

Textiles as building components

Fire Protection in Buildings

Textile material

Textile materials are used today in various types of buildings: one example is the Commerzbank Arena in Frankfurt, which uses a textile membrane for roofing, while another is the Allianz Arena in Munich which uses textile membranes for both roofing and wall materials. Bangkok International Airport is another example of an advanced application of textile membranes for a permanent building. Applications in Sweden include exhibition centres, aircraft hangars and use as functional/decorative building elements, such as room dividers or floating ceilings in atria. Advantages of these materials include low weight, translucency and their potential for architectonic expression. However, a common limitation on all textile materials is their fire behavior, which emphasizes the importance of correct fire safety assessments when using such materials in building structures.



The Contex-T project

The EU-project Contex T, 'Textile Architecture – Textile Structures and Buildings of the Future', was a major 'Integrated Project' in the Sixth Framework programme, bringing together a consortium of more than 30 partners from ten countries. The project's aims included development of new lightweight buildings incorporating textile structures, together with development of the necessary safety, health and cost aspects. SP Fire Technology has provided the necessary fire technology expertise in the project. The work has covered everything from testing of materials and large-scale reference trials, to development of design methods for analytical fire protection design.



Prescriptive fire safety regulations which in detail regulate the design and classification of building components can exclude the use of textile materials which do not conform to the required fire rating. In such cases, a performance based approach to comply with the overall fire safety level of the building can be a valid alternative. Both these methods of fire design using textile building materials have been used in the Contex-T project, with particular emphasis on textile membranes.

The Swedish Fire Research Board (Brandforsk) has partly financed SP's work on the project, and has engaged Lund Institute of Technology, consultants Brandskyddslaget and a reference group in order to apply the information from the project for Sweden and Swedish conditions.

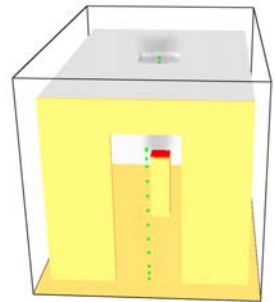
Fire requirements for textile membranes

Textile membranes for building applications have previously been tested in accordance with various national test standards, often German or French, but are increasingly being tested by the SBI method (EN 13823) in accordance with EN 13501-1. However, very little was known concerning the correlation between the SBI method for these materials and their behaviour under real fire conditions.

Large-scale reference tests were therefore carried out, using a selection of various membranes that had previously been tested using the SBI-method. One conclusion of this work was that the SBI-method gave a conservative classification of PVC-PES (polyester) products, i.e. the products behaved better in the large-scale fire test than had been indicated by the SBI-tests. Another conclusion was that the method of mounting thin PVC-PES membranes for an SBI-test entirely determines the classification results. Installation using a 'corner support' is generally recommended in order to achieve correct and repeatable results.

Analytical design

When used as ceiling or wall materials, PVS-PES textile membranes exposed to fire can burn through, which can change the ventilation and air supply conditions in a building fire. The project included mathematical modelling of burn-through and hole-opening. This was done using CFD (FDS code) and the 'burn away' alternative, together with two different pyrolysis models. Input data for the model was taken from the cone calorimeter (ISO 5660), thermogravimetric analysis (TGA) and thermal conductivity properties (TPS). The simulations were validated against full scale experiments which investigated the behaviour of two different membranes. More practical applications of the model were investigated using two of the Contex-T project demonstration buildings, the VUB and Wagner buildings.



The work showed that the simulation tool, for a given fire loading, can open up a representative hole in a textile membrane in a building fire simulation. It was, however, shown that there are several relatively substantial uncertainty factors in such modelling. Uncertainty comes from the difficulty to determine the correct input data for the model and also due to the complex mechanism of hole-opening, which includes both shrinking and melting prior to combustion of the material.

Reports

A summary of fire regulations, requirements and test methods for technical textiles used in buildings. SP Report 2007:20

Fire tests with textile membranes on the market - results and method development of cone calorimeter and SBI test methods. SP Report 2010:23

Fire Safety Engineering of textile buildings following the prescriptive requirements in Sweden. SP Report 2010:24

A burn-through model for textile membranes in buildings as a tool in performance based fire safety engineering. SP Report 2010:54

Large-scale fire tests with textile membranes for building applications. SP Technical Note 2010:03

The reports can be downloaded from www.sp.se and from www.brandforsk.se, project number 307-071.

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