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SPECIFYING BOX PERFORMANCE

TYPICALLY, BOXES BULGE BECAUSE OF A LACK OF FLEXURAL RIGIDITY AND THEN COLLAPSE.

A VARIETY OF MEASUREMENTS EXIST, BUT DO THEY REALLY PROVIDE THE INFORMATION NEEDED TO GUARANTEE PERFORMANCE?

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Many years ago, box makers in the U.S. used to specify burst as a measure of box strength to satisfy transport requirements. Burst is essentially a paper strength property but it did give an idea of box component weight and liner strength. It suited board made from kraft liners but was hardly a measure of box performance as apart from a higher paper weight giving an overall improvement in most properties, it had no compression load component.

After lots of contemplation, burst was replaced by the Edge Crush Test (ECT) which is a combined board compression load measure, but gives little indication of how well the corrugated board or the box has been made. The idea of a box compression measure like ECT is excellent, but unfortunately boxes do not often fail purely in an ECT type failure mode. Typically, they bulge because of a lack of flexural rigidity and then collapse. This collapse is initiated by the bulge directing more load onto the corner regions close to the points where the horizontal and vertical edges meet. After this, the panels of the box break through compression failure in the inside liner. If a box was stiffer, this bulge would take longer to develop under load so the box would last a lot longer.

The Box Compression Test (BCT) is also commonly quoted but seldom guarantees a box's performance in the service environment and is impractical to use as a quick QC tool. BCT is better used as a box design tool. In a stacking situation in the service environment with changing humidity the load a box can take may only be a quarter or less than the BCT result. This is why we need to apply a safety or stacking factor to take a guess at how well the box will perform in real life.

None of these measures tell the box maker or his client how well the boxes have been made, and the difference between two boxes made from the same components with the same ECT but at different sites can be poles apart in box performance in real life. These differences can even be seen on the same site using the same board off the corrugator but converted on different flexo folder-gluers or box makers.

We need a number that specifies the stiffness and therefore the potential load carrying capacity of the box and a number that guarantees this performance.

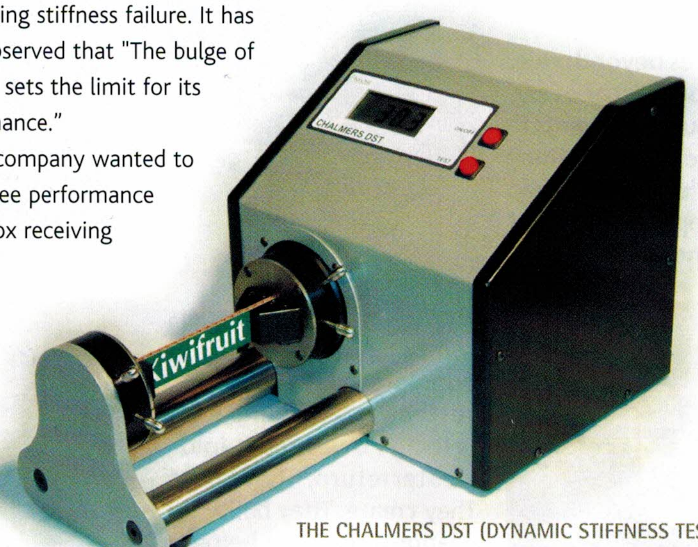
Alternative Method

Currently, many box producers are using nomenclature like 32 ECT or 44 ECT to describe a box's possible load carrying capacity to their customers. The ECT value can be achieved by quite a few different paper combinations, and the overall effect of this is a wide range in potential load carrying performance.

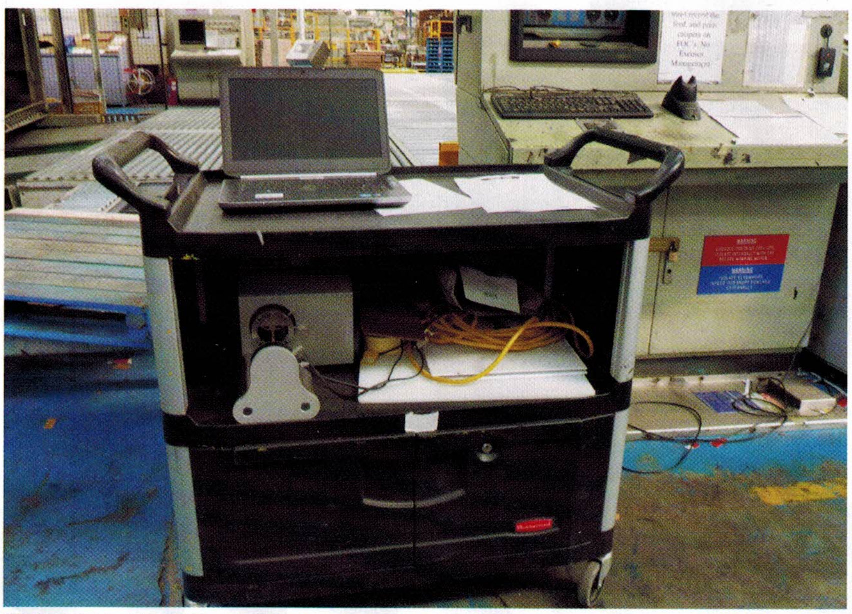
To properly define the potential load carrying performance of the box, we also need an engineering variable that describes how well the board has been made, the quality of the components and how well the board has been handled during the printing and formation stages. We would like to suggest that MD Torsional Stiffness using a Chalmers DST (dynamic stiffness tester) has been proven to be an extremely accurate measure of all the box making variables mentioned. Torsional stiffness is an easier way to measure shear stiffness, which is the primary failure mode that leads to bending stiffness failure. It has been observed that "The bulge of the box sets the limit for its performance."

If a company wanted to guarantee performance to its box receiving clients, it would specify the ECT for the grade plus the DST result to guarantee a level of this performance. This would be very simple. The figure would look like 32 ECT/10 where 32ECT is the current board grade and 10 is the DST result. The proposed DST figure can be obtained from a model using the paper components or from experience using this grade in your plant.

Most corrugating companies will



THE CHALMERS DST (DYNAMIC STIFFNESS TESTER) MEASURES THE MD TORSIONAL STIFFNESS (SHEAR STIFFNESS) OF CORRUGATED BOARD.



THIS DST AT AN AUSTRALASIAN BOX PLANT USES WI-FI TO CONNECT TO THE PLANT'S DATABASE COMPUTER SO THE INFORMATION IS AVAILABLE IMMEDIATELY.

require a bit of time to adjust their processes to meet the DST model figure, but it has been found that some corrugators can do this easily off the corrugator but destroy their advantage in the box making process.

We have seen many examples of where a 32 ECT box has failed miserably in service; the ECT result may be well over 32 (up to 40) but the board has been crushed and the DST result is something like 3 or 4 when it should be over 12.

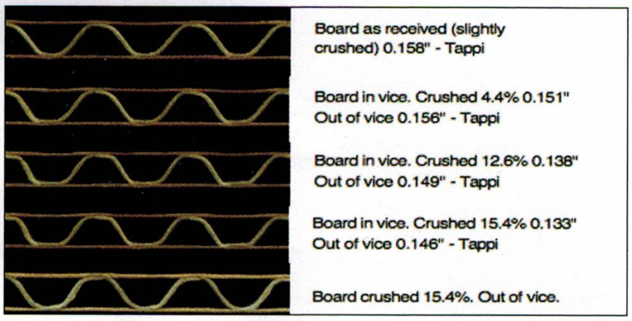
Table 1 (below) shows some data from an AICC box maker and how his results would look using the new suggested terminology.

TABLE 1: A TYPICAL AICC MEMBER'S TEST DATA.

Name	Flute	Board Combo	New Name	DST Model	Actual Board DST	Bd DSTpi
32ECT	C	33-23-33	32ECT/10	10.5	10.1	96%
32ECT	C	36-23-33	32ECT/10	10.9	12.8	117%
32ECT	B	33-33-33	32ECT/13	13.4	13	97%
44ECT	C	52-23-52	44ECT/15	15.5	12.6	81%
48ECT	BC	33-23-33-23-33	48ECT/26	26.8	29	108%
			nnECT/DST		One result below par	
					Most board meets spec	

The DST performance indicator (DSTpi) is the DST result expressed as a percentage of the theoretical model for the paper grades used.

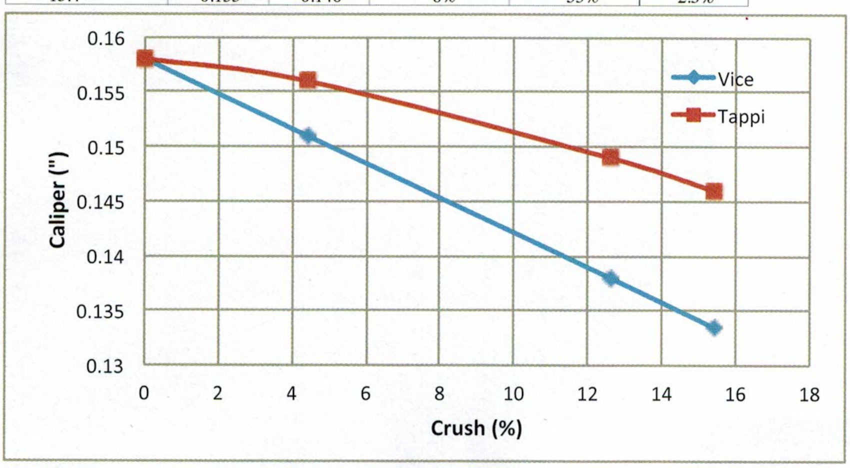
THIS C-FLUTE SAMPLE OF BOARD CRUSH HAS NO EFFECT ON ECT, BUT A SIGNIFICANT EFFECT ON DST. THE TOP FOUR PROFILES WERE PHOTOGRAPHED IN THE VICE AND THE BOTTOM PROFILE WAS PHOTOGRAPHED OUT OF THE VICE AFTER INSTANTANEOUS SPRING BACK. THE SPRING BACK HIDES A LOT OF CRUSH DAMAGE. THE 'OUT OF VICE – TAPPI' FIGURE IS THE THICKNESS AFTER SPRINGBACK USING A TAPPI WEIGHTED CALIPER BUT ISO UNITS.



BELOW: THE PLOT SHOWS THE BOARD SPRINGBACK CALIPER ON THE TAPPI CALIPER. THE TYPICAL CRUSH RESULTS FOR DST AND ECT ARE FROM A PREVIOUS STUDY BUT ARE TYPICAL FOR C-FLUTE PROPERTY LOSS VERSUS BOARD CRUSH.

TYPICAL CRUSH RESULTS

Crush %	Caliper Vice inch	Caliper Tappi inch	Caliper Lost	DST Lost	ECT lost %
0	0.158	0.158	0%	0%	0.0%
4.4	0.151	0.156	-1%	15%	0.8%
12.6	0.138	0.149	-6%	45%	1.9%
15.4	0.133	0.146	-8%	53%	2.5%



WE HAVE SEEN MANY EXAMPLES OF WHERE A 32 ECT BOX HAS FAILED MISERABLY IN SERVICE.

This plant makes good corrugated board and it is now up to the box making operators to produce boxes without crushing.

If higher quality medium is used (type or weight) or a different board combination is used, then a stiffer board can be made which will perform significantly better. We can then upgrade our board type or name from 32ECT/10 to say 32ECT/13. If other board grade names are used instead of the ECT series names, then the /DST can be added to the back of these names as well to guarantee board quality, e.g., 69B/12 or 108C/15. ■

Ian Chalmers is the principal of Korutest Limited. He has spent his entire career in the technical side of the paper and packaging Industry. For 17 years, up to 2009, he was employed as a senior scientist/Group Leader at Papro (Scion) researching corrugated board performance. He can be reached at Ian@korutest.com