中国船舶工业行业协会

7th ASEF in Kobe, Japan 7-8 Nov. 2013

Consequence Assessment on Harmonized CSR (April version) from Chinese Shipbuilding Industry

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China Association of the National Shipbuilding Industry

(CANSI)

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Agenda

- Introduction
- Consequence Assessment for Oil Tankers
- Consequence Assessment for Bulk Carriers
- Technical issues on CSR-H
- Conclusions

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Introduction – Status/Schedule

Common Structural Rules for

Bulk Carriers and

Oil Tankers

EXTERNAL RELEASE 1 APR 2013

- CSR-H Status:
  - 2 periods of Industry external review have been finished
  - Still some issues to be revised
- CSR-H Schedule:
  - Class TC review from 1 Nov 2013 to 15 Dec 2013
  - IACS Adoption at the end of 2013
  - Release Rules on 1 Feb 2014

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Introduction – Principles

- Basic **principles** for CSR harmonization
  - At the adoption of the original Rules (CSR), to harmonize them based on a consistent methodology
  - Will be in compliance with the IMO Goal Based Standards where GBS Functional Requirements fall within the scope of CSR-H
  - The level of the harmonized Rule criteria in relation to the current CSR will be equivalent to or higher than the current CSR criteria. The scantlings will be used as a proxy for level of structural safety.

IACS

INTERNATIONAL ASSOCIATION OF CLASSIFICATION SOCIETIES

BASIC PRINCIPLES FOR CSR MAINTENANCE AND HARMONIZATION

A Background

1 The IACS goal which led to the development of the Common Structural Rules (CSR) for Oil Tankers and Bulk Carriers (hereinafter called **the Rules**) was to develop common minimum structural requirements for the design and construction of robust ships, based on transparent methods, supported by published technical background documents and providing a rational link between the requirements for new buildings and ships in service.

2 IACS intends that the Rules be maintained and updated taking into account experience of application, feedback from service, research and technical development, in order to be recognized by the international community as the principal reference for the minimum structural requirements for oil tankers and bulk carriers.

B Maintenance of the Rules

1 To manage the maintenance of the Rules, IACS has put in place an organization and process to answer questions and to provide common interpretations. Teams were also put in place to develop benchmark data to assist with verification of software and rule interpretation.

2 To maintain the originally intended level of structural safety provided by the Rule criteria, IACS has adhered and will continue to adhere to the following Rule maintenance principles:

2.1 Editorial corrections and Common Interpretations will not result in any change to the required scantlings in relation to the original intention of the relevant Rule.

2.2 Rule changes will result in an improvement or enhancement of the Rules, reflecting a genuine advancement of knowledge, a reflection of operating experience, new technology, advances in design technology or harmonization with other relevant requirements.

2.3 Rule changes will be fully evaluated to determine the consequences on a representative range of ships. Common Interpretations will similarly be evaluated to confirm that they will not result in changes to the required scantlings as mentioned in 1 above.

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Introduction – CA by CANSI

	L_{BP}	B	D	T_S	DWT
VLCC	320	60	30.5	22.5	320K
Suezmax	264	48	24	17.5	160K
Aframax	234	42	21.6	15.45	110K
Panamax	220	32.26	21.2	14.7	76K
MR	176	32.2	18.6	12.4	48K
Capesize1	294	50	24.9	18.4	206K
Capesize2	285	46	24.8	18.1	180K
Baby Cape	254	43	20.3	14.5	118K
Post Panamax	221	36.8	19.9	14.2	87K
Panamax	225.1	32.26	20.2	14.45	82K
Handymax1	185	32.26	18	12.8	57K
Handymax2	172	30	14.7	10.1	35K

- Introduction
- Consequence Assessment for Oil Tankers
  - 320K VLCC
- Consequence Assessment for Bulk Carriers
- Technical issues on CSR-H
- Conclusions

Local Min T
Local Pres.
HG Buckling
Fatigue

VLCC – Midship: Prescriptive Requirement

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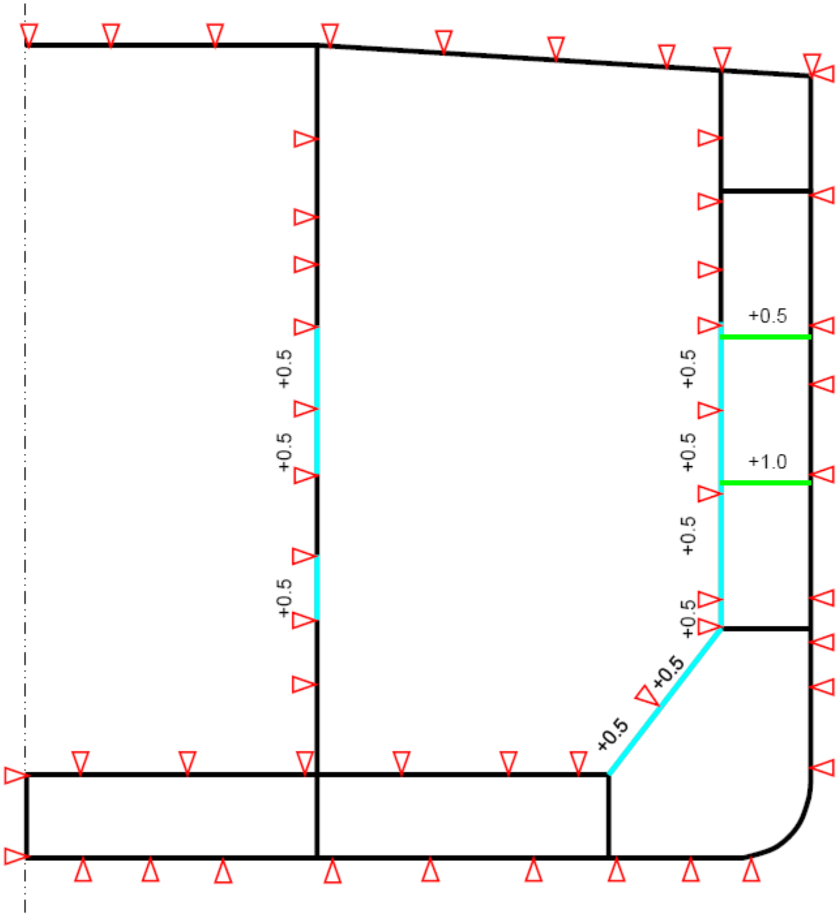
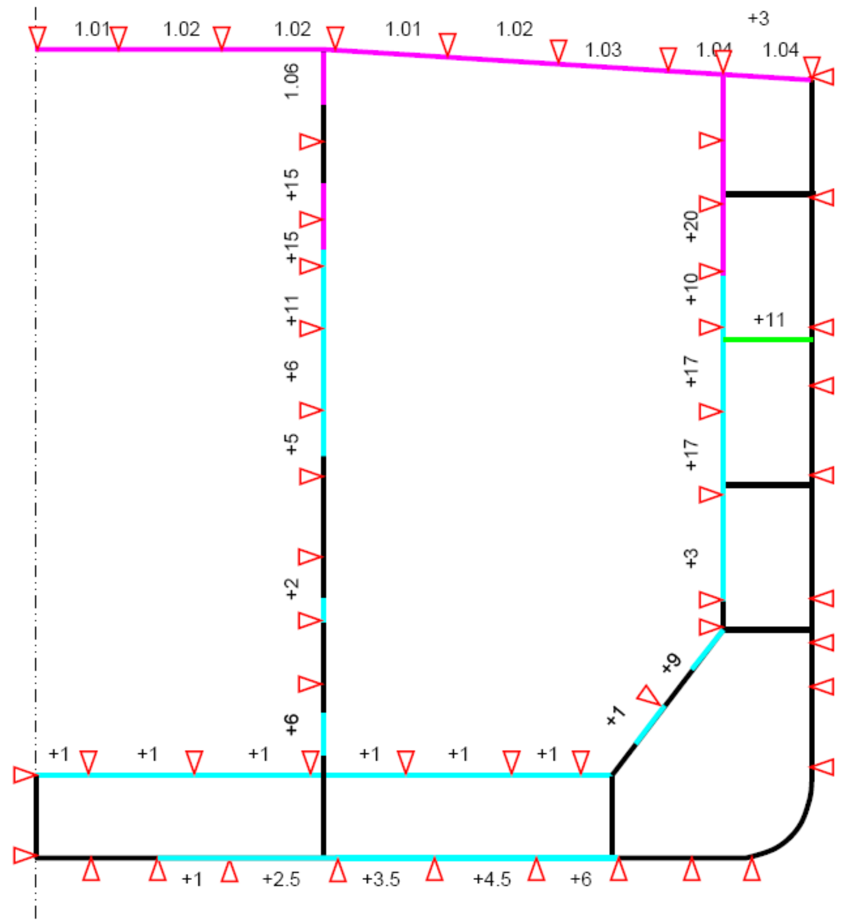
For Plates: [mm]

For Stiffeners: [%]

CSRH – As-built



(CSRH – As-built) / As-built



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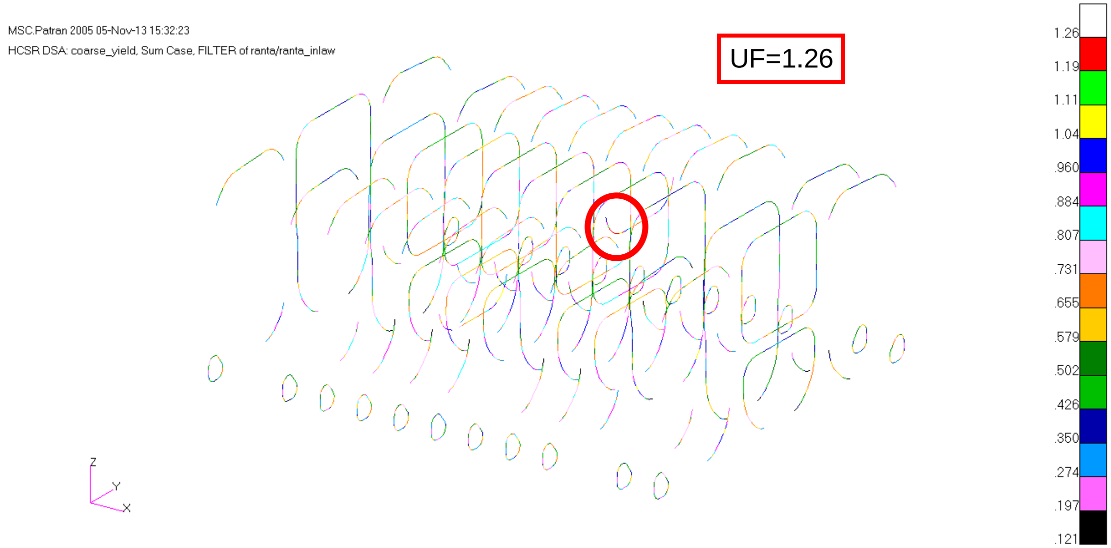
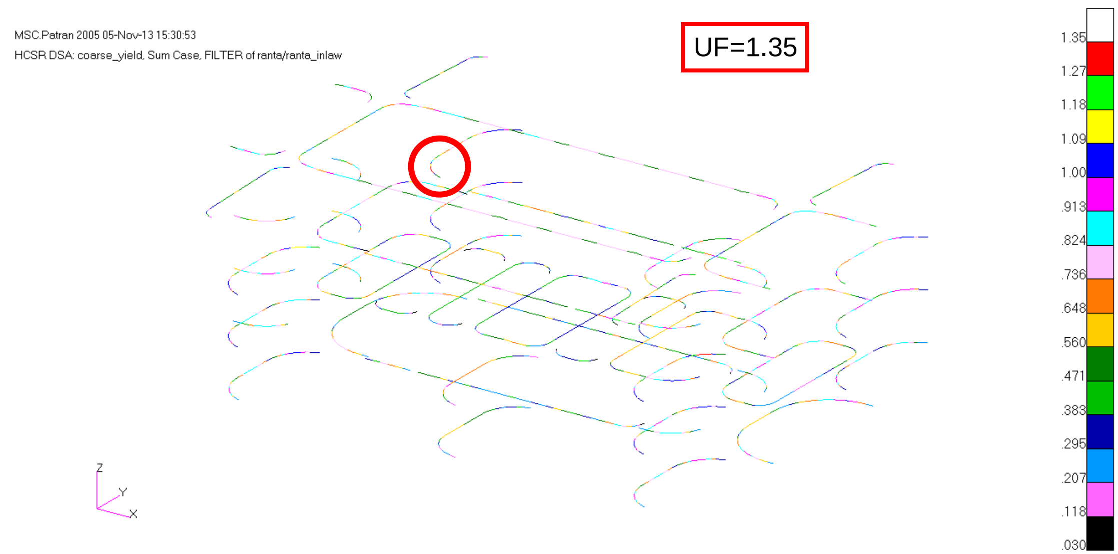
VLCC – Midship: FEM yielding



Face plate of web frames

Face plate of Horiz. girder



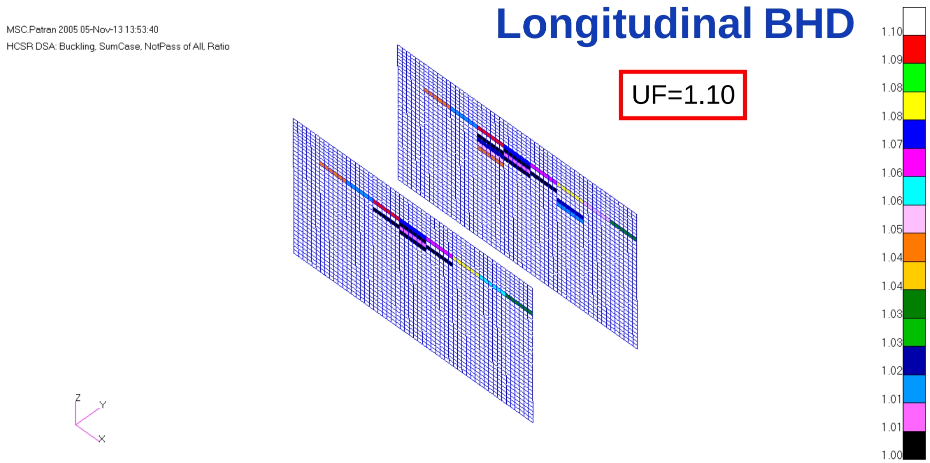
The main reasons is:

1. **internal loads increased compared to CSR-OT,**
2. **the yielding criteria of oil tanker decreased.**

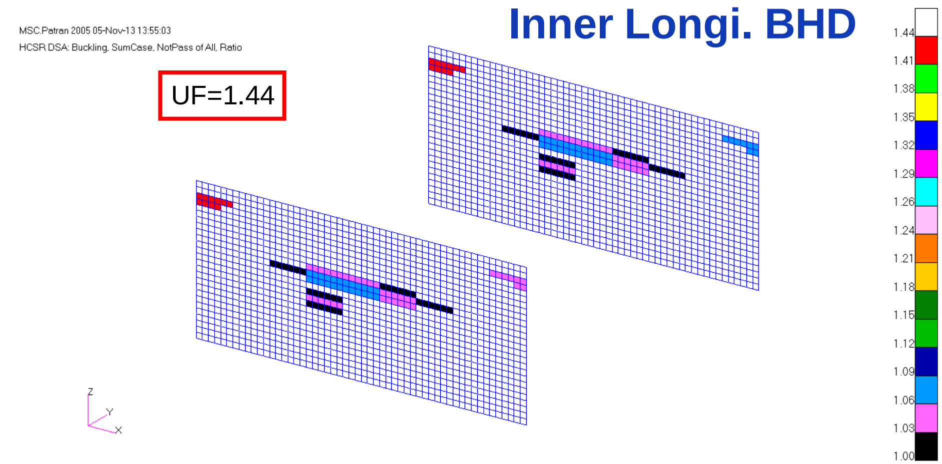
2013-11-07

VLCC – Midship: FEM buckling

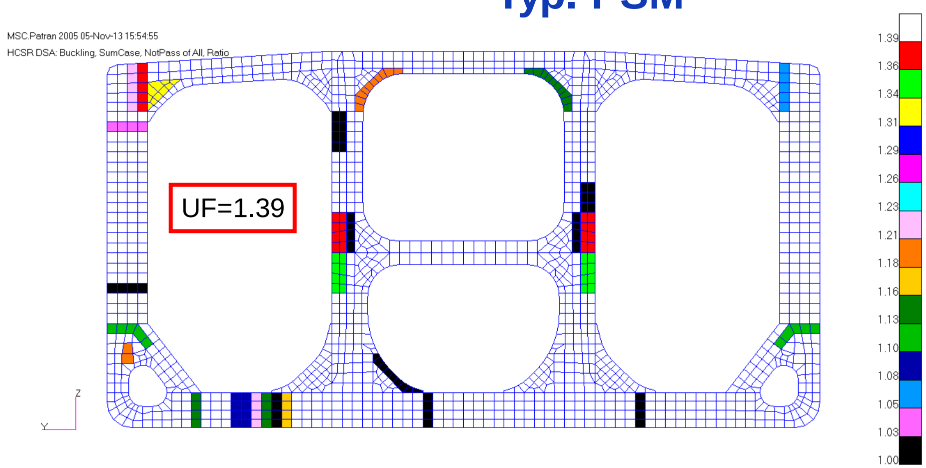
Longitudinal BHD



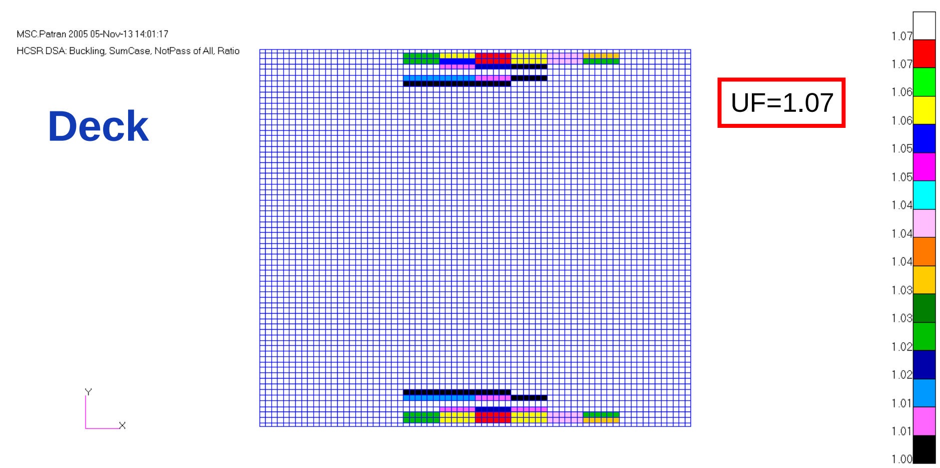
Inner Longi. BHD



Typ. PSM



Deck



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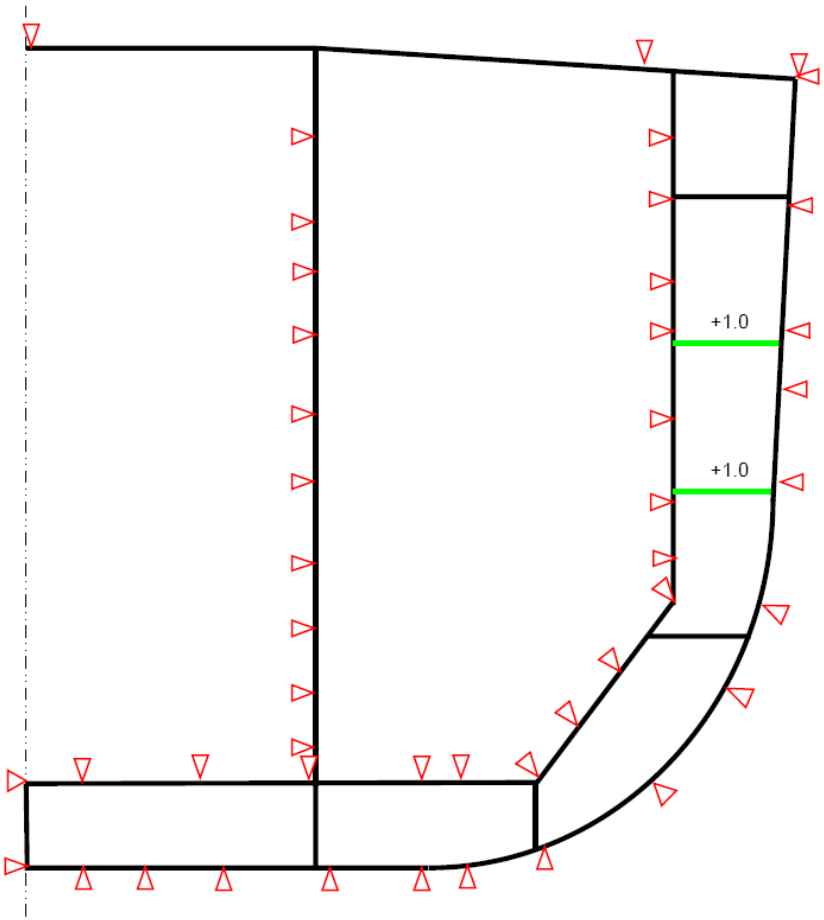
VLCC – Foremost CT: Prescriptive

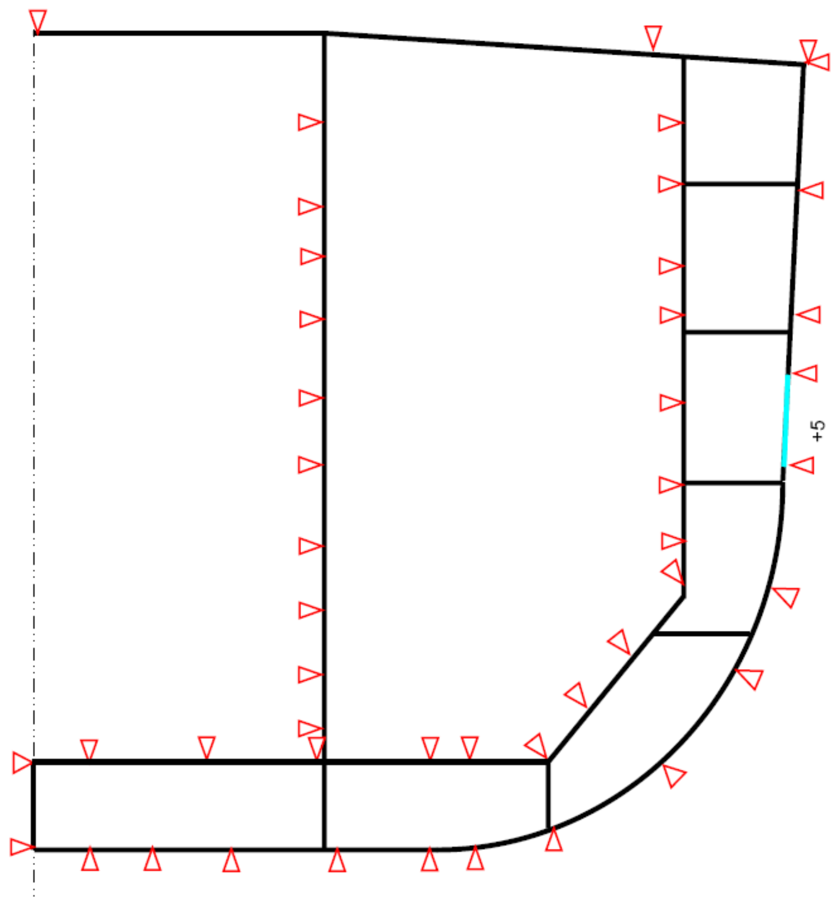
For Plates: [mm]

CSRH – As-built



For Stiffeners: [%]

(CSRH – As-built) / As-built



VLCC – Foremost CT: FEM yielding

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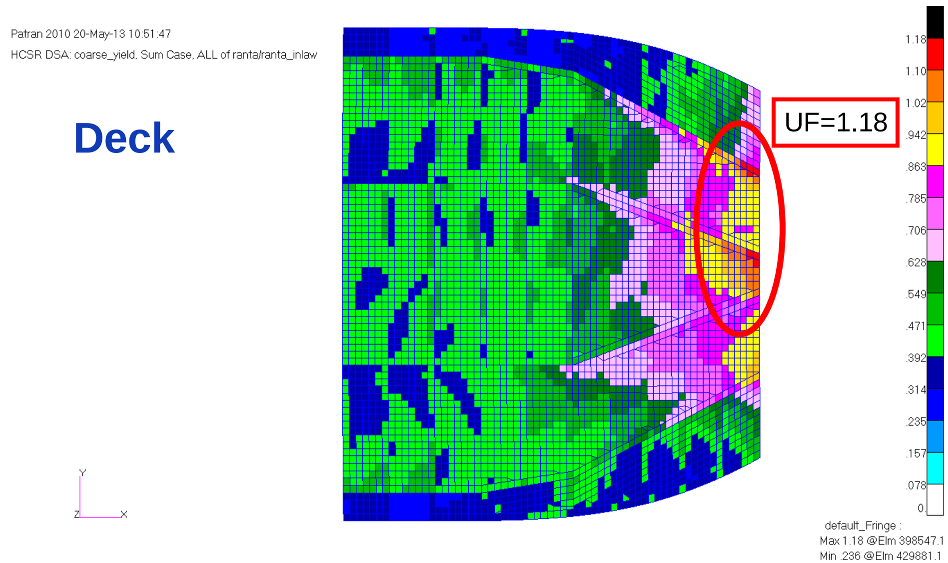

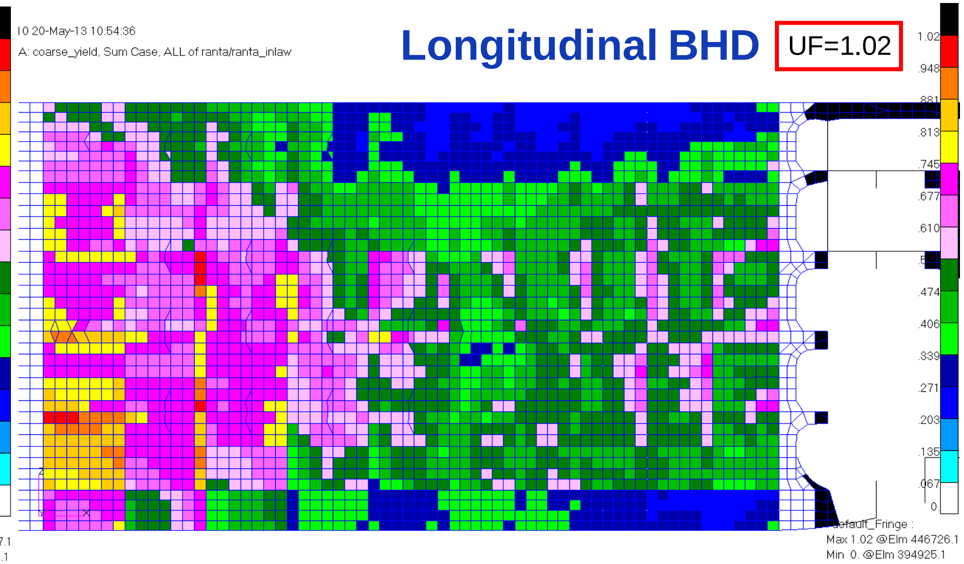

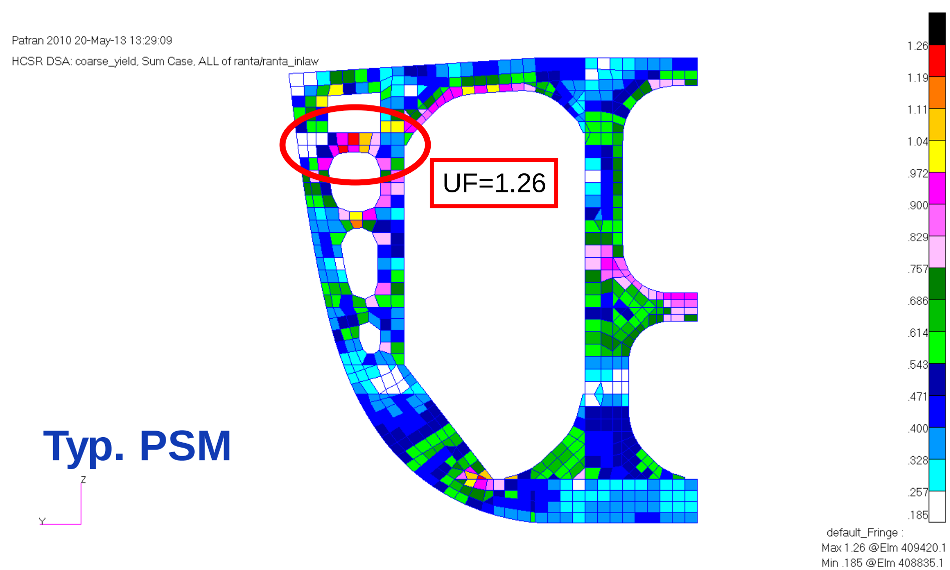

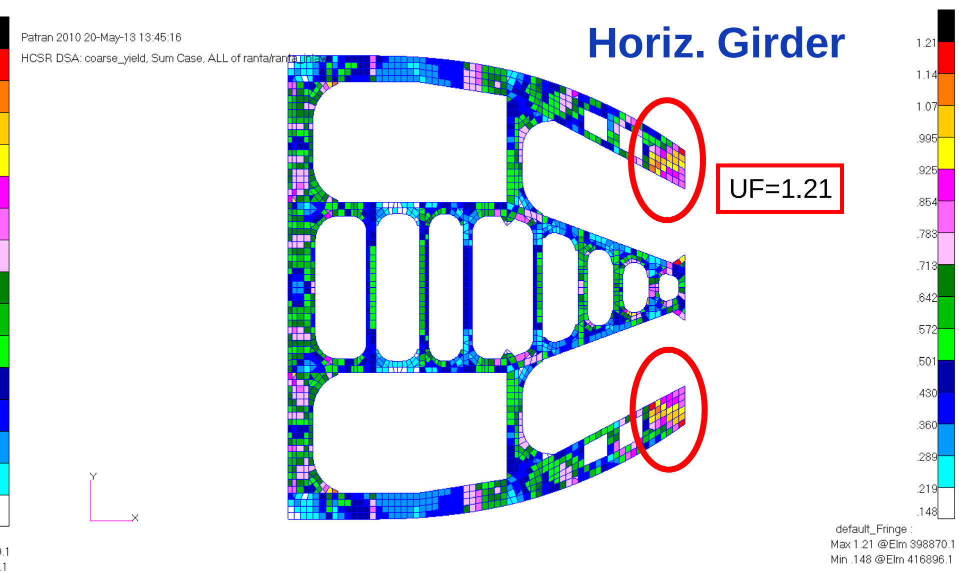

VLCC – Foremost CT: FEM buckling

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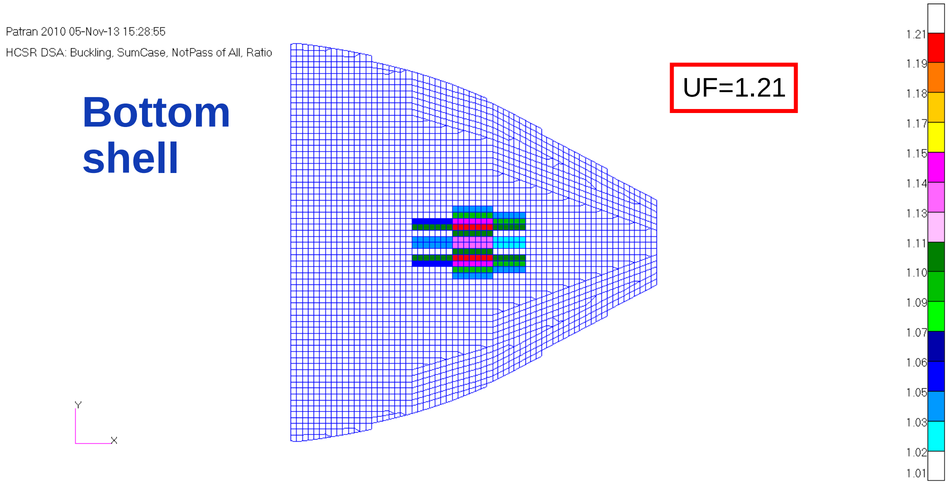
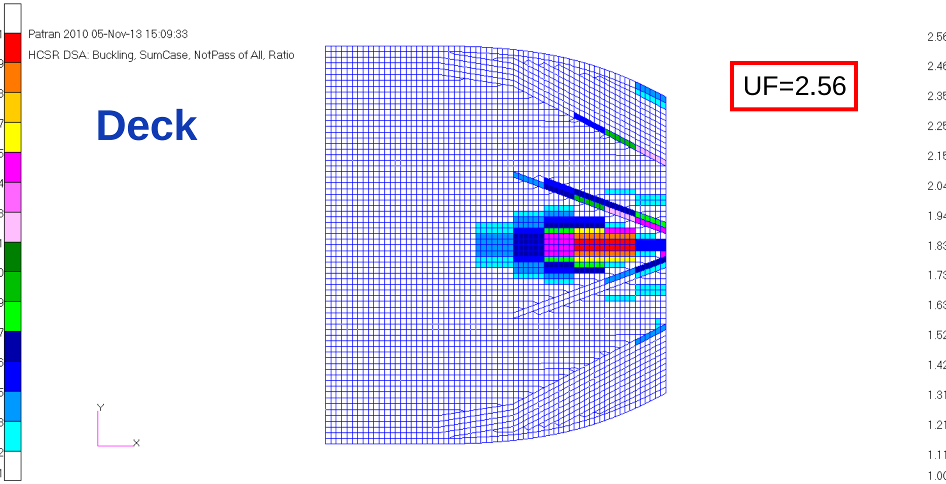
Bottom shell

UF=1.21



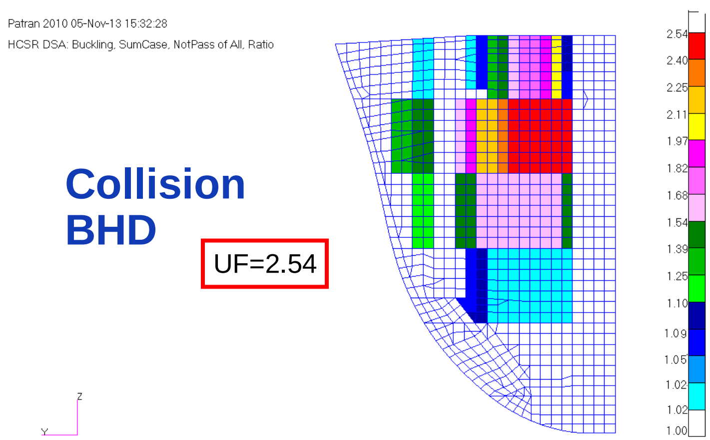
Deck

UF=2.56



Collision BHD

UF=2.54



Inner hull longi. BHD

UF=1.30

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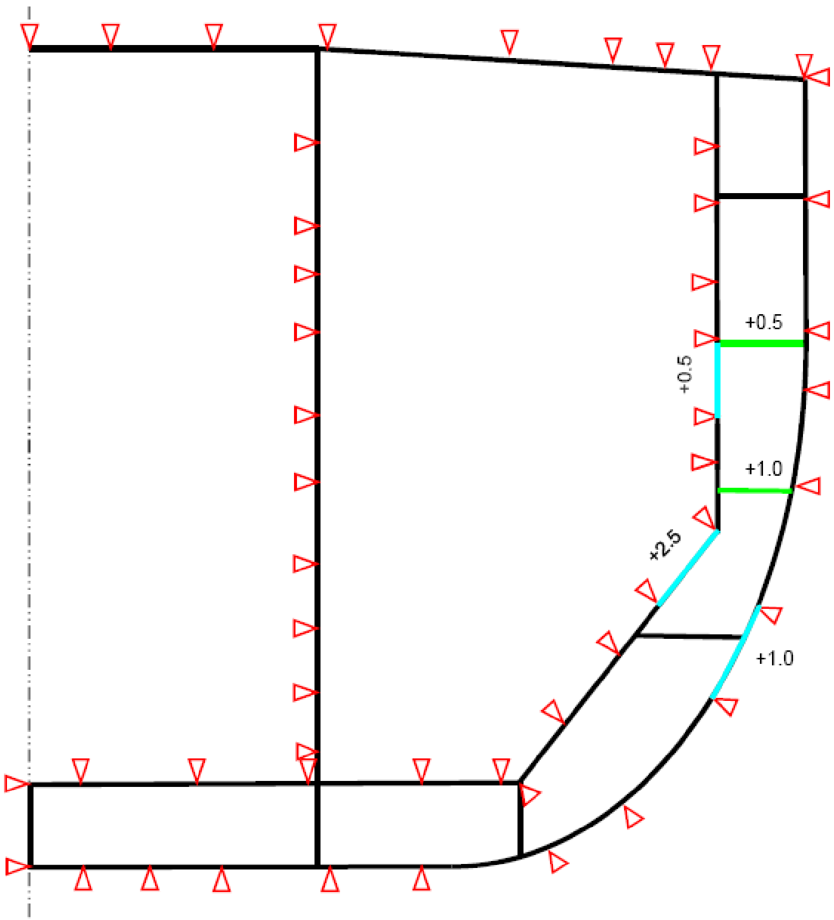
VLCC – Aftmost CT: Prescriptive

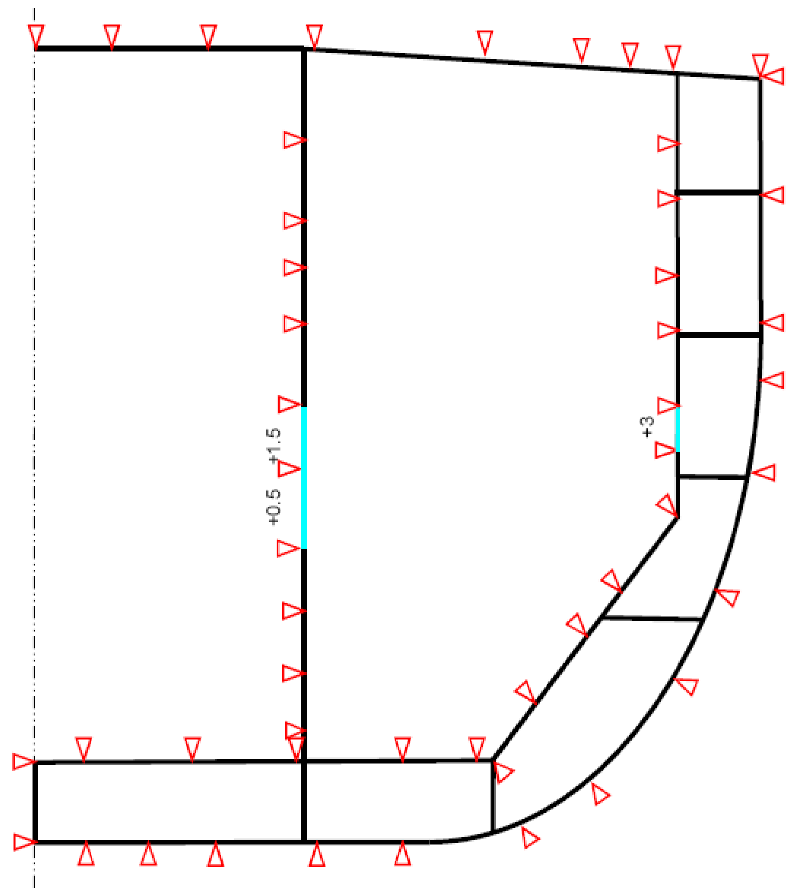
For Plates: [mm]

CSRH – As-built



For Stiffeners: [%]

(CSRH – As-built) / As-built



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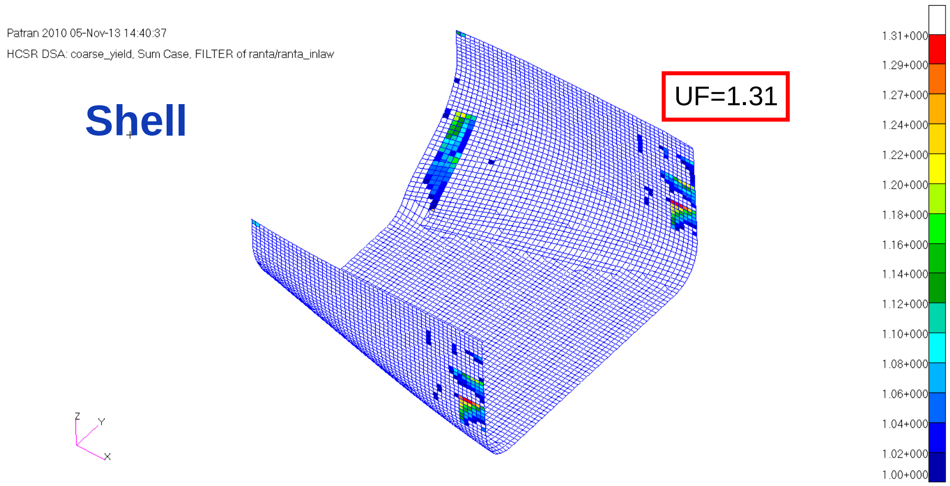
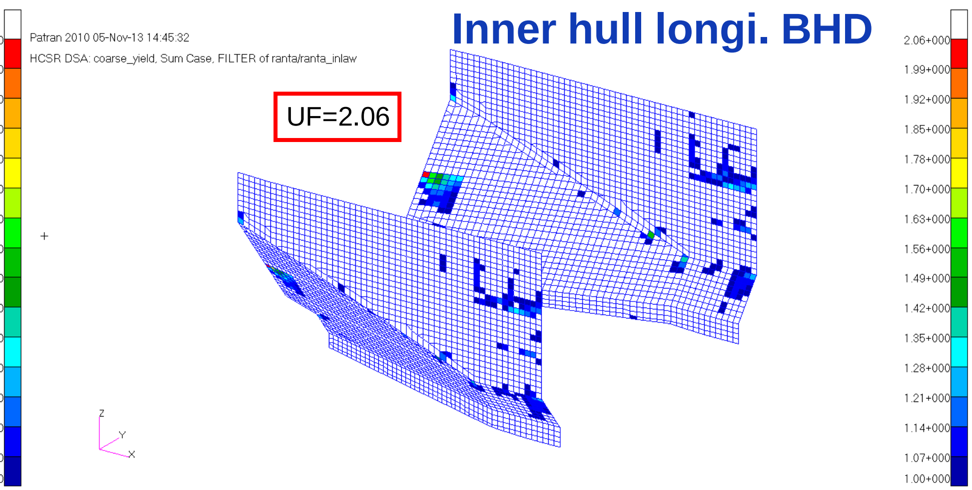
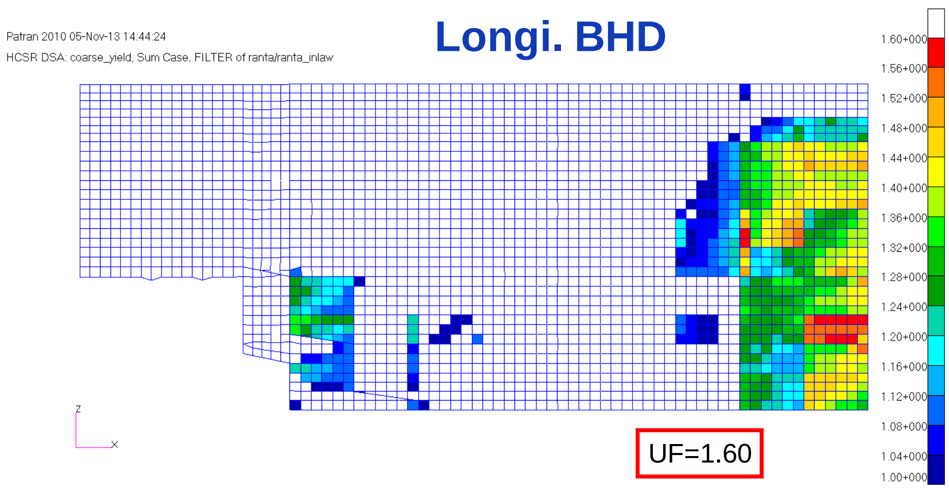
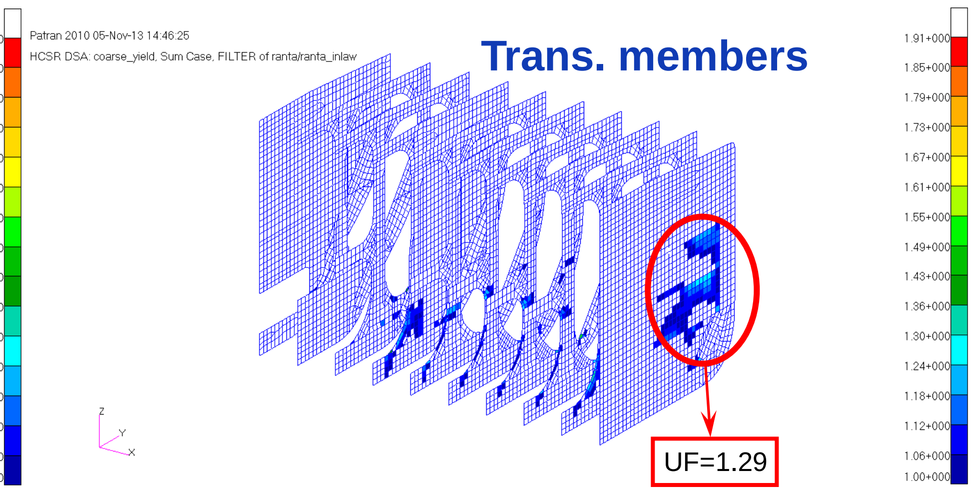
VLCC – Aftmost CT: FEM yielding









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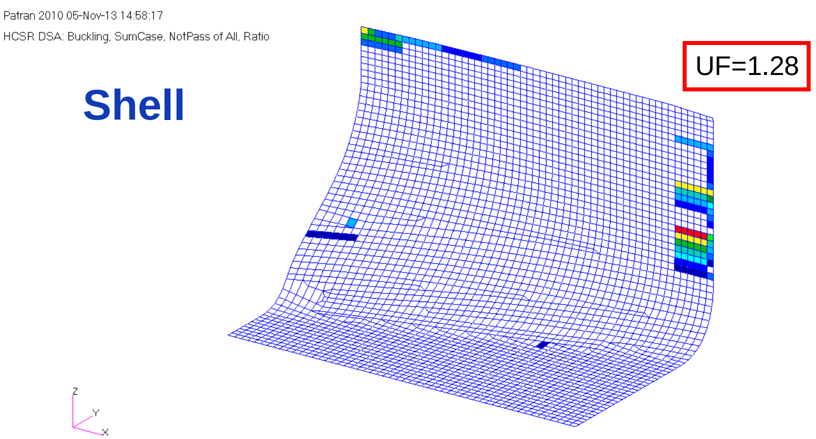
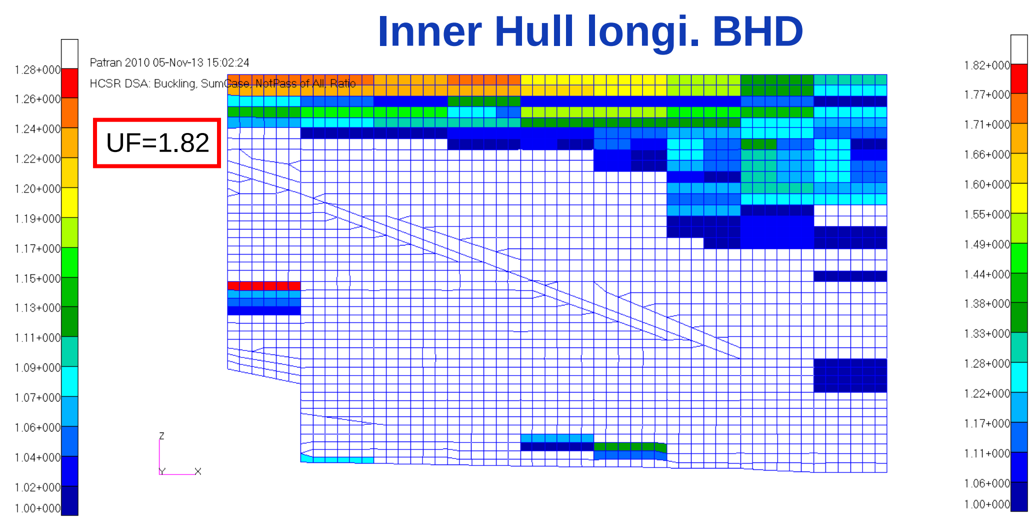
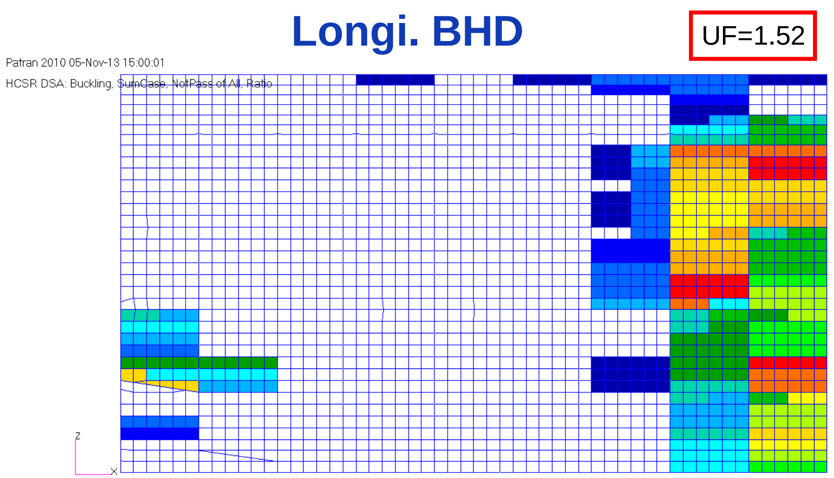
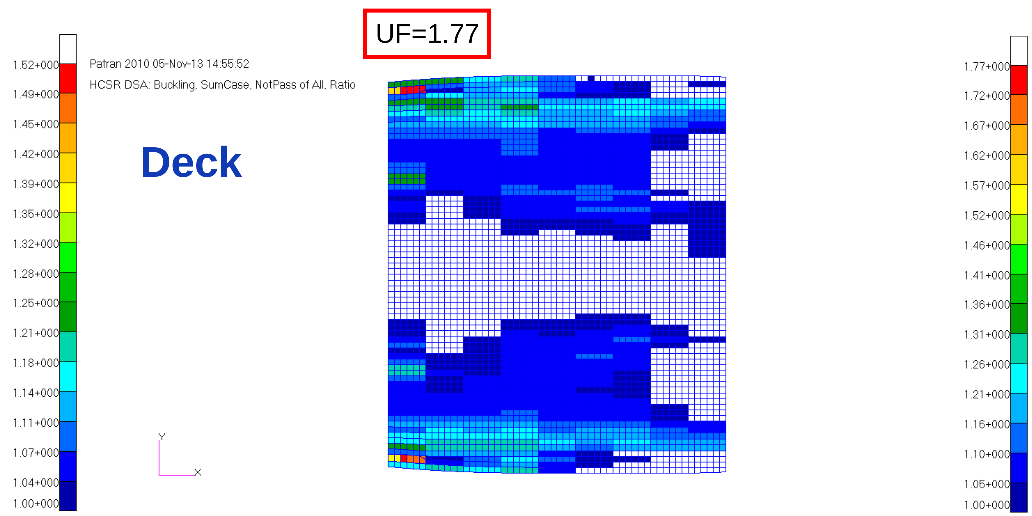
VLCC – Aftmost CT: FEM buckling









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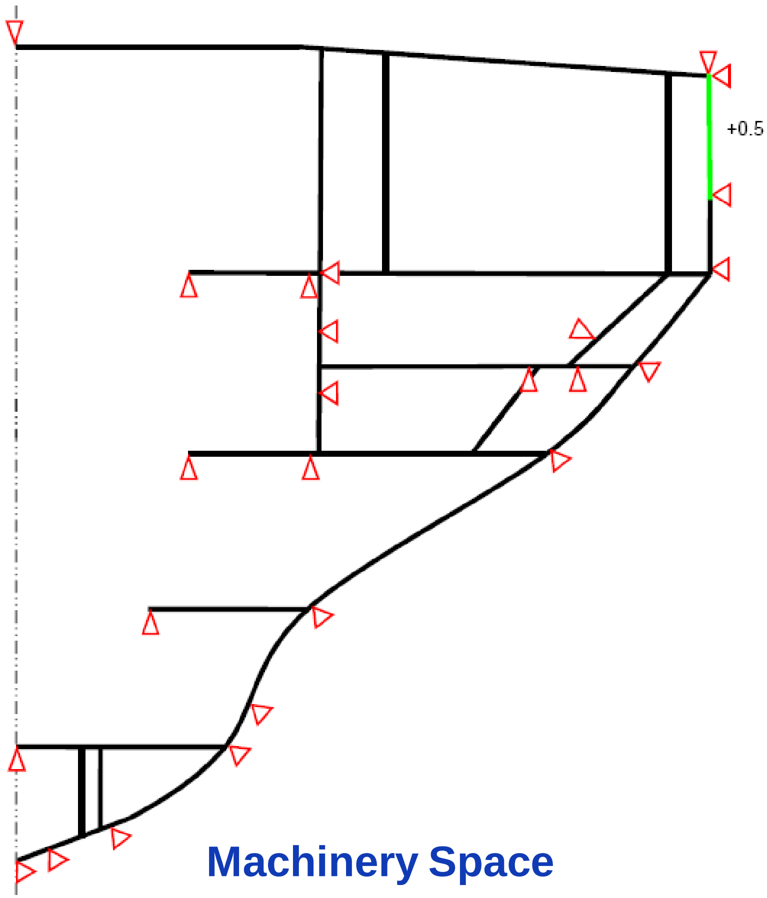
VLCC – Other Parts: Prescriptive

For Plates: [mm]

CSRH – As-built



Other parts including fore and aft ends have no change compared with CSR.

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VLCC – Summary for CA

- Sheer strake, stringer plating in DH and shell plating in machinery space and aft are increased due to higher Rule Min. thickness.
- Boundaries of cargo tanks is 0.5~1.0mm increased for plating and about 10% increased for section modulus of stiffeners due to increased local pressure.
- Buckling utilization factor for stiffeners in upper deck and below 0.1D from deck is increased due to prescriptive buckling requirement.
- For midship area, FE yielding is of less impact except for PSM, while FE buckling will induce increasing for some structural members.
- For foremost and aftmost cargo tank, FE yielding is dominant for some local area, while FE buckling will induce much increasing.

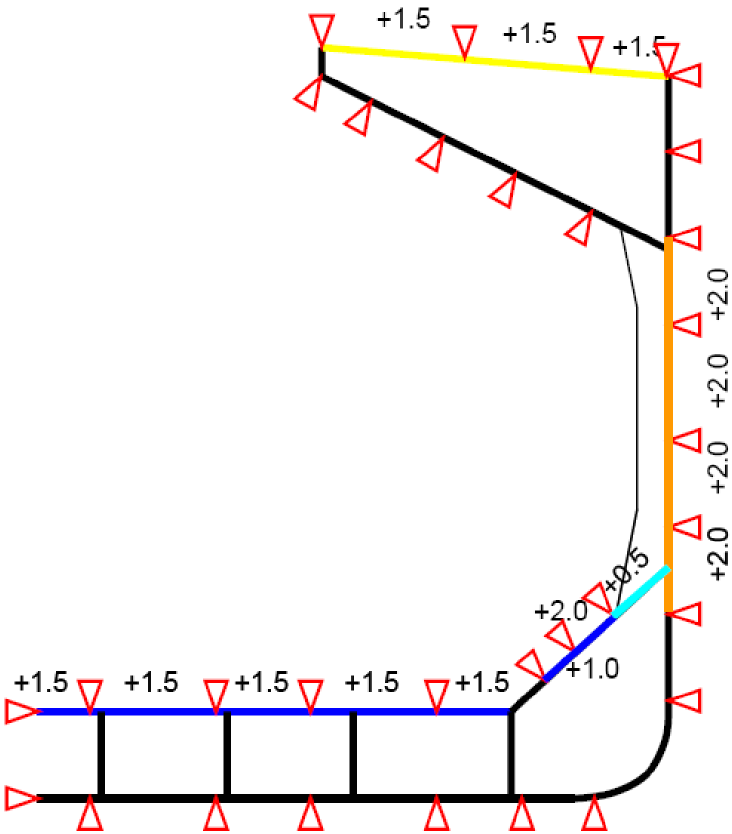
- Introduction
- Consequence Assessment for Oil Tankers
- **Consequence Assessment for Bulk Carriers**
  - **Panamax Bulk Carrier**
- Technical issues on CSR-H
- Conclusions

	Local Min T
Steel Coils	Local Pres.
Local GRAB	HG Buckling
Pres. Buckling	Fatigue

Panamax BC - Midship: Empty hold

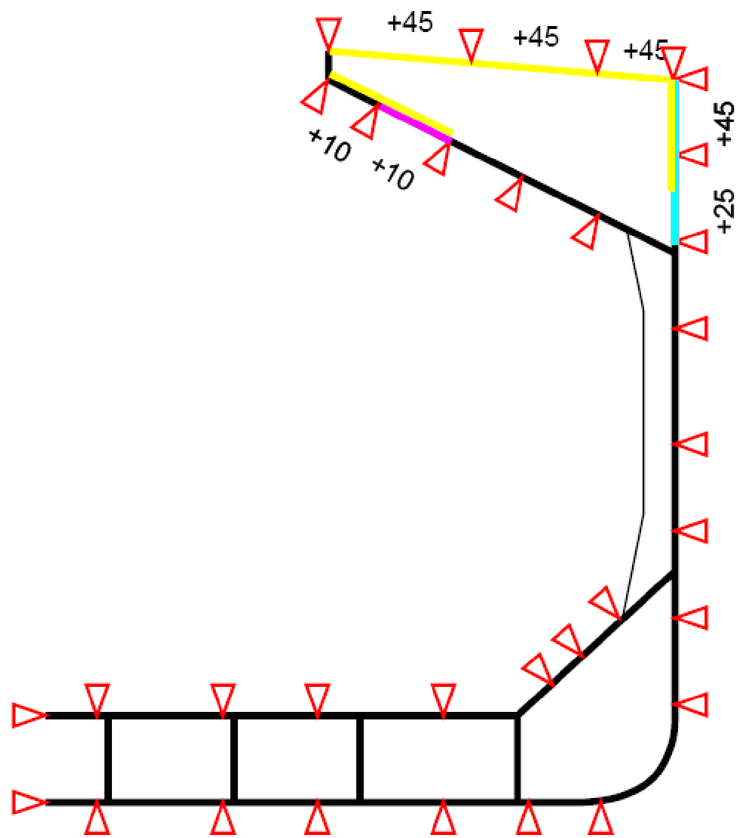
For Plates: [mm]

HCSR-As built



For Stiffeners: [%]

(HCSR-As built)/As-built



Grab notation is GRAB[20] by CSR-BC

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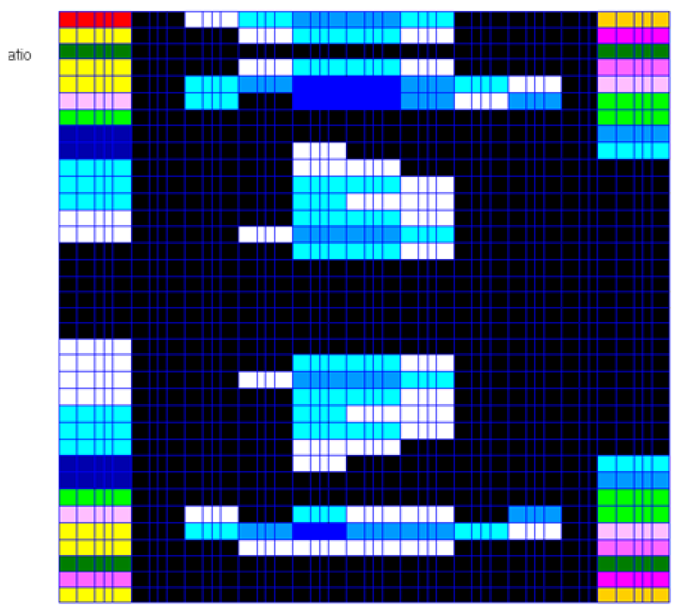
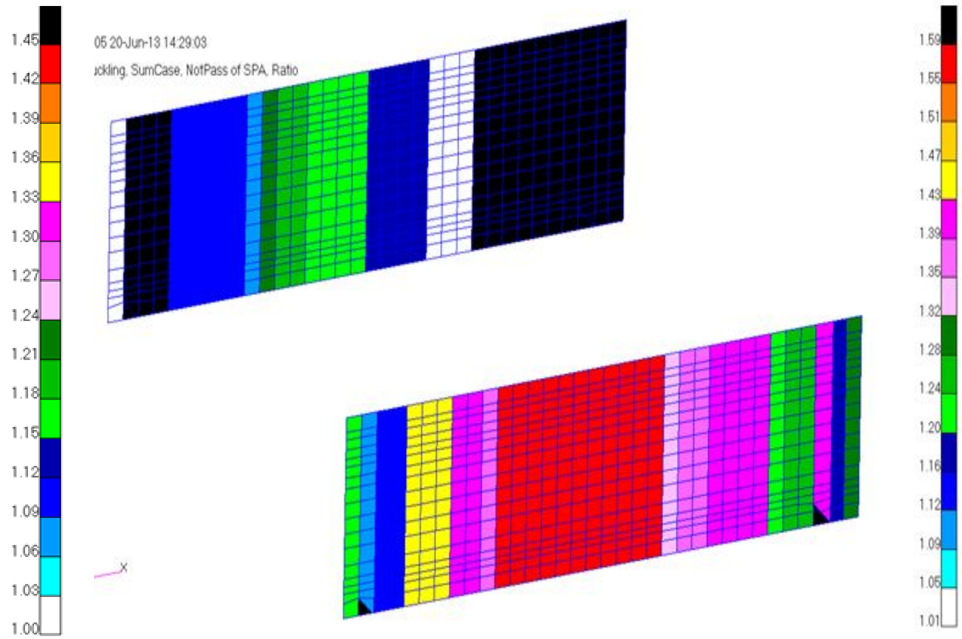
Panamax BC - Midship: FE Buckling

Outer shell (buckling)



Empty C.H

Side Shell (Buckling)



Empty C.H

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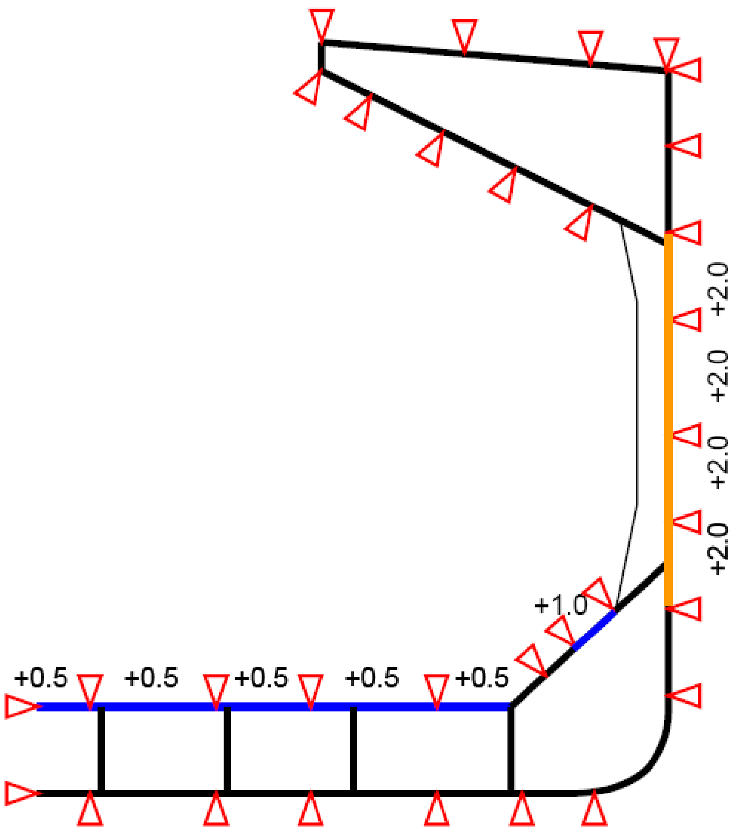
Panamax BC - Midship: Loaded hold

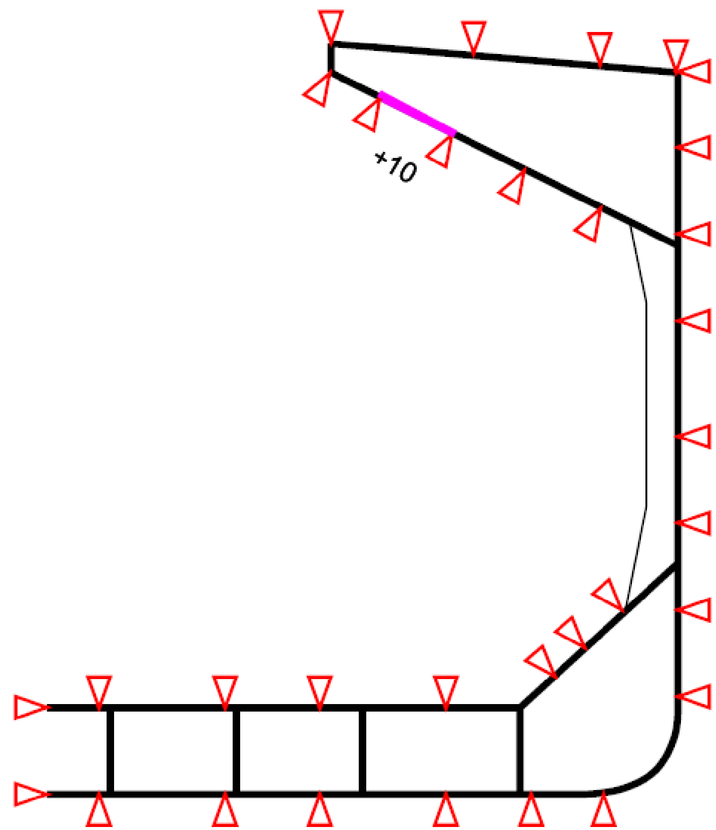
For Plates: [mm]

HCSR-As built



For Stiffeners: [%]

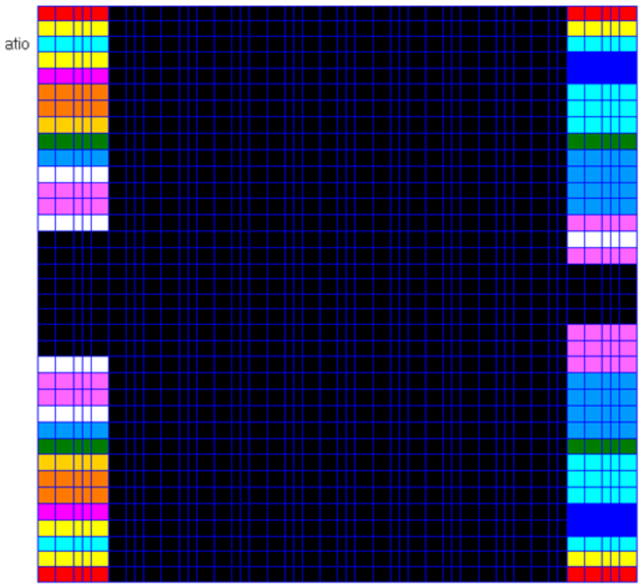
(HCSR-As built)/As-built



Grab notation is GRAB[20] by CSR-BC

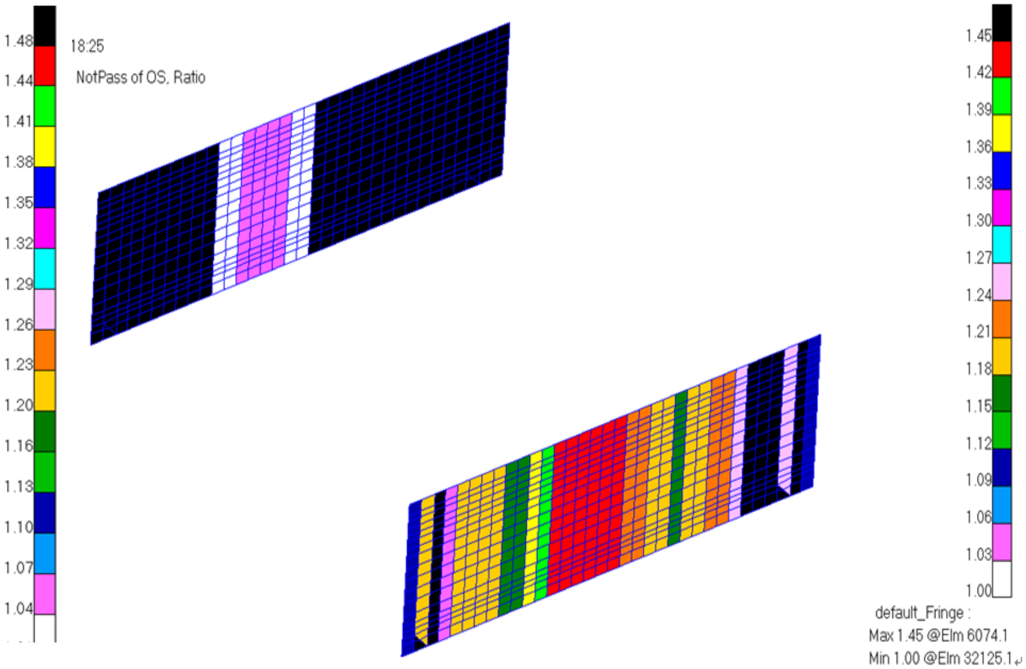
Panamax BC - Midship: FE Buckling

Outer shell (buckling)



Loaded C.H

Side Shell (Buckling)



Loaded C.H

Panamax BC - Foremost: Prescriptive

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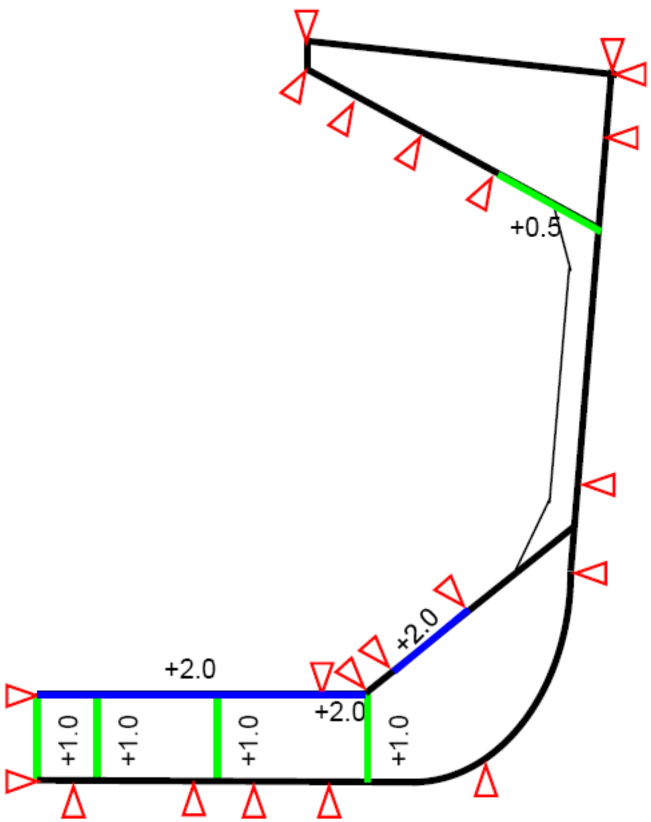
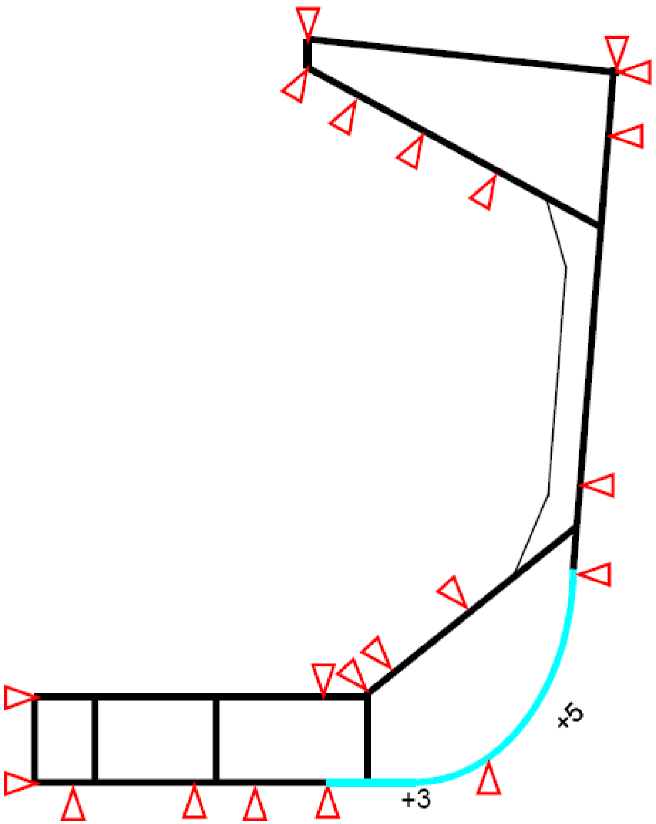
For Plates: [mm]

HCSR-As built



For Stiffeners: [%]

(HCSR-As built)/As-built



Grab notation is GRAB[20] by CSR-BC

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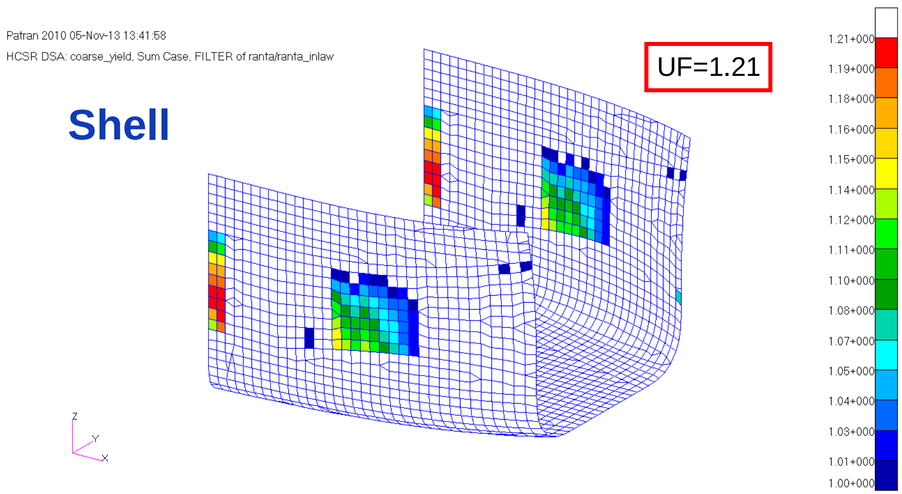
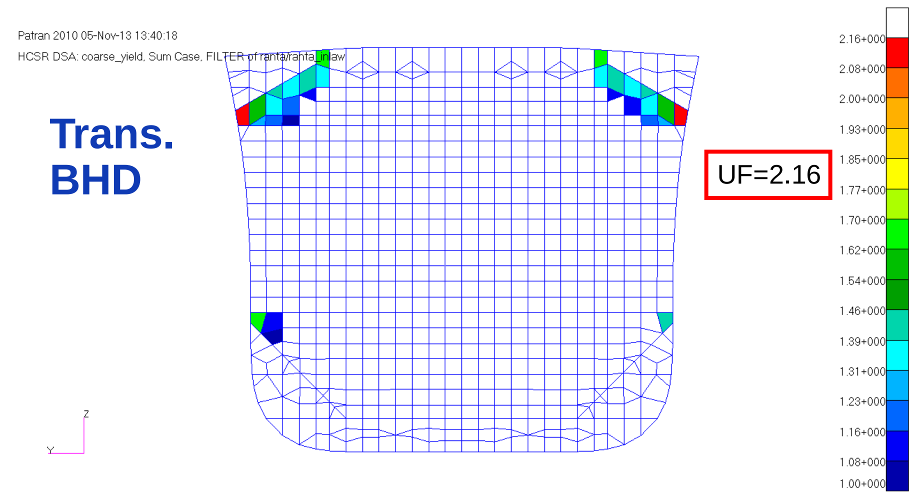
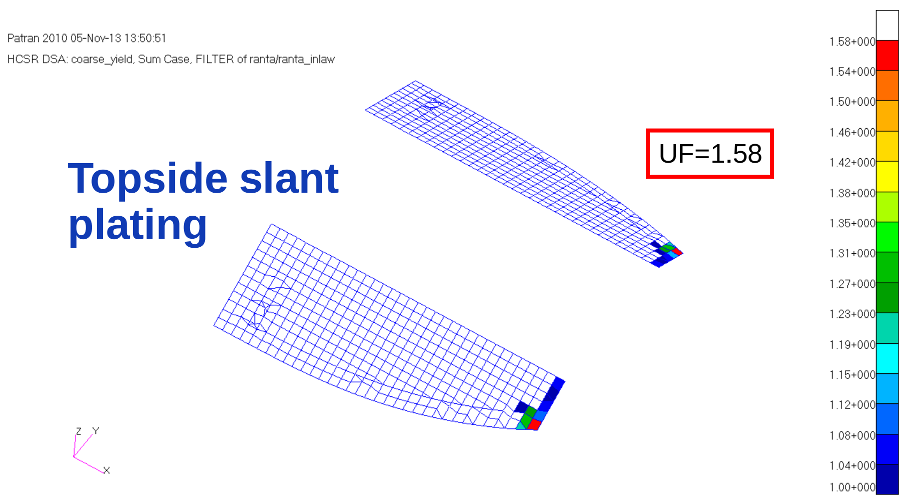
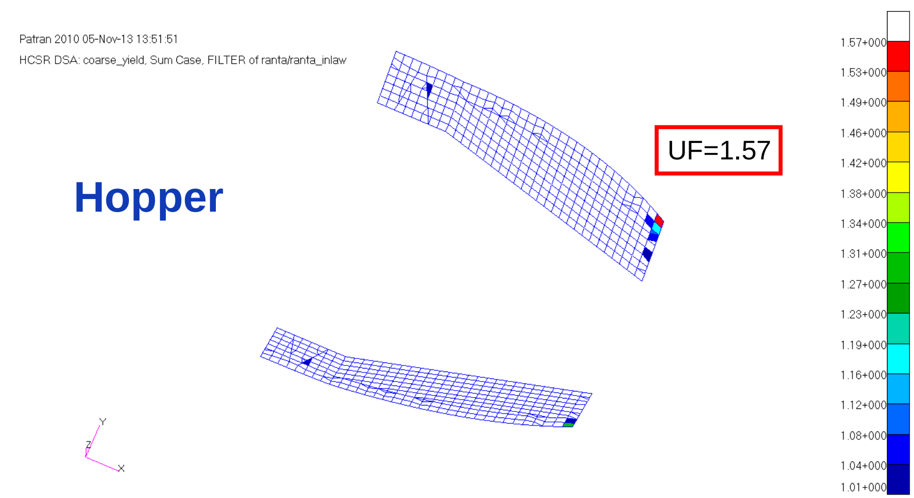
Panamax BC - Foremost: FE yielding



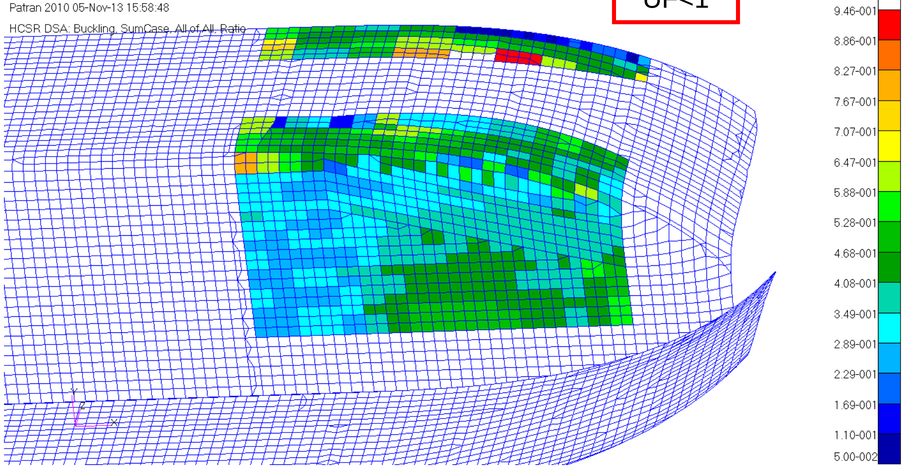




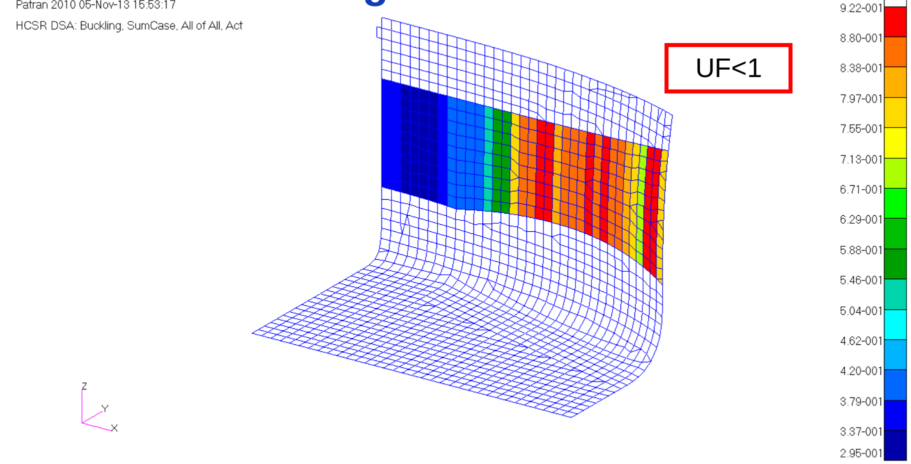


Panamax BC - Foremost: FE buckling

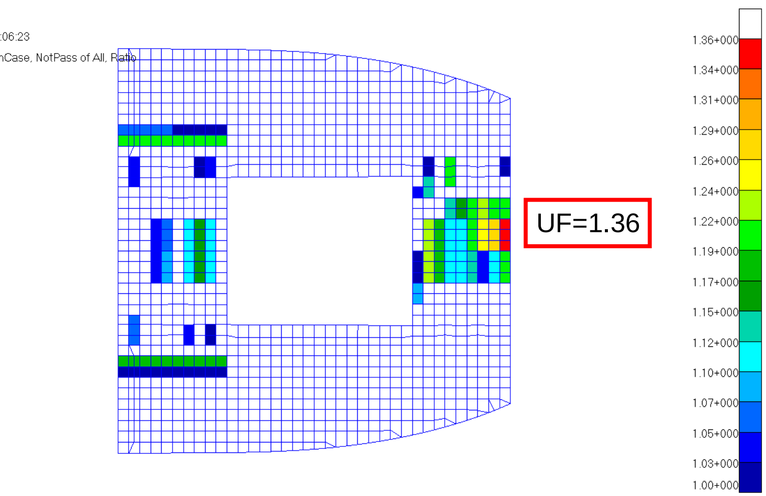
Shell



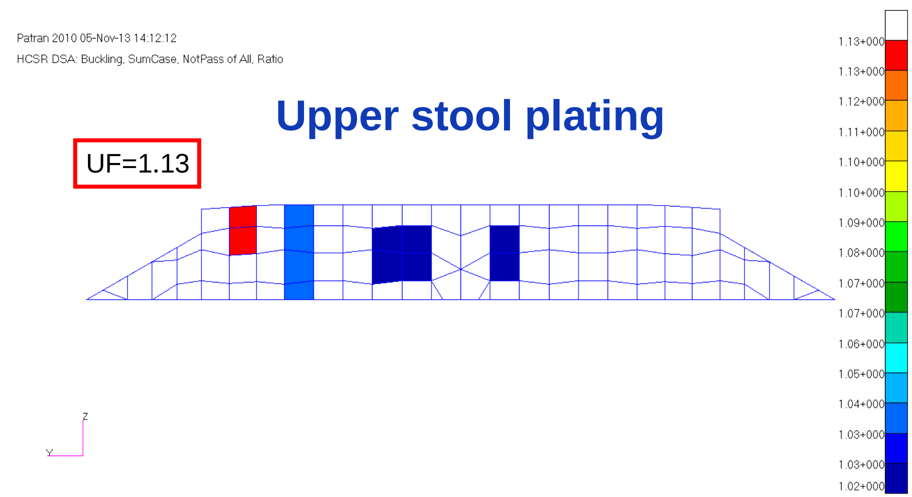
Single Side Shell



Deck



Upper stool plating



Panamax BC - Aftmost: Prescriptive

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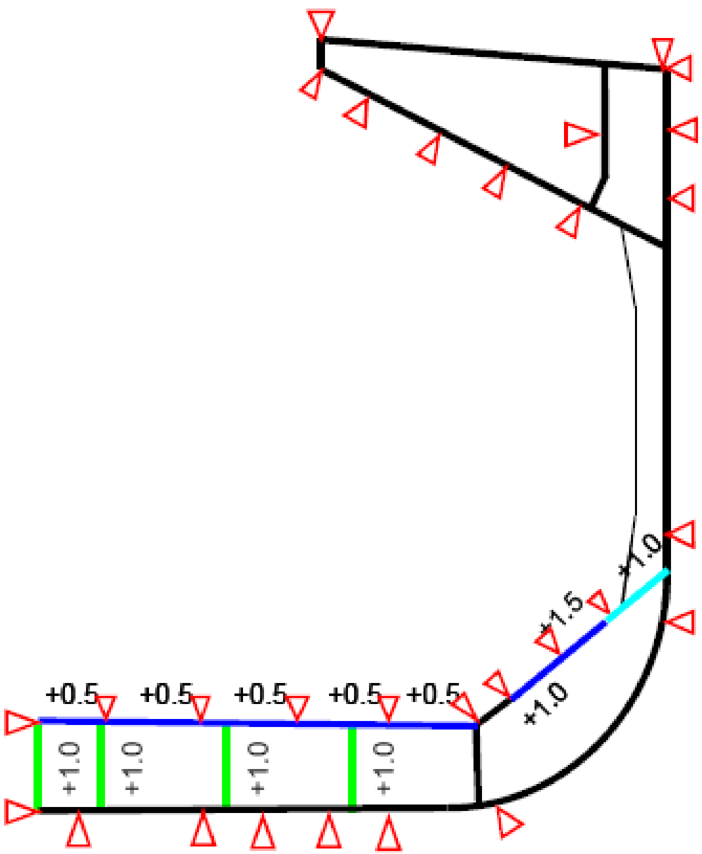
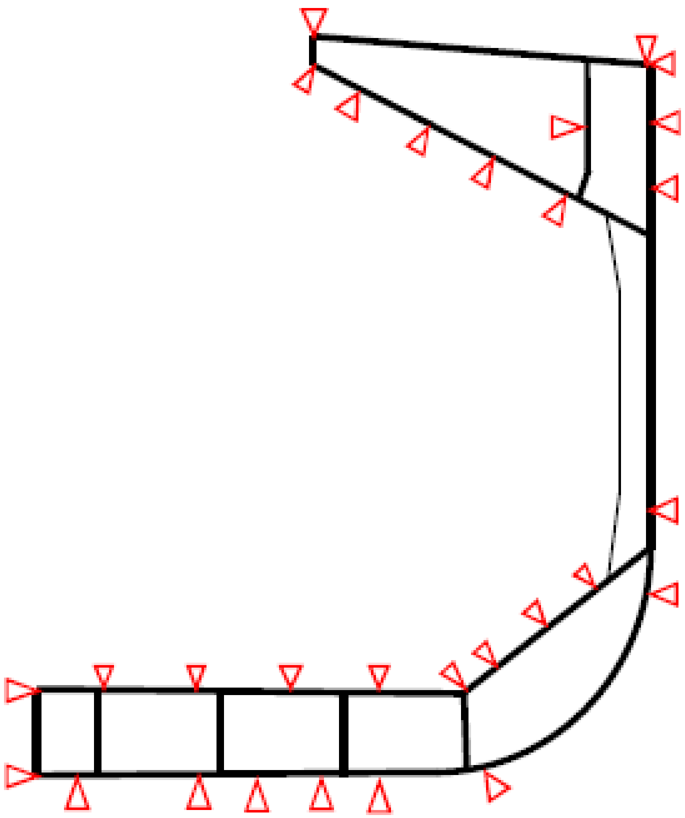
For Plates: [mm]

HCSR-As built



For Stiffeners: [%]

(HCSR-As built)/As-built



Grab notation is GRAB[20] by CSR-BC

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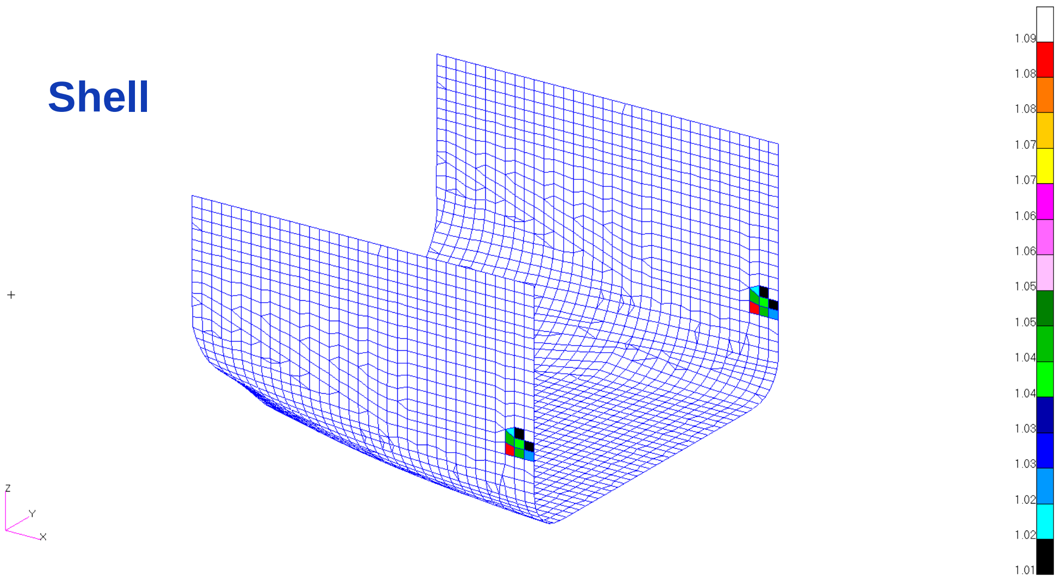
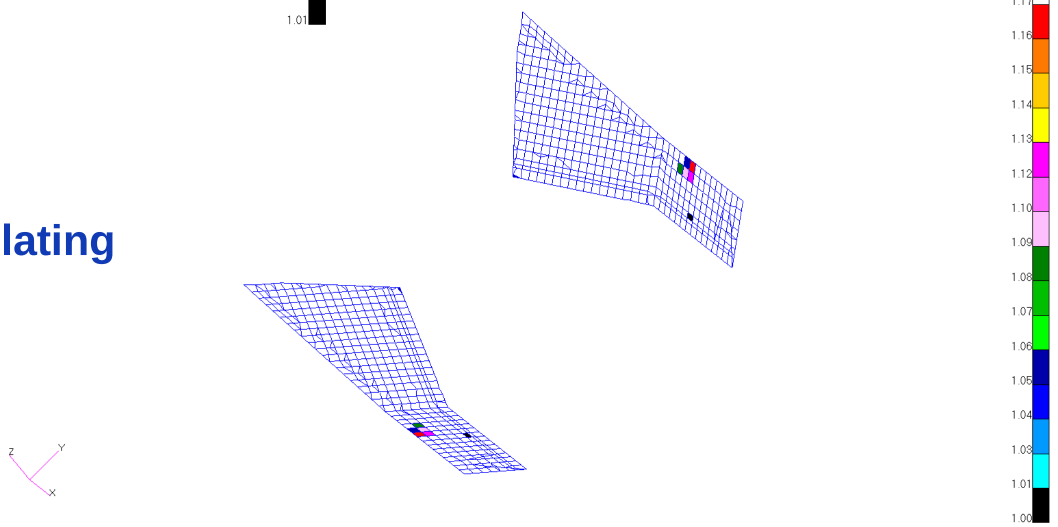
Panamax BC - Aftmost: FE yielding

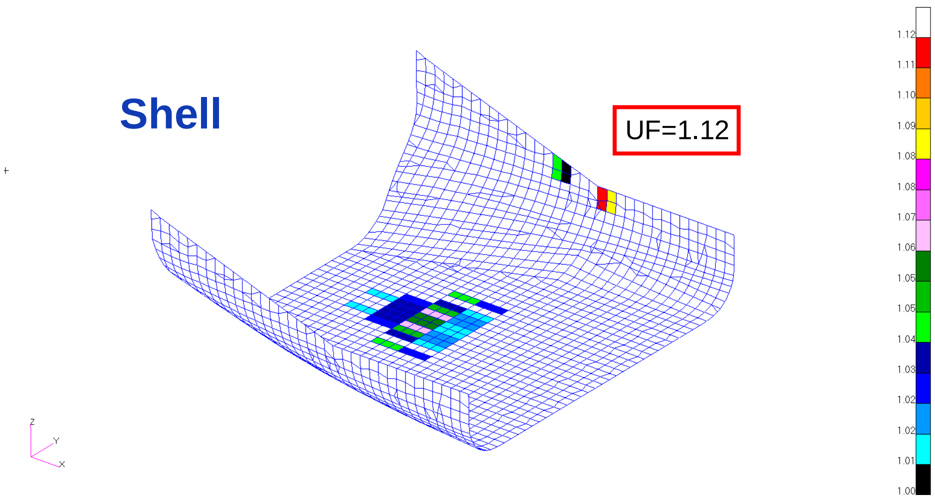
Shell

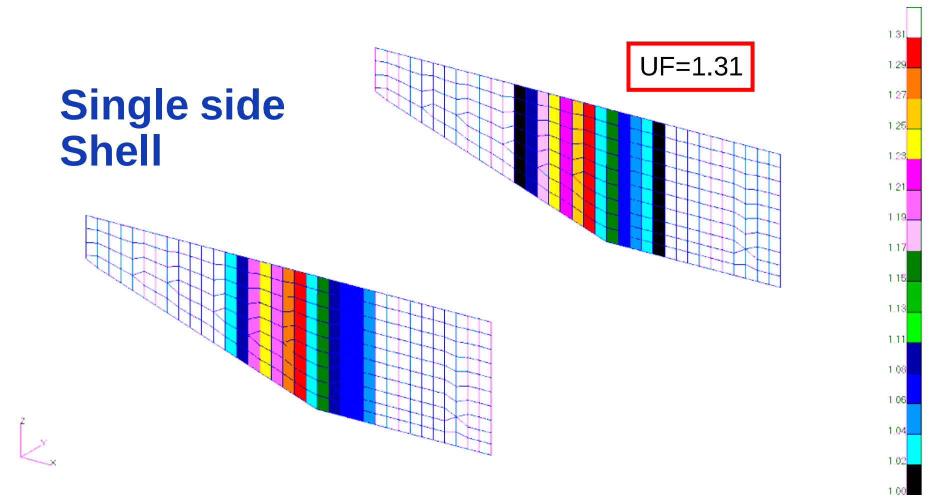


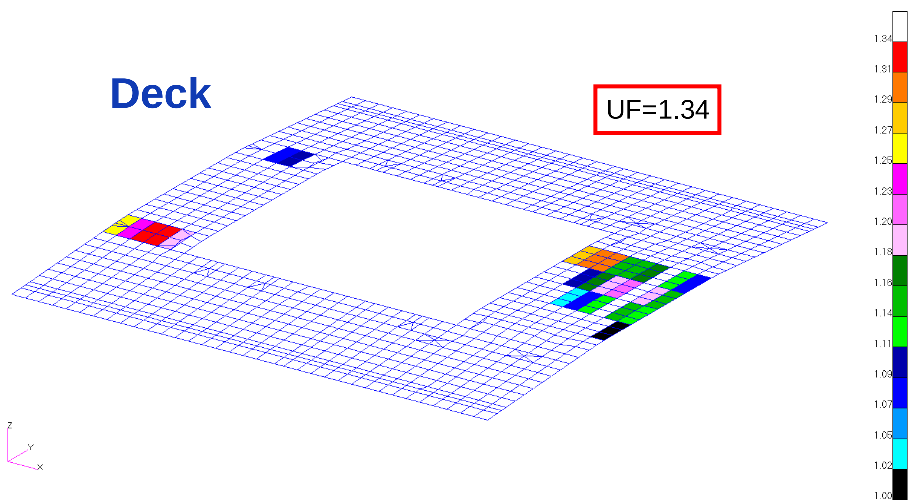
Hopper plating

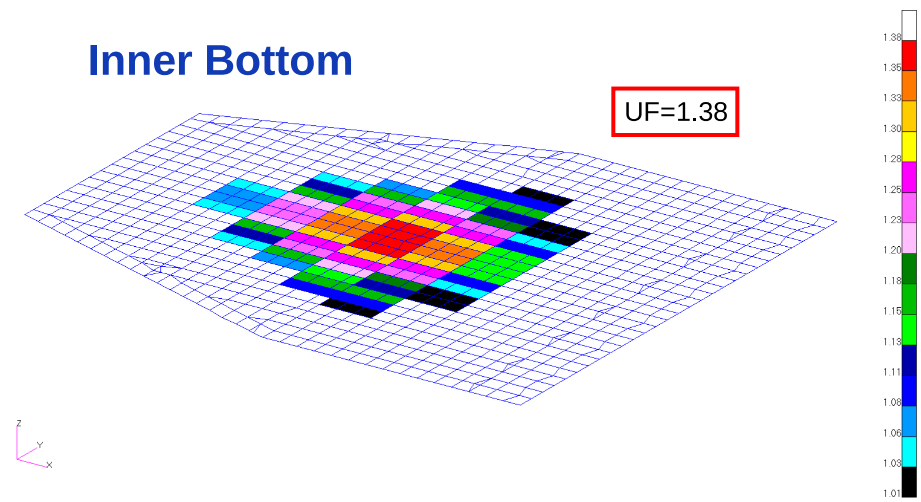


Panamax BC - Aftmost: FE buckling 1



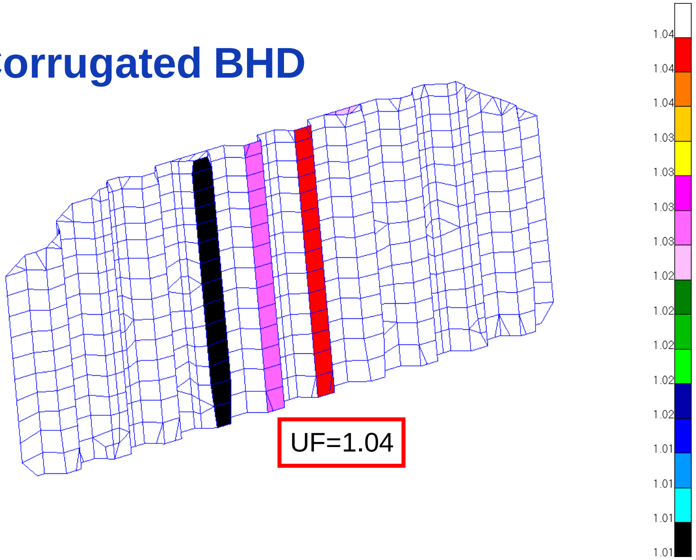




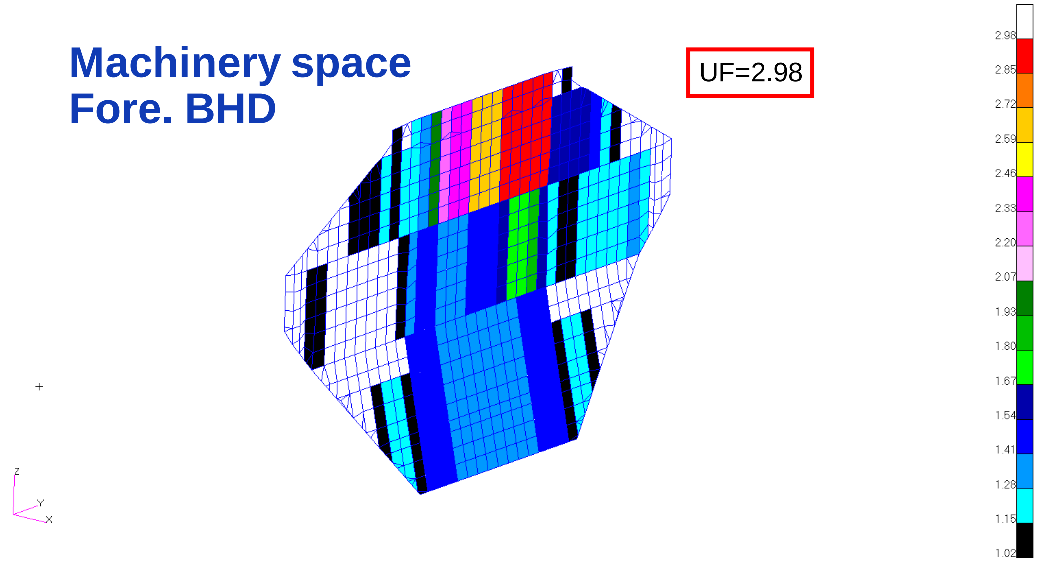


Panamax BC - Aftmost: FE buckling 2

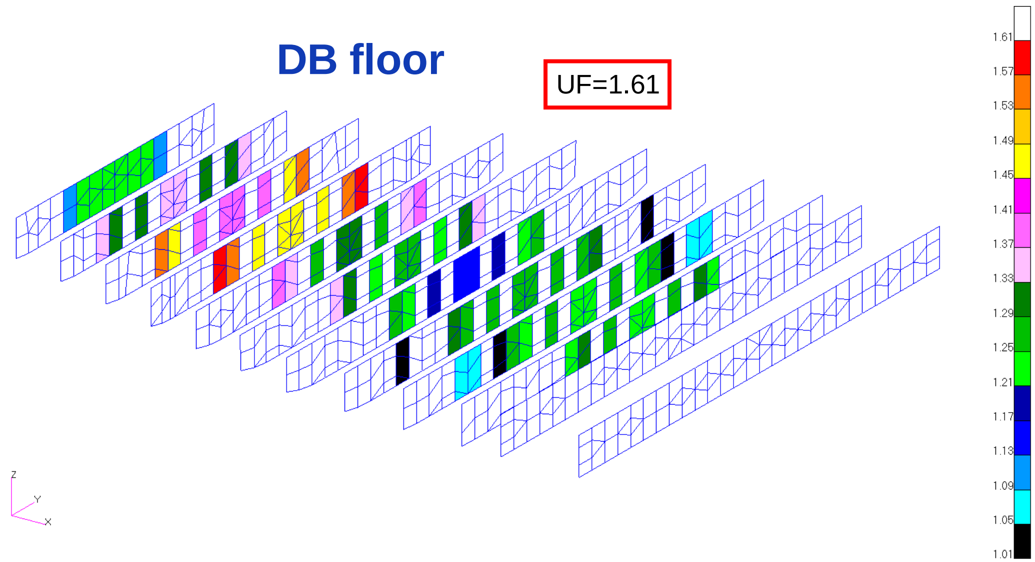
Corrugated BHD



Machinery space Fore. BHD



DB floor

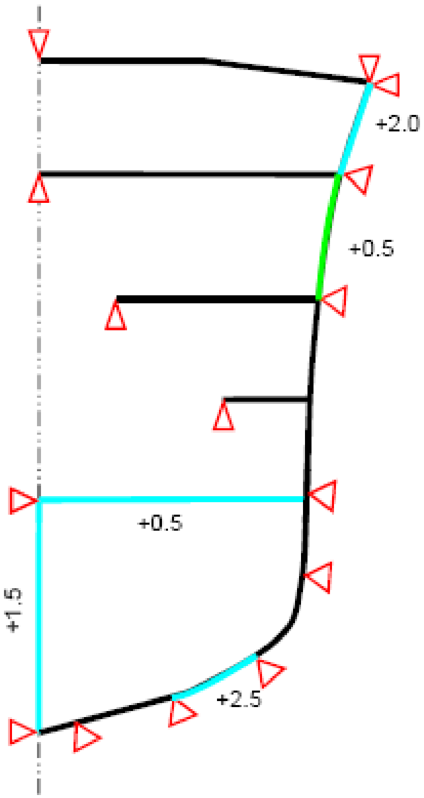


Panamax BC – Fore/Aft end: Prescriptive

For Plates: [mm]

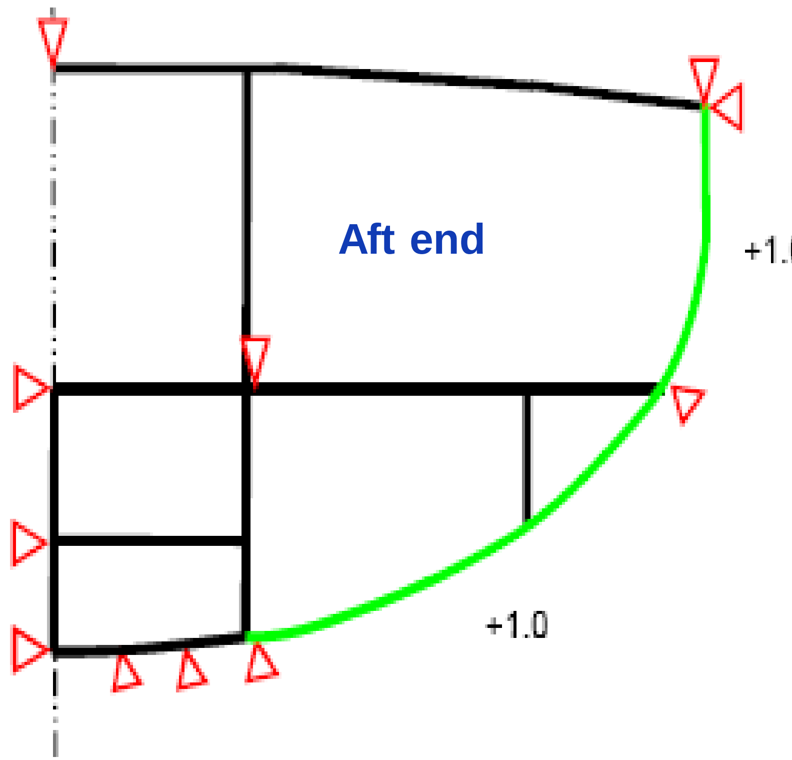
HCSR-As built

Fore end



For Plates: [mm]

HCSR-As built



For stiffeners, no change compared with CSR.

Panamax BC – Machinery Space: Prescriptive

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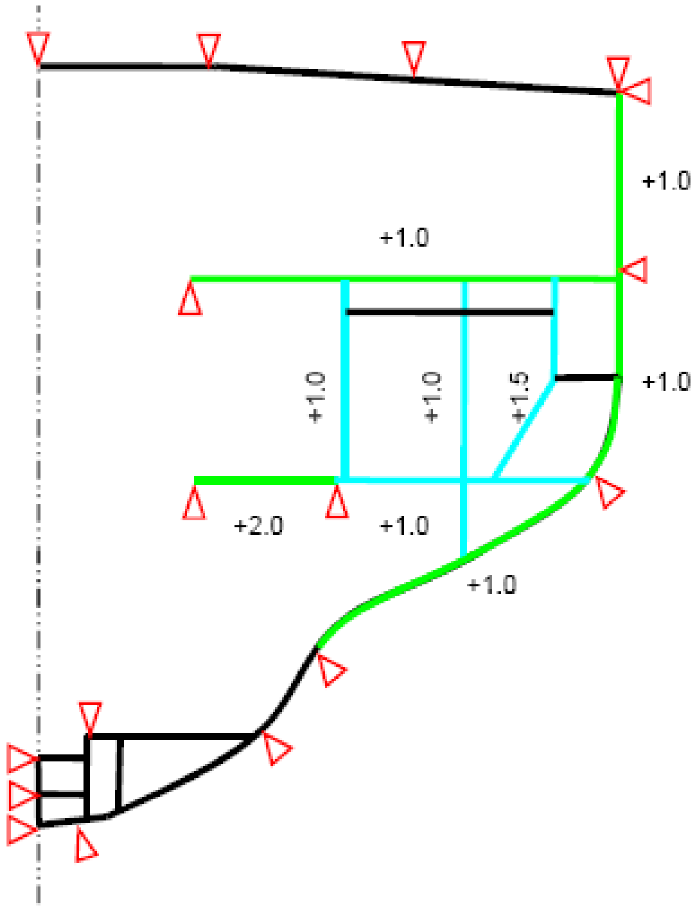
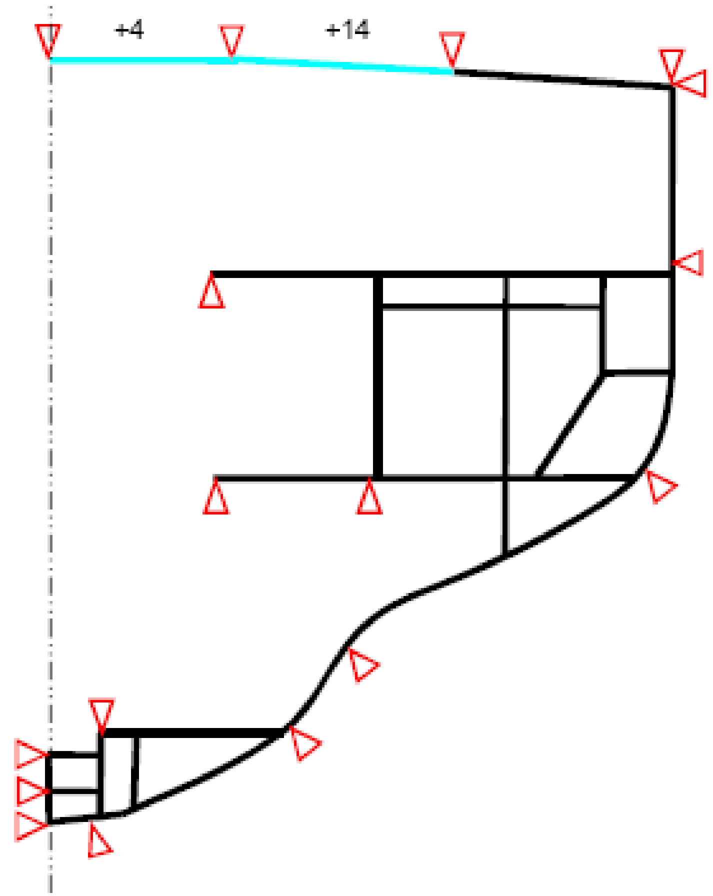
For Plates: [mm]

HCSR-As built



For Stiffeners: [%]

(HCSR-As built)/As-built



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Panamax BC – Summary for CA

- Harbour design load scenario would impact hull girder ultimate strength and some local structural members.
- GRAB requirement for IB, Hopper and lower stool plate is dominant, especially for empty hold due to higher grab weight, and will induce 0.5~2.5mm increase.
- Buckling utilization factor for stiffeners in topside slop plate below 0.1D from deck is increased due to prescriptive buckling requirement.
- Although revised and improved in the 2nd draft version of CSR-H,
  - Fatigue of the longitudinals on strength deck and within 0.1D below deck at side is still a big problem for bulk carriers;
  - Side shell buckling for Panamax is still a big problem for midship area.
- For aftmost cargo hold, FE yielding is dominant for some local area, while FE buckling will induce much increasing.

- Introduction
- Consequence Assessment for Oil Tankers
- Consequence Assessment for Bulk Carriers
- **Technical issues on CSR-H**
  - Weight Increase
  - Hull girder ultimate strength
  - FEA - Foremost cargo hold/tank
  - Fatigue issues on:
    - longitudinal connections
    - Hot spot
  - Rule Min. thickness requirement
  - Prescriptive buckling of longi.
- Conclusions

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Weight Increase for OT

- Weight increase percentage: about 1%~2% within mid cargo region **based on April version**

Criteria \ Size	VLCC	Suezmax	Aframax	Panamax	MR
Prescriptive requirement	+182	+50	+74	+11	+15
FEA	+38	+45	+31	+41	+26
Total	+220	+95	+105	+52	+41
Percentage	1.2%	0.8%	1.9%	1.0%	1.6%

- The detail dominant criteria:
  - Min. Rule thickness requirement
  - Local pressure
  - Buckling issue: prescriptive buckling for longitudinals and FE buckling

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Weight Increase for BC

- Weight increase within mid cargo region **based on April version**

Size / C/H	206K	180K	118K	87K	82K	57K	35K
Typ. Empty C/H	+70.1	+90	+27.5	+42	+37	+40.6	+27.5
Typ. Loaded C/H	+53.1	+75	+26.2	+32	+25	+32.6	+16.9
Typ. Ballast C/H	+32.1	+80	+26.2	+39	+33	+32.6	+16.9

- The detail dominant criteria:
  - GRAB: the formula to determine the plate thickness will be modified, heard from 2013 Tripartite Meeting.
  - Harbour condition for hull girder strength and local scantling
  - Side shell buckling
  - Buckling issue: prescriptive buckling for longitudinals and FE buckling
  - Fatigue issue

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Rule Min. thickness for OT

Elements	Scantling locations	Areas	CSR-H	CSR-OT	Impact on Oil Tankers and brief explanation
Min. net thickness for plating					
Shell	Keel		$7.5+0.03L_2$	$6.5+0.03L_2$	**0.5~1.0mm** ↑ for all OTs with longi. centerline BHD
	Bottom/Side shell/Bilge	Machinery space/ Aft part	$7.0+0.03L_2$	$4.5+0.03L_2$	**0.5~2.0mm** ↑ except shell plating connected with stern frame
		Cargo area	$5.5+0.03L_2$		**0.5~1.0mm** ↑ for regions outside fender contact zone
Inner bottom		Cargo area	$5.5+0.03L_2$	$4.5+0.02L_2$	● **0.5mm** ↑ for some Suezmax ● If IB plating with HT36, more increasing
Min. net thickness for Primary Support Members (PSM)					
Other bottom girder		Fore part	$0.7L_2^{1/2}$	$5.5+0.02L_2$	**0.5mm** ↑ for local areas
Bottom floor		Fore part	$0.7L_2^{1/2}$	$5.5+0.02L_2$	**0.5mm** ↑ for local areas
Aft peak floor			$0.7L_2^{1/2}$	$5.5+0.02L_2$	**0.5mm** ↑
Web plates of other PSM in double hull		Cargo Area	$0.6L_2^{1/2}$	$5.0+0.015L_2$	**0.5~1.0mm** ↑ for upper part of side trans. and platforms in DH
Web and flanges of other PSM		Aft part/Fore part	$0.7L_2^{1/2}$	$6.5+0.015L_2$	**0.5~1.0mm** ↑
		Elsewhere	$0.6L_2^{1/2}$	$5.5+0.015L_2$	Only for VLCC: ● **0.5mm** ↑ for deck trans. and upper part of vert. trans. in C.O.T. ● **0.5mm** ↑ for PSM in machinery space

For OTs with longi. centerline BHD, such increase is not necessary!

Tapering for shell plating:

- **Hull girder strength**
- **Material?**
- **longitudinal spacing?**

Not reasonable for OTs, especially for IB with HT36

Necessary?

From 2013 Tripartite Meeting, the Rule Min. thickness requirement for PSM in cargo tank area is prescribed separately. Different from double hull or other PSM in cargo tank?

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Rule Min. thickness for BC

Elements	Scantling locations	Areas	CSR-H	CSR-BC	Impact on Bulk carriers and brief explanation
Min. net thickness for plating					
Shell	Side shell/ Bilge	Fore Part	$6.5+0.03L_2$	$0.85L^{1/2}$	**0.5mm ↑** for some Panamax and Handysize with HT32 used
		Machinery space/ Aft part	$7.0+0.03L_2$		● **0.5~1.0mm ↑** for most bulk carriers ● If plating with HT36, more increasing
Deck	Platform deck	Machinery space	3.3+0.0067s	6.5	A great increase (up to **2.5mm ↑**) for some bulk carriers
Other	Other plates in general		$4.5+0.01L_2$	None	A great increase (up to **2.5mm ↑**) for some bulk carriers
Min. net thickness for Primary Support Members (PSM)					
D.B centerline girder		Elsewhere (excl. Machinery space)	$5.5+0.025L_2$	$0.6L_2^{1/2}$	**1.5~2.0mm ↑** for most bulk carriers, generally in pipe tunnel or foremost CH
Other bottom girder		Elsewhere (excl. Machinery space/ Fore part)	$5.5+0.02L_2$	$0.6L_2^{1/2}$	**0.5~1.0mm ↑** for most bulk carriers, but only local areas in the middle of each cargo hold

Tapering for shell plating:
- **Hull girder strength**
- **Material?**
- **longitudinal spacing?**

Proposal 1:
Lower the requirement for shell plating in machinery space and aft part;

Proposal 2:
Separate the requirement for OT and BC for keel plate, inner bottom, PSM in cargo tank area.

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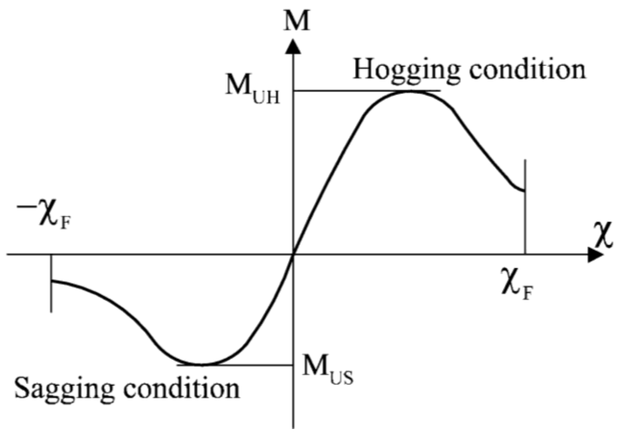
Hull girder ultimate strength 1

$$M = \gamma_S M_{sw-U} + \gamma_W M_{wv} \qquad M \le \frac{M_U}{\gamma_R}$$

γ_R : Partial safety factor

$$\gamma_R = \gamma_M \gamma_{DB}$$



CSR	$\gamma_R = 1.1$
CSR-H	$\gamma_R = \gamma_M \cdot \gamma_{DB}$
	$\gamma_M = 1.1$

	Hogging		Sagging
	BC-A	BC-B,BC-C,OT	All
γ_{DB}	1.25	1.1	1.0
γ_R	1.375	1.21	1.1
CSR-H/CSR for γ_R	1.25	1.1	1.0

Hull girder ultimate strength 2

- For sagging condition, the same requirement for hull girder ultimate strength by CSR-H and CSR except for the calculation of Mu.
- For hogging condition:
  - If **M/Mu<=0.727** (**M/(Mu/ γ_R)<=0.8**) for BC-A bulk carriers by CSR, such carriers could meet the hull girder ultimate strength requirement by CSR-H;
  - If **M/Mu<=0.826** (**M/(Mu/ γ_R)<=0.9**) for oil tankers and BC-B and BC-C bulk carriers by CSR, such carriers could meet the hull girder ultimate strength requirement by CSR-H;

Vessels	Design load scenario	Hog or Sag	Msw (kNm)	Mwv (kNm)	Mu (kNm)	M/(Mu/ γ_R)	
						CSR	CSR-H
180K_BC	Seagoing	Hog	4650000	6330292	13143140	0.832	**1.040**
	Flooding	Hog	6585000	5064234		0.860	**1.075**
206K_BC	Seagoing	Hog	5630940	7351198	19678421	0.808	**1.010**

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Prescriptive buckling of longitudinals 1

CSR-OT

3.3.2.2 The buckling utilisation factor for column buckling of stiffeners is to be taken as:

$$\eta = \frac{\sigma_x + \sigma_b}{\sigma_{yd}}$$

Where:

σ_x compressive axial stress in the stiffener, in N/mm², in way of the midspan of the stiffener. See *Section 3/5.2.3.1*

CSR-BC

4.2.1 Checking criteria

The longitudinal and transverse ordinary stiffeners are to comply with the following criteria:

$$\frac{\sigma_a + \sigma_b}{R_{eH}} S \le 1$$

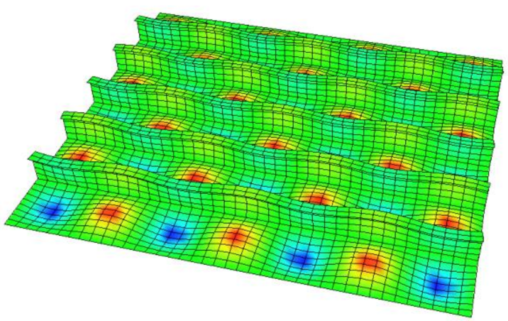
σ_a : Uniformly distributed compressive stress, in N/mm² in the direction of the stiffener axis.

$\sigma_a = \sigma_n$ for longitudinal stiffeners

$\sigma_a = 0$ for transverse stiffeners

σ_n : Normal stress resulting from hull girder bending, in N/mm²

CSR-H



2.3.4 Ultimate buckling capacity

When $\sigma_a + \sigma_b + \sigma_w > 0$, the ultimate buckling capacity for stiffeners is to be checked according to the following interaction formula:

$$\frac{\gamma_c\ \sigma_a + \sigma_b + \sigma_w}{R_{eH}} S = 1$$

where:

σ_a : Effective axial stress, in N/mm², at mid span of the stiffener, acting on the stiffener with its attached plating.

$$\sigma_a = \sigma_x \frac{s\ t_p + A_s}{b_{eff1}\ t_p + A_s}$$

σ_x : Nominal axial stress, in N/mm², acting on the stiffener with its attached plating.

- For FE analysis, σ_x is the FE corrected stress as defined in [2.3.6] in the attached plating in the direction of the stiffener axis.
- For prescriptive assessment, σ_x is the axial stress calculated according to Ch 8, Sec 3, [2.2.1] at load calculation point of the stiffener, as defined in Ch 3, Sec 7, [3].

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Prescriptive buckling of longitudinals 2

$$\sigma_a = \sigma_x \frac{st_p + A_s}{b_{eff1}t_p + A_s}$$

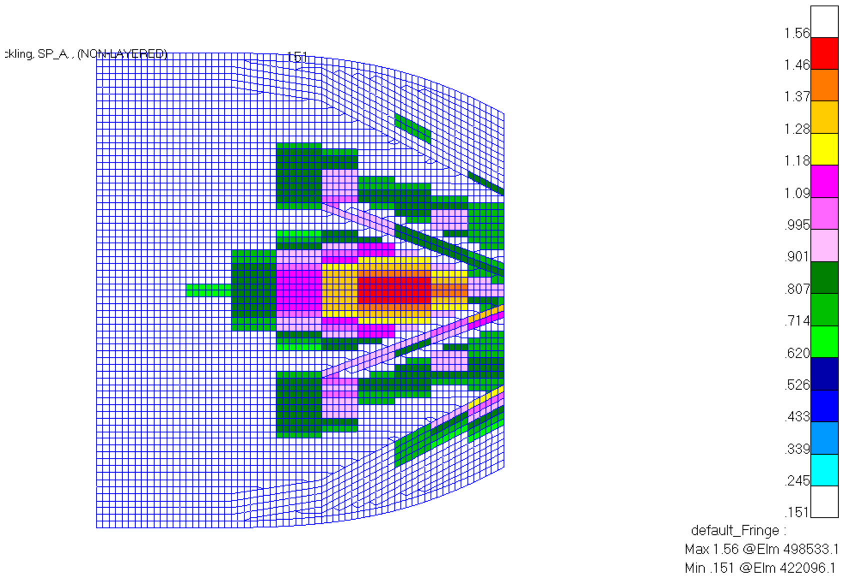
$$F = \frac{st_p + A_s}{b_{eff1}t_p + A_s}$$

TB of CSR-H:
Account for the effective width of attached plate

Vessels/Location		s (mm)	t_p (mm)	A_s (mm^2)	b_{eff1} (mm)	F (Factor)	CSR-H η_{act}	CSR		CSR-H/ CSR
								η_{column}	$\eta_{torsion}$	
VLCC	DL	876.8	14.5	6508	669.0	1.186	1.02	0.73	0.89	1.15
	IHL	800	13.0	5120	605.6	1.195	1.07	0.73	0.89	1.20
Aframax	DL	820.8	14.0	6088	641.9	1.166	0.91	0.72	0.87	1.05
	IHL	790	11.0	2860	548.3	1.299	1.12	0.68	0.88	1.27
	LL	750	11.0	3042	528.8	1.275	1.04	0.67	0.86	1.21
Panamax	DL	786	11.5	2890	552.6	1.290	1.08	0.74	0.84	1.29
	IHL	670	9.0	2453	452.3	1.300	0.96	0.62	0.75	1.28
	LL	640	9.5	2098	459.5	1.265	1.11	0.71	0.82	1.35
MR	DL	800	10.0	2944	559.2	1.283	1.05	0.71	0.80	1.31
	IHL	648.8	9.5	2223	512.6	1.182	0.96	0.65	0.74	1.30
	LL	781.3	9.5	2613	549.3	1.282	1.06	0.68	0.74	1.43
Capesize	TWL	890	12.0	3167	552.7	1.413	1.27	1.00	0.70	1.27
Panamax	TWL	820	13.0	4214	587.1	1.255	1.00	0.95	0.75	1.06
Handysize	TWL	760	10.0	4260	487.9	1.298	1.03	0.92	0.72	1.12

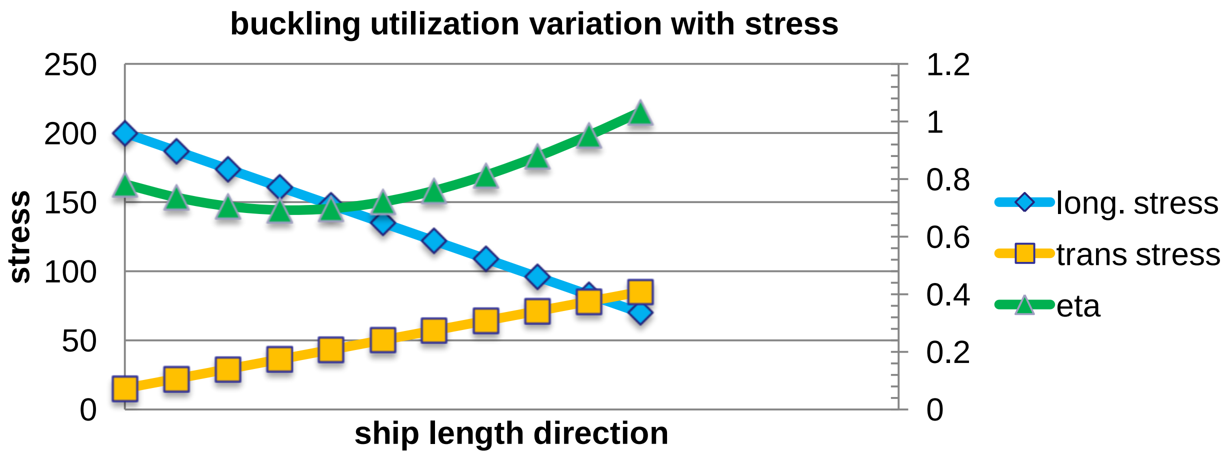
- Such requirement will induce the scantling increase for the longitudinals at the upper deck area and 0.1D below, similar to oil tankers and bulk carriers.

FEA - Foremost cargo hold/tank



Buckling results comparison

Critical Load case	Panel in midship cargo tank	Panel in foremost cargo tank	
A1-HSM1		original	modified
σ_x (MPa)	205.0	68.3	60.4
σ_y (MPa)	13.2	85.0	78.2
τ (MPa)	14.5	1.4	1.6
t_{net} (mm)	14.5	12	14.5
Material	HT32	HT32	HT32
Buckling factor	0.811	1.331	0.949
Allowable factor	1.0	1.0	1.0
Buckling Ratio	0.811	1.331	0.949



The transverse stresses induced by external and internal loads in foremost COT are a bit higher than that in midship COT, which may be decreased.

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Fatigue issues on longi. connection 1

- Average fatigue life in year for longitudinal end connections for bulk carriers:

Vessels	C/H	Fatigue life (CSR)	Fatigue life (CSR-H)	C/H	Fatigue life (CSR)	Fatigue life (CSR-H)
Capesize1	Empty	47.5	21.0	Loaded	51.5	19.9
Capesize2	Empty	47.3	21.0	Loaded	47.6	23.6
Babycape	Empty	43.6	35.7	Loaded	43.8	22.1
Post-Panamax	Empty	76.1	37.2	Loaded	52.0	28.2
Panamax	Empty	54.7	13.5	Loaded	53.0	33.0
Handysize1	Empty	>50	26.0	Loaded	>50	32.0
Handysize2	Empty	>100	27.5	Loaded	>100	29.7

- For bulk carriers, fatigue life for the longitudinal connection by CSR-H is lower than that by CSR-BC.

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Fatigue issues on longi. connection 2

- Average fatigue life in year for longitudinal end connections for oil tankers:

Vessels	Fatigue life (CSR)	Fatigue life (CSR-H)
VLCC	34.8	29.1
Suezmax	31.3	33.5
Aframax	30.3	33.3
Panamax	25.8	35.5
MR	70.8	53.9

- For oil tankers, similar fatigue life for the longitudinal connection both for CSR-H and CSR-OT.

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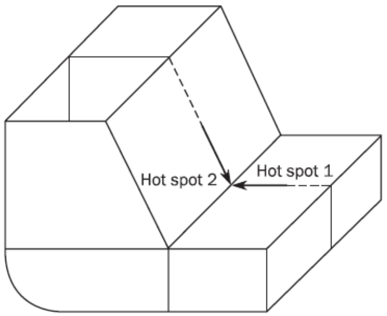
Fatigue issues on hot spot

- For hopper lower knuckle area:



Hot spot 1 (year)		
Vessels	Fatigue life (CSR)	Fatigue life (CSR-H)
Capesize1	>25.0	27.2
Capesize2		47.6
Post-Panamax		>100
Panamax		9.6 (Empty)
Handysize1		28.1
Handysize2		73.9

Hot spot 1 (year)		
Vessels	Fatigue life (CSR)	Fatigue life (CSR-H)
VLCC	>25.0	25.4
Suezmax		35.1
Aframax		18.5
Panamax		7.8
MR		17.1

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Conclusions

- Based on April version, the estimated weight increase for cargo area is about 1%~2% for oil tankers and about 2%~3% for bulk carriers, where the increase by prescriptive requirement is normally more than that by FE analysis except for corrugated bulkhead.
- How to solve the other issues may need further detail technical discussion between Owners, shipbuilders and IACS, based on not only theory but shipping experience and damage report.
- Although much reasonable modification for 2nd external draft (April version), there are still some revisions after the 2nd external review by industry. Essential time for external review and feedback for such revisions are to be ensured for industry by IACS.

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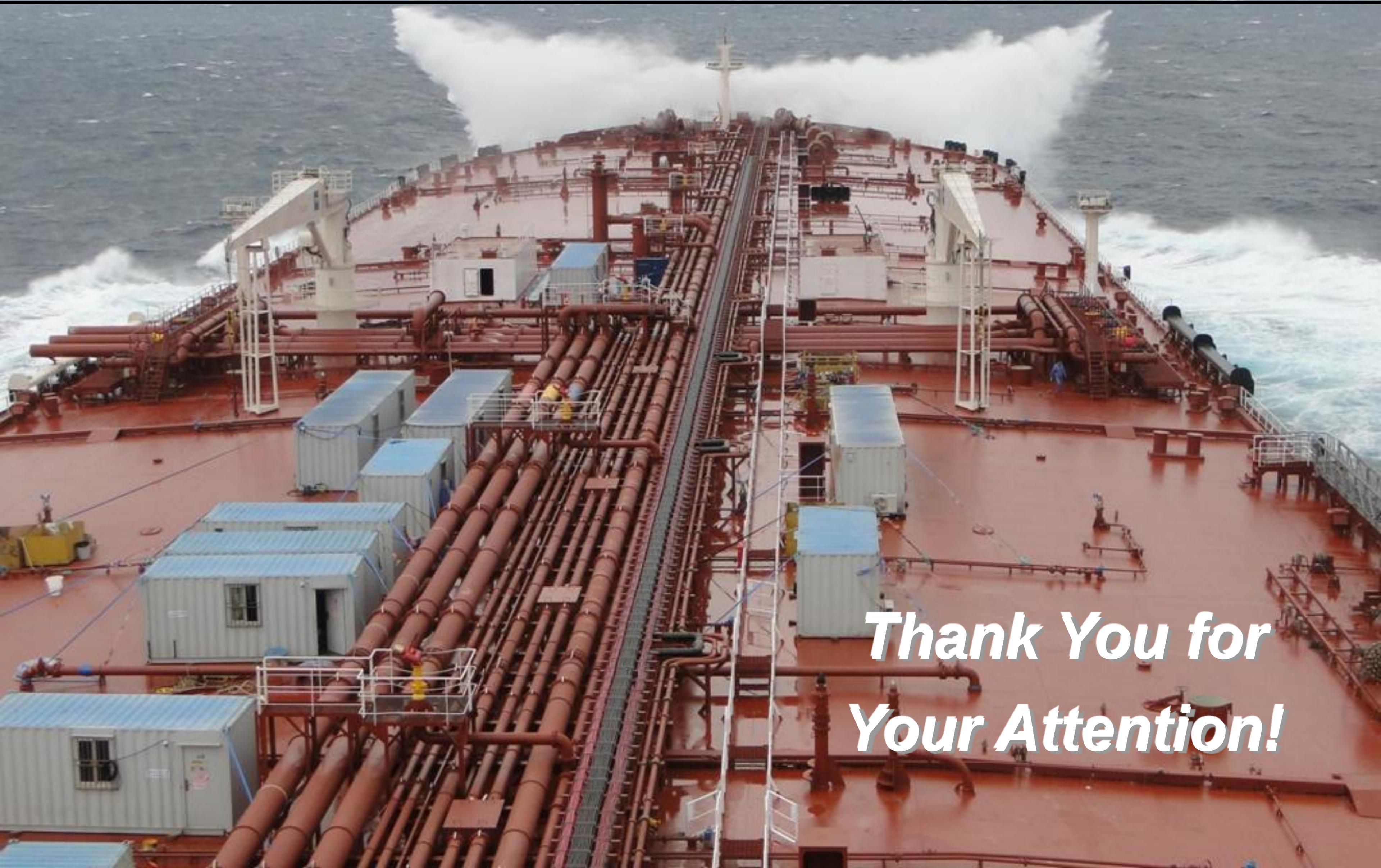

Thank You for Your Attention!