MATERIAL AND EQUIPMENT STANDARD

FOR

PALLETS

FIRST EDITION

SEPTEMBER 2013

FOREWORD

The Iranian Petroleum Standards (IPS) reflect the views of the Iranian Ministry of Petroleum and are intended for use in the oil and gas production facilities, oil refineries, chemical and petrochemical plants, gas handling and processing installations and other such facilities.

IPS is based on internationally acceptable standards and includes selections from the items stipulated in the referenced standards. They are also supplemented by additional requirements and/or modifications based on the experience acquired by the Iranian Petroleum Industry and the local market availability. The options which are not specified in the text of the standards are itemized in data sheet/s, so that, the user can select his appropriate preferences therein

The IPS standards are therefore expected to be sufficiently flexible so that the users can adapt these standards to their requirements. However, they may not cover every requirement of each project. For such cases, an addendum to IPS Standard shall be prepared by the user which elaborates the particular requirements of the user. This addendum together with the relevant IPS shall form the job specification for the specific project or work.

The IPS is reviewed and up-dated approximately every five years. Each standards are subject to amendment or withdrawal, if required, thus the latest edition of IPS shall be applicable

The users of IPS are therefore requested to send their views and comments, including any addendum prepared for particular cases to the following address. These comments and recommendations will be reviewed by the relevant technical committee and in case of approval will be incorporated in the next revision of the standard.

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GENERAL DEFINITIONS:

Throughout this Standard the following definitions shall apply.

COMPANY:

Refers to one of the related and/or affiliated companies of the Iranian Ministry of Petroleum such as National Iranian Oil Company, National Iranian Gas Company, National Petrochemical Company and National Iranian Oil Refinery And Distribution Company.

PURCHASER:

Means the “Company” where this standard is a part of direct purchaser order by the “Company”, and the “Contractor” where this Standard is a part of contract documents.

VENDOR AND SUPPLIER:

Refers to firm or person who will supply and/or fabricate the equipment or material.

CONTRACTOR:

Refers to the persons, firm or company whose tender has been accepted by the company.

EXECUTOR:

Executor is the party which carries out all or part of construction and/or commissioning for the project.

INSPECTOR:

The Inspector referred to in this Standard is a person/persons or a body appointed in writing by the company for the inspection of fabrication and installation work.

SHALL:

Is used where a provision is mandatory.

SHOULD:

Is used where a provision is advisory only.

WILL:

Is normally used in connection with the action by the “Company” rather than by a contractor, supplier or vendor.

MAY:

Is used where a provision is completely discretionary.

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1. SCOPE

This Standard Specification covers the minimum requirements for pallets for materials handling to be used in Iranian Petroleum Industries. Compliance by the pallet Vendor with the provisions of this Standard dose not relieve him of the responsibility of furnishing pallets of proper design, mechanically suited to meet operating guarantees.

No deviation or exception from this Standard shall be permitted, without explicit approval of the Company, Intended deviations shall be separately listed by the Vendor, supported by reasons thereof and submitted for company's consideration.

1.1 Conflicting Requirements

In case of conflict between this Standard, and purchase order following priority of documents shall govern:

a) Purchase order and variations thereto,

b) This Standard.

All conflicting requirements shall be referred to the Purchaser in writing. The Purchaser will issue confirmation document if needed for clarification.

Note:

This is a revised version of this standard, which is issued as revision (1)-2013. Revision (0)-1997 of the said standard specification is withdrawn.

2. REFERENCES

Throughout this Standard the following dated and undated standards/codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this standard. For dated references, the edition cited applies. The applicability of changes in dated references that occur after the cited date shall be mutually agreed upon by the Company and the Vendor. For undated references, the latest edition of the referenced documents (including any supplements and amendments) applies.

BSI (BRITISH STANDARD INSTITUTIONS)

BS EN ISO 445: 2009	"Pallets for Materials Handling – Vocabulary"
BS ISO 6780: 2003	"Flat pallets for Intercontinental Materials Handling –Principal Dimensions and Tolerances"
BS ISO/TR 10232: 1995	"General – Purpose Flat Pallets for through Transit of Goods-Design Rating and Maximum Working Load"

ISO (INTERNATIONAL ORGANIZATION FOR STANDARDIZATION)

ISO 8611-1: 2011(E)	"Pallets for Materials Handling – Flat Pallets – Part 1: Test Methods"
ISO 8611-2: 2011	"Pallets for Materials Handling – Flat Pallets – Part 2: Performance requirements and Selection of Tests"

IPS (IRANIAN PETROLEUM STANDARDS)

IPS-E-GN-100	"Engineering Standard for Units"

3. UNITS

This Standard is based on International Systems of Units (SI), as per IPS-E-GN-100 except where otherwise specified.

4. DEFINITIONS AND TERMINOLOGY

For the purpose of this Standard, the following definitions apply.

4.1 Pallets

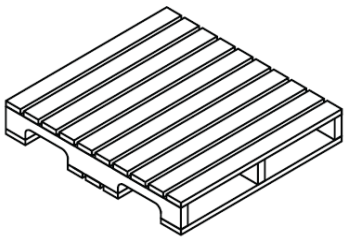
Rigid horizontal platform of minimum height, compatible with handling by pallet trucks and/or fork lift trucks and other appropriate handling equipment used as a base for assembling loading, storing, handling, stackings, transporting, or displaying goods and loads.

The pallet can be constructed with, or fitted with, a super structure.

4.2 Pallet Types

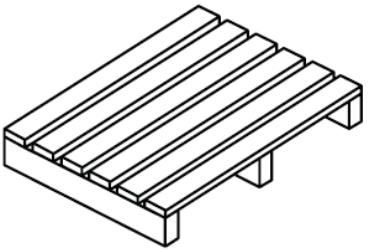
4.2.1 Flat pallet

Pallet with a top deck without a raised superstructure.



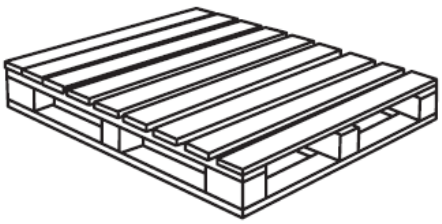
4.2.1.1 Single-Deck pallet

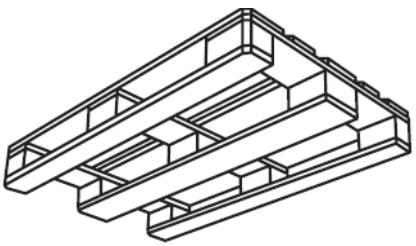
Flat pallet where the lower bearing surface area is less the percentage specified in ISO 6780: 2003 (4.6).



4.2.1.2 Double-Deck pallet

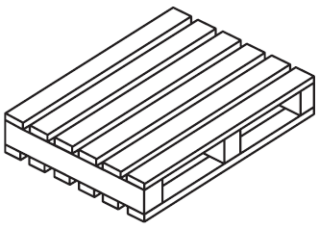
Flat pallet with a top and a bottom deck.

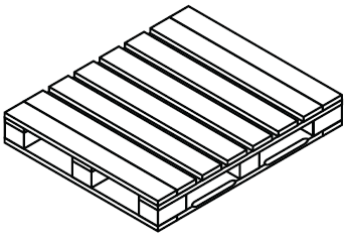




4.2.2 Reversible pallet

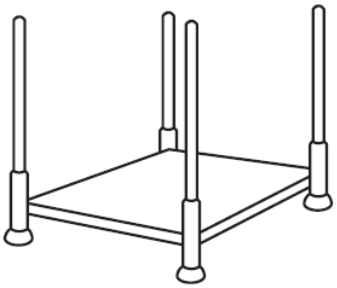
Double-deck flat pallet with similar top and bottom decks, either of which can take the same load.





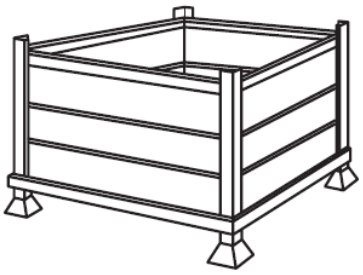
4.2.3 Post pallet

Pallet having posts to permit stacking, and fitted with either removable rails or gates.



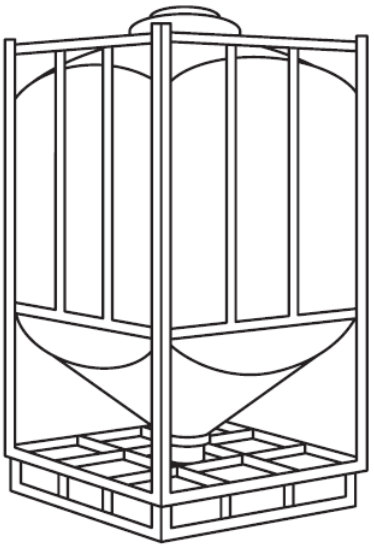
4.2.4 Box pallet

Pallet with solid or close boarded sides, one or more of which can have hinged or removable gates for access.



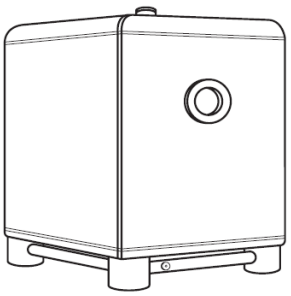
4.2.5 Silo pallet

Sealed four-sided box pallet fitted with a sealable lid and an emptying device in the base. Commonly used for carrying dry powders or granules.

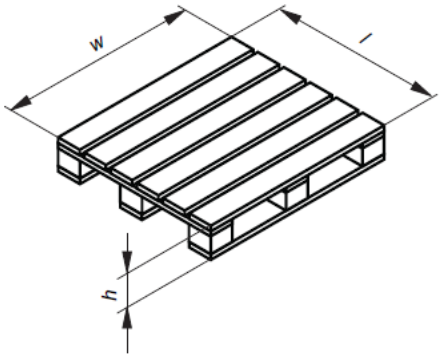


4.2.6 Tank pallet

Sealed four-sided box pallet, fitted with a sealable lid, which can be emptied by a tap fitted to the base or by aspiration through the top opening. Commonly used for carrying liquids and gases.



4.3 Dimension of Flat Pallets



4.3.1 Length

Deck dimension in direction of stringers (bearers) or stringer-boards

Note:

The length dimension is quoted first when designating the pallet size.

4.3.2 Width

Deck dimension at right angles to the length. (see W in the figure.)

4.3.3 Height

Overall dimension vertical to the horizontal plane of the length/width axes. (see H in the figure.)

4.4 Rating (R)

The designated load capacity of the pallet, in Kilograms, assuming an evenly and uniformly distributed load.

5. DESIGN RATING AND MAXIMUM WORKING LOAD

For through transit, pallets are often loaded in such a way that the load being carried (the payload) contributes to the overall performance of the loaded pallet. Therefore a given design of pallet is suitable for several different payloads and will have nature of the particular payload.

However, a given pallet without payload has only one rating (R), namely its designated load capacity with a uniformly distributed load. The rating, expressed in kilograms, is verified by test and cannot be changed, for example a rating of 1000 kg might be referred to in a test report as 1000 kg.

During palletization, it is the duty of the responsible supervisor to ensure that a safe working load is not exceeded. Table 5.1 shows the relationship, for different types of load, between the pallet rating (R) and the payload of the pallet which may be considered the maximum working load.

TABLE 5.1 - RATING AND MAXIMUM WORKING LOAD RELATIONSHIP WITH DIFFERENT TYPES OF PAYLOAD

DISPOSITION OF LOAD ON PALLET	EXAMPLE OF LOAD ON PALLET	AREA OF DECK UNDER LOAD[1)]	MAXIMUM WORKING LOAD AS A FACTOR OF THE RATING
Point load	Electric motor	< 0.3 A	0.6 R
Patch or concentrated load	Large case (but smaller than pallet)	Between 0.3 A and 0.85 A	R
Uniformly distributed or articulated load (UDL)	Cold flowing butyl rubber sheets	> 0.85 A	R
Unbounded-uniformly placed load	Non-interlocked cases	> 0.85 A	1.25 R
Bonded uniformly placed load	Interlocked cartons in regular pattern	> 0.85 A	1.5 R
Solid load	Horizontal concrete slabs	> 0.85 A	1.5 R

1) A = Total plan area of pallet deck

6. PRINCIPAL DIMENSIONS AND TOLERANCES

6.1 Plan Dimensions and Tolerances

6.1.1 Rectangular plan dimensions

The rectangular plan dimensions of pallets conforming to this International Standard shall be as indicated in Table 6.1. Regional use of these pallet sizes is given in Appendix A.

TABLE 6.1 - RECTANGULAR PLAN DIMENSION SIZES

Metric mm	Imperial in
1 200 × 800	47,2 × 31,5
1 200 × 1 000	47,2 × 39,4
1 219 × 1 016	48 × 40
NOTE 1 The above plan dimensions describe pallet sizes only. They do not suggest or imply preferred pallet lengths or preferred pallet widths as defined in ISO 445. NOTE 2 With sawn timber, the dimensions stated should be associated with a specified moisture content. For plastics, dimensions should be measured at a temperature of 23 °C ± 2 °C.	

6.1.2 Square plan dimensions

The square plan dimensions of pallets conforming to this International Standard shall be as indicated in Table 6.2. Regional use of these pallet sizes is given in Appendix A.

TABLE 6.2 - SQUARE PLAN DIMENSION SIZES

Metric mm	Imperial in
1 067 × 1 067	42 × 42
1 100 × 1 100	43,3 × 43,3
1 140 × 1 140	44,9 × 44,9
NOTE The Notes given in Table 6.1 apply.	

6.1.3 Tolerances

Manufacturing tolerances on the plan dimensions given in 6.1.1 and 6.1.2 shall be $^{+3}_{-6}$ mm.

6.2 Vertical Entry Clearances for Lifting Devices

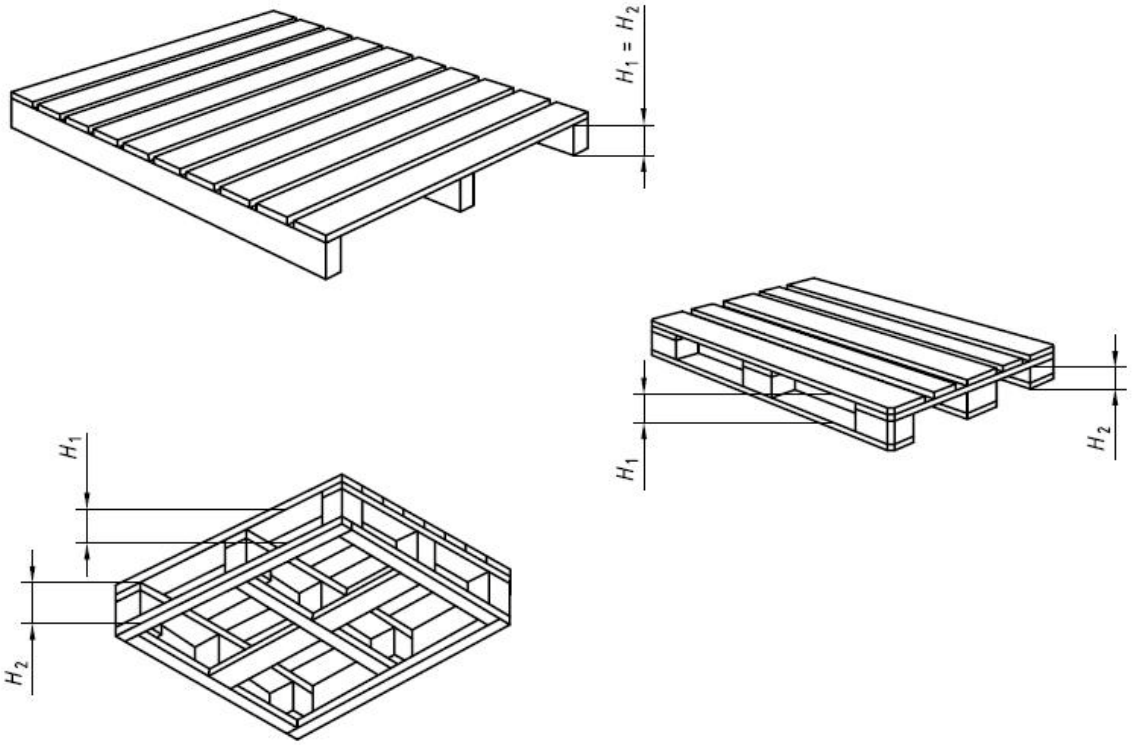
6.2.1 Pallet trucks

The vertical entry clearance *H*1 under the top deck for the entry of fork arms of pallet trucks, as shown in Figure 6.1, shall not be less than those values listed in Table 6.3. The distance from the top of the opening to the bottom surface of the pallet, *H*2 as shown in Figure 6.1, shall not exceed 156 mm.

The vertical clearance for some pallet designs are shown in Figure 6.1.

TABLE 6.3 - MINIMUM VERTICAL ENTRY CLEARANCE FOR PALLETS IN USE WITH PALLET TRUCKS

Pallet	**Minimum vertical entry clearance mm**
High profile	100
Standard profile	95
Low profile	89



H1 is the vertical entry clearance.

H2 is the distance from the top of the opening to the bottom surface of the pallet.

VERTICAL ENTRY CLEARANCE FOR LIFTING DEVICES FOR TWO-WAY AND FOUR-WAY ENTRY PALLETS

Fig. 6.1

6.2.2 Fork-lift trucks

The vertical clearance for the entry of fork arms of fork-lift trucks shall not be less than 50 mm.

The minimum clearance of 50 mm may not be sufficient in certain European countries where 55 mm is needed.

6.2.3 Other types of handling/lifting devices

For other types of handling/lifting devices, the dimensions given in 6.2.1 apply. The minimum clearance for pallets used in automatic handling systems is recommended as 100 mm.

6.3 Horizontal Clearances for Lifting Devices

6.3.1 End and side entry

Horizontal clearances for the entry of pallet trucks into the ends of two-way and partial four-way pallets and into the ends and sides of four-way pallets shall conform to those dimensions specified in Table 6.4 and shown in Figure 6.2 and Appendix B.

When the distance between fork arms is greater than 180 mm, as in ISO 509, L_1 and W_1 shall be at least 20 mm less than the distance between the fork arms.

TABLE 6.4 - HORIZONTAL CLEARANCES FOR LIFTING DEVICES

Dimensions in millimeters

Nominal dimension of pallet L or W	Entries and openings	
	L1 max. and W1 max.	L2 min. and W2 min.
800	160	580
≥ 1 000	160	710

6.3.2 Horizontal clearance of entries and openings for side entry into partial four-way pallets

Horizontal clearances for the entry of pallet trucks into the sides of partial four-way pallets shall conform to those dimensions specified in Table 6.5 and shown in Figure 6.3.

Note:

The dimension L_3 as illustrated in Figure 6.3 can be as great as 200 mm in partial four-way entry pallets designed to be handled by fork-lift trucks.

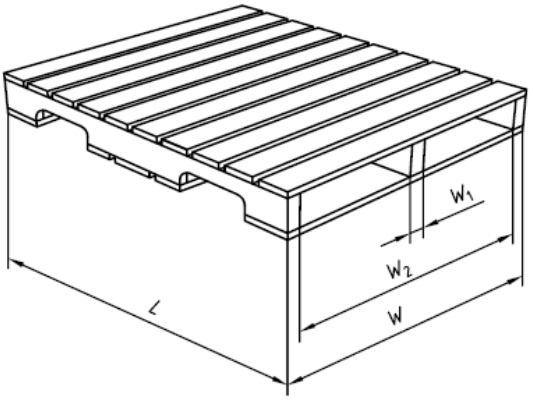
TABLE 6.5 - HORIZONTAL CLEARANCE OF ENTRIES AND OPENINGS FOR SIDE ENTRY INTO PARTIAL FOUR-WAY PALLETS

Dimensions in millimeters

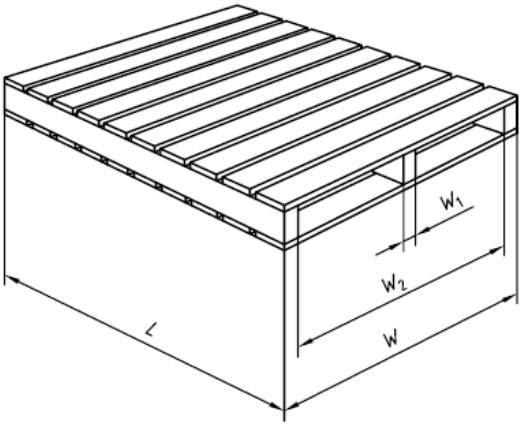
Pallet length L	Entries and openings					
	L_5		L_4		L_3	
	min.	max.	min.[a]	max.	min.	max.
800[b]	90	140	200	210	100	220
1 000	90	155	200	255	180	420
1 016	90	155	200	255	196	436
1 067	90	155	200	255	247	487
1 100	90	155	200	255	280	520
1 140	90	155	200	255	320	560
1 200	90	155	200	255	380	620
1 219	90	155	200	255	399	639

[a] Pallets with these minimum dimensions cannot be handled by pallet trucks equipped with tandem trail wheels.

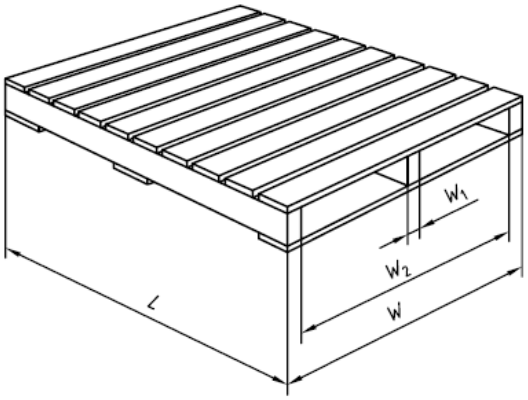
[b] Pallets of this length cannot be handled by pallet trucks equipped with tandem trail wheels.



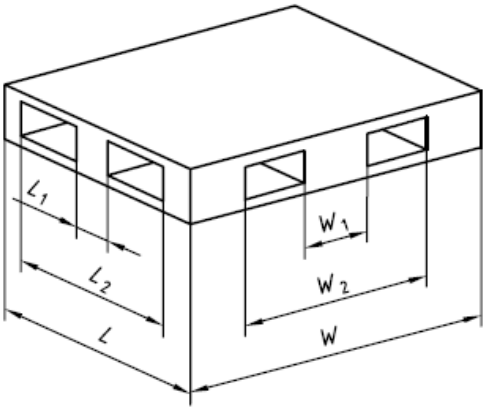
a) Entries: partial four-way pallet



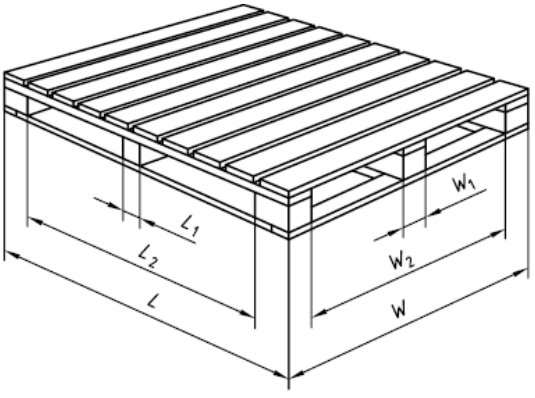
b) Entries: reversible two-way pallet



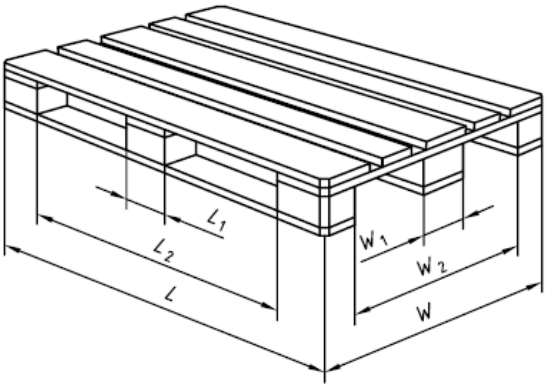
c) Entries: non-reversible two-way pallet



d) Entries: four-way pallet

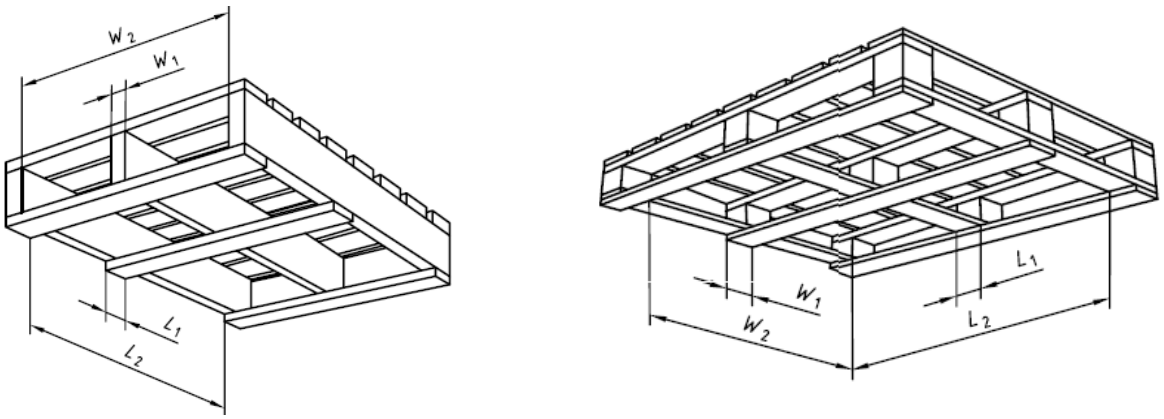


e) Entries: four-way pallet



f) Entries: four-way pallet

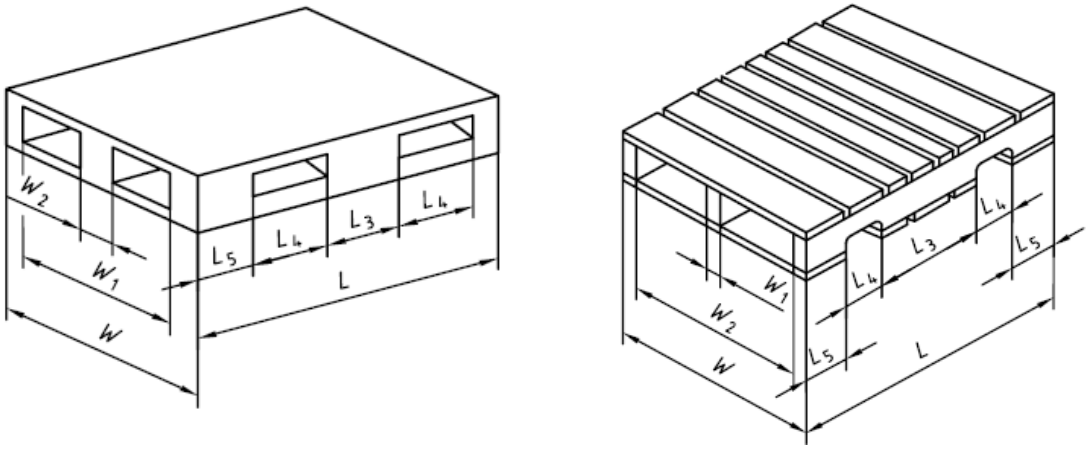
Fig. 6.2 (Continued)



g) Openings: non-reversible two-way pallet **h) Openings: four-way pallet**

HORIZONTAL CLEARANCE OF SIDE OR END ENTRIES AND BOTTOM DECK OPENINGS

Fig. 6.2



HORIZONTAL CLEARANCE OF ENTRIES AND OPENINGS FOR SIDE ENTRY INTO PARTIAL FOUR-WAY ENTRY PALLETS

Fig. 6.3

6.4 Dimensions of Bottom Deck Chamfers

Dimensions of bottom deck chamfers, where required for ease of handling with pallet trucks, shall be as follows:

a) The chamfer face shall be 40° ± 5° from the horizontal;

b) The height of the vertical face of the chamfered member shall not exceed 16 mm;

c) The maximum distance from the end of the chamfers to deck separating members shall be 65 mm.

Under certain conditions of handling that does not include pallet trucks, the thickness of the bottom deck may exceed 28 mm.

6.5 Bearing Surface of Bottom Deck Double-Deck Pallets

The bearing surface of the element or elements of the bottom deck shall be equal to or greater than

35% of the nominal overall plan dimensions.

Note:

35% should be regarded as the absolute minimum and should be increased wherever practicable.

6.6 Dimensions of Pallet Deck Projections

Projections of pallets up to 65 mm are known as lips; projections of 65 mm or longer are considered as wings.

6.7 Limits of Diagonal Distortion

The difference in length between the two diagonals shall not exceed 1 % of the original diagonal length at the time of manufacture.

6.8 Flatness

Vertical deviation from the target horizontal plane of the pallet deck shall not exceed 7 mm.

Intentional protrusions in the deck may exceed 7 mm.

6.9 Squarness

At the time of manufacture, the difference in length of the two diagonals shall not exceed 13 mm.

7. MATERIAL

Pallets may be fabricated and supplied in materials such as processed or unprocessed woods, wood-based composites plastics and metals according to the Purchaser's request, provided that all these materials shall be subjected to test specified in this Standard and approved.

8. TEST METHOD

8.1 Measurements

Pallets selected for testing shall be measured to ensure that materials, construction and dimensions conform to their associated written specification.

The mass and the material of each pallet shall be determined and recorded at the time of testing. The moisture content of wooden pallets shall be measured and recorded in accordance with EN 13183-2 at the time of testing.

Clause 9 gives further details on what should be recorded during testing and in the written report.

8.2 Precision and Accuracy of Tests and Apparatus

Test apparatus shall satisfy the following requirements.

a) In the design of the test equipment, the tolerances on all dimensions shall be ±2 %.

b) The accuracy of measuring equipment for tests shall be ±0.5 mm.

c) The accuracy of positioning of every component, excluding the test load, shall be ±2 mm; measurement gauges shall be positioned to ±4 mm.

d) The accuracy of positioning of the centre of application of test load (where used) shall be ±10 mm.

e) The total mass of the test load applied shall be within ±3 % of the prescribed value.

No part of any test rig shall distort an amount greater than ±3 mm when under maximum test load. Distortion of the test rig shall be taken into account in measuring deflections of the pallet.

Note 1:

Using heavy duty steel box sections in the construction of fixtures in tests 1 and 6 (see Table 8.1) normally results in central distortions approaching the 3 mm given limit.

The inclined plane apparatus shall be constructed as specified in ISO 2244 and shall permit inclined travel distance to change by 250 mm increments from 250 mm to 1 250 mm, each increment to within ±5 mm.

Note 2:

Experience suggests that the interlaboratory test precision for conducting tests 1a and 7a is 16.7 %; and 19.8 % when conducting tests 1b and 7b.

8.3 Test Load

A general value for the test load is not fixed. The test load for each test shall be determined in accordance with ISO 8611-2.

The test load shall be applied with a testing machine, hydraulic or air pressure, or with dead load and shall increase continuously or in steps to the failure (for determination of ultimate load) or up to the fixed value (for qualification tests).

8.4 List of Tests

Table 8.1 provides a matrix of the tests (in this part of ISO 8611) that shall be performed on flat pallets. Tests numbered 1, 2, 3, 4, 5, 6 and 7 shall be performed with new pallets.

Note 1:

Tests 1, 2, 4, 5, 6 and 7 can be carried out on one test sample (first stiffness, then strength, when there is a declared nominal load) or on two separate samples.

Note 2:

The tests are grouped into the three sections shown in Table 8.1. The selection of tests and evaluation of pallet performance are set out in ISO 8611-2 and ISO 8611-3.

8.5 Tests

8.5.1 Test 1 - Bending tests

8.5.1.1 Purpose

The purpose of these tests is to determine the bending strength (test 1a) and bending stiffness (test 1b) of the pallet in racking situations.

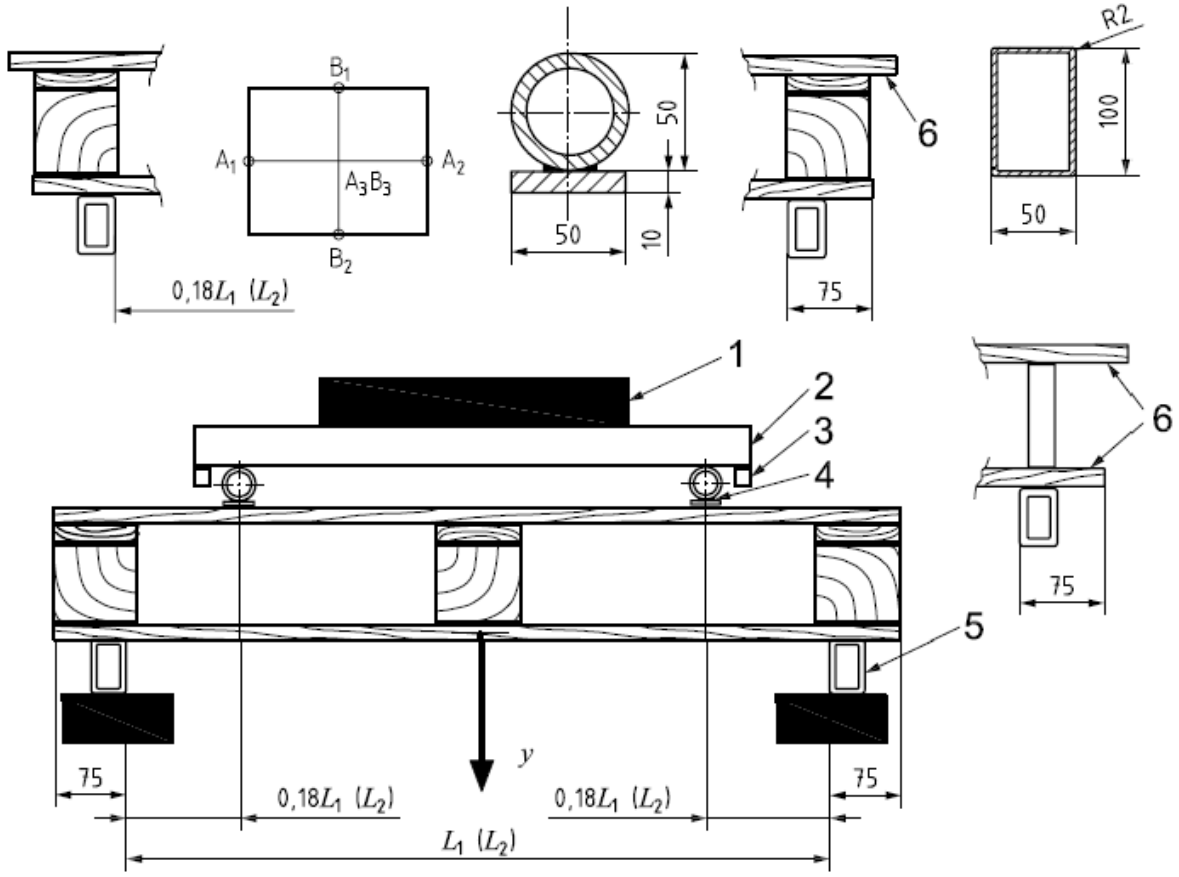
TABLE 8.1 - LIST OF TESTS

Test no.	Test measurement	Characteristic	Handling activity or purpose of the test	(Sub)clause ref.
Nominal load tests				8.5
1	**Bending tests**	Pallet length, width	Racking	8.5.1
1a	Bending strength			8.5.1.3.1
1b	Bending stiffness			8.5.1.3.2
2	**Forklifting tests**	Top deck	Lifting with forklift and pallet trucks	8.5.2
2a	Bending strength			8.5.2.3.1
2b	Bending stiffness			8.5.2.3.2
3	**Compression tests for blocks or stringers**	Height of blocks, stringers	Any activity that compresses blocks or stringers, including stacking	8.5.3
3a	Block or stringer strength			8.5.3.3.1
3b	Block or stringer stiffness			8.5.3.3.2
4	**Stacking tests**	Top and bottom deck	Stacking	8.5.4
4a	Deck strength test			8.5.4.3.1
4b	Deck stiffness test			8.5.4.3.2
5	**Bottom deck bending tests**	Bottom deck	Twin track conveyors	8.5.5
5a	Bending strength			8.5.5.3.1
5b	Bending stiffness			8.5.5.3.2
6	**Wing pallet bending tests**	Pallet length, width	Lifting with slings	8.5.6
6a	Bending strength			8.5.6.3.1
6b	Bending stiffness			8.5.6.3.2
Maximum working load tests — With payload or airbag				
1	**Bending test**	Pallet length, width	Racking	8.5.1
1b	Bending stiffness			8.5.1.3.2
7	**Airbag bending tests**	Pallet length, width	Racking	8.5.7
7a	Bending strength			8.5.7.3.1
7b	Bending stiffness			8.5.7.3.2
2	**Forklifting tests**	Top deck	Lifting with forklift and pallet trucks	8.5.2
2b	Bending stiffness			8.5.2.3.2
4	**Stacking tests**	Top and bottom deck	Stacking	8.5.4
4b	Deck stiffness test			8.5.4.3.2
5	**Bottom deck bending tests**	Bottom deck	Twin track	8.5.5
5b	Bending stiffness		Conveyors and narrow span beam racking	8.5.5.3.2
6	**Wing pallet bending tests**	Pallet length, width	Lifting with slings	8.5.6
6b	Bending stiffness			8.5.6.3.2
Durability tests				
8	**Static shear test**	Decks, blocks, stringers	Distortion resistance	8.5.8
9	**Corner drop test**	Diagonal rigidity	Resistance to impacts	8.5.9
10	**Shear impact test**	Decks, blocks, stringers	Distortion resistance	8.5.10
11	**Top deck edge impact test**	Top leading deckboard	Resistance to fork arms	8.5.11
12	**Block impact test**	Corner block, stringer	Resistance to fork tip	8.5.12
13	**Static coefficient of friction test**	Under deck/fork arms	Slip resistance on fork arms	8.5.13
14	**Slip angle test**	Top deck/payload	Slip resistance of loads	8.5.14

8.5.1.2 Procedure

8.5.1.2.1 In order to establish the weakest pallet support dimension, test one pallet across the length of the pallet and then a second pallet across the width of the pallet. There is no requirement for further tests on the stronger dimension unless the result is within 15 % of the weaker.

8.5.1.2.2 This having been established, place a fresh pallet across its weakest side, top deck uppermost, on pallet supports positioned with their inside edges 75 mm from the outer edges of the pallet. The load applicators shall be positioned at 0.18 L_1 or 0.18 L_2, where measured as shown, where L_1 or L_2 is the distance between the pallet supports (see Figure 8.1).



Key

1 Test load

2 Load board

3 Safety stop

4 Load applicator

5 Support

6 Wing

y Deflection

BENDING TEST

Fig. 8.1

8.5.1.2.3 Load applicators and supports shall be flush with or project beyond the edges of the pallet. Edges shall be relieved with (2 ± 1) mm radii. Where load applicators coincide with gaps between deckboards, in-fill pieces of equal thickness to deckboards with 3 mm to 6 mm overall clearance on each shall be used. Place on the pallet deck, the load applicators and the load board, then apply the rest of the test load.

8.5.1.3 Measurements

8.5.1.3.1 Test 1a - Determination of bending strength

Place a load on the load board until breakage of one of the components of the pallet or until reaching an excessive deflection or deformation. Record the ultimate load.

8.5.1.3.2 Test 1b - Determination of bending stiffness

Apply a datum load of (1.5 ± 0.5) % of the ultimate load determined in test 1a. Depending on the support location, the deflection, *y*, shall be measured at points A [maximum of *y* at A_1 (B_1), A_2 (B_2) A_3 B_3]:

a) After positioning of datum load;

b) Immediately after full test load is applied;

c) At end of the full test load period;

d) After the relaxation period.

8.5.2 Test 2 - Forklifting tests

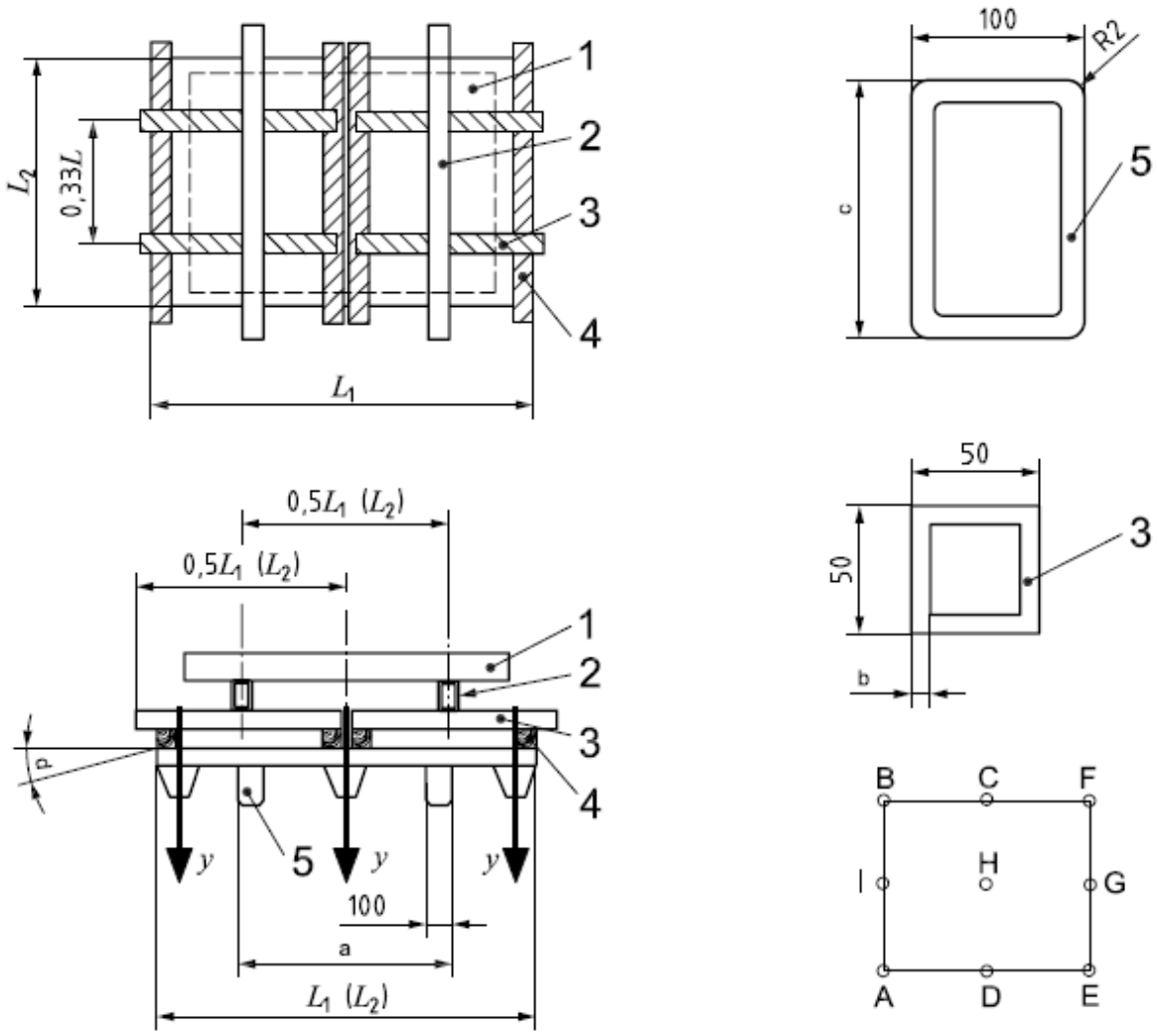
8.5.2.1 Purpose

The limiting condition of use for non-rackable and non-stackable single or double-deck pallets is the bending of the pallet on fork arm supports under the top deck of the pallet.

8.5.2.2 Procedure

The forklifting test is shown schematically in Figure 8.2. The test method permits simulation of the forklifting condition of use in each direction of pallet length and width. The supports shall conform to Figure 8.2. The support distances may be either 570 mm or 690 mm (see Figure 8.2, footnote a). The shorter of the two distances that occur during pallet use shall be used in the test. For pallets greater than 1 219 mm in length or width, footnote a of Figure 8.2 may be adjusted according to the dimensions of the pallet.

Perform the test in both directions.



Key

1 Test load

2 Load applicator

3 Steel load bar, $50\ mm \times 50\ mm \times L\ \left[\geq \frac{L_1}{2}\right]$

4 Steel load bar, $50\ mm \times 50\ mm \times L\ [\geq L_1]$

5 Support

A to I Deflection measuring points

y Deflection

a The distance between the supports 570 mm or 690 mm.

b Steel load bar thickness ≥2 mm.

c Support length ≤200 mm.

d Bend angle of pallet deck while testing.

FORKLIFTING TEST

Fig. 8.2

8.5.2.3 Measurement

8.5.2.3.1 Test 2a - Determination of bending strength

Apply the test load until breakage occurs in one of the components of the pallet or until reaching an excessive deflection or deformation. Record the ultimate load.

8.5.2.3.2 Test 2b - Determination of bending stiffness

Apply a datum load of (1.5 ± 0.5) % of the ultimate load determined in test 2a. Depending on the support location, the deflection, *y*, shall be measured simultaneously at the middle of the two ends or sides and at the corners (maximum value of *y* at points A, B, C, D, E, F, G, H, I, depending on direction of supports):

a) After positioning of datum load;

b) Immediately after full test load is applied;

c) At end of the full load period;

d) After the relaxation period.

8.5.3 Test 3 - Compression tests for blocks or stringers

8.5.3.1 Purpose

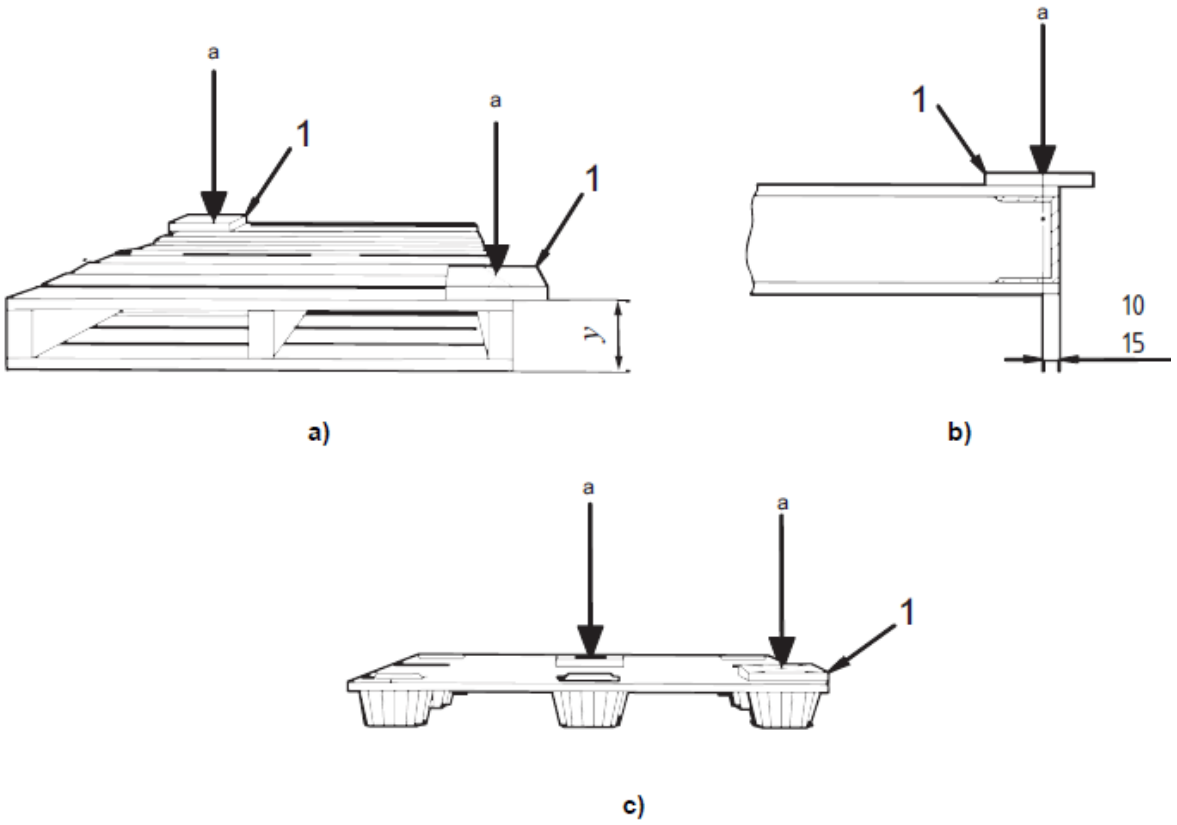
The purpose of this test is to determine the compression strength (test 3a) and stiffness (test 3b) of the blocks, stringers or columns of the pallet. Blocks or stringers supporting superstructures or heavy rigid loads shall be tested.

8.5.3.2 Procedure

Place the pallet in a normal position on a flat, hard, rigid and horizontal surface. Place a rigid load applicator of dimensions (300 ± 5) mm × (300 ± 5) mm × (25 ± 5) mm, over a block or a portion of a stringer (as shown in Figure 8.3).

Place the test load centrally on to the load applicator, as shown by the arrows in Figures 8.3 a), b) and c). When the blocks or stringers differ in design, each design shall be tested.

Alternatively, the test may be carried out on several identical corners, blocks or stringers.



Key

1 Load applicator

y Deflection

a Test load.

CORNER COMPRESSION TEST

Fig. 8.3

8.5.3.3 Measurement

8.5.3.3.1 Test 3a - Determination of strength of blocks or stringers

Apply the load until breakage occurs in one of the blocks or stringers of the pallet or upon reaching an excessive deflection or deformation. Record the ultimate load.

8.5.3.3.2 Test 3b - Determination of stiffness of blocks or stringers

Apply a datum load of (1.5 ± 0.5) % of the ultimate load determined in test 3a.

The deflection, *y*, shall be measured:

a) After positioning of datum load;

b) Immediately after the full test load is applied;

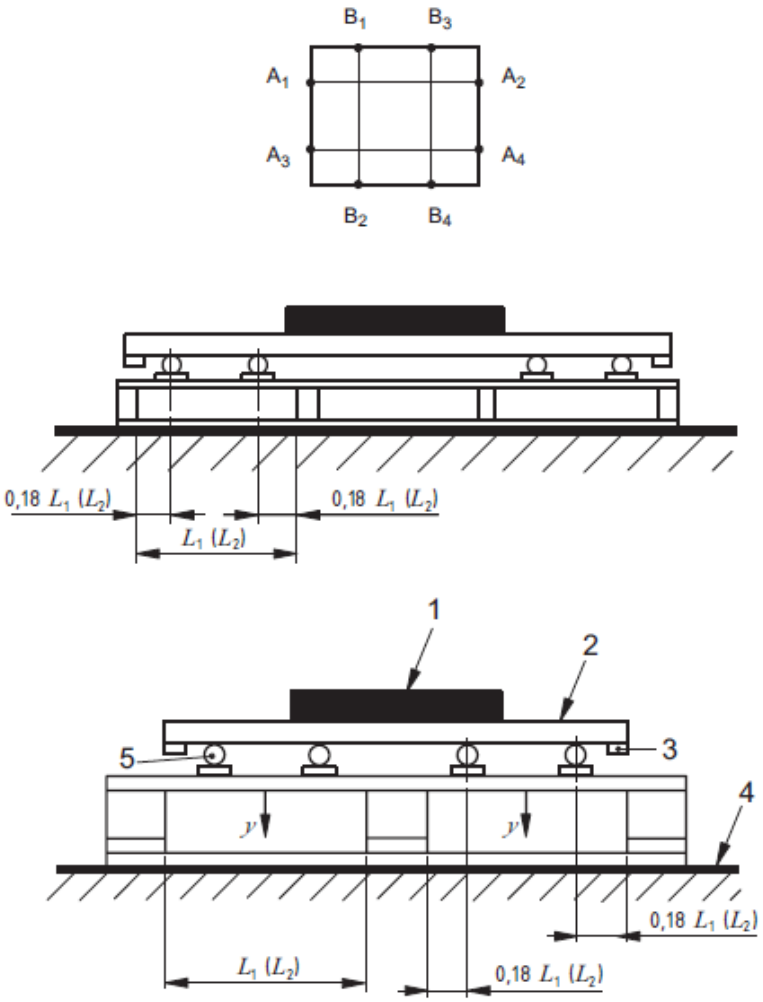
c) At end of the full test load period;

d) After the relaxation period.

8.5.4 Test 4 - Stacking test

8.5.4.1 Purpose

The purpose of this test is to determine the ability of the pallet top and bottom decks to withstand the local effects of widely varying payloads on subspans of decks between blocks or stringers in a block stacking situation. For pallets with more than two spans (openings), the load applicators shall be applied to the two openings of greatest span as shown in Figure 8.4. Where a single span is the largest, the test is not applicable.



Key

1 Test load 4 solid support

2 Load board 5 load applicator

3 Safety stop *y* deflection

DECK STRENGTH AND STIFFNESS TEST

Fig. 8.4

8.5.4.2 Procedure

Test both the top and bottom decks.

Place the pallet, as shown in Figure 8.4, on a flat, hard, rigid horizontal surface and place four applicators, as described in 8.5.1.2 and Figure 8.1, across the top or bottom boards so that the centers of the load applicators are at 0.18 L_1 or 0.18 L_2. The load applicators shall project over or

be flush with the edge of the pallet deck and shall be symmetrically placed about the centre line of the pallet.

8.5.4.3 Measurement

8.5.4.3.1 Test 4a - Deck strength test

Apply the test equipment and then the rest of the test load. If dead weight is used for the test load, it shall be symmetrically built up during loading. If the pallet has bottom boards in both directions the test shall be carried out in both the length and the width dimensions.

Place a load on the load board until breakage occurs or until reaching an excessive deflection or deformation.

Record the deflections at half ultimate load.

Depending on the orientation of the load applicators, the deflection, *y*, shall be measured at points A (maximum of *y* at A_1, A_2, A_3, A_4) or B (maximum of *y* at B_1, B_2, B_3, B_4).

8.5.4.3.2 Test 4b - Deck stiffness test

Support the bottom pallet on a solid surface. Apply a datum load of (1.5 ± 0.5) % of the ultimate load determined in test 4a. The deflection, *y*, shall be measured at points A (maximum of *y* at A1, A2, A3, A4) or B (maximum of *y* at B1, B2, B3, B4), depending on pallet design and orientation of load applicators.

Measure the maximum local deflection, *y*:

a) After positioning the datum load;

b) Immediately after the full test load is applied;

c) At the end of the full load period;

d) After the relaxation period.

8.5.5 Test 5 - Bottom deck bending tests

8.5.5.1 Purpose

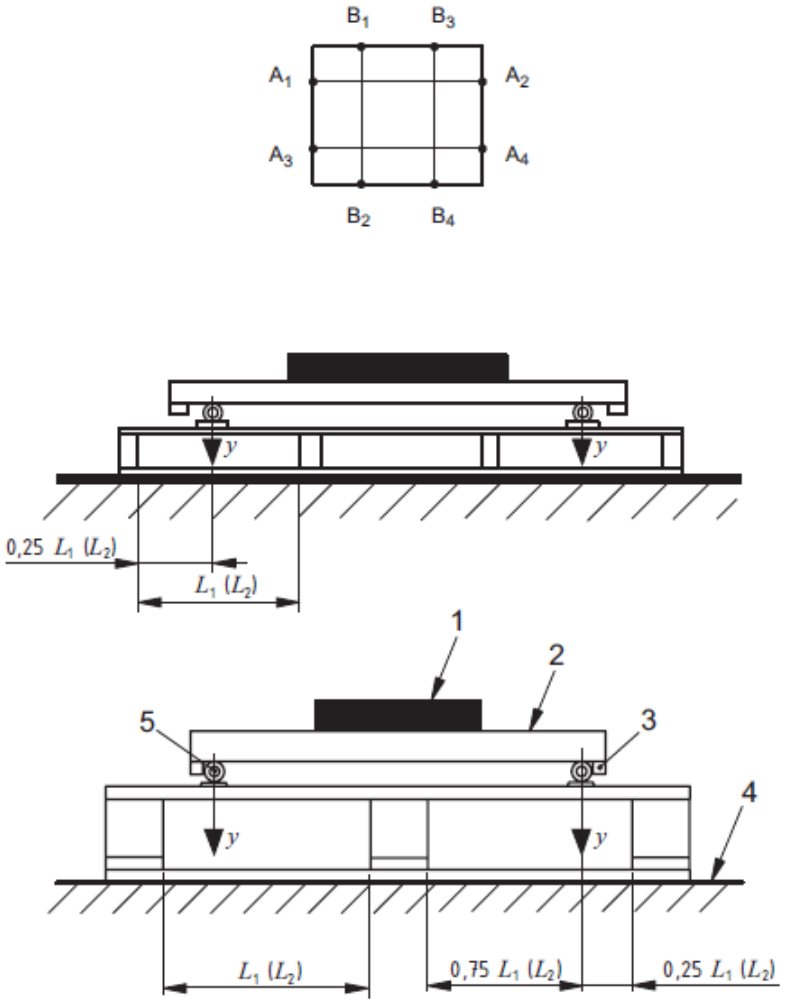
The purpose of these tests is to determine the strength and stiffness of the bottom deck between blocks or stringers when handling on twin track conveyors or narrow span beam rack supports.

8.5.5.2 Procedure

Place the top deck downwards, as shown in Figure 8.5, on a flat, hard, rigid horizontal surface and place two inverted applicators, as described in 8.5.1.2 and Figure 8.1, across the bottom boards so that the centers of the load applicators are at a distance of 0.25 L_1 or 0.25 L_2 from the inside edge of the outer blocks or stringers.

The load applicators shall project over or be flush with the edge of the pallet base and shall be symmetrically placed about the centre line of the pallet.

Apply the test equipment and then the rest of the test load. If dead weight is used for the test load, it shall be symmetrically built up during loading. If the pallet has bottom boards in both directions, the test shall be carried out in both the length and the width dimensions.



Key

1 Test load

2 Load board

3 Safety stop

4 Solid support

5 Load applicator

y Deflection

BOTTOM DECK STRENGTH AND STIFFNESS TEST

Fig. 8.5

8.5.5.3 Measurement

8.5.5.3.1 Test 5a - Determination of bending strength

Place a load on the load board until breakage in one of the bottom boards occurs or until reaching an excessive deflection or deformation. Record the ultimate load.

8.5.5.3.2 Test 5b - Determination of bending stiffness

Apply a datum load of (1.5 ± 0.5) % of the ultimate load determined in test 5a. Depending on the orientation of the load applicators, the deflection, *y*, shall be measured at points A (maximum of *y* at A_1, A_2, A_3, A_4) or B (maximum of *y* at B_1, B_2, B_3, B_4):

a) After positioning of datum load;

b) Immediately after full test load is applied;

c) At end of the full load period;

d) After the relaxation period.

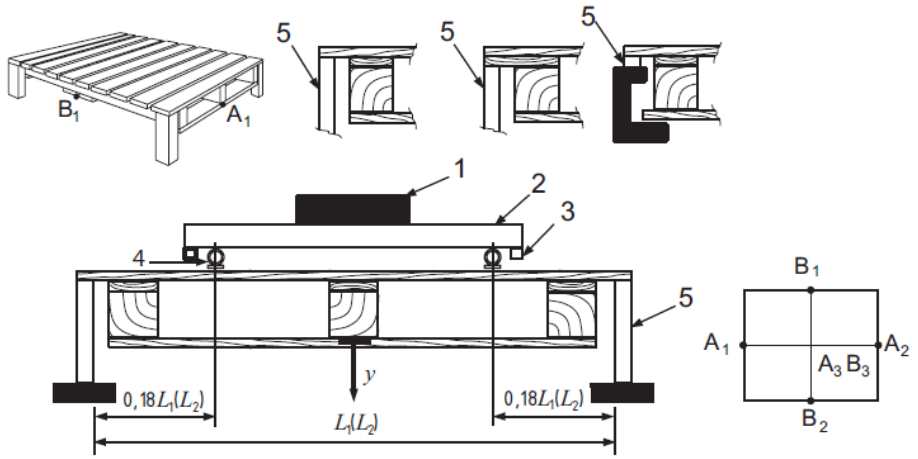
8.5.6 Test 6 - Wing pallet bending tests

8.5.6.1 Purpose

The purpose of these tests is to determine the bending strength (test 6a) and the bending stiffness (test 6b) of winged pallet during lifting with slings.

8.5.6.2 Procedure

Place the wing pallet, top deck uppermost, on four posts 50 mm × 50 mm positioned beneath the wings of the top deck flush with the ends of the pallet. The supports shall be fixed at such a height that a space of at least 50 mm is between the underside of the bottom deck and the ground or test frame. Each load applicator shall be positioned such that the dimension from the inside edge of the support to the centre line of the load applicators shall be 0.18 L_1 as shown in Figure 8.6. Place the load board on the load applicators and then apply the rest of the test load.



Key

1 Test load

2 Load board

3 Safety stop

4 Load applicator

5 Support

y Deflection

WING PALLET BENDING TEST

Fig. 8.6

8.5.6.3 Measurements

8.5.6.3.1 Test 6a - Determination of bending strength

Place a load on the load board until breakage of one of the components of the pallet or until reaching an excessive deflection or deformation. Record the ultimate load.

8.5.6.3.2 Test 6b - Determination of bending stiffness

Apply a datum load of (1.5 ± 0.5) % of the ultimate load determined in test 6a. Depending on the support location, the deflection, *y*, shall be measured at points A [Maximum of *y* at A_1 (B_1) and A_2 (B_2)]:

a) After positioning the datum load;

b) Immediately after the full test load is applied;

c) At end of the full test load period;

d) After the relaxation period.

8.5.7 Test 7 - Airbag bending tests

8.5.7.1 Purpose

The purpose of this form of bending test is to simulate, as near as is practically feasible, certain load applications as commonly encountered in the field. The load applicator used for this bending test is an analogue for common uniform flexible loads often supported by pallets, such as cased or bagged goods.

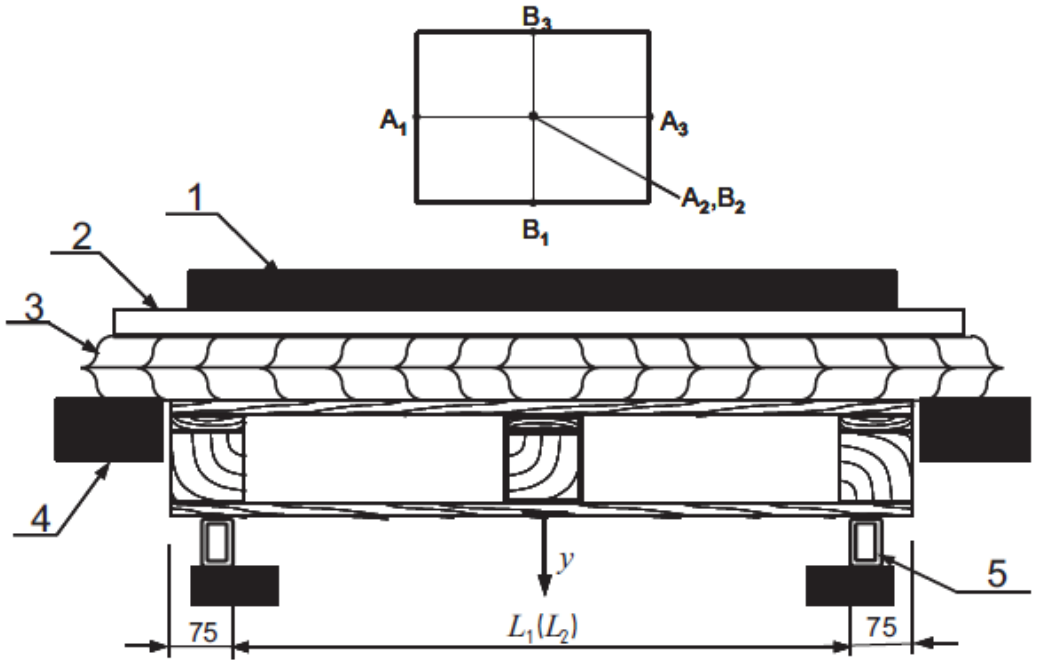
This uniform flexible load analogue is used when, under certain circumstances, the primary load applicators, as described in 8.5.1.2, cannot be used, or when the application of simulated uniform loads can aid the pallet designer in selecting the most appropriate pallet for a given use.

8.5.7.2 Procedure

8.5.7.2.1 In order to establish the weakest pallet support direction, test one pallet across the length of the pallet and then a second pallet across the width of the pallet. There is no requirement for further tests on the stronger dimension unless the result is within 15 % of the weaker dimension.

8.5.7.2.2 The load applicator shall be a medium or low-pressure envelope airbag, commonly called a “lifting” or “dunnage” bag, shown in Figures 8.7 a) and b). Airbags of this type are specified by size (length and width), containment (maximum working pressure) and stroke (maximum unrestricted expansion in bag height).

Dimensions in millimeters



Key

1 Dead weight

2 Load board

3 Airbag

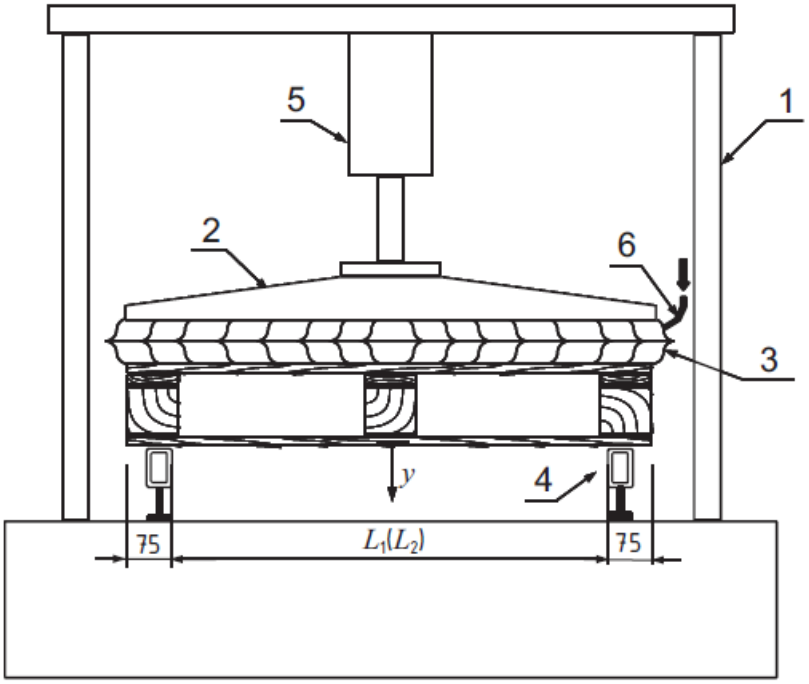
4 Airbag support beam

5 Supports

y Deflection

a) TEST USING DEAD WEIGHT

Fig. 8.7 (Continued)



Key

1 Test rig frame

2 Load platen

3 Airbag

4 Supports

5 Load applicator

6 Inflation tube

y Deflection

b) TEST USING TEST RIG - AIRBAG BENDING TESTS

Fig. 8.7

8.5.7.2.3 The size of a bag shall be such that, when inflated, the bag is in contact with the entire deck of the pallet. This is often possible with bags approximately 150 mm longer and wider than the top deck of the pallet to be tested.

8.5.7.2.4 Where bag sides overhang the pallet by more than 75 mm on either edge or end, an airbag support beam is necessary to maintain the bag overhang at the same level as the upper pallet deck during testing.

Where the load applied to the pallet is measured above the pallet during the test, the supports shown in Figure 8.7 b) shall not be used and the bag should fit the pallet as described in 8.5.7.2.3.

8.5.7.2.5 The containment or working pressure in the bag shall be adequate to structurally fail all pallets to be tested. Experience indicates that the working pressure shall be at least 0.07 MPa to 0.08 MPa.

8.5.7.2.6 The stroke or level of expansion in bag height depends on the design of the testing apparatus.

Where expansion varies along the centre or edges of the bag, the region of least expansion shall govern bag selection. In order to avoid the influence of bag stiffness on the test data, the bag

expansion shall be at least twice that necessary to cause pallet failure. The pallet supports shall be positioned as described in Figure 8.1 and shall be positioned with their centre lines 75 mm from the outer edges of the pallet.

8.5.7.2.7 Loading or testing rates shall be controlled by appropriately inflating the restrained airbag or by pressing the inflated airbag on to the upper pallet deck.

8.5.7.3 Measurement

8.5.7.3.1 Test 7a - Determination of bending strength

Increase the load until breakage occurs in one of the components of the pallet or until reaching an excessive deflection or deformation. Record the ultimate load.

8.5.7.3.2 Test 7b - Determination of bending stiffness

Apply a datum load of (1.5 ± 0.5) % of the ultimate load determined in test 7a. Depending on the support location, the deflection, y, shall be measured at points A (maximum of y at A_1, A_2, A_3) or B (maximum of y at B_1, B_2, B_3):

a) After positioning of datum load;

b) Immediately after the full test load is applied;

c) At end of the full load period;

d) After the relaxation period.

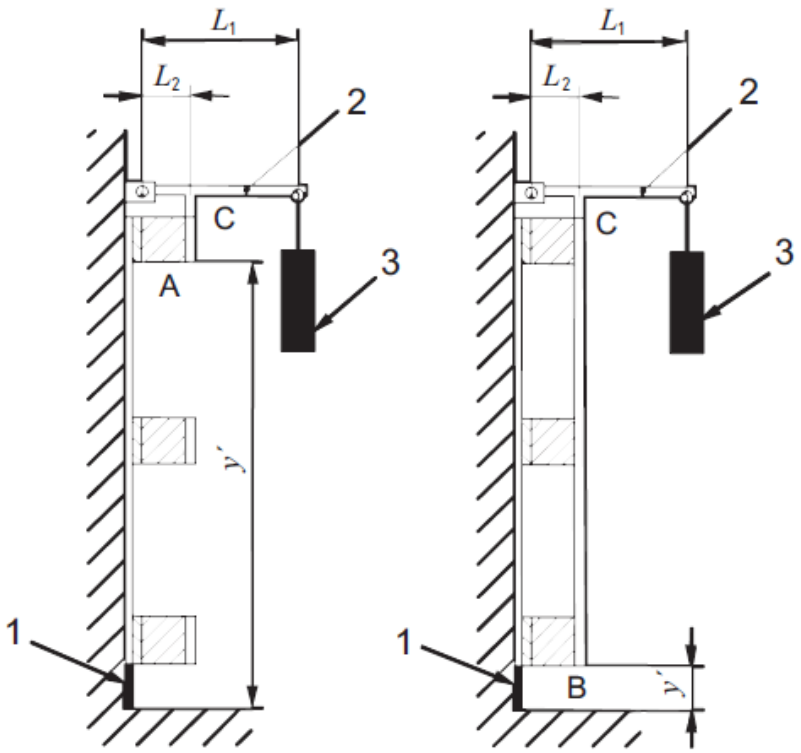
8.5.8 Test 8 - Static shear test

8.5.8.1 Purpose

The purpose of this test is to simulate the approximate forces induced through lateral deck shear.

8.5.8.2 Procedure

Place the pallet vertically, top deck on the test frame, on a vertically positioned board with the same thickness as the deck boards. The length of the board shall be at least equal to the length or width of the tested pallet (see Figure 8.8). The load applicator at C touches the entire pallet length (or width) along the bottom deck. An alternative test method is to apply the same line load using a compression tester at point C; however, whenever this method is used, then the loading point C platen shall be restrained from movement in any plane other than vertical with L_2 >150 mm.



Key

1 Support

2 Load applicator

3 Load *W*

y' Deflection

A to C Distortion measurement points

STATIC SHEAR TEST

Fig. 8.8

8.5.8.3 Measurement

The applied test load at C, *F,* resulting from the application of load, *W*, gives rise to the vertical distortion which shall be measured at A or B, depending upon whether the pallet has a continuous bottom board. Distortion (change in *y'*) shall be measured after release of load and after a relaxation period.

$$F = \frac{L_1 . W}{L_2}$$

8.5.9 Test 9 - Corner drop test

8.5.9.1 Purpose

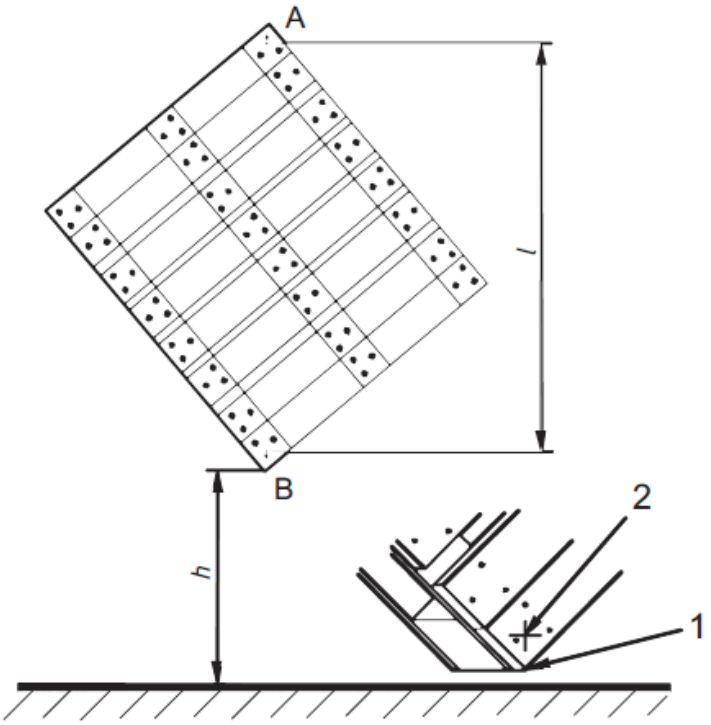
The purpose of this test is to determine the diagonal rigidity of the top deck of the pallet and its resistance to impact.

8.5.9.2 Procedure

Mark the two measuring points, A and B, as shown in Figure 8.9 at approximately 50 mm from the corners of the pallet. While suspending the pallet as shown in Figure 8.9, drop the pallet freely on to its top deck corner edge from a height, *h*, on to a hard horizontal impact surface. Whenever possible, carry out the drop three times, always on the same corner and from the same height.

Note:

For asymmetric pallets, it is necessary for the tester to make a judgment as to the orientation of the pallet before dropping.



Key

1 Pallet corner

2 Measuring point

h Height (fall)

l Length of diagonal

CORNER DROP TEST

Fig. 8.9

8.5.9.3 Measurement

The length of diagonal, *l*, shall be measured before the first and after the third drop. Any damage shall be noted.

8.5.10 Test 10 - Shear impact tests

8.5.10.1 General

The test load comprises the dead load, a load-spreading sheet and a load box, having a plan size of (600 ± 50) mm × (800 ± 50) mm. Place the load within the box, which shall be placed in a position dependent upon the individual test requirements described in 8.5.10.3 and 8.5.10.4. The detachable supporting edges shall be at least as long as the pallet deck under test. The test load shall not include the mass of the dolly.

For each of the inclined plane tests, before release the dolly is raised a distance, *L*, up the incline from the point of impact.

Inclined plane tests are potentially hazardous in view of large masses travelling at high speeds. The design of such test rigs shall incorporate special safety features to reduce risks to both operators and observers.

8.5.10.2 Purpose

The purpose of this test is to determine the resistance to side horizontal impacts of the assembly between the top deck, blocks, stringers, stringer boards and bottom deck.

8.5.10.3 Procedure

Secure a steel or high-density hardwood beam, (90 ± 10) mm × (90 ± 10) mm in nominal cross-section and at least as long as the longer dimension of the pallet, to the face of the backstop. The upper edge of the barrier shall be 15 mm above the bottom surface of the pallet (top surface of the dolly) whenever the dolly is in its lowest position (see Figure 8.10).

Place the pallet on the dolly of the inclined plane testing machine such that when the forward edge of the pallet is resting against the barrier, the dolly is 25 mm ± 5 mm clear of it.

The test load is distributed over the pallet deck surface with the exception of the leading 100 mm (which are left exposed) by means of a load-spreading sheet. This may conveniently comprise a sheet of strong plywood 18 mm to 25 mm thick, which is cut to cover all but the exposed strip, as shown in Figure 8.10.

Note:

The load-spreading sheet is often a sheet of plywood, which distributes load such that failures occur at the location of impact. This sheet is often necessary for testing paper pallets.

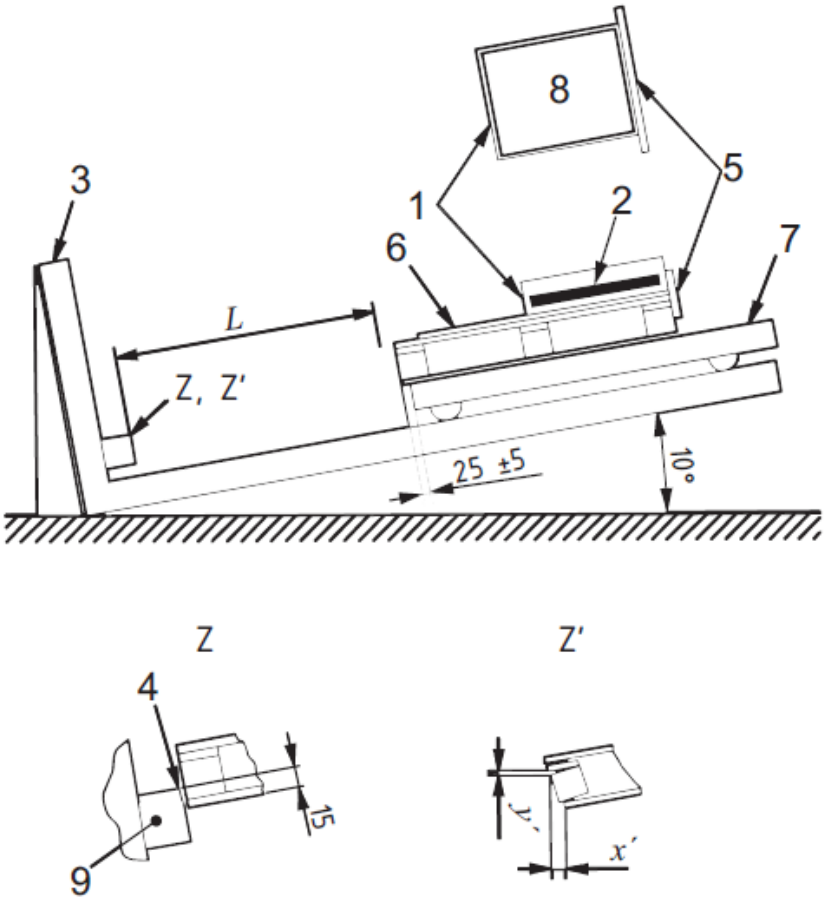
Attach the load box centrally on the pallet with the rest of the test load such that loading is central to the axis of movement down the rails, but biased towards the higher end of the pallet.

Bring the dolly and the loaded pallet up to a predetermined position on the incline at a distance, *L*, from the point of impact and release. Repeat as required.

Carry out a similar sequence of impacts along the second horizontal axis of the pallet.

8.5.10.4 Measurement

The distortion (x' and y') in X and Y planes and any damage shall be noted. The changes shall be recorded at a number of positions along the impacted surface.



Key

1 Load box 7 dolly

2 Test load 8 top view

3 Backstop 9 barrier

4 Line of impact 15 mm overlap *x'* distortion in X plane

5 Detachable support for load box *y'* distortion in Y plane

6 Load-spreading sheet

SHEAR IMPACT TEST

Fig. 8.10

8.5.11 Test 11 - Top deck edge impact test

8.5.11.1 Purpose

The purpose of this test is to determine the resistance of the top deck edge to side horizontal impacts by the fork arms of a forklift truck.

8.5.11.2 Procedure

The inclined plane tester described in 8.5.10.3 is used with the impact stops shown in Figures 8.11 and 8.12.

Place the pallet, the load box and the spreading sheet with the test load on the dolly of the incline testing machine so that when the forward edge of the pallet is resting against the impact stops, the dolly is (25 ± 5) mm clear of it. The load shall be central to the axis of movement.

Align the impact stops with the fork openings of the pallet at a height that allows the leading edge to touch the stop surface of the blade at a point between 100 mm and 250 mm from the vertical face of the impact stops (see Figure 8.11). The points of impact shall be within this area for each impact. The impact stops shall be positioned at the midpoints between the blocks or stringers.

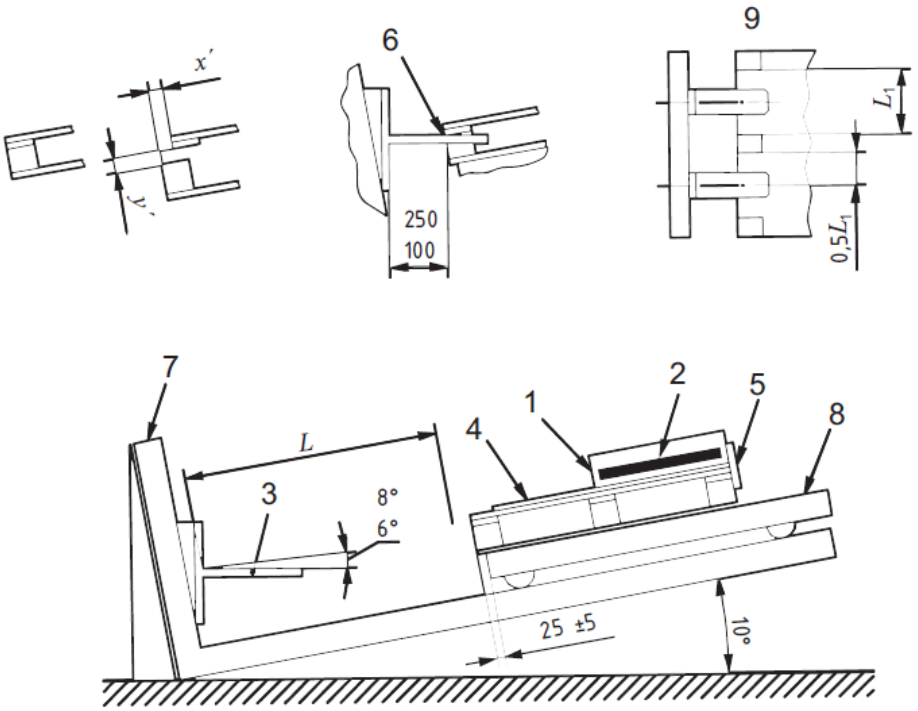
Raise the pallet with the dolly until the pallet is a distance, *L*, from the vertical face of the impact stop (see Figure 8.11) and release. Repeat as required.

Carry out a similar sequence of impacts along the second horizontal axis of the pallet.

8.5.11.3 Measurement

Deformation (*x*′ and *y*′) in X and Y planes shall be recorded. The penetration depth and general damage at points of impact shall also be recorded.

Dimensions in millimeters



Key

1 Load box 7 backstop

2 Test load 8 dolly

3 IMPACT stop 9 top view

4 Load-spreading sheet *L* distance from the point of impact and release

5 Detachable support for load box *x*′ distortion in X plane

6 Point of impact *y*′ distortion in Y plane

TOP DECK EDGE IMPACT TEST

Fig. 8.11

8.5.12 Test 12 - Block impact test

8.5.12.1 Purpose

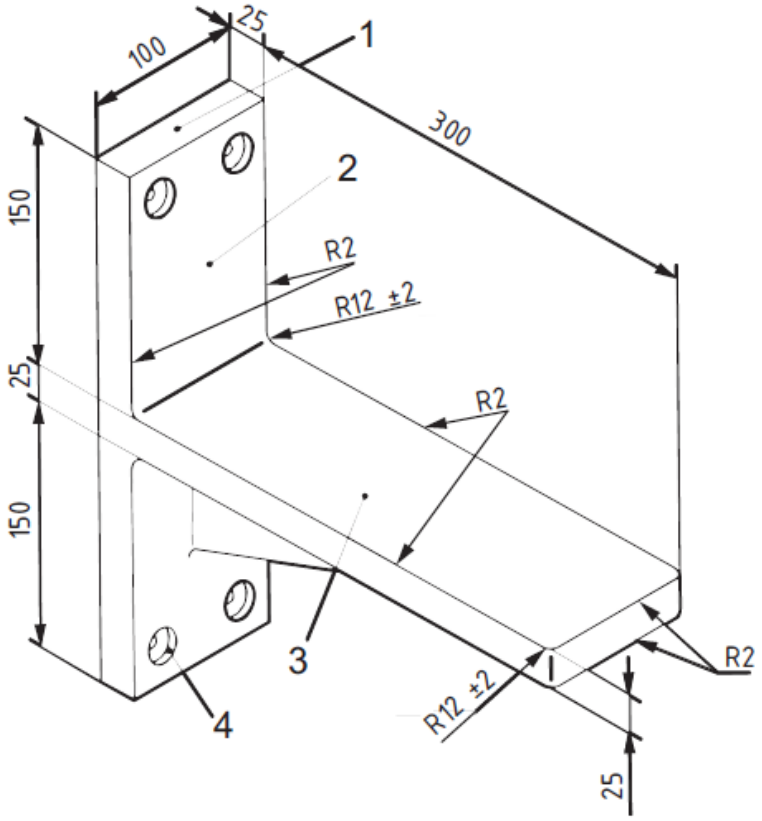
The purpose of this test is to determine the resistance of blocks, stringers and connections to impact by the fork arm tips of forklift trucks.

8.5.12.2 Procedure

The inclined plane tester described in 8.5.10.3 is used with the impact stop as shown in Figure 8.12.

Place the pallet and load box with the test load on the dolly of the incline test machine so that when the forward edge of the pallet is resting against the tip of the impact stops, the dolly is (25 ± 5) mm clear of it. The load shall be centered with respect to the sides or ends of the pallet.

Dimensions in millimeters



Key

1 Shank

2 Shank face

3 Blade

4 Counterbore

R Radius of curvature

IMPACT STOP FOR TOP DECK EDGE AND BLOCK IMPACT TESTS

Fig. 8.12

Place the pallet so that lines parallel to the direction of travel shall be drawn from the edges of the impact stops through the points on the front face of the blocks D and E shown in Figure 8.13. The impact stops shall be positioned accordingly, with the top of their leading edge blades 75 mm above the top surface of the dolly and offset 30 mm as shown in the inset to Figure 8.13.

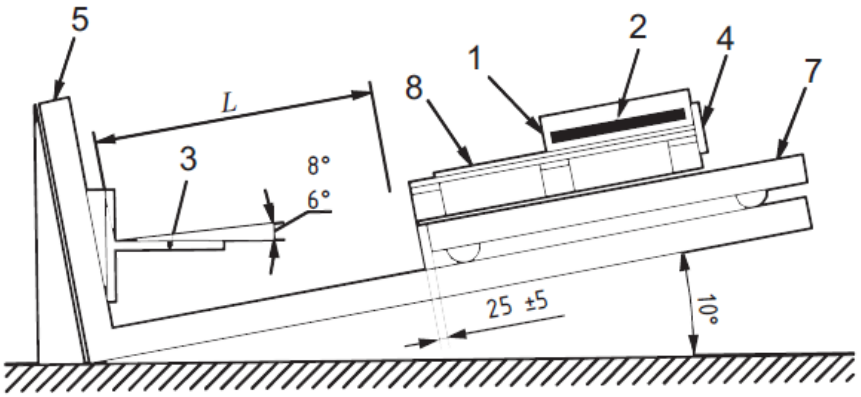
Raise the dolly and pallet so that they travel a distance, *L*, before impact then release. Repeat as required.

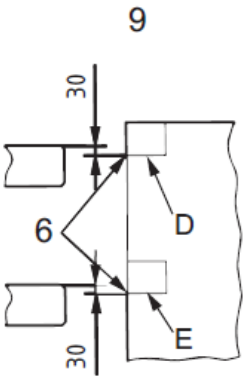
Carry out a similar sequence of impacts along the second horizontal axis of the pallet.

8.5.12.3 Measurement

Displacements shall be recorded after each impact, together with indentation depth. All other damage shall be noted.

Dimensions in millimeters





Key

1 Load box 6 points of impact

2 Test load 7 dolly

3 Impact stop 8 load-spreading sheet

4 Detachable support for load box 9 top view

5 Backstop *L* distance from the point of impact and release

INCLINE BLOCK IMPACT TEST

Fig. 8.13

8.5.13 Test 13 - Static coefficient of friction test

8.5.13.1 Purpose

The purpose of this test is to determine the static coefficient of friction between the underside of the top deck and the forks of forklift trucks.

Note:

The test is conducted using an unloaded pallet because this result can be used to predict the slip of large masses.

8.5.13.2 Procedure

Weigh the unloaded pallet, then place it on horizontally positioned, grease-free, dry, steel forks shall be horizontal and level to the nearest 1° as shown in Figure 8.14. The width of the arms shall be 100 mm.

The test shall be carried out at the openings parallel to the length and parallel to the width of the unloaded pallet. If rubber or high friction inserts are set into the bottom of the top deck, note whether these engage on the steel forks during the test.

8.5.13.3 Measurement

Gradually increase force until motion commences and record this maximum value, F_s.

$$\mu_s = \frac{F_s}{W_s}$$

where

μ_s is the static coefficient of friction;

F_s is the force required to commence movement;

W_s is the pallet mass

STATIC COEFFICIENT OF FRICTION TEST

Fig. 8.14

8.5.14 Test 14 - Slip angle test

8.5.14.1 Purpose

The purpose of this test is to determine the angle at which the test box commences to slip and thus compare pallet/load interface results for different pallets and construction materials.

8.5.14.2 Procedure

Load a box 600 mm × 400 mm, having a bottom contact surface faced with a grease-free, dry, steel surface, to 30 kg and tilt the pallet from the horizontal at a rate of (45°± 4.5°)/min as shown in Figure 8.15. Repeat on the length and width of the pallet.

Slip angle tests are potentially hazardous in view of masses travelling at speed. The design of such test rigs shall incorporate special safety features to reduce risks to both operators and observers and to ensure repeatability.

8.5.14.3 Measurement

Record the angle, *β*, at which the load commences to slip down the deck.

Note:

Steel has been chosen as the test surface for repeatability reasons. It is intended that care be exercised when predicting from these tests slip resistance for other packaging materials. It can be necessary to test each actual packaging material to confirm its slip resistance by using it as the friction material in this test.

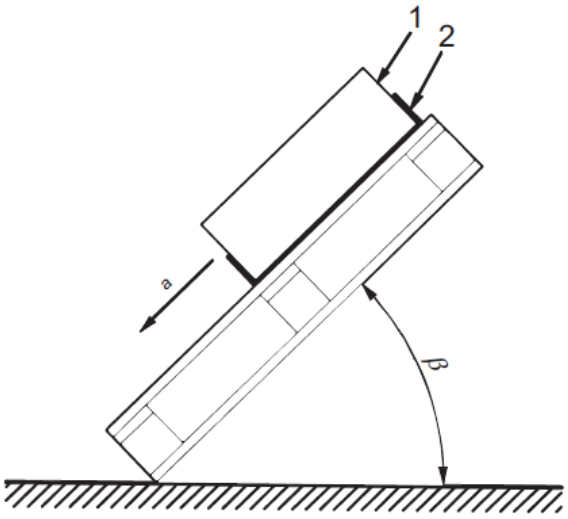
Slip angle tests are potentially hazardous in view of masses travelling at speed. The design of such test rigs shall incorporate special safety features to reduce risks to both operators and observers and to ensure repeatability.

8.5.14.3 Measurement

Record the angle, *β*, at which the load commences to slip down the deck.

Note:

Steel has been chosen as the test surface for repeatability reasons. It is intended that care be exercised when predicting from these tests slip resistance for other packaging materials. It can be necessary to test each actual packaging material to confirm its slip resistance by using it as the friction material in this test.



Key

1 400 mm × 600 mm box

2 Friction material

β Angle at which the load commences to slip down the deck

a Direction of fall.

SLIP ANGLE TEST

Fig. 8.15

9. TEST REPORT

9.1 General Information - all Materials

The test report for all materials shall contain at least the following:

a) Reference to this part of ISO 8611, i.e. ISO 8611-1:2011;

b) All information necessary for identification of the sample tested;

c) Date of the test;

d) Signature of the tester;

e) Type and dimensions of the pallet (standard or description);

f) Material of the pallet;

g) Test apparatus used;

h) Precision/accuracy of applied loading as appropriate;

i) Location of testing;

j) Laboratory humidity and temperature at the time of test;

k) Number of replicate tests performed;

l) Test number and test results for each test performed;

m) Results of the test, including the results of the individual determinations and their mean;

n) Any deviations from the procedure specified;

o) Any unusual features (anomalies) observed during the test.

9.2 In addition to the information required in 9.1, the following information shall be given for wooden and woodbased composite pallets:

a) Species, if feasible and the density of the components;

b) Moisture content of wood specimens at assembly using electrical resistance method;

c) Moisture content at time of testing;

d) Grade and quality of components;

e) Elapsed time period between specimen assembly and testing, if known;

f) Fasteners used with dimensions and shank profile;

g) Fastener bending strength measured in accordance with ISO 12777-1;

h) Any withdrawal of fasteners during testing.

9.3 Information for Plastics Pallets

The following information shall be given for plastics pallets:

a) Compound, if feasible, from which the pallet is made;

b) Reference number, serial number, product code, etc.

9.4 Information for Pallets Made of other Materials.2 Information for Wooden and Wood-Based Composite Pallets

The following information shall be given for pallets made of materials other than those covered in 9.2 and 9.3:

a) Fastening method;

b) Characteristics of the material, if feasible, that affect the pallet performance in tests.

10. PERFORMANCE REQUIREMENTS

Performance requirements for tests 1, 2, 3, 4, 5, 6 and 9 in ISO 8611-1 are given in Table 10.1. The maximum observation from the tests shall be compared with the performance requirements in Table 10.1.

Performance requirements for tests 8, 10, 11, 12, 13 and 14 in ISO 8611-1 are not included in Table 10.1, pending more experience with these tests.

TABLE 10.1 - LIST OF TESTS

Test no.	Test measurement	Handling activity or purpose of the test	Test load level	Performance limits	ISO 8611-1:2011 subclause ref.
Nominal load tests					
1	**Bending tests**	Racking			8.5.1
1a	Bending strength[ad]		Ultimate load (U_1) or a load causing 6 % of L_1 (L_2) deflection		8.5.1.3.1
1b	Bending stiffness[bd]		u50 % of U_1	2 % of L_1 (L_2) under load 0,7 % of L_1 (L_2) after relaxation period	8.5.1.3.2
2	**Forklifting tests**	Lifting with forklift and pallet trucks			8.5.2
2a	Bending strength[a]		Ultimate load, U_2		8.5.2.3.1
2b	Bending stiffness[b]		u50 % of U_2	20 mm or bend angle of less than 4,5[g], whichever is the lesser deflection, under load 7 mm after relaxation period	8.5.2.3.2
3	**Compression tests for blocks or stringers**	Any activity that compresses blocks or stringers, including stacking			8.5.3
3a	Blocks or stringers strength		Ultimate load, U_3, per block or load causing 10 % of y deflection		8.5.3.3.1
3b	Blocks or stringers stiffness[c]		u50 % of U_3 per block	4 mm under load 1,5 mm after relaxation period	8.5.3.3.2
4	**Stacking tests**[f]	Stacking	Payload		8.5.4
4a	Decks strength test		Ultimate U_4 top deck and ultimate U_4 bottom deck or a load causing 6 % of deflection L_1 (L_2)		8.5.4.3.1
4b	Deck stiffness test[b]		u50 % of U_4	2 % of L_1 (L_2) under load 0,7 % of L_1 (L_2) after relaxation period	8.5.4.3.2
5	**Bottom deck bending tests**	Twin track conveyors			8.5.5
5a	Bending strength[ae]		Ultimate load (U_5) or a load causing 6 % of L_1 (L_2) deflection		8.5.5.3.1
5b	Bending stiffness[be]		u50 % of U_5	15 mm under load, 7 mm after relaxation time	8.5.5.3.2

TABLE 10.1 (Continued)

Test no.	Test measurement	Handling activity or purpose of the test	Test load level	formance limits	ISO 8611-1:2011 subclause ref.
6	**Wing pallet bending tests**	Lifting with slings			8.5.6
6a	Bending strength[a]		Ultimate load (U_6) or a load causing 6 % of L_1 (L_2) deflection		8.5.6.3.1
6b	Bending stiffness[b]		u50 % of U_6	2 % of L_1 (L_2) under load 0,7 % of L_1 (L_2) after relaxation period	8.5.6.3.2
Maximum working load tests — With payload or airbag					
1	**Bending test**	Racking			8.5.1
1b	Bending stiffness		Payload	Deflection shall not exceed the deflection at ½ U_1	8.5.1.3.2
7	**Airbag bending tests**	Racking			8.5.7
7a	Bending strength[a]		Ultimate load (U_1) or a load causing 6 % of L_1 (L_2) deflection		8.5.7.3.1
7b	Bending stiffness[b]		Airbag	Deflection shall not exceed the deflection at ½ U_1	8.5.7.3.2
2	**Forklifting tests**	Lifting with forklift and pallet trucks			8.5.2
2b	Bending stiffness[b]		Payload	Deflection shall not exceed the deflection at ½ U_2	8.5.2.3.2
4	**Stacking tests[f]**	Stacking			8.5.4
4b	Deck stiffness test		Payload	Deflection shall not exceed the deflection at ½ U_4	8.5.4.3.2
5	**Bottom deck bending tests**	Twin track conveyors			8.5.5
5b	Bending stiffness[be]		Payload	15 mm under load, 7 mm after relaxation time	8.5.5.3.2
6	**Wing pallet bending tests**	Lifting with slings			8.5.6
6b	Bending stiffness[b]		Payload	Deflection shall not exceed the deflection at ½ U_6	8.5.6.3.2
Durability tests					
8	**Static shear test**	Distortion resistance		Comparative testing	8.5.8

Table 10.1 1 (Continued)

Test no.	Test measurement	Handling activity or purpose of the test	Test load level	Performance limits	ISO 8611-1:2011 subclause ref.
9	**Corner drop test**	Resistance to impacts	Empty pallet	$\Delta y \leq 4\ \% \ h = 0.5$ m No breakage or damage that limits the performance or functionality of the pallet	8.5.9
10	**Shear impact test**	Distortion resistance		Comparative testing	8.5.10
11	**Top deck edge impact test**	Resistance to fork arms		Comparative testing	8.5.11
12	**Block impact test**	Resistance to fork tip		Comparative testing	8.5.12
13	**Static coefficient of**	Slip resistance on fork arms	Self weight, W_s	Comparative testing	8.5.13
14	**Slip angle test**	Slip resistance of loads	Self weight	Comparative testing	8.5.14

a The pallet shall be tested using the direction(s) in which it is intended to be racked (see also Appendix C).

b The rate of deformation during stiffness tests shall be decreasing.

c Handling activities that compress blocks are stacking with or without superstructures or posts and heavy rigid loads.

d Wherever failure of the pallet occurs due to stress concentrations at the load applicator, the test shall be rejected and shall be repeated.

e The top deck of the pallet shall remain flat during the test.

f Test 4b shall be used for determining maximum working load of pallets as described in ISO 8611-3.

g The angle is measured between the line from the edge of the support beam in a horizontal plane to the edge of the pallet before loading and the line from the edge of the support beam to the same point after loading.

11. GUARANTEE AND WARRANTY

During a period of 18 months after the date of shipment the Vendor shall with all possible speed and without cost to the Purchaser, replace the pallets found to be defective due to faulty material, workmanship or to any act or omission of the Vendor.

APPENDICES

APPENDIX A
(INFORMATIVE)

REGIONAL USE OF INTERCONTINENTAL PALLET SIZES

It is recognized that there are pallet sizes other than those given in Table A.1 in use in current world trade. Although these sizes do not conform to the requirements of this International Standard, it is recommended that the provisions of 6.2 to 6.8 are taken into account where possible.

TABLE A.1 — PALLET SIZES USED INDIFFERENT REGIONS

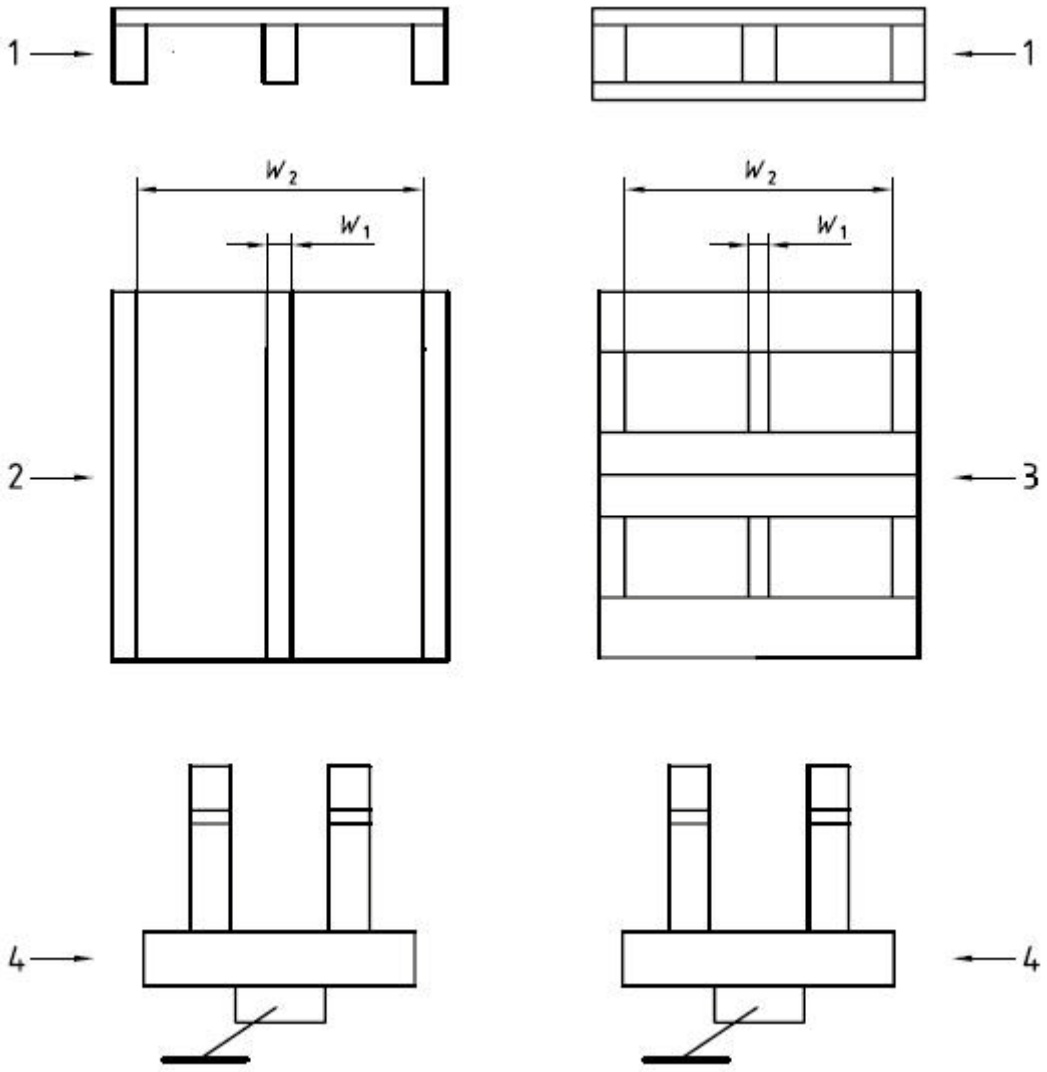
Europe		North America		Pacific rim	
Metric mm	Imperial in	Metric mm	Imperial in	Metric mm	Imperial in
1 200 × 800	47 1/4 × 31 1/2	1 219 × 1 016	48 × 40	1 100 × 1 100	43 1/4 × 43 1/4
1 200 × 1 000	47 1/4 × 39 3/8	1 067 × 1 067	42 × 42		
1 140 × 1 140	44 7/8 × 44 7/8				

APPENDIX B

(NORMATIVE)

HORIZONTAL CLEARANCES FOR PALLET TRUCKS AND FORK-LIFT TRUCKS

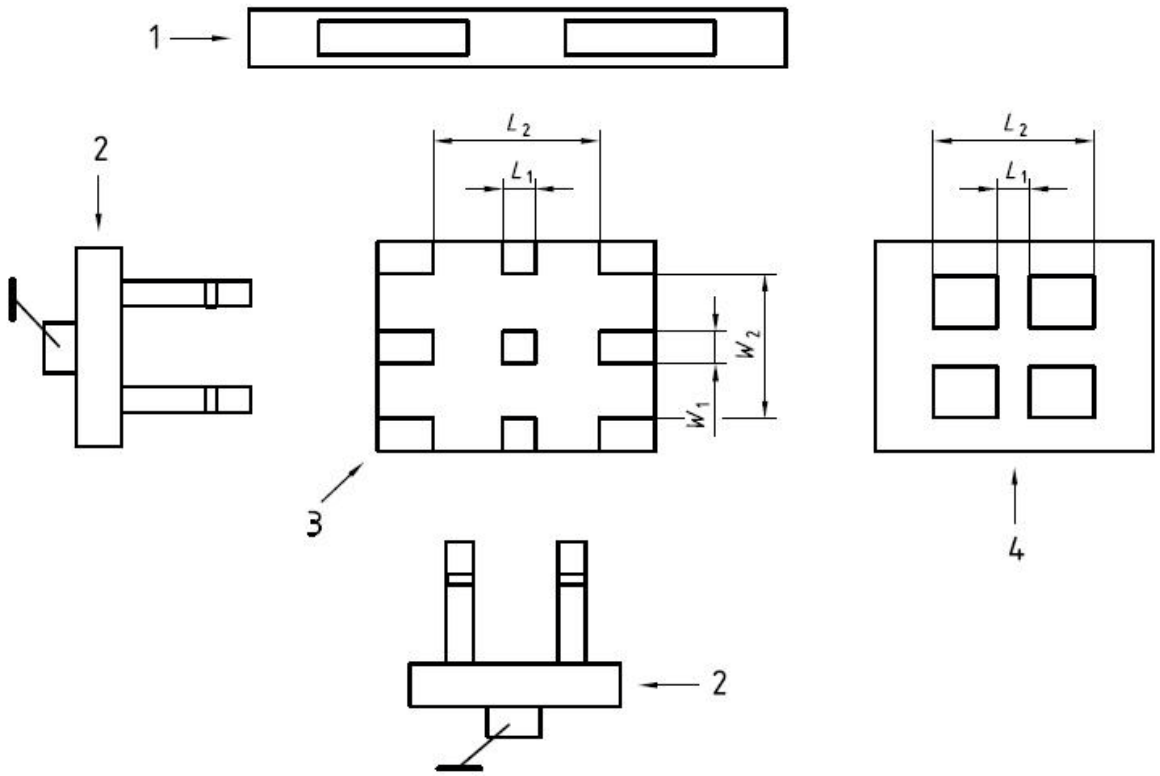
The horizontal clearances for pallet trucks and fork-lift trucks shall be as shown in Figures B.1, B.2 and B.3.



Key

1 end view
2 bottom deck
3 bottom deck view
4 fork arms of pallet trucks or fork-lift trucks

Figure B.1 — HORIZONTAL CLEARANCE FOR PALLET TRUCKS AND FORK-LIFT TRUCKS — EXAMPLES OF TWO-WAY PALLET DESIGNS

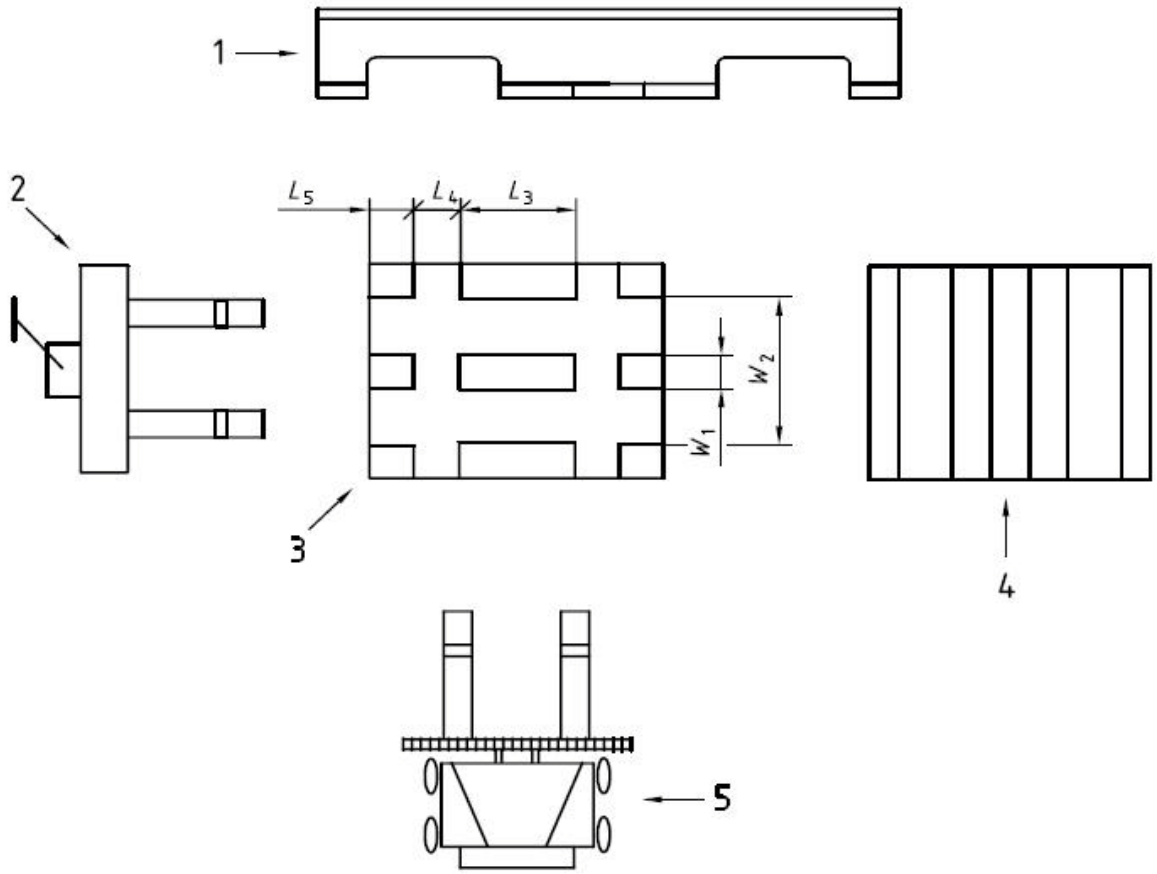


Key

1 end or side view
2 fork arm of pallet truck or fork-lift truck
3 bottom view without bottom deck
4 bottom deck view

Note:
If l_1 is more than 160 mm, the pallet is a partial four-way pallet to be handled by fork-lift trucks.

Figure B.2 — HORIZONTAL CLEARANCE FOR PALLET TRUCKS AND FORK-LIFT TRUCKS - FOUR-WAY PALLET DESIGNS



Key

1 bottom deck view
2 fork arms of pallet truck or fork-lift truck
3 bottom view without bottom deck
4 bottom view with bottom deck
5 fork arm of fork-lift truck

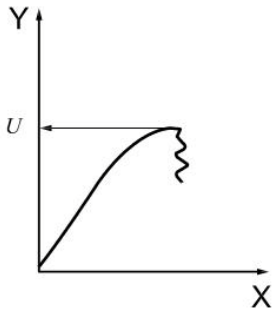
Figure B.3 — HORIZONTAL CLEARANCE FOR PALLET TRUCKS OR FORK-LIFT TRUCKS - PARTIAL FOUR-WAY PALLE

APPENDIX C

(INFORMATIVE)

PLOTS OF TYPICAL FORCE VERSUS DEFORMATION FROM PALLET TESTS SHOWING THE DEFORMATION OF ULTIMATE LOAD, *U*

Plots of typical force versus deformation from pallet tests showing the deformation of ultimate load, *U*, are shown in Figures C.1, C.2 and C.3.



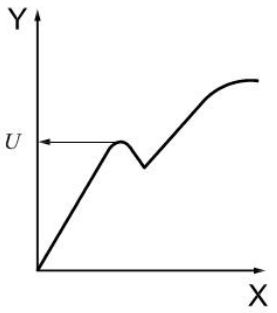
Key

X load

Y deformation

U ultimate load

Figure C.1 — Force versus deformation plot indicating total pallet failure



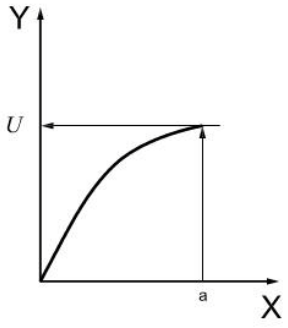
Key

X load

Y deformation

U ultimate load

Figure C.2 — Force versus deformation plot indicating a component failure



Key

X load

Y deformation

U ultimate load

a 6 % of test span.

Figure C.3 — Force versus deformation plot indicating excessive deformation