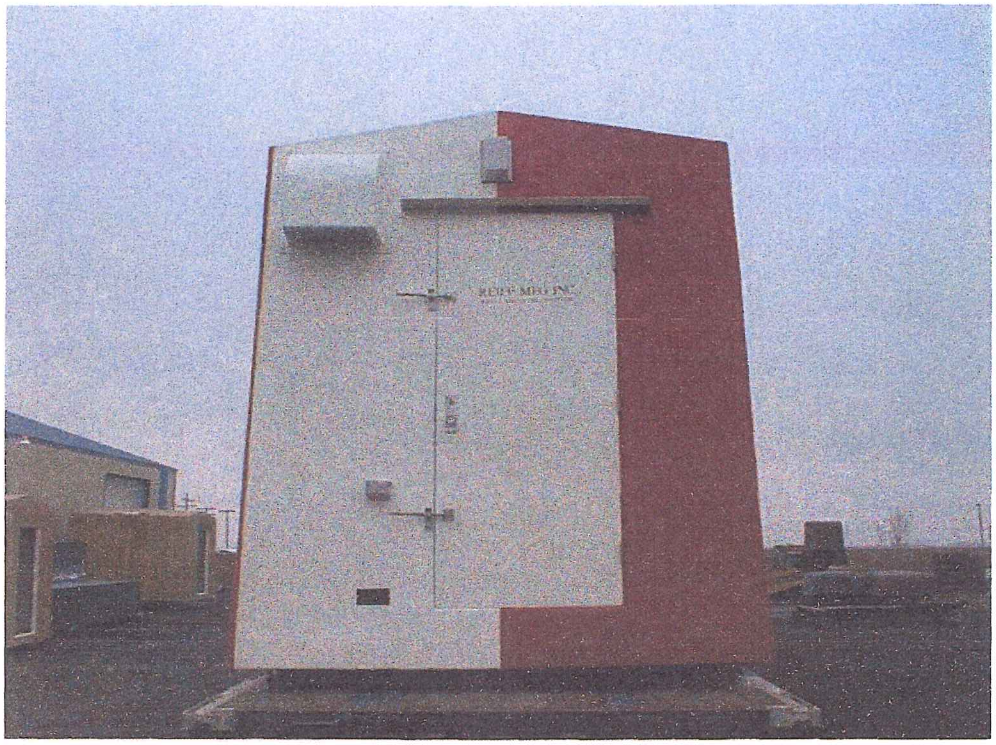
Reiff manufacturing

Fiberglass shelters

DESIGN MANUAL



Reiff Manufacturing Shelters:

Sizes: 4x4, 6x8, 8x8, 8x10, 8x12, 8x16, 10x12, 10x16, 10x20, 12x24, and 12x40

MAURICE E. FORTNEY STATE OF WASHINGTON 20313 REGISTERED PROFESSIONAL ENGINEER

EXPIRES: 02/02/13

REGISTERED PROFESSIONAL ENGINEER 16245 OREGON DEC. 1, 1992 MAURICE E. FORTNEY

PROFESSIONAL ENGINEER REGISTERED 6533 STATE OF IDAHO MAURICE E. FORTNEY

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Reiff Manufacturing
Fiberglass Shelter
Design Documents

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INTRODUCTION

The Reiff Fiberglass Shelter was originally designed to withstand wind loads of 250 mph. The original shelter was design for the FAA for use in housing Instrument Approach equipment at various airports around the country.

The basic design used in the original shelter has been modified to meet the demands of other user-groups. Cellular telephone companies have used the buildings as repeater shelters. The design has also been used as emergency shelters for stranded airmen in Alaska.

Seven different shelter sizes are built. The basic wall section is used on all shelters and design calculations apply to all the shelter models. All Shelters will withstand the 120-mph wind loading analyzed in this document.

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1.0 SCOPE OF WORK

The scope of work is to determine if the Reiff Manufacturing Fiberglass shelter can withstand 120 mph wind loading under Category C conditions with Importance class of 1.11.

Computer modeling and laboratory testing were used to determine the adequacy of the shelters.

RISA-3D was the computer model used. Test sections of the wall were subjected to bending stresses using a three-point beam loading and the bending stresses calculated.

Loads were placed on either 3-inch or 6-inch test sections during the laboratory tests. The analysis was done on the computer models using a 12-inch wide wall section.

This resulted in an actual larger load being placed on the wall sections during the laboratory testing.

2.0 Description of Project

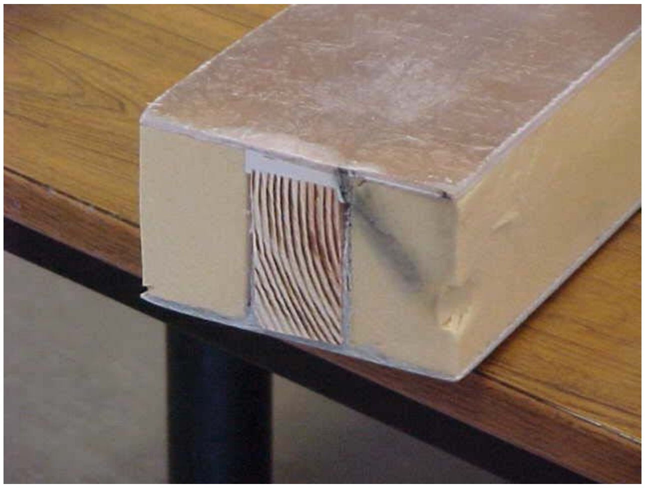
A computer modeling programs was used to calculate bending moments and stresses induced into the structure walls.

In addition, two sections were tested under a beam load test using three-point loading.

From the loads measured by the apparatus, the induced bending moments were determined and then compared to the calculated values.

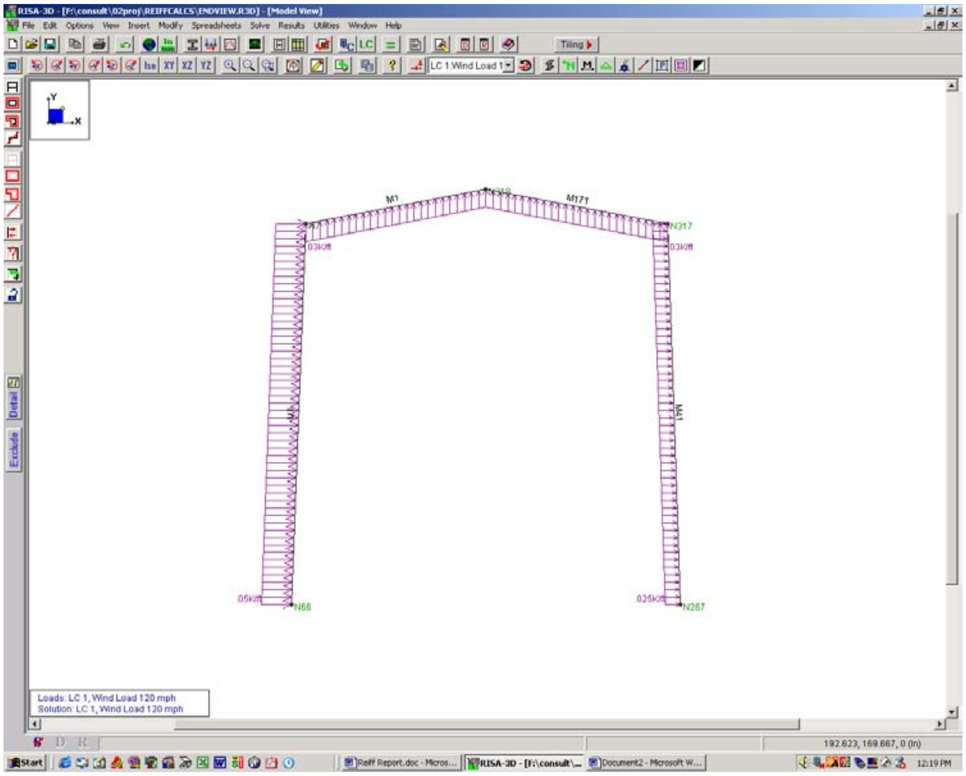
The two sections tested were the fiberglass laminate on the outside surfaces separated by a fiberglass foam material. And the same section with a 1.50" x 2.69" wood member inside the laminate surfaces.

The photo on the right shows the typical reinforced wall section that was tested.



This was sections was 5.50 inches +/- wide. The computer model was based on a 12-inch wide wall section. This results in an actual slightly larger load being applied to the test sample as opposed to the mathematical model.

3.0 Modeling



The model was loaded with wind loads from the windward side of the structure and the lee side. ANSI standards were used to determine all loads.

Uplift was also included in the calculations of the model.

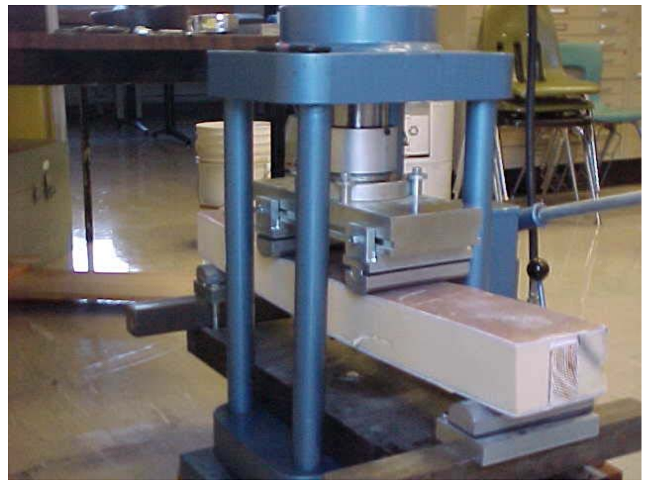
The model produced shear and moment diagrams for all the members.

The program is geared to analyze wood and steel structures and fiberglass is not part of the program.

Because of the unusual nature of the fiberglass and its infrequent use in the construction industry, the program calculated only reactions. Stresses and allowable loads are not included in the programs code requirement features.

The program was limited to determining stresses and deflections only.

4.0 Laboratory testing and design calculations



To test calculations and actual against actual failure of the walls, test sections we placed into a SOILTEST compressive load device to see at what point the wall sections would fail.

The photo on the right shows the reinforced wall section under load in the testing equipment. The reinforced wall section failed at loads in excess of 3,000 pounds.

The moment produced by these tested exceeded the predicated bending moments from the computer model.

Typical bending moments from the test of the samples were 1.25 K'. Maximum bending moments from the 120-mph load were 0.264 K'.

Tests run on the un-reinforced wall sections were inconclusive. The gages on the apparatus were not reliable enough to make accurate measurements. The typical bending moments from the test of the un-reinforced sections were from 0.200 K' to 0.417K'.

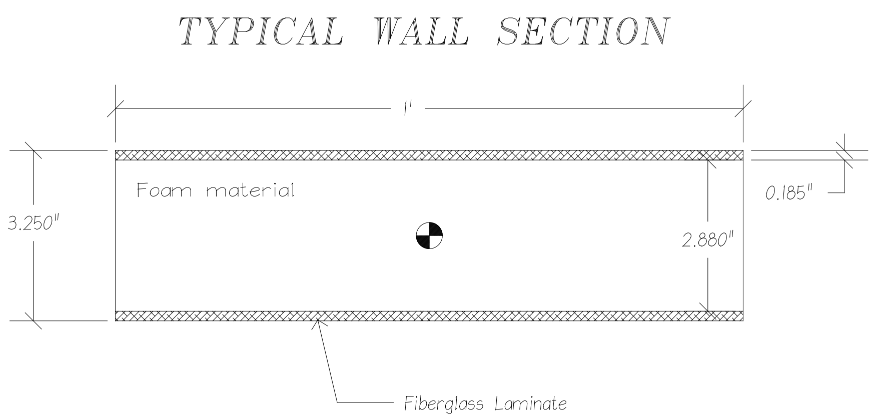
Because of the unsatisfactory nature of the testing of the un-reinforced beams, calculations were done based on laboratory data supplied by Elliott Company of Indianapolis Inc. Elliott is the fiberglass material supplier for Reiff Manufacturing.

For the analysis of the typical wall section, the added strength of the foam material between the laminate layers was neglected. The actual strength of the structure will be higher than calculated.

Since the calculated strength exceeded the expected stresses induced by the wind loading, the foam acts as a safety factor.

The first step in the analysis was to determine the moment of inertia (I) for the typical section.

The equation used to determine the moment of inertia was:



$$I = (BH^3 / 12) \quad + Ad^2$$

$$= 12 * (0.185)^\wedge 3/12 \; + \; (12*0.185)*1.533^\wedge 2$$

$$= 5.220$$

Since there are two sections of laminate the final I = 10.440 in^4.

Allowable bending stress is 12,500 psi (from Elliot).

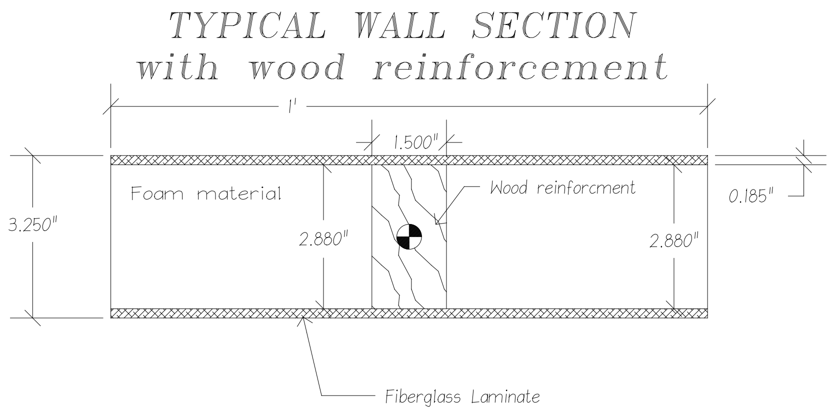
F_b = Mc/I

Allowable bending moment = F_b I / c

= 12,500 * (10.440)/1.625 = 80.304 lb-in
= 6.692 k-ft there for we will use 5.00 k-ft as check to see if adequate for design loads

The 5.00 k-ft exceeds the maximum expected loads of 0.264 k-ft.

The typical reinforced wall section is shown on the right. The wood is spaced at 24-inches on center and gives the wall additional strength not found in the fiberglass section alone.



The section tested was the same as the section shown except the width of the sample was 5.369 inches wide and not 12 inches as shown in the typical sample.

The test samples failed in bending at 3,000 pounds of load. The sample beam was then loaded to 3,400 pounds and that load was held for five minutes before the beam failed catastrophically.

No failures in shear were found.

A 120-mph wind will result in a maximum of 3,200 in-lbs of moment in the wall sections. A 2,000-lb load, as tested in the laboratory produces 10,000 in-lbs of moment in the beam. The 120-mph wind produces the equivalent load of 640 pounds.

5.0 Summary

The conclusions drawn for this analysis is that the Reiff Fiberglass shelters are adequate for wind loads that exceed the required 120-mph Category C, Importance 1.11.

The original shelter was designed for 250-mph winds and it appears that the shelter will meet that requirement. Although no calculations were done for any loads beyond the 120-mph wind loads.

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Appendix A – Computer Modeling

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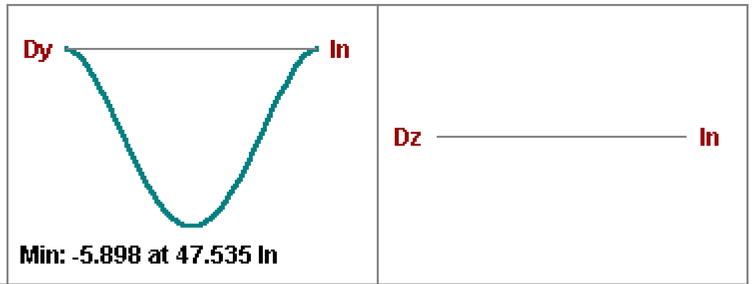
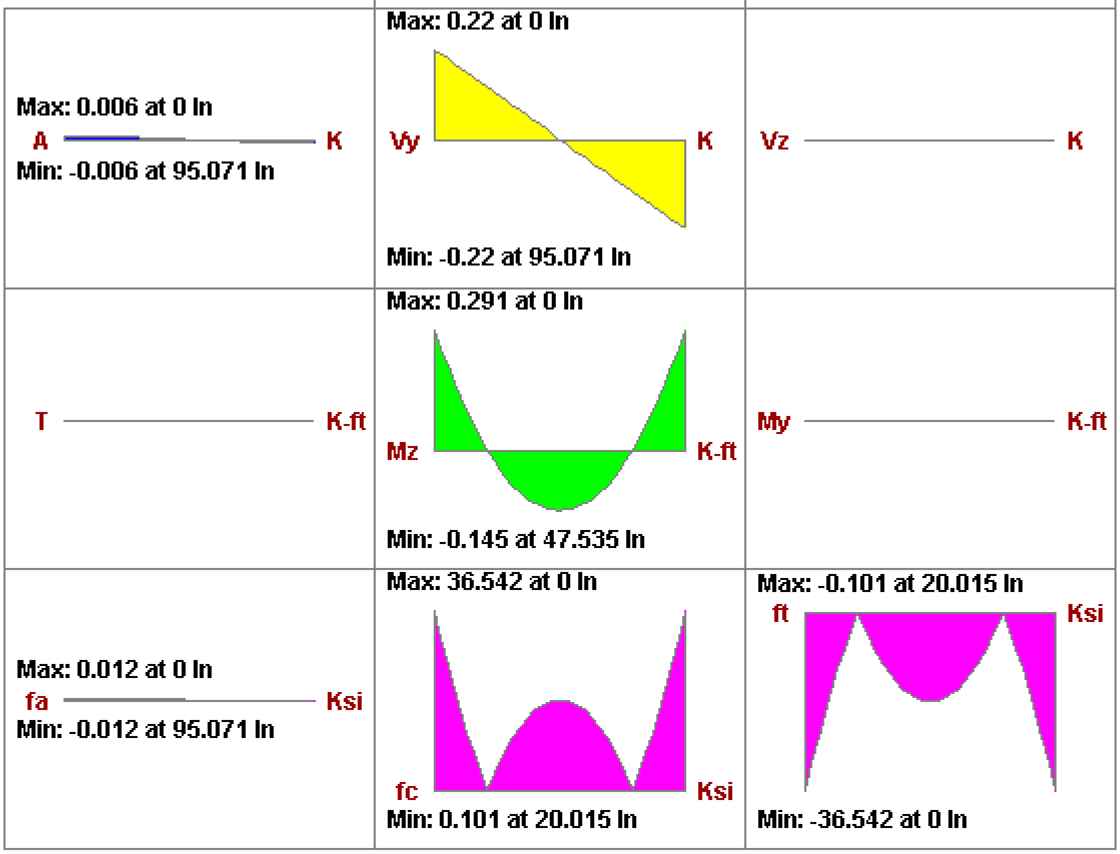
Member: ***M149***

Shape: **CORE**
Length: **95.071 In**
I Node: **N2421**
J Node: **N2414**

LC 1: WIND ONE

Max Code Check: **No Calc**





AISC ASD 9th Ed. Code Check

- Compressive stress fa exceeds F'e (Euler buckling) -

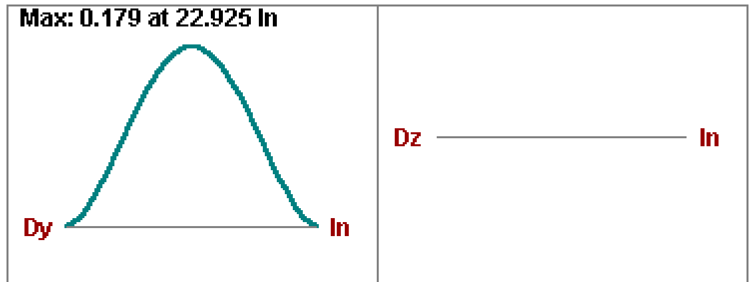
Max Defl Ratio **L/16**

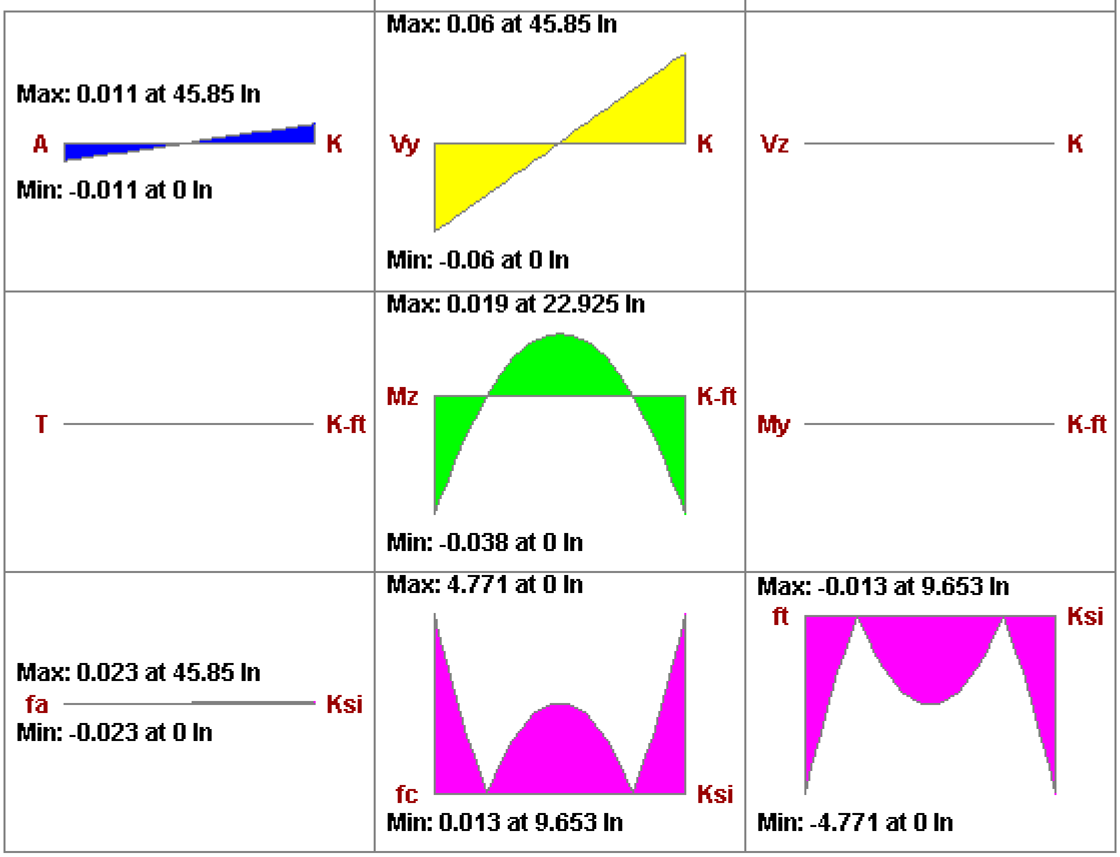
Member: *M150*

Shape: CORE
Length: 45.85 In
I Node: N2414
J Node: N2430

LC 1: WIND ONE

Max Code Check: No Calc





AISC ASD 9th Ed. Code Check

- Compressive stress fa exceeds F'e (Euler buckling) -

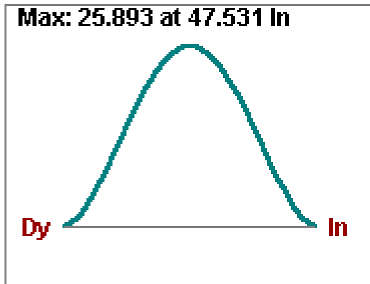
Max Defl Ratio L/256

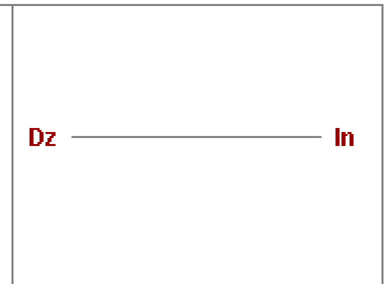
Member: ***M152***

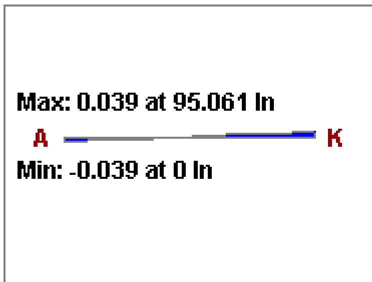
Shape: **CORE**
Length: **95.061 In**
I Node: **N2429**
J Node: **N2423**

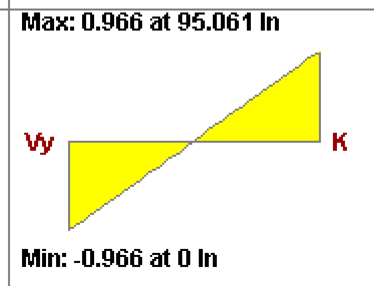
LC 1: WIND ONE

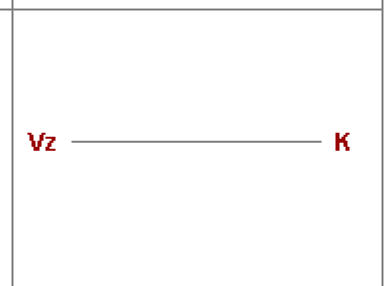
Max Code Check: **No Calc**

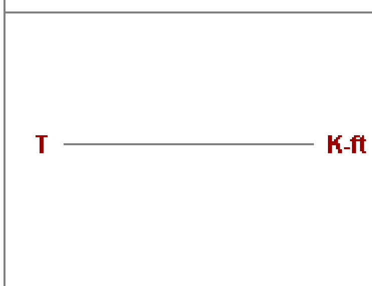


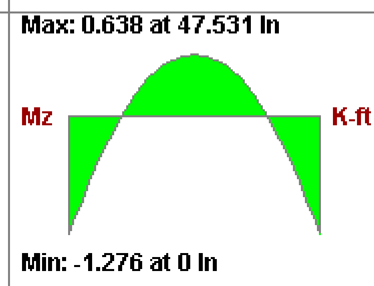


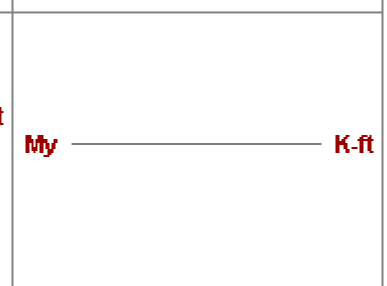


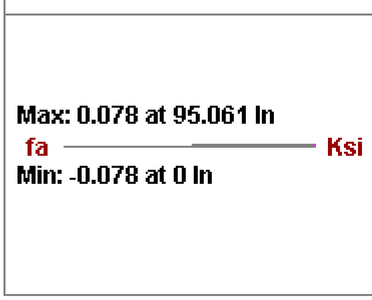


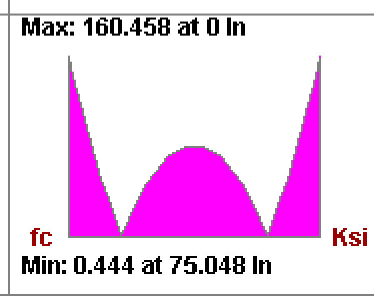


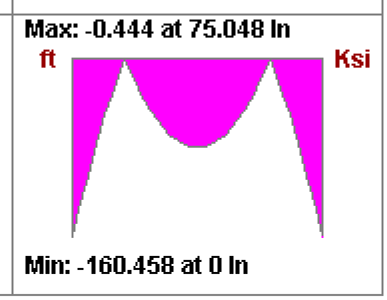












AISC ASD 9th Ed. Code Check

- Compressive stress fa exceeds F'e (Euler buckling) -

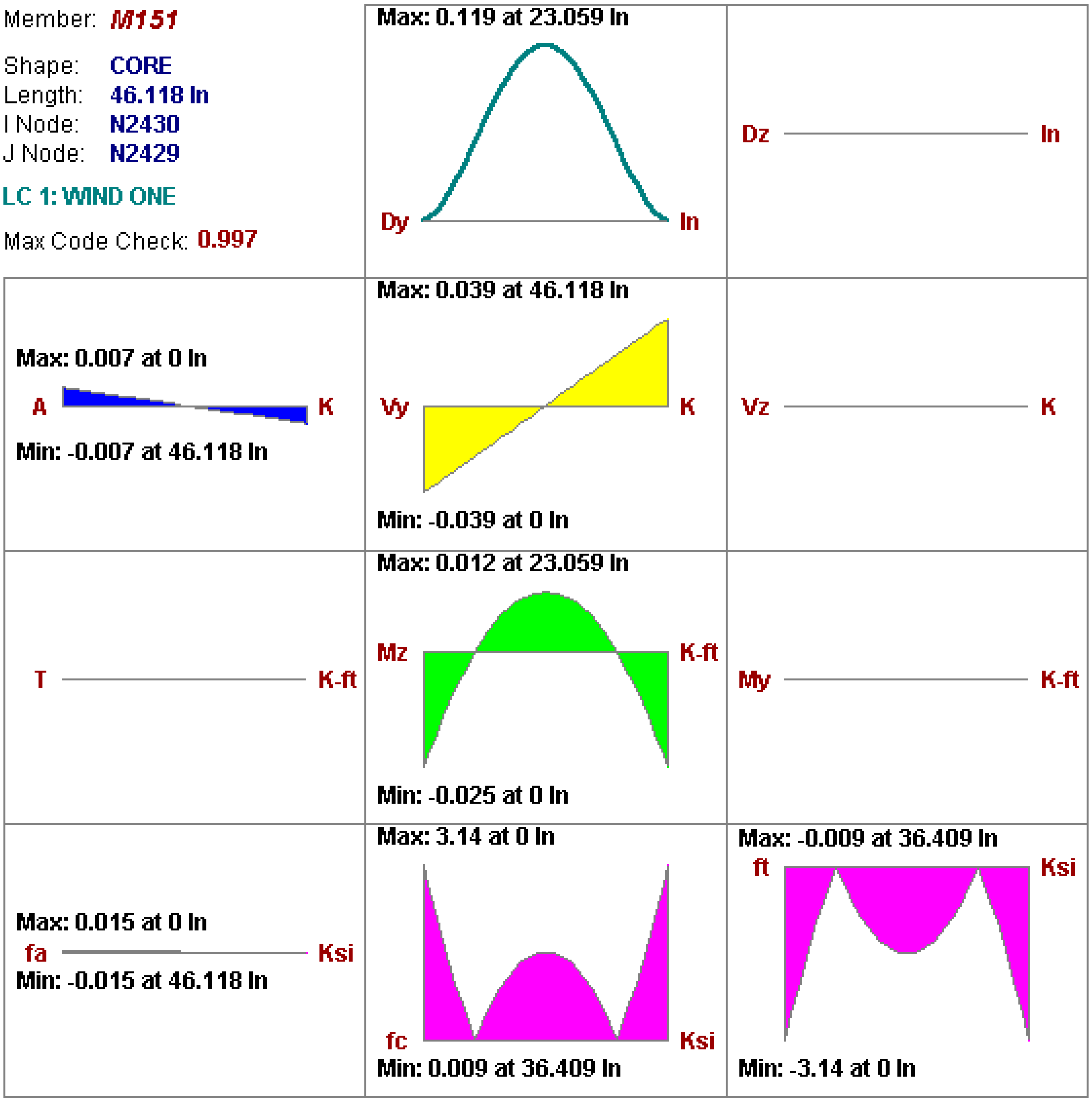
Max Defl Ratio **L/4**

Member: ***M151***

Shape: **CORE**
Length: **46.118 In**
I Node: **N2430**
J Node: **N2429**

LC 1: WIND ONE

Max Code Check: **0.997**



AISC ASD 9th Ed. Code Check

Max Code Check	**0.997**	Max Shear Check	**0.015 (y)**
Location	**0 In**	Location	**0 In**
Equation	**H1-1**	Max Defl Ratio	**L/387**

Compact
Allowables Increase: **1.333**

Fy	**12 Ksi**		Y-Y	Z-Z
Fa	**0.019 Ksi**	Cm	**0.6**	**0.85**
Ft	**9.598 Ksi**	Lb	**46.118 In**	**46.118 In**
Fby	**10.557 Ksi**	KL/r	**595.379**	**79.799**
Fbz	**11.997 Ksi**	Sway	**No**	**No**
Fvy	**6.398 Ksi**			
Fvz	**6.398 Ksi**	L Comp Flange	**46.118 In**	
Cb	**1**	Torque Length	**NC**	