Effect of Fines on the Strength Properties of Bamboo Paper

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Introductin

Several studies have been made to investigate the role of fines in the strength properties of pulps. Marton and Alexander[1] studied the difference in the strength of pulp fractions from softwoods. Simmonds and Hyttinen[2] investigated the effects of fines on the strength properties of hardwood pulps. Haywood[3] did similar studies on both hardwood and softwood pulps. In all these cases fineswere found to affect adversely the strength of the pulp sheets.

Cruz-Gonzalez and Escolano[4] conducted experiments on pulp from giant bamboo (Gigantochloa aspera kurz) and compared the differences in strength properties of the fractions both in the beaten and unbeaten states. The burst and tensile strengths of the pulp fractions increased while the tearing strength decreased from the coarser to the finer fractions. Unbeaten, the whole pulp was higher in strength, but when beaten the longest fiber fraction had the highest strength. The same trend was shown by Krishnagopalan *et al*[5], who experimented on the effect of refining on the strength properties of bamboo (Bamboosa arundanacea). They found in the unrefined condition, paper made from whole pulp, was generally superior in strength properties to paper made from the sized fractions. On refining, however, the paper from the longest fraction developed the highest strength. 30 to 35% of the whole pulp was fines passing through 100 mesh screen. The fines which in this case were mainly parenchyma cells contributed no strength to the paper.

In the present study, an attempt was made to evaluate directly the exact extent of the effect of fines on the strength properties by comparing papers made with different proportions of fines in them.

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Experimental Procedure

Fiber Classification

25 grams of bamboo pulp were classified in Bauer-McNett classifier for 15 minutes using 14, 28 and 100 mesh screens. The fines passing through 100 mesh screen were collected. Only three screens were used in the classification process instead of four (14, 28, 48 and 100 mesh) in the previous study by Krishnagopalan *et al.*[5] In the present study, interest was in the fines passing through the 100 mesh screen to be mixed with the rest of the pulp in different proportions. The longer fiber fractions collected (in 14, 28 and 100 mesh screens) were combined and the process was repeated until sufficient pulp was collected for runs in a Mead laboratory refiner.

Refining

The combined long fraction pulp was refined in the Mead laboraory refiner to two different freeness levels, 520 and 390 ml CSF. Initially, the combined fractions were assumed to contain negligible fines. The refined pulp was combined with the fines passing 100 mesh so as to contain 0, 10, 15, 20 and 30% added fines and handsheets were made. Handsheets were also made from the whole pulp refined without classification to the same two freeness levels, and from the whole pulp at 520 ml CSF so as to contain 35.5 and 40% fines.

The preparation of handsheets, couching, pressing and drying procedures were conducted in accordance with TAPPI standards. The handsheets were conditioned in a constant humidity, constant temperature room before testing. The tests were basis weight, bursting strength, tensile breaking length, fold and tearing strength also according to TAPPI standards.

Results and Discussion

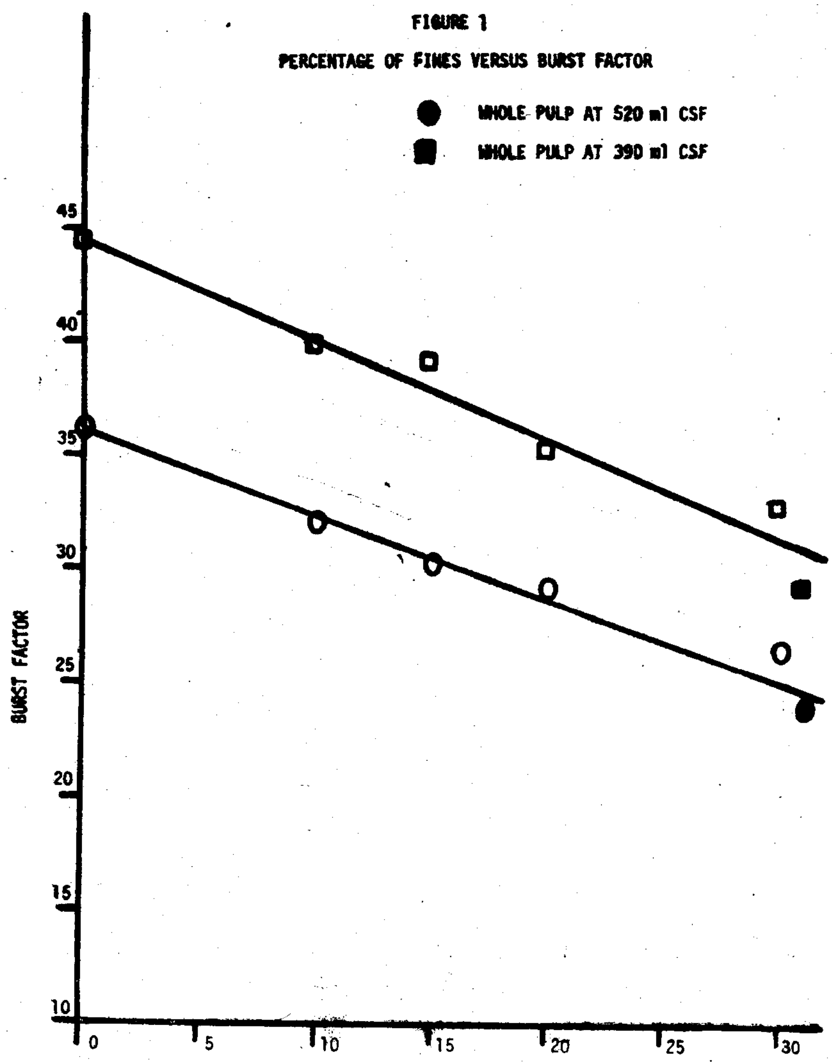
The strength properties of the whole pulp and the longer fractions mixed with different proportions of fines are shown in Figures 1 through 4 and Tables I and II.

Figures 1 and 2 show the variation in burst and tensile strength expressed as burst factor and breaking length respectively, on mixing different proportions of fines to the refined mixture of long fractions. Figures 3 and 4 show similarly the tear factor and fold variations. As seen from the figures, the pulp with no fines added has the highest strength, and the strength properties are inversely proportional to the amount of fines added. This is true at both freeness levels studied —the two lines are parallel and straight indicating direct proportionality of the amount of fines to the strength properties of the pulp handsheet. The whole pulp strength values are on line with the other values corresponding to 31% fines.

Table III shows the effect of

FIGURE 1

PERCENTAGE OF FINES VERSUS BURST FACTOR



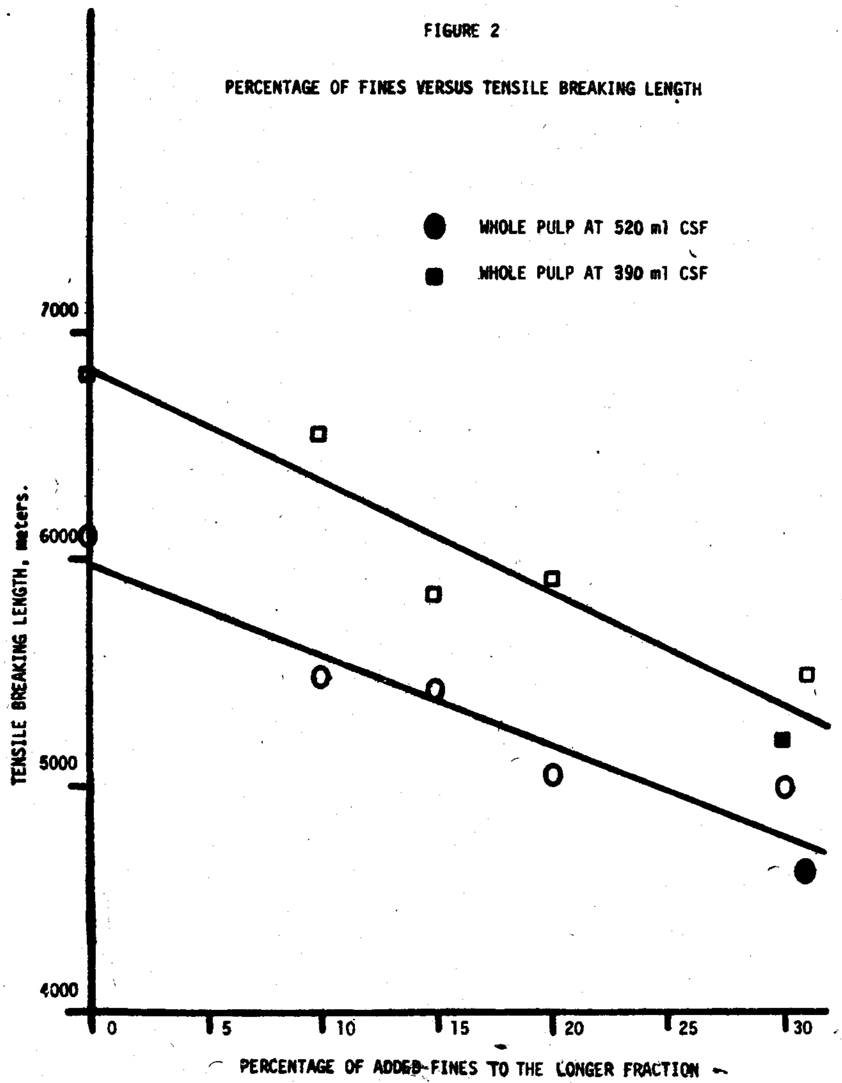
TABLE–I

Strength Properties of Handsheets From Pulp Containing Various Percentages of Fines and at 500 mlCSF.

Pulp	%Fines	Freeness ml CSF	Burst Factor	Tensile Breaking Length (meters)	Tear Factor	Fold
Whole Pulp	—	520	23.3	4560	108	14
Long fiber Fractions	0	520	36.0	6100	152	61
,, ,, ,,	10	510	32.0	5470	137	44
,, ,, ,,	15	500	30.0	5420	130	31
,, ,, ,,	20	495	29.0	5040	120	29
,, ,, ,,	30	485	26.0	4980	108	18

FIGURE 2

PERCENTAGE OF FINES VERSUS TENSILE BREAKING LENGTH



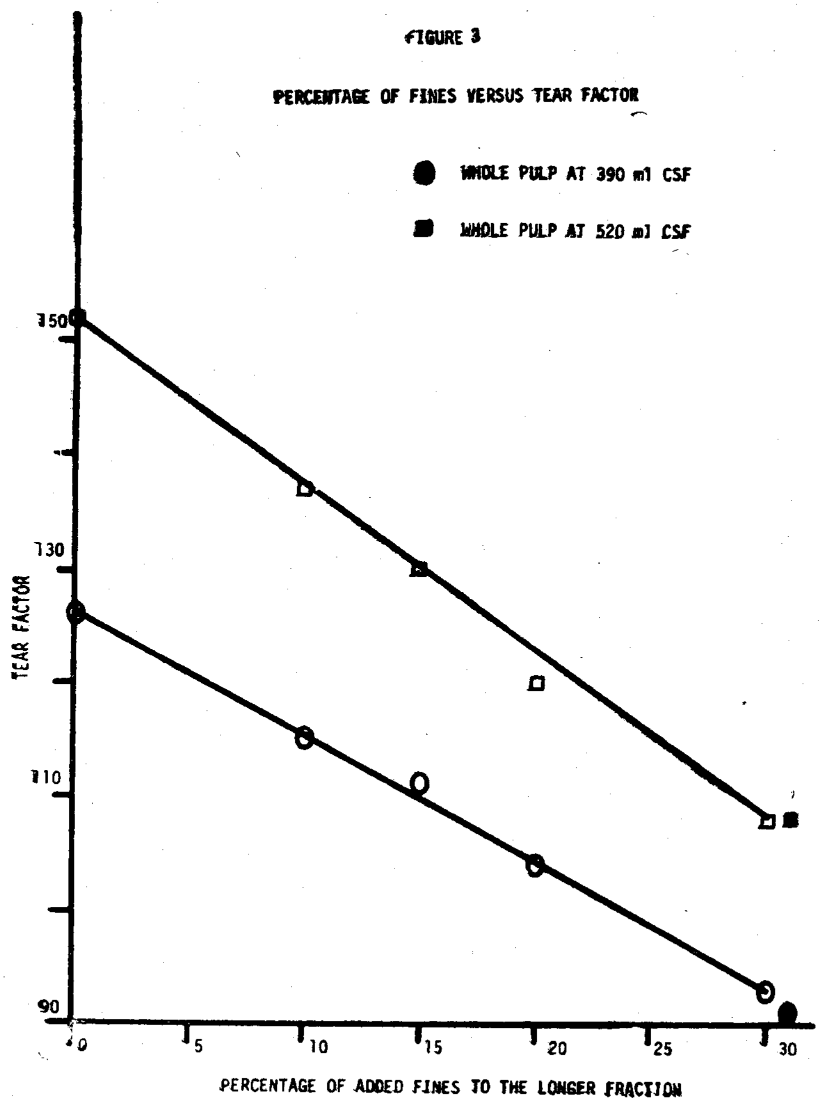
TABLE–II

Strength Properties of Handsheets From Pulp Containing Various Percentages of Fines and at 390 ml CSF.

Pulp	%Fines	Freeness ml CSF	Burst Factor	Tensile Breaking Length (meters)	Tear Factor	Fold
Whole Pulp	—	390	31.5	5470	91	32
Long fiber Fractions	0	390	44.5	6820	126	161
,, ,, ,,	10	385	39.9	6540	115	105
, ,, ,,	15	380	38.9	5830	111	54
,, ,, ,,	20	370	35.1	5890	104	69
,, ,, ,,	30	365	32.3	5180	93.	32

FIGURE 3

PERCENTAGE OF FINES VERSUS TEAR FACTOR



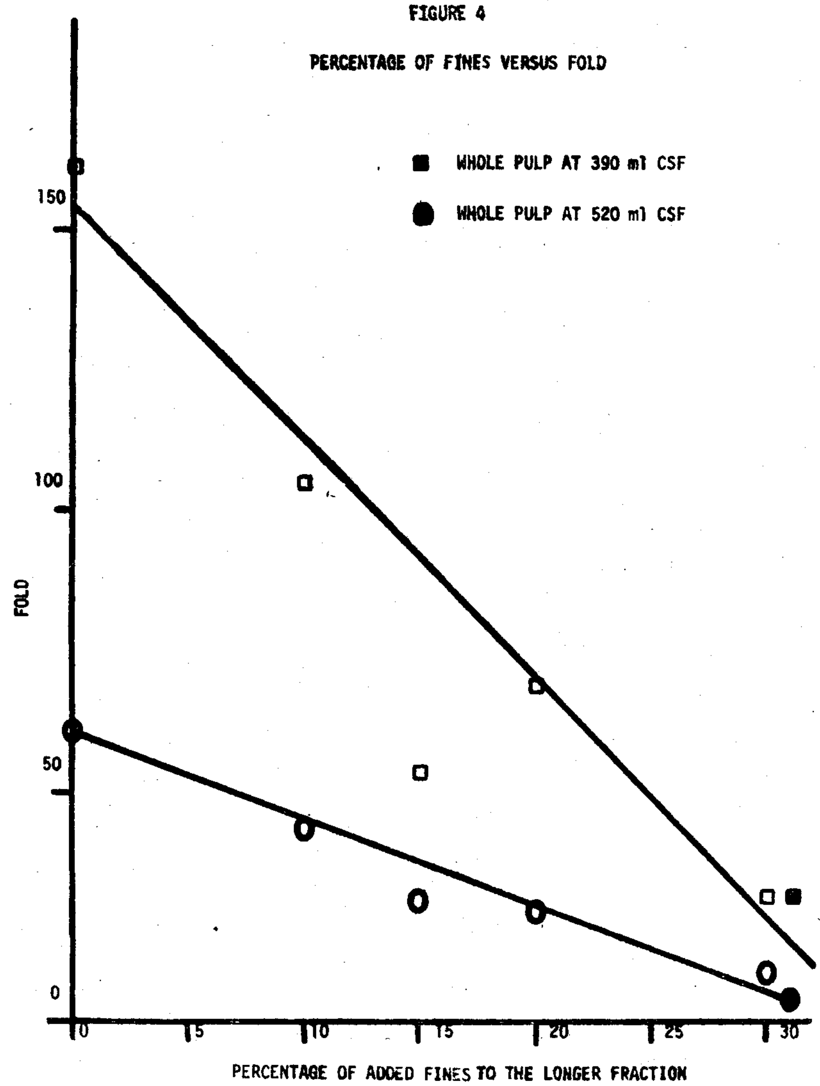
TABLE–III

Strength Properties of Handsheets From Whole Pulp With Added Fines at 500 ml CSF.

Pulp	%Fines	Freeness (ml CSF)	Burst Factor	Tensile Breaking Length (meters)	Tear Factor	Fold
Whole pulp	31.0	520	23.3	4560	108	14
Whole Pulp	35.5	510	20.5	4320	94	12
Whole Pulp	40.0	500	19.4	4090	94	10

FIGURE 4

PERCENTAGE OF FINES VERSUS FOLD



adding up to 40% fines to the whole pulp. As can be seen, the strength properties deteriorated still further

Conclusions

It is clear that fines (primarily parenchyma cells) are detrimental to the strength properties of bamboo paper. The reduction of strength was directly proportional to the amount of fines in the pulp at the two freeness levels studied. It may be possible to remove the fines from the whole pulp to allow adjustment of the amount in the pulp to meet strength requirements. Higher amounts of fines could be added to papers where strength properties are of secondary importance. Eliminating all the fines from the pulp, however, may not be practical.

References cited

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