Foil assisted catamaran delivered to Kitsap Transit

All American Marine has delivered Teknicraft Design 24m foil assisted catamaran *Rich Passage 1* to Kitsap Transit in Washington.

According to the builder, "The catamaran is unlike any other craft ever constructed in the United States. The innovative vessel has been built specifically for low wake research purposes, with the objective of creating an ultra low wake energy hull design that can be used for high speed passenger transport applications on wake sensitive routes. The core elements of the new design include an optimized aluminum hull with a composite superstructure and deck, and a composite foil.

"Before the first weld was made, Teknicraft Design's principal naval architect, Nic de Waal, worked with hydrodynamicists from the University of Iowa's IIHR-Hydroscience and Engineering Research Center and naval architects from INSEAN in Rome, Italy, to digitally model and test the ultra low wake hull design.

"By creating a digital model of the hull, the vessel's wake wash properties could be studied and predicted. The optimization study utilized Computational Fluid Dynamics techniques to help refine the shape of the hull and foil to produce lower wake heights with less wake energy.

"Complementing the hull design, the research ferry also features 'smart' technology for wake wash mitigation. A control system for the adjustable composite foil and wake mitigating interceptors has been integrated with GPS technology to automatically position the foil and interceptors for the lowest wake energy signature when the vessel enters wake sensitive coastal areas.

"The system will also make adjustments for optimizing performance and fuel efficiency when wake mitigation is not critical. The adjustable foil can be manipulated to make minor adjustments to optimize speed without increasing engine rpm or fuel consumption. An adjustable foil is highly beneficial for commuter ferry applications where the passenger load may be heavier in one direction than in the other."

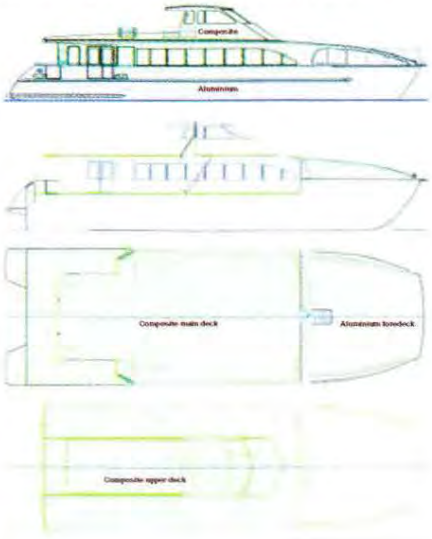
Tracing the background to the project, Nic de Waal says, "In 2003 Washington State Ferries were forced to terminate their passenger service to the Kitsap Peninsula, between Seattle and Bremerton, due to wake erosion of the local shorelines. Since then, Kitsap Transit has been searching for an economically feasible solution to bring fast and environmentally safe passenger only ferry service back.

"The low wake signature of Teknicraft's hydrofoil assisted catamarans made them the ideal candidate for this task. We embarked upon an intensive research and engineering program to further optimise the wake without compromising low resistance, fuel consumption or seakeeping. Working with various hydrodynamicists, the ultra low wake, high speed hull was developed to meet the new stringent wave height and energy criteria.

"Our hydrofoil supported hull has been developed and refined over the last decade. With the additional benefit of sophisticated and intensive CFD modelling, we now have one of the most advanced and environmentally friendly hulls in terms of the combination of low wake, high speed and low fuel consumption."

Teknicraft Design 24m foil assisted catamaran Rich Passage 1 *on trials last month*

The hull and superstructure of Rich Passage 1 *is a combination of aluminium and composite sandwich construction*



Hull

Rich Passage 1 has been built to United States Coast Guard Subchapter T requirements. To reduce weight, composite grp sandwich has been used in place of aluminium for the superstructure and both the main deck and the upper deck. Fabrication of the composite parts was subcontracted by All American Marine to another Washington company, James Betts Enterprises.

Rich Passage 1 has a full width adjustable foil forward and a short, fixed foil inboard towards the rear of each hull. The forward foil has two standard settings, one for low wake operation at approximately 28 knots and another for a service speed of up to 37 knots or a maximum speed of 42 knots.

The forward foil is a carbon fibre and glass reinforced composite construction. Explaining why a composite foil was chosen, Kitsap Transit has said that it weighs approximately 450 kg, or about half that of a stainless steel foil, and composite fabrication allows much finer tolerances to be achieved in the shape.

Wake wash control system

The wake wash control system on *Rich Passage 1*, and the interceptors, were developed and supplied by Naiad Dynamics. The company reports, "Naiad designed customized interceptors since the depth below the waterjets was limited to 63mm. They also feature a unique 'Strike Relief System' to allow them to automatically stow in the event of a debris strike.

"The interceptor design spans the hull to create significant lift over a wide range of hull speeds. The lift generated is used to balance the vessel trim about the lifting foil to provide the correct vessel attitude for reduced wake wash. The wake wash control system also provides control of the forward foil to optimize the portion of vessel displacement carried by the foil. The reduced vessel draft produced by the foil is a prime contributor to the low wake operation.

"The use of the low wake feature can be limited to specific areas prone to wake wash concerns. The portion of the passage requiring wake control is automatically triggered via GPS input of vessel longitude and latitude position. In a wake control area, the wake wash control system automatically optimizes the interceptor and foil positions to provide the lowest wake generation from the hull.

"Actively controlling the interceptors and foil also allows compensation of vessel loading and displacement variations, which is not possible with a fixed foil system. This flexibility provides a wider loading envelope for more efficient operation of the vessel.

"When the vessel is outside a low wake operation zone, the wake wash control system automatically operates in a performance and fuel efficiency mode. In this mode, vessel trim and list are controlled to provide optimum speed for a constant power setting.

"In addition, during either low wake operation or performance operation modes, a full active ride control input can be overlaid in the system to reduce vertical accelerations and enhance overall ride quality."

General arrangement of Teknicraft Design 24m foil assisted catamaran Rich Passage 1

Main engines

Rich Passage 1 is powered by four Caterpillar C18 ACERT diesels, rated at 651 kW at 2,200 rpm, and HamiltonJet HJ 403 waterjets. All American Marine reports, "The engines are fitted with CleanAIR Permit filters to reduce emissions by up to 99%. The vessel's noise emission is mitigated with acoustic foam insulation and the composite sandwich decking material."

Passenger saloon

The passenger saloon has 114 Beurteaux Ocean Traveller seats, four wheelchair positions and three toilets. Racks for 16 bicycles are located on the aft deck. The saloon is fitted out with recyclable aluminum honeycomb wall panels and recyclable aluminum ceiling tiles with acoustic insulation.

Wheelhouse

Equipment in the two-man wheelhouse includes a HamiltonJet MECS steering system, Furuno FR-1934 C/NT and 2117 BB/DC radars, FCV 620 depth sounder, GP32 12 channel GPS and FA 150 AIS.

Teknicraft Design
24m foil assisted catamaran
Rich Passage 1

Length overall	23.9m
Beam moulded	8.6m
Depth moulded	2.3m
Draught	1.0m
Fuel capacity	3,000 litres
Passengers	118
Crew	4
Speed	
- Maximum	42 knots
- Service	37 knots
Range	200 n miles
Main engines	4 x Caterpillar C18 ACERT 651 kW at 2,200 rpm
Auxiliary power	1 x Northern Lights M944W 30 kW
Waterjets	4 x HamiltonJet HJ 403

Trials

The development programme of *Rich Passage 1* has been longer than planned. All American Marine started building the catamaran in May 2009 and it was ready for trials, as scheduled, in April 2010. However, the decision to fit a composite foil delayed the project.

As Kitsap Transit concedes, "There was little direct industry experience to draw upon for construction of a composite foil. The first design and fabrication attempt was undertaken by Western Washington University's engineering school. While a useful learning experience for students, actual fabrication of the foil proved to be more than the school was equipped to take on."

Consequently, a foil was fabricated by a local company but this failed on the third day of trials. The trailing edge began to delaminate, causing the foil to break away from the strut and hinges that secured it to the vessel.

Kitsap Transit explains, "The foil broke away as designed for a catastrophic failure, leaving the hull of *Rich Passage 1* undamaged. Following several months of forensic review, insufficient structural strength and lower than advertised performance of the bonding glue were found to be the primary causes of the foil failure.

"A renowned marine designer and structural engineer was hired to redesign the structure of the foil, maintaining the shape, and to oversee the fabrication process. This has yielded a substantially stronger foil as the redesign looked in more detail at the forces at play. Following that, there was some finite element analysis of the structure of the foil to make sure it matched up to the forces involved."

The test programme resumed in October. Speaking earlier this month, All American Marine said, "*Rich Passage 1* recently completed a series of performance based sea trials and has commenced wake wash trials." The anticipated performance for the vessel is a wake wash of less than 0.10m at 6 seconds at 300 metres distance in deep water and a wake wash wave energy at 30-40 knots of less than 630 J/m at 6 seconds at 300 metres distance in deep water.

Commenting on the data to date, Nic de Waal says, "Following initial sea trials, we are very pleased with the results which prove that the vast amount of work that went into optimizing the hull shape and hydrofoil system has certainly been worthwhile. The performance exceeded predictions and we are confident that the vessel will break new ground in terms of both fuel economy and low wake."

The Seattle-Bremerton route includes a transit of Rich Passage, a strait between the southern coast of Bainbridge Island and the Kitsap Peninsular where fast ferry speeds have previously been limited to 12 knots

Wake wash trials are being conducted by Golder Associates, which has supplied a specialized monitoring system for the hull and foil system to provide detailed performance data. Referring to future testing, the company says, "A series of detailed vessel wake and performance trials are needed to provide data for calibration and validation of the computational fluid dynamics models that were used for the optimization and design of *Rich Passage 1*, to provide data for optimization and tuning the Naiad Dynamics ride control system and to provide boundary conditions (wake signature) for the wake transformation models that are used for wake response prediction and assessment.

"An iterative series of tests will be conducted at fixed foil, interceptor, loading and speed settings in order to provide the data needed to tune and optimize the ride control system and validate models. The data to be acquired includes both in-water measurements of wakes, currents and water levels and on-board measurements of vessel operation and performance."

The objectives of the final phase of testing will be to validate the impact models developed in earlier phases to predict wake performance using data collected from wake acceptance testing and beach response testing, assess the shoreline impacts of regular operation of *Rich Passage 1*, and evaluate the overall feasibility of the vessel and the Bremerton-Seattle service model, including the impact of various levels of service.

Service

The acquisition of *Rich Passage 1* by Kitsap Transit has cost $5.8 million. The design and construction of the vessel and the wake wash trials programme is being funded by the Federal Transit Administration. To date, the total amount of grants allocated since the wake wash project was initiated by Washington State Ferries in 2004 is $14.8 million.

Kitsap Transit assumed responsibility for the project in 2005. The authority claims, with some justification, that the amount of research work carried out, especially beach monitoring, has been enormous and Rich Passage is now the most studied marine passage in the world.

The name of the foil assisted catamaran tackles head on the major operational problem of a fast ferry service on the Bremerton-Seattle route. Rich Passage is a strait between the southern coast of Bainbridge Island and the Kitsap Peninsular, and for a fast ferry service to be viable vessels have to transit Rich Passage at a speed of at least 25 knots.

When Washington State Ferries introduced a catamaran between Seattle and Bremerton in 1986, the journey time was 35 minutes but a speed limit of 12 knots subsequently imposed on almost half the length of the 14 nautical mile route increased crossing times to 50 minutes, which was only 10 minutes faster than the journey time of WSF's passenger/vehicle ships.

Kitsap Transit hopes that *Rich Passage 1* will be given clearance to cross between Seattle and Bremerton in 30-37 minutes. The intention is to operate at a fuel efficient speed of 28-29 knots but to transit Rich Passage at a wake wash reduction speed of up to 37 knots.

Following the completion of the current wake wash test programme in December, the catamaran is due to be operated during May-October 2012 on a six month trial passenger service on the Seattle-Bremerton route to evaluate any changes to beaches in Rich Passage and the passenger response to the service.

Two return crossings will be timetabled during both the morning and evening commuter periods each day on Monday-Friday, and possibly one during the middle of the day. Following the completion of the trial service, data analysis and impact modelling will continue until 2013.