Thermoplastic Single Ply Roofing — Will U.S. History Repeat Itself?

By Brian Whelan

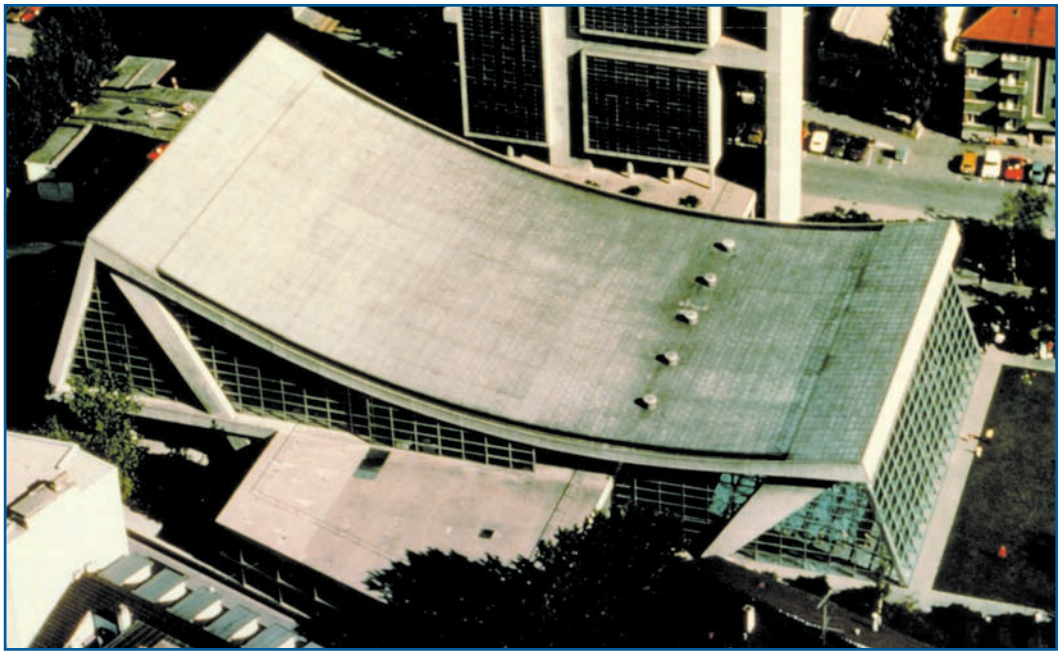
Thermoplastic roof membranes were first introduced and installed in Europe in the early 1960s. Almost a decade later, these membranes surfaced in the United States. At that time, most of the original membranes were based on vinyl (polyvinyl chloride - PVC) and were produced and supplied to the U.S. market by European companies.

Vinyl roofing was a well-received option in the 1970s, especially due to the oil crisis that had a major impact on the cost and quality of built-up roofing. Vinyl roof membranes were user-friendly and could be installed by a variety of attachment methods and under many different weather conditions. Today, vinyl roof membranes have the longest track record of any thermoplastic roofing membrane.

The use of PVC roofs continues to grow in the U.S., according to RSI's 2001 State of the Industry Report[1]. In 1999, PVC accounted for 7% of the average contractor's roofing volume. In 2001, that figure climbed to 10.07%. "There's a remarkable and rejuvenated interest in reinforced PVCs," said *RSI* technical consultant, Dr. René Dupuis.

Reinforced PVC roof membranes have many important attributes that complement their proven track record. Besides the important feature of heat-welded seam technology, PVC or vinyl roof membranes offer many other inherent features. These additional features include:

- System flexibility to match project and construction needs.
- A comprehensive history of product testing.
- An ability to be made in a spectrum of colors, including white reflective roofing that has proven to save energy, mitigate urban heat island effects, and improve air quality.
- High resistance to puncture and impact.
- Excellent resistance to flame exposure and subsequent fire propagation.
- Proven durability against rooftop soiling and contamination.
- Good low-temperature flexibility and high-temperature tolerance.
- Excellent roof installation productivity.



The Congress Center and Swimming Pool, Biel, Switzerland, has a Sarnafil PVC roof that was installed in 1964.

PVC - A Mixed Performance History

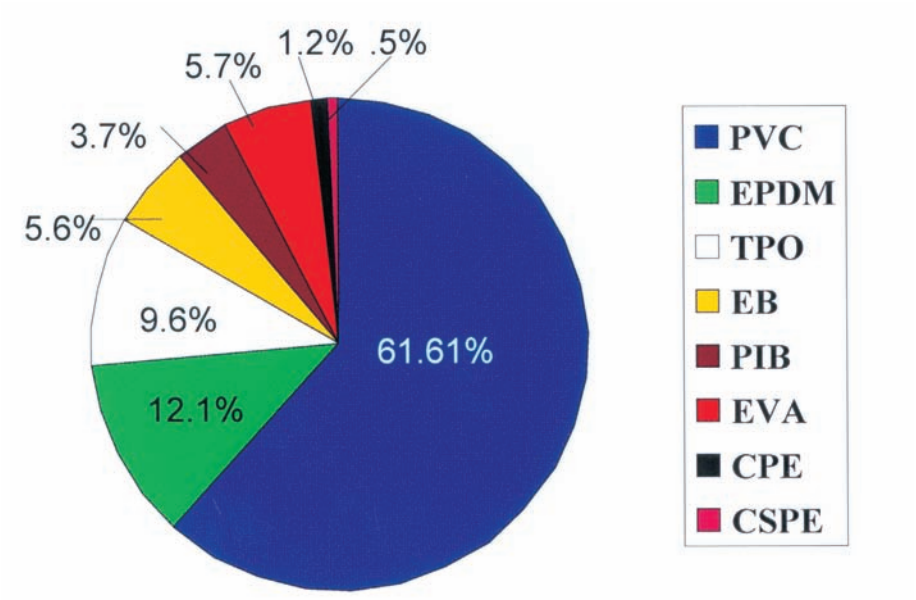
As mentioned above, quality reinforced vinyl membranes have a long history of installations worldwide. Many that were installed over 20 years ago in North America and approaching 40 years ago in Europe are still performing today.

Unfortunately, some vinyl roof membranes were not good performers. In the 1980s, there was a rash of problems with vinyl roofs installed in the late 1970s and early 1980s. A survey conducted by the National Roofing Contractors Association (NRCA) in 1990 indicated common denominators: thin membrane (commonly 32-40 mils), and unreinforced, poorly-formulated membranes installed in stone-ballasted applications. Many of these products were used successfully in mild European climates, but could not withstand the temperature swings that occur in much of North America.

The sometimes sudden and catastrophic failures of PVC roofs were well documented. The overall growth of vinyl roof membranes stalled in the late 1980s into the early 1990s due to this problem. Unfortunately, many people painted this product category with a broad brush, saying, "All PVCs are the same." There were a number of single ply formulations (i.e., CSPE-Hypalon, CPE) that were introduced in this time frame that have come and gone due to their poor performance. Throughout all this negativity, there were a few manufacturers who continued to produce high quality vinyl roof and waterproofing products. Some held their flag high while others disguised their colors by calling their products copolymers and alloys. The fact is that well-formulated, reinforced, dimensionally-stable vinyl roofing has one of the best track records in the roofing industry.

In the European market, vinyl roofing continues to grow.

European Single Ply Roofing Market 2001[2]



It is apparent that after close to 40 years in the marketplace, PVC continues to hold the lion's share of the European single ply market.

The 2001 European study states, "PVC material has emerged as the most cost-effective and proven single ply option. The outlook for PVC single ply membranes is thus positive, with volumes forecast to grow by between 3% and 4% per annum." This is in a market where the overall outlook for traditional flat roofing is not very positive, with projections of 0.7% to 0.9% growth.

TPO Comes Onto the Scene

FPO (Flexible Polyolefin) membranes were first introduced in Europe for roofing in 1991. They were quickly introduced in the United States (as TPO – thermoplastic polyolefin) in the early '90s. The U.S.-produced TPO membranes are very different from the FPOs in Europe:

- The average flexible polyolefin membrane in Europe is 0.064 inches (1.6 mm [63 mils]) thick. The most common TPO thickness in the U.S. is 45 mils. However, many of the products labeled "45 mils" actually have as little as 32 mils of actual polymer[3].
- One European manufacturer uses fiberglass reinforcement in addition to polyester reinforcement to improve dimensional stability. A reinforced TPO membrane will move (expand and contract) five to seven times more than a reinforced PVC membrane[4].
- At least one European manufacturer has determined that solvent wiping of seams is necessary before welding–even with new material–to achieve consistent seaming.
- One FPO manufacturer that also produces automatic, hot air welding equipment has introduced a patented, integrated prep nozzle that helps to scarify the membrane overlap prior to welding. The prep nozzle eliminates the need for cleaning of the seams prior to welding. For those who have worked with both membranes (PVC and TPO), it is clear that TPO needs more attention during the welding process.
- In Europe, a high-quality, well-produced FPO with a minimum polymer thickness of 60 mils is actually more expensive than high quality PVC membrane of similar thickness. In contrast, U.S.-produced TPO membranes are quickly becoming a commodity, price-driven product, typically sold much cheaper than PVC.

Flexible polyolefins for roofing were introduced in Europe in 1991. They quickly grew in popularity for four to five years, just as they have in the United States. Since then in Europe, their growth stalled, primarily because of what contractors perceive as problems with seam consistency and detailing. Here in the United States, TPO membrane usage continues to increase. At this time it appears TPO is taking away from EPDM and dark colored membrane market share.

A significant advantage of thermoplastic membrane is the ability to hot-air weld the seams.

Do TPO Membranes Meet Building Code Requirements?

Building code compliance for TPO membrane roof assemblies is unclear and should concern those involved with specifying and installing them. Model building codes do not provide specific approval criteria for TPO roof assemblies. This is partly due to the fact that there is no appropriate material standard, such as an ASTM standard, for the TPO membrane products. As a result, TPO roof membranes are not specifically approved by model building codes[5].

In addition, there are significant questions regarding the fire performance of TPO roof membranes. Much has already been written about the use of bromine as a fire retardant and its negative impact on the UV stabilizer package commonly used in a TPO roofing membrane formulation.[6] The NRCA conducted a study in 2000 that confirmed that two of the nine TPO manufacturers continued to use bromine as their fire retardant package.[7] The others used magnesium hydroxide as the fire retardant. Although magnesium hydroxide is more compatible with the UV package, it is yet to be determined what the long-term effects on fire performance will be.

Dr. René Dupuis presented results of fire testing of the five leading TPO membranes produced in the U.S. during the Midwest Roofing Contractors Association Convention held in Chicago in September 2002. The results were alarming. Not one TPO membrane roof assembly with membrane applied directly over isocyanurate insulation at 1/4" per foot slope passed a Class A rating. Dens-Deck® was needed to keep the spread of flame (ASTM E-108 Test) below 6' (Class A Rating).

U.S. TPO producers openly admit they are still working on the membrane formulation. The chemistry is not finalized yet.

A Word of Caution

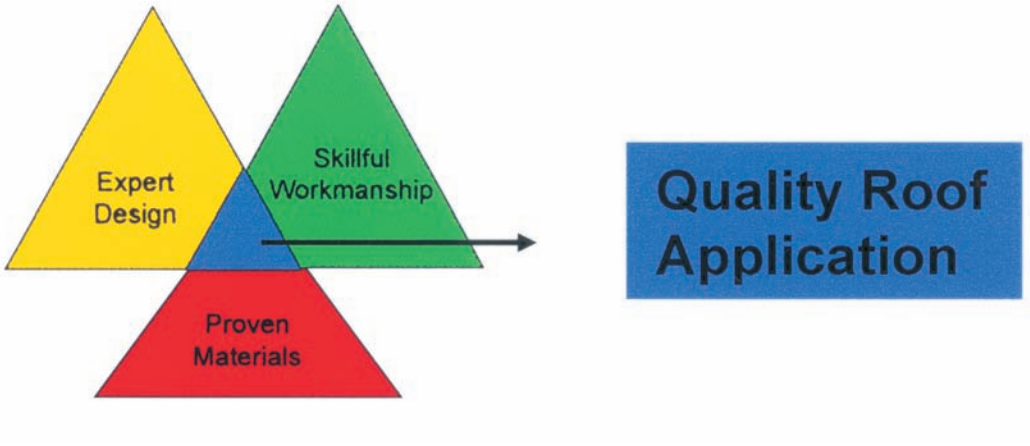
We see similar things happening to TPO in the U.S. that we saw in the 1970s and early 1980s with PVC membranes. Manufacturers must think quality first and quantity second. A high-quality TPO membrane with a proven, consistent formulation, when properly installed, can result in a very good roof. However, evidence is mounting that a compromise on material quality and inadequate seaming training are resulting in problem TPO projects. A number of owners, specifiers, and contractors are concerned about what the performance of U.S.-produced TPO has been to date. One of the major retailers in the U.S. has just eliminated TPO from its corporate specifications after using it almost exclusively for years. One major membrane manufacturer had a recall on its initial TPO formulation. If TPO manufacturers are not careful, they will create a negative perception of TPO membranes and potentially all thermoplastic roofs. Sound familiar?

To specifiers, we recommend caution in selecting quality products and companies with a track record. Be careful with dark-colored TPO membranes or TPO membranes that use brominated fire retardants. Adhered TPO membranes may also be problematic. They move too much, and glues don't like to stick to them.[8] Establish a minimum number of years of expected consistent membrane formulation with a track record and include those requirements in the specification. Establish a desirable minimum polymer thickness (the European experience

suggests 60 mil minimum) and specify it. Establish the proper product and system based on the occupancy of the building and the sensitivity to roof leakage or failure. A property owner who is going to sell the building within 10 years may need a very different roof than what a computer chip company needs.

PVC and TPO may look alike but are very different products and will perform very differently. Just because they look similar and are heat weldable, a generic specification containing both PVC and TPO will not mean similar results. If price is the deciding factor, the customer will get the cheapest product, not the best long-term value!

Expert Design + Proven Materials + Quality Installation =
QUALITY ROOF



The Future is Bright

According to the Single Ply Roofing Institute (SPRI), thermoplastic (PVC and TPO) roof membranes have been the fastest growing product category of the commercial/industrial flat single ply roofing market. Although TPO membranes are getting most of the press, vinyl roof membranes continue to outsell TPO.

With the trend to white, reflective, energy-efficient, heat-weldable single ply roof systems, the future is bright. The introduction of wider membranes and double weld seam technology will build more competitive and better wind performing roof systems.

The formula for a successful roof is noted here and in the chart above: Expert Design + Proven Materials + Quality Installation = Quality Roof. ■

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About the Author

Brian Whelan has been employed by Sarnafil, Inc., the worldwide leading producer of thermoplastic roofing and waterproofing membranes, for 20 years and is currently the vice president of sales and marketing. Whelan spent five years as the general manager of Sarnafil Services, the construction management division of Sarnafil, Inc., and six years as the technical director of Sarnafil's Roofing and Waterproofing business. He jointly has two patents and another pending on hot air welding of thermoplastic membranes and profiles. Prior to joining Sarnafil, Inc., Brian was a project manager for the consulting/engineering company of Simpson, Gumpertz & Heger. Brian is a graduate of Harvard University's Business School PMD program and has a degree in Architectural Technology. He was one of the original members of SPRI (Single Ply Roofing Institute), where he later became member of the board of directors and chairman of the thermoplastic subcommittee. Whelan is a member of the RICOWI Board of Directors and has been a member of both RCI and CSI for over 10 years. He has participated in many ASTM committees on roofing and waterproofing, as well as published numerous articles on roofing and waterproofing. Brian lives in Canton, Massachusetts, with his wife Mary Kay and two daughters, Brianna (12 years old) and Michelle (10 years old). Brian enjoys sports of all kinds, especially skiing, golf, and baseball.

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