Proven Performance: Aged TPO Field Study

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1 Introduction and Main Conclusions

Flexible Polyolefin (FPO) roof membranes have been part of the European roofing market since the late 1980’s. In the early 1990’s, this technology migrated to the United States as Thermoplastic Polyolefin (TPO). FPO and TPO are the same polymer that use different terminology in the European and United States markets, respectively, and will be referred to as TPO throughout this paper.

TPO roof membranes are the fastest growing commercial roof membrane on the market, and has grown significantly over the past 20 years. According to the European Single Ply Waterproofing Association (ESWA), TPO is growing in market share in Europe, and according to the Single Ply Roofing Institute, TPO represents almost half of the installed low-slope roofing in the United States. The global TPO roof membrane market is expected to reach $2.2 billion by 2024, with a compound annual growth rate (CAGR) of 3.7-percent from 2019 to 2024. These membranes are now regarded as a mature technology with properties defined by the ASTM International material standard for TPO membranes, ASTM D6878 - *Standard Specification for Thermoplastic Polyolefin Based Sheet Roofing* and by European Standards, EN 13956 – *Flexible Sheets for Waterproofing. Plastic and Rubber Sheets for Roof Waterproofing*. These standards have been improved since their inception to incorporate more demanding tested-product performance, including stronger requirements for accelerated weathering and aging.

TPO membranes in the United States have been extensively analyzed in laboratories and under accelerated weathering conditions. This work demonstrated the ability of TPO to provide superior performance in heat aging and UV stability. Some data has been collected through regional studies (WSRCA, 2011), and anecdotal case studies of field-installed TPO roofs, predominantly those that have been improperly designed and/or installed, and membranes with early formulations that resulted in premature failure. TPO field studies have also been conducted in Europe.

Today, there are TPO roofs that have been in service for over 20 years. As single-ply systems provide no inherent redundancy, their water tightness depends on both the
mechanical performance of the materials and the welded seams, together with the weathering resistance of the polymer. The real-world performance of any roof membrane also depends on the quality of the installation, maintenance, and ability to repair the membrane. This paper reviews the long-term performance of field-aged TPO roof membranes installed throughout the United States to assess performance and the ability to repair aged TPO roof membranes.

### Table 1: Performance of Field-Aged TPO Roof Membranes

| **60 mil (1.5mm) white TPO** | **Average** | **Performance** |
|-----------------------------|-------------|-----------------|
| Membrane Thickness          | 1.40mm (55 mils) | Exceeds ASTM D6878 |
| Thickness over Scrim         | 0.56mm (22 mils) | Exceeds ASTM D6878 |
| Low Temperature Flexibility  | -40°C (-40°F) | Meets ASTM D6878 |
| Heat Aging/Weather Resistance (7X Magnification mandrel bend) | Pass | Meets ASTM D6878 |
| Aged Ply Adhesion            | 8.93 N/mm (51 lb/in) | > Avg. ply adhesion for new TPO membrane³ |
| Repair Ply Adhesion to Cap   | 8.23 N/mm (47 lb/in) | \* |
| Repair Ply Adhesion to Core  | 9.98 N/mm (57 lb/in) | \* |

**Figure 1.** Average findings from study to date for 60-mil (1.5mm equivalent) membranes.

In summary, the aged TPO membrane roofs in this study are performing well and typically meet the ASTM requirements for newly manufactured membranes (see Figure 1). The aging welds appear to be performing well and are of adequate strength. Ply adhesion values of new repair membrane to the aged TPO membrane are above the average ply adhesion value for new TPO membranes. This provides some validity to the integrity of properly executed repairs to aged TPO membranes. This is an ongoing effort and to date, membrane samples from 20 roofs across the United States have been analyzed. Specifically addressed are known failure modes of some manufactured TPO membranes which include erosion of the cap (thickness over scrim) down to the scrim and surface cracking, as well as concerns surrounding the ability to repair aging TPO membranes.

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**References**

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