

Score Crack and Crack Angle Study



Purpose:

Client has expressed a concern over recycle content in their furnish exacerbating a score cracking problem. Samples were submitted to IPST for fold crack testing using the AF&PA protocol using a Honshu score crack tester. In addition the crack angle of the sample set was measured using the IPST developed method and equipment. The details of the procedures are available as separate pdf files upon request.

Method:

Samples were conditioned for 48 hours at 14% RH humidity at 23 degrees C using a large high volume fan and a conditioning room set at 14%RH as shown in **Fig 1**. The caliper of the samples were measured to range from 0.17 to 0.23 mm to set the Honshu nip gap.



Figure 1. Conditioning the sample set in dry conditioning room PTB 337.

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Samples were enclosed in sealed plastic bags and taken to the Honshu tester in the IEC 1305 dry room which had a humidity of 21% RH at the time of testing. The Honshu tester was fitted with flat faced rolls for folding of the samples at a prescribed nip setting of 0.2 mm (7 mils). Samples were retrieved one at a time, folded loosely by hand (**Fig. 2**) and sent through the Honshu nip running at 400 fpm.



Figure 2. Typical loosely folded sample being sent through the Honshu tester nip.

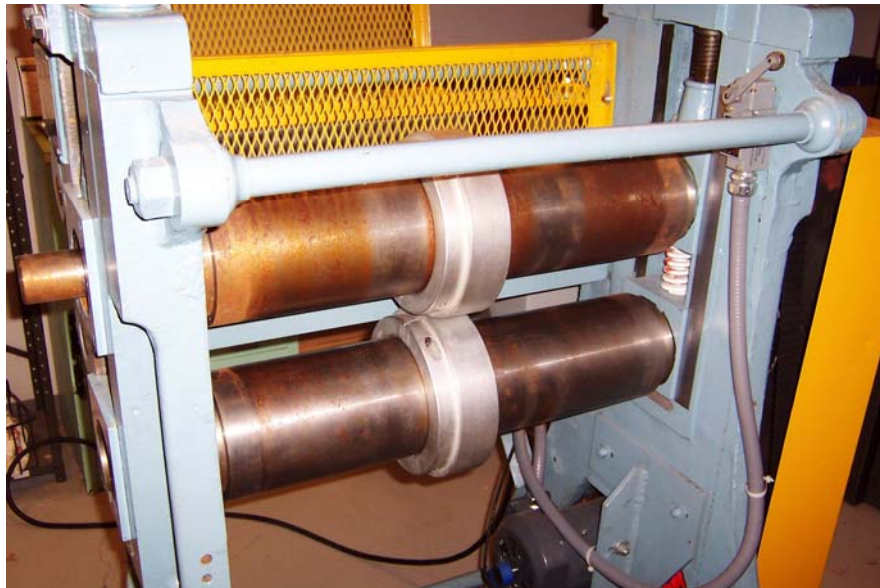


Figure 3. Sample exiting side of the Honshu tester set with the nip set for fold cracking

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Samples exiting the Honshu tester are collected and the fold examined at low magnification for visible cracking along the fold line. Lengths of the cracks along the fold line are added and divided by the length of the fold such that the cracking is expressed as a percentage of cracked length.

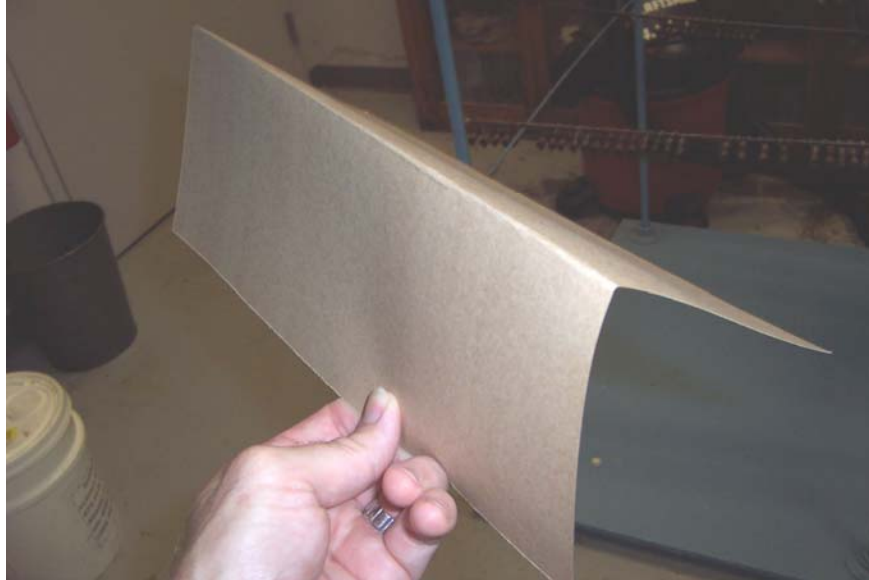


Figure 4. Sample after exiting the Honshu tester nip. The resulting sharp fold is examined for visual signs of cracking.

Generally, the amount of cracking observed is proportional to the caliper of the specimen since cracking is largely dictated by the amount of strain surface that surface fibers are subjected.

The sample set was divided and painted flat black for examination of crack angle. In this apparatus, the samples are clamped and progressively folded to the point where fibers underneath the blackened surface show through along the fold line as may be seen in **Fig.5** below.

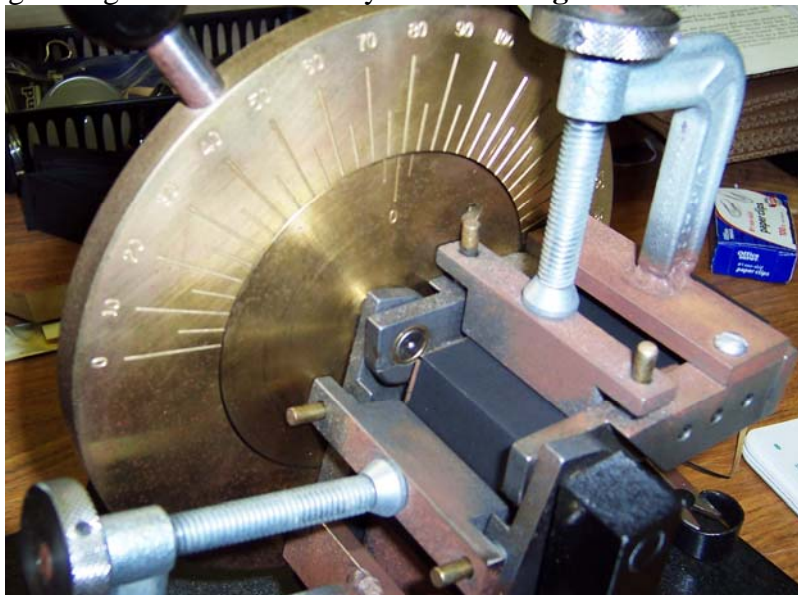


Figure 5. Photograph of the IPST crack angle tester, the sample is progressively folded to larger angles until the fibers underneath show through the blackened top surface.

Data:

Sample ID		% AVG	STDEV
Sample 10	28# 5205 Old	1.13	1.90
Sample 10	26# 5204 Old		
Sample 10	36# 5205 Old		
Sample 10	28# 5205 New	1.8	1.00
Sample 10	26# 5204 New		
Sample 10	36# 5205 New		
Sample 7	42# 5204 Old	0.8	1.01
Sample7	36# 5205 Old		
Sample 7	26# 5204 Old		
Sample 7	28# 5205 Old		
Sample 7	42# 5204 New		
Sample7	36# 5205 New		
Sample 7	26# 5204 New		
Sample 7	28# 5205 new		

Figure 6. Fold Cracking results. Very little fold cracking was observed approximately, 1- 2 % of the length examined (10 inches) showed signs of cracking in only 3 of the samples tested. Each sample has 6 repeat specimens. This suggests that to measure the effects of recycling on folding strength a more appropriate method may be to use the MIT fold testing method (Tappi method T 511) and report the folding strength as the base ten logarithm of the number of folding cycles to break. All samples left blank had no measurable cracking.

Sample ID		AVG	STDEV	CONF INT
Sample 10	28# 5205 Old	80.2	4.263541	2.642521
Sample 10	26# 5204 Old	89.6	8.248906	5.112631
Sample 10	36# 5205 Old	82.3	3.973523	2.46277
Sample 10	28# 5205 New			#NUM!
Sample 10	26# 5204 New			#NUM!
Sample 10	36# 5205 New	85.3	3.653005	2.264114
Sample 7	42# 5204 Old			#NUM!
Sample7	36# 5205 Old			#NUM!
Sample 7	26# 5204 Old			#NUM!
Sample 7	28# 5205 Old			#NUM!
Sample 7	42# 5204 New	83.7	5.056349	3.1339
Sample7	36# 5205 New			#NUM!
Sample 7	26# 5204 New	86.9	6.384878	3.957316
Sample 7	28# 5205 new	84.1	5.486347	3.40041

Figure 7. Data as currently available for crack angle. A larger crack angle indicates a higher resiliency against cracking. Although there may appear to be differences overlapping error bars when plotting the 95% confidence intervals indicates that the differences are statistically insignificant.

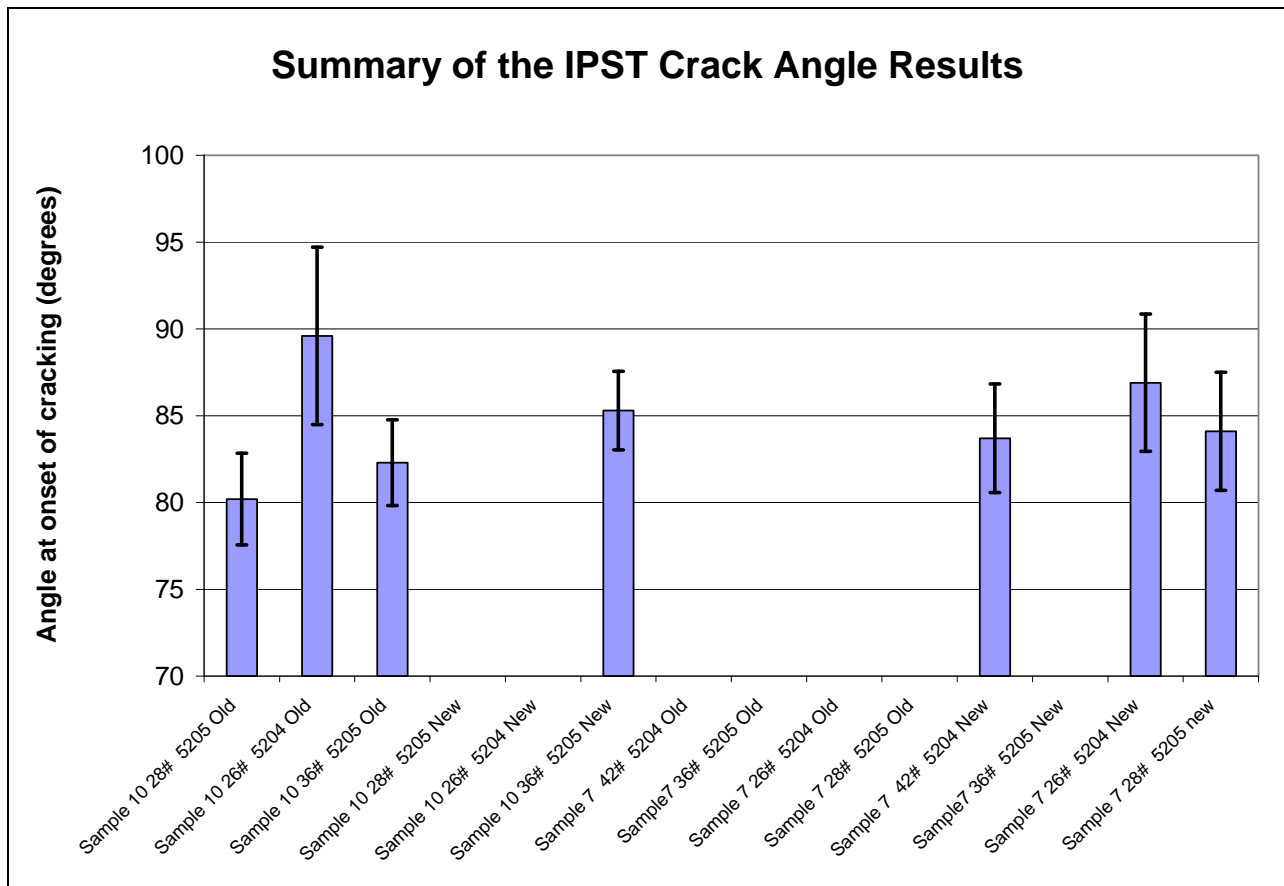


Figure 8. Crack angle summary, although “Sample 10 26# 5204 Old” appears to have the highest crack angle it is only marginally better and largely insignificantly so compared to the rest of the measured sample set. Therefore, it may be concluded at this time that there are no significant measurable furnish effects witnessed by these tests.

Report prepared by Roman Popil, August 2008.

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