Model Test Report

Hull	**KVLCC1 / KVLCC2**
Test type	**Free Model Test**
Appendages	**Appended**
Organization	**HSVA, Germany**
Year	**2006**
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SUMMARY
Manoeuvring and course keeping tests with the models of the KVLCC1 and KVLCC2 have been performed at the *Hamburg Ship Model Basin* (HSVA). The objective of the model tests was to collect experimental data to be used as blind data for validation of manoeuvring simulation methods during the Workshop SIMMAN 2008, to be held in Copenhagen in April 2008.

MODEL GEOMETRY

Identification: INSEAN models No 2486 (KVLCC1) and 2487 (KVLCC2)

Scale: 1:45.714

Hull: Dimensions of model of the hulls (KVLCC1/KVLCC2) are as the following particulars:

L_{pp}	[m]	7.0000
B	[m]	1.2688
T	[m]	0.4550
∇	[m^3]	3.2737 / 3.2724
S	[m^2]	13.0732 / 13.0129
C_B	[-]	0.8101 / 0.8098
LCB	[%Lpp]	3.48

(LCB positive forward of midships)

Propeller:

type	FPP
blades	4
d [m]	0.204
P/D at 0.7R	0.808
Ae/A0	0.448
hub ratio	0.165
rotation	Right

Rudder: The models were equipped with one semi balanced horn rudder:

lat. area including horn	[m^2]	0.0654
movable lat. area	[m^2]	
helm rate	[deg/s]	15.8

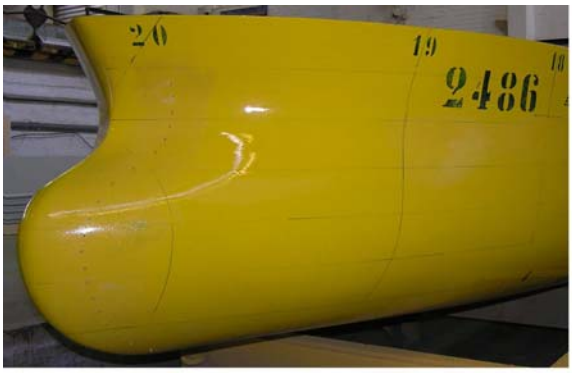
Bilge keels: None.

Turbulence stimulation: The bows of the models were fitted with studs roughly placed following the stem contour for turbulence stimulation.

Comment: The tested models were identical to the used for free model tests at MARIN (2007) with the exception that MARIN used a new rudder (with same particulars) built at CTO, while HSVA used for both models one of the two rudders delivered by INSEAN.

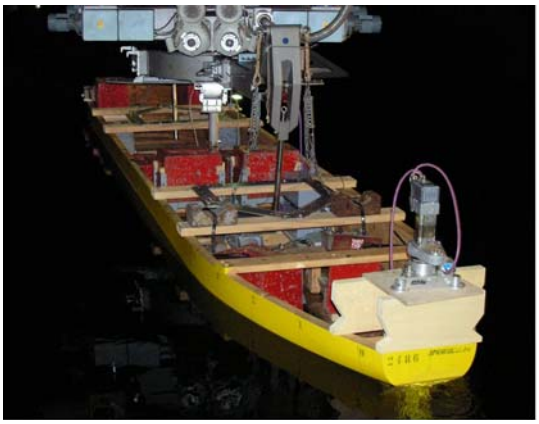
The zigzag tests with the KVLCC1 model were performed by deflecting the rudder starting from the neutral rudder angle (1° to stb) while those with the KVLCC2 model were performed starting from the geometric zero rudder angle.

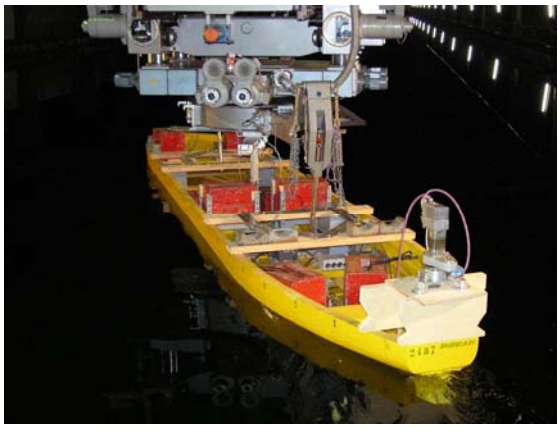
Model photos



Photos of the bow and stern of the KVLCC1 model

Photos of the bow and stern of the KVLCC2 model





KVLCC1 (left) and KVLCC2 (right) model during a test run

TEST CONDITIONS

Loading condition

Both ship models were trimmed on even keel with a metacentric height of almost GM_0 = 0.125 m (0.1247 and 0.1248 for KVLCC1 and KVLCC2, respectively). The radii of gyration about the vertical z-axis amidships practically amounted to $i_{zz} = 0.25\ L_{pp}$ (0.2488 and 0.2486, respectively). The radii of gyration about the longitudinal x-axis amounted to $i_{xx} = 0.375\ B$ and $k_{xx} = 0.372\ B$, respectively. These latter values were determined by a roll experiment and include the contribution due to added moment of inertia.

m	[kg]	3274/3272
i_{xx}/B	[-]	0.37
i_{zz}/L_{pp}	[-]	0.25
GM	[m]	0.125

Nominal speeds and RPM:

Test series		15.5 knots
Nominal speed U_0	[m/s]	1.179
Froude number Fn	[-]	0.142
Nominal revs. N_0	[RPM]	614

Self-propulsion point: Model (No friction deduction force applied)

RPM strategy: Constant RPM

Degrees of freedom: 6 DOF

Set-up: Free model test arrangement with CPMC following the model to measure 4 DOF

TEST PROGRAM

With each model, a small series of modified zigzag manoeuvres with a switching angle of $\psi_s = 1°$ and decreasing maximum rudder angles of $\delta_m = 15°$, 10° and 5° was performed. Further, a full series of standard zigzag manoeuvres with switching angle $\psi_s = 5°$ or 10° was performed with the maximum rudder angle set to values ranging from $\delta_m = 10°$ to 35°. The following table gives a summary of the delivered zigzag manoeuvres:

manoeuvre	max. rudder angle	heading change	starting to
Z_05_01	5°	1°	stb
Z_10_01	10°	1°	stb
Z_10_05	10°	5°	stb
Z_10_10_S	10°	10°	stb
Z_10_10_P	10°	10°	port
Z_15_01	15°	1°	stb
Z_15_05	15°	5°	stb
Z_20_05	20°	5°	stb
Z_20_10_S	20°	10°	stb
Z_20_10_P	20°	10°	port
Z_25_05	25°	5°	stb
Z_30_05	30°	5°	stb
Z_35_05	35°	5°	stb

MEASUREMENT SYSTEM

Facility: The tests were done with the free model test set-up as standard zigzag manoeuvres with the CPMC in the large towing tank of the HSVA with dimensions 300 m x 18 m x 6 m.

Water depth: 6.0 m water depth, ratio h/T = 13.2 (deep water)

Water temperature: 17°

Measurements: All data was measured with a sampling rate of 100Hz. However, every fifth value has been written into the submitted files. Especially with the KVLCC1 model, some tests had to be interrupted before a periodic phase was reached (e.g. 5°/1°), before the 2nd overshoot angle was reached (10°/10°) or could not be performed at all (20°/20°) due to the model size and the limited width of the tank.

Sampling frequency: 100Hz

DATA PROCESSING

Coordinate system: The coordinate system is fixed in the model. Origin is the centre line plane amidships. The x-axis is positive in the forward direction, the y-axis is positive towards starboard side and the z-axis is positive downwards. Angles, moments and directions of rotation follow the general right hand rule.

Filtering of raw data: The data was filtered with a low pass filter.

Motion variables: 4 DOF

OUTPUT DATA

All measured values have been transformed to full scale without regard of scale effects.
The resulting output files of free model tests contain the channels listed below.

Column.	Designation	Dimension	Description
1	time	sec	Duration from the 1st rudder execution
2	x	m	x-position in earth-fixed coordinate system
3	y	m	y-position in earth-fixed coordinate system
4	phi	deg	roll angle, positive to starboard side down
5	psi	deg	heading angle, positive to starboard turn
6	u	m/s	longitudinal velocity component of ship
7	v	m	lateral velocity component of ship
8	p	deg/s	roll rate (not observed)
9	r	deg/s	yaw rate
10	delta	deg	rudder angle, positive steering to port side
11	n	rpm	propeller revolution
12	thrust	KN	propeller thrust
13	torque	KNm	propeller torque

UNCERTAINTY ANALYSIS

No UA was performed. However the 10°/10° tests to port and starboard have been performed at least 3 times each with both models. The largest differences between obtained 1st overshoot angles were 1.2° and 0.9° with the KVLCC1 model starting to starboard and port, respectively. The largest differences were just 0.2° and 0.5°, respectively, with the KVLCC2 model. The submitted 10°/10° test results correspond to those runs being closest to the mean values.