Results of an 18 Year Case Study: Examination, Testing and Evaluation of DARLYN® 1100CB from TVA Cumberland

Background:

TVA has long specified the use of DARLYN 1100CB in many of the expansion joints in its coal-fired power plants. Recently, the opportunity arose to remove an intact belt from an expansion joint after approximately 18 years of service. This material was returned to Saint-Gobain Performance Plastics (SGPPL) for evaluation.

Discussion:

The used DARLYN 1100CB belt was returned to the Merrimack, NH site of SGPPL (current manufacturing location for DARLYN 1100CB) to be examined by an R&D technician familiar with the material and application. Additionally, the used material was tested with the same equipment, with the same procedures and by the same personnel that new material is tested on. Expansion joints are exposed to widely varying conditions within the ductwork common to coal-fired power plants. This particular material was reported by TVA to have been taken from the following location and conditions:

- Removed from 2-FGD-EJ-5 at Cumberland
- Downstream of precip inlet and before a scrubber
- Low ash content in flue gas (after precip)
- Operating temperature of 321°F
- Operating pressure of 5.95” H20
- In service for approximately 18 years

For this analysis, the objective was to test the used material against the new material specification and compare the results. Due to the size and very good condition of the used belt segment, we were able to obtain sufficient samples to perform all the required testing.

The following assumptions/conditions were used in determining sample location and gathering/analyzing the data:

- Samples were cut from the center area of the belt. *(This is the “working area” of the belt; material from the edges – under the back-up bars – often sees little if any flexural stress and is not representative of the conditions the center area of the belt experiences. Unless exposed to excessively high temperatures, the portion under the back-up bars often show little deterioration in physical properties.)*
- Section of belt received was representative of overall belt condition.
- Average physical property values of current production *(last several years)* are similar to properties of material produced 18+ years ago. *(The specification remains unchanged.)*
- Material was not damaged in handling during installation or removal.

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Results:

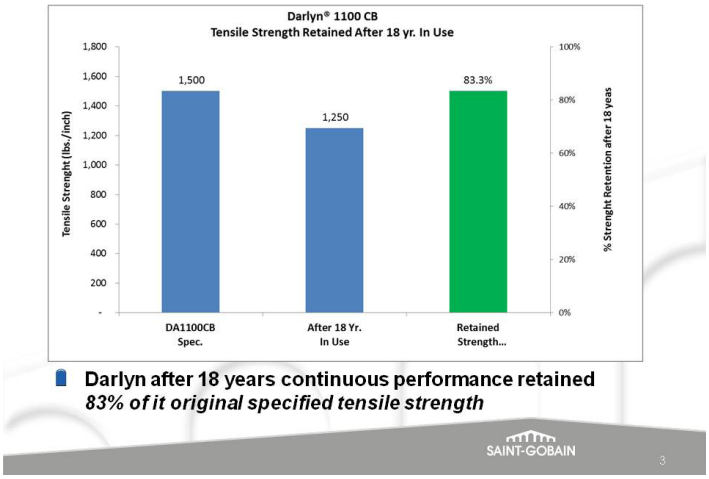
General observations on the condition of the segment of used belt:

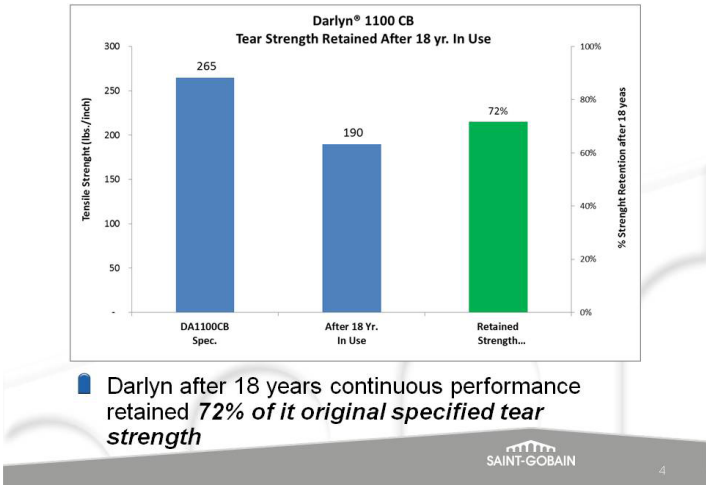
Visual inspection revealed no physical damage or high stress areas.

There was no sign of chemical attack on film or fabric reinforcement.

There was no sign of excessive heat exposure (usually indicated by discolored film and/or lightened areas in fabric).

The results of physical testing are shown in the graphs that follow.





Comments on Results of DARLYN 1100CB after 18 years versus new production values:

Breaking strength retention:

- 77% of Breaking Strength[1] in the warp[2] (machine) direction
- 94% of Breaking Strength[1] in the fill (cross-machine) direction

Strength retention after Flexfold test3 of 18 year old material was very good:

- 83% retention in warp direction
- 94% retention in fill direction

SGPPL is an associate member of the Ducting Systems Non-Metallic Expansion Joint Division of the Fluid Sealing Association, and actively participates on the Technical Committee which creates specifications and guidelines for the manufacture, design, installation and use of expansion joints. These guidelines include FSA-DSJ-403-07, an FSA Standard entitled “Fluoroplastic Belt Guidelines”. While not a specification, it includes minimum recommendations for material properties.

[1]Breaking Strength values compared to values for current production values. Breaking Strength is also sometimes called Ultimate Tensile.

[2]Hoop stresses are in warp (machine) direction.

[3]Flexfold test measures breaking strength retention after a sample is folded 180 degrees and a 10 lb roller is passed over the fold 10 times.

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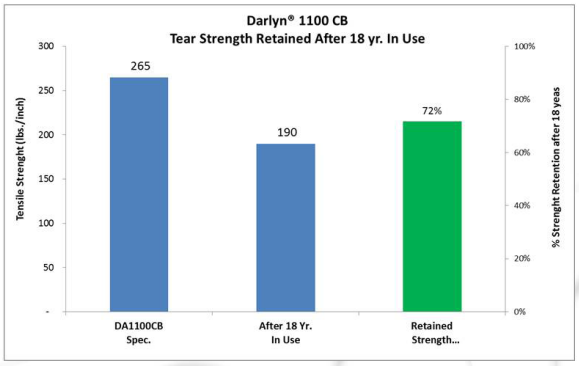

Comments on Results of DARLYN 1100CB after 18 years versus FSA recommendation:

- Breaking strength in the warp direction averages more than 70% higher than FSA recommendation for new material.
- Breaking strength retention after flexfold approaches 100%, while the FSA guidelines call for a minimum of 60% strength retention for new material.
- Values for trap tear strengths are at least 3X the minimum values recommended by the FSA for new material.

Conclusions:

Assuming the used DARLYN 1100CB had initial physical property values comparable to current production, one would conclude that the reduction in strength is primarily in the warp direction of the fabric. This corresponds with the fact that the hoop stresses experienced by the fabric (warp direction) are significantly greater than those for the short expanse of fabric bridging the face to face gap (fill direction). With breaking strength values well over 1000 lbs./in., the DARLYN 1100CB is still very strong after 18 years in service.

Tear strengths remain quite high after many years in service. The reduction in tear strength in both directions (warp and fill) corresponds to the changes seen in breaking strength values. Overall, the property retention of the material indicates stable operation of the system – significant deterioration in properties is often seen in systems with multiple starts and stops, excessive flutter or misalignment, or other severe stresses.

The FSA recommendation provides guidelines on minimum properties for expansion joint materials. It does not, and really cannot, address property retention of these materials after use given the myriad options for design, installation and operating conditions of expansion joints. However, one could conclude that these results indicate that the DARLYN 1100CB tested had many years of service life remaining; even after 18 years in service, the physical properties of the used DARLYN 1100CB far exceed the minimum recommendations of the FSA for new materials.

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