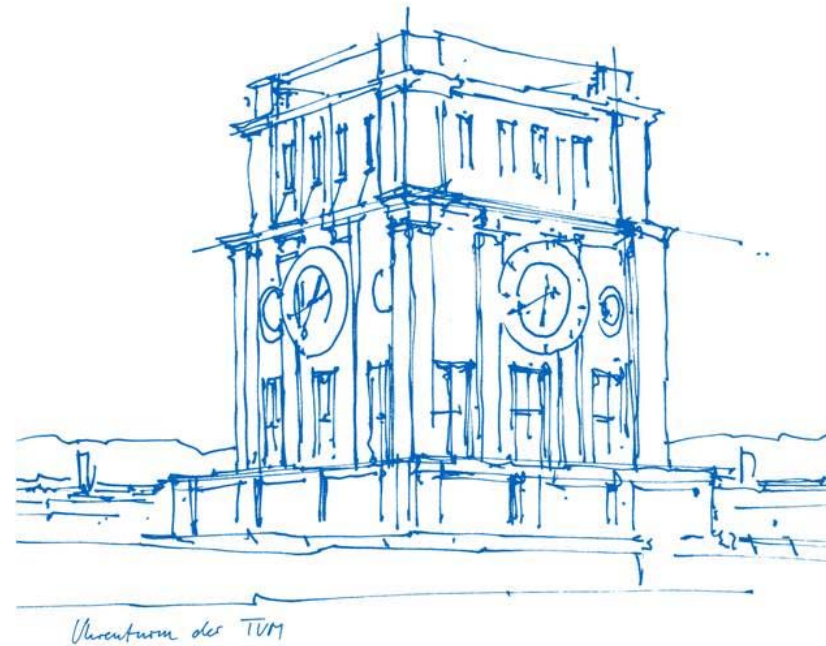


Nachhaltiger Umgang mit Böden und Baustoffen im Erdbau

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München, 14.09.2022

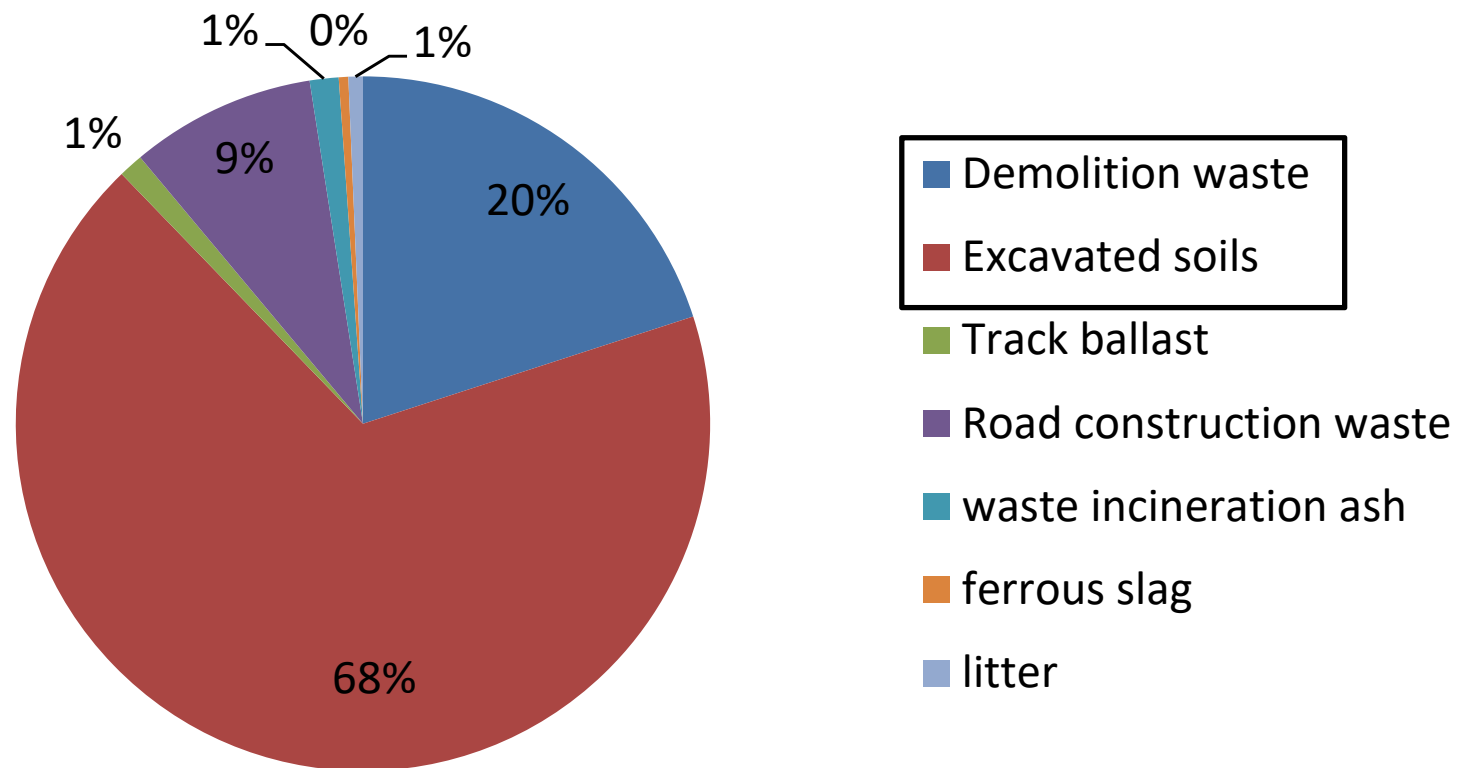


Background



Approx. 70 % of total
waste volume is
mineral waste

**sources of mineral waste (Bavaria 2012) total waste
mass 44 Mio. T.**



→ Approx. 50 % of total waste is excavated soil / C&D waste!

Practical experience using material in earthworks

- Preference in using high quality soils in earthworks (e.g. gravel)
- There are concerns about the use of secondary raw materials (e.g. recycled building material, steel slags, municipal solid waste incineration ash) for earthworks
- Secondary raw materials partly have different properties than soils → test procedures have to be adopted
- Excavated soils which show different material properties compared to natural gravelly soils are barely used (e.g. soils with organic content, weak rock, soils with mineral impurities)

→ Huge amount of excavated soils / mineral waste are dumped instead of being reused! (Even if they are not environmentally problematic)

Waste management for mineral waste



According to § 6 KrWG

1. Waste reduction

Reuse of materials at source of generation (building site), minimization of excavated materials

→ e.g. use of excavated, non-contaminated soils („primary building materials“)

2. Reuse (preparation for reuse)

*Construction material for technical buildings (embankments, dikes, dams)
top layers (vegetation layer)*

→ e.g. excavated soils (soils with organic content, slightly contaminated soil or industrial by-products) („secondary building materials“)

3. Recycling

Recycling plant (separation, sizing, treatment...),

→ e.g. recycled materials, after treatment use as secondary building materials

4. Revalorization, utilization

Filling (e. g. in gravel pits)

5. Disposal

Landfilling

Criteria for reuse of mineral materials



Environmental properties

→ environmental effects (contamination of soil, groundwater, air, uptake of contaminants by plants)

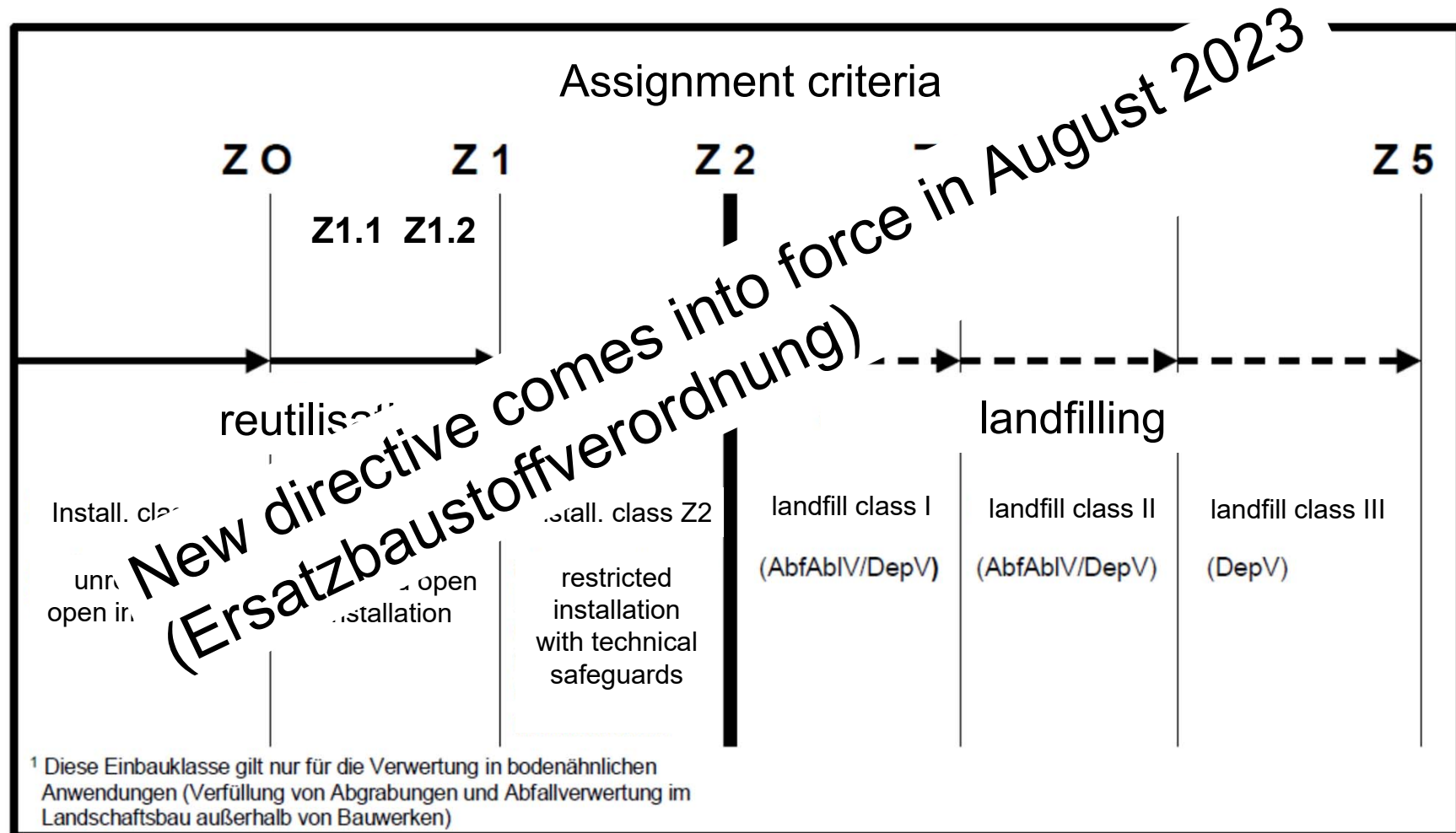
Mechanical properties

requirements on stability and serviceability of buildings

(Life cycle assessment)

Criteria for reuse of mineral materials

Environmental criteria for reutilisation



Criteria for reuse of mineral materials

Environmental criteria for reutilisation

Ersatzbaustoffverordnung

(ab 01.08.2023)

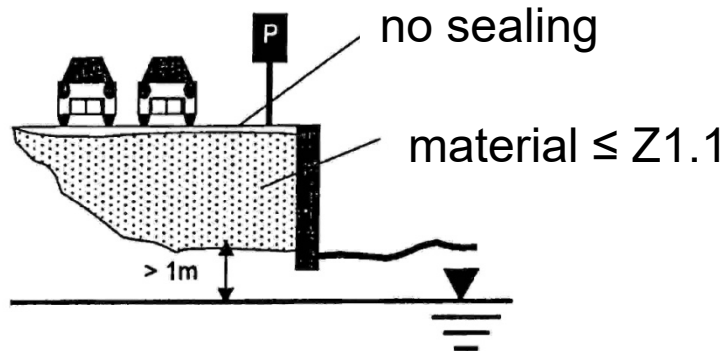
Example BM-F3

Bodenmaterial der Klasse F3 (BM-F3), Baggergut der Klasse F3 (BG-3)										
Einbauweise		Eigenschaft der Grundwasserdeckschicht								
		außerhalb von Wasserschutzbereichen			innerhalb von Wasserschutzbereichen					
		ungün- stig	günstig		günstig					
			Sand	Lehm, Schluff, Ton	WSG III A HSG III		WSG III B HSG IV		Wasservor- ranggebiete	
		Sand			Lehm, Schluff, Ton	Sand	Lehm, Schluff, Ton	Sand	Lehm, Schluff, Ton	
		1	2	3	4		5		6	
1	Decke bitumen- oder hydraulisch gebunden, Tragschicht bitumengebunden	+	+	+	+	+	+	+	+	+
2	Unterbau unter Fundament- oder Bodenplatten, Bodenverfestigung unter gebundener Deckschicht	+	+	+	+	+	+	+	+	+
3	Tragschicht mit hydraulischen Bindemitteln unter gebundener Deckschicht	+	+	+	+	+	+	+	+	+
4	Verfüllung von Baugruben und Leitungsgräben unter gebundener Deckschicht	+	+	+	-	-	+	+	+	+
5	Asphalttragschicht (teilwaserdurchlässig) unter Pflasterdecken und Plattenbelägen, Tragschicht hydraulisch gebunden (Dränbeton) unter Pflaster und Platten	-	+	+	-	-	-	+	+	+
6	Bettung, Frostschutz- oder Tragschicht unter Pflaster oder Platten jeweils mit wasserundurchlässiger Fugenabdichtung	+	+	+	+	+	+	+	+	+
7	Schottertragschicht (ToB) unter gebundener Deckschicht	-	+	+	-	+	-	+	+	+
8	Frostschuttschicht (ToB), Baugrundverbesserung und Unterbau bis 1 m ab Planum jeweils unter gebundener Deckschicht	-	-	+	-	-	-	-	-	+
9	Dämme oder Wälle gemäß Bauweisen A-D nach MTSE sowie Hinterfüllung von Bauwerken im Böschungsbe- reich in analoger Bauweise	+	+	+	-	-	+	+	+	+
10	Damm oder Wall gemäß Bauweise E nach MTSE	-	+	+	-	+	-	+	+	+

Criteria for reuse of mineral materials

Example of „open installation“

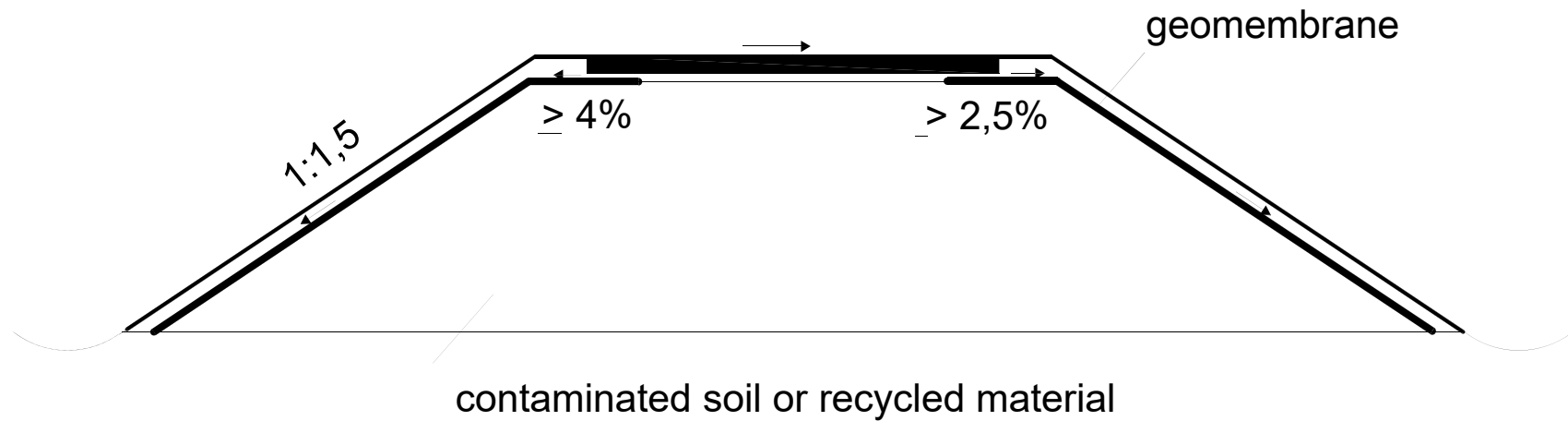
→ seepage flow through compacted earth material can be accepted without restrictions



Criteria for reuse of mineral materials

Example of „technical safeguards“

→ seepage flow through compacted earth material has to be minimized



Criteria for reuse of mineral materials

Example of „technical safeguards“

Construction methods according to MTSE

Bodenmaterial der Klasse F3 (BM-F3), Baggergut der Klasse F3 (BG-3)											
Einbauweise		Eigenschaft der Grundwasserdeckschicht									
		außerhalb von Wasserschutzbereichen			innerhalb von Wasserschutzbereichen						
		ungün- stig	günstig		günstig						
				Sand	Lehm, Schluff, Ton	WSG III A HSG III		WSG III B HSG IV		Wasservor- rangsgebiete	
						Sand	Lehm, Schluff, Ton	Sand	Lehm, Schluff, Ton	San d	Lehm, Schluff, Ton
1	2	3	4		5		6				
1	Decke bitumen- oder hydraulisch gebunden, Tragschicht bitumengebunden	+	+	+	+	+	+	+	+	+	
2	Unterbau unter Fundament- oder Bodenplatten, Bodenverfestigung unter gebundener Deckschicht	+	+	+	+	+	+	+	+	+	
3	Tragschicht mit hydraulischen Bindemitteln unter gebundener Deckschicht	+	+	+	+	+	+	+	+	+	
4	Verfüllung von Baugruben und Leitungsgräben unter gebundener Deckschicht	+	+	+	-	-	+	+	+	+	
5	Asphalttragschicht (teilwaserdurchlässig) unter Pflasterdecken und Plattenbelägen, Tragschicht hydraulisch gebunden (Dränbcton) unter Pflaster und Platten	-	+	+	-	-	-	+	+	+	
6	Bettung, Frostschutz- oder Tragschicht unter Pflaster oder Platten jeweils mit wasserundurchlässiger Fugenabdichtung	+	+	+	+	+	+	+	+	+	
7	Schottertragschicht (ToB) unter gebundener Deckschicht	-	+	+	-	+	-	+	+	+	
8	Frostschuttschicht (ToB), Baugrundverbesserung und Unterbau bis 1 m ab Planum jeweils unter gebundener Deckschicht	-	-	+	-	-	-	-	-	+	
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10	Damm oder Wall gemäß Bauweise E nach MTSE	-	+	+	-	+	-	+	+	+	

Objectives of sustainable use of materials

Material Efficiency
<ul style="list-style-type: none">• Optimum use of natural building material in earthworks• Usage of nearly all on site available soils• Usage of secondary raw materials• Avoid dumping• Optimize construction methods

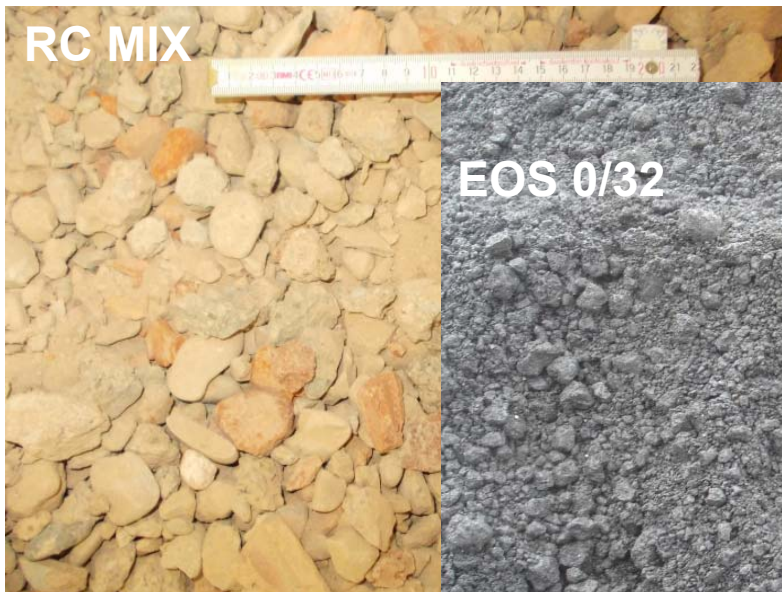


Saving Resources
<ul style="list-style-type: none">• Reservation of pits/quarries for high quality materials• Minimize the demand on land• Minimize and optimize transport routs• Optimize the durability of earthworks• Minimize CO₂e emissions

Examples of sustainable use of materials

Use of all excavated soils and industrial by-products:

- Recycled materials (e. g. 0/4 mm grain size), industrial by-products, soils with mineral impurities



Examples of sustainable use of materials

Use as construction material for embankments



Examples of sustainable use of materials

Basic material for flowable fill



Examples of sustainable use of materials

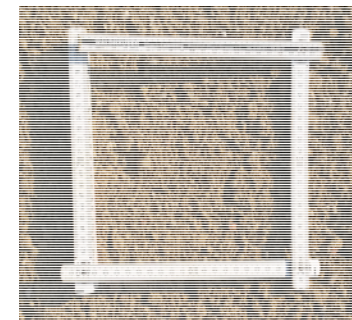
Use of all excavated and locally available soils, including „problematic“ soils:

- Soils of soft consistency



Examples of sustainable use of materials

Mechanical soil improvement with RC-Sand



Soft soil (TL)

+

RC-Mix 0/4 mm

→
**Mixing by means of conventional
tiller ("stabilizer")**

**High quality
earthwork material**

Examples of sustainable use of materials

Use of all excavated and locally available soils, including „problematic“ soils:

- Organic soils/soils with organic content



Use as construction material for fills (e. g. for noise and view protection)

Application of mineral materials in earthworks

- dams
- protective barriers
- backfilling and covering structures
- seepage layers
- filling of building pits and pipe trenches (e. g. as flowable fill)
- soil improvement
- mechanical soil improvement, soil stabilization
- landfill construction: compensating layer, gas collection layer
- bearing layers for sports ground
- roadway for site traffic

What has to be done?



Establishing the requirements for use

Creating or modifying legal regulations

Implementation in standards for road constructions

No difference between natural and secondary raw materials

Consideration in building contracts

Development of best methodologies/practice

Life cycle assessment of different applications

Verifying the feasibility

Verifying civil engineering and environmental feasibility

Creating model projects

Scientific monitoring of model projects

Development of innovative solutions for soil improvement

→ Need for research / dissemination / information

Thank you for your attention!