engineering report

Fertilizer Project Sapugaskande–25 days Round–the–Clock Slipform Construction of the Urea Prilling Tower

1.0 Introduction

Construction is now in progress at the Rs. 2,200 m Fertilizer complex for the State Fertilizer Manufacturing Corporation of Sri Lanka. The construction works are scheduled to be completed by August 1979, and the factory when completed will have a daily production capacity of 540 tonnes of Ammonia and 940 tonnes of Urea.

The main contractors for the works are Kellog Overseas Corporation, while Engineering Construction Corporation Ltd. of India, with Samuel, Sons & Co. Ltd., as sub-contractors have undertaken the construction of certain special civil works in the project.

2.0 Special Civil Works

The works referred to in this report comprise :

—the construction of a 70 m. high x 14 m. dia. Urea Prilling Tower with a concrete wall thickness of 200 mm., and

a 120 m. x 38 m. A Frame Silo for bulk storage of prilled urea, with precast roof units making up the A frames, and resting on in situ concreted retaining walls.

The special feature of the Prilling Tower construction was the use of the Slipform technique from 8 m to 70 m height of the tower, ensuring both rapidity and economy in construction.

The construction of the A Frame Silo is essentially a precasting operation involving the casting and erection of the trough units constituting the A frames, the internal tie beams and cross beams and the rib slabs for the walkway inside the Silo.

The Engineering Construction Corporation of India have earned a reputation by their ability to achieve economy, speed and high quality finish in construction works through their mastery of the Slipform Technique and by adopting precast construction methods as opposed to in situ construction. The design of the A Frame Silo now under construction was also carried out by E.C.C.

3.0 Slipform Construction

The construction of the Prilling Tower foundation up to a height of 8 m. was by conventional methods. The Slipform construction from 8m. to 70 m. commenced on 5 May 1978 and was completed by 31 May, notwithstanding severe disruptions caused by the monsoonal rains.

A brief description of the Slipform method is given below :

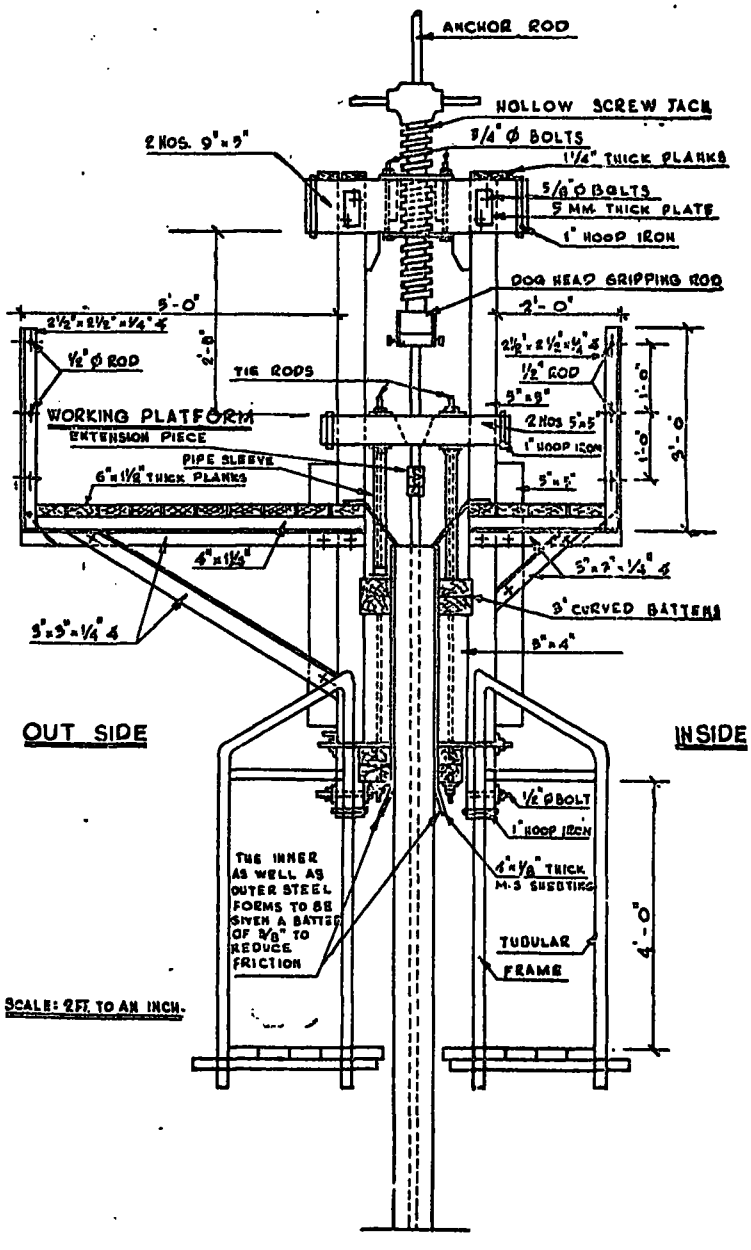

Fig. 1. Sectional View Through the Screw Jack

3.1 Assembly and Operation of Slipform

The Slipform consisted of a yoke assembly of jacks and 4 ft. high 3 mm. thick steel shuttering mounted on a timber framework. The shuttering was of the self-supporting type with a 10 mm.splay at the bottom for easy slipping. The jacks consisted of hollow threaded shafts with thrust bearing rotating heads in front and drive ends on top. Each jack had a grip assembly with a

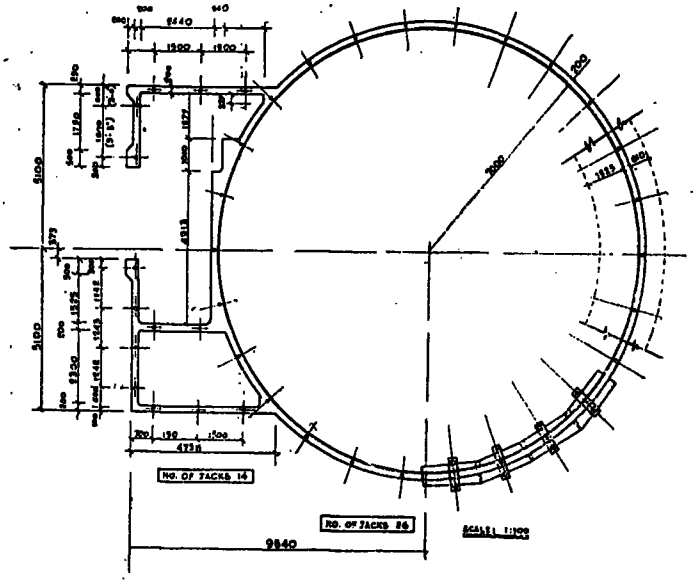

Fig. 2.

serrated dog chuck enabling the jack to mount on its anchorage—the jack rod. The jack rods were straight steel rods, circular in section and in lengths not exceeding 4 m. with threaded couplers to suit insertion and anchorage through the hollow shafts (Fig. 1).

40 Nos. jacks were used on the circular wall and the lift wall projections as shown in Fig. 2. The shuttering had a ring with radial ties to control the dimensional requirements of the shaft. The assembly carried a working platform (with a chute arrangement for swift placing of concrete) for movement of workmen, for transporting concrete etc., and also had two suspended platforms on either side of the wall, carrying masons attending to concrete finishing as the Slipform kept climbing up.

Deviations in verticality/twist were continuously monitored by means of plumbs at the jacks measured from the Datum at 8 m. level on the wall, and were corrected by appropriate operation of the jacks. In order to prevent twisting, alternate jacks were turned in the same (clockwise or anticlockwise) direction.

The concreting for the first lift was done up to 4 ft. (the full height of the Slipform) and at the end of the first lift the Slipform was moved up by 150 mm. and the concreting done. The operation was repeated at hourly intervals until the completion of the tower. There were however, interruptions varying from 2 hrs. to 14 hrs. owing to inclement weather, power failures, equipment breakdown etc., but the movement of the Slipform was kept up even at the rate of 1 mm. per hour to prevent the adhesion of shutter to the concrete.

The speed of Slipform operation ultimately depends on the setting time of concrete and under the best of conditions ascents of over 1.7 m. per 12-hour shift were achieved on a number of occasions.

The entire operation lasted from 8 a.m. on 5 May, until 8 p.m. on 31 May 1978, comprising a total of 49 actual working shifts, after allowing for loss of time due to reasons as indicated above.

3.2 Concrete Requirement

The tower walls in the final form being unlined, great emphasis was placed on ensuring the achievement of adequate concrete density and good surface smoothness.

The following mix proportions for one m^3 of concrete were used :

Cement :	350 kg. (Slump 8 mm.)
Dry sand :	712 kg. (Grain size: 2.71)
Dry gravel :	1170 kg. (Grain size 6.71)
Water :	162 kg. (Grain size of mixed batch: 5.22)
Densifier :	3.5 kg.

(Manufactured by Tillman N.V. of Netherlands)

The use of the densifier enabled the reduction of water by 10–15% without affecting the workability. Great care was taken in regard to the proper duration of application for vibrating immersion needles. During the concrete finishing operations a curing compound was applied to the concrete surface to prevent rapid drying out and consequent appearance of irregularities through dust formation. Immediate repairing of damaged areas upon each slide, constant grinding to remove surface protrusions and application of cement mortar ensured the achievement of satisfactory surface smoothness.

3.3 The Role of the Timber Access Tower

A remarkable feature of the whole operation was the role played by the Timber Tower, 8 ft. x 8 ft. square and 280 feet high, with ladders and landings within (see cover photograph).

The tower consisted of 8 Nos. 5" x 5" x 10' lapped verticals with horizontal and diagonal bracing and anchored by guy ropes at every fifty feet height. As the mainshaft of the Prilling Tower went up, the guy ropes were removed and the Timber Tower was anchored to the main shaft itself.

The Tower provided the guides for the lifting up of concrete, reinforcement etc., by power driven winches, and also the access to the Slipform platform for the workmen. It was an economic and effective substitute for a crane.

3.4 Manpower

The operation was essentially labour intensive—prefabrication of reinforcement steel, loading and mixing concrete in the concrete mixer, transporting reinforcement, concrete etc., in buckets lifted by winches, tying of reinforcement, transporting concrete on the Slipform by wheel barrows, placing and compacting concrete, operating the jacks to lift the Slipform after filling up with concrete etc. In all, an average of 150 skilled and unskilled men of various categories worked per shift under the supervision of Shift Engineers, Foremen and Chargehands.

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