The revision of the BSS and its implications for the building industry and EU society

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- Building materials in Belgium & The Netherlands
- National and international regulations
- Ecological & environmental issues
- A closer look to cement and concrete
- Comments

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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

(*without phosphogypsum*)

BUILDING MATERIAL	Ra-226 (Bq/kg)			Th-232 (Bq/kg)			K-40 (Bq/kg)			Gamma-index		Contributor Max	
BELGIUM (1990)	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Max**	**Isotope**	**%**
Facade bricks- clay (13)	41	31	73	36	26	44	569	400	810	**0,51**	**0,64**	K-40	39
Building blocks-clay (4)	47	40	62	47	43	50	815	650	980	**0,66**	**0,76**	K-40	40
Brick-sand-lime (1)	15			12			140						
Floor tiles (6)	70	56	89	64	43	86	830	650	950	**0,83**	**1,04**	Th-232	41
Casted concrete (13)	21	14	28	18	13	26	280	170	460	**0,25**	**0,38**	K-40	40
Concrete blocks (3)	15	7	23	9	6	15	115	80	160	**0,13**	**0,19**	Ra-226	40
Argex blocks (3)	42	22	58	42	22	53	490	430	550	**0,51**	**0,6**	Th-232	44
Aerated concrete (4)	6	5	7	5	5	6	85	30	170	**0,07**	**0,11**	K-40	52
Mortars (6)	11	5	20	10	5	17	70	50	280	**0,11**	**0,21**	Th-232	43
Natural stone (14)	19	5	50	16	5	84	240	10	1020	**0,22**	**0,82**	Th-232	51
Natural plasters (6)	13	6	43	5	5	5	80	20	120	**0,1**	**0,21**	Ra-226	67
Chemical plasters (6)	250	170	275	105	90	155	35	30	40	**1,37**	**1,41**	Ra-226	64

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Building materials in The Netherlands

BUILDING MATERIAL	Ra-226 (Bq/kg)			Th-232 (Bq/kg)			K-40 (Bq/kg)			Index
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**

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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 "

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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*"

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International regulations (III)

Revised EU-BSS

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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 ≤ 1	B1 I > 1
(2) Superficial and restricted use	A2 I ≤ 6	B2 I > 6

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

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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
- …

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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)

- Portland cement: 0,7-0,9 ton CO_2/ton cement
- Blast furnace cement: 0,2-0,4 ton CO_2/ton cement
- Cement use Belgium: $5{,}8.10^6$ ton/y
  (40% clinker substitution)
- Cement use The Netherlands: $4{,}8.10^6$ ton/y
  (60% clinker substitution)

B	NL
750 kg CO_2/ton cement	540 kg CO_2/ton cement

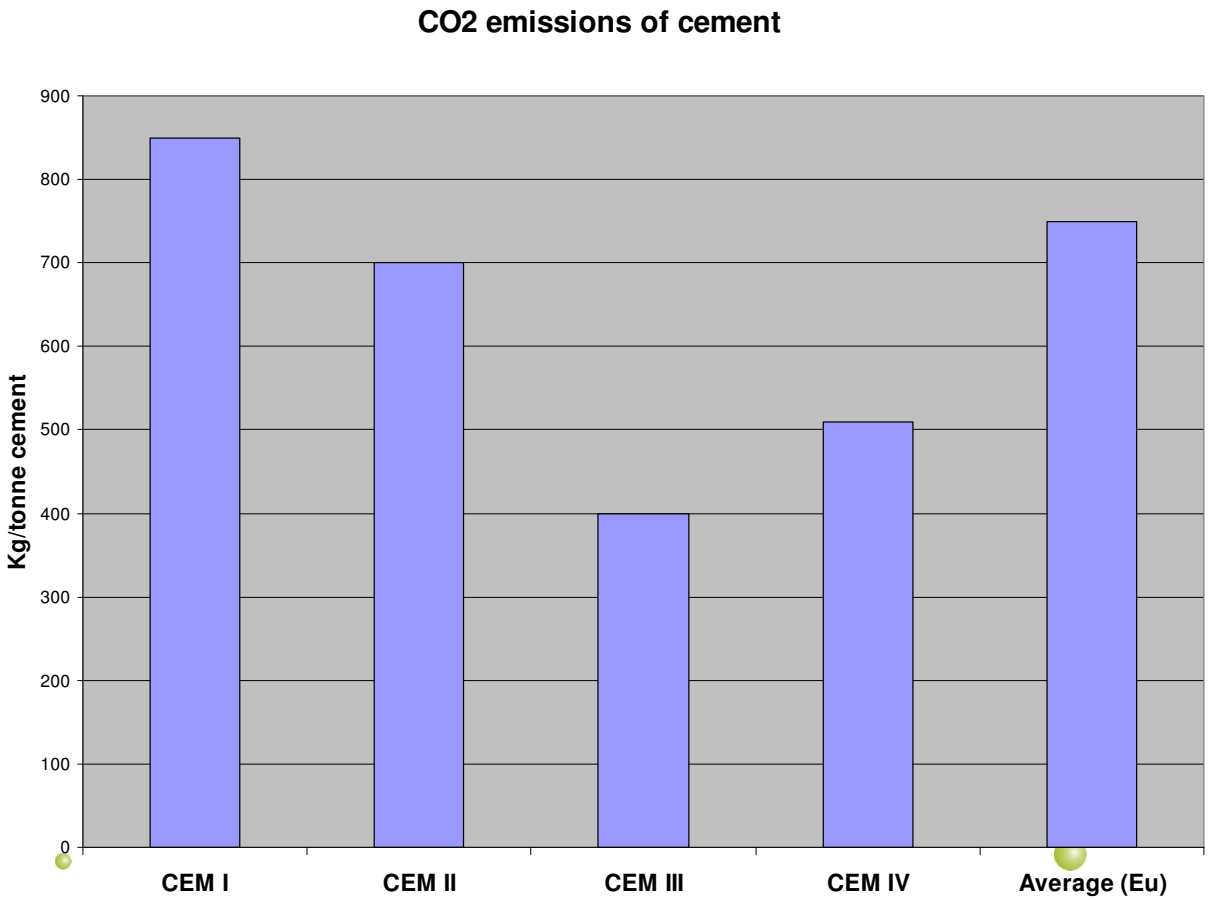
NL less CO_2 from cement production…
more radioactive concrete???

Cement classification

(BS EN 197-1)

Name	Abbreviation	Clinker (%)	BFS (%)	Fly Ash (%)	Limestone (%)	Extra (%)
Portland cement	CEM I	95-100	-	-	-	0-5
Portland-Lime stone cement	CEM II /A	80-94	6 - 20			
Portland-Fly ash cement	CEM II /B	65-79	21- 35			
Blast furnace cement 36/65	CEM III/A	35-64	36-65	-	-	0-5
Blast furnace cement 66/80	CEM III/B	20-34	66-80	-	-	0-5
Blast furnace cement 81/95	CEM III/C	5-19	81-95	-	-	0-5
Composite cement	CEM V/A	40-64	18-30	18-30	-	0-5

Carbon footprint cement (III)



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Radioactivity of cement & cementitious products in B & NL

Name	Ra-226 (Bq/kg)	Th-232 (Bq/kg)	K-40 (Bq/kg)
CEM I	28 (10-53)	20 (14-31)	180 (110-230)
CEM II/B	60 (41-77)	44 (36-51)	330 (290-470)
CEM III	82 (49-116)	120 (10-223)	260
BFS	100 (10-350)	40 (5-115)	200 (20-1400)
FA	181 (112-316)	150 (74-277)	580 (460-730)

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 blocks (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 blocks (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.)

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

  ⇒ 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
- Most rather « old » data. Representative for current/future situation??? ⇒ study B-NORM (Xios)
- **Property enhancement** products ??? (silica fume,…)