Consideration on Suitable Ship Design for Voyage through Northern Sea Route

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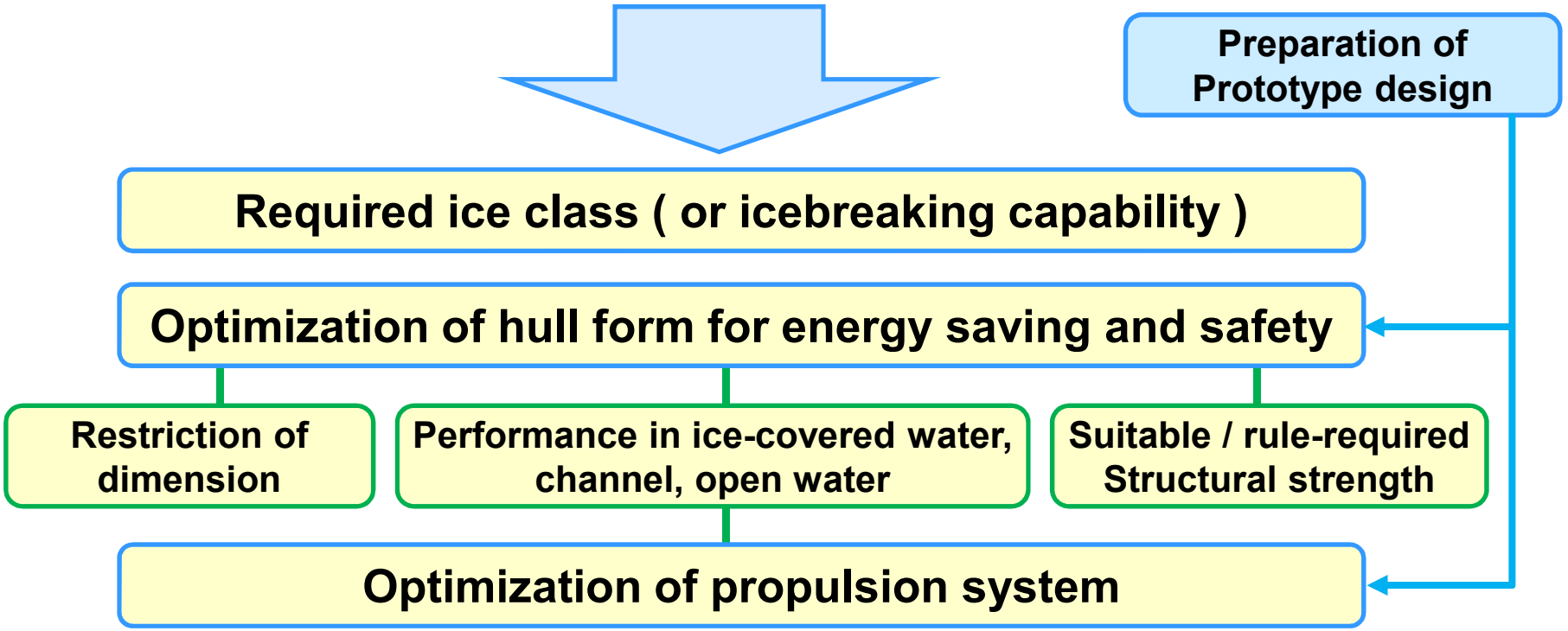
Study on Suitable Ice Class Ship for NSR Voyage

- Kind of cargo and capacity ?
- NSR transit voyage or regional voyage (Kara / Laptev / E.Siberian / Chukchi) ?
- Voyage season / period in Northern Sea Route ?
- Icebreaker assisted voyage or unassisted voyage ?



High Ice Class Ship

Ice Class / Polar Class Merchant Ship

Ice-strengthened merchant ship

- Almost no icebreaking capability
- Assisted voyage by icebreaker in ice-covered water basically
- FSIC IA Super and under (IAS, IA)

Icebreaking merchant ship

- Having icebreaking capability
- Unassisted voyage in ice-covered water basically
- Polar class 5 and over (PC5, PC4, ...)

Ice Class / Type of Merchant Ship for NSR Voyage

Northeast Passage
Transit voyage

Escort by Russian Icebreaker

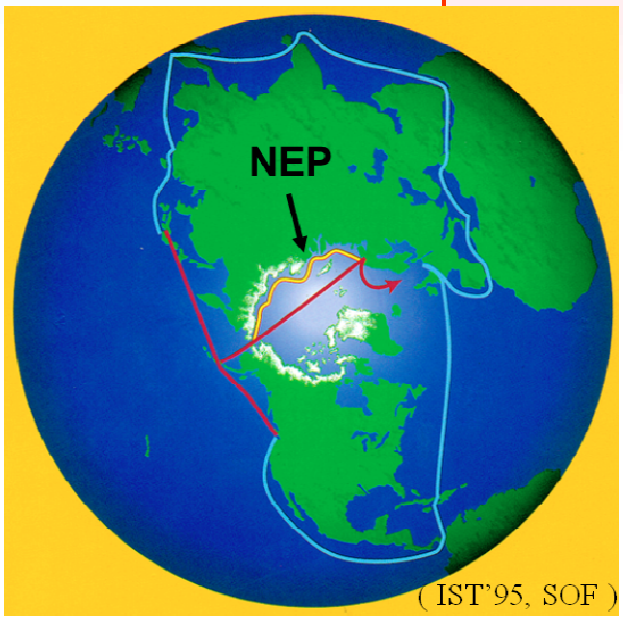
Ice Class Ship (IA / Arc4, mainly)

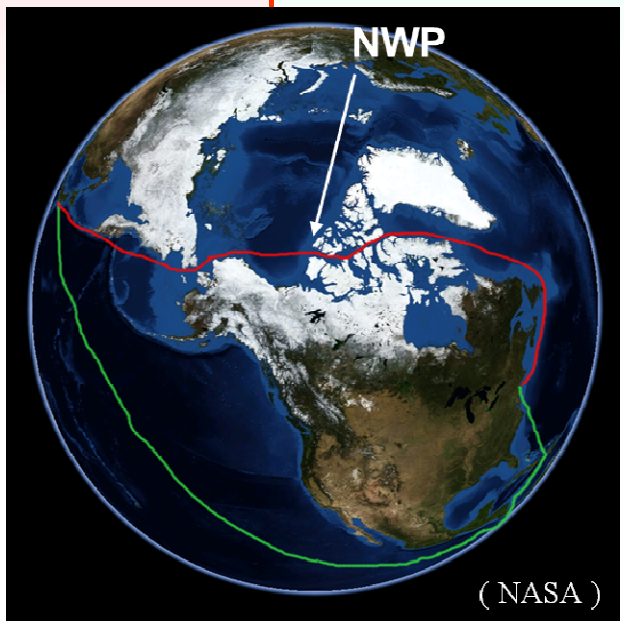
Northwest Passage
Transit voyage

Regional Voyage in NSR
for Polar resource transport

Ice Class Ship

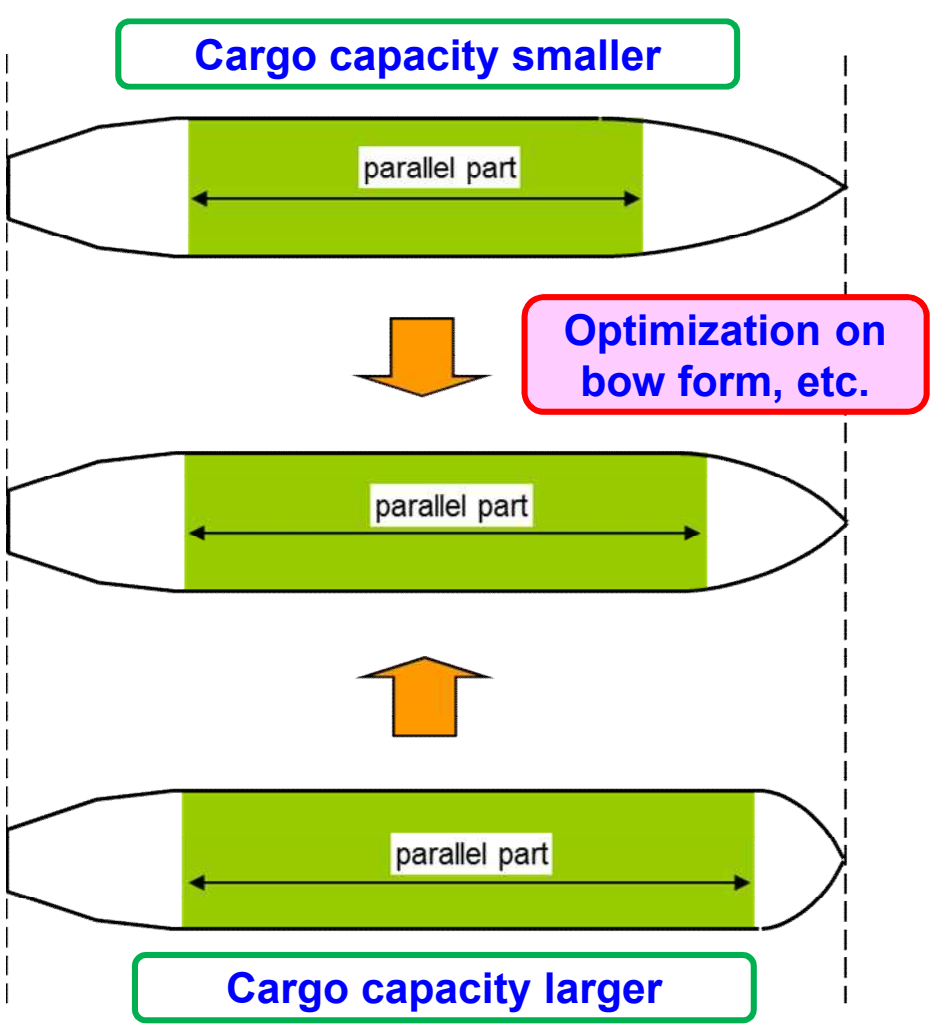
Icebreaking Merchant Ship



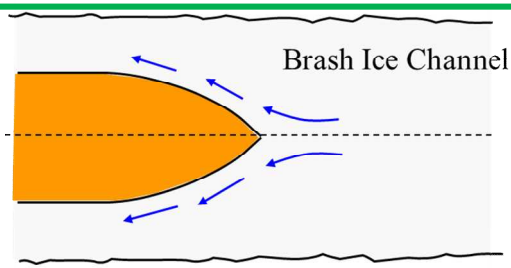


Ship Performance and Problem for NSR Transit Voyage

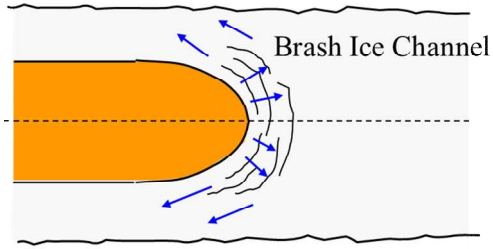
- Improvement of performance in broken ice channel or brash ice channel (for example, Ice Class IA ship)



Channel resistance smaller



Brash ice channel test for Ice Class Certificate
(at JMU Ice Model Basin)

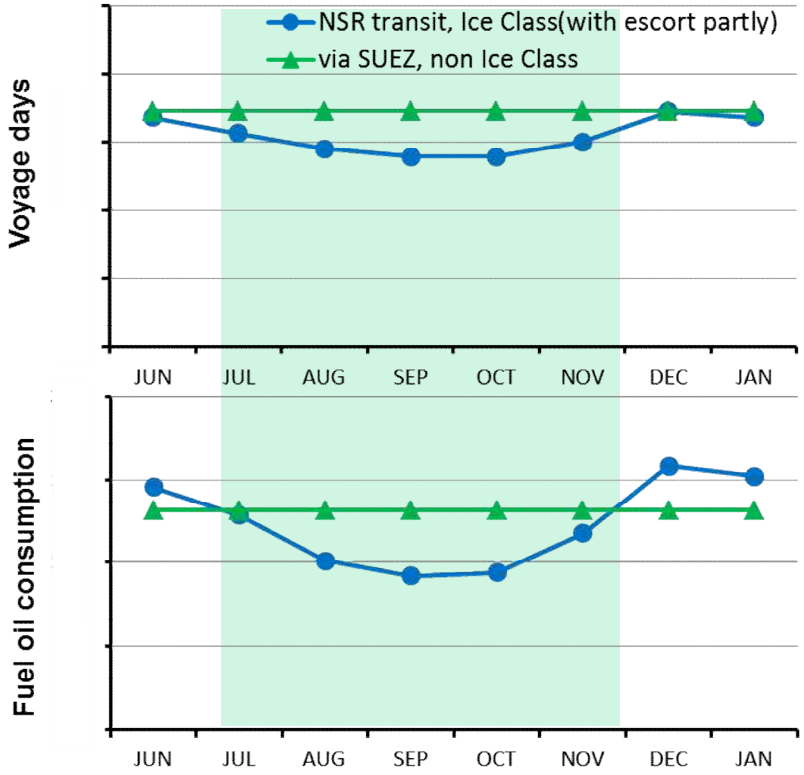


Channel resistance larger

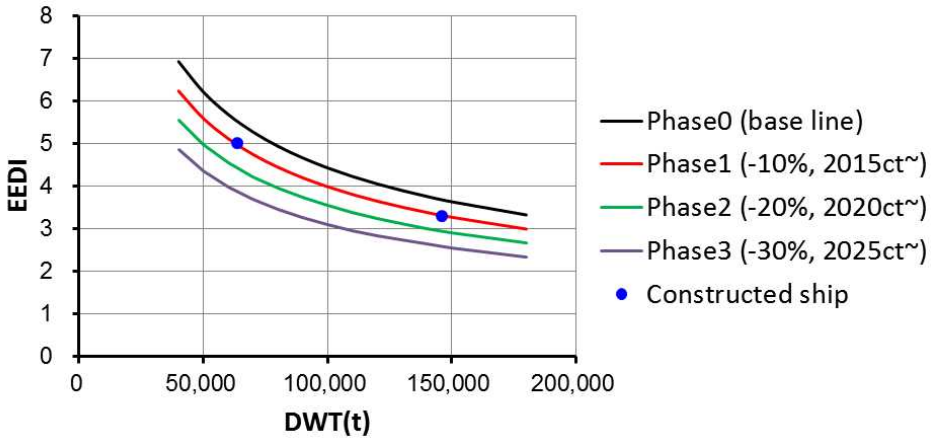
Ship Performance and Problem for NSR Transit Voyage

- **Suitable performance balance in ice-covered water and open water**
  - NSR transit voyage in a half year, South route voyage via Suez Canal in other half year, for example
  - Suitable response to EEDI control (reduction of CO_2 emission)

Example of voyage simulation (Yokohama ~ Hamburg)



Example of EEDI evaluation (Ice Class IA Tanker)



$$EEDI = \frac{CO_2\ emission}{Transport\ work} \fallingdotseq \frac{Fuel\ consumption \times C_F}{DWT \times Speed}$$

(in open water, at 75%MCR)

Consideration on Ice Class Ship for Efficient Use of NSR

- Suitable selection of Ice Class matching to planned voyage (season of NSR use, period, sea area)
- Suitable performance balance in ice-covered water and open water, in consideration of rate of each voyage period
- Improvement of performance in ice-covered water
  (reduce resistance in broken ice channel, brash ice channel)
- Improvement of performance in open water also

Thank you for your attention !