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EMship Advanced Design

Title: **Torsional hull girder response of containerships – feasible with Cargo Hold models?**

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Supervisors: Dr. Jörg Rörup, Germanischer Lloyd
Prof. Patrick Kaeding, University of Rostock

Torsional hull girder response of containerships – feasible with Cargo Hold models?

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- 1. INTRODUCTION
- 2. CARGO HOLD FE MODEL ANALYSIS IN RULES
- 3. WORK WITH THE SMALL CONTAINERSHIP
- 4. WORK WITH THE BIG CONTAINERSHIP
- 5. CONCLUSIONS

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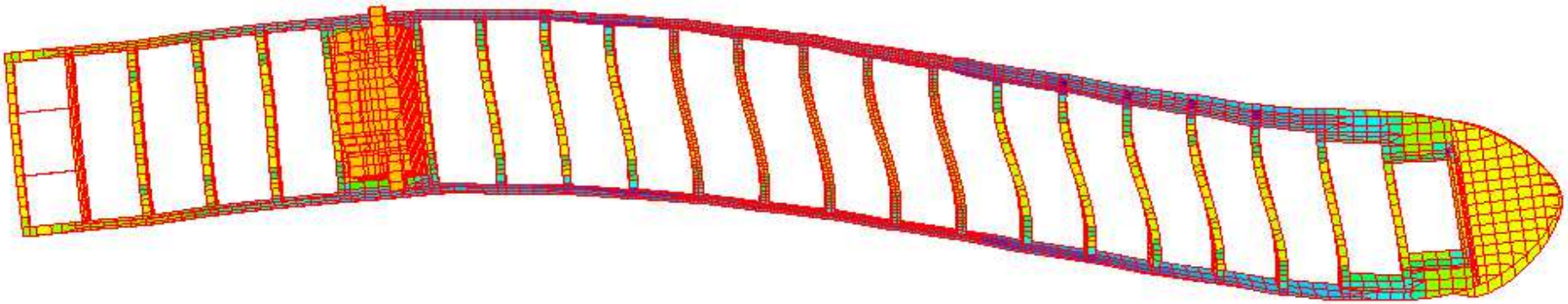
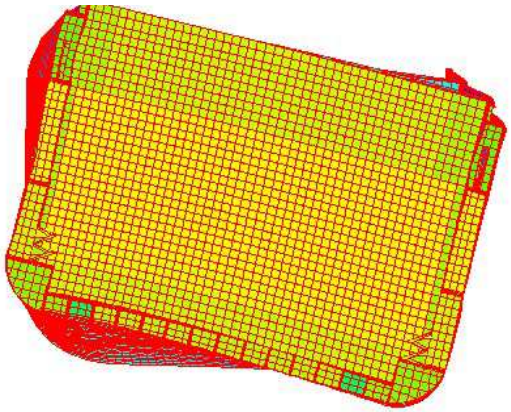
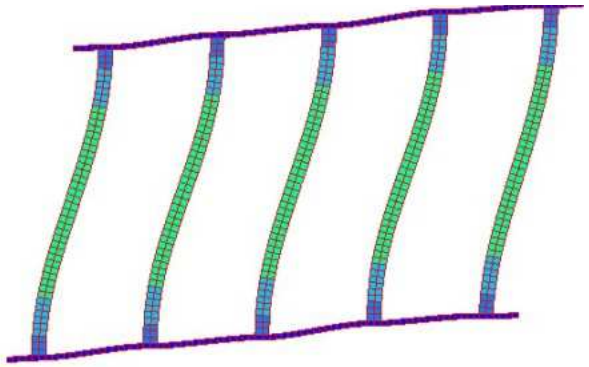
- Objectives: Global strength FE analysis of Cargo Hold structures in case of oblique sea and beam sea

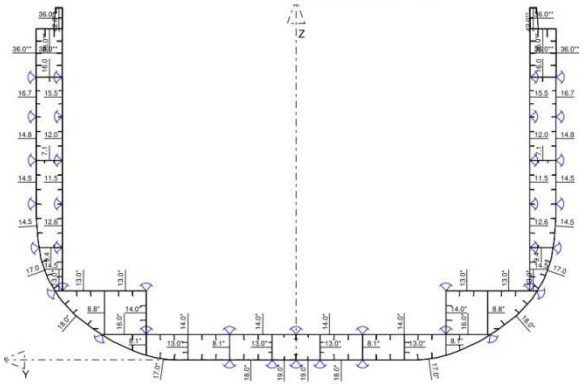




Twisting effect



Warping effect



Midship section of containership

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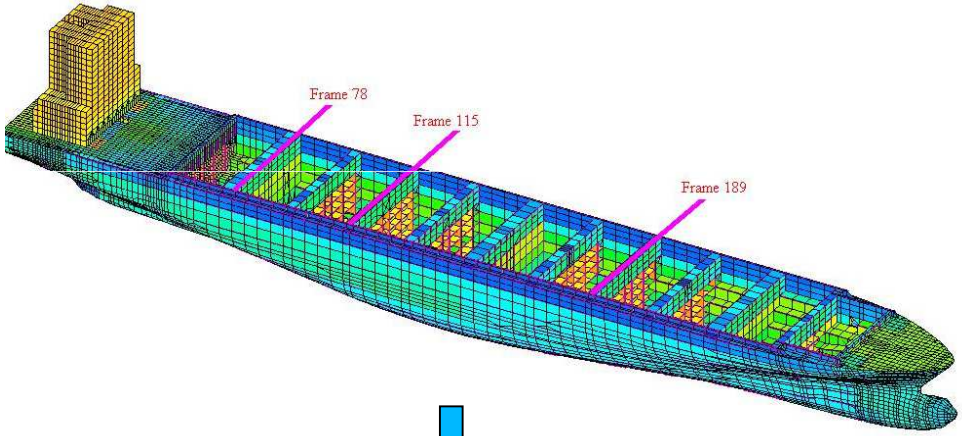
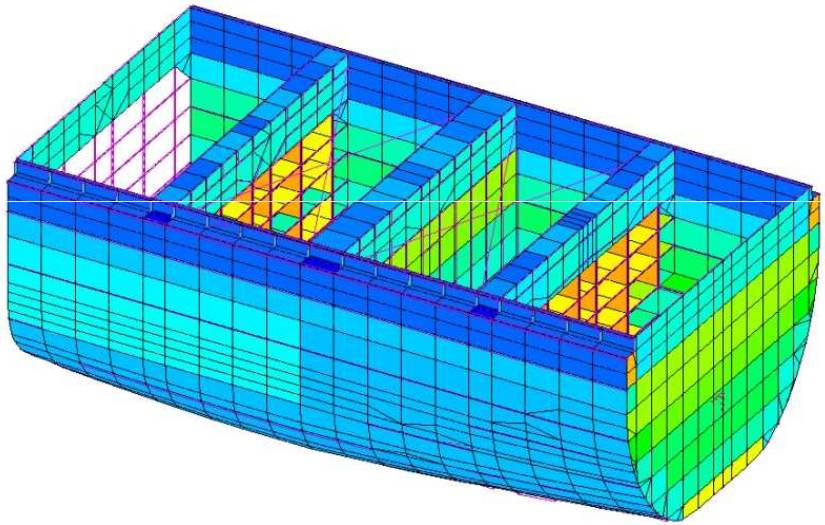
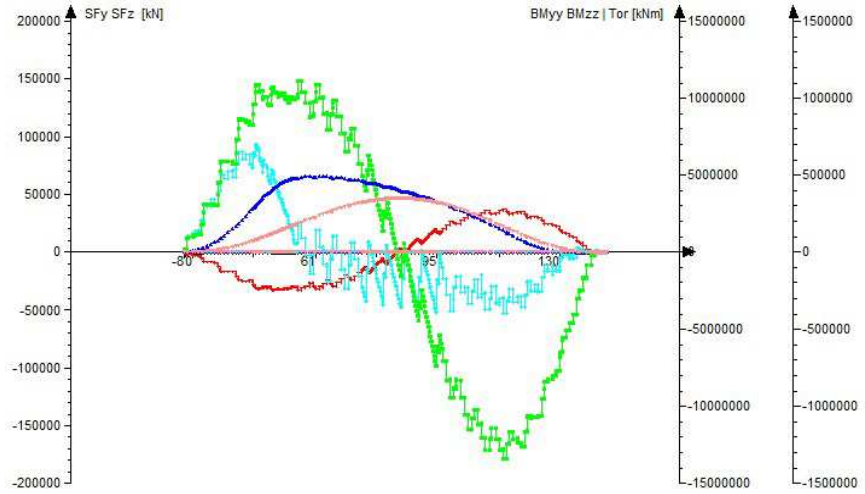
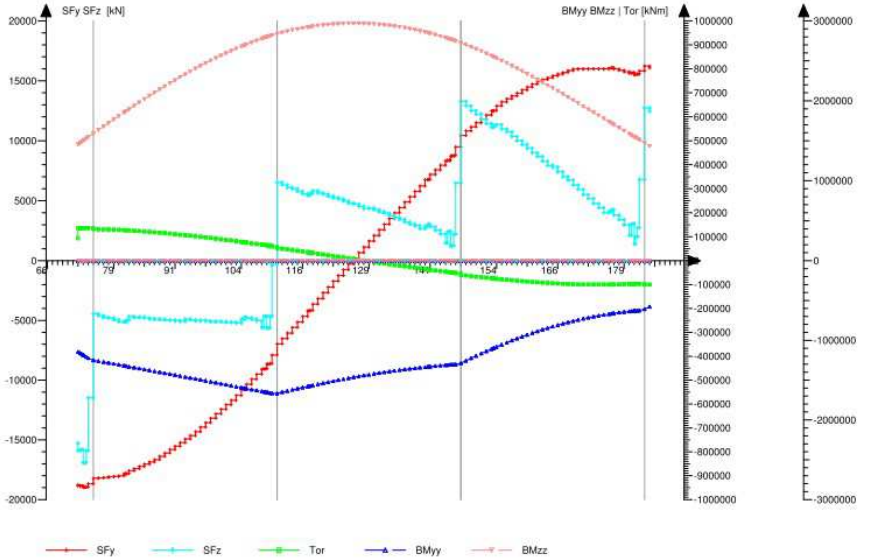
1. INTRODUCTION

➢ Cargo Hold model



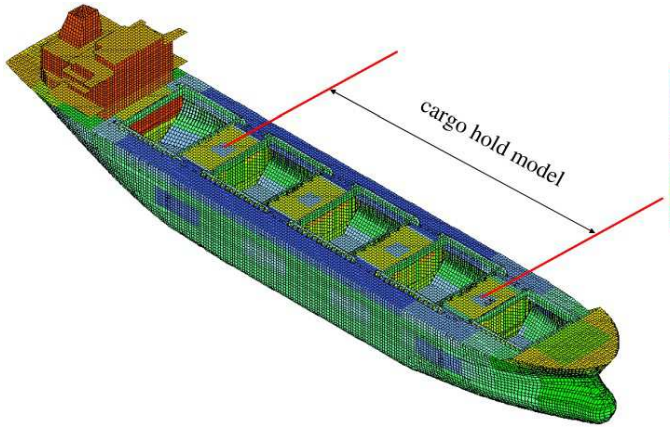


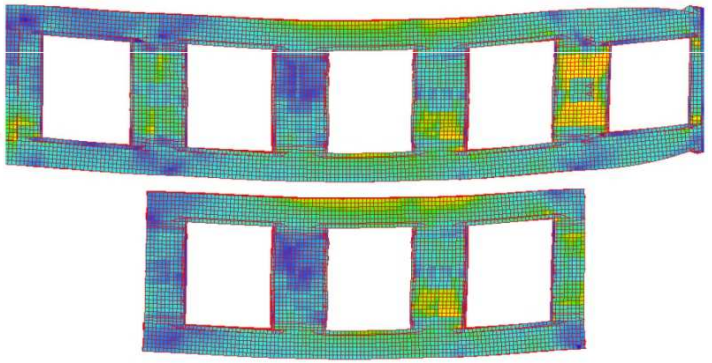




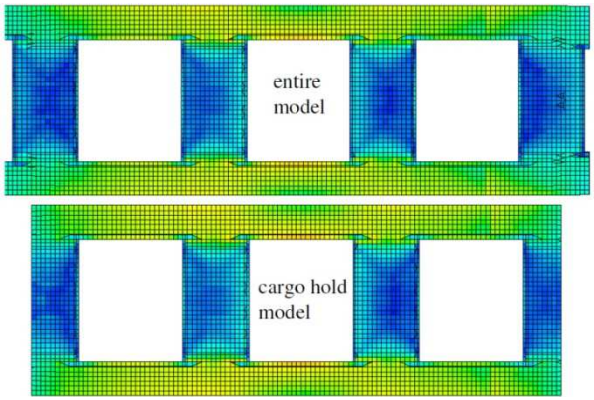
1. INTRODUCTION

- Cargo Hold FE model in future HCSR (Harmonized Common Structural Rules) for bulk carriers and tankers

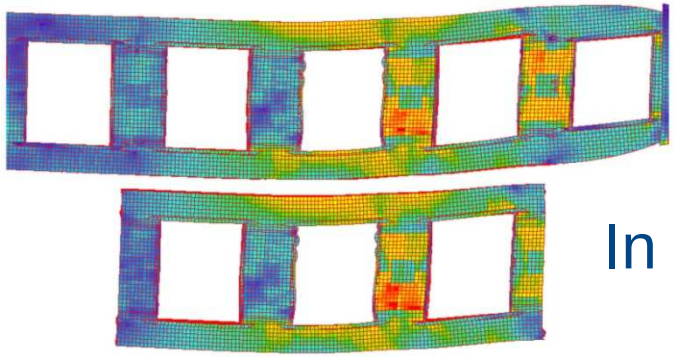




In oblique sea



In vertical bending

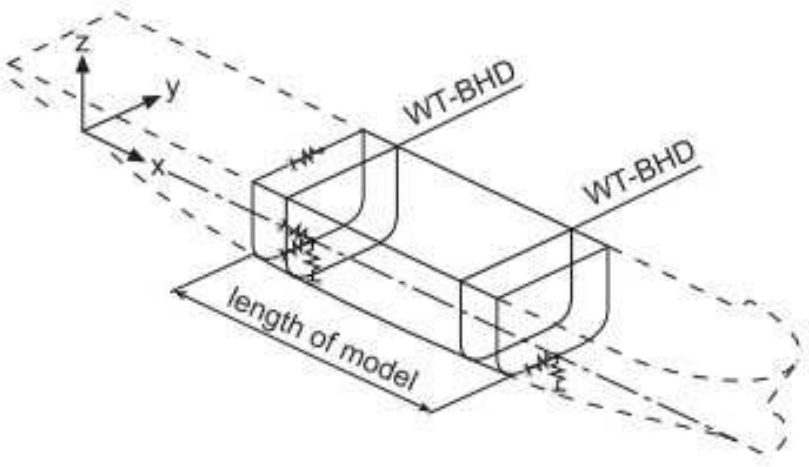


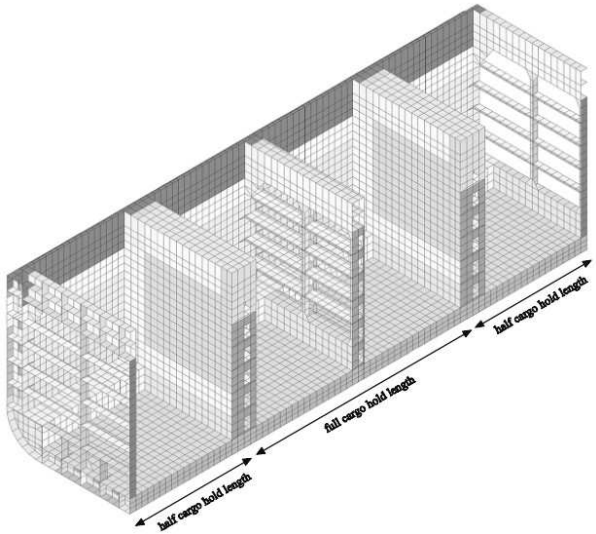
In roll condition

Source: Dr. Rörup's work

2. CARGO HOLD MODEL IN RULES

➢ GL RULES 2011





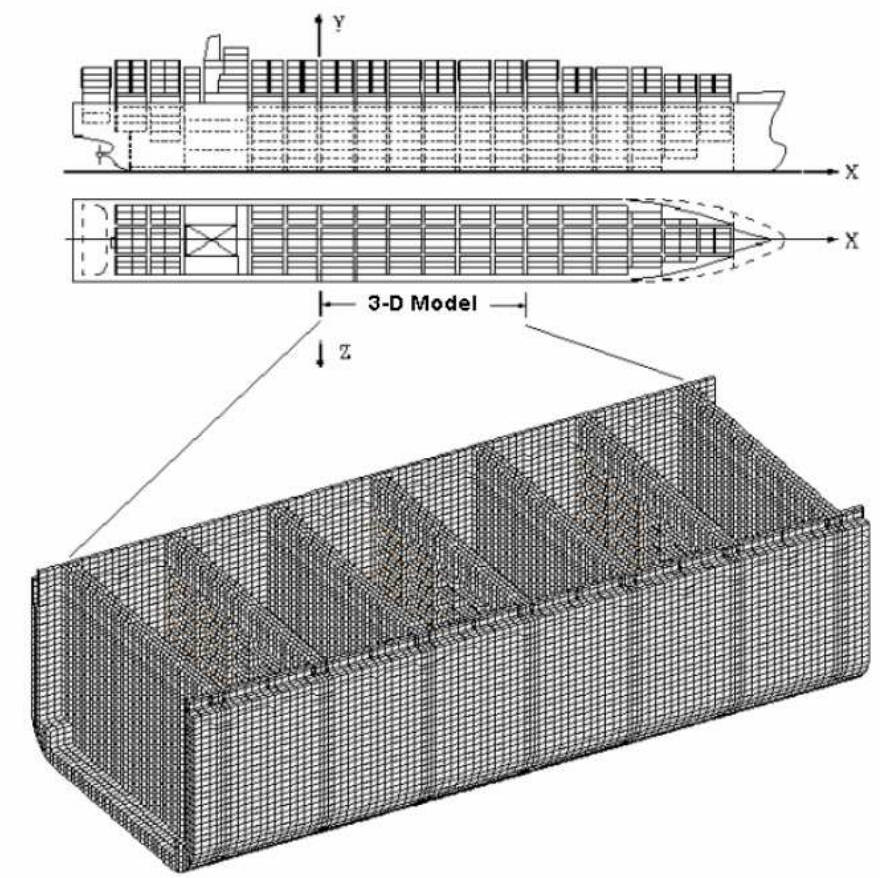
Location	Translation			Rotation		
	δ_x	δ_y	δ_z	θ_x	θ_y	θ_z
Aft End						
Intersection of Centerline and outer bottom	Fix	Fix	Fix	-	-	-
Intersection of Centerline and deck	-	Fix	-	-	-	-
Fore End						
Intersection of Centerline and outer bottom	-	Fix	Fix	-	-	-
Where: - no constraint applied (free)						

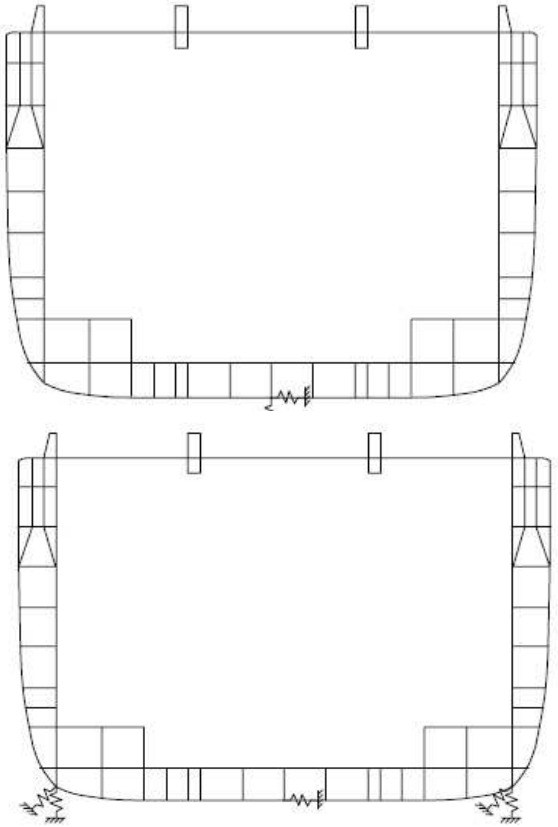
Source: GL rules

➢ ABS RULES

Constraint beams: $I_{xx} = I_{yy} = I_{zz} = 1/3\ I_{midship\ sections}$

$A_x = A_y = A_z = 1/10\ A_{bottom\ plate}$

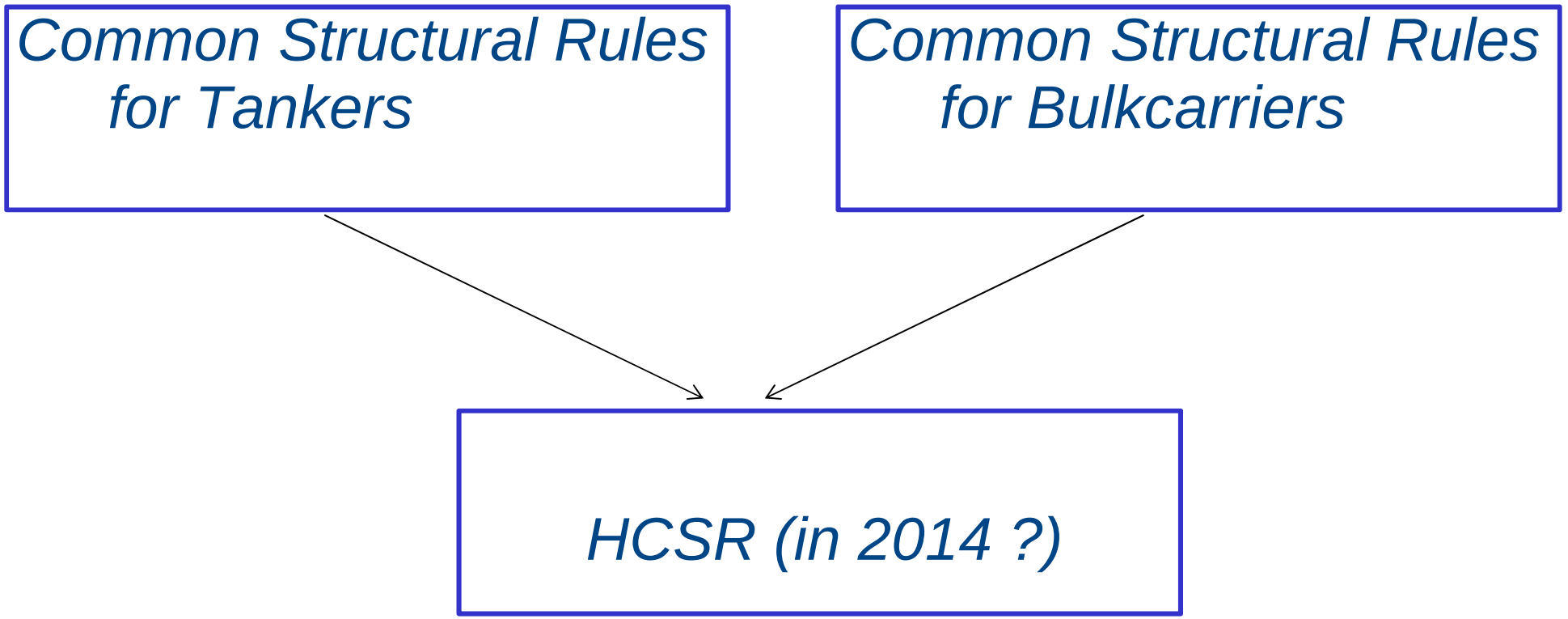




Source: ABS rules

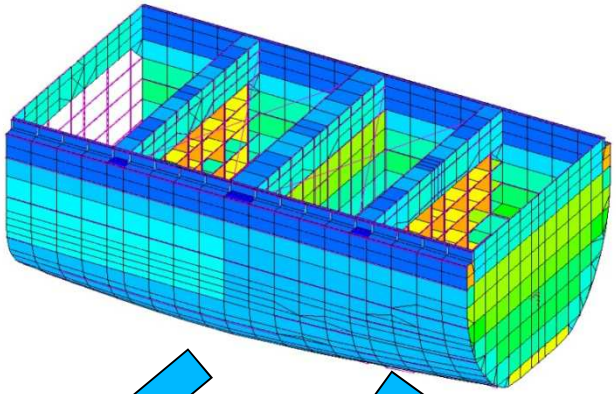
2. CARGO HOLD MODEL IN RULES

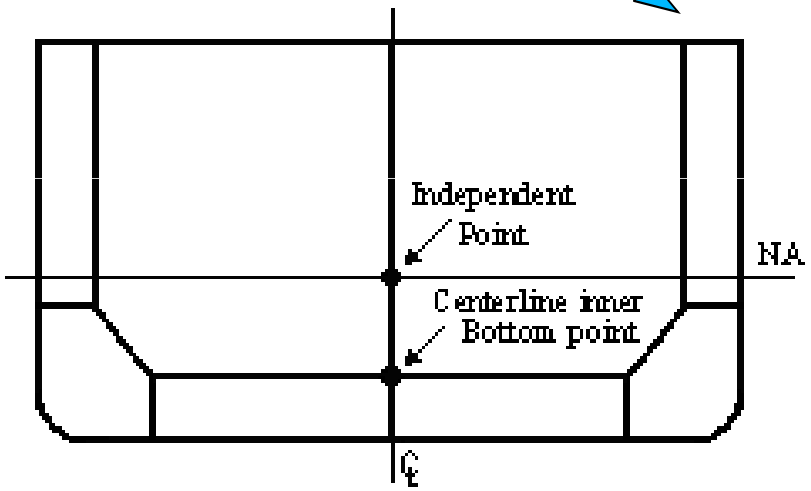
- HCSR RULES (Harmonized Common Structural Rules)

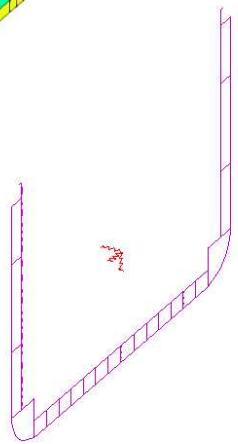


➢ Cargo Hold Model in HCSR Rules

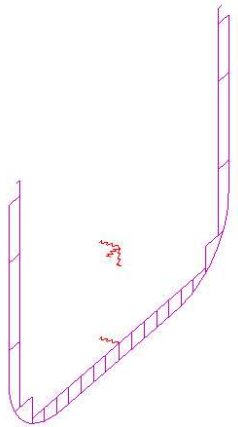
Constraint beams and independent points







Constraint beams



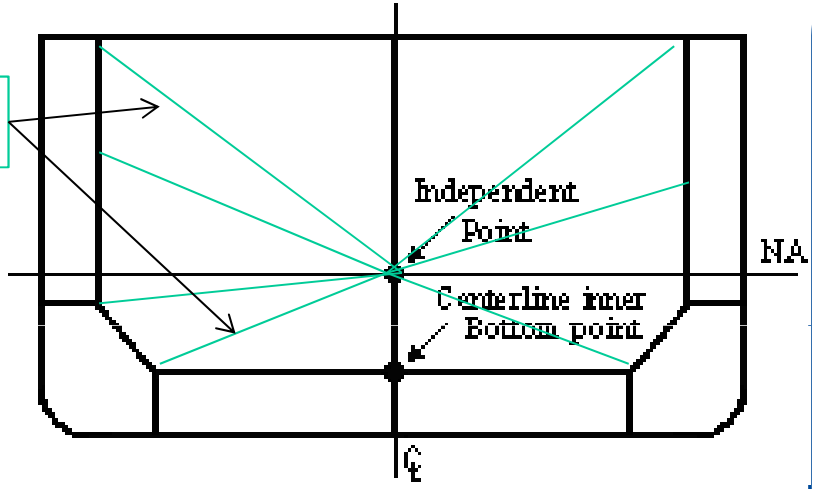
2. CARGO HOLD MODEL IN RULES

➢ HCSR RULES

Constraint beams:

$$I_{xx} = I_{yy} = I_{zz} = 1/25\ I_{end\ cross\ section}$$

$$A_x = A_y = A_z = 1/10\ A_{bottom\ plate}$$



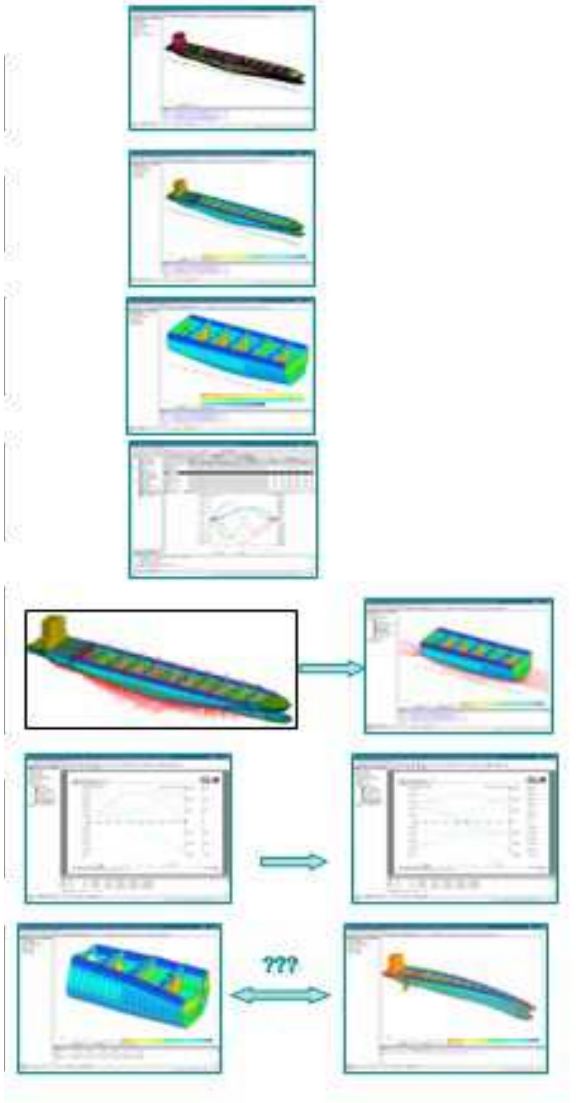
Location	Translation			Rotation		
	δ_x	δ_y	δ_z	θ_x	θ_y	θ_z
Aft End						
Cross section	-	Rigid link	Rigid link	Rigid link	-	-
Independent point	-	Fix	Fix	M_{T-end}	-	-
Fore End						
Cross section	-	Rigid link	Rigid link	Rigid link	-	-
Independent point	-	Fix	Fix	Fix		
Intersection of Centerline and inner bottom	Fix	-	-	-	-	-

Source: HCSR rules

3. WORK WITH THE SMALL CONTAINERSHIP

➢ GENERAL WORKING PROCEDURE

1. GEOMETRIC MODEL IN POSEIDON
↓
2. ENTIRE FE MODEL IN GL FRAME
↓
3. CARGO HOLD FE MODEL IN GL FRAME
↓
4. LOAD GENERATION OF THE ENTIRE FE MODEL IN SHIPLOAD
↓
5. LOAD TRANSFER FROM THE ENTIRE FE MODEL TO THE CARGO HOLD FE MODEL
↓
6. ADJUSTMENT OF THE FORCES IN THE CARGO HOLD FE MODEL
↓
7. COMPARISON BETWEEN THE ENTIRE FE AND CARGO HOLD FE MODEL (Deflexion and warping stress)



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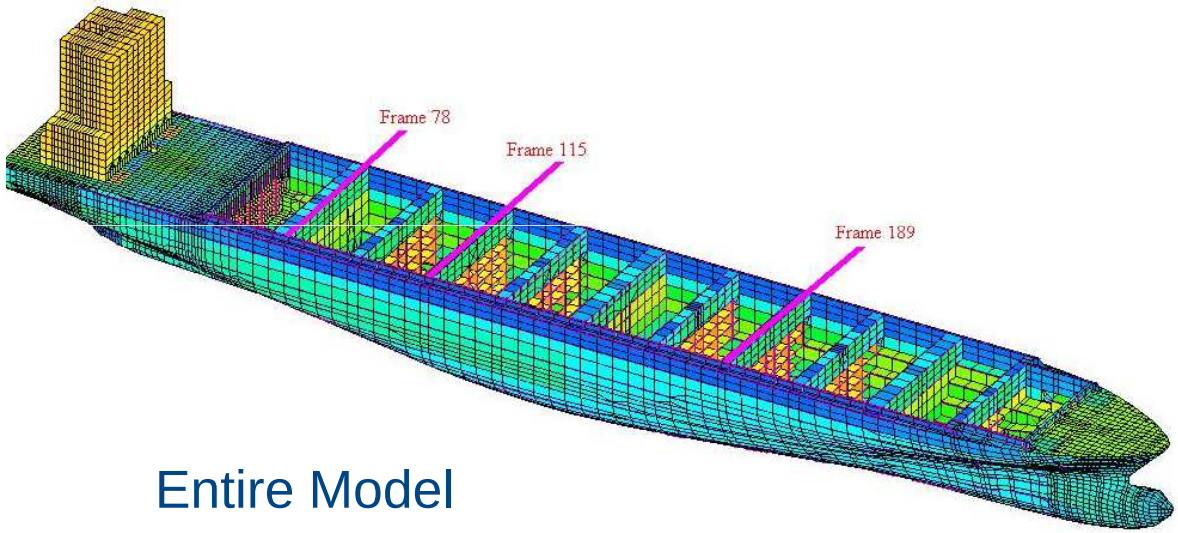
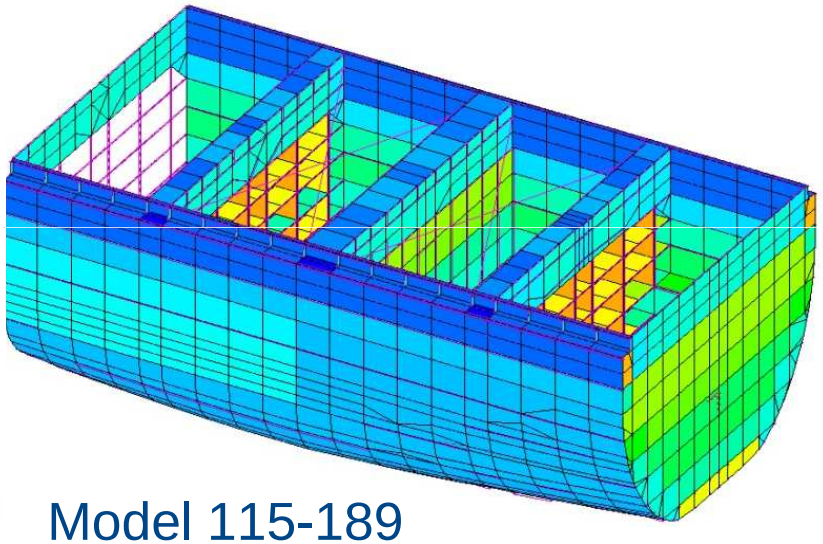
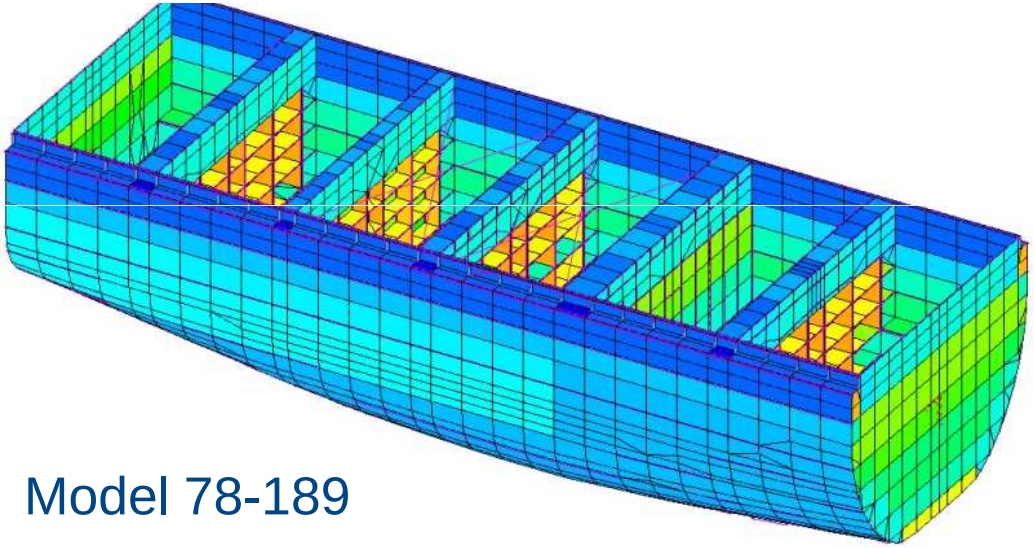
➢ TWO CARGO HOLD FE MODELS



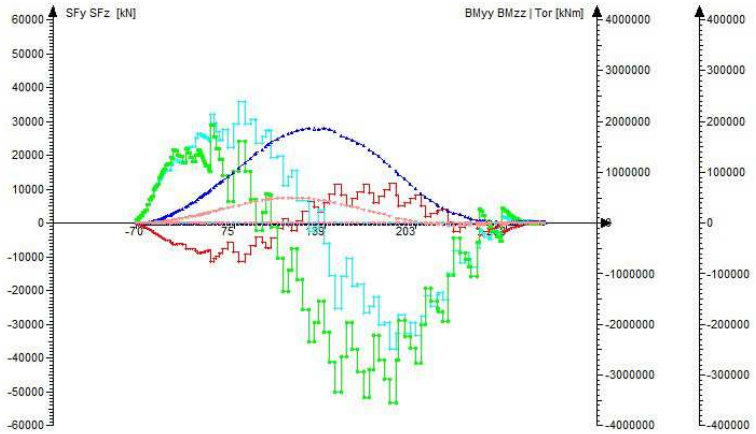
Entire Model



Model 115-189



Model 78-189



Loadcase 7: *A9 -tor m*

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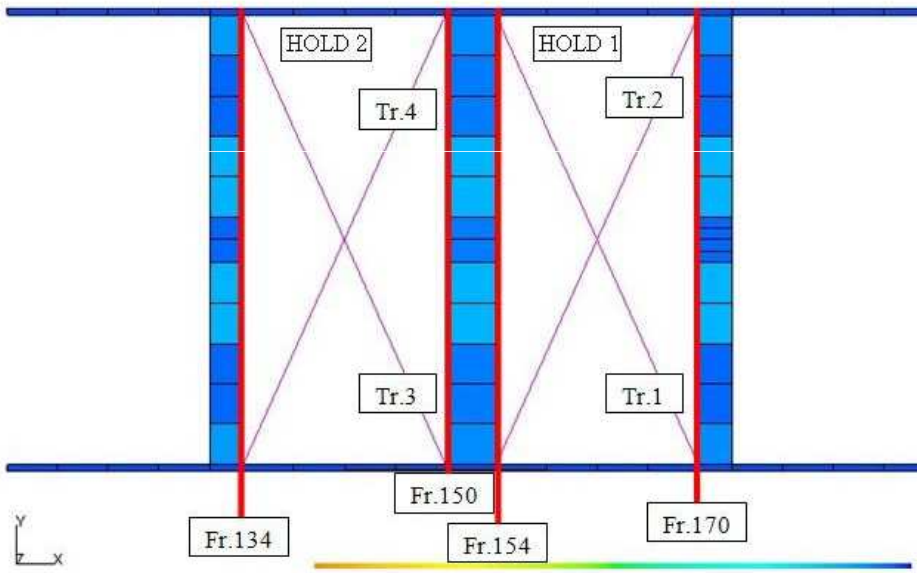
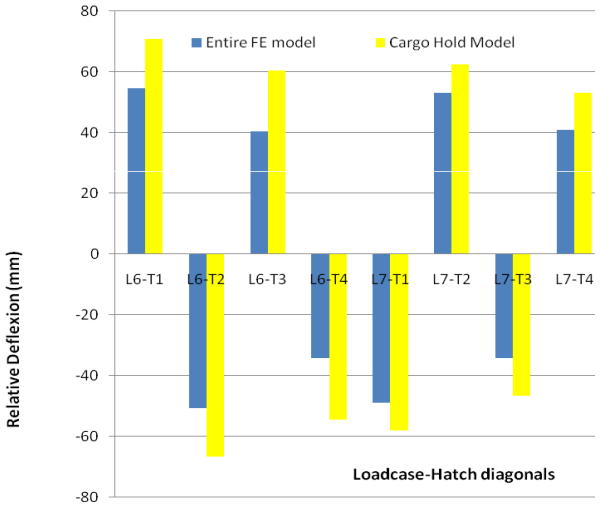
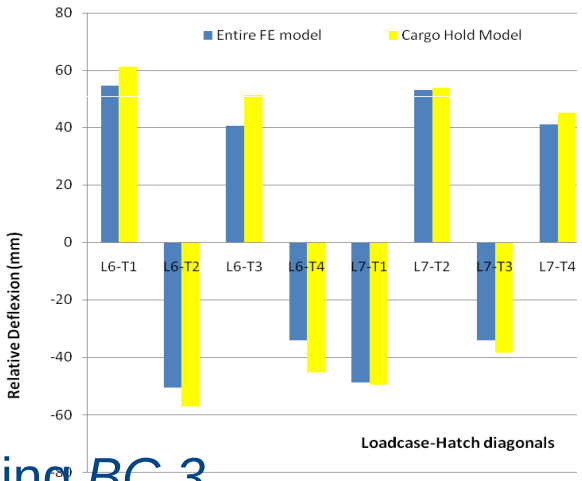
➢ BOUNDARY CONDITION WITH 1 TYPE OF CONSTRAINT BEAMS IN 1 SECTION

		Initial BC	*BC 3*
Aft part (Section 115)	A (m^2)	A_{a0} = 0.023	2 x A_{a0}
	I (m^4)	I_{a0} = 7.794	2 x I_{a0}
Fore part (Section 189)	A (m^2)	A_{f0} = 0.015	2 x A_{f0}
	I (m^4)	I_{f0} = 7.159	2 x I_{f0}
BC: Boundary Condition			





Using *Initial BC* (LC 7: *A9 -tor m*)



Using *BC 3*

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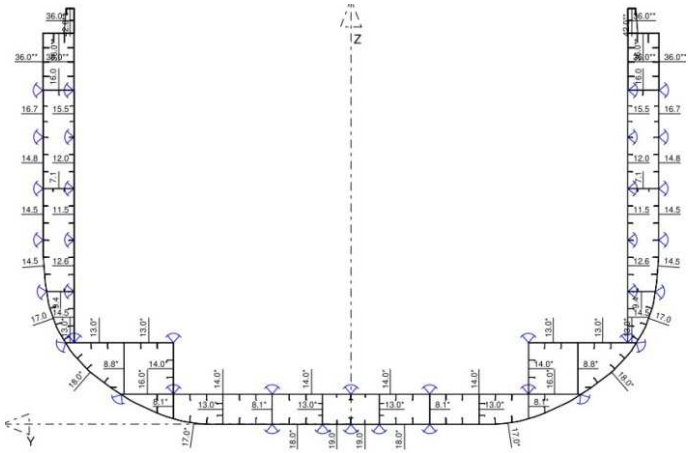
➢ BOUNDARY CONDITION WITH DIFFERENT TYPES OF CONSTRAINT BEAMS IN 1 SECTION

- Plates:

First group: small thickness of about 8mm

Second group: thickness of about 16 mm

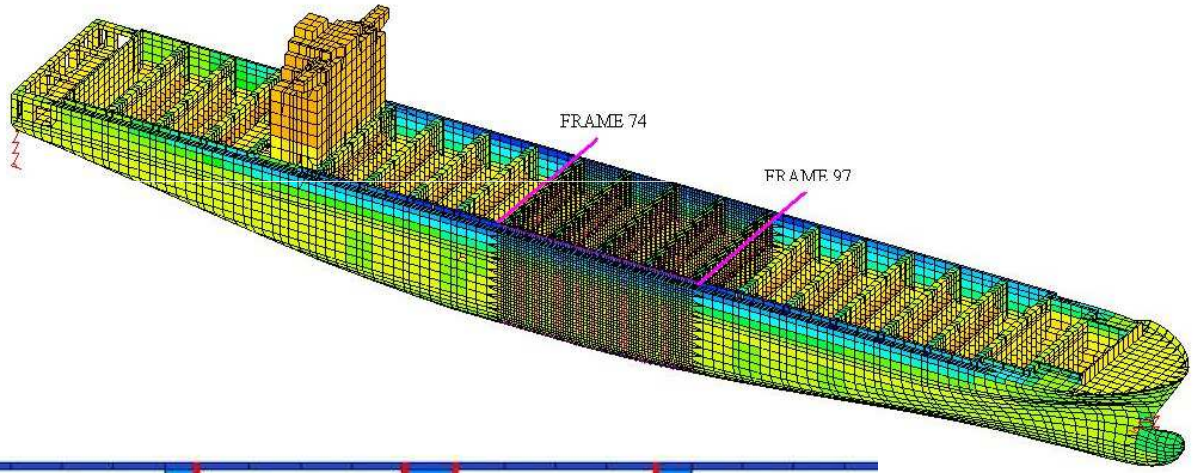
Third group: thickness of 36 mm

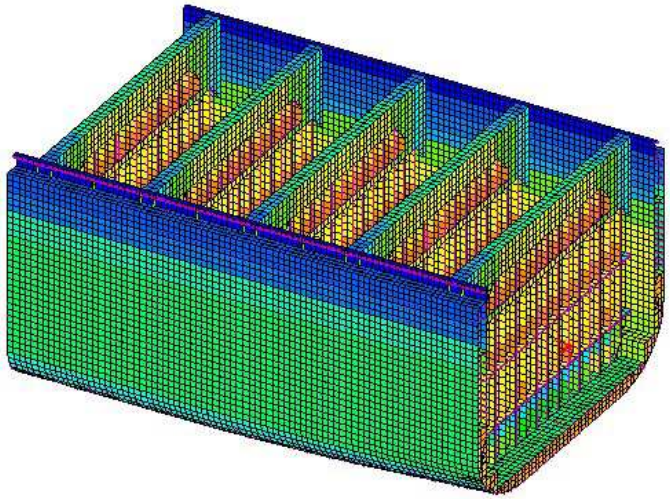


	Relative Deflexion			
	Entire FE model	Cargo Hold model		
		1BC/section	Linear	Exponential
	mm	%	%	%
L7-T1	-48.8	**2**	**-1**	**-3**
L7-T2	53.3	1	-1	-3
L7-T3	-34.3	**12**	**10**	**7**
L7-T4	41.1	10	7	5

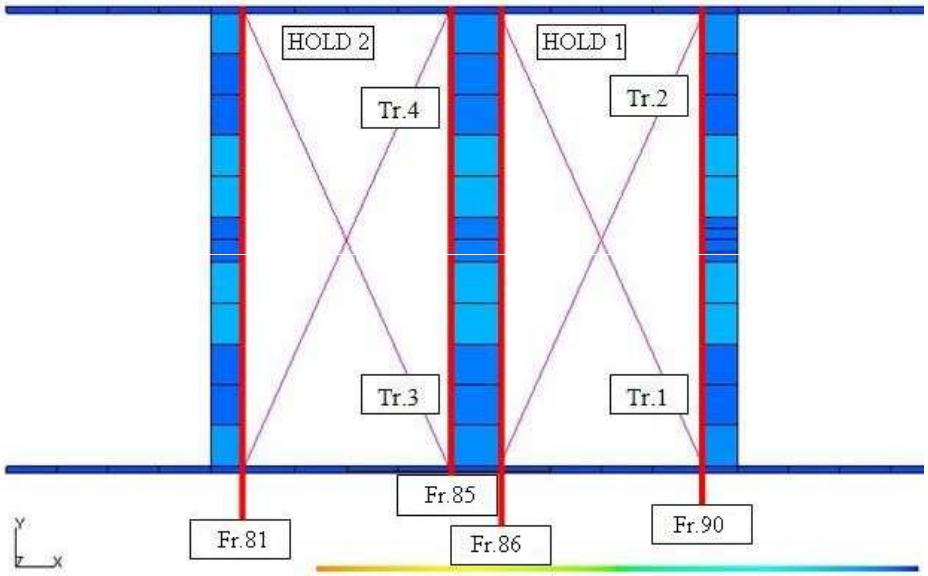
4. WORK WITH THE BIG CONTAINERSHIP

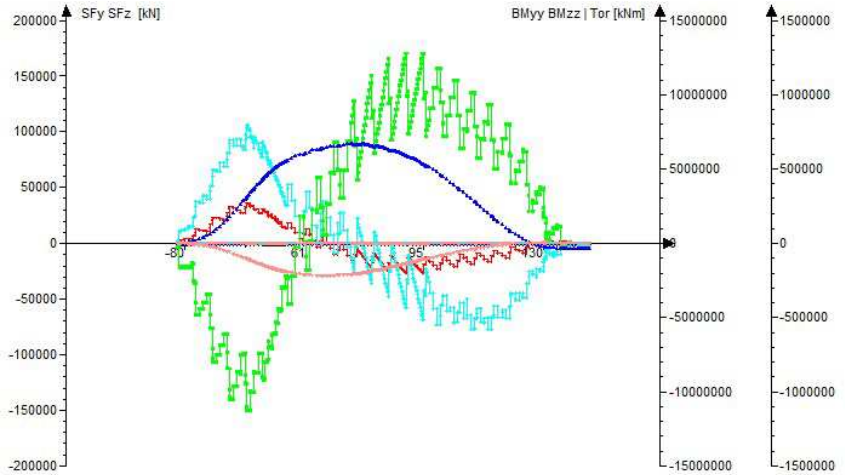
➢ CARGO HOLD FE MODEL





Model 74-97





Loadcase 6: *A9 +tor m*

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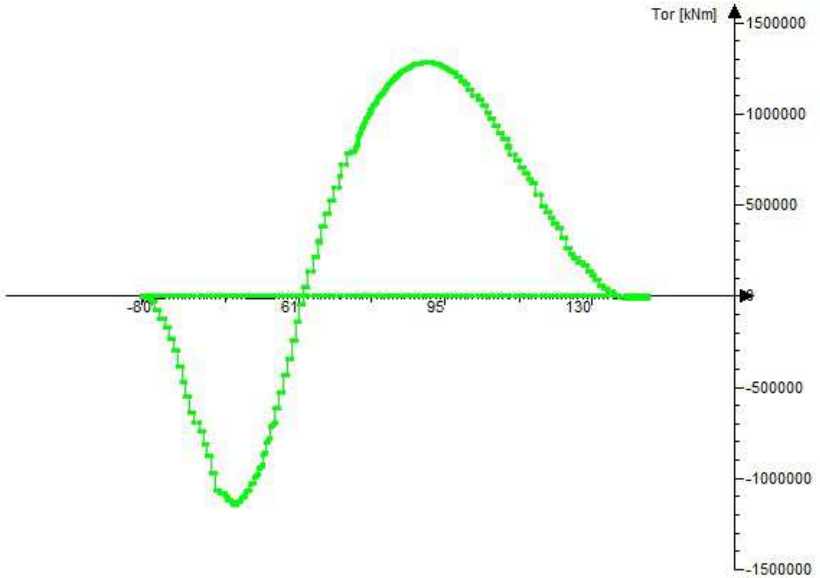
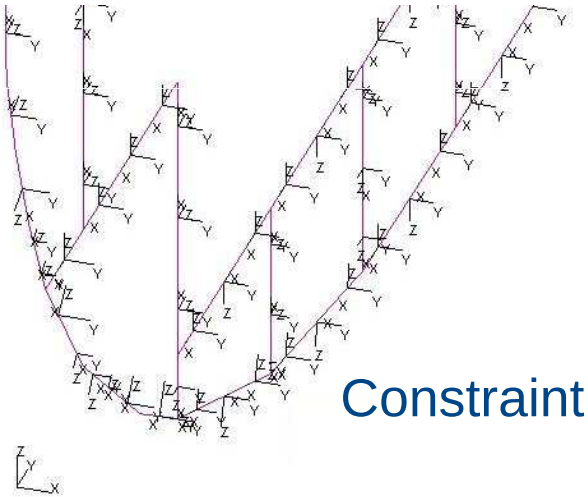
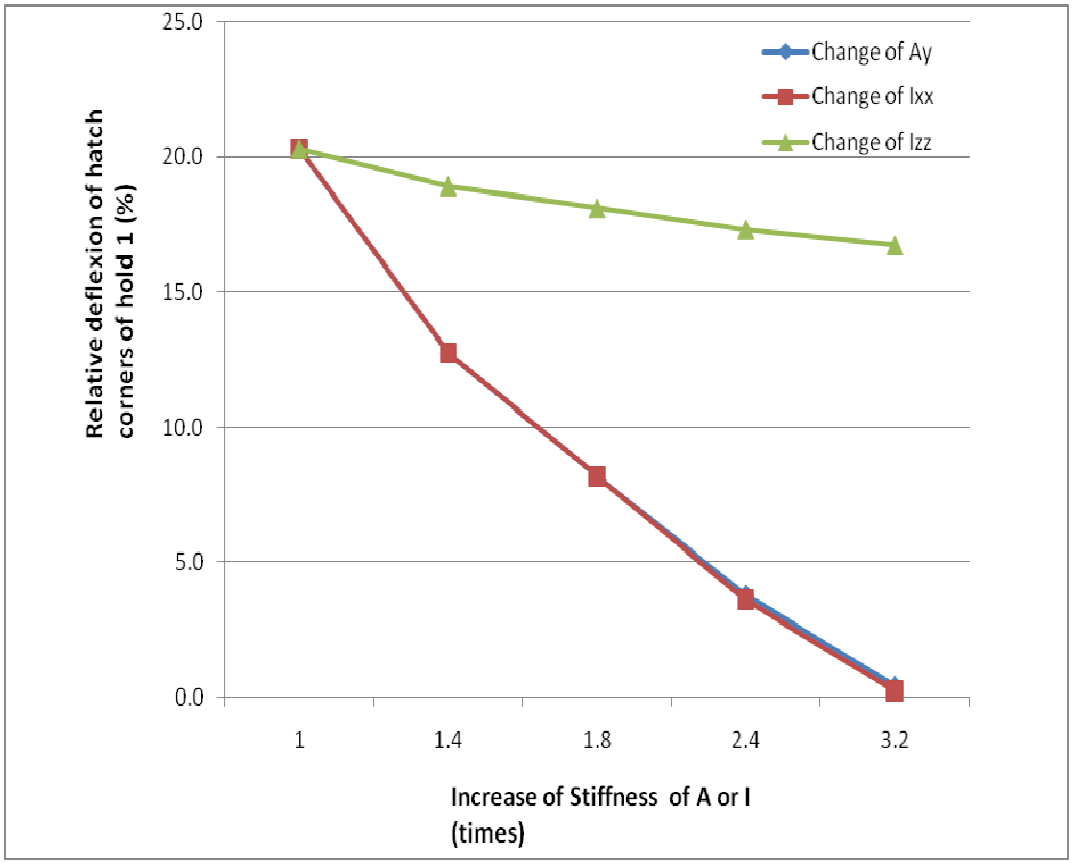
➢ INFLUENCE OF EACH CONSTRAINT BEAMS' PARAMETER ON FE MODEL'S STIFFNESS





Constraint beams



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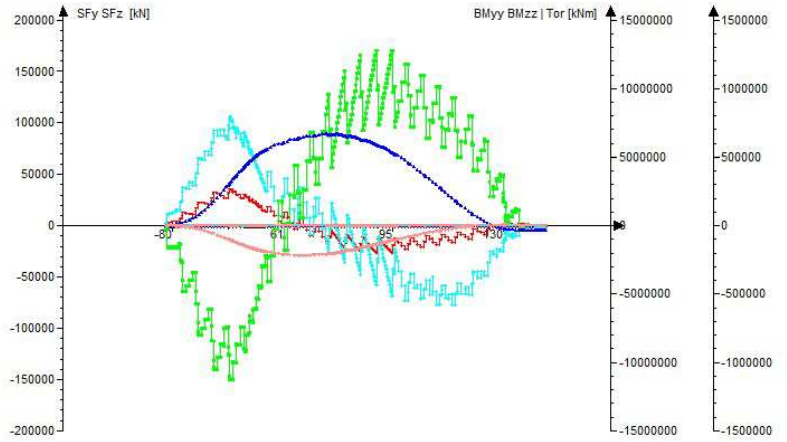
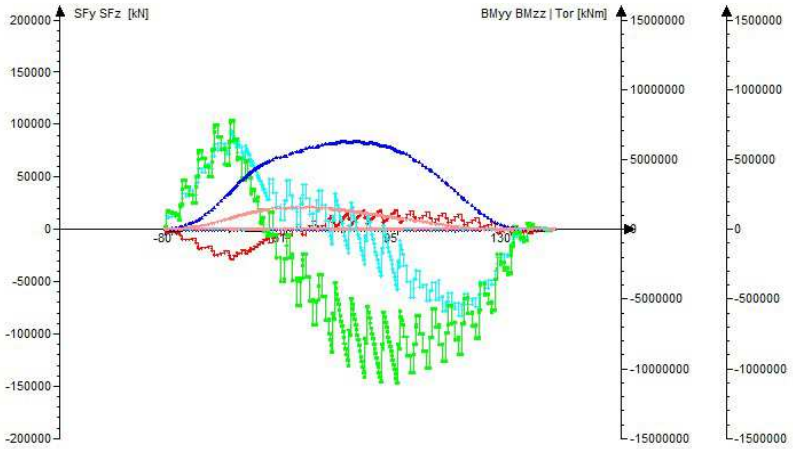
4. WORK WITH THE BIG CONTAINERSHIP

➢ MODEL'S STIFFNESS IN DIFFERENT BOUNDARY CONDITIONS

	Relative Deflexion		
	Entire FE	Cargo Hold model	
		Initial	(A_y,I_{xx}) 30% stiffer
	mm	%	%
L6-T1	94.0	9	**-1**
L6-T2	-87.0	10	**-1**
L6-T3	75.1	20	**7**
L6-T4	-67.4	22	**8**
L7-T1	-80.3	**0**	-10
L7-T2	87.4	**0**	-10
L7-T1	-63.1	**9**	-4
L7-T1	70.1	**8**	-4



Loadcase 6: *A9 +tor m*



Loadcase 7: *A9 -tor m*

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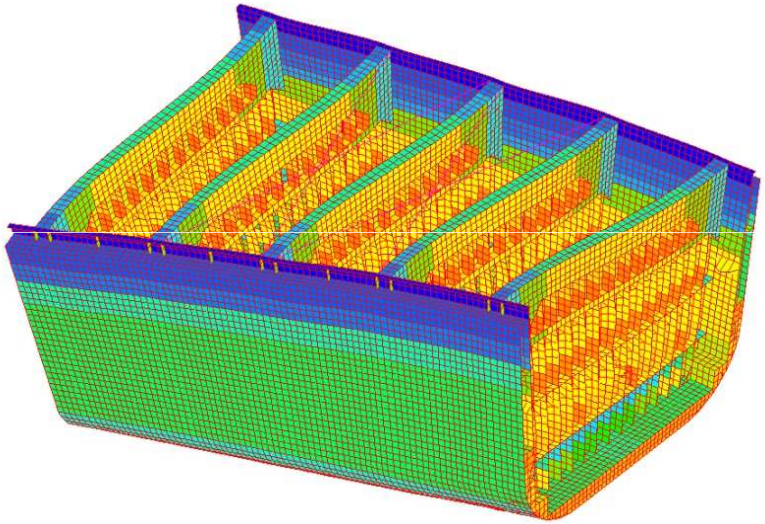
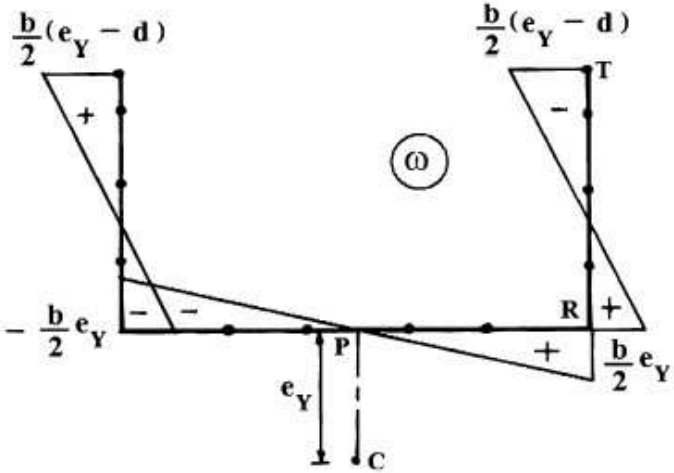
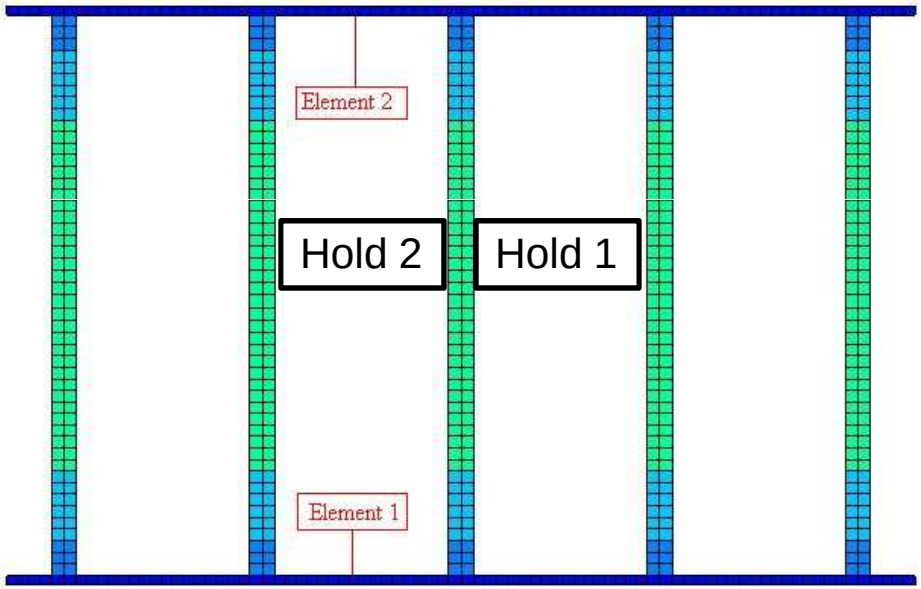
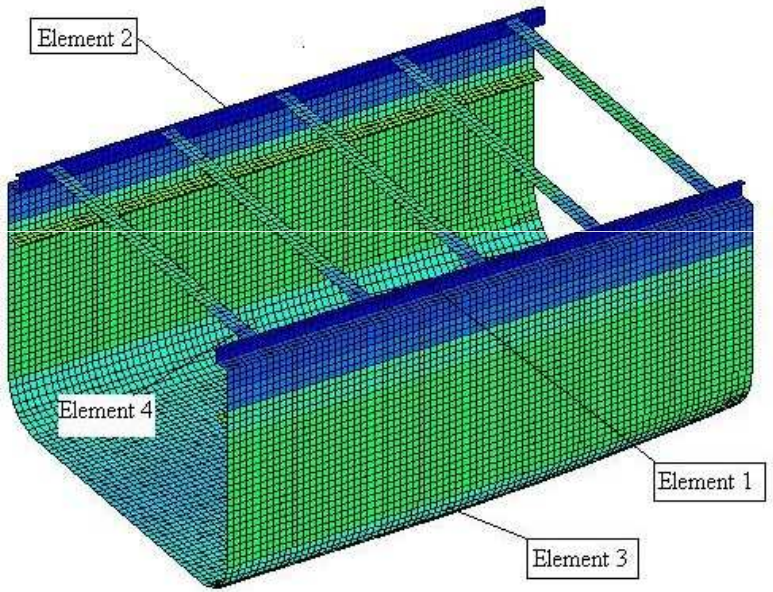
➢ WARPING STRESS IN THE CARGO HOLD MODEL









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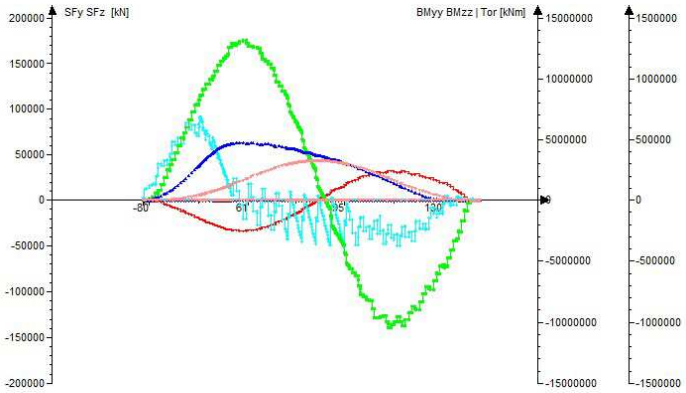
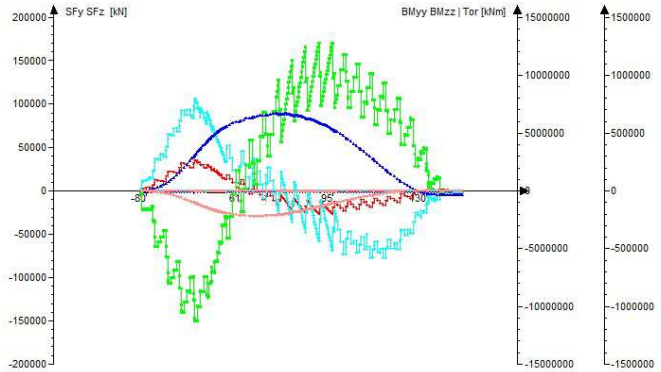
➢ WARPING STRESS IN THE CARGO HOLD MODEL

	Longitudinal stress σ_x (MPa)			
		Entire model	Cargo Hold model	
			Initial BC	(A_y,I_{xx}) 30% stiffer
A0 +tor a	Element 1	**97**	**59**	**59**
	Element 2	60	97	97
	Element 3	-138	-88	-87
	Element 4	25	-3	-3
A9 +tor m	Element 1	**108**	**138**	**137**
	Element 2	159	124	125
	Element 3	-134	-90	-90
	Element 4	-34	-53	-53



Loadcase *A0 +tor a*



Loadcase *A9 +tor m*

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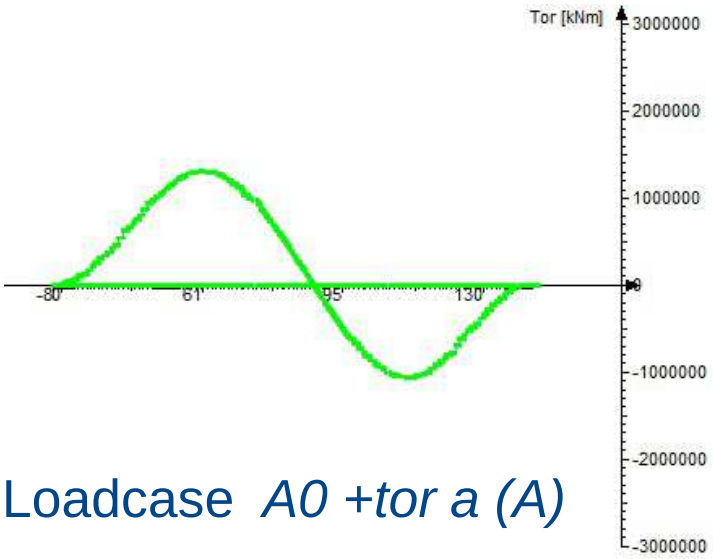
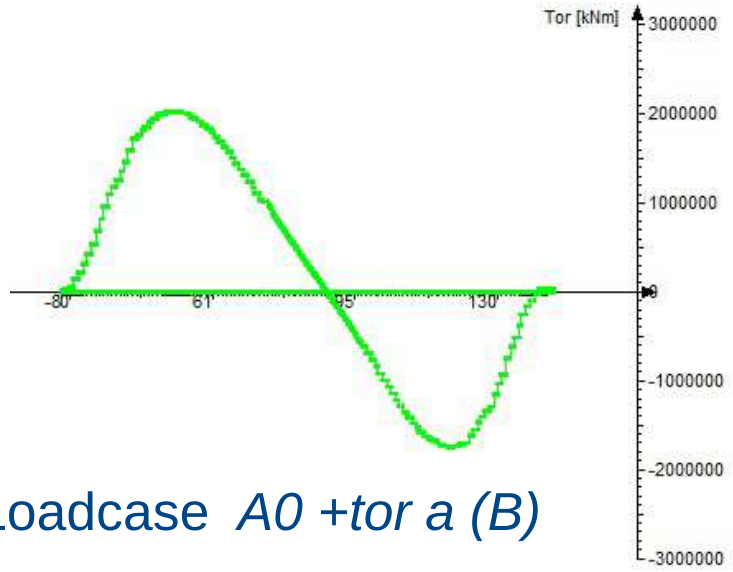
4. WORK WITH THE BIG CONTAINERSHIP

➢ INFLUENCE OF THE TORSION AT THE AFT AND FORE PART ON THE MIDSHIP'S STRUCTURE



Loadcase *A0 +tor a (A)*



Loadcase *A0 +tor a (B)*

	Deflexion (mm)		**Warping stress (MPa)**	
	Truss 1 (hold 1)	Truss 3 (hold 2)	Element 1	Element 2
A0 +tor a (A)	**-6**	8.5	**-69**	68.7
A0 +tor a (B)	**-18**	0.6	**-95**	95.4

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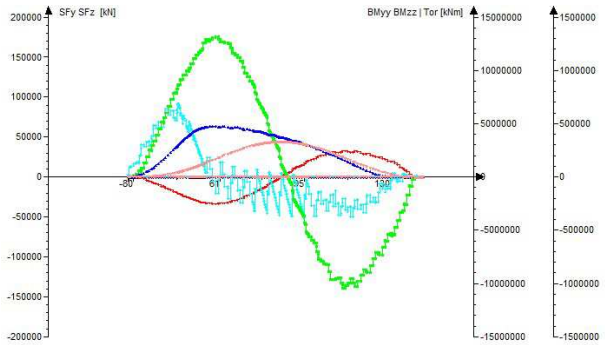
➢ INFLUENCE OF CONSTRAINT BEAMS' ON WARPING STRESS

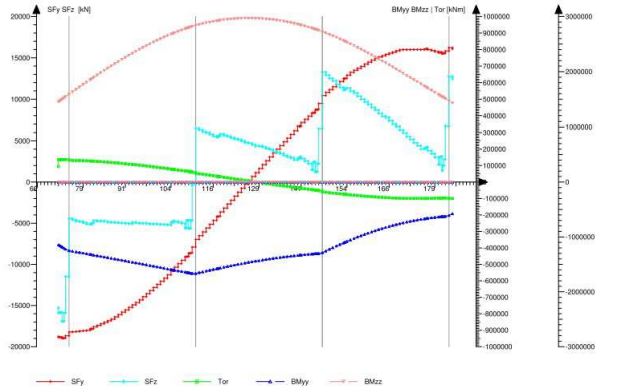
	A **(m^2)**	***I*** **(m^4)**	**Longitudinal stress in *A0 +tor a* (MPa)**	
			Element 1	Element 2
Very soft BC	$A_0 = 0.01$	$I_0 = 0.1$	**56**	82
Very stiff BC	$50 \times A_0$	$1000 \times I_0$	**51**	86



Loadcase *A0 +tor a*

11000 TEU Containership

	A **(m^2)**	***I*** **(m^4)**	**Longitudinal stress in *LC1 Tor1* (MPa)**	
			Element 1	Element 2
Very soft BC	A_0	I_0	**-57**	-35
Very stiff BC	$4 \times A_0$	$4x\ I_0$	**-54**	-38



Loadcase LC1 Tor1 (MPa)

48000 DWT bulkcarrier

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5. CONCLUSIONS

Use of current set of boundary conditions in HCSR with containerships:

- Not give good results with regards to deflexion and warping stress of containerships
- Stiffnening the BC only gives good deflexion in some loadcases not all
- Different sets of constraint beams in 1 section: not give better results
- The constraint beams have small effect on the warping stress

Torsional hull girder response of containerships – feasible with Cargo Hold models?

THANK YOU FOR YOUR ATTENTION !
CÁM ƠN !