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ABSTRACT



The main purpose of this project was to improve the transport test simulation used by ETI in terms of cost, workforce and time. Before this project, ETI used only the distance parameter as a multiplier when calculating BCT which can be considered as a criteria to determine package strength. We suggested to them such parameters as humidity, temperature, stack height, storage time and distance should also be used when calculating BCT. Afterwards, we calculated the proposed parameters, BCT by classifying countries and determining coefficients. With this work, we aimed to increase the efficiency of the strength calculation, to reduce the damage that may be caused by product damage during transportation, and to reduce the cost and non-efficient workforce.

On the other hand, ETI carried out a test process by loading packages into a truck and observing that the truck traveled a certain kilometer and how much of the products were damaged after this transportation process. With this project, we proposed two test devices to the company, these are vibration test device and compression test device. At the same time, we interviewed various companies in this process and researched ways to get these test devices at affordable prices.

OBJECTIVES

- To provide knowledge about testing applications for food products before logistics, transportation package suitability and product damage throughout the world.
- To be able to develop approaches and suggestions that can improve the current transport test model.
- To be able to develop approaches and suggestions that can improve the existing parcel strength calculation system of ETI.

RESEARCHES I -McKee Equation

- Purpose of the study: To verify the accuracy of McKee's formula.
- 7 different box sizes

$$BCT = 5.876 \times ECT \times \sqrt{U \times d} \quad \dots \dots \text{Equation 1}$$

where BCT = Box compression test/strength (lb), ECT = Edge crush test (lb/in), U = Footprint perimeter (in), and d = Wall thickness (in).

1. Effect of loading direction
2. The effect of base circumference and box volume
3. Influence of height
4. 50.48% overestimate for 5"x5"x48" box size
5. 69.36% underestimation for 6"x6"x12" box size

- As the box volume increases, the compressive strength per unit volume decreases rapidly.

The buckling curve is not linear.

It shows that the McKee formula can be significantly inaccurate.

Pm : Edge-Crush Value
Dx, Dy = bending stiffness value of the parcel in all directions
Z = circumference of the parcel to be modeled
P = total average strength
b ~ 0.75
a ~ 2 or 3

$$P = aP_m^b (\sqrt{D_x D_y})^{1-b} Z^{2b-1}$$

RESEARCHES II – BCT/ECT METHOD



$$ECT = k \cdot (\sigma_{L1} + \sigma_{L2} + \alpha \sigma_f)$$

k : Sabit sayı

σ_{L1} : Üst yüzey kâğıdı RCT (kN/m) veya SCT direnci (kN/m)

σ_{L2} : Alt yüzey kâğıdı RCT (kN/m) veya SCT direnci (kN/m)

α : Oluklandırma katsayısı

σ_f : Oluklu tabaka kâğıdı CCT direnci (kN/m)

When we look at the studies, it is seen that some process conditions influence the crush resistance of the corrugated box, as well as the edge crush resistance, the plate thickness and the box circumference. Many environmental factors such as transportation conditions, amount of glue, humidity are not included in the McKee formula. Firms should create their own formula variations by considering the following components (Anon, 1998).

1. Paper Combinations
2. Corrugation Coefficient and Weight of Intermediate Paper
3. Environmental Factors; Humidity, Storage Time, Pallet Spacing Factor
4. Factory k Variable (TOPSWIN program can be used)
 - ECT (edge crush test) is the edge crush strength of corrugated board
 - Edge crush resistance measures the resistance of corrugated boards to load parallel to the corrugations. When the boxes are stacked, they are under load in the same direction as the panels. This is an important resistance parameter for corrugated board. The ECT value is obtained in kN/m.
 - ECT values can be found with the formula or directly with the test machine.

BCT Formula on an Example

Let's assume that ETI will export to Norway in January. So, first we should check the season and apply the formula shown below.

- -9.9°C
- 82.30%
- 4271 km



TEMPERATURE	HUMIDITY	SHIP (1.5)	FOREIGN MARKET(3)
VERY COLD (3)	VERY HUMID(4)	Norway	Netherlands
Canada	Mauritius	USA	Belgium
Norway	Norway	Australia	Norway
China	South Africa	Algeria	Algeria
Mongolia	Israel	Morocco	Morocco
	Albania	Palestine	Palestine
		Canada	Lebanon
		Mauritius	Iraq
			Cyprus

$$3 * 4 * 1.5 * 3 = 54$$

CONCLUSION

After grouping the countries and giving different BCT coefficients suitable for these groups, the project was completed. However, ETI said that they will continue the project themselves, test the data found by us and make changes in their formulas according to the results. Therefore, our responsibility has been completed and there will be no future works.

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