SPENS
Sustainable Pavements for European New Member States

General Technical Description

Crushed Concrete in Road Constructions

Translated and summarised from Swedish Road Administration's "Allmän teknisk beskrivning – Krossad betong i vägkonstruktioner" Publ 2004:11.

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Foreword

This is a summarised translation of the Swedish technical description for crushed concrete in road constructions. In Swedish it is named: “Allmän teknisk beskrivning – Krossad betong i vägkonstruktioner” Publ 2004:11.

In its original language it can be found in the following internet address:
http://www.vv.se/filer/publikationer/ATB_Krossad_betong_2004-11.pdf

The chapters in this document follow the numbers of the chapters in the Swedish original document.

19 february 2008
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Contents

1 General

1.1 Description of the material

The raw material considered is derived from two main sources; recycled from concrete production plants, i.e. “residue concrete” or crushed concrete from building demolition, i.e. “demolition concrete”.

2 Projecting requirements

2.1 Environmental impact

2.1.1 Residue Concrete

Crushed concrete recycled from concrete production plants should be considered to be free of substances that have negative environmental impact.

2.1.2 Demolition Concrete

Demolition concrete should not be to any environmental hazard. It should not contain substances like PAH, PCB, CFC, asbestos, mercury or any other of the buyer specified substances.

2.2 Quality class

A classification of the crushed concrete according to material properties should be performed according to chapter 2.3.

2.2.1 Concrete quality

The quality of the concrete should be determined either by compressive strength or by micro-Deval.

Methods to be used:

EN 12390-3: Testing hardened concrete - Part 3: Compressive strength of test specimens

EN 1097-1: Tests for mechanical and physical properties of aggregates - Part 1: Determination of the resistance to wear (micro-Deval)

2.2.2 Purity

Purity means absence of other materials than paste of cement and aggregates of crushed rock or natural gravel.

2.3 Classification

A concrete material with either high compressive strength or low micro-Deval value gives a crushed concrete of Quality class 1.

Table 2.3-1 Classification of crushed concrete

Quality class	Concrete quality One of these requirements should be fulfilled				Purity			
Crushed concrete	Documented records Strength class C-value	K-value	Compressive strength, drill cores	Micro-Deval	Amount of concrete minimum	"Brick", density >1.6 maximum	"Light weight concrete", density <1.6 maximum	Others maximum
No	MPa	MPa	MPa		Weight %	Weight %	Weight %	Weight %
1	≥ C30/37	≥ K40	≥ 30	≤ 25	100	0	0	0
2	≥ C20/25	≥ K25	≥ 20	≤ 35	95	5	1	0.5
3	≥ C12/15	≥ K12	≥ 10	≤ 50	80	20	5	2
4	-	-	-	-	50	50	50	10

C-value: according to EN 206-1
"Brick" = mineral material with particle density > 1.6 Mg/m³
"Light weight concrete" = mineral material with particle density < 1.6 Mg/m³
Others = e.g. wood, plastic, paper, bitumen etc.

2.4 Road base material for pedestrian and bicycle lanes

Material for base layer for pedestrian and bicycle lanes should fulfil requirements for quality class 1 or 2.

The micro-Deval value should not exceed 25. *If the traffic passes of heavy vehicles, during construction, are few the maximum of micro-Deval value of 35 can be accepted.*

Particle size distribution should be determined according to EN 933-1 (sieving). The requirements are described in table 2.4-1

Table 2.4-1 Requirements for particle size distribution for base layer of crushed concrete

Sieve, mm	0.063	0.25	1	4	16	31.5	45	63
Upper maximum	7	14	28	50	90			
Normal maximum	6	12	25	45	79	98		
Normal minimum	3	6	13	25	56	75	90	
Lower mimimum	2	4	10	20	46	64	80	98

2.5 Sub base material

Material for sub base layer should fulfil requirements for quality class 1 or 2.

The micro-Deval value should not exceed 25. *If the traffic passes of heavy vehicles, during construction, are few the maximum of micro-Deval value of 35 can be accepted.*

Particle size distribution should be determined according to EN 933-1 (sieving). The requirements are described in table 2.4-1

Table 2.5-1 Requirements for particle size distribution for sub base layer of crushed concrete

Sieve, mm	0.063	0.25	1	4	16	31.5	45	63	90	125
Upper maximum	7	14	28	50	90					
Normal maximum	6	12	25	45	79	98				
Normal minimum	-	-	-	10	26	42	50			
Lower mimimum	-	-	-	2	14	28	35	43	90	98

2.6 Capping layer material

Material for the capping layer should fulfil requirements for quality class 3.

Particle size distribution should be determined according EN 933-1 (sieving). The requirements for the amount of fines (0.063/tot) should not exceed 11 % (by weight).

2.7 Material for substructure and other fillings

Material for unbound substructures and other fillings should fulfil requirements for quality class 4.

2.8 Pavement design conditions

For pavement design input from chapter 2.8.1 and 2.8.2 should be used. If other properties are used they should be declared and approved by the "buyer".

2.8.1 Bearing capacity

The modulus of elasticity from table 2.8-1 should be used for each quality class. The modulus of elasticity is not dependent of the time of the year.

Table 2.8-1 Modulus of elasticity for unbound materials

Quality class	Modulus of elasticity MPa
1-2	450
3	250
4	150

If a higher modulus of elasticity should be used the increase of strength must be shown.

2.8.2 Frost heave

Crushed concrete of quality class 1/3 is normally not susceptible for frost heave and considered to belong in frost susceptibility class 1, quality class 4 is slightly susceptible for frost heave and belongs to frost susceptibility class 2.

For recommended parameters for pavement design with respect to frost heave, see table 2.8-2.

Table 2.8-2 Recommended parameters for pavement design with respect to frost heave

Quality class	Water content	Dry density	Poro-sity	Water saturation ratio	Frost susceptibility class	Frost heave velocity	Heat conductivity not frozen	Heat conduct. frozen
1-2	6 %	1.8 t/m³	0.32	0.34	1	0	1.1 W/m°K	1.2
3	10 %	1.6 t/m³	0.40	0.40	1	0	1.0 W/m°K	1.1
4	12 %	1.5 t/m³	0.43	0.42	2	0	0.9 W/m°K	1.0

2.9 Constructive design

- Crushed concrete should be avoided in base layer of mainly two reasons. The concrete can be susceptible for salt intrusion (from de-icing in wintertime) and it can also be affected by high stress which can increase crushing of the layer.

Crushed concrete should be surfaced by a tight bound layer to resist intrusion of salt solutions.

- To be able to use the growth of strength of the material the thickness of the layer ought to be greater than 150 mm.

3 Performance

Handling of crushed concrete does not need to vary from the handling of regular materials such as gravel and crushed rock. Methods for compaction of unbound layers are described in following chapters.

3.1 Base layer

Base layer should be compacted with vibrating or oscillating single drum roller according to table 3.1-1. The speed of the roller should be constant within the interval 2.5/4 km/h. The linear load should not exceed 45 kN/m.

Table 3.1-1 Maximum of layer thickness (m) after compaction of road base material.

Roller	Water content >8%*	Water content >8%*	Water content <8% or not determined
linear load	6 passes	8 passes	6 passes
> 15 kN/m	0.08	0.15	-
> 25 kN/m	0.20	0.25	0.10
> 35 kN/m	0.25	0.30	0.12

* If optimum water content is known, replace 8 % with optimum water content -2 %.

3.2 Sub base layer and capping layer

Base layer should be compacted with vibrating or oscillating single drum roller according to table 3.2-1. The speed of the roller should be constant within the interval 2.5/4 km/h. The linear load should not exceed 45 kN/m.

Table 3.2-1 Maximum of layer thickness (m) after compaction of sub base material and capping layer.

Roller	Water content >7%*	Water content >7%*	Water content <7% or not determined
linear load	6 passes	8 passes	6 passes
> 15 kN/m	0.25	0.30	-
> 25 kN/m	0.40	0.45	-
> 35 kN/m	0.50	0.55	0.25

* If optimum water content is known, replace 7 % with optimum water content -2 %.

3.3 Substructure

Specifications are described in “ATB VÄG” (ATB ROAD) chapter E5.4.1

4 Statements in construction plans

In the construction plans, except for the normal statements, also the following statements should be included:

- Quality class of the materials
- Reference to this document: “Crushed Concrete in Road Constructions”.

5 Quality requirements and control

In this chapter only the sub headlines will be shown.

This chapter is about certified materials, declared properties, environmental impact, non certified materials, reception control and verification of the performance.

5.1 General

5.2 Declared properties

5.3 Reception control

5.4 Verification of the performance

6 References

See corresponding chapter in the Swedish original document.

The references are: Swedish laws, European standards (EN 206-1, EN 933-1 and EN 12390-3), data bases and some significant reports in Swedish (except the only report in English: Arm M. 2003. Mechanical Properties of residues as unbound road materials. Doctoral thesis) etc.

Annex 1 Environmental hazard

-When estimating environmental hazard there are three significant parameters:

- *Total content: The total amount of different substances in the material.*
- *Leachable quantity: how much of the total content will leach in reasonable period of time*
- *Leaching velocity: how fast the leach will occur at different water current.*

The most interesting environmentally hazardous substances are heavy metals, salt and organic substances (e.g. PCB).

Annex 2 Purity

In this annex it is in more detail described how to perform the Purity analysis in Table 2.3-1 Classification of crushed concrete.

The analyse fraction is 8/tot.