Trellis Co.

INNOVATIVE CONSTRUCTION TECHNIQUES POST CONSTRUCTION

Hillside Heights
Elk River, Minnesota
January 22, 2024

Introduction

Trellis Co. has developed a new three-story elevator affordable apartment building at 117451 Twin Lake Road Northwest, Elk River, MN 55330, close to the NorthStar Rail Station.

The development consists of 52 units comprised of 10 one-bedrooms, 25 two- bedrooms, 11 three-bedrooms, 6 four-bedrooms and 52 underground and 48 surface parking spaces. Common amenities include storage, a roof deck off the third-floor amenity room, fitness room, community room, patio area, playground, and community garden.

Hillside Heights is a general occupancy affordable workforce rental apartment project primarily for families. The development has secured eleven units of site-based housing support to effectively serve four persons with disabilities (PWD) and seven high priority homeless (HPH) households.

This project was selected as meeting the preference criteria for the Innovative Construction Techniques for the 2021 Multifamily Consolidated Request for Proposals. As a part of the selection the team is required to write this post construction report.

I. Innovative Construction Techniques (ICT) Utilized at Hillside Heights

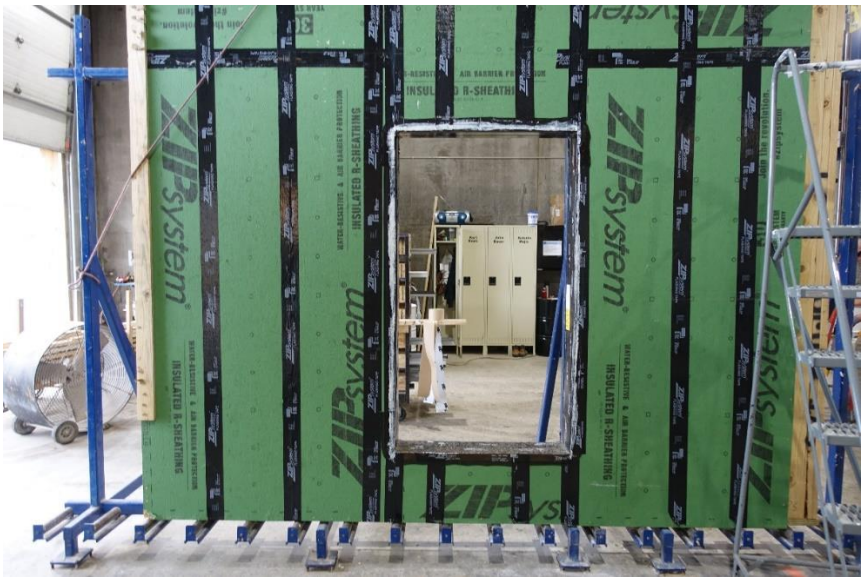
a. Closed wall panels manufactured off site with the exterior insulation, weather barrier, windows, and interior spray foam insulation applied at the factory.
b. Floor and roof sections assembled off site.
c. Bulk procurement of lumber, windows, insulation, and weather barrier.
d. Quality and construction scheduling assigned to dedicated off site staff for critical components.
e. On site building "zoning"

II. Lessons Learned

a. What worked well

i. Closed Wall Panels

The project used pre-manufactured closed wall panels for the first time, which were produced by the general contractor, Frana Companies. Frana began manufacturing open wall panels in 2000. It improved its process in 2010 and 2012 when it added insulated zip sheathing and weather barriers as it adjusted to the new energy codes. In 2015, it began manufacturing and setting floor and roof truss sections instead of individually installing them on-site. In this project, Frana also installed spray foam insulation and windows in its wall frames. Hillside Heights utilized wall frames with Zip sheathing, spray foam, and installed windows.



Wall panel at the factory ready for a window to be installed.

Wall panel at the factory with window installed. Note gray shipping frame.

ii. Spray foam

Spray foam is not widely utilized in this market but remains one of the most cost- effective ways to improve building performance in Minnesota's climate. Spray foam is applied to the wall panels in the factory allowing for a climate and air-controlled environment. 2 ½" of spray foam equates to an R value of 17.50 and acts as a vapor retarder.

Spray foam application at the factory

The primary barrier to adding spray foam in the factory is the potential environmental hazar to factory workers. To address this, Frana created a new factory space and process with air flow and safety protection devices for its workers to ensure a safe working environment.

iii. Windows

Installing the windows in a climate-controlled environment ensures proper adherence of all adhesive components and allows for better quality control of the installation.

Installation of the top cap flashing on the window in the factory.

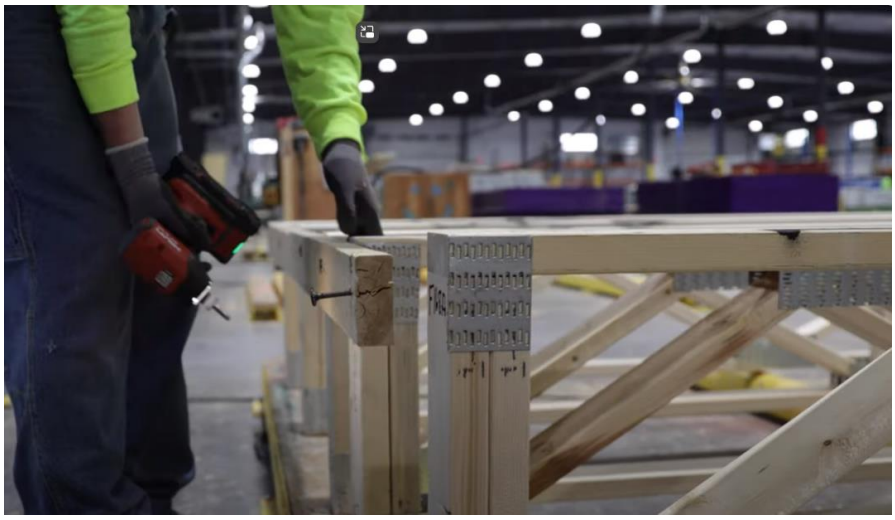
iv. Weather barrier

Utilizing Zip sheathing, installed in the factory ensures a quality job. The Zip sheathing installed on the Hill Side Height project are manufactured with 1" of rigid insulation (out insulation) glued to a ½" OSB board. The weather barrier is then glued to the exterior of the board during the wall panel assembly process all the seams and nail heads are tapped to ensure a air and water tight assembly.

Wall panel with sheathing attached and joints and nail heads tapped.

v. Floor panels

Manufacturing the floor sections in a factory again ensures quality and an environment allowing the glues, used to set. It has the further safety advantage of working on the ground, not on dangerous ladders or scaffolding.



Assembly of a floor section.

vi. Factory controlled environment

Sheathing and weather barrier configurations have been adapted to the factory wall panel layout configuration to ensure the assembly comes off the line fully weather tight and structurally sound. Each panel is produced and numbered in a sequence determined by the field which ensures a systemized and efficient site installation.

Factory manufacture of closed wall panels resolve critical on- site labor and weather bottlenecks by allowing field and factory crews to work simultaneously in all seasons.

Having the procurement and scheduling of the critical wall panel components (weather barrier, insulation, and windows) assigned to a dedicated factory staff ensures better quality control and eliminates on site delivery of these critical components by various material and subcontractors. The quality improvement and time savings of this approach cannot be underestimated.

Factory assembly line for wall panels.

b. What Did Not Work Well

i. Panel joints

Due to manufacturing and transportation constraints, wall panels are typically built no longer than 12 feet. This of course requires the panels to be joined at the job site. These joints need careful attention both for proper attachment to each other but also tape-ing the joints on the exterior and caulking on the interior to stop air and

moisture movement through the joint.

Typical panel to panel joint looking from the interior.

ii. Fire rating at one-hour walls

There is no UL listing for a one-hour fire assembly for a wall panel with spray foam insulation. This can prevent the use of this type of panel when the exterior wall is required to meet a one-hour fire rating. This requires on-site installation of batt insulation and a vapor retarder, both more time consuming to the project schedule.

One-hour exterior wall at Hillside Heights

III. Challenges and Barriers and How They Were Overcome

a. Transportation of panels

One of the critical issues is the window glass breaking in transit, so Frana entered into a partnership with a custom trailer manufacturer to use its products and engineering to modify a trailer so the closed wall panels, with windows

installed, could be shipped in vertical frames for a safe and secure transit to the project site. The wall panels are loaded in special frames that attach to the trailers and are craned from the trailer onto the building. This was a major innovation. No other wall panel plant in Minnesota preinstalls windows and one of the main reasons is the difficulty with transportation.

Wall panels in transport frames on the second deck at Hillside

IV. How Future Projects can Effectively Implement and Use the Techniques, Promising Practices, and Lessons Learned

a. Installing siding on panels

Frana Companies is exploring the installation of siding materials on the wall panels in the factory. This again would save on-site project time and result in a more quality-controlled installation. It has the joint treatment issue, which becomes a technical challenge and mostly aesthetic problem.

b. Installing joint gaskets on the wall panels

Frana Companies is exploring the use of a joint gasket to better seal the panels when jobsite connected. This would reduce the job site time and cost of caulking the interior seam of the panels and would increase the air and water tightness of the joint. This would be particularly important if the siding was preinstalled.

Panel wall joint at end of last wall panel installed at 1st floor

V. Cost Reductions

a. Bulk buying power for materials

Lumber prices have increased 100% since April 2020. Purchasing products by volume is even more important now than ever before. In addition to the cost reduction, bulk purchasing ensures firm pricing if closing is delayed, which is valuable in rising markets, without the owner prepaying for these materials which further saves interest cost. Supply chain delays have also been a large impediment to job schedules recently and with bulk proposing, the material is not delivered by job and is not dependent on closing or pay applications. The bulk purchasing applies to all the wall components, including the windows. This can be both a cost and time saving measure. No other general contractor has the panel facilities or the ability to provide this service.

Material yard

b. Window preinstallation

On-site window installations cost on average $195 per window. Using their new automated manufacturing process, Frana realizes a 35% - 40% reduction in the cost for the actual window installation process. Most onsite windows are installed from a lift, the factory installation has the installation completed on the ground with the cost of the lift and extra time of raising and lower, all saved.

Wall panels installed with windows preinstalled. Note the masonry work has started at fall end.

c. Reduction of winter conditions

A critical path for all multifamily projects is the time from the start of framing to the building being dried in. No electrical wire rough-ins can start until the building is dried in. It also marks the time that temporary heat can be introduced into the building. During the winter months the sooner heat can be introduced, the sooner onsite productivity increases. At Hillside Heights the masonry exterior could not start until the weather barrier, windows, and all exterior mechanical penetrations were completed. The preinstallation of these components allowed all the masonry work to be completed before heat and cover was required. Heat and cover is the most expensive of all winter conditions.

VI. Time Reductions

a. Drying in time significantly decreased / building zoning

Reducing the time from framing start to dried in, reduces the time a project is under construction by at least 20%: The on-site construction sequence changes because there is no lost time in the spray foam process and no possibility of weather delays. Spray foaming on-site halts all other work during installation because of the ventilation requirements for the materials and worker safety. By manufacturing closed panels, interior trades can continue while exterior work is being completed. This time savings is especially powerful in the winter because of weather delays due to inclement weather and the sensitivity of spray foam to temperatures and humidity.

Wall panels stored vertically in racks; floor sections stacked awaiting installation.

b. Building zoning

The section pictured above is zone 1 of 2 building zones, the building being divided into two areas, one framed to the roof before the other is started, essentially building two connected buildings. The first section of Hillside Heights was built from the start of framing until dried in, in 60 days, with a typical job site construction process this time would be 90 days. Dividing the building into 2 zones and using complete wall panels, this section can begin rough in and then sheet rocking while zone 2 is being framed.

VII. Total Cost and Schedule Documentation

a. Cost

The following charts show the cost reductions that can be attributed to the use of the wall panels at Hillside Heights.

Work Item	Estimated	Actual	Difference	
Rough Carpentry	2,245,762	2,165,903	(79,859)	
Doors windows glass	322,320	378,712	56,392	Attributable to store front
Sealants Insulation	283,096	250,513	(32,583)	
Totals			(56,047)	
Percentage gained from estimated to actual			2.01%	

Comparison of site installed versus factory installed

Frana - rough, glass, insulation (adjust to remove store front)	2,695,128
Frerichs - rough, glass, insulation	3,365,619
Savings attributed to ICT	670,491
Percent savings	20%

Overall project costs

	Estimated	Actual	Difference
Frana	13,306,000	13,878,838	572,838

Frerichs	14,790,978	
Percent savings Frana actual to Frerich estimated		6.17%

Comparing the actual to an estimate is not apples-to-apples as the owner added scope to the project as do all tax credit funded projects. But, the cost savings due to ICTs of 20% is without dispute, and 6.17% savings should not be dismissed.

The amount saved by factory installation of the weather barrier, windows and spray foam is 74% of the total savings achieved in the total project cost differences. The rest of the saving can be attributed to the administrative savings of using a zoned building approach and the use of a dedicated off-site staff managing the panel and its components.

b. Time

Actual dates at Hillside Heights
Footing Start: March 9th
Framing Zone 1: May 22nd - July 7th
Framing Zone 2: June 19th- July 28th
Roofing Zone 1 complete July 21st
Roofing Zone 2 complete August 25th
Footing start to dried in 100% was 96 days or about 3 months
Zone 1 completed 35 days before Zone 2, allowing for this time to be spent on finish work
Project turn over: January 16, 2024
Footing start to turn over 252 days or 8.4 months

Work Item	Estimated	Actual	Difference
Zone 1	50 days	46 days	(4)
Zone 2	45 days	42 days	(3)
Percentage gained from estimated to actual			8%

Comparison of site installed versus factory installed

Frana – panel install	67 days
Frerichs - rough, framing, weather barrier, windows	100 days
Savings attributed to ICT	33 days
Percent savings	33%

Overall project time

Frana - actual	334 days	
Frerichs - estimated	569 days	
Percent savings Frana actual to Frerich estimated		41%

The original starting date for Frana schedule was June 3, 2022, and the actual start date was February 2, 2023. Despite starting during winter, Frana held the schedule along with the overall project costs dropping 2%. This can be contributed to the use of ICTs.

Conclusions

Wood framed buildings remain the most cost effective, common multifamily building type in Minnesota. Exploring and using innovative techniques such as those used at Hillside Heights shows great promise for further increasing

the use of wood framed construction, while reducing the cost and time of construction.
Energy efficiency has become more important as climate change accelerates. Wood framed construction with continuous insulation on the exterior and spray foam on the interior shows great promise for energy reductions. The use of these techniques at Hillside Heights was made possible because of the cost and time reductions of incorporating these techniques in the prefabricated closed wall panels. Construction has not embraced new technological advances as much as other manufacturing processes and the use of factory assembled parts with the inherent quality and time saving produced with the use of automated assembly lines is a great step forward for the industry. With any automated process and supply chain advances, the dedicated office staff that is assembled for factory production should not be overlooked as an innovative technique. Construction administration is key to cost and time reductions. Both the panel plant staff and the use of on-site building zoning made cost and time reductions possible and these administrative effects in construction are underestimated. Hillside Heights shows a promising path forward for the housing industry.