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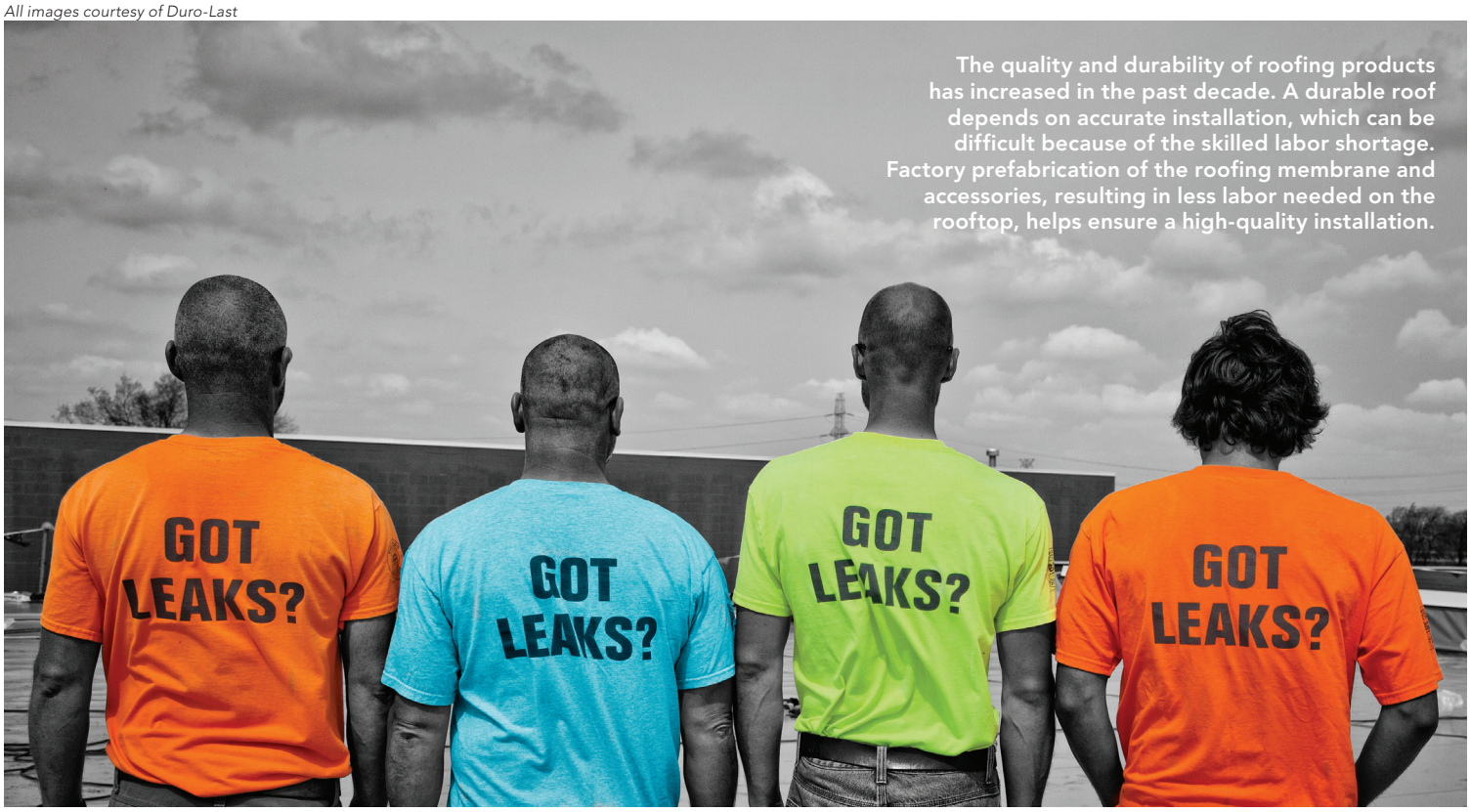

The quality and durability of roofing products has increased in the past decade. A durable roof depends on accurate installation, which can be difficult because of the skilled labor shortage. Factory prefabrication of the roofing membrane and accessories, resulting in less labor needed on the rooftop, helps ensure a high-quality installation.

Labor Shortage Solution — Specifying a Factory-Made Roofing Membrane

Prefabricated membranes and custom prefabricated accessories increase a roof's quality and durability

Sponsored by Duro-Last | *By Kathy Price-Robinson*

In a perfect world, the architect designs a building and the contractor builds it, accurately and on time, with all the skilled labor necessary.

In the real world, the supply of skilled construction labor ebbs and flows. Today it 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.

This article is about how skilled labor shortages are affecting construction timetables and quality, with a focus on the roofing industry, and how a solution that architects can specify—factory-controlled, prefabricated membrane roofing systems that install onsite in a fraction of the time and with fewer workers—is helping to solve the problem.

THE DECLINE OF SKILLED BUILDING LABOR

While the construction labor shortage has been many years in the making, it has recently received wide attention.

- A recent headline in *The Atlantic* reads: "Where Have All the Construction Workers Gone?"
- A headline in *Engineering News Record* reads: "Contractors Turning Down Work Due to Labor Shortages."
- Even back in 2013, a Forbes.com article

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Learning Objectives

After reading this article, you should be able to:

1. Discuss the decline of skilled building labor in the United States and its effect on building quality and durability.
2. Explain the history and benefits of a controlled factory setting for building components that decrease faulty onsite installation.
3. Discuss studies of roof failures that show that most moisture intrusion and uplift problems occur because of installation errors.
4. Describe how single-ply membrane roofing assemblies work for quality control and increased durability.
5. 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.

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Many skilled workers left the building industry during the downturn and never came back.

rang the warning bell with the headline: "As Construction Begins Rebound, Looming Labor Shortages Raise Concerns."

With the recent upturn in the construction industry, unemployment levels for construction trades are at their lowest level in a decade and a half.

"Expanding job opportunities throughout the economy make it increasingly difficult for contractors to find experienced construction workers," Ken Simonson, the chief economist of the Associated General Contractors of America, notes in a press release.

"This scarcity shows up in record workweeks for craft workers and flattening of employment totals despite higher construction spending," Simonson adds.

Recent Census Bureau data on construction spending indicates there is robust demand for new construction, particularly for apartments and private nonresidential projects.

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

A recent survey released by the Associated General Contractors of America revealed that 83 percent of construction firms struggle to fill positions for qualified craftworkers, carpenters, equipment operators, and laborers. Roofing labor shortages were a problem for 64 percent of firms surveyed.

The Ebb and Flow of Construction Labor

There are several reasons why construction labor decreased.

Fewer unions, fewer union apprentices. The percentage of workers belonging to a union in the United States peaked in 1954 at almost 35 percent and the total number of union members peaked in 1979 at an estimated 21 million. Membership has declined since, with private sector union membership beginning a steady decline that continues into the 2010s, even while the membership of public sector unions grew steadily. Today, union membership is down to 11 percent overall. Traditionally, unions have operated training and apprenticeship programs, therefore with decreasing union power comes decreased worker training.

Dismantling of vocational and technical education. Decades ago, vocational and technical education was a viable and popular path for high school students not headed to college. However, in efforts to send nearly every student to college, much of that vocational funding has been shifted to college-preparatory programs.

In economic downturn, workers left construction field. As the Forbes article noted, "Hundreds of thousands of workers left the field in the downturn, changing career paths or retiring altogether. Young adults haven't clamored to enter the field and even for the ones that have, training programs have shrunk or evaporated altogether."

Changes in immigration policy. According

to the Bureau of Labor Statistics, 53 percent of roofers today are Hispanic, with a large number of that population being immigrants. Legal immigration for people in jobs like roofing, which is a skilled trade but doesn't require higher education, is becoming increasingly difficult.

Roofing Industry Affected

In the roofing industry, labor shortages rank as a top concern for contractors. According to the most recent State of the Industry Report from *Roofing Contractor* magazine, business is good but labor shortages are tempering the growth.

"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., tells the magazine.

"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," says Scott Baxter, a commercial sales manager for Interstate Roofing Inc. in Portland, Oregon, in an interview with the magazine.

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

Roofing Problems and Faulty Installation

The shortage of skilled roofing workers is particularly concerning when the impact of roofing failures is examined. We'll discuss later in the article how and why faulty roofing installations lead to massive and costly building failures. But suffice it to say that a failed roofing system has far greater implications than sloppy interior trim work, for instance, or sloppy drywall finishing. While those installation failures may well stem from a similarly debilitating shortage of skilled workers, the outcomes are not likely as consequential as those caused by a poorly executed roofing job.

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. The most common installation errors include:

- *Improper Fastening.* Fasteners are installed at specified intervals, depending on the height of the roof and wind speeds, to reduce flutter and properly absorb the load. Not installing fasteners correctly 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.* In addition to the membrane, proper installation of edge metal terminations is equally important. Recent statistics estimate that more than half of all roof warranty claims are attributed to metal edge failures.
- *Lack of Code Knowledge.* Another downfall of using unskilled laborers is that they 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.

LABOR SHORTAGE SOLUTIONS

Leaders in the construction industry have presented logical solutions to the skilled labor shortage. The AGC of America suggests several strategies in a report titled: "Preparing the Next Generation of Skilled Construction Workers: A Workforce Development Plan for the 21st Century." It suggests:

- Reform and reinvigorate the Carl D. Perkins Career & Technical Education Act, which is the primary federal funding vehicle for career and educational programs;
- 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 and collect more comprehensive data on all apprenticeship programs;
- Enact immigration reform;
- Offer community college career and technical programs for high school students for free; and
- Make it easier to establish public schools focused on career and technical education.

FOR THE ROOFING INDUSTRY, FACTORY-FABRICATED SYSTEMS EMERGE AS A LABOR SHORTAGE SOLUTION

Certainly the ideas presented by the AGC, if enacted, would bring more trained construction workers into the industry. But the timeframe is long and the outcome uncertain.

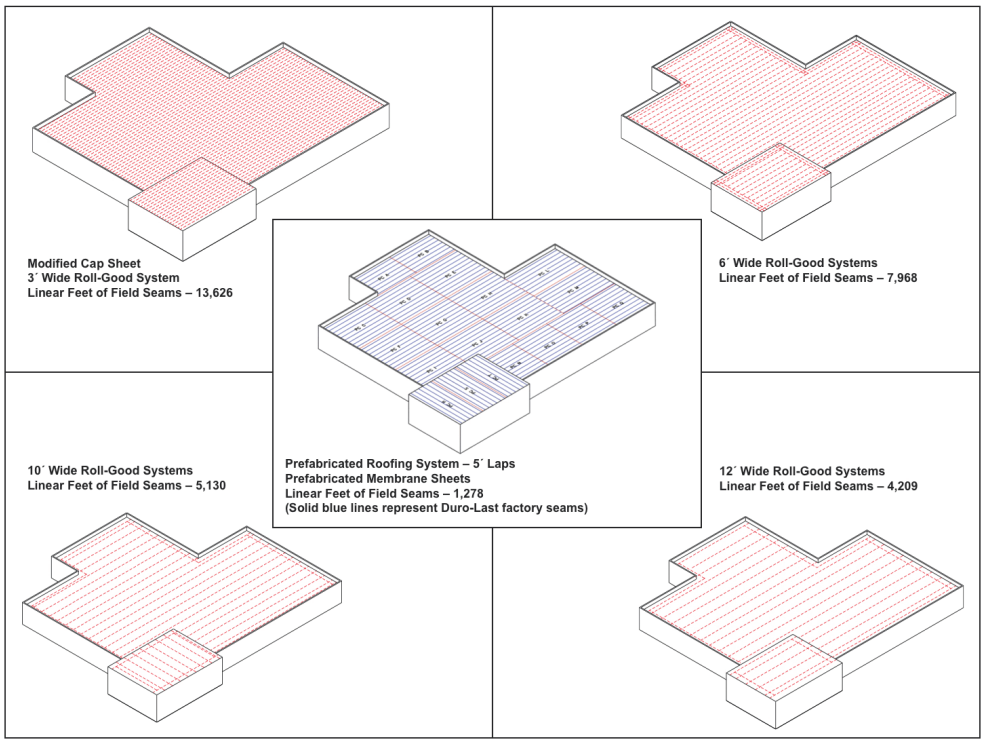
However, innovation, as it often does, may provide a quicker solution. A case in point is the growing use of prefabricated, factory-made building systems that are brought to the site and installed in a fraction of the time of site-built systems.

This solution includes prefabricated roofing membrane systems that not only install on-site with an 80 percent to 85 percent reduction in on-site seam welding, but that also solve the problem of faulty sealing around penetrations, which as we'll see later on cause the most problems in roofing failures.

Factory-Made Building Components: A Long History

While prefab has become a buzzword in the past decade, the practice of specifying and installing prefabricated systems in buildings has quite a long history.

Membranes up to 2,500 square feet can be prefabricated in a factory setting.



When the vast majority of the seaming for a prefabricated membrane is done in the factory, that leaves very little to do on the rooftop. When the entire roofing system is fabricated on the rooftop, the number of seams to weld on-site increases dramatically.

PREFABRICATED SYSTEM

A prefabricated system could include:

A. An insulation system and/or cover boards.
B. Roofing membranes that can be precision-fabricated to rooftop.
C. Curb, stack, parapet, and other flashings — made of membrane material in a factory. — enable a watertight installation at critical roof transitions.
D. Edge details for an aesthetic and secure termination around the edge of the building.

While specifying window systems is now normal, at one time it was common for window frames to be made and glazed onsite. Carpenters measured and cut the framing and trim members, assembled them, added glazing, and installed them into the window opening.

Cabinets were also once made primarily on-site. Eventually, factory-made cabinets, with all the quality controls inherent in such a manufacturing setting, became the norm.

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.

Prefabricated homes became prevalent in England following World War, when 3 million, or one quarter of the country's homes, had been damaged or destroyed. The post-war years brought a great need for housing along with a shortage of skilled building labor. Plus, empty factories once engaged in the war effort were ready for new products. The homes prefabricated in these factories and then shipped to the sites were designed to last 10 to 15 years, but a few of them survive today.

Some methods of easing on-site labor needs were a hybrid of site-built and factory controls. Kit homes popular in the early 20th Century were delivered to the site with each piece of lumber cut in a factory and numbered for quick assembly on the lot. This reduced labor and eliminated cutting mistakes.

Between 1908 and 1940, Sears, Roebuck and Co. sold and shipped more than 70,000 kit homes through its Modern Homes mail order program.

In 1927, for instance, The Sears, Roebuck and Co. kit house named the Vallonia bungalow cost from $1,500 to $2,500, depending on size. Delivered to the site were the pre-cut framing lumber, wood lath, millwork, doors, windows, roofing, siding, hardware, paint, etc. Plumbing, heating, wiring, and electrical were extra.

The prefabricated method of construction may have taken over the construction industry were it not for the Levitt Brothers, who transferred the genius of Henry Ford's assembly line for automobiles into the mass production of site-built homes. With the vast need for homes for returning veterans following World War II, the incredible efficiency of moving materials and skilled labor from house-to-house covering great tracts of land changed the home building industry. The mass produced site-built method became king.

It is, however, an incredibly inefficient and error-prone process.

"It's incredible that we're still building stick by stick on-site," says Bill Robinson, president of Train2Build and a moisture management expert based in New Orleans.

Recent decades have seen the prefab method of building rising once again. The oil embargo of the 1970s kick-started the movement to build energy-efficient homes, which brought about changes to construction methods and materials. Innovations by manufacturers brought further changes to "how things are done."

However, keeping up with current materials and methods is increasingly difficult in the great morass of non-unionized world of skilled construction labor. This can be concerning for architects, contractors, and specifiers, particularly as roofing is concerned.

Roofing Failure Consequences

Studies of roof failures show that many problems occur because of installation errors, particularly at changes in the plane on the roof, such as projections, curbs, drains, perimeters, and abutting walls.

It is often during forensic investigation of roofing failures that installation or compatibility errors are discovered. For single-ply membrane roofing, the errors can include open laps from improper on-site heat welding, loose flashings from improper on-site fabrication and installation, loose flashings from sealant failure, compromised flashings that are made of unreinforced membrane material, etc.

The consequences are immense. While exact statistics are difficult to come by because of out-of-court settlements, 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. Calavera faced more legal action from the owner of a winery with a persistently leaky roof.

When considering the design of imaginative buildings, it's hard to fault architects for their vision. As Frank Lloyd Wright famously declared, "If the roof doesn't leak, the architect hasn't been creative enough."

In most commercial building design, however, the design program is fairly straightforward. Still, a typical roofing installation presents craftsmanship challenges for the installers: onsite seaming, flashings of projections, edge details, and so on. If these challenges are not skillfully met, leaking problems will likely develop.

For the health of the building, as well as the health of designer's reputation and finances, specifications that remove potential problems are worth some consideration.

Factory Controls Bring Many Benefits

There are multiple benefits to fabricating components inside a controlled environment like a factory. The workers and materials are protected from weather, which means fewer lost days to snow, storms, or heat, and less damage to the materials because of weather.

The workers in a factory can be trained and supervised more easily. This means fewer construction defects, which means fewer building failures, lawsuits, and unhappy owners and tenants.

Recycling and reusing materials is more streamlined in a factory than on-site, where massive dumpsters filled with construction waste headed for a landfill are a common sight.

On the jobsite, factory fabricated components, such as prefabricated roofing, means that the installation goes faster, and construction schedules get met. In the case of roofing, a custom prefabricated membrane means that workers spend less time on the roof itself, which translates to fewer jobsite accidents, and lower insurance premiums.

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

A. Structural Insulated Panels (SIPs)
B. Precast concrete
C. Steel framing
D. Roofing trusses
E. Membrane roofing

For building owners and managers, custom fabrication of single-ply membrane roofing systems offers several advantages:

- Prefabricated roofing systems are 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.
- Single-ply roofing prefabrication dramatically reduces waste, both during the manufacturing process and installation. The roofing contractor orders the exact amount of roof membrane necessary for roof coverage, rather than a collection of raw materials.
- Prefabrication also 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.
- Finally, prefabrication allows the roofing contractor to take control of a construction operation in a highly unstable environment. Roofing contractors must plan their roofing projects carefully, and prefabrication affords greater worker productivity, a higher-quality installation, and potentially more satisfied customers.

HOW A ROOFING MEMBRANE IS PREFABRICATED IN A FACTORY-CONTROLLED SETTING

Typically, a membrane manufacturer that offers prefabrication has an engineering services department to provide technical support, including CAD services, to create a roof customized to each building's specifications.

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

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.

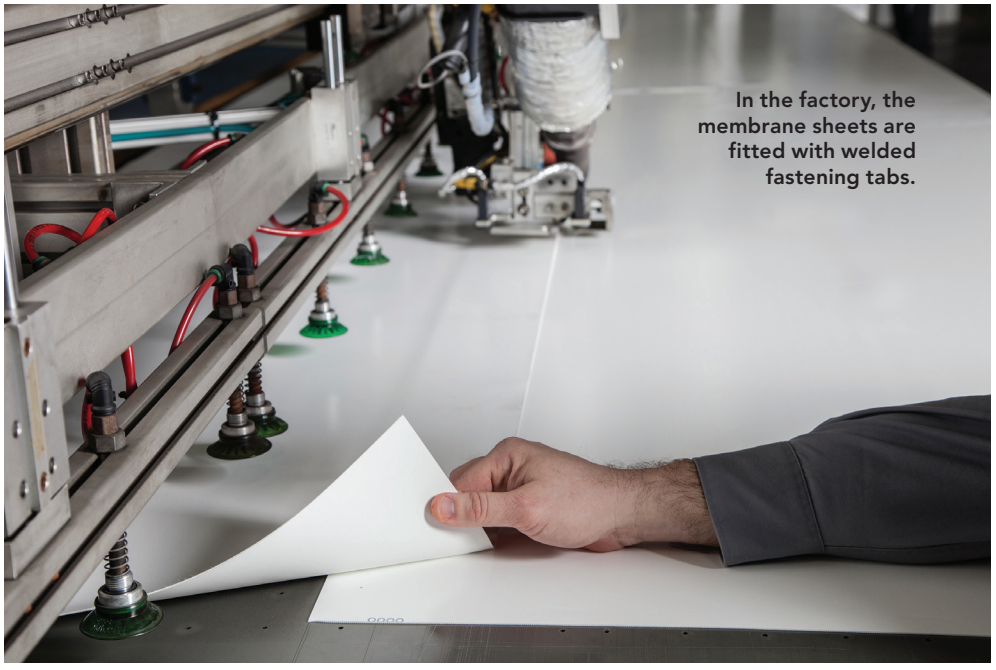
Prefabricated membrane roofing companies may offer custom-made accessories for penetrations and details. Scuppers, pitch pans, and collector boxes eliminate the need for field fabrication and help increase installation efficiencies.

Factory-made edge metal can also be specified, designed, and delivered to the jobsite for a more precise installation that can prevent leakage troubles later on. Finally, all pieces are rolled and shrink wrapped, ready for delivery to the site.

How a Roofing Membrane Is Installed

On-site, the full package of a custom roofing system is unwrapped. 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. The next section of roofing membrane is then positioned to provide a



In the factory, the membrane sheets are fitted with welded fastening tabs.

minimum of six inches overlap. The above procedure is repeated for each roof section.

Hot Air Welding

While 80 to 85 percent of welding is done in a factory controlled setting, there is still welding to do on-site. 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 hand-held 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.

Roof Penetrations and Prefabricated Flashings and Accessories

Penetrations are to a roof what windows are to a wall. Both are of extreme value to the function of the building, yet they 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. Even a slightly flawed installation on the rooftop could have massive implications later on.

As it is with vertical walls, transitions of any kind on a roof require the utmost attention and skills to avoid failure.

While up to 85% of the seam welding is done in the factory, the remainder is done on-site with an automatic welding machine, or a hand-held welder, and a silicone roller.

Prefabricated flashings and accessories help ensure a leak-free finished product with less labor time on the roof.

To save on labor demands on the roof, and to ensure quality control, prefabricated accessories are custom designed to fit each penetration. These include: pipes, drains, curbs, pitch pans, and expansion joints. For roofing systems that are covered under a thorough warranty, prefabricated flashings are often required. Examples are:

- **Stack flashing**

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

- **Two-way vent with skirt**

Custom fabricated two-way vent flashing with skirt. A two-way vent valve will allow for both exhaust and convective movement of air between breathers, and the cap prevents the entry of rain or snow. But if it is not flashed correctly, it will leak water into the building.

- **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.

A custom prefabricated flashing is made inside a factory-controlled setting.

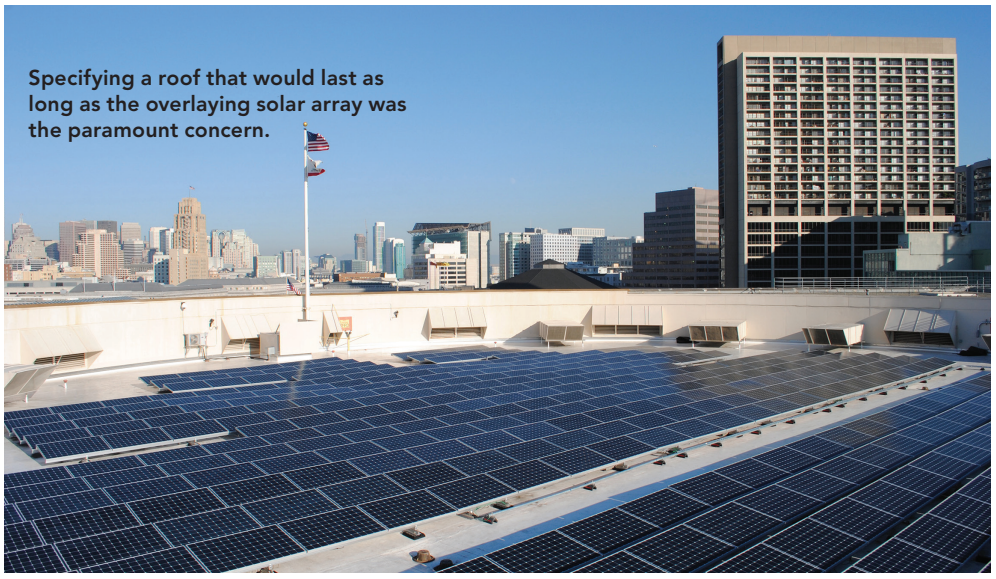
Other prefabricated accessories for quicker field installation and factory quality control include metal fascia covers, collector boxes with downspout, metal flange scupper, gutter systems, etc.

Conclusion Section

The shortages in skilled construction 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 that 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.

Innovations by roofing manufacturers, particularly factory-fabricated roofing systems,

The 25,000 square feet roof of the Louise M. Davies Symphony Hall in San Francisco was slated for a photovoltaic solar system. However, a deteriorating roof had to be addressed first.



Specifying a roof that would last as long as the overlaying solar array was the paramount concern.

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 jobsite 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.

A REVITALIZED SOLAR ROOF FOR SAN FRANCISCO'S DAVIES SYMPHONY HALL

San Francisco has long been known as a center for culture and the performing arts. Showcased by its War Memorial Opera House, considered the last Beaux Arts building constructed in the United States, this legacy continued with construction of the adjoining Louise M. Davies Symphony Hall. Opened in 1980 and renovated in 1992, its modern design was a collaboration of architects and acoustical engineers working in concert to create an intimate environment to enhance the music of the San Francisco Symphony and the beauty of the structure itself.

A few years ago, the San Francisco Public Utilities Commission (SFPUC) determined that installing a photovoltaic (PV) solar system on Davies Symphony Hall 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 feet roof.

The project team for the roof revitalization and PV solar system installation included Technical Roof Services (TRS) of Concord, Calif., and Fidelity Roof Company of Oakland, Calif.

Moisture Issues Emerged

Initially, the installation of a rooftop solar energy system seemed to be straightforward. However, significant moisture issues were discovered in the underlying roof insulation, contributing to deteriorating conditions in the 14-year-old tar-and-gravel roof.

"We knew the roof had some leaks and wanted to correct any problem areas before the solar panels were installed. Our goal was to ensure that the roof could last the life of the solar array, or a minimum of 25 years," said Venk Mani of APEC.

"We were aware of leaks in the exterior concrete walls but there had to be another source of wetting," added Phillip Dregger of TRS. "The wet insulation on the roof just didn't follow any typical patterns."

After exhaustive testing, TRS and Dregger determined that there was substantial moisture leaking around the HVAC duct support posts that contributed to the saturation of the roof's insulation. It was clear that extensive repairs were needed, including replacing the 4,000 square feet of wet insulation, to protect the longevity of the new roof system.

The solar panel installation was the primary consideration.

"It's relatively expensive to turn off and disconnect a solar array and to repair the roof," Dregger explained. "Therefore, the owner required the roof life to match the service life of the PV system. In other words, they needed a new roof."

Options for Roof Ready for PV Solar

The SFPUC was presented with two available options:

A. Tear off the current roof and install a new one.

B. 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.

After evaluating the available membrane alternatives, 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," he explained. "The PVC roof membrane would be quicker to install. Additionally, we needed to mechanically attach the cover board and new roof membrane through the existing roof down to the concrete deck."

Material Prefabrication Expedited Installation

Prefabrication was another advantage of the roofing system selected. The membrane was prefabricated into 22-feet wide rolls, reducing

The school board of the Joseph Kushner Hebrew Academy in Livingston, New Jersey, wanted a reroofing job quiet and safe enough to not disrupt classes.

the application time and on-site welding.

In addition, the penetration flashings, parapet wall membrane, membrane curbs, solar hold down boots, and other related roof materials were all custom fabricated at the factory. This not only assured installation accuracy at changes in plane on the roof, such as projections, curbs, drains, perimeters, and abutting walls, but of equal importance was the roofing company's ability to expedite the installation process and meet critical deadlines.

Solar Ready

The first step in the roof overlay process was to remove the existing gravel from the built-up roof as well as the wet roof and insulation areas. Once cleared, the design called for half inch high-density gypsum cover board to be 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 process assured the roof met wind uplift as well as seismic design requirements.

Working Around Rehearsals and the Streets of San Francisco

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.

Work schedules were adjusted to meet the symphony's pre-established rehearsal and performance requirements. This meant sometimes working late into the evenings and weekends to meet the scheduled completion. The onsite time and labor saved by the prefabricated roofing system helped keep the project on track.

A PREFABRICATED ROOFING SYSTEM WAS INSTALLED RELATIVELY QUIETLY AND QUICKLY

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

Multiple companies offered various solutions for reroofing the facility. The reroofing project had been left open to bid for five years and the school board had many options to consider before awarding the work for the 200,000 square foot project.

Because the reroofing job was to be done over the existing EPDM system while school was in session, several factors had to be considered prior to choosing a bid.

Primarily concerned about the occupants of the building, the Academy's decision makers wanted a roofing option that would not produce noise or fumes and would be completed within budget and in a reasonable timeframe.

Although other options were considered, a prefabricated single-ply membrane was chosen for several reasons: 1) Its clean and safe application method met the requirements necessary for maintaining classes during installation; 2) The membrane manufacturer offered custom prefabrication; 3) The mechanical attachment; 4) Competitive pricing; and 5) 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

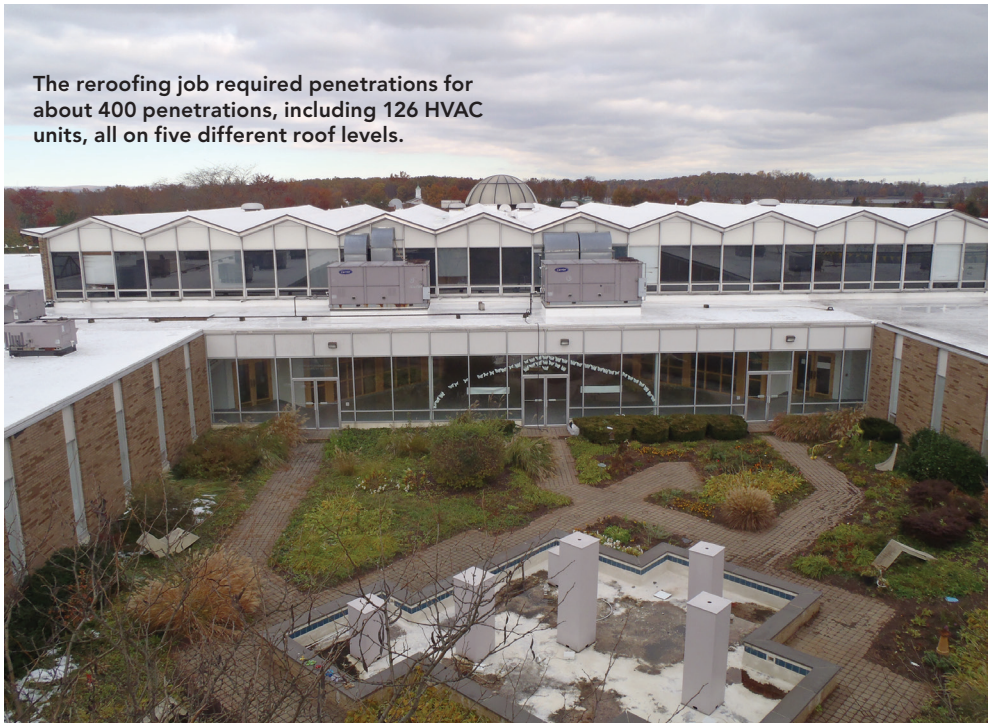
The job was enormous. It required flashing approximately 400 penetrations, including 126 HVAC units, on five different roof levels.

The flashings – made of membrane material that connects horizontal and vertical roof surfaces on rooftop protrusions such as curbs and stacks – are prefabricated in the manufacturer's plant, and then delivered to the job site. Had the flashings not been prefabricated, workers would have had to manufacture them on top of the roof, during installation, which could increase the risk of worker error and thus increase the chance of roofing failure.

Because so much of the roof can be manufactured in a controlled factory environment prior to on-site installation, roofing contractors can typically complete jobs more quickly and efficiently and with less disruption than contractors using other systems.

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 reroofing job required penetrations for about 400 penetrations, including 126 HVAC units, all on five different roof levels.

The warranty on the new prefabricated membrane roof did not exclude ponding.

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.

Following the wishes of the school board, the installation team was successful in reroofing the Academy with no interruptions to classes. Staff and students held classes as usual inside the building during construction.

TIME AND LABOR SAVED FOR CHURCH RE-ROOFING PROJECT CASE STUDY

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

Several types of roofing systems were reviewed during the initial phases of the re-roofing project.

"We looked at built-ups again, synthetic rubber, spray-on coatings as well as thermoplastic single-plies," recalled church maintenance director John Nettles. Officials at Summerville weighed their options and the benefits of each type of system before determining that a prefabricated membrane roofing system would be the best choice.

John Congdon, owner of Congdon Roofing, Inc. in Charleston, South Carolina, agreed: "We knew that the mechanically-attached . . . single-ply roofing system would be a perfect fit for the Summerville Baptist Church facilities," Congdon said. "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."

On-site Labor and Time Saved

Another benefit of the (membrane) roofing system is prefabrication. With 80 percent to 85 percent of the seams being factory-welded at one of the (membrane manufacturer's) facilities, 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.

Congdon noted that 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.

Plus, because the warranty on the prefabricated membrane roofing system does not exclude ponding water or consequential damages, church officials did not have to worry about the minor ponds associated with low-sloped roofs that had caused the previous roof to fail.

The church officials liked the new membrane roofing system so much that they recommended it to another nearby church that needed a new roof for its nursery building.

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To receive AIA/CES credit, you are required to read the entire article and pass the test. Go to **ce.architecturalrecord.com** for complete text and to take the test. The quiz questions below include information from this online reading

1. **A recent survey released by the Associated General Contractors of America revealed that 83% of construction firms struggle to fill positions for qualified workers. Which of the following is NOT one of the three areas of skilled labor with the greatest shortages?**
   - A. Roofers
   - B. Carpenters
   - C. Drywall installers
   - D. Equipment operators

2. **Which of the following is a cause of skilled construction labor shortages?**
   - A. Fewer unions means there are fewer union apprentices. essinvelias
   - B. Dismantling of vocational and technical education.
   - C. Workers left industry during downturn.
   - D. All of the above

3. **What is not one of the most common installation errors for single-ply roofing membranes?**
   - A. Problems involving weather conditions.
   - B. Improper fastening.
   - C. Problems at the flashings.
   - D. Installer's lack of code knowledge.

4. **For a prefabricated membrane roofing system, what percentage of the seaming is done in a factory setting rather than on the rooftop during installation?**
   - A. Up to 25%
   - B. Up to 45%
   - C. Up to 65%
   - D. Up to 85%

5. **What is the impact of weather on the onsite hot-air welding methods used for single-ply membrane roofing?**
   - A. Hot-air welding cannot be done if the outdoor temperature is above 90°F.
   - B. Hot-air welding cannot be done if the outdoor temperature is below 40°F.
   - C. Hot-air welding cannot be done in damp conditions.
   - D. Hot-air welding methods are virtually unaffected by weather conditions.

6. **Labor is saved onsite with a prefabricated roofing membrane because seaming is done in a factory and then larger panels are delivered to the jobsite. According to the article, what is the maximum size of panel that is available?**
   - A. Up to 1,000 sq. ft.
   - B. Up to 1,500 sq. ft.
   - C. Up to 2,500 sq. ft.
   - D. Up to 5,000 sq. ft.

7. **After the 14-year-old tar and gravel roof deteriorated on San Francisco's Davies Symphony Hall, the team decided on a prefabricated membrane roof that would last a minimum 25 years. Why was the main driver for an extended anticipated service life?**
   - A. To ensure that the roof will last the life of a new rooftop solar array.
   - B. To prevent further disruption of street traffic from construction equipment.
   - C. The hall's endowment would not have more funds for 25 years.
   - D. San Francisco's unique codes require a 25-year service life for all roofs.

8. **Penetrations and transitions on a rooftop require extra quality control to prevent faulty installation, failures and future leaks. How is this extra quality control handled with a prefabricated membrane system?**
   - A. Extra workers are brought to the jobsite to fabricate the complicated flashings as needed on the rooftop.
   - B. Certified flashing specialists are brought in to fabricate the flashings onsite.
   - C. Flashings and accessories are prefabricated in the factory and delivered to the jobsite with the prefabricated membrane.
   - D. Membrane roofing does not require flashings.

9. **When the Joseph Kushner Hebrew Academy in Livingston, N.J. needed a new roof, a prefabricated membrane roof was specified. According to the article, what was the main concern of the decision makers?**
   - A. A relatively quiet and fume-free process to protect the health and safety of the occupants while the roofing was installed.
   - B. Meeting the budget.
   - C. Meeting a reasonable timeframe.
   - D. All of the above.

10. **True or False: The warranty for single-ply membrane roofing excludes coverage for ponding problems.**
    - A. True
    - B. False

END NOTES

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