

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

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Terraced houses



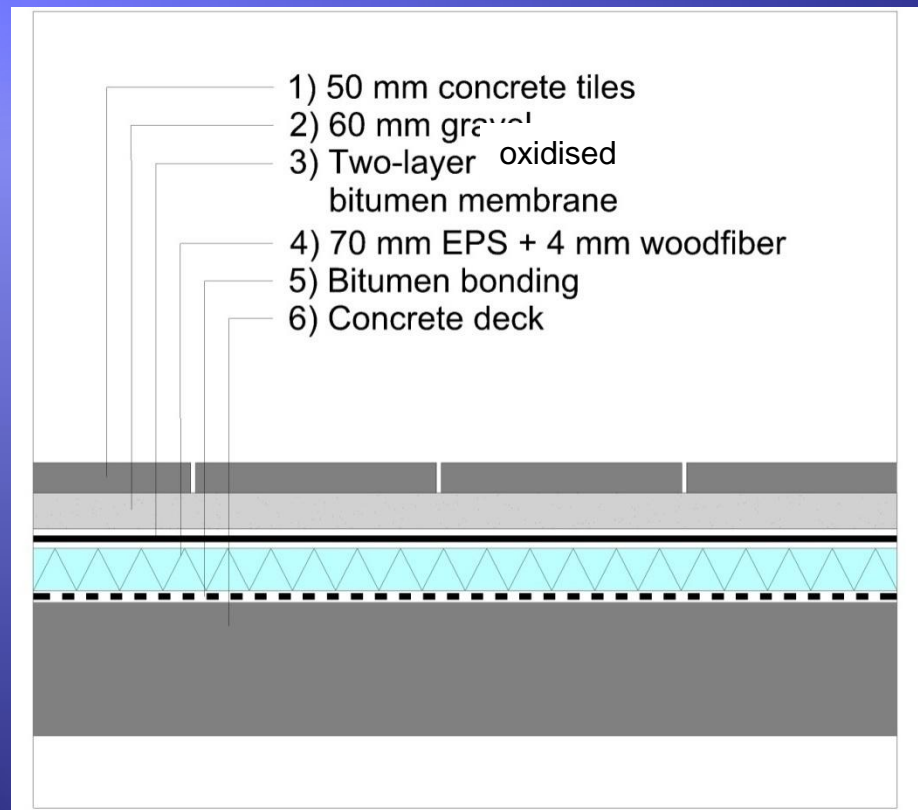
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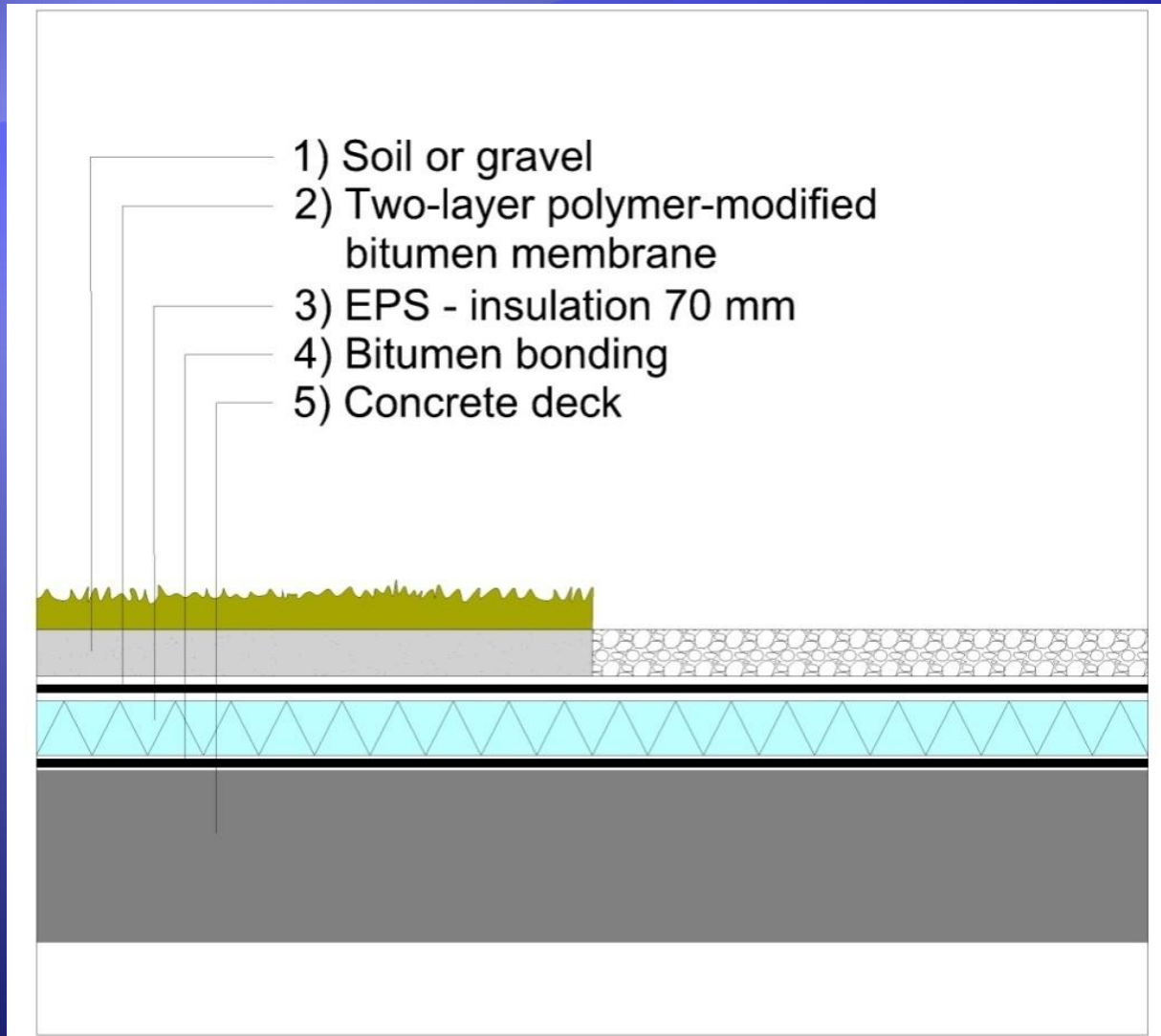
Observations from 1973 - 2011

- ◆ 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

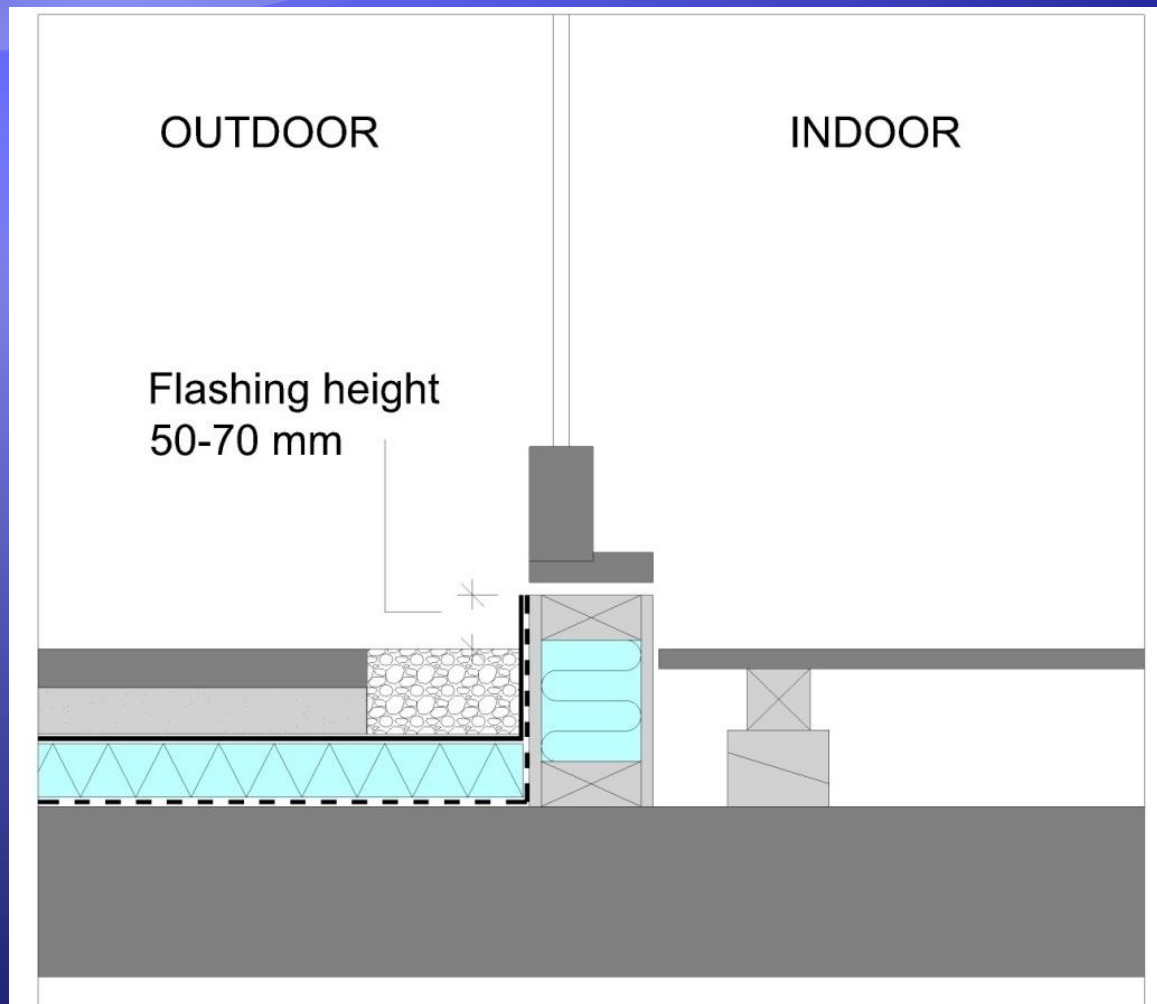
Roof terraces - original design



Green and ballasted roofs



ORIGINAL DESIGN



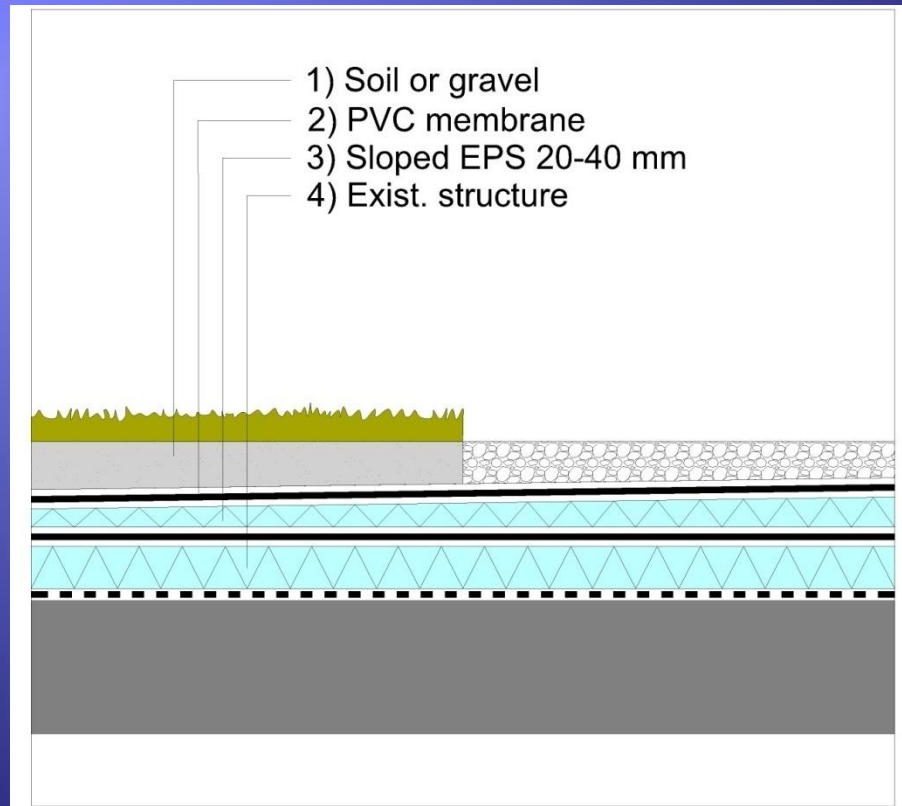
Roofing material

- ◆ 2 layer oxidized bitumen
- ◆ 70 mm EPS with 3 mm wood fibre board
- ◆ No slope

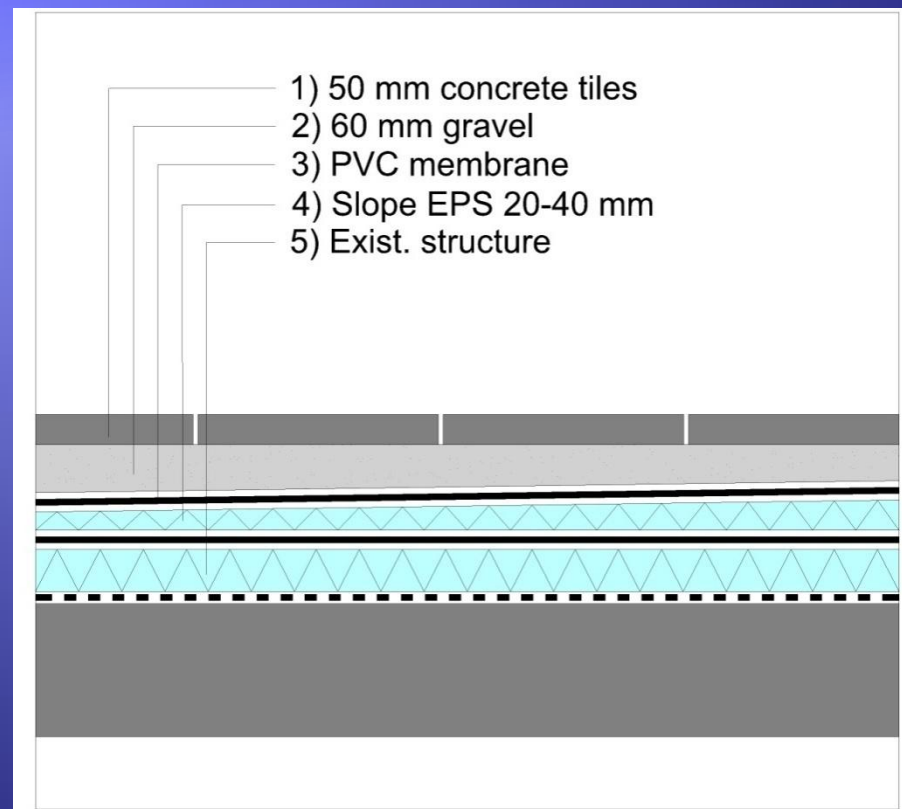
First renovation in 1990-91

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

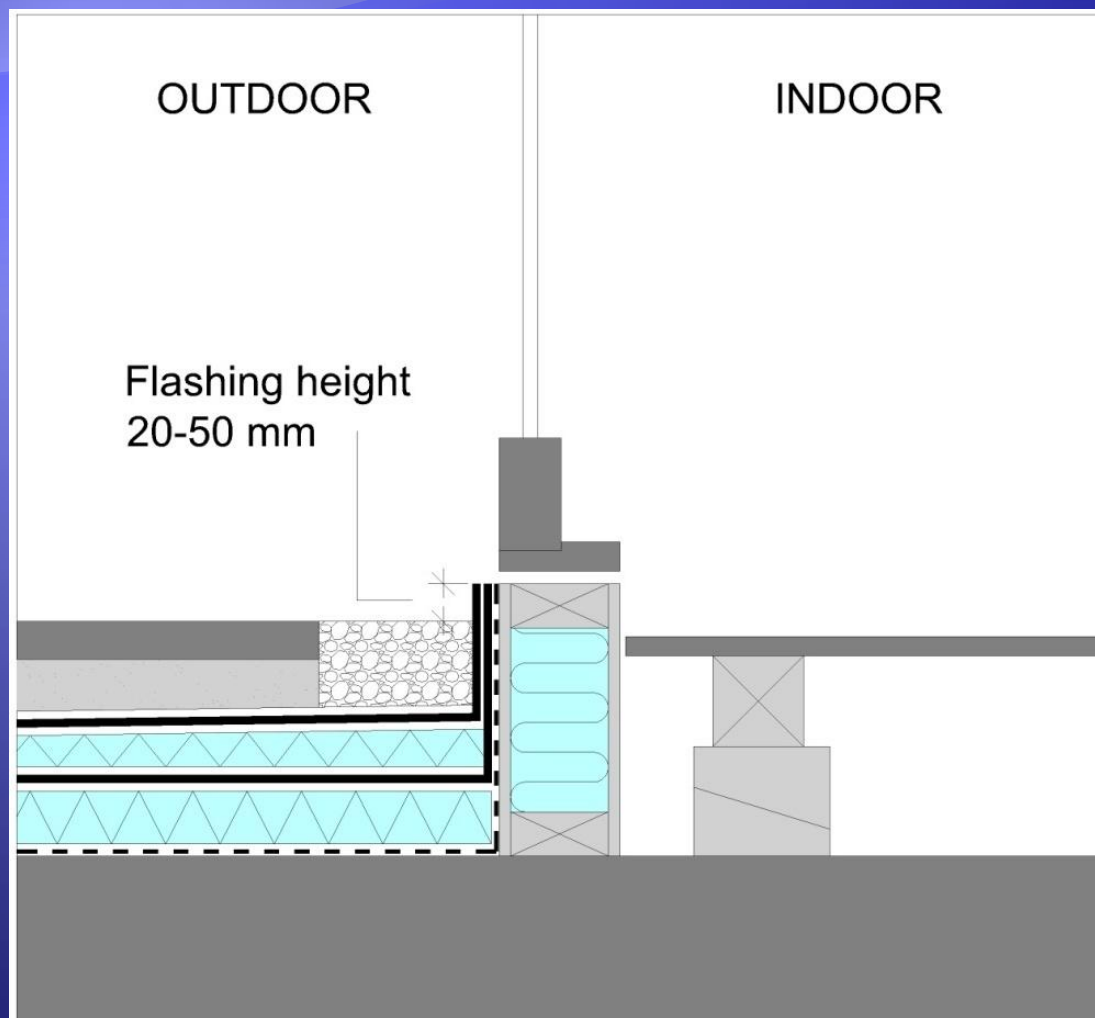
Vegetated and ballasted roofs



Roof terraces



Lower height of flashings



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



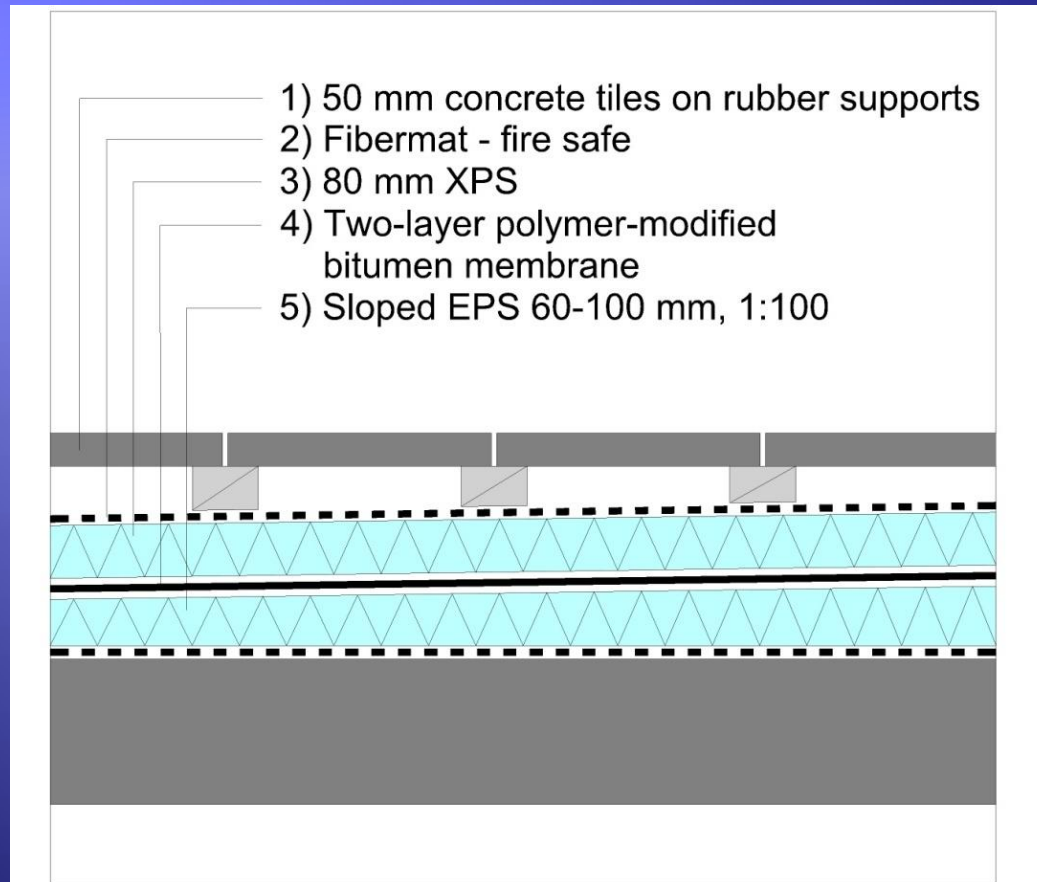
Insulation from 1th renovation

- ◆ 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

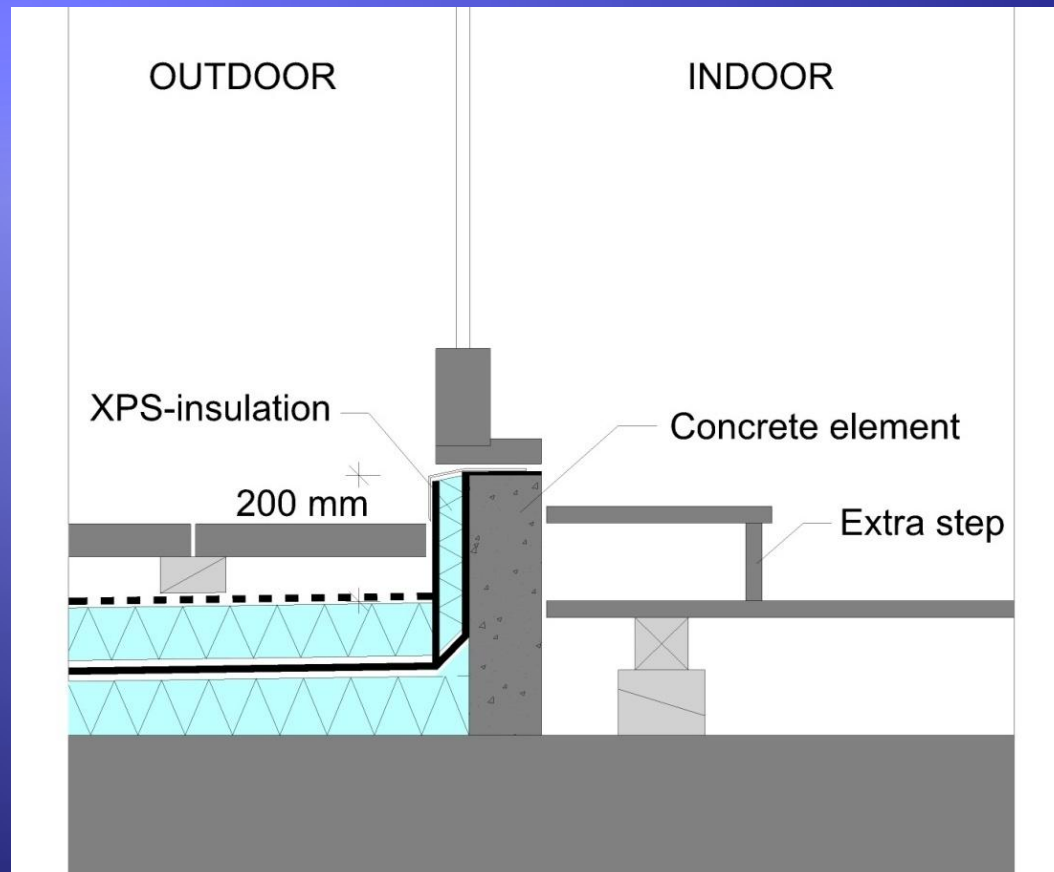
2nd renovation 2001-04

- ◆ 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



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
- ◆ 1st layer loose laid with torched overlapping
- ◆ 2nd layer fully torched to 1th layer
- ◆ Insulation EPS (150 kN/m²)
- ◆ XPS for the insulation on top of membrane

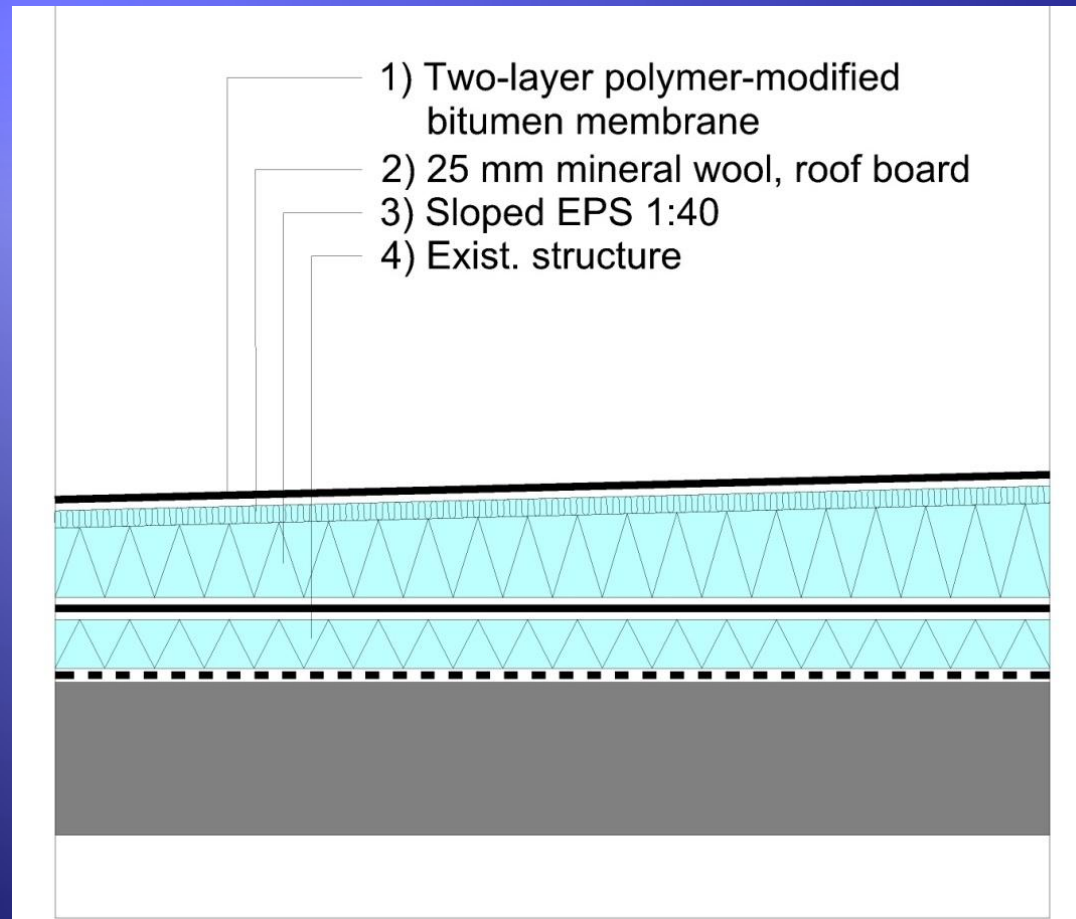
Torching



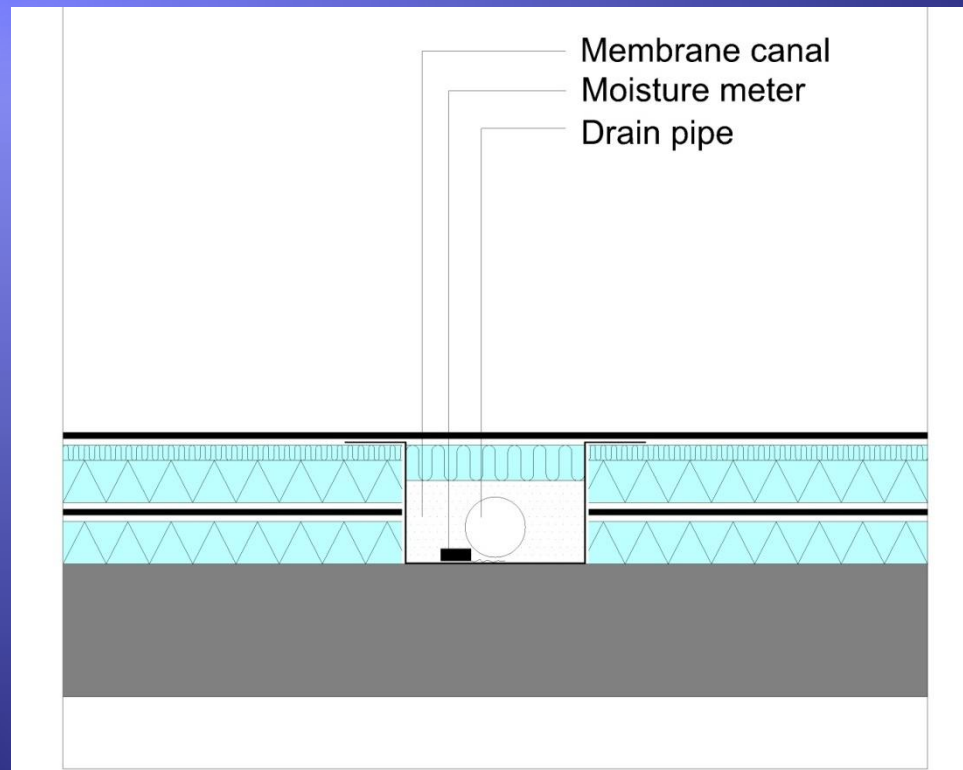
Vegetation in the edge of the roof was removed



Roofs with mechanically fixed membrane



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



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Roof terrace



The tenants use the terraces for all purposes



The architect was not happy





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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



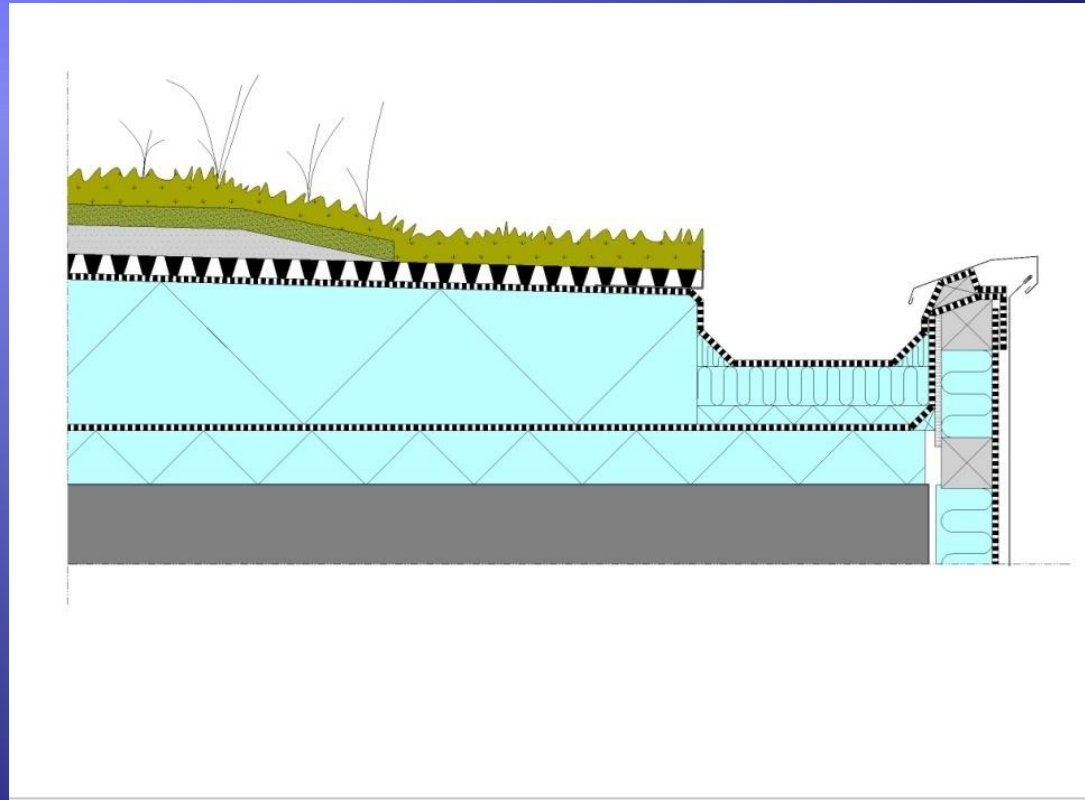
Small green roofs

- ◆ 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



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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



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