Residential Garage Addition: Final Design Report

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ACKNOWLEDGMENTS

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1 PROJECT DESCRIPTION

1.1 PROJECT BACKGROUND AND PURPOSE

Mark Haven has requested that Hawkeye Engineering design a two-car, two-story garage addition to his residence in Munds Park, Arizona. Mr. Haven's residence is a pre manufactured home located on a 6500 square foot plot of land. The residence does not currently have a garage. The proposed location of the garage addition is on the north side of the residence, along the existing driveway and facing Trout Creek Road (the street north to the lot).

Figure 1: Map of Munds Park Relative to Flagstaff, AZ

Munds Parks is a rural, unincorporated census-designated place in Coconino County, Arizona [1]. It is located approximately 19 miles south of Flagstaff, AZ. Munds Park experiences an average snowfall of 70 inches per year [2]. The owner requires a garage for accessibility to his vehicle during harsh weather conditions. Mr. Haven's secondary needs for a garage are storage for his personal property and a den/photography studio on the second floor of the garage. The structure must be accessible on both floors, durable, and have as many windows as possible.

1.2 DESIGN CONSTRAINTS AND CRITERIA

The criteria required the design of a two story garage. The garage must be designed within a 5 foot setback from the west property line, and a 20 foot setback from the front property line [3]. Given the location of the client's house on the property, there is limited space for the design. The client required the garage to be attached to the existing house, and to have a second story observatory for photography and for storage. It is also required that we not change the existing landscapes (particularly the trees located in the north lawn). Another constraint was that the garage must be designed to meet all structural standards required by Coconino County. The garage must to have room to add a small elevator to the inside, as well as a staircase for emergency exit requirements.

1.3 STAKEHOLDERS

The client, Mark Haven, is the primary stakeholder for this project. As the owner of the property, the client stands to benefit the most from the addition of a garage or carport. Mr. Haven has a direct need for garage design and is the main financial investor, thus is a stakeholder in the outcome of the project. The future contractor will also hold a stake in the successful completion of this project. The future contractor will use the technical drawings from this project to complete construction. Therefore, drawings must be easily understood and effectively communicate design of the garage addition.

2 SCOPE

2.1 Surveying and Site Investigation

The team established a control point at the northeast corner of the property to collect points on all the features and utilities on the property. The back-sight was taken with respect to the control point. Points were taken along the perimeter of the house that helped to establish the actual position of the house with respect to the property line and setbacks. The team surveyed the property boundaries, the driveway boundaries, the slope of the property, and the offset of the roof [4]. The team used surveying equipment which included a total station, prism, prism rod, and data collector. For the backyard, the team used laser measurements to measure the boundaries of the backyard and the backside of the house.

The collected data was uploaded into the computer to use in Civil 3D and create a site plan of the existing property of the house. The points of the house and driveway were used to select the area for the proposed garage with respect to the side setback and front setback. The dimensions of the existing area that the team found to be used for to design the garage is 13.25 ft wide and 36.5 ft long. Appendix B shows the site plan of the client's residence.

2.2 Code Research

The team followed Coconino County Building codes and International standards for the completion of the structural design. The building codes used include:

1. Coconino County Building Ordinance 2014 was used to specify the area of building design by including the boundary created by setbacks and the zone of the building with respect to Coconino County, Arizona code [7].

2. 2012 International Building Code (2012 IBC) was used to determine the classification of the structure, which is group R1-4, in order to complete the structural design as it is classified in the code. The 2012 IBC was used to determine the structural components required when designing a garage. The next sentence also doesn't make sense. Maybe say "Stairs will be provided from the second floor to the first floor in order to meet the non-electrical emergency exit by the 2012 IBC [7].
3. The ASCE 7-10 was used to determine the design live load, dead load, snow load, wind load, and seismic load-[7].

2.3 Structural Design and Analysis

2.3.1 Gravity Load Determination The initial step for structural design, was to determine the loads that will act on the garage. The team first calculated gravity loads acting on the structure. Dead loads are constant gravity loads in a structure that are due to the weight of its members, the supported structure, and permanent attachments or accessories [6]. Live loads are any loads that are not attached to the building, such as people and furniture.

2.3.1.1 Dead Load

Dead loads were determined using the ASCE 7-10. Commentary 3 displays average loading values for different materials. The group assumed build materials for the roof, floor, and walls of the building. Heavier than average materials were chosen in every category in order to ensure the design would be conservative. Values were also selected for mechanical loading, and miscellaneous loading, to account for any unforeseen areas of loading in the future.

2.3.1.2 Roof Live Load

The Coconino County design criteria states to use a minimum roof live load of 40 psf [2]. If the calculated snow load is larger than 40 psf, the calculated roof snow load is used in place of the roof live load of 40 psf. This was the case for this garage design. The group determined that the design roof snow load would be 46.2 psf. To calculate this value, the equation involved the ground snow load value of 60 psf, the roof slope factor, .9, the exposure factor, 1.0, the thermal factor, 1.1, and the importance factor, 1.0. All of these values were multiplied together and by 0.7 to get the design roof snow load.

2.3.1.3. Floor Live Load

Live loads for the interior second floor of the garage were taken to be 40 psf [8].

2.3.1.4 Drift Snow Load

Drift snow load is relevant for the flat roof. Snow has a possibility of accumulating against the wall of the second story room, therefore it was taken into account in this area for the design of the garage. The height and width of the drift were calculated using the equations provided in the ASCE 7-10, chapter 7. Drift snow load is added to the regular snow load, and was determined to be 40.77 psf.

2.3.1.5 Wind Uplift

Wind uplift and downward loading was calculated from chapter 30 of the ASCE 7-10. Uplift was used in connection design, and downward wind loading was taken into account along with other gravity loads [8]. Uplift was determined to be 23.7 psf, and downward wind loading was determined to be 9.7 psf.

2.3.2 Lateral Load Determination

2.3.2.1 Lateral Wind

Lateral wind loading was determined from chapter 26 of the ASCE 7-10. Using the equation and factors provided, it was determined that the lateral wind loading for the top of the walls would be 19.2 psf, and 18.6 for the bottom of the wall. To allow for easier calculations, while at the same time increasing the conservativeness of the design, 19.2 was used for both values.

2.3.2.2 Seismic

Seismic loading factors were determined from chapter 12 of the ASCE 7-10. The seismic response coefficient was determined to be .0538. To determine the seismic loading on each wall, the total tributary loading for each wall was determined, and used in conjunction with the height and length of the wall to determine the weight that each wall is responsible for. The total weight on each wall was multiplied by the seismic response coefficient, resulting in the total seismic loading for each wall on the building.

2.3.3 Joist Design

All joists for the roofs and floor were designed using ENERCALC software. Previously determined loading was inputted into the system, along with the corresponding span length of each joist and respective tributary width. Appropriate sizes were selected for each joist to ensure that the design was adequate.

2.3.4 Beam Design

All beams for the garage were designed using ENERCALC software. Point loads from the joists were converted into distributed loads on the beam, and the proper span length and tributary width was inputted. ENERCALC provides options that work, and the most economical size was selected for each beam. All beams were selected to use regular construction lumber, with the exception of the ridge beam for the gable roof. A glu-lam beam was the most economical choice for the ridge beam due to the high loading values.

2.3.5 Header Design

Headers were designed using ENERCALC software. Gravity loads used were the same loads that were used for stud design. In addition to this, point loads from the studs on top of the headers were analyzed and taken into account in the design.

2.3.6 Column Design

Columns were designed using ENERCALC software. Appropriate loads for each column were selected and inputted, as well as the length of each column, and the most economical size was selected.

2.3.7 Load Bearing Wall Design

All walls were designed as load bearing walls for the garage. Individual studs were designed as columns within the wall. Total amounts of gravity loads were determined and applied to each wall

2.3.8 Foundation Design

Foundations were designed using ENERCALC software. The total amount of loads translating off of the wall were summed up and used for the sizing of foundations. Continuous strip foundations were used to bear the weight of every load bearing wall of the garage.

2.3.9 Shear Wall Design

Shear walls were designed by hand with the aid of Bluebeam software. Seismic loading and lateral wind loading were both considered. The governing load case was used for design, and sheathing of an adequate thickness was used on every wall. Simpson Strong-walls were used for the north facing wall.

2.3.10 Connection Selection

Connections were selected on the basis of downward capacity and uplift. Simpson connections that met both of these requirements were selected. Simpson connectors were selected for beam to joist connections, and for beam to column connections.

2.4 Construction Documents and Drafting

The team created roof framing plans, floor framing plans, details, and a site plan in AutoCAD. The AutoCAD drawings were scaled and placed on a title block. Revit was used to create elevation views of the garage. These construction documents are needed to obtain a building permit in Coconino County.

3 DESIGN ALTERNATIVES

3.1 CONCEPT DESIGN

Three distinctly different architectural designs for the garages addition were presented to the client. These alternative designs have the general form and function of the structure (i.e. general garage door and window location, preliminary dimensions, and basic aesthetic concepts). The criteria in which the final design was chosen was purely based off of the client's choice. Once a conceptual design was determined, structural design of that particular model began. Appendix c show the site plan that the team generated to aid in the development the alternative designs. Figure 2, 3, and 4 are preliminary conceptual designs that were presented to the client. Decision matrices were not used for this project due to the fact that the design was selected by client. Structural decisions were dictated by the loading, and plan layout decisions were dictated by the limited amount of space for the garage on the property.

3.1.1 Design Alternative 1

Considerations/Justifications:

This design is the simplest design that can be accomplished by the team. This design maximizes interior space on the second floor and provides windows in on the wall to maximize the owner's view. The design also includes an outside staircase to access to the second floor with a second level door. This design provides ample space on the second floor that meets the client's criteria of providing more space for storage and photography. Pros of this design include the staircase will not be a good source for accessibility during winter. The biggest con would be that the building is not attached to the house.

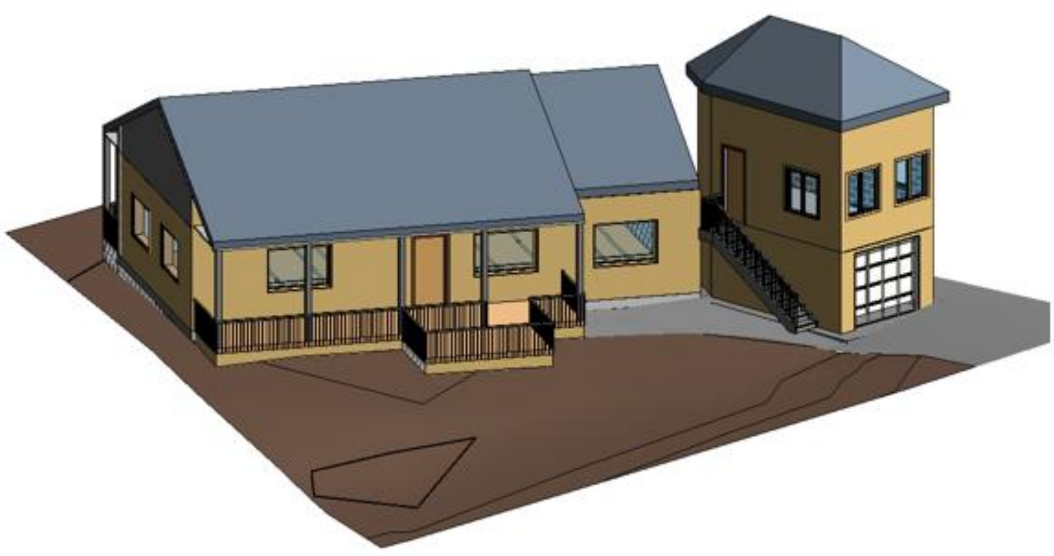

Figure 2: Alternative Design 1

3.1.2 Design Alternative 2

Considerations/Justifications:

This design offers a shaded front deck, which reduces dead loads from walls on the front of the building while offering outdoor seating and views. This design provides room for a 3x3 foot elevator located at the east side of the building that allows access to the second floor of the building. The pros of the design are that is aesthetically attractive, and provides a deck. The cons of the design are that the building is not attached to the house and has a small space for the second floor due to the deck design.

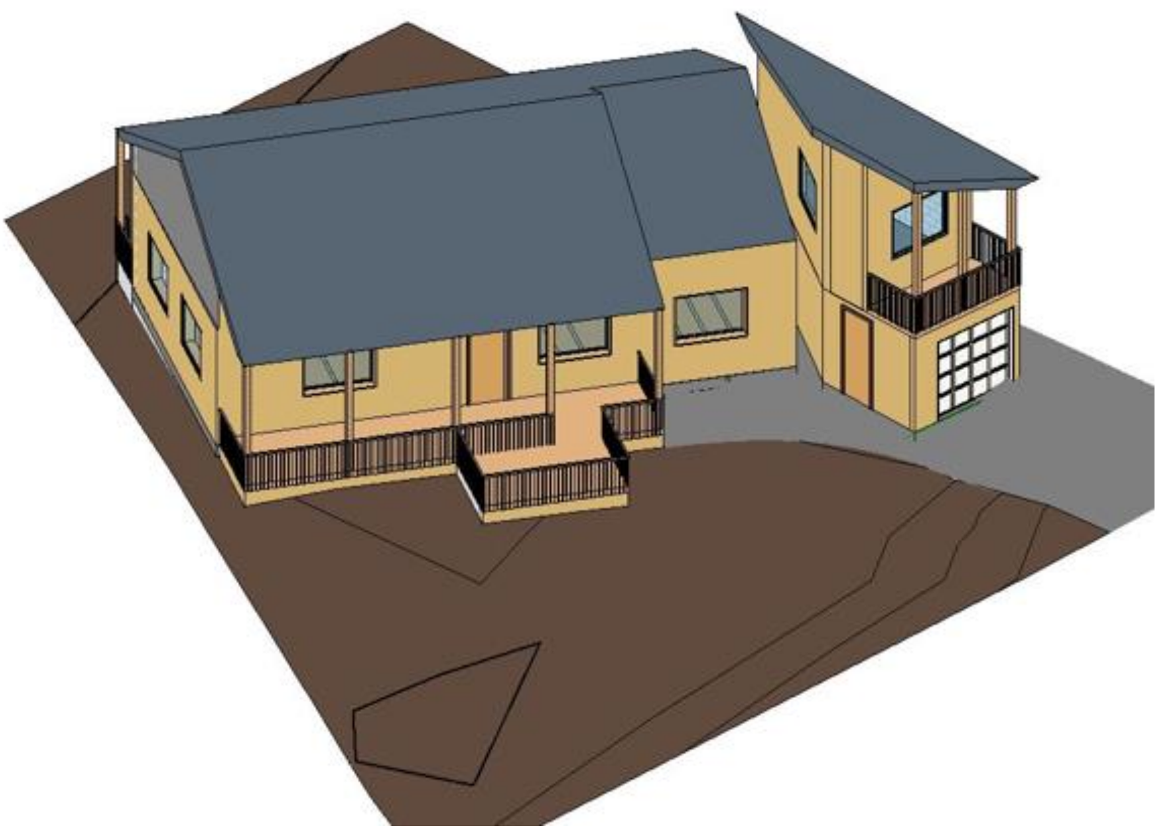

Figure 3: Alternative Design 2

3.1.3 Design Alternative 3

Consideration Justifications

The second floor of this design consists of a hexagonal shaped room with windows on every wall. This allows for a 360-degree view of the surrounding area. The pros of the design is have a good shape design for the second floor that provide good view from all sides of the walls. Because of the limited space in the second floor, it's possible to design an elevator to access to the second floor. The cons of the design are that there is an even more limited amount of space for the proposed elevator.

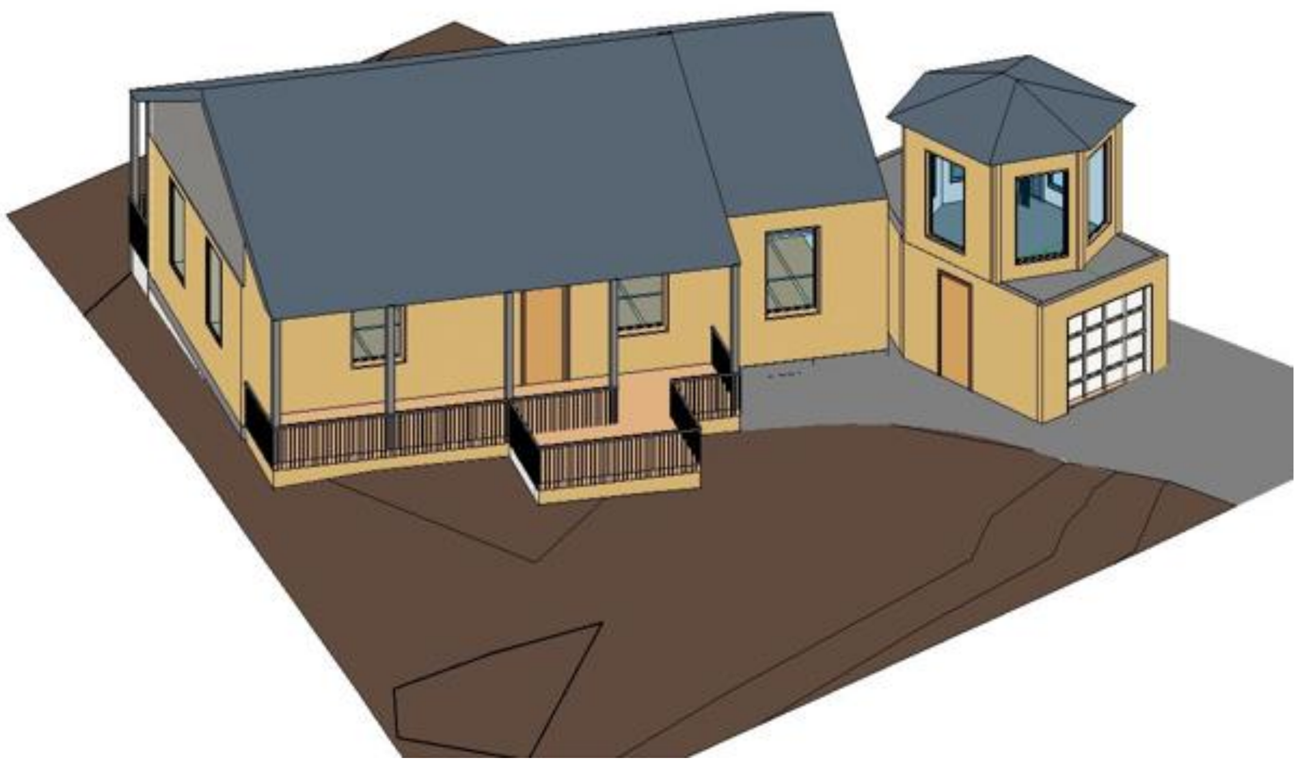

Figure 4: Alternative Design 3

4 FINAL DESIGN

4.1 FINAL DESIGN SUMMARY

After presenting the alternative designs to the client, the client specified the changes that must be completed in order to meet the criteria of the garage design. The client requested to attach the garage building to the residential building by adding firewall with a fire door. The roof design is a gable roof that will allow for more space on the second floor. The final design selected can be seen in Appendix D. With input from the client, the team selected a two story garage that fit within the boundaries of the property with setback limitations, and also met the needs of the client. The final design involves a first floor garage with a spot set aside for a future elevator in the northeast corner of the building. This leaves enough space for one vehicle. Due to the dimensional constraints of this garage, an exterior staircase will be added to along the east wall from the building. The staircase will be a pre-manufactured staircase.

The second story of the garage contains a 13.5 by 13.0 foot room with windows for views on three sides. A gable roof covers the second story, while a flat roof covers the remainder of the first floor that isn’t covered by the second story room. The second floor of the building has windows on three sides to meet the criteria of providing a good view to the backyard from the second floor. The first floor was optimized The final design meets the critical objectives of the project such as building a two story garage in limited area, having accessibility to the second floor, having more storage space in the second floor, and being accessible during snowstorms. Appendix D shows the floor plan of first and second floor of the building design that meet the client’s requirements and Coconino County Ordinance Zone setbacks.

4.2 STRUCTURAL DESIGN

4.1.1 Gravity Load Determination

Load Calculations are shown in Appendix C. The loads are an overestimate, meant to increase the conservativeness of the design. Common materials used in construction and typical beam sizing and spacing used in residential structures was recommended by the technical advisor.

The roof and floor load values used for design are summarized in Tables 1 and 2.

Table 1: Roof Design Loads

Loading	Values
Total Roof Dead Load	18.6 psf
Balanced Snow Load	46.2 psf
Snow Drift Load	40.8 psf
Upward Wind Pressure	-23.8 psf
Downward Wind Pressure	9.70 psf

Table 2: Floor Design Loads

Loading	Values
Floor Dead Load	25.6 psf
Floor Live Load	40.0 psf

Table 3: Gable Roof Design Loads

Loading	Values
Total Roof Dead Load	18.6 psf
Balanced Snow Load	46.2 psf
Upward Wind Pressure	-23.8 psf
Downward Wind Pressure	9.70 psf

4.1.2 Lateral Load Determination

Table 4 below shows the lateral loads results by using shear wall determination in ASCE 7-10.

Table 4: Lateral Loads

Loading	Maximum Value
Seismic Loading	748 lbs
Wind Loading	2138 lbs

4.1.3 Joist Design:

Gable roof joists were determined to be 2x8 structural lumber at 18 inches on center. Flat roof joists were determined to be 2x12 structural lumber at 18 inches on center.

4.1.4 Beam Design:

Second story interior beam was determined to be 2 2x10's bolted together, the ridge beam was determined to be a 5.125x10.5 glu-lam beam. The flat roof beam was determined to be a 3 2x12's bolted together.

4.1.5 Header Design:

Headers were designed using ENERCALC software. Gravity loads used were the same loads that were used for stud design. In addition to this, point loads from the studs on top of the headers were analyzed and taken into account in the design.

4.1.6 Column Design:

The ridge beam support column was determined to be 3 2x6's bolted together. The column to support the 2nd story wall beam was determined to be 3x6 structural lumber.

4.1.7 Load Bearing Wall Design:

The second story wall stud was determined to be 2x6 structural lumber, the first story studs were determined to be 2x6 structural lumber.

4.1.8 Foundation Design:

Foundations were designed using an allowable soil bearing capacity of 1500 psf. This is the worst case value to use in this area. Continuous strip foundations were determined to be 6 inches thick, 1 foot wide, with number 3 reinforcement used.

4.1.9 Shear Wall Design:

Shear wall design ranged from 5/16" sheathing to 15/32" sheathing. Nail sizing ranged from 8D nails to 6D nails, both at 6 inch on center spacing. Simpson Strong Wall WSW 12x7 was selected for the garage door wall.

4.1.10 Connection Selection:

All connections are specified as Simpson StrongTie brand. Flat roof beam connections will be LUS210-3 connectors, flat roof joist connections will be LUS210 connectors, gable roof joist connections will be LUS26 connectors, and beam to column connections will be H2.5a connectors.

Appendix D shows the ENERCALC designs results of beam design, column design, and foundation design.

5 ENGINEERING COSTS

5.1 Cost of Implementation

The cost to make implement the design is presented below in Table 5. All materials used for the construction of the garage are listed. Quantities of each item were determined and used to calculate the final cost. Unit costs from each item were determined and applied to calculate a total final cost to implement the design.

Table 5: Cost of Implementation

Garage Construction Costs					
Quantity	Item Description	Unit	Material ($/Unit)	Labor ($/Unit	Subtotal
308	Hem Fir #2 Beams (Roof)	L.F.	0.9	0.83	$532.84
243	Hem Fir #2 Beams (Interior)	L.F.	1.97	1.11	$748.44
14.5	Glulam Ridge (5.5 x 12)	L.F.	38.67	4.52	$626.26
75	Fascia Board (1 x8)	L.F.	1.85	1.77	$271.50
124	Stud Walls (2 x 6 18")	L.F.	1.75	1.21	$367.04
326	Sheathing (Plywood)	Sq. Ft.	2.4	1.23	$1,183.38
326	Underlayment	Sq. Ft.	4.02	0.56	$1,493.08
300	Insulation	Sq. Ft.	1.2	0.89	$627.00
300	Drywall	Sq. Ft.	1.5	1.21	$813.00
35	Connections (Strong Ties)	Ea.	26	0	$910.00
5	Windows (6' Casement)	Ea.	459.43	37.54	$2,484.85
2	Doors	Ea.	158	39.62	$395.24
323	6" Slab	Sq. Ft.	1.56	0.54	$678.30
90	Excavating	C.Y	28.76	8.04	$3,312.00
275	Continuous Concrete Foundation	Sq. Ft.	3.59	3.02	$1,817.75
90	Backfill	C.Y	9.76	16.8	$2,390.40
				Total	**$18,651.08**

4.1 Cost of Engineering Services

Five engineering positions were necessary to complete the tasks of this project. Cost rates were assigned to each position. Hours were documented for the entire project, and presented in Appendix B. The actual cost of the project is compared to the estimated cost of the project.

6 PROJECT SCHEDULE AND STAFFING

6.1 Project Schedule

Appendix A shows the updated schedule of the project's tasks and dates that were done to complete the project. Appendix B shows the hours spent on the project by each position on the team. The hours predicted are directly compared to the hours spent. More hours were spent on the project in actuality than were originally estimated. Surveying and site plan development took longer than originally anticipated. The team also had trouble getting software licenses, which delayed structural design, thus increasing the cost of the project overall.

7 PROJECT SUMMARY

Based on the constraints and criteria, a design was selected that met all of the requirements. Every structural member in building was then designed to ensure that the garage would not only be durable, but that it would meet all Coconino County standards. The team produced a garage design that not only met the needs of the client, but that is safe and effective in its use of space.

8 REFERENCES

[1] "Munds Park, Arizona," 2017. [Online]. Available: http://www.city-data.com/city/Munds-Park-Arizona.html. [Accessed 07 02 2017].
[2] C. C. Arizona, "Coconino County Zoning Ordinance," 26 07 2016. [Online]. Available: http://coconino.az.gov/DocumentCenter/View/12230. [Accessed 27 01 2017].
[3] Z*ONING ORDINANCE*, 1st ed. Coconino County, 2016, pp. 5-8.
[4] "Horizontal and Vertical Control," [Online]. Available: http://www.gresurv.com/hvcontrol.html. [Accessed 20 February 2017].
[5] Mott MacDonald Consultants, "Design Basis for Civil, Structural & Architectural," Mumabi, 2009.
[6] "Minimum Design Loads for Buildings and Other Structures." *Minimum Design Loads for Buildings and Other Structures | Standards*, 2010, ascelibrary.org/doi/book/10.1061/9780784412916.
[7] (COR), International Code Council. *International Building Code, 2012*. International Code Council, 2011
[8] ASCE 7-10 "Minimum Design Loads for Buildings and Other Structures (7-10, Third Printing)." American Society of Civil Engineers (ASCE), 2010, www.asce.org/templates/publications-book-detail.aspx?id=6725.

9 APPENDICES

Appendix A: Updated Project Schedule

Appendix B: Cost of Engineering Services

Table 6: Staffing and Cost

Staffing and Cost						
	Project Manager	**Principal Engineer**	**Land Surveyor**	**Staff Engineer**	**Drafter**	**Subtask Total Labor**
Billing Rate ($/hr)	$125	$170	$60	$65	$70	
Task 1.0 Survey & Site Analysis	6	0	25	6	20	**$ 4,040.00**
Task 2.0 Conceptual Design	3	4	3	15	25	**$ 3,960.00**
Task 3.0 Structural Design & Analysis	24	120	0	265	0	**$ 40,625.00**
Task 4.0 Construction Documents And Drafting Services	9	2	0	10	105	**$ 9,465.00**
Task 5.0 Project Management	30	0	1	2	3	**$ 4,150.00**
Total Hours	**72**	**126**	**29**	**298**	**153**	**$ 62,240.00**

Table 7: Staffing and Cost Estimate

Staffing and Cost Estimate						
	Project Manager	**Principal Engineer**	**Land Surveyor**	**Staff Engineer**	**Drafter**	**Subtask Total Labor**
Billing Rate ($/hr)	$125	$170	$60	$65	$70	
Task 1.0 Survey & Site Analysis	9	0	25	2	15	**$ 3,805.00**
Task 2.0 Conceptual Design	3	4	0	15	15	**$ 3,080.00**
Task 3.0 Structural Design & Analysis	12	114	0	230	0	**$ 35,830.00**
Task 4.0 Construction Documents And Drafting Services	9	2	0	10	105	**$ 9,465.00**
Task 5.0 Project Management	30	0	1	2	6	**$ 4,360.00**
Total Hours	**63**	**120**	**26**	**259**	**141**	**$ 56,540.00**

Appendix C: Site Plan

Appendix D: Final Design Plan

Appendix F: Load Calculations and Justifications

Table 8: Roof Dead Loads

Roof Dead Load		
Sheathing	3 PSF	ASCE 7-10 Chapter C3 Table C3-1 specifies wood sheathing (per inch thickness) is approximately 3 psf
Underlayment	1.5 PSF	Bituminous, a water-resistant or waterproof barrier material, was the chosen underlayment for the roof. It is common in most residential homes. ASCE 7-10 Chapter C3 Table C3-1 specifies Bituminous (smooth surface) is approximately 1.5 psf
Shingles	3 PSF	ASCE 7-10 Chapter C3 Table C3-1 specifies wood shingles is approximately 3 psf
Insulation	1.1 PSF	Traditional fiberglass is most common in residential homes, is the most inexpensive, and provides the easiest installation. ASCE 7-10 Chapter C3 Table C3-1 specifies fibrous glass is approximately 1.1 psf
Joist Self-weight	6 PSF	Assuming 2x8 wooden joist, spaced 16" on-center. ASCE 7-10 Chapter C3 Table C3-1 recommends using 6 psf. (Not included in joist loading calculation for second and first floor).
Misc. Loading	2 PSF	This arbitrary value is used to accommodate future changes/additions to the roof
Mechanical Loading	2 PSF	This arbitrary value is used to accommodate future mechanical additions to the roof, that were excluded from this scope of work
Total Roof Dead Load	**18.6 PSF**	

Table 9: Snow Loading

Snow Load (Part I/Balance Snow Load)		
Equation/Value	Definition	Comments/Justification
$p_s = 0.7C_sC_eC_tI_sp_g$	p_s is the sloped roof (balanced) snow load, psf	Snow loads acting on a sloping surface shall be assumed to act on the horizontal projection of that surface. Equation from ASCE 7-10 Equation 7.4-1
$C_s = 0.9$	The roof slope factor	Determined using ASCE 7-10 Figure 7-2b (the roof slope is currently designed for 4":12" slope for a gable roof)
$C_e = 1.0$	Exposure factor	ASCE 7-10 Table 7-2, the chosen Terrain Level was B, with a Partial Exposure of the roof (due to the obstruction of the existing house).
$C_t = 1.1$	Thermal Factor	Thermal Condition: Structures kept just above freezing and others with cold, ventilated roofs. The roof doesn't not meet other thermal conditions. ASCE 7-10 Table 7-3
$I_s = 1.0$	Importance Factor	Importance factor is based on ASCE 7-10 Table 1.5-2, with the Risk Catergory II (this is a residential, low occupancy structure)
$p_g = 60\ psf$	Ground Snow Load	The Coconino County Building Ordinance specifies a 60 psf ground snow load for the area of Munds, to be used to calculate the live snow load (no less than 40 psf for calculated live load)
Balanced Snow Load	**54.9 psf**	This balanced snow load will only apply to the roof over the second floor. There is a flat roof over the first floor that the second floor does not cover (see Final Concept Design). The loading on the flat roof will be ${p_s}/{C_s} = 66\ psf$

Table 10: Snow Load Part 2

Snow Load (Part II/ Snow Drift) Figure 7-8 from ASCE 7-10 added below for reference		
Equation/Value	Definition	Commetns/Justification
$p_d = h_d\gamma$	The maximum intensity of the drift surcharge load, p_d	ASCE 7-10 Section 7.6.2
$\gamma = 21.8\, pcf$	$\gamma = 0.13p_g + 14$ Where p_g = 60 psf	Snow density, in lb/ft^3. Determined using ASCE 7-10 Equation 7.7-1
$h_d = 1.87$ft	Drift Height	ASCE 7-10 Table 7-9. The drift height produced in the leeward and wind ward direction were calculated. The drift height in the leeward direction was greater than the windward direction, therefore controls in the snow drift calculations.
$w = 7.48ft$	Drift width	The drift height is smaller than the height of the second story, h_c. According to ASCE 7-10 Section 7.7.1, the drift width will be $4h_d$.
$p_g = 60\, psf$	Ground Snow Load	The Coconino County Building Ordinance specifies a 60 psf ground snow load for the area of Munds, to be used to calculate the live snow load (no less than 40 psf for calculated live load)
Snow Drift Load	**40.77 psf**	The snow drift will only apply to the lower lever flat roof over the first floor

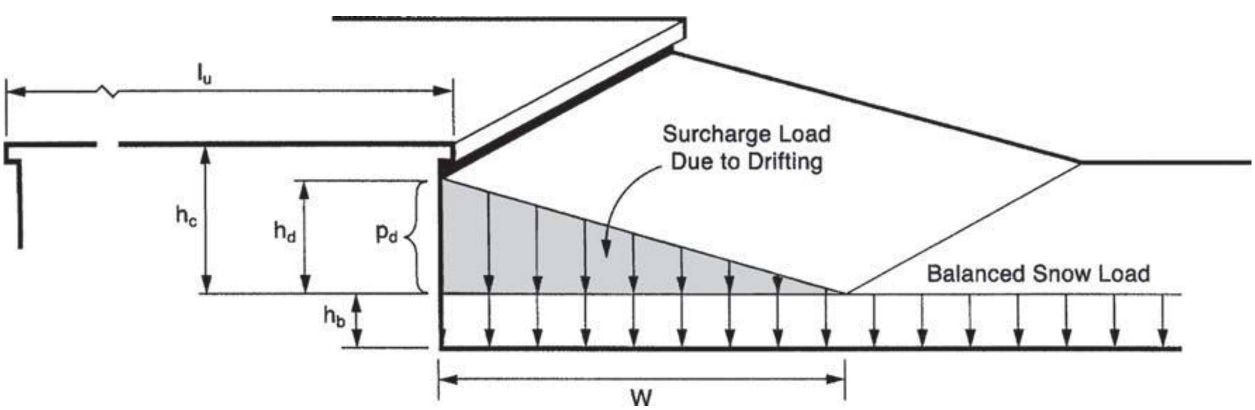

Figure 5: Snow Drift Graphic

Table 11: Design Wind Pressures on Components and Cladding

Design Wind Pressures on the Components and Claddings		
Equation/Value	Definition	Comments/Justification
$p = q_h[(GC_p) - (GC_{pi})]$		Equation from ASCE 7-10 Equation 30.4-1
$q_h = 0.0025K_zK_{zt}K_dV^2$	Velocity pressure at height of building	Determined using ASCE 7-10 Equation 30.3-1 for a low rise building (h<60').
$K_z = 0.7$	Velocity pressure exposure efficient	Defined in ASCE 7-10 Section 30.3.1, listed under Category B Exposure for 20ft building
$K_{zt} = 1.0$	Topographic Factor	ASCE 7-10 Section 26.8
$K_d = 0.85$	Wind Directional Factor	Defined by ASCE 7-10 section 26.6
$V = 115\ mph$	Basic Wind Speed	Defined by ASCE 7-10 section 26.5
GC_p= -1 and 0.3	External Pressure coefficients	Defined by ASCE 7-10 Figure 30.4-2B, for Gable/Hip Roofs. The values will produce values for the uplift and downward pressure on the roof
$GC_{pi} = \pm 0.18$	Internal Pressure coefficient	Defined by ASCE 7-10 Table 26.11-1
$p_{uplift} = -23.77\ psf$	Upward Wind Pressure	
$p_{down} = 9.70\ psf$	Downward Wind Pressure	

Table 12: Loads on Interior Beams

Loads on Interior Beams (Second and First Floor)		
Equation/Value	Definition	Comments/Justification
Floor Live Load	40 psf	
Ceiling	8 psf	Defined by ASCE 7-10 Chapter C3 Table C3-1. Plaster on wood lath was selected due to its accessibility.
Beams Self-weight	3.5 psf	Assuming 2x12 wooden joist, spaced 16" on-center. ASCE 7-10 Chapter C3 Table C3-1 recommends using 6 psf. (Not included in joist loading calculation for second and first floor).
Flooring	1.5 psf	Defined by ASCE 7-10 Chapter C3 Table C3-1. Linoleum was selected as floor material
Mechanical Duct Allowance	Ground Snow Load	The Coconino County Building Ordinance specifies a 60 psf ground snow load for the area of Munds, to be used to calculate the live snow load (no less than 40 psf for calculated live load)
Snow Drift Load	**40.77 psf**	The snow drift will only apply to the lower lever flat roof over the first floor

Appendix E: ENERCALC Calculation Report

Appendix F: Structural Plan Set