STIFFENING FRAME: FEA & WELD REPORT

ASME BTH-1-2017

June 15th, 2017
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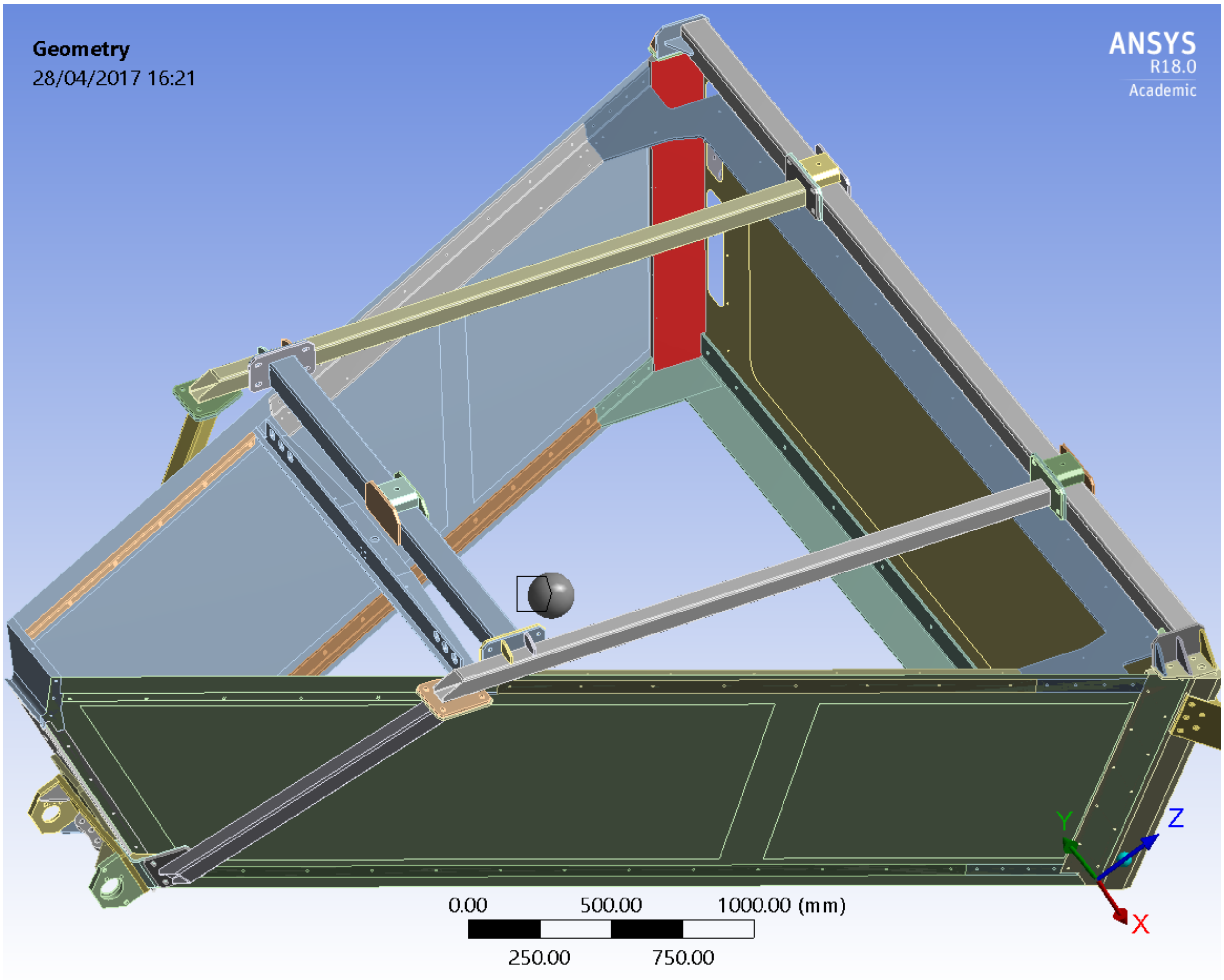
Rev.	Date	Author	Note
1	2017-07-11	S. Tomassini	1. Removed PIN load at page 3 2. Added Appendix
2	2017-07-19	S. Tomassini	3. Load Test analysis with Cart from page 22



Introduction

The stiffening tool will be used to install the RICH detector to the transportation trolley and to the strongback. The stiffening tool must support the RICH in the horizontal position while lifting off of the truck and it must support the RICH to mate the strongback.

MATERIAL

ASTM A500 Steel, grade B[1], shaped structural tubing

- Modulus of Elasticity, E = 29 Msi (**200 Gpa**)
- Yield Strength, σ_y = 45700 psi (**315 Mpa**)
- Tensile Strength, S = 58000 psi (**400 Mpa**)

ASTM A36 Steel, plate[1]

- Modulus of Elasticity, E = 29 Msi (**200 Gpa**)
- Yield Strength, σ_y = 36300 psi (**250 Mpa**)
- Tensile Strength, S = 58000 psi (**400 Mpa**)

ASME BTH-1-2017 Allowable Stresses

The Stiffening tool qualifies as Design Category A with a Service Class 0. This results in a design factor (N_d) of 2.[1]

3-2 MEMBER DESIGN

Determine if the metal extrusions have compact sections:

Square tube 01: b/t = 3/0.185 = 16.21 (Table 3-2)
Limiting Width-Thickness Ratio = $1.12\sqrt{(E/F_y)} = 1.12\sqrt{(29E6 \text{ psi}/45.7E3 \text{ psi})} = 28.2$
Therefore, the square tube 01 is considered a compact section.

Square tube 02: b/t = 4/0.188 = 21.28 (Table 3-2)
Limiting Width-Thickness Ratio = $1.12\sqrt{(E/F_y)} = 1.12\sqrt{(29E6 \text{ psi}/45.7E3 \text{ psi})} = 28.2$
Therefore, the square tube 02 is considered a compact section.

Allowable stress (F_b) for strong axis bending of compact shaped sections
= $1.10F_y/N_d$ (equation 3-6) = 1.10 * 45700 psi/2 = **25135 psi (173 Mpa)**

[1] ASME BTH-1-2017, pages 11-14

3-3.4.1 WELDED CONNECTIONS

a) The design strength of the welds subject to tension or compression shall be equal to the effective area of the weld multiplied by the allowable stress of the base metal (**23155 psi (159 Mpa)**).
b) Weld filler metal of 62 Ksi tensile strength or higher is required
c) The allowable stress (F_v) for weld joints in shear:
    a. (3-55) $F_v = 0.60\ Exx/1.2/N_d = 0.60 * 62000\ psi/1.2\ /2.00 =$ **15500 psi (106 Mpa)**, where Exx = nominal tensile strength of the weld metal

3-3.3 Bolted Connections

The allowable bearing stress $F_p = (1.8*F_y)/1.2/N_d = 1.8*36300/1.2/2=$**27225** psi (**187.7 Mpa**)
The allowable tensile stress $F_t = F_u/1.2/N_d = 36300/1.2/2=$**15125** psi (**104.2 Mpa**)
The allowable shear stress $F_v = 0.62*F_u/1.2/N_d = 0.62*36300/1.2/2=$**9377.5** psi (**64.65 Mpa**)

Design Loads

The design loads for the stiffening tool are:
- **2425** lbs (**1100** kg) STIFFENING TOOL load capacity
- Lifting eyes will support the 2425 lbs stiffening tool load capacity and the 640 lbs (290 kg) stiffening tool weight = 3065 lbs (**1390** kg)

Load Test

The load test will be performed at 125% of the stiffening tool rating (1100*1.25=1375 kg)

Lifting eyes will support the 2425*1.25=3031 lbs stiffening tool load capacity and the 640 lbs (290 kg) stiffening tool weight = 3671 lbs (**1665**kg)

Simulation

ANSYS Workbench 18 was used to analyze the stiffening tool using the following methods.

The RICH module and the stiffening tool are modeled together with a rough mesh just to get the reacion force in the interface between the stiffening tool and the RICH mechanical connection. The system is modeled in the horizontal position and the stiffening tool is constrained with a remote point to simulate the effect of the forces induced by the straps. The remote constraint is deformable to let the structure free to deform.

The stiffening tool was submodeled with a better mesh representation and importing the desplacement field at the contact areas with the RICH.

Each weld joint was modeled as a bonded contact and the resultant forces and moments at the contact were used to calculate the weld stresses.

The stiffening tool and RICH is also lifted and rotated with a 3 point lift and a crane to fit the strongback for the CLAS12 installation.

The RICH module and the stiffening tool are modeled together with a rough mesh just to get the reacion force in the interface between the stiffening tool and the RICH mechanical connection. The system is modeled with a tilt angle of 65° with respect the floor and is constrained with a remote point to simulate the effect of the forces induced by the straps. The remote constraint is deformable to let the structure free to deform.

Three load cases were analyzed based on the intended use of the stiffening tool:

1. 3 point lift with Stiffening tool and RICH horizontal when setting on the truck
2. 3 point lift with Stiffening tool and RICH horizontal at **Load Test** (125% of the rating)
3. 3 point lift with stiffening tool and RICH tilted 65^0 to fit the strongback at **Load Test** (125% of the rating)

RESULTS

The stress and deflection results for the load cases listed before are shown in Figures 1-15. All stresses are below the allowable stresses and all deflections are acceptable for this application.

Case Study 01

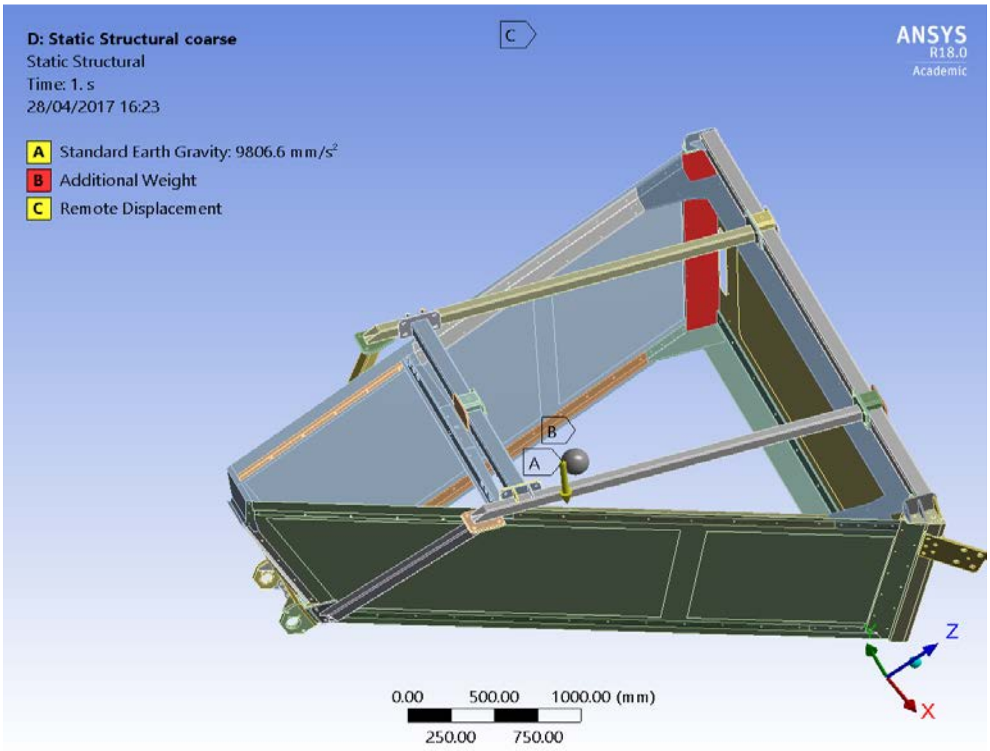


Figure 1: Horizontal lift

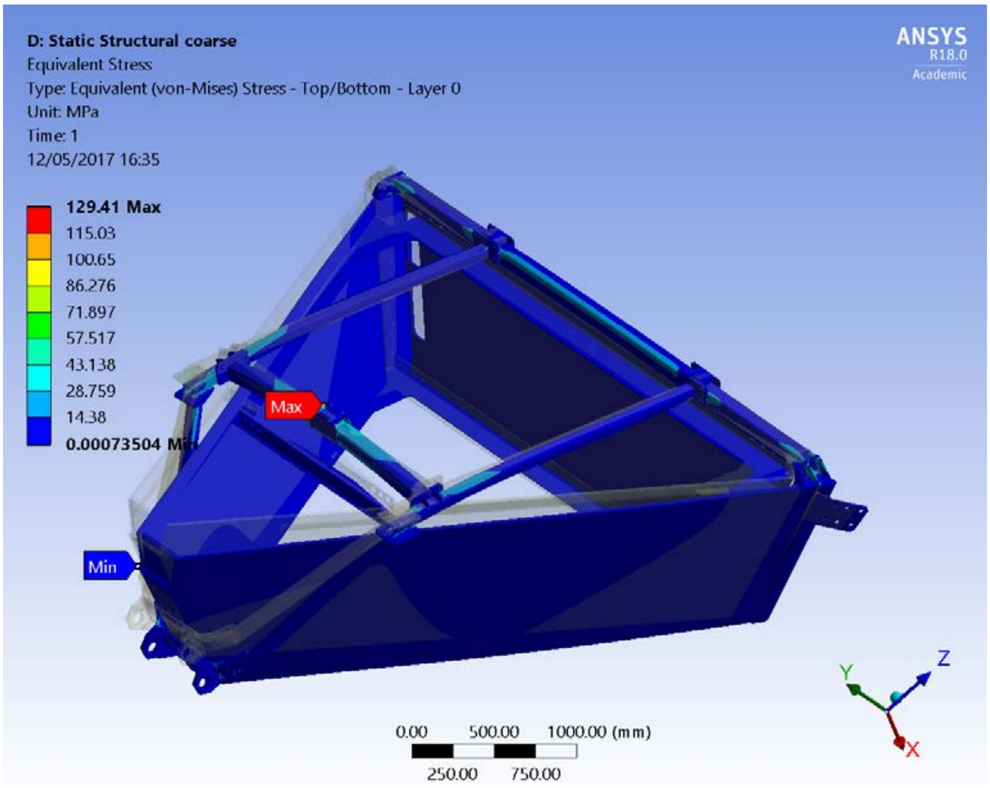


Figure 2: Horizontal lift Equivalent Stress at Load (1100kg)

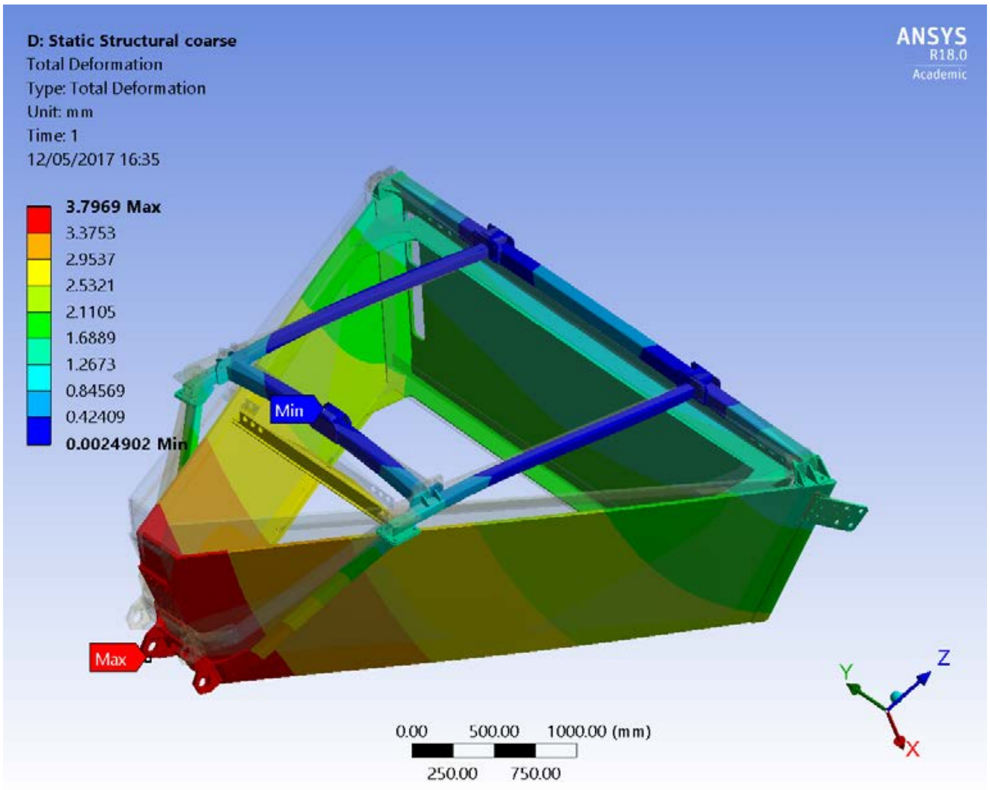


Figure 3: Horizontal lift Deformation at Load (1100 kg)

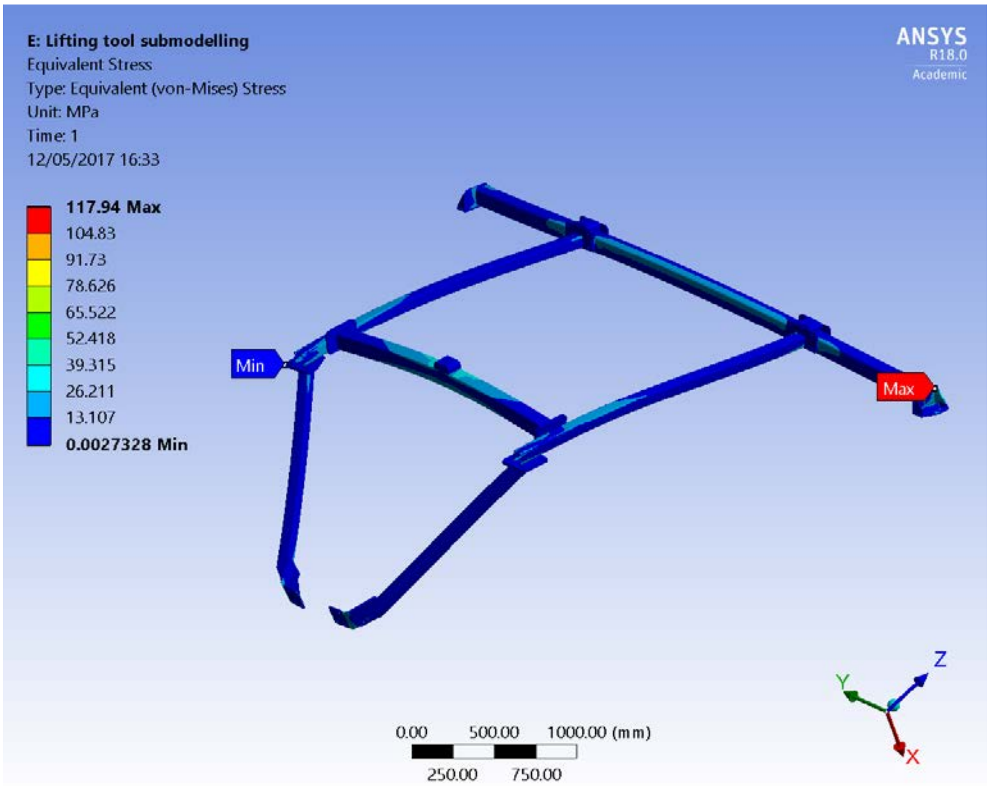


Figure 4: Horizontal lift Equivalent Stress at Load (1100kg) (**Submodelling**)

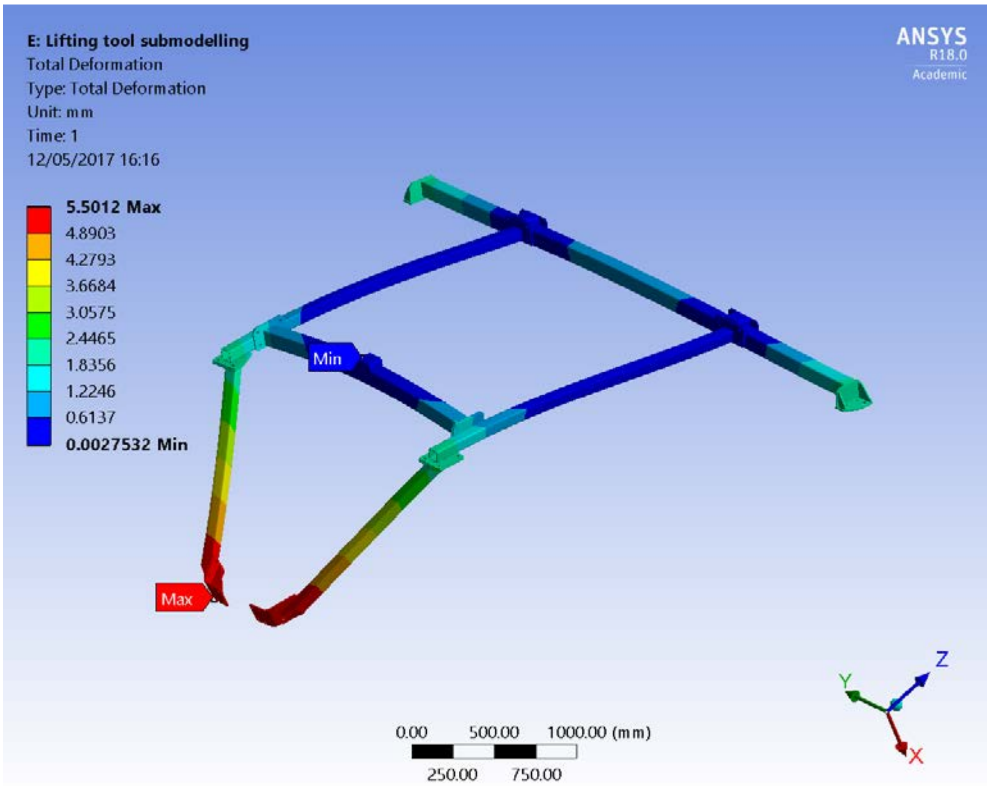


Figure 5: Horizontal lift Deformation at Load (1100 kg) (**Submodelling**)

Case Study 02

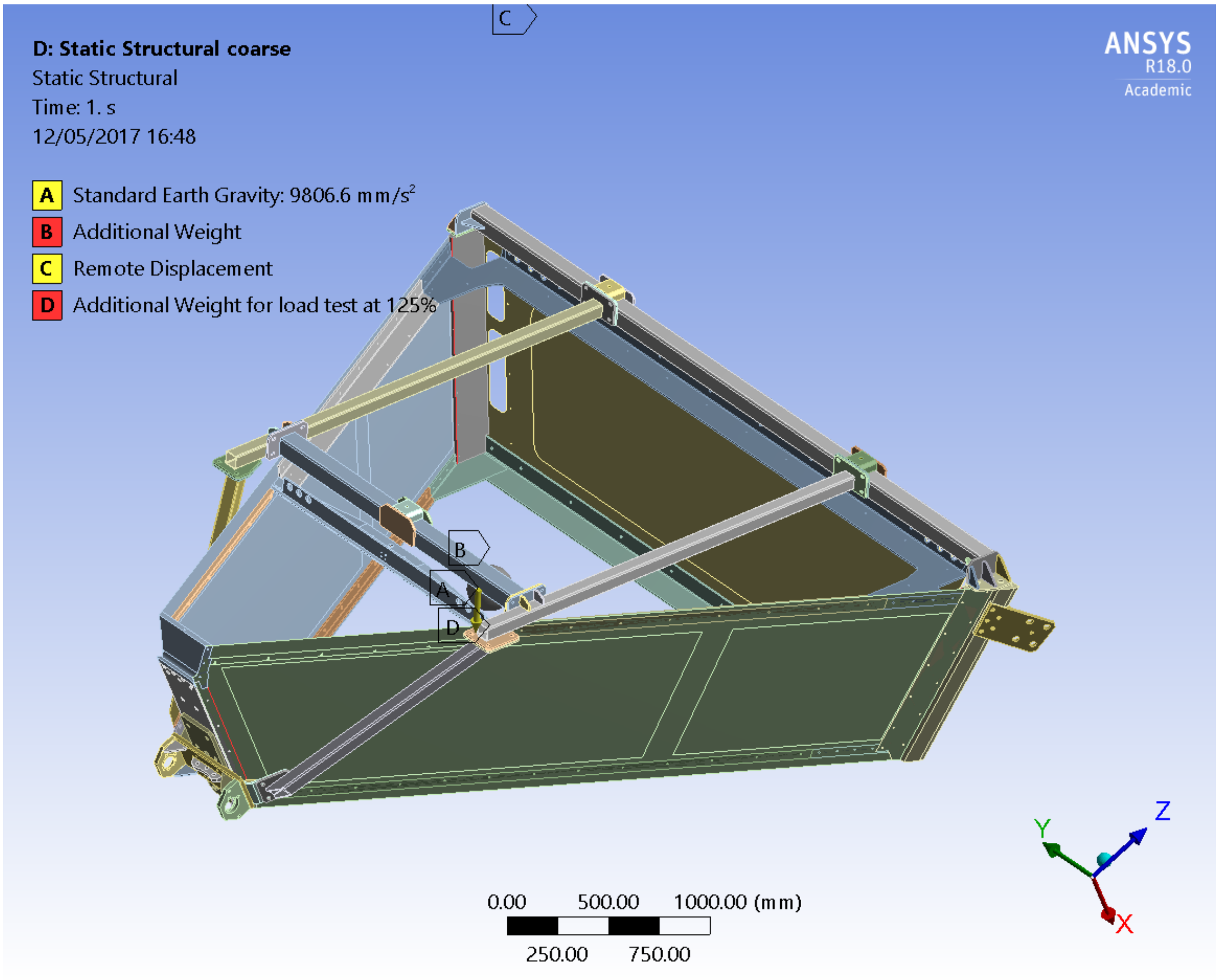


Figure 6: Horizontal lift at 125% of the rating (1100 kg)

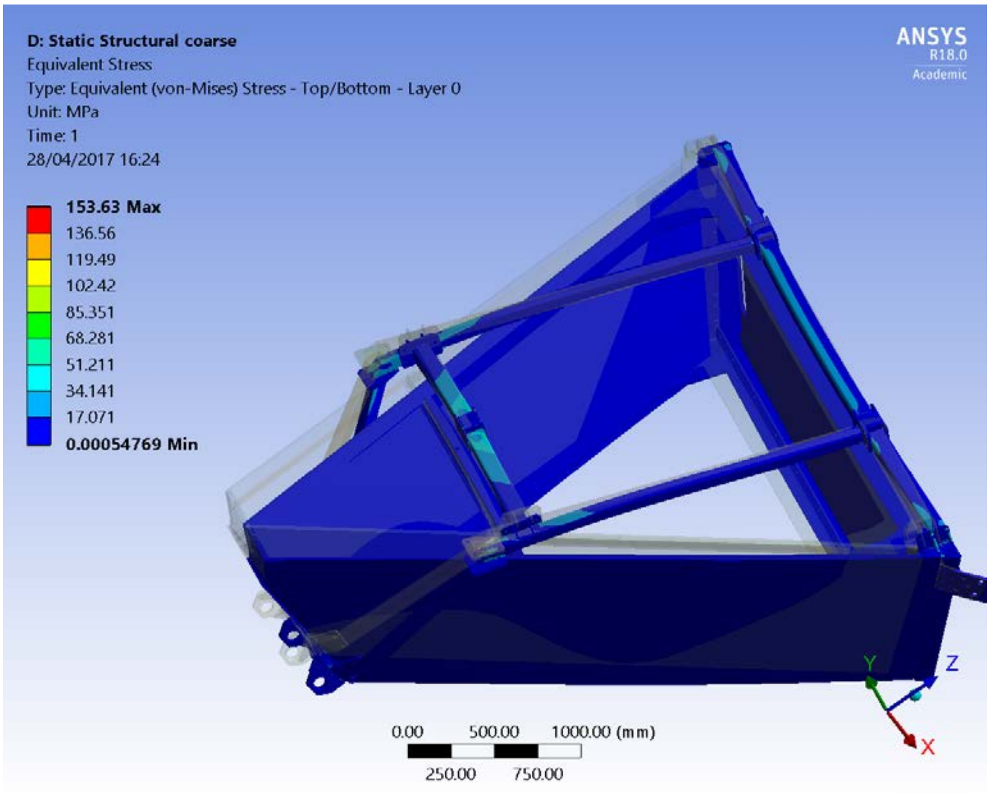


Figure 7: Horizontal lift Equivalent Stress at 125% of (1100kg)

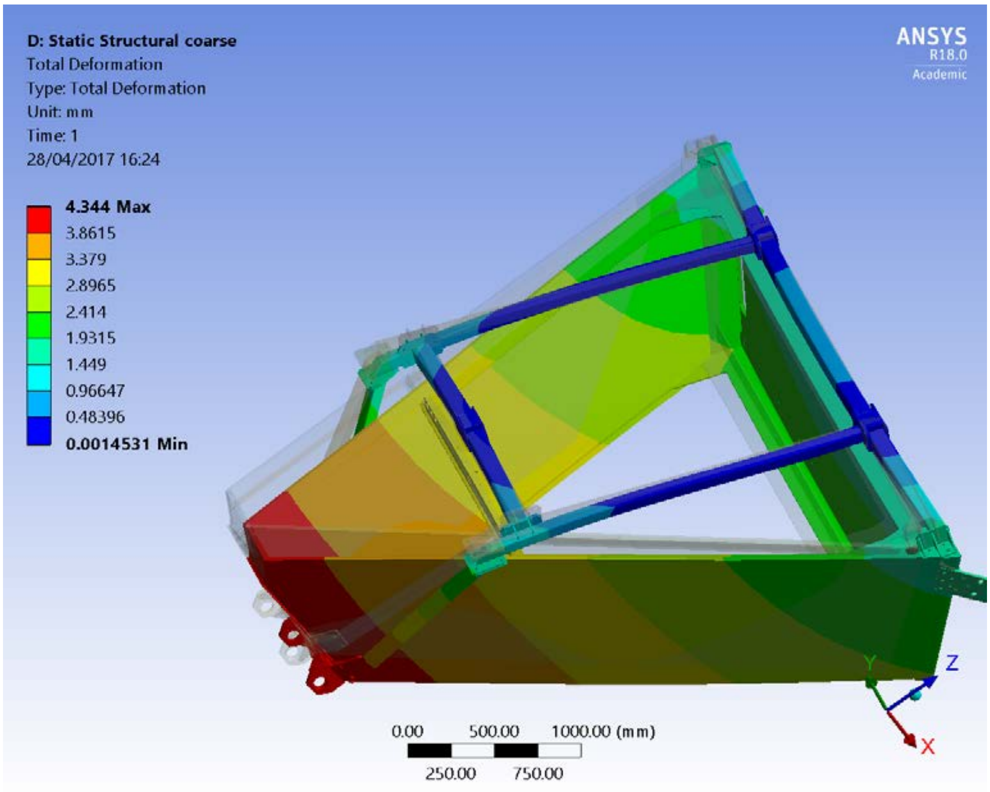


Figure 8: Horizontal lift Deformation at 125% of (1100kg)

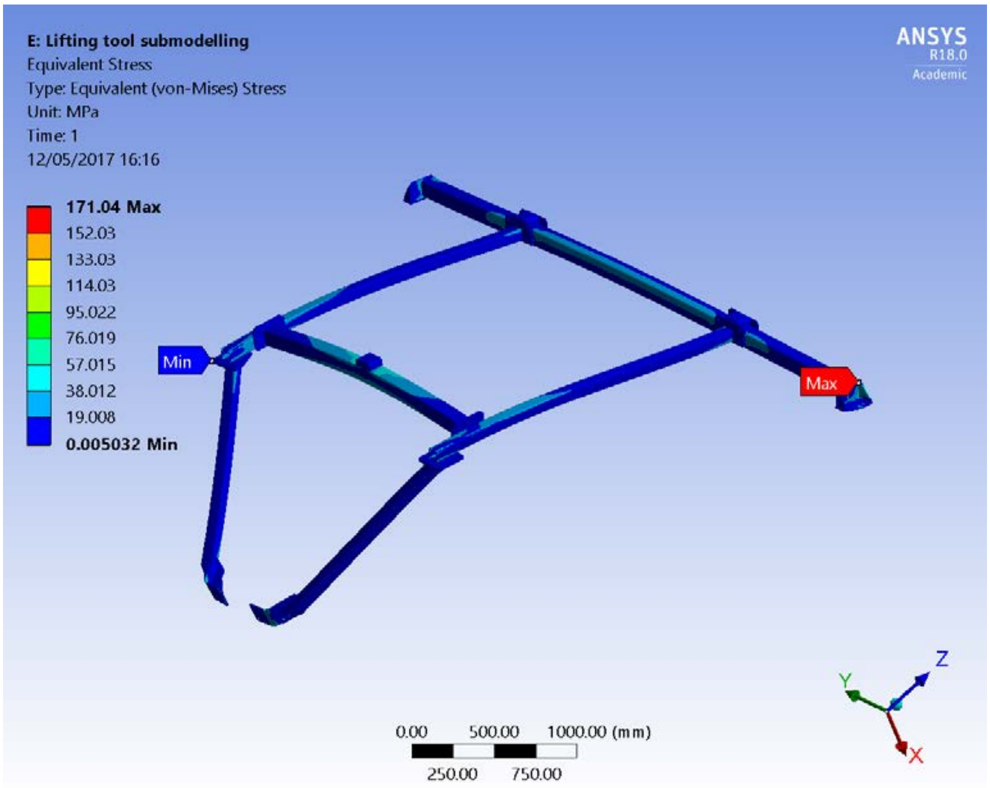


Figure 9: Horizontal lift Equivalent Stress at 125% the load (**Submodelling**)

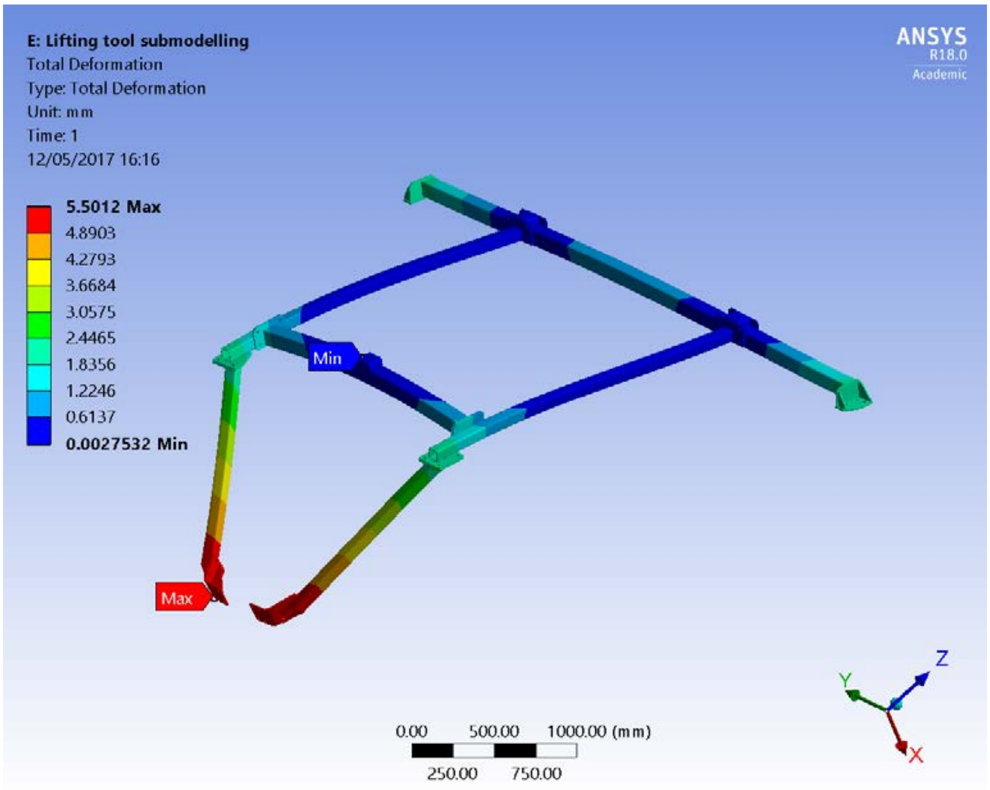


Figure 10: Horizontal lift Deformation at 125% the load (**Submodelling**)

Case Study 03

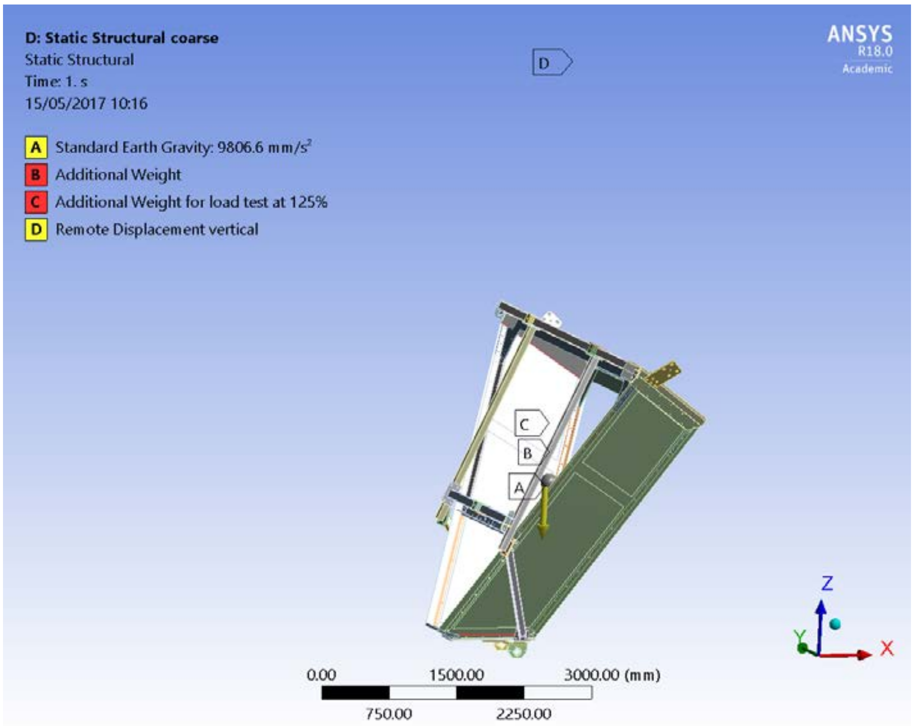


Figure 11: Horizontal lift at 125% of the rating (1100kg)

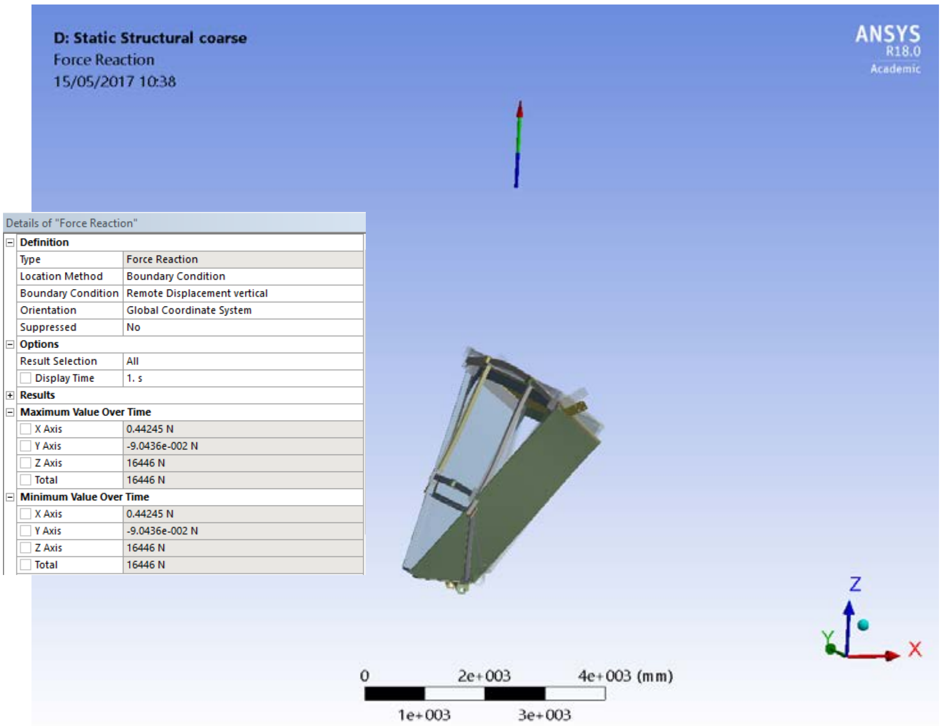


Figure 12: Horizontal lift at 125% of the rating (1100kg), **reaction force**

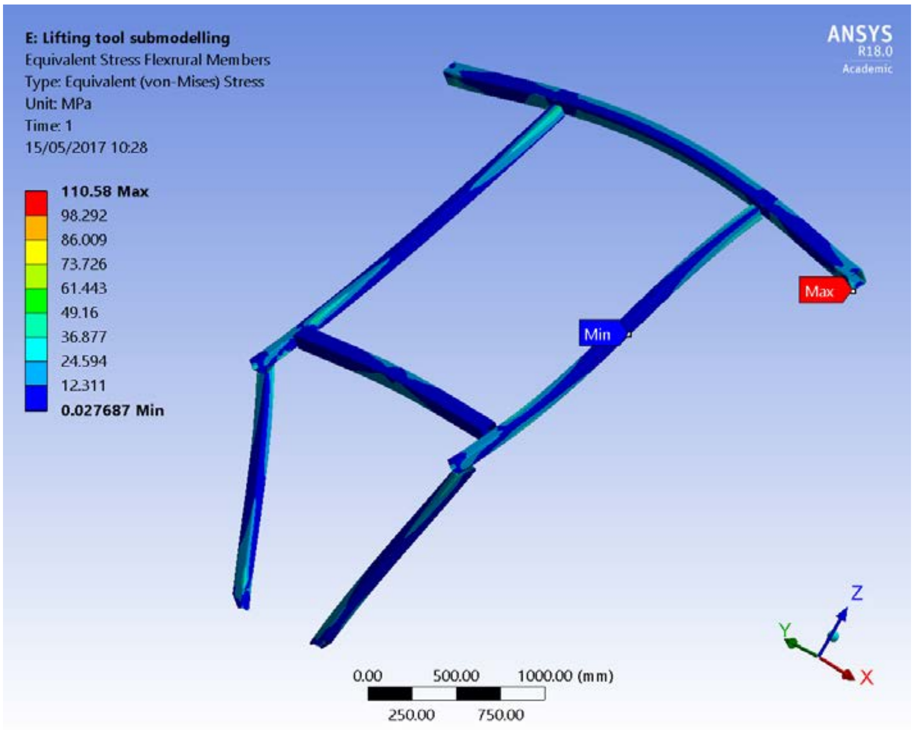


Figure 13: Equivalent Stress, tilted 65^0 to fit the strongback at 125% the load (**Submodelling**)

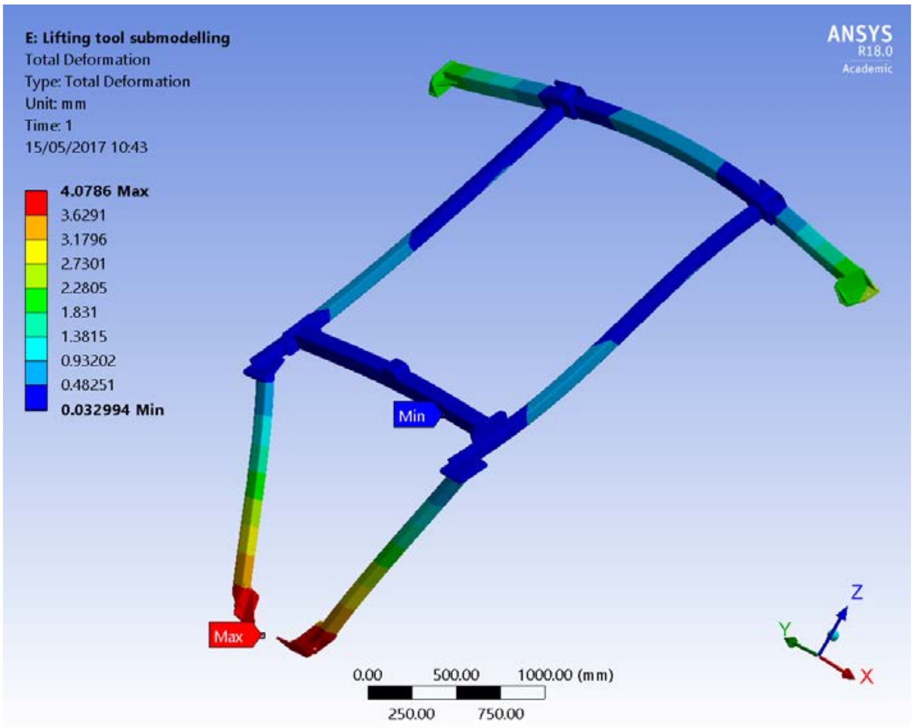


Figure 14: Total deformation, tilted 65^0 to fit the strongback at 125% the load (**Submodelling**)

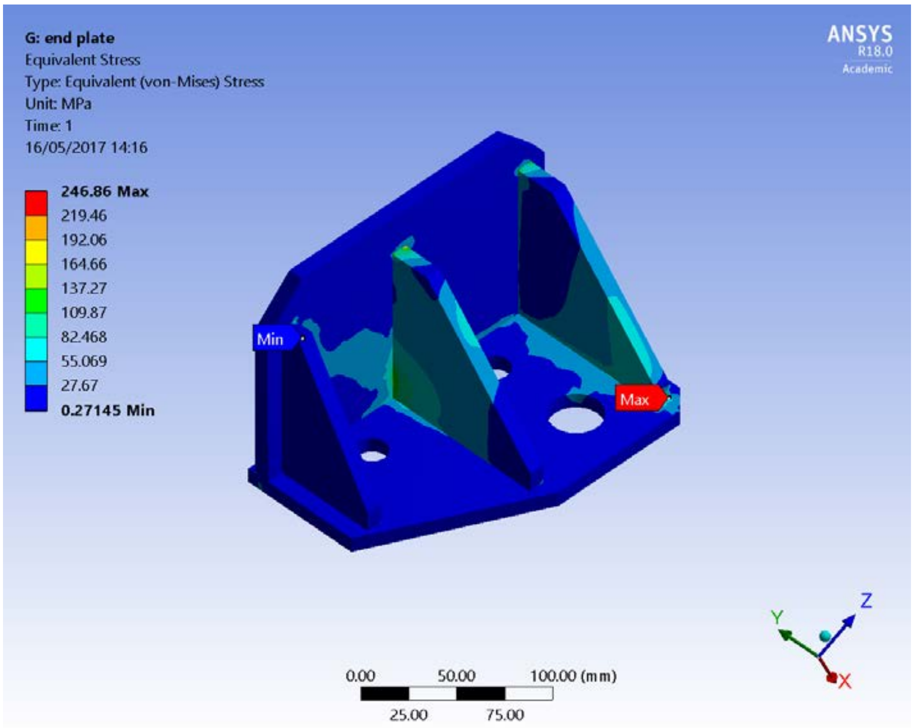


Figure 15: Equivalent Stress at the weld joint of the RICH interface, tilted 65^0 to fit the strongback at 125% the load (**Submodelling**). Note that the high intensity stress at the rib corners is because of the stress concentration at the rib corners.

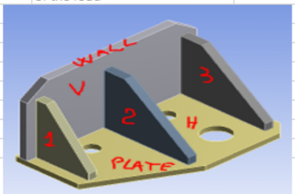
Weld Analysis

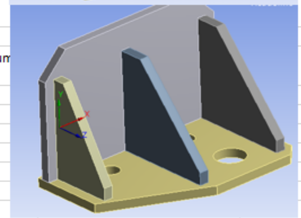
The weld analysis was completed using the following method:

1. Model each weld joint as two separate parts with a bonded contact in ANSYS
2. Evaluate the equivalent stress of the model and choose the weld joints with the highest stress or critical locations for a detailed weld stress calculation
3. Probe the force reaction and moment reactions at the contact
4. Use the force and moments to calculate the weld stress using a spreadsheet
5. Compare the weld stress to the allowable weld stress

All the weld joints were analyzed and the weld stresses were below the allowable stress. Samples of the weld stress calculations are shown in Figures 16-17.

Description	FEA Loads Fx	Fy	Fz	Mx	My	Mz	Location	Load Case
Joint 1	-37	268	-379	-42	-10	-18	Rib01_V	Load case 03 (vertical & 125% of the load
Joint 2	-37	-736	-4558	11049	-144	77	Rib02_V	
Joint 3	-223	-2701	3891	2445	-348	-228	Rib03_V	
Joint 4	37	-379	-268	455	52	-33	Rib01_H	
Joint 5	41	-4562	736	-416	164	67	Rib02_H	
Joint 6	223	3889	2702	-4799	242	-104	Rib03_H	
Joint 7	-1038	-3442	-2504	1029	11151	-67	Wall_plate	
Joint	10	20	30	100	200	300	Test	



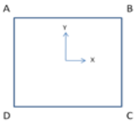


Transform FEA Load into Analysis Coordinates.........

Analysis Case	Fx	Fy	Fz	Mx	My	Mz
Joint 7	1038	3442	2504	-1029	-11151	67

Set last digit in function to the desired colum for all joints

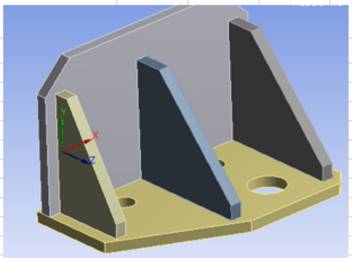
Weld Dimensions			
Length	Lx	8	in
Width	Ly	0.374	in
Total Weld Length	L	16.748	in

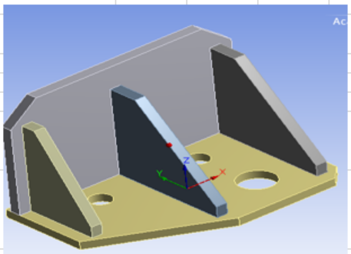


Weld	Dimensions (in) Xi	Yi	Center Location (in) xi	yi	Weld CG (in) (Xi+Yi)*xi	(Xi+Yi)*yi	Weld Inertia (in^3) $(Xi+Yi)*(yi-gy)^2+Yi3/12$	$(Xi+Yi)*(xi-gx)^2+Xi3/12$
AB	8	0	0	0.187	0	1.496	0.3	42.7
BC	0	0.374	4	0	1.496	0	0.0	6.0
CD	8	0	0	-0.187	0	-1.496	0.3	42.7
DA	0	0.374	-4	0	-1.496	0	0.0	6.0

gx	0.0			
gy		0.0		
Ix			0.6	
Iy				97.3
Polar Moment of Inertia	J		97.9	in^3

Location	Shear Forces (lb/in) X	Y	Z	Total	Allowable Weld Stress (psi)	Mininum Weld Size (in)	Weld Size (in)	Weld Stress (psi)
A	62	203	-648	681	**15500**	**0.062**	0.250	3855
B	62	208	269	346	**15500**	**0.032**		1958
C	62	208	947	971	**15500**	**0.089**		5495
D	62	203	30	214	**15500**	**0.020**		1212





Part thickness 1	0.374	
Part thickness 2	0.374	

Fillet Welds

Table 3-3.4.3-1 ASTM BTH-1-2017

Material Thickness of Thicker part joined	Min Weld Size (inch)	
0 to 1/4	1/8	3 mm
over 1/4 to 1/2	3/16	5 mm
over 1/2 to 3/4	1/4	6 mm
over 3/4	5/16	8 mm

	Max Weld Size	
Material thickness less than 1/4	max weld = material thickness	NULL
Material thickness 1/4 or greater	max weld = material thickness - 1/16	0.3115

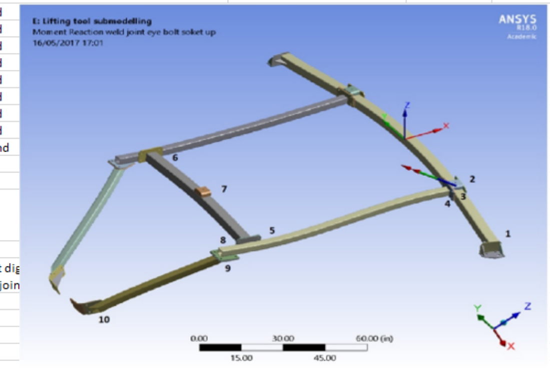
Skip Welds

The effective length of any intermitten fillet shall be not less than 4* the weld size with a minimum of 1-1/2

Intermitten welds shall be made on both sides of the joint for at least 25% of its length. The maximum spacing of intermitten fillet welds is 12 inches.

Figure 16: Weld Stress at weld Joint with RICH interface

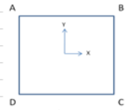
Description	Fx	Fy	Fz	Mx	My	Mz	Lx	Ly	Location	Load Case
	FEA Loads						FEA Dim			Load case 03 (vertical & 125% of the load
Joint 1	823	-395	-161	9157	14559	2661	4.0	4.0	1. Bond	
Joint 2	-335	846	460	-2451	-900	-171	4.0	4.0	2. Bond	
Joint 3	135	-132	64	5472	-54506	-35478	10.0	5.5	3. Bond	
Joint 4	-134	133	-65	-4636	-6214	-151	3.0	3.0	4. bond	
Joint 5	-449	-100	-372	1168	4798	1065	9.5	3.0	5. bond	
Joint 6	-450	-99	385	-1004	-4486	1317	3.0	3.0	6. bond	
Joint 7	14	-899	-201	897	14	0	4.0	4.0	7. bond	
Joint 8	514	-237	237	-52	-8498	-9044	6.0	3.0	8. Bond	
Joint 9	514	237	-235	106	5809	3268	3.0	3.0	9. Bond	
Joint 10	-611	5	42	-2063	3842	16	5.0	3.0	10. Bond	
Joint	10	20	30	100	200	300	1.0	1.0	Test	



Transform FEA Load into Analysis Coordinates.........

Analysis Case	Fx	Fy	Fz	Mx	My	Mz	Lx	Ly	
Joint 4	.34	-133	65	4636	6214	151	3	3	Set last dig for all join

Weld Dimensions			
Length	Lx	3	in
Width	Ly	3	in
Total Weld Length	L	12	in



Weld	Dimensions (in) Xi	Yi	Center Location (in) xi	yi	Weld CG (in) (Xi+Yi)*xi	(Xi+Yi)*yi	Weld Inertia (in³) (Xi+Yi)*(yi-gy)²+Yi3/12	(Xi+Yi)*(xi-gx)²+Xi3/12
AB	3	0	0	1.5	0	4.5	6.8	2.3
BC	0	3	1.5	0	4.5	0	2.3	6.8
CD	3	0	0	-1.5	0	-4.5	6.8	2.3
DA	0	3	-1.5	0	-4.5	0	2.3	6.8
gx					0.0			
gy						0.0		
Ix							18.0	
Iy								18.0
Polar Moment of Inertia						J	36.0	in³

Location	Shear Forces (lb/in) X	Y	Z	Total	Allowable Weld Stress (psi)	Mininum Weld Size (in)	Weld Size (in)	Weld Stress (psi)
A	5	-17	910	910	**15500**	**0.083**	0.188	6863
B	5	-5	-126	126	**15500**	**0.012**		953
C	17	-5	-899	899	**15500**	**0.082**		6781
D	17	-17	137	139	**15500**	**0.013**		1049

Part thickness 1	0.25		
Part thickness 2	0.374		
Fillet Welds			
Table 3-3.4.3-1 ASTM BTH-1-2017			
Material Thickness of Thicker part joined	**Min Weld Size (inch)**	**Inch**	**mm**
0 to 1/4	1/8	0.125	3
over 1/4 to 1/2	3/16	0.188	5
over 1/2 to 3/4	1/4	0.250	6
over 3/4	5/16	0.313	8
	Max Weld Size		
Material thickness less than 1/4	max weld = material thickness	NULL	
Material thickness 1/4 or greater	max weld = material thickness - 1/16	0.188	

Figure 17: Weld Stress at weld Joint with flexural elements

Bolted connection Analysis

The bolted connection were calculated using the following method:

1. Model each bolted joint as two separate parts with a bonded contact in ANSYS
2. Probe the force reaction and moment reactions at the contact
3. Use the force and moment reactions to calculate the bolts stress using a spreadsheet
4. Compare the bolts stress to the allowable bolts stress

All the bolted joints were analyzed and the bolted stresses were below the allowable stress. Samples of the bolted stress calculations are shown in Figures 18-23.

Load Case	FEA Loads [lbf & lbf*in]						Location
	Fx	Fy	Fz	Mx	My	Mz	
Case A	-451	89	-390	1580	-4650	1021	**Connection 01**
Case B	-140	142	-83	-4872	-6484	-376	Connection 02
Case C	-251	-535	-231	-6487	260	3322	Connection 03
Case D	632	-17	-40	763	356	-6035	Connection 04

Transform FEA Load into Analysis Coordinates.........

Analysis Case	Fx	Fy	Fz	Mx	My	Mz
Case A	451	-89	390	-1580	4650	-1021

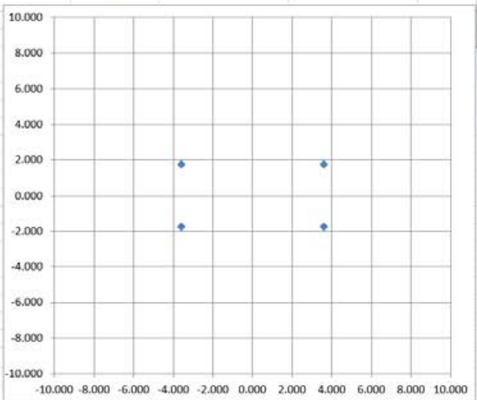
Bolt	Location (in)		Bolt Inertia (in2)	
	xi	yi	xi2	yi2
A	3.6	1.75	13.0	3.1
B	3.6	-1.75	13.0	3.1
C	-3.6	-1.75	13.0	3.1
D	-3.6	1.75	13.0	3.1
E				
F				
G				
H				

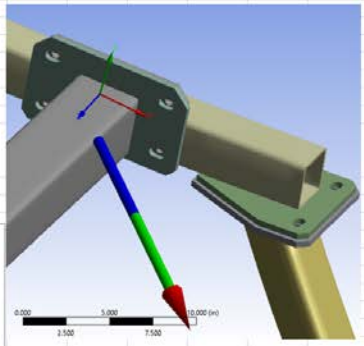
Number of bolts 4

gx	0.0			
gy		0.0		
Ix				12.3
Iy			51.8	

Polar Moment of Inertia J 64.1 in²

Bolt Material	Class 10.9 High Strength steel
Bolt Diameter (in)	0.5
Stress Area (in²)	0.141
Tensile Strength (psi)	150800

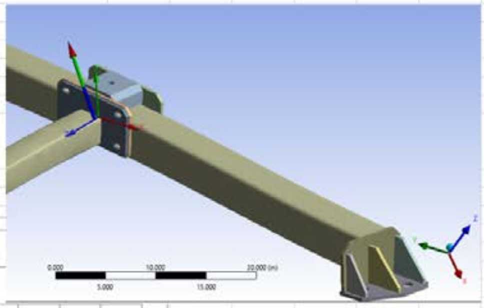




Bolt	Forces (lb)			Bolt Strength (lb)		Factors of Safety	
	Shear X	Shear Y	Tensile Z	Shear	Tensile	Shear	Tensile
A	85	-80	-451	12758	21263	>10	>10
B	141	-80	0	12758	21263	>10	>10
C	141	35	646	12758	21263	>10	>10
D	85	35	195	12758	21263	>10	>10
E	113	-22	98	12758	21263	>10	>10
F	113	-22	98	12758	21263	>10	>10
G	113	-22	98	12758	21263	>10	>10
H	113	-22	98	12758	21263	>10	>10

Figure 18: Bolted Stress at connection 01

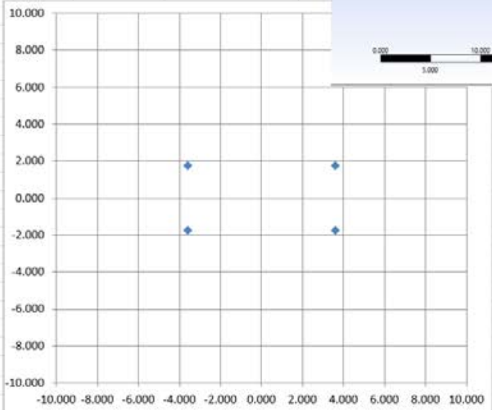
Load Case	FEA Loads [lbf & lbf*in]						
	Fx	Fy	Fz	Mx	My	Mz	Location
Case A	-451	89	-390	1580	-4650	1021	Connection 01
Case B	-140	142	-83	-4872	-6484	-376	**Connection 02**
Case C	-251	-535	-231	-6487	260	3322	Connection 03
Case D	632	-17	-40	763	356	-6035	Connection 04



Transform FEA Load into Analysis Coordinates.........

Analysis Case	Fx	Fy	Fz	Mx	My	Mz
Case B	140	-142	83	4872	6484	376

Bolt	Location (in)		Bolt Inertia (in2)	
	xi	yi	xi2	yi2
A	3.6	1.75	13.0	3.1
B	3.6	-1.75	13.0	3.1
C	-3.6	-1.75	13.0	3.1
D	-3.6	1.75	13.0	3.1
E				
F				
G				
H				



Number of bolts **4**

gx	0.0			
gy		0.0		
Ix				12.3
Iy			51.8	

Polar Moment of Inertia J 64.1 in^2

Bolt Material	**Class 10.9 High Strength steel**
Bolt Diameter (in)	0.5
Stress Area (in²)	0.141
Tensile Strength (psi)	**150800**

Bolt	Forces (lb)			Bolt Strength (lb)		Factors of Safety	
	Shear X	Shear Y	Tensile Z	Shear	Tensile	Shear	Tensile
A	45	-14	266	12758	21263	>10	>10
B	25	-14	-1126	12758	21263	>10	>10
C	25	-57	-225	12758	21263	>10	>10
D	45	-57	1167	12758	21263	>10	>10
E	35	-36	21	12758	21263	>10	>10
F	35	-36	21	12758	21263	>10	>10
G	35	-36	21	12758	21263	>10	>10
H	35	-36	21	12758	21263	>10	>10

Figure 19: Bolted Stress at connection 02

Load Case	FEA Loads [lbf & lbf*in]						Location
	Fx	Fy	Fz	Mx	My	Mz	
Case A	-451	89	-390	1580	-4650	1021	Connection 01
Case B	-140	142	-83	-4872	-6484	-376	Connection 02
Case C	-251	-535	-231	-6487	260	3322	**Connection 03**
Case D	632	-17	-40	763	356	-6035	Connection 04

Transform FEA Load into Analysis Coordinates.........

Analysis Case	Fx	Fy	Fz	Mx	My	Mz
Case C	251	535	231	6487	-260	-3322

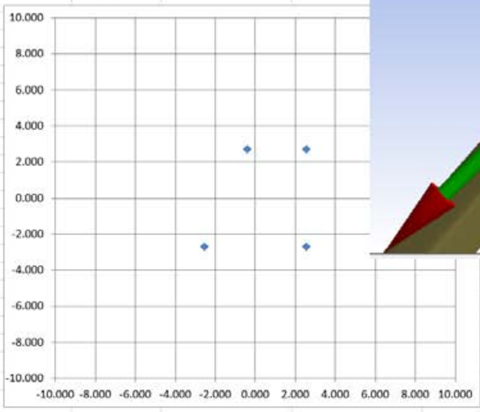
Bolt	Location (in)		Bolt Inertia (in2)	
	xi	yi	xi2	yi2
A	2.53	2.7	6.4	7.3
B	2.53	-2.7	6.4	7.3
C	-2.53	-2.7	6.4	7.3
D	-0.4	2.7	0.2	7.3
E				
F				
G				
H				

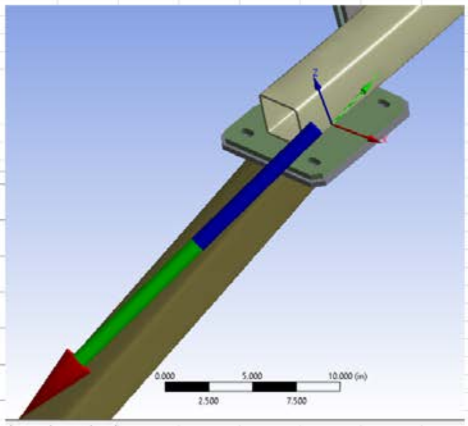
Number of bolts **4**

gx	0.5			
gy		0.0		
Ix				29.2
Iy			19.4	

Polar Moment of Inertia J 48.5 in^2

Bolt Material	**Class 10.9 High Strength steel**
Bolt Diameter (in)	0.5
Stress Area (in^2)	0.141
Tensile Strength (psi)	**150800**

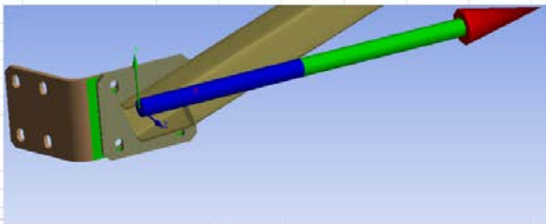




Bolt	Forces (lb)			Bolt Strength (lb)		Factors of Safety	
	Shear X	Shear Y	Tensile Z	Shear	Tensile	Shear	Tensile
A	-122	-3	685	12758	21263	>10	>10
B	248	-3	-516	12758	21263	>10	>10
C	248	343	-584	12758	21263	>10	>10
D	-122	198	646	12758	21263	>10	>10
E	63	170	51	12758	21263	>10	>10
F	63	170	51	12758	21263	>10	>10
G	63	170	51	12758	21263	>10	>10
H	63	170	51	12758	21263	>10	>10

Figure 20: Bolted Stress at connection 03

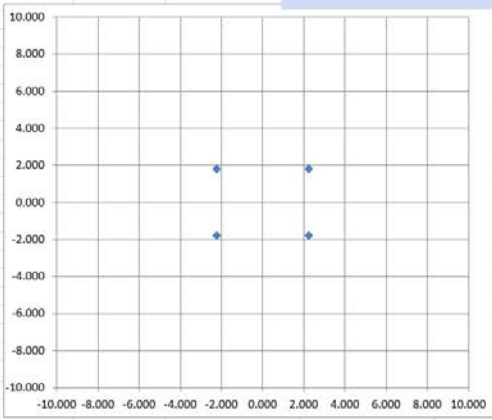
Load Case	FEA Loads [lbf & lbf*in]						Location
	Fx	Fy	Fz	Mx	My	Mz	
Case A	-451	89	-390	1580	-4650	1021	Connection 01
Case B	-140	142	-83	-4872	-6484	-376	Connection 02
Case C	-251	-535	-231	-6487	260	3322	Connection 03
Case D	632	-17	-40	763	356	-6035	**Connection 04**



Transform FEA Load into Analysis Coordinates........

Analysis Case	Fx	Fy	Fz	Mx	My	Mz
Case D	-632	17	40	-763	-356	6035

Bolt	Location (in)		Bolt Inertia (in2)	
	xi	yi	xi2	yi2
A	2.25	1.8	5.1	3.2
B	2.25	-1.8	5.1	3.2
C	-2.25	-1.8	5.1	3.2
D	-2.25	1.8	5.1	3.2
E				
F				
G				
H				



Number of bolts: 4

gx	0.0			
gy		0.0		
Ix				13.0
Iy			20.3	

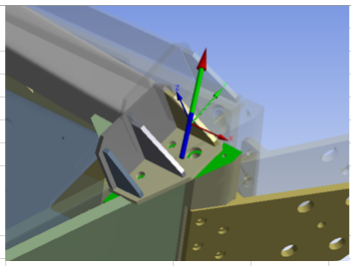
Polar Moment of Inertia J 33.2 in^2

Bolt Material	Class 10.9 High Strength steel
Bolt Diameter (in)	0.5
Stress Area (in^2)	0.141
Tensile Strength (psi)	150800

Bolt	Forces (lb)			Bolt Strength (lb)		Factors of Safety	
	Shear X	Shear Y	Tensile Z	Shear	Tensile	Shear	Tensile
A	169	413	-56	12758	21263	>10	>10
B	-485	413	156	12758	21263	>10	>10
C	-485	-405	76	12758	21263	>10	>10
D	169	-405	-136	12758	21263	>10	>10
E	-158	4	10	12758	21263	>10	>10
F	-158	4	10	12758	21263	>10	>10
G	-158	4	10	12758	21263	>10	>10
H	-158	4	10	12758	21263	>10	>10

Figure 21: Bolted Stress at connection 04

Load Case	FEA Loads [lbf & lbf*in]						Location
	Fx	Fy	Fz	Mx	My	Mz	
Case A	-506	1149	283	1753	10448	-15429	**Stiffening UP right**
Case B							
Case C							
Case D							



Transform FEA Load into Analysis Coordinates.........

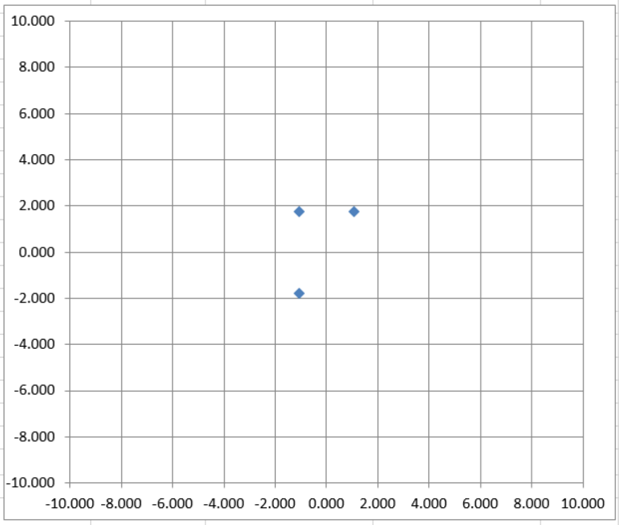
Analysis Case	Fx	Fy	Fz	Mx	My	Mz
Case A	506	-1149	-283	-1753	-10448	15429

Bolt	Location (in)		Bolt Inertia (in2)	
	xi	yi	xi2	yi2
A	1.085	1.77	1.2	3.1
B	-1.085	-1.77	1.2	3.1
C	-1.085	1.77	1.2	3.1
D				
E				
F				
G				
H				

Number of bolts **3**

gx	-0.4			
gy		0.6		
Ix				9.4
Iy			3.5	

Polar Moment of Inertia J 12.9 in^2



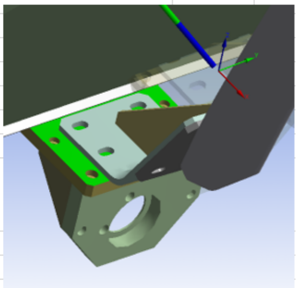
Bolt Material	**Class 10.9 High Strength steel**
Bolt Diameter (in)	0.375
Stress Area (in^2)	0.077
Tensile Strength (psi)	**150800**

Note: the real connection is made with 2 M10 bolts puls 1 M24. The calculation was performed with 3 bolts 3/8"

Bolt	Forces (lb)			Bolt Strength (lb)		Factors of Safety	
	Shear X	Shear Y	Tensile Z	Shear	Tensile	Shear	Tensile
A	1577	1343	3965	6967	11612	3.364	2.928
B	-2647	-1246	-1794	6967	11612	2.381	6.472
C	1577	-1246	-2454	6967	11612	3.467	4.731
D	-535	49	1086	6967	11612	>10	>10
E	-535	49	1086	6967	11612	>10	>10
F	-535	49	1086	6967	11612	>10	>10
G	-535	49	1086	6967	11612	>10	>10
H	-535	49	1086	6967	11612	>10	>10

Figure 22: Bolted Stress at connection Stiffening Up Right

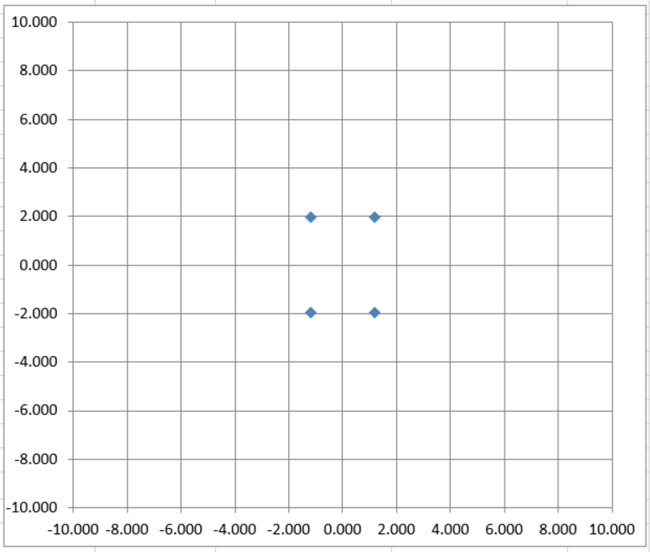
Load Case	FEA Loads [lbf & lbf*in]						
	Fx	Fy	Fz	Mx	My	Mz	Location
Case A	-506	1149	283	1753	10448	-15429	Stiffening UP right
Case B	251	32	562	-5412	-2642	4098	**Stiffening Down right**
Case C							
Case D							



Transform FEA Load into Analysis Coordinates.........

Analysis Case	Fx	Fy	Fz	Mx	My	Mz
Case B	-251	-32	-562	5412	2642	-4098

Bolt	Location (in)		Bolt Inertia (in2)	
	xi	yi	xi2	yi2
A	1.181	1.97	1.4	3.9
B	1.181	-1.97	1.4	3.9
C	-1.181	-1.97	1.4	3.9
D	-1.181	1.97	1.4	3.9
E				
F				
G				
H				



Number of bolts **4**

gx	0.0			
gy		0.0		
Ix				15.5
Iy			5.6	

Polar Moment of Inertia J 21.1 in^2

Bolt Material	**Class 10.9 High Strength steel**
Bolt Diameter (in)	0.5
Stress Area (in^2)	0.141
Tensile Strength (psi)	**150800**

Bolt	Forces (lb)			Bolt Strength (lb)		Factors of Safety	
	Shear X	Shear Y	Tensile Z	Shear	Tensile	Shear	Tensile
A	-445	-237	-13	12758	21263	>10	>10
B	320	-237	-1387	12758	21263	>10	>10
C	320	221	-268	12758	21263	>10	>10
D	-445	221	1106	12758	21263	>10	>10
E	-63	-8	-141	12758	21263	>10	>10
F	-63	-8	-141	12758	21263	>10	>10
G	-63	-8	-141	12758	21263	>10	>10
H	-63	-8	-141	12758	21263	>10	>10

Figure 23: Bolted Stress at connection Stiffening Down Right

Conclusion

The RICH stiffening frame meets ASME-BTH-1-2017 Below the Hook Lifting Devices code.

LOAD TEST

CONCEPTUAL DESIGN:
The stiffening tool is load tested by means of the transportation cart to compensate the RICH shell stiffness. An additional mass (**635** kg or **1400** lb), made of lead or concrete brick, is fixed to the cart circular plate to reach the required load test. The **total weight at the hoist point** must be equal to **16350N** that includes **M1+M2**

where

- **M1**=**290** kg is the stiffening tool mass
- **M2**=1100*1.25=**1375 kg** is the stiffening tool rating plus the overload test (125% of the rating)

Two different load cases have been studied:

1. Case 01: Stiffening tool is horizontal wrt the floor
2. Case 02: Stiffening tool is tilted with an angle of 65° wrt the floor.

See figures 24 and 25 respectively.

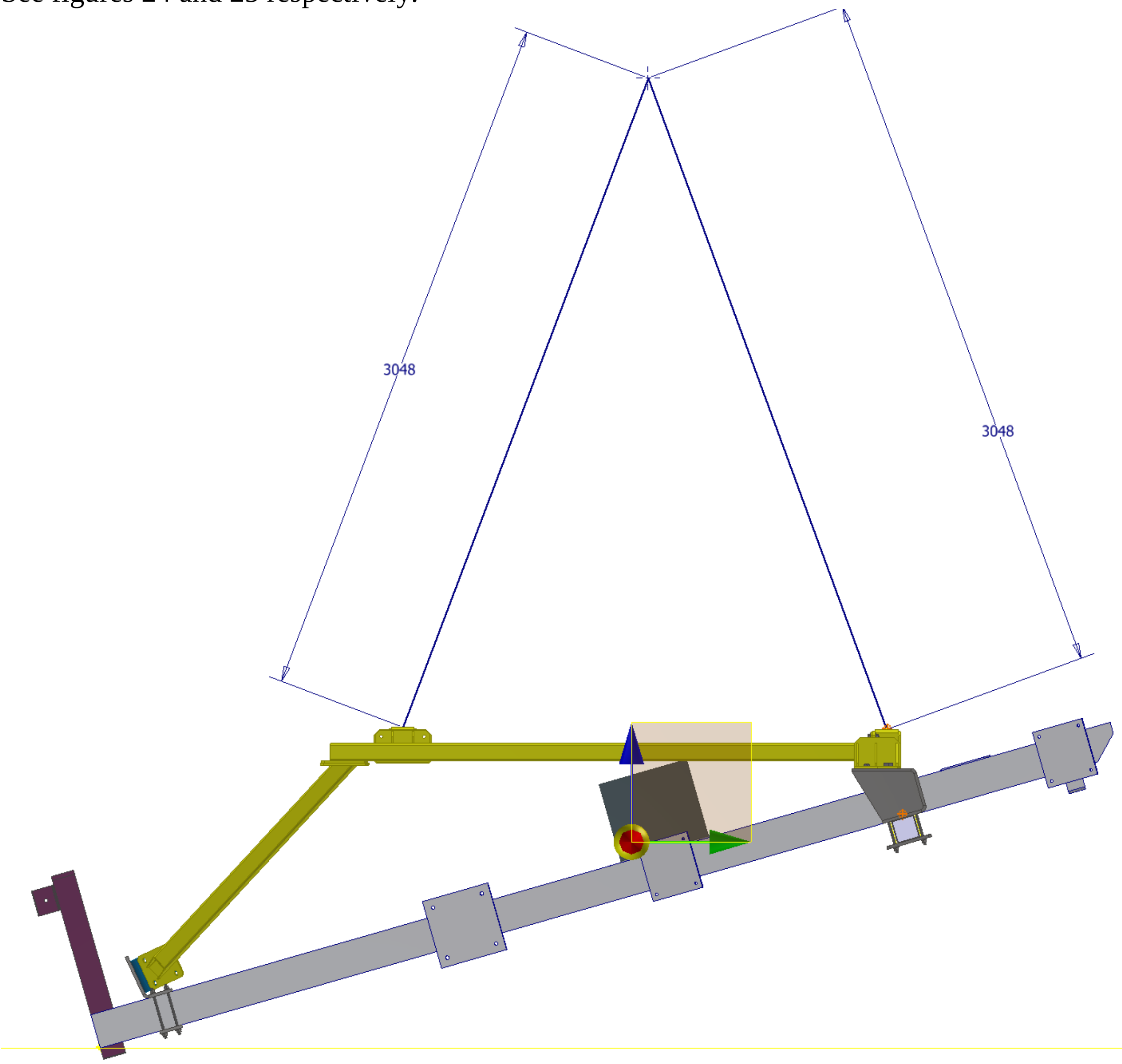


Figure 24: Load test case 01, Horizontal wrt the floor

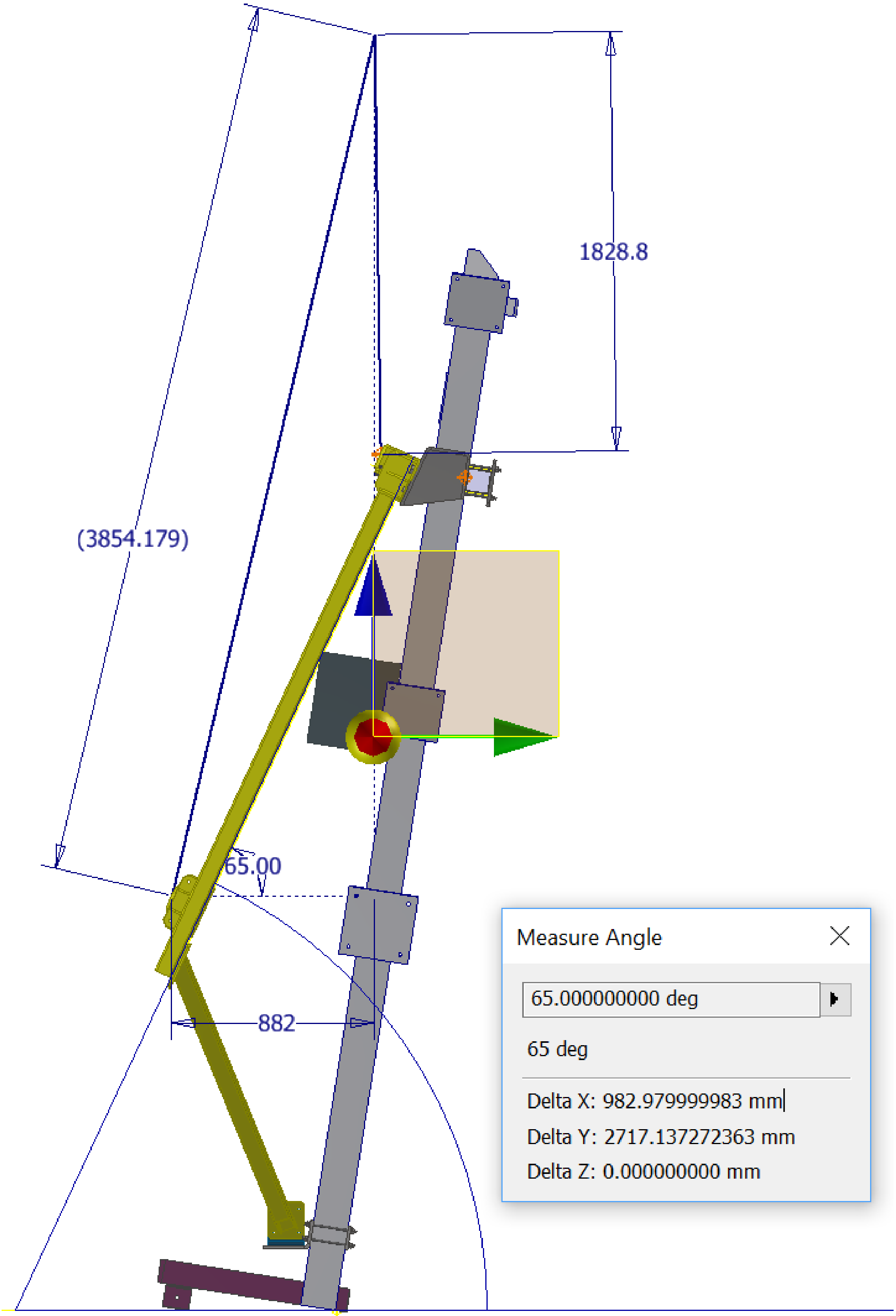


Figure 25: Load test case 02, at 65° wrt the floor

FEA RESULTS:

The FEA of the load test stand was performed considering the two load cases as shown in the conceptual design paragraph.
Results are listed from figure 26 to figure 34.

LOAD CASE 01:

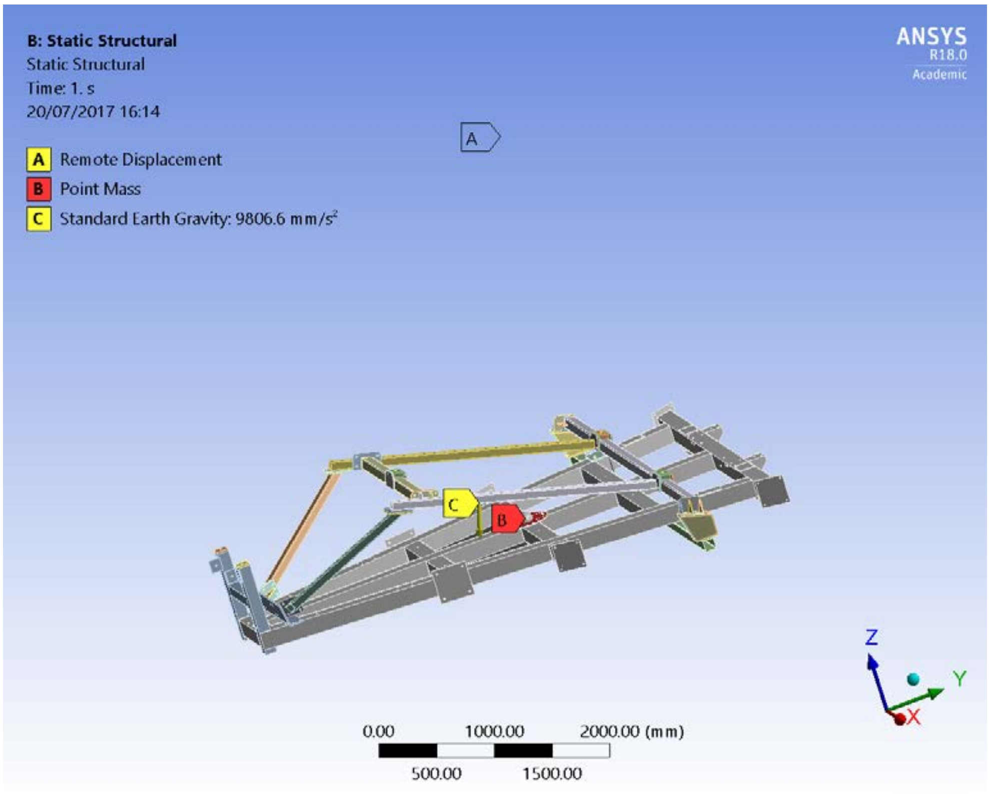


Figure 26: Load case 01, at 0° wrt the floor

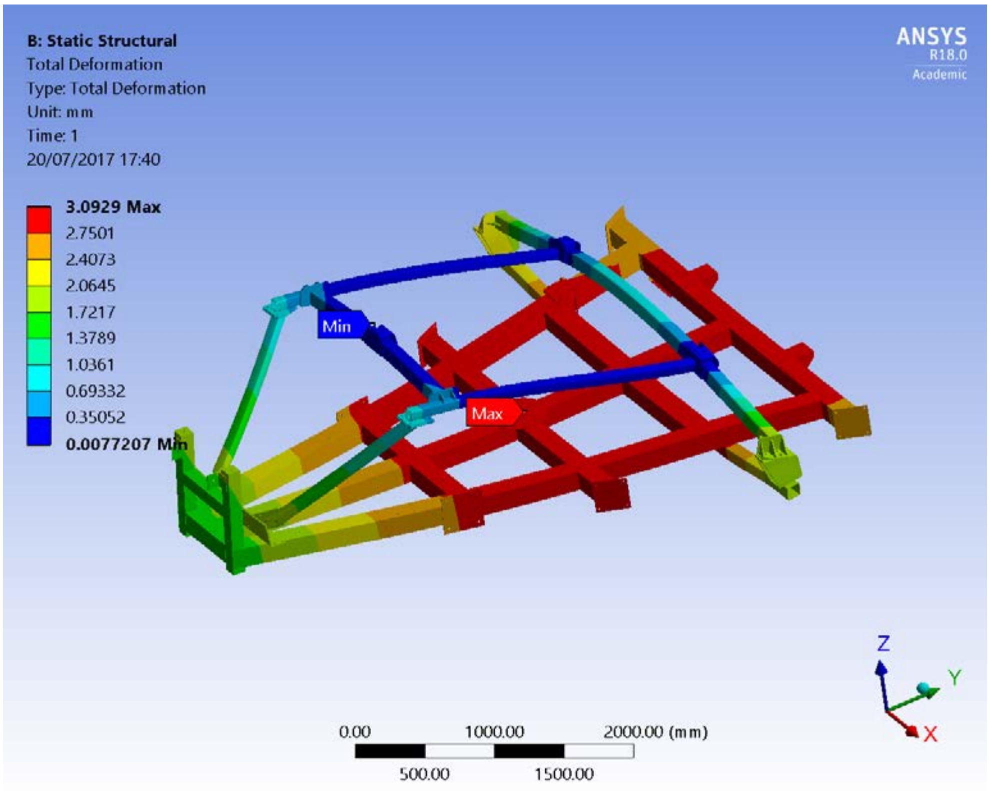


Figure 27: Load case 01, Total deformation

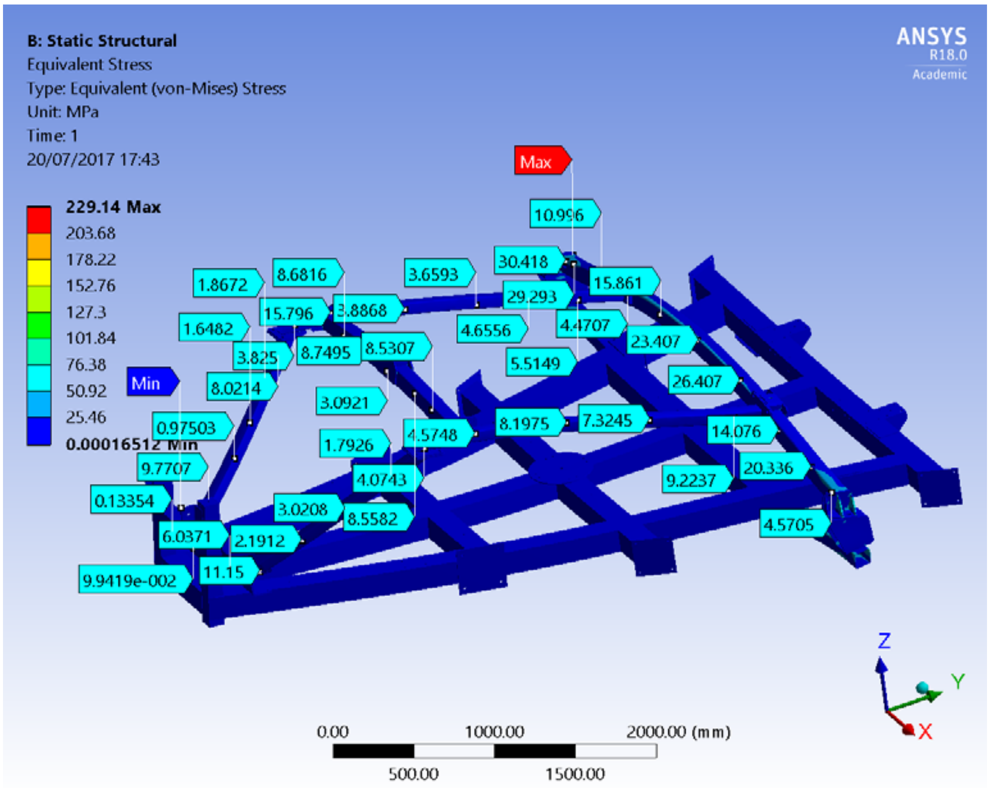


Figure 28: Load case 01, Stress equivalent (Von Mises)

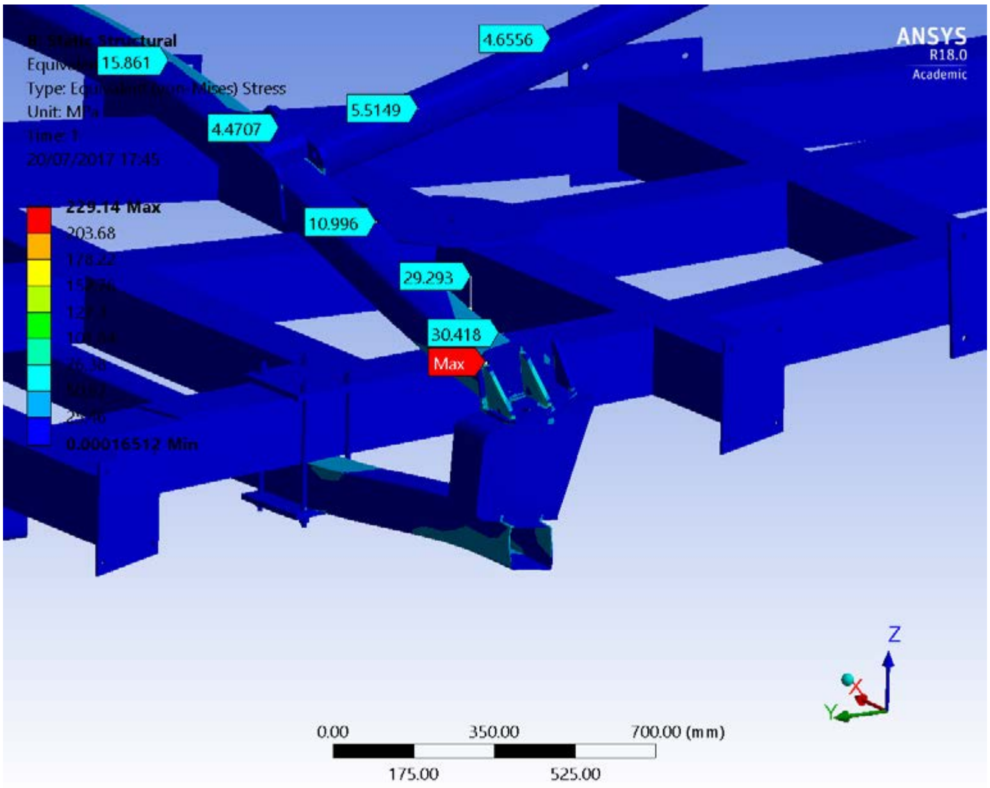


Figure 29: Load case 01, Stress equivalent (Von Mises). Detailed view of the connecting flange

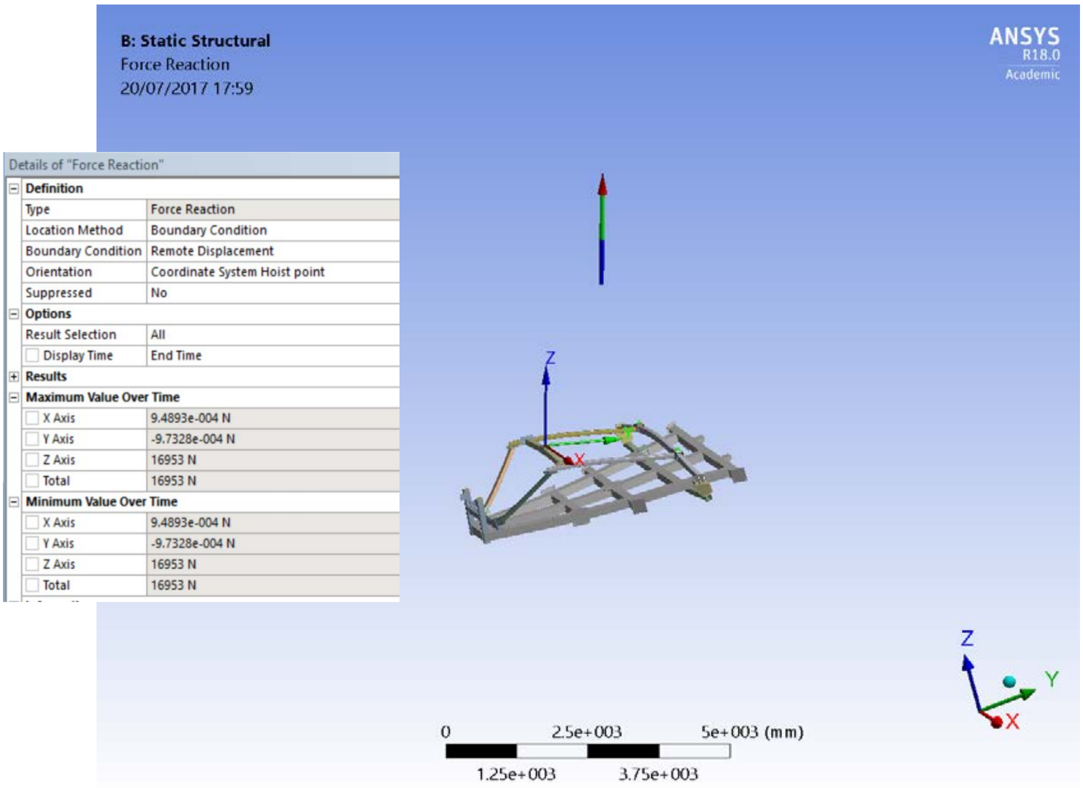


Figure 30: Load case 01, Reaction force at the Hoist point (**16953 N**)

LOAD CASE 02:

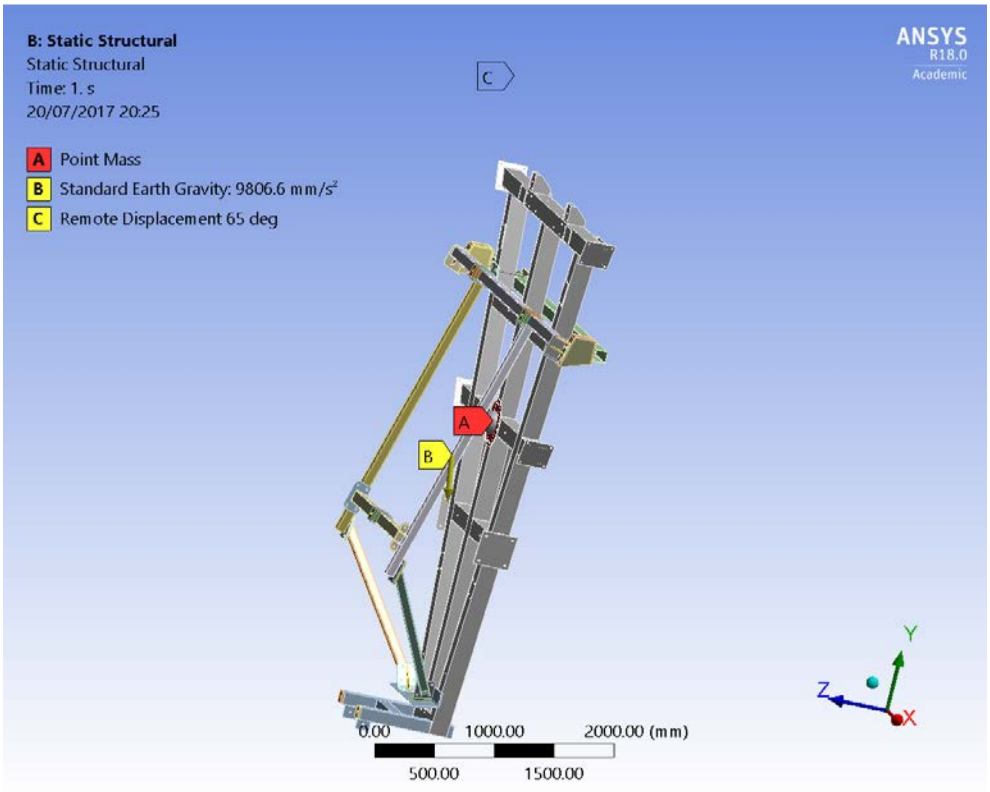


Figure 31: Load case 02, at 65° wrt the floor

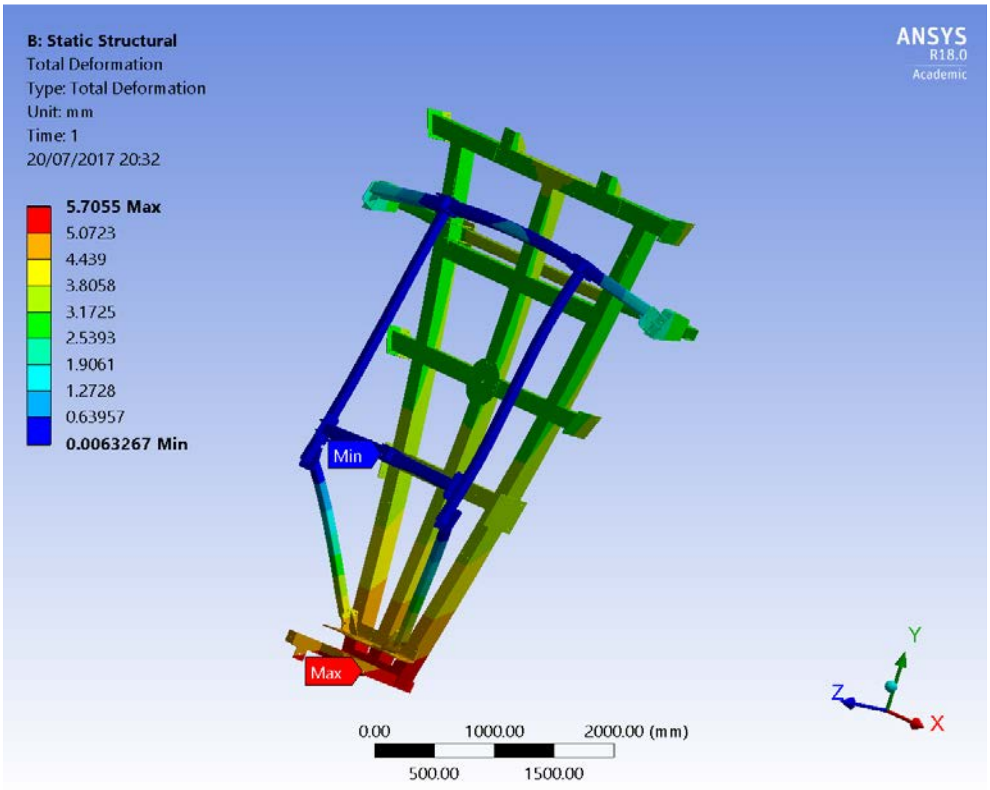


Figure 32: Load case 02, Total deformation

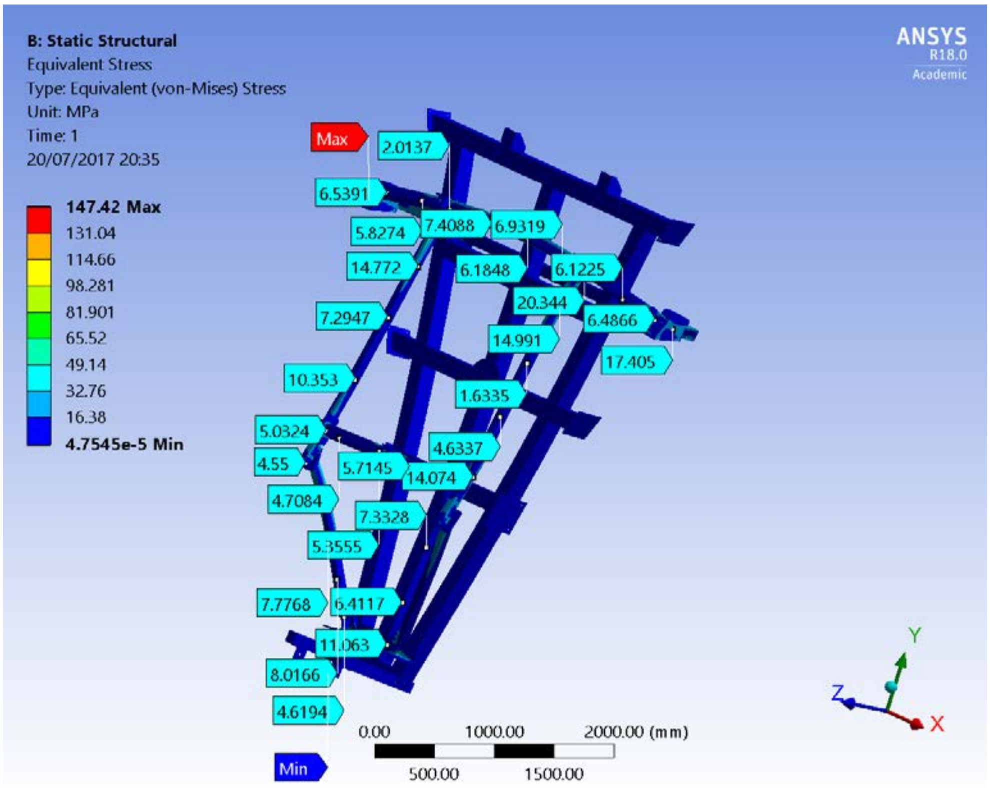


Figure 33: Load case 02, Stress equivalent (Von Mises)

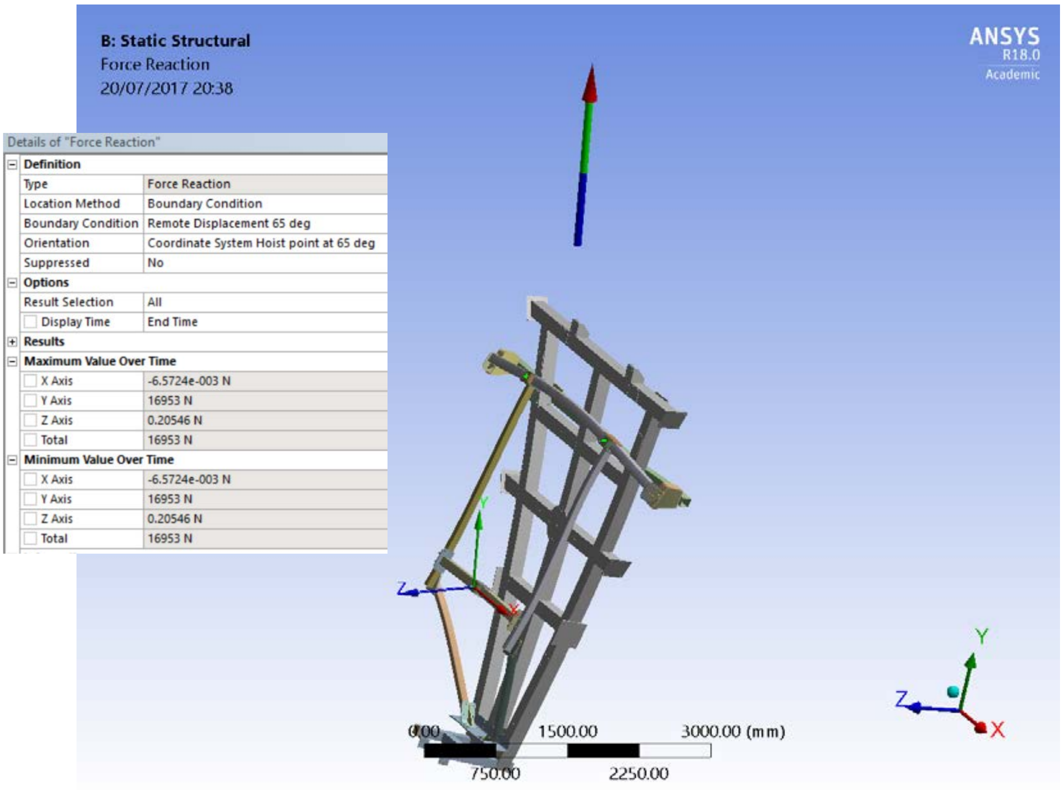


Figure 34: Load case 02, Reaction force at the Hoist point (**16953 N**)

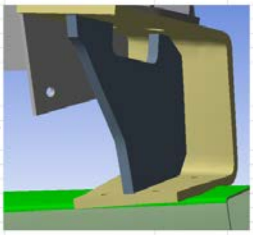
Weld Analysis

The weld analysis was performed taking into account the **load case 02** since it is the worst load case for the stiffening tool. The following method was used:

1. Model each weld joint as two separate parts with a bonded contact in ANSYS
2. Evaluate the equivalent stress of the model and choose the weld joints with the highest stress or critical locations for a detailed weld stress calculation
3. Probe the force reaction and moment reactions at the contact
4. Use the force and moments to calculate the weld stress using a spreadsheet
5. Compare the weld stress to the allowable weld stress

All the weld joints were analyzed and the weld stresses were below the allowable stress. Samples of the weld stress calculations are shown in Figure 35.

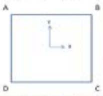
	FEA Loads						FEA Dim			Load Case
Description	Fx	Fy	Fz	Mx	My	Mz	Lx	Ly	Location	
Joint 1	-275	-654	-132	505	-918	-1204	0.500	6.000	Rib01_H	
Joint 2	75	275	-30	71	5	328	0.500	4.800	Rib01_V	
Joint 3	200	-646	-37	3470	980	-721	0.500	4.500	Rib01_Obliq	
Joint	10	20	30	100	200	300	1.000	1.000	Test	



Transform FEA Load into Analysis Coordinates.......

Analysis Case	Fx	Fy	Fz	Mx	My	Mz	Lx	Ly	
Joint 3	-200	646	37	-3470	-980	721	0.5	4.5	Set last digit in function to the desired column for all joints

Weld Dimensions			
Length	Lx	0.5	in
Width	Ly	4.5	in
Total Weld Length	L	10	in



	Dimensions (in)		Center Location (in)		Weld CG (in)		Weld Inertia (in³)	
Weld	Xi	Yi	xi	yi	(Xi+Yi)*xi	(Xi+Yi)*yi	(Xi+Yi)*(yi-gy)²+Yi3/12	(Xi+Yi)*(xi-gx)²+Xi3/12
AB	0.5	0	0	2.25	0	1.125	2.5	0.0
BC	0	4.5	0.25	0	1.125	0	7.6	0.3
CD	0.5	0	0	-2.25	0	-1.125	2.5	0.0
DA	0	4.5	-0.25	0	-1.125	0	7.6	0.3
gx	0.0							
gy		0.0						
Ix							20.3	
Iy								0.6
Polar Moment of Inertia	J						20.8	in³

Location	Shear Forces (lb/in)				Allowable Weld Stress	Mininum Weld Size	Weld Size	Weld Stress
	X	Y	Z	Total	(psi)	(in)	(in)	(psi)
A	-98	56	-802	810	**15500**	**0.074**	0.250	4581
B	-98	73	38	128	**15500**	**0.012**		725
C	58	73	809	815	**15500**	**0.074**		4609
D	58	56	-31	86	**15500**	**0.008**		487

Part thickness 1	0.5				
Part thickness 2	0.5				
Fillet Welds					
Table 3-3.4.3-1 ASTM BTH-1-2017					
Material Thickness of Thicker part joined	**Min Weld Size (inch)**	**inch**			
0 to 1/4	1/8	0.125	3 mm	NULL
over 1/4 to 1/2	3/16	0.188	5 mm	0.188
over 1/2 to 3/4	1/4	0.250	6 mm	NULL
over 3/4	5/16	0.313	8 mm	NULL
	Max Weld Size				
Material thickness less than 1/4	max weld = material thickness	NULL			
Material thickness 1/4 or greater	max weld = material thickness - 1/16	0.438			
Skip Welds					
The effective length of any intermitten fillet shall be not less than 4* the weld size with a minimum of 1-1/2					

Figure 35: Weld Stress of the connecting flange

Bolted connection Analysis

The bolted connection analysis was performed taking into account the **load case 02** since it is the worst load case for the stiffening tool. The following method was used:

1. Model each bolted joint as two separate parts with a bonded contact in ANSYS
2. Probe the force reaction and moment reactions at the contact
3. Use the force and moment reactions to calculate the bolts stress using a spreadsheet
4. Compare the bolts stress to the allowable bolts stress

All the bolted joints were analyzed and the bolted stresses were below the allowable stress. Samples of the bolted stress calculations are shown in Figures 36-38.

	FEA Loads [lbf & lbf*in]						
Load Case	Fx	Fy	Fz	Mx	My	Mz	Location
Case A	-139	-585	8	1140	15	4656	**Connection 01**
Case B	-3	-1846	-480	14090	-82	-97	Connection 02
Case C	-1	-1404	-404	175	1	1	Connection 03
Case D	632	-17	-40	763	356	-6035	test

Transform FEA Load into Analysis Coordinates.........

Analysis Case	Fx	Fy	Fz	Mx	My	Mz
Case A	139	585	-8	-1140	-15	-4656

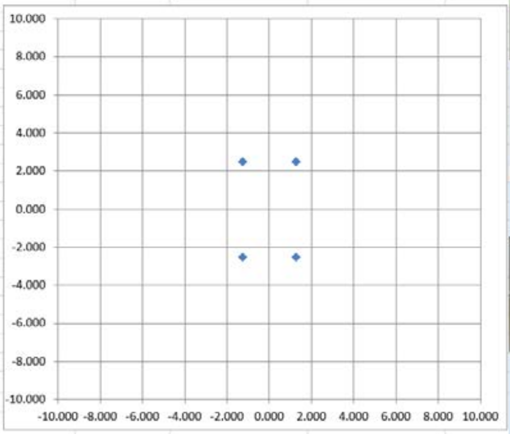
	Location (in)		Bolt Inertia (in2)	
Bolt	xi	yi	xi2	yi2
A	1.25	2.5	1.6	6.3
B	1.25	-2.5	1.6	6.3
C	-1.25	-2.5	1.6	6.3
D	-1.25	2.5	1.6	6.3
E				
F				
G				
H				

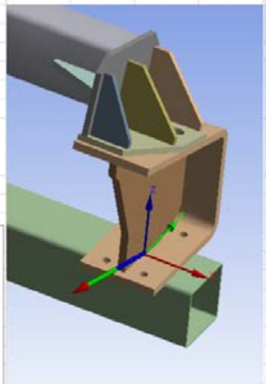
Number of bolts **4**

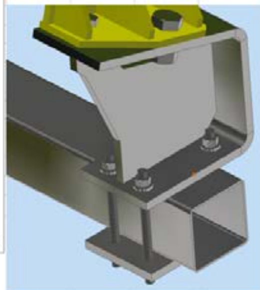
gx	0.0			
gy		0.0		
Ix				25.0
Iy			6.3	

Polar Moment of Inertia J 31.3 in²

Bolt Material	**Class 10.9 High Strength steel**
Bolt Diameter (in)	0.5
Stress Area (in²)	0.141
Tensile Strength (psi)	**150800**







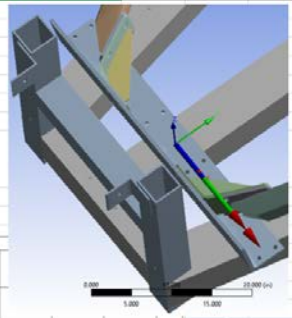
Bolt	Forces (lb)			Bolt Strength (lb)		Factors of Safety	
	Shear X	Shear Y	Tensile Z	Shear	Tensile	Shear	Tensile
A	-338	-40	-113	12758	21263	>10	>10
B	407	-40	115	12758	21263	>10	>10
C	407	332	109	12758	21263	>10	>10
D	-338	332	-119	12758	21263	>10	>10
E	35	146	-2	12758	21263	>10	>10
F	35	146	-2	12758	21263	>10	>10
G	35	146	-2	12758	21263	>10	>10
H	35	146	-2	12758	21263	>10	>10

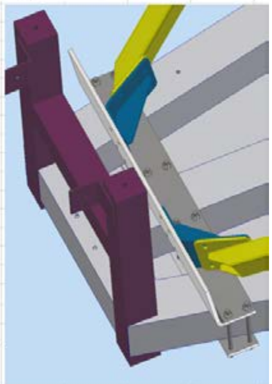
Figure 36: Bolted Stress at connection 01

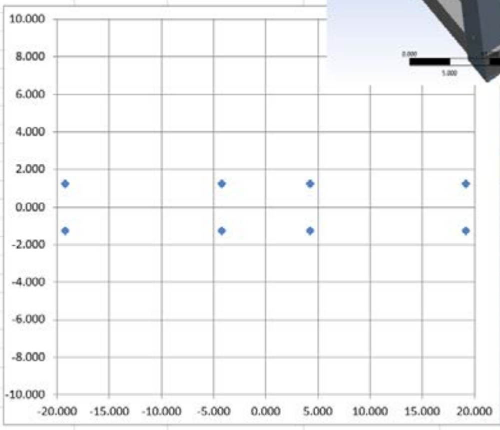
Load Case	FEA Loads [lbf & lbf*in]						Location
	Fx	Fy	Fz	Mx	My	Mz	
Case A	-139	-585	8	1140	15	4656	Connection 01
Case B	-3	-1846	-480	14090	-82	-97	**Connection 02**
Case C	-1	-1404	-404	175	1	1	Connection 03
Case D	632	-17	-40	763	356	-6035	test

Transform FEA Load into Analysis Coordinates.........

Analysis Case	Fx	Fy	Fz	Mx	My	Mz
Case B	3	1846	480	-14090	82	97







Bolt	Location (in)		Bolt Inertia (in2)	
	xi	yi	xi2	yi2
A	4.21	1.25	17.7	1.6
B	4.21	-1.25	17.7	1.6
C	-4.21	-1.25	17.7	1.6
D	-4.21	1.25	17.7	1.6
E	19.21	1.25	369.0	1.6
F	19.21	-1.25	369.0	1.6
G	-19.21	-1.25	369.0	1.6
H	-19.21	1.25	369.0	1.6

Number of bolts **8**

gx	0.0			
gy		0.0		
Ix				12.5
Iy			1547.0	

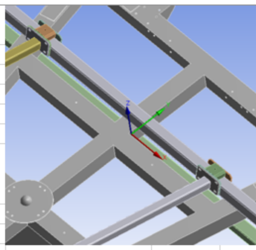
Polar Moment of Inertia J 1559.5 in^2

Bolt Material	**Class 10.9 High Strength steel**
Bolt Diameter (in)	0.5
Stress Area (in^2)	0.141
Tensile Strength (psi)	**150800**

Bolt	Forces (lb)			Bolt Strength (lb)		Factors of Safety	
	Shear X	Shear Y	Tensile Z	Shear	Tensile	Shear	Tensile
A	0	231	-1349	12758	21263	>10	>10
B	0	231	1469	12758	21263	>10	>10
C	0	230	1469	12758	21263	>10	>10
D	0	230	-1349	12758	21263	>10	>10
E	0	232	-1350	12758	21263	>10	>10
F	0	232	1468	12758	21263	>10	>10
G	0	230	1470	12758	21263	>10	>10
H	0	230	-1348	12758	21263	>10	>10

Figure 37: Bolted Stress at connection 02

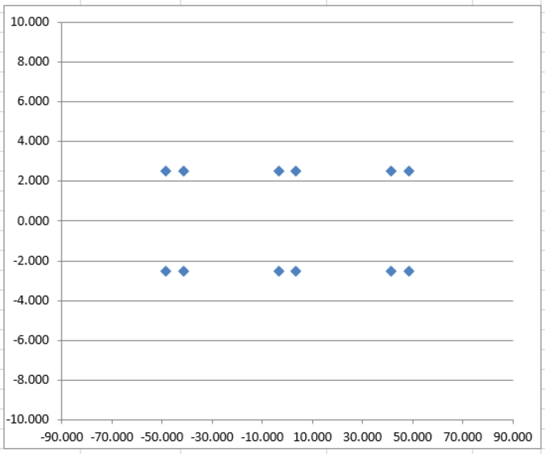
Load Case	FEA Loads [lbf & lbf*in] Fx	Fy	Fz	Mx	My	Mz	Location
Case A	-139	-585	8	1140	15	4656	Connection 01
Case B	-3	-1846	-480	14090	-82	-97	Connection 02
Case C	-1	-1404	-404	175	1	1	**Connection 03**
Case D	632	-17	-40	763	356	-6035	test



Transform FEA Load into Analysis Coordinates........

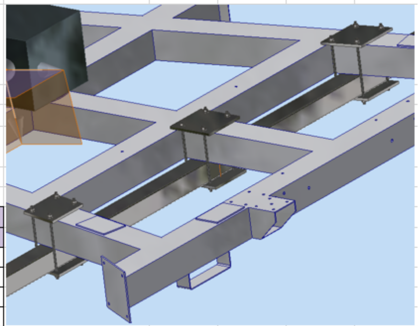
Analysis Case	Fx	Fy	Fz	Mx	My	Mz
Case C	1	1404	404	-175	-1	-1

Bolt	Location (in) xi	yi	Bolt Inertia (in2) xi2	yi2
A	3.5	2.5	12.3	6.3
B	3.5	-2.5	12.3	6.3
C	-3.5	-2.5	12.3	6.3
D	-3.5	2.5	12.3	6.3
E	41.5	2.5	1722.3	6.3
F	41.5	-2.5	1722.3	6.3
G	-41.5	-2.5	1722.3	6.3
H	-41.5	2.5	1722.3	6.3
I	48.5	2.5	2352.3	6.3
J	48.5	-2.5	2352.3	6.3
K	-48.5	-2.5	2352.3	6.3
L	-48.5	2.5	2352.3	6.3
Number of bolts	12			
gx	0.0			
gy		0.0		
Ix				75.0
Iy			16347.0	



Polar Moment of Inertia J 16422.0 in^2

Bolt Material	Class 10.9 High Strength steel
Bolt Diameter (in)	0.5
Stress Area (in^2)	0.141
Tensile Strength (psi)	**150800**



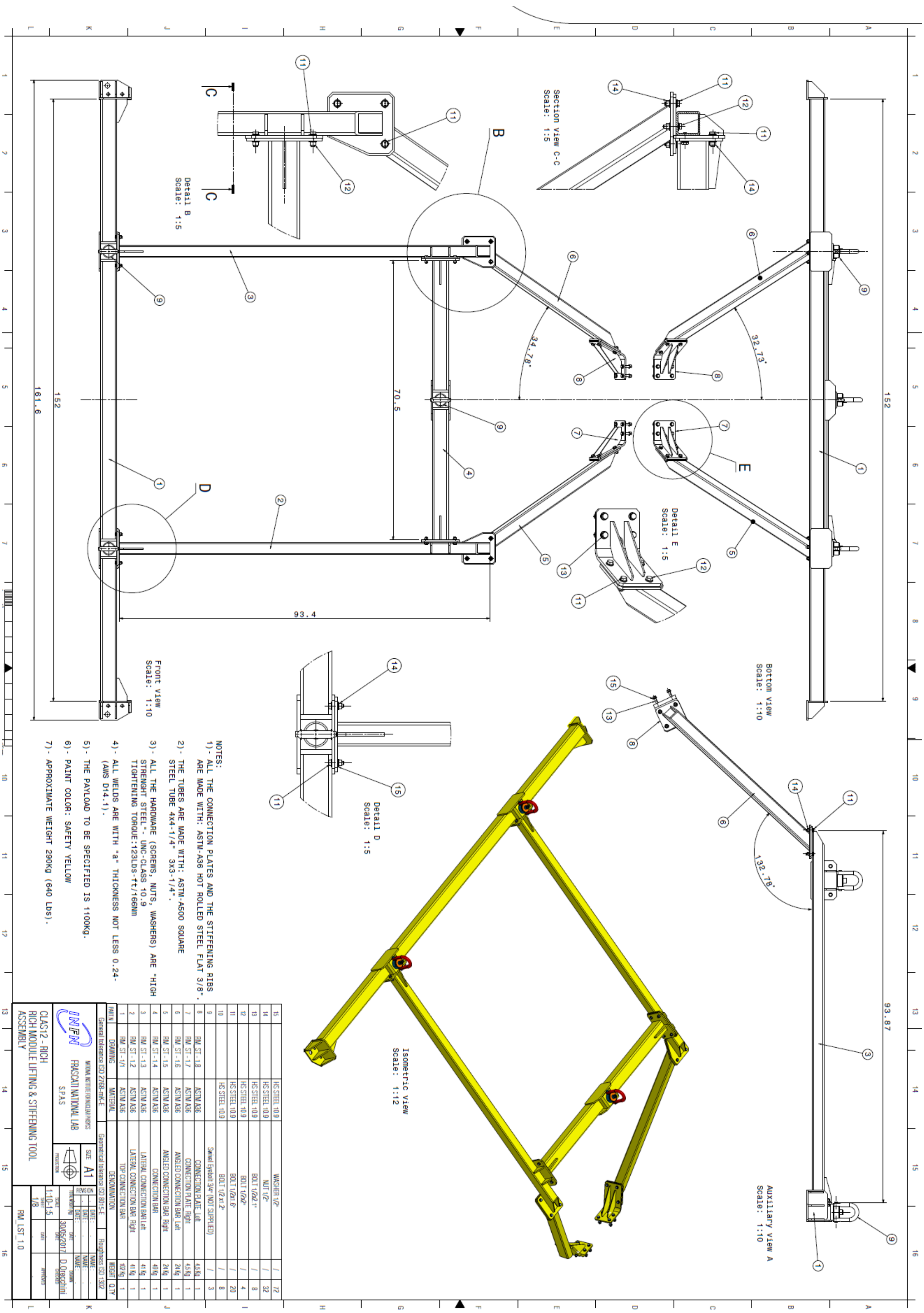
Bolt	Forces (lb) Shear X	Shear Y	Tensile Z	Bolt Strength (lb) Shear	Tensile	Factors of Safety Shear	Tensile
A	0	117	28	12758	21263	>10	>10
B	0	117	40	12758	21263	>10	>10
C	0	117	39	12758	21263	>10	>10
D	0	117	28	12758	21263	>10	>10
E	0	117	28	12758	21263	>10	>10
F	0	117	40	12758	21263	>10	>10
G	0	117	39	12758	21263	>10	>10
H	0	117	28	12758	21263	>10	>10
I	0	117	28	12758	21263	>10	>10
J	0	117	40	12758	21263	>10	>10
K	0	117	39	12758	21263	>10	>10
L	0	117	28	12758	21263	>10	>10

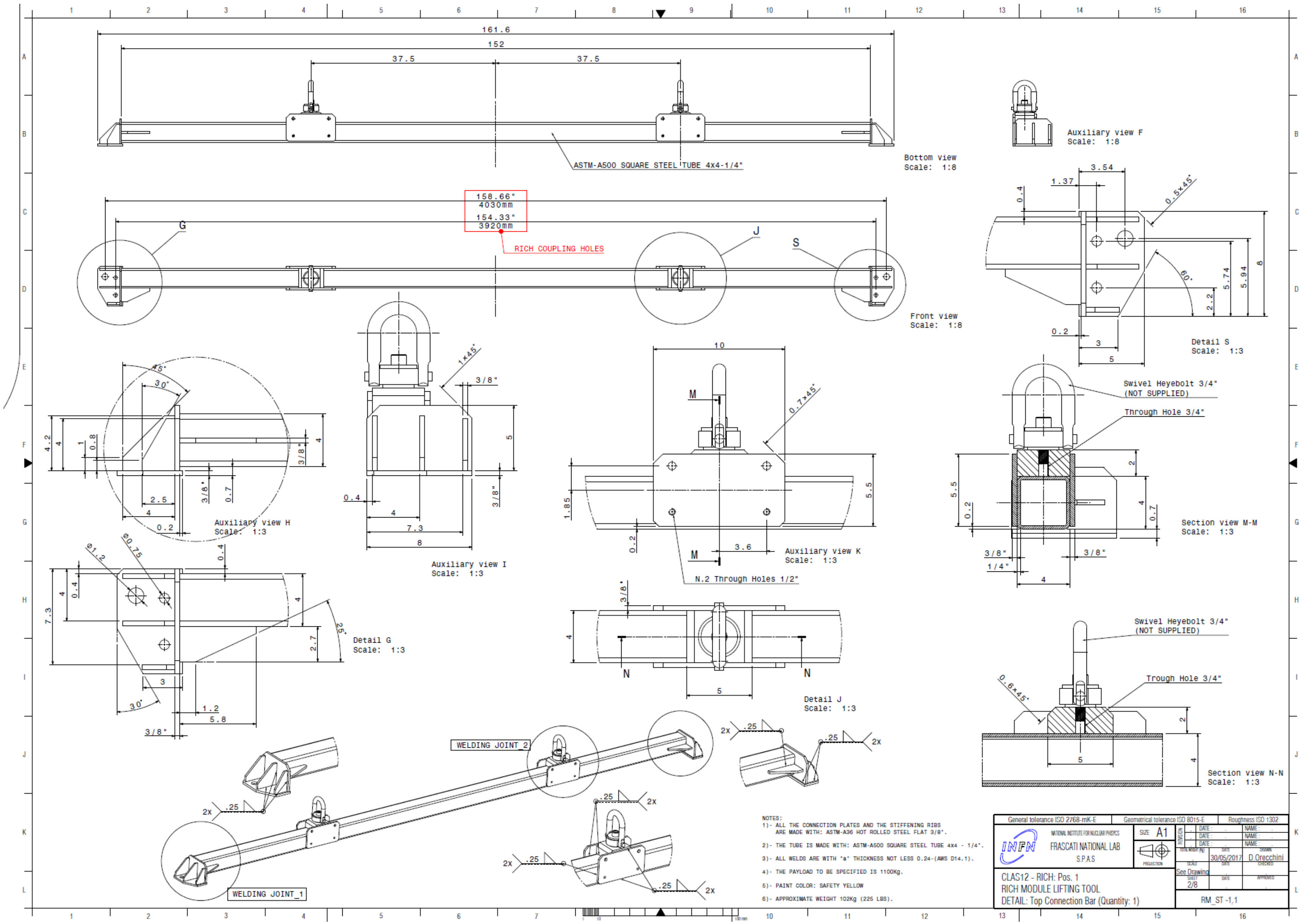
Figure 38: Bolted Stress at connection 03

Conclusion

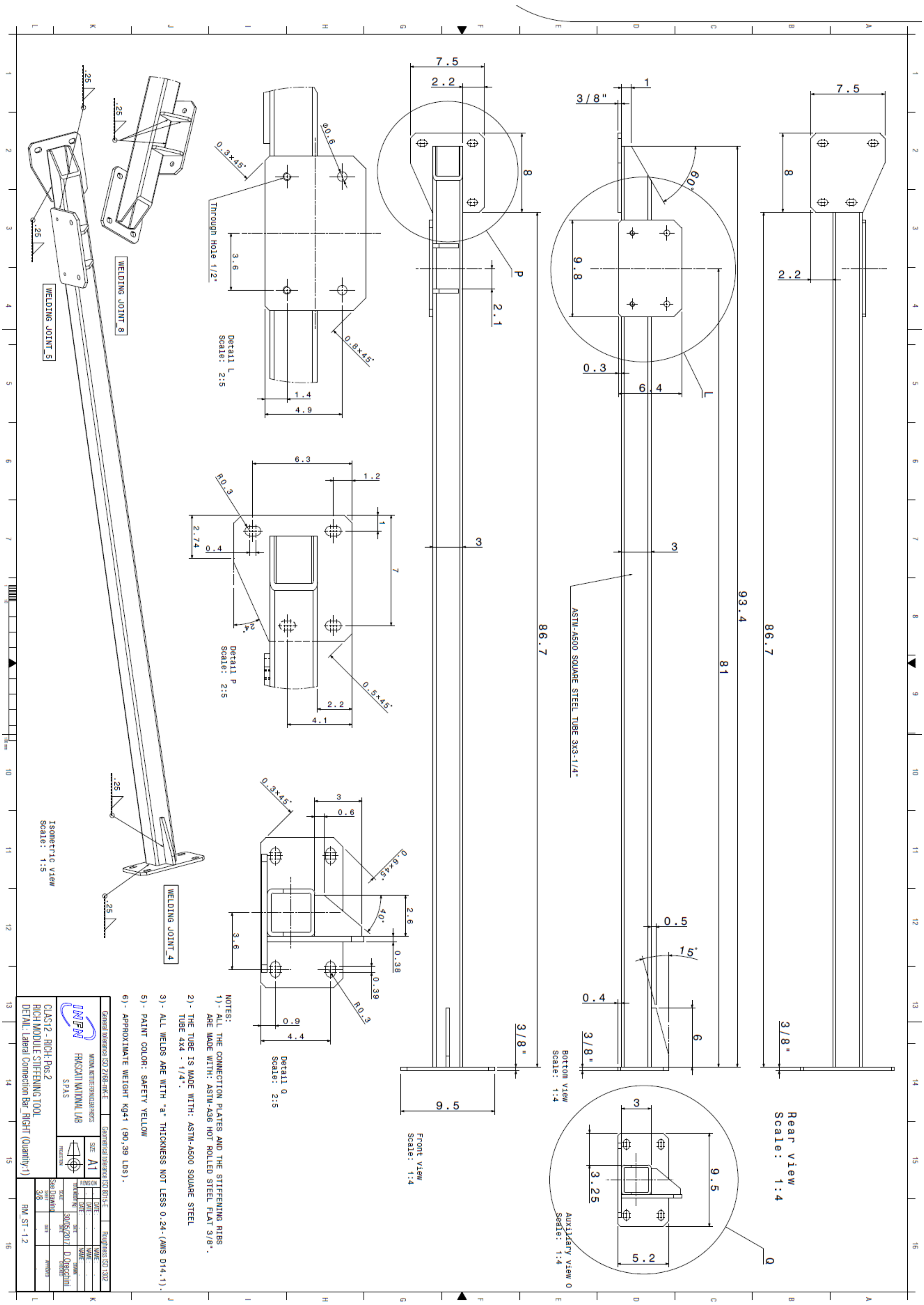
The RICH stiffening frame, during the load test phase, meets ASME-BTH-1-2017 Below the Hook Lifting Devices code.

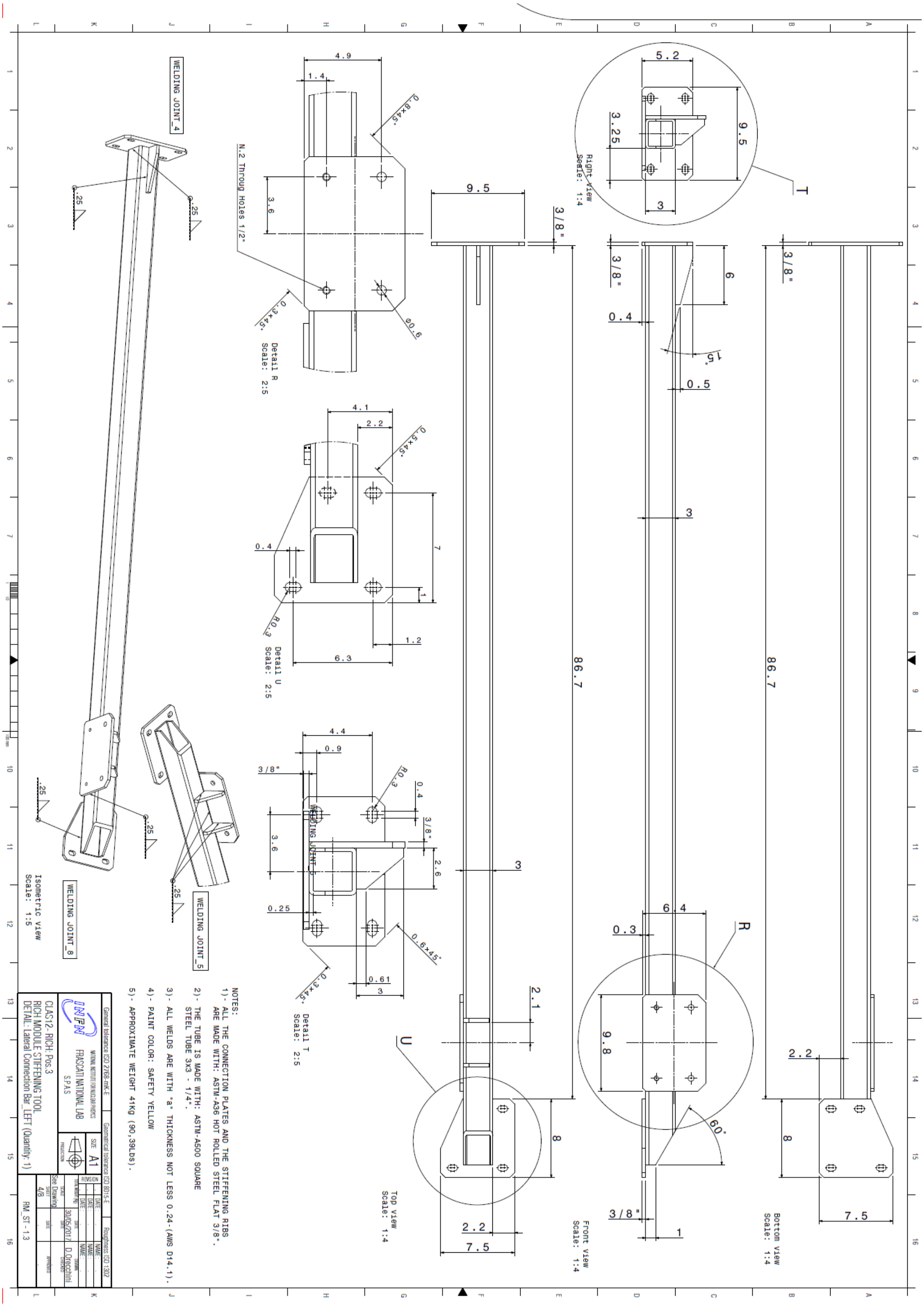
APPENDIX

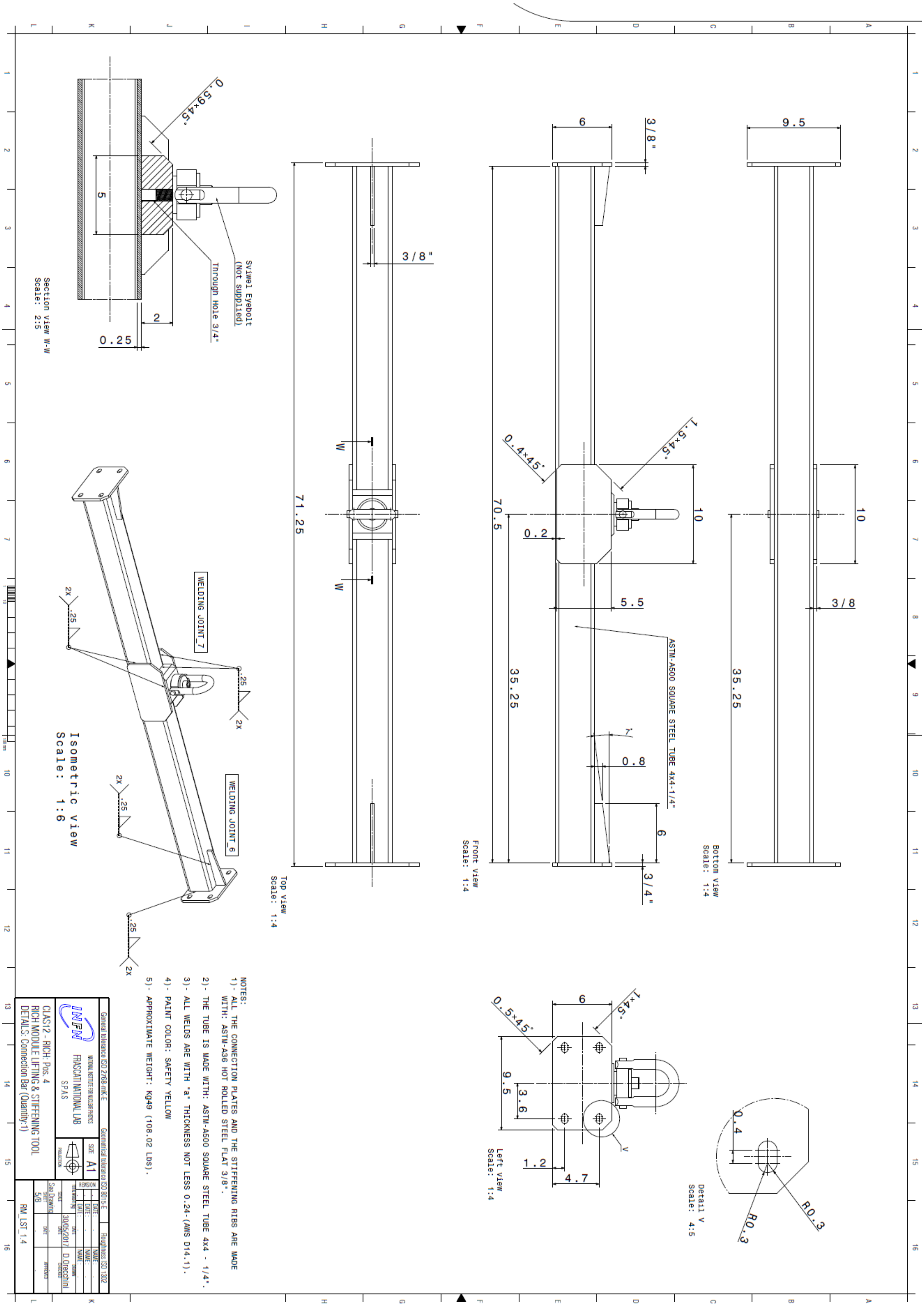

NOTES:
1) - ALL THE CONNECTION PLATES AND THE STIFFENING RIBS ARE MADE WITH: ASTM-A36 HOT ROLLED STEEL FLAT 3/8".
2) - THE TUBES ARE MADE WITH: ASTM-A500 SQUARE STEEL TUBE 4x4-1/4" 3x3-1/4".
3) - ALL THE HARDWARE (SCREWS, NUTS, WASHERS) ARE "HIGH STRENGHT STEEL". UNC-CLASS 10.9 TIGHTENING TORQUE:123Lbs-ft/166Nm
4) - ALL WELDS ARE WITH "a" THICKNESS NOT LESS 0.24- (AWS D14.1).
5) - THE PAYLOAD TO BE SPECIFIED IS 1100Kg.
6) - PAINT COLOR: SAFETY YELLOW
7) - APPROXIMATE WEIGHT 290Kg (640 Lbs).
Front view Scale: 1:10
Bottom view Scale: 1:10
Detail B Scale: 1:5
Section view C-C Scale: 1:5
Detail E Scale: 1:5
Detail D Scale: 1:5
Isometric view Scale: 1:12
Auxiliary view A Scale: 1:10



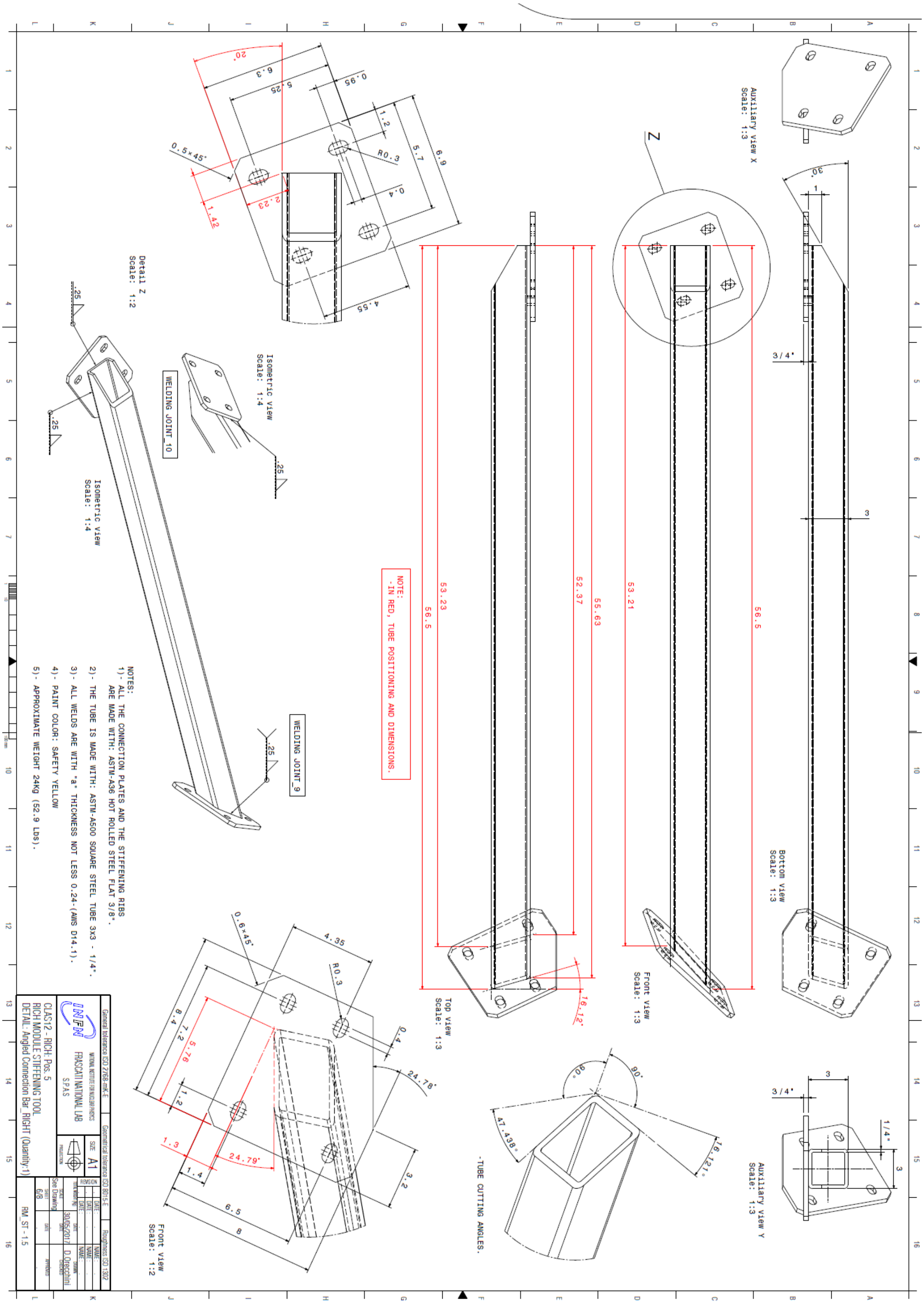
Bottom view
Scale: 1:8
ASTM-A500 SQUARE STEEL TUBE 4x4-1/4"
161.6
152
37.5
37.5
Front view
Scale: 1:8
158.66"
4030mm
154.33"
3920mm
RICH COUPLING HOLES
G
J
S
Auxiliary view F
Scale: 1:8
Detail S
Scale: 1:3
Auxiliary view H
Scale: 1:3
Auxiliary view I
Scale: 1:3
Auxiliary view K
Scale: 1:3
N.2 Through Holes 1/2"
Section view M-M
Scale: 1:3
Swivel Heyebolt 3/4"
(NOT SUPPLIED)
Through Hole 3/4"
Detail G
Scale: 1:3
Detail J
Scale: 1:3
Section view N-N
Scale: 1:3
Trough Hole 3/4"
WELDING JOINT_1
WELDING JOINT_2
NOTES:
1)- ALL THE CONNECTION PLATES AND THE STIFFENING RIBS ARE MADE WITH: ASTM-A36 HOT ROLLED STEEL FLAT 3/8".
2)- THE TUBE IS MADE WITH: ASTM-A500 SQUARE STEEL TUBE 4x4 - 1/4".
3)- ALL WELDS ARE WITH "a" THICKNESS NOT LESS 0.24-(AWS D14.1).
4)- THE PAYLOAD TO BE SPECIFIED IS 1100Kg.
5)- PAINT COLOR: SAFETY YELLOW
6)- APPROXIMATE WEIGHT 102Kg (225 LBS).
General tolerance ISO 2768-mK-E
Geometrical tolerance ISO 8015-E
Roughness ISO 1302
INFN
FRASCATI NATIONAL LAB
S.P.A.S
SIZE A1
30/05/2017
D.Orecchini
See Drawing
2/8
CLAS12 - RICH: Pos. 1
RICH MODULE LIFTING TOOL
DETAIL: Top Connection Bar (Quantity: 1)
RM_ST -1,1


NOTES:
1) - ALL THE CONNECTION PLATES AND THE STIFFENING RIBS ARE MADE WITH: ASTM-A36 HOT ROLLED STEEL FLAT 3/8".
2) - THE TUBE IS MADE WITH: ASTM-A500 SQUARE STEEL TUBE 4x4 - 1/4".
3) - ALL WELDS ARE WITH "a" THICKNESS NOT LESS 0.24-(AWS D14.1).
5) - PAINT COLOR: SAFETY YELLOW
6) - APPROXIMATE WEIGHT Kg41 (90,39 Lbs).
General tolerance ISO 2768-mK-E
Geometrical tolerance ISO 8015-E
Roughness ISO 1302
FRASCATI NATIONAL LAB
S.P.A.S
SIZE A1
CLAS12 - RICH: Pos.2
RICH MODULE STIFFENING TOOL
DETAIL: Lateral Connection Bar_RIGHT (Quantity:1)
See Drawing
3/8
30/05/2017
D.Orecchini
RM_ST-1.2
Detail L
Scale: 2:5
Through Hole 1/2"
Detail P
Scale: 2:5
Detail Q
Scale: 2:5
Isometric view
Scale: 1:5
WELDING JOINT_4
WELDING JOINT_5
WELDING JOINT_8
Front view
Scale: 1:4
Bottom view
Scale: 1:4
Rear view
Scale: 1:4
Auxiliary view Q
Scale: 1:4
ASTM-A500 SQUARE STEEL TUBE 3x3-1/4"

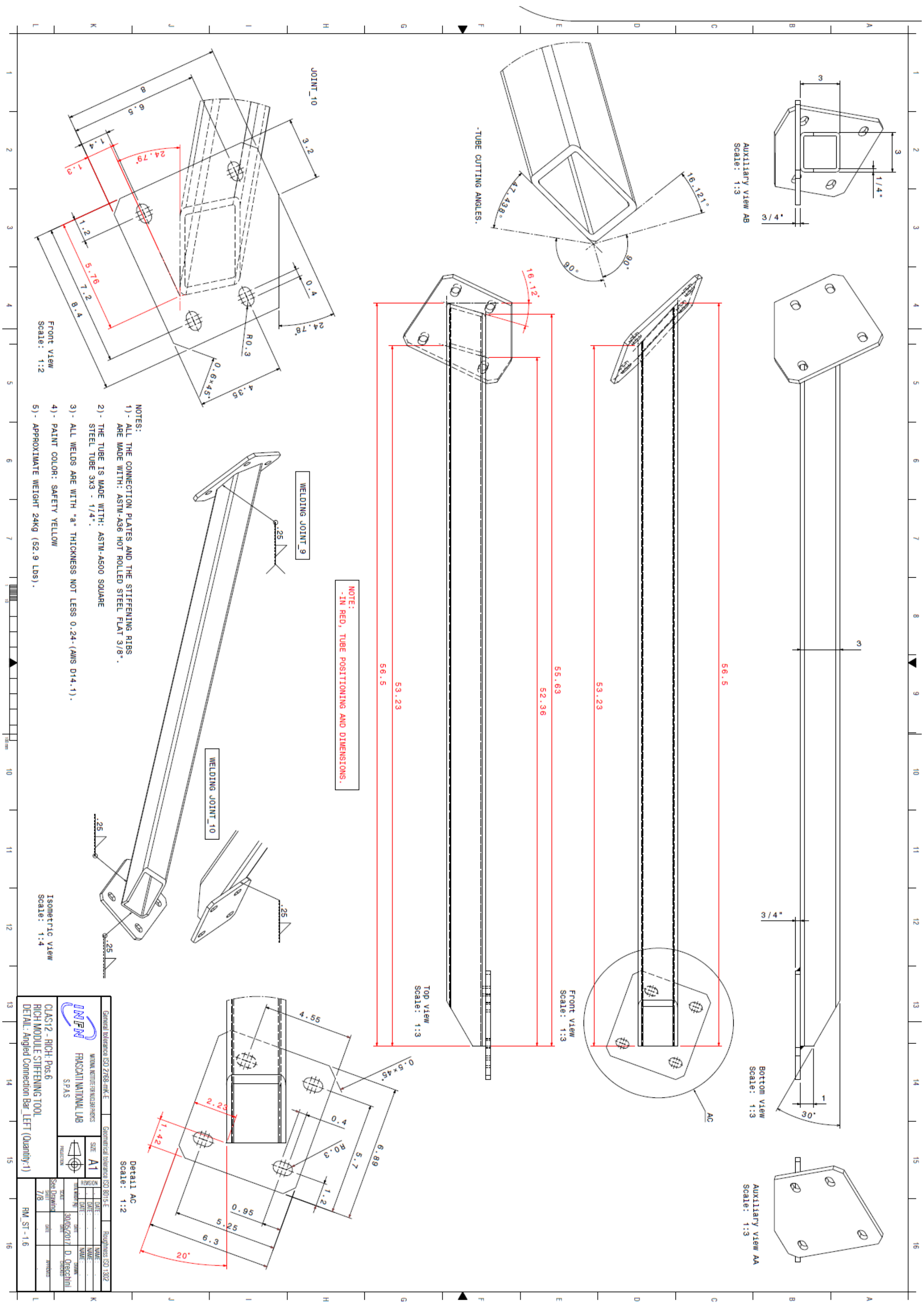

WELDING JOINT_4
WELDING JOINT_5
WELDING JOINT_8
Isometric view
Scale: 1:5
N.2 Throug Holes 1/2"
Detail R
Scale: 2:5
Detail U
Scale: 2:5
Detail T
Scale: 2:5
Right View
Scale: 1:4
Top View
Scale: 1:4
Front View
Scale: 1:4
Bottom View
Scale: 1:4
86.7
NOTES:
1)- ALL THE CONNECTION PLATES AND THE STIFFENING RIBS ARE MADE WITH: ASTM-A36 HOT ROLLED STEEL FLAT 3/8".
2)- THE TUBE IS MADE WITH: ASTM-A500 SQUARE STEEL TUBE 3x3 - 1/4".
3)- ALL WELDS ARE WITH "a" THICKNESS NOT LESS 0.24- (AWS D14.1).
4)- PAINT COLOR: SAFETY YELLOW
5)- APPROXIMATE WEIGHT 41Kg (90,39Lbs).
FRASCATI NATIONAL LAB
SPAS
CLAS12- RICH: Pos.3
RICH MODULE STIFFENING TOOL
DETAIL: Lateral Connection Bar_LEFT (Quantity: 1)
A1
4/8
RM_ST-1.3
30/05/2017
D.Orecchini

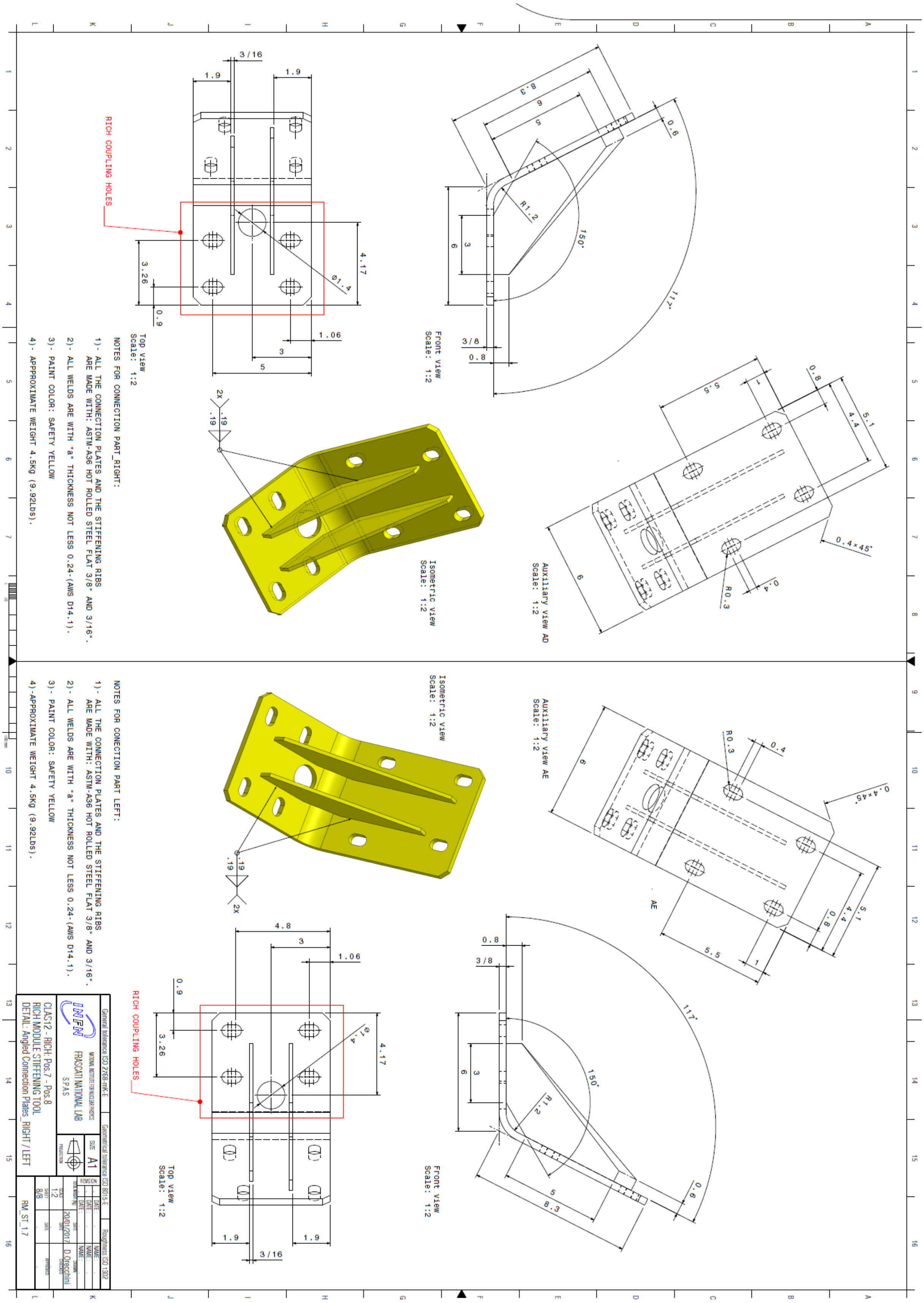


Section view W-W
Scale: 2:5
0.59x45°
5
2
0.25
Swivel Eyebolt (Not supplied)
Through Hole 3/4"
Isometric view
Scale: 1:6
WELDING JOINT_7
WELDING JOINT_6
Top view
Scale: 1:4
71.25
3/8"
Front view
Scale: 1:4
70.5
35.25
0.4x45°
1.5x45°
0.2
5.5
0.8
ASTM-A500 SQUARE STEEL TUBE 4x4-1/4"
Bottom view
Scale: 1:4
9.5
10
3/8
Left view
Scale: 1:4
0.5x45°
1x45°
Detail V
Scale: 4:5
R0.3
NOTES:
1)- ALL THE CONNECTION PLATES AND THE STIFFENING RIBS ARE MADE WITH: ASTM-A36 HOT ROLLED STEEL FLAT 3/8".
2)- THE TUBE IS MADE WITH: ASTM-A500 SQUARE STEEL TUBE 4x4 - 1/4".
3)- ALL WELDS ARE WITH "a" THICKNESS NOT LESS 0.24 (AWS D14.1).
4)- PAINT COLOR: SAFETY YELLOW
5)- APPROXIMATE WEIGHT: Kg49 (108.02 Lbs).
FRASCATI NATIONAL LAB
S.P.A.S
CLAS12 - RICH: Pos. 4
RICH MODULE LIFTING & STIFFENING TOOL
DETAILS: Connection Bar (Quantity:1)
A1
30/05/2017
D.Orecchini
RM_LST_1.4



Auxiliary view X
Scale: 1:3
Z
Detail Z
Scale: 1:2
Isometric view
Scale: 1:4
WELDING JOINT_10
WELDING JOINT_9
Isometric view
Scale: 1:4
NOTE:
- IN RED, TUBE POSITIONING AND DIMENSIONS.
Front view
Scale: 1:3
Top view
Scale: 1:3
Bottom view
Scale: 1:3
Auxiliary view Y
Scale: 1:3
- TUBE CUTTING ANGLES.
Front view
Scale: 1:2
NOTES:
1) - ALL THE CONNECTION PLATES AND THE STIFFENING RIBS ARE MADE WITH: ASTM-A36 HOT ROLLED STEEL FLAT 3/8".
2) - THE TUBE IS MADE WITH: ASTM-A500 SQUARE STEEL TUBE 3x3 - 1/4".
3) - ALL WELDS ARE WITH "a" THICKNESS NOT LESS 0.24 - (AWS D14.1).
4) - PAINT COLOR: SAFETY YELLOW
5) - APPROXIMATE WEIGHT 24kg (52.9 Lbs).
General tolerance ISO 2768-mK-E
Geometrical tolerance ISO 8015-E
Roughness ISO 1302
INFN
FRASCATI NATIONAL LAB
S.P.A.S
SIZE A1
CLAS12 - RICH: Pos. 5
RICH MODULE STIFFENING TOOL
DETAIL: Angled Connection Bar_RIGHT (Quantity:1)
See Drawing
6/8
30/05/2017
D.Orecchini
RM_ST - 1.5


JOINT_10
-TUBE CUTTING ANGLES.
Auxiliary view AB
Scale: 1:3
Front view
Scale: 1:2
NOTES:
1)- ALL THE CONNECTION PLATES AND THE STIFFENING RIBS ARE MADE WITH: ASTM-A36 HOT ROLLED STEEL FLAT 3/8".
2)- THE TUBE IS MADE WITH: ASTM-A500 SQUARE STEEL TUBE 3x3 - 1/4".
3)- ALL WELDS ARE WITH "a" THICKNESS NOT LESS 0.24 (AWS D14.1).
4)- PAINT COLOR: SAFETY YELLOW
5)- APPROXIMATE WEIGHT 24kg (52.9 Lbs).
WELDING JOINT_9
WELDING JOINT_10
NOTE:
- IN RED, TUBE POSITIONING AND DIMENSIONS.
Isometric view
Scale: 1:4
Top view
Scale: 1:3
Front view
Scale: 1:3
Bottom view
Scale: 1:3
Auxiliary view AA
Scale: 1:3
Detail AC
Scale: 1:2
FRASCATI NATIONAL LAB
SPAS
CLAS12 - RICH Pos.6
RICH MODULE STIFFENING TOOL
DETAIL: Angled Connection Bar_LEFT (Quantity:1)
30/05/2017
D. Orecchini
RM_ST-1.6


RICH COUPLING HOLES
Top view
Scale: 1:2
Front view
Scale: 1:2
Isometric view
Scale: 1:2
Auxiliary view AD
Scale: 1:2
NOTES FOR CONECTION PART_RIGHT:
1) - ALL THE CONNECTION PLATES AND THE STIFFENING RIBS ARE MADE WITH: ASTM-A36 HOT ROLLED STEEL FLAT 3/8" AND 3/16".
2) - ALL WELDS ARE WITH "a" THICKNESS NOT LESS 0.24-(AWS D14.1).
3) - PAINT COLOR: SAFETY YELLOW
4) - APPROXIMATE WEIGHT 4.5KG (9.92LBS).
NOTES FOR CONECTION PART LEFT:
1) - ALL THE CONNECTION PLATES AND THE STIFFENING RIBS ARE MADE WITH: ASTM-A36 HOT ROLLED STEEL FLAT 3/8" AND 3/16".
2) - ALL WELDS ARE WITH "a" THICKNESS NOT LESS 0.24-(AWS D14.1).
3) - PAINT COLOR: SAFETY YELLOW
4) -APPROXIMATE WEIGHT 4.5KG (9.92LBS).
Auxiliary view AE
Scale: 1:2
FRASCATI NATIONAL LAB
SPAS
CLAS12 - RICH: Pos.7 - Pos.8
RICH MODULE STIFFENING TOOL
DETAIL: Angled Connection Plates_RIGHT / LEFT
A1
D.Orecchini
RM_ST_17