Simulation of Spreader Beam 65 t SWL

55t upper Pad eyes and 35t Lower Pad eyes

Date: Tuesday, 31/December, 2024
Study name: Proof load tests Simulation study
Analysis type: Static
Client: HALLIBURTON WORLDWIDE LIMITED
Department: HPS
Report No: ATS-HAL-2024-SB-001

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Description:

65 t Spreader Beam:

- 2 x 55 t upper pad eyes
- 2 x 35 t lower pad eyes
- SHS 200*200 built-up beam section
- 15 mm Flanges thickness, 12 mm webs thickness
- 2652 mm upper span (Distance between the centers of upper pad eyes)
- 2638 mm lower span (Distance between the centers of lower pad eyes)
- Dimensions: L: 2902 x W: 200 x H: 500 [mm]
- Self-Weight: 370 Kg

1. Introduction:

This simulation study has been intended as a guidance for the relative standard requirements, related calculations and mechanical simulations for the induced stresses during the proof load tests to check the fitness of the tested spreader beam for purpose and its safety for use.

2. Relative Standard:

- **BS EN 13155:2020** - Crane — Safety — Non-fixed load lifting attachments.
- **DNVGL-ST-E271:2017** - Offshore containers.

3. Pad Eyes Design:
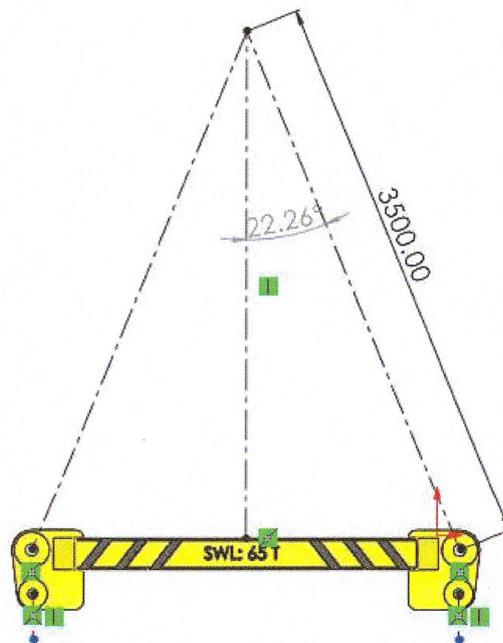
- By referring to the relative standard (**BS EN 13155:2020**), Annex A (General verification methods), The test shall be conducted by applying a static force *F*2 equivalent to 2 × working load limit in a manner which replicates the conditions in which the attachment is intended to be used.

- Pad eyes have been designed to withstand 2 times the WLL as per the reference standard, and hereby the pad eyes design calculations:

1. Upper Pad eyes study and calculations: *Note

Each upper pad eye will subject to 37.53 t load after completely applying the Working Lod Limit (65 t), and the shackle size matching this load is 55 t.

*Note: The sling included angle was considered to be 30 degrees maximum, and the provided upper slings shall only be used in association with the spreader beam.

1.1.Calculation of tear-out stress (DNVGL-ST-E271:2017):

Pad eye material: SA 235 Jr (yield strength is Re= 235 N/mm^2)

RSL= 375300 N (Resulting sling load)

H= 125 mm (The shortest distance from center of pinhole to the edge of pad eye)

DH= 75 mm (Pinhole diameter)

t (pad eye thickness in mm)

$$Re \geq \frac{3 \times RSL}{2 \times H \times t - D_H \times t}$$

t= 28 mm (the minimum thickness of pad eye plate)

1.2.Calculation of Contact stress (DNVGL-ST-E271:2017):

$$Re \geq 23.7 \times \sqrt{\frac{RSL}{D_H \times t}}$$

t= 51 mm (the minimum thickness of pad eye with cheek plates)

Results from above:

1. The actual Pad eye thickness is 50 mm which exceeds the minimum thickness as per the equation 1.1 above.
2. Pinhole diameter is: 75 mm (to achieve a tolerance no more than 6% of shackle pin diameter between the pad eye pinhole and shackle pin)
3. Cheek plates thickness is: 15 mm (to achieve a thickness ≥ 75% of shackle internal jaw width), and the total pad eye thickness with cheek plates is 80 mm which exceeds the minimum thickness as per the equation 1.2 above.

2. Lower Pad eyes study and calculations:

Each lower pad eye will subject to 32.5 t load after completely applying the Working Lod Limit (65 t), and the shackle size matching this load is 35 t.

2.1.Calculation of tear-out stress (DNVGL-ST-E271:2017):

Pad eye material: SA 235 Jr (yield strength is Re= 235 N/mm^2)

RSL= 325000 N (Resulting sling load)

H= 100 mm (The shortest distance from center of pinhole to the edge of pad eye)

DH= 62 mm (Pinhole diameter)

t (pad eye thickness in mm)

$$Re \geq \frac{3 \times RSL}{2 \times H \times t - D_H \times t}$$

t= 30 mm (the minimum thickness of pad eye plate)

2.2. Calculation of Contact stress (DNVGL-ST-E271:2017):

$$Re \geq 23.7 \times \sqrt{\frac{RSL}{D_H \times t}}$$

t= 54 mm (the minimum thickness of pad eye with cheek plates)

Results from above:

4. The actual Pad eye thickness is 50 mm which exceeds the minimum thickness as per the equation 1.1 above.
5. Pinhole diameter is: 62 mm (to achieve a tolerance no more than 6% of shackle pin diameter between the pad eye pinhole and shackle pin)
6. Cheek plates thickness is: 8 mm (to achieve a thickness ≥ 75% of shackle internal jaw width), and the total pad eye thickness with cheek plates is 66 mm which exceeds the minimum thickness as per the equation 1.2 above.

4. Beam Design:

- The beam section shall be designed and fabricated to sustain compression and tensile stresses during the lifting operations.
- The beam section was designed as a built-up box (square hollow section 200 x 200 x 12 mm), which consists of horizontal plates (flanges), and vertical plates (webs) joined together by welding.
- The actual thickness of beam flanges was increased from 12 mm to 15 mm in order to increase the strength in the vertical plan. The actual thickness of beam webs was kept as designed 12 mm
- The beam was designed to sustain 130.0 t (2 times the WLL of the spreader beam)
- The following calculation sheet was used to check that the induced stresses are not exceed the maximum allowed for the construction material.
- All the results were pass, and the beam is considered acceptable for fabrication.
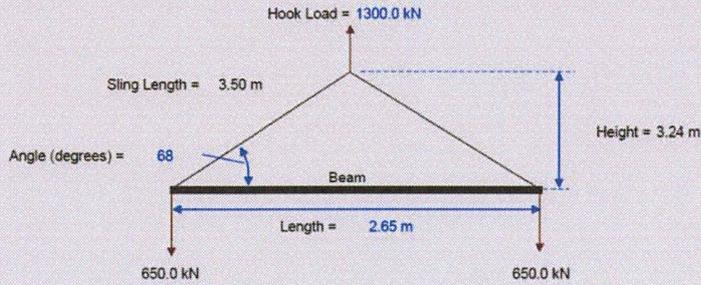
ABERDEEN TECHNICAL SERVICES AND GENERAL TRANSPORTATION LTD.
Spreader Beams Design Calculation Sheet

Hook Load = 1300.0 kN

Sling Length = 3.50 m

Angle (degrees) = 68

Height = 3.24 m

Beam

Length = 2.65 m

650.0 kN   650.0 kN

Beam Details			
Type		**SHShf**	
Size		**200 x 200 x 12**	
Material		**S235**	
Yield		**235**	**N/mm²**
E		**200000**	**N/mm²**
Mass / m	M	69.6	kg/m
Depth	h	200	mm
Width	b	200	mm
Web thickness	s	12	mm
Flange thickness	t	12	mm
Root radius	r	18	mm
Depth between fillets	d	164	mm
Second Moment of Area (x-x)	I_x	5171	cm⁴
Second Moment of Area (y-y)	I_y	5171	cm⁴
Radius of gyration (x-x)	r_x	7.64	cm
Radius of gyration (y-y)	r_y	7.64	cm
Elastic modulus (x-x)	Z_x	517	cm³
Elastic modulus (y-y)	Z_y	517	cm³
Area of section	A	88.7	cm²
Slenderness ratio	L/r_x	35	
Slenderness ratio	L/r_y	35	

Loads

Sling Load		702.3 kN
Compression on beam		265.9 kN
Self weight of Beam (184.44 kg)		0.682776 kN/m

Beam Stress

pcy	131 N/mm²	(for S235)	<	fc	30.0 N/mm²	**PASS**
pcx	131 N/mm²	(for S235)	<	fc	30.0 N/mm²	**PASS**
Bending str	157 N/mm²	(for S235)	<	fc	1.2 N/mm²	**PASS**

Buckling Load Check - Ideal struts no eccentricity or initial curvature

|					
Euler failure:	x-x	Failure load	14534.92 kN	1639 N/mm²	(Theory inapplicable)
Rankine Gordon:	x-x	Failure load	1823.29 kN	206 N/mm²	
Euler failure:	y-y	Failure load	14534.92 kN	1639 N/mm²	(Theory applicable)
Rankine Gordon:	y-y	Failure load	1823.29 kN	206 N/mm²	

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5. Proof Load Tests Simulation Study:

5.1.   65 t Load Test – One Time of WLL:
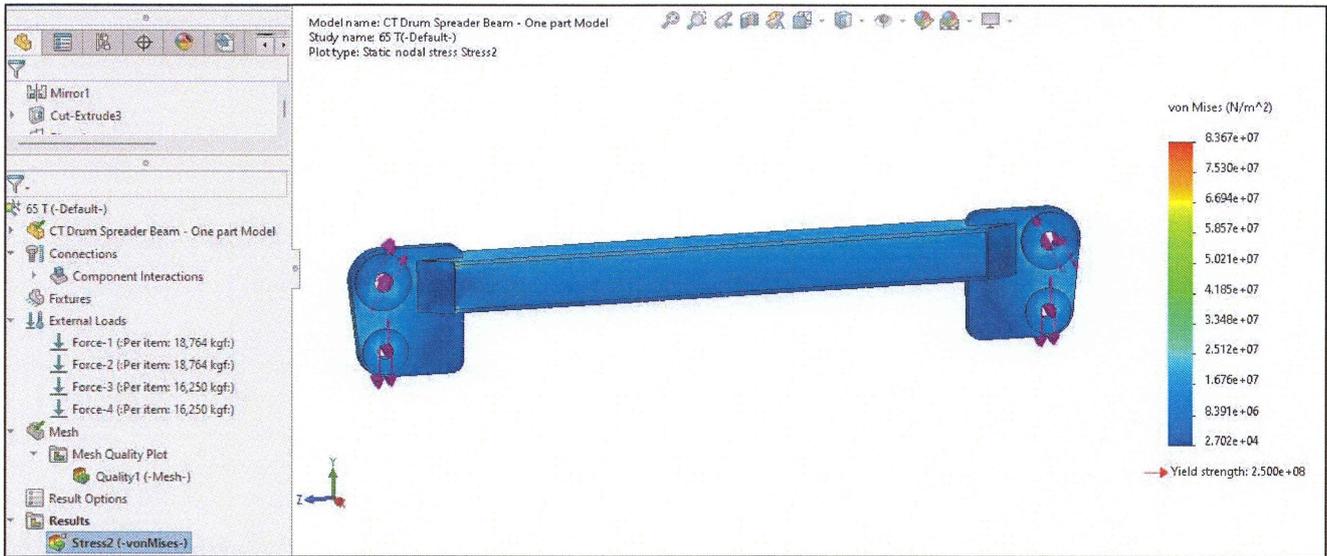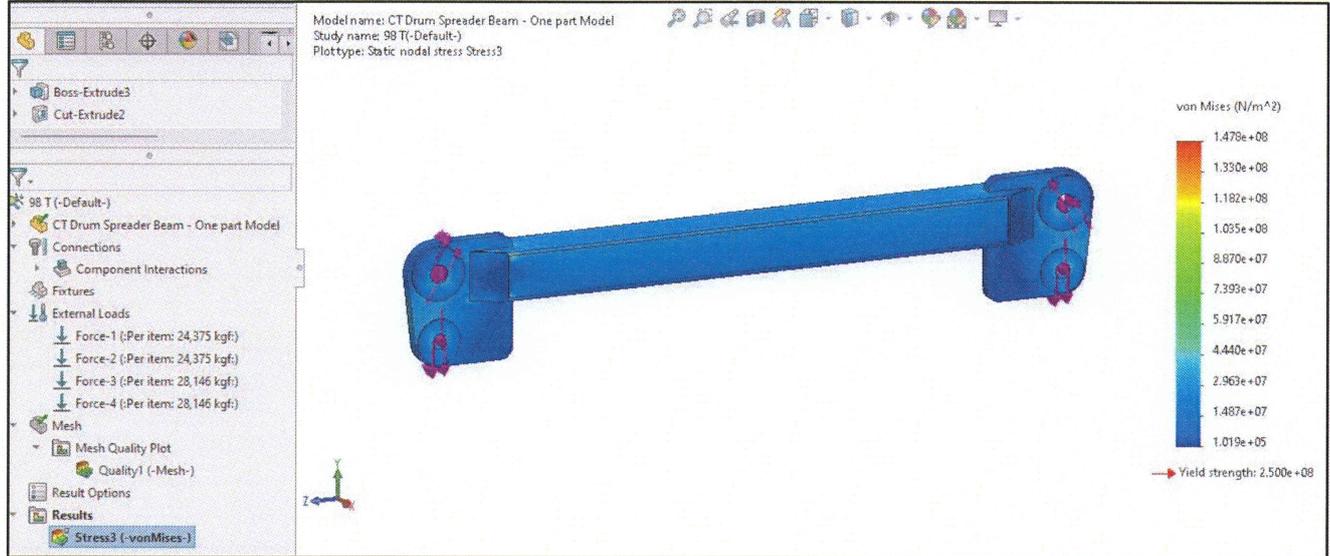

5.2.   81.25 t Proof Load Test – 1.25 Times the WLL:
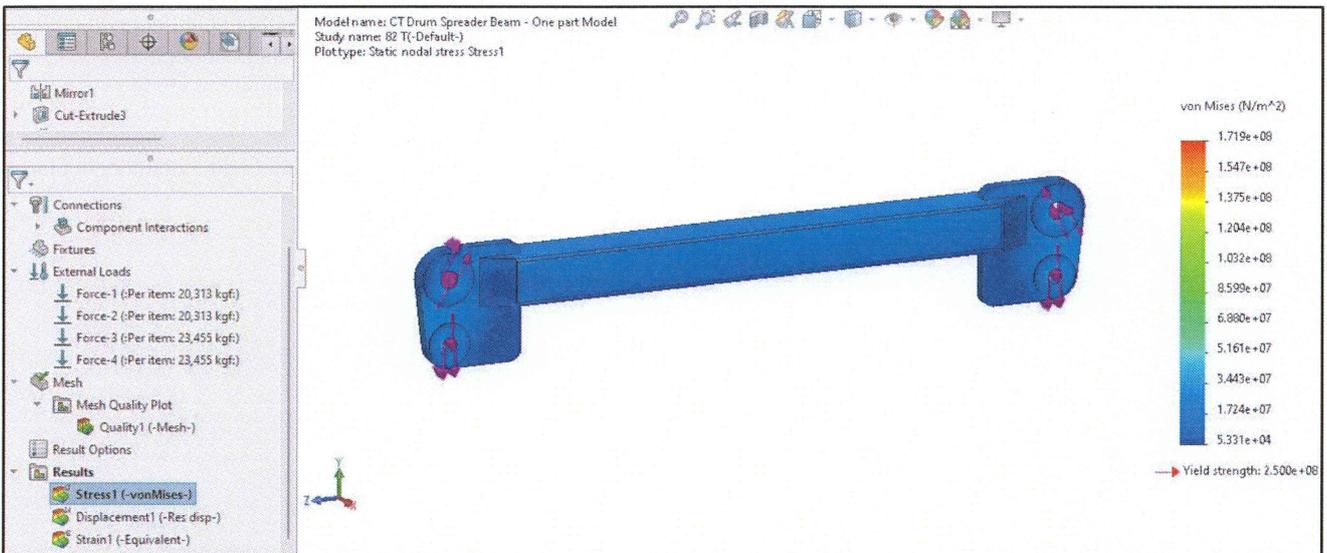
5.3.   97.5 t Proof Load Test – 1.5 Times the WLL:

5.4.   130 t Proof Load Test – 2 Times the WLL:
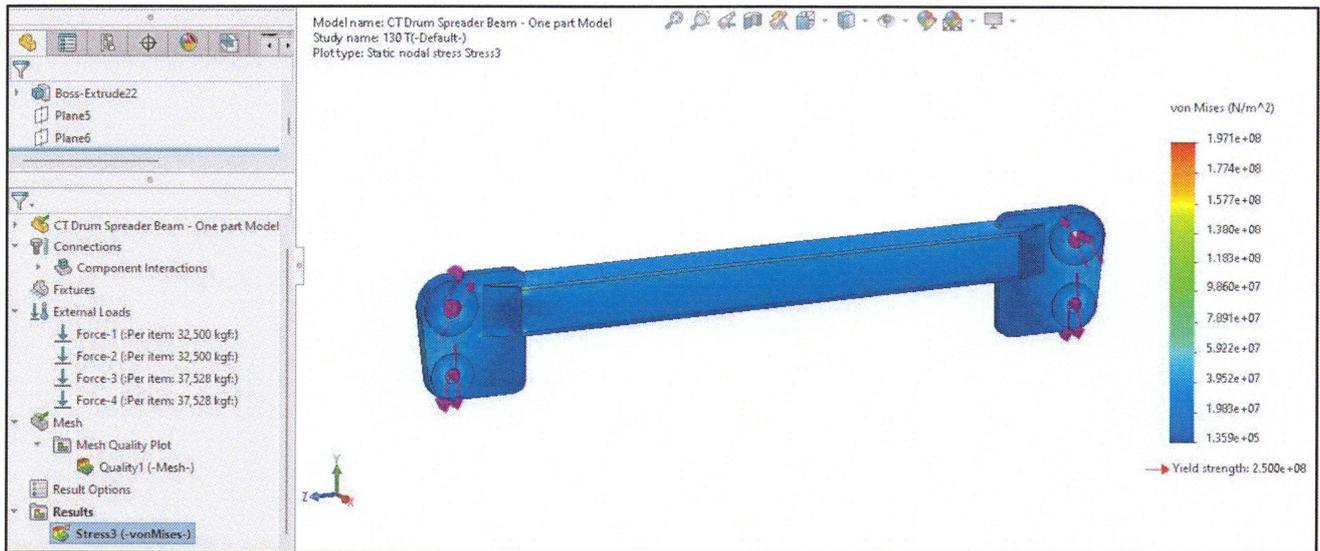
5.5. 130 t Proof Load Test for Upper Pad Eyes:
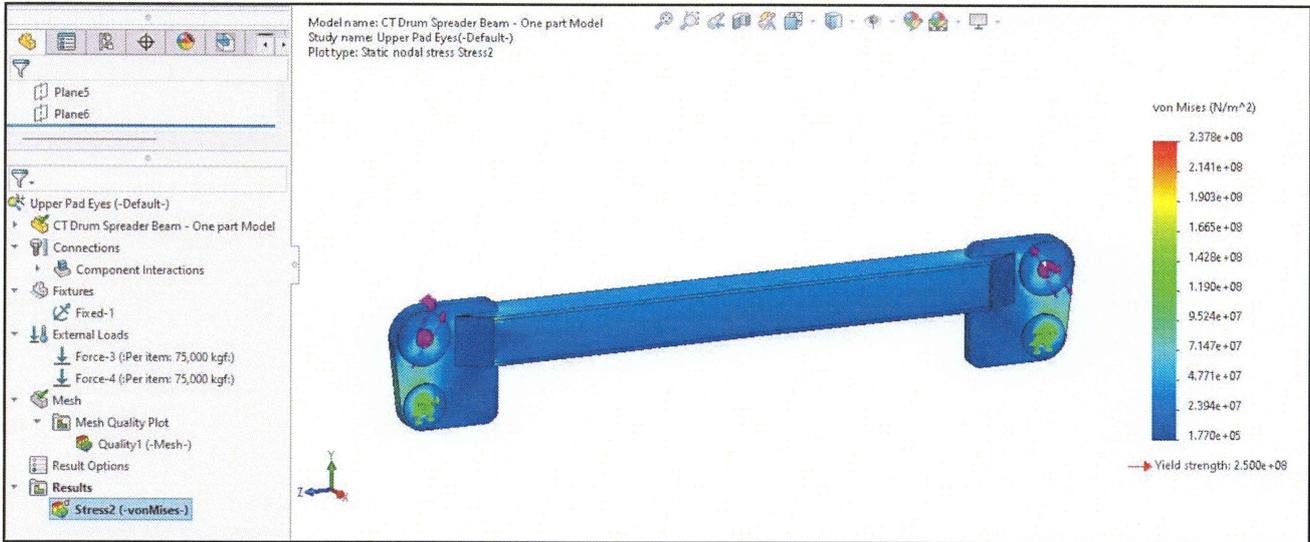
5.6. 130 t Proof Load Test for Lower Pad Eyes:
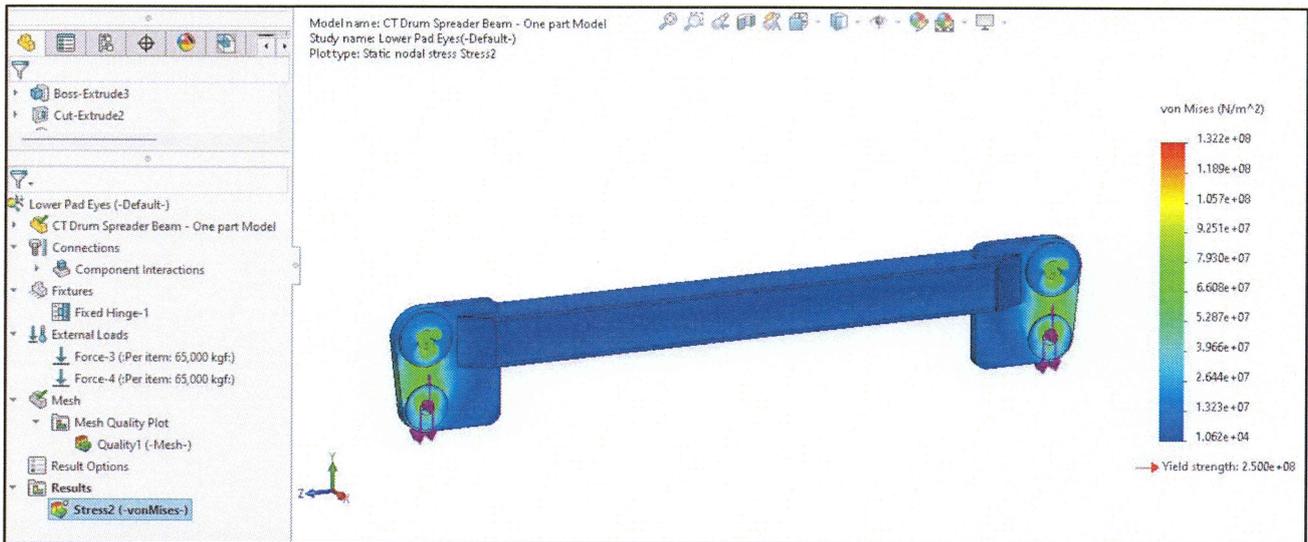
6. Simulation Study Conclusion:

- Spreader Beam has been designed in accordance with BS EN 13155:2020, which states the Following:

1. Verification of the mechanical strength. The manufacturer has a choice:

- This may be done by calculation alone in accordance with EN 13001-3-1.
- or it may be done by a static test

2. The relative standard EN 13001-3-1 has been stated that the (von Mises equivalent stresses) may be used for the design instead of calculated stresses. (Paragraph 5.3 Execution of the proof)

3. spreader beam has been designed and tested by simulation to withstand 2 times the SWL, and all the induced stresses (von-Misses stresses) during all simulation studies found less than the yield strength of the construction material (SA 36), and this means that even after the application of 130 t load, the beam material will be in the elasticity range and no permanent deformation will occur.

- The designed Spreader Beam found safe as it has been passed the simulation of all load tests.

7. General Information and Instructions:

- The Spreader Beam shall be used only in conjunction with the supplied lifting set (Steel wire rope slings and shackles).
- The upper slings included angle (the angle between the sling leg and the vertical) shall not exceed 30 degrees.
- The spreader beam has been designed, and fabricated by Aberdeen Technical Services.
- All repair services - if any- shall be done at Aberdeen Technical Services Workshop.
- All Design and Fabrication rights are reserved with Aberdeen Technical Services and any attempt to re-produce these documents or Beam are forbidden.
- Spreader beam is intended for horizontal use only.
- Spreader Beam has manufactured in accordance with (BS EN 13155 :2020).

8. Name Plate and Marking:

Aberdeen Technical Services

Iraq – Basrah – Al Barjesiah Main Road

www.aberdeents-iq.com

Email: workshop@aberdeents-iq.com

Mobile: 00964 7858908960 / 00964 7800000427

Unit: Spreader Beam for Coiled Tubing Reel

Owner: HALLIBURTON – HPS

Serial Number: ATS-HAL-SB-24-01

SAP Number: 14307580

SWL: 65 MT

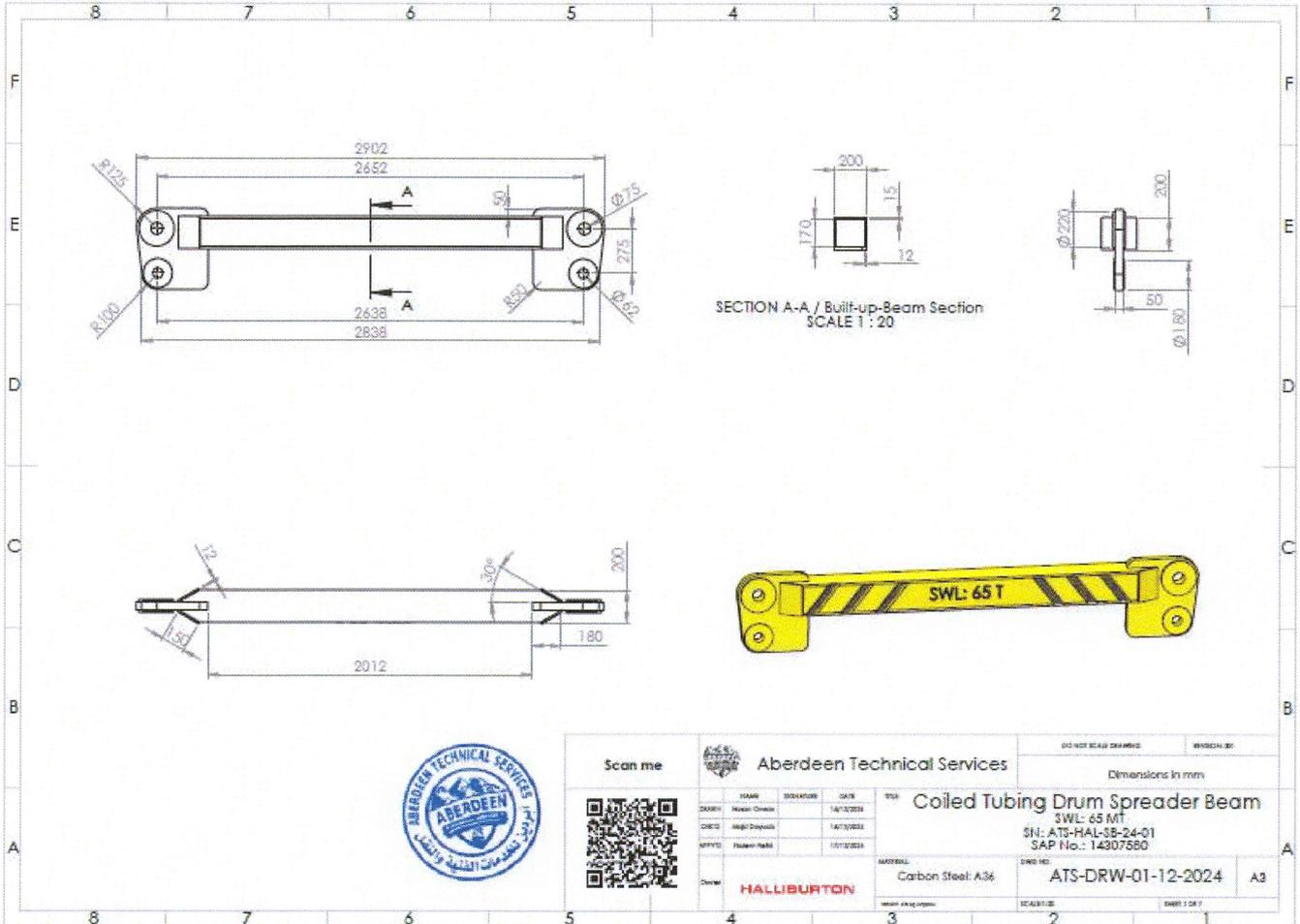Tare Weight: 370 Kg

Date of Manufacture: 12-2024

9. Drawing:

SECTION A-A / Built-up-Beam Section
SCALE 1 : 20

Scan me

Aberdeen Technical Services

Coiled Tubing Drum Spreader Beam
SWL: 65 MT
SN: ATS-HAL-SB-24-01
SAP No.: 14307580

HALLIBURTON

Material: Carbon Steel: A36

DWG NO.: ATS-DRW-01-12-2024