New Concepts and Materials For Roof Designers to Consider

By René M. Dupuis, Ph.D., PE

Roof consultants and designers select membranes to use in their specifications primarily based on performance. Since performance is measured in years of leak-free service, we are forced to think in the past, not the future. New materials are not directly sought out or met with open arms in the roofing industry; the related product development effort needed to bring them to market is costly and time consuming. These facts work against change in our industry and help keep existing products in use for decades.

Today, needs for new roofing materials are driven by both performance and environmental issues. Code compliance is another weighty issue, especially fire and wind resistance. New product development is driven quietly but with unrecognized force. This paper will examine new concepts that may be forthcoming along with the justification for doing so. New membrane materials are under development; the cost-benefit analysis at this time shows major risk involved.

The ASTM standards are written from a minimal viewpoint; that is, meeting the ASTM standard implies a product has met some minimum value for tensile, elongation, etc. It is interesting to note that TPO has been commercially available since 1992. The current draft of an ASTM standard for TPO may finally pass. If it does, ten years will have elapsed from the time of introduction (1992) to having a minimal ASTM standard for TPO. Thus, we have living proof that new materials coming to market take an unreasonably long time before roof designers can refer to a recognized standard. Standard writing can be a slow and laborious process; a process which also inhibits the development of new materials or changes in the industry.

Built-up Roofing

This historic roof system has been with us for over 100 years in one form or another. Its popularity is high and comfortably founded on past performance. To its credit, BUR covered every type of building designers could imagine.

Lightweight construction, structural movement, and poor materials (at specific periods in the past) led to single ply membrane use. Single ply was not welcomed universally; in fact, the 10-year roof warranty was born with the single ply movement. Without the 10-year warranty, owners simply were not going to take a chance on performance. The 10-year warranty is now expected as a minimum in low slope roofing. Any new product that intends to break into our market must now provide at least a 10-year warranty. Built-up roofs never had to promise performance; in fact they preceded many codes that are in use today.

The United States version of the built-up roof uses organic, fiberglass, and polyester felts. We do not see a wholesale change in felts; however, a new fiber product that is heat stable at 450ºF could displace fiberglass felts if it were competitive.

The primary waterproofing and adhesives used in BUR roofs are asphalt, coal tar, or modified asphalt. Herein lies a potential change: health issues and the perception by the public at large that any offensive odor is damaging to their health may drive development toward the wholesale use of cold process materials. Thus, hot mopping could become a thing of the past, allowing for cold process bulk materials to replace hot kettles, tankers, and their associated hardware.

Cold process is desirable from many aspects; it was used in the past when felts were much weaker than today's fiberglass and polyester felts. The primary difficulty with cold process is in the time needed (30 days or more) for the solvents to evaporate off the finished membrane. Cold process works well with modified bitumen membranes but the solvents leave these membranes soft and subject to damage from foot traffic.

Modified Bitumens

These products are basically prefabricated versions of a built up roof as they are composed of fiberglass, polyester, or a combination of both, embedded in a waterproofing medium of modified asphalt or coal tar. Cold process adhesives can join multiple plies together, negating the need for hot mopping of bitumen. Torch-down versions of modified bitumen will be around for a long time, provided that flameless heat welding devices are used.

In summary, we could see hot methods for applying bulk asphalt or coal tar disappear if a fast-acting, low-odor, cold process solvent became available. The objective of switching from a hot process to a totally cold process will, however, be only partially met. Fiberglass felts could be displaced by another fiber, provided it is heat stable and economically competitive. While this is the historic material segment of the low slope roofing industry, some change should be expected. Efficient cracking of crude oil may limit roofing asphalt availability in the form we know it today. On the other hand, refiners may bring us a cold process solvent currently working in roadway paving that, with slight modification, could be ideal for roofing.

Single Ply Technology

The use of single ply roof materials now gravitates around EPDM. This product is well beyond 25 years of use and is approaching 30 years in national specifications. Reinforced PVC and TPO are picking up the remaining market share. Plain EPDM (non-reinforced) will continue to be available. Competitive forces may cause both plain and reinforced EPDM to lose popularity with designers and contractors. White reinforced TPO can offer high reflectivity at an in-place cost equal to or less than EPDM. Here a change in technology has allowed a fairly new product (TPO) to begin displacing the oldest performing single ply (EPDM). Copolymer manufacturing techniques are now available, yielding thermoplastic materials that can be extruded in sheet widths heretofore unavailable: 10′, 12′, and 14′ widths.

This raises a number of questions for future materials. Will thermoset products decline and never be in the majority again? Perhaps, but keep in mind that thermoset materials, such as EPDM, have proven to be superior in weatherability. Thermoplastics have the one quality, weldability, which thermosets do not. A new polymer could be introduced that has weldability as well as long-term performance of a thermoset like EPDM.

Large extruders are now making wider sheets available, namely 12- to 14-feet-wide products. The single ply market enjoys popularity for mechanically fastened systems due to the speed of installation. Can our vast inventory of aged metal decks hold down these wide membranes? Probably not; the new extra strength fastener is not the answer. It is the answer for new construction where the grade of steel deck and method of deck attachment can be specified. These 12-foot (or more) wide sheets can only be used on a few of the existing steel decks unless we re-engineer the existing deck system. Cold-formed steel stiffener plates may have to be designed and retrofitted to existing steel decks before 12-foot-wide sheets can be universally installed. These new cold-formed steel profiles may need to be 18 gauge or heavier; they will also require direct mechanical attachment to the steel bar joist. One problem unforeseen by the wide sheet single ply manufacturer is the lateral loading limit of 22 gauge steel deck, especially if it is poorly attached or has broken puddle welds.

In summary, single ply technology is strongly pursuing reinforced thermoplastics and jumping to wide sheets (12 to 14 feet). The wide sheet technology may be acceptable for ballasted or adhered systems. It will become problematic if blindly used on the existing steel deck inventory without deck modification. This is even more important in view of the higher wind speed resistance being specified for some areas.

Spray Foam

Spray foam and low-rise spray foam adhesives will continue to grow in use. New adhesive formulations may allow for a wider window of application temperature. Spray foam as a flashing system for other roofing systems may come into use. Spray foam has the ability to adhere to many construction materials, including masonry, metal, and wood. Given that membrane roofs (including built-up and single ply) can have flashing failures before failure in the field, spray foam as a flashing system may offer many long-range possibilities. In the future, hybrid roof systems may become a specification reality. Presently, a handful of consultants and designers have made use of the hybrid concept of spray foam flashing with a membrane roof.

Rigid Foam Board Roof Insulation

Environmental concerns for the ozone layer have forced manufacturers of rigid foam (polyisocyanurate and extruded polystyrene) roof insulation to change blowing agents. New blowing agents are now available in various forms, including pentane. This segment of the roofing industry has undergone change in the past ten years and will probably see more. Designers will need to be aware of specific blowing agents in use, as the aged R-value (thermal resistance) will be somewhat dependent on the blowing agent. The polyisocyanurate insulation manufacturers have endorsed the use of the long-term thermal resistance (LTTR) method; this will make it easier for designers to know the particular aged R-value on the polyisocyanurate board they are using.

Currently, many of the facer materials used on polyisocyanurate rigid foam board insulation contain paper as the primary material. The issue of mold growth and propagation on organic building materials is of concern. The use of paper and glass facers may continue, but look for several new facer technologies to appear. The attempted use of recycled thermoplastics as a facer material occurred some time ago. Additional research is underway; we may see some new facer materials shortly that will not host or support mold growth in the presence of water.

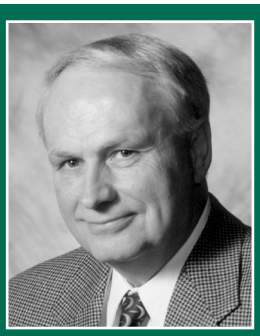
Conclusion

Each material segment of the low slope roofing industry will see some change in the foreseeable future. Environmental concerns may drive much of the development. New polymer technologies may impact single ply systems the most. Cold process materials may improve and become more popular with consultants, designers, and contractors, allowing for the continued use of bitumen materials.

Wide sheet, reinforced, single ply technology has, in the author's opinion, now surpassed the capability of numerous existing steel decks to hold it in place during high winds. Given the large and varied inventory of steel roof deck, a structural review along with deck modification will be needed before installing wide sheet, mechanically-fastened, reinforced, single ply roof systems.

Other outside forces will continue to affect change. Insurance requirements and stricter code demands will help drive the change for newer materials and better installation methods. Long-term fire ratings of pre-
manufactured roof membranes may also become a concern as our roofs last longer today than ever before. This is due to the dedicated effort of many, including designers, manufacturers, and roofing contractors. ■

About the Author



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René M. Dupuis obtained his B.S., M.S., and Ph.D. degrees in Civil Engineering from the University of Wisconsin at Madison. He has worked for the National Science Foundation, the University of Wisconsin, and was an Assistant Professor at the State University of New York at Buffalo. He is a Professional Engineer and a principal and President of Structural Research, Inc., a consulting engineering firm located in Middleton, Wisconsin. Since 1974, Dr. Dupuis has been involved in materials research with much of this effort devoted to the roofing industry as a consultant, with emphasis on built-up roofing, single ply systems, and insulation materials. He has written and presented many articles and research reports on roofing materials technology and has conducted numerous investigations for building owners, architects, contractors, and manufacturers. Dr. Dupuis is a member of ASTM, CSI, NSPE and ASCE. He has participated in numerous roofing conferences throughout the United States, Canada and Europe. He participated as a member of the CIB/RILEM International Committee on Single Layer Roofing and served on the Roof Advisory Panel for the DOE/Oak Ridge National Laboratory's Roof Test Center. Dupuis has served as Technical Advisor to the Midwest Roofing Contractors Association (MRCA) and the National Roofing Contractors Association (NRCA).

