Bending Creep of Corrugated Fibreboard in Cycling Relative Humidity

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Andrew David McKenzie

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Abstract

Packaging of fresh fruit for export is a major use for corrugated fibreboard manufactured in New Zealand. However the cold and humid conditions used to preserve fruit quality are particularly detrimental to the strength of corrugated packaging.

The main objective of this study was to develop a method to measure the performance of corrugated fibreboard in high and cycling relative humidity environments. This method was then used to compare the performance of three corrugated fibreboards[1].

The creep performance of corrugated fibreboard was measured by subjecting samples to four point bending stress under controlled cyclic relative humidity conditions using a computer controlled testing apparatus. A mathematical model by Urbanik (1995) and an empirical exponential model were reviewed before selecting a three term model developed by Pecht (1985) to describe the deflection of the corrugated board.

Cyclic relative humidity accelerated the rate of creep compared to a static high humidity environment. The rate of creep in the machine direction was found to be considerably lower than that in the cross machine direction. It was also found that increasing the peak relative humidity from 80% to 90% RH dramatically changed the deflection response. This provides a solution to conflicting data in the literature on relative humidity cycling effects.

Isochronous deflection curves were used to compare the creep performance of the corrugated fibreboard samples in an environment cycling between 50% and 90% RH. Corrugated fibreboard sample *CB1* had a slightly lower creep stiffness than corrugated boards *CB2* (p=0.0580, n=8) and *CB3* (p=0.0398, n=8). However a greater number of tests would be required on a wider range of samples to conclusively determine if there were differences in board performance.

[1]For commercial reasons these will be referred to as 'CB1', 'CB2' and 'CB3'

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Glossary of Terms

Creep: deformation caused by stress applied over time

Doublebacker Linerboard glued to single face corrugated board

Furnish: the mix of fibre and chemical used to make paper

Grammage: mass per unit area in g/m^2 of an air dried sheet (also called ***Basis weight***)

Hygroexpansion: dimensional changes due to the sorption of moisture

Isochronous curve: stress versus strain at constant time

Isometric curve: stress versus time at constant strain

Kraft: wood pulp made using sodium hydroxide and sodium sulphide to dissolve wood lignin

Kraft linerboard: contains not less than 80% kraft pulp fibre

Mechanosorption: nonlinear interaction between applied stress and changing moisture content exhibited in creep behaviour

Mechanosorptive creep: cumulative ratcheting of deformation following each change in material moisture content

Medium: Paperboard used to form the corrugated centre of corrugated fibreboard

Singleface corrugated board: Linerboard glued to corrugated medium

Single facer: First linerboard glued to corrugated medium

Stress induced hygroexpansion: additional dimensional changes due to stress during sorption

Viscoelastic creep: deformation caused by stress and the time required for deformation to respond to stress