

SSAB



*A stronger,
lighter and more
sustainable world*



SSAB is a global steel company with a leading position in high-strength steels and related services.

SSAB in brief

57 BILLION
SEK
annual net sales in 2015

Steel making since
1878



16,000
professionals
in 50 countries

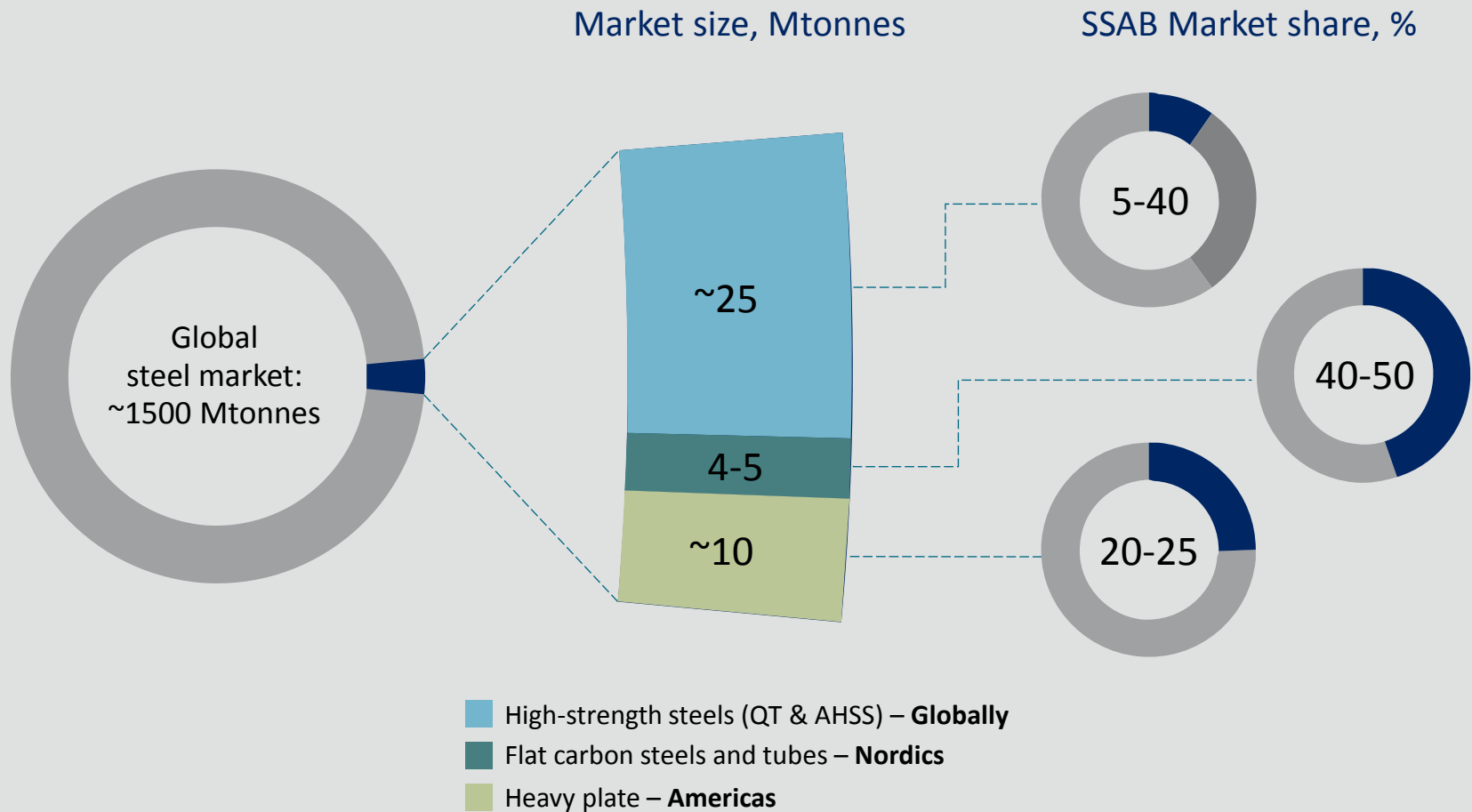
Annual steel
production capacity:

8.8 MILLION
TONNES

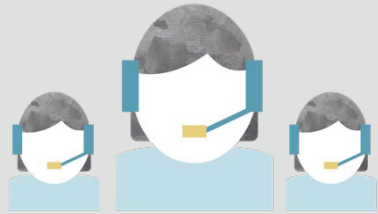
OUR BUSINESSES:

SSAB Special Steels,
SSAB Europe,
SSAB Americas, Tibnor,
Ruukki Construction

SSAB in the global steel market



SSAB in brief



**WIDE TECHNICAL
SUPPORT**

Strong
END-USER FOCUS

★★★★★ Best in
QUALITY



**GLOBALLY
RECOGNIZED BRANDS**
for selected customer segments



**STEEL
PRODUCTION
FACILITIES**

in Sweden, Finland and the US



Focus on
SAFETY

Our businesses

– Leaders in their respective sectors



SSAB SPECIAL STEELS

Global steel and service partner in Quenched & Tempered Steels (Q&T) and Advanced High-Strength Steels (AHSS)



SSAB EUROPE

Leading Nordic-based steel producer of high-quality strip, plate and tube products



SSAB AMERICAS

Market-leading North American producer of quality steel plate and coil



TIBNOR

Leading Nordic distributor of steel and non-ferrous metals



RUUKKI CONSTRUCTION

European provider of energy-efficient building and construction solutions

Killing the myths

- ▶ You can not use high strength steel when producing in low cost countries
- ▶ The weight reductions and benefits are not that high
- ▶ Using high strength steel is not safe enough
- ▶ Offshore and marine classification societies do not allow these steel grades
- ▶ You will end up with stability and stiffness issues when using high strength steels
- ▶ You can not make use of high strength steels when you have fatigue load case
- ▶ High strength steels are difficult to weld
- ▶ Using high strength steels is expensive

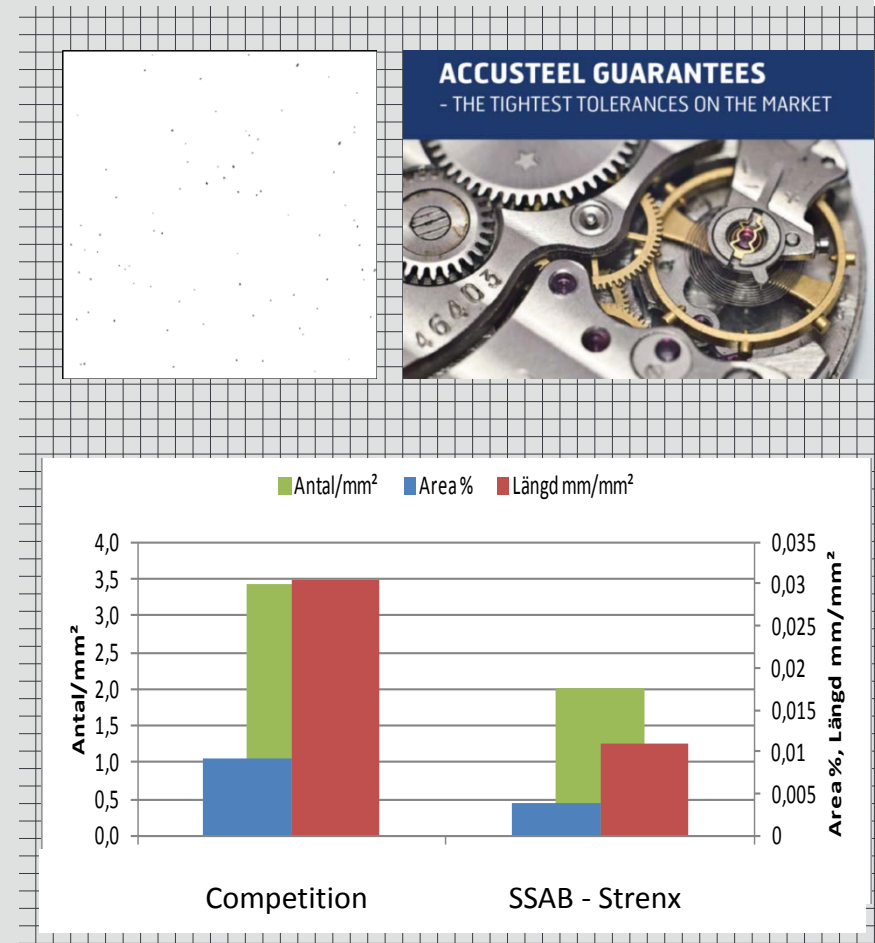
Specifying it right, It is safe!

The extreme consistency and precision of Strenx steel is the result of

- ▶ An exceptionally clean steel
- ▶ A carefully controlled steel-making process

Your benefits

- ▶ Guaranteed product properties
- ▶ Predictable workshop performance
- ▶ Efficient production
- ▶ Higher quality
- ▶ More accurate dimensioning
- ▶ Excellent weldability



SSAB EMEA AB, SE-613 80 OXELÖSUND, Sweden

| | | | | | | | | | | | |
|---|-----|--|-----|--------------------|-----|----------------------------|-----|------------|-----|--|-----|
| Inspection certificate EN 10 204 - 3.1 | A02 | Issuing department Quality inspection | A05 | Purchaser order no | A07 | Our order no 174169-100 | A08 | Invoice no | A19 | Certificate no and date 15951338 2016-04-25 | A03 |
|---|-----|--|-----|--------------------|-----|----------------------------|-----|------------|-----|--|-----|

| | | | | | | | | | | | |
|---|--|-----|--|---------|---|-----|-------------------|-----|------------------------|-----|-----|
| Purchaser A11 46172 SSAB EMEA AB C/O Bvba Thor Shipping & Transport Quay 117-123, Vrieskaaiport 2030 Antwerpen Belgium | Product Structural steel | B01 | Marking (Stamping) Steel grade, Manufacturer, MATERIAL ID | B06 | Standard/rules OX STRENX 700 Steel grade STRENX 700 E | B02 | | | | | |
| | Quantity 1 | B08 | Dimensions [mm] T 20 W 2500 L 6000 | B09-B11 | Weight [kg] 2355 | B12 | Deliv. Cond. Q | B04 | Internal code 23341 | B16 | |
| | Consignee SSAB EMEA AB Antwerp Stock C/o Bvba Thor Shipping & Transport 2030 Antwerpen Belgium | A06 | Customer marks 2302 | B15 | | | | | | | |
| MATERIAL ID 117054-556249 | | | | | | | | | | | B07 |

| | | | | | | | | | | | | | | | | | | |
|----------------------|----------|-----------------------|------------|-----------|-----------|-----------|-----------|------------|-----------|------------|-----------|------------|------------|-----------|-----------|-----------|-------------|---|
| Chemical composition | C71-C92 | Carbon equivalent etc | C93-C99 | | | | | | | | | | | | | | | |
| Heat no 117054 | C .14 | Si .31 | Mn 1.16 | P .010 | S .001 | Cr .30 | Ni .06 | Mo .171 | V .013 | Ti .008 | Cu .01 | Al .039 | Nb .001 | B .001 | N .003 | EW .43 | C14 .289 | CEV (EW) = C + Mn/6 + (Cr+Mo+V)/5 + (Ni+Cu)/15 C14 = CET = C + (Mn+Mo)/10 + (Cr+Cu)/20 + Ni/40 |

| Testtype | C04 | Millcode | C00 | Specimen position | C01 | Direction | C02 | Treatment | B05 | Specimen type | C10 | Temp [degr C] | C03 | Test results | | | | |
|--------------|-----|----------|-----|-------------------|-----|-----------|-----|--------------------|-----|-------------------|-----|---------------|-----|---------------------------|------------------------|---------------------|---|-----------------------|
| Tensile Test | | 664534 | | Top end | | Transvers | | Delivery condition | | Rectangular | | | | C11 Rp0.2 [MPa] 780 | C12 Rm [MPa] 826 | C13 A5 [%] 17 | <div style="border: 2px solid red; padding: 5px; width: fit-content;"> <p>CEV = 0,435</p> <p>CET = 0,290</p> </div> | |
| Impact test | | 664534 | | Top end | | Transvers | | Delivery condition | | Charpy-V 10x10 | | -40 | | C42 E [J] 185 | C42 E [J] 211 | C42 E [J] 233 | | C43 Ave [J] 210 |
| Impact test | | 664547 | | Tail end | | Transvers | | Delivery condition | | Charpy-V 10x10 | | -40 | | C42 E [J] 218 | C42 E [J] 262 | C42 E [J] 257 | | C43 Ave [J] 246 |

B02: EN 10025-6/S690QL

EN 10025-6, OPTION 30.

ALSO MEETS REQUIREMENTS OF WELDOX 700E

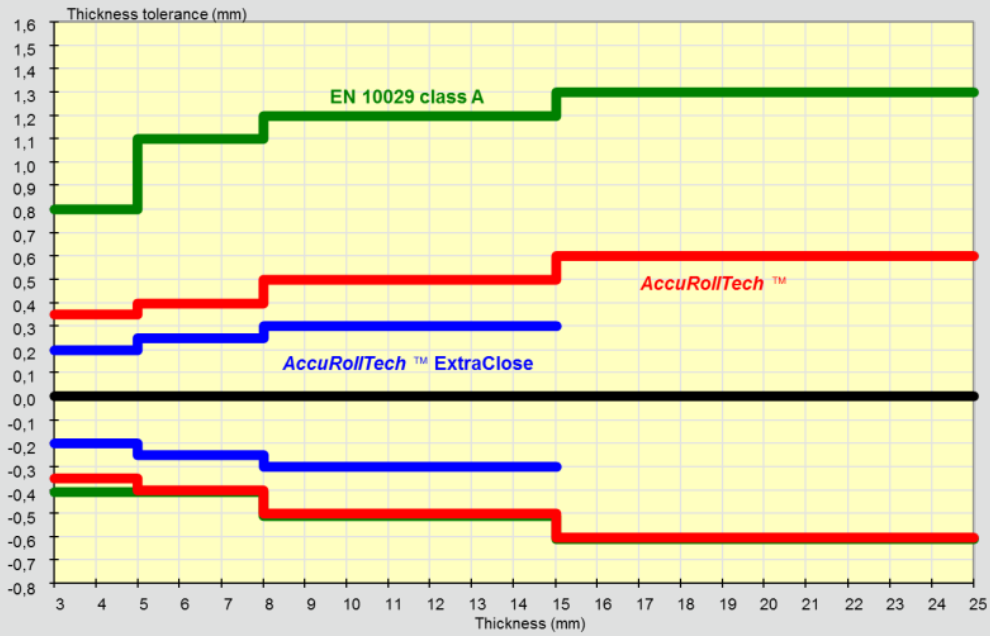
Customer article no: 2302

| | | | | | | | | |
|--|---|-----|---|---|-----|---|-----|-----|
|  | It is hereby certified that the material described above complies with the requirements of the order. | Z02 |  10 0045-CPD-0637 www.ssab.com/download | This certificate is produced with EDP and valid without signature | Z01 |  www.strenx.com | A22 | A04 |
| | Quality Inspection Department/ R Tschememjack / A Backlund | | | | | | | |

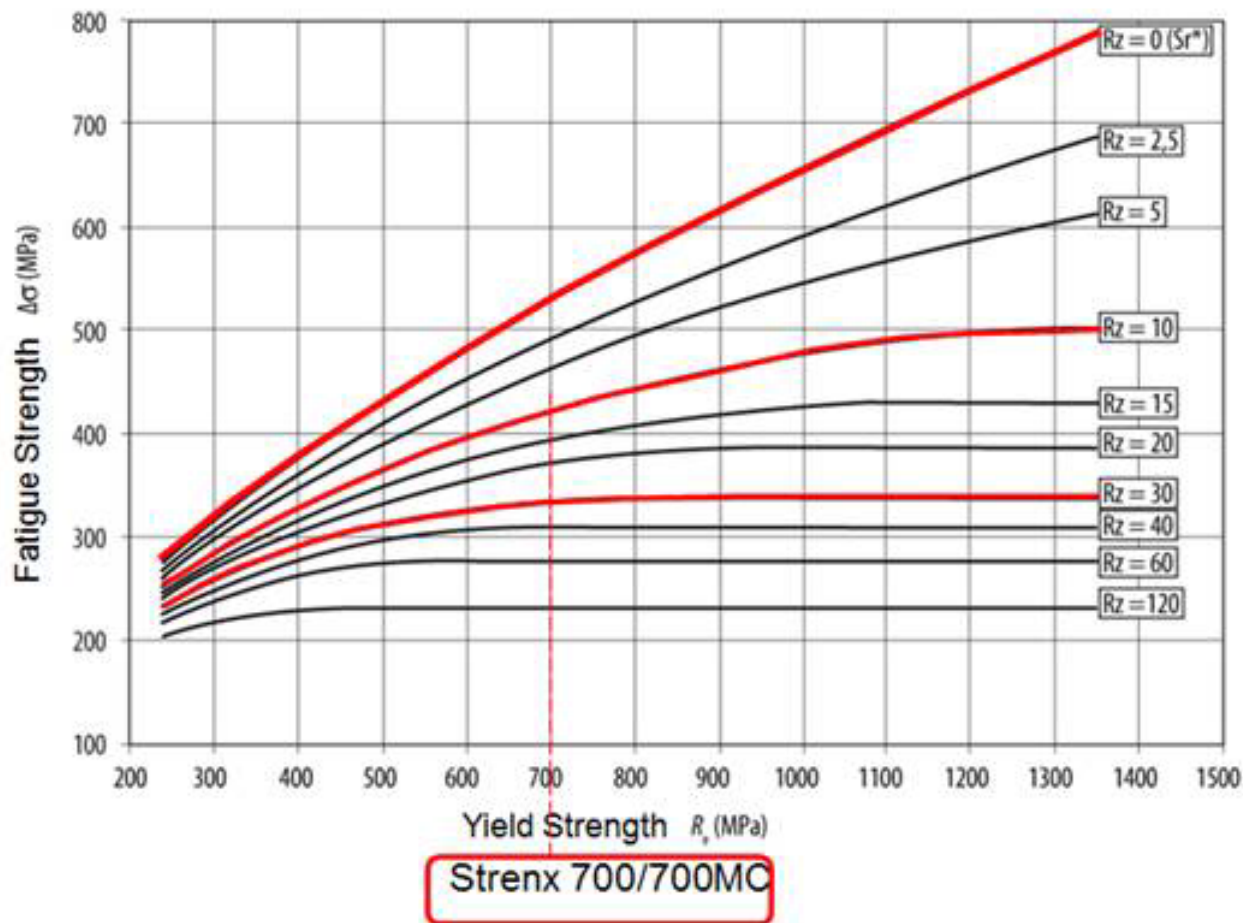
Extended guarantees

Strenx guarantees cover:

- ▶ Granted tight Thickness tolerances
- ▶ Granted Flatness of plate
- ▶ Bending of plate



Fatigue Strength with Yield Strength



Mirror polished, material fatigue strength

Ground

Machined
Cold rolled

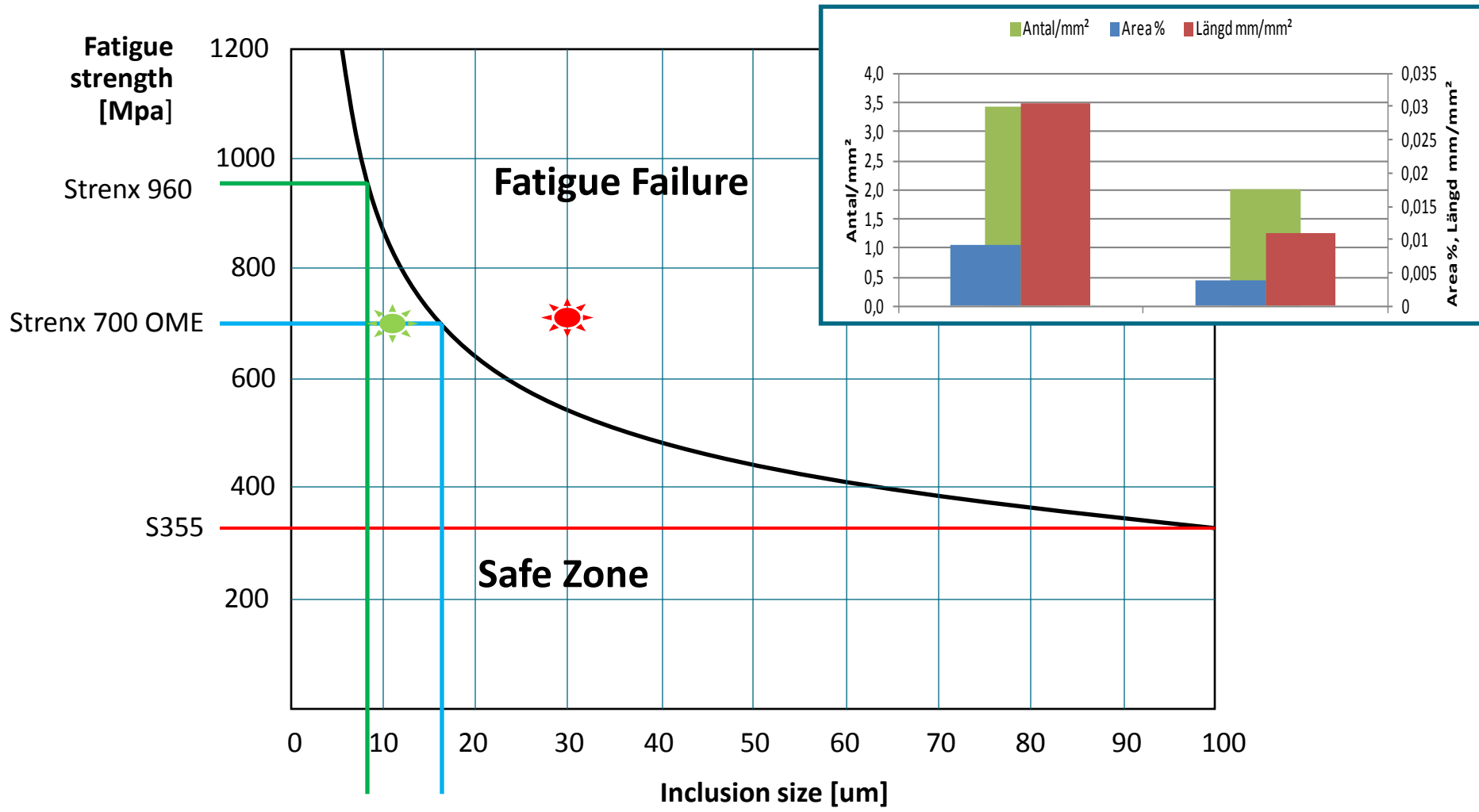
High quality hot-rolled

Good quality hot-rolled

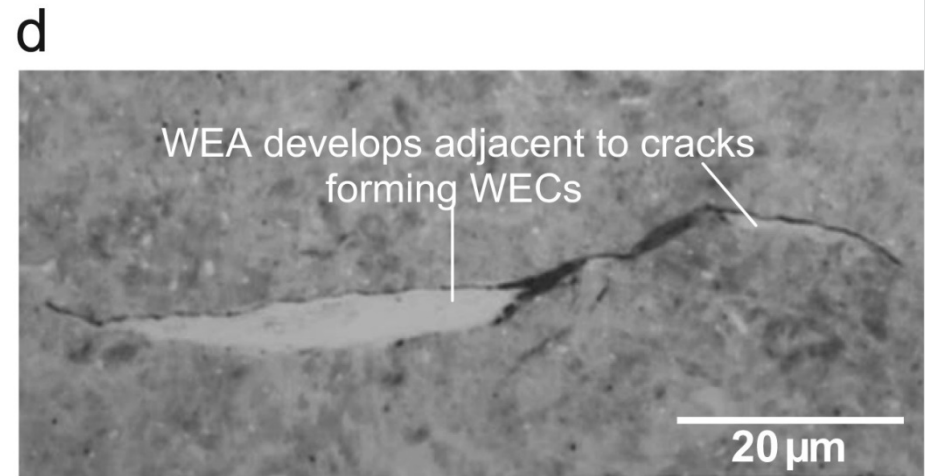
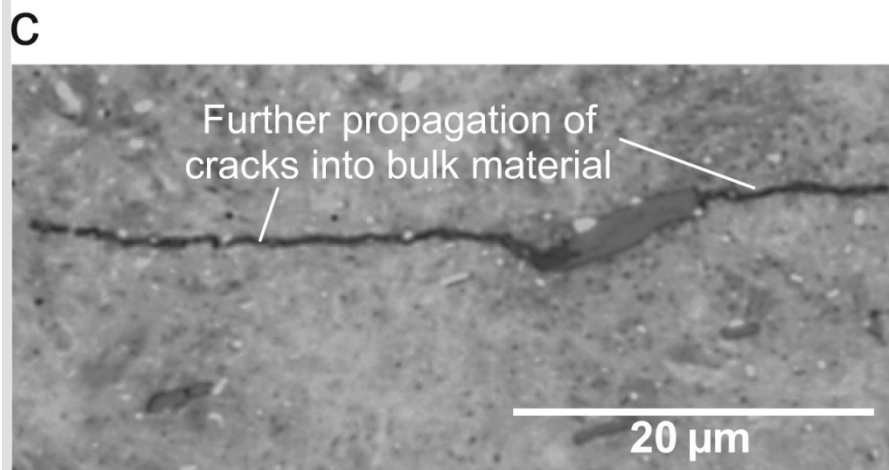
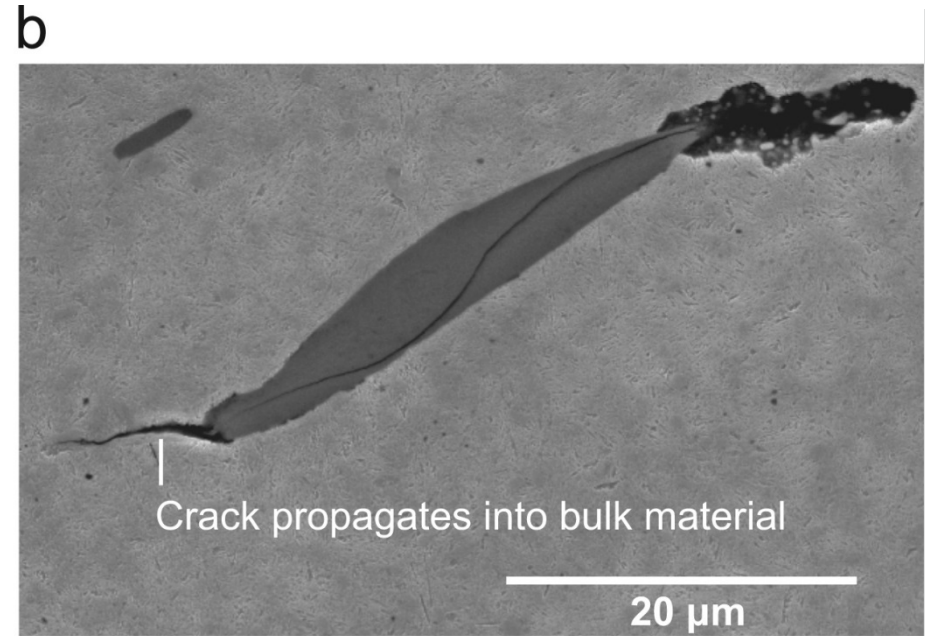
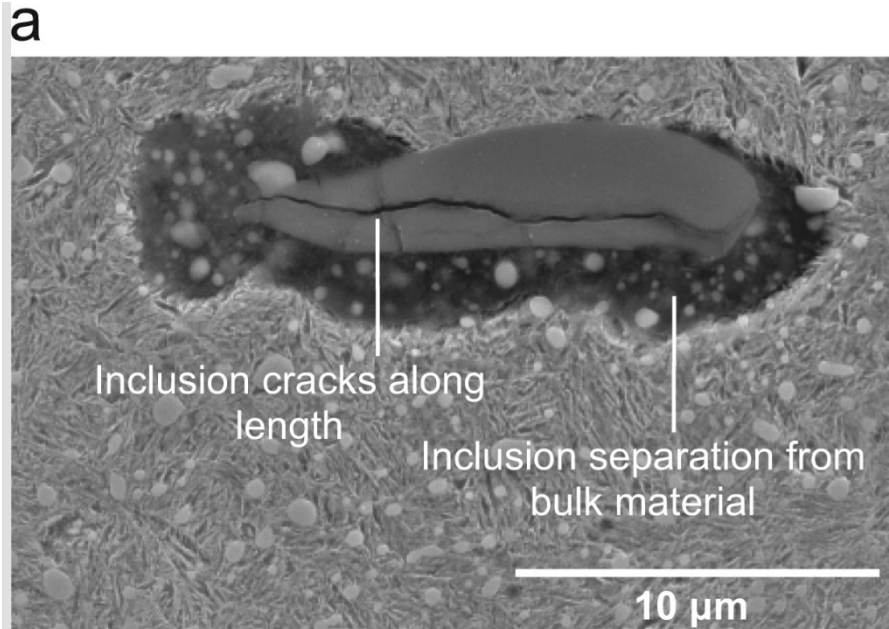
Four high rolled, blasted

Gas cut edge

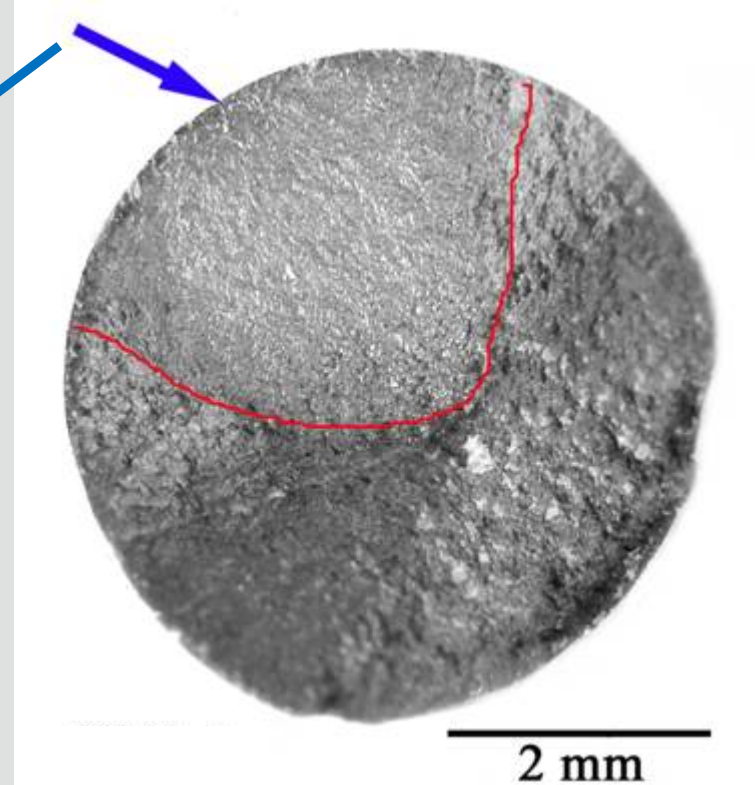
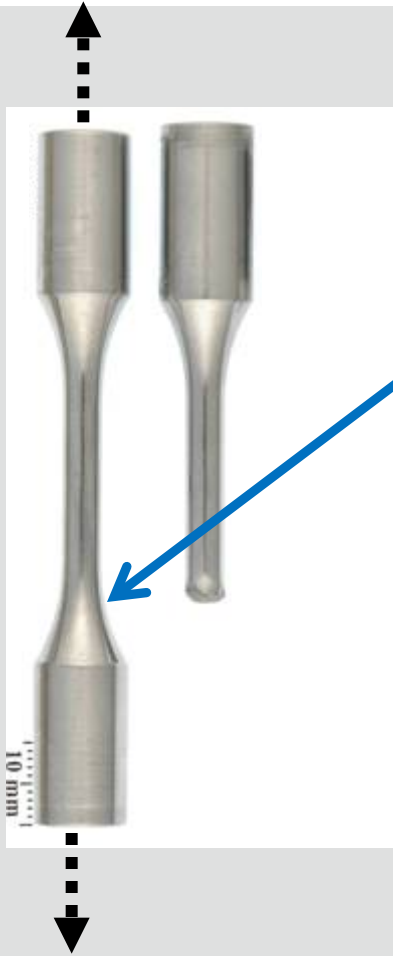
Fatigue Strength vs Cleanness in parent material



Inclusion crack initiations in wind turbine gearbox



Fatigue test



Specifying it right, It is safe and efficient!

Specifying it right:

- ▶ ~~S690 QL based on EN 10025-6 without further options~~
- ▶ Strenx 700 E = EN 10025-6 + SSAB Clean steel, CSR Casting & Strenx Guarantees
- ▶ Classified 690 = DNV-GL VLE690, LR EH69, ABS EQ70
- ▶ Strenx 700 OME = Class approval + SSAB Clean steel, CSR Casting & Strenx Guarantees

Additional Options:

- ▶ Z35 = Guaranteed strength properties in Z directions
- ▶ Ultrasound test = Up to S3E3, Assure no large inclusions, lamination or center defects
- ▶ Cleanness = SS ISO 11 11 16 or ASTM E45 Method A

Your benefits

- ▶ Guaranteed product properties
- ▶ High fatigue performance
- ▶ Predictable workshop performance
- ▶ Efficient production
- ▶ Higher quality
- ▶ More accurate dimensioning
- ▶ Excellent weldability

Where can we use
Extra high strength steels in ships

Your input from yesterday

- ▶ FPSO Blast walls
- ▶ Container Ship Shear Box
- ▶ Cruise Ship upper Decks
- ▶ Steel / Composite joints
- ▶ High Speed Crew supply ships for platforms and wind mills
- ▶ Primary barriers for LPG tankers
- ▶ Weldable Reinforcement wires for composite structures
- ▶ Aircraft structures
- ▶ Deck bottom Transition connections
- ▶ Pillars between decks
- ▶ Palest for Ship decks
- ▶ Propeller and rodders

Blast Protection

For Naval ships:

- ▶ SSAB Strenx 700 grades have been used in Sub-marines since the 80ies
- ▶ Reinforcements of hulls to resist collisions and blasts close to the ships
- ▶ Weight and performance optimized bulkheads and safety doors
- ▶ Protection of ammunition storages

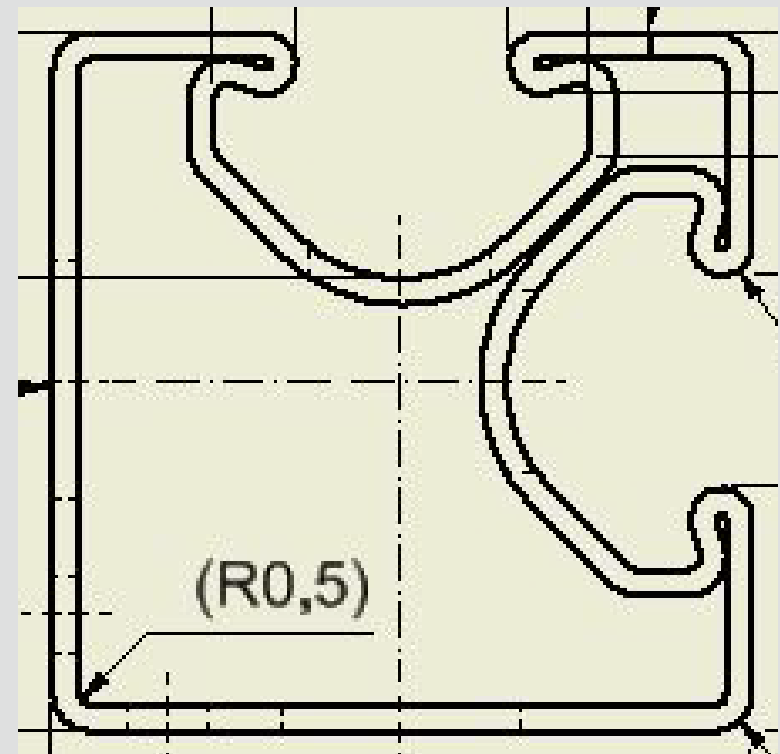
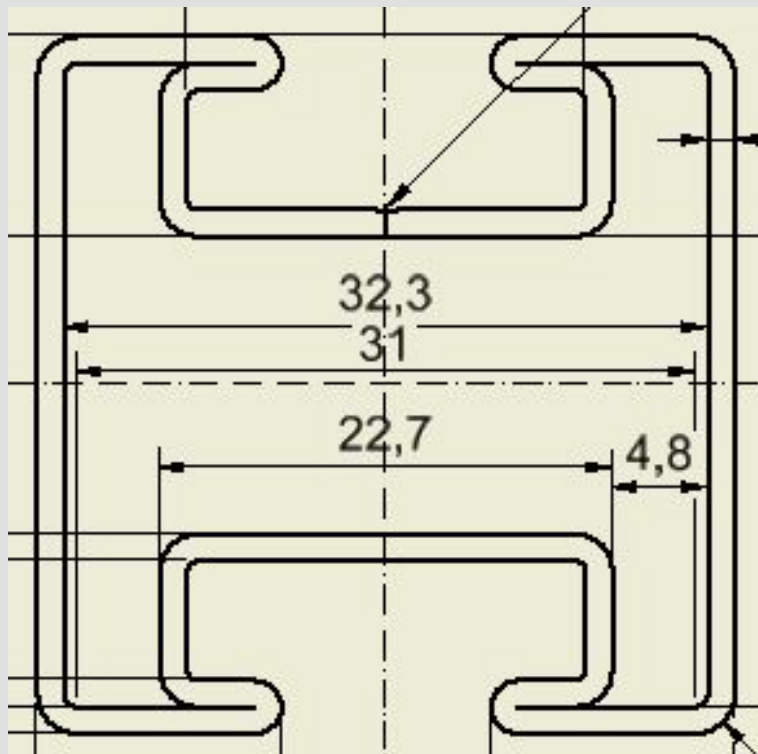


Fatigue improvements of critical components

By using formed or bolted Strenx 700

- ▶ Around window and door corners
- ▶ In joints of steel profiles
- ▶ In moving car decks and Ro-Ro Ramps
- ▶ In Container securing bridges
- ▶ In Hatch covers

Rollforming High Strength steels



The Fire Challenge

Hardox HiTemp – a structural wear steel that resist heat

- ▶ Provides a cost-efficient solution for strength (1100 Mpa) and wear resistance (400HB) at high temperatures in the 300–500° C range (570–930° F).
- ▶ Whereas traditional quenched and tempered wear-resistant steels lose hardness at higher temperatures, Hardox® HiTemp high-temperature steel delivers extreme wear resistance. Its properties are achieved by using high-quality raw material combined with a carefully controlled manufacturing process.
- ▶ Hardox® HiTemp is delivered as 5–51 mm (0.197”–2”) plate. It can be cut, welded and machined using the same kind of machinery and technology as for conventional steel.

3D forming of SSAB Steel with 1500 MPa



50% weight reduction

- ▶ 3D forming taking away all critical welds enable massive weight reduction.
- ▶ This 3D forming is done in hot condition using a grade that is 1300 – 1500 MPa after hardening.

2D forming of SSAB Steel with 700 MPa

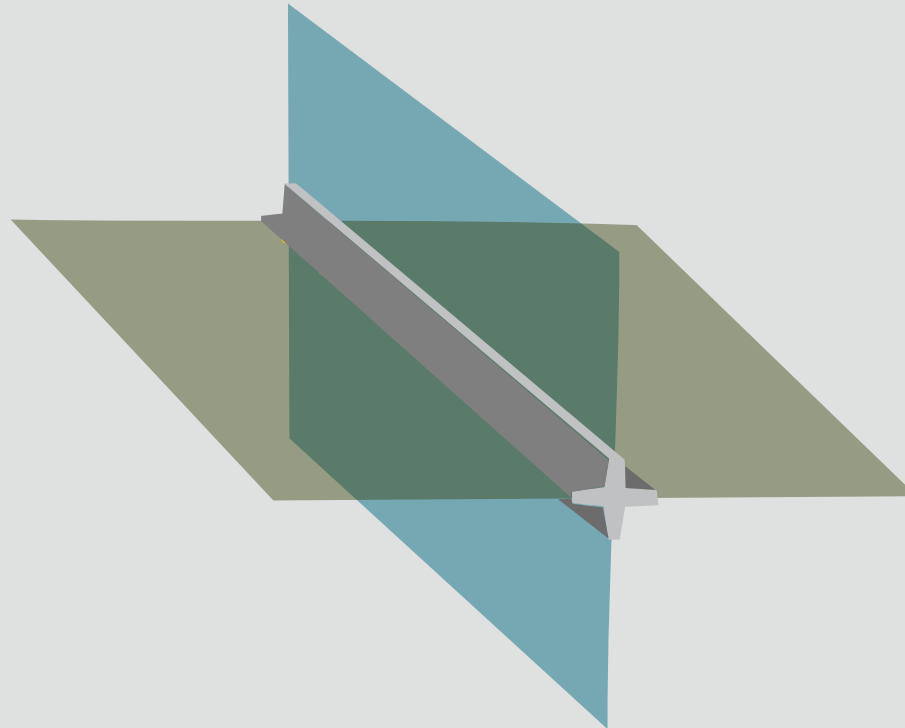
- ▶ Keel, Rodder, Propeller – Everyting is possible



Fatigue improvements of critical components

Strenx 700 in combination with Composite Joints

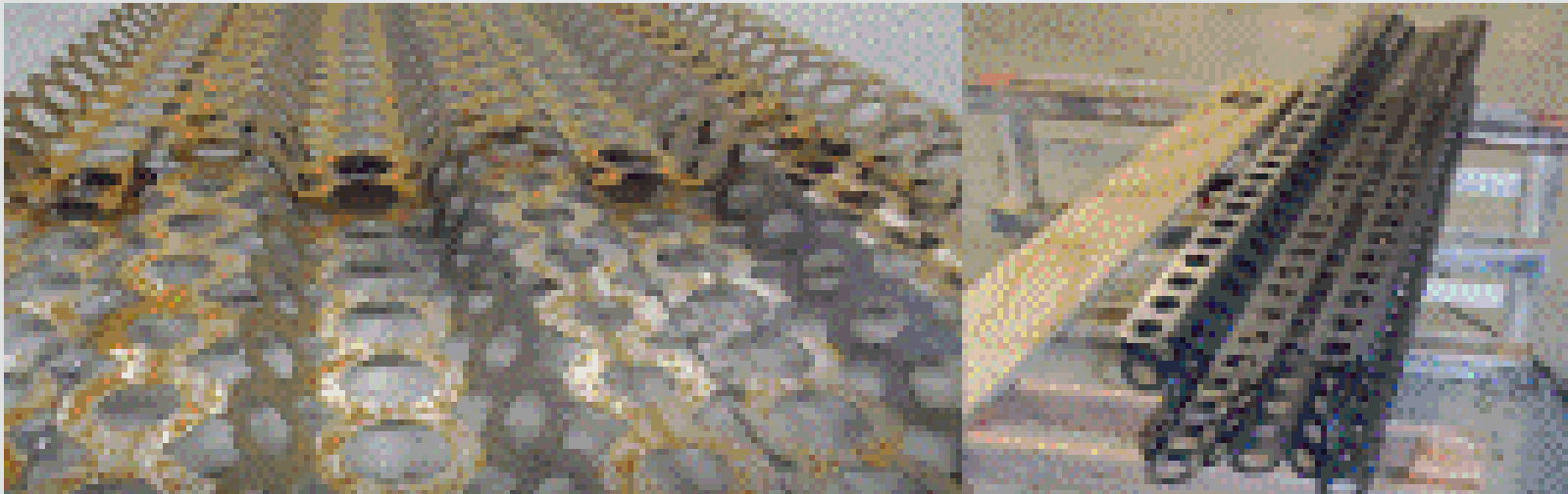
- ▶ In joints of steel profiles
- ▶ In inner structures of ship hulls



Fatigue improvements of critical components

Strenx 700 in combination with Composite Joints

- ▶ In joints of steel profiles
- ▶ In inner structures of ship hulls



Ice breaking reinforcements

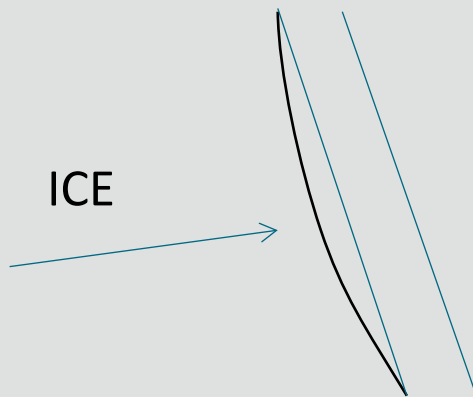
For commercial vessels with ICE class 1A:

- ▶ Enable keeping normal thickness based on fatigue in the welds save weight and welding cost compared to increasing thickness using mild steel or EH36
- ▶ Good weldability with high Impact toughness will secure safety form Ice hits.

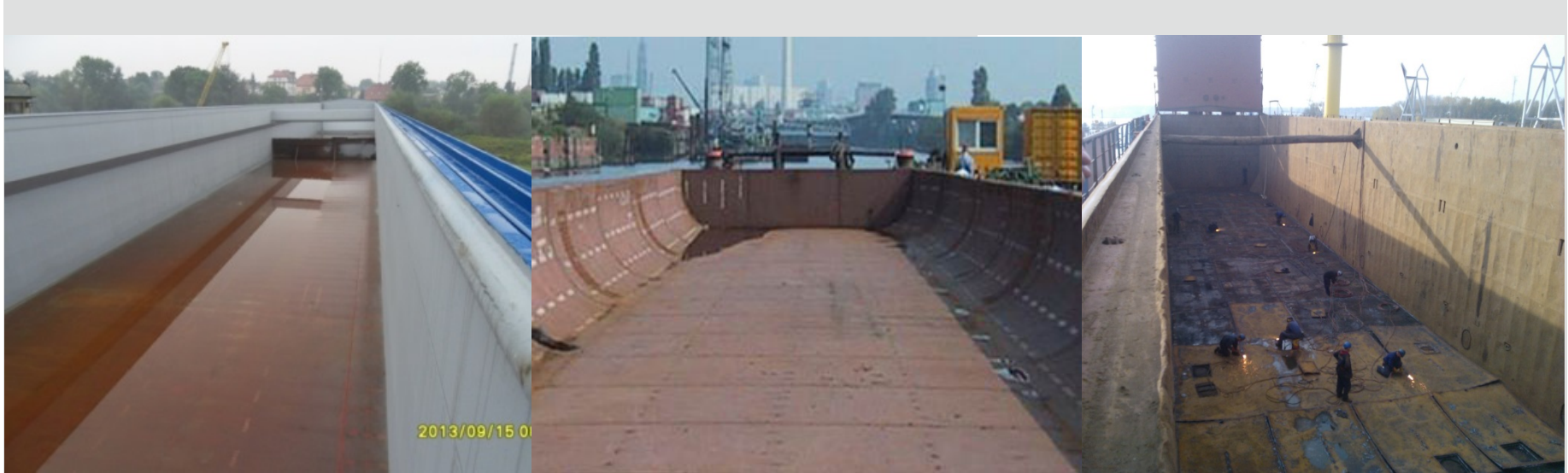
Ice breaking reinforcements

For Ice Breakers:

- ▶ SSAB has developed structural design solutions used in Mining truck industry that we believe can be used for heavy Ice Breaking.
- ▶ Based on more flexible joining of the hull plate to the scantling the shear forces can be reduced.
- ▶ Using this method the forces will be more distributed in the plates and thus enable better utilization of high strength steels.
- ▶ This can be done both along the ship as well as transvers the ship length.



Bulk Cargo Lining – Hardox in Cargo Boxes



Inland barges:

- ▶ Hardox 400
- ▶ Hardox 450
- ▶ Hardox 500

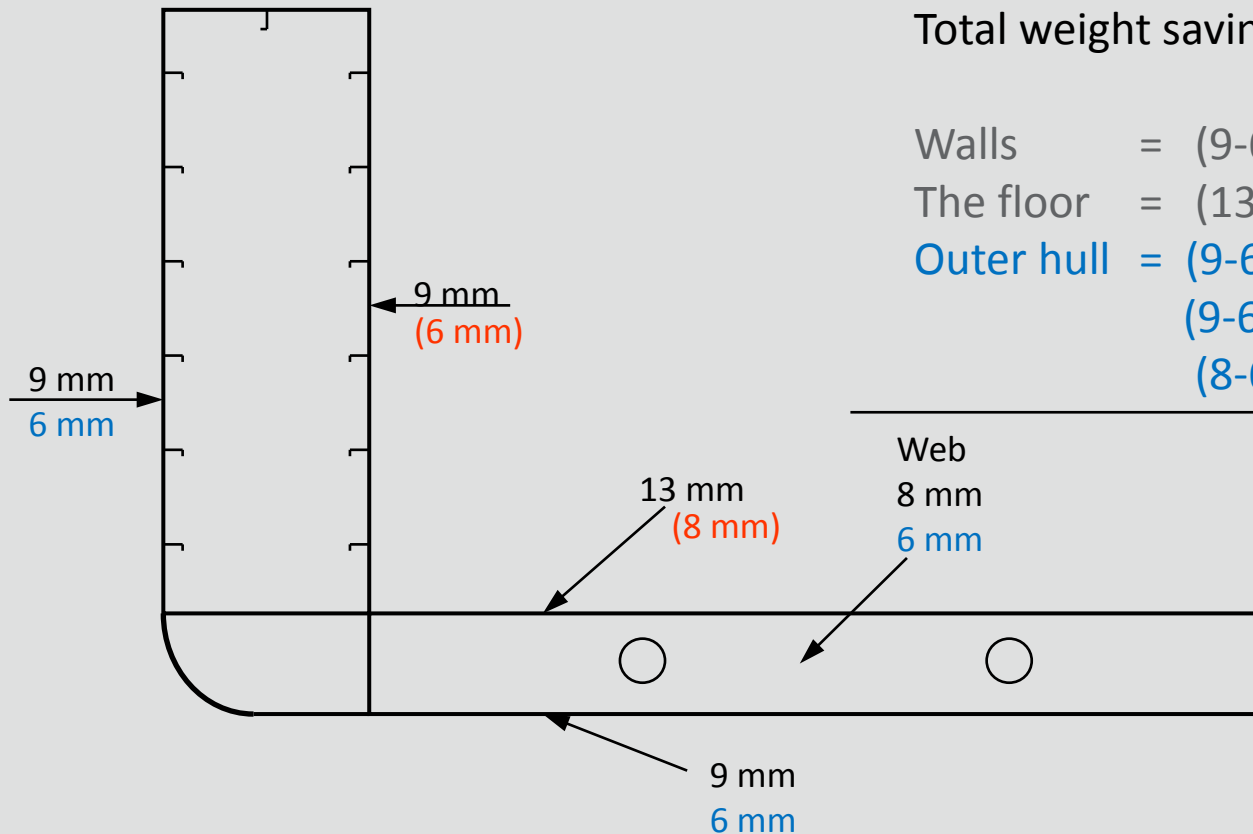
Sea going bulk carriers:

- ▶ Hardox 400
- ▶ Hardox 450

Picture replacing ordinary ship plates for Hardox 450. Easy to understand that the normal mild steel gets damaged and hard to clean.

Payload

- ▶ Traditional plate thickness using Grade A
- ▶ Example using HARDOX 400
- ▶ Adding Strenx 700 OME in structural hull



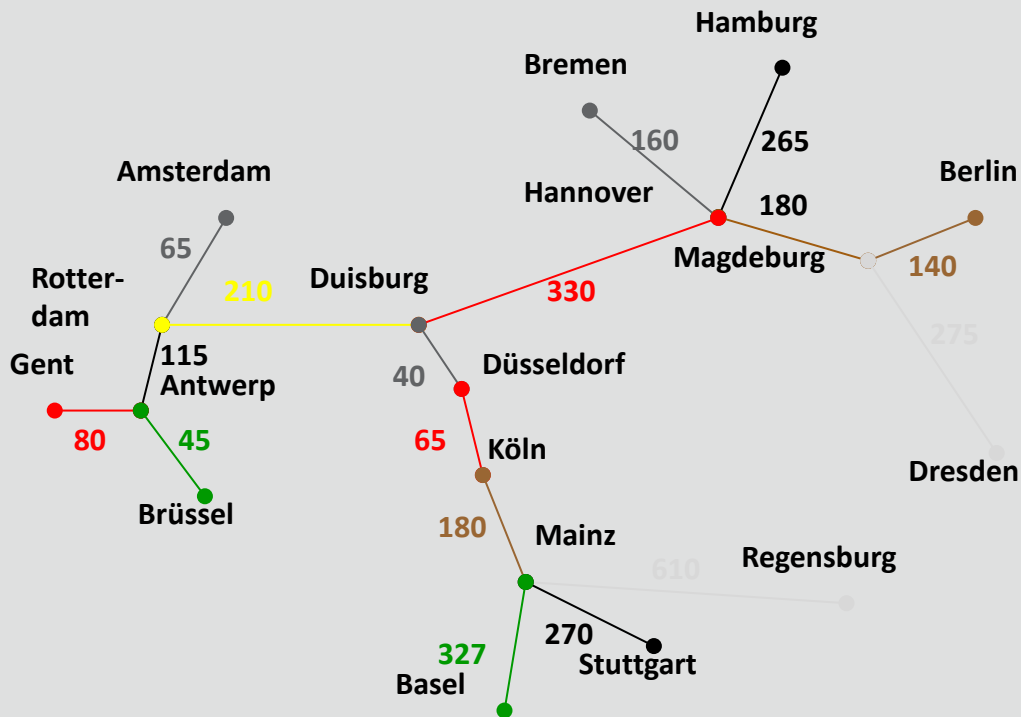
Total weight saving:

| | | | | |
|------------|---|---------------|---|-------------------|
| Walls | = | (9-6) x 3760 | = | 11280 kg |
| The floor | = | (13-8) x 4880 | = | 24400 kg |
| Outer hull | = | (9-6) x 3760 | = | 11280 kg |
| | | (9-6) x 4880 | = | 14640 kg |
| | | (8-6) x 2000 | = | 4000 kg |
| | | | | Σ 65600 kg |

Economic benefit

What is the benefit of 65 tons higher payload?

Distances in km between some of the inland waterway ports.



Example

Travel distance over a year [km]: 35 000 x

Average price per ton and km [€]: 0.008 x

Increased payload [tons]: 65 tons =

18200 €/yr

Bulk Cargo Lining – Hardox in Cargo Boxes

Benefits:

- ▶ Longer life time
- ▶ No need of re-lining
- ▶ Higher payload
- ▶ Easier cleaning the box
- ▶ Shorter time at harbor
- ▶ Lower fuel consumption

Design Challenges:

- ▶ Need material adapted welding procedure
- ▶ For sea going ships, acid conditions (NaCl) at sea increase hydrogen cracking risk. This means that it is not suitable using higher grade than Hardox 450.

Class and certification:

- ▶ Classification mandatory
- ▶ General approval for Hardox and RAEX in inland bulk cargo barges.
- ▶ For sea going ships we have to get separate approvals for each ship with detailed instructions on how to weld in the Hardox steels in the hull in order to maintain the fatigue strength of the hull.

Offshore and Marine cranes

Benefits:

- ▶ Reaching longer
- ▶ Larger lift capacity
- ▶ Lower weight footprint
- ▶ Additional safety margin
- ▶ Production cost reduction
- ▶ Installation cost reduction

Design Challenges:

- ▶ Not only vertical load
- ▶ Twist and torsion load
- ▶ Heave compensation
- ▶ Fatigue due to general ship movements both while in lifting use as well as in transportation mode
- ▶ Acid conditions (NaCl) at sea increase hydrogen cracking risk. Max 960 grade.

Class and certification:

- ▶ Classification non mandatory
- ▶ 3rd party Certification mandatory
- ▶ Some classification societies offer guidelines for lifting appliances based on class rules. Often very conservative.
- ▶ Good design with well worked through calculations open up for certification using high strength steels up to 960 Mpa

Offshore and Marine cranes



Knuckle boom crane:

- ▶ Boom parts
- ▶ Joints and knees
- ▶ Winch drums
- ▶ Winch structures
- ▶ Base tower
- ▶ Rotation gears



A-frame crane:

- ▶ Top Boom
- ▶ Wheels and Lifting devices
- ▶ Lift arms
- ▶ Critical joints



Mast crane:

- ▶ Tension bars
- ▶ Pedestal/mast
- ▶ Lattice boom
- ▶ Winch structures
- ▶ Critical joints
- ▶ Rotation gears

Davits and Launch and Recovery Systems



Applications:

- ▶ Boom parts
- ▶ Joints and knees
- ▶ Winch equipment



Jack-up legs and pylons

Benefits:

- ▶ Larger lift capacity
- ▶ Lower weight footprint
- ▶ Additional safety margin
- ▶ Production cost reduction
 - Welding
 - Bending of chords
- ▶ Installation cost reduction

Design Challenges:

- ▶ Not only vertical load
- ▶ Twist and torsion load
- ▶ Fatigue due to waves and wind
- ▶ Acid conditions (NaCl) at sea increase hydrogen cracking risk.

Class and certification:

- ▶ Classification mandatory
- ▶ Need classed grades:
Strenx 7000ME / AB EQ70
Strenx 7000ME / VLE 690
Strenx 7000ME / LR EH69
- ▶ Very high demands on the welds: 46 J at -40 Deg C in fusion line

Jack-up legs and Pylons



Tube Pylons for lift boat:

- ▶ Pylon tubes
- ▶ Jacking system
- ▶ Structure around jacking system



Lattice Jack-up legs:

- ▶ Gear racks
- ▶ Stiffening chords
- ▶ Jacking gears
- ▶ Structure around jacking system
- ▶ Bracing tubes

Ocean Energy

Benefits:

- ▶ Reaching longer
- ▶ Larger lift capacity
- ▶ Lower weight footprint
- ▶ Additional safety margin
- ▶ Production cost reduction
- ▶ Installation cost reduction

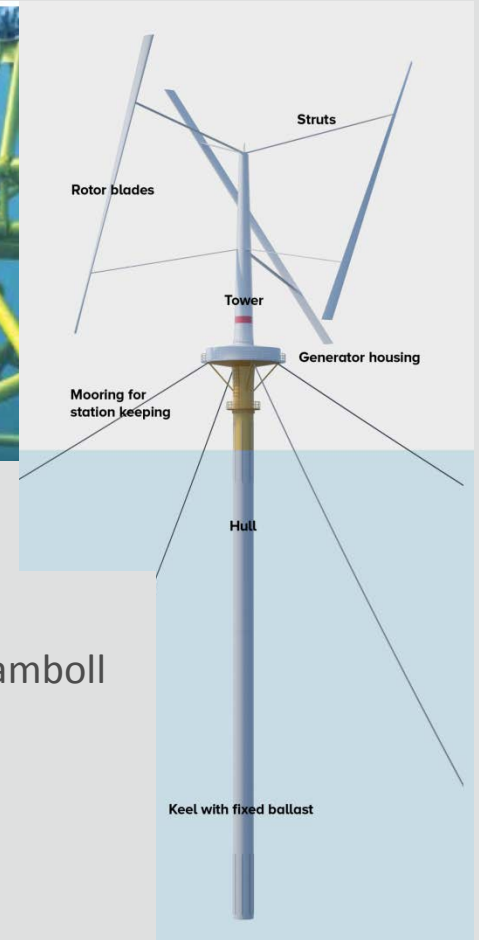
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Ocean Energy



Wave Energy Converters:

- ▶ CorPowerOcean
- ▶ Waves4power
- ▶ Wello
- ▶ Ocean Harvesting

Tidal & Stream Energy Converters:

- ▶ Scotrenewables
- ▶ Gaiatellus
- ▶ Minesto

Offshore Wind:

- ▶ SSAB, Bladt, Ramboll consortium
- ▶ Seatwirl
- ▶ Vattenfall
- ▶ FlowOcean

Dredging and bulk cargo buckets

Benefits:

- ▶ Longer life time
- ▶ Higher payload

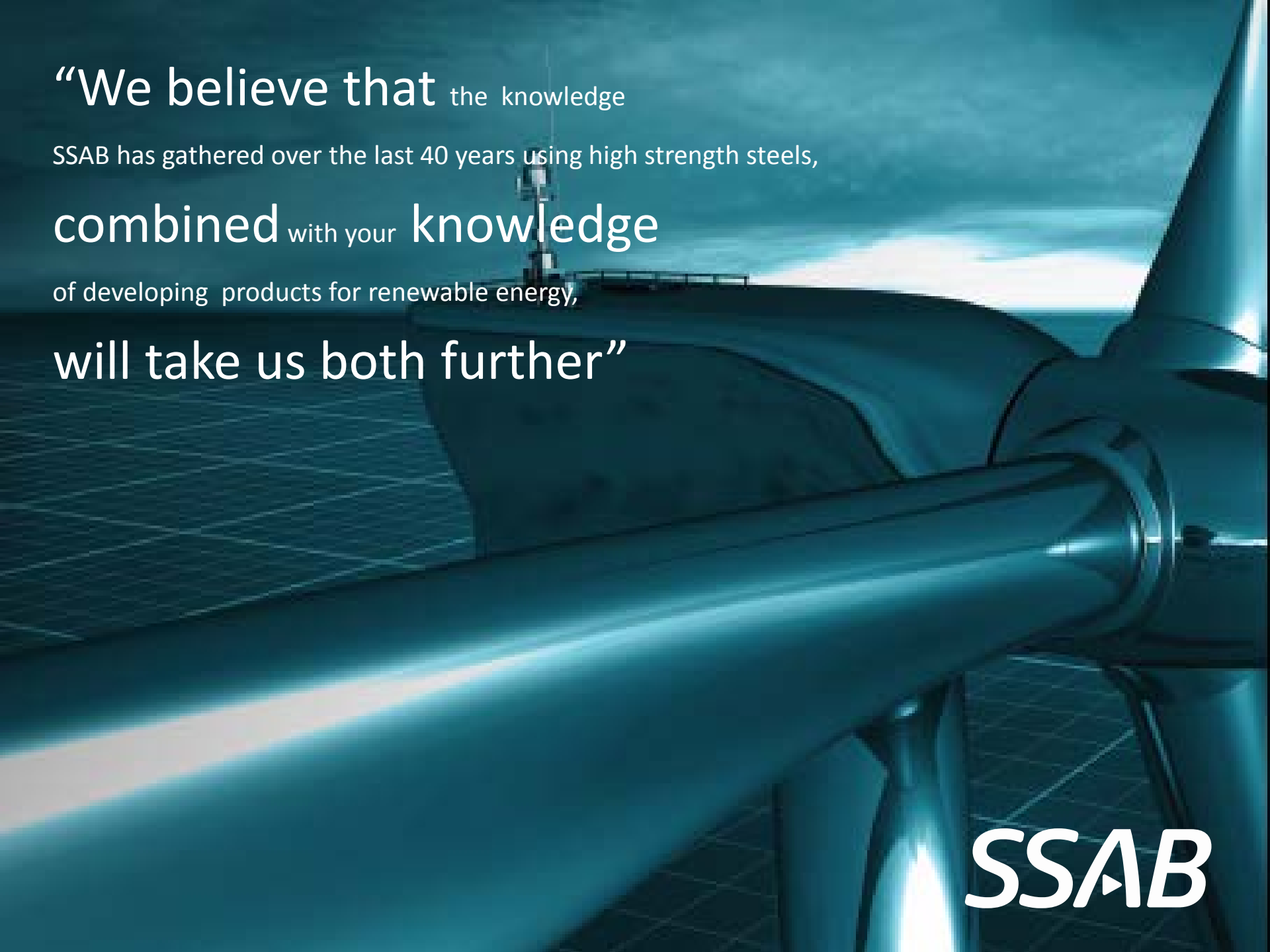
Design Challenges:

- ▶ Need material adapted welding procedure
- ▶ For work in salt water, acid conditions (NaCl) increase risk of hydrogen cracking. This means that it is not suitable using higher grade than Hardox 450.

Class and certification:

- ▶ No classification mandatory





“We believe that the knowledge
SSAB has gathered over the last 40 years using high strength steels,
combined with your knowledge
of developing products for renewable energy,
will take us both further”

SSAB