



Dutch Soil Quality Decree on secondary aggregates for BSM

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Introduction

Marcel Sprenger

- 56 years of age
- 26 years of employment with BAM Infra Wegen
- 14 years of employment as Pavement Engineering Consultant
- 5 years of involvement with BSM



Royal BAM Group



creating infrastructure that not only meets today's mobility needs but also contributes to a more sustainable, climate-resilient future. Within BAM Infra Wegen, we translate this ambition into practice through innovative road construction, sustainable asphalt technologies, circular materials, and smart asset management solutions.

Aggregates in BSM (ART guideline definition)

Bitumen Stabilised Material (BSM) – A cold-recycled **granular** pavement layer stabilised with low amounts of bitumen and active filler, exhibiting non-continuous bound behaviour and shear deformation as the primary failure mechanism.

The **granular aggregate** can be virgin aggregates, reclaimed asphalt pavement (RAP), other secondary aggregates or **a blend of those**, but must have a suitable continuous grading with sufficient fines and must comply with (local) environmental requirements.

Dutch Soil Quality Decree on secondary aggregates for BSM

- BSM and aggregates in BSM
- Dutch soils and pavement buildup;
- The Dutch Environmental regulatory framework
- Case-study with 2 trial projects;
- Plan of attack on trial projects;
- Protocol steps (sampling, test specimens, testing, supervision);
- Results so far;
- (preliminary) conclusions en implications for practice;
- Follow up;

Dutch soils and pavement constructions

The Dutch subsurface is dominated by soft soils (peat, clay, sand, silt sediments) and high groundwater levels: limited bearing capacity, settlement, stability issues, frost/thaw issues

Pavement design: replacement of soft material with more stable materials for subgrade and subbase:

- Crushed gravel, natural crashed rock (imported)
- Rebuilding after WWII: increasing demand of materials and surplus of demolition debris
- Booming population: further increase in demand: industrial by-products (slags) and waste materials (landfill, embankments)
- Dominant attitude was practical rather than environmental: strenght, stability, bearing capacity

The Wake-up call

- New residential area Lekkerkerk-West build on waste disposal landfill (1970-1978)
- In 1979 a burst waterpipe showed chemical damage
- Investigation showed in 1980 that landfill contained household waste mixed with industrial and chemical waste (xylenes, toluene, benzene)
- Evacuation of residents (300+ households) and major cleanup operation (1980-1981)



The Aftermath:

- Awareness for the need of controlled application:
 - environmental quality became as important as engineering quality;
 - waste disposal rules became stricter;
 - regulations for secondary construction materials were introduced;
 - producers had to demonstrate material quality and composition.
- Development of environmental legislation:
 - 1983: Interim Soil Remediation Act
 - 1987: Soil Protection Act
 - 1990's: Building Materials Decrees
 - 2007: Soil Quality Decree
 - 2024: Integration into the Environmental and Planning Act framework (Omgevingswet)

Transformation from a pragmatic approach to waste reuse, into a rigorous risk-based system of soil protection, remediation, certification and quality controlled reuse of secondary construction materials

transition from “applying waste” to “applying controlled secondary construction materials”

The Dutch Soil Quality Decree

The Soil Quality Decree remains a cornerstone within the Environmental and Planning Act

It's objectives are:

1. Protect soil and groundwater.
2. Enable the safe reuse of secondary materials.
3. Ensure trust through certification, testing, and regulatory oversight.

Oversight: decentralized implementation with national oversight:

- Human Environment and Transport Inspectorate ILT (national policy)
- Provinces (competent authority for regional policy)
- Municipalities (competent authority for local policy)
- Environmental Agencies (technical environmental tasks on behalf of provinces and municipalities)

The Dutch Soil Quality Decree

This is why modern in-situ recycling projects typically involve extensive research:

- pre-investigation;
- sampling;
- chemical (batch)testing;
- risk assessment;
- documentation;
- traceability.

Activities for sampling to be performed in accordance to specific Guideline (BRL SIKB 1000)

Activities for assessment from different frameworks for specific material type (soil, construction materials, asphalt)

RAP for reuse in asphalt: limited testing protocol based on quality assurance within industry and acceptance protocols for incoming RAP at mixing plants (testing for coal tar contamination (PAH's))

Strong preference for 100% RAP based BSM

Case-study on blend of aggregates

BSM in the Netherlands in introduction-phase:

mostly on low-volume (low risk) rural roads: limited asphalt thickness, subbase, constructed before 1980's (before modern environmental legislation)

Limited asphalt thickness: insufficient materials for 100% RAP based BSM.

Options for recycling:

- Additional RAP from external origin (stockpile) resulting in higher road surface road level
- Use blend of aggregates in-situ: RAP, subbase-material, subgrade-material

What are exactly the implications of the Soil Quality Decree on the application of a blend of aggregates for BSM?

Can we find possibilities to reduce these implications?

Case-study on blend of aggregates: trial projects

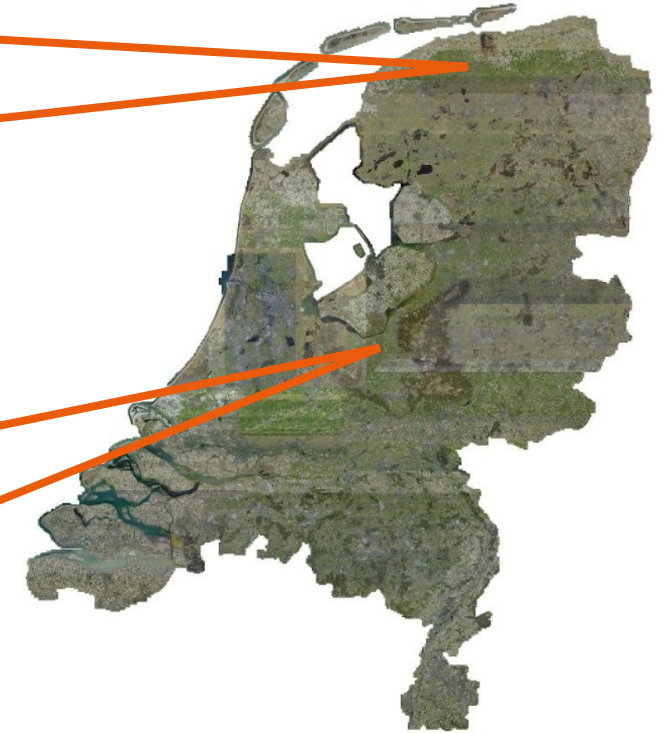
Mûnewei, Ljussens

- Low-volume country road
- Concrete block pavement
- Subgrade: sand
- Additional RAP from stockpile



Zeedijk, Nijkerk

- Low-volume rural road
- Asphalt pavement
- Subbase: RAP
- Subgrade: blend of granulated materials
- Additional RAP from stockpile



Investigation in consultation with:

- National oversight Inspectorate ILT,
- Municipalities (Nijkerk, Noardeast-Fryslân)
- Environmental Agencies (Omgevingsdienst De Vallei, FUMO)
- Expert Environmental Consultant (Certicon Bodemexperts)

Plan of attack trial projects

Protocol-steps for sampling and testing in accordance to Environmental and Planning Act framework:

- Pre-investigation:
- Sampling:
- Preparation of test specimens
- Batch-testing of material specimens
- Preparing BSM test specimens
- Testing of BSM test specimens
- Reporting



Everything to be performed under supervision of certified Expert Consultant

Plan of attack trial projects

SIKB BRL 1000 protocols for sampling of different material types:

- 1001: soil and dredged materials
- **1002: unmoulded construction materials**
- **1003: moulded construction materials**
- 1004: granular waste materials intended for disposal



‘moulded’ vs ‘unmoulded’:

- a moulded construction material retains a durable shape under normal conditions
- An unmoulded construction material is any material that does not meet the ‘moulded’ definition.

Different frameworks for assessment for different material types:

- | | |
|--|---|
| • Subgrade/sand: | Soil Quality Decree (quality classes) |
| • Subbase/granulated construction materials: | unmoulded construction materials (batch testing AP04) |
| • Asphalt: | moulded/unmoulded construction materials (limited, CROW210) |

Protocol steps: pre-investigation

Pre-investigation:



– BSM mix-design (aggregate ratio's)

- 60% RAP (pavement)
- 30% RAP (subbase)
- 10% subbase material

- 45% concrete pavement blocks
- 38% RAP from stockpile
- 17% subgrade (sand)

– Dimensions of trial-section (quantities of materials)

- RAP (pavement): 813 tons
- RAP (subbase): 406 tons
- Subbase material: 126 tons

- concrete pavement blocks: 242 tons
- RAP from stockpile: 200 tons
- subgrade (sand): 91 tons

– batch definitions (separation of materials)

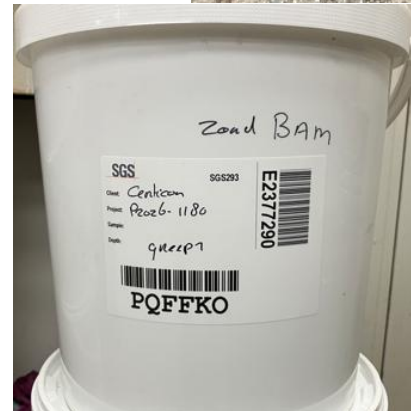
- RAP (pavement): 12 cores Ø 350 mm (70 mm)
(granulated 195 kg)
- RAP (subbase): 100 kg (40 mm)
- Subbase material: 32 kg (15 mm)

- concrete pavement blocks: 36 blocks (210x105x70 mm)
(granulated: 135 kg)
- RAP from stockpile: 110 kg
- subgrade (sand): 30 kg (36 mm)

Protocol steps: sampling

Quantity and distribution of grab samples:

- 12 grab samples per 10.000 ton material
(in a construction layer)
- Stratified random sampling to avoid bias
- Representative depth in construction
- Sampling method (prevent mixing materials)
- Sample storage and registration (traceability)



Protocol steps: preparation of test specimens

- Preparation of test specimens:
 - Crushing / granulating



- Prepare at least 2 composite samples
- Transport and handover to certified laboratory



Protocol steps: batch testing materials (unmoulded)

Environmental Laboratory analyses are performed for parameters such as:

- Volatile aromatic hydrocarbins
- Phenols
- Polycyclic Aromatic Hydrocarbons (PAH's)
- Polychlorinated Biphenyls (PCB's)
- Mineral oils
- Metals in eluate
- General chemical parameters in eluate

MINERALE OLIE		ELUAAT NATCHEMISCHE BEP.		FENOLEN		POLYCYCLISCHE AROMATISCHE		ELUAAT METALEN	
fractie C10 - C12	benzeen	fluoride(2)		fenol		naftaleen		antimoon	
fractie C12 - C22	tolueen	bromide(2)				antraceen		arseen	
fractie C22 - C30	ethylbenzeen	chloride(1+2)				fenantreen		barium	
fractie C30 - C40	o-xyleen	sulfaat(2)				fluoranteen		cadmium	
totaal olie C10 - C40	p- en m-xyleen					benzo(a)antraceen		kobalt	
	xylenen (som)					chryseen		chroom	
	totaal BTEX (som)					benzo(a)pyreen		koper	
						benzo(ghi)peryleen		kwik	
						benzo(k)fluoranteen		lood	
						indeno(1,2,3cd)pyreen		molybdeen	
						PAK (10 VROM)		nikkel	
								seleen	
								tin	
								vanadium(1)	
								zink	

Protocol steps: Preparing BSM test specimens

- Mixing BSM



- Preparing BSM test specimens:

- 12 specimens
- Ø 150 mm, 150 mm height: triaxial moulds
- Compaction with vibrating hammer



- Curing test specimens:

- Protocol based on cementitious binding: 'hardening period' (28 days)
- BSM Guidelines based on 'drying period' (72+ hours)



Protocol steps: Testing BSM specimens

Leaching tests on BSM test specimens:

Column leaching test:

- test specimens crushed to particle size < 4 mm;
- Crushed material placed in a glass column
- Water (pH = 7) passed through for app. 3 weeks at an L/S ratio of 10
- Analysis of eluate for 15 metals and 4 anions

Diffusion leaching test (only when results of column leaching test show non-compliance):

- BSM test specimen placed in water for 64 days;
- Separation of eluate after 0.25, 1, 2.25, 4, 9, 16, 36 and 64 days
- Analysis of eluate for 15 metals and 4 anions

Protocol steps: Reporting

Detailed report on batch and BSM specimen testing per material type:

- Pre-investigation (sample sizes, randomising, stratification)
- Sampling (location, sampling method, grab samples, registration-codes)
- Preparation of test specimens (composite samples)
- Analysis certificat for batch-testing
-?

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[illegible]

(preliminary) conclusions and implications for practice

- Extensive planning in preparation due to complex rules (example: moulded and unmoulded);
- Specific planning for sampling (random, stratified, representative depth)
- Sampling is elaborate and very time consuming (road-closure!);
- Sampling amounts are based on BSM mix-design: environmental research after mix-design research
- Sampled materials may need granulating before testing;
- BSM test specimens are different from those in BSM mix-design (ITS, triaxial);
- Restrictions on the use of additives (no matter how small in amount);
- Handling and storage of samples, batch specimens and BSM specimens is also elaborate;
- Multiple parties involved makes planning of entire process complex;
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(preliminary) conclusions and implications for practice

What are exactly the implications of the Soil Quality Decree on the application of a blend of aggregates for BSM?

- Complex protocols;
- Elaborate and time-consuming process;
- Extra road-closures and temporal road maintenance;
- Extra research after research for BSM mix-design (despite comparable activities!);
- Extra costs;

Paradox:

- For the sake of our environment and future we aim for a circular economy  full in-situ recycling
- The Soil Quality Decree demands for 'demonstrable environmental acceptability' which in its current practice makes application of a blend of materials not the most desirable solution

(preliminary) conclusions and implications for practice

Can we find possibilities to reduce these implications?

- Learn and gain experience on protocols;
- Align sampling procedures for BSM mix-design and environmental research (techniques, location, amounts);
- Align processing of and research on materials between BSM mix-design and environmental research;
- Align tests on BSM specimens (ITS, triaxial, leaching), maybe even reuse test-specimens?
- Attain BSM specific adjustments in the regulatory protocols;
- Waive leaching test on BSM test specimen, when batch tests of individual materials comply;
- Attain limited testing protocol requirements as with RAP based on quality assurance within industry?
- ...
- ...

Acknowledgements



- Municipality Noardeast-Fryslân



- Municipality Nijkerk



- Expert Environmental Consultant Certicon Bodemexperts



- Environmental Agency De Vallei

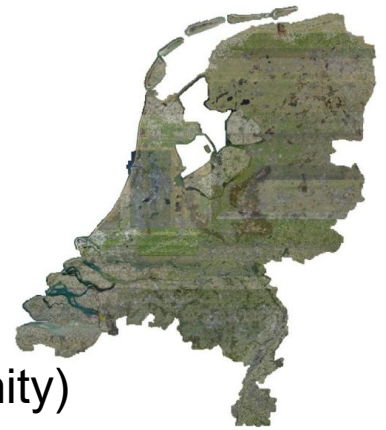


- Environmental Agency Fryske Utfieringstsjinst Miljeu en Omjouwing (FUMO)



- National oversight Inspectorate Inspectie Leefomgeving en Transport (ILT)

A uniquely Dutch issue..... is it?



1980 Lekkerkerk toxic waste scandal:

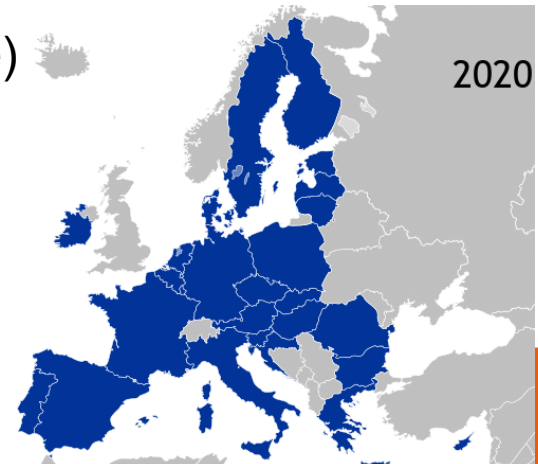
hardly any influence from Europe (EEC European Economic Community)

In 1993 the EU (European Union) was established with growing integration including environmental policy:

- REACH Regulation (1907/2006): addressing (chemical) contaminations of (recycled) building materials;
- Waste Framework Directive (2008/98/EC): determines the waste status of materials;
- Soil Monitoring Law (2025): the EU's first comprehensive soil-health directive, requiring Member States to monitor soil condition, identify contaminated sites, and work towards having all soils in a healthy state by 2050

the Dutch Environmental and Planning Act framework (and Soil Quality Decree) now is largely a detailed elaboration of EU legislation:

No longer just a Dutch issue?





Contact

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Predictable performance
'I deliver what I promise'



Proactive ownership
'I take initiative to
prevent, rather than fix'



Open collaboration
'I share, so we all gain'



Scalable learning
'I ask, listen and support,
so that we learn collectively'