LABOR SHORTAGE SOLUTION

SPECIFYING A FACTORY-MADE ROOFING MEMBRANE

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Course Outline

Section 1 — Decline of Skilled Building Labor in the U.S.

Section 2 — History of Factory-Made Building Components

Section 3 — Consequences of Roofing Failures

Section 4 — Benefits of Factory Controls

Section 5 — How Roofing Membranes are Fabricated

Section 6 — How Roofing Membranes are Installed

Section 7 — Case Studies

Learning Objectives

At the conclusion of this course, you should be able to:

- Discuss the decline of skilled building labor in the United States and its effect on building quality and durability.
- Explain the history and benefits of a controlled factory setting for building components that decrease faulty onsite installation.
- Discuss studies of roof failures that show that most moisture intrusion and uplift problems occur because of installation errors.
- Describe how single-ply membrane roofing assemblies work for quality control and increased durability.
- List case studies where prefabricated membrane roofing saved labor time onsite, decreased disruptions to building occupants, and increased durability of the roof and health and comfort for the occupants.

DECLINE OF SKILLED BUILDING LABOR IN THE U.S.

SECTION 1

Perfect World vs. Real World

- **Perfect world** — The architect designs a building and the contractor builds it, accurately and on time, with all the skilled labor necessary.
- **Real world** — The supply of skilled construction labor ebbs and flows.

Today the skilled labor supply has ebbed.

The scarcity of skilled labor drives up costs and drives down quality as crews rush from project to project in a quickening market.

Construction Labor Shortage in Headlines

“Where Have All the Construction Workers Gone?”
— The Atlantic

“Contractors Turning Down Work Due to Labor Shortages.”
— Engineering News Record

“As Construction Begins Rebound, Looming Labor Shortages Raise Concerns.”
— Forbes. com

AGC Economist Alarmed

“Expanding job opportunities throughout the economy make it increasingly difficult for contractors to find experienced construction workers.”

“Some projects may be delayed or put on hold without new measures to recruit and prepare future workers."

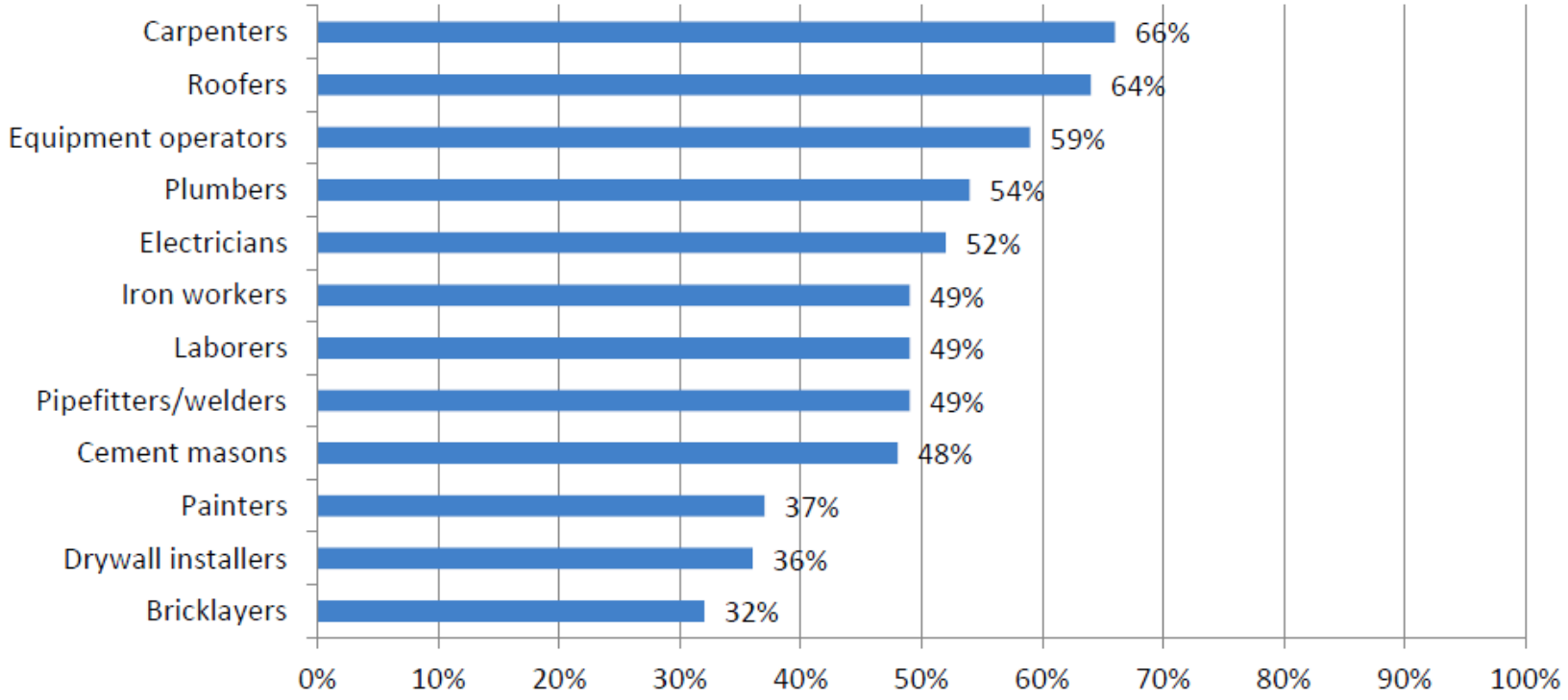
— Ken Simonson, Chief Economist, Associated General Contractors of America

Ebb and Flow of Construction Labor — Reasons Why

1. Fewer unions, fewer union apprentices.
2. Dismantling of vocational and technical education.
3. In economic downturn, workers left construction field.
4. Changes in immigration policy.

AGC Survey Results

5. If you hire, and are having trouble filling key craft worker positions, please indicate the position types you are having trouble filling (mark all that apply):



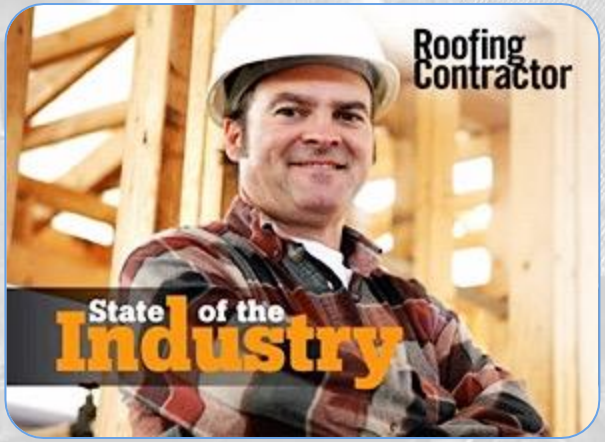
State of the Industry Report

Quoted — “The past recession has put us in a tough spot. We lost a generation or more of trained workers in our industry.”

— Kent Schwickert, senior vice president, national business unit - Tecta America Corp.

Quoted — “An extreme labor shortage is going to impact the entire country, in my opinion. This is going to drive up wages and make competition for experienced roofers fierce.”

— Scott Baxter, a commercial sales manager for Interstate Roofing Inc. in Portland.



One solution noted in the State of the Industry report is factory-made roofing systems to minimize labor needed in the field.

Roofing Problems and Faulty Installation

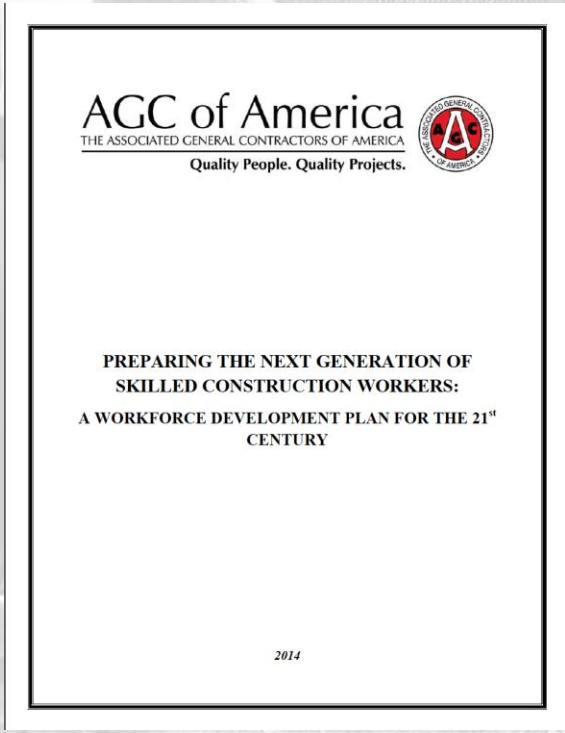
- Roof installation is unique in the construction industry because it is one of the only building components that is partially or fully constructed on the job site.
- This means that the performance of the roof–which is a building's defense against the elements–relies heavily on the workmanship used to complete the installation.
- Many rooftop problems are caused by installation workmanship, not material failure.

Installing a membrane roof on-site requires skill. Prefabrication eliminates potential for failures.

Labor Shortage Solutions

Suggestions from AGC:

- Reform the Carl D. Perkins Career & Technical Education Act
- Encourage private funding for craft training programs
- Improve the Workforce Investment Act
- Make it easier for veterans to get training and to be hired
- Encourage partnerships between registered apprenticeship programs and community colleges
- Expand federal apprenticeship resources
- Enact immigration reform
- Provide free community college and high school technical programs
- Make it easier to establish public schools focused on career and technical education



A Solution Emerges

- One solution: Prefabricated, factory-made building systems that are brought to the site and installed in a fraction of the time of site-built systems.
- Prefabricated roofing membrane systems install on-site with an 80 percent to 85 percent reduction in on-site seam welding.
- They also solve the problem of faulty sealing around penetrations, which cause the most problems in roofing failures.

Innovation provides a solution — prefabricated systems.

HISTORY OF FACTORY-MADE BUILDING COMPONENTS

SECTION 2

History of Prefab Components

- Windows were once built on site.
- Cabinets were once built primarily on-site.
- Eventually, factory-made windows and cabinets became the norm.
- That trend continues with prefabricated membrane roofing systems.

Prefab Houses

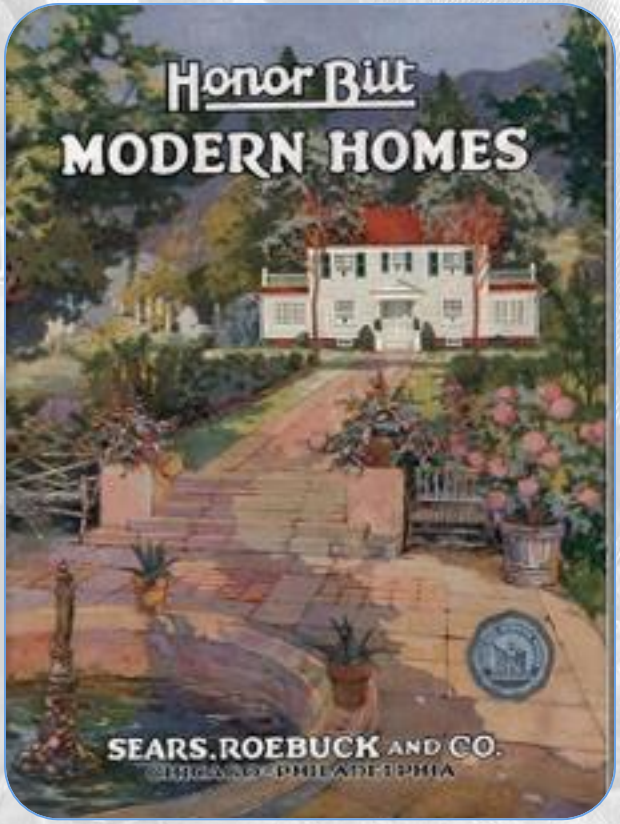
- During WWII 3 million homes in England, or one quarter of the country's homes, had been damaged or destroyed.
- Post-war homes prefabricated in factories and then shipped to the sites were designed to last 10 to 15 years, but a few of them survive today.

Loren Iron House, circa 1850s

Entire prefabricated houses go back at least until the 1850s, when the Loren iron house was prefabricated in England and shipped to Melbourne, Australia. It was moved to its current site in 1968.

Kit Homes Gave Way to the Levitt Brothers

- In the early 20th Century kit homes were delivered to the site with each piece of lumber cut in a factory and numbered for quick assembly on the lot.
- The result: Reduced labor and no cutting mistakes.
- After WWII, the Levitt Brothers transferred the genius of Henry Ford's assembly line for automobiles into the mass production of site-built homes.
- And the mass produced site-built method became king.



Between 1908 and 1940, Sears, Roebuck and Co. sold and shipped more than 70,000 kit homes.

Site Built Inherently Inefficient and Error Prone

How we got here:

- The oil embargo of the 1970s kick-started the movement to build energy-efficient homes.
- This brought about changes to construction methods and materials.
- Innovations by manufacturers brought further changes to "how things are done."
- Keeping up with current materials and methods is increasingly difficult for labor.
- This can be concerning for architects, contractors, and specifiers.

"It's incredible that we're still building stick by stick on-site."

— Bill Robinson, president of Train2Build and a moisture management expert based in New Orleans.

CONSEQUENCES OF ROOFING FAILURES

SECTION 3

Most Common Installation Errors

Improper Fastening — Can cause individual fasteners to fail, putting increased pressure on the remaining fasteners and eventually causing the entire roof to fail.

Flashings — Precise workmanship is required at all roof penetrations or transitions. These are the most critical areas of a rooftop and failure to properly seal these areas can lead to leaks and deterioration of the entire roof.

Perimeter Edges — Recent statistics estimate that more than half of all roof warranty claims are attributed to metal edge failures.

Lack of Code Knowledge. Unskilled laborers often lack knowledge of local building codes, which vary greatly around the country and change depending on the building's location, height, and if it is located in a high wind zone.

Litigation Claims Add Up

One industry source calculates that approximately 60 percent of litigation claims related to a building originate from the roof area. And that can be tough news for architects. High-profile litigation cases include:

- Architect Frank Gehry and a construction company were sued by the Massachusetts Institute of Technology for leaks, cracks, and drainage failure in MIT's $300 million Stata Center.
- Santiago Calatrava, a world-famous Spanish architect, faced legal action in 2014 from his native city of Valencia after the roof fell off the opera house he designed. Calatrava faced more legal action from the owner of a winery with a persistently leaky roof.

MIT's $300 million Stata Center

Frank Lloyd Wright on Architects

But most commercial building design programs are fairly straightforward.

But a typical roofing installation presents craftsmanship challenges for the installers:

- On-site seaming
- Flashings of projections
- Edge details
- Etc.

As Frank Lloyd Wright famously declared:

”If the roof doesn’t leak, the architect hasn’t been creative enough.”

BENEFITS OF FACTORY CONTROLS

SECTION 4

Multiple Benefits to a Controlled Environment

- **The workers and materials are protected from weather**
  - Fewer lost days to snow, storms, or heat
  - less damage to the materials because of weather
- **The workers in a factory can be trained and supervised more easily**.
  - Fewer construction defects
  - Fewer building failures, lawsuits, and unhappy owners and tenants

An in-house training class with roofing contractors.

More Benefits to a Controlled Environment

- **Recycling and reusing materials is more streamlined in a factory**
  - On-site massive dumpsters get filled with construction waste headed for a landfill
- **On-site, the installation goes faster**
  - Construction schedules get met
- **Roofing workers spend less time on the roof**
  - Fewer jobsite accidents
  - Potentially lower insurance premiums

Industry-Accepted Factory-Made Components

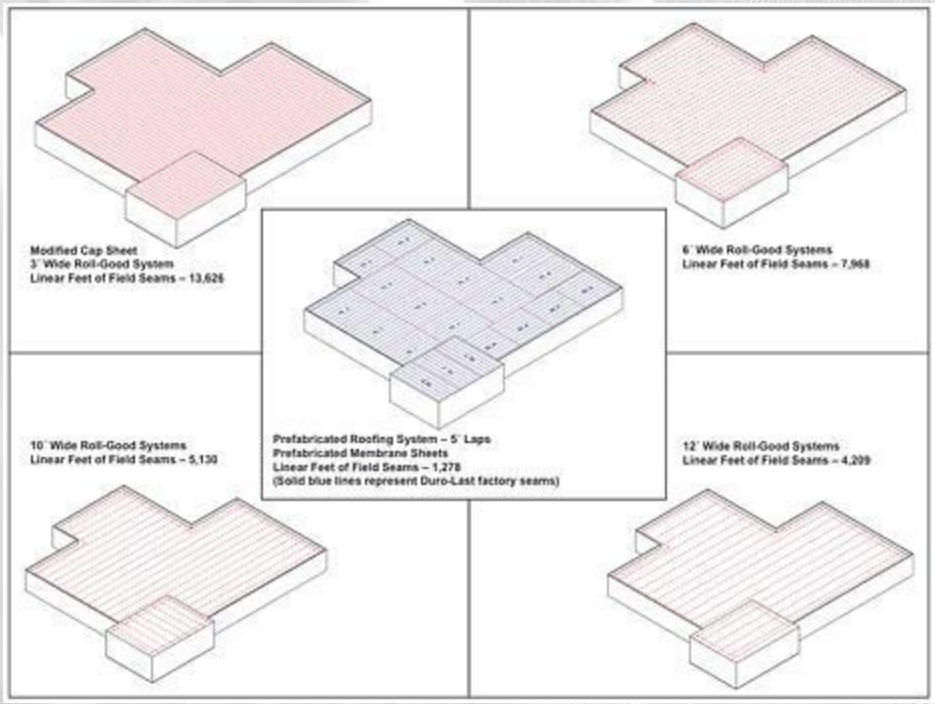
Factory-built components that were once cutting edge but have now become commonplace include:

- Structural Insulated Panels (SIPs)
- Precast concrete
- Steel framing
- Roofing trusses
- Membrane roofing

Grinnell Community Center, Grinnell, Iowa

Benefits of Fabricated Membrane Roofing Systems — Installation time

- Easier to install throughout the year, even during adverse weather conditions.
- Installation time is reduced so the contractor can get on and off the job quickly.
- The relatively small amount of roof membrane seaming done in the field is completed with hot-air welding methods, which are virtually unaffected by cold or damp weather conditions.



Fewer seams to weld on site with prefabricated membrane roofing system

Benefits of Fabricated Membrane Roofing Systems — Reduces Waste

- Single-ply roofing prefabrication reduces waste:
  - During the manufacturing process
  - During installation

The roofing contractor orders the exact amount of roof membrane necessary for roof coverage, rather than a collection of raw materials.

Benefits of Fabricated Membrane Roofing Systems — Appeals to Architects and Engineers

- Prefabrication appeals to engineers and architects who would like to address a particular structural or aesthetic design problem.
- Panel sizes, shapes, and colors can be pre-planned and prefabricated to achieve desired visual results.

Membrane roof on St. Michael's Lutheran church, Traverse City, Mich.

Benefits of Fabricated Membrane Roofing Systems — Better Outcome for Roofing Contractors

- Allows the roofing contractor to take control of a construction operation in a highly unstable environment.
- Roofing contractors must plan their roofing projects carefully.
- Prefabrication affords:
  - Greater worker productivity
  - A higher-quality installation
  - Potentially more satisfied customers

HOW ROOFING MEMBRANES ARE FABRICATED

SECTION 5

Engineering

And engineering services department provides technical support, including CAD services, to create a roof customized to each building’s specifications.

Up to 2,500 sq. ft.

- Membrane sheets are manufactured and inspected for quality control.
- According to the plans, membrane sheets are heat-welded together and prefabricated to dimensions as specified by the architect, specifier, or contractor.
- At least one manufacturer offers prefabricated panels up to 2,500 square feet.

Fastening Tabs Installed

Fastening tabs are welded into the membrane sheet for attachment to the roof deck.

Inspected and Folded

- Orders are measured, squared up, and all seams are inspected before the membrane leaves the manufacturing facility.
- The custom-made pieces are then folded from fastening tab-to-fastening tab, with the goal of making unfolding easier and more straightforward for the installation crew.

Custom Accessories and Edging

- Prefabricated membrane roofing companies may offer custom-made accessories for penetrations and details.
- Scuppers, pitch pans, and collector boxes eliminate the need for field fabrication and help increase installation efficiencies.
- Factory-made edge metal can also be specified, designed, and delivered to the job-site for a more precise installation that can prevent leakage troubles later on.

Rolled, Wrapped and Ready to Go

Finally, all pieces are rolled and shrink wrapped, ready for delivery to the site.

HOW ROOFING MEMBRANES ARE INSTALLED

SECTION 6

On-Site: Unwrapped and Unfolded

- To begin, a prefabricated roof section is unrolled and positioned on the deck to expose the first securement tab.
- The securement tab is mechanically fastened to the deck with approved fasteners and stress distribution plates.
- The roof section is then unfolded and pulled taut to remove any wrinkles exposing the second securement tab.
- This process is repeated until the entire roof section has been mechanically fastened to the deck, including all securement tabs and edges.

Hot Air Welding

- The workers position the membrane so that the top membrane overlaps the bottom membrane, ensuring the welding area is dry, clean, and free of foreign material.
- Workers then weld the top membrane to the bottom membrane using a handheld welder or an automatic welding machine, and silicone roller.
- All field-welded seams must be inspected with a tack claw or similar tool (cotter key extractor), and all deficiencies repaired prior to inspection for warranty purposes.

Ensuring a Leak-Free Product

- Penetrations are to a roof what windows are to a wall.
- Both are vulnerable points in the structures that, if not sealed correctly, create pathways for unwanted, corrosive, and destructive water and air intrusion.
- Roof penetrations require extremely precise flashing and sealing.
- Transitions of any kind on a roof require the utmost attention and skills to avoid failure.

Prefabricated Accessories

- A custom prefabricated flashing is made inside a factory-controlled setting.
- Cuts down on labor demands on the roof.
- Ensures quality control.
- Custom designed to fit each penetration.
- **Penetrations include**:
  - Pipes
  - Drains
  - Curbs
  - Pitch pans
  - Expansion joints.

For roofing systems that are covered under a thorough warranty, prefabricated flashings are often required.

Stack Flashings

- Stack flashings for round penetrations are prefabricated with a reinforced roofing membrane.
- The installed roofing membrane is mechanically fastened around the penetration.
- The flashing is placed.
- Then the seam around the skirt is heat-welded to the roofing membrane for a waterproofing seal.

Two-Way Vent Flashing

- Custom fabricated two-way vent flashing with skirt.
- A two-way vent valve allows for both exhaust and convective movement of air between breathers, and the cap prevents the entry of rain or snow.

Prefabricated Curb Flashings

- Prefabricated curb flashings are custom made to fit the units and features of each roof.
- The one-piece design eliminates the risk of several pieces cut for field fabrication and the potential for installation and sealing errors from piece-to-piece.

Other Prefabricated Accessories

- Other prefabricated accessories are available for quicker field installation and factory quality control.
- **They include:**
  - Metal fascia covers
  - Collector boxes with downspout
  - Metal flange scupper
  - Gutter systems
  - Etc.

CASE STUDIES

SECTION 7

Case Study 1: San Francisco's Davies Symphony Hall

- The Louise M. Davies Symphony Hall in San Francisco opened in 1980 and renovated in 1992.
- A few years ago, the San Francisco Public Utilities Commission (SFPUC) determined that installing a photovoltaic (PV) solar system the building would benefit the people of San Francisco.
- The SFPUC retained engineering consultant AEPC of San Ramon, Calif., to design the PV solar system for the 25,000-square-foot roof.

Moisture Issues Emerged

- Significant moisture issues were discovered in the underlying roof insulation, contributing to deteriorating conditions in the 14-year-old tar-and-gravel roof.
- The team determined that there was substantial moisture leaking around the HVAC duct support posts that contributed to the saturation of the roof's insulation
- It's relatively expensive to turn off and disconnect a solar array and to repair the roof. explains. Therefore, the owner required the roof life to match the service life of the PV system.

"Our goal was to ensure that the roof could last the life of the solar array, or a minimum of 25 years."

— Venk Mani, engineering consultant

Two Options for Roof Ready for PV Solar

The SFPUC was presented with two available options:

1. **Tear off the current roof and install a new one.**
2. **Overlay the existing roof with a new membrane.**

The SFPUC opted to re-cover the existing roof as replacing the old roof would take longer and interfere with the symphony's rehearsal and performance schedule.

Dregger recommended a white 60-mil-thick thermoplastic PVC roof system.

"Dealing with the dust, debris, odors, and noise would be important considerations on this project. The PVC roof membrane would be quicker to install."

— Phillip Dregger, Technical Roof Services

Material Prefabrication Expedited Installation

- The membrane was prefabricated into rolls that were 22 feet wide, reducing the application time and on-site welding.
- Penetration flashings, parapet wall membrane, membrane curbs, solar hold down boots, and other related roof materials were all custom fabricated at the factory.
- The company was able to expedite the installation process and meet critical deadlines.

Solar Ready

- First step: Remove existing gravel from built-up roof as well as the wet roof and insulation areas.
- Next step: A ½-inch high-density gypsum cover board mechanically fastened through the existing roof and insulation, to the concrete deck, which provided a smooth surface for the adhered 60-mil overlay membrane.
- This assured the roof met wind uplift as well as seismic design requirements.

Working Around Rehearsals and the Streets of San Francisco

- Work schedules were adjusted to meet the symphony's pre-established rehearsal and performance requirements.
- The on-site time and labor saved by the prefabricated roofing system helped keep the project on track.

Scheduling commitments at a busy location in the center of the city meant that the materials and equipment could only be delivered and crane-loaded onto the rooftop on weekends.

Case Study 2: Hebrew Academy in Livingston, N.J.

The EPDM roof was failing and nearing the end of its useful life on the Joseph Kushner Hebrew Academy in Livingston, New Jersey.

Primarily concerns:

- A roofing option that would not produce noise or fumes
- Completed within budget and in a reasonable timeframe.

A prefabricated single-ply membrane was chosen for several reasons:

- Its clean and safe application method met the requirements necessary for maintaining classes during installation
- The membrane manufacturer offered custom prefabrication
- The mechanical attachment
- Competitive pricing
- The 15-year warranty

The membrane's high-reflectivity was also attractive to the board members, as it would save the school energy and money.

Scope of the Project

The school board was impressed by the roofing contractor's ability to finish the job in just 60 days—less than the estimated timeframe—despite consistently poor weather conditions, which hindered the team's progress.

- Prefabrication also helped provide the assurance of a roof that would be leak-proof and virtually maintenance free, and under the protection of a vigorous warranty.

The job was enormous. It required flashing approximately 400 penetrations, including 126 HVAC units, on five different roof levels.

Planning and Preparation Before Installation

- In preparation for the large project, the owner of the roofing company spent three days on top of the roof with the membrane manufacturer's representative estimating the number of deck sheets that would be required. They also measured all of the roof's penetrations.
- As part of the academy's roof replacement project, a uniquely designed pitched roof was installed on the front of the building, making the new roof impressive not only in terms of necessity and practicality, but also aesthetically.

Case Study 3: Church Reroof, Summerville, S.C.

At the Summerville Baptist Church in Summerville, South Carolina, ponding water on the gym's existing modified bitumen roof and the built-up roof on several classrooms had created leak problems.

With the buildings in constant use, officials at the church worried an accident would occur where there was a leak, endangering the approximately 175 children that attended the church's daycare center.

Dodging buckets or closing down the facility in order to make repairs on the roof were not options. At risk from water damage were office and school equipment such and the gym's brand-new parquet floor.

Roofing Systems Considered

“We looked at built-ups again, synthetic rubber, spray-on coatings as well as thermoplastic single-plies.”

— John Nettles, church maintenance director

Officials at Summerville determined that a prefabricated membrane roofing system would be the best choice.

“Both of these problem roofs had parapet walls to deal with. With the (membrane) roofing system, you can encapsulate the parapet walls to resolve leaking problems that normally occur in walls made of mortar.”

— John Congdon, owner of Congdon Roofing, Inc. in Charleston, South Carolina

On-Site Labor and Time Saved

- The Congdon Roofing crew had less rooftop field seaming to complete, thus making the roof easier and quicker to install with fewer hours of labor.
- The warranty on the prefabricated membrane roofing system does not exclude ponding water or consequential damages.

The system is clean and uses no hazardous materials, which was important to church officials who did not want any messy tar kettles on the roofs or near the buildings that were occupied during the installation.

CONCLUSION

Conclusion

- The shortages in skilled construction labor are real and many years in the making.
- While the finest minds in economics, labor, and construction are advocating for changes to build up a skilled workforce, that result will not manifest immediately.
- That means in a robust building environment, projects may be delayed or, worst yet, be constructed with flawed installation.
- For roofing, poor installation brings expensive damages, the exact causes of which can be difficult to determine.

Conclusion

Innovations by roofing manufacturers, particularly factory-fabricated roofing systems, can help ease problems caused by skilled labor shortages.

Prefabricated membrane systems typically provide four main benefits:

- Factory-welded seams for better first-time quality and fewer callbacks
- Easier transitions for superior waterproofing and aesthetics
- Less labor required for the installation time on the roof
- Cleaner installations with less job-site waste and disruptions

As engineers, architects, installers, and owners realize the continuing benefits of specifying prefabricated buildings systems, the way buildings are constructed may well shift in favor of prefabricated systems for many decades to come.

Thank You

Thank you for your time.

This concludes the AIA Continuing Education System Program.

Questions?

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