I.F.H. Quarter Module

Lifting Fixture

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The main purpose of this report is to explain the procedure for lifting the I.F.H. quarter module from a "prone" position to a "standing" position and then into the liquid nitrogen test vessel.

The main objective for the design of the lifting fixtures was simplicity. The fixtures are to be made of .75 in. thick stainless steel plates which is a stock item for the steel companies. The fixtures are stainless steel so they will be able to keep their structural integrity when immersed in the liquid nitrogen.

A.I.S.C. Allowable Stresses for SS304 ($S_y=30$ ksi.)

Stress State	Equation	Allowable Stress
Bearing	$1.5 \cdot S_u$	112.5 ksi.
Bending (solid rectangle)	$.75 \cdot S_y$	22.5 ksi.
Shear	$.40 \cdot S_y$	12.0 ksi.
Bending (general)	$.66 \cdot S_y$	19.8 ksi.
Tension	$.60 \cdot S_y$	18.0 ksi.

STRESS CALCULATIONS:

We were given module weights ranging from 8500 to 18000 lbs.

For safety, 18000 lbs. was used.

1) Top Lifting Fixture:

1. Pull-out Shear in main pin hole:

$$\text{Stress} = \text{Force} / \text{Area}$$

$$\text{Stress} = \text{Force} / (N * (2 * t * L))$$

N=Number of Plates

t=Plate Thickness

L=Shear Length

$$\text{Stress} = 18000 / (2 * (2 * .75 * 5))$$

$$\text{Shear Stress} = 1200 \text{ psi.}$$

2. Bearing Stress in main pin hole

$$\text{Stress} = \text{Force} / \text{Area}$$

$$\text{Stress} = \text{Force} / (N * t * L)$$

N=Number of Plates

t= Plate Thickness

L= bearing Length

$$\text{Stress} = 18000 / (2 * .75 * 2)$$

$$\text{Stress} = 6000 \text{ psi.}$$

3. Bolt Shear between the spreader beam flange plates and the face plates:

$$\text{Stress} = \text{Force} / \text{Area}$$

$$\text{Stress} = \text{Force} / (N * (\pi * D^2 / 4))$$

N=Number of Bolts

D= Bolt Diameter

$$\text{Stress} = 18000 / (8 * (\pi * .75^2 / 4))$$

$$\text{Bolt Shear} = 5093 \text{ psi.}$$

4. Bolt Shear between the face plates and the module:

$$\text{Stress} = \text{Force} / \text{Area}$$

$$\text{Stress} = \text{Force} / (N * (\pi * D^2 / 4))$$

N= Number of Bolts

D= Bolt Diameter

$$\text{Stress} = 18000 / (10 * (\pi * 1^2 / 4))$$

Bolt Shear= 2291.8 psi.

5. Pull-out shear in lifting lugs:

$$\text{Stress} = \text{Force} / \text{Area}$$

$$\text{Stress} = \text{Force} / (t * L * 2)$$

t= Plate Thickness

L= Shear Length

$$\text{Stress} = 18000 / (1.5 * 1.375 * 2)$$

$$\text{Stress} = 4363.6 \text{ psi}$$

6. Bearing Stress in lifting lugs:

$$\text{Stress} = \text{Force} / \text{Area}$$

$$\text{Stress} = \text{Force} / (t * L)$$

t= Plate Thickness

L= Bearing Length

$$\text{Stress} = 18000 / (1.5 * 1.25)$$

$$\text{Stress} = 9600 \text{ psi.}$$

7. The lifting lugs will be attached to the face plate by .25 in. fillet welds. In order to calculate the stresses in the weld, the weld's nominal depth was determined to be .177 in.

$$\text{Stress} = \text{Force} / \text{Area}$$

$$\text{Stress} = \text{Force} / (t * L)$$

t = Nominal Weld Thickness

L = Weld Length

$$\text{Stress} = 18000 / (.177 * 13)$$

$$\text{Weld Stress} = 7826 \text{ psi.}$$

It is plain to see that all of the stresses are well within the allowable limits. The calculations performed on the lifting lugs represents

the case where the entire load is taken by *one* lug.

2) Bottom Lifting Fixture:

The only stress calculations that have to be performed on the bottom lifting fixture are those that involve the 1 in. stainless steel bolts that attach the face plat of the fixture to the module.

1. Shear Stress in Bolts:

$$\text{Stress} = \text{Force} / \text{Area}$$

$$\text{Stress} = \text{Force} / (N * \pi * D^2 / 4)$$

N=Number of Bolts

D=Bolt Diameter

$$\text{Stress} = 18000 / (3 * (\pi * .5^2))$$

$$\text{Bolt Shear} = 7639.4 \text{ psi.}$$

Any calculations done on the bottom lifting lugs would be redundant because the exact calculations were already done on the top lifting lugs.

Because the module is going to be approximately 18 in. thick, the fixture was designed so that the back plate of the fixture will match up with the back plate of the module, therefore providing a "seat" for the module. Compression of the stainless steel will not be a problem and is omitted.

The proposed procedure for placing the D-O I.F.H. Quarter Module into the liquid nitrogen test vessel is as follows:

- 1) Attach the entire bottom lifting assembly directly to the face-plate of the module using three 1"-8UNC stainless steel bolts.
- 2) Attach the front plate and the spreader plates of the top lifting assembly to the face-plate of the module using five 1"-8UNC stainless steel bolts.

- 3) Using the lifting lugs on the top and bottom, lift the entire module off the floor and set on blocks (preferably 1 to 2 feet off the ground). Then attach the back faces plate to the module and spreader plates.

- 4) Now, hook a sling to the main hole in the spreader plates and a "come-along" to the bottom lifting lugs.

- 5) Lower the "come-along" until the module is vertical.

- 6) Set the module on the floor and remove the slings. Place the main hook around the pin and lift the module into the liquid nitrogen test vessel.