

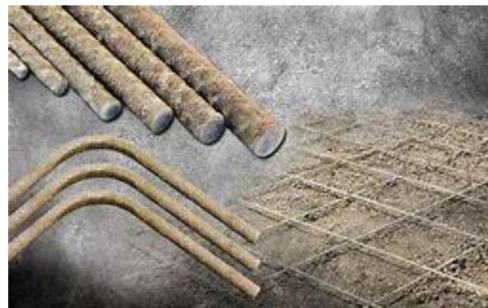
Workforce Housing Panelization and Materials

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Material Choices

Construction Cost Summary				
Project Name: Weed Affordable Housing		Project Owner: Great Northern Services		
Project Location: 870 S. Davis Ave 870 S. Davis Ave, Weed, CA		310 Boles St. Weed, CA		
Level 1 Major Group Elements	Level 2 Group Elements	Level 3 Individual Elements	Totals	
A. Substructure	A10 Foundations	Standard Foundations Special Foundations Slab on Grade	\$ 9,859 \$ 6,179 \$ 1,886	
B. Shell	B10 Superstructure	Floor Construction Roof Construction	\$ 6,687 \$ 22,025	
	B20 Exterior Encloure	Exterior Walls Exterior Windows Exterior Doors	\$ 30,592 \$ 4,714 \$ 5,543	
		B30 Roofing	Roof Coverings Roof Openings	\$ 12,487 \$ -
C. Interiors	C10 Interior Construction	Partitions Interior Doors Fittings	\$ 3,681 \$ 3,550 \$ -	
	C30 Interior Finishes	Wall Finishes Floor Finishes Ceiling Finishes	\$ 14,491 \$ 4,635 \$ 2,664	
D. Services	D10 Plumbing	Plumbing Fixtures Domestic Water Dist. Sanitary Waste Rain Water Drainage Other Plumbing Systems	\$ 6,635 \$ - \$ 191 \$ - \$ 2,934	
		D30 HVAC	Energy Supply Heat Generating Systems Cooling Generating Systems Distribution Systems	\$ - \$ 1,295 \$ - \$ -
			Controls & Instrumentations	\$ 269
			D40 Fire Protection	Sprinklers
		D50 Electrical	Electrical Service & Distributio Lighting and Branch Wire Communications & Security	\$ 1,625 \$ 3,163 \$ -
	Small Tools and Hardware Markup	3%		\$ 4,516
	General Conditions	2%		\$ 3,011
	SUBTOTAL			\$ 158,052
	Contractor O/H & Profit	10%		\$ 17,561
	GRAND TOTAL			\$ 175,613
Cost per Square Foot			\$ 103.30	

Final Costs				
	Target	Optimistic	Pessimistic	
CONSTRUCTION TOTAL	\$ 150,526	\$ 135,473	\$ 165,578	
	\$ 4,516	\$ 4,064	\$ 4,967	
	\$ 3,011	\$ 2,709	\$ 3,312	
SUBTOTAL	\$ 158,052	\$ 142,247	\$ 173,857	
	\$ 17,561	\$ 15,805	\$ 19,317	
GRAND TOTAL	\$ 175,613	\$ 158,052	\$ 193,174	
Cost per Square Foot (1673)	\$ 104.97	\$ 94.47	\$ 115.47	



Material choice and pricing for the homes was one of the most important parts of the design. The homes needed to be affordable, resilient, aesthetically pleasing, structurally sound, and weather resistant. Different skill sets worked together through the process of Integrated Project Delivery. The knowledge from Architects for aesthetics, Architectural Engineers for Structure, Weather, and resiliency, and knowledge of Affordability from the Construction Management side. The main goal was affordability. GNS had hoped for the homes to

positively impact low income families and provide them with a high quality of living. The price cap was one hundred and forty thousand dollars. This was very difficult to meet for even a normal home, let alone a home designed with these goals. What the teams would come to find is that in their brilliant ideas to innovate were constantly needing to be rejected despite the benefit, something common in non-profit work. The price range was a constant burden but forced the teams to explore options which can be cheaper, yet just as durable. Examples were using TUF-BAR, a

Introduction

Cal Poly students had the opportunity to work in a collaborative design cohort in the fall quarter of 2017. The purpose of the cohort was to aid a company called Greater Northern Services (GNS) in developing workforce housing for the city they operate in, Weed California. In order to effectively develop the plot of land they had acquired, GNS would have to be extremely cost-effective in their design and construction methodology.

One aspect of the project that was intended to help drive the cost of the house down was to panelize the exterior wall system of the house. Those panels would then be built by Cal Poly students with lumber donated from a national lumber manufacturer with a local plant. The purpose of this study is to analyze the design choices of those panels and how they effected the design and price of the house overall.

Panelization

The plan was for the students of the IPD class to design the panels and then for a different class to build the panels. This meant that the panels had to be light and small enough for students to handle them without damaging themselves or the panels. In addition, the panels would be shipped from Cal Poly to Weed, so they had to fit inside of a shipping container with dimensions only slightly larger than eight feet.

The panels were designed concurrent with the design of the building using Autocad to create 3D models of the panels and shop drawings. Many of the panels in the areas without the pitched roof ended up being eight foot high and very long. In the places where the roof was pitched, the panels are eight foot or less in width with heights up to around eighteen feet. The tops of these panels would be slanted to follow the 3:12 roof line.

Another aspect of the project that was intended to provide a cost save was the choice of materials used. With a very small budget allowed for the project, it was crucial to use the best materials possible to provide an aesthetically pleasing, weather resistant, resilient, and most important an affordable building. Very extensive research brought many ideas of innovative materials to use in these homes.

The panels were built using conventional framing methods. They have 2x6 studs and 16" O.C. spacing along with one bottom and top plate. A second top plate is to be installed in the field that overlaps the panels to help tie them together. Even though 16" spacing was maintained, we found that due to many of the panels being eight feet wide the final bay would only be 14.5". This was simply an oversight that led to dimensions on shop drawings that could be confusing.

Material Choices

fiberglass rebar which is more durable and cheaper than normal rebar. Barn-board was used for exterior sheathing which is more aesthetically pleasing and cheaper than normal siding. These are a few examples of how the integrated discussion of material choice was beneficial, but the price allowed impacted the home in exponentially negative ways compared to positively. Another important factor was the effort to design a resilient building. There were many new ideas brought forth. One common idea

was fireproofing the walls. Adding fireproofing to homes allowed more durability also increasing the R-value. The last important factor designing the home with effective MEP equipment. With a low price there was not many options. Pellet furnaces were used as cheaper and smaller heating systems. The homes were also designed to allow natural light to cut down the usage of electrical systems. The homes had one plumbing wall close to the intake systems to reduce the amount of plumbing fixtures needed.

Panelization

