Tanker Structure Cooperative Forum
2010 Shipbuilders Meeting

Information Paper on Cargo Tank Corrugated Bulkhead Damages of Double Hull Tankers

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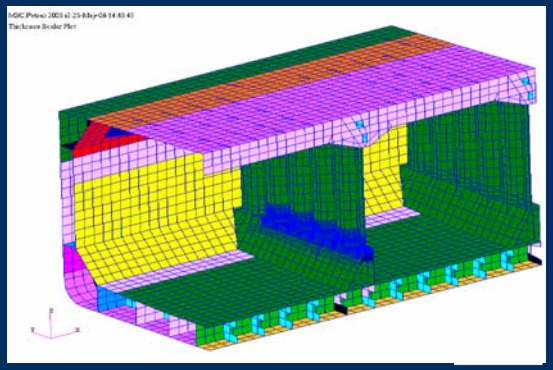
LIFE MATTERS

Today

- Background
- The Information Paper
- Corrugated bulkheads & Critical Areas
- Damage Cases
- Summary



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Background

- TSCF Members reported problems with cracking of corrugated bulkheads.
- Proposal for a work item to produce an information paper regarding issues with corrugated bulkheads …
- The information paper has not been approved by the TSCF Steering Committee.

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Cargo tank corrugated bulkhead damages of Double Hull Tankers

Information Paper on Cargo Tank Corrugated Bulkhead Damages of Double Hull Tankers

SUMMARY

The paper reviews current corrugated bulkhead design practise and provides details of damage experience of TSCF members. Failure modes and critical areas of high stress or stress concentration are discussed and recommendations for design improvement offered.

1. Introduction

The paper covers

Typical bulkhead arrangement, description, and a discussion of the various corrugated bulkhead arrangements.

Types of damages are described in general terms. Failure modes considered are fractures, buckling, deformation, and material wastage are described.

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Cargo tank corrugated bulkhead damages of Double Hull Tankers

The paper covers:

Damage experience covering 23 cases, providing a description of the damage, the repair carried out, probable cause identified, and a description of the repair carried out.

The experience has in the paper been categorised into damages due to detail design, insufficient support, lack of continuity, misalignment, and welding. This enables the reader to easily go through the recommendations.

The review of the corrugated bulkhead damage cases, covering vessels up to 237m, and the experience of TSCF members are amalgamated in the recommendations for design improvement.

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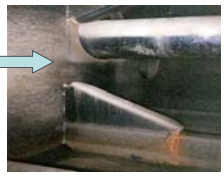
Reasons for Structural Defects

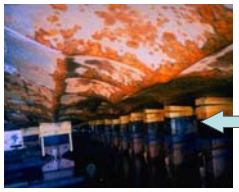
Poor Detail Design



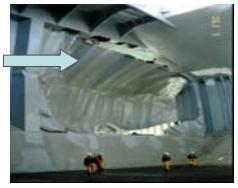
Local Stress Concentration

Poor Workmanship

Corrosion



Operational Incident



Wear and Tear

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Reasons for Structural Defects

Structural performance is affected by standards of construction as well as design:

- Misalignment and poor fit-up
- Material defects
- Welding defects
- Fabrication procedures
  - Residual Stresses
  - Stress concentrations
- Unfairness of plating

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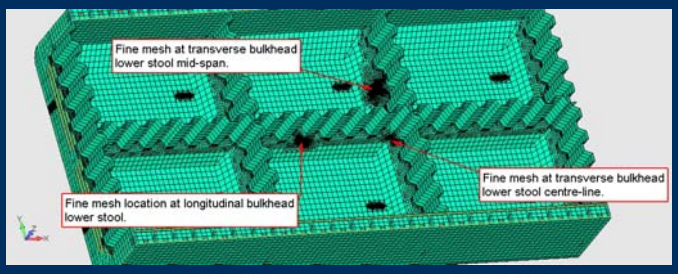
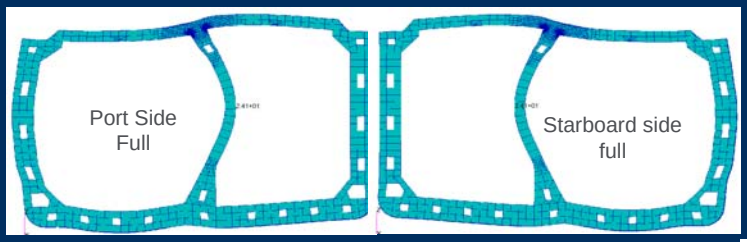
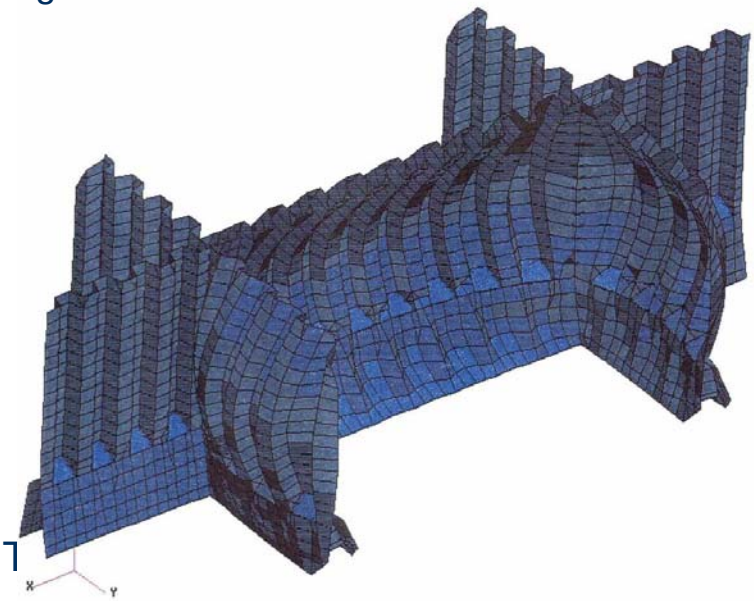
Corrugated Bulkheads & Critical Areas





Corrugated Bulkheads & Critical Areas



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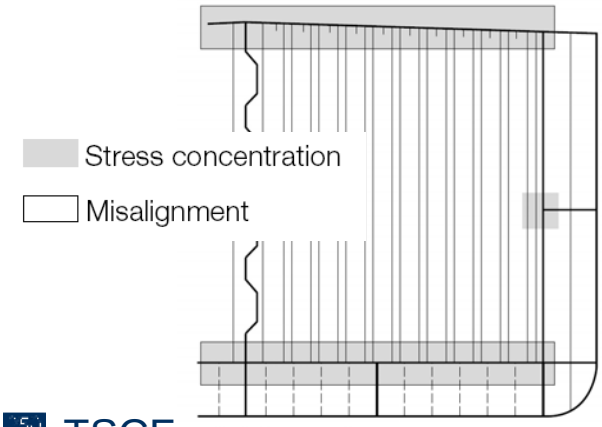
Critical Areas – Vertically Corrugated

- Areas susceptible to higher stress levels and misalignment



Connection of corrugations to deck

Connection of corrugation to side girder

Connection of corrugations to inner bottom

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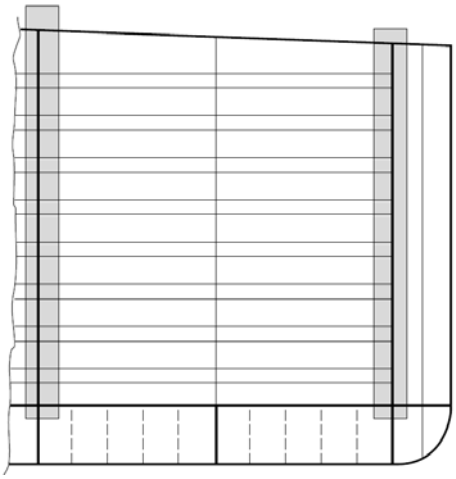
Critical Areas – Horizontally Corrugated

- Areas susceptible to higher stress levels and misalignment



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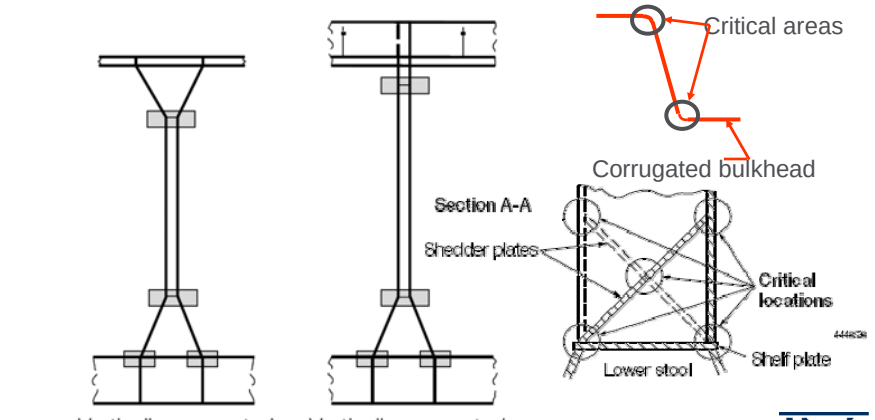
Critical Areas

- Areas susceptible to higher stress levels and misalignment



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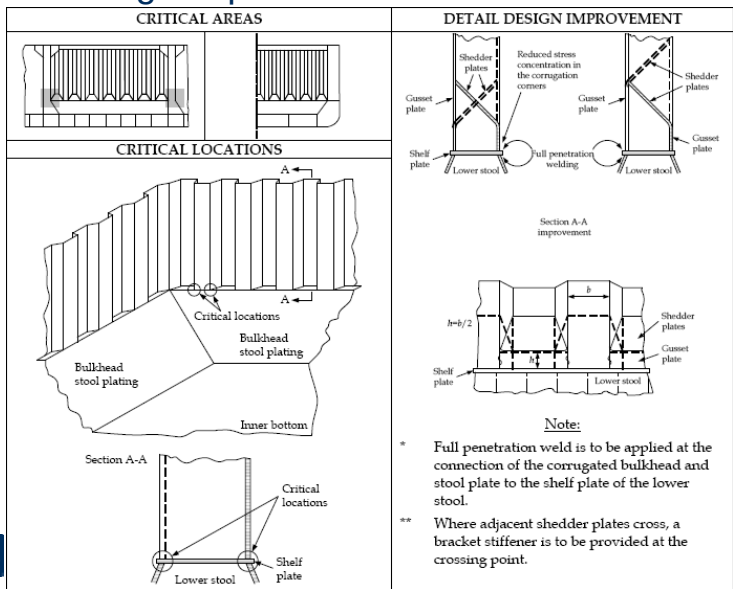
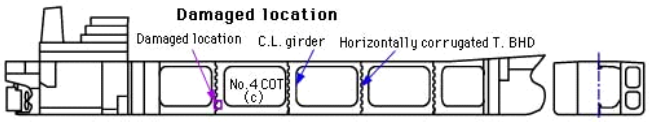
Detail design improvements



Damage Experience

Case 1.2

Case 1.2				
Ship-Type	Product Tanker		**Capacity [tdw]**	Abt. 30,000
Year of build	1990	**Vessels age when damage found**		11 years
Main dimensions	**L**	160 m	**B**	-
	T	-	**D**	-
Bulkhead	Horizontally corrugated		Transverse bulkhead	
Stool	None fitted			
Material	HT32			
Overview of Damage location	Transverse corrugated bulkhead (horizontal type) in way of cargo tank area. 			

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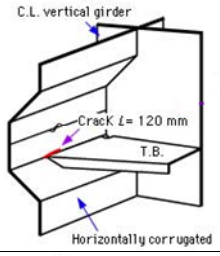
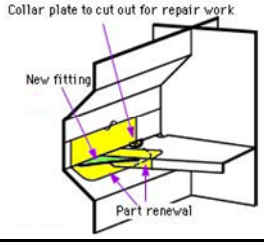
Case 1.2

Description of damage	
Description of repair	

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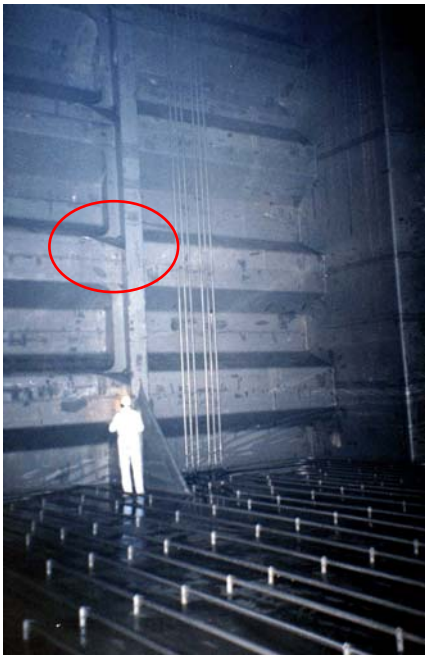
Case 1.2

- Brackets ideally be aligned with the inclined web of the corrugation



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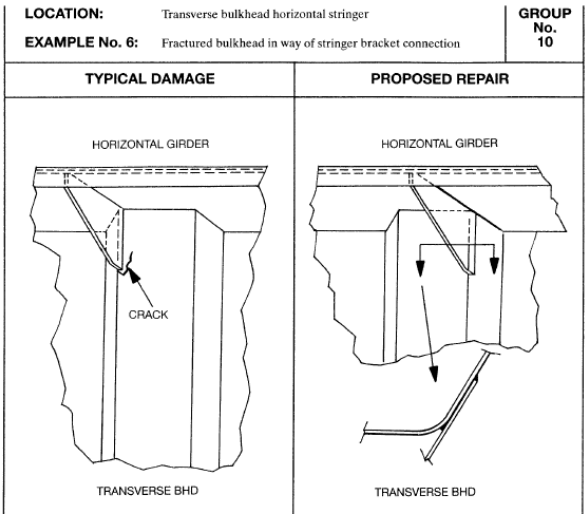
TSCF - Guidance Manual for Tanker Structures



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Case 1.18 – Lower Stool

Case 1.18				
Ship-Type	Product Tanker		**Capacity [tdw]**	46,000 tonnes
Year of build	2005	**Vessels age when damage found**		4 years
Main dimensions	**L**	174 m	**B**	32.2 m
	T	11	**D**	18.8 m
Bulkhead	Vertically corrugated		Transverse bulkhead	
	Height from tank top to deck		16.65	
Stool	Lower and upper stool			
Material	Grade A			

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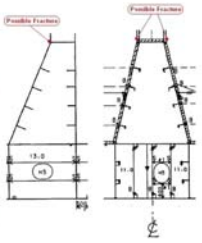
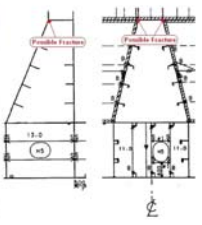
Case 1.18 – Lower Stool

Description of damage	  Inside stool space:  

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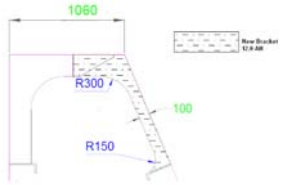
Case 1.18 – Lower Stool

Description of repair	• Welds gouged out, replaced with full penetration welds and ground • Brackets modified as below to remove the toe of the bracket within the stool from the shelf plate/sloping plate weld 

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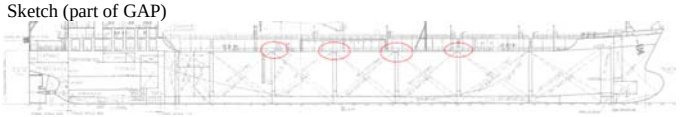
Case 1.6 - Overdeck Girder/Deck longitudinal connections

Case 1.6				
Ship-Type	Chemical tanker		**Capacity [tdw]**	29,000 tonnes
Year of build	2005	**Vessels age when damage found**		3 years
Main dimensions	**Length**	LPP: 167.00 m	**Breadth mld.**	29.20 m
	Draft mld.	9.50 m	**Depth mld.**	13.85 m
Bulkhead	Vertically corrugated		Transverse bulkhead	
Stool	No upper stool		Height lower stool	1400 mm
Material	Bulkhead Grade A		Damaged Area AH36	
Overview of damage location	Sketch (part of GAP) 			

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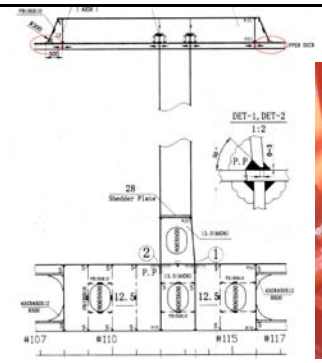
Case 1.6 - Overdeck Girder/Deck longitudinal connections

Description of damage	 

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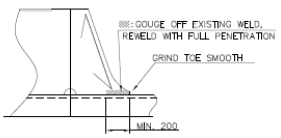
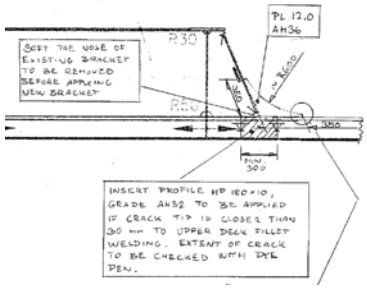
Case 1.6 - Overdeck Girder/Deck longitudinal connections

Description of repair	**Cracks in bracket toe welding and/or bulb:**  **Cracks in profile deeper than 50% of profile height:** 

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Summary

- Attention to detail design, additional fatigue considerations and control over construction standards remain important.
- Cracks are often attributed to lack of support at corrugation corners.
- If a more onerous trading route than the default is anticipated then additional fatigue analysis is essential. Otherwise significant reduction in fatigue life can be expected.
- Attention to continuity of support for the flanges of the corrugation.
- Full penetration welding is essential as partial penetration welding may introduce additional misalignment affecting the fatigue life.
- Proper alignment is imperative.
- One solution does not necessarily solves all problems.
- Poor design can have costly consequences.

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Any questions?

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