

## CHAPTER 4

### TEST RESULTS OF CORRUGATED FIBREBOARD BOXES

#### NECESSITY OF TESTS

The objective of this research is to study problems on corrugated fibreboard and corrugated fibreboard boxes used for packing canned products and to find out factors affecting the strength of these boxes.

In order to identify these factors, study should be conducted on these boxes starting from the canning factory and continuing until they reach their destination. Evaluating from physical appearance of corrugated fibreboard boxes does not suffice to tell which properties have deteriorated and what their actual residual strengths are. Therefore, it is necessary to determine the mechanical properties of box material before and after in-house transportation (from factory to warehouse), then compare the test results with those obtained from similar boxes before packing.

In addition, the minimum requirement of compression strength for corrugated fibreboard boxes for canned products was determined. So that the optimal design of corrugated fibreboard boxes for canned products can be obtained.

#### PREPARATION FOR TESTS

In preparing for tests, the following steps were taken.

## 1. Selecting Sources of Test Samples

Two factories were selected for this research as follows :

1.1 One factory is located not too far away from the destination.

### Kiang Hua Co., Ltd.

Testing Samples<sup>\*)</sup> : (a) Product - Sardine in round can, size 202x308 (i.e.  $2 \frac{2}{16}$  inches in diameter and  $3 \frac{8}{16}$  inches in height). Total weight of product (average) is 212.15 g. per can and 21.22 kg. per box. A box contains 100 cans in configuration pattern lxxd of 10x 5x2

(b) Box - Corrugated fibreboard box, single wall type with B-flute, having the dimension lxxd of 550.0 mm. x 272.4 mm. x 180.4 mm. and manufacturer's joint (glued joint) of 27.6 mm. Box type is RSC, the inner and outer flaps being closed with glue and glue paper used to seal the joint between the outer flaps. Basis weight (average) of the components of corrugated fibreboard for outer liner, corrugating medium and inner liner is 177.39, 131.88 and  $181.35 \text{ g/m}^2$ , respectively. Interlocking stacking pattern was applied composing of 6-8 layers of boxes with 8 boxes in each

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\*) Data obtained from the laboratory tests.

layer. Duration of storage in warehouse averaged 2 days and frequency of transferring 3 times. The storage condition averaged 31.5°C in temperature and 67 % in relative humidity.

Factory Address : 31 Sukumvit Road, Tumbon Parknum, Amphur Maueng, Samutprakarn.

Transportation Distance: 40 kilometres from factory to warehouse which located on Sipraya Road, Bangrug , Bangkok.

Transporting Mode : By trucks.

1.2 The other is located at a further distance from the destination.

Kwaung Paisarn Food Product Co., Ltd.

Testing Samples<sup>\*)</sup> : (a) Product. - Sardine in round can, size 202x308 (i.e.  $2 \frac{2}{16}$  inches in diameter and  $3 \frac{8}{16}$  inches in height). Total weight of product (average) is 210.50 g. per can and 21.05 kg. per box. A box contains 100 cans in configuration pattern lxxd of 10x5x2

(b) Box. - Corrugated fibreboard box, single wall type with B-flute, having

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\*) Data obtained from the laboratory tests.

the dimension l<sub>x</sub>w<sub>x</sub>d of 554.2 mm. x 282.0 mm. x 190.8 mm. and manufacturer's joint (glued joint) of 26.9 mm. Box type is RSC, the inner and outer flaps being closed with glue and glue paper used to seal the joint between the outer flaps. Basis weight (average) of the components of corrugated fibre-board for outer liner, corrugating medium and inner liner is 196.99 , 123.04 and 190.71 g/m<sup>2</sup>, respectively. Interlocking stacking pattern was applied composing of 15 layers of boxes with 18 boxes in each layer. Duration of storage in warehouse averaged 60 days and frequency of transferring at least 6 times. The storage condition averaged 30<sup>o</sup>C in temperature and 69 % in relative humidity.

Factory Address : 321/23 Hua Yod Road, Amphur Maueng, Trung.

Transportation Distance: 880 kilometres from factory to warehouse which located on Chiangmai Road, Klongsarn, Bangkok.

Transporting Mode : By trucks.

## 2. Studying Transportation System of Factories.

Study was conducted and data obtained from both factories,

such as, capacity of production, configuration pattern of product, unit weight of product, manufacturing process, characteristic and frequency of handling or transportation, total units of product per box, gross weight of total products, weight of box, configuration pattern of boxes, condition of the storage, type of transporting vehicle, and transportation distance from the canning factories to their destinations.

### 3. Box-Sampling for Tests

Thirty-six corrugated fibreboard boxes were sampled, i.e. eighteen boxes from Kiang Hua Co., Ltd. (six pre-packing boxes and twelve post-shipment boxes), and other eighteen boxes from Kwaung Paisarn Food Product Co., Ltd. (six pre-packing boxes and twelve post-shipment boxes).

Sample size and method of sampling for testing are in accordance with ISO. 186-1977.<sup>15)</sup>

### 4. Testing

All pre-packing boxes and post-shipment boxes were conditioned in accordance with TIS. 321-1979.<sup>14)</sup> (at  $27.0 \pm 2.0^{\circ}\text{C}$  ,  $65.0 \pm 2.0\%$  RH and at a minimum of 24 hours condition-period).

### 5. Analysis.

Factors affecting corrugated fibreboard boxes strength were determined for the optimal design of corrugated fibreboard boxes.

## TESTING

The following tests are conducted at the Thai Packaging Centre of the Thailand Institute of Scientific and Technological Research.

### 1. Bursting Strength Test.<sup>17)</sup>

ISO 2759, ASTM D2738, TAPPI T810, or FEFCO Testing Method No. 4 may be applied for test on bursting strength (Figure 4.1).



Figure 4.1 : Bursting Strength Test

### 2. Puncture Resistance Test.<sup>18)</sup>

ISO 3036, ASTM D781, TAPPI T803, or FEFCO Testing Method No. 5 may be applied for puncture resistance test (Figure 4.2).

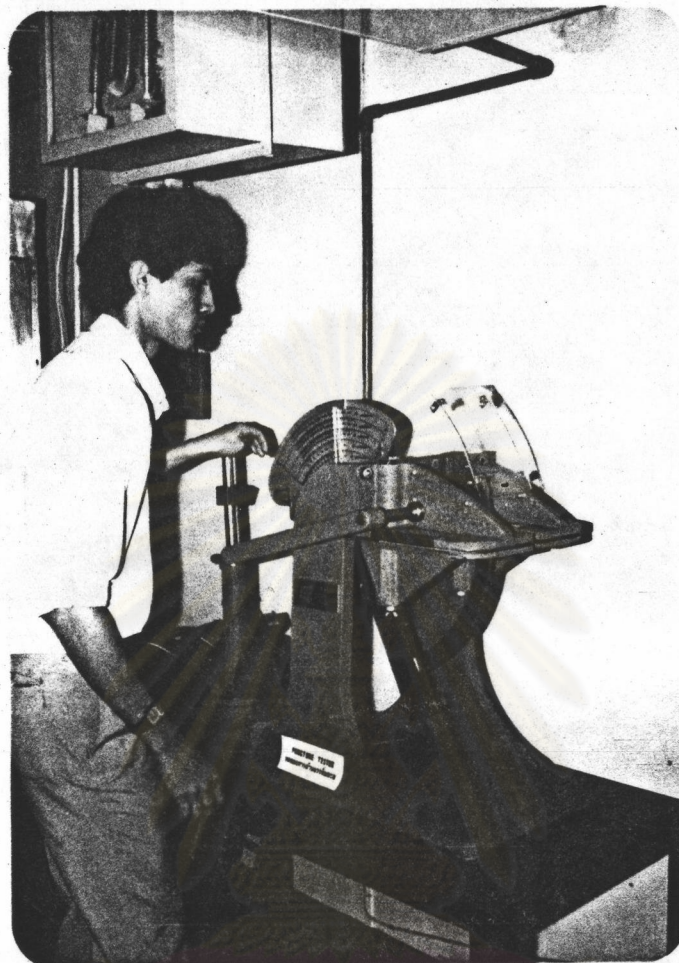


Figure 4.2 : Puncture Resistance Test

3. Edgewise Crush Test.<sup>19)</sup>

ISO 3037, ASTM D2808 or FEFCO Testing Method No. 8 may be applied for ECT (Figure 4.3).

4. Flat Crush Test.<sup>16)</sup>

ISO 3035, ASTM D1225, TAPPI T808, or FEFCO Testing Method No. 6 may be applied for FCT (Figure 4.4).

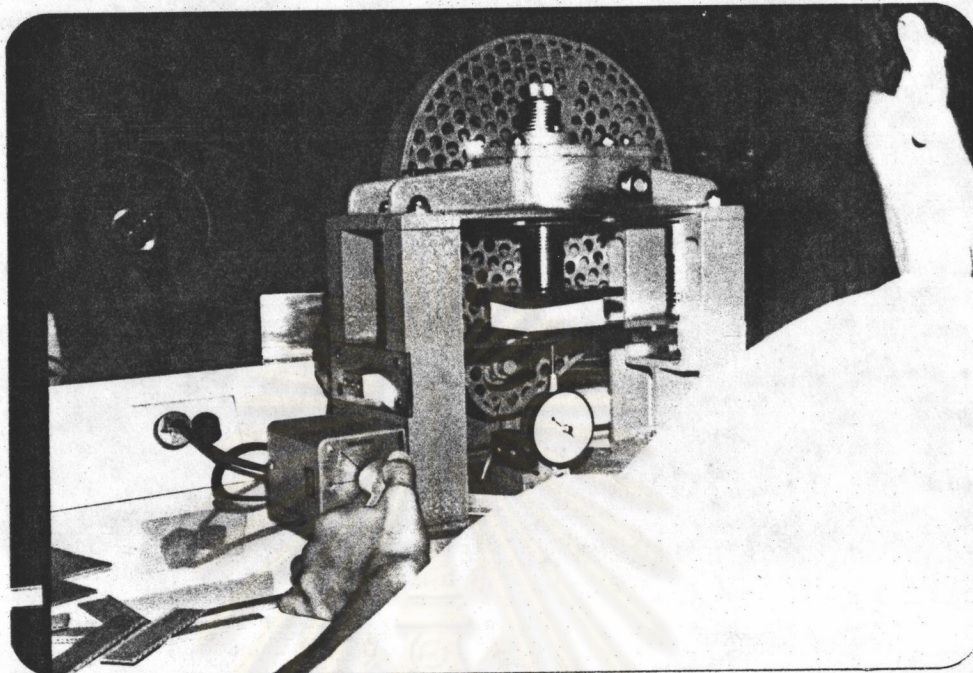


Figure 4.3 : Edgewise Crush Test

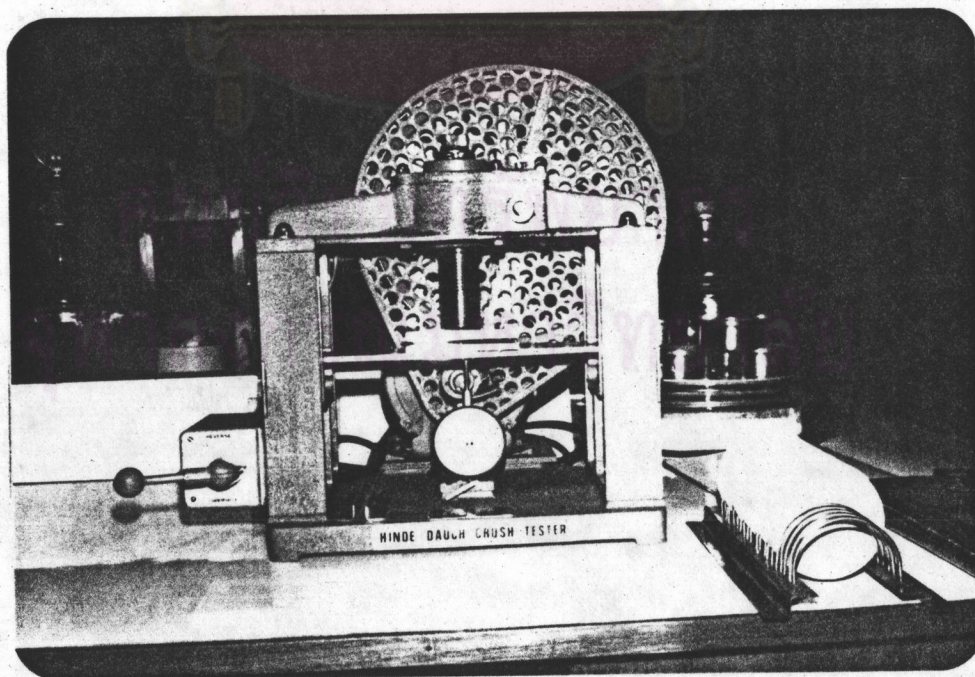


Figure 4.4 : Flat Crush Test



### 5. Ring Crush Test.<sup>21)</sup>

TIS 321, ASTM D1164, or TAPPI T472 may be applied for RCT (Figure 4.5).



Figure 4.5: Ring Crush Test

### 6. Basis Weight Test.

TIS 170, ISO 3039, ASTM D646, TAPPI T410, or FEFCO Testing Method No. 2 may be applied for basis weight test (Figure 4.6).

### 7. Box Compression Test<sup>22)</sup>

ASTM D642 or FEFCO Testing Method No. 50 may be applied for BCT.

## TEST RESULTS

The test results are divided into 2 sections, based on the sources of test samples, i.e. Kiang Hua Co.,Ltd. and Kwaung Paisarn Food Product Co., Ltd.

The following characteristics and properties were determined.

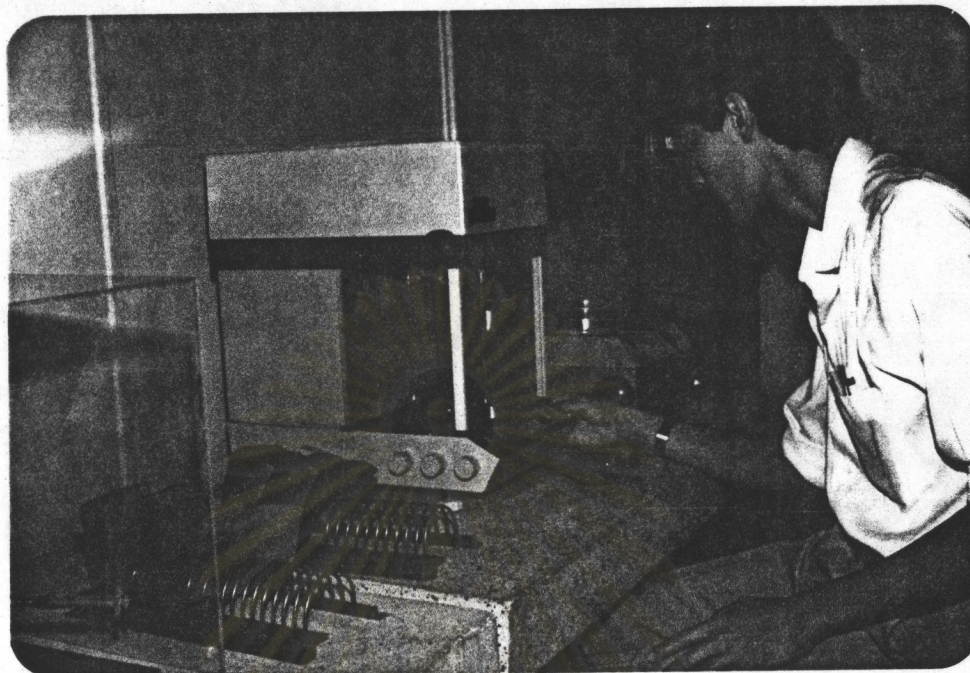


Figure 4.6 : Basis Weight Test

1.1 Inside Dimensions. The length, the width and the depth of box were measured. Five readings in millimetres were obtained for each dimension.

1.2 Manufacturer's Joint. Five readings per box of overlapping width of the manufacturer's joint were obtained. Sample size of 5 boxes were measured, in mm.

1.3 Thickness of Corrugated Fibreboard. Five test pieces were measured and the thickness values were reported in mm.

1.4 Number of Flutes per Metre. Five readings were obtained on 5 test pieces.

1.5 Bursting Strength. Twenty 15 cm. x 15 cm. test pieces

were tested in accordance with ISO 2759<sup>17)</sup>, and the results reported in  $\text{kgf./cm}^2$ .

1.6 Puncture Resistance. Eight 30 cm. x 30 cm. test pieces were tested in accordance with ISO 3036<sup>18)</sup>, and the results reported in  $\text{kgf. cm}$ .

1.7 Flat Crush Resistance. Ten  $66.58 \text{ cm}^2$  test pieces were tested in accordance with ISO 3035<sup>16)</sup>, and the results reported in  $\text{kgf./cm}^2$ .

1.8 Ring Crush Resistance. Thirty test pieces, i.e. 10 from outer liners, 10 from corrugating mediums and 10 from inner liners, each with a length of 153.0 mm. and a width of 12.5 mm., were tested in accordance with ASTM D1164<sup>21)</sup>, and the results reported in  $\text{kgf./cm}$ .

1.9 Edgewise Crush Resistance. Ten 10 cm. x 2.5 cm. test pieces were tested in accordance with ISO 3037<sup>19)</sup> and the results reported in  $\text{kgf./cm}$ .

1.10 Basis Weight. Thirty test pieces, i.e. 10 from outer liners, 10 from corrugating mediums and 10 from inner liners, each with the dimension 10 cm. x 10 cm., were tested in accordance with ISO 3039<sup>20)</sup> and the results reported in  $\text{g/m}^2$ .

1.11 Box Compression Test. Five boxes were tested in accordance with ASTM D642<sup>22)</sup> and the results reported in N.

Details of the test results of Kiang Hua boxes are shown in Table 4.1 for pre-packing boxes and in Table 4.2 for post-shipment boxes. Table 4.3 gives the comparison between the test results of the both.

Details of the test results of Kwaung Paisarn Food Product boxes are shown in Table 4.4 for pre-packing boxes and in Table 4.5 for post-shipment boxes. Table 4.6 gives the comparison between the test results of the both.

#### PROPOSED BOXES : TESTING AND RESULTS.

In the second stage of the research, Kiang Hua Co., Ltd. was selected to be subjected to the test for the model of the proposed boxes for the reasons of the short distance of transportation and short period of storage. The author was able to follow up the performance of the model during the shipping. The proposed boxes, in addition, could decrease the cost per unit of corrugated box (see Table 5.5).

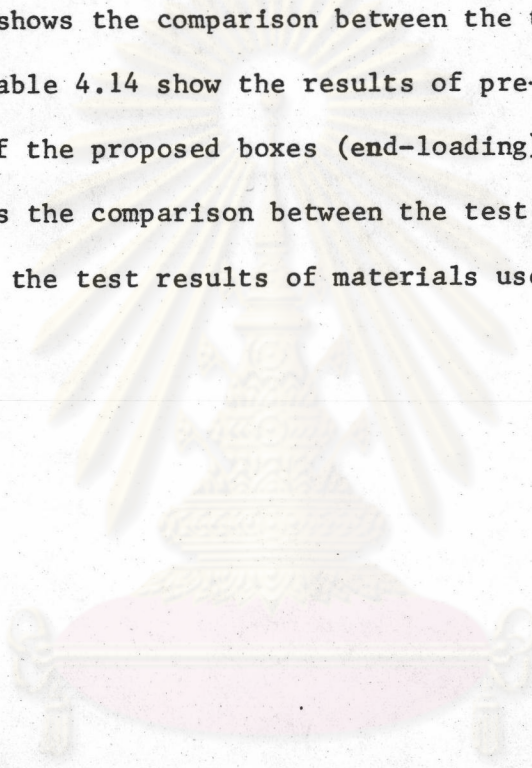
Forty eight of model boxes used in this experiment (sample size and method of sampling for testing are in accordance with ISO 186-1977<sup>15)</sup>) were equally divided into 3 groups as follows.

- 1) Controllable Box (factory's box),
- 2) Proposed Box (RSC, top-loading),
- 3) Proposed Box (RSC, end-loading).

All boxes were positioned as shown in Figure 4.7.

The following tests were conducted : box compression strength, bursting strength, ring crush resistance, box dimension and basis weight. The test results from the first stage as shown in Tables 4.1-4.6 indicated that the other properties of box were not the main effects to weaken the box.

Details of the test results of the models are shown in Tables 4.7-4.15. Table 4.7 and Table 4.8 show the results of pre-packing and of post-shipment boxes of the controllable boxes, respectively, and Table 4.9 shows the comparison between the test results of both. Table 4.10 and Table 4.11 show the results of pre-packing and of post-shipment boxes of the proposed boxes (top-loading), respectively, and Table 4.12 shows the comparison between the test results of both. Table 4.13 and Table 4.14 show the results of pre-packing and of post-shipment boxes of the proposed boxes (end-loading), respectively, and Table 4.15 shows the comparison between the test results of both. Table 4.16 shows the test results of materials used for the models.



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Front of  
the truck

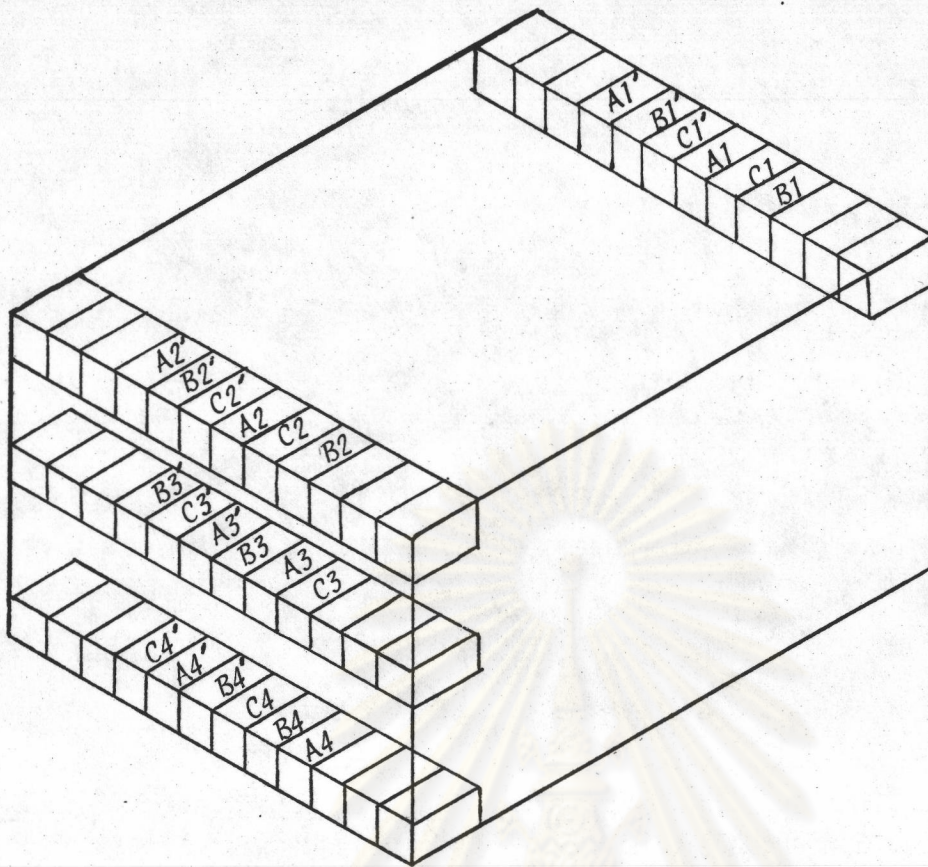
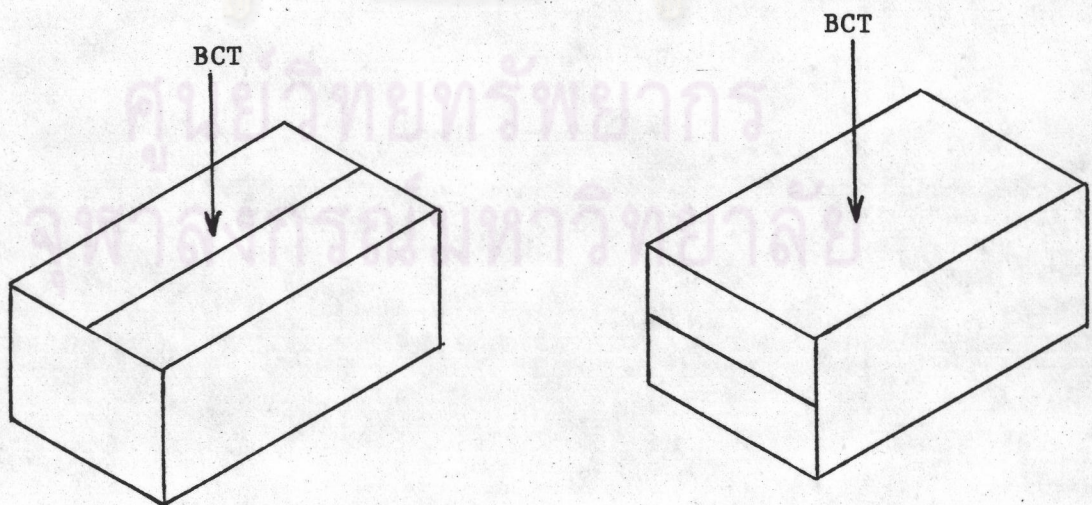


Figure 4.7 : Positioning of the Models on the Truck.

Remark : A = Controllable boxes

B = Proposed boxes (top-loading)

C = Proposed boxes (end-loading)



(a) top-loading style

(b) end-loading style

Figure 4.8 : Two Styles of the Proposed Boxes.

### Calculation for Proposed Boxes

(1). A corrugated fibreboard box will be designed for canned sardines of Kiang Hua Co., Ltd. based on the following data :

- dimension of can (diameter x height) : 5.4 cm x 8.9 cm;
- package size (box) : 100 cans ;
- configuration pattern : 10 l x 5 w x 2 d ;
- total weight of contents per box : 21.22 kg ;
- stacking pattern : interlocking with 8 layers of boxes laid on the rigid floor ;
- storage duration : 2 days at 67 % RH ;
- handling frequency : 3 times, max.

Calculation : The research reveals that the formulae 1 and 2 can be used under the following conditions, either :

(1) When it has been determined how the box and the contents (cans) will receive the load between them.

(2) When the minimum requirement of compression strength of the box has been determined. The research reveals that the latter method gives a more accurate result. The minimum requirement of BCT of Kiang Hua Co., Ltd. obtained from the research (see Table 4.3 in chapter 4.) is,

$$\begin{aligned} \text{BCT} &= 783 \text{ N} \\ &= 79.82 \text{ kg.} \end{aligned}$$

With the aid of the program computer (Appendix D.), the dimensions of box are given below,

Box dimensions (length x width x depth) : 54 cm x  
27 cm x 17.8 cm

Style of box : RSC

Pattern configuration : 10 l x 5 w x 2 d

Area of board used per box : 7,681.04 cm<sup>2</sup>

ECT of corrugated fibreboard can be determined from the  
formula,

$$BCT = 5.87 ECT \sqrt{ZH}$$

when  $BCT = 79.82 \text{ kg}$

$$Z = 2 (54+27)$$

$$= 162 \text{ cm}$$

$H = 0.30 \text{ cm}$  (Table A.2 in Appendix A.). B-flute  
is selected for making the package for canned sardines (see under  
"Properties of Corrugated Fibreboard" and "Uses of Corrugated Fibre-  
board" in chapter 2).

$$79.82 = 5.87 \times ECT \times \sqrt{(162) \times (0.30)}$$

then  $ECT = 1.95 \text{ kg/cm}$

Find RCT of linerboards (single-wall board and corrugating  
medium grade of CA 125<sup>\*)</sup> are used) :

$$ECT = k \left| \sum RCT_{\text{liners}} + \sum (c.RCT_{\text{mediums}}) \right|$$

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\*) See Table A.1 in Appendix A.



when

$$\begin{aligned} \text{ECT} &= 1.95 \text{ kg/cm} \\ k &= 1.20 \text{ (Table A.2 in Appendix A.)} \\ c &= 1.36 \text{ (Table A.2 in Appendix A.)} \\ \text{RCT}_{\text{medium}} &= 0.62 \text{ kg/cm (Table A.1 in Appendix A.)} \end{aligned}$$

$$1.95 = 1.20 \left| \Sigma \text{RCT}_{\text{liners}} + (1.36)(0.62) \right|$$

then

$$\Sigma \text{RCT}_{\text{liners}} = 0.78 \text{ kg/cm}$$

$$\begin{aligned} \text{RCT of each linerboard} &= \frac{0.78}{2} \\ &= 0.39 \text{ kg/cm} \end{aligned}$$

Using Table A.1 in Appendix A., the RCT value obtained will give the grade of linerboard required. In this case KI125 is selected.

The design derived for corrugated fibreboard box for canned sardine of the company includes the following :

- box dimension (length x width x depth) : 54 cm x 27 cm x 17.8 cm ;
- pattern configuration : 10 l x 5 w x 2 d ;
- box style : RSC ;
- fibreboard used : single wall with B-flute ;
- area of board used per box : 7,681.04 cm<sup>2</sup> ;
- basis weight of linerboards : 125 g/m<sup>2</sup> ;
- basis weight of medium : 125 g/m<sup>2</sup>.

(2) . A corrugated fibreboard box will be designed for canned sardines of Kwaung Paisarn Food Product Co., Ltd. based on the following data :

- dimension of can (diameter x height) : 5.4 cm x 8.9 cm ;
- package size (box) : 100 cans ;
- configuration pattern : 10 l x 5 w x 2 d ;
- total weight of contents per box : 21.05 kg ;
- stacking pattern : interlocking with 15 layers of boxes laid on the pallet ;
- storage duration : 60 days , min. at 69 % RH ;
- handling frequency : 6 times , min.

Calculation : From Table 4.6 in chapter 4. , BCT of box of Kwaung Paisarn Food Product Co., Ltd. is obtained,

$$\begin{aligned} \text{BCT} &= 1760 \text{ N} \\ &= 179.41 \text{ kg.} \end{aligned}$$

Using the program computer (Appendix D.), the derived dimensions of box are given below,

Box dimensions (length x width x depth) : 54 cm x 27 cm x 17.8 cm.

Style of box : RSC

Pattern configuration : 10 l x 5 w x 2 d

Area of board used per box : 7,681.04 cm<sup>2</sup>.

Obtain ECT of corrugated fibreboard form the formula :

$$\text{BCT} = 5.87 \text{ ECT} \sqrt{\text{ZH}}$$

when

$$\text{BCT} = 179.41 \text{ kg}$$

$$\text{Z} = 2(54 + 27)$$

$$= 162 \text{ cm}$$

$H = 0.30$  cm (Table A.2 in Appendix A.), B-flute is selected for making package for canned sardines (see under "Properties of Corrugated Fibreboard" and "Uses of Corrugated Fibreboard" in chapter 2.).

$$179.41 = 5.87 \times \text{ECT} \times \sqrt{(162) \times (0.30)}$$

then  $\text{ECT} = 4.38$  kg/cm

Obtain RCT of linerboards (single-wall board and corrugating medium grade of CA 125<sup>\*)</sup> are used) :

$$\text{ECT} = k \left| \sum \text{RCT}_{\text{liners}} + \sum (c \cdot \text{RCT}_{\text{mediums}}) \right|$$

when  $\text{ECT} = 4.38$  kg/cm

$$k = 1.20 \text{ (Table A.2 in Appendix A.)}$$

$$c = 1.36 \text{ (Table A.2 in Appendix A.)}$$

$$\text{RCT}_{\text{medium}} = 0.62 \text{ kg/cm (Table A.1 in Appendix A.)}$$

$$4.38 = 1.20 \left| \sum \text{RCT}_{\text{liners}} + (1.36)(0.62) \right|$$

then  $\sum \text{RCT}_{\text{liners}} = 2.81$  kg/cm

$$\therefore \text{RCT of each liner} = \frac{2.81}{2}$$

$$= 1.40 \text{ kg/cm.}$$

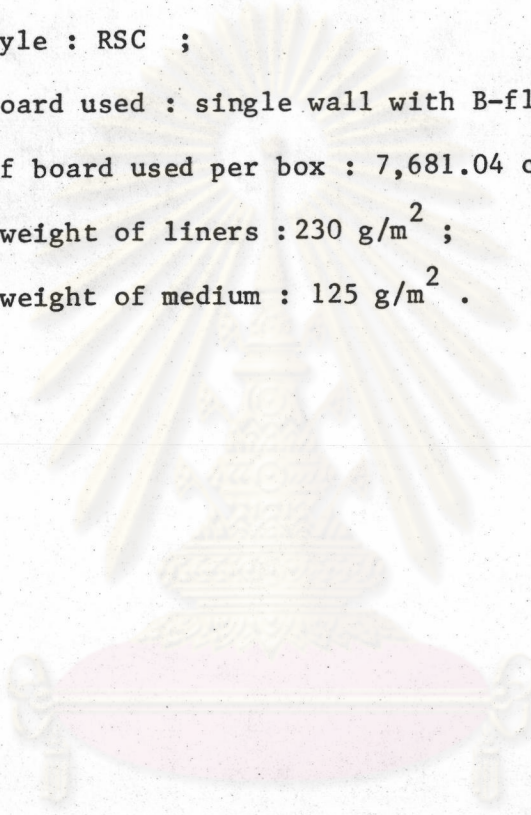
Using Table A.1 in Appendix A., the RCT value obtained will give the grade of linerboard required. In this case, KA 230 is selected.

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\*) See Table A.1 in Appendix A.

The design derived for corrugated fibreboard box for canned sardine of the company includes the following :

- box inside dimension (length x width x depth) : 54 cm x 27 cm x 17.8 cm ;
- pattern configuration : 10 l x 5 w x 2 d ;
- box style : RSC ;
- fibreboard used : single wall with B-flute;
- area of board used per box : 7,681.04 cm<sup>2</sup> ;
- basis weight of liners : 230 g/m<sup>2</sup> ;
- basis weight of medium : 125 g/m<sup>2</sup> .



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Table 4.1 Test Results : Corrugated Fibreboard Boxes (Pre-Packing) of Kiang Hua Co., Ltd.

Items of test	Units	Results of test						
		1	2	3	4	5	$\bar{x}$	S.D.
1. Dimensions of box	mm.							
1.1 Length		552 <sup>M</sup>	550	551	549 <sup>m</sup>	550	550.4	1.14
1.2 Width		273	272	272	274 <sup>M</sup>	271 <sup>m</sup>	272.4	1.14
1.3 Depth		180	182 <sup>M</sup>	180	179 <sup>m</sup>	181	180.4	1.14
2. Overlapping of manufacturer's joint.	mm.	29	27	23 <sup>m</sup>	30 <sup>M</sup>	29	27.6	2.79
3. Combined board thickness	mm.	2.6 <sup>m</sup>	2.7	2.9	2.9 <sup>M</sup>	2.7	2.76	0.13
4. Number of flutes per metre	-	154	154	154	154	154	154	0

Remark : M = Maximum value

m = Minimum value

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Table 4.1 (Continued)

Items of test	Units	Results of test											$\bar{x}$	S.D.
		1	2	3	4	5	6	7	8	9	10			
		11	12	13	14	15	16	17	18	19	20			
5. Basis weight	g/m <sup>2</sup>													
5.1 Outer liners		175.24	177.45	175.85	177.85	174.69 <sup>m</sup>	179.67	182.18 <sup>M</sup>	181.62	175.72	175.62	177.589	2.71	
5.2 Corrugating mediums		133.58 <sup>M</sup>	132.03	132.42	130.77	129.84 <sup>m</sup>	132.06	131.76	132.34	132.82	131.85	131.947	1.04	
5.3 Inner liners		183.55	185.55 <sup>M</sup>	177.60 <sup>m</sup>	182.60	183.20	181.48	181.00	178.43	180.90	179.11	181.342	2.48	
6. Puncture resistance	kgf.cm.	31.11 <sup>m</sup>	34.16	31.41	34.16	31.72	37.21	37.82 <sup>M</sup>	35.68	-	-	34.159	2.61	
7. Flat crush resistance	kgf/cm <sup>2</sup>	2.10 <sup>M</sup>	2.02	2.01	1.67 <sup>m</sup>	1.93	1.76	2.00	1.88	1.83	1.98	1.918	0.13	
8. Ring crush resistance	kgf/cm													
8.1 Outer liners		1.83	1.83	1.67	1.86 <sup>M</sup>	1.80	1.67	1.78	1.60 <sup>m</sup>	1.80	1.70	1.754	0.09	
8.2 Corrugating mediums		0.78	0.82 <sup>M</sup>	0.75	0.82	0.82	0.65	0.73	0.67	0.64 <sup>m</sup>	0.78	0.746	0.07	
8.3 Inner liners		1.83	1.93	1.86	1.80 <sup>m</sup>	1.99 <sup>M</sup>	1.93	1.93	1.96	1.90	1.88	1.901	0.06	
9. Edgewise crush resistance	kgf/cm	4.75	4.70	4.90	4.70	4.80	4.80	5.10 <sup>M</sup>	4.60 <sup>m</sup>	4.60	4.70	4.765	0.15	
10. Bursting strength	kgf/cm <sup>2</sup>	10.2	10.6	11.0	11.6	10.4	10.2	11.2	10.4	10.2	9.4	10.9	0.79	
		9.4 <sup>m</sup>	10.8	11.2	11.6	12.0 <sup>M</sup>	12.0	11.8	11.8	11.0	11.2			

Remark : M = Maximum value

m = Minimum value

Table 4.2 Test Results : Corrugated Fibreboard Boxes (Post-Shipment) of Kiang Hua Co., Ltd.

Items of test	Units	Results of test						
		1	2	3	4	5	$\bar{x}$	S.D.
1. Dimensions of box	mm.							
1.1 Length		551	550 <sup>m</sup>	552 <sup>M</sup>	550	551	550.8	0.84
1.2 Width		277 <sup>m</sup>	279 <sup>M</sup>	277	278	277	277.6	0.89
1.3 Depth		177 <sup>m</sup>	178	178	179 <sup>M</sup>	178	178.0	0.71
2. Overlapping of manufacturer's joint	mm.	23 <sup>m</sup>	26 <sup>M</sup>	25	24	26	24.8	1.30
3. Combined board thickness	mm.	2.9 <sup>M</sup>	2.9	2.8 <sup>m</sup>	2.9	2.9	2.88	0.04
4. Number of flutes per metre	-	154	154	154	154	154	154	0

Remark : M = Maximum value

m = Minimum value

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Table 4.2 (Continued)

Items of test	Units	Results of test										$\bar{x}$	S.D.	
		1	2	3	4	5	6	7	8	9	10			
		11	12	13	14	15	16	17	18	19	20			
5. Basis weight	$g/m^2$													
5.1 Outer liners		174.66 <sup>m</sup>	180.27	178.56	184.86 <sup>M</sup>	177.96	179.45	177.45	176.08	179.47	177.53	178.629	2.75	
5.2 Corrugating mediums		134.89	126.27 <sup>m</sup>	131.20	132.83	135.53 <sup>M</sup>	127.64	132.95	132.34	132.40	127.63	131.368	3.17	
5.3 Inner liners		174.21	166.89	179.27	175.62	180.12 <sup>M</sup>	176.12	166.86	163.71 <sup>m</sup>	179.86	167.46	173.012	6.21	
6. Puncture resistance	kgf.cm	32.63	32.02	31.11	30.50 <sup>m</sup>	34.16	38.12 <sup>M</sup>	34.46	31.11	-	-	33.01	2.51	
7. Flat crush resistance	kgf/cm <sup>2</sup>	2.10	2.58	2.13	2.33	2.24	2.27	2.60 <sup>M</sup>	2.10	1.98 <sup>m</sup>	2.21	2.254	0.20	
8. Ring crush resistance	kgf/cm													
8.1 Outer liners		1.68	1.70	1.67	1.81 <sup>M</sup>	1.60	1.52 <sup>m</sup>	1.73	1.67	1.73	1.65	1.676	0.08	
8.2 Corrugating mediums		0.77	0.72	0.78	0.63 <sup>m</sup>	0.82 <sup>M</sup>	0.71	0.74	0.71	0.74	0.74	0.736	0.05	
8.3 Inner liners		1.44	1.31	1.31	1.23 <sup>m</sup>	1.31	1.50 <sup>M</sup>	1.27	1.50	1.50	1.50	1.387	0.11	
9. Edgewise crush resistance	kgf/cm	4.60	4.70	3.70 <sup>m</sup>	4.00	3.90	4.95 <sup>M</sup>	4.45	4.75	4.95	4.55	4.455	0.44	
10. Bursting strength	kgf/cm <sup>2</sup>	10.8	11.0	10.8	10.2	10.2	9.2	10.8	10.8	10.2	8.0 <sup>m</sup>	10.43	0.80	
		11.2	9.2	11.0	10.4	11.8	11.4 <sup>M</sup>	10.6	10.6	10.8	10.6			

Remark : M = Maximum value

m = Minimum value



Table 4.3 : Comparison between Test Results of Pre-Packing and Post-Shipment Boxes of Kiang Hua Co., Ltd.

Items	Units	Pre-packing boxes	Post-shipment boxes	Residual strengths(%)
1. Bursting strength	kgf/cm <sup>2</sup>	10.9	10.43	95.69
2. Puncture resistance	kgf.cm	34.16	33.01	96.63
3. Flat crush resistance	kgf/cm <sup>2</sup>	1.92	2.25	117.19
4. Ring crush resistance	kgf/cm			
4.1 Outer liners		1.75	1.68	96.00
4.2 Corrugating mediums		0.75	0.74	98.87
4.3 Inner liners		1.90	1.39	73.16
5. Edgewise crush resistance	kgf/cm	4.76	4.45	93.49
6. Box compression strength	N	2400	1617 <sup>*)</sup>	67.37

Remark : <sup>\*)</sup> May be used for the determination of the minimum requirement of compression strength of the box :

$$\begin{aligned}
 \text{Minimum requirement of BCT} &= 2400 - 1617 \\
 &= 783 \text{ N} \\
 &= 79.82 \text{ kg}
 \end{aligned}$$

Table 4.4 : Test Results : Corrugated Fibreboard Boxes (Pre-Packing) of Kwaung Paisarn Food Product Co., Ltd.

Items of test	Units	Results of test						
		1	2	3	4	5	$\bar{x}$	S.D.
1. Dimensions of box	mm.							
1.1 Length		554 <sup>m</sup>	555 <sup>M</sup>	554	554	554	554.2	0.45
1.2 Width		280 <sup>m</sup>	282	285 <sup>M</sup>	282	281	282.0	1.87
1.3 Depth		191 <sup>M</sup>	191	190 <sup>m</sup>	191	191	190.8	0.45
2. Overlapping of manufacturer's joint	mm.	28.4	27.9	24.9 <sup>m</sup>	28.5 <sup>M</sup>	25.0	26.94	1.83
3. Combined board thickness	mm.	2.8 <sup>m</sup>	2.8	2.9 <sup>M</sup>	2.8	2.8	2.82	0.04
4. Number of flutes per metre	-	154	154	154	154	154	154	0

Remark : M = Maximum value

m = Minimum value

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Table 4.4 (Continued)

Items of test	Units	Results of test										$\bar{x}$	S.D.	
		1	2	3	4	5	6	7	8	9	10			
		11	12	13	14	15	16	17	18	19	20			
5. Basis weight	$g/m^2$													
5.1 Outer liners		196.35	201.08	202.48 <sup>M</sup>	198.24	194.49	198.19	196.40	193.62 <sup>m</sup>	193.82	195.25	196.992	3.01	
5.2 Corrugating mediums		119.19 <sup>m</sup>	122.58	121.89	121.43	126.34	125.61	121.55	122.98	122.27	126.59 <sup>M</sup>	123.043	2.40	
5.3 Inner liners		191.09	192.14	191.81	189.41	193.56 <sup>M</sup>	188.19	192.40	191.79	189.86	186.89 <sup>m</sup>	190.714	2.08	
6. Puncture resistance	kgf.cm	34.16 <sup>m</sup>	34.77	43.00	35.68	43.61 <sup>M</sup>	35.07	37.21	39.65	-	-	37.89	3.76	
7. Flat crush resistance	kgf/cm <sup>2</sup>	1.49	1.82	1.81	1.54	1.64	1.49	1.84	1.89 <sup>M</sup>	1.44	1.39 <sup>m</sup>	1.635	0.19	
8. Ring crush resistance	kgf/cm													
8.1 Outer liners		1.86 <sup>m</sup>	1.93	1.93	2.09	2.03	1.93	1.99	2.16 <sup>M</sup>	2.03	1.96	1.991	0.09	
8.2 Corrugating mediums		0.56	0.52	0.50	0.52	0.44 <sup>m</sup>	0.72 <sup>M</sup>	0.52	0.62	0.72	0.52	0.564	0.09	
8.3 Inner liners		1.83	1.86	1.67 <sup>m</sup>	1.83	1.83	1.83	1.67	1.93	2.19 <sup>M</sup>	2.06	1.870	0.16	
9. Edgewise crush resistance	kgf/cm	4.40	4.50	4.40	3.70 <sup>m</sup>	3.70	4.90 <sup>M</sup>	4.60	4.60	3.80	4.00	4.260	0.43	
10. Bursting strength	kgf/cm <sup>2</sup>	11.4	11.6	13.4 <sup>M</sup>	9.2 <sup>m</sup>	12.4	11.2	10.6	12.0	13.0	10.2	11.61	1.30	
		13.2	10.4	12.4	9.6	13.0	13.2	11.6	10.4	12.8	10.6			

Remark : M = Maximum value

m = Minimum value

Table 4.5 : Test Results : Corrugated Fibreboard Boxes (Post-shipment) of Kwaung Paisarn Food Product Co., Ltd.

Items of test	Units	Results of test						
		1	2	3	4	5	$\bar{x}$	S.D.
1. Dimensions of box	mm.							
1.1 Length		553 <sup>m</sup>	553	555 <sup>M</sup>	554	553	553.6	0.89
1.2 Width		282 <sup>M</sup>	282	280 <sup>m</sup>	281	280	281.0	1.00
1.3 Depth		192 <sup>M</sup>	190 <sup>m</sup>	191	191	190	190.8	0.84
2. Overlapping of manufacturer's joint	mm.	28.5	28.5	27.8 <sup>m</sup>	29.2	29.5 <sup>M</sup>	28.70	0.67
3. Combined board thickness	mm.	2.4 <sup>m</sup>	2.6	2.8 <sup>M</sup>	2.5	2.8	2.62	0.18
4. Number of flutes per metre	-	154	154	154	154	154	154	0

Remark : M = Maximum value

m = Minimum value

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Table 4.5 (Continued)

Items of test	Units	Results of test										$\bar{x}$	S.D.										
		1	2	3	4	5	6	7	8	9	10												
		11	12	13	14	15	16	17	18	19	20												
5. Basis weight	$g/m^2$																						
5.1 Outer liners		174.32 <sup>m</sup>	184.12	182.65	185.52	187.78	193.75 <sup>M</sup>	187.45	190.84	189.17	186.18	186.178	5.27										
5.2 Corrugating mediums		129.58	128.85	131.83 <sup>M</sup>	128.99	126.95	123.66 <sup>m</sup>	127.13	124.54	124.98	124.26	127.077	2.71										
5.3 Inner liners		172.83 <sup>m</sup>	179.67	178.23	181.72	180.85	185.40 <sup>M</sup>	182.92	181.53	184.33	181.39	180.887	3.51										
6. Puncture resistance	kgf.cm.	39.04	39.34 <sup>M</sup>	32.94	31.11	28.67	28.36	28.06 <sup>m</sup>	28.06	-	-	31.947	4.79										
7. Flat crush resistance	kgf/cm <sup>2</sup>	0.66	0.51 <sup>m</sup>	0.62	0.74	0.96 <sup>M</sup>	0.63	0.57	0.54	0.60	0.81	0.664	0.14										
8. Ring crush resistance	kgf/cm																						
8.1 Outer liners		1.71	1.93 <sup>M</sup>	1.60 <sup>m</sup>	1.72	1.64	1.70	1.74	1.78	1.83	1.82	1.747	0.10										
8.2 Corrugating mediums		0.67	0.72	0.75	0.64 <sup>m</sup>	0.76	0.84 <sup>M</sup>	0.78	0.83	0.79	0.66	0.744	0.07										
8.3 Inner liners		1.41 <sup>m</sup>	1.84	1.64	1.79	1.82	1.54	1.41	1.75	1.90 <sup>M</sup>	1.48	1.658	0.19										
9. Edgewise crush resistance	kgf/cm	1.35 <sup>m</sup>	2.36	3.00	2.50	1.47	2.15	1.58	2.83	1.51	3.02 <sup>M</sup>	2.177	0.66										
10. Bursting strength	kgf/cm <sup>2</sup>	12.4	14.4 <sup>M</sup>	9.8	10.3	11.7	10.7	11.1	12.7	11.6	10.3	11.79	1.30										
		12.0	13.0	9.5 <sup>m</sup>	11.0	12.0	13.2	12.2	11.4	12.9	13.6												

Remark : M = Maximum value

m = Minimum value

Table 4.6: Comparison between Test Results of Pre-Packing and Post-Shipment Boxes of Kwaung Paisarn Food Product Co., Ltd.

Items	Units	Pre-packing Boxes	Post-shipment boxes	Residual strength(%)
1. Bursting strength	kgf/cm <sup>2</sup>	11.61	11.79	101.55
2. Puncture resistance	kgf.cm	37.89	31.95	84.3
3. Flat crush resistance	kgf/cm <sup>2</sup>	1.64	0.66	40.2
4. Ring crush resistance	kgf/cm			
4.1 Outer liners		1.99	1.75	87.9
4.2 Corrugating mediums		0.56	0.74	132.14
4.3 Inner liners		1.87	1.66	88.8
5. Edgewise crush resistance	kgf/cm	4.26	2.18	51.1
6. Box compression strength	N	2470	710 <sup>*)</sup>	28.7

Remark : <sup>\*)</sup> May be used for the determination of the minimum requirement of compression strength of the box :

$$\begin{aligned}
 \text{Minimum requirement of BCT} &= 2470-710 \\
 &= 1760 \text{ N.} \\
 &= 179.41 \text{ kg.}
 \end{aligned}$$

Table 4.7 : Test Results : Pre-Packing Boxes of Kiang Hua Co., Ltd.

Items of test	Results of test							
	Units	1	2	3	4	5	$\bar{X}$	S.D.
1. Inside dimensions of box	mm							
1.1 Length		551	552	550	549	551	550.6	1.14
1.2 Width		272	273	271	272	274	272.4	1.14
1.3 Depth		180	181	181	182	179	180.6	1.14
2. Box compression strength	N	2375	2530	2310	2075	2410	2340.0	168.34

Items of test	Results of test												
	Units	1	2	3	4	5	6	7	8	9	10	$\bar{X}$	S.D.
		11	12	13	14	15	16	17	18	19	20		
3. Basis weight													
3.1 Outer liners	g/m <sup>2</sup>	179.6	179.8	178.2	178.4	178.2	179.5	174.8	180.0	180.0	178.0	178.65	1.57
3.2 Mediums		135.0	127.6	130.3	133.0	123.3	132.0	132.0	130.0	131.8	128.7	130.37	3.27
3.3 Inner liners		183.8	179.5	181.2	181.1	181.2	181.0	181.3	177.8	181.2	180.9	180.90	1.51
4. Ring crush resistance													
4.1 Outer liners	kg/cm	1.37	1.50	1.40	1.37	1.39	1.47	1.36	1.50	1.50	1.37	1.423	0.061
4.2 Mediums		0.80	0.64	0.82	0.75	0.78	0.72	0.77	0.82	0.78	0.65	0.753	0.064
4.3 Inner liners		1.50	1.54	1.49	1.63	1.62	1.44	1.50	1.50	1.41	1.41	1.504	0.076
5. Bursting strength	kg/cm <sup>2</sup>	6.5	6.2	7.5	6.2	7.2	7.1	7.3	7.1	7.6	6.8	7.215	0.76
		8.5	8.2	6.8	6.9	6.9	6.6	6.2	7.7	8.5	8.5		

Table 4.8 : Test Results : Post-Shipment Boxes of Kiang Hua Co., Ltd.

Items of test	Units	Results of test						
		A1	A2	A2	A3	A4	$\bar{X}$	S.D.
1. Inside dimensions of box	mm							
1.1 Length		553	550	551	549	553	551.2	1.79
1.2 Width		276	275	274	276	277	275.6	1.14
1.3 Depth		182	183	183	184	184	183.2	0.84
2. Box compression strength	N	1520	1550	1500	1410	1680	1532.0	97.83

Items of test	Units	Results of test											Remark		
		1	2	3	4	5	6	7	8	9	10	$\bar{X}$		S.D.	
		11	12	13	14	15	16	17	18	19	20				
3. Basis weight															
3.1 Outer liners	g/m <sup>2</sup>	173.5	172.5	173.5	175.5	171.9	174.6	178.4	180.2	177.8	180.1	175.82	3.10	A3, A4	
3.2 Mediums		133.2	133.2	128.6	134.5	133.0	127.8	129.4	131.2	134.0	128.4	131.33	2.56		
3.3 Inner liners		180.0	176.1	176.6	178.9	173.4	172.0	181.0	176.5	174.8	180.2	176.95	3.03		
4. Ring crush resistance															
4.1 Outer liners	kg/cm	1.31	1.37	1.37	1.40	1.41	1.31	1.31	1.44	1.31	1.34	1.357	0.048	A3	
4.2 Mediums		0.59	0.64	0.69	0.72	0.67	0.56	0.67	0.60	0.72	0.62	0.648	0.055		
4.3 Inner liners		1.37	1.37	1.37	1.37	1.39	1.31	1.37	1.45	1.44	1.32	1.376	0.044		
5. Bursting strength	kg/cm <sup>2</sup>	6.3	7.9	7.9	7.2	7.9	8.4	8.6	8.1	8.4	8.0	7.985	0.608	A1	
		7.9	8.5	8.6	7.6	7.2	8.1	8.5	8.9	8.2	7.5				



Table 4.9 : Comparison between test Results of Pre-Packing and Post-  
Shipment Boxes of Kiang Hua Co., Ltd. (after research)

Items	Units	Pre-packing boxes	Post-shipment boxes	Residual strength %
1. Bursting strength	kgf/cm <sup>2</sup>	7.21	7.98	110.7
2. Ring crush resistance	kgf/cm			
2.1 Outer liners		1.50	1.38	92.0
2.2 Corrugating mediums		0.75	0.65	86.7
2.3 Inner liners		1.42	1.36	95.8
3. Box compression strength	N	2340	1532	65.5

Remark : RSC-type box with top-loading style, basis weight is 185 g/m<sup>2</sup>  
for liner and 125 g/m<sup>2</sup> for medium.

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Table 4.10 : Test Results : Pre-Packing Boxes of Proposed Boxes (Top-Loading)

Items of test	Units	Results of test						
		1	2	3	4	5	$\bar{X}$	S.D.
1. Inside dimensions of box	mm							
1.1 Length		542	542	541	540	541	541.5	0.837
1.2 Width		270	271	271	270	272	270.8	0.837
1.3 Depth		180	181	180	179	180	180.0	0.707
2. Box compression strength	N	1620	1838	1650	1710	1900	1743.6	120.97

Items of test	Units	Results of test												$\bar{X}$	S.D.
		1	2	3	4	5	6	7	8	9	10				
		11	12	13	14	15	16	17	18	19	20				
3. Basis weight	g/m <sup>2</sup>														
3.1 Outer liners		150.2	148.3	147.0	141.9	141.1	148.8	146.7	148.4	147.8	151.2	147.14	3.27		
3.2 Mediums		126.1	127.8	128.7	125.8	130.1	129.7	124.3	124.5	126.8	127.9	127.17	2.02		
3.3 Inner liners		125.5	121.1	120.1	118.6	126.4	125.4	125.3	120.5	122.5	122.5	122.79	2.72		
4. Ring crush resistance	kg/cm														
4.1 Outer liners		1.18	1.24	1.11	1.31	1.18	1.08	1.11	1.11	1.10	1.08	1.15	0.076		
4.2 Mediums		0.82	0.52	0.59	0.59	0.59	0.59	0.62	0.62	0.69	0.77	0.64	0.092		
4.3 Inner liners		0.85	0.88	0.78	0.78	0.84	0.82	0.85	0.90	0.78	0.86	0.83	0.043		
5. Bursting strength	kg/cm <sup>2</sup>	5.3	6.5	5.9	6.8	6.3	6.5	6.1	5.5	6.5	6.6	5.94	0.471		
		6.0	5.8	5.8	5.4	5.5	5.9	6.0	5.2	5.5	5.7				

Table 4.11 : Test Results : Post-Shipment Boxes of Proposed Boxes (Top-Loading)

Items of test	Units	Results of Test						
		B1	B2	B2'	B3	B4	$\bar{X}$	S.D.
1. Inside dimensions of Box	mm							
1.1 Length		542	542	542	541	540	541.4	0.894
1.2 Width		271	271	271	272	270	271.0	0.707
1.3 Depth		180	181	180	181	181	180.6	0.548
2. Box compression strength	N	1450	1350	1170	1410	1440	1364.0	115.24

Items of test	Units	Results of test												Remark			
		1	2	3	4	5	6	7	8	9	10	$\bar{X}$	S.D.				
		11	12	13	14	15	16	17	18	19	20						
3. Basis weight																	
3.1 Outer liners	g/m <sup>2</sup>	144.0	146.2	146.2	144.8	144.1	139.4	140.2	138.5	140.1	140.0	142.35	2.95	B3,B4			
3.2 Mediums		122.6	135.5	135.3	134.2	135.6	128.9	127.5	128.8	130.1	125.8	130.43	4.56				
3.3 Inner liners		120.7	120.0	119.0	119.3	118.6	124.5	123.4	125.6	127.1	124.4	122.26	3.09				
4. Ring crush resistance																	
4.1 Outer liners	kg/cm	1.08	0.85	1.18	1.11	1.10	1.05	0.99	1.11	1.14	1.10	1.07	0.093	B3			
4.2 Mediums		0.75	0.75	0.81	0.82	0.84	0.85	0.85	0.86	0.78	0.77	0.81	0.043				
4.3 Inner liners		0.80	0.88	0.85	0.67	0.85	0.82	0.78	0.78	0.75	0.85	0.80	0.062				
5. Bursting strength	kg/cm <sup>2</sup>	6.0	7.0	7.1	6.2	6.5	6.2	6.4	6.0	5.9	6.3	6.12	0.493	B1			
		5.6	5.5	6.2	6.1	6.4	6.7	6.5	5.9	5.2	5.7						

Table 4.12 : Comparison between Test Results of Pre-Packing and Post-Shipment Boxes of Proposed Boxes (after research).

Items	Units	Pre-packing boxes	Post-shipment boxes	Residual strength %
1. Bursting strength	kgf/cm <sup>2</sup>	5.94	6.12	103.0
2. Ring crush resistant	kgf/cm			
2.1 Outer liners		1.15	1.07	93.0
2.2 Corrugating mediums		0.64	0.81	126.6
2.3 Inner liners		0.83	0.80	96.4
3. Box Compression strength	N	1744	1364	78.2

Remark : RSC-type boxes with top-loading style, basis weight is 125 g/m<sup>2</sup> for liner and 125 g/m<sup>2</sup> for medium.

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Table 4.13 : Test Results : Pre-Packing Boxes of Proposed Boxes (End-Loading)

Items of test	Units	Results of test						
		1	2	3	4	5	$\bar{X}$	S.D.
1. Inside dimensions of box	mm							
1.1 Length		270	270	272	271	271	270.8	0.84
1.2 Width		181	180	181	180	180	180.4	0.55
1.3 Depth		540	540	541	542	542	541.0	1.00
2. Box compression strength	N	1350	1210	1220	1260	1250	1258.0	55.41

Items of test	Units	Results of test												
		1	2	3	4	5	6	7	8	9	10	$\bar{X}$	S.D.	
		11	12	13	14	15	16	17	18	19	20			
3. Basis weight														
3.1 Outer liners	g/m <sup>2</sup>	145.5	147.6	145.0	146.1	145.8	147.9	142.3	140.7	145.8	142.9	144.96	2.31	
3.2 Mediums		123.8	123.2	128.6	125.7	131.0	127.4	125.2	124.6	127.6	130.2	126.69	2.66	
3.3 Inner liners		124.0	129.3	128.3	125.9	127.2	128.1	131.5	129.6	130.5	127.3	128.17	2.21	
4. Ring crush resistance														
4.1 Outer liners	kg/cm	1.14	1.18	1.14	1.11	1.18	1.11	1.20	1.14	1.16	1.16	1.152	0.030	
4.2 Mediums		0.59	0.65	0.67	0.69	0.72	0.72	0.69	0.62	0.67	0.72	0.674	0.044	
4.3 Inner liners		0.95	0.92	0.88	0.90	0.92	0.85	0.91	0.82	0.82	0.82	0.879	0.048	
5. Bursting strength	kg/cm <sup>2</sup>	6.0	6.0	5.6	6.1	6.5	6.2	6.2	7.1	5.7	5.6	5.97	0.371	
		6.0	6.0	6.1	6.1	5.5	5.8	5.8	5.9	5.6	5.6			

Table 4.14 : Test Results : Post-Shipment Boxes of Proposed Boxes (End-Loading)

Items of test	Units	Results of test						
		C1	C2	C2'	C3	C4	$\bar{X}$	S.D.
1. Inside dimensions of box	mm							
1.1 Length		271	270	272	270	270	270.6	0.894
1.2 Width		180	181	180	180	180	180.2	0.447
1.3 Depth		541	540	540	541	542	540.8	0.837
2. Box compression strength	N	770	760	690	720	660	720	46.37

Items of test	Units	Results of test											$\bar{X}$	S.D.	Remark			
		1	2	3	4	5	6	7	8	9	10							
		11	12	13	14	15	16	17	18	19	20							
3. Basis weight																		
3.1 Outer liners	g/m <sup>2</sup>	144.6	145.3	148.3	144.8	145.9	140.7	141.2	140.5	141.5	142.8	143.56	2.61	C3,C4				
3.2 Mediums		132.7	133.3	135.8	129.8	130.1	127.8	130.4	128.7	124.5	122.4	129.55	4.01					
3.3 Inner liners		129.1	124.9	125.8	128.0	126.0	124.7	126.8	127.4	125.6	129.1	126.74	1.61					
4. Ring crush resistance																		
4.1 Outer liners	kg/cm	1.18	1.18	1.16	1.11	1.18	1.08	1.20	1.20	1.24	1.14	1.167	0.047	C3				
4.2 Mediums		0.69	0.74	0.85	0.75	0.84	0.65	0.69	0.78	0.75	0.82	0.756	0.067					
4.3 Inner liners		0.91	0.98	0.84	0.82	0.91	0.88	0.95	0.85	0.86	0.93	0.893	0.052					
5. Bursting strength	kg/cm <sup>2</sup>	6.0	6.0	7.1	5.7	5.5	7.1	6.0	6.4	6.3	5.7	6.06	0.501	C1				
		6.0	6.5	5.6	6.0	5.5	5.8	5.8	5.4	6.0	6.8							

Table 4.15 : Comparison between Test Results of Pre-Packing and Post-Shipment Boxes of Proposed Boxes (after research)

Items	Units	Pre-packing boxes	Post-shipment boxes	Residual strength %
1. Bursting strength	kgf/cm <sup>2</sup>	5.97	6.06	101.5
2. Ring crush resistance	kgf/cm			
2.1 Outer liners		1.15	1.17	101.7
2.2 Corrugating mediums		0.67	0.76	113.4
2.3 Inner liners		0.88	0.89	101.1
3. Box compression strength	N	1258	720	57.2

Remark : RSC-type boxes with end-loading style, basis weight is 125 g/m<sup>2</sup> for liner and 125 g/m<sup>2</sup> for medium.

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Table 4.16 : Test Results of Materials of Boxes

Items of test	Units	Results of test												$\bar{X}$	S.D.
		1	2	3	4	5	6	7	8	9	10				
		11	12	13	14	15	16	17	18	19	20				
1. Linerboard (KI 185)															
1.1 Basis weight	g/m <sup>2</sup>	184.4	183.3	185.0	184.2	184.2	185.5	188.7	191.5	190.5	192.2	186.99	3.46		
1.2 Ring crush resistance	kgf/cm	2.65	2.61	2.65	2.65	2.58	2.65	2.61	2.61	2.65	2.61	2.627	0.026		
1.3 Bursting strength	kgf/cm <sup>2</sup>	4.0	4.0	3.7	3.8	3.6	3.8	3.8	4.1	3.7	4.0	3.825	0.192		
		3.5	3.9	3.5	3.7	3.8	3.7	4.0	3.7	4.1	4.0				
2. Linerboard (KI 125)															
2.1 Basis weight	g/m <sup>2</sup>	128.5	128.4	127.2	131.7	125.5	129.6	126.9	130.0	129.4	128.4	128.56	1.756		
2.2 Ring crush resistance	kgf/cm	1.70	1.54	1.49	1.70	1.56	1.44	1.44	1.73	1.73	1.52	1.585	0.119		
2.3 Bursting strength	kgf/cm <sup>2</sup>	2.8	2.8	3.1	2.8	3.0	2.9	2.9	2.9	2.9	3.0	2.815	0.189		
		2.7	2.6	2.8	2.7	3.1	3.0	2.8	2.5	2.5	2.5				
3. Medium (CA 125)															
3.1 Basis weight	g/m <sup>2</sup>	125.7	124.7	125.3	126.2	127.1	125.7	126.3	129.0	125.9	130.1	126.6	1.70		
3.2 Ring crush resistance	kgf/cm	1.27	1.37	1.41	1.36	1.39	1.41	1.37	1.44	1.34	1.37	1.373	0.046		
3.3 Bursting strength	kgf/cm <sup>2</sup>	2.1	2.0	2.1	2.1	2.1	2.2	2.1	2.3	2.4	2.3	2.235	0.131		
		2.2	2.3	2.3	2.3	2.2	2.3	2.4	2.4	2.2	2.5				

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