# Studies on variations in the properties of the Indian paper boards

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### SUMMARY

A study has been made on the variations in the physical properties of some of the commonly available carton boards from small waste paper based and reputed pulp board manufacturer. The choice of properties was governed by selecting those which might have a bearing on the creasing and the strength of the boards. Some of the results were analysed statistically for the relationships. It was observed that while the pulp board based on the regulated and quality controlled bamboo pulp could provide relationships having potentials for the non destructive quality evaluations, boards from small mills employing purchased waste paper gave irregular and even unexpected relationships.

Indian packaging industry utilizes annually over 1.5 lakh tonnes of paper boards for various packaging purposes. The important varieties used are duplex board, mill board, grey board, pulp board, and M. F. stiffner board. The specific weights of these products varies from 180-350 gsm. The largest varieties employed are 250-350 gsm, although due to continuously increasing prices of all types of papers, the usage trend is shifting to lower weight qualities, where the packaging surface available is more per tonne of the production. Further the employment of pulp board, which is normally produced in the range of 180-250 gsm, had shown faster rate of production and consumption than the thicker variety.

The board utilizing packaging industry is concentrated in large, medium and small sector. While the large and medium sector paper board consuming factories have, in house, paper testing laboratories, where the in feed material is continuously checked and evaluated before its acceptance, most of the small sector consumers do not have regular testing facilities and they accept or reject the material on experience, feeling and past records.

These qualitative accepting judgments are not always correct. Further without a prior knowledge of the inherent fluctuations in the properties of the products from different suppliers, one could not formulate safe and reliable sampling techniques which could effectively guard against the flow of sub-standard goods.

In addition, it is useful, if correlations between certain quality decisive criteria are established on non-destructive procedures so that from some simple tests, such as weight and density of the board, one could predict some of the vital properties required for a particular application.

With the above aspects in view, a number of studies were undertaken to get a spectrum of variations in some of the basic strength properties of the paper boards available in the country especially from small board producers who are an important source of supply to most of the small paper and board converters.

Selection of the Experimental Material:—There are over twenty big, m edium and small producers of duplex, mill and pulp boards in the country. While the big producers employ mainly virgin bamboo pulp with small admixture of waste paper-as the raw material for the boards, small manufacturers employ mainly waste paper and limited quantity of purchased pulp in the present

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study it was desirable that the analyses should be made on the bulk data, so that statistical relations could be worked out and reliable variation figures obtained. For the present study, three known small producers of boards and one big reputed pulp board manufacturer was randomly selected and their data ar alysed by testing a large number of samples for a long period. In order to conceal their identities these producers are designated as A,B,C etc. except the pulp board supplier, who being only one, is left undesignated.

One of the chief aims of this study was to find out the trends and relationships, so that the converters could, if possible derive some connections between simple tests, such as say gram weight, thickness and tensile strength, bursting strength, stiffness and Cobb test. These are some of the important criteria adopted by most of the small converters, Although other tests such as oil absorbancy, tear, folding endurance etc are also vital, these properties were not studied and could possibly be discussed in a future publication. The selection of tests of this study was mainly dictated by object of analysing only those physical properties which the converters thought had a bearing on the creasing and folding aspects of the end product. Although the testing list was by no means complete, the published data of this study could excite and nourish more enquiry and investigation in this field for which probably no published information is available to the converters in India.

Some of the boards were manufactured out of 100% bamboo pulp on a Fourdrinier machine, while others from pure waste paper on Cylinder mould machine.

These boards, as received from the manufacturer, were subjected to atmospheric conditioning and treated as per the procedures laid out in appropriate I.S. Standards Since the main aim of the study was to determine the scatter, Variations and correlations, rather than the prices values, in many cases tensile strength for 15 mm. strip was directly carried on the graphs, and also trends. Again as some of the factories had old F. P. S. calibrated instruments, especially burst tester, the values were used as they were-since in this case also the chief aim was to estimate the trends.

**Results and the Discussion:** The statistical analyses of the results were carried out, wherever the graphic representations were not shown. In case the trend were not evident or where total absence of correlations was exhibited by the diagram, the conclusions were derived as such, since statistical computations in such cases would not have served much purpose. The role of individual properties is considered below.

Influence of Gram Weight: The relationships between the basis weight and the tensile strength for 15mm strip of board is shown in Figures 1-5 for both mill board and coloured duplex from three



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suppliers. These boards were produced manly from waste paper by small mill producers.

Surprisingly and quite unexpectedly the three figures reveal absolutely no relationship between the basis weight and tensile strength for duplex and mill board. This relationship is in fact quite revealing and contradictory to theory and general assumptions especially among many converters, that heavier boards are necessarily stronger boards. Many converters, even those having adequate paper and board testing facilities, work on this assumption and change over to heavier boards whenever faced with the problems of strength of the packaging box. This assumption, atleast within the gram weight considered here, does not seem to be born out by the analyses. In fact this presumption on account of the higher consumption of board per box, increases the cost of the packaging without any benefit to the converter.

The same relationship when tried in the case of pulp board indicated fair trends for folding endurance, tensile strength, in both directions, bursting strength, sizing seconds and calipre. These relationships are exhibited in figures 4, 5 and 5A.

Unexpectedly folding endurance in the cross direction did not reveal any relationship.

The probable explanation for a relationship for pulp board and non existence in coloured duplex and mill board, could be attributed to the furnish used in the manufactre of both these products. Whereas the pulp board tested was produced out of a single furnish of tested and regulated bamboo pulp in a big well equipped plant, the grey and mill boards, although manufactured in good machines, were produced from 100% waste paper, whose basic qualities and strength properties could widely be varying and unpredictable.



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Table-1 also shows the results of the ratins of the tensile strengths in the two directions for different producers of board.

This ratio normally depends upon the type of the machine, consistency of the pulp, speed of the machine, drying etc. Some of the unpublished studies undertaken on boards of Europeon manufacture, have shown a wide flucatuation in this ratio varying from 1.6-3.6.

Influence of Calipre : Calipre of the board is one of the easily determinable criteria and is normally useful as one of the non-destructive tests, although such non-destructive studies have probably not been done atleast with the Indian products. Non destructive correlations, have however, been established in the case of some of the pulp based products such as fibre boards<sup>1</sup>. The relationship between tensile strength and board thickness is shown in Figures 6 & 7 for 350 gsm waste paper based board. The bulk versus gsm correlation is exhibited for pulp board, in Fig. 8.

As in the case of gsm, while pulp board indicated some trend, there was no relation hip for the waste paper based board for the products studied, even within the same mill product.

This trend is again contray to expectationsalthough this must be emphasised that some studies carried out abroad on products from several mills, have also revealed contrary trends-though in majority of the cases, in general it is observed, that increase in calipre resulting in increase in gsm, enhances the tensile strength of the board.

## PULP BOARD



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| TABLE-1 |  |
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RATIO OF TENSILE STRENGTH IN TWO DIRECTIONS FOR PULP AND OTHER PAPER BOARDS

| Quality     |                 | Producer | Ratio | Range     |  |
|-------------|-----------------|----------|-------|-----------|--|
| (1)         | Coloured Duplex | Α        | 1.70  | 1.53-1.88 |  |
| (2)         | Mill board      | Α        | 1.69  | 1.58-2.01 |  |
| (3)         | Coloured Duplex | B        | 2.33  | 2.14-2.48 |  |
| <b>(</b> 4) | Ditto           | C        | 2.05  | 1.66-2.25 |  |
| (5)         | Pulp Board.     | ·        | 2.47  | 1.83-3.19 |  |

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**Density of the Board**: Density is considered to be one of the important non-destructive criteria for the strength properties of some of the pulp based materials, such as fibre hardboards'. Although probably its role as a non-destrutive test for paper or paper board has not been fully investigated, although potentially it does offer a promising criteria to judge a product without actually subjecting to detailed testing.

The test results for the boards studied are plotted as a function of the density of the product in Figures 9 and 10.

Unfortunately like other tests, in the case of density also, the relationship was more evident in the case of the pulp board than the waste paper based products. This could again be attributed to widely varying nature of the raw material in the latter case, which could introduce uncontrolled fluctuations in the properties of the boards.

On the other hand in case board is produced from regularly controlled and step wise tested pulp and on good machines, the end product could be of a technically more predictable characteristics. The relationship for pulp board is shown in Fig. 11

Bending Stiffness:- Stiffness or resistance to bending is probably more important quality in

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This vital property decides the minimum weight and calipre of a board that is available for any job. It determines the resistance of packaging to bowing of panels and flaps and crusing load met in stacking and use. Consequently some limited data were gathered to estimate the correlation between stiffness as determined on Patra designed instrument, and the density of the board, for two manufacturers whose products was favoured by the converters where the study was conducted.

The relationship between the two variables was estimated and the results shown in Figure 12.

It is observed that the relationship tends to be linear in atleast two products, although it must be emphasised that more data and study is needed to come to more dependable conclusions. Another noticable observation was, that a board produced out of virgin pulp was showing the same stiffness at 20-30% lower basis weight than the product from waste paper only, which is evidently due to the superior pulp in the former case.

Inter Dependence of Strength Properties : Some of the converters work on the assumption that the bursting strength, which is an easily determinable property on cheap machines, gives a "fair" indication of other vital strength properties, such as

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one criterion from the other for any of the producers.

Concluding the analyses discussed above, it would be useful exercise of practical value especially to small paper and board converters, to further study the products of different suppliers and from

# TABLE-2

CORRELATION COEFFICIENT BETWEEN BURSTING STRENGTH AND TENSILE STRENGTH (Average of M. D. and C. D.)

| Quality |                  | ····· | Producer |  | Correlation<br>Coefficient |  |
|---------|------------------|-------|----------|--|----------------------------|--|
| (1)     | Mill Board       |       | Α        |  | 0.28                       |  |
| (2)     | Duplex (300 gsm) |       | В        |  | 0.14                       |  |
| (3)     | Duplex (350 gsm) | 4     | В        |  | 0.21                       |  |
| (4)     | Duplex "         | •     | C        |  | 0.07                       |  |

tensile strength along and across the board. In order to check the validity of this assumption, the relationship between the average of along and across tensile strength was determined by estimating the correlation coefficient of the two characteristics.

The regression coefficient assembled in table 2 shows that, while there may be some qualitative relationship between bursting strength and tensile strengths, one cannot reliably predict

the actual test data work out the real relationship rather than depend entirely on brand name, price, appearance etc. as some investigations abroad have revealed that there is no clear correlation between decisitve quality and other factors, such as ppearance. price etc.

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