ER-87451

World Shelters

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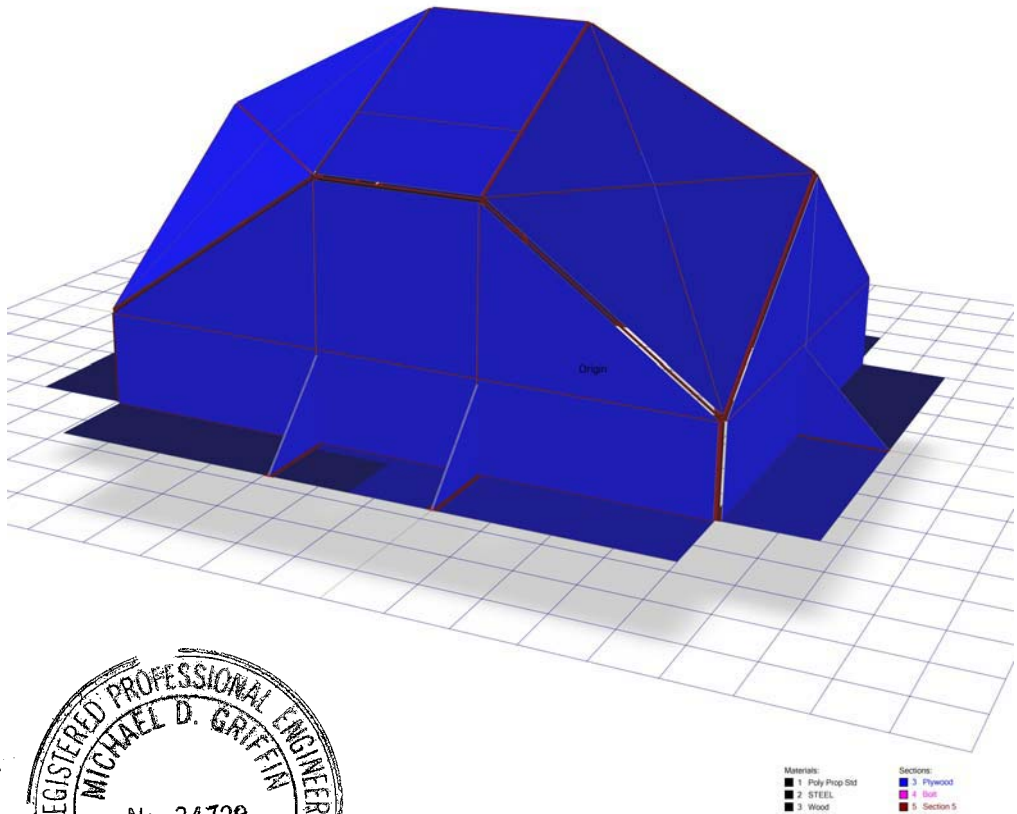
Transitional Shelter Prototype

Transhel

Draft Engineering Report:

Shell Structure

24 April 2009



1.0 Introduction

The Transitional Shelter Guidelines project is part of a coordinated initiative with the Transitional Shelter Standards project and the Transitional Shelter Prototypes project. This draft report summarizes the load analysis of one proposed shelter, the Transhel, using the draft Standards.

The Transhel is constructed of panels fastened together to create a living space of 3.67m by 5.0m at its base that stands 3m tall at the peak. The enclosed area in plan is some 18.3 m^2.

The planned panel material is a 5mm flame retardant corrugated polypropylene connected with 6mm (¼") diameter nylon fasteners. A 10mm (3/8") plywood segment is installed at four locations of the interior of the shell to provide strength continuity of the tri-layer polypropylene "beams" along the down sloping direction.

2.0 Summary of Results

Preliminary results of the analysis indicates the shell structure is capable of withstanding the live and wind loading as defined in the Transitional Shelter Standards of Dec. 08.

The base of the Transhel has an outer lip of panel material on which weight is added to provide stability against overturning in wind. Analysis results indicates 70 kg of material distributed on either side of each triangular leg (four legs total) and 40 kg/m typically around the remaining perimeter maintains a safety factor of 1.5 against overturning. This material could be loose materials such as sand or dirt contained in bags or solid materials such as stone, bricks or concrete blocks.

As the analysis results of the Transhel under the 18m/s wind speed indicated reserve strength, a 22m/s case was added. Peak shell bending stress for snow loading is 2.83MPa (411 psi), 0.84MPa (122 psi) for an 18m/s wind and 1.38MPa (200 psi) for a 22m/s wind. Plots of stress locations are included in appendix C.

Deflection of the largest roof panel during snow loading is as much as 16cm (6 ½"). Deflection of the largest side panel during 22m/s wind is 12cm (5") but the door frame stiffness will greatly reduce this. Individual panel segments may deflect significantly but still maintain significant load capability during high loading.

3.0 Input Data

Documentation provided by World Shelters to conduct the structure analysis includes:

1. Panel construction of 5mm Polypropylene co-polymer with a density of 90 g/cc, tensile strength at yield of 4000 psi and elongation at yield of 10%. Stiffness of the 5mm panels is currently based upon the non-flame retardant material and future testing is required to determine any differences in material properties.
2. Bolts and nuts are ¼" (6 mm) diameter nylon 66.

Assumptions made by Engineering Review International include:

1. Wind forces are calculated per the 2006 International Building Code/ ASCE 7-05 for exposure C (Open terrain with scattered obstructions having heights generally less than 9.1 m. This category includes flat open country, grasslands, and all water surfaces in hurricane-prone regions). Wind speeds of 18 m/s (40 mph) and 22 m/s (50 mph) are analyzed.
2. The Transhel is not placed adjacent to the top of escarpments, hills or ridges that could result in increased wind loading.

4.0 Loading

Using methods from the 2006 IBC, the structure is checked for an 18 m/s 3 second gust wind speed and 22 m/2 3 second gust wind speed for wind exposure C. Wind loading on the shell structure surface is approximated using ASCE Standard 7-05 and specifically figure 6-6 for an enclosed building. A roof snow load of 300 N/m2 (6.3 psf) is used per the standard. A case with snow and additional hanging loads simultaneously is also analyzed.

The loading conditions modeled for the structure include:

11. D	Dead loads
12. D + S	Dead + Roof Snow loads of 300 N/m^2 (6.3 psf)
13. D + S_n + L_h	Dead + Roof Snow + Additional Hanging Live loads of 30kg x6
14. D + W_{18}	Dead + Wind in Y direction @18 m/s (40 mph)
15. D + W_{22}	Dead + Wind in Y direction @22 m/s (50 mph)

5.0 System Analysis

The analysis is conducted using the program Spacegass which is described in Appendix B. Plate elements are used to model the exterior surfaces and beam elements are used to model the triple layer of the panel surfaces on the interior side of the structure. The "flanges" created by the panel folds or added segments spot welded to the panel are modeled at a thickness of 7.5 mm on each side connected by a bolt element instead of the actual three 5 mm sections. In the model, panel to panel loads are generally transmitted through the bolts only. In reality, panels also transmit loads to one another in compression along the sides and in tension at the bolts. It is assumed using the bolts alone to transmit compression and tension forces is conservative.

A summary of the analysis model is included in Appendix C including member property location plots, plots for the panels, flanges, bolts and input/output summary data. In this finite element model, non linear affects of large displacements are accounted for. Buckling values for each load combination are determined.

6.0 Next Steps

In the future, the analysis model should be modified to include the door frame stiffness. Peak lateral deflections indicated in the current model at these two door locations should reduce significantly with this change.

Panel and bolt to panel connections require testing with the flame retardant materials. With these values, member capacities and stiffness can be updated and compared with forces from the analysis.

Full size testing of the largest panel under live load would verify capacity, determine if acceptable safety factors against buckling are attainable and confirm deflections.

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i n t e r n a t i o n a l

Appendix A

Calculations:

- Wind Loading of 18 m/s (40.3mph)
- Foundation Dead Load Support

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6.5 METHOD 2- ANALYTICAL PROCEDURE

6.5.12. Design Wind Loads on Enclosed and Partially Enclosed Buildings. (all Heights)

MWFRS Velocity pressure q_z = .00256 K_z K_{zt} K_d V^2 I_w (6-15)

Exposure C Roof Height h = 8.266 feet

Exposure coefficient K_z = Section 6.5.6.6, is obtained from Table 6-3, Case 2 for MWFRS

Topography factor K_{zt} = 1.00 6.5.7.2, Figure 6-2

Directionality factor K_d = 0.85 Table 6-4

Wind Speed V = 40.3 mph

Importance factor I_w = 1.00 Table 6-1

q_z = 3.53 K_z psf

Internal Pressure Coefficient (GC_{pi}) = ± 0.18 Figure 6-5 for Enclosed Building

Gust effect factor G = 0.85 6.5.8.1

Pressures for MWFRS p = $qGC_p - q_i(GC_{pi})$ (6-17)

Wall and Roof External pressure Coefficients C_p from Fig. 6-6 or 6-8

Wind Normal to Ridge (⊥ to 16.41) L/B = 0.73 h/L = 8.266/12.00.69 θ= 27.0

Windward wall C_p = 0.8 Windward roof C_p = -0.32

Leeward wall C_p = -0.500 for L/B = 0.73 Leeward roof C_p = -0.60

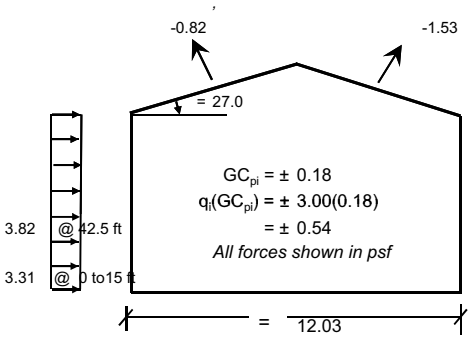
Side wall C_p = -0.7 or Roof C_p =

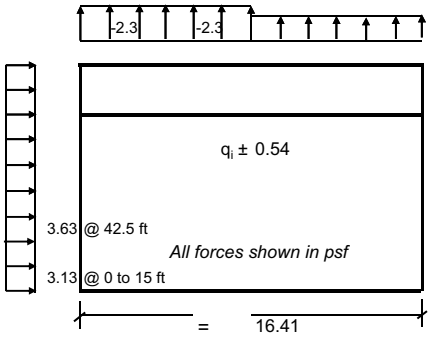
Wind Parallel to Ridge (⊥ to 12.03) L/B = 1.36

Windward wall C_p = 0.8 h/L = 8.266/16.40.50

Leeward wall C_p = -0.427 for L/B = 1.36 Roof C_p = -0.9 -0.9

Side wall C_p = -0.7 for dist 4.1 8.3





$p = qGC_p - q_i(GC_{pi})$ Eq. 6-15 For Exp C

where $q = q_z$ for windward z_g = 900 α = 9.5

$q = q_h$ for leeward wall, side wall and roof @8.266 ft $K_z = 2.01(z/z_g)^{2/\alpha}$

$q_i = q_h$ for enclosed building @8.266 ft K_z (min) $= 2.01(15/z_g)^{2/\alpha}$

Roof Ht, h = 8.266 ft				Normal to Ridge ⊥ to 16.41		Parallel to ridge ⊥ to 12.03		
	Height	K_h	q_h	C_p	q_hGC_p	C_p	q_hGC_p	
Leeward wall	all	0.849	3.00	-0.5	-1.28	-0.43	-1.09	
Side wall	all	0.849	3.00	-0.7	-1.79	-0.70	-1.79	
Roof	ww	-0.320				-0.90	-2.30	fr 0 - 4.1
	Lw	-0.600				-0.90	-2.30	fr >4.1
								fr 8.3-
								fr

				Wind Normal to Ridge			Wind Parallel to Ridge		
	z, Ht. (ft)	K_z	q_z	C_p	$p = q_zGC_p$	WW+LW	C_p	$p = q_zGC_p$	WW+LW
Windward wall	0 to 15	0.849	3.00	0.8	2.04	3.31	0.80	2.04	3.13

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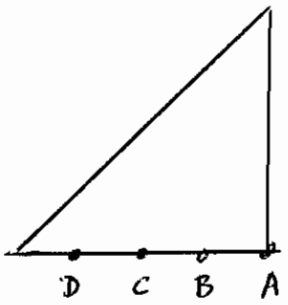
project no. 87451 date 4/24/09
by: mgj page 1 of 1
project TRANSbel
subject FOUNDATION

OBJECTIVE: ESTIMATE WEIGHT DISTRIBUTION AT SHELL BASE TO PROVIDE SAFETY FACTOR OF 1.5 AGAINST OVERTURNING.

1.0 AT TRIANGULAR BRACES (ADJACENT TO DOORS) 22 m/s wind



	NODE NO.	F_z
A	549	3
	552	9
B	900	1
	901	-11
C	906	-14
	907	-31
D	904	-16
	905	-28

ΣF_{upward} = 100 Lbs. (45.4 kg)

× 1.5 SF 150 Lbs. (68.0 kg)

∴ use 70 kg distributed on either side of brace

2.0 AT TYPICAL FLANGE SIDES (EXCEPT AT DOORS)

HIGHEST UPLIFT = -30.3 Lbs. @ node 885 @ 20" spacing
(13.7 kg " " " " 50.8 cm)

30.3 Lbs. × 1.5 SF = 45.5 Lbs./20" ⇒ 28 Lb/ft

⇒ 40.6 kg/m

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Appendix B

Analysis Program description - SPACEGASS

TITLE: 3D or 2D general frame analysis and steel design. ACCESSIBILITY: Any computer running Windows 95, 98, NT, 2000, ME and Vista.

MAINTENANCE: Integrated Technical Software CAPABILITY: Analyses 3 dimensional frames with straight prismatic members. Capacity is theoretically unlimited but depends on the available memory in the computer. Units may be any consistent set. Input methods include graphical input, datasheet input, free format text file input, standard structure input and CAD input. Features include linear and non-linear static analysis, dynamic frequency analysis, dynamic response analysis, buckling analysis, master-slave constraints, tension-only members, compression-only members, cable members, 3D member offsets, extensive data generation facilities, non-sequential numbering, automatic re-numbering, elastic supports, complete or partial member end fixity, comprehensive data checking for inconsistencies and instabilities and wavefront analysis method with wavefront optimizer. Permissible loading conditions include any combination of concentrated and distributed forces and moments on nodes and members, thermal loads, self weight, and prescribed node displacements. Numerous primary and combination load cases can be analyzed in a single run. Frames or sub-frames can be moved, rotated, copied or mirrored. Section and material properties can be input manually or can be read directly from a library. Data can be transferred into or from a CAD program such as AutoCAD via DXF files. Integrated steel member design modules for the latest codes including AISC-LRFD (17), AISC-ASD (16), EUROCODE 3 (18), AS1250 (3), AS4100 (4), SABS0162 (5), BS5950 (6), NZS3404 (7), AS3990 (11) and AS/NZS4600 (13). Selected members or the entire frame can be designed or checked in accordance with the appropriate code.

Integrated steel connection design and drafting module for AS4100 (4). Connections can be designed and connection drawings can be viewed, printed or exported to DXF files.

Integrated concrete design module for AS3600 (14). Selected members or the entire frame can be designed or checked in accordance with the code.

INPUT: Node coordinates, member connectivity and fixity, node restraints, section and material properties, master-slave constraints, member offsets, node loads, prescribed displacements, member concentrated and distributed loads, self weight, combination load cases, load case titles, lumped masses, dynamic response spectra, steel member design data, steel connection design data and concrete design data.

OUTPUT: Printout of all input data plus displacements, forces, moments, reactions, stresses, equilibrium summary, bill of materials, centre of gravity coordinates, dynamic natural frequencies and mode shapes, buckling load factors and member effective lengths, steel member design results, steel connection design results and concrete design results.

Output can be chosen selectively and can be limited to user defined nodes, members, load cases, member design groups and connections. Results envelopes can be produced. Deflections, forces and moments can be output at numerous points along members (not just at the end nodes). Graphical output on screen, printer or plotter includes the frame geometry, loading diagrams, deformed geometry, bending moment diagrams, shear force diagrams, axial force diagrams, stress diagrams, dynamic mode shapes, buckling mode shapes, 3D full member geometry with hidden line removal, steel connection drawings, concrete column interaction diagrams.

METHOD: Stiffness analysis method using wavefront equation solver with optimization.

LANGUAGE: Fortran and C.

AUTHORS: Integrated Technical Software

DOCUMENTATION: Comprehensive user manual with worked examples.

INFORMATION: www.spacegass.com

ABSTRACT BY: Integrated Technical Software

Appendix C

Spacegass Models, TSV2-03.sg

- Model images with property locations
- Applied Hanging Live load locations
- Panel Stress plots for load combinations
- Model frame deflected shape for total Live Load x 5
- Model frame deflected shape for 22 m/s Wind Load x 5
- Input/Output Summary of Model

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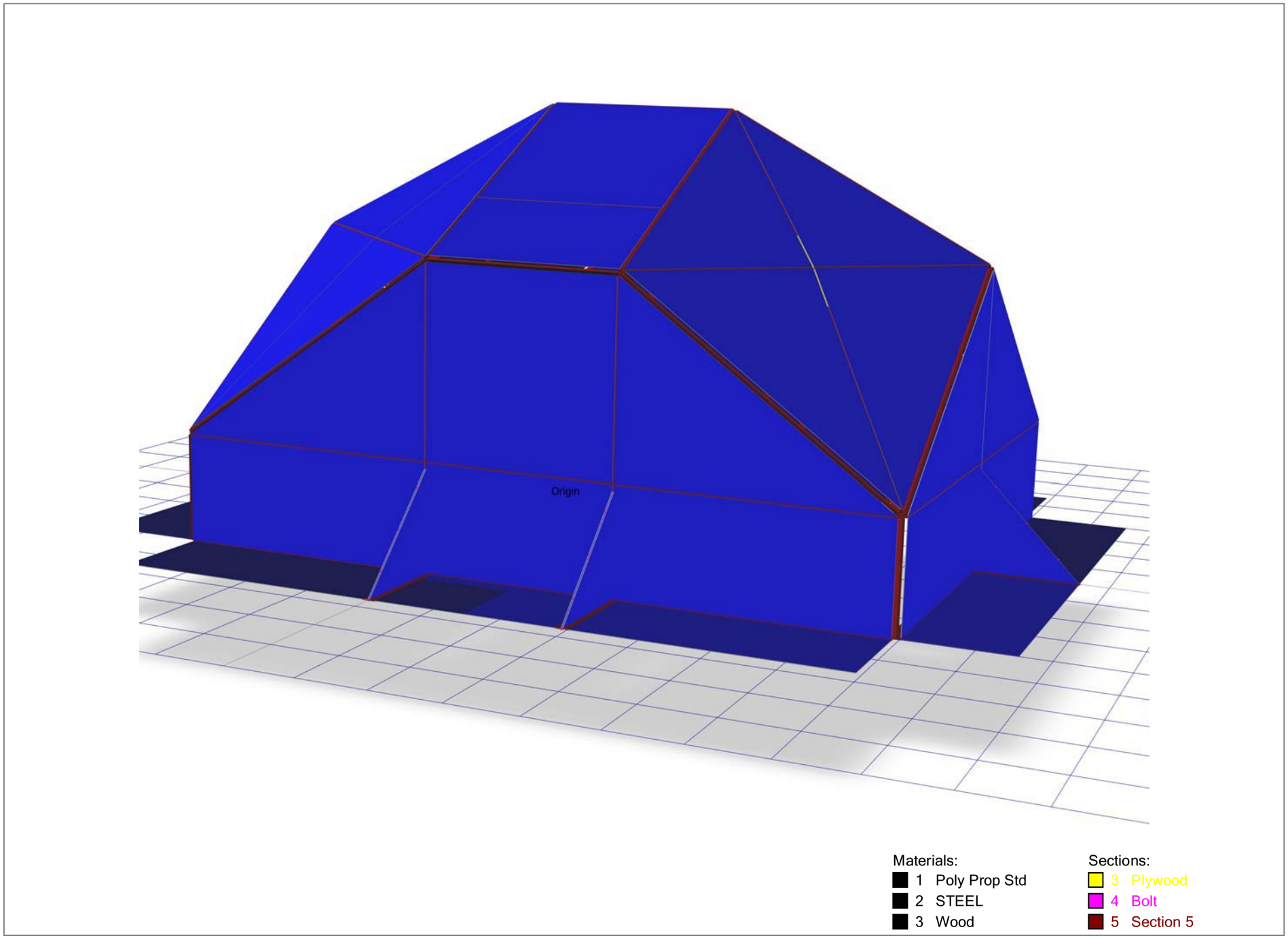
SPACE GASS 10.70a - C:\USERS\STAPLES\DOCUMENTS\ERI\39-WORLD SHELTERS\87451 TRANSHEL\5 COMPUTER MODELS\TSV2-03.SG



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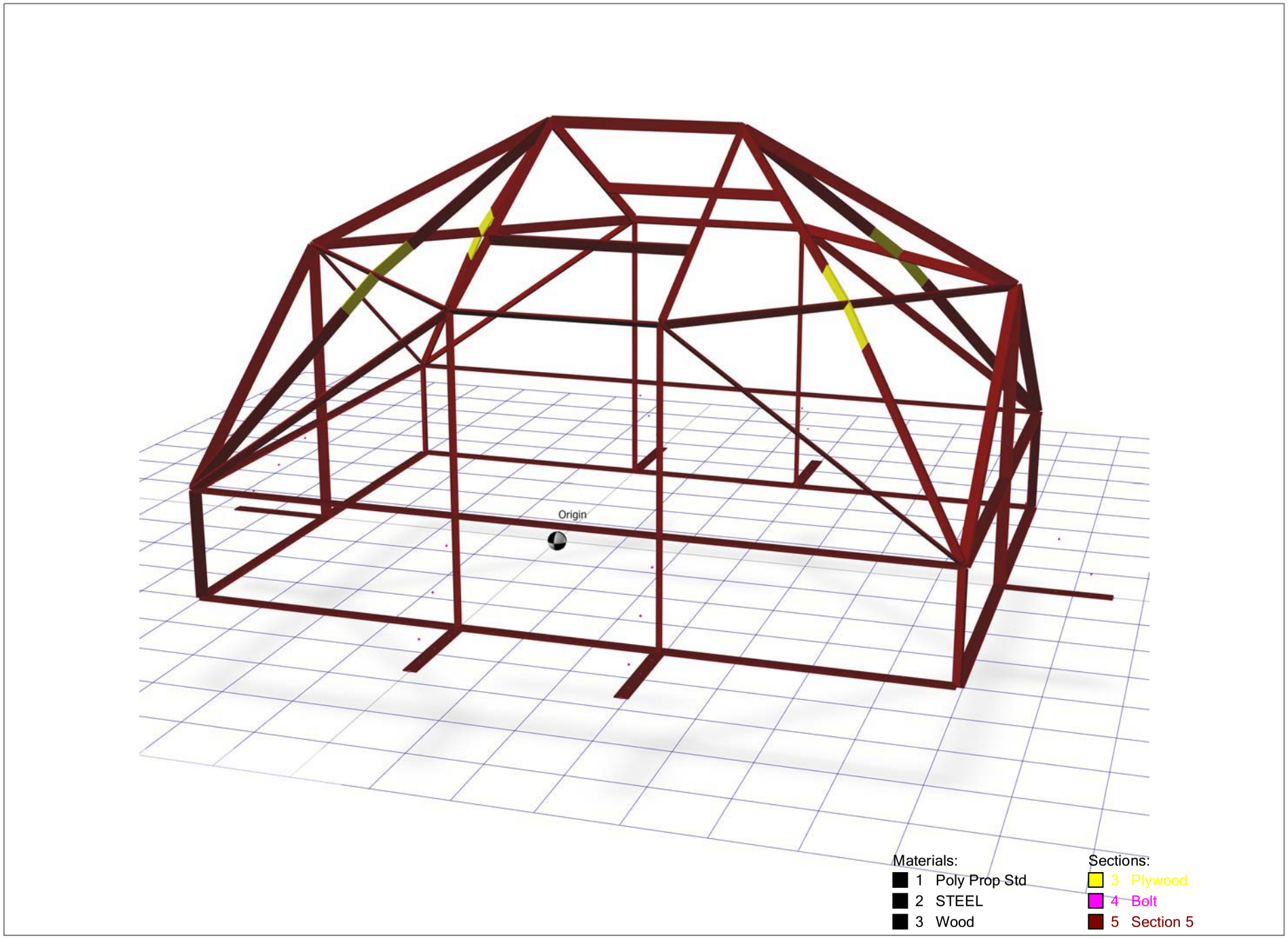

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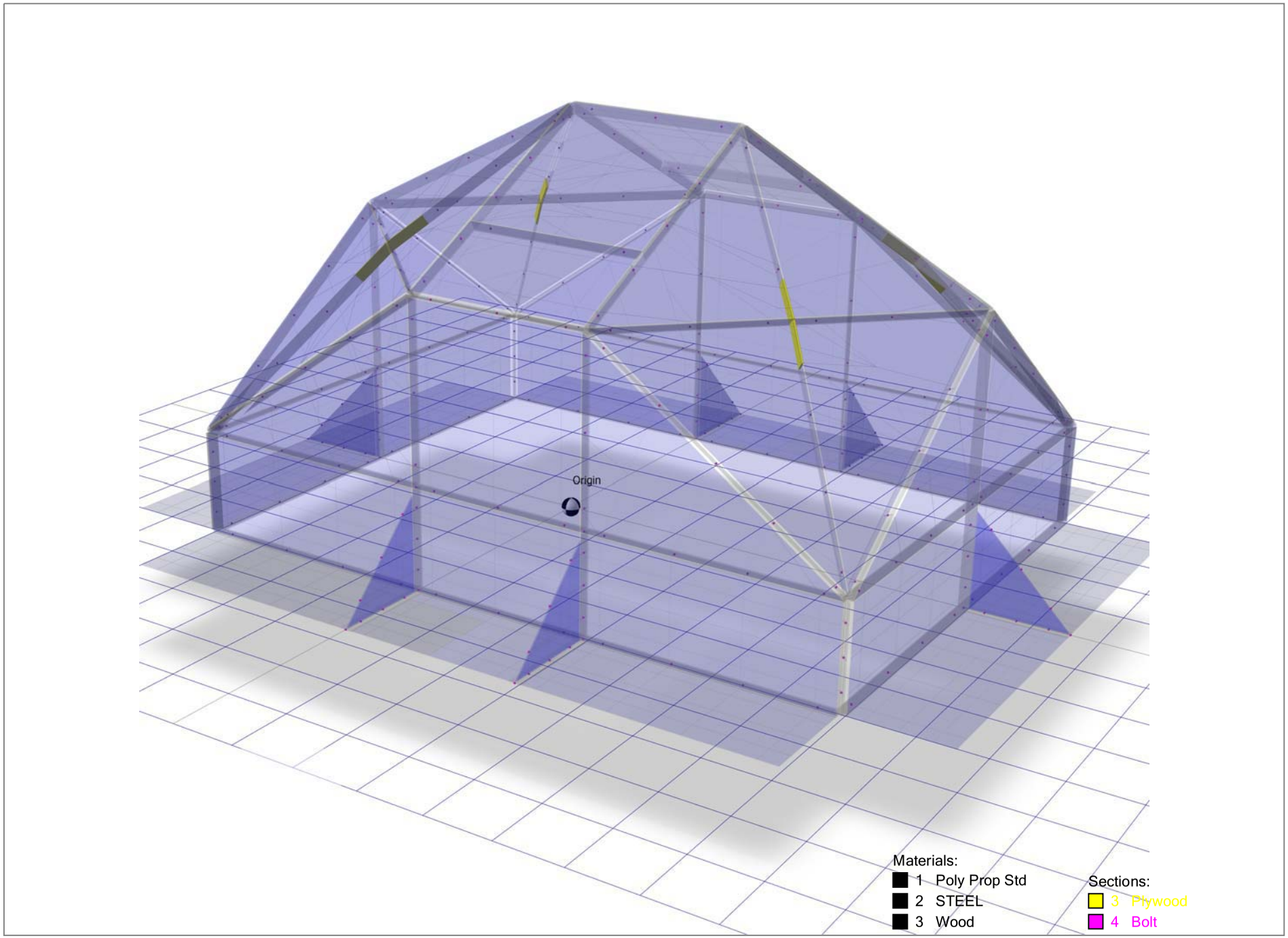

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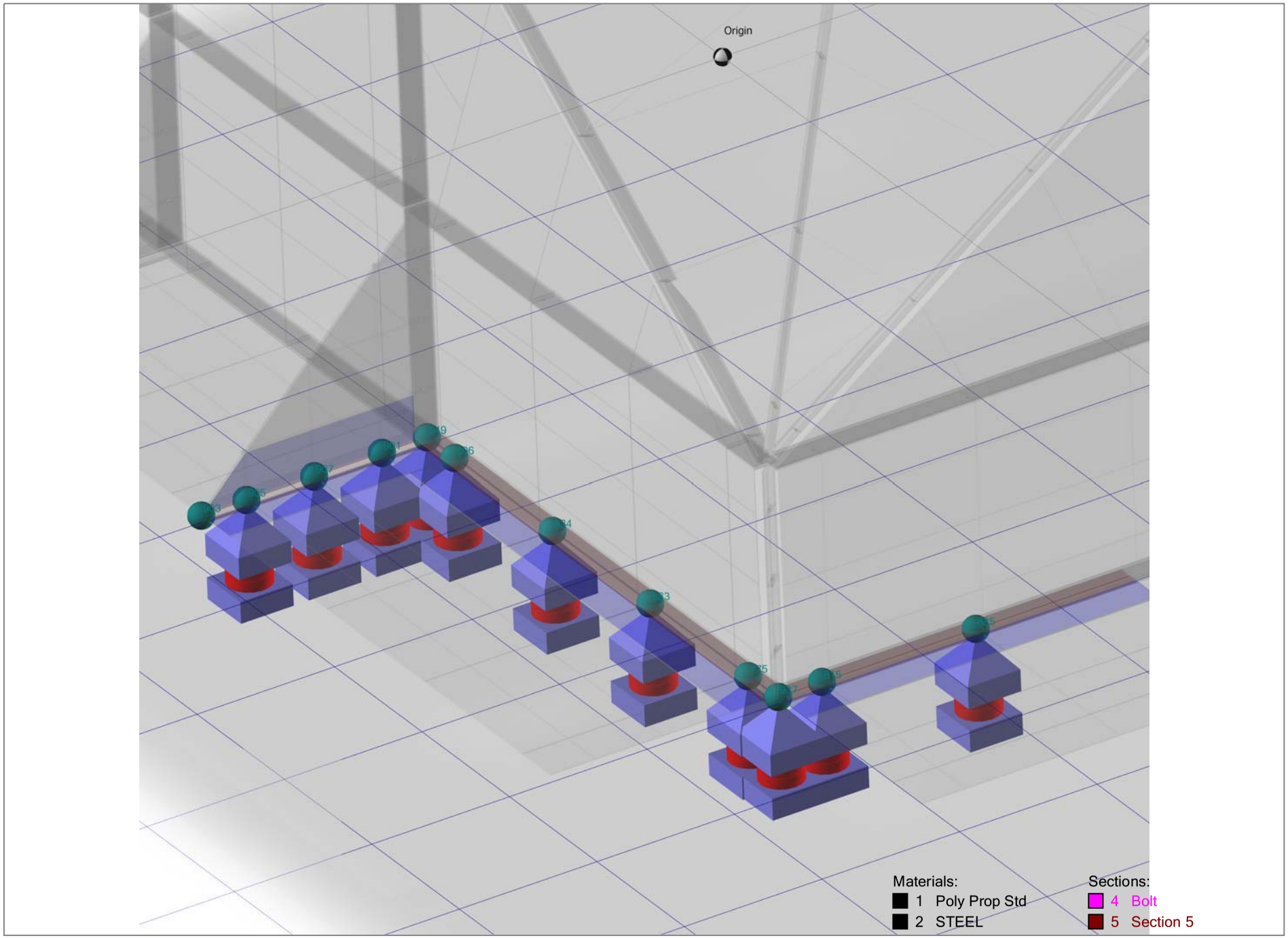

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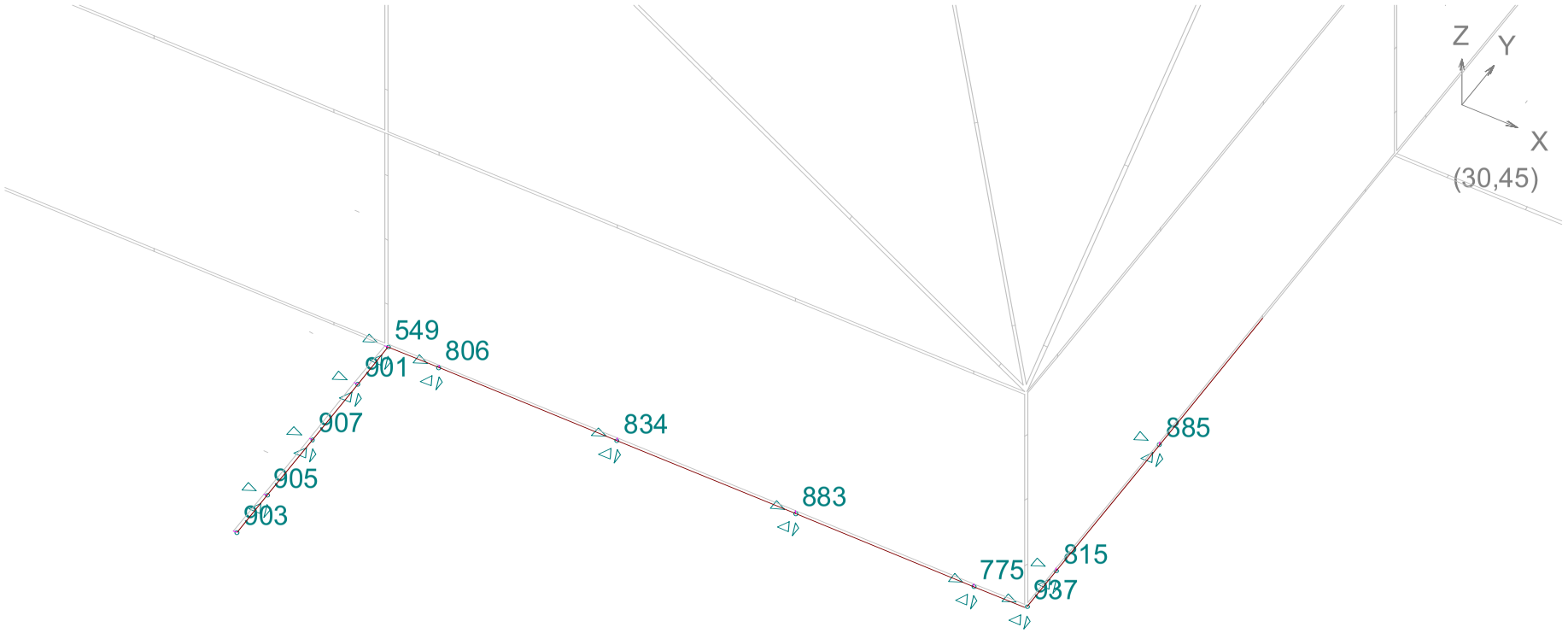

Sample of Support Node Numbers
No general restraint

Materials:
1 Poly Prop Std
2 STEEL
3 Wood

Sections:
4 Bolt
5 Section 5

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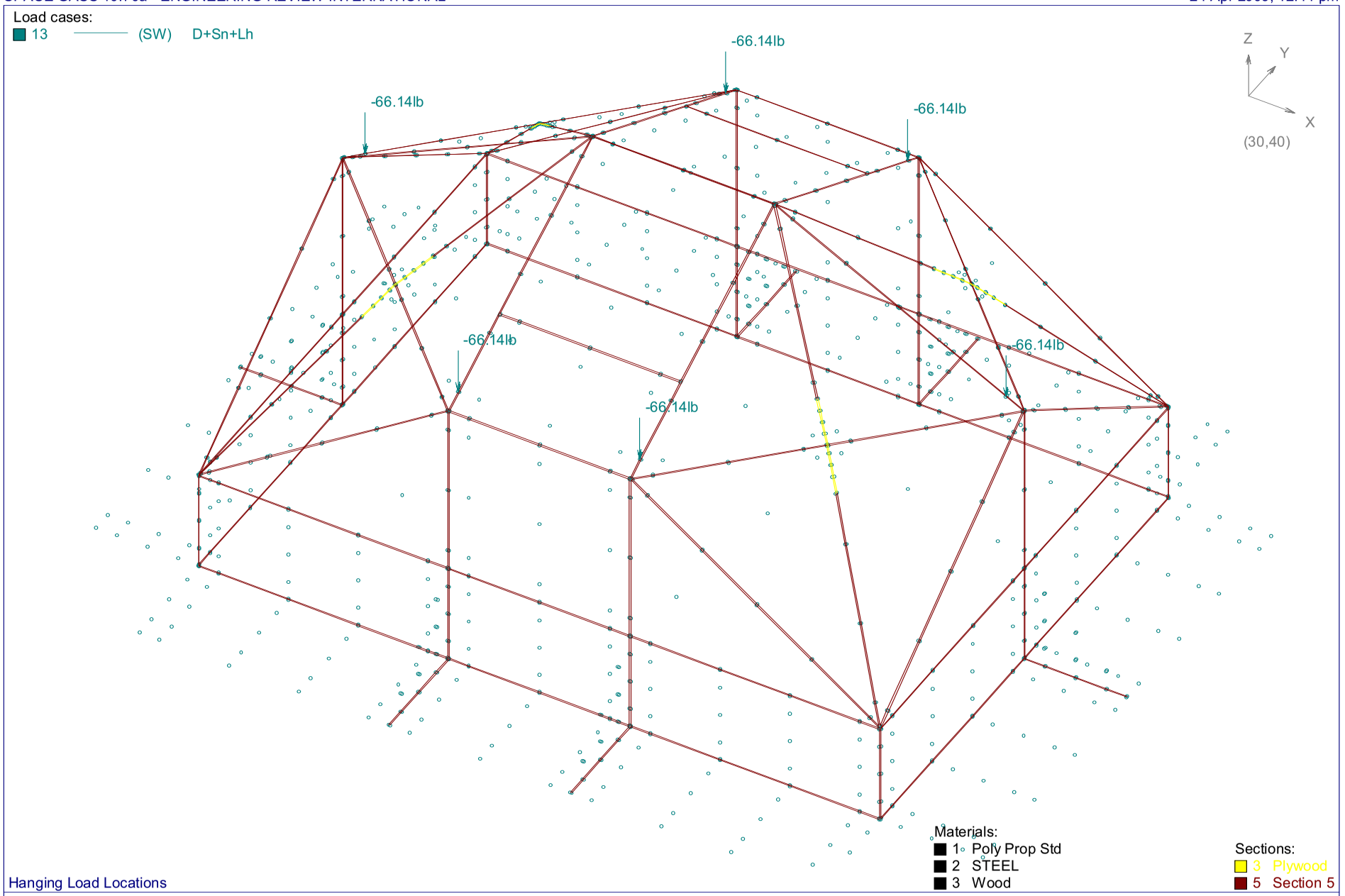

Transitional Shelter Prototype Study - Prototype Transhel - mdg
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Scales - Frame: 1:34, Load: 1, Disp: None, Moment: None, Shear: None, Axial: None, Torsion: None

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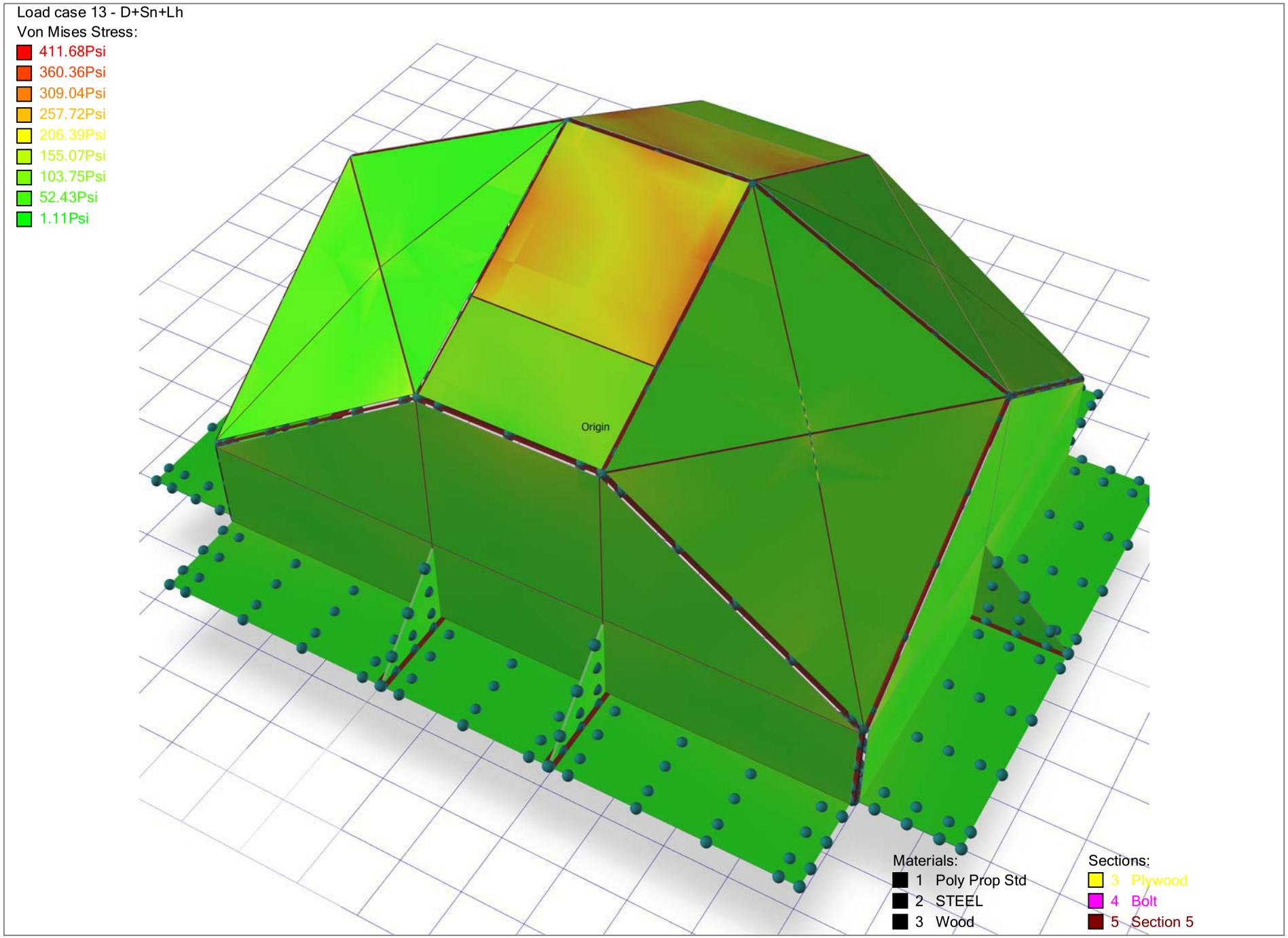

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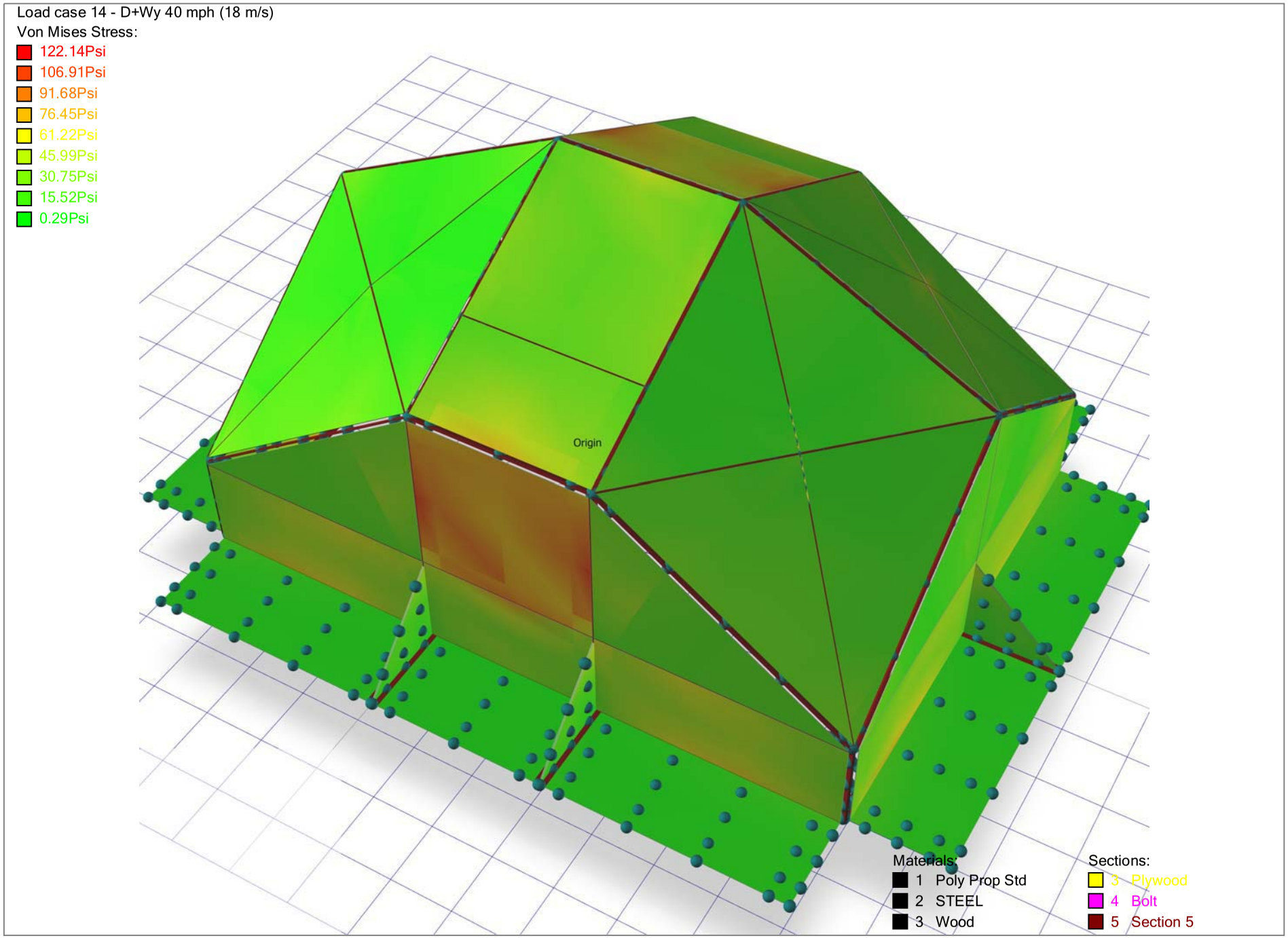

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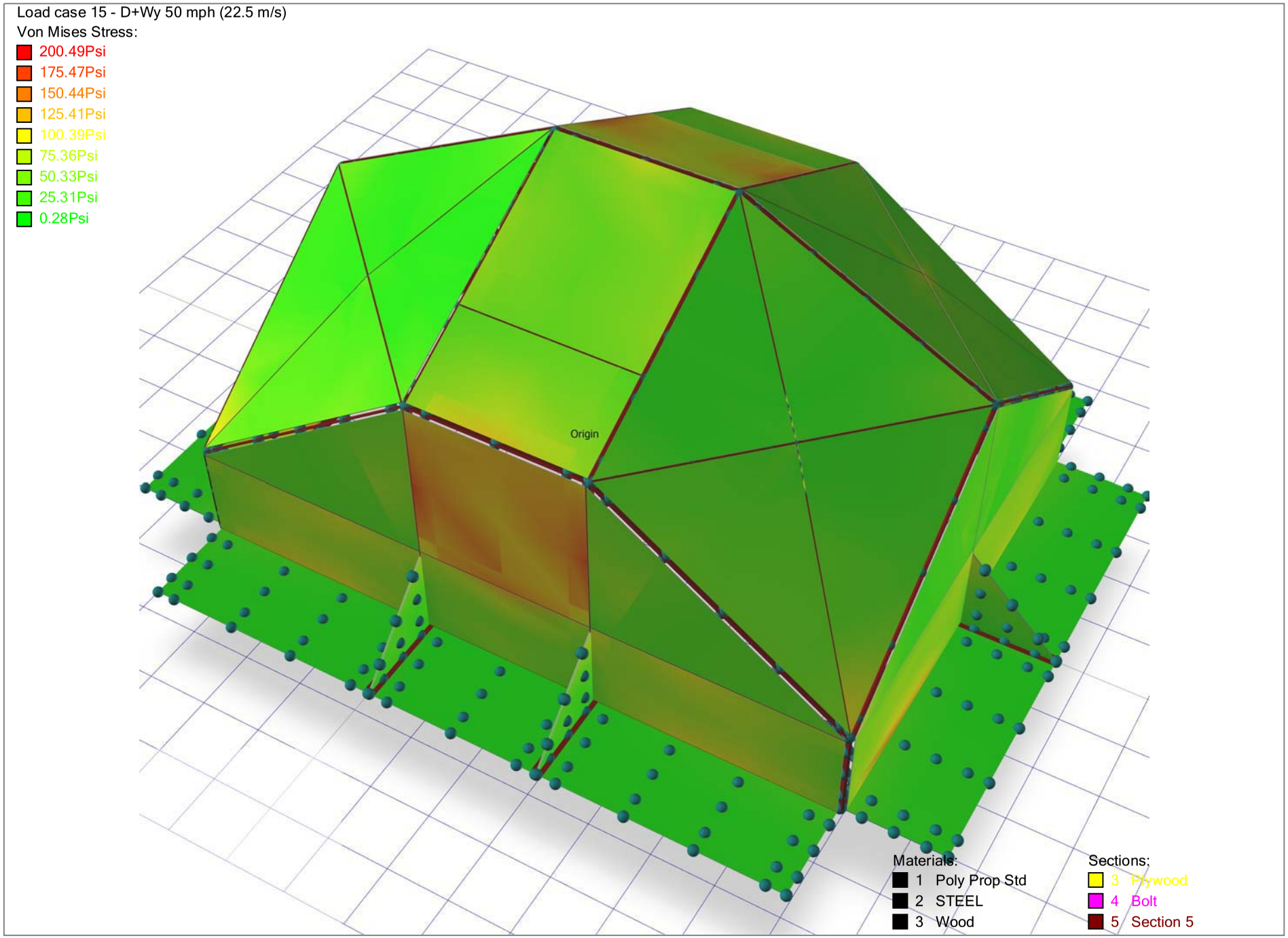
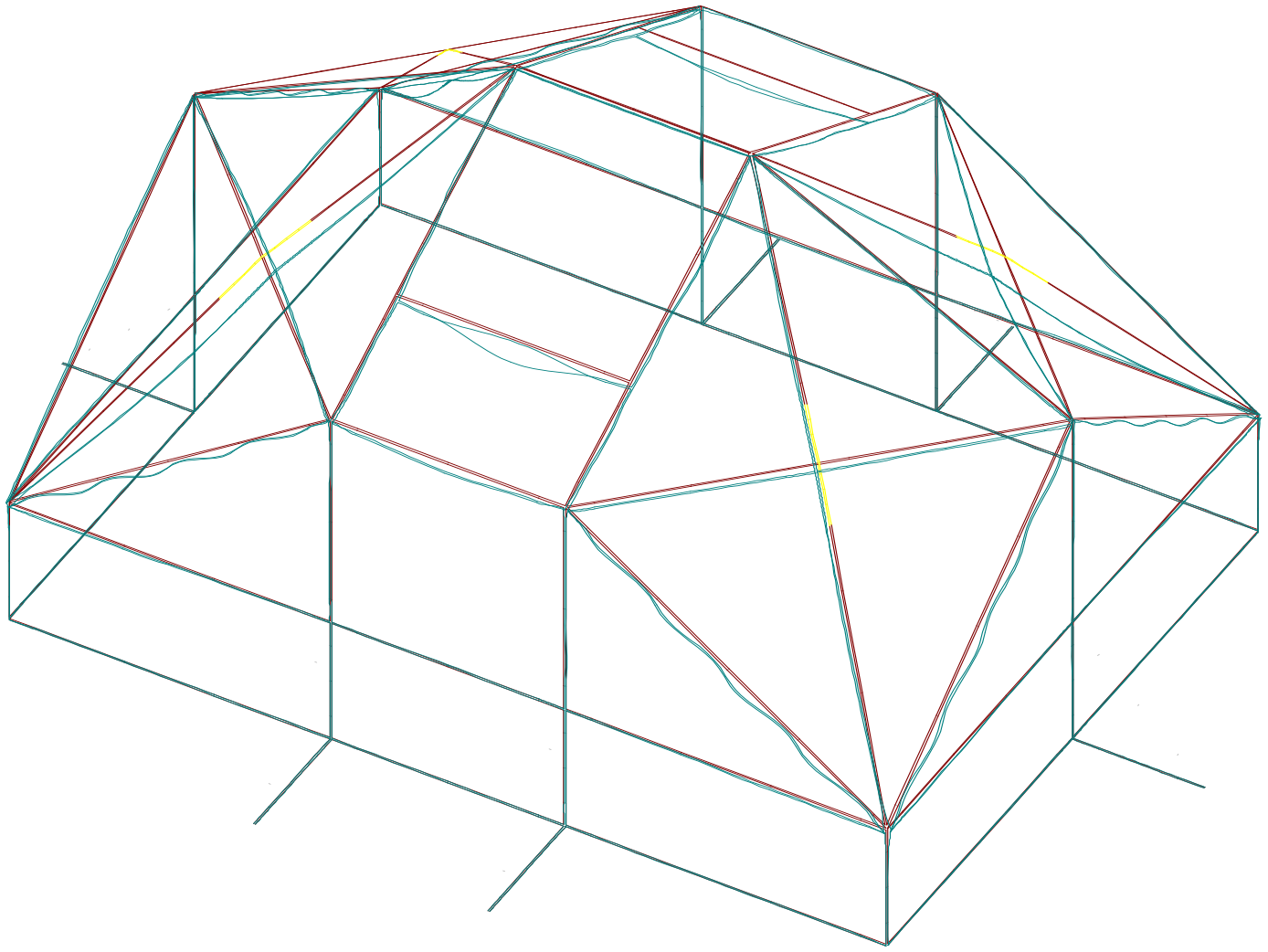


Load cases:
13 (SW) D+Sn+Lh



Materials:
1 Poly Prop Std
2 STEEL
3 Wood

Sections:
3 Plywood
5 Section 5

Live Load Deflection x 5

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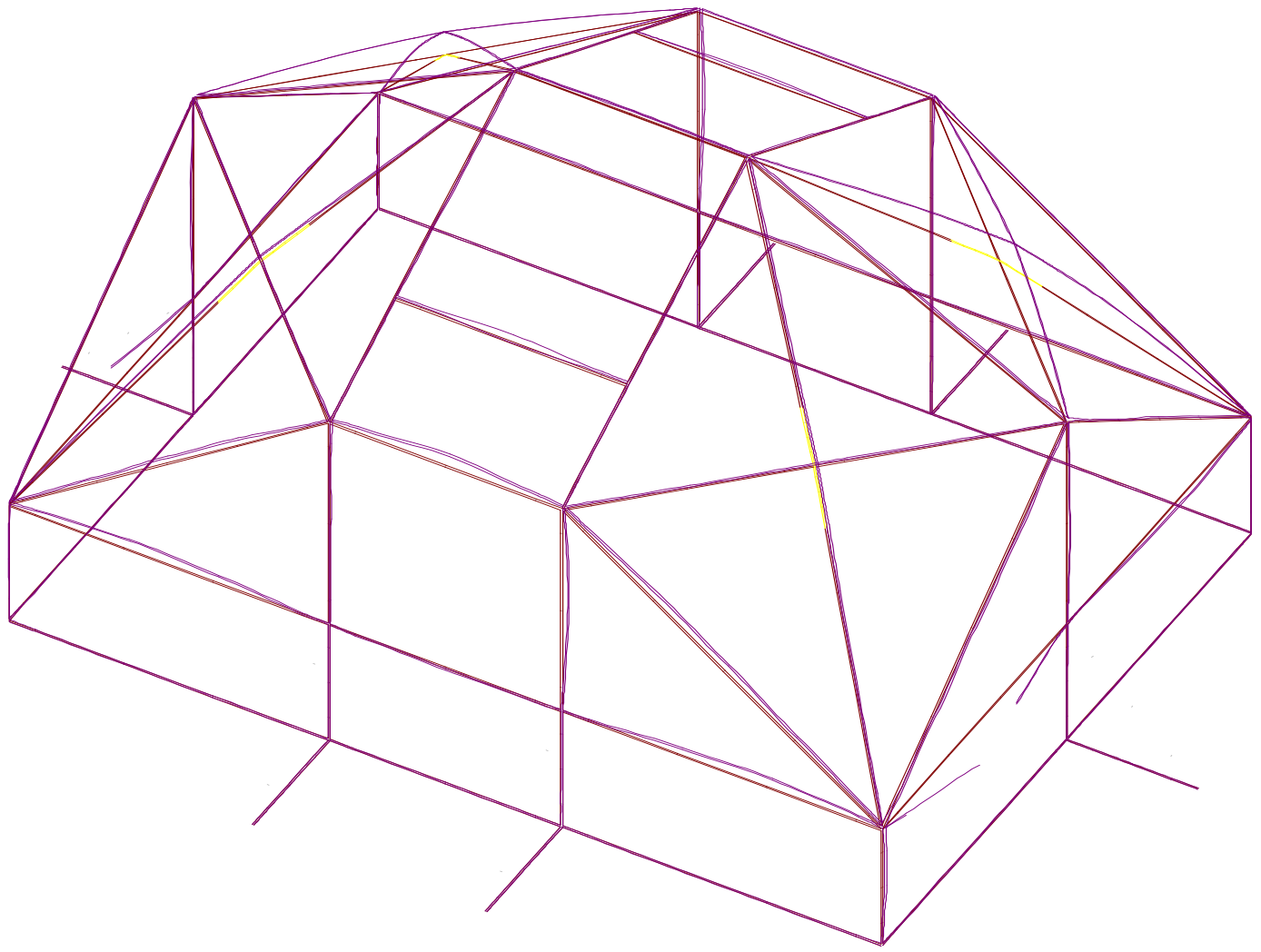
Load cases:
15 (SW) D+Wy 50 mph (22.5 m/s)



Materials:
1 Poly Prop Std
2 STEEL
3 Wood

Sections:
3 Plywood
5 Section 5

50 mph (22 m/s) Wind Load Defl x 5

Transitional Shelter Prototype Study - Prototype Transhel - mdg
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Designer: mdg Date: 24 Apr 2009, 11:51 AM Page: 1
Filter: partial support nodes
Transitional Shelter Prototype Study
Prototype Transhel

ANALYSIS STATUS REPORT

Job name TSV2-03
Location ..... C:\USERS\STAPLES\DOCUMENTS\ERI\39-WORLD SHELTERS\87451 TRAN...

Length units ..... in
Section property units ..... in
Material strength units ..... Psi
Mass density units ..... lb/in^3
Temperature units ..... Fahrenheit
Force units ..... lb
Moment units ..... lbin
Mass units ..... lb
Acceleration units ..... g's
Translation units ..... in
Stress units ..... Psi

Nodes	1253	(32765)
Members	1124	(32765)
Plates	948	(32765)
Restrained nodes	158	(32765)
Nodes with spring restraints	0	(32765)
Section properties	5	(999)
Material properties	3	(999)
Constrained nodes	0	(32765)
Member offsets	0	(32765)
Node loads	6	(32765)
Prescribed node displacements	0	(32765)
Member concentrated loads	0	(32765)
Member distributed forces	0	(32765)
Member distributed torsions	0	(32765)
Thermal loads	0	(32765)
Member prestress loads	0	(32765)
Plate pressure loads	1144	(32765)
Self weight load cases	1	(999)
Combination load cases	5	(999)
Load cases with titles	9	(999)
Lumped masses	0	(32765)
Spectral load cases	0	(999)
Static analysis	Y	
Dynamic analysis	N	
Response analysis	N	
Buckling analysis	Y	
Ill-conditioned	N	
Non-linear convergence	Y	
Frontwidth	405	
Total degrees of freedom	7044	
Static load cases	4	(999)
Mass load cases	1	(999)

NODE COORDINATES (in)

Node	X Coord	Y Coord	Z Coord
549	52.69	-72.18	0.00
775	118.77	-72.18	0.00
806	58.40	-72.18	0.00
815	124.67	-66.28	0.00
834	78.52	-72.18	0.00
883	98.64	-72.18	0.00
885	124.67	-46.15	0.00
901	52.69	-78.09	0.00
903	52.69	-101.71	0.00
905	52.69	-95.80	0.00
907	52.69	-86.94	0.00
937	124.67	-71.98	0.00

NODE RESTRAINTS (lb/in,lbin/rad)
(F=Fixed, R=Released, S=Spring, *=General)

Node	Rest Code	X Axial Stiffness	Y Axial Stiffness	Z Axial Stiffness	X Rotation Stiffness	Y Rotation Stiffness	Z Rotation Stiffness
549	FFFRRR						
775	FFFRRR						
806	FFFRRR						
815	FFFRRR						
834	FFFRRR						
883	FFFRRR						
885	FFFRRR						
901	FFFRRR						
905	FFFRRR						
907	FFFRRR						
937	FFFRRR						

SECTION PROPERTIES (in,in^2,in^4,deg)

Sect	Section Name	Mark	Angle Type	Flipped	Source
1	1/2 Trifold	S1	Not applicable	No	Transhel
2	T1.250x14g	S2	Not applicable	No	allied
3	Plywood	S3	Not applicable	No	Standard shape
4	Bolt	S4	Not applicable	No	Standard shape
5	Section 5	S5	Not applicable	No	Standard shape

Sect	Area of Section	Torsion Constant	Y-Axis Mom of In	Z-Axis Mom of In	Y-Axis Shr Area	Z-Axis Shr Area	Princ Angle
1	9.3008E-01	2.5438E-02	6.7587E-03	7.6886E-01	INFINITE	INFINITE	0.00
2	3.4471E-01	1.0000E+00	5.7870E-02	5.7870E-02	INFINITE	INFINITE	0.00
3	5.6250E-01	6.3322E-03	1.6479E-03	4.2188E-01	INFINITE	INFINITE	0.00
4	1.9635E-01	6.1359E-03	3.0680E-03	3.0680E-03	INFINITE	INFINITE	0.00
5	9.3008E-01	2.5438E-02	6.7587E-03	7.6886E-01	INFINITE	INFINITE	0.00

Sect	Section Shape	D	B/Bt	Bb/Hf	Tw	Tf
3	Rectangle	3.00	0.19			
4	Circle	0.50				
5	Rectangle	3.15	0.30			

MATERIAL PROPERTIES (Psi,lb/in^3,strain/degF)

Matl	Material Name	Young's Modulus	Poisson's Ratio	Mass Density	Coeff of Expansion	Concrete Strength
1	Poly Prop Std	7.5000E+04	0.30	7.1000E-03	0.000E+00	
2	STEEL	2.9000E+07	0.25	2.8356E-01	6.500E-06	
3	Wood	1.5000E+06	0.30	2.0255E-02	0.000E+00	

SELF WEIGHT (g's)

Load Case	X-Axis Accel'n	Y-Axis Accel'n	Z-Axis Accel'n
1	0.00	0.00	-1.00

COMBINATION LOAD CASES

Load case 11: D

1.000 * Load case 1: Dead

Load case 12: D+Sn

1.000 * Load case 1: Dead
1.000 * Load case 2: Snow/Live

Load case 13: D+Sn+Lh

1.000 * Load case 1: Dead
1.000 * Load case 2: Snow/Live
1.000 * Load case 3: Live Hanging (6 x 30 kg)

Load case 14: D+Wy 40 mph (18 m/s)

1.000 * Load case 1: Dead
1.000 * Load case 4: Wind Y

Load case 15: D+Wy 50 mph (22.5 m/s)

1.000 * Load case 1: Dead
1.562 * Load case 4: Wind Y

LOAD CASE TITLES

Load Case	Title
1	Dead
2	Snow/Live
3	Live Hanging (6 x 30 kg)
4	Wind Y
11	D
12	D+Sn
13	D+Sn+Lh
14	D+Wy 40 mph (18 m/s)
15	D+Wy 50 mph (22.5 m/s)

NODE REACTIONS (lb,lbin)

Load case 11 (Non-linear): D
Non-linear effects: P-Δ, P-δ, 3 Iterations, 100.000% Convergence

Node	X-Axis Force	Y-Axis Force	Z-Axis Force	X-Axis Moment	Y-Axis Moment	Z-Axis Moment
549	0.03	-2.81	5.10	0.00	0.00	0.00
775	0.78	-0.31	1.71	0.00	0.00	0.00
806	3.33	0.36	0.60	0.00	0.00	0.00
815	0.30	-1.03	1.72	0.00	0.00	0.00
834	1.54	0.06	0.68	0.00	0.00	0.00
883	1.77	0.12	0.85	0.00	0.00	0.00
885	-0.09	-1.92	0.86	0.00	0.00	0.00
901	-0.03	1.20	6.15	0.00	0.00	0.00
905	-0.01	-0.32	-0.55	0.00	0.00	0.00
907	0.00	0.18	1.03	0.00	0.00	0.00
937	0.10	0.00	0.01	0.00	0.00	0.00
Load	0.00	0.00	-207.80	0.00	0.00	0.00
Reac	0.00	0.00	207.80	0.00	0.00	0.00
Frame	-3.964E-09	-3.103E-09	0.000E+00			
Nodes	1.082E-08	1.194E-08	1.744E-08	3.583E-09	2.748E-09	1.764E-09

Load case 12 (Non-linear): D+Sn
Non-linear effects: P-Δ, P-δ, 3 Iterations, 99.936% Convergence

Node	X-Axis Force	Y-Axis Force	Z-Axis Force	X-Axis Moment	Y-Axis Moment	Z-Axis Moment
549	0.23	-24.66	37.77	0.00	0.00	0.00
775	15.09	-3.41	14.93	0.00	0.00	0.00
806	21.67	2.31	3.51	0.00	0.00	0.00
815	3.28	-18.23	14.72	0.00	0.00	0.00
834	17.57	0.01	5.20	0.00	0.00	0.00
883	11.79	0.88	6.78	0.00	0.00	0.00
885	-0.45	-13.88	6.82	0.00	0.00	0.00
901	-0.18	9.11	44.75	0.00	0.00	0.00
905	-0.04	-1.27	-6.46	0.00	0.00	0.00
907	0.00	1.59	8.86	0.00	0.00	0.00
937	0.10	0.00	0.06	0.00	0.00	0.00

SPACE GASS 10.70a - ENGINEERING REVIEW INTERNATIONAL
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Filter: partial support nodes
Transitional Shelter Prototype Study
Prototype Transhel

Node	X-Axis Force	Y-Axis Force	Z-Axis Force	X-Axis Moment	Y-Axis Moment	Z-Axis Moment
Load	0.00	0.00	-1420.15	0.00	0.00	0.00
Reac	0.00	0.00	1420.15	0.00	0.00	0.00
Frame	-3.782E-09	7.850E-08	0.000E+00			
Nodes	1.617E-07	1.450E-07	2.754E-07	4.002E-08	4.288E-08	2.320E-08

Load case 13 (Non-linear): D+Sn+Lh
Non-linear effects: P-Δ, P-δ, 3 Iterations, 99.942% Convergence

Node	X-Axis Force	Y-Axis Force	Z-Axis Force	X-Axis Moment	Y-Axis Moment	Z-Axis Moment
549	0.30	-30.73	51.04	0.00	0.00	0.00
775	18.38	-4.58	19.81	0.00	0.00	0.00
806	26.60	2.89	4.70	0.00	0.00	0.00
815	4.35	-23.56	19.31	0.00	0.00	0.00
834	21.34	0.17	6.58	0.00	0.00	0.00
883	13.11	1.19	8.80	0.00	0.00	0.00
885	-0.61	-16.99	8.61	0.00	0.00	0.00
901	-0.25	12.34	60.83	0.00	0.00	0.00
905	-0.06	-1.99	-9.63	0.00	0.00	0.00
907	-0.01	1.88	11.44	0.00	0.00	0.00
937	0.13	0.00	0.09	0.00	0.00	0.00
Load	0.00	0.00	-1816.98	0.00	0.00	0.00
Reac	0.00	0.00	1816.98	0.00	0.00	0.00
Frame	-4.605E-08	-1.217E-08	0.000E+00			
Nodes	7.370E-08	6.161E-08	2.047E-07	2.585E-08	2.874E-08	2.835E-08

Load case 14 (Non-linear): D+Wy 40 mph (18 m/s)
Non-linear effects: P-Δ, P-δ, 3 Iterations, 99.986% Convergence

Node	X-Axis Force	Y-Axis Force	Z-Axis Force	X-Axis Moment	Y-Axis Moment	Z-Axis Moment
549	-0.14	6.78	2.93	0.00	0.00	0.00
775	-11.91	-2.63	2.05	0.00	0.00	0.00
806	-6.73	-2.93	4.45	0.00	0.00	0.00
815	-5.10	-6.80	-12.76	0.00	0.00	0.00
834	-8.69	-4.23	13.20	0.00	0.00	0.00
883	-7.37	-4.40	13.63	0.00	0.00	0.00
885	-3.51	-12.45	-16.14	0.00	0.00	0.00
901	0.13	-2.52	-5.63	0.00	0.00	0.00
905	0.02	-7.50	-17.92	0.00	0.00	0.00
907	0.10	-8.01	-19.30	0.00	0.00	0.00
937	-2.18	0.00	-0.30	0.00	0.00	0.00
Load	-19.42	322.67	18.45	-2.31	0.00	0.00
Reac	19.42	-322.67	-18.45	0.00	0.00	0.00
Frame	0.000E+00	0.000E+00	0.000E+00			
Nodes	3.676E-08	3.532E-08	6.868E-08	9.123E-09	9.582E-09	8.728E-09

Load case 15 (Non-linear): D+Wy 50 mph (22.5 m/s)
Non-linear effects: P-Δ, P-δ, 7 Iterations, 99.986% Convergence

Node	X-Axis Force	Y-Axis Force	Z-Axis Force	X-Axis Moment	Y-Axis Moment	Z-Axis Moment
549	-0.23	11.52	2.55	0.00	0.00	0.00
775	-18.57	-4.49	3.30	0.00	0.00	0.00
806	-11.52	-4.75	6.67	0.00	0.00	0.00
815	-8.56	-13.74	-21.98	0.00	0.00	0.00
834	-13.43	-6.67	20.36	0.00	0.00	0.00
883	-11.78	-6.84	21.26	0.00	0.00	0.00
885	-6.18	-22.42	-30.26	0.00	0.00	0.00
901	0.22	-4.47	-11.39	0.00	0.00	0.00
905	0.03	-11.60	-27.88	0.00	0.00	0.00
907	0.15	-12.63	-30.61	0.00	0.00	0.00
937	-3.71	0.00	-0.52	0.00	0.00	0.00
Load	-30.34	504.18	145.72	-3.60	0.00	0.00
Reac	30.34	-504.18	-145.72	0.00	0.00	0.00
Frame	0.000E+00	0.000E+00	0.000E+00			
Nodes	9.769E-08	8.535E-08	1.490E-07	1.837E-08	2.419E-08	1.019E-08

BUCKLING LOAD FACTORS

Load Case	Mode	Load Factor	Tolerance	Iterations	Node at Max Trans	Node at Max Rotn
11	1	72.39	0.007812	21	721 (X)	1090 (Y)
12	1	72.39	0.007812	21	721 (X)	1090 (Y)
13	1	5.82	0.007812	13	1168 (Z)	1168 (Z)
14	1	72.30	0.007812	21	202 (X)	287 (Y)
15	1	72.25	0.007812	21	650 (Y)	287 (Y)