

TABLES AND FIGURES

Table 4.1 Physical Properties of Type II Cement Samples

Physical Data	ASTM C-150	Law Engineering Testing		NBS	
		NBS Sample	OSHA Sample	NBS Sample	OSHA Sample
1. Air Content (% by volume)	Max. 12	7.4	7.2	---	---
2. Fineness,* min. (specific surface cm <sup>2</sup> /g)	2800	3710	3720	3788	3750
3. Compressive Strength of mortar,** psi (MPa)					
	3 days	1500 (10.3)	1680 (11.6)	---	---
7 days	2500 (17.2)	2200(15.2)	1900 (13.1)	---	---
4. Time of setting *** (Gilmore Test)					
Initial Set	Not less than 1 hr	2 hr 49 min	3 hr 10 min	---	---
Final Set	Not more than 10 hr	4 hr 45 min	4 hr 50 min	---	---

\* ASTM C 204 [4.2]  
 \*\* ASTM C 109 [4.2]  
 \*\*\* ASTM C 266 [4.2]

Table 4.2 Chemical Properties of Type II Cement

Chemical Elements	ASTM C 150 %	Wet Chemical Analysis	
		NBS Sample %	OSHA Sample %
Silicon Dioxide	Min. 21.0	20.6	20.0
Aluminum Oxide	Max. 6.0	5.3	5.2
Ferric Oxide	Max. 6.0	3.0	3.9
Calcium Oxide	—	64.1	63.5
Magnesium Oxide	Max. 6.0	2.4	2.1
Sulfur Trioxide	Max. 3.0	2.1	2.0
Total Alkalies	—	0.38	0.44
Loss on Ignition	Max. 3.0	1.2	1.6
Insoluble Residue	Max. 0.75	0.22	0.25
Tricalcium Silicate	—	60	60
Dicalcium Silicate	—	14	12
Tricalcium Aluminate	Max. 8.0	7.1	7.1
Tetracalcium Alumioferrite	—	9	12

Table 4.3 Element Analysis of Flyash

Element	NBS Sample (in %)	OSHA Sample (in %)
Aluminum	12.8	11.3
Boron	0.05	0.05
Barium	0.15	0.20
Carbon	0.50	1.30
Calcium	2.00	3.00
Chromium	0.01	0.01
Copper	0.01	0.01
Iron	9.8	10.5
Potassium	2.00	2.00
Lithium	0.15	0.12
Magnesium	2.00	2.00
Manganese	0.05	0.05
Sodium	0.30	0.30
Nickel	0.01	0.01
Rubidium	0.01	0.01
Silicon	20.9	20.7
Strontium	0.07	0.10
Titanium	0.50	0.50

Table 4.4 Chemical Composition of Fly Ash

	NBS Sample	OSHA Sample	ASTM C 618
Aluminum Oxide	24.1	21.3	--
Iron Oxide	14.0	14.9	--
Silicon Dioxide	44.6	44.2	--
Sum	82.8	80.5	70.0

Table 4.5 Data Sheet for Concrete Mix

Field Data On Concrete Compression Test Specimens

Send to PITTSBURGH TESTING LABORATORY, 850 Poplar Street, Pittsburgh, Pa., Telephone: 922-4000

Date Mailed: April 26, 1972 Order No.: PS-18936

Project: Pleasantts Pavilion Station Units 1 & 2

At: Willow Island, W. Va.

Contractor: Research-Coffell, Inc.

Reported to: United Engineers & Constructors, Inc.

Concrete Supplier: Criss' Concrete St. Marys Plant

Quantity represented: 90 Cu. Yds. Specimens made by: Domingo #12 No. Submitted: 6

Location of pour: South Ceiling Tower; Veil Lift # 28

Strength requirement: 4000 psi at 28 days

MATERIAL PROPORTIONS USED (Quantities per cubic yard of concrete) MIX No. 200A STRUCTURE: CEILING

Cement	410	lb.	Brand	<u>PORTLAND</u>
Fine Aggregate (SSD)	1174	lb.	Source	<u>DINO RICE SAND &amp; GRAVEL</u>
Coarse Aggregate (SSD)	1900	lb.	Size	<u># 57</u>
Water	276	Gals.	Source	<u>HARRISBURG STATE</u>
Water Total	276	Gals.	Gal. per Bag	<u>5.65</u>
Admixtures: Amount	5.0	ozs.	Kind	<u>NAIVE</u>
Admixtures: Amount	5.0	ozs.	Kind	<u>NAIVE</u>

Strength requirement: 4000 psi at 28 days

Entr. Air: 5.2 % Actual Slump: 66 in. Ticket No.: CL040

Temperature: Air: 52 °F Concrete: 66 °F Weather: Cloudy

Mixing: Control Mix:  Truck Mix:  Job Mix:  Project Engineer:  Contractor:

Above Site Information obtained from: PTL Inspection:  Other:  (Designate) Concrete Supplier:  Contractor:  Common Carrier:

TEST NO.	TEST DATE	TEST RESULT	TEST METHOD	TEST RESULT
163 A	7	5-9-78	5-3-78	
163 B	7	5-3-78	5-3-78	
163 C	28	5-24-78	5-24-78	
163 D	28	5-24-78	5-24-78	
163 E	28	4-28-78	4-28-78	0760
163 F	28	4-27-78	4-27-78	8000 0283

Cyls. delivered to laboratory by: PTL  Contractor  Common Carrier

If test results are low, they may be due to any of the following reasons:  
 1. Poorly mixed concrete  
 2. Poorly placed concrete  
 3. Poorly cured concrete  
 4. Poorly stored concrete  
 5. Poorly handled concrete

Remarks: TEST SPECIMENS MADE AT PLEASANTTS PAVILION STATION, WILLOW ISLAND, W. VA.

Signature: M. Brando

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Admixtures: Amount	5.0	ozs.	Kind	<u>NAIVE</u>
Admixtures: Amount	5.0	ozs.	Kind	<u>NAIVE</u>

Strength requirement: 4000 psi at 28 days

Entr. Air: 5.0 % Actual Slump: 71/2 in. Ticket No.: CL040

Temperature: Air: 52 °F Concrete: 66 °F Weather: Cloudy

Mixing: Control Mix:  Truck Mix:  Job Mix:  Project Engineer:  Contractor:

Above Site Information obtained from: PTL Inspection:  Other:  (Designate) Concrete Supplier:  Contractor:  Common Carrier:

TEST NO.	TEST DATE	TEST RESULT	TEST METHOD	TEST RESULT
164 A	7	5-3-78	5-3-78	
164 B	7	5-3-78	5-3-78	
164 C	28	5-24-78	5-24-78	
164 D	28	5-24-78	5-24-78	
164 E	28	4-27-78	4-27-78	8150 0299
164 F	28	4-27-78	4-27-78	8150 0299

Cyls. delivered to laboratory by: PTL  Contractor  Common Carrier

If test results are low, they may be due to any of the following reasons:  
 1. Poorly mixed concrete  
 2. Poorly placed concrete  
 3. Poorly cured concrete  
 4. Poorly stored concrete  
 5. Poorly handled concrete

Remarks: TEST SPECIMENS MADE AT PLEASANTTS PAVILION STATION, WILLOW ISLAND, W. VA.

Signature: M. Brando

Table 4.6 Data on Fresh Concrete

	Range	Average
1. Unit Weight of Concrete lb/ft <sup>3</sup> (kg/m <sup>3</sup> )	140.5 - 144.4 (2251 - 2313)	143.1 (2292)
2. Slump in (mm)	6 - 9 (152 - 229)	7.4 (188)
3. Air Content %	4.5 - 5.9	5.1
4. Temperature of Concrete at the Time of Pour °F (°C)	66.3 - 66.9 (17.2 - 20.6)	66.4 (19.1)

Table 4.7 Results of Tension Tests of Cables

	Hoist End Section	Drum End Section
1	28.53 kip (126.91 kN)	26.55 kip (118.10 kN)
2	26.82 (119.30)	27.00 (120.01)
3	27.20 (120.99)	26.20 (116.54)
4	27.75 (123.44)	27.45 (122.10)
5	27.40 (121.88)	27.78 (123.57)
Average	27.54 kip (122.50 kN)	27.00 kip (120.01 kN)

Table 6.1 Cathead Forces and Reactions Induced by Hoisting Loads -  
(for load case 5)

	(a)		(b)	
Impact Factor	0%		100%	
$W_B$ lb (kg)	2900 (1315)		5800 (2630)	
$s_0$ ft (m)	219.17 (66.80)		219.17 (66.80)	
Condition of Support G	Fixed	Elastic	Fixed	Elastic
$F_D$ lb (N)	2460.14 (10943.24)	2451.69 (10905.66)	4928.35 (21922.31)	4931.73 (21937.42)
T lb (N)	5378.64 (23925.37)	4772.26 (21228.06)	8860.59 (39413.85)	7670.59 (34120.47)
$F_c$ lb (N)	11311.67 (50316.80)	10131.61 (45067.63)	18760.19 (83449.45)	16339.25 (72680.58)
$A_p$ lb (N)	18630.78 (82873.81)	16913.27 (75233.95)	31858.23 (141712.41)	28461.90 (126604.79)
$B_p$ lb (N)	296.91 (1320.72)	496.14 (2206.94)	1213.33 (5397.15)	1602.59 (7128.67)
$A_z$ lb (N)	3453.00 (15359.70)	3134.69 (13943.79)	5904.57 (26264.83)	5275.10 (23464.81)
$B_z$ lb (N)	57.71 (256.71)	96.44 (428.99)	235.84 (1049.07)	311.51 (1385.67)
$L_1$ ft (m)	95.0 (29.0)	100 (30.5)	95.0 (29.0)	100 (30.5)
$L_2$ ft (m)	123.56 (37.66)	118.56 (40.41)	123.56 (37.66)	118.56 (40.41)

Table 6.2a Stress Resultants in Lift 28 for Sum of Load Cases at Angles of 0 and 1.875 Degrees

Sum of Load Cases: 1, 2, 3, 4, 5  $\theta = 0^\circ$

Point of Load Application	Location	Top of Element	Node	$N_\phi$ k/ft	$N_\theta$ k/ft	$N_{\theta\phi}$ k/ft	$M_\phi$ in-k/ft	$M_\theta$ in-k/ft	$Q_\phi$ k/ft	$Q_\theta$ k/ft
I	TL 28	1	1	0.000	-27.11	0.0	0.000	-2.449	0.0000	0.0
		2	2	0.034	-25.81	0.0	1.912	-1.255	0.0295	0.0
K		3	3	-0.047	-22.95	0.0	8.804	-3.632	0.7103	0.0
		4	4	-0.114	-18.64	0.0	23.532	-7.699	0.9382	0.0
L		5	5	-0.127	-14.94	0.0	36.840	-10.286	0.9345	0.0
		6	6	-0.099	-11.72	0.0	47.892	-11.707	0.8683	0.0
J	TL 27	7	7	0.023	-9.46	0.0	54.312	-11.344	0.9559	0.0
		8	8	0.102	-13.18	0.0	60.768	-24.696	0.4627	0.0

Sum of Load Cases: 1, 2, 3, 4, 5

 $\theta = 1.875^\circ$ 

Point of Load Application	Location	Top of Element	Node	$N_\phi$ k/ft	$N_\theta$ k/ft	$N_{\theta\phi}$ k/ft	$M_\phi$ in-k/ft	$M_\theta$ in-k/ft	$Q_\phi$ k/ft	$Q_\theta$ k/ft
I	TL 28	1	1	-0.001	-31.91	0.000	0.000	-76.416	0.000	4.3880
		2	2	-5.341	-28.28	-1.122	-8.732	-81.792	8.594	1.4400
K		3	3	-3.644	-22.59	-1.276	18.492	-62.628	4.707	-0.5434
		4	4	-1.869	-17.64	-1.362	35.400	-34.080	3.234	0.2385
L		5	5	-0.814	-13.97	-1.671	49.908	-13.788	3.074	0.1788
		6	6	0.374	-10.94	-1.343	70.644	3.307	2.322	-1.5720
J	TL 27	7	7	-3.811	-9.06	-0.792	89.520	13.704	-3.506	-0.5855
		8	8	-2.012	-12.28	-1.387	62.556	5.300	-1.526	1.6810

Table 6.2b Screws Resultants in Lift 28 for Sum of Load Cases  
at Angles of 0 and 1.875 Degrees

Sum of Load Cases: 1, 2, 3, 4, 5

$\theta = 0^\circ$

Point of Load Application	Location	Top of Element	Node	$N_\phi$ KN/m	$N_\theta$ KN/m	$N_{\theta\phi}$ KN/m	$M_\phi$ KN-m/m	$M_\theta$ KN-m/m	$Q_\phi$ KN/m	$Q_\theta$ KN/m
I	TL 28	1	1	0.002	-395.7	0.00	0.000	-0.908	0.000	0.00
		2	2	0.493	-376.7	0.00	0.708	-0.465	0.431	0.00
K		3	3	-0.679	-335.0	0.00	3.263	-1.346	10.368	0.00
		4	4	-1.667	-272.1	0.00	8.721	-2.853	13.694	0.00
L		5	5	-1.858	-218.1	0.00	13.653	-3.811	13.640	0.00
		6	6	-1.438	-171.1	0.00	17.749	-4.339	12.674	0.00
J	TL 27	7	7	0.342	-138.1	0.00	20.128	-4.204	13.952	0.00
		8	8	1.486	-192.4	0.00	22.521	-9.152	6.754	0.00

Sum of Load Cases: 1, 2, 3, 4, 5

$\theta = 1.875^\circ$

Point of Load Application	Location	Top of Element	Node	$N_\phi$ KN/m	$N_\theta$ KN/m	$N_{\theta\phi}$ KN/m	$M_\phi$ KN-m/m	$M_\theta$ KN-m/m	$Q_\phi$ KN/m	$Q_\theta$ KN/m
I	TL 28	1	1	-0.01	-465.8	0.00	0.00	-32.03	-0.00	64.05
		2	2	-77.95	-412.8	-16.38	-3.24	-30.31	125.40	21.02
K		3	3	-53.19	-329.7	-18.62	6.85	-23.21	68.70	-7.93
		4	4	-27.28	-257.5	-19.88	13.12	-12.63	47.20	3.48
L		5	5	-11.88	-203.9	-24.39	18.50	-5.11	44.67	2.61
		6	6	5.47	-159.7	-19.60	26.18	1.23	33.89	-22.95
J	TL 27	7	7	-55.63	-132.3	-11.56	33.18	5.08	-51.17	-8.55
		8	8	-29.37	-179.2	-20.25	23.18	1.96	-22.27	24.54

Table 7.1 Shear Forces in Lift 28

Loading Cond. 1,2,3,4,5	$Q_{\theta}$ Shear Strength (in pounds)	$Q_{\phi}$ Shear Strength (in pounds)
At Center	0      2539	30      2225
At Rib	4388      2594*	8594      2286*

\* Capacity of the section is less than shear force.

$Q_{\theta}$  = Radial shear in the vertical cross section

$Q_{\phi}$  = Radial shear in the horizontal cross section

1.0 lbf = 4.44822 N

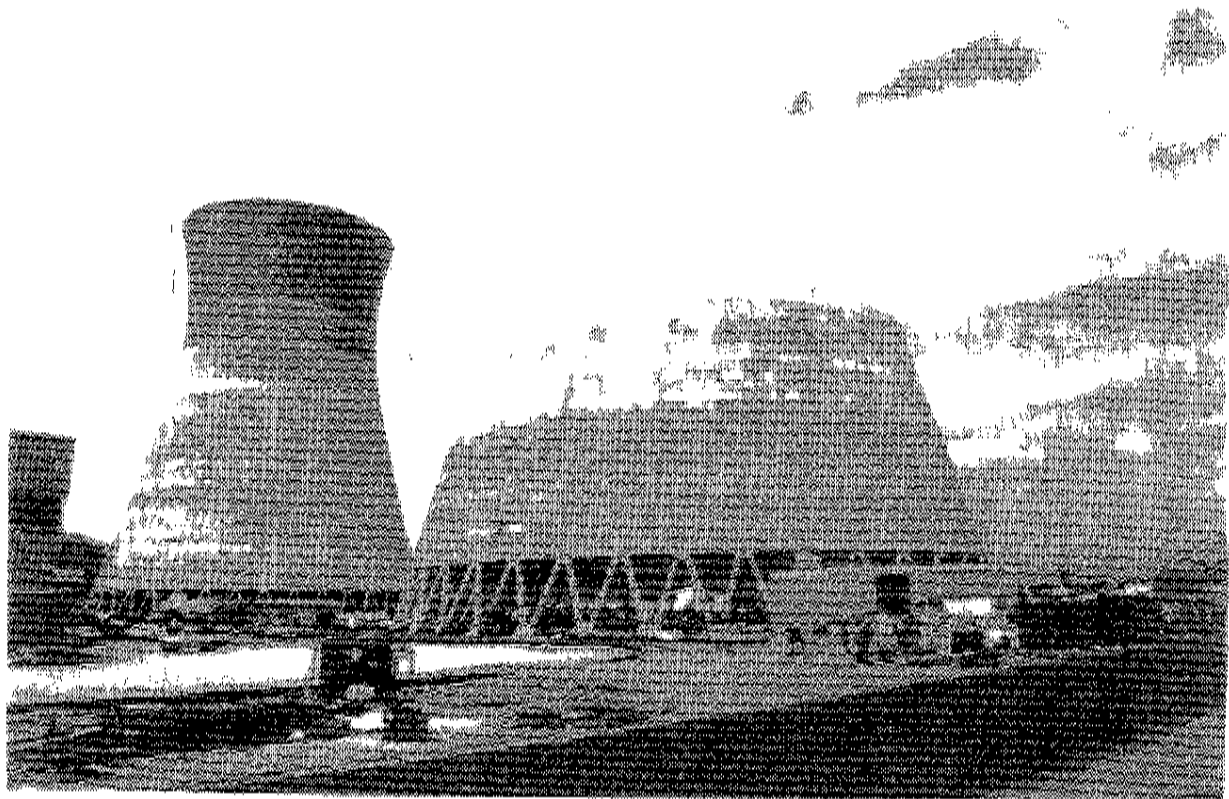


Figure 1.1 A General View Showing Completed Tower Unit No. 1 and Unit No. 2

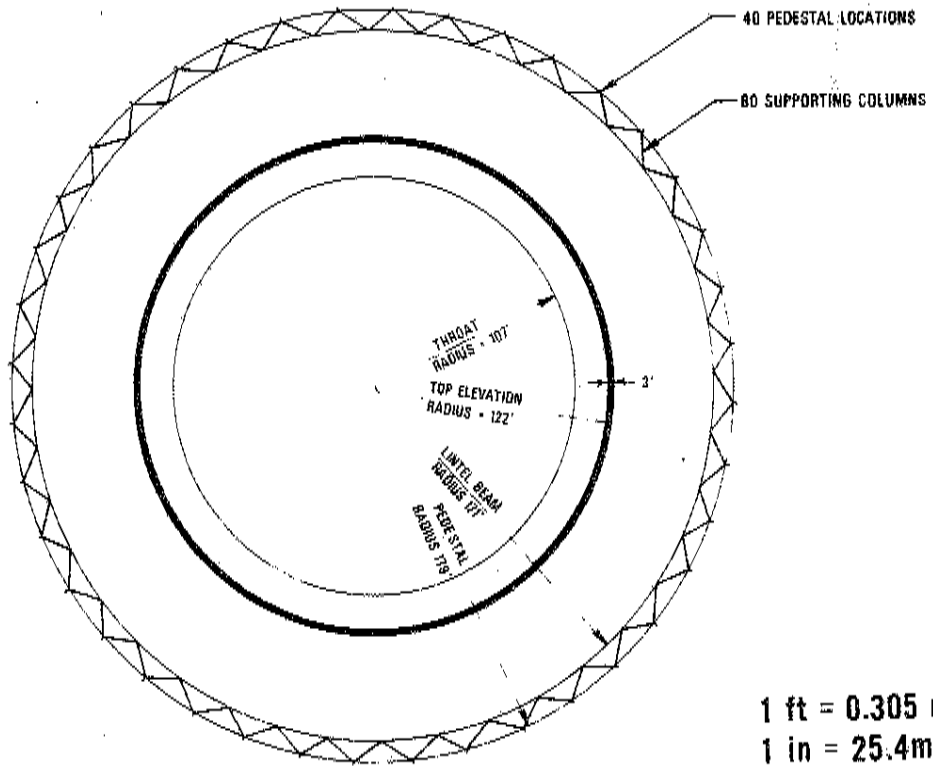
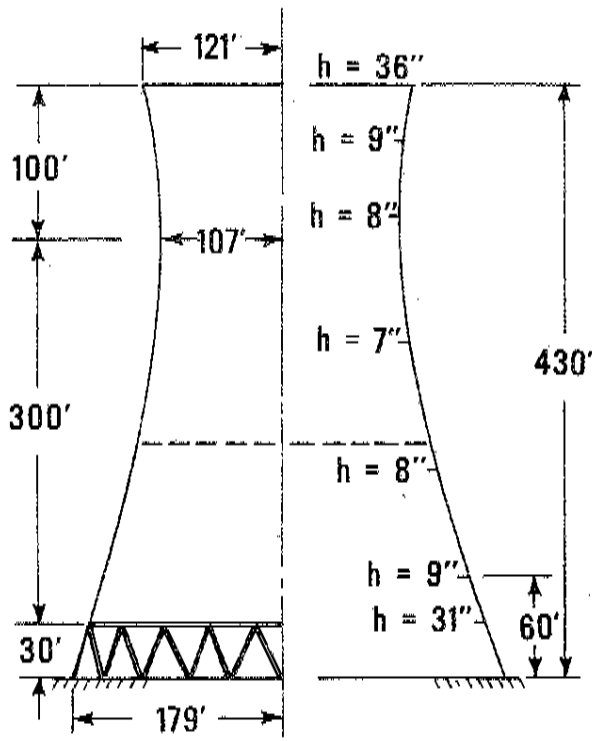
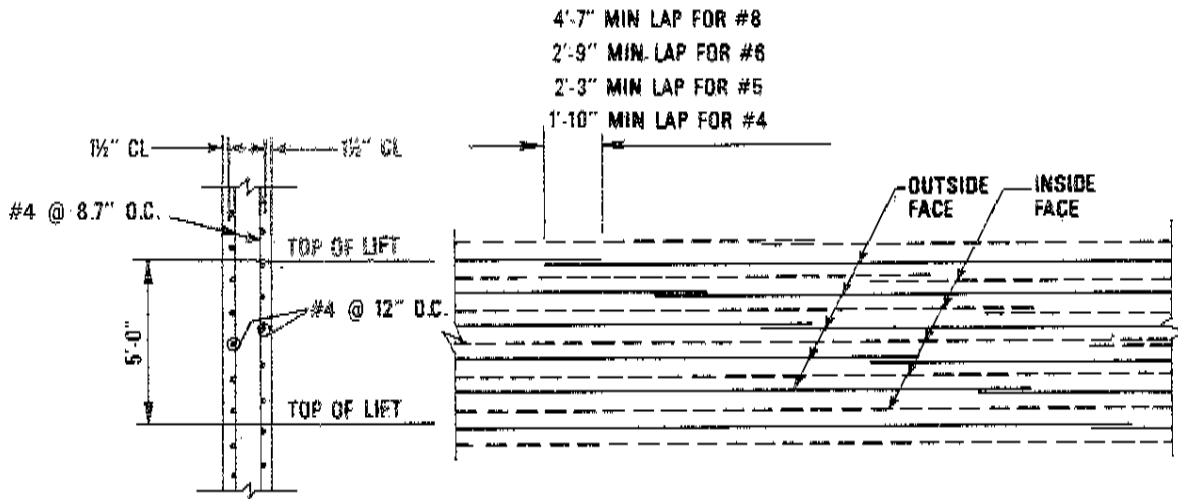
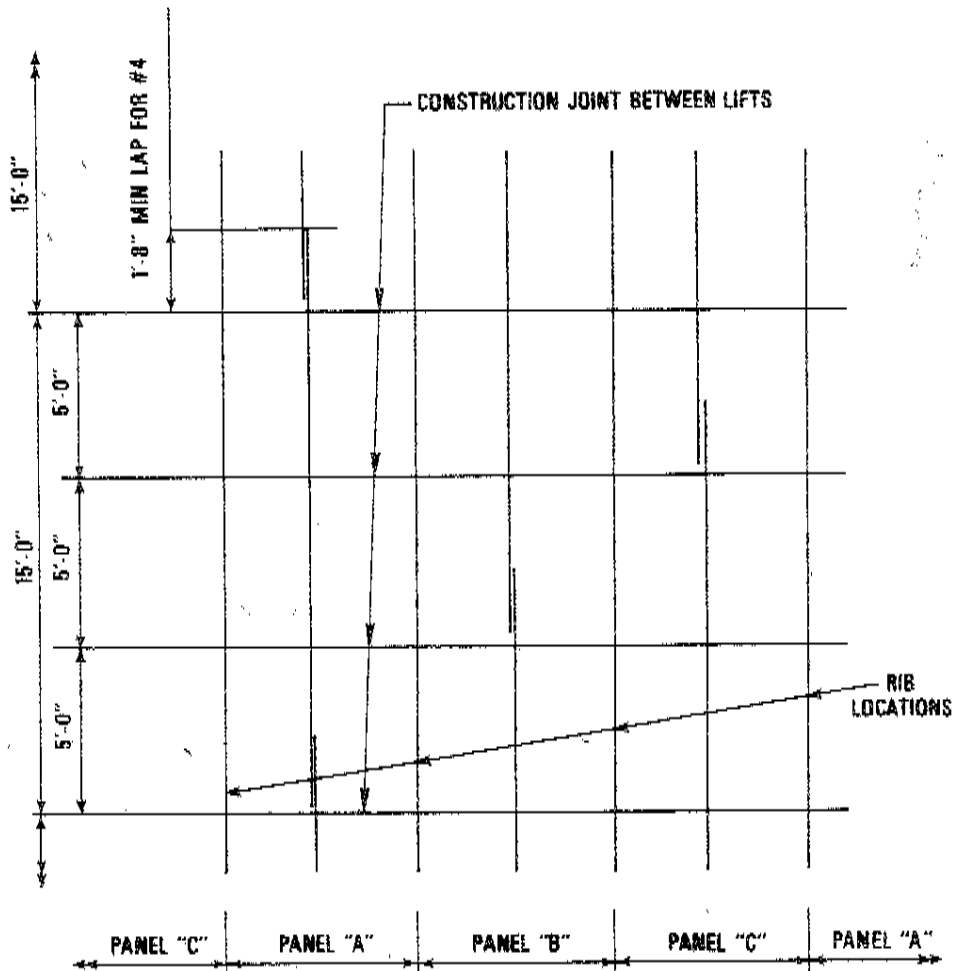


Figure 2.1 Elevation and Plan View of Cooling Tower Unit No. 2



(a) Bar Sizes and Spacing for Lift 28

(b) Splice Detail for Horizontal Bars



(c) Splice Detail for Vertical Bars

1 ft = 0.305m  
1 in = 25.4mm

Figure 2.2 Detail of Wall Reinforcement

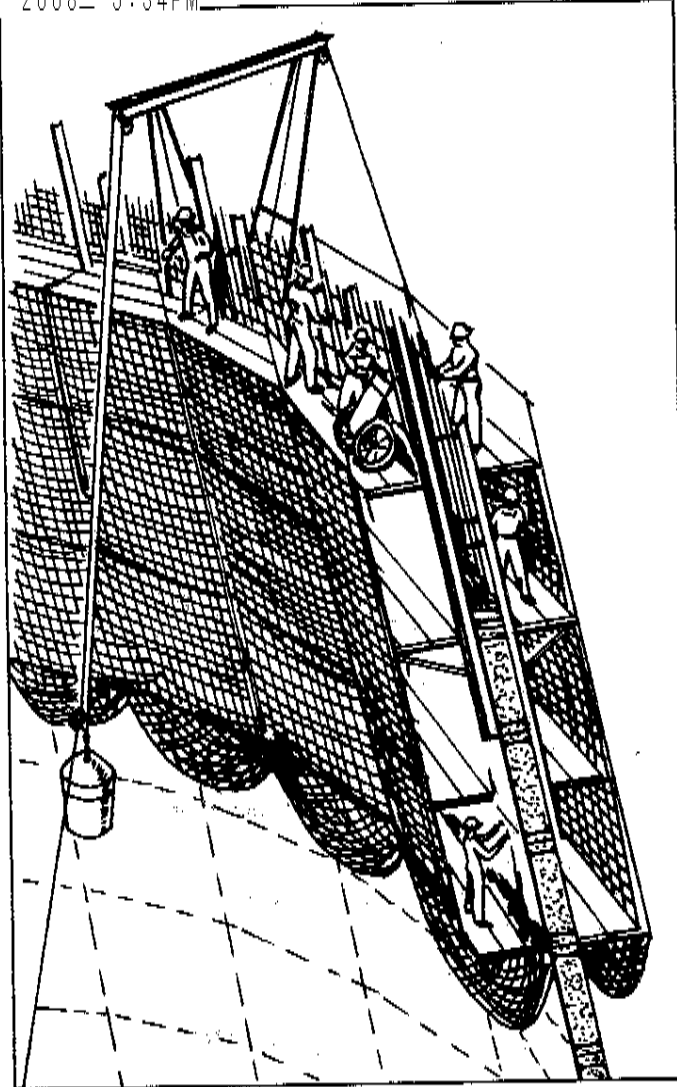


Figure 2.3 Perspective View of the Scaffolding System

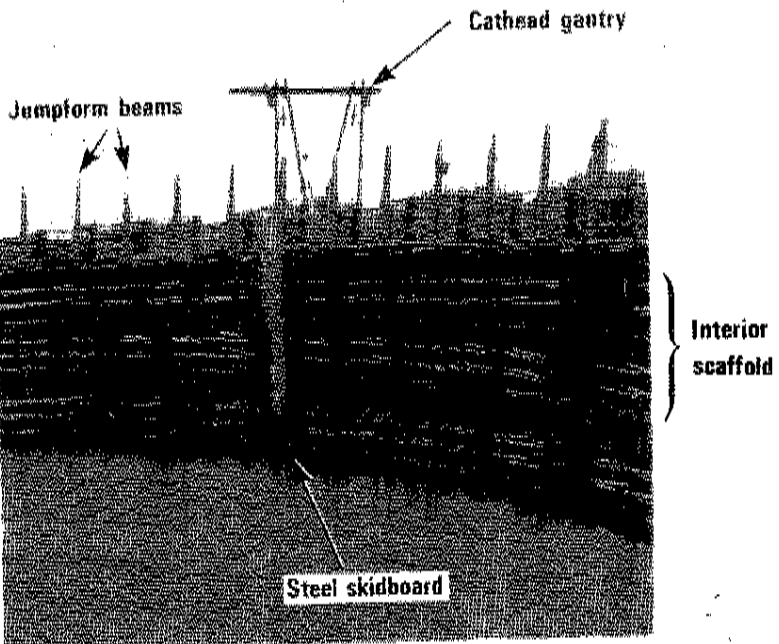


Figure 2.4 Interior View of a Tower Under Construction

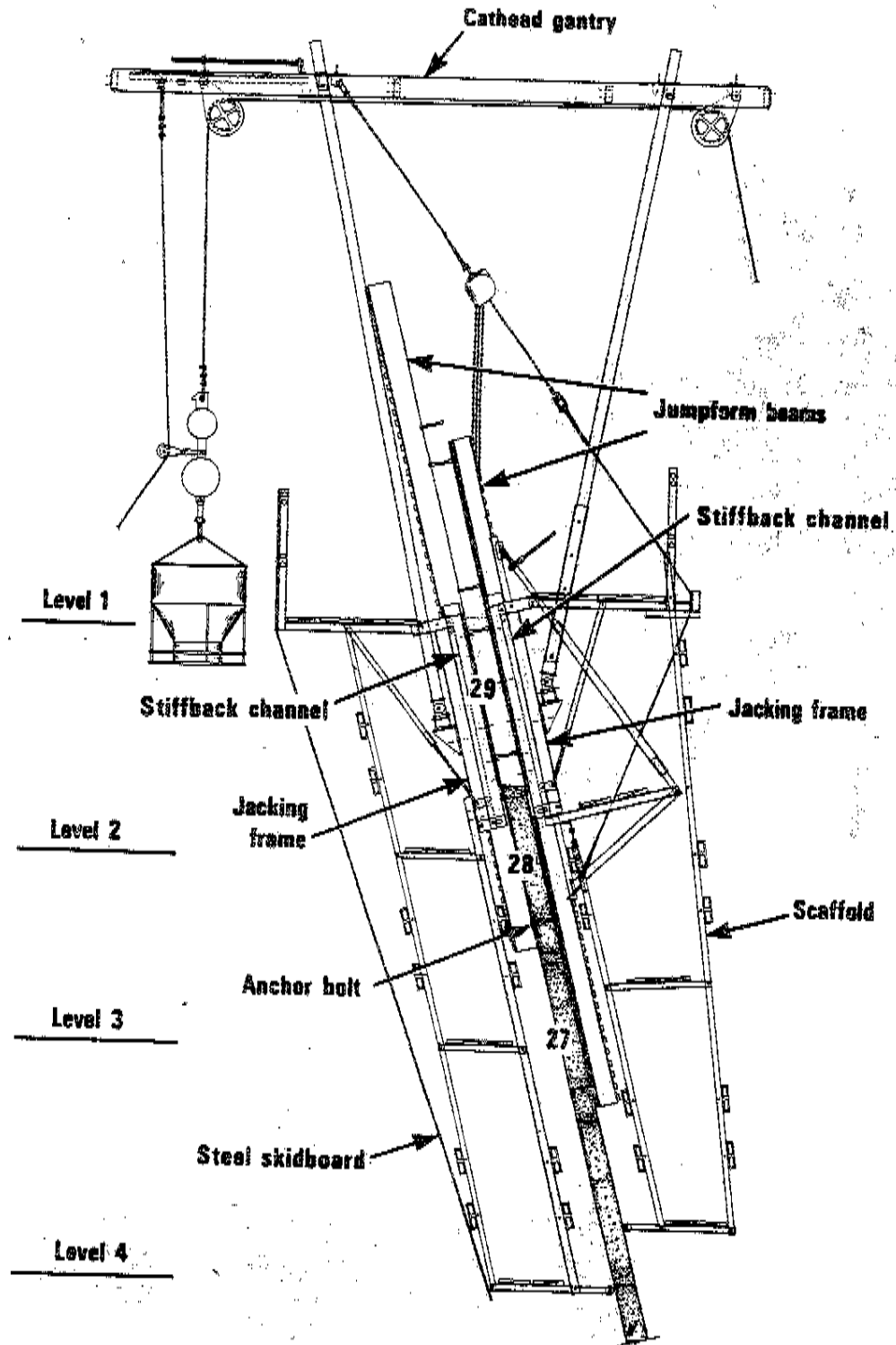


Figure 2.5 A Cross Section through the Formwork and Scaffolding Systems

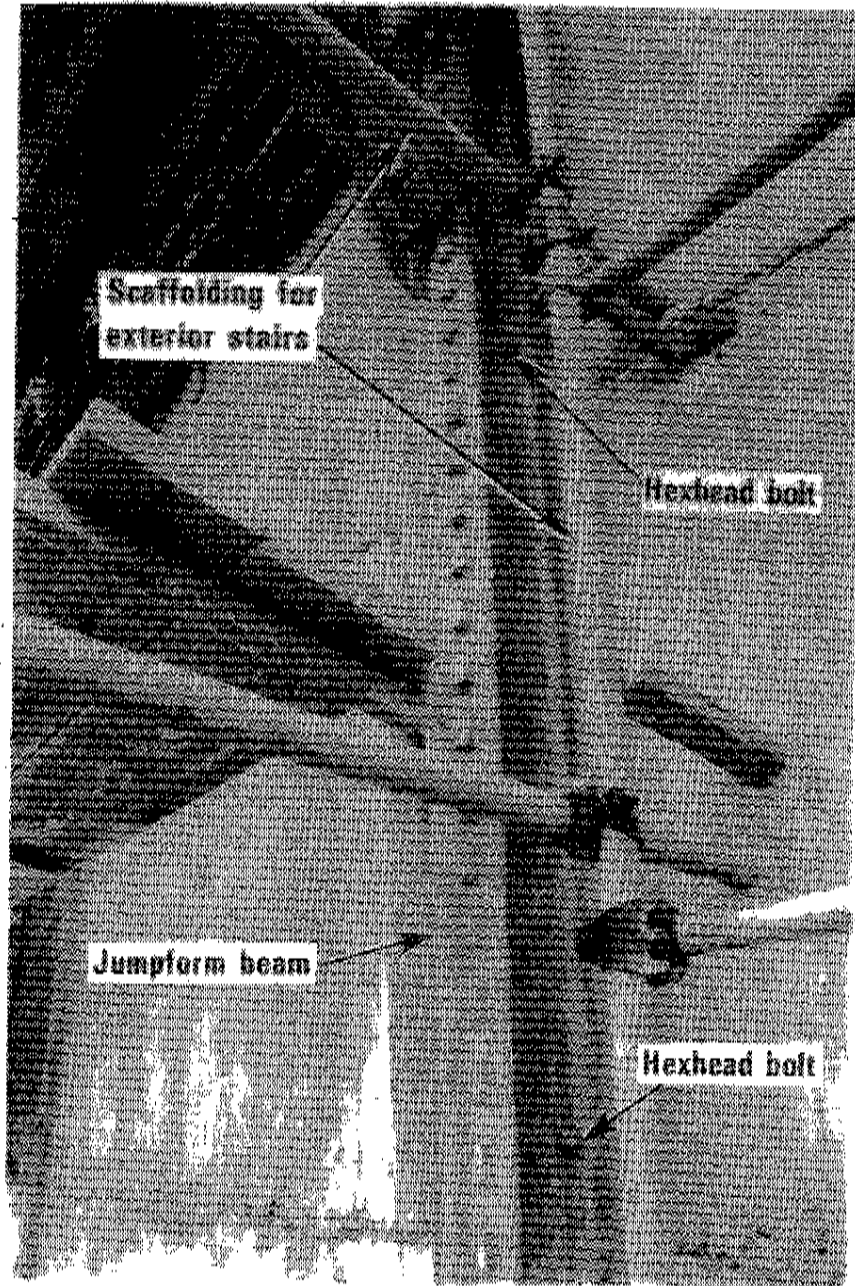


Figure 2.6 Attachment of Jumpform Beam to the Exterior of Shell

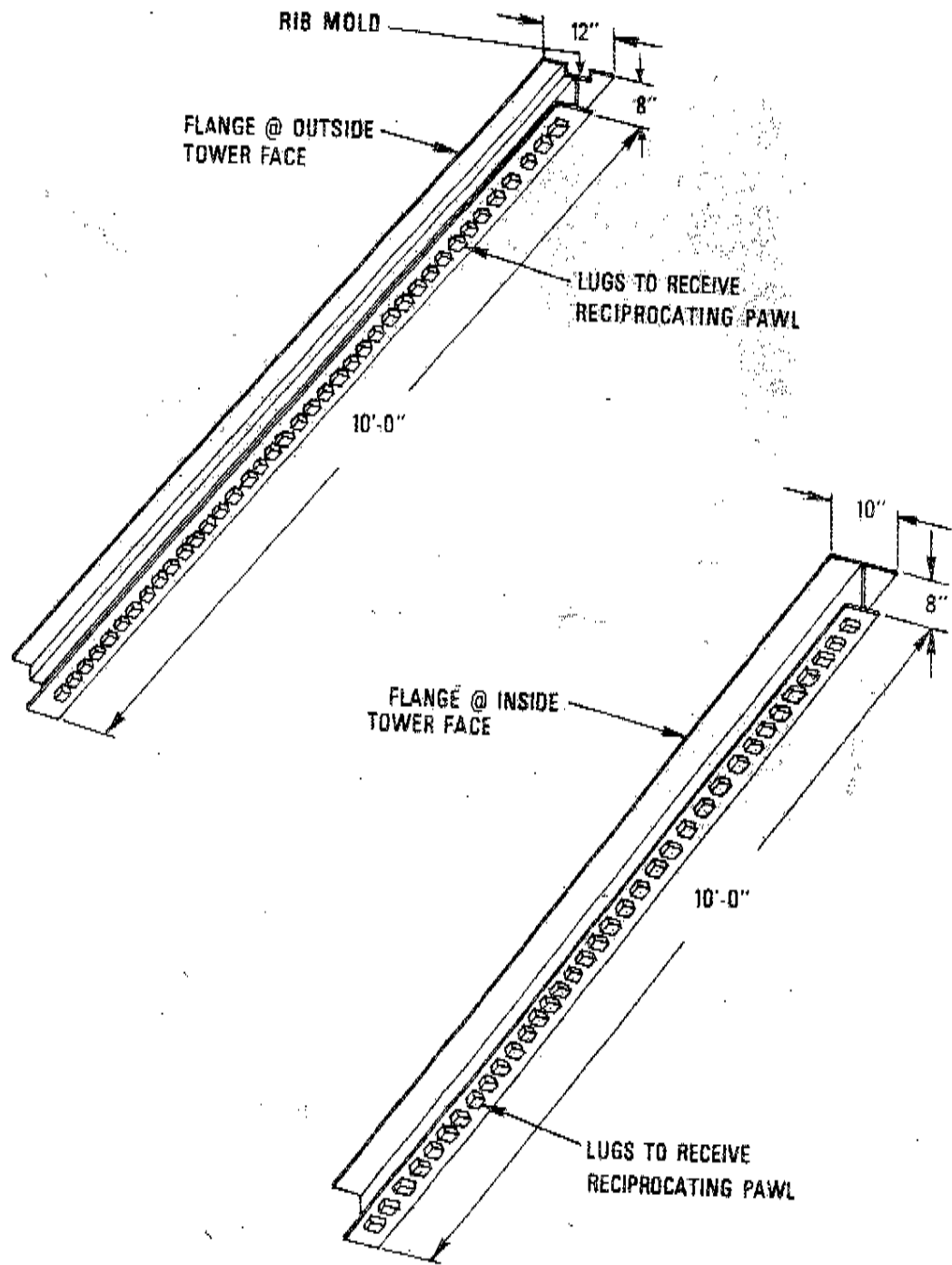


Figure 2.7 Jumpform Beam Detail

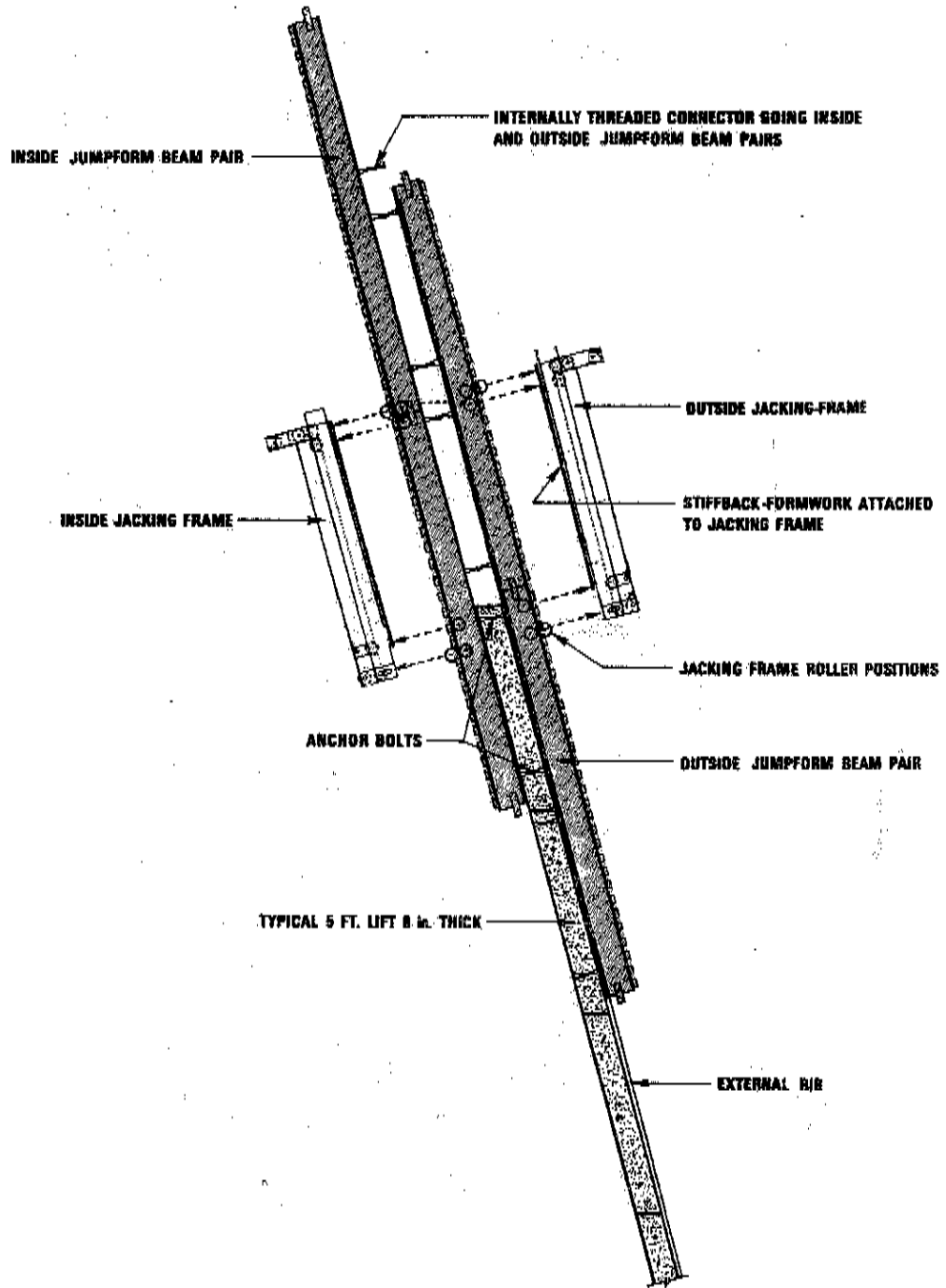


Figure 2.8 Attachment Detail of Jumpform Beams and Jacking Frames

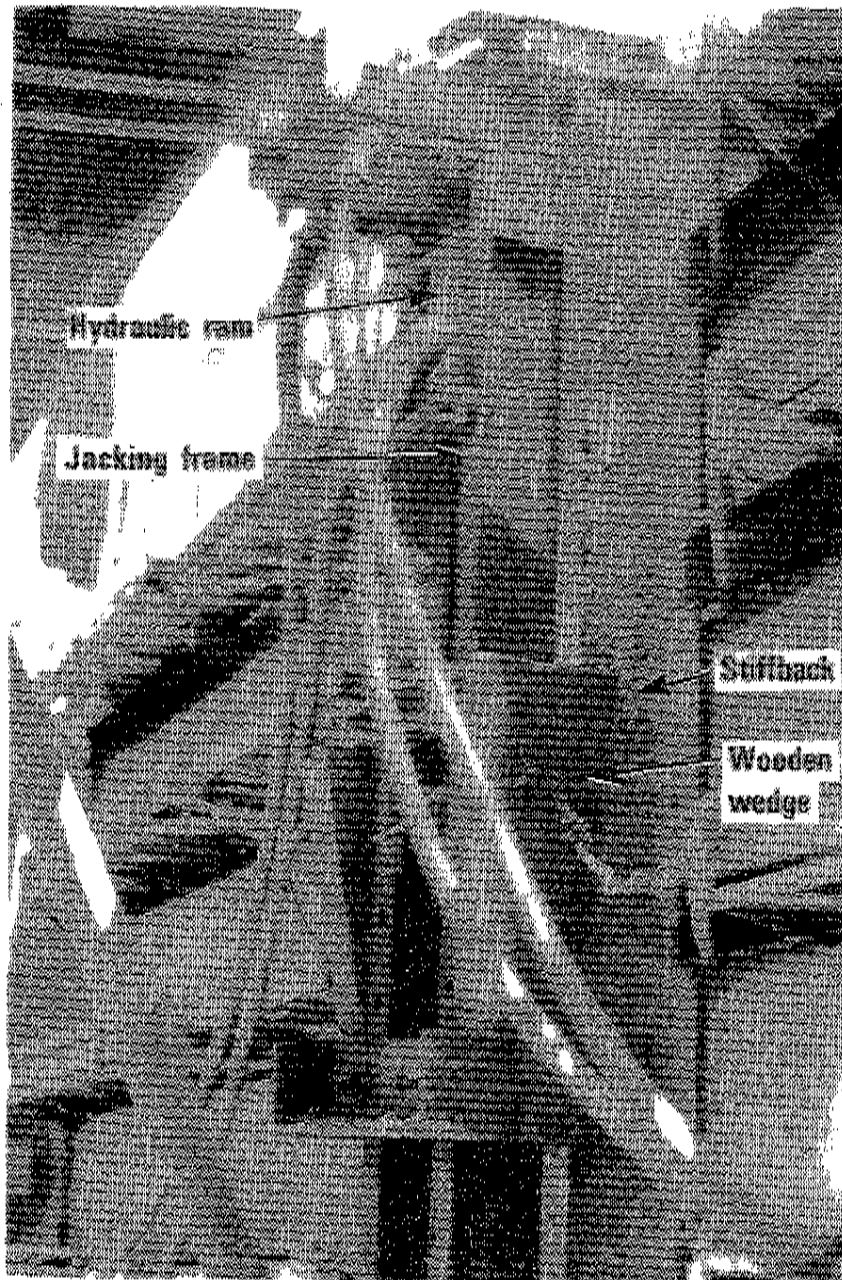


Figure 2.9 Jacking Frame Assembly

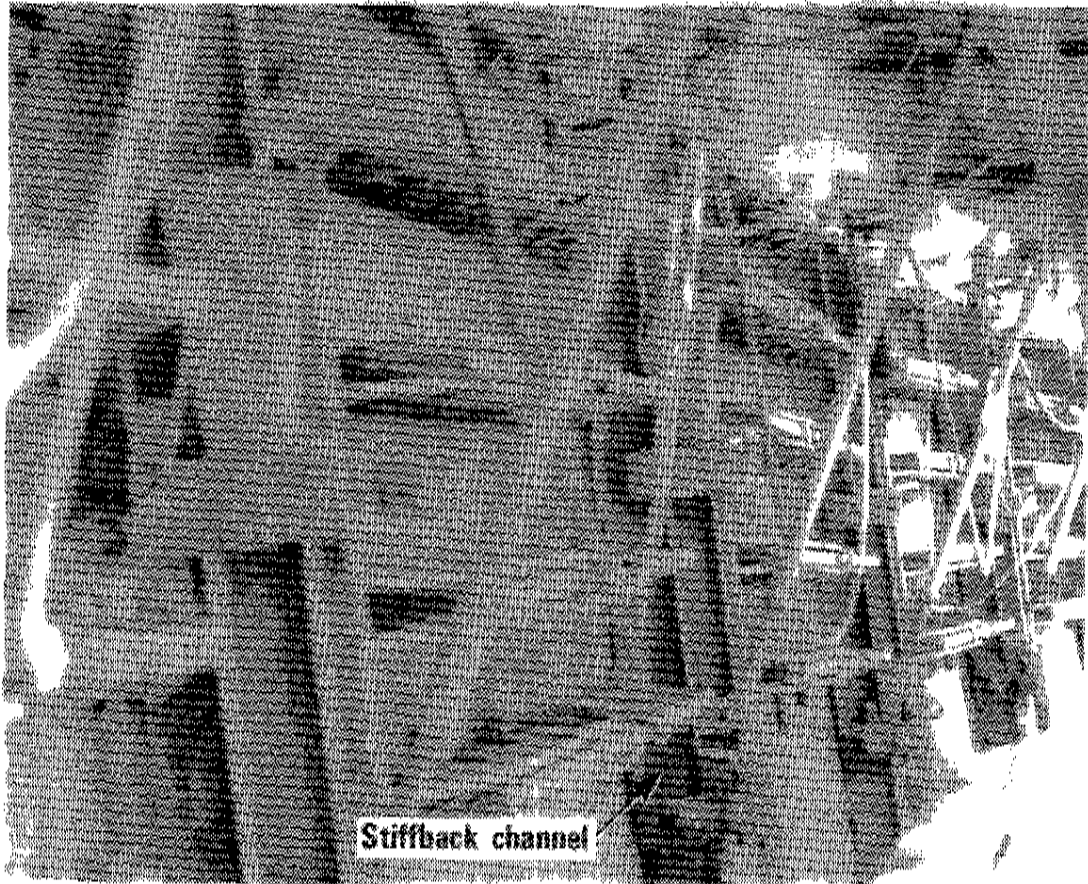


Figure 2.10 Formwork Support System  
(Note five levels of adjustable joists are used per lift.)

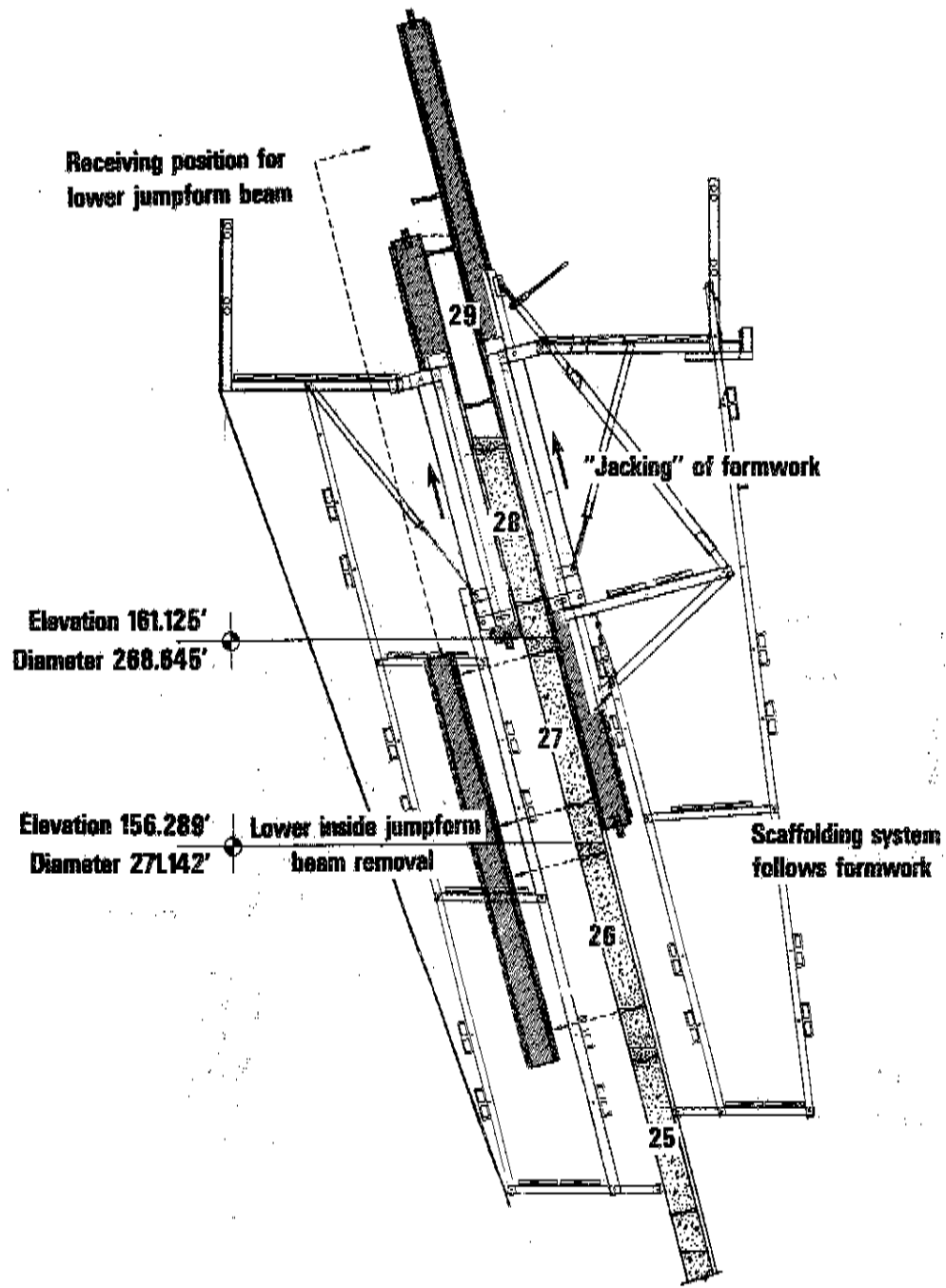


Figure 2.14 Raising of Formwork and Relocation of Jumpform Beam after Casting of Lift 28

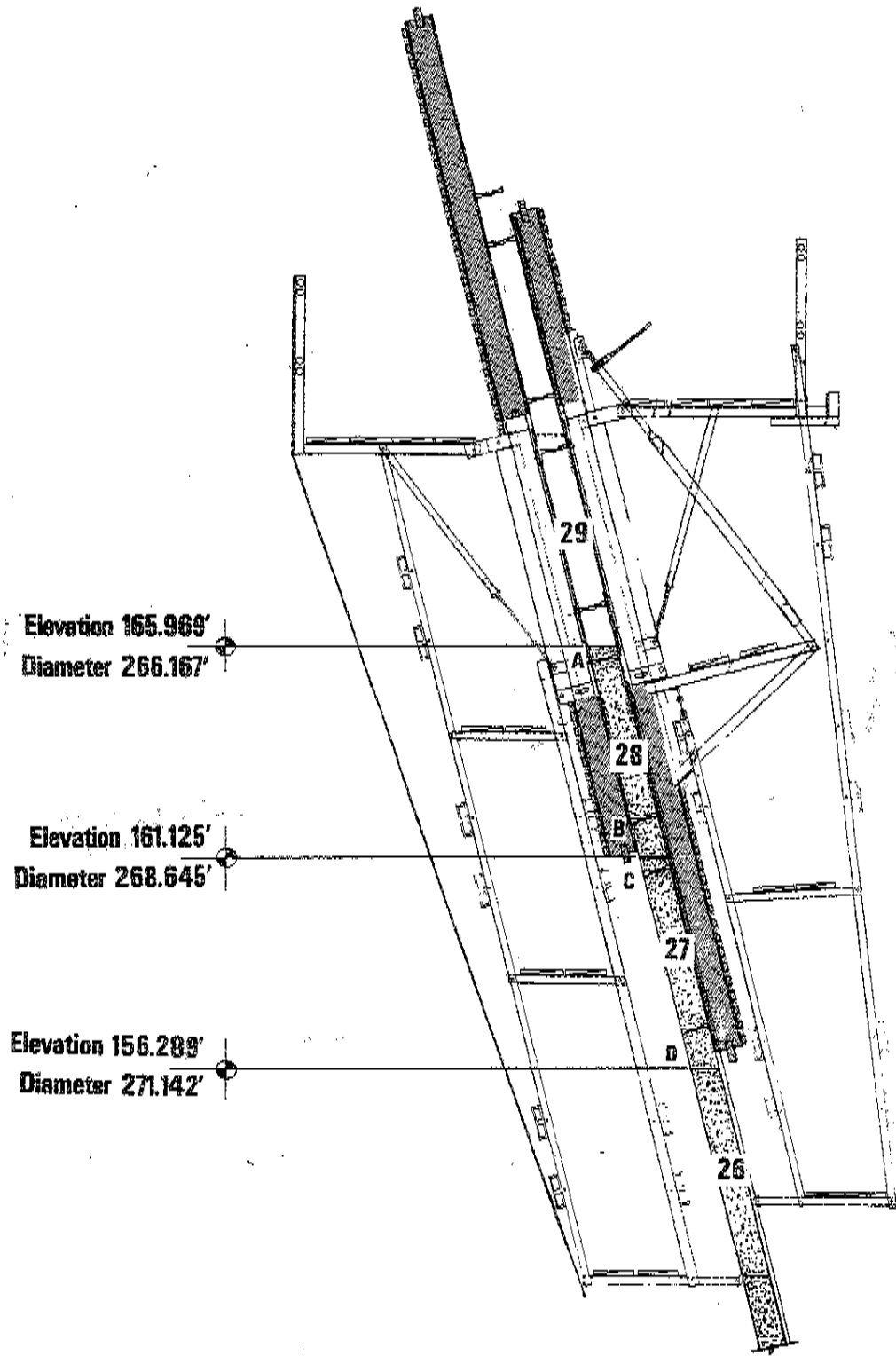


Figure 2.15 Position of Jumpform Beams Prior to Concrete Placement for Lift 29

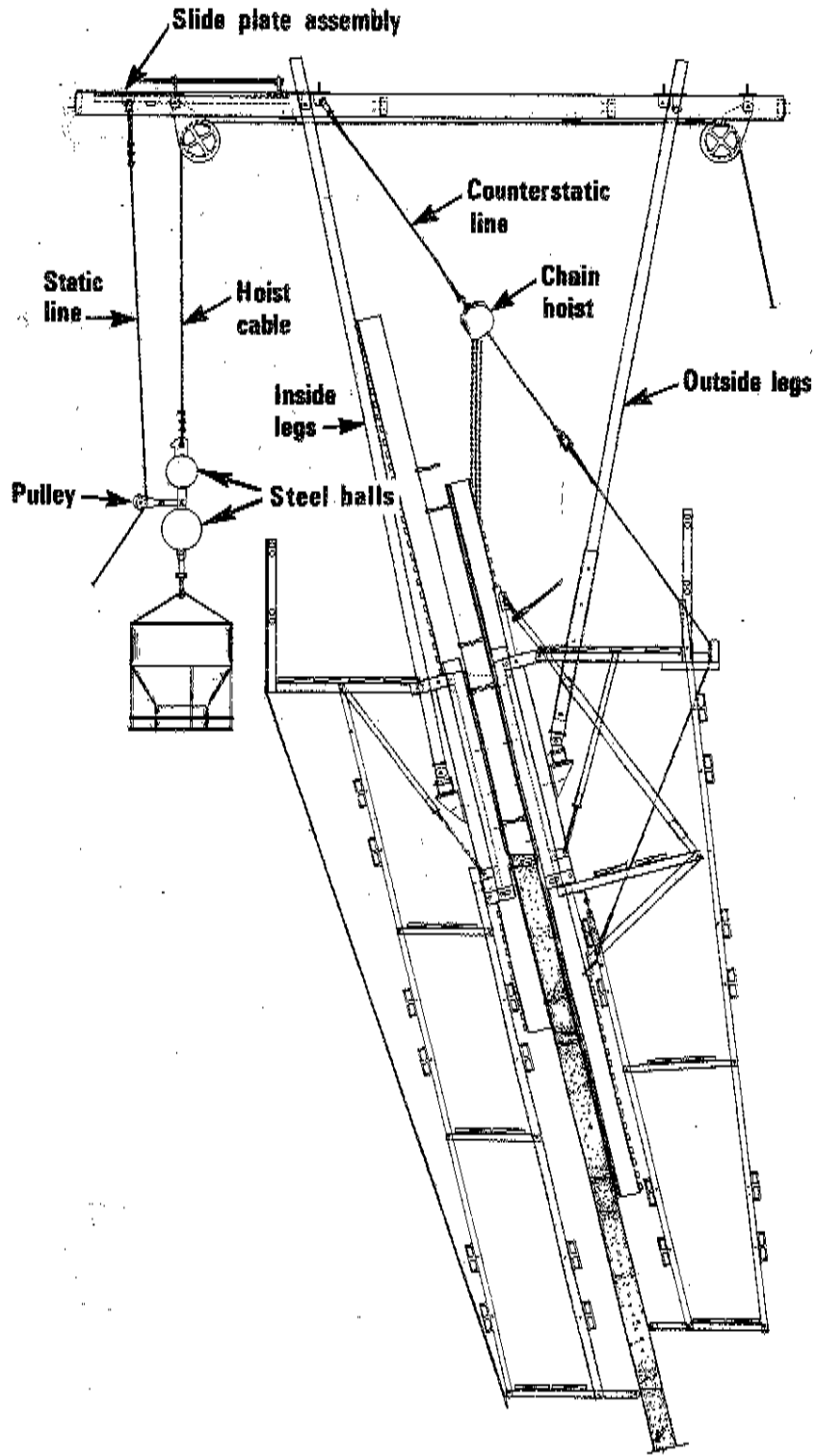


Figure 2.16 Cathead Gantry Assembly

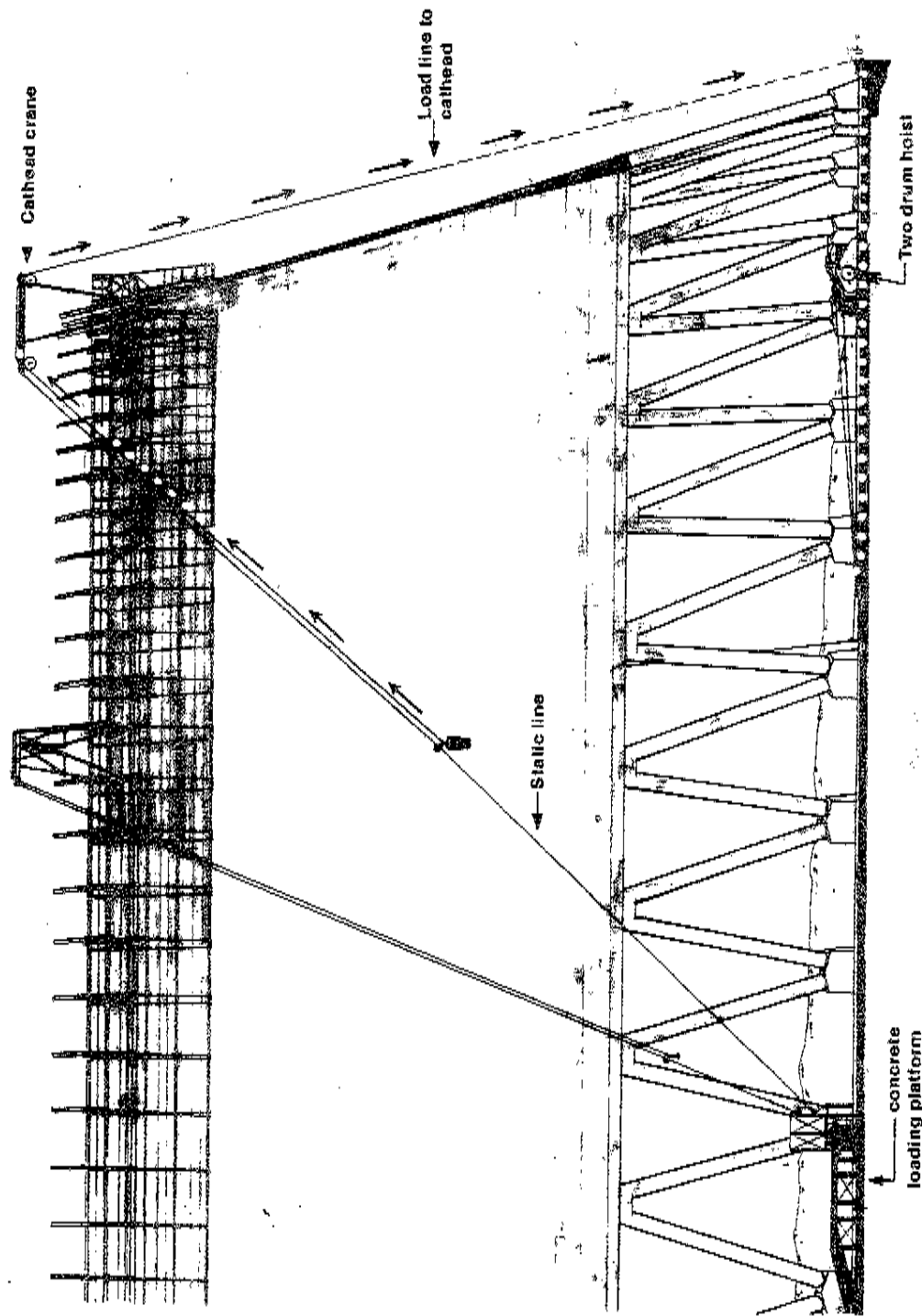


Figure 2.17 A Schematic View of the Hoisting System

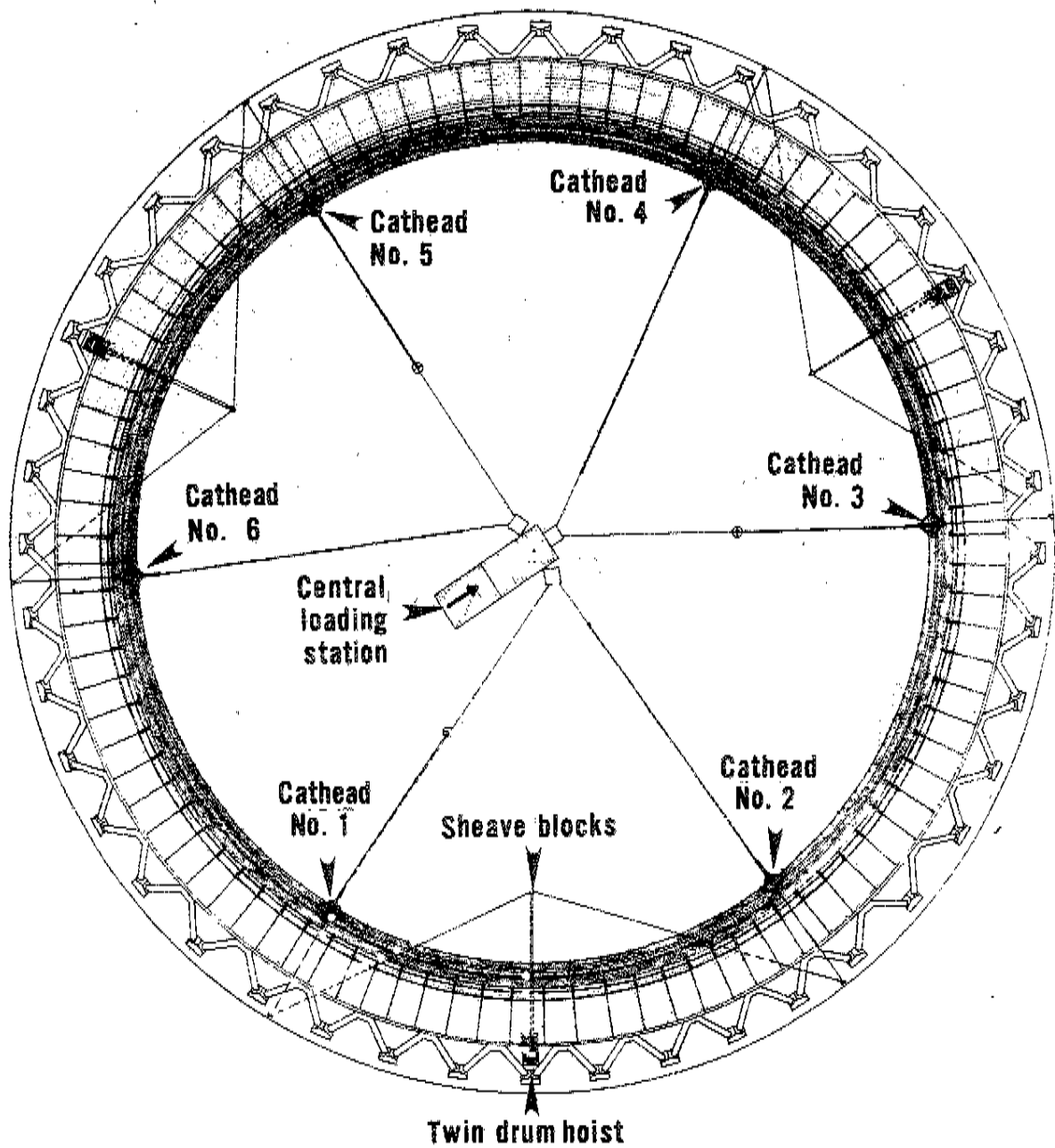


Figure 2.18 Location of Drum Hoist Relative to Cathead Gantries

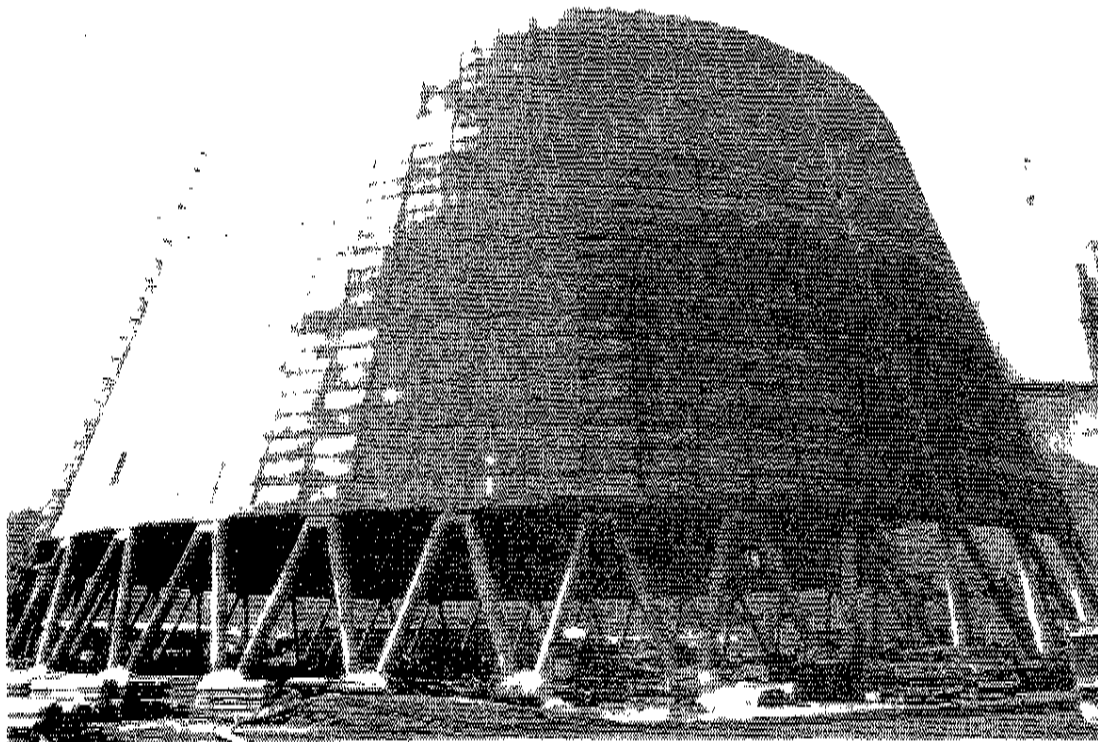


Figure 3.1 Exterior View of Tower Unit No. 2

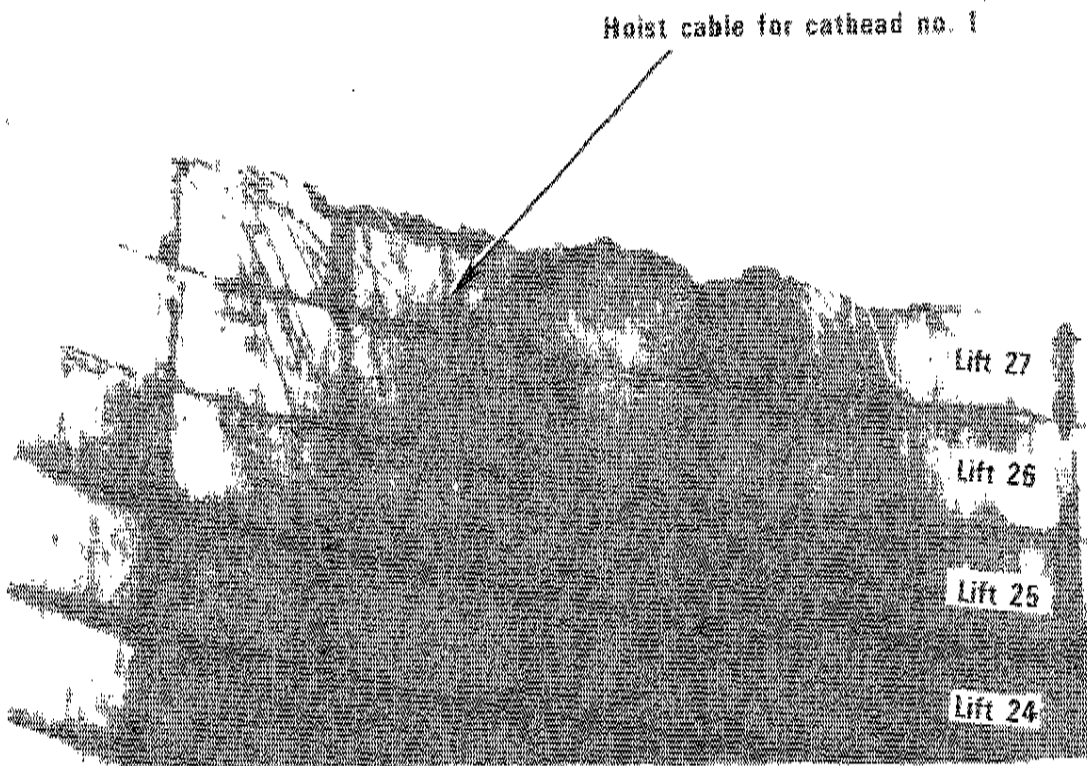


Figure 3.2 Top of Lift 27 Showing Jagged Edge

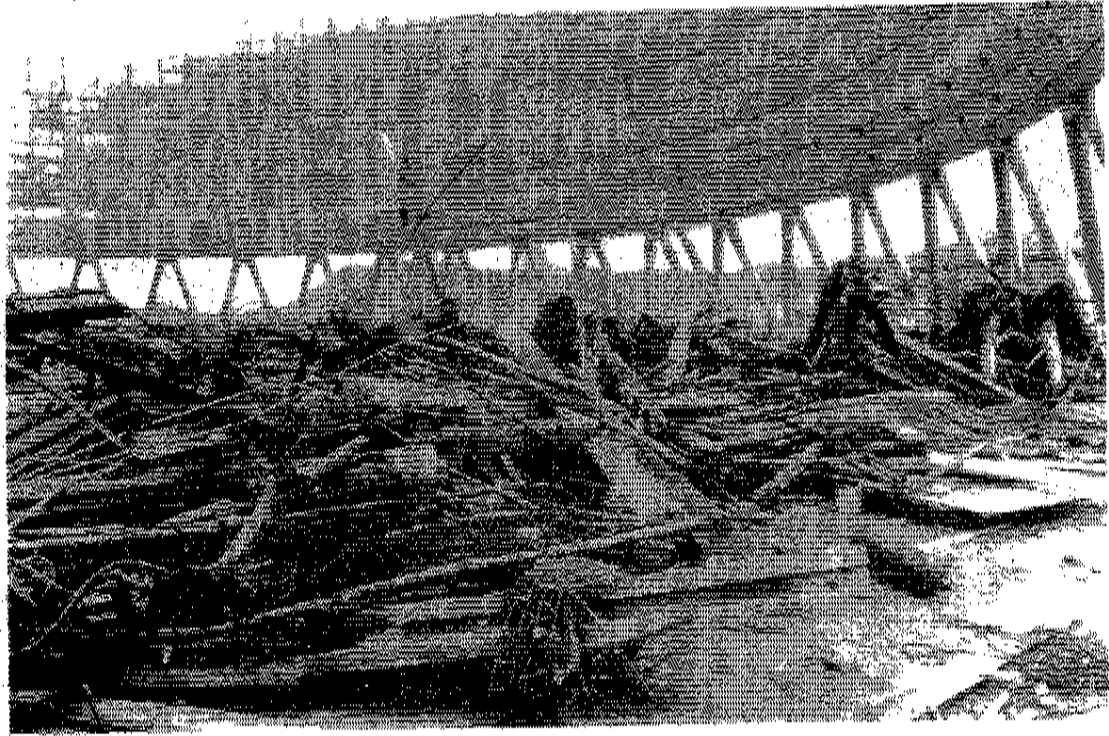


Figure 3.3 Debris Piled up Inside the Tower

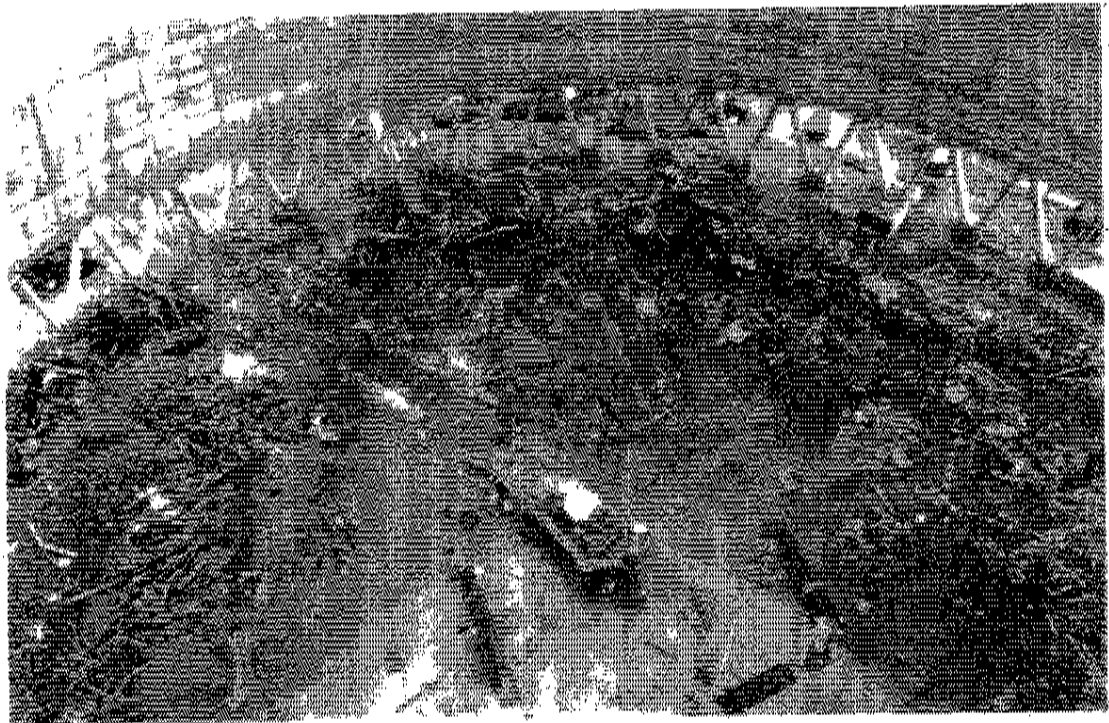


Figure 3.4 Distribution of Debris Around the Base of the Tower

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No. 2448 P. 28

