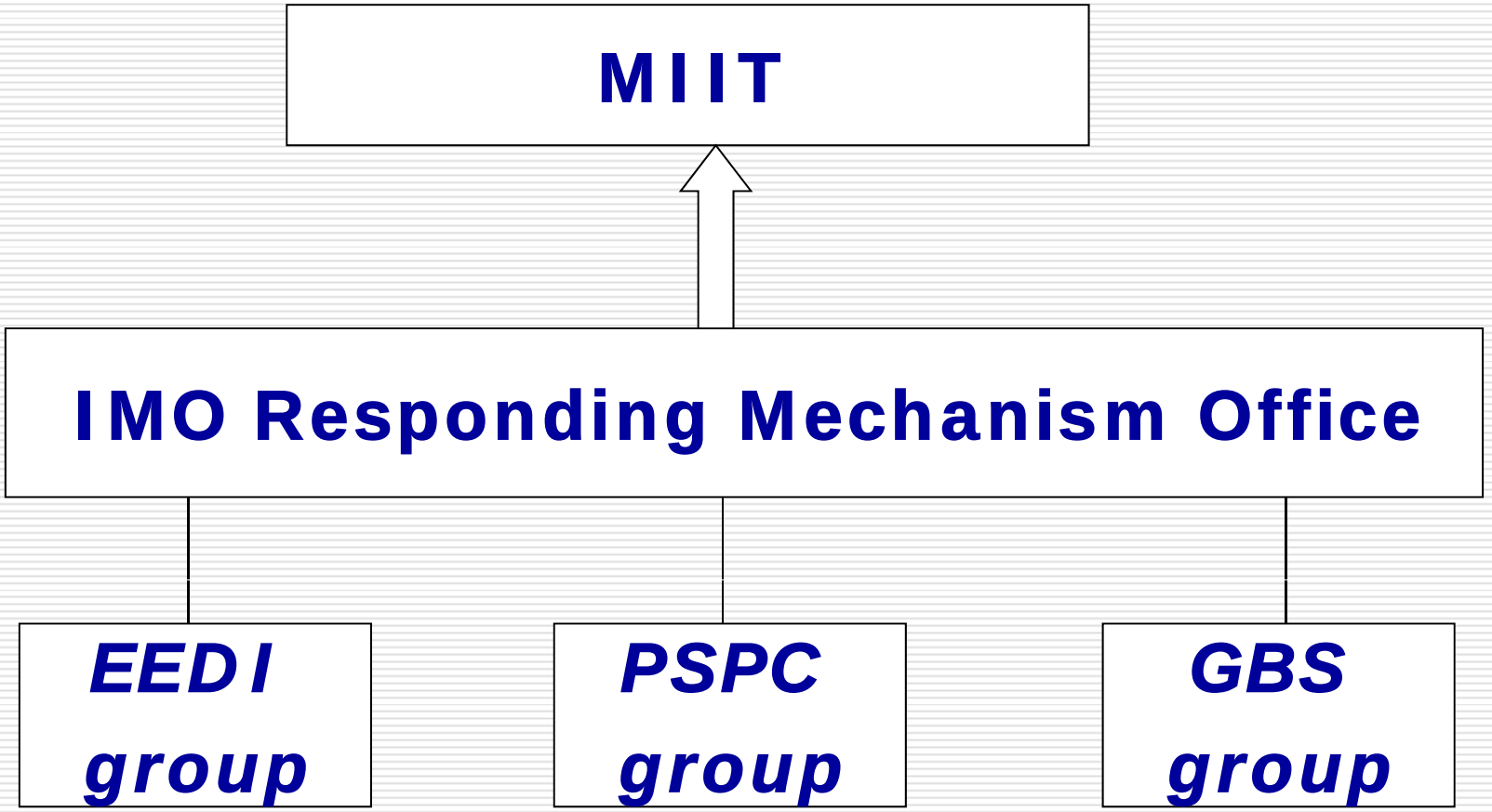
Harmonized Structural Rules and Ship Construction Files

CONTENTS

IMO Responding Mechanism



GBS & HSR

GBS : Goal based ship construction standard

2002 IMO89, proposed by Bahamas & Greece

2004 MSC79, Tier I and Tier II developed

2005 MSC80, Basic principles for GBS .

2009 MSC86, “GBS SOLAS enter into force at 2012”

GBS & HSR

Five-Tier system

Tier I: Goals

High-level objectives to be met

Tier II: Functional requirements

Criteria to be satisfied to conform to the goals

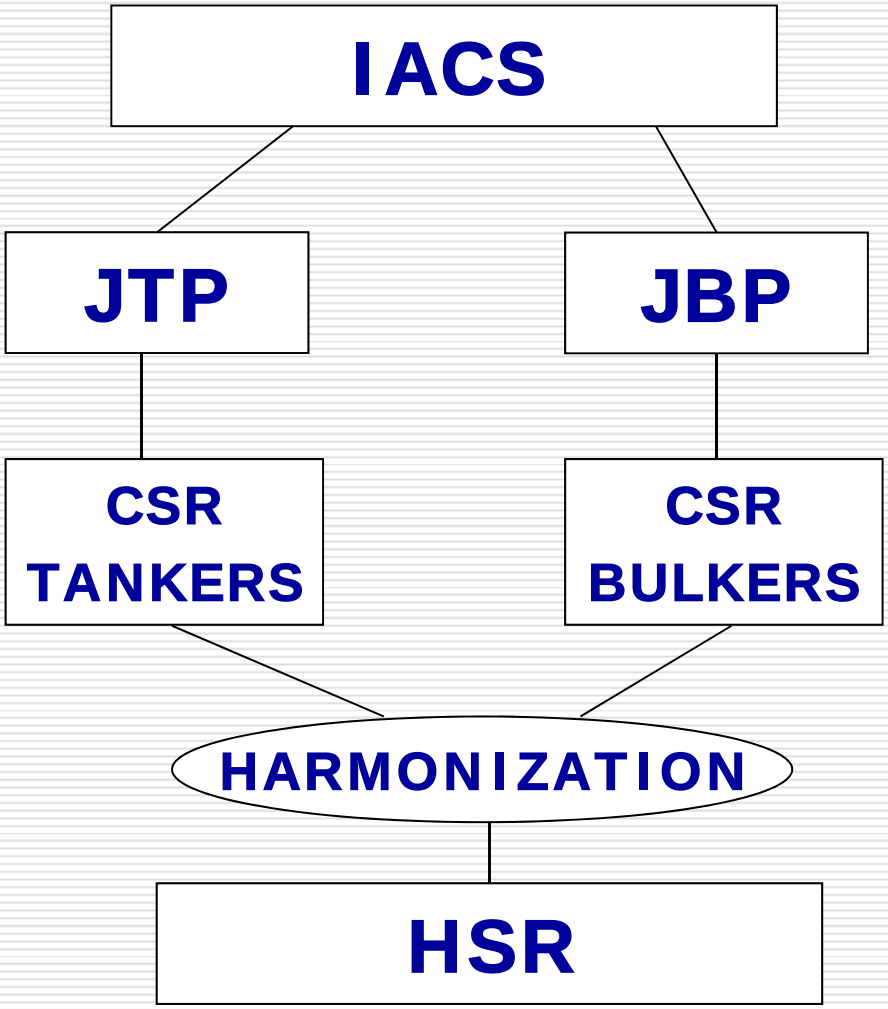
Tier III: Verification of conformity

Five-Tier system

Tier IV: Rules & regulations for ship design and construction

Tier V: Industry practices & standards

GBS & HSR



GBS & HSR

Benefit to IMO:

Reduced effort to undertake the verification procedure.

Benefit to builders:

Less impact on the ship structure design and construction

Effective date of CSR: April 1st 2006

Common Structural Rules for Double Hull Oil Tankers

Rules

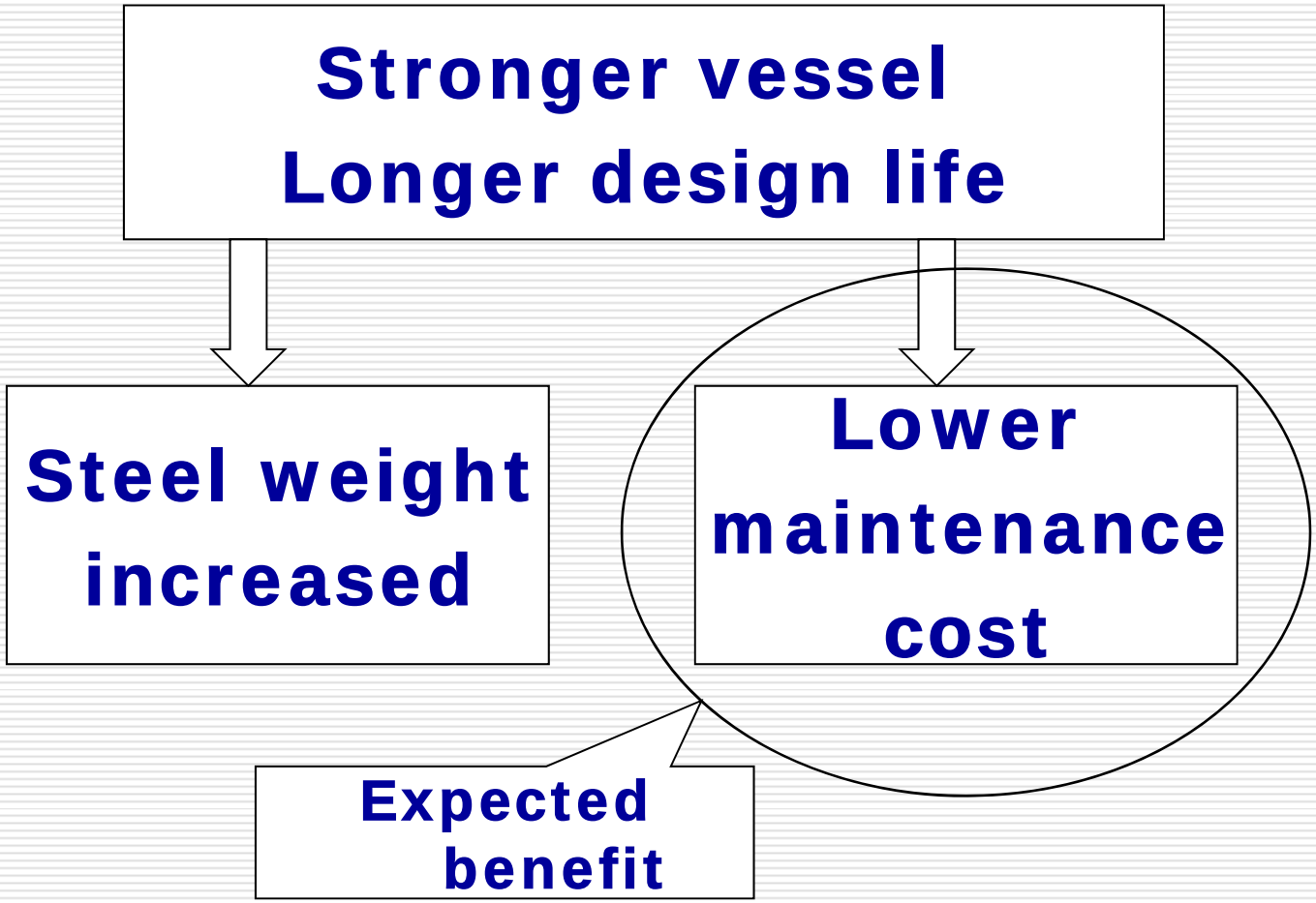
Common Structural Rules for Bulk Carriers

Rules

GBS & HSR

- **common minimum structural requirements**
- **stronger ships of transparent design**
- **supported by published technical background documents**
- **rational link between the CSR and ships in service**

CSR Impact


Stronger vessel
Longer design life
Steel weight increased
Lower maintenance cost
Expected benefit

GBS & HSR

	GBS Tier II	CSR
Design Life:	25 years	25 years
Environmental condition:	North Atlantic 10^{-8}	North Atlantic 10^{-8}
Fatigue life:	Yes	Yes
Corrosion addition:	net scantling approach	net scantling approach

GBS & HSR

Two sets of existing CSR are developed independently.

Different approach for some key items.

- **Wave loads**
- **Buckling strength**
- **Fatigue assessment**

GBS & HSR

Wave load:

Both are developed on the basis of the hydrodynamic study with North Atlantic wave data.

Formulae of wave pressure and ship motions are not similar.

Buckling strength:

In CSR bulk carriers, the prescriptive formulae are used.

- longitudinally framed plating

$$\left(\frac{|\sigma_x| S}{\kappa_x R_{eH}}\right)^{e1} + \left(\frac{|\tau| S\sqrt{3}}{\kappa_\tau R_{eH}}\right)^{e3} \le 1.0$$ for stress combination 1 with $\sigma_x = \sigma_n$ and $\tau = 0.7\tau_{SF}$

$$\left(\frac{|\sigma_x| S}{\kappa_x R_{eH}}\right)^{e1} + \left(\frac{|\tau| S\sqrt{3}}{\kappa_\tau R_{eH}}\right)^{e3} \le 1.0$$ for stress combination 2 with $\sigma_x = 0.7\sigma_n$ and $\tau = \tau_{SF}$

- transversely framed plating

$$\left(\frac{|\sigma_y| S}{\kappa_y R_{eH}}\right)^{e2} + \left(\frac{|\tau| S\sqrt{3}}{\kappa_\tau R_{eH}}\right)^{e3} \le 1.0$$ for stress combination 1 with $\sigma_y = \sigma_n$ and $\tau = 0.7\tau_{SF}$

$$\left(\frac{|\sigma_y| S}{\kappa_y R_{eH}}\right)^{e2} + \left(\frac{|\tau| S\sqrt{3}}{\kappa_\tau R_{eH}}\right)^{e3} \le 1.0$$ for stress combination 2 with $\sigma_y = 0.7\sigma_n$ and $\tau = \tau_{SF}$

Buckling strength:

In CSR tankers, for stiffened panels subjected to combined stress fields, the advanced buckling assessment method is to be used.

Buckling strength:

the advanced buckling assessment method is to consider the effects like:

(a) non linear geometrical behaviour

(b) inelastic material behaviour

(c) initial imperfections (geometrical out-of flatness of plate and stiffeners)

(d) welding residual stresses

(e) interactions between structural elements; plates, stiffeners, girders etc.

(f) simultaneous acting loads; bi-axial compression / tension, shear and lateral pressure

(g) boundary conditions

Fatigue assessment:

Two sets of CSR have same philosophy.
Based on the following assumption:

- **SN curve approach for the fatigue strength capacity**
- **The use of cyclic stresses derived from specified loading conditions**
- **Designed fatigue life equal to 25 years**
- **A long-term stress load history represented by a two-parameter Weibull probability distribution**
- **Palmgren-Miners summation method for accumulative damage ratio calculation**

Fatigue assessment:

Different implement results in diverse aftermath.

- **Stress range approach**
- **Mean stress effect**
- **Grinding effect**
- **Relative deflection effect**

GBS & HSR

Stress range approach:

CSR Bulk carrier:

Notch stress + unique SN curve

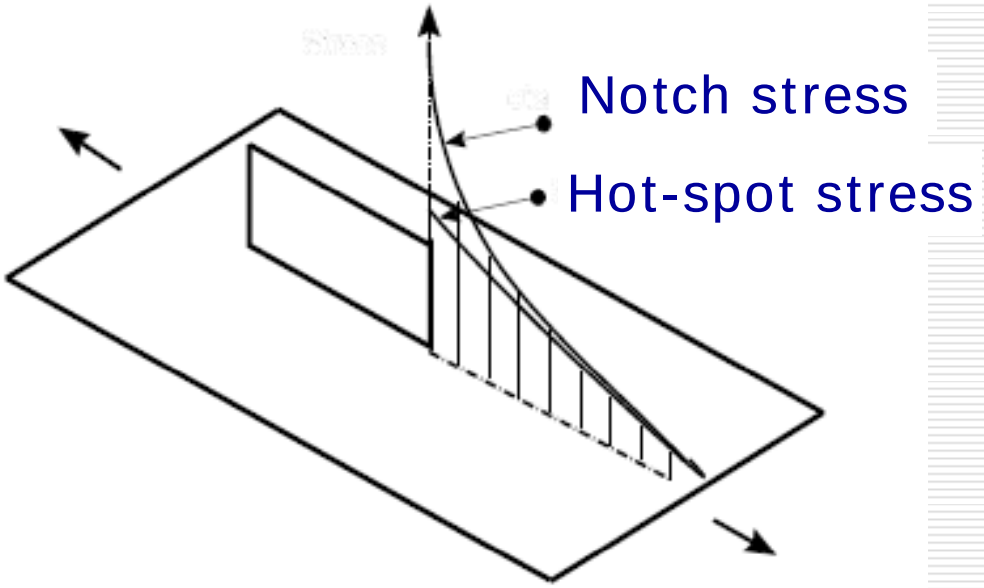
CSR Tankers:

Nominal stress + selection of SN curve

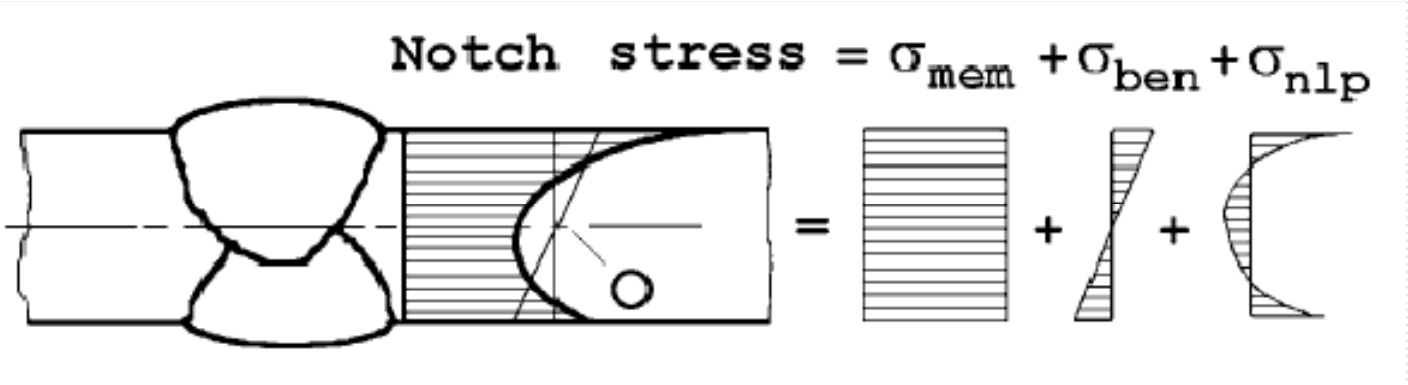
Notch stress:

Notch stress is defined as the peak stress at the weld toe taking into account stress concentrations due to the effects of structural geometry as well as the presence of welds.

Notch stress:



Notch stress:



S-N Curve:

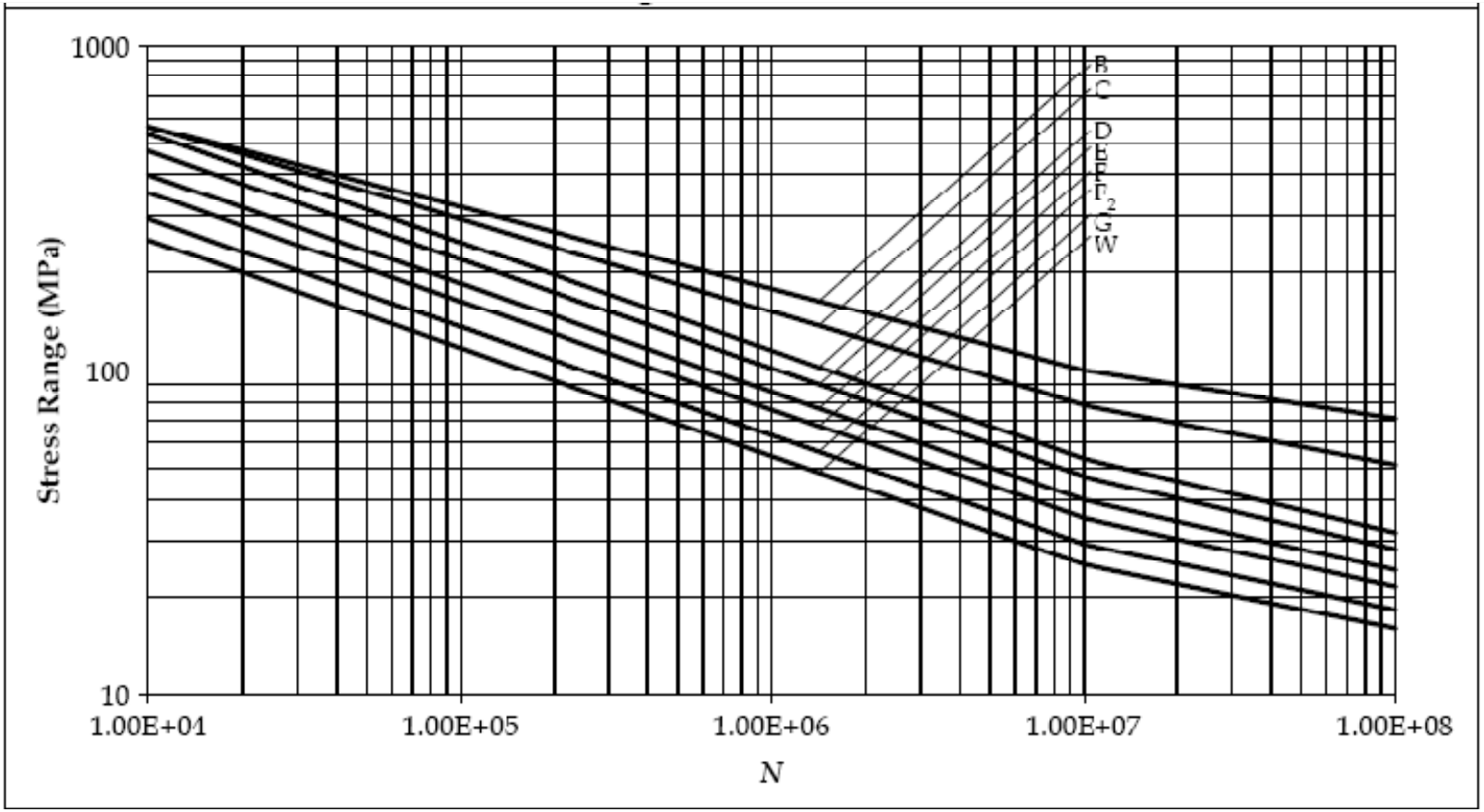
Since the notch stress approach used the peak stress, same S-N curve can be used irrespective of the type of structural detail.

K : S-N curve parameter, taken equal to $1.014 \cdot 10^{15}$

Nominal stress:

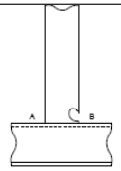
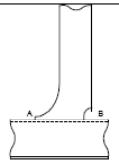
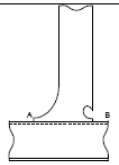
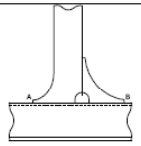
Nominal stress is the stress calculated in the sectional area under consideration, disregarding the local stress raising effects of the welded joint, but including the stress raising effects of the macro-geometric shape of the component in the vicinity of the joint, such as e.g. large cutouts.

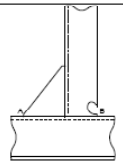
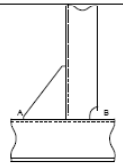
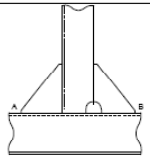
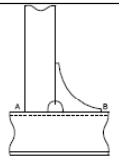
S-N Curve:


1000
100
10
Stress Range (MPa)
1.00E+04
1.00E+05
1.00E+06
1.00E+07
1.00E+08
N

S-N Curve:

Curves E, F, F2, G are used according to the type of detail to be analyzed

ID	Connection type	Critical Locations Notes (1), (2), (3) A	B
2		F2	F2(4)
3		F	F2
4		F	F2(4)
5		F	F

ID	Connection type	Critical Locations Notes (1), (2), (3) A	B
6		F2	F2(4)
7		F2	F2
8		F2	F2
9		F2	F

Mean stress effect:

Both rules considered the mean stress effect but in different way.

CSR Tankers

$$S_{Ri} = \sigma_{tensile} - 0.6\,\sigma_{compressive} \quad \text{if } \sigma_{compressive} < 0 \text{ and } \sigma_{tensile} > 0$$

$$S_{Ri} = S \quad \text{if } \sigma_{compressive} \geq 0$$

$$S_{Ri} = 0.6S \quad \text{if } \sigma_{tensile} \leq 0$$

Mean stress effect:

Both rules considered the mean stress effect but in different way.

CSR Bulk carriers

$f_{mean,j}$: Correction factor for mean stress:

- for hatch corners $f_{mean,j} = 0.77$
- for primary members and longitudinal stiffeners connections, $f_{mean,j}$ corresponding to the condition "j" taken equal to:

$$f_{mean,j} = \max\left\{0.4, \left[\max\left(0, \frac{1}{2} + \frac{-\ln\left(10^{-4}\right)}{4}\frac{\sigma_{m,j}}{\Delta\sigma_{W,j}}\right)\right]^{0.25}\right\}$$

Grinding effect:

CSR bulkers take into account the effect of grinding effect. It was included in the notch factors.

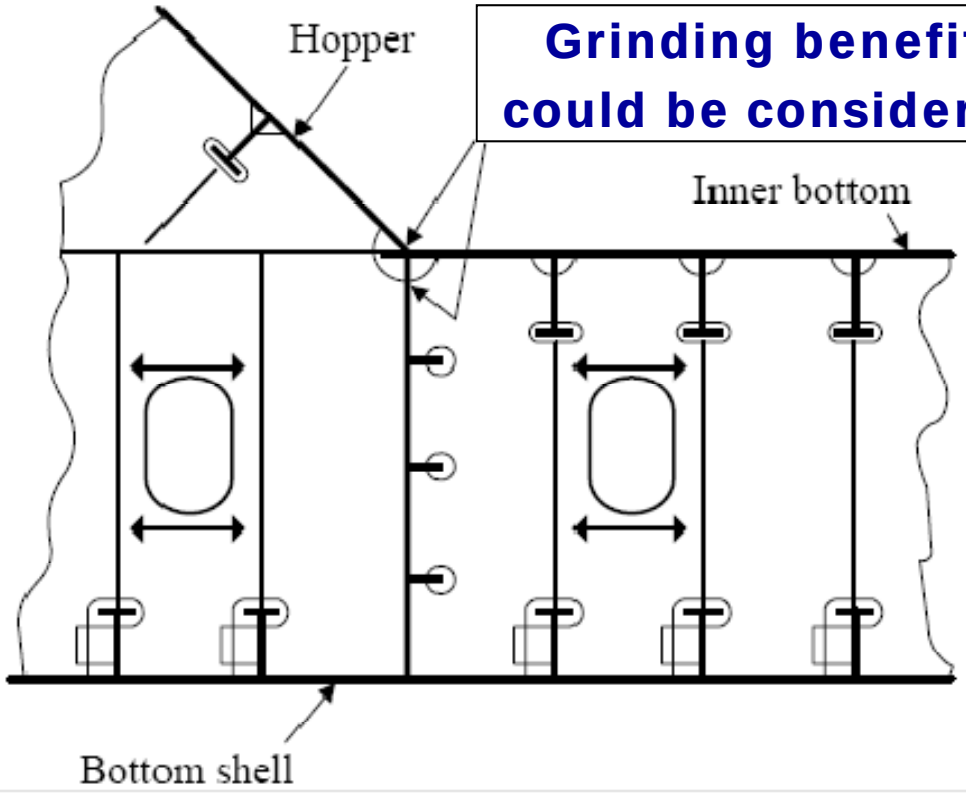
Table 1: Fatigue notch factors K_f *(RCN 3, effective from 12 Sept 2008)*

Subject	Without weld grinding	With weld grinding (not applicable for ordinary stiffeners and boxing fillet welding[1])
Butt welded joint	1.25	1.10
Fillet welded joint	1.30	1.15[2]
Non welded part	1.00	-

Grinding effect:

CSR tankers didn’t consider benefits of weld toe grinding in general. However, an exception may be made for the weld connection between the hopper plate and inner bottom if the calculated fatigue life is greater than one half of the design fatigue life or minimum 17 years excluding the grinding effects, whichever is greater.

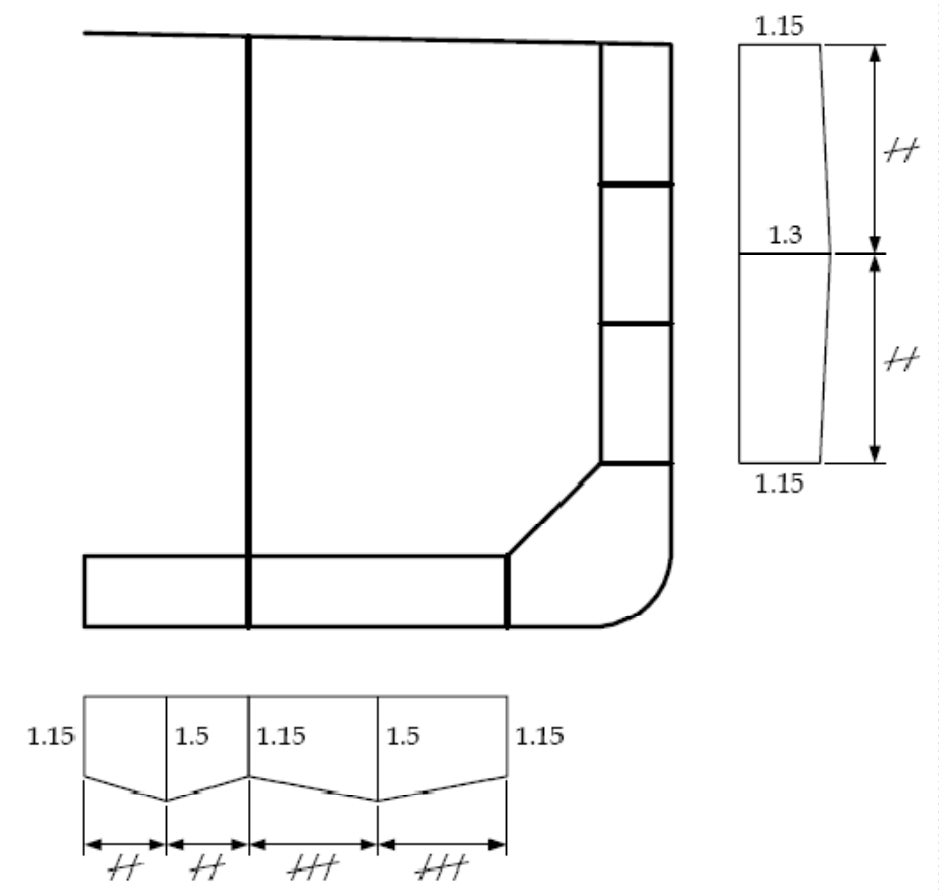
Grinding effect:



Relative deflection effect:

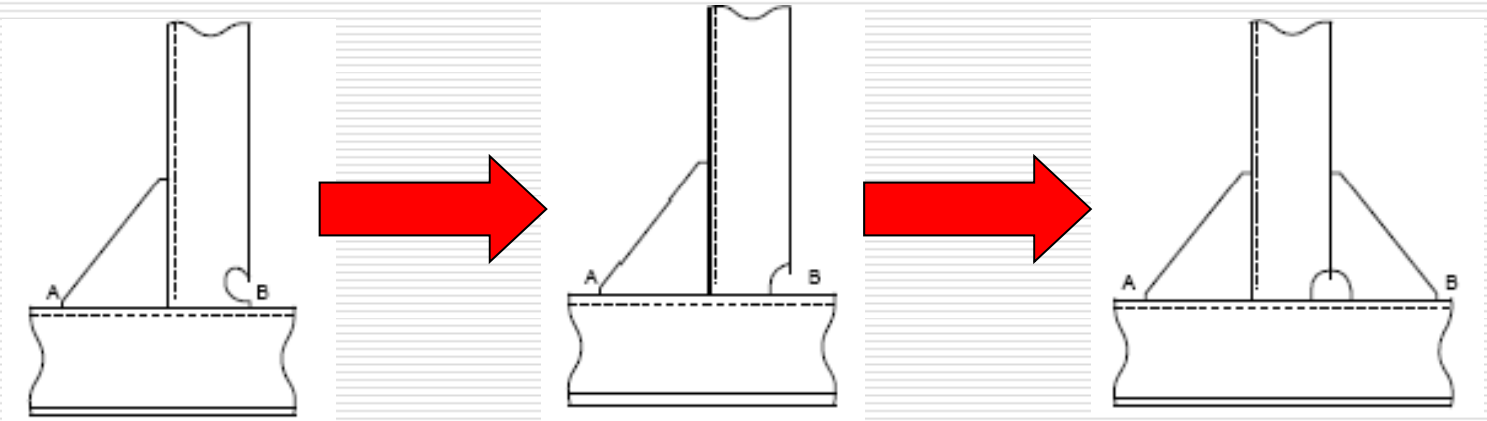
Both rules considered this effect. CSR tankers provided a simplified method.

Relative deflection effect:

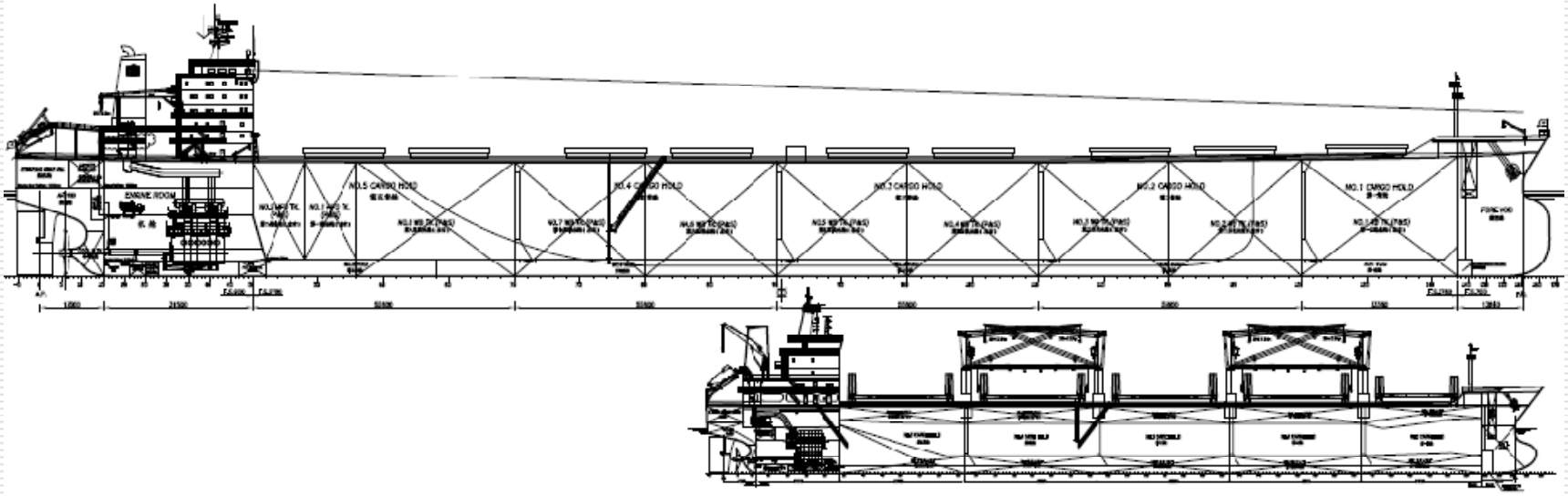


Unified implement should be developed in HSR.

It could influence the joints detail design.



Critical ship length for fatigue requirement is reduced in CSR.



GBS & HSR

GBS Tier II requirements not covered by CSR.

Residual strength

Structure redundancy

Etc.

Residual strength

Ships should be designed to have sufficient strength to withstand the wave and internal loads in specified damaged conditions such as collision, grounding or flooding.

CSR Tankers:

"all strength calculations are based on the assumption that the structure is intact. The residual strength of the ship in a structurally damaged condition is not assessed."

CSR Bulkers:

The strength after flooding was considered.

Requirements are from the IACS URS.

Residual strength evaluated using intact structure.

Residual strength:

Ships should be of redundant design and construction so that localized damage of any one structural member will not lead to immediate consequential failure of other structural elements leading to loss of structural and watertight integrity of the ship.

GBS & HSR

Technical issues in 5 categories

a) **Fully covered by CSR**

b) **Fully covered by CSR, TB to be verified**

c) **Partly covered by CSR**

d) **Not covered by CSR, new rule requirements needed**

e) **Not covered by CSR, but covered by IMO documentation**

GBS & HSR

1 July 2011	GBS SOLAS amendments deemed to be accepted
July 2012	Commences work on the establishment of the GBS verification scheme
1 Jan. 2012	GBS SOLAS amendments enter into force
Jan.2012 to Dec.2015	Secretariat organizes and finalized all audits requested
31 Dec.2013	Deadline for the receipt of initial verification requests at IMO
2014	MSC reviews progress made in GBS inplementation
May 2016	MSC96 takes decisions on conformity with GBS for all rules submitted
1 July 2016	GBS SOLAS amendments become applicable

GBS & HSR

Will the HSR be the final version for GBS?

When will the FSA be introduced in GBS Rules?

Ship Construction File

"A Ship Construction File with special information on how the functional requirements of the goal based ship construction standards for bulk carriers and oil tankers have been applied in the ship design and construction shall be provided upon delivery of a new ship."

Ship Construction File

GBS Tier II Functional requirements:

Design Transparency required necessary documentation to be available.

GBS & SCF

The available documentation should include the main goal-based parameters, including:

- Areas requiring special attention throughout the ship’s life.
- All design parameters limiting the operation of a ship.
- Any alternatives to the rules, including structural details and equivalency calculations.
- Approved and stamped “As built” drawings and information which incorporate all design alteration approved by the classification society or flag State during the construction process.
- Procedures for updating the Ship Construction File over the lifetime of the ship throughout the ship’s life.
- Net scantlings for all the structural members.
- Minimum hull girder section modulus along the length of the ship which has to be maintained throughout the life of the ship ship’s life.

SCF framework:

- SCF onboard
- SCF Supplement ashore

GBS & SCF

Points under discussion:

- Who’s going to run the ashore archive?
- How to supervise the access control?
- Who’s going to choose the archive?

Thanks!