Bay of Bengal Programme

Development of Small-Scale Fisheries

FURTHER DEVELOPMENT OF
BEACHLANDING CRAFT
IN INDIA AND SRI LANKA

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based on the work of

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This paper describes eight new prototypes of beachlanding craft developed by the small-scale fisheries project of the Bay of Bengal Programme (BOBP). It also describes the technical trials of the craft with emphasis on surf crossing abilities. This working paper is a sequel to BOBP/WP/7, "Technical Trials of Beachcraft Prototypes in India" which described BOBP's first trials of four prototypes. Other relevant documents on BOBP's efforts to develop and introduce BLC are:

BOBP/WP/26	—	Commercial Evaluation of IND-13 Beachcraft at Uppada, India.
BOBP/WP/25	—	Fishing Craft Development in Kerala: Evaluation Report
BOBP/WP/44	—	Pivoting Engine Installation for Beachlanding Craft
BOBP/WP/51	—	Hauling Devices for Beachlanding Craft

Several articles have also been published in the *Bay of Bengal News.*

The craft were designed by project staff A. Overa (Marine Engineer) and R. Ravikumar (Naval Architect), and by consultant O. Gulbrandsen (Naval Architect). P. A. Hemminghyth (Marine Engineer) and SO. Johansen (Naval Architect) both Associate Professional Officers at BOBP, also assisted in the work. All prototypes were built by the project — most of them at the Royapuram boatyard in Madras.

The surf-crossing trials described in this paper were conducted and reported on by G. Gowing, surf crossing consultant. Staff of the fisheries administration and fishermen in Tamil Nadu, Andhra Pradesh, Orissa and Kerala in India and in Sri Lanka participated in the trials.

The small-scale fisheries project of the Bay of Bengal Programme (BOBP) is funded by Swedish International Development Authority (SIDA) and executed by the Food and Agriculture Organization of the United Nations (FAO). It covers five countries bordering the Bay of Bengal — Bangladesh, India, Malaysia, Sri Lanka and Thailand. It is a multidisciplinary project, active in fishing craft, gear, coastal aquaculture, extension, information and development support. The project's main goals are to develop, demonstrate and promote appropriate technologies and methodologies to improve the conditions of small-scale fisherfolk in BOBP's member countries.

This document is a working paper and has not been cleared by the FAO or by the concerned government.

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1. RATIONALE

Traditional craft operated from beaches account for the bulk of fish landings on India's east coast. Over 65,000 craft in some 860 fishing villages provide livelihood for close to 150,000 fisherfolk families.

Nearly three-fourths of the traditional craft operating from the beaches are kattumarams. These craft are virtually unsinkable and are well suited to landing on wave-beaten beaches and for surf crossing. They have, nonetheless, serious shortcomings like low carrying capacity, limited endurance and range of operation and lack of protection for crew and catch.

In order to increase the productivity and thereby the standard of living, beach-based small-scale fisherfolk need better fishing craft. Building fleets of conventional boats will not solve their problems since such boats can be operated only from harbours or naturally protected areas of which there are very few along the east coast of India.

A better craft should be able to (a) store and carry more fishing gear and catch, (b) operate over a wider area to exploit fishing grounds beyond the reach of traditional craft (c) provide protection to crew during long fishing trips and adverse weather conditions. But a prerequisite for a successful beachianding craft is its ability to cross moderate to heavy surf with a high degree of reliability and safety.

While a new craft has to meet these requirements it is important to keep it as small as possible. One reason is the problem of hauling the boat up on the beach and launching it which becomes increasingly difficult with increased weight. Another reason is the cost; too large and expensive units will limit the target group's access to them.

The technical considerations that went into the design and development of the prototypes are detailed in BOBP/WP/7.

2. PREVIOUS TRIALS

Four beachlanding craft of different designs and construction were built and tested in India during 1980. They were:

IND-IO was 7 m long and relatively beamy (2.45 m) with a high depth (0.85 m). It was built with a strip-planked bottom and seam battened sides and deck. Though it performed well in the surf, it was found to be too heavy and difficult to handle on the beach.

IND- 11(7.4 x 2.25 x 0.72 m) was built on the 'buoyancy block' principle. Gaps were provided in the planked hull and deck to enable quick draining of water while polystyrene blocks inside the hull provided buoyancy. This craft was popular with kattumaram fishermen who saw in it similarities to their traditional craft.

IND-13 was a plywood craft of the same size and shape as IND-li. It was flush decked to prevent water entry into the craft while negotiating surf. Also successful during the trials, this craft was chosen for further trials by Nava fishermen from Andhra Pradesh.

IND-14 was a twin-hull craft built in marine plywood. Handling on the beach was difficult and the bridge was exposed to the breaking waves. The inherent directional stability of a twin-hull craft meant that it was virtually impossible to correct a broach by rudder action. This was in contrast to the mono hull designs tested which, although possessing less directional stability, responded very quickly to rudder action.

IND-10, 11 and 13 were powered by a 4.8 hp air-cooled diesel engine installed in a pivoting watertight box allowing retraction of propeller and rudder into a tunnel in the hull. IND-14 was powered by an 8 hp outboard engine. Further details of the craft and the trials were reported in BOBP/WP/7.

The main lessons learned during the trials were:

- A mono hull craft is preferable to twin hulls,
- It should not have a deep forefoot and the forward sections should provide ample lift (Fig. 1),
- Beachlanding craft must have a smooth bottom without keel, and a large deep rudder behind the propeller is essential to avoid broaching and possible capsize (Fig. 2),
- The method of installing the engine in a pivoting watertight box is very successful as it allows easy lifting of propeller, rudder and skeg (Fig. 3),
- Transom width should be moderate,
- Lateral resistance under sail should be provided by a dagger board, which would also dampen rolling,
- Boats should be designed to prevent water entering them by being decked or by providing a method for quick draining as in the case of buoyancy block craft,
- A rockered keel is advantageous for handling the craft on the beach,
- Planked craft will be too heavy if they are to be strong enough to withstand surf-landing every day.

As a follow up to the technical trials, three craft of the IND-13 type were built for commercial fishing trials from Uppada, Andhra Pradesh, by Nava fishermen. The trials lasted 17 months during which the craft operated 16 days per month (overall average). The details are reported in BOBP/WP/26. The main conclusions were:

- The craft should be larger than IND-13 to overcome the shortcomings of crew discomfort and lack of storage space. Sheer forward should be increased to reduce water over the bow while surf crossing.
- The engine was not powerful and durable enough for continuous heavy duty operations. (The craft were kept in operation by the use of spare engines during frequent breakdowns.)

Two craft of the IND-11 type were also built by BOBP for further testing from Injambakkam (South of Madras) by kattumaram fishermen. The experiences there were similar to those in Uppada.

3. NEW PROTOTYPE CRAFT

On the basis of the experience from previous trials, the development of a new generation of beachlanding craft of different sizes and materials commenced in 1981. In India the successful track of IND-11 and 13 was followed. In Sri Lanka the primary need was a beachlanding alternative to the common and popular 3½ tonners usually employed in large mesh driftnetting. The main dimensions of the eight new prototypes are given in Table 1. General arrangements are shown in Figures 4—11.

All craft had the ‘pivoting engine installation’ (Fig. 3). Most of the engines were air-cooled but because of overheating problems, trials were taken up with water-cooled engines in Sri Lanka during 1984 and in India during 1985. More details about the engine installations are given in BOBP/WP/44. All craft were equipped with a daggerboard and sails. Lateen or Gunter rigs were used in India and Marconi rigs in Sri Lanka. The powering details are given in Table 2.

All new prototypes were technically tested before they were put into long-term commercial fishing trials. Technical trials were limited to testing the craft's ability to cross the surf to and from the beach since this is the key to a successful beachlanding craft.

Each craft was tested by having several runs going out and coming in through the surf. Possible accident situations were simulated to assess the performance and design of each craft.

The craft were made to ride on a breaking wave while coming in, to test broaching tendencies.

On going out through the surf the craft were once again placed in situations (within the limits of personal safety) that would test their surf crossing ability. This was achieved by driving the craft into the surf at various stages of wave build-up and break.

Handling of the craft on the beach was also assessed but this will form a minor part of this report, being restricted to comment on general handling of the craft at the water's edge both during landing and departure. A beachhauling device developed by BOBP is described in BOB P/WP/51.

Most of the tests were conducted in 1981 and 1982 by a surf-crossing specialist (Gowing) together with the designers of the craft; he had also tested the first generation of BOBP beach-landing craft (BOBP/WP/7). The test reports presented in this paper are reproduced verbatim from the specialist's comments at the time of the testing. IND-25 and SRL-14 were tested by project staff and by fishermen who were trained by Gowing.

3.1 IND-18, 19

Two craft, labelled IND-18 and IND-19, were designed and constructed for use in Kerala under a UNDP-funded project (RAS/77/044). The main dimensions of the two hulls are identical and they differ only slightly in the bow and stern shape. They are intended for fishing with large-mesh driftnets. They were built of marine plywood sheathed with FRP. The shape of the hull was a stretched version of IND-13. They are flush decked with removable hatches over the net hold. The net hold also provided crew shelter. The craft were motorized with the same installation as used in IND-1 3, i.e. the 4.8 hp air-cooled engine. Atthe time of construction, the IND-13 trials were still in progress and better engine solutions had not yet been finalized. IND-18 and 19 were equipped with 8 hp VST engines later on.

"The testing of IND-18 in Madras was carried out in extremely difficult surf and weather conditions.

"IND-18 showed good surf crossing capabilities although conclusive results could not be obtained because of damage to the stern gear which occurred during the third attempt to depart the beach and cross the surf.

"Based on the previous experience with IND-13, it appeared that this craft had very similar surf-crossing characteristics. However, it appeared to be marginally faster and easier to handle on a wave than IND-13.

"It was easy to handle on the beach also, although once again a definite conclusion cannot be formed at this early stage.

"Damage to the stern gear was caused by the skeg being bent sideways when the craft was being handled at the water's edge while waiting for the correct moment to commence a run out through the surf.

"Revision of the helmsman sequence by leaving the removal of the pin* until the last moment of commitment to get under way will help reduce the number of times when the stern gear may be open to damage. In addition, the modification of the skeg to include a propeller guard that will prevent the skeg being bent sideways could eliminate the possibility of damage and subsequent down time of the craft

* A pin put through a hole in the rudder shaft at deck level to keep the stern gear in the upper position (Fig. 3).

"It is suggested that this be manufactured of heavy gauge aluminium to reduce weight. The loss of efficiency caused by the additional drag would be offset by the reduction of damage.

"During testing in Kerala, the surf was moderate with some freak waves approaching two metres in height. The crew had gained some experience of handling the craft prior to the test runs.

"The crew demonstrated their ability to me and apart from a broach while coming in through the surf due to their reluctance to run the craft with the wave, the surf crossing and beach-landing were quite successful. On the next run I showed them how to come in using the surf and the power of the craft and this crossing and landing were also quite successful. I then allowed the crew to take the craft again and we attempted a third return to the shore.

"When at the critical point in the surf zone — that is, where the waves rise and drop on to the sand bar — a two metre wave caught the craft and caused it to broach. The steepness of the waves and the low sides of the craft caused it to roll over, resulting in the engine stopping and the rudder shaft breaking in two places. The craft was retrieved and brought to shore upside down and then rerighted at the shore quite easily.

"Inspection of the craft revealed very little water in the hull and no water in the engine box — there was sand present and I think that the water escaped from the engine box when the craft was rerighted.

"The engine was checked and indications were that there was some water in the cylinder — not sufficient to prevent the engine from being turned over but enough to prevent it being restarted. The engine was removed and taken back to the boatyard where it was cleaned and restarted and a new rudder was made and the craft placed back into service.

"It is interesting to note that the project or the craft suffered no credibility loss at all — in fact the crew and other fishermen were impressed that the craft remained intact and did not break up as is their experience with their traditional boats.

"As a general comment, I felt that the engine (Lombardini 523) was not developing its full power at the time and the craft was 'painfully' slow in crossing the surf in both directions. I felt that although the craft was in a difficult situation prior to the roHover, I am sure that there may have been a better chance of avoiding the rollover if more engine power had been available."

After the testing and demonstration, the craft were used for commercial fishing trials. They compared well with more expensive harbour-based conventional gillnetters. A detailed report is found in BOBP/WP/25. The only clear deficiency was the 4.8 hp engine. It was replaced after about a year by an 8 hp VST Shakti unit, which from that time has been the only engine used in the beachlanding craft in India. BOBP did not undertake any further follow up work since the craft were outside BOB P's geographical area. However, it is learnt that the craft continued to operate (off and on) from south Kerala till mid-i 985. One craft was damaged extensively during a storm. The other is not operating due to crew problems over ownership rights. It was earlier sold to the head fisherman at a discounted price. It is interesting to note how well the plywood construction stood up; no serious repair or maintenance problems were encountered.

3.2 IND-20

This craft was designed to overcome some of the shortcomings experienced during the IND-i 3 trials. Built of FRP, it is longer and has rounded bottom sections with a stepped chine. The original layout was similar to the IND-i9. It was flush decked in FRP sheathed plywood, with hatches over the net hold and crew shelter. It was equipped with the 8 hp diesel engine in a pivoting box installation. The craft was seen as an alternative to the nava being operated in Andhra Pradesh with large mesh driftnets as the fishing gear.

"The IND-20 was tested on four separate days in the surf.

"The wave-riding ability of this craft was quite acceptable during the initial slide or run down the face of the wave, exhibiting quite stable characteristics that permitted good control of the craft during this period. It was quite fast.

"Once the craft had completed its run down the face of the wave it slowed down appreciably and when caught up by the broken waves showed a tendency to broach due to loss of rudder efficiency in the turbulent water and the relatively low speed of the craft. The wave action then pushed the craft either to the right or the left, in most cases to the left.

"Careful attention to the direction of the craft and observation of slightest deviation could give sufficient time for applying some corrective action – although once the craft was more than a few degrees off, the rudder forces were too small to counteract the change of course and the craft broached.

"By moving the ballast (8 sandbags of wet sand weighing a total of 450 kg to simulate operational loads) and the crew to a position further aft, this tendency to broach was reduced but not eliminated.

"Though broaching is not desirable, it is acceptable provided the craft does not roll over. This craft did not show any alarming tendency to roll over in the broached condition as it was after the wave had passed. And the action of the crew of moving to the "high side", i.e., the wave side of the craft, during broaching, virtually eliminated any chance of a roll over.

"On going out through the surf the craft was quite easy to handle and responded to any rudder corrections that were made.

"On-coming breaking waves did not present any problems. There was sufficient lift action on the bow to ensure that the craft lifted clearly over the waves. On most occasions during the trials very little water was taken over the deck when going out through the waves. At the time when the craft was pushed through a wave the exposed crew on the deck did have some problems with hanging on.

"I consider the power of the 8 hp VST Shakti engine to be quite adequate for surf crossing, although for normal cruising, reduction of the power output by reducing the throttle setting must be observed.

"Landing of the craft on the beach presented no real problems with the exception of the usual problems of maintaining control of a large craft at the water's edge.

"Refloating the craft proved difficult on most occasions, the cause being the flat bottom creating a suction seal with the wet sand and preventing the craft from being slid into deeper water where it could be floated off. A few degrees of 'Vee' on the bottom could assist in overcoming this probTem.

"Once again I reiterate comments from previous reports on the use of sand stuck to the deck to provide a non-slip surface. During trials when boarding and disembarking the craft on numerous occasions, wear and tear on the skin resulted in abrasions and possible infection. Some other form of non-slip surface must be considered – or the sand can be added after the trials.

"In summary, IND-20 is a good surf crossing and beachianding craft. Its tendency to broach while not desirable is acceptable since the craft does not exhibit any capsize traits. Modification of the bottom to assist with launching the craft across the wet sand would be desirable. Engine power is adequate. The use of sand stuck to the fibreglass resin to provide a non-slip surface should be reviewed."

The broaching tendency of the craft was attributed to lack of buoyancy in the stern. The hull was thus modified incorporating wider stern sections and a flatter run. The new hull form is labelled IND-20A.

Six craft of IND-20 and 20A (three of each) were supplied to the Government of Andhra Pradesh in 1983—1984, against reimbursement of full costs, for trial and demonstration purposes in three villages. The craft have performed well; the only technical problem encountered is poor maintenance of engines and scarcity of spares and repair facilities. The problems are, however, gradually being overcome. BOBP is continuously monitoring the performance of these craft and others. A summary of observations is given in Appendix I.

An interesting point is that there has been no difference in the performance of the older and new versions. The earlier tendency to broach has been completely eliminated by providing a larger rudder.

In a modified version of this type (IND-20B) the working deck has been lowered to provide better comfort and safety for the crew particularly during handling of the fishing gear. IND-20B is being commercially produced by the Corporation boatyard in Kakinada since 1985. The cost of a complete craft with engine and sails (in 1985) is about Rs. 85,000 (about US $ 7,100). Estimated costs and earnings data are given in Appendix 2.

In the latest version (IND-20C) a 10 hp VST Shakti fresh water cooled engine with a 2: i reduction gear in a pivoting box is being tested. Cooling pipes are fixed to the underside of the engine box. This engine and propulsion system will provide better manoeuvrability for fishing operations and higher speed and will probaby be more durable, all of which are of significance to offshore fishing with long running hours. The tests started in the middle of 1985 and the results are promising.

3.3 IND-21

Based on the IND-il buoyancy block type of construction, the IND-21 was designed with a wider stern, higher ends, higher freeboard and wider beam to improve surf-crossing ability and provide more carrying capacity. The frame assembly was riveted and scantlings increased to make the hull stronger to better withstand shocks on landing. The engine installation was the same as in the IND-20. The craft was primarily meant for kattumaram fishermen.

> "IND-21 was tested on three separate days in the surf. During the first day of test using this craft it capsized when coming in on a wave approximately 1.5 m high. I concluded that there were two main causes for the craft's rolling over:
>
> "Firstly, on previous incoming runs through the surf the response of the craft to the rudder was slow — the craft took a long time to respond to any corrective action and as a result the craft tended to oversteer before coming about. This resulted in the craft broaching quite easily on the 1.5 metre wave—something that a craft of this size should not have done.
>
> "Secondly, when the craft broached the crew were moved out of position going to the low side of the craft. This together with the general sluggishness of the craft caused by the mass of water contained within the interstices of the foam blocks and reduction in buoyancy when the craft was heeled over were the factors that contributed to the roll-over.
>
> "The rolling action was quite slow and at that stage I felt that corrective action by the crew may have averted it.
>
> "To improve the steering response of the craft an additional piece 75 mm wide was added to the rudder blade. This proved to be adequate during further trials and no further serious loss of control or capsizing of this craft occurred.
>
> "The wave-riding ability of craft was quite acceptable once the rudder had been modified. Directional stability during the run down the wave was quite good.
>
> "Because the craft is not as fast as IND-20 and IND-23 it tended to hold onto the face of the wave and not race out in front. This I feel can be a desirable characteristic because the craft is not ahead of the wave when it drops, to be then caught up by the rushing water. This sometimes causes a craft to leap ahead and broach because of temporary instability.
>
> "Crew placement is important with this craft. Generally the crew should be positioned at the aft half of the craft for coming in through the surf and at the mid-section when going out. "Action by the crew to go to the "high side" of the craft when broaching is necessary to ensure maximum stability and to reduce the tendency to capsize.

"On going out through the surf IND-21 was easy to handle and responded well to rudder corrections. The oncoming surf did not present any major problem. The craft, because of the mass of water contained within the planks, tended to penetrate the waves more than lift over them. This resulted in the craft taking more waves over the deck than any of the others. Some foredeck to deflect the waves coming over the bow may be desirable on this type of craft.

"Crew exposure was reduced and security was improved by the deck being dished. The crew had a less exposed feeling and also there was a tendency to be washed into the craft rather than off it.

"I consider the power of the engine adequate. My comments on throttle reduction for IND-20 also apply to this craft.

"Beachlanding presented no real problems other than those mentioned for IND-20.

"Refloating the craft was not difficult provided sufficient manpower (6—8) was available and handling the craft on the short break was relatively easy provided the crew all teamed together to keep it under control.

"In summary, IND-21 is a good surf crossing and beachlanding craft of already proven design (IND-11). It handles quite well both coming in and going out. Correct placement of the crew and load is important and some form of foredeck to deflect the water coming over the bow when going out through surf is required."

A fishermen's cooperative in Injambakkam (south of Madras) that found IND-21 suitable ordered 30 craft from a private boatbuilder under a State Government 50% subsidy scheme. During the construction phase of the first five hulls which BOBP supervised it was found that the boatbuilder was unable to meet the required construction standards as to the quality of wood and workmanship. This was not considered a unique shortcoming. It is quite likely to happen with any boatbuilder. The high cost of good timber and fasteners in addition to that of the polystyrene also became a matter of concern. It was therefore recommended that the "buoyancy block" principle should be abandoned and no further development work was undertaken. The above mentioned scheme was subsequently modified to include craft of the IND-25 type.

Two prototypes which were built by BOBP were used in commercial fishing trials and for demonstration purposes in Injambakkam (Tamil Nadu) and Gopalpur (Orissa). A slight disintegration of the polystyrene blocks was noted. The damaged material had to be replaced with new material to maintain the buoyancy. Eventually, in 1984 one hull was badly damaged in a collision with a trawler. In 1985, the other was damaged during a roll over (capsize). The damages proved the vulnerability of the construction. Since this construction principle was not to be pursued, the craft were scrapped.

3.4 IND-23, 24

To explore the potential of using aluminium as a construction material for beachlanding craft, IND-23 was built of a fully welded hard chine construction. It was fully decked with a large hatch over the net hold. Quick drainage of water was achieved by having a 'dished' deck. In the first engine installation, aluminium was used for the engine box housing the 8 hp engine. Later this was replaced, due to cracking, with the standard plywood box. Since IND-23 was the smallest of the new prototypes, the kattumaram fishermen were seen as the prime potential users of this craft.

"The IND-23 was tested on two separate days in the surf. The light weight of the craft (620 kg) made for quite easy handling in all aspects. When coming in through the surf it was able to catch the waves at an earlier stage and with greater ease than any of the other craft. This allowed early control of the craft on the wave to be obtained and therefore a more stable and secure ride is achieved.

"It was very fast down the face of the wave and because of its lightness was much easier to control once the wave had been broken and caught up with it. It had excellent directional stability. The good rudder response was due to the short length of craft and the large rudder. This made it more controllable on a wave and any tendency to swing off course could be corrected quite rapidly and positively.

"Crew positioning and loading is important. The crew and load must be placed from the middle to the aft of the craft. The large buoyant area is provided for this type of load distribution.
"The surface of the aluminium chequer place decking became quite slippery when wet but by adding loose sand to the deck a reasonable grip was obtained. As time passes I feel the corrosive etching of the deck by sea water will provide a good nonslip surface.

"Going out through the surf, the craft exhibited good lift over the waves and only on rare occasions when it was placed under the breaking wave did water come over the bow and across the deck.

"The lightness of the craft did allow the craft to leave the water easily and care must be taken by the crew to ensure that they are holding on and watching to prevent being thrown out by the sudden directional changes.

"The engine power was more than adequate for this craft providing it with good running speed. Optimum throttle setting must be used to ensure good economics.

"Beachlanding of IN 0-23 was excellent. Once again its light weight made it easy to handle on to the beach with only four crew members. Launching and beach departure were also easy. Control of the craft in the shore break by the crew was simple and easily maintained. But some form of handles or grips around the gunwales would be desirable.

"In summary IND-23 is an excellent surf crossing beach-landing craft. Its light weight makes it easy to handle on the beach and provides it with good free running qualities in the surf. The design of the hull appears to be ideal with plenty of buoyancy at the stern to prevent squatting when overtaken by breaking waves. Crewmen must be aware of the lightness of the craft which makes it prone to throw them out. Some handles or grips for handling the craft are required. Plenty of power from the engine ensures that there is reserve power for difficult situations."

The aluminium alloy plating used in the construction of the IND-23 was found to crack badly after a short while. The manufacturers claimed that this was due to too wide tolerances during heat treatment of the material. It was also felt that a hull shape with a sharper bow and wider transom would improve sea performance. Higher free board and capacity was also thought desirable. A new design resulted – IND-24. The surf-crossing ability of this craft was the same as that of IND-23. Plating with a different temper was supplied free of charge by the manufacturer. One craft was built and has been in operation off and on for two years. Cracks have developed even on this craft.

Aluminium is in theory the best material for beachlanding craft because it is light and maintenance-free. The higher costs would probably be compensated for by reduced maintenance and the residual scrap value. IND-23 was in fact sold as scrap to test the residual value. Despite these advantages, it was felt that it may require considerable effort to attain a quality standard as to material and welding at which aluminium craft can be produced commercially without serious deficiencies. There would also be very few workshops with special equipment where craft could be repaired in case of hull damages.

It is therefore, at least for the time being, not advisable to use aluminium as construction material for any large-scale introduction of beachlanding craft.

3.5 IND-25

The setback caused by the structural failure of IND-21 prompted a new design of a craft in FRP with similar capacity. The resulting design was IND-25. One departure in concept was to try the boat partially undecked to improve net handling at sea; the fishermen prefer to stand low down in a boat. This was done before lowering of the deck in the IND-20B. Not having a full deck also reduced cost. This craft is available in two versions, with or without hatch covers. While trials without hatches in Tamil Nadu proved successful, hatches have been provided for fishing trials off Orissa. It has proved to be a good surf craft and its well flared sections deflect the wave, provide lift and keep the craft dry.

This type, together with IND-20B, has been included in a Government - supported subsidy scheme for introduction of beachlanding craft. Craft are commercially produced, after initial BOBP assistance, by four boatyards: Orissa (2), Andhra Pradesh (1) and Tamil Nadu (1).

3.6 SRL-11

This craft was designed to match the fishing capacity of the common 3½ tonner in Sri Lanka. It was built in marine plywood sheathed in FRP. Unlike the Indian craft, this craft had a lower conventional deck. A whale-back forward kept the craft dry. Large freeing ports were provided for quick drainage of water if a wave broke over the craft. Being heavier, it was equipped with a 12.5 hp air-cooled engine with a 2.72 reduction gearbox in a pivoting engine box. Accent was put on sailing performance and a mast-head Bermuda rig was provided. Terylene sails, aluminium spars and stainless steel rigging were used after unsuccessful tests with galvanised stays which rusted away after 3—4 months. The craft was meant primarily for large mesh driftnetting and longlining.

"The surf crossing tests were conducted on the beaches north of Negombo on four occasions in surf sizes varying from an average height of one metre upto 2.5 m. The craft was fully loaded on each occasion with masts, sails, nets and a crew of 4—6. Total weight of the craft was calculated to be 2.1 tonnes plus crew.

"The first test was conducted in moderate surf conditions, waves averaging 1.5 to 2 m in height with a SW. wind of 5 knots blowing from offshore. On coming into the beach the craft showed good directional stability. It did show a tendency to roll with the movement of the rudder, making initial alignment of the craft at right angles to the incoming wave a little difficult. This was overcome with continued use of the craft and consequent familiarity with its feel. On one occasion during this trial when coming in to the beach the craft was in a position when the wave face steepens just prior to breaking. At this point the bow of the craft was completely submerged upto the stem-head. At no time did the craft give any indication of broaching and as it gained speed the bow lifted clear of the water and the craft progressed to the beach under full control.

"At one point the craft commenced its run down the face of a wave at a slightly incorrect angle — this was caused by the unevenness of the surf and some side wash — as a result of which the craft showed a tendency to broach. I was able to maintain the craft on an angular course but not able to bring it around to the ideal position because I had reached the limit of rudder control.

"A total of seven runs into and away from the beach were conducted with the Sri Lankan crew taking over the helm and handling the craft quite capably. It was felt at that stage that further practice was required for the crew although indications were that Adley Fernando (skipper) retained much of the basic skills in handling the craft, on and off the beach, given to him in Madras.

"The second test was conducted in relatively mild surf conditions with the waves being only about 1 m high. This provided an excellent opportunity to give the crew additional training and also to develop the method of holding the craft ready for beach departure.

"As already experienced in Madras the craft is difficult to handle at the water's edge, when a longshore current is present.

"A technique was developed where a crewman would stand at the stern of the craft and by moving the stern to counteract the movement to the right or left of the bow he could quite easily keep the bow directly into the waves and the prevailing wind. He is required to keep This up until the craft departs the beach and the propeller catches and the rudder can take over the control.

"This crewman is not able to go with the craft as it is too late for him to board the craft. The person selected to carry out his function must be trained in what is required and cannot just be a well meaning helper. The safety aspects of somebody working so close to the propeller must be considered as with any craft operating on the beach there are always a number of hazards involved either from being struck by the craft when a wave hits or being washed under the craft with the backwash. Although the hazard exists, I feel that if the handler is made aware of it and with the added advantage of him standing in shallow water he should be able to keep his footing; and provided he never lets go, even if he does lose his footing he should be safe. I suggest that some form of handle or grip be installed on the transom for this purpose.

"A total of eight runs in and out through the surf were completed with the emphasis being placed on the crew's handling the craft on the beach.

“The third test was conducted in medium surf conditions with a wave height of 1.5 m. During this trial a strong off-shore breeze of about 12 knots was causing the surf to come into the beach at an angle. This provided the crewmen with additional training and experience in handling the craft in a variety of conditions. The craft was also operated with the mast in the erected position.

“The previous practice of handling the craft off the beach proved invaluable and the take off technique was considerably improved resulting in a cleaner departure from the beach. This eliminates the need to consider abandoning a beach departure except in extreme cases. Throughout the trials it was not necessary to abandon any departure.

“With the mast in the erected position there was no apparent increase in difficulty experienced in the surf handling of the craft although there was a tendency for the crew to believe the craft more unstable than it was.

“I can see no problem with beachlanding the craft with the mast erected when the surf conditions are moderate – say 1.5 m. A total of ten runs were conducted into and away from the beach.

“The fourth and final test was conducted in the most difficult conditions experienced so far in all of the beach landing and departure runs. Over the past few days as a result of squalls and high wind conditions the surf had built up to a consistent 2.5 m. The test was conducted late in the afternoon and the tide was high.

“A total of four runs were made with the craft performing exceptionally. On all occasions except one it maintained its directional stability and it was kept under full control and brought to the beach. On one run the craft broached and turned sideways to the wave. In this position the craft remained stable and at no time did I feel that it was going to roll over. There was sufficient side slip for the craft to remain upright. The crew had been instructed previously on how to act in the event of a broach occurring. This they did and the craft was brought under control again and taken out to sea to return to shore again.

“On leaving the beach, the take off was performed each time without any problem with the crew's previous training ensuring that the element of chance and risk was at the minimum. Going out through the surf zone, the craft did all that it was designed for and it was often necessary to reduce the speed to prevent the craft from becoming airborne over the waves. On many occasions waves broke over the bow and a large amount of water was taken on deck—this was removed immediately via the freeing ports and no effect of the water on deck was felt.

“At no stage was I not confident that the craft could handle the conditions as they were. I am sure that it could be subjected to rougher seas without fear of loss of the craft in a roll over.

“In conclusion the craft, engine and stern gear assembly and crew performed within expectations and I am sure that the SRL-11 is a true surf crossing and beachlanding craft.”

Shortly after the testing in Negombo, the SRL-11 was employed in commercial fishing trials. For regular operation from a beach, a winch would be required because of the high weight of the craft. No suitable winch was however available at that time and the craft was therefore operating from the Negombo lagoon. After a full year of trials a thorough evaluation was undertaken (by Gulbrandsen). The conclusions were:

The SRL-11 has the following *advantages* compared with the standard 28 ft. craft:

- Approximately 50% lower fuel consumption,
- Lower investment due to a smaller engine (12.5 hp versus 30 hp).
- Handling of bottom set longline gear easier because of lower deck level and less windage,
- Beachlanding and shallow draft capability,
- Good sailing performance.

The SRL-11 has the following *disadvantages* compared with the standard 28 ft. craft:

- Crew shelter forward subjected to high pitching movements when going to or from the fishing grounds
- Inadequate cooling of the engine prevents the craft undertaking long distance pelagic longline/drift net fishery during May—August.

Sails were utilized for 7% of the total travelling time. This is insufficient in terms of fuel saving •to cover the yearly cost of the sail rig. The crew's lack of interest in the use of sail is mainly due to the low fuel cost of the SRL-11 which accounts for only 9% of the gross income. The inconvenience of handling rig and sails is another reason. A sailing rig is however necessary for emergency and for use with favourable winds. The skipper felt that the local lateen rig would be adequate for this purpose. A sailing rig with a good windward performance such as the present Marconi rig could, however, be required in a future situation when fuel cost is high or fuel is scarce.

The beachlanding trials proved that SRL-11 handles very well in surf upto 2.5 m. Due to the weight (2.1 tonne) a winch is required to haul the craft up the beach.

Data on catch, costs and earnings compiled during the evaluation are given in Appendix 3.

SRL-11 continued to fish for another two years and was also used during this period for beachlanding demonstrations. The overheating of the engine, however, caused many breakdowns and the consumption of spare parts was high. It was therefore taken out of operation when the "final" BLC version SRL-14 was ready. Very valuable experience was gained from SRL-11 which formed the basis for the design of SRL-12 and the SRL-14.

3.7 SRL-12

While SRL-11 proved to be a good fishing craft it was considered a little too small and slow by the fishermen used to the 3½ tonners. As an improvement, SRL-12 was therefore made longer but similar in layout to the SRL-11. To improve speed performance a sharp entry and a longer waterline were incorporated. Though this meant a departure from the spoon shape of earlier craft, its performance during surf crossing was good. Two craft of this design were built in FRP-sheathed plywood. A larger engine (14.3 hp), air cooled with a 5.5: 1 reduction gearbox was installed in a pivoting box. The efficient propulsion system was installed to facilitate bottom trawling, thus giving beach-based fishermen access to this very rewarding fishing in some fishing grounds.

> "SRL-12 was tested on four separate days in the surf in Madras. It is a much larger craft than the ones previously tested and the surf was not heavy enough for a complete test, although it was possible to get some feeling about the performance of this craft.
>
> "The large slow-turning propeller coupled to the Deutz 14 hp engine provided more than sufficient power to move the craft on to an incoming wave. Its large area of rudder gave very good control and apart from the rolling motion that was sometimes set up by corrective action on the rudder, the craft behaved very well on the waves. There was no feeling at all that the craft would broach and I feel that the power and length relationship of the craft made it easy to control.

"On going outthrough the surf, the high sides, bow and lift kept it a dry craft with little water coming over the bow. Any water that came over the bow when the craft was placed under a wave moved to the aft of the craft and left quickly via the large scuppers.

"Rudder response going out (and coming in) was good with the craft moving readily to course corrections.

"Landing the craft on the beach worked well but once at the water's edge it became very difficult to handle because of its large surface area. Any current or wave hitting the side of the craft made it difficult to manhandle.

"In summary SRL-12 is a good surf crossing craft showing excellent stability and is easily controlled. Beachlanding and departure are much more difficult and I feel that the overall size of this craft is beyond the desirable size of a beachlanding craft. In all other aspects the craft is good."

The two craft underwent trials in both single and pair trawling with and without sails. The fishing gear used was of the light, high opening type of BOBP design successfully demonstrated earlier in Tamil Nadu. The trials suffered from several teething problems with the engine installation, particularly the stern gear, but did indicate a potential for trawling with beachlanding craft equipped with efficient propulsion systems. The thrust produced was about twice that of a conventional engine installation. The particular installation of SRL-12, however, proved inadequate after a relatively short trial period due to overheating of the engine. The air cooling in the engine box was not sufficient during heavy trawling duty. This line of development was therefore discontinued and a change over to water cooled systems for larger beachlanding craft was effected.

3.8 SRL-14

A final design of a 'beachable' craft in Sri Lanka was made in FRP offering the same fishing capacity as the 3½ tonners. The craft SRL-14 is similar in size and shape to the SRL-12, but with sections designed to suit the material. Flared forward sections, sharp entry and a longer waterline are prominent features. To overcome the problem of overheating of air-cooled engines a 15 hp water-cooled engine has been fitted. The engine is freshwater-cooled with the cooling pipes fixed to the bottom of the box. Heat transfer due to contact with the seawater in the well is similar to the 'keel cooling' principle. A reverse gear is essential for safe handling of a craft of this size. A reverse reduction gearbox of 3.65: 1 is used The sailrig was initially the same as in SRL-12 – a masthead Bermuda rig – but has been changed to a dipping lug.

Being similar to SRL-11 and SRL-12, SRL-14 has also proven to be an excellent craft for surf crossing. It is undergoing commercial trials from a beach south of Colombo and has so far performed to expectations. This is true of the water-cooled engine as well. It is being hauled up by a mechanical winch. The safe landing and departure from steep beaches during heavy surf conditions remains a problem. The boat needs to be hauled Out of the water quickly, turned on the beach and launched with bow first for quick departure. This point is elaborated on in BOBP/WP/51.

BOBP Beachcraft in Pictures

IND—20 under sail.

SRL—11 under sail.

IND 20C — the 8.5 m FRP Beachcraft.
IND 25 — the 6.7 m FAP Beachcraft.

Ready to meet the surf – the start of a fishing trip.

The effect of a strong longshore current

Crossing the surf: up-up and away!

4. CONCLUSIONS

The very extensive design, testing and demonstration efforts undertaken to develop suitable beachlanding craft over a period of about six years have resulted in two technically feasible solutions in India (IND-20 and IND-25) and one in Sri Lanka (SRL-14). Long-term fishing trials have shown that these craft are capable of operating from beaches under moderate to heavy surf conditions unlike other craft of conventional design. The key to the success is the pivoting engine installation which is described in detail in BOBP/WP/44. Other technical aspects can be summarized as follows.

Size

Though this factor affects the cost of the craft directly, it must suit the kind of fishing it is meant for. Craft engaged in large - mesh driftnetting in offshore areas and staying out overnight or longer should be provided with adequate crew shelter. The net holds must be large enough for carrying adequate fishing gear.

The other aspect of size is the problem of handling the craft on the beach. Though problems in hauling heavy beachcraft can be overcome by having winches ashore, waves breaking at the water's edge and a longshore current can make things difficult. For most of India's eastcoast and Sri Lanka, the maximum size would be a craft of 8.50 m length weighing 2.5 tonnes.

Hull Shape

A rockered keel, partial flat bottom and cutaway forefoot with lift - inducing forward sections are essential in beachcraft design.

Over the years, sharper bows and wider transoms combined with a flat run aft were adopted to improve speed performance in the open sea. Provision of a large efficient rudder deep down still permits adequate control when crossing in and out through heavy surf.

High sheer at the ends provides reserve buoyancy and minimizes the chance of a wave breaking over the craft. The freeboard has to be low enough in the 'get-on-board area' for the crew to get onboard easily.

Flared forward sections with a spray chine (easily incorporated in an FRP craft), enable the craft to deflect the wave and keep it dry.

Deck Layout

To prevent the craft from being swamped by a breaking wave, several arrangements have been tried.

In small craft, provision of a flush deck with hatches works well. To improve crew comfort, 'dishing' the deck to provide a lower deck works well. Any water on deck is quickly drained when the craft heels. In the case of buoyancy block craft, provision of gaps in deck and hull planking enables quick draining.

In larger craft, a more conventional lower working deck with watertight hatches and large freeing ports on the hull sides has worked well.

In areas of moderate surf an open craft may be acceptable. These craft should however have a higher freeboard with well flared forward sections and high sheer at ends.

Construction Material

The basic costs of different materials are as follows:

Material	Panel thickness mm	Panel weight kg/sq.m.	Panel cost US $/sq.m.
Wood	**22**	**17**	**30**
Plywood with FRP cover	12	13	36
FRP with plywOod stiffeners	6	10	41
Aluminium	3	8	40

We should however view this table with some caution. The cost of the finished craft will not show the same price difference when one considers other construction factors like labour cost, tooling and time required. Other factors like weight saving, service life and maintenance costs will further change the picture.

From Table 1 it is seen that BOBP has used all the above materials in beachcraft construction. The conclusions are:

- A wooden craft to withstand regular shocks in beachlanding will have to be strong and will therefore be the heaviest. Considering the steep increase in timber prices, using wood for beachcraft construction is not attractive.
- Plywood covered with FRP has worked very well. It is ideal to build prototypes in this material. Longevity is unknown, but craft built four years ago are still serviceable. Joints are however subject to leaks after operation over a period of time. Only developable hull forms are possible.
- Aluminium is potentially an excellent material for beachcraft in view of its high strength and lightness. An added bonus is the high scrap value when the craft has eventually to be taken out of service. However, fabrication in aluminium requires special skills in aluminium welding using special equipment. Correct grade of alloy is usually not available in the retail market. Trials in India have not been conclusive due to faults in the material supplied.
- FRP (fibreglass reinforced plastic) is a known material, both in India and Sri Lanka. Repairs are easy to make at site. The increase in price over a plywood craft is marginal when the other advantages are taken into account. Moulding of the hull in one piece with the propeller and shaft tunnel built in makes it leakproof. The material also allows curved hull shapes which can increase panel stiffness and reduce surface area. Well-flared topsides can easily be incorporated. Chafing protection must be provided to the flat bottom since FAP has low abrasion resistance against sand.

Engine power

All beachcraft built by BOB P are easily driven. A look at Table 2 reveals that for the craft to attain a speed length ratio $(V/\sqrt{L})$ of 1.4, 4 hp per tonne of displacement is adequate. Use of a gearbox to reduce propeller rpm results in better propeller efficiency, i.e., more thrust at lesser power and lower fuel consumption. All craft except SRL-14 and IND-20C are equipped with air-cooled diesel engines. A continuous problem has been overheating because of the engine's installation in a small box not giving much room for air circulation. In India, where craft have low power. the air-cooled engines have stood up reasonably well. In Sri Lanka, however, aircooled engines on the SRL-11 and SRL-12 got overheated during regular fishing operations. A watercooled engine installation is therefore used in Sri Lanka (SRL-14). The potential problem of sand entering the cooling system is avoided by circulating the fresh water through copper pipes attached to the underside of the box and in contact with the seawater in the well.

Sails

All the BOBP beachcraft are provided with sails (see Table 2). Various types of rigs have been used, namely the lateen, Marconi, Gunter and dipping lug. In October 1983, a sail conference conducted by the FAO and BOBP in Madras, used two identical craft (IND-20A) to test out various rigs and compare them for cost, performance and ease of raising the mast at sea necessary on a beachcraft. It was concluded that the Gunter rig was the most suitable rig for larger beach-craft while the lateen is better on smaller craft.

All craft are provided with a daggerboard to resist leeway under sail. This board also dampens rolling when the craft is stationary.

Simplified Bermuda rigs using terylene sails, aluminium masts and stainless steel rigs have been used in the SRL series of beachcraft while Gunter rigs with casuarina spars, polypropylene rope rigging and cotton sails have been used in India. In Sri Lanka sails have not been used as much as in India due to the extremely fuel-efficient propulsion system and the crew's reluctance. Therefore, a simpler rig like the dipping lug may be more useful for emergency situations.

In India, the majority of traditional craft use the lateen rig, despite the easier tacking and shorter spars with the Gunter rig. The use of sails in the craft is much more regular in India than in Sri Lanka.

All BOBP beachcraft have proved to have excellent sailing hulls. The fact that they are easily driven ensures good speed performance under sail or with low engine power compared to similar-sized displacement craft.

Table 1

Main dimensions of BOBP beachlanding craft

Craft	Material	Cuno LOA x B x D (m3)	Dimensions (m) LOA	B	D	LWL	BWL	Weight (kg) Hull	Engine	Gear & Crew	Total
IND-18, 19	Plywood	14	8.40	2.24	0.76	6.40	1.91	800	250	850	1900
IND-20A, B	FRP	16	8.48	2.28	0.83	6.86	1.90	900	250	850	2000
IND-20C	FRP	16	8.48	2.28	0.83	6.86	1.90	900	300	850	2050
IND-21	Wood & Polystyrene	13	7.50	2.30	0.76	6.40	1.94	670	250	500	1420
IND-23, 24	Aluminium	9	7.00	2.00	0.64	5.65	1.60	400	250	500	1150
IND-25	FRP	12	6.70	2.20	0.82	6.17	1.96	650	250	500	1400
SRL-11	Plywood	20	8.00	2.60	0.96	6.80	2.30	1240	300	850	2390
SRL-12	Plywood	21	8.50	2.60	0.96	7.65	2.30	1200	420	850	2470
SRL-14	FRP	24	8.60	2.62	1.07	8.15	2.42	1350	350	850	2550

Table 2

Powering details of BOBP beachlanding craft

Craft	Engine Model	DIN Power (hp/rpm)	Reduction Ratio	Propeller Diameter (mm)	Speed Maximum (knots)	Power Displacement Ratio (hp/t)	Sail Area (m2)			Sail Displacement Ratio (m2/t)
							Main	Jib	Total	
IND-18, 19	Lombardini* LDA 523	4.8/3600	2	318	6.5	4.2	17.6	9.1	26.3	13.8
IND-20A, B	VST Shakti AD8	8/3000	2	318	6.6	4.0	17.6	9.1	26.3	13.2
IND-20C	VSTShakti** AD10	10/3000	1.78	381	7.2	5.0	17.6	9.1	26.3	13.2
IND-21	VSlShakti AD8	8/3000	2	330	6.0	5.6	19.0	—	19.0	13.4
IND-23, 24	VST Shakti AD8	8/3000	2	318	6.3	6.9	19.0	—	19.0	16.5
IND-25	VSlShakti AD8	8/3000	2	318	6.0	5.7	12.2	5.4	17.6	12.6
SRL-11	Deutz FIL 210 D	12.5/3000	2.72	508	6.4	5.2	10.8	16.7	29.5	11.5
SRL-12	Deutz FIL 511 D	14.3/2800	5.1	660	7.4	5.8	14.0	20.0	34.0	13.8
SRL-14	Faryman R30	20/2500	3.65	610	7.3	7.8	14.0	20.0	34.0	13.3

* Later changed to VST Shakti (8/3000)

** VST Shakti AD1O is a water cooled engine