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T 844

DRAFT NO. 02 SARG

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SUBJECT CATEGORY Fiberboard Shipping Container Testing

RELATED METHODS See "Additional Information"

CAUTION:
This Test Method may include safety precautions which are believed to be appropriate at the time of publication of the method. The intent of these is to alert the user of the method to safety issues related to such use. The user is responsible for determining that the safety precautions are complete and are appropriate to their use of the method, and for ensuring that suitable safety practices have not changed since publication of the method. This method may require the use, disposal, or both, of chemicals which may present serious health hazards to humans. Procedures for the handling of such substances are set forth on Material Safety Data Sheets which must be developed by all manufacturers and importers of potentially hazardous chemicals and maintained by all distributors of potentially hazardous chemicals. Prior to the use of this method, the user must determine whether any of the chemicals to be used or disposed of are potentially hazardous and, if so, must follow strictly the procedures specified by both the manufacturer, as well as local, state, and federal authorities for safe use and disposal of these chemicals.

Determining construction (nominal basis weight) of corrugated board

(Five-year review of Official Method T 844 om-15)

(Minor editorial comments from draft 1 incorporated. Proceed to SARG)

1. Scope

1.1 This method describes a procedure to determine the nominal basis weight (grade) of the components of corrugated board. Test specimens of corrugated fiberboard are treated with water so that the component layers can be separated, dried, and weighed. The goal of the method is not to determine the exact basis weights of the papers comprising a corrugated specimen, but rather to identify the probable marketing grade under which the papers were likely sold.

1.2 This method is applicable to all types of corrugated fiberboard

2. Significance

2.1. Boxplants and laboratories are often called upon to determine what grades were used in the construction of a corrugated board sample for sales and marketing purposes. While this type of analysis does not provide information on combined board strength or quality, it can be used in a general manner to provide guidance to manufacturing facilities as to what combined board they might make that could potentially be "similar" in their efforts to reproduce a board specimen.

2.2. This approach can also be used as a troubleshooting tool to "deconstruct" existing corrugated board samples in order to provide assurance/confirmation that the proper nominal grades of paper were combined in the manufacturing process to meet a customer's requirements or specifications.

3. Safety precautions

3.1 Care should be taken with cutting instruments when preparing any specimen for testing.

4. Definitions

4.1 *Layer*. A component of corrugated fiberboard. A singlewall board is composed of three layers, two flat layers (liner) on each side of a corrugated layer (medium).

4.2 *Nominal*. Measured in a general amount rather than an actual value.

4.3 *Grade*. The sale unit classification of the containerboard, based on typical grades of containerboard produced as defined by the American Forest & Paper Association (AF&PA).

4.4 *Nominal basis weight or nominal grade*. The estimated grade of paper used as one of the components of the corrugated board. As distinct from (but related to) the basis weight or grammage of a paper, which is a report of the actual mass per unit area of the corrugated board, the nominal grade relates to the marketing classification under which the paper was likely sold in the marketplace.

5. Apparatus

5.1 A cutting device that can be used to produce samples of corrugated board of known dimensions. These can include but are not limited to a "four square cutter" of the type often used to prepare basis weight samples [see T 410 "Grammage of Paper and Paperboard (Weight Per Unit Area)"], circular cutters used to cut flat crush specimens [T 825 "Flat Crush Test of Corrugated Board [Rigid Support Method)"], manual or pneumatic cutters used in the preparation of pin adhesion samples [T 821 "Pin Adhesion of Corrugated Board by Selective Separation"], or even a box cutter used with the guidance of a metal template.

5.1.1 The cutting method should be capable of repeatedly cutting out test specimens whose area is known to within ±0.5%.

5.2 A tank or sink of sufficient size to hold water that will allow for immersion of the test pieces.

5.3 A drying oven capable of holding a temperature of 105°C (221°F)

5.4 A weighting device in conformance with TAPPI T 410.

6. Sampling and test specimens

6.1 This evaluation is typically performed on a single sample due to limitations in the available material. Make sure that the test specimen is representative of the lot to be evaluated. Should greater confidence be desired multiple samples may be used.

6.2 The surface layers of the specimen (the liners) should be free from any damage or abrasions that may lead to loss of fiber or otherwise impact the test results. They should also be free from tape or other foreign contaminants. Ideally, the sample will also be taken from a flat area of the board away from score lines.

6.3 Since the corrugated board sample is immersed in water, there is typically no need to condition specimens before testing. Conditioning takes place after drying (see 7.6). However, in some cases it is desirable to double check results by summing the measured weights of each component and comparing those weights to the initial basis weight of the combined sample. In that case, the grammage of the sample should be assessed according to TAPPI T 410 at the appropriate point in the procedure below (see Note 2).

7. Procedure

7.1 *Sample preparation*. Carefully cut the combined board specimen to a known area. Note that the sample size will depend in part on the amount of material available. The cut area shall be clean with edges perpendicular to the faces of the corrugated board.

7.1.1 Typical sizes used in the industry include 930 cm^2 (144 $in.^2$, one square foot), 387 cm^2 (60 $in.^2$), 205 cm^2 (31.75 $in.^2$), 100 cm^2 (15.5 $in.^2$). Different sizes are used for ease of calculation, balanced against the amount of material available for testing.

NOTE 1 The ISO method (ISO 3039) specifies a 100 cm^2 area.

7.1.2 Larger specimen sizes will reduce the impact of measurement error in the weighing stages relative to the final result. However, round robin testing (9.1.2 and 9.1.3) indicates that total sources of error significantly exceed the precision of a balance, indicating that accuracy in cutting to a known size and issues associated with sample separation (7.4) likely far exceed sample size itself as contributors to variation in results.

7.2 Identify and mark the singleface and doubleback surfaces of the sample with a waterproof marker.

NOTE 2 If it is desirable to compare the final component weights with the initial sample weight, follow the procedure in TAPPI T 410 at this point.

7.3 Immerse the sample in water long enough to cause the component layers of the corrugated fiberboard to separate spontaneously or with an extremely light pull.

7.3.1 For corrugated board fabricated with regular adhesive, 10-20 minutes in water at 23-38°C (73-100°F) is typically sufficient.

7.3.2 For corrugated board fabricated with moderately or highly water resistant adhesives, it is typically necessary to soak the sample for longer periods of time and/or at higher temperatures, e.g. up to 24 hours in water up to 60°C (140°F).

NOTE 3 The degree of separation difficulty following soaking can aid in judging whether water resistant adhesive has been used and aids in judging the quality of the singleface and doubleback wet bonds.

7.4 While the papers are still wet, carefully remove/scrape adhesive from the layers as completely as possible without disturbing the fibers. Complete removal of the absorbed adhesive cannot be expected. One must take care to disturb the fiber network as little as possible.

7.5 Oven dry the samples at 105°C (221°F) until the samples are bone dry

NOTE 4: This process can take an hour or more if many samples are placed close together or touching in a typical oven. In cases where a forced air oven of sufficient capacity is used, samples may become dry in 20 minutes or less.

7.6 Remove the samples from the oven and recondition at standard TAPPI conditions until equilibrium is reached. (See T 402 “Standard Conditioning and Testing Atmospheres for Paper, Board, Pulp Handsheets and Related Products,” section 5.5)

7.7 Weigh each component to the nearest hundredth of a gram (0.01 g).

7.7.1 The calculated basis weight of the linerboard specimens (CBWL) can then be calculated as follows:

$$[\text{Measured weight (g)} / \text{Area (cm}^2\text{)}] \times 10{,}000 = \text{Grammage (g/m}^2\text{)}$$

$$\text{Grammage (g/m}^2\text{)} \times 0.2049 = \text{CBWL (lb/1000 ft}^2\text{)}$$

7.7.2 For medium, one must also account for the increase in area due to the corrugation of the medium, the take up factor (TUF). Typical take up factors are tabulated below along with nominal flutes per foot to aid in identification of the flute structure. Actual take up factors can be impacted by the construction of the corrugating roll, the operation of the equipment (i.e. tension of the papers) and other variables. The true TUF for a given piece of

combined board cannot be determined from only a combined board sample, and may vary by as much as 3-4% from the numbers indicated below.

Flute	Typical Take Up Factor	Flutes per Ft
A	1.54	33 ± 3
C	1.43	39 ± 3
B	1.31	47 ± 3
E	1.26	89 ± 10
F	1.21	127 ± 3

The calculated basis weight of the medium specimens (CBWM) can then be calculated as follows:

[(Measured weight, g / Area, cm^2) / TUF] × 10,000 = Grammage (g/m^2)

Grammage (g/m^2) × 0.2049 = CBWM ($lb/1000\ ft^2$)

7.8 Estimate the nominal grade of paper used based on the calculated basis weights obtained in 7.7. The nominal grades in use in the industry change regularly, and an assessment of the potential grades must leverage as much information as possible regarding current grade structures, geographic tendencies for use of specific grades at local manufacturing facilities, marketplace tendencies for use of specific grades in given industries, the tendency for balanced or unbalanced board combinations for particular uses, and other factors. The following basis weights are "common" for grades of containerboard in North America as tracked by the AF&PA in their Containerboard monthly surveys and baseline reports. Note that nominal basis weights in North America are measured in $lb/1000\ ft^2$, and are reported as such in the table below. Other grades, while perhaps less common, are also possible.

Linerboard, $lb/1000\ ft^2$	Medium, $lb/1000 ft^2$

26	23
31	26
33	33
35	36
42	40
46	
52	
56	
62	
69	
73	
82	
90	

8. Report

8.1 Report the nominal grade for each layer of the board, identified sequentially from the doubleback side of the combined board to the singleface side. Also include the actual calculated values (CBWLs and CBWMs) for each layer so that a reassessment of the nominal estimations could be performed at a future date if necessary. Additionally, report the nominal flute type and number of flutes per foot for each medium layer in the board structure.

9. Precision

9.1 Because of the requirement for estimation of the nominal grade, and the qualitative reasoning that encompasses such an estimation, no true statement of precision can be made for this method. However, the following information on precision of related tasks can inform our assessment of the potential precision of the procedure discussed above.

9.1.1 Typical production specifications on a basis weight defined grade of North American containerboard (i.e. 42 kraft linerboard or 33 semichem medium) from some manufacturers allows for a range in weight of ±5% around the nominal basis weight. Thus, a medium with a nominal weight of 161g/m^2 (33 lb/1000 ft^2) can actually have a basis weight between 153–169 g/m^2 (31.4−34.6 lb/1000 ft^2). Performance grades of containerboard typically have no fixed production basis weight targets, and can have wider ranges of variation even from the same manufacturing facility. European containerboard is typically produced with a range of ±3% or ±4% depending on the nominal basis weight.

9.1.2 The repeatability and reproducibility of basis weight measurements on containerboard from T 410 set the maximum precision one could possibly hope to attain using this method.

T 410 repeatability = 0.94%

T 410 reproducibility = 2.84%

9.1.3 In 2008 and 2009, the ISO/TC 6/SC 2/ WG 40 committee executed a round robin study to identify the reproducibility and repeatability of the ISO version of this method (ISO 3039). While the medium was treated differently from the approach described in this method, the linerboard results provide another assessment as to the possible precision of this method. Eight singlewall board samples were studied, and each of 13 labs separated five specimens of each sample.

ISO Liner Average Repeatability = 3.2%

ISO Liner Average Reproducibility = 5.7%

9.1.4 One might assume that the uncertainty in medium estimation is similar to that for liner estimation combined with the additional uncertainty from the TUF (see 7.7.2 above). These errors are independent, so one may estimate the overall impact by taking the square root of the sum of the squares of the different sources of error. On that basis, one might estimate the precision for medium as

Estimated medium repeatability = 5.2%

Estimated medium reproducibility = 7.0%

9.2 Because of this level of inherent uncertainty and the process of estimating grades based on weight for papers separated in the manner described above, this test is capable of only very limited accuracy. However, it can give useful information concerning the component papers that might have been used to fabricate the board.

9.2.1 For typical US lightweight liners and most mediums, nominal weights of adjacent grades differ by on the order of 10% (2−3 lb/1000 ft^2). The estimates of repeatability combined with the typical weight ranges on production cause the likely ranges of two adjacent grades to overlap. For example, a sample of linerboard that weighs 166 g/m^2 (34 lb/1000 ft^2) in this test cannot conclusively be identified with 33 lb/1000 ft^2 or 35 lb/1000 ft^2 linerboard. However, if one has a singlewall board where one liner measures 166 g/m^2 while the other measures 175 g/m^2 (35.9 lb/1000 ft^2), one might reasonably assume a balanced board construction and indicate that two "35 lb/1000 ft^2" liners were used.

9.2.2 Examining European papers, we find, for example, that medium (fluting) weights of 140 g/m^2 and 150 g/m^2 are both common. With only a slight variation in the testing the results for these grades, measured values can easily overlap. Nominal 140 g/m^2 paper can be made anywhere from 136-144 g/m^2, while nominal 150 g/m2 paper can be made anywhere from 145−155 g/m^2.

10. Keywords

Construction, Corrugated boards, Basis weight, Linerboards, Corrugating medium

11. Additional information

11.1 Effective date of issue: To be assigned.

11.2 The changes made to this standard in 2015 were editorial in nature. There were concerns with the calculation of the basis weight so some parentheses were added for clarification. Some abbreviations were eliminated and spelled out instead. The option to take multiple samples if a higher degree of precision was desired was also included.

11.3 The change made to this Standard in 2020 is to correct a clerical error in type of Standard. The SSIG and SARG approved upgrade to Official Method, but the copy published did not reflect the change approved.

11.4 Change where AF&PA is defined in section 4.3 and then corrected in section 7.8.

Your comments and suggestions on this procedure are earnestly requested and should be sent to the TAPPI Standards Department.

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