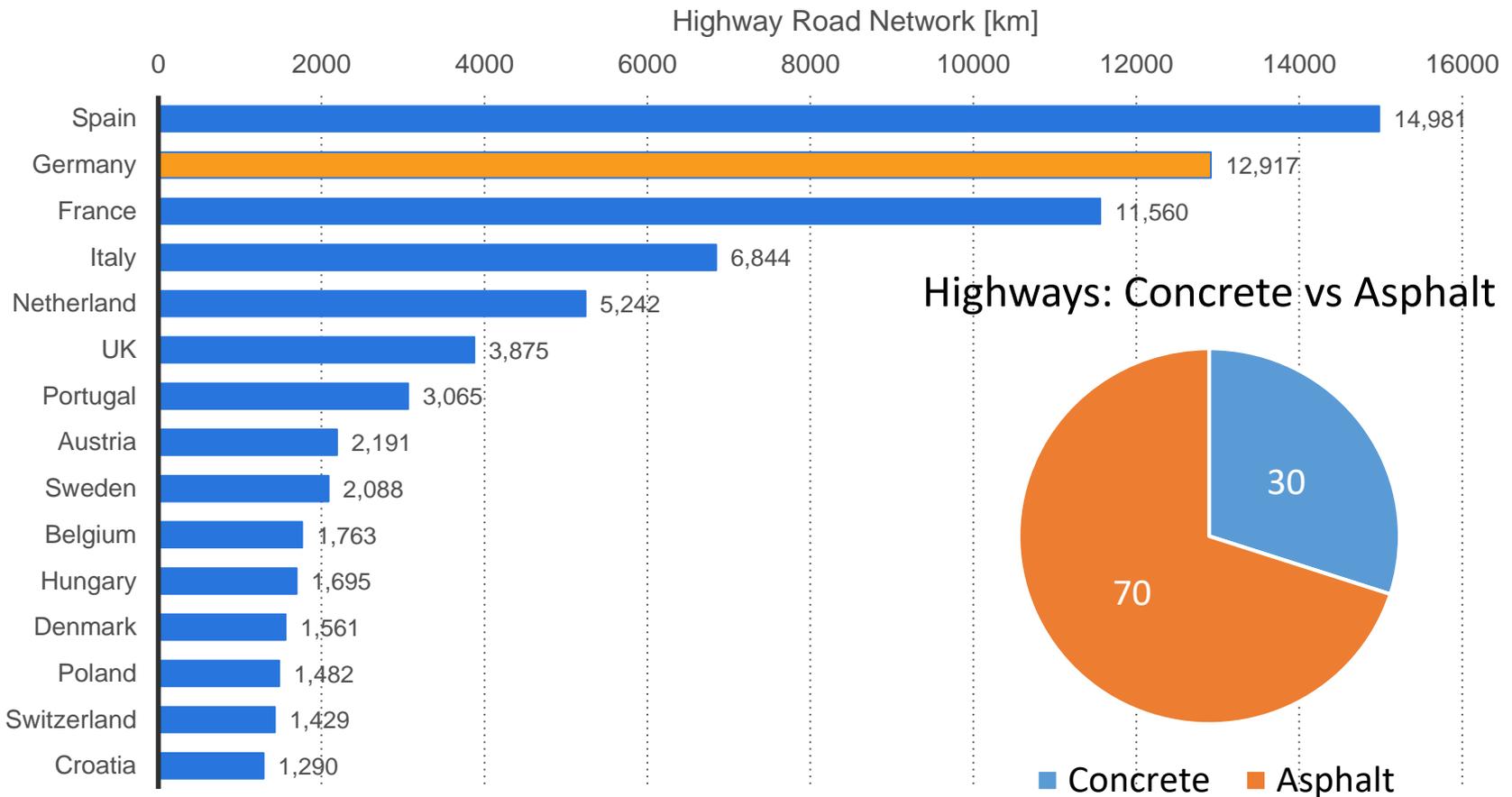




„Concrete roads in Germany case study: Design parameters and challenges”

Prof. Dr. Thomas Matschei

Germany has the 2nd largest highway network in Europe



Source: Eurostat; UNECE; Bundesanstalt für Straßenwesen; IRTAD [ID_154113](#)

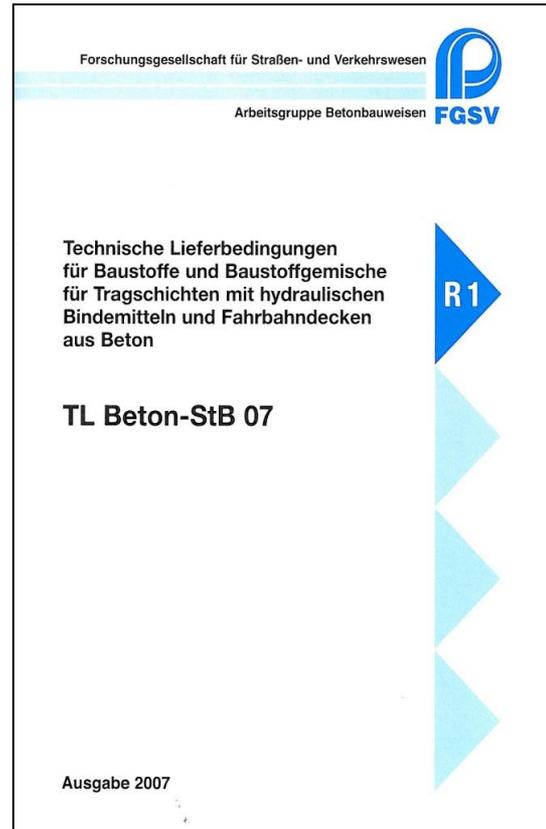
With ~5.6% of the total road network highways carry ~ 48% of all traffic related loads in Germany;

Concrete Paving _ Very strict national technical design and test guidelines, but so far only limited consideration of environmental impacts



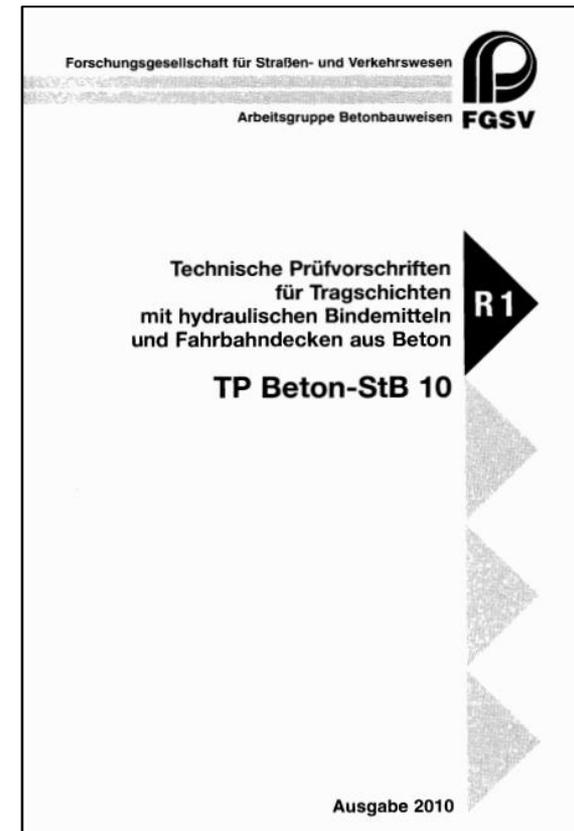
ZTV Beton-StB 07

German
Enhanced Technical Specs for
Concrete Roads



TL Beton-StB 07

Execution guidelines



TP Beton-StB 10

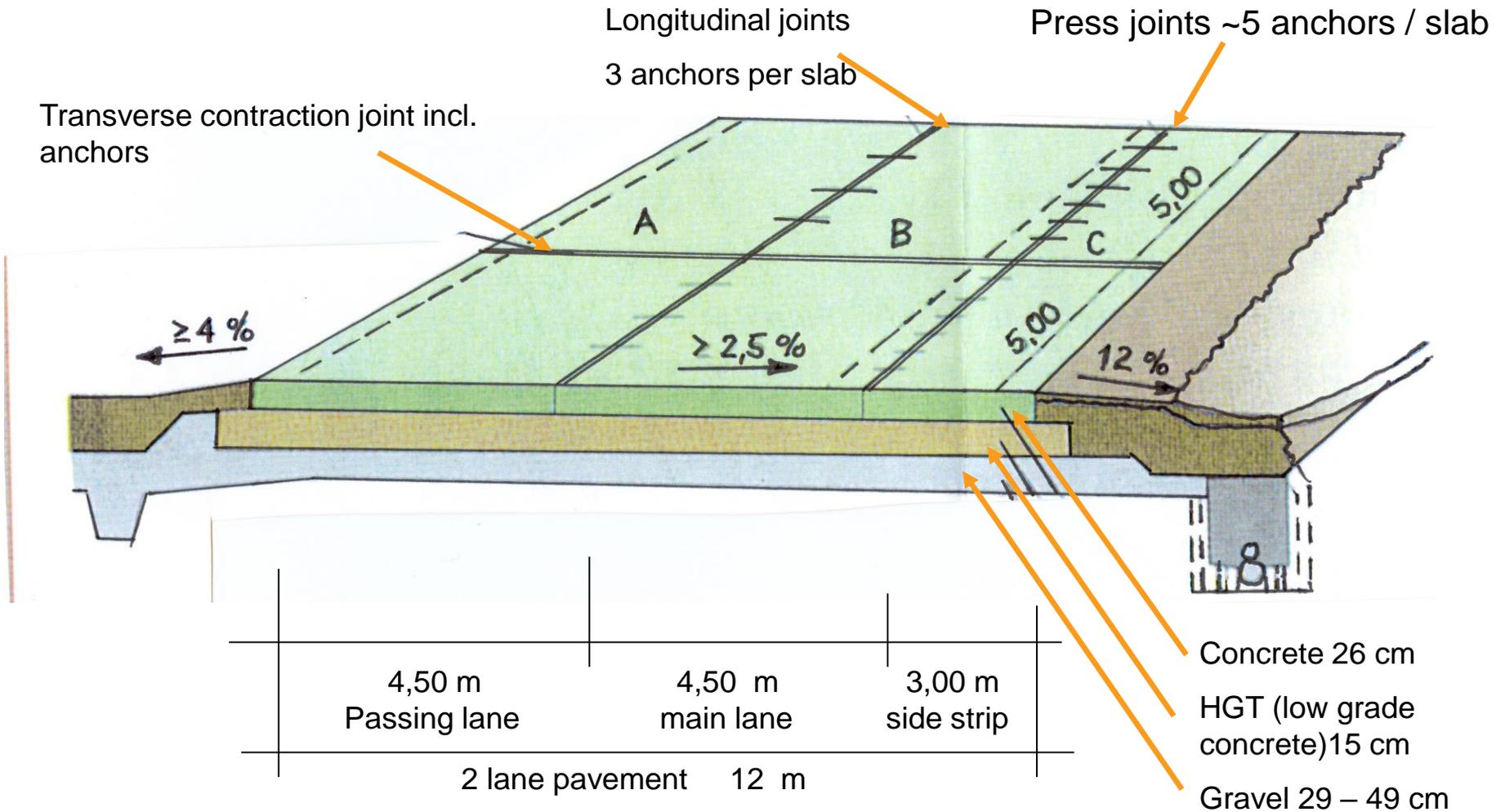
Testing guidelines

Depending on the expected loads there are different Design possibilities

(Dickenangaben in cm; ∇ E_{v2} -Mindestwerte in MN/m²)

Zeile	Bauklasse	Bk ₁₀₀	Bk ₃₂	Bk ₁₀	Bk _{3,2}	Bk _{1,8}	Bk _{1,0}	Bk _{0,3}										
	B [Mio]	> 32	> 10 - 32	> 3,2 - 10	> 1,8 - 3,2	> 1,0 - 1,8	> 0,3 - 1,0	≤ 0,3										
	Dicke des frostsich. Oberbaues ¹⁾	55 65 75 85	55 65 75 85	55 65 75 85	45 55 65 75	45 55 65 75	35 45 55 65	35 45 55 65										
1.1	Asphalttragschicht und Tragschicht aus frostunempfindlichem Material																	
	Betondecke																	
	Vliesstoff ⁸⁾	<p>Upper layer ≥40mm (min. 420kg cement)</p> <p>Lower layer (>20cm; min 350kg cement)</p> <p>Sublayer ~15cm (typically lower grade concrete)</p> <p>Gravel layer 20-40cm (e.g. recycled concrete)</p> <p>Main concrete</p>																
	Hydraulisch gebundene Tragschicht (HGT)																	
	Frostschutzschicht	<p>Upper layer ≥40mm (min. 420kg cement)</p> <p>Lower layer (>20cm; min 350kg cement)</p> <p>Sublayer ~15cm (typically lower grade concrete)</p> <p>Gravel layer 20-40cm (e.g. recycled concrete)</p> <p>Main concrete</p>																
	Dicke der Frostschutzschicht																	
1.2	Betondecke																	
	Vliesstoff ⁸⁾																	
	Verfestigung	<p>Upper layer ≥40mm (min. 420kg cement)</p> <p>Lower layer (>20cm; min 350kg cement)</p> <p>Sublayer ~15cm (typically lower grade concrete)</p> <p>Gravel layer 20-40cm (e.g. recycled concrete)</p> <p>Main concrete</p>																
	Schicht aus frostunempfindlichem Material -weit- oder intermittierend gestuft gemäß DIN 18196-																	
	Dicke der Schicht aus frostunempfindlichem Material	<p>Upper layer ≥40mm (min. 420kg cement)</p> <p>Lower layer (>20cm; min 350kg cement)</p> <p>Sublayer ~15cm (typically lower grade concrete)</p> <p>Gravel layer 20-40cm (e.g. recycled concrete)</p> <p>Main concrete</p>																
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	Dicke der Schicht aus frostunempfindlichem Material	3 ⁴⁾ 13 ⁴⁾ 23 33	9 ⁴⁾ 19 29 39	10 ⁴⁾ 20 30 40	1 ⁴⁾ 11 ⁴⁾ 21 31	2 ⁴⁾ 12 ⁴⁾ 22 32	10 ⁴⁾ 20 30 40	-	10 ⁴⁾ 20 30									
2	Asphalttragschicht auf Frostschutzschicht																	
	Betondecke																	
	Asphalttragschicht																	
	Frostschutzschicht	<p>Upper layer ≥40mm (min. 420kg cement)</p> <p>Lower layer (>20cm; min 350kg cement)</p> <p>Sublayer ~15cm (typically lower grade concrete)</p> <p>Gravel layer 20-40cm (e.g. recycled concrete)</p> <p>Main concrete</p>																
	Dicke der Frostschutzschicht																	
	Dicke der Frostschutzschicht	-	29 ³⁾ 39 49	-	30 ²⁾ 40 50	-	31 ²⁾ 41 51	-	-	32 ²⁾ 42	-	25 ³⁾ 35 45						

Typical design of today's German highways made of concrete



Asphalt vs. Concrete

	Asphalt	Concrete
Installation Cost (incl. Manufacturing)	Depending on oil Price, but generally lower than concrete	Higher than asphalt
Maintenance Cost	Typically higher due to lower mechan. performance	Ideally less maintenance; longer service life
Construction Speed	Depending (hardens within hours)	Depending (hardens within hours/days)
Durability	Lower especially at extreme temperatures	Ideally significant higher than asphalt
Safety	Darker	Advantages due to bright color at night; longer better grip than A.
Recyclability	Common practice	Doable but more difficult than A.
GWP		Concrete w. slight advantage

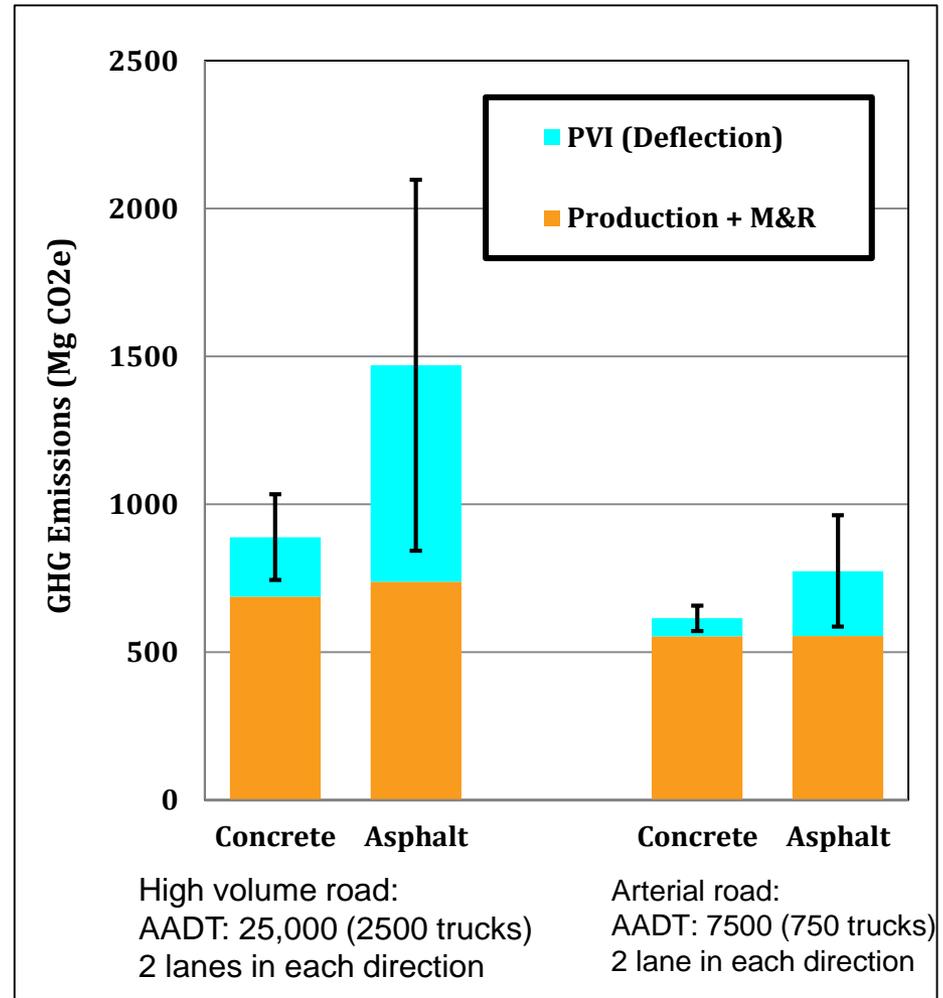
Concrete roads save fuel??



Pavement Deflection (Not to Scale)



Pavement Roughness (Not to Scale)



Source: MITCShub 2016
<https://www.nrmca.org>

Ideally Concrete roads should have lower total cost impact over a longer Service life?

Unfortunately the image of concrete roads suffered, due to durability issues in Germany

27. Juli 2014, 15:47 Uhr Kaputte Autobahnen

Wenn der Betonkrebs ausbricht



Dahme-Fläming
Betonkrebs zerfrisst südlichen Berliner Ring
Ein T...
oder 80 Kilometer pro Stunde auf vielen Abschnitten des südlichen Berliner Rings nervt Berufskraftfahrer
maßnahmen. Sie sollten nicht damit rechnen, dass sie bald wieder schnell fahren dürfen: Der Betonkrebs zerfrisst
heraus. Bis repariert werden kann, wird es noch dauern.

Drucken Text

WISSENSCHAFT SAHARA-HITZE
Tödliches Blow-up auf deutschen Autobahnen
Von Harald Czycholl | Veröffentlicht am 20.06.2013 | Lesedauer: 5 Minuten



An der Anschlussstelle Abersberg war die Autobahn A93 in der Hitze regelrecht aufgeplatzt
Quelle: dpa



NÄCHSTER ARTIKEL
Umbaupläne für die B96

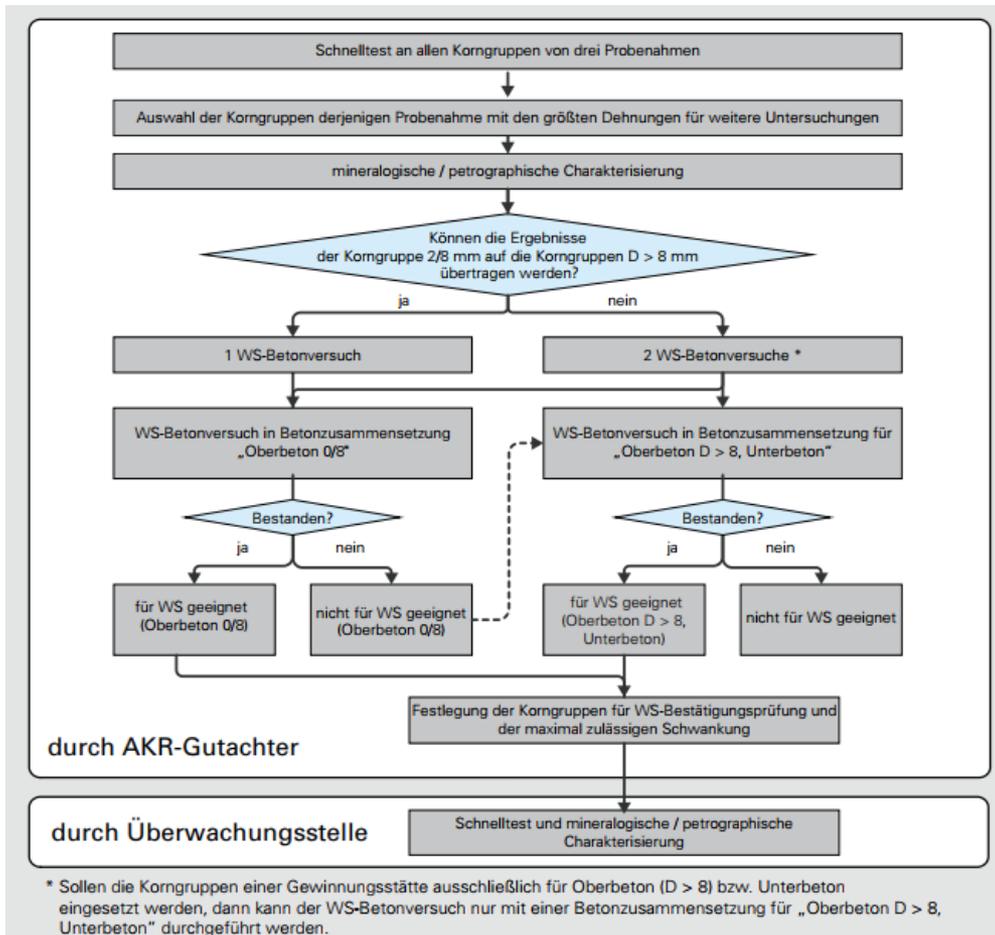
Die Alkali-Kieselsäure-Reaktion verursacht auch auf vergleichsweise neuen Autobahnen wie dem Berliner Ring erhebliche Schäden.

Quelle: Aireye



auf Autobahnen
(Foto: dpa)

Very strict testing scheme in place to avoid deleterious durability problems in the future



Authorities are currently not clear which material concept is the preferred choice for the future!

Challenges to be tackled

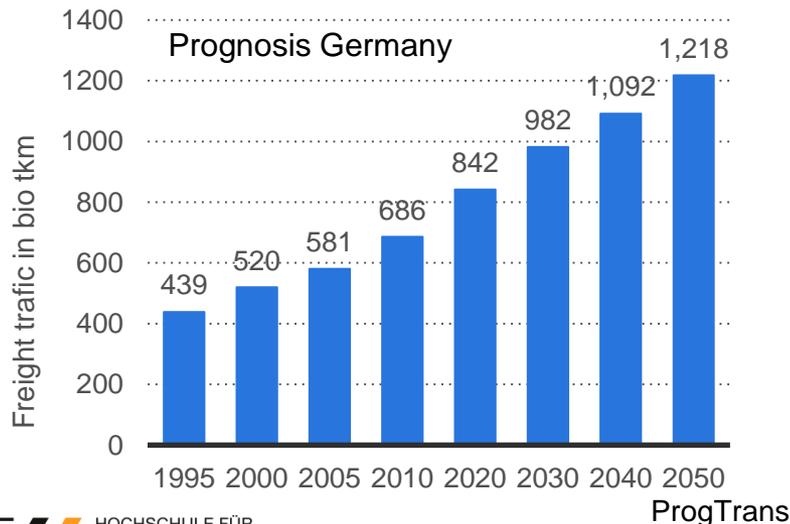
Environmental restrictions



Increasing frequency of extreme temperature conditions + global warming



Increased freight traffic especially on highways expected



Aging Infrastructure

