

Structural Engineering CIVL 310

Prepared For: Dr. Robabeh Jazaei

> Prepared By: C.T

RISA Final Project Structural Analysis Report

Abstract

This final report will discuss my project, which consists of creating a floor plan and 3D model of a structure that has elements of wood, concrete, and steel used within the design of the structure. I chose to structurally design and analyze my house for my final project. This report will display the floor plan that I created in AutoCAD, and it will show data collected by RISA software.

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Dimensions

To begin my project, I have retrieved measurements of the layout of my house from documents given to my parents when they moved into the house (Fig. 1). The house consists of four bedrooms and a bathroom upstairs, and a kitchen, living room, dining room, foyer, attic, and basement. The house is 30-feet by 28.2-feet, which yields an area of 846-square-feet for each floor.

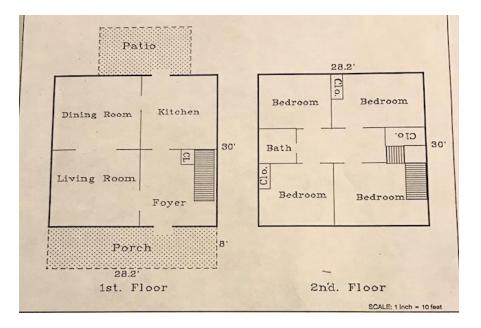


Figure 1. Floor plan dimensions of the house.

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Area	Name of Area	Size	Totals	Bre	eakdo	wn	Subtotals
GLA1	First Floor	846.00	846.00	28.20	x	30.00	846.00
GLA2	Second Floor	846.00	846.00	0.65	x	0.10	0.07
POR	Porch	225.60		28.20	X	30.00	846.00
	Porch	160.00	385.60	0.65	x	0.10	0.07
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	Real Property in the						
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OTAL	LIVADEL (IOUI)	ucu)	1092				1692

Figure 2. Calculated area of each floor within the house.

Floor Plan

Using this given data, I created a floor plan using AutoCAD software. This allows me to find more dimensions for the house, in which I can use to model the structure onto RISA. I created a floor plan of the floor layouts, as well as where doors, stairs, and columns are located (Fig. 3).

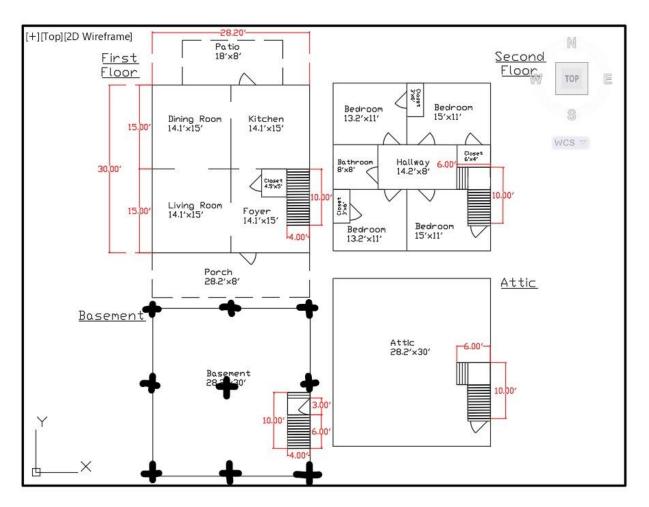


Figure 3. Floor plan of designed on AutoCAD, plus marks are where concrete columns are located to support the house.

Modeling

The new floor plan gives me dimensions to create an accurate 3D model of the structure. The structure's foundation is built with 3000NW concrete columns that support the structure. The space withing the columns acts as the basement of the house. The concrete columns are

rectangular 8-inch by 8-inch columns that stand 8-feet tall (Fig. 4). The concrete columns have fixed boundary conditions to where they are connected to the ground.

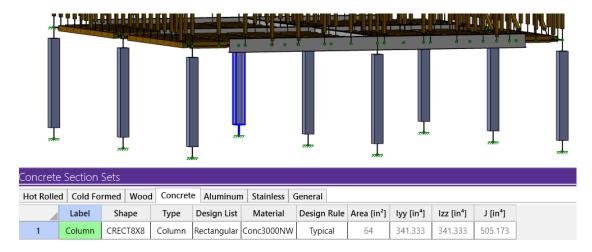


Figure 4. Nine concrete columns located in the basement of the house.

The concrete columns connect to the A992 hot rolled steel girders and beams that support a majority of the load acting from the wood supports of the house. The steel girders and beams are wide flanged, which prevents deflection of the beam (Fig. 5). The steel beams will support more weight due to the weight of the walls on the edges of the house.

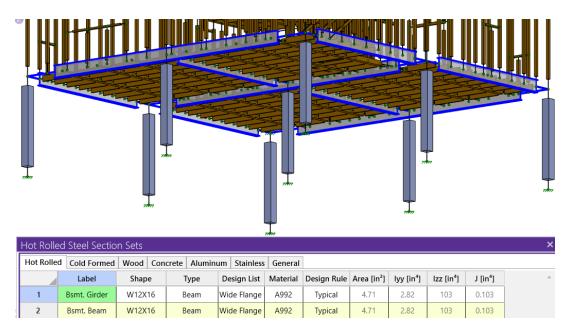


Figure 5. Three steel girders stretching across the bottom level of the house, with four steel beams coming off the steel girders.

The rest of the structure consists of DF wood studs, girders, and beams. All of the wood within the structure has a rectangular shape. Each section set has different cross-sectional areas because of their purposes withing the structure. There are several types of labeled wood identifications used for how each section of wood is oriented differently (Fig. 6).

Wood Se	ection Set	S									×
Hot Rolle	d Cold Fo	rmed Wood	Concrete	Aluminum Stair	less General						
	Label	Shape	Туре	Design List	Material	Design Rule	Area [in ²]	lyy [in⁴]	lzz [in⁴]	J [in⁴]	
1	Stud	3X3	Column	Rectangular	DF	Typical	6.25	3.255	3.255	5.501	
2	Girder	3X6	Beam	Rectangular	DF	Typical	13.75	7.161	34.661	20.472	
3	Beam	5X5	Beam	Rectangular	DF	Typical	20.25	34.172	34.172	57.75	
4	Bracing	3X3	VBrace	Rectangular	DF	Typical	6.25	3.255	3.255	5.501	
5	Header	2X3	Beam	Rectangular	DF	Typical	3.75	0.703	1.953	1.761	
6	Footer	3X3	Column	Rectangular	DF	Typical	6.25	3.255	3.255	5.501	
7	Joist	2X6	Beam	Rectangular	DF	Typical	8.25	1.547	20.797	5.125	1
8	Truss Be	4X4	Beam	Rectangular	DF	Typical	12.25	12.505	12.505	21.134	
9	Truss St	2X2	Column	Rectangular	DF	Typical	2.25	0.422	0.422	0.713	
10	Truss Di	2-2X4	VBrace	Rectangular Do	DF	Typical	10.5	7.875	10.719	15.255	Ŧ
e			·								

Figure 6. Wood section sets used in the structure such as beams, columns, and vertical braces.

Usually studs are 1.5-feet apart from each other, so when I created the model, I used the global tool to make multiple copies of the studs that are distance the same amount apart from each other. The internal and external walls of the house consist of these studs that are 1.5-feet apart and that stand 8-ft tall (Fig. 7).

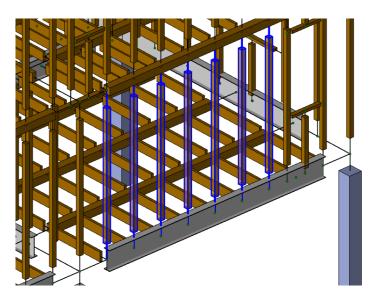


Figure 7. The external wall on the first floor of the house.

Along with the studs, there are window frames and door frames placed within the house (Fig. 8). The frames are made from footers and headers. There are also two staircases within the house that are supported by studs and braces (Fig. 9). The roof consists of multiple trusses in order to support live loads that act on the house (Fig. 10). The floors of the house have wooden joists in between the wooden beams as well for extra support (Fig. 11).

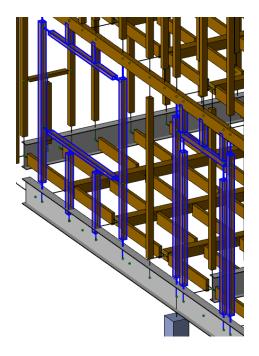


Figure 8. Door frame and window frame.

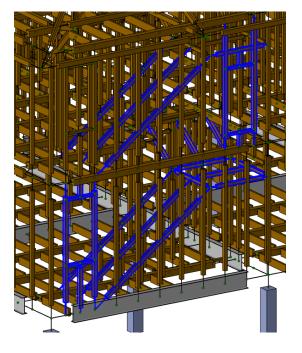


Figure 9. Stairs framing and window frames.

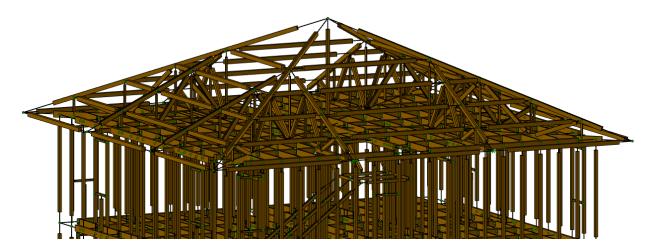


Figure 10. Roof trusses used to support live loads acting on roof.

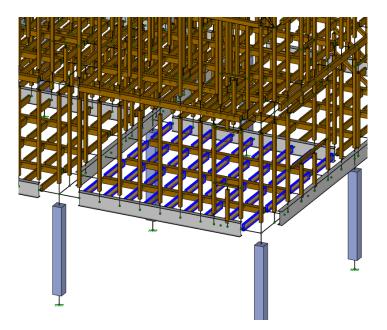


Figure 11. Wooden joists to support floors.

The structure is supported with many pins and fixed boundary conditions. The structure can support the dead load of itself as well as live loads such as rain, snow, and moving loads. The structure itself is 24-feet tall. The house is built with all of the materials required for the project and contains over a thousand members (Fig. 12).

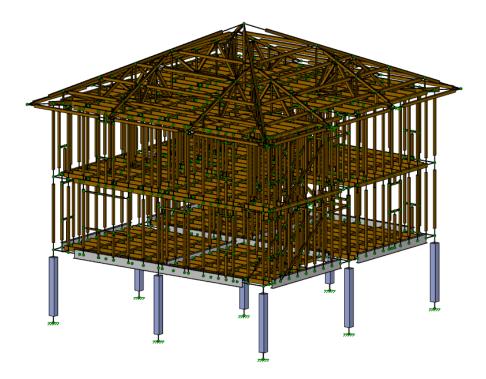


Figure 12. Finalized 3D model of the house.

Structural Analysis

The concrete columns hold all of the dead load of the house and any live loads that act on the house also. The central concrete column has deflection in both the y-direction and z-direction, but no shear force in those directions (Fig. 13). When compared to the concrete columns on the corners of the house, these columns do have shear force in both y-direction and z-direction, and moment in both y-direction and z-direction also (Fig. 14).

Detail Report: M7		Unity Check: 0.025 (axia	l/bending)	Load Co	ombination: Envelop
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	x z	Shape: Member Type: Length (ft): Material Type: Design Rule: Number of Internal Sections: Design Code:	CRECT8X8 Column 8 Concrete Typical 97 ACI 318-19	l Node: J Node: I Release: J Release: I Offset (in): J Offset (in):	N13 N14 BenPIN BenPIN N/A N/A
Material Properties:					
Material:	Conc3000NW	Therm. Coeff. (1e⁵°F⁻¹):	0.6	Lambda:	1
E (ksi):	3156	Density (k/ft ³):	0.145	Flex Steel (ksi):	60
G (ksi):	1372	f'c (ksi):	3	Shear Steel (ksi):	60
Nu:	0.15				
Shape Properties:					
D (in):	8	W (in):	8		
Design Properties:					
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C _{m z-z} :	N/A	Cracked Sections Used:	Yes	Shear Rebar Set:	ASTM A615
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K _{z-z} :	1	Effective "I" (in ⁴):	238.933	Bottom Cover (in):	1.5
	No	Effective "I" (Service) (in ⁴) :	341.675	Side Cover (in) :	1.5
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Figure 13. Data from central concrete column.

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Figure 14. Data from corner concrete column.

The steel girders and beams are wide-flanged which would prevent any possible buckling. They are very strong supports for the rest of the house and its wood sections. The steel girder in the center of the house has a great amount of force acting on it, as seen in the diagrams (Fig. 15). The diagrams show that there is deflection, shear and moment in the y-direction and z-direction. The steel girder on the edge has las forces acting on it, but still enough for there to be deflection, shear, and moment in both the y-direction and the z-direction (Fig. 16).

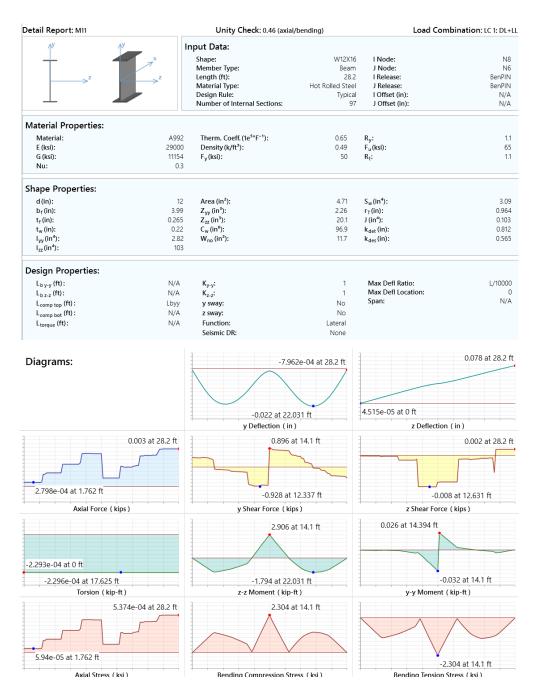


Figure 15. Data collected from central steel girder.

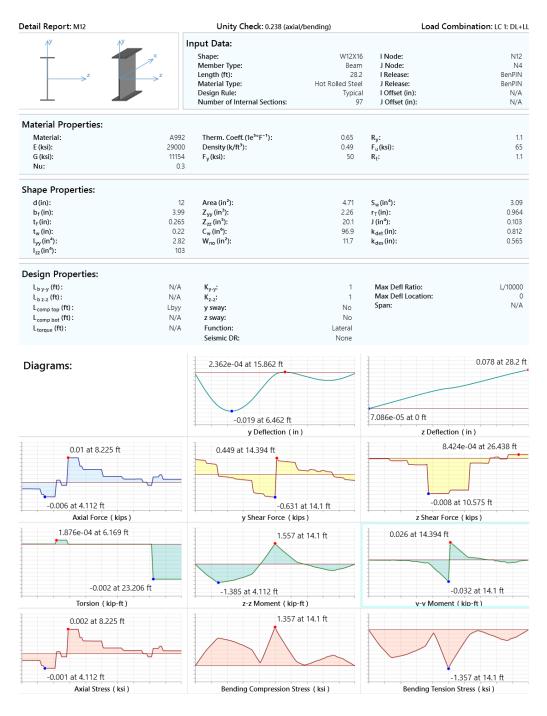


Figure 16. Data collected from right edge steel girder.

There are a lot of wooden member throughout the entire structure that have similar properties, so I will give information on only some of the members. I have gathered information on the central wooden stud on the first floor, the corner stud on the first floor, the wooden girder of the second floor, the wooden beam of the first floor, the wooden joist of the first floor, the wooden stud in the attic and the wooden diagonal truss of the roof support. The central wooden stud within the first floor shows deflection and shear in both directions (Fig. 17).

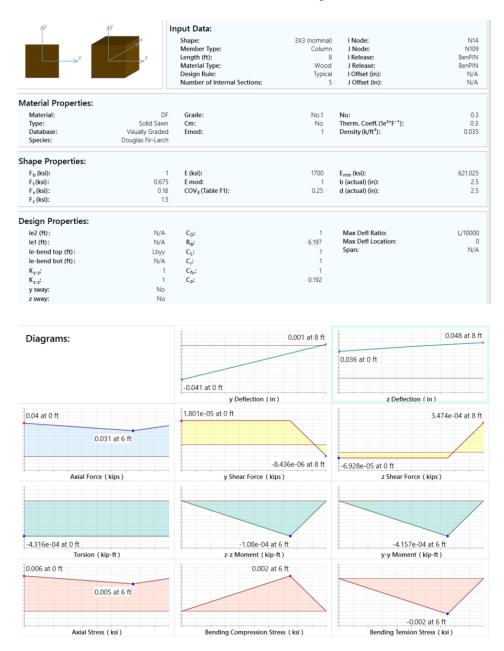


Figure 17. Data collected from central wooden stud on first floor.

The wooden stud located at the corner of the house on the first floor gives different data in comparison to the wooden stud in the central part of the house on the first floor. The wooden stud has deflection in both directions but shows no signs of shear force in any of the directions (Fig. 18).

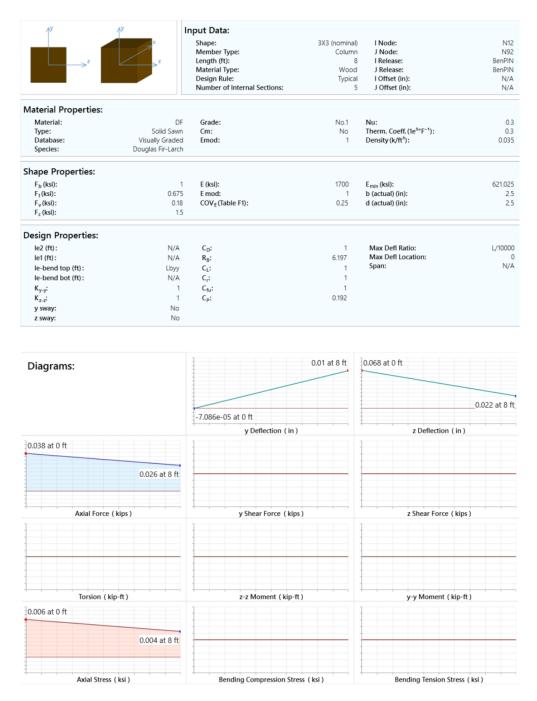


Figure 18. Data collected from corner wooden stud on first floor.

The wooden girder on the second floor has many members attached to it so it should receive a great amount of external force. There is deflection and shear forces present within the member, as well as moment (Fig. 19).

Type: Sold Saven Database: Cm: No Them. Coeff (de ^{M-F1}): 0.0 Shape Properties: F_(k0): 1 Emod: 1 Denity(k/R): 0.0 F_(k0): 0.075 Emod: 1 Denity(k/R): 0.0 F_(k0): 0.075 Emod: 1 b factual (in): 6210 F_(k0): 0.075 Emod: 1 b factual (in): 6210 F_(k0): 0.018 COV_(Table FI): 0.25 d factual (in): 1 Design Properties: K2 (fit): NA Fg: 0 Max Def factoritic: U/00 Kr/# 1 Cg: 0 Max Def factoritic: V/00 Kr/# 1 Cg: 0 Max Def factoritic: V/00 Kr/# 1 Cg: 0 0 Max Def factoritic: V/00 Jougas t/05 ft 0 Cg: 0 0 0.01 at 0 ft 0.01 at 0 ft Jougas t/05 ft 0 0.022 at 7.05 ft 0.024 at 0 ft <th>× ×</th> <th>\overrightarrow{x} \overrightarrow{x} \overrightarrow{x}</th> <th>ut Data: hape: fember Type: ength f(t): flaterial Type: besign Rule: lumber of Internal Sections:</th> <th>3X6 (nominal) Beam 28.2 Wood Typical 5</th> <th>l Node: J Node: I Release: J Release: I Offset (in): J Offset (in):</th> <th>N92 N96 BenPIN BenPIN N/A N/A</th>	× ×	\overrightarrow{x}	u t Data: hape: fember Type: ength f(t): flaterial Type: besign Rule: lumber of Internal Sections:	3X6 (nominal) Beam 28.2 Wood Typical 5	l Node: J Node: I Release: J Release: I Offset (in): J Offset (in):	N92 N96 BenPIN BenPIN N/A N/A
Type: Sold Save Duals/Gade Cm: No Therm. Coeff (1e ¹⁰ F ⁻): 0.0 Shape Properties: Fig. (bi): 1 Emod: 1 Density (k/ft): 0.0 Shape Properties: Fig. (bi): 0.075 Emod: 1 Density (k/ft): 0.0 Fig. (bi): 0.075 Emod: 1 b factual (in): 6210 Fig. (bi): 0.075 Emod: 1 b factual (in): 6210 Fig. (bi): 0.075 Emod: 0 Max Deff Ratio: L/000 Ite (ff): N/A Cp: 0 Max Deff Ratio: L/000 Ite (ff): N/A Cp: 0 Max Deff Ratio: L/000 Ite (ff): N/A Cp: 0 Max Deff Ratio: L/000 Visway: No Cp: 0 Max Deff Ratio: L/000 Visway: No Cp: 0 Max Deff Ratio: L/000 Visway: No Cp: 0 0 Doil at 0f:	Material Properties:					
Dividualse: Visually Graded Douglas Friench Emod: 1 Density (k/f*): 0.00 Shape Properties: Fp.(k0): 0.75 E.0601: 1.0 bersity (k/f*): 6210 525 6210 6						0.3
Species: Douglas Finlanch Eddl: 1700 Endl: Eddl: 1700 Endl: Eddl: 1700 Endl: Eddl: 6210 Endl:						0.3
Fr (sol): 0.075 E 6x0:: 100 E sub:: 6210 b b chall (n): 6210 b chall (n): 6210 b chall (n): 6210 b chall (n): 6210			Emod:	1	Density (k/ft³):	0.035
F ₁ (k0): 0.675 F ₁ (k0): 0.17 0.25 b (actual) (n): F ₁ (k0): 0.18 Cov (Table FI): 0.25 d (actual) (n): 1 Design Properties: 0.25 d (actual) (n): 1 0.025 d (actual) (n): 1 let (f0): N/A Rg: 0 Max Deff Ratio: U/000 let (f0): N/A Rg: 0 Max Deff Ratio: U/000 k+p* 1 Cg: 0 Max Deff Ratio: U/000 way: N/A Cg: 0 Max Deff Ratio: U/000 ysway: N/A Cg: 0 Max Deff Ratio: U/000 ysway: N/A Cg: 0 Max Deff Ratio: U/000 ysway: N/A Cg: 0 0 0.04 at 28.2 ft 0 0.028 at 7.05 ft 0 0.024 at 0.5 ft 0.014 d.1 ft 0.014 d.2 ft 0.014 d.1 ft 0.011 at 28.2 0.002 at 7.05 ft 0.002 at 7.05 ft 0.024 at 7.05 ft 0.034 at 21.15 ft 2.5676-04 at 7.05 ft 2.9676-04 at 7.05 ft 2.9677-04 at 7.05 ft 2.9677-04 at 7.05 ft	Shape Properties:					
F ₁ (ke): F ₁ (ke): 15 CoV ₄ (Table FI): 0.25 d (actual) (in): 15 CoV ₄ (Table FI): 0.25 d (actual) (in): 15 CoV ₄ (Table FI): 0.25 d (actual) (in): 15 CoV ₄ (Table FI): 0.25 d (actual) (in): 15 Max Defl Ratio: 1000 Max Defl Ratio: 1000	F _b (ksi):	1	E (ksi):	1700	E _{min} (ksi):	621.025
$F_c(kol):$ 13 Design Properties: Image: Color of the static state					b (actual) (in):	2.5
Design Properties: te? (ft): te? (ft): te / fth: te / bend top (ft): te / bend top (ft):	F _v (ksi):		COV _E (Table F1):	0.25	d (actual) (in):	5.5
let(f0): N/A Ca: 0 Max Defl Ratio: L/100 let(f0): N/A Ca: 0 Max Defl Ratio: L/100 Span: N/A Ca: 0 Max Defl Ratio: L/100 Krp: 1 Cp: 0 Max Defl Ratio: L/100 Krp: 1 Cp: 0 Max Defl Ratio: N Span: N Cp: 0 Max Defl Ratio: N Span: N Cp: 0 Max Defl Ratio: N Span: N Cp: 0 N N Jaway: No Cp: 0 N N Diagrams: -7.178e-04 at 28.2 ft -0.01 at 0 ft -0.028 at 21.15 ft -0.028 at 21.15 ft -0.028 at 21.15 ft -0.028 at 21.15 ft -0.024 at	F _c (ksi):	1.5				
let Image: Mark Defl Location: Span: Max Defl Location: Span: Max Defl Location: Span: N It -bend bop (ft): Lbyy C;: 0 Max Defl Location: N Ky;* 1 C;: 0 Max Defl Location: N Ky;* 1 C;: 0 0 Span: N Jagrams: C;: 0 0 0.04 at 28.2 ft 0.04 at 28.2 ft 0.04 at 28.2 ft 0.01 at 0 ft 2 beflection (in) Jagrams: -0.028 at 7.05 ft y beflection (in) 0.011 at 28.2 ft 0.028 at 7.05 ft 0.011 at 28.2 ft 0.028 at 7.05 ft 0.028 at 7.05 ft 0.024 at 21.15 ft 0.034 at 21.15 ft 0.034 at 21.15 ft 0.034 at 21.15 ft 0.034 at 21.15 ft y y Moment (kip-ft) y y Moment (kip-ft) 0.017 at 7.05 ft 0.017	Design Properties:					
le-bend top (ft): le-bend bot (ft): ky						L/10000
$\frac{1}{1} = bend but (tr): K_{y,2} y way: No z sway: No Diagrams: \frac{-7.178e-04 \text{ at } 28.2 \text{ ft}}{\sqrt{2}; 0} \frac{-7.178e-04 \text{ at } 28.2 \text{ ft}}{\sqrt{2}; 0} \frac{-7.178e-04 \text{ at } 28.2 \text{ ft}}{\sqrt{2}; 0} \frac{-0.028 \text{ at } 7.05 \text{ ft}}{\sqrt{2}; 0} \frac{-0.028 \text{ at } 21.15 \text{ ft}}{\sqrt{2}; 0} \frac{-4.967e-04 \text{ at } 7.05 \text{ ft}}{\sqrt{2}; 0} \frac{-4.967e-04 \text{ at } 7.05 \text{ ft}}{\sqrt{2}; 0} \frac{-1.336e-04 \text{ at } 14.1 \text{ ft}}{\sqrt{2}; 0}$	le1 (ft):	N/A	R _B :			0
K _y ; 1 C ₀ : 0 ywwy: No Diagrams: -7.178e-04 at 28.2 ft 0.028 at 7.05 ft 0.04 at 28.2 ft 0.028 at 7.05 ft 0.01 at 0 ft 0.028 at 7.05 ft 0.01 at 0 ft 0.002 at 7.05 ft 0.004 at 0 ft 0.002 at 7.05 ft 0.054 at 14.1 ft 0.002 at 7.05 ft 0.117 at 7.05 ft 0.002 at 7.05 ft 0.117 at 7.05 ft 0.002 at 7.05 ft 0.117 at 7.05 ft				-	Span:	N/A
K ₁ : 1 Cp: 0 ywwy: No Diagrams: -7.178e-04 at 28.2 ft 0.028 at 7.05 ft -0.028 at 7.05 ft 0.002 at 7.05 ft 0.004 at 0 ft 0.002 at 7.05 ft 0.011 at 28.2 0.002 at 7.05 ft 0.0117 at 7.05 ft 0.002 at 7.05 ft 0.117 at 7.05 ft 0.002 at 7.05 ft 0.117 at 7.05 ft	le-bend bot (ft):	N/A	C _r :	0		
y sway: z sway: Diagrams: Diag	К _{у-у} :	1	C _{fu} :	0		
y wwy: z sway: No Diagrams: D	K _{z-2} :	1	C _P :	0		
Diagrams: -7.178e-04 at 28.2 ft -0.028 at 7.05 ft -0.017 at 7.05 ft	y sway:	No				
y Deflection (in) 2 Deflection (in) 2 Deflection (in) 0.028 at 7.05 ft -0.002 at 14.1 ft Axial Force (kips) 0.002 at 7.05 ft 0.002 at 7.05 ft -0.122 at 7.05 ft -0.122 at 7.05 ft -0.122 at 7.05 ft -0.117 at 7.05 ft -0.117 at 7.05 ft -0.117 at 7.05 ft			\checkmark			
0.028 at 7.05 ft -0.002 at 14.1 ft Axial Force (kips) 0.002 at 7.05 ft Torsion (kip-ft) 0.002 at 7.05 ft -1.336e-04 at 14.1 ft -1.336e-04 at 14.1 ft -1.336e-04 at 14.1 ft -1.336e-04 at 14.1 ft -0.044 at 0 ft -0.044 at 7.05 ft -0.044 at 7.05 ft -0.044 at 7.05 ft -0.028 at 21.15 ft 2.5hear Force (kips) 0.054 at 14.1 ft 0.034 at 21.15 ft -0.028 at 21.15 ft 2.5hear Force (kips) 0.054 at 14.1 ft 0.011 at 28.2 -0.028 at 21.15 ft 2.5hear Force (kips) 0.054 at 14.1 ft 0.117 at 7.05 ft -0.117 at 7.05 ft			-0.028 at 7.05 ft		-0.01 at 0 ft	
-0.002 at 14.1 ft -0.044 at 7.05 ft -0.028 at 21.15 ft -0.002 at 7.05 ft -0.028 at 21.15 ft 2 Shear Force (kips) 0.002 at 7.05 ft 0.054 at 14.1 ft 0.034 at 21.15 ft 0.002 at 7.05 ft -0.122 at 7.05 ft -4.967e-04 at 7.05 ft 0.002 at 7.05 ft 0.117 at 7.05 ft -0.117 at 7.05 ft			y Deflection (in)	z Deflection	(in)
-0.002 at 14.1 ft -0.044 at 7.05 ft -0.028 at 21.15 ft Axial Force (kips) 0.054 at 14.1 ft 0.034 at 21.15 ft 0.002 at 7.05 ft 0.054 at 14.1 ft 0.034 at 21.15 ft 0.002 at 7.05 ft 0.012 at 7.05 ft -0.122 at 7.05 ft 0.002 at 7.05 ft 0.117 at 7.05 ft y Moment (kip-ft)	0.028 at 7.05 ft	0.	004 at 0 ft			0.011 at 28.2 ft
Axial Force (kips) y Shear Force (kips) z Shear Force (kips) 0.002 at 7.05 ft 0.054 at 14.1 ft 0.034 at 21.15 ft 0.002 at 7.05 ft -0.122 at 7.05 ft -4.967e-04 at 7.05 ft 0.002 at 7.05 ft z-2 Moment (kip-ft) y-y Moment (kip-ft) 0.002 at 7.05 ft 0.117 at 7.05 ft -0.117 at 7.05 ft						
Axial Force (kips) y Shear Force (kips) z Shear Force (kips) 0.002 at 7.05 ft 0.054 at 14.1 ft 0.034 at 21.15 ft 0.012 at 7.05 ft -0.122 at 7.05 ft -4.967e-04 at 7.05 ft 0.002 at 7.05 ft z-z Moment (kip-ft) y y Moment (kip-ft) 0.002 at 7.05 ft 0.117 at 7.05 ft -0.117 at 7.05 ft	-0.002 at 14	.1 ft	-0.044 at 7.05 ft		-0.028 at	21.15 ft
-0.122 at 7.05 ft -0.122 at 7.05 ft -2.123 at 7.05 ft -2.1336e-04 at 14.1 ft			y Shear Force (ki	os)	z Shear Force	(kips)
Torsion (kip-ft) 0.002 at 7.05 ft -1.336e-04 at 14.1 ft	0.002 at 7.05 ft		0.054 a	et 14.1 ft	0.034 at	21.15 ft
Torsion (kip-ft) 0.002 at 7.05 ft -1.336e-04 at 14.1 ft			0 122 at 7 05 ft		-4.967e-04 at 7	.05 ft
-1.336e-04 at 14.1 ft	Torsion (kip-ft)	+		ft)		
	0.002 at 7.05 ft		0.117 at 7.05 ft			
	1000				V	
Axial Stress (ksi) Bending Compression Stress (ksi) Bending Tension Stress (ksi)		at 14.1 ft				

Figure 19. Data collected from wooden girder on second floor.

The wooden beam located on the first floor of the house holds the joists of the floor and is attached to the steel beams of the first floor. The girder has deflection in the y-direction that appears to be symmetrical due to having wooden joists attached to the member symmetrically in each direction. Shear force and moment is present in each of the directions also (Fig. 20).



Figure 20. Data collected from wooden beam on the first floor.

The wooden joist between each of the wooden beams are there to support the weight from the floor and the live loads that could possibly act on it. The joists have identical data with each other throughout the structure. Each joist has deflection, shear force, and moment within them (Fig. 21).

∧ ^v > ^z		put Data: Shape: Member Type: Length (ft): Material Type: Design Rule: Number of Internal Sections:	2X6 (nominal) Beam 3.525 Wood Typical 5	l Node: J Node: I Release: J Release: I Offset (in): J Offset (in):	N187 N456 Fixed N/A N/A
Material Properties:					
Material: Type: Database: Species:	DF Solid Sawn Visually Graded Douglas Fir-Larch	Grade: Cm: Emod:	No.1 No 1	Nu: Therm. Coeff. (1e ^{so} F ⁻¹): Density (k/ft ³):	0.3 0.3 0.035
Shape Properties:					
F _b (ksi):	1	E (ksi):	1700	E _{min} (ksi):	621.025
F _t (ksi):	0.675	E mod:	1	b (actual) (in):	1.5
F _v (ksi):	0.18	COV _E (Table F1):	0.25	d (actual) (in):	5.5
F _c (ksi):	1.5				
Design Properties:					
le2 (ft):	N/A	C _D :	1	Max Defl Ratio:	L/10000
le1 (ft):	N/A	R _B :	10.169	Max Defl Location:	0
le-bend top (ft):	Lbyy	CL:	0.989	Span:	N/A
le-bend bot (ft):	N/A	C _r :	1		
К _{у-у} :	1	C _{fu} :	1.15		
K _{z-z} :	1	C _P :	0.351		
y sway:	No				
z sway:	No				

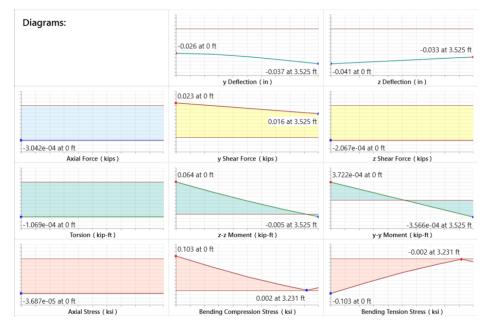


Figure 21. Data collected from wooden joist on the first floor.

The wooden stud that is located in the center of the attic is connected to each of the diagonal trusses of the roof. There is deflection within the member, but there is also moment that is greater more at the top of the stud and then it decreases as it reaches the bottom support of the stud (Fig. 22).

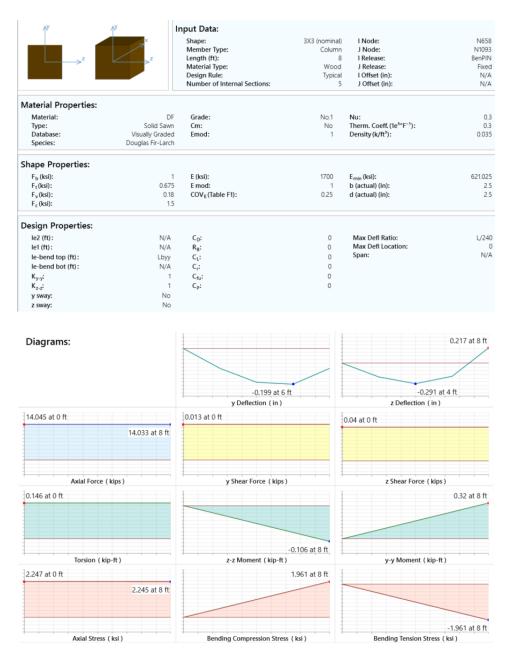


Figure 22. Data collected from wooden stud in the attic.

The truss of the roof is where the live load is specifically located. The live load acts on the roof and the forces are distributed throughout the rest of the members of the house. The truss has deflection, shear, and moment form the dead load and live load, as well as the supports of the other parts of the truss acting on it (Fig. 23).

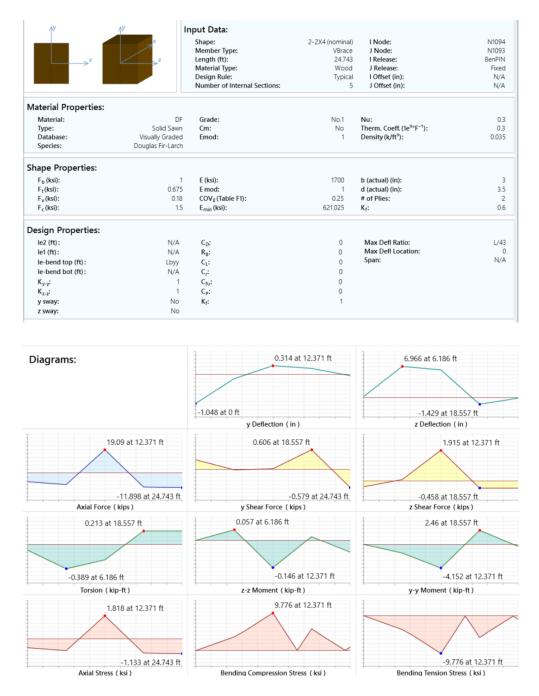


Figure 23. Data collected from wooden truss from roof.

The roof trusses support a combination of both dead load and live load. The live load primarily acts on the beams of the connecting trusses with an estimated load of -0.2 k/ft (Fig 24). Dead load is applied to every member of the structure, due to each member's own weight.



Figure 24. Load combination of the structure, mainly the live load acting on roof trusses.

Cost Analysis

The structure has hot rolled steel, wood, and concrete used for the design. The estimated cost can be calculated using the information given from the material takeoff tab in RISA. This gives us the information about the material, size, number of pieces, length, and weight of each of the members (Fig. 25). Using different sources, I found the price of the different sizes of steel, wood, and concrete needed to construct the structure. The total cost of the project's framework equates to an estimate of \$18,711.79 (Fig 26). This does not include the cost to construct walls, floors, or any utilities needed in the structure.

Material	Size	Pieces	Length[ft]	Weight[K]
Hot Rolled Steel				
A992	W12X16	9	174.6	2.798
Total HR Steel		9	174.6	2.798
Wood				
DF	5X5	49	710	3.495
DF	3X3	341	2263	3.438
DF	3X6	6	169.2	0.565
DF	2X3	70	212.7	0.194
DF	2X6	432	1588.9	3.186
DF	2-2X4	48	360.5	0.92
DF	2X2	40	118.7	0.065
DF	4X4	60	528.2	1.573
Total Wood		1046	5951.2	13.436
Concrete Members			Volume (yds	
Conc3000NW	CRECT8X8	9	1.2	4.64
Total Concrete		9	1.2	4.64

Figure	25.	Material	takeoff	of	the	structure.
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Material	Size	Pieces	Length[ft]	Weight[K]	Weight[lb] per Length[ft]	Cost per Piece	Total Cost for Pieces
Hot Rolled Steel							
A992	W12X16	9	174.6	2.798	16.025		
Total HR Steel		9	174.6	2.798	16.025	\$ 674.19	\$ 6,067.71
Wood	Size	Pieces	Length[ft]	Weight[K]	Length[ft] per Piece		
DF	5X5	49	710	3.495	14.5	\$ 39.98	\$ 1,959.02
DF	3X3	341	2263	3.438	6.6	\$ 15.62	\$ 5,326.42
DF	3X6	6	169.2	0.565	28.2	\$ 46.98	\$ 281.88
DF	2X3	70	212.7	0.194	3.0	\$ 2.98	\$ 208.60
DF	2X6	432	1588.9	3.186	3.7	\$ 5.18	\$ 2,237.76
DF	2-2X4	48	360.5	0.92	7.5	\$ 4.25	\$ 204.00
DF	2X2	40	118.7	0.065	3.0	\$ 3.48	\$ 139.20
DF	4X4	60	528.2	1.573	8.8	\$ 15.62	\$ 937.20
Total Wood		1046	5951.2	13.436			\$ 11,294.08
	Size	Pieces	Length[ft]	Weight[K]			
Concrete Members			Volume (yds^3)			Cost per Cubic Yard (yd^3)	Total Cost for Pieces
Conc3000NW	CRECT8X8	9	1.2	4.64		\$ 125.00	\$ 1,350.00
Total Cost:							
\$ 18,711.79							

Figure 26. Cost estimate of the materials needed to construct the house.

Conclusion

The structure was designed starting with a floor plan, then moving onto creating a 3D model of the structure, and then going through structural analysis using RISA. The process of designing the structure deals with a lot of detailed steps and calculations. The structure successfully stands, and RISA gives good, detailed data about the characteristics and properties of each of the members built within the structure. The project gives me a better understanding of how programs like AutoCAD and RISA work, and how to fix issues with different types of situations when designing.