14th International
Passive House
Conference

Dresden,
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2010

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The first apartment house renovation with Passive House components in Norway

168 flats,

one-bedrooms (55 m²) and

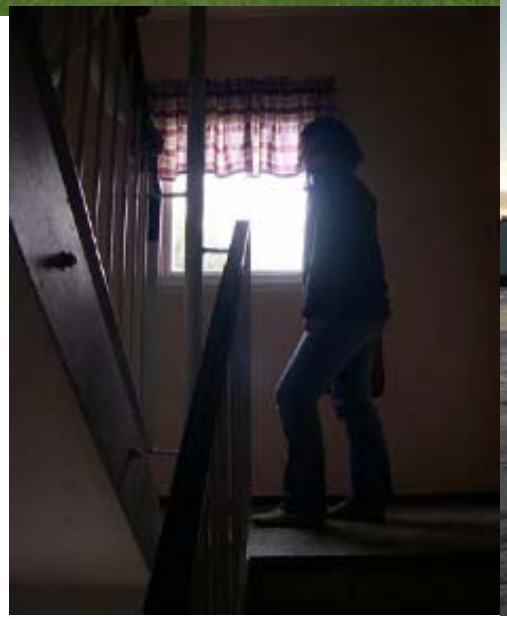
two-bedrooms (68 m²)

7 similar blocks, 3 storeys high with unheated cellar, built 1968-70

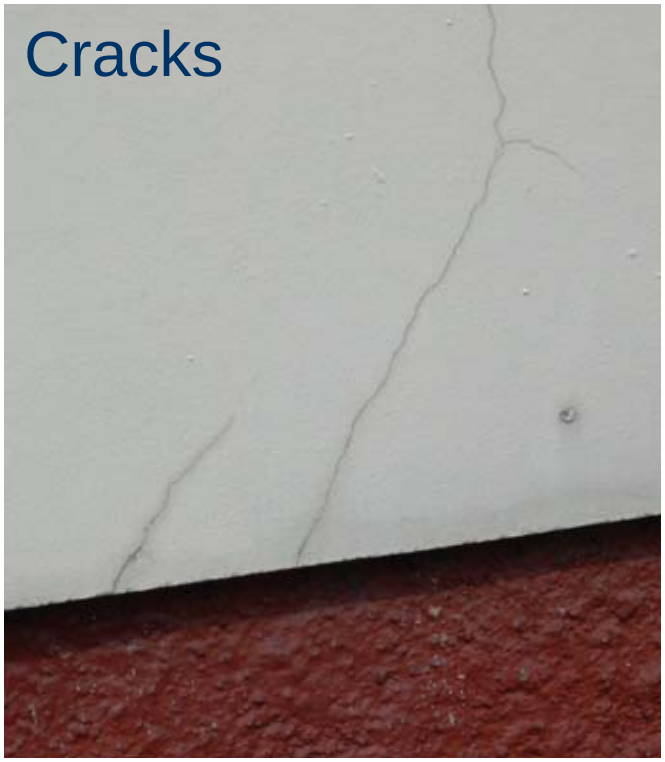
Myhrerenga housing cooperative at Skedsmokorset, 15 km north east of Oslo, nearly same climate with annual mean temperature around 6 °C

Fine …

… and sad



Cracks



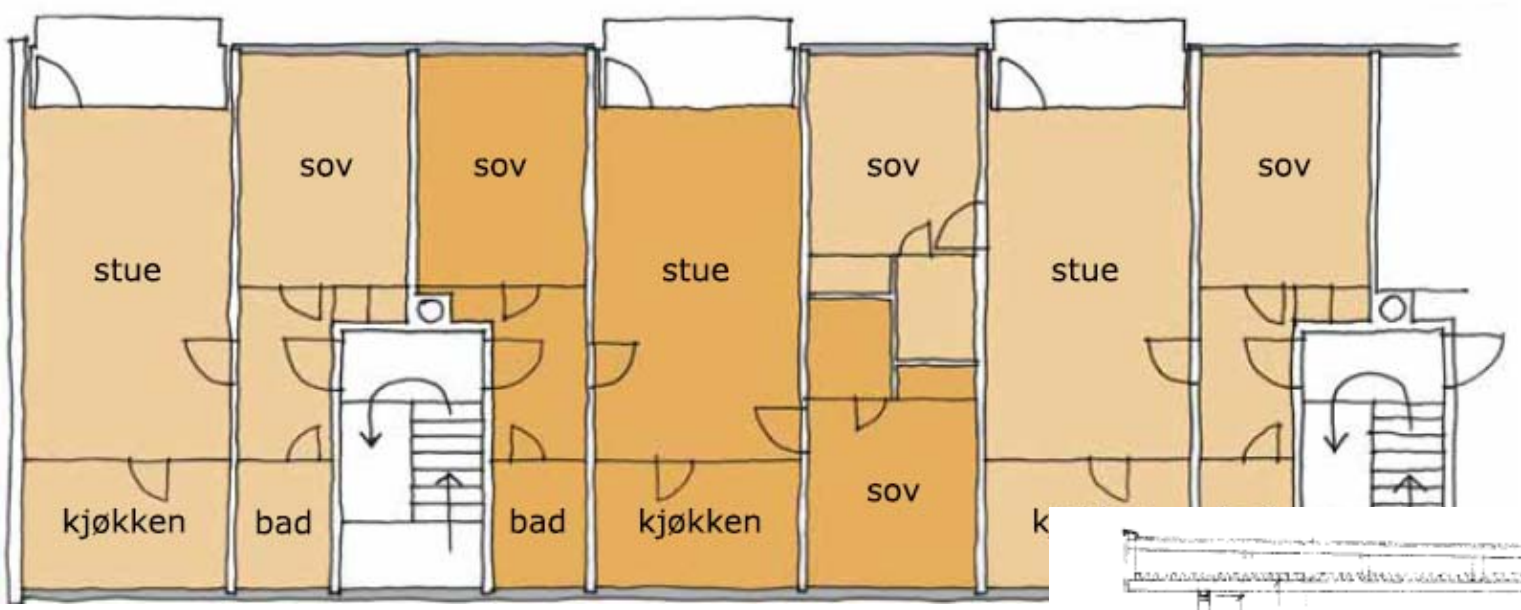
Many damages

Rot

Moisture

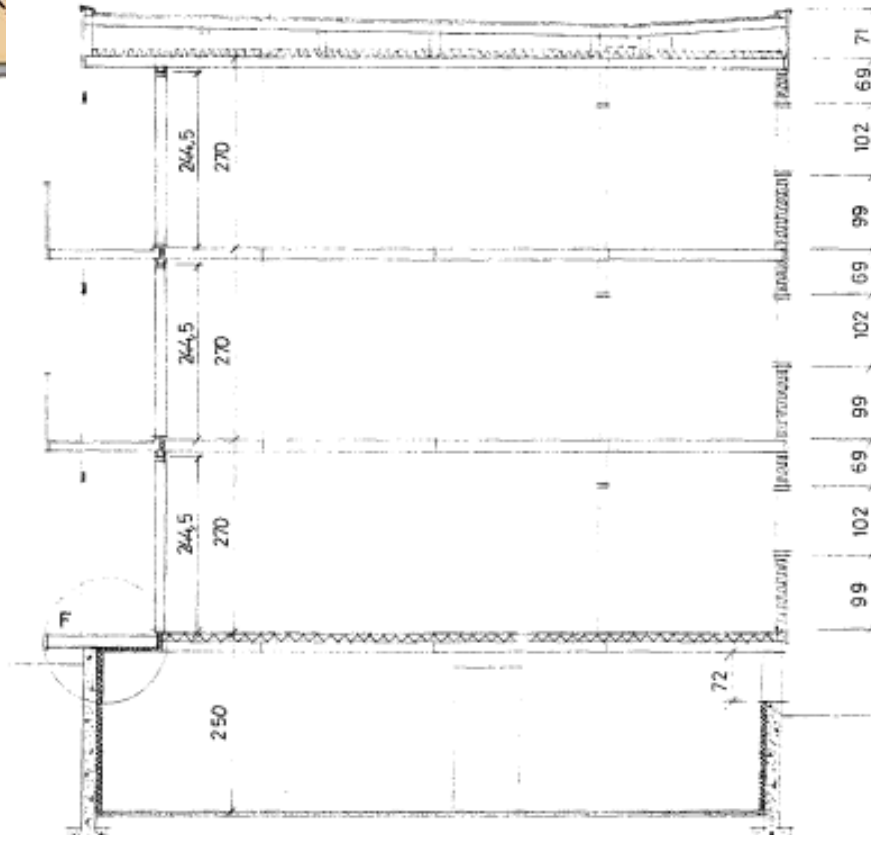
Myhrerenga before renovation

- Complaints about poor indoor climate, draft problems and cold floor
- Exhaust ventilation system
- Central heating with radiators
- High energy consumption (275 – 300 kWh/m²år, overall)
- 2006: The cooperative wants a facade rehabilitation and larger balconies
- Housing Bank and SINTEF suggest retrofit with PH-components
- Demonstration project within EKSBO and IEA SHC task 37 – Construction work starts in February 2010



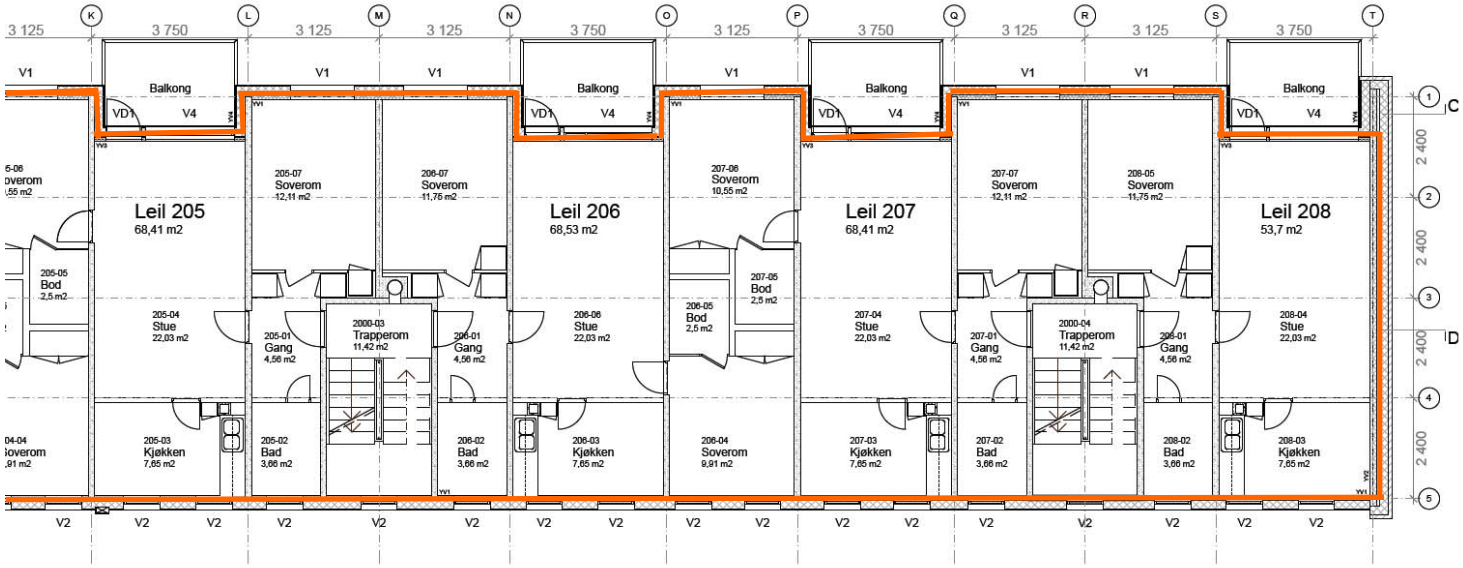
Building fabric before renovation

- 5 – 10 cm insulation in floors towards cellar, walls and roof construction
- Poor air tightness
- Lot of thermal bridges



Renovation concept

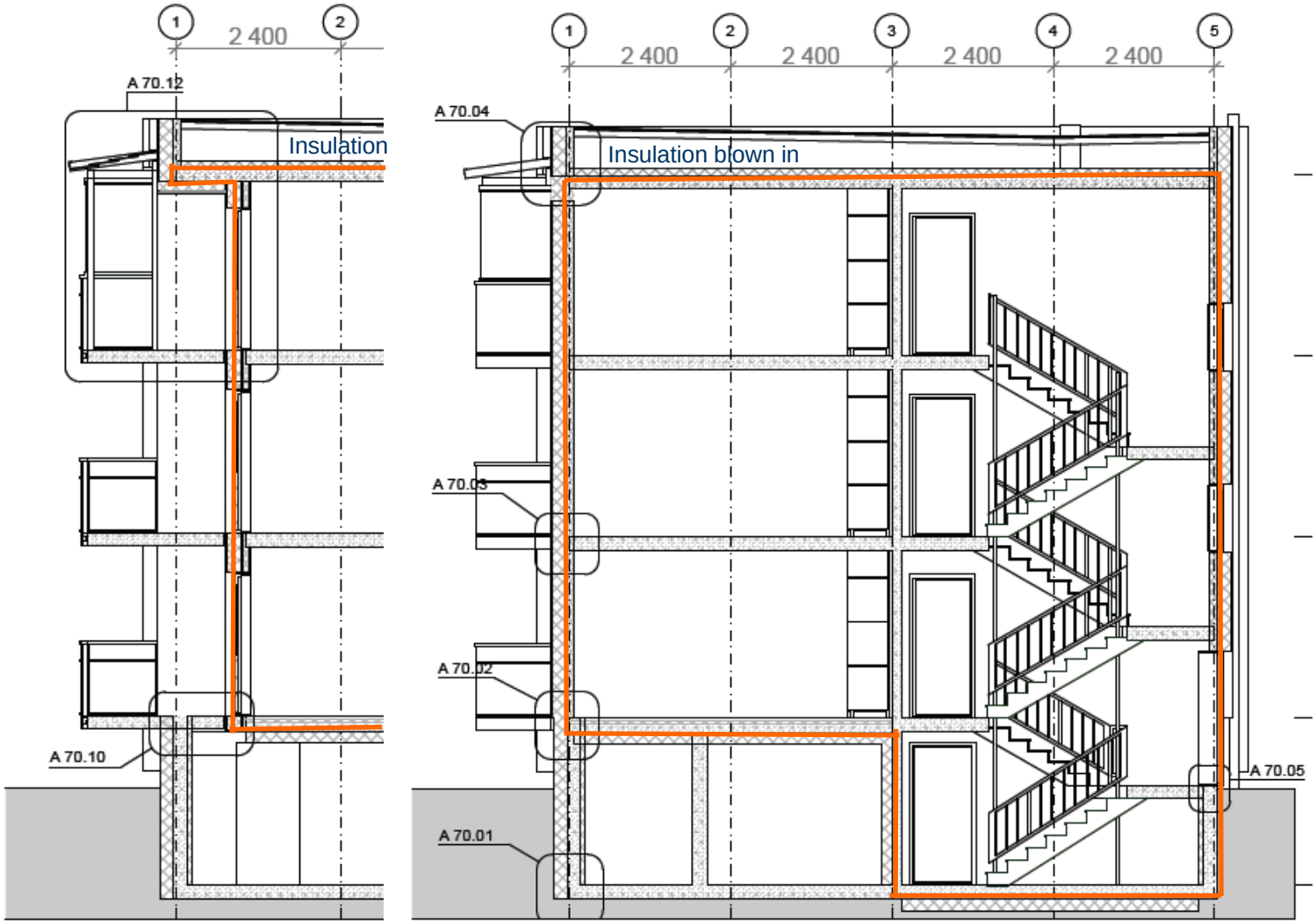
- Added insulation in cellar ceiling, walls and roof
- Passive House windows and doors
- Increased air tightness and reduction of thermal bridges
- Highly efficient balanced ventilation
- Replacement of oil and electric boilers with air to water heat pumps and solar collectors
- Reuse of existing heat distribution system
- Individual energy accounting (heat and electricity)



Airtight building envelope

including staircase in the cellar

Many details to design



Airtight building envelope

including staircase in the cellar

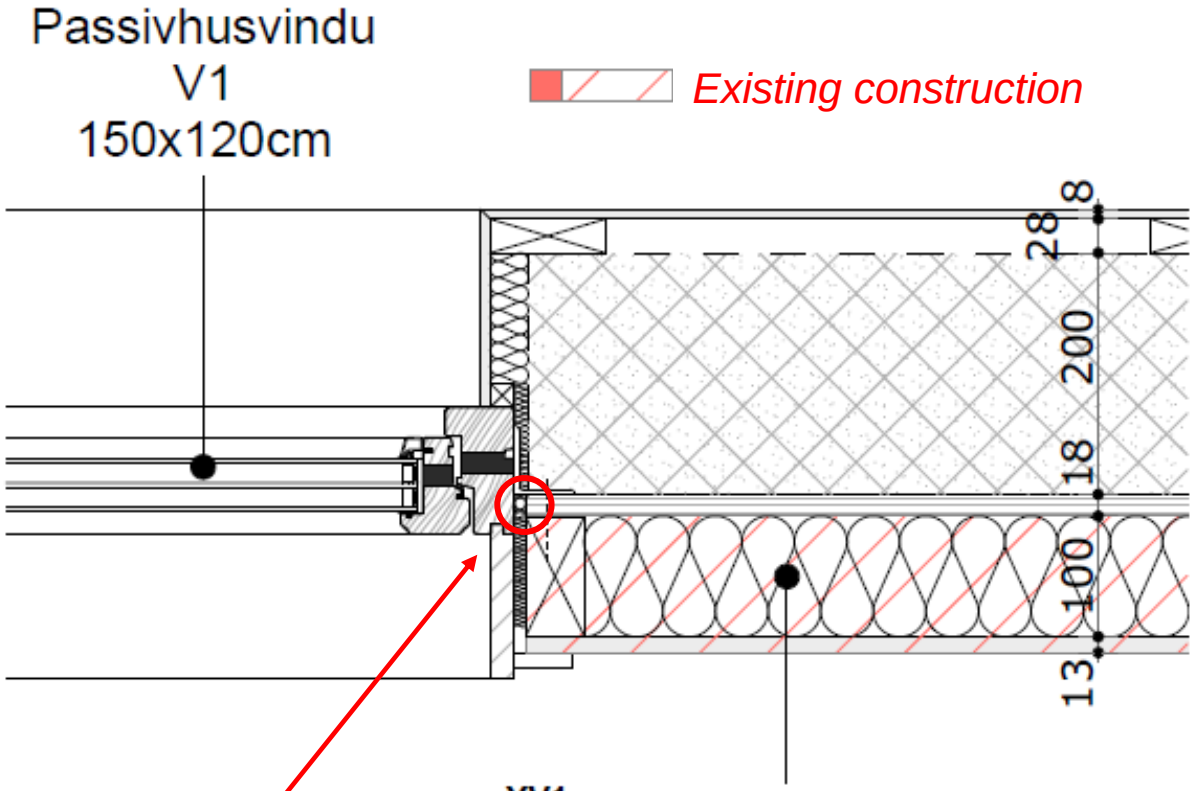
No insulation below, but on wall

Air tightness: expanding foam caulking

Test wall

PH-window and vapor permeable wall

Passivhusvindu
V1
150x120cm

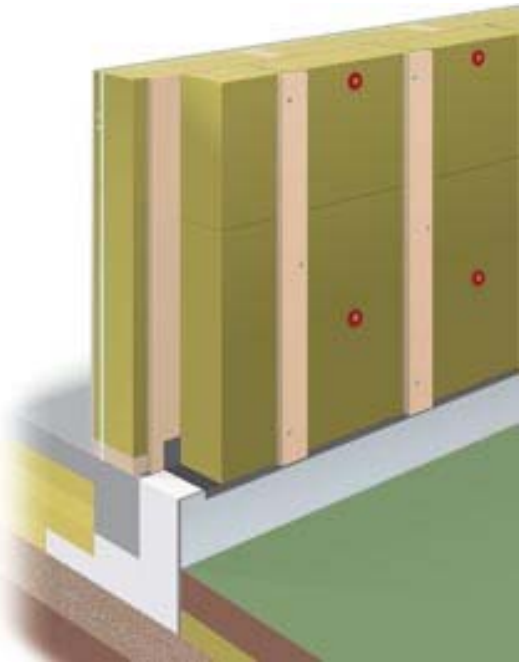


YV1

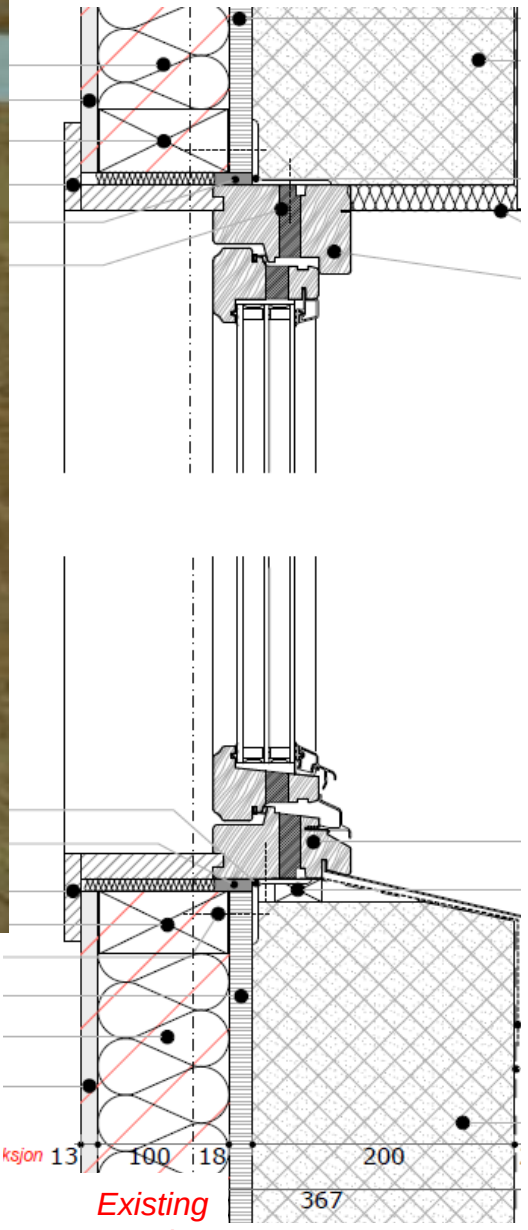
8 mm	Cemberit fasadeplate
28X95mm	vertikal utlekting
	vindsperre
200 mm	Rockwool flex systemplate
18 mm	OSB-plate m/tapede skjøter
4"	stendervegg med isolasjon
13 mm	gipsplate

Air tightness:
expanding
foam caulking

Arkitektskap AS

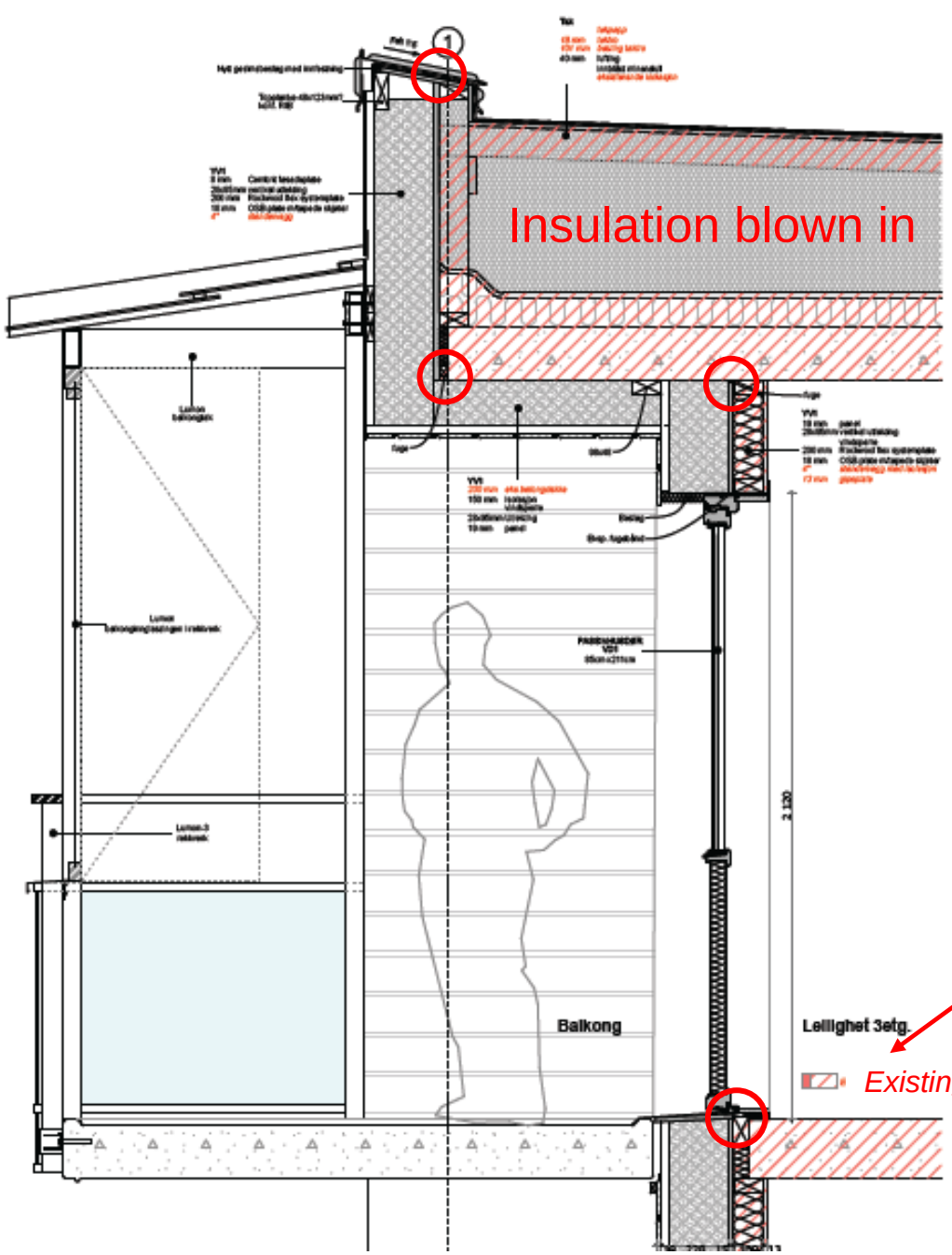


OSB-boards and
20 cm unbroken
insulation on the
existing 10 cm stud wall
+ new facade lining



Existing construction

Airtight window/wall solution after discussion on-site



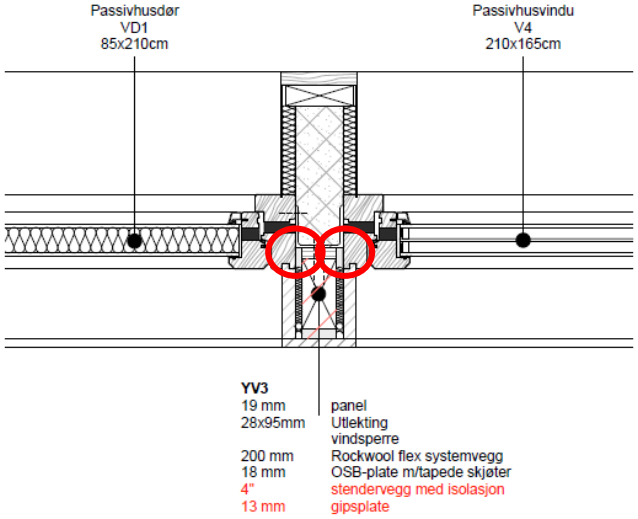
Air tightness measures:

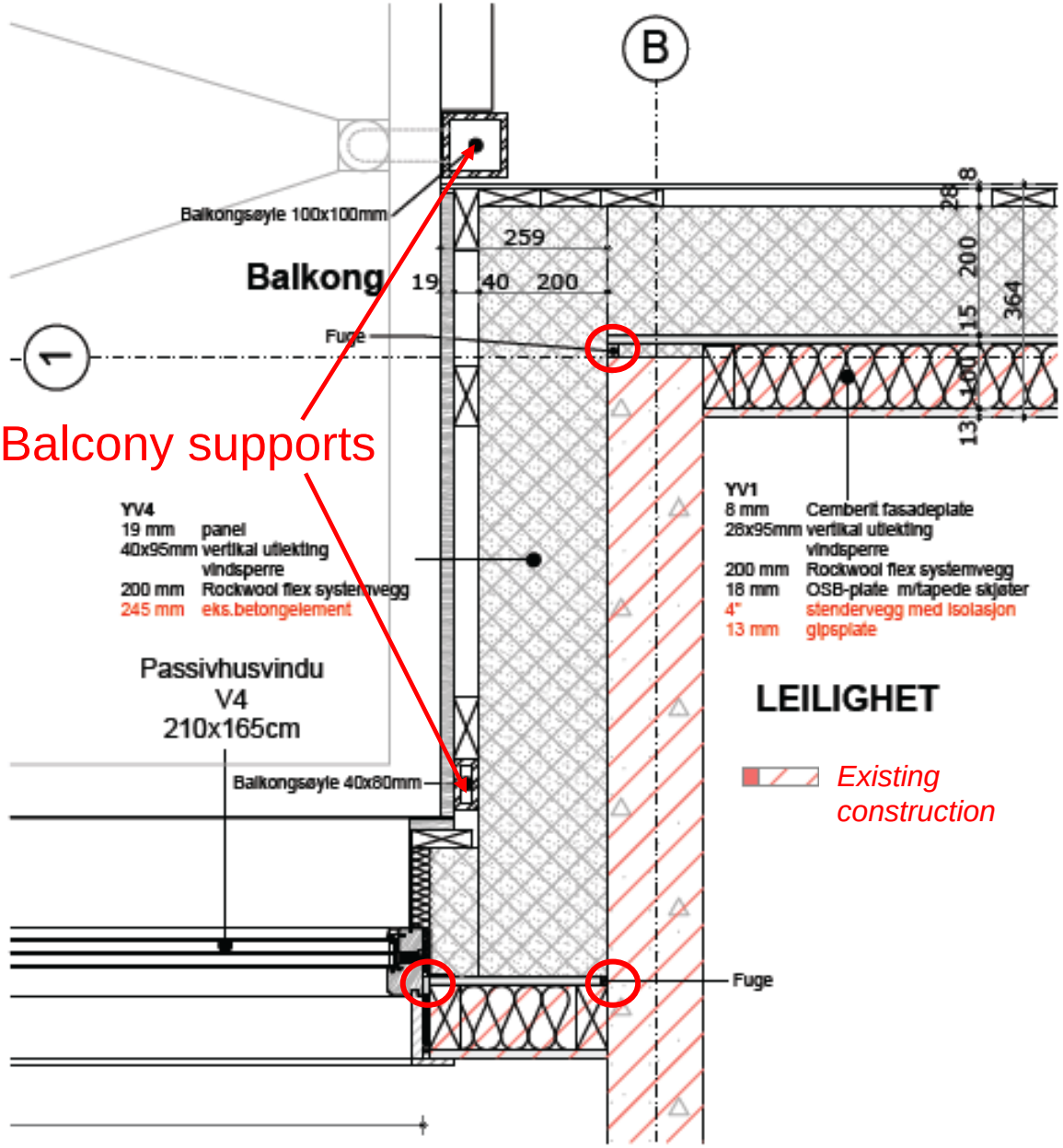
Air tightening OSB – frame and between stories

Roof and balcony

Balcony and window/door

Air tightness measures:





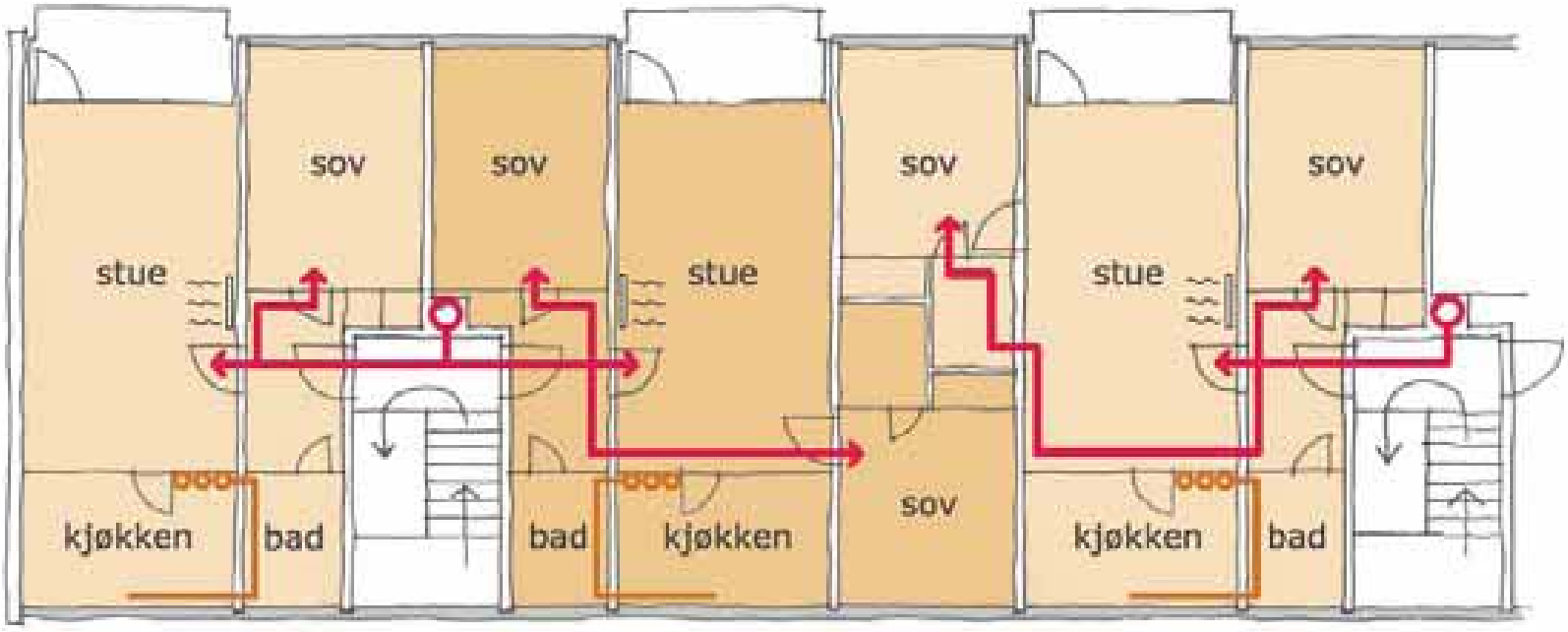
Calculated U-values [W/m²K]

Construction	U-value before renovation	U-value after renovation
External walls main façade	0.40	0.12
External walls gable	~ 0.45	0.15
Roof	0.35	0.11
Floor construction*	0.58	0.23
Windows and balcony doors	2.8	0.80
Entry doors	2.7	1.20

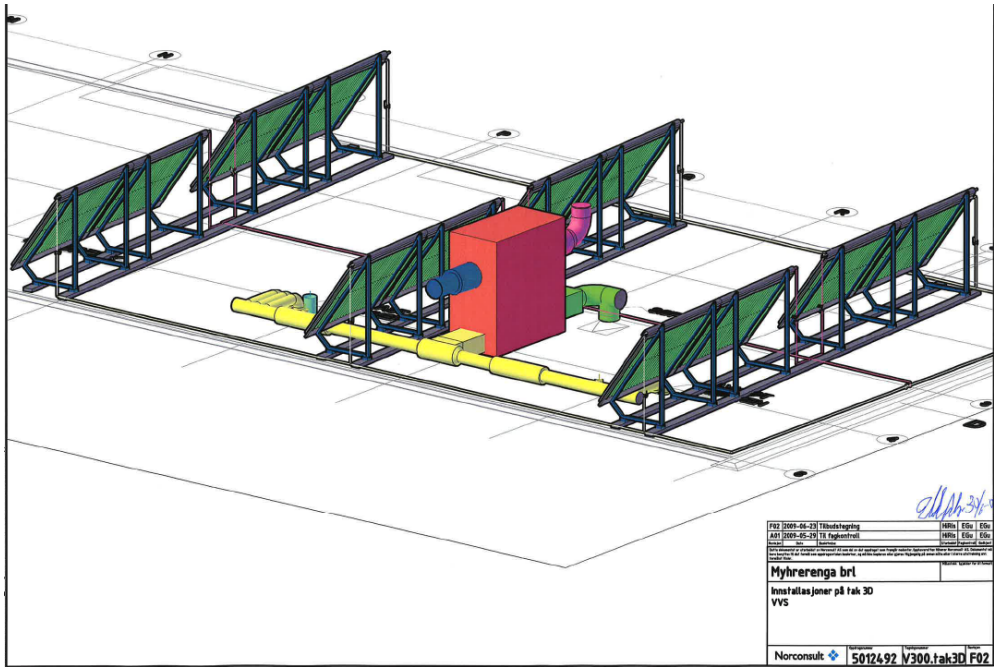
* U-value included the thermal resistance of the unheated cellar

- One central air handling unit per block, placed in the cellar
- Double cross flow heat exchanger (probably) with high efficient heat recovery
  - (η > 80 %, SFP < 1,5 kW/m³/s
- Air supply through old garbage chute
- Air extract through existing extract shaft
- >> limited interior work

Balanced ventilation



Energy supply



- Only one radiator in the living room (1-1,5 kW) + existing radiator in the bath room
- Individual energy accounting (heat and electricity)
- Renovated boiler house:
  - 3 air-to-water heat pumps (25 kW each, run in cascade)
  - 44 vacuum solar collectors on the nearest block roof
  - 1 electric boiler kept (peak load)
- Reuse of existing heat distribution system

New and larger balconies

Arkitektskap AS

New entrances

Arkitektskap AS

Calculated energy demand

Energy Demand [kWh/m²a]	Before renovation (measured)*	After renovation** (simulated)	
		Net energy demand	Delivered energy
Space Heating	195 – 220	25 - 88 %	15
DHW	30	30	15
Fans and pumps	10	10	10
Electricity use (lighting and appliances)	40	40	40
Sum	275 – 300	105	80

- 72 %

* Varying from year to year

** To be measured after renovation

Increased investment cost for PH-retrofit, in addition to façade renovation – but ...

	Project cost million NOK	Cost NOK/m²	Cost EUR/m²
Overall construction cost	70.0	6430	800
Design + construction supervision	4.5	410	50
Overall investment cost PH-retrof.	74.5	6840	850
Conventional façade renovation	53.8	4940	615
Gross additional cost PH-retrofit	20.7	1900	235
Allowances from ENOVA	6.4	590	75
Net additional cost PH-retrofit	14.3	1310	160

VAT included

… lower rent per month …

	One-bedroom apartment	Two-bedroom apartment
Total monthly cost (capital and energy) PH-retrofit [NOK]	3190	3990
Total monthly cost (capital and energy) conventional façade renovation [NOK]	3510	4390
Savings NOK/month	320	400
Savings EUR/month	40	50

4,7 % interest rate for PH-retrofit (Norwegian state housing bank), 5,7 % for facade renovation (ordinary bank), 30 years, energy price 0,1 Euro/kWh

… and additional advantages like:

- Increased comfort and indoor climate
- Lower maintenance cost
- Substantially higher marked value for the flats, maybe increased by 2000 kr/m²

Preliminary conclusions:

- Cost effective renovation with PH-components is possible in Norwegian average climate
- Decision making and design/optimization process is more challenging than in Central-Europe