Sea Trials of "SAF-27": How Sail and Outboards Work Together

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ABSTRACT

A series of sea trials of a sail-assisted Fiberglass Reinforced Plastic (FRP) fishing boat of Loa 27 feet is described. The combination of sail and gasoline outboard motor as the power source was examined from the viewpoint of total efficiency, then three kinds of sail rig were selected for the sea trials. Of these the Ljungstrom rig was most favored by the test operators due to its simple mast setting and easy sheet handling. The importance of sail-assistance is emphasized not only for displacement hulls but also for outboard motored semi-planing or full-planing boats. The difference in sail operation between the above two categories is discussed.

INTRODUCTION

After two critical energy crises in the 1970s, the worldwide trend towards sail-assistance has become very popular both in commercial shipping and fishing sectors. This movement now seems to be continuing steadily although current fuel oil prices have been relatively stable in recent years.

In Japan, study of sail-assistance applications to coastal oil tankers and cargo liners has progressed remarkably (Nippon Kokan, 1983) and as a result, some sail-assisted ships are operating successfully. In this aspect Japan may be said to lead the world. On the contrary, application of sail-assistance to commercial fishing vessels is not so active in Japan when compared to other nations, particularly those on both sides of the Atlantic. The industry still lacks basic studies and useful test reports on the subject. In these circumstances, Yamaha Motor Co., Limited, made an exceptionally early start some five years ago in sail-assistance application to small Fiberglass Reinforced Plastic (FRP) fishing boats, and to date it has been playing a leading part in Japan. The outcome of the applications are several types of fishing canoes delivered to the Third World (Fukamachi, 1984; 1986). All of these canoes have displacement hulls with small diesel engines.

Another type of small craft mechanization, i.e. outboard motorization, is also very popular in many of the world's coastal fisheries as well as in Japan. Certainly such motorization has played a role in the modernization of coastal fishing craft. The fact that most of these fishing craft were used as sailboats prior to the introduction of outboards sometimes misleads us as to the ease of sail retrofit,

regardless of other changes such as modification of hull form or dimensions. Indeed, most of these craft changed their class from displacement boats to semi-planing or even full-planing form after outboard motorization. For these craft it is of primary importance to determine what are the advantages of sail-assistance and how these can be obtained relative to desired operating conditions.

SAF-27

Given the necessity to determine the relevant conditions mentioned above, a series of sailing trials were planned and have been carried out using a small FRP fishing boat designed for an outboard motor. The model used for the test was a Yamaha W-27CF-II, one of the very popular coastal fishing/aquaculture workboats - so called "WASEN" in Japan. Its hull consists basically of five flat planes, i.e., flat keel on the centerline, shallow V angle bottom planes and almost upright side plates. The boat also has a self-bailing flush deck just above the waterline. The designation of the boat, "SAF-27", stands for Sail-Assisted Fishing boat of Loa 27 feet and the principal dimensions are:

Loa	8.27 m	(27.11 ft)
Bmax	1.85 m	(6.07 ft)
Dmidship	0.66 m	(2.16 ft)
Hull weight	270 kg	(595 lb)

SAIL RIGS

Being able to work on deck during fishing operations is a crucial factor for sail-assisted fishing boats (Sainsbury, 1983). After considering several rig plans which are popular among existing boats, we finally selected two rigs: one was the boomless sprit rig and the other the Ljungstrom rig, with the normal Bermuda sloop rig selected as the yardstick. Figures 1, 2 and 3 respectively show these sail plans, and the rig specifications were:

	Main	Jib	
Sprit	$7.6m^2$	$3.2m^2$	(Fig. 1)
Ljugstrom	$7.6m^2$ x 2		(Fig. 2)
Bermuda	$7.6m^2$	$3.2m^2$	(Fig. 3)

Sprit rig and Bermuda rig use the same mast and jib, to which a roller furling device is attached. The Ljungstrom rig uses a self-standing mast made of aluminum alloy which can be separated into 3 parts for transportion. For this mast, a plywood mast thwart was installed across the gunwale top. A pair of leeboard boxes made of stainless steel plate were bolted on the sides, just abeam of the mast thwart. A kick-up rudder borrowed from a

FIG. 1

SAIL PLAN: A "BERMUDA RIG"

SAIL AREA: MAIN 7.8 M² JIB 3.7 M²

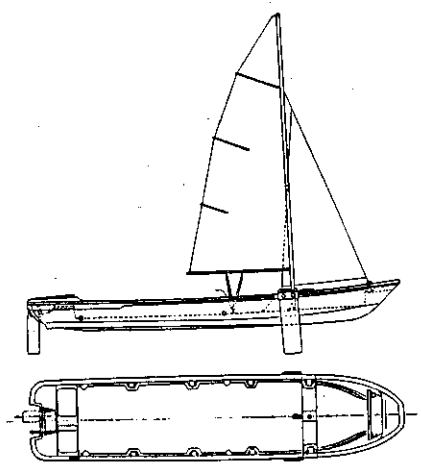


FIG. 2

SAIL PLAN: B "SPRIT RIG"

SAIL AREA: MAIN 7.8 M² JIB 3.7 M²

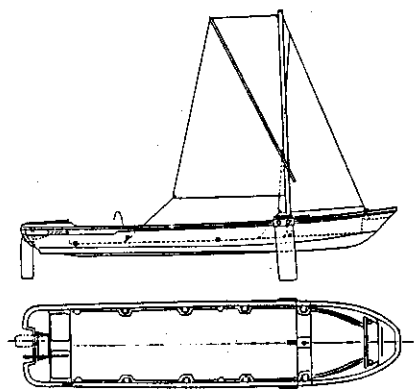
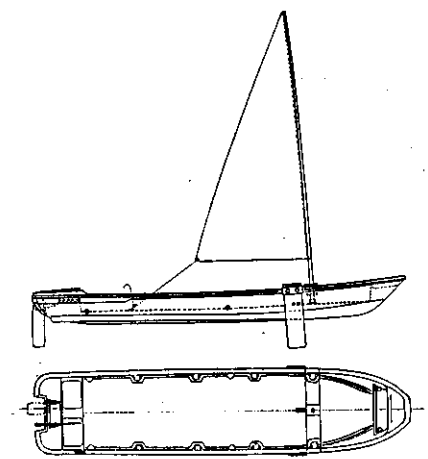


FIG. 3

SAIL PLAN: C "LJUNGSTROM RIG"

SAIL AREA: 2 x 7.7 M²



470 class dinghy was fitted on the transom slightly offset from the centerline to avoid interference with the outboard motor.

DIVISION OF WORK

Maximum speed of the SAF-27 with a 9.9 hp outboard motor is 15 kt in light conditions. Maximum sailing speed predicted from the sail area, at designed wind speeds is not more than 6 kt on a broad reach. Thus, the fuel savings during the joint use of sail and outboard are not expected to be great. The best possible fuel efficiency will be obtained by the alternative use of the two propulsion methods according to the wind speed, direction and the required cruising time. In short, it is not sail and outboard, but sail or outboard.

This concept is quite different from the case with diesel powered displacement hulls for which the maximum obtainable speed does not exceed the hull speed of about 7 knots for a boat size of about 27 feet.

The fishermen who have become accustomed to the use of outboards and have learned the feeling of planing would probably not retard the throttle when using the motor. (Also from a technical point of view, a partial throttle opening is not necessarily fuel efficient). Therefore, one major problem to be overcome is that of the fishermen's approach to the problem. Fishermen, weighing costs versus speed, must enjoy (accept) a sailing speed of 6 kt, which is free of charge, compared with a planing speed at a cost of 25 cents per mile.

SEA TRIALS (Fig. 4 - 8)

Up to the time of this paper several trial runs have been conducted on Hamana Bay which is located in front of the company's boat plant. Maximum sailing speeds for each rig were obtained (see below), but due to lack of trial time and fluctuating wind conditions, the results of performance comparisons between the three rigs has not yet been determined.

Speed trial results:	Wind Speed	Max. Boat Speed
Sprit	6m/sec.	4 knots
Ljungstrom	7.5m/sec.	6 knots
Bermuda	7m/sec.	4.5 knots

As far as ease of operation is concerned, most of the trial operatators preferred the Ljungstrom rig for its simple mast setting, easy furling and better down-wind performance. One potential drawback of the rig is said to be chafing of the sail downwind. This problem, however, would not be serious in our case because the sail is separated for most of the time. More quantitative and technical comparisons of each rig are to be conducted, and the results will be reported at a later date.

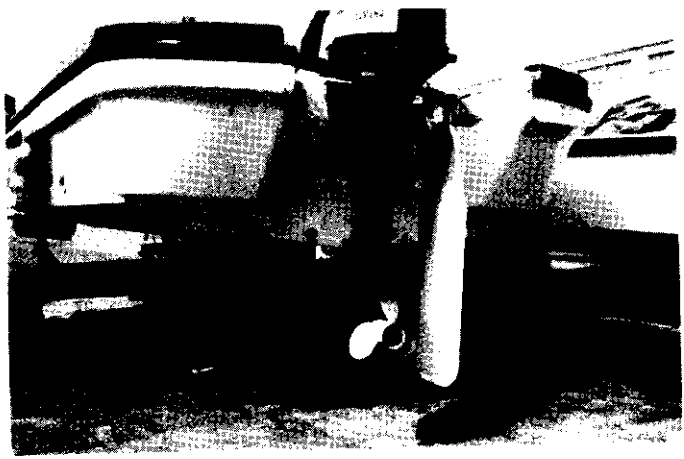


Figure 4. SAF-27: Transom arrangement

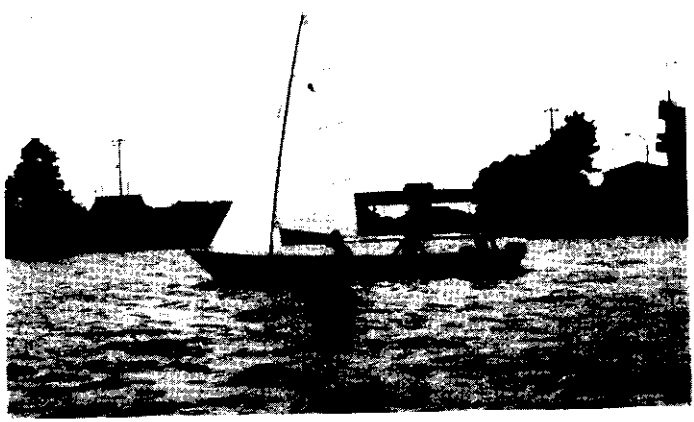


Figure 5. SAF-27: Bermuda rig.

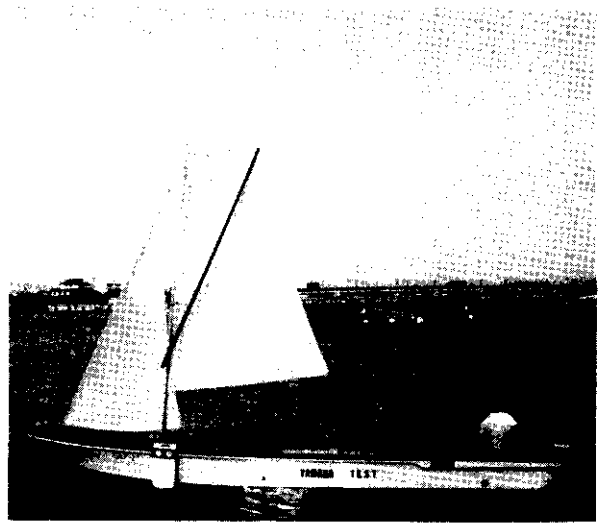


Figure 6. SAF-27: Sprit rig.

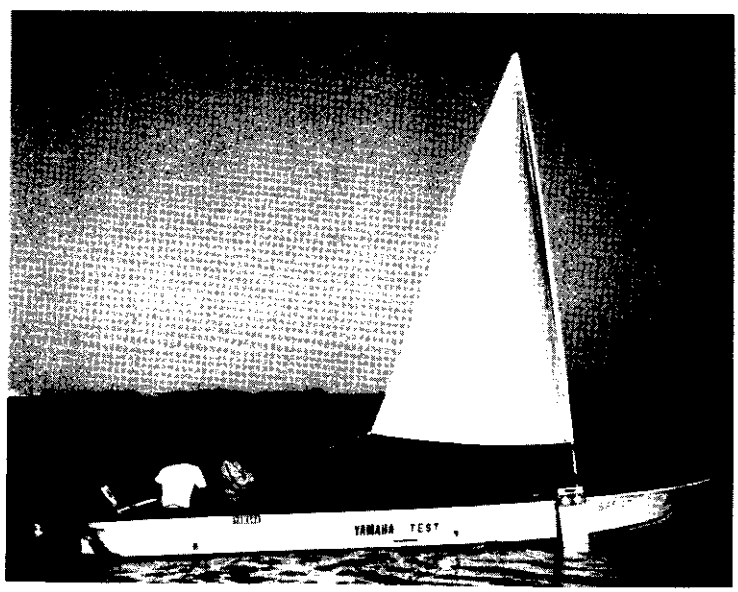


Figure 7. SAF-27: Ljungstrom rig - wind abeam.

Figure 8. SAF-28: Ljungstrom rig - down wind.

CONCLUSION

Although the obtained sailing speed of 6 knots may differ from person to person, the long-term fuel savings through sail-assistance, should it be carefully designed and operated, will definitely compensate for the sail rig cost and the loss of speed during the fishing cruise. Such studies require continuous attention to the areas where constant favorable winds prevail, in preparation for any, seemingly inevitable, energy crisis in the future.

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