Foil Assisted Ship Development

By Prof. Dr.-Ing. K.G.W. Hoppe
MD : Foil Assisted Ship Technologies cc

1. Historical Background
2. Optimisation of the Hysucat
3. The BMI-Hysucat Sea Model
4. Evaulation of Hysucraft
5. The Hysuwac Development
6. Milestones in Hysucraft Development Significant Examples

Bureau for Mechanical Engineering

at

the University of Stellenbosch

TECHNICAL REPORT ON

MODELTESTS ON IMT CATAMARAN

DOLOMEDE

15 July, 1979

Director: PROF H V HATTINGH (Pr.Eng.)

Division Head: PROF D G KRÖGER (Pr.Eng.)

Project Leader: DR K G HOPPE (Pr.Eng.)

Fig. 1a: Report giving evidence of foil-assist improvement

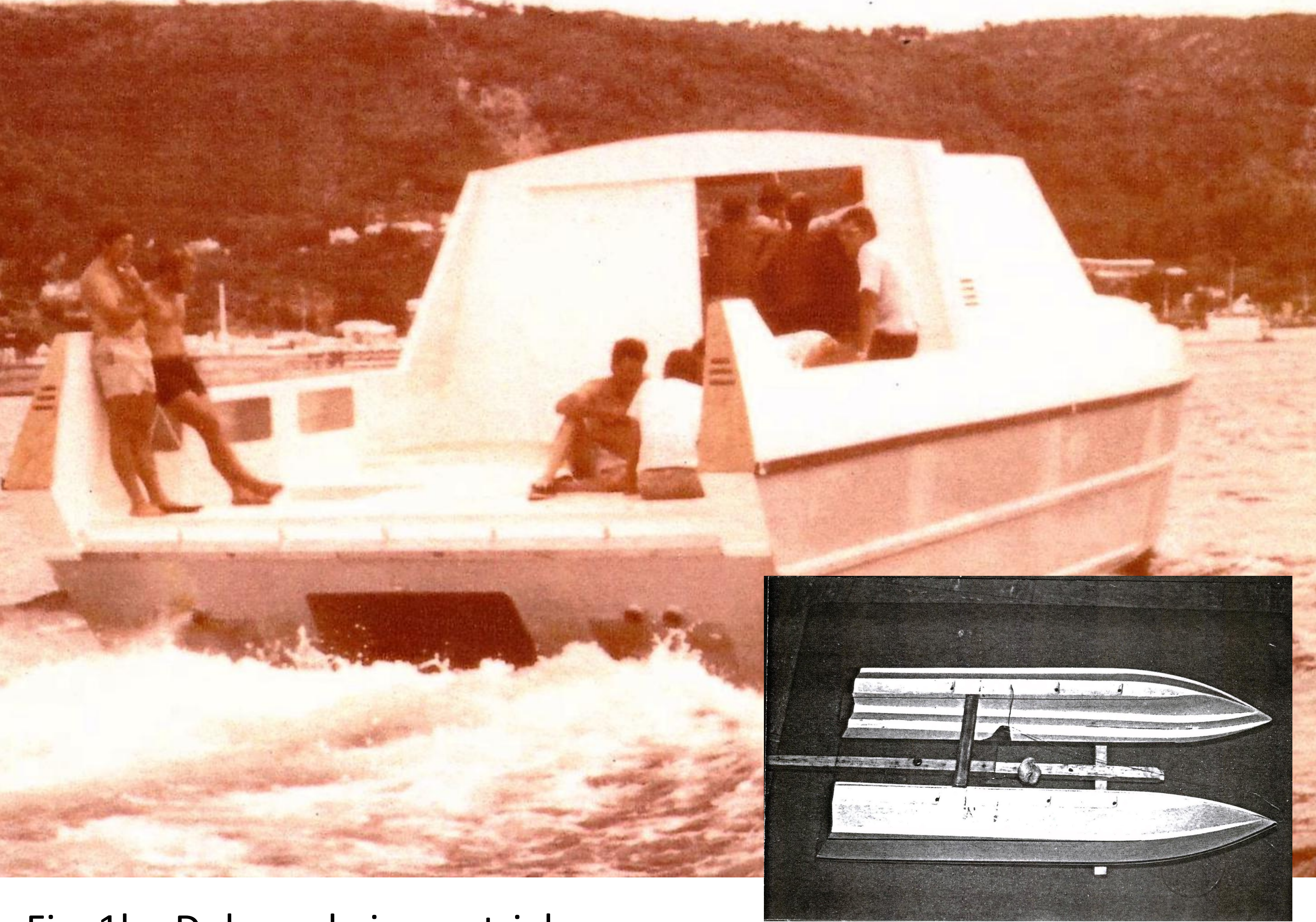


Fig. 1b : Dolomede in sea trial

Dolomede as BM-Model with Hydrofoil

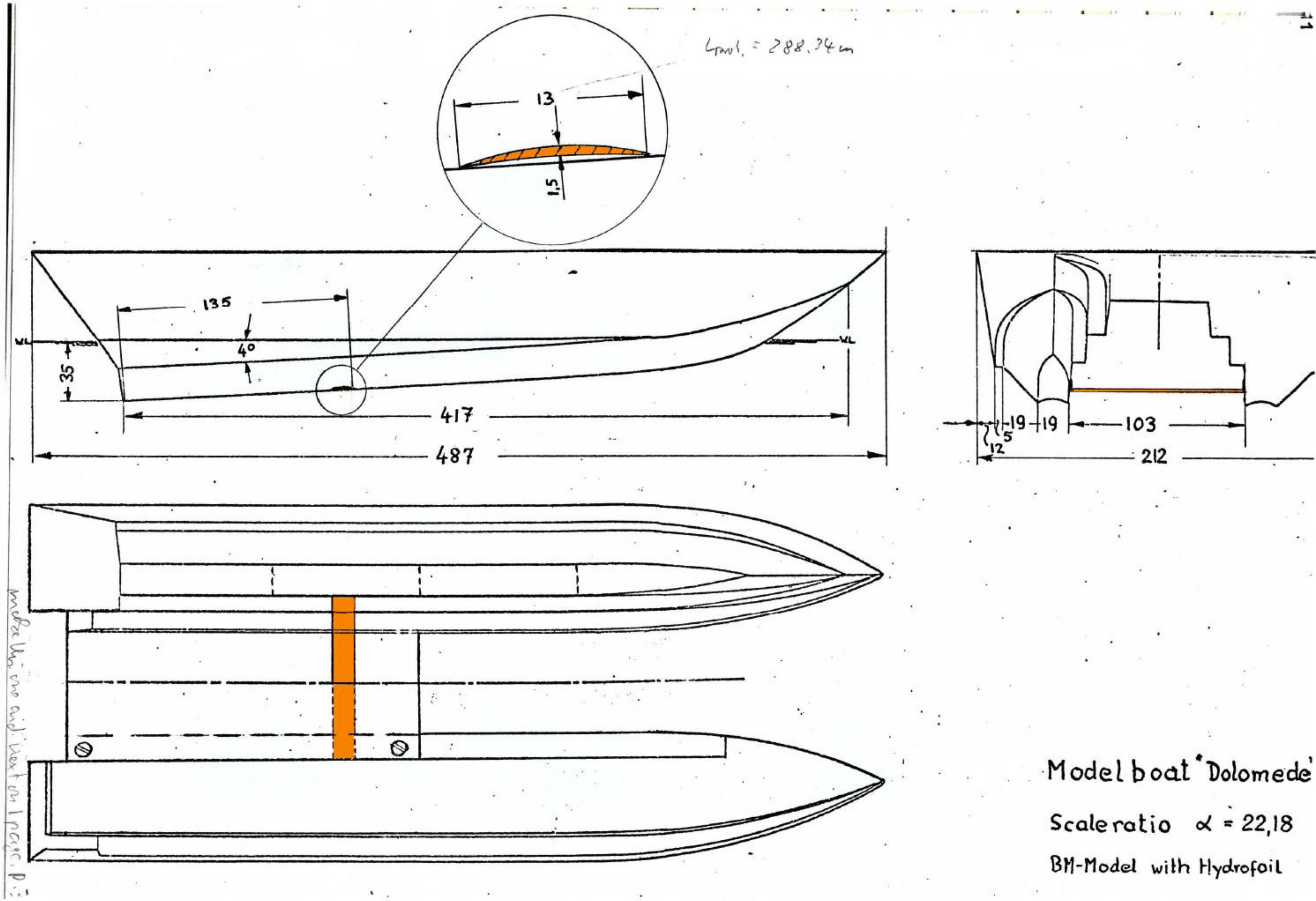


Fig. 1c: Dolomede with Foil System

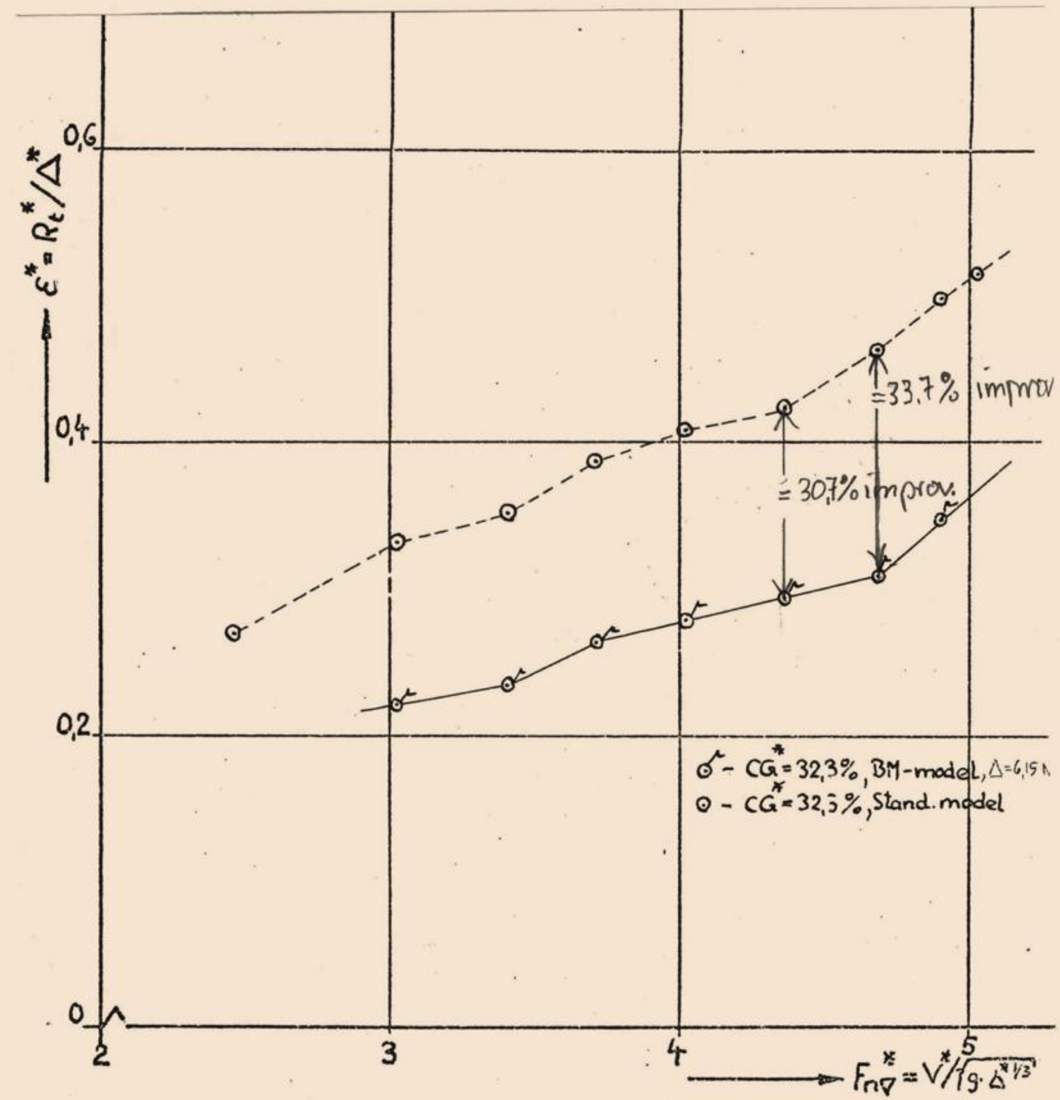
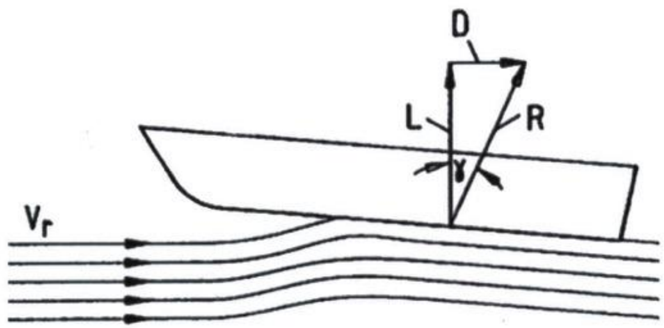


Fig. 56 Model Resistance Coefficient ε^*, $\Delta^* = 5{,}64$ N (6,3 t), $CG^* = 32{,}3\%$, BM-model, L.T.P.

Fig. 1d: Model Resistance Improvement due to Foil

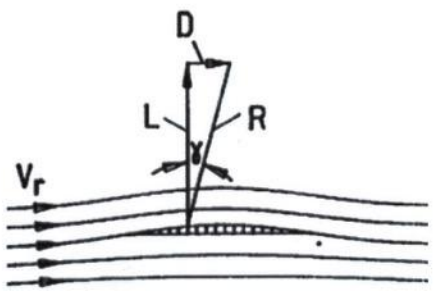
Foil has 10 times higher lift-drag ratio than hulls

For fast planing hulls



L/D = 3.33 to 4

For fast hydrofoil wing



L/D = 20 to 33.3

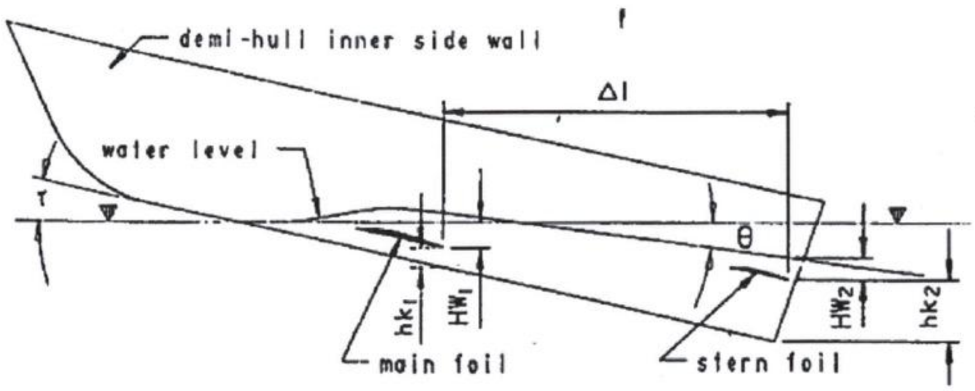
Hybrid has lower resistance and requires less power

Fig. 2: Hull and Foil Dynamic forces

Hull lifted higher out of water by foils

Foils carry 75% of craft weight

Resistance 40% less



Hulls provide stability

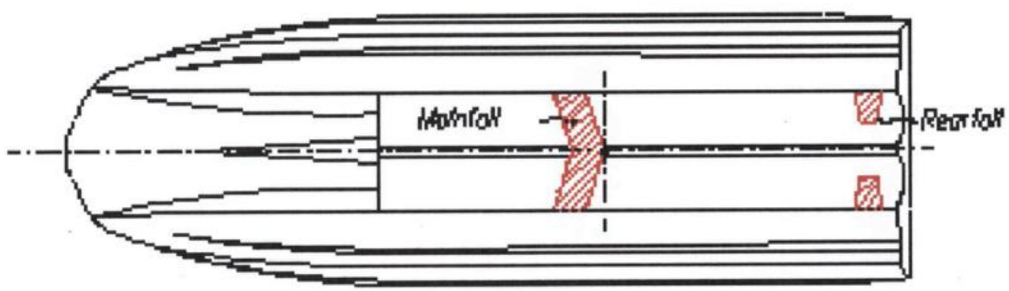


Fig. 3: Typical Hysucat Foil Arrangement

Fig. 4: Model Tests in Circulating Tunnel and In Towing Tank at the University of Stellenbosch

Fig. 5: Typical Hydrofoil System (Fn...) and Hysucat 5,6 on Sea

DESIGN INSTITUTE/Shell Design Awards 1983

Consumer Product
Hysucat

Manufacturer
Bureau of Mechanical Engineering
Universitity of Stellenbosch
STELLENBOSCH
7600
Tel. (02231) 77392

Designer
Dr K G Hoppe

The Hysucat, a unique South African designed Hydrofoil Supported Catamaran, has found export markets in Australia and Canada.

Designed by the Bureau of Mechanical Engineering (BMI) at the University of Stellenbosch, the prototype 5,6 m Hysucat has undergone highly successful sea and inland water trials around South Africa. Its principal advantage over conventional craft is that it offers greatly improved economy, stability and seakeeping. This is achieved by reduced water resistance as a result of the lift force created by the hydrofoils which span the tunnel between the two hulls.

Tests conducted on the prototype of the Hysucat confirmed that, with the hull lifted nearly clear of the water, a considerable reduction in resistance is achieved. The relatively small engines on the prototype (2 x 25 kW for a 5,6 m boat of 1 000 kg) powered it to 24,5 knots, the maximum speed allowed by the low pitch propellers. This speed was maintained in waves and even when running into a 30 knot South Easter. The Hysucat has considerable stability reserves at rest and, even when all crew members move to the same side of the boat, there is no excessive trim.

Accurate fuel consumption tests confirmed the major reductions in resistance, of up to 47 %, measured on the tank models. A comparable deep-V-monohull has consumption of about 1,0 ℓ per kilometer under favourable conditions, and suffers a further increase in fuel consumption in rough seas.

At speed, the Hysucat traverses the waves smoothly and gently. The hammering due to high accelerations normally experienced in strong waves by ski boats, is not present at all. The effect of shorter waves is nearly imperceptible.

Attempts made to broach the Hysucat riding down wave crests at various angles were totally unsuccessful. There was no indication of the slightest instability.

1983 DESIGN INSTITUTE Shell Design Award

THE DESIGN INSTITUTE/Shell Design Awards are organised annually by the Design Institute and sponsored by Shell South Africa (Pty) Ltd

For further information:
Design Institute, Private Bag X191, Pretoria 0001.

Fig. 6: Innovative Design Award

Table I: Needed for Hysucat Development and Optimization

Foil Data:

Towing Tank Tests

(Drag and lift) See Fig. 2

Profile section

(K – Profiles)

Lift-Drag Ratios

in Surface Mode

Reynolds numbers

for laminar and turbulent

boundary layer flow

Foil strength Calculations

Beam theory

Influence of Support Struts

Cavitation flow, foil use limited

Theory of Correlation for low Reynolds numbers, laminar

boundary layers

Theoretical foil data:

Early air craft theory

Aerodynamic approach

Aircraft profiles, large literature!

Wind tunnel tests, large database but no surface

effect and no cavitation limits.

Software, Subrontine foil:

Theoretical lift and drag calculations for foil wings,

dependent on foil geometry, effective aspect ratio, attack angle,

depth of submergence (Froude Depth Number!)

max thickness ratio.

Evaluation of ship-near flow conditions.

Incorporation in Hysucat Mathematical Program

Table II

Hull data:

Series tests of planing hull hull and Deep-V-planing craft collected.

A so-called Split-Deep-V-planing hull catamaran investigated and model test conducted.

Quality of flow-through tunnel tested, Asymmetrical demi-hulls give best flow conditions.

Theoretical hull data:

So-called Savitzki Equations for planing hulls investigated,

correction for hump resistance, Results applied to Hysucat hulls and compared to model test results.

Software developed for Hysucat hull calculations,

Combined with foil software (Sub routine programs)

Mathematical Hysucat Fortran Program

Mathematical Hyscraft program extended to include Hysuwac foil Systems.

Today version 53, which gives all hydrodynamic detail results and performance data.

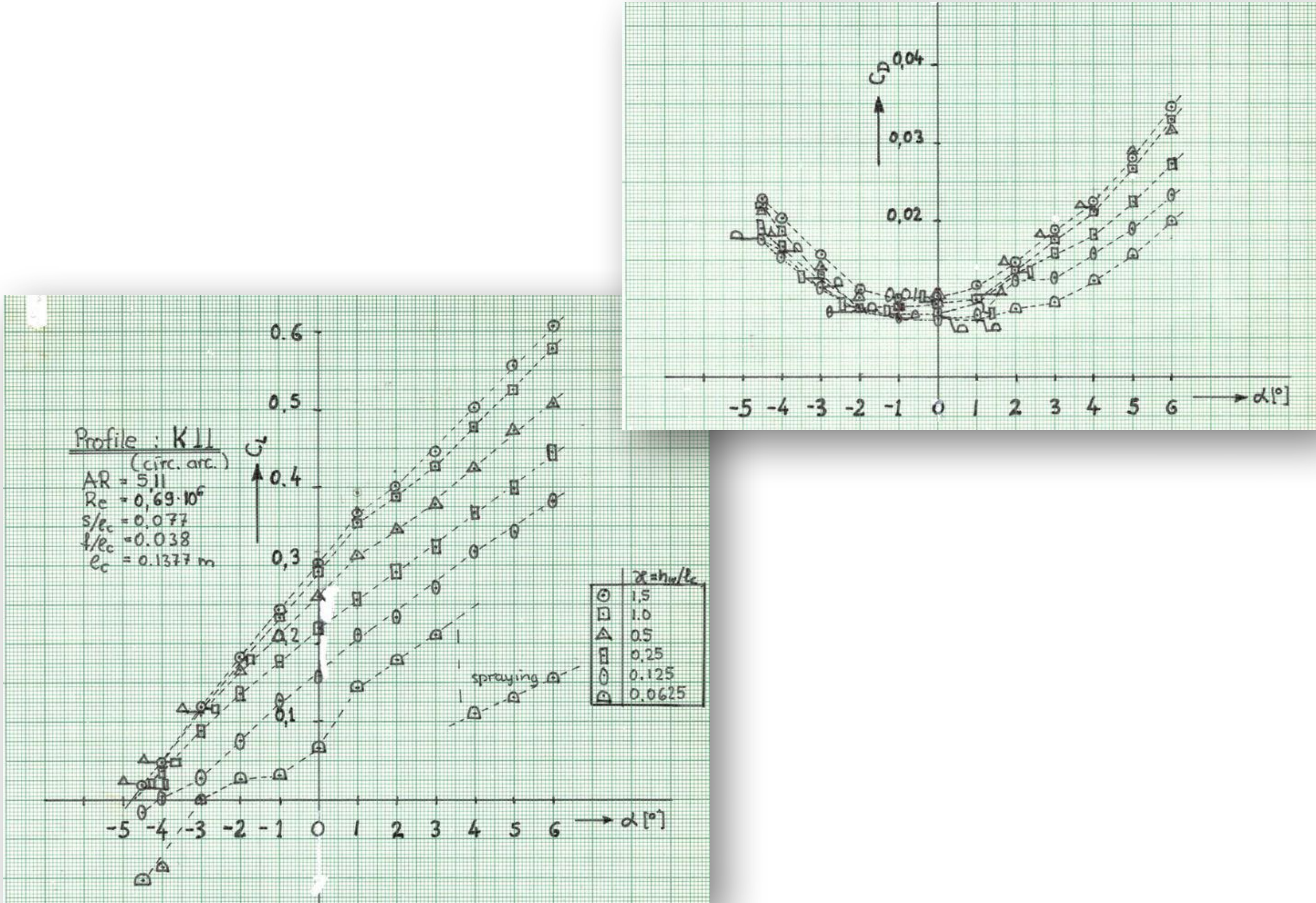


Fig. 7a: Drag and Lift ratios of large foil in surface effect

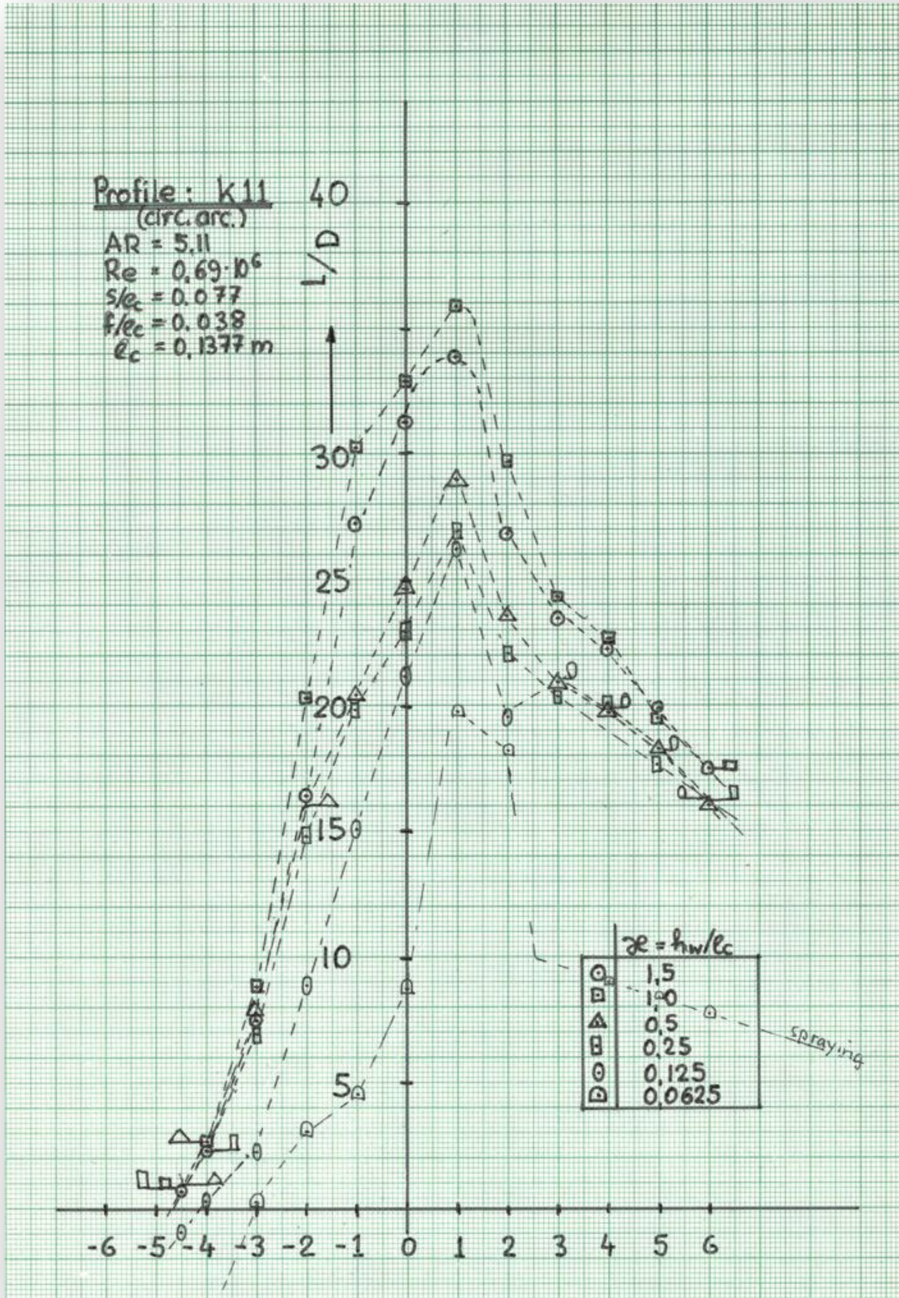
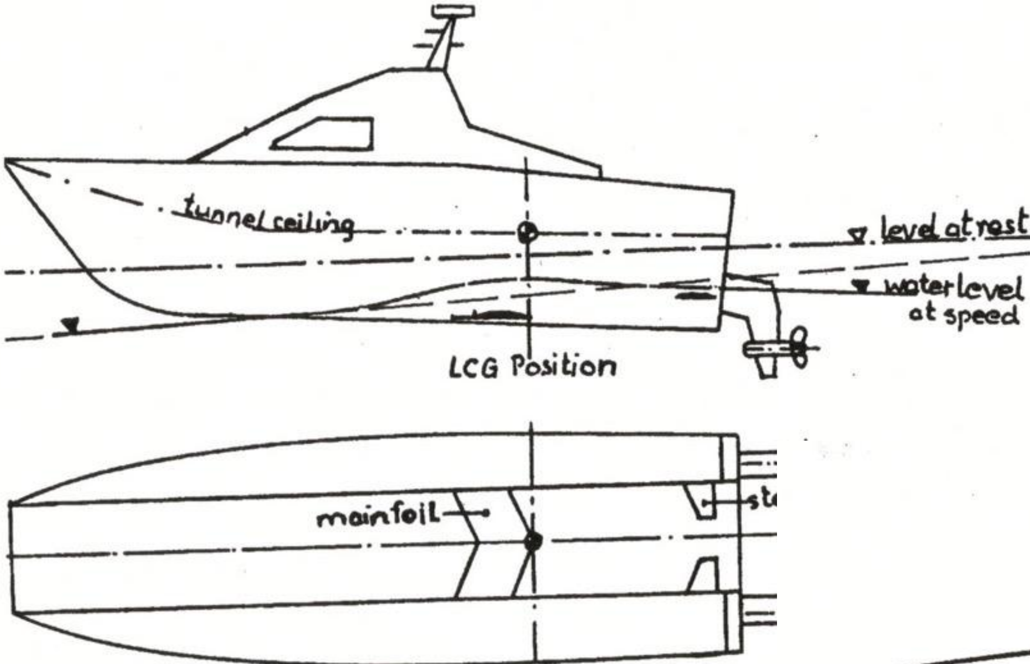
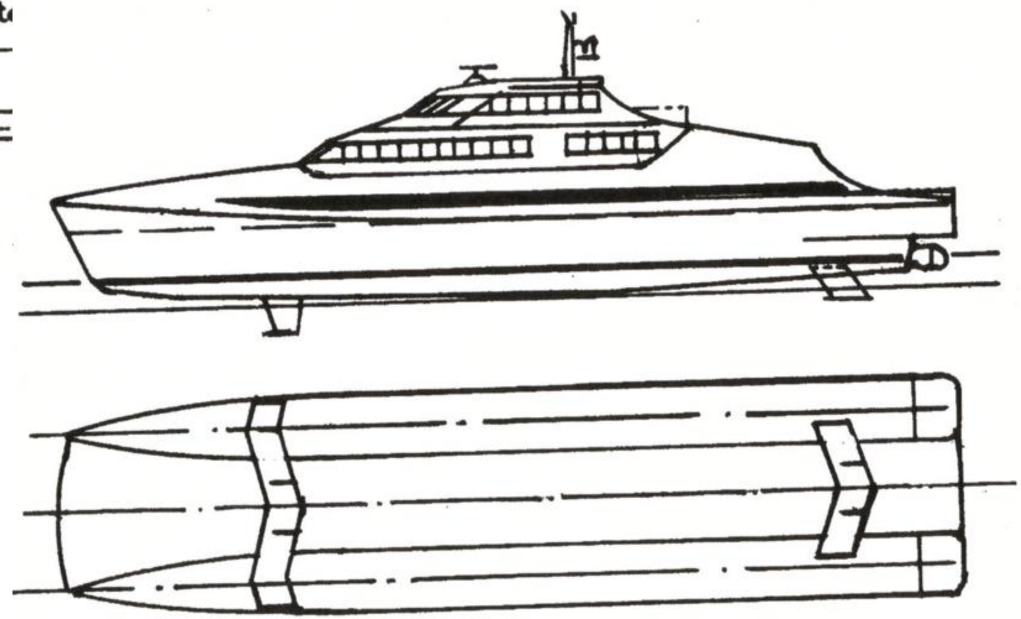


Fig. 7b: Lift Drage Ratios of large foil with Circular Arc Sections



Hysucat



Hysuwac

Fig. 8: Different foil Arrangements

Fig. 8a: E-Cat 45m 182 [t] 2 x2000kW V = 42 knots Hysuwac foil system

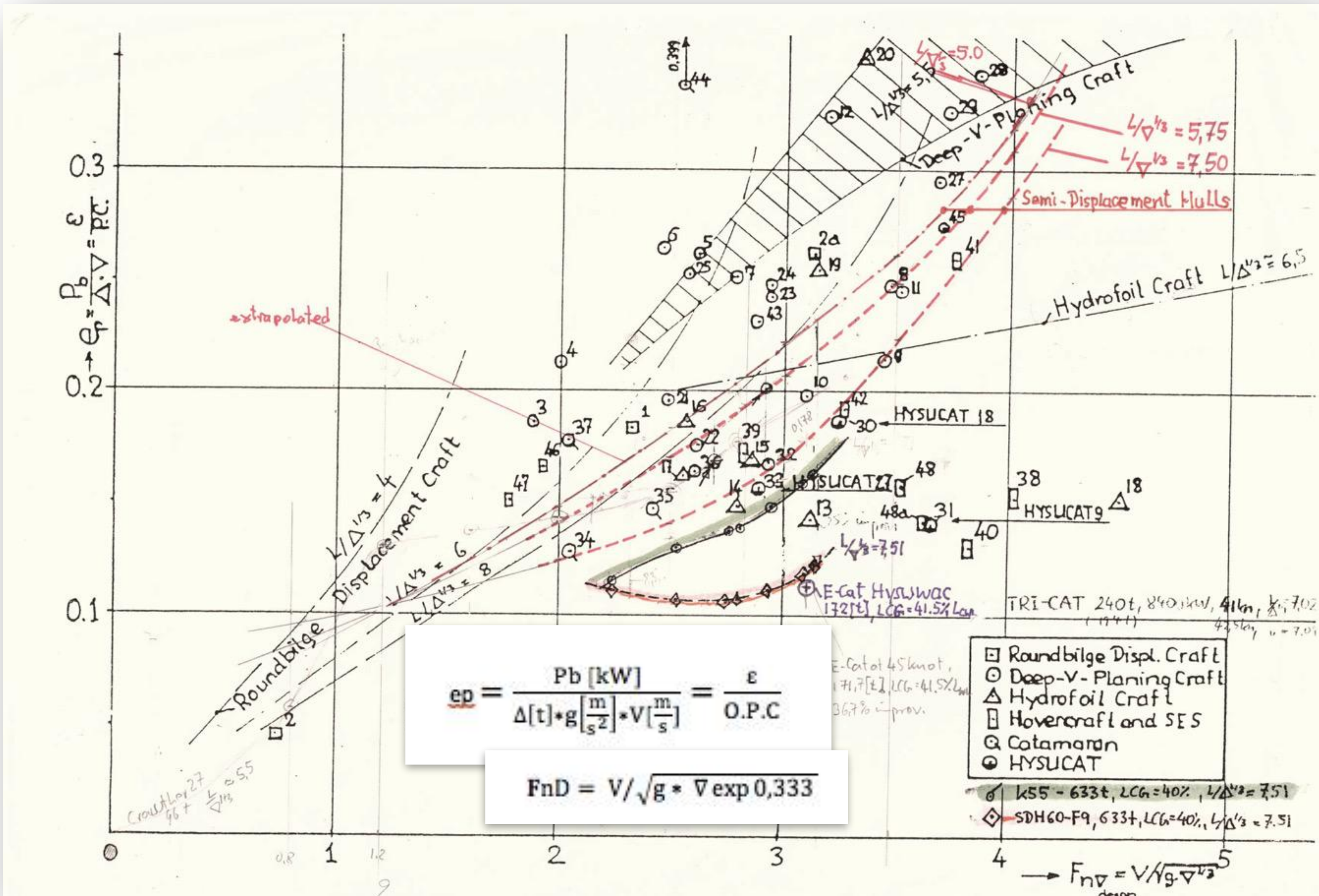


Fig. 9: High Speed Surface Craft Power-ratio ep

Fig. 10: T-Craft (Cape Town) Hysucats

Fig. 11: Foil system of 20m S.A. Navy Offshore Patrol Hysucat

“Chief Flying Sun”

of

Sir David Brown

Fig. 12: T-Craft 36m Luxury Yacht

35.6 ton, 2 x 620 kW, 36.5 knot, ep = 0.19

Fig. 13: 18m Thai Navy Patrol Boat

27 ton, 2 x 500 kW, 37 knot, ep = 0.191

Fig. 14: 19m Luxury Yacht Ultimaratio, Germany

27.5 ton, 2 x 500 kW, 37.3 knot, ep = 0.194

Fig. 15: 18m Fast River Ferry Rheinjet (60 pax), Germany

58 ton, 2 x 700 kW, 34 knot, 22m, 110 passengers

Fig. 16: Nordblitz 22m, 110 pax

Fig. 17: Canard Hysucat Foil System of Nordblitz

6,5m Hysucat RIB

Fig. 18: Original 8,5m Hysucat RIB of Stealth Marine

Fig. 19: Stealth Marine 12m Hysucat Yacht with Seafury SP Systems

22 ton, 2 x 820 HP, 45 knot, 16m with Q-Speed SP Propellers

Fig. 20: 15m Stealth Yacht (540)

36.5 ton, 2 x 1150 HP, 42 knot, 19.5m with Waterjets

Fig. 21: Prout Panther 64' high speed Yacht

Prof. Hoppe & Max Raez (Owner-Builder)

70 ton, 4 x 800 HP, 41 knot with Waterjets

Fig. 22: Kingcat Hysucat

Fig. 23: US Army Corps of Engineers Survey Hysucraft built by Kvichak Marine, Seattle USA

Fig. 24: US Army Corps of Engineers Survey Boat Redlinger, by Geo Shipyard in Louisina

Fig. 25: Alpha Yacht 80’, Styling Design by Luiz De Basto

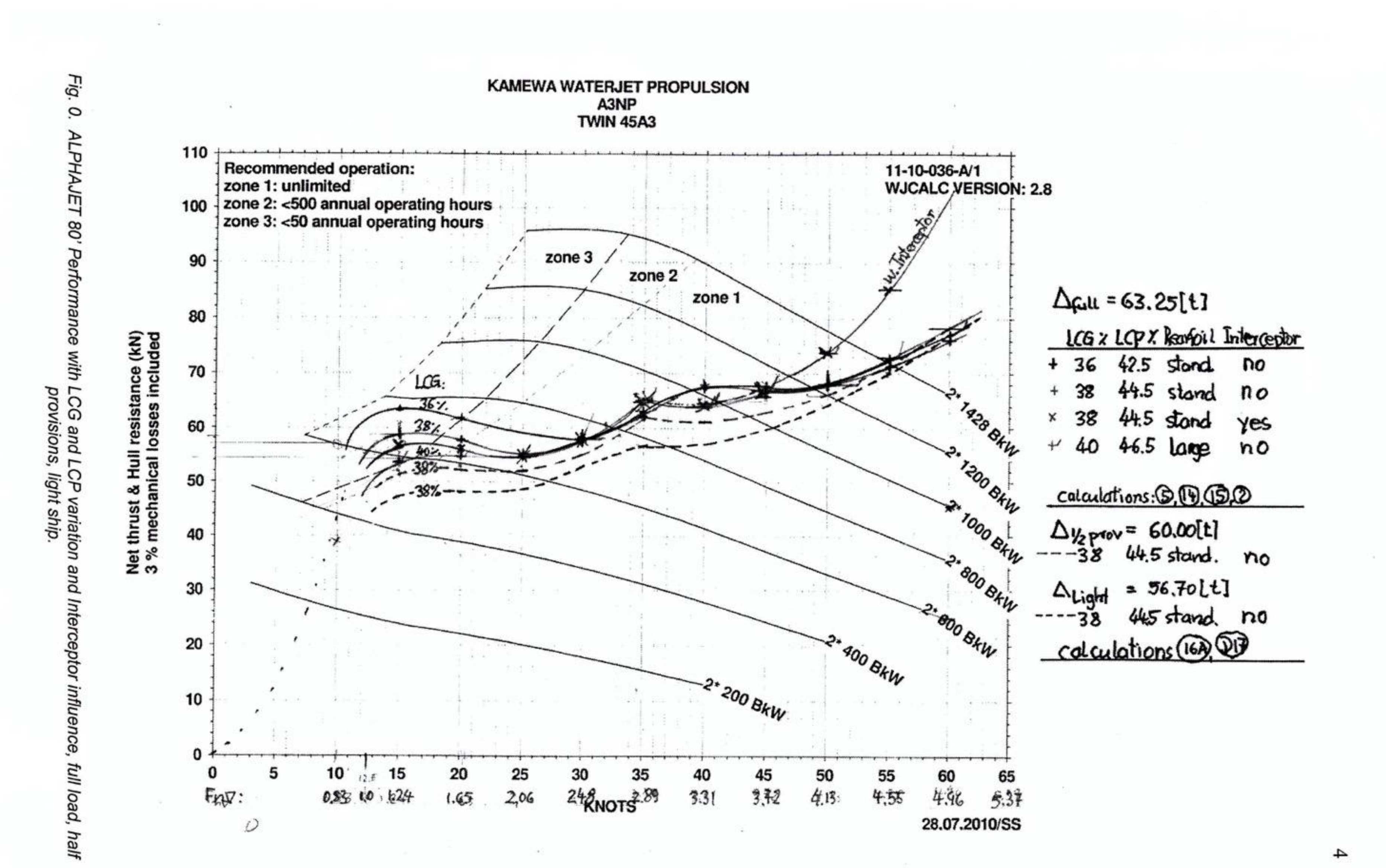


Fig. 26: Alpha Yacht Performance diagram

Thank you for your attention.

For more information, please visit

www.hysucraft.com