Technical Summary

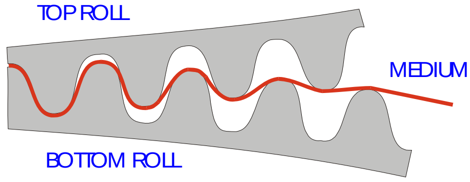
Korutest

# The global leader in box performance technology

## Quality - Sustainability - Profitability

## Introduction

The Chalmers DST (Dynamic Stiffness Tester) presents corrugated board manufacturers and users with a very powerful new tool to measure the quality of their corrugated board. The tester measures the MD Torsional Stiffness ( =Shear Stiffness) of a sample of corrugated board. This test is very sensitive to the structure of the board and the condition of the fluted medium.




$$F = F_t . e^{\mu\alpha}$$

$F$ = Force on medium
$F_t$ = Transport Tensile Force
$\mu$ = Coefficient of Friction
a = Sum of Angles of Wrap

Figure 1: Tensile forces on medium in nip

## Fluting process

During the corrugating process huge forces are imposed on the fluting medium. Figure 1 shows the tensile forces that the medium has to endure. With recycled fibre mediums the sheet is soft enough for easy compliance in the fluting labyrinth and there is usually enough wax in the paper to act as a lubricant to lower the friction and prevent flute fracture. Semichem mediums are more prone to fracture because of higher stiffness and a lack of lubricant. Wax bars or allowance in manufacture can overcome this.

The actual forces on the medium in the embossing zone are even higher than the equation shows because the medium gets wedged and comes to a stop just before full engagement of the embossing teeth. The tips of the flutes take the bulk of this effect. Intra-fibre bonding is repaired to a large extent by the emboss itself and the application of starch for the lamination of the liners.

Figure 2 shows bad flute fracture on a semichem medium.

Some interesting questions are:

How much damage is occurring in your corrugating process?

How well are the flutes being made on your corrugator?

Are your fluting rolls worn out?

What is the cross machine medium strength profile like?

How well does your gluing process work?

In short – how well are you making your corrugated board. Forget about the raw material quality we can easily measure that with Ring crush, SCT and tensile tests. What about the corrugated board?

If you do make the board right, then how much damage is incurred in the printing and case making process?

## Chalmers DST

The basis of the Chalmers DST is a torsion pendulum where the frequency of the pendulum oscillation is measured to directly give a measure of the torsional stiffness of the corrugated board sample.

Figure 2: Fractured SC medium

## *Some corrugating myths dispelled*

### *ECT and BCT tell me how well my boxes will perform.*

Wrong.

ECT tells you how well your supplier made the liners and medium. Flute damage occurs in the MD while ECT measures in the CD. There will be some loss in result with crushed board but ECT is not very sensitive to crush. ECT and BCT are closely related.

BCT tells you how well your boxes perform on a short term compression test. Boxes do not fail like this. If they are going to fail in a compression mode it is over time in the service environment at a much lower load than the BCT test will tell you. Cyclic humidity compression creep performance is a much better indicator of box performance in the service environment.

### *Caliper will tell me if the board is crushed.*

This is only partly true because of springback and the relative insensitivity of caliper to crush, the board will be much more damaged than you appreciate.

### *Flatcrush will tell me the strength of the medium in the board.*

Wrong.

Flatcrush is the compression resistance of the final collapse of the medium. The mediums performance as an engineering component of the corrugated board has long been destroyed at this stage. The final collapse is influenced by the mediums grammage but the difference in results of a badly crushed board versus a good board of the same material would not tell you the board had been crushed. Hardness is a much more reliable indicator for medium damage compared to flatcrush.

### *Corrugated board as an engineered material*

Corrugated board can be modelled using Finite Element Modelling or more simply as a three ply sandwich material using classical lamination theory where board stiffness is proportional to the tensile stiffness of the two liners multiplied by the square of the distance between them. It is the mediums job to keep this distance constant to maximise stiffness. If the medium is damaged by crushing, the thickness is reduced but even worse in a buckling situation, bending forces reduce this thickness even more. The stiffness is reduced by the factor of the square of the reduced thickness divided by the square of the original thickness. When buckling reaches a certain point the panel can no longer take compression loads which then fall entirely onto the corners and the tertiary failure zone is approached.

The problem of using board thickness to measure crush and ultimately board performance is in the fact that the springback effect after crush on board is quickly absorbed on bending and the true thickness effect occurs.

Bending stiffness is a much better test for board crush and likely performance than thickness, but MD torsional stiffness is an even better test for medium performance in the board structure.

***In a corrugated box under compression in the service environment, torsional stiffness failure precedes bending stiffness failure which precedes compression failure which leads to box failure.***