



WORLD HEALTH ORGANIZATION
REGIONAL OFFICE FOR THE WESTERN PACIFIC

**TRAINING GUIDE
FOR CONSTRUCTION OF THE
'COOK ISLANDS' MODULAR WATER TANK**

TRAINING OF WATER SUPPLY
AND SEWERAGE MANPOWER PROJECT
SUVA, JULY 1982

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ACKNOWLEDGEMENT

PREPARATION OF A PICTORIAL TRAINING GUIDE, SUCH AS THIS ONE, REQUIRES ENORMOUS AMOUNT OF EFFORT. IT IS NOT POSSIBLE TO ACKNOWLEDGE EVERYONE WHO HAS CONTRIBUTED EXCEPT IN A GENERAL WAY THROUGH THIS.

THE LION'S SHARE WAS ENTHUSIASTICALLY SHOULDERED BY MR STEVEN IDDINGS, THE AUTHOR OF THIS GUIDE. THE PHOTOGRAPHS WERE TAKEN BY THE AUTHOR HIMSELF, DURING THE ACTUAL CONSTRUCTION OF THESE TANKS IN FIJI, SAMOA AND VANUATU. HE HAS DEVELOPED THIS GUIDE BASED UPON ON-THE-JOB EXPERIENCE GAINED DURING THE SUCCESSFUL TRAINING EXERCISES IN THE ABOVE THREE COUNTRIES IMPARTING THIS TECHNOLOGY TO MORE THAN FORTY (40) POTENTIAL TRAINERS.

OUR APPRECIATION GOES FOR THE GOVERNMENTS OF FIJI, SAMOA AND VANUATU FOR THEIR KIND CO-OPERATION IN THE PROPAGATION OF THIS TECHNOLOGY AND FOR OFFERING THEIR FACILITIES AND SUPPORT FOR THE CONSTRUCTION DEMONSTRATION.

THE ENVIRONMENTAL HEALTH STAFF MEMBERS OF THE WESTERN PACIFIC REGION CONTRIBUTED TO THE ENRICHMENT OF THIS GUIDE BY THEIR VALUABLE COMMENTS ON THE DRAFT GUIDE. SPECIAL MENTION SHOULD BE MADE OF THE STAFF MEMBERS OF ICP/BSM/001 FOR THEIR GENEROUS AND CONTINUOUS HELP AND FOR SHARING THEIR RICH EXPERIENCES OF THE COOK ISLANDS' PROJECT, IN WHICH THIS PARTICULAR METHOD WAS INITIALLY DEVELOPED.

OUR THANKS ARE ALSO DUE TO MR P. REDDY OF THE EDUCATION RESOURCE CENTRE OF THE FIJI GOVERNMENT AND THE FIJI INSTITUTE OF TECHNOLOGY FOR THEIR EXPERT ADVISE AND HELP IN THE PRINTING OF THIS GUIDE.

DR. O. V. NATARAJAN
PROJECT CO-ORDINATOR, ICP/BSM/005
WORLD HEALTH ORGANIZATION
P. O. BOX 113, SUVA, FIJI ISLANDS

P R E F A C E

THE 'COOK ISLANDS' MODULAR TANK PROVIDES A CHEAP AND DURABLE MEANS OF WATER STORAGE.

IT IS THE PURPOSE OF THIS GUIDE TO EXTEND THE TECHNOLOGY NEEDED TO BUILD THIS NEW TYPE OF WATER TANK TO THE PEOPLE OF THE PACIFIC REGION.

THE OVERALL AIM, IS TO PROVIDE MORE CONVENIENT SUPPLIES OF SAFE DRINKING WATER A GOAL OF THE INTERNATIONAL DRINKING WATER SUPPLY AND SANITATION DECADE. THE DEVELOPMENT OF THIS GUIDE IS ONE PART OF THE DECADE ACTIVITIES OF THE WESTERN PACIFIC REGIONAL OFFICE.

ABOUT THE PROJECT

THE WHO PROJECT FOR TRAINING OF WATER SUPPLY AND SEWERAGE MANPOWER, FUNDED BY UNDP, COVERS THIRTEEN ENGLISH SPEAKING ISLAND COUNTRIES OF THE SOUTH PACIFIC. THE ACTIVITIES INCLUDE:

- A. STRENGTHENING OF TRAINING INSTITUTIONS
- B. TRAINING OF NATIONAL TRAINERS
- C. DEVELOPMENT OF TRAINING MODULES
- D. CONDUCTING PILOT NATIONAL TRAINING COURSE AND
- E. THE PROPAGATION OF FERROCEMENT TECHNOLOGY.

THIS TRAINING GUIDE IS THE FIRST OF MANY TRAINING MODULES TO BE PRODUCED

FOR FURTHER INFORMATION PLEASE CONTACT:

THE PROJECT CO-ORDINATOR
ICP:BSM 005
WHO — P. O BOX 113
SUVA, FIJI ISLANDS

TRIAL EDITION : SUGGESTIONS FOR IMPROVEMENTS ARE WELCOME.

CONTENTS

	PAGE
INTRODUCTION	1
THE STEPS	3
BACKGROUND	5
PURPOSE	5
TOOLS AND EQUIPMENT	6
SPECIAL TOOLS	7
MATERIALS	8
NOTES ON CONSTRUCTION	13
WORKYARD	13
LABOUR	13
MIXING	13
CURING	15
MANHOLE & FITTINGS	15
INSTRUCTIONS FOR BUILDING THE CUBICAL TANK	16
1 WIRING THE MOULD	17
2 CASTING A PANEL	18
3 REMOVING & BENDING	20
4 ERECTING THE TANK	21
5 CASTING THE BOTTOM EDGES & CORNERS	23
6 CASTING THE TOP EDGES	26
7 FINISHING	28

INTRODUCTION

THE 'COOK ISLANDS' MODULAR TANK HAS BEEN DEVELOPED TO PROVIDE A MORE DURABLE ALTERNATIVE TO THE COMMON GALVANIZED STEEL WATER TANK.

THE DESIGN EMPLOYS **HIGH TENSILE WIRE REINFORCED FIBROUS FERROCEMENT (HTWRFF)**: THAT IS GALVANIZED HIGH TENSILE WIRES AND SPECIALLY MANUFACTURED STEEL FIBRES PLACED IN A NORMAL CEMENT MORTAR MIX.

THIS NEW TECHNOLOGY ALLOWS FOR A STRUCTURE THAT IS STRONG, YET THINNER AND LIGHTER THAN ORDINARY 'FERROCEMENT' OR REINFORCED MORTAR TANKS WHICH MAKE USE OF FENCING, CHICKEN WIRE OR WELDED MESH FOR REINFORCEMENT.

THE RESULT IS A WATER TANK WHICH IS TRANSPORTABLE AS A WHOLE OR IN PARTS AND THEREFORE PERMITS THE EFFICIENCY AND CONVENIENCE OF WORKYARD PRODUCTION.

THE TANK IS 'MODULAR' BECAUSE A FULL RANGE OF SIZES MAY BE CONSTRUCTED BY JOINING THE BASIC PANELS TO FORM EITHER ONE 5M³ (1100 IMP. GAL) CUBICAL 'MODULE' OR LARGE MULTIPLE UNITS.

THE BASIC CUBICAL MODULE ITSELF IS MADE FROM SIX IDENTICAL PRECAST PANELS 1.65M SQUARE AND 16MM THICK JOINED AT THE EDGES. LARGER TANKS CAN BE ASSEMBLED USING THE VERY SAME PANELS JOINED WITH THE SAME TECHNIQUE.

THE METHOD IS INTENDED FOR THE CENTRALIZED PRODUCTION OF THE PRECAST PANELS IN A WORKYARD WHERE ELECTRICITY, TRAINED LABOUR AND SUPERVISION ARE AVAILABLE. THE FLAT PANELS (WEIGHING ABOUT 120KG EACH) ARE THEN STACKED AND TRANSPORTED TO THE SITE FOR ASSEMBLY UTILIZING PRIMARILY LOCAL LABOUR. COMPLETE CUBICAL TANKS MAY ALSO BE ASSEMBLED IN THE WORKYARD SINCE THE BASIC CUBICAL MODULE (ABOUT 1000KG) IS TRANSPORTABLE.

FOR LOCATIONS WITH VERY LIMITED ACCESSIBILITY WATER TANKS THAT ARE CONSTRUCTED ON SITE WOULD BE MORE SUITABLE. A SMALL 'COOK ISLANDS' MODULAR TANK CONSTRUCTION METHOD IS NOW AVAILABLE FROM WHO FOR SUCH APPLICATIONS.

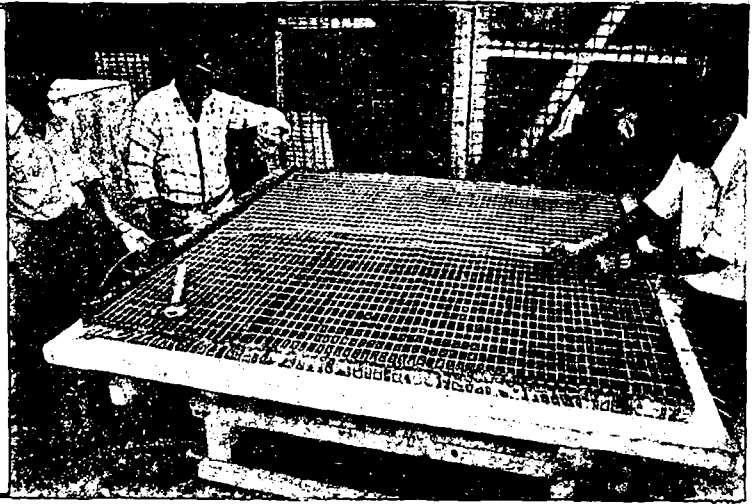
THE PHOTO SEQUENCE ON THE FOLLOWING PAGES OUTLINES THE SIX BASIC STEPS FOR THE CONSTRUCTION OF A CUBICAL TANK. THESE STEPS ARE SHOWN IN DETAIL IN THE LAST SECTION OF THIS GUIDE.

THE STEPS:

1.

WIRING THE MOULD

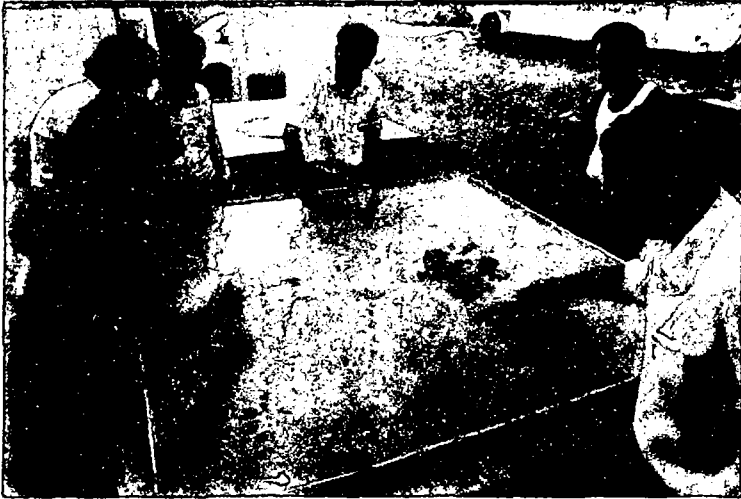
THE SPECIALLY PREPARED MOULD IS LACED WITH HIGH TENSILE WIRES



2.

CASTING A PANEL

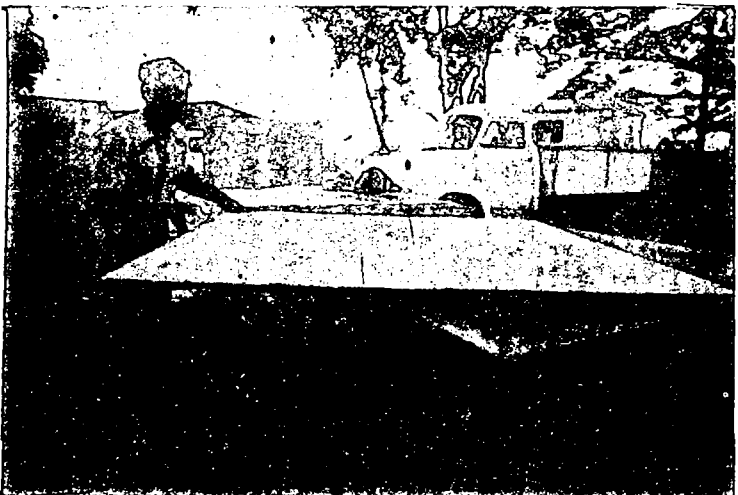
A PANEL IS CAST USING A RICH CEMENT MORTAR WITH STEEL FIBRES MIXED IN FOR ADDITIONAL REINFORCEMENT

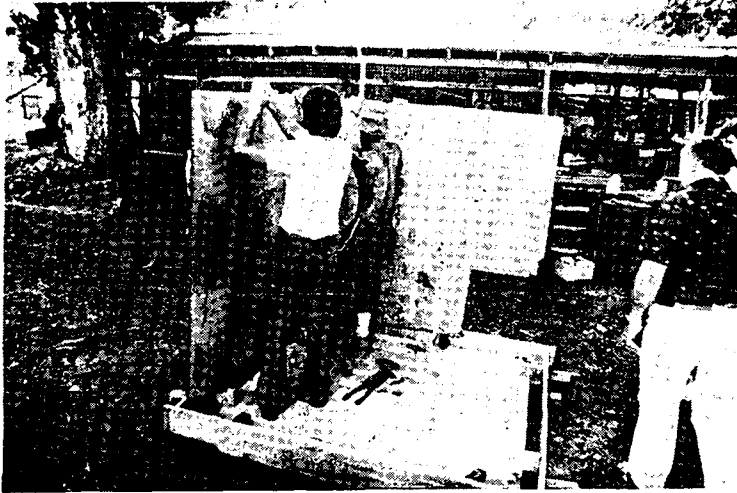


3.

REMOVING & BENDING

THE NEXT DAY THE PANEL IS REMOVED FROM THE MOULD. SIX ARE NEEDED TO BUILD A 5M³ (1100 IMP. GAL.) CUBICAL WATER TANK





4.

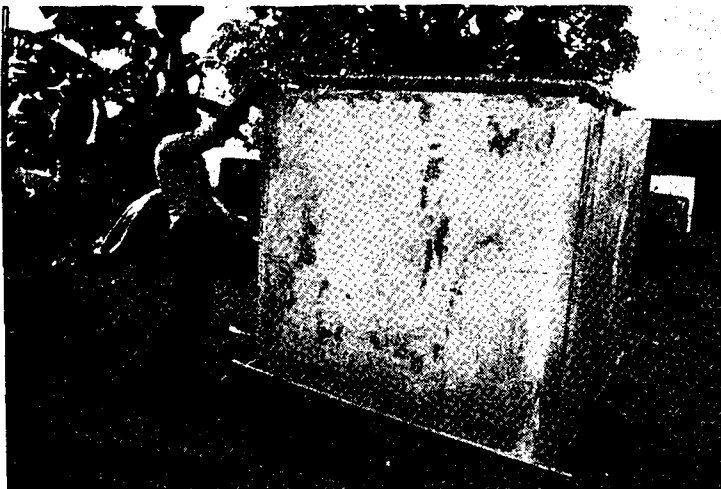
ERECTING THE TANK

THE PANELS ARE ERECTED IN A PREPARED 'BOX' AND HELD IN POSITION WITH TIE WIRES ...

5.

CASTING THE BOTTOM EDGES & CORNERS

...THEN THE CORNERS ARE CAST USING THE SAME MIX—TURE OF CEMENT MORTAR AND STEEL FIBRES.



6.

CASTING THE TOP EDGES

THE NEXT DAY THE TOP PANEL IS POSITIONED AND THE EDGES CAST IN THE SAME WAY.

BACKGROUND

THIS PRESENT 'STATE OF THE ART' OF WATER TANK CONSTRUCTION HAS EVOLVED FROM THE HTWRFF TECHNOLOGY FIRST MADE WIDELY AVAILABLE TO THE PACIFIC REGION IN A CONSTRUCTION MANUAL PUBLISHED BY WHO IN 1980.

THE PARTICULAR METHOD ILLUSTRATED IN THIS GUIDE WAS DEVELOPED IN RAROTONGA, COOK ISLANDS IN 1981 AS PART OF A WHO ASSISTED PROJECT. THE EXPERIENCE OF THAT PROJECT IS RECORDED IN ANOTHER WHO PUBLICATION TITLED: **MANUAL ON THE CONSTRUCTION OF COOK ISLANDS TYPE MODULAR WATER TANKS**. THAT MANUAL IS NOW AVAILABLE AS A DETAILED REFERENCE FOR ENGINEERS AND TECHNICIANS.

IN 1982 THIS METHOD WAS DEMONSTRATED IN FIVE ADDITIONAL SOUTH PACIFIC COUNTRIES. SPECIAL TRAINING COURSES INVOLVING WATER SUPPLY AND HEALTH PERSONNEL WERE HELD IN FIJI, SAMOA, T.T.P.I., VANUATU AND KIRIBATI.

PURPOSE

THIS GUIDE IS INTENDED AS A FOLLOW-UP TO THE COMPLETED TRAINING COURSES AND TO SERVE AS AN AID FOR TEACHING THE METHOD ELSEWHERE THROUGH LOCAL TRAINERS.

AS FAR AS POSSIBLE THE BENEFITS OF THE EXPERIENCE OF TRAINING BOTH SKILLED AND UNSKILLED PERSONNEL HAVE BEEN INCORPORATED. THOSE DETAILS OF CONSTRUCTION REQUIRING THE MOST EMPHASIS HAVE BEEN TREATED ACCORDINGLY.

AS THIS GUIDE HAS BEEN WRITTEN FOR USE AT 'FIELD LEVEL' IT IS INTENDED TO COMPLEMENT THE ENGINEERS CONSTRUCTION MANUAL MENTIONED ABOVE. THE READER WILL BE FREQUENTLY DIRECTED TO THIS REFERENCE AS SIMPLY **THE MANUAL**.

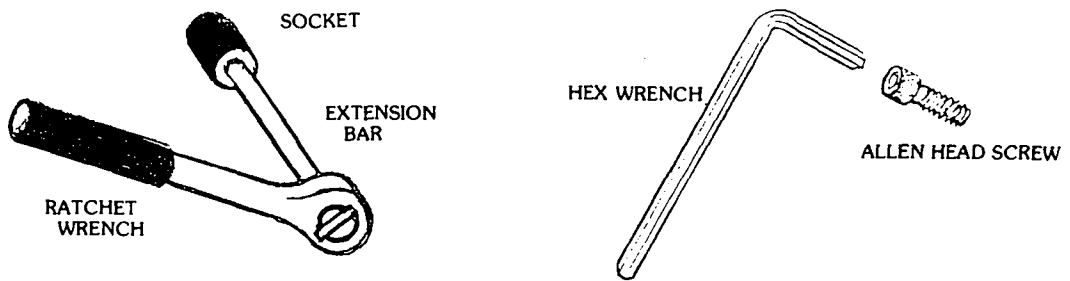
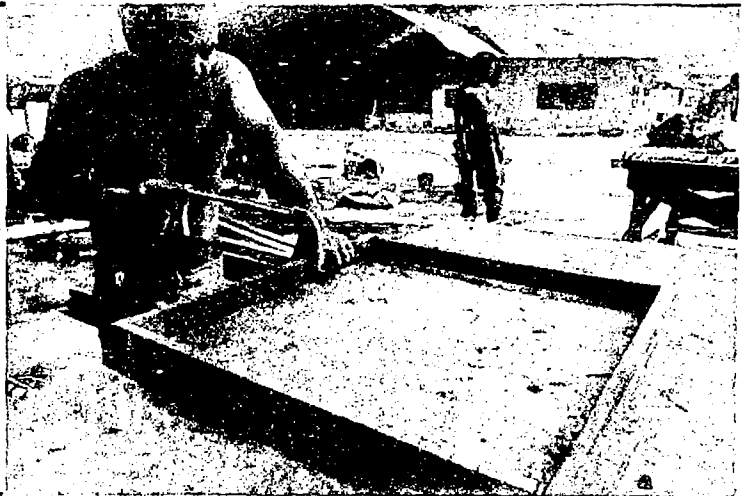
TOOLS AND EQUIPMENT

ITEM	MIN. NO. REQUIRED
PANEL MAKING MOULD	1 OR MORE (SEE THE
STAND FOR VIBRATING THE MOULD	'MANUAL' FOR DETAILS
SOURCE OF VIBRATION	ON MOULDS AND
	VIBRATION.)
TOOLS NORMALLY REQUIRED FOR CONCRETE WORK:	
SHOVELS	2
SIEVE FOR SAND, 4MM OPENINGS	1
PLASTIC BUCKETS	2
POINTED TROWELS	2
WOODEN FLOATS	2
STEEL FLOATS	2
TOOLS NORMALLY REQUIRED FOR CARPENTRY WORK:	
CLAW HAMMERS	2
HAND SAW	1
TAPE MEASURE	1
SQUARE	1
LARGE SCREWDRIVER	1
LEVEL	1
OTHER TOOLS REQUIRED:	
COLD CHISEL	1
WIRE CUTTERS	2
BOLT CUTTERS FOR 2MM AND LARGER H/T WIRE	1
LOCKING PLIERS OR TENSIONING TOOL	2 (SEE NEXT PAGE)
RATCHET WRENCH WITH EXTENSION BAR & SOCKET	1 (SEE NEXT PAGE)
WIRE BRUSH	1
HEX WRENCHES TO SUIT ALLEN HEAD SCREWS	6, KEEP EXTRAS
SLUMP CONE AND TAMPING ROD	1
PLASTIC SHEETING FOR CURING, 2M X 2M	2
SCALES OR SPRING BALANCE TO 10KG	1
USEFUL BUT NOT REQUIRED:	
CEMENT MIXER	
TEST CYLINDER MOULDS	
WHEELBARROW	
TOOL BOX (FOR TOOLS, SCREWS, TAPE, ETC)	
CROWBAR FOR REMOVING FORMWORK	

Special tools:

FIGURE A

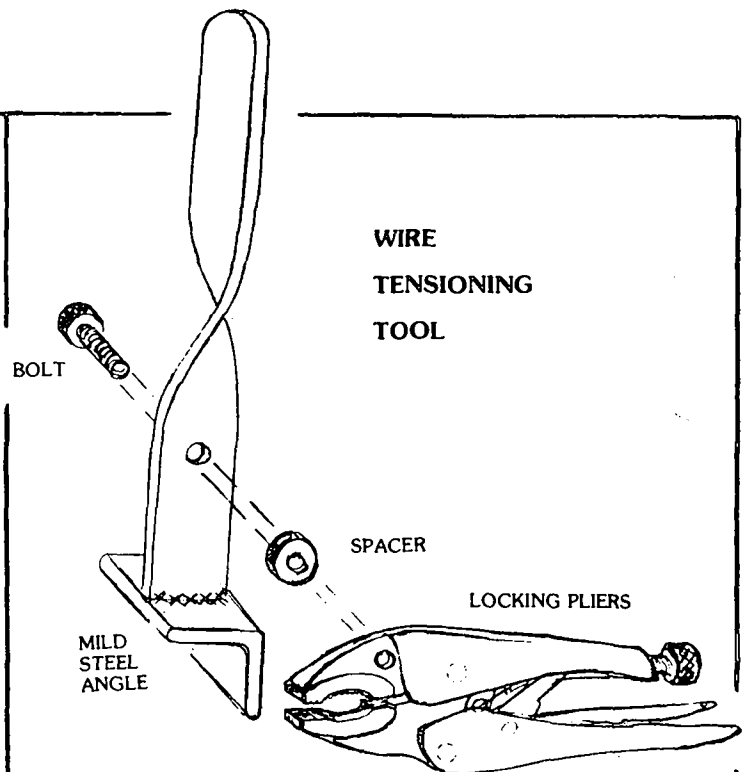
A SIMPLE FRAME TO LEAVE A MANHOLE IN A PANEL CAN BE CONSTRUCTED FROM TIMBER AS SHOWN. IT SHOULD BE 60 CM (24IN.) SQUARE. SAW SLOTS TO MATCH THE WIRES. THIS FRAME MAY LEAVE A MANHOLE IN THE CENTRE AS IN FIG 2F PG. 19. TO LEAVE A MANHOLE IN THE CORNER ONLY AN 'L' SHAPE FRAME WILL BE NEEDED.



(SEE FIG. 3A PG. 20) WRENCH SIZES TO SUIT THE PREPARED MOULD (SEE FIG. 1B PG. 17)

FIGURE B

THIS DRAWING SHOWS HOW A TENSIONING TOOL CAN BE MADE. A DRILL PRESS IS NEEDED TO DRILL THE PLIERS. THE HOLE MAY BE TAPPED TO SUIT AN EXTRA ALLEN HEAD BOLT FROM THE MOULD EDGE BARS. THE SPACER WILL ALLOW THE PLIERS TO WORK PROPERLY. THE TOOL IS USED AS SHOWN ON PG. 17 FIG. 1 C.



MATERIALS

THE MATERIALS NEEDED TO BUILD THE BASIC 5 M³ (1100 IMP. GAL.) TANK ARE SHOWN IN THE TABLE BELOW. FOR REFERENCE THE 1982 UNIT PRICES (INCLUDING SHIPPING) OF THESE MATERIALS IN SUVA FROM NON-GOVERNMENT RETAILERS ARE LISTED.

A LIST OF SUPPLIERS OF H/T WIRE, STEEL FIBRE AND ADDITIVE TO THE PACIFIC REGION IS ON PAGE 12.

TABLE OF QUANTITIES AND SAMPLE PRICES:

	FOR ONE PANEL	TOTAL FOR JOINING	TOTAL FOR ONE TANK	UNIT PRICE F\$/KG	UNIT PRICE US\$/KG ⁽¹⁾	COST US \$
SAND	80 KG	240 KG	720 KG	\$.01/KG	\$.01/KG	\$ 7.20
CEMENT	40 KG	120 KG	360 KG	\$.10/KG	\$.11/KG	39.60
STEEL FIBRE	7.6 KG	23 KG	69 KG	\$.82/KG	\$.91/KG	62.79
H/T WIRE⁽²⁾	6 KG		36 KG	\$.97/KG	\$1.08/KG	38.88
ADDITIVE⁽³⁾	21 GRAMS	63 GRAMS	189 GRAMS	\$6.00/KG	\$6.67/KG	1.26
TIE WIRE, TAPE, NAILS, WIRE SCREEN (FOR INLET AND OVERFLOW PIPE)						2.00
LOCKING BRASS TAP, WASHOUT PLUG AND SOCKETS (3/4")						7.50
OVERFLOW PIPE (SCRAP PVC)						

(1) RATE OF EXCHANGE: US \$ 1.00 F \$.90 **TOTAL COST PER TANK** US \$ 160

(2) USING 1440M OF 2.0MM Ø WIRE ON 25MM SPACINGS

(3) CHROMIUM TRIOXIDE (IF NEEDED) SEE PG. 11 **COST PER M³ OF STORAGE** \$ 32

THE COST PER CUBIC METER OF STORAGE WILL BE MUCH LESS FOR LARGER SIZED TANKS WHERE THE CUBICAL MODULES ARE JOINED TOGETHER. THIS IS EXPLAINED IN DETAIL IN THE 'MANUAL'. NOTE THESE COSTS ARE FOR MATERIALS ONLY.

SAND

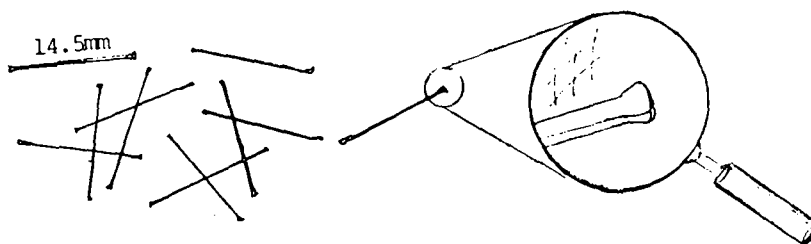
SAND MUST BE CLEAN AND PASSED THROUGH A SIEVE WITH 4MM (3/16 in) OPENINGS. RIVER SAND IS USUALLY BETTER THAN CORAL SAND. IF BEACH SAND IS USED COLLECT IT FROM HIGH ON THE BEACH WHERE THE RAIN WILL HAVE WASHED OUT THE SALT. FINE SAND OR A MIXTURE OF FINE AND COARSE SANDS IS BEST.

CEMENT

ANY ORDINARY PORTLAND CEMENT WILL DO. IT MUST BE FRESH WITHOUT ANY LUMPS.

STEEL FIBRE

MOST COMMON IS 'FIBRESTEEL' AVAILABLE FROM AUSTRALIAN WIRE INDUSTRIES. THIS MATERIAL IS MANUFACTURED ESPECIALLY FOR USE IN CONCRETE. THE FIBRES ARE SHOWN IN THE DIAGRAM BELOW:



THE STEEL FIBRES ARE ADDED AFTER THE CEMENT AND SAND AND SOME WATER ARE MIXED. THEY MUST BE SPRINKLED IN WHILE MIXING TO AVOID LUMPS. THE MIXTURE IS THEN USED LIKE ORDINARY CEMENT MORTAR.

HIGH TENSILE WIRE

THE DESIGN OF 'FIBROUS FERROCEMENT' IS BASED UPON THE USE OF GALVANIZED HIGH TENSILE (H/T) 'SPRING QUALITY' WIRE AS REINFORCEMENT. ORDINARY MILD STEEL WIRE OR MESHES HAVE ONLY ONE THIRD THE STRENGTH OF H/T WIRE. THEIR USE IS NOT RECOMMENDED. THE RECOMMENDED WIRE IS NOTED BELOW:

DIAMETER	TYPE	NEEDED FOR ONE PANEL
2.0MM	H/T 'SPRING QUALITY' (GALVANIZED)	6.0KG

H/T WIRE IS NORMALLY SOLD IN 100KG COILS. PANEL MAKING IS EASIER IF WIRES ARE ORDERED IN **STRAIGHTENED LENGTHS**, PRECUT TO 1.80M. IF STRAIGHTENED LENGTHS ARE USED **SLOTTED** MOULD EDGE BARS MAY BE USED ON TWO SIDES AND THE WIRES ARE PULLED TIGHT IN ONLY ONE DIRECTION (SEE THE 'MANUAL').

TIE WIRE

A LIGHT, SOFT WIRE: BLACK OR GALVANIZED IS NEEDED TO BIND H/T WIRES TOGETHER. (SEE FIGURE 4E PG 22). H/T WIRE IS TOO STIFF FOR THIS PURPOSE. REQUIRED: 1KG PER CUBICAL TANK.

ADDITIVES

CHROMIUM TRIOXIDE, CR O₃ MAY BE NEEDED TO PREVENT GAS BUBBLES FROM FORMING IN THE WET MORTAR. THIS CAN OCCUR WHEN CEMENTS LOW IN CHROMIUM CONTENT ARE USED. ADDING 5 GRAMS OF CR O₃ PER 10KG OF CEMENT WILL KEEP THIS FROM HAPPENING.

MASKING TAPE

TAPE IS NEEDED TO COVER THE SCREWS (FIG 2 A PG 18) TO KEEP CEMENT MORTAR FROM CLOGGING THE SCREW SOCKETS. REQUIRED: 50M (1 ROLL) PER CUBICAL TANK.

FORMWORK

THE FOLLOWING TIMBER IS REQUIRED FOR THE ASSEMBLY OF THE BASIC CUBICAL MODULE, AS ILLUSTRATED IN STEPS 4 THROUGH 6:

ITEM NO.	SIZE	QUANTITY	SEE
1)	25 x 150 x 1950mm (1"x6"x6'6')	12 PIECES	FIGURE 4a, PAGE 21
2)	25 x 125 x 1830mm (1" x 5" x 6')	4 "	" 6b " 26 5c, " 23
3)	60 x 60 x 300mm (2 ³ / ₈ " x 2 ³ / ₈ " x 1')	8 "	" 4b, " 21
4)	45 x 45 x 700mm (1 ³ / ₄ " x 1 ³ / ₄ " x 28")	4 "	" 6a, " 26
5)	100 x 100 x 2100mm (4" x 4" x 7')	2 "	" 4a, " 21

THE TIMBERS SHOULD BE STRAIGHT BUT DO NOT NEED TO BE DRESSED. THE SIZES LISTED WILL BE SQUARED AND CUT AS NECESSARY IN STEPS 4, 5 & 6. ALL PIECES WILL BE REUSABLE.

SCRAPS OF TIMBER FOR MAKING SPACERS AND FOR PRYING AND LEVELLING WOULD PROBABLY BE AVAILABLE AT MOST WORK SITES.

LISTING OF SUPPLIERS

H/T WIRE

AUSTRALIAN WIRE INDUSTRIES, PTY LTD.
P. O. BOX 55, FIVE DOCK, N.S.W. 2046, AUSTRALIA

FIJI WIRE INDUSTRIES
P. O. BOX 628 NADI, FIJI

STEEL FIBRE

SOLD AS 'FIBRESTEEL' BY A.W.I. LISTED ABOVE

SOLD AS 'FIBRE CON'
MITCHELL FIBRECON, INC.
9800 McKNIGHT ROAD, SUITE 250.
PITTSBURGH, P.A. 15237, U.S.A

SOLD AS 'STEEL FIBRE'
NOZAWA CORPORATION
KYOTOMI BLDG., 3-16, SONEZAKI - SHINCHI
1 - CHOME, KITA-KU, OSAKA, JAPAN

ADDITIVE

CHROMIUM TRIOXIDE (CR O₃)
AJAX CHEMICALS
SYDNEY, AUSTRALIA

NOTES ON CONSTRUCTION

WORKYARD

INDOOR WORKSPACE FOR THE MAKING OF PANELS IS BEST BUT NOT REQUIRED. A SHADED AREA WITH COVERINGS FOR MOULDS IN CASE OF RAIN IS ENOUGH.

A CLEAN, FLAT AREA OR A CEMENT MIXER IS NEEDED FOR MIXING. CHOOSE A WORK AREA SO THAT WATER, ELECTRICITY FOR VIBRATION, AND THE MATERIALS STOREROOM ARE NEARBY.

ASSEMBLY OF A TANK IN THE FIELD WILL NOT REQUIRE ELECTRICITY OR THE SPECIAL TOOLS USED FOR MAKING PANELS.

LABOUR

NO VERY SPECIAL SKILLS ARE REQUIRED TO LEARN THE CONSTRUCTION OF THIS TANK. THESE INSTRUCTIONS ASSUME HOWEVER, THAT AT LEAST SOME OF THE LABOURERS KNOW HOW TO MIX CONCRETE OR MORTAR.

AT LEAST TWO PERSONS ARE NEEDED FOR THE MAKING OF PANELS. TWO TRAINED MEN CAN PRODUCE TWO PANELS PER DAY USING TWO MOULDS.

FOUR PERSONS WILL BE NEEDED TO ERECT THE WATER TANK FROM THE PANELS. ONE EXPERIENCED TANK BUILDER WITH THREE UNTRAINED HELPERS CAN COMPLETE THIS TASK IN ONE DAY AND A HALF.

MIXING

THE INSTRUCTIONS LIST THE AMOUNT OF EACH MATERIAL BY WEIGHT (PG 18 FIG 2C). VOLUME MEASUREMENTS MAY ALSO BE USED. AFTER SOME PRACTICE THE PROPER VOLUMES IN THE BUCKETS OR BOXES BEING USED WILL BECOME WELL KNOWN.

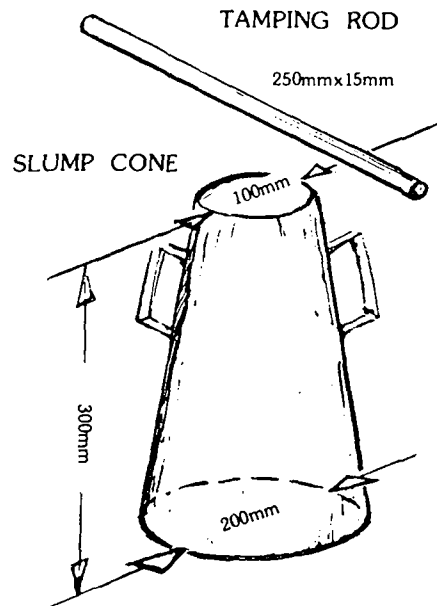
THE CORRECT 'WORKABILITY' OF THE MIX (HOW WET OR DRY IT IS) IS IMPORTANT. THE WORKABILITY IS CHECKED USING THE **SLUMP TEST** SHOWN ON THE NEXT PAGE AND ALSO IN THE PHOTO AT THE TOP OF PAGE 19. THE PROPER SLUMP IS 25 TO 35MM (1 TO 1 1/2") FOR CASTING PANELS AND FOR CASTING CORNERS AND EDGES.

THE SLUMP TEST

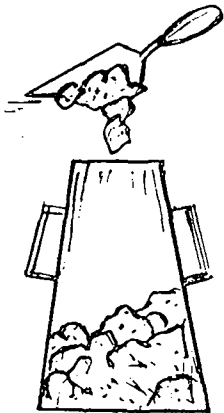
A SLUMP TESTER IS SHOWN IN THE DRAWING (RIGHT) THIS MAY BE BORROWED FROM A CONSTRUCTION CONTRACTOR. THEN A COPY CAN BE MADE USING GALVANIZED METAL SHEETING 1.6MM (16 GAUGE) THICK.

TO TEST:

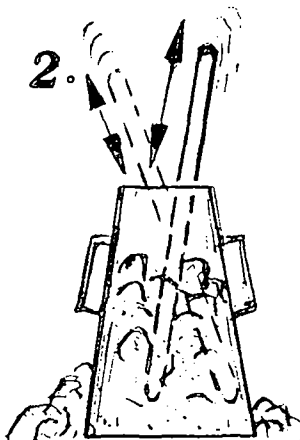
1. ON A FLAT, LEVEL SURFACE FILL THE CONE HALF WAY WITH THE MIXTURE.
2. GIVE 10 FULL STROKES WITH THE TAMPING ROD THEN FILL TO THE TOP AND GIVE 10 MORE STROKES THEN FILL TO THE TOP AGAIN AND GIVE 10 MORE.
3. LEVEL OFF THE EXTRA MORTAR WITH THE TROWEL AND CLEAR MORTAR AWAY FROM THE BASE.
4. LIFT THE CONE STRAIGHT UP & MEASURE THE SLUMP.
5. IF THE MIX IS TOO DRY ADD MORE WATER IF THE MIX IS TOO WET ADD MORE CEMENT AND USE LESS WATER NEXT TIME.
6. AFTER ADJUSTING THE MIX CHECK THE SLUMP AGAIN.



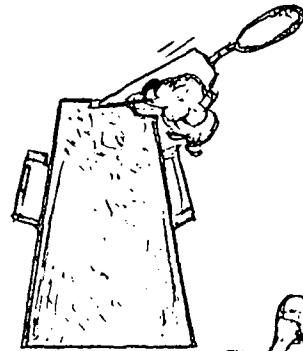
1.



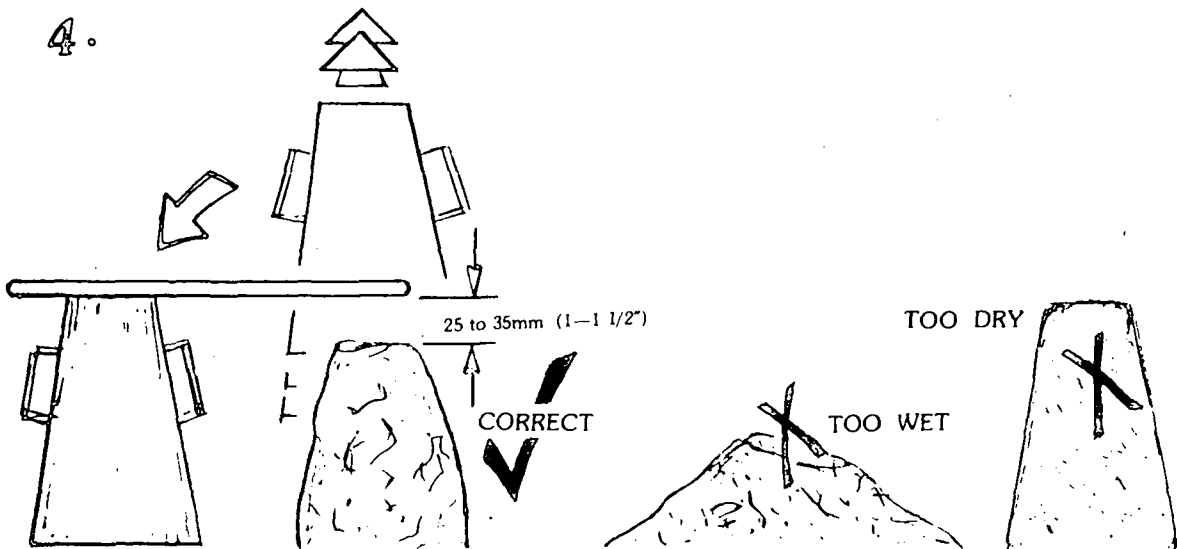
2.



3.



4.



PLACING

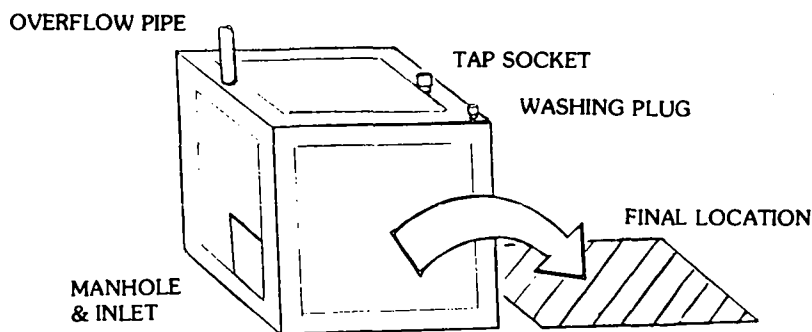
THE PROPER USE OF TROWELS AND FLOATS WILL BE LEARNED ONLY BY PRACTICE. TRY USING ONLY THE **WOODEN** FLOATS FOR LEVELLING PANELS AND SHAPING CORNERS. THEN USE THE **STEEL** FLOATS FOR FINISHING AFTER THE MORTAR HAS BEGUN TO SET. IF THE BOTTOM OR VERTICAL CORNERS SEEM TOO SOFT TO SHAPE, LEAVE THEM FOR 30 MINUTES. THEN SHAPE THEM WITH THE **WOODEN** FLOAT.

CURING

CONCRETE OR MORTAR HARDENS BY 'CURING' NOT BY DRYING. CURING IS A CHEMICAL REACTION WHICH CONSUMES THE WATER IN THE MIXTURE. DRYING IN THE SUN OR WIND IS HARMFUL AND COULD CAUSE CRACKS OR WEAKNESS. FOR THIS REASON IT IS BEST TO KEEP PANELS OR ANY FRESHLY CAST CORNERS WITH PLASTIC OR WET SACKS FOR AT LEAST THREE DAYS. FINISHED TANKS SHOULD BE KEPT PARTLY FILLED WITH WATER AND ALLOWED TO CURE FOR FIVE DAYS BEFORE FILLING.

MANHOLE AND FITTINGS

THE TANK IS MOST EASILY CONSTRUCTED ON ITS SIDE. THIS WILL MAKE IT EASY TO GET IN AND OUT DURING CONSTRUCTION AND THE FITTINGS WILL BE SIMPLE TO PUT INTO PLACE. THE TANK CAN THEN BE TURNED ONTO ITS FINAL LOCATION AS SHOWN IN THE DRAWING BELOW:



STEP—BY—STEP INSTRUCTIONS

1. Wiring the mould:

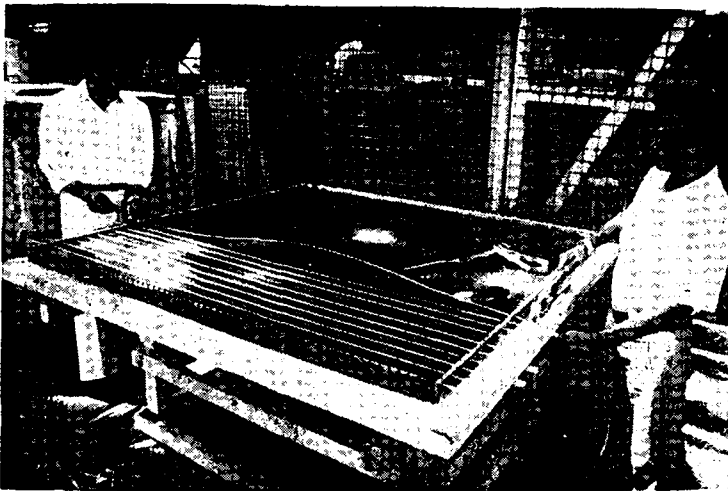


FIGURE 1 A

THE MOULD IS FIRST VERY LIGHTLY OILED. H/T WIRE IS THEN INSERTED AND CUT TO LENGTH USING THE OUTER EDGE OF THE MOULD AS A GUIDE, OR THE WIRES MAY BE PRECUT TO 180 CM (5' 11"). THE SCREWS ARE TIGHTENED ON ONE SIDE ...

FIGURE 1 B

... AND LOCKING PLIERS ARE USED ON THE OPPOSITE SIDE TO PULL THE WIRE STRAIGHT. DO NOT MAKE THE SCREWS TOO TIGHT; ONLY TIGHT ENOUGH TO HOLD THE WIRE STRAIGHT.



FIGURE 1 C

THIS TOOL IS USEFUL FOR PULLING THE WIRES STRAIGHT. THE TOOL CAN BE MADE IN A WORKSHOP AS SHOWN IN THE DRAWING FIG. B PG. 7. REMEMBER IT IS ONLY NECESSARY TO PULL THE WIRE STRAIGHT IT DOES NOT HAVE TO BE VERY TIGHT.

COMPLETE THE WIRING IN THE OTHER DIRECTION IN THE SAME WAY. THEN CHECK AGAIN TO SEE THERE ARE NO LOOSE WIRES. TRIM WIRES EVEN, IF NECESSARY USING THE TIMBER EDGE AS A GUIDE. THEY SHOULD EXTEND 75MM (3").



2. Casting a panel:

FIGURE 2 A

BEFORE MIXING THE CEMENT PROTECT THE SCREWS BY COVERING THEM WITH MASKING TAPE. THIS WILL KEEP THE MORTAR FROM CLOGGING THE SCREW SOCKETS.



FIGURE 2 B

IF CHROMIUM TRIOXIDE IS REQUIRED (PAGE 11) ADD IT TO THE WATER THAT WILL BE USED FOR MIXING THE MORTAR FOR THE PANEL. ONLY 21 GRAMS (OR ABOUT ONE CAPFUL) IS NEEDED.

CAUTION

CHROMIUM TRIOXIDE IS POISONOUS
BE CAREFUL AND WASH HANDS CLEAN AFTER USING

FIGURE 2 C

IN A CONCRETE MIXER OR ANY CLEAN SURFACE
MIX FOR 10 MINUTES:

SAND	80KG	(180LBS)
CEMENT	40KG	(90LBS)
WATER	16KG	(36LBS)
FIBRE	7.6KG	(17LBS)

ADD WATER A LITTLE AT A TIME.....LESS THAN 16KG IS USUALLY ENOUGH FOR THE PROPER 'SLUMP'. THEN SPRINKLE IN THE STEEL FIBRES. DO NOT ALLOW LUMPS OF FIBRES IN THE MIX.



FIGURE 2 D

AFTER MIXING IN THE FIBRES (BUT BEFORE ALL OF THE WATER IS ADDED) THE 'SLUMP' MUST BE CHECKED. THIS TEST IS EXPLAINED ON PAGE 14. MAKE THE TEST ON A LEVEL SURFACE. ADJUST THE MIX UNTIL THE SLUMP IS FROM 25-35MM (1 TO 1 1/2 IN).

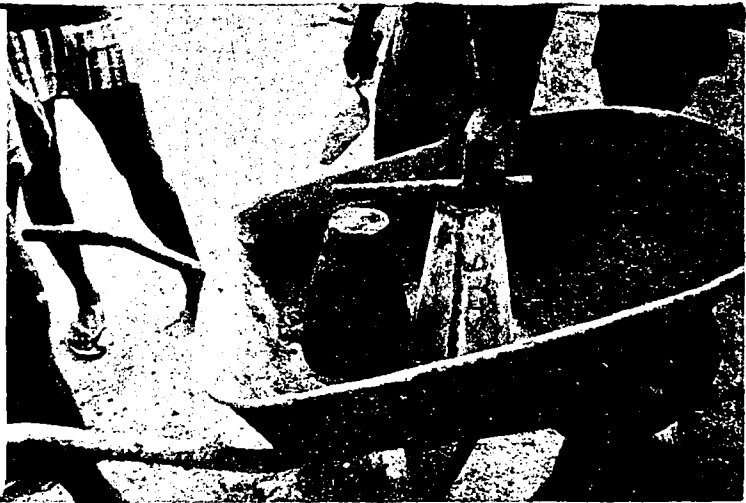


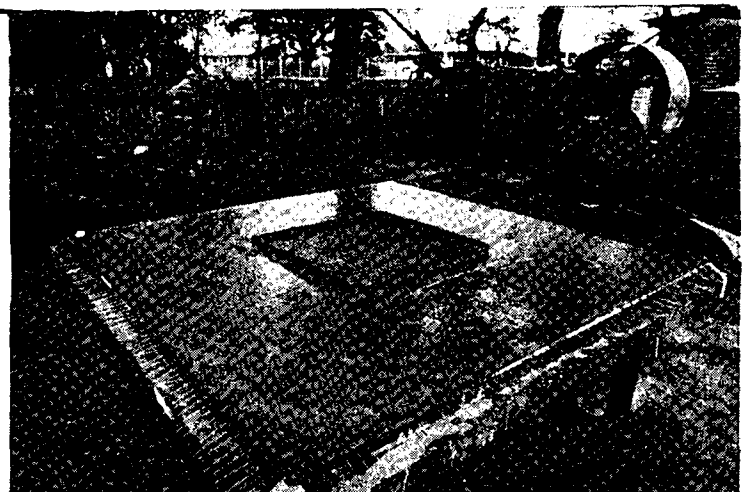
FIGURE 2 E

WHEN THE SLUMP IS CORRECT SPREAD THE MIX ON THE MOULD EVENLY. TURN ON THE VIBRATION AND USE WOODEN FLOATS TO LEVEL THE SURFACE WITH THE EDGES OF THE MOULD. IF EXTRA MIXTURE IS LEFT OVER USE LESS MATERIALS FOR THE NEXT PANEL. THREE TO TEN MINUTES OF VIBRATION IS ENOUGH. (SEE THE MANUAL)



FIGURE 2 F

THIS CASTING HAS A MANHOLE LEFT IN BY USING A WOODEN FRAME TO KEEP OUT THE MIX (SEE PG 7) FINISH THE PANEL SMOOTH WITH A STEEL FLOAT, AND SMOOTH AGAIN AFTER IT HAS SET FOR 30 MINUTES. COVER AND LEAVE FOR ABOUT 24 HOURS (SEE NOTS ON CURING PG 15).



3. Removing and bending:

FIGURE 3 A

THE FOLLOWING DAY ALL SCREWS ARE LOOSENED THREE TURNS. THE BOLTS THAT HOLD THE MOULD EDGE BARS ARE REMOVED WITH THE RATCHET WRENCH (SEE PG. 7). THE BAR WILL PRY EASILY FROM THE MOULD. IF IT IS STUCK CHECK THAT ALL THE SCREWS ARE LOOSE.



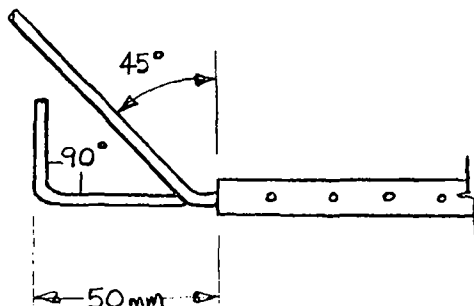
FIGURE 3 B

WHEN ALL FOUR BARS ARE REMOVED ROTATE THE PANEL SLIGHTLY TO FREE IT FROM THE MOULD. LIFT EXACTLY AS SHOWN.

DO NOT LIFT ON THE WIRES.
DO NOT LIFT AT THE CORNERS.
PLACE THE PANEL ON LEVEL SUPPORTS. IT SHOULD BE KEPT WET AND COVERED FOR THREE DAYS.

FIGURE 3 C

BEFORE ERECTING THE TANK THE WIRES SHOULD BE BENT EXACTLY AS SHOWN. A SMALL PIPE CAN BE USED FOR THIS JOB. MAKE THE BENDS SHARP BY BENDING FORWARD (ARROW). DO NOT PUSH DOWN BECAUSE THIS CAN BREAK THE MORTAR.



4. Erecting the tank:

FIGURE 4 A

CONSTRUCT A SQUARE BOX AS SHOWN. USE TIMBERS (8 PIECES) DESCRIBED IN ITEM NO. 1 PAGE 11. THE INSIDE DIMENSION MUST BE 177CM (70") IN BOTH DIRECTIONS. BE SURE ALL CORNERS ARE SQUARE AND NAILED TIGHT. LEVEL THE BOX ON TIMBERS (ITEM 5) NEXT TO THE FINAL LOCATION FOR THE TANK.

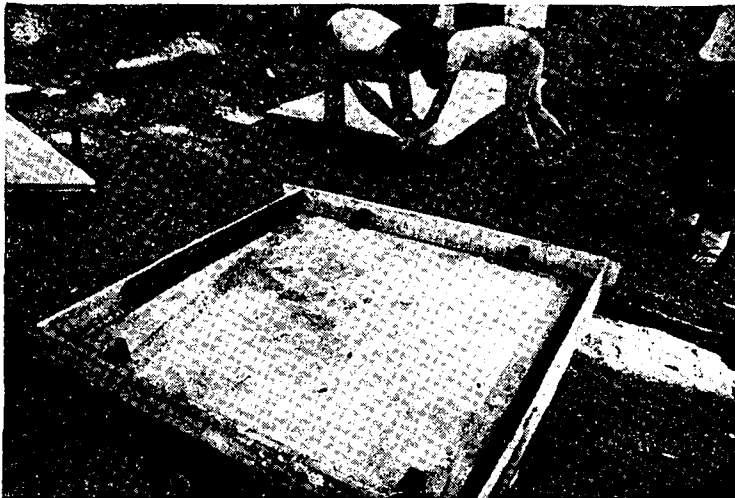
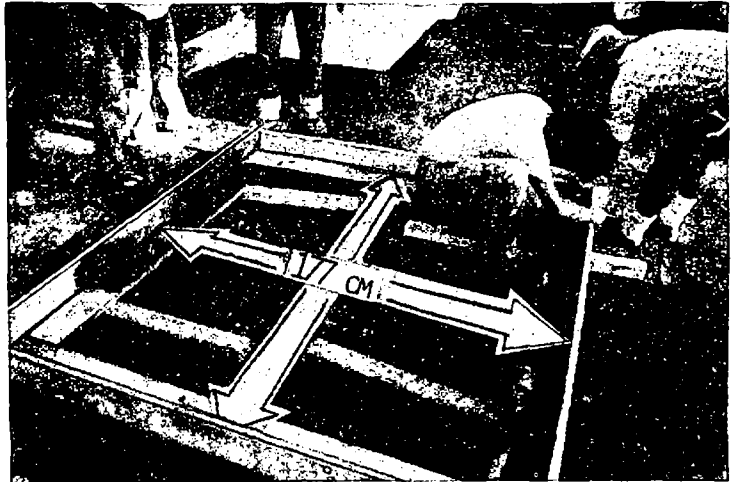


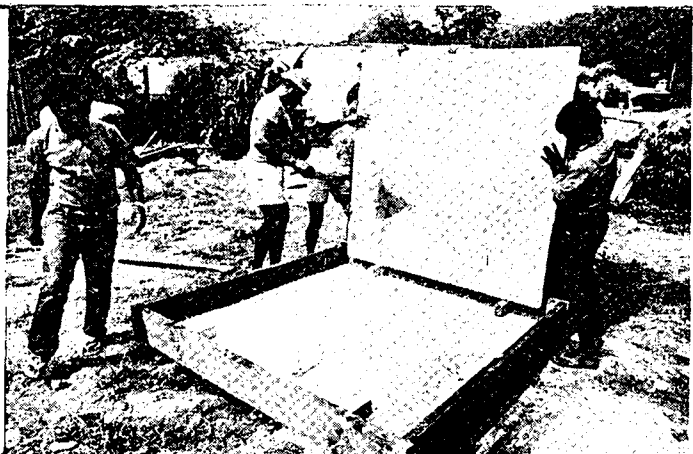
FIGURE 4 B

PLACE THE FIRST PANEL IN THE BOX AND CENTER IT WITH A 60MM (2 3/8") SPACE ON EACH SIDE. THEN 8 SPACER BLOCKS, 60MM HIGH ARE PLACED ON THE PANEL AND AGAINST THE BOX. ONLY FOUR SPACER BLOCKS ARE SHOWN.

(ITEM NO. 3 PG. 11)

FIGURE 4 C

TWO SPACER BLOCKS WILL SUPPORT EACH PANEL. KEEP THIS PANEL PRESSED AGAINST THE SIDE OF THE BOX



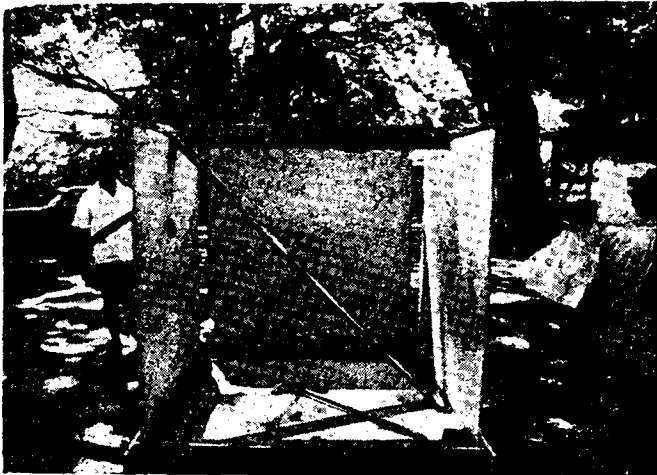


FIGURE 4 D

NEXT PUT THE OTHER PANELS INTO PLACE. THE MANHOLE PANEL IS USED AS ONE OF THE SIDES. THIS IS EXPLAINED ON PAGE 15 AND PAGE 4 STEP FOUR.

HOLD THE PANELS VERTICAL OR PROP THEM...

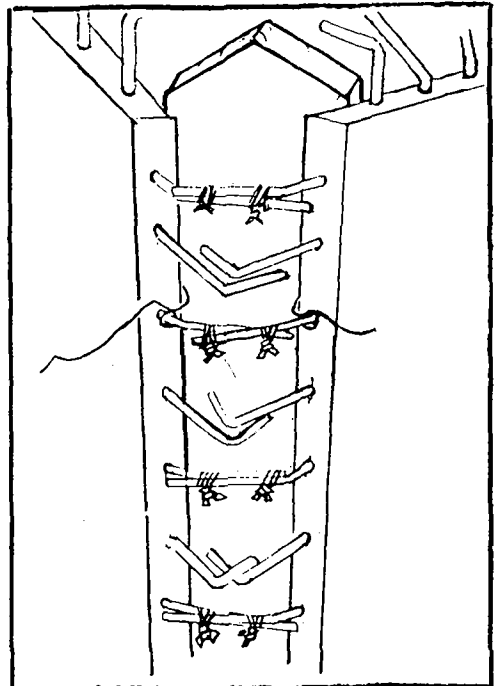


FIGURE 4 E

... UNTIL THE 45° WIRES CAN BE BOUND TOGETHER WITH TIE WIRE. IT IS NOT NECESSARY TO BIND THE 90° WIRES. DO NOT TWIST THE H/T WIRES. LEAVE THEM AT 45° AND 90° FOR STRENGTH.

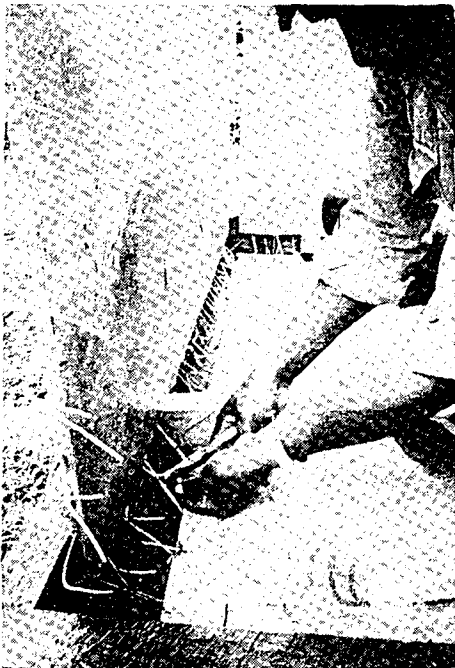


FIGURE 4 F

BIND ALL 45° WIRES ON THE BOTTOM IN THE SAME WAY AS SHOWN IN FIGURE 4 E.



FIGURE 4 G

THE SPACER BLOCKS MAY REST AS SHOWN. WHEN ALL OF THE 45° WIRES ARE BOUND TIGHT THE BLOCKS MAY BE REMOVED. THOUGH IT IS BEST TO LEAVE THEM UNTIL THE TIME OF CASTING. CLEAN UP ALL SCRAPS.

5. Casting the bottom edges & corners:

FIGURE 5 A

PREPARE A MIX WITH STEEL FIBRES THE SAME AS FOR MAKING A PANEL (PG 18 FIG. 2 B, C AND D). BEFORE CASTING SOAK THE EDGES AND FORMWORK WITH WATER. THEN CAREFULLY REMOVE THE SPACER BLOCKS. USE A STICK TO POKE MORTAR INTO ALL THE GAPS.

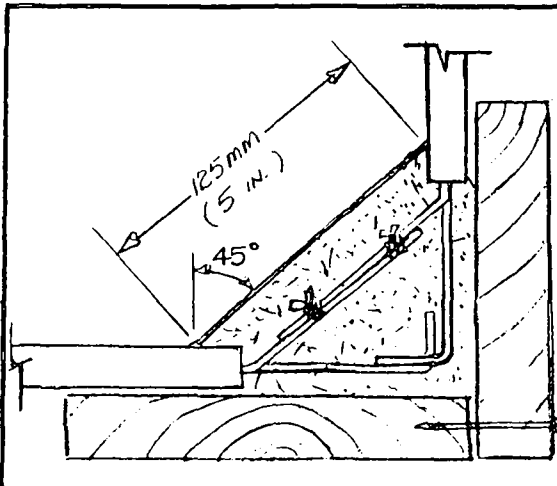


FIGURE 5 B

FINISH WITH A WOODEN FLOAT TO 45° AS SHOWN IN THE DRAWING. PROVIDE THE SAME 45° SLOPE AT THE MANHOLE ALSO.

FIGURE 5 C

CASTING THE VERTICAL CORNERS DOES NOT HAVE TO WAIT FOR THE BOTTOM EDGES TO SET. PREPARE FOUR TIMBERS (ITEM 2 PG 11) WITH THE ENDS POINTED (LEFT). WIRE THEM AS SHOWN TO THE OUTSIDE (SEE ALSO FIG. 4 E).

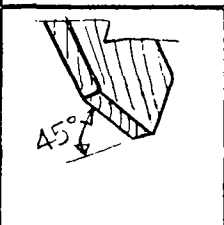




FIGURE 5 D

PREPARE THE SAME MIXTURE AGAIN (FIGURES 2 B, C AND D PG. 18. THE SLUMP MUST BE CORRECT FOR THIS TO WORK WELL.

WET THE PANEL EDGES AND FORMWORK BEFORE CASTING. DO THIS WITH VERY LITTLE WATER IF THE BOTTOM EDGES ARE STILL SOFT.

USE THE POINTED TROWEL AND THE PLASTER'S 'HAWK' AS SHOWN. PRESS THE MIX IN BETWEEN THE WIRES. START AT THE BOTTOM AND GO PART WAY TO THE TOP...

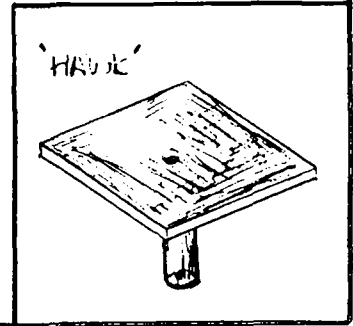
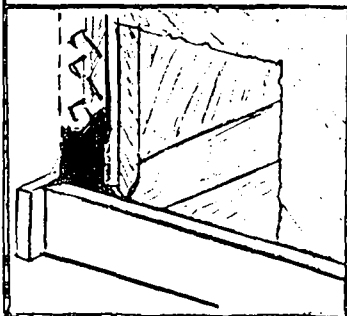


FIGURE 5 E

... THEN USE A STICK TO POKE THE MORTAR INTO THE CORNERS.

**DO NOT TRY TO HURRY THIS JOB.
DO NOT TRY TO FINISH THE CORNER SQUARE.**

LEAVE THE CORNER VERY ROUGH ON THE FIRST COAT. USING THE POINTED TROWEL AND THE STICK AS SHOWN



FINISH THE CORNER TO THE TOP. THEN LET IT SET AND COMPLETE THE OTHER CORNERS. IF THE MANHOLE (LEFT) IS IN ONE CORNER COMPLETE THAT CORNER TO LOOK LIKE THE OTHER CORNERS.



FIGURE 5 F

AFTER AN HOUR PLACE A BOARD (ITEM 1 PG. 11) AGAINST ONE SIDE OF THE CORNER. MAKE IT FLUSH AND PROP IT TIGHT AS SHOWN.

THE CORNER MAY NOW BE FILLED IN SQUARE. WORK FROM BOTTOM TO TOP. USE THE HAWK AND TROWEL.

DO NOT TRY TO MAKE IT SMOOTH YET. COMPLETE THE OTHER CORNERS IN THIS WAY.



FIGURE 5 G

AFTER ANOTHER HOUR REMOVE THE SIDE BOARD. USE A WOODEN FLOAT TO 'SHAPE-UP' THE CORNER. PRESS LIGHTLY AND USE EASY CIRCULAR MOTIONS. FINISH THE FOUR VERTICAL CORNERS THIS WAY.

AFTER SEVERAL HOURS OR THE NEXT DAY REMOVE THE FORMWORK FROM THE INSIDE, AND ALSO FROM THE BOTTOM.



6. Casting the top edges:

FIGURE 6 A

WHEN THE FORMWORK INSIDE IS REMOVED. . . LIFT THE LAST PANEL INTO PLACE. REST IT ON 45 MM (1 3/4") SPACERS AS IS SHOWN. WHEN THE PANEL IS LEVEL AND SQUARE BIND ALL 45 H/T WIRES TOGETHER WITH TIE WIRE. THE SPACERS MAY THEN BE TAKEN OUT

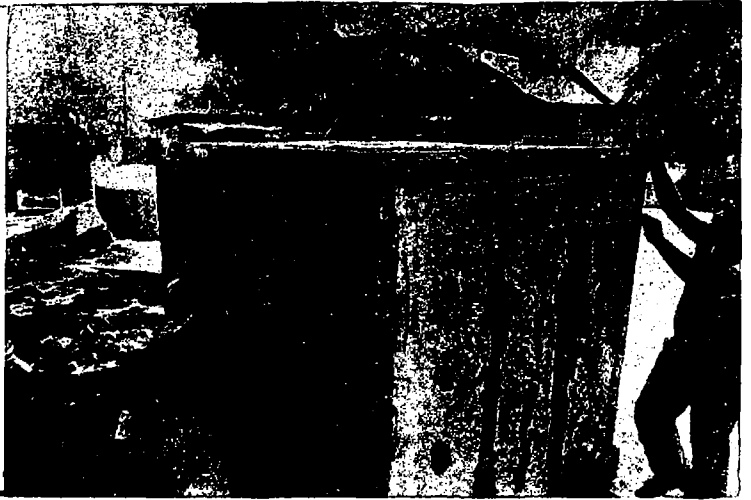
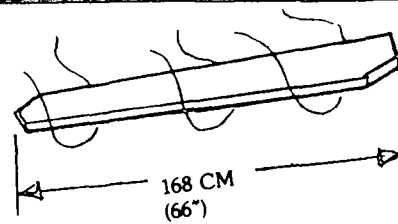


FIGURE 6 B

CUT THE TIMBERS FROM FIGURE 5 C PG. 23 TO THE SIZE SHOWN IN THE DRAWING BELOW. TIE THEM INTO PLACE AS SHOWN AT LEFT WITH 3 LOOPS OF TIE WIRE.



MAKE 1
PIECES

NEXT USE THE FOUR SIDE BOARD FROM FIGURE 5 F TO MAKE A FRAME AROUND THE TOP OF THE TANK AS SHOWN IN FIGURE 6 C BELOW. THE TOP OF THE FRAME SHOULD BE EVEN WITH THE TOP PANEL. TO HOLD THE FRAME IN PLACE PROP IT ...

FIGURE 6 C

... WITH TIMBERS FROM THE OUT SIDE. ALSO TIE WIRES ACROSS THE TOP TO HOLD THE BOARDS TIGHT TO THE SIDES. PREPARE THE SAME MIX AND FILL IN THE FRAME ABOVE THE TOP. POKE MORTAR INTO ALL THE GAPS. BEFORE FINISHING PUSH IN THE TAP SOCKET, WASH-OUT AND OVERFLOW PIPE AS SHOWN ON THE NEXT PAGE.

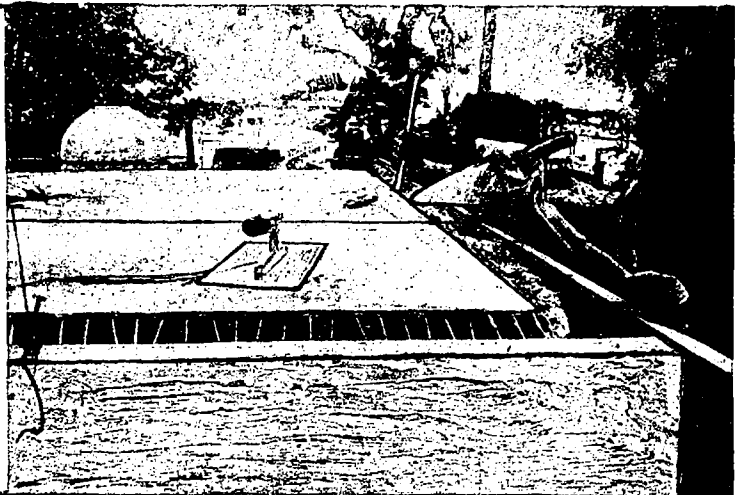
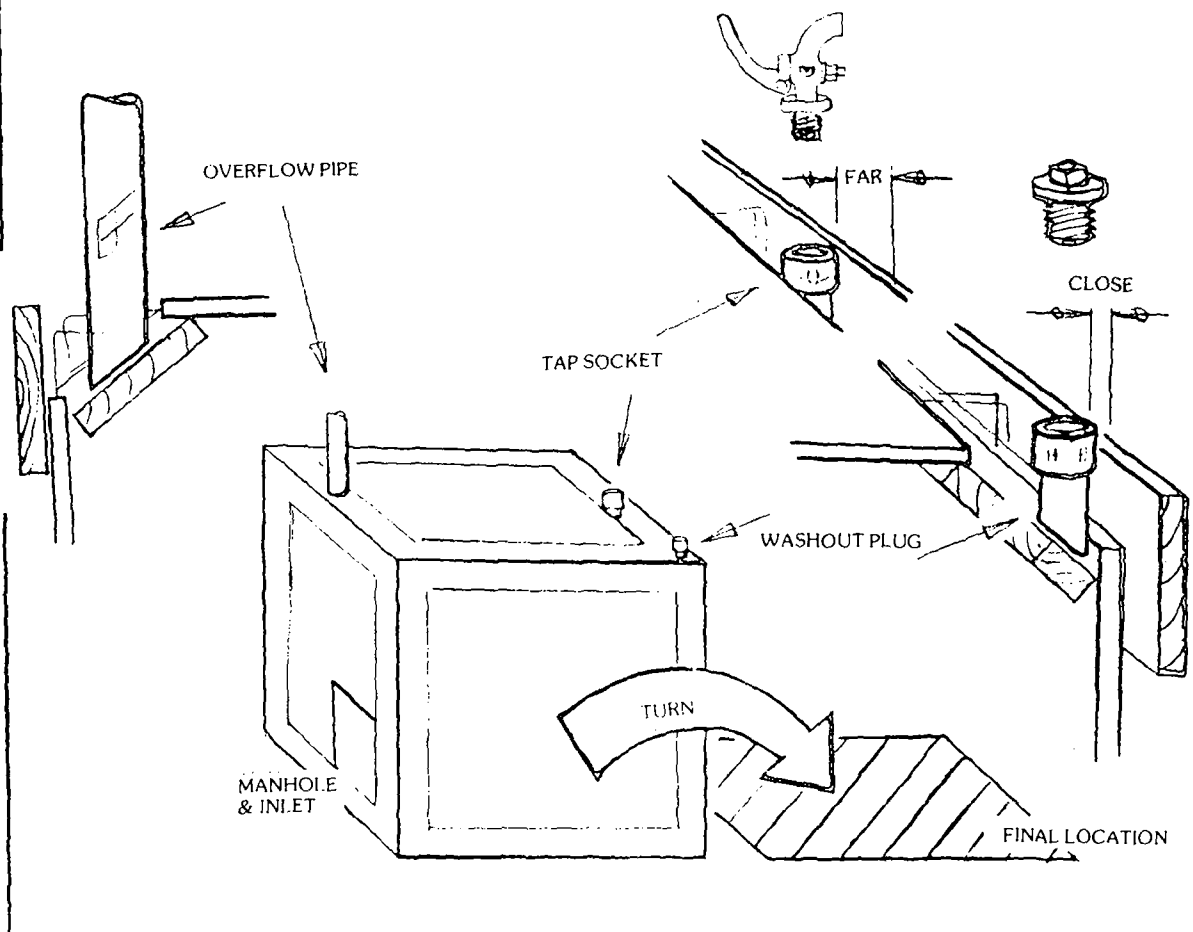


FIGURE 6 D

PIPES INSERTED FOR THE TAP, WASHOUT PLUG AND OVERFLOW ARE CUT TO 45° AS SHOWN. THE OPEN ENDS ARE PACKED WITH PAPER TO KEEP OUT THE MORTAR.

LOCATE THE TAP SO THAT IT WILL BE ABOVE THE WASHOUT WHEN THE TANK IS TURNED UPRIGHT.

LOCATE THE WASHOUT SO THAT IT WILL DRAIN ALL OF THE WATER.



7. Finishing:

FIGURE 7 A

AFTER FIVE HOURS OR THE NEXT DAY REMOVE THE INSIDE FORM WORK. THE CORNERS WILL BE ROUGH. USE CEMENT MORTAR **WITHOUT** FIBRES TO FINISH THEM SMOOTH.

THE VERTICAL CORNER SHOWN HAS BEEN FINISHED.

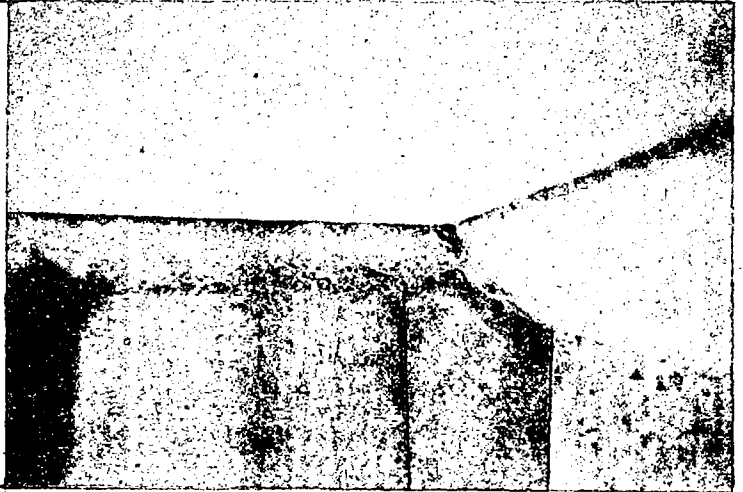


FIGURE 7 B

ONE DAY AFTER CASTING THE TOP THE TANK WILL BE STRONG ENOUGH TO TURN. EIGHT TO TEN PERSONS ARE NEEDED. USE HEAVY TIMBERS TO PRY ONE SIDE UP. GO SLOW. USE SHORT PROPS TO KEEP IT FROM FALLING, THEN USE THE TIMBERS ON THE OTHER SIDE TO LOWER THE TANK.

FIGURE 7 C

A COVER FOR THE MANHOLE WITH A SCREENED INLET CAN BE CAST ON A FLAT SURFACE COVERED WITH NEWSPAPER. MAKE THIS MANHOLE COVER WITH MIXTURE THAT IS LEFT OVER WHEN CASTING PANELS OR CORNERS.

