Various Considerations in the Manufacture and Applications of Extensible Kraft Papers from Bamboo Pulp Furnishes

N.S. Sadawarte
A.K. Prasad

The paper touches briefly on the various methods in practice for the manufacture of extensible kraft papers. Actual results obtained by clupak technique on Central Pulp Mills' unbleached kraft pulp are discussed. The applications for extensible kraft papers as well as their advantages over regular kraft papers are discussed.

Commercial applications of clupak technique prove that satisfactory multi-wall saeks could be produced from furnishes having around 60% bagasse pulp. It is feasible to manufacture quality extensible kraft papers from 70% bomboo pulp and 30% softwood pulp furnishes or perhaps even 100% bamboo pulp furnishes, after research into necessary modifications on equipment and process parameters.

A regular kraft paper has a good tensile strength but little extensibility, particularly in the machine direction, accounting for its poor energy absorption. It is now recognised that tensile energy absorption (TEA) is the main requirement of a packaging paper–as it denotes the toughness of the paper, that is, its ability to absorb a large quantity of energy before breakage occurs. The TEA value is obtained by the area under the paper's stress/strain curve, its units are cm. kgs/cm^2 or ft.lbs/ft^2. The stress-relation of a typical North American kraft paper is shown in Fig. 1. At 50% R.H., the tensile energy absorption of this kraft paper are 4.2 ft lbs/ft^2 and 7.2 ft.lbs/ft^2 in the machine and cross directions respectively.

Table 1 gives comparative test results on North American and European regular and extensible kraft clupak papers. It can be seen that TEA values in machine direction due to compaction in extensible kraft paper have increased by as high as 300 to 400% of the uncompacted papers. This increase is essentially due to the increase in the machine direction stretch. A small gain in cross direction tearing strength is also obtained.

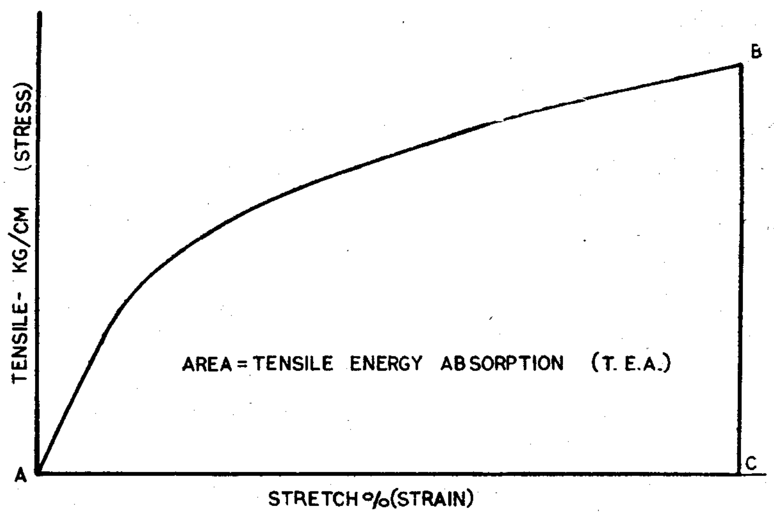

Figure 1–Graphical Representation of T.E.A. (Ref. 1)

N.S. Sadawarte,
Executive Director
A.K. Prasad
Technical Manager
The Central Pulp Mills Ltd.,
Fort Songad, Dist. Surat (Gujarat)

The present methods to increase extensibility in paper :

The presently used techniques in manufacturing extensible kraft

TABLE 1

Comparative Physical Test Results On Regular And Extensible Papers (Ref. 1)

Properties	Sheet Direction	North American Paper (1) Regular	North American Paper (1) Extensible	European Paper (2) Regular	European Paper (2) Extensible
Basis weight, g/m^2	—	81	81	80	80
Caliper, in	—	0.0051	0.0049	—	—
Tensile strength, lb/in	Machine	32.3	23.2	34.3	28.8
	Cross	20.0	18.7	22.5	18.5
Stretch, per cent	Machine	1.9	9.6	3.2	108
	Cross	4.2	5.6	6.0	7.3
T.E.A., ft lb/ft^2	Machine	4.2	16.8	10.8	32.4
	Cross	7.2	8.4	17.7	16.4
Tearing strength, g	Machine	130	136	—	—
	Cross	150	172	—	—
Air permeability, sec/100 cm^3	—	7	9	—	—
Air permeability, cm^3/min	—	—	—	260	240

(1) Tested at 50 percent RH (2) Tested at 65 percent RH

papers are the widely practised clupak method, differential speed technique in the paper drying rolls patented by Scott Paper Company and the air-flotation drying system (Flakt drying). These techniques have been commercially used to achieve varying degrees of extensibility in commercial papers. High consistency refining and treatment of paper with ammonia or alkylamines also improve the stretch in regular kraft papers. Yet another method that could find some application, especially in non-wood pulps, is the Black Clawson's technique of separating fibered pulp from the short the long fibered fraction in the pulp furnish through fractionation and then individually treating the long fibered fraction for kraft liner and the short fibered fraction for corrugating medium. The TEA value of the long fiber fraction will be certainly higher than that of the composite pulp having both the long and short fibered fractions.

Among all the techniques referred to above, clupak technique has been widely used on short fibered pulps in the manfacture of extensible kraft pulps. In Latin American installations, for example, bagasse pulp has been successfully used in clupak technique replacing over 50% of the long fibered wood pulp in the furnish for extensible kraft papers. The successful utilisation of bagasse pulp in extensible kraft papers paves the way for upgrading bamboo pulp (bamboo being an inherently stronger fiber than bagasse) by clupak technique for use in multi-wall sack constructions.

In the clupak method, the moist web of paper while still in plastic form is subjected to the recoilaction of an endless elastic surface, a rubber blanket. Fig 2 illustrates the set up for the rubber blanket and the fundamental parts of the unit. The unit is installed in the dryer section of the paper machine at a point when the paper is about 65% dry.

Laboratory and pilot plant work on Indian Bamboo kraft pulp by clupak :

Clupak, Inc. worked on the suitablility of Central Pulp Mills' unbleached bamboo kraft pulp. The details of this pulp are given in Table 2. Extensible papers by clupak technique from clupak's experimental paper machine are compared with papers produced on the same machine under the same operating conditions using 100% North American long fibered softwood pulp. These results are shown in Table 3 and illustrated in Figures 3 to 7. (Ref. 3). The following conclusions could be drawn from the findings :

1. The increase in TEA as a result of compaction was 140-330% more than that of the uncompacted sheet. The TEA

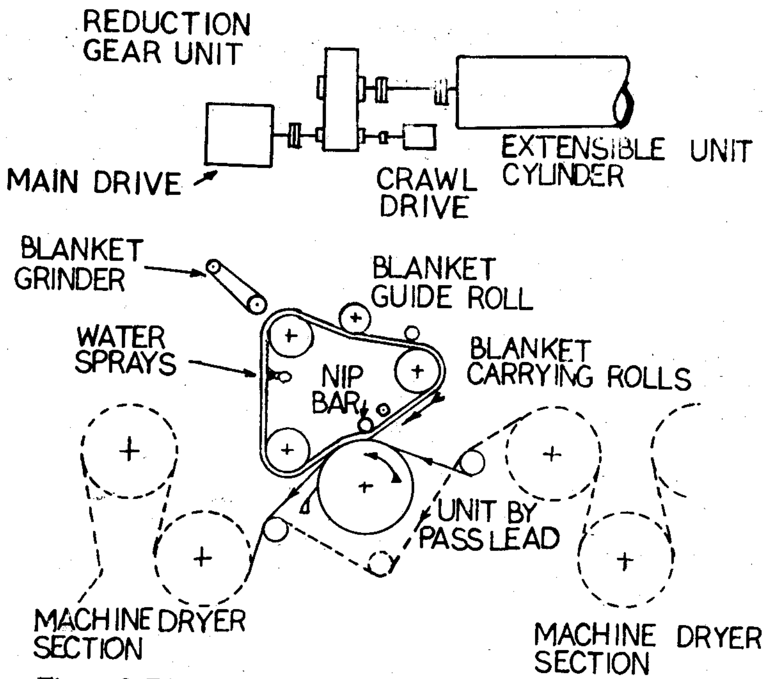

Figure 2–Digrammatic Arrangement of Blanket Extensible Unit (Ref. 1)

TABLE 2

Details Of Central Pulp Mills' Bamboo Kraft Pulp Sent For Compaction Study

Raw Material :	—	Bamboo
Species :	—	*Dendrocalamus Strictus*
Forest :	—	Dangs and Vyara Districts of Gujarat State.
Quality of pulp :	—	Unbleached Bamboo Kraft.
Process	—	Sulphate
Cooking Conditions :		
Chemicals	—	15% as Na_2O on OD chips
Chip to liquor	—	1 : 2.5 (direct steaming)
Time to temperature	—	2½ hrs. (includes impregnation period)
Temperature	—	155°C
Time at temperature	—	2 hours
Permanganate number	—	24 (on 40 ml test)

Pulp Evaluation Report (Valley Beater)

1. Initial freeness (ml CS)	700
2. Final freeness (,,)	250
3. Burst factor	39.4
4. Tear factor (Elm)	97
5. Breaking length (M)	5900
6. Double folds (MIT)	77
7. Bulk (cm^3/g)	1.58
8. Beating time (Min)	48

9. **Fibre Classification (%) Clark**

+20 mesh	+50 mesh	+65 mesh	+125 mesh	−125 mesh
40.5	64.0	70.5	75.0	25.0

of the compacted sheet with 100% bamboo pulp is almost 40% more than that of the uncompacted sheet from 100% North American long fibered softwood pulp.

2. The machine direction stretch registered a dramatic increase by clupak compaction technique.
3. The tear values of the sheets improve in compaction by 10 – 15%.
4. The compacted sheets register a drop in tensile strength. The percent loss in tensile strength is independent of the percent bamboo pulp in the furnish.
5. The tensile strength of the compacted bamboo sheet (100% bamboo) is 1.53 kgs/15 mm while that of the sheet having 75% wood pulp and 25% bamboo pulp is 1.73, only a gain of 12% roughly paralleting the gain of 15% in tear at the same composition.
6. 70% bamboo pulp in admixture with 30% soft-wood pulp could be used to produce quality multi-wall sacks to meet Indian market requirements.

Applications :

Extensible papers are used where toughness, resistance to impact, puncture and tear are required such as in multi-wall sacks, wet strength and saturating grades, plastic and foil laminates,

TABLE 3

Physical Tests Of Uncompacted And Control Sheets vs. % Bamboo Kraft Pulp In Furnish

% Kraft Pine	% Bamboo Kraft	TENSILE (kg/15 mm) Compacted	TENSILE (kg/15 mm) Control	ELONGATION (%) Compacted	ELONGATION (%) Control	T.E.A. (cm kg/100 cm²) Compacted	T.E.A. (cm kg/100 cm²) Control	INTERNAL TEAR (gms) M.D. Compacted	INTERNAL TEAR (gms) M.D. Control	INTERNAL TEAR (gms) C.D. Compacted	INTERNAL TEAR (gms) C.D. Control
100	0	2.20 ±0.19	3.35 ±0.13	17.1 ±0.8	3.6 ±0.6	14.0 ±1.0	5.7 ±0.9	120	88	152	96
75	25	1.72 ±0.08	2.44 ±0.05	16.2 ±1.0	2.0 ±0.2	11.2 ±0.6	2.7 ±0.5	120	88	128	122
50	50	1.66 ±0.05	2.39 ±0.16	15.4 ±0.6	1.9 ±0.5	10.9 ±0.4	2.5 ±0.3	100	80	120	96
25	75	1.63 ±0.11	2.25 ±0.11	13.7 ±1.1	2.4 ±0.8	10.6 ±0.9	2.8 ±0.6	96	96	4	104
0	100	1.53 ±0.08	1.85 ±0.08	11.3 ±0.7	2.9 ±0.2	7.8 ±0.6	2.5 ±0.3	26	80	112	96

NOTE : All values average of five tests from centre of web.

Tear values are averaged during test so that no measure or variation is available.

All values reported are corrected to 83.0 gms/m² basis weight.

Basis weight variation was from 82.0 gms/m² to 84.8 gms/m² on uncompacted sheets.

Cross direction tensile, stretch, and TEA tests are not reported because of edge effects of the narrow machine.

laminated kraft liner, cable papers, insulation board and pressure sensitive tape stock.

Table 4 lists multi-wall sack constructions in regular and extensible kraft paper. It can be seen from the results that extensible multi-wall sacks will contain less paper than with a regular construction, thus showing a substantial financial saving and at the same time outclassing the regular sack in performance.

The actual drop test results for regular and extensible kraft multi-wall sacks are given in Table 5. These observations confirm the findings of Mckee and Whitesitt[5] that a sack drop test performance is improved with increase in machine direction stretch. The data in Table 5 also show the substantial savings in paper for extensible kraft multi-wall sacks over regular kraft for various applications. Another advantage with extensible kraft paper is its stability with changes in relative humidity, an important factor with hot packing such as cement.

Indian Scene :

Market survey reveals enough

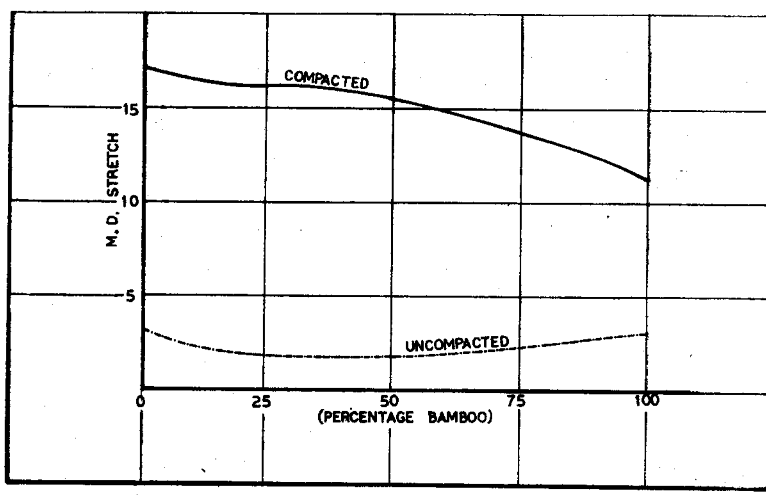

Figure 3–Machine Direction Stretch Vs. Bamboo Proportion of Furnish (Ref. 3)

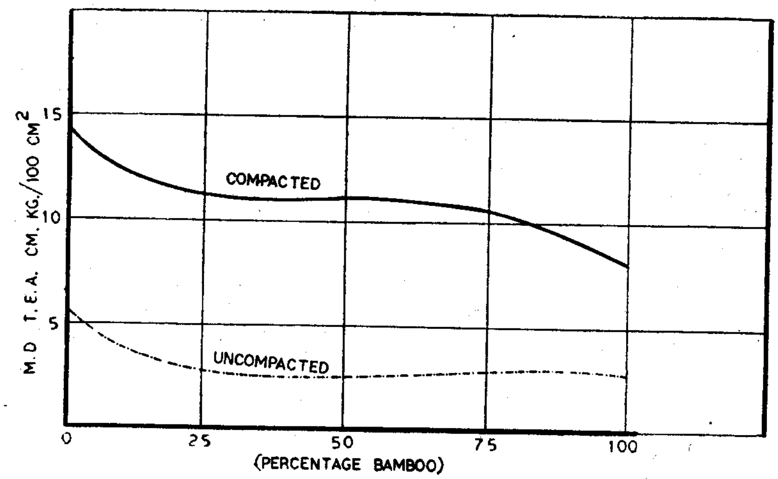

Figure 4–Tensile Energy Absorption Vs. Bamboo Proportion of Furnish (Ref. 3)

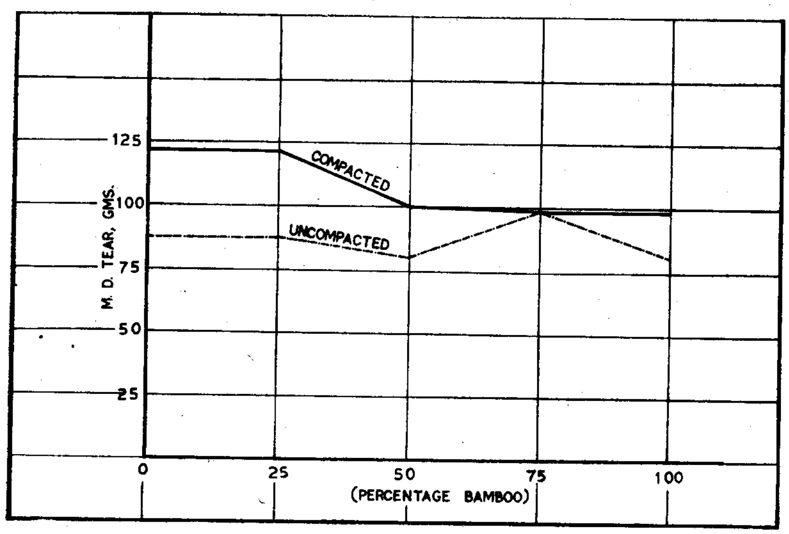

Figure 5–Machine Direction Tear Vs. Bamboo Proportion of Furnish (Ref 3)

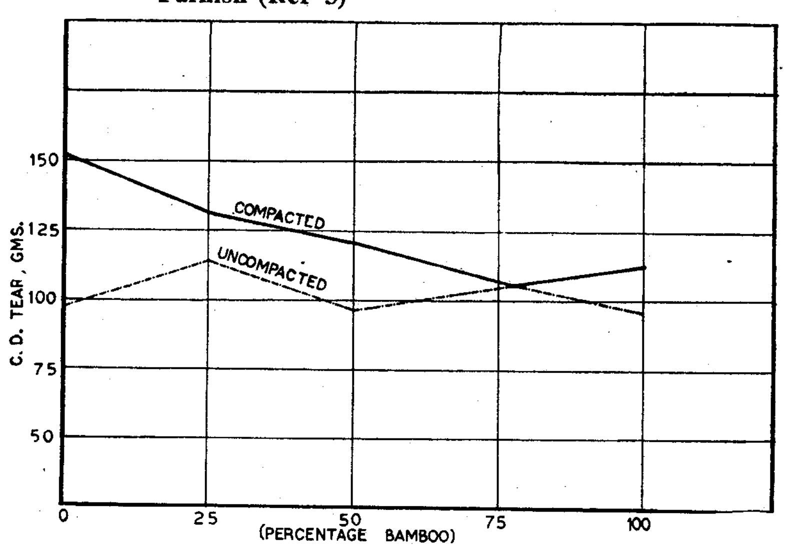

Figure 6–Cross Direction Tear Vs. Bamboo Proportion of Furnish (Ref. 3)

demand for extensible kraft papers for packaging cement, sugar for export, refuse sacks, fertilizers, etc. Extensible kraft papers not only help in packing these materials better but also result in substantial paper savings thus conserving valuable cellulosic fiber.

The technology for the commercially produced extensible kraft papers from furnishes having over 50% short fibered pulps is well established. It is hence quite possible to produce satisfactory extensible kraft papers from relatively much long fibered bamboo pulp furnishes, especially with mixed bamboo pulp and pine pulp furnishes where bamboo pulp percent is around 70%. After some research on the various process and equipment parameters, even 100% bamboo pulp furnishes could perhaps be used. Certainly it is not essential to use 100% softwood pulp for extensible kraft papers, except in exceptionally tough multi wall sacks. The premier softwood pulp which is not so abundant in India could be set apart specially for the manufacture of high quality speciality papers.

It may not be economically feasible to have a mill by itself for the manufacture of extensible kraft papers. It could perhaps be so planned sa to produce partly extensible kraft papers and partly other varieties on a paper machine, providing for the introduction of clupak unit in the dryer section. The Central Pulp Mills, Ltd. are taking a good look at this agreement to meet the country's growing needs for extensible kraft papers. None of the Indian kraft and sack kraft papers in the market today adequately fulfil the requirements for multi-wall sack constructions.

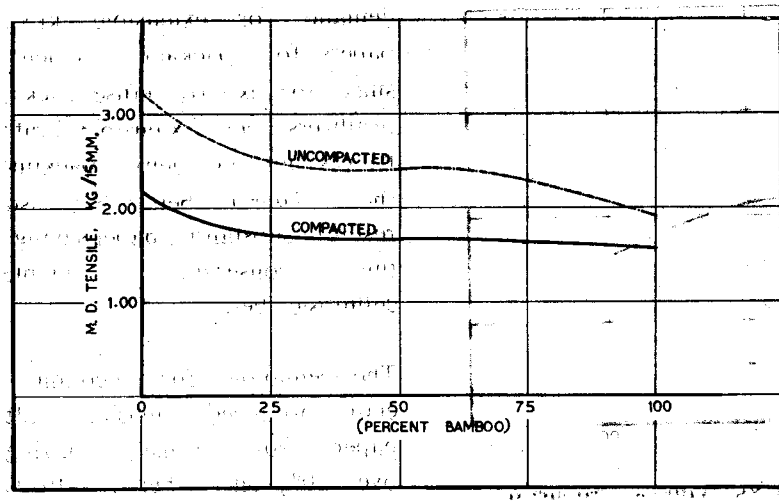

Figure 7–Machine Direction Tensile Vs Bamboo Proportion of Furnish. (Ref. 3)

TABLE 4

Multi-Wall Sack Constructions In Regular And Extensible Kraft Paper (Ref. 1)

Weight of filled sack	Product filling the sack	Original Contruction* regular paper	Total basis weight, g/m²	New construction* extensible paper	Total basis weight, g/m²	Saving percent
110 lb	Saltpetre	1/75PE 3/75 1/75PE	375	1/90PE 1/90 1/90PE	270	28
—	Refuse Sack	2/80	160	2/75	150	6
				or 1/120WS	120	25
110 lb	Cement	3/80	240	2/90	180	25
10 lb	Cement for export			or 2/100	200	17
		4/80	320	3/90	270	16
				or 3/80	240	25
110 lb	Iron powder	6/80	480	4/90	360	25
110 lb	Sugar	4/80	320	3/90	270	16
75 lb	Phthalic anhydride flake	4/88	352	2/80 1/80 WS	240	32
50 lb	Polystyrene pellets	1/88 PE4/88	440	2/88 1/88PE1/88 WS	342	29
50 lb	Polystyrene pellets for export	1/88PE 4/88 2/80	600	3/88 1/88PE 1/88WS	440	27
110 lb	Cement for export	5/75	375	3/90	270	28

*Construction details give plies with their basis weight in g/m², the inside plies being listed first, PE=Polythene-coated WS=Wet strength

TABLE 5

Drop Test Results For Regular And Extensible Kraft Multi-Wall Sacks (Ref. 1)

Weight of filled sack	Product filling the sack	Original construction* regular paper	New construction* extensible paper	Paper saving, per cent	Flat drop of 4 ft Original	Flat drop of 4 ft Extensible
94 lb	Cement	2/65 2/81	3/81	17	3.8	11
94 lb	Mortar	4/65	2/65 1/81	19	3.0	5.7
51 lb	Animal feed	2/65 1/81	2/98	8	9.0	18
80 lb	Ferti-lizer	1/45 AL 2/65 1/81	1/162 AL 1/65 1/81	14	4.0	8

* Construction details give plies with their basis weights in g/m², the inside plies being listed first

Conducted under standard laboratory conditions of 50 percent rh, 73°F AL=Asphalt-laminated

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