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Sealants, Adhesives and Their Application to Mortar Net Solutions Products

The performance of sealants and adhesives applied to the substrates used in various Mortar Net Solutions products is critical to the performance of the systems in which they are used. This document provides background information on the use of sealants and adhesives, discusses test methods and results, and concludes with recommendations on the use of MPE-1 and BTL-1 with other products by Mortar Net Solutions.

Sealants vs. Adhesives

Typically, gun-applied formulations are used both as sealants and adhesives, though the two functions are not identical. As commonly used in construction applications, sealing refers to the ability of the formulation to block liquids and vapors. The strength of the bond to the substrate and the failure mode—adhesive or cohesive[1]—is of low importance as long as the penetration of liquids and vapors is prevented. Formulations functioning as adhesives are looked to have sufficient bonding strength to maintain the level of mechanical stability between the bonded surfaces suitable for the application. The sealing and adhesive functions sometimes are combined into a single product referred to as a "structural sealant."

Adhesion Mechanisms

The most interesting mechanisms of adhesion are chemical and mechanical, and both mechanisms are present in all interactions between sealants/adhesives and substrates, though in different degrees depending on the combinations of materials.

In chemical adhesion, molecular forces between the adhesive and substrate bond the two materials to each other. The strength of the adhesive bond depends on the reactivity of the adhesive and substrate materials in contact with each other. Materials of low surface energy have less tendency to bond and, conversely, high surface energy materials bond more readily and stronger. Surface energy is the characteristic of the substrate that determines its bonding tendencies. For example, with Mortar Net MPE-1 modified polyether formulation, chemical bonding dominates adhesion.

If MPE-1 is applied to substrates above a critical surface energy, strong bonding will occur and the failure mode in a peel test will be cohesive. If applied to a lower energy substrate, the failure mode will be adhesive.

Mechanical bonding typically depends upon the formulation filling the irregularities always present on a surface to create mechanical "hooks." Mechanical bonding is the main means of adhesion by Mortar Net Solutions BTL-1 butyl sealant. The failure mode of BTL-1 is typically cohesive. This means that the bonding strength to the substrate is stronger than the internal tensile strength of the BTL-1. The BTL-1 formulation has a cohesive failure strength, while maintaining strong adhesion, indicating that it is suitable for use as a sealant in most cases, but applications using it as a high strength adhesive are not recommended. The only applications in which it might be considered an adhesive are those in which its low tensile strength is adequate for the particular situation, such as the points at which TotalFlash® Masonry Cavity Wall Solution panels or rolls overlap each other or overlap CompleteFlash™ one piece, injection molded corners and end dams. In these situations, BTL-1 has more than adequate adhesive strength and excellent sealing properties.

[1] In cohesive failure the adhesive remains bonded to both surfaces and the failure is determined by the tensile strength (resistance to stretching) of and within the adhesive. In adhesive failure the adhesive separates from the substrates under test.

Measuring the Strength of Adhesion

Adhesion usually is measured by a 180 degree peel test. In this test a stainless steel mesh is used as one substrate and the test material as the second substrate. Stainless steel has a very high surface energy, so it bonds strongly to adhesives. The stainless mesh and test substrate are joined by the adhesive and fully cured. During testing the mesh and the substrate are clamped into a test apparatus in which one is held stationary while the other is pulled at a constant rate (2 in/min is a common speed) such that peeling occurs. The test setup is shown in Figure 1. In Figure 2, note that the adhesive on the right remains attached both to the mesh and the substrate, indicating separation within the thickness of the adhesive, showing a cohesive failure. The left strip shows no adhesive attached to the substrate. The entire thickness of the adhesive was removed from the substrate, indicating an adhesive failure at the interface of the sealant and substrate.

Figure 1 Peel test setup

Figure 2 Adhesive failure (L) Cohesive failure (R)

During the peeling, the force is measured and a series of data points of force stated in pounds per linear inch (pli)[2] versus position are plotted on a graph (see Figure 3) showing plots of peel test results of three samples. Fifty data points were taken at 5 second intervals with a pull rate of 2 inches per min.

The variations within each sample are normal and typically relate to sample preparation variables—adhesive thickness, for example.

According to the ASTM C920 Standard Specification for Elastomeric Joint Sealants, an average value of 5 pli is a typical target for acceptable adhesion in construction applications. To insure adequate adhesion for MPE-1, Mortar Net uses an internal specification as follows: average > 6.5 pli and mean minus 1 standard deviation > 5 pli with >75% cohesive failure. For sample A2 above, the mean is 8.3 and the standard deviation is 2.6 pli. 8.3 – 2.6 yields 5.7

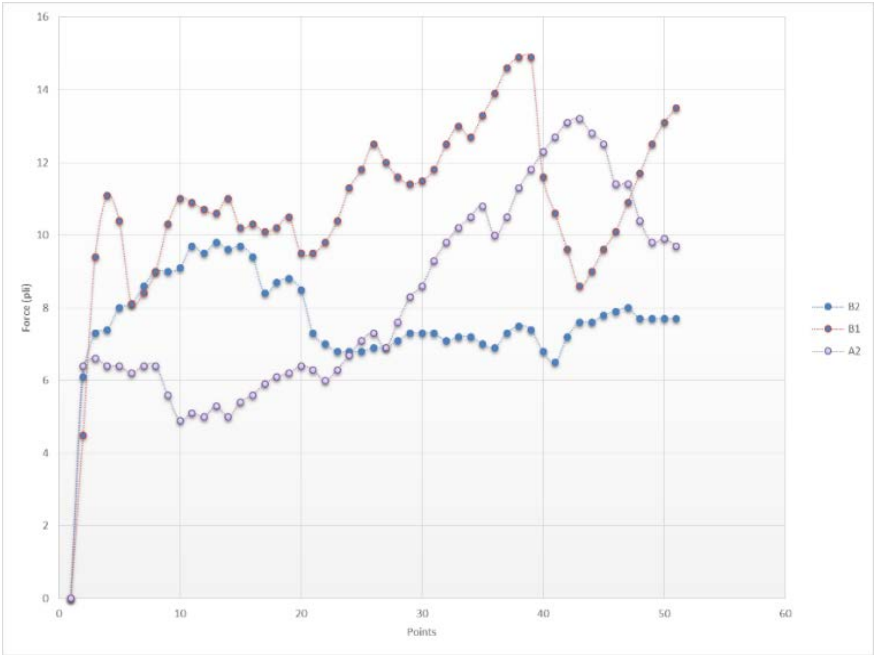

Figure 1 Adhesion force versus position

[2] The "inch" referred to in pounds per linear inch (pli) is the *width* of the adhesion, not the length. For example, the force to peel a particular sample with an adhesive strip 2 in wide might be 6 lb, or 3 pli. If the same adhesive and substrate had used an adhesive strip 3 inches wide, the force would have been 9 lb, resulting, once again, in 3 pli.

pli, exceeding the internal criteria to pass. The failures were 100% cohesive.

Testing BTL-1 with an EPDM substrate shows 0.1 pli and 100% cohesive failure. MPE-1 with the polypropylene-copper sandwich (MultiFlash™ by York Manufacturing) shows a similar adhesion strength (0.1 pli) with adhesive failure. Though neither result is acceptable for a structural adhesive, the cohesive failure mode of BTL-1 indicates that it will maintain continuity across the sealant after limited mechanical movement and continue to function as a sealant, while MPE-1 would not bridge any gaps in the event a tensile force (a force tending to pull apart the joint) was applied. Therefore, BTL-1 is an acceptable sealant, despite its low structural capability. MPE-1, when applied to substrates in which it will fail adhesively, can be an effective sealant only if the mechanical structure is stabilized by other means, such as screws. Generally speaking, adhesive/substrate combinations that exhibit adhesive failure are not recommended.

Mortar Net has tested its MPE-1 and BTL-1 formulations with the membranes available for TotalFlash and the materials of the injection molded corners and end dams. There are many other sealants/adhesives on the market which may perform well with Mortar Net products. However, the quality and consistency of their formulations are beyond the control of Mortar Net, so our testing and recommendations relate only to Mortar Net MPE-1 and BTL-1. The results of Mortar Net testing and recommended applications are summarized in Table 1, below.

Substrate	Application	MPE-1	BTL-1
EPDM	TotalFlash membrane	✓	✓
Synthetic rubber/polypropylene	Corners and dams	✓	✓
Rubberized asphalt	TotalFlash membrane	See note[3]	✓
Thermoplastic vinyl (PVC)	TotalFlash membrane, termination bar, corners and dams	✓	✓
Copper with polypropylene composite	TotalFlash membrane	×	✓
Thermoplastic polyolefin (TPO)	TotalFlash membrane, corners and dams	×	✓
Stainless steel	Drip edge and termination bar	✓	✓
Kynar® coated steel	Drip edge	✓	✓

Table 1 ✓= acceptable, ×= not acceptable

Mortar Net Solutions MPE-1 modified polyether and BTL-1 butyl sealants have been tested thoroughly for performance and compatibility with TotalFlash membranes, drip edges and termination bars and with CompleteFlash high corner boots and end dams. Their effectiveness is not limited to Mortar Net Solutions products and they may be suitable for use in many other common construction applications.

For more information, please e-mail technicalservices@mortarnet.com or visit www.mortarnet.com

[3] MPE-1 exhibits adhesive failure with rubberized asphalt. However, the TotalFlash rubberized asphalt membrane is supplied with a self-adhesive layer and Mortar Net Solutions installation instructions for TotalFlash require that the self-adhesive be used at lap joints, under the termination bar, and at joints between the TotalFlash membrane, corners and end dams. If used, MPE-1 is applied between the metal drip edge (stainless steel or Kynar with good adhesion) and the brick ledge, and to seal the top edge of the termination bar, an area in which strong adhesion is not critical due to stabilization by the weight of the bricks on the ledge and the screws affixing the termination bar to the structure. Also, at the top of the termination bar, there is the important consideration that the sealant is in contact only with the thickness of the rubberized asphalt membrane.