Measurement of residual span in zero span testing

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As part of a program of measuring the stress-strain properties of paper fibres, SCA Graphic Research have recently added instrumentation to a commercial zero/short-span tester to measure load and displacement during the test. To convert the measured displacements into strains the residual span underneath the jaw needs to be determined. The residual span arises because the force applied to the sheet of paper through the jaws must be balanced by friction between the sheet of paper and the jaws. The distance from the jaw edge required to hold the sheet is termed the residual span. Previously, no adequate method for determining the residual span was available.

In this paper, a theoretical description of the load-displacement curve in a zero/short span test will be presented. The residual span, G_r, is assumed to be given by $G_r = kF / P_c$, where F is the force applied to the sample, k is a parameter, and P_c is the clamping pressure under the jaws. From the theory, two methods to determine *k,* and therefore the residual span for any load, will be presented. In the first method, complete load-displacement curves at several spans in the range 0.0-0.25 mm are fitted to determine *k* and other parameters included in the theory. The second method uses the breaking loads and displacements measured at the same spans as for the first method.

Four samples were tested- one unbleached Swedish softwood kraft, one bleached Swedish softwood kraft and two Swedish TMP samples. It was found that all tests showed significant sample take up- a sharp increase in jaw displacement at the start of the test as the slack in the sample is removed. The amount of take-up appeared to be related to the degree of shrinkage during drying. The effect of sample take-up was removed by fitting the data to estimate the true starting position of the test and then calculating all displacements with reference to this position.

At a load of 100 N/cm the estimated residual span for the unbleached kraft was 0.43mm. This is twice as large as previous estimations of residual span. The difference is likely due to a combination of the errors in previous methods in determining residual span as well as differences in jaw materials and effective clamping pressures between different versions of the zero span tester.

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