DESIGN OF CONTAINER SHIP PROPULSION SYSTEM

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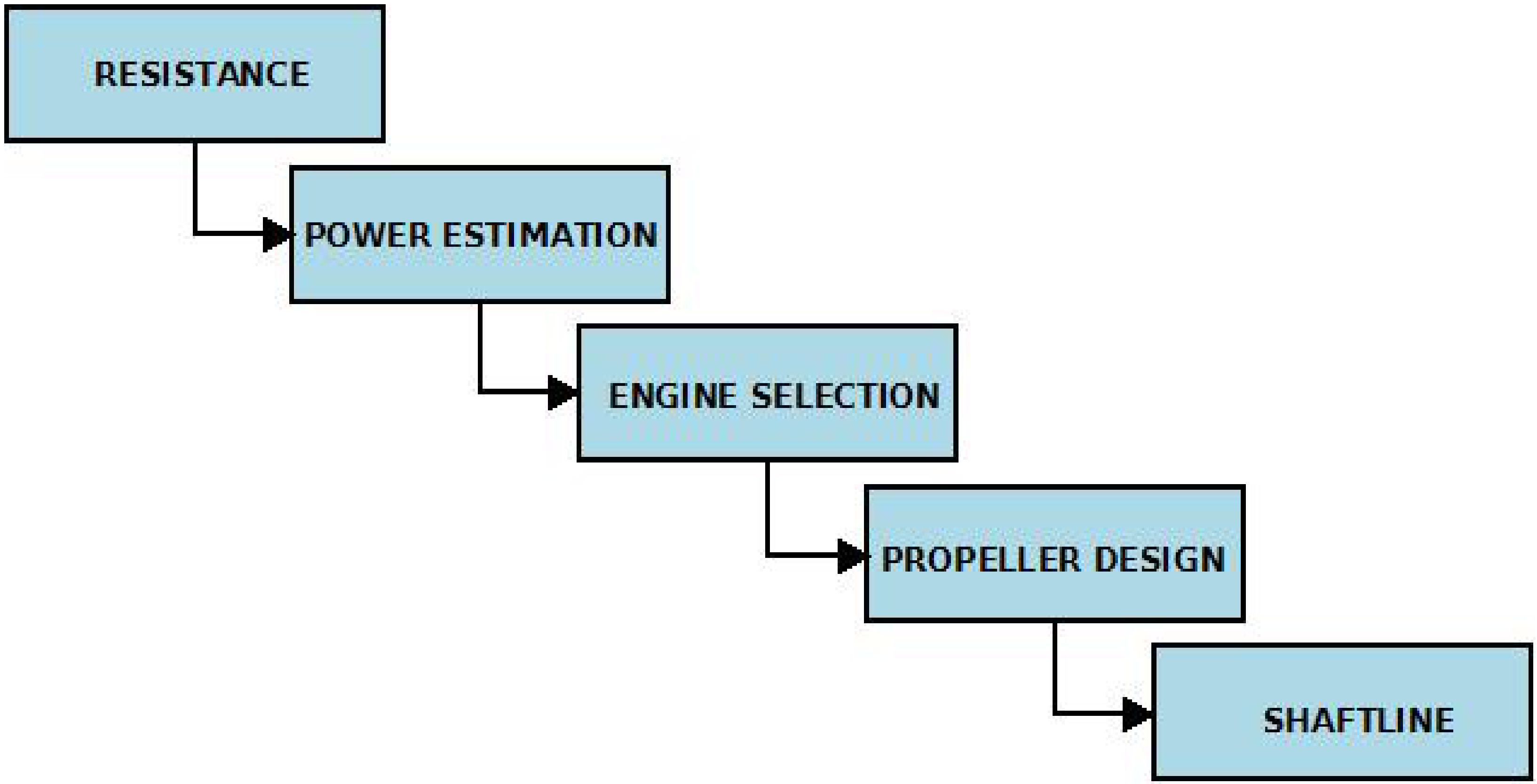
INTRODUCTION

- The main purpose of this work was to design the propulsion system including Main Engine, an optimized Propeller and Transmission line for a Container ship with following characteristics.

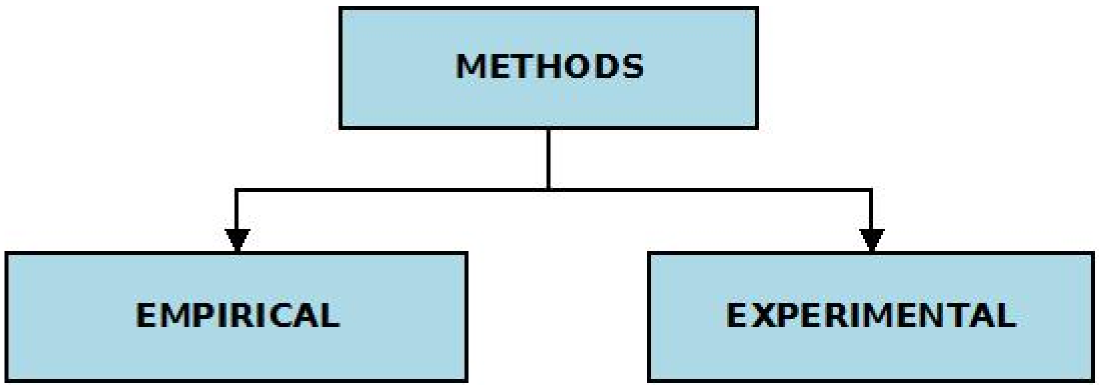
Particulars	Dimension
LENGTH BETWEEN PERPENDICULARS(M)	145.9
BREADTH(M)	23.25
DRAFT(M)	7.3
DEPTH(M)	11.5
SERVICE SPEED(KNOTS)	20
TEU	1200

OBJECTIVES


RESISTANCE
POWER ESTIMATION
ENGINE SELECTION
PROPELLER DESIGN
SHAFTLINE

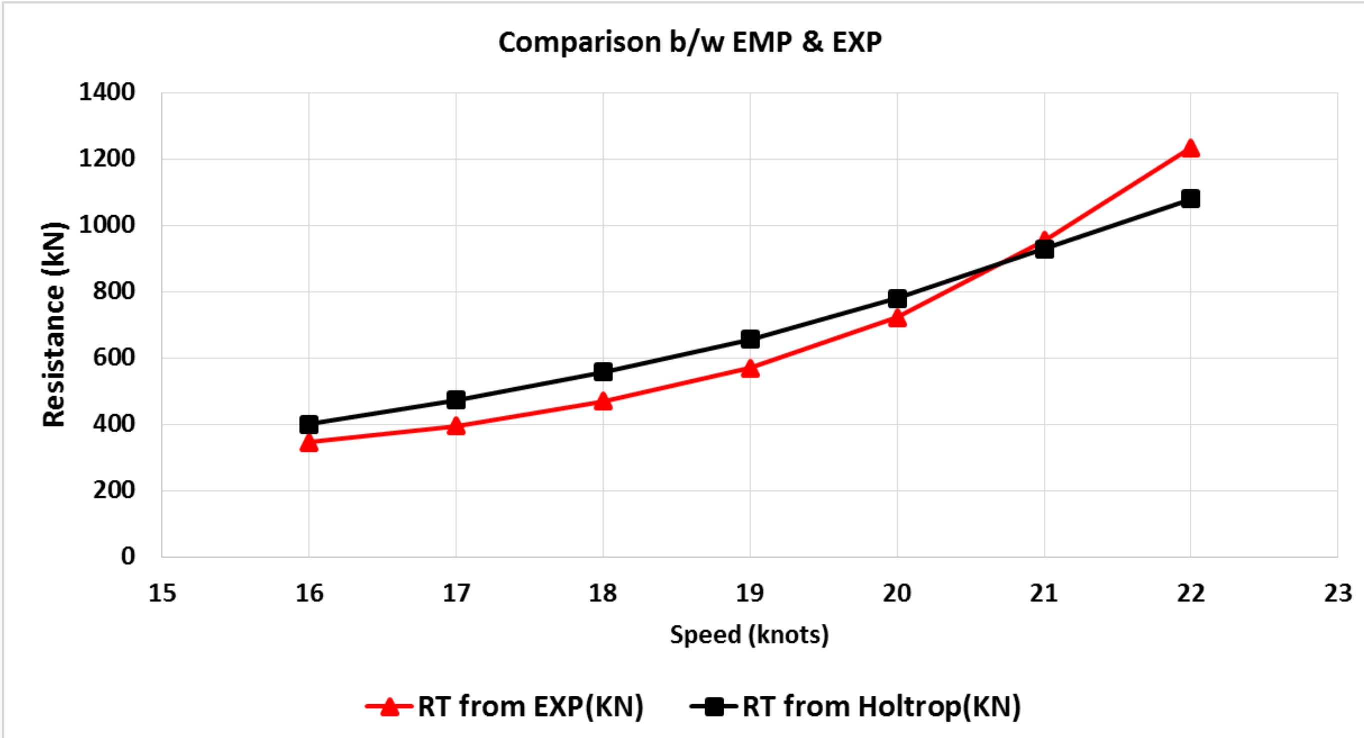
RESISTANCE

- The opposing hydrodynamic fluid force experienced by the ship due to its motion.



- Resistance calculations were performed for a range of speeds from 16 to 22 Knots.

RESULT COMPARISON



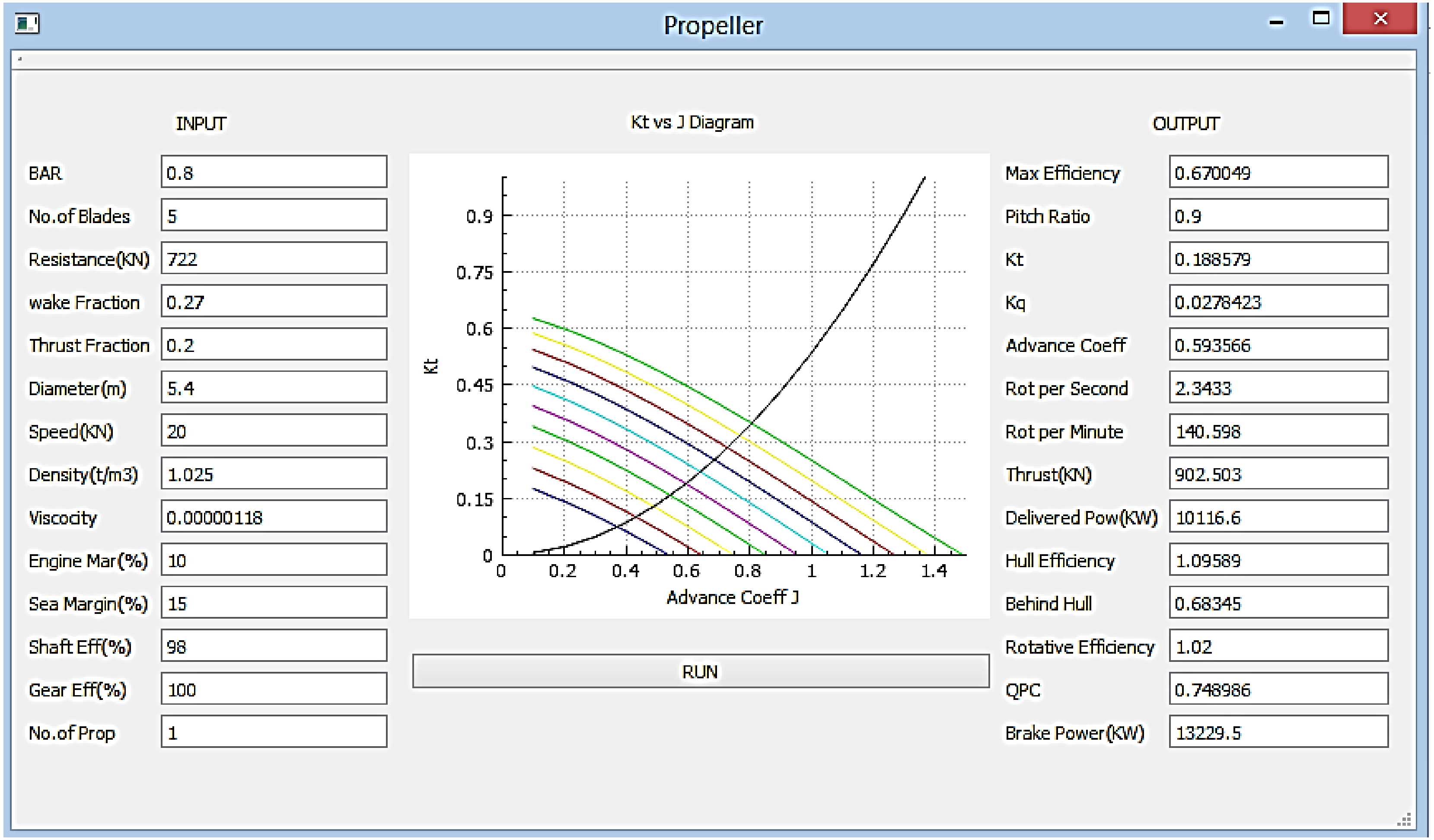
- The experimental method is more accurate compared to empirical methods.
- Hence the experimental result obtained as 722 KN at 20 knots has been used to start propeller design.

POWER ESTIMATION

The brake power of engine is influenced by

- Hull-Propeller interaction coefficients
- Hull, Relative rotative & Open water efficiencies.
- Sea and Engine margin as per owners requirement.

POWER & OPTIMUM RPM

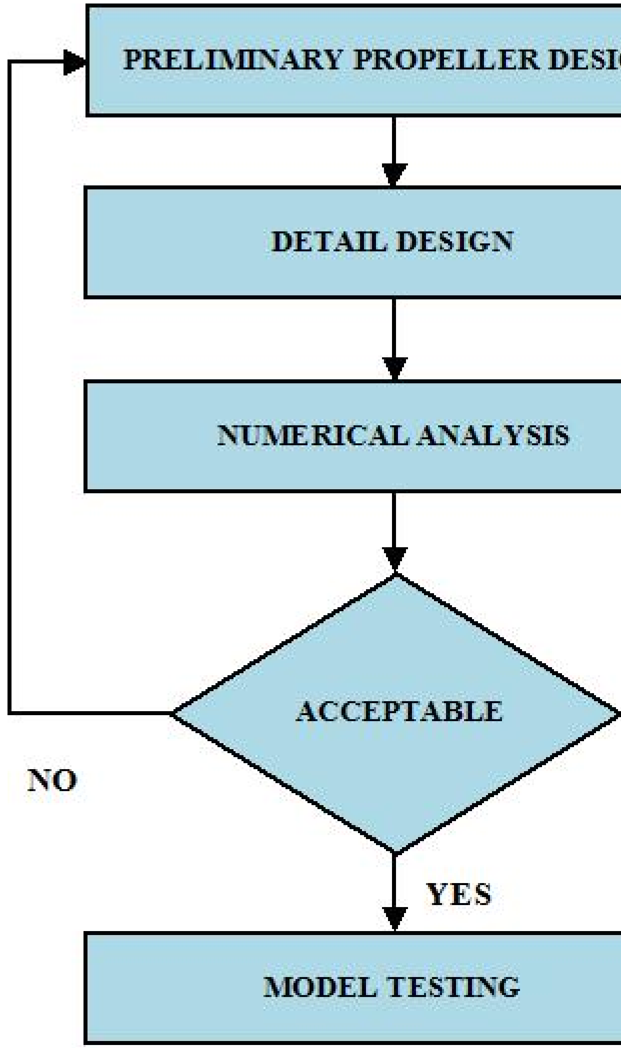


ENGINE SELECTION

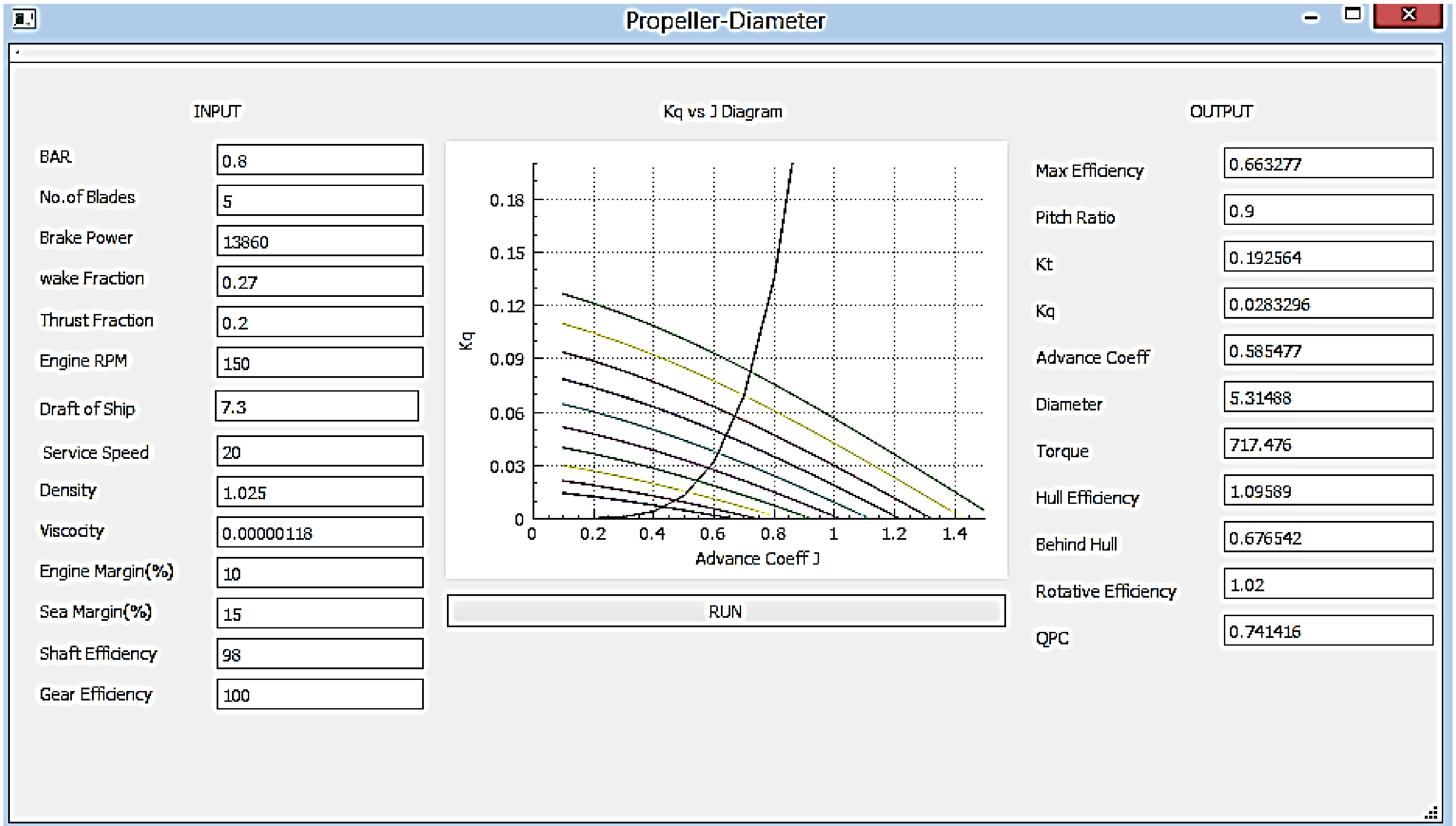
- Low speed diesel engine has been selected as per the required brake power and RPM estimated.
- Main advantages include compatibility with inexpensive fuel and low maintenance.

ENGINE MANUFACTURER	MAN
MODEL	K60MC-S
NO.OF CYLINDERS	7
BRAKE POWER	13860 KW
RPM	150

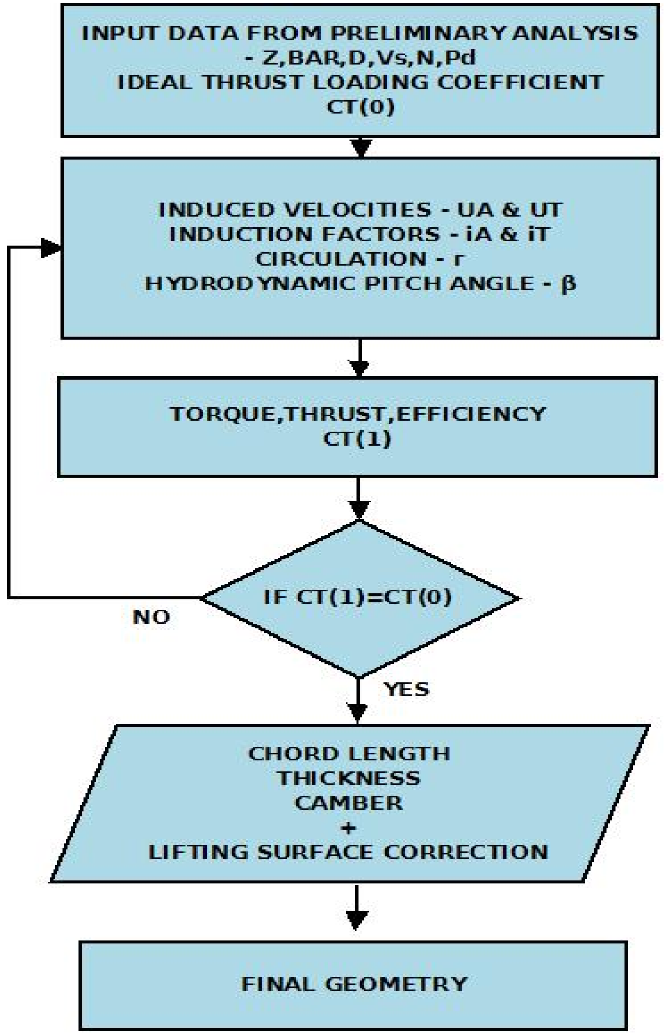
PROPELLER DESIGN



PRELIMINARY DESIGN



DETAIL DESIGN

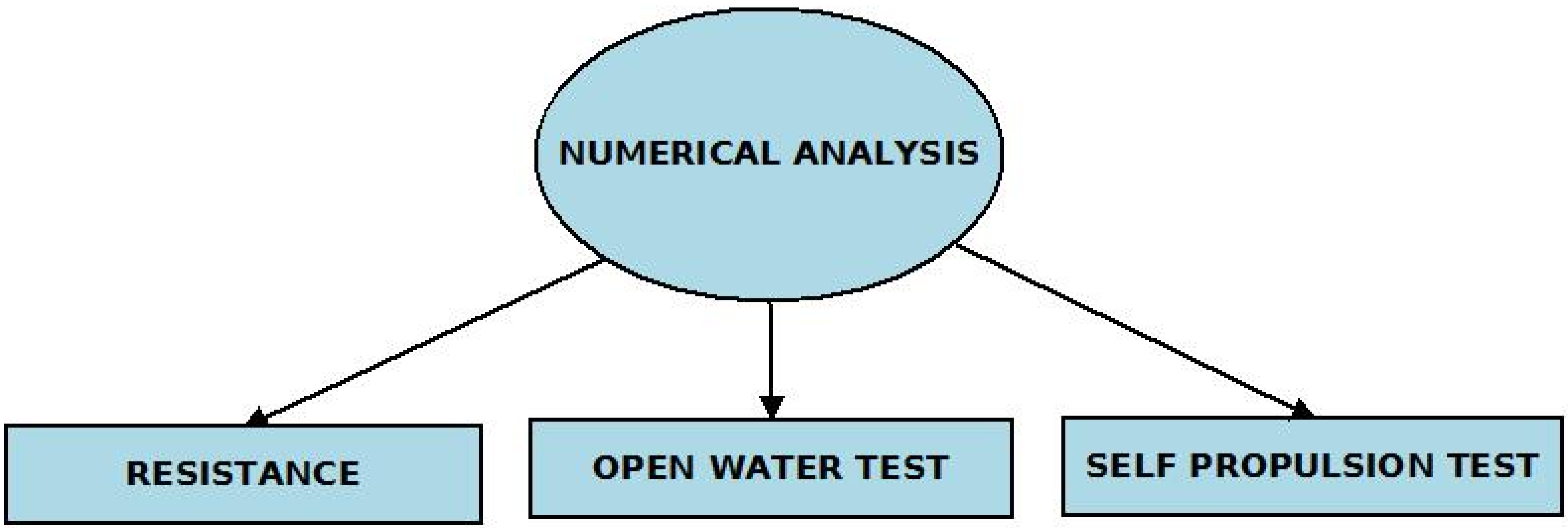


PROPELLER CHARACTERISTICS

r/R	CHORD LENGTH (MM)	THICKNESS (MM)	CAMBER (MM)	PITCH (MM)
0.2	1454.6	255.5	0	3622.1
0.3	1609.9	218.9	82.3	4174.6
0.4	1749.3	185	54.3	4328.8
0.5	1866.7	152.9	43	4373
0.6	1952.1	123.5	34.4	4403.7
0.7	1987.1	95.8	28.8	4426.1
0.8	1933.8	69.4	24.8	4451.7
0.9	1685.5	44.7	22.2	4447
1	0	2.3	10.6	4443.7

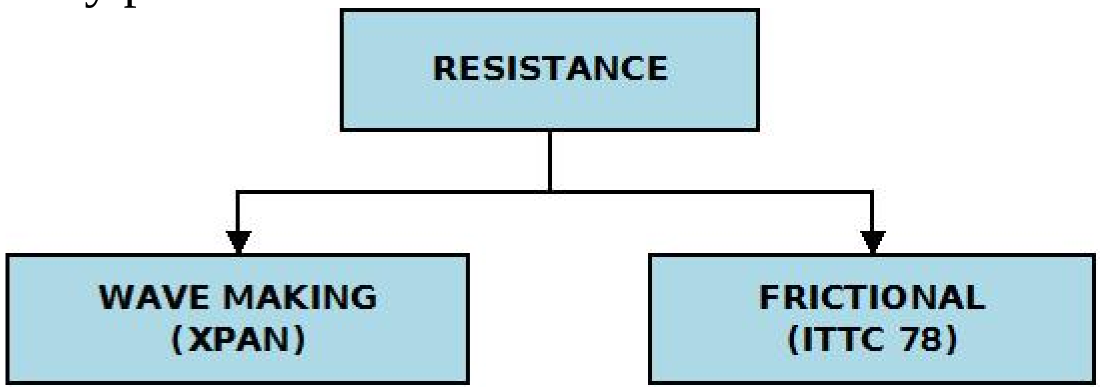
NUMERICAL ANALYSIS

- To study hydrodynamic performance of propeller under steady as well as unsteady flow conditions.
- Helps to select a most promising candidate design for model testing to save time and cost.



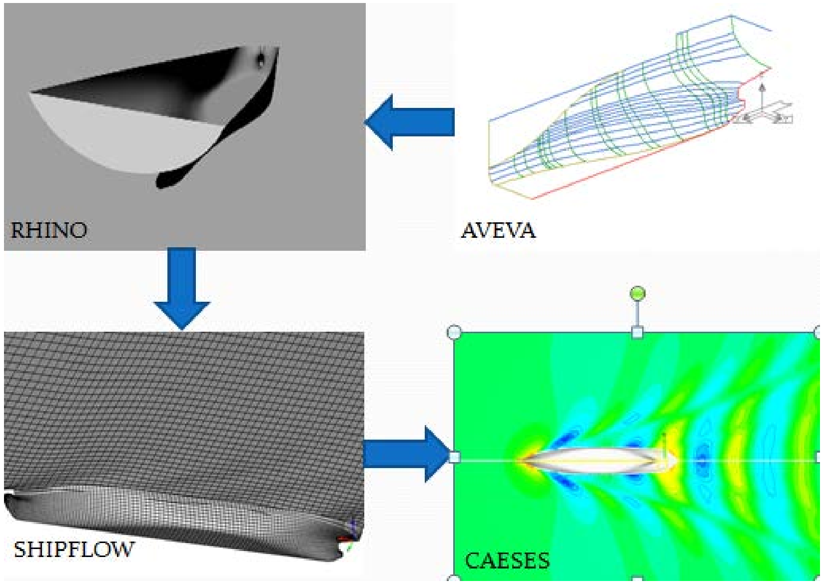
RESISTANCE - CFD

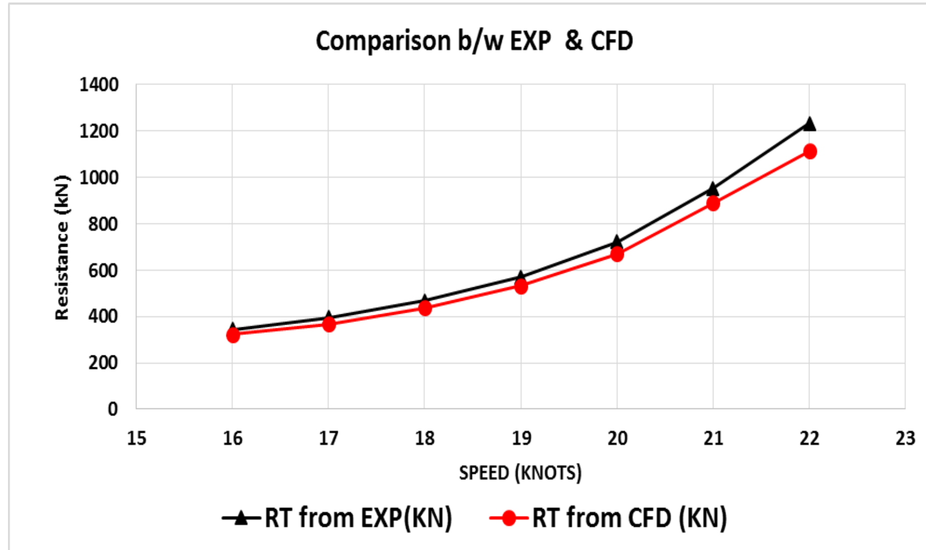
- Resistance computation by potential flow solver of shipflow based on a surface singularity panel method.



- Discretization by automatic medium mesh generation mode to perform faster computation.(No of Panels – 6666)

RESISTANCE - CFD





- The resistance data obtained from CFD method is in good agreement with experimental results.
- Result from CFD has been used during self-propulsion simulation.

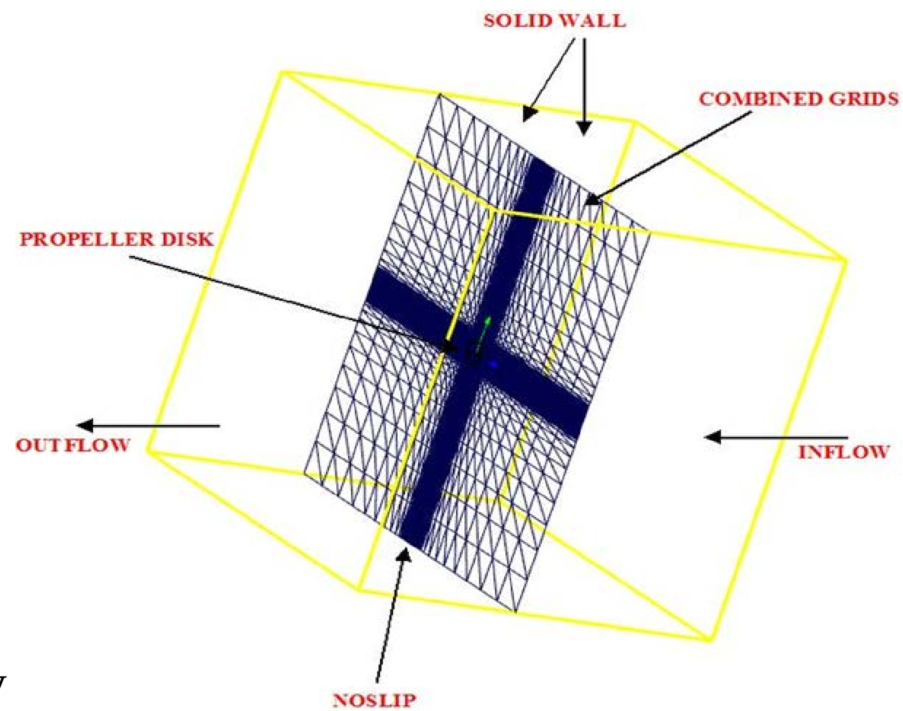
OPEN WATER TEST

- Simulation to study the propeller characteristics in steady flow.

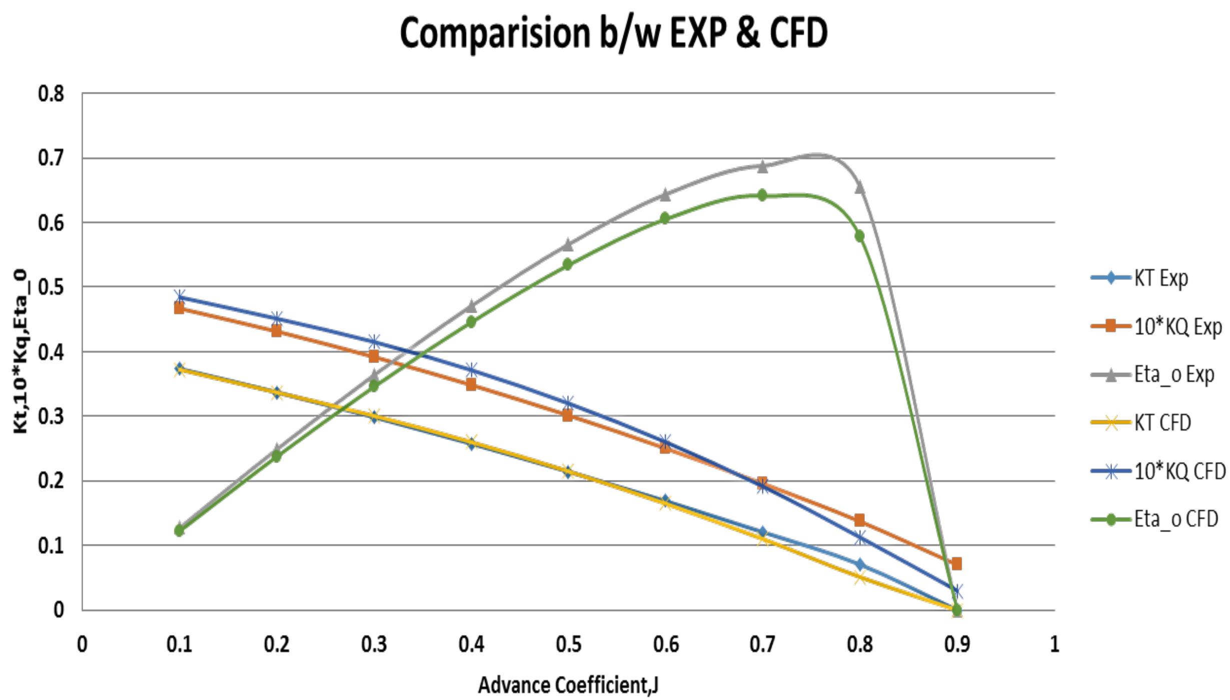
Pre – Processing
Structured Grid
Turbulence – EASM

Computation
RANSE solver – XCHAP

Post – Processing
Propeller Characteristics
Kt, Kq and open water efficiency



RESULT COMPARISON



- Propeller characteristics obtained through CFD analysis are in good agreement with experimental results as it follows same pattern.
- Variations are within the range of 2-3%.

SELF PROPULSION TEST

- The self-propulsion simulations were carried out to study the performance of propeller in non-uniform flow condition.

Pre – Processing

Structured & Overlapping Grids

Turbulence – EASM

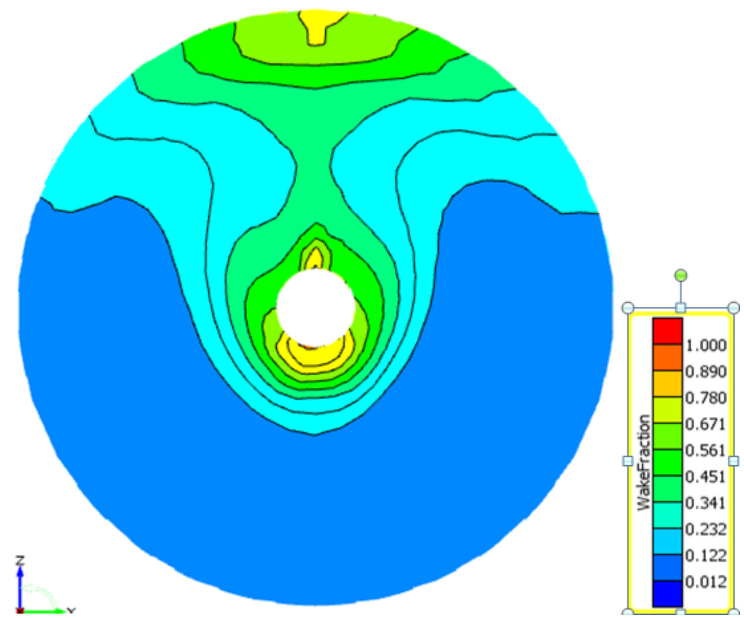
Computation

RANSE solver – XCHAP

Post – Processing

Wake, Propeller Characteristics,

Propeller Hull interactions, Delivered Power & RPM



RESULT COMPARISON

PARAMETERS	NUMERICAL	EXPERIMENTAL	DIFFERENCE IN %
Effective Mean Wake, w	0.277	0.273	1.44
Thrust Deduction, t	0.18	0.1766	1.88
Resistance(KN)	649	722	10.11
Thrust Coefficient, K_T	0.178	0.177	0.5
Torque Coefficient, K_Q	0.0242	0.026	7.4
Propeller Speed (RPM)	141	144.16	2.24
Delivered Power (KW)	8234	10243.7	19.6
Hull efficiency,η_H	1.183	1.1326	4.2
Relative rotative eff, η_R	1.018	1.0225	4.2
Propeller Efficiency, η_D	0.71	0.73	2.8

CONCLUSION

- Preliminary design, detail design and numerical analysis of final propeller were carried out.
- Strength has been verified at 0.25R and 0.6R blade sections using classification rules.
- Numerical method have predicted efficiently the hull-propeller interaction factors w, t & efficiencies($\eta_{R,}\eta_{H,}\eta_0$). Kt computed using CFD has a very reasonable accuracy while for Kq a larger deviation was observed.
- The wake adapted NACA propeller has been concluded as best available solution for containership with respect to its hydrodynamic performance.
- Finally a transmission system has been designed as per classification society requirement.