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Gypsum in C&D aggregates – Origin, Effects, [Separation] and Utilization

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CDW Recycling in Germany
⇨ Amount of CDW
⇨ Fields of application
⇨ Rates of recycling and substitution
⇨ Processing technologies
⇨ Standards and guidelines

Origin of gypsum in C&D aggregates
⇨ Gypsum products
⇨ Estimation of gypsum content in CDW and C&D aggregates
⇨ Forecast of future flows of gypsum waste

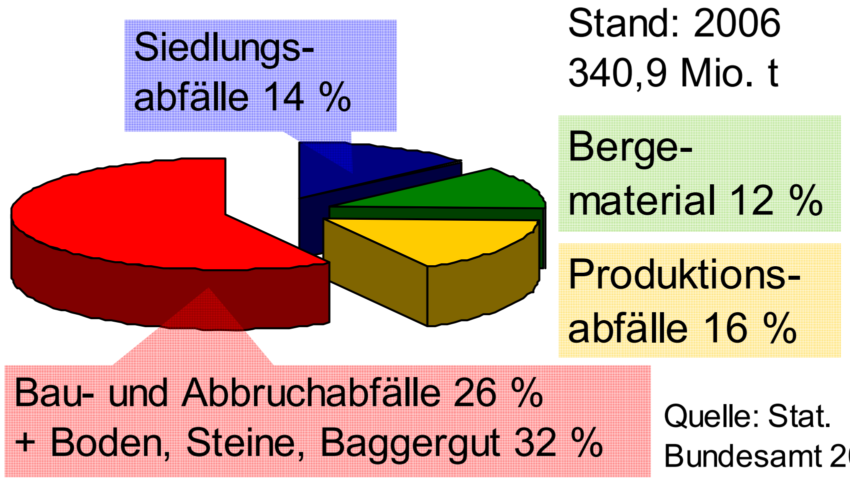
Effects of gypsum in C&D aggregates

Utilization of C&D gypsum

Generation of Construction and Demolition Waste (CDW)

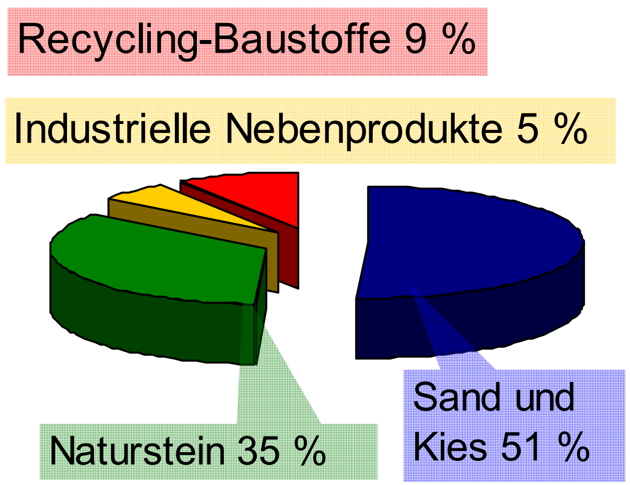
[Mio. t]	1996	1998	2000	2002	2004	2006
CDW from buildings	58,1	58,5	54,5	52,1	50,8	57,1
CDW from roads / traffic areas	17,6	14,6	22,3	16,6	19,7	14,3
Mixed rubble (from 2004 including gypsum waste)	7,5	4,0	11,8	4,3	2,2	11,3
Total	83,2	77,1	88,6	73,0	72,4	82,7

Comparision with other wastes



Quelle: Stat. Bundesamt 2009

Comparision with raw materials



Stand: 2004
548,5 Mio. t

Quelle: 5. Monitoring-Bericht 2007

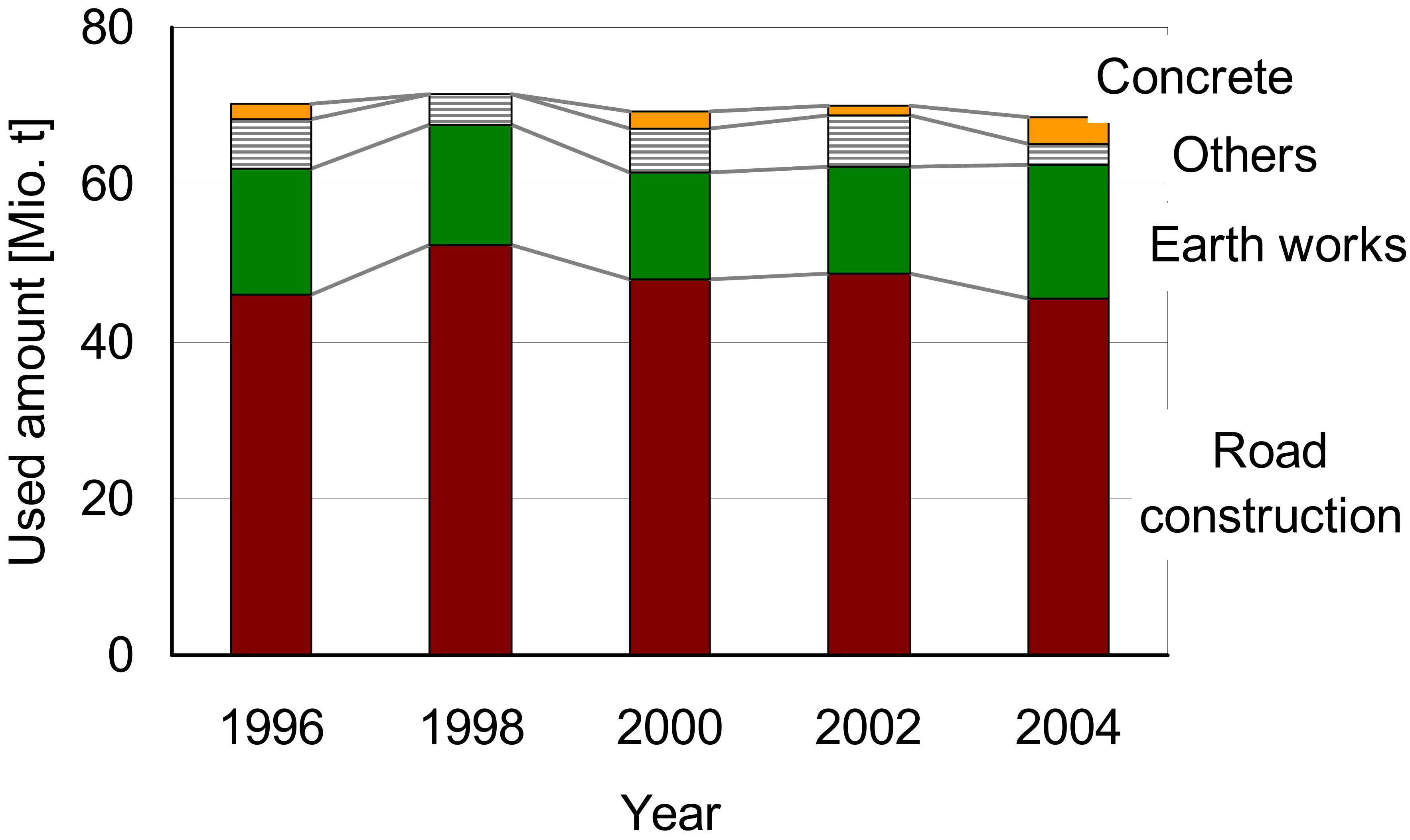
Fields of application

Production of concrete →
- Concrete for constructions
- Lean concrete
- Subbase layers

Road construction →
- Unbound courses
- Frost protection courses
- Hydraulicy bound course
- Bituminous bound courses
- Paving beddings, joint fillers

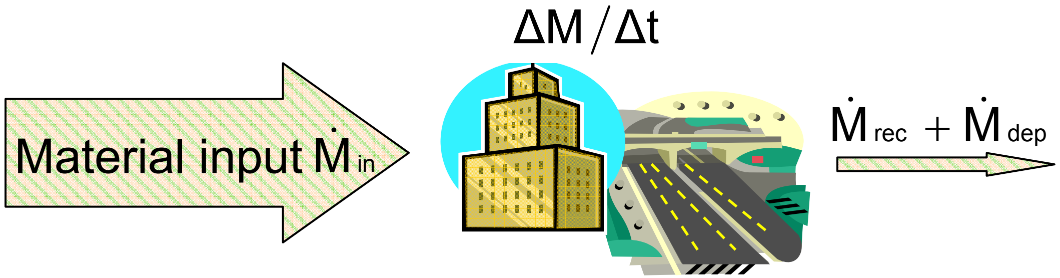
Earthworks and Landscaping →
- Backfilling
- Vegetation layers
- Noise barriers
- Embankments
- Underground improvements

Shares of the different fields of application



Rates of recycling and substitution

Definition based on the material balance of the construction sector



$$\dot{M}_{in} = \frac{\Delta M}{\Delta t} + \dot{M}_{rec} + \dot{M}_{dep}$$

$$\text{Rate of recycling} = \frac{M_{rec}}{M_{rec} + M_{dep}} \cdot 100\ [\%]$$

$$\text{Rate of substitution} = \frac{\dot{M}_{rec}}{\dot{M}_{in}} \cdot 100\ [\%]$$

Rates of recycling of CDW

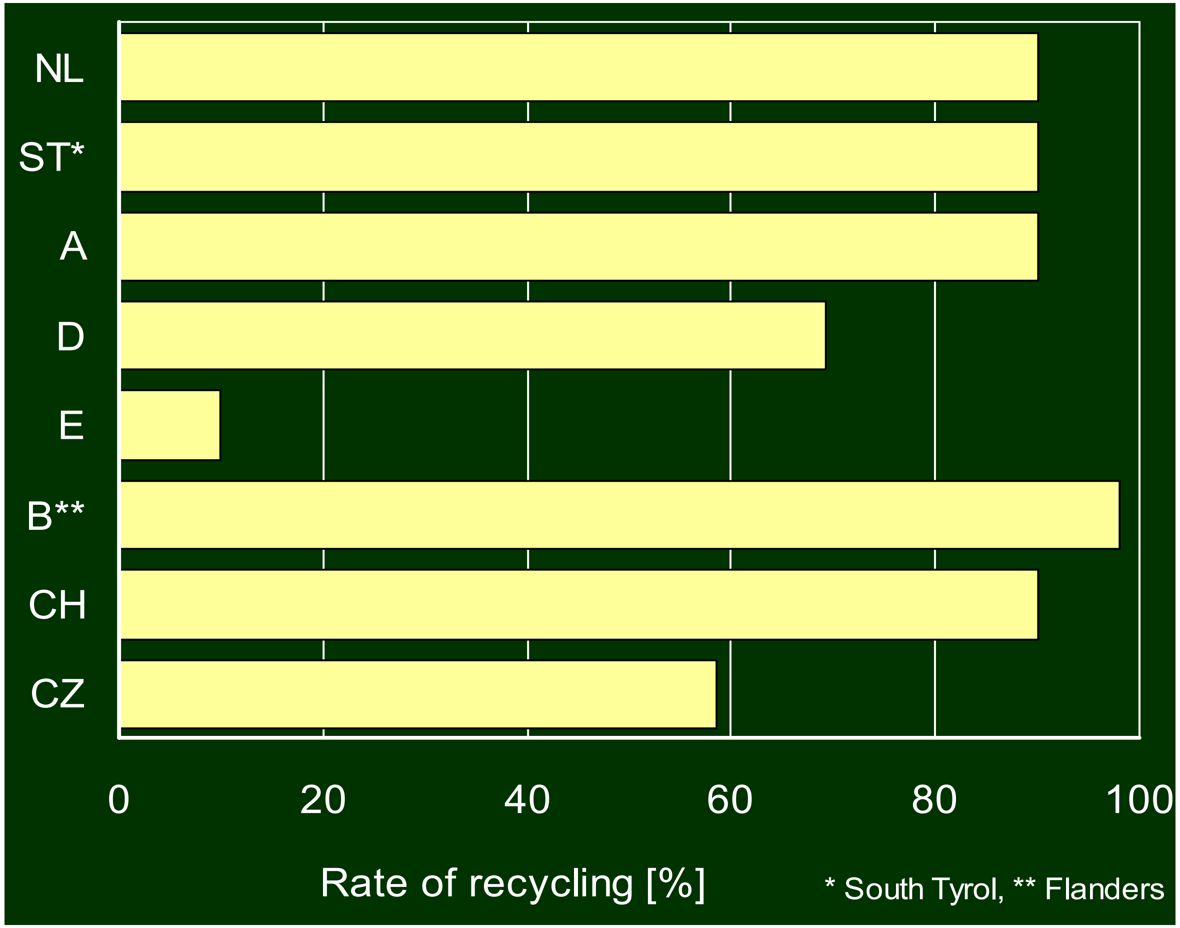
Material-spezific

Asphalt: 82 %

Concrete: 68,6 %

Masonry → 0

Country-spezific



Ref:
1- 13. F.I.R.-Interforum, Salzburg 2005
2-Asphaltproduktion in Deutschland, Stand März 2008, dav
3-Zahlen und Daten, 2008-2009, BDZ

Rates of substitution of CDW

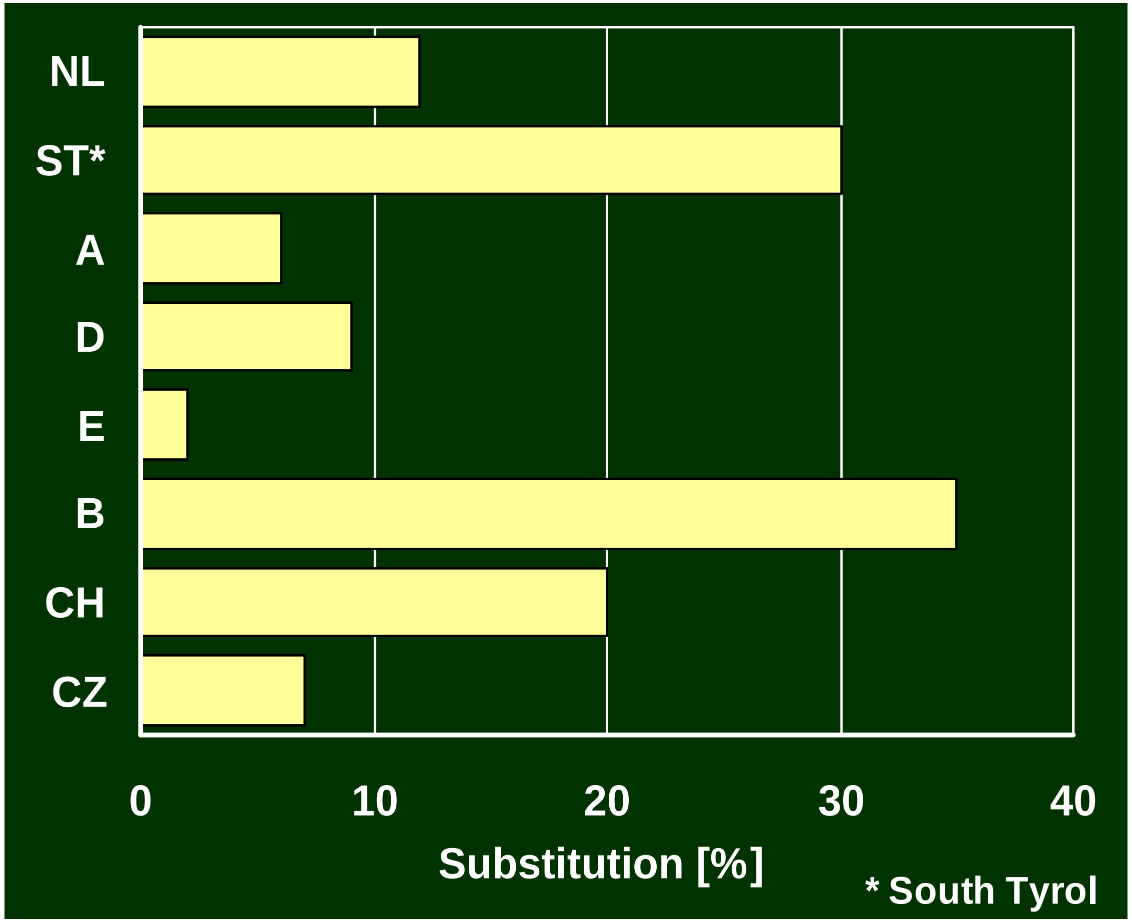
Material-spezific

Asphalt: 23 %

Concrete: 0..4,9 %

Masonry → 0

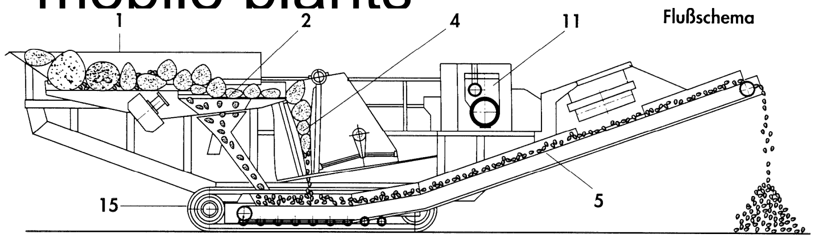
Country-spezific



Structure and equipment of recycling industry

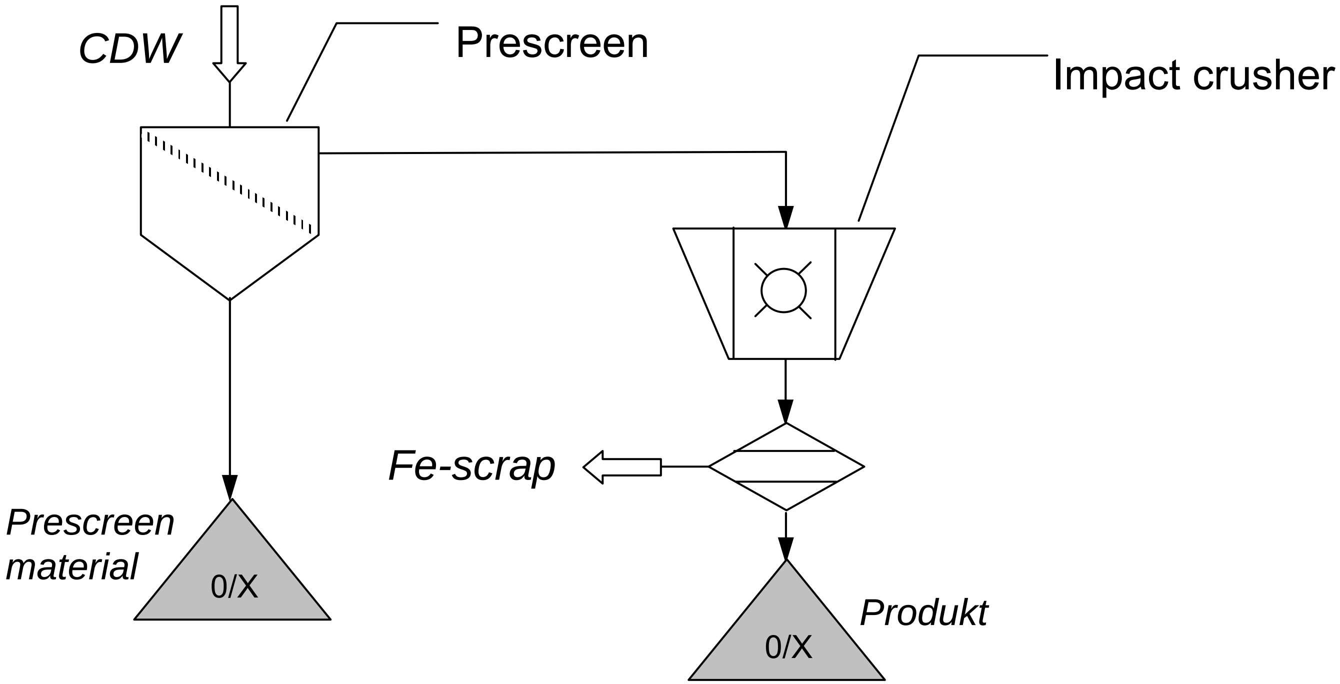
Mobile plants, including storage places served by mobile plants

Stationary plants

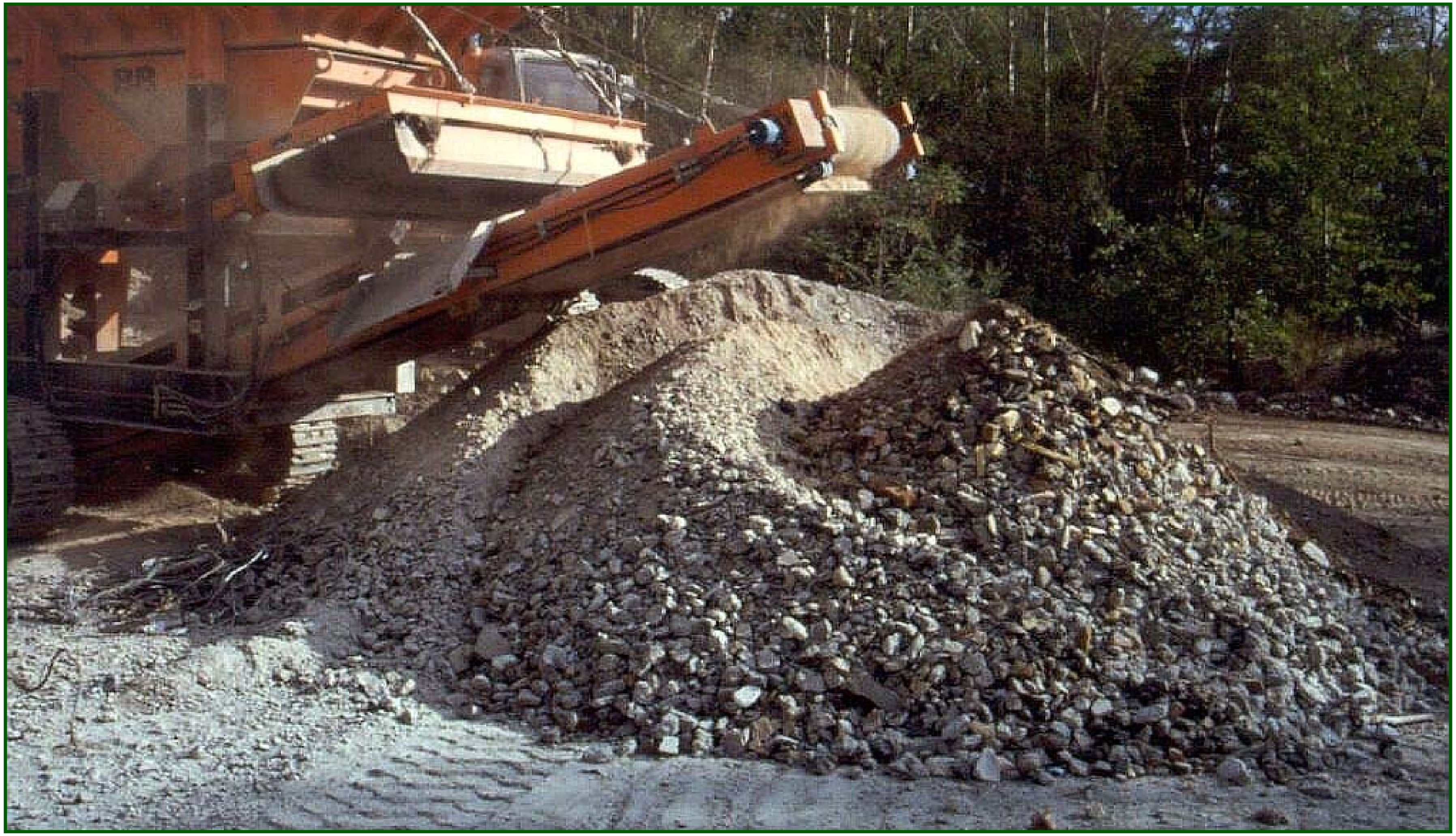


	Mobile plants	Stationary plants	Total
Number	3.313	1.600	4.913
Amount of processed material [tons/a]	33.079.100	26.696.200	59.775.300
Throughput (average) [ton/a]	9.985	16.685	12.167

Mobile plants



Mobile plants



Characteristics of mobile processing of CDW

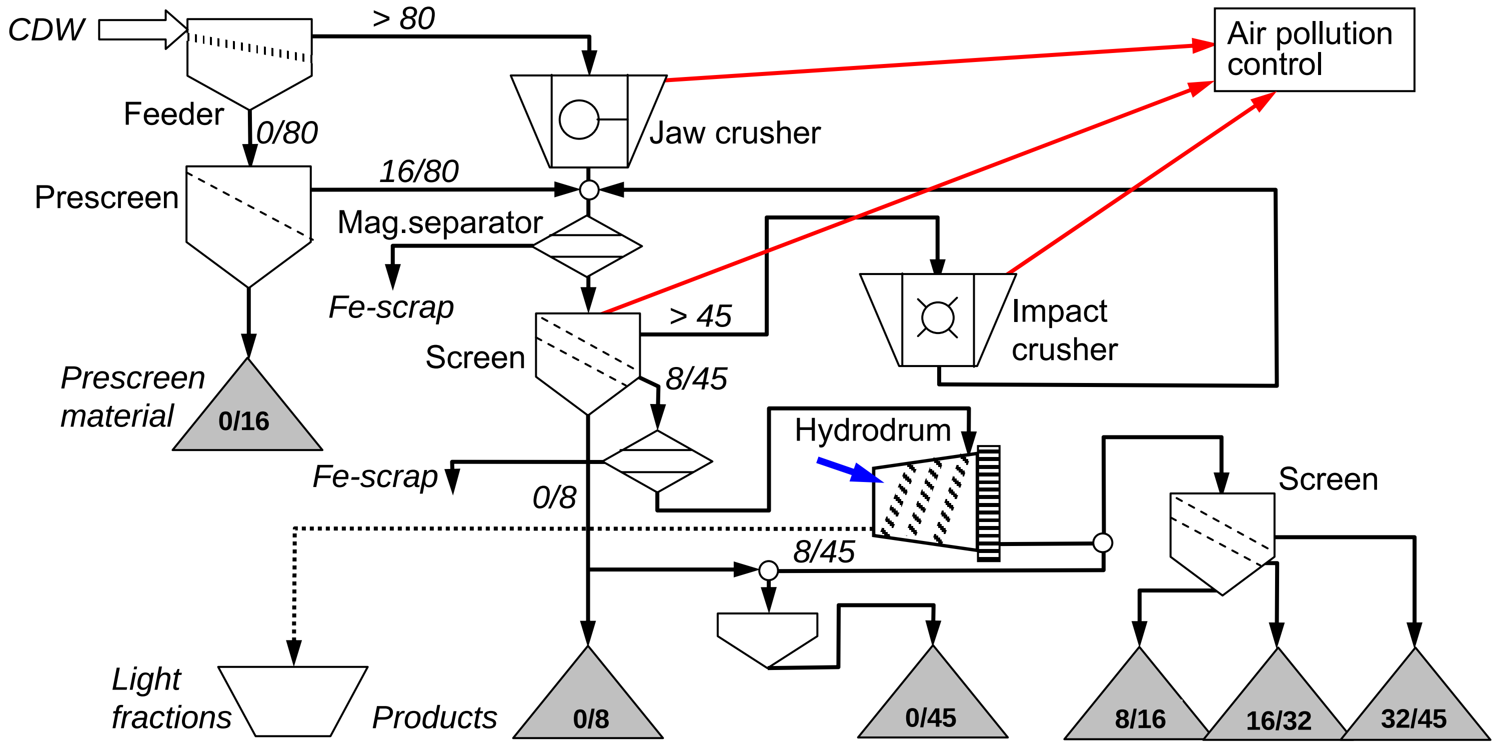
Capacity	Sites with large quantities of CDW (> 6000 t)
Technoloy	Crushing (+ product screening)
Variability of products	Limited
Types of products	“Robust” products for fillings, embankments, soil and subgrade improvements etc.
Quality of products	Products of good quality only if input is homogenous
Application	Reuse on site possible

Stationary plants

Capacity: 150,000 tons/year

Employees: 10 (2 engineers, 8 workers)

Products: Concrete and masonry RC in different fractions or as material 0/8 and 0/45 mm



Stationary plants

Jaw crusher 1,200 x 900 mm
throughput 120 – 180 m³/h

Impact crusher1,220 x 800 mm

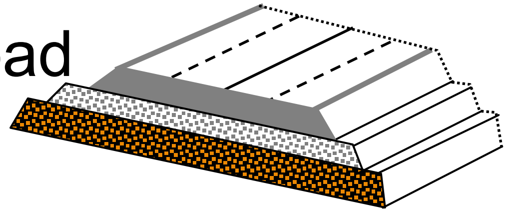
Product screen 32 mm,16 mm
1,600 x 4,000 mm

Hydrodrum

Characteristics of stationary processing of CDW

Capacity	about 200.000 t/a, located in regions with high population density, Sufficient input must be available within a certain haul distance (about 25 km)
Technoloy	Crushing + product screening + sorting in several stages
Variability of products	Large
Types of products	“Qualified” products for road construction and concrete and “Robust” products
Quality of products	Products of good quality also if input is heterogeneous Quality control
Application	Active marketing necessarily, in order to ensure the sales of the products

Secondary aggregates for base courses in road construction: Engineering specifications



Asphalt in the fraction > 4 mm	max. 30 %
Clinker, dense clay brick in the fraction > 4 mm	max. 30 %
Calcium silica brick, plaster etc. in the fraction > 4 mm	max. 5 %
Mineral lightweight and insulating materials in the fraction > 4 mm	max. 1 %
Foreign materials like wood, rubber, plastic, textiles in the mixture	max. 0,2 %

Requirement on acid-soluble sulfates: -

Further requirements: Frost resistance, resistance against abrasion, content of fines < 0,063 mm

Ref.: TL-Gestein 2004.

Secondary aggregates for base courses in road construction: Environmental specifications

Leachable substances		TL StB 2004		LAGA			
		RC-1	RC-2	Z 0	Z 1.1	Z 1.2	Z 2
pH- value		7-12,5	7-12,5	7-12,5	7-12,5	7-12,5	7-12,5
el. conductivity	[µS/m]	2500	3000	500	1.000	2000	3000
Cl^-	[mg/l]	20	40	10	20	40	150
SO_4^{2-}	[mg/l]	150	300	50	75	150	600
As	[µg/l]	10	40	10	10	40	50
Pb	[µg/l]	40	100	20	40	100	100
Cd	[µg/l]	2	5	2	2	5	5
Cr_{gesamt}	[µg/l]	30	75	15	30	75	100
Cu	[µg/l]	50	150	50	50	150	200
Ni	[µg/l]	50	100	40	50	100	100
Hg	[µg/l]	0.2	1	0,2	0.2	1	2
Zn	[µg/l]	100	300	100	100	300	400
Phenolindex	[µg/l]	10	50	< 10	10	50	100

Ref.:
TL-Gestein 2004.
LAGA Mitteilung M 20 2003/2004.

German standard on C&D aggregates DIN 4226-100

Ref.: DIN 4226-100

<table>
<tr><th>Constituents [% by mass]</th><th>Type 1</th><th>Type 2</th><th>Type 3</th><th>Type 4</th></tr>
<tr><td>DIN 4226-100: Recycled aggregates</td><td>Concrete chippings + crusher sand</td><td>Construction chippings + c. sand</td><td>Masonry chippings + c. sand</td><td>Mixed chippings + c. sand</td></tr>
<tr><td>Concrete and natural aggregates acc. DIN 4226-1</td><td>≥ 90</td><td>≥ 70</td><td>≤ 20</td><td rowspan="3">≥ 80</td></tr>
<tr><td>Clinker, non-pored bricks</td><td rowspan="2">≤ 10</td><td rowspan="2">≤ 30</td><td>≥ 80</td></tr>
<tr><td>Sand-lime bricks</td><td>≤ 5</td></tr>
<tr><td>Other mineral materials (i.e. pored brick, lightweight concrete, no-fines concrete, plaster, mortar, porous slag, pumice stone)</td><td>≤ 2</td><td>≤ 3</td><td>≤ 5</td><td rowspan="2">≤ 20</td></tr>
<tr><td>Asphalt</td><td>≤ 1</td><td>≤ 1</td><td>≤ 1</td></tr>
<tr><td>Foreign substances (i.e. glass, non ferrous metal slag, lump gypsum, plastic, metal, wood, plant residue, paper, others)</td><td>≤ 0.2</td><td>≤ 0.5</td><td>≤ 0.5</td><td>≤ 1</td></tr>
<tr><td>OD density/oven dry [kg/m³]</td><td>≥ 2000</td><td>≥ 2000</td><td>≥ 1800</td><td>≥ 1500</td></tr>
<tr><td>Max. water absorption/10 min [%]</td><td>10</td><td>15</td><td>20</td><td>No limit</td></tr>
</table>

Additional requirements on recycled aggregates acc. to DIN 4226-100

- ⇨ Fines content (< 0,063 mm) < 4 % by mass
- ⇨ Content of leachable contaminations limited

All other requirements like

- ⇨ Acid-soluble chloride (< 0.04 M.-% Cl^-)
- ⇨ Acid-soluble sulfate (< 0.8 M.-% SO_3)
- ⇨ Organic matter
- ⇨ Particle size distribution, particle shape corresponding to natural aggregates
- ⇨ Resistance against frost and mechanical stresses

Guideline of the German Committee for Reinforced Concrete (DAfStb) for use of recycled aggregate in concrete

Philosophy: No changes of properties of concrete with recycled aggregates compared with normal concrete

- Only chippings > 2 mm of recycled aggregates type 1 and type 2 can be used for the production of structural concrete
- Crusher sand is excluded from the reuse as aggregate
- Maximum strength class C30/37
- No lightweight concrete, no prestressed concrete
- Evidence of resistance against frost and ASR must be proofed
- Application in dry environments or in environments with low humidity
- Decreasing replacement of natural by recycled coarse aggregates with increasing environmental effects or “attacks” on concrete

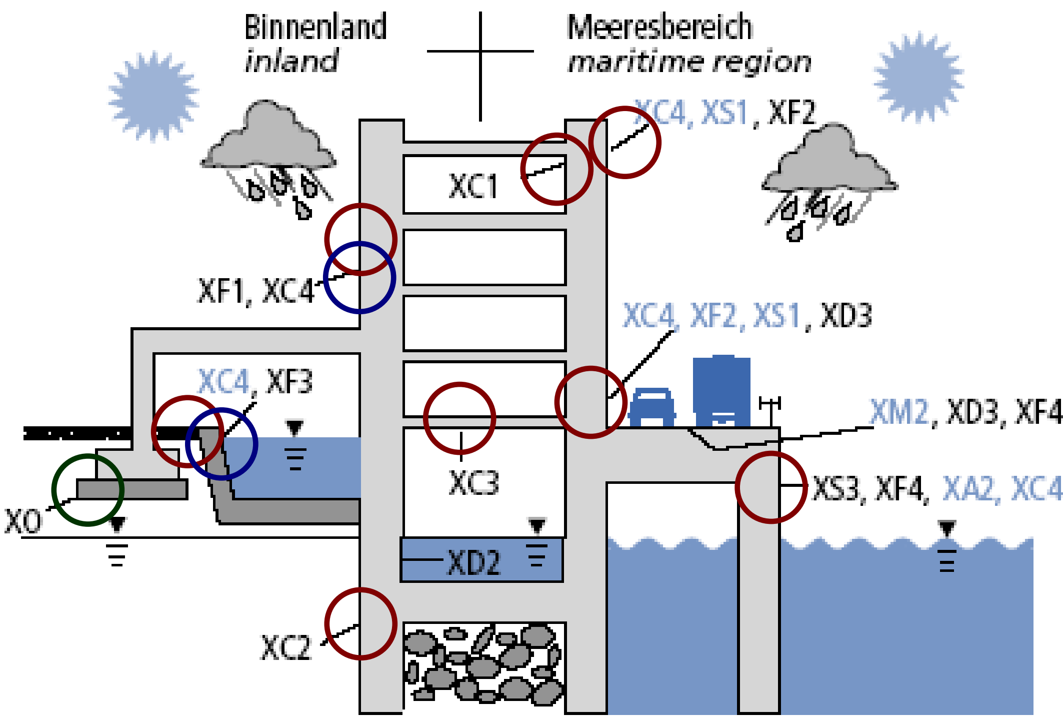
Ref.: RiLi DAfStb

Allowed replacement of recycled aggregates versus exposure classes acc. to DAfStb guideline

X 0

XC 1 to XC 4

XF 1 and XF 3



Field of application				Replacement by RCA [vol.-%]	
ASR-guideline	DIN EN 206-1 and DIN 1045-2			Type 1	Type 2
	Exposure class	Effect	Stress		
WO (dry)	XC 1	Carbonation	dry	≤ 45	≤ 35
WF (humid)	X 0	No concrete attack			
	XC 1 to XC 4	Carbonation	dry to wet		
	XF 1 and XF 3	Freeze-thaw **without** salt	moderate **and** high water saturation	≤ 35	≤ 25
	XA 1	Chemical attack	weakly corrosive	≤ 25	≤ 25

Additional requirements and recommendations for the use of recycled aggregates acc. to the Guideline DAfStb

- Technical approval: Extended initial testing necessary
- Processing

Aggregates shall be produced of a feed material of > 32 mm
→ prevention of fine foreign materials and soft materials

- Quality control during production

Visual inspection
Measurement of density and water absorption weekly
Measurement of density and air content of fresh concrete

- Placing

Instruction for addition of superplasticizer on site prepared

→ prevention of loss of workability by water absorption of recycled aggregates

Secondary aggregates for concrete: Environmental specifications

Leachable substances		DIN 4226-100	LAGA			
			Z 0	Z 1.1	Z 1.2	Z 2
pH- value		12.5	7-12,5	7-12.5	7-12.5	7-12.5
el. conductivity	[µS/m]	3000	500	1000	2000	3000
Cl^-	[mg/l]	150	10	20	40	150
SO_4^{2-}	[mg/l]	600	50	75	150	600
As	[µg/l]	50	10	10	40	50
Pb	[µg/l]	100	20	40	100	100
Cd	[µg/l]	5	2	2	5	5
Cr_{gesamt}	[µg/l]	100	15	30	75	100
Cu	[µg/l]	200	50	50	150	200
Ni	[µg/l]	100	40	50	100	100
Hg	[µg/l]	2	0,2	0.2	1	2
Zn	[µg/l]	400	100	100	300	400
Phenolindex	[µg/l]	100	< 10	10	50	100

Ref.:
DIN 4226-100.
LAGA Mitteilung M 20 2003/2004.

Summary of requirements on content of gypsum respectively SO_3/SO_4^{2-} in C&D aggregates

Road construction

Engineering specifications:

- SO_4^{2-} 150 resp. 300 mg/l

Environmental specifications:

- SO_4^{2-} 75 resp. 150 mg/l

Concrete

Engineering specifications:

- lump gypsum < 0.2 mass-% resp. < 0.5 mass-%
- acid-soluble sulfate < 0.8 mass-% SO_3
- SO_4^{2-} max. 600 mg/l

Environmental specifications:

- SO_4^{2-} max. 600 mg/l

Questions

Are the requirements compatible ?

lump gypsum < 0.2 mass-%

$$\rightarrow 0{,}45 \cdot 0.2\ mass-\% = 0.09\ mass-\%\ SO_3 \text{ in solid sample} << 0.8\ mass-\%\ SO_3$$

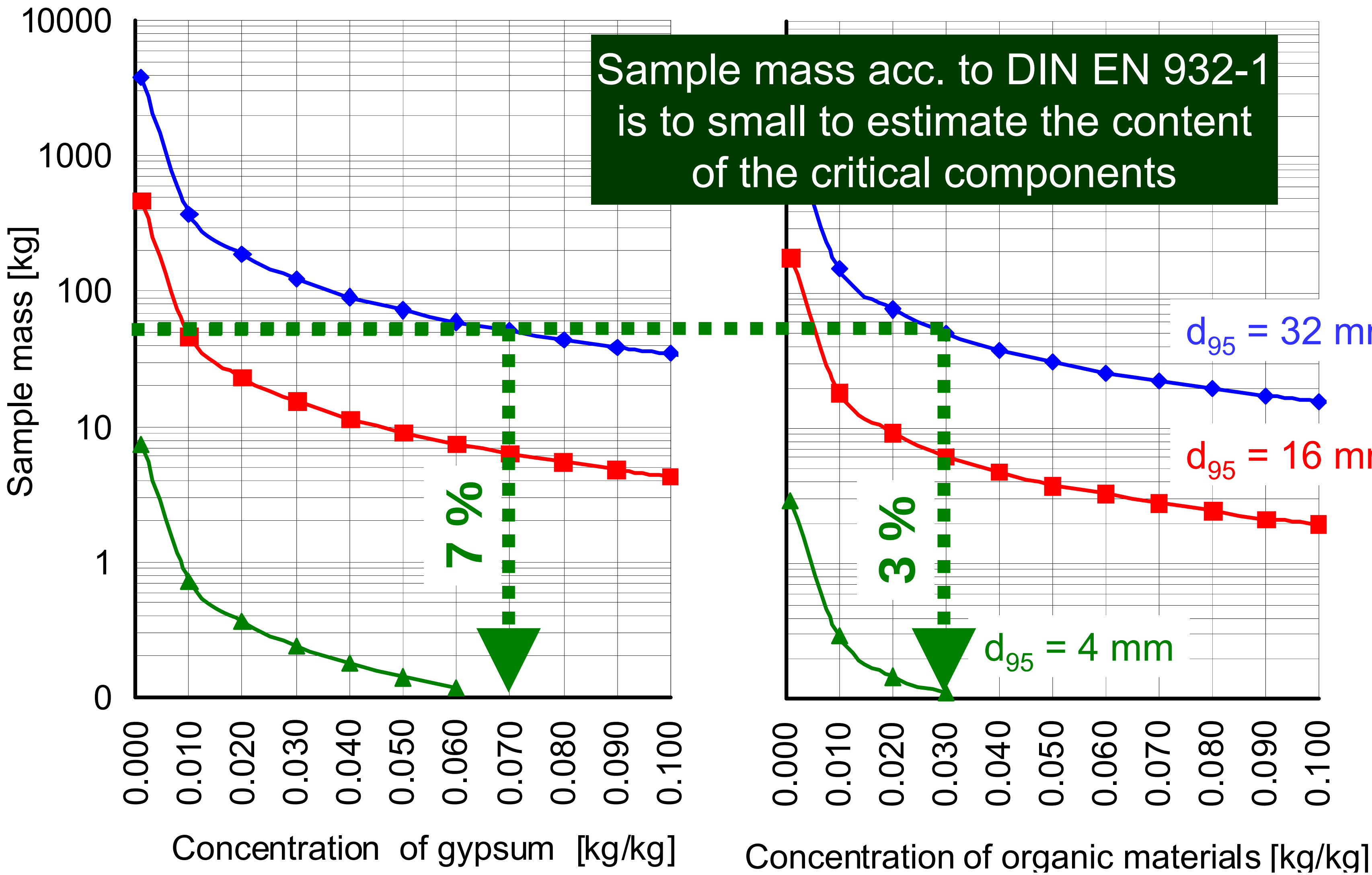
$$\rightarrow \frac{0.09\ g\ SO_3}{100g\ sample} \cdot \frac{100g\ sample}{1l\ H2O} \cdot \frac{1000mg}{1g} = 90\,mg\ SO_3/l \approx 100\ mg\ SO_4^{2-}/l << 600\ mg\ SO_4^{2-}/l$$

Are the requirements practicable?

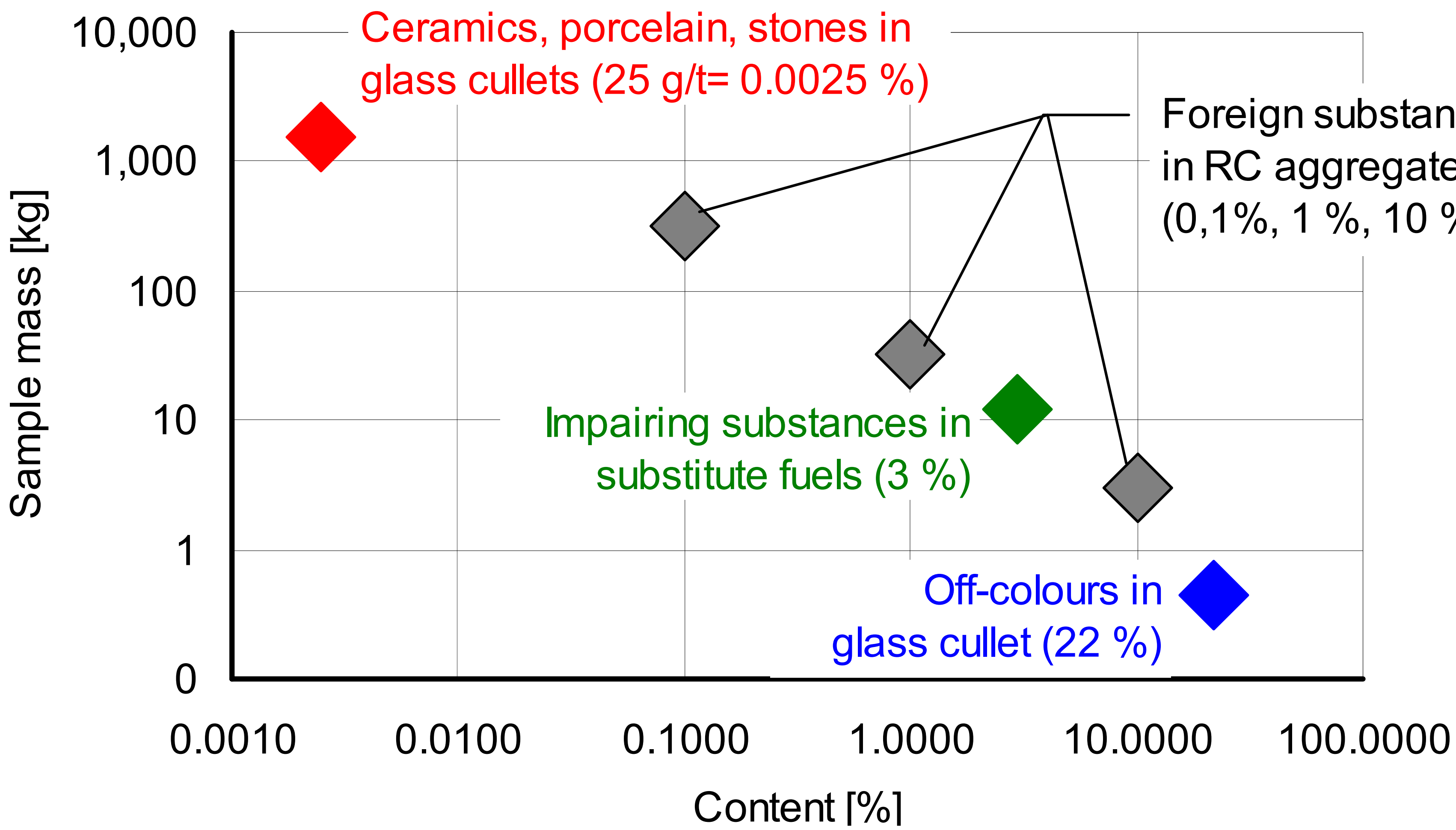
Hand sorting as method of the measurement of the content of gypsum particles is not reliable

Reasons: Sample mass, sampling procedure, identification procedure

Influence of sample mass on the result of sorting analyses

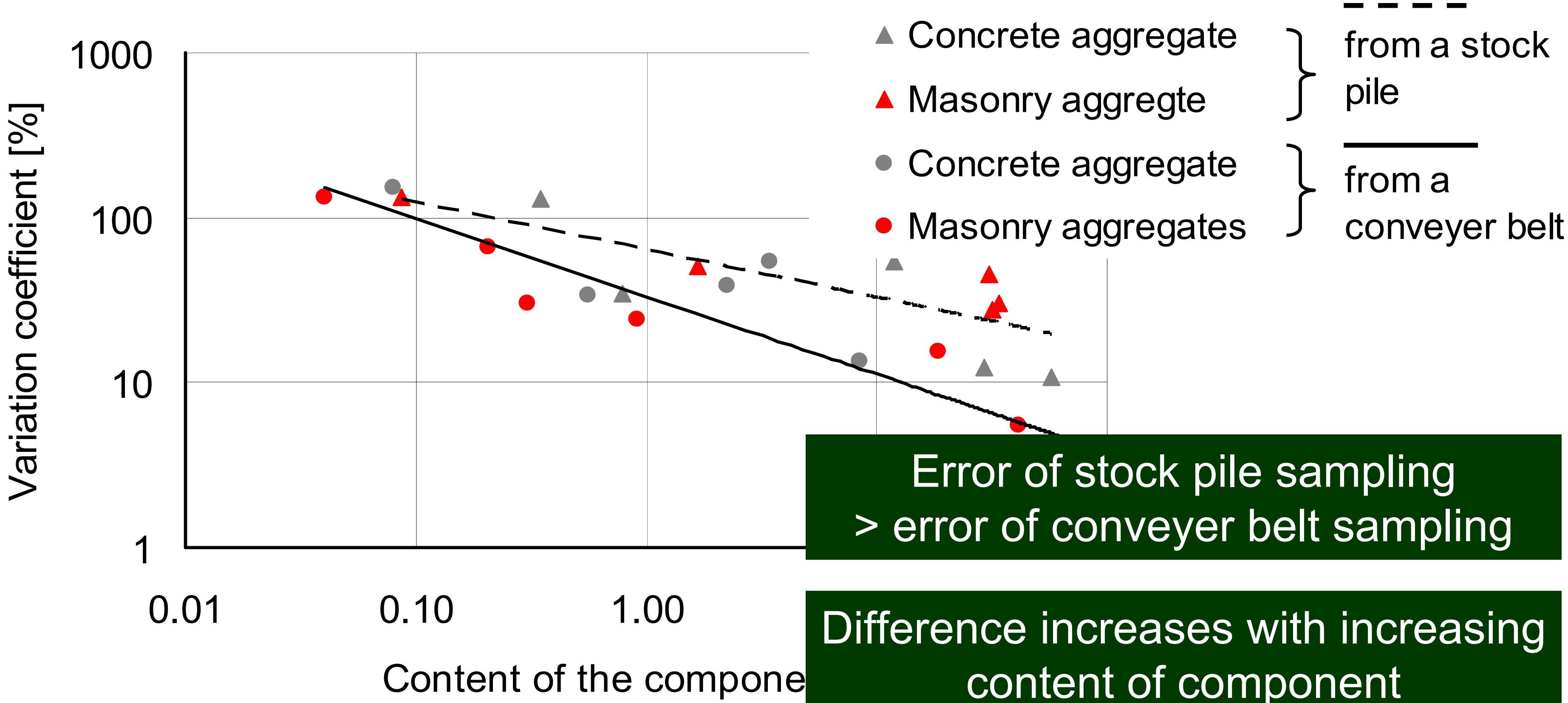


Comparison of sample masses for quality control of secondary materials



Influence of sampling procedure

Sampling at the end of a conveyer belt ⟷ Sampling from a stock pile



Error of stock pile sampling > error of conveyer belt sampling

Difference increases with increasing content of component

Influence of identification procedure (1)

Concrete and natural aggregates

Fragments of coarse natural aggregate, partly covered with cement paste ++

Clinker, non-pored bricks

Red color +++

Asphalt

Black color +++

Plaster, mortar

No coarse aggregate visible, fragments totally covered with adhered cement paste and sand -

Pored brick, AAC, light-weight concrete, porous slag, pumice stone

Concluded from the typical appearance of the primary material, i.e. shape, color, weight +/-

Glass, metal
Plastic, wood, plant residue, paper… +

Lump gypsum, non ferrous metal slag -

Influence of identification procedure (2)

Errors due to wrong identification

- between mortar and concrete
- between gypsum lumps and plaster, mortar, plaster floor, calcium silica brick etc.

Errors due to “unknown materials”

- considerable amount of unidentified material in dependence of the experience of the laboratory technician

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Origin of gypsum in C&D aggregates
⇨ Gypsum products
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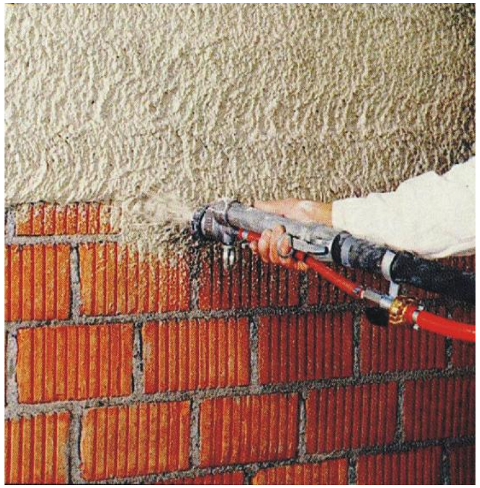
Effects of gypsum in C&D aggregates

Utilization of C&D gypsum

Kinds of gypsum building materials

Plaster



Plasterboard

Anhydrite floor

Gypsum wall block

Properties of gypsum products

	Bulk density	Comp.strength	E-Modulus
	[g/cm³]	[N/mm²]	[N/mm²]
Plaster	0.8-1.2	2.5-5	2,800-5,200
Anhydrite floor	1,.8-2.1	16-45	15,000- 20,000
Plaster board*	1.0 / 10-12 kg/m²	5-10	≥ 2,000
Gypsum wall board or block	0.6-1.3		5,500-11,000

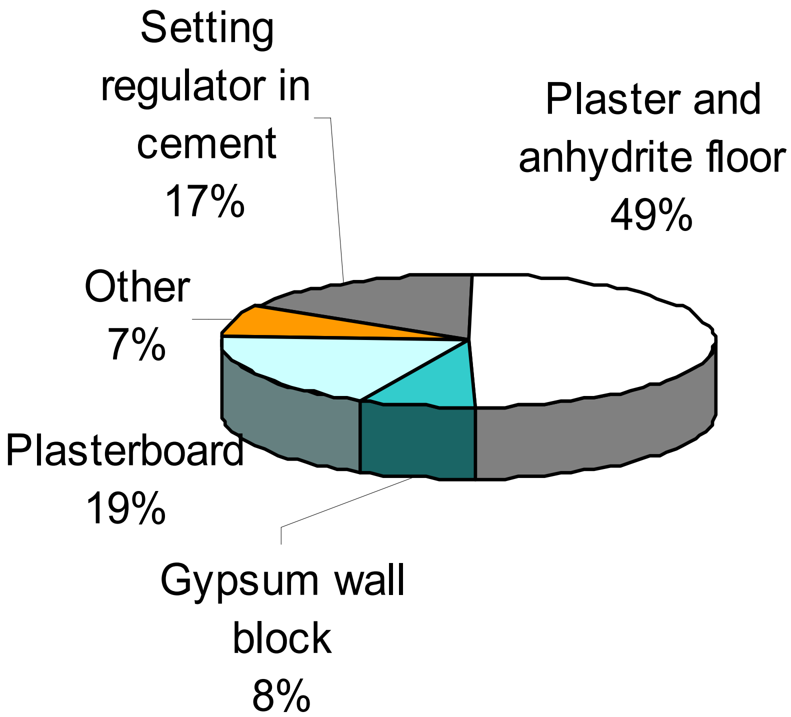
Composition of plaster board

Gypsum	94.05 mass-%
Paper	3.5 mass-%
Starch	0.24 mass-%
Surfactants	0.04 mass-%
Silicon	0.21 mass-%
Others	1,96 mass-%

Gips-Datenbuch. Bundesverband der Gipsindustrie e.V.
Birkenweg 13 · 64295 Darmstadt, 2003

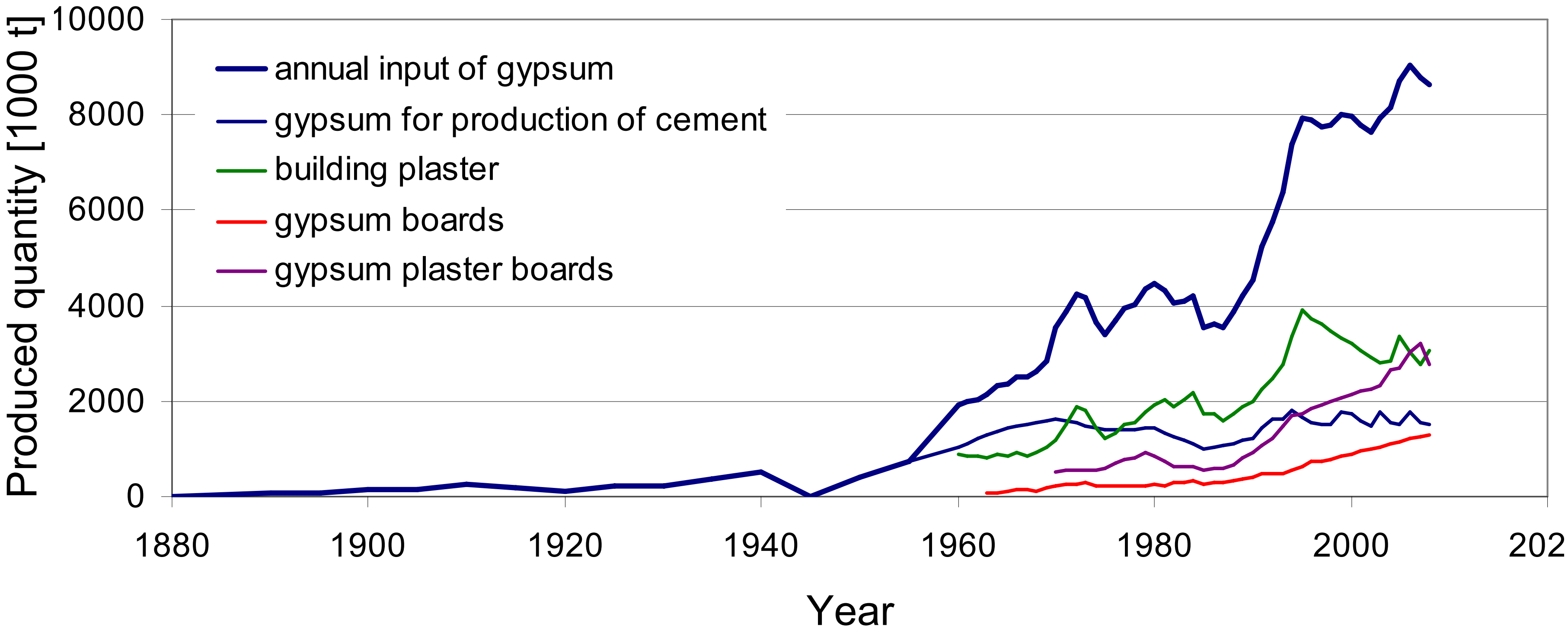
Quantities of the different gypsum products in Germany 1996

	Amount [Mio. t]
Plaster, anhydrite floors	4.6
Plasterboard	1.7
Blocks	0.6
Other	0.5
Additive for cement	1.6
Sum	9.1



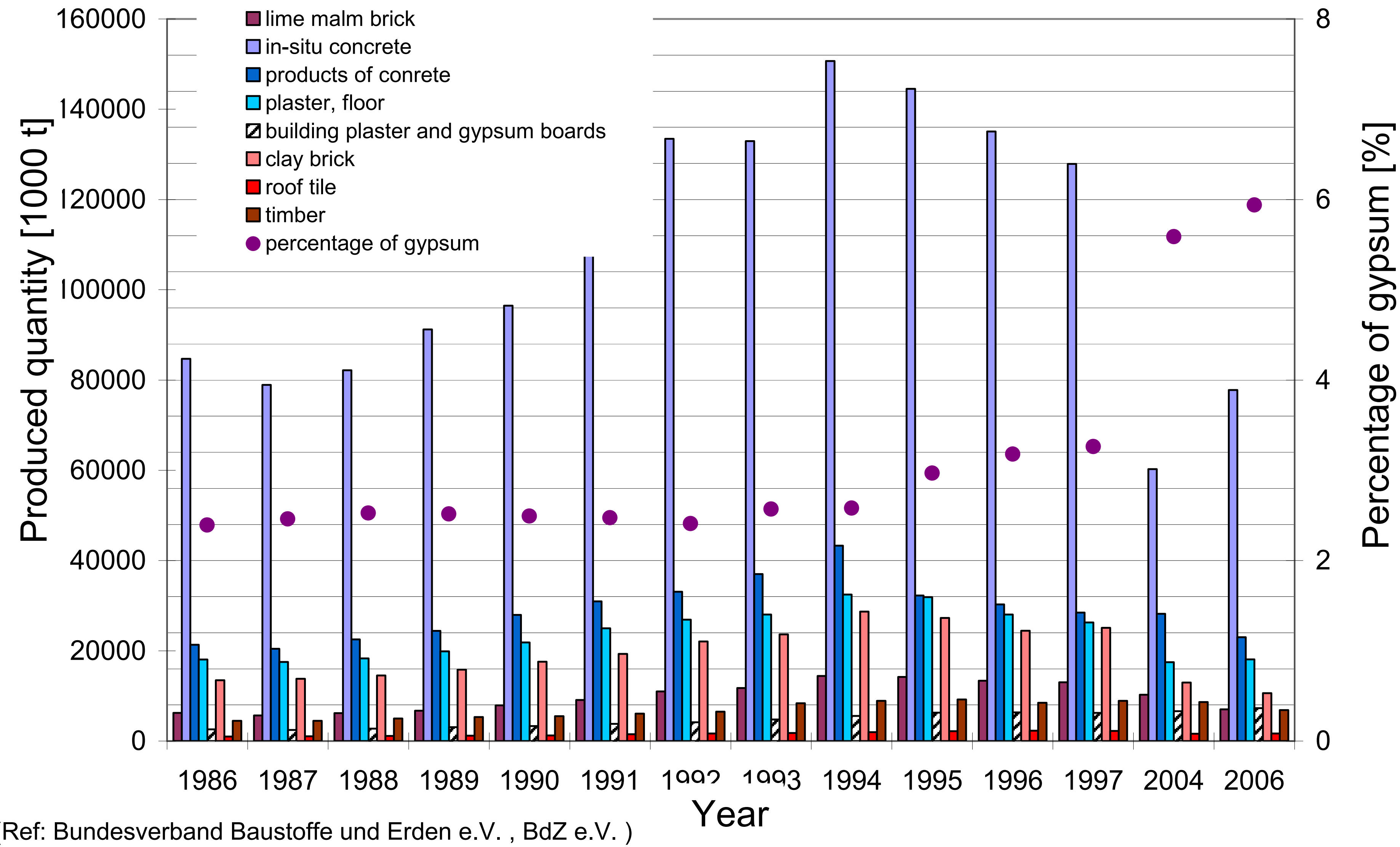
"Gypsum has a very low embodied energy per ton, compared to other construction materials, such as aluminum (30 times as much), steel (5 times as much), plastics (5 times as much), glass (3 to 4 times as much) and concrete (twice as much)"

Growth of quantities of the different gypsum products



Ref: Until 1997 [Bundesverband Baustoffe und Erden e.V.], from 2003 [Statistisches Bundesamt]

Actual data of quantities of construction materials in building construction

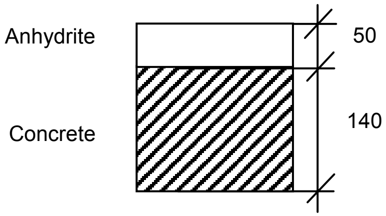


(Ref: Bundesverband Baustoffe und Erden e.V. , BdZ e.V.)

Gypsum contents in various structures and thereby caused sulfate levels

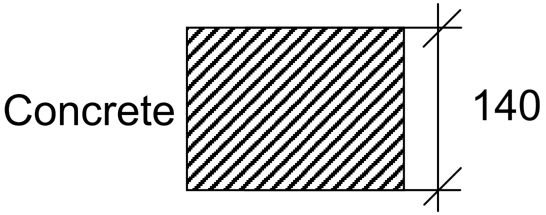
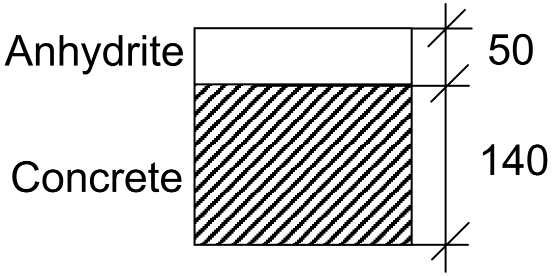
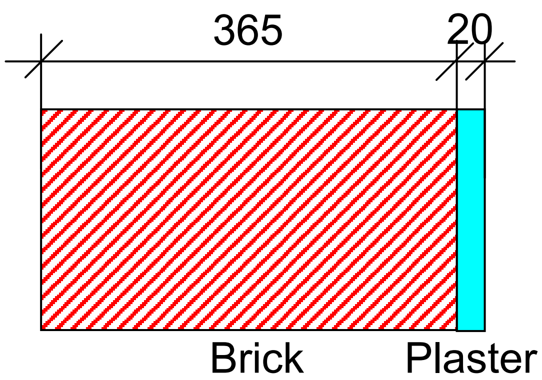
Level 3: Measured content of gypsum in CDW

Level 2: Calculated content of gypsum in model buildings



Level 1: Calculated content of gypsum in typical constructions

Level 1: Calculated content of gypsum in typical constructions

		Content of gypsum/SO_3
Pure concrete		Gypsum: 0 m.-% SO_3: 0.7 m.-%
Concrete ceiling with anhydrite floor		Gypsum: 15.4 m.-% SO_3 : 2.4 m.-%
Brick wall with gypsum plaster		Gypsum: 3.4 m.-% SO_3 : 1.6 m.-%

Level 2: Calculated content of gypsum in model buildings

	Content of gypsum including gypsum in-corporated in cement	Content of gypsum excluding gypsum in-corporated in cement
1,5-storey apartment building of massive construction, built at the end of the 19th century	0.9 – 1.2 mass.-%	about 1 mass.-%
Apartmentstore, timber frame construction from 1910	2.0 – 2.3 mass.-%	about 2 mass.-%
Grammar school in France, massive construction of reinforced concrete from 1965	2.4 – 3.0 mass.-%	about 2.4 mass.-%
Private residential building built 2006	1.8 – 2.2 mass.-%	about 1.4 mass.-%
Apartment building built of prefabricated concrete panels 1970		3.1(only anhydrite floor) – 6.6 (floor and bath cubicle) mass.-%

Level 3: Measured content of gypsum in CDW

	Content of gypsum excluding gypsum incorporated in cement	Content of SO_3 including gypsum incorporated in cement
Masonry CDW	0 – 5.2 mass % Mean: 0.55 mass-%	0.10 - 3.3 mass-% Mean: 0.90 mass-%
Concrete CDW	Not measured	0.3 - 1.3 mass-% 0.7 mass-%
Pure concrete	0	0.07 – 1.07 mass-% 0.68 mass-%
Apartment building built of prefabricated concrete panels 1970	1.80 – 5.35 mass-% Mean: 2.73 mass %	1.3 mass-%

Gypsum content resp. SO3 content in Masonry CDW >

Gypsum content resp. SO3 content in Concrete CDW

Methods for estimation of future mass flows of gypsum in CDW

Level 3: TOP-DOWN-Approach: Production data for gypsum building materials, assumptions of life cycle of gypsum products

Level 2: OUTPUT-Approach: Measured content of gypsum in CDW and statistics of waste generation

Level 1: BOTTOM-UP-Approach: Life cycle model for buildings, assumption of the content of gypsum in the model buildings

Level 2: OUTPUT-Approach: Measured content of gypsum in CDW and statistics of waste generation

Waste	Waste from excavation	Waste from road construction	Demolition waste	Waste from construction sites	Gypsum waste
Amount of waste [Mio. tons]	106.0	14.3 of which 50% concrete	57.1	10.9	0.4
Content of gypsum [m.-%]	0	0.35 - 0.9	1 %	1 %	90 %
Amount of gypsum [Mio. tons]	0	0.02 - 0.06	5.71	1.09	0.36
Total	**7.2 Million tons**				

Ref: Monitoringbericht 2008

Level 3: TOP-DOWN-Approach: Production data for gypsum building materials, assumptions of life cycle of gypsum products

Data base: Production of gypsum, production of cement

Calculation base: Life cycle model of Goerg (1997)

Gypsum products		T[a]	α[-]
Building plaster	Anhydride screed	30	6
	Gypsum screed	30	6
	Plaster	35	4
	Adhesive plaster	40	2
	Bonding agent	40	2
Gypsum boards	Plaster panels	40	2
	Gypsum fibre board	40	2
	Gypsum plaster board	40	2
Other applications	Cement	90	3

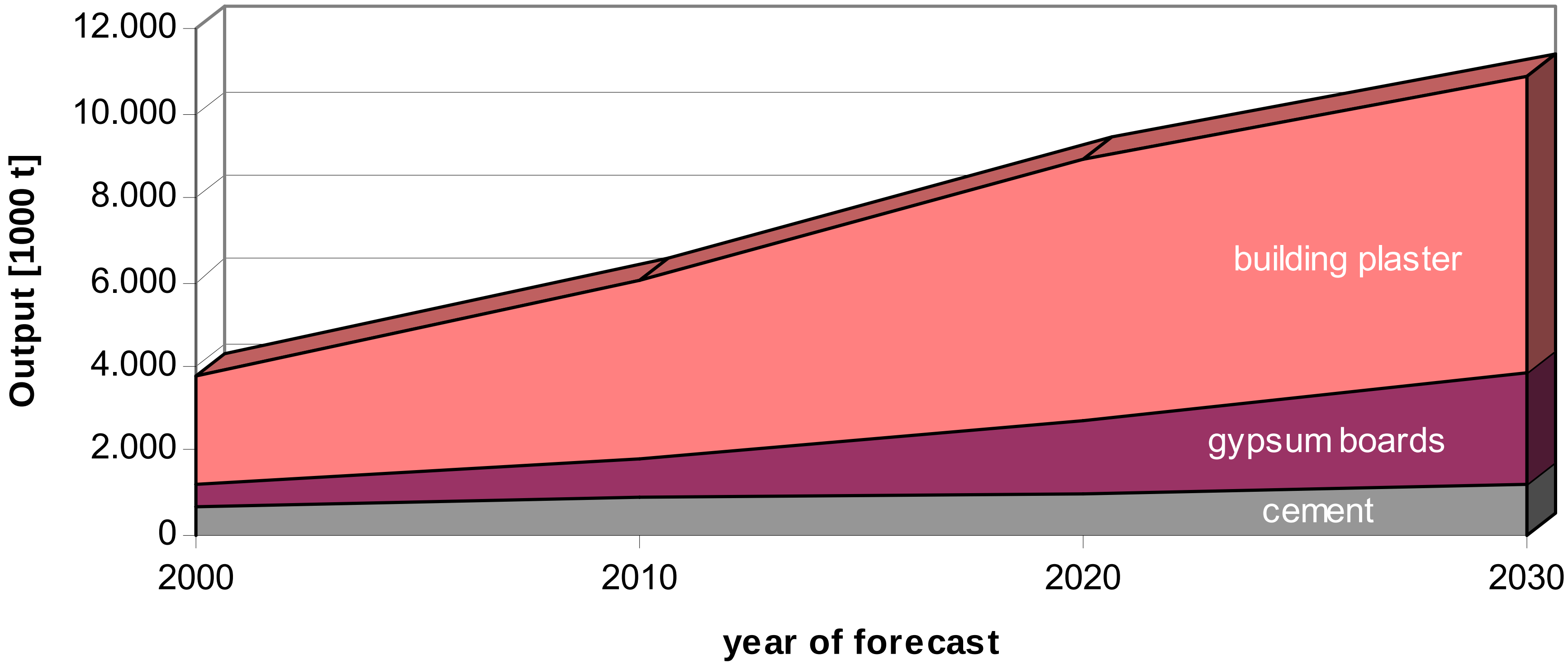
Gypsum products	T [a]	α[-]
Building plaster	35	6
Gypsum boards	40	2
Cement	63	3

Ref: Arendt, M.; Kreislaufwirtschaft im Baubereich: Steuerung zukünftiger Stoffströme am Beispiel Gips; Dissertation; 2000

Level 3: TOP-DOWN-Approach: Production data for gypsum building materials, assumptions of life cycle of gypsum products

Data base: Production of gypsum, production of cement

Calculation base: Life cycle model of Goerg (1997)



CDW Recycling in Germany
⇨ Amount of CDW
⇨ Fields of application
⇨ Rates of recycling and substitution
⇨ Processing technologies
⇨ Standards and guidelines

Origin of gypsum in C&D aggregates
⇨ Gypsum products
⇨ Estimation of gypsum content in CDW and C&D aggregates
⇨ Forecast of future flows of gypsum waste

Effects of gypsum in C&D aggregates

Utilization of C&D gypsum

Effects of gypsum in C&D aggregates

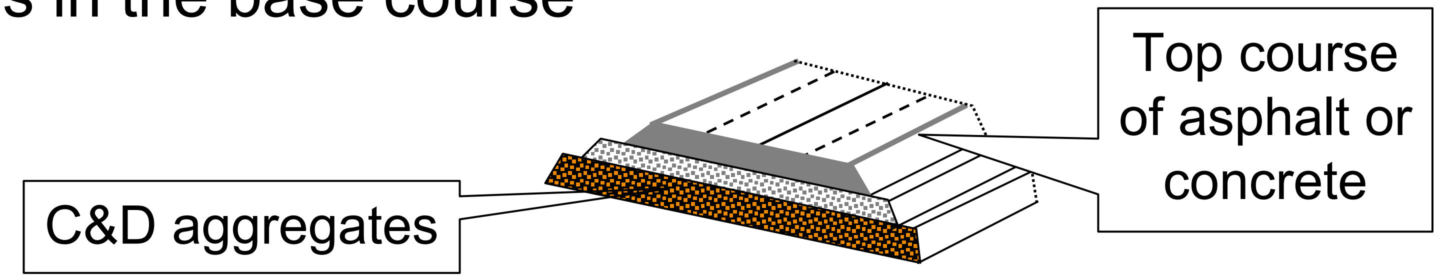
Unbound systems

- Expansion and heaving
- Impairment of stability due to formations of holes by leaching
- Leaching and contamination of ground water

Concrete

- Impairment of setting behavoir
- Expansion

Most commonly described types of damage: Expansion and heaving of asphalt bound or cement bound courses with C&D aggregates in the base course



Reaction which cause expansion (simplified)

Sulfat + Lime + Aluminium oxide + Water → Ettringite $C_3Ax3CaSO_4x32H_2O$

Sulfat + CSH + Carbonate + Water → Thaumasite $CSxCaSO_4xCaCO_3x15H_2O$

Origin of the reactants

A	Sulfate Lime Aluminium oxide	} from C&D aggregates
B	Lime Aluminium oxide	} from C&D aggregates
	Sulfate	from the soil
C	Lime	from C&D aggregates
	Sulfate Aluminium oxide	} from the soil

Conditions that favor the reaction:

- Adequate moisture supply
- Low temperatures
- High compaction of the layers

Case study A: The RC material is the sinner.

Sulfat + Lime + Aluminium oxide + Water → Ettringite

Components in RC material from prefabricated buildings

Material acc.TL Gestein-StB with SO_4^{2-} < 150 mg/l resp. < 600 mg/l

Features of the obseved heavings

- Especially after the first winter
- Typical non-uniform heaving which resulted in bumps and waves of road surface
- Heaving up to 30 cm, typical 3 – 10 cm
- No voids beneath the bumps
- Major heaving at the wettest places
- After removal of the top layers: greasy surface of the base course
- Reduction of the strength measured by plate load tests

Heaving of a road

Heaving of a concrete floor plate caused by the C&D aggregates beneath the floor plate

Case study B: Both parties are involved.

Sulfat + Lime + Aluminium oxide + Water → Ettringite

- Sulfat: Component of the soil
- Lime + Aluminium oxide + Water: Components of RC material

Features of the obseved heavings

- Pure RC concrete aggregates from the demolition of takeoff and landing paths of airports at different locations in the U.S.
- In the case of reuse only in the airport in New Mexico damage was observed although the initial concrete was made from a sulfate resistance cement
- No gypsum, ettringite or thaumasite has been found into the stored material
- Main reason for the heavings:very high sulfate content in the soil in New Mexico

Ref: Athar Saeed u.a.
Applied Research Associates; Vicksburg 2006

Case study C: The RC material is the supplier of the CaO only.

Lime + Sulfat + Aluminium oxide + Water → Ettringite

Lime: Component of RC material

Sulfat + Aluminium oxide: Components of the soil

Ettringite formation analogous to the soil stabilization with lime.

Avoidance of expansion phenomena by formation of Ettringite

- Separation of gypsum by controlled demolition or sorting
- Quality control of C&D aggregates
- Quality control of soil

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Effects of gypsum in C&D aggregates

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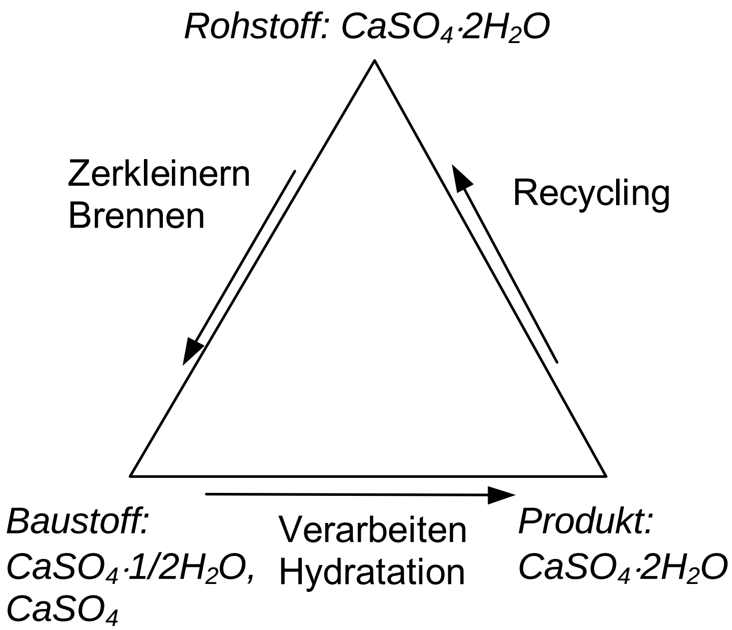
Circuit of gypsum

Raw material:
Dihydrate $CaSO_4 \cdot 2H_2O$

Binder:
Hemihydrate or Anhydrite

Hardened produkt:
Dihydrate $CaSO_4 \cdot 2H_2O$



The circuit of gypsum is applicable for pure substances. In technical products are additives, in gypsum waste are contained contaminants with consequences for the circuit.

Classification of gypsum waste acc. to EWC

EWC-Number for waste with high content of gypsum: 17 08 02 Building materials from gypsum without contaminations by harmful substances
EWC-Numbers for waste with low content of gypsum: 17 01 07 Mixtures of concrete, brick, tiles, ceramik without contaminations by harmful substances 17 09 04 mixed building rubble without contaminations by harmful substances

Recycling of plaster board

About GRI: This is

About GRI: This is how the system works

<u>***The waste does not have to be "clinically clean" – up to 2% contamination***</u>

- ***New construction waste***
- ***Demolition and renovation waste (normally accepted)***

Acceptable:

- Gypsum waste based on FGD/DSG or natural gypsum raw materials
- Virgin gypsum board cut-offs
- Gypsum board underlayers/dunnage
- Gypsum blocks
- Complete boards or broken parts
- Gypsum ceilings, floors, walls, stucco etc.
- The gypsum waste may contain <u>nails and screws</u>
- <u>Wallpaper, glass tissue and other wall coverings on the gypsum boards</u>

Non-acceptable:

- Plastics, foils and insulation materials (glass wool/stone wool/Rockwool)
- Steel rails and bars
- Wood
- Anhydrite
- Other impurities

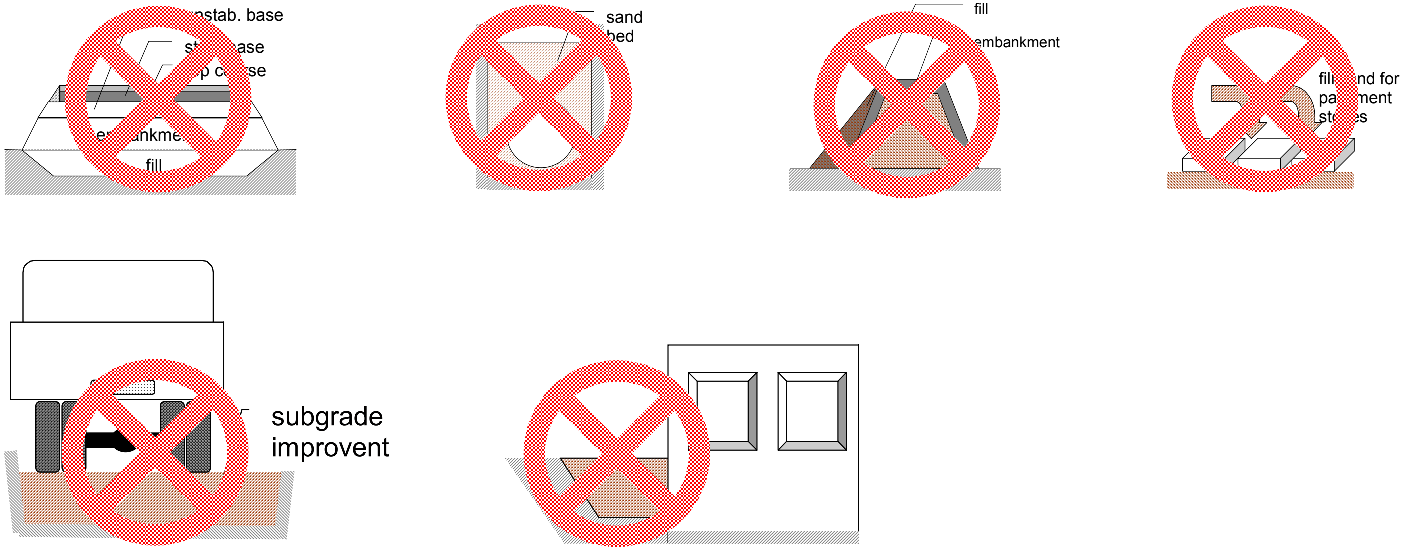
From Gypsum Recycling International

GYPSUM RECYCLING INTERNATIONAL

C&D waste from demolition

When gypsum is mixed with other types of CDW no use - either for the C&D aggregates nor for the gypsum is possible.

- Unbound application not possible because gysum leaches out or reacts with lime containig materials resulting in expansion



- Bound application in concrete not possible because gypsum disturbs the setting and has a negative effect on durability

C&D waste from demolition utilization in agriculture? Only for wastes with constant content of gypsum and without impurities.

"Gypsum wallboard from construction waste is increasing being viewed for recovery in agriculture. Gypsum is used in agriculture as both a fertilizer and soil amendment and both calcium and sulfur are essential plant nutrients. Gypsum does not increase pH as does lime, and, in large applications, may even decrease pH."

"Potatoes and peanuts both respond to calcium fertilization and research done in Wisconsin found that potato quality (especially for hollow hearts and calcium levels in the peels) increased with the application of gypsum from wallboard. However, there were no increases in yields."

334. "Using Recycled Wallboard for Crop Production", Richard P. Wolkowski, University of Wisconsin, May 2003, 8 pages. Publication A3782. Accessed on June 16, 2003 at http://www1.uwex.edu/ces/pubs/pdf/A3782.pdf.

Drywall bibliography prepared by John Reindl, Recycling Manager Dane County Department of Public Works 1919 Alliant Energy Center Way Madison, WI 53713-1400

Utilization of C&D gypsum

Gyp Monster

http://www.gypmonster.com/

Thank you for your attention!

Homepage: www.uni-weimar.de/Bauing/aufber/