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Material Choices and Resource Use

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Specifying the right products can have a huge impact on sustainability. The steps involved in processing materials, such as extraction, processing, and transportation, can pollute air and water and use up natural resources. Using recycled or salvaged materials can help minimize waste products, while selecting local or lightweight materials can potentially reduce the environmental impact of transportation.[1]

Spray polyurethane foam
Performance studies and research suggest spray polyurethane foam (SPF) roofing systems can last more than 30 years. They frequently require little maintenance, can add structural strength, minimize moisture damage within the building envelope by fending off impact damage from hail and wind-driven debris, and are resistant to the effects of high wind blow-off.[2]

Field observations of SPF performance during Hurricanes Allen, Hugo, and Andrew led the industry to conduct laboratory testing of SPF systems at Underwriters Laboratories Inc. (UL) and Factory Mutual (FM). Spray polyurethane foam's wind-uplift resistance exceeded the capacity of UL's equipment, and the testing organization also observed SPF applied over built-up roofs (BURs) and metal roofs increased the resistance of those coverings.[3] An SPF roofing system limits moisture intrusion because of its 90-percent closed-cell properties. Many types of damage to the system cause no leaks into the building, and moisture intrusion is isolated to the areas of damaged foam cells.

According to Oak Ridge National Laboratories (ORNL), the need for multiple roofs makes roofing one of the largest contributors of solid waste.[4] Since SPF adds little weight and can be applied in various thicknesses to add slope and fill in low areas, SPF roofing systems are often used as a recover system over existing roofs, without tear-off. Therefore the application of SPF roofing systems over existing roof coverings can greatly reduce the amount of construction debris in the nation's landfills.[5]

Spray polyurethane foam's on-site application process also generates very little debris and waste. A typical 929-m2 (10,000-sf) roofing project produces less than 0.4 m3 (0.5 cy) of scrap SPF, tape and plastic (used for masking), and from 0.5 to 11.4 L (0.125 to 3 gal) of waste solvent (depending on type of protective covering used). When compared to the typical re-roofing project that produces more than 7.6 m3 (10 cy) of construction debris from tear-off and application waste, the material's advantages in sustainability become clear. As a further testament to SPF's green possibilities, there is currently so little scrap of the material its recycling is impractical.[6]

Franklin and Associates Ltd.'s 1991 study, Comparative Energy Evaluation of Plastic Products and their Alternatives for the Building and Construction and Transportation Industries, compares the total energy requirements for the manufacture of plastic products to the total energy requirements for the manufacturer of the alternatives. The unique feature of this type of analysis is its focus on all the major steps in the manufacture of a product—raw material extraction from the earth, fabrication, and even transport—rather than a single manufacturing step.

The study concludes plastic products in the building and construction industry use less energy from all sources than the alternative materials. According to the report, polyurethane foam insulation saved 3.4 trillion BTU in manufacturing energy over other insulation in 1990. One trillion BTUs are equivalent to almost 170,000 barrels of oil and approximately 28.3 million m3 (1 billion cf) of natural gas.

Vinyl

Many vinyl products have low ‘embodied energy,’ which means the amount of energy required to convert the raw material into a final product is lower than for many alternatives. A study by life-cycle analysis (LCA) and solid-waste management consultant firm, Franklin Associates, has shown vinyl windows require only about one-third the manufacturing energy compared to products made of traditional materials.[7]

The relatively light weight and compactness of vinyl roofing membranes (approximately 14.4 pascals [Pa] [0.3 psf]) makes for energy-efficient transportation of the product to the installation site. The manufacturing process for vinyl roofing membranes is also more energy efficient than that of some alternatives. However, vinyl’s most notable advantage in energy efficiency comes in the use-phase of the product. Since they are typically light in color, vinyl roofing membranes are known as ‘reflective’ roof surfaces, reflecting sunlight and radiant heat away from a building, and thereby helping the structure to stay cool, while reducing energy use for air conditioning.[8]

Polyisocyanurate

Polyisocyanurate (polyiso) is often reused when building renovations include roof re-cover applications or partial tear-offs, in which only the membrane is removed. The material has a 15-year long-term thermal resistance (LTTR) value and thus can often be reused when a roof is replaced. Polyiso insulation can also be part of a waste management plan, aimed at diverting debris from landfills, redirecting recyclable recovered resources back to the manufacturing processes, and allocating reusable materials to appropriate sites.

Virtually all polyiso insulation is manufactured using recycled material, with the percentage of the recycled material indicated by weight depending on the individual manufacturer and the product thickness. Many facers on polyiso products contain up to 100-percent recycled materials.[9]

Expanded polystyrene

Expanded polystyrene (EPS) building products can be made with recycled content and is the only rigid foam material that can incorporate recycled content via the regrind process explained below.[10] EPS manufacturers normally incorporate recycled content into their products by blending used expanded particles from products they take in and grind down to bead level. Technical considerations generally limit the level of recycled content loading to avoid compromising the integrity of the product. Other EPS waste can be reground and mixed with concrete to produce new building products, such as prefabricated concrete blocks. Adding EPS regrind increases the thermal performance of these applications in addition to providing an alternative to landfill disposal. Another example of recycled content EPS use can be found in commingling plastics products, such as decking, lumber, and interior trim.

The performance properties of rigid-foam expanded polystyrene insulation generally reduce labor and material needs. EPS can also help provide an environmentally sustainable structure with long-term thermal resistance. EPS is custom-manufactured to meet specifications for the required R-value, compressive load, and other project demands that can help minimize waste.

For example, when designing a project using structural insulated panels made with EPS, architects are able to provide a manufacturer with the exact dimensions needed, decreasing excess waste on-site. The benefits are not solely environmental—structural insulated panels (SIPs) are joined together quickly and easily by inset splines. According to many manufacturers, an experienced three-person crew can complete the panel erection of a standard 186-m2 (2000-sf) house in as little as one day and completely 'dry-in' in as little as three days.[11] Structural insulated panels also offer another potential sustainable advantage in that they are constructed by sandwiching EPS foam sheathing between oriented strand board (OSB). This renewable resource is made from fast-growing timbers, demonstrating an efficient use of resources.

Extruded polystyrene

Extruded polystyrene (XPS) can also potentially achieve points for green-building rating systems in categories dealing with building and resource reuse. Extruded polystyrene insulation products have a proven long-term insulation performance and may be reused depending on installation techniques and attachments. They can employ polystyrene that has been recycled from post-consumer material or from up to 40-percent post-industrial material.[12]

Notes

[1] Many different plastics manufacturers have plants throughout the country; selecting a facility within 805 km (500 mi) of the project site fulfills requirements in some rating programs to reduce transportation impacts on the environment.

[2] This information comes from a 1996 Low-slope Sustainable Roofing Conference seminar by Mason Knowles, entitled "Sustainability Characteristics of SPF Roofing Systems."

[3] This information comes from a 1996 Mason Knowles presentation at the Association of Collegiate School of Architecture (ACSA) Construction Materials and Technology Institute, entitled "Energy Conservation and Thermal Envelope Design Using Polyurethanes, Spray Polyurethane Foam."

[4] See ORNL's Building Thermal Envelope Systems and Materials: Update (Envelope Research Center, 1996).

[5] See note 2.

[6] See note 3.

[7] TK

[8] For the results of a study on how vinyl roofing membranes lowered plenum temperatures and air-conditioning costs, visit www.vinylbydesign.com/coolroof.

[9] Recycling varies from state to state. Check to see if recycling is available in your area.

[10] See previous footnote.

[11] For more information on SIPs, see "ICF SIP 101," by Deniz Carroll in the May 2005 issue of Modern Materials.

[12] See footnote [9].