast inclined columns into position



Photograph 3 Manual erection of shell formwork

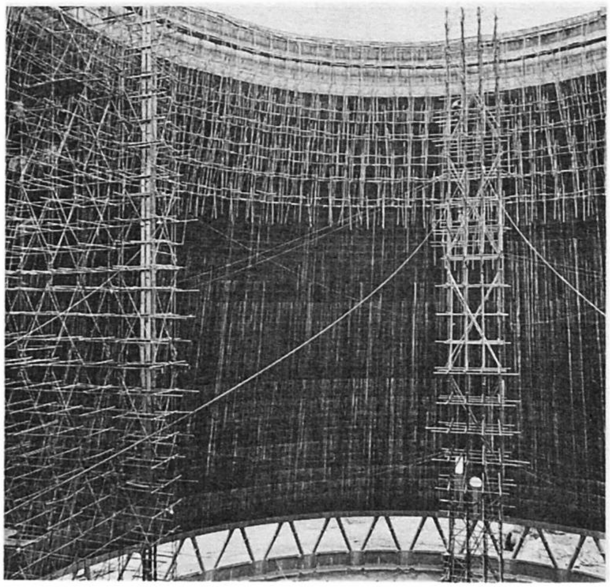
The splash type internal fill comprises of 5 cm wide and 5 cm high precast prestressed pear shaped splash bars, specially developed by Gammon India for extensive use in India.

The splash bars are provided with a single 2.5 mm diameter prestressing wire and are prestressed in a casting yard (seen in the foreground of second tower in photograph 1) by a long-line method.

A remarkable improvement in the construction period, a better quality control and economy was effected by a preplanned use of precast concrete. All the 40 pairs of inclined columns as well as 40 units of RC channel shaped segments conforming to the shell bottom edge profile were precast on the basin floor and erected in their final positions by a crane (photograph 2).

The channel segments served as a permanent self-supporting side and bottom formwork for the first lift of the shell, thus eliminating the heavy scaffold. When concreted solid, these segments formed the bottomost lift of the shell above which the balance portion was cast in situ. Further time saving was effected on this project by increasing the lift height to 1.0 m which was found optimal for manual erection and stripping of shell formwork (photograph 3). The access for manual placement of shell concrete was provided by a climbing scaffold supported from the internal face of the shell (photograph 4).

Besides the prestressed splash bars, all the fill-supporting RC blocks, beams and columns were also precast in a precasting yard. These beams and columns were erected in position by specially designed travelling gantries assembled and dismantled inside the tower. For further time saving, the column and beam erection activity was commenced in a 15 m wide annular strip adjoining the basin wall as soon as the tower shell construction proceeded above the throat level.



Photograph 4 Central guyed tower for holding vertical plumbline and side climbing scaffold to provide access to shell formwork

The 28 day concrete cube crushing strengths for various members were as follows:

a) Piles and internal fill support blocks: 20 N/mm^2
b) Basin floor, basin wall, shell and internal precast columns beams: 25 N/mm^2
c) Shell supporting precast inclined columns, prestressed splash bars: 35 N/mm^2

The minimum reinforcement in the shell with HYS deformed bars was 0.25 percent in each direction.

The two cooling towers together consumed 15150 t of cement, 1160 t of Mild Steel, 1040 t of NYS deformed bars, and 45 t of prestressing wire.

(P. B. Patil, S. V. Lonkar)