Technical Note No 75 - supersedes TN52

Impact performance of building envelopes: guidance on specification

Facades may be subject to impact during normal use. They must be able to resist such impacts without causing safety hazards. Damage affecting serviceability should also be minimized but may be accepted where components are readily replaceable. This Technical Note provides guidance on specification of impact performance of walls for a range of conditions appropriate for the UK. Technical Note TN 76 describes a method of test for cladding panels.

Introduction

Materials such as masonry and concrete are robust and can generally be expected to resist normal impacts however many materials used in modern building envelopes are more susceptible to damage and require testing to assess their performance.

The CWCT Standard for systemized building envelopes states that 'the envelope shall withstand specified impact loads' but gives limited guidance on the severity of impact loads to be specified. BS 8200 which has formed the basis for specification of impact performance for many years has now been withdrawn.

This Technical Note reviews the need for impact testing of building envelopes under typical UK conditions and provides guidance on specification of impact performance. The impacts considered are generally horizontal and the guidance is considered applicable to surfaces within 15º of vertical. At greater slopes, performance requirements may be modified based on the perceived risk of impact. Additional considerations may apply in particular locations. Examples include resistance to wind blown debris in areas affected by hurricanes, resistance to sustained attack and vehicle impacts.

Technical Notes TN 66 and TN 67 give guidance on impact requirements for glass roofs resulting from maintenance activities at roof level but more severe impacts from objects dropped from greater heights are not included. Impacts considered in Technical Notes 66 and 67 are vertical arising from falling people and objects.

Types of impact

Hard and soft body impacts

The building envelope may be subject to impact from a variety of causes. Surfaces are required to be resistant to impact from soft bodies, principally people, which deform on impact to distribute the load, and from more rigid objects referred to as hard bodies. Hard body impacts are generally considered to have lower impact energy than soft body impacts but hard body impacts from access equipment, skateboards etc could be at higher levels of impact energy. Hard body impacts tend to cause failure by localised punching whereas soft body impacts tend to cause failure by generalised bending. For this reason hard impacts can be damaging even at low impact energy.

Serviceability impact

It has been UK practice to require serviceability under impact. Following a serviceability impact test, there should be no loss of performance. Damage of an aesthetic nature such as indentations on metal panels may be acceptable depending on the severity of the damage, the nature of the material and location of use.

Failure of components under serviceability impacts may be acceptable where the components are readily replaceable. Where materials may require replacement following impact, the acceptability depends both on the ease of replacement and the ease of obtaining replacement materials several years after construction.

Where it is impractical to use materials that can withstand serviceability impacts without damage, the loss of performance can be mitigated. For example brittle materials may be reinforced with a mesh backing to prevent cracks opening up so that they remain in place.

Safety impact
The building envelope may be subject to more severe accidental impacts which it is unreasonable to resist without damage but where the consequences for the safety of those in and around the building must be considered. Safety considerations include:

- Ensuring that the structural stability of the building or parts of the building are not compromised
- Ensuring that the wall is not penetrated by the impact presenting a risk to people inside the building
- Ensuring that people outside the building are not put at risk from falling debris
- Ensuring that the failure mode of the cladding does not create risks to a person impacting the surface disproportionate to the impact

The third of these requirements is normally the most relevant. Failure of cladding panels will rarely affect structural stability of components other than the panels themselves and even if a cladding panel is penetrated by the impact, the back wall will normally prevent risk to people inside the building. The fourth requirement may be applicable with some cladding materials that produce sharp edges on failure.

Impacts in normal building use

Impact by people
Soft body impacts may arise from falls, trips or people being pushed against the building envelope. These Impacts are generally limited to areas within approximately 1.5m of the adjacent ground or floor. Impact above this level may be associated with maintenance particularly when rope access or cradles are used.

Impact by objects
Shopping trolleys and other moving manually operated hard objects can cause large localised impact loads. Where there is a risk of such moving objects being able to impact the envelope and cause significant damage a barrier may be used to prevent impact.

Impacts are limited to areas within approximately 1.5m of the adjacent ground or floor. Smaller impacts from thrown objects can occur at higher levels.

Impact by furniture
Furniture may be pushed against the inner face of the building envelope. The impact energy is limited by the ability of an individual to impart energy to the relatively heavy furniture. It is normally assumed that meeting the requirements of a soft impact safety test will give adequate robustness. BS 5234-2 gives guidance on impact requirements for internal partitions which would also be applicable to the internal face of an external wall.

Malicious behaviour
A degree of abuse must be expected however where there is a high risk of vandalism, impact resistance has to be considered on a project-by-project basis. An alternative approach to increasing resistance against impact loads is to provide additional security. Availability of materials that can be used to cause damage, such as loose stones, can also be reduced. If increased resistance to impact is required it may be advantageous to use a different wall construction at ground level and other affected areas. For example a brick or block wall at ground level with rainscreen panels above.

Several organisations including the Home Office, local crime prevention office, the 'secured by design' website and specialist consultants can also provide guidance.

Appendix 6 of CIRIA 'Guidance for glazing at height' gives information on the resistance of glass to deliberate impact.

Roofs
Roofs are vulnerable to impacts from dropped and falling objects. These can range from stones dropped by birds to falling masonry and large objects dropped by vandals. Specific guidance is outside the scope of this Technical Note. TN66 and 67 give guidance on fragility of rooflights and contain a suitable test regime. Guidance on fragility of opaque roofing materials is given at www.roofworkadvice.info.

Maintenance
Building envelopes have to sustain loads imparted to them during maintenance and repair operations. For vertical surfaces, impacts may occur due to ladders being placed against the wall, handling of scaffold poles, use of mobile elevating work platforms, cradles and rope access.

Impacts from permanent cradles will normally be reduced by use of suitable buffers or, less commonly, guide rails. Specifiers can require that cradles are designed to limit the severity of potential impacts to the values given in Tables 4 and 5 below.

Impacts from other forms of access equipment are more dependent on the care taken by the operators and no specific guidance on impact loads to be expected is available.

The risk of injury from fractured material falling during maintenance work can be controlled by ensuring equipment is tethered and keeping people away from the area during the work.

Hail resistance
This is not normally specified separately in the UK but is considered to be covered by the overall robustness requirements. It is a problem associated with particular regions of the world and micro-climates such as those in the Alps.

EN 13583:2001 gives a method of test for determining the hail resistance of some roofing materials. Existing UK practice is to have a general requirement for hard body impact (BS 8200) on the outer surface of all building envelopes. Where there is concern about hail conditions components can be tested according to the method in EN 13583:2001 but note that impact will depend on orientation of the component and the micro-climate that it is to be used in. Alternatively a hard body impact test can be specified with an appropriate impact energy.

Exceptional actions

This Technical Note considers normal impacts which a façade may be expected to withstand. Some facades will be exposed to higher levels of impact described below.

Vehicular collisions
An envelope should not be expected to withstand vehicular impact without incurring damage or without penetration. This could result in safety risks to people inside the building and to the need for the building envelope to be rebuilt at great cost. Where there is a significant risk of such impacts a barrier should be placed in front of the envelope.

Guidance on protecting the envelope from impact and on the loads that such barriers should resist is given in Building Regulations Approved Document K and EN 1991-1-1.

Intrusion
Components of the building envelope can be broken by impact in order to gain access or entry to the inside of the building.

The most vulnerable areas are glazing, and opening lights. Detailed guidance is outside the scope of this Technical Note. Further guidance is given in the following Standards.

- BS 8220-2
- LPS 1175
- BS 7950
- EN 356
- EN 1627

Wind blown debris
This impact load is not normally specified in the UK; it is associated with geographical locations affected by hurricanes and typhoons, such as Florida.

In areas prone to hurricanes and typhoons, buildings may be damaged by wind blown debris. ASTM E1886 describes a test for impact using a piece of 50 mm x 100 mm timber 1.2 to 4.0m long.

Assessment of impact performance

Assessment of impact performance requires the use of tests to simulate the types of impact the wall may be subjected to in service.

All impact tests comprise an impactor and a method by which it is swung, dropped or fired at the component under test. Full definition of a test includes the following:

- Details of test specimen,
- Type of impactor,
- Impact energy,
- Location of test on sample,
- Number of impacts,
- Assessment criteria.

Test specimen
The performance of a surface in an impact test will depend on how it is supported. If the specimen can deflect or move during the test, some of the impact energy will be absorbed in this movement.

For project tests, assessment of impact performance is normally carried out on a sample of the wall constructed for weathertightness testing. The behaviour of these samples should closely represent the behaviour in service.

For tests on a cladding system that may be used with different support structures, the support should normally be at least as rigid as

that likely to occur in service as more rigid support conditions absorb less energy and therefore increase the severity of the test. This may be achieved by supporting the test specimen on a concrete wall.

There may be some situations where deflection of the support structure changes the load distribution in a panel and creates a more severe load case than a test with a rigid support. This is more likely to occur with large panels with more than four fixings.

Types of impactor
Hard body tests are commonly carried out with a steel ball of 0.5 or 1kg that is allowed to swing against a vertical sample.

Soft body tests have traditionally been carried out using a bag filled with sand or glass spheres that is allowed to swing against a vertical specimen. The most common impactor is a spheroconical bag filled with glass spheres and weighing 50kg. More recently the double tyre pendulum impact test has been developed and this is now used for glass (EN 12600), windows (EN 13049) and curtain walling (EN 14019). The total mass of the impactor is 50kg and the tyres are inflated to a pressure of 3.5bar.

Test impact energy
The severity of the impact test is defined by the drop height or impact energy of the impactor. These are related by the formula:

$E=mgh$

Where:

E	is the impact energy (J)
m	is the mass of the impactor (kg)
g	is the acceleration due to gravity (m/s^2)
h	is the vertical distance through which the impactor falls before hitting the surface (m).

For hard body tests, the impact energy is normally in the range 3 to 10J. For soft body tests it ranges from 100 to 600J.

These figures relate to the kinetic energy of the impactor at the moment of impact. During the impact some of this energy is absorbed by deformation of the impactor and some is transferred to the impacted surface either in the form of elastic deflection or permanent damage.

Tests by Newman (2004) have shown that the double tyre pendulum impactor transfers significantly more energy to the test sample than a bag filled with glass spheres and thus for the same impact energy is a more severe test.

Impact location
The most critical location will depend on the type of test and type of construction. For example the critical location for a soft body test would normally be in the centre of a panel if the failure mode is by bending of the panel but may be adjacent to a fixing where the failure mode is localised around the fixing point.

Assessment criteria
Assessment criteria for impact tests depend on the purpose of the test (safety or serviceability) as well as the test specification. Failure criteria are described in the CWCT Standard test methods for building envelopes for both safety and serviceability.

For a safety test the criteria in the CWCT Standard are:

- Fracture of components,
- Punching failure,
- Dislodgement of components.

These test criteria appear simple but some commonly used materials such as terracotta tiles have low resistance to hard body impact and are unlikely to satisfy them (unless reinforced). Fracture of components may be considered acceptable if they remain in place however the risk of fractured materials going unnoticed and falling subsequently should be considered. For brittle materials that may fracture, a reinforcement mesh can be bonded to the back of the panel to aid retention in the event of fracture.

The location of use may also be relevant. Small pieces of a cladding unit falling from a height of less than 1.5m are unlikely to constitute a significant risk but the same pieces falling from greater height may be unacceptable. The probability of the fall zone being occupied should also be considered.

In Technical Note TN 76 the results of impact tests are assessed using the classification in Table 1 below. Using this classification the preferred outcome would be negligible risk but low risk would normally be acceptable with the possible exception of areas where debris could fall from a significant height onto an area where people are likely to be present. Moderate risk would normally be acceptable for cladding

within 1.5m of ground level and at higher levels where any falling debris is unlikely to hit people below and high risk would only be acceptable where falling debris is unlikely to hit people even if only falling from low level.

Class	Explanation/examples
Negligible risk	No material dislodged during test, and No damage likely to lead to materials falling subsequent to test, and No sharp edges produced that would be likely to cause severe injury to a person during impact, and Cladding not penetrated by impactor
Low risk	Maximum mass of falling particle 50g, and Maximum mass of particle that may fall subsequent to impact 50g, and Cladding not penetrated by impact, and No sharp edges produced that would be likely to cause severe injury during impact
Moderate risk	Maximum mass of falling particle less than 500g, and Maximum mass of particle that may fall subsequent to impact less than 500g, and Cladding not penetrated by impact, and No sharp edges produced that would be likely to cause severe injury during impact.
High risk	Maximum mass of falling particle greater than 500g, or Cladding penetrated by impact, or Sharp edges produced that would be likely to cause severe injury during impact.

Table 1 Classes for safety performance

For a serviceability test the criteria in the CWCT Standard are:

- Fracture of components,
- Punching failure,
- Indentation of any component surfaces,
- Displacement of panels or components such as gaskets,
- Subsequent failure of an air permeability or water penetration test.

Some judgement is required in interpreting these requirements as metal panels may suffer minor dents which are acceptable and fracture of components such as terracotta tiles may be acceptable if they are readily replaceable. In considering the acceptability of damage the ability to obtain replacement materials some time after construction should be considered. The classification given in Table 2 is used to assess the results of tests in Technical Note TN 76

Class	Definition	Explanation/Examples
1	No damage	No damage visible from 1m, and Any damage visible from closer than 1m unlikely to lead to significant deterioration
2	Surface damage of an aesthetic nature which is unlikely to require remedial action	Dents or distortion of panels not visible from more than 5m (note visibility of damage will depend on surface finish and lighting conditions - damage will generally be more visible on reflective surfaces), and Any damage visible from closer than 5m unlikely to lead to significant deterioration.
3	Damage that may require remedial action or replacement of components to maintain appearance or long term performance but does not require immediate action	Dents or distortion of panels visible from more than 5m, or Spalling of edges of panels of brittle materials, or Damage to finishes that may lead to deterioration of the substrate.
4	Damage requiring immediate action to maintain appearance or performance. Remedial action may include replacement of a panel but does not require dismantling or replacement of supporting structure	Significant cracks in brittle materials eg cracks that may lead to parts of tile falling away subsequent to test, or Fracture of panels causing significant amounts of material to fall away during test.
5	Damage requiring more extensive replacement than 4	Buckling of support rails.

Table 2 Classes for serviceability performance

Specification of impact performance

Specification of impact performance should consider the risk of impact occurring, the type and severity of impact test and the acceptable performance of the cladding in the test.

Exposure categories
Table 3 gives six exposure categories for impact. This classification was originally given in BS 8200 and has now been adopted in BS 8298 which relates to stone cladding. Risk of impact can be reduced by site security, design of site layout to keep people away from the building surfaces and avoiding the presence of materials that could be used as missiles.

	Areas within 1.5m of ground	
	Description	Examples
A	Readily accessible to the public and others with little incentive to exercise care. Prone to vandalism and abnormally rough use.	External walls in vandal prone areas.
B	Readily accessible to the public and others with little incentive to exercise care. Chance of accident occurring and of misuse.	Walls adjacent to pedestrian thoroughfares when not in category A.
C	Accessible primarily to those with some incentive to exercise care. Some chance of accident occurring or of misuse.	Walls adjacent to private open gardens. Back walls of balconies.
D	Only accessible, but not near a common route, to those with a high incentive to exercise care. Small chance of accident occurring or of misuse.	Walls adjacent to small fenced decorative garden with no through paths.
	Areas more than 1.5m above ground	
E	Above zone of normal impacts from people but liable to impacts from thrown or kicked objects. May also be subject to impact during maintenance.	1.5 to 6m above pedestrian level in location categories A and B.
F	Above zone of normal impacts from people and not liable to impacts from thrown or kicked objects. May also be subject to impact during maintenance.	Wall surfaces at higher positions than those defined in E above.

Table 3 Exposure categories

Impact test energy
Specification of impact resistance in the UK has generally been based on BS 8200. Experience has shown that the impact requirements in BS 8200 have proved satisfactory and therefore these recommendations may continue to be used following the withdrawal of BS 8200.

The retention of the spheroconical bag from BS 8200 in preference to the double tyre impactor is partly because deformation of the bag is considered to give a better representation of human impact and partly due to the difficulty of establishing an equivalent level of impact energy for the double tyre impactor.

The values given in Tables 4 and 5 below are based on BS 8200. The test procedure is given in Technical Note TN 76. This is also based on the procedure given in BS 8200 but gives more detail both of the construction of the impactor and the test procedure.

Exposure category	**Safety**	**Serviceability**
A	No values are given as severity of potential vandalism needs to be assessed	
B	500J	120J
C	500J	120J
D	No values given as risk of impact is minimal	
E	350J	120J
F	350J	120J

Table 4 Soft body impact test energy

For locations E and F, BS 8200 did not give soft body serviceability impacts and these have been added.

Exposure category	**Safety**	**Serviceability**
A	No values are given as severity of potential vandalism needs to be assessed	
B	10J	10J
C	10J	6J
D	No values given as risk of impact is minimal	
E	10J	6J
F	3J	3J

Table 5 Hard body impact test energy

BS 8200 did not give a hard body safety impact for exposure category F. These areas are above the normal range of thrown objects and impacts are only likely to occur during

maintenance activities. During maintenance work the areas below would normally be kept clear of people hence there is a low risk of injury from falling debris however it is possible that impact damage may go un-noticed and debris may fall at a later date. A safety impact of 3J has therefore been added for this location.

Performance
When specifying impact tests, the specifier should clarify the required performance using the classification system given in Tables 1 and 2.

Application to building envelopes

In this Technical Note, the following parts of the building envelope are considered:

- Rainscreen panels
- Curtain wall systems
- Windows
- Doors
- Glass

A summary of recommendations and test methods for impact resistance of building components is given in Appendix A.

Rainscreen panels
The recommendations above are readily applicable to rainscreen panels and there is no conflicting alternative advice for most panel materials.

Metal rainscreen panels will normally satisfy safety requirements but may suffer unacceptable aesthetic deformation in serviceability tests.

Brittle materials such as terracotta tiles often perform poorly especially under hard body impacts. Despite their poor performance in tests, they are widely used. This may indicate that tests are unnecessarily severe but the acceptance of such materials may be based on the ability to replace damaged panels. Where safety is the primary issue, brittle materials may be reinforced by bonding a mesh on the back to minimise the risk of falling debris.

BS 8298 gives requirements for stone cladding including stone used as a rainscreen. The requirements are limited to soft body tests for safety using the double tyre impactor. Although the impact energy is less than proposed above for the spheroconical bag, these tests are probably still more onerous than recommended above.

In some cases it may be possible to estimate the effect of changes to the shape and size of a panel but this is not generally possible due to the number of factors that influence impact performance.

Curtain wall systems
EN 14019 gives a method of assessing impact resistance of curtain walling using the double tyre impactor.

EN 14019 sets out impact test locations as follows:

- Mid height of a vertical framing member,
- Midspan between mullions at cill height (on transom or infill as appropriate),
- Crossing of mullion and transom
- Mid point of a spandrel panel.

The impact at mid height of the mullion is only carried out on the external face. The impact at cill level midspan between mullions is carried out on both the internal and external faces. The Standard does not specify which face should be tested at the remaining locations.

Only one impact is permitted at any location but there is no guidance on the number of repeat tests (if any) required to assess performance.

There are six classes of impact performance as shown in Table 6 below.

Class	Drop height (mm)	Impact energy (J)
0	n/a	n/a
1	200	98
2	300	147
3	450	221
4	700	343
5	950	466

Table 6 EN 14019 impact classes

To satisfy the test, the curtain wall is required to remain safe and maintain its integrity. Breakage or dislodgement of components is not permitted but limits on permanent deformation are not given.

Testing a curtain wall system in this way does not necessarily give the most critical impact loading. The impact carried out at the intersection of a mullion and transom will

normally be applied directly to the mullion and will apply little if any impact load on the transoms or mullion/transom connection. An impact on the end of the transom will apply the maximum impact load on the connection between the mullion and transom. Similarly the impact at the centre of the spandrel may be less critical than an impact near the edge of the spandrel panel, particularly if it is applied to the internal face of the spandrel.

Tests on standard stick curtain wall systems (Newman) have shown that the framing members are capable of resisting the class 5 impact without damage although there may be some deformation of cover caps. The performance will depend on the depth of the framing member box which is not stated for the tests described by Newman and shallow depth transoms may give lower performance.

The class 5 impact is significantly more severe than the 500Nm impact from the spheroconical bag. Newman concluded that class 4 is likely to be at least as severe as the 500J impact with the spheroconical bag and class 3 is likely to be at least as severe as the 350J impact with the spheroconical bag.

Windows
EN 13049 gives a method for testing soft body impact resistance of windows using the double tyre impactor. The specified test locations are:

- The centre of the infill,
- A corner of the infill,
- The centre of the longest edge of the largest area of infill.

The same classes are used as for curtain walls.

The test on windows is concerned with the interaction of the components and the main requirement is to prevent the formation of an opening through which an ellipsoid 400 mm x 300 mm can pass. The opening could be formed by:

- failure of hardware allowing the window to open,
- glazing being dislodged due to failure of the retention mechanism, or
- distortion of the frame.

Failure of the glazing material is excluded.

BS 6375-2 which gives guidance on the specification of windows recommends class 0 (ie testing is not required) and states that the need for impact testing of windows has not been established.

Glazing
There are safety requirements for glass in the Building Regulations relating to impact from people however there are no impact requirements requiring serviceability after impact and no requirements for hard body impacts. The requirements for safety glass only apply to glass within 800mm of the adjacent ground or floor, and within 1500mm of the adjacent ground or floor in doors or panels adjacent to doors. Other areas of glazing have generally been excluded from impact tests on walls. However where walls contain large areas of glass it is reasonable to expect the glass to be subject to the same level of impact as opaque areas.

Tests carried out in accordance with EN 12600 are a test of the material and relate to the use of glass in a four sided frame.

In modern buildings glass can be used as an opaque cladding material either for curtain wall spandrel panels or rainscreen panels. In such cases they may not be recognised by building occupants or maintenance staff as being any different to other cladding materials. It would be reasonable to treat glass used in this way in the same manner as other rainscreen panels.

References

ACR[M]001:2005 Test for fragility of roofing assemblies (Work in Hand), available from http://www.roofworkadvice.info >publications > the red book

ASTM E1886-05 Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials

BS 5234-2: Partitions (including matching linings). Specification for performance requirements for strength and robustness including methods of test.

BS 6206: Specification for impact performance requirements for flat safety glass and safety plastics for use in buildings.

BS 6262-4: Code of practice for glazing for buildings Part 4 Safety related to human impact.

BS 7950: Specification for enhanced security performance of windows for domestic applications

BS 8200: Code of practice for design of non-loadbearing external vertical enclosures of buildings.

BS 8220-2: Guide for security of buildings against crime. Offices and shops.

EN 356: Glass in building. Security glazing. Testing and classification of resistance against manual attack.

EN 950: Door leaves - Determination of the resistance to hard body impact.

EN 1873: Prefabricated accessories for roofing. Individual roof lights of plastics. Product specification and test methods.

EN 12600: Glass in building - Pendulum test - Impact test method and classification for flat glass.

EN 13049, Windows – Soft and heavy body impact – Test method, safety requirements and classification.

EN 13583: Flexible sheets for waterproofing - Bitumen, plastic and rubber sheets for roof waterproofing - Determination of hail resistance

EN 14019: Curtain walling - Impact resistance - Performance requirements.

EN 1627: Pedestrian doorsets, windows, curtain walling, grilles and shutters - Burglar resistance - Requirements and classification.

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Newman, C. J., 2004, Evaluation of an impact standard for curtain walling, Proceedings of the Institution of Civil Engineers, Structures and Buildings 157, October 2004, p333-341.

TN 66, Safety and fragility of overhead glazing: guidance on specification, CWCT 2010.

TN 67, Safety and fragility of overhead glazing: testing and assessment, CWCT 2010.

BS 8298-1, Code of practice for the design and installation of natural stone cladding and lining. General

TN76, Impact performance of building envelopes – method of impact testing cladding panels.

BS 6375-2, Performance of windows and doors. Classification for operation and strength characteristics and guidance on selection and specification.

EN 1991-1-1 Eurocode1: Actions on structures Part 1-1: General actions- Densities, self weight, imposed loads for buildings.

CWCT
The Studio, Entry Hill, Bath, BA2 5LY

T: +44 (0) 1225 330945
cwct@cwct.co.uk
www.cwct.co.uk

Appendix A

Summary of impact requirements for building components

Construction Type		Guidance on performance requirements	Type of impact	Performance classification	Test Method
Roofs	Glass	CWCT TN66	Hard	CWCT TN66	CWCT TN67
			Soft	CWCT TN66	CWCT TN67
	Potentially fragile materials	ACR(M)001:2005	Hard		
			Soft	ACR(M)001:2005	ACR(M)001:2005
	Flexible roof sheeting		Hail	EN 13583	EN 13583
	Plastic rooflights		Hard	BS EN 1873	BS EN 1873
			Soft	BS EN 1873	BS EN 1873
Walls	Curtain walling	CWCT TN75	Hard	CWCT TN75	CWCT Standard test methods for building envelopes and TN76
			Soft	CWCT TN75 EN 14019	CWCT Standard test methods for building envelopes and TN76 BS EN 13049
	Other walls (Rainscreen, render, etc)	CWCT TN75	Hard	CWCT TN75	CWCT Standard test methods for building envelopes and TN76
			Soft	CWCT TN75	CWCT Standard test methods for building envelopes and TN76
	Stone cladding	BS 8298	Soft	EN 14019	EN 12600
	Windows		Hard		
		CWCT TN75 BS 6375-2	Soft	EN 13049	EN 13049
	Doors		Hard		EN 950
			Soft		EN 949
	Glass	Building Regs N1 BS 6262-4	Hard		
			Soft	EN 12600	EN 12600
	Glass in barriers	BS 6180	Soft	EN 12600	EN 12600
	Plastic glazing	Building Regs N1 BS 6262-4	Hard		
			Soft	BS 6206	BS 6206
	Internal partitions	BS 5234-2	Hard	BS 5234-2	BS 5234-2
			Soft	BS 5234-2	BS 5234-2