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(Reaffirmed 1995)

Indian Standard

CODE OF PRACTICE FOR CONSTRUCTION OF DIVERSION WORKS

PART 1 CELLULAR COFFER DAMS

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CODE OF PRACTICE FOR CONSTRUCTION OF DIVERSION WORKS

PART 1 CELLULAR COFFER DAMS

0. FOREWORD

0.1 This Indian Standard (Part 1) was adopted by the Indian Standards Institution on 30 January 1984, after the draft finalized by the Diversion Works Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 Prior to the commencement of actual construction of any work under water, it becomes obligatory in most cases, to exclude temporarily water from the proposed work area during the construction period, so as to permit the work to be done in the dry or semi-dry condition. An efficient scheme of diverting water away from the work area should be capable of limiting the seepage into the work area to a minimum (generally limited to 0·5 cumecs) so that the work area can be kept dry.

0.3 A temporary diversion scheme essentially consists of :

a) coffer dam(s) built across a part or full width of the water way to divert water away from the work area;

b) works to transfer the diverted water from upstream to the downstream of the work area without affecting the same, such as :

1) diversion through (construction) sluices in the main work,

2) diversion by one or more tunnels along the side of the main work area,

3) diversion through low level blocks of the main structure left for the purpose or through channels excavated outside the main structure, and

4) secluding part of the work area for construction and allowing the river to flow through the remaining work area ; and

c) coffer dam built to exclude water from the working area for construction to be undertaken in still water.

Reference may be made to IS : 9795 (Part 1) - 1981* for the proper choice of the type of coffer dam after considering all the relevant aspects mentioned in the standard.

0.4 This standard is one of a series of standards covering the choice, design and construction of coffer dams. The standards already published in this series are IS : 9461-1980† and IS : 9795 (Part 1) - 1981*.

0.5 In the formulation of this standard, due weightage has been given to the practices prevailing in the field in this country.

0.6 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960‡. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard (Part 1) lays down guidelines for the construction of cellular coffer dams.

2. GENERAL

2.1 Cellular coffer dams are constructed from steel sheet piles of various sections interlocked together to form cells which are filled up by free draining material. The cells and arcs form an enclosure to exclude water from the working area inside the coffer dam. These types of coffer dams are used in excavation/construction under water as well as in soil. These types of coffer dams are economical because stability is achieved by using a soil fill for deadweight and sheet piles forming a cellular ring which takes membrane tensile stresses and supports the soil fill.

2.2 There are many types of cellular structures as described below and shown in Fig. 1.

2.2.1 *Circular Cellular Type* — These are made up by forming circular cells of same or different radii intersecting each others. The cell intersection angle is usually between 30° and 45°. At the joint tee made up from sheet pile is provided. Each cell can be constructed independently and forms a stable unit by itself. The collapse of the circular type cell is local failure without endangering the stability of whole coffer dam. Hence this type provides high safety during construction.

*Guidelines for choice of the type of diversion works : Part 1 Coffer dams.
†Guidelines for data required for design of temporary river diversion works.
‡Rules for rounding off numerical values (*revised*).

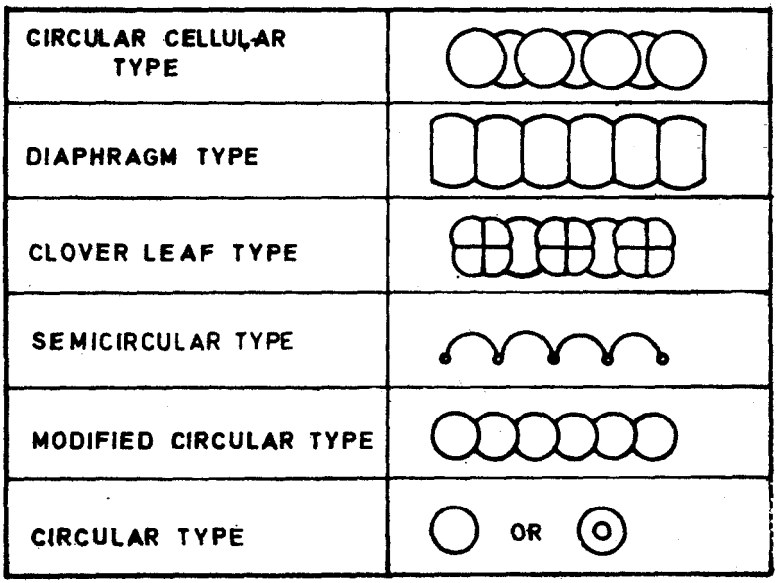

FIG. 1 PLAN OF VARIOUS TYPES OF CELLULAR STRUCTURES

2.2.2 *Diaphragm Type* — These are made up of a series of circular arcs connected by cross walls (diaphragms). The arcs are connected to diaphragms by Y-pile of 120°. The radius of arc is often made equal to the cell width that is distance between two diaphragms in order that the interlock tension in arcs and diaphragms may be equal. The stability of each unit depends upon adjacent cells. Unlike circular type, each cell is not independently stable and failure of one cell affects the others. This type is sensitive to differential filling in adjacent cells. Hence all cells are to be filled simultaneously. Holes in the intermediate diaphragm are provided at suitable height for equalisation of pore pressures in the cells.

2.2.3 *Clover Leaf Type* — Clover-leaf type cells consist of four circular arcs fixed on two transverse walls perpendicular to each other, and connected by means of small arcs. Each cell is independent like circular cellular cells. This type is suitable where the water depth is considerable.

2.2.4 *Semi-circular Type* — This type involves special construction method using master piles. This involves smaller quantity of sheet piling and simple method of backfill. But its design and construction of master piles are complicated.

2.2.5 *Modified Circular Type* — In this type the circular cells are intersected by each other. There are no arcs to connect the circular cells.

2.2.6 *Circular Type* — This type of coffer dam has a circular shape and is used for small localised diversion works.

3. DESIGN CONSIDERATION

3.1 Reference should be made to IS : 10084 (Part 1) - 1982* and IS : 9527 (Part 4) - 1980†.

4. STABILITY REQUIREMENTS

4.1 Reference should be made to **7.5.3.4** of IS : 10084 (Part 1) - 1982*.

5. MATERIAL

5.1 Steel Sheet Piles — Straight web steel sheet piles conforming to IS : 2314-1963‡ shall be only suitable for cellular coffer dams. Other sections Z or U type shall not be used for cellular coffer dams. Properties of the sheet piles shall be given by the manufacturer or should be in accordance with IS : 226-1975§ or IS : 961-1975‖ or IS : 2062-1980.**

5.2 Fill Material — Fill material used in cellular coffer dam should be freely draining, non-cohesive with high shear strength and high unit weight. Very fine fill material may flow out with seepage water and is therefore avoided. Properties of fill materials should conform to the design requirement in respect of unit weight of fill material (saturated, moist and dry), the angle of internal friction for saturated, moist and dry soils and the angle of repose. Usually natural deposits of mixed sand and gravel possess most of the desirable properties required for cell fills. Organic and most deleterious materials should be removed from the fill.

5.3 Paint — Steel piles shall be cleaned and painted with at least two coats of special marine paints over one coat of primer (*see* IS : 1404-1970***) before pitching and driving.

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*Criteria for design of diversion works : Part 1 Coffer dams.

†Code of practice for design and construction of port and harbour structures : Part 4 Cellular steel pile structures.

‡Specification for steel sheet piling sections.

§Specification for structural steel (standard quality) (*fifth revision*).

‖Specification for structural steel (high tensile) (*second revision*).

**Specification for structural steel (fusion welding quality) (*second revision*).

***Specification for anti-corrosive paint, brushing for ships' bottoms and hulls, red, chocolate or black, as required (*first revision*).

5.4 Sealing — Suitable sealing would be required at the bottom contact and side contact in case of cellular coffer dam resting on rock or concrete.

6. CONSTRUCTION AND LAYOUT OF CELLULAR COFFER DAM

6.1 In cellular coffer dams circular cellular type is the most commonly preferred because the circular cell is easier to form by using templates. It forms a stable single unit and each cell may be filled individually. For circular type even by increasing the diameter of cell the quantity of sheet piling is practically constant for a given depth and length to be covered, as the number of cells will be reduced. This is not true in other types of cellular coffer dams. Most commonly used coffer dams are circular and diaphragm types.

6.1.1 *Circular Cellular Type Coffer Dam* — Circular cell construction requires accurate pitching and driving to ensure closing of a cell with the required number of standard piles. Cell diameter, spacing, connecting arcs radius, number of piles, etc, may be adopted from Table 1 read with Fig. 3 (*see* IS : 2314-1963*). To construct circular cells first a circular template of suitable shape is fabricated (typical template is shown in Fig. 6). This template is located where the circular cells are to be constructed, then sheet piles are driven around the template. At the intersection points, 4 tee-piles are driven after completing the circular cell the template is lifted up and relocated for the construction of another cell. After completion of the circular cells, sheet piles are driven to form the connecting arc. The cells are filled with suitable fill material (*see* Fig. 2).

6.1.2 *Diaphragm Type Cellular Coffer Dam* — The various details are given in Table 2 read with Fig. 5 (*see* IS : 2314-1963*).

6.1.3 Following guidelines are suggested for proper construction of circular as well as diaphragm type cell :

a) The height of template should be about one-third the length of piles to be pitched. A tensioned rope is put outside to keep the piles conforming to the ring. Hence sheet piles are driven between outer periphery of template and inner periphery of ring;

b) First sheet pile shall be put very accurately ensuring plumb in both planes and driven a few metres only. Subsequent piles can be pitched on either side. Clutching is done as per manufacturer's instructions. Care should be taken to avoid small stone pieces entering inside the interlocks. Indian

*Specification for steel sheet piling sections.

standard piles are pitched with alternate faces appearing on either side. After pitching 7 to 8 piles, next one is driven after giving due corrections. Ring should thus be completed before down by stages to design level;

c) Tee-piles should not be put initially till the ring is completed. These should be pitched after the closure of ring when the ordinary piles are withdrawn and tee-piles are inserted in their places;

d) Piles are best driven by wire suspended double acting hammers operated by steam, compressed air or diesel combustion. For sandy soils, vibrating hammers are very efficient;

e) Cellular structures are provided with a RCC or steel ring on top and at least alternate piles are bolted to it. This helps in retention of shape on deflection. Welding of piles to each other on top for a distance of about 30 cm helps in rigidity of cell and helps in its stability;

f) Where used as permanent structure, sheet piles in tidal zone are recommended to be encased in concrete or provided with cathodic protection against rusting;

g) Main cells are to be filled first and then the area enclosed by connecting arcs; and

h) Cellular structures can be straight or an arch, shape to over an opening. Where there is change of direction, it should be ensured that tee-piles are not closer than one-twelfth of the circumference.

7. DEVIATIONS

7.1 Closing of cells may be permitted with one additional or less pile from the design number.

7.2 Verticality of Piles — Deviation to verticality to the extent that the cell diameter does not vary more than 1·5 percent at any point may be accepted.

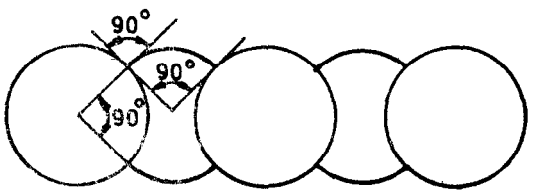

FIG. 2 GENERAL LAY OUT OF CIRCULAR CELLULAR SHEET PILES

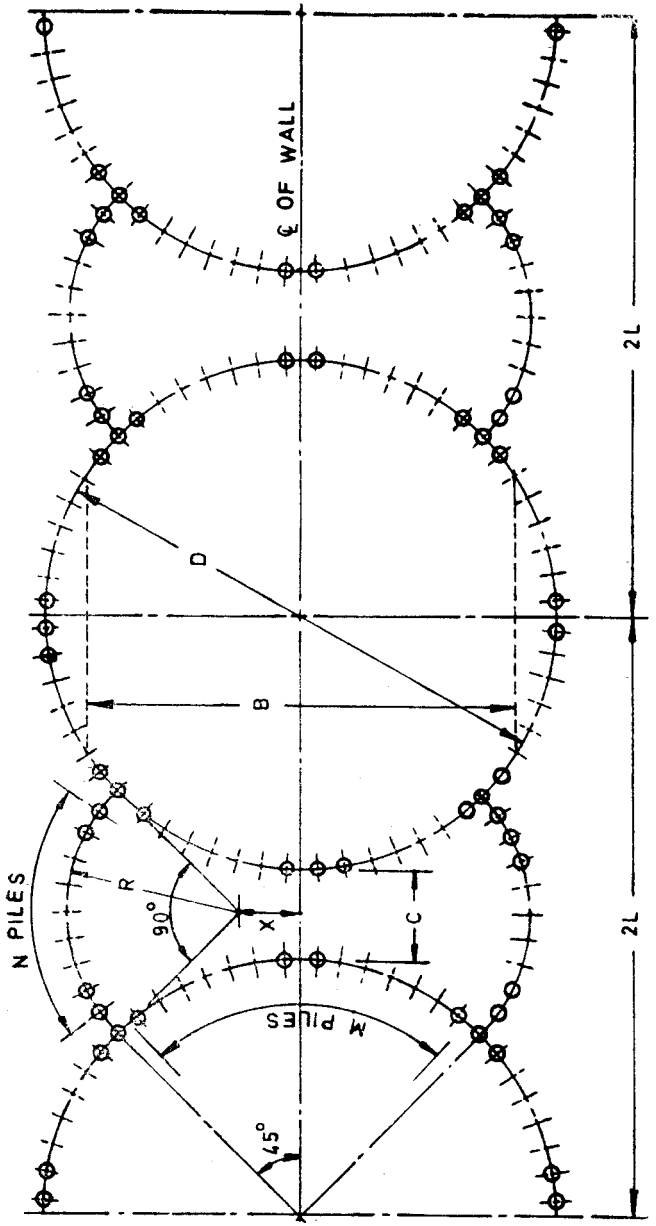

FIG. 3 DETAILS FOR LAY OUT OF CIRCULAR CELLULAR TYPE SHEET PILES

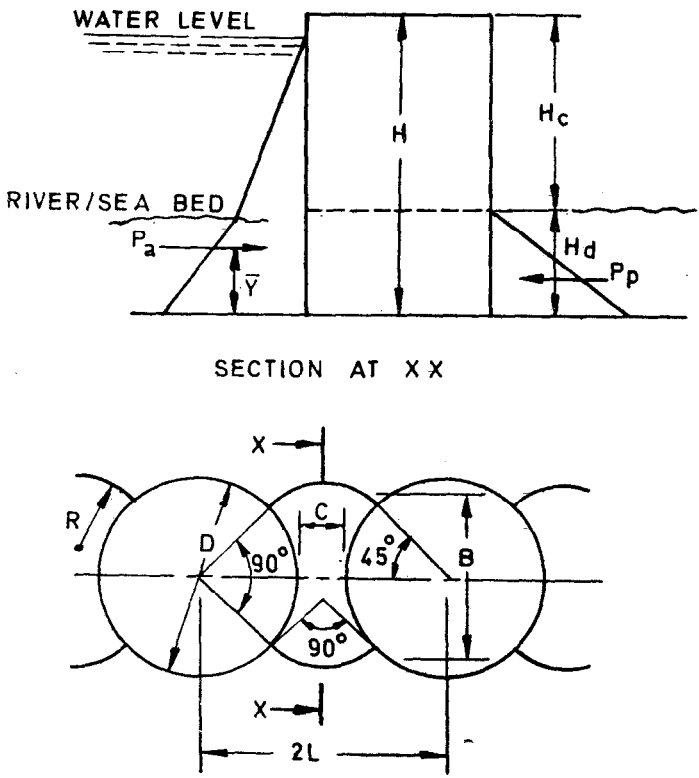

FIG. 4 DETAILS OF NOTATIONS

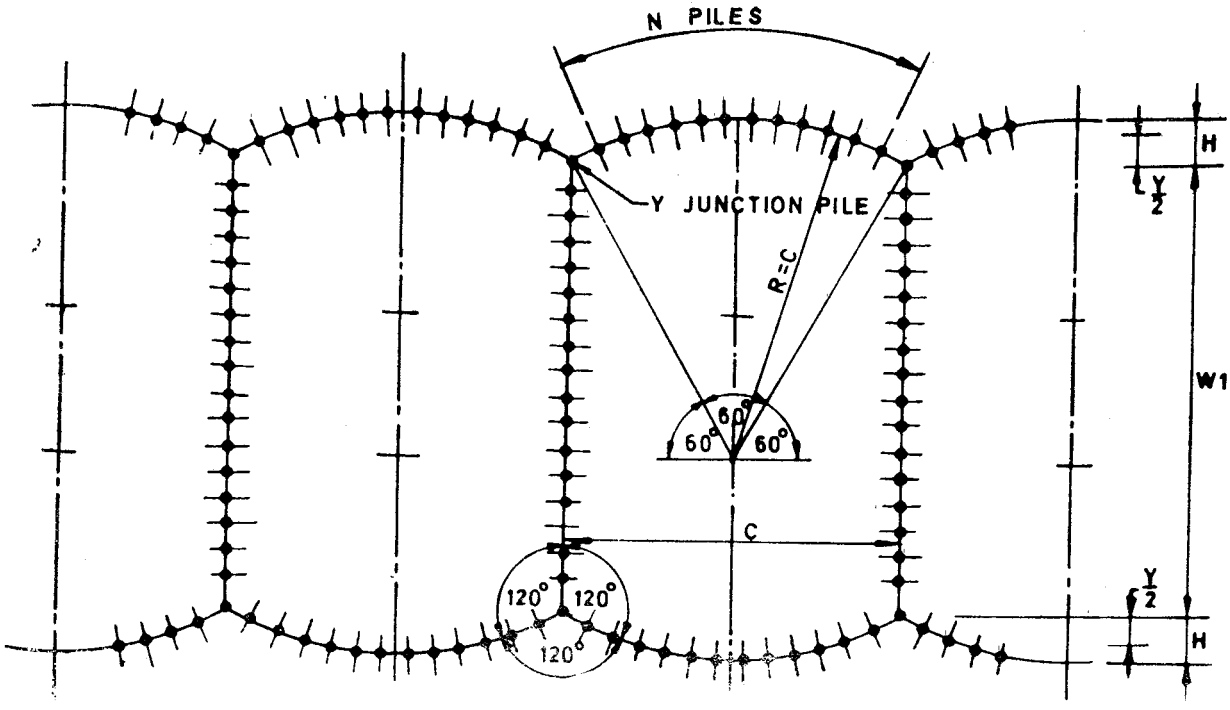

FIG. 5 DETAILS OF LAY OUT OF DIAPHRAGM TYPE SHEET PILE CELL

TABLE 1 DETAILS OF LAYOUT OF CIRCULAR CELLULAR TYPE OF SHEET PILE STRUCTURE PILES ARE ISPS 100 F

(*Clause* 6.1.1)

No. of Piles in Cell	*D*	2*L*	No. of *M* Piles	*R*	No. of *N* Piles	*X*	*C*	*B*	Area	
									Within Circle	Between Circle
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	m	m		m		m	m	m	m²	m²
60	7·64	9·01	14	2·55	9	0·90	1·36	6·40	45 87	14·83
64	8·15	9·37	15	2·55	9	1·03	1·21	6·81	52·19	14·98
68	8·66	9·73	16	2·55	9	1·26	1·06	7·23	58·93	15·06
72	9·17	10·09	17	2·55	9	1·44	0·51	7·64	66·04	15·06
76	9·68	10·81	18	2·80	10	1·44	1·13	8·07	73·59	18·22
80	10·19	11·53	19	3·06	11	1·44	1·34	8·51	81·55	21·67
84	10·70	11·89	20	3·06	11	1·62	1·19	8 92	89·92	21·70
88	11·21	12·61	21	3·31	12	1·62	1·40	9·35	96·70	25.46
92	11·71	12·97	22	3·31	12	1·80	1·25	9·76	107·77	25·48
96	12·23	13·69	23	3·57	13	1·80	1·46	10·20	117·44	29·53
100	12·74	14·05	24	3·57	13	1·98	1·31	10·61	127·44	29·53
104	13·25	14·77	25	3·82	14	1·98	1·52	11·05	137 84	33·91
108	13·76	15·13	26	3·82	14	2·16	1·37	11·46	148·62	33·89
112	14·27	15·85	27	4·08	15	2·16	1·59	11·89	159·84	38·59
116	14·74	16·18	28	4·08	15	2·33	1·45	12·27	170·55	38·56
120	15·29	16·57	29	4·08	15	2·52	1·29	12·72	183·52	38·45
124	15·80	17·29	30	4·33	16	2·52	1·50	13·15	195·97	43·51
128	16·30	17·65	31	4·33	16	2·70	1·35	13·57	208·77	43·39

132	16.81	18·37	32	4·59	17	2·70	1·56	14·00	222·04	48·75
136	17·32	18·73	33	4·59	17	2·88	1·41	14·42	235·71	48·60
140	17·83	19·46	34	4·84	18	2·88	1·62	14.85	249·80	54·30
144	18·34	19·81	35	4·84	18	3·06	1·47	15·26	264·23	54·14
148	18·85	20·18	36	4·84	18	3·24	1·32	15·68	279·13	53·90
152	19·36	20·90	37	5·10	19	3·24	1·53	16·11	294·44	59·97
156	19·87	21·26	38	5·10	19	3.42	1·39	16·53	310·15	59·71
160	20·38	21·98	39	5·35	20	3·42	1·60	19·96	326·27	66·10
164	20·89	22·34	40	5·35	20	3·60	1·45	17·38	342·74	65·83
168	21·40	22·70	41	5·35	20	3·78	1 30	17·79	359·68	65·48
172	21·91	23·42	42	5·61	21	3·78	1·51	18·22	377·03	72·24
176	22·42	23·78	43	5·61	21	3·96	1·36	18·64	394·79	71·87
180	22·93	24·14	44	5·61	21	4·14	1·21	19·06	412·88	41·43
184	23·42	24·85	45	5·86	22	4·14	1·42	19·48	430·94	78 48
188	23·95	25·22	46	5·86	22	4·33	1.27	19·91	450·43	78·01

NOTE 1 — The smallest circular cell that can be built using flat-type sheet piles is about 3 m in radius, but construction can be expedited by making the radius larger than 3 m.

NOTE 2 — The number of sheet piles required to form a cell is always even because of the shape of the joint. If an odd number of sheet piles required, one special shaped pile shall be used.

TABLE 2 DETAILS OF LAYOUT OF DIAPHRAGM TYPE CELLULAR SHEET PILE STRUCTURE—PILES ARE ISPS 100 F

(*Clause* 6.1.2)

No. of *N* Piles	*R*=*C*	*H*	*Y*
(1)	(2)	(3)	(4)
	m	m	m
10	4·20	0·56	0·76
11	4·58	0·61	0·83
12	4·96	0·66	0·90
13	5·35	0·72	0.97
14	5·73	0·76	1·04
15	6·11	0·82	1·10
16	6·49	0·87	1·17
17	6·87	0·92	1·24
18	7·26	0·97	1·31
19	7·64	1·02	1·38
20	8·02	1·07	1·45
21	8·40	1·12	1·52
22	8·78	1·18	1·59
23	9·16	1·23	1·66
24	9·55	1·28	1·73
25	9·93	1·33	1·80
26	10·31	1·38	1·87
27	10·70	1·44	1·94
28	11·08	1·48	2·00
29	11·46	1·54	2·08
30	11·84	1·59	2·14

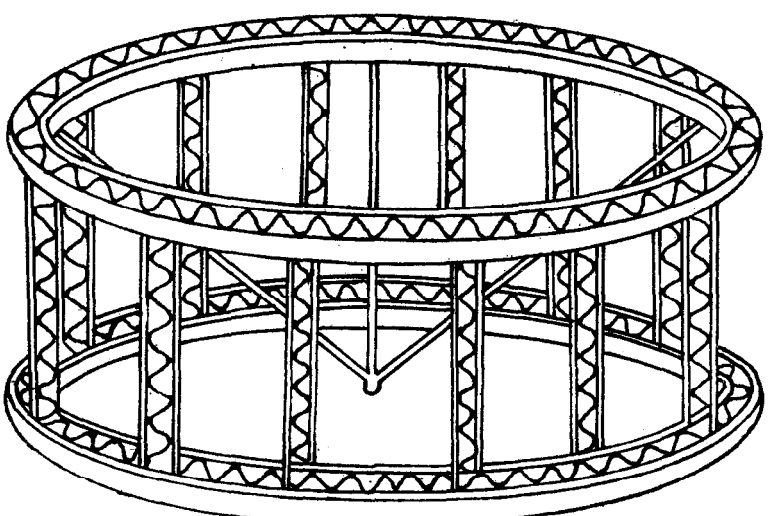

FIG. 6 TYPICAL TEMPLATE