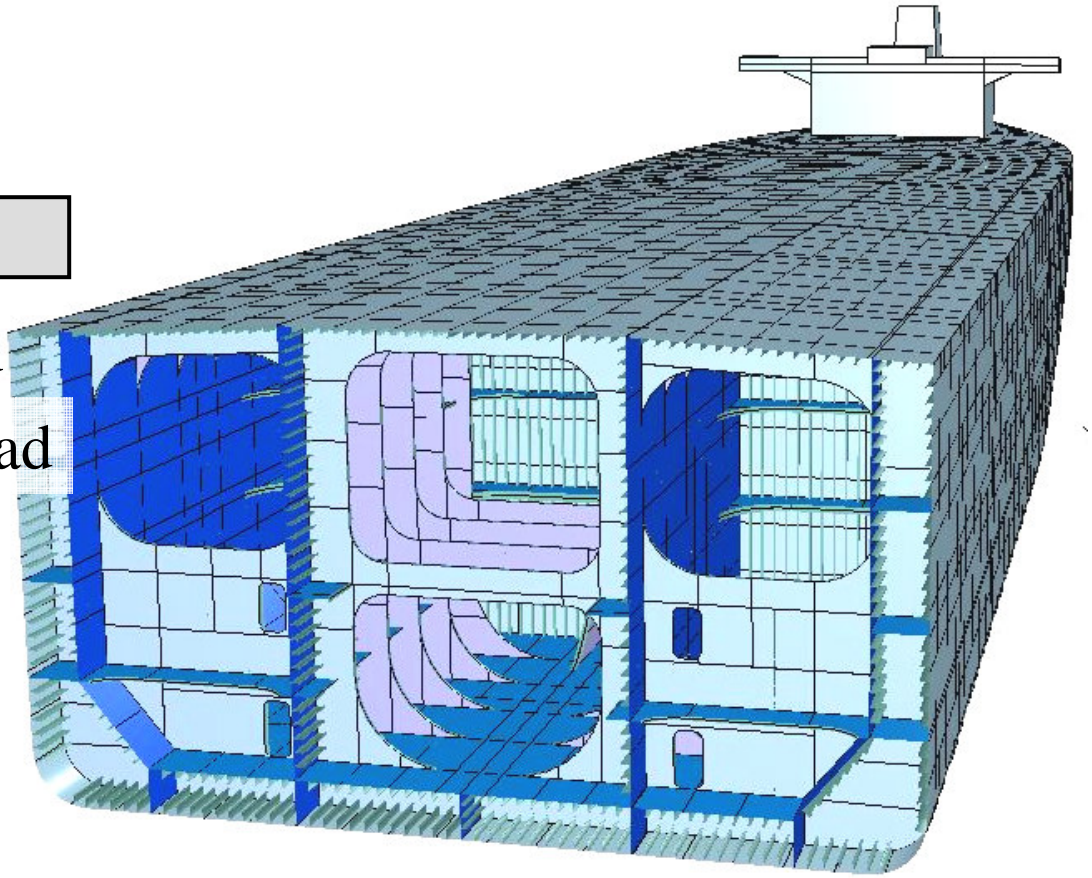
Oil Tankers

Hull Structural Breakdown - Deck

3. Deck

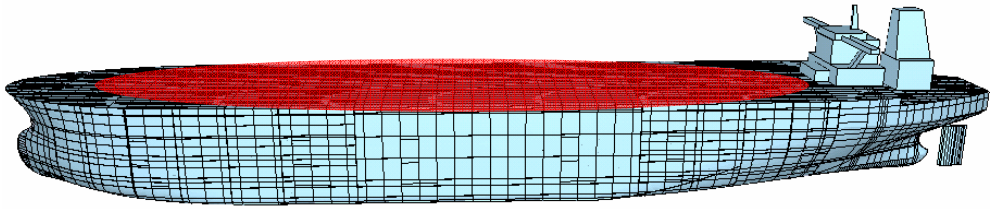
1. Side
2. Bottom
3. Deck
4. Transverse bulkhead
5. Longitudinal bulkhead
6. Web frames



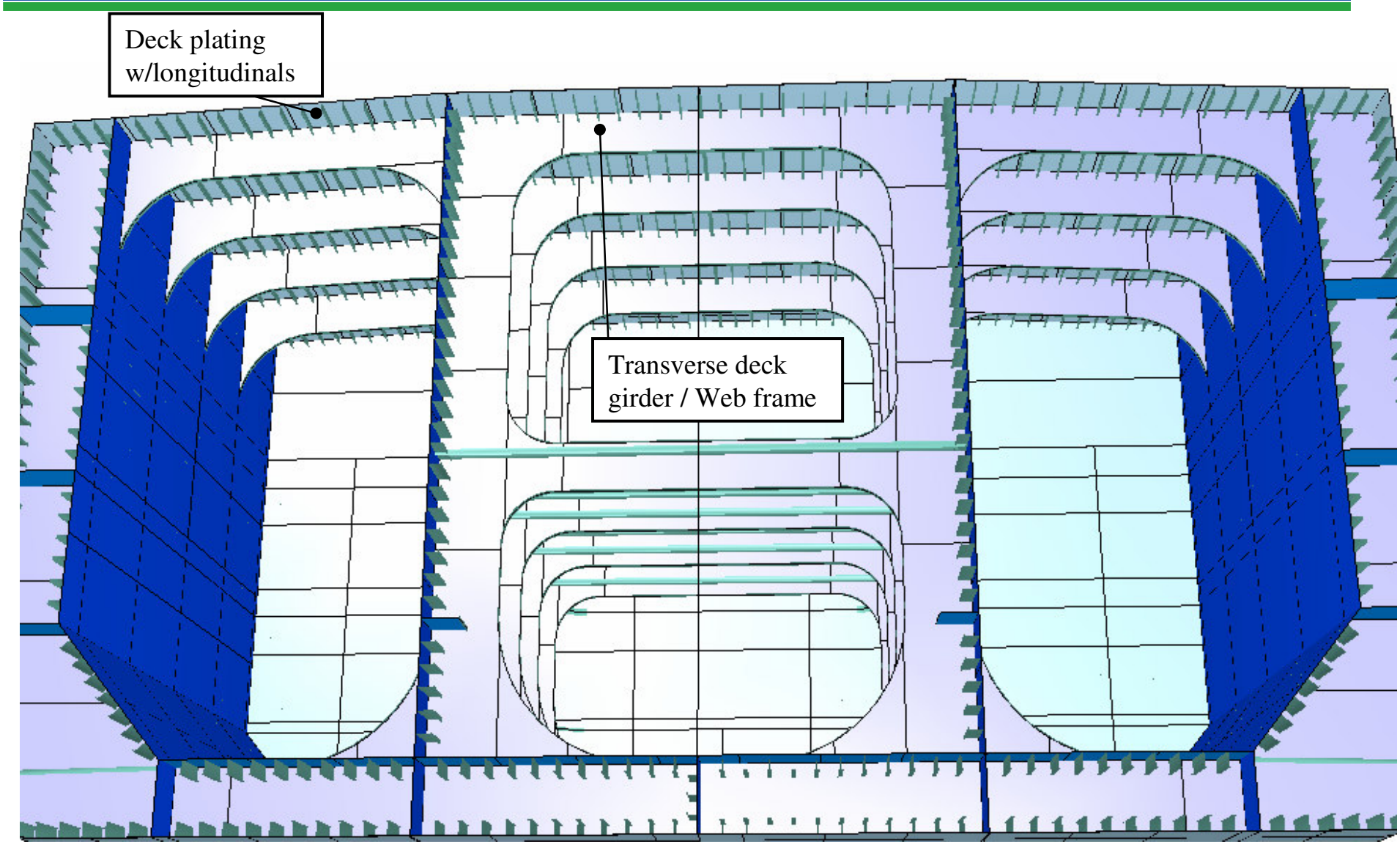
Structural functions of deck

Flange in hull girder

- Deck plating and longitudinals act as the upper flange in the hull girder beam

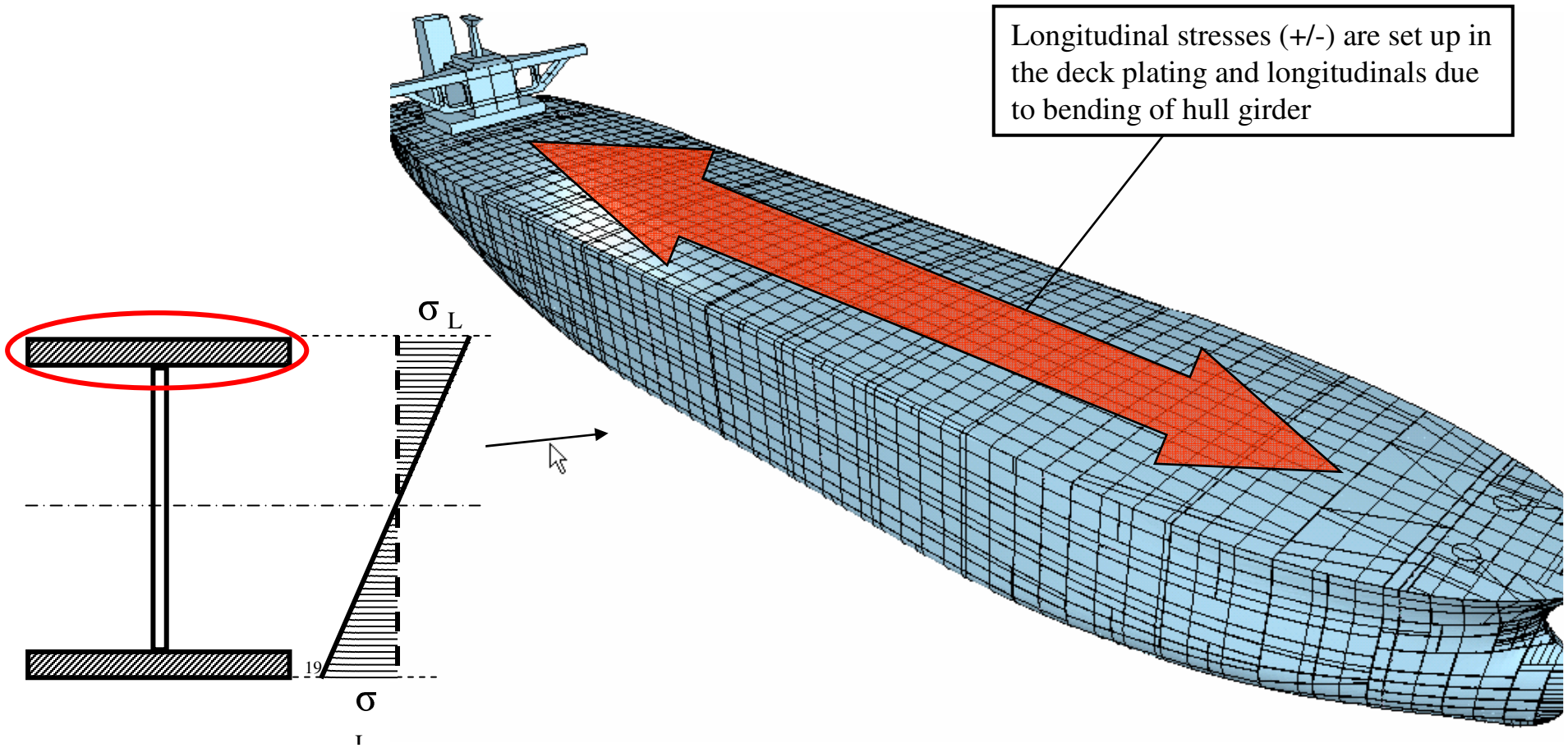


Structural build up of deck



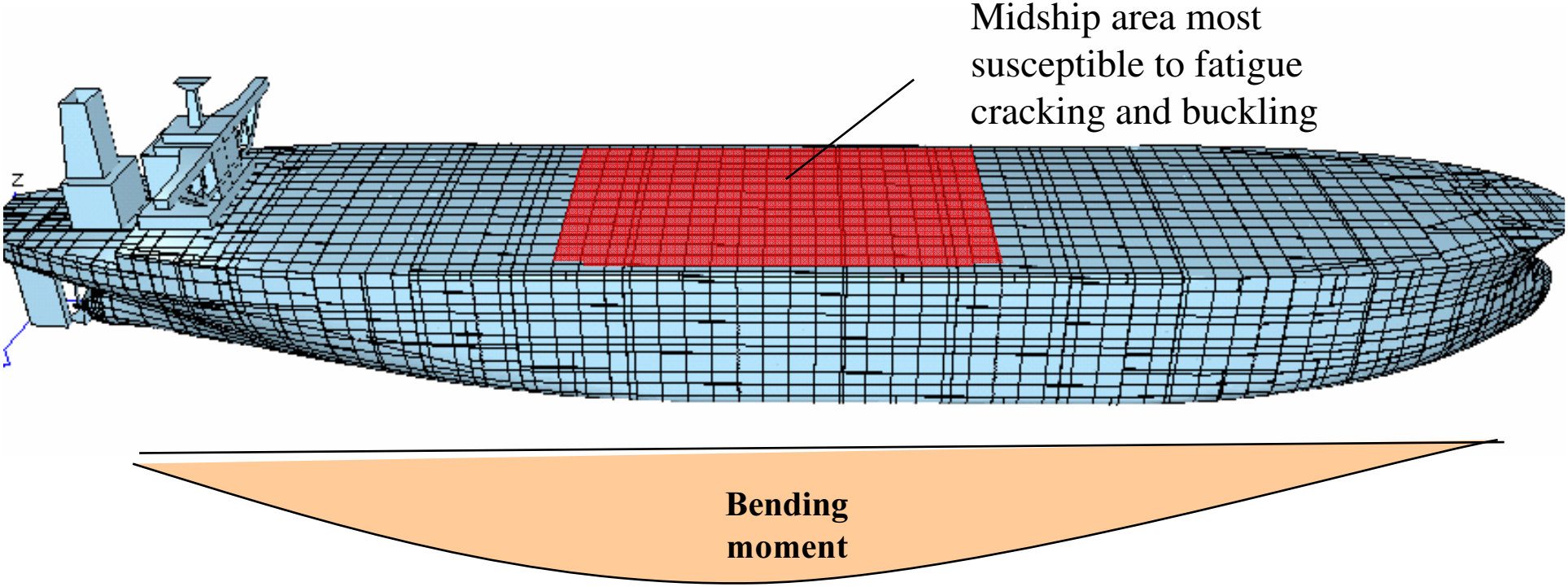
Function: Flange in hull girder

Hull girder bending moment induces longitudinal stresses in the deck plating and longitudinals



Longitudinal stresses in deck

Longitudinal stresses from bending of hull girder is maximum at midship



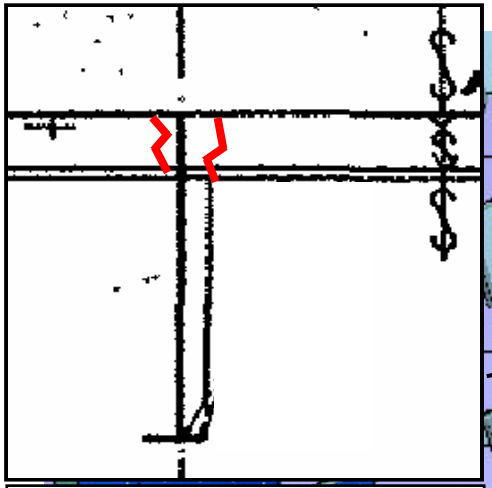
Characteristic damages

1. Cracks in deck longitudinals
2. Crack in deck plating
3. Corrosion of deckhead
4. Buckling of deck

Oil Tankers

Cracking in deck longitudinals

3. Deck



Deck longitudinal connection to web frames

Deck longitudinal connection to transverse bulkhead

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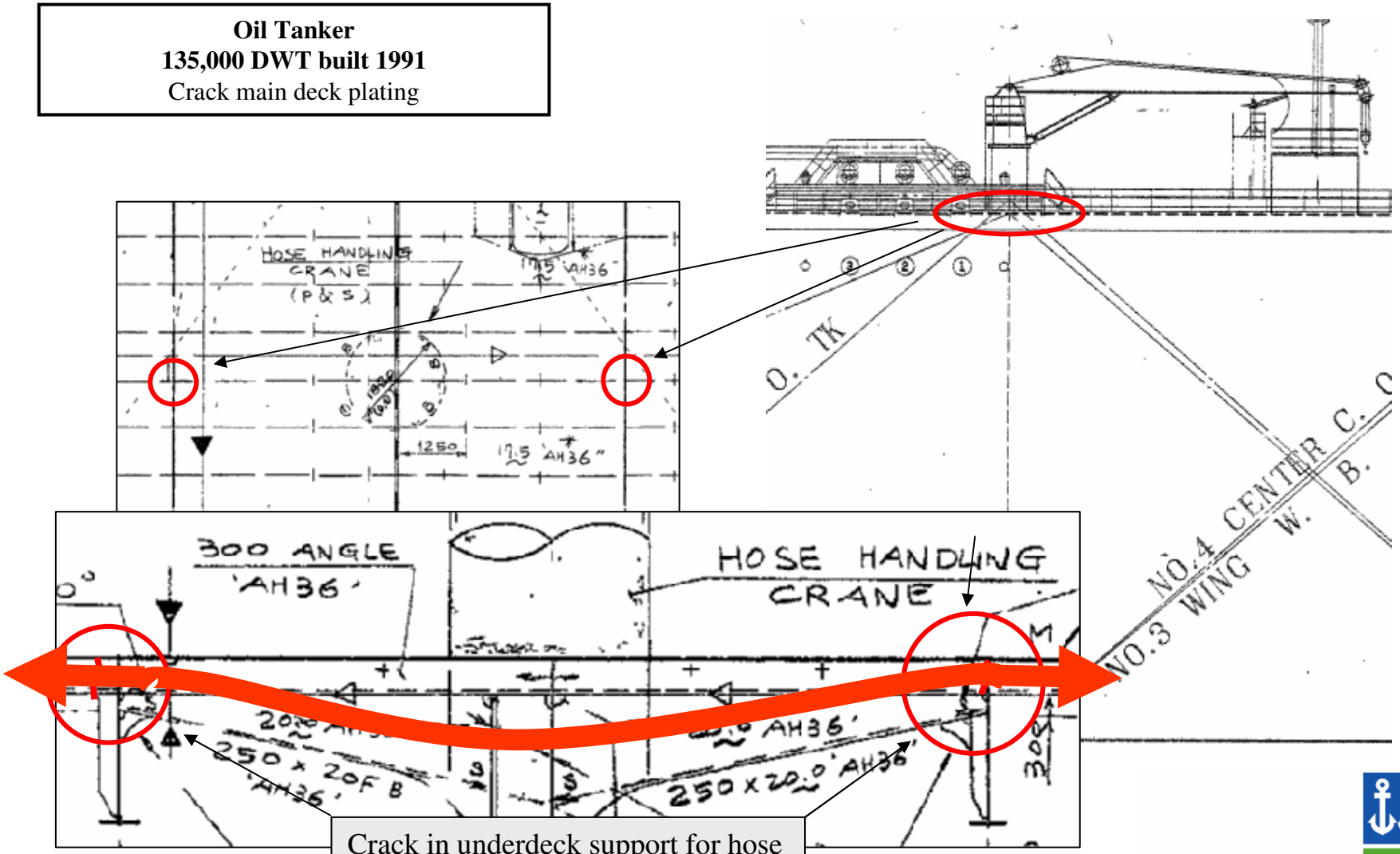
Cracking in deck longitudinals

3. Deck

Oil Tanker
135,000 DWT built 1991
Crack main deck plating

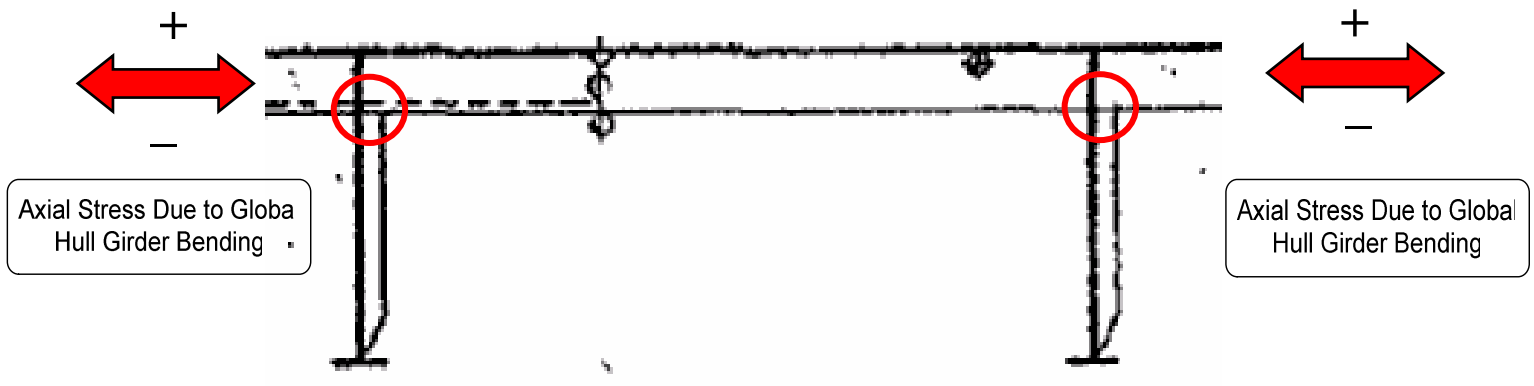


Crack in underdeck support for hose handling crane (P/S, midship area)

MANAGING RISK DNV

Cause for cracking in deck longitudinals

The wave induced excitation of the hull girder leads to dynamic axial stress in the deck longitudinals

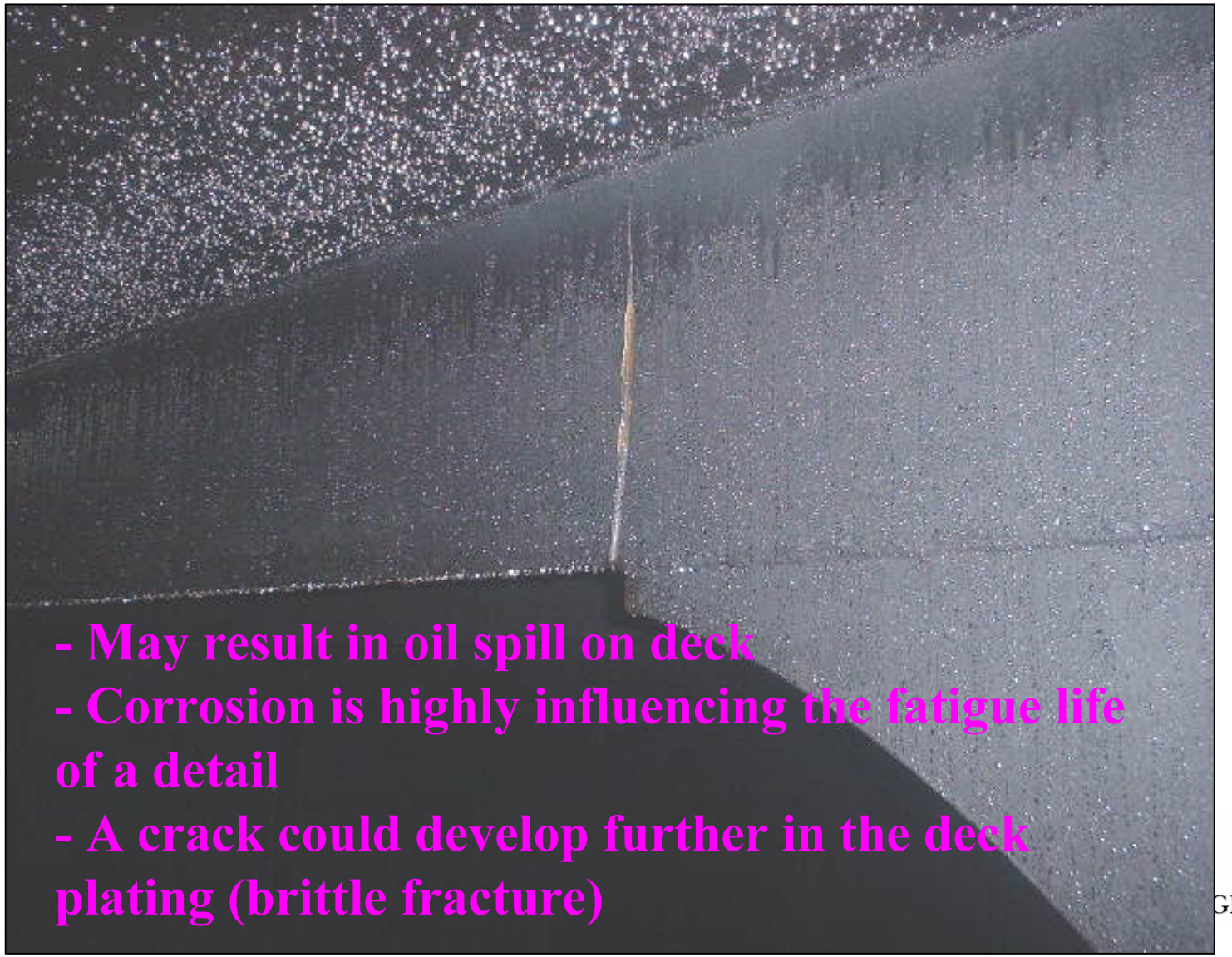


The cyclic variation of axial stress may lead to fatigue cracks initiating at hot spots

A loaded condition will normally induce compression stress in the deck **(sagging)**

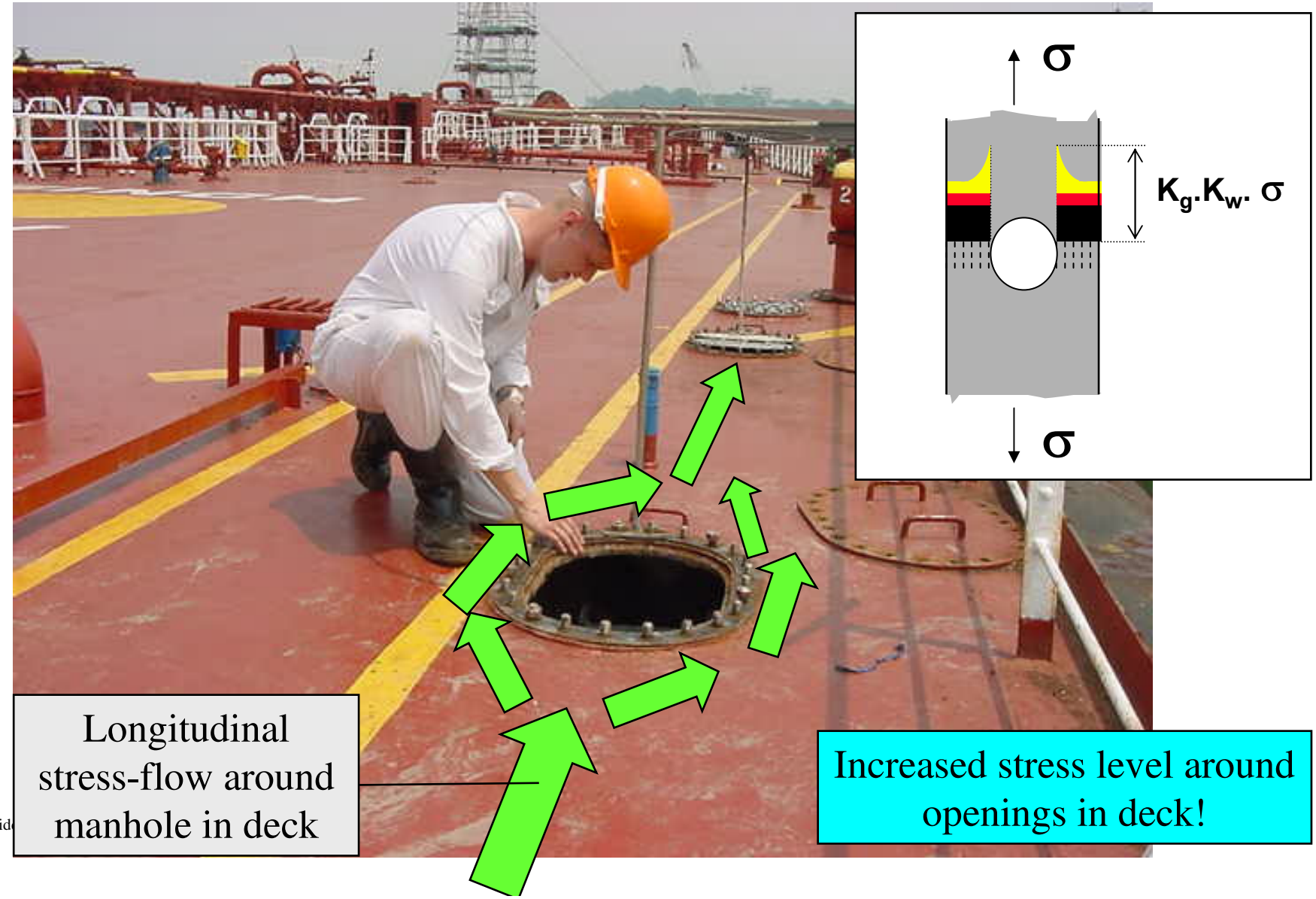
A ballast condition will normally induce tension stress in the deck **(hogging)**

Cracks in deck longitudinals



- May result in oil spill on deck
- Corrosion is highly influencing the fatigue life of a detail
- A crack could develop further in the deck plating (brittle fracture)

Openings in deck



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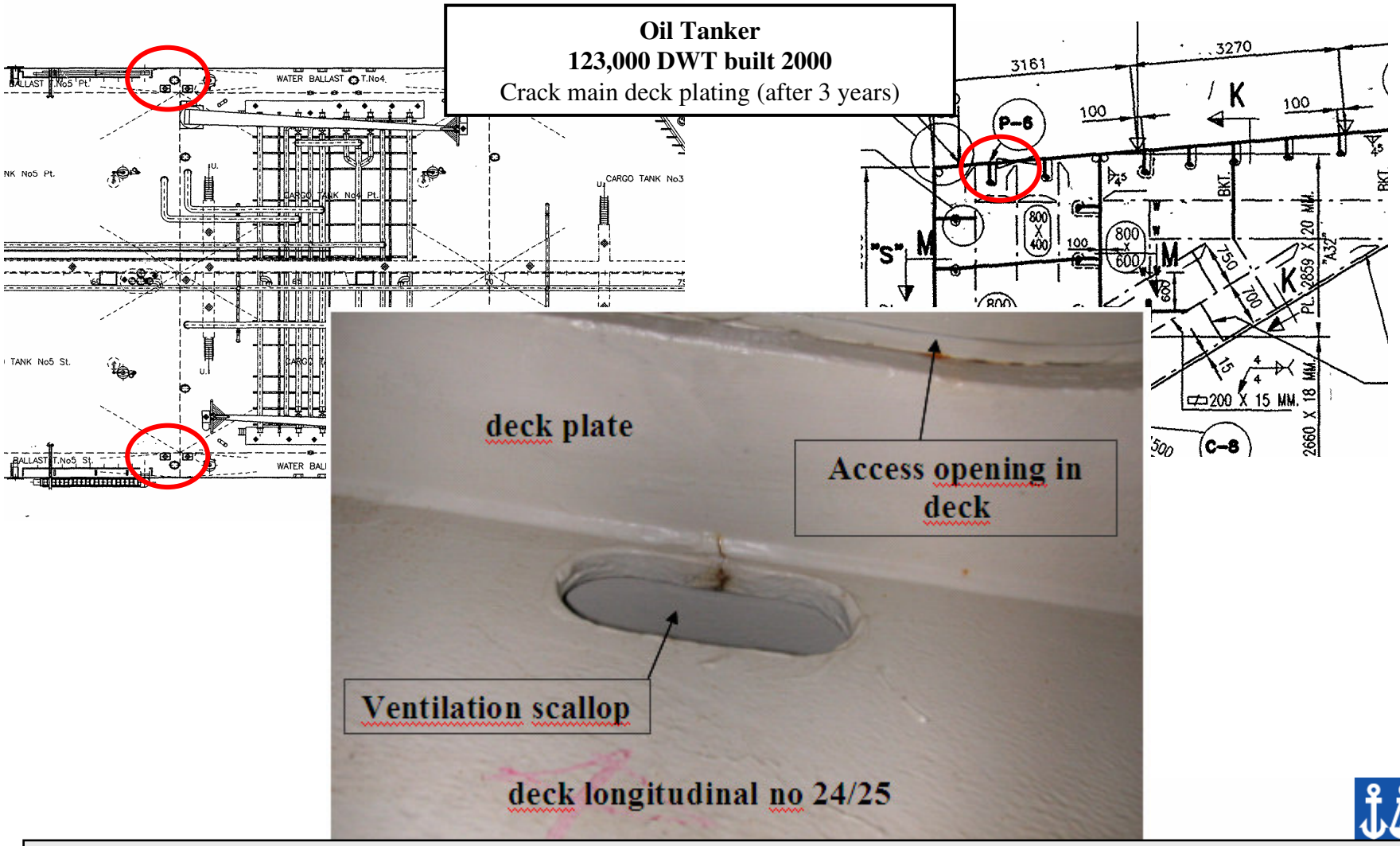
Example: crack in scallop in deck longitudinal

3. Deck

Oil Tanker
123,000 DWT built 2000
Crack main deck plating (after 3 years)



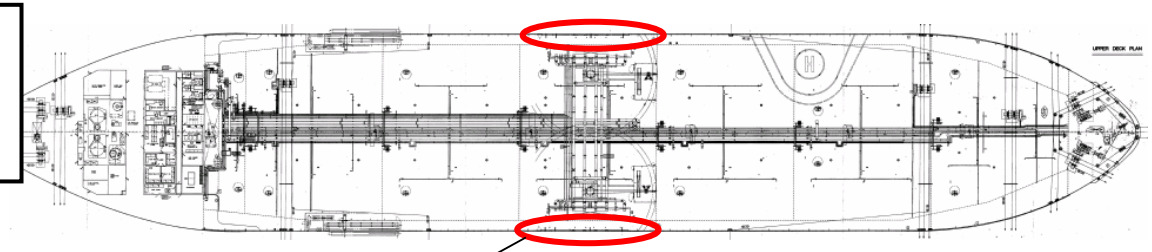
Scallop in deck longitudinal is close to access opening in deck. This will give an additional accumulated stress in the longitudinal, which is believed to be the cause for the damage.

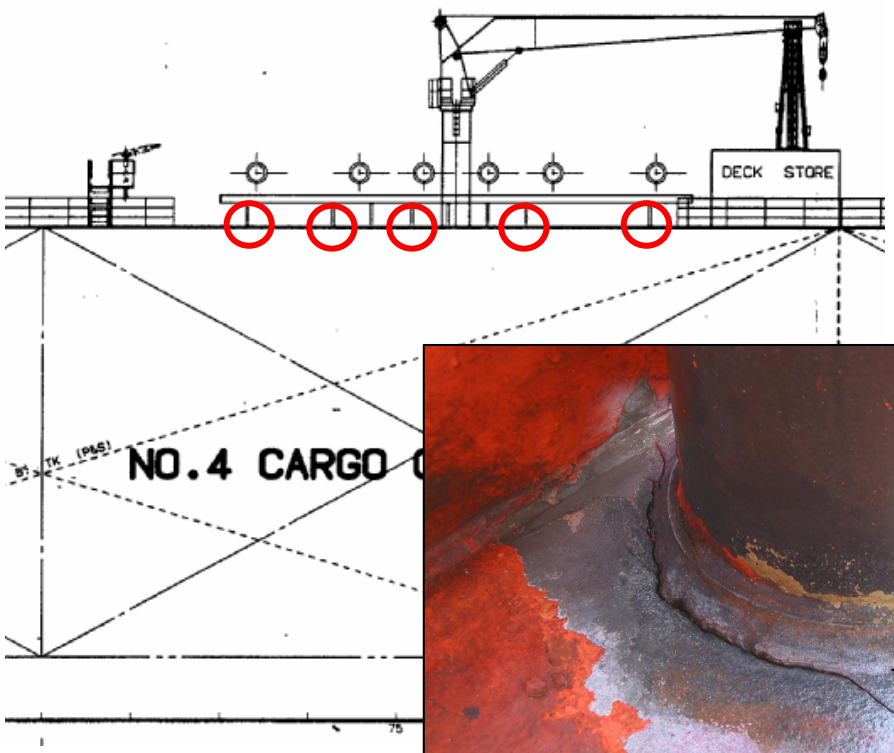
Oil Tankers

Crack in deck plating

3. Deck

Tanker for Oil
99328 DWT
built 1996
Crack in deck plating





Crack in deck plating at hose saddle support (midship area)

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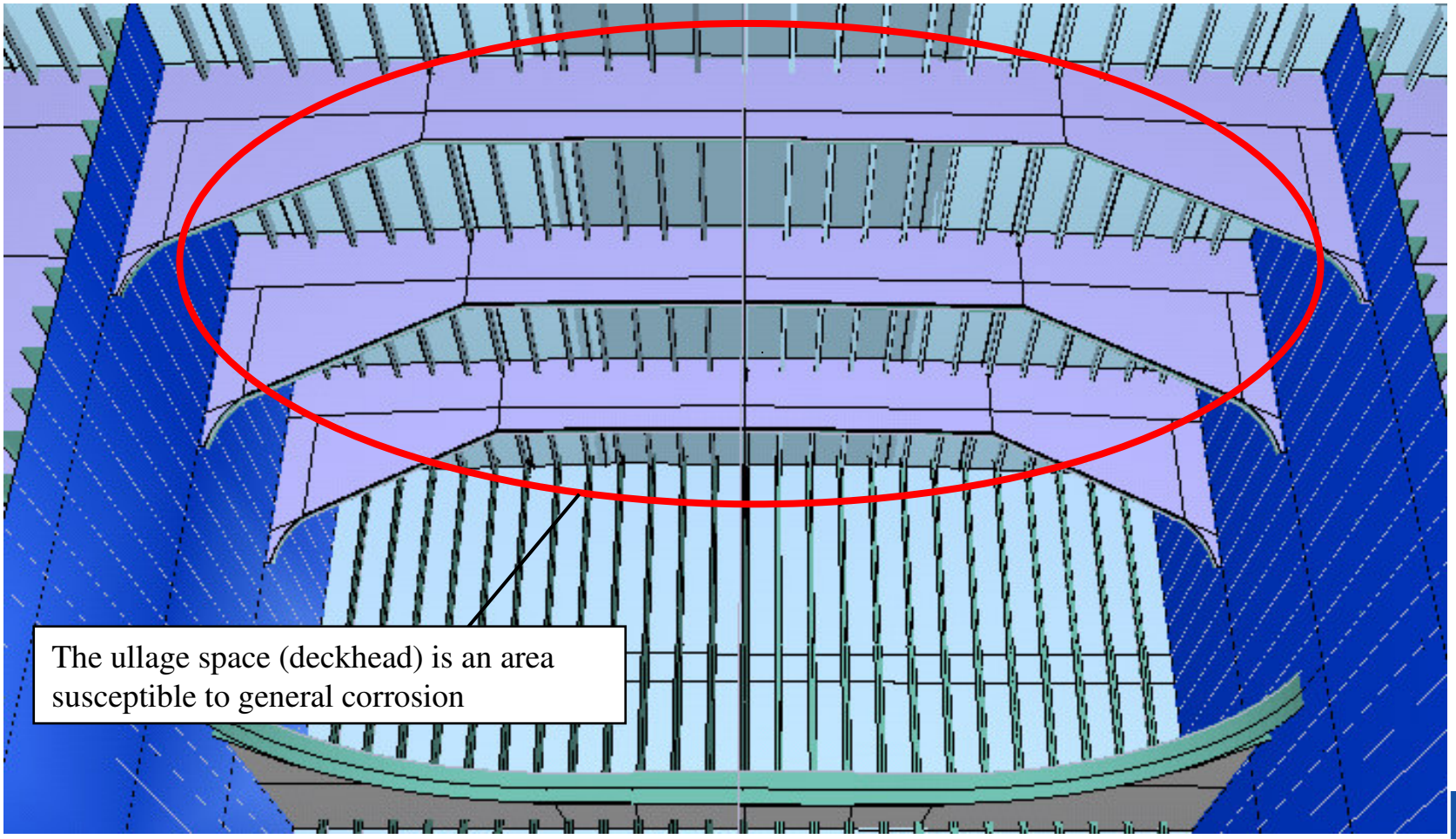
Corrosion of deckhead



Corrosion of deckhead

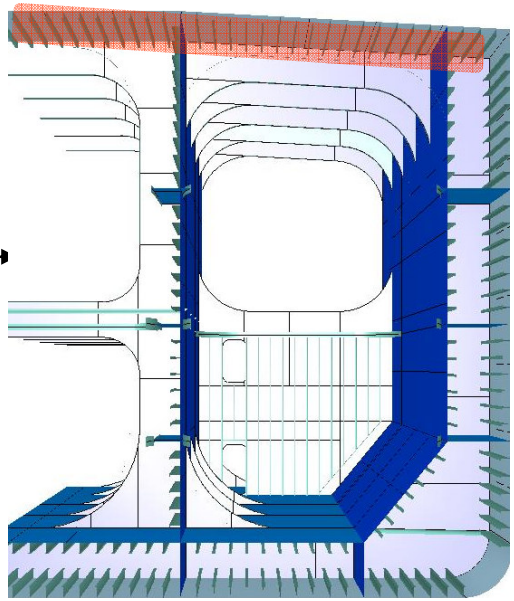
A reduction of the deck transverse sectional area due to general corrosion will lead to an increased stress level in deck

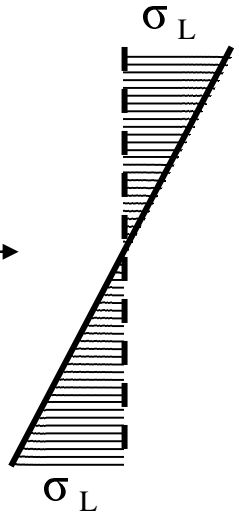
Longitudinal stress

$$\sigma_L = \frac{F}{A}$$

Force

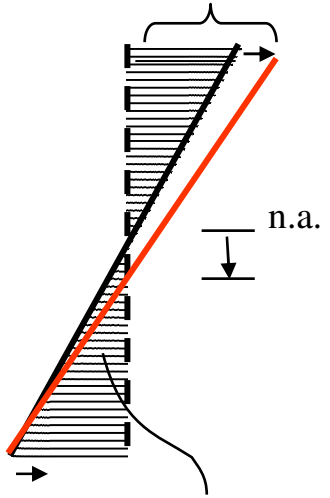
Area





Longitudinal stress distribution

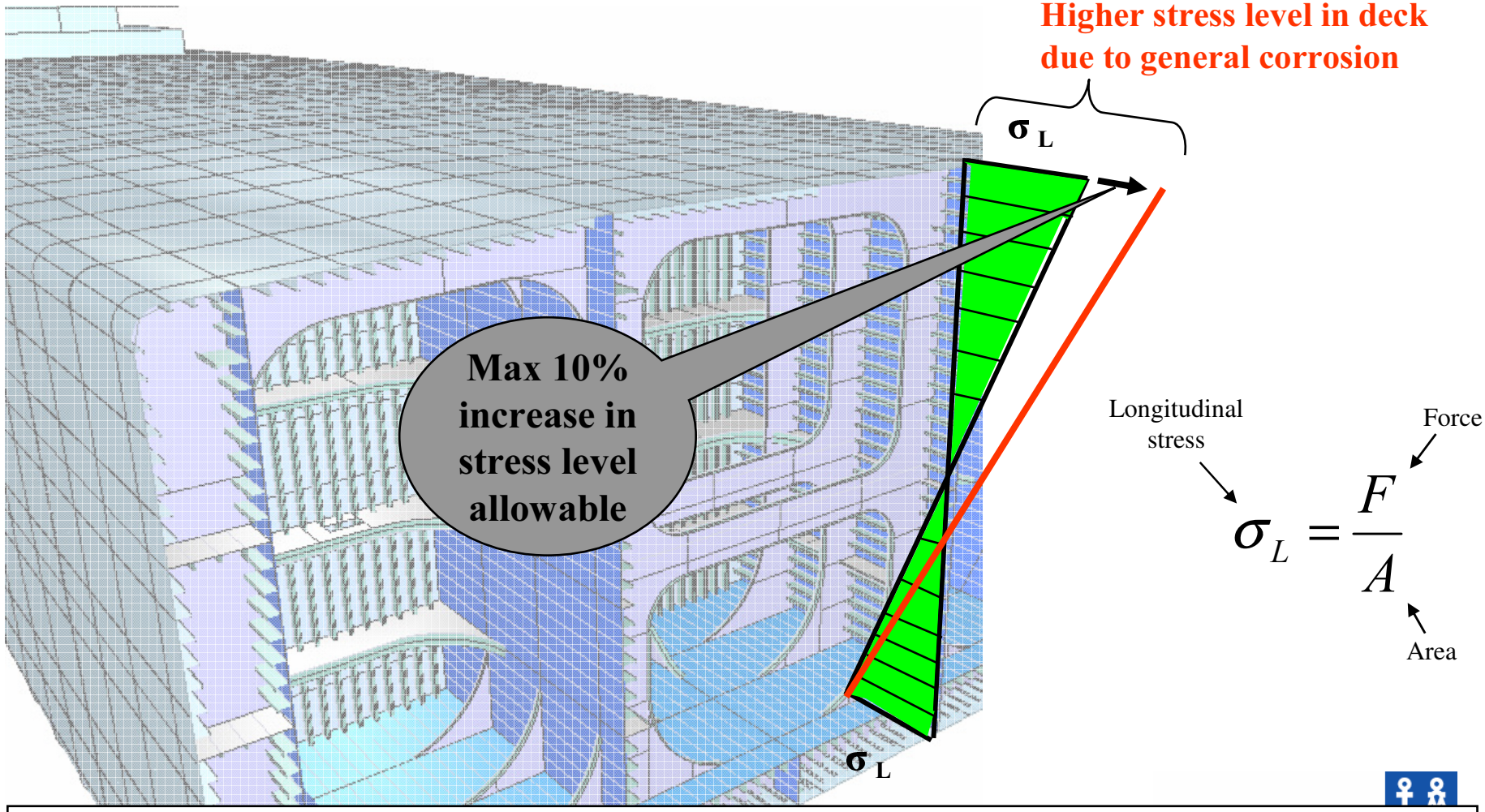
Higher stress level in deck



Long. stress distribution (with reduced deck sectional area)

Reduced sectional area in deck may lead to plate buckling

Corrosion of deckhead



A reduction of the deck transverse sectional area due to general corrosion will lead to an increased stress level in deck ➡ may lead to buckling problems

Oil Tankers

Acceptance criteria - corrosion

3. Deck

- T-min list

Minimum Thickness List

Vessel name:		*Date:*	2003-09-23
Yard:		*Sign.:*	Elil
Yard number:			
Class Id.:			
Year built:			

The minimum thickness provided in this table is for guidance, the final decision on steel renewal will be taken by the attending surveyor. The list is valid within 0,4L amidship.

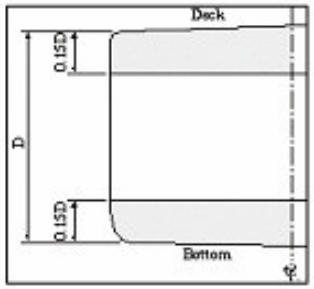
Longitudinal strength evaluation is based on the following stillwater bending moment limits:

Sagging: 150 000 Tm
Hogging: 210 000 Tm

The list is based on the following overall area reduction in deck and bottom:

Deck: 5 %

Bottom: 10 %



If the measured overall area reduction of longitudinal elements within 0.15D from deck and bottom is larger than the given values, this tmin list is not valid and further evaluation of longitudinal strength and local renewals is required.

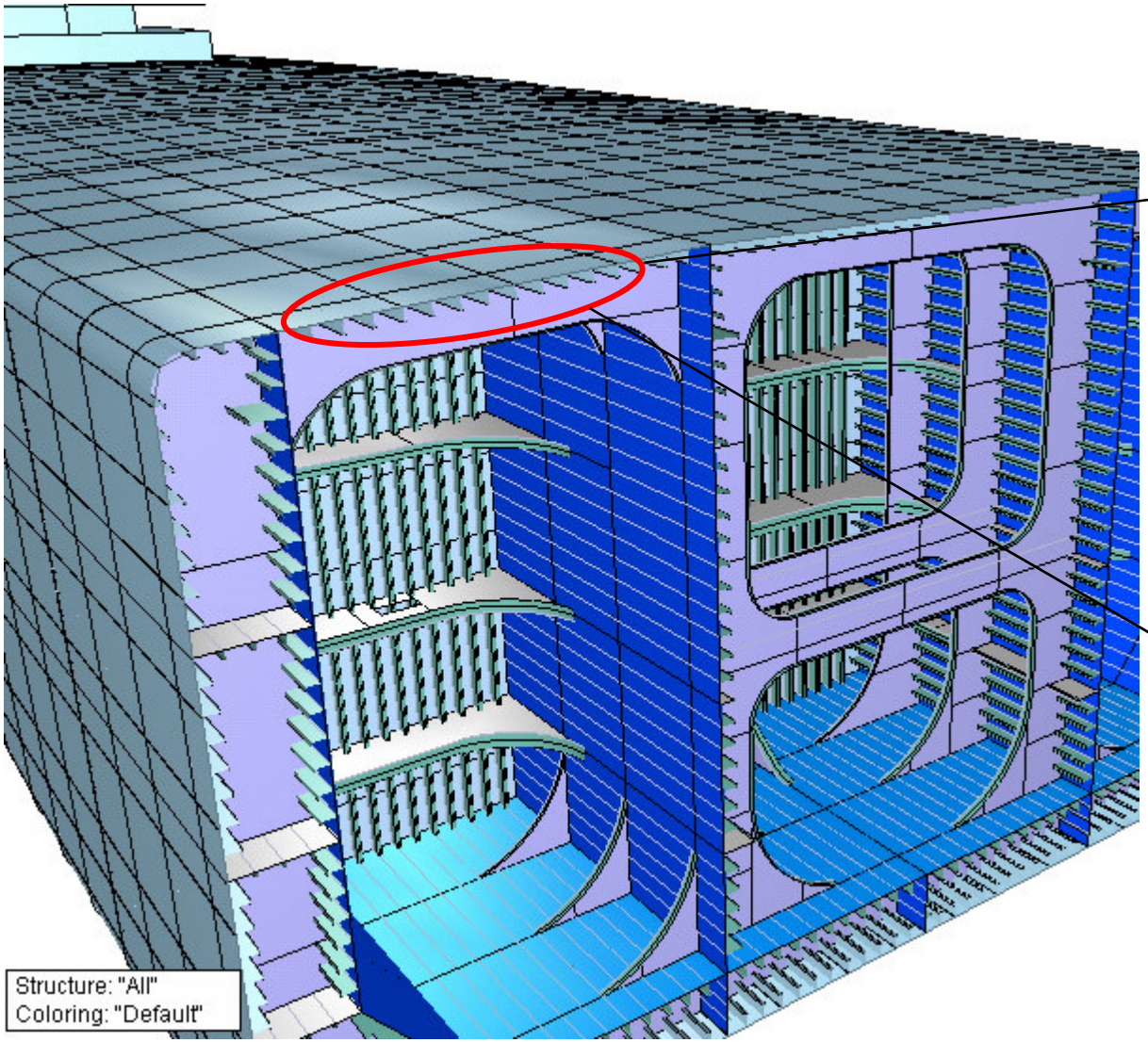
Structural elements	$t_{as\ built}$	t_{min}	$t_{residential}$
Deck Area			
Deck plating	16,0	15,2	15,4
Longitudinal web	9,0	7,2	7,7
Longitudinal flange	14,0	12,0	12,5
Deck long. Girder web	14,5	13,0	13,4
Deck long. Girder flange	30,0	27,0	27,8
Longitudinal girder st. web	9,0	7,2	7,7
Longitudinal girder st flange	14,0	12,0	12,5
Outer side			
Sheer strake	15,5	15,2	15,3
Remaining ship side	15,5	12,4	13,2
Longitudinals 25 %	reduction		
Inner side			
1st strake	14,5	13,0	13,4
2'ndt strake	11,0	8,8	9,4
3'rd strake	12,0	9,6	10,2
4'th strake	13,0	10,4	11,1
5'th strake	15,0	12,0	12,8
1st strake	15,0	12,0	12,8
Longitudinals 25 %	reduction		
Bottom Area			
Keel plate	16,5	13,2	14,0
Bottom plate	15,0	12,0	12,8
Longitudinal web	12,0	9,0	9,8
Longitudinal flange	17,0	12,8	13,8
Longitudinal Girder in centre	16,0	12,8	13,6
Longitudinal Girders 3, 6, 9 &14e	11,5	9,2	9,8
Longitudinal Girder no. 19	13,0	10,4	11,1
Inner Bottom			
Plate	14,5	11,6	12,3
Outboard strake	16,0	12,8	13,6
Longitudinal web	11,5	8,6	9,3
Longitudinal flange	16,0	12,0	13,0

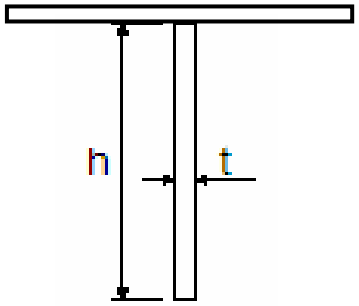
$t_{as\ built}$: thickness as shown on the as built drawing
t_{min}: minimum thickness
$t_{residential} : t_{as\ built} - 0.75(t_{as\ built} - t_{min})$

Oil Tankers

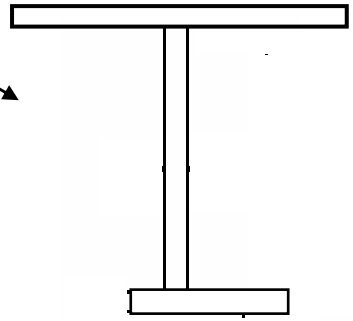
Corrosion of deckhead

3. Deck





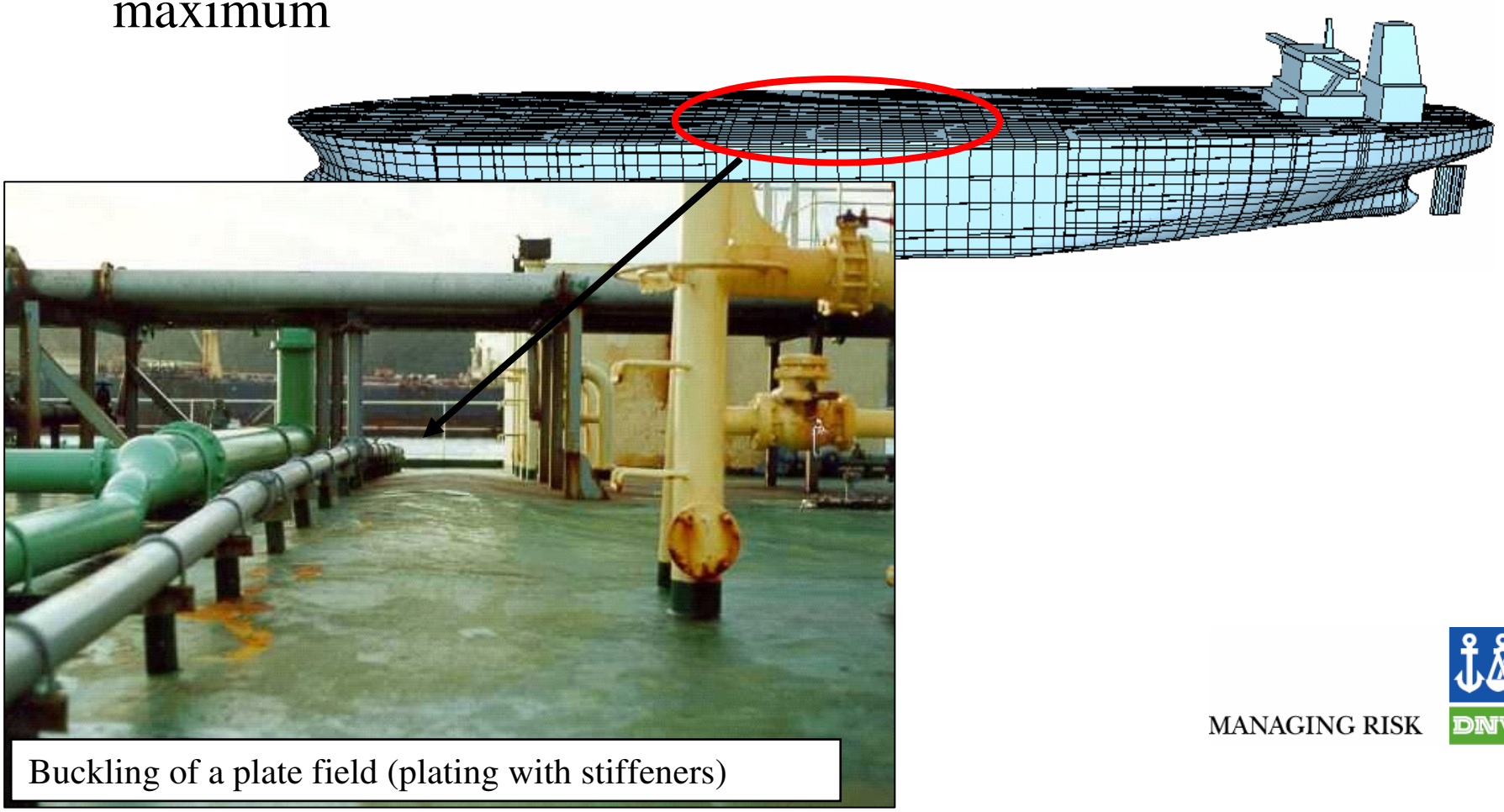
Flatbars have poor buckling capacity



L-profiles have good buckling capacity

Buckling in deck

Buckling in deck is most likely to occur in the midship region where the hull girder bending moment is at its maximum



Buckling of a plate field (plating with stiffeners)

No. 17 — shows the buckling of the deck longitudinals in the port PBT and the forward displacement of transverse bulkhead 79. It will be noted that the deck longitudinals in the No. 3 wing tank are not buckled.

Corrosion of deckhead / buckling

- Heavy corrosion of deck may lead to buckling

- Small buckles (plate between stiffeners) is a strong warning sign that longitudinal stresses are high!

- Large buckles (plate field) may lead to loss of global strength and in worst case a total collapse of the hull girder

Remember max 10% diminution of deck transverse sectional area!