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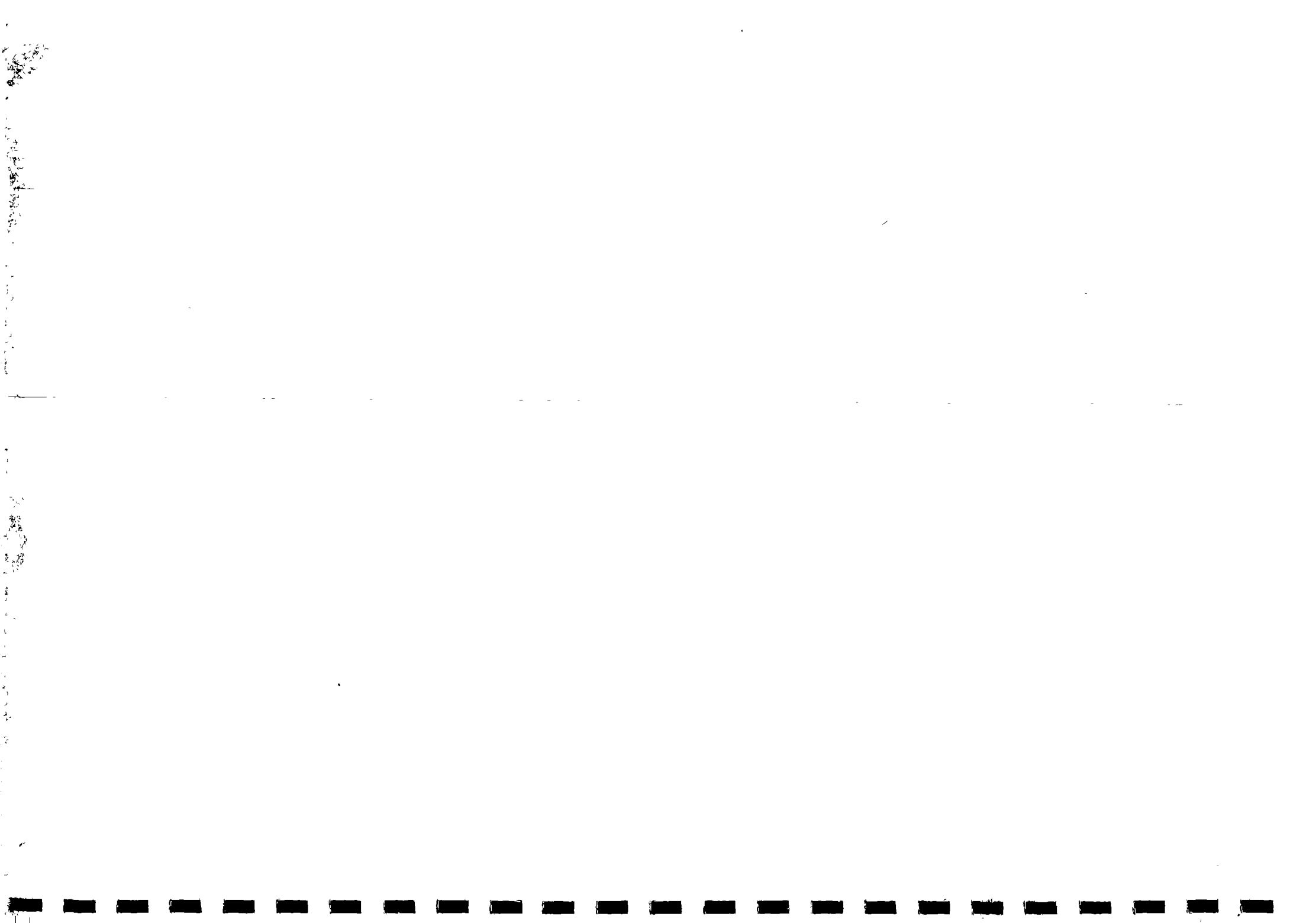
Cook Island's Modular Water Tanks



October, 1983

Suva

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MANUAL

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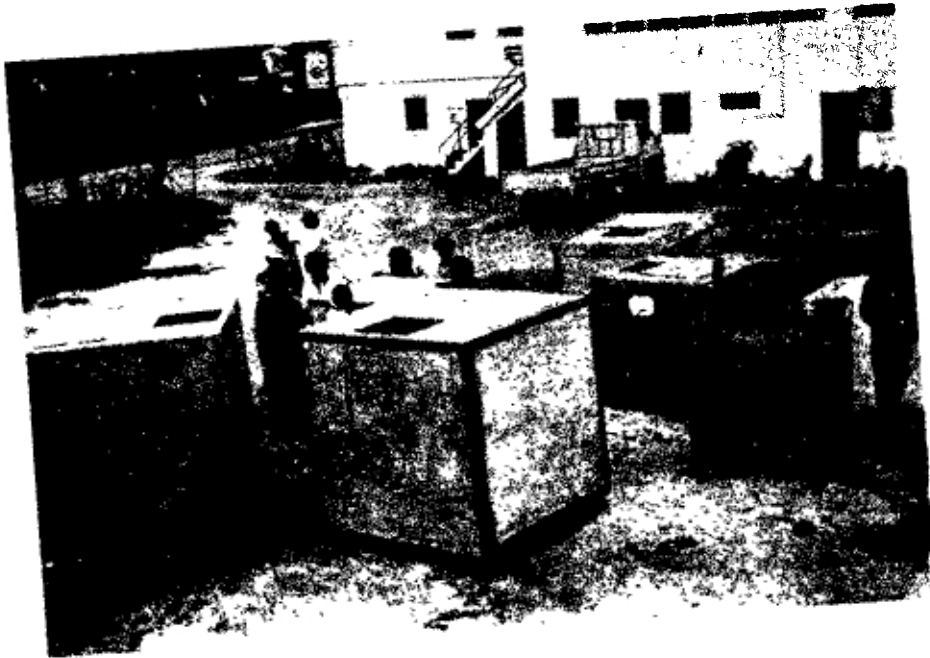
Cook Island's Modular Water Tanks



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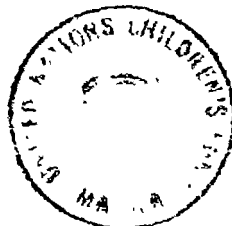
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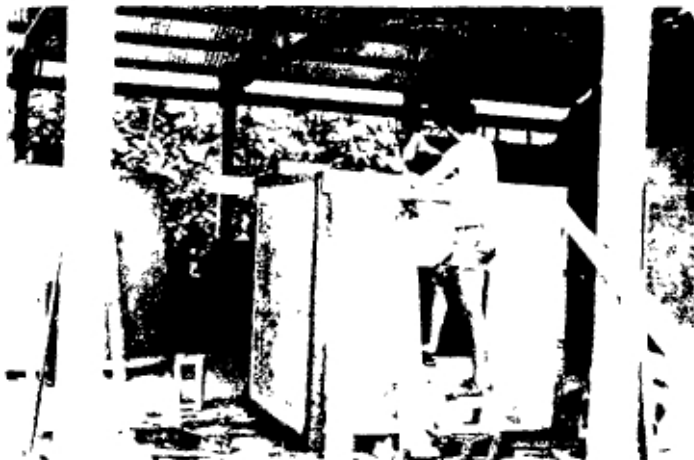
A C K N O W L E D G E M E N T

The composition and design criteria for the structures constructed of Fibrous Cement Mortar (FCM), and High Tensile Wire Reinforced Fibrous Ferrocement (HTWRFF), were developed and formulated by Mr Douglas Alexander, WHO Consultant. These are described in his Manual* on the Construction of Ferrocement Water Tanks, as well as in a number of other publications on the application of HTWRFF.

Subsequently, the technological procedures for the construction of Modular Water Tanks were developed on the basis of the experience in 1980-81 in the Cook Islands by the WHO Environmental Health Engineering Advisory Services Project, COK/BSM/001 and the Resident Engineer's Office. Mr Pairat Sirikige now a UNCDF Project Engineer in Western Samoa, was actively involved during the initial stages of the development of this technology. Mr Eliahu Dekel, WHO Sanitary Engineer, (now based in Manila) provided continuous support during the development of this technology, as well as assistance in the preparation of the first edition of the Manual.

The staff and the consultants of WHO and other international agencies involved in programmes for the improvement of drinking water supply and sanitation in the Pacific have contributed through their comments on the first edition of the Manual and on the draft of the second. Special appreciation and thanks to the UNICEF Office for the Philippines and the Pacific for their assistance and promotion of this technology.

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* Manual for the Construction of Water Tanks using High Tensile Wire Reinforced Fibrous Ferrocement, Manila. 1980.



INTRODUCTION

The reference to Cook Islands in the title to this Manual on Construction of Modular Water Tanks is historical. It was in the Cook Islands that the construction of modular water tanks was refined to its current simplicity of design, ease of construction and low cost. Although the manual has been prepared for use in the construction of modular water tanks, the technique can be used to produce panels for such other purposes as, septic tanks, sewerage, etc...

The technology is based on the use of Fibrous Cement Mortar for precasting of standard components - (square, thin-walled, strong and durable panels) - for the construction of modular units at very low costs. The modular units can be assembled in various combinations to satisfy different requirements for function and capacity. Moreover, the simplicity of this particular construction method allows the utilization of unskilled labour. A semi-skilled carpenter or mason can easily produce panels of high quality. The technology can be included in the training curriculum of vocational schools.

By using the square panel as an elementary component, it is possible to construct a simple cubical module, double module or a multiple module.

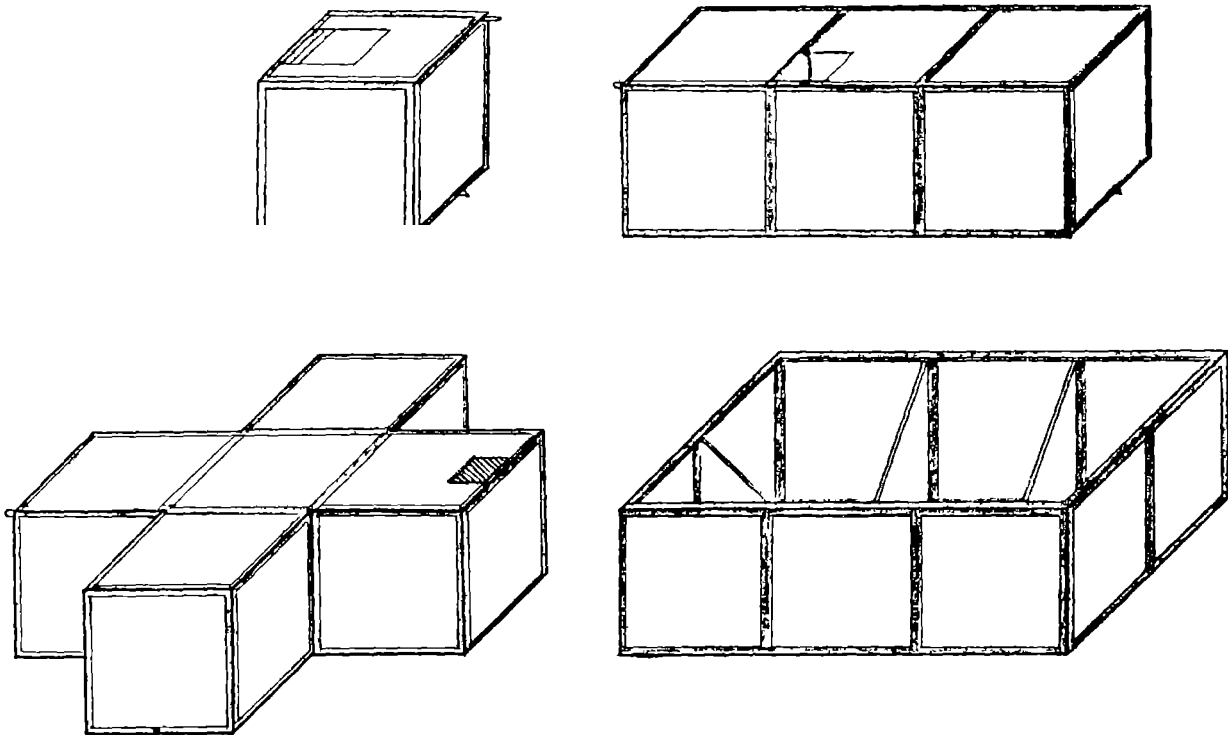


Figure 1.

Depending on the availability of facilities, tools and equipment, two different standard elementary components have been developed :

(i) Fibrous Cement Mortar Panel - As-series

Standard square panel 1.20m x 1.20m (47" x 47")
dimensions suitable for small tanks of 2,050 litres
(450 Imp. Gallon) capacity; and

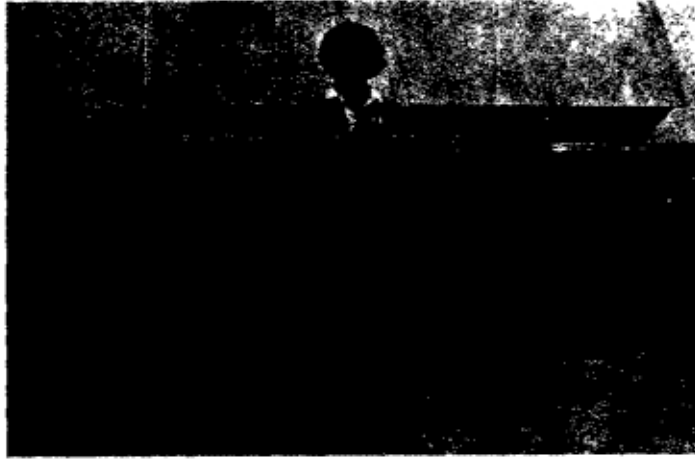


Illustration 1: As-series panel can be handled with ease by two persons.

(ii) Fibrous Ferrocement High Tensile Wire Reinforced Panel - Al-Series

Standard square panel 1.65m x 1.65m (65" x 65")
dimensions suitable for larger tanks of 5,000 litres
capacity.



Illustration 2: Al-series panels can be handled by four persons with ease.

Fibrous Cement Mortar

(i) Composition

The following materials are required for the preparation of fibrous cement mortar:

- a) Cement: All Portland cements are suitable. However, the cement should be in good condition, that is, free of lumps. Cement over six months old should not be used.
- b) Sand: The sand should be well sieved through 4mm $\frac{5}{32}$ " screen, and free from mud and salt. Beach sand may be used. However, since such sand has a high salt content, it requires some 'washing'. This could be done by depositing the sand in a non-salt area and leaving it to be leached by rain for a period of three months.
- c) Water: Only fresh water should be used for preparing the mix. No sea or brackish water should be used.
- d) Steel Fibres: A 0.25mm diameter, 13mm long or 0.3mm x 0.4mm cross-section and 14.5mm, 18mm or 20mm long chopped steel fibre is required. A number of manufacturers in Australia, USA and Japan produce such steel fibres (Annex 1 page 1).
- e) High Tensile Wire: 2.0mm diameter bright, hard drawn phosphate coated, galvanized or brass-coated high tensile spring quality wire with ultimate tensile strength of 1,800 MPa, is used for the production of all modular panels and derivative components. The wires should be ordered in straightened pre-cut lengths of 1800mm (71") for the construction of A1-series water tanks and 300mm (12") for the construction of As-series water tanks. (Annex 1 page 1).
- f) Additives: If galvanized wire is used for reinforcing the addition of hexavalent Chromium compound is required in order to passivate the galvanizing activity and prevent the development of bubbles - Hydrogen evolution.

The exact dosage of hexavalent Chromium additive can be determined by laboratory test, but if such facilities are not available the following compounds and concentrations per tonne of cement are recommended:

- Chromium Trioxide (Cr_2O_3) = 120 grs/tonne cement
- or - Potassium Bichromate ($K_2Cr_2O_7$) = 140 grs/tonne cement
- or - Sodium Bichromate ($Na_2Cr_2O_7$) = 120 grs/tonne cement

The Chromates and Bichromates are strong oxidizing agents and are classified as hazardous cargo; therefore, they should be handled with rubber gloves in the powder form or in strong solution.



Illustration 3: If galvanized wires are used for reinforcement or fingering, an additive compound of hexavalent Chromium is required to be mixed with water for the preparation of the mortar.

(ii) Mix Proportions

Generally, the best quality fibrous mortar is prepared with the following mix proportions:

Cement	1.00 part by weight
Sand	2.00 parts by weight
Water	0.40 parts by weight
Steel Fibres	0.19 parts by weight

The compressive strength of the above mix is usually 35 MPa. When the sand is very fine, in order to obtain the above strength, it is necessary to increase the cement ratio.

For centralized production where transportation of the precast panel is required, it is advisable to obtain a higher initial strength. This can be achieved by adding crushed fine aggregate to the mix sieved through a 4mm ($\frac{5}{32}$ ") screen, and some crusher dust up to the following proportions:

Cement	1.00 part by weight
Crushed fine aggregate	0.75 parts by weight
Sand	1.00 part by weight
Crusher dust	0.50 parts by weight
Water	0.40 parts by weight
Steel Fibres	0.19 parts by weight

(iii) Preparation



Illustration 4: The cement mortar is mixed on a clean flat level surface.



Illustration 5: Measuring boxes are used for proper proportioning of the mortar components.

When using the measuring boxes (Annex 3), the required amount of sand and cement are deposited on a clean flat base (or in the cement mixer) and mixed thoroughly. The steel fibres are then added in small portions, while mixing continuously. Hold handfuls of the fibre in both hands and shred the fibres over the mix in a rolling action to obtain even distribution. The water is added after, in small portions, with-holding a small quantity. Thorough mixing continues for at least 10 minutes. Using the slump cone, the slump test is carried out and then the remaining water is added if the slump is too small.

(iv) Control of the water in the mix - Slump Cone Test

The amount of water is critical for obtaining proper mortar strength. It depends on the dryness of the sand and the quality of the cement. The slump test is a very good indicator and should be carried out regularly. This is done by using a slump cone as described in Annex 3 page 1. If not available, a cone can be easily prepared from a sheet of galvanized iron using the enclosed pattern in Annex 3 page 5.

The slump cone should be placed on a flat surface and filled to above half level before rodding with a 15mm ($\frac{5}{8}$ ") diameter steel rod 350mm (14") long. A specific number of strokes should be used to prevent the operator's error. Normally ten strokes is sufficient, but whatever number is selected, should be consistently used. The cone is then topped up and "rodded" again and this is repeated a third time before levelling the cone. The cone is then lifted away from the mortar and the slump measured.



Illustration 6: The cone is placed on a flat level surface and filled half way with mortar



Illustration 7: With tamping rod, 10 full strokes are given.



Illustration 8: Level the top before lifting the cone



Illustration 9: Lift the cone straight up.

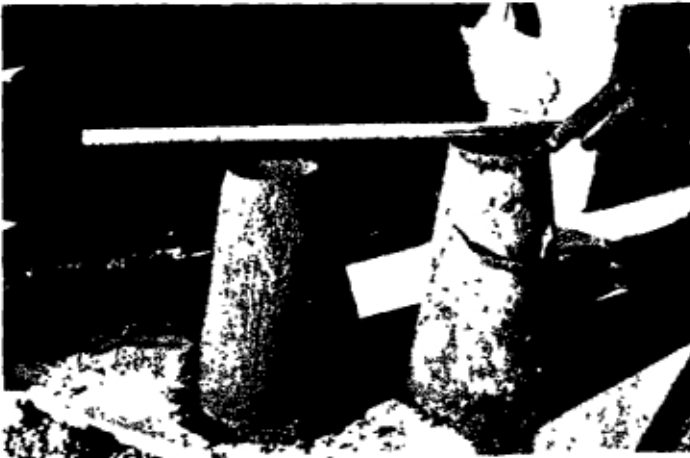


Illustration 10 and 11: If the slump is less than 35mm (1½"), more water has to be added. If the slump is more than 35mm (1½"), more cement has to be added.

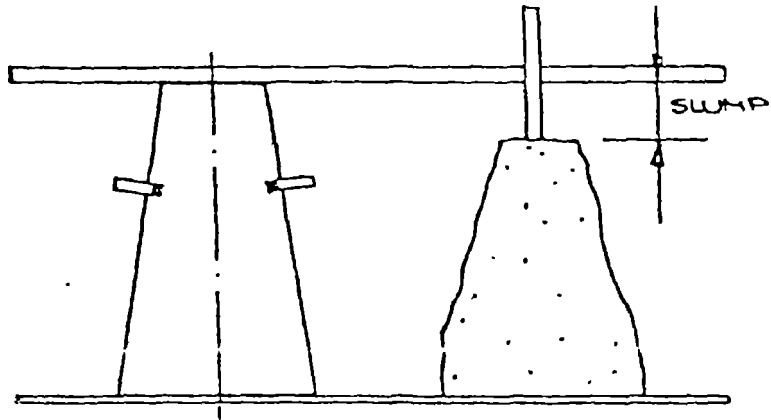


Figure 2

The slump of a good quality mortar should be about 35mm (1½")

COOK ISLANDS' MODULAR WATER TANKS

PART 1

FIBROUS CEMENT MORTAR STRUCTURES

As - SERIES

NOTE: ALL DIMENSIONS IN THIS PART ARE IN MM EXCEPT AS OTHERWISE NOTED.

1. CONSTRUCTION OF MODULAR WATER TANKS FROM STANDARD PREFABRICATED FIBROUS CEMENT MORTAR PANELS (As SERIES - 2050 L. Unit Capacity)

1.1 The Structure

The water tanks of As Series are designed to be constructed using essential tools only (Annex 2, paragraph 1) under rural conditions where skilled manpower and technical facilities are not readily available.

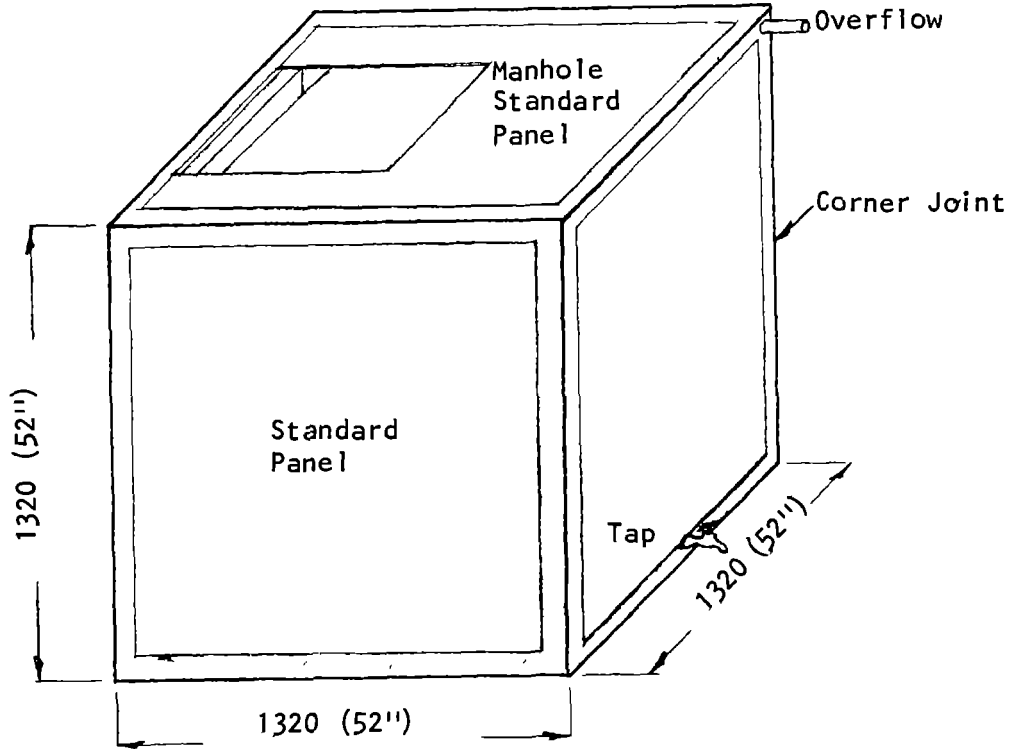


Figure 1.1

The flat plates (panels) used in the modular system are produced of fibrous cement mortar and provided with joint fingering around the edges. The fingering is of ϕ 2mm galvanized or bright steel wires usually 300mm (12") long and embedded in the mortar around the edges of the plates at 25mm (1") intervals, protruding 75mm (3").

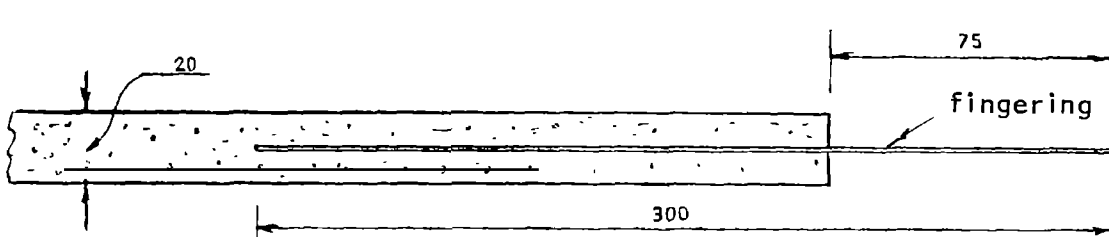
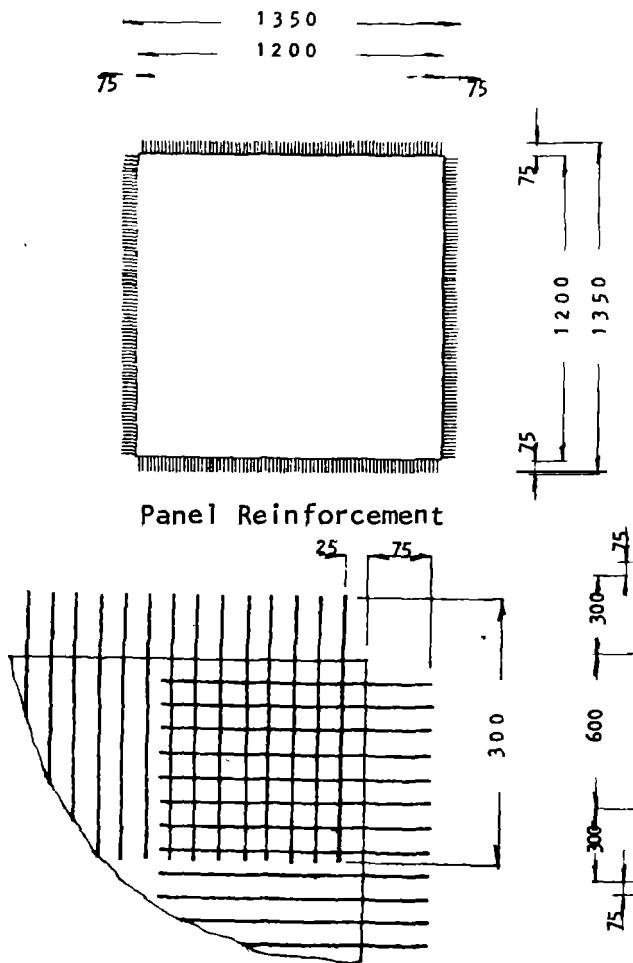


Figure 1.2

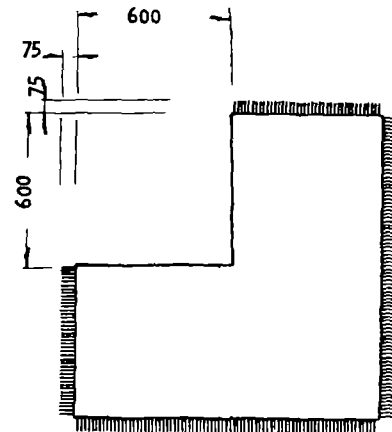
The following component elements are generally used for construction in the modular system.

a) Modular Standard Panel



b) Manhole Standard Panels

Alternate (i)



Alternate (ii)

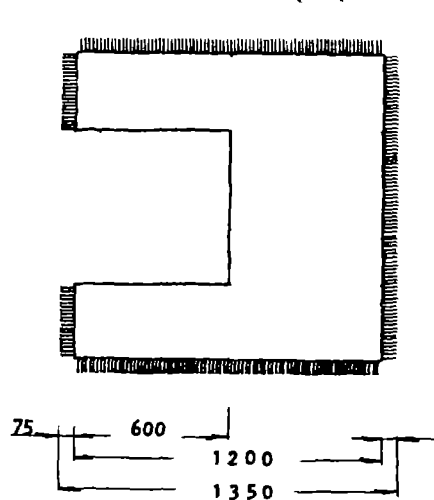


Figure 1.3.

a) Modular Standard Panel (As Series) has the following dimensions :

1200mm x 1200mm x 20 mm (47'' x 47'' x 3/4'')



b) Standard Panel with manhole has the same dimensions as above but it is provided with a manhole opening of 600mm x 600mm (24'' x 24'')

Illustration 12: Manhole As Series Standard Panel

One cubical tank made of the modular panels-As series has a capacity of 2,050 litres (450 Imp. gallons) and is made of the following elements:

- 5 - Standard As Panels
- 1 - Manhole As Panel
- 12 - Corner Joints

1.2. Moulds for Casting Standard Panels As-Series

The quality of the moulds plays an essential role for successful modular water tank construction. The base of the mould should be solidly built in order to allow easy manual or mechanical handling, without causing deflection. The surface of the base should be finished with a polyurethane resin and lightly oiled before use.

1.2.1. Steel moulds are the best and long lasting. However these are costly, requires skill and equipment for construction.

1.2.2. The timber mould is more suitable, particularly for casting the As-Series modular component elements under rural conditions. It requires only limited selection of tools and not much carpentry skill. (Annex 4). A timber mould as shown in Figures 1.4. and 1.5. is composed of the following elements :

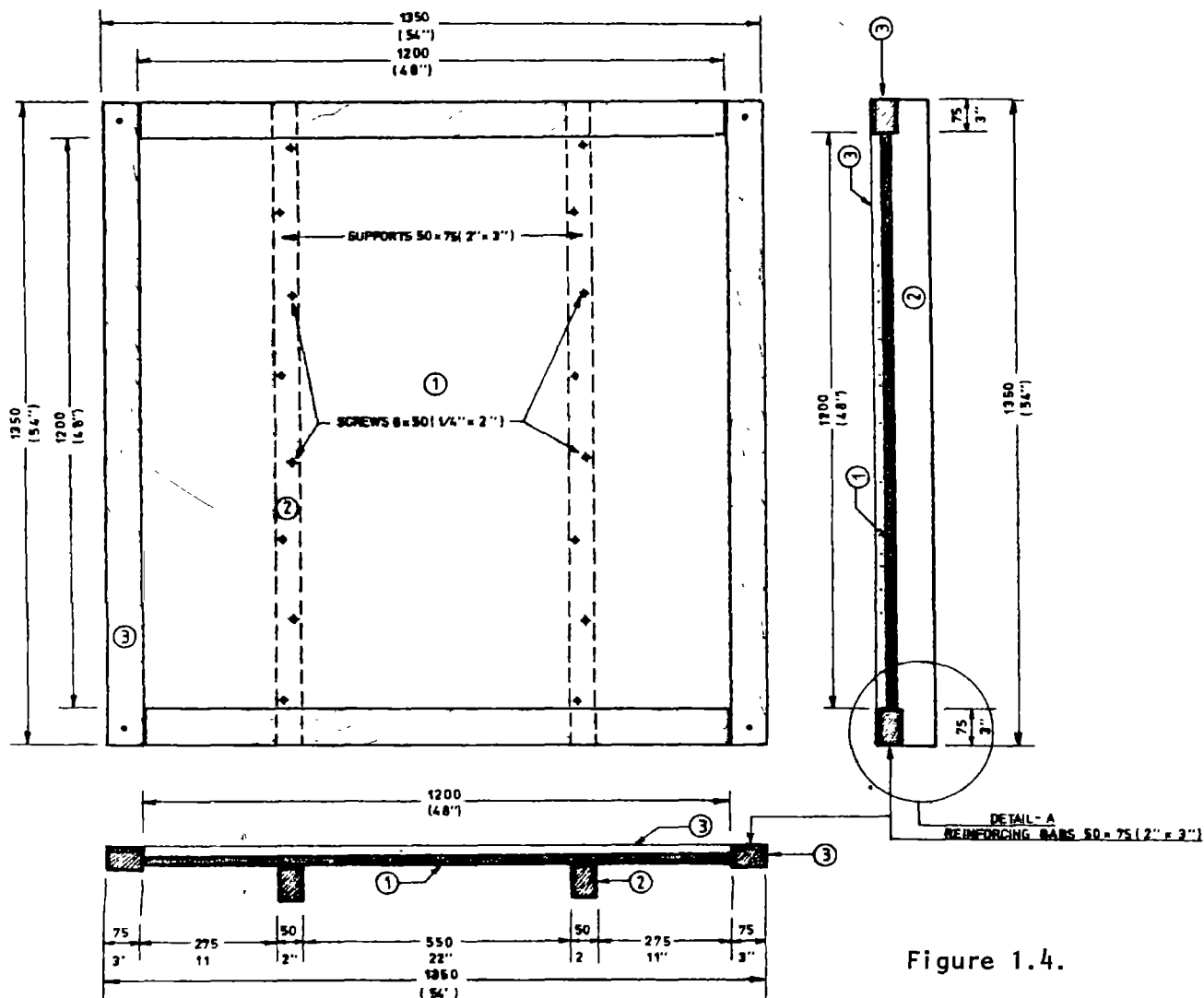


Figure 1.4.

- a) Casting base ① of 20mm (3/4") marine or outdoor plywood with dimensions of 1200mm x 1200mm (48" x 48") glued and fixed by screws on two 50mm x 75mm (2" x 3") timber supports ② . - Annex 4, page 5.
- b) Four fingering spacing bars ③ are 50mm x 75mm (2" x 3") of hard treated timber with 3.0mm (1/8") holes located 10mm (3/8") from the upper edges of the bars and spaced at 25mm (1") intervals - Annex 4, pages 3 and 4.

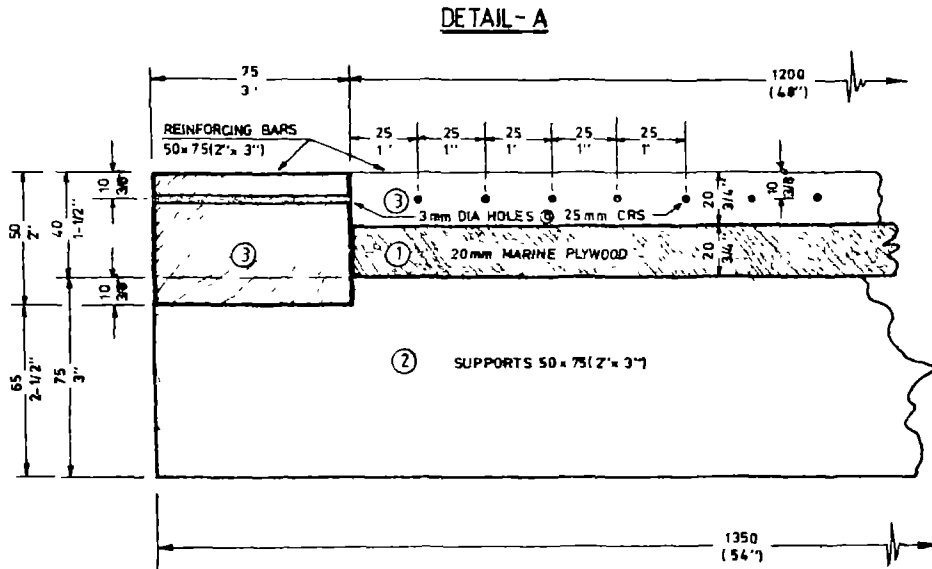


Figure 1.5.



Illustration 13: The spacing bars are kept in position only by a single nail for each corner threaded through a hole provided at the end of each bar (Fig 1.6)

1.3. Casting of Modular Standard Panels As Series



Illustration 14: At least two hours before use, the mould should be oiled very lightly.

1.3.1. The following are the steps for casting panels of Fibrous Cement Mortar, As Series:

1st Step: The mould base is placed on a horizontal platform or a vibration table and the spacing bars attached by connecting bolts or nails. (Figure 1.6.)

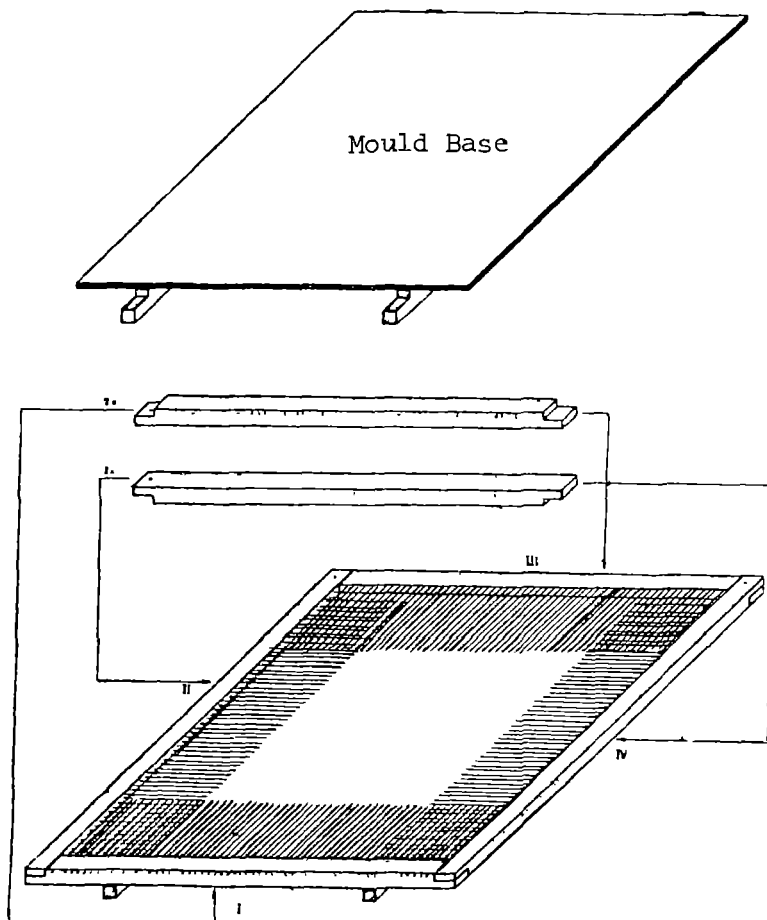


Figure 1.6.

2nd Step: High tensile fingering wires of 2mm or 2.5mm diameter, 300mm (12") long are threaded through the spacing bar holes.

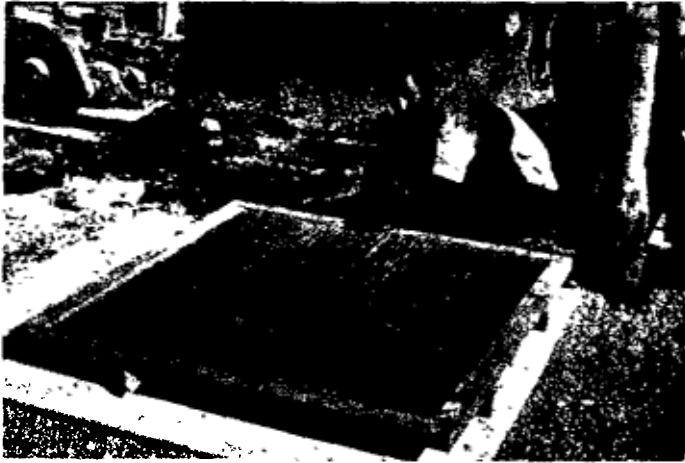


Illustration 15: Before placing the mortar in the mould, each fingering wire is adjusted to protrude 75mm (3") from the inner side of the spacing bars.

3rd Step: The mortar is placed on the mould in small portions and evenly spread out by using a metal trowel. Use the skid to check again whether all fingering wires are even. They should extend 75mm (3") from the inner edge of the spacing bar.

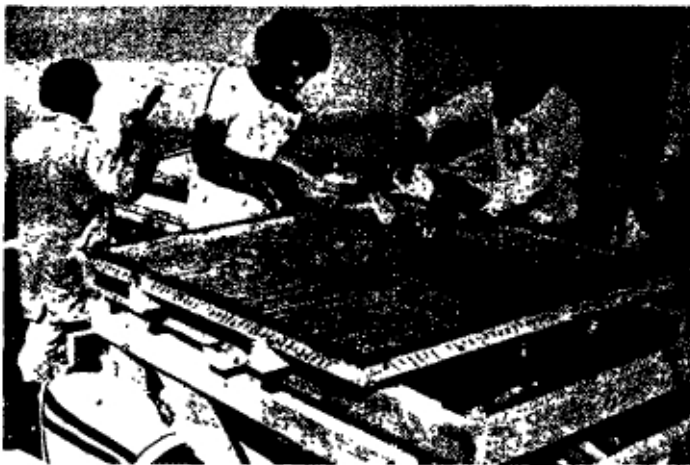


Illustration 16: Make sure some mortar is placed below the fingering in the corners of the mould.

4th Step: The vibration and compaction are carried out manually by slapping with wood float and subsequent levelling of the surface with the skid until slurry appears on the top. If electricity or generator is available the vibration could be carried out by using Vibration Saddle - Annex 3, page 2-4.

5th Step: The surface is finished off by using a metal trowel and repeated three times at intervals of 30 minutes.

6th Step: The panel thus cast is left to harden for 24 hours prior to removing from the mould.

The procedures for casting the Standard Manhole Panel are identical but after the 1st step is completed, the manhole area of 600mm x 600mm (24" x 24") square is blinded.

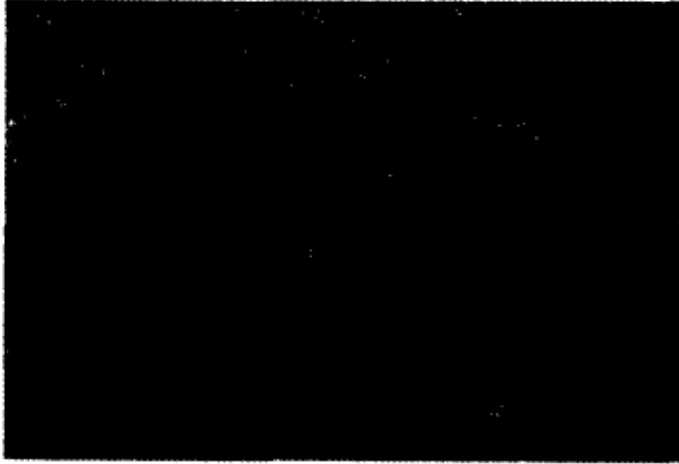


Illustration 17: The blinder for the manhole panel could be placed in the middle of the sides or in the corner.

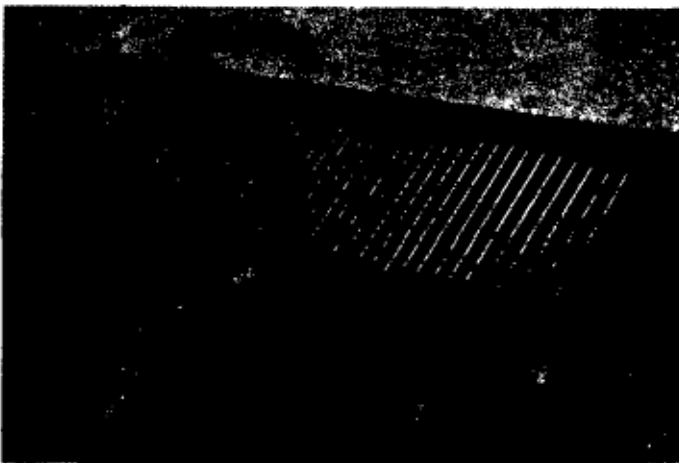


Illustration 18: To prevent the panel breaking when removed from the mould, the two sides of the manhole are longitudinally reinforced.

1.4. Assembly of Modular Tank: As Series

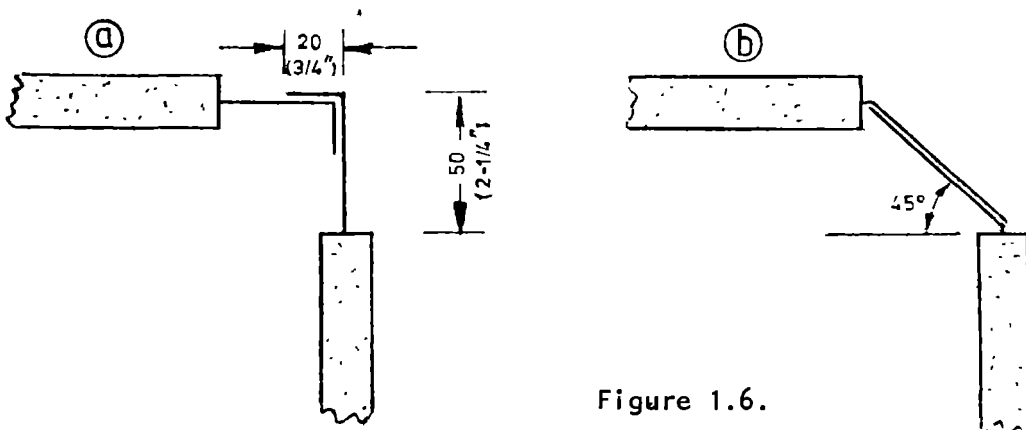


Figure 1.6.

1st Step: The fingering wires of five standard As panel and one Manhole As panel are bent for the subsequent plaster of the joints. Every alternate wire is bent as shown in Figures (a) and (b).



Illustration 19: The fingering wires are bent by using a 6mm (1/4") diameter pipe 150mm (6") long.

2nd Step: The Assembly Box for the As series is placed horizontally adjacent to the required tank location. It should have enough area around to allow free access from all sides for installation of panels. (Figure 1.7 and Annex 5 - page 1)

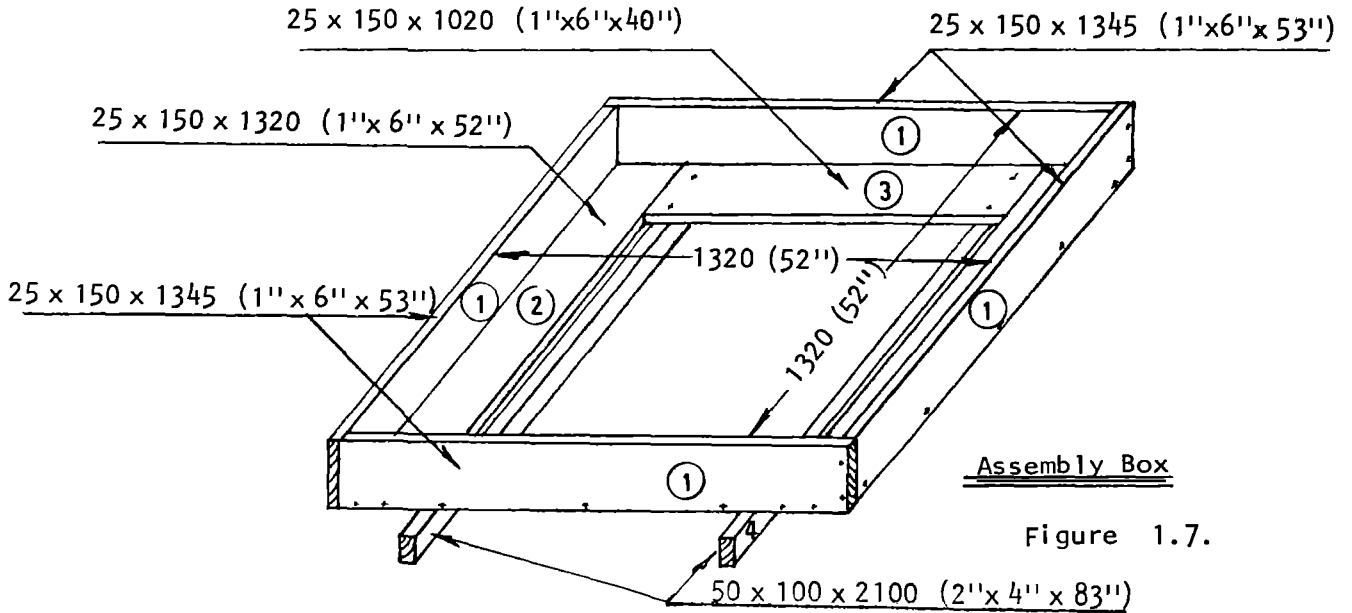


Figure 1.7.

3rd Step: One standard panel is placed horizontally in the Assembly Box ensuring equal distance of 60mm (2 3/8'') all around ①.

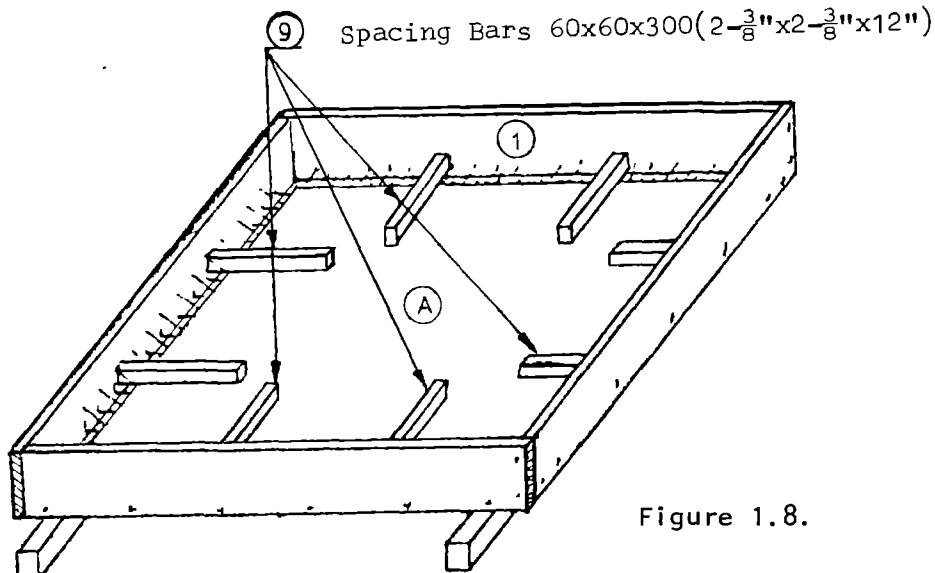


Figure 1.8.

4th Step: On top of this panel eight spacing bars ⑨, (See Fig 1.8.) two for each side are positioned at right angles against the board ①, in order to ensure the required uplift spacing for installation of the vertical side panels.

5th Step: The manhole panel and three standard panels are installed in vertical positions on top of the spacing bars ⑨ against each side board ① of the Assembly Box. Each panel is bound immediately to the next with the fingering wires using tie wires. The upper part of the vertical panels are held in position by the Top Corner Box ⑥



Illustration 20: Install the first vertical panel into position, pressed against the side of the box.

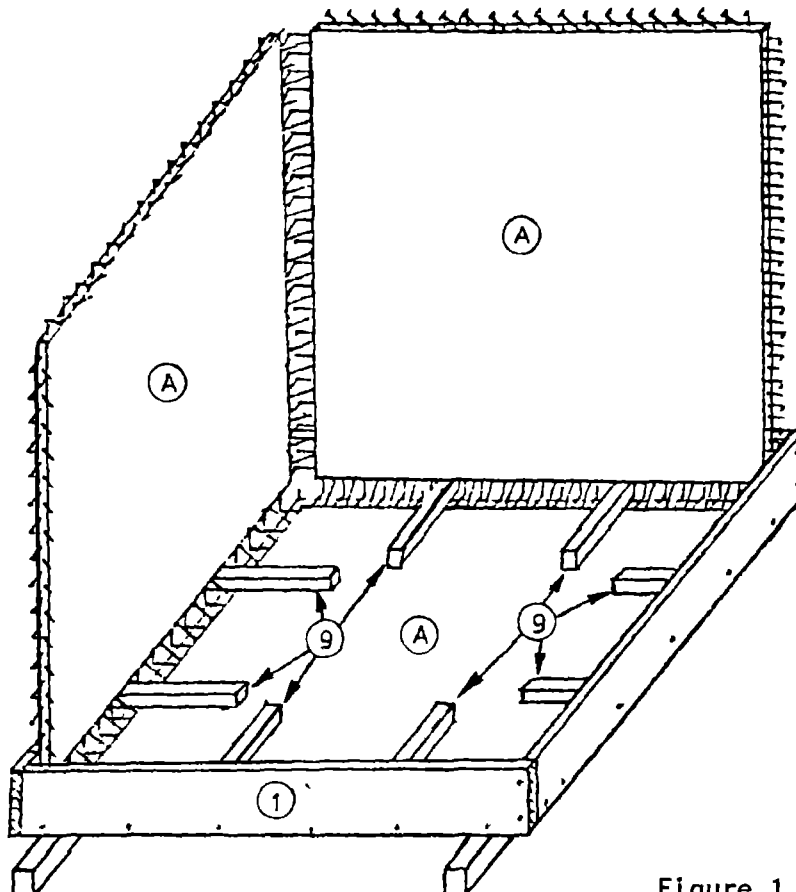


Figure 1.9.

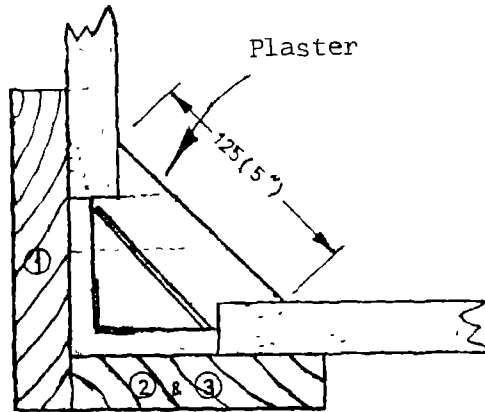


Figure 1.10.

6th Step: All Base-Assembly-Spacing-Bars (9) are removed and the lower horizontal corners plastered with fibrous mortar from the inside.

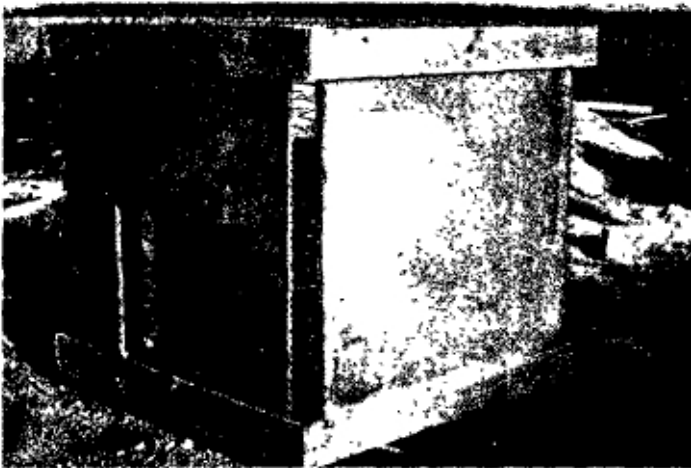


Illustration 21: Use the top form boxing to adjust the panels into position.



Illustration 22: The mortar is introduced to the lower corner in small portions compacted with the tamping rod and later shaped using a steel trowel.

7th Step: From the inside, against each vertical corner is the Corner Board Boxing (8) is fixed and secured to the fingering wires by tie wires threaded through drilled holes and bound - (Figure 1.12.)

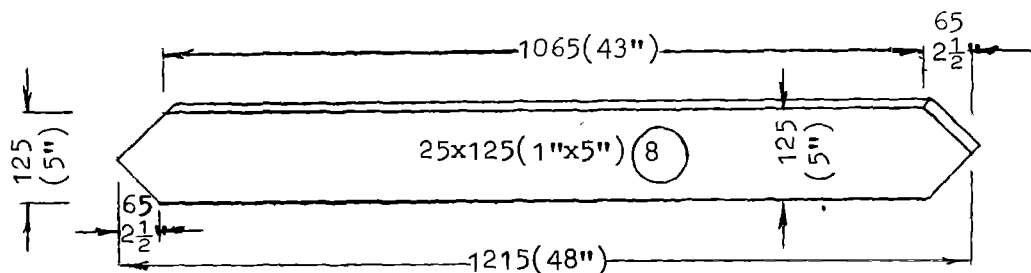


Figure 1.11.

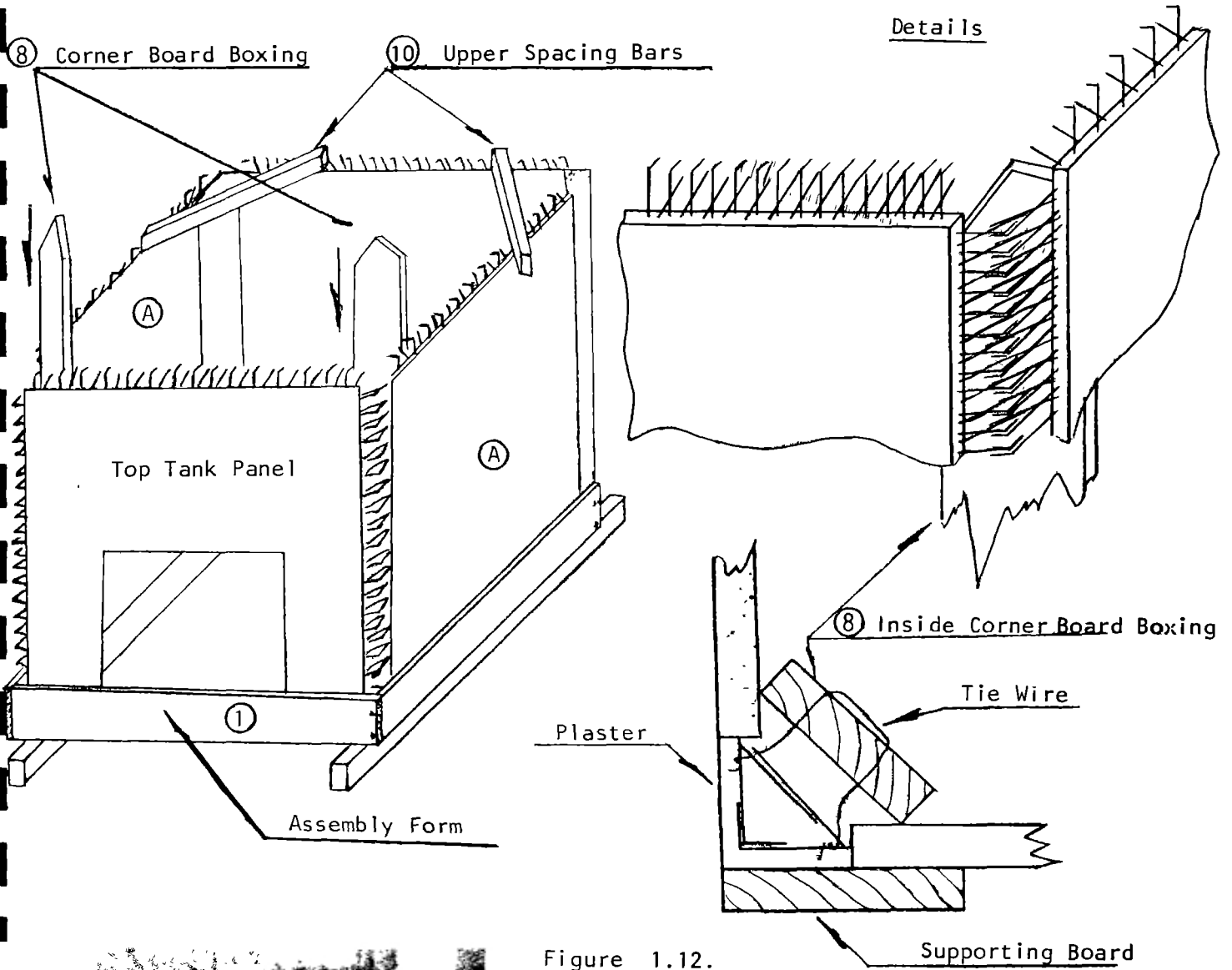


Figure 1.12.

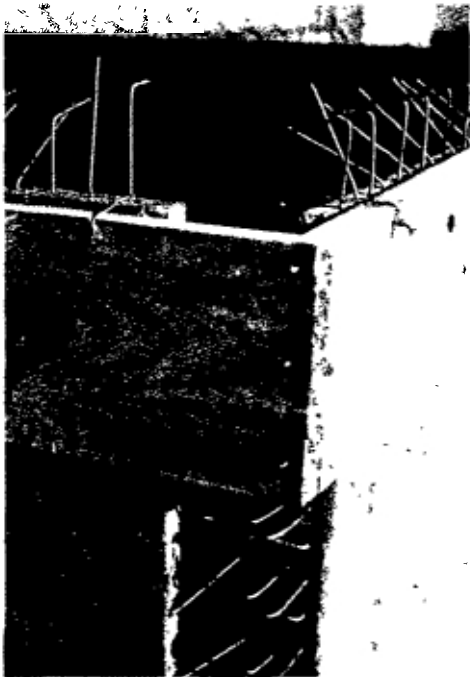


Illustration 23: The Top Corner Boxing is used for template to install the panels in position.



Illustration 24: The corner boxing is fixed from the inside of the tank structure.



Illustration 25: The tamping rod is used to place and compact the mortar between the fingering wires

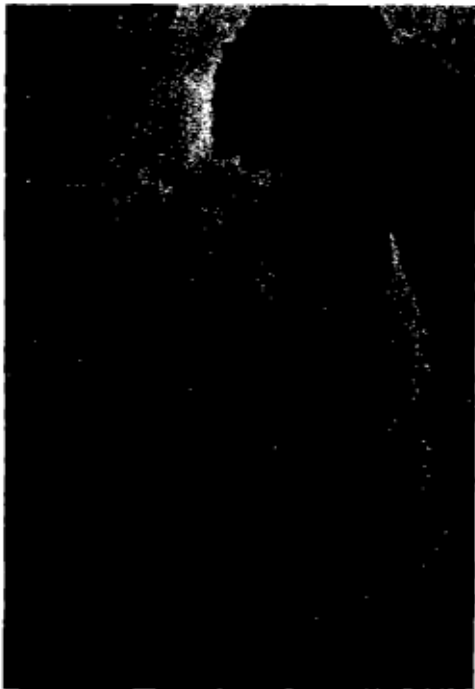
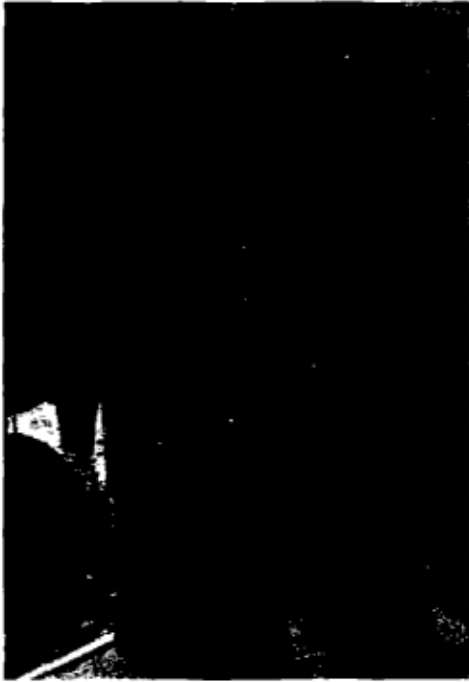


Illustration 26: The corner is formed by using a support board on one side and plastering from the other.



Illustration 27: A steel trowel is used to complete the corners.

- 8th Step: The fibrous mortar is placed on the vertical corners from the outside in two stages: first, the mortar is fed upwards into the space between the Corner Boxing (8) and the fingering wires compacting and vibrating by hand, using the tamping rod, and second, by plastering to complete the corner by using a metal trowel and supporting one side of it using a timber board.
- 9th Step: Twelve hours should be allowed for the mortar of the plastered corners to harden prior to continuing the assembly of the tank.
- 10th Step: The inside Corner Boxing Boards (8) are removed by cutting the tie wires from the inside. The Top Assembly Spacing Bars (10) are placed on the top across each corner. In order to place the spacing bars properly, some of the fingering wires have to be bent sideways.
- 11th Step: The upper standard panel is placed on top of the spacing bars (10). Thence the fingering wires of the upper panel are bound with tie wire to the fingering on the vertical panels.
- 12th Step: The top spacing bars (10) are removed and the bent fingering wires are adjusted to their places.
- 13th Step: The Inside Corner Boxing Boards (8) are fixed horizontally from the inside against each corner and secured by tying through the perforations to the fingering wires.
- 14th Step: The Assembly Top Form-Boxing (6) is inserted from the top and adjusted to the vertical panels and supported against slipping down using supporting wires (7).
- 15th Step: In the corner adjacent to the Manhole Panel a 32mm (1½") diameter PVC Pipe 300mm (12") long overflow pipe is inserted. Also from the top on the opposite side is inserted a 12mm (½") PVC socket with pipe 50mm long for an outlet.
- 16th Step: The mortar is placed into the upper corners from the top and carefully vibrated with the tamping rod.



Illustrations 28 and 29: At least 12 hours after the corners are plastered. The corner boxing is removed and to correct any imperfections and cavities, a thin layer of 1 : 1 cement : sand mortar is plastered from the inside.



Illustration 30: In the top corner boxing, the mortar is placed and compacted using the tamping rods.



Illustrations 31 and 32: After three days, the tank is turned over on a pallet for convenient transportation to the site for utilization.

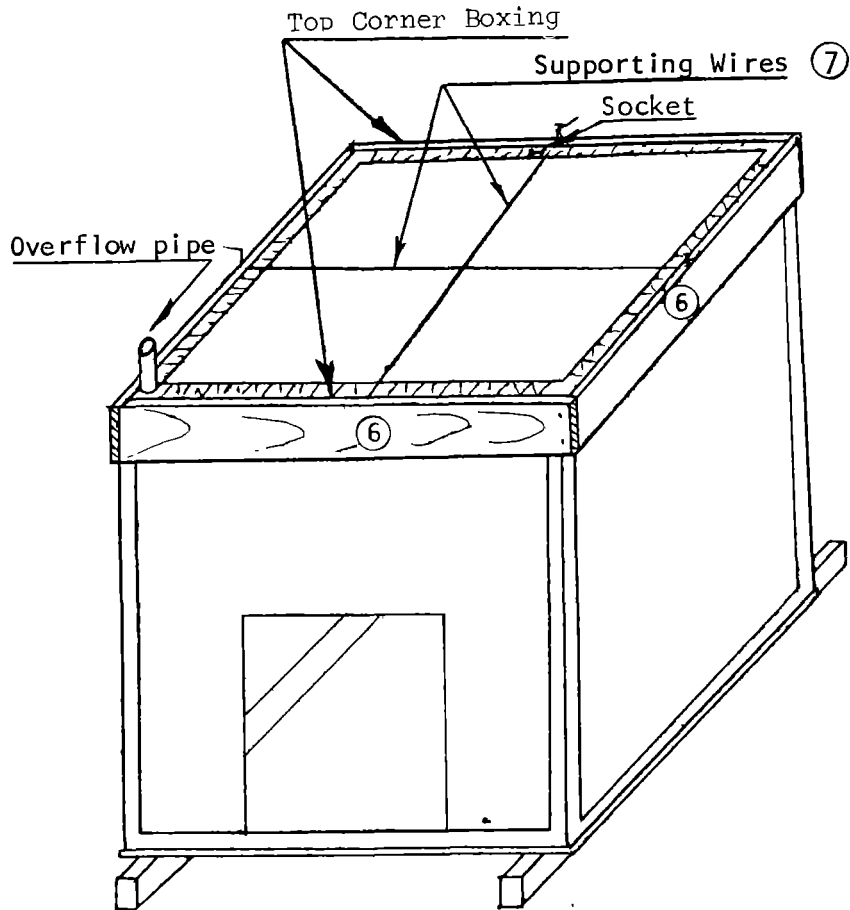


Figure 1.13.

17th Step: After 12 hours when the plastered mortar is well harden, all boxing boards are removed and any imperfections are patched using mortar mix with proportions of one part cement and one part sand.

18th Step: After at least another 60 hours, the water tank can be turned over with the manhole side on the top and transported to the required place for use.

COOK ISLANDS' MODULAR WATER TANK

PART 2

H T W R F FERROCEMENT STRUCTURES

AL - SERIES

NOTE: ALL DIMENSIONS IN THIS PART ARE IN MM EXCEPT AS OTHERWISE NOTED.

2. CONSTRUCTION OF MODULAR WATER TANKS FROM STANDARD PREFABRICATED HTWRF FERROCEMENT PANELS (A1 SERIES - 500 LITRES UNIT CAPACITY)

2.1 The Structure

The water tanks of A1 Series are designed to be constructed in the rural communities where it is possible to establish a yard for the production of prefabricated elements. Not many facilities are needed, but a few essentials are required such as electric power (or generator), vibration table and mortar mixer, in order to maintain good quality and high productivity. However if electricity is not available very good quality could be achieved also by using additives as Cement Mortar Super Plasticizer and Air Entraining Agent.

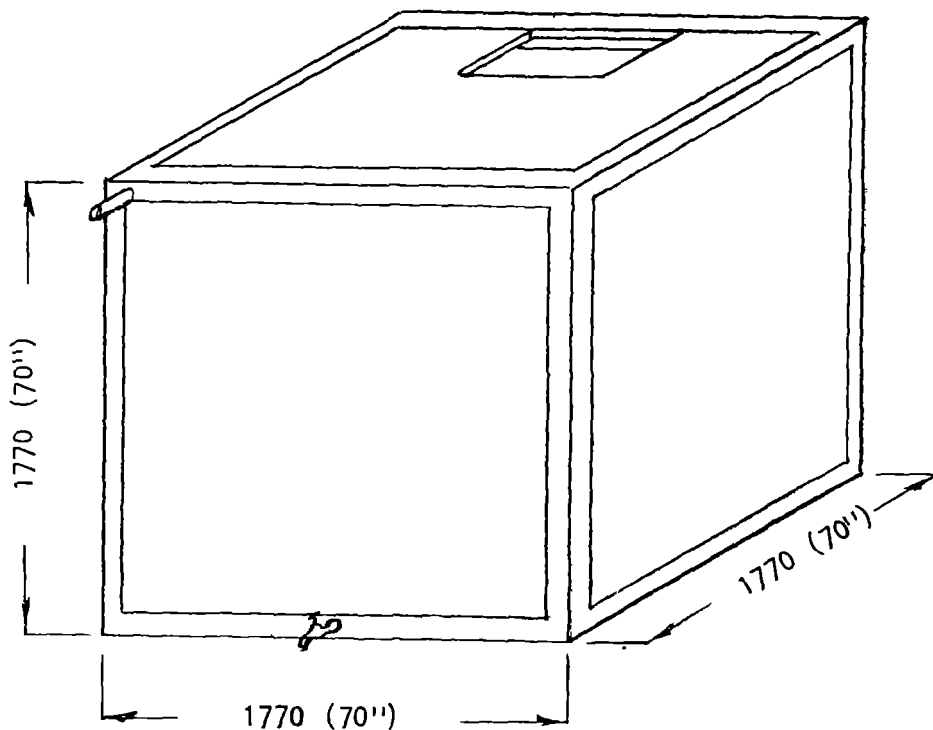


Figure 2.1

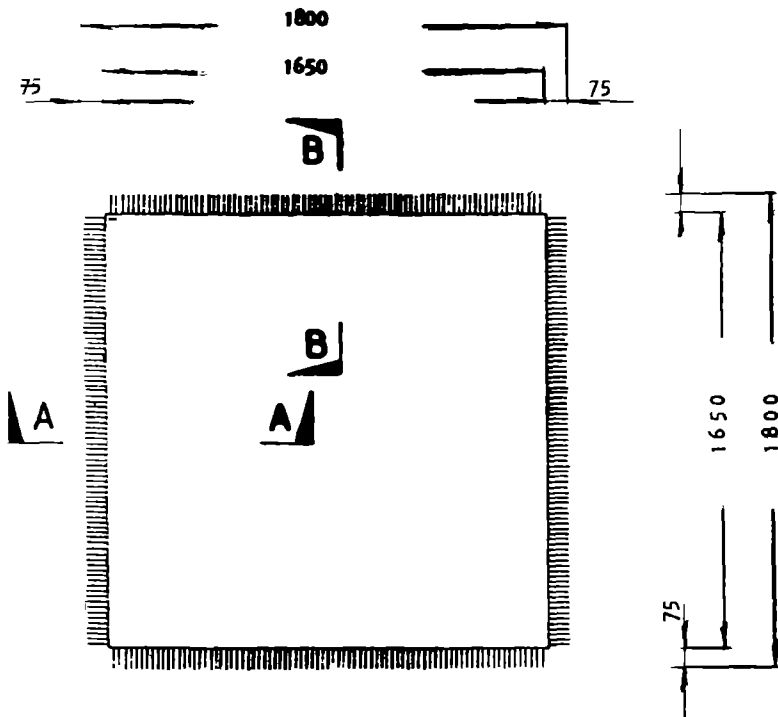
The component elements used in the A1 Series Modular System are produced of HTWRF ferrocement provided with joint fingering around the edges. The reinforcement consist of 2mm bright, galvanized or brass-coated high tensile spring quality wires, placed at 25mm (1'') intervals two directionally. The fingering is provided by the reinforcing wires which protrude 75mm (3'') at each edge.

The following component elements are generally used in the construction systems :

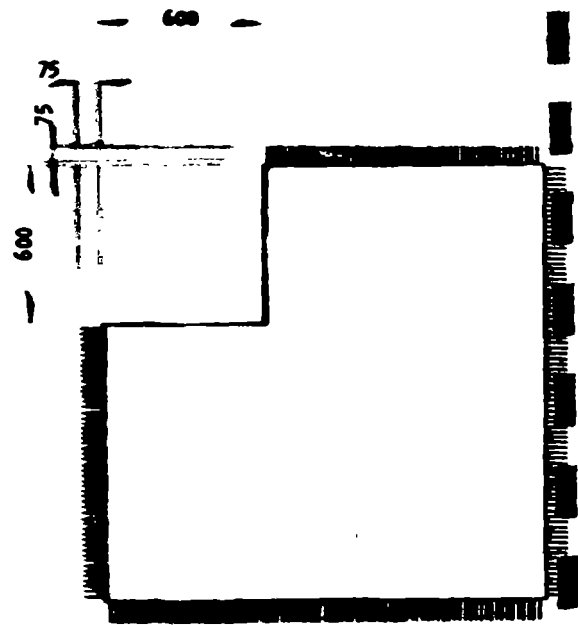
a) Standard Panel

b) Manhole Standard A1 Panel

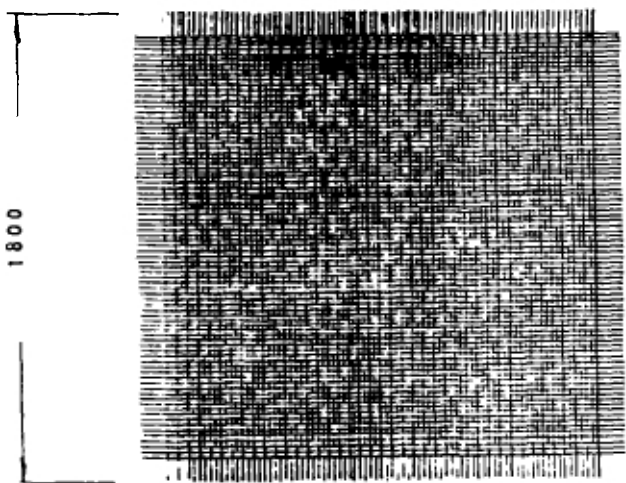
Alternate (i)



Panel Reinforcement



Alternate (ii)



Detail
Section A - A

Figure 2.2.

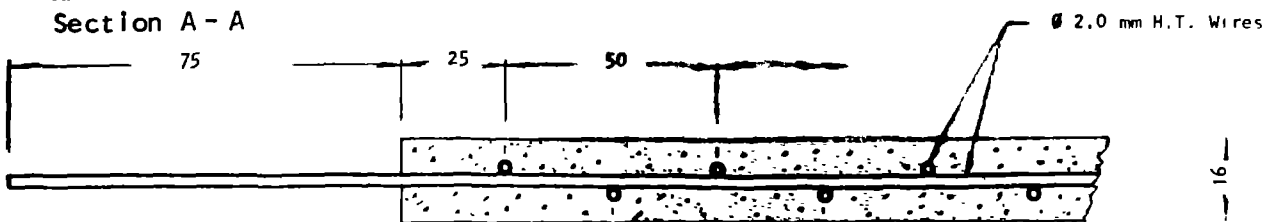
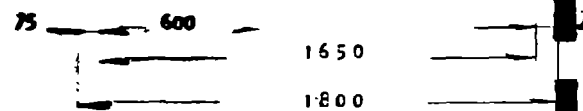


Figure 2.3.

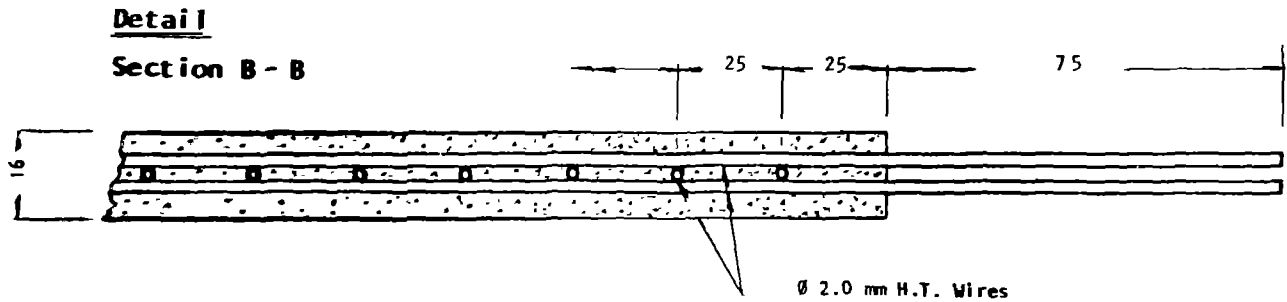


Figure 2.4.

- a) **Modular Standard Panel (A1 series)** has the following dimensions:

1650mm x 1650mm x 16mm (65" x 65" x 5/8")

- b) **Standard Manhole Panel (A1 series)** has the same dimension but is provided with a manhole opening size 600mm x 600mm (24" x 24") located in one of the corners or the middle of the edges.

One Modular Unit Water Tank constructed of panels of A1 series has a capacity of 5,000 litres (1,100 Imp.gallons) and is made of the following components :

5	-	Standard A1 panels
1	-	Manhole A1 panel
12	-	Corner Joints

The outside dimensions of a constructed One Modular Unit Tank are:

1770mm x 1770mm x 1770m (70" x 70" x 70")

2.2. Moulds required for A1 series panels (Annex 4, pages 6-14)

The moulds for production of modular component elements for the A1-series water tanks are, principally, similar to those described on page 11 for the As series, but differ in size and construction of the reinforcing spacing bars.

- 2.2.1. The steel moulds are relatively expensive but are much longer lasting and ensure precise and high quality production. Where facilities exist for the fabrication of steel moulds, they are recommended for use in central yards for the production of modular component elements. In the construction of the steel moulds, the following elements

are required. (See Annex 4, pages 13 and 14).

- a) Higher level casting base of 3mm (1/8") steel sheet with dimensions of 1650mm x 1650mm (65" x 65") - ① welded on a steel frame of two parallel U-shaped 102mm x 50mm x 6mm (4" x 2" x 1/4") steel sides - ②, and two parallel L-shaped 75mm x 75mm x 6mm (3" x 3" x 1/4") steel sides - ③ and one 75mm x 75mm x 6mm (3" x 3" x 1/4") steel brace - ④.



Illustration 33: Steel Mould Al-series.

- b) The lower level fringe ⑤ consist of four 75mm x 75mm (3" x 3"), 1725mm long timber members bolted to the frame of the base. It is designed to guide the length of the exposed reinforcing wires for fingering and supporting the spacing bars.



Illustration 34: Lower level timber fringe is bolted to the steel base.



Illustration 35: The tops of the spacing bars are positioned 16mm higher above the base.

- c) (i) Two End Plates (11), 50mm x 12mm (2" x ½") steel are required, provided with 3mm Ø (1/8") low level holes at 50mm (2") centers and located 11mm from the top of the plates and 6mm Ø holes at the same locations, tapped from the top and provided with 6mm Ø bolts for locking. Between the locking holes at the upper level, the end plates are also provided with 3mm (1/8") wide, 6.5mm deep slots at 50mm (2") centers.
- (ii) And two End Plates (12) of 50mm x 6mm (2" x ¼") steel provided with 3mm (1/8") wide and 9.5mm deep slots at 25mm (1") centers.

2.2.2. High quality modular elements of A1 series can also be produced using timber moulds if properly and precisely constructed. The A1 series timber mould is composed of following elements : (Fig. 2.6. and Annex 4 pages 6-12)

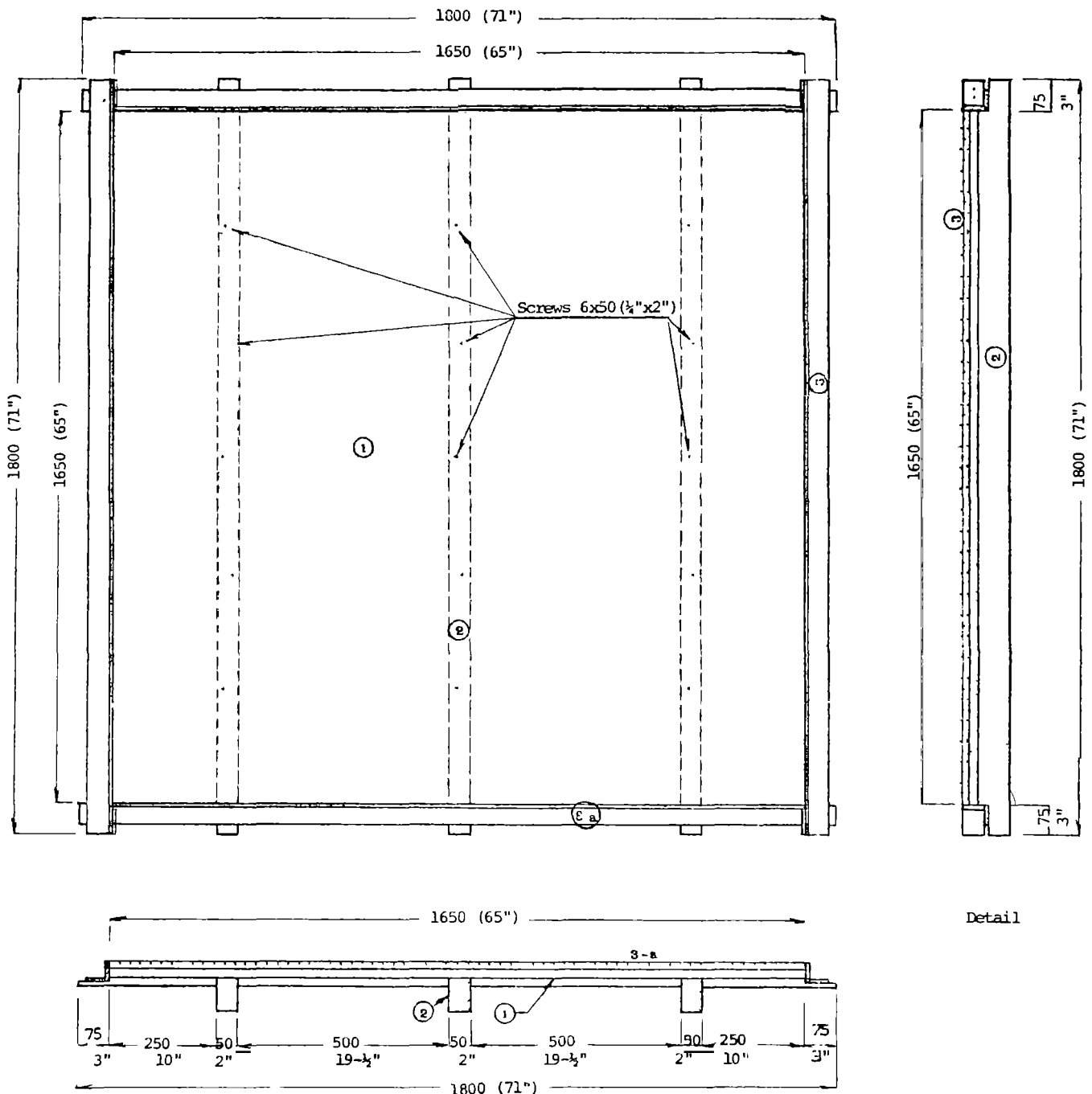


Figure 2.6.



Illustration 36: Plywood casting base with steel spacing bars Al-series.

- a) Casting base ① of 20mm (3/4") marine plywood with dimensions of 1650mm x 1650mm (65" x 65") glued and fixed by screws on three 50mm x 75mm (2" x 3") timber supports ②. The top surface of the base should be varnished with a polyurethane resin. (Annex 4 page 12)

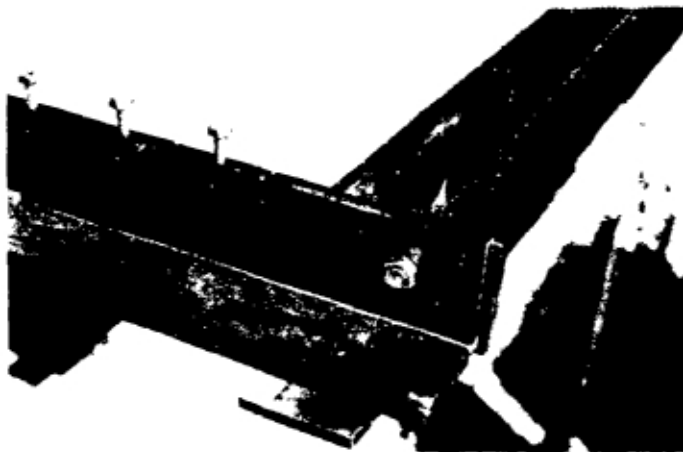


Illustration 37: The locking spacing bars are placed and bolted to the extended end of the slotted spacing bars.

- b) The spacing bars are similar to those for the steel moulds but for stability in the locking of the four corners and the plywood base, every bar is braced from below for support with a 12mm (1/2") steel bar welded at right angle. (Annex 4, pages 8 and 9).

Detail for steel spacing bars

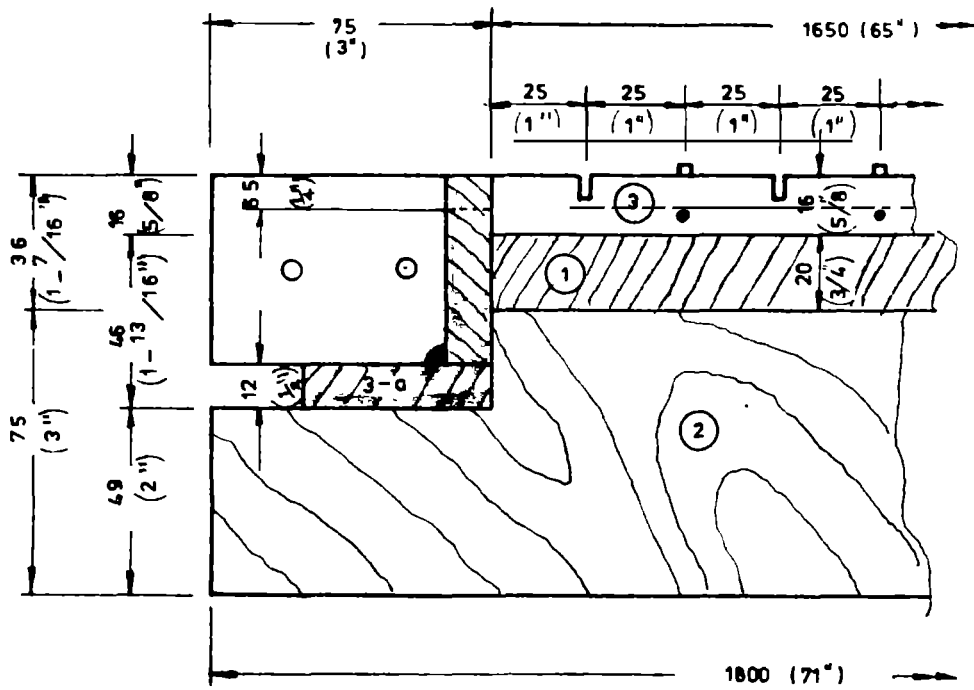


Figure 2.7.

- c) Timber spacing bars can also be used but they require more attention to ensure proper position of the spacing wires. They could be constructed of hard treated timber, 50mm x 75mm, provided respectively with spacing slots and holes. (Annex 4, pages 10 and 11).

Detail for timber spacing bars

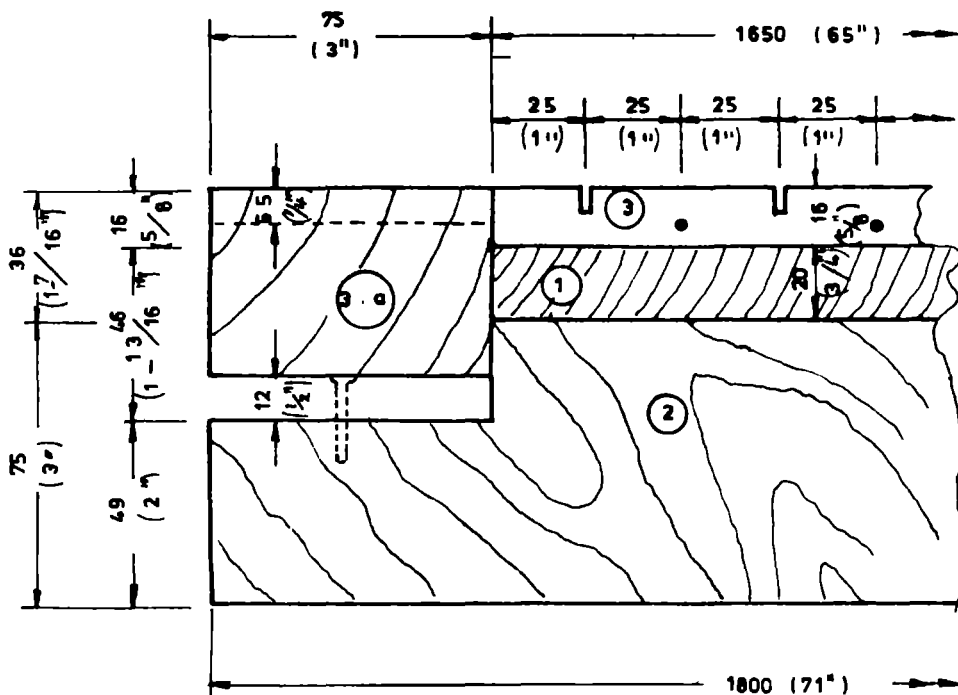


Figure 2.8.

2.3. Casting of Modular Standard Panels from A1 Series

The following are procedures to be followed in the casting of HTWRF Ferrocement Modular component elements of A1 Series:

1st Step: The mould base is placed on a horizontal platform or on the vibration table, and the spacing bars attached by the connecting bolts (9).

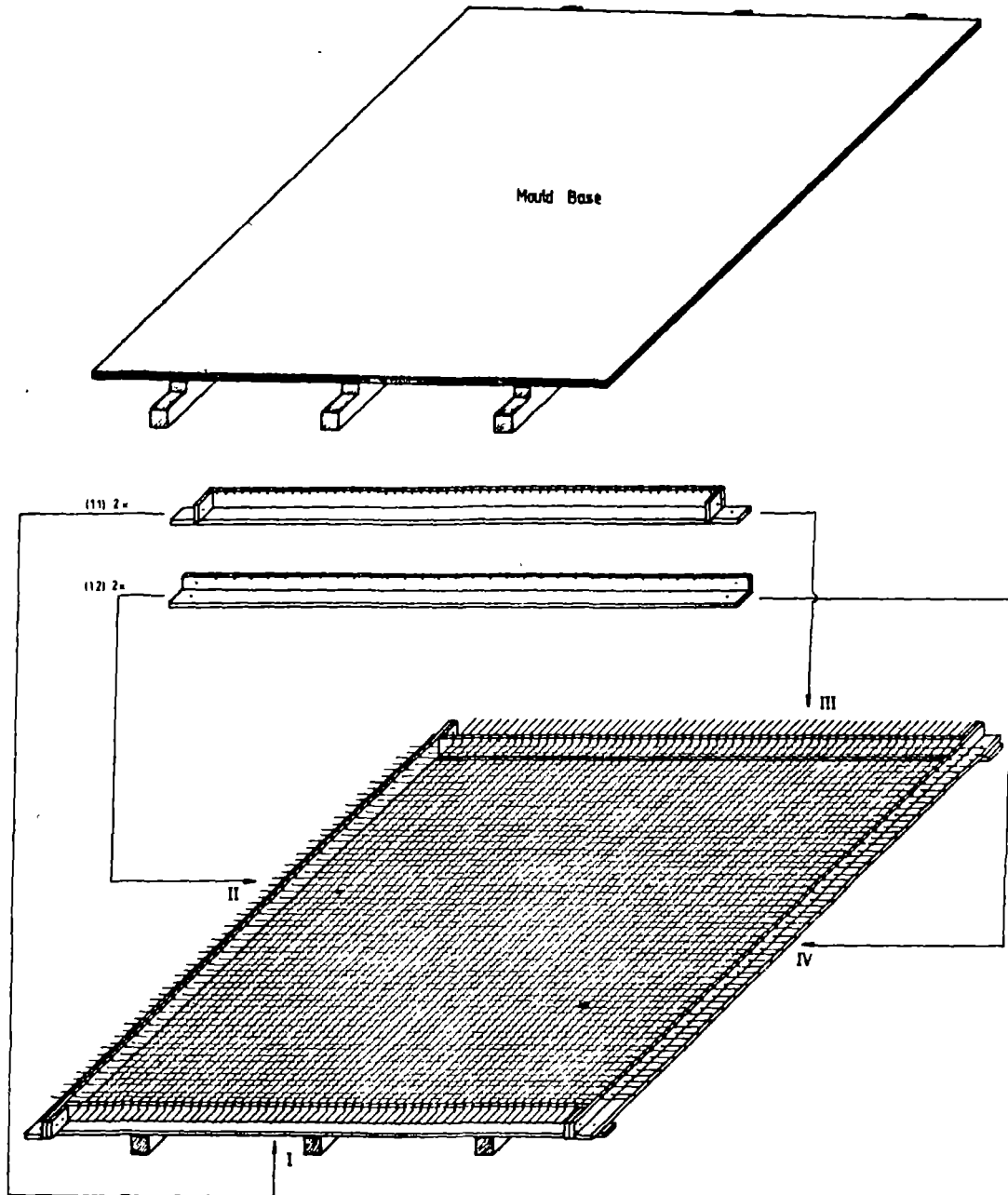


Figure 2.9.

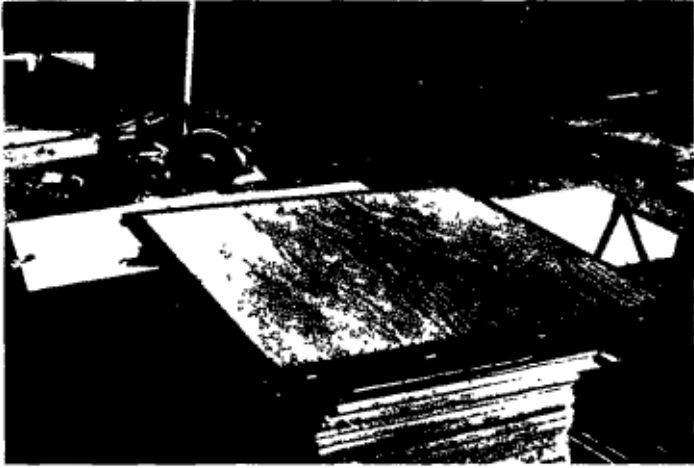


Illustration 38: Mould prepared for placing of the reinforcing wires



Illustration 39: Lowest level reinforcing wires are adjusted to be even - extended 75mm (3") from the inner edges of the spacing bars and locked in position with the bolts.



Illustration 40: The wires to be straightened are pulled by pliers from the opposite side and the bolts tightened by ratchet wrench or spanner.

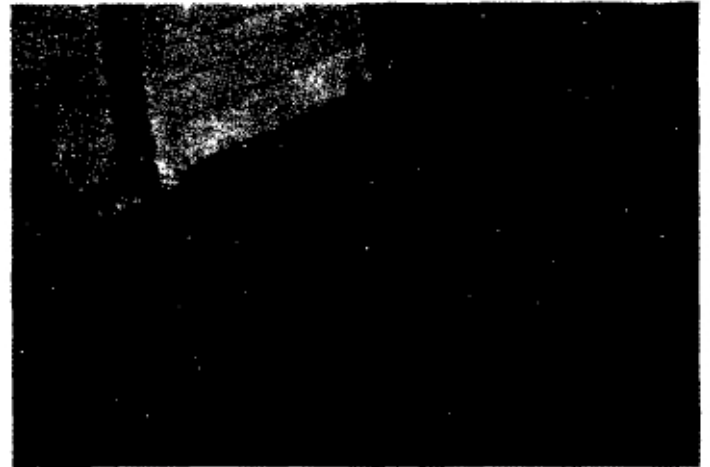


Illustration 41: Make sure that all wires are elevated from the mould base



Illustration 42: The next layer is placed in the opposite direction in the spacing bar slots.

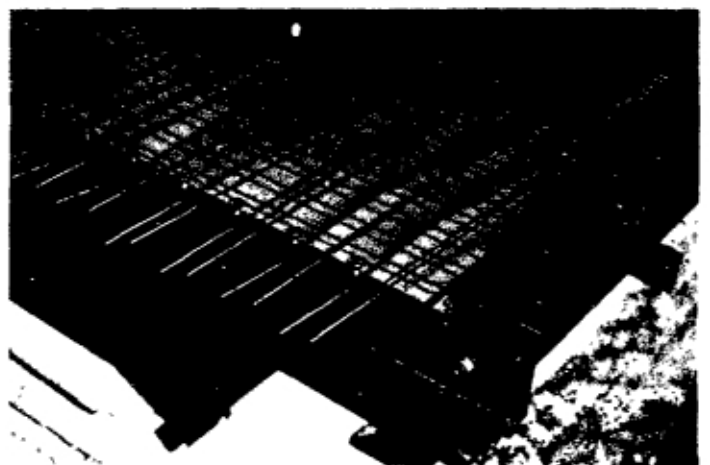


Illustration 43: The top layer reinforcing wires is placed on the slots of the locking spacing bars.

Similar in procedure if timber spacing bars are used.

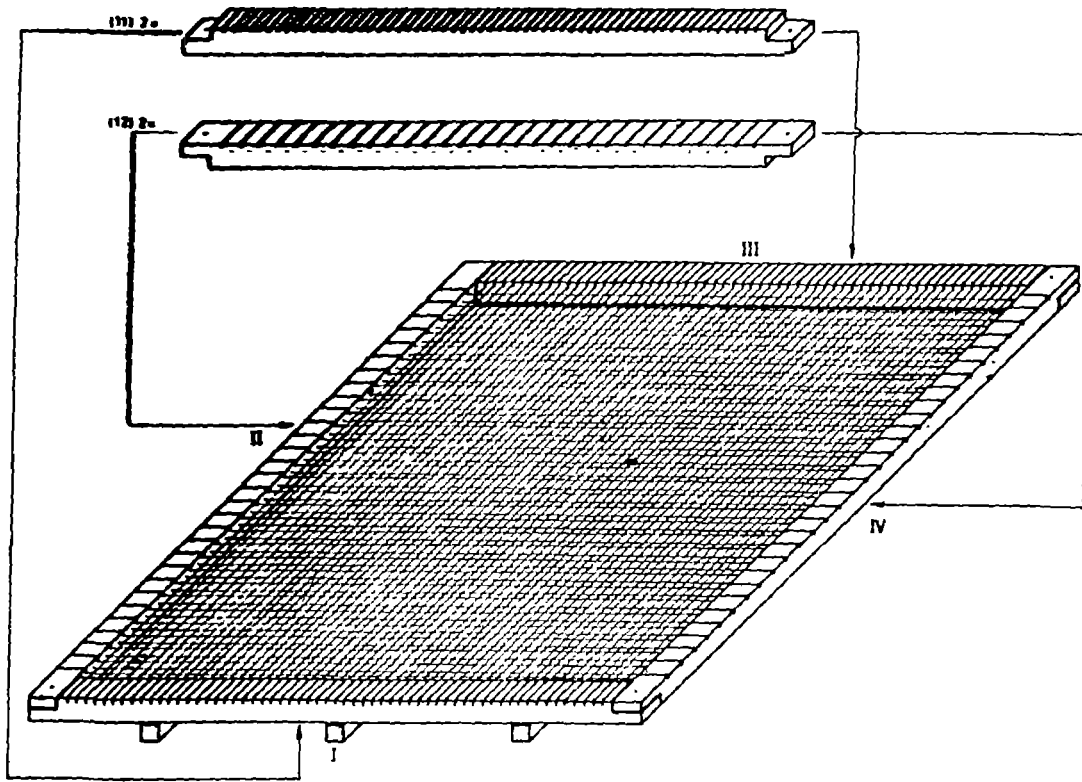


Figure 2.10.

2nd Step: The reinforcing wires are placed in the following sequence:

- First, the lowest level reinforcing wires are threaded through the holes of the Locking Spacing Bars.
For maintaining proper positioning between the Locking Spacing Bars the wires are locked by the bolts on one of the bars, whilst pulling the other end of the wires with pliers and locking the bolts on the other bar.
- Secondly, the middle layer of reinforcing wires are placed across those of the lowest level through each slot of the Slotted Spacing Bars.
- The upper level reinforcing is placed on the top across the medium reinforcing in the direction of the lowest level, through the slots of the Locking Spacing Bars.



Illustrations 44 and 45: With timber spacing bars, high quality panels can also be produced.

3rd Step: The reinforcing is adjusted all around for required fingering, by insuring that all wires extend 75mm (3") from the inner edges of the mould.

4th Step: The mortar is placed on the mould in small portions and evenly spread, using a metal trowel and timber skid.

If Timber Spacing Bars are used, the first portions of the mortar are placed in the centre of the mould and the reinforcing of the middle section adjusted by lifting the wires with fingers, allowing some of the mortar to drop below to support the position.

5th Step: The vibration is continued until slurry appears on the surface.

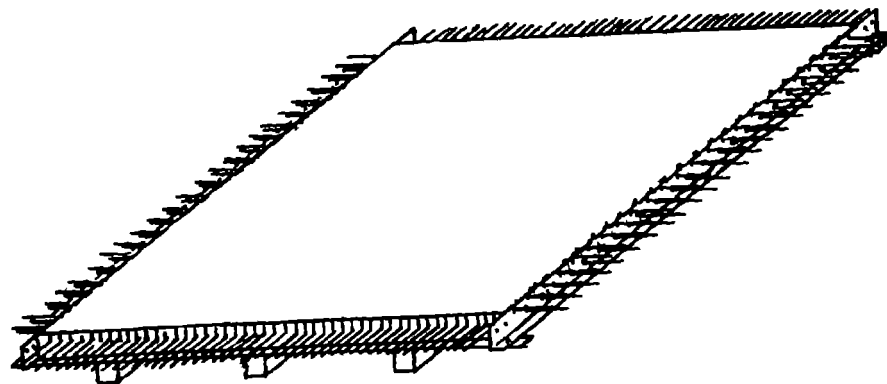


Figure 2.11.



Illustration 46: The mortar is placed on the mould in small portions.

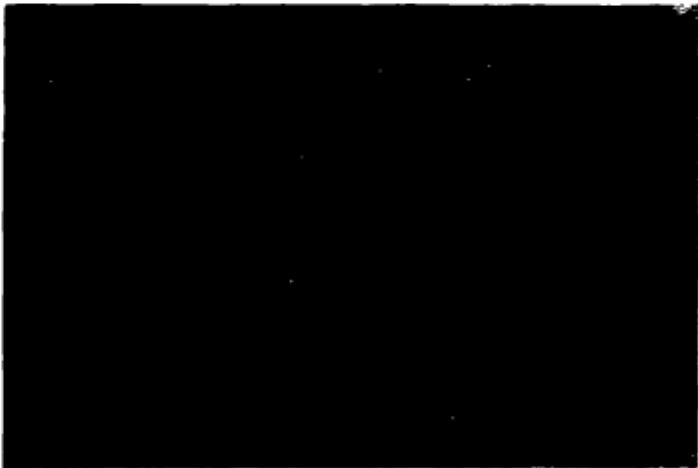


Illustration 47: For casting of the manhole panel, a blinder frame is constructed of size 60cm x 60cm (24" x 24") with saw slots on the bottom to match the wires.



Illustration 48: The vibrated panel is removed from the vibration table and left to harden for 24 hours.



Illustration 49: The exposed wires of the manhole are cut by hack-saw, flush with the panel sides.

6th Step: The surface is finished by using metal trowel. The operation is repeated three times at intervals of 30 minutes.

7th Step: The casted panel is left to harden for 24 hours prior to being removed from the form. The spacing bars can be removed after 6 hours and used for casting with another mould base.

2.4. Assembly of Al series Modular Tanks



Illustration 50: The fingering wires are bent by using small pipe 6mm (1/4") diameter and 150mm (6") long.

1st Step: The fingering wires of five standard Al panels and one Manhole Al panel are bent for the subsequent plastering of the joints. Every alternate wire is bent as shown in Figures 2.12. (a) and (b).

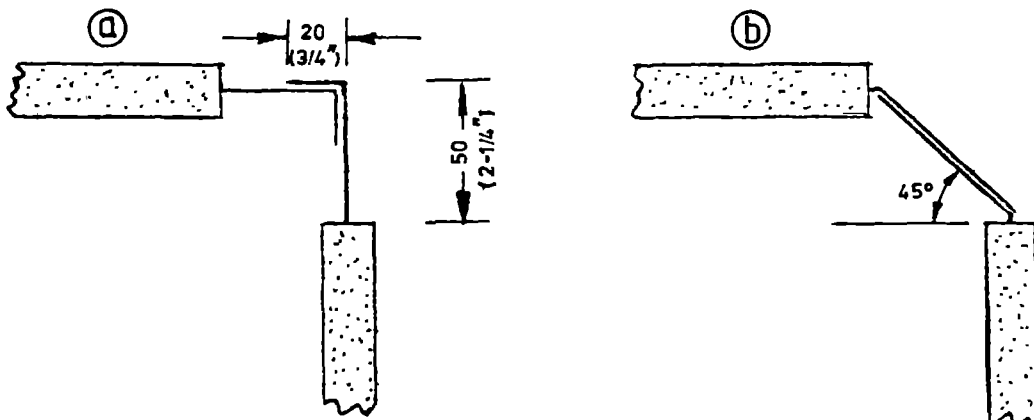


Figure 2.12.

2nd Step: The Box for assembly of the A1 series is placed horizontally adjacent to the required tank location . There should be enough area around the box to allow free access from all sides for installation of the panels.

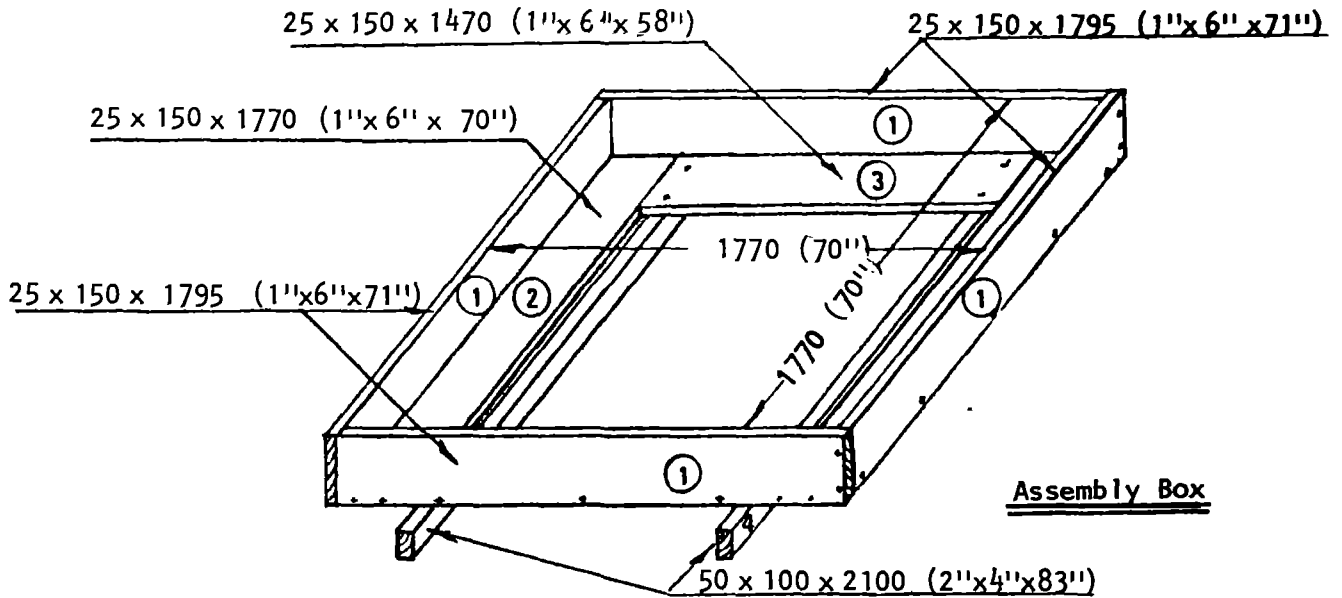


Figure 2.13.

3rd Step: One standard panel is placed horizontally in the Assembly Box ensuring equal distance of 60mm (2 1/8") all around ①.

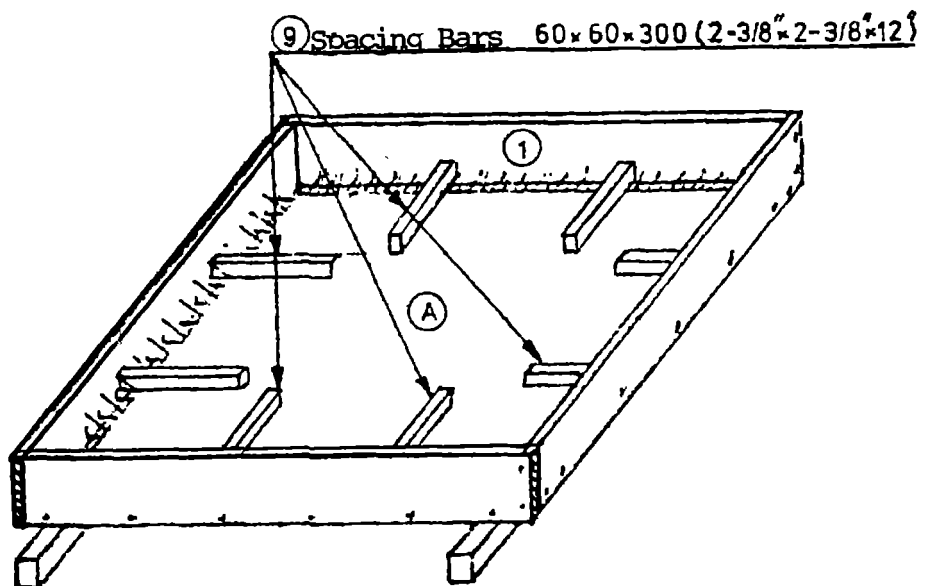


Figure 2.14.



Illustration 51: Assembly form box for Al - 1 water tank.

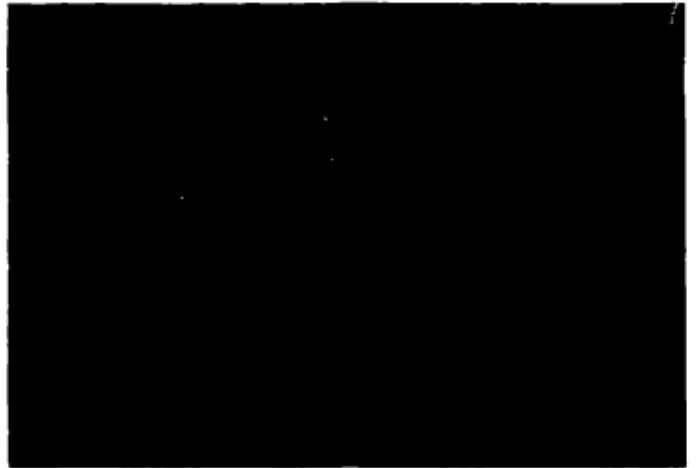


Illustration 52: Assembly top-form for Al - 1.



Illustration 53: The first panel is placed in the assembly box and adjusted to maintain even spaces on all sides.



Illustration 54: The cement mortar is placed between the fingering wires by using tamping rod.



Illustration 55: The final formation of the corner is made with the help of a side board.

4th Step: On top of the installed panel, eight spacing bars ⑨ are placed, two for each side, positioned at right angles against the side board ① in order to ensure the required uplift spacing for installation of the vertical side panels.

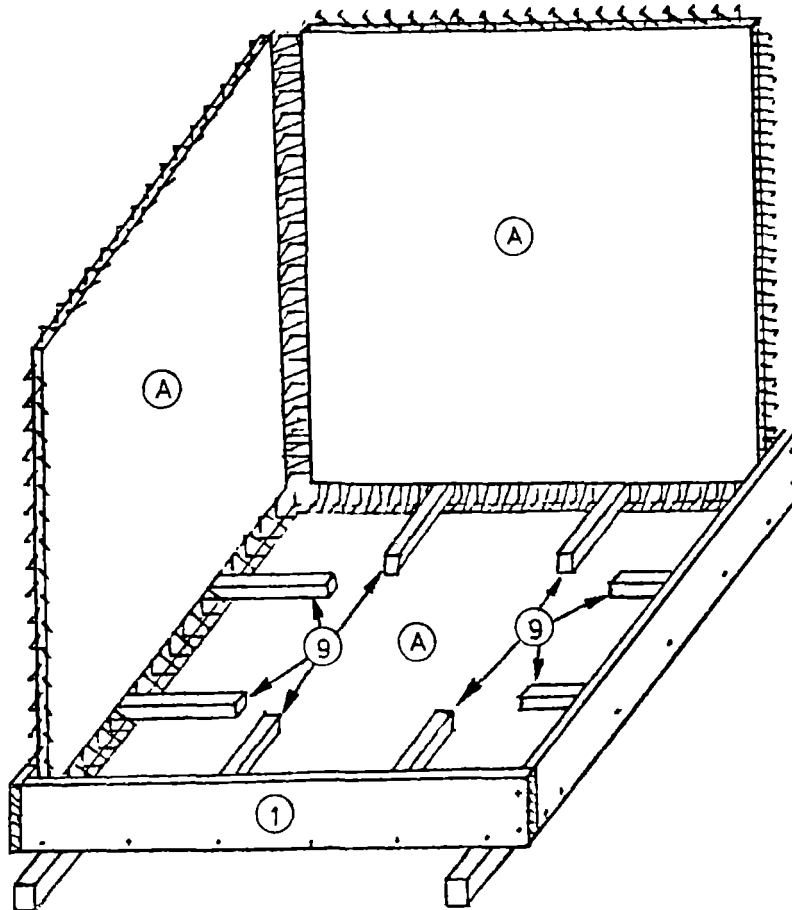


Figure 2.15.

5th Step: The manhole panel and three standard panels are installed in vertical positions on top of the spacing bars ⑨ against each side board ① of the Assembly Box. Each panel is bound immediately to the next with the fingering wires using tie wires. The upper parts of the vertical panels are held in position by the Top Corner Frame ⑥.

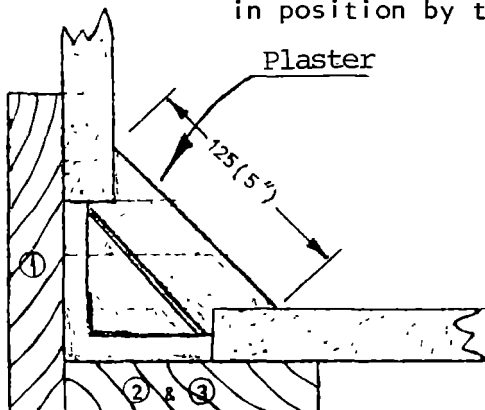


Figure 2.16.

6th Step: All Base-Assembly-Spacing Bars ⑨ are removed and lower horizontal corners plastered with fibrous mortar from the inside.

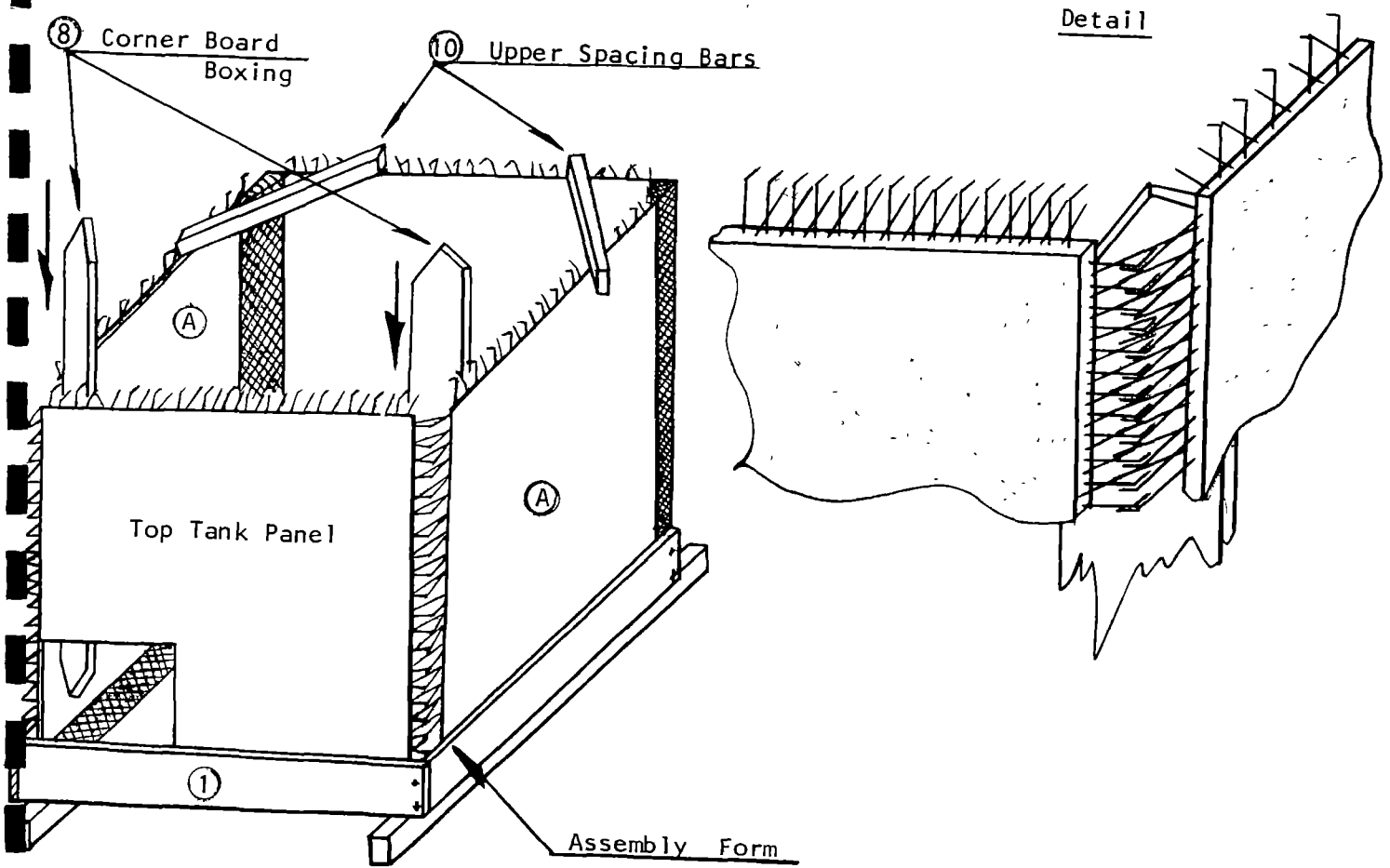


Figure 2.17.

7th Step: From the inside, against each vertical corner, the Inside Corner Boxing Board (8) is fixed and secured to the fingering wires by the tie wires threaded through the drilled holes and bound. (Fig. 2.19.)

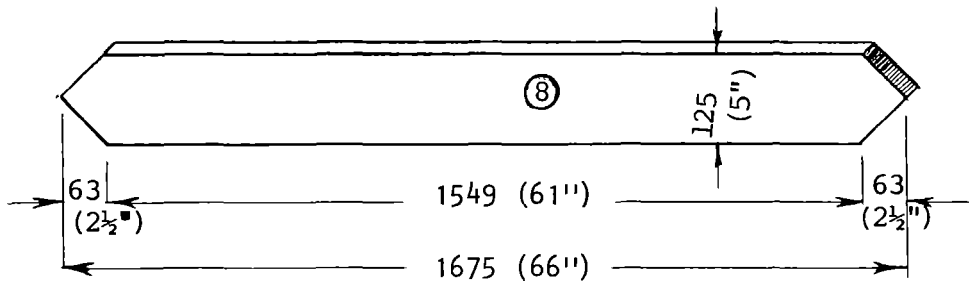


Figure 2.18.

8th Step: The fibrous mortar is placed on the vertical corners from the outside in two stages: first, the mortar is fed upwards into the space between the Corner Boxing (8) and the fingering wires, compacting and vibrating by hand, using a tamping rod, and second, by plastering the corner, using a metal trowel, and supporting one side of it using a timber board.

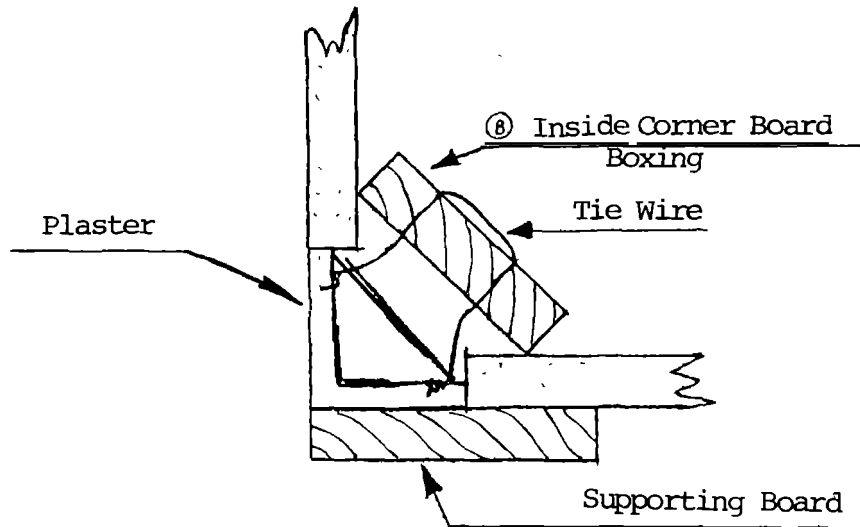


Figure 2.19.

9th Step: Twelve hours should be allowed for the mortar of the plastered corners to harden, prior to continuing the assembly of the tank.

10th Step: The Inside Corner Boxing Boards (8) are removed by cutting the tie wires from the inside. The Top Assembly Spacing Bars (10) are placed on top across each corner. In order to place the spacing bars properly, some of the fingering wires have to be bent sideways.

11th Step: The upper standard panel is placed on top of the spacing bars (10). Thence the fingering wires of the upper panel are bound by tie wires to the fingering of the vertical panels.

12th Step: The top spacing bars (10) are removed and the bent fingering wires adjusted to their places.



Illustration 56: The corner board boxing is placed horizontally from inside and fixed into position with tie wires to the upper corner fingering wires.

13th Step: The Inside Corner Boxing Boards (8) are fixed horizontally from the inside against each corner and secured with tie wire through the perforations to the fingering wires.

14th Step: The Assembly Top Form-Boxing (6) is inserted from the top and adjusted to the vertical panels and fixed by supporting wires (7) to prevent its slipping down (Fig. 2.20).

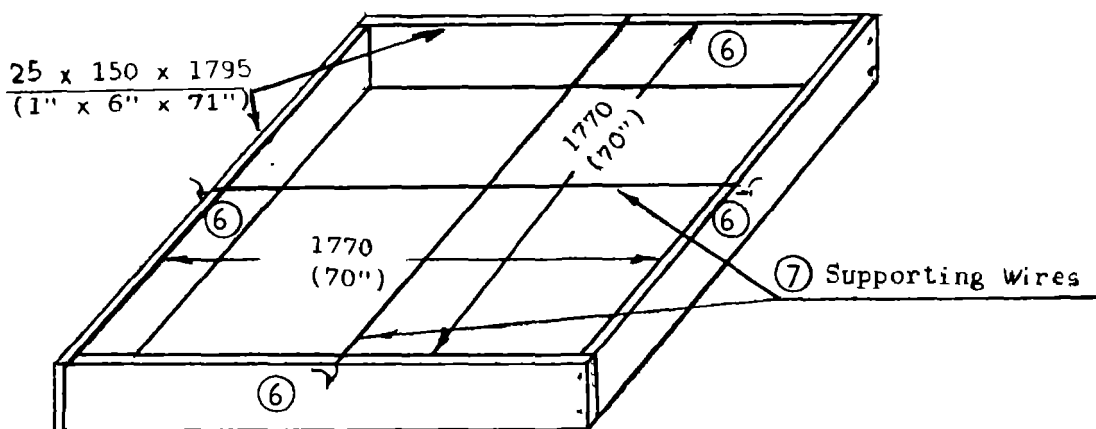


Figure 2.20.

15th Step: In the corner adjacent to the Manhole Panel a 32mm (1½") diameter PVC Pipe 300mm (12") long overflow pipe is inserted from the top. Also from the top on the opposite side is inserted a 12mm (½") diameter PVC socket with pipe 50mm long for outlet.

16th Step: The mortar is placed into the boxing of the upper corners from the top and carefully vibrated with tamping rod.

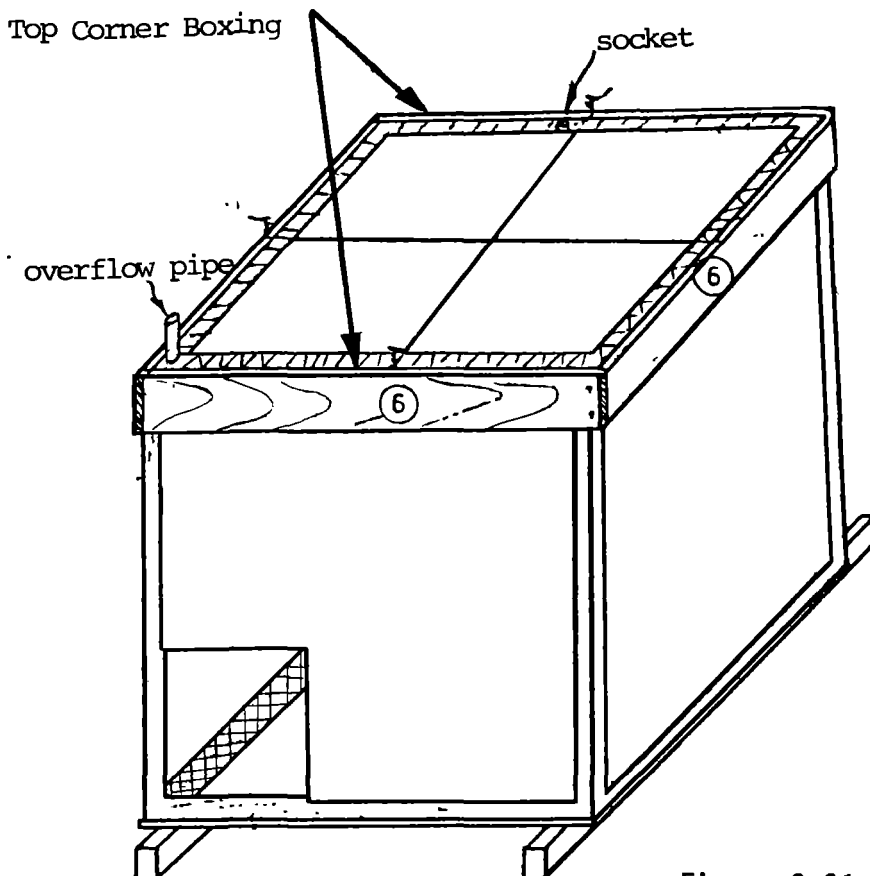


Figure 2.21.

17th Step: After 12 hours when the plastered mortar is well harden, all boxing boards are removed and any imperfections are patched using mortar mix with proportions of one part cement and one part sand.

18th Step: After at least another 70 hours, the tank can be turned over with the manhole side on the top and transported to the required place for use.



Illustrations 57 and 58: The tank is turned over after three days on a pallet for convenient transportation to the site of utilization.

COOK ISLANDS' MODULAR WATER TANKS

PART 3.

CONSTRUCTION OF MULTI-COMPONENT STRUCTURES

NOTE: IN THIS PART ALL DIMENSIONS ARE IN MM EXCEPT AS OTHERWISE STATED

3. CONSTRUCTION OF LARGER CAPACITY WATER TANKS USING STANDARD MODULAR SERIES UNIT COMPONENTS

Water tanks of larger capacity can be constructed with standard modular components to satisfy different requirements for capacity, space and function.

Three structural design systems were developed utilizing the standard series for construction of multi-component water tanks:

- Rectangular System

The unit modules are positioned side by side to form rectangular shaped tanks of various sizes. Standard Manhole Panels are used to form the inner structural skeleton for joining the wall panels to the top and bottom panels :

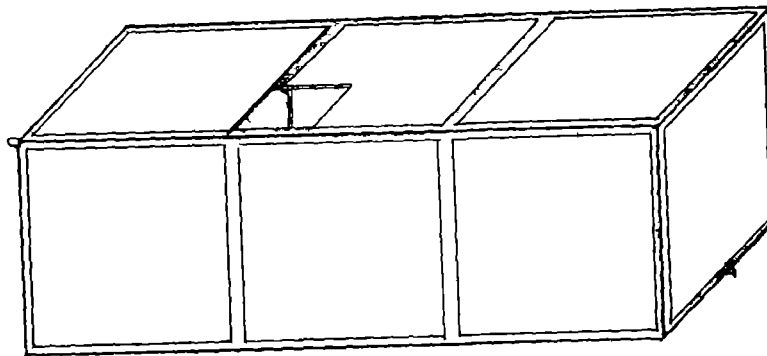


Figure 3.1.

- Cross System

The cross shaped multi - modular water tanks are constructed using the structural skeleton of five or more modular units. The standard modular braces, together with the corner joints

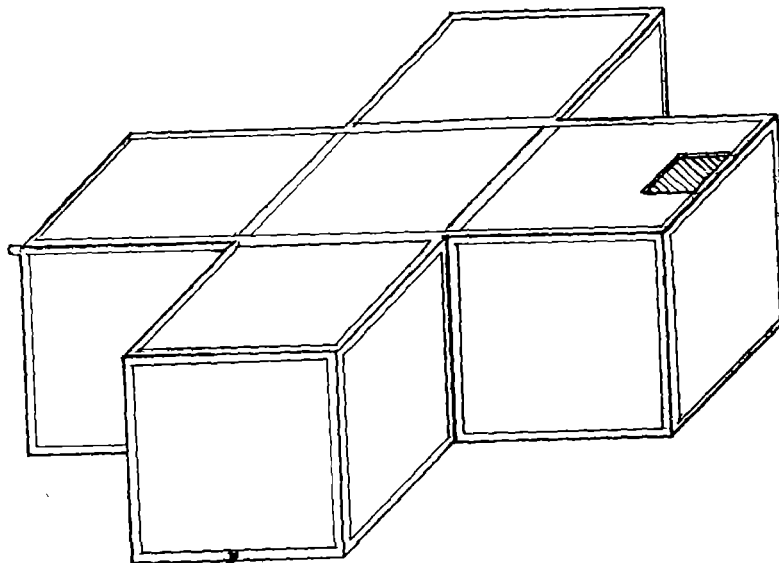


Figure 3.2.

are used to bind the standard panels into one structure. Although the construction of this system requires a larger area, it is cheaper because less total panels are required.

Open Rectangular System

This modular system is suitable for the construction of open storage tanks, pools, slow sand filters, etc.

The triangular components of half standard panels are used for the construction of the structural skeleton and in combination with corner and T-joints, binds together the wall and floor standard panels into one tank.

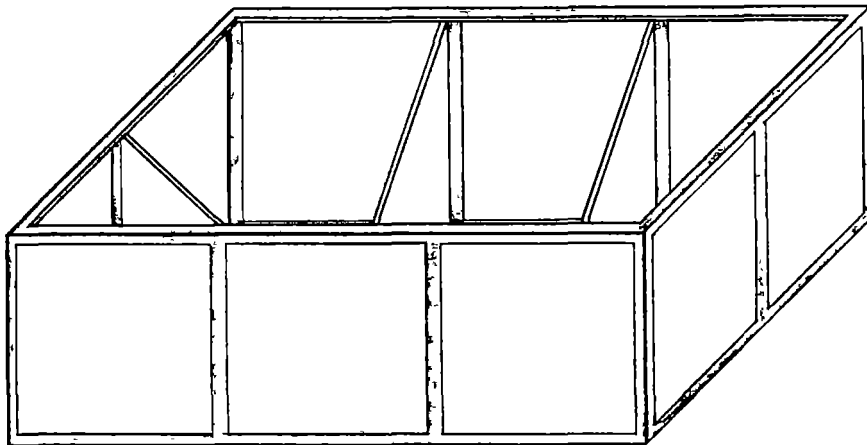


Figure 3.3.

3.1. Modular Standard Brace

The modular brace is an essential structural component for the construction of some multi-component modular systems. It plays an important role in the construction of cross system water tanks, replacing structurally required beams and columns, and serves as a convenient skeleton for assembling and joining the standard wall panels to the top and floor panels.



Illustration 59: Modular brace.

The brace is reinforced in one direction longitudinally with five H.T. Wires \varnothing 2.0mm diameter. The reinforcing wires stick out from both sides for finger joining with the other components. The standard modular brace has the following dimensions:

		a) <u>As-series</u>	b) <u>Al-series</u>
Length	(l)	1,200mm (47")	1,650mm (65")
Width	(w)	125mm (5")	125mm (5")
Thickness	(t)	20mm (3/4")	16mm (5/8")

Modular Brace

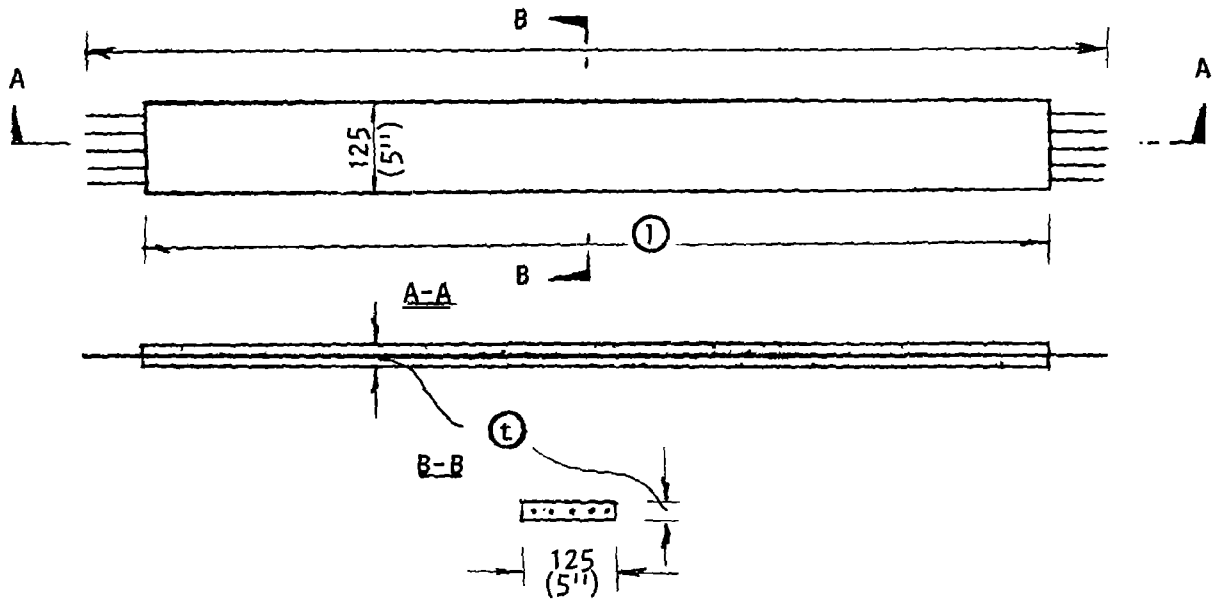


Figure 3.4.

Two methods are developed for producing the standard brace using the same mould as for the standard modular panel:

- 3.1.1. - by casting normal sizes panels reinforced only in one direction and after three days curing, cut them into stripes 150mm (5") wide parallel to the reinforcement by circular handsaw with masonry blade;

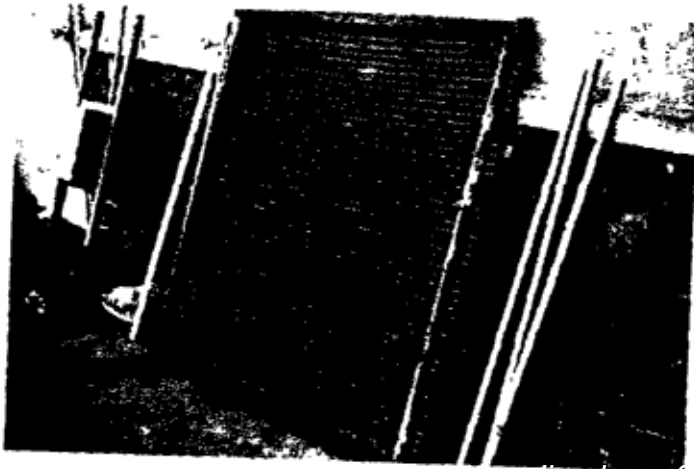


Illustration 60: Mould reinforced in one direction for casting of modular braces.

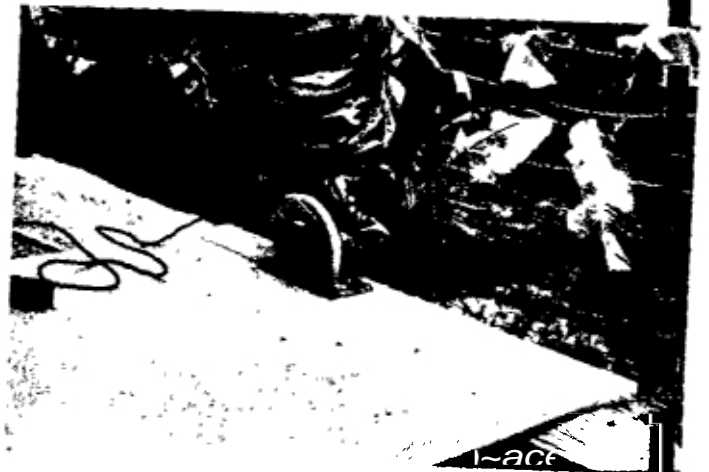


Illustration 61: Cut off braces with circular saw

3.1.2. by placing the reinforcement in the mould also in one direction but in the place of every sixth reinforcing wire insert a 25mm x 20mm (1" x 3/4") separator of timber, steel or plastic. The braces are removed from the mould 24 hours after casting.

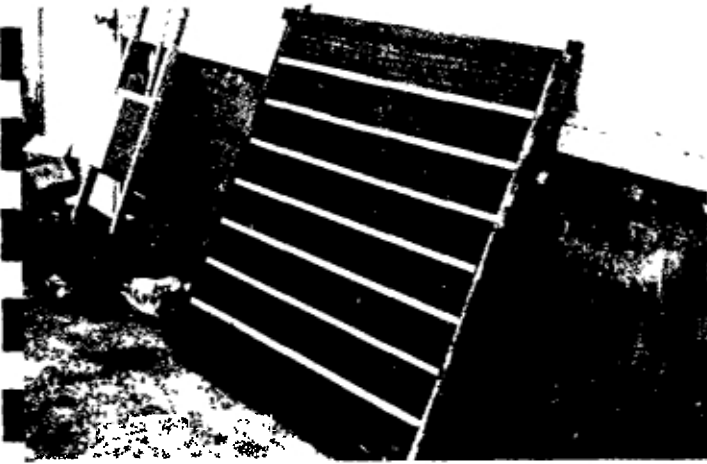


Illustration 62: As-series mould with separators reinforced for casting of braces.



Illustration 63: Al-series mould with separators reinforced for casting of braces.

3.2. Rectangular-Half Standard Panel

In the construction of water tanks, the rectangular-half standard panel is used in combination with other components to satisfy certain functional and capacity requirements. It is very useful, particularly in constructing the upper structure of two storey header tanks (Fig. 3.18.).

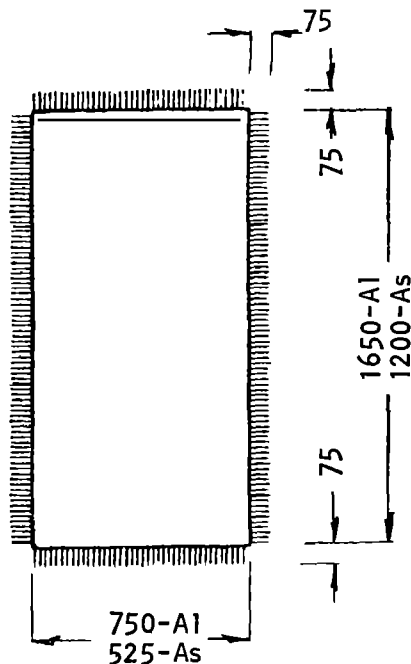


Figure 3.5.

3.2.1. The rectangular-half panel is two directionally reinforced with \varnothing 2.0mm diameter H.T. Wires in 25mm (1") spacing. The reinforcing wires protrude 75mm (3") all around the edges for finger joining with other components. The structural dimensions are as follows :

	a) <u>As-series</u>	b) <u>A1-series</u>
Length	1,200mm (47")	1,650mm (65")
Width	525mm (20½")	750mm (29½")
Thickness	20mm (¾")	16mm (5/8")

3.2.2. The method for production of the rectangular-half panel is similar to that used for casting of modular brace using the mould for standard panels, but the reinforcement placed in two directions and with only one separator 150mm (6") wide used and positioned in the middle of the mould. The separator is provided with slots at 25mm (1") spacing through which pass the reinforcing wires.

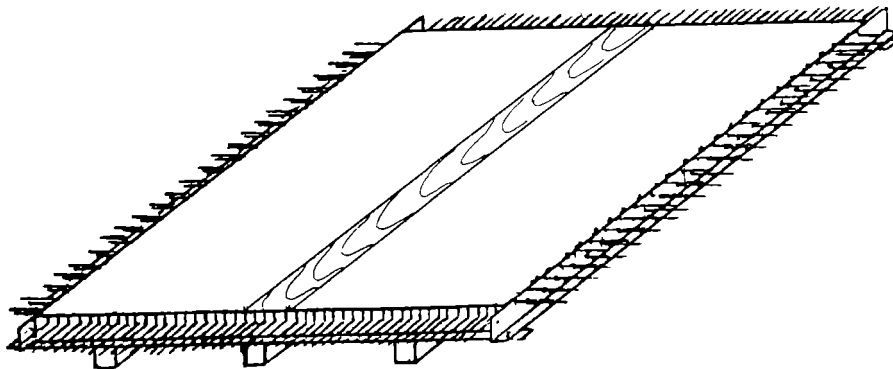


Figure 3.6.

3.3. Quarter Standard Panel

Another component which is usually used in combination with the rectangular-half panel for the construction of certain multi-component structures is the Quarter Standard Panel.

3.3.1. The quarter panel is two directionally reinforced with 2.0mm diameter H.T. Wires in 25mm (1") spacing. The reinforcing stick out 75mm (3") all around the edges for finger joining with other components. The structural dimensions are as follows:

	a) <u>As-series</u>	b) <u>A1-series</u>
Length	525mm (20½")	750mm (29½")
Width	525mm (20½")	750mm (29½")
Thickness	20mm (¾")	16mm (5/8")

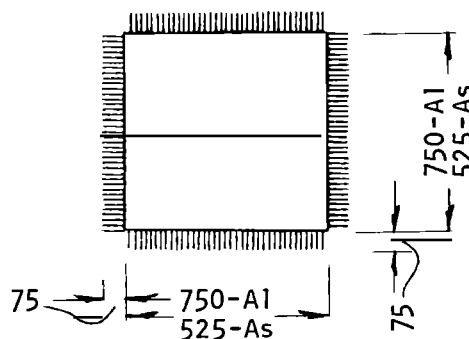


Figure 3.7.

3.3.2. The method for production of quarter panels is the same as described under 3.2. using the mould for standard panels, but with additional separators provided at right angles to the separator used for half-panels (Fig. 3.8.). The additional separators are also provided with slots at 25mm (1") spacing through which pass the reinforcing wires.

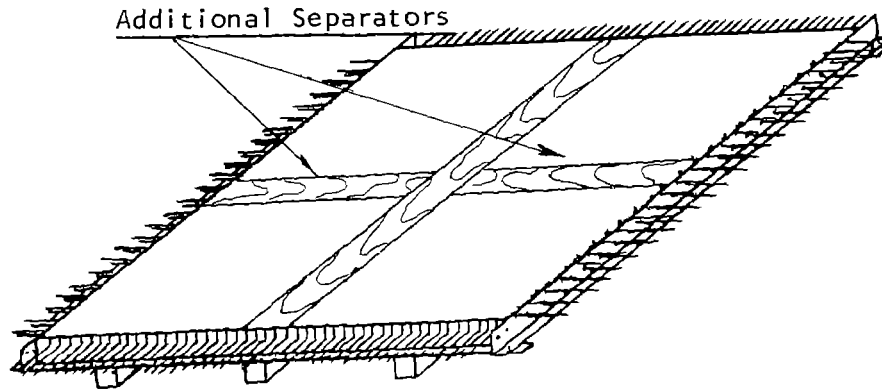


Figure 3.8.

3.4. Triangular-Half Standard Panel

In the construction of Open Rectangular System Water Tanks, Triangular Panels play an essential part in the formation of the structural skeleton.

3.4.1. The triangular panel is two directionally reinforced with \varnothing 2.0mm diameter H.T. Wires at 25mm (1") spacing. The reinforcing wires protrude 75mm (3") on the two right angle edges for finger joining with the wall and floor standard panels. The structural dimensions are as follows :

	a) <u>As-series</u>	b) <u>Al-series</u>
Sides	1,200mm (47")	1,650mm (65")
Thickness	20mm (3/4")	16mm (5/8")

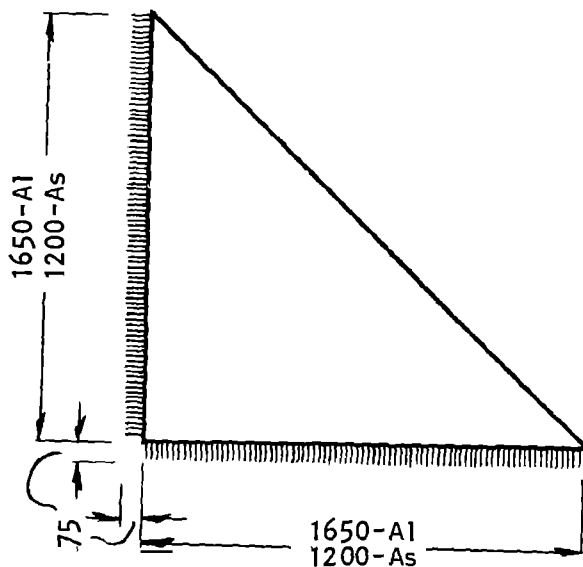


Figure 3.9.

3.4.2. Two methods are developed for producing the triangular panel, using the same mould as for the standard modular panel.

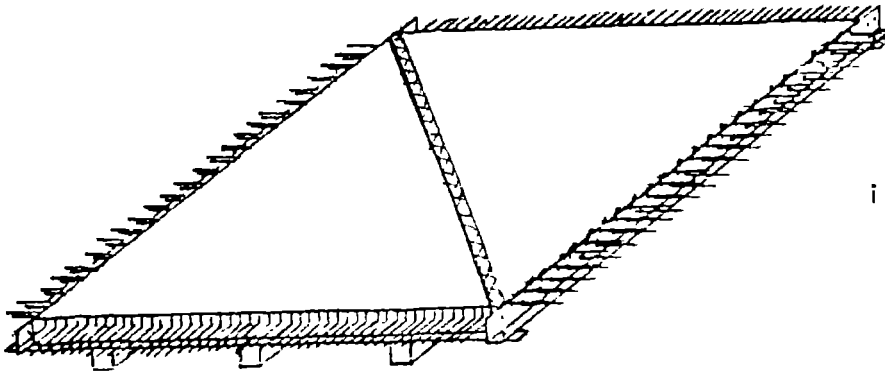


Figure 3.10.

- i) by casting a normal standard panel and after three days of curing, cutting the panel in two halves diagonally using a circular saw with a masonry blade;
- ii) by using separator, 25mm (1") wide, placed diagonally in the mould before placing the fibrous cement mortar. The panel is removed after 24 hours and the connecting wires cut to form the two triangular panels. As in the former methods the separator is provided with slots through which the reinforcing wires may pass.

3.5. Modular Joints

The joints are an essential part of the modular design for the formation of the structural skeleton, as well as in the construction of component elements for joining the modular units to one system.

Construction of good quality joints is a primary necessity for the successful performance of the modular structure. Although not much skill is needed, attention in the performance is required in order to achieve smooth water tight joints.

3.5.1. Corner Joints

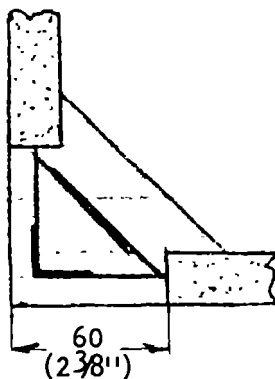


Figure 3.11.

The Corner Joint is required for the construction of the corner between two panels. The fingering of the panels are positioned and the fibrous mortar is introduced as described in Sections 1.4. and 2.4. It is an essential component included in all structures of both the rectangular and cross system design of the As and A1 series.

3.5.2. T-Joint

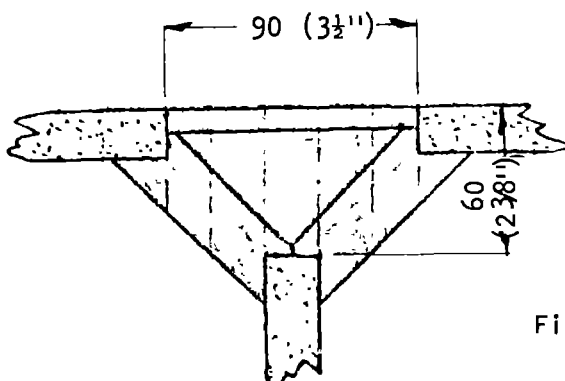


Figure 3.12.

The T-joint is required for the construction of the connection between three panels. It is included in the construction of all multi-modular rectangular system design and plays an important role in the formation of the structural skeleton.

3.5.3. Cross-Joints

The Cross-joint is used for binding together four panels into one structure. It is included in the construction of the four and six modular units tank of the rectangular modular system design and has an important task serving as a central column in the structure.

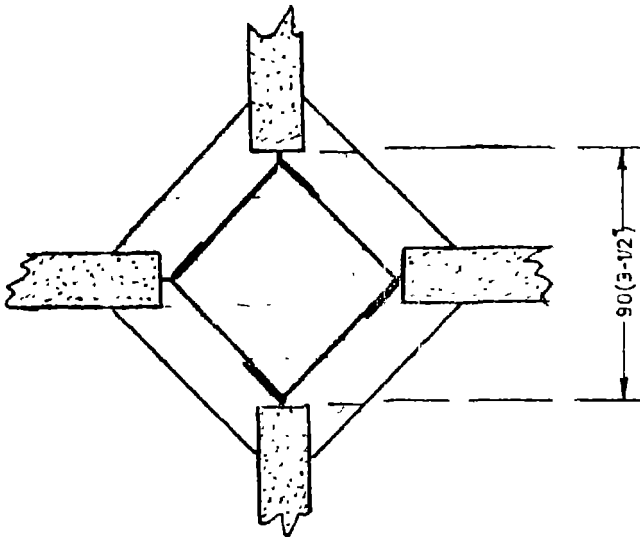


Figure 3.13.

3.5.4. Brace Joint

The Brace joint is composed of two components :

- a) A standard modular brace and
 - b) fibrous mortar plastered section, longitudinally reinforced.
- In the formation of the tank structure, it plays a dual role: to establish a water tight connection between two adjacent panels, as well as to form a structural element (beam or column) in the modular structure. It is used mainly in the construction of the cross modular system, but could be used also in the rectangular design for replacing some of the internal panels.

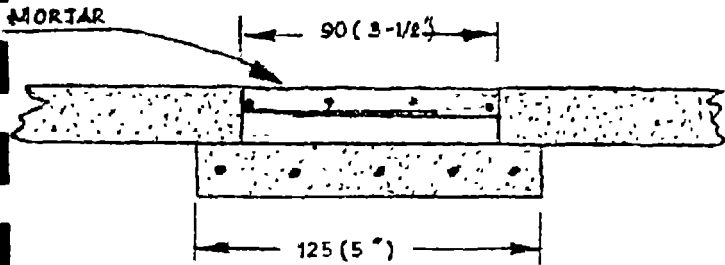


Figure 3.14.

3.5.5. Column Joint

The Column joint is composed of two standard modular braces jointed together as a sandwich with fibrous cement mortar. It is used mainly in the cross modular system design for the formation of an internal vertical support of the structure. In the rectangular modular system it can also be used for replacing the required Cross joints.

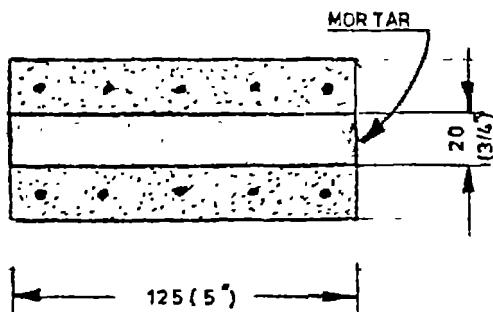


Figure 3.15.

3.5.6. Flat Joint

The flat joint is used in both rectangular and cross modular system designs for joining the base panels to insure the construction of a strong, water tight water tank bottom. It is composed of fibrous cement mortar plaster longitudinally reinforced with four H.T. Wires placed on the fingering between two panels.

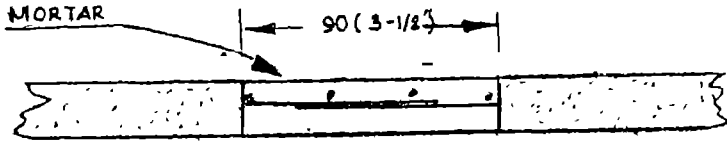


Figure 3.16.

3.6. Rectangular Modular System Designs

3.6.1. Single Unit Modular Tank

- (i) As series (As-1), capacity 2050 litres (450 Imp.gallons)
- (ii) Al-series (Al-1), capacity 5000 litres (1100 Imp.gallons)

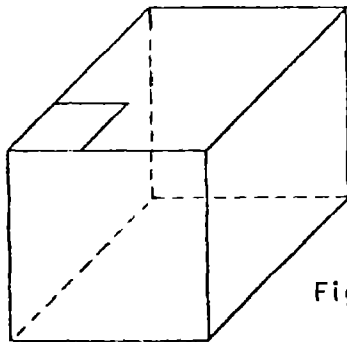


Figure 3.17.

Component Elements

- Standard Panels	- 5
- Manhole Panel	- 1
- Corner Joints	- 12

3.6.2. One and One-Quarter Unit Modular Tank

- (i) As series (As-1 $\frac{1}{4}$), capacity 2560 litres (560 Imp.gallons)
- (ii) Al series (Al-1 $\frac{1}{4}$), capacity 6250 litres (1370 Imp.gallons)

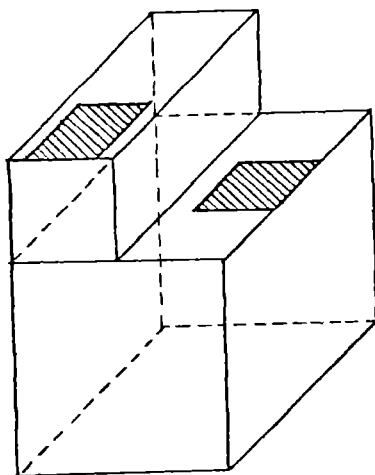


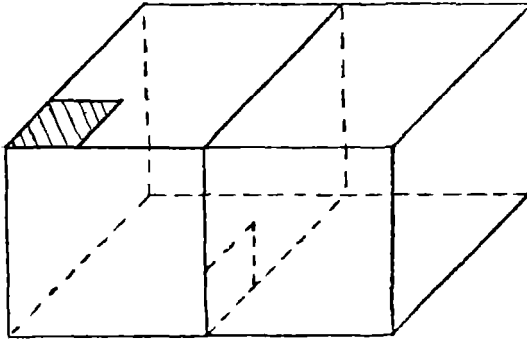
Figure 3.18.

Component Elements

- Standard Panels	- 5
- Manhole Panels	- 1
- Rectangular Half Panels	- 2
- Half Manhole Panels	- 1
- Quarter Panels	- 2
- Corner Joints	- 15
- T-Joints	- 2
- Half Corner Joints	- 6

3.6.3. Two Unit Modular Tank

- (i) As-series (As-2), capacity 4100 litres (900 Imp.gals)
- (ii) A1-series (A1-2), capacity 10000 litres (2200 Imp.gals)



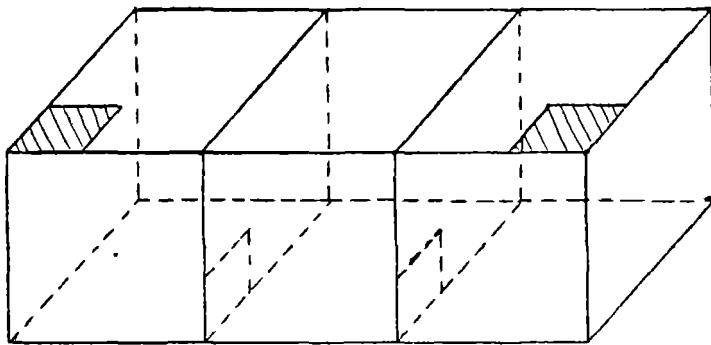
Component Elements

- Standard Panels - 9
- Manhole Panels - 2
- Corner Joints - 16
- T-Joints - 4

Figure 3.19.

3.6.4. Three Units Modular Tank

- (i) As-series (As-3), capacity 6150 litres (1350 Imp. gals)
- (ii) A1-series (A1-3), capacity 15000 litres (3300 Imp. gals)



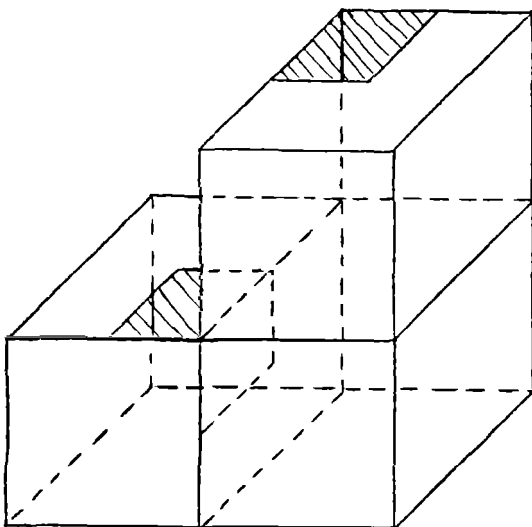
Component Elements

- Standard Panels - 12
- Manhole Panels - 4
- Corner Joints - 20
- T-Joints - 8

Figure 3.20

3.6.5. Three Unit Two Storey Modular Tank

- (i) As-series (As-3'') capacity 6150 litres (1350 Imp.gals)
- (ii) A1-series (A1-3'') capacity 15000 litres (3300 Imp.gals)



Component Elements

- Standard Panels - 13
- Manhole Panels - 3
- Corner Joints - 20
- T-Joints - 6
- Cross Joints - 1

Figure 3.21.



Illustration 64



Illustration 65

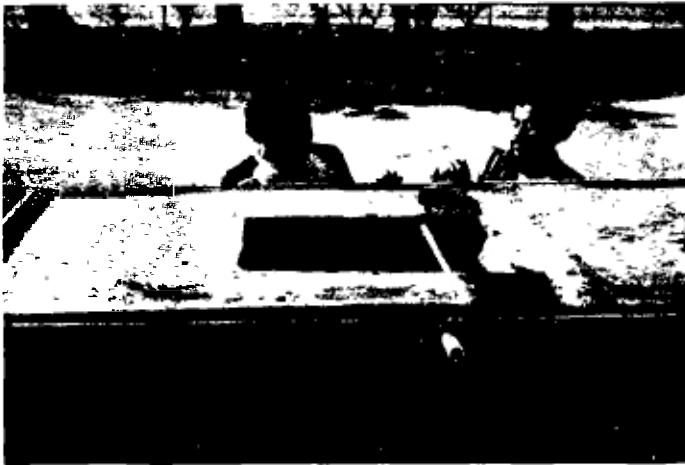


Illustration 66

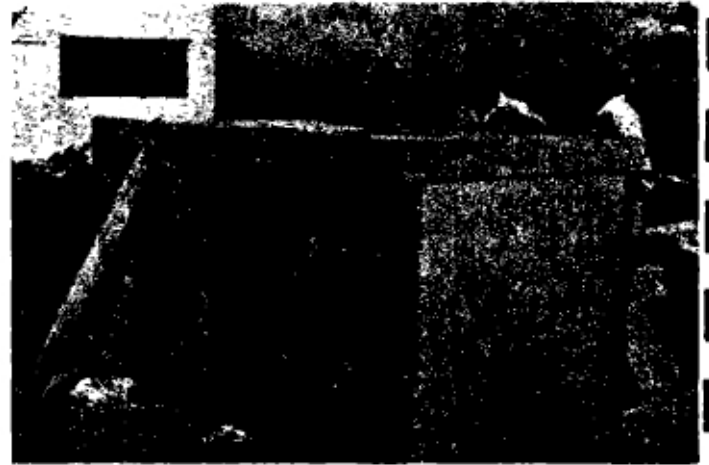
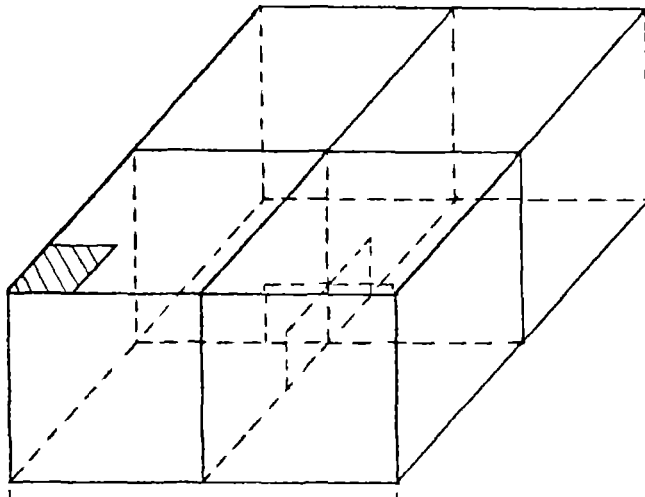


Illustration 67

Illustrations 64, 65, 66 and 67: Different stages of the construction of the As-2 Water Tank, 4100 litres (900 Imp. gallons) capacity.

3.6.6. Four Units Modular Tank

- (i) As-series (As-4) capacity 8200 litres (1800 Imp. gals)
- (ii) Al-series (Al-4) capacity 20000 litres (4400 Imp. gals)



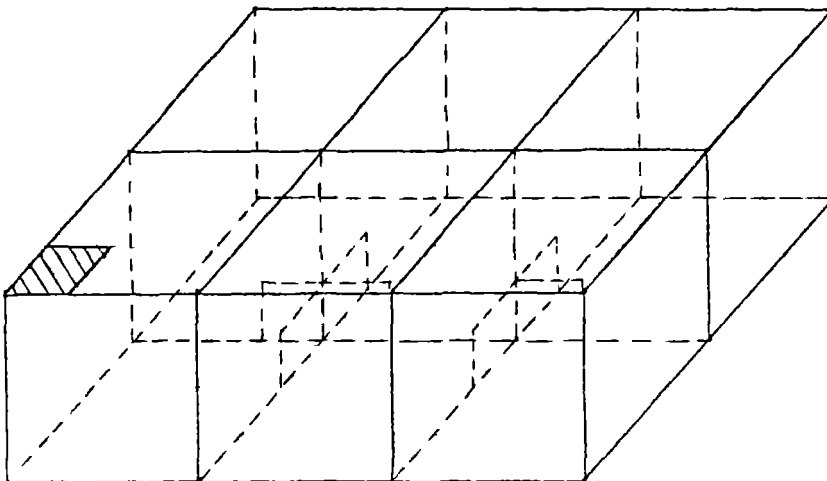
Component Elements

- Standard Panels - 15
- Manhole Panels - 5
- Corner Joints - 20
- T-Joints - 12
- Cross Joints - 1

Figure 3.22.

3.6.7. Six Units Modular Tank

- (i) As-series (As-6) capacity 12300 litres (2700 Imp.gals)
- (ii) AL-series (Al-6) capacity 30000 litres (6600 Imp.gals)



Component Elements

- Standard Panels - 21
- Manhole Panels - 8
- Corner Joints - 20
- T-Joints - 20
- Cross Joints - 2

Figure 3.23.

3.6.8. Eight Units Modular Tank

- (i) As-series (As-8) capacity 16400 litres (3600 Imp.gals)
- (ii) Al-series (Al-8) capacity 40000 litres (8800 Imp.gals)

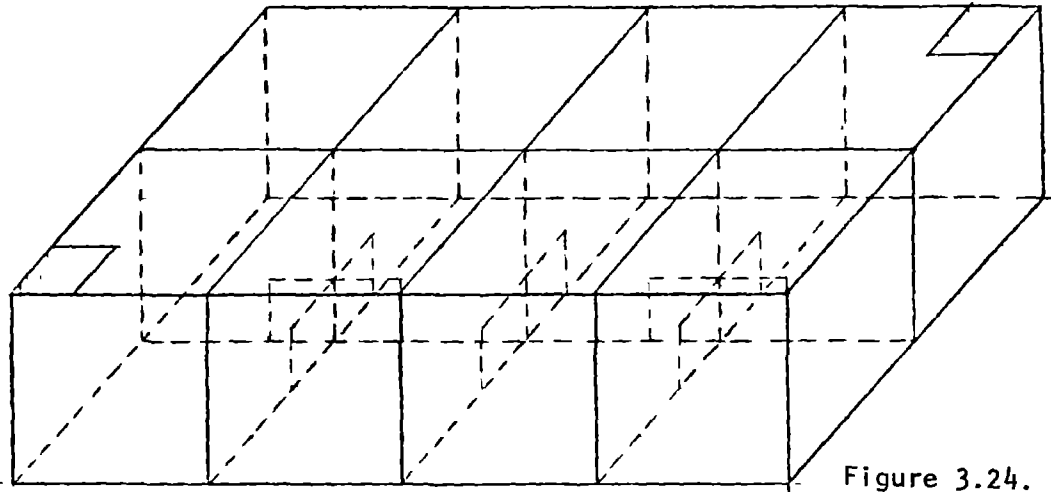


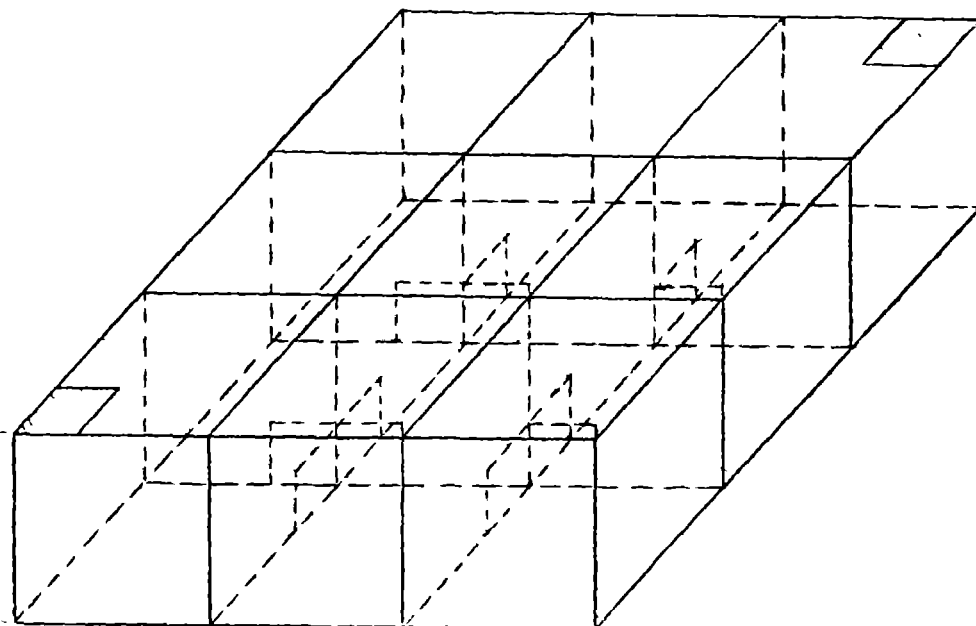
Figure 3.24.

Component Elements

- Standar Panels	- 22
- Manhole Panels	- 12
- Corner Joints	- 24
- T-Joints	- 24
- Cross Joints	- 3

3.6.9. Nine Units Modular Tank

- (i) As-series (As-9) capacity 18450 litres (4050 Imp.gals)
- (ii) Al-series (Al-9) capacity 45000 litres (9900 Imp.gals)



Component Elements

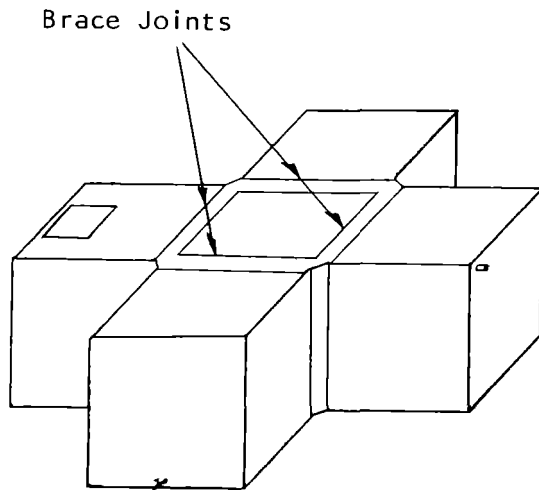
- Standard Panels	- 26
- Manhole Panels	- 14
- Corner Joints	- 28
- T-Joints	- 32
- Cross Joints	- 4

Figure 3.25.

3.7. Cross Modular System Designs

3.7.1. Five Unit Modular Tank

- (i) As-series (As-5) capacity 10250 litres (2250 Imp gals)
- (ii) Al-series (Al-5) capacity 25000 litres (5500 Imp.gals)



Component Elements

- Standard Panels	-	21
- Manhole Panels	-	1
- Brace Joints	-	4
- Flat Joints	-	4
- Corner Joints	-	36

Figure 3.26.

3.7.2. Nine Unit Modular Tank

- (i) As-series (As-9) capacity 18450 litres (4050 Imp.gals)
- (ii) Al-series (Al-9) capacity 45000 litres (9900 Imp.gals)

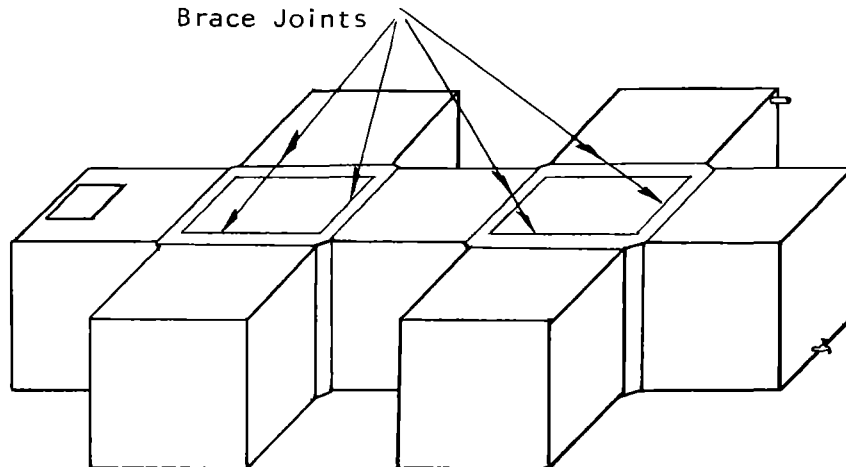


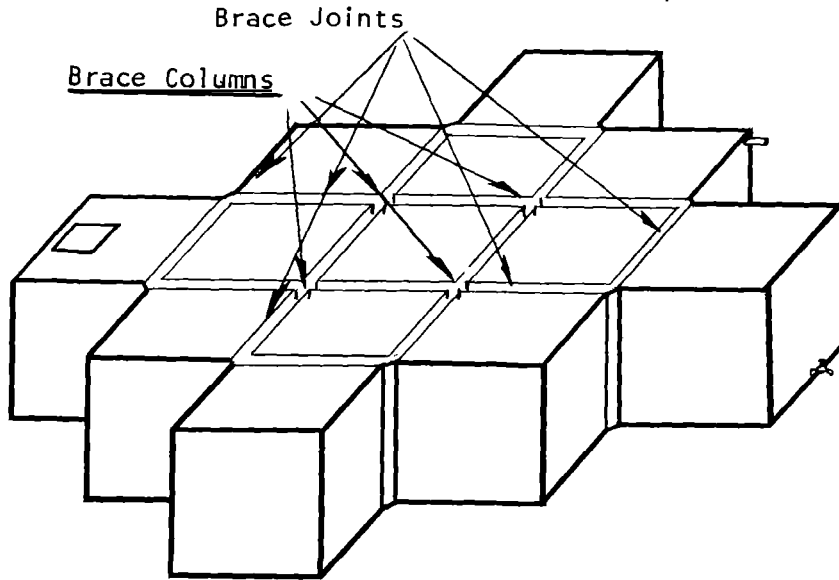
Figure 3.27.

Component Elements

- Standard Panels	-	37
- Manhole Panels	-	1
- Brace Joints	-	8
- Flat Joints	-	8
- Corner Joints	-	60

3. 3.7.3. Thirteen Unit Modular Tank

- (i) As-series (As-13) capacity 26650 Litres (5850 Imp gals)
- (ii) Al-series (Al-13) capacity 65000 Litres (14300 Imp gals)



Component Elements

- Standard Panels - 45
- Manhole Panels - 1
- Brace Columns - 4
- Brace Joints - 16
- Flat Joints - 16
- Corner Joints - 60

Figure 3.28.

3.7.4. Twenty five Unit Modular Tank

- (i) As-series (As-25) capacity 51250 Litres (11250 Imp gals)
- (ii) Al-series (Al-25) capacity 125000 Litres (27500 Imp gals)

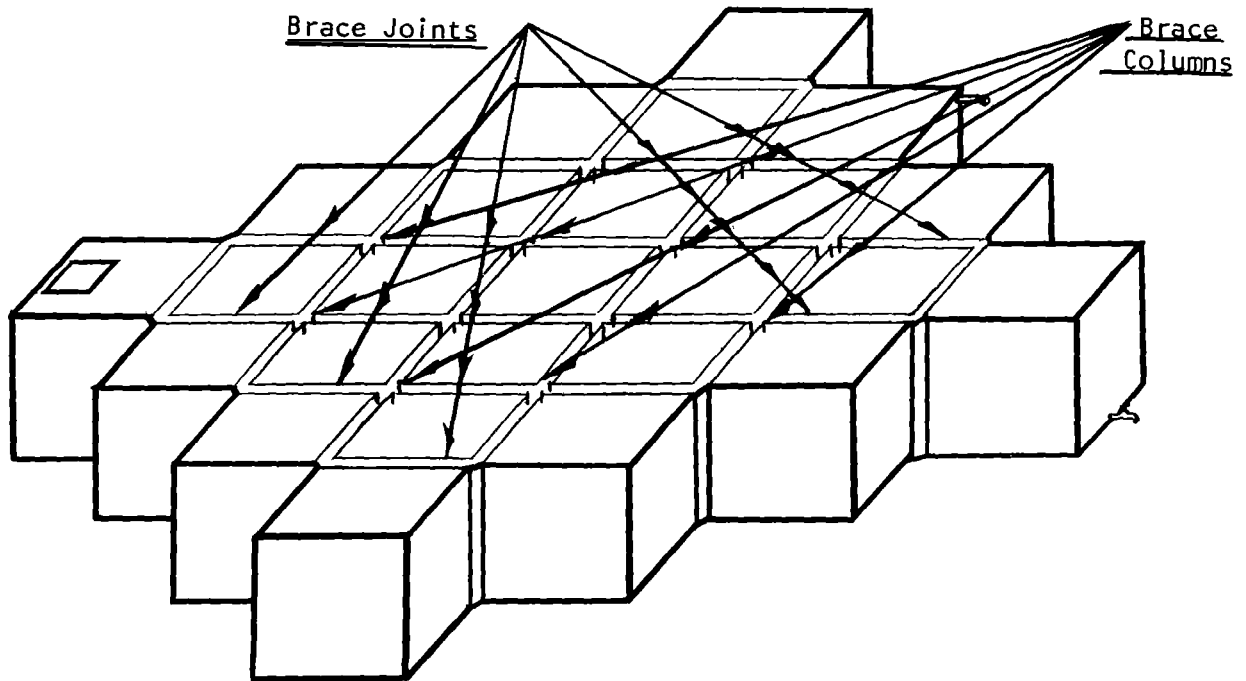


Figure 3.29.

Component Elements

- Standard Panels - 77
- Manhole Panels - 1
- Brace Columns - 12
- Brace Joints - 36
- Flat Joints - 36
- Corner Joints - 84

3.8. Open Rectangular System

3.8.1. Four Units Open Tank

- (i) As-series (Rs-4) capacity 7300 litres (1600 Imp gals)
- (ii) Al-series (R1-4) capacity 18200 litres (4000 Imp gals)

Component Elements

- Standard Panels - 12
- Triangular Panels - 4
- Corner Joints - 20
- T-Joints - 8

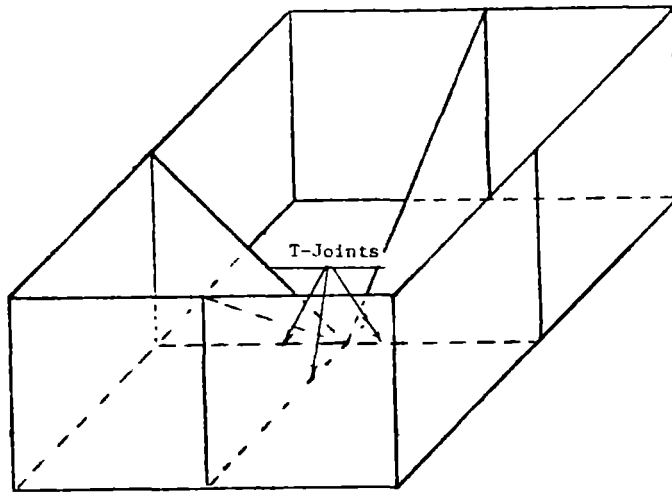


Figure 3.30.

3.8.2. Six Units Open Tank

- (i) As-series (Rs-6) capacity 9700 litres (2400 Imp gals)
- (ii) Al-series (Rs-6) capacity 27300 litres (6000 Imp gals)

Component Elements

- Standard Panels - 16
- Triangular Panels - 6
- Corner Joints - 24
- T-Joints - 12
- Flat Joints - 1

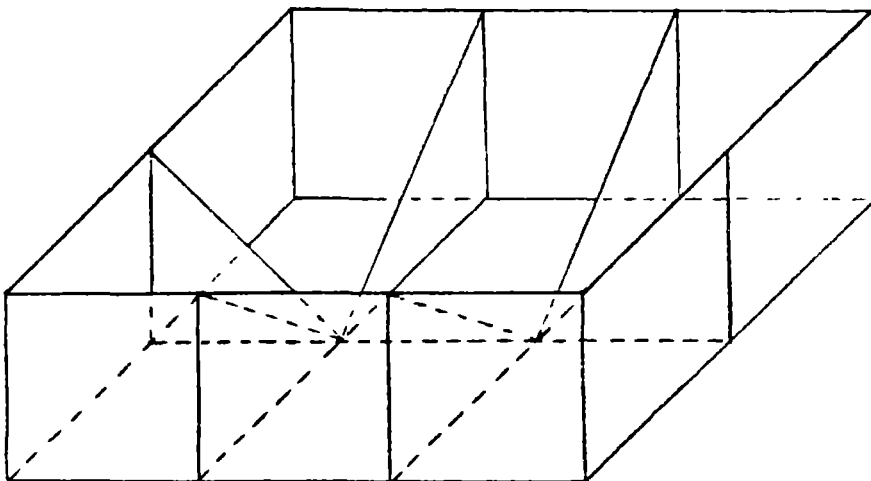


Figure 3.31.

3.8.3. Nine Units Open Tanks

- (i) As-series (Rs-9) capacity 10900 litres (2400 Imp gals)
- (ii) Al-series (R1-9) capacity 40950 litres (9000 Imp gals)

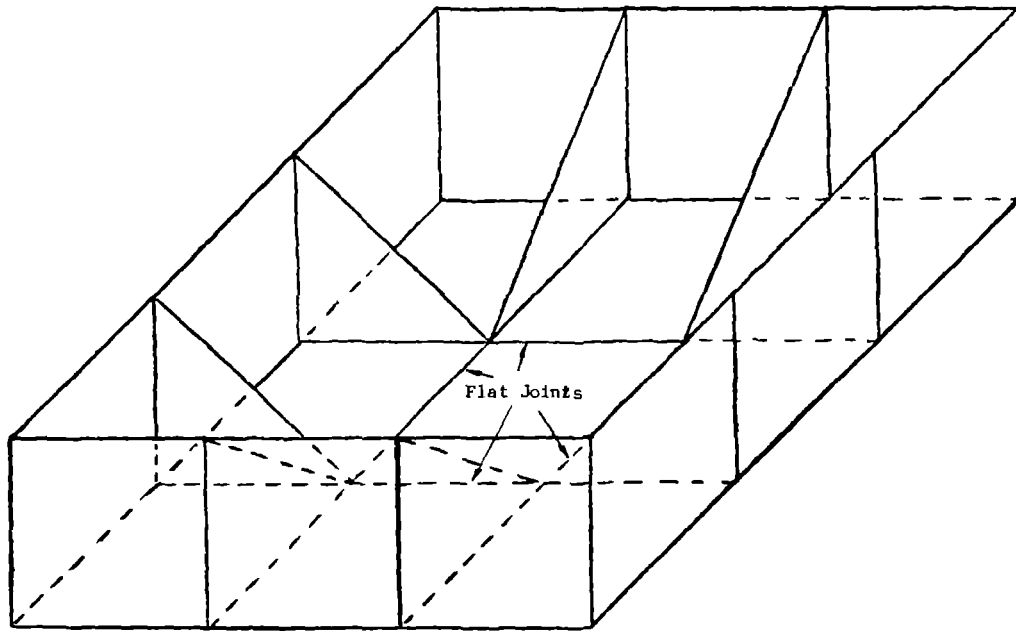


Figure 3.32.

Component Elements

- Standard Panels	-	21
- Triangular Panels	-	8
- Corner Joints	-	28
- T-Joints	-	16
- Flat Joints	-	4

3.9. Assembly of Multi-Component Water Tanks

The procedures for assembling of multi-component modular tanks are principally similar to those described under 1.4. and 2.4. However, a few additional hints are recommended:

- 3.9.1. The assembly of the larger tanks must be done at the utilization site and on a levelled flat platform constructed from cemented cobblestones.
- 3.9.2. All bottom panels are placed on the surface in accordance with the selected construction design.

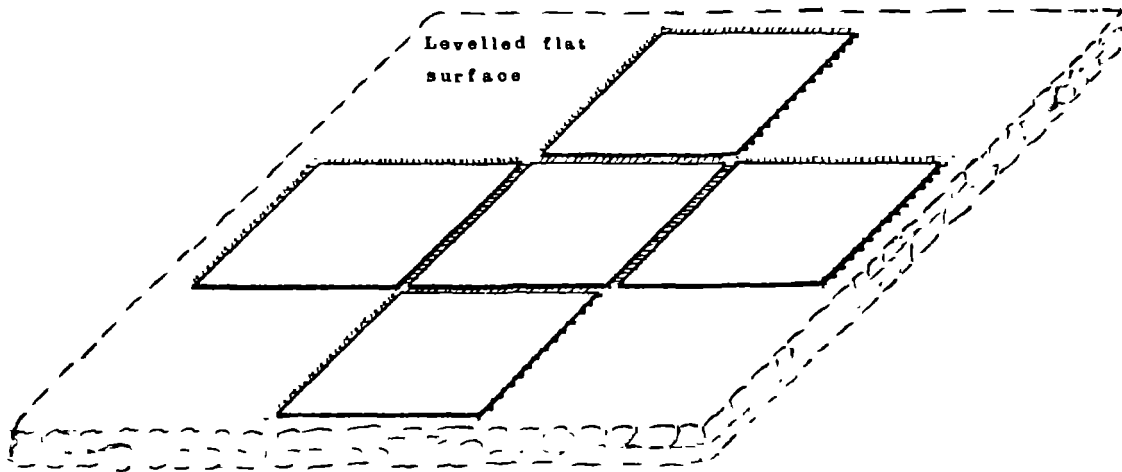


Figure 3.33.

- 3.9.3 The walls of the two opposite sides are erected first, using the standard top-boxing to adjust the panels into position, following which the corners are plastered with mortar.

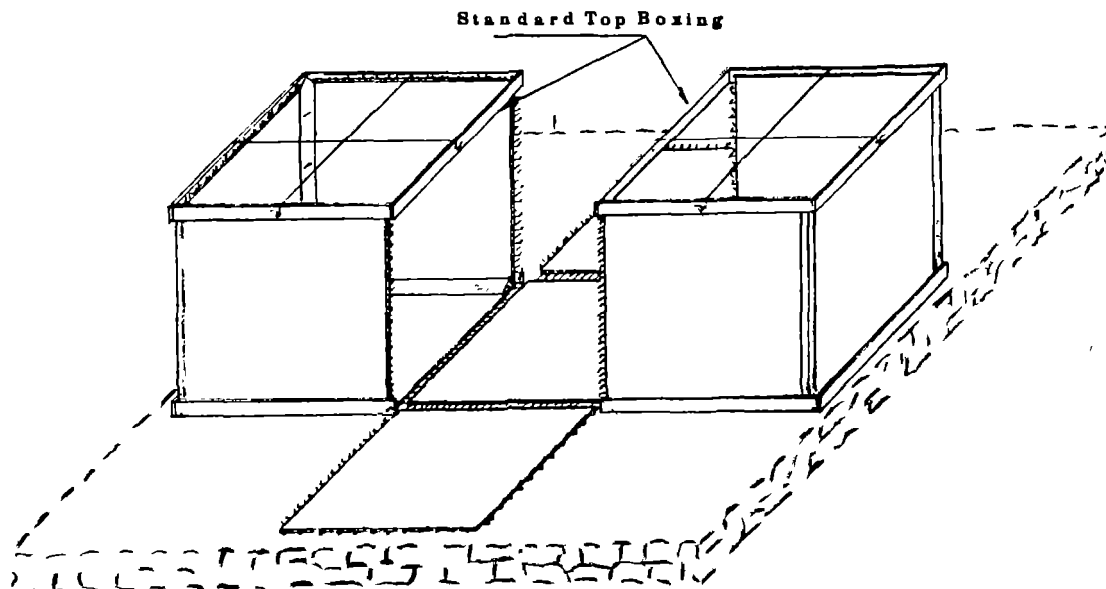


Figure 3.34.

3.9.4. All but one of the remaining wall panels are then erected and the corners and flat joints plastered with mortar. It is convenient for access during assembly of the tank top to leave one of the side panels to be erected last.

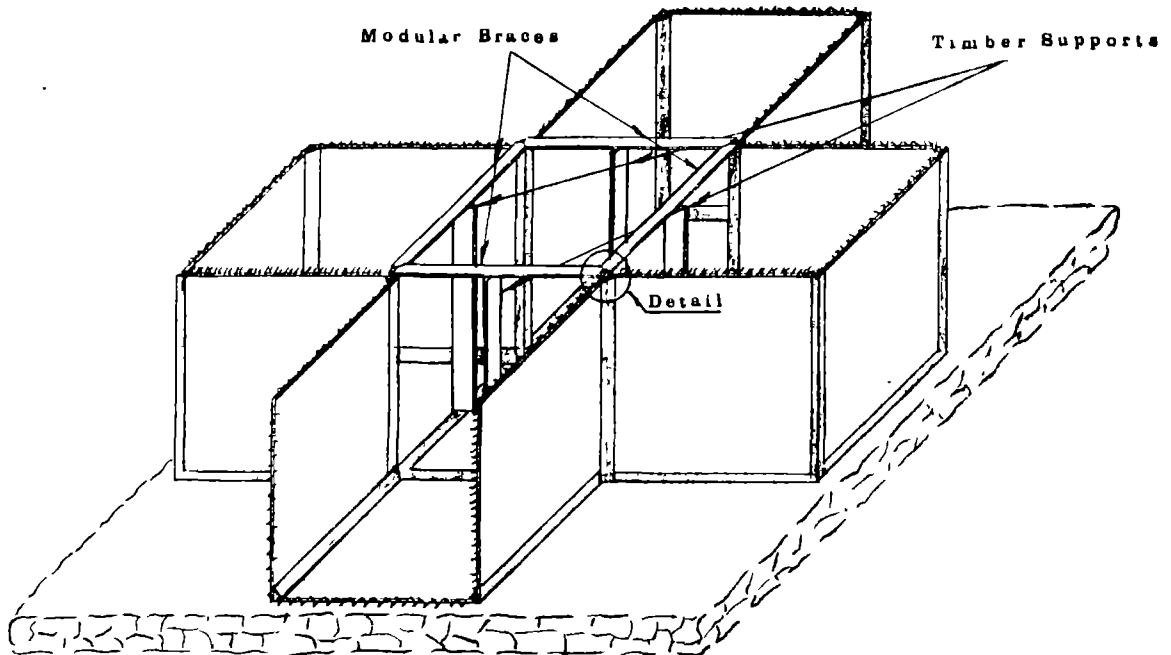


Figure 3.35.

3.9.5. 16 hours later the construction of the tank is continued with the installation of the Modular Braces supported from below with timber and fixed into position by tying the fingering wires to the inside corners.

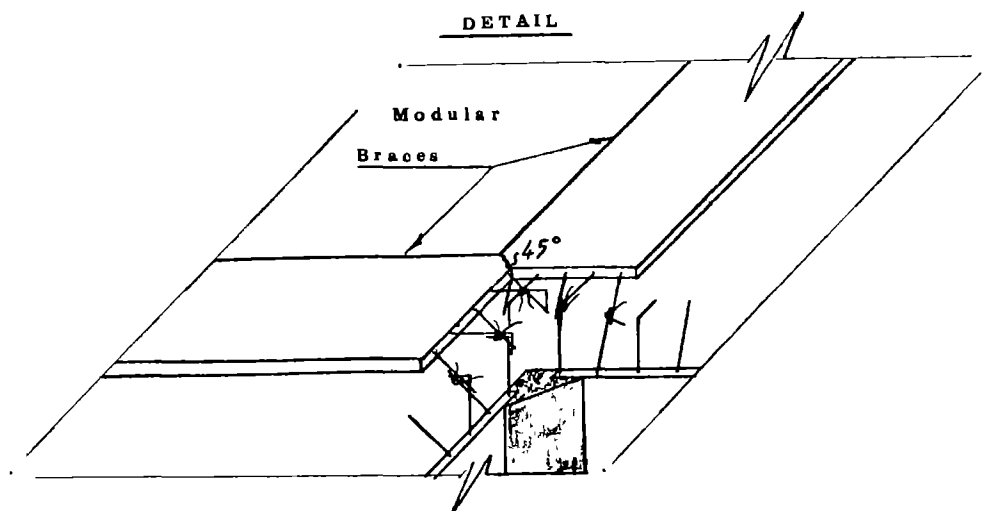


Figure 3.36.

- 3.9.6. In order to ensure proper seating of the top panels and formation of the brace joints, the internal corners of the braces are chipped out at 45° to the fingering wires.

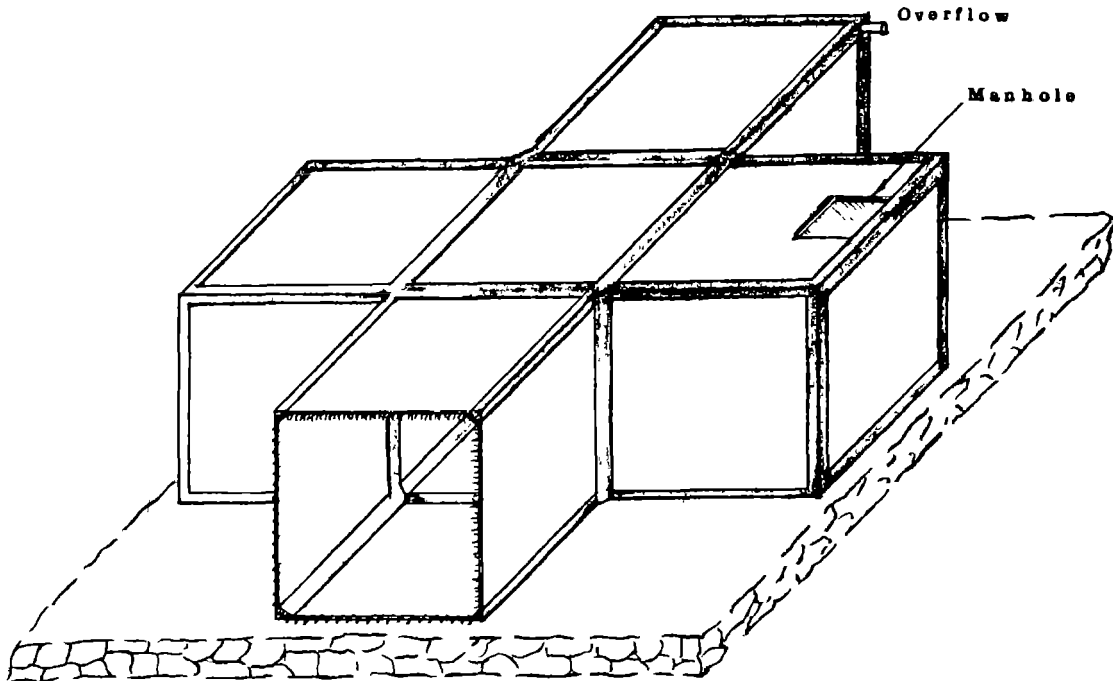


Figure 3.37

- 3.9.7. Prior to the installation of the top panels, corner spacing bars are placed on the external corners, which are removed after binding of the fingering wires with tie wire.
- 3.9.8. The corner forms are fixed from the inside to each horizontal corner, top-boxing fixed from outside and then all joints are plastered in the usual manner.

4. TANK REPAIR PROCEDURE

Two types of repair may be required in the case of damage to the tanks.

4.1. Cracking due to impact and minor shattering. No damage to fabric. Repairs are undertaken as follows :

4.1.1. For Shattering:

(i) Mix a mortar of:

1.0 of sand,
1.0 of cement,
0.45 of water
to a trowelling consistency

(ii) Clean up area and remove loose debris.
Straighten if necessary.

(iii) Trowel on the mortar and finish the surface.

4.1.2. For Cracking:

(i) Chip out the line of crack with a cold chisel
or scrape it out with a sharp blade instrument.

(ii) Fill the crack with an epoxy resin cement. These
repair kits are almost universally obtainable at
hardware stores.

4.2. Pierced and holed tanks with fabric damaged.

4.2.1. Mix mortar as for modular joints .

4.2.2. Pulverize the area of damage to free the wires from the
concrete until a clean looking area is obtained, in which
the intact perimeter wire is uncovered.

4.2.3. Straighten up the reinforcement as well as possible and then
tie on new bridging reinforcement or tie in two pieces of mesh.

4.2.4. Paste the edges of the old concrete with a neat cement wash:
1.0 to 1.0 of cement and water to make a liquid paste.

4.2.5. Mortar the area to complete the repair. A back up piece of
plywood can be used if practical.

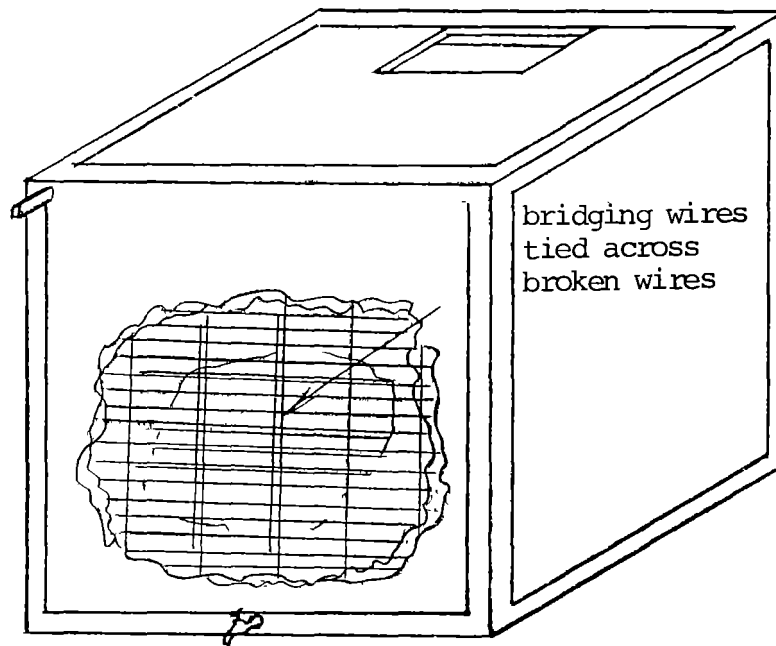


Figure 4.1.

4.3. Internal Porosity

After mortaring some porosity may be found on the interior surfaces at the mould interface. If these are small, they may be filled by 'bag' washing the surface which is done by rubbing in a neat cement mortar, using a piece of coarse hemp sacking.

For larger clusters of holes, filling should be done with the aid of a pointed trowel to work the cement into the holes.

M A T E R I A L S

Specifications, Quantities and Listing Suppliers

1. SPECIFICATIONS:

1.1. Steel Fibres

1.1.1. Size :

- 13mm ϕ x 0.25mm
- 14.5mm x 0.4mm x 0.3mm
- or - 18 mm x 0.4mm x 0.3mm
- 20 mm x 0.4mm x 0.3mm

1.1.2. Grade : Mild or H. T. Steel

1.1.3. Type : Enlarged or Twisted Ends

1.2. Reinforcing Wire

1.2.1. Size : ϕ 2.0 mm diameter

1.2.2. Grade : Bright phosphate coated hard drawn range 2, or galvanized or brass coated High Tensile Spring Quality Wire with an ultimate tensile strength of 1800 MPa.

1.2.3. Type : Straightened Pre-cut

- a) for fingering only: 300mm (12") pre-cut length
- b) for reinforced panels : 1800mm (71") pre-cut length.

2. LISTING OF SUPPLIERS

2.1. Australian Wire Industries Pty Ltd
P.O. Box 55
N. S. W. 2046
Australia

TELEX: AA 20767

2.2. Mitchell Fibercon Inc
9800 McKnight Road
Suite 250
Pittsburgh, P.A. 15237
U. S. A.

TELEPHONE : (412) 366-03-4

2.3. NOZAWA Corporation
Kyotomi Building
3-16 Sonezaki - Sinchi
1 - Chome, Kita-ku
Osaka
Japan

TELEX: 5234445

3.1. QUANTITIES OF MATERIALS REQUIRED FOR CONSTRUCTION
OF DIFFERENT MODULAR COMPONENTS AND SYSTEMS OF AS SERIES

Item No.	As Series System	Cement kg (lb)	Sand kg (lb)	Water litres(Imp- Gallon)	Steel Fibre kg (lb)	H.T. Wire kg(lb)
1.	<u>Components</u>					
1.1.	Standard panel	28(61)	56(122)	11.3(2.5)	5.36(12)	2.04(4.5)
1.2.	Manhole panel	21(46)	42(92)	8.5(1.8)	4(9)	1.68(3.8)
1.3.	Standard brace	2.45(5.4)	4.9(10.8)	0.98(0.22)	0.5(1.1)	0.12(0.26)
1.4.	Corner Joint	7(15.4)	14(30.8)	2.83(0.62)	1.34(3)	-
1.5	T-Joint	12.77(28.15)	25(56.3)	5.21(1.15)	2.35(5.2)	-
1.6	Cross Joint	22(48.5)	44(9.7)	9(2)	4(9)	-
1.7	Brace Joint	4.7(10.4)	9.4(20.8)	1.9(0.42)	0.97(2.14)	0.23(0.51)
1.8	Column Brace	7.35(16.2)	14.7(32.4)	2.94(0.65)	1.5(3.3)	0.25(0.55)
1.9	Flat Joint	2.25(5)	4.5(10)	0.92(0.2)	0.47(1)	0.10(0.22)
2.	<u>Rectangular Modular System</u>					
2.1.	One Unit Tank As-1	245(540)	490(1080)	93(21)	47(104)	12(27.5)
2.2.	Two Unit Tank As-2	449(990)	898(1980)	182(40)	85(187)	21(46.5)
2.3.	Three Unit Tank As-3	643(1417)	1286(2834)	260(57)	121(268)	31(68)
2.4.	Three Unit Two-storey Tank As-3/II	662(1460)	1324(2920)	268(59)	127(280)	31(68)
2.5.	Four Unit Tank As-4	824(1817)	1648(3634)	334(73)	156(343)	39(85)
2.6.	Six Unit Tank As-6	1178(2598)	2356(5196)	447(105)	223(492)	55(123)
3.	<u>Cross Modular System</u>					
3.1.	Five Unit Tank As-5	900 (1984)	1800 (3968)	364 (80)	171 (377)	64 (102)
3.2.	Nine Unit Tank As-9	1550 (3417)	3100 (6834)	628 (138)	288 (635)	79 (175)
3.3.	Thirteen Unit Tank As-13	1832 (4039)	3664(8078)	714 (157)	349 (769)	97 (214)
3.4.	Twenty Five Unit Tank As-25	3129 (6898)	6258 (13796)	1266(278)	599 (1232)	172(381)

3.2. MATERIALS REQUIRED FOR CONSTRUCTION OF
DIFFERENT MODULAR COMPONENTS OF AL-SERIES

Item No.	Al Components	Cement kg (lb)	Sand kg (lb)	Water litres (Imp. gallon)	Steel Fibre kg (lb)	H.T. Wire kg (lb)
1	Standard panel	40 (88.18)	80 (176.36)	16 (3.5)	7.6 (16.75)	6 (13.5)
2	Manhole panel	34.78 (76.68)	69.56 (153.35)	13.89 (3)	6.6 (14.55)	5.2 (11.46)
3	Rectangular-half panel	18.7 (41)	37.4 (82)	7.3 (1.6)	3.72 (8.20)	3 (6.61)
4	Quarter panel	8.16 (18)	16.32 (36)	3.31 (0.73)	1.69 (3.73)	1.23 (2.71)
5	Triangular-half panel	20 (44.09)	40 (88.18)	8 (1.75)	3.8 (8.37)	3 (6.61)
6.	Standard brace	2.53 (5.5)	5.06 (11)	1.02 (0.23)	0.52 (1.15)	0.16 (0.36)
7	Corner Joint	10 (22)	20 (44)	4 (0.88)	1.9 (4.19)	-
8	T- Joint	17.15 (37.81)	34.30 (75.62)	7 (1.5)	3.57 (7.87)	-
9	Cross-Joint	30 (66.14)	60 (132.28)	12.25 (2.6)	6.25 (13.78)	-
10	Brace Joint	4.84 (10.67)	9.68 (21.34)	1.96 (0.43)	1.0 (2.20)	0.30 (0.66)
11	Column Brace	9.34 (20.59)	18.68 (41.18)	3.77 (0.84)	1.92 (4.23)	0.33 (0.73)
12	Flat Joint	2.31 (5.09)	4.62 (10.18)	0.94 (0.20)	0.48 (1.06)	0.13 (0.29)

3.3. MATERIALS REQUIRED FOR CONSTRUCTION OF
DIFFERENT MODULAR SYSTEMS OF AL-SERIES

Item No.	Al Systems	Cement kg (lb)	Sand kg (lb)	Water litres Imp.gallon)	Steel Fibre kg (lb)	H.T. Wire kg (lb)
1.	<u>Rectangular System</u>					
1.1.	One Unit Tank Al-1	355 (782)	710 (1564)	142 (31)	67 (148)	36 (79)
1.2.	One and Quarter Unit Tank Al-1½	524 (1155)	1048 (2310)	210 (46)	100 (220)	46 (102)
1.3.	Two Unit Tank Al-2	650 (1432)	1300 (2864)	260 (57)	124 (274)	64 (142)
1.4.	Three Unit Tank Al-3	716 (1579)	1432 (3158)	384 (84)	184 (405)	94 (207)
1.5.	Four Unit Tank Al-4	1197 (2639)	2394 (5278)	480 (107)	231 (509)	115 (256)
1.6.	Six Unit Tank Al-6	1713 (3776)	3426 (7552)	688 (151)	332 (732)	168 (369)
1.7.	Eight Unit Tank Al-8	1983 (4372)	3966 (8744)	797 (176)	384 (846)	195 (402)
1.8.	Nine Unit Tank Al-9	2390 (5269)	4780 (10538)	960 (211)	464 (1022)	229 (354)
2.	<u>Cross System</u>					
2.1.	Five Unit Tank Al-5	1263 (2784)	2526 (5568)	505 (111)	240 (529)	132 (291)
2.2.	Nine Unit Tank Al-9	2172 (4788)	4344 (9576)	869 (191)	414 (913)	229 (505)
2.3.	Thirteen Unit Tank Al-13	2546 (5613)	5093 (11226)	1119 (246)	486 (1071)	274 (604)
2.4.	Twenty Five Unit Tank Al-25	4324 (9533)	8648 (19066)	1732 (381)	828 (1825)	480 (1057)
3.	<u>Open Rectangular System</u>					
3.1.	Four Unit Tank RI-4	1028 (2266)	2056 (4532)	413 (91)	199 (439)	102 (225)
3.2.	Six Unit Tank RI-6	1137 (2507)	2274 (5014)	496 (109)	219 (483)	132 (291)
3.3.	Nine Unit Tank RI-9	1444 (3183)	2888 (6366)	580 (128)	279 (615)	150 (330)

TOOLS AND EQUIPMENT

1. Suggested essential tools required for construction of Modular Tanks of As and Al series with tank moulds for small communities.

Item No.	Item description	Quantity	Unit
1.	Saw, cross-cut, 500 mm length: thin back, taper ground, hardened tempered steel, 16 points per 50 mm	2	each
2.	Drill, electric, portable, 10 mm capacity, pistol grip, variable speed, 3 jaw geared chuck and key, 110V, 50/60 Hz, single phase or 220V, 50/60 Hz single phase	1	"
3.	Bit, drill, twist, high speed, straight shanks, set consisting of one each of: 1/16", 5/64", 3/30", 7/64", 1/8", 5/32", 3/16", 7/32", 1/4", 9/32", 5/16", 11/32", 3/8", 13/32", 7/16", 15/32" and 1/2"	2	set
4.	Brace, hand, 10" sweep, 8 point open ratchet, ball bearing head, spring alligator jaws	1	each
5.	Bits, brace, twist, dowel, set of one each of 1/4", 5/16" and 3/8"	2	set
6.	Hacksaw, adjustable, lengths 250 - 300 mm	1	each
7.	Hacksaw blades, 36 points/50 mm, 16 x 300 mm	100	"
8.	Cutter, bolt, clipper cut jaws: 8 mm capacity	1	"
9.	Screwdriver, 250 mm x 9.5 mm	2	"
10.	Pliers, combination, 200 mm x 30 mm capacity	2	"
11.	Pliers, side-cutting, 178 mm	2	"
12.	Hammer, nail head, curved claw, 450G	2	"
13.	Chisel, woodworking, bevel edge, with shatter-proof handle. Set of one each of the following sizes: 6 mm, 13 mm, 19 mm, 25 mm	1	set
14.	Square, carpenter's, Try, 200 x 200 mm, steel, graduated in mm and inches	1	each
15.	Sieve, 4 mm mesh, size 1200 mm x 800 mm	1	"

Item No.	Item description	Quantity	Unit
16.	Shovel, round point blade of 230 mm x 300 mm "D" handle, hallow back	4	each
17.	Wheelbarrow, 0.10 cu. mtrs. capacity, tray stamped from one piece seamless alloy metal, tubular steel handles with plastic hand grips, oilable bearings, steel disc wheel with puncture-proof tire	1	"
18.	Scale, household, utility, spring type, airplane dial, approx. 165 mm in diameter, legible <u>black</u> figures, all metal <u>case</u> and platform: platform approx. 140 mm square, removable for easy cleaning: dimensions 246 x 158 x 165 mm, complete with adjustment nut to balance a scoop. 10 kg x 50 g or 25 lb x 10 oz	1	"
19.	Rule, 2 m/6', folding in mm and inches	3	each
20.	Trowel, brick, mason's, 115 x 200 mm	2	"
21.	Trowel, cement finishing, 120 x 280 mm	2	"
22.	Trowel, pointing, 70 mm x 140 mm	2	"
23.	Paint brush, assorted, set of 6 consisting two each of following sizes: 25 mm, 50 mm and 45 mm	2	sets
24.	Garden hose, ID, 12.7 mm x 15.25 metres, 100% vinyl, 2-ply construction with washers, with full flow brass couplings	50	<u>mtrs</u>
25.	Pail, with <u>bail</u> handle, 10 litre capacity, polyethylene	3	each
26.	Slump cone	1	"

2. Suggested tools for production of modular components and modular water tanks in central yards for larger communities.

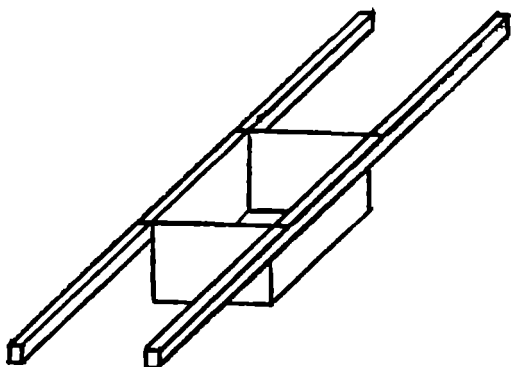
Item No.	Item description	Quantity	Unit
1.	Saw, cross-cut, 500 mm length: thin back, taper ground, hardened tempered steel, 16 points per 50 mm	2	each
2.	Circular saw, portable, 1-1/2", steel handle, 110V, 50/60 cycles or 220V, 50/60 cycles	1	"
3.	Circular blades, 6" diam, 1/8" thick, masonry for cutting concrete	10	"
4.	Drill, electric, portable, 10 mm capacity, pistol grip, variable speed, 3 jaw geared chuck and key, 110V, 50/60 Hz, single phase or 220V, 50/60 Hz single phase	1	"
5.	Bit, drill, twist, high speed, straight shanks, set consisting of one each of" 1/16", 5/64", 3/30", 7/64", 1/8", 5/32", 3/16", 7/32", 1/4", 9/32", 5/16", 11/32", 3/8", 13/32", 7/16", 15/32" and 1/2"	2	set
6.	Brace, hand, 10" sweep, 8 point open ratchet, ball bearing head, spring alligator jaws	1	each
7.	Bits, brace, twist, dowel, set of one each of 1/4", 5/16" and 3/8"	2	set
8.	Hacksaw, adjustable, lengths 250 - 300 mm	1	each
9.	Hacksaw blades, 36 points/50 mm, 16 x 300 mm	100	"
10.	Cutter, bolt, clipper cut jaws: 8 mm capacity	1	"
11.	Screwdriver, 250 mm x 9.5 mm	2	"
12.	Pliers, combination, 200 mm x 30 mm capacity	2	"
13.	Pliers, side-cutting, 178 mm	2	"
14.	Wrench, plier, locking, 180 mm long, 32 mm capacity	2	"
15.	Wrench, adjustable, rounded head, 100 mm	4	"
16.	Hammer, nail head, curved claw, 450G	2	"

Item No.	Item description	Quantity	Unit
17.	Level, carpenter's, plumb & spirit, 30 x 70 x 600 mm	1	each
18.	Mitre-box, 54 x 230 mm, seasoned beachwood	1	"
19.	Chisel, woodworking, bevel edge, with shatter-proof handle. Set of one each of the following sizes: 6 mm, 13 mm, 19 mm and 25 mm	1	set
20.	Square, carpenter's Try, 200 x 200 mm, steel, graduated in mm and inches	1	each
21.	Sieve, 4 mm mesh, size 1200 mm x 800 mm	1	"
22.	Shovel, round point blade of 230 mm x 200 mm "D" handle, hallow back	4	"
23.	Wheelbarrow, 0.10 cu. mtrs. capacity, tray stamped from one piece seamless alloy metal, tubular steel handles with plastic hand grips, oilable bearings, steel disc wheel with puncture-proof tires	1	"
24.	Scale, household, utility, spring type, airplane dial, approx. 165 mm in diameter, legible black figures, all metal case and platform: platform approx. 140 mm square, removable for easy cleaning: dimensions 246 x 158 x 165 mm, complete with adjustment nut to balance a scoop. 10 kg x 50 g or 25 lb x 10 oz	1	"
25.	Rule, 2 m/6', folding in mm and inches	3	each
26.	Measuring tape, 3 mtrs, in mm and inches, self-retracting with brake, 16 mm steel blade	2	each
27.	Trowel, brick, mason's, 115 x 200 mm	2	"
28.	Trowel, cement finishing, 120 x 280 mm	2	"
29.	Trowel, pointing, 70 mm x 140 mm	2	"
30.	Paint brush, assorted, set of 6 consisting two each of following sizes: 25 mm, 50 mm and 45 mm	2	sets
31.	Garden hose, ID, 12.7 mm x 15.25 metres, 100% vinyl, 2-ply construction with washers, with full flow brass couplings	50	mtrs

Item No.	Item description	Quantity	Unit
32.	Pail, with bail handle, 10 litre capacity, polyethylene	3	each
33.	Slump cone	1	"
34.	Electric generator, AC - 2,500 Watts	1	"
35.	Concrete mixer, portable 3.0 cu. ft. capacity, with electric motor (110V or 220V) 50/60 cycles, single phase	1	"
36.	Electric motor, 1.5 H.P. with 5-1/0" steel pulley, complete with bush & plate, single phase (110V or 220V) 50/60 cycles	1	each

RECOMMEND APPLIANCES1. Measuring Boxes

The materials for preparation of the fibrous mortar must be accurately proportioned. Therefore separate boxes should be made for each material and cut down to the exact size required to hold the specified weight. The material to which it applies should be clearly painted on each of these boxes together with the weight involved. The proportions should be based on whether production small size standard panels As series are envisaged or the large panels from A1 series.



Boxes required for production of small size panels for modular tank of As series.

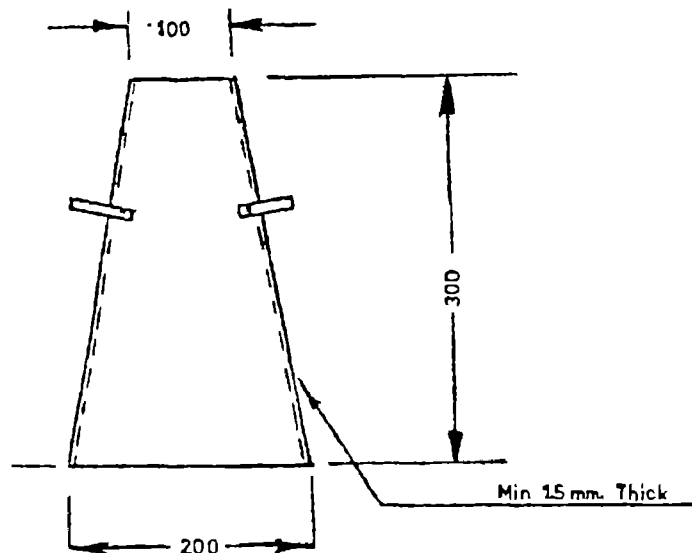
- for cement use 1 box holding 28 kg (61 lb)
- for sand use 2 boxes holding 28 kg each (61 lb)
- for water use 1 container holding 11.3 litres (2.5 gal)
- for steel fibres use 1 box holding 5.36 kg (12 lb)

Boxes required for production of large size panels for modular tank of A1 series

- for cement use 1 box holding 40 kg (88 lb)
- for sand use 2 boxes holding 40 kg each (88 lb)
- for water use 1 container holding 16 litres (3.5 gal)
- for steel fibres use 1 box holding 7.6 kg (16.1b 12 oz)

2. Slump Cone

In order to ensure good quality mortar regular checking of the mix is required and is done by using a slump cone made of galvanized iron sheet 1.5mm thick. (Refer to Annex 3 page 5).

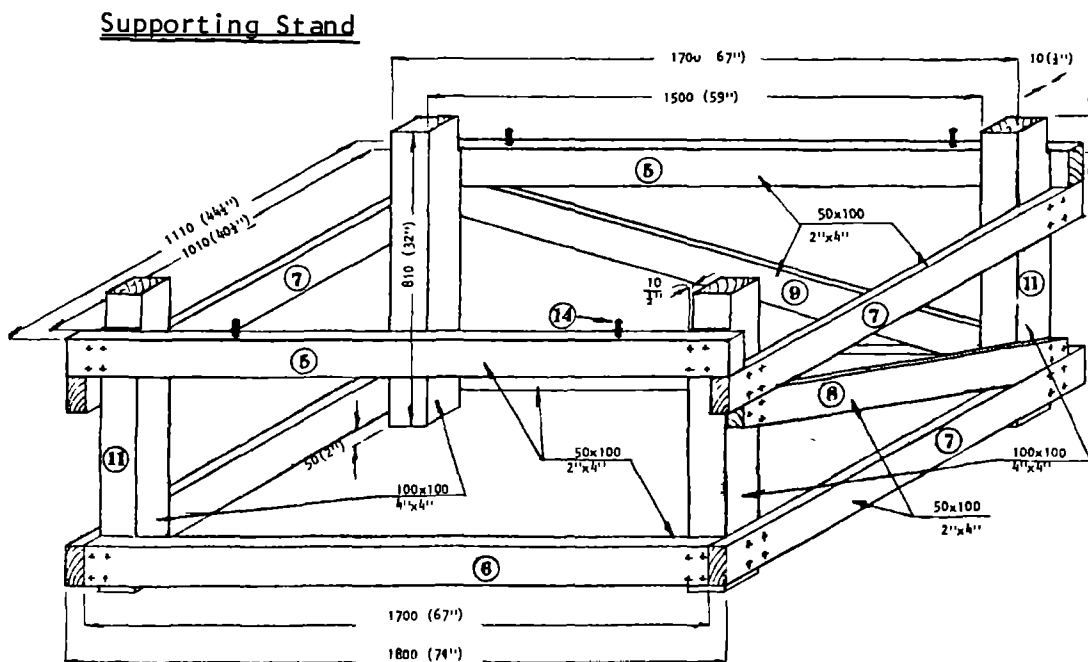
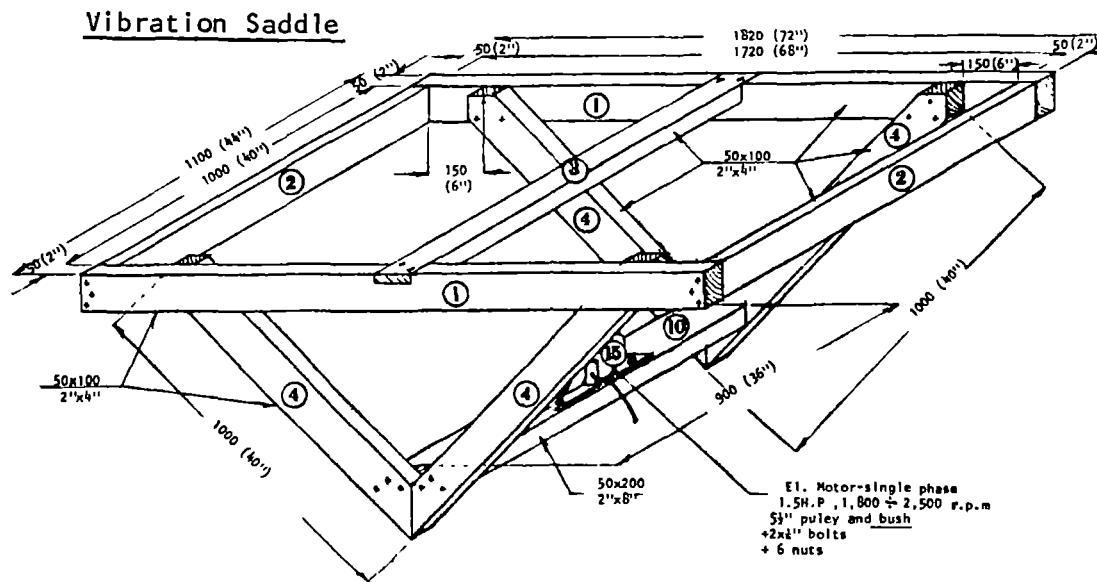


3. Vibration Saddle

In the production of panel and components of the AI series without additives it is difficult to achieve satisfactory vibration manually. Therefore, in order to ensure good quality product, a vibration table is required.

3.1. The vibration table is composed of two parts :

Vibration Frame or Saddle and Supporting Stand. On the lower side of the vibration saddle a single phase electric motor with 1.5 H.P. is fixed. The vibration is generated by attaching to the rotor a half broken pulley or another suitable eccentric.



3.2. Required Materials(i) Timber

No.	Size mm (inches)	Length mm (inches)	Quantity
1	50x100 (2''x4'')	1820 (72'')	2
2	50x100 (2''x4'')	1000 (40'')	2
3	50x100 (2''x4'')	1100 (44'')	1
4	50x100 (2''x4'')	1000 (40'')	4
5	50x100 (2''x4'')	1800 (71'')	2
6	50x100 (2''x4'')	1700 (67'')	2
7	50x100 (2''x4'')	1110 (44½'')	4
8	50x100 (2''x4'')	900 (36'')	1
9	50x100 (2''x4'')	1750 (69'')	1
10	50x200 (2''x8'')	900 (36'')	1
11	100x100 (4''x4'')	810 (32')	4

(ii) Screws

No.	Dia Ø mm (inches)	Length mm (inches)	Quantity
12	5 (¼'')	95 (3½'')	104

(iii) Bolts and Nuts

No.	Dia Ø mm (inches)	Length mm (inches)	Quantity
13	5 (¼'')	90 (3½'')	16

(iv) Appliances

No		Quantity
14	Shock absorbers (springs and valves from benzine engine)	4
15	Electric motor single phase, 1.5 H.P. 1700-2500 r.p.m.	1
16	Electric cable 2m long with plug	1



Illustrations 68 and 69: The saddle frame with electric motor is inserted into the stand.

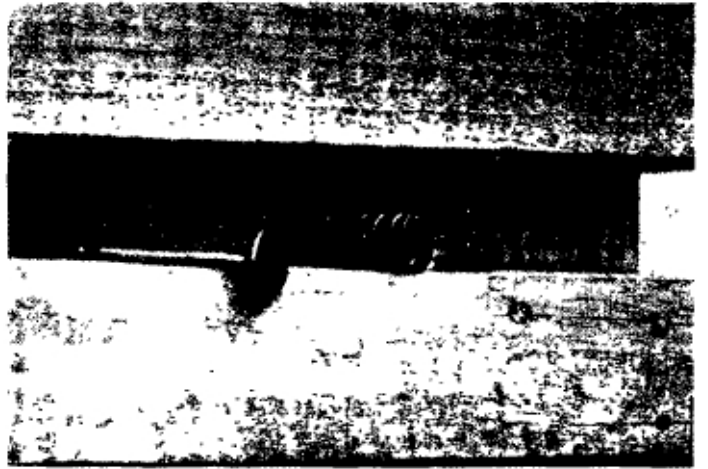
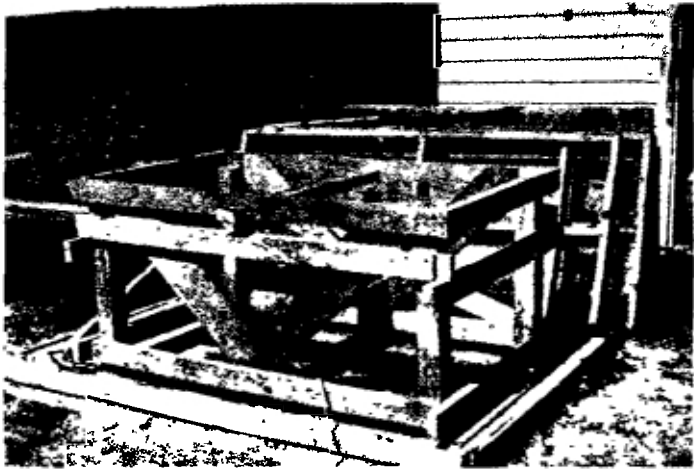


Illustration 70: Vibration saddle should be installed on levelled surface.

Illustration 71: Four thermo valves and springs from car engine are used for suspension of the saddle.

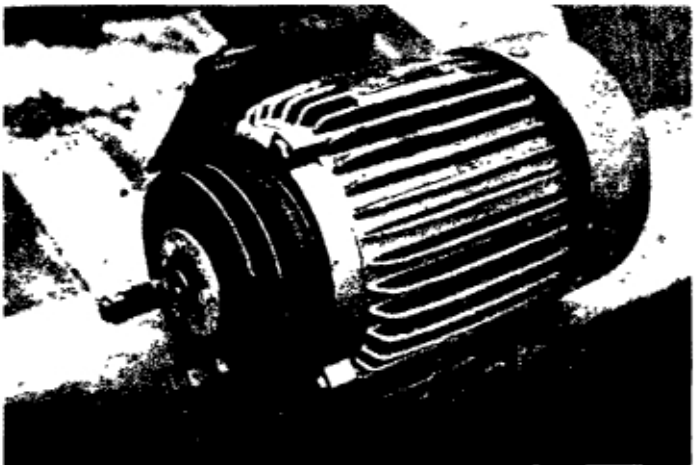


Illustration 72: One or two bolts with nuts are attached to the pulley for eccentric rotation

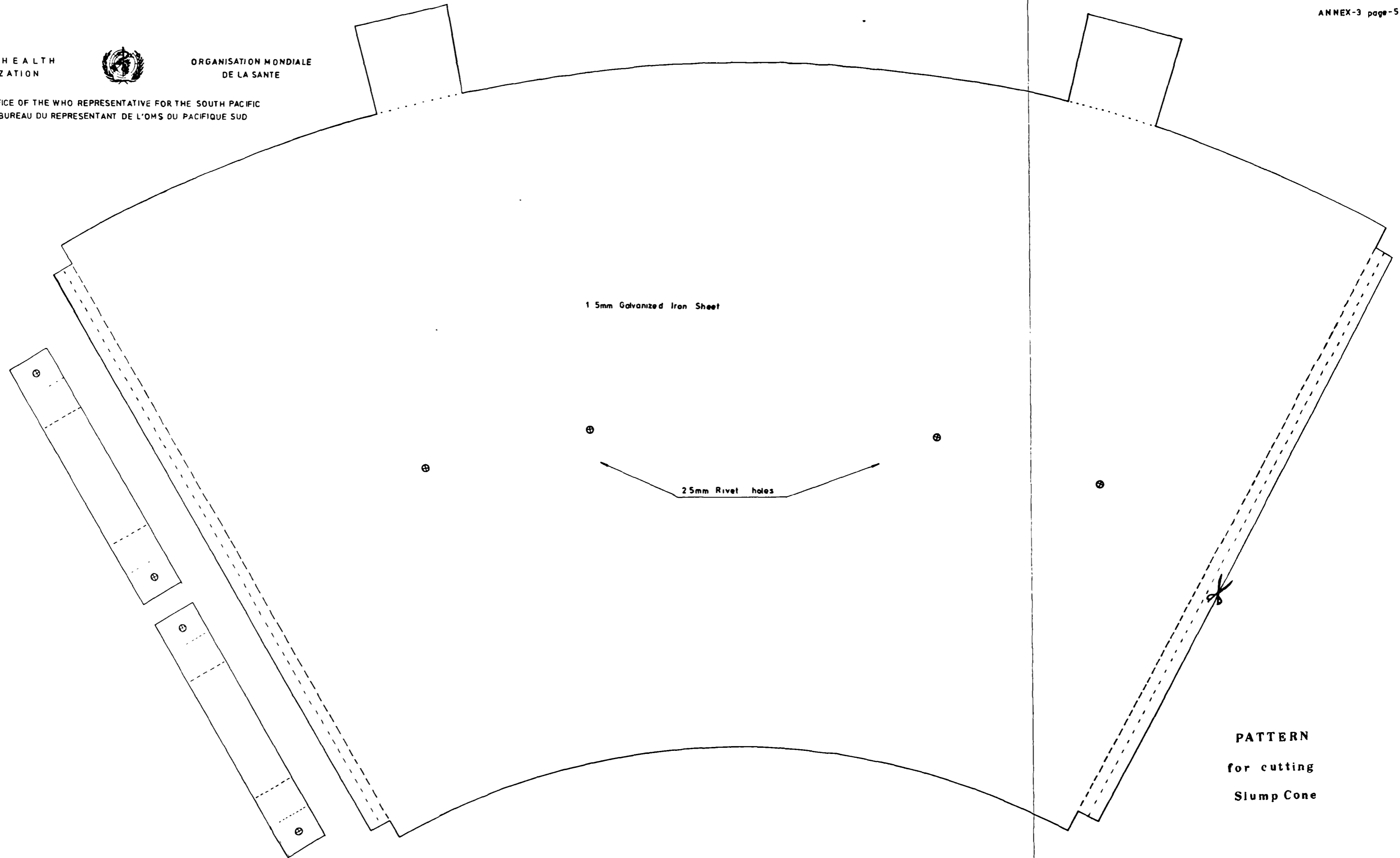
Illustration 73: The electric motor is fixed by bolts to the bridge of the saddle.

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1 5mm Galvanized Iron Sheet

2.5mm Rivet holes

PATTERN
for cutting
Slump Cone

MOULDS

1. Materials required for one all timber mould for production of modular components of the As-series.

1.1. Plywood

<u>Item No.</u>	<u>Specification and Size</u>	<u>Quantity</u>
①	Marine or exterior plywood 20mm (3/4") thick and cut to size with dimensions 1200mm x 1200mm (47" x 47")	1

1.2. Timber

<u>Item No.</u>	<u>Size</u>		<u>Unit Length</u>		<u>Quantity</u>
	mm	(Inches)	mm	(inches)	
②	50 x 75	(2" x 3")	1350	(54")	2
③	50 x 75	(2" x 3")	1350	(54")	4

1.3. Screws

<u>Item No.</u>	<u>Ø Dia</u>		<u>Length</u>		<u>Quantity</u>
	mm	(Inches)	mm	(inches)	
④	6	(1/4")	36	(1 1/2")	16

1.4. Glue

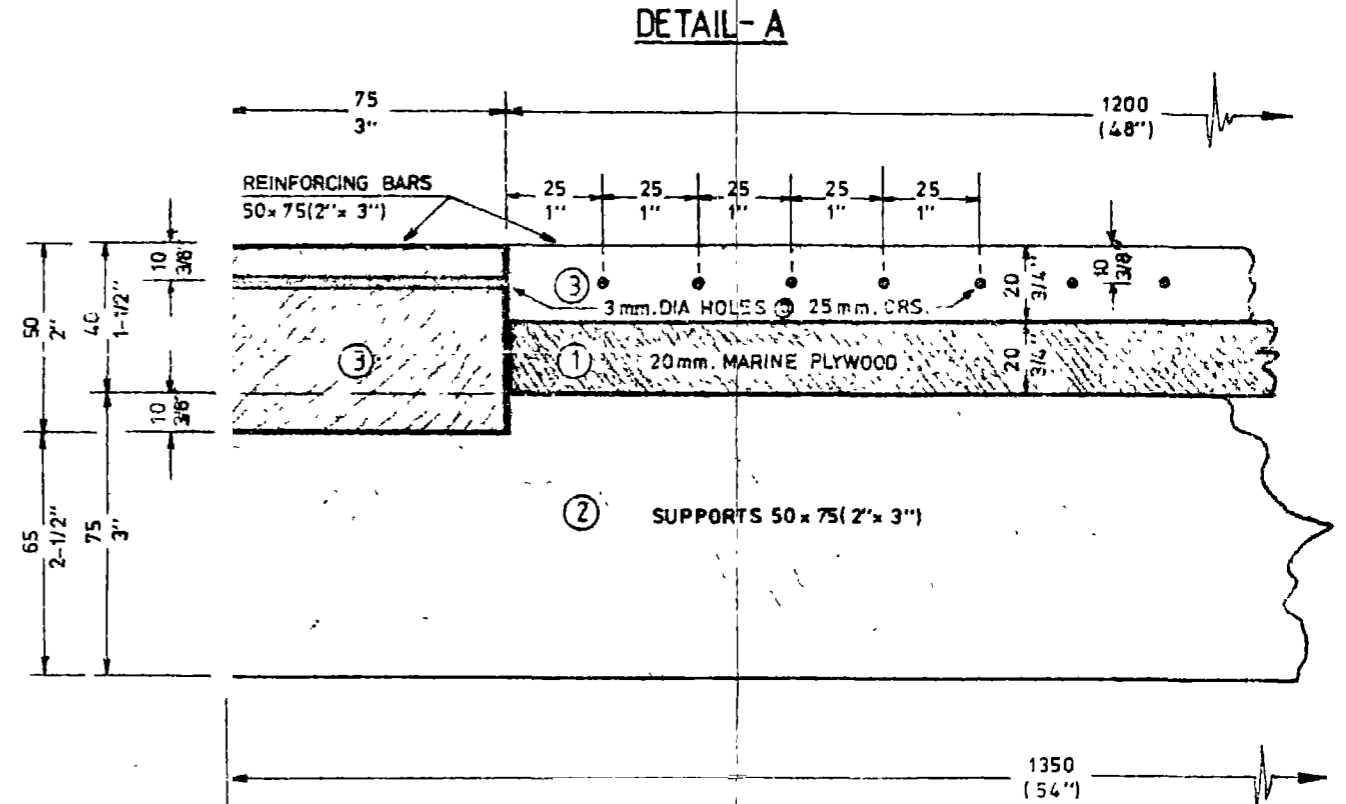
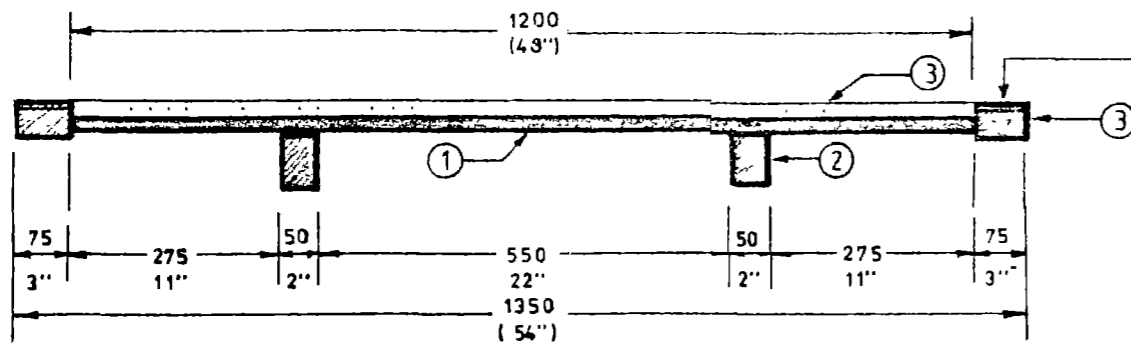
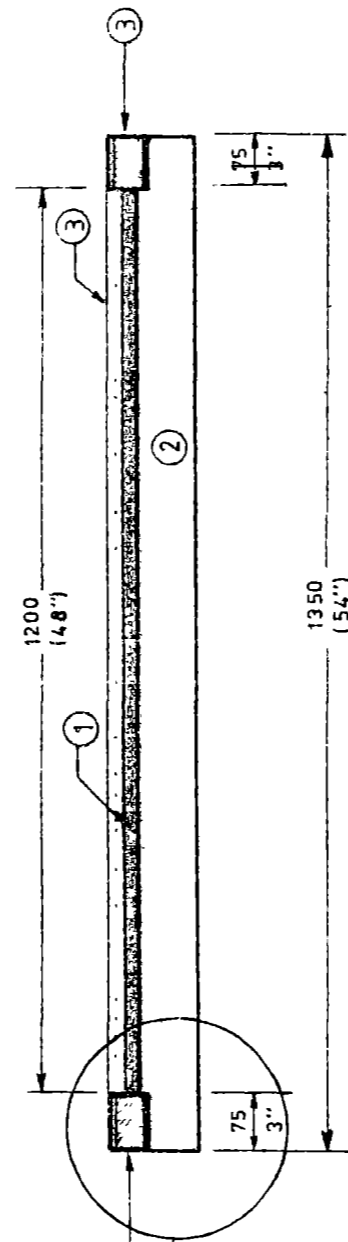
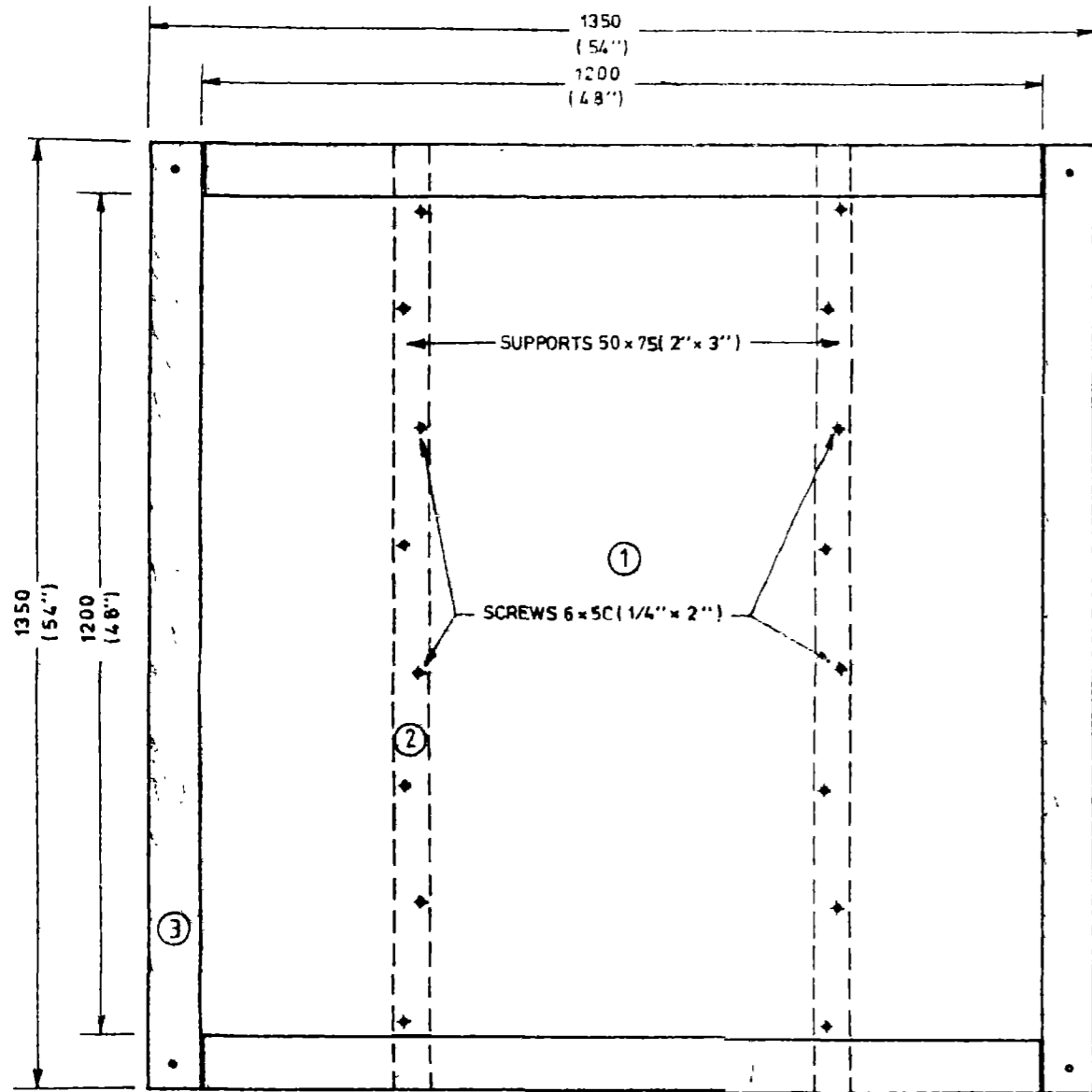
<u>Item No.</u>	<u>Specification</u>	<u>Quantity</u>
⑤	Water Resistant Adhesive	100cc (3.5 fl.oz)

1.5. Varnish

<u>Item No.</u>	<u>Specification</u>	<u>Quantity</u>
⑥	Polyurethane resin varnish	150cc (5 fl.oz)



MOULD for Standard Panel As-series



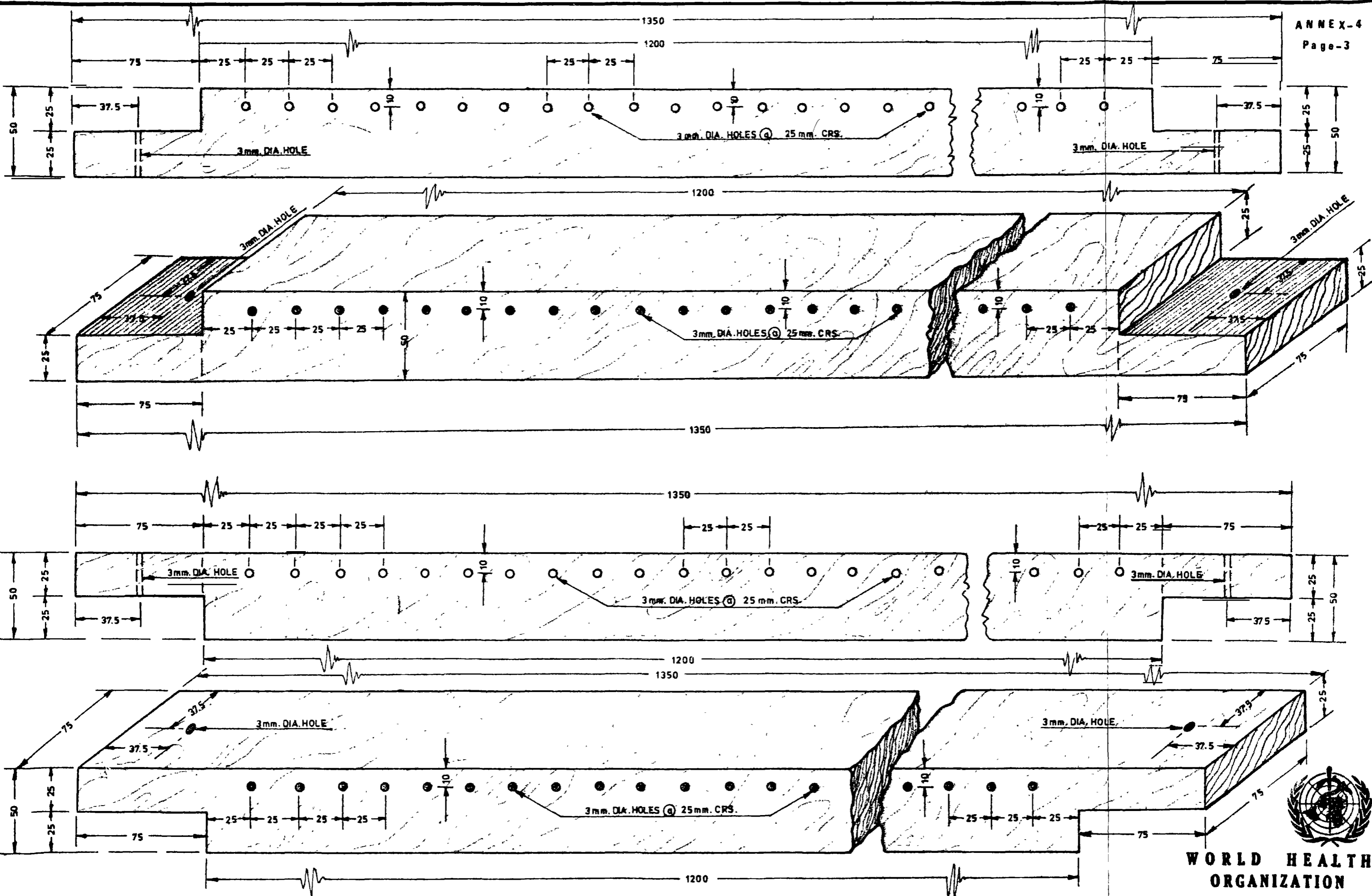
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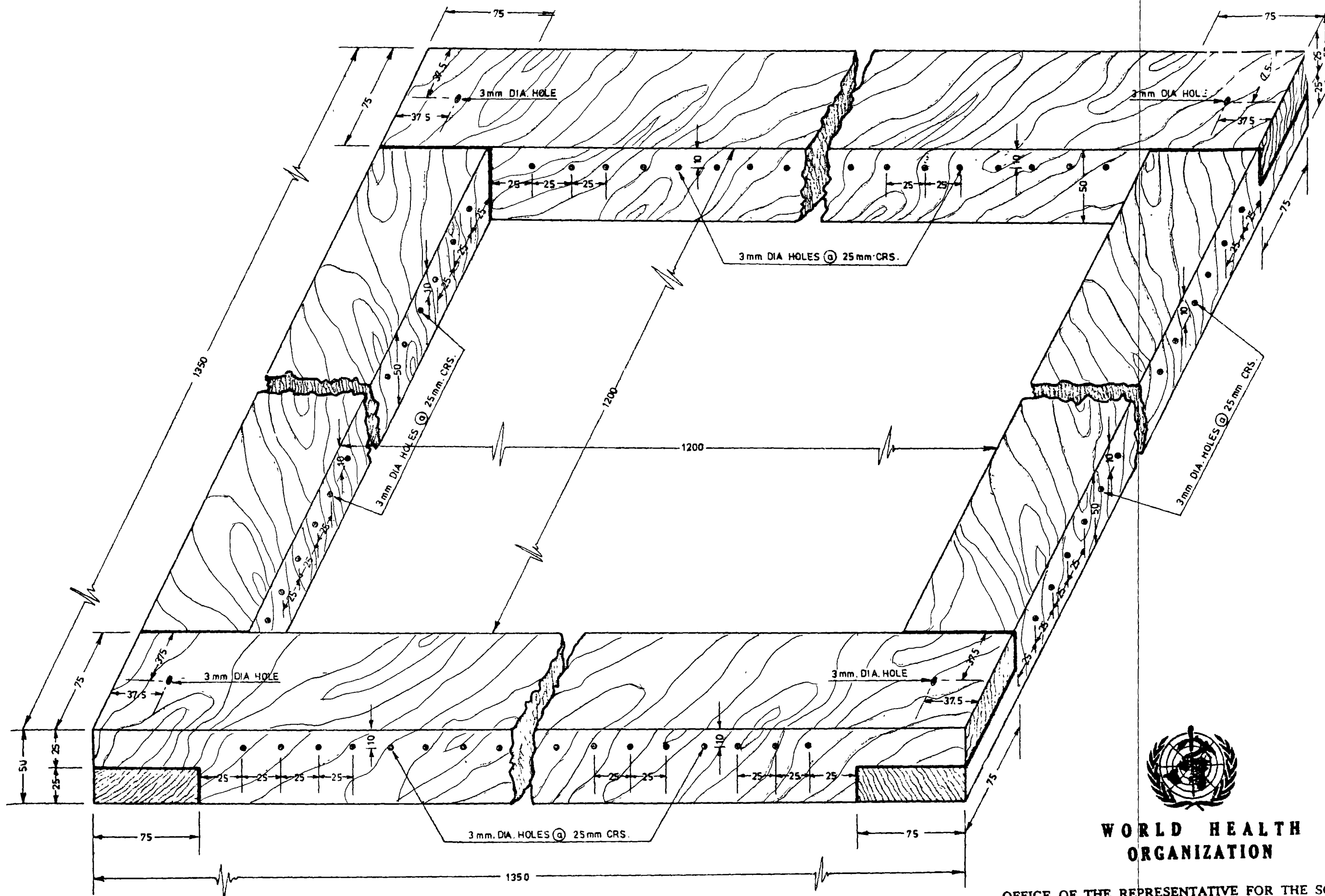
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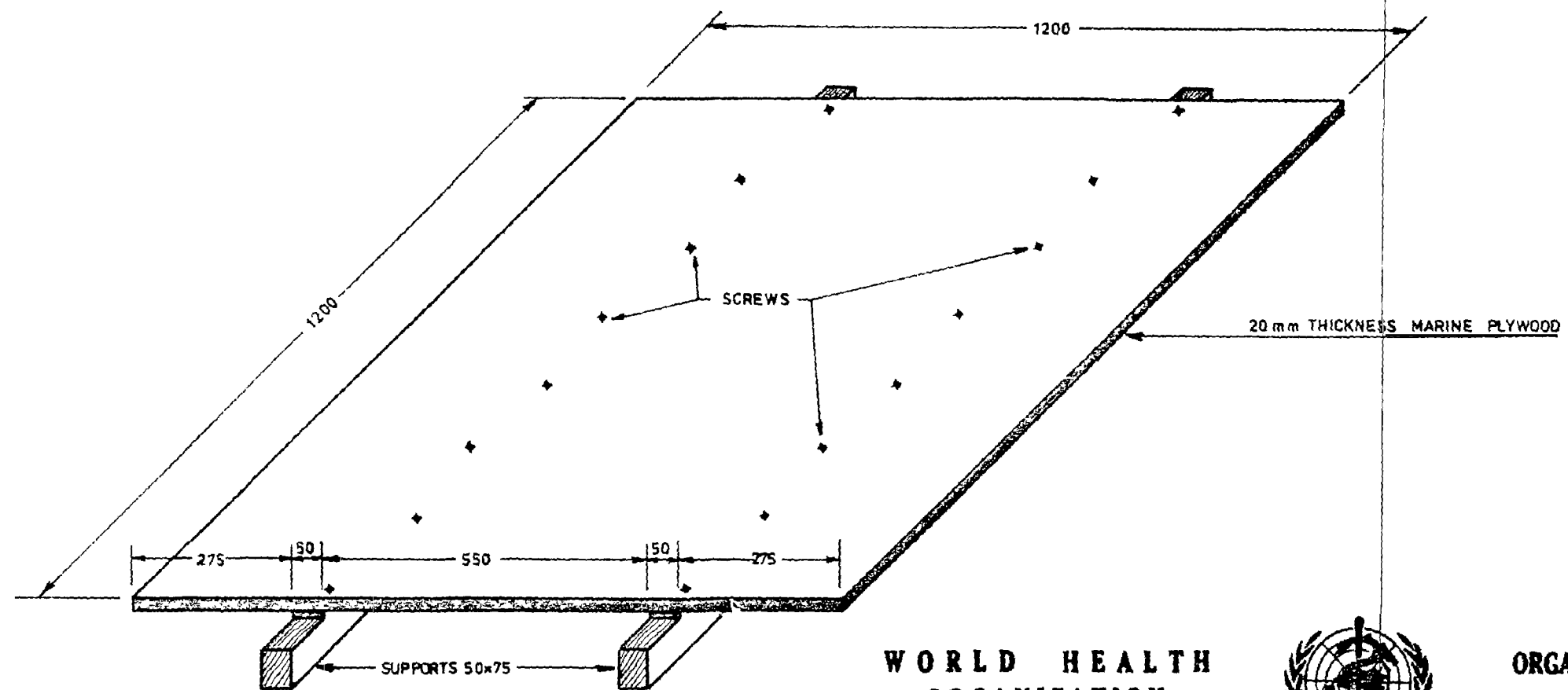
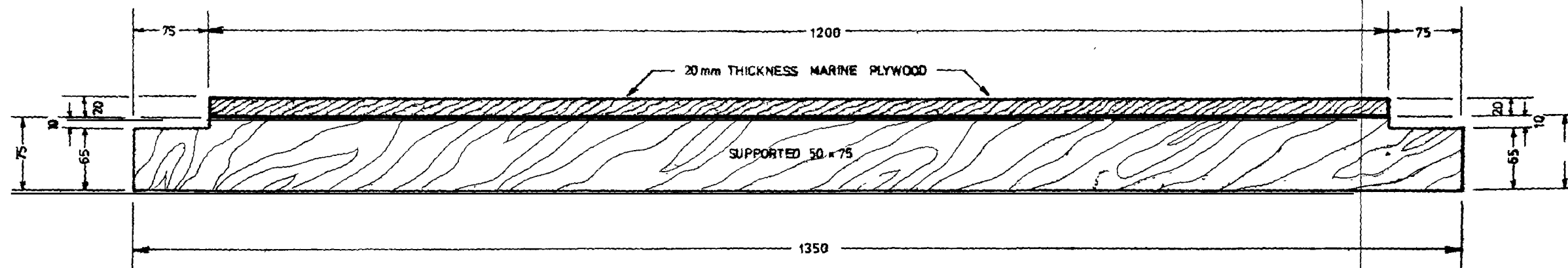
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2. Materials required for one mould - timber base with steel spacing bars for production of modular components of A1-series.

2.1. Plywood

<u>Item No.</u>	<u>Specification</u>	<u>Quantity</u>
①	Marine or exterior plywood 20mm (3/4") thick and cut to size with dimensions 1650mm 1650mm x 1650mm (65" x 65")	1

2.2. Timber

<u>Item No.</u>	<u>Size</u> mm (inches)	<u>Length</u> mm (inches)	<u>Quantity</u>
②	50x75 (2"x3")	1800 (71")	4

2.3. Steel Spacing Locking Bars

<u>Item No.</u>	<u>Size</u> mm (inches)	<u>Length</u> mm (inches)	<u>Quantity</u>
③	12x50 (1/2"x2")	1800 (71")	4

2.4. Steel Slotted Spacing Bars

<u>Item No.</u>	<u>Size</u> mm (inches)	<u>Length</u> mm (inches)	<u>Quantity</u>
③-a	12x50 (1/2"x2")	1800 (71")	4

2.5. Bolts

<u>Item No.</u>	<u>Ø Dia</u> mm (inches)	<u>Length</u> mm (inches)	<u>Quantity</u>
⑧	6 (1/4")	12 (1/2")	66
⑮	8 (5/16")	30 (1 1/4")	12

2.6. Screws

<u>Item No.</u>	<u>Ø Dia.</u> mm (inches)	<u>Length</u> mm (inches)	<u>Quantity</u>
④	6 (1/4")	50 (2")	15

2.7. Glue

<u>Item No.</u>	<u>Specification</u>	<u>Quantity</u>
⑤	Water Resistant Adhesive	150cc (5fl.oz)

2.8. Varnish

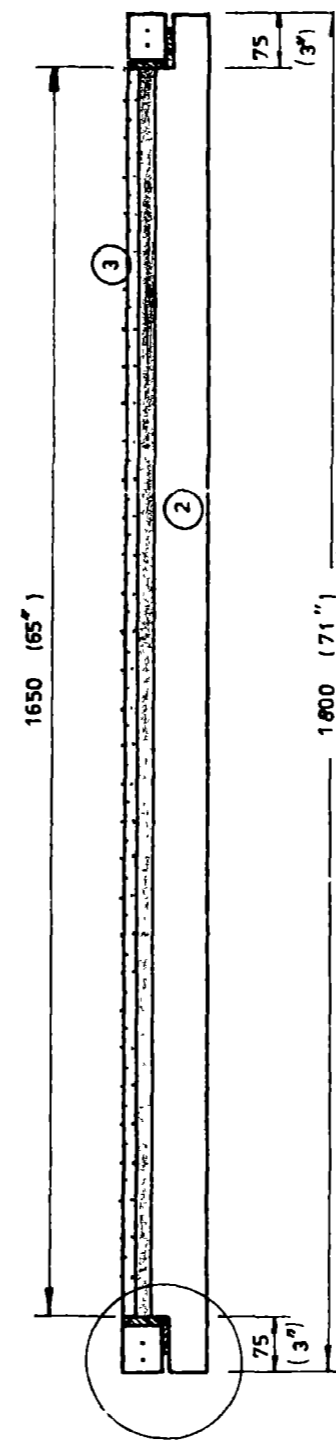
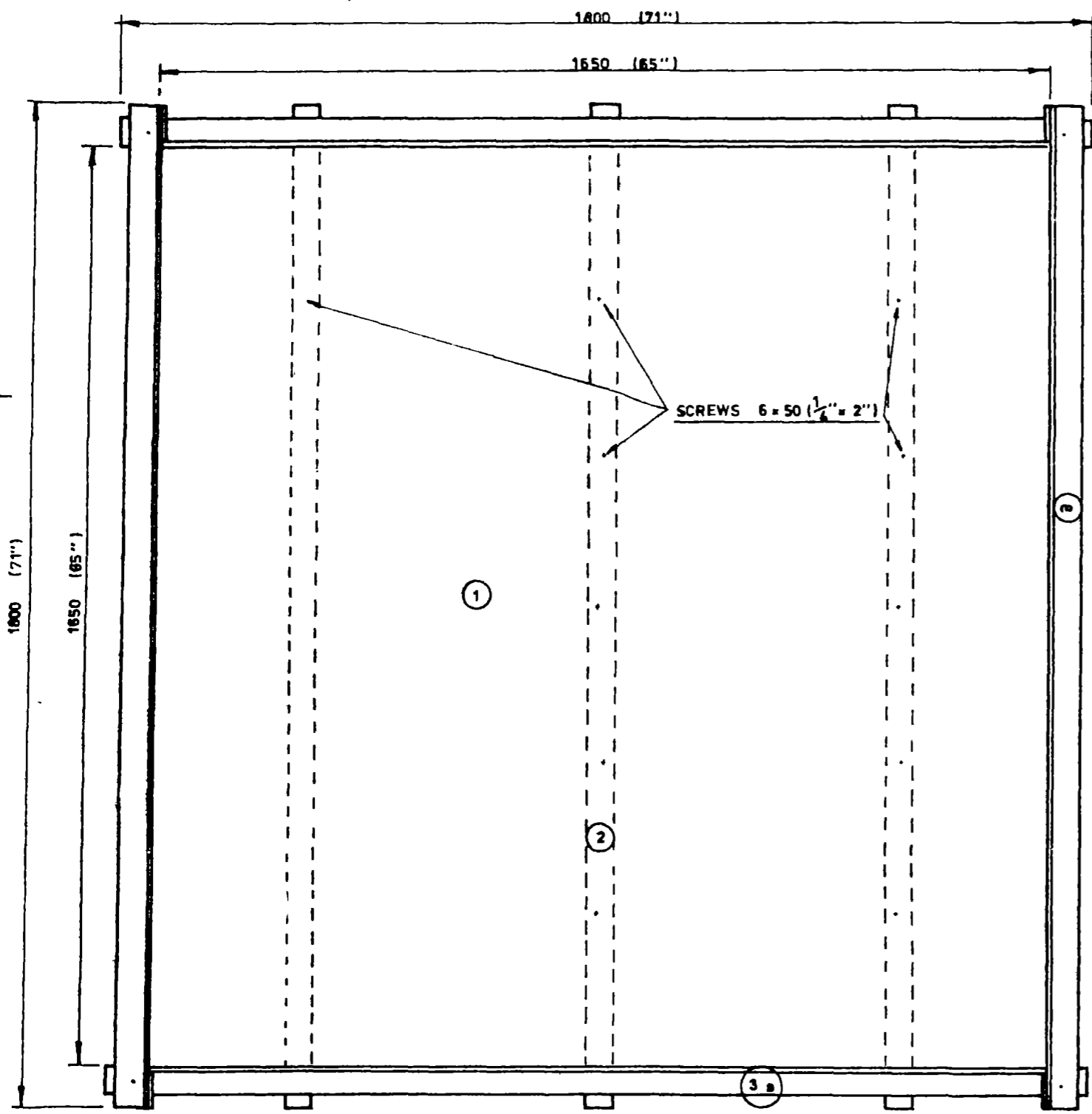
<u>Item No.</u>	<u>Specification</u>	<u>Quantity</u>
⑥	Polyurethane resin varnish	230cc (8fl.oz)



MOULD

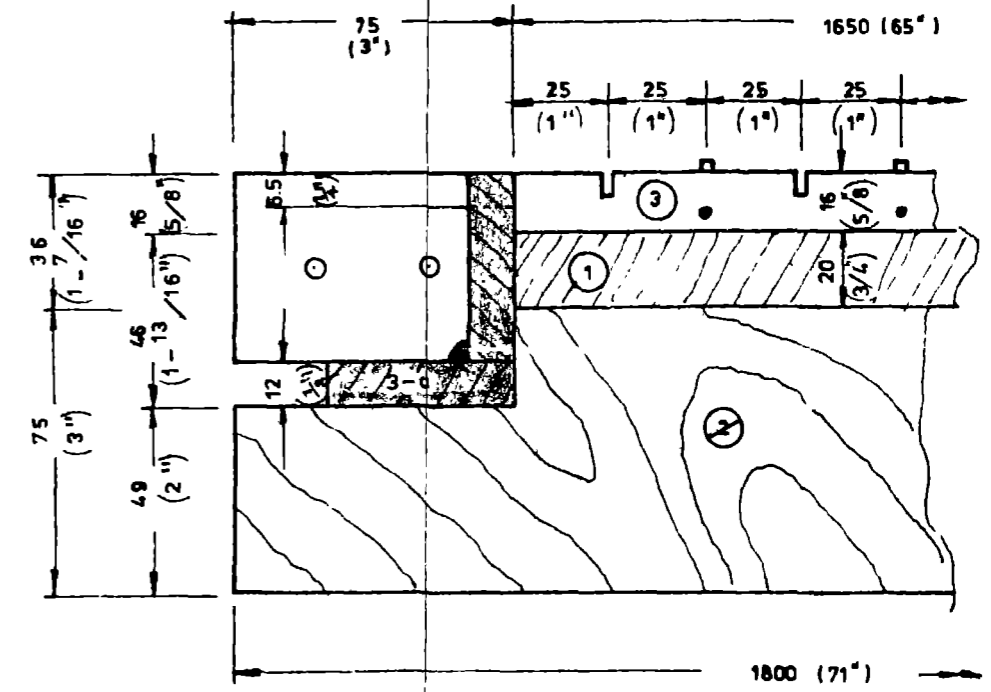
for Standard Panel

Al-series

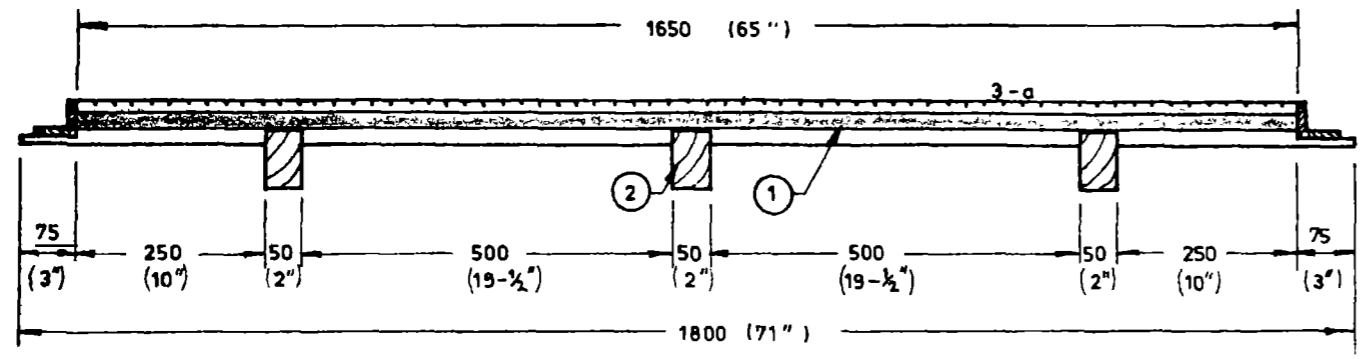
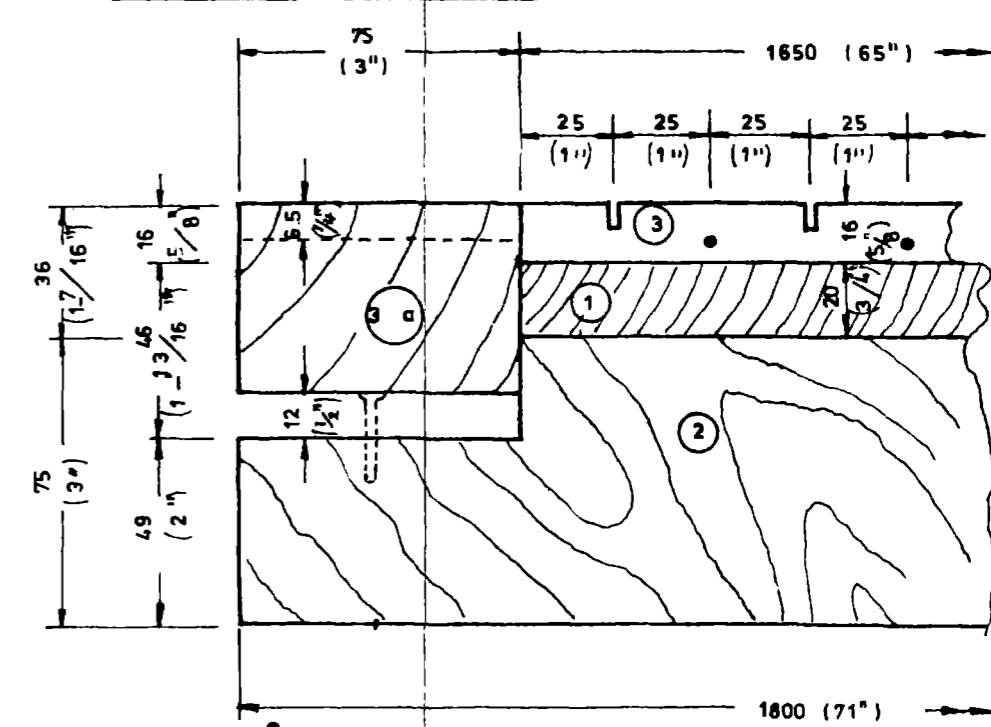


DETAIL

DETAIL FOR STEEL SPACING BARS



DETAIL FOR TIMBER SPACING BARS



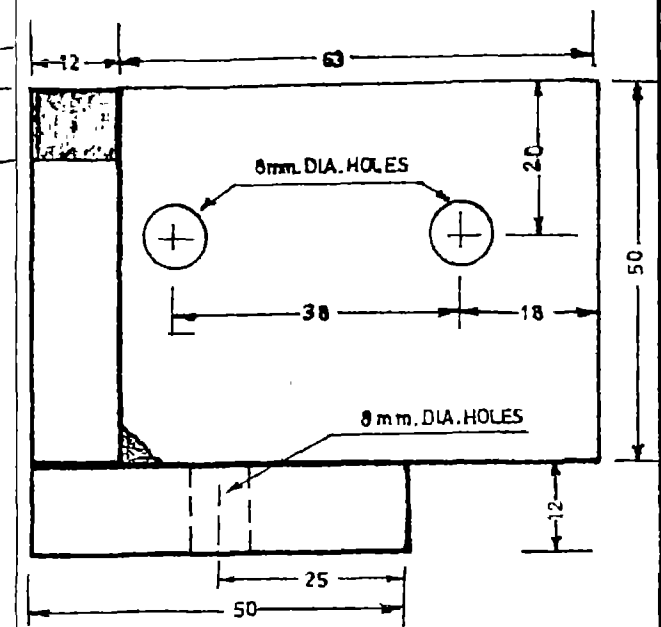
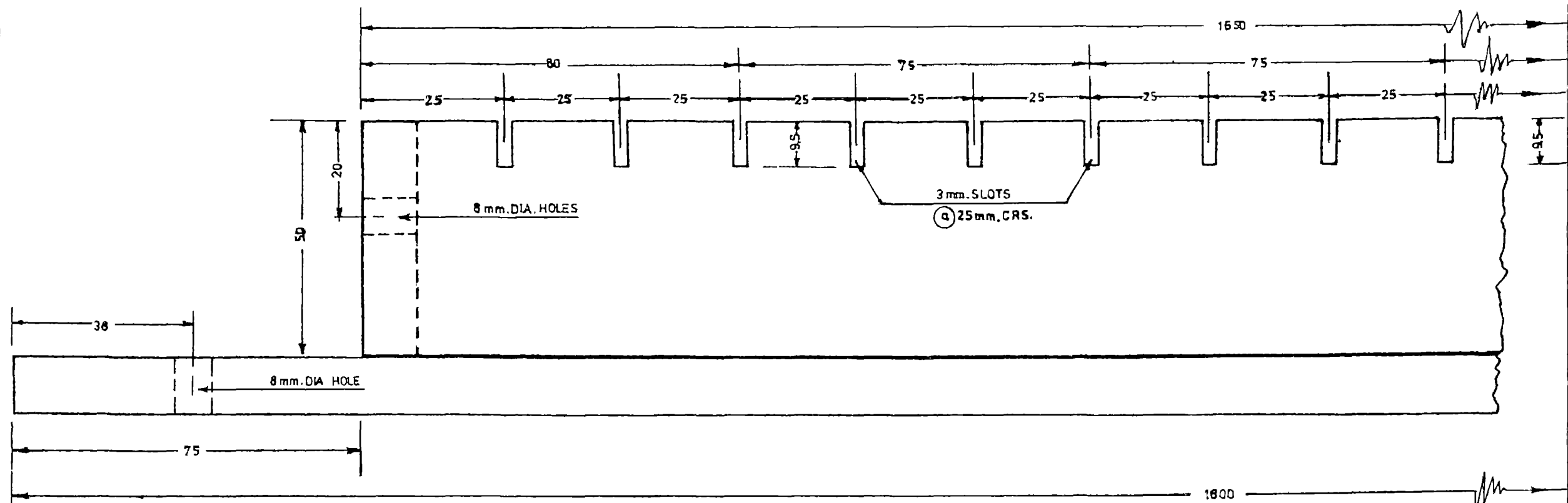
WORLD HEALTH ORGANIZATION
WESTERN PACIFIC REGION



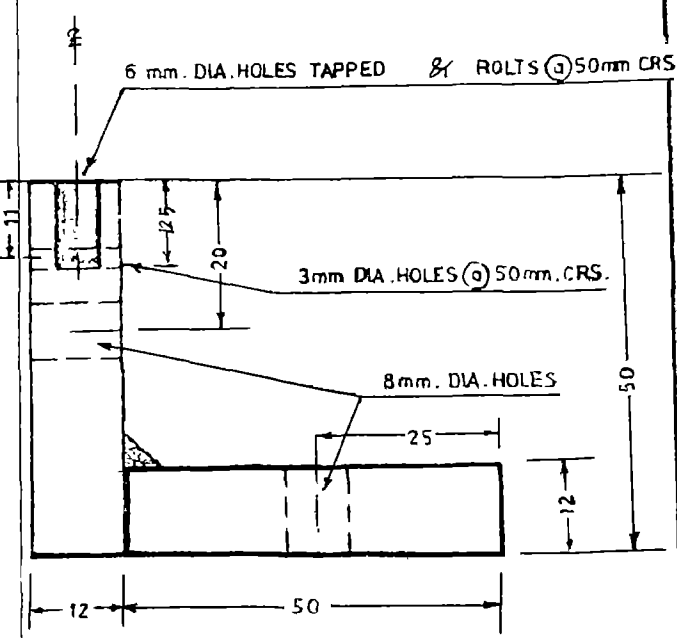
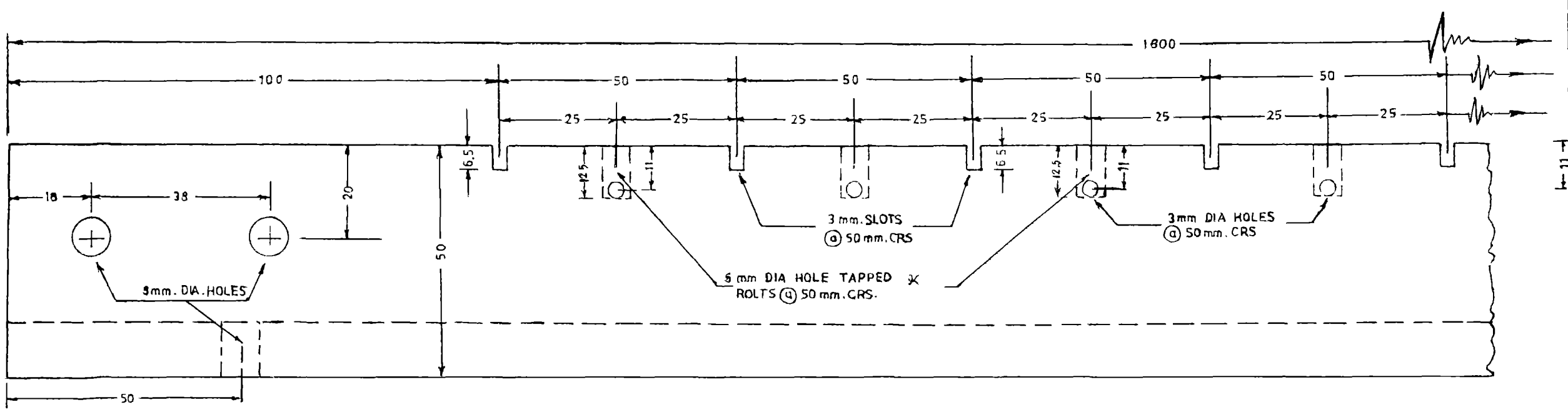
ORGANISATION MONDIALE DE LA SANTE
REGION DU PACIFIQUE OCCIDENTAL

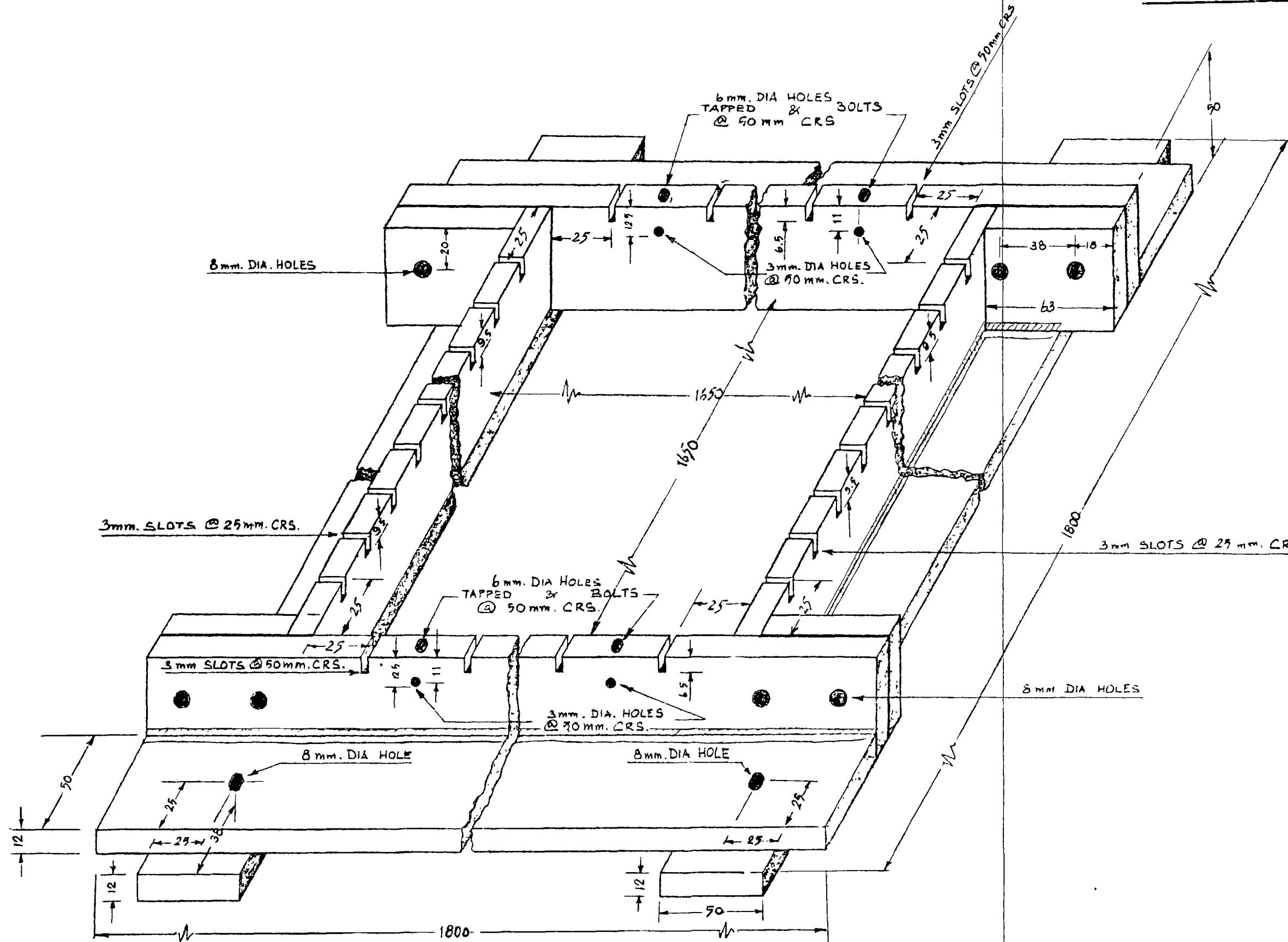
OFFICE OF THE WHO REPRESENTATIVE FOR THE SOUTH PACIFIC
BUREAU DU REPRESENTANT DE L'OMS DU PACIFIQUE SUD

SLOTTED SPACING BARS 50x12 ms END PLATES x $\frac{1800}{1650}$ LONG



SPACING BARS 50x12 ms. END PLATES x 1800



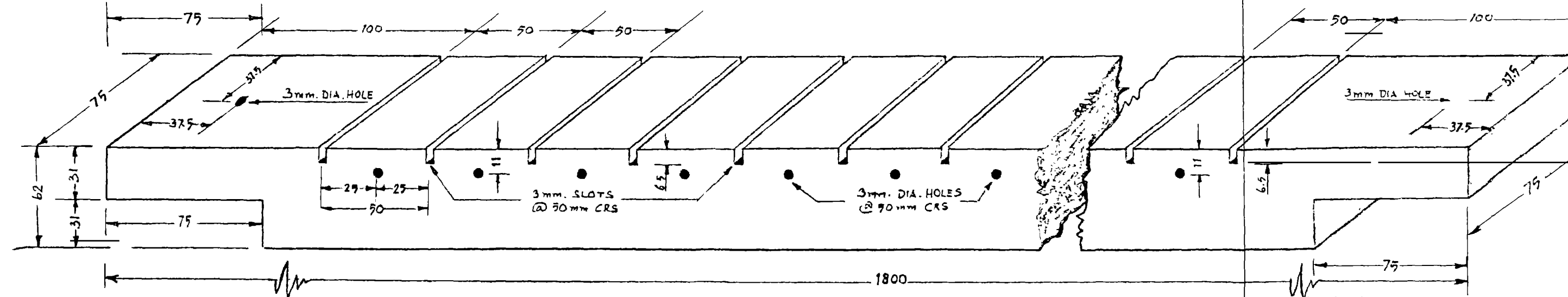
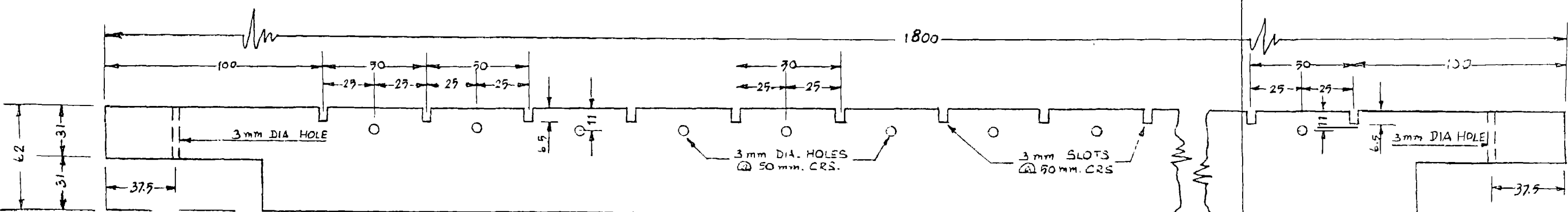
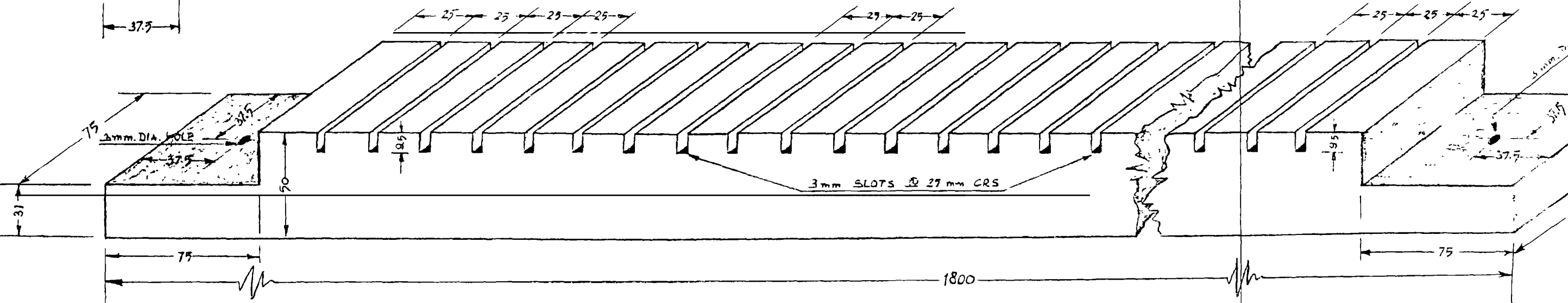
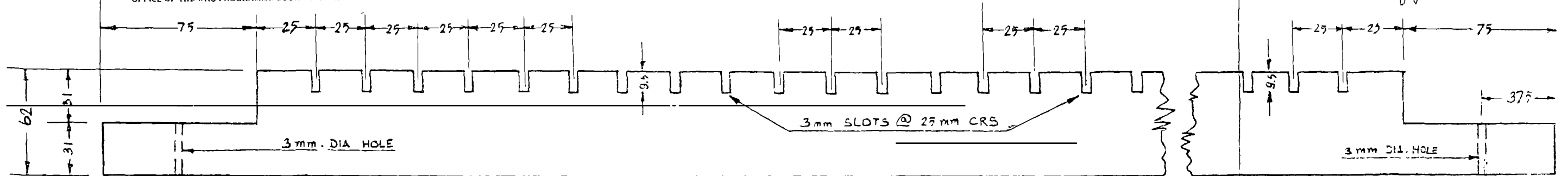


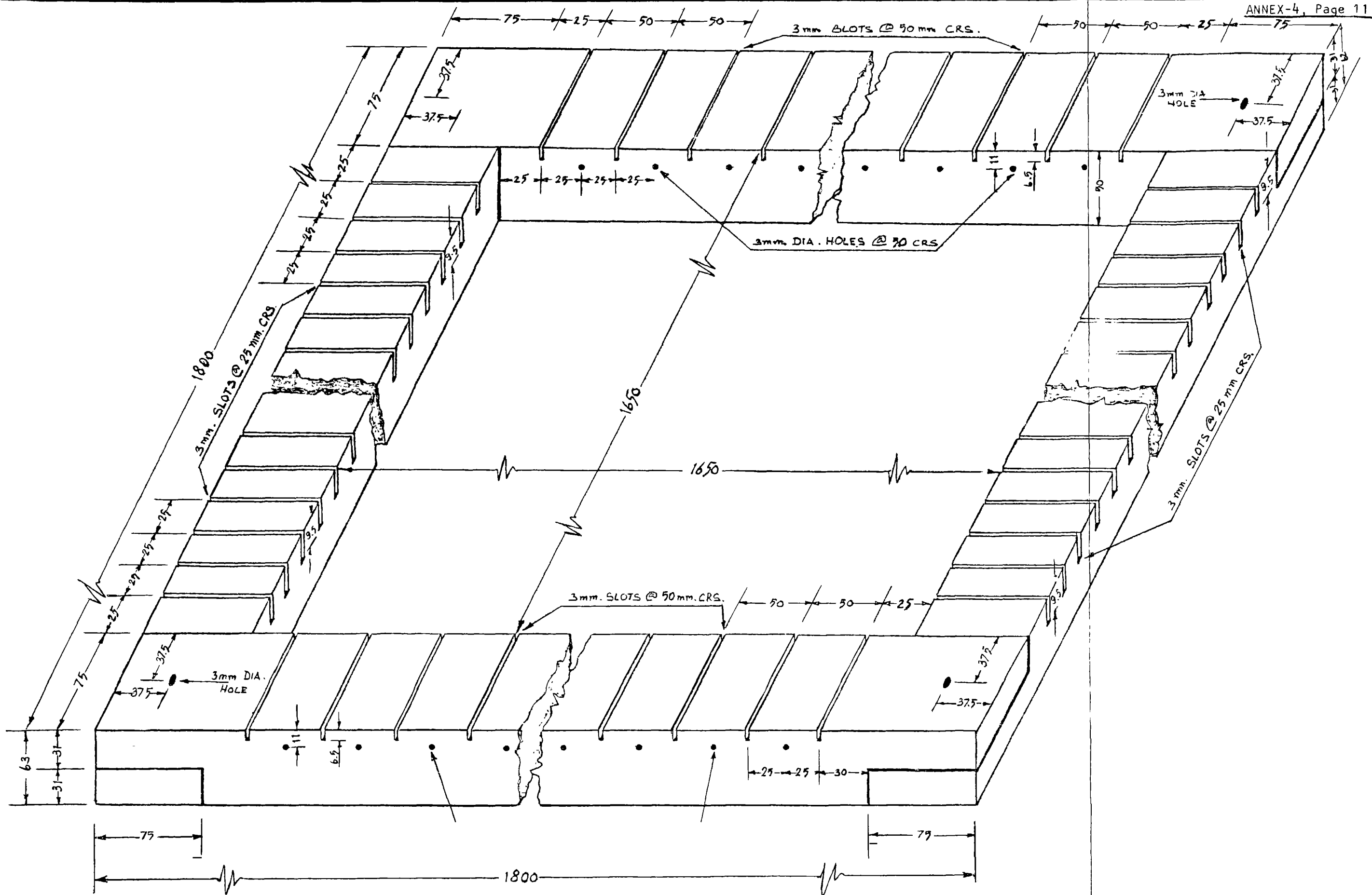


SLOTTED SPACING BARS 90x75 (2"x3")x1800 LONG

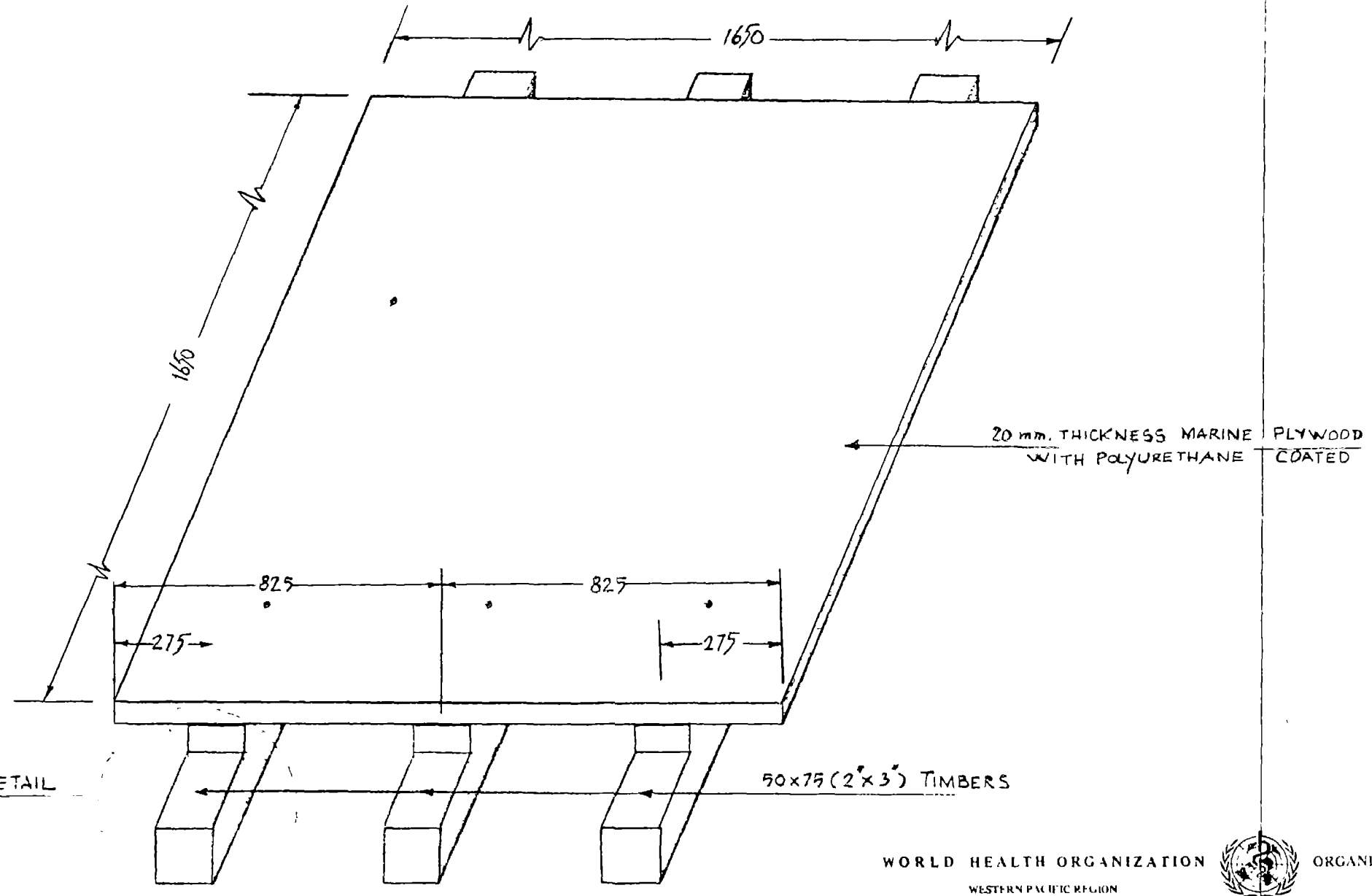
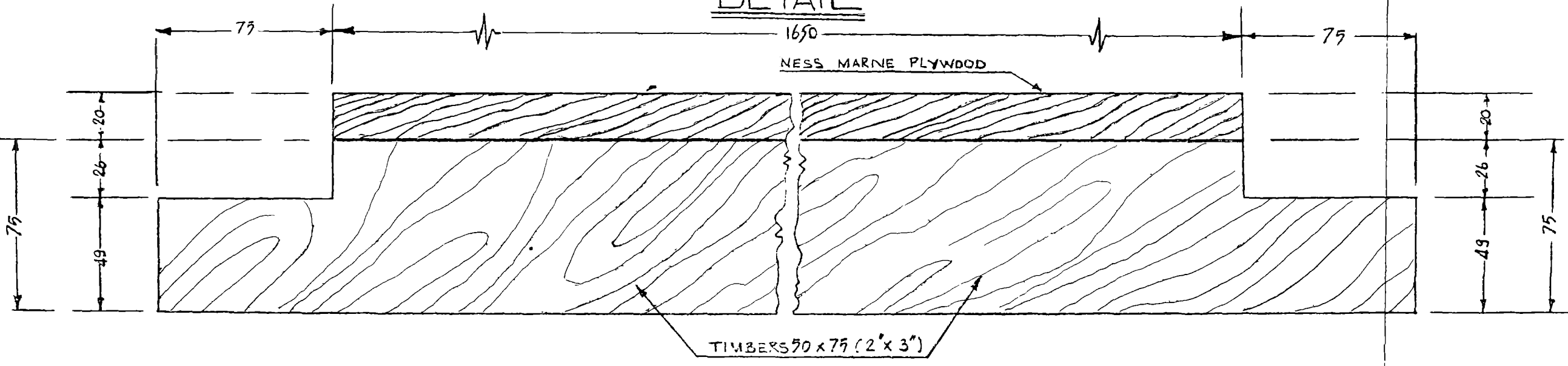
OFFICE OF THE WHO PROGRAMME COORDINATOR FOR THE SOUTH PACIFIC

1800





DETAIL



SEE DETAIL



3. Materials required for one steel mould for production of modular components of A1-series.

3.1. Steel Sheet

<u>Item No</u>	<u>Size</u> mm (inches)	<u>Thickness</u> mm (inches)	<u>Quantity</u>
①	1650x1650 (65"x65")	3 (1/8")	1

3.2. U-Steel Frame

<u>Item No.</u>	<u>Size</u>	<u>Length</u>	<u>Quantity</u>
②	102x50x6 (4"x2"x1/4")	1650 (65")	2

3.3. L-Steel Frame

<u>Item No.</u>	<u>Size</u>	<u>Length</u>	<u>Quantity</u>
③	75x75x6 (3"x3"x1/4")	1625 (64")	2

3.4. L-Steel Brace

<u>Item No.</u>	<u>Size</u>	<u>Length</u>	<u>Quantity</u>
④	75x75x6 (3"x3"x1/4")	1625 (64")	1

3.5. Timber

<u>Item No.</u>	<u>Size</u>	<u>Length</u>	<u>Quantity</u>
⑤	75x75 (3"x3")	1725 (64")	4

3.6. Bolts

<u>Item No.</u>	<u>Ø Dia.</u> mm (inches)	<u>Length</u> mm (inches)	<u>Quantity</u>
⑧	6 (1/4")	16 (5/8")	66

3.7. Steel Spacing Locking Bars

<u>Item No.</u>	<u>Size</u> mm (inches)	<u>Length</u> mm (inches)	<u>Quantity</u>
⑪	50 x 12 (2x1/2")	1650 (65")	2

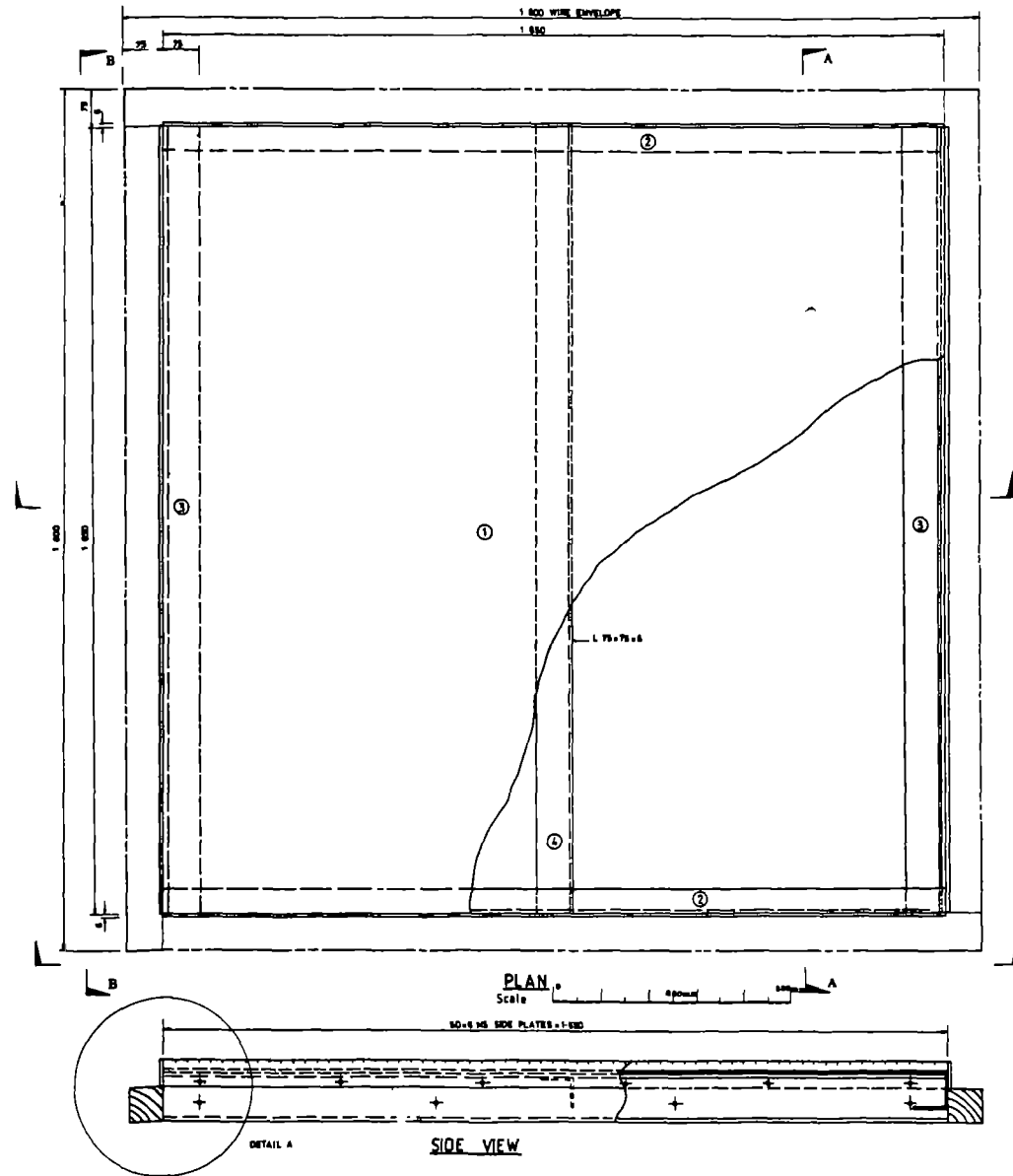
3.8. Steel Slotted Spacing Bars

<u>Item No.</u>	<u>Size</u>	<u>Length</u>	<u>Quantity</u>
⑫	50 x 6 (2"x1/4")	1650 (65")	2

3.9. Bolts

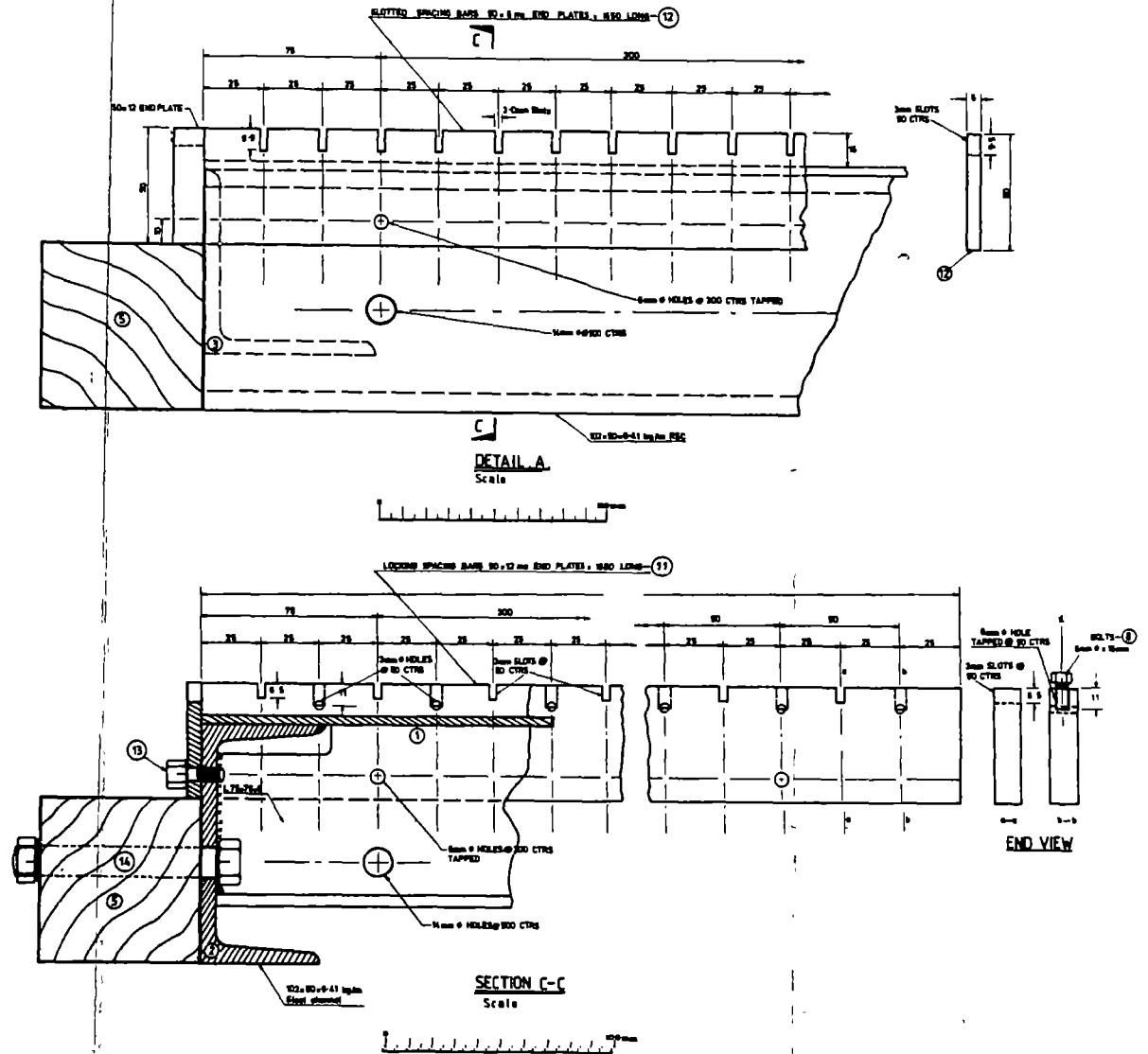
<u>Item No.</u>	<u>Ø Dia</u>	<u>Length</u>	<u>Quantity</u>
⑬	5 (1/4")	30 (1-1/4")	24
⑭	12 (1/2")	90 (3-1/2")	16





HALF VIEW ON A-A

HALF VIEW ON B-B



DETAIL A
Scale

SECTION C-C
Scale

END VIEW

WORLD HEALTH ORGANIZATION
ORGANISATION MONDIALE DE LA SANTE

OFFICE OF THE WHO REPRESENTATIVE FOR THE SOUTH PACIFIC
BUREAU DU REPRESENTANT DE L'OMS DU PACIFIQUE SUD

GOVERNMENT OF THE COOK ISLANDS
RESIDENT ENGINEERS DEPARTMENT
ENGINEERING DIVISION

DESIGNED BY: [Signature]
CHECKED BY: [Signature]
DATE: [Date]
SCALE: [Scale]
STEELE MOULD FOR STANDARD MODULAR PANEL #1 SERIES

DESIGNED BY	CHECKED BY	DATE	REVISION	BY	DATE	JOB NO.
[Signature]	[Signature]	[Date]				
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[Signature]	[Signature]	[Date]				
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WHO PROJECT E.H.E.A.S COK/BSM/001

FORMS AND BOXINGSpecifications for required materials

1. Required Materials for Assembly Form-Boxing of As Series Water Tanks

1.1. Assembly Base Form-Boxing (Fig. 1.7.)1.1.1.. Timber

Item No.	Size mm (inches)	Length mm (inches)	Quantity
①	25x150 (1"x6")	1345 (53")	4
②	25x150 (1"x6")	1320 (52")	2
③	25x150 (1"x6")	1020 (40")	2
④	100x100 (4"x4")	2100 (83")	2

1.1.2. Nails

⑤	3 (1/8")	50 (2")	40
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1.2. Assembly Top Form-Boxing (Fig. 1.13)1.2.1. Timber

Item No.	Size mm (inches)	Length mm (inches)	Quantity
⑥	25x150 (1"x6")	1345 (53")	4

1.2.2. Galvanized Wire

Item No.	Ø Dia. mm (inches)	Length mm (inches)	Quantity
⑦	2 (1/16")	1470 (58")	4

1.2.3. Nails

⑤	3 (1/8")	50 (2")	12
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1.3. Inside Corner Board-Boxing (Fig. 1.11)Timber

Item No.	Size mm (inches)	Length mm (inches)	Quantity
⑧	25x130 (1"x5")	1192 (47")	4

1.4. Base Assembly Spacing Bars (Fig. 1.8)Timber

⑨	60 x 60 (2 3/8" x 2 3/8")	300 (12")	8
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1.5. Top Assembly Spacing Bars (Fig. 1.12)Timber

⑩	45 x 45 (1 3/4" x 1 3/4")	700 (28")	4
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2. Required Materials for Assembly Box of A1 Series Water Tanks.

2.1. Assembly Box for Base2.1.1. Timber

Item No.	Size mm (inches)	Length mm (inches)	Quantity
①	25x150 (1"x6")	1795 (71")	4
②	25x150 (1"x6")	1770 (70")	2
③	25x150 (1"x6")	1470 (58")	2
④	100x100 (4"x4")	2100 (83")	2

2.1.2. Nails

Item No.	Ø Dia. mm (inches)	Length mm (inches)	Quantity
⑤	3 (1/8")	50 (2")	40

2.2. Assembly Top Form Boxing2.2.1. Timber

Item No.	Size mm (inches)	Length mm (inches)	Quantity
⑥	25x150 (1"x6")	1795 (71")	4

2.2.2. Galvanized Wire

Item No.	Ø Dia. mm (inches)	Length mm (inches)	Quantity
⑦	2 (1/16")	1920 (76")	4

2.2.3. Nails

Item No.	Ø Dia. mm (inches)	Length mm (inches)	Quantity
⑤	3 (1/8")	50 (2")	12

2.3. Inside Corner Board-BoxingTimber

Item No.	Size mm (inches)	Length mm (inches)	Quantity
⑧	25x130 (1"x5")	1675 (66")	4

2.4. Base Assembly Spacing BarsTimber

Item No.	Size mm (inches)	Length mm (inches)	Quantity
⑨	60 x 60 (2 ³ / ₈ " x 2 ³ / ₈ "	300 (12")	8

2.5. Top Assembly Spacing BarsTimber

Item No.	Size mm (inches)	Length mm (inches)	Quantity
⑩	45 x 45 (1 ³ / ₄ " x 1 ³ / ₄ "	700 (28")	4

COST ESTIMATE

(For Materials Only - 1982 Prices, Suva, Fiji)

1. Hints on Tank Selection

When the actual required capacity of the tanks is established from the cost comparison tables, select the tank with the lowest total cost figure.

It is always easier however, to construct single unit tanks on account of labour costs. The labour costs of multi-unit tanks are expected to be governed by the number of the units rather than the size of the tank components.

2. Modular Systems of As Standard Panels2.1. Rectangular Modules

Modular System	Capacity Imp. Gal.	Est. Cost US\$	Unit Cost £ Imp. Gal
As-1	450	82	18
As-2	900	148	16
As-3/11	1,350	220	16
As-3	1,350	212	16
As-4	1,800	271	15
As-6	2,700	389	14

2.2. Cross Shaped

Modular System	Capacity Imp. gal	Est. Cost US\$	Unit Cost £ Imp Gal
As-5	2,250	300	13
As-9	4,050	510	12
As-13	5,850	614	10
As-25	11,250	1,057	9

COST ESTIMATE

(For Materials Only - 1982 Prices, Suva, Fiji)

3. Modular System of A1 Standard Panels3.1. Rectangular Modular System

Modular System	Capacity Imp. Gal	Est. Cost US\$	Unit Cost ₣ Imp. Gal.
A1-1	1,100	140	13
A1-1½	1,370	202	15
A1-2	2,200	255	12
A1-3	3,300	350	11
A1-4	4,400	470	11
A1-6	6,600	676	10
A1-8	8,800	783	9
A1-9a	9,900	941	9.5

3.2. Cross Modular System

Modular System	Capacity Imp. Gal.	Est. Cost US\$	Unit Cost ₣ Imp. Gal
A1-5	5,500	499	9
A1-9b	9,900	862	9
A1-13	14,300	1,016	7
A1-25	27,500	1,738	6

3.3. Open Rectangular System

Modular System	Capacity Imp. Gal	Est. Cost US\$	Unit Cost ₣ Imp. Gal
R1-4	4,000	407	10
R1-6	6,000	463	8
R1-9	9,000	575	6





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