Protan Vacuum Roofing System

...ventilated roofing which hugs tightly to the substrate...

PROTAN

General

Differences in pressure occur when a building is exposed to wind. Negative pressure forms over the roof, whereas positive pressure is exerted against the facades and can penetrate into the building and up into the roof structure from below. In a strong wind and over large surfaces, this results in high forces, which the roof structure and the roofing membrane must be dimensioned to withstand, and the loads are transferred to the supporting structure. The following methods are applied in principle for anchoring the roofing membrane and insulation to the substrate:

Ballasting

This method was once in very widespread use for flat roofs, although it is rarely specified on new buildings. Modern structures are often optimized in respect of loads, and upgrading to enable them to support gravel or some other form of ballast is thus relatively costly. A ballast layer also makes the roofing membrane inaccessible for inspection and difficult to replace.

Adhesion

The dependence on the weather makes this an unreliable method in a Nordic climate, although welding to the underlay is carried out to some extent in conjunction with renovation with an asphalt membrane. The method is used to a greater extent in warmer parts of Europe. Compact, adhered constructions depend upon the interaction between the materials in the build-up layer, if delamination is to be prevented from occurring.

Mechanical fixing

This is the predominant method used today, and it has been in continuous development since the middle of the seventies. Calculation models and dimensioning bases have been developed, which permit secure and effective installation regardless of the weather and wind. The method is labour-intensive, however, especially on a concrete substrate which requires pre-drilling. This also causes puncturing of the vapour barrier, which can be a disadvantage if the indoor climate is associated with the risk of condensation in the insulating layer.

Vacuum

A roofing membrane in contact with a completely airtight and load-bearing underlay will, when subjected to a wind load, transmit the forces involved to the underlay as suction and without movement. Extensive experiences and documentation of the method are available from the USA, and individual roofs have been on trial in Norway since 1985. In association with the Norwegian «Statsbygg» and NBI, Protan has developed and adapted the method to Nordic climatic conditions -ref. NBI Technical Approval No. 2281. In the case of substrates, which are suitable for vacuum installation, the method forms the basis for the most optimal roofing membrane system in terms of both technical and economic considerations.

Principle

When the airflow causes negative pressure to form over the roof, the air volume between the roofing membrane and the airtight underlay expands, and it expands most where the negative pressure is greatest, i.e. in corner and edge zones. In order to «drain» out this positive pressure and any losses from leaks, so-called vacuum vents are installed where the negative pressure is expected to be greatest. We have acquired detailed knowledge from our experience of and studies into the aerodynamic flow conditions around building structures. This knowledge provides the basis for determining the frequency and positioning of the vents. The vents have valves, which let the air out, but not in.

Wind comes over the roof in relation to rapid changes in its intensity and the local direction. These sudden gusts of wind can be seen as «rippling» in the roofing membrane, similar to the effect over a stretch of water. It takes a few seconds for the pressure to be equalized. However, large movements over time indicate a faulty function. A correctly designed and installed vacuum roof «sucks» itself firmly to the substrate.

A condition for establishing negative pressure in the intermediate layer is that both the substrate and the attachment of the roofing membrane to it are airtight, or sufficiently airtight in relation to the vent capacity. In practice 100% airtightness is sought, and the vent system then acts as a form of security in the case of any leaks.

The manner in which load transmission takes place is for the negative pressure to be transferred down into the airtight layer or substrate, which in turn transmits the forces onwards into the supporting structure. The underlay can be a reroofing underlay or a surface of fibre board or concrete, for example. The procedure is based on the fact that this underlay is both sufficiently airtight and suffici-

Vent locations

All vacuum-installed Protan roofing membranes must be designed by Protan's AVT (Technical Applications) Department. Guidelines for the calculation principles and the associated basis for NTG No. 2281 are regulated in a separate agreement between NBI and Protan AS.
Many factors have an influenceon the vent positions:

- topography around the building, adjacent building mass
- the form and height of the building
- form of the roof
- form, height and projection by the perimeter
- inset storeys and installations inside the flat area of the roof

On an «ordinary» flat roof, two vents are installed at each corner, both at the internal and external corners and at a distance of every 15m along the free perimeter.

No vents are normally required along higher, adjacent buildings.

The loading is different on pitched roofs and curved roofs and in these cases vents are also installed on either side of the roof ridge. Exiting roofs with different forms must be evaluated in every individual case to establish whether they are suitable for vacuum installation.

New roofing

In the case of new buildings and roofs where the Protan vapour barrier constitutes the vacuum-sealing layer, this must be designed and mechanically fixed as appropriate for an exposed roofing membrane. The vapour barrier can then also serve as a temporary roofing membrane during the construction period or for a longer period if it is anchored against being blown off by the wind. The rest of the insulation and the final vacuum roofing membrane can be laid at a later stage.

Reroofing

The wind load capacity of a vacuum-installed roof can never be greater than the capacity of the existing waterproofing. In reroofing, it is important to examine the load-transfer capacity of the old roofing membrane. This is in practice an equivalent evaluation to that for the adhesion or welding of a new roofing membrane to the old roofing membrane. The fundamental requirement is considered to be an intact bitumen membrane of inorganic origin either mechanically fixed or fully adhered to the insulation and concrete underlay or lightweight concrete substrate. The examination of an existing mechanically installed roofing membrane dating from before 1985 should also take into account possible corrosion of the fasteners.Provided that the roofing membrane and fixings are still intact, a roof that has been in place for 15 years or more will normally be sufficiently securely attached. If upgrading of the fixing is required in relation to today's wind load standard, this can be done by increasing the fixing density and sealing the penetrations in the original roofing membrane. This question may arise for buildings in areas that are particularly exposed to the wind.

ently strong to transmit the wind suction forces from the roof. It is also possible for positive pressure to occur in individual buildings, which presses up against the roof from inside. The roof construction must be dimensioned to withstand these loadings, and this is an important condition for vacuum roofs.

Insulation between the roofing membrane and the airtight underlay has no significance for the vacuum effect and function. Protan vacuum-roofing systems can be used both for new roofing and for reroofing. The system requires an airtight layer in the substrate. This makes it particularly well suited for reroofing projects where the existing roofing membrane is still considered to be sufficiently intact and with sufficient anchoring to the supporting system.

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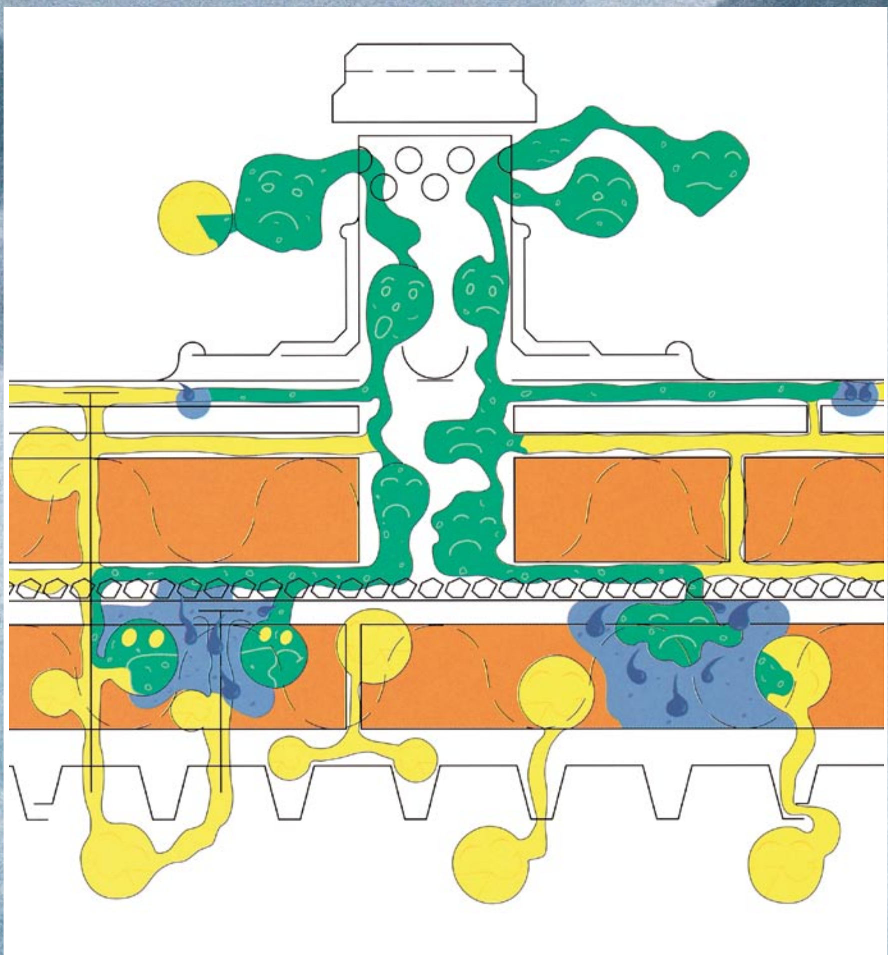
Humidity

A vacuum installed roofing system is based on an airtight underlay, and negative pressure over the flat area of the roof which will accordingly not suck up warm and humid indoor air into the cold part of the roof structure. The vacuum vents will help any humidity trapped in or over the subjacent airtight layer to dry out more rapidly and without weakening the fixing function (corrosion).

This is an added benefit compared to other systems. Humidity trapped in roof structures can be an «environmental bomb» if fungus and mould growth occur. Especially in Nordic climates, it is almost an impossibility to operate an all-year-round roofing business without trapping in some water and humidity. The vacuum system, used in combination with a roofing membrane material that is open to diffusion, is a more secure way of avoiding this problem, and this is justifiably described as «the most ventilated roofing system».



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