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FOREST PRODUCTS LABORATORY

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TESTS OF FIBRE BOXES FOR THE KIECKHEFER BOX COMPANY

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TESTS OF FIBRE BOXES FOR THE KIECKHEFER BOX COMPANY

Summary

Tests of 280 fibre boxes were made in the small revolving drum. Twenty boxes of each of 14 different designs were tested to furnish averages upon which reliable conclusions might be based.

The purpose was to determine, for certain loads of canned goods, the relative serviceability of corrugated and solid fibre boxes; and the relative serviceability of solid fibre boxes with grain vertical and grain horizontal in sides and ends. Two different sizes of boxes were used, the smaller filled with 24 number two cans of corn, the larger with 48 tall size cans of milk. As was expected, the smaller boxes withstood much more tumbling in the drum.

The tests showed distinctly that the solid fibre boxes with the grain of the board vertical in sides and ends withstood considerably more tumbling in the drum before cutting and tearing occurred along the scores than the solid fibre boxes with horizontal grain. The direction of the grain of the board in the solid fibre boxes did not appear, in these tests, to have any constant relation to the number of drops required to spill the contents of the box. With contents of a different nature -- for example,

smaller cans -- the vertical grain would doubtless have shown an advantage in resisting loss of contents.

The solid fibre boxes were made of two different grades of fibre board, "AA" and "FF", the difference being in the liners. The solid fibre board used in these tests was four-ply board. The two outside plies of the Grade "AA" board were a better grade of liner and showed a higher average Mullen test than those of the Grade "FF" board. The boxes with the better grade of liner withstood considerably more rough handling, both before cutting and tearing occurred in the scores, and before final failure as shown by loss of contents.

The corrugated boxes, of which only one grade was tested in each size, gave results between the two grades of solid fibre boxes.

The results of the Mullen and Webb tests on any particular box did not prove to be an accurate indication of the amount of rough handling the box would withstand. It was true for the solid fibre boxes, however, that when the averages of the Mullen and the Webb tests for one series of boxes was appreciably higher than for another series, the first series withstood an appreciably larger number of drops in the drum before the contents spilled.

Both the Mullen and the Webb tests showed practically no difference due to testing the board from different sides. The Mullen test of the corrugated boxes was applied to the combined board, and the average results were comparatively low. All the Mullen and Webb tests were made under standard and constant humidity conditions.

A slight advantage in the use of "90-point" fibre board instead of "80-point" board was shown in the drum tests of the boxes of Grade "AA". This advantage did not appear in the boxes of Grade "FF".

Purpose

The main purpose of these tests of fibre boxes was two-fold:

1. To obtain a comparison of the general serviceability of solid fibre and corrugated boxes for carrying certain loads of canned foods.

2. To establish, for those loads, the relative value of solid fibre boxes with the grain of the board running vertically in sides and ends and solid fibre boxes with the grain running horizontally.

The results of the tests were also expected to furnish valuable information on the following points:

3. The value of the Mullen and Webb tests for predetermining the ability of a fibre box to withstand rough handling.

4. The relation of the average Mullen and Webb tests of a series of several boxes to the average amount of rough handling which the boxes of that series will withstand.

5. A comparison of Mullen and Webb test values when the fibre board is punched from opposite sides.

6. The relative serviceability of solid fibre boxes made of grade "AA" board and of grade "FF" board.

7. The relative serviceability of solid fibre boxes made of "80-point" board and of "90-point" board.

Description of Material

The cooperating company sent to the laboratory 25 boxes of each of the following designs:

Company designation	Contents	Grain	Grade of liner	Rated Thickness
A	24 #2 corn	Up and down	FF	.080
"	24 #2 corn	Around	FF	.080
B	24 #2 corn	Up and down	AA	.080
"	24 #2 corn	Around	AA	.080
C	48 Tall milk	Up and down	FF	.080
"	48 Tall milk	Around	FF	.080
D	48 Tall milk	Up and down	FF	.090
"	48 Tall milk	Around	FF	.090
E	48 Tall milk	Up and down	AA	.080
"	48 Tall milk	Around	AA	.080
F	48 Tall milk	Up and down	AA	.090
"	48 Tall milk	Around	AA	.090
G	24 #2 Corn	(Corrugated)	AA	.016*
H	48 Tall milk	(Corrugated)	AA	.016*

Four-ply fibre board was used in all of the solid fibre boxes. The inside dimensions of the boxes were as follows:

For 24 #2 cans, grain up and down 13-7/8 x 10-5/16 x 9-1/8
For 24 #2 cans, grain around 13 -13/16x 10-1/4 x 9-3/16
For 24 #2 cans, corrugated " x " x "
For 48 tall cans, grain up and down, 18-1/16 x 12 x 8-13/16
For 48 tall cans, grain around 18 x 11-15/16 x 8-7/8
For 48 tall cans, corrugated " x " x "

The boxes with the grain around were made 1/16 inch shorter, 1/16 inch narrower, and 1/16 inch deeper than the boxes with the grain up and down. The purpose of this variation in dimensions is to take care of the shrinkage of the fibre board, which is greater in the direction across the grain than in the direction of the grain.

* Each liner

The board used in the boxes was made of the following grades and thicknesses of ply:

.080 FF	2 plies	.016 F - R.R. Liner Av. Mullen 80-85
	1 ply	.019 Chip
	1 ply	.025 Chip
.080 AA	2 plies	.016 A - R.R. Liner Av. Mullen 105-110
	1 ply	.019 Chip
	1 ply	.025 Chip
.090 FF	2 plies	.016 F - R.R. Liner Av. Mullen 80-85
	2 plies	.025 Chip
.090 AA	2 plies	.016 A - R.R. Liner Av. Mullen 105-110
	2 plies	.025 Chip
200-pound corrugated board	2 plies	.016 A - R.R.Liner Av. Webb test 110
	1 ply	.009 corrugated strawboard

Matching and marking

Twenty boxes of each design were tested. Each set of twenty boxes is called in this report a "series". Each box was designated by series letter and by number.

All the boxes in a series were cut from the same sheet of fibre board. The solid fibre boxes were cut alternately with grain vertical and grain horizontal, and were numbered consecutively as they were cut from the sheet. The boxes with the grain vertical in sides and ends were given odd numbers; those with grain horizontal were given even numbers.

Description of Tests

The drum tests were made in the small revolving drum, a description of which is attached at the end of this report. The humidity of the drum room, as observed at half hour intervals during the tests, was fairly constant at from 33 to 38 per cent.

The Mullen and Webb tests were made in a room in which the humidity was automatically kept constant at about 63 per cent. Two Mullen tests were made on each box before the drum test was made. After the drum test, a disc was cut from each box and subjected to two Mullen, four Webb, and two thickness tests. The boxes and discs to be tested were placed in the constant-humidity chamber several hours before the Mullen and Webb tests, in order to be properly seasoned.

The boxes were all machine-sealed with silicate of soda on the day before the drum tests were made. The marking of the boxes for test was according to the standard laboratory method which is shown on the sketch attached at the end of this report.

The stages of failure observed in the drum tests were as follows: (1) First cut -- the first break an inch or more in length in any score. (2) Knockout -- a break thrucut the full length of any score. (3) Failure of the box as indicated by spilling of the contents.

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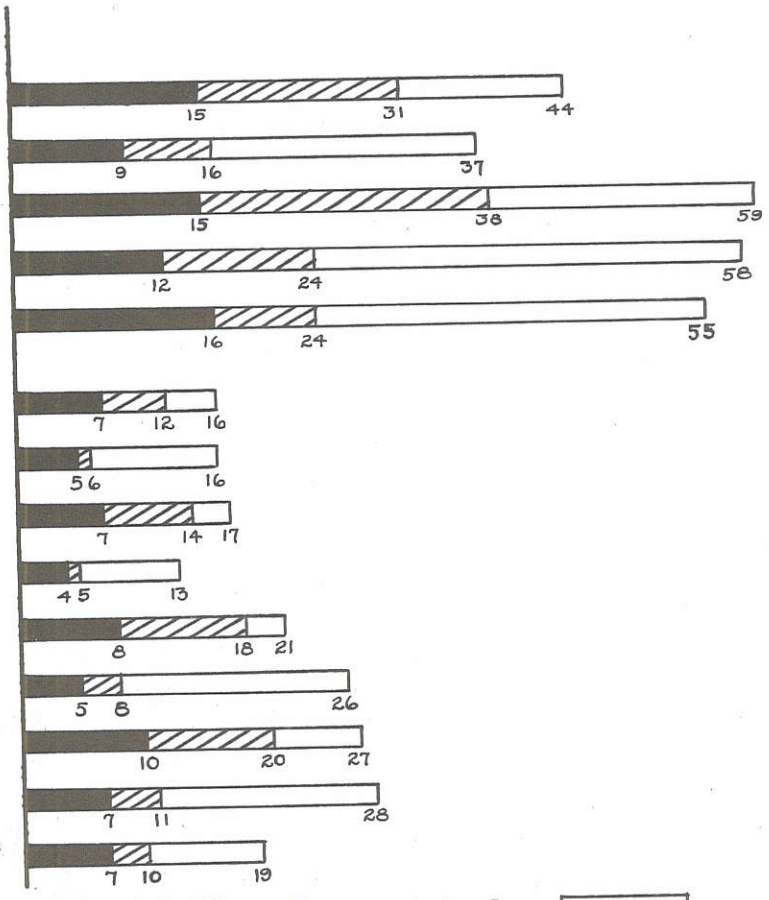
Summary of Results

Graph showing number of drops required to cause (1) first cut over one inch long in any score, (2) knockout - break along entire length of any score, (3) failure-spilling of contents. Load during test: Series A, B, and G,- 24 Number 2 cans of corn, 35 pounds net; series C, D, E, F, H,- 48 tall cans of milk, 56 pounds net.

Series	Grain	Grade	Average for series Mullen	Webb	Thickness
A	Vert.	FF	264	348	.081
A	Hor.	FF	263	353	.082
B	Vert.	AA	331	369	.085
B	Hor.	AA	331	366	.085
G	Corrugated		233	126*	.018*
C	Vert.	FF	266	344	.081
C	Hor.	FF	262	344	.081
D	Vert.	FF	274	342	.092
D	Hor.	FF	278	339	.092
E	Vert.	AA	326	364	.085
E	Hor.	AA	329	366	.085
F	Vert.	AA	358	381	.092
F	Hor.	AA	358	383	.093
H	Corrugated		233	124) 128	.018*



To first cut ■■■■ First cut to knockout ▨▨▨ Knockout to loss of contents □

*Each liner

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Analysis of Results

The first knockout (break thru the entire length of a score) occurred, nearly every time, in a horizontal end score. Thrucut the 280 boxes tested, there were only 27 exceptions to this rule. In 18 of the solid fibre boxes with horizontal grain, and in three corrugated boxes, the first knockout occurred in a horizontal side score. Six solid fibre boxes with vertical grain were also among the exceptions: in three of these a horizontal side score knocked out first; and in three a vertical end score knocked out first.

The knockout of a single score was not sufficient, with the size and shape of the cans used, to cause the contents of the boxes to spill. Loss of contents was usually due to the knockout of two scores meeting at a corner. Altho, as stated above, the first knockout was nearly always in a horizontal end score, the location of the subsequent knockouts was influenced by the direction of the grain of the board. With few exceptions, the knockout at which loss of contents occurred was in a vertical score when the grain of the board was vertical and in a horizontal side score when the grain of the board was horizontal.

Analysis of the results brings out some interesting points regarding the reliability of the Mullen and Webb tests for pre-determining the amount of rough handling

any particular box will withstand. A box which gave the highest Mullen test of a series was, in these tests, just as often below the average number of drops required to cause loss of contents as above, and vice versa; while the box giving the maximum Webb test in each series withstood less than the average number of total drops in 25 cases out of 42. Moreover, in one series, the box with the minimum Mullen test went the longest in the drum before spilling its contents. In each of three series, the box with the highest Mullen test withstood the least number of total drops. The box with the minimum Webb test in each of two series gave the highest total drops; while in one series, the box with the maximum Webb test withstood the least total number of drops.

While the Mullen and Webb tests did not give reliable indication of the serviceability of any particular box, the boxes made from the material with the higher Mullen and Webb tests gave, on the average, the better results.

Conclusions

The results of these tests of fibre boxes demonstrated the marked superiority of the box made of Grade "AA" board over the box made of Grade "FF" board for both loads tested. This superiority was shown both in increased resistance to cutting and knocking out of the scores and in the larger amount of rough handling required to cause loss of contents.

The corrugated boxes, of which only one grade was tested, gave results between the two grades of solid fibre boxes.

The solid fibre boxes with the grain vertical in sides and ends showed a marked advantage over those with the grain horizontal. This advantage appeared in the form of increased resistance to cutting and knocking out of the scores. But the direction of the grain of the board did not appear, in these tests, to have any constant relation to the total number of drops required to spill the contents of the box. If the contents had been of such a nature as to spill readily through the knockout of a single score, the vertical grain would doubtless have shown an advantage in resisting loss of contents.

The results of the Mullen and Webb tests on any particular box, of either corrugated or solid fibre, did not prove to be an accurate indication of the amount of rough handling the box would withstand before losing its contents. It was true for the solid fibre boxes, however, that when the averages of the Mullen and the Webb tests for one series of boxes were appreciably higher than for another series, the first series withstood an appreciably larger number of drops in the drum.

Neither the Mullen nor the Webb tests showed any appreciable difference due to testing the board from opposite sides.

The boxes made of Grade "AA", "90-point" fibre board withstood, on the average, slightly more tumbling in the drum before losing their contents than the boxes made of Grade "AA", "80-point" fibre board. This advantage of the "90-point" board did not appear in the boxes of Grade "FF".

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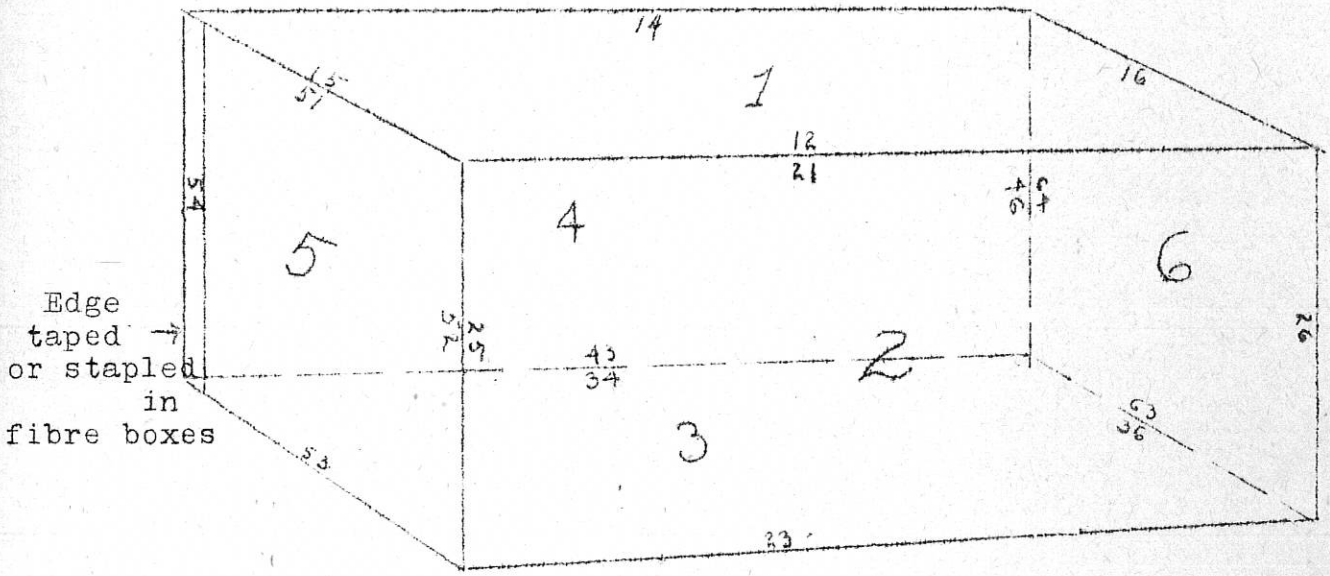
THE FOREST PRODUCTS LABORATORY STANDARD DRUM TEST

The most practical method yet devised for testing packing boxes is the revolving drum. This drum, as developed and used at the Forest Products Laboratory, is hexagonal in vertical cross section and revolves slowly. The box to be tested is packed with material simulating as closely as possible the actual contents carried in commercial service. On the six faces of the drum are a series of hazards, so arranged that the box tumbles and strikes on ends, sides, top, bottom, edges and corners. On one of the faces of the drum are knobs which represent the corners of another box. Each face of the drum is counted as one drop. These drops simulate the actual stresses, shocks, and rough handling which a package encounters in commercial service.

As the box moves on from one drop to the next, the observer notes and records each failure and the number of the drop at which it occurs. Such tests determine points of weakness in individual boxes and give a relative comparison of serviceability. The test is usually continued until the container loses its contents.



STANDARD MARKING OF BOXES FOR TEST.

Sketch showing method used by the Forest Products Laboratory of designating sides, top, bottom, and edges of a box under test.