Refurbishing Roof System and Roof Terraces on a Major Residential Building Complex

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Tommy Bunch-Nielsen, Danish Roofing Advisory Board
Erik Brandt, Danish Building Research Institute
Terraced houses
Observations from 1973 - 2011

- Build in 1970 - 1973
- First leaks in 1973
-Leaks in 1981: 500 out of 1725 apartments
- Renovated first time 1990-1991
- First leaks in 1991
- Renovated second time 2001-2004
- Costs 100 mill. $ each time
Roof terraces - original design

1) 50 mm concrete tiles
2) 60 mm gravel
3) Two-layer oxidised bitumen membrane
4) 70 mm EPS + 4 mm woodfiber
5) Bitumen bonding
6) Concrete deck
Green and ballasted roofs

1) Soil or gravel
2) Two-layer polymer-modified bitumen membrane
3) EPS - insulation 70 mm
4) Bitumen bonding
5) Concrete deck
ORIGINAL DESIGN

OUTDOOR

Flashing height
50-70 mm

INDOOR
Roofing material

- 2 layer oxidized bitumen
- 70 mm EPS with 3 mm wood fibre board
- No slope
First renovation in 1990-91

- Tapered insulation and PVC membrane
- Slope 1:100 or 1%
- Height of up stands unchanged
- Flashing height lower due to extra insulation
Vegetated and ballasted roofs

1) Soil or gravel
2) PVC membrane
3) Sloped EPS 20-40 mm
4) Exist. structure
Roof terraces

1) 50 mm concrete tiles
2) 60 mm gravel
3) PVC membrane
4) Slope EPS 20-40 mm
5) Exist. structure
Lower height of flashings

OUTDOOR

INDOOR

Flashing height
20-50 mm
LOW FLASHING HEIGHT
Loss of plasticizer from 35% to 5%
Loss of plasticizers

- Bacteria and mould in soil and ballast
- Bad quality of plasticizers
- No significant loss to EPS insulation due to separation layer of glass fiber felt
- Membrane gets stiff and shrinks
- Extremely bad PVC quality
Shrinkage of the EPS insulation up to 0.5%
Wet EPS insulation
Acceptance of 1 kg water/m²


**Insulation from 1th renovation**

- Criteria: max 1,0 kg/ m² of water
- Corresponding to 1 litre of water per square meter in a 100 mm thick insulation
- New criteria from 2010 is 0.5 vol. % due to thicker insulation
- EPS with a density of 20 kg/m³ can contain up to 98 vol. % water
- Original insulation was dry on the roofs
New increased insulation thickness
Slope 1:40 or 1.5 degrees on roof systems
Slope 1:100 in duo-roofs on terraces
Two layer SBS polymer-modified bitumen membrane
Better drainage
Higher up stands
Roof terraces – duo roof concrete tiles on rubber footings

1) 50 mm concrete tiles on rubber supports
2) Fibermat - fire safe
3) 80 mm XPS
4) Two-layer polymer-modified bitumen membrane
5) Sloped EPS 60-100 mm, 1:100
Higher up stands by changing the façades to be 200 mm smaller.
New concrete up stands and new façades
2 layer SBS polymer-modified bitumen membrane
Membrane on roof terraces

- Two-layer SBS polymer-modified bitumen
- 4.2 mm polyester reinforced with 180 g/m² polyester carrier
- 1\textsuperscript{st} layer loose laid with torched overlapping
- 2\textsuperscript{nd} layer fully torched to 1\textsuperscript{th} layer
- Insulation EPS (150 kN/m\(^2\))
- XPS for the insulation on top of membrane
Torching
Vegetation in the edge of the roof was removed
Roofs with mechanically fixed membrane

1) Two-layer polymer-modified bitumen membrane
2) 25 mm mineral wool, roof board
3) Sloped EPS 1:40
4) Exist. structure
Symphonic drain with pipes built into the insulation
Mechanical fixing and built in pipes is a dangerous combination.
Construction period

- The tenants stayed in the apartments
- The building was covered with a movable tent in the renovation period
- Moisture damages was limited
Roof terrace
The tenants use the terraces for all purposes
The architect was not happy
Roof terraces can be used in different ways
Green roofs

- 3rd renovation
- Going on now
The small green roofs were not renovated in 2nd renovation
Small green roofs

- 1.2 mm PVC membrane
- 1.5 mm PVC membrane as sacrificial layer
- The loss of plasticizer occurred mainly in the sacrificial layer
- Service life was extended with 10 years
- Problems at flashing where there was no sacrificial layer
- The thickness of the vegetation has increased
Renovation

- PVC membrane and insulation from first renovation is removed
- New tapered insulation of EPS
- 2 layer SBS polymer modified bitumen membrane
- Vegetation system
Edge detail
Prefab vegetations
Finished green roof
Terraced apartments
It looks a bit rusty but it is water tight
Conclusions

- Always look at the critical details first - in this case the up stands
- Choose the right material for the actual environment and get documentation
- Include an inspection plan in the contract
- No drainage built into the insulation
- Drainage system with redundancy - overflow possibility lower than the flashing height
The contractor will not have his head chopped off but will have no fee for maintenance if there are more than 5 call backs per year
Green roof
Contact details

- Erik Brandt, senior researcher, Danish Building Research Institute, ebr@sbi.dk
- Tommy Bunch-Nielsen, director, Danish Roofing Advisory Board, tbn@byggeteknik.com