FEA OF OFFSHORE JACKET STRUCTURE SUBJECTED TO DEFORMABLE VESSEL COLLISIONS

MASTER THESIS

Developed at ICAM, FRANCE
in the framework of the

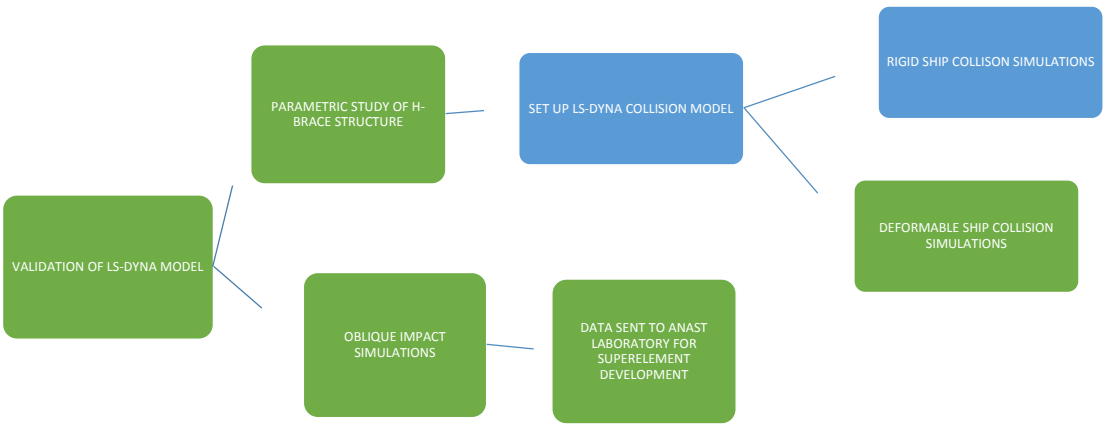
"EMSHIP"
Erasmus Mundus Master Course
in "Integrated Advanced Ship Design"

CONTENTS

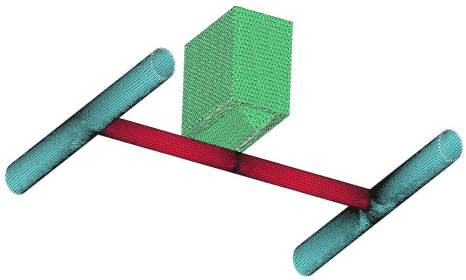
1. INTRODUCTION

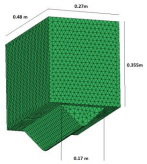

BIGORANGE XVIII

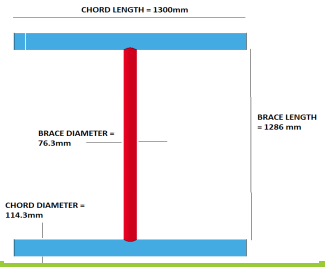
3. WORKFLOW


PARAMETRIC STUDY OF H-BRACE STRUCTURE
SET UP LS-DYNA COLLISION MODEL
RIGID SHIP COLLISON SIMULATIONS
DEFORMABLE SHIP COLLISION SIMULATIONS
VALIDATION OF LS-DYNA MODEL
OBLIQUE IMPACT SIMULATIONS
DATA SENT TO ANAST LABORATORY FOR SUPERELEMENT DEVELOPMENT

4. H-BRACE STRUCTURE



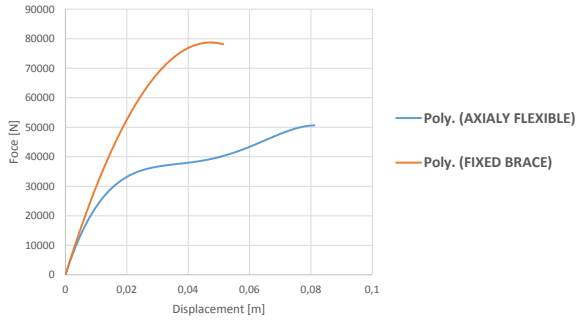




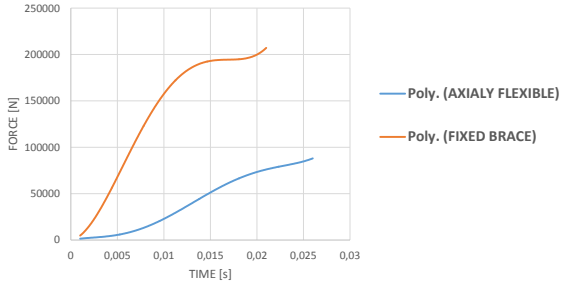
ICAM ERROR IN COMPARISON TO TEST RESULTS- %		UNIVERSITY OF ULSAN - ERROR IN COMPARISON TO TEST RESULTS- %	
Local Denting Damage, d_d .mm	Overall Denting Damage, d_0 .mm	Local Denting Damage, d_d .mm	Overall Denting Damage, d_0 .mm
-10.324	-54.231	-10.1	-29.7
10.003	-53.243	19.3	13.5
7.267	-35.458	10.5	6.7
26.058	-64.579	44.1	3.6
13.047	-42.769	30.3	-2.4
7.867	-53.873	28.7	28.1
22.004	-49.501	32.9	18.6

EFFECT OF BOUNDARY CONDITIONS

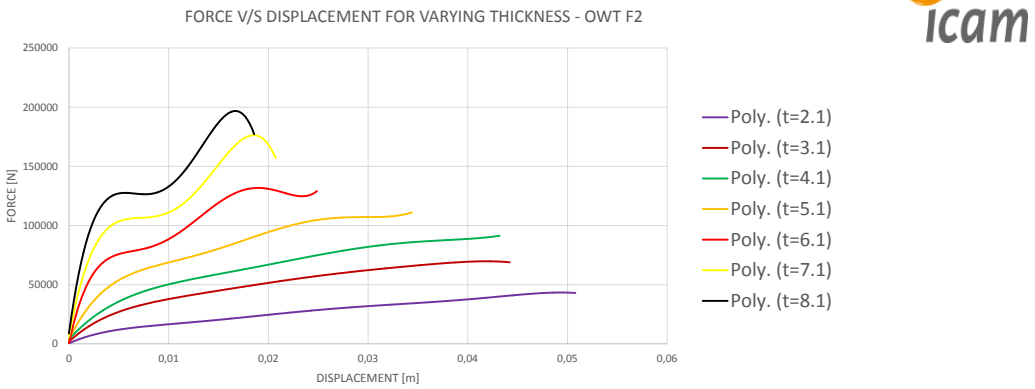
OWT A2 FORCE DISPLACEMENT CURVE

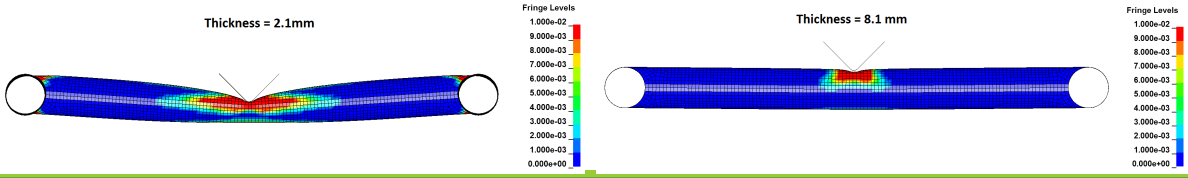


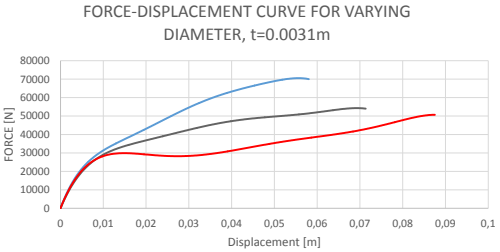
MEMBRANE FORCES - OWT-A2

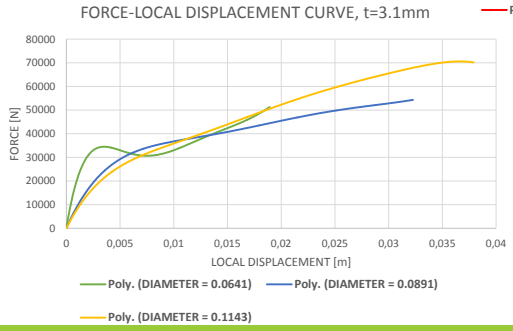


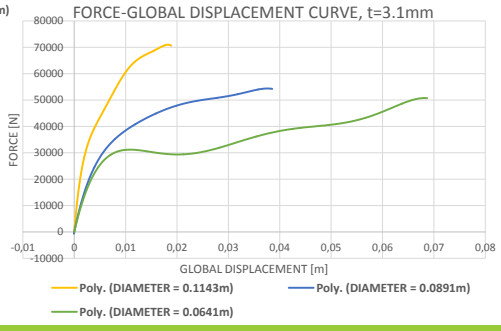
EFFECT OF THICKNESS



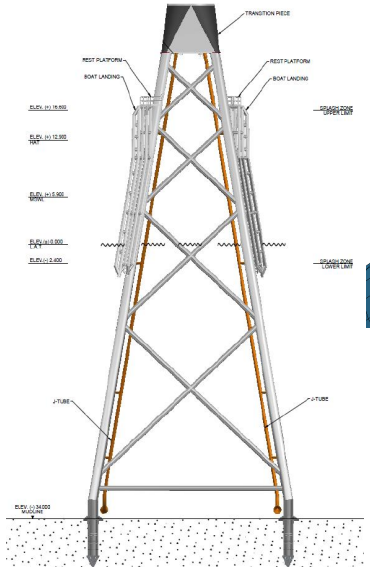


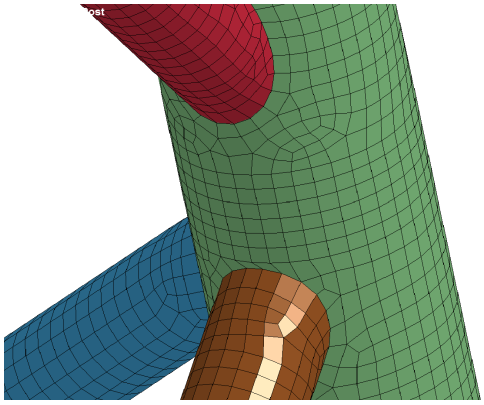




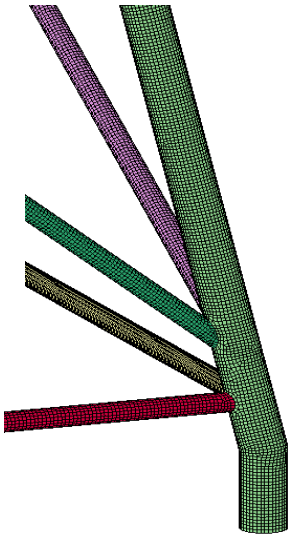


5. JACKET STRUCTURE

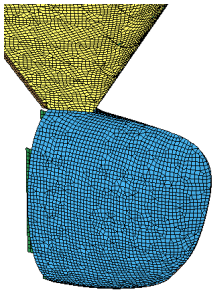


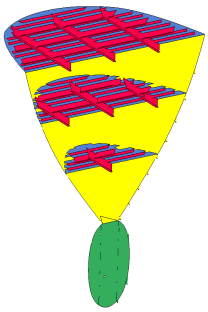


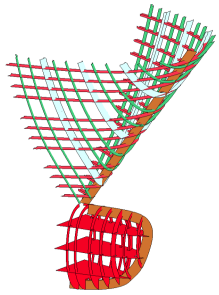
MODEL		UNITS
Yield Strength	260	Mpa
Density	7850	kg/m3
Young's Modulus	210000	Mpa
Poisson's Ratio	0.3	
Strain Rate Parameter, C	40.4	
Strain Rate Parameter, P	5	

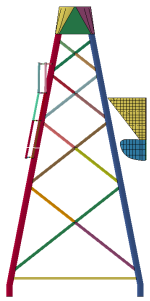


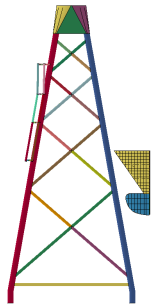
6. OSV BOW STRUCTURE





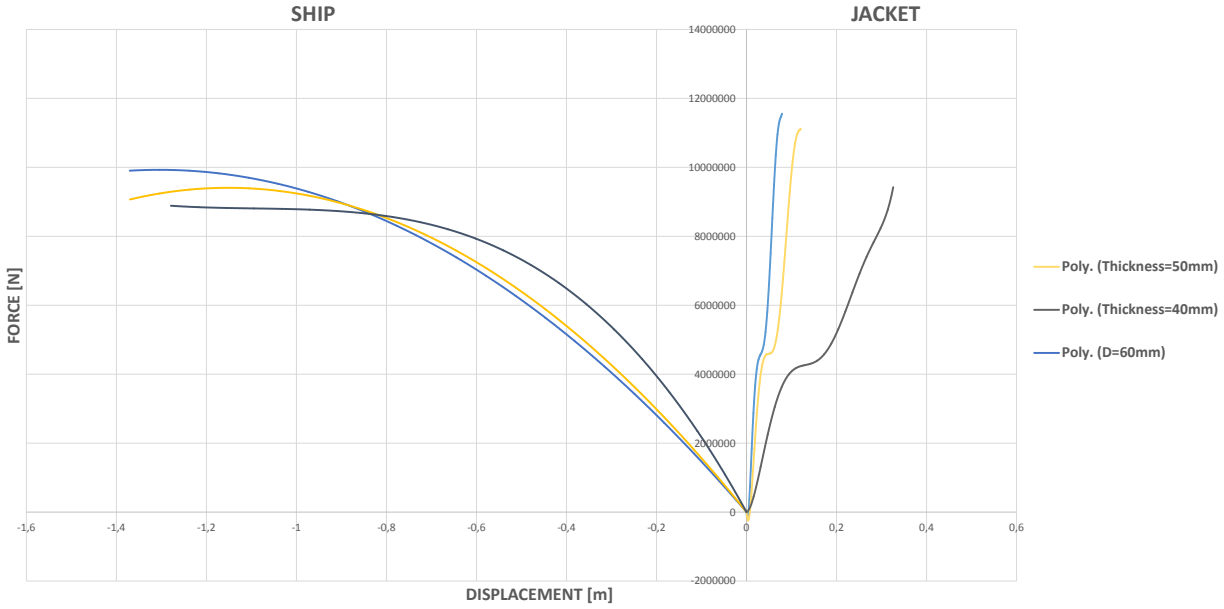


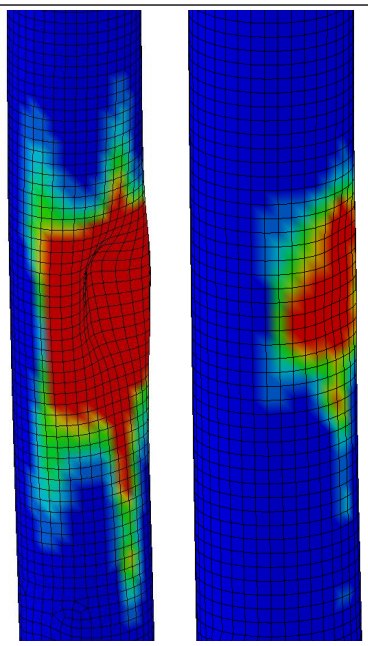


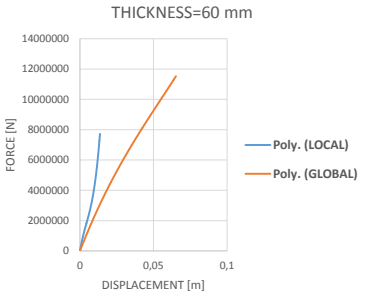


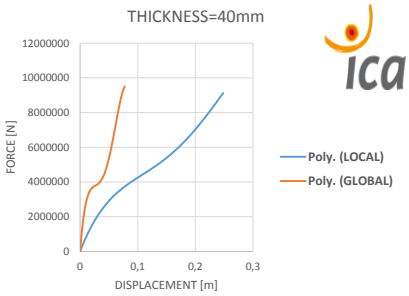
SHIP PARTICULARS	
Length	78m
Depth	13.8m
Breadth	17.6
Double Bottom Height	1.4m
Displacement	3000 T

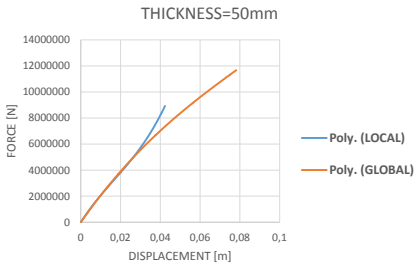
IMPACT LOCATION - 1

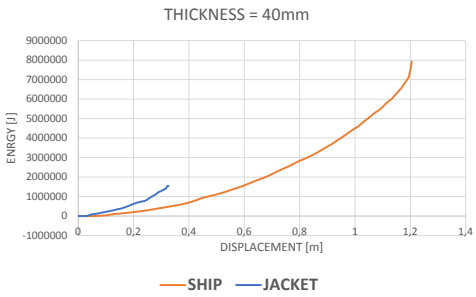


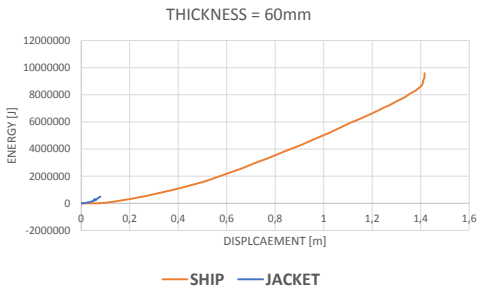












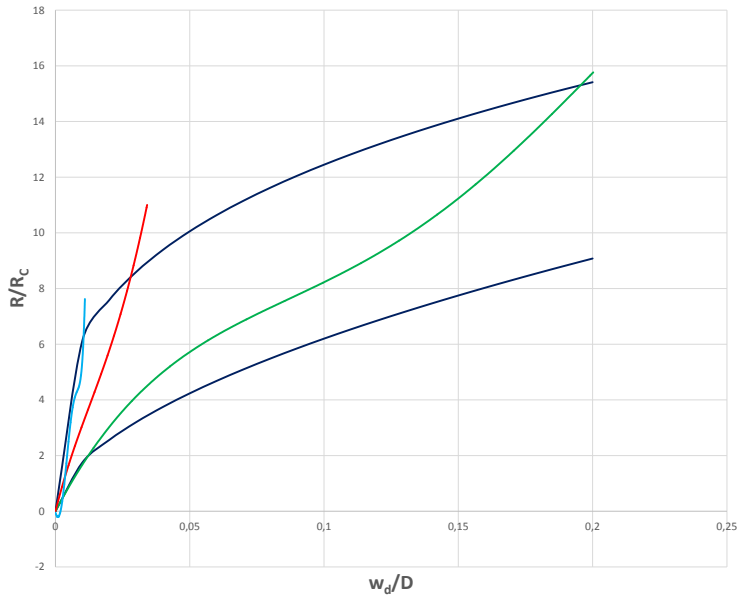
40mm jacket leg, jacket dissipated 16%. Shared Energy Design. 77% Leg.

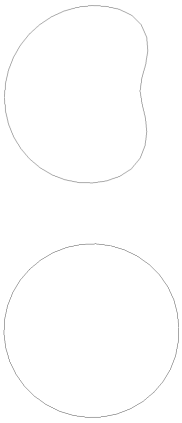
50mm jacket, the jacket dissipated 7%. Shared Energy Design. 58% Leg.

60mm jacket, the jacket dissipated 4%. Close to Strength Design. 50% Leg.

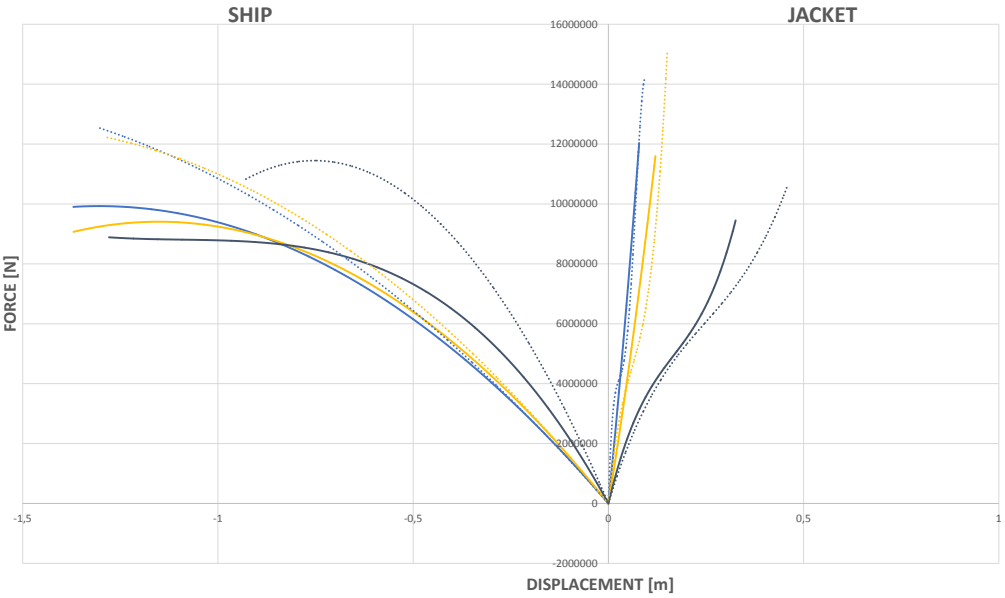
STRUCTURAL MEMBER	ENERGY ABSORBED %
DECK PLATES	30
DECK STIFFENERS	24.13
CENTER GIRDER	20.32
HULL SHELL	14.89
SHELL LONGITUDINALS	12.93
FRAMES	1.8
WEB FRAMES	0.65

RESISTANCE TO LOCAL INDENTATION - COMPARISON TO NORSOK CODE





COMPARISON BETWEEN 2 IMPACT LOCATIONS



DOTTED LINE = IMPACT LOCATION CLOSER TO LEG BOTTOM

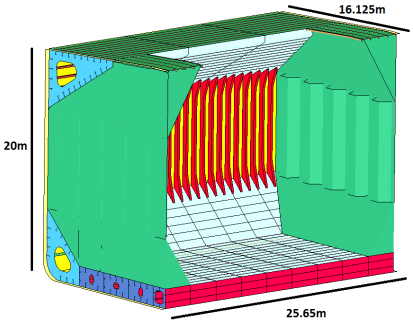
SOLID LINES = IMPACT LOCATION FURTHER AWAY FROM LEG BOTTOM

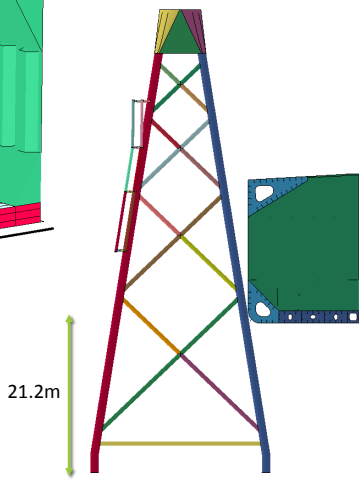
Poly. (Thickness=50mm)

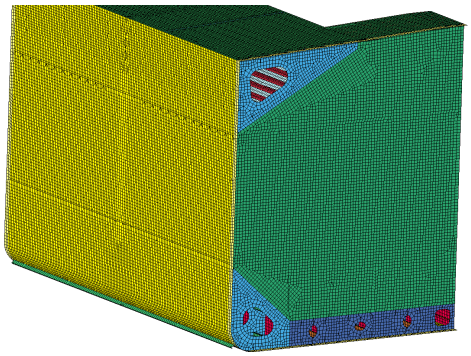
Poly. (Thickness=40mm)

Poly. (Thickness=60mm)

7. BULK CARRIER STRUCTURE

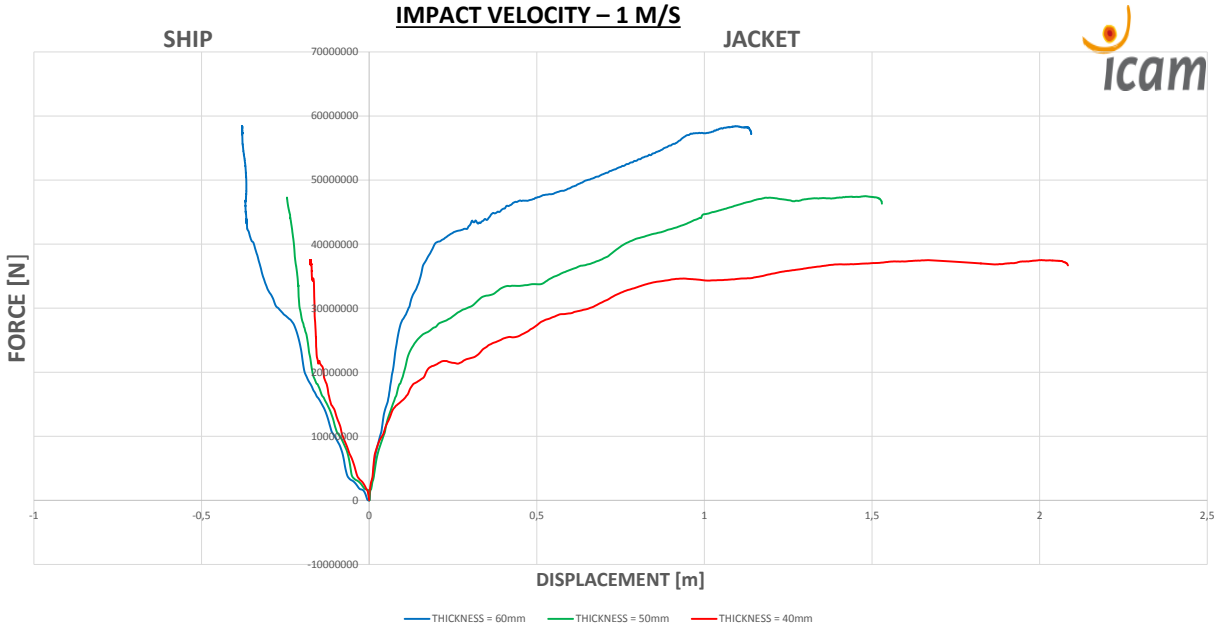


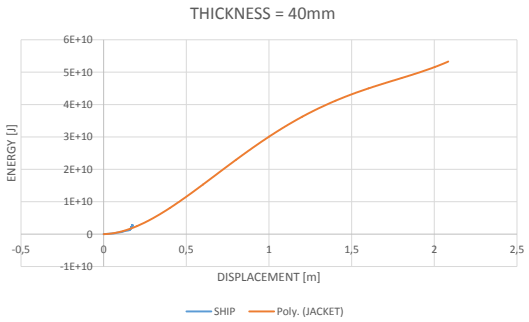


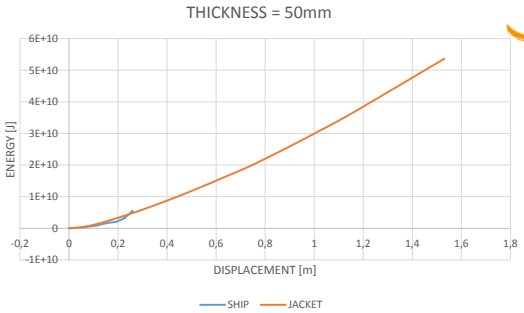


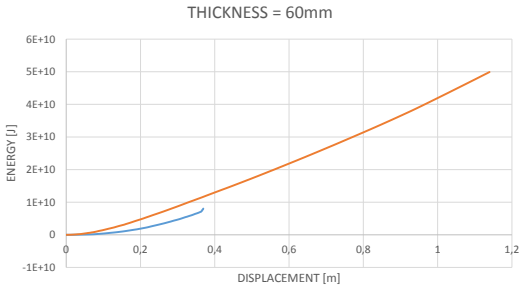
SHIP PARTICULARS	
Length, OA	224.9m
Depth, MLD	20m
Breadth, MLD	32.25m
Double Bottom Height	1.7m
Draft, Scantling	14.15m
Scantling Displacement	88000 T

IMPACT VELOCITY – 1 M/S









40mm leg, the jacket dissipated 90%. Close to ductile Design.

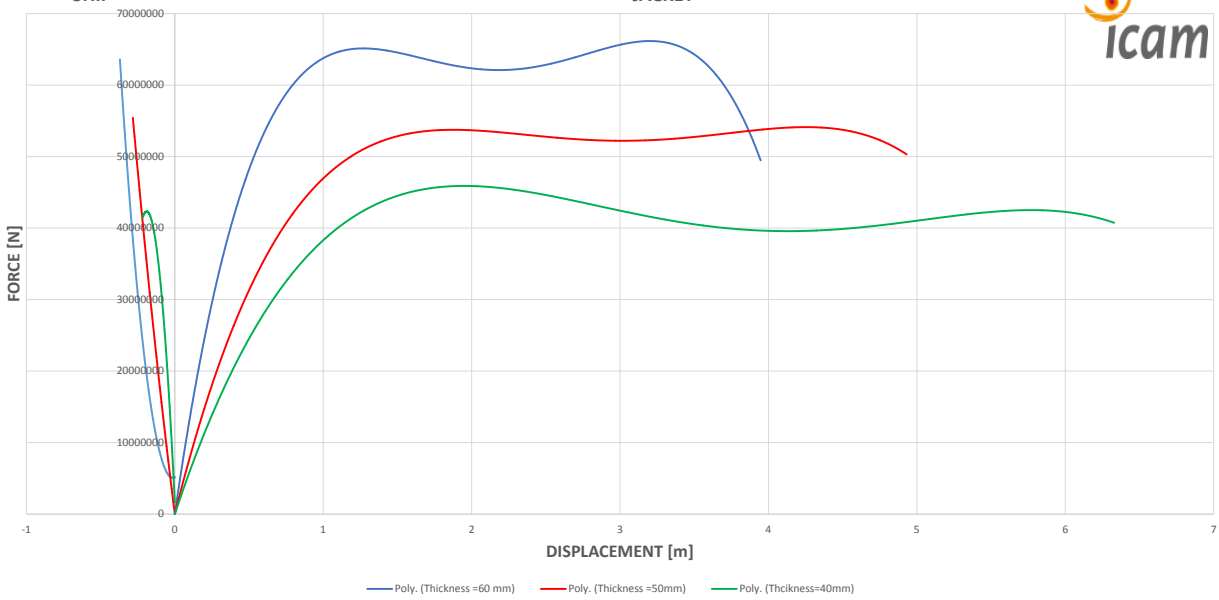
50mm leg, the jacket dissipated 87%. Close to ductile Design.

60mm jacket leg, the jacket dissipated 80% of the. Shared Energy Design.

STRUCTURAL MEMBER	ENERGY ABSORBED %
HULL SHELL	44
HOPPER TANK LONGITUDINALS	30
WEB FRAMES	24
OTHER STRUCTURAL MEMBERS	2

IMPACT VELOCITY 2 M/S

SHIP JACKET



CONCLUSIONS

- **H-BRACE Parametric Study:**
  - Important to consider the effect of surrounding member, increasing thickness leads to increasing strength, increase in diameter leads to overall increase in strength with increasing susceptibility to local indentation.
  - In the initial stage of impact, the total deformation of the brace is totally dependent on the local indentation of the brace.
- **OSV Bow Collision:**
  - Majority of energy absorbed by the ship. Conservative to consider a rigid ship.
  - Comparison with NORSOK code suggests it is conservative in nature.
  - When impact location, is closer to the seabed, results suggest that the jacket strength is slightly reduced.
- **Bulk Carrier Side Collision:**
  - Majority of energy absorbed by the jacket. Realistic to consider a rigid ship.
  - When impact location, is closer to the seabed, results suggest that the jacket strength is slightly reduced.
- **All the results & data will aid in the validation of the super-element based analytical tool**

FURTHER WORK

- **We will publish a paper in the Journal of Marine Science and Technology - " *H. Le Sourne, A. Barrera, J.B. Maliakel – Numerical crashworthiness analysis of an offshore wind turbine jacket impacted by a ship* "**
- Post collision analysis with global loads would yield complete picture.
- An analysis which includes the soil stiffness would provide further more accurate insights into the overall jacket behavior.
- Windfarm support vessels constantly service the windfarm and a collision analysis of the same would also be advisable.
- Offshore windfarm installation vessels and installation barges may also pose a significant threat to the jacket structure, since it functions in close proximity to jacket structures, a collision analysis could be relevant.