

## Key points

- External wood joinery such as windows and doors are subject throughout their service life to the effects of wind, rain, ultraviolet light from the sun and attack by fungi and wood boring insects.
- External joinery must therefore be designed to be as weathertight as possible and the timbers used should be resistant to degradation over a long period of time.
- EN 14351-1 is the product standard for windows and doors and is a harmonised standard describing performance requirements of windows and doors. The standard requires the application of CE marking and a 'Declaration of Performance' must be drawn up describing the technical characteristics of the product and its performance rating.
- Weather performance tests have been developed for windows and doors which can assess performance for air permeability, watertightness and resistance to deflection under wind load. A performance classification system based on these test results has been developed and is described in this information sheet.
- The weather performance tests and the classification system are described in a series of European standards which have been adopted in both Ireland and the UK as national standards and are also referenced in this information sheet.
- The requirements for CE marking and the provision of a Declaration of Performance became law under the Construction Products Regulation in July 2013.
- Air permeability testing should be carried out in accordance with EN 1026 and the results classified in accordance with EN 12207.
- Water tightness testing should be carried out in accordance with EN 1027 and the results classified in accordance with EN 12208.
- Resistance to wind loads testing should be carried out in accordance with EN 12211 and the results classified in accordance with EN 12210.
- The DoP (Declaration of Performance) issued on the joinery product should list the performance test classification results from the weather performance tests on the windows and doors.
- The DoP should be checked to confirm that the declared performances of the essential characteristics are suitable for the intended end use location with regard to local environmental factors such as maximum wind speeds and the driving rain index.

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## Wooden joinery (windows and doors)

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### Introduction

This information sheet gives some background to the requirements for wooden windows and external doors; some of these requirements are applicable to other types of joinery. Durability is also addressed as this can be critical for timber windows. The primary purpose is to help ensure that manufacturers, specifiers and users understand some of the basic requirements for wooden windows and doors.

The information sheet also addresses the interpretation of test results for the three main performance criteria for window criteria: air permeability, water tightness and resistance to wind loads. The information provided here is intended to aid in the interpretation of test data and in the preparation of project specifications.

While the information provided relates primarily to windows, the requirements for doors are similar. In all cases EN 14351-1 should be consulted for more detailed information.

### Terminology

**Air permeability:** The degree to which the window or door unit is airtight. This is measured as air permeability at different test pressures over the full area of the window or door in a performance test chamber. There are four performance classes.

**Watertightness:** The ability of the window or door to resist the penetration of water from the outside. This is also measured in a test chamber at a series of increasing pressures and time intervals. There are nine performance classes.

**Wind resistance:** The degree to which the window is affected by wind pressures both positive and negative as measured by deflection of the front of the window. There are five performance classes.

**Durability:** The degree to which the timber species is resistant to biological degradation by fungi and insects.

**DoP:** This relates to 'Declaration of Performance' which is the document listing the most important technical characteristics and performance values of the product in accordance with the requirements of the harmonised European standard for the product.

**CE marking:** A marking requirement where a harmonised European standard applies to the product. CE marking is evidence that the product has been legally placed on the market in the EU.

Pressure measurement units: The pressure test units for weather performance are expressed as pascals. One pascal (Pa) is equal to one newton (1N) of force and is defined as one newton per square metre.

## Performance testing of windows and doors

### EN 14351-1:2016+A2:2016

EN 14351-1 “Windows and doors – Product standard, performance characteristics Part 1: Windows and external pedestrian doorsets without resistance to fire and/or smoke leakage characteristics” as the product standard for joinery which is therefore required to have a Declaration of Performance (DoP) and also to be CE marked. The performance characteristics in the standard cover a number of areas; this information sheet focuses on durability and the performance requirements for joinery in relation to weather.

EN 14351-1 specifies the test standards to be used in relation to weather resistance (listed below) and how the test results should be expressed (the classification is also referred to below).

Table 1 of the standard summarises the classification values for windows (Table 2 covers doors); the relevant sections of Table 1 are reproduced below; items 1 and 2 refer to resistance to wind loads, items 5 and 6 to water tightness and item 14 to air permeability; these are the properties most relevant to this information sheet. The project architect or similar would normally specify and/or approve the performance requirements.

The resistance to wind test includes a deflection test, a repeated pressure test, an air permeability test and a safety test. As the safety test could damage the performance of the window in other areas it is usually carried out last. Not all the performance characteristics in EN 14351-1 are applicable to every product or every intended end use. Where performance characteristics are required EN 14351-1 identifies the means of their determination and provides a way to express the results in a classification system in a uniform way. When reading a DoP the user or specifier should ensure that the declared performance characteristics are adequate for the intended end use, if they are not or if a required performance is not declared then they should consider a different product.

### Watertightness

A watertightness test should be carried out in accordance with EN 1027 and the results expressed in accordance with EN 12208.

Items 5 and 6 are taken from Table 1 of EN 14351-1 and relate to the specified test pressure (using EN 1027) for a particular classification; the test pressures are not directly related to the wind loads for resistance to wind. The non-shielded test (Item 5) would be appropriate to an exposed building or window. The classification declared by the manufacturer

therefore indicates whether the test was for a shielded or unshielded case with, for example, 3A being a classification for an unshielded window and 3B for a shielded window.

Watertightness is largely a visual inspection for water penetration rather than a specific measurement of water ingress. The point at which water penetration is observed during the test determines the end of the test and also the test result.

No	Clause	Characteristic	Classification/value										
5	4.5	Watertightness											
		Non-shielded (A)	Npd	1A	2A	3A	4A	5A	6A	7A	8A	9A	Exxx
		Test pressure (Pa)	(0)	(50)	(100)	(150)	(200)	(250)	(300)	(450)	(600)	(>600)	
6	4.5	Watertightness											
		Shielded (B)	Npd	1B	2B	3B	4B	5B	6B	7B			
		Test pressure (Pa)	(0)	(50)	(100)	(150)	(200)	(250)	(300)				

The window manufacturer could test beyond the 600 Pa to a specific value (Exxx) but 600 Pa has commonly been an accepted test value for Ireland, although windows have in some cases been tested until failure. In very exposed situations higher test pressures could be specified or looked for.

A window designated Class 6A for watertightness indicates that no water ingress was observed for a test pressure of 250 Pa for the fully exposed window test. A window designated Class 4B for watertightness indicates that no water ingress was observed for a test pressure of 150 Pa for the partially shielded window test.

### Air permeability

Two air permeability tests should be carried out in accordance with EN 1026, one with positive test pressures and one with negative test pressures. The test result, defined as the numerical average of the two air permeability values (m<sup>3</sup>/h) at each pressure step should be expressed in accordance with EN 12207:1999, 4.6.

Item 14 below is taken from Table 1 of EN 14351-1 and relates to test pressures (150, 300 and 600 Pa) carried out in accordance with EN 1026.

No	Clause	Characteristic	Classification/value				
14	4.14	Air permeability	1	2	3	4	5
		Max. test pressure (Pa)	Npd	(150)	(300)	(600)	(600)
		Reference air permeability at 100 Pa (m <sup>3</sup> /h.m <sup>2</sup> ) or m <sup>3</sup> /(h.m)	(50 or 12,5)	(27 or 6,75)	(9 or 2,25)	(3 or 0,75)	

The classification limits are related to a reference air permeability of 100 Pa, the relevant reference values being given in Tables 1 (overall area) and Table 2 (joint length) of EN 12207. The maximum test values for a specific class are obtained by multiplying the reference value by (P/100)<sup>2/3</sup>; where P is the test pressure.

**Table 1 (EN 12207): Reference air permeability at 100Pa and maximum test pressures related to overall area.**

Class	Reference air permeability at 100 Pa m <sup>3</sup> /h.m <sup>2</sup>	Maximum test pressure Pa
0	Not tested	
1	50	150
2	27	300
3	9	600
4	3	600

**Table 2 (EN 12207): Reference air permeability at 100Pa and maximum test pressures related to joint lengths.**

Class	Reference air permeability at 100Pa m <sup>3</sup> /h.m	Maximum test pressure Pa
0	Not tested	
1	12,5	150
2	6,75	300
3	2,25	600
4	0,75	600

As an example for a window to be designated class 3 to Table 1 of EN 14351-1; the window would have to have been tested to 600 Pa and the reference permeability value is 9 for the area value and 2.25 for the joint length. The resultant permeability test values would have to be less than 29.7 m<sup>3</sup>/h.m<sup>2</sup> (from 9 x (600/100)<sup>2/3</sup>) for the overall area value and less than 2.25 m<sup>3</sup>/h.m (from 2.25 x (600/100)<sup>2/3</sup>) for the opening joint length value.

The air permeability classification is based on the window area and the length of the opening joint (i.e. the perimeter of the opening part of the window). The overall air leakage (m<sup>3</sup>/h) is divided by the window area and the opening perimeter to get the appropriate values. Obviously if there is no opening part of the window then the joint length does not apply; and a door will of course always have an opening joint length.

Class 1 is the least air tight window, Class 4 the most air tight. A window could be given a classification of 0 which would mean it was not tested.

Air permeability does not directly relate to wind pressures at a site but obviously an exposed site or a tall building should use windows that have higher air tight performances.

### Resistance to wind loads

Testing should be carried out to EN 12211 and results expressed in accordance with EN 12210 with the results declared to EN 12210. The deflection of frame elements can be determined by calculation or by test.

There are three test pressures defined in EN 12210; P1 which is directly related to the calculated wind pressures acting on the window, P2 which is equal to 0.5P1 and P3 which is a safety test and is equal to 1.5P1.

P1 should be calculated from I.S.EN 1991-1-4 using the Irish National Annex (this would not apply to windows in other

jurisdictions) taking into account the location and position where it is to be used. Wind forces tend to be higher at building corners, on taller buildings and in the western coastal regions of Ireland compared to the east coast, and therefore higher performance windows would be required.

Items 1 and 2 below are taken from Table 1 of EN 14351-1 and relate to P1 test pressures (Pa) as shown (400, 800, 1200, 1600, 2000 and >2000) carried out in accordance with EN 12211.

No	Clause	Characteristic	Classification/value					
1	4.2	Resistance to wind Test pressure P1 (Pa)	1 Npd	2 (400)	3 (800)	4 (1200)	5 (1600)	Exxxx (>2000)
2	4.2	Resistance to wind Frame deflection	A (≤1/150)		B (≤1/200)		C (≤1/300)	

There should be no visible failure under P1 and P2 and the test specimen should remain functional. The air permeability is also measured and should not exceed by 20% of the upper limit of the claimed air permeability from the earlier permeability test to EN 12207; the original permeability classification may be changed if it fails this test.

The frontal deflection is measured under P1 and the resultant values are classified accordingly. Class A (≤1/150) is the largest deflection, followed by Class B (≤1/200) and then Class C (≤1/300) with the smallest deflection criteria. Any deflection over Class A would be a failure.

The safety test P3 has a visual inspection for failure as well; however if some components fail they are allowed to be replaced and the test repeated; more details are given in EN 12210.

Table 3 of EN 12210 (see below) combines the wind load class (see test pressure P1 above) and the frontal deflection (A, B or C above) into a single classification:

Wind load class	Resistance to wind load - classification		
	A	B	C
1	A1	B1	C1
2	A2	B2	C2
3	A3	B3	C3
4	A4	B4	C4
5	A5	B5	C5
Exxxx	AExxxx	BExxxx	CExxxx

NOTE: In the resistance to wind classification, the letter refers to the relative frontal deflection, see Table 2 and the number to the wind load class, see Table 1

As an example a B3 classification relates to a wind load classification of 3 (P1 = 1200 Pa) and a deflection classification of B (≤1/200).

Some manufacturers test for a high P1 enabling their windows to be used in a larger range of exposure conditions. They can also test a larger window which means that the test results would apply in general to smaller windows.

### Performance characteristics

As EN 14351-1 is a harmonised standard it means that a

manufacturer should draft a Declaration of Performance (DoP) and CE mark the product. The DoP should contain a full list of the essential characteristics given in EN 14351-1 and the determined performances against each characteristic. However, a manufacturer is not required to declare all performances; but at least the performance of one essential characteristic must be declared. In addition the declared performances in the DoP should be the same as the CE mark.

It would be impractical and expensive for a manufacturer to test every window except in the largest of contracts. Annex E of EN 14351-1 gives some guidance on the determination of window characteristics and should guide window testing if the results are to be used for different windows.

### Specifying window performance

In specifying a window or checking a DoP the design wind pressure (P1) must first be determined as this determines the test pressures and the resulting classifications. The term for wind load or pressure in EN 1991-1-4 is *peak velocity pressure* which is essentially the wind pressure acting on the site; the actual pressures acting on a window could be larger when they are factored by pressure coefficients which depend on a number of factors too detailed to be covered here. Wind pressures acting on a window or building would usually be calculated by the building designer.

Watertightness and air permeability have traditionally been tested at 600 Pa in Ireland; however higher exposure conditions may warrant higher test pressures. These test pressures are not associated with P1 above.

As an example with a P1 of 1500 Pa acting on an *exposed* window the following classifications would be appropriate:

Watertightness	9A (tested at 600Pa)
Air permeability	3* (tested at 600Pa)
Resistance to wind	4 (test pressure 1600Pa) B (frame deflection $\leq 1/200$ ) This would be combined into a single class 4B.

\*or 4 if a particularly air tight window was wanted, tested at 600 Pa.

Therefore the window classification sought should be 9A, 3 and 4B for the different criteria above.

BS 6375-1 “Performance of windows and doors. Classification for weathertightness and guidance on selection and specification” is the UK national application document for EN 14351-1 and gives guidance for specifying the performance requirements for joinery. Ireland does not have an equivalent standard and usually in such a case a British Standard would be used by default. However, care should be taken in specifying windows to BS 6375-1 as the new 2015 (with A1:2016) version calculates wind loads to EN 1991-1-4 but uses the UK

National Annex and not the Irish National Annex. BS 6375-1 combines all the EN classifications into a ‘national’ classification based on the design wind load (P1) which is probably not relevant to Ireland, especially if the EN classification system is understood and the important performances are declared in the DoP. Furthermore, over much of GB wind loads are generally lower than in Ireland and windows are commonly used which would not comply with the conditions experienced in Ireland. Failures of such windows when used in Ireland have been noted to occur on a number of occasions.

## Durability

The durability of wooden windows will be dependent on the natural durability of the timber or whether it is treated with a timber preservative. However, attention to good detailing and the use of proper materials can help to extend the service life of joinery.

The relevant standards in determining the durability characteristics of a window are discussed below.

### Natural durability

EN 350: Durability of wood and wood-based products - Testing and classification of the durability to biological agents of wood and wood-based materials

This Standard gives guidance on the classification of the durability of wood and wood-based materials against biological wood-destroying agents as well as information on the natural durability of a particular timber. The classifications are based on the durability of heartwood in ground contact although there is now some concern relating to the durability of the heartwood of some commonly used timbers. Few components or windows are completely made of heartwood and all sapwood should be considered as not naturally durable unless there is evidence to the contrary.

There are five classes of durability against fungal decay: DC1 is very durable, DC2 durable, DC3 moderately durable, DC4 slightly durable and DC5 not durable.

There are two classes of durability against attack by wood boring beetles: DCD durable and DCS not durable.

There are also three durability classes against attack by termites and another three classes for marine organisms.

The standard gives the durability classifications for a range of timber species and also information on treatability of various timbers. Some of this information is given below in slightly modified tables, treatability and the scientific names have not been included; the standard gives more information and should always be consulted.

**Table B.1 (EN 350) – Durability<sup>1</sup> of heartwood of softwood species.**

No.	Common name	EN 13556 code	Origin	Density kg/m <sup>3</sup> @ 12% MC	Durability of heartwood			
					Fungi	Hylotrupes	Anobium	Termites
14	Sitka spruce	PCST	N America and Europe	400 – 440 -450	4-5	D	S	S
17	Southern Pine	PNEL PNTD	C/N America	400-450-500	4	D	D	S
24	Scots pine Redwood	PNSY	Europe	500-520-540	3-4 (2-S)	D	D	S

**Table B.2 (EN 350) – Durability<sup>1</sup> of temperate hardwood species.**

No.	Common name	EN 13556 code	Origin	Density kg/m <sup>3</sup> @ 12% MC	Durability of heartwood			
					Fungi	Hylotrupes	Anobium	Termites
10	American Cedar	CEXX	C/S America	450-490-600	2	n/a	n/a	M
26	Poplar	POCN PONG POAL	Europe	420-440-480	S (S)	n/a	S	S
31	European oak	QCXE	Europe	650-670-710-760	2-4 (1-2)	n/a	D	M1

**Table B.3 (EN 350) - Durability<sup>1</sup> of tropical hardwood species.**

No.	Common name	EN 13556 code	Origin	Density @ 12% MC	Durability of heartwood			
					Fungi	Beetle	Termites	Marine borer
76	Mahogany	KHXX	W/E Africa	490-520-530	3	D	S	S
87	Iroko	MIXX	W/E Africa	650-720-800 630-650-570	1-2	D	D	D

<sup>1</sup> Two durability classifications are used for fungi. The first figure is usually based on laboratory or field tests while the second one ( ) is based on laboratory tests aimed at determining the durability against basidiomycetes.

**Table B.4 (EN 350) - Durability classification of commercial groupings.**

Grouping name	Origin	Durability of heartwood			
		Fungi	Hylotrupes	Anobium	Termites
Douglas fir /larch	Canada USA	3	D	D	S
European Whitewood	Europe	4	S	S	S
Picea sp.pl	C Europe	4	S	S	S
Spruce/pine/fir	Canada	4	S	S	S

The standard allows better understanding of the natural durability of timber which might be declared on the DoP.

### Use classes

EN 335: Durability of wood and wood-based products - Use classes: definitions, application to solid wood and wood-based products

This defines five use classes which represent different service conditions. Windows and doors are generally considered to be in use class 3.1 which refers to timber components that will not remain wet for long periods and where water will not accumulate; if this is not the case then the windows might fall into use class 3.2. The next use class (UC 4) refers to timber in contact with ground or fresh water and is not appropriate for building joinery. The main source of attack in joinery is fungi although some beetles may represent a risk.

When selecting or considering joinery timber, if the natural durability is inadequate then it is recommended that the tim-

ber be treated with a suitable preservative. Care should be taken with components treated before assembly as the treatment might be compromised by cutting or planing.

### Preservative treatment

Timber preservatives are often needed to provide an acceptable service life especially for softwoods. BS 8417 “Preservation of wood – Code of practice” provides good guidance in deciding whether to treat timber and on the type of treatment; similar information is available from the Wood Preservation Association (WPA).

Most joinery is treated with a preservative that complies with EN 599-1, although a boron formulation may be used instead (see Tables 4 and 5 of BS 8417).

The treatment will be dependent on the desired service life

and on the treatability of the timber. To get a service life beyond 30 years the timber would have to be coated to provide additional protection.

The treater should be able to provide information on the treatment in line with the requirements of EN 15228 “Structural timber – Structural timber preservative treated against biological attack” but additional information may be required. It should be noted that few treaters are in a quality scheme that is monitored by a third party and testing of timber may be necessary to ensure that the treatment is adequate.

### Heat treatment

Heat treatment is a relatively new process and will usually improve a timber by two durability classes. Heat treated timbers may be machined after treatment without the durability being significantly compromised.

Heat treatment for durability improvement should not be confused with the much milder heat treatment for phytosanitary and biosecurity purposes.

More information on heat treatment can be found in the COFORD Connects Note: *Heat treatment of softwoods to improve stability and durability*, Number 44 under Wood Processing and Product Development ([www.coford.ie/publications/cofordconnects/](http://www.coford.ie/publications/cofordconnects/)).

### European test and classification standards

Windows and doors can be classified depending on test results to a number of European standards. The window performance can then be specified for a particular building; the resistance to wind loads (EN 12211) is specifically relevant to the building and its location; there is also an air permeability test as part of this test meaning that there are effectively two air permeability test requirements.

There are three basic tests to determine the joinery performance:

- EN 1026 for Air permeability;
- EN 1027 for Water tightness; and
- EN 12211 for Resistance to wind loads.

Classification of the joinery test performances is given by the following European standards:

- EN 12207 for Air permeability;
- EN 12208 for Water tightness; and
- EN 12210 for Resistance to wind loads.

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