EMSEAL Corporation

Seismic Joint System Analysis

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Revision Level - 0

Revision Date -

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Project Description

The EMSEAL Seismic Joint System configuration will be used in a fork lift application applying loads up to 2500 lb_f per wheel, for a total load of 5000 lb_f. Using Finite Element Analysis, it has been requested to analyze the cover plate and spine together, and the cover plate alone when the load is applied. The loading case will include both front wheels of the fork lift on one plate. The plate will be considered at ½" thickness at 18" width made from 304 stainless steel. The spline is 6061-T6 aluminum. A series of joint sizes will be tested: 7", 13", and 15" with the spline included, and then with the spline removed.

Objective

To determine the safety factor of the assembly with the given loads. Also, to demonstrate what effect the spline has in strengthening the assembly, if any.

Given

Materials are used for the cover plate

1. Stainless Steel 304

Item Description	Material	Yield Strength	Ultimate Strength
Cover Plate	Stainless Steel 304	39,800 psi	84,000 psi
Spline	Aluminum 6061-T6 Alloy	40,000 psi	45,000 psi

Material mechanical properties are shown in detail in the appendix at the end of this report.

Load applied per Wheel = 2500 lbs

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Assumptions

1) The elastomeric supports on each side of the cover plate can be replaced by rigid supports.
2) Foundation (stiff) springs are used to simulate the effects of the connection between splines.
3) These stiff springs were given a spring rate equal to 50,000 lbf/inch as with previous studies.

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Results

Parameters	Units	Set1	Set2	Set3
Max Unsupported Span	in	7	13	15
Cover Plate Width	in	18	18	18
Thickness	in	0.5	0.5	0.5
1/2" SS Plate With Spline				
Nominal Stress	psi	4800	8200	9300
Maximum Displacement	in	0.006	0.014	0.019
Factor of Safety (YTS)		8.3	4.9	4.3
1/2" SS Plate Without Spline				
Nominal Stress	psi	8320	12978	13800
Maximum Displacement	in	0.006	0.02	0.028
Factor of Safety (YTS)		4.8	3.1	2.9

Set 1, set 2 and set 3 represent the three different studies carried out for each of the unsupported spans. The first group of results reflects the 304 stainless cover plate with the 6061-T6 spline and the second group reflects the 304 stainless cover plate without the supporting spline.

The safety factor was calculated using nominal stresses. Nominal stresses are defined as “stresses developed by load and geometrical discontinuities” and do not include contact stresses.

The reaction force created by the supporting spring on each end of the spine is approximately 295 lb_f. This implies that 590 lbs of the applied load or 27% is transferred to the adjacent plates.

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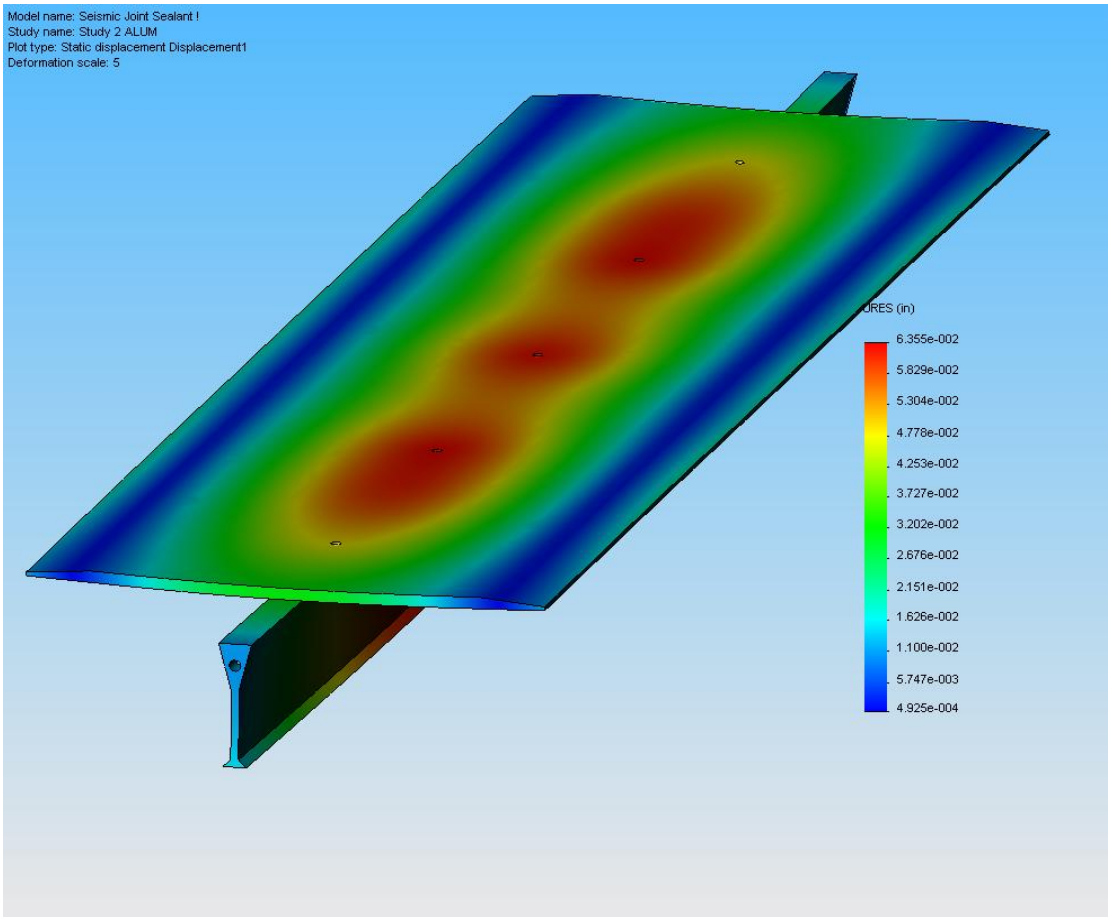
Deformation Graphic



Note: Deformations are exaggerated by a factor of 5.

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Conclusions

The results of the above studies indicate that the aluminum spline contributes significantly to the overall strength of the assembly. The safety factor is, on average, 59.7% higher with the supporting spline. At the largest unsupported span the safety factor without the spline drops as low as 2.9, while the assembly with supporting spline is 4.3 – approximately 48% higher safety margin.

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Appendix – Material Properties

Aluminum 3003

Density (×1000 kg/m^3)	2.73	25	
Poisson's Ratio	0.33	25	
Elastic Modulus (GPa)	70-80	25	
Tensile Strength (Mpa)	130	25	H12 more
Yield Strength (Mpa)	125		
Elongation (%)	10		
Reduction in Area (%)			
Hardness (HB500)	35	25	H12 more
Shear Strength (MPa)	83	25	H12 more
Fatigue Strength (MPa)	55	25	H12 more

Aluminum 6061

Density (×1000 kg/m^3)	2.7	25	
Poisson's Ratio	0.33	25	
Elastic Modulus (GPa)	70-80	25	
Tensile Strength (Mpa)	115	25	O (Alclad) more
Yield Strength (Mpa)	48		
Elongation (%)	25		
Reduction in Area (%)			
Hardness (HB500)	30	25	O more
Shear Strength (MPa)	83	25	O more
Fatigue Strength (MPa)	62	25	O more

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Stainless Steel 304

Density (×1000 kg/m^3)	2.7	25	
Poisson's Ratio	0.33	25	
Elastic Modulus (GPa)	70-80	25	
Tensile Strength (Mpa)	115	25	O (Alclad) more
Yield Strength (Mpa)	48		
Elongation (%)	25		
Reduction in Area (%)			
Hardness (HB500)	30	25	O more
Shear Strength (MPa)	83	25	O more
Fatigue Strength (MPa)	62	25	O more

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