



# **Safety Plate Testing**

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## 1.0 INTRODUCTION

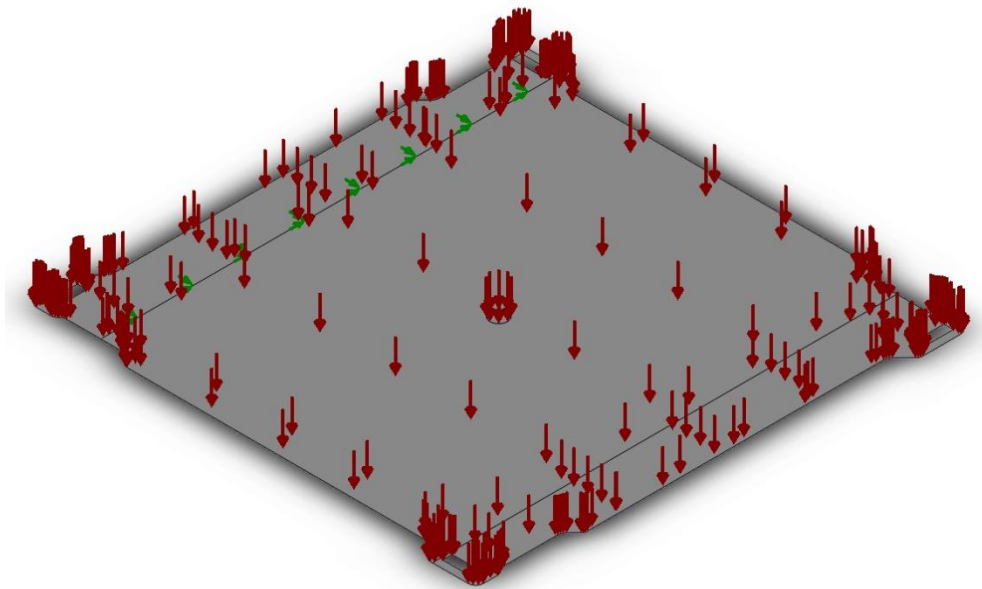
This calculation documents the test results for a safety plate used as part of an elevated floor system. The safety plate is constructed of 14 gauge galvanized steel and supported at each corner by an elevated pedestal. Test methods are in accordance with ASTM Standard E2322-03 (2015), *Standard Test Method for Conducting Transverse and Concentrated Load Tests on Panels used in Floor and Roof Construction*. Finite element analysis software was used to simulate the test methods and calculate the rated loads. The safety plate has a maximum rating of 4.47 kPa (93 psf) distributed load and 0.67 kN (150 lbf) concentrated load when no deflection criteria is used. The maximum rating is 1.03 kPa (21 psf) distributed load and 0.18 kN (40 lbf) concentrated load when the deflection is limited to L/100.

## 2.0 DESCRIPTION OF TEST METHODS

ASTM E2322-03 requires a transverse load test and a concentrated load test. The Standard does not provide stress or deflection criteria, so allowable stress and deflections were calculated in accordance with the AISC Steel Construction Manual, 14<sup>th</sup> Edition. Results are provided for both stress-limited and deflection-limited loads. The deflection-limited loads use L/100 for the deflection criteria. Deflection requirements may change depending on the application.

### Test 1: Transverse Load Test

The transverse load test can be performed with either a uniformly distributed load using an air pressure bag or a vacuum chamber, or with quarter point loading using two beams located a quarter of the way from each edge of the panel. A pressure load was applied to the FEA model to simulate the use of an air pressure bag or vacuum chamber. Two edges of the panel are simply supported across the entire length in accordance with the test method. The setup for the FEA model is shown in Figure 2-1.

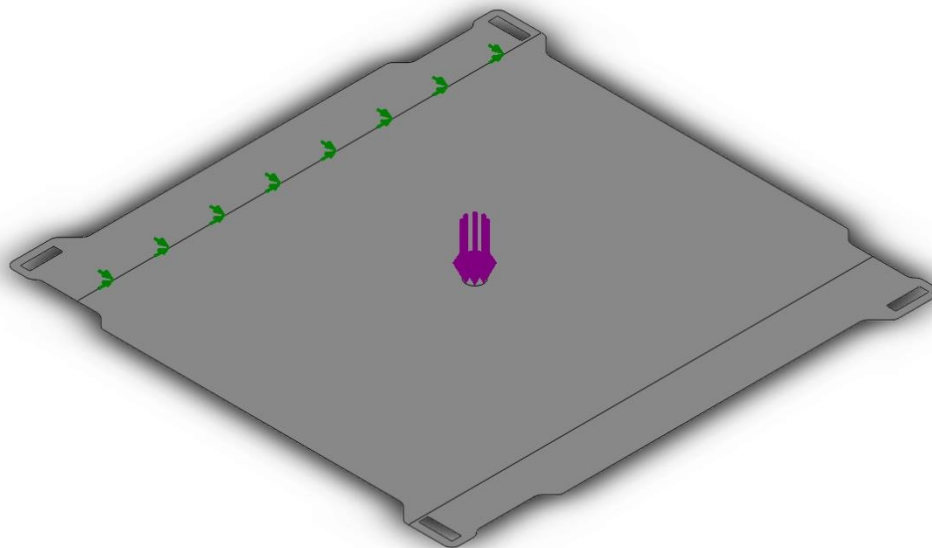


**Figure 2-1: Transverse Load Test Setup**

### Test 2: Concentrated Load Test

The concentrated load test is performed using a steel bar with a diameter of 25.4 mm (1 in) to apply a compressive load of 4.45 kN (1,000 lbf) to the center of the panel. The safety plate is required to be fully supported for the concentrated load test. The safety plate is constructed of single-ply steel, so there is negligible deflection when fully supported. This test is intended for panels made with sandwich construction to measure the permanent deformation in the upper sheet.

Because the ASTM E2322-03 concentrated load test does not yield useful results for this design, a modified concentrated load test is included in this calculation. The modified concentrated load test is a force applied to a 25.4 mm (1 in) diameter circle in the center of the plate with two edges supported. The setup for the FEA model is shown in Figure 2-2.



**Figure 2-2: Concentrated Load Test Setup**

### **2.1 Material Properties**

The safety plate was assumed to be Grade 33 galvanized steel, which is the lowest grade that meets ASTM A653-09 specifications. The allowable bending stress was calculated as 75% of the yield stress in accordance with the AISC Steel Construction Manual. Material properties are listed in the table below.

Grade 33 Galvanized Steel	
Density	7750 kg/m <sup>3</sup> (0.28 lbm/in <sup>3</sup> )
Modulus of Elasticity	207 GPa (30 x 10 <sup>6</sup> psi)
Poisson's Ratio	0.28
Allowable Bending Stress	170,645 kPa (24,750 psi)
Yield Strength	227,527 kPa (33,000 psi)
Ultimate Tensile Strength	310,264 kPa (45,000 psi)

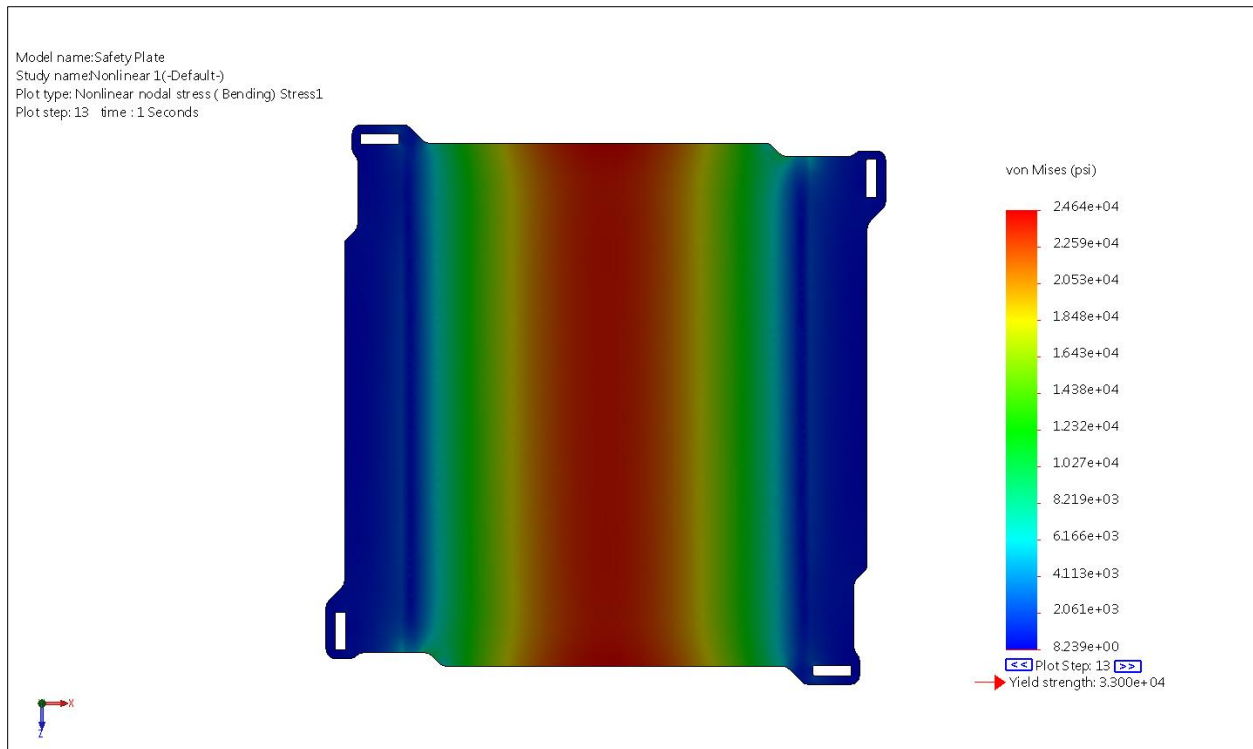
### 3.0 RESULTS

#### Test 1: Transverse Load Test

Stress-limited maximum rated load: 4.47 kPa (93 psf)

Deflection-limited maximum rated load (L/100): 1.03 kPa (21 psf)

Bending stress is shown in Figure 3-1. The maximum bending stress is 169,887 kPa (24,640 psi), which is below the allowable bending stress of 170,645 kPa (24,750 psi).



**Figure 3-1: Bending Stress – Transverse Load**

The maximum displacement is 19 mm (0.749 in) at the center of the plate as shown in Figure 3-2. This corresponds to a deflection ratio of L/24.

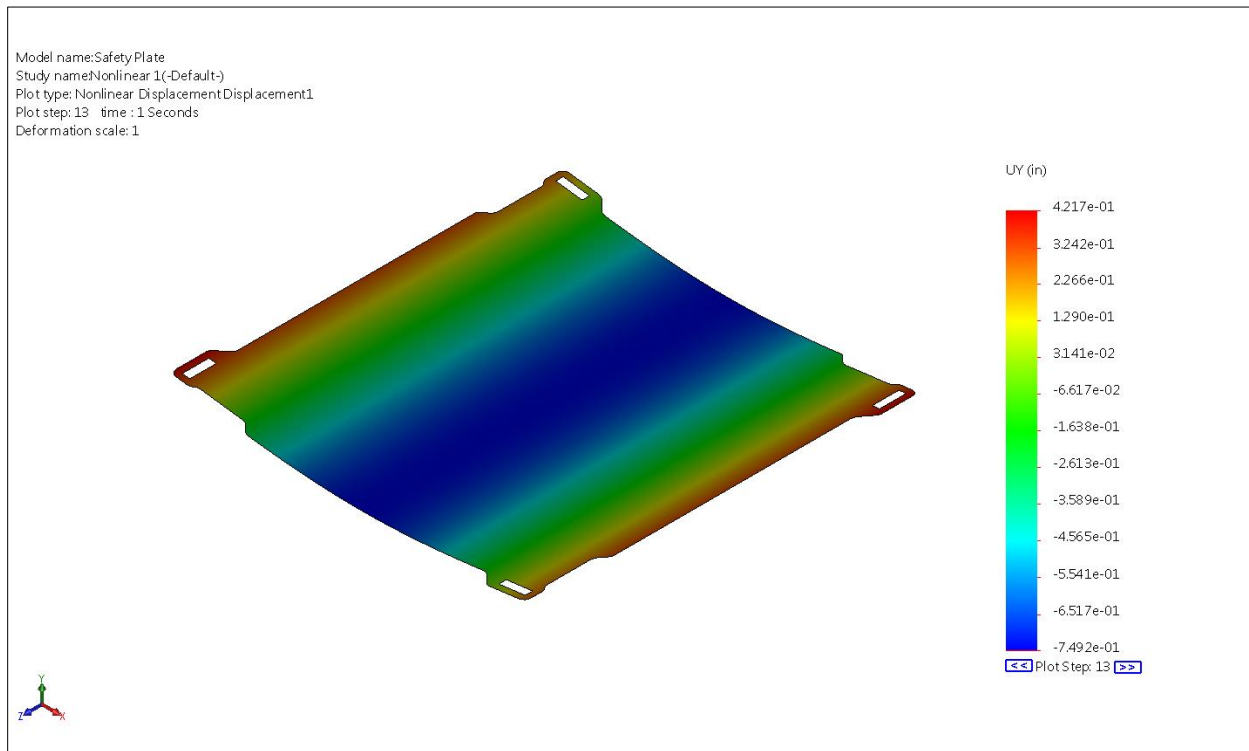
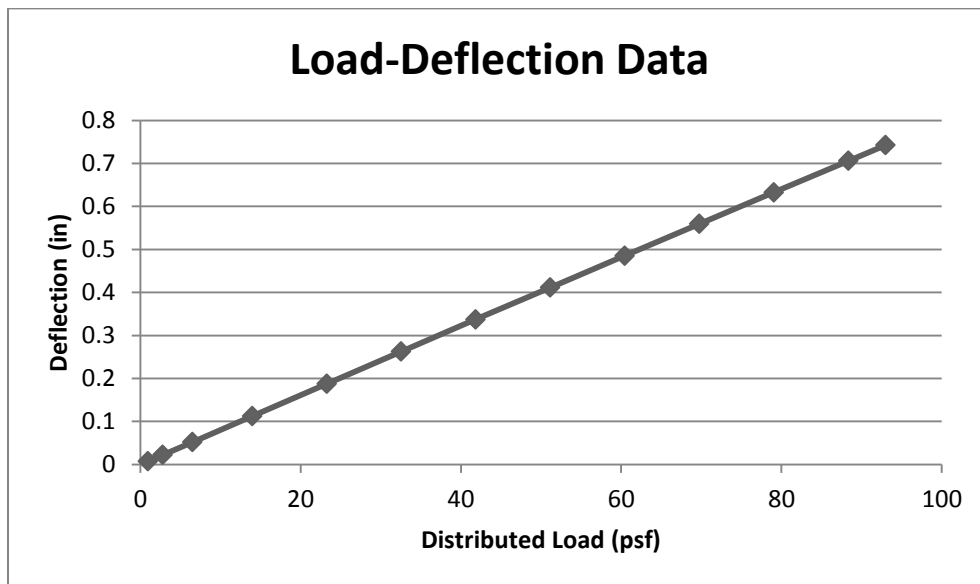


Figure 3-2: Vertical Displacement – Transverse Load

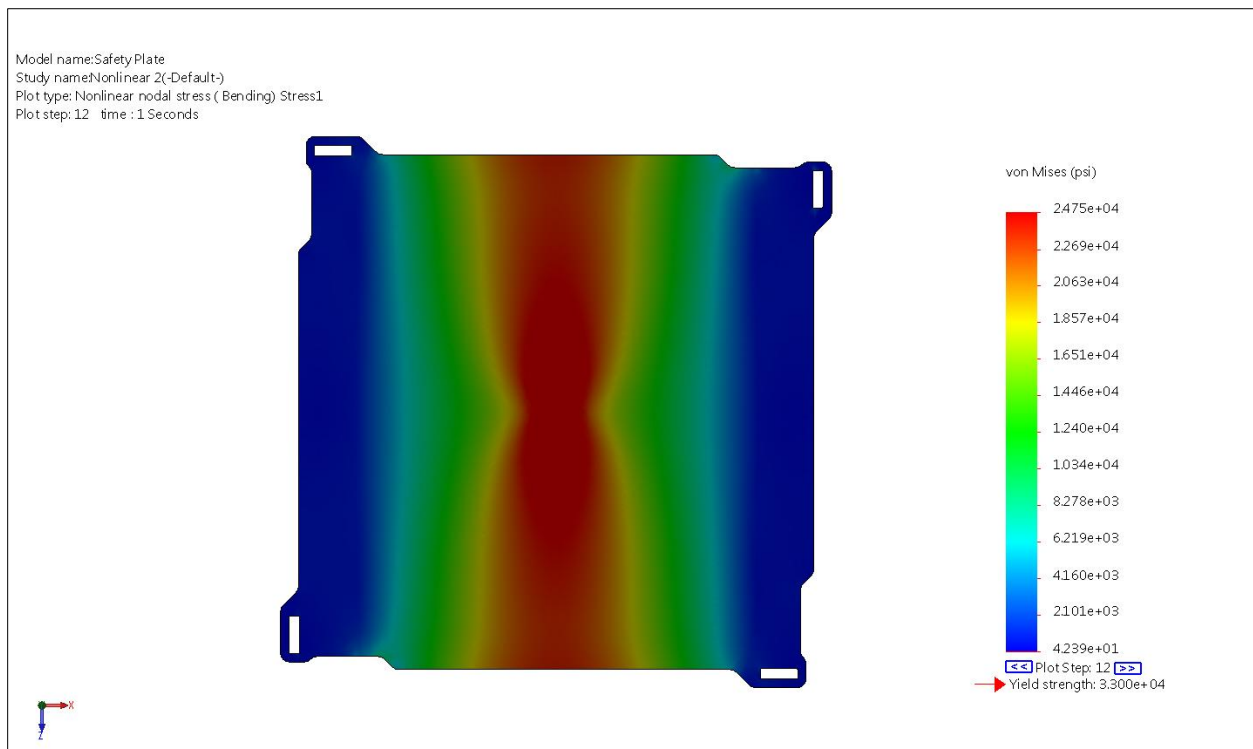


## Test 2: Concentrated Load Test

Stress-limited maximum rated load: 0.67 kN (150 lbf)

Deflection-limited maximum rated load (L/100): 0.18 kN (40 lbf)

Bending stress is shown in Figure 3-3. The maximum bending stress is below the allowable bending stress of 170,645 kPa (24,750 psi) at the edges of the plate. There is some permanent deformation at the center of the plate due to the concentrated load, but it will not cause the entire plate to collapse.



**Figure 3-3: Bending Stress – Concentrated Load**

The maximum displacement is 18 mm (0.726 in) at the center of the plate as shown in Figure 3-4. This corresponds to a deflection ratio of  $L/25$ .

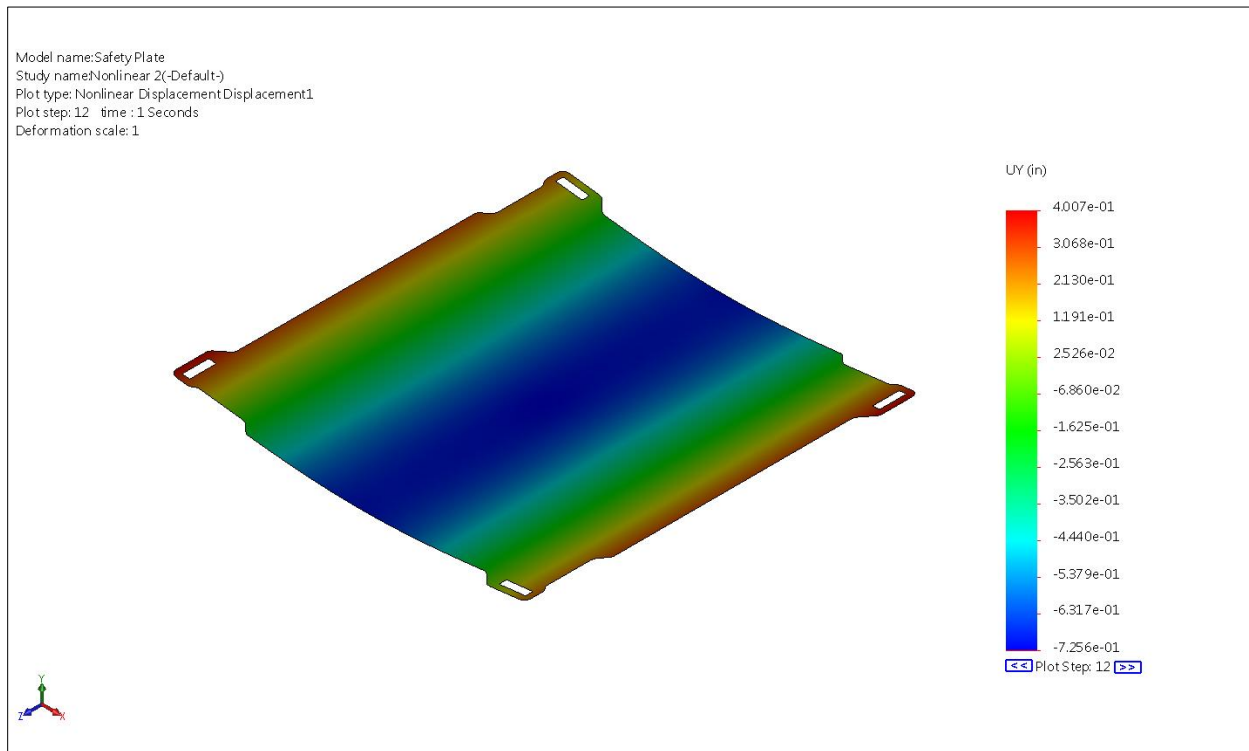
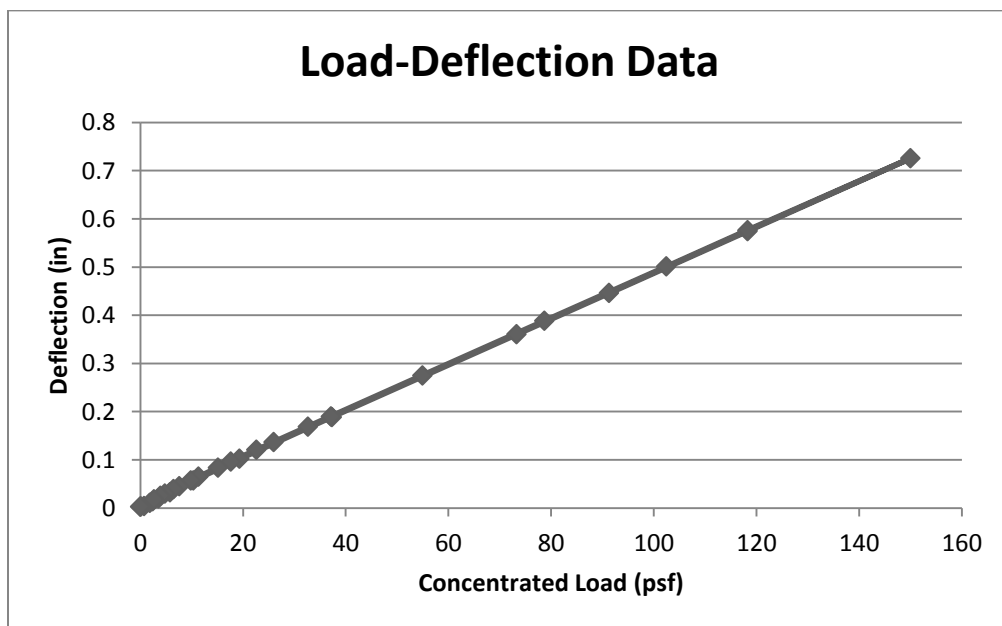


Figure 3-4: Vertical Displacement – Concentrated Load





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#### 4.0 CONCLUSION

The safety plate has a stress-limited maximum distributed load rating of 4.47 kPa (93 psf) when tested in accordance with ASTM E2322. The distributed load rating is 1.03 kPa (21 psf) if deflection is limited to  $L/100$ . When testing for a concentrated load of 4.45 kN (1,000 lbf) with continuous vertical support in accordance with ASTM E2322, there is no significant deflection due to the single-ply steel construction.

In addition to the ASTM E2322 concentrated load test, the plate was tested for a concentrated load with edge supports instead of a continuous support. The safety plate has a stress-limited maximum concentrated load of 0.67 kN (150 lbf) at the center of the plate when tested in this configuration. The concentrated load rating is 0.18 kN (40 lbf) if deflection is limited to  $L/100$ .



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