

Laboratory / Sami Similä

16.03.2015

USE OF CRUSHED ROOFING FELT IN "AC 16 SURF" –ASPHALT PAVEMENT

Order: 10 February 2015 Kati Tuominen/TarPaper Finland Oy
Laboratory work number: 23-2015

1. Objective of the study:

The objective of the study was to examine the usability of crushed roofing felt to partially replace road bitumen and the separately added limestone filler in AC 16 wearing course asphalt. The idea is to add the crushed felt in relatively small, cold doses (2–4 percent by weight of the overall mass) using an additive scale at the asphalt mixing plant. In this study, the quantity of crushed felt was estimated at 3.0 percent by weight of the total mass. No other concentrations were examined. The details of crushed felt production were anticipated and, to a certain extent, modified. For more detailed information on the differences, please see section 3.

2. The materials chosen for comparison:

AC 16 reference mixture (Appendix 1), gabbro stone + limestone filler, aggregate A_N7, binder B 70/100 (penetration 74). The used AC 16 asphalt recipe has been ascertained to function in practice.

AC 16 crushed felt mixture (Appendix 2), same aggregate frame as in the reference, share of crushed felt 3.0 percent by weight of the total mass, added binder grade 160/220 (penetration 176), resulting in the same overall binder penetration of 70/100 (penetration 85).

AC 16 crushed felt mixture contains Danish crushed felt (Appendix 3), granularity 0/4 mm, soluble binder concentration 52.1% and binder penetration 15 [1/10 mm + 25°C].

3. Similarities and differences with reference mass in the production of crushed felt mass:

The aggregate frame and granularity of the reference mixture and the crushed felt mixture were exactly the same with the exception of the aggregate contained in the crushed felt, approx. 1.5 percent by weight of the aggregate content, some of which was also replaced with limestone filler and crushed rock.

The overall binder content of the crushed felt mixture was increased by 0.3 percentage points in comparison with the reference mixture optimum.

The mixing and compression temperature of the aggregate in the crushed felt mass was increased by +10°C (+175°C) compared with the reference mixture (+165°C).

The crushed roofing felt was added when it was room temperature and was mixed in with the aggregate 45 seconds before the additional binder was added, with a total mixing period (both mixtures) of 3 minutes, which is normal mixing time in laboratory.

The other production specifications were the same for both mixtures, including compression work, sample production, etc.

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4. Void characteristics

The chosen recipes was subjected to a void characteristics comparison by using a gyratory compactor in accordance with the standard SFS-EN 12697-31. The void characteristics of the samples produced are listed in the table below.

property/method	result reference mixture	result crushed felt mixture	guideline value in accordance with the Finnish norms
Voids filled with binder VFB [% by volume] SFS-EN 12697-8	87	88	75–93
Air voids content V [% by volume] SFS-EN 12697-8	1.9	1.9	1–4
Voids in the mineral aggregate VMA [% by volume] SFS-EN 12697-8	15	15	13–17
Theoretical mixture max.density [kg/m ³] SFS-EN 12697-5	2,684	2,669	-
Bulk density [kg/m ³] SFS-EN 12697-6	2,633	2,619	-

Within the scope of the chosen consistency, both pavements comply with the guideline values set in Asfalttinormit 2011 (Finnish asphalt norms published in 2011). Both mixtures condensed like normal asphalt concrete mixture and the binder coverage of both mixtures after mixing was a perfect 100%.

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5. Functional properties

Results concerning the functional properties of water sensitivity, resistance to permanent deformation and resistance to abrasion by studded tyres are provided below.

property / method	result, reference mixture	result, crushed felt mixture	Asphalt norm class/requirement
Indirect tensile strength of the dry group at +10°C, SFS-EN 12697-23	2009 kPa	1861 kPa	-
Indirect tensile strength of the wet group at +10°C, SFS-EN 12697-23	2007 kPa	1774 kPa	-
Binder coverage at the exposed aggregate	100 %	99 %	-
Water sensitivity, indirect tensile strength ratio ITSR, SFS-EN 12697-12 A	100 %	95 %	≥ 80%
Resistance to permanent deformation, dynamic, creep test, SFS-EN 12697-25 A	1.92 %	1.93 %	$\epsilon_{n2,0}$
Resistance to abrasion by studded tyres, Prall test, SFS-EN 12697-16 A	27 ml	25 ml	Abr _{A28}

Both asphalt pavements comply with the water sensitivity requirements set in Finnish Asphalt Norms (Asfalttinormit 2011 Korjauslehti 1.1.2013). Both asphalt pavements are in class I regarding resistance to deformation and in class II regarding resistance to abrasion by studded tyres.

In the resistance to abrasion test, the crushed felt pavement formed a slight rubber film on the cleavage surface, similarly to rubber bitumen, which decreases abrasion in the Prall test. If necessary, a more accurate comparison concerning resistance to abrasion can be performed using an SRK device (SFS-EN 12697-16 B). However, it can be assumed that crushed felt does not in any way affect the resistance of abrasion by studded tyres within the limits of measurement accuracy if it is used in such small doses.

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6. Conclusions

In the void characteristics comparison, both mixtures condensed like normal AC mixture and the void characteristics of both mixtures was almost exactly the same. However, when talking about void characteristics comparison, it must be observed that the total binder concentration of the crushed felt recipe was 0.3 percent units higher than that of the reference.

Based on deformation and abrasion tests, both mixtures complied with the same requirement classes with no differences in practice. Regarding indirect tensile strength test, the maximum load showed a level difference which is likely due to difference in binder content and binder penetration.

The only significant difference was the water sensitivity. The comparison results showed that the water sensitivity of the crushed felt mixture was 5 percent units lower than that of the reference mixture. However, the requirement set in the norms concerning asphalt ($\geq 80\%$) was exceeded by a large margin. Moreover, the cleavage surfaces of the crushed felt coating showed some (sand) grains clean of bitumen, which were probably from the crushed felt.

The water sensitivity test provides indicative information of the long-term durability of the coating, but does not really indicate the effects of, for example, salting and weather variation on pavements durability. For this reason, the research should be continued with field testing and by using mixtures with poorer bonding properties. The aggregate frame used in this study had good bonding properties. The impact of crushed felt was not examined using aggregate with poorer bonding properties.

Tuusula, 16 March 2015



Sami Similä

APPENDICES Granularity comparison AC 16 reference, Appendix 1
 Granularity comparison AC 16 crushed felt, Appendix 2
 Binder content and granularity of Danish crushed felt, Appendix 3

Date:
26.2.2015
Name:
Sami Similä

ASPHALT MIX DESIGN

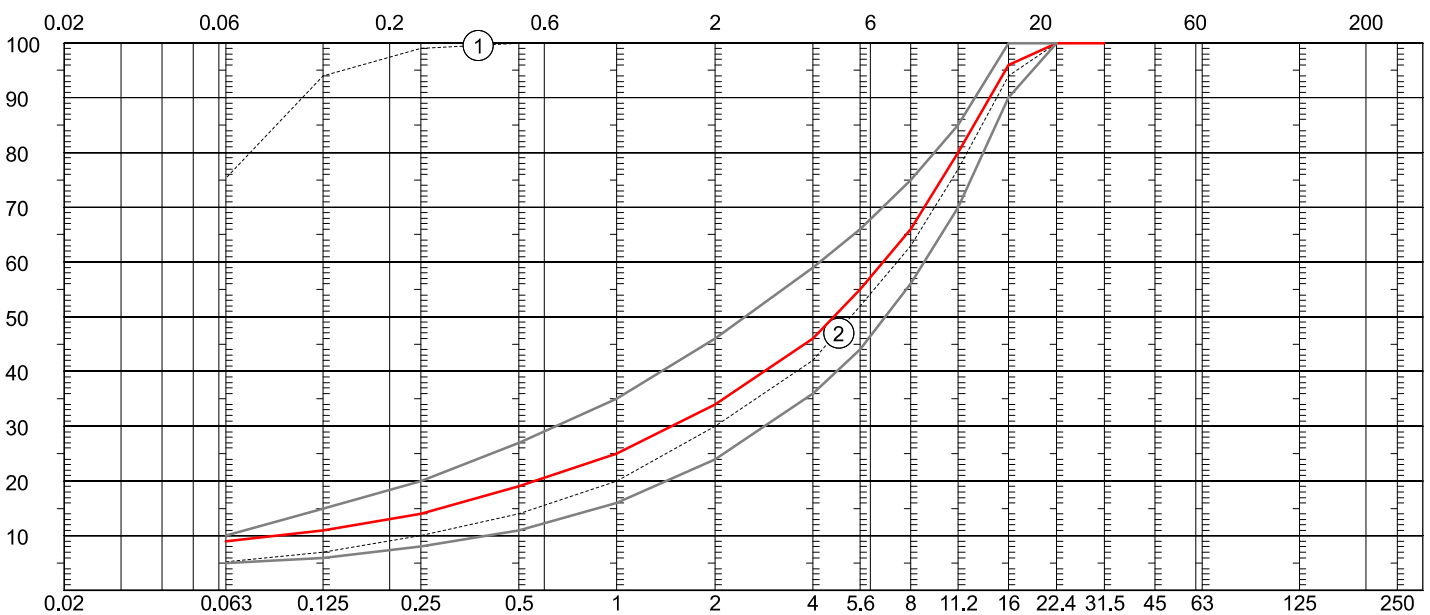
Pavement type: AC 16 surf
 Bitumen content [%]: 5,0
 Aggregate
 Material 1 Limestone filler
 Material 2 Crushed rock 0/16

Mixture: 2013 AB 16
 Bitumen type: B 70/100
 Mix -%
 3.0 %
 97.0 %

Sieve [mm]	Result Pass.-%	Allowed difference	
		Bulk	Road(B)
31.5	100,0		
22.4	100,0	-2 - +0	
16	96,0	-8 - +5	
11.2	80,0		
8	66,0	± 7	± 7
5.6	55,0		
4	46,0		
2	34,0	± 6	± 6
1	25,0		
0.5	19,0	± 4	± 5
0.25	14,0		
0.125	11,0		
0.063	9,0	± 2	± 3

Comments:

Penetration of the binder 74 [1/10 mm +25 C]



Date:
5.3.2015
Name:
Sami Similä

ASPHALT MIX DESIGN

Pavement type: AC 16 with crushed roofind felt
 Bitument content [%] : 5,3
 Aggregate
 Material 1 Limestone filler
 Material 2 Crushed rock 0/16
 Materia 3 Aggregate from roofing felt

Mixture: 2013 AB 16
 Bitumen type: B 160/220
 Mix -%
 2.0 %
 96.5 %
 1.5 %

Sieve [mm]	Result Pass.-%	Allowed difference	
		Bulk	Road(B)
31.5	100,0		
22.4	100,0	-2 - +0	
16	96,0	-8 - +5	
11.2	80,0		
8	66,0	± 7	± 7
5.6	55,0		
4	46,0		
2	34,0	± 6	± 6
1	25,0		
0.5	19,0	± 4	± 5
0.25	14,0		
0.125	11,0		
0.063	9,0	± 2	± 3

Additive: crushed roofind felt 3,0 per cent by mass

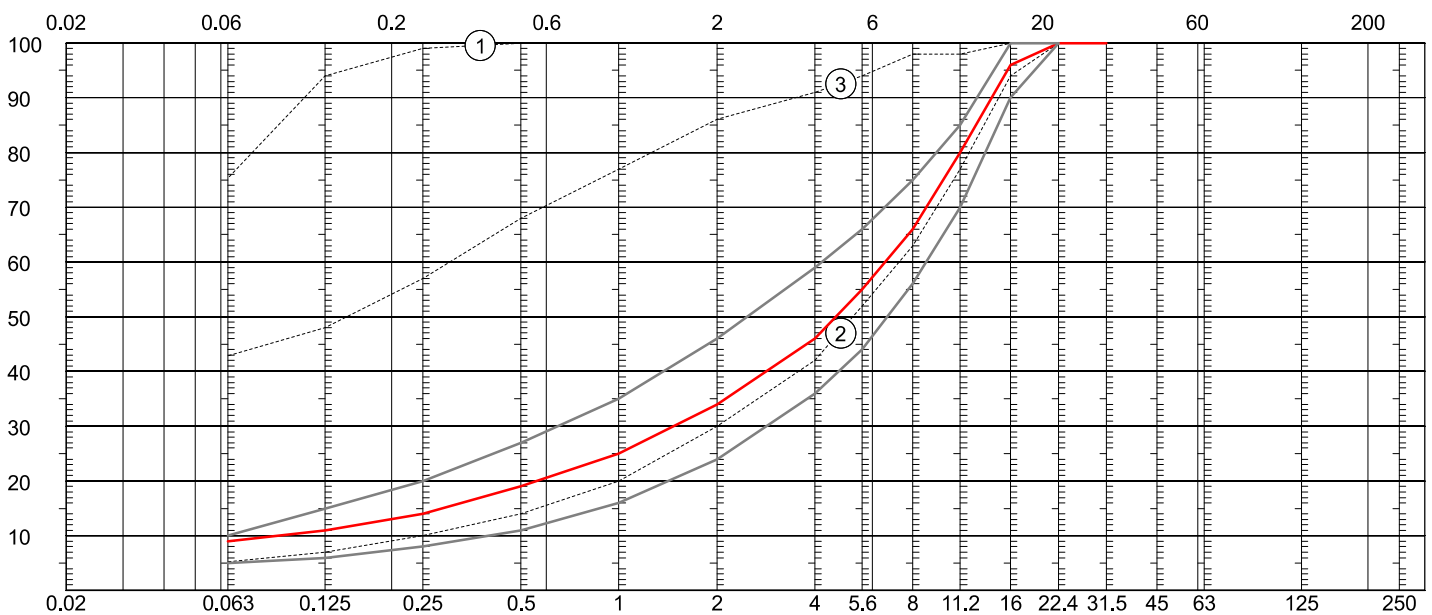
Kommentti:

Penetration of binder mixture 85 [1/10 mm +25 C]

Added new bitumen 3,85 % calculated from "clean" mixture, 3,74 % calculated from whole mixture

Savings in bitumen consumption 13 kg/tn

Savings in limestone filler consumption 10 kg/tn



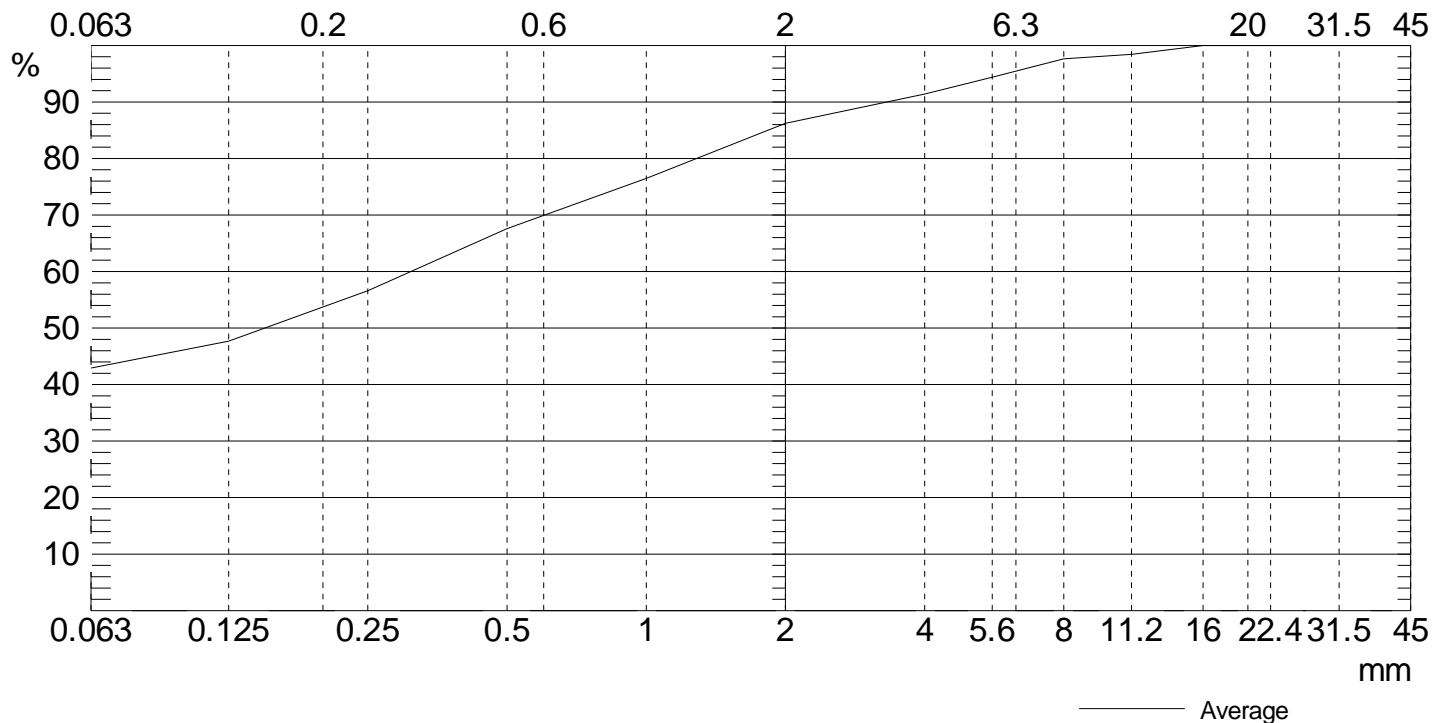
AVERAGE OF SAMPLES

Contractor		Material	Crushed felt
Customer	TarPaper Recycling Oy	Recipe	
Location		Project	
Add. information	Danish crushed roofing felt		

Number of samples	3
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Binder content	52.13
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Sieve mm	Guideline value		Passing %
	min	max	
8			98
5.6			94
4			91
2			86
1			77
0.5			68
0.25			57
0.125			48
0.063			42,9



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Date 11.02.2015

Signature

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