The radiological & environmental impact of the new EU regulation on building materials

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- Building materials in Belgium & The Netherlands
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Use of Building materials in B & Nl
(residential buildings)

- In B and Nl building: cavity wall with bricks on the facade

- Remarkable difference in the materials used for inner load bearing walls:
  - In Belgium most perforated clay blocks, minor contribution of concrete and aerated concrete blocks and almost no calcium silicate elements
  - In The Netherlands almost no clay and concrete blocks (4%) but most (74%) calcium silicate elements

- Exterior walls in B and Nl most in clay bricks

  Remark in southern Belgium: natural stone blocks

Building materials in Belgium

Campaign 2011 (XIOS)						
Category	Number	Ra-226 (Bq/kg)	Th-232 (Bq/kg)	K-40 (Bq/kg)	ACI	Worst case
Bricks	7	50 (20-80)	50 (40-60)	570 (470-750)	0,6	0,8
Concrete	10	50 (10-140)	20 (< 10-90)	260 (80-750)	0,4	1,2
Cement	10	130 (40-250)	40 (20-60)	150 (50-480)	0,5	1,3
Natural stone	27	110 (10-1010)	160 (< 10-550)	750 (< 10-1700)	1,4	6,7
Tiles	56	80 (< 10-190)	80 (30-160)	530 (210-910)	0,8	1,7
Campaign 1990 (UGENT)						
Category	Number	Ra-226 (Bq/kg)	Th-232 (Bq/kg)	K-40 (Bq/kg)	ACI	Worst case
Bricks	13	40 (30-70)	40 (30-40)	570 (400-810)	0,5	0,7
Concrete	20	20 (< 10-60)	15 (< 10-50)	280 (90-550)	0,3	0,6
Cement	4	50 (40-60)	40 (20-50)	260 (110-470)	0,4	0,6
Natural stone	14	20 (< 10-50)	20 (< 10-80)	240 (10-1020)	0,2	0,9
Tiles	6	70 (60-90)	60 (40-90)	830 (650-950)	0,8	1,1

Building materials in The Netherlands

BUILDING MATERIAL	Ra-226 (Bq/kg)			Th-232 (Bq/kg)			K-40 (Bq/kg)			ACI
THE NETHERLANDS (2010)	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
Bricks-clay (21)	47	27	75	51	36	84	552	300	750	**0,60**
Bricks-sand-lime (22)	10	4	17	9	4	14	230	70	360	**0,16**
Concrete (28)	24	11	36	18	7	32	160	120	230	**0,22**
Aerated concrete (14)	11	6	16	8	5	12	170	120	210	**0,13**
Mortars (6)	12	7	18	9	6	14	150	100	190	**0,14**
Gypsum (10)	8	3	14	2	4	14	10	3	17	**0,04**

Current regulation in B & NI

Belgium

- Building materials not mentioned in ARBIS
- Fanc has the possibility to impose restrictions on the producers of building products if necessary for the protection of workers, public, environment
- The Royal Decree of 19.08.1998 concerning the construction products (implementation of Council Directive 89/106/EEC)… « *the emission of dangerous radiation*»

The Netherlands

- Building materials not mentioned in BS « Besluit Stralingsbescherming »
- « Besluit Bodemkwaliteit » (protection of the soil): leaching of building products in contact with the soil considered
- Convenant between industry and government to maintain « stand still » in the indoor environment for radon and gamma ray exposure
- Construction Directive 2003: implementation Council Directive 89/106/EEC

International regulations (I)

International Basic safety Standards (IAEA)

[GRS Part 3 (interim)]

Exposure due to radionuclides in commodities

(requirement 51)

"The regulatory body shall establish **reference levels** for radionuclides in construction materials in order not to exceed an annual effective dose of **1 mSv** for the representative person "

International regulations (II)

Construction Products Regulation (305/2011/EU - CPR)
(adopted 9 March 2011)

- It repeals the Construction Products **Directive** (89/106/EEC)
- A Better Regulation initiative;
- Clarification of the basic concepts and of the **use of CE marking**;
- **Simplification of the procedures** (reduction of costs for enterprises, in particular SMEs);
- **Increased credibility** for the whole system;
- The main parts shall apply from **1/07/ 2013.**

…
"Avoid threat of emissions of *dangerous radiation*"
"Sustainable use of *natural sources*"

International regulations (III)

Revised EU-BSS

Revised EU-BSS (I)

Annex 14

Indicative list of types of building materials considered for control measures with regard to their emitted gamma radiation

Natural materials

- Alum-shale
- Building materials or additives from natural **igneous** origin, such as:
  - Granite,
  - Gneiss,
  - Porphyries,
  - Syenite,
  - Basalt,
  - Tuff,
  - Pozzolana,
  - Lava.

Materials incorporating residues from NORM processing industries, such as:

- Fly ash
- Phosphogypsum
- Phosphorus slag
- Tin slag
- Copper slag
- Red mud (residue from Al prod.)
- Residues from steel production

Revised EU-BSS (II)

Annex 15

Definition and use of the activity concentration index for the gamma radiation emitted by building materials

- The activity concentration index I is given in the following formula:
  $I = C_{Ra226}/300\ Bq/kg + C_{Th232}/200\ Bq/kg + C_{K40}/3000\ Bq/kg$

Use	A (≤ 1 mSv)	B (> 1 mSv)
(1) Bulk	A1 $I \leq 1$	B1 $I > 1$
(2) Superficial and restricted use	A2 $I \leq 6$	B2 $I > 6$

The distinction into (1) or (2) based on national building codes

Ecological & environmental issues

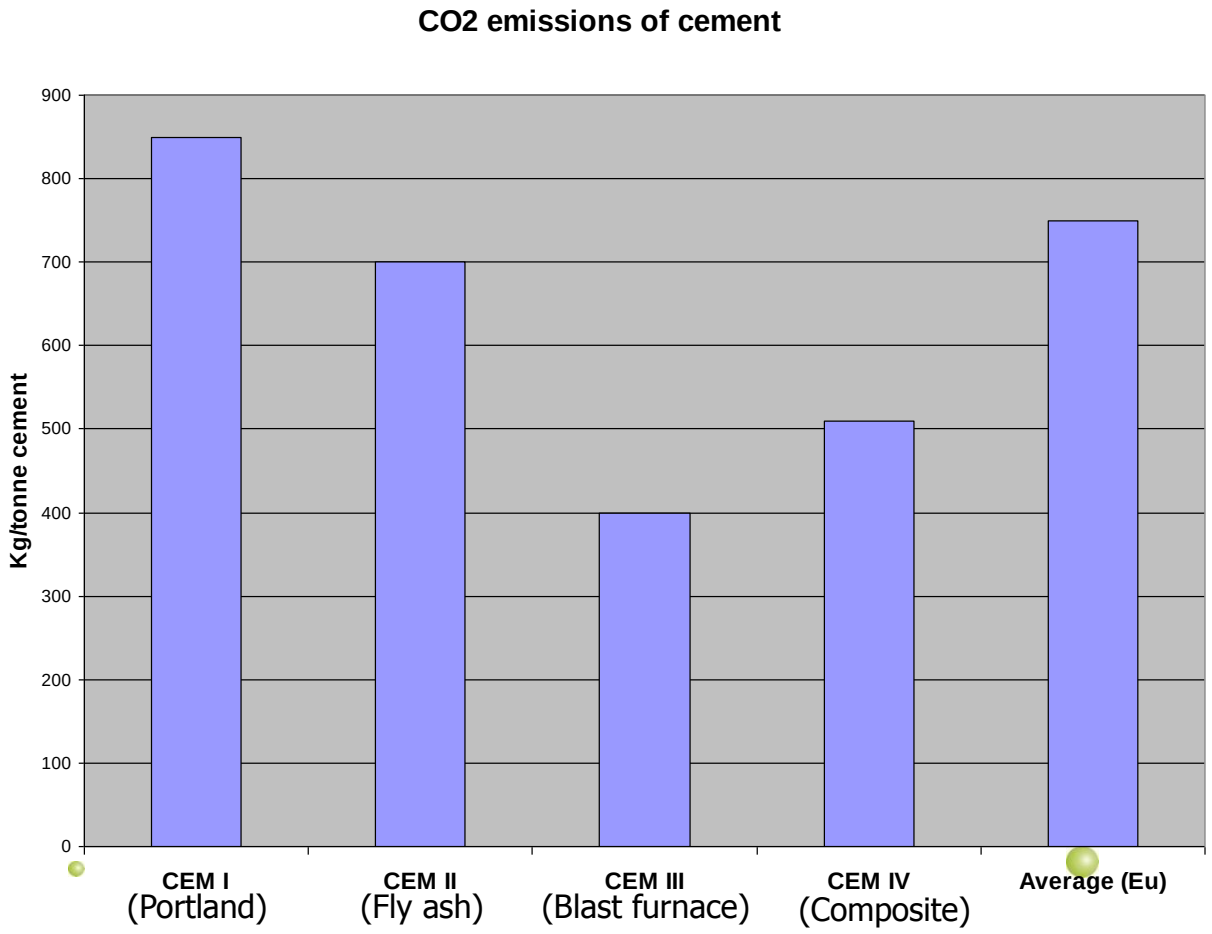
- EU approval of Kyoto protocol (Decision 2002/358/EC)
- **Reduce the total emissions of the developed** countries by at least 5% below 1990 levels, during the period 2008 to 2012

- Climate change
- Sustainability
- Cradle to cradle (C2C)
- Life cycle asssessment
- Waste free
- BAT
- IPPC
- Carbon footprint
- …

Carbon footprint cement (I)

- Cement industry: 5% of man-made CO_2 emissions
- Cement production: Portland clinker + additives
- Major contributions:
  - 40% from fossil fuel burning ($C + O_2 \rightarrow CO_2$)
  - 50% from clinker production ($CaCO_3 \rightarrow CaO + CO_2$)
- Emission reduction:
  - Substitute portland clinker by fly ash/blast furnace slag *(substitute little bit more radioactive!)*
  - Replace fossil by biomass fuels

Carbon footprint cement (II)



Carbon footprint cement (III)

Cement in Belgium

$5{,}8.10^6$ ton/y

40% clinker substitution

750 kg CO_2/ton cement

Cement in The Netherlands

$4{,}8.10^6$ ton/y

60% clinker substitution

540 kg CO_2/ton cement

NL less CO_2 from cement production…
more radioactive concrete???

Concrete

- Composition (% by weight/volume):
  - Fine granulates (sand): 23-35/22-32
  - Coarse granulates (gravel): 33-35/30-48
  - Cement: 9-18/7-15
  - Water: 6-9/14-19
  - Air: /2-6
- Carbon load largely determined by cement, also additives, transport,… play a role

Making of concrete (I)

Mixing conditions (%) Activity concentration (Bq/kg)

	A	B	C	D		Ra-226	Th-232	K-40
Sand	33,5	33,4	33,5	41,6		8	10	154
Gravel	47,9	47,7	47,9	-		10	12	105
Sintered FA	-	-	-	34,0		128	74	567
Portland cement	13,7	-	-	17,0		49	28	201
BFS cement	-	13,7	_	_		98	109	237
Portland FA cement	-	-	13,7	-		77	51	316
Water	4,9	5,2	4,9	7,4		-	-	-

Making of concrete (II)

Code	Ra-226 (Bq/kg)	Th-232 (Bq/kg)	K-40 (Bq/kg)	Gamma index
A (Portl)	11	10	111	0,13
B (BFS)	17	22	137	0,21
C (FA)	15	15	140	0,17
D	55	38	328	0,48

Comments

- Worst case calculation: max. values for Ra-226, Th-232 and K-40 values for **cement** (422, 266, 846 Bq/kg database by C. Nuccetelli et al.)

$$I_{max,\ concrete} = 0{,}52$$

$\Rightarrow$ Radioactivity cement in concrete no problem

- **Substitution** of clinker does surely much more good than harm (reduction of CO_2 emission, use of primary material)
  - Concrete can largely be recovered
  - Towards a sustainable cement industry

- **Property enhancement** products ??? (silica fume,…)