Stacking Strength

The TOPS Pro software uses the McKee formula to calculate the stacking strength of a regular slotted container (RSC). Even though the McKee formula is a generally accepted design formula, it is still up to the packaging engineer to evaluate the degree to which this formula might apply and perform the physical tests to assure safety. Stacking Strength evaluations in TOPS normally begin by building the desired pallet pattern and selecting Stacking Strength menu option from the Tools menu.

New Feature: You can get stacking strength results for Non-RSC boxes. You can do this by specifying a Strength Factor (as % of RSC) for a non-RSC box through Define | Box Styles menu.

Note: Unless otherwise specified, all menu item references apply to TOPS Pro Config program.

The McKee Formula

McKee Formula = $(FC) \times (ECT) \times (BP)^{.4924} \times (Caliper)^{.5076}$

Lab Compression = [(McKee Formula) × (Shape Factor) × (Length-to-Width Ratio Factor) × (HFF) × (Printing Factor)]

Box Performance = [(Lab Compression) × (Flap Gap Factor) × (Humidity Factor) × (Storage Time Factor) × (Pallet Spacing Factor) × (Interlock Factor) × (Overhang Factor) + (Product Support)]

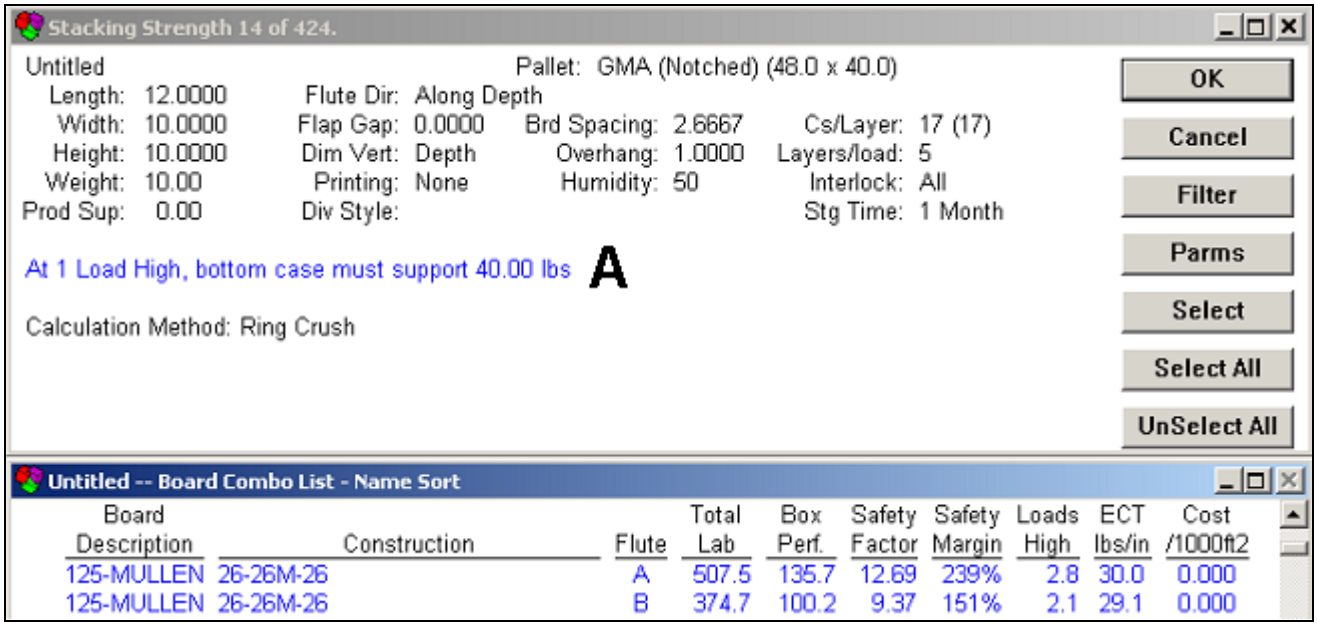
Key

FC - Flute Constant (5.87)
ECT - Edge Crush Test
BP- Box Perimeter
Overhang Factor =1 – [minimum of (square root of Overhang) × 32.25 ÷ 100, 1]
HFF-Horizontal Flute Factor = 1 unless non-vertical flute is selected. If non-vertical flute selected, TOPS Pro looks at HFF for the specific board grade. However, there is no generally accepted industry standard for how much a non-vertical flute's compression will degrade. TOPS currently ships with a HFF of 0.9 for a 10% reduction. Adjusted through Define | Board Combinations menu
Shape Factor - Table lookup based on proportions of box (relative to box depth) and dimension vertical. Adjusted through Define | Box Design Factors menu
Printing Factor - Table lookup based on printing type and quantity. Adjusted through Define | Box Design Factors menu
Product Support – Additional support to the overall stacking strength provided by the product inside the shipcase

For all other factors, TOPS Pro looks up the value in the table of environmental factors, in the TOPS Pro Config program. Other factors, which the McKee formula does not account for, include rough handling, transportation conditions, workers sitting on the box, die cuts, adhesive additives, etc. Users may adjust their stacking strength variables in TOPS Pro Config menu through Define | Environment Factors, Box Design Factors, Board Combinations, Paper, and Flute.

Suggestion: To reduce chances of "no answers" when calculating, do not filter (by flutes, loads high, compression strength, or safety factor) until you have seen the resulting Boards Grades, and then filter out the extras.

TOPS Pro Stacking Strength Results



Field Descriptions

Note: Board Combinations listed in blue color are acceptable stacking strength results

A: Amount of weight that a box on the bottom layer of bottom pallet must support

Lab Div: Lab Compression of the divider. This column appears if you have a divider specified. Each divider has a support factor that determines the amount of additional support that divider adds. (A support factor of 1 = no change.)

Lab Box: Lab Compression of the box without the divider. This column appears if you have a divider specified

Total Lab: Total Lab Compression = Lab Div + Lab Box

Box Perf.: Box Performance. The resulting compression strength taking into account the environmental conditions you've specified.

Safety Factor: Total Lab divided by the weight that the bottom case must support.

Safety Factor = Lab Box / A

Safety Margin: The percentage that the box performance exceeds the weight the bottom case must support. Boards with Safety Margins that are greater than zero are highlighted in blue.

Safety Margin = (Box Perf – A) / A

Load High: How many unitloads it takes to reach the limit (Box Perf) of a bottom-most case.

ECT lbs/in: The ECT of the board. If the calculation method is Edge Crush, it will be the empirical value entered for each board in the TOPS Config program. If the

calculation method is Ring Crush, TOPS will calculate the ECT from the Ring Crush Factor's (RCF) of each board's paper.

Cost/1000 ft2: The cost per 1000 square feet as entered into the board grade database.

Ring Crush to Edge Crush

When entering a new Board combination and when using the "Ring Crush" calculation method, single and double wall ECT's are calculated from liner/medium ring crush factors.

For Single Wall

A= (Liner1 RCF) +(Liner2 RCF)+
(Medium RCF)*(Flute TakeUp)

For Double Wall

A= (Liner1 RCF) +(Liner2 RCF)+(Liner3 RCF)+(Medium1 RCF)*(Flute TakeUp1)+(Medium2 RCF)*(Flute TakeUp2)

Then if the combined weight of the outside liners is <= 85 lbs per 1000 square feet then
ECT= (A/6)*.8+12 otherwise
ECT= (A/6)*1.27-6

This method of ECT calculation is known as the **"Over-Under 200" method**.