Study of Recycled Concrete in Asphalt Mixes

This research project consisted of 301 mixes; virgin, 10% crushed concrete & 20% crushed concrete. The mix design was set @ 4.7 AC using PG 64-22. The percent passing the # 4 sieve was 45%.

Mixes Used

The virgin mix: #57 LS (40%) Shelly Co. @ Frank Rd. Columbus, Ohio.
#8 LS (20%) " ".
NSD (40%) " "

The 10% Crushed Concrete: #57 LS (40%) Shelly Co. @ Frank Rd. Columbus, Ohio.
#8 LS (20%) " "
NSD (30%) " "
Crushed Concrete (10%) Martin Marietta @ Fairfield, Oh.
(used only crushed concrete passing the # 4 sieve.)

The 20% Crushed Concrete: #57 LS (40%) Shelly Co. @ Frank Rd. Columbus, Ohio.
#8 LS (20%) " "
NSD (20%) " "
Crushed Concrete (20%) Martin Marietta @ Fairfield, Oh.
(used only crushed concrete passing the # 4 sieve.)

Procedural Comments

We used only the material passing the # 4 sieve because we were trying to get the most consistent gradation we could to match the virgin design. We also felt that if we used larger material from the crushed concrete(1" , ½" etc.) it would break down during plant production and give us a much finer mix then the JMF.

The compaction of 6% to 8% voids was achieved much easier with the 10% crushed concrete & the 20% crushed concrete. (35 blows) The virgin required (70 blows). Compacting all mixes using 75 blows showed results as follows:

Mix type	Stability	Flow	Air Voids
Virgin	4780	0.96	6.6%
	3715	1.00	6.6%
	3975	0.88	6.3%
			Ave= **6.5%**

Crushed Concrete (10%)	3530	1.09	5.8%	
	3805	0.99	6.1%	
	4480	1.04	5.5%	
				Ave= **5.8%**
Crushed Concrete (20%)	4715	0.99	4.3%	
	4440	0.98	4.8%	
	4090	0.96	4.6%	
				Ave= **4.6%**

Passing the 200 sieve is as follows:

301 Virgin	1.8%
301 Using 10% Crushed Concrete	2.1%
301 Using 20% Crushed Concrete	2.7%

TSR Values

Mix type	**TSR Value**	**TSR Ave.**
301 virgin	103.6*	
	102.4	
	102.8	**102.9**
301 10% Crushed Concrete	104.8	
	105.6	
	105.2	**105.2**
301 20% Crushed Concrete	106.8	
	105.6	
	105.2	**105.9**

* These numbers indicate a possible problem in testing. For good mixes they should be in the 80-95% range. However, visual exam under a microscope shows no evidence of stripping.

Conclusions:

There is more dust in the crushed concrete than in the natural sand and the material itself is finer then the natural sand. (Actual P 200 values would be higher had the mix had plus No. 4 material so the testing was done giving the concrete the best chance of working.) Compaction breaks down the concrete easily creating more dust and lower voids. High dust makes for a stiff binder removing the benefit of a flexible binder for durability. This results in more temperature cracking and mix raveling.

In mixes designed by volumetric properties (301 typically is not) the higher dust will yield a lower asphalt binder content. This is very undesirable in surface and intermediate course and lean mixes such as 302.

The mixes all showed high TSR values and no apparent stripping. Crushed concrete is not overly dirty in mixing so binder adhesion is not an issue.

The samples obtained were of concrete derived from a variety of sources. They had little foreign material but had high variability in quality and type of the concrete. Some of the concrete was quite crumbly and disintegrated readily. It was unsuitable for asphalt and was one reason that only minus No 4 material was used in the experiment.