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NOTAT 74

STATENS BYGGEFORSKNINGSINSTITUT
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Ydeevne

NON-LOADBEARING
EXTERNAL WALLS
General SBI Performance Statement 3

RESUMÉ:

Notatet, som er på engelsk, er en oversættelse af SBI-Ydeevnebeskrivelse 3: Ikke-bærende ydervægge.
Oversættelsen er tilvejebragt af arkitekt DAL Olaf Skipper Nielsen, der i mange år har arbejdet i England, og som yderligere i sit arbejde for det britiske Public Services Agency har arbejdet netop med ydeevnetankegangen. Ved Skipper Nielsens mellemkomst har oversættelsen også været forelagt det britiske byggeforskningsinstitut.

Når netop denne ydeevnebeskrivelse er blevet oversat, skyldes det bl.a. at materialet nu har fundet en form, som det synes muligt at fastholde og udbygge. Ikke mindst de graduerede - og nu ensartede - vurderingsskalaer, som gør det muligt for de projekterende individuelt at vælge værdier til hvert enkelt projekt, har vakt interesse - også i udlandet.

På opfordring af CIB, den internationale byggeforskningsorganisation, og ISO, den internationale standardiseringsorganisation, er nærværende notats indhold for øjeblikket under bearbejdelse. Målet er et paradigma for en kommende serie af ydeevne-baserede ISO-standarder om byggekomponenter.

Notatet indeholder en kortfattet beskrivelse af, hvordan ydeevnetankegangen kan anvendes på forskellige projektstadier. Fra en indledende markedsoversigt og til udbud og endeligt valg af løsning.
Foreløbige erfaringer synes at vise, at notatets indhold med fordel kan anvendes af danske rådgivende firmaer, der arbejder i udlandet. Valget af skalaværdier vil være forskelligt fra projekt til projekt og fra land til land, men arbejdsmetoden er generelt anvendelig, og det samme gælder mange af prøvningsmetoderne.

Oktober 1977

YDERLIGERE OPLYSNINGER KAN FÅS VED HENVENDELSE TIL:

Klaus Blach eller Georg Christensen

TRANSLATION:

3

NON-LOADBEARING EXTERNAL WALLS

GENERAL SBI PERFORMANCE STATEMENT 3

Definition of subject and range of application

Non-loadbearing external walls are defined for the purpose of this document as vertical storey-high building assemblies, which form a boundary for enclosed spaces and which separate external and internal environments.
Non-loadbearing external walls are not assumed to be designed for the transmission of structural loadings from adjoining building assemblies.
The non-loadbearing external walls dealt with in this document are intended for use primarily in residential buildings.

	FUNCTION	STRESSES	ATTRIBUTE	CIB x)
1	to provide physical separation	static and dynamic forces	strength and rigidity	4.01
2	to exclude precipitation	precipitation	resistance to precipitation	4.04.03
3	to separate air and gases	differential air pressure	air tightness	4.03.01
4	to separate thermally	temperature differentials	thermal insulation	4.07.01
5	to prevent condensation	humidity and temperature	resistance to vapour diffusion from room air	4.03.01
6	to separate acoustically	sound	sound insulation	4.09.03
7	to remain physically safe	use and deterioration	stability	4.01
8	to provide safety in fire	fire	fire resistance	4.02.01
9	to be durable	chemical, physical and biological agents	durability	4.14
10	to be hygrothermally stable	humidity and temperature	hygrothermal stability	4.14
11	to resist compression	concentrated static forces	resistance to indentation and perforation	4.01
12	to resist impact	concentrated dynamic forces	robustness	4.01
13	to transmit imposed loadings	loadings from shelves, installations	fixing potential	4.01
14	to present intended appearance	-	appearance	7.03
15	to be sound absorbing	sound	sound absorption	4.09.05
16	to be detailed dimensionally and technically	-	compatibility	5.05
17	to be easy to handle	transport, storage and erection	ease of transport and erection	6.04

x) CIB Report Nc 18, section: "Master List for Components" (English version 1972)

PERFORMANCE STATEMENTS FOR BUILDING COMPONENTS AND ASSEMBLIES

Performance statements can form part of a number of documents used in the planning process to define aims and requirements for the intended structure.

A performance statement may deal with subjects at various levels; for example: buildings, building systems, building assemblies, components, component parts and materials. SBI's series of performance statements is intended primarily to form guidance for selection at the planning stage. They may also in many cases form a useful starting point for further development work.

Non-loadbearing external walls is the third performance statement for components and assemblies in the SBI series. The two earlier issues were: Performance statement 1: Non-loadbearing partitions, and Performance statement 2: Windows. Additional performance statements for doors, wet rooms, floors and floor deck constructions, and other subjects will be issued as soon as the work on the concomitant test methods has advanced sufficiently.

In the selection of subjects for the SBI series of general performance statements preference is given to, inter alia, those types of components which are being produced in many different forms, often using new materials or constructions which make a quality assessment difficult.

By using a performance statement a systematic evaluation may be conducted on an informed basis, - for example by means of testing. When preparing a performance statement it must be accepted that not all attributes are, or can be made, measurable. Nevertheless they should still be included in the performance statement because they can be of considerable significance in a choice situation, even though their adequacy may have to be assessed subjectively.

When submitting tenders or preparing trade descriptions or performance declarations it is important that contractors and manufacturers use the same terminologi as the planners and the buyers. If a particular level for performance, related to a specified method of test, is called for, the stated performance of a given component should be quoted in relation to the same test method. Like the building regulations the SBI performance statements use the new units (SI = Systeme Internationale). The same units should be used by contractors and manufacturers.

THE USE OF PERFORMANCE STATEMENTS IN THE PLANNING PROCESS

SBI's performance statements may be used at different stages in the planning process according to the constraints imposed upon the freedom of choice.

Performance statements for market surveys

During the planning process it is often expedient at an early stage to conduct a preliminary market survey to obtain better information about market components and to ascertain whether any components exist at all, which would appear to be suited for the purpose. A description, adequate for this purpose, can often by put togetner on the basis of a few clauses from the sections Proposed fulfilment. Such a statement will accomodate different solutions, both in the terms of cost and quality, and may thus contribute towards the emergence of new solutions, especially in large building projects.

Performance statements for preliminary comparison

At a later stage during the planning process it becomes necessary to compare systematically several feasible solutions. It is often at this stage that a first assessment of price/quality can be conducted. In many cases a statement for the purpose of an early comparison of possible solutions may be prepared using 5-10 clauses from the sections Proposed fulfilment, supplemented by selected values from the evaluation scales. For some attributes the statement may be quantified, for example: "the sound insulation of a non-loadbearing partition shall be between 40 dB and 44 dB".

Performance statements for detailed comparison

Just before the completion of the planning process the choice may have become narrowed down to either a clear preference of the selection from a few, almost identical, options, - or the systematic comparison may have indicated that it is unlikely that an acceptable solution is marketed. In such a situation a detailed comparison will be needed. The statement will at this stage probably need to include at least 15 - 20 clauses, similar to the SBI performance statements. For large building projects it may be expedient or necessary to conduct test programmes.

Performance statements for tenders

In case it has not been possible to make a final choice before inviting tenders, or if no acceptable components have been located on the market, the tender documents must include a precise statement of the performance required. For this purpose one of the SBI performance statements may be used, supplemented by an indication of the values on the evaluation scales, which should form the target levels.

Performance statements for final selection

For final selection, - for example in connection with acceptance of tenders, - a final assessment is carried out. An objective decision with regard to quality may be reached on the basis of a performance statement, possibly by means of a valueanalysis. The final assessment of an attribute much always be based on factual information about the project in question, because the design may affect the relevance of a particular attribute.

1. STRENGTH AND RIGIDITY

Presupposed wish

The wall shall form a safe physical boundary for an enclosed space.

Proposed fulfilment

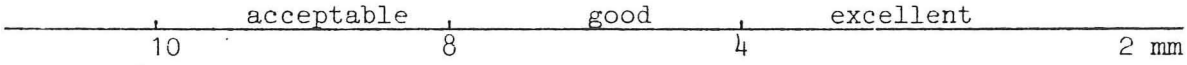
The wall shall have sufficient strength and rigidity to enable it to withstand sustained wind loadings (wind pressure and suction) and wind gusts, without showing visible deformations or damage or suggesting instability. The wall shall have sufficient strength and rigidity to withstand persons leaning or falling against it without evidence of deterioration or any sensation of instability.

Testing

a) For walls to be used at less than 6 m above ground level a horizontal linear loading of 500 N/m is gradually applied centrally between floor and ceiling level. Similarly, for walls to be used at 6-30 m above ground level a linear loading of 1000 N/m is applied. (Test method, see SBI Note 33).
b) At the location assumed to be the weakest area a dynamic area load is applied to the wall by a sand bag (weight 400 N); the test comprises 3 impacts of 120 Nm and 1 impact of 240 Nm. (Test method, see SBI Note 33).

Evaluation

a) The wall is sufficiently rigid against horizontal linear loading if the deformations measured do not exceed 10 mm and the shape of the load/deformation curve is even, almost linear. In addition any residual deformations shall not exceed 2 mm.
The rigidity of the wall against linear loading is furthermore assessed in accordance with the following scale:



Deformation.
b) The wall provides adequate strength against soft body impact if no damage, such as cracks, occur under impacts of 120 Nm, nor any residual deformations, such as rupture, occur after the impact of 240 Nm.

Remarks

The test described under a)may be replaced by calculation in accordance with DS 410, Loading Norms, and eg DS 412, Steel Constructions, or DS 413, Timber Constructions. In principle the wall shall have the same strength and rigidity, whether load is applied from the inside or from the outside face. In exposed situations it may be necessary to make special provisions to prevent wind suction from dislocating parts of the external wall (cladding panels), but no test method for this contingency has been developed. Operational loadings can normally be ignored for those parts of external walls which are not situated at ground level or facing access balconies, etc.

2. RESISTANCE TO PRECIPITATION

Presupposed wish

Precipitation shall not penetrate to the inside face of the wall and must not adversely affect the wall proper, nor its surroundings, by transmission through the wall.

Proposed fulfilment

a) Driving rain shall not penetrate to the inside face of the wall.
b) Driving rain shall not cause any reduction of the thermal resistance of the wall.
c) Driving rain shall not give rise to damage resulting from dampness in any constituent materials of the wall.

Testing

a) A section of the wall is selected, containing a normal vertical joint and a normal horizontal joint (intermediate joints between wall components). The test specimen is mounted in an airtight box in which an excess pressure can be maintained, and also wind-driven rain can be simulated in the form of water spray at a rate of approximately 10 l/m as well as rain run-off on the surface, approximately 100 l/m h. The test is conducted at a pulsating pressure (0,16 Hz) which is raised incrementally up to 1500 Pa (Pascal = N/m^2).
The pressure at which water penetration through the wall is recorded (Test method, see SBI Note 26).
b) and c) None.

Evaluation

a) The wall's resistance to penetration by driving rain is assessed in accordance with the following scale:

	acceptable		good		excellent	
500		700		1100		1500 Pa

Pressure difference.
b) and c) Subjective evaluation.

Remarks

External walls are subjected to widely differing levels of exposure to precipitation, depending on climate and positioning.
Requirements for resistance to precipitation of external walls can often be relaxed for walls positioned below overhanging eaves, balconies or similar projections; conversely more stringent requirements may be needed for the upper storeys of tall buildings. For walls near ground level it may be necessary to take into account any backsplash of mud and rainwater resulting from precipitation.
For external walls designed as two-stage weather screens it must be ascertained that any precipitation penetrating the first stage is channelled out of the fabric.
Joints between wall components and adjoining building assemblies, which are exposed to precipitation, may also be tested in accordance with SBI Note 26. Modifications to the test rig may be necessary, depending on the shape and construction of the adjoining building assemblies.

3. AIR TIGHTNESS

Presupposed wish

The wall shall be impenetrable to wind.

Proposed fulfilment

The wall shall be sufficiently wind tight to avoid an undesirable rate of air change being generated in the enclosed space, or any uncomfortable draughts in the vicinity of the wall. In addition it must be ascertained that no air currents, which reduce the thermal resistance of the wall, occur within its fabric.

Testing

A section of the wall is selected, containing a normal vertical joint and a normal horizontal joint (intermediate joints between wall components). The test specimen is mounted in an airtight box, where excess pressures corresponding to heavy wind pressures can be maintained. When an excess pressure has been established, the air volume penetrating the wall is measured. At a distance of 150 mm from the wall the velocities of air passing horizontally through its fabric are measured by a thermoanemometer. (Test method, see SBI Note 26).

Evaluation

The airtightness of a wall (at a pressure difference of 700 Pa (Pascal = N/m^2)) is evaluated in accordance with the following scales:

Scale 1: Applicable mainly for the evaluation of smaller wall components.

	acceptable	good	excellent	
6		4	2	$m^3/h\ m^2$

Air penetration per m^2 of wall.

Scale 2: Applicable mainly for the evaluation of large wall components.

	acceptable	good	excellent	
1,0		0,6	0,3	$m^3/h\ m$

Air penetration per m length of joint.

Scale 3: For the evaluation of point leakage.

	acceptable	good	excellent	
0,50		0,35	0,25	m/s

Maximum air velocity.

Remarks

In "Joint Nordic Building Regulations for Curtain Walls", NKB Document No 5, Dec. 1965, item 5.1, it is proposed that convective air currents must not increase the thermal transmittance coefficient (k) "U-value" in the UK by more than 10%. Test methods for an assessment of this eventuality do not yet exist.

4. THERMAL INSULATION

Presupposed wish

The wall shall prevent heat loss to its surroundings.

Proposed fulfilment

The wall should provide sufficient thermal insulation to avoid waste of energy. Under winter conditions the temperature of the wall surface facing the heated room must not at any point fall below the dew point of the room air (12°C under normal conditions). The surface temperature should be as uniform as possible in order to avoid the formation of dust patterns.

Testing

The thermal resistance of the wall may be computed in accordance with the "Code of Practice for the calculation of heat loss in buildings" (Danish Institute of Civil Engineers: DIF Norm No 55).
For composite constructions the inside surface temperature may be determined by calculation, based on (the) rules for calculation of multi dimensional heat flow. A more accurate determination of inside surface temperatures may be made by mounting the wall between a cold and a warm enclosure (-12°C and +22°C respectively) and recording surface temperatures on the warm side by means of thermographic equipment or thermocouples.

Evaluation

The thermal resistance of a wall is evaluated in accordance with the following scales:

	acceptable		good		excellent	
0,6		0,35		0,25		0,15 W/m^2 °C

Transmittance coefficient k. "U-value" in the UK.

	acceptable		good		excellent	
12		17		19		21°C

Surface temperature at the coldest point.

Remarks

BR 72, chapter 8.2.1, require the following thermal resistance (transmittance coefficient) depending on the mass of the wall:
External walls weighing less than 100 kg/m^2 transmittance coefficient k < 0,6 W/m^2 °C. External walls weighing more than 100 kg/m^2 transmittance coefficient k < 1,0 W/m^2 °C.

The thermal inertia (especially thermal capacity) of external walls may be utilized to a partial equalization of variations in room temperature caused by fluctuating heat inputs, for example solar radiation or extreme low outside temperatures. In external walls enclosing bathrooms, where the moisture content of the room air often can be substantial, there may be a particular risk of thermal bridges giving rise to surface condensation and discolouration.

5. RESISTANCE TO WATER VAPOUR DIFFUSION FROM ROOM AIR

Presupposed wish

No detrimental condensation shall be generated in the wall.

Proposed fulfilment

The wall shall be constructed so that no damage to its fabric can be caused by moisture migrating from inside the room; in addition any moisture condensing within the insulation shall reduce its thermal resistance only temporarily and to a very limited degree. The inside surface of the wall shall be sufficiently airtight to prevent room air from infiltrating into cold portions of its fabric through cracks and joints, thus giving rise to detrimental condensation.

Testing

The wall is mounted so as to form the separation between a cold and a warm enclosure where temperatures and humidity can be maintained at $-12^{\circ}C$ and 90% RH - and $+22^{\circ}C$ and 50% RH on the cold and the warm sides respectively. On the warm side a constant slight excess pressure of 20 Pa (Pascal = N/m^2) is maintained. The wall is exposed to test conditions for 60 days.
Immediately after the conclusion of the test the wall is dismantled and it is ascertained whether any condensation, including ice formation, has occurred in any portion of its fabric.

Evaluation

In those cases where condensation (ice formation) is observed, its possible effects, such as reduced durability or thermal resistance of the wall, must be assessed. Such an evaluation should take into account any dispersal of moisture by capillary action or other means, which can be expected prior to the commencement of the next condensation cycle.

Remarks

The requirements stated above will normally be met by lightweight composite walls, if the layers situated at the warm side of the insulation have a resistance to water vapour transmission which is 10 times greater than that of the layers at the cold side of the insulation. The permeance of foils or sheet materials may be measured in accordance with ASRM method E-96 (thin materials) or C-355 (thick materials).
Materials to be used on the cold side of the insulation are examined in accordance with the so-called "wet cup" method, ie at a high level of relative humidity. Materials used on the warm side of the insulation are similarly examined by the so-called "dry-cup" method at a low level of relative humidity. In addition the inner layers must be more airtight than the outer layers, and all perforations of the impermeable layer must therefore be sealed. With regard to values for resistance to water vapour transmission see SBI Note 77 "The external wall as a weather screen".

6. SOUND INSULATION

Presupposed wish

The wall shall provide insulation against external noise.

Proposed fulfilment

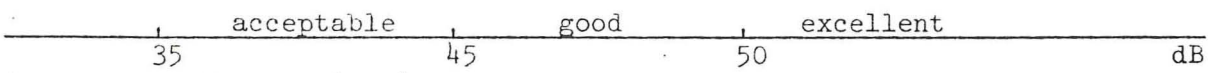
The wall shall provide sufficient sound insulation to ensure that normal noise from the outside does not raise the noise level in the enclosed space so as to cause inconvenience.

Testing

The wall is mounted to as to form the separation between two reverberant rooms, and its sound reduction index is measured at 16 different frequences from 100 to 3150 Hz. (See ISO/R 140).

Evaluation

The sound reduction index of a wall is evaluated in accordance with the following scale:



Average sound reduction index.

Remarks

Windows and walls should be constructed so that the resultane noise level in the dwelling does not exceed 30 dB(A) at night and 35 dB(A) during the day. In most cases the window will be the factor deciding whether it is possible to achieve the necessary attenuation of external noise. ISO/R 140 is being revised with a view to developing a more exact method of evaluation in relation to traffic noise.

With regard to walls containing doors and windows: Where the aggregate area of doors and windows constitutes a minor portion of the total wall areas, a significant improvement of the total sound insulation can not be achieved by raising the sound reduction in index of the wall if it is already 20 dB above the sound reduction indices of the doors and windows installed. Similarly if the aggregate area of doors and windows constitutes a major portion of the total wall area it is fruitless to make the wall more than 10 dB better than the doors and windows.

7. STABILITY

Presupposed wish

The wall shall not be liable to total or partial collapse resulting in bodily harm.

Proposed fulfilment

The wall shall be sufficiently stable to ensure that even abnormally heavy static and dynamic loadings do not cause total or partial collapse.

Testing

a) A horizontal linear loading of 1500 N/m is applied gradually to the inside face of the wall, centrally between floor and ceiling. (Test method, see SBI Note 33).
b) A dynamic area loading of 360 Nm is applied to the wall by means of a sand bag (weight 400 N) striking the wall through a pendular movement. The impact is applied at a height of 1500 mm above floor level (shoulder height) to the location considered most critical for the stability of the wall. For sheet faced stud walls this location will usually be in line with one of the studs, (excluding any studs along the edges of the test specimen). (Test method, see SBI Note 33).

Evaluation

a) The wall provides adequate strength and stability against a horizontal linear loading of 1500 Nm if the load/deformation curve from 0 - 1500 Nm forms a straight line and the fastenings to floor and ceiling remain fully operative.
b) The wall provides adequate stability against dynamic area loadings if, at 360 Nm, it does not collapse, overturn or suffer damage to such an extent that bodily harm can result.

Remarks

The test mentioned under a) may be replaced by calculation in accordance with DS 410 Loading Norms, and for example, DS 412, Code of Practice for Steel Constructions, or DS 413, Code of Practice for Timber Constructions.
The wall's stability against wind pressure may be taken as being satisfactory if, during tests for resistance to precipitation, no damage to the wall or its fastenings are observed (at a pressure difference of 1100 Pa for walls up to 6 m above the ground; at a pressure difference of 1500 Pa for walls 6-30 m above the ground).

8. FIRE RESISTANCE

Presupposed wish

In case of fire no risk of bodily harm shall arise.

Proposed fulfilment

a) The wall shall provide resistance against flame penetration.
b) The inside and outside surfaces of the fabric shall be constructed so that they do not aggravate the risk of bodily harm in case of fire, through either:
1. surface spread of flame
2. fire propagation
3. development of dense smoke
4. development of toxic gases.

Testing

a) The resistance to flame penetration of the wall is determind in accordance with DS 1051, the "Fire Chamber Method".
b)1. Surface spread of flame is determind in accordance with the National Testing Institute's fire test SPA No 8, the "Panel method". For surfaces with a low rating of flame spread - surfaces of class 1 - the assessment can also be carried out on the basis of Scandinavian test method SFTM No 2 B, the "Schlyter-metod".
b)2 and b)3. Fire propagation and smoke development are assessed in accordance with Scandinavian fire test method SFTM No 4, the "Box-method".
b)4. There is as yet no test method.

Evaluation

a) Classification of the fire resistance of the wall shall be in accordance with the criteria given in DS 1052.
BR 72, chapter 6, stipulates that external walls which are assessed in accordance with DS 1052, must, as a minimum, be classified as in the following example:

Detached dwellingshouses, Semi-detached dwellinghouses, Terraced dwellinghouses etc.	Other residential buildings, up to 2 storeys (BD-60) Residential buildings in 3 or more storeys (BS-60 or BD-60 with supplementary clauses)	Separating wall, 2,5 m from boundary for semi-detached dwellinghouses, terrached dwellinghouses, etc. (BD-90 or BS-60)
30	60	90 minutes

Fire resistance

b)1, b)2 and b)3. BR 72, chapter 6, stipulates requirements for resistance to surface spread of flame of external walls as in the following example:

Detached dwellinghouses, Semi-detached dwellinghouses Terraced dwellinghouses etc.	Multi-storey residential buildings means of escape in hotels, hostels, nursing homes, etc., Dormitories in nursing homes, convalescent homes, etc.	Surfaces in staircases which form means of escape in nursing homes, convalescent homes, rest homes, etc.
class 2	class 1	non-combustible material

Remarks

BR 72, chapter 6.20, contains a series of examples of constructions deemed to satisfy the stipulated requirements.

9. DURABILITY

Presupposed wish

The constituent materials of the wall shall be resistant to chemical, physical and biological agents.

Proposed fulfilment

The chemical, physical and biological stability of the constituent materials of the wall shall be adequately preserved over an extensive period of years, when subjected to normal deterioration agents, such as uv-radiation, corrosion, fungi, internal chemical decomposition and cleaning agents.

Testing

None. (For facades with applied surface finish durability under weathering conditions can be tested in accordance with ASTM G 23-69).

Evaluation

Subjective evaluation.

Remarks

The constituent materials of the wall shall not emit unacceptable amounts of toxic/noxious gases, or any nuclear radiation.
It must be ascertained whether easy and inexpensive repair or replacement can justify a serviceable life of less than 60 years.

10. HYGROTHERMAL STABILITY

Presupposed wish

Variations in temperature and humidity shall not give rise to inconvenient or detrimental changes in the dimensions and shape of the wall.

Proposed fulfilment

The hygrothermal properties of the wall shall be such that no inconvenient or detrimental deformations will result from normal variations of temperature and humidity in its surroundings. For walls incorporating openings for doors and windows any changes in dimensions and shape shall not impair the intended operation of such doors and windows.

Testing

a) The wall is mounted between 2 enclosures in which outside and inside climatic conditions can be simulated. (Inside: 20°C and 35% RH. Outside: 1) -20°C and 95% RH, corresponding to winter conditions; 2) 35°C and 95% RH and 65°C surface temperature, corresponding to summer conditions). Changes in dimensions and shape are recorded. (SBI Test method in preparation).
b) For external walls to be used as enclosures for a wet room, the inside face is sprayed alternately for short period with cold and hot water. (Test method, see SBI Note 33).

Evaluation

a) and b) The changes in dimensions and shape must not result in that the dimensions or form of the wall exceed given tolerances.

Remarks

When the test method referred to under "Testing, a)" has been prepared, a graduated scale for changes in dimensions and shape can be established.
On the basis of test results and details of the construction of a particular wall, the effects of any changes in dimensions and shape on its other properties (eg airtightness) can also be assessed.
In many cases the deformation on the wall may be calculated on the basis of experience of thermal and moisture movements in its constituent materials (see SBI Reprint 234).

11. RESISTANCE TO INDENTATION AND PERFORATION

Presupposed wish

The wall shall not be liable to suffer damage when subject to concentrated static loadings.

Proposed fulfilment

The inside face of the wall shall provide adequate resistance against minor concentrated static loadings so that it shows only slight deformation, no deep indentation marks and no perforation as a result of such loadings.

Testing

a) A static loading of 250 N is applied to the inside face of the wall by a steel ball, 20 mm in diameter. The depth of any indentation marks is recorded.
b) A static loading of 200 N is applied to the inside face of the wall by a steel rod, 25 mm in diameter. The depth of any deformation is recorded. Subsequently the loading is increased until perforation of the surface occurs. The loadings are applied to those areas which are considered the most vulnerable of the wall. When testing for assessment of rigidity, the loadings must therefore be applied to, for example, the centre of an unsupported panel.

Evaluation

a) The resistance to indentation of the wall's surface is evaluated in accordance with the following scale:

	acceptable		good		excellent	
0,6		0,4		0,2		mm

Depth of indentation.

b) The wall provides adequate partial rigidity if a loading of 200 N does not produce a deformation greater than 5 mm. The partial strength (perforation resistance) is evaluated in accordance with the following scale:

	acceptable		good		excellent	
600		1000		1400		1800 N

Loading for perforation.

Remarks

For external walls near the ground, or facing access balconies, etc., the requirements, specified here for its inside face, should apply also to its outside face.

12. ROBUSTNESS

Presupposed wish

The wall shall not be liable to suffer damage when subjected to concentrated dynamic loadings.

Proposed fulfilment

The wall shall provide adequate resistance to minor concentrated dynamic loadings, for example from cleaning utensils, so that it shows no deep indentation marks, nor any perforation.

Testing

a) A dynamic loading of 15 Nm is applied to the inside face of the wall by a steel ball, 50 mm in diameter.
For external walls near the ground, or facing access balconies, etc., the same test is applied to the outside face of the wall. External walls away from the ground, or access balconies, etc., are tested similarly on the outside face by a dynamic loading of 2,5 Nm.
b) A glancing impact of 10 Nm is applied to the inside face of the wall by a serrated pendulum impactor (see SBI Reprint 210).

Evaluation

a) The wall is considered sufficiently robust if the tests only produce marks, but no actual breakage or perforation.
b) The wall is considered sufficiently robust if the test does not produce marks deeper than 1,0 mm. In wet rooms any facing materials, which are intended to prevent water penetrating into hygrosensitive materials behind them, must not be perforated by this loading.

Remarks

Amongst those loadings to which the outside face of an external wall may be subjected, especially near the ground, the following should be mentioned: kicks, ball- games, parking of bicycles and glancing impact from branches.

13. FIXING POTENTIAL

Presupposed wish

The wall shall be capable of supporting typical decorative and utility objects, as well as sanitary fittings and other service installations, if required.

Proposed fulfilment

The inside face of the wall shall be capable of supporting typical decorative and utility objects, as well as sanitary fittings and other service installations, if required.

Testing

a) A uniform eccentric loading of 2000 N/m^2, with an eccentricity of 150 mm, is applied to the inside face of a section of the wall, 1200 - 1800 mm long. x)
b) A handbasin is mounted on the inside face of the wall as prescribed and loaded with a vertical eccentric load of 1500 N, with an eccentricity of 350 mm measured from the surface of the wall.
c) The resistance to axial extraction load and transverse load of fastenings is tested in a tension test apparatus.

Evaluation

a) After 24 hours the wall shall not have become dislodged or show a horizontal deformation of more than 10 mm.
b) There shall be no evidence of detrimental deformation, including any dislodgment, at the fastenings or in the wall.
c) Screws shall be capable of resisting an axial extraction load of not less than 600 N and a transverse load of not less than 1500 N.

Remarks

In situations where objects are required to be fastened to the external face of a wall the tests and evaluations mentioned under a) and c) may be used.

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x) The purpose of the test method is to simulate the loading which may be expected to be transferred to a wall from suspended shelves, filled with books.

14. APPEARANCE

Presupposed wish

The wall shall at any time present an intended appearance.

Proposed fulfilment

a) The surface geometry of the wall shallbe as intended.
b) Any patination shall progress in a uniform manner.
c) No areas of the wall, which have been repaired, shall, after a period of time, show any unintensional visual difference from the remainder of the wall.
d) The wall shall show only slight dirt retension and shall provide good camouflage for dirt.
e) The inside face of the wall shall permit the removal of common forms of dirt by means of simple cleaning methods.

Testing

a), b), c) and d). None.
e) A given quantity of standard dirt is deposited on a section of the wall, using the "fingerprint-method". The wall is subsequently cleaned by means of an apparatus which can simulate various cleaning methods. The cleaning method requiring the minimum effort to remove the dirt is herewith determined. (Test method in preparation).

Evaluation

a), b), c) and d). Subjective evaluation.
e) The wall is evaluated for its cleaning affinity in accordance with the following scale:

	acceptable	good	excellent
Cleaning method.	brush and 1% detergent solution	sponge and 1% detergent solution	sponge and clean water

Remarks

An evaluation of the wall's affinity to cleaning should include an assessment of the cleaning frequency which is considered nescessary and, alternatively, any means of a relatively simple replacement of surfaces (for example, by painting or wallpapering). The final selection may depend on particular intended features of surface structure (texture) and colour of the wall.
Requirements relating to texture may be difficult to formulate, other than by using terms such as: high or low relief - coarse or even - rough or smooth - matt or glossy, etc.
Surface texture and colour therefore will often be judged on the basis of a subjective evaluation.

15. SOUND ABSORPTION

Presupposed wish

The wall shall be able to contribute to the achievement of satisfactory acoustic conditions in the room which it encloses.

Proposed fulfilment

The sound absorbing properties of the wall shall, in conjunction with the sound absorbing properties of other walls, floor, ceiling and furnishings of the room, provide a satisfactory reverberation time.

Testing

The sound absorption coefficient of the wall is calculated on the basis of measurements of the reverberation time in a standardized reverberant enclosure in which the wall forms one surface. (DS/ISO/R 354).

Evaluation

Subjective evaluation on the basis of test results, related to details of the shape, intended use, etc. of the room.

Remarks

BR 72, chapter 9.2.6, items 1 and 2, require that the reverberation time in the frequency range above 500 Hz does not exceed 1,5 second in communal staircases and 0,1 second in communal corridors.
Only on rare occasions will it be reasonable to base the choice of wall type or wall facing material on the need to adjust the reverberation time of the room.

16. COMPATIBILITY

Presupposed wish

The wall and any prefabricated components of which it is assembled shall be designed for general use under differing boundary conditions.

Proposed fulfilment

Wall components should be of modular overall height and length. Details of boundary conditions (jointing solutions) in relation to adjoining assemblies and at salient and re-entrant corners between individual wall components shall be provided.

Testing

None.

Evaluation

Modular sizes, basic sizes and tolerances shall be in accordance with DS 1010.2, DS 1011.3 and DS/R 1050.
Details of boundary conditions (jointing solutions) shall be provided, drawn to a scale and including modular reference lines. The adequacy of boundary details can be roughly evaluated in accordance with the following scale:

acceptable	good	excellent
one set of internal boundary details provided	one set of internal and one set of external boundary details provided	one set of internal and several sets of external boundary details provided

Remarks

BR 72.4.1.4, item 2 stipulates that dwellings erected for leasehold shall be designed in accordance with the principles for dimensional coordination.
The term "internal boundary conditions" refers to the jointing between external wall components belonging to the same assembly. The term "external boundary conditions" refers to the jointing of the external wall to adjoining components, or to the jointing between external wall components from different assemblies.
It may be desirable in certain cases that additional details are provided, indicating possible means of incorporating or fastening services (pipes, brackets, radiators, etc.). In some cases it may be expedient to examine the possible consequences of floors above deflecting more than antipated, thus transferring a certain amount of structural load to the non-loadbearing walls.

17. EASE OF TRANSPORT AND ERECTION

Presupposed wish

Transport (storage) and erection (and demounting, where applicable) of wall components shall require a minimum of manual and mechanical effort and, in addition, shall not give rise to any risk of bodily harm or other form of damage.

Proposed fulfilment

Transport and storage: None.
During erection the sealing of joints between individual wall components and between wall components and adjoining assemblies should be planned as assembly operations without the use of scaffold.

Testing

None.

Evaluation

Jointing solutions can roughly be categorized as follows:

Two-stage solutions, to be executed in one assembly operation

Two-stage solutions to be executed by means of prefabricated components in several operations

Two-stage solutions, to be executed by means of materials prepared or formed on site

Single-stage solutions by means of prefabricated components

Single-stage solutions, to be executed by means of materials prepared or formed on site

should be aimed at

should be avoided

Remarks

Any installation of services impinging on the external wall must be organized so that it can be made to suit the erection sequence.
Any preparatory and/or final installation of services impinging on the external wall should be organized so that it can be executed without the assistance of the erection contractor for the external wall.
In certain situations it is desirable that an external wall or parts of it can be demounted and re-used. In this connection it must be ascertained that easy demountability does not facilitate forced entry.