PAPER NO.437

CONSTRUCTION OF PRILLING TOWERS WITH SLIPFORM AT PAKARAB FERTILIZERS FACTORY MULTAN

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1.0 INTRODUCTION

In the new Fertilizers Complex at Multan, there are two Prilling Towers; one tower is for the prilling of Calcium Ammonium Nitrate and the other is for Nitrophosphate. The prilling tower for the Calcium Ammonium Nitrate is 22 metres internal diameter and 61 metres in height. This tower is capable of prilling 1500 tons of Calcium Ammonium Nitrate in 24 hours. The Nitrophosphate Prilling Tower is only 19 metres internal diameter with a total height of 67 metres and is capable of producing 1050 tons of prilled Nitrophosphate Fertilizer in 24 hours.

A prilling tower is a circular structure which has a revolving bucket fitted on its top to receive the liquid fertilizer. The bucket sprinkles the liquid fertilizer which while falling through the tower is converted into prills by a rising draught of air created by powerful exhaust fans fitted on top of the tower. Fertilizer in the prilled form finds favour with the farmers as it is easier to spread in the fields.

Since the prilling towers were very high and the schedule of the Pakarab Fertilizers very tight, it was considered necessary to use the slipform for these towers as otherwise traditional construction would have taken atleast 9 months to one year for each tower.

2.0 SLIPFORM & ITS FABRICATION

The German designed system of slipforming manufactured by M/s AHL & Co., West Germany has been used in the high speed slipform carried out successfully at the site of Pakarab Fertilizers Ltd., Multan.

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The main components of the slipform assembly shown in figure No. 1 can be devided into two parts.

1. Steel Components
2. Wooden Components

Pakarab Fertilizers Ltd., only purchased 55 sets of hydraulic double acting rams (8 tons), two hydraulic pumps, 55 sets of hydraulic tubing etc. In addition one sample of each of the following items were obtained for fabricating them locally.

1. Yoke
2. Hanging Scaffold
3. External Scaffold,bracket for working platform
4. Draw Tube
5. Support trestle
6. Sliding or jacking rod
7. Cross Beam
8. Key bolt

The above samples were reproduced locally by a sister concern, Pak American Fertilizers at Daudkhel.

Table-1 given below shows the steel components in one yoke assembly which was required to be fixed after about every 1.5 M length of the circumference.

TABLE-1

STEEL PARTS IN ONE YOKE ASSEMBLY

S.No	*Description*	*Number*	*Section of the Member(mm)*
1.	*Yoke*	*2*	*2 Tee Sections 65x65x7*
2.	*Cross Beam*	*2*	*130 x 65 x 7*
3.	*Bracket for working platform.*	*2*	*76 x 38 x 7*
4.	*Railing*	*2*	*Angle 65 x 65 x 7*
5.	*Hanging Scaffold*	*2*	*Pipe, dia 48 & Wall thickness 5*
6.	*Key bolts with key*	*4*	*Dia 23, Length 60*
7.	*Bolts*	*4*	*Dia 20, Length 150*

Table-2 given below shows the quantity of wood required per metre circumference of the tower.

TABLE-2

QUANTITY OF WOOD REQUIRED PER METRE CIRCUMFERENCE OF TOWER

Sr. No	Description	Section mm	Length mm	Quantity per Metre Length M^3	Total M^3
1.	Outer shuttering plank	100x28	1000	0.028)	
2.	Removable shuttering plank	100x28	1000	0.028)	0.080
3.	Inner Shuttering plank	100x28	1000	0.024)	
4.	Outer runner	200x50	1196	0.040)	
5.	Inner runner	200x50	1148	0.050)	0.1032
6.	Removable runner	72x80	1111	0.006)	
7.	Removable runner	72x50	1111	0.0072)	
8.	Support for working platform	10x10	2000	0.060	0.060
9.	Planks for inner working platform	150x24	1750	0.0409)	
10.	Planks for outer working platform	150x24	1750	0.0409)	0.0818
11.	Toe boards	150x24	1750	0.0036	0.0036
12.	Planks for outer hanging platform	200x40	2000	0.024)	
13.	Planks for inner hanging platform	200x40	2000	0.024)	0.048
14.	Toe board for hanging platform	150x40	1750	0.0144	0.0144
15.	Removable top pieces of removable shuttering	130x20	1111	0.0052	0.0052
				Total	0.3962
		Add 20% wastage			0.0792
				Total	0.475

The quantities of steel and wood have been worked out with which it is possible to guage the total quantity of steel and wood required for any other job.

3.0 ASSEMBLY OF SLIPFORM ON GROUND

The first step consisted of placing the runners of the formwork on a specially prepared circular platform on the ground (Fig.2). These pieces were bolted together in a length of about 6 metres according to the inside and outside radii of Prilling Towers. Then wooden strips 1000x100x28 were fixed on the runners and were lined with G.I.Sheet of 22 gauge, thus making each piece in form of plate of 6 M x 1 M size as shown in Fig.3 & 4.

The idea of assembling the slipform at the ground level was to rectify conveniently any defects in the body of the slipform and to make any modifications in any part.

4.0 ERECTION PLATFORM

CAN Prilling Tower was constructed in the traditional manner upto 113.750 level and NP Prilling Tower upto 111.585 level where 100.000 was the grade level to which all levels refer. At these levels erection platform were made both inside and outside with the help of ordinary scaffolding and shuttering and pieces of slipform placed internally and externally. The working surface of these circular erection platform was 2 metres in width.

5.0 PLACING OF INNER SLIPFORM

The 6 M x 1 M assembled pieces of slipform were then transferred with the help of crane to the inside erection platform prepared around the prilling towers at a height from where the slipping was to start. The pieces were bolted together forming a ring. The inside ring of slipform was assembled first, to facilitate the steel binders to place and bind the steel. If outer ring of slipform is fixed first then it will interfere in handling of steel on inner erection platform and outer ring can be damaged easily.

6.0 STEEL BINDING

After assembling the inner slipform, the vertical and horizontal rebars were put in position. For easy working and keeping in view the required lap between the steel bars the vertical bars were cut and placed in such a manner that laps were staggered at starting point. The horizontal bars in both the prilling towers consisted 3/4" dia bars spaced at 200 mm centre to centre and vertical bars consisted of 5/8" dia bars at 200 mm centre to centre. There are two layers of steel on inside as well as on outside faces and a clear cover on both the sides was 40 mm. Wooden blocks of 40 mm thickness were inserted temporarily between steel bars and slipform so as to maintain 40 mm cover untill outside and inside rings of slipform were erected firmly in position with yokes. Then wooden blocks were removed and permanent spacers made of angle iron were fixed which provided uniform cover to re-bars.

7.0 PLACING OF OUTER SHUTTERING

When the first operation of steel binding was over, the outer pieces of slipform were placed on outside erection platform with the help of a small crane. Each piece of outer shuttering about 6 metres in length was also bolted together to form a ring on the outside. Fig.5 shows the outer & inner rings of the slipform. The space between the inner shuttering and outer shuttering was 400 mm. A second outer removable shuttering was inserted between outer layer of steel and outer fixed shuttering. This shuttering was introduced as the diameter of the prilling tower changed on top. The removable shuttering was pre-assembled in pieces of about 1 M x 1 M size (Fig. 6) and was slipped alongwith whole assembly. The top pieces of removable shuttering were fixed with square head screws which were removed when change in thickness of wall was required. In all 64 removable plates were used for each of the prilling tower.

7.1 Fixing of Yokes

When both inside and outside elements of the slipform where placed in position, the steel yokes were

erected. The yokes were placed at a distance of about 1.5 M from centre to centre along the periphery of the ptilling towers (Fig.7). This distance is determined keeping in view the design of the structure, size of the planks and capacity of each set of jacks. However the distance between the yokes is not allowed to be more than 2 metres and that too in special cases with stronger slipform.

7.2 Fixing of Jacks

The jacks with frames were fixed on the top of each yoke and jacking rods were inserted between the jaws of jacks . The frame has 2 jacks which are a patent of M/s AHL & Company. These jacks are operated with the help of hydraulic pump which is run electrically. After fixing of the jacks, the hydraulic tubing was fixed which interconnected all the jacks together.

7.3 Fixing of Climbing Rods

When the jacks were placed in position, the climbing or jacking rods were passed through them. These rods were of mild steel 3 M in length and 28 mm in dia. These are the rods against which jacks develop the reaction and move upwards. These rods were extended in their height by placing new rods on top of each other with the help of threaded studs. For the CAN Prilling Tower which had 48 jacks working on it 800 pieces of the climbing rods were used. These rods remain burried in concrete.

7.4 Fixing of Outside Rope

Steel rope of 12 mm diameter was wrapped around the slipform on the outside. The rope had 6 turn buckles along the periphery of the slipform for tightening the rope so as to keep the shuttering always in position.

7.5 Fixing of Inside Stiffners

To keep the inside of the slipform in its correct position and to avoid any relative movement of one element against the other, vertical pipe posts were attached with the

runners of slipform. The stiffners consisted of 48 mm diameter mild steel pipes normally used in scaffolding.The arrangement of the stiffners is shown in Fig.8.

7.6 Fixing of Brackets for Working Platform

The brackets for outside and inside of the working platforms were then put in position (Fig.9) and planks were laid. The railing of the platform consisted of 3/4" diameter reinforcing steel. Originally it was planned to have wooden railing but since there are many chances of the unloading bucket to strike the railing, the wooden railing was ommitted which could easily break.

7.7 Fixing of Plumbing Posts

Twelve plumbing posts spaced uniformally on the outer working platform of the slipform were fixed at 6 metres centre to centre. The plumbing posts are fixed before laying of planks on working platforms otherwise it will be difficult to work under working platform when the slipform is still on erection platform. The posts were 3 ft high with a steel bracket to take the optical plumbing instrument as shown in Fig. 10. Under each plumbing post a small opening of 6" x 6" was provided on the working platform through which the fixed target placed on the erection platform could be sighted after every operation of the slipform. A typical plastic coated target of size 50M x 50M is shown in Fig. 11.

7.8 Fixing of Spacers

To provide for proper cover to steel, angle iron spacers made from 1½" x 1½" x 1/8" and 9" long were fixed both inside and outside on the slipform elements at a distance of about 1.5 metre directly under the yokes.

7.9 Fixing of Hanging Platforms

By now every thing is placed in position. The hanging platforms are now attached on both sides of the slipform but in a horizontal position.After the slipform is

moved up the horizontal platforms became vertical and were tightened with bolts.

8.0 LAYOUT OF THE CRANE & MIXERS

The overall layout of the prilling towers and position of tower crane, hoists, winches, mixers, steel yard and water tank etc. is shown in Fig.12. Crushed stone local and Lawrencepur sands were located centrally so that they could be used conveniently for both the prilling towers. The basic idea in layout of equipment and machinery in this manner was easy access to all the pieces of equipment and to maintain the supply line which was required throughout 24 hours of the slipping operation. The crane was placed in a position so that it could be moved without touching any of the building and it could deliver both the steel and concrete at all positions, of the prilling towers. The crane boom was 30 metres in length and the bucket could be slided over the boom freely in any position. The lifting capacity of the crane varied from 1½ to 3 metric tons depending on the position of the bucket on the boom. The hoists which were used for the carriage of men and material on top of the slipform had a carrying capacity of 6 persons at a time and were operated by winch which was run electrically with the help of a 30 H.P. Motor.

The steel yard had all the steel cut, and bound according to the required sizes and placed in bundles in such a position that it could be lifted easily according to requirement during the slipping of the slipform.

A 3 M x 3 M water tank was made near each prilling tower from which water was pumped with the help of 2 small multistage centrifugal pumps each run by 7½ H.P.Motor.These pumps were to supply water for curing during the slipping.

A set of six mixers was deployed as shown in Fig.13 .Four of the mixers were electrically operated while 2 of them were operated by diesel. The diesel mixers were kept in the circuit so that they could be used in case of electric failure. Each mixer was of one bag cement capacity

and chutes were attached with the discharge ends of the mixers so that concrete could flow straight into bucket which was placed in an excavated pit right at the centre of the mixers. Three mixers were run for 12 hours and the other 3 mixers were kept as standbyes and were used either in the second shift or in case one mixer was out of order, the mixer from the other set was introduced in the circuit. The discharge of the 3 mixers which was about 15 to 17 cft. matched the capacity of the bucket which was 0.6 M^3.

An emergency 3 phase generator of capacity 125 KVA as shown in the layout was kept as a standby. This generator could be operated in the case of failure of electric during slipping of prilling towers.

8.1 Crane and its Erection

The tower crane which was used for the lifting of steel and concrete had a lifting capacity of 1½ ons with a boom length of 30 M. The height of crane could be increased by telescoping the crane with the help of built-in hydraulic jack and maximum height that could be achieved with this crane was 103 M. The crane was supported on four foundations each of the dimension 1.7 M x 1.7 M x 1.0 M. The counter weights required for the boom consisted of 2 weights of precast concrete (1960 mm x 1400 mm x 260 mm) each weighing 1650 Kgs. and the counter weight at the bottom also consisted of precast concrete units with a total weight of 30 metric tons.

The crane had to be telescoped after every 12 metres and it was also braced with the prilling tower as shown in Fig. 14. The bracing of the crane was done with the help of 3 number I-sections which were placed at calculated angles (Fig.15). The crane was also held by steel wire guy ropes of 1¾" diameter at intervals of 12 metres and in four directions.

9.0 ERECTION OF HOIST

Hoist was erected on south side of CAN Prilling Tower and on east side of NP Prilling Tower. It was daily

extended to reach the working platform due to daily increase in the height of the prilling tower after slipping. The hoist was normally used for the carriage of men & material upto the working platform of slipform. Hoist had the provision of emergency stairs so that if it goes out it was possible to come down from or go upto the slipform. It was braced with the help of 2 scaffolding pipes at every 2 metres along the height of the prilling tower.

10.0 WORKING OF SLIPFORM

When slipform was completely assembled on the erection platform, the concrete was poured in between the formwork after proper steel has been put in position. In the first pour the concrete was poured about one metre in layers of 25 cm which took about 5 hours after which first slipping of the formwork was started. The slipping was done usually at the rate of 20 cm to 25 cm each time. After the slipping has been done for the first time, steel was bound in position and further concrete was poured upto depth of 20 cm and the formwork was again slipped all round. Each layer of concrete was vibrated with the help of vibrators. While vibrating the concrete it was ensured that the poker of the vibrator penetrated into previous layer so as to maintain the monolithicity of the concrete.

11.0 TIME MOTION STUDY

Initially on the CAN Prilling Tower, the pouring of concrete for a slipform lift of 20 cm could be done in about 2 hours time. This time was excessive as it was found that the poker of the vibrator in upper layer could not penetrate into the previous layer which had already substantially set. To cut out the time of pouring of one layer of 20 cm, it was considered necessary that the bucket should take minimum time from its position of its being loaded with concrete to the position of its discharge on the slipform. To start with this was achieved in 10 to 12 minutes. To cut down this time the following steps were taken:

1. Mixers were placed in elevated position so that they could quickly discharge the concrete into bucket.

2. The bucket was discharged on the inner working platform after which the concrete was shovelled in the slipform.

The basic idea has been to relieve the bucket to go back for its loading as quickly as possible. In this way the time of the Bucket cycle was reduced to about 7 minutes. The total time taken to slip is shown in the Table-3 below:-

TABLE-3
TIME TAKEN FOR SLIPPING OF PRILLING TOWERS

CAN PRILLING TOWER		NP PRILLING TOWER	
Date of start	= 11/6/77	Date of start	= 4/8/77
Date of completion	= 5/7/77	Date of completion	= 28/8/77
Total hours of work	= 567	Total hours of work	= 575
Time lost in extension of crane and other problems	= 154	Hours lost due to extension of crane & other problems	= 240
Net hours of slipping	= 413	Net hours of slipping	= 335
Total volume of concrete	=1026.7 M^3	Total volume of concrete	= 950.92 M^3
Average volume of concrete poured per hour.	= 2.47 M^3	Average volume of concrete poured per hour	= 2.838 M^3
Height slipped	=161.000 -113.75 = 47.25 M	Total height slipped	= 162.750 - 111.585 = 51.165M
Average slipping per hour	= 117 mm	Average slipping per hour	= 152 mm.

Figs: 16 & 17 show the progress achieved in two weeks on CAN Prilling Tower. The speed of work can be visualized from them.

12.0 QUALITY OF CONCRETE

The quality of concrete in the prilling towers had to be such that its 28 days strength was 4500 psi. Normally this strength has been achieved with the ratio of 1½ : 1½ : 3 cement, sand and crushed stone with a water cement ratio of 0.5. This type of concrete has already been used in the pile caps of these prilling towers. In the case of prilling towers it was desired by the specialist of M/s AHL & Co., to introduce in concrete Natrium Pyrophosphate at the rate of 0.025 to 0.07% by weight of cement so as to retard the setting time of the concrete. Natrium Pyrophosphate is a retarder which slows down the setting of cement. The introduction of the retarder in concrete was necessitated to ensure that when the vibrator in the upper layer is used, its poker could penetrate into previous layer so as to promote monolithicity of the concrete and avoid horizontal rings on the surfaces.

Retarders are used to delay the setting of the cement but they are also reported to decrease the rate of development of strength and can also reduce the ultimate strength by as much as 50 percent. Literature on the retarders does not advocate their use in hich quality concrete but on the recommendation of the Specialist of M/s AHL & Co., which was approved by M/s UHDE, Engineering Contractors for the prilling towers, retarder was used in the concrete for towers. However to offset the effect of retarder the quantity of cement was increased per batch by 1/4 bag. It was ensured that the concrete is throughout homogeneous and easy to work in the presence of vibrator. The consistency of concrete was such that it did not segregate.

The concrete was unloaded from the bucket of the crane on the inner working platform of the slipform and was hurriedly shovelled in the slipform with the help of shovels and 1½" dia vibrator was used in concrete so as to have a dense concrete. 6" cubes were moulded after every 3 to 4 metres height of the slipping. The cubes strength for CAN & NP Prilling Towers is given in Appendix A & B.

13.0 CURING OF CONCRETE

Since the strength of concrete very much depends upon its curing, special arrangements were made with slip-form for taking the water up and spreading in a manner that it uniformally wets outer and inner surfaces of the towers. For this purpose a pipe line of 1½" dia was run along with the hoist and was continuously extended. This pipe through rubber hose was connected with 2 pipes, one fixed internally and the other externally through the external and internal working platforms to 1" dia perforated pipe rings installed at a distance of 20 mm from the bottom of shuttering. These rings were clamped with the pipe frames of hanging scaffolding 30 mm away from the surface of prilling tower walls. Water was pumped up from the water tank below. One spare pump was always kept ready as a standby. The surfaces of the prilling towers were constantly watered in the form of spray through holes of perforated pipe rings to achieve the desired quality (Fig. 18).

14.0 VERTICALITY OF SLIPFORM

It goes without saying that the structure to be slipped has to be truly vertical and for this reason 12 wooden posts 3 feet high in case of CAN Prilling Tower and same 10 posts in case of NP Prilling Tower were erected as mentioned earlier. After every slipping of 20 to 25 cm the target was sighted and deviation in verticality was observed and recorded. The correction of the verticality was done by placing or removing reinforcing bars as weights at proper places either on the inside or on the outside working platforms in front of plumb posts. This was a simple but very watchfull operation to keep the slipform and structure vertical.

15.0 CHANGE OF THICKNESS OF WALL OF TOWER

In both the towers the wall thickness was changed near the top from 300 mm to 400 mm. In case of CAN Tower the thickness changed at an elevation of 156.550 and in case of NP Tower it changed at 155.550. To achieve this thickness

the removable shuttering (refer Fig.1 item 12) was eliminated by unscrewing and removing the top pieces of the removable shuttering. Two nails 100 mm long were driven half way in the removable shuttering near upper corners so that remaining portion of the nails are embedded in the concrete. The main slipform was slipped over the removable shuttering which remained in its position.After one metre of slipping of slipform the removable shuttering was free to be removed in pieces one at a time.

16.0 LIST OF FIXTURES & OPENINGS

It is always necessary to prepare before hand a list showing the fixtures to be embedded in concrete at different elevations of the structure and also to show the location of pockets and opening which are to be left out during the slipping. A typical list prepared in case of CAN Prilling Tower is shown in Annexure "C".The diagram in this appendix indicates the method of locating the fixture on the opening. This method is feasible for easy installation. Fig. 19 also shows the method of leaving an opening at a place which is intercepted by a yoke.

17.0 MEASUREMENT OF SLIPPING & HEIGHT OF PRILLING TOWERS

Slipping was measured by graduated rods of rectangular section (15 mm x 10 mm) and 850 mm long which had minimum graduation of 2 cm each. These measuring rods are passed through clamps. At start the clamps were fixed with the jacking rods over each jack at zero mark of measuring rod which can slide through the clamps. During each operation of lifting of slipform the measuring rod also slide through the clamp showing the slipping height. After two pours of 25 cm height each the slipform is levelled at 50 cm mark and then clamps are re-set at zero mark to continue this procedure till the final height is achieved. This procedure is adopted only to control and check that the concrete is placed in uniform layers with a maximum thickness of 25 cm over the entire structures.

To measure the height of prilling tower a level with reference to grade level was marked on jacking rods. This mark was transferred by 1 metre upward regularly and the height of prilling tower as well as levels of fixtures and openings were checked by this method, successfully.

18.0 NIGHT WORK

Since the slipforming was required to be done continously it was necessary to provide required facilities of electricity both on the working platform as well as on the erection platform. Full illumination was done with row of 100 watt bulbs on the top of platform which is shown in Fig. No. 20. Illumination was also done on the external and internal hanging platforms around the perimeter. On the ground level search lights were fixed to light up the area for mixing of materials.

19.0 TWO-WAY TELEPHONE SYSTEM

Two-way telephone system run on batteries was installed on the slipform. One telephone was placed on the working platform of the slipform which moved along and the other was placed down below. This system was necessary to transmit messages from top to bottom and vice versa. This arrangement was handy and very helpful in the proper execution of the slipping work.

20.0 DISMENTALLING OF SLIPFORM

The dismentalling of slipform is a technique in itself as various pieces of the formwork are to be removed from large heights. Safety is the principal motto in dismentalling. The process of dismentalling the slipform consists in removing the different elements in a manner which does not jeoperdise the safety of the persons involved in the dismentalling as well as the removal of pieces in sequence. The steps involved in dismentalling are given below serially:-

i) Angle iron pieces fixed for providing cover are removed 50 cm before the desired elevation is reached. This is necessary to avoid permanent impression of angle iron on concrete. After pouring the remaining concrete the slipform is further moved up without any concrete upto 50 cm although very slowly so as to detach the form work from concrete.

ii) A platform supported on angle iron brackets is erected about 1 metre below the finished elevation to dismental the slipform. Steel sleeves for fixing of this platform are left in the wall during pouring.

iii) Before any dismentalling is started vertical wooden props of 100 mm x 100 mm section are placed under every yoke. These props are held tight between the bottom edge of shuttering and top of angle iron brackets so that shuttering was resting on them after the removal of yokes.

iv) The bolts of the jack are loosened and nails are inserted in the levers of the chucks so that chucks remain open till the removal of the jacking (climing) rods.

v) The valves of the jacks are closed and caps are screwed on the valves. The ends of the hydraulic piping are also closed down by screwing with the proper nipples provided for the purpose. This operation is necessary to avoid spillage of the hydraulic oil from the jacks and pipes.

vi) Then the draw tubes are taken out.

vii) The jacks from the yokes are disconnected and the nails from the levers of the chucks are also removed so as to release tension in the spring of the chucks.

viii) The dismentalling of the working platform is now started. It is always easier and convenient to start the dismentalling of working platform from a point exactly opposite to the hoist position. The removal should proceed simultaneously and equally on either side from point of start so as to keep the balance.

ix) The next step is to take out the planks from hanging platform and place the same over angle iron bracket to make platform for dismentalling of equipment. Afterwards unscrew the hanging scaffold frame both from inside as well as from outside. It is necessary at this stage to provide safety belts to the workers.

x) The inner stiffening pipes are then removed.

xi) Next the wire rope from the outside of the slip-form is removed.

xii) The only major equipment left in position are the yokes which are removed four at a time, two from either side from the point of removal.

xiii) The hydraulic piping alongwith yoke is removed.

xiv) When all the parts have been dismentalled, they could be all cleaned and oiled so as to be fit for use for next job.

21.0 USES OF SLIPFORM

Slipform is an equipment which can be used for high speed works. It has been used for the construction of two prilling towers in Pakarab Fertilizers Factory,Multan but can also be used for slipping of;

1. High-rise buildings
2. S i l o s
3. Stairwells
4. Bridge piers

5. Chimneys
6. Water towers
7. Round or rectangular tanks
8. Shafts
9. Retaining Walls
10. Telecommunication towers

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ANNEXURE-'A'

REPORT ON TESTING OF CONCRETE CUBES (Sheet 1 of 2)

NAME OF BUILDING: PRILLING TOWER (NP PLANT)

SIZE OF CUBES: 6" x 6"

Sr. No	Location	Date of pouring of concrete	Date of Testing		Crushing Strength Lbs./sq. in.		Specified strength after 28 days
			7 days	28 days	7 days	28 days	
1	2	3	4	5	6	7	8
1.	El. 111,600-115,090	4.8.77	11.8.77	1.9.77	2778 2778 2639	4722 4722 4583	4500
2.	El. 115,090-119,240	5.8.77	12.8.77	2.9.77	2778 2917 2639	4861 4722 4583	4500
3.	El. 119,240-123,600	6.8.77	13.8.77	3.9.77	3750 3611 3472	4861 4722 4583	4500
4.	El. 123,600-128,100	7.8.77	14.8.77	4.9.77	3472 3333 3194	4861 4861 4722	4500
5.	El. 128,100-132,120	8.8.77	15.8.77	5.9.77	3333 3194 3333	5277 5138 4861	4500
6.	El. 132,120-136,780	9.8.77	16.8.77	6.9.77	3333 3611 3333	4861 4722 4583	4500
7.	El. 136,780-138,800	10.8.77	17.8.77	7.9.77	3611 3472 3333	4861 4861 4722	4500

1	2	3	4	5	6	7	8
8.	El.138,800-142,820	12.8.77	19.8.77	9.9.77	3750 3611 3333	4861 4722	4500
9.	El.142,820-145,120	13.8.77	20.8.77	10.9.77	3750 3750 3611	5138 5000 5138	4500
10.	El.145,120-149,550	14.8.77	21.8.77	11.9.77	3750 3611 3611	5416 5138 5277	4500
11.	El.149,550-153,800	17.8.77	24.8.77	14.9.77	3611 3611 3472	5277 5138 5416	4500
12.	El.153,800-155,200	20.8.77	27.8.77	17.9.77	3472 3333 3194	5138 5138 4861	4500
13.	El.155,200-158,100	24.8.77	31.8.77	21.9.77	3611 3472 3472	5138 5000 4861	4500
14.	El.158,100-160,100	25.8.77	1.9.77	22.9.77	3750 3611 3472	5555 5138 5000	4500
15.	El.160,100-163,000	27.8.77	3.9.77	25.9.77	3472 3333 3333	5000 4861 4722	4500

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NAME OF BUILDING: PRILLING TOWER (CAN PLANT)

SIZE OF CUBES: 6" x 6"

Sr. No.	Location	Date of pouring of concrete	Date of testing 7 days	Date of testing 28 days	Crushing Strength Lbs./Sq.in 7 days	Crushing Strength Lbs./Sq.in 28 days	Specified strength after 28 days
1	2	3	4	5	6	7	8
1.	El. 113,650-114,650	11.6.77	18.6.77	9.7.77	2500 2500 2500	4862 4861 4722	4500
2.	El. 114,650-117,800	12.6.77	19.6.77	10.7.77	3639 3389 4306	4861 4722 4722	4500
3.	El. 117,800-119,000	13.6.77	20.6.77	11.7.77	3133 3472 3611	4861 4522 4522	4500
4.	El. 119,000-122,130	14.6.77	21.6.77	12.7.77	2778 2361 2500	4861 4722 4861	4500
5.	El. 122,130-124,800	15.6.77	22.6.77	13.7.77	4028 3750 3472	4861 4722 4583	4500
6.	El. 124,800-127,770	16.6.77	23.6.77	14.7.77	4028 4167 4028	5000 4861 4861	4500
7.	El. 127,770-133,300	17.6.77	24.6.77	15.7.77	4306 3750 3472	5139 5000 5139	4500
8.	El. 133,300-135,800	18.6.77	25.6.77	16.7.77	3611 3472 3056	5139 5000 4861	4500
9.	El. 135,800-136,650	19.6.77	26.6.77	17.7.77	4167 4028 3194	5000 4861 4722	4500

Mian M. Hanif

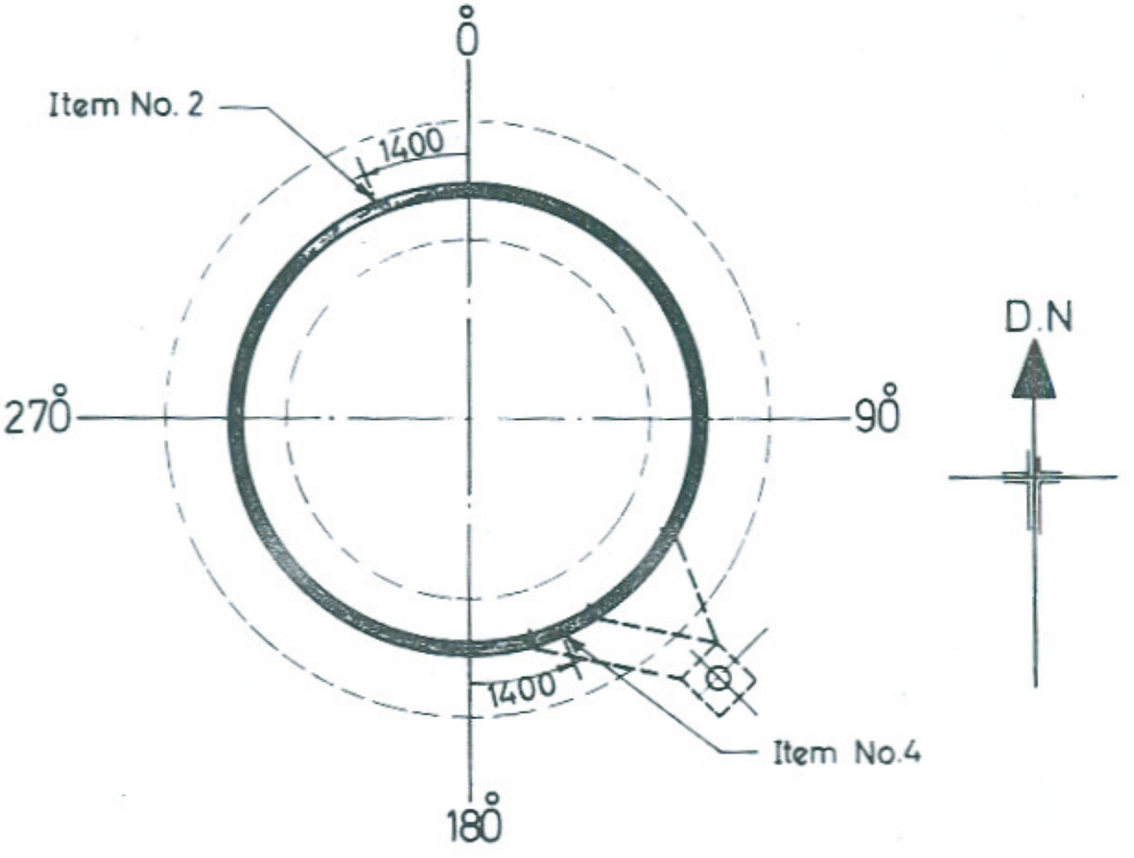
ANNEXURE-'B'
(Sheet 2 of 2)

1	2	3	4	5	6	7	8
10.	El. 136,650-138,350	20.6.77	27.6.77	18.7.77	4444 4306 4167	5000 4861 4861	4500
11.	El. 138,350-142,300	22.6.77	29.6.77	20.7.77	4161 4028 3889	4861 4722 4583	4500
12.	El. 142,300-143,800	23.6.77	30.6.77	21.7.77	4161 3750 3611	4861 4722 4722	4500
13.	El. 143,800-144,600	24.6.77	1.7.77	22.7.77	3472 3194 3472	4861 4722 4722	3194 4500
14.	El. 144,600-147,850	25.6.77	2.7.77	23.7.77	3611 3472 3333	4861 4722 4861	4500
15.	El. 147,850-150,500	26.6.77	3.7.77	24.7.77	4306 4167 4167	4861 4722 4722	4500
16.	El. 150,500-154,200	29.6.77	6.7.77	27.7.77	4167 4028 4028	4861 4722 4583	4500
17.	El. 154,200-156,500	30.6.77	7.7.77	28.7.77	4028 3889 3889	4861 4722 4722	4500
18.	El. 156,500-159,200	3.7.77	10.7.77	1.8.77	4028 3889 3750	4861 4722 4583	4500
19.	El. 159,200-161,080	4.7.77	11.7.77	2.8.77	3611 3472 3611	3861 4722 4861	4500

ITEM No.	ELEVATION	DETAIL	LOCATION			Nos
1	114.150	Pockets for crane anchor	Marked on platform			3
2	114.900	Plate for drain pipe	0°	1400	270°	1
3	117.900	Plate for pipe	0°	1400	270°	1
4	120.000	Plate for pipe	180°	1400	90°	1
5	120.900	Plate for pipe	0°	1400	270°	1
6	123.000	Plate for pipe	180°	1400	90°	1
7	123.900	Plate for pipe	0°	1400	270°	1
8	126.000	Plate for pipe	180°	1400	90°	1
9	126.150	Pockets for crane anchor	Marked on platform			3
10	126.900	Plate for pipe	0°	1400	270°	1
11	129.000	Plate for pipe	180°	1400	90°	1
12	129.900	Plate for pipe	0°	1400	270°	1
13	132.000	Plate for pipe	180°	1400	90°	1
14	132.900	Plate for pipe	0°	1400	270°	1
15	133.800	Hole 520 ϕ	0°	2400	270°	1
16	135.000	Plate for pipe	180°	1400	90°	1
17	135.900	Plate for pipe	0°	1400	270°	1
18	138.000	Plate for pipe	180°	1400	90°	1
19	138.150	Pockets for crane anchor	Marked on platform			3
20	138.900	Plate for pipe	0°	1400	270°	1
21	141.000	Plate for pipe	180°	1400	90°	1
22	141.900	Plate for pipe	0°	1400	270°	1
23	144.000	Plate for pipe	180°	1400	90°	1
24	144.900	Plate for pipe	0°	1400	270°	1
25	147.000	Plate for pipe	180°	1400	90°	1
26	147.900	Plate for pipe	0°	1400	270°	1
27	150.000	Plate for pipe	180°	1400	90°	1
28	150.150	Pockets for crane anchor	Marked on platform			3
29	150.900	Plate for pipe	0°	1400	270°	1
30	153.000	Plate for pipe	180°	1400	90°	1
31	153.900	Plate for pipe	0°	1400	270°	1
32	156.000	Plate for pipe	180°	1400	90°	1
33	156.900	Plate for pipe	0°	1400	270°	1
34	Bottom at 157.500	Window 2100 x 2000	Centre at 0°			1
35	Bottom at 158.125	Window 2000 x 2000	Centre at 180°			1
36	Bottom at 158.125	Windows 1000 x 2000	Centre at 90°, 270°			2
37	Bottom at 158.125	Windows 1000 x 2000	0°	8957	90°	4
			90°	8957	180°	
			180°	8957	270°	
			270°	8957	0°	
38	159.000	Plate for pipe	180°	1400	90°	
39	159.000	Plate for pipe	0°	1400	270°	

ANNEXURE-C
PAPER No. 437

EMBEDDED ITEMS IN CAN PRILLING TOWER



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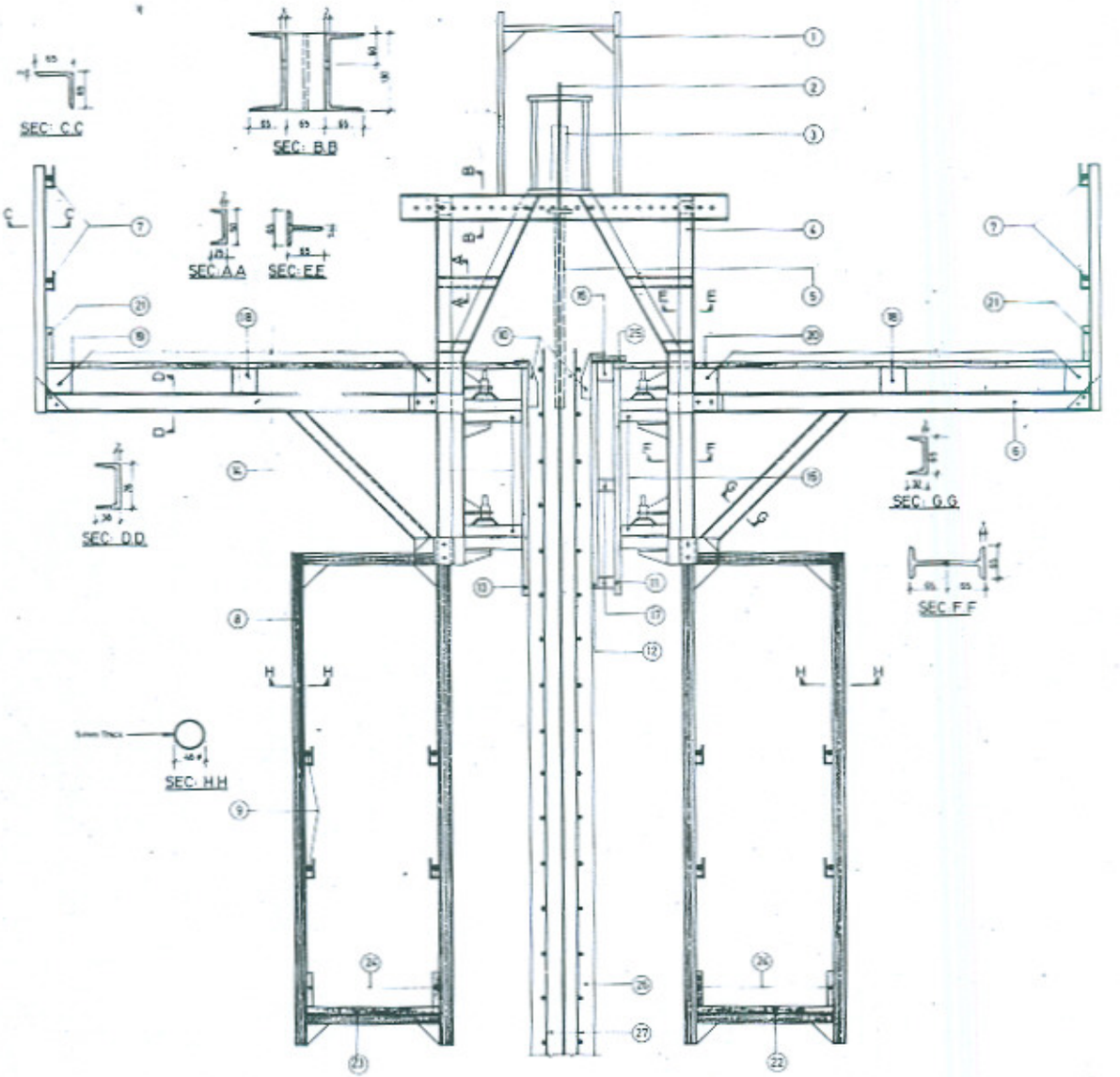
1. "Up, up and away as slipform rises rapidly to shape West's tallest tower in Calgary" by Walter Rooke, Heavy construction News. The Canadian, Kellogg Company Ltd.,Quebec, CANADA.

2. Concrete Roads, Design and construction issued by Ministry of Transport,Road Research Laboratory, H.MSO & Published by Lowe and Brydone (Printers) Ltd.,London NW 10, 1966

FIGURE - 1

SLIPFORM ASSEMBLY



STEEL PARTS

1. Support trestle.
2. Sliding rod.
3. Hydraulic jack.
4. Yoke assembly.
5. Casing tube.
6. Bracket for working platform.
7. Safety railing for working platform.
8. Pipe frame for hanging platform.
9. Safety railing for hanging platform.
10. Spacer for rebars.

WOODEN PARTS

11. Outer shuttering planks.
12. Removable shuttering planks.
13. Inner shuttering planks.
14. Outer runner.
15. Inner runner.
16. Removable runner.
17. Removable runner.
18. Supports for working platform.
19. Planks for inner working platform.
20. Planks for outer working platform.
21. Toe boards.
22. Planks for outer hanging platform.
23. Planks for inner hanging platform.
24. Toe boards for hanging platform.
25. Removable top pieces of removable shuttering.
26. Concrete wall.
27. Rebars.

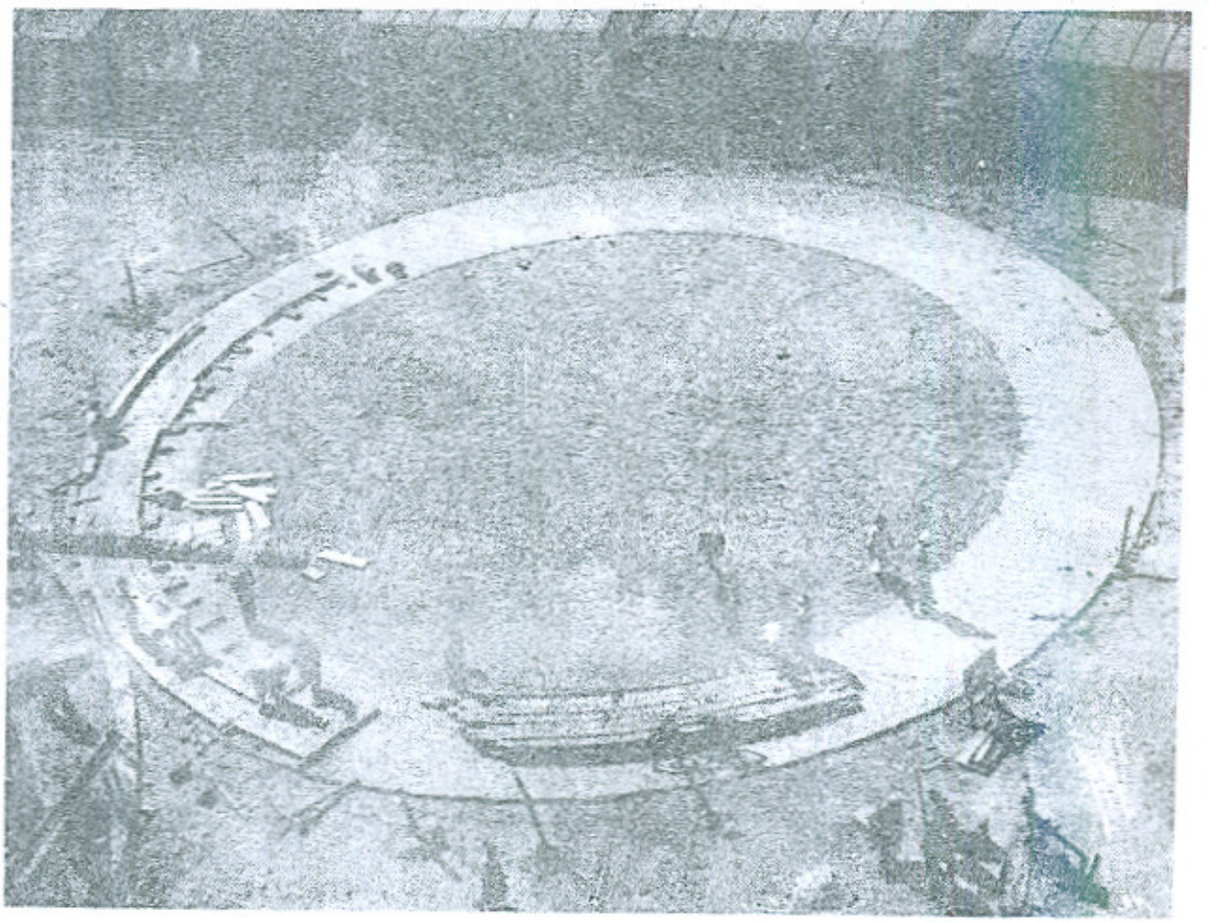


Fig. 2 Platform for Ground Assembly

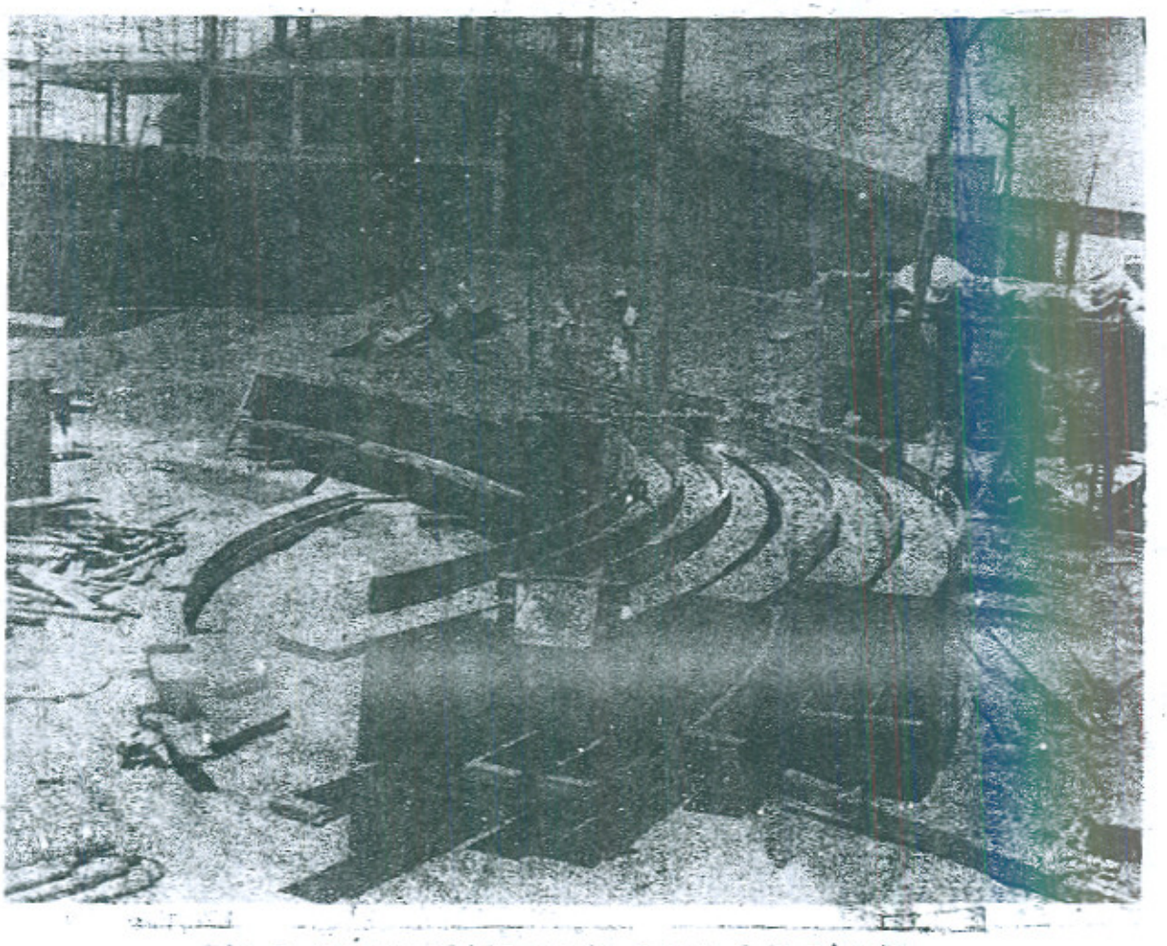


Fig.3 Outer Slipform in 6 M x 1 M Pieces