Ronald L. Strykowsky

From: Peter Titus
Sent: Wednesday, June 01, 2011 2:34 PM
To: Ronald L. Strykowsky
Subject: FW: lid umbrella attachment/Collar friction Joint

From: Peter Titus
Sent: Thu 5/26/2011 6:06 PM
To: Mark Smith
Subject: RE: lid umbrella attachment/Collar friction Joint

You are marginal taking the load in pure shear using eighteen 718 bolts. The NSTX criteria allows .6*Sm for average shear. Sm for 718 is the lesser of 2/3*150 of 1/3*180 = 60 ksi. .6*Sm = 36 ksi. the average shear in the shoulder bolts is 18000/(pi/4*.75^2) = 40.7 ksi. You can increase the sizes, but I don't think you can keep it in pure shear. The load transfers to the bolt via some compression distribution above the shear plane and transfers to the opposite member via a compressive distribution below the shear plane. What results is a bending on the pin due to the offsets in the two compressive stress cenrtroids. Assume that the compressive stress distribution is ~ a diameter high above and below. then the offset is one diameter. 18000*.75/(pi/32*d^3) = 326000 psi. The compressive stress distributions in the G-10 would be 18000/(*.75*.75*1.5) = 48 ksi (the 1.5 factor comes from a cosine distribution)

On the TF flag connection. Danny tried vertical pins and couldn't make them work for the above reasons. - He chose the radial pins connecting the TF- which are in double shear instead of single shear. For the TF connection, we have 36 pins in double shear, or 72 shear planes, and you propose carrying the torque in 18 shear planes. -Peter

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From: Mark Smith
Sent: Thu 5/26/2011 3:39 PM
To: Peter Titus
Cc: Lawrence E. Dudek; James H. Chrzanowski; Ali Zolfaghari
Subject: RE: lid umbrella attachment/Collar friction Joint

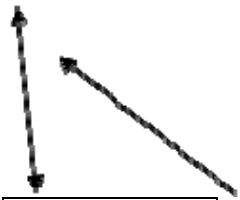
Pete.

The bolts would carry the shear.
The load path would be (if starting from the TFI Legs): legs to crown, crown to the bushing (projected area), into the shoulder bolt (shear).
There is of course some transfer from the square insert into the bolt as well.

At 18,000 lbf per shoulder bolt (shear load), 0.437 in^2 area = 41 ksi.
Using .57 * [Sy*(2/3)]= 45.6 ksi allowable for shear.

There is some option for increasing the hole size and the metal insert dimensions as well.

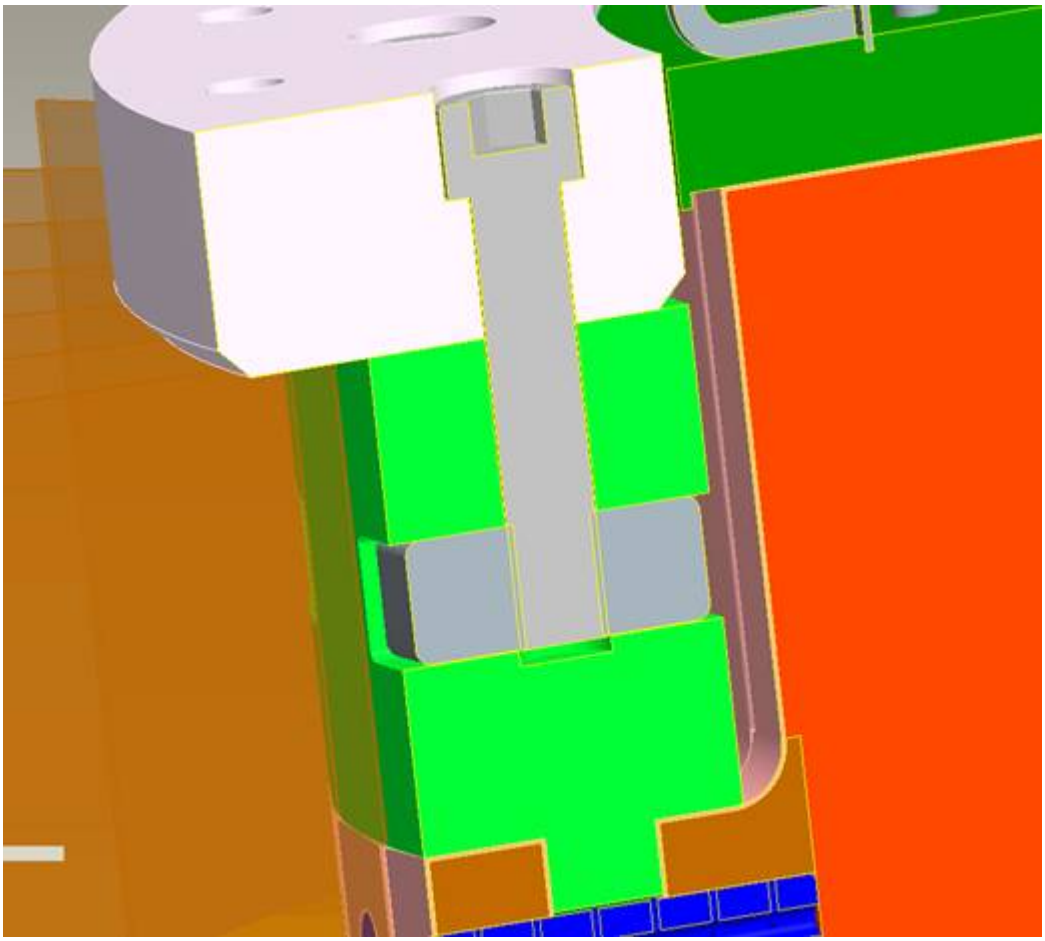
1.5 in



bushing

use drill bushing and shoulder bolt to ensure tight fit. Bushing can be bonded to the g10. match drill plate to crown.

shear



Mark Smith

From: Peter Titus
Sent: Thursday, May 26, 2011 2:51 PM
To: Mark Smith
Cc: Lawrence E. Dudek; James H. Chrzanowski; Ali Zolfaghari
Subject: RE: lid umbrella attachment/Collar friction Joint

- Let me get this straight: you match drill from your metal rim into the G-10. The bushing would be oversize so that the bolt isn't loaded in shear. Then you tension the bolt as much as allowed and take the torque in combined friction and shear at the bushings? - I think Danny looked at vertical pins - they weren't good because they were essentially cantelevered from the metal rim into the G-10, they saw a moment and the shear translated to nasty compressions - If the idea is to use this as a redundant feature and still take the load as frictional shear, That sounds OK, but I think we are getting into Jim's territory. -Peter

From: Mark Smith
Sent: Thu 5/26/2011 2:27 PM
To: Peter Titus
Cc: Lawrence E. Dudek; James H. Chrzanowski
Subject: RE: lid umbrella attachment/Collar friction Joint

Hey Pete.

What about match drilling the bolt plate and the crown?
Larry mentioned using shoulder bolts and drill bushings to carry the shear.
The metal insert into the crown (i.e. the tapped hole) would then just hold the shoulder bolt.
The bolts could be still be preloaded within capacity, 2/3 yield.
However, the friction would be providing margin since the load is carried via the shoulder bolts.

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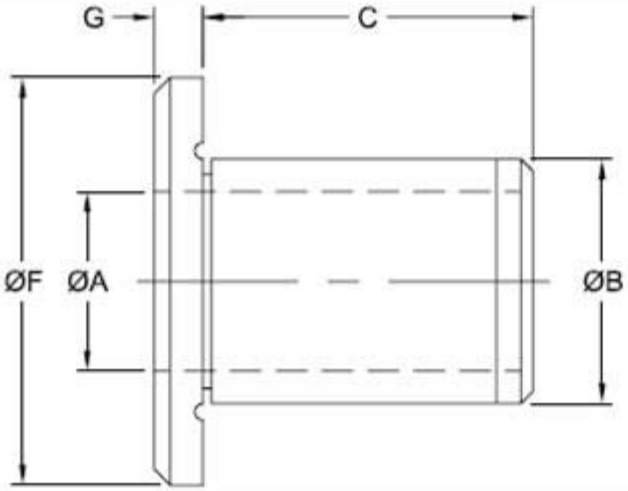

Inner Dia (in.)	Outside Dia (in.)	Available Length Under the Head									
A	B	C									
		5/16	3/8	1/2	3/4	1	1-3/8	1-3/4	2-1/8	2-1/2	3
5/16	1/2	Y	Y	Y	Y	Y	Y				
1/2	3/4	Y	Y	Y	Y	Y	Y	Y	Y		
3/4	1			Y	Y	Y	Y	Y	Y	Y	Y
1	1-3/8			Y	Y	Y	Y	Y	Y	Y	Y
1-3/8	1-3/4				Y	Y	Y	Y	Y	Y	Y
1-3/4	2-1/4				Y	Y	Y	Y	Y	Y	Y
2-1/4	2-3/4				Y	Y	Y	Y	Y	Y	Y

Technical Data - ANSI Head Liners Dimensions								
Body OD(in.)		1/2	3/4	1	1-3/8	1-3/4	2-1/4	2-3/4
Head	Thick(F)	3/32	3/32	1/8	1/8	3/16	3/16	3/16
Head	Dia(G)	5/8	7/8	1-1/8	1-1/2	1-7/8	2-3/8	2-7/8

Mark Smith

From: Peter Titus
Sent: Thursday, May 26, 2011 2:09 PM

To: Mark Smith; Ali Zolfaghari
Cc: James H. Chrzanowski; Lawrence E. Dudek; Phil Heitzenroeder
Subject: FW: lid umbrella attachment/Collar friction Joint

The G-10 friction report would qualify mu=.45 but based on the criteria we should use .3 (see Below) The enhanced grip materials look like you could go above mu=.5 and an allowed of .35 or maybe a bit better.

We have specified 9000 lbs per flag as the torque load - actually it is 7000 and change plus an allowance for halo loads - which don't load the upper crown. - If we use 18 bolts loaded to the 50 kip preload, and a friction factor of .3 then this is 15,000 shear capacity, when we need 14000 to 18000. The yield of 718 is 150 ksi.
Our criteria says use a preload of 75% of yield. - not 90% - so If we specified .75* yield as preload,The stress area for the 3/4 bolts is .3340 sq.in. That would be 37 kips for 3/4 bolts or 150*.75**.46 = 51 kips for 7/8 in bolts if they fit. The insert might need to be slightly larger for 7/8 bolts. but it looks like they will fit. - so we need to take credit for the torque without halo loading - or increase the friction factor with a special interface. These were being investigated when we were still looking for a solution. Phil Heitzenroeder provided some info on the materials that were investigated for NCSX.

If we rely on friction I would like to have a belleville stack under the bolts to ensure G-10 creep doesn't relax the preload.

I see Ali was more concise - use 7/8 bolts and improve the friction factor.

I still prefer castellations - or better a combination of friction and castellations -Peter

From the Criteria:

manner. Unlike stress, in some cases it is conservative to permit a coefficient of friction

higher than the average measured value and, in some cases, lower than the measured

value. The guidelines are:

$amin = a - 0.15 \text{ but} \geq 0.02$

$amax = a + 0.15$

Friction values outside the range 0.1-0.4 require exceptional justification. The case of

friction coefficient extremes must be considered as anticipated upset conditions in the

design.

From: Lawrence E. Dudek
Sent: Fri 2/18/2011 4:11 PM
To: Peter Titus
Cc: Mark Smith; Ali Zolfaghari; Phil Heitzenroeder
Subject: Re: lid umbrella attachment/Collar friction Joint

For NCSX we did tests of G10 on sandblasted SS and got results around 0.45 mu. See attached.
Larry