COMPLETION REPORT

ON

THE PROJECT

SURVEY AND MODERNIZATION OF THE TRADITIONAL FISHING CRAFTS AND GEARS IN THE LAKES AND WETLANDS OF MANIPUR, PHASE – II

SUBMITTED TO:

STATE S&T COUNCIL DIVISION
DEPARTMENT OF SCIENCE & TECHNOLOGY
GOVERNMENT OF INDIA
TECHNOLOGY BHAVAN, NEW MEHRAULI ROAD
NEW DELHI – 110 016

SUBMITTED BY:

MANIPUR SCIENCE & TECHNOLOGY COUNCIL
CENTRAL JAIL ROAD, IMPHAL – 795 001

C O N T E N T S

1. **Project Title**:

Survey and Modernization of the Traditional Fishing Crafts and Gears in the Lakes and Wetlands of Manipur, Phase – II

2.

2.1 Principal Investigator (PI)

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3. Implementing Agency and Other Collaborating Institutions

3.1. Implementing Institution:

Manipur Science & Technology Council,
Central Jail Road, Imphal, Manipur.

3.2 Other Collaborating Agency:

a) Indian Institute of Technology, Kharagpur
b) Central Institute of Plastic Engineering and Technology, Takyelpat Imphal
c) Moirang Boat Factory, Moirang Kumam Leikai.
d) Department of Electronics and Accredited Computer Course (DOEACC), Akampat, Imphal.
e) Fisheries Department, Govt. of Manipur

4. Date of commencement : September 2003.

5. Planned date of completion : September 21st 2005.

6. Actual date of completion : December 2005.

7. OBJECTIVES:

i) To survey and inventories the traditional infra- technologies associate with the existing gears and crafts of fisher folk in Manipur Valley (work already completed in 1st phase).

ii) To cause modernisation or introduction of appropriate technologies through modification of existing gears /crafts or introduction of new ones under scientific guidance and research.

iii) To cause enhancement of fishing efficiency through modernised tools.

iv) To cause growth of small-scale industries of fishing gears and crafts in the fishermen society.

v) To save ecology and environment in the state through reduction of felling of large trees for canoe making and use of pesticides in capture fishery.

vi) To bring about the overall economic development in a sustainable manner for the fishing community of Manipur.

8. DEVIATION MADE FROM ORIGINAL OBJECTIVES IF ANY:

There had been no deviations in the objectives of the project from the original at the time of implementing the project.

9. DETAIL TECHNICAL REPORT

9.1 Introduction

About 45,000 fishermen and fisherwomen fish in the lakes and wetlands of Manipur valley comprising a total fishing area of 550 sq. km. These fisher-folks who maintain a subsistence economy have no other alternative other than using primitive and traditional fishing crafts and gears. The craft they use are either the dugout wooden canoe or a simple improvised wooden plank canoe. The various gears include wounding spears, pole and line, gorges, hooks, traps, nets etc. These fisher-folks are sinking more and more in this drudgery of working with primitive tools and techniques.

With the commissioning of Loktak Hydel Project, the water depth in the Loktak Lake and other adjacent wetlands has got increased permanently. This change in water regime caused many of the traditional fishing gears and crafts unserviceable or less effective in these water bodies. This resulted in, the desperate fisher-folks started using insecticide in one of

the traditional fishing methods called *"Phoom Namba"* and this became a big environmental issue 5 years ago.

Another dimension of the problem is the wasteful and environmentally disastrous process of making the traditional dugout wooden canoes. Hardly, anything else is processed from the huge log as a by-product while carving out the canoe. In such a process of carving out one canoe from one log, the future of the forest cover in the state remains in jeopardy.

To improve the overall fishing activity, the fishing crafts and gears are to be improved. This can be achieved either by modification of the existing ones or by introduction of new ones.

The canoes presently being used are not all-weather craft and also they can not stand the waves caused even by a moderate wind. Due to the slender shape (i.e. very high L/B ratio) of these canoes, they do not posses adequate stability and have high chance of capsizing. Because of the very low beam, they cannot carry much weight and also do not have any form of fish hold. The deck area being small, teamwork in fishing activity also is not possible.

It is observed that the dug out canoes, though more durable compared to plank built canoes, are becoming lesser in number day by day because of the unavailability of huge log for its construction. The plank-built canoes are comparatively cheaper than dug out canoes but less durable. None of' the fishing crafts is treated with any chemicals or paints. Since the canoes are uncovered, fishermen are exposed to sun and rain.

For increasing fishing efficiency, suitable modification of the existing ones or introduction of new fishing crafts and gears under scientific guidance and research is highly necessary.

Manipur Science and Technology Council (MASTEC), Imphal in co-ordination with IIT Kharagpur conducted a detail survey of the various water bodies, fishing crafts and gears, fishing methods etc. during November 23 – 24, 2003 and a brain storming session with IIT official and local experts which involved State Fisheries Department and Loktak Development Authority was also held on November 25, 2005 at the conference hall of the Manipur Secretariat, Imphal to work out various alternatives. Photographs of brain storming session are at Photo No. 1 and Photo No. 2.

9.2 Study of existing canoe

Fishing craft is a carrier of floating plate form by which fishermen go to the fishing grounds along with equipments and back along with the catches to the shore.

The classification of fishing crafts is based on various factors such as

1) Depth of the water – where the craft has to be operated.

2) Based on the material used: such as wooden, fibre glass reinforced plastic or G.R.P. – (Glass reinforced plastic), ferro – cement, steel, alluminium etc.

3) Based on construction of hull: such as open, half decked or decked.

4) Based on the propelling: such as rowing and sailing, propelled by oars, propelled by sails.

5) Based on the work: auxiliary vessels, fishing vessels, factory vessels.

6) Based on the fishing gears and methods of fishing: gill netters, trawlers, purse seiner, long liners, drifters etc.

7) Craft used for training and research.

The fishing crafts found in the valley of Manipur are of small and medium size wooden canoes, either dugout canoes (made from a single log) or plank built (made by joining planks). During the survey not a single mechanized boat/canoe was found to be used by fishermen in fishing.

The wooden canoes used in the valley of Manipur are of multipurpose. They are used both for fishing and transportation. These canoes are used in lakes, wetlands, reservoirs and rivers of different depths.

The material used for the construction of dugout canoes is large trunks of trees. There are various types of woods locally used for the canoe construction.

1) Cham – *Artocarpus chaplasha*

2) Tairel – *Cedrella tuna*.

3) Teak – *Tectona grandis* – because of its high price it is not commonly used.

4) Uningthou – *Phoebe hensiana.*

5) Tan – tolhau – *Terminalia myriocarpa*.

6) Mango – *Mangifera indica.*

Depending on the size of the canoe, the dugout canoes and plank built canoes are of two types commonly known as the *Lukai hee* and *injing hee*.

Lukai hee: This is used for the operation of trap fishing (*Lu* – means trap). It is comparatively small in size. It is around 14 ft in length and 1½ft in breadth.

Injing hee: The construction is similar to that of the lukai hee. It is either dugout canoe or plank built. The size of this canoe is comparatively bigger than lukai hee. It has about 23 ft in length and about 1.8ft in breadth. It is used for the operation of dip-net midwater. Hence the name *injing hee* (*il – chingba* means operation of small dip-net commonly known as *Nupi-il*). The operation of this gear is done by sitting on the specially flattened platform (*Hirubak*) on the stern.

The dugout canoes are made by scooping a timber in the form of a canoe. The aft side (i.e., the front side) is pointed and the stern side (back side) of the canoe is slightly decked (broad and flat at the top). The hull portion of the canoe is the letter "U" shaped having a flat bottom. No sharp keel canoes are found in Manipur Valley.

The plank built canoes are made by joining the planks. The bow and stern portion of the plank built canoe is made separately by joining several pieces of wood. The aft side of the canoe is provided with a hole and is commonly known as *hi-nao*. The hole at *hi-nao* is used to tie the canoe at the shore when not in used to avoid drifting by wind or current. The stern side is broadened. The stern side is known as the *Hirubak*. A typical wooden canoe is shown in Photo No. 3.

Availability of large size logs for construction of dugout canoes are becoming lesser day by day and therefore plank built canoes are commonly used. The plank built canoes are commonly known as *Kaichan*. The main problem of kaichan is the leakage at the joints. Most of the plank built *kaichan* required repairing after 2/3 years in operation.

The thickness of the side wall varies from 1 inch to 1.5 inches, depending on the size of the canoe. The lower portion of the hull plank is thicker than the side plank. If the thickness of the side plank is 1 inch, the hull plank is 1.5 inches thick. Usually the plank built canoes are made with slightly curved hull which makes the canoe easy for oaring, but too curving makes the canoe difficult to carry goods when loaded. If the hull plank is less in thickness the canoe is unstable in operation.

Table 1 & 2 shows certain characteristics of the dugout and plank built canoes used in Manipur.

Table No. 1: Dugout Canoes

Type of wood used	Over all length OAL	Width of the canoe	Depth of the hull portion	Durability of the canoe	Cost of the canoe (Rs.)
Cham *(Artocarpus chaplasha)*	23′4″	1′8″	1.3′	12 to 18 years	9,200/- to 10,800/-
Cham	13′2″	1′3″	1.3′	12 to 18 years	6,250/- to 7,500/-
Cham	20′	1′6″	1.3′	12 to 18 years	8,500/- to 10,000/-
Tairen (*Cedrella tuna)*	20′	1′6″	1.3′	8 to 10 years	7,000/- to 8,500/-
Ton-tolhou (*Terminalia myriocarpa)*	20′	1′6″	1.3′	7 to 9 years	6,500/- to 7,000/-
Mango (*Mangifera indica)*	20′	1′6″	1.3′	7 to 8 years	6,000/- to 6,500/-

Table No. 2 Plank built Canoes

Type of wood used	Over all length OAL	Width of the canoe	Depth of the hull portion	Durability of the canoe	Cost of the canoe (Rs.)
Cham	20′	1′6″	1.2′	3 to 5 years	5,000/- to 6,000/-
Cham	13′2″	1′3″	1.2′	3 to 5 years	3,500/- to 3,800/-
Tairen	13′2″	1′3″	1.2′	2½ to 3½ years	3,000/- to 3,200/-
Others	13′2″	1′3″	1.2′	2 to 3 years	2,700/- to 3,000/-

Cham built dugout canoes are highly demanded by the fishermen, but the unavailability of comparatively large size log is the main problem for the construction of dugout canoes. When we visited two canoe building yard one at Moirang and another at Moirang Sendra Road, the Moirang canoe building yard was found without any activity. The yard at Moirang Sendra Road is the lone manufacturing unit which supplies canoes to different parts of Manipur. Interestingly enough, no dugout design was seen in the yards. They were waiting for the logs to arrive. These logs come from the Myanmar border of Chandel district and

Churachandpur – Mizoram border. A Photograph of Moirang Boat Factory at Moirang Sendra Road is at Photo No. 4.

The canoes manufactured here are not treated with any paints even in some cases the outer portion is not fully polished.

When discussed, if there can be a change of material for the construction of canoe by fibre glass or any other suitable materials, the craftsmen were found totally unaware of any materials other than wood.

The construction of dugout canoes, its utilisation for fishing activities is an age old practice in Manipur. There is no change in the shape or design of the canoes. No other materials have ever been tried for substitution to wood.

Not a single mechanized fishing canoe operates in Manipur. The fishermen have not visualized this. Many fishermen go to the far fishing grounds covering a distance of 4/5 Km in their canoes for fishing. So there is a scope for introducing the OBM - fitted canoes/boats in the waters of Manipur. This may require design modification of the existing canoes.

A typical plank built canoe was chosen for detail investigation. As per the measurements taken at the site of its construction, lines plan as shown in Fig. 1 for the same had been developed. Based on this lines plan, the cross curves of stability of a typical canoe and hydrostatics particulars for this type of canoe were calculated as shown in Fig. 2 and Fig. 3.

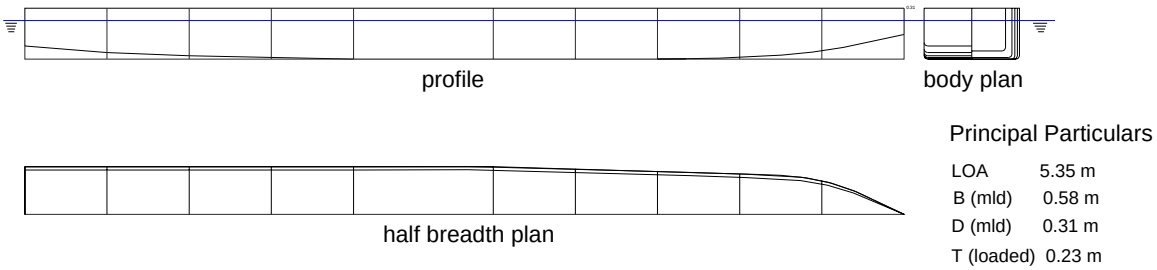


Fig.1. Lines plan of a typical wooden canoe

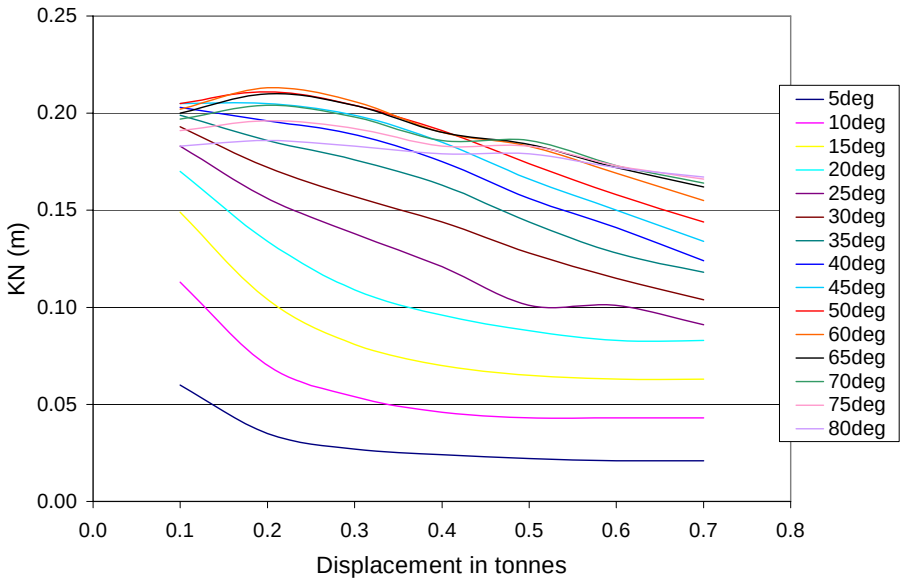


Fig.2. Cross curves of stability of a typical canoe

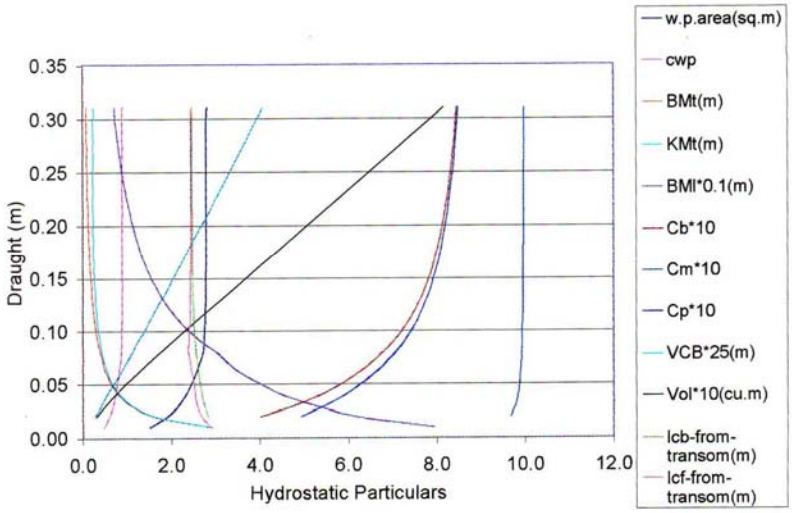


Fig 3: Hydrostatic particulars of 5.35 m canoe.

Based on the cross curves of stability as shown in Fig. 2, the GZ curves had been plotted for varying vertical centre of gravity (VCG) positions (Fig. 4) to study the statical stability condition of the canoe. The variation of VCG position signifies different loading conditions.

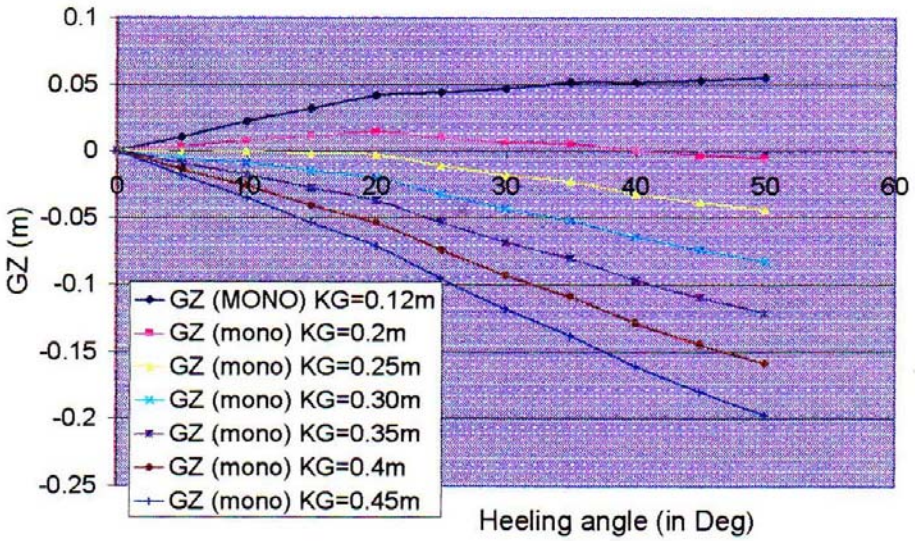


Fig. 4: Statical stability curve of 5.35 m canoe at different VCG positions.

From fig. 4, it was evident that for the loading conditions leading to a VCG positions of less than 0.2 m, the canoe had a marginally GZ value, which implies that at this loading condition, the canoe will have a positive righting movement upto a heeling angle of 40^0.

However, for any other loading conditions, which led to a VCG positions greater than 0.2 m, the canoe did not have a positive GZ value; thereby the canoe will be in a unstable equilibrium condition. Any little heeling movement will lead to capsize of the canoe.

The significance is, the fisherman in sitting condition with none or very little catch, the canoe will remain stable. The same will become unstable, with the fisherman in standing condition and/ or with substantial catch or cargo loaded in the canoe.

9.3 MODELS DEVELOPED

PART - A

9.3.1. Catamaran configuration

The most effective way to achieve improvement in stability as well as increase in work space was by providing a catamaran configuration. It had been felt that the best way to do that would be by putting two similar canoes together in a catamaran configuration. In this way it would require no modification of the existing canoes. Only thing was properly joining of two identical canoes together. Catamarans of full size canoes as well as with half size canoes were developed. The idea was to cut two existing canoes in two halves and then with two halves each, two individual catamarans were produced with necessary attachment in the forward and aft of the cut canoes. By doing so, the cost of each catamaran will remain closer to that of an individual full-length canoe. But at the same time, the operational characteristics, i.e. stability, work area and carrying capacity were improved substantially.

9.3.1. (i) Catamaran of two full size canoes

General arrangement

A catamaran configuration with full size canoe is shown in Fig. 5. Section through XX (Mid ship section) of the Full size catamaran showing details of spacing of individual canoe and frames, cross tie and wooden deck is shown in fig. 6.

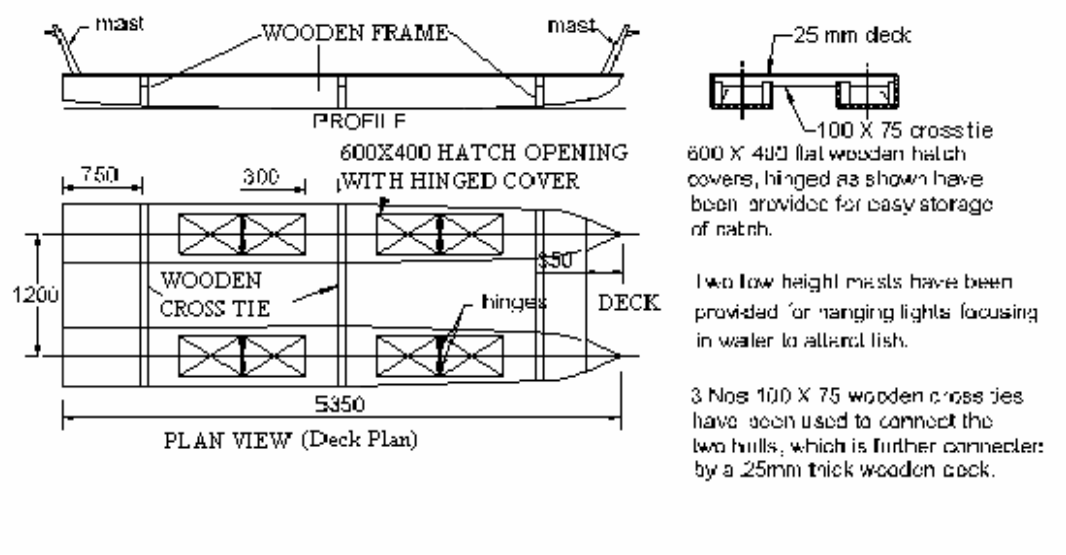


Fig. 5: General arrangement of Catamaran configuration of two full size canoes

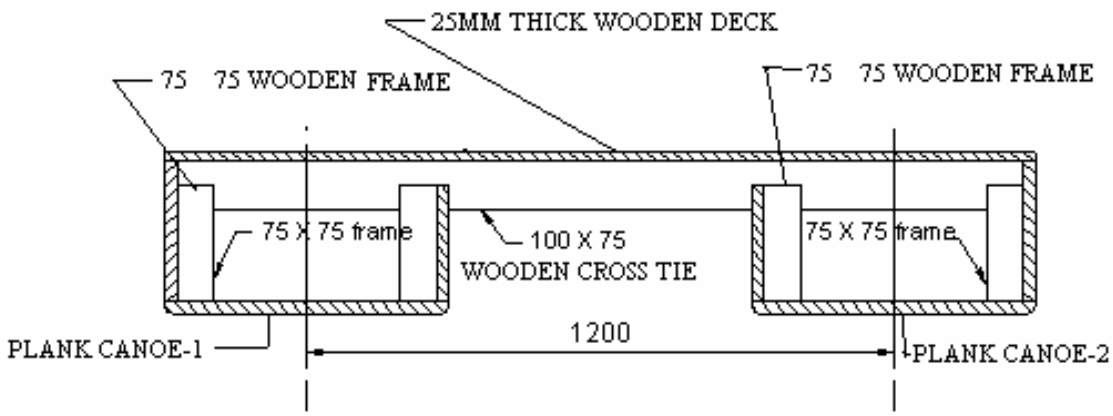


Fig. 6: Section through XX (Mid ship section) of the Full size catamaran showing details of spacing of individual canoe and frames, cross tie and wooden deck (all dimensions are in mm)

Construction Technique:

Two wooden plank canoes were placed side by side at a spacing of 1200 mm (between center lines of individual canoe). A 75 mm by 75 mm square frames were fitted at three locations as shown in Fig. 5 & Fig. 6 above. At the location of the above-referred frames, 100 mm by 75 mm wooden cross ties (3nos.) fitted along the full breadth and 25 mm thick planks used over the cross tie covering the full breadth and almost the full length (350 mm less from ford end) which formed the deck. Four (4) openings, two at the bow and two at the stern, each of 600 mm by 400 mm were provided on the deck plate and act as hatch openings. Hinge covers were provided to act as hatch covers on top of these openings. Two (2) low height (500 mm) wooden masts were also fitted both at the bow and stern portion for hanging lights for attraction of fish. To make the craft more durable, the craft was painted with Black Japan (3 coats). All wood work (joints and connections) were carried out as per good carpentry practice. A full size catamaran constructed under the project is at Photo No. 5. The particulars of the Full size Catamaran Configuration are given in Table No. 3.

Table No. 3: Particulars of the Full size Catamaran Configuration

Material used	: Wood (Cham) *Artocarpus chaplasha*
Length	: 17 ft 1 inch
Breadth	: 1ft 10 inch (Single Canoe), 6 ft (Catamaran configuration)
Depth	: 11 inches
Wall thickness	: 1 inch
Bottom thickness	: 1.25 inches
Depth at bottom	: 7.5 inches
Depth at centre	: 9.75 inches
Depth at aft	: 6 inches
Depth of side wall	: 10 inches
Area of Deck	: 90 Sq. Ft. (15 X 6) Ft. (catamaran configuration)
Wall thickness of Deck	: 1 inch.
Date of construction	: 1st March 2005
Workshed	: Moirang Boat Building yard and MASTEC work shed
Cost in Rupees	: Rs. 11,500/-
Owner	: MASTEC
Length Breadth Ratio	: 9.3 (single canoe)
Length Breadth Ratio	: 2.8 (catamaran configuration)
Sealing Materials	: Saw Dust, Amber and Kerosene oil (Proportion - 1: $^1/_4$: $^1/_2$)
Paint	: Black Japan (3 coat)
Expected Life span	: 4 to 5 years (Required repairing from 3rd year's onward)
Carrying capacity	: 4 fishermen + 1000 kg load
Mode of oaring	: Manual (Oar/ Bamboo Pole)

Sealing and Painting Material:

The traditional indigenous mixture of Saw Dust, Amber and Kerosene oil in the ratio of 1 : $^1/_2$: $^1/_4$ in the form of paste was used as sealing material. The traditional sealing materials have certain advantages and have some superior quality when compare with new synthetic adhesives such as Putty, Fevicol, Dendrite etc. The synthetic adhesives serves fine when the craft is in the water, however if the craft is lifted from the water body when not in use the synthetic adhesives easily cracked and leakages are developed. In case of the

indigenous adhesives, though cracks are developed, there is no leakage as the sealing material expands on retaining to water. The use of this traditional low cost adhesive has been practiced since time immemorial and is found to be one of the best filling materials/adhesives for craft making.

The crafts so far used are not painted with any painting material. For more durability, the present craft was painted with Black Japan in three coats.

Stability:

The GZ curves of different VCG positions (different loading conditions) had been plotted for the catamaran configuration of canoe as shown in Fig. 7

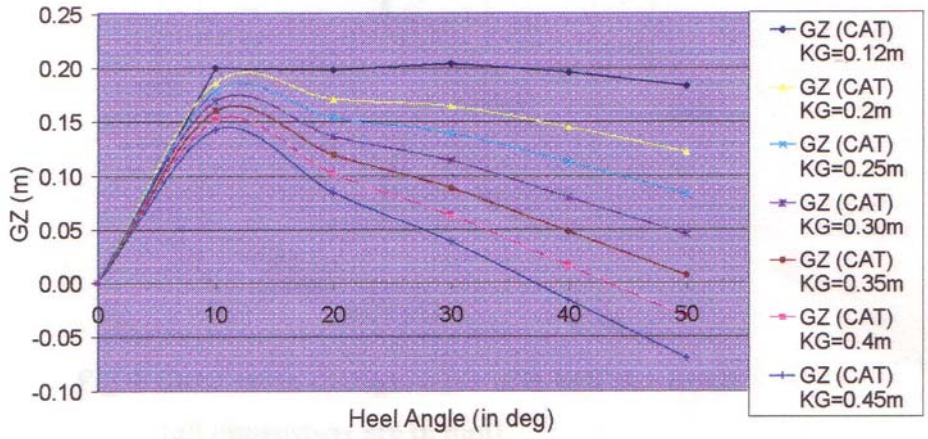


Fig.7: Statical stability curves for canoe catamaran at different VCG positions.

It could be observed from Fig.7, that upto a VCG position of 0.45 m, the catamaran remained in stable equilibrium, i.e. provided positive righting moment, up to a heel angle of almost 40^0. This implies that not only the fisherman can work in standing position of the deck but also certain amount of deck cargo can be carried without rendering the vessel unstable.

Hence with the catamaran configuration, the working condition improved substantially because of improved stability. At the same time, the deck working area increases many fold. The deck area available in case of the single hull canoe is about 2.8 m^2 , whereas in case of catamaran, the area available is about 8.6 m^2.

Field Trial

As a part of the activity of the said project, IIT- Kharagpur team comprising of Prof. N.R. Mandal, Department of Ocean Engineering and Naval Architecture and Prof. C.K. Mukherjee, Department of Agricultural and Food Engineering made a visit to Imphal during March 9 – 10, 2005 to test the models developed under the project. IIT, Kharagpur and MASTEC team carried out final field test of the model at Loktak Lake. Photograph of field

trial of catamaran configuration with IIT team is at Photo No. 6.

Field Trial Observation:

The stability of the full size catamaran is good and working area is increased. The model can be multiplied for demonstration / awareness generation. The model will be good for group fishing and transportation. Night Fishing can also be encouraged by fixing Rechargeable Halogen Bulb torch to the two masts of the catamaran.

9.3.1. (ii) Catamaran of two half size canoes

The general arrangement of half size catamaran is shown in Fig.8. Section through XX (Mid ship section) of the half size catamaran showing details of spacing of individual canoe and frames, cross tie and wooden deck is given in Fig. 9

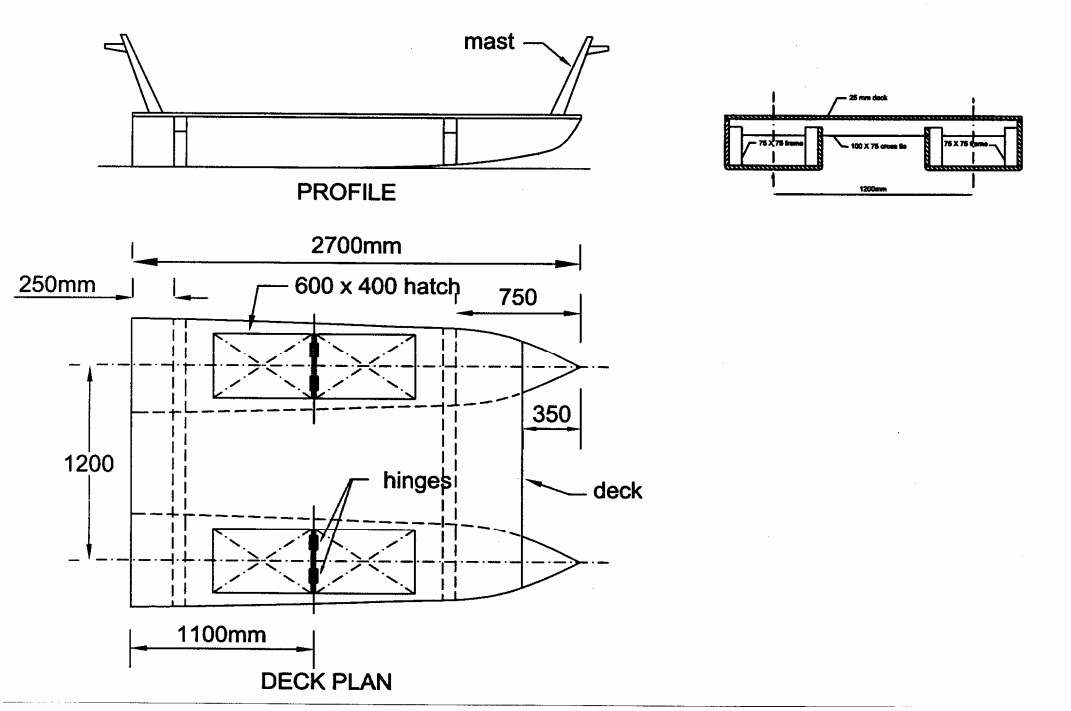


Fig. 8: Catamaran Configuration of Half Size Canoe

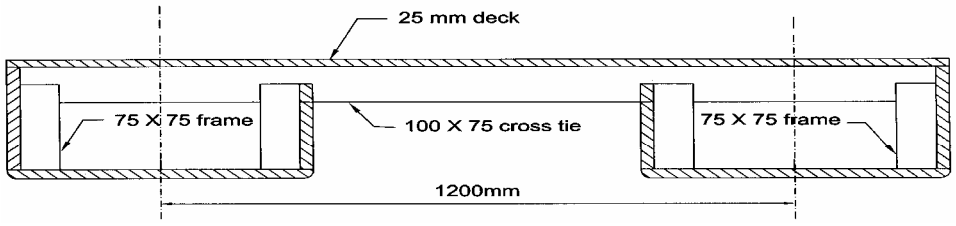


Fig. 9: Section through XX (Mid ship section) of the half size catamaran
spacing of individual canoe and frames, cross tie and wooden deck (all dimensions are in mm)

Construction Technique:

The construction of half size catamaran is the same to that of full size catamaran except in dimension. A half size catamaran photograph is shown in Photo No. 7. Kerosene oil and Coal tar in the proportion of (50: 50) was used as painting material. The particulars of the half size Catamaran Configuration are detailed in Table No. 4.

Table No: 4. Particulars of the half size Catamaran Configuration

Material used	:Wood (cham) *Artocarpus chaplasha*
Length	: 10ft 10 inches
Breadth (single canoe)	: 1ft 8.5inches (aft- 1ft.10 inches, bow -1ft. 1inches)
Breadth (catamaran configuration)	: 5 ft 7 inches
Depth (mean)	: 11.5 inches
Wall thickness	: 1 inch
Bottom thickness	: 1.25 inches
Hull dimensions	: As follows
Depth at bow	: 7.5 inches
Depth at centre	: 10.5 inches
Depth at aft	: 8 inches
Width of hull bottom at centre	: 1ft.5.5 inches
Width of hull at bow	: 9 inches
Wall thickness of Hirubak	: 1inch
Area of Hirubak	: 1ft.10 inches x 5 inches
Length Breadth Ratio (catamaran)	: 1.7
Date of manufacture	: 14th February 2005
Workshed	: Moirang Boat Building Yard & MASTEC Workshed
Cost in Rupees	: Rs. 8000/-
Owner	: Manipur Science & Technology Council
Type of Bottom	: Flatten “U” shape
Expected life span	: 4 to 5 Years
Sealing Materials	: Saw Dust, Amber and Kerosene oil (Proportion - 1: $^1/_4$: $^1/_2$)
Paint	: Coal tar and Kerosene oil (3 layers)
Carrying Capacity	: 2 Fisherman + 1000 kg load
Mode of operation	: Manual (ore/ bamboo pole)

Stability:

The catamaran with half size canoe had been found to be stable and showed sufficient positive righting movement in the event of any heeling caused by external forces.

Field Trial Observation:

Field trial of the model was carried out with IIT, Kharagpur team. The stability of the half size catamaran is good and working area is increased. The model can be multiplied for demonstration / awareness generation. The model will be good for group fishing and transportation. Night Fishing can also be encouraged by fixing Rechargeable Halogen Bulb torch to the two masts of the catamaran.

9.3.2 Wooden Outrigger Canoe (Single)

The existing canoe because of its slender and high length – breadth ratio is quite unstable while in operation. For improvement of the existing plank built and dug out canoe, attachment of a single outrigger with double attached arm (detachable) was tried. The single outrigger showed better stability and there was no disturbance while oaring and the fishing activity could be performed on the other non attached side of the canoe effectively.

The General Arrangement of the wooden outrigger canoe is shown in fig. 10. Sectional view of the canoe with the outrigger is given in Fig. 11.

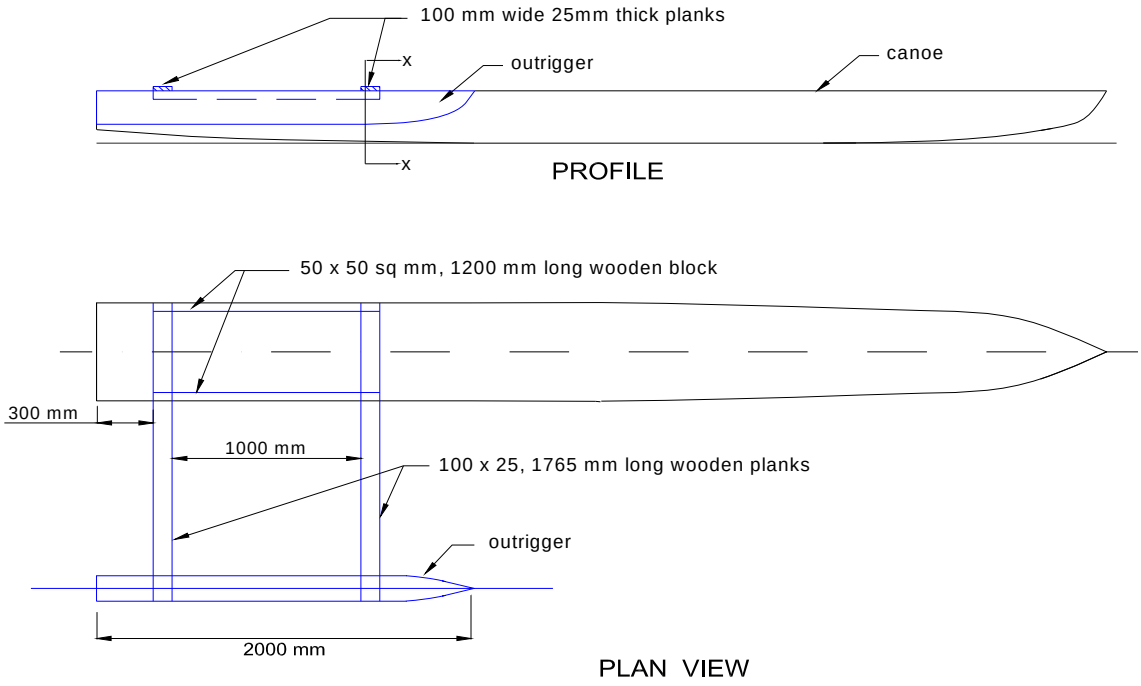


Fig. 10.General Arrangement of the wooden outrigger

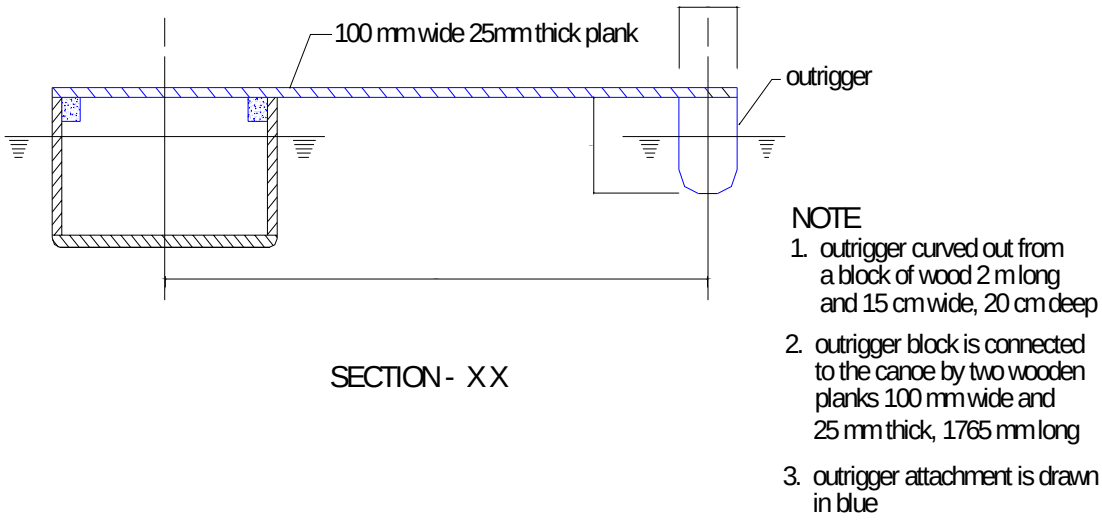


Fig. 11: A sectional view of canoe with the outrigger

Construction Technique:

A canoe of the existing size i.e. 17' x 1' 10" x 11" (l x b x d) was constructed. The outrigger unit of the size 2000 mm x 150 mm x 200 mm (l x b x d) was made of wooden plank as shown in Fig. 10. The sections of the outrigger remained the same for about ¾ th of its length from aft. The corners of the outrigger in this region were rounded to a radius of 50 mm (bilge radius 50 mm). The forward shape was almost similar to that of the canoe. The single outrigger structure was attached to the right side of the canoe at the aft portion with the help of two wooden planks (arm) of 100 mm wide and 25 mm thick as shown in the Fig. 11. Hooks were used at desirable portions to make the structure detachable for enabling easy handling and convenience. A photograph of the wooden outrigger canoe constructed under the project is at Photo No. 8. The particulars of the single outrigger canoe of plank are given in Table No. 5.

Table No. 5: Particulars of Wooden Outrigger Canoe

Features	**Mother Cannoe**	**Attached Structure**
Material used	Wood (Cham) *Artocarpus chaplasha*	Wood (cham) *Artocarpus chaplasha*
Length (LOA)	20 ft.11 inches. (Length of the hull portion is 17ft. 11 inches.)	6 ft. 11.5 inches
Breadth	1 ft. 8.5 inches (bow – 11.5 inches, stern -1ft 8 inches)	9.5 inches
Depth	1ft.	8 inches
Wall thickness	1inches	0.75 inches
Bottom thickness	1.25 inches	1 inches
Expected life span	4 to 5 years (required repairing after 2 to 3 yrs.)	4 to 5 years (required repairing after 2 to 3 yrs.)
Hull dimensions (at centre)	Depth - 11inches Width - 1ft.7inches	Depth – 6.5 inches Width – 7.5 inches
Depth at bow	7 inches	5 inches
Depth at centre	11 inches	6.5 inches
Depth at aft	7 inches	5 inches
Area of Hirubak	4.8 Sq Ft	NA
Wall thickness of Hirubak	1.25 inches	NA
Mode of oaring	Manual (Ore/ Bamboo Pole)	NA
Date of manufacture	25th February 2005	25th Feb 2005
Workshed	Moirang Boat Factory, Sendra Road, Moirang & MASTEC Workshed	Moirang Boat Factory, Sendra Road, Moirang & MASTEC Workshed
Cost (in Rs.)	Rs.5000/- (including attached craft)	NA
Owner	MASTEC	MASTEC
Length Breadth Ratio (L/B)	12.5	8.8
Sealing material	Amber, kerosene oil and saw dust (paste form)	Amber, kerosene oil and saw dust (paste form)
Carrying capacity	2 Fishermen + 600 Kg. pay load	NA

Field trial and stability:

Field trial of the model was conducted at Imphal with the IIT team comprising of Prof. N.R. Mandal and Prof. C.K. Mukherjee. The single canoe (existing) was very unstable because of high length - breadth ratio (12.5). After attaching the single outrigger at the right side of the aft, the stability was found to be considerably high and ultimately the carrying capacity of the craft had increased to almost double of the single canoe. The model is recommended for multiplication, demonstration/awareness generation.

9.3.3: MONOHULL DESIGN

Designs for two sizes have been developed, one with a carrying capacity of 2 fishermen and 200 kg. pay load and the other one with a carrying capacity of 4 fishermen and 1000 kg. pay load. Both of these were fabricated at the workshed of the project at Takyelpat, Imphal using fibre reinforced plastic (FRP). A photograph of the workshed is placed at Photo No. 9.

9.3.3 (i) 3 m FRP Boat

The general arrangement of the 3 m FRP boat is shown in Fig. 12.

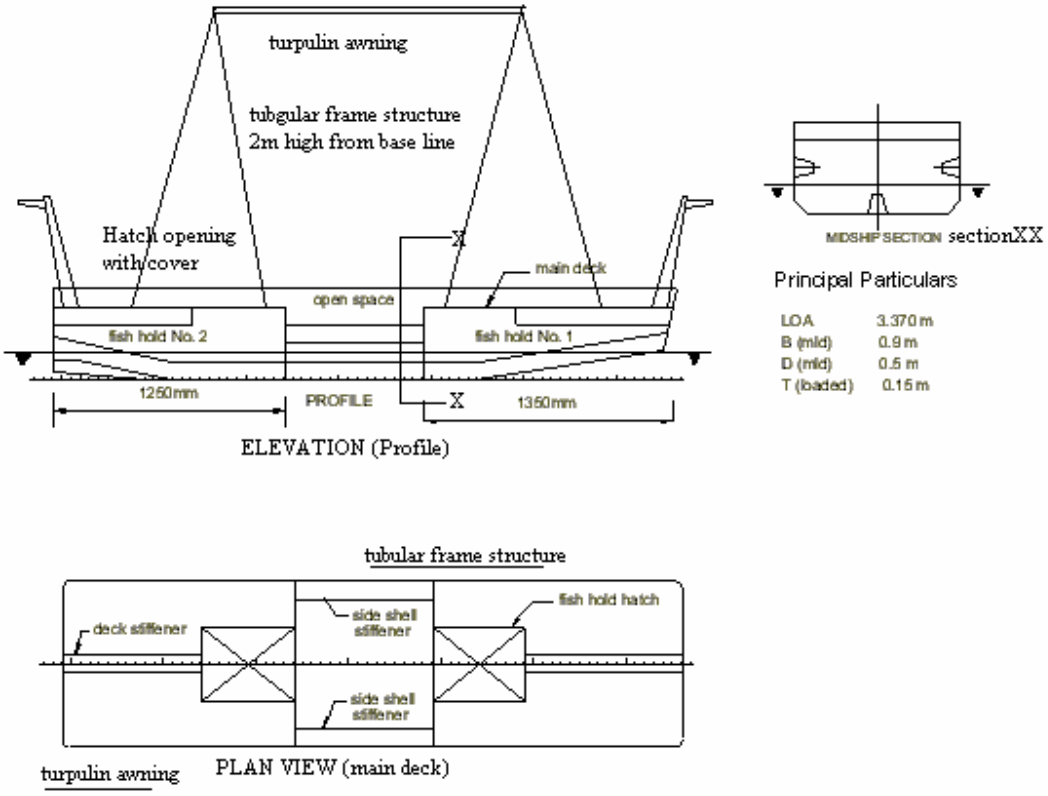


Fig. 12: General arrangement plan of 3 m FRP boat

Lines plan of 3 m FRP boat

The lines plans for the 3m FRP boat are shown in Fig. 13, Fig. 14, Fig. 15 and Fig. 16. The profile view i.e. the view through centre line of the vessel and the plan view i.e. the deck plan is shown in Fig.13. AP and FP indicates Aft Perpendicular and Ford Perpendicular respectively. L_{pp} is length between perpendiculars, B (mld) is the breadth without the plate thickness, D (mld) indicates the depth from the base line to the side shell at side, T (loaded) is the draft at full load and LOA is the length overall. The length between perpendiculars is

divided in 10 equal parts termed as stations with station 0 for AP and station 10 for FP. Also half stations are taken at the aft and ford sections of the vessel. Body plan shows the sectional views at different stations, starting from aft end till the ford end. Half sections of the transom to station 6 are shown on the left half of the body plan and station 7 to the ford end are shown on the right half of the body plan. Transom means the aftermost section of the vessel. The hull is of chill construction i.e. made of straight sections as can be seen in the body plan.

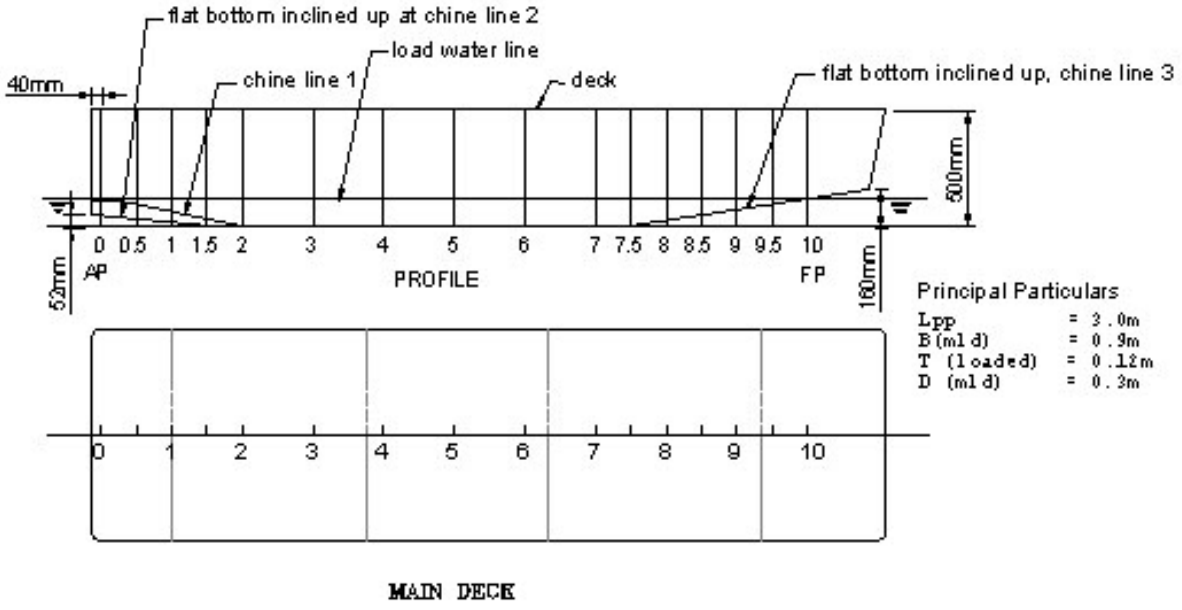


Fig. 13: Profile and main deck plan of 3 m FRP boat

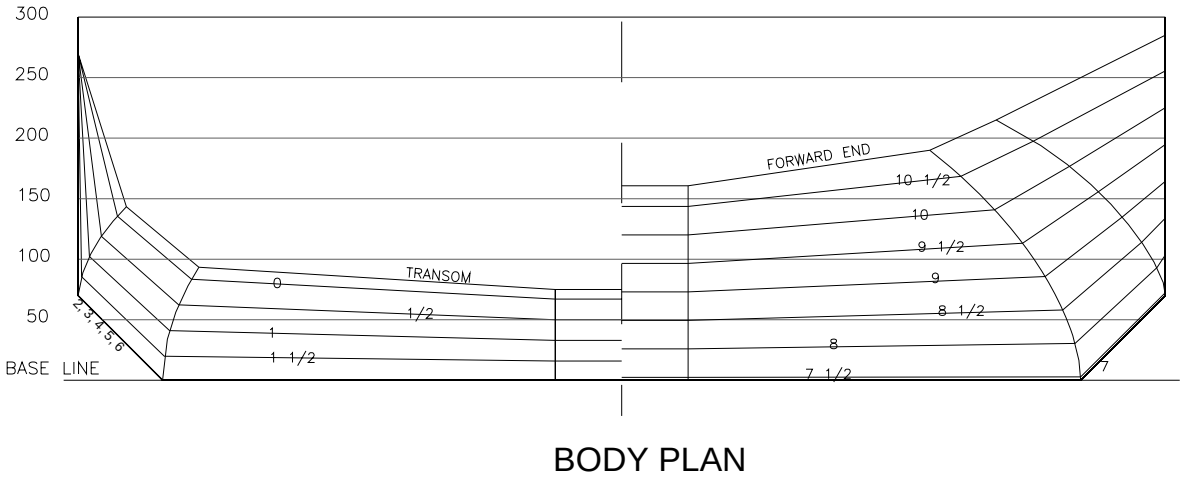


Fig. 14: Transverse Section from transom to station 6 of 3 m FRP boat

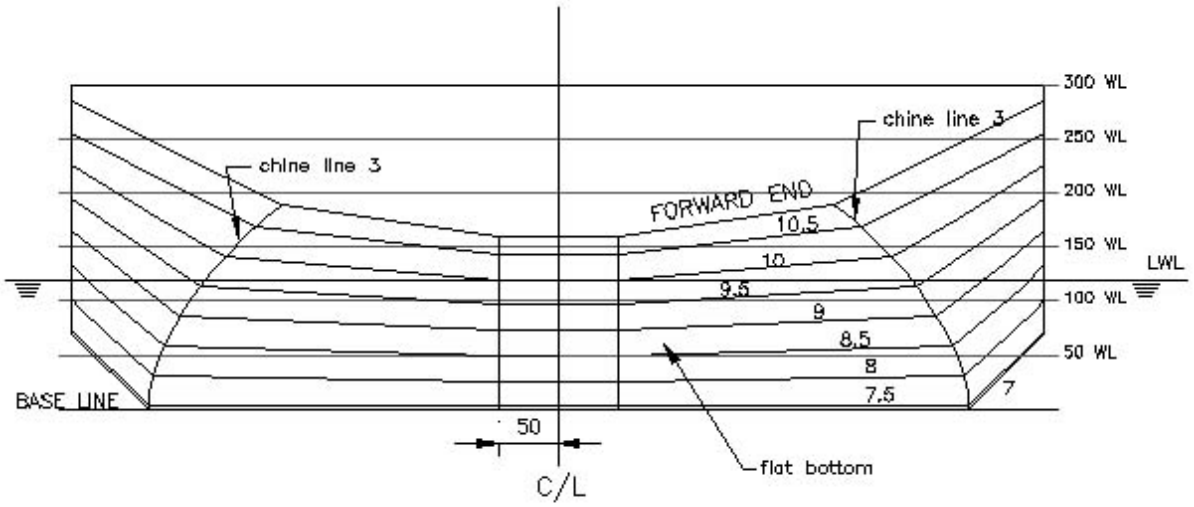


Fig. 15: Transverse Section from station 7 to ford end of 3 m FRP boat

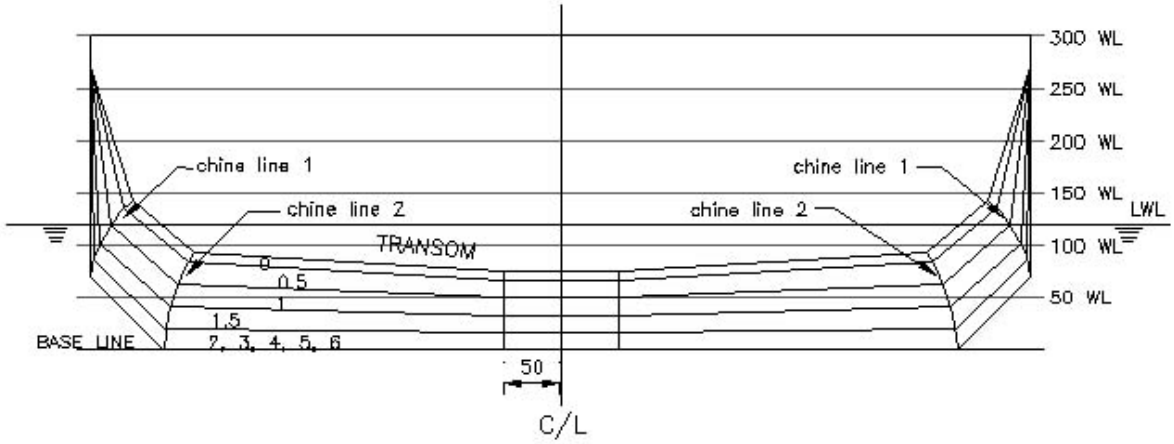


Fig. 16: Transverse section from Transom to station 6 of 3 m FRP boat

Construction Technique

The first step in laying up a fiberglass part in the mould was to carefully wax the mould surface for easy removal of the part after cure. The waxed or coated mould surface was then sprayed with a thin (10 to 30 mils) layer of gel coat resin, to avoid production of thin spots or ripples. The gel coat was then reinforced with a fiber glass surfacing mat, which precedes the lay up of the structural laminate. This layer of mat served both to stabilize and strengthen the get coat, and to prevent “print-through” of the coarse pattern of CSM/woven roving. The gel coat resin was applied by brush to avoid the wastage caused by over spray. Colour pigment was added in the gel coat resin to obtain the desired colour. Resin (Isopthalic variety) mixed with accelerator (2 – 4% of resin by vol.) was dispensed to the laminators in buckets, to which catalyst was added just prior to use. The quantity of catalyst required to cure a given amount of resin was very small (2- 4% of resin by vol.), and requires thorough mixing to achieve a uniform distribution.

The curing process is highly sensitive to temperature variations, and requires a temperature range of from about 22 to 30 degrees C.

The piles of fiberglass reinforcement were precut to the desired and packed in packs which contain all of the pieces necessary for a given part. After a thin layer of resin had been spread over the surface of the mould, one layer of dry reinforcement was placed on the surface, and the resin was forced up through the reinforcement by rolling on the surface with grooved metal rollers. The process completely saturated the reinforcement with resin, distributed the resin properly, and removed air trapped behind the reinforcement. The required laminate thickness was built up by applying alternate layers of chopped strand mat (CSM) and woven roving (WR) CSM of density 450 gm/m^2 and WR of density 610 gm/m^2. This process was repeated many times to achieve the desired laminate thickness of 4 mm (side walls) and 6 mm (bottom).

Following the FRP fabrication techniques, the 3 m FRP boat (prototype model) had been fabricated out of a wooden mould at the workshed of Fishing Crafts and Gears Project. The boat had been provided with two fish holds one forward and one aft. Each hold has its opening (500 mm x 500 mm) with cover. The middle part was kept emptied for the fishermen to operate the boat with comfort. Good freeboard of 350 mm had been provided. Longitudinal stiffening arrangement with hat stiffeners had been used to the sidewalls and hull portion to strengthen the boat. Wooden rods were embedded at the opening of the fish holds to stiffen the deck portion. The carrying capacity as calculated is 300 kg. (2 fishermen + 200 kg load). A photograph of the 3 m FRP boat fabricated under the project is at Photo No. 10. Table No.6 shows the particulars of the 3 m FRP boat.

Table No.6: Particulars of the 3 m FRP boat.

Material used	FRP
Length	11ft. 3 inches
Breadth	3ft. 2.5 inches
Depth	1ft.
Wall thickness	4 mm (5 layers of 3 Chopped Strand Mat and 2 Woven Roving)
Bottom thickness	6 mm (7 layers of 4 CSM and 3WR)
Width of rain cap	2 inches.
Hull dimensions	As follows
Depth at bottom	9 inches
Depth at centre	1ft (less 6mm)
Depth at bow	5 inches at centre
Depth of side wall	9inches + 3inches
Area of the fish hold at bow	3 ft x 4 ft. 2 inches = 12.5 Sq. ft.
Area of the fish hold at aft	3 ft x 4 ft.1inches = 12.2 Sq. ft.
Depth of the fish hold at centre	10.5 inches
Area of fish hold cover	Aft- l ft 11.inches x 1ft.8 inches =3.2 Sq. ft. Bow-1ft.10 inches x 1ft. 8.5 inches =3.1 Sq. ft.
Weight of the Boat	100 kg (95 kg of FRP materials + 5 kg of wood)
Date of manufacture	12th Feb 2005
Manufacture at	MASTEC work shed at Takyelpat
Cost in Rs.	11,500/- (without labour charge)
Owner	Manipur Science & Technology Council
L/B	3.5
Type of Bottom	Flat bottom (without keel)
Mode of operation	Manual (ore/ bamboo pole)
Expected life span	15 years
Carrying Capacity	2 fishermen + 200 kg load

Longitudinal stiffening arrangement with hat stiffeners had been used as shown in the GA plan (Fig. 12). Fig. 17 shows the design of the pre moulded hat stiffener. Details of the stiffening arrangement with hat stiffeners are as under –

Scantlings:

Bottom shell plate thickness – 6 mm
Weather deck plate – 4 mm
Stiffener web thickness – 4 mm (bottom shell)
Stiffener web thickness – 4 mm (weather deck)
Side shell plate – 4 mm
Stiffener web thickness – 4 mm (side shell)
Bulkhead plate – 4 mm

Pre-moulded Hat Stiffener:

Pre - moulded hat stiffeners can be used as shown in Fig. 17.

Width of base – 100mm

Width of crown – 50mm

Web & crown thickness – 4mm

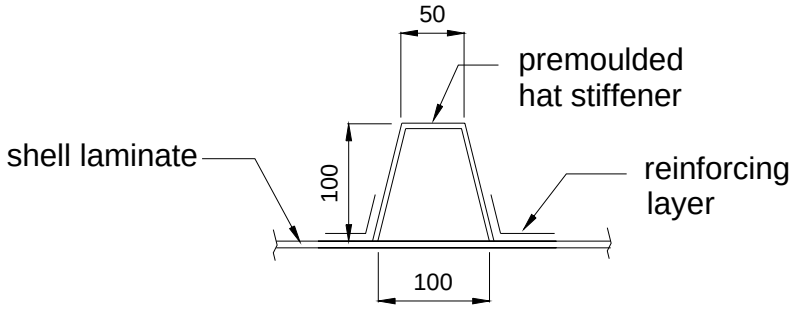


Fig. 17: Pre – moulded Hat Stiffener (dimensions in mm)

Field Trial Observation:

Field trial and stability test was conducted with the IIT team. A photograph of the field trial of 3 m FRP boat is at Photo No. 11. Stability of the boat is good and working area and carrying capacity is considerably increased. Cleats/hooks were provided to facilitate double oaring. The model is recommended for multiplication for awareness generation / demonstration programme.

Hydrostatics and stability

The hydrostatic particulars of the 3m boat had been calculated as shown in Fig 18 and Table No. 7.

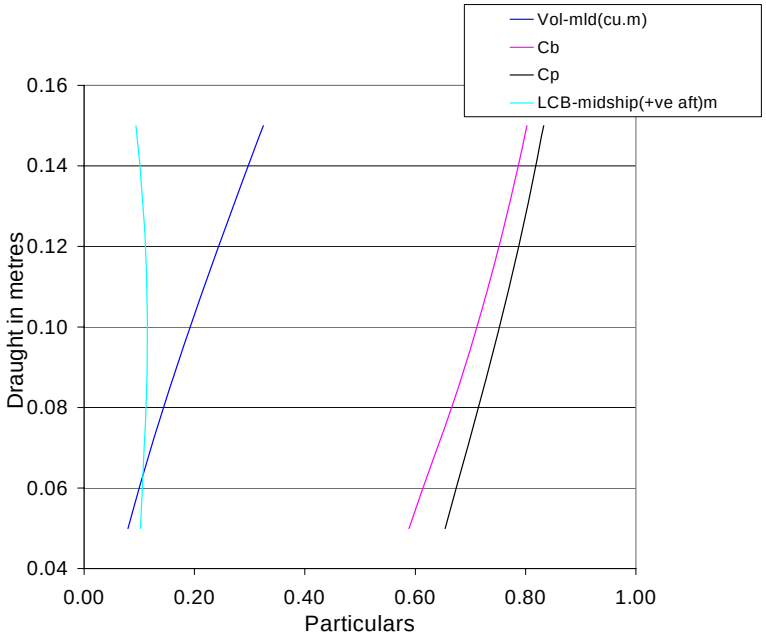


Fig.18. Hydrostatic particulars of 3m FRP boat

Table No. 7: Hydrostatics Characteristics (3m FRP boat)

Length between perpendiculars =	3	metres
Breadth moulded =	0.9	metres
Draught =	0.12	metres

Draught (m)	Displacement moulded (cu.m)	LCB -midship positive aft (m)	Cb	Cp
0.050	0.079	0.102	0.589	0.654
0.060	0.100	0.106	0.614	0.674
0.070	0.121	0.109	0.640	0.694
0.080	0.144	0.112	0.666	0.714
0.090	0.168	0.114	0.690	0.734
0.095	0.180	0.115	0.701	0.743
0.100	0.192	0.115	0.712	0.753
0.105	0.205	0.114	0.722	0.762
0.108	0.212	0.114	0.728	0.767
0.110	0.218	0.114	0.732	0.771
0.115	0.230	0.113	0.742	0.779
0.120	0.244	0.111	0.752	0.788
0.125	0.257	0.109	0.761	0.796
0.130	0.270	0.107	0.770	0.803
0.132	0.276	0.106	0.773	0.807
0.140	0.297	0.101	0.787	0.818
0.150	0.325	0.094	0.802	0.833

Powering

The powering requirements for a speed range up to 4 knots had been shown in Fig. 19.

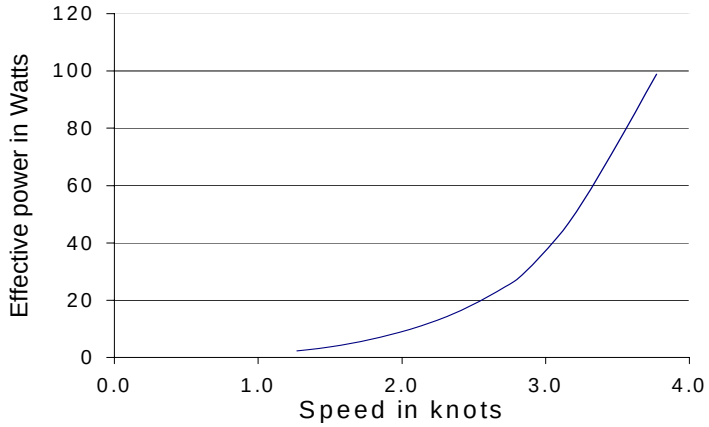


Fig. 19: Speed power curve for 3m FRP boat

This information may be used for possible mechanized propulsion of this craft. For example for a speed of operation of about 3 knots, an installed power of about 80 watts will be enough.

9.3.3 (ii) 6m FRP Boat

Lines plan

The lines plan of the 6m FRP boat is shown in Fig.20 and Fig. 21a & Fig. 21b

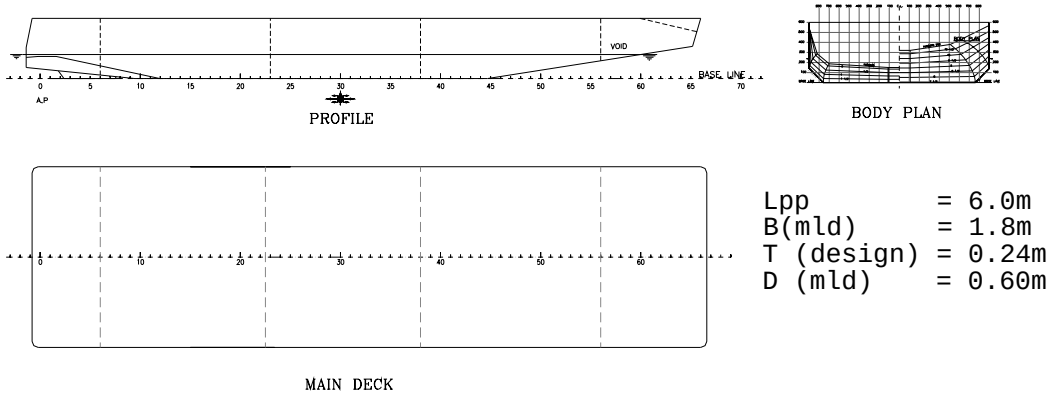


Fig. 20: Lines plan of 6m FRP boat

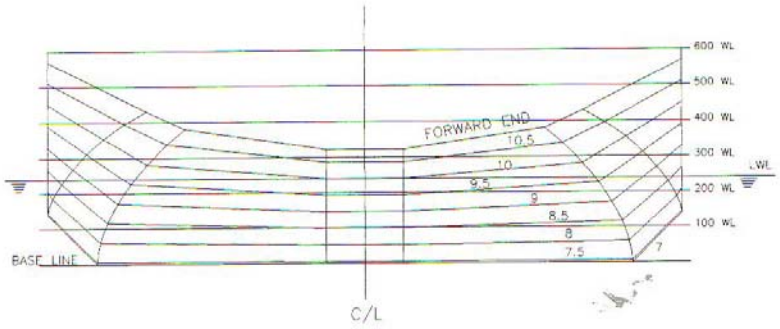


Fig. 21a: Body Plan of 6 m FRP boat (aft)

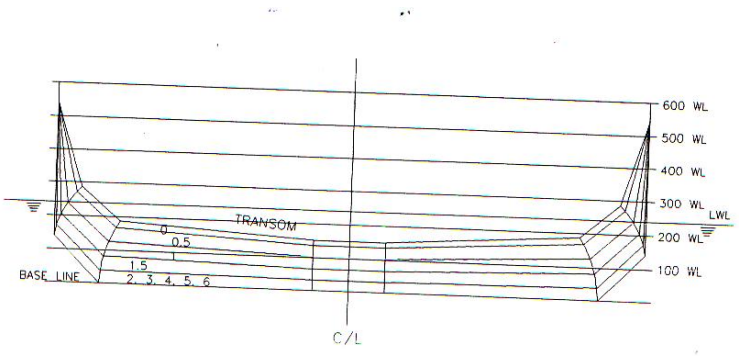


Fig. 21b: Body Plan of 6 m FRP boat (ford)

General arrangement and scantlings:

The general arrangement is same as that of the 3m craft except in size. Following the same FRP fabrication techniques as that of the 3 m FRP boat, the 6 m FRP boat had been fabricated out of a wooden mould at the workshed of the fishing crafts and gears project. A photograph of the 6 m FRP boat wooden mould is shown in Photo No. 12. The boat had been provided with two fish holds – one forward and one aft. Each hold has its opening with cover. The middle part was kept emptied for the fishermen to operate with hat stiffeners similar to the side walls and 3 m FRP boat had been used to the side walls and hull portions to strengthen the boat. Wooden rods were embedded at the openings of the fish holds to stiffen the deck portion. A photograph of the 6 m FRP boat is at Photo No. 13 and the particulars of the boat are given in Table No. 8.

Table No. 8 : Particulars of 6 m FRP Boat

Material used	FRP
Length	22 ft
Breadth	6 ft
Depth	2 ft.
Wall thickness	4 mm (5 layers of 3 Chopped Strand Mat and 2 Woven Roving)
Bottom thickness	6 mm (7 layers of 4 CSM and 3WR)
Width of rain cap	4 inches.
Hull dimensions	As follows
Depth at bottom	1.6 ft
Depth at centre	2 ft (less 6mm)
Depth at bow	1ft 6 inches at centre
Depth of side wall	1.5 ft + 8 inch
Area of the fish hold at bow	7 ft x 6 ft. = 42 Sq. ft.
Area of the fish hold at aft	6 ft 4 inch x 6 ft.1inches = 39.04 Sq. ft.
Depth of the fish hold at centre	1.5 ft
Area of fish hold cover	Aft- 2 ft 6.inches x 2 ft. = 5 Sq. ft. Bow-2ft. x 1ft 8.5 inches = 3.7 Sq. ft.
Weight of the Boat	350 kg
Date of manufacture	2.12.2005
Manufacture at	MASTEC work shed at Takyelpat
Cost in Rs.	44,500/- (without labour charge)
Owner	Manipur Science & Technology Council
L/B	3.7
Type of Bottom	Flat bottom (without keel)
Mode of operation	Manual (ore/ bamboo pole)
Expected life span	15 years
Carrying Capacity	4 fishermen + 1000 kg load

Hydrostatics and stability

The hydrostatics and stability of the 6 m FRP boat is given in Table No. 9.

Table No. 9 : Hydrostatics Characteristics 6m FRP Boat

Length between perpendiculars =	6	metres
Breadth moulded =	1.8	metres
Draught =	0.24	metres

Draught (m)	Displacement moulded (cu.m)	LCB -midship positive aft (m)	Cb	Cp
0.100	0.636	0.205	0.589	0.654
0.120	0.796	0.211	0.614	0.674
0.140	0.968	0.218	0.640	0.694
0.160	1.150	0.224	0.666	0.714
0.180	1.340	0.228	0.690	0.734
0.190	1.438	0.229	0.701	0.743
0.200	1.537	0.229	0.712	0.753
0.210	1.638	0.229	0.722	0.762
0.216	1.699	0.228	0.728	0.767
0.220	1.740	0.228	0.732	0.771
0.230	1.844	0.226	0.742	0.779
0.240	1.949	0.222	0.752	0.788
0.250	2.055	0.218	0.761	0.796
0.260	2.162	0.214	0.770	0.803
0.264	2.205	0.211	0.773	0.807
0.280	2.379	0.202	0.787	0.818
0.300	2.599	0.187	0.802	0.833

Powering

The powering requirement for a speed range upto 4 knots have been shown in Fig. 22.

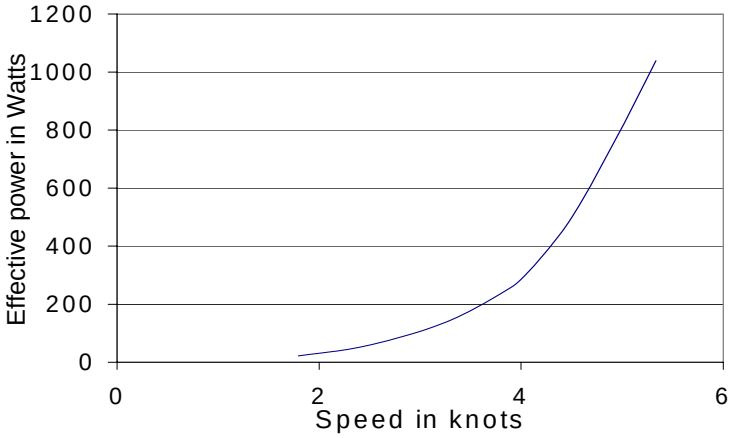


Fig. 22: Speed power curve for 6m FRP boat

Field Test:

Field Test was done. Stability is good and working area and carrying capacity is highly increased. The model will be very good for group fishing and transport.

9.3.4 FRP Outrigger Canoe (Double):

General Arrangement:

The profile and plan view of the FRP outrigger canoe (double) is detailed in the following line plan Fig. 23a and Fig. 23b.

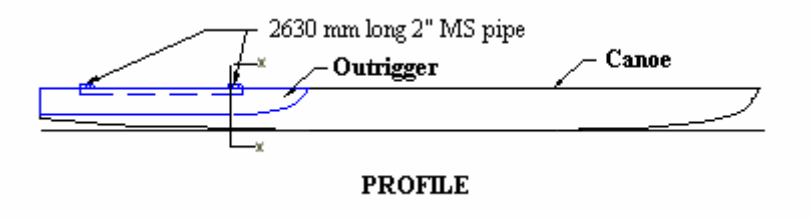


Fig. 23a: FRP Outrigger Canoe - Profile

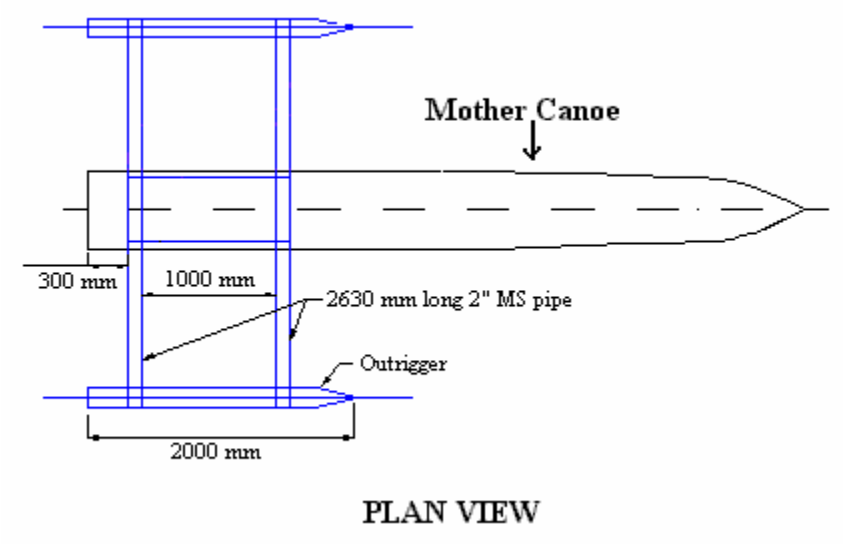


Fig 23b: FRP Outrigger Canoe - Plan view

Construction Technique:

Wood mould:

The existing plank built canoe was used as mould for fabrication of the mother FRP canoe. The mould for the attached structure was also made of plank.

Production Procedure:

Following the same FRP fabrication technique cited in the 3 m FRP boat, a FRP canoe of the existing canoe of thickness 3 mm side walls and 3 mm bottom shell was fabricated. 5 nos. of flattened U - shaped Stiffeners of 4 mm were mounded at five different points of the

hull of the canoe for strength and rigidity. The attached structures (double) were also fabricated of FRP using a wooden mould. The attached structure is detachable and the arm can also be adjusted according to convenience. The thicknesses of the side wall and bottom part of the attached outrigger were fabricated so as to maintain a thickness of side wall and bottom shell to 3 mm. A photo graph of the FRP Outrigger canoe is at Photo No. 14. Particulars of the FRP Outrigger Canoe (Double) are given in Table No. 10.

Table No. 10 : Particulars of the FRP Outrigger Canoe (Double)

Features	**Mother Cannoe**	**Attached Structure**
Material used	FRP	FRP
Length (LOA)	20 ft.11 inches. (Length of the hull portion is 17ft. 11 inches.)	6 ft. 11.5 inches
Breadth	1 ft. 8.5 inches (bow – 11.5inches, aft-1ft.8inches)	9.5 inches
Depth	1ft.	8 inches
Wall thickness	3 mm	3 mm
Bottom thickness	3 mm	3 mm
Expected life span	5 to 10 years	5 to 10 years
Hull dimensions (at centre)	Depth - 11inches Width - 1ft.7inches	Depth – 6.5 inches Width – 7.5 inches
Depth at bow	7 inches	5 inches
Depth at centre	11 inches	6.5 inches
Depth at aft	7 inches	5 inches
Area of Hirubak	4.8 Sq Ft	NA
Wall thickness of Hirubak	4 mm	NA
Mode of oaring	Manual (Ore/ Bamboo Pole)	NA
Date of manufacture	22th March 2005	22 th March 2005
Manufacture at	MASTEC work shed	MASTEC work shed
Cost (in Rs.)	Rs. 10,000/- (including attached craft)	NA
Owner	MASTEC	MASTEC
Length Breadth Ratio (L/B)	12.5	8.8
Sealing material used	FRP	FRP
Carrying capacity	4 Fishermen + 100 Kg. load	NA

Field Trial and Stability:

The single FRP canoe of existing model is unstable because of high length - breadth ratio (12.5) and lightness of the canoe weight. After attachment of the double outrigger at both sides of the canoe at the aft portion, the stability is found to be maintained and ultimately the carrying capacity of the craft has increased to almost triple times to that of single FRP canoe. Depending on the water body, type of fishing gears and its fishing methods to be employed the fishermen can have the option to use the craft in 3 different modes such as a canoe, a single outrigger canoe or double outrigger canoe. Single outrigger has certain advantage since the stability is maintained and fishing activity can be carried out freely without any obstruction to the free non attached side of the craft.

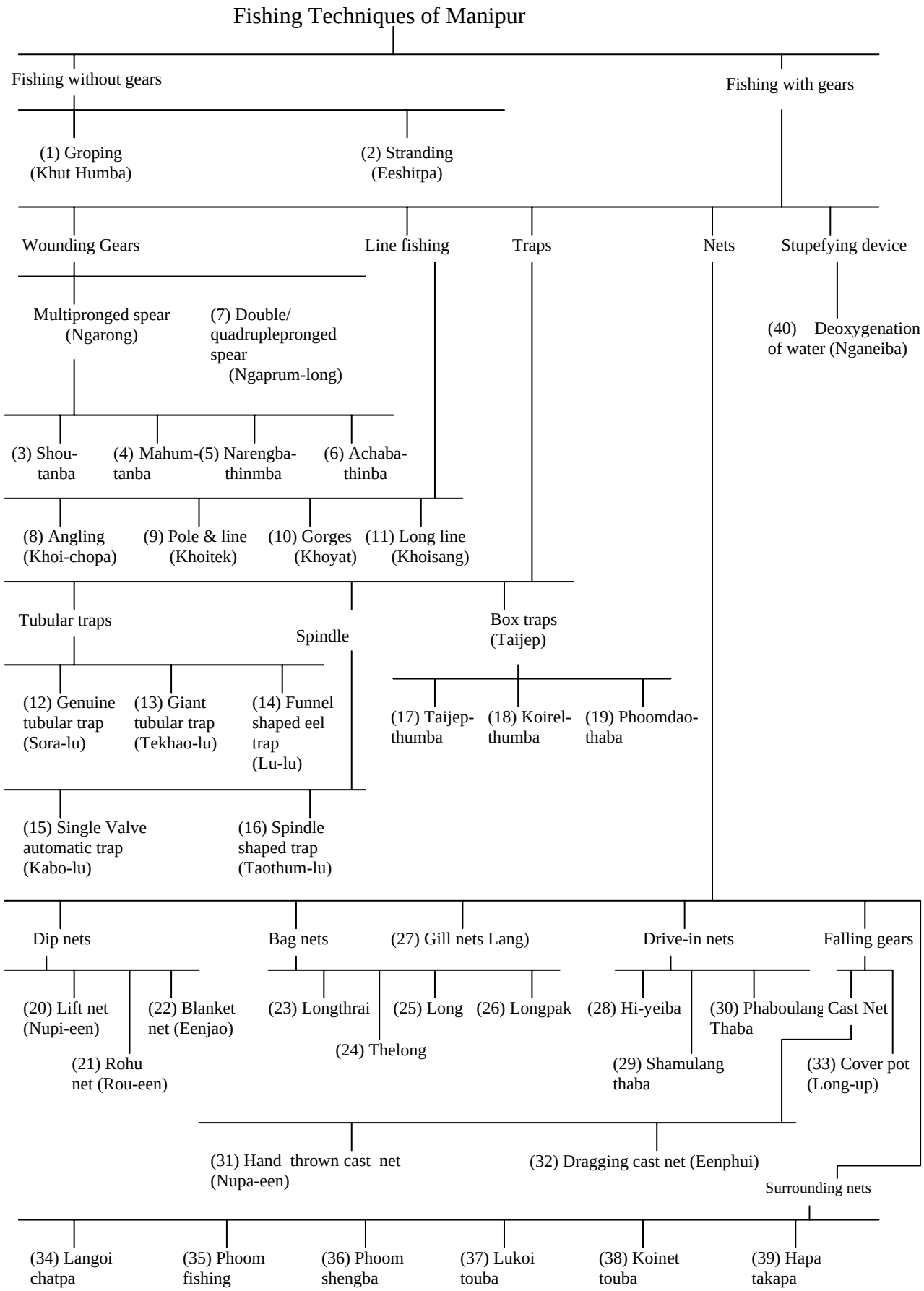
Field trial had been conducted and IIT, Kharagpur had recommended for multiplication. A photograph of the field trial is at Photo No. 15.

PART – B : FISHING GEARS

9.3.5 Fishing gears of Manipur:

The fishermen in Manipur use wide varieties of fishing gears. The gears include gill net, cast net, dip net, dragged net, surrounding net, lift net, traps hook and lines, wounding gears, even explosives, fish poisoning (both from plant derivatives and chemical poison) etc. are some of the fishing gears and fishing methods used by the fisherman in Manipur. The classification of fishing techniques of Manipur is shown in the following flow chart.

Flow Chart


Fishing Techniques of Manipur
Fishing without gears
Fishing with gears
(1) Groping (Khut Humba)
(2) Stranding (Eeshitpa)
Wounding Gears
Line fishing
Traps
Nets
Stupefying device
Multipronged spear (Ngarong)
(7) Double/ quadruplepronged spear (Ngaprum-long)
(40) Deoxygenation of water (Nganeiba)
(3) Shou-tanba
(4) Mahum-tanba
(5) Narengba-thinmba
(6) Achaba-thinba
(8) Angling (Khoi-chopa)
(9) Pole & line (Khoitek)
(10) Gorges (Khoyat)
(11) Long line (Khoisang)
Tubular traps
Spindle
Box traps (Taijep)
(12) Genuine tubular trap (Sora-lu)
(13) Giant tubular trap (Tekhao-lu)
(14) Funnel shaped eel trap (Lu-lu)
(17) Taijep-thumba
(18) Koirel-thumba
(19) Phoomdao-thaba
(15) Single Valve automatic trap (Kabo-lu)
(16) Spindle shaped trap (Taothum-lu)
Dip nets
Bag nets
(27) Gill nets Lang)
Drive-in nets
Falling gears
(20) Lift net (Nupi-een)
(22) Blanket net (Eenjao)
(21) Rohu net (Rou-een)
(23) Longthrai
(25) Long
(26) Longpak
(24) Thelong
(28) Hi-yeiba
(30) Phaboulang Thaba
(29) Shamulang thaba
Cast Net
(33) Cover pot (Long-up)
(31) Hand thrown cast net (Nupa-een)
(32) Dragging cast net (Eenphui)
Surrounding nets
(34) Langoi chatpa
(35) Phoom fishing
(36) Phoom shengba
(37) Lukoi touba
(38) Koinet touba
(39) Hapa takapa

9.3.6 Study of the existing Gill Net

Gill net:

These are single walled nets with a mesh opening of such a size that the required fish can gill themselves in the netting. This is a passive gear, but fish can also be driven into the gill nets. The nets are used singly or in series. This is the most widely used fishing gear. They are vertical walls of netting normally set out in a straight line. Floats and sinkers are attached and plastic ropes are used as head ropes and foot ropes.

There are various mesh size of gill net used commencing from number 0 to 120 mm. Very few extra large mesh size are also found used in the fishing operation by the fisherman of Manipur. This extra large mesh size is made by the fisherman to suit their requirements.

The gill nets are directly purchase from the market or purchase as twine and making of net is done at home. The other materials such as footrope, head rope, float, sinker etc. are also purchased from the market.

Net No. 0: The name indicates this is the smallest mesh size gill net. Hence, it is known as 0 number. They are used to catch the smallest fish.

Muka-nga lang: Net No. 20: Even though Net No. 0 is come under the gill net the most commonly used gill net for catching smaller size fish is the No. 20. One handful of net is commonly known as One Utong. It is around 180 metres in length and 4ft in depth and it cost about Rs. 400/- to 450/-. It fluctuates from time to time. Generally one utong of net make two or even 3 gill nets according to the convenience by the fisherman. If operate in the lake long net can be used whereas in swampy area, river, one utong of netting can make 3 nets of gill net. The fixing of the gill net with float line and float, foot rope and sinkers are done independently by the fisherman or by the experts, cost around Rs. 70/- to 100/- per net depending on the size of the net. The main sinkers used are made of ignited clay with a hole at the centre to pass the food rope. These sinkers are elongated in shape. The floats mainly used

are the rubber plastic. These rubber plastic are found in market in roles and cost about Rs. 20/- per square feet, old unused slipper are also used as float after cutting into small rectangular pieces.

The catch by this net is of smaller size fish such as *Esomus danricus* (Ngasang), *Amblypharyngodon mola* (Mukanga) etc. Fishing is mainly done in the lakes throughout the year.

Net No. 25 (Phabou lang): The number 25 net is commonly known as *Phabou lang*, because the main species caught by these nets are of *Puntius spp (Puntius chola* - Phabounga). The other important fish caught in Manipur by these nets are the *Notopterus notopterus* and other similar size fishes. This net operates throughout the year in the lakes of Manipur. Few *Glossogobius giuris* and *Amblypharyngodon mola* are also caught.

Net No. 35 (Ukabi lang): The net No. 35 is commonly known as *Ukabi lang*. The main species of fishes caught by this net is *Anabas testudineus* (climbing purch). The other fish species caught by these gears are *N. notopterus, Mystus spp., Clarius batrachus, Chana spp.* etc. The peak season for operation of this gear is June to October (rainy season) even though used throughout the year in lake fisheries. The net No. 40 is also commonly known as *Ukabi lang*.

Net No. 50-60: This type of gill net having mesh size is used for the capture of *Notopterus notopterus, Labeo dero* (Khabak), *Labeo angra* (Ngaton). Commonly known as *Khabak lang*. These nets are extensively used in lakes and reservoirs with good catch. Fishing is done throughout the year.

Net No. 70 to 90: This mesh size gill net is commonly known as “Porong (*Chana spp.*) lang”. This net is operated in lakes as well as in rivers. The other species caught are the *Accrossocheilus hexagonolepis* (Ngara) etc.

Net No. 100 to 120: This net is commonly known as the “Langjao”. They are operated in the deep waters of rivers, lakes, reservoirs etc. Catch comprises of large size fish such as *Wallgo attu* (Sareng), *Crossocheilus burmanicus* (Ngaroi), *Bagarius bagarius* (Ngarel), *Anguilla bengalensis* (Ngarin leina), *Cyprinus carpio, Catla catla, Labeo rohita* (Rohu), *Hypothalmetrix molitrix* (Silver carp) etc. Because of the different in mesh size of the gill net floats and sinkers used are also different. For Net No. 100 to 120 the float used are of bamboo tubes closed at both the ends and the sinkers used are stones which are fitted in a longitudinal bag at the foot rope. This gear is a common gill net in riverine fishing.

The No. 100 to 120 net of about 100 metres in length 10ft in depth cost around Rs. 1,000/- to Rs. 1,300/- including the foot rope, head rope, float sinkers, i.e., as readymade net.

The larger mesh size gill nets are mainly operated in the river. If operated in the river the net are set by fixing one end to the shore. The other end is also fixed after setting the net through an angle according to the intensity of the current and nature of the water depth. These nets are made at home by the fisherman by using gauge and needle.

9.3.7 Catch Composition from Gill nets and Optimum Mesh Size

Catch composition from the gill nets operated in Loktak Lake and other wetlands of the State was studied in different locations. The data were collected during December to January 2003. Catch composition data in Table No.11 shows low catch, it is because of various reasons such as low temperature, stagnant nature of water, high water transparency etc prevailing at that particular time. Because of low temperature, the movements of the fishes are restricted and at the same time due to less wind action and inflow of water to the lake, the movement of the floating aquatic mass remain stationary. Fishes remained hidden in these floating aquatic masses, resulting in low catch by Gill nets.

Table No. 11: Fish catch composition data from Gill nets

Sl. No.	Length (m)	Depth (m)	Mesh Size (mm)	No of floats	Type of floats	No of sink-ers	Type of sinkers	Duration of operation (hours)	No of fishes caught	Total length of the fish caught in (cm)	Main Species caught.
1.	60	1.2	15	80	Rubber	100	Ignited clay	12 hrs	25	3.5 to 4	*Esomus denricus*
2.	60	1.2	25	80	Rubber	100	Ignited clay	12 hrs	18	4.5 to 5	*Punctius spp*
3.	60	1.2	35	100	Rubber	125	Ignited clay	12 hrs	9	10 to 12	*Anabas testudineus &N.notopterus*
4.	90	1.5	50 to 60	150	Rubber	180	Ignited clay	12 hrs	6	18 to 22	*N.notopterus, C.carp, Labeo Spp*
5.	60	2.5	70	120	Rubber	150	Ignited clay	12 hrs	2	20 to 24	*Cyprinus carpio, L.rohita,H.molitrix, Chana spp.*

Mesh Size

The meaning of mesh size and bar length is explained in Fig 24. Bar length is the length between two consecutive knots and mesh size is twice the bar length. Mesh size is probably the most important parameter in gill net fishing as the success of capturing a fish depends largely on the relative sizes of the girth of a fish body and mesh opening. The meaning of girth of a fish body is also been explained in Fig. 25. The relation between the optimum mesh size and the girth of a fish body is experimentally found to be as follow:

Optimum Mesh Size = 0. 4x Girth of fish body

In determining optimum mesh size, the girth of that size of fish should be considered, which is available in maximum quantity in the water body. The size of fish, which is available in maximum quantity in the water body, should be obtained from catch composition data.

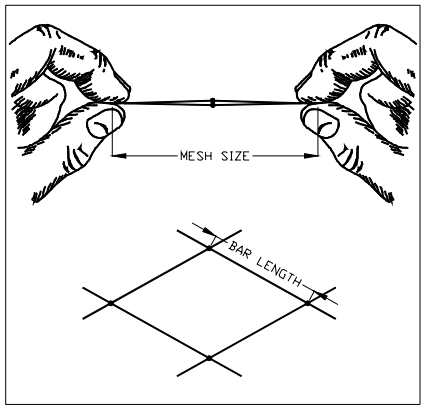


Fig. 24: Mesh size and bar length

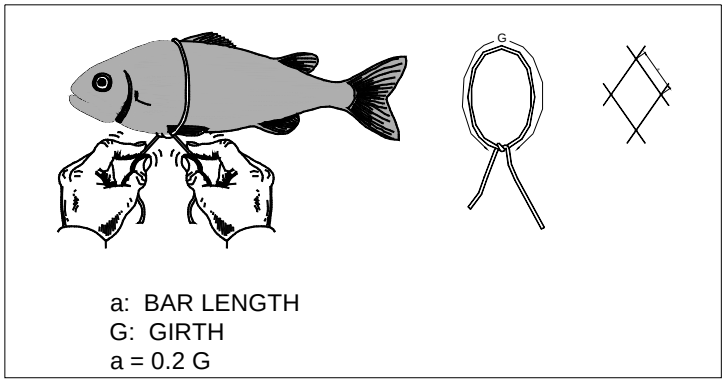


Fig. 25: Girth of a fish body

All varieties caught from various gill nets were recorded and from this catch composition data, optimum mesh size for a few species of fishes had been identified for effective fishing. The optimum mesh sizes of gill net for a few varieties of fishes which are abundantly available in Loktak Lake are shown in Table No. 12. The optimum mesh sizes had been calculated according to the grit of the following fish species.

Table No. 12: Optimum mesh size of gill net for various species

Sl No.	Main Species	Optimum Mesh Size in mm
1.	*Esomus denricus, Amblypharyngodon mola*	15
2.	*Punctius* spp, *Glossogobius giuris*	25
3.	*Anabas testudineus*, *Notopterus notopterus*	35
4.	*C. Carp*, *Labeo Spp*.	50 – 60
5.	*Cyprinus carpio, L. rohit, Hypophthalmitrix molitrix*	70

9.3.8 Improvisation of Fishing Gears.

The water body of Loktak Lake as far as fishing is concerned may be divided into two types of zones: (i) Zones covered by dense mass of weeds and (ii) Zones free of weed. Considering the techno-socio-economic factors related to fisheries of Loktak Lake and other water bodies of Manipur, thrust were given to improve the existing fishing gear. Some improved traps were designed under the project.

i) Improved Traps

Traps are implements in which the fish enters voluntarily but it hampered from coming out. Mostly in these traps a retarding device like gorges or funnels is provided to avoid the coming out of the fish. In order to increase the fishing efficiency the following models were developed under the project.

a) Trap (Taijep) made of bamboo strips and nylon net with single entrance.

This trap is rectangular in shape, four sides of the structure are surrounded are surrounded by nylon netting and the other two sides (top and bottom) are made of bamboo strips. A longitudinal entrance is provided along the entire middle portion of one side of the trap to enable easy entrance of fishes voluntarily. A comb like bamboo strips commonly known as funnel was fitted at a rubber string to prevent escape of fishes. Once the fish is entered it is trapped inside. The particulars of this trap are given in Table No. 13.

Table No.13: Particulars of Trap (Taijep) made of bamboo strips and nylon net with single entrance

Sl. No.	Particulars	Features
1	Material of construction	Bamboos Strips and Nylon Net
2	Shape of the gear	Rectangular
3	Length of the gear	1.8 Feet
4	Breadth	1.8 Feet
5	Depth	3.2 Feet
6	Mouth of the Funnel	120 mm
7	Depth of the Funnel	170 mm.
8	Mesh size of the Nylon Netting Yarn	1 Inch (Bar Length)
9	No of rows of bamboo strips at the top and bottom	13 nos. each
10	Size of the bamboo strips	10 mm.
11	Mesh Size of bamboo strips	14 mm.
12	Mouth of the funnel	100 mm
13	Depth of the Funnel	150 mm.
14	Cost of the gear	Rs. 300 to 400/-
15	Durability of the gear	4 – 5 Years
16	Source of the gear	Made by the local fishermen
17	Season of operation	Throughout the year
18	Type of water body	Lakes and Stagnant Water
19	Duration of operation	6 to 8 hours
20	Species caught	Mixed Species of small size.

The material used for the construction of this gear was bamboo strips of small and finger size. These traps are set longitudinally by tightening to a floating weeds or by submerging 3/4 portion to the gapes found at floating weeds. They are also operated in shallow water near the shore of channels, paddy fields etc. either singly or even in series. The main species caught by this gear include *Notopterus notopterus*, Chana sp., *Anabas testudeneous, clarias batrachus,* Common carp etc. The gear can be operated all the year round. A photograph is at Photo No. 16 is the model developed under the project.

Field test was conducted in different water bodies. The model is lighter, maintenance free, more durable and easy to handle and operate.

b. Double entrance Taijep (trap) of bamboo strips:

This trap is rectangular in shape; all sides of the structure are surrounded by bamboo strips. Two longitudinal entrances are provided on two sides of the trap to enable easy entrance of fishes voluntarily. Comb like bamboo strips commonly known as funnel were fitted at a rubber string to prevent escape of fishes. The entrances are arranged in such a fashion that the two entrances are not directly opposite to each other. Once the fish is entered it is trapped inside. Table No. 14 shows the particulars of this trap.

Table No. 14: Particulars of Double entrance Taijep (trap) of bamboo strips

Sl. No.	Particulars	Features
1	Construction Material	Bamboo Strips
2	Shape of the gear	Rectangular
3	Length of the gear	1.8 feet
4	Breadth of the gear	2.0 feet
5	Depth of the gear	3.6 feet
6	Mesh Size	10 mm.
7	Bamboo Strips Diameter	15 mm
8	Mouth of the funnel	120 mm.
9	Depth of the Funnel	200 mm.
10	Cost of the gear	Rs 400 - 500/-
11	Durability of the gear	3 – 5 Years
12	Source of the gear	Made by the local fishermen
13	Season of operation	Throughout the year with a peak during August to March
14	Type of water body	Lake and other Stagnant water bodies
15	Duration of operation	8 to 10 hours
16	Species caught	Mixed fishes of large size.

This gear is made of small size of bamboo strips. These traps are set longitudinally by tightening to a floating weeds or by submerging 3/4 portion to the gapes found at floating weeds. They are also operated in shallow water near the shore of channels, paddy fields etc. either singly or even in series. The main species caught by this gear include *Notopterus notopterus*, *Chana* sp., *Anabas testudeneous*, *Clarias batrachus*, Common carp etc. The gear

can be operated all the year round. A photograph of the Double entrance Taijep (trap) of bamboo strips is shown in Photo No. 17.

After field trial in various water bodies, the model had been multiplied and mass popularisation programme was held to popularise the model. Since, the trap has a large mesh size, larger fishes such as exotic carps and murels are trapped in. Percentage of fish trap is comparatively high because of double entrance. A photograph of the field trial by the local fisherman at Loktak Lake is at Photo No. 18.

c. Folding Trap (Taijep) made of Bamboo strips

This trap is small and rectangular in shape. All sides of the structure were surrounded by bamboo strips of small size. A longitudinal entrance was provided on one side of the trap for entry of fishes. Comb like bamboo strips commonly known as funnel were fitted at a rubber string to prevent escape of fishes. Once the fish is entered, it is trapped inside. The particulars of this trap are given in Table No. 15.

Table No. 15: Particulars of Folding Taijep made of Bamboo strips

Sl. No.	Particulars	Features
1	Construction Material	Bamboo Strip
2	Shape of the Gear	Rectangular
3	Length	1 Ft
4	Breadth	1 Ft
5	Depth	1.6 Ft
6	Size of the bamboo strips	6 mm.
7	Mesh Size	10 mm.
8	Mouth of the funnel	100 mm
9	Depth of the Funnel	130 mm
10	Cost of the gear	Rs. 80 to 100/-
11	Durability of the gear	4 – 5 Years
12	Source of the gear	Made by the local fishermen
13	Season of operation	September to February
14	Type of water body	Lakes and Stagnant Water
15	Duration of operation	6 to 8 hours
16	Species caught	Mixed Species of small size

This gear is made of small size of bamboo strips. These traps are set longitudinally by tightening to a floating weeds or by submerging 3/4 portion to the gapes found at floating weeds. They are also operated in shallow water near the shore of channels, paddy fields etc. either singly or even in series. Species caught by this gear are of small size of mixed varieties. The gear showed good results during September to February.

After field trial in various water bodies, the model had been multiplied and mass popularisation programme was held to popularise the model. The trap is also found suitable for fishes like *Anabas testudineus, Channa Sp. etc.* Because of the folding system, it is easy to operate and transport and storage is not a problem. A fisherman can carry a good no. of traps at a time for operation. The model is found effective with satisfactory results. A photograph of the model is shown in Photo No. 19.

d. Rectangular Trap with folding wings for riverine fishery.

This trap is rectangular in shape and designed particularly for riverine fishery. All sides of the structure were surrounded by bamboo strips. Two foldable wings were attached to the two sides and the length of the wings can be varied according to the fishing ground. The advantage of these wings is to cover more fishing area and also act as fish leader. A longitudinal entrance is provided on one side of the trap to enable easy entrance of fishes voluntarily. Comb like bamboo strips commonly known as funnel were fitted at a rubber string to prevent escape of fishes. This trap can be deployed to catch fishes of both ascending and descending according to the seasonal changes. Though, the traps are of passive fishing gears type, the two wings at the sides increase the catch. This trap can be operated both in the stagnant and running water bodies. The particulars of this model are shown in Table No. 16.

Table No. 16: Particulars of Rectangular Trap with folding wings

Sl. No.	Particulars	Features
1	Construction Material	Bamboo Strips
2	Shape of the gear	Rectangular with the attachment of Wings
3	Length of the gear	6 ft.
4	Depth of the gear	3 ft
5	Length of the wing	6 ft
6	Depth of the wing	3 ft
7	Mesh Size	20 mm
8	Bamboo Strips Diameter	15 mm.
9	Mouth of the funnel	1.7 Feet
10	Depth of the Funnel	2.10 Feet
11	No. of rows in length	8 no of which 6 nos. are of 3 mm. (Iron Wire)
12	No. of rows in depth	5 no (bamboo strips 15 mm. Diameter)
13	Mesh size of the Nylon Netting Yarn	1 inch (Bar Length)
14	Material used to tie	Strip Fibre Black in Colour
15	Cost of the gear	Rs. 700-800/-
16	Durability of the gear	3 – 5 Years
17	Source of the gear	Made by the local fishermen
18	Season of operation	September to February
19	Type of water body	Riverine
20	Duration of operation	6 to 8 hours
21	Species caught	Riverine Fishes
22	Method of operation	Against the current & along the current according to the season of operation,

After field trial in various water bodies, the model had been multiplied and mass popularisation programme was held to popularise the model. The trap is also operative in stagnant water bodies. Operational area is increased with the attachment of two folding side wings and hence catch rate is high. A photograph of the model is shown in Photo No. 20.

ii) **Introduction of Purse-seine Fishing**

At present, Phoom fishing (Phoom namba) is the most common type of fishing practised in the Loktak Lake. This is because of aggregation of fishes for taking shelter to the floating aquatic masses because of low water depth. Other types of fishing methods such as operation of dip net, drag net (small), traps etc. are also reduced considerably.

Main season of Phoom fishing (Phoom namba) is during the winter season (October to January), with a peak season at December & January. In the phoom fishing both surrounding and drag nets are used. The length and depth of both the surrounding net and drag net depends on the circumference of the floating aquatic mass (Phoom) and the depth of the water column where the fishing operation has to be carried out. According to depth of the water column number of 3ft. dragnet are joined to form a single drag net with sufficient length and depth.

No particular floats have been used for both surrounding nets and the drag net. The floating aquatic mass is used as float as well as working place for Phoom fishing. Four to Five Canoes are used as floats for drag net.

The catches are of mixed species, it comprises from very small size fishes to large table size fishes. Fishermen usually earn a sum of Rs 1000 to Rs 5000 or more depending on their luck and various factors such as season of operation, nature of the Lake bed, experience of the fishermen and location of the Phoom etc. Lots of manpower is required for operating the phoom fishing. In order to remove drudgery, introduction of purse seine will be an appropriate alternative.

With an aim to substitute the Phoom fishing in Loktak Lake, Purse Seine fishing had been fabricated. A purse- seine is a big wall of netting, which is set around a school of fish as shown in Fig 26. The topside of a purse seine is hung from a float-line, which is a rope fitted with floats and its bottom side is weighted by a lead-line, which is a rope fitted with sinkers. The lead line is fitted with purse-rings, which are metal rings hung by short ropes (called bridles) from the lead-line. Through these rings passes a rope called a purse-line and by pulling this rope, the fishermen bring the rings together. The rings in turn pull the lead line together until the bottom part of the purse seine is closed. In this way the purse seine becomes like a very big bag or purse, and the fish cannot get out. Fig. 27 shows how the net is pursed. After the purse seine has been pursed, the netting is hauled on the ground or on the deck of the boat, until only a small part, with the catch crowded in it, remains in the water. Then the fish and finally, the rest of the netting are hauled on board. The method of purse-seine fishing is generally practiced in the sea to trap the school of fish like tuna, mackerel, sardines etc. The conditions of fishing in weed occupied zones of a lake are different than those at the sea. In a lake the water depth is relatively less, current and waves are almost absent and the school of fish is stationary. It is therefore necessary to introduce a simple version of marine purse seine for phoom fishing in Loktak Lake. Fig. 28 shows how the net

will be pursed in case of newly designed purse seine for phoom fishing. The details of purse seine for phoom fishing at Loktak Lake are shown in Fig. 29 and will consist of following parts:

(i) Body of netting (ii) Float-line with floats (iii) Gavels

(iv) Leadline (v) Purse-line (vi) Purse – rings cum sinkers

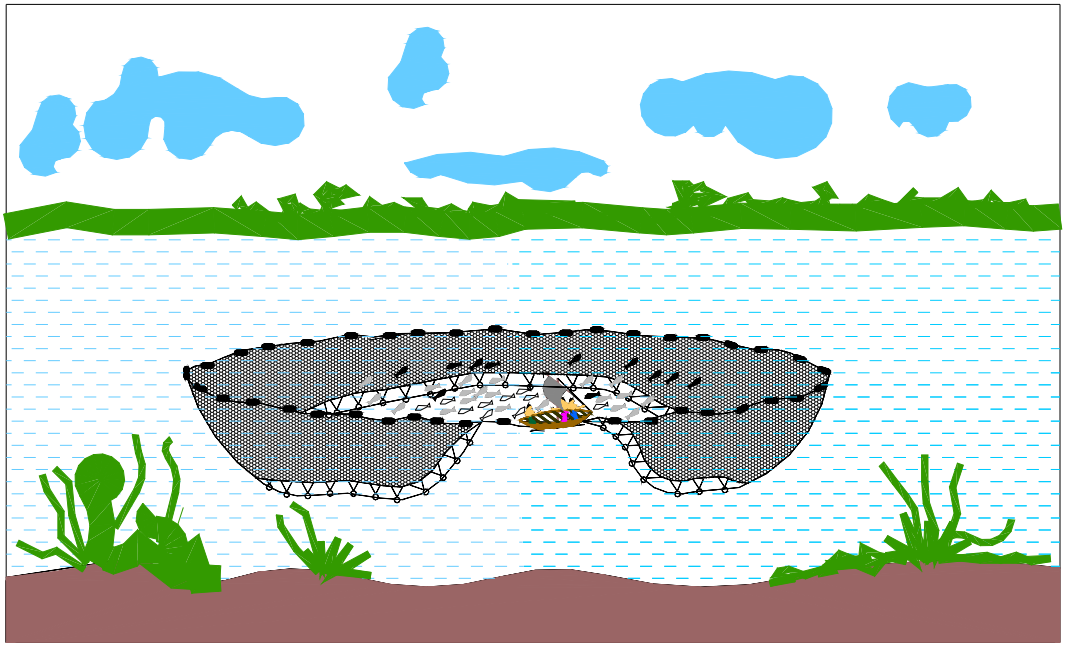


Fig. 26: School of fish surrounded by a purse seine

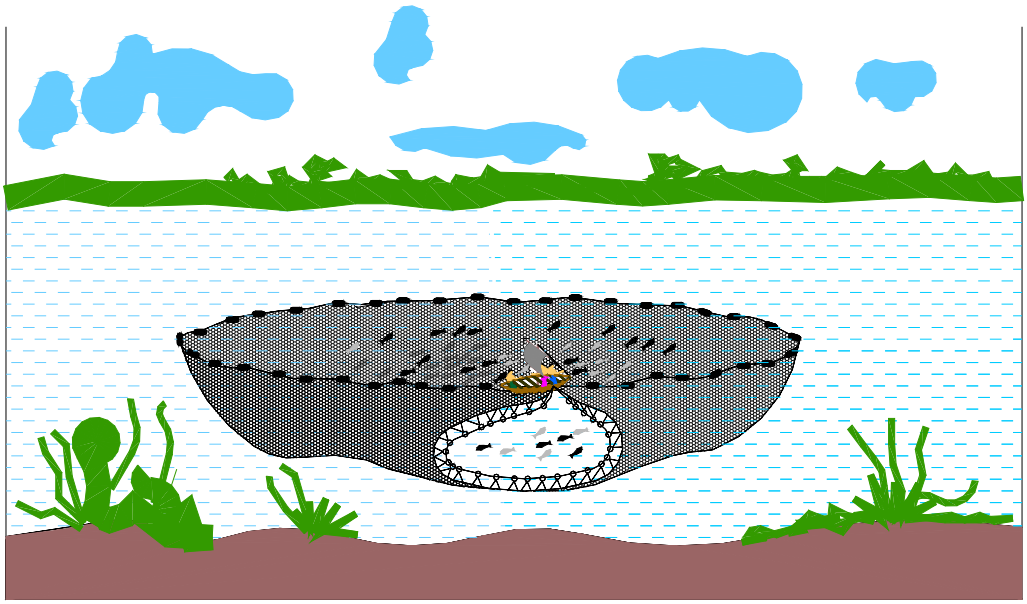


Fig. 27: Pursing of net

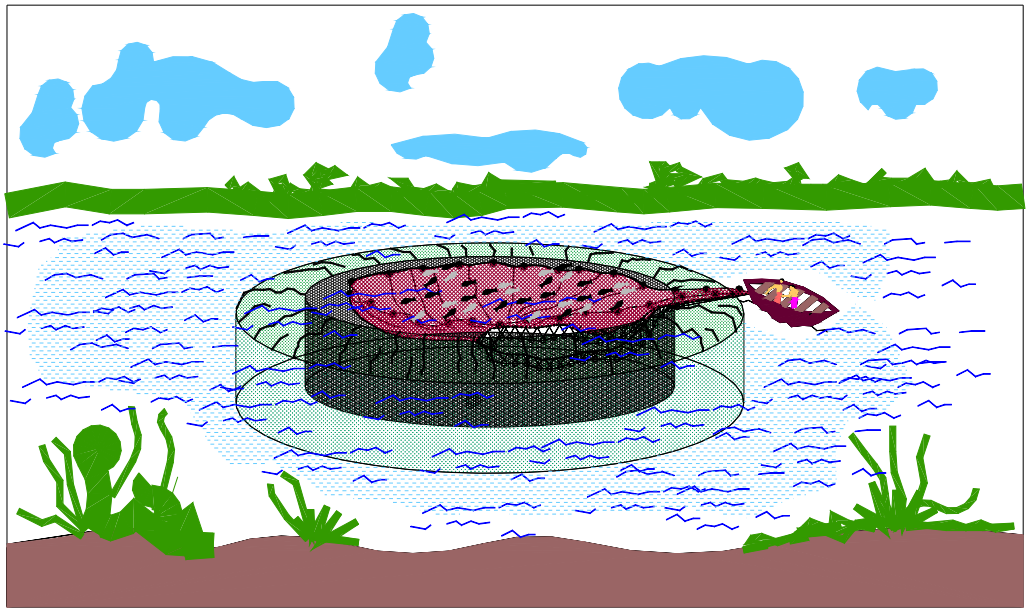


Fig. 28: Pursing of net for phoom fishing

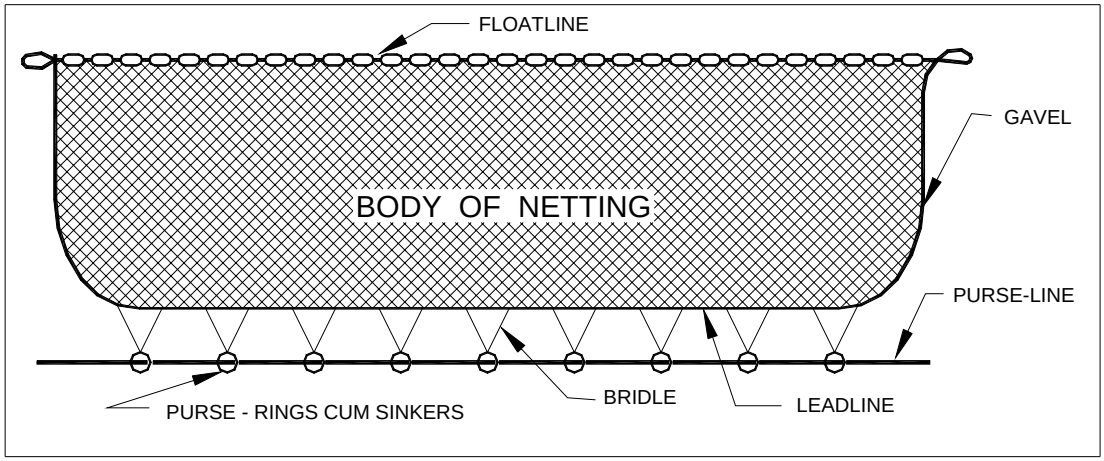


Fig. 29: Details of purse seine for phoom fishing

Body of Netting

The length of netting should be approximately equal to the circumference of the phoom circle. For trial run, the length and depth of the netting was made to 250 ft and 25 ft. respectively. The material of netting was made of nylon. The mesh size of the netting should be small enough to avoid large scale gilling and at the same time, the mesh size should not be so small that it would require large force and energy for pulling the net during fishing and therefore it was made to mesh size of 2 x 3 mm^2 (rectangular).

Float-line with floats

The ropes made of polyethylene, polypropylene or polyamides were used as float-line. The diameter of the rope was adjusted to 6 mm – 8 mm and rounded in shape. Two types of floats were designed and fabricated – cylinder shaped made of poly propylene (plastic) and Spherical shaped made of plastic (Poly propylene). The cylinder and spherical shaped float designed and fabricated out of iron mould is shown in Photo No. 21and Photo No. 22 A photograph of the iron mould for the cylinder shaped float is at Photo No. 23 The size of each cylinder shaped float was 3 cm in diameter and 5 cm in length, one such float was attached to every 3 ft of the float line. In a purse seine of 250 ft long, there should be 84 such floats on that float-line. Details of the Cylinder shaped float is shown in Table No. 16.

Table No. 16: Details of Cylindrical shaped floats

Sl No.	Feature	Unit/material
1	Outer diameter (D)	3 cm
2	Inner diameter (d)	1 cm
3	Wall thickness (D-d)	1 cm
4	Float Material	Plastic (Poly propylene)
5	No of floats	84
6	Length (l)	5 cm
7	Volume of the float V = $\pi/4$ (D^2 – d^2) x l	31.4 cu. cm.
8	Weight of the float	24.5 gm
9	Sp. Weight = Weight / Volume	0.78 gm/ cu cm
10	Buoyancy (up thrust of the float)	24.5 gm
11	Float gap	3 ft
12	Cost of float	Rs. 2.50/-

In case of the Spherical shaped float, the diameter of the float was made to 7 cm. Details of the spherical shaped float is shown in Table No. 17. In a purse seine of 250 ft long, there should be 126 such floats on that float-line.

Table No. 17: Details of Spherical shaped floats (with a neck)

Sl. No.	**Feature**	**Unit/material**
1.	No of floats	126
2.	Float Material	Plastic (Poly propylene)
3.	Diameter of the float (D)	7 cm
4.	Wall thickness	0.1 cm
5.	Weight of the float	26 gm
6.	Volume of the float (Sphere) = $4/3\pi\ r^3$	179.66 cm^3
7.	Sp weight =Weight/Volume	0.145 gm/cm^3
8.	Buoyancy (up thrust of the float)	61 gm
9.	Float gap	2 Ft
10.	Cost of float per piece	Rs. 2.50/-

Gavels

The gavels are the ropes, which are attached to the sides of netting. The rope of the same material and thickness used for float line were used as gavels. The Details of the ropes used as purse-line is shown in Table No.18.

Table No. 18: Details of Rope used for Purse Seine

Head rope (plastic)	8 mm
Float line (plastic)	4 mm
Foot rope (plastic)	8 mm
Purse line (plastic)	8 mm
Length of purse line	285 Ft (10 m longer than foot rope)
Letter "V" shape ring bridle (Plastic) for ring fixing	4 mm
"V" mouth	8 inch
"V" height	6 inch
Distance between two "V" shaped bridles	1 Ft 4 inch

Lead-line

The lead-line of the improvised fishing gear will not be fitted with any sinkers. The purse rings, which will be hung from the lead line, would act as sinkers. However, the bottom of the netting was attached to the lead-line. In fact the lead-line may be considered as the continuation of float-line and gavels. The rope of the same material and thickness used for float-line and gavels was used as lead-line. The Details of the ropes used as purse-line is shown in the above Table No. 18.

Purse-line

The purse-line is the line running through the purse ring, which is used to close the bottom of net. The purse line was made about 10 m longer than the combined length of the lead-line and the gavels. The Details of the ropes used as purse-line is shown in the above Table No 18. Hand driven reel made can be used to make the hauling simpler as shown in Fig. No. 30.

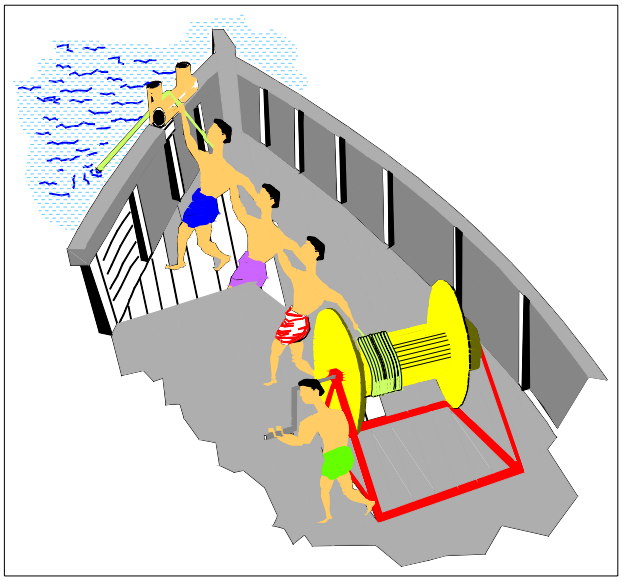


Fig.30: Hauling of purse line

Purse-rings cum sinkers

The lead rings each of 42 mm diameters and weighing 78 gms were fabricated out of iron mould and used as sinkers. Photographs of Iron mould for the Sinkers and Lead sinkers are shown in Photo No. 24. One hundred and twenty five (125) of such rings were hung from the lead-line with the help of short pieces of ropes called bridles. The polyamide rope of approximately 4 mm diameter was used as bridles. Details of the lead sinkers of the purse seine are detailed in Table No. 19.

Table No. 19: Details of the Lead Sinker of the Purse Seine.

Sl. No.	Feature	Unit/Material
1	No of sinkers	125
2	Sinker Material	Lead
3	Shape of the sinker	Circular (ring)
4	Outer diameter of the sinker (D)	4.2 cm
5	Inner diameter of the sinker (d)	2.6 cm
6	Thickness of the ring	0.8 cm
7	Volume of the ring $V=\pi /4 (D^2-d^2) \times H$	6.84 cm^3
8	Weight of the ring	78 gm.
9	Sp Weight= Weight/Volume	10.6 gm /cm^3
10	Sinkers gap	2 Ft
11	Cost of sinker	Rs.6/ piece

Assembling the above components, a purse seine had been fabricated. The details of the net fabricated are detailed in Table No. 20.

Table No. 20: Dimension and data sheet of the net

Length	250 Ft
Depth	25 Ft
Mesh size	Rectangle mesh of 2x3 mm^2
Material of the net	Nylon
Method of fabrication	Loom
Cost of net	Rs 14,500/-

Efficiency test of the Purse Seine was conducted. During the trial fishes like *Cirhinus mrigala, Catla catla, Ctenopharyngodon idella, Amblypharyngodon mola, Hypophthalmichthys molitrix* Common carp, Big head etc. are caught in this net. The Purse Seine is effective and almost all types of fish ranging from small to big ones are easily caught. Operation of Purse Seine at Loktak Lake and other water bodies are at Photo No. 25, 26 & 27. Catch from an operation at Loktak Lake is shown in the photograph at Photo No. 28.

A comparative data indicating advantages of Purse seine over the traditional Phoom fishing is shown in Table No. 21

Table No. 21: Advantages of Purse seine over traditional Phoom Fishing

Sl no.	**Phoom Fishing**	**Purse seine**
1	Required two types of net (Surrounding net and drag net)	Required only one net
2	Crafts are used as floats	Plastic floats are used
3	Stone are used as sinkers	Lead sinkers are used
4	Large volume of the net	Half of the net volume
5	Cost around Rs.40, 000/-	Cost around Rs.16,000/- (medium size)
6	Man power required during is 9-10 Fishermen	Man power required during operation is 4-5 Fishermen
8	Crafts required 5-6	Crafts required 2
9	Time taken 5-6 hours	Time taken 2 hours
10	Difficult to catch bottom dweller fish	Caught all types of fishes including the bottom dwellers.

Electro Fishing Device:

Electro fishing is the use of electric fields in water to capture or control fish.

Electro fishing depends on the generation of sufficiently strong electric fields around or between the electrodes in the water. The position, size and shape of the electrodes and the electro potential difference, type of current and the wave form generated between the electrodes play an important role. Also the water conductivity, water capacity to conduct an electric current, is the most critical factor in establishing an electro fishing field.

About the device:

Electro fishing using AC type of current is considered to be the most harmful to the fishes and DC to be the least fatiguing and injurious. So, we have designed a device to produce an AC current from a simple 12 volt DC battery. It is easy to operate and above all, light in weight so that it can easily be carried.

Components:-

1. Transformer
2. Transistor
3. IC
4. Resistance
5. Heat Sink
6. Diode
7. Circuit Board
8. Wiring System
9. Electrodes (one Anode and one Cathode)

Battery Capacity and Output:

A simple battery is used to give a power supply of maximum 12 volt. and a varying voltage of 4, 6 and 8 volts. The device can produce an output of three different voltages180 volts, 220 volts and 320 volts.

Fishes after introduction of the current becomes motionless when the body voltage exceeds a certain value from nose to tail. Longer periods in the field can cause to death, and conversely shorter periods are ideal as fishes will recover and return to normal.

At 180 volts the fishes show initial movements away from the anode and they appear to be sinking but later found coming back to the surface in a semi-narcosis state. At 220 volts the fish ceases to swim, they commonly turn over and then go into a state of narcosis. At 320 volts fishes get totally stunned.

PART C: POPULARISATION

9.3.9 Popularisation

A demonstration/ awareness generation programme of Fishing Crafts & Gears developed under the project for the fisherman of the state was organised by MASTEC in association with Loktak Lake Environment Conservation Centre, Thanga on 20thSeptember 2005 at Thanga Khunjem Leikai, Thanga (Loktak lake). Officials of State Fisheries Department, Adhakshya, Bishnupur Districts and Pradhans of the surroundings of the Loktak Lake were involved in the programme. The fishing crafts and gears developed under the project were demonstrated and the fishermen were allowed to operate them of their own. Some photographs of the popularisation programme are at Photo No. 29 and Photo No. 30. The significance and efficiency of the various models were explained to the local fishermen by making trial on the spots. The local fishermen know the significance and advantages of the improved models developed. They readily accepted the models. The fishermen have started asking about the availability of the models. This is a clear example of successful outcomes of the project. People from the electronic and print media were also involved in the popularisation programme and the programme was covered in the print and electronic media. A press cutting is at Annexure 1 for reference.

The models were replicated and kept at Loktak Lake under the supervision and care of the Loktak Lake Environment Conservation Centre, Thanga for taking up mass popularisation programmes in the surroundings of the Loktak Lake.

9.3.10 Video Filming of the Models:

State S&T Councils Division, Department of Science and Technology, Government of India under its programme of video filming of the achievements of all State S & T Councils in India had sent a team to Manipur for film shooting of success stories of Manipur S & T Council. Film shooting of the crafts and gears developed under the project was made by a team from Lucrative Eye Communications, New Delhi. Direct interaction with the local fishermen on the efficiency and advantages of the models was also visualised in the film. The positive comments from the fishermen can be seen in the film when the film is released by DST, GOI.

10 RESULTS

The two catamaran configurations i.e. the full and half size catamaran are very good models for group fishing and transport. Stability has been maintained and the working area is increased and hence any types of fishing activities can be carried out easily. Chances of capsizing the boat are very low.

The stability of the wooden outrigger structure is considerably high and ultimately the carrying capacity of the craft is increased. The outrigger structure can easily be detached.

In case of the 3 m FRP boat, the breadth of the 3 m FRP boat is considerably wider comparing to the breadth of the existing plank built canoe and therefore propelling by single oar is a problem. Hence double oaring system is provided by fixing two cleats at the midship portion of the side walls. Stability of both the 3 m FRP and 6 m FRP boat is high. The 6 m FRP boat is good for group fishing and transport.

The FRP outrigger Canoe (double) has high stability and the speed of the craft is higher than that of the plank built canoe. Depending on the type of water bodies and fishing activities, the craft can be used as a canoe, with only one outrigger structure (single) or with two outrigger structures (double). The arm of the attached structures can also be adjusted to the desirable length according to convenience.

Of the fishing gears items, the traps designed under the project such as a) Trap (taijep) made of bamboo strips and nylon nets with single entrance, b) Double entrance Trap (taijep) made of bamboo strips, c) Folding Trap (taijep) made of bamboo strips, d) Rectangular trap (taijep) with folding wings for riverine fisheries etc. have certain advantages over the traditional ones. The Trap (taijep) with bamboo strips and nylon nets is cost effective. Catch is high in case of Double entrance Trap (taijep). Handling of Folding Trap (taijep) is easy and transport is not a problem. A fisherman can load this trap as much as he can at a time for operation.

The advantages of the trap with folding side wings is that it covers more fishing area and the wings can act as a fish leader.

Regarding the Purse Seine, the net with the Spherical shaped floats can be operated with effective results. The buoyancy of a cylinder shaped PP floats is less and not proportionate to the corresponding weight of 78 gm sinker. Because of the less buoyancy, the float line dipped in the water when the net is pulled and as a result fishes jumped out of the net. In case of the spherical shaped PP float, the buoyancy is about 61 gm which is comparatively high enough to balance the weight of the sinker i.e. 78 gm. Hence, at the time of pulling the footropes for closing the net, the float line floats and fishes cannot jump out of the net. However, fixing of two weights at the two bottom ends of the net is required since the bottom part at the two ends are lifted when the sinker line is pulled to close the whole bottom part of the net. This will enhance efficiency of the purse seine.

11 CONCLUSION:

The local fishermen know the significance and advantage of the fishing crafts and gears developed under the project. However, of the various crafts, the 3 m FRP boat and FRP outrigger canoe are more attracted and are of high demand by the local fishermen. A few FRP entrepreneurs are keen to know the technologies of these two FRP boats. This may be because of the demand made by the fishermen.

If mass popularisation programme of these two models can be taken up by providing these boats to selected beneficiaries, the technology may be accepted by the fishermen of this state. For mass popularisation of these two models, we have submitted a proposal to Department of Science and Technology, Govt. of Manipur for financial grant. Once the material for boat making is substituted by FRP, then felling of large trees for canoe making will be reduced and the disturbance to the ecology and environment of the state may be brought down.

Photo No. 1: Interaction meeting of the local experts with IIT , Kharagpur, team

Photo No. 2: Presentation during the interaction meeting

Photo No. 3: A Typical Wooden Dug-Out Canoe

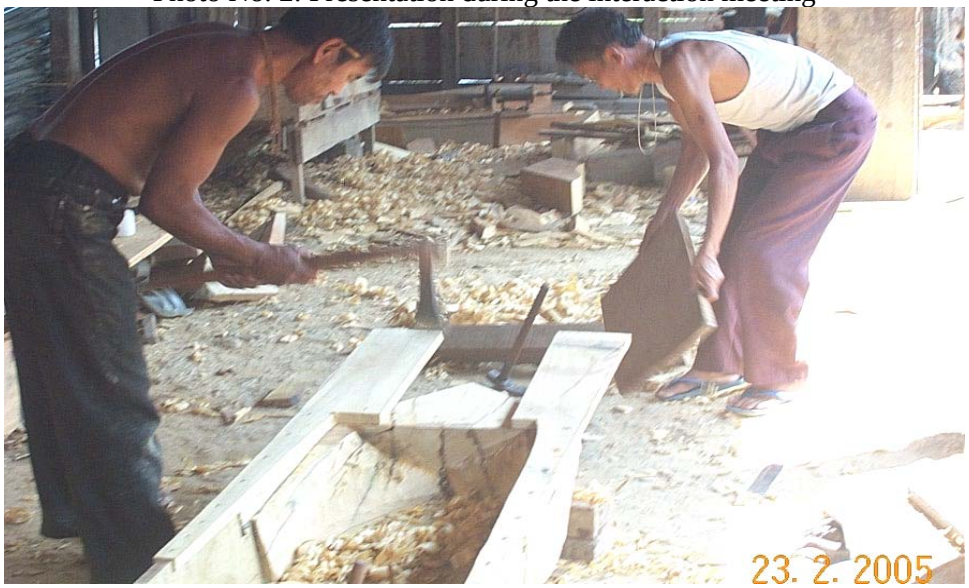


Photo No. 4: Men at work at Moirang boat factory

Photo No.5: Full Size Catamaran Configuration showing deck portion

Photo No.6: Trial of Full size Catamaran with IIT team

Photo No. 7. Trial of Half size Catamaran with IIT team

Photo No.8: A wooden outrigger canoe (single)

Photo No. 9: Semi Pucca Workshed of the Project.

Photo No. 10: A 3 m FRP boat

Photo No.11: Inclination test of 3 m FRP boat by IIT, Kharagpur team

Photo No. 12: Wooden mould of 6 m FRP boat

Photo No. 13: A 6 m FRP boat

Photo No. 14: FRP Outrigger canoe (double)

Photo No. 15: Field trial of FRP Outrigger canoe (double)

Photo No. 16: Trap (taijep) made of bamboo strips and nylon netting

Photo No. 17: Double entrance trap (taijep)

Photo No. 18: Trial of Double entrance trap (taijep)

Photo No. 19: Folding trap (taijep)

Photo No. 20: Rectangular trap with folding wings for riverine fishery

Photo No. 21: Cylinder shaped HDPE float

Photo No. 22: Spherical shaped HDPE float

Photo No. 23: Iron mould for Cylinder shaped HDPE float

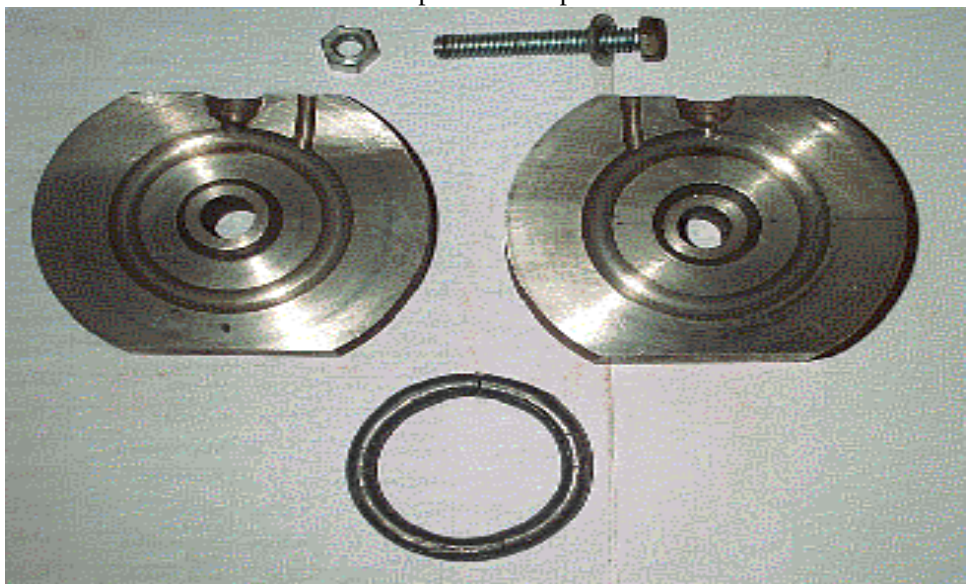


Photo No. 24: Iron mould and Lead sinker for purse seine

Photo No. 25 Purse seine operation at Loktak Lake

Photo No. 26: Purse Seine operation at Ningthem Pukhri

Photo No. 27: Purse Seine operation at a farm

Photo No. 28: Catch from Purse Seine operation at Loktak Lake

Photo No. 29: Popularisation of the models at Loktak Lake

Photo No. 30: Trial of the models by the fishermen at Loktak Lake