Background

The project «EURopean performance requirements and guidance for ACTIVE ROOFERS» (Eur-Active Roofer for short) has its origin in the increasing variety of new products being introduced in roofing, such as photovoltaic (PV) systems, solar collectors, roof lights, ventilation devices, insulation and safety devices. These products change the roof into an active roof, a roof supplying electricity and hot water while providing daylight and ventilation. An active roof may contribute significantly to the quality of the living space underneath it.

When installed in a roof system, the quality of these products, as well as the quality of safety equipment for installation and maintenance, is in many cases insufficient. There are no standards or legislation to assess their performance. Also, inexperienced roofers often fail to install these products adequately. This leads to a significant number of (preventable) failures from rain and snow water ingress, wind damage and condensation. In the EU, such failures cost a total of approx. €2 000 million each year. The secondary damage to the interior of the building is, at least, of the same order of magnitude. (See Eur-Active Roofer, Description of Work.)

Active roofs

The definition active roofs covers all roofs that in one way or another contributes beyond the traditional task of protecting the building’s inside from various climate exposure factors. Several installations typical of active roofs are depicted in figs. 1 and 2.

The increased attention to active roofs is due to:

- New types of installations
- Increased use of installations
- Change in climate and climate loads
- Increased focus on moisture problems and the indoor environment

Project objectives

The main strategic aim of the Eur-Active Roofer project is to supply tools for the European roofing trade. The tools will enable the European roofers to:

1. Respond to the new demands for integration of roof accessories and fittings
2. Upgrade from delivering just roof tiles to delivering total (active) roofs

Eur-Active Roofer aims at both newly built active roofs and existing roofs which will be upgraded (retrofitted) towards active roofs. This will be achieved through the following specific objectives for the project:
1. Develop conceptual solutions and best practice recommendations for integrated active roofs
2. Identify typologies to describe different European roofs. The roofing industry can use the typologies, and they will also be used as input in the different work packages on environmental actions, i.e. development of a central database.
3. Develop performance criteria and assessment methods for environmental actions on different types of roofs, including wind uplift, driving rain, snow and ice load, condensation risks, and seismic effects. This will result in guidelines and pre-standardisation documents as a basis for subsequent standardisation within CEN and EOTA.
4. Develop guidelines for the installing of new roof accessories. The aim is to reduce the number of reported roof failures from the current level of approx. 20% to no more than 5% within five years.
5. Develop best practice examples of roof maintenance and safety devices. The aim is to promote safe working practices on active roofs and reduce deaths and injuries caused by falls from height.
6. Develop national training programs to train the SMEs (small and medium enterprises) on:
   - the application of the pre-standards developed under (3)
   - the application of the guidelines developed under (4) and (5)

**Work packages**

The Eur-Active Roofer project is divided into ten work packages (WPs) as shown in table 1 (see also tab. 2, Participants).

As shown in table 1, SINTEF Building and Infrastructure leads the WP E-project – Snow and Ice Load, while TNO is main project leader and coordinator.

### WP E – Snow and ice load

In this context, snow and ice load includes:

- Snow and ice load problems
  - Weight, structure strain, freezing and thawing cycles
  - Snowdrift problems
    - Snow accumulation at leeward side
    - Blocking of entrances etc.
  - Ventilation inlet (and outlet) problems
  - Downfall of snow and ice
    - Snow and ice avalanches – snow and ice friction
    - Formation and downfall of icicles

### Snow and ice related problems

Typical problems related to installations on roofs exposed to snow and ice loads are:

- Snow and ice
  - Snow accumulation
  - Ice formation (e.g. freezing/thawing)
  - Icicles (e.g. downfall)
  - Snow and ice avalanches
  - Etc.
- Snow intake through ventilation inlet (and outlet)
- Snow intake through air gap opening at the eaves of air ventilated cold attics
- Increased use of active roof installations
  ⇒ increased traffic on the roofs and
  ⇒ increased demand for safety systems
- Detailed design of installations

### Proposed work tasks in WP E

Proposed work tasks in WP E are:

**WT A.** Friction between snow/ice and roofing/active roof installation surfaces

**WT B.** Prevention of snow intake in ventilation inlets

**WT C.** Insulated, naturally ventilated pitched roofs and problems associated with solar cell installations

Most emphasis will be on WT A.

### WT A – Friction

Traditionally, roofs have been designed to keep the snow in place on top of the roofs. However, solar cell roofs should ideally have no snow at all covering the cells, in order to maximize the energy production. Other active roofs may also require as little snow as
Figure 3. Snow from roof effectively covering the glass facade of a school building. (Photo: SINTEF Building and Infrastructure)

Figure 4. Large icicles in front of a school building’s glass facade, representing a hazard to the children. (Photo: SINTEF Building and Infrastructure)

Figure 5. Large icicles covering a shopping centre’s glass facade. To the right there is complete ice coverage. (Photo: SINTEF Building and Infrastructure)

Figure 6. Snow friction experiments, method A at the top and method B at the bottom (Photo: SINTEF Building and Infrastructure)
possible covering the installations, e.g. roof windows. One may think of both new material surface technology and new architectural roof design in order to accomplish this objective.

In order to gain experience in this field and attempt to achieve parts of this objective, experiments have been started up measuring the friction between snow/ice and roofing/active roof installation surfaces.

Part of the WT A results will be the development of the new NBI Method 169, further divided into two methods, A and B, as follows:

- **NBI Method 169**
  Measurement of Friction between Snow and Roofing

  - **Method A**
    Friction Coefficient Determination between Snow and Roofing by Horizontal Plane Applied Pulling Force Method

  - **Method B**
    Friction Coefficient Determination between Snow and Roofing by Inclined Plane Slip Method
Complex Matter – Countless Variations
A vast number of factors may and will influence the snow and ice friction experiments. Hence, care has to be taken by carrying out these experiments and the evaluation of them with respect to real outdoor conditions.

- Very Complex Experimental Method
  - Why?
  - Friction measurements? – No, relatively simple
  - Complex due to:
- The Complex Nature of Snow and Ice
  - Snow and ice in countless variations
  - Dependent on a vast number of factors
  - Variable indoor and outdoor climatic conditions
  - Interaction between snow/ice and roofing

WT B – Snow intake
Snow intake in ventilation inlets may lead to moisture problems and subsequent mould growth with increasing health risks.

Ventilation inlet designs will be studied in order to develop designs that reduce the risk of snow and rain inlet.

WT C – Active installations
Mounting of active installations, e.g. solar cell panels, will be studied, and recommendations and design details will be worked out. The results will be incorporated in existing Building Research Design Sheets.
Participants

Table 2. Participant list for Eur-Active Roofer. Project leaders are shown in table 1. WP E participants are colour marked in orange, where SINTEF Building and Infrastructure is WP E project leader. TNO is main project leader and coordinator and is colour marked as blue.

IAG = industrial associations and groupings
SME = small and medium enterprise
RTD = research and technology development.
(See Eur-Active Roofer, Description of Work, Collective research project, Sixth framework program.) See also figure 13.

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Figure 13. Eur-Active Roofer participant map. See also table 2.