
Floor Panelized Systems

Introduction

In construction, an easier and faster way of completing a job is always top priority. Using wood as a construction material allows for an easily obtainable and replenished building material. It is also a very versatile material; a dimensional piece of lumber could be used in various applications. For example, a 2x4 can be used as part of a post, girder, or joist. This same 2x4 can also be cut as needed on site as the use of the board is determined. However, having many of the same pieces that are used for various applications can become tedious.

Precast concrete has been used successfully for some time now. The benefit of this is that the structural element is cast and cured off site in a controlled environment. When the project is ready for the piece it is shipped to site and installed. This eliminates the on site construction of the structural element which ultimately saves time. This same idea can be used in timber construction as well. Panelized wall systems are already being used but panelized floor systems are a new innovation. This floor system is constructed the same way as it would be on site but in a controlled environment. Both on site assembled and panelized floor systems are effective. This is a study of the implication of using a panelized floor system on The Cascades project in Cumberland, MD.

Structure Construction in The Cascades

Process description

A traditional timber framed building is built one piece of wood at a time. Each board, plank, and board are used as posts, girders, joists, and sheathing. These posts, girders, joists, and sheathing are assembled into various combinations to the structure. The material is stock piled on site and the pieces are pulled from the pile when they needed for construction.

Cost, Time, and Labor

Table 9 shows the cost per square foot for the material needed and the cost per hour for the labor to install the system. It also shows the square footage that can be installed in an hour with a crew of sixteen. The numbers used to find this information is based on The Cascades project.

Table 9

Cost		
Material	\$3.03	cost/SF
Labor	\$47.00	cost/hour
Time		
Installation	300	SF/hour

Advantages

With on site construction of the flooring system, the process becomes more flexible. The materials needed, can be stored on site as long until they are ready to use with minimal demand on site space as they are sufficiently protected from the weather. In addition, the flooring system is built when the project is ready for it, so if there are any major changes to the floor plan design they can easily be adapted during construction. The only consequence to a major change would be an increase or decrease in the material needed, which would not be a major problem if the materials are ordered as they are needed.

Another advantage to a stick build systems would be the familiarity to the system. This is the same type of construction that was used when timber first began to be used as a building material. The process has been refined over the years and is very customary to installers.

Disadvantages

The entire construction of the flooring system is constructed on site. This on site construction takes a long time. All other construction activities depend on the structure to finish before they can start. In addition, the material needed must be delivered to site prior to installation. This material must be stored on site, which, if the site is tight for space, takes up a lot of valuable space.

Panelized Floor System

Description

Panelized floor systems take the assembly of the floor system off the construction site and bring it into a controlled environment of a manufacturing plant. It is the same idea as precast concrete but using a different building material. The floor panel is constructed from specific dimensions, shipped to site, and installed. It is structurally identical to a floor system built of site with individually delivered materials but the process creates possibilities that are not feasible with on site construction.

Process description

The first and most important step is to collaborate. The design team, manufacturing team, builder, and owner work closely together to achieve the desired product most effectively. The structural system is then completely designed, the entire framing design, including layout and engineering of roof, walls, and the floor systems, must be completed in order to begin creating the floor panel sections. The design is then sent to the manufacturing plant to be cut and prepared to delivery. Finally, it is delivered to site and installed.

Software and Manufacturing Plant

In order for the manufacturing plant to be able to use the design plan, the design must be completed using a program called TJ-XPRT. This is a proprietary design program developed by Trus Joist, a Weyerhaeuser Business. The design files created in TJ-XPRT are then sent to PANEL-MATE. The program PANEL-MATE takes the designed floor plan and creates the panel sections dimensions and shapes. Finally, the panel sections created in PANEL-MATE are sent to OPT-FAB. OPT-FAB is used in the manufacturing plant, it allows the saw to cut the panel sections to the size and dimensions desired. The program is accurate up to a 1/16" and uses the dimensions from PANEL-MATE to cut the panel to the specific unique size. The panels are now ready to be stacked on the delivery truck and shipped to site.

Delivery

The program PANEL-MATE also creates a stacking plan for the delivery truck from the layout, which takes into consideration the order in which each piece will be installed. The panels are stacked in a very particular order on the truck so that the panels can be picked directly off the truck and installed when they are delivered to site. See *Appendix VII* for a detailed drawing on the stacking and shipping details and *Figure 6* for a photo of the delivery truck ready for delivery.

Installation

The installation of the panels is the fastest part of the process. Each piece is clearly marked for the location in the building. The builder follows a script for the location and the pieces are craned into place. The panels should fit together easily and all that is needed is for the panel to be connected. See *Figure 8* and *Figure 9* for photos of the panels being installed.

There are five typical connections that are used: panel to wall connection, panel-to-panel connection, panel to beam connection, panel to interior bearing wall, and strap to panel. See *Appendix VIII* for a detailed connection plan. The panel to wall connection uses toenails of 12d at 16" on center. The panel-to-panel connection requires the panels edge has to be cut in a tough and groove method, called a flying edge to split edge. The connection then requires glue and edge nails of 10d at 6" on center. In the panel to beam connection, the beam can be installed prior to or during the installation of the panels. The panel to interior bearing wall requires blocking to be fastened to the bearing wall with 12d nails staggered at 12" on center. Lastly, for the straps to panel connection, the straps must be installed prior to the installation of the panel.

Cost, Time, and Labor

One of the biggest appeals of these panelized floor systems is the reduced time that is required compared to the conventional stick-built system. The panelized floor system can reduce the time by almost five times. With efficient layout, delivery, and a crew of five, up to 3400 square feet can be installed in four hours. With a typical panel 304 square feet, approximately 2.8 panels can be installed per hour and 22 panels can be installed in a day.

Table 10 shows the cost per square foot for the material needed and the cost per hour for the labor to install the system. It also shows the square footage that can be installed in an hour

with a crew of five. The numbers used to find this information is based on projects where the Trus Joist panelized floor system was used.

Table 10

Installation Rate	
850	SF/hour
2.8	panels/hour
22	panels/day

Equipment needed

The most important piece of equipment needed to install the floor panels is a crane. The crane used to lift the roof trusses is sufficient. The crane should be able to lift a maximum load of 40 tons. However, the most important aspect of the crane should be the reach. A crane with a reach of 75 feet would be ideal. See *Figure 7* for a photo of the crane placing a panel.

Site storage/staging

The most desired situation is that the panels are delivered on the day they are needed and the crane picks them directly off the truck, eliminating the need for a site storage or staging area. If the panels must be delivered prior to installation, a large area is needed. A typical panel can range from 8'x32' to 8'x44' and needs a large enough area that they can be layout in order for them to be installed with easy.

Sequencing/Impact on other trades

The floor panel system is one of the first components to be completed in the building. After the foundation is poured, the first floor panels are installed, then the wall panels followed by the second floor panels. This process continues through the roof truss. The building is then closed in more quickly than with a conventional stick-built system and the interior trades can begin working. The floor panels are conveniently precut, according to the design, for the mechanical, electrical, and plumbing work.



Figure 6: Delivery truck stacked with panels at the manufacturing plant ready to delivery.



Figure 7: Panel being picked with a crane.



Figure 8: A first floor panels being swung into place.



Figure 9: A first floor panel being installed.

Advantages

The three major advantages of a panelized floor system over a stick-built system are decreased time, increased quality, and a safer installation process. These three advantages are a result of the pre-fabrication of the floor panels. The panels are built in a controlled environment, this controlled environment allow for more control over the process.

Decreasing schedule time helps to move the project along more quickly. Constructing the floor panels indoors eliminates the risks of encountering inclement weather; the panels can be built regardless of the weather. In addition, the use of the manufacturing plant increases the

productive of the construction of the panels. As the process becomes more familiar, the process becomes easier and is completed more quickly. Along with decreased time, the quality also increases with more familiarity. The panels are built in a controlled environment, which allows the fabrications to be more controlled than on site construction. Lastly, the manufacturing plant brings the construction inside and controls it, which helps to decrease on site accidents.

Disadvantages

The two major disadvantages to a panelized floor system are the decreased flexibility to make changes and the space needed if on site storage is required. Since the panels are cut to such precision in the plant, if a panel shows up to site and is drastically miss-sized, the only way to rectify the situation is to order a replacement panel. Ordering a new panel will completely halt all construction until the new panel arrives. This new panel could take up to a week to arrive to site. However, small alteration can be done to the panels on site if needed. If a panel does not fit perfectly it is completely safe to make small cut to the panel so that it fits. The other major disadvantage of the panelized floor system is that it takes up large amount of space if the panel needs to be stored on site. Ideally, the panels would be scheduled to be delivered the day they are needed, however that is not always possible. The panels take up four times more space than the material needed to construct the panels. These two major disadvantages, however, can be avoided if the process is well planned.

Implication on The Cascades***Schedule impact***

One of the leading reasons to use a panelized floor system would be to reduce schedule time. The Cascades is a four-story building with the first floor as slab on grade, leaving three floors that would be panelized floors. Using the square footage of each floor and the square footage rate of installation for the panelized floor system, the total time of installation would be 8.5 days. Using the rate of number of panels per day the installation time would 10 days. Moreover, using the rate of number of panels per days the installation time would be 10.2 days.

Table 11

Installation Rate		Units per Floor		Installation Time per Floor		Number of Floors	Total Time of Installation	
850	SF/hour	19205	SF	22.6	hours	3	8.5	days
2.8	panels/hour	75	panels	26.8	hours	3	10.0	days
22	panels/day	75	panels	3.4	days	3	10.2	days

Finding the installation times this way is accurate, except it does not take into consideration the layout of the building. For instant, if a floor is finished with half a day left it is not possible to start the next floor that day, because obviously the walls need to be constructed before the next floor is started. Therefore, the most accurate calculation to find the number of days for installation to use the layout of the building to find the layout of the panels to determine the number of days it will take. *Figure 10* is the plan of The Cascades showing a break down of the floor panels. Each color represents the amount that can be completed in one day. The blue, red, and green areas are all a full day of work; the yellow area is a half day of work. As each area is completed, work can begin on framing the walls, which on The Cascades are also panelized. According to the layout, it will take four days to complete the flooring system on one floor. Therefore, it will take a total of 12 days to complete the flooring system for The Cascades using a panelized floor system, compared the original stick-built system, which took 32 days. This is a reduction in the schedule by 62.5%, seen in *Table 12*.

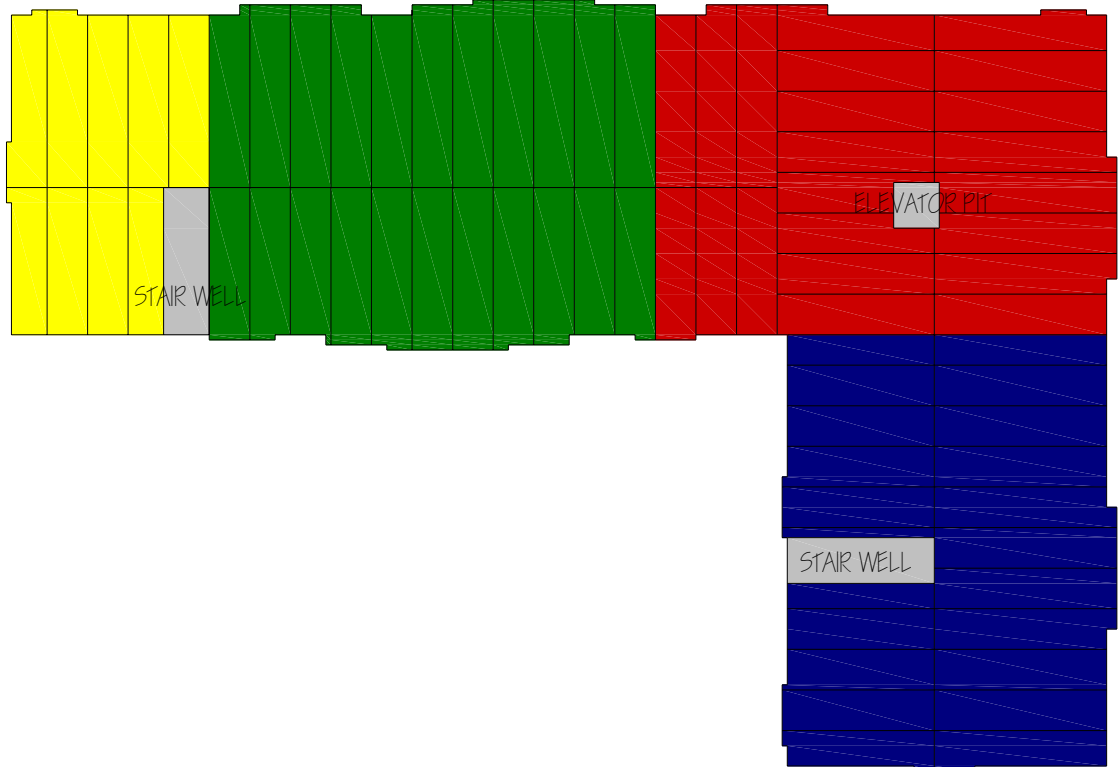


Table 12

The Cascades Schedule Time Comparison	
Original System	Panelized System
32 Days	12 Days
6.4 Weeks	2.4 Weeks
Total reduction of 62.5%	

Figure 10

Recommendation

Using a panelized floor system is an excellent means of reducing schedule time. In The Cascades, it reduced the schedule by four weeks. A reduction of this amount of time could help to enclose a building sooner when building during colder months. In addition, the panelized floor system can be used when other aspects of the project are time consuming to be able to apply the saved time to the more time consuming areas. Lastly, it can lead to an early turnover, saving a month's worth of rents, salaries, and time spent on the project. Using a panelized floor system is recommended when time is of an essence on the project.