XPSA
EXTRUDED POLYSTYRENE FOAM ASSOCIATION
Technical **INSIGHT**

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Making Sense of the ASTM C578 Types of Rigid, Cellular Polystyrene Insulations

Understanding the Differences between the "Types" of EPS and XPS

For projects involving polystyrene foam, a building enclosure consultant, engineer, or architect requires understanding the 14 RCPS classification types listed in Table 1 of ASTM C578. They are numbered I, II, and IV to XV. (Type III has been discontinued.)

The columns in ASTM C578 Table 1 do not list the types in numerical order, but there is a logic to how the columns are arranged:

- Types XI, I, VIII, II, IX, XIV, and XV are listed in the first seven columns. These are typically EPS insulations.
- Types XII, X, XIII, IV, VI, VII, and V are listed the next seven columns. These are typically XPS insulations.
- Within each of set of seven columns, the types are then listed in order according to their specified minimum value for compressive resistance. The first row gives the compressive resistance for each of the 14 types, ranging from 5.0 to 60.0 psi for the EPS types and from 15.0 to 100.0 psi for the XPS types.

Note that ASTM C578 does not specify that EPS or XPS products must be assigned to specific types. For example, there is no requirement that only XPS products can be classified as Type X or that only EPS products can be classified as Type XII.

So long as the product meets the standard's specifications for a type, it can qualify as that type. Realistically, however, there is widespread industry agreement regarding "EPS types" and "XPS types." Manufacturers rarely market an XPS product as one of the EPS types. The paper ignores those rare exceptions and informally refers to EPS types and XPS types. (Note: Type XIII, a specialized type of RCPS for pipe insulations, is not relevant to this article.)

The first row in Table 1 of ASTM C578 gives the standard for minimal compressive resistance because compressive resistance is an important physical property to specify in design documents. Compressive resistance determines how much load can be placed on the RCPS foam board. Although 100 psi is only a fraction of the compressive resistance of steel (25,000

psi) or concrete (up to 10,000 psi), the compressive resistance of the foam boards could be a key specification for a protected membrane roof assembly, a basement floor, or an airport runway, to give a few examples. Obviously, RCPS foam board is not meant to be a structural material. However, when the load is distributed, a compressive resistance of 100 psi could adequately support vehicular traffic in plaza decks or airplanes taking off from or landing on an insulated airport runway.

Typical *R*-Values

The second row in ASTM C578 Table 1 lists the minimal thermal resistance as measured at 75°F. Thermal resistance varies significantly with temperature. In general, the *R*-value of RCPS decreases as the temperature increases. In other words, *R*-values are consistently higher at 25°F and 40°F compared with 75°F and 110°F for both EPS and XPS types **(Fig. 1)**.

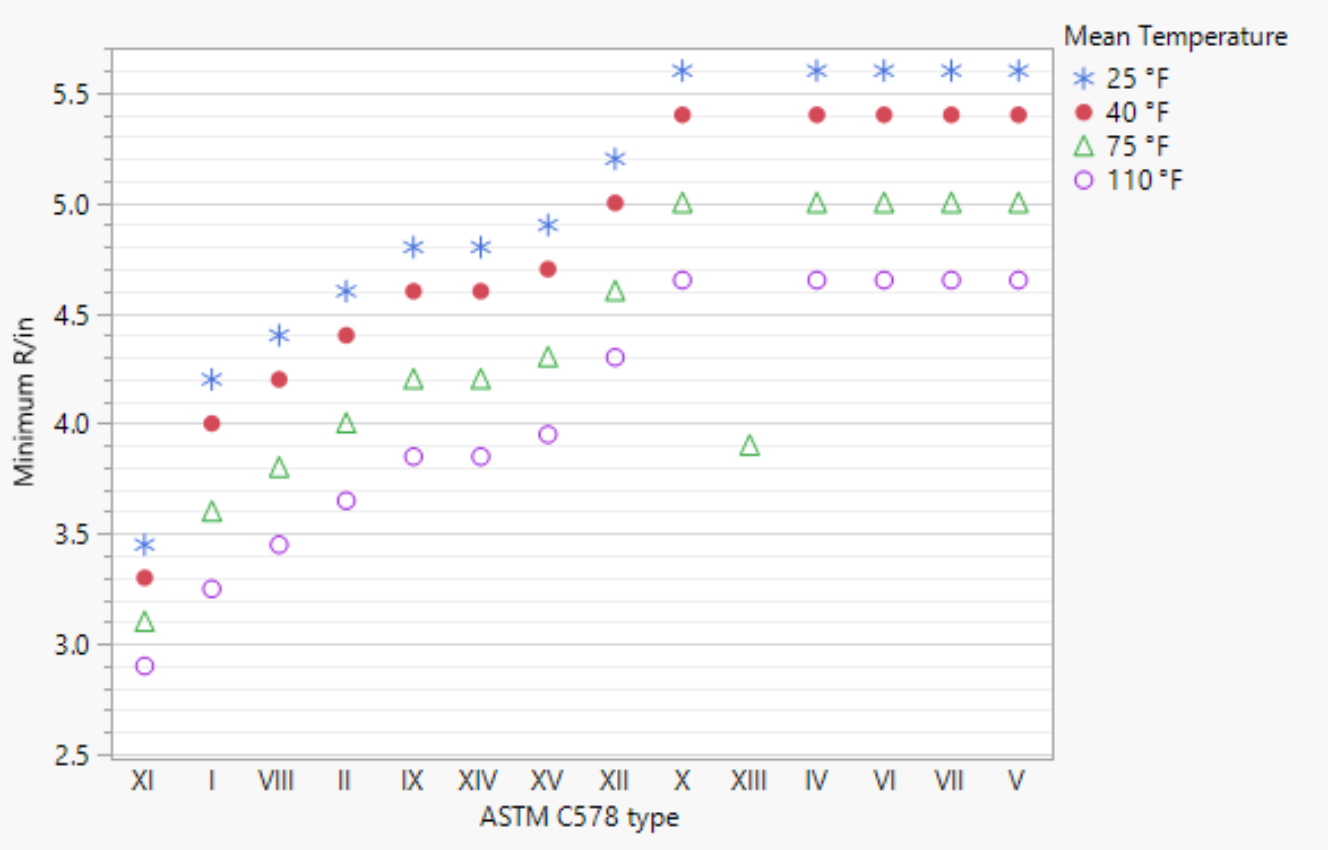
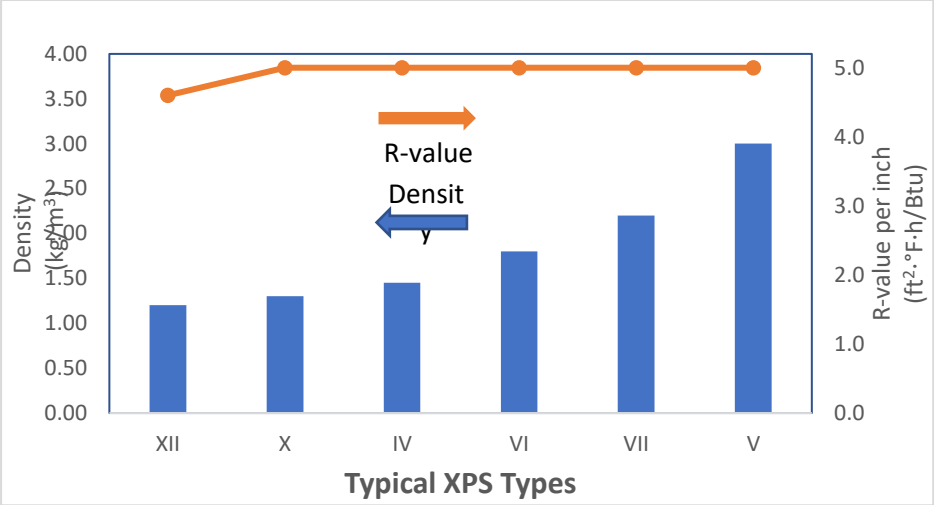


Figure 1. *R*-value per inch increases as temperature decreases for both "EPS types" and "XPS types" of rigid, cellular polystyrene insulation in the ASTM C578 classification [1]. Note: EPS = expanded polystyrene; XPS = extruded polystyrene.

In ASTM C578, the table that recommends minimum *R*-values at 25°F, 40°F, and 110°F is Table X1.1 in Appendix X1. As noted earlier, that appendix is intended to collect "nonmandatory" information. However, these higher *R*-values at lower temperatures are relevant when specifying insulation for colder climate zones or environments.

At each of the test temperatures, five of the XPS types (X, IV, VI, VII, and V) are specified in ASTM C578 to have the same minimum *R*-values per inch, which plateau at 5.60, 5.4, 5.0, and 4.65 for temperatures of 25°F, 40°F, 75°F, and 110°F, respectively. That is remarkable considering that other performance characteristics vary substantially for these five XPS types. This is because *R*-values have less correlation with density for XPS types and a much stronger correlation for EPS types. Furthermore, **Fig. 2** shows that the *R*-values for XPS types are consistently higher than the *R*-values for EPS types of similar densities.



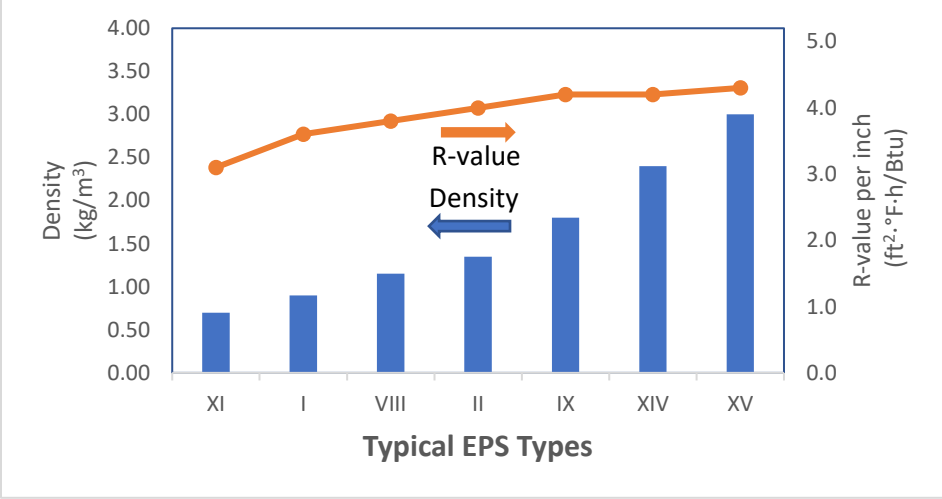


Figure 2. *R*-value increases with density for both "EPS types" and "XPS types" of rigid, cellular polystyrene insulation in the ASTM C578 classification [1], although *R*-value peaks at higher values and relatively low density for XPS types. Note: EPS = expanded polystyrene; XPS = extruded polystyrene. Values are from ASTM C578.

Density is perhaps the least relevant material property of RCPS foam boards in terms of building enclosure design. The additional load on a building from the weight of RCPS foam boards is negligible. Density may only be relevant when calculating the buoyancy of the foam boards used on a protected membrane roof assembly or a flotation device. In those cases, there will need to be enough ballast to keep the foam boards from floating. Also, the weight of the protected membrane roof assembly is relevant to the design for wind uplift resistance.

References

1. ASTM International. 2023. *Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation*. ASTM C578-23. West Conshohocken, PA: ASTM International.