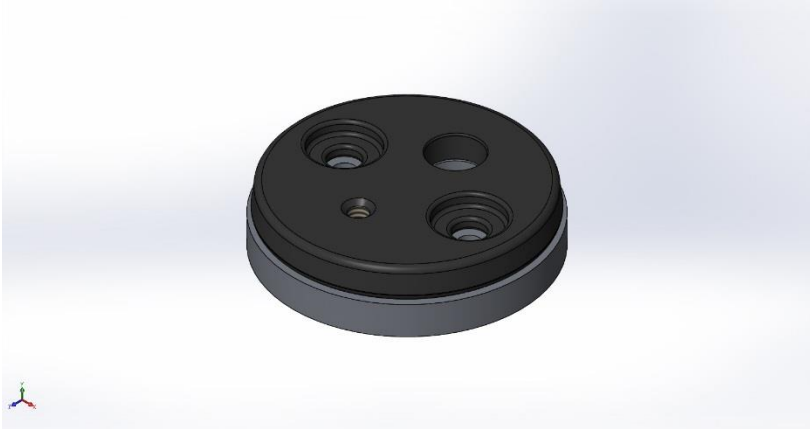




Simulation of Piston Cup Retainer

Date: Friday, May 10, 2019
Designer: Justin Palmer
Study name: Screw Clamp Load - 5 in-lb
Analysis type: Static

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Description

A linear, static FEA of the 2105 piston cup retainer when #2-56 cup retainer screws are installed and torqued to 5 in-lb.

Assumptions

Comments:

The model is assumed to behave statically with only a clamping load applied due to the installation of the #2-56 retainer screws.

The connecting rod has been replaced with a simplified rod pan geometry. The cup retainer has been simplified to remove the sealing bead on the bottom of the retainer and to remove the valve coining surface and debris traps. The piston cup has been removed (due to unknown material properties) and the flat bottom of the cup retainer has been fixed directly to the simplified rod pan.

The material of both the simplified rod pan and the simplified cup retainer are AZ91D magnesium, which is assumed to obey Hooke's Law.

Model Information

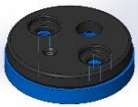


Model name: 637080-FEA
Current Configuration: Default

Solid Bodies

Document Name and Reference	Treated As	Volumetric Properties	Document Path/Date Modified
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<637080-CAST>-<Split Line2>	Solid Body	Mass:0.00253607 lb Volume:0.0387835 in ³ Density:0.0653904 lb/in ³ Weight:0.00253435 lbf	C:\SWPDM\GDT\Solidworks\User Files\2110-(POC1)\2110 REFRESH\637080.SLDPRT May 10 08:03:49 2019
Tap Drill for #2-56 Tap1 	Solid Body	Mass:0.00325863 lb Volume:0.0498335 in ³ Density:0.0653904 lb/in ³ Weight:0.00325642 lbf	C:\Users\jrp1031\AppData\Local\Temp\swx4772\VC~~\637080-FEA\ROD PAN SIMPLIFIED^637080-FEA.sldprt May 10 09:25:54 2019

Study Properties

Study name	Screw Clamp Load - 5 in-lb
Analysis type	Static
Mesh type	Solid Mesh
Thermal Effect:	On
Thermal option	Include temperature loads
Zero strain temperature	77 Fahrenheit
Include fluid pressure effects from SOLIDWORKS Flow Simulation	Off
Solver type	Direct sparse solver
Inplane Effect:	Off
Soft Spring:	Off
Inertial Relief:	Off
Incompatible bonding options	Automatic
Large displacement	On
Compute free body forces	Off
Friction	Off
Use Adaptive Method:	Off
Result folder	SOLIDWORKS document (C:\SWPDM\GDT\Solidworks\User Files\2110-(POC1)\2110 REFRESH)



Units

Unit system:	English (IPS)
Length/Displacement	in
Temperature	Fahrenheit
Angular velocity	Hertz
Pressure/Stress	psi

Material Properties

Model Reference	Properties	Components
	Name: AZ91D Model type: Linear Elastic Isotropic Default failure criterion: Unknown Yield strength: 23206 psi Tensile strength: 33358.7 psi Elastic modulus: 6.5267e+06 psi Poisson's ratio: 0.35 Mass density: 0.0653904 lb/in^3 Thermal expansion coefficient: /Fahrenheit	SolidBody 1(<637080-CAST>-<Split Line2>)(637080-1), SolidBody 1(Tap Drill for #2-56 Tap1)(ROD PAN SIMPLIFIED^637080-FEA-1)
Curve Data:N/A		



Loads and Fixtures

Fixture name	Fixture Image	Fixture Details
Fixed-1		Entities: 1 face(s) Type: Fixed Geometry

Resultant Forces				
Components	X	Y	Z	Resultant
Reaction force(lbf)	-0.00251406	-0.00204532	0.0065356	0.00729506
Reaction Moment(lbf.in)	0	0	0	0



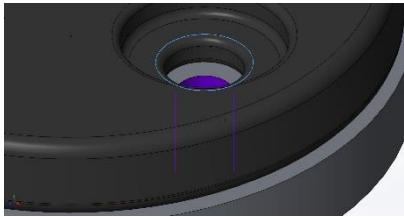
Connector Definitions

Pin/Bolt/Bearing Connector

Model Reference	Connector Details	Strength Details
 Countersink Screw-1	Entities: 1 edge(s), 1 face(s) Type: Bolt(Head/Nut diameter)(Counterbore screw) Head diameter: 0.164 in Nominal shank diameter: 0.086 Preload (Torque): 5 Young's modulus: 2.1e+11 Poisson's ratio: 0.28 Preload units: lbf.in	No Data

Connector Forces

Type	X-Component	Y-Component	Z-Component	Resultant
Axial Force (lbf)	0.34408	260.08	0.024997	260.08
Shear Force (lbf)	-50.514	0.066854	-0.25786	50.515
Bending moment (lbf.in)	0.17856	0.00043161	-6.9524	6.9547

 Countersink Screw-2	Entities: 1 edge(s), 1 face(s) Type: Bolt(Head/Nut diameter)(Counterbore screw) Head diameter: 0.164 in Nominal shank diameter: 0.086 Preload (Torque): 5 Young's modulus: 2.1e+11 Poisson's ratio: 0.28 Preload units: lbf.in	No Data
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Connector Forces

Type	X-Component	Y-Component	Z-Component	Resultant
Axial Force (lbf)	-0.33497	259.29	0.022863	259.29
Shear Force (lbf)	50.684	0.065509	-0.38886	50.685
Bending moment (lbf.in)	0.17857	-0.00037902	6.919	6.9213

Comments:

Connector is simulating standard #2-56 button head screws torqued to 5 in-lb.



Contact Information

Contact	Contact Image	Contact Properties
Global Contact		Type: No penetration (Surface to surface) Components: 1 component(s)

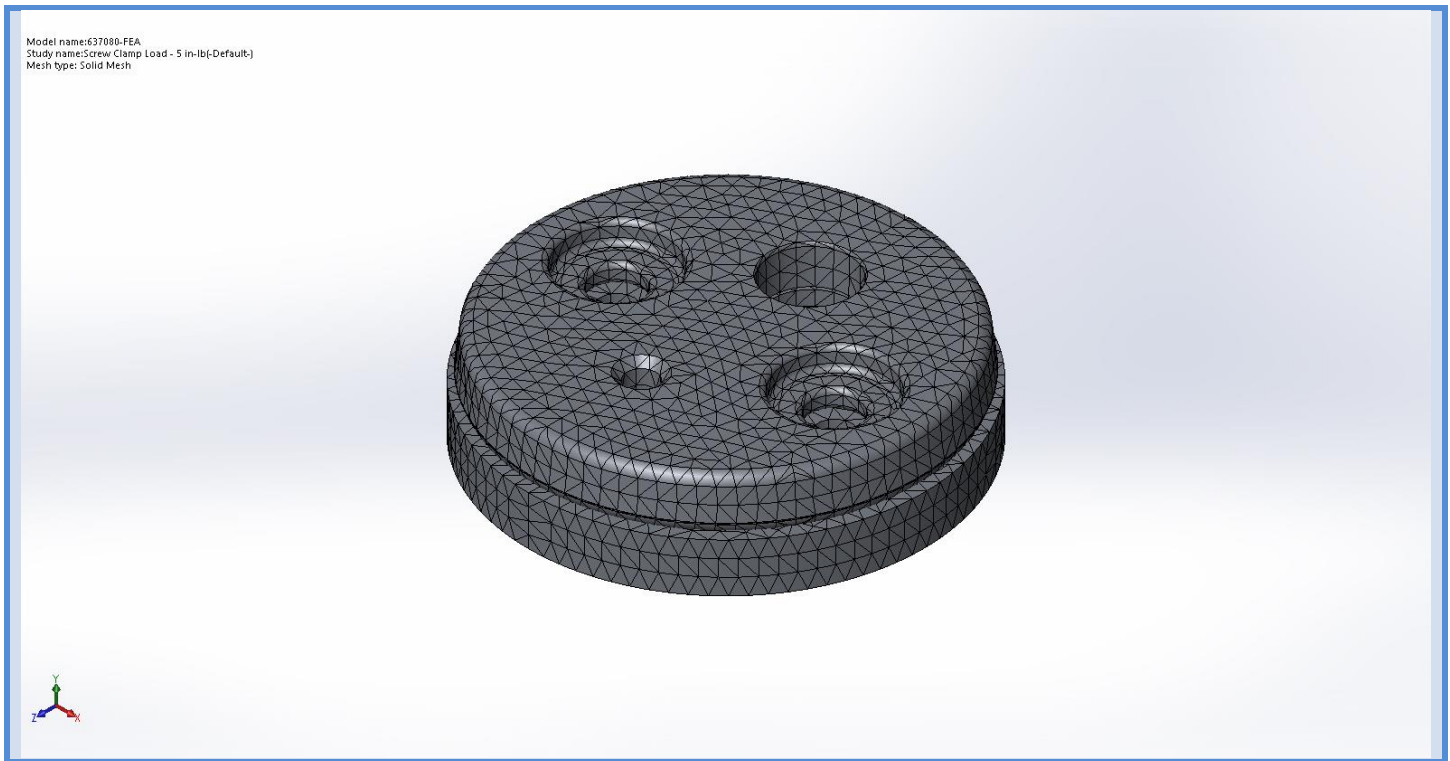
Mesh information

Mesh type	Solid Mesh
Mesher Used:	Standard mesh
Automatic Transition:	Off
Include Mesh Auto Loops:	Off
Jacobian points	4 Points
Element Size	0.03 in
Tolerance	0.0015 in
Mesh Quality Plot	High
Remesh failed parts with incompatible mesh	Off

Mesh information - Details

Total Nodes	46072
Total Elements	29007
Maximum Aspect Ratio	16.727
% of elements with Aspect Ratio < 3	96
% of elements with Aspect Ratio > 10	1.36
% of distorted elements(Jacobian)	0
Time to complete mesh(hh:mm:ss):	00:00:03
Computer name:	SHEWS-14022





Resultant Forces

Reaction forces

Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Model	lbf	-0.00251406	-0.00204532	0.0065356	0.00729506

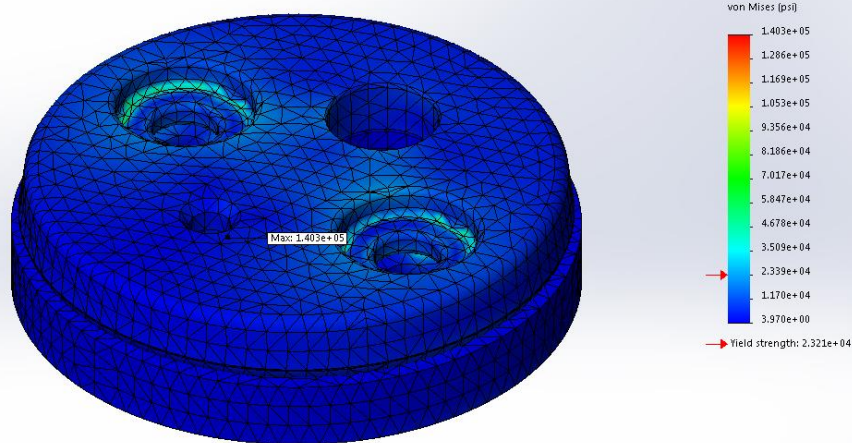
Reaction Moments

Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Model	lbf.in	0	0	0	0

Study Results

Name	Type	Min	Max
Stress1	VON: von Mises Stress	3.970e+00 psi Node: 41973	1.403e+05 psi Node: 43480

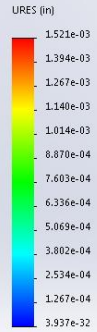
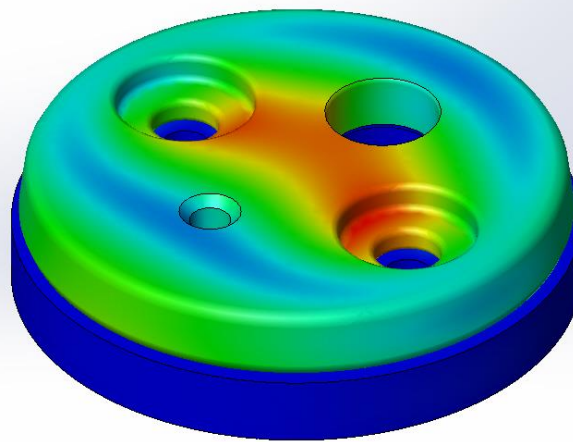
Model name: 637080-FEA
Study name: Screw Clamp Load - 5 in-lb-Default-
Plot type: Static nodal stress Stress1
Deformation scale: 1
Global value: 3.97047 to 140334 psi



637080-FEA-Screw Clamp Load - 5 in-lb-Stress-Stress1

Name	Type	Min	Max
Displacement1	URES: Resultant Displacement	0.000e+00 in Node: 24376	1.521e-03 in Node: 56

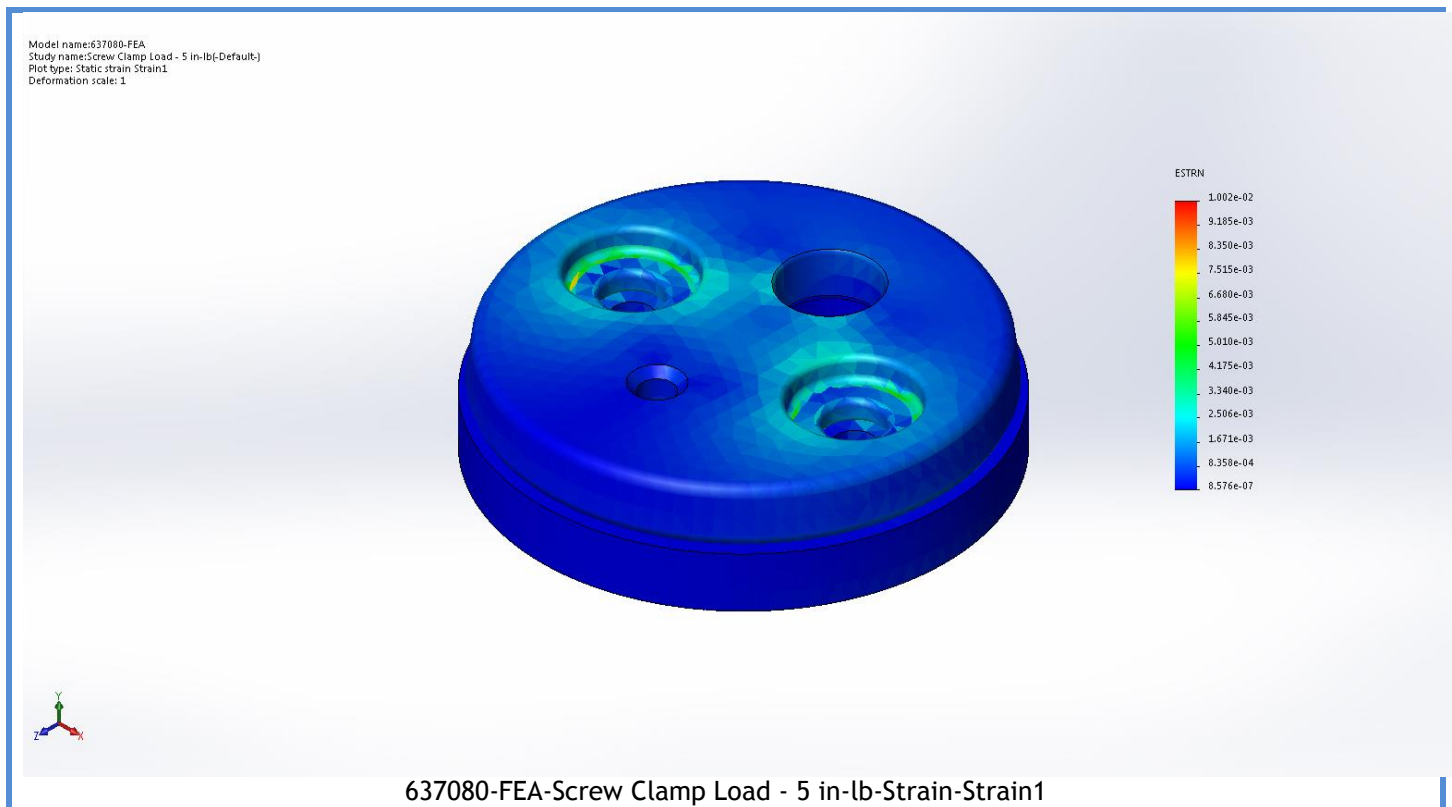
Model name: 637080-FEA
Study name: Screw Clamp Load - 5 in-lb (-Default-)
Plot type: Static displacement Displacement1
Deformation scale: 1



637080-FEA-Screw Clamp Load - 5 in-lb-Displacement-Displacement1

Name	Type	Min	Max
Strain1	ESTRN: Equivalent Strain	8.576e-07 Element: 20348	1.002e-02 Element: 24589





Conclusion

Comments:

With a 5 in-lb torque load applied to each #2-56 screw, the maximum deflection in the retainer is 0.0015, which is likely higher than reality due to the fixed geometry between the retainer and the rod pan.

The part is acceptable as-is and requires no further modifications.