A Novel Method of Testing Surface Softness of Household Papers — CK method *

Lan-Sheng Kuo**  Yin-Lie Cheng**

家庭用紙表面柔軟度之新測試法 — CK 法*

郭蘭生** 鄭殷立**

【Abstract】A novel method, dubbed CK method to determine the surface softness of embossed or creped tissue papers was developed. The testing results of this new method were compared favorably with those of artificial finger tip method and the subjective hand-feel method. The CK method is a simple way to measure paper surface softness. Some problems involved in the practical application of this method are also discussed. Practically, it is advisable for determining the tensile strength of paper specimen which is over 170g/15mm.

【Keywords】Surface softness, Tissue papers, Artificial finger tip method, Hand-feel method, CK method.

【摘要】CK 法為一新開發之壓花或皺紋衛生紙表面柔軟度測試法。測試結果顯示 “CK 法” 較現行之人工手指測試法及手感測試法為優。CK 法為一種家庭用紙表面柔軟度之簡易測試法，本法在實際應用上也加以討論。CK 法於實際利用上應注意試樣之紙張抗張強度必須大於 170g/15mm 以上。

* This paper was presented at the Third International Non-Wood Pulp and Paper Conference held in Beijing on Oct. 16-18, 1996.
** Kuo is a professor and Cheng is a Ph. D. graduate student at the Graduate Research Institute of Forestry, National Chung Hsing University, Taichung., Taiwan 402
I. Introduction

High degree of softness and water absorbency are the specific characteristics found primarily in household paper (e.g., tissue paper and paper towels). The quality requirements of these household papers are quite different from those of packaging paper, paperboards or printing and writing papers. The quality assessment of these specimens with a set of standards by hand which is subjective and dependent on the individual making the test. This method is also lacking reproducibility and accuracy. Household paper products are often based on how the paper is felt by hand, and how bouncy they are when stacked. The traditional hand-feel method compares a paper to be useful in quality control application. Development of a more objective method of assessing surface softness of household paper is, therefore, urgently needed and has also been the focus of much attention in paper industry.

Hollmark\(^1\) suggests that softness of paper can be divided into: a) bulk softness, which is what one feels when clamping a stack of the paper with hands, and is relevant to paper resiliency and b) surface softness, which is what one feels when tracing fingers slowly along the surface of the paper. Koran\(^2\) indicates that bulk softness can be assessed with various methods, such as cantilever method, Brown softness method, Taber stiffness, Instron stiffness, and Gurley stiffness etc. There is, however, only one well known method-artificial finger tip method, originally proposed by Hollmark, that can be used for measuring surface softness of paper objectively. Finger tip method indicates that the tip of a photographic head is modified as an "artificial finger tip" to measure the irregularities of paper surface. Through the device, signals corresponding to surface irregularities caused by creped features can be obtained. Despite its novelty, the method is difficult to apply to measuring surfaces of embossed papers\(^3,4\). We need a radically different approach to determine the surface softness of embossed papers.

Theoretically, we tend to consider the more resilient and the finer creped features there are, the higher surface softness of the paper is\(^5\). Based on this concept, and after three years' effort, we have developed the CK method to undertake the task of determining surface softness of papers. The results of the CK method have been compared with those of the artificial finger tip method and the hand-feel method. Regression analysis employed has verified the CK method as a simple, practical and easy to use method for the purpose.
II  Principle of the CK method

Compressibility and smoothness of paper are closely related to its surface softness\(^1\). Under known applied pressure, the effective bonded area and the extent of bonding (expressed as shear tensile strength, gf) between a paper specimen and a removable self-stick label paper with predefined bonding ability are highly dependent on the roughness and resiliency of the paper surface is. Based on this premise, paper surface softness can be determined by the extent of bonding force between the paper specimen and a removable self-stick label paper. The result as expressed as shear tensile strength, is what we call the CK softness value of this paper specimen.

III  Experimental

( I ) Materials:

Seven different creped or embossed household papers, i.e., facial tissue toilet paper and napkin papers in basis weight range of 15 to 35 g/m\(^2\) were sampled. These were the products from several local paper mills.

( II ) Apparatus:

1. Tensile tester that generates data descriptive of shear tensile strength in gf. The higher the test value, the better CK surface softness is. Precision of the test shall be 0.001 kgf.

2. Rubber covered press roll, with a weight of 110±1 g, diameter of 4 cm, and a width of 10 cm. The rubber cover shall have a hardness of 84(JIS).

3. Smooth inclined surface: As shown in Fig. 1, a ramp with 4° tilt, made of plastic or aluminum with smooth surface. The combined paper specimen and removable self-stick tab placed on the ramp will be pressed by a free rolling press roll.

4. Removable self-stick label paper (3M brand); size 76 mm x 76 mm, with glue coated area of 10 mm x 76 mm.

( III ) Procedure:

All paper samples were conditioned at 20°C and 65% R.H. for at least 24 hrs before testing. The specimens shall be free of fold, crease and other defects. Avoid touching specimens with fingers.

Commercial removable self-stick label paper (3M brand) is cut 50 mm x 100 mm tabs
carefully. Paper sample is cut into 10 cm (MD) by 25 cm (CD) specimens. Place the paper specimen (MD) along the upper side of an inclined surface (see Fig. 1) and let the upper margin of the paper specimen flush even with a fixed straight line which is parallel to the CD of the paper specimen and is 17 cm from the press roll stopper. Place the removable self-stick label paper glue side down gently in the middle of the paper specimen. Make sure that the unglued end of the label paper tab meets the top margin of the paper specimen (Fig. 2). Place the rubber-covered press roll on the stopper and keep it still. Release the stopper button quickly and let the roll rolling down the incline. Repeat the roll pressing process once more. Trim the removable label tab and paper specimen assemblies to 25 mm by 200 mm sizes.

Fig 1. The test assembly of paper specimen and removable paper

Fig 2. The incline surface for the CK method

Clamp the unglued top side of the sticker tab and the bottom paper specimen end in the jaws of a tensile tester. Follow the procedure for tensile test of paper as specified in pertinent TAPPI standard. Report the shear tensile strength in gf as the CK surface softness of the paper specimen. Test both sides of a sample at least 5 times and report the averages as test
results. Because the test values for cross directions of the samples are low and variable, test and report the CK surface softness only in machine direction.

Except for the embossed paper samples, the smooth or creped samples were also sent to STFI in Sweden to be tested for their surface softness by the artificial finger tip method\(^{(6)}\). Twenty lab workers were also assembled to hand-feel the surface softness of all the paper samples. The hand-feel results were reported in terms of percentage, with 90% the highest softness and 10% the lowest. The averages of the test results were reported as the hand-feel surface softness.

IV. Results and Discussion

(1) Comparisons of CK method with artificial finger tip method:

Fig. 3 shows that a linear relationship with coefficient of correlation, \( R = 0.927 \), is obtained between the CK method and the artificial finger tip method for the same sets of paper samples. The CK method is thus deemed to provide similar and reliable test results as that of the artificial finger tip method.

As noted above, despite its success, the artificial finger tip method suffers from the limited scope of applicability. It is suitable for measuring only the surface softness of facial tissue and unembossed papers. The CK method, on the other hand, can readily apply to papers with embossed surfaces.
Fig 3. Correlation of paper surface softness results between the CK method and the artificial finger tip method.

(II) Comparisons of CK method with hand-feel method:

Fig. 4 shows that good linear correlation with $R = 0.978$ was obtained between the hand-feel data and the CK softness. Both embossed and unembossed paper specimens were compared. Apparently, if there is not much differences among surface softness of the paper samples, then, it would be difficult to get hand-feel results with precision and objectivity. The CK method, on the other hand, has no such limitations, and can provide reliable and objective results.

Fig 4. Correlation of paper surface softness results between the CK method and the hand-feel method.

Although the advantages are apparent in the CK method, there are certain issues need
to be addressed before it becomes a practical method. First, whether there is a consistent sticker tab paper that provides a given bonding ability for each test? The bonding ability between the sticker tab and paper specimen has to be definite for the CK method, otherwise, inconsistent and poorly reproducible data will result. Our experience suggests that among the commercially available sticker labels, the 3M brand sticker paper provides the most satisfactory performance in testing surface softness of paper samples. As Fig. 5 shows, however, when three pads of 3M stickers were tested on three different paper samples, they gave slightly different, but consistent variation in test results. These results suggest that different pads of sticker labels tend to have somewhat different bonding ability. Before any practical test, calibration is needed to establish the hand-feel test correlation with the new pad results, using a set of standard paper samples. Secondly, the quality consistency of different sticker tabs from the same pad need to be addressed. Our tests suggest that when applied to test identical tissue and paper towels, the first 50 or so sheets give fairly consistent results, whereas the remaining sheets give results that are more variable, as Fig. 6 shows.

![Graph showing the results of testing three paper samples with three different pads of sticker label tabs.](image)

**Fig 5.** The results of testing three paper samples with three different pads of sticker label tabs.
V. Conclusions

1. The effective contact area and bonding ability between a MD paper specimen and a sticker label under a fixed pressure can reflect surface softness of the paper meaningfully.

2. The new CK method for paper surface softness test gives comparable results with those of the artificial finger tip method and hand-feel method.

3. The CK method compares favorably as a rapid and easy to use method when applied to the determination of both embossed and creped papers.

4. Certain problems need to be addressed when using the CK method. These are Sticker labels must be consistent in quality with predefined and repeatable bonding ability; and that acceptable and recognized calibration procedure for the bonding ability of the sticker label paper need to be established.

VI. References


