

Institute of International Container Lessors

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PERFORMANCE STANDARD
FOR
PLYWOOD FLOOR PANELS
FOR
INTERNATIONAL FREIGHT CONTAINERS

The purpose of this document is to outline **performance** requirements for **marine grade plywood** to be used in general cargo containers. The manufacturer and/or supplier have ultimate responsibility for the design and quality of the product and should incorporate and adopt all standards and practices necessary to ensure that the product will meet the intended service requirements.

Buyer(s) retain the right of final acceptance for products manufactured according to this bulletin.

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INTRODUCTION

This Technical Bulletin outlines performance requirements for marine grade plywood. These performance requirements are based on historical performance of apitong, keruing and similar traditional species of hardwoods. This document recommends minimum, but by no means absolute, panel requirements to suit the service to which these panels will be subjected. The performance requirements set forth in this bulletin focus on ensuring floor panel bond strength, new panel planar shear strength, and long-term adhesive bond durability, as well as other more traditional requirements aimed at achieving a minimum of **12-15 years of service life** from installed panel floors.

Current ISO fork truck and container gross weight test procedures were developed when container floors were manufactured from hardwood planks. This document adds new performance requirements and test procedures to the ISO requirements for container hardwood plywood floor testing. The added test procedures include a short span small specimen bending test to examine panel shear strength and test procedures to examine adhesive bond durability. Plywood, when overloaded and supported by closely spaced cross members, will fail internally due to what is known as a rolling shear failure within the middle veneers of the panel. This internal failure is frequently without, or before any visible, external bending failure occurs. As internal rolling shear failure is difficult to detect, strength tests in this bulletin are designed with such a defect, amongst others, in mind.

Mechanical tests and adhesive bond durability tests are introduced in this bulletin which have been specifically selected to examine rolling shear failures within panels, as well as the long term serviceability of the adhesive bond.

SCOPE

This document covers the following:

1. General Specifications for Container Floor Plywood Panels.
2. Performance requirements for the Manufacture and Testing of Hardwood, Plywood Floor Panels.
3. References and Technical Information.

1. GENERAL SPECIFICATIONS

The following outlines the recommended minimum requirements for container floor plywood panels.

1.1 Standards¹

(All plywood must be Marine grade and comply with the standards listed below, except where specifically exceeded by any other IICL requirements.)

- **BS EN 636: 2003, Class 3**, – Plywood Specifications
- **BS 1088-1: 2003 including Annexes A&B**, Requirements for Standard Marine Plywood with Phenolic Resin
- **BS EN 314-1: 2004, Part 1** – Test Methods
- **BS EN 314-2: 1993, Part 2**, Requirements for Plywood-Bonding Quality, non covered exterior service requirements.
- **BS 1203: 2001**, Classification and Test Methods for Hot setting phenolic & Amnioplastic wood adhesives to meet H4 adhesive requirements
- **DD EN 1099: 1998**, Plywood-Biological Durability-Guidance for Assessment of Plywood for Use in Different Hazard Classes
- **ASTMD 2718-00** – Planner shear test
- **ASTMD 143 and ASTMD 4442** – Moisture Content
- **ASTMD 2395**, Method B - Specific Gravity

NOTE: Additionally, all plywood must be capable of withstanding repeated high horizontal shear loads applied through forklift truck wheels or other loading equipment, as experienced and expected in its normal operational environment.

¹ British Standards – See B.S.I. Website: <http://www.bsi-global.com>

1.2 Wood Species

All wood species used must **match or exceed the performance of traditional apitong/keruing** panels. Suppliers are required to provide evidence of satisfactory performance for all plywood panels regardless of wood species used in the manufacture of plywood.

Performance details must include the following:-

- Type of species
- Minimum ultimate bending and shear strengths of species and panel assembly
- Specific Gravity
- Decay resistance
- Type of adhesive to be used, its cured strength, and proof of long range compatibility to species and its resins, and to container service environment
- Adhesive tension & shear and bonding strengths in proposed species.
- Adhesive bonding guidelines to be followed
- Expected panel service life in container normal service, w/ background for prediction

In any case, final panel acceptance of any panels will be up to the owners' decisions

1.3 Plies

A minimum of 19 plies is required.

Unless a specific lay-up is specified by owner, manufacturer(s) may use any ply lay-up that will allow the plywood to meet all of the requirements outlined in this document, as well as in all ISO requirements.

Note:

It should be noted that longitudinal plys carry both bending and shear loads. They have long been used in container floor panels in top and bottom and mid panel thickness locations in either 3x1x3 or 3x3x3 lay-up patterns.

Increasing the quantity of exterior (top & bottom) longitudinal plies over 3 has been seen to result in surface cracks in some panels. Increasing the center longitudinal plys from one to three has been seen to slightly increase strength in some panels, and technically would be predicted to result in more resistance against panel shear failure – the usual panel failure cause. These results are not always certain.

1.4 Veneer Quality

Per **B.S. 1088-1, 2003, 4.1.1.9 Table 1**, Top veneer must be one (1) piece.

1.5 Moisture Content

Per **B.S. EN 322**. - Not to exceed 14% at the time of manufacture.

Each panel shall have all edges sealed with a suitable exterior grade varnish or equivalent coating to minimize moisture ingress.

1.6 Density/Specific Gravity

Density

700 kgs – 880 kgs/cubic meter

Specific Gravity

0.70 – 0.88

1.7 Adhesive and Bond Performance Requirements

Phenol formaldehyde, per **B.S. 1203:2003 with B.S. H4 rating**.

- Bond quality for all adhesives must be **Class 3 (per EN 314-2:1993)**

All adhesives shall incorporate an approved treatment as required by Australian Commonwealth Department of Health Division of Plant Department (TCT).

Note:

The ease of bonding varies between wood species. Some wood species are easily bonded while others are difficult to bond. Therefore, some wood species may need special adhesive formulations to overcome the difficulty in achieving a satisfactory adhesive bond. Where multiple species are involved in a single panel, an adhesive formulation compatible with both species is required. Proposed multi-species panels must include adhesive details and in-depth background data to prove long range service capability.

1.8 Panel Dimensions

1.8.1 Thickness

Overall thickness must be 28 mm minimum.

1.8.2 Length

Should approximate the IICL standard design for 20 ft and 40 ft containers.
(See attached drawings on pages 22-23.)

1.8.3 Width

Variable, depending on container factory's design and customer's choice of flat bar or omega center floor divider.

1.8.4 Rout Dimensions

(for either profile center divider [flat bar or omega])--To provide minimum clearances for either style divider:

- Rout height tolerance: Divider thickness +1.0 mm/-0.0 mm
- Rout width tolerance: Divider width under panel +2.0 mm/-0.0 mm

1.8.5 Squareness

Diagonal dimensions must be to requirements stated in BS 1088-1, Table 4, or to container factory requirements, whichever is less.

1.8.6 Chamfers

1mm -2mm x 45Degree chamfered edges shall be provided on top edges of all panels.

1.8.7 Tolerances

As per **B.S. 1088-1:2003** requirements unless noted otherwise.

Note: Buyers, at their discretion, may consider different tolerances.

1.9 Identification

Product Identification and Traceability

Each panel manufactured must be branded or stamped, or otherwise permanently identified to allow tracing in case of quality defects or product (and/or test) failures. Identification must follow the recommended practices outlined in Section 3.5.

At a minimum, each plywood panel should be identified with:-

- A. Plywood manufacturer's brand and name
- B. Date of manufacture of the panel
- C. Number glue spreader
- D. Number of hot press
- E. Production line

Permanent identification must be placed on the longitudinal edges along the thickness of each panel, per latest IICL requirements for markings that will be legible for the service life of the panels.

1.10 Miscellaneous

1.10.1 Floor coatings

Coatings can be applied when required.

Note: Coatings may differ according to buyer(s).

1.10.2 Additional requirements

Each user can add additional requirements to the general specifications.

2. PERFORMANCE REQUIREMENTS FOR THE MANUFACTURE AND TESTING OF PLYWOOD FLOOR PANELS

All plywood floor panels manufactured for use in general cargo containers, regardless of wood species used or ply lay up design must successfully meet the performance requirements outlined in the following testing criteria:

- IICL short span test with a test failure load greater than 690 kgs (1525 lbs).
- IICL floor board strength test (1.3 ISO floor truck test).

Note: For details on the above IICL tests, see section 3 of this bulletin.

- Bonding test per **BS EN314-1. 2004.**
- Bonding Quality Test Methods per **BS EN314-1:2004, Part 1** and Bond Quality per **BS EN314-2:1993, Class 3** requirements.
- Determination of bonding quality using knife test, per **BS 1088-2:2003.**

Use this standard for qualification of knife test, and then only for optional internal factory bond quality checks, if needed for process control.

- Planar shear test per **ASTMD2718-00**, latest revision.

Plywood manufacturers are required to perform the above mentioned tests to verify and ensure all plywood panels meet or exceed the performance requirements outlined in this bulletin.

All tests must be carried out on a minimum of three (3) different panels per shift of production. Test panels must be chosen randomly to ensure adequate cross sampling. It is recommended that one panel be selected at the beginning of each shift, another during the shift and another near the end of each shift.

Test samples must be identified in the same manner as the indicated in section 1.9 of this bulletin and the test results must be kept for a minimum of three (3) months.

Note: All testing data and results must be available for inspection and/or review upon request.

3. REFERENCES AND TECHNICAL INFORMATION

3.1 IICL Short Span Test (“250 mm Span Shear Test”)³

3.1.1 Preface

In the container industry, engineered panels are often used for the construction of container floors. These floors are frequently subjected to dynamic loading conditions from loaded forklifts. The panels used for these floors are commonly a 19-ply plywood product, approximately 1.10 inches (28 mm) thick, with mixed hardwood species. The plywood panels are currently manufactured in many Asian countries. At this time, there is no standard or quality control test available to estimate the structural properties of these plywood panels. Wood Advisory Services, Inc. was retained to recommend a test procedure to be used for evaluating the shear strength of small clear test specimens fabricated from these types of plywood panels.

Three point bending test is recommended for estimating the shear strength of these types of plywood panels. This bending test is a straightforward test, which induces a bending load in short spanned, deep test specimens that in turn induces high levels of horizontal shear in the test specimens.

3.1.2 Scope

This procedure is only a test procedure and not a performance standard. There are no minimum structural requirements for evaluating these types of plywood panels and this test procedure does not promulgate any minimum structural criterion for these types of plywood panels. It is up to the discretion of the panel producer or purchaser to set and establish those criteria and to monitor those criteria through the use of this test procedure. Also, this test procedure does not establish any criterion to test for panel variations such as panel construction, wood species, or panel dimensions.

3.1.3 Test Sample Size

A minimum of three (3) (different) panels per shift of production should be selected randomly to ensure adequate cross sampling. It is recommended that one panel be selected at the beginning of each shift of production, one during the shift and another near the end of each shift.

3.1.4 Frequency of Tests

- The “IICL Short Span Bending Test” - should be performed once on each panel selected.
- The Bonding Test - should be performed once per production day on one (1) of the panels selected for the Short Span Bending Test.

³ Developed by Wood Advisory Services Inc., 121 Valley Farm Road, P.O. Box 1322, Millbrook, New York 12545, USA. Tel: 845-677-3091, Fax: 845-677-6547, Website: <http://www.woodadvisory.com> as “Test Procedures for Small Clear Test Specimens from Plywood Used for Container Floors”.

3.1.5 Control of Moisture and Temperature

Specimens to be tested using this procedure should be equilibrated to a constant moisture content of approximately 10% prior to testing. To establish and remain at constant moisture conditions, it is recommended that the samples be stored in a room, prior to and during testing, that has the capability of maintaining equilibrium moisture content (EMC) in the test specimens of approximately 10% (i.e. an approximate temperature of 70°F and relative humidity of 55%). If these conditions are not possible, then the variability of the EMC of this type of plywood will need to be evaluated and a relationship will need to be established between relative humidity and EMC.

3.1.6 Specimen Preparation and Testing

3.1.6.1 Test Specimen Dimensions

The tests shall be conducted on test specimens 2" X panel thickness X 12". (Figure 1 illustrates a typical test specimen). The test specimens shall be fabricated using appropriate sawing equipment (e.g. table saw). Also, the specimens shall be fabricated to ensure that no strength reducing defects such as knots, sloping grain, or lap marks are included in the test specimens.

Figure 1. Typical Test Specimen

3.1.6.2 Number of Test Specimens per Panel

At this time, it is unknown how many test specimens should be evaluated per panel. The plywood exhibits within panel and between panel variability, both of which are currently unknown quantities. Characteristics of these plywood panels that can influence the variability are panel construction (i.e. number of plies, ply thickness, ply orientation, etc.) knots, slope of grain, lap marks and wood species. It is up to the discretion of the individuals conducting the test to determine the number of test specimens to be evaluated per panel. If only one (1) test specimen is evaluated then it is assumed that no variability exists within the panel. *[It is recommend to test more than one test specimen per panel, however, in order to determine the minimum number of tests required, it will be necessary to perform an exploratory evaluation to estimate within panel variability for this type of product. Similarly, between panels, variation can only be determined following a similar type of evaluation].*

Figure 2. Test Assembly

3.1.6.3 Test Span, Load Support, Bearing Block and Center Loading

The test specimens shall be tested over a 10” span using an applicable load support. The supports shall either be rounded or if knife-edges are used then rounded supports shall be placed over the knife-edges. The supports shall be designed to ensure that no localized crushing occurs in the test specimens at these points. (Figure 2 illustrates an applicable test assembly.)

A loading block with a radius of 0.25 inches shall be used to apply a constant load at the center span of the test specimen. The loading block shall also contact the entire width of the test specimens at the center point.

The test specimen shall be positioned in the load support such that the top of the panel is face up. The top of the panel is the face that would be loaded in the field, as from within the interior of the container.

3.1.6.4 Measurements

The panel length, and width and thickness at center span shall be recorded to the nearest 0.01 inches prior to testing using calipers. A drawing illustrating the panel construction shall also be recorded. The test specimens shall also be weighed prior to testing to the nearest 0.01g using an appropriate balance.

3.1.6.5 Speed of Testing

Each test specimen shall be tested using a constant loading block rate of motion of 0.08 in/min until maximum load is attained and failure has occurred. Record maximum load upon test specimen failure.

3.1.6.6 Load Deflection Data

Load and deflection data shall be recorded during the test to the nearest 0.001 in. using a yoke and dial gauge assembly. (Figure 3 illustrates a typical yoke and dial gauge assembly.)

3.1.6.7 Description of Failure

Classify and provide a drawing or photograph of each failure. Failures are classified as rolling shear or bending tension. Rolling shear occurs in the center plies of the test specimen near the neutral plane, and manifests horizontally within a ply(s) or within a glue-line(s) along the length of the test specimen. Each rolling shear failure shall be classified as occurring within a ply(s) or within glue-line(s). A bending tension failure occurs on the bottom face and/or edge of a test specimen usually close to the mid-span. It generally occurs across the width of a test specimen and usually

propagates vertically upward from the bottom face and/or edge a short distance. In addition to classifying each test specimen failure, the location of the failure within a test specimen shall also be recorded.

Often a combination of these failures can occur. If they do, then classify the failure as a rolling shear/bending tension failure and record the rolling shear failure accordingly. If only a bending tension failure occurs, the test may not be acceptable if a low strength was recorded. If a low strength is recorded again this may be indicative of material anomalies.

Figure 3. Typical Yoke and Dial Gauge Assembly

3.1.7 Determination of Moisture Content and Specific Gravity

3.1.7.1 General

It is important to report the moisture content and resulting specific gravity at the time of testing because mechanical properties of wood are affected by variation in moisture content. A 1” test piece cut from the test specimen will be used to determine both the moisture content and specific gravity at the time of the testing.

3.1.7.2 Moisture Content

(described in ASTM D143 & ASTM D4442 Method A Oven-Drying)

Immediately following each test a 1” thick test piece of wood shall be cut from the test specimen nearest to the point of failure but shall not include the failure. This test piece shall be used to determine the moisture content at the time of testing. The weight of each piece shall be recorded to the nearest 0.01g using an appropriate balance. Each piece shall be dried in a vented oven at a temperature of 103 ± 2°C until constant weight, or oven dry weight, has been attained (approximately 24 hrs.). Oven dry weight is verified by two successive hourly test piece weights with no change in weight recorded. Once oven dry weight has been attained, weigh the test piece to the nearest 0.01g using a balance and calculate moisture content using the following equation:

$$\text{MC\%} = \frac{\text{Test Weight} - \text{Oven Dry Weight}}{\text{Oven Dry Weight}} \times 100$$

3.1.7.3 Specific Gravity

(described in ASTM D2395 Method B – Volume by Water immersion)

Specific gravity is determined using the oven dry weight and oven dry volume of the test piece. After the oven dry weight of the test piece had been determined, the oven dry volume of the test piece is determined by water immersion. First, dip the 1” test piece in paraffin wax to seal the specimen. Then insert a sharp pointed slender rod into the test piece and completely immerse it into a known quantity of water. A known quantity of water is determined by using approximately 400 ml of water in a 400 ml beaker and placing the beaker onto a balance. Completely immerse the test piece into the water within the beaker and record the change in weight to the nearest 0.01g. This weight is the oven dry volume. (Figure 4 illustrates an immersed test piece in a 400 ml beaker on a balance.) Calculate the specific gravity using the following equation:

$$\text{Specific Gravity} = \frac{\text{Oven Dry Weight}}{\text{Oven Dry Volume}}$$

Figure 4. Immersed Test Piece in a 400 ml Beaker on a Balance

3.1.8 Calculations

- Properties - the following are the calculations used to calculate the mechanical properties for each test specimen:

Shear Force (V): $V = \frac{1}{2}P_{\max}$

Shear Strength (F): $F = \frac{3}{2} V/bd$

b = base or width

d = depth or thickness

Modules of Elasticity (MOE):

$$\text{MOE} = P/a \cdot \frac{3}{4bh^3}$$

P/a = slope of linear section of load deflection data

E = test span

3.2 IICL Floorboard Strength Test (“1.3 ISO Floor Fork Truck”)

3.2.1 Scope of Testing

All batches of production should be tested. The first container of each production batch and one container –RANDOMLY PICKED BY THE BUYER’S REPRESENTATIVE – of every 50 (fifty) units built thereafter should be tested as below. These test units should be moved directly to the testing area after they are off-lined. NO undercoating should be applied until after successful floor testing has been carried out.

Testing should be done in a location such that the buyer’s representative can witness the test with minimal interruption of his on-line inspection duties. The testing should be done immediately after pulling the unit from the line so as to minimize the number of units manufactured prior to the test results being determined.

This test procedure does not replace in any way the ISO Floor Strength Test carried out as part of the prototype and batch production tests. It is a FLOORBOARD STRENGTH test only, so it is not necessary to monitor and record base deflection during testing EXCEPT IN THOSE CASES IN WHICH THE RANDOMLY PICKED CONTAINER HAPPENS ALSO TO BE SCHEDULED FOR THE ISO BATCH TEST.

3.2.2 Testing Vehicles

Each floor should be tested using a test vehicle that is consistent with the test vehicle description in ISO 1496-1, Section 6.9.2, Test No. 8 – Floor Strength.

3.2.3 Testing Procedure

Step 1: Testing shall be carried out with the above described test vehicle loaded with an axle load of 3630 kg per wheel (2 wheel load 7260 kg), ISO 33%. Load must be centered over the two 180 mm wide wheels evenly.

Step 2: The test vehicle shall be maneuvered SLOWLY (**AT MAX SPEED OF 0.5 FT PER SECOND/152MM PER SEC**), in such a way that the entire floor area is covered. Care should be taken to avoid impact or other dynamic loads by starting, stopping and rolling the test vehicle gently and slowly.

Step 3: The test vehicle shall be maneuvered over the floor area for a total of 5 (five) cycles. One cycle is considered to be a complete pass into the container from the door to the front panel and from the front panel to the door and out of the container. The wheels of the test vehicle shall follow the same path on the inward and outward passes.

Step 4: The test vehicle should be repositioned outside the container between cycles so as to avoid imposing any dynamic loads on the container floor.

Step 5: At the end of EACH cycle the inspector should, using a hammer, tap the floor in search of hollow sounds, which will indicate delamination between plywood components. In addition, the inspector should look for other obvious signs of failure such as waviness and/or bulges on the outer plies, and cracks in the outer (usually lower) plies of the tested boards.

Step 6: If tapping after one of the cycles produces a hollow sound but there are no obvious signs such as waviness, bulges, or cracks as mentioned above; the area should be marked for further inspection after all cycles are completed.

Step 7: The inspection procedure in Step 5, above, shall be repeated for each cycle until all five cycles are completed or until a failure is detected in any board. If obvious signs of failure (waives, bulges, or cracks) occur at any time during the test, the container has failed the floor test, and the test should be stopped.

Step 8: At the end of the test (5 cycles), and if no problems are noted during testing, random floor boards should be removed (two for a 20 ft and four for a 40 ft) for further inspection and determination of the presence of delamination/ply separation between plies. **IF THERE IS ANY SUSPICION WHATSOEVER THAT THESE PANELS HAVE FAILED, THE PANELS ARE TO BE SECTIONED FOR FURTHER INSPECTION.** In addition, any boards marked in Step 5, above, and any boards showing visible permanent downward deflection should be removed and inspected. **THESE PANELS SHOULD BE SECTIONED TO CONFIRM THAT FAILURE HAS NOT OCCURRED INWARD FROM THE PANEL EDGES.** If no problems are found, the undamaged and uncut boards should be reinstalled and the floor test considered successful.

3.2.4 Floor Pass/Fail Criteria

3.2.4.1 Breakage

Any BREAKAGE constitutes failure of the floor tested.

BREAKAGE is defined as follows:

- Any DELAMINATION/PLY SEPARATION resulting from the internal shearing of the veneer or failure of the adhesive including peeling of the surface plies such that the plywood panel no longer acts as a single, composite structure.

NOTE: Delaminations at the edges caused by the abrasive action of the panels rubbing together at panel-to-panel joints is NOT considered breakage.

- Any cross-grain or transverse **CRACKS** in the plywood exterior veneers.

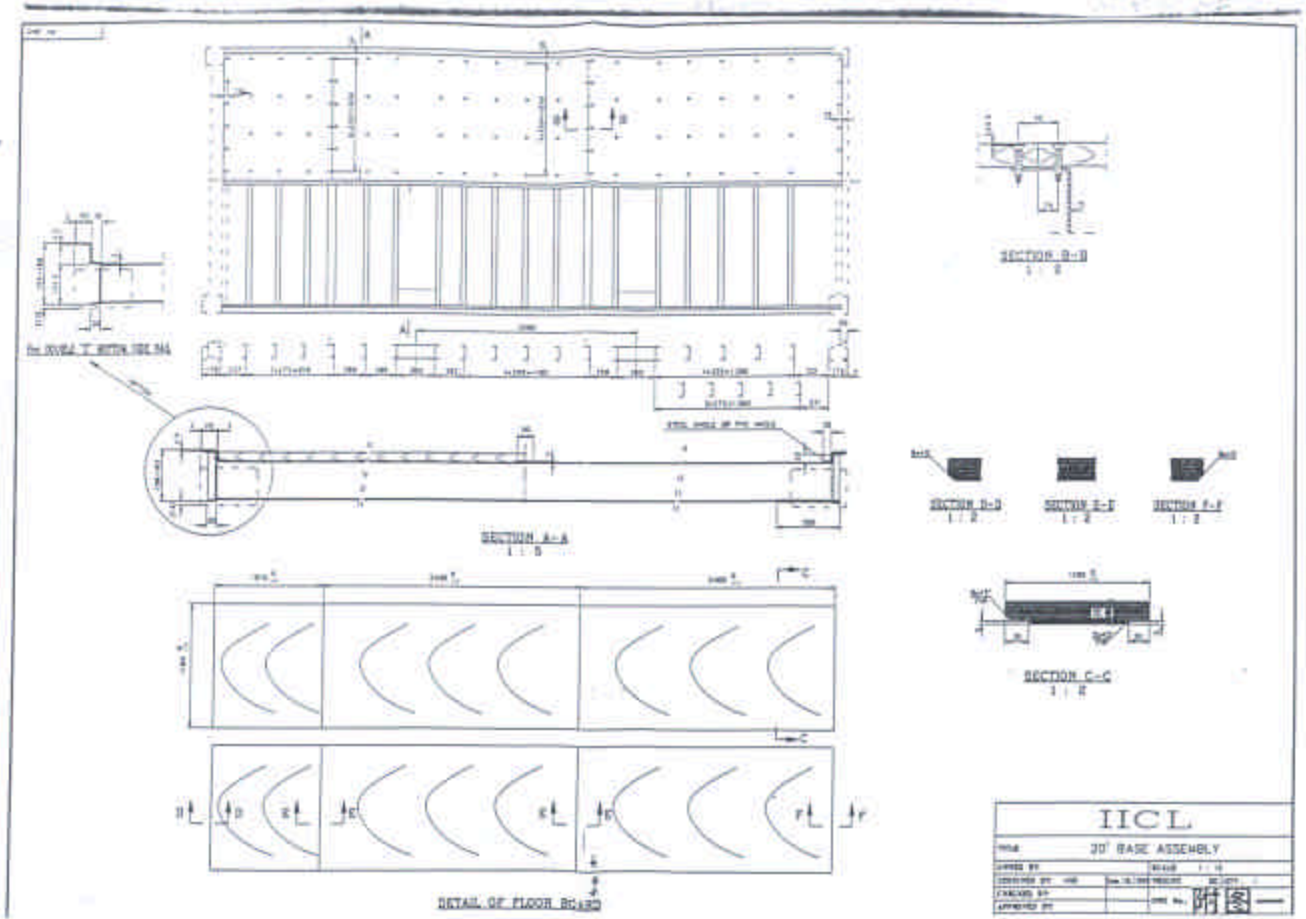
NOTE: Splits or cracks running parallel to the exterior grain are NOT considered breakage (THIS EXCLUSION IS SUBJECT TO FURTHER CONSIDERATION, AS IT MAY BE NECESSARY TO DIFFERENTIATE BETWEEN MINOR SPLITS AND LARGER SPLITS THAT MAY INDICATE FLOOR BREAKAGE.)

3.2.4.2 Failed Units

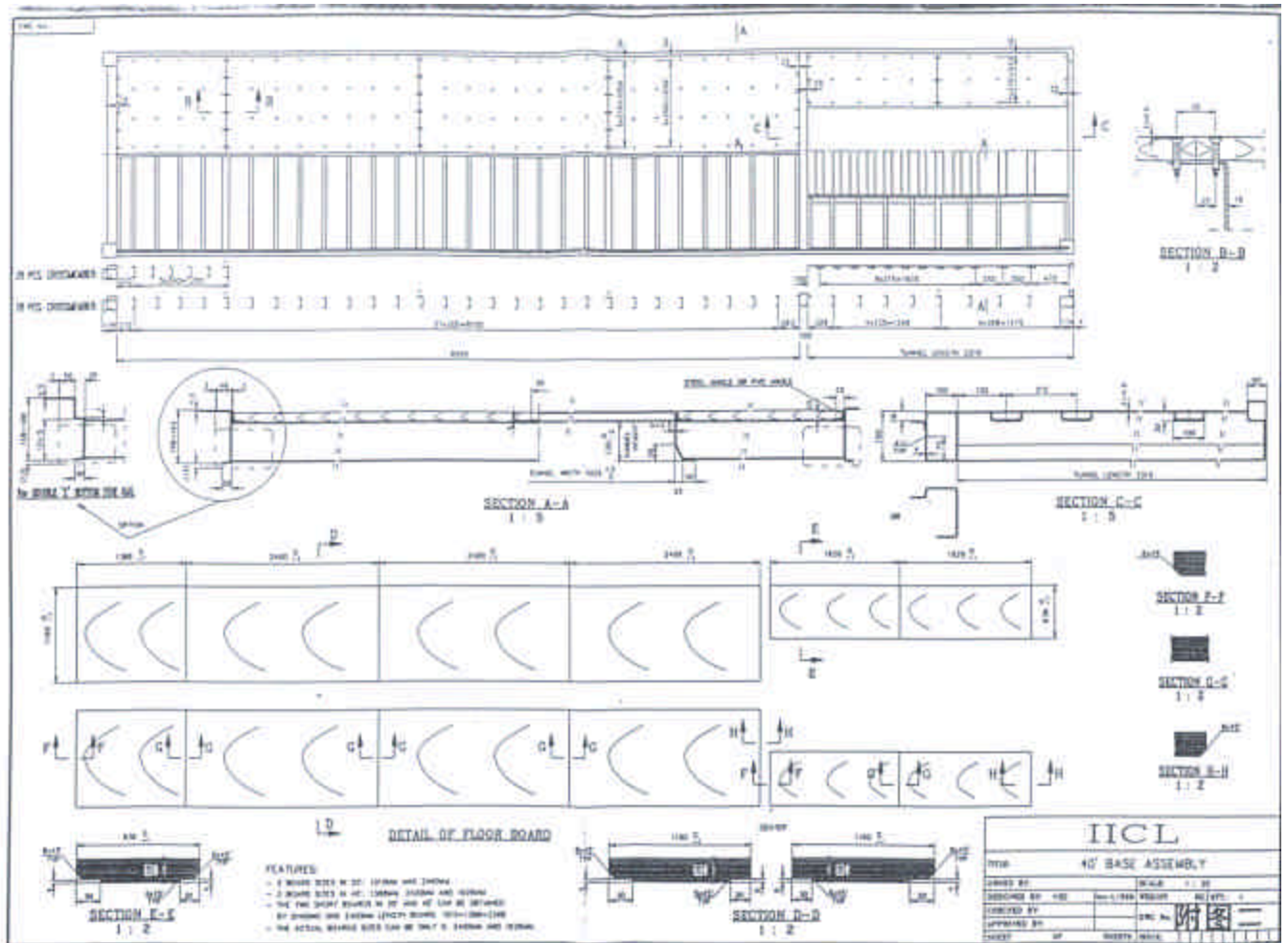
- Should breakage be found, a second container from the same batch shall be tested as above.
- If the second unit passes the test, the batch is considered acceptable, and testing is to return to the one (1) in fifty (50) sampling cycle.

If the second container fails, the batch is considered to be failed, and the buyer shall be contacted for instructions. AT THE BUYERS OPTION, ADDITIONAL TESTING MAY BE REQUIRED AND TESTING MAY INCLUDE UNITS PRODUCED PRIOR TO OR BETWEEN EARLIER TESTS THAT WERE SATISFACTORILY PASSED.

3.3 IICL 20FT BASE ASSEMBLY



3.4 IICL 40FT BASE ASSEMBLY



3.5 IICL Floor Board Identification

Below is our project recommendation regarding the implementation of compulsory identification of the floorboard supplier incorporated into the container manufacturing process.

- a) Container floorboard suppliers should be identified by the classification society representative, and the floorboard supplier name should be included on the Certificate of Inspection.
- b) AU container floorboards should be permanently marked by the flooring supplier as follows:
 - Flooring supplier's brand should be stamped on the upper face of each board.
 - The initials of the flooring supplier should be stamped on the board edge.
 - The adhesive spreader and hot press numbers should be stamped on the board edge.
 - The month, day, and year that the board was manufactured should be stamped on the board edge.
- c) The container manufacturer's Specification Data Decal that is applied to the interior rear of each container should have an area for a small overlay decal listing the floorboard type and flooring supplier's name. If the Specification Data Decal is not required by an owner, the floor supplier's decal will be applied at the interior rear of the container.

Attachments:

- Attachment (a): Sample of the Certificate of Inspection.
- Attachment (b): Examples of floorboard markings.
- Attachment (c): Sample of Specification Data Decal.
- Attachment (d): Sample of flooring supplier's decal.

Attachment (b)

Upper Face of Board

- Plywood supplier's name
- Brand stamped



Board Edge

- Plywood supplier's initials
- Adhesive spreader number
- Hot press number
- Manufacture month, date, and year



SPECIFICATION DATA

- (A) PAINT SYSTEM:
PAINT MFR'S NAME:
HEMPEL-HAI HONG COATINGS CO., LTD.
EXTERIOR COATING:
HEMPADUR ZINC 1536/1983
HEMPADUR PRIMER 1530/2178
HEMPATEX HI-BUILD 4637/6181
INTERIOR COATING:
HEMPADUR ZINC 1536/1983
HEMPADUR HI-BUILD 4520/1115
BASE COATING:
HEMPADUR ZINC 1536/1983
HEMPINOL 1022/1999
- (B) DOOR HARDWARE:
SAEJIN SJ-13BF WITH SECURA CAM & KEEPER
- (C) DOOR, SIDE, FRONT AND ROOF PANEL,
DOOR FRAME, REAR AND FRONT HEADER,
REAR AND FRONT SILL, CROSSMEMBER,
FORK POCKET TOP PLATE, FORK POCKET SIDE RAIL,
REAR AND FRONT CORNER POST:
TOP AND BOTTOM SIDE RAIL,
CORTEN A Y.P.=35 KG/MM²
 T.S.=49 KG/MM²
- (D) THE OTHER MATERIAL:
SS41 Y.P.=25 KG/MM²
 T.S.=41 KG/MM²
- (E) Floorboards: Place floor supplier's decal here

Attachment (d)

Floorboard type: Apitong Plywood

Supplier: P.T. Harjohn Timber

Size to fit Specification Decal

4. DEFINITIONS

4.1 Plywood: An engineered structural material consisting of veneer/plys of wood at different thicknesses glued or bonded together with the wood grain of adjacent layers arranged at right angles or parallel to each other. Depending on the desired properties in container plywood panels, up to 3 plies in specific locations all run in the same longitudinal direction, for special increased strength reasons. Also, see lay-up configuration definition below.

4.2 Internal Forces: When any structural member is supported on an approx 300-350 mm span and experiences a vertical load, such as a rolling fork truck wheel, it experiences both vertical and horizontal induced forces. The vertical forces are maximum on the member's top & bottom surface. The top surface is loaded in a compression mode, while the bottom surface is loaded in a tension mode. These forces are zero at the center of the thickness. The horizontal forces are maximum at the center of the member's thickness, and are "0" at the top and bottom surfaces. In wood, these horizontal forces create the potential for a sliding motion between the upper and lower portions of the member.

4.3 Internal forces, Wood Plank in container floor: When a hardwood plank is subjected to vertical loads, such as a rolling fork truck wheel, and is used in container flooring that is supported on approx 300-350 mm spans, the plank experiences both vertical and horizontal internal forces. Common oak and apitong/keruing planks generally are stronger in resisting horizontal internal, shear forces, and thus fail from vertical overloading (in bending), which usually results in splits on their lower exterior surface.

4.4 Internal forces, Plywood panels in container floor: When a plywood panel is subjected to vertical loads, such as a rolling fork truck wheel, in container flooring that is supported on approx 300-350 mm spans, the panel experiences both vertical and horizontal internal forces. Traditional apitong/keruing panels generally are stronger in resisting the internal vertical forces, and thus fail from horizontal shear overloading. This failure usually results in splits/separations within the interior "middlemost" transverse layers. These failures occur between, or within, a veneer/ply as fibers rolling over each other. This is referred to as a rolling shear failure.

4.5 Rolling Shear Failure: When veneers/plys in a plywood panel are loaded ACROSS/at right angles to the grain, a sufficient load can become more than their natural shear strength. This overload then causes grains to rip free of each other, and begin to roll over each other, in what is known as a rolling shear failure.

4.6 Delamination: A true delamination is when the adhesive/glue fails in a plywood panel, and adjacent veneer/plys are no longer permanently joined to one another as a result of the adhesive bond failure. Because panels are made from the same batches of glue, multi veneer/plys and multi panels should show delamination in any container with true delamination.

4.7 Separation: When a panel fails due to overload, veneers/plys pull apart/separate; In these cases, because horizontal stresses are highest at the center of the panel thickness, the first failure (a rolling shear failure) usually occurs in a transverse layer above or below the center of the panel's thickness. Sometimes secondary failures occur at approx ½ thickness of the remaining thicknesses. After shear failures, extreme loads can also cause splitting/bending failures of outermost longitudinal plys..

Note: Continuous overloading/fork truck travel can result in “rubbing” internal friction forces between adjacent, previously separated veneers/plys. This may result in a smooth appearance at the location of the adhesive bond. This “smoothing” should not be confused with a “true delamination”.

4.8 High Impact Over Small Area : A high impact can cause another type of failure. If a heavy impact occurs over a small area, it can cause simultaneous multi ply rolling shear failures through the thickness, and also a bending failure of outermost longitudinal plys

4.9 Wood failure: In testing when solid wood is overloaded in bending, it will usually fail/crack through its thickness, similar to a tree branch broken over one's knee.

When plywood is tested according to the test procedures in this bulletin, it generally fails in rolling shear, separating within inner veneers/plys. As long as the adhesive bond is good, wood fibers will remain attached to the adhesive. This is considered wood failure within a plywood panel.

4.10 Decay: Decay is deterioration of wood as a result of fungal attack. The typical appearance of decayed wood include splitting across the grain, soft and punky, stringy, or crumbly. The presence of wood decay can result in significant reductions in strength. Decay must NOT exist in wood to be used for panels, as it has no strength and, under some conditions, may continue to spread into surrounding good wood.

4.11 Decay resistance: The resistance of a wood species or panel treated with a wood preservative to stop/retard wood decay.

4.12 Plywood layup: Layups are the ply directions of each layer in a panel, and these are transverse (at rt angle to panel length) and longitudinal (parallel to panel length). Traverse plys maintain panel dimensional stability (minimize length and width dimensional changes from moisture changes, frequently noted in planks), and allow smaller pieces to be used in these layers to best use varying log trimmings; Longitudinal plys resist bending and shear forces, but must be used full length for attaining panel strength. Lay-up is a part of the “engineered” feature of the panel to meet specific service requirements.

4.13 Density: The weight of a sample divided by its volume. Density is expressed in kilograms per cubic meter (KCM), pounds per cubic foot (pcf), etc.

4.14 Specific gravity: The ratio of the oven dry weight of wood to an equal volume of water. Specific gravity is a unit-less value. This value is most often used in industry testing procedures for comparative purposes for wood strength and is cited in wood science textbooks. As the specific gravity increases, strength generally increases. As the specific gravity decreases, strength generally decreases. Specific gravity is typically determined with the oven dry weight, or zero moisture content, and oven dry volume of a tested sample.

4.15 Marine Grade Plywood: Plywood manufactured to the highest standards and longest service life. Panels of this grade can be permanently exposed to moisture or elevated moisture conditions.

4.16 Moisture Content: The amount of water in wood usually expressed as a percentage of the weight of the oven-dry wood. Moisture content is sensitive to changes in the surrounding environment. As the surrounding relative humidity increase, the wood moisture content will also increase, and as the surrounding relative humidity decreases the wood moisture content will also decrease.