Radon resistant construction in Finland in 2007

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"The Radon Groke" in construction in Finland in 2007

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Figure: Moomins, the Groke - Tove Jansson
Mårran in Swedish, Mörkö in Finnish,
Hufsa in Norwegian?

Radon in Finland

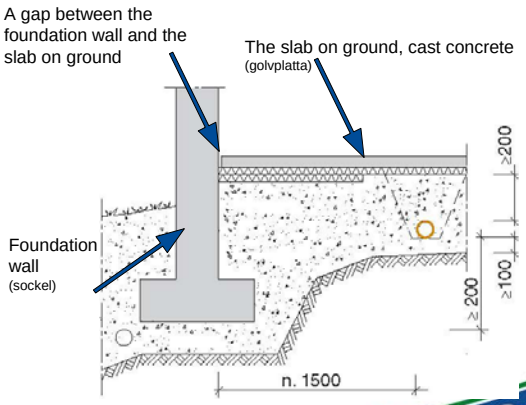
- Reference level for indoor radon concentration
  - existing dwellings 400 Bq/m^3
  - new dwellings 200 Bq/m^3
- 60 000 dwellings (3.6%) exceed 400 Bq/m^3
  - 200 000 dwellings exceed 200 Bq/m^3
  - the new VARO study will update this information
- over wide areas (especially heavily populated southern Finland) 10-20% exceed 200 Bq/m^3

National Building Code
part B3, substructures, 2004

- **requires** radon-technical **design** and radon-resistant **structures** in new building throughout Finland
- reference level 200 Bq/m^3 for new buildings
- the Code refers to the Radon Prevention Guidelines for Radon Resistant Building (2003)

Guidelines: Radon prevention
RT-10791 (LVI 37-10791)

- Guidelines for radon prevention in new building
- published 2003
- Key advice:
  - radon-resistant foundations are crawl-space and uniform concrete slab
  - slab on ground (most common foundation in Finland):
    1. seal the joint between the foundation wall and slab using bitumen felt (sockel, golvplatta)
    2. install sub-slab piping ("radon piping")



Soil air

"Soil" contained about 40% of air.

"The Radon Groke" hides in soil air - and streams with it.

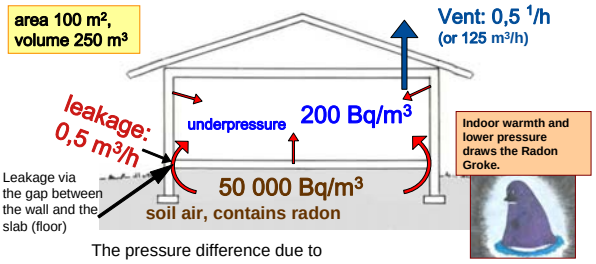
Soil air streams in soil - like wind in a very dense forest.
Comparison with water helps to understand its behaviour.

Indoor radon concentration

$$\frac{50000\ \mathrm{Bq/m^3} \times 0{,}5\ \mathrm{m^3/h}}{250\ \mathrm{m^3} \times 0{,}5\ \mathrm{1/h}} = 200\ \mathrm{Bq/m^3}$$

area 100 m², volume 250 m³

Vent: 0,5 1/h (or 125 m³/h)



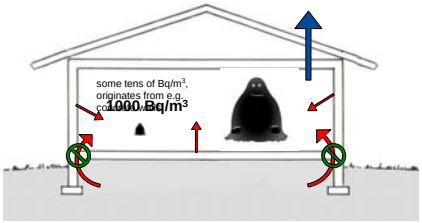
Leakage via the gap between the wall and the slab (floor)

The pressure difference due to
- temperature difference
- ventilation

In winter the Radon Groke gets fat!

- The Groke of Tove Jansson grew larger during the winter
- the pressure difference increases due to temperature difference → radon is typically a harder problem in winter than in summer

Radon prevention



Block the entry - seal the gap between the foundation wall and the slab (floor)!
People do not sail with a leaking boat, why would they live in a leaking house?

Bitumen felt

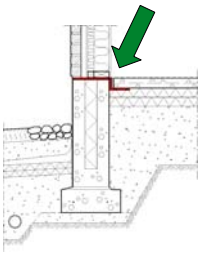
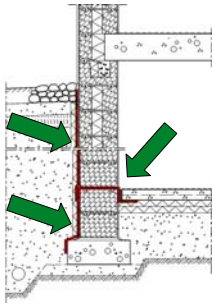


Fig. from RT L-36846 Katepal

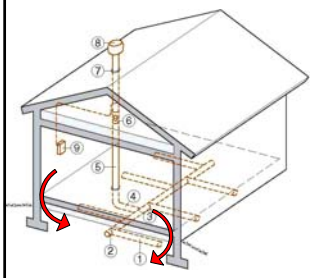
foundation wall: concrete

light concrete blocks (porous material)

Bitumen felt and walls in contact with soil



- wall in contact with soil made of **porous light-weight concrete** blocks
- soil air penetrates easily
- plastering reduces penetration by a factor of 1000 (slamning)
- sealing with bitumen felt



Radon piping

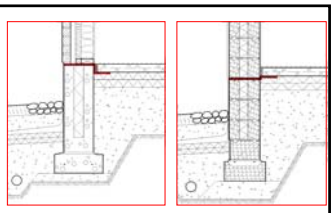
1. suction (radon) piping
2. collector duct
3. air removal point
4. transmission duct
5. exhaust duct
6. damper
7. roof follow-through
8. exhaust fan
9. possible electrical regulator system for the fan

Piping depressurizes the sub-slab volume, when activated

Questionnaire

- selected 133 new buildings, completed in 2004 or later
- in Tampere, Kotka, Vantaa, Hyvinkää areas
- first radon measurement ordered and carried out by the owner occupants during 2004 - 2006
- questionnaire was sent, 101 responded
- questions mainly about foundations, materials, sealing, radon piping and ventilation
- new radon measurement during winter 2006 - 2007

Radon measurements and sealing



Dwellings with slab on ground:

Sealing method	*Number of dwellings exceeding 200 Bq/m³*	mean Bq/m³	median Bq/m³
Bitumen felt	7 / 23	280	150

Quite many dwellings (7 of 23) in which bitumen felt was used still exceeded the reference level 200 Bq/m³.

But the table does not indicate the entry points!

Hydrogen as a tracer

tracer gas:
95% N_2
5% H_2

Results of the tracer studies:

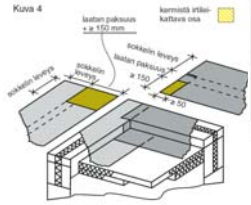
Leakage point and leakage severity	*# of affected dwellings (total of 11 dwellings with bitumen felt)*
Lead-throughs:	
Significant leakages	10
Insignificant leakages	2
Joints of bitumen felt strips:	
In corners	6
In the joint between the bearing separating wall and the slab	5
Close to doors	7
The joint between the wall and slab, straight segments of the walls:	
Significant	1
Insignificant	5
Elsewhere	
Close to electric wall sockets and plug points	3
Close to fireplace	1

Lead throughs:

Can be sealed afterwards - but not always easily.

Why do corners leak?

- Joints of bitumen felts strips not seamed!
  - mainly in corners
  - sealing with hot air, gas burner or with specific kind of sealing glue
  - maybe not the worst deficiency



Figs. from RT L-36846 Katepal

No sealing at all...

- the joints between the wall and the slab often leak throughout the dwelling
- very hard to seal afterwards
- may disturb the activated radon piping

Radon piping

Exhaust fan status	*Number of dwellings*	*Mean Bq/m³*	*Median Bq/m³*	*Mean Bq/m³*	*Median Bq/m³*	*Average reduction in Rn concentration*
		Before activation		After activation		
All dwellings	14	630	430	130	34	82%
With fan, below ref. lev	11	530	420	37	28	83%
With fan, above ref. lev.	3	1000	1000	490	470	46%

- radon piping is commonly installed
- usually effective even alone
- in some cases extra sealing work or other measures needed
- high permeability sub-slab filling may decrease efficiency (need for a future study)

Conclusions 1:

Radon piping

- commonly installed
- usually effective if activated with a fan; if not, sealing may improve
- efficiency of sub-slab depressurization may be defective in the case of high permeability sub-slab filling materials

Conclusions 2:

Sealing

- not as common as radon piping
- very hard to seal afterwards if problems arise
- non-sealed joints of the slab and the wall often leak throughout the dwelling
- lead-throughs are not sealed well enough
- joints of the bitumen felt strips should be seamed

The Groke "melted down" finally.

(Muumipappa ja meri - Pappa och havet - Moominpappa at Sea)

But the Radon Groke should not enter indoors!

More information: www.radon.fi