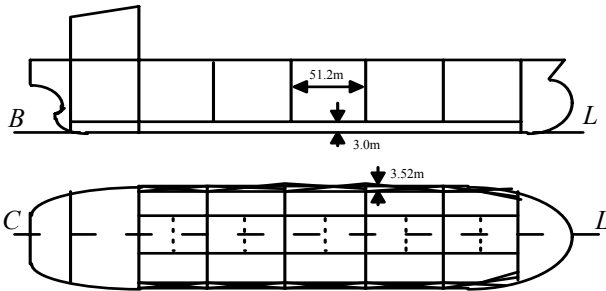


LBR5 --> Optimization of a Tanker

Application - Example



$L=320\text{m}$ $B=58\text{m}$ $D=31\text{m}$ $T=22\text{m}$ $C_B=0.83$

1

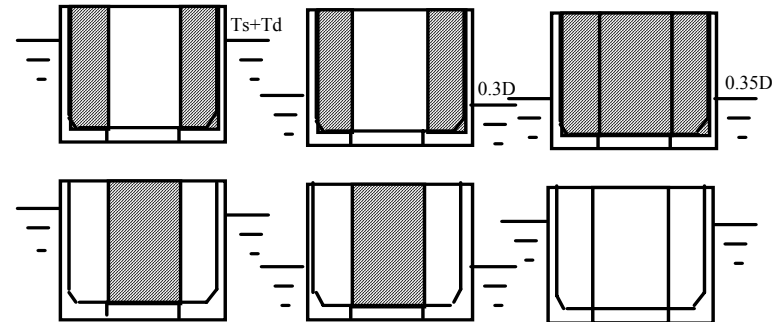
ANAST - ULG

Application --> Tanker

Full load conditions

Ballast load conditions

Abreast load conditions



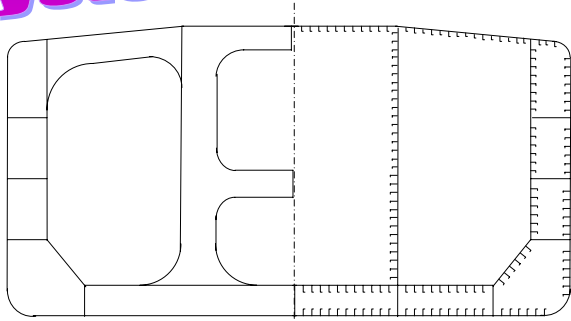
T_s : static draft T_d : dynamic draft

2

ANAST - ULG

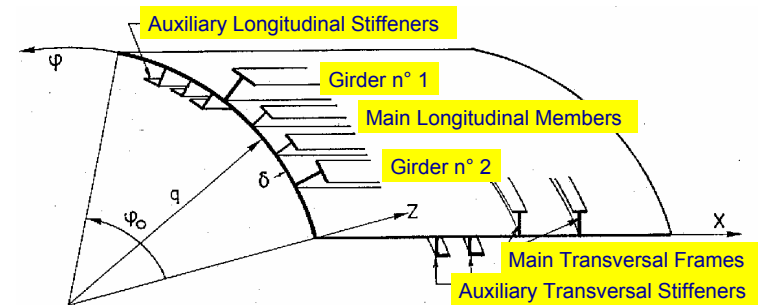
LBR5 --> Optimization of a Tanker

System definition



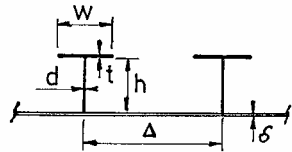
LBR-5 --> Product model

1 STIFFENED PANEL- 9 design variables -



Design Variables

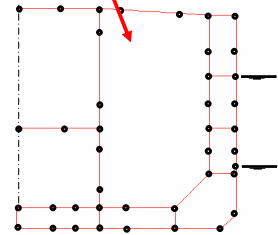
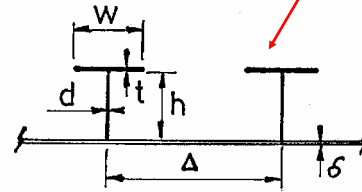
- Shell plate thickness
- Longitudinals
 - Sizes (web and flange)
 - Spacing
- Web Frames
 - Sizes (web and flange)
 - Spacing



5

LBR-5 --> Design Variables

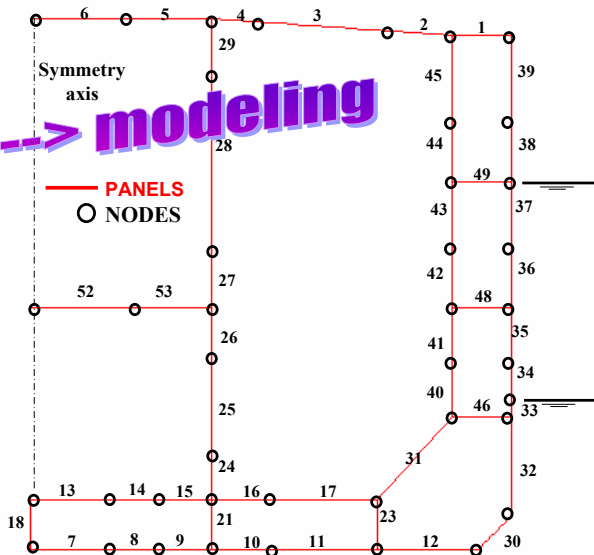
- 423 design variables (9 x 47 panels).
- 70 to 250 equality constraints.



6

LBR-5 --> modeling

A Framework
for Simulation
Based Design
of Ship
Structures



ANAST - ULG

LBR-5 --> Process Model

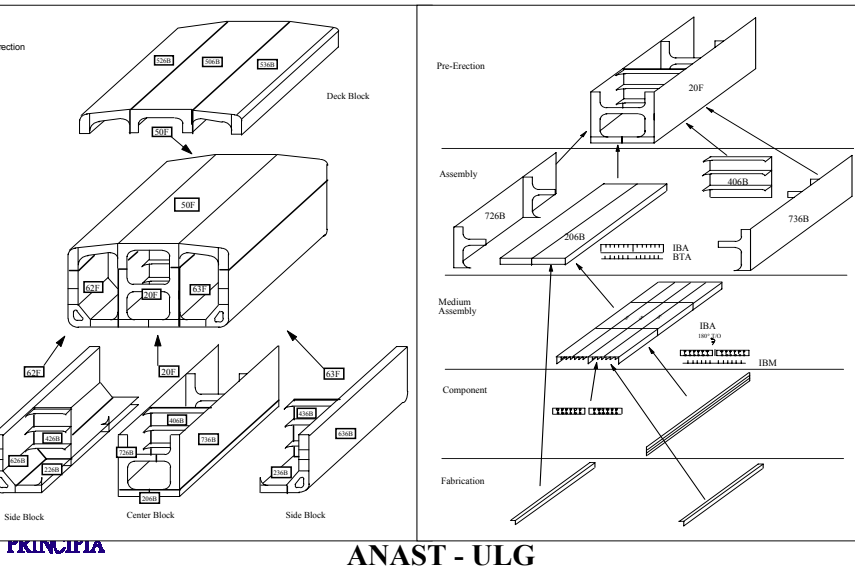
COST-LBR5:

Unitary material, fabrication costs and Unitary working loads:

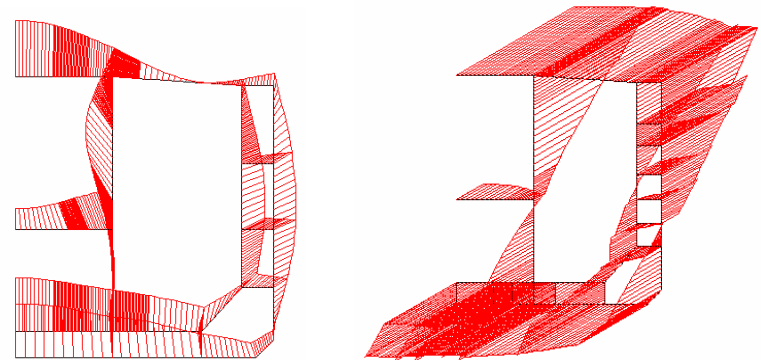
k = Unitary Labor Cost (€/m-h) / Material Cost (€/t)
= 0.08 (in Europe) or 0.03 (in Korea)

- *** Unitary price of steel: $C1 = 1.00$ €/kg,
- *** Unitary price of welding (materials only): $C8 = 2.00$ €/m,
- *** Unitary working load (labor):
 - Plate assembling: $P10 = 0.25$ m-h/m²,
 - Welding stiffeners on the panel: $P4 = 0.5$ m-h/m,
 - Welding frames on the panel: $P5 = 1.5$ m-h/m,
 - Built the members: $P9 = 1.5$ m-h/m (if built on site),
 - Slot for stiffener: $P6 = 0.6$ m-h/piece,
 - Bracket or web stiffener: $P7 = 0.6$ m-h/piece.

LBR5 (COSTCAT)



LBR-5 --> Simulation response



LBR-5 --> Design Criteria (G)

The R Response Metrics

- 2015 structural constraints (5 load cases; 8~11 constraints per panel);
- 2 constraints on the hull ultimate bending moment;
- 1 constraint on the vertical position of the gravity center,
- 198 geometrical constraints (7 x 47 panels).

The G Constraint acceptance criteria:

- Against yielding the criteria is : $\sigma(\text{von Mises}) < 1.0 \text{ Yield Stress}$.
- For plate buckling: $\sigma(\text{effective}) < 1.0 \sigma(\text{buckling})$.
- For stiffened panel (axially compressed): $\sigma(\text{effective}) < 0.8 \sigma(\text{ultimate strength})$.
- For ultimate bending moment of hull girder (in sagging and hogging): $M(\text{required by Class. Soc.}) < 0.8 M (\text{Ultimate Bending Moment})$
- Position of the gravity center

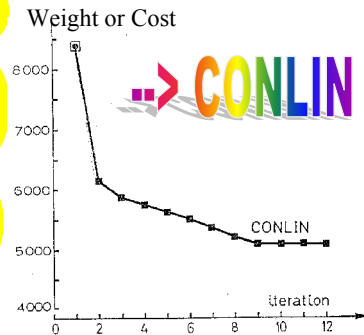
LBR-5 --> Optimization Algorithm

Responses → Implicit & Non Linear
CONSTRAINED PROBLEM

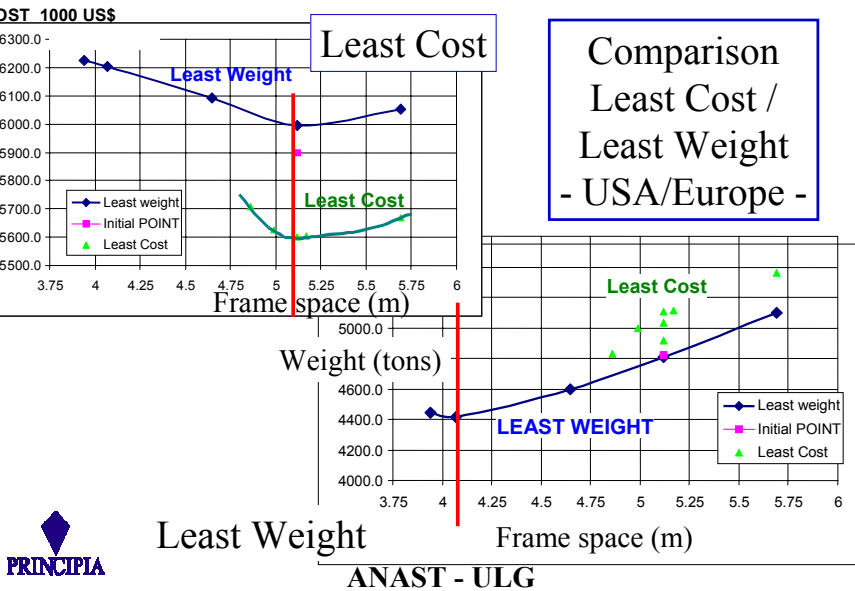
→ CONVEX LINEARIZATION ←
Responses → Explicit & Linear
CONSTRAINED PROBLEM

→ DUAL APPROACH ←
Unconstrained, Explicit & Linear
Problem → EASY

Needs only 10 iterations.
Convergence in Feasible Space



LBR5 --> Optimization of a Tanker



LBR5 --> Optimization of a Tanker

