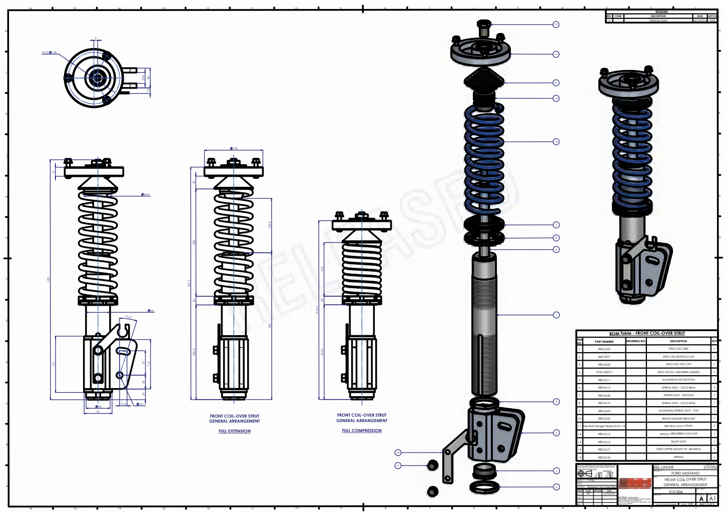
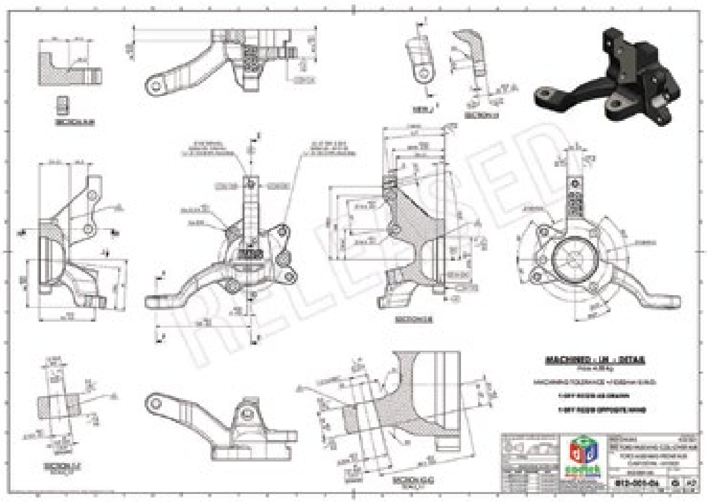
Engineering Information

Component Information

RRS PTY LTD of Sydney Australia product information for the RRS HO2 Coil-over strut independent front suspension system for limited Ford & Mercury passengers vehicles.



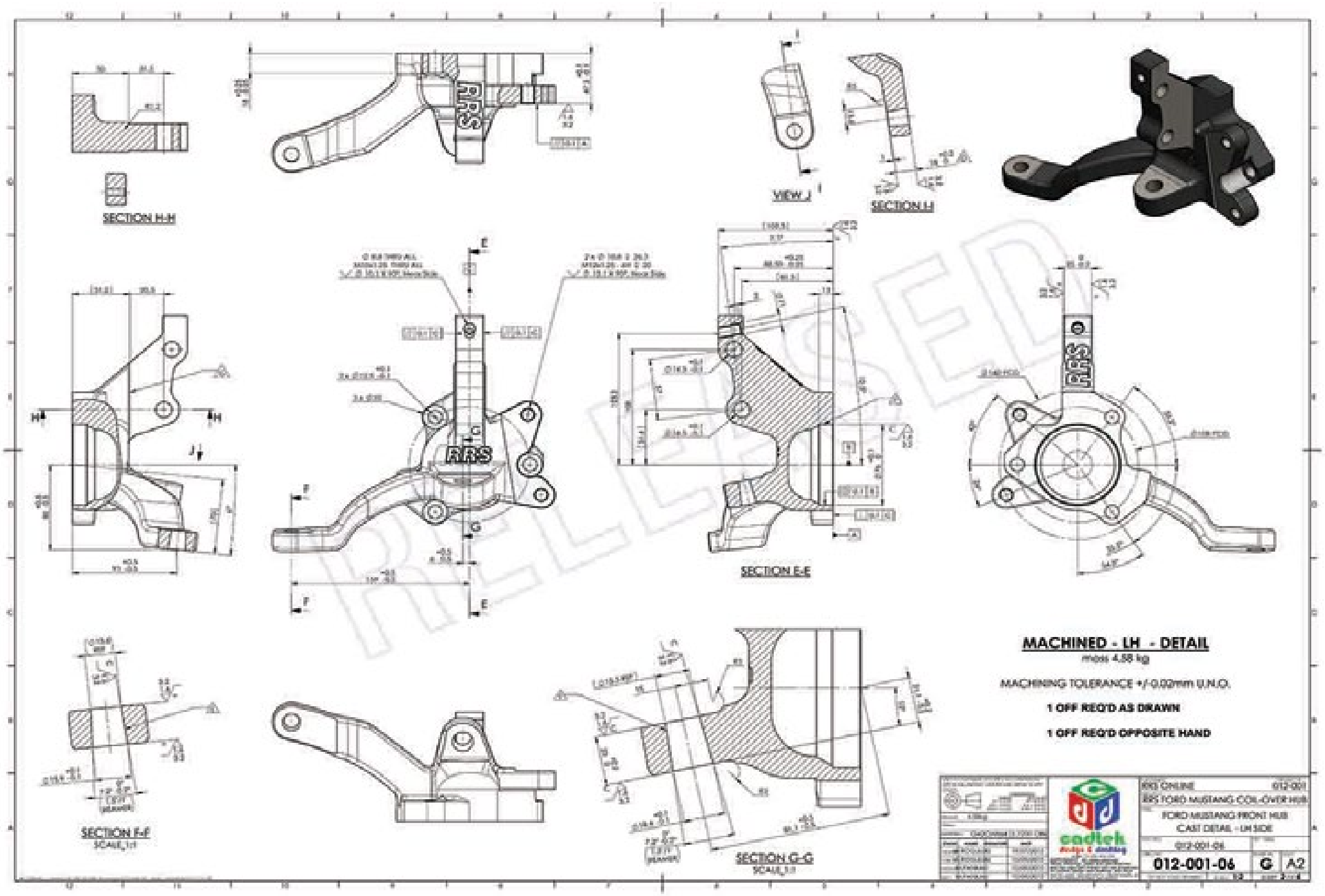


Contents

H.O.2

RRS "HO2" coil over strut and custom knuckle for selected Ford and Mercury passenger vehicles. The HO2 improves axis of inclination, reaction time, height adjustment, reduces unsprung weight, improves negative camber, increases safety margin, while maintaining factory pivot locations.

This document will prove fitting the HO2 is to approved models is compliant with LS3 and LS4 within the VSB14 2019.



RRS PTY LTD.
57/42-46 Wattle Road
Brookvale NSW 2100
Sydney Australia

Ph: 61 2 9907 3755
Mob 61 417 226 693
Email: alex@rrs-online.com

Throughout this document, RRS refers to the coil-over strut leg and custom knuckle as the HO2.
To prove the design concept and the stress loading RRS has had finite analysis conducted on the product, including the load-bearing capacity of the stub axle, the clevis, and top mount.
The simulations run through CADTEK PL (a certified FEA supplier).
RRS has compiled the manufacturer's data on the bearing hub axle, the top bearing, the thrust bearing, the shock absorber, and the spring.

The "HO2" mounts in the original shock tower location, the reduction in motion ratio from original suspension reduces stress on the shock tower and lower pivot points.

The data shows an increased load-bearing capacity of the front suspension from stock.

The Ford OEM design has spring rates 225% more than the vehicle front axle weight, because of the lever mounted spring, a typical 400lb per inch of travel the OEM spring has 1000lbs of pressure at 2½ inches of compression at the top of the tower and 500lbs of sheer load at
the upper control arm mounting point.
Dynamically this sheer load can vary between 250 lbs and 1750 lbs.

The RRS strut operates with spring rates 100% the same as vehicle front axle weight.
A typical RRS strut spring would be 250lbs per inch of travel. At 2inches of travel, this would exert 500lbs pressure to the upper part of the shock tower eliminating both static and dynamic loading to the middle of the tower.

The RRS strut incorporates a compression rubber rather than a bump stop, which further reduces impact shock transference to the chassis.

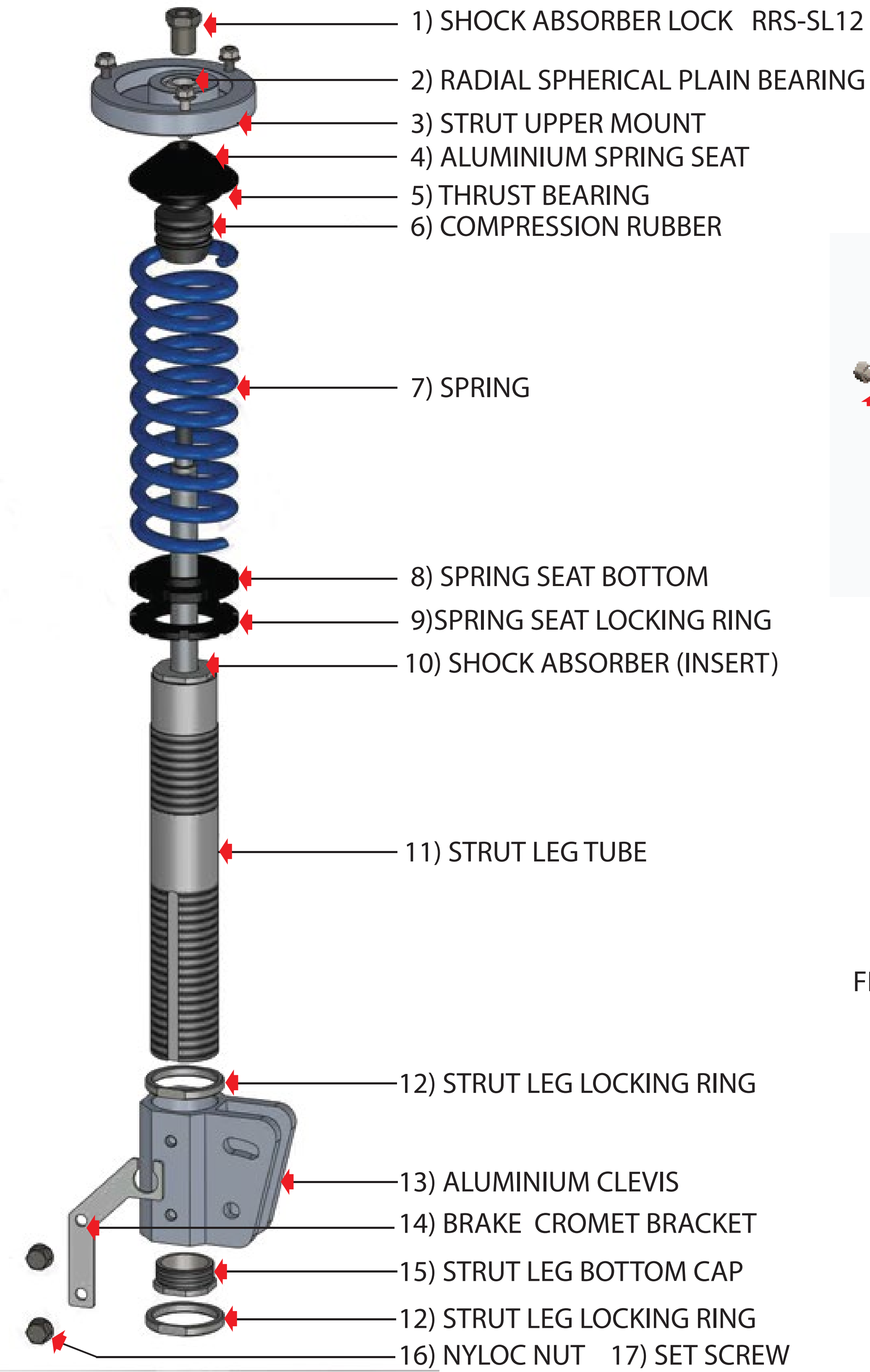
RRS PTY LTD.
57/42-46 Wattle Road
Brookvale NSW 2100
Sydney Australia

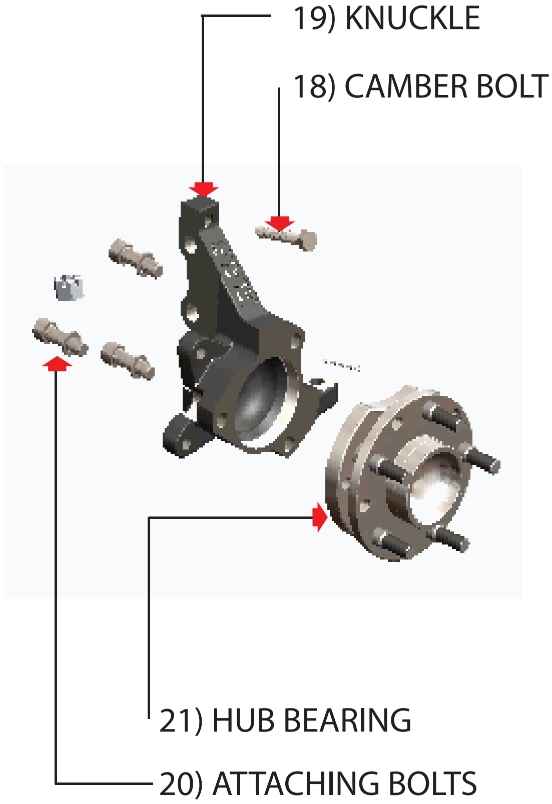
Ph: 61 2 9907 3755
Mob 61 417 226 693
Email: alex@rrs-online.com

H.O.2

Materials List

PART NUMBERS AND NAMES





RRS PARTS BREAKDOWN
FRONT COIL OVER STRUT KIT

For this document all parts will given prefix HO2-

RRS PTY LTD.
57/42-46 Wattle Road
Brookvale NSW 2100
Sydney Australia

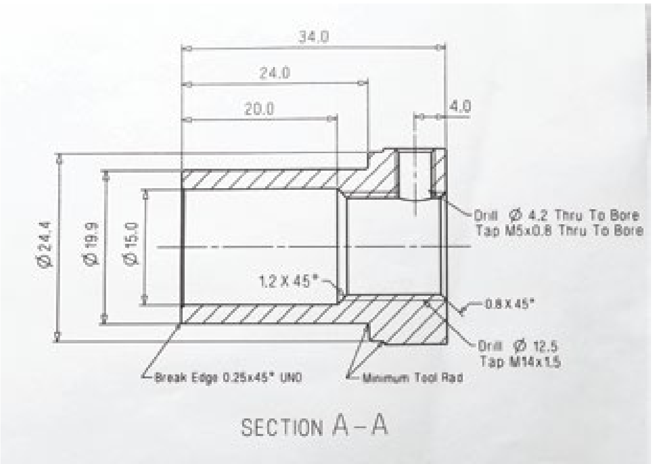
Ph: 61 2 9907 3755
Mob 61 417 226 693
Email: alex@rrs-online.com

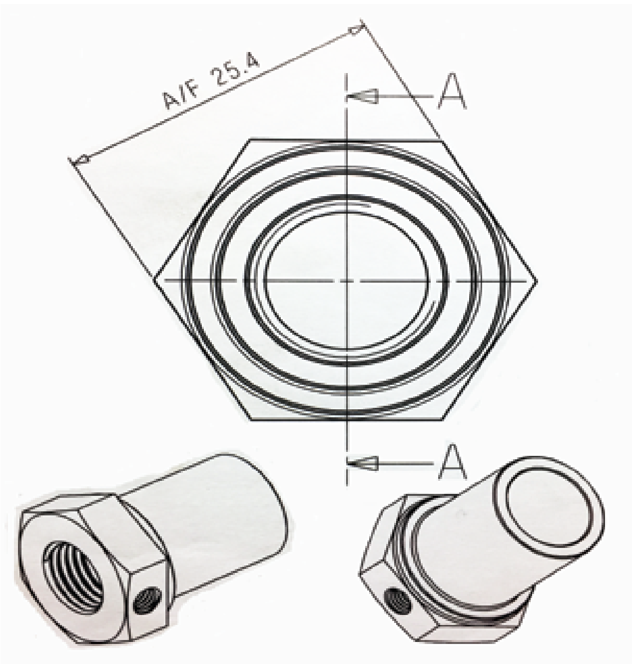
H.O.2

Materials List

HO2-1 Shock absorber lock nut

The shock absorber lock nut is constructed from K1045 medium carbon steel.
Uses a set screw with compression ball to secure the top of the shock absorber.



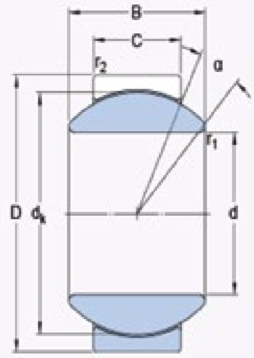


Function: Secure shock absorber to spherical bearing while maintaining access to shock absorber dial adjuster.

HO2-2. Top Bearing

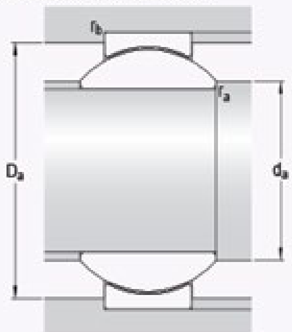
The top bearing is the SKF GEH20C
(see attached data sheet for load & dimensions).

Dimensions



d		20	mm
D		42	mm
B		25	mm
C		16	mm
α		17	°
d_k		35.5	mm
r_1	min.	0.3	mm
r_2	min.	0.6	mm

Abutment dimensions



d_a	min.	22.1	mm
d_a	max.	25.2	mm
D_a	min.	33.7	mm
D_a	max.	39.5	mm
r_a	max.	0.3	mm
r_b	max.	0.6	mm

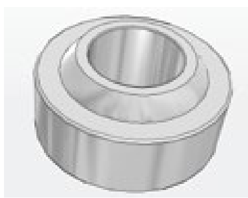
Calculation data

Basic dynamic load rating	C	51	kN
Basic static load rating	C_0	127	kN
Specific dynamic load factor	K	100	N/mm²
Specific static load factor	K_0	250	N/mm²
Material constant	K_M	1400	

Mass

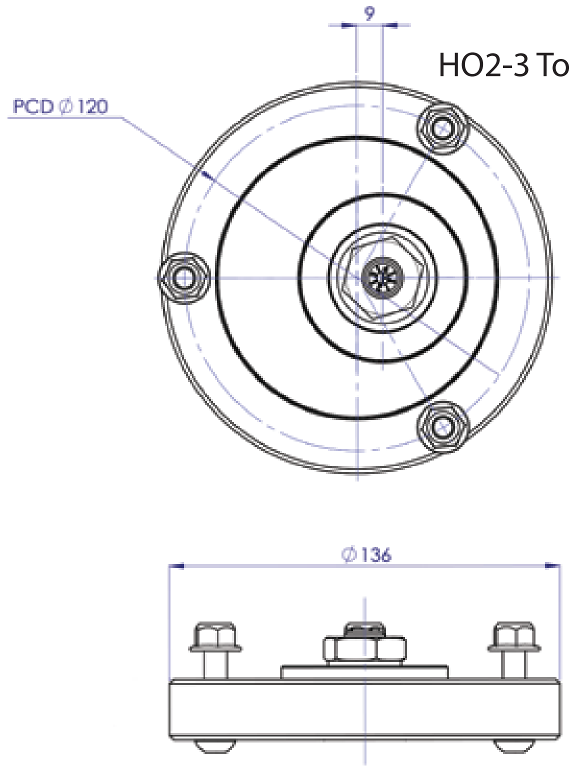
Mass plain bearing	0.16	kg

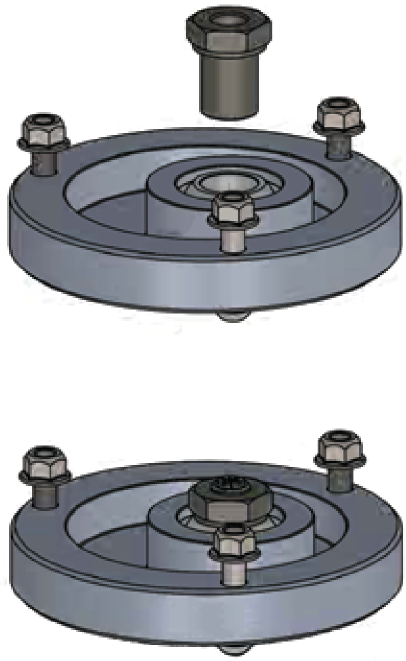
Function: Allow roll of shock absorber while maintaining tower position.



Materials List

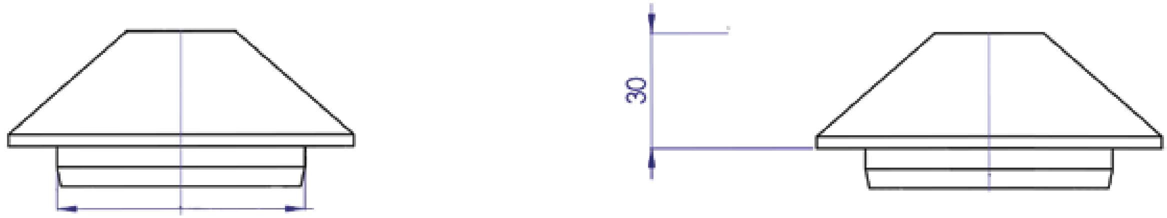
HO2-3 Top Bearing mount and nut





The HO2-3 billet top is constructed from 6061 alluminium custom CNC milled for RRS.

HO2-4 Aluminium spring seat



The HO2-4 billet top spring seat is constructed from 6061 alluminium custom CNC milled for RRS.
Function: locate the top of the spring to HO2-2.

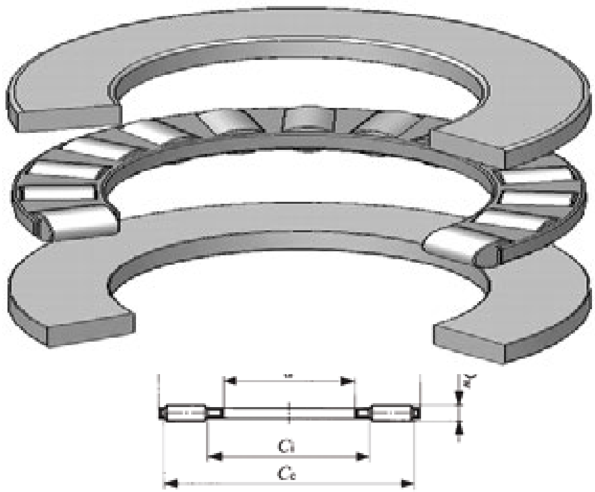
RRS PTY LTD.
57/42-46 Wattle Road
Brookvale NSW 2100
Sydney Australia

Ph: 61 2 9907 3755
Mob 61 417 226 693
Email: alex@rrs-online.com

H.O.2

Materials List

HO2-5 Thrust bearing NTB 6590



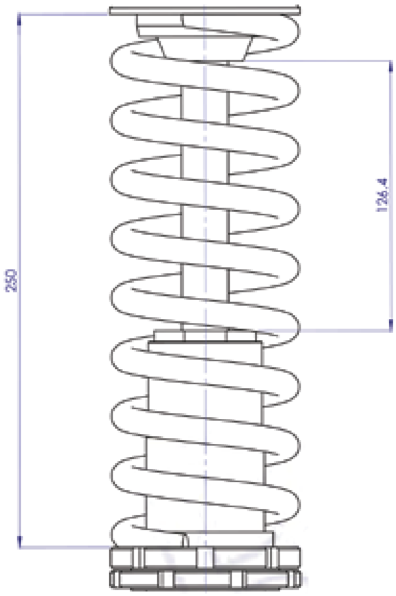
NTB

Shaft dia. mm	Identification number: Thrust needle roller bearing	Mass (Ref.) g	Thrust washer	Mass (Ref.) g	Inner ring	Outer ring	Mass (Ref.) g	Boundary dimensions mm: d	D	D_w	s	B	$r_{s\,min}$ (1)	C_i	C_e	Basic dynamic load rating C N	Basic static load rating C_0 N	Allowable rotational speed(2) rpm
65	NTB 6590	41.5	AS 6590	23.5	WS 6590	GS 6590	124	65	90	3	1	5.25	1	71	87	40 100	237 000	3 000

HO2-6 Compression rubber

Compression rubbers from KYB BSK005

Function: Bump stop & secondary dampener.

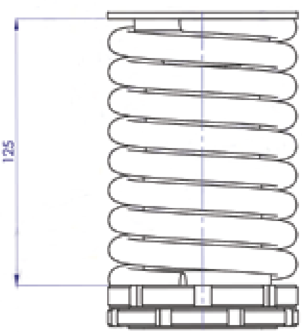


FRONT COIL-OVER STRUT GENERAL ARRANGEMENT

FULL EXTENSION

HO2-7 Spring

Spring is lovells -cold formed chrome silicon wire spring. Spring ratingt set per application.
The steel used is oil tempered wire, cold coiled and then stress relieved.

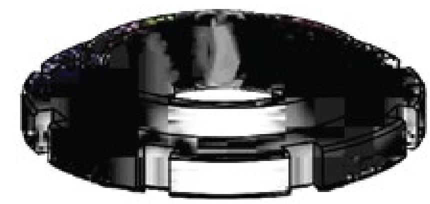


FRONT COIL-OVER STRUT GENERAL ARRANGEMENT

FULL COMPRESSION

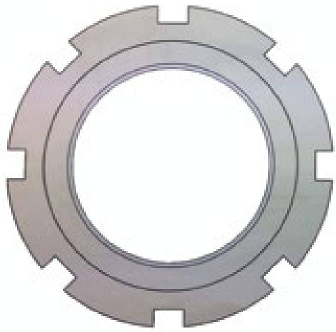
Materials List

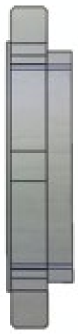
HO2-8 Spring bottom seat



The spring seat bottom is machined from 6061 aluminium.

Function: Hold base of the spring, can be adjusted for spring tension.

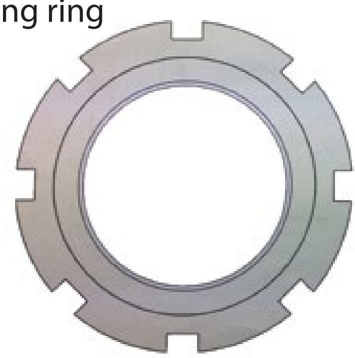


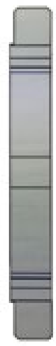


HO2-9 Spring seat locking ring

The spring seat locking ring is machined from 6061 aluminium.

Function: Lock HO2-8 in place.





HO2-10 Shock absorber

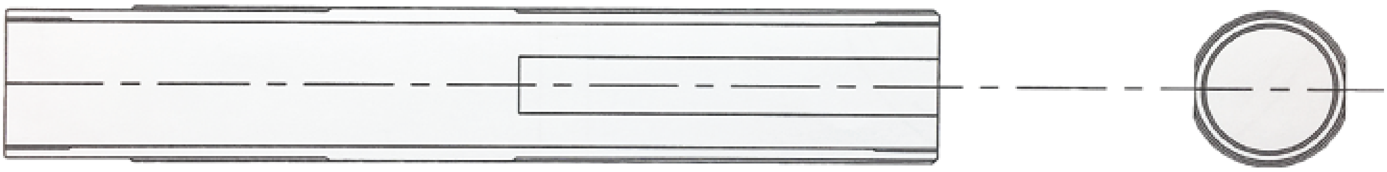
RRS uses KYB AGX 765017 shock absorbers.
KYB cylinders are extruded, sintered iron pistons, multi lip seals, with velocity sensitive valving.
Built to TS-3034.

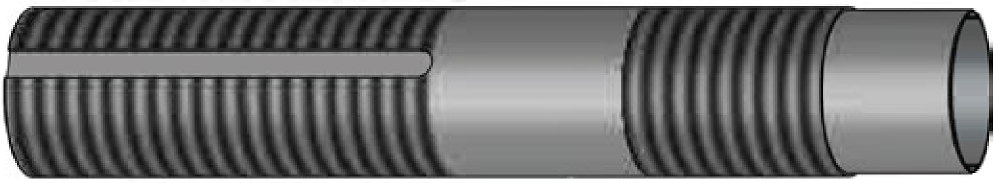
Function: Shock Absorber

Materials List

HO2-11 Strut leg tube

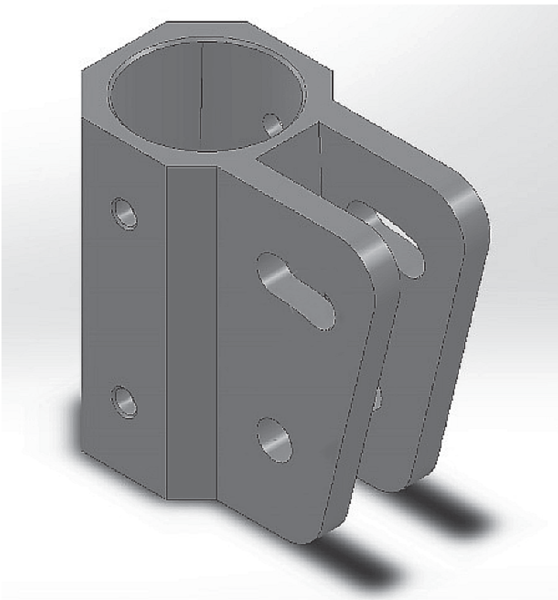
HO2-11 is CNC machined from MS steel tube with two threads machined and two lock nut channels.





HO2-12 Strut leg tube

HO2-12 is CNC machined from 6061 aluminium, it is used to secure HO2-13 in place.



HO2-13 clevis mount

HO2-13 is CNC machined from 6061 aluminium, it is used to secure HO2-13 in place.
A detailed study of stress loading is attached.
See attached RRS SL11

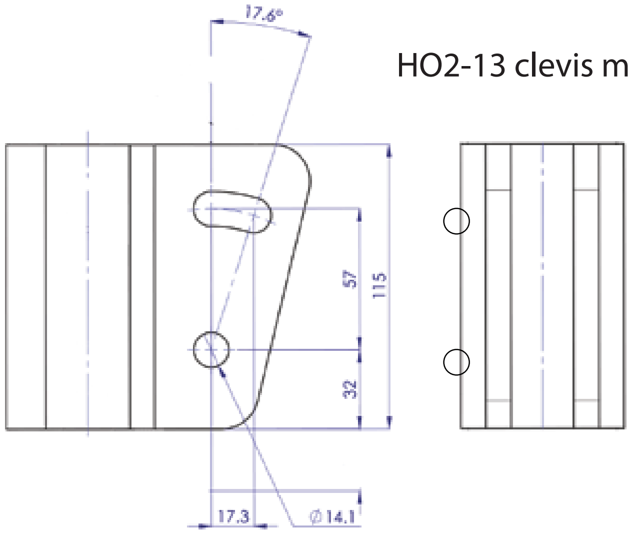
Function to secure HO2-18 & 19 to strut leg while allowing for camber variation.

RRS PTY LTD.
57/42-46 Wattle Road
Brookvale NSW 2100
Sydney Australia

Ph: 61 2 9907 3755
Mob 61 417 226 693
Email: alex@rrs-online.com

Materials List

HO2-13 clevis mount



Simulation of RRS-SL11

Date: Tuesday, 13 December 2016
Designer: W. ROGULSKI
Study name: SimulationXpress Study
Analysis type: Static

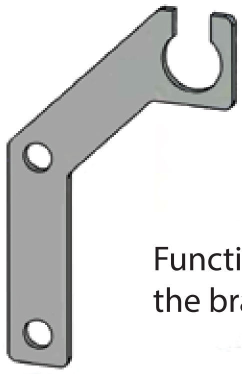
Table of Contents

Description

RRS-ONLINE
Application: FORD MUSTANG
Location: FRONT COIL-OVER STRUT
Part: CLEVIS BRACKET

SOLIDWORKS Analyzed with SOLIDWORKS Simulation — Simulation of RRS-SL11 1

HO2-14 Brake gromet bracket

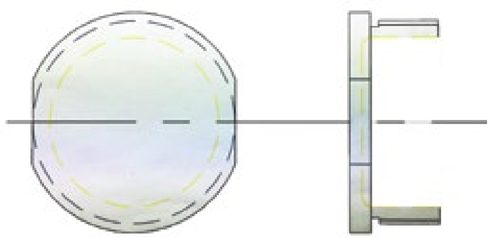


HO2-14 is made from 2mm metal

Function: To position the brake hose.

HO2-15 Strut leg Cap

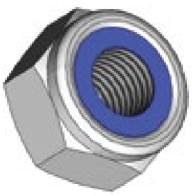
HO2-15 is machined from K1045 Medium Carbon steel
Function: to support the base of the shock absorber insert.



HO2-17 set screw

Set screw
20.3x 9.9mm
class 8.8
Function to hold HO2-13 in place once height is set

HO2-16) Nyloc nut



Nyloc nut
12.6 x 8.7mm
class 8.8
Function to lock HO2-17 in place

HO2-18) Camber bolt

Hex bolt
55 x 10mm
class 8.8

Function to set camber angle.

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57/42-46 Wattle Road
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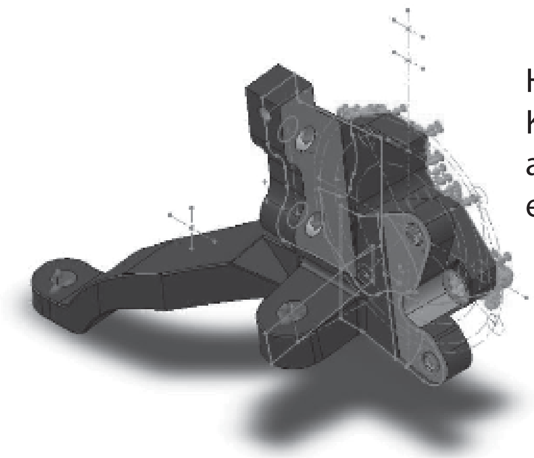
Sydney Australia

Ph: 61 2 9907 3755
Mob 61 417 226 693
Email: alex@rrs-online.com

H.O. 2

STRESS ANALYSIS OF RRS FRONT WHEEL HUB

Materials List



HO2-18) The RRS custom Knuckle, has a finite analysis attached to prove exceed OEM load capacities


Simulation of 012 - 001 -01

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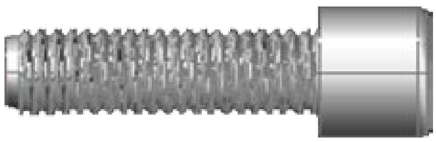
Description 1
Assumptions 2
Model Information 2
Material Properties 3
Loads and Fixtures 4
Mesh information 6
Study Results 8
Conclusion 11

Description
RRS-ONLINE
FORD MUSTANG FRONT WHEEL HUB

CAST IRON VERSION

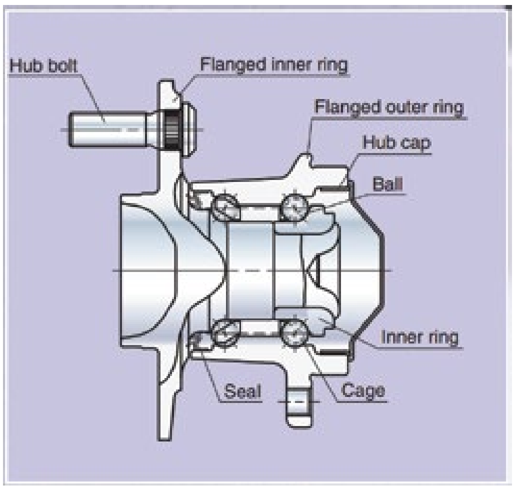
BASELINE SETTING

SOLIDWORKS



HO2-19) The RRS custom knuckle is attached to the bearing hub with three socket head 12.9 bolts 11.85mm x 33.39mm

Property Class	Nominal Size Range (mm)	Proof Strength (MPa)	Yield Strength, min(MPa)	Tensile Strength, min(MPa)	Material
12.9	1.6-100	970	1100	1220	Alloy steel, quenched and tempered



HO2-20) Hub bearing is a NSK 55BWKHO1T (92115770) found on many passenger vehicles (eg Holden Commodore/Calais) with a GVM of +1880kg stock tyres P275/30R20.
This hub bearing has 35%+ higher load capacity than Ford/Mercury stock.

H.O. 2 Testing

Ray Cross and Associates

Consultant Mechanical & Automotive Engineer (M.I.E. Aust.) ABN 50 078 280 458
Autotech Enterprises Pty. Ltd. T/A Ray Cross & Associates ACN 0789 280 458

83 MckenzieRoad ELTHAM N.S.W. 2480
Telephone (02) 66291 439 Fax (02) 66291 451

29th April 2003

Mr Matthew Pankau
RRS Pty Ltd.
53/46 Wattle Rd
BROOKVALE -2100

As requested I hereby submit an evaluation and assessment of the RRS Pty Ltd Conversion Kit for early Ford vehicles for installation of upgraded front disc brakes and McPherson Strut type front suspension.
The kit has been extensively road and track tested by RRS and components subjected to quality tests by ETRS Test Laboratory.
A detailed report on steering and suspension seometry and performance is held by RRS.

SUITABLE VEHICLES :

It is proposed to fit the kit to the following vehicles:

Australian XK to XF Falcons, Fairlanes, Fairmounts, LTDs

USA 1965- 1973 Mustang 1967-1970 Cougars, Montegos, Rancheros, Sprints, Fairlanes 1970-1977 Maverick

CONVERSION KIT :

The Conversion Kit essentially consists of:

1. Suspension tower upper mounting plate with spherical bearing
2. 2 x Lovells coil springs (formerly Eibach)
3. 2 x KYB AGX front struts (formely modified Statesman)
4. RRS CNC machined from 6061 aluminium clevis (formely investment cast), LH / RH steering knuckes complete with hub bearings
5. Choice of 6 RRS brake packages (3 DBA brake callipers, RRS "Cobra" callipers, VTTR callipers) plus dog bone adaptors for Wilwood brake packages.

Note : The Kit to be installed as per RRS installation instructions
All fastners high tensile - ISO grade 8.8 or equivalent.
All tapers machined to match OEM ball joints.
Kit is constructed from all new components
No heating, bending or welding of any components required for installation.

RRS PTY LTD.
57/42-46 Wattle Road
Brookvale NSW 2100
Sydney Australia

Ph: 61 2 9907 3755
Mob 61 417 226 693
Email: alex@rrs-online.com

Testing

COMPLIANCE :

The conversion if installed as directed as directed in the RRS Installation Manual and fitted with rims approved by RRS meets the requirements of the following sections of the NSW code of practice for modified vehicles.

Section 3.3 - Brakes
Section 3.4 - Steering
Section 3.5 - Suspension

Note: Road testing and Brake testing of each modified vehicles by an Authorised Signatory required for Certification.
Check for correct installation by Authorised Signatory required at time of inspection.

FEATURES :

Makes a classic Ford muscle car and early Falcons handle and brake like a modern high performance vehicle.

Improved steering geometry - Produces a more accurate and responsive steering feel.
Suits modern radial type tyres.

Improved suspension geometry - Decreased un-sprung weight.
Decreased chassis stress and deflection.
More effective shock absorber dampening.

Readily adjustable vehicle ride height.

All suspension and steering operating clearances maintained or improved.

TESTING :

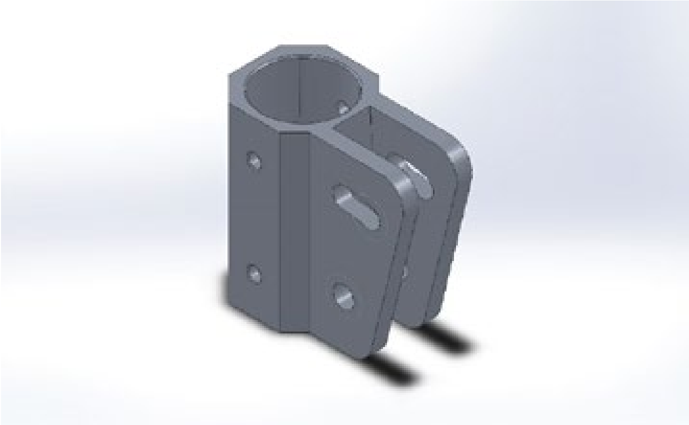
The conversion has been successfully and extensively road tested for improved handling, braking and reliability in a number of different vehicles and also track tested for performance under race conditions at Wakefield Raceway in a 1966 Mustang.
A summary of results held by RRS.

CONCLUSION :

The inspection and assessment shows the conversion kit is manufactured to sound engineering practice and to a high level of Quality Assurance.
I beleive the conversion is safe and offers considerable advantages in handling and braking and meets the requirements of the NSW RTA Code of Practice for modified vehicles.

R. C. CROSS

Stress Analysis



Simulation of RRS-SL11

Date: Tuesday, 13 December 2016
Designer: W. ROGULSKI
Study name: SimulationXpress Study
Analysis type: Static

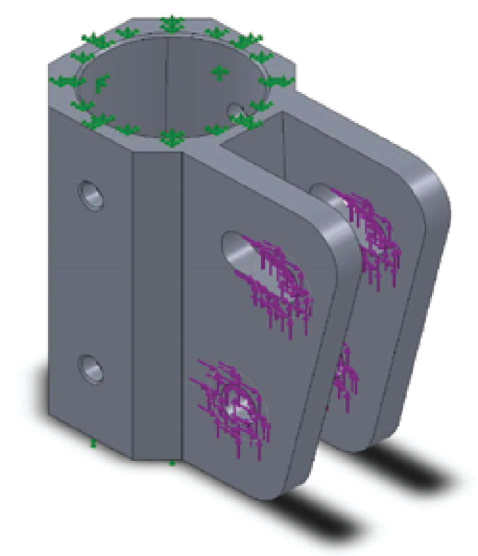
Table of Contents

Description

RRS-ONLINE
Application: FORD MUSTANG
Location: FRONT COIL-OVER STRUT
Part: CLEVIS BRACKET

Assumptions

Model Information



Model name: RRS-SL11
Current Configuration: FEA

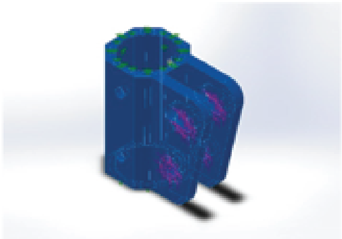
Solid Bodies

Document Name and Reference	Treated As	Volumetric Properties	Document Path/Date Modified
Split Line6 	Solid Body	Mass:0.764896 kg Volume:0.000283295 m^3 Density:2700 kg/m^3 Weight:7.49598 N	W:\CADtek\customers\012 RRS\012-006 Mustang front strut\RRS-SL11.SLDPRT Dec 13 19:44:38 2016

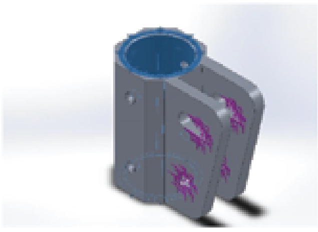
Stress Analysis

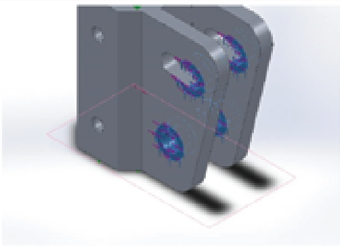
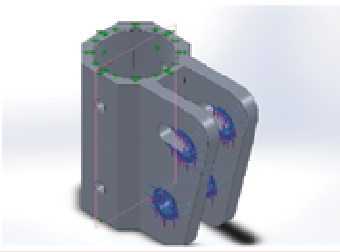
W. ROGULSKI
13/12/2016

Material Properties

Model Reference	Properties	Components
	Name: 6061-T6 (SS) Model type: Linear Elastic Isotropic Default failure criterion: Max von Mises Stress Yield strength: 2.75e+008 N/m^2 Tensile strength: 3.1e+008 N/m^2	SolidBody 1(Split Line6)(RRS-SL11)

Loads and Fixtures

Fixture name	Fixture Image	Fixture Details
Fixed-3		Entities: 3 face(s) Type: Fixed Geometry

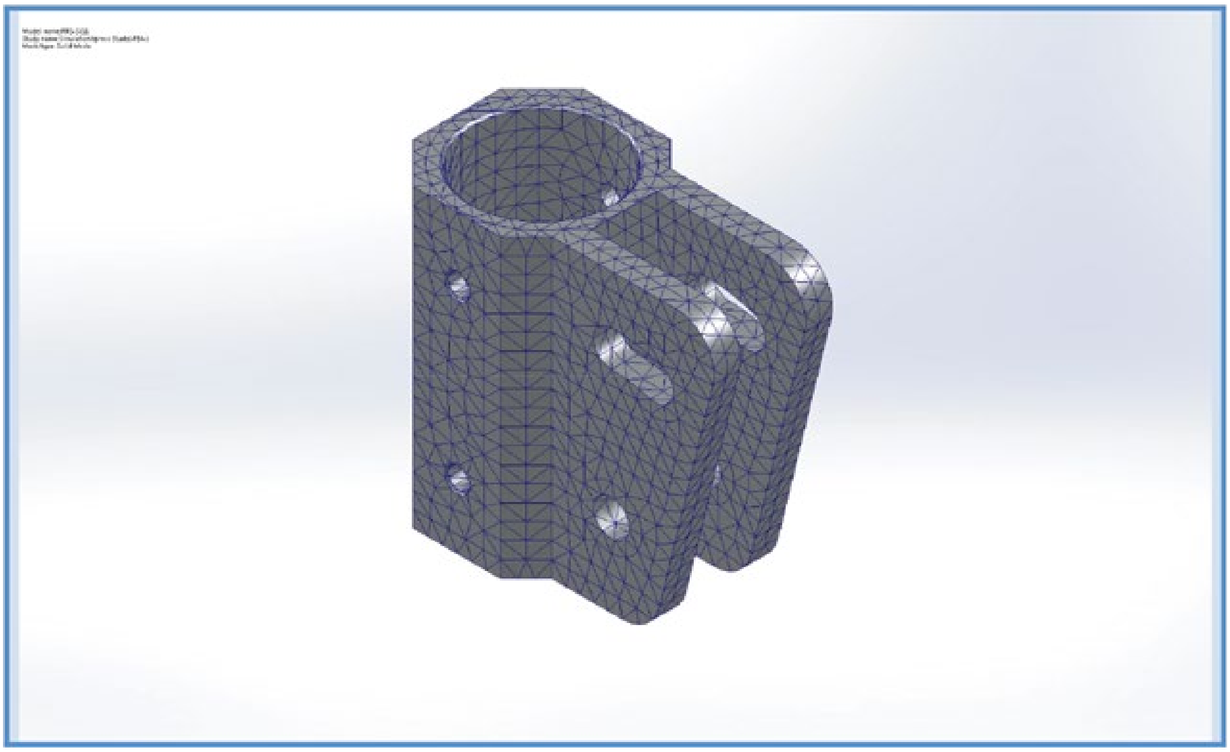
Load name	Load Image	Load Details
Force-3		Entities: 12 face(s), 1 plane(s) Reference: Top Plane Type: Apply force Values: ---, ---, 11662 N
Force-4		Entities: 12 face(s), 1 plane(s) Reference: Right Plane Type: Apply force Values: ---, ---, 83300 N

Mesh information

Mesh type	Solid Mesh
Mesher Used:	Standard mesh
Automatic Transition:	Off
Include Mesh Auto Loops:	Off
Jacobian points	4 Points
Element Size	6.56948 mm
Tolerance	0.328474 mm
Mesh Quality Plot	High

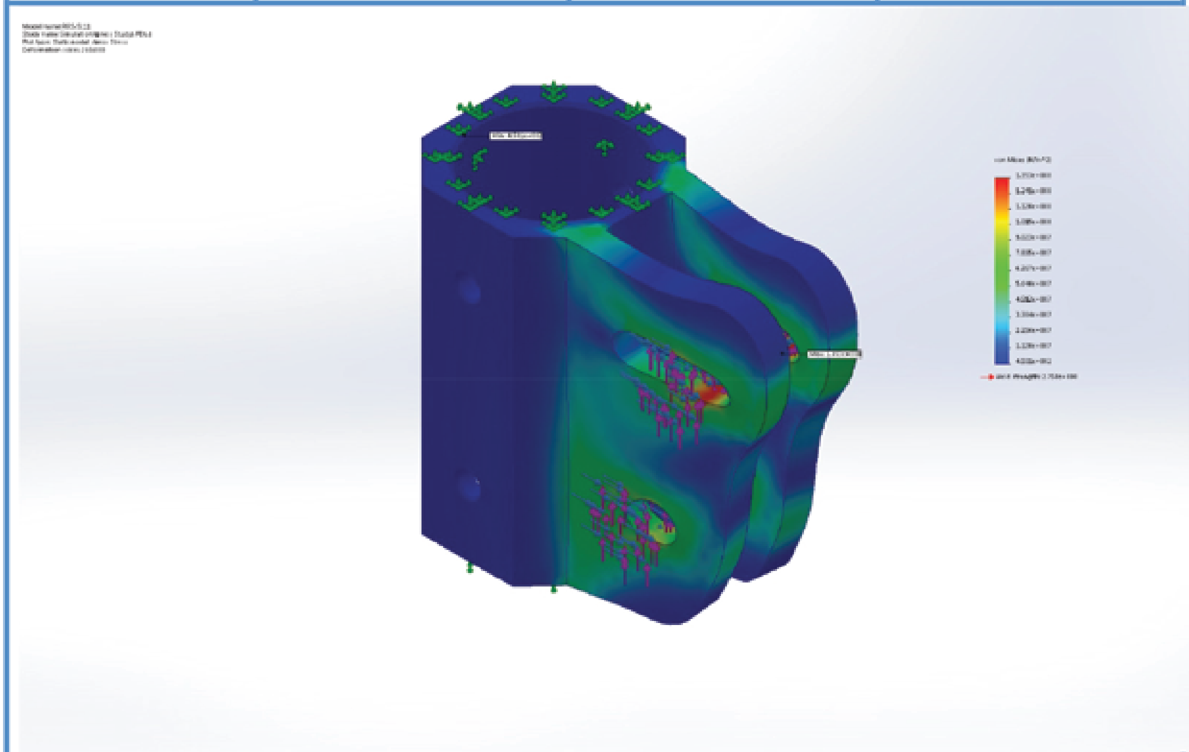
Mesh information - Details

Total Nodes	16649
Total Elements	9393
Maximum Aspect Ratio	11.603
% of elements with Aspect Ratio < 3	96
% of elements with Aspect Ratio > 10	0.0319
% of distorted elements(Jacobian)	0
Time to complete mesh(hh;mm;ss):	00:00:01
Computer name:	DUPA-JASIU



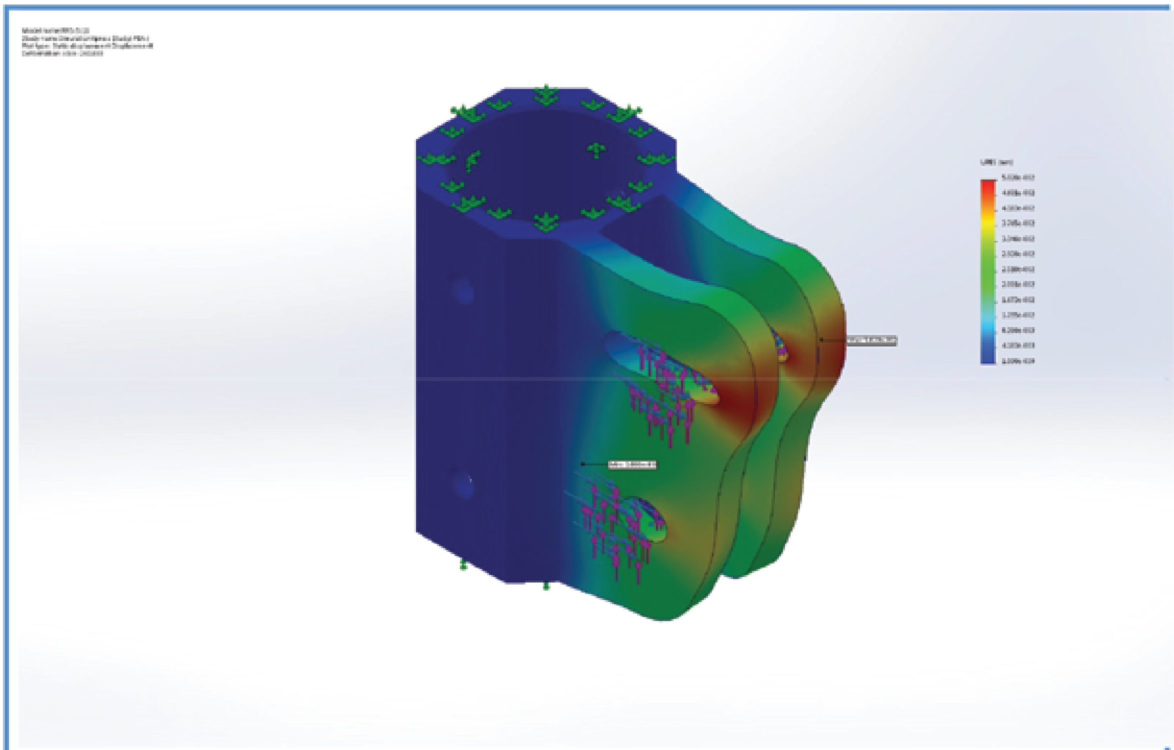
Study Results

Name	Type	Min	Max
Stress	VON: von Mises Stress	4.501e+002N/m^2 Node: 15567	1.353e+008N/m^2 Node: 7929



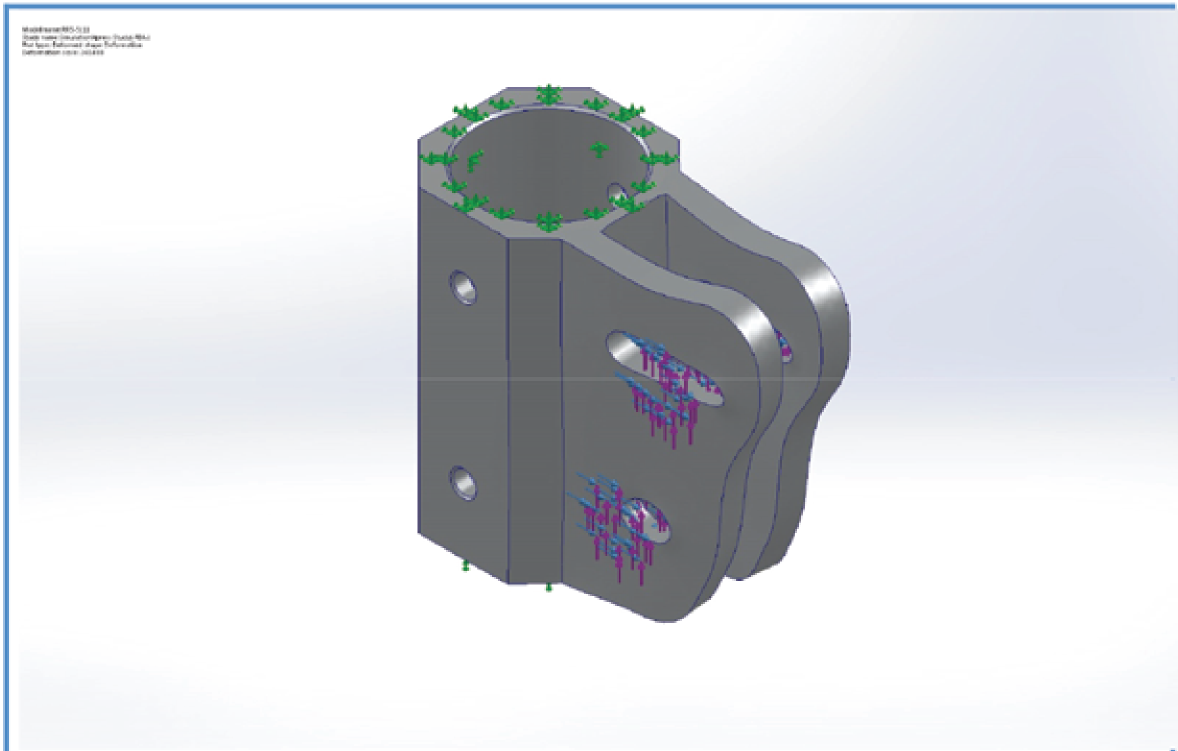
RRS-SL11-SimulationXpress Study-Stress-Stress

Name	Type	Min	Max
Displacement	URES: Resultant Displacement	0.000e+000mm Node: 15	5.020e-002mm Node: 15742



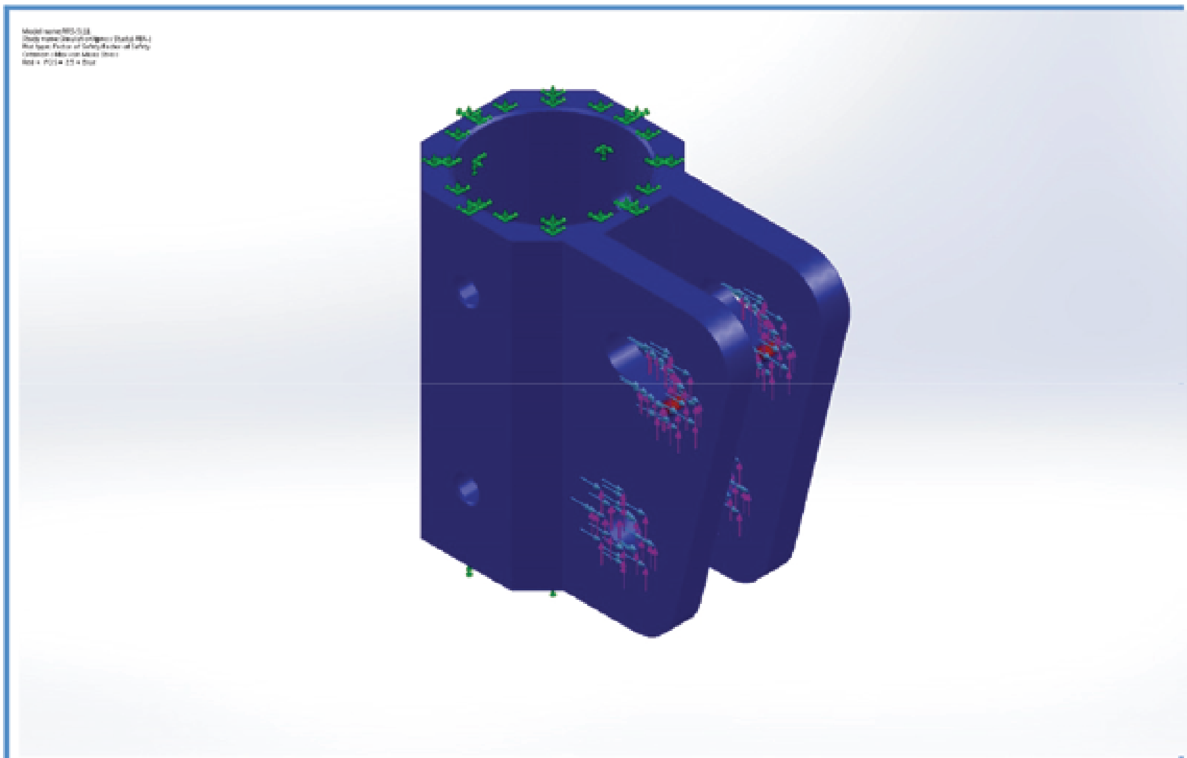
RRS-SL11-SimulationXpress Study-Displacement-Displacement

Name	Type
Deformation	Deformed shape



RRS-SL11-SimulationXpress Study-Displacement-Deformation

Name	Type	Min	Max
Factor of Safety	Max von Mises Stress	2.032e+000 Node: 7929	6.110e+005 Node: 15567



RRS-SL11-SimulationXpress Study-Factor of Safety-Factor of Safety

Conclusion

FEA STUDY CARRIED OUT FOR PURPOSE OF DESIGN VALIDATION.

APPLIED LOADS BASED ON STATIC LOAD (VERTICAL) PLUS SIDE CURB IMPACT LOAD (HORIZONTAL).

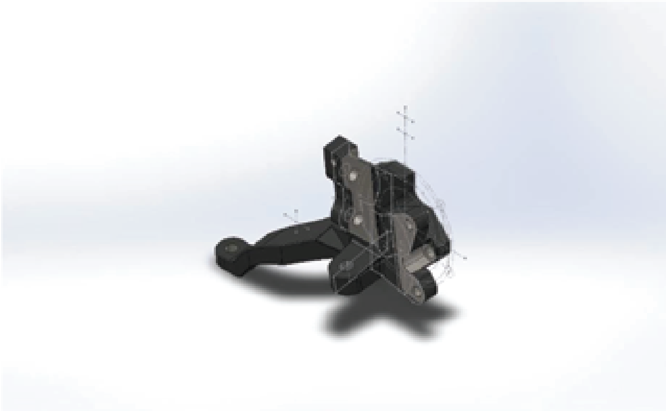
FEA STUTY RESULTS SHOW MONIMUM F.O.S. OF 2.03, WHICH IS DEEMED SATISFACTORY.

RRS PTY LTD.
57/42-46 Wattle Road
Brookvale NSW 2100
Sydney Australia

Ph: 61 2 9907 3755
Mob 61 417 226 693
Email: alex@rrs-online.com

Stress Analysis

STRESS ANALYSIS OF RRS FRONT WHEEL HUB



Simulation of 012 - 001 -01

Date: Monday, 23 February 2015
Designer: W. ROGULSKI
Study name: SimulationXpress Study
Analysis type: Static

Table of Contents

Description

RRS-ONLINE
FORD MUSTANG FRONT WHEEL HUB

CAST IRON VERSION
MOLYCARBIDE M23C6

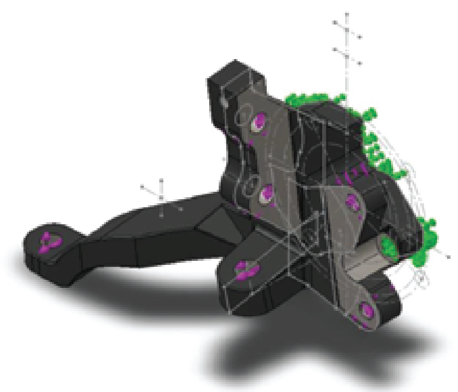
BASELINE SETTING

STRESS ANALYSIS OF RRS FRONT WHEEL HUB

W. ROGULSKI
23/02/2015

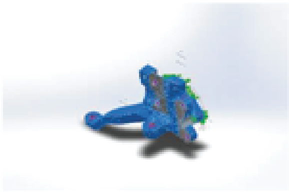
Assumptions

Model Information

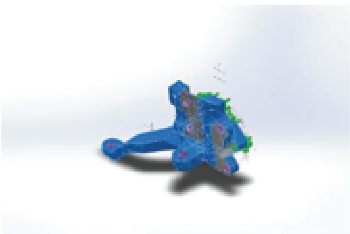


Model name : 012-001-01
Current Configuration : Default<As Machined>

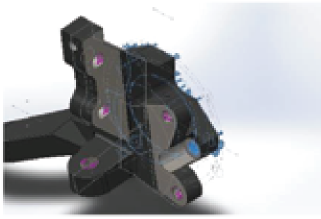
Solid Bodies			
Document Name and Reference	Treated As	Volumetric Properties	Document Path/Date Modified

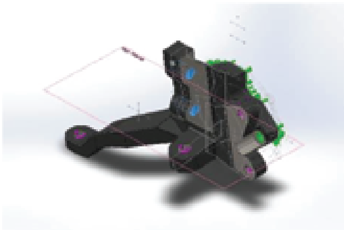
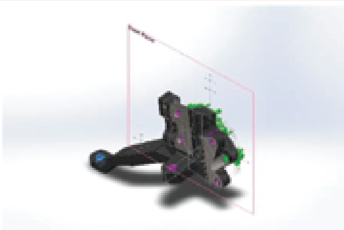
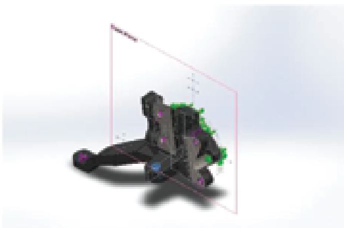
Fillet49 	Solid Body	Mass:3.96105 kg Volume:0.000540389 m^3 Density:7330 kg/m^3 Weight:3 8.8183 N	W: \CADtek Design and Drafting \CADtek customers \012 RRS \012 - 001 Mustang hub \012 - 001 -01.SLDPRT Feb 23 23:00:30 2015

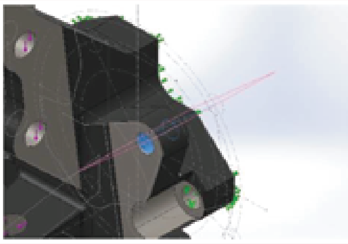
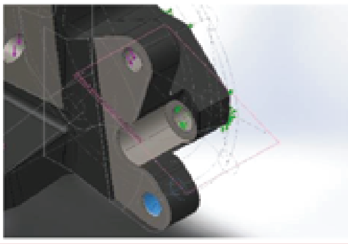
Material Properties

Model Reference	Properties	Compo nents
	**Name :** Molycarbide M23C6 **Model type:** Linear Elastic Isotropic **Default failure criterion:** Unknown **Yield strength:** 5.2e+008 N/m^2 **Tensile strength:** 6e+008 N/m^2	SolidBody 1(Fillet49)(012 - 001-01)

Loads and Fixtures

Fixture name	Fixture Image	Fixture Details
Fixed-1 WHEEL HUB		**Entities:** 5 face(s) **Type:** Fixed Geometry

Load name	Load Image	Load Details
Force-1 STRUT		**Entities:** 2 face(s), 1 plane(s) **Reference:** Top Plane **Type:** Apply force **Values:** ---, ---, -11662 N
Force-2 STREERING ARM		**Entities:** 1 face(s), 1 plane(s) **Reference:** Front Plane **Type:** Apply force **Values:** ---, ---, 4500 N
Force-3 BALL JOINT		**Entities:** 1 face(s), 1 plane(s) **Reference:** Front Plane **Type:** Apply force **Values:** ---, ---, 83300 N

Force -4 BRAKE CALIPER TOP HOLE		**Entities:** 1 face(s), 1 plane(s) **Reference:** Plane7 brake caliper top hole **Type:** Apply force **Values:** --- , --- , 6250 N
Force -5 BRAKE CALIPER BOTTOM HOLE		**Entities:** 1 face(s), 1 plane(s) **Reference:** Plane8 brake caliper bottom hole **Type:** Apply force **Values:** --- , --- , 6250 N

Mesh information

Mesh type	Solid Mesh
Mesher Used:	Standard mesh
Automatic Transition:	Off
Include Mesh Auto Loops:	Off
Jacobian points	4 Points
Element Size	4.88607 mm
Tolerance	0.244303 mm
Mesh Quality	High

Mesh information - Details

Total Nodes	62779
Total Elements	39776
Maximum Aspect Ratio	26.17
% of elements with Aspect Ratio < 3	96.1
% of elements with Aspect Ratio > 10	0.103
% of distorted elements(Jacobian)	0
Time to complete mesh(hh;mm;ss):	00:00:10
Computer name:	DUPA-JASIU

STRESS ANALYSIS OF RRS FRONT WHEEL HUB

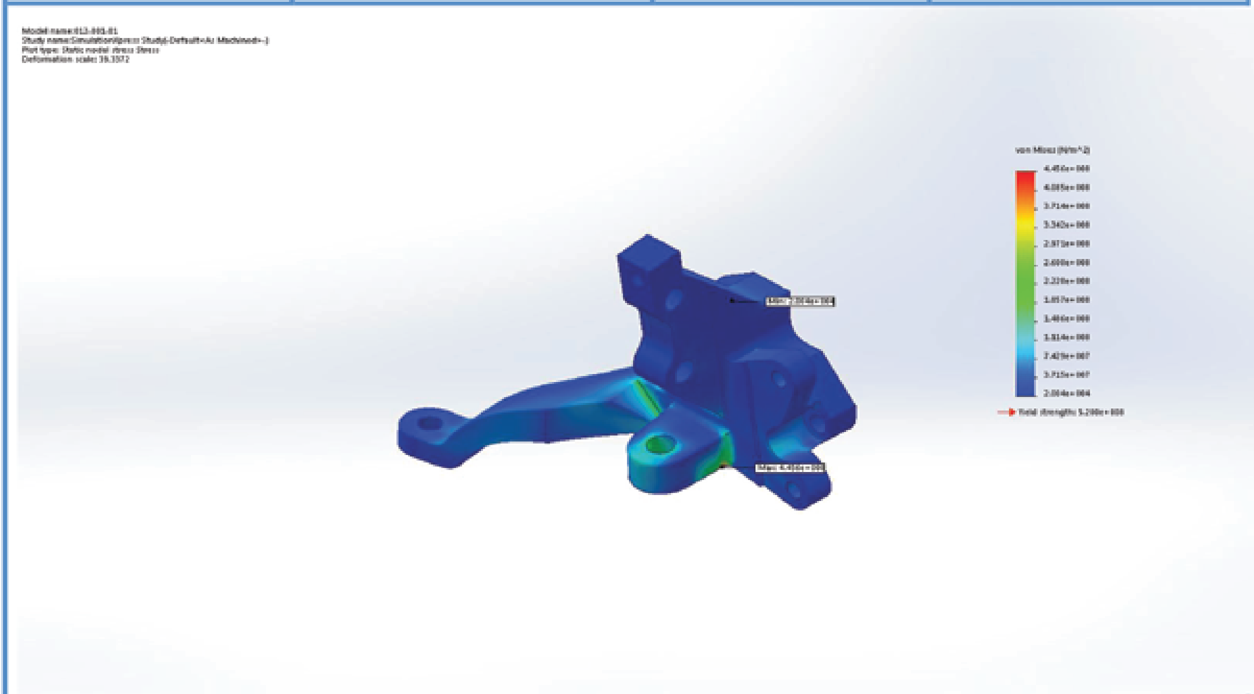
W. ROGULSKI
23/02/2015

STRESS ANALYSIS OF RRS FRONT WHEEL HUB

W. ROGULSKI
23/02/2015

Study Results

Name	Type	Min	Max
Stress	VON: von Mises Stress	20042.7 N/m^2 Node: 59517	4.45627e+008 N/m^2 Node: 36769

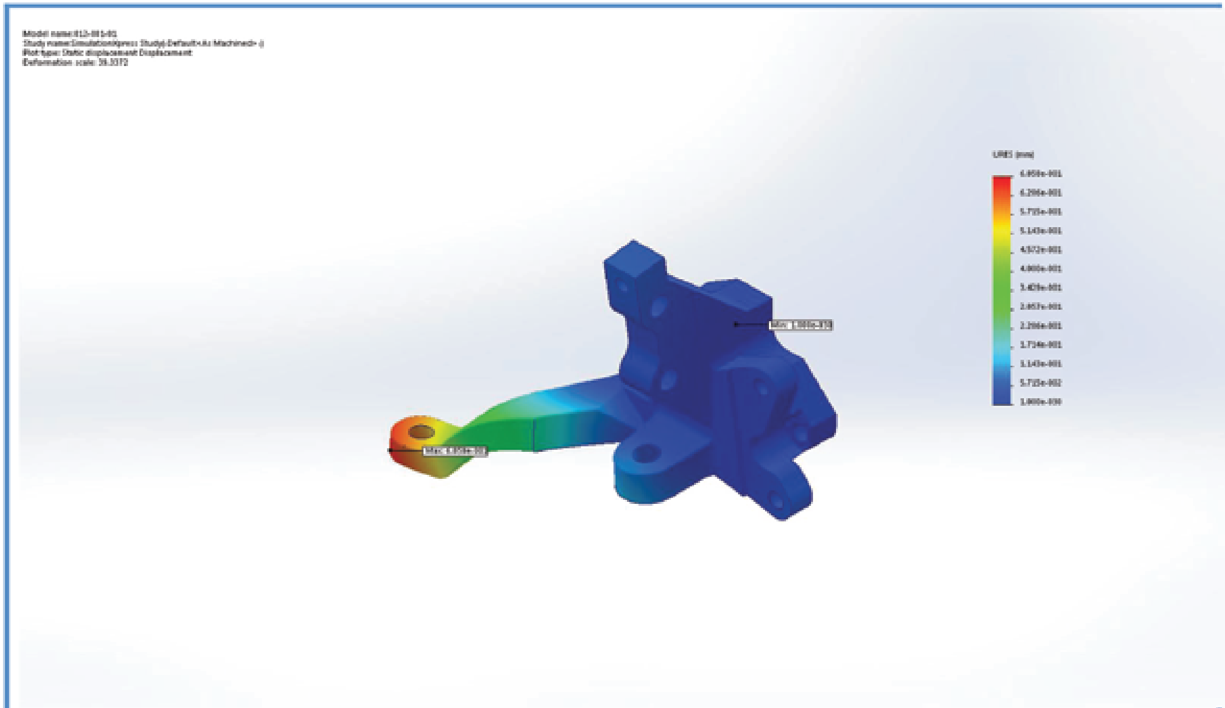


012-001-01-SimulationXpress Study -Stress -Stress

Name	Type	Min	Max
Displacement	URES: Resultant Displacement	0 mm Node: 18	0.685782 mm Node: 55797

STRESS ANALYSIS OF RRS FRONT WHEEL HUB

W. ROGULSKI
23/02/2015

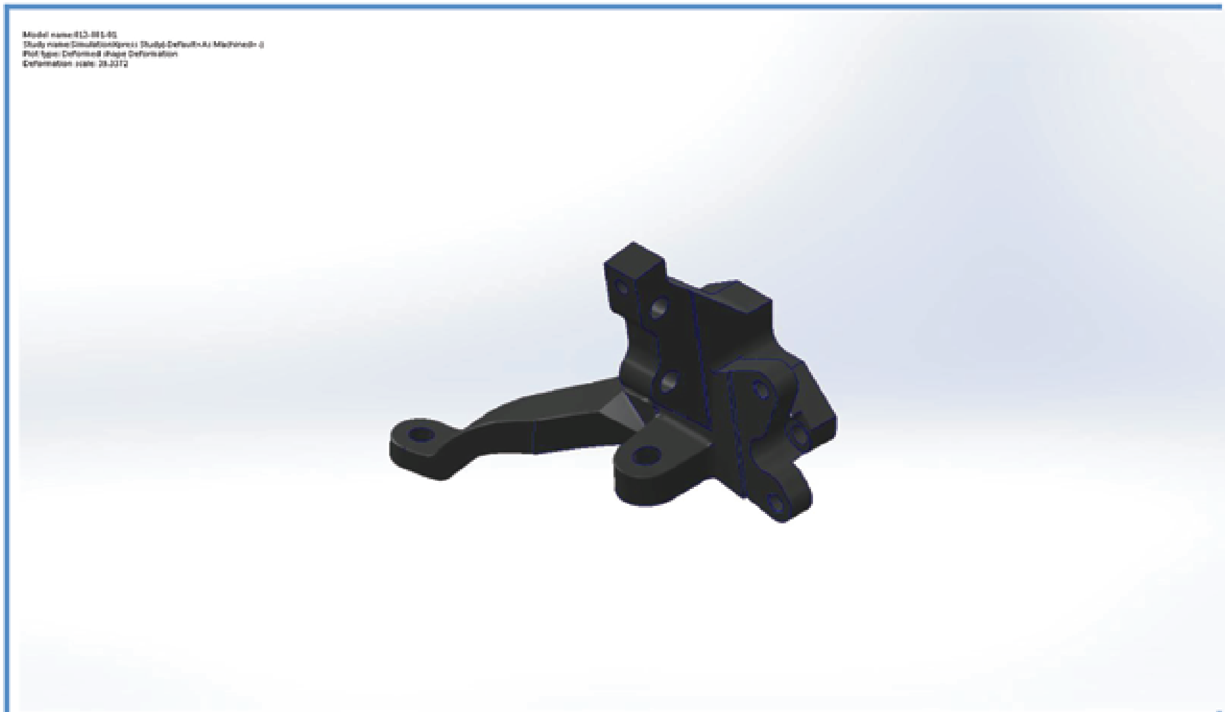


012-001-01-SimulationXpress Study -Displacement -Displacement

Name	Type
Deformation	Deformed shape

STRESS ANALYSIS OF RRS FRONT WHEEL HUB

W. ROGULSKI
23/02/2015

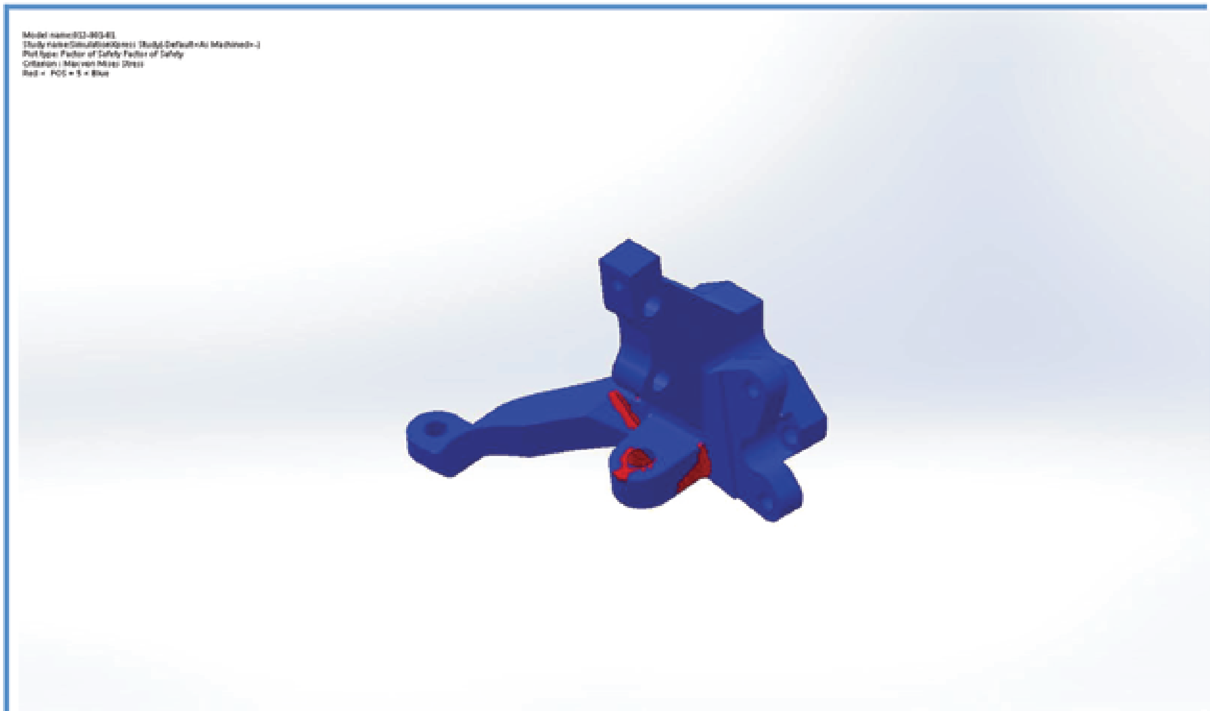


012-001-01-SimulationXpress Study -Displacement -Deformation

Name	Type	Min	Max
Factor of Safety	Max von Mises Stress	1.1669 Node: 36769	25944.6 Node: 59517

STRESS ANALYSIS OF RRS FRONT WHEEL HUB

W. ROGULSKI
23/02/2015



012-001-01-SimulationXpress Study -Factor of Safety -Factor of Safety

Conclusion

BASELINE SETTINGS ACHIEVED FOR PURPOSE OF RE -DESIGNING HUB TO ALUMINIUM VERSION.

RRS PTY LTD.
57/42-46 Wattle Road
Brookvale NSW 2100
Sydney Australia

Ph: 61 2 9907 3755
Mob 61 417 226 693
Email: alex@rrs-online.com

Stress Analysis

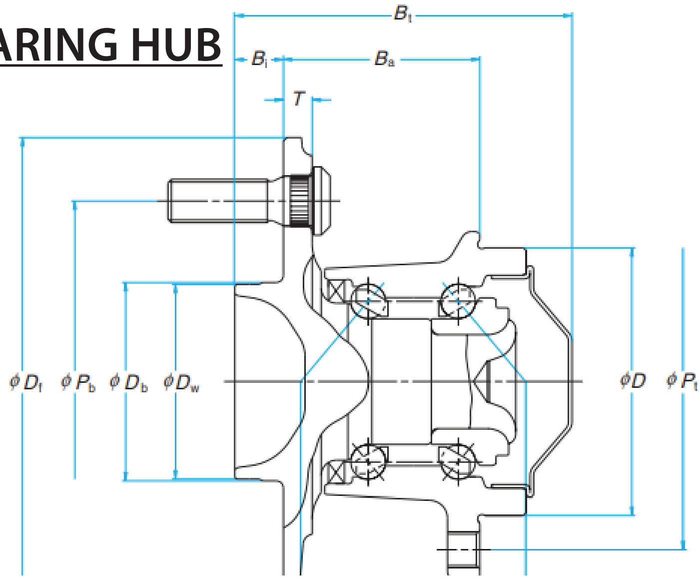
The NSK 55BWKH01 is HUB III type with double row bearings load rated 50,000N and 41,500N, this bearing hub is used by OEM manufacturers globally (GM, BMW, Mercedes, etc.) these vehicles have a GVM up to 2140Kg and tyre placards up to 275/30/R20. NSK certified testing shows bump rut and impact testing for these vehicles with safety factor of +3.

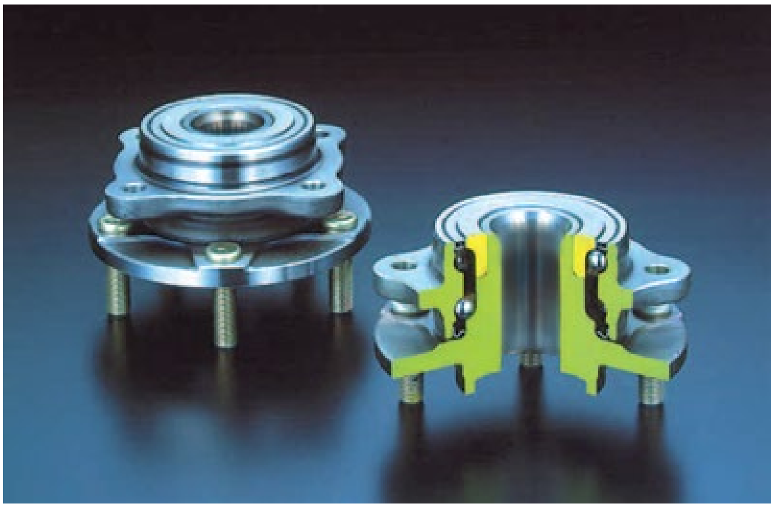
NSK being an OEM supplier have all test results are independently audited, this allows RRS to load rate the hub bearing for use within the Ford Mercury models the HO2 is designed for. The restrictions RRS have are a GVM of less than 2000Kg and a wheel and tyre combination with a rolling diameter of less than 68cm (without specifying offset).

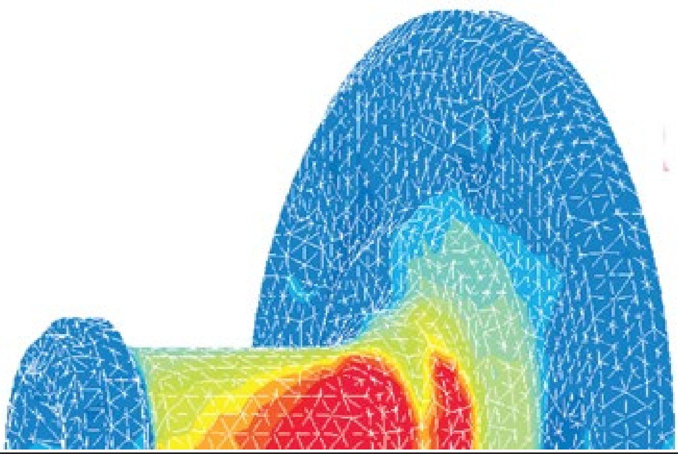
Boundary dimensions (mm)										Distance between effective load centers ℓ (mm)	Bearing reference	Basic load ratings (N) Double row		No. of flanged inner ring hub bolts	No. of outer ring flange tapped holes	Mass (kg) (approx.)	ABS Sensor integral type
D_w	D	D_b	B_a	T	B_i	B_t	P_b	P_t	D_t			C_r	C_{or}				
69.5	76	71.5	43	10.4	25	86.1	120	108	140	63.0	55BWKH01	50 000	41 500	5	3	3.8	○

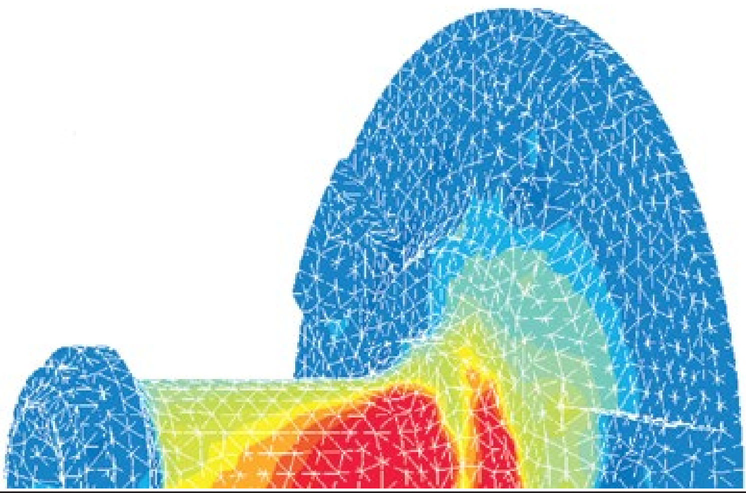
DATA FROM NSK

BEARING HUB









RRS PTY LTD.
57/42-46 Wattle Road
Brookvale NSW 2100
Sydney Australia

Ph: 61 2 9907 3755
Mob 61 417 226 693
Email: alex@rrs-online.com

Stress Analysis

(1) Bore hub flange
Relieved stress concentration in the inboard row of the hub units and reduced unit weight

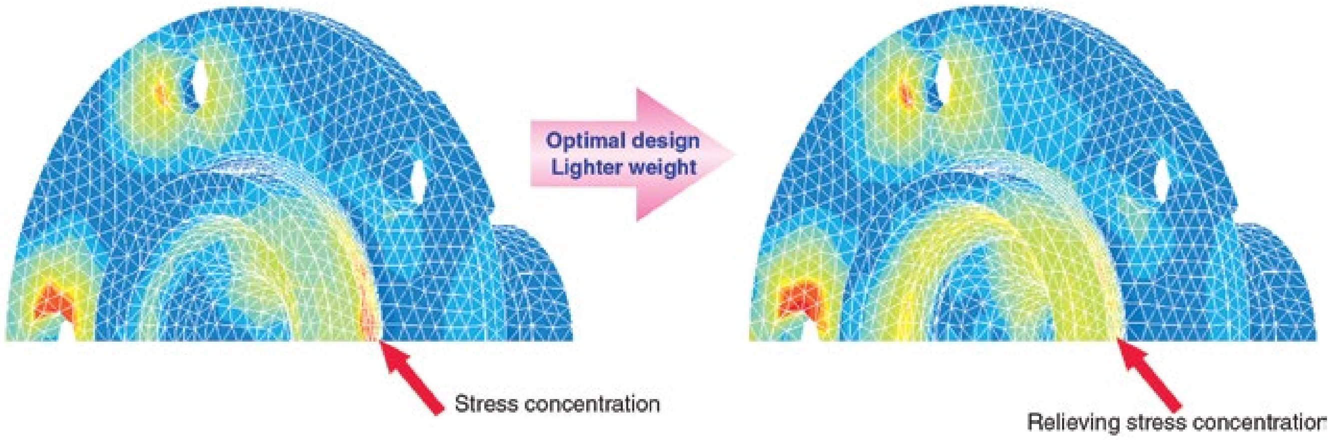
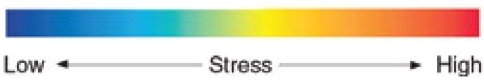


Fig. 5 Sample of FEA (bore flange)



(2) Outboard hub flange
Realized optimal design of outside hub flanges by FEA for keeping stress concentration within the permissible range, and for weight reduction

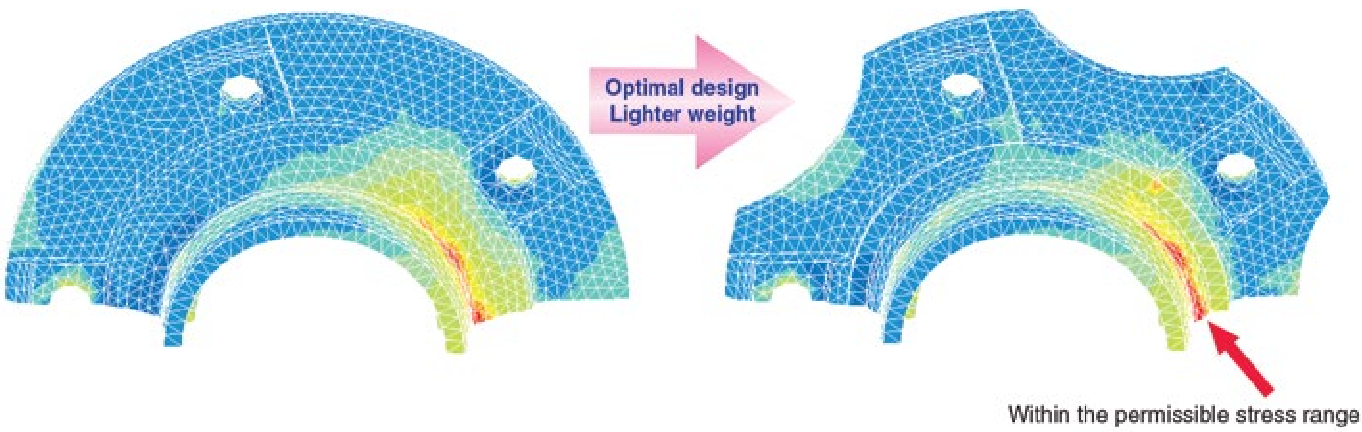


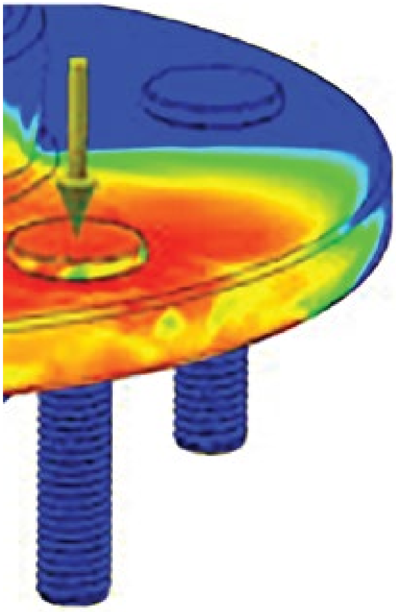
Fig. 7 Sample of FEA (outboard flange)

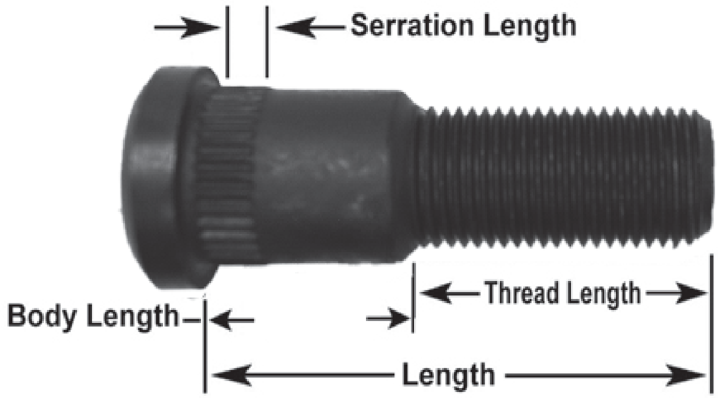
RRS PTY LTD.
57/42-46 Wattle Road
Brookvale NSW 2100
Sydney Australia

Ph: 61 2 9907 3755
Mob 61 417 226 693
Email: alex@rrs-online.com

Stress Analysis

WHEEL STUD HARDNESS AND TENSILE STRENGTH





MATERIAL HARDNESS

The hardness of the sample was determined on a Rockwell test machine, in accordance with AS1815.
The results were as follows

Component	Hardness, HRC	SAE J1102 specification limits
S222 NICE	36.5	25 - 34 HRC

MATERIAL TENSILE STRENGTH

The tensile strength of the sample was determined in accordance with AS1391.
The results were as follows

Component	Breaking Load, lb	SAE J1102 specification limits
S222 NICE	26100-26800	19200 lb minimum

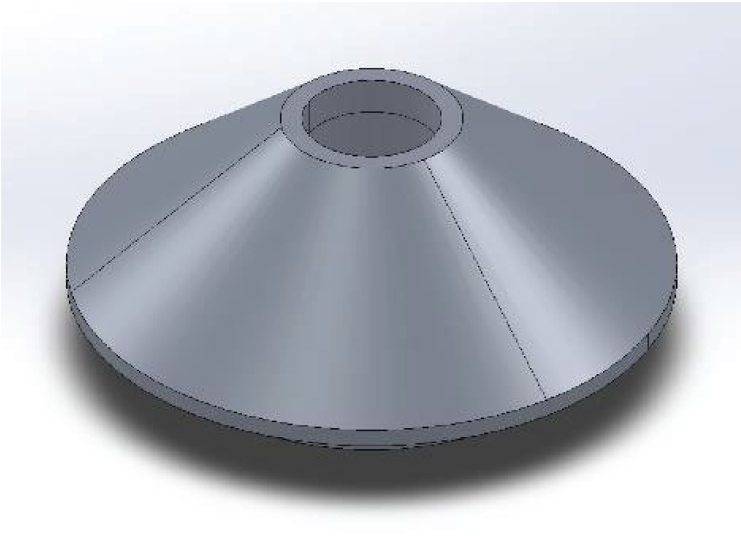
Tests were conducted by:

Metallurgical Testing & Consulting Engineers
A.B.N. 65 402 291 430
2 Sales Ave Silverdale NSW 2752

Stephen Hooker. BSc(Tech)
METALLURGIST

RRS PTY LTD.
57/42-46 Wattle Road
Brookvale NSW 2100
Sydney Australia
Ph: 61 2 9907 3755
Mob 61 417 226 693
Email: alex@rrs-online.com

Stress Analysis



Simulation of RRS-SL05

Date: 05 May 2019
Designer: W. Rogulski
Study name: SimulationXpress Study
Analysis type: Static

Table of Contents

Description

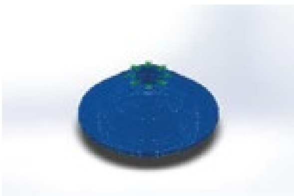
RRS-ONLINE
Application: FORD MUSTANG
Location: FRONT COIL-OVER STRUT
Part: UPPER SPRING SEAT

RRS PTY LTD.
57/42-46 Wattle Road
Brookvale NSW 2100
Sydney Australia

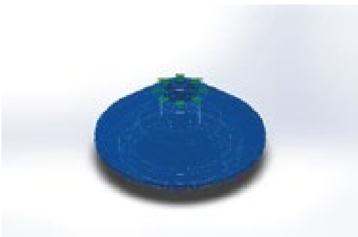
Ph: 61 2 9907 3755
Mob 61 417 226 693
Email: alex@rrs-online.com

Assumptions

Model Information

Model name: RRS-SL05 Current Configuration: Default<As Machined>			
Solid Bodies			
Document Name and Reference	**Treated As**	**Volumetric Properties**	**Document Path/Date Modified**
Revolve1 	Solid Body	Mass:0.215697 kg Volume:7.98878e-05 m^3 Density:2,700 kg/m^3 Weight:2.11383 N	W:\CADtek\JOBS\012 RRS\012-006 Mustang front strut\RRS-SL05.SLDPRT May 5 13:55:06 2019

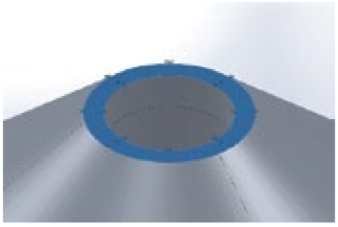
Material Properties

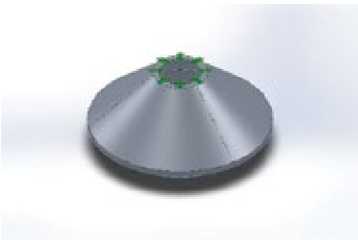
Model Reference	Properties	Components
	**Name:** 6061-T6 (SS) **Model type:** Linear Elastic Isotropic **Default failure criterion:** Unknown **Yield strength:** 275 N/mm^2 **Tensile strength:** 310 N/mm^2	SolidBody 1(Revolve1)(RRS-SL05)

Stress Analysis

W. Rogulski
05/05/2019

Loads and Fixtures

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

Load name	Load Image	Load Details
Force-1		**Entities:** 1 face(s) **Type:** Apply normal force **Value:** 23,324 N

Mesh information

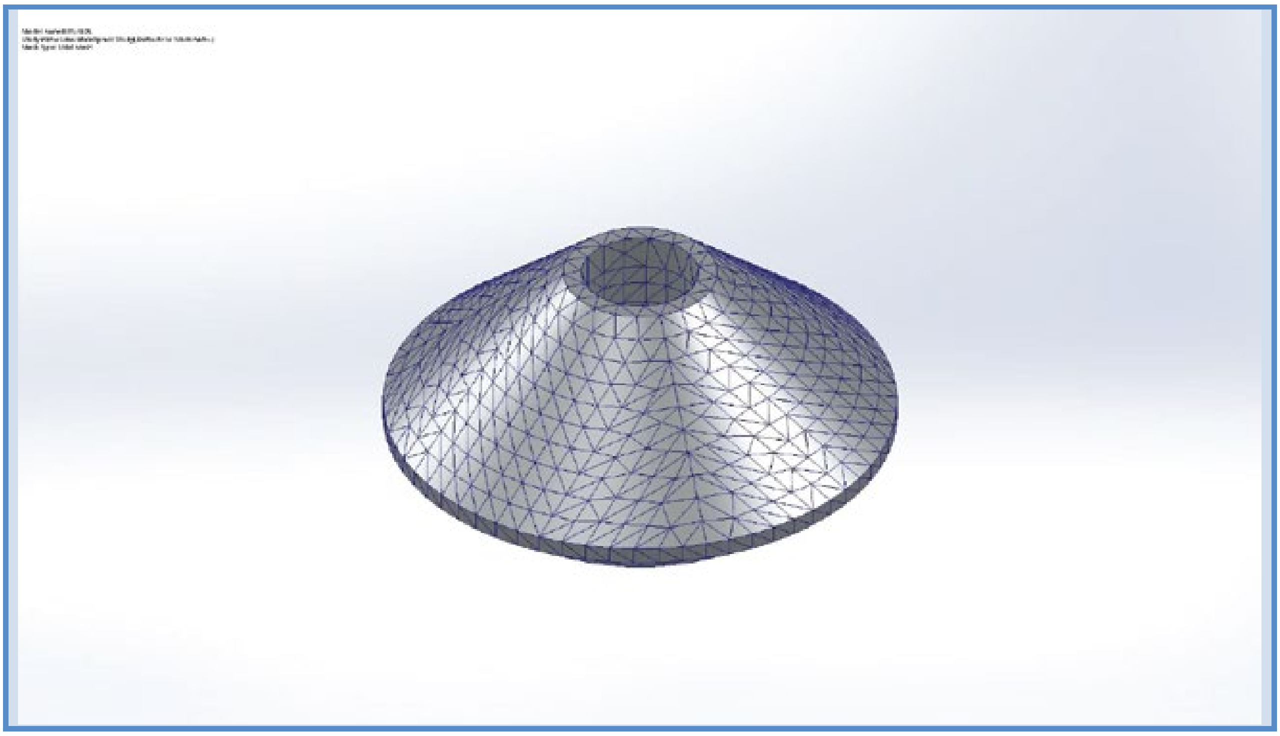
Mesh type	Solid Mesh
Mesher Used:	Standard mesh
Automatic Transition:	Off
Include Mesh Auto Loops:	Off
Jacobian points	4 Points
Element Size	4.30821 mm
Tolerance	0.21541 mm
Mesh Quality Plot	High

Mesh information - Details

Total Nodes	12595
Total Elements	7629
Maximum Aspect Ratio	8.4703
% of elements with Aspect Ratio < 3	98
% of elements with Aspect Ratio > 10	0
% of distorted elements(Jacobian)	0
Time to complete mesh(hh;mm;ss):	00:00:01
Computer name:	DUPA-JASIU-02

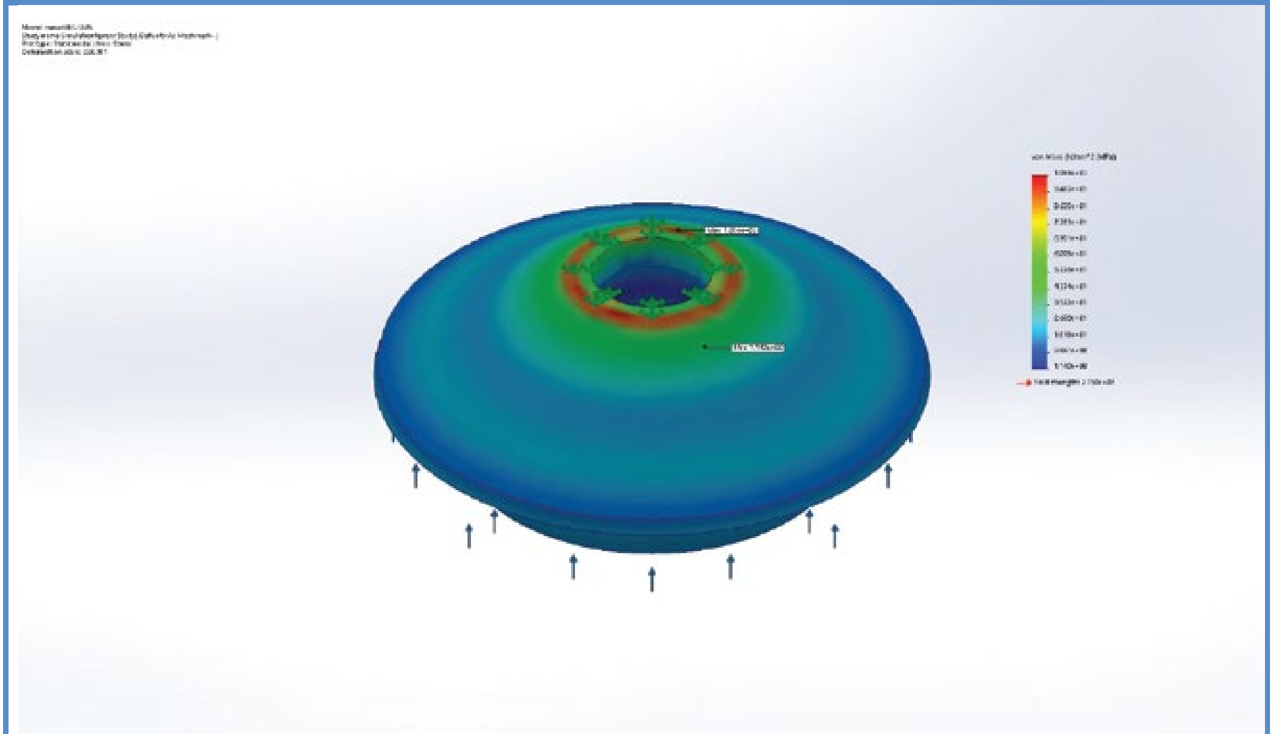
Stress Analysis

W. Rogulski
05/05/2019



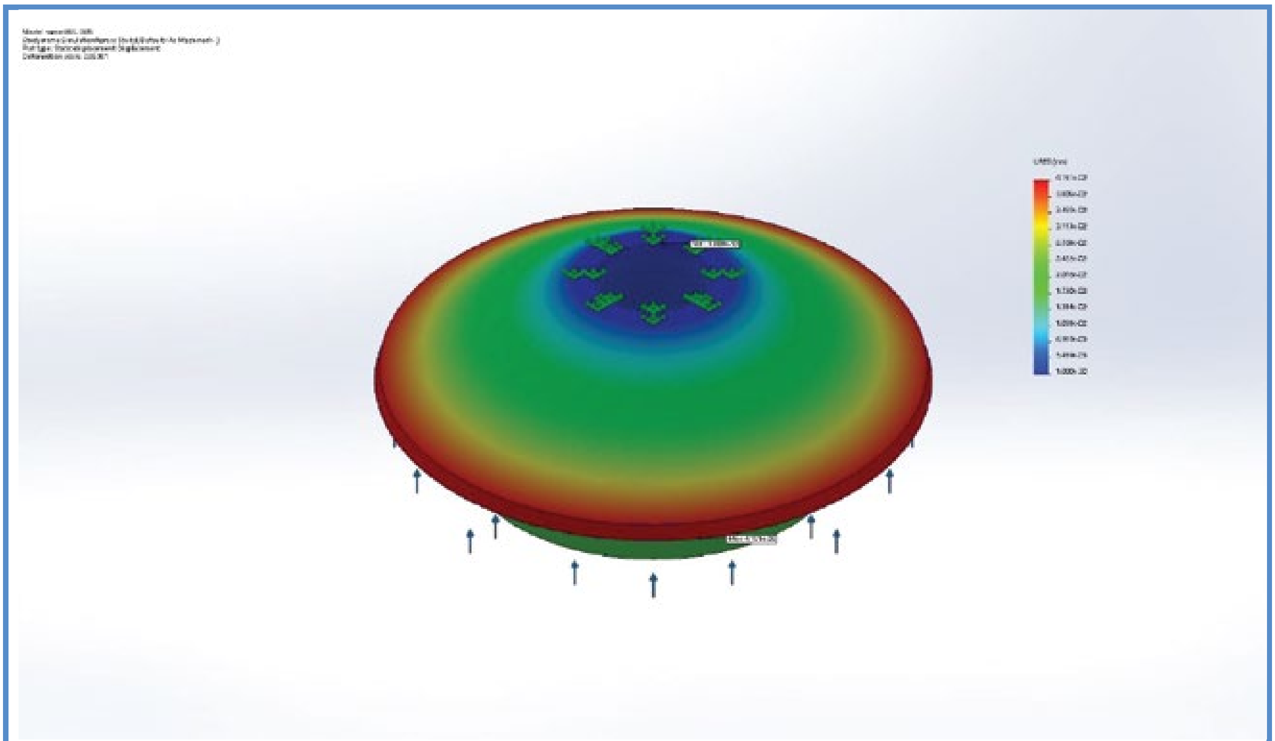
Study Results

Name	Type	Min	Max
Stress	VON: von Mises Stress	1.140e+00 N/mm^2 (MPa) Node: 4696	1.034e+02 N/mm^2 (MPa) Node: 7338



RRS-SL05-SimulationXpress Study-Stress-Stress

Name	Type	Min	Max
Displacement	URES: Resultant Displacement	0.000e+00 mm Node: 421	4.151e-02 mm Node: 387

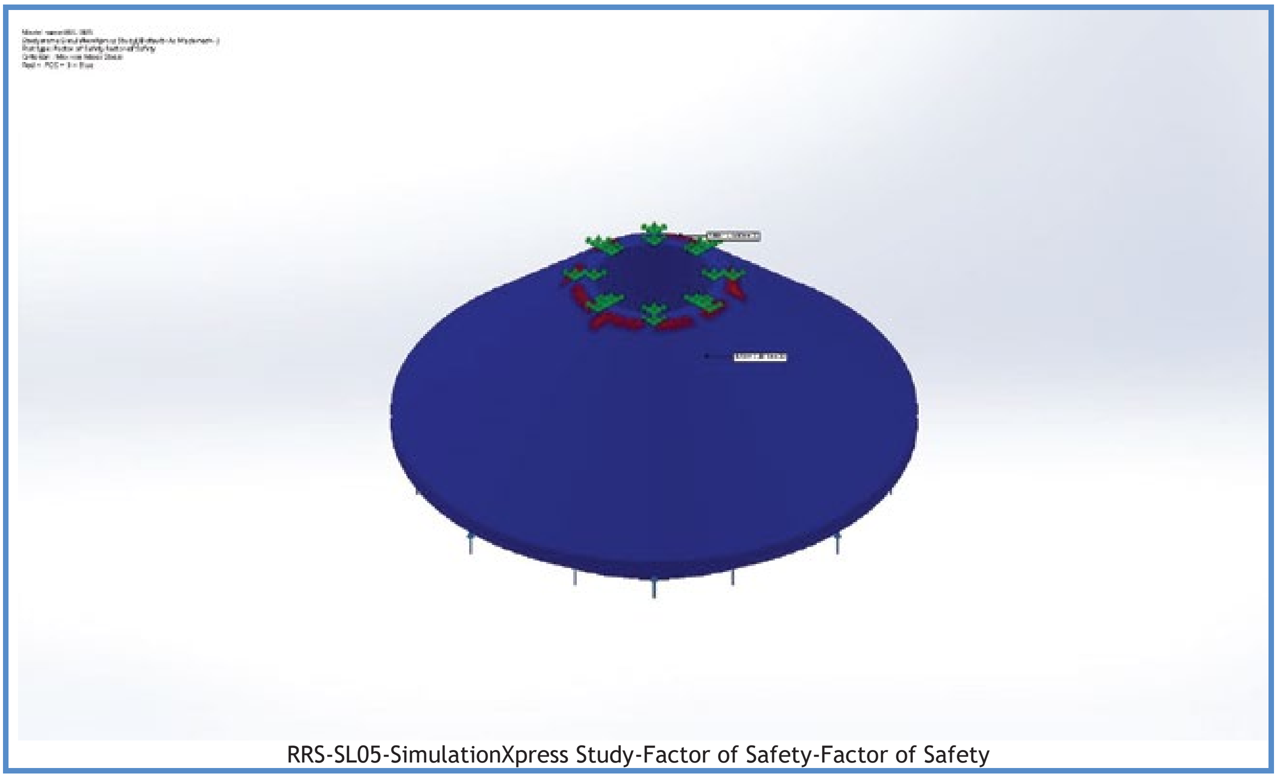


RRS-SL05-SimulationXpress Study-Displacement-Displacement

Name	Type
Deformation	Deformed shape

RRS-SL05-SimulationXpress Study-Displacement-Deformation

Name	Type	Min	Max
Factor of Safety	Max von Mises Stress	2.660e+00 Node: 7338	2.413e+02 Node: 4696



RRS-SL05-SimulationXpress Study-Factor of Safety-Factor of Safety

Conclusion

FEA study carried out for purpose of design validation.

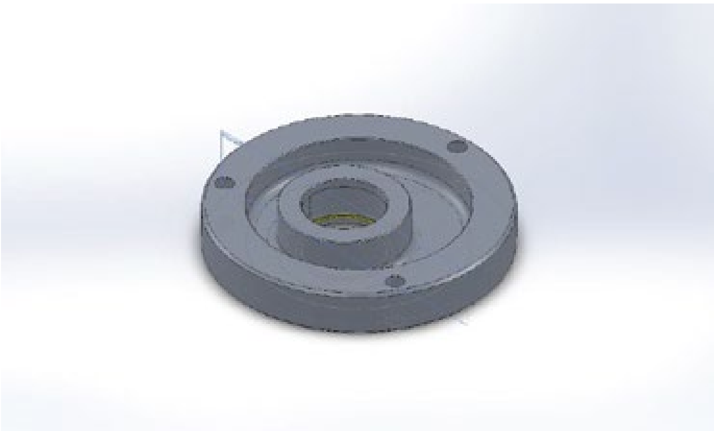
Applied loads are based on static load (vertical) plus bump impact load (vertical). That is, total load equals twice normal static load.

FEA study results show minimum FOS of 2.67, which is deemed satisfactory.

RRS PTY LTD.
57/42-46 Wattle Road
Brookvale NSW 2100
Sydney Australia

Ph: 61 2 9907 3755
Mob 61 417 226 693
Email: alex@rrs-online.com

Stress Analysis



Simulation of RRS-SL17 (V2)

Date: 06 May 2019
Designer: W. Rogulski
Study name: SimulationXpress Study
Analysis type: Static

Table of Contents

Description

RRS-ONLINE

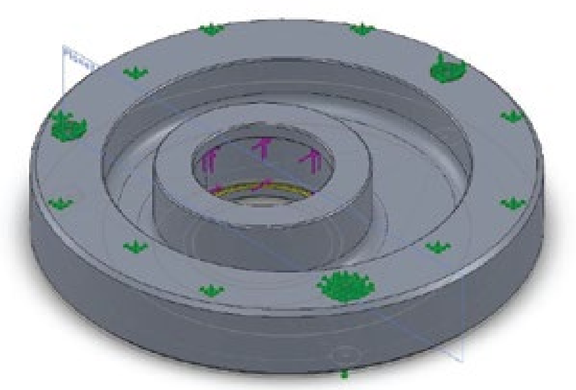
Application: **FORD MUSTANG**
Location: **FRONT COIL-OVER STRUT**
Part: **UPPER STRUT MOUNT**

Stress Analysis

W. Rogulski
06/05/2019

Assumptions

Model Information



Model name: RRS-SL17
Current Configuration: V2 FEA

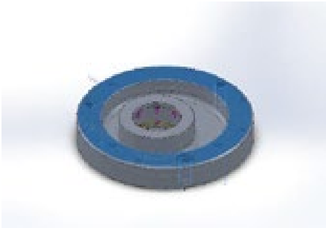
Solid Bodies			
Document Name and Reference	Treated As	Volumetric Properties	Document Path/Date Modified

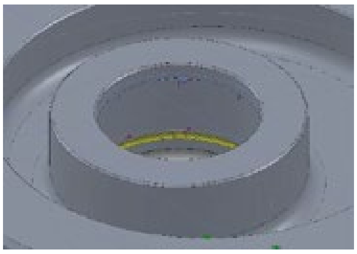
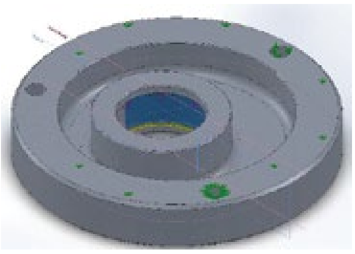
Split Line2	Solid Body	Mass:0.560656 kg Volume:0.00020765 m^3 Density:2,700 kg/m^3 Weight:5.49443 N	W:\CADtek\JOBS\012 RRS\012-006 Mustang front strut\RRS-SL17.SLDPRT May 6 21:35:27 2019
			

Material Properties

Model Reference	Properties	Components
	**Name:** 6061-T6 (SS) **Model type:** Linear Elastic Isotropic **Default failure criterion:** Unknown **Yield strength:** 2.75e+08 N/m^2 **Tensile strength:** 3.1e+08 N/m^2	SolidBody 1(Split Line2)(RRS-SL17)

Loads and Fixtures

Fixture name	Fixture Image	Fixture Details
Fixed-1		**Entities:** 10 face(s) **Type:** Fixed Geometry

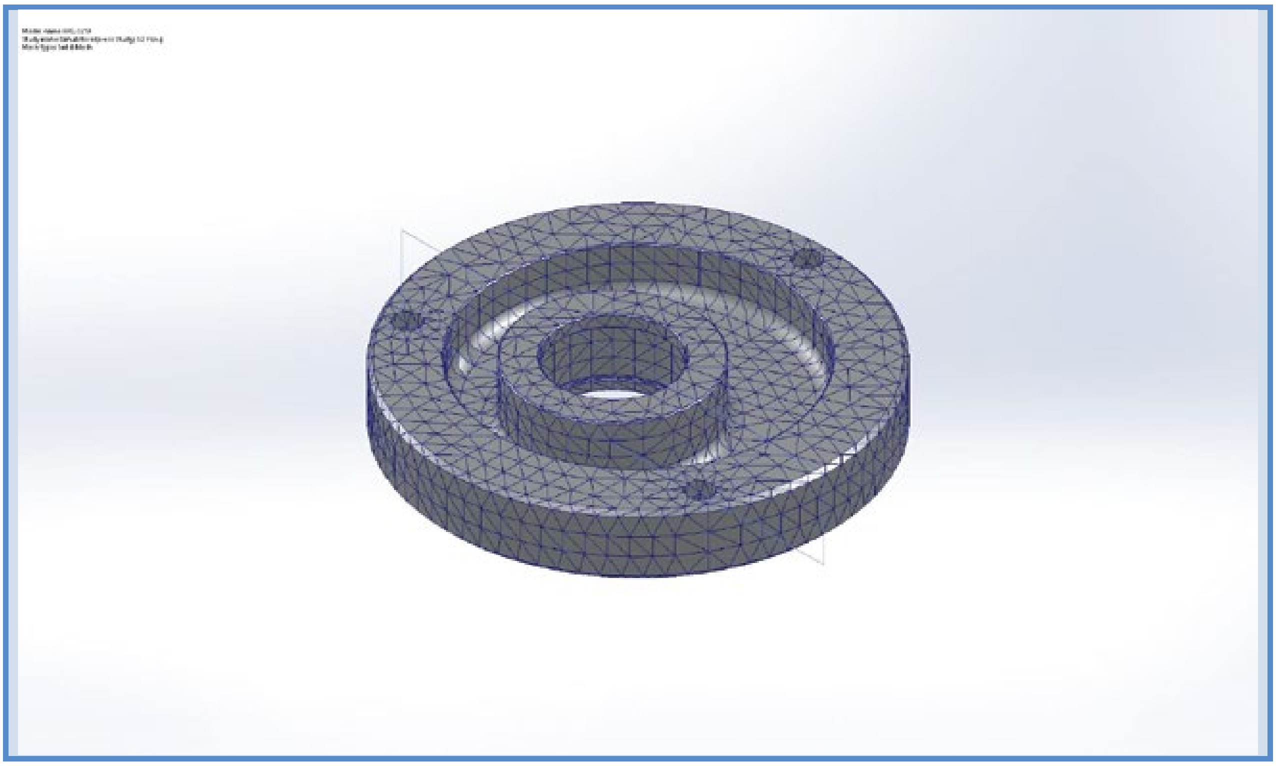
Load name	Load Image	Load Details
Force-1 STATIC LOAD		**Entities:** 1 face(s) **Type:** Apply normal force **Value:** 11,662 N
Force-2 LATERAL LOAD		**Entities:** 1 face(s), 1 plane(s) **Reference:** Front Plane **Type:** Apply force **Values:** ---, ---, -4,139 N

Mesh information

Mesh type	Solid Mesh
Mesher Used:	Standard mesh
Automatic Transition:	Off
Include Mesh Auto Loops:	Off
Jacobian points	4 Points
Element Size	5.90777 mm
Tolerance	0.295389 mm
Mesh Quality Plot	High

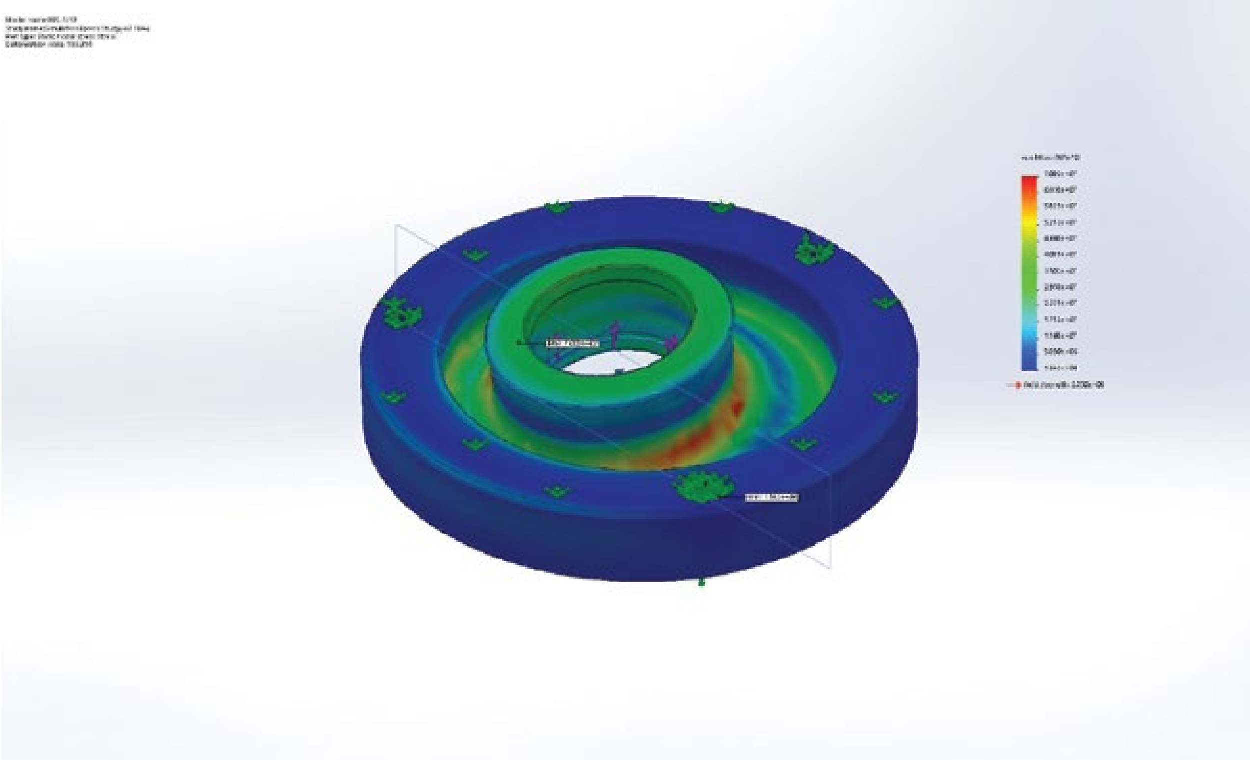
Mesh information - Details

Total Nodes	18491
Total Elements	11000
Maximum Aspect Ratio	19.417
% of elements with Aspect Ratio < 3	88.8
% of elements with Aspect Ratio > 10	1.96
% of distorted elements(Jacobian)	0
Time to complete mesh(hh;mm;ss):	00:00:01
Computer name:	DUPA-JASIU-02



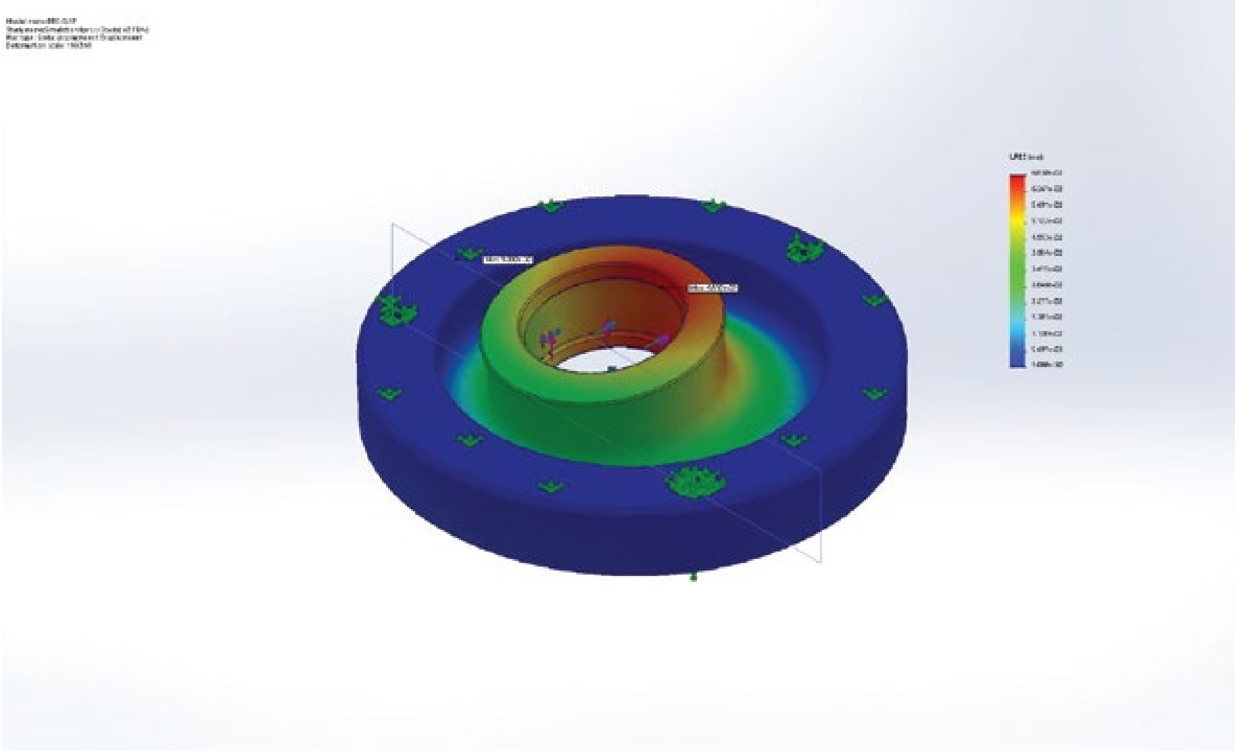
Study Results

Name	Type	Min	Max
Stress	VON: von Mises Stress	1.642e+04 N/m^2 Node: 18231	7.002e+07 N/m^2 Node: 15596



RRS-SL17-SimulationXpress Study-Stress-Stress

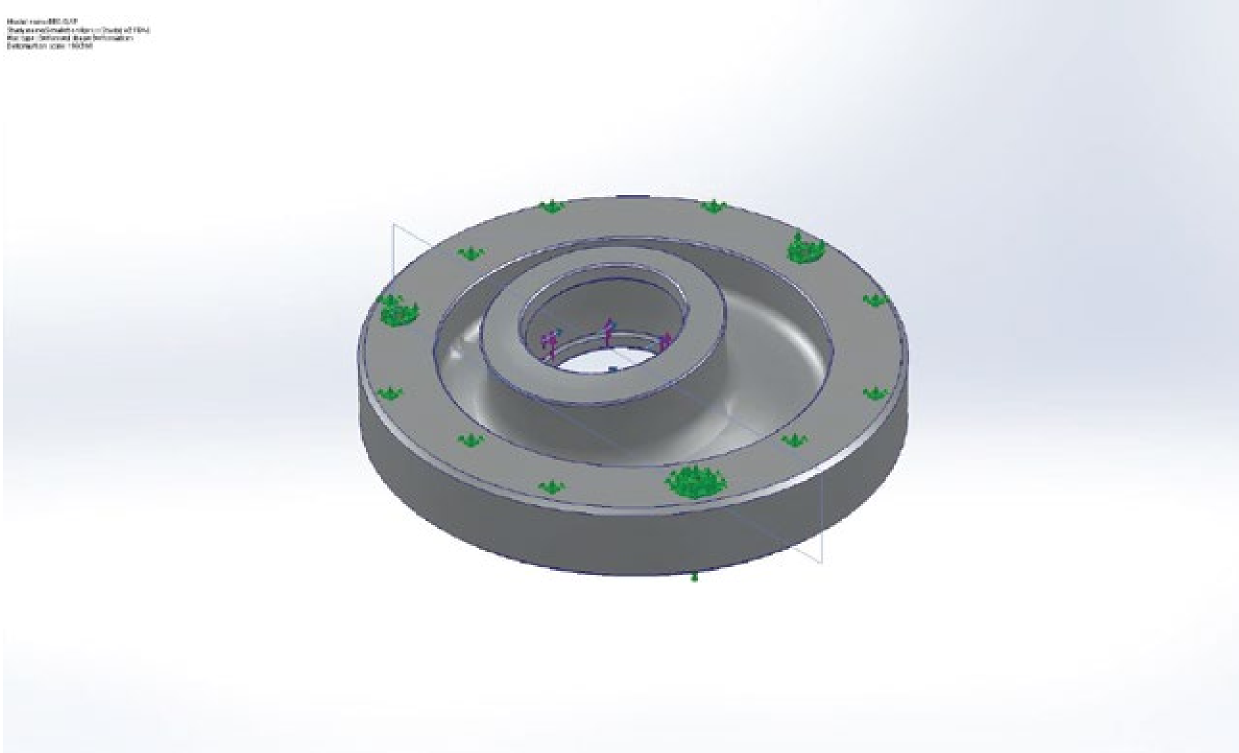
Name	Type	Min	Max
Displacement	URES: Resultant Displacement	0.000e+00 mm Node: 1	6.830e-02 mm Node: 83



RRS-SL17-SimulationXpress Study-Displacement-Displacement

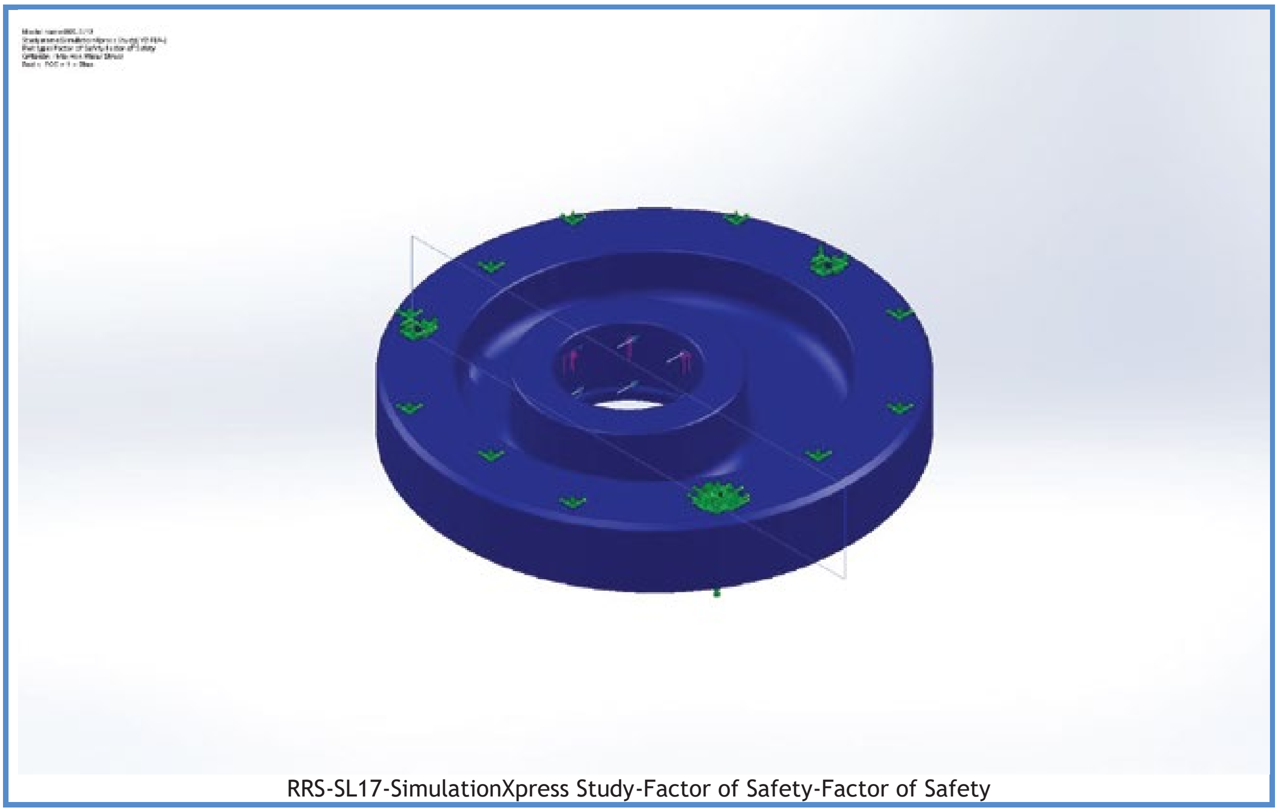
Name	Type
Deformation	Deformed shape

W. Rogulski
06/05/2019



RRS-SL17-SimulationXpress Study-Displacement-Deformation

Name	Type	Min	Max
Factor of Safety	Max von Mises Stress	3.928e+00 Node: 15596	1.675e+04 Node: 18231



RRS-SL17-SimulationXpress Study-Factor of Safety-Factor of Safety

Conclusion

FEA study carried out for purpose of design validation.

Applied loads are based on twice static single corner load (vertical), plus resultant factored kerb lateral impact load.

FEA study results show minimum FOS of 3.9, which is deemed satisfactory.

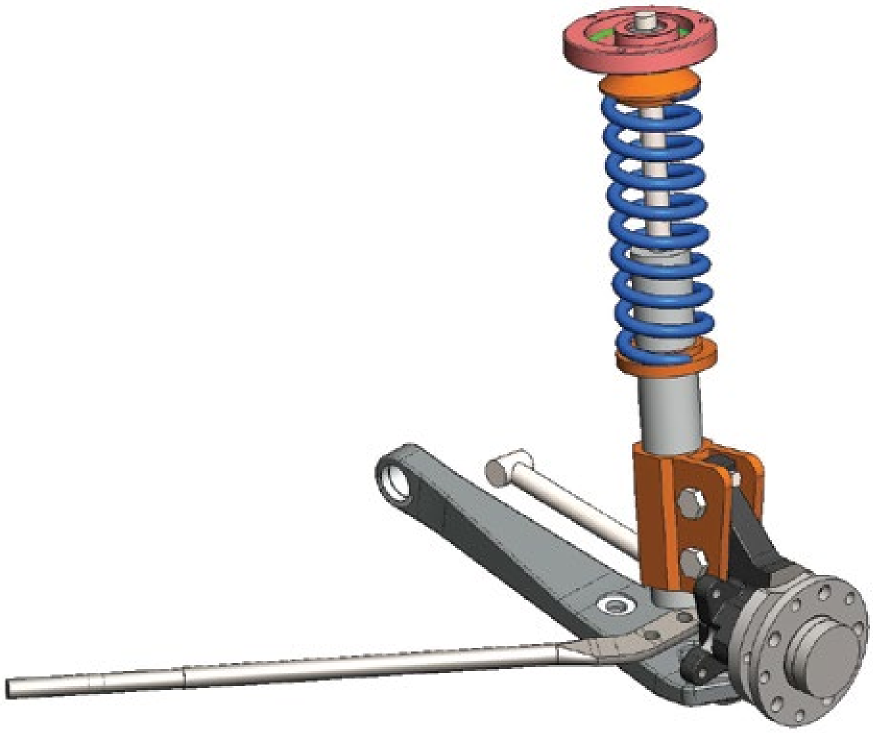
ENGINEERING FEA REPORT

FINITE ELEMENT ANALYSIS

of

RRS FRONT SUSPENSION ASSEMBLY

including RRS H.O.2 bolt-in coil-over system for Classic Ford Mustang, Falcon, Fairlane, etc.



Report Prepared for:

RRS Pty Ltd
57/42-46 Wattle Rd, Brookvale NSW 2100 Australia

Report Prepared by:

Wojtek Rogulski
CADtek Design & Drafting

6th September 2019

W. Rogulski
06/09/2019

Table of Contents

1. Description

FINITE ELEMENT ANALYSIS of RRS FRONT SUSPENSION ASSEMBLY including RRS H.O.2 bolt-in coil-over system for Classic Ford Mustang, Falcon, Fairlane, etc.

The front axle suspension was provided by RRS, as manufactured by RRS, and supplied to CADtek in partly physical form partly 2D CAD drawings where a 3D CAD model was built for the purpose of Finite Element Analysis (FEA).

The objective of the FEA was to determine the stresses within the assembly when loaded to a front axle weight of 900kg by applying the forces produced by particular road conditions and wheel and tire size and wheel offset.

Figure 1.1. General image of front-end assembly, half model. Top view, Front view, Side view.

Using design safety factors as specified in VSB14 'Light Vehicle Construction & Modification' and RRS' calculated factors of safety (see section 3.1 of this report), the stress for the 900kg load rating is acceptable, provided the specifications detailed in section 4 of this report are adhered to.

VSB14 Section LS p44 -

3 COMPONENT STRESS LEVELS

The stress levels of any production component in the suspension system must not be increased over that at which it has been demonstrated to be capable of satisfactory operation. Stress analysis should be carried out for modified or specially fabricated components and the following load conditions are suggested as a guide:

· bump loads: 4g vertical; Section LS Tires, Rims, Suspension and Steering Version 2.1

1 November 2015 Page 45/LS80

· rut loads: 1g vertical combined with ±0.6g lateral; and

· skid loads: 2g vertical combined with 1.2g skid (longitudinal). Overturning loads: 2g vertical combined with 2.5g overturning; where g is the static load at the tire contact patch when the vehicle is stationary. The stress levels that are acceptable under these conditions will depend on the materials and the number of times in the life of the vehicle that the loads can be expected to occur. Other factors which can affect suspension loads and should be considered are:

· rim offset;

· combination of braking at lock while striking an obstacle;

· steering scrub radius; and

· the effect of steering system loads on the suspension components

2. Assumptions

Chassis

Vehicle Chassis – for the purpose of this FEA study, vehicle chassis has been assumed to be infinitely stiff. This assumption, however, is grossly exaggerated where it is known that a finite chassis stiffness and rigidity will absorb a portion of loads applied onto and through the suspension system. Based on this assumption, FEA results on individual suspension components are equally exaggerated, this can be acknowledged as further factor of safety margin.

Chassis to suspension connections

Lower control arm and Radius Rod to chassis connections – for the purpose of this FEA study, these connections have been assumed to be infinitely rigid. This assumption, however, is grossly exaggerated as both these connections comprise flexible rubber bushings, which absorb high impact loads applied onto and through the suspension system. Based on this assumption, FEA results in individual components are equally exaggerated, this can be acknowledged as further factor of safety margin.

Anti-roll Bar

Further, a normally fitted and active anti-roll bar which would normally distribute the loads over to the opposite half-axle sub-system has been ignored from this FEA study.

3. Conclusions

The front suspension and axle assembly has been subjected to typical loads as would be seen in highway operation, these being 0.3g braking, 0.25g cornering and 1.0g download. The target safety factor used for the FEA is 3:1 based on each material yield strength.

Providing that the limitations specified in section 4 of this report are adhered to, the stresses in the front suspension and axle assembly are within the material design limits, and the 3:1 safety factor has been achieved. Therefore, the design is acceptable and can safely be used on vehicles with a front axle load of up to 900kg.

Knuckle

The Knuckle complies with the design safety factor of 3:1 when restricted to specific wheel offset limit of >+5mm and a maximum wheel/tire height (rolling diameter) of 673mm.

Strut Clevis Bracket

The Strut Clevis Bracket complies with the design safety factor of 3:1 when restricted to wheel offset limit of >+5mm and a maximum wheel/tire height (rolling diameter) of 673mm.

Lower Control Arm

The RRS lower control arm complies with the design factor of safety of 3:1 using a material yield stress of 275MPa when subjected to 0.3g braking and 0.25g cornering forces combined with a 1.0g download force.

3.1. Design Safety Factors & Material specifications

VSB14 – 'Light Vehicle Construction and Modifications' suggests a design loading of 4.0g for 'bump loads' this is conservative and for the FEA the value of 3.0g was adopted, this corresponds to the 3:1 factor of safety used for the analysis.

The 3:1 design factor of safety generates a maximum design stress limit dependent on the material yield strength – see table below.

Component / Part# / Material	Yield Strength (MPa)	Design Stress Limit (MPa)	FEA max Stress (MPa) (Braking / Cornering)	Factor of Safety (Braking / Cornering)
RRS components				
Knuckle / 012-001-07 / XK1340	624	208	187 / 81	3.3:1 / 7.7:1
Lower control arm / 012-011 / 6061-T6	275	92	41 / 27	6.7:1 / 10:1

Strut clevis bracket / RRS-SL11 / 7075-T6	505	168	132 / 81	3.8:1 / 6.2:1
Strut leg tube / RRS-SL02 / AISI 1045	530	177	147 / 82	3.6:1 / 6.5:1
Lower spring seat / RRS-SL08 / 7075-T6	505	158	42 / 36	12:1 / 14:1
Upper spring seat / RRS-SL05 / 6061-T6	275	92	42 / 36	6.6:1 / 7.6:1
Strut top mount / RRS-SL17 / 6061-T6	275	92	70 / 69	3.9:1 / 4:1
OEM or equivalent parts (not in FEA scope, .: can be ignored)				
Ball joint pin / 012-005-02 / SCM435	785	262	306 / 111	2.6:1 / 7:1
Radius rod / 012-009-01 / AISI 4130 Steel	460	153	70 / 52	6.6:1 / 8.5:1
Ball joint housing / 012-005-01 / AISI 1020	352	118	121 / 85	2.9:1 / 4.1:1
Bearing hub / 012-007-1 / AISI 1020	352	118	120 / 24	2.9:1 / 15:1
Hub wheel mount / 012-007-2 / AISI 1020	352	118	106 / 50	3.3:1 / 7:1

Table 1 - Materials, Design Stress, Max Stress and Safety Factors

Considering the factors of safety and the VSB14 load conditions, braking and cornering forces corresponding to ‘g’ value of 0.3 and 0.25 respectively were applied to the assembly. These ‘g’ values represent typical driving conditions.

4. Required Design, Limitations and Configurations

4.1. Knuckle

Figure 4.1.1. - Strut clevis thickness 29mm

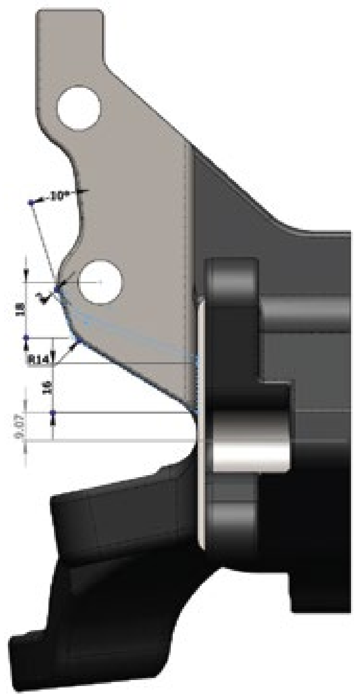


Figure 4.1.4.2. - Strut clevis profile additional material.

Figure 4.1.4.3. - Ball-joint lug thickness 24mm.

4.2. Strut Clevis Bracket

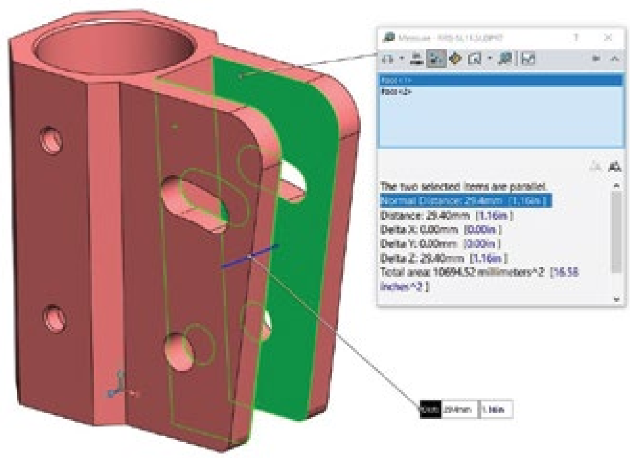


Figure 4.2.1 - Strut clevis plate distance 29mm.

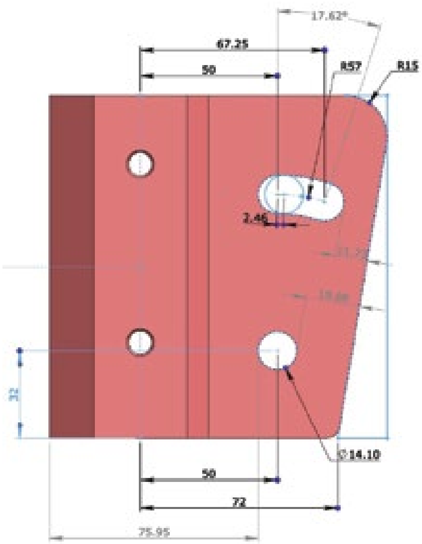


Figure 4.2.2 - Strut clevis bracket profile.

4.3. Wheel Offsets

To satisfy the 3:1 safety factor the wheel offset has to be limited from +40mm to +5mm, as shown in Figure 4.3 below.

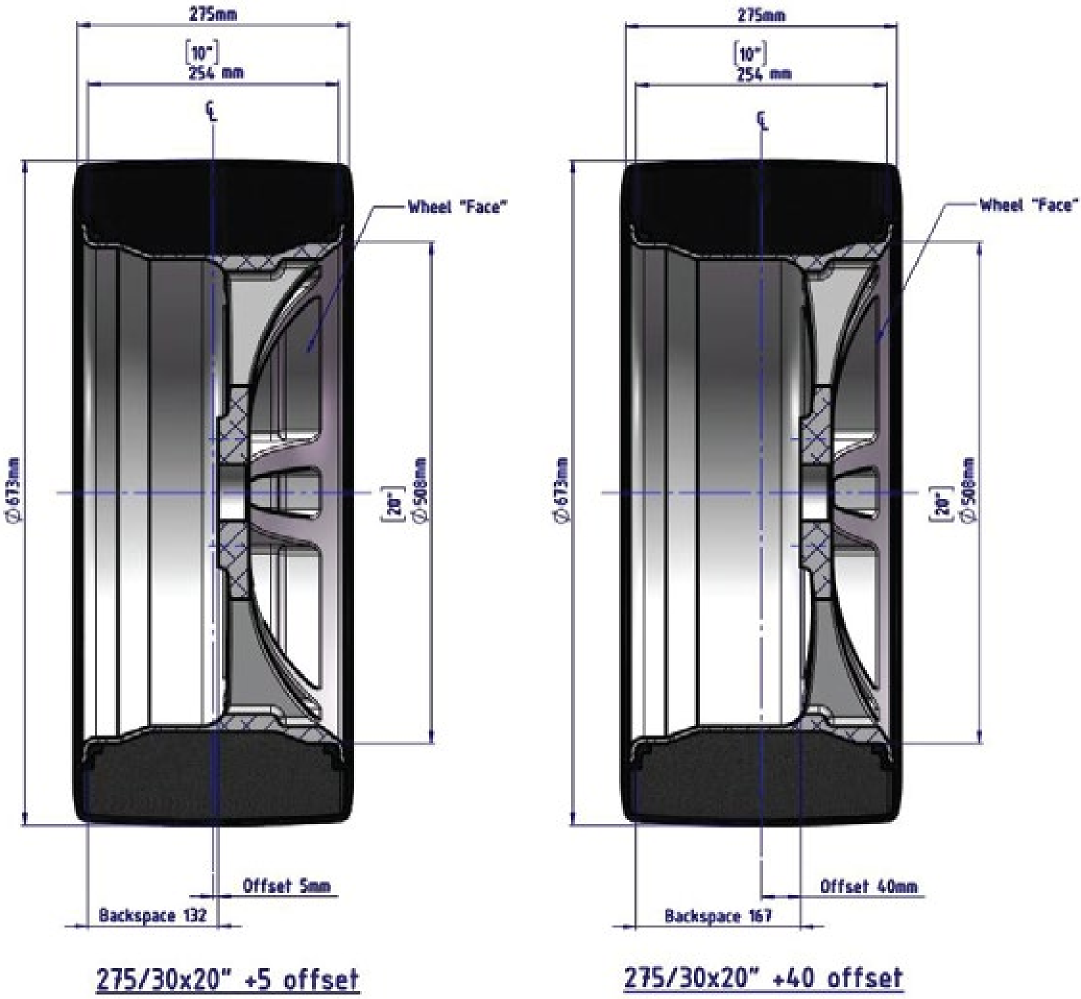


Figure 4.3 - Wheel Offset limitations

4.4. Wheel Diameter

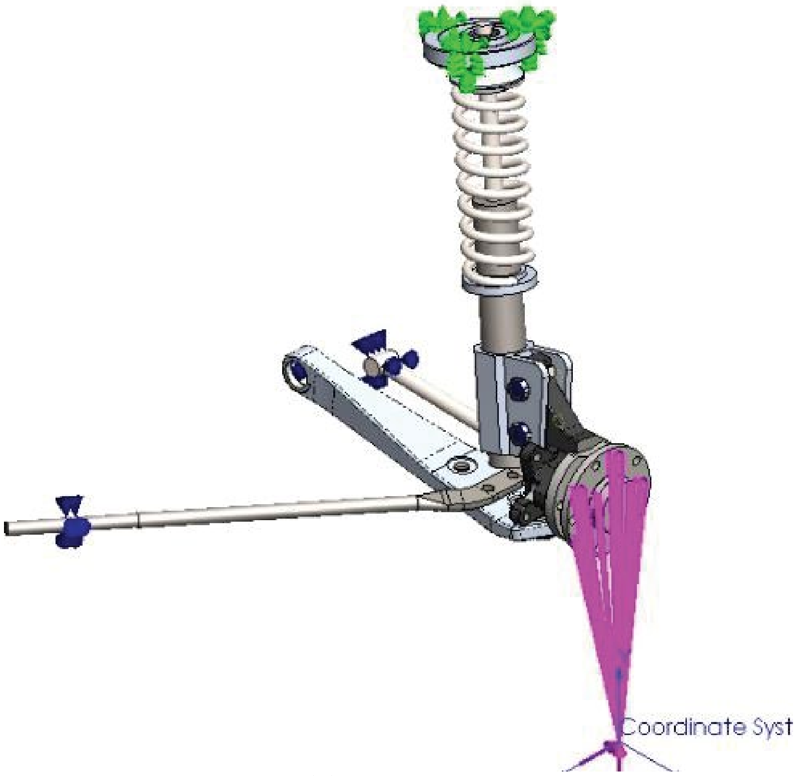
The maximum static loaded radius used in the calculations for this FEA was 336.5mm. As this is the loaded radius, this figure correlates to a maximum unloaded wheel diameter of Ø673mm.

5. FEA Study 1 - 0.3g Braking Condition

Simulation of 012-004

Date: 08 September 2019
Designer: W. Rogulski
Study name: Static BRAKING 30%g
Analysis type: Static

5.1. Model Information



Model name: 012-004
Current Configuration: FEA

Solid Bodies

Document Name and Reference	Treated As	Volumetric Properties	Document Path/Date Modified
Fillet138 	Solid Body	Mass:4.54926 kg Volume:0.00057805 m^3 Density:7,870 kg/m^3 Weight:44.5827 N	W:\CADtek\JOBS\012 RRS\012-001 Mustang hub\012-001-07\012-001-07.SLDPRT Sep 8 00:39:49 2019
SurfaceCut1	Solid Body	Mass:0.0266215 kg Volume:3.45734e-06 m^3 Density:7,700 kg/m^3 Weight:0.260891 N	W:\CADtek\JOBS\012 RRS\012-004 Mustang front suspension\012-004-01.SLDPRT Aug 24 15:03:10 2019

			
Fillet7	Solid Body	Mass:0.691137 kg Volume:8.74857e-05 m^3 Density:7,900 kg/m^3 Weight:6.77314 N	W:\CADtek\JOBS\012 RRS\012-005 Mustang Ball-joint\012-005-01.SLDPRT May 27 20:37:30 2019
Cut-Revolve2	Solid Body	Mass:0.272432 kg Volume:3.47047e-05 m^3 Density:7,850 kg/m^3 Weight:2.66983 N	W:\CADtek\JOBS\012 RRS\012-005 Mustang Ball-joint\012-005-02.SLDPRT Sep 7 23:33:18 2019
Revolve-Thin1	Solid Body	Mass:0.0277908 kg Volume:3.51782e-06 m^3 Density:7,900 kg/m^3 Weight:0.27235 N	W:\CADtek\JOBS\012 RRS\012-005 Mustang Ball-joint\012-005-03.SLDPRT Jul 29 14:50:07 2019
Revolve1	Solid Body	Mass:0.0124585 kg Volume:8.89895e-06 m^3 Density:1,400 kg/m^3 Weight:0.122094 N	W:\CADtek\JOBS\012 RRS\012-005 Mustang Ball-joint\012-005-04.sldprt Sep 7 23:34:28 2019
Boss-Extrude1	Solid Body	Mass:0.0405192 kg Volume:5.26223e-06 m^3 Density:7,700 kg/m^3 Weight:0.397088 N	W:\CADtek\JOBS\012 RRS\012-005 Mustang Ball-joint\012-005-05.sldprt Aug 23 15:49:26 2019
Boss-Extrude5	Solid Body	Mass:0.156447 kg Volume:2.03177e-05 m^3 Density:7,700 kg/m^3 Weight:1.53318 N	W:\CADtek\JOBS\012 RRS\012-006 Mustang front strut\012-006-01.SLDPRT Aug 26 19:53:32 2019
Boss-Extrude5	Solid Body	Mass:0.156447 kg Volume:2.03177e-05 m^3 Density:7,700 kg/m^3 Weight:1.53318 N	W:\CADtek\JOBS\012 RRS\012-006 Mustang front strut\012-006-01.SLDPRT Aug 26 19:53:32 2019
Boss-Extrude3	Solid Body	Mass:1.33349 kg Volume:0.00017318 m^3 Density:7,700 kg/m^3 Weight:13.0682 N	W:\CADtek\JOBS\012 RRS\012-006 Mustang front strut\KYB-765017-02.SLDPRT Aug 25 11:29:52 2019
Boss-Extrude2	Solid Body	Mass:2.18501 kg Volume:0.000278345 m^3 Density:7,850 kg/m^3 Weight:21.4131 N	W:\CADtek\JOBS\012 RRS\012-006 Mustang front strut\RRS-SL02.SLDPRT Aug 13 15:01:30 2019
Cut-Extrude1	Solid Body	Mass:0.214938 kg Volume:7.96067e-05 m^3	W:\CADtek\JOBS\012 RRS\012-006 Mustang

RRS PTY LTD.
57/42-46 Wattle Road
Brookvale NSW 2100
Sydney Australia
Ph: 61 2 9907 3755
Mob 61 417 226 693
Email: alex@rrs-online.com

		Density:2,700 kg/m^3 Weight:2.10639 N	front strut\RRS-SL05.SLDPRT Aug 2 20:03:17 2019
Cut-Extrude5	Solid Body	Mass:0.923651 kg Volume:0.000328702 m^3 Density:2,810 kg/m^3 Weight:9.05178 N	W:\CADtek\JOBS\012 RRS\012-006 Mustang front strut\RRS-SL11.SLDPRT Aug 26 19:51:46 2019
Imported1	Solid Body	Mass:0.098507 kg Volume:1.27975e-05 m^3 Density:7,697.39 kg/m^3 Weight:0.965368 N	W:\CAD Library\BEARINGS\SKF\GEH-20-C_GEH 20 C-part1.sldprt Aug 20 13:44:57 2019
Imported1	Solid Body	Mass:0.0568692 kg Volume:7.3828e-06 m^3 Density:7,702.92 kg/m^3 Weight:0.557318 N	W:\CAD Library\BEARINGS\SKF\GEH-20-C_GEH 20 C-part2.sldprt Aug 20 13:44:56 2019
Chamfer3	Solid Body	Mass:0.560695 kg Volume:0.000207665 m^3 Density:2,700 kg/m^3 Weight:5.49481 N	W:\CADtek\JOBS\012 RRS\012-006 Mustang front strut\RRS-SL17.SLDPRT Sep 8 01:20:22 2019
Boss-Extrude5	Solid Body	Mass:1.04252 kg Volume:0.000131965 m^3 Density:7,900 kg/m^3 Weight:10.2167 N	W:\CADtek\JOBS\012 RRS\012-007 Mustang Bearing Hub\012-007-1.SLDPRT Sep 7 22:37:03 2019
Boss-Extrude7	Solid Body	Mass:2.38132 kg Volume:0.000301433 m^3 Density:7,900 kg/m^3 Weight:23.3369 N	W:\CADtek\JOBS\012 RRS\012-007 Mustang Bearing Hub\012-007-2.SLDPRT Aug 13 15:03:19 2019
Boss-Extrude1	Solid Body	Mass:0.359225 kg Volume:4.66527e-05 m^3 Density:7,700 kg/m^3 Weight:3.52041 N	W:\CADtek\JOBS\012 RRS\012-007 Mustang Bearing Hub\012-007-6.SLDPRT Jul 31 23:30:58 2019
Split Line1	Solid Body	Mass:1.49507 kg Volume:0.000190457 m^3 Density:7,849.94 kg/m^3 Weight:14.6517 N	W:\CADtek\JOBS\012 RRS\012-009 Mustang front radius rod\012-009-01.SLDPRT Jul 31 15:53:45 2019
Combine2 	Solid Body	Mass:1.38994 kg Volume:0.000514795 m^3 Density:2,699.99 kg/m^3 Weight:13.6214 N	W:\CADtek\JOBS\012 RRS\012-011 Mustang fr lwr ctrl arm\012-011.SLDPRT Jul 29 14:48:16 2019
Boss-Extrude3	Solid Body	Mass:0.324588 kg Volume:4.21543e-05 m^3 Density:7,700 kg/m^3	W:\CADtek\JOBS\012 RRS\012-020 Mustang

		Weight:3.18097 N	Steering Arm\012-020-01.SLDPRT Aug 29 20:44:53 2019
Sweep2	Solid Body	Mass:1.3503 kg Volume:0.000175337 m^3 Density:7,701.19 kg/m^3 Weight:13.233 N	W:\CADtek\JOBS\012 RRS\012-020 Mustang Steering Arm\012-020-02.SLDPRT Aug 21 22:42:28 2019

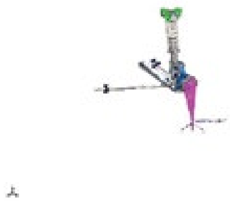
5.2. Study Properties

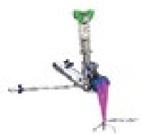
Study name	Static BRAKING 30%g
Analysis type	Static
Mesh type	Mixed Mesh
Thermal Effect:	On
Thermal option	Include temperature loads
Zero strain temperature	298 Kelvin
Include fluid pressure effects from SOLIDWORKS Flow Simulation	Off
Solver type	Automatic
Inplane Effect:	Off
Soft Spring:	Off
Inertial Relief:	Off
Incompatible bonding options	Automatic
Large displacement	Off
Compute free body forces	Off
Friction	Off
Use Adaptive Method:	Off
Result folder	SOLIDWORKS document (W:\CADtek\JOBS\012 RRS\012-004 Mustang front suspension\Simulation Results\Static BRAKING 30%g)

5.3. Units

Unit system:	SI (MKS)
Length/Displacement	m
Temperature	Celsius
Angular velocity	Rad/sec
Pressure/Stress	N/mm^2 (MPa)

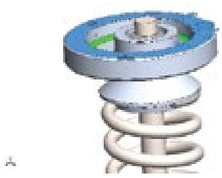
5.4. Material Properties

Model Reference	Properties		Components
	**Name:** **Model type:** **Default failure criterion:** **Yield strength:** **Tensile strength:** **Elastic modulus:** **Poisson's ratio:** **Mass density:** **Shear modulus:**	XK1340 +QT 830°C, 540°C Linear Elastic Isotropic Max von Mises Stress 624 N/mm^2 827 N/mm^2 200,000 N/mm^2 0.29 7.87 g/cm^3 80,000 N/mm^2	SolidBody 1(Fillet138)(012-001-07-1)
Curve Data:N/A			
	**Name:** **Model type:** **Default failure criterion:** **Yield strength:** **Tensile strength:** **Elastic modulus:** **Poisson's ratio:** **Mass density:** **Shear modulus:** **Thermal expansion coefficient:**	Alloy Steel Linear Elastic Isotropic Unknown 620.422 N/mm^2 723.826 N/mm^2 210,000 N/mm^2 0.28 7.7 g/cm^3 79,000 N/mm^2 1.3e-05 /Kelvin	SolidBody 1(SurfaceCut1)(012-004-01-1), SolidBody 1(Boss-Extrude1)(012-005-1/012-005-05-1), SolidBody 1(Boss-Extrude5)(012-006-1/012-006-01-1), SolidBody 1(Boss-Extrude5)(012-006-1/012-006-01-2), SolidBody 1(Boss-Extrude3)(012-006-1/KYB-765017-1/KYB-765017-02-1), SolidBody 1(Imported1)(012-006-1/RRS-SL17-1/GEH 20 C-1/_GEH 20 C-part1-1), SolidBody 1(Imported1)(012-006-1/RRS-SL17-1/GEH 20 C-1/_GEH 20 C-part2-1), SolidBody 1(Cut-Extrude1)(012-006-1/RRS-SL18-1), SolidBody 1(Boss-Extrude1)(012-007-1/012-007-6-1), SolidBody 1(Boss-Extrude3)(012-020-1/012-020-01-1), SolidBody 1(Sweep2)(012-020-1/012-020-02-1)
Curve Data:N/A			

	**Name:** AISI 1020 **Model type:** Linear Elastic Isotropic **Default failure criterion:** Max von Mises Stress **Yield strength:** 351.571 N/mm^2 **Tensile strength:** 420.507 N/mm^2 **Elastic modulus:** 200,000 N/mm^2 **Poisson's ratio:** 0.29 **Mass density:** 7.9 g/cm^3 **Shear modulus:** 77,000 N/mm^2 **Thermal expansion coefficient:** 1.5e-05 /Kelvin	SolidBody 1(Fillet7)(012-005-1/012-005-01-1), SolidBody 1(Revolve-Thin1)(012-005-1/012-005-03-1), SolidBody 1(Boss-Extrude5)(012-007-1/012-007-1-1), SolidBody 1(Boss-Extrude7)(012-007-1/012-007-2-1)
Curve Data:N/A		
	**Name:** SCM435 Steel **Model type:** Linear Elastic Isotropic **Default failure criterion:** Max von Mises Stress **Yield strength:** 785 N/mm^2 **Tensile strength:** 930 N/mm^2 **Elastic modulus:** 205,000 N/mm^2 **Poisson's ratio:** 0.3 **Mass density:** 7.85 g/cm^3 **Shear modulus:** 80,000 N/mm^2 **Thermal expansion coefficient:** 1.23e-05 /Kelvin	SolidBody 1(Cut-Revolve2)(012-005-1/012-005-02-1)
Curve Data:N/A		
	**Name:** Nylon 6/10 **Model type:** Linear Elastic Isotropic **Default failure criterion:** Max von Mises Stress **Yield strength:** 139.043 N/mm^2 **Tensile strength:** 142.559 N/mm^2 **Elastic modulus:** 8,300 N/mm^2 **Poisson's ratio:** 0.28 **Mass density:** 1.4 g/cm^3 **Shear modulus:** 3,200 N/mm^2 **Thermal expansion coefficient:** 3e-05 /Kelvin	SolidBody 1(Revolve1)(012-005-1/012-005-04-1)
Curve Data:N/A		
	**Name:** AISI 1045 Steel, cold drawn **Model type:** Linear Elastic Isotropic **Default failure criterion:** Unknown **Yield strength:** 530 N/mm^2 **Tensile strength:** 625 N/mm^2 **Elastic modulus:** 205,000 N/mm^2 **Poisson's ratio:** 0.29 **Mass density:** 7.85 g/cm^3 **Shear modulus:** 80,000 N/mm^2 **Thermal expansion coefficient:** 1.2e-05 /Kelvin	SolidBody 1(Boss-Extrude2)(012-006-1/RRS-SL02-1)
Curve Data:N/A		

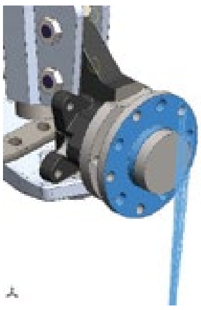
	**Name:** 6061-T6 (SS) **Model type:** Linear Elastic Isotropic **Default failure criterion:** Unknown **Yield strength:** 275 N/mm^2 **Tensile strength:** 310 N/mm^2 **Elastic modulus:** 69,000 N/mm^2 **Poisson's ratio:** 0.33 **Mass density:** 2.7 g/cm^3 **Shear modulus:** 26,000 N/mm^2 **Thermal expansion coefficient:** 2.4e-05 /Kelvin	SolidBody 1(Cut-Extrude1)(012-006-1/RRS-SL05-1), SolidBody 1(Chamfer3)(012-006-1/RRS-SL17-1/RRS-SL17-1), SolidBody 1(Combine2)(012-011-1)
Curve Data:N/A		
	**Name:** 7075-T6 (SN) **Model type:** Linear Elastic Isotropic **Default failure criterion:** Unknown **Yield strength:** 505 N/mm^2 **Tensile strength:** 570 N/mm^2 **Elastic modulus:** 72,000 N/mm^2 **Poisson's ratio:** 0.33 **Mass density:** 2.81 g/cm^3 **Shear modulus:** 26,900 N/mm^2 **Thermal expansion coefficient:** 2.4e-05 /Kelvin	SolidBody 1(Boss-Extrude2)(012-006-1/RRS-SL08-1), SolidBody 1(Cut-Extrude5)(012-006-1/RRS-SL11-1)
Curve Data:N/A		
	**Name:** AISI 4130 Steel, normalized at 870C **Model type:** Linear Elastic Isotropic **Default failure criterion:** Unknown **Yield strength:** 460 N/mm^2 **Tensile strength:** 731 N/mm^2 **Elastic modulus:** 205,000 N/mm^2 **Poisson's ratio:** 0.285 **Mass density:** 7.85 g/cm^3 **Shear modulus:** 80,000 N/mm^2	SolidBody 1(Split Line1)(012-009-1/012-009-01-1)
Curve Data:N/A		

5.5. Loads and Fixtures

Fixture name	Fixture Image	Fixture Details
Fixed-1		**Entities:** 4 face(s) **Type:** Fixed Geometry

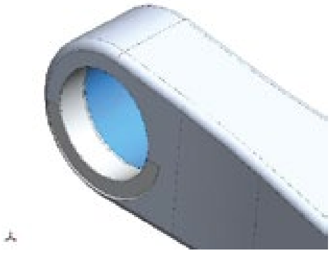
Resultant Forces

Components	X	Y	Z	Resultant
Reaction force(N)	5,063.41	-8,726.13	298.167	10,093.2
Reaction Moment(N.m)	0	0	0	1e-33

Load name	Load Image	Load Details
Remote Load/Mass (Rigid connection)-3 SKID LOAD (1g vertical & 0.3g longitudinal)		**Entities:** 7 face(s) **Connection Type:** Rigid **Coordinate System:** Coordinate System1 **Translational Components:** ---,8,820 N,-2,646 N **Rotational Components:** ---,---,--- **Reference coordinates:** 0 0 0 mm

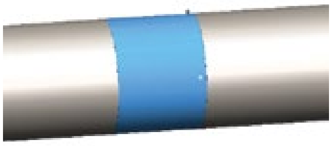
5.6. Connector Definitions

Pin/Bolt/Bearing Connector

Model Reference	Connector Details	Strength Details
 Bearing Support-5	**Entities:** 1 face(s) **Type:** Bearing	No Data

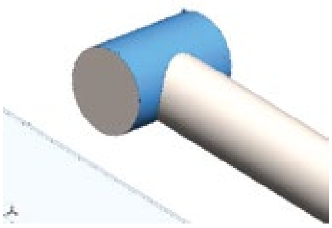
Connector Forces

Type	X-Component	Y-Component	Z-Component	Resultant
Axial Force (N)	-1.505	-7.9022	-179.03	-179.21
Shear Force (N)	-2,857.8	-216.75	33.591	2,866.2
Bending moment (N.m)	7.9219e-07	2.9996e-07	-1.9899e-08	8.4731e-07

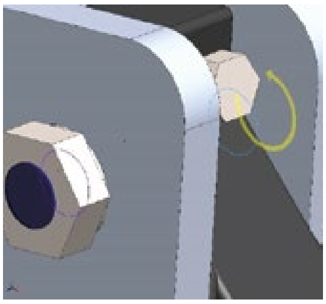
Model Reference	Connector Details	Strength Details
 Bearing Support-6	**Entities:** 1 face(s) **Type:** Bearing	No Data

Connector Forces

Type	X-Component	Y-Component	Z-Component	Resultant
Axial Force (N)	-1,722	154.73	2,500.2	3,039.7
Shear Force (N)	-2.133	2.4958	-1.6236	3.697
Bending moment (N.m)	-7.8802e-06	-6.3042e-05	-1.5258e-06	6.3551e-05

Model Reference	Connector Details	Strength Details
 Bearing Support-4	**Entities:** 1 face(s) **Type:** Bearing	No Data

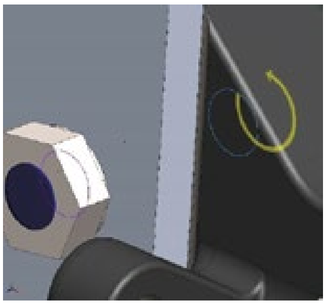
Connector Forces				
Type	X-Component	Y-Component	Z-Component	Resultant
Axial Force (N)	-0.22221	-2.8632	-16.093	-16.348
Shear Force (N)	-479.73	-23.569	10.817	480.43
Bending moment (N.m)	-1.7652e-07	1.2795e-08	1.6085e-10	1.7699e-07



Counterbore with Nut-1

Entities:	2 edge(s), 2 face(s)	No Data
Type:	Bolt(Head/Nut diameter)(Counterbore)	
Head diameter:	21.75 mm	
Nut diameter:	21.75 mm	
Nominal shank diameter:	14.5 mm	
Preload (Torque):	160	
Young's modulus:	2.1e+11	
Poisson's ratio:	0.28	
Preload units:	N.m	

Connector Forces				
Type	X-Component	Y-Component	Z-Component	Resultant
Axial Force (N)	845.72	-9,355.4	-54,371	55,177
Shear Force (N)	124.73	-57.802	11.886	137.99
Bending moment (N.m)	-0.44304	-0.95087	0.15672	1.0607

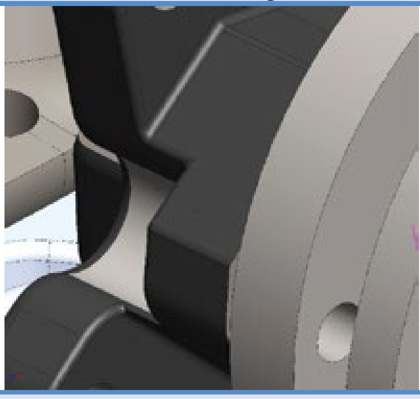


Counterbore with Nut-2

Entities:	2 edge(s), 2 face(s)	No Data
Type:	Bolt(Head/Nut diameter)(Counterbore)	
Head diameter:	0.02175 m	
Nut diameter:	0.02175 m	
Nominal shank diameter:	0.0145 m	
Preload (Torque):	160	
Young's modulus:	2.1e+11	
Poisson's ratio:	0.28	
Preload units:	N.m	

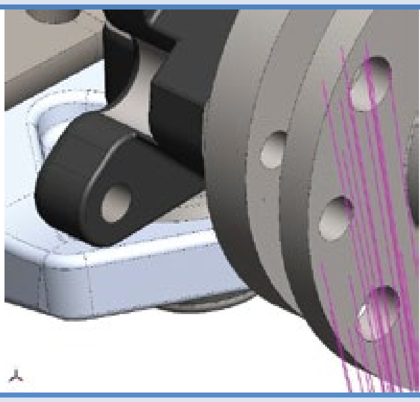
Connector Forces				
Type	X-Component	Y-Component	Z-Component	Resultant
Axial Force (N)	845.53	-9,352.5	-54,354	55,160
Shear Force (N)	-47.582	-90.43	14.82	103.25
Bending moment (N.m)	-0.77804	0.27987	-0.060258	0.82904

5.7. Contact Information

Contact	Contact Image	Contact Properties
Contact Set-13554		**Type:** Bonded contact pair **Entities:** 2 face(s) **Friction Value:** 0.2

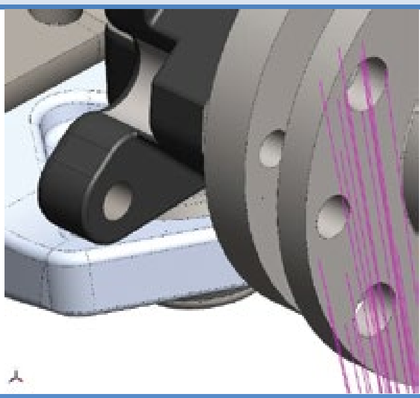
Contact/Friction force

Components	X	Y	Z	Resultant
Contact Force(N)	0.28268	-0.90542	0.16019	0.96195

Contact	Contact Image	Contact Properties
Contact Set-13845		**Type:** No Penetration contact pair **Entities:** 2 face(s) **Advanced:** Node to surface

Contact/Friction force

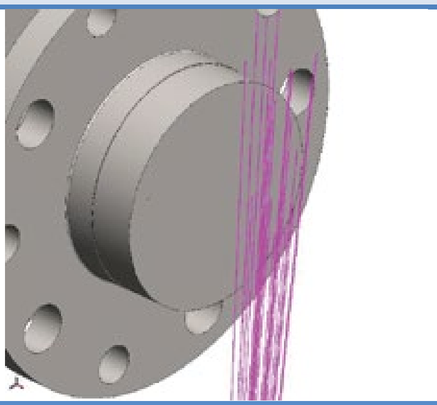
Components	X	Y	Z	Resultant
Contact Force(N)	-1,516.9	1,346.2	63.416	2,029.2

Contact	Contact Image	Contact Properties
Contact Set-13846		**Type:** No Penetration contact pair **Entities:** 2 face(s) **Advanced:** Node to surface

Contact/Friction force

Components	X	Y	Z	Resultant
Contact Force(N)	-3,066.5	-1,413.7	2,289.7	4,079.8

Contact Set-13847

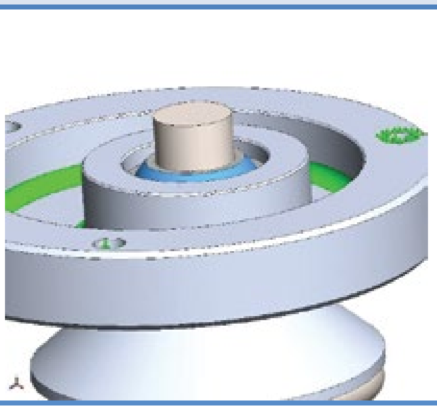


Type: No Penetration contact pair
Entities: 2 face(s)
Advanced: Surface to surface

Contact/Friction force

Components	X	Y	Z	Resultant
Contact Force(N)	-3.284E-13	2.893E-13	3.0176E-13	5.316E-13

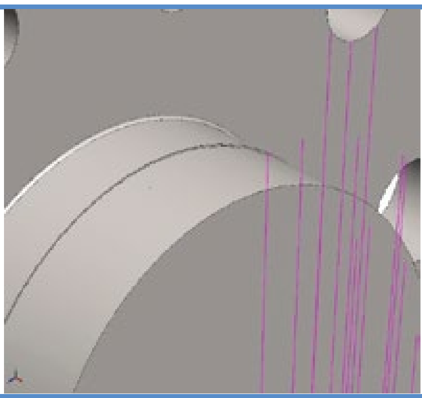
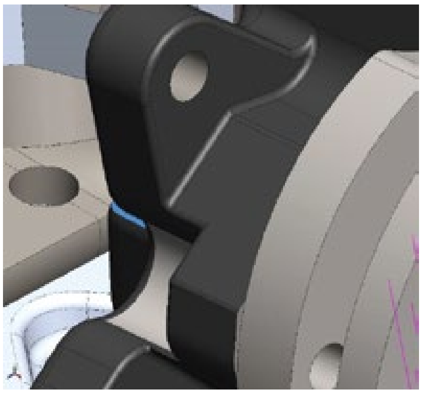
Contact Set-13848



Type: No Penetration contact pair
Entities: 2 face(s)
Advanced: Surface to surface

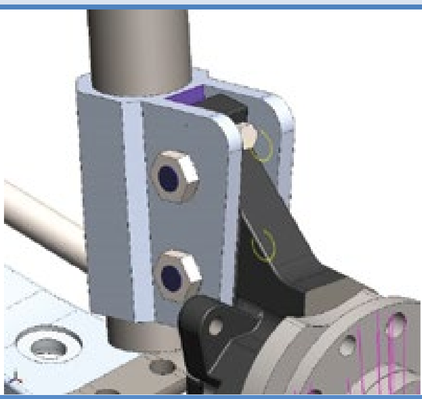
Contact/Friction force

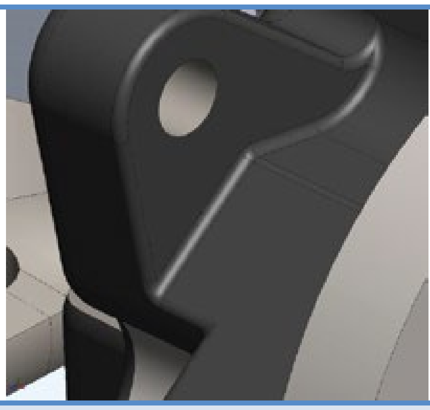
Components	X	Y	Z	Resultant
Contact Force(N)	-8.4079E-12	-3.8811E-12	3.7511E-12	9.9913E-12

Contact Set-16247		**Type:** Bonded contact pair **Entities:** 2 face(s)
Contact Set-16525		**Type:** No Penetration contact pair **Entities:** 2 face(s) **Advanced:** Node to surface

Contact/Friction force

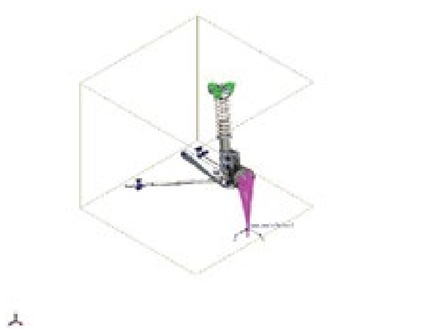
Components	X	Y	Z	Resultant
Contact Force(N)	3.5055E-14	1.0214E-13	2.5924E-14	1.1106E-13

Contact Set-19226		**Type:** Bonded contact pair **Entities:** 2 face(s)

Contact Set-24949		**Type:** Bonded contact pair **Entities:** 2 face(s)

Contact/Friction force

Components	X	Y	Z	Resultant
Contact Force(N)	1.7373	-5.5648	0.98455	5.9123

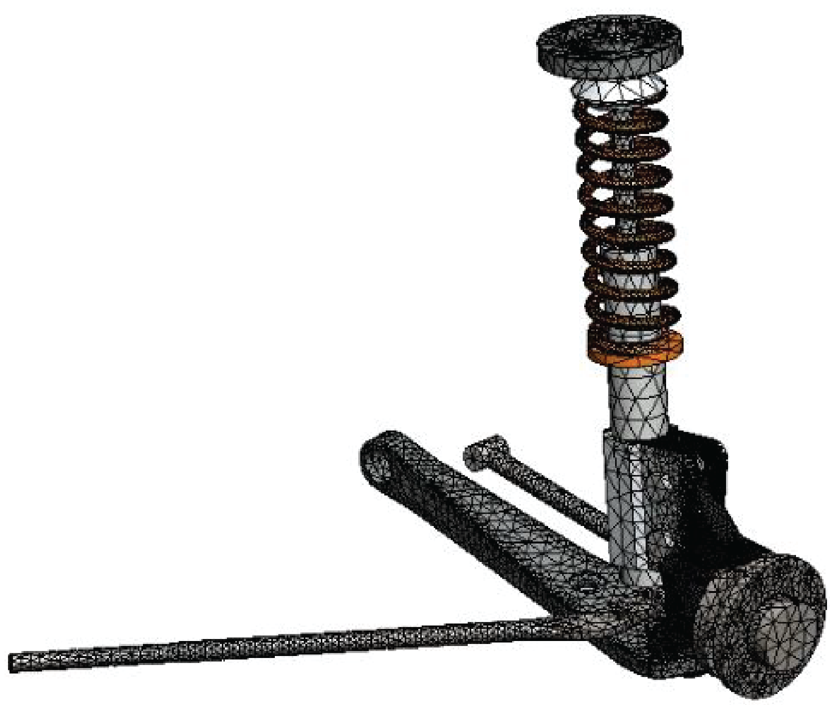
Global Contact		**Type:** Bonded **Components:** 1 component(s) **Options:** Incompatible mesh
Component Contact-1		**Type:** Bonded **Components:** 2 component(s), 3 Solid Body (s) **Options:** Incompatible mesh

5.8. Mesh information

Mesh type	Mixed Mesh
Mesher Used:	Curvature-based mesh
Jacobian points	4 Points
Jacobian check for shell	On
Maximum element size	36.131 mm
Minimum element size	7.2262 mm
Mesh Quality Plot	High
Remesh failed parts with incompatible mesh	Off

Mesh information - Details

Total Nodes	267878
Total Elements	162417
Time to complete mesh(hh;mm;ss):	00:00:05
Computer name:	DUPA-JASIU-03

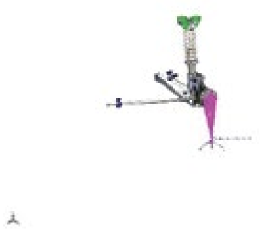


Mesh Control Information:

Mesh Control Name	Mesh Control Image	Mesh Control Details
Control-1		**Entities:** 1 Solid Body (s) **Units:** mm **Size:** 5 **Ratio:** 5
Control-2		**Entities:** 2 face(s) **Units:** mm **Size:** 2.5 **Ratio:** 2.5
Control-3		**Entities:** 5 face(s) **Units:** mm **Size:** 3 **Ratio:** 3

Control-4		**Entities:** 1 face(s) **Units:** mm **Size:** 3 **Ratio:** 3
Control-5		**Entities:** 1 face(s) **Units:** mm **Size:** 2 **Ratio:** 2
Control-36		**Entities:** 5 face(s) **Units:** mm **Size:** 2.5 **Ratio:** 2.5

5.9. Sensor Details

Sensor name	Location	Sensor Details
Stress1		Value : 3.06e+08 N/m^2 Entities : Result :Stress Component :VON: von Mises Stress Criterion :Model Max Step Criterion : Across all Steps Step No.:1 Alert Value: is greater than 2 N/m^2
Stress2		Value : 3.06e+08 N/m^2 Entities : Result :Stress Component :VON: von Mises Stress Criterion :Model Max Step Criterion : Across all Steps Step No.:1 Alert Value: is greater than 2 N/m^2

5.10. Resultant Forces

Reaction forces

Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Model	N	5,063.41	-8,726.13	298.167	10,093.2

Reaction Moments

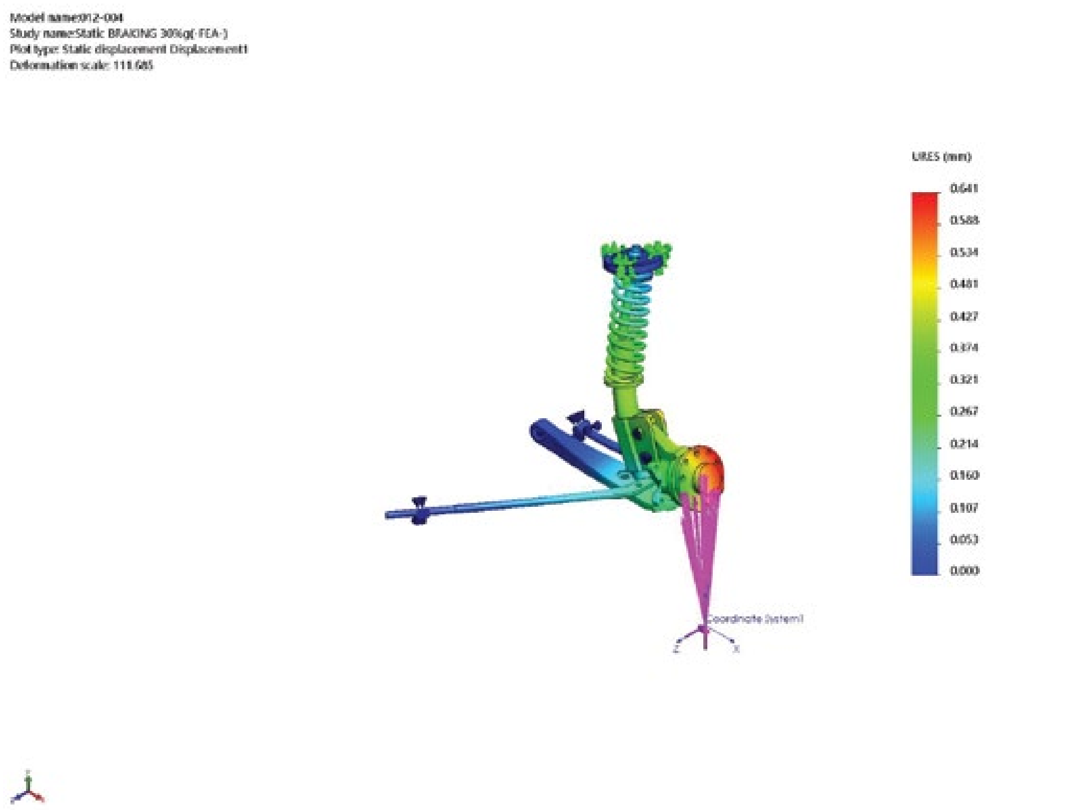
Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Model	N.m	0	0	0	1e-33

5.11. Beams

No Data

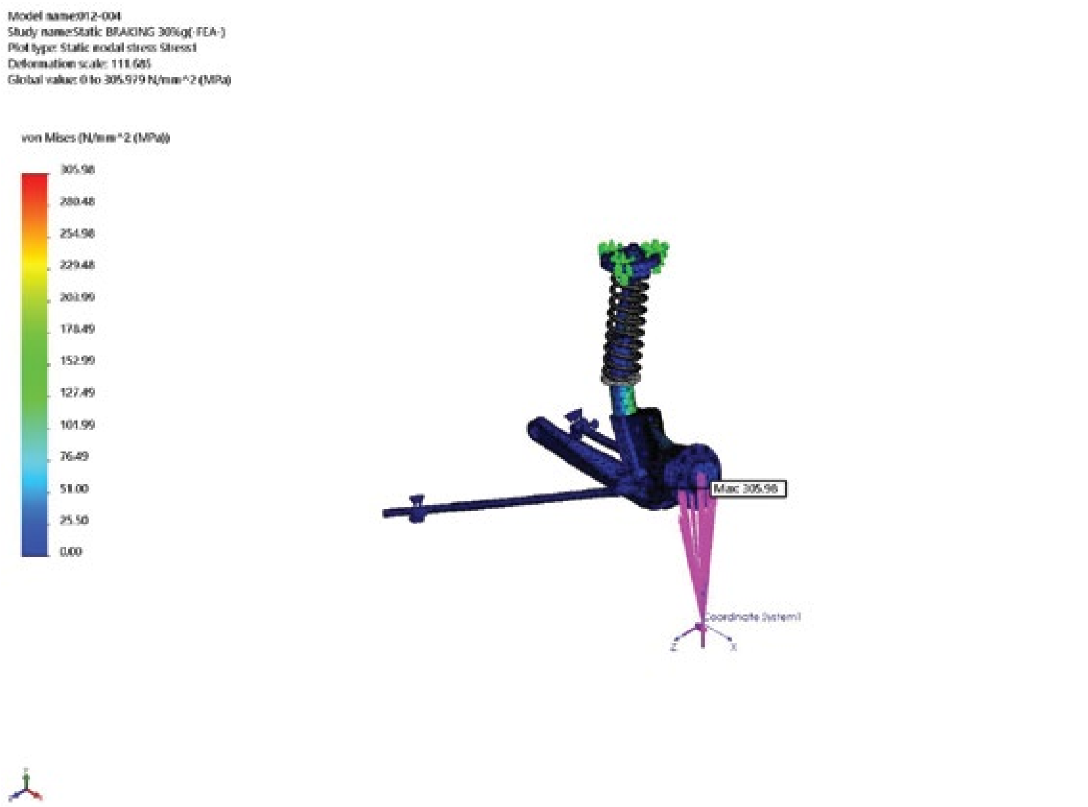
5.12. Study Results

Name	Type	Min	Max
Displacement1	URES: Resultant Displacement	0.000 mm Node: 67729	0.641 mm Node: 92674



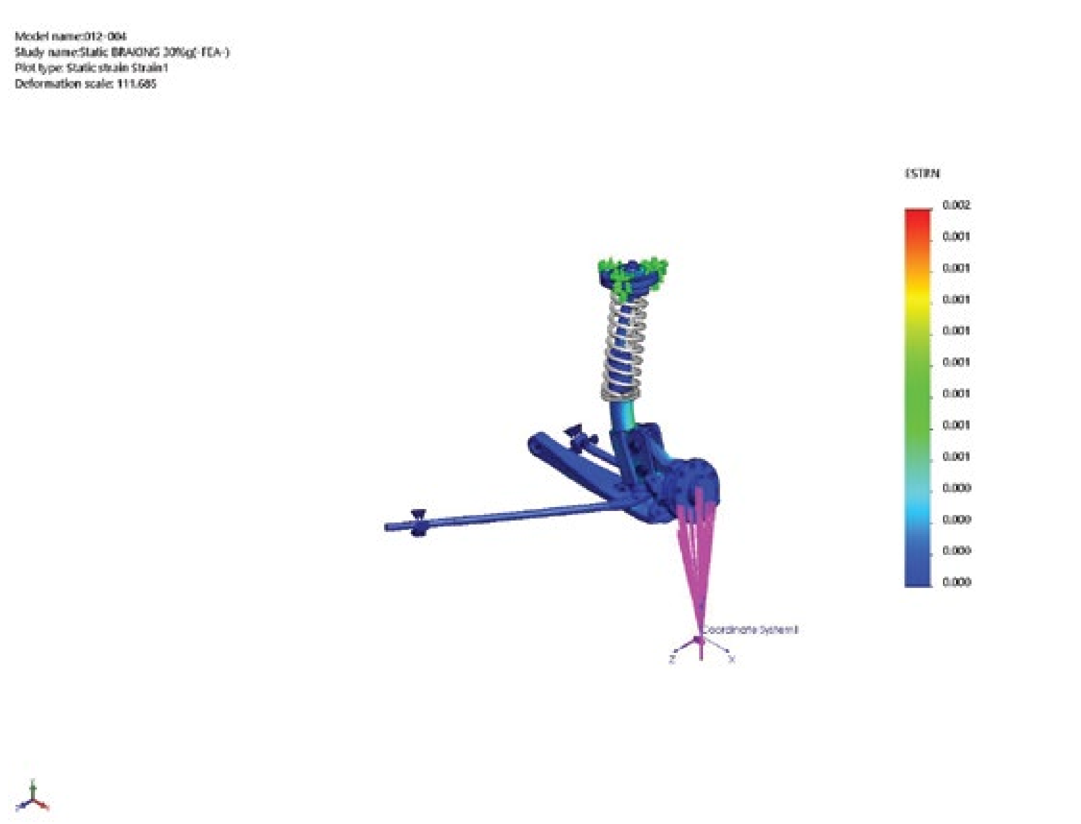
012-004-Static BRAKING 30%g-Displacement-Displacement1

Name	Type	Min	Max
Stress1	VON: von Mises Stress	0.00 N/mm^2 (MPa) Node: 24523	305.98 N/mm^2 (MPa) Node: 11792



012-004-Static BRAKING 30%g-Stress-Stress1

Name	Type	Min	Max
Strain1	ESTRN: Equivalent Strain	0.000 Node: 24523	0.002 Node: 31532



012-004-Static BRAKING 30%g-Strain-Strain1

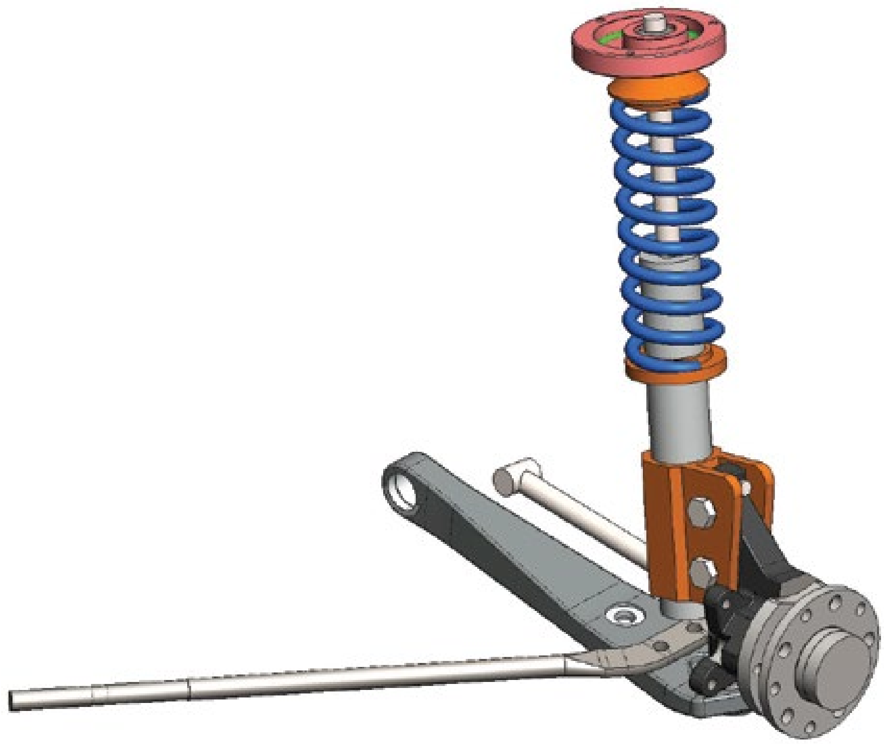


Image-18 - **Front suspension system, half axle - Isometric view.**

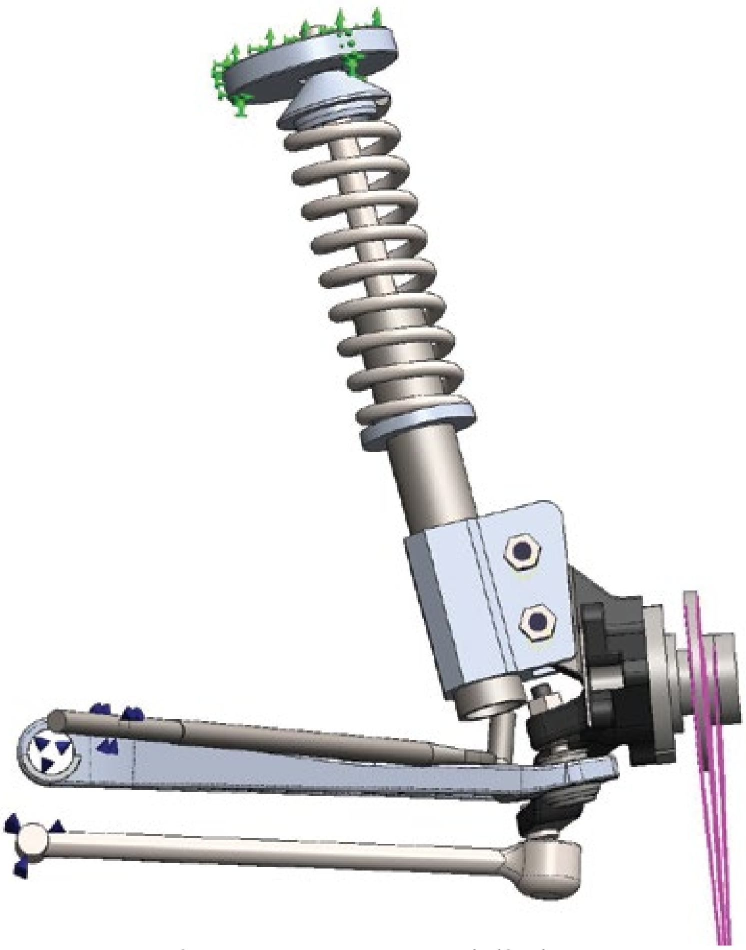


Image-19 - **Front suspension system, half axle - Front view.**

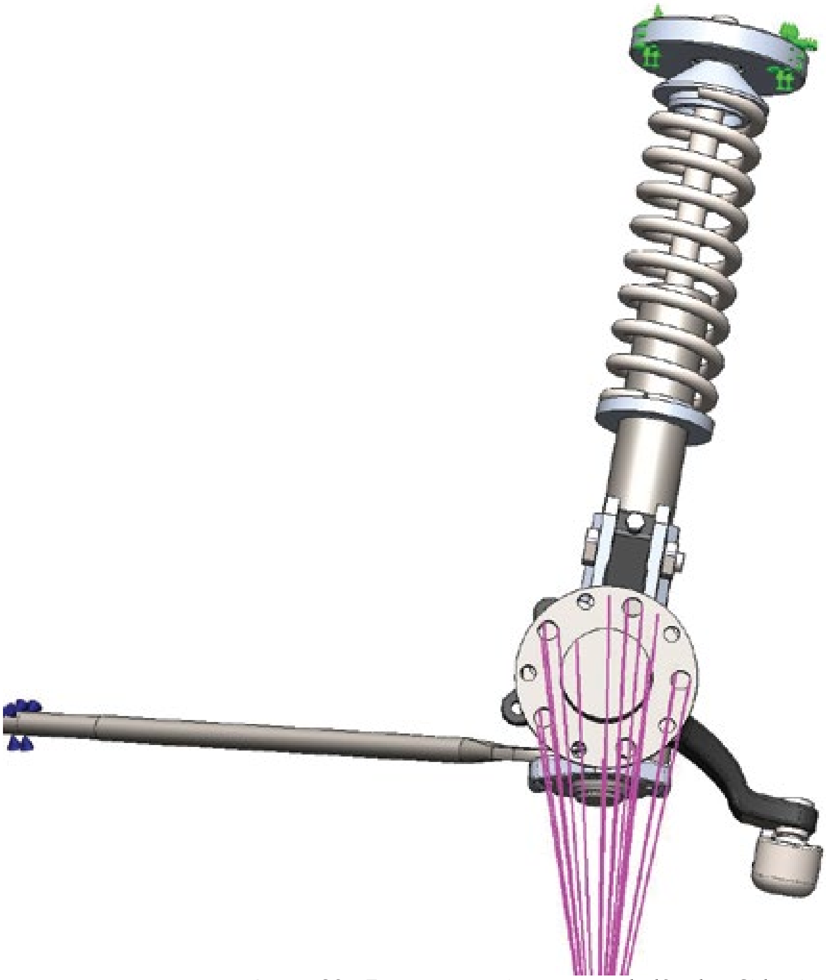


Image-20 - **Front suspension system, half axle - Side view.**

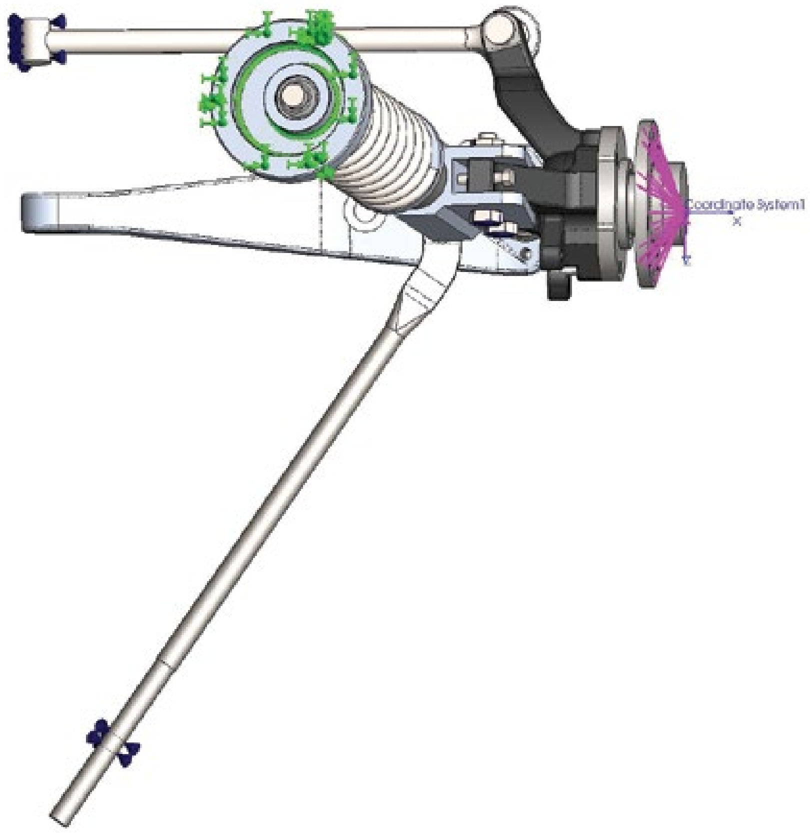


Image-21 - **Front suspension system, half axle - Top view.**

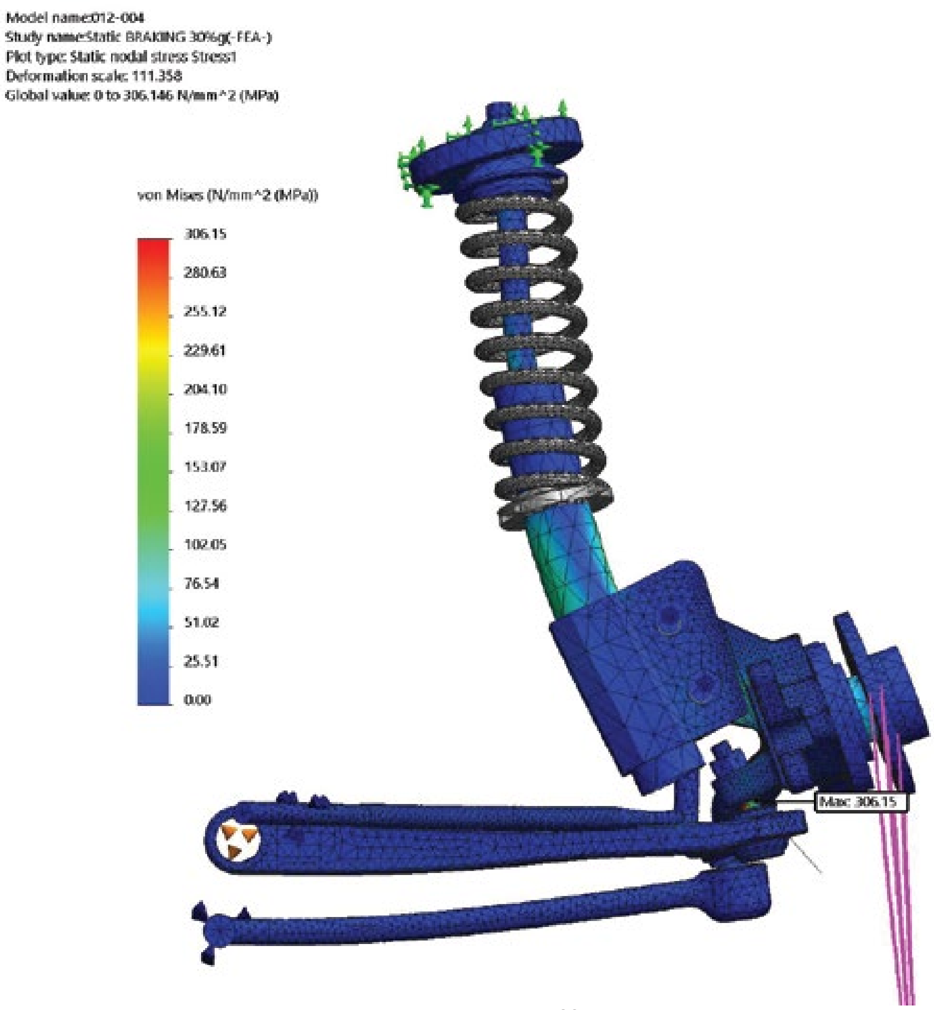

Model name:012-004
Study name:Static BRAKING 30%g(-FEA-)
Plot type: Static nodal stress Stress1
Deformation scale: 111.358
Global value: 0 to 306.146 N/mm^2 (MPa)
von Mises (N/mm^2 (MPa))
306.15
280.63
255.12
229.61
204.10
178.59
153.07
127.56
102.05
76.54
51.02
25.51
0.00
Max: 306.15

Image-23

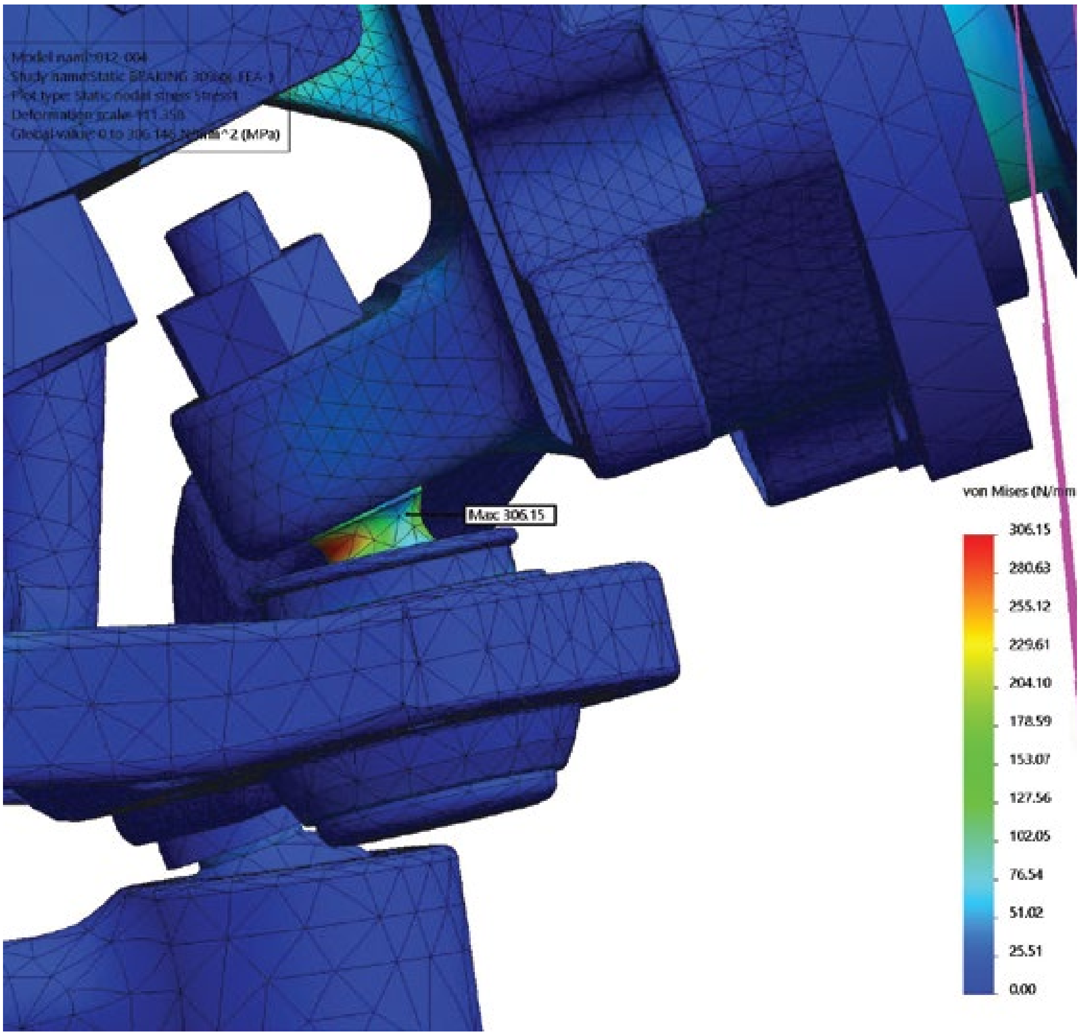


Image-24 – Ball joint pin, max Stress 306MPa

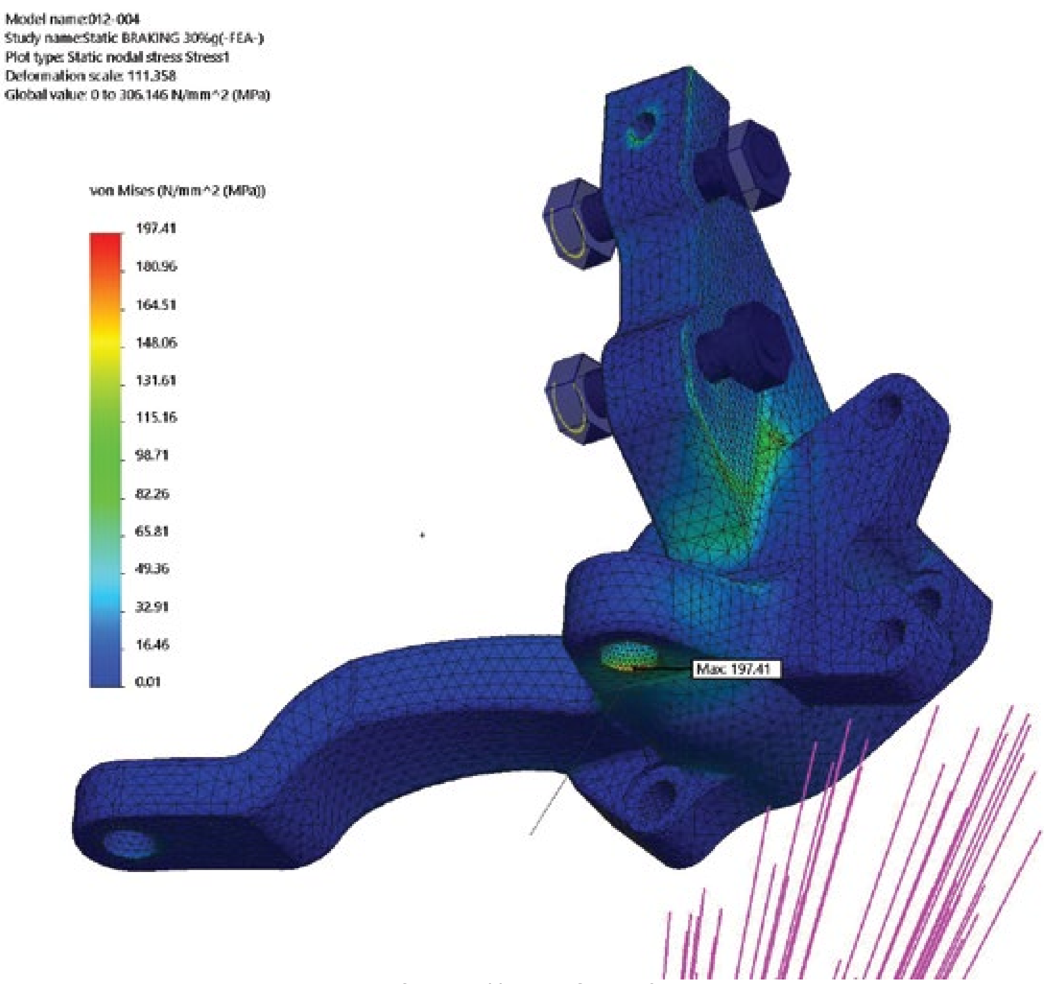


Image-25 - Knuckle, max Stress 197MPa

Model name:012-004
Study name:Static BRAKING 30%g(-FEA-)
Plot type: Static nodal stress Stress1
Deformation scale: 111.358
Global value: 0 to 306.146 N/mm^2 (MPa)

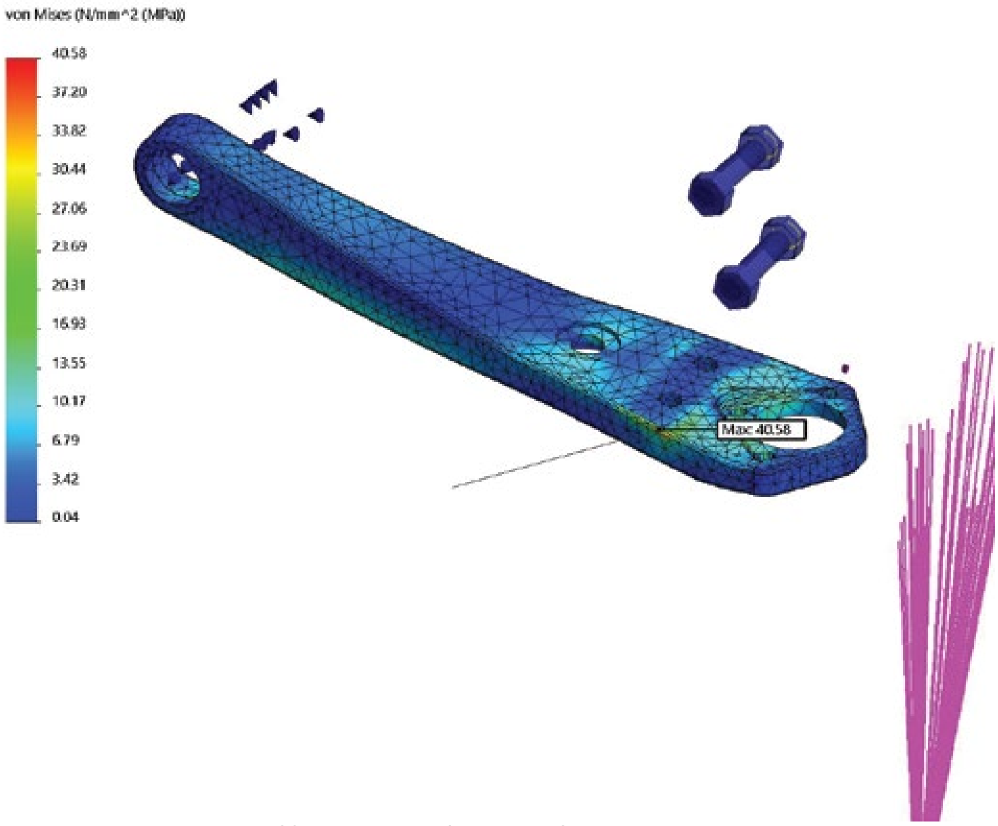


Image-28 – Lower control arm, max Stress 41MPa

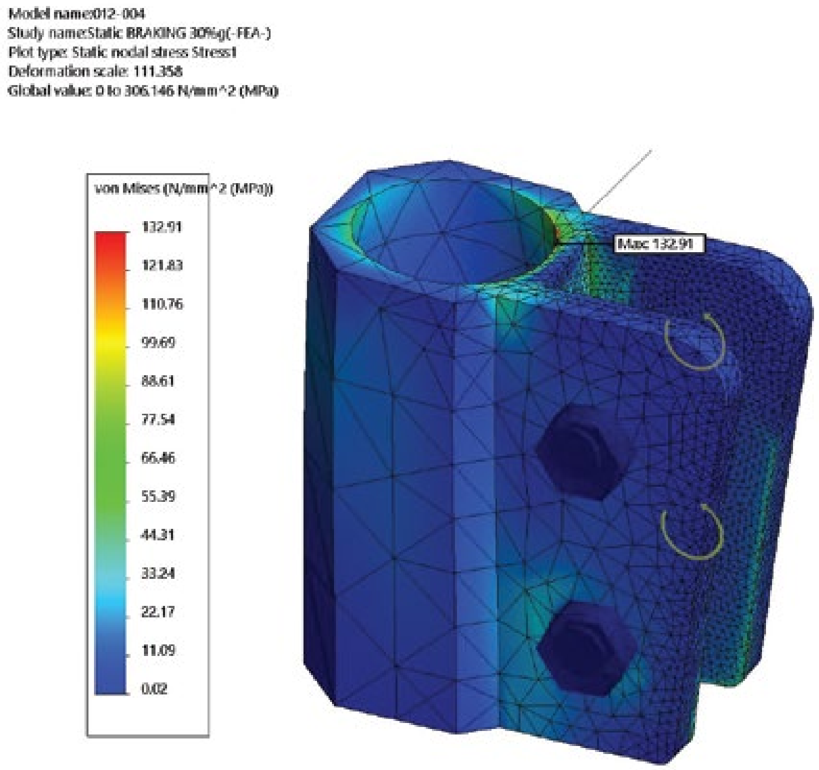


Image-30 – Strut Clevis Bracket, max Stress 133MPa.

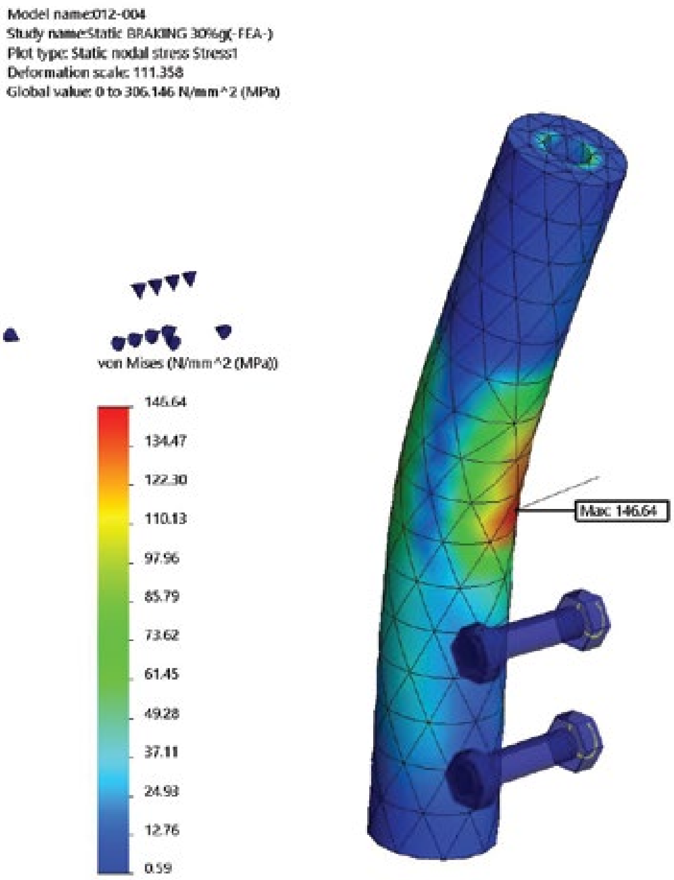


Image-31 – Strut Tube, max Stress 147MPa

Model name:012-004
Study name:Static BRAKING 30%g(-FEA-)
Plot type: Static nodal stress Stress1
Deformation scale: 111.358
Global value: 0 to 306.146 N/mm^2 (MPa)

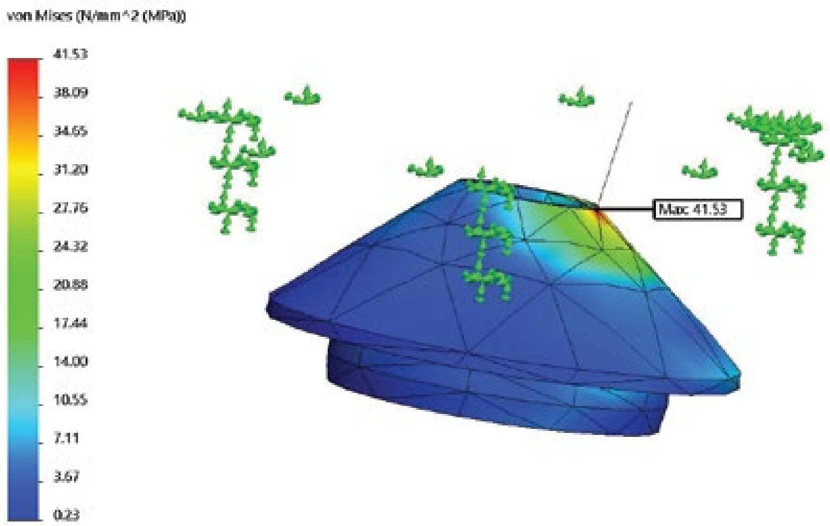


Image-32 – Upper Spring Seat, max Stress 42MPa.

Model name:012-004
Study name:Static BRAKING 30%g(-FEA-)
Plot type: Static nodal stress Stress1
Deformation scale: 111.598
Global value: 0 to 306.011 N/mm^2 (MPa)

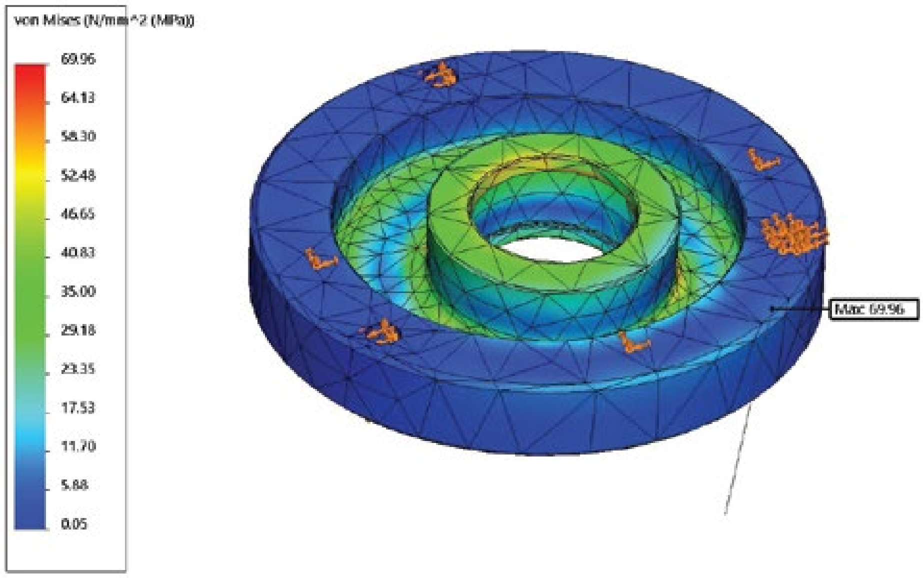


Image-33 – Upper Strut Mount, max Stress 70MPa.

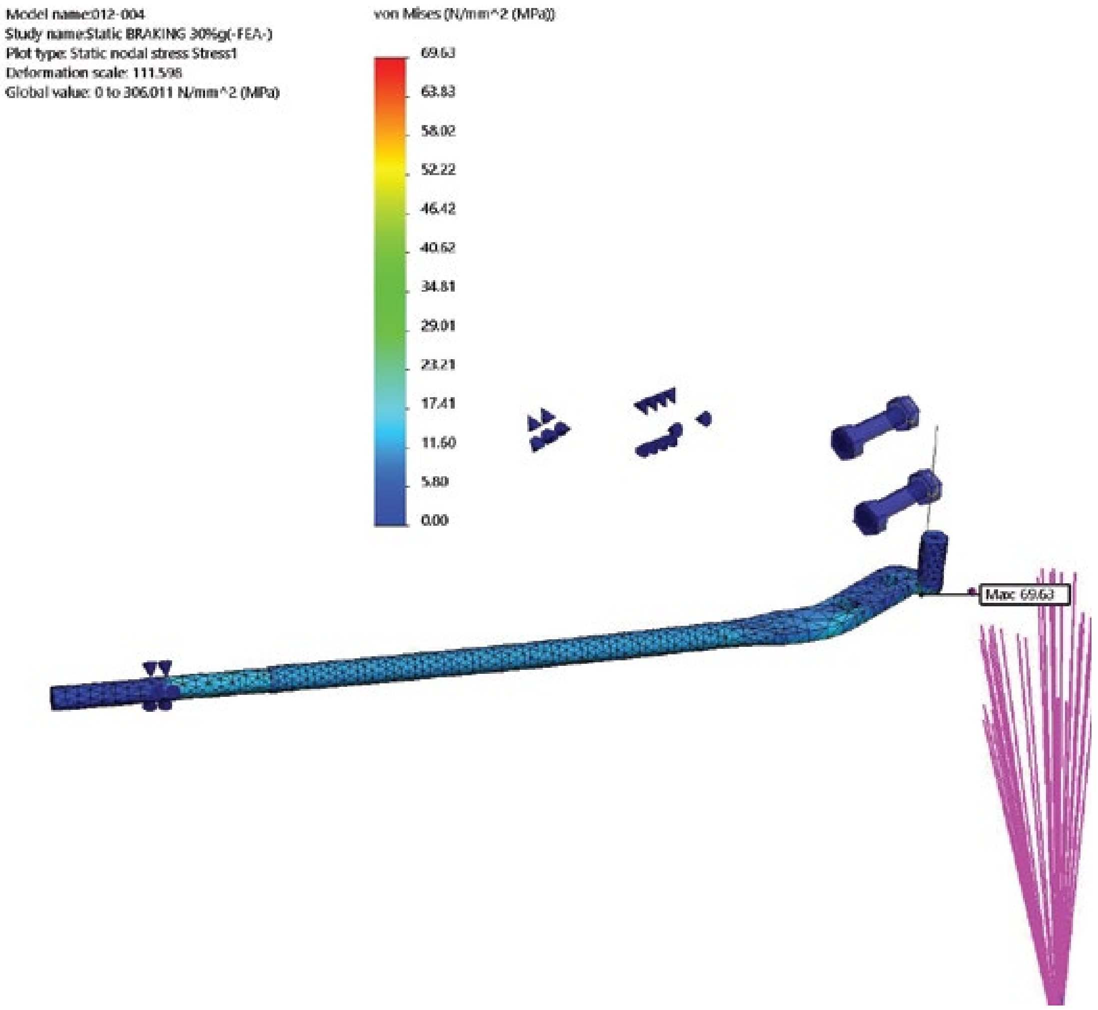


Image-34 – Radius Rod, max Stress 70MPa.

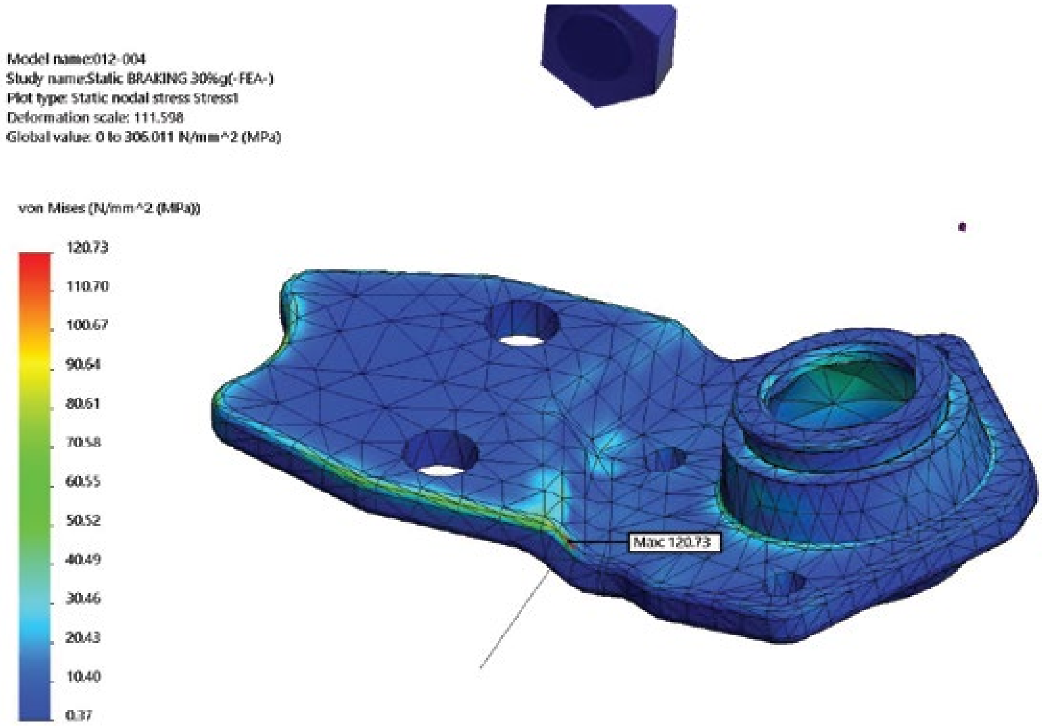


Image-35 – Ball-joint Housing, maxc Stress 121MPa.

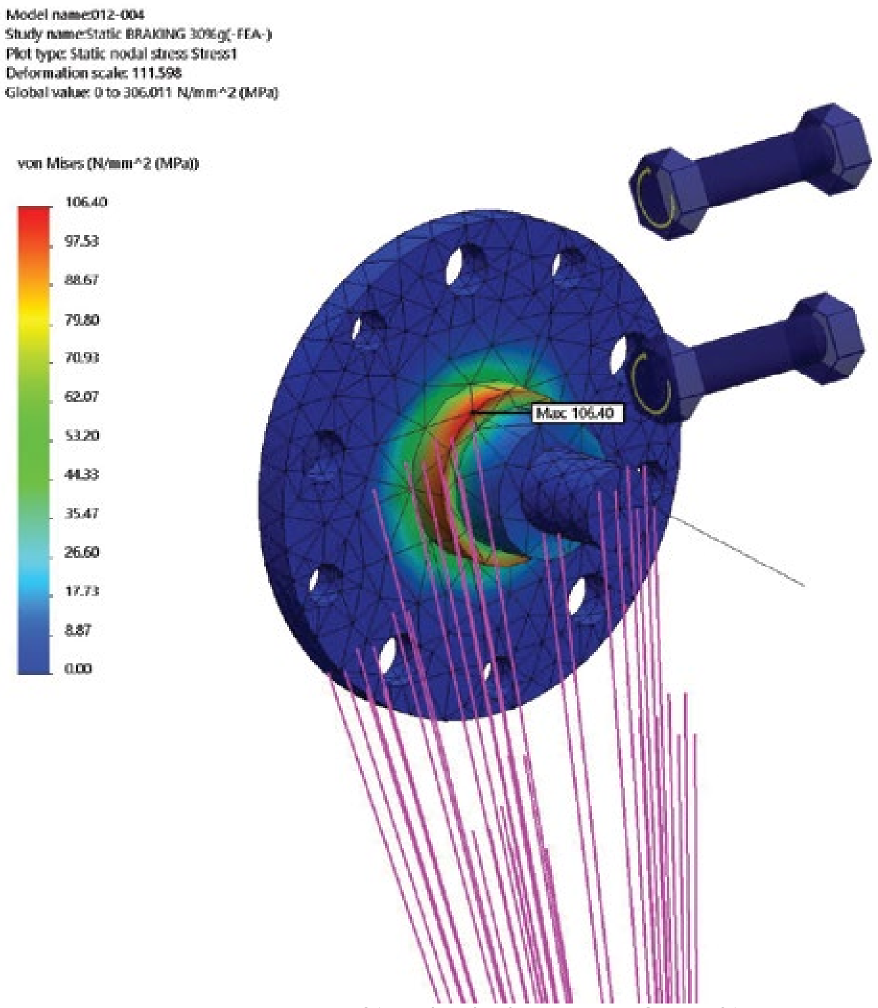


Image-36 – Hub, wheel mount, max Stress 106MPa

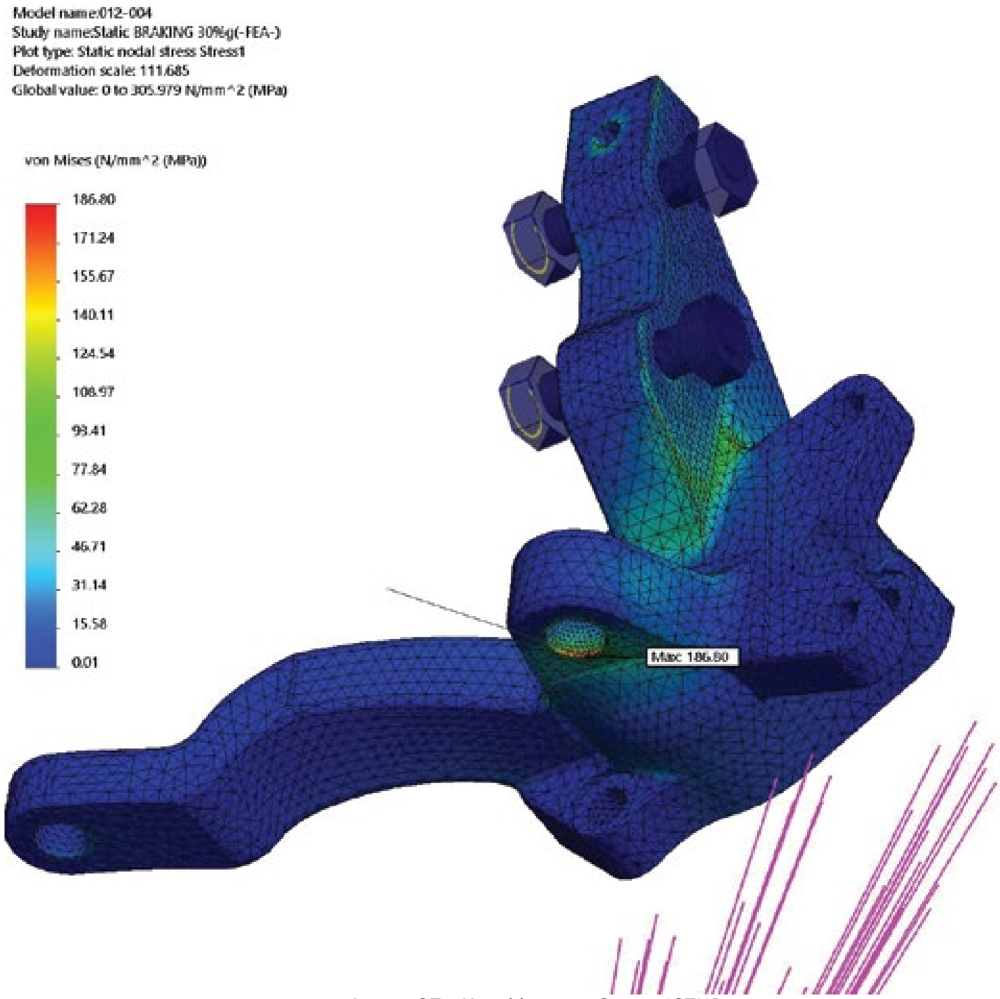


Image-37 – Knuckle, max Stress 187MPa.

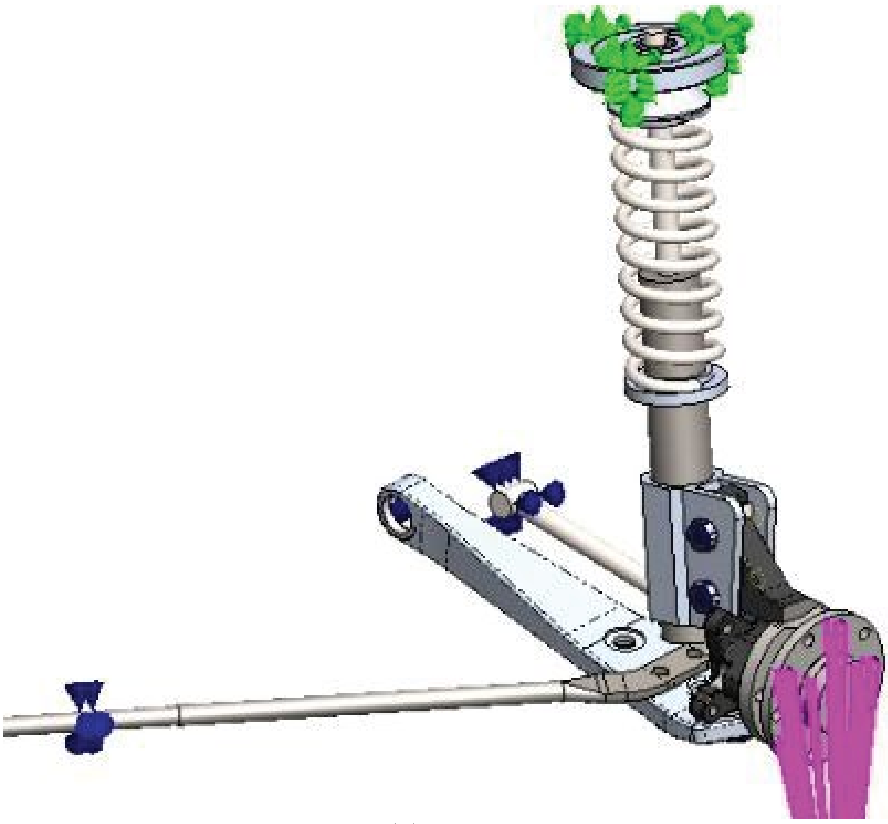
6. FEA Study 2 - 0.25g Cornering Condition

Simulation of 012-004

Date: 08 September 2019
Designer: W. Rogulski
Study name: Static CORNERING 25%g
Analysis type: Static

W. Rogulski
06/09/2019

6.1. Model Information



Model name: 012-004
Current Configuration: FEA

Solid Bodies			
Document Name and Reference	**Treated As**	**Volumetric Properties**	**Document Path/Date Modified**
Fillet138 	Solid Body	Mass:4.54926 kg Volume:0.00057805 m^3 Density:7,870 kg/m^3 Weight:44.5827 N	W:\CADtek\JOBS\012 RRS\012-001 Mustang hub\012-001-07\012-001-07.SLDPRT Sep 8 00:39:49 2019
SurfaceCut1	Solid Body	Mass:0.0266215 kg Volume:3.45734e-06 m^3 Density:7,700 kg/m^3 Weight:0.260891 N	W:\CADtek\JOBS\012 RRS\012-004 Mustang front suspension\012-004-01.SLDPRT Aug 24 15:03:10 2019

			
Fillet7	Solid Body	Mass:0.691137 kg Volume:8.74857e-05 m^3 Density:7,900 kg/m^3 Weight:6.77314 N	W:\CADtek\JOBS\012 RRS\012-005 Mustang Ball-joint\012-005-01.SLDPRT Sep 8 02:30:15 2019
Cut-Revolve2	Solid Body	Mass:0.272432 kg Volume:3.47047e-05 m^3 Density:7,850 kg/m^3 Weight:2.66983 N	W:\CADtek\JOBS\012 RRS\012-005 Mustang Ball-joint\012-005-02.SLDPRT Sep 7 23:33:18 2019
Revolve-Thin1	Solid Body	Mass:0.0277908 kg Volume:3.51782e-06 m^3 Density:7,900 kg/m^3 Weight:0.27235 N	W:\CADtek\JOBS\012 RRS\012-005 Mustang Ball-joint\012-005-03.SLDPRT Jul 29 14:50:07 2019
Revolve1	Solid Body	Mass:0.0124585 kg Volume:8.89895e-06 m^3 Density:1,400 kg/m^3 Weight:0.122094 N	W:\CADtek\JOBS\012 RRS\012-005 Mustang Ball-joint\012-005-04.sldprt Sep 7 23:34:28 2019
Boss-Extrude1	Solid Body	Mass:0.0405192 kg Volume:5.26223e-06 m^3 Density:7,700 kg/m^3 Weight:0.397088 N	W:\CADtek\JOBS\012 RRS\012-005 Mustang Ball-joint\012-005-05.sldprt Aug 23 15:49:26 2019
Boss-Extrude5	Solid Body	Mass:0.156447 kg Volume:2.03177e-05 m^3 Density:7,700 kg/m^3 Weight:1.53318 N	W:\CADtek\JOBS\012 RRS\012-006 Mustang front strut\012-006-01.SLDPRT Aug 26 19:53:32 2019
Boss-Extrude5	Solid Body	Mass:0.156447 kg Volume:2.03177e-05 m^3 Density:7,700 kg/m^3 Weight:1.53318 N	W:\CADtek\JOBS\012 RRS\012-006 Mustang front strut\012-006-01.SLDPRT Aug 26 19:53:32 2019
Boss-Extrude3	Solid Body	Mass:1.33349 kg Volume:0.00017318 m^3 Density:7,700 kg/m^3 Weight:13.0682 N	W:\CADtek\JOBS\012 RRS\012-006 Mustang front strut\KYB-765017-02.SLDPRT Aug 25 11:29:52 2019
Boss-Extrude2	Solid Body	Mass:2.18501 kg Volume:0.000278345 m^3 Density:7,850 kg/m^3 Weight:21.4131 N	W:\CADtek\JOBS\012 RRS\012-006 Mustang front strut\RRS-SL02.SLDPRT Aug 13 15:01:30 2019
Cut-Extrude1	Solid Body	Mass:0.214938 kg Volume:7.96067e-05 m^3	W:\CADtek\JOBS\012 RRS\012-006 Mustang

		Density:2,700 kg/m^3 Weight:2.10639 N	front strut\RRS-SL05.SLDPRT Aug 2 20:03:17 2019
Cut-Extrude5	Solid Body	Mass:0.923651 kg Volume:0.000328702 m^3 Density:2,810 kg/m^3 Weight:9.05178 N	W:\CADtek\JOBS\012 RRS\012-006 Mustang front strut\RRS-SL11.SLDPRT Aug 26 19:51:46 2019
Imported1	Solid Body	Mass:0.098507 kg Volume:1.27975e-05 m^3 Density:7,697.39 kg/m^3 Weight:0.965368 N	W:\CAD Library\BEARINGS\SKF\GEH-20-C_GEH 20 C-part1.sldprt Aug 20 13:44:57 2019
Imported1	Solid Body	Mass:0.0568692 kg Volume:7.3828e-06 m^3 Density:7,702.92 kg/m^3 Weight:0.557318 N	W:\CAD Library\BEARINGS\SKF\GEH-20-C_GEH 20 C-part2.sldprt Aug 20 13:44:56 2019
Chamfer3	Solid Body	Mass:0.560695 kg Volume:0.000207665 m^3 Density:2,700 kg/m^3 Weight:5.49481 N	W:\CADtek\JOBS\012 RRS\012-006 Mustang front strut\RRS-SL17.SLDPRT Sep 8 01:20:22 2019
Boss-Extrude5	Solid Body	Mass:1.04252 kg Volume:0.000131965 m^3 Density:7,900 kg/m^3 Weight:10.2167 N	W:\CADtek\JOBS\012 RRS\012-007 Mustang Bearing Hub\012-007-1.SLDPRT Sep 8 02:30:14 2019
Boss-Extrude7	Solid Body	Mass:2.38132 kg Volume:0.000301433 m^3 Density:7,900 kg/m^3 Weight:23.3369 N	W:\CADtek\JOBS\012 RRS\012-007 Mustang Bearing Hub\012-007-2.SLDPRT Aug 13 15:03:19 2019
Boss-Extrude1	Solid Body	Mass:0.359225 kg Volume:4.66527e-05 m^3 Density:7,700 kg/m^3 Weight:3.52041 N	W:\CADtek\JOBS\012 RRS\012-007 Mustang Bearing Hub\012-007-6.SLDPRT Jul 31 23:30:58 2019
Split Line1	Solid Body	Mass:1.49507 kg Volume:0.000190457 m^3 Density:7,849.94 kg/m^3 Weight:14.6517 N	W:\CADtek\JOBS\012 RRS\012-009 Mustang front radius rod\012-009-01.SLDPRT Jul 31 15:53:45 2019
Combine2 	Solid Body	Mass:1.38994 kg Volume:0.000514795 m^3 Density:2,699.99 kg/m^3 Weight:13.6214 N	W:\CADtek\JOBS\012 RRS\012-011 Mustang fr lwr ctrl arm\012-011.SLDPRT Jul 29 14:48:16 2019
Boss-Extrude3	Solid Body	Mass:0.324588 kg Volume:4.21543e-05 m^3 Density:7,700 kg/m^3	W:\CADtek\JOBS\012 RRS\012-020 Mustang

		Weight:3.18097 N	Steering Arm\012-020-01.SLDPRT Aug 29 20:44:53 2019
Sweep2	Solid Body	Mass:1.3503 kg Volume:0.000175337 m^3 Density:7,701.19 kg/m^3 Weight:13.233 N	W:\CADtek\JOBS\012 RRS\012-020 Mustang Steering Arm\012-020-02.SLDPRT Aug 21 22:42:28 2019

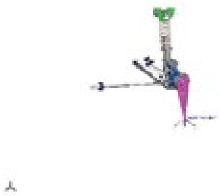
6.2. Study Properties

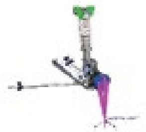
Study name	Static CORNERING 25%g
Analysis type	Static
Mesh type	Mixed Mesh
Thermal Effect:	On
Thermal option	Include temperature loads
Zero strain temperature	298 Kelvin
Include fluid pressure effects from SOLIDWORKS Flow Simulation	Off
Solver type	Automatic
Inplane Effect:	Off
Soft Spring:	Off
Inertial Relief:	Off
Incompatible bonding options	Automatic
Large displacement	Off
Compute free body forces	Off
Friction	Off
Use Adaptive Method:	Off
Result folder	SOLIDWORKS document (W:\CADtek\JOBS\012 RRS\012-004 Mustang front suspension\Simulation Results\Static CORNERING 25%g)

6.3. Units

Unit system:	SI (MKS)
Length/Displacement	m
Temperature	Celsius
Angular velocity	Rad/sec
Pressure/Stress	N/mm^2 (MPa)

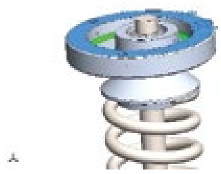
6.4. Material Properties

Model Reference	Properties	Components
	**Name:** XK1340 +QT 830°C, 540°C **Model type:** Linear Elastic Isotropic **Default failure criterion:** Max von Mises Stress **Yield strength:** 624 N/mm^2 **Tensile strength:** 827 N/mm^2 **Elastic modulus:** 200,000 N/mm^2 **Poisson's ratio:** 0.29 **Mass density:** 7.87 g/cm^3 **Shear modulus:** 80,000 N/mm^2	SolidBody 1(Fillet138)(012-001-07-1)
Curve Data:N/A		
	**Name:** Alloy Steel **Model type:** Linear Elastic Isotropic **Default failure criterion:** Unknown **Yield strength:** 620.422 N/mm^2 **Tensile strength:** 723.826 N/mm^2 **Elastic modulus:** 210,000 N/mm^2 **Poisson's ratio:** 0.28 **Mass density:** 7.7 g/cm^3 **Shear modulus:** 79,000 N/mm^2 **Thermal expansion coefficient:** 1.3e-05 /Kelvin	SolidBody 1(SurfaceCut1)(012-004-01-1), SolidBody 1(Boss-Extrude1)(012-005-1/012-005-05-1), SolidBody 1(Boss-Extrude5)(012-006-1/012-006-01-1), SolidBody 1(Boss-Extrude5)(012-006-1/012-006-01-2), SolidBody 1(Boss-Extrude3)(012-006-1/KYB-765017-1/KYB-765017-02-1), SolidBody 1(Imported1)(012-006-1/RRS-SL17-1/GEH 20 C-1/_GEH 20 C-part1-1), SolidBody 1(Imported1)(012-006-1/RRS-SL17-1/GEH 20 C-1/_GEH 20 C-part2-1), SolidBody 1(Cut-Extrude1)(012-006-1/RRS-SL18-1), SolidBody 1(Boss-Extrude1)(012-007-1/012-007-6-1), SolidBody 1(Boss-Extrude3)(012-020-1/012-020-01-1), SolidBody 1(Sweep2)(012-020-1/012-020-02-1)
Curve Data:N/A		

	**Name:** AISI 1020 **Model type:** Linear Elastic Isotropic **Default failure criterion:** Max von Mises Stress **Yield strength:** 351.571 N/mm^2 **Tensile strength:** 420.507 N/mm^2 **Elastic modulus:** 200,000 N/mm^2 **Poisson's ratio:** 0.29 **Mass density:** 7.9 g/cm^3 **Shear modulus:** 77,000 N/mm^2 **Thermal expansion coefficient:** 1.5e-05 /Kelvin	SolidBody 1(Fillet7)(012-005-1/012-005-01-1), SolidBody 1(Revolve-Thin1)(012-005-1/012-005-03-1), SolidBody 1(Boss-Extrude5)(012-007-1/012-007-1-1), SolidBody 1(Boss-Extrude7)(012-007-1/012-007-2-1)
Curve Data:N/A		
	**Name:** AISI 4130 Steel, normalized at 870C **Model type:** Linear Elastic Isotropic **Default failure criterion:** Max von Mises Stress **Yield strength:** 460 N/mm^2 **Tensile strength:** 731 N/mm^2 **Elastic modulus:** 205,000 N/mm^2 **Poisson's ratio:** 0.285 **Mass density:** 7.85 g/cm^3 **Shear modulus:** 80,000 N/mm^2	SolidBody 1(Cut-Revolve2)(012-005-1/012-005-02-1), SolidBody 1(Split Line1)(012-009-1/012-009-01-1)
Curve Data:N/A		
	**Name:** Nylon 6/10 **Model type:** Linear Elastic Isotropic **Default failure criterion:** Max von Mises Stress **Yield strength:** 139.043 N/mm^2 **Tensile strength:** 142.559 N/mm^2 **Elastic modulus:** 8,300 N/mm^2 **Poisson's ratio:** 0.28 **Mass density:** 1.4 g/cm^3 **Shear modulus:** 3,200 N/mm^2 **Thermal expansion coefficient:** 3e-05 /Kelvin	SolidBody 1(Revolve1)(012-005-1/012-005-04-1)
Curve Data:N/A		
	**Name:** AISI 1045 Steel, cold drawn **Model type:** Linear Elastic Isotropic **Default failure criterion:** Unknown **Yield strength:** 530 N/mm^2 **Tensile strength:** 625 N/mm^2 **Elastic modulus:** 205,000 N/mm^2 **Poisson's ratio:** 0.29 **Mass density:** 7.85 g/cm^3 **Shear modulus:** 80,000 N/mm^2 **Thermal expansion coefficient:** 1.2e-05 /Kelvin	SolidBody 1(Boss-Extrude2)(012-006-1/RRS-SL02-1)
Curve Data:N/A		

	Name: 6061-T6 (SS) Model type: Linear Elastic Isotropic Default failure criterion: Unknown Yield strength: 275 N/mm^2 Tensile strength: 310 N/mm^2 Elastic modulus: 69,000 N/mm^2 Poisson's ratio: 0.33 Mass density: 2.7 g/cm^3 Shear modulus: 26,000 N/mm^2 Thermal expansion coefficient: 2.4e-05 /Kelvin	SolidBody 1(Cut-Extrude1)(012-006-1/RRS-SL05-1), SolidBody 1(Chamfer3)(012-006-1/RRS-SL17-1/RRS-SL17-1), SolidBody 1(Combine2)(012-011-1)
Curve Data:N/A		
	Name: 7075-T6 (SN) Model type: Linear Elastic Isotropic Default failure criterion: Unknown Yield strength: 505 N/mm^2 Tensile strength: 570 N/mm^2 Elastic modulus: 72,000 N/mm^2 Poisson's ratio: 0.33 Mass density: 2.81 g/cm^3 Shear modulus: 26,900 N/mm^2 Thermal expansion coefficient: 2.4e-05 /Kelvin	SolidBody 1(Boss-Extrude2)(012-006-1/RRS-SL08-1), SolidBody 1(Cut-Extrude5)(012-006-1/RRS-SL11-1)
Curve Data:N/A		

6.5. Loads and Fixtures

Fixture name	Fixture Image	Fixture Details
Fixed-1		**Entities:** 4 face(s) **Type:** Fixed Geometry

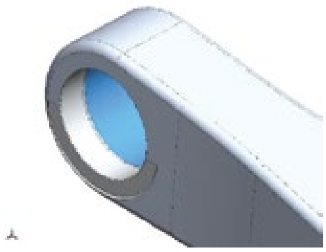
Resultant Forces

Components	X	Y	Z	Resultant
Reaction force(N)	3,889.48	-8,477.63	1,449.87	9,439.3
Reaction Moment(N.m)	0	0	0	1e-33

Load name	Load Image	Load Details
Remote Load/Mass (Rigid connection)-2 RUT LOAD (1g vertical & 0.25g lateral)		**Entities:** 7 face(s) **Connection Type:** Rigid **Coordinate System:** Coordinate System1 **Translational Components:** -2,205 N,8,820 N,--- **Rotational Components:** ---,---,--- **Reference coordinates:** 0 0 0 mm

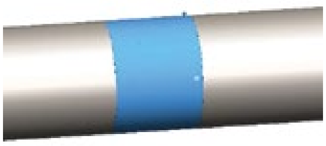
6.6. Connector Definitions

Pin/Bolt/Bearing Connector

Model Reference	Connector Details	Strength Details
 Bearing Support-5	Entities: 1 face(s) Type: Bearing	No Data

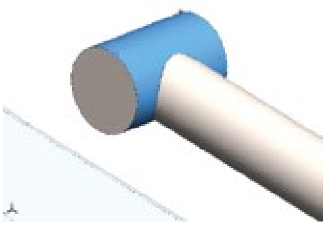
Connector Forces

Type	X-Component	Y-Component	Z-Component	Resultant
Axial Force (N)	0.35749	1.8771	42.526	42.569
Shear Force (N)	-2,096.7	-247.74	28.56	2,111.5
Bending moment (N.m)	2.2122e-07	2.2521e-07	-1.18e-08	3.1591e-07

Model Reference	Connector Details	Strength Details
 Bearing Support-6	Entities: 1 face(s) Type: Bearing	No Data

Connector Forces

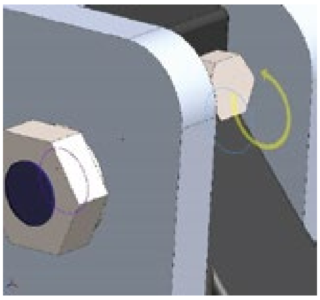
Type	X-Component	Y-Component	Z-Component	Resultant
Axial Force (N)	1,046	-93.992	-1,518.7	-1,846.5
Shear Force (N)	0.96805	-3.6043	0.88982	3.849
Bending moment (N.m)	-3.0562e-06	4.958e-05	-5.1734e-06	4.9943e-05

Model Reference	Connector Details	Strength Details
 Bearing Support-4	Entities: 1 face(s) Type: Bearing	No Data

Connector Forces

Type	X-Component	Y-Component	Z-Component	Resultant
Axial Force (N)	-0.15661	-2.0179	-11.342	-11.522
Shear Force (N)	-634.96	3.1043	8.2147	635.02
Bending moment (N.m)	1.4301e-07	-2.2371e-07	3.7825e-08	2.682e-07

RRS PTY LTD.
57/42-46 Wattle Road
Brookvale NSW 2100
Sydney Australia
Ph: 61 2 9907 3755
Mob 61 417 226 693
Email: alex@rrs-online.com



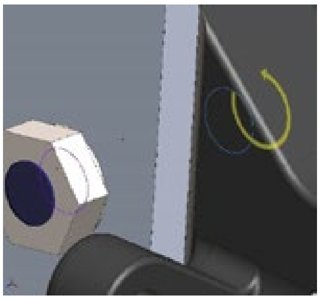
Counterbore with Nut-1

Entities:	2 edge(s), 2 face(s)
Type:	Bolt(Head/Nut diameter)(Counterbore)
Head diameter:	21.75 mm
Nut diameter:	21.75 mm
Nominal shank diameter:	14.5 mm
Preload (Torque):	160
Young's modulus:	2.1e+11
Poisson's ratio:	0.28
Preload units:	N.m

No Data

Connector Forces

Type	X-Component	Y-Component	Z-Component	Resultant
Axial Force (N)	845.73	-9,355.5	-54,372	55,177
Shear Force (N)	50.432	-37.808	7.29	63.451
Bending moment (N.m)	-0.28273	-0.37997	0.060981	0.47753



Counterbore with Nut-2

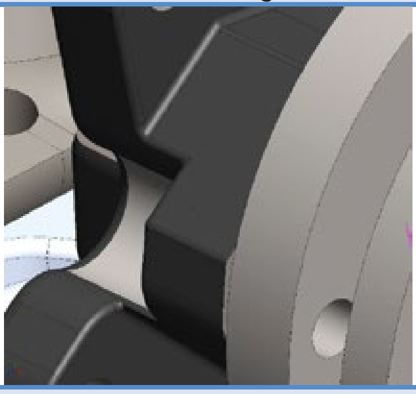
Entities:	2 edge(s), 2 face(s)
Type:	Bolt(Head/Nut diameter)(Counterbore)
Head diameter:	0.02175 m
Nut diameter:	0.02175 m
Nominal shank diameter:	0.0145 m
Preload (Torque):	160
Young's modulus:	2.1e+11
Poisson's ratio:	0.28
Preload units:	N.m

No Data

Connector Forces

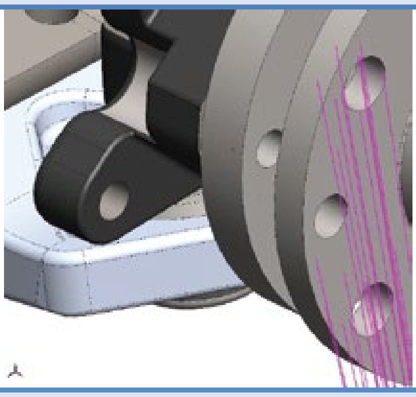
Type	X-Component	Y-Component	Z-Component	Resultant
Axial Force (N)	845.72	-9,354.6	-54,367	55,172
Shear Force (N)	-13.531	-39.86	6.6481	42.616
Bending moment (N.m)	-0.28951	0.082543	-0.018706	0.30162

6.7. Contact Information

Contact	Contact Image	Contact Properties
Contact Set-13554		**Type:** Bonded contact pair **Entities:** 2 face(s) **Friction Value:** 0.2

Contact/Friction force

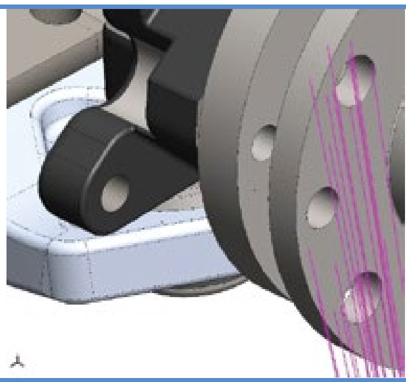
Components	X	Y	Z	Resultant
Contact Force(N)	0.149	-0.47724	0.084434	0.50704

Contact	Contact Image	Contact Properties
Contact Set-13845		**Type:** No Penetration contact pair **Entities:** 2 face(s) **Advanced:** Node to surface

Contact/Friction force

Components	X	Y	Z	Resultant
Contact Force(N)	-454.5	415.81	-124.35	628.44

Contact Set-13846

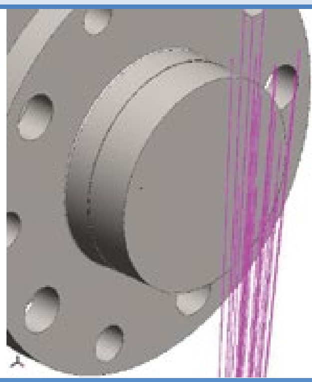


Type: No Penetration contact pair
Entities: 2 face(s)
Advanced: Node to surface

Contact/Friction force

Components	X	Y	Z	Resultant
Contact Force(N)	-594.86	-759.27	-1,322.4	1,636.8

Contact Set-13847

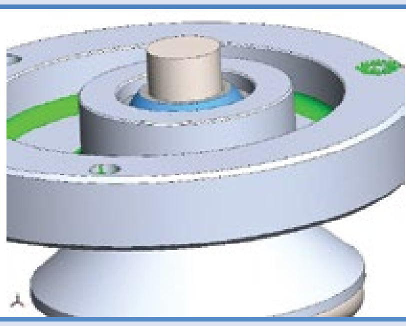


Type: No Penetration contact pair
Entities: 2 face(s)
Advanced: Surface to surface

Contact/Friction force

Components	X	Y	Z	Resultant
Contact Force(N)	1.9118E-12	-1.994E-13	3.7303E-14	1.9225E-12

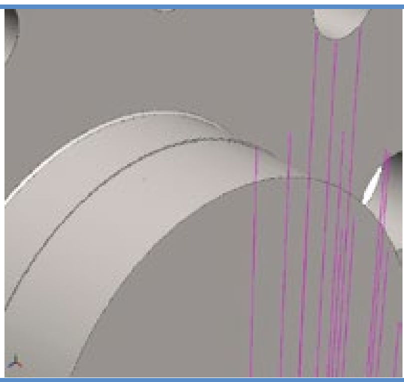
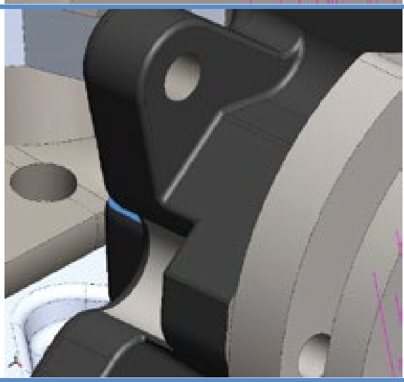
Contact Set-13848



Type: No Penetration contact pair
Entities: 2 face(s)
Advanced: Surface to surface

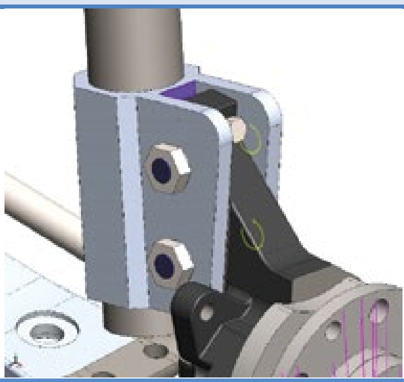
Contact/Friction force

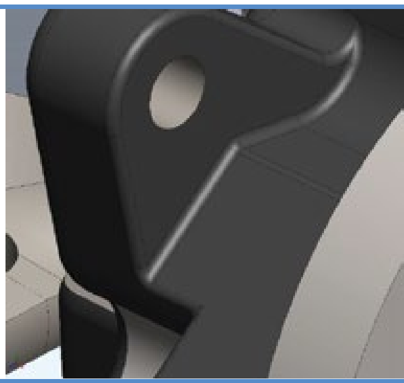
Components	X	Y	Z	Resultant
Contact Force(N)	3.4817E-12	4.8175E-12	-5.3575E-12	8.002E-12

Contact Set-16247		**Type:** Bonded contact pair **Entities:** 2 face(s)
Contact Set-16525		**Type:** No Penetration contact pair **Entities:** 2 face(s) **Advanced:** Node to surface

Contact/Friction force

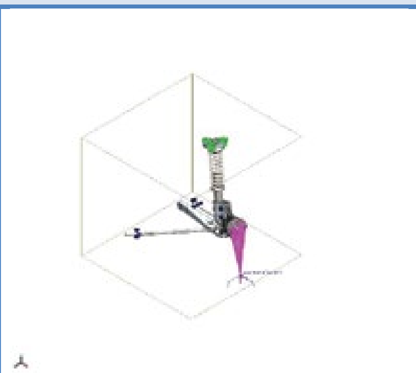
Components	X	Y	Z	Resultant
Contact Force(N)	1.2599E-14	1.0372E-13	-6.5703E-15	1.0469E-13

Contact Set-19226		**Type:** Bonded contact pair **Entities:** 2 face(s)

Contact Set-24949		**Type:** Bonded contact pair **Entities:** 2 face(s)

Contact/Friction force

Components	X	Y	Z	Resultant
Contact Force(N)	0.57113	-1.8294	0.32366	1.9436

Global Contact		**Type:** Bonded **Components:** 1 component(s) **Options:** Incompatible mesh
Component Contact-1		**Type:** Bonded **Components:** 2 component(s), 3 Solid Body (s) **Options:** Incompatible mesh

6.8. Mesh information

Mesh type	Mixed Mesh
Mesher Used:	Curvature-based mesh
Jacobian points	4 Points
Jacobian check for shell	On
Maximum element size	36.131 mm
Minimum element size	7.2262 mm
Mesh Quality Plot	High
Remesh failed parts with incompatible mesh	Off

Mesh information - Details

Total Nodes	267878
Total Elements	162417
Time to complete mesh(hh;mm;ss):	00:00:05
Computer name:	DUPA-JASIU-03

Mesh Control Information:

Mesh Control Name	Mesh Control Image	Mesh Control Details
Control-1		**Entities:** 1 Solid Body (s) **Units:** mm **Size:** 5 **Ratio:** 5
Control-2		**Entities:** 2 face(s) **Units:** mm **Size:** 2.5 **Ratio:** 2.5
Control-3		**Entities:** 5 face(s) **Units:** mm **Size:** 3 **Ratio:** 3

Control-4		**Entities:** 1 face(s) **Units:** mm **Size:** 3 **Ratio:** 3
Control-5		**Entities:** 1 face(s) **Units:** mm **Size:** 2 **Ratio:** 2
Control-36		**Entities:** 5 face(s) **Units:** mm **Size:** 2.5 **Ratio:** 2.5

6.9. Sensor Details

Sensor name	Location	Sensor Details
Stress1		Value : 1.87e+08 N/m^2 Entities : Result :Stress Component :VON: von Mises Stress Criterion :Model Max Step Criterion : Across all Steps Step No.:1 Alert Value: is greater than 2 N/m^2
Stress2		Value : 1.87e+08 N/m^2 Entities : Result :Stress Component :VON: von Mises Stress Criterion :Model Max Step Criterion : Across all Steps Step No.:1 Alert Value: is greater than 2 N/m^2

6.10. Resultant Forces

Reaction forces

Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Model	N	3,889.48	-8,477.63	1,449.87	9,439.3

Reaction Moments

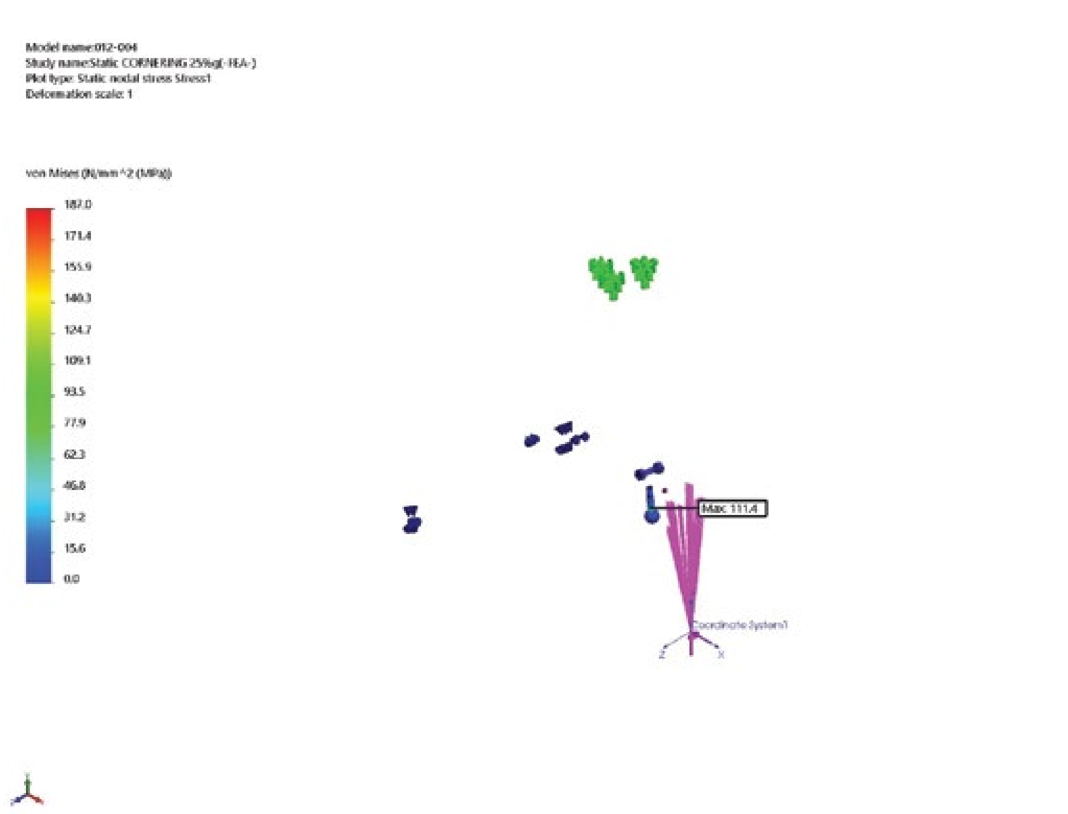
Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Model	N.m	0	0	0	1e-33

6.11. Beams

No Data

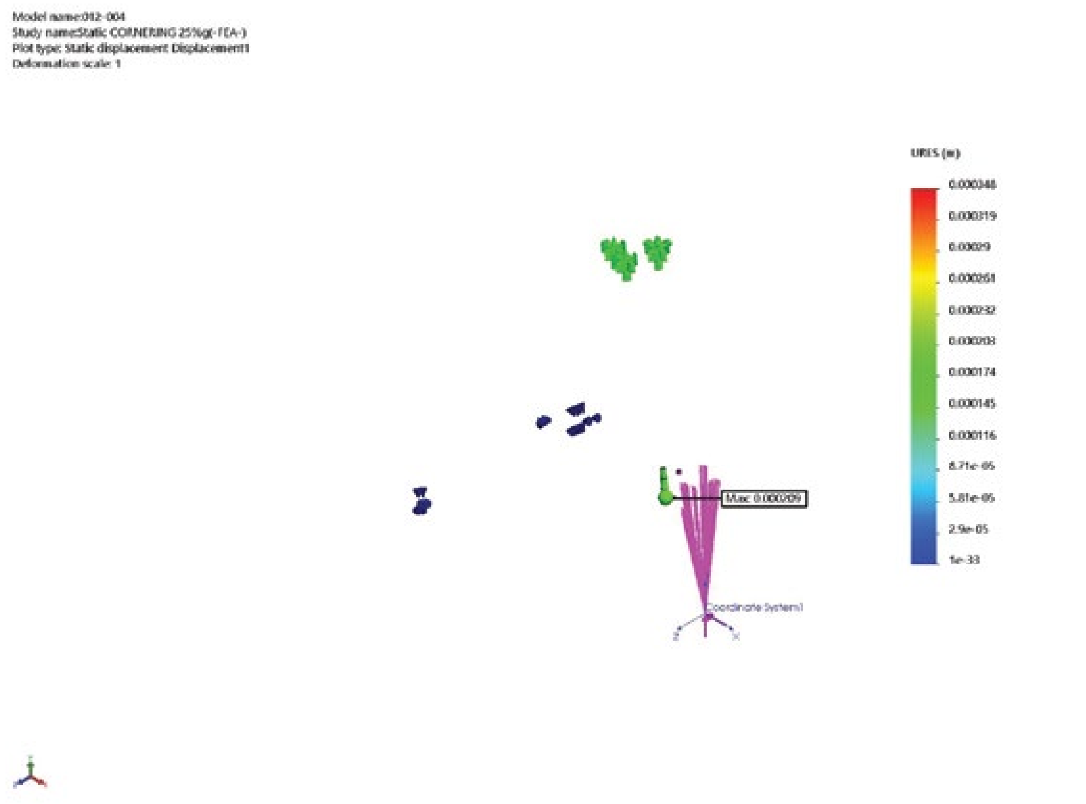
6.12. Study Results

Name	Type	Min	Max
Stress1	VON: von Mises Stress	0.0 N/mm^2 (MPa) Node: 24523	187.0 N/mm^2 (MPa) Node: 66727



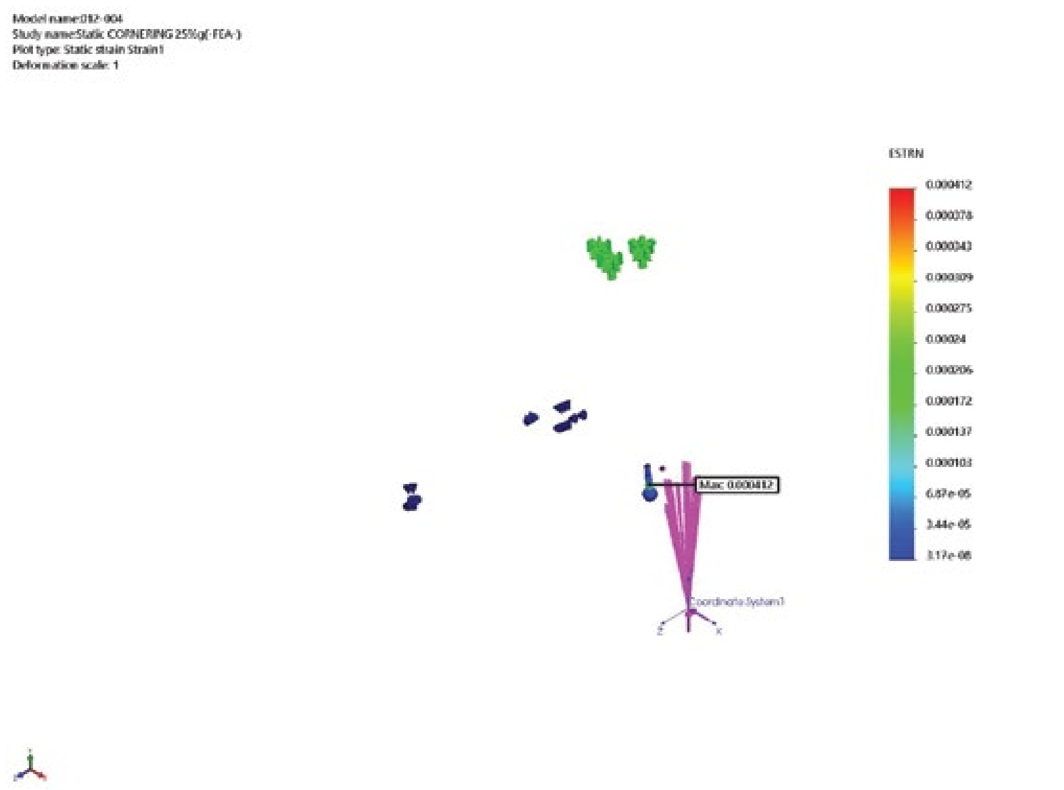
012-004-Static CORNERING 25%g-Stress-Stress1

Name	Type	Min	Max
Displacement1	URES: Resultant Displacement	0m Node: 67729	0.000348 m Node: 92800



012-004-Static CORNERING 25%g-Displacement-Displacement1

Name	Type	Min	Max
Strain1	ESTRN: Equivalent Strain	0 Element: 13056	0.000652 Element: 40784



012-004-Static CORNERING 25%g-Strain-Strain1

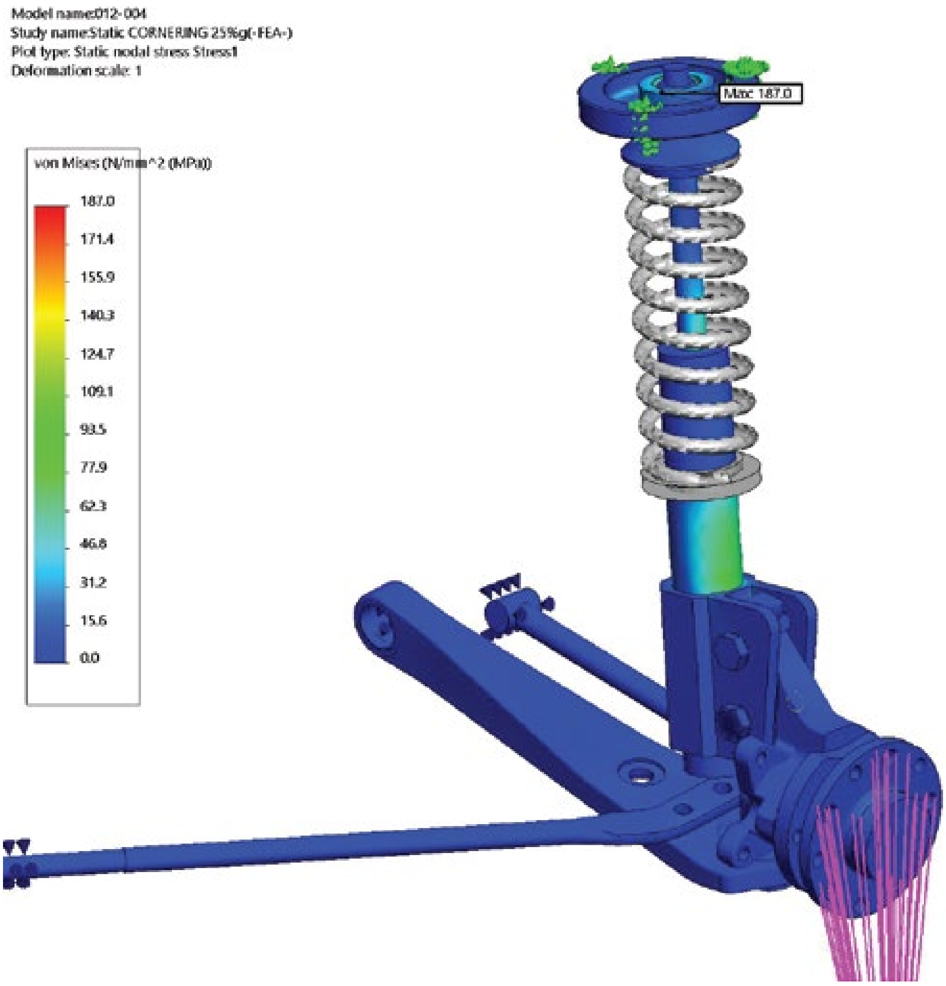


Image-19 – Front suspension system, half axle – max Stress 187MPa.

Model name:012-004
Study name:Static CORNERING 25%g(-FEA-)
Plot type: Static nodal stress Stress1
Deformation scale: 1

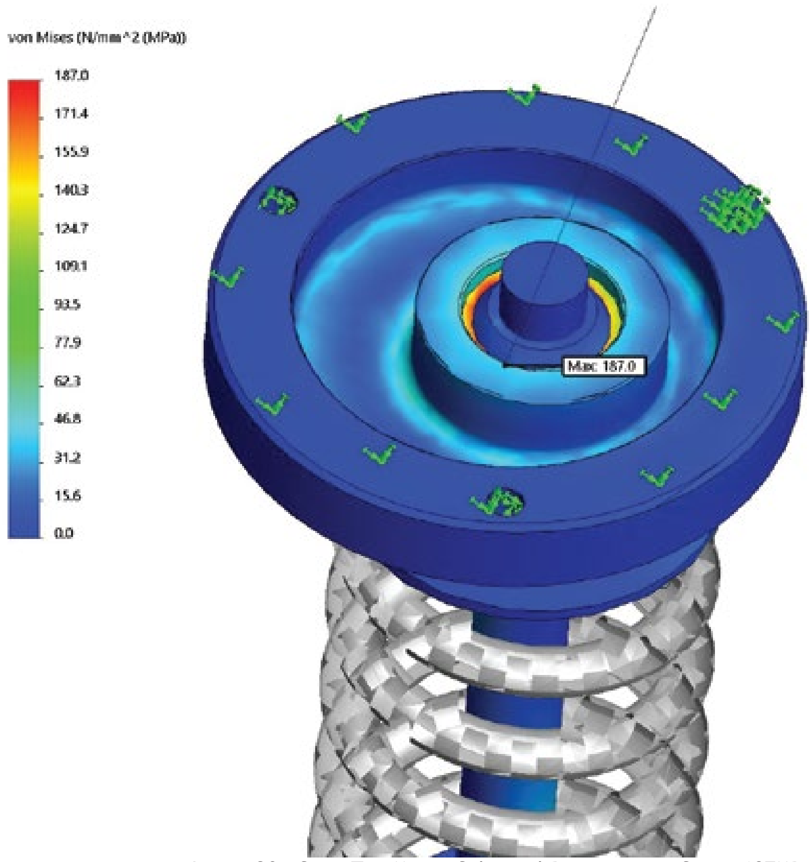


Image-20 – Strut Top Mount Spherical Bearing, max Stress 187MPa.

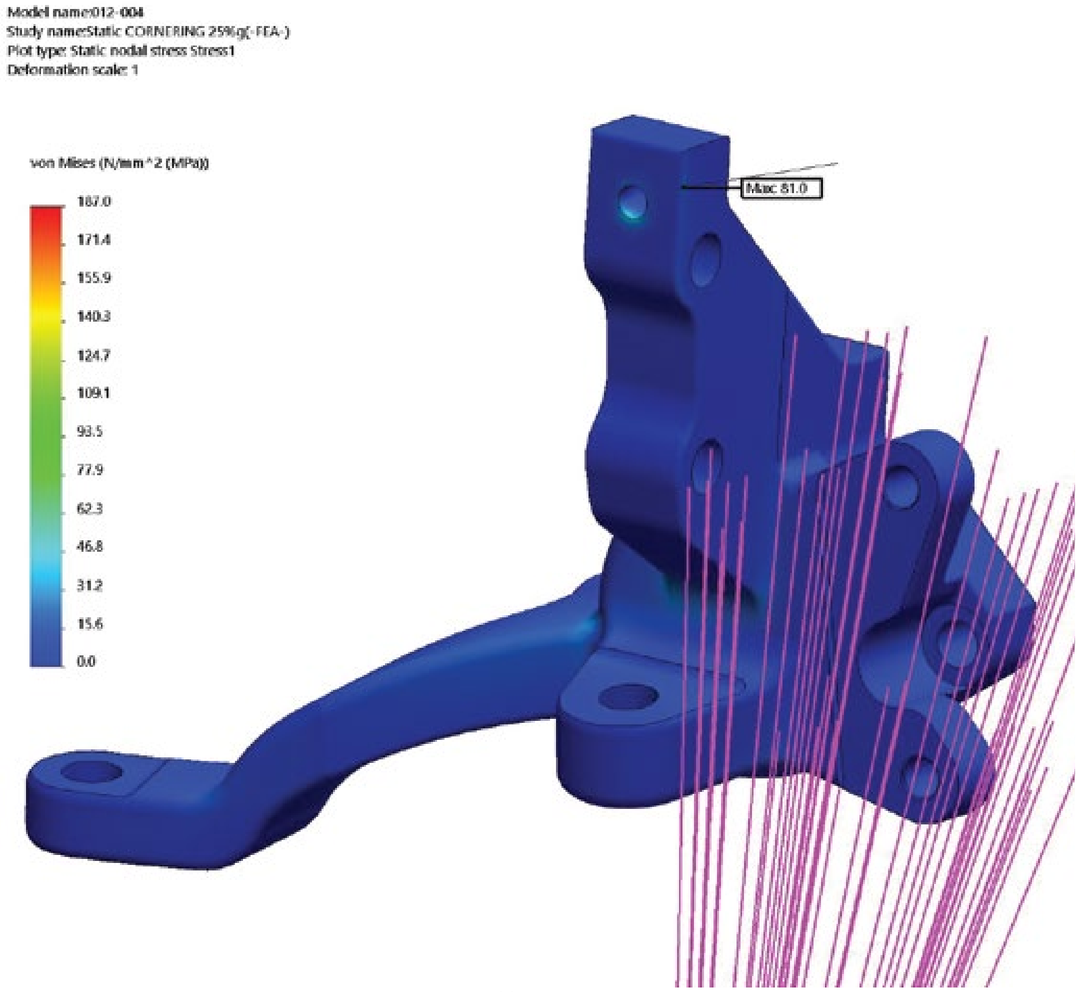


Image-22 – Knuckle, max Stress 81MPa.

Model name:012-004
Study name:Static CORNERING 25%g(-FEA-)
Plot type: Static nodal stress Stress1
Deformation scale: 1

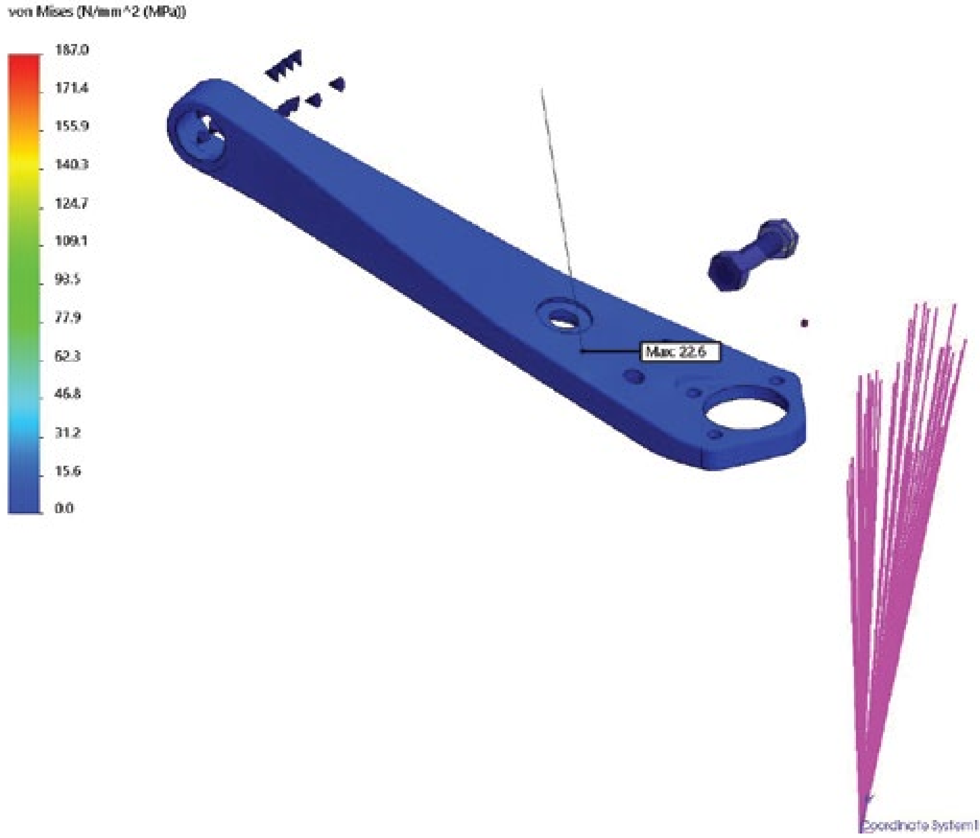


Image-23 – Lower control arm, max Stress 23MPa.

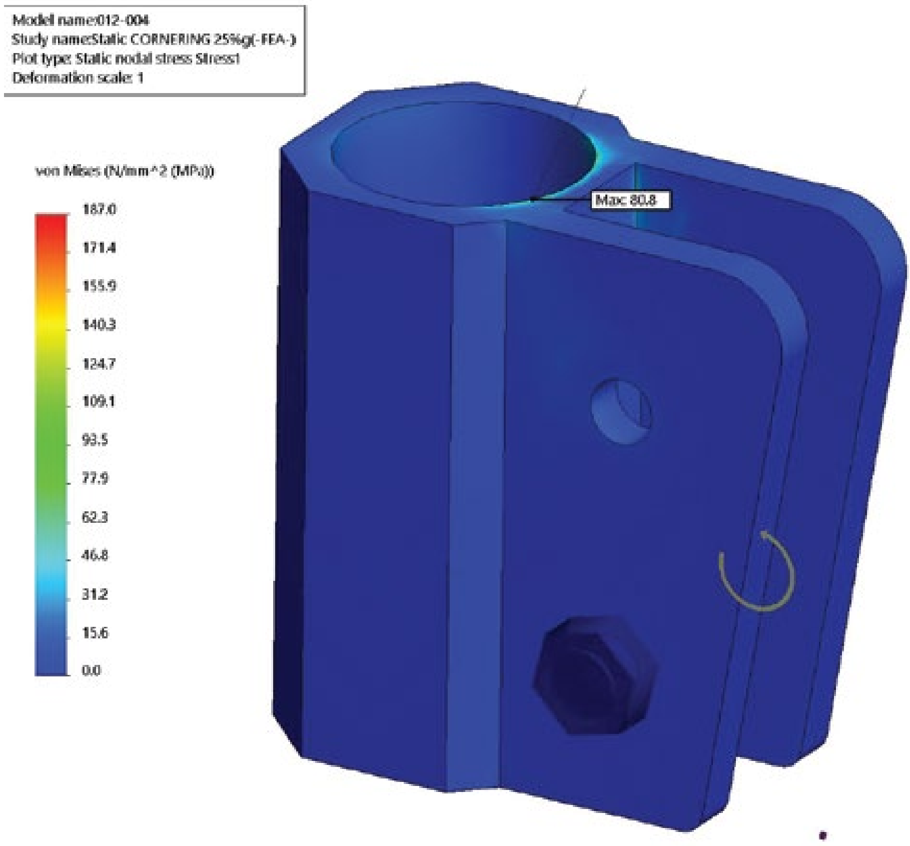


Image-24 – Strut Clevis Bracket, max Stress 81MPa.

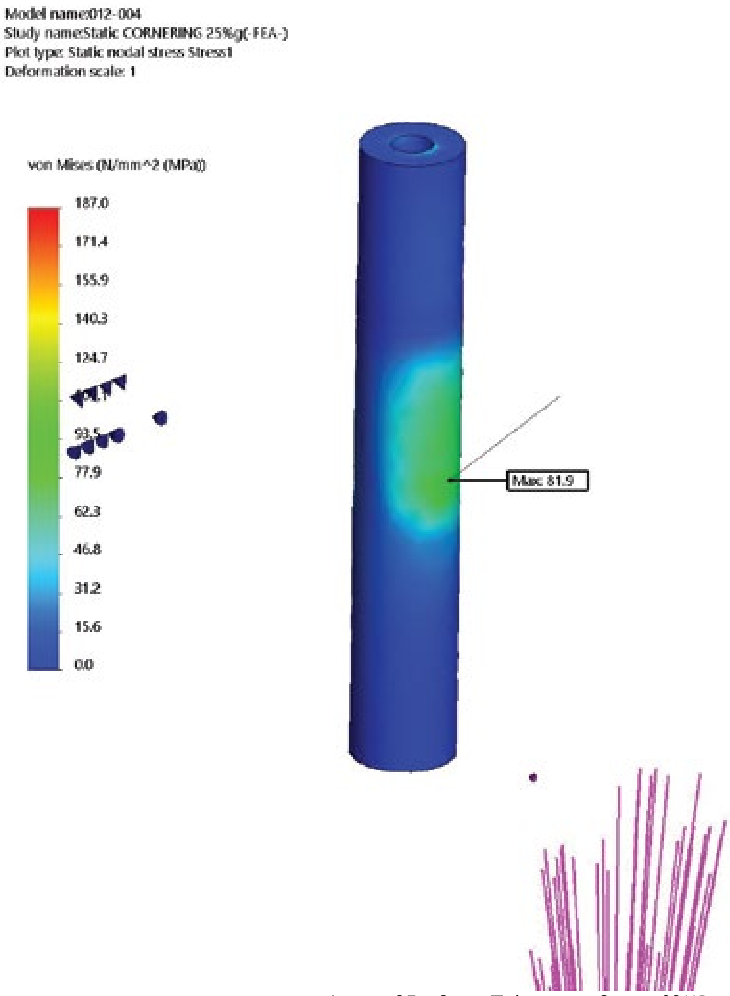


Image-25 – Strut Tube, max Stress 82MPa.

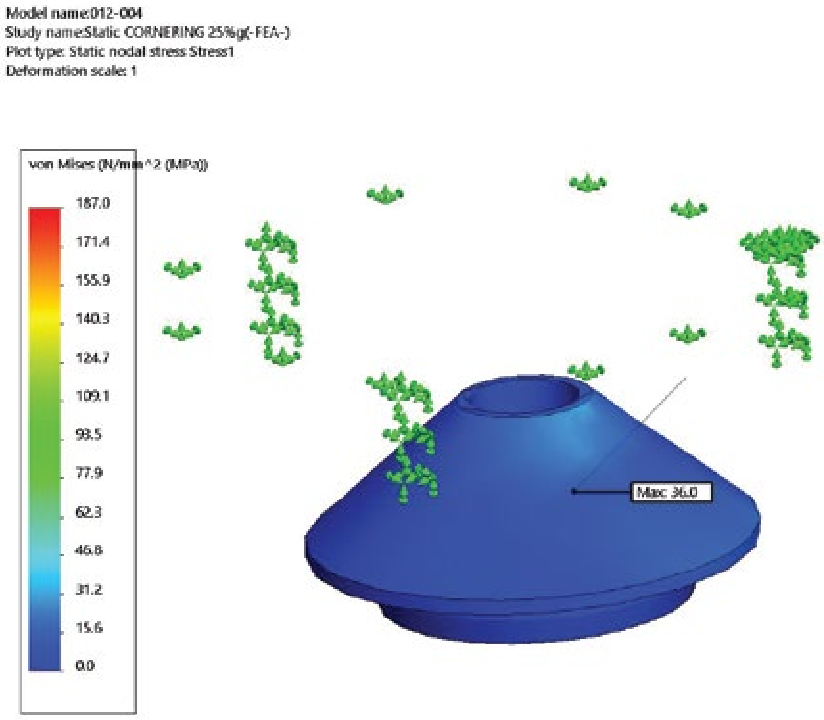


Image-26 – Upper Spring seat, max Stress 36MPa.

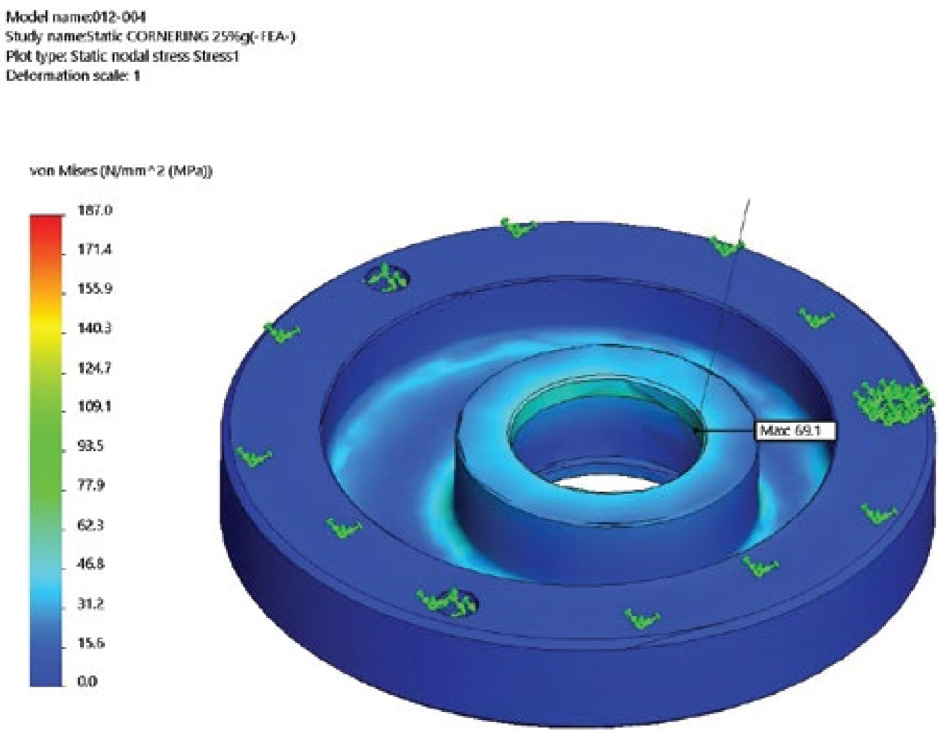


Image-27 – Strut Top mount, max Stress 69MPa.

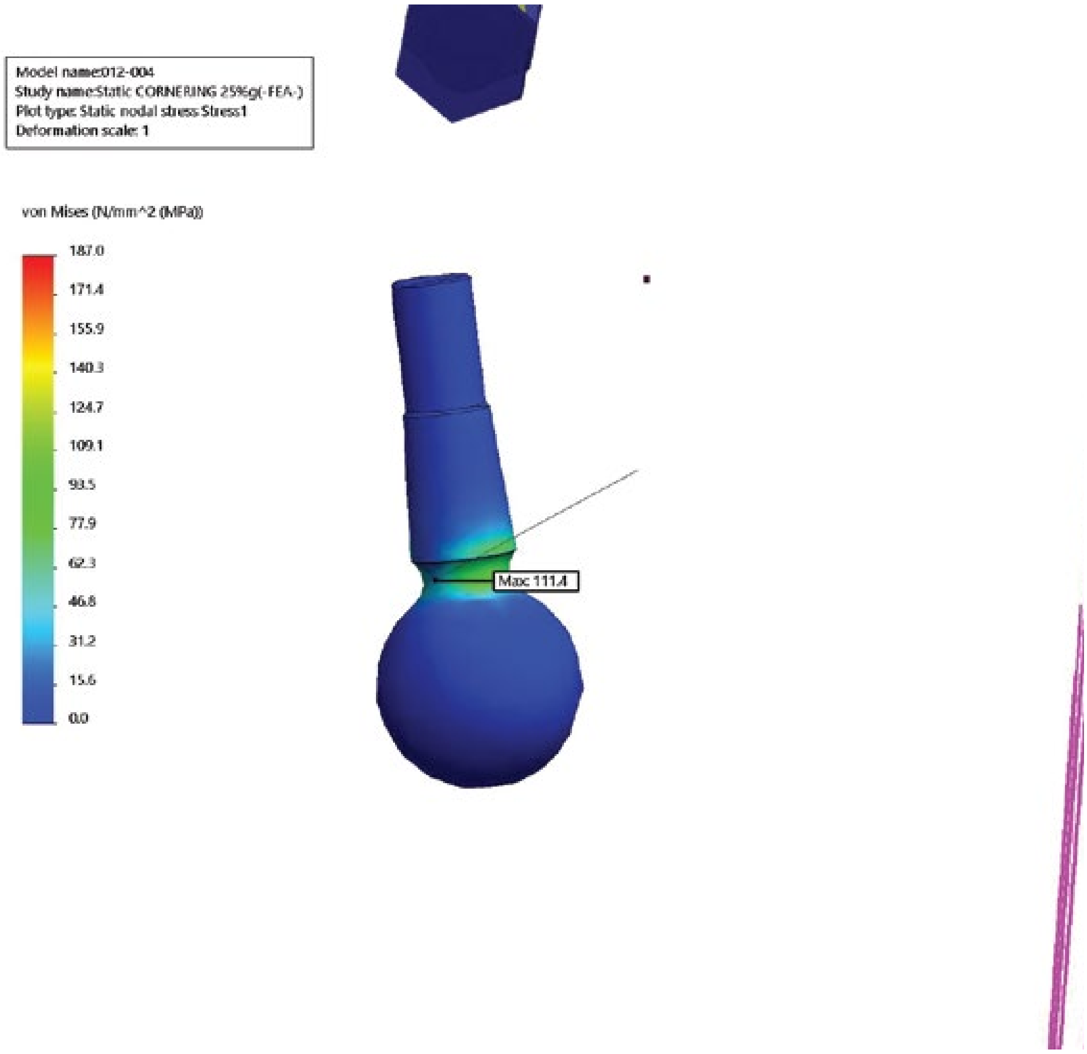


Image-28 – Ball-joint pin, max Stress 111MPa.

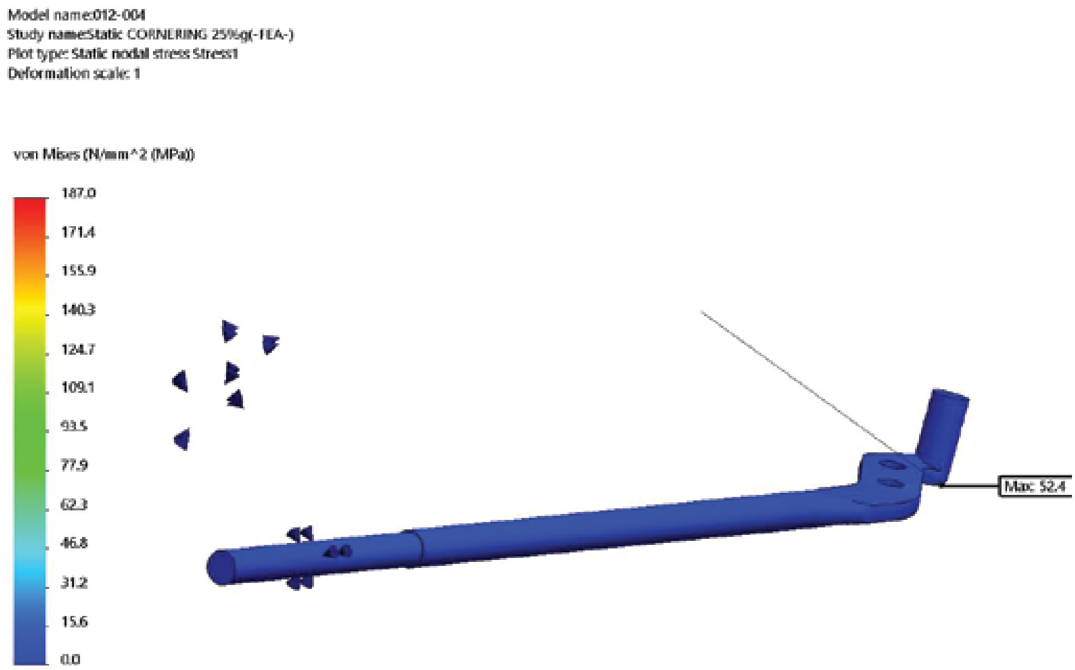


Image-29 – Radius rod, max Stress 52MPa.

Image-30 – Ball-joint housing, max Stress 85MPa.

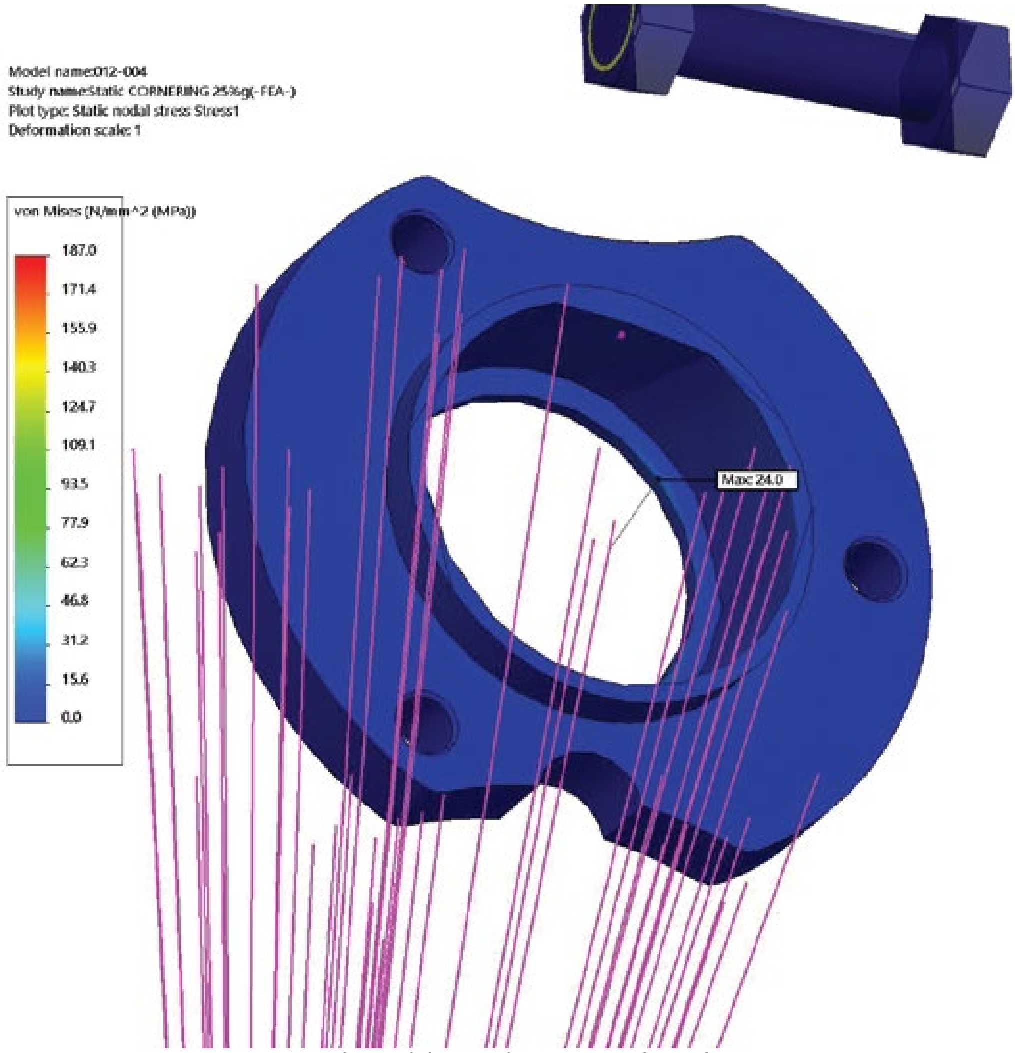


Image-31 – Hub bearing housing, max Stress 24MPa.

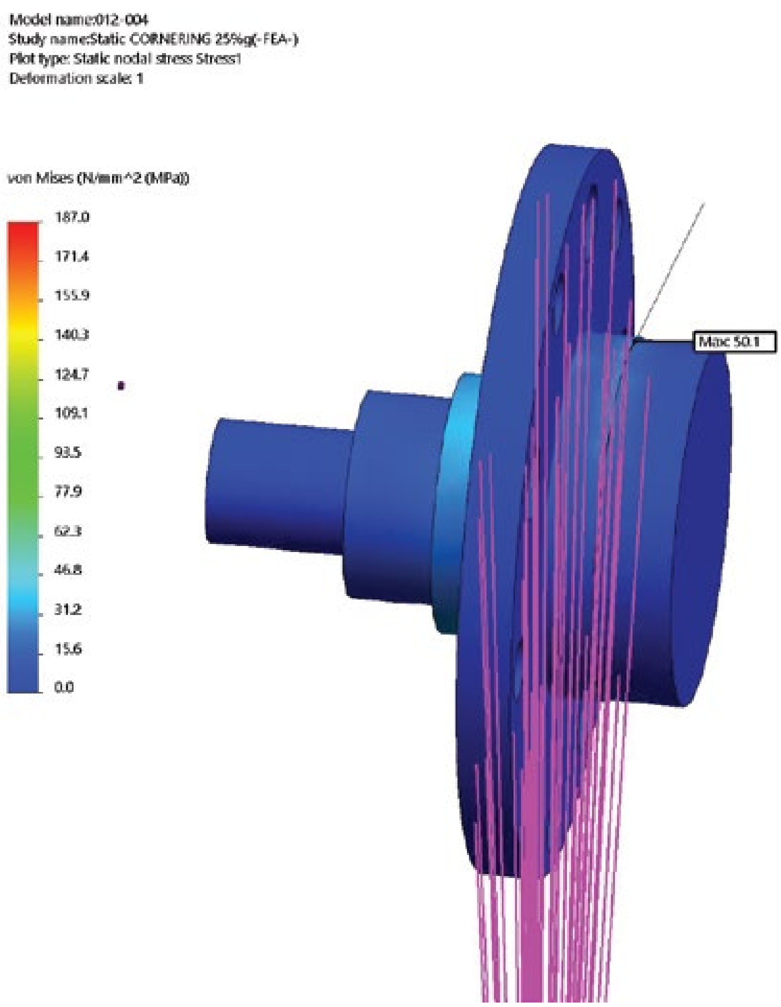


Image-32 – Hub Wheel mount, max Stress 50MPa.

RRS PTY LTD.
57/42-46 Wattle Road
Brookvale NSW 2100
Sydney Australia

Ph: 61 2 9907 3755
Mob 61 417 226 693
Email: alex@rrs-online.com

VSB 14 Compliance

2.1 Drive-ability

2.1.5 Turning Circle
The vehicle must have a sufficient turning circle in each direction and must meet all ADR dimensional regulations.

Vehicle Standard (Australian Design Rule 43/04 - Vehicle Configuration and Dimensions) 2006
TURNING CIRCLE

Every vehicle must have a turning circle in either direction, as determined by reference to the extreme outer edge of the tyre track at ground level, not exceeding 25 metres in diameter.

The RRS HO2 maintains original vehicle turning circle on all models covered. HO2 maintains the factory steering stops and the design allows for full rotation, so is therefore compliant to VSB 14 2.1.5

2.1.6 Tyre Deflation
Any Modification to suspension and steering, including replacement tyres and rims, must ensure that the vehicles body, exhaust system, axles, suspension or steering components do not contact the road when the tyre(s) deflate. Therefore, if one or more tyres deflate when the vehicle is level road, the rims and tyres must be the only part of the vehicle in contact with the road.

T***he RRS HO2 lowest point on stock (14") rims with no tyre clears the road by 1.65cm therefore is complaint with VSB 14 2.1.6***

2.1.7 Ride Height
Ride height is a very important parameter as it has a direct influence on a vehicle's centre of mass (centre of gravity) and hence its stability and performance.

The RRS HO2 can be set to maintain the stock ride height or adjusted 2" lower or raised 1", therefore is complaint with VSB 14 2.1.7

2.1.8 Suspension Travel
It is important to retain at least two thirds of the original suspension travel in either direction in border to maintain safe road holding characteristics.

The RRS HO2 retains more than 90% of original suspension, therefore is complaint with VSB 14 2.1.8

RRS PTY LTD.
57/42-46 Wattle Road
Brookvale NSW 2100
Sydney Australia

Ph: 61 2 9907 3755
Mob 61 417 226 693
Email: alex@rrs-online.com

VSB 14 Compliance

VSB 14 Compliance

2.2 Strength and Flexibility

2.2.1 Strength of Suspension and Steering Components

Changes in wheel width and offset, and bump clearance can cause significant increases in stress levels in suspension and steering components of both independent and beam axle suspensions.

The RRS HO2 uses A NSK axle bearing hub rated up to 275/30 R20 tyres 48mm offset wheel. RRS HO2 independent FEA showing the knuckle has A 12.5% greater load capacity than like OEM designs on vehicles with GVM 0f 1840Kg. Therefore if GVM less than 2000kg - rolling diameter less than 720mm with offset of less than 48mm, the RRS HO2 is complaint with VSB 14 2.2.1

2.2.2 Fatigue Strength

Some modifications that are satisfactory in the short term (e.g. on competition cars that travel relatively short distances) are often completely unsuitable for road because of the effects of metal fatigue. A suspension component on a road car can break from metal fatigue at stresses much less than that experienced during competition use.

***The RRS HO2 maintains original arcs of motion, and stressed components are load rated.
Therefore the RRS coil over is compliant with VSB 14 2.2.2***

2.2.3 Flexible Arms and Joints

Some suspension components (flexible arms and joints) are designed to twist when the suspension moves vertically. Boxing-in these components and/or using stiffer replacement bushes can cause large stresses in mounting bolts and brackets causing them to break or tear out. It is recommended that replacement of rubber flexing bushes with harder bushes should only be done in applications where single plane movement occurs.

***The RRS HO2 maintains original arcs of motion, and stressed components are load rated.
Therefore the RRS coil over is compliant with VSB 14 2.2.3***

VSB 14 Compliance

2.3 Fabrication

All work must be performed in accordance with recognised engineering standards. Cutting, heating, welding or bending of components should be avoided by choosing unmodified production components wherever possible.

2.3.1 Welding, Fasteners and Electroplating

Mandatory requirements and guidance on the above items are contained in Section LZ Appendices.

- For the use of fasteners refer to Appendix A Fasteners;
- For welding techniques and procedures refer to Appendix C Heating and Welding of Steering Components; and
- For electroplating refer to Appendix D Electroplating.

The RRS HO2 has no welded parts.
The RRS HO2 uses ISO Grade 8.8 or SAE grade 5 fasteners.
The RRS HO2 has no chrome plated parts.
Therefore the RRS HO2 is compliant with VSB 14 2.3.1

2.3.2 Mating Parts

Standard features such as splines, tapers and keyways must conform to published standards and their mating parts must conform to matching standards.

RRS HO2 uses splines, tapers and keyways that conform to all matching standards.
Therefore the RRS HO2 is compliant with VSB 14 2.3.2

VSB 14 Compliance

SPECIFIC REQUIREMENTS

The following requirements apply to all suspension and steering LS Codes: Where change is made to the suspension or steering system design, the basic functional and construction requirements are provided as a guide for suitably qualified and experienced signatories when designing or certifying such modifications or conversions. Each design should be fully documented, with drawings, calculations, procedural details, test results, wheel alignment specifications and any other data necessary to fully describe the vehicle modifications and should have a unique design number.
The design document should contain:
• Details of all drawings needed to fully describe the full extent of the modification;
• Details of any special modification techniques, procedures or adjustments; and
• Details of any testing of components (e.g. X-rays of modified drag links) and performance (e.g. bump steer plots) with related acceptance criteria. It is recommended that suspension and steering conversions utilise production components that do not require cutting, heating, bending or welding.

1 SUSPENSION AND STEERING GEOMETRY
Modified or redesigned suspension systems should meet the following requirements:

Free Movement. Suspension members and pivot bushes must be free to move through the full range of suspension travel from metal to metal positions at full bump and full rebound, without any geometric binding within the linkage and without any pivot being articulated beyond its design angles. This requirement applies when one wheel is at full bump and the opposite side wheel is at full rebound;

The RRS HO2 can move through its full range of travel without any binding.
The RRSHO2 can rotate 360 degree freely from its top mounting.
The conical top design allows for 23 degrees of swing movement.
Therefore the RRS HO2 complies with the free movement criteria

Roll Centre. The vehicle's roll axis is determined by the relative roll centre heights of the front and rear suspensions. A higher roll centre will reduce body roll but can result in unsatisfactory track variations and camber change on independent suspensions. The front suspension roll centre should not be higher than the rear suspension roll centre;

The RRS HO2 lowers the roll centre by 100-120mm.
The RRS HO2 creates a jacking affect to compensate for the increase in body roll.
Therefore the RRS HO2 complies with the roll centre criteria

Camber and Track Change. The suspension design should minimise track change with vertical wheel travel and maintain the outside wheel as close to vertical (or at slightly negative camber) as the body rolls under cornering. This will maximise cornering adhesion and minimise tyre wear;

The RRS HO2 increases negative camber, introduces a jacking affect, maximizing the tyre contact surface.
Therefore the RRS cHO2 meets the camber and track change criteria

RRS PTY LTD.
57/42-46 Wattle Road
Brookvale NSW 2100
Sydney Australia

Ph: 61 2 9907 3755
Mob 61 417 226 693
Email: alex@rrs-online.com

VSB 14 Compliance

Anti-squat, anti-dive. The amount of anti-dive geometry at the front suspension and anti-squat geometry at the rear is a matter of choice, depending on the vehicle characteristics desired. The pitch axis of the front suspension should be behind the front wheels while that for the rear suspension should be ahead of the rear wheels;

T***he RRS cHO2 uses the offset ball joint position and optimum axis of inclination, the design achieves improved anti-dive characteristics.***
Therefore the RRS HO2 meets the anti-squat anti-dive criteria

Vertical Wheel Travel. Spring rates and damper settings need to be selected to suit the character required for the vehicle. Spring rates should not be so high that an uncomfortably firm ride is achieved while they should not be so low that vehicle handling is compromised. Similarly damper settings should be selected to complement the spring rates. The latter may require some development effort. In general, the more vertical wheel-travel the better, because it allows larger wheel movements before bump rubbers are contacted;

The RRS HO2 spring rates are set at the time of ordering per GVM, weight bias, type of driving.
The RRS HO2 shock absorber is adjustable.
Therefore the RRS HO2 meets the vertical wheel travel criteria

Bump steer. When a wheel turns or steers as a result only of vertical suspension movement, this behaviour is called bump steer. A wheel can also steer as a result of longitudinal wheel movement in longitudinally compliant suspensions. The bump steer characteristic must be selected to suit the entire vehicle dynamics and should be established in conjunction with the rear suspension bump steer characteristics. As a guide, a very small toe-out on bump will produce a stable understeer characteristic. The toe-out must not be excessive because it produces unresponsive steering and tyre wear. Front wheels should never toe-in on bump (unless the rear suspension also toes-in) because this causes unstable oversteer.
When the front wheels are deflected rearwards under the influence of road shocks, the wheel direction should either remain unchanged or should toe out slightly. Toe-out under these conditions produces a smoother ride. However too much can cause excessive tyre wear.

The RRS HO2 does not affect the bump steer

Ball joint operating angles. The complete range of combinations of steering/suspension travel must be considered to ensure that there is no possibility of joints being over-articulated.

The RRS HO2 attaching points are in stock locations and subject to OEM movement restriction so the ball joint can not over articulate.
Therefore the RRS HO2 meets theball joint operating angles criteria

RRS PTY LTD.
57/42-46 Wattle Road
Brookvale NSW 2100
Sydney Australia

Ph: 61 2 9907 3755
Mob 61 417 226 693
Email: alex@rrs-online.com

VSB 14 Compliance

Over-articulation, even by a small amount can result in joint failure. An allowance must be made for deflection of suspension bushes under dynamic loading, as this can be significant at the extremes of travel. The compound angle of articulation of all steering and suspension ball joints must be established and compared with the manufacturer's specification for each joint.
Note: The specification will usually quote a slightly smaller angle than might be measured using a production component.

The RRS HO2 attaching points are in stock locations and subject to OEM movement restrictions, the top mount has an articulation range of 23 degrees and the strut leg can rotate 360 degrees.
Therefore the RRS HO2 meets the over articulation criteria

Operating Clearances. All suspension members and steering levers and linkages must clear other vehicle components such as engine, transmission exhaust system and chassis members etc. over the full envelope of steering/suspension travel, after allowing for any likely movement of engine or other mechanical assembly. It is recommended that a clearance of at least 10mm be provided between these components and 25mm be provided for tyres.

The RRS HO2 clears alls stock components with 10mm of clearance
.Therefore the RRS HO2 meets theoperating clearances criteria

Track. Where non-original axle or suspension cross-member components are fitted, the offset of the wheel in relation to the axle or hub assembly used must not be increased by more than 12.5mm each side of the vehicle based on the specifications of the axle components used. If an axle assembly is shortened then the track width limitis taken as the axle manufacturers original track dimension, less the amount the assembly has been narrowed, plus 25mm.

The RRS Ho2 does not change track width.
Therefore the RRS HO2 meets the Track criteria

Linkage stability. Steering linkages must be evaluated to ensure that they cannot over-centre at any stage, under the influence of either steering gear forces or road wheel forces. Allowance must be made for significant deflection and wear in pivot bushes in the steering and suspension and a large safety margin must be maintained.

The RRS HO2 has had FEA proving a high safety factor.
The RRS HO2 retains OEM tie rods, bump stops and steering stops are retained.
Therefore the RRS HO2 meets thelinkage stability criteria

VSB 14 Compliance

Steering stops. Must be provided and be installed as per those from the donor vehicle or as approved by the steering gear manufacturer. Reductions in steering gear travel must be designed to ensure that operating loads or stresses on the steering system are not increased.

The RRS HO2 maintains the factory steering stops.
Therefore the RRS HO2 meets the steering stops criteria

Ackermann principle. The Ackermann principle ensures accurate wheel geometry and tyre contact in turns avoiding excessive scuffing. All vehicles should incorporate a reasonable degree of Ackermann steering geometry. This concept is important when designing replacement steering systems and when altering the wheelbase of vehicles, e.g. limousine conversions.
At full lock, the lock angles must be appropriate for the desired turning circle and must not change significantly over the range of suspension travel. The toe-out at full lock should be selected, bearing in mind the true Ackermann angle, the types of tyres to be catered for and the use intended for the vehicle. At partial lock, the toe-out should be suitable for the vehicle application. This usually means slightly less than the true Ackermann angle due to the operating slip angle of the outside front tyre.

The RRS HO2 improves or has neutral affect on Ackermann.
Therefore the RRS HO2 meets the Ackermann criteria

2 STRUCTURE

The body/chassis structure should meet the following requirements:

Body/Chassis. Reinforcements must be added to achieve comparable structural strength and stiffness at body attachment points whenever a replacement suspension or steering system from a different vehicle model is used. The modifications must not create local stress concentrations; and Cross-member. When a cross-member is modified, or when a cross-member from another vehicle model is fitted, it must be reinforced where necessary to maintain its original structural strength and stiffness.

The RRS HO2 does not increase to chassis load.
Therefore the RRS HO2 meets the body chassis criteria

3 COMPONENT STRESS LEVELS

The stress levels of any production component in the suspension system must not be increased over that at which it has been demonstrated to be capable of satisfactory operation.

The RRS HO2 component stress level are capable of satisfactory operation (see report page 58-140).
Therefore the RRS HO2 meets the component stress level criteria

VSB 14 Compliance

4 MODIFIED COMPONENTS

Where modifications of steering components cannot be avoided, the operations employed should be determined and controlled such that the final properties can be predicted and verified on an individual component basis by a NATA approved materials laboratory, using relevant Australian or International Standards as a reference. The following post process testing by the laboratory is a minimum for such components:

- Welded parts should have the weld material identified, a hardness test traversing across the weld area including the heat affected zone, an X-Ray inspection and a statement of weld integrity;
- Heated parts should be stress relieved, heat treated to a defined specification and undergo non-destructive testing such as magnetic particle or ultrasonic;
- Parts which have been cold worked (where permitted) must be checked to ensure that the cold working is not excessive, stress relieved if required and undergo nondestructive testing such as magnetic particle or ultrasonic.

Section LZ Appendices provides further information and guidance on heat treatment and welding. The mandatory provisions of Section LZ must be complied with

RRS HO2 have no welded parts
RRS HO2 have no heated parts
RRS HO2 have no cold worked parts
Therefore the RRS HO2 complies with modified components criteria

RRS PTY LTD.
57/42-46 Wattle Road
Brookvale NSW 2100
Sydney Australia
Ph: 61 2 9907 3755
Mob 61 417 226 693
Email: alex@rrs-online.com

VSB 14 Compliance

4.1 Standard Features

Standard features such as splines, tapers and keyways must conform to published standards and mating parts to matching standards.

RRS HO2 uses OEM tapers therefore HO2 satisfies 4.1

4.2 Machining of Input Shafts

Machining of input shafts is allowable to reduce length, provided that welding is not involved, the same spline is machined at the new length and the minimum cross section, including radii, of the shaft is not reduced below that of the original. The modified pinion shaft should not be subsequently heat-treated.

RRS HO2 shafts are machined to size, not cut or welded therefore satisfies 4.2

4.3 Machining of Any Components

Machining of any components must meet the relevant specifications of tolerance and radii.

RRS HO2 components are CAD drawn, laser cut to the program, and CNC machined to the program, all critical components are checked with GO/NO GO gauges therefore satisfies 4.3

4.4 All Splines

All splines must meet the original vehicle specifications and must engage over the same length as the original.

N/A

4.5 Threaded Bosses

Threaded bosses where used for steering gear mounting, must provide full depth thread for engagement over 1.5 times the mating bolt diameter.

N/A

4.6 Welding of Steering Components to Chassis

Steering components must not be welded to the chassis structure.

RRS HO2 is a bolt in system and no part of the steering linkage in welded therefore satisfies 4.6

4.7 Re-machining of Ball Joint Tapered Stud Holes in Steering Arms

Re-machining of ball joint tapered stud holes in steering arms may be undertaken provided that the re-machining does not reduce the safety of the design and the surface finish is equivalent to that of the original manufacture.

RRS HO2 use OEM tapers on the drag bar therefore satisfies 4.7

VSB 14 Compliance

4.8 Tapered Adaptor Sleeves
Tapered adaptor sleeves may be used provided they are made of suitable steel, i.e. equivalent in strength and hardness to the stud to be mounted.
N/A

4.9 Mounting Surfaces
Mounting surfaces for steering components must designed and in a condition that ensures no stress inducing deflection of either mounting surface or steering component occurs when the attachment bolts are tightened.

RRS HO2 are mounted to original mounting locations therefore satisfies 4.9

4.17 Tie-rods
Tie Rods may be modified by:
• shortening by extending the thread and removing the excess threaded portion, provided that the rod is suitable for this operation, the length of thread engagement is equal to or greater than the original manufacturer's specification; or
• extending by provision of threaded adaptors, provided that the original manufacturer's specification in respect to buckling trength, shear strength, thread engagement, thread locking and material selection are all maintained.

RRS HO2 uses OEM outer tie rods therefore satisfies 4.17

4.23 Change in Vehicle Height. Where changes in vehicle height occur as a result of modifications, the requirements detailed under Modified Components above that are applicable to individual steering and suspension components continue to apply. Important items such as spline engagement, operating angles of drive shaft joints and in the case of CV joints, the range of axial movement, must remain within design limits for the full range of suspension travel. Also other components such as gear levers, brake hoses etc. may need to be extended depending on the nature of the lift. Steering linkages must continue to operate efficiently and sufficient spline contact surface must be retained for the full range of suspension travel to ensure the safe operation of the vehicle. Otherwise an appropriate steering shaft extension must be used. Following the completion of modifications the vehicle attitude must remain as per original specifications – i.e. the original relationship between the front and rear suspension heights must not be changed and therefore the front and rear suspensions must be both raised by the same amount. Vehicles whose ride height is raised by more than 50mm must undergo a lane-change manoeuvre test in accordance with ISO 3888-1 Passenger Cars – Test Track for a Severe Lane-Change Manoeuvre – Part 1: Double Lane-Change to ensure its stability has not been compromised

N/A

RRS PTY LTD.
57/42-46 Wattle Road
Brookvale NSW 2100
Sydney Australia

Ph: 61 2 9907 3755
Mob 61 417 226 693
Email: alex@rrs-online.com

RRS STRUT FRONT END - KEY ENGINEERING POINTS

The RRS front McPherson strut system replaces the original short upper wish-bone (control arm) and original stub axle.

The design is similar to HSV Commodore Statesman 2000.

The RRS knuckle design (as tested by Cadtek) has a 12.5 % greater load-bearing capacity than the Holden OEM component.

The RRS hub bearing is the NSK built OEM Holden component with a Ford stud pattern.

RRS knuckles evaluated to ensure quality by ETRS according to quality management system certified by NCS International Pty Ltd that complies with the requirements of Australia/New Zealand's ISO9001:1994, NATA accredited laboratories.

RRS steering knuckles CNC machined to plus or minus 0.020mm

The following is IKO (bearing company) load-bearing capacity for XC-XF Falcon front wheel bearing assemblies:
35,700 kgf Dynamic load
48,500 kgf static load
The RRS bearing hub manufactured by NSK (bearing company) has the following load-bearing capacity:
45,000 kgf dynamic load
54,000 kgf static load
RRS strut assembly Basic dynamic load rating (kgf) 2300 per side
RRS strut assembly Basic Static load rating (kgf) 2500 per side
RRS strut top mounting dynamic load capacity 5680 kgf
RRS strut top mounting static load capacity 34100 kgf

The suspension provides the original Ford bump wheel travel with a 12% reduction in a droop.

Clearance between the tyre and suspension is increased by 32 mm over the original for suspension.

No chassis modifications are needed to enable the fitment of the RRS coil-over suspension.

The vertical load (on the chassis) is reduced, as the spring-shocker is direct-acting compared to the 2:1 mechanical leverage (wheel load to the spring load).

All elements of the RRS HO2 have had stress limits, and material yield strength tested.
All elements have 3:1 factor of safety.

RRS PTY LTD.
57/42-46 Wattle Road
Brookvale NSW 2100
Sydney Australia

Ph: 61 2 9907 3755
Mob 61 417 226 693
Email: alex@rrs-online.com

Conclusions

A classic Ford fitted with the RRS HO2 coil-over strut assembly achieves an improvement in load-bearing capacity, suspension geometry, and unsprung weight over the original Ford design.

The RRS HO2 coil-over strut is a bolt in system that improves the handling, reduces chassis stress.

This document proves the RRS HO2 is compliant with all elements of the VSB14.