Durability of Sarnafil® T Polymeric Roofing Membrane

December 2014

Summary report

from Expert report 80740 dated 05 August 2014

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Publisher
Sika Services AG and Sika Technology AG, 6060 Sarnen, Switzerland

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Preservation of structures, construction materials, building physics

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Durability of Sarnafil® T polymeric roofing membrane

Summary report

This report is an addition to Expert report No. 80740 dated 05. August 2014, which concerns the durability of polymeric roofing membrane types **Sarnafil® TS** and **Sarnafil® TG** (based on a study of five 17 to 25 years old roofs, plus 158 additional roofs that were investigated and assessed by Sika personnel in a field survey, and also including Sika's internal production monitoring data and test results).

Commissioned by Sika Services AG and Sika Technology AG (hereafter called Sika) on 15. February 2013 and 04. April 2014.

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1. Background information and objectives

Sika produces and sells a range of polymeric waterproofing membranes, some of which are based on flexible polyolefin (FPO). The product line of this membrane type (based on flexible polyolefin) is called **Sarnafil® T**.

Sarnafil® T membranes have been in use now for 25 years. They are mainly used for the waterproofing of flat roofs.

In our Expert report No. 3460 dated 17 Dec. 1999 we reported the results of various studies on polymeric roofing membranes of the product groups **Sarnafil® TS** and **Sarnafil® TG** for roofs aged from 3 to 10 years.

In our Expert report No. 4708 dated 10 Nov. 2004 we reported the results of investigations on these roofing membranes at the ages of 9 to 15 years.

In our investigation No. 70006, dated 02 July 2009, we reported the results of investigations on these roofing membranes at the ages of 16 to 20 years.

Four of the specific membrane roofs that were previously investigated in 1999, 2004, 2009 were re-examined in 2014. An additional investigation was also carried out on another roof that was 17 years old. Sika instructed us to conduct these investigations into the roofing membranes of these five roofs on 15 February 2013 and 04 April 2014.

The findings gathered on site and the results of laboratory studies were to be assessed, including consideration of the testing and results from Sika (internal production monitoring data and data from the additional roofs), plus the results of the earlier studies conducted in 1999, 2004 and 2009, with particular regard to the following aspects:

– Condition and properties of the polymeric roofing membranes in place on the roofs of the buildings, in comparison with the results of internal monitoring on the materials, including the results of our laboratory tests on specimens taken during this year's production (specimens from 2014), and the results of our studies conducted in 1999, 2004 and 2009.

– Comparison with the project data collected by Sika.

– Estimation of the long-term stability and durability of polymeric roofing membranes **Sarnafil® TS** and **Sarnafil® TG**.

– Examination of the repair capabilities during the course of time, by checking the welding seams of new polymeric roofing membranes on to the existing exposed membranes.

This summary report has been compiled as a supplement to Expert report 80740 dated 05. August 2014 on the durability of polymeric roofing membranes ***Sarnafil® TS*** *and* ***Sarnafil® TG****. For details please refer to the full Expert report.*

2. Methodology and procedure

2.1 Methodology

By using accelerated ageing tests for short-term investigations, any changes of the material properties can be measured in the laboratory and their nature and appearance can be described.

In addition to conducting short-term tests, the reliable prediction of service life and life span also requires the study of long-term data collected from specific roof investigations. The longer the time period before inspection, and the larger the number of roofs inspected and assessed, the more reliable is the data obtained.

2.2 Procedure

The inspection and assessment described here is based on five roofs covered with **Sarnafil® TS** and/or **Sarnafil® TG** systems with different ages, which were examined and evaluated in detail by our institute. A field study and monitoring of the same roofing membranes on another 158 roofs by Sika are also taken into consideration for the overall evaluation.

Thus in total, more than 250 samples (Fig. 1) of roofing membranes type **Sarnafil® T**, with an age distribution spread over 25 years, were collected and examined.

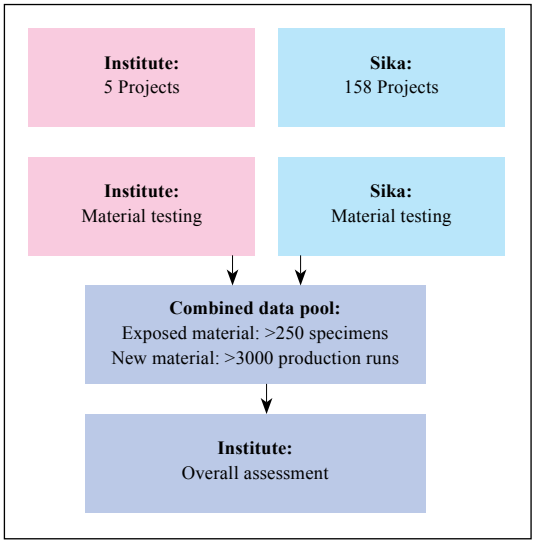

Fig. 1: Expert report data structure

The roof assessment and testing of the material samples from the five roofs that we examined was conducted independently of the Sika surveys and testing, according to following criteria:

– **Roof assessment**: General condition of the roof, roof build-up / assembly, flashings, welded seams, structural aspects.

– **Material samples**: Thickness, tensile strength, elongation at break, low temperature foldability, peel strength and shear strength of site-welded seams, including the seams of new membranes welded onto existing exposed membranes, together with microscopic investigation of the membrane surface. These properties are those regarded as essential for predicting the durability of polymeric waterproofing membranes.

By merging the data determined by us with the data collected by Sika surveys, the long-term stability and durability of the polymeric waterproofing membranes **Sarnafil® TS** and **Sarnafil® TG** can therefore be reliably predicted, supported by a broad base of data and using the methodology described in Section 2.1 above.

3. Results

3.1 Roof assessments

All five of the roofs that we inspected and examined were found to be in good general condition (Pictures 3 and 4). Specifically it was noted that the edge terminations and the flashings at penetrations such as skylights (Picture 4) were all intact.

All seams checked with a seam tester were tight. All sampling locations could be patch repaired with no problems, simply by welding according to the standard method statement described in the installation guidelines (Picture 5).

Compared with our studies conducted in 1999, 2004 and 2009, we detected no significant changes to the technical capabilities or visual condition of the Sarnafil® roof membranes.

Fig. 2: Front view of the Meusburger Building in Wolfurt (Austria)

Fig. 3: Overall view of the roof of the Meusburger Building in Wolfurt (Austria)

Fig. 4: Fig. 4: Overall view of the roof of the Brunner Building in Flawil (Switzerland)

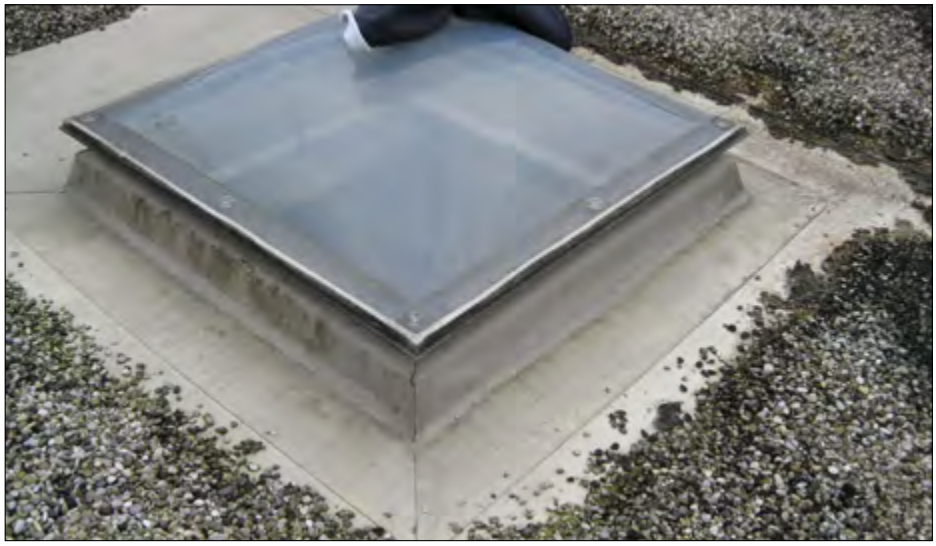

Fig. 5: Flashing at a skylight, roof of Brunner building in Flawil (Switzerland)

*Fig. 6: Hot air welding of new to existing mbranes (**Sarnafil® TS 77-18**) Meusburger Building in Wolfurt (Austria)*

3.2 Mechanical properties

To summarize the characteristics of different polymeric waterproofing membranes in uniform terms, one can express these in terms of the changes in their properties over time in relation to the properties of the new material. This method was used in our Expert report.

Mechanical properties of the new material always show a range of values and test result variations, due to aspects of production, sampling and measurement for example. However, this distribution of values can be quantified using standard deviation methods. For the graphic display of our results we chose a confidence interval of 99%, meaning that of 100 measured values, 99 are to be within the expected range of distribution. If the values measured on a sample from an exposed roof lie within this same confidence interval, then the material properties have not changed significantly in comparison with the original material.

Sarnafil® TS

The material investigations of **Sarnafil® TS** showed that the values of the mechanical properties elongation at break and tensile strength, even after more than 20 years exposure on the roofs, lie within the originally expected distribution range for the new material. Hence there has been no significant change of the membrane properties. Fig. 7 and Fig. 8 are representative examples illustrating the measured tensile strength of the **Sarnafil® TS** specimens over time.

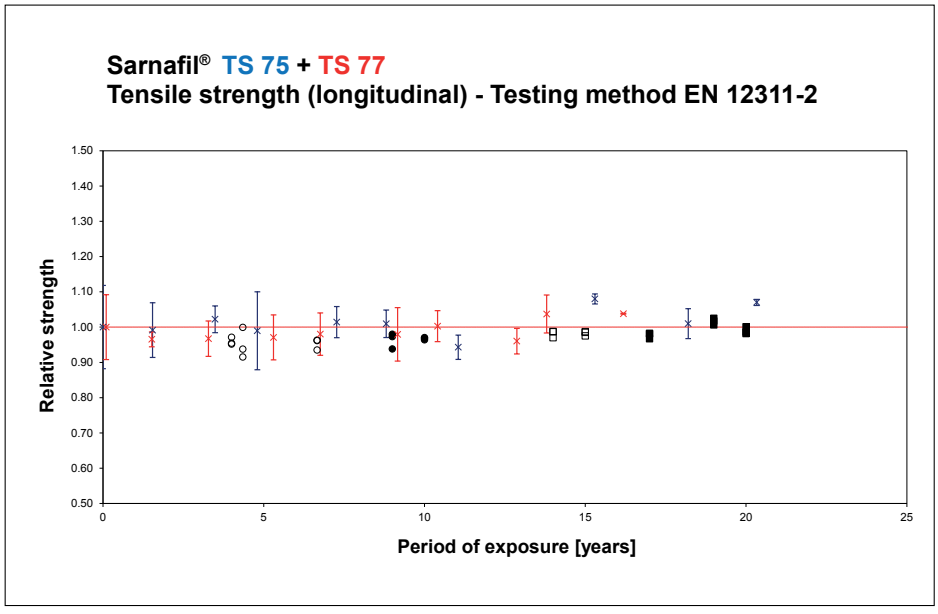

Fig. 7: Tensile strength (longitudinal) of Sarnafil® TS after exposure
○ Values measured in 1999 by Institut für Bautenschutz, Baustoffe und Bauphysik
● Values measured in 2004 by Institut für Bautenschutz, Baustoffe und Bauphysik
□ Values measured in 2009 by Institut für Bautenschutz, Baustoffe und Bauphysik
■ Values measured in 2014 by Institut für Bautenschutz, Baustoffe und Bauphysik
X Values measured by Sika with distribution range (158 roofs)

Sarnafil® TS

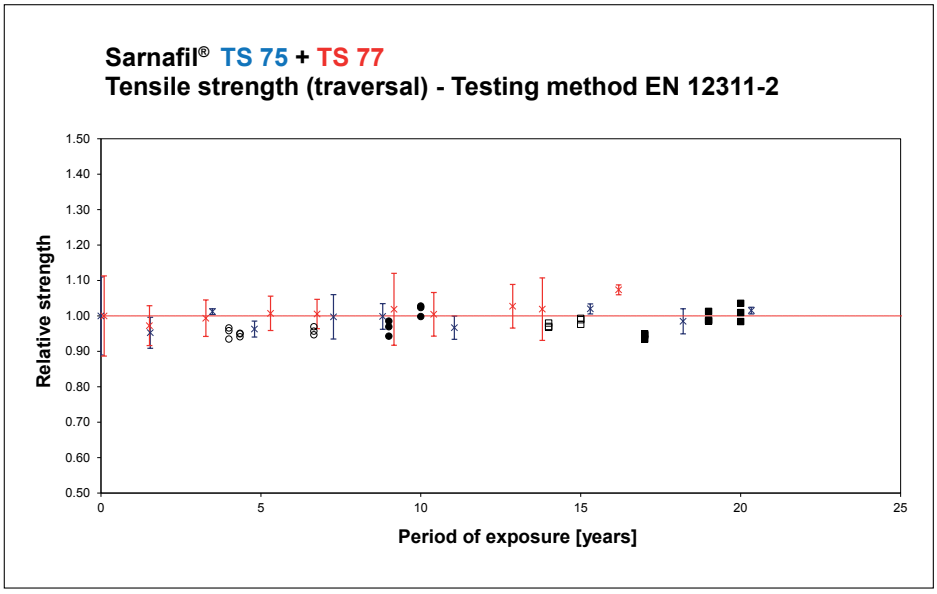

Fig. 8: Tensile strength (traversal) of Sarnafil® TS after exposure

○ Values measured in 1999 by Institut für Bautenschutz, Baustoffe und Bauphysik
● Values measured in 2004 by Institut für Bautenschutz, Baustoffe und Bauphysik
□ Values measured in 2009 by Institut für Bautenschutz, Baustoffe und Bauphysik
■ Values measured in 2014 by Institut für Bautenschutz, Baustoffe und Bauphysik
X Values measured by Sika with distribution range (158 roofs)

Sarnafil® TG

The measured values of elongation at break for **Sarnafil® TG** were similar to the results of **Sarnafil® TS**; i.e. even after up to 25 years of exposure there was no significant change over time (Fig. 9 and Fig. 10: Elongation at break).

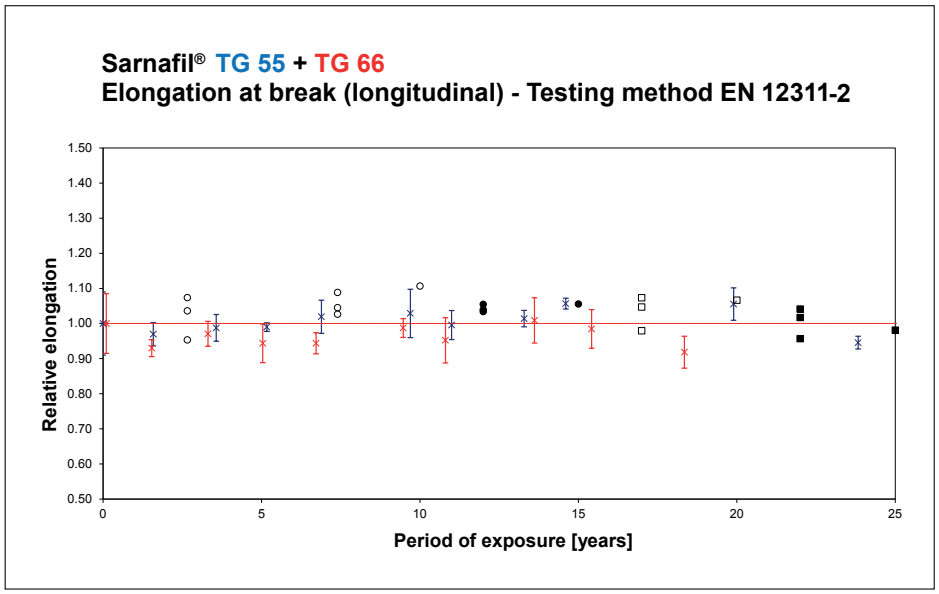

Fig. 9: Elongation at break (longitudinal) of Sarnafil® TG after exposure
○ Values measured in 1999 by Institut für Bautenschutz, Baustoffe und Bauphysik
● Values measured in 2004 by Institut für Bautenschutz, Baustoffe und Bauphysik
□ Values measured in 2009 by Institut für Bautenschutz, Baustoffe und Bauphysik
■ Values measured in 2014 by Institut für Bautenschutz, Baustoffe und Bauphysik
X Values measured by Sika with distribution range (158 roofs)

Sarnafil® TG

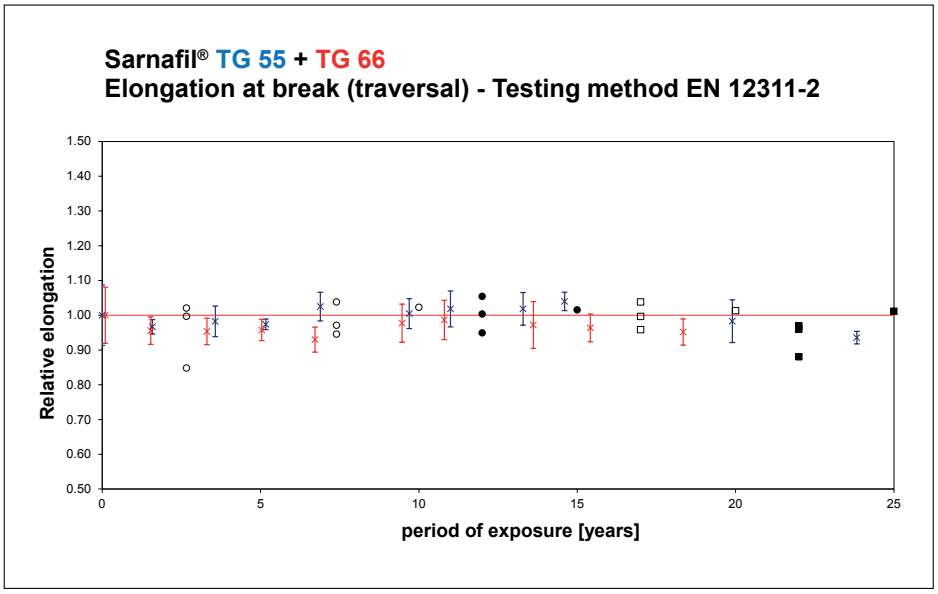

Fig. 10: Elongation at break (traversal) of Sarnafil® TG after exposure
○ Values measured in 1999 by Institut für Bautenschutz, Baustoffe und Bauphysik
● Values measured in 2004 by Institut für Bautenschutz, Baustoffe und Bauphysik
□ Values measured in 2009 by Institut für Bautenschutz, Baustoffe und Bauphysik
■ Values measured in 2014 by Institut für Bautenschutz, Baustoffe und Bauphysik
X Values measured by Sika with distribution range (158 roofs)

The tensile strength of **Sarnafil® TG** showed a total mean value decrease of 15% after the first 12 years. However, this decrease is significantly slower over the following years.

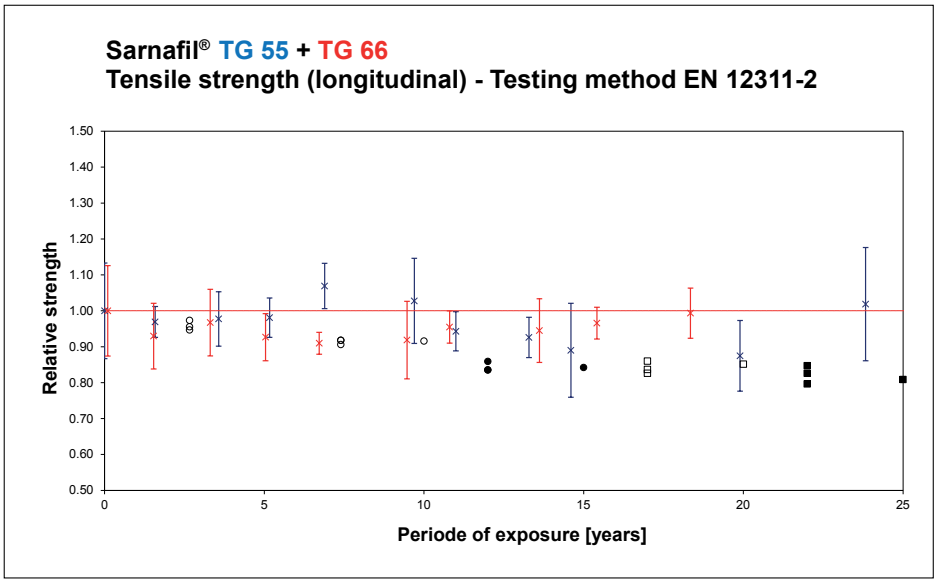

Fig. 11: Tensile strength (longitudinal) of Sarnafil® TG after exposure
○ Values measured in 1999 by Institut für Bautenschutz, Baustoffe und Bauphysik
● Values measured in 2004 by Institut für Bautenschutz, Baustoffe und Bauphysik
□ Values measured in 2009 by Institut für Bautenschutz, Baustoffe und Bauphysik
■ Values measured in 2014 by Institut für Bautenschutz, Baustoffe und Bauphysik
X Values measured by Sika with distribution range (158 roofs)

Other properties

For both **Sarnafil® TG** and **Sarnafil® TS** no significant change in the material thickness was found due to their exposure on the roofs.

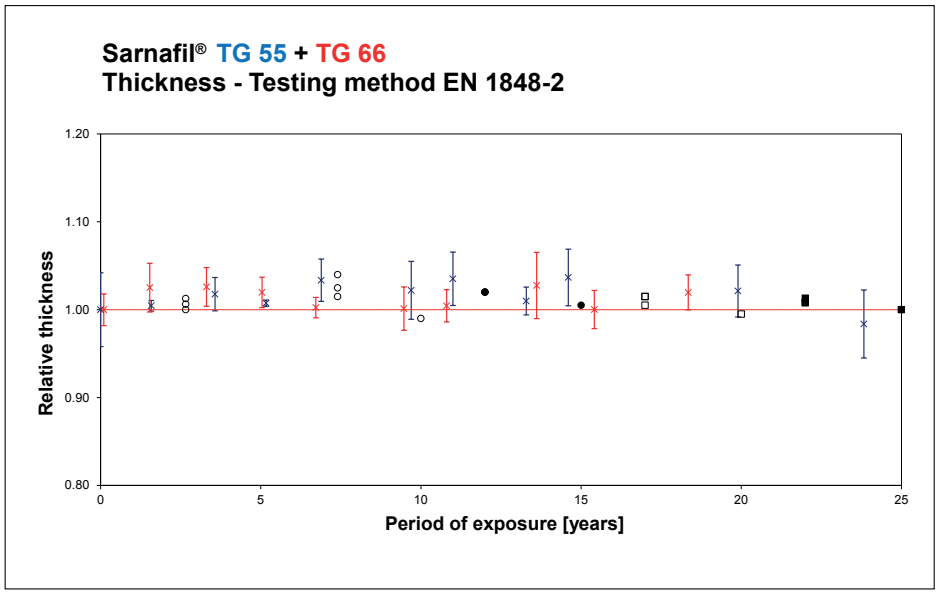

Fig. 12: Thickness of Sarnafil® TG after exposure
○ Values measured in 1999 by Institut für Bautenschutz, Baustoffe und Bauphysik
● Values measured in 2004 by Institut für Bautenschutz, Baustoffe und Bauphysik
□ Values measured in 2009 by Institut für Bautenschutz, Baustoffe und Bauphysik
■ Values measured in 2014 by Institut für Bautenschutz, Baustoffe und Bauphysik
X Values measured by Sika with distribution range (158 roofs)

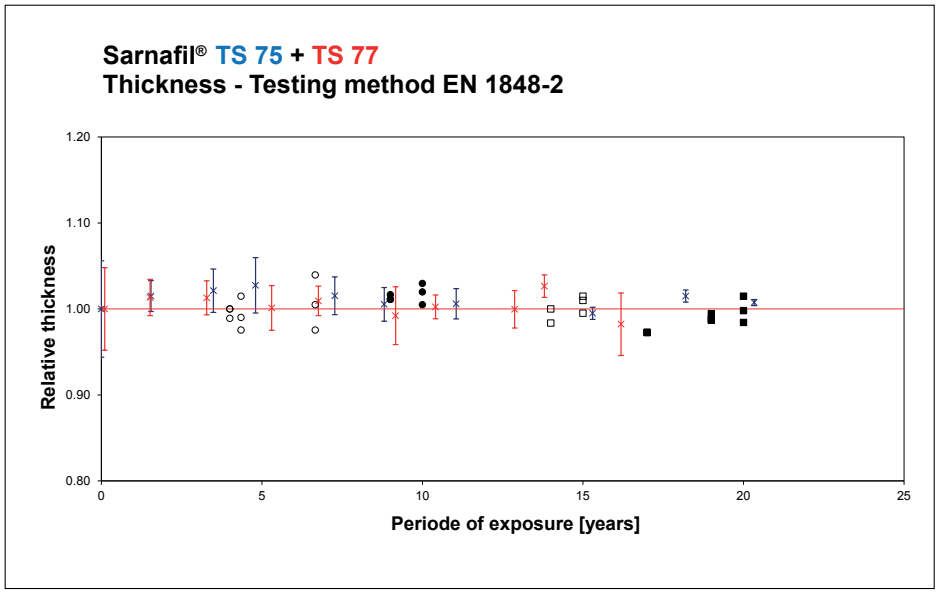

Fig. 13: Thickness of Sarnafil® TS after exposure
○ Values measured in 1999 by Institut für Bautenschutz, Baustoffe und Bauphysik
● Values measured in 2004 by Institut für Bautenschutz, Baustoffe und Bauphysik
□ Values measured in 2009 by Institut für Bautenschutz, Baustoffe und Bauphysik
■ Values measured in 2014 by Institut für Bautenschutz, Baustoffe und Bauphysik
X Values measured by Sika with distribution range (158 roofs)

The low temperature folding test, where the sample is rapidly folded by 180°, produced no cracks on almost all of the samples at -25°C. Cracks were only found on one 19-year-old trial material which never went into standard production. To consider a possible impact on its waterproofing function these membranes were additionally tested against hail resistance. All membrane samples tested exceeded the hail resistance of 17 m/s required according to SIA V280 and they were even tight at 25 m/s.

Sarnafil® TG which is used for ballasted roofing applications showed no cracks even at -35°C.

Optical microscope inspection at 30 times magnification, which is a tightened inspection compared to the 6 times magnification prescribed by European Standard EN 495-5 for new materials, showed no surface cracks on **Sarnafil® TG 66**, and only minor surface crazing on **Sarnafil® TS 77** membranes, used for exposed applications.

All the welded seams tested broke outside the seam area as required by the standards. There were no significant changes in this over the different times of exposure. Also the results of tests on the welding seams for new membranes onto the exposed polymeric membranes on the roofs, also confirm this performance and repairability even after up to 25 years.

4. Assessment of durability

Sarnafil® TS

Our investigations of **Sarnafil® TS** membranes show that the results of specimens from roofs aged 17, 19 and 20 years lie within the same distribution range of the normal results obtained during Sika's internal monitoring of new materials production. As far as a comparison with specimens from this year's production (2014) was possible, the studies also show that no significant changes had occurred in the products mechanical properties, even after 17 and 19, respectively 20 years in service on the roofs. The tests of low temperature folding and resistance to hail on 17 up to 20 years old membranes showed no cracks and still being watertight.

Thus our investigation results confirm the data collected by Sika for roofs up to 25 years old. The 1999, 2004 and 2009 durability assessments of **Sarnafil® TS** are therefore further confirmed after an additional 5 years in service by the results of this investigation on 25-year-old membranes.

There is now 25 years of proven, positive experience for the durability of Sarnafil® TS. Therefore given the standard roof conditions and use in compliance with the products application and maintenance requirements, these results also suggest that the polymeric roofing membranes Sarnafil® TS will continue to fulfill their waterproofing function for many more years.

Sarnafil® TG

The two roofs investigated with **Sarnafil® TG** polymeric roofing membrane have been in exposed service for 22 and 25 years respectively. The properties tested here, for example elongation at break and especially the materials thickness, show no significant changes over these time periods.

The repairability by welding a new to a 25-year-old **Sarnafil® TG** membrane on the roof, also results in a perfect seam weld with no failures in the welding seam tests.

A difference in the tensile strength was observed and this decrease is time related. In our previous studies a maximum decrease of 15% of the tensile strength after 12 years was found. Considering the results from 2009, the last five years show a much slower reduction of the tensile strength during this period in comparison to the reduction during the first 12 years, as the maximum reduction of the tensile strength measured after 25 years was 20%.

There are two ways to predict the service life of **Sarnafil® TG**. Both are based on this time-related change of the materials tensile strength:

The German assessment standard DIN 18531-2:2008-11 requires a value of at least 5 N/mm^2 for new materials. Modelled calculations show that it will take 55 to 100 years before the tensile strength of the materials would drop to 5 N/mm^2. The requirement for tensile strength of at least 5 N/mm^2 applies to new material. However, we consider that a tensile strength requirement of 3 N/mm^2 would be reasonable and sufficient for calculating the service life of the **Sarnafil® TG** material on a roof. Using the same method of calculation, this results in an estimated service life in excess of 100 years. Therefore assessment of all the above mentioned data would indicate a minimum service life of 55 years by the requirement for new materials, or more than 100 years for **Sarnafil® TG** according to the second criteria.

Thus, the service life of **Sarnafil® TG** corresponds to the required service life assumed for building structures in general. The 1999, 2004 and 2009 durability assessments of **Sarnafil® TG** are confirmed after an additional 5 years by the results of this investigation on 25-year-old membranes.

The results of this long term study and the 25 years of proven, positive experience for the durability of Sarnafil® TG suggests that given ensuring the standard roof conditions and use in compliance with the products application and maintenance requirements, the polymeric roofing membranes Sarnafil® TG will continue to fulfil their waterproofing function for many more years.

Note

This Summary report has been compiled as a supplement to our Expert report No.80740 dated 05 Aug. 2014 on the durability of the polymeric roofing membranes **Sarnafil® TS** and **Sarnafil® TG**. For more details please refer to the full Expert report.

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