Retention Factors for Compression Strength of Corrugated Fibre Board Boxes

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Effect of Lateral Box Offset and Pallet Overhang on Compression Strength of Stacked Fiberboard Boxes and Impact on Stability, MSU 2008-2010

The last similar study was done in 1975 by FPL, Wisconsin
Part 1: Testing empty boxes (RSC)

• The single box compression strength for each box size was determined to represent as the box control compression strength.

• The compression strength of control boxes were compared to overall strength of a three-high stack and in three different offset configurations.

• In addition, a set of perfectly aligned boxes stacked three high were compression tested for comparison with control and mis-aligned stacked boxes.

• The stack configurations were offset either in the length, width or diagonally (both length and width) with an offset distance of 12.7 mm, 25.4mm or 38.1mm (0.5, 1, and 1.5 inches).
Effect of pallets and pallet patterns – GMA/CHEP

• The second part of the study compared column stack configurations with a three high stack on a CHEP® (block style) or GMA (stringer style) wood pallets.

• The unitized loads also compared the effect of pallet overhang and role of tie-sheets in between layers.
Keywords!

Box compression strength, Warehousing
Stack misalignment
Instability
Pallet under and overhang
Summary of 1975 Study

Presented as “CORRU~FACTS” that summarized “corrugated facts for users of corrugated packaging”

Pallet Overhang can reduce top to bottom compression up to 32%. Wooden pallets can reduce top to bottom compression up to 32%. Interlocked pattern can reduce top to bottom compression up to 55%.
Recommendations ’75 Study

To provide load stability of stacked corrugated boxes in transit a shipper had four options. These were reported as:

• Use of anti-skid treatment on the flaps of the containers to increase the coefficient of friction.
• Spot-gluing the tiers of a pallet load
• Use of a plastic or corrugated shroud.
• Use of a Master Pack
Pre-conditioning and Testing
How many D10 members test boxes regularly?

• Sample size
• Variation
• Pre-conditioning and actual test condition
<table>
<thead>
<tr>
<th>Box Type</th>
<th>ECT Kgf/cm</th>
<th>Length (m)</th>
<th>Width (m)</th>
<th>Height (m)</th>
<th>Fiberboard box Supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Box 1</td>
<td>5.71</td>
<td>0.48</td>
<td>0.38</td>
<td>0.25</td>
<td>Coastal Container, MI</td>
</tr>
<tr>
<td>Box 2</td>
<td>5.71</td>
<td>0.48</td>
<td>0.33</td>
<td>0.15</td>
<td>Coastal Container, MI</td>
</tr>
<tr>
<td>Box 3</td>
<td>5.71</td>
<td>0.38</td>
<td>0.25</td>
<td>0.25</td>
<td>South Haven Packaging, MI</td>
</tr>
<tr>
<td>Box 4</td>
<td>5.71</td>
<td>0.41</td>
<td>0.30</td>
<td>0.25</td>
<td>Michcor Container, MI</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Box Type</th>
<th>Compression Strength (lbs)</th>
<th>Max</th>
<th>Min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Box 1</td>
<td>227.7±14.7</td>
<td>261.9</td>
<td>196.5</td>
</tr>
<tr>
<td>Box 2</td>
<td>280.8±20.8</td>
<td>317.0</td>
<td>230.6</td>
</tr>
<tr>
<td>Box 3</td>
<td>138.1±15.1</td>
<td>160.4</td>
<td>102.4</td>
</tr>
<tr>
<td>Box 4</td>
<td>191.2±16.2</td>
<td>233.4</td>
<td>164.7</td>
</tr>
</tbody>
</table>
Percent Loss in box compression strength of aligned stack
3 stacked boxes v. single box

<table>
<thead>
<tr>
<th>Box. Type</th>
<th>Percent Loss Compression Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>Box 1</td>
<td>6.5%</td>
</tr>
<tr>
<td>Box 2</td>
<td>19.0%</td>
</tr>
<tr>
<td>Box 3</td>
<td>8.0%</td>
</tr>
<tr>
<td>Box 4</td>
<td>7.8%</td>
</tr>
</tbody>
</table>
Loss in Strength Due to Stack Offset

<table>
<thead>
<tr>
<th>Box Type</th>
<th>Length Panel</th>
<th>Off set (inches)</th>
<th>Off set 12.7 mm</th>
<th>Off set 25.4 mm</th>
<th>Off set 38.1 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Offset</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>12.7 mm</td>
<td>25.4 mm</td>
<td>38.1 mm</td>
<td></td>
</tr>
<tr>
<td>Box 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>11%</strong></td>
<td><strong>32%</strong></td>
<td><strong>40%</strong></td>
<td></td>
</tr>
<tr>
<td>Box 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>30%</strong></td>
<td><strong>40%</strong></td>
<td><strong>47%</strong></td>
<td></td>
</tr>
<tr>
<td>Box 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>32%</strong></td>
<td><strong>39%</strong></td>
<td><strong>42%</strong></td>
<td></td>
</tr>
<tr>
<td>Box 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>24%</strong></td>
<td><strong>41%</strong></td>
<td><strong>46%</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Width Panel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Box 1</td>
</tr>
<tr>
<td>Box 2</td>
</tr>
<tr>
<td>Box 3</td>
</tr>
<tr>
<td>Box 4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Adjacent Panels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Box 1</td>
</tr>
<tr>
<td>Box 2</td>
</tr>
<tr>
<td>Box 3</td>
</tr>
<tr>
<td>Box 4</td>
</tr>
</tbody>
</table>
Column v. Interlocked

Overhang v. Under-hang
### Percent Loss of Palletized Box Compression Strength on **GMA** with no Tie-Sheet

<table>
<thead>
<tr>
<th></th>
<th>Interlocked (Kg)</th>
<th>Overhang (Kg)</th>
<th>Interlocked Overhang (Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Box 1</td>
<td>28%</td>
<td>19%</td>
<td>34%</td>
</tr>
<tr>
<td>Box 2</td>
<td>23%</td>
<td>6%</td>
<td>24%</td>
</tr>
<tr>
<td>Box 3</td>
<td>15%</td>
<td>10%</td>
<td>28%</td>
</tr>
<tr>
<td>Box 4</td>
<td>35%</td>
<td>17%</td>
<td>34%</td>
</tr>
</tbody>
</table>

### Percent Loss of Palletized Box Compression Strength on **CHEP®** with no Tie-Sheet

<table>
<thead>
<tr>
<th></th>
<th>Interlocked (Kg)</th>
<th>Overhang (Kg)</th>
<th>Interlocked Overhang (Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Box 1</td>
<td>26%</td>
<td>--</td>
<td>27%</td>
</tr>
<tr>
<td>Box 2</td>
<td>25%</td>
<td>--</td>
<td>19%</td>
</tr>
<tr>
<td>Box 3</td>
<td>25%</td>
<td>16%</td>
<td>25%</td>
</tr>
<tr>
<td>Box 4</td>
<td>21%</td>
<td>5%</td>
<td>19%</td>
</tr>
</tbody>
</table>
CONCLUSIONS

1. A perfectly aligned stack of boxes shows a 6-19% reduction in compression strength when compared to the individual compression strength of a box. Stack misalignment contributes to significant reduction in box compression strength as shown in the results.

2. Reduction in box compression strength was the highest for stack offset along both the adjacent panels followed by length and width panel.

3. The compression strength of unitized and stacked boxes in an inter-lock pattern is lower than that of column stacked boxes, and is dependent on the size and shape of the box.
CONCLUSIONS

4. The compression strength of palletized empty corrugated boxes on a CHEP® pallet is higher than compression strength of similar stacked boxes on a GMA specified wood pallet.

5. The loss in compression strength with no tie-sheet between layers is more than with a tie-sheet when comparing stacked empty and palletized boxes.

6. The average loss in compression strength due to three-high palletization is 25% or boxes retain 75% of their original empty box compression strength.

7. The average loss in compression strength due to over-hang on a three high stacked boxes on a pallet is 13% or boxes retain 87% of their original empty box compression strength.
8. Loss of strength in stacked configurations affects the overall stability of stacked loads during warehousing and storage and can result in fatal results in the form of damage or injury.

9. Boxes tested for compression within 24 hours, show less variation (2-4%) in BCT as compared to those pre-conditioned for one week from the same lot (4-10%).
Questions?

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