A new generation of coated belts for structural membranes

Hubertus Poeppinghaus

IF_Group, Ingenieure für Flächentragwerke GmbH
Am Dachsberg 3, 78479 Reichenau-Waldsiedlung, Germany
e-mail: hubertus@arqintegral.com, web page: http://www.if-group.de

ABSTRACT

Belts have always been an important part of textile light weight structures. They can be folded together with the membrane and as a two dimensional element they are capable to transmit forces into the flat surface of the coated textile materials. But the standard belt sold in the market is fabricated with the intention to lift or convey weight. Initial slippage or slack is not important in this field. The standard belt might be pre-stretched or not and is usually not UV-protected. The protected belts are PVC-coated by submersion which leads to a shrinkage during the process of welding. Normally the belt is sewn onto the membrane. The force transmitted depends on the ability of the person in charge and the value of the pre-stretch used for the yarn. Most of the belts in textile constructions are used as flat curved elements in order to reinforce the border of the membranes. Their solicitation functions against the logic of a straight lifting belt: The inner part of the curved belt is compressed and the outer part stretched. Last but not least the typical off-centered fixation on either side of the membrane leads to a torque and introduce a twist into the components. By means of introducing a high security factor of 3 the engineers try to cope with all these imponderabilities.
Our engineering firm If_group is specialized on large scale retractable textile roofs where the use of belts is mandatory. Being aware of the present limitations we initiated a co-financed German federal project in order to expand knowledge and develop new products together with one of the oldest German belt making company´s Vom Baur GmbH and counting on the expertise on tent making of the well-known CenoTec-Sattler group.
To overcome the above mentioned shortcomings the objectives of the research project were to develop a straight and curved, UV-resistant belt with an equal or lower elongation than that of the textile membrane base, an equal or even higher stiffness and a joining process that allows a continuity in the introduction of tension. The experimental part has been carried out at the University of Konstanz under the guidance of Professor Francke, head of the Laboratory of building dynamics.
Vom Baur GmbH developed a new coated Dyneema®-Stängelfadengurt (Dyneema®-stem-thread-belt) that should transmit the tensions directly through the straight high strength dyneema®-fibers. Four 3x3 m hp-sails have been fabricated by CenoTec with different belt-solutions for the testing. The upper surface was packed with layers of sand sacks simulating a snow load that started from 200 Kg up to 600 Kg. In order to fix the four points of the hp-sail, a metal rig has been especially designed and built for the testing purpose. Force and deformation have been monitored by a group a students as part of a master class project with the title “optimization of belts in membrane construction”. It was therefore possible to study the different solutions in a controlled environment at the University.
CenoTec tested at their premises the ease of welding of the curved belt in comparison to the traditional stitching method. In order to better the results of stiffness Vom Baur also studied the influence of pre-tensioning combined with vaporization fixation techniques of different straight belts.