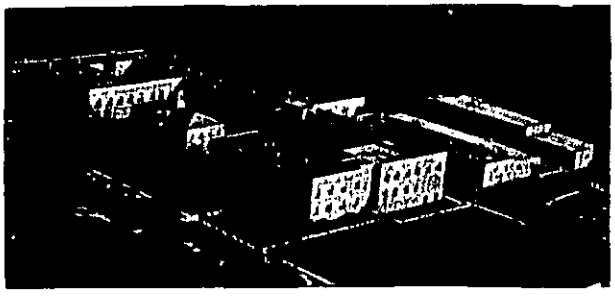
Technical meeting
June 18, 1963
(New York



THE INSTITUTE OF PAPER CHEMISTRY, APPLETON, WISCONSIN

FAILURE OF CORRUGATED BOXES UNDER LONG TERM LOADING— SUMMARY OF RESULTS AS OF JUNE 12, 1963

Project 1108-30

Report One

A Preliminary Report

to

TECHNICAL COMMITTEE OF THE
FOURDRINIER KRAFT BOARD INSTITUTE, INC.

June 13, 1963

THE INSTITUTE OF PAPER CHEMISTRY

Appleton, Wisconsin

FAILURE OF CORRUGATED BOXES UNDER LONG TERM LOADING— SUMMARY OF RESULTS AS OF JUNE 12, 1963

Project 1108-30

Report One

A Preliminary Report

to

TECHNICAL COMMITTEE OF THE
FOURDRINIER KRAFT BOARD INSTITUTE, INC.

June 13, 1963

TABLE OF CONTENTS

THE INSTITUTE OF PAPER CHEMISTRY

Appleton, Wisconsin

FAILURE OF CORRUGATED BOXES UNDER LONG TERM LOADING— SUMMARY OF RESULTS AS OF JUNE 12, 1963

INTRODUCTION

It may be recalled that the Fourdrinier Kraft Board Institute has initiated a study of the creep or storage characteristics of corrugated boxes. The purpose of this study is to predict the box stacking (long-time) performance from a knowledge of the creep characteristics of the combined board via the present equations for top load box compression.

The experimental program involves determination of the creep characteristics of (a) corrugated boxes in compression subjected to various dead loads, and (b) combined board subjected to edgewise compression and flexural stresses.

MATERIALS

Fifteen box samples have been received as described in Table I. A number of additional samples were received too late for inclusion in the table. The top load compression results for a number of the samples are shown in Table II.

TABLE I

DESCRIPTION OF BOX SAMPLES

Sample No.	Flute	Series	Size	Mfg. Joint
2406	A	200	16x12-1/4x9-1/2	Taped
2407	A	200	21x17-1/2x19	Taped
2408	A	200	23-1/2x23-1/2x19	Taped
2430	A	200	23-1/2x14x12	Taped
2456	A	175	13-1/4x6-5/8x12-1/2	Taped
2460	A	175	20-1/4x11-1/4x7-1/4	Glued
2467	A	275	24x14-1/2x17-1/4	Taped
2500	A	200	23-1/8x11-1/4x16-1/8	Stitched
2457	C	350	12-1/4x12-1/4x19-3/16	Glued
2461	C	350	16x11-1/2x30-1/2	Taped
2496	C	200	11-1/2x8-1/2x6	Glued
2468	B	275	23x22-3/4x13	Glued
2497	B	200	15-3/8x10-1/4x11-3/4	Glued
2498	B	275	17-7/8x16x11-3/8	Stitched
2499	B	350	18-7/8x16x11-5/16	Taped

TABLE II

TOP LOAD COMPRESSION RESULTS

Code	Flute	Series	Top Load Compression, lb. 0-0.75	Top Load Compression, lb. 0-1.0	Max. Deflection, inch
2406	A	200	940	940	0.59
2407	A	200	975	975	0.64
2408	A	200	1180	1180	0.67
2430	A	200	1060	1060	0.61
2456	A	175	555	555	0.44
2457	C	350	975	1235	0.93
2460	A	175	775	775	0.43
2461	C	350	1650	1715	0.70
2467	A	275	1270	1270	0.58

DISCUSSION OF RESULTS

BOX CREEP TESTS

Equipment has been built to permit simultaneous testing of twenty-four boxes. In general, it is planned to evaluate four boxes from each box sample at four ratios of applied load to top load box compression strength. These ratios are: 0.50, 0.55, 0.625, and 0.75. Based on the work of Kellicutt and Landt (1), these applied load ratios should result in average failure times of approximately 300, 85, 14, and 0.6 days.

The results obtained to date are summarized in Tables III and IV in terms of failure life and deflection prior to failure, respectively. It may be noted that

a. At 0.75 load ratio average times to failure ranged from 0.38 to 12.13 days for the three A-flute Samples 2406, 2407, and 2456. Thus, it appears that the average time to failure will be considerably greater than the expected value of 0.6 days based on Reference (1).

b. At the lower load ratios, it also appears that longer average failure lives will be obtained. For example, all four boxes from Sample 2407 at 0.55 ratio have survived 114 days whereas the expected average would be 85 days.

c. Box deflections near creep failure are about equal to those obtained in the conventional top load compression test.

With regard to (a) and (b) above, it may be noted that the results in Reference (1) were based on tests involving one B-flute and one or more solid

fiber samples. More recently Kellicutt suggests that considerably longer creep failure lives for A-flute and double-wall boxes may be obtained. This would be more in line with the results in Table III. If additional tests continue to confirm this trend, the load ratios selected above will be revised to give more practical time periods.

TABLE III

SUMMARY OF BOX CREEP RESULTS

Applied Load Ratio	Specimen No.	Failure Time, days					
		Sample 2406	Sample 2407	Sample 2408	Sample 2430	Sample 2456	Sample 2457
0.75	1	0.22	0.44			6.46	17.74
	2	0.47	32.08			4.16	
	3	0.50	15.49			0.03	
	4	0.32	0.70			0.24	
	Av.	0.38	12.13			2.72	
0.625	1	33.8	15.8	16.5	29.8	over 9	
	2	4.8	13.6	over 65	over 60	" 3	
	3	over 113	95.9			" 3	
	4	" 85	over 107				
	Av.						
0.55	1	113.1	over 114				
	2	114.5					
	3	over 118					
	4	" 118					
	Av.						
0.50	1	over 120	over 114				
	2						
	3						
	4						
	Av.						

TABLE IV

COMPARISON OF BOX CREEP DEFLECTIONS PRECEDING FAILURE WITH MAXIMUM DEFLECTION IN THE BOX COMPRESSION TEST

	Deflection, inch					
	Sample 2406	Sample 2407	Sample 2408	Sample 2430	Sample 2456	Sample 2457
Max. deflection (box compression test), inch	0.59	0.64	0.67	0.61	0.44	0.93
Creep failure defl., inch[a]						
0.75 load ratio						
1	0.64	0.57			0.44	0.84
2	0.65	0.68			0.39	
3	0.56	0.61			0.39	
4	0.59	0.54			0.37	
Av.	0.61	0.60			0.40	
0.625 load ratio						
1	0.63	0.67	0.62	0.61		
2	0.63	0.56				
3		0.68				
4						
Av.						
0.55 load ratio						
1	0.60					
2	0.58					
3						
4						
Av.						

[a]The creep failure deflection is defined as the last recorded value of the box deflection prior to box collapse.

COMBINED BOARD CREEP TESTS

On the assumption that the edgewise compression strength of combined board is the dominant factor in box compression under creep conditions as well as in short-term tests, attention has been directed to developing a column creep test. In a later phase, the creep behavior of combined board in flexure will be studied.

A prototype model of a column creep tester has been constructed and found to perform satisfactorily. It is anticipated that several additional testers will be constructed in the near future, incorporating a number of simplifications, several improvements and some additional deflection and time-measuring devices.

A limited amount of column creep data have been obtained for Sample 2407, as shown in Table V. The tests have been restricted thus far to the higher load ratios, leading to short duration times. At the present time there are insufficient box creep data and column creep data for this sample to enable drawing conclusions as to the relationship between box and combined board creep performance.

TABLE V

PRELIMINARY DATA ON COLUMN CREEP BEHAVIOR
OF COMBINED BOARD FROM SAMPLE 2407

Applied Load Ratio[a]	Specimen No.	Failure Time, days
0.75	1	0.17
	2	0.05
	Av.	0.11
0.686	1	0.56
	2	2.26
	Av.	1.41 ± 0.31
0.625	1	12.30
	2	Test in progress, 46 days

[a]Edgewise compression strength = 41.2 lb./in.

LITERATURE CITED

1. Kellicutt, K. Q., and Landt, E. F. Basic design data for use of fibreboard in shipping containers. Forest Products Laboratory Report No. 1911, Sept., 1958.

THE INSTITUTE OF PAPER CHEMISTRY

William J. Whitsitt
Research Aide, Container Section

Robert C. McKee, Chief
Container Section