



THE BUILDING REGULATIONS 2010 – ENGLAND & WALES REQUIREMENT A3 – DISPROPORTIONATE COLLAPSE

Purpose

BCA technical guidance notes are for the benefit of its members and the construction industry, to provide information, promote good practice and encourage consistency of interpretation for the benefit of our clients. They are advisory in nature, and in all cases the responsibility for determining compliance with the Building Regulations remains with the building control body concerned.

This guidance note is based upon information available at the time of issue and may be subject to change. The Approved Documents should be consulted for full details in any particular case.

Introduction

This technical guidance note outlines BCA's interpretation of the disproportionate collapse Requirement A3 of the Building Regulations 2010 as detailed in the 2004 edition of Approved Document A incorporating 2004, 2010 and the 2013 amendments. References are given to Eurocodes, although it is recognized that withdrawn British Standards may still be acceptable (ref. DCLG Circular Letter - 30 July 2013). Where Eurocodes are cited, reference to the relevant UK National Annex applies. The guidance in Section 5 of the Approved Document is supplemented by the additional guidance in Section 2 of this document.

This note was originally written by NHBC and has been adopted by BCA as best practice.

Key Issues

This guidance note has been written by NHBC and adopted by BCA after liaison with the Department for Communities and Local Government (DCLG), whose help is gratefully acknowledged, to cater for specific new build and conversions situations that may typically be encountered by Building Control Bodies, but that are not explicitly dealt with in the Approved Document guidance.

Disproportionate Collapse Guidance for Part A 2004 (incorporating 2004, 2010 and the 2013 amendments)

1. INFORMATION

- a) Requirement A3 is reproduced below:

Disproportionate Collapse

A3. The building shall be constructed so that in the event of an accident the building will not suffer collapse to an extent disproportionate to the cause.

Requirement A3 is mandatory and applies to all buildings. The Requirement is met by an appropriate choice of measures to reduce the sensitivity of a building to disproportionate collapse should an accident occur. The means of achieving this is open to limited interpretation based on risk management principles and each application should be considered on its merits.

- b) **Section 5 of Approved Document A** contains guidance on measures that will meet Requirement A3. This has been developed from commissioned research and consideration of the recommendations given in Eurocode EN1991-1-7:2006 *Actions on structures – Part 1.7: General actions - Accidental actions* with its UK National Annex. The approach adopted is to apply a level of robustness measures appropriate to the Consequence Class of the building. Four classes of building (1, 2a

[lower risk group], 2b [upper risk group] and 3) are listed using building type and occupancy as their defining criteria. The building size and number of storeys are also critical in determining which Consequence Class applies. The guidance states the measures to be provided to ensure sufficient robustness for each Consequence Class.

- c) Compliance with the Building Regulations is the responsibility of the builder. Each building should be considered according to its individual circumstances. **This technical guidance note outlines concepts which, if proposed by a builder or consultant, would be considered by NHBC in principle to meet Requirement A3.** There is no obligation to adopt any particular solution contained in the Approved Document or this technical guidance note if there is a preference to meet the requirement in some other way and compliance can be demonstrated.
- d) It is important that disproportionate collapse provisions are considered in conjunction with other aspects of the building's required performance to avoid conflict.
Note: for all separating walls and separating floors a check is needed to ensure the performance satisfies all the requirements of Building Regulations, such as Part E (Resistance to the passage of sound) and Part L (Conservation of fuel and power).
- e) In addition to the disproportionate collapse issues in Approved Document A and Section 2 of this technical guidance note, PD 6697:2010 *Recommendations for the design of masonry structures to BS EN 1996-1-1 and BS EN 1996-2* draws attention to the need to consider the potential effect of vehicular impact with masonry structures. Where there is a possibility that this could damage or remove vital load-bearing members of the structure, protective measures (such as the provision of bollards or barriers) should be considered. This would apply regardless of the Building Consequence Class in the Approved Document and would apply to all construction types.
- f) Approved Document A Section 5 paragraph 5.4 recognises that alternative approaches to meeting disproportionate collapse requirements may be appropriate to certain buildings. No guidance on interpreting alternative approaches to robustness measures is given in this Technical Guidance Note. However, NHBC's stance on assessment of robustness design philosophies employing an alternative approach following the recommendations given in the publications referenced in paragraph 5.4 is provided in a separate document, 'Assessment of robustness measures following the 'Alternative approach' given in Approved Document A Section 5 paragraph 5.4.'

2. GUIDANCE AND INTERPRETATION

2.1 Robustness measures

- a) **Consequence Class 1 building robustness measures**
Buildings designed in accordance with the guidance for meeting compliance with Requirements A1 and A2 contained in
 - Sections 2 – 4 of Approved Document A (2004 Edition incorporating 2004, 2010 and 2013 amendments), or
 - the documents referenced under Section 1 of Approved Document A (2004 Edition incorporating 2004, 2010 and 2013 amendments) are considered to provide designs that have adequate robustness to meet Requirement A3 for Consequence Class 1 buildings.

Section 2 of Approved Document A gives sizes of structural elements for certain residential buildings and other small buildings of traditional masonry and timber construction. Note: the guidance relating to thickness of walls and other general stability considerations is contained in Section 2C and applies to residential buildings of not more than 3 storeys.

Example 1:

Up to and including 3-storey houses of masonry construction

Apply:

- Consequence Class 1 robustness measures, provided by design and construction in accordance with Sections 2 – 4 of Approved Document A.

Example 2:

4-storey houses of masonry construction

Apply:

- Consequence Class 1 robustness measures, provided by design and construction in accordance with Sections 2 – 4 (**excluding Section 2C, which applies exclusively to residential buildings of not more than 3-storeys, small single-storey non-residential buildings and small annexes and outbuildings to residential buildings**) of Approved Document A, PD 6697:2010 *Recommendations for the design of masonry structures to BS EN 1996-1-1 and BS EN 1996-2*, and other references in Section 1 of Approved Document A.

Consequence Class 1 buildings include “*Buildings into which people rarely go...*”. This is intended to cater for buildings such as plant rooms, sub-stations and storage warehouses.

b) Consequence Class 2a building robustness measures

The robustness measures required for Consequence Class 2a buildings consist of the robustness measures for Consequence Class 1 buildings and, in addition

- effective horizontal ties, **or**
- effective anchorage of suspended floors to walls

in accordance with the Codes and Standards referenced in Section 5 of Approved Document A, paragraph 5.2.

In the case of masonry wall construction, the connection details in Clause 6.1.2 of PD 6697:2010 *Recommendations for the design of masonry structures to BS EN 1996-1-1 and BS EN 1996-2* may be assumed to provide effective anchorage of suspended floors to walls where:

- straps or restraint type joist hangers are provided at the spacing specified for the building type and occupancy under consideration (see (i) below); **or**
- a precast concrete plank floor, precast concrete beam and block floor or in-situ concrete floor spanning on to a wall has a bearing 90 mm or one-half the thickness of the wall or inner leaf of a cavity wall, whichever greater; **or**
- a precast concrete plank floor or in-situ concrete floor spanning parallel to a wall is effectively built into the wall (see (v) below).

Attention is drawn to the following:

- i) Where provided, anchors (i.e. straps or restraint type hangers) should be at intervals of not more than 2 m in houses of not more than 3 storeys and not more than 1.25 m for all storeys in all other buildings. This means, for example, that 2-storey flats would require anchors at 1.25 m intervals.
- ii) Galvanised mild steel anchors having a cross section of 30 mm x 5 mm may be assumed to have adequate strength for Consequence Class 2a buildings.
- iii) Where timber joists run parallel to the wall straps should be carried over and secured to at least three joists.
- iv) Floors (timber and concrete) abutting internal walls should be anchored at intervals as noted in (i) above.
- v) For effective anchorage of a precast concrete plank floor or in-situ concrete floor spanning parallel to a wall, the “built-in width” should not be less than 90mm or one-half the thickness of the wall or inner leaf of a cavity wall, whichever is greater. In addition, for a precast concrete plank floor, the built-in plank should:
 - be fully bedded on wet mortar extending to the full built-in width of the floor, taking account of any pre-camber, and
 - extend a minimum distance of 800 mm from the inner face of the wall. Where floors are built in but these conditions are not met or workmanship is unsatisfactory (e.g. due to the method of placement of the planks), effective anchorage should not be assumed and anchors are required at intervals as noted in (i) above. These should be located **either** on top of the floor in which case they should turn up the cavity, **or** on the underside of the floor in which case they should turn down the cavity.

Example 3:

4-storey flats of masonry construction

Apply:

- **Consequence Class 2a** robustness measures, provided by design and construction in accordance with PD 6697 *Recommendations for the design of masonry structures to BS EN 1996-1-1 and BS EN 1996-2*, including anchorage of suspended floors to walls using the details in Clause 6.1.2 of PD 6697 (see also 2.1(b)(i) above) or other details providing equivalent or better anchorage.

c) Consequence Class 2b building robustness measures

The robustness measures required for Consequence Class 2b buildings consist of the robustness measures for Consequence Class 1 buildings and, in addition

- effective horizontal ties **and** effective vertical ties in all supporting columns and walls (both in accordance with the Codes and Standards referenced in Section 5 of Approved Document A, paragraph 5.2), **or alternatively**
- checks can be made that upon the notional removal of supporting elements the building remains stable and that the risk of collapse does not exceed limits stated in Section 5 of Approved Document A, paragraph 5.1d. Where these limits are exceeded the relevant member should be designed as a “key element” as defined in Section 5 of Approved Document A, paragraph 5.3.

d) Consequence Class 3 building robustness measures

The robustness measures required for Consequence Class 3 buildings should be determined after a systematic risk assessment has been undertaken in accordance with Section 5 of Approved Document A, paragraph 5.1e. (In addition, the ISE ‘*Manual for the systematic risk assessment of high-risk structures against disproportionate collapse*’ pub. October 2013 provides useful guidance for Consequence Class 3 buildings.)

Note: The UK National Annex to BS EN 1991-1-7:2006 *Action on structures - Part 1.7: General actions - Accidental actions* (Clause NA.3.1 Design for consequences of localized failure in buildings from an unspecified cause) states that the nationally determined values for minimum horizontal tie forces in the case of lightweight building structures (e.g. those whose primary structure is timber or cold formed thin gauge steel) in expressions A.1 (internal ties) and A.2 (perimeter ties) should be taken as 15 kN and 7.5 kN respectively.

2.2 Determining the number of storeys in a building

In determining the number of storeys in a building:

- i) some small areas may justifiably be excluded provided they do not significantly increase either the chance of an accident occurring or the extent of damage that would arise from an accident. Examples include the following provided the total area of each is not more than 20% of the plan area of the building or 20m², whichever is the **smaller**:
- light structures or service housings above the main roof level
 - mezzanine and gallery floors and similar habitable accommodation.

Note: common areas should not be excluded under this category.

- ii) a basement storey may be excluded provided that it fulfills the robustness requirements of Consequence Class 2b buildings. To qualify as a basement storey, the distance between external ground level and the top surface of the basement floor should be at least 1.2m for a minimum of 50% of the plan area of the building. See also 2.5, which includes examples.

Note: this exclusion may only be applied to buildings that include a single basement storey. When a structure contains multiple basement storeys, a systematic risk assessment should be undertaken in accordance with Section 5 of Approved Document A, paragraph 5.1e and Consequence Class 3 robustness measures incorporated as appropriate.

- iii) ground floor storeys should be included unless a case, satisfactory to the Building Control Body, can be made for their exclusion. For example, it may be possible to justify exclusion of a ground floor storey of in situ reinforced concrete construction where all its structural elements (including connec-

tions) are designed as key elements in accordance with the relevant guidance in Approved Document A paragraph 5.3 and consideration is given to the risk to the structural elements, such as from vehicle impact damage.

Note: a ground floor storey should not be excluded where the basement storey has already been excluded.

iv) habitable areas of roof space should be included as a storey irrespective of the slope of the roof.

2.3 Buildings with varying numbers of storeys

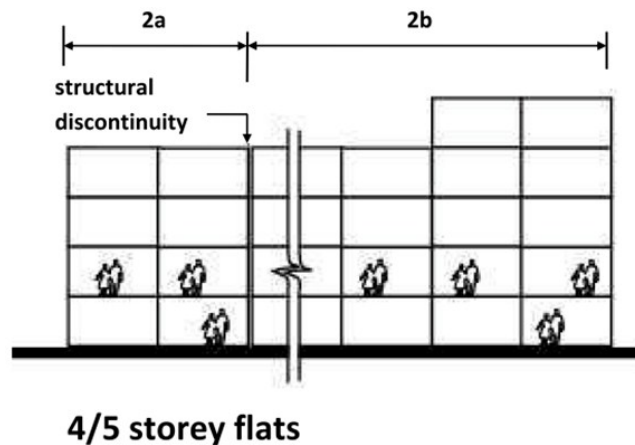
For buildings with varying numbers of storeys that fall into more than one Consequence Class, the robustness measures for the more onerous Consequence Class may need to continue until a structural discontinuity (that provides structural robustness separation between building parts) is achieved. However, each case should be considered on its merits. This is the case even where the only areas of more onerous Consequence Class are common parts such as stairwells.

Example 4:

Block of flats partly 4 storeys and partly 5 storeys.

Apply:

- **Consequence Class 2b** robustness measures to the 5-storey areas and extending to a suitable structural robustness discontinuity in the 4-storey area and **Consequence Class 2a** robustness measures to the remaining 4-storey areas.



2.4 Buildings of mixed occupancy

For buildings intended for more than one type of use, the Consequence Class should be that pertaining to the most onerous type.

Example 5:

1 storey educational use (e.g. nursery) over 2 storeys of flats should be taken as an educational building of 3 storeys

Apply:

- **Consequence Class 2b** robustness measures to the whole of the building.



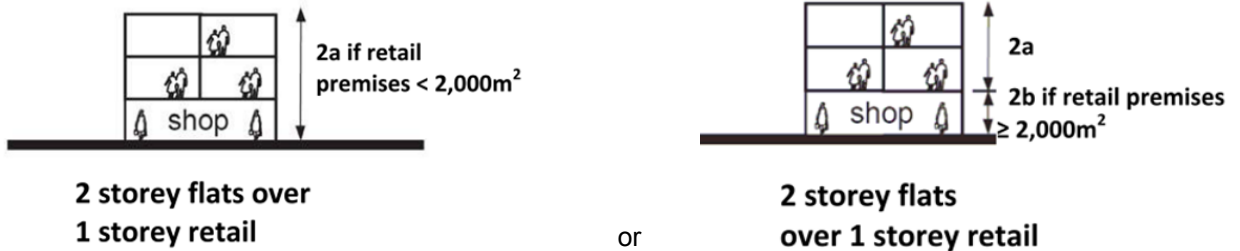
However, where the upper storeys are of less onerous Consequence Class than the lower floors, robustness measures to storeys may vary, as shown in example 6.

Example 6:

2 storeys of flats over 1 storey of retailing premises.

Apply:

- **Consequence Class 2a** robustness measures to the whole building if floor area of retail premises is less than 2000m², or
- **Consequence Class 2b** robustness measures to the lowest storey if floor area of retailing premises is 2000m² or more and **Consequence Class 2a** robustness measures to the remaining two residential storeys.



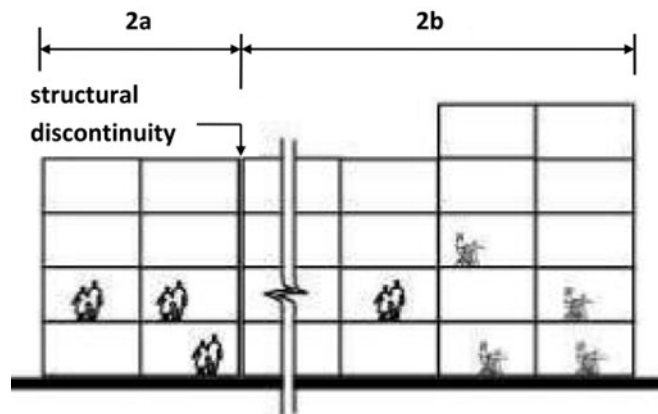
Where different occupancies are in horizontally adjacent parts of the same building, the same approach to robustness measures may be adopted as described in 2.3 above for buildings with varying numbers of storeys. i.e. the robustness measures for the more onerous Consequence Class may need to continue horizontally until a structural robustness discontinuity is achieved. Each case should be considered on its merits.

Example 7

4 storeys of flats adjacent to (same building) 5 storeys of offices

Apply:

- **Consequence Class 2b** robustness measures to the 5-storey office area and extending to a suitable structural discontinuity in the 4-storey residential area and **Consequence Class 2a** robustness measures to the remaining 4-storey residential area.



4 storey flats attached to 5 storey offices

2.5 Buildings above basements

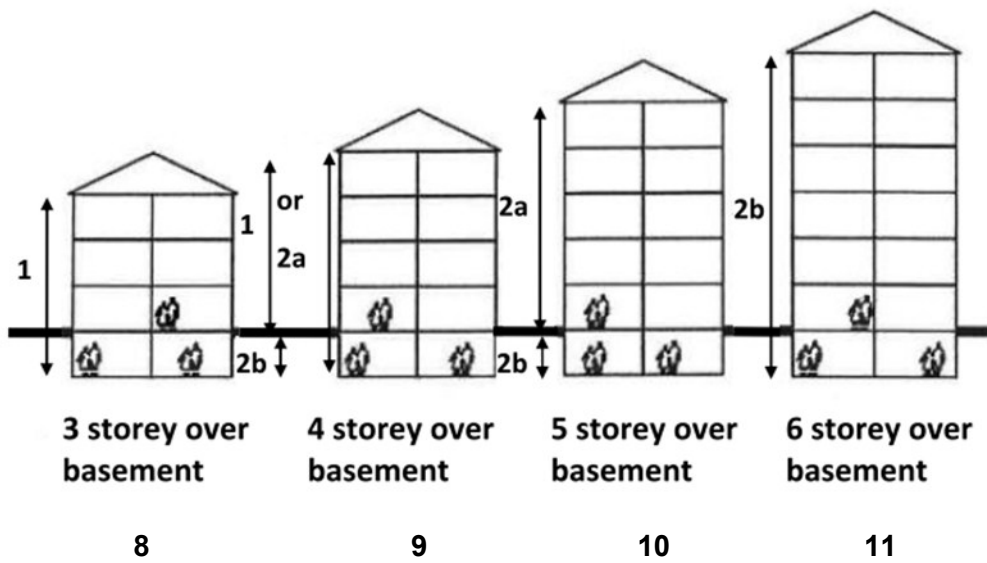
Refer to 2.2 (ii) above. The minimum robustness measures required to the part of the building above the basement depend on the total number of storeys and the robustness measures applied to the basement storey. The following examples illustrate the appropriate robustness measures to be applied where a single basement level is required.

Examples 8 - 11:

Single occupancy houses over basements

Apply:

- Classes of robustness measures shown in the sketches below

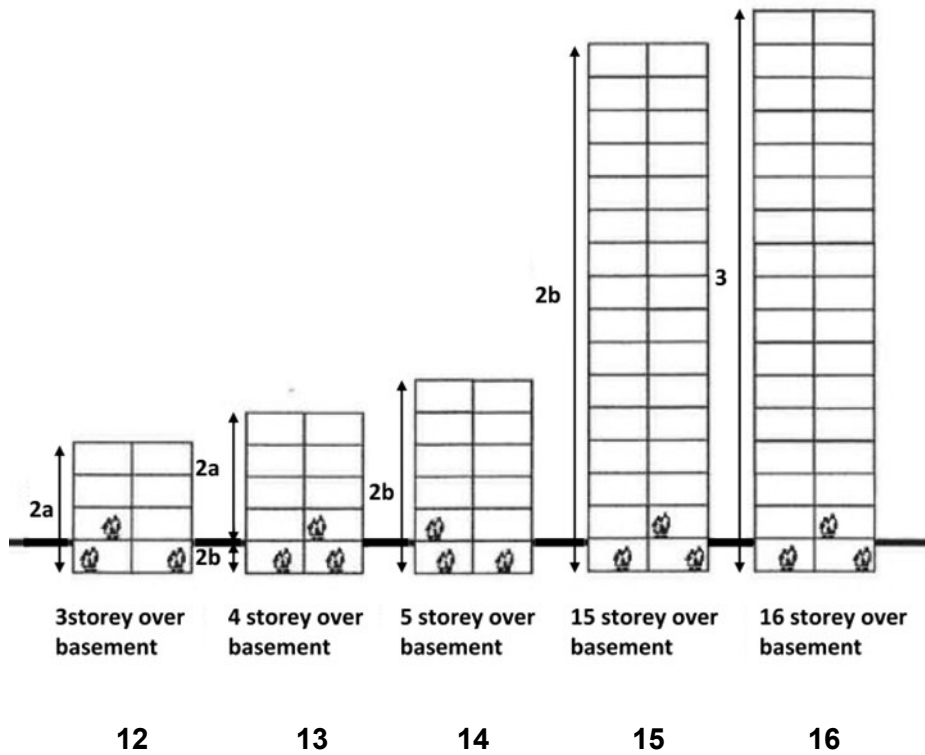


Examples 12 - 16:

Flats above basements

Apply:

- Classes of robustness measures shown in the sketches below



2.6 Conversions, alterations and extensions (i.e. existing buildings – change of use and/or building work)

The application of Requirement A3 is dependent on consideration of the following aspects of the project, as defined in The Building Regulations:

- i. *material change of use* of the building
- ii. *building work* to be undertaken.

i. Material change of use

Regulation 5 states that: *there is a material change of use where there is a change in the purpose for which, or the circumstances in which, a building is being used, so that after the change*

- a) *the building is used as a dwelling, where previously it was not;*
- b) *the building contains a flat, where previously it did not;*
- c) *the building is used as a hotel or a boarding house, where previously it was not;*
- d) *the building is used as institution, where previously it was not;*
- e) *the building is used as public building, where previously it was not;*
- f) *the building is not a building described in Classes I to VI in Schedule 2, where previously it was (i.e. it was previously exempt);*
- g) *the building, which contains at least one dwelling, contains a greater or lesser number of dwellings than it previously did;*
- h) *the building contains a room for residential purposes where previously it did not;*
- i) *the building, which contains at least one room for residential purposes, contains a greater or lesser number of such rooms than it did previously; or*
- j) *the building is used as a shop, where previously it was not.*

Where a material change of use takes place, **Regulation 6** requires works to be carried out to ensure compliance with A3, but only in the case of categories (c), (d), (e), and (f) above. Similar works are not required due to a change of use involving categories (a), (b), (g), (h), (i) or (j), **but additional works and/or checks on the structure may be necessary where “building work”** is being undertaken (see (ii) below).

ii. Building work

For the purpose of possible implications for A3, “*building work*” means:

- the extension of a building, including construction of additional storeys, or
- the material alteration of a building.

An alteration is “*material*” if the work would at any stage result:

- in a building not complying with A3 where previously it did, or
- in a building, which before the work commenced did not comply with A3, being more unsatisfactory in relation to A3.

Regulation 4 requires that:

- the building work shall be carried out so that it complies with A3, and
- after the work has been completed, the whole building which is extended or to which a material alteration is made, complies with A3 or, where it did not previously comply with A3, is no more unsatisfactory in relation to A3 than before the work was carried out.

Note: a building whose Consequence Class increases during the course of building work, is likely to be less satisfactory in relation to A3 after the work because the change in Consequence Class brings with it a requirement for a higher level of robustness measures for the building.

Example 17: **5-storey house converted to 5-storey hotel.**

Regulation 5 material change of use category (c) applies

Regulation 6 **requires** work to be carried out to ensure compliance with A3.

Apply:

- **Consequence Class 2b** robustness measures to the whole building

Example 18: 4-storey house converted to 4-storey flats. No extension to the building. Consequence Class changes from CC1 to CC2a. In this example, checks undertaken on the structure indicate that the alteration works will not result in a 'material alteration' of the building. Therefore, no 'building work' undertaken (see (ii) above).

Regulation 5 material change of use category (b) or (g) applies

Regulation 6 **does not require** work to be carried out to ensure compliance with A3

AND

Regulation 4 **does** apply, but as checks on the whole structure revealed no material alteration of the building, it does not require additional works to ensure compliance with A3. (i.e. either the existing building previously complied with A3 and it still complies after completion of the work, or, if it did not previously comply, it is no more unsatisfactory in relation to A3 after completion of the work.)

Apply:

- **Consequence Class 2a** robustness measures to the whole building.

Example 19: 4-storey house converted to 4-storey flats. No extension to the building. The Consequence Class of the building after completion of the works increases from CC1 to CC2a. In this example, checks undertaken on the structure indicate that the alteration works will result in a 'material alteration' of the building. Therefore, 'building work' undertaken (see (ii) above).

Regulation 5 material change of use category (b) or (g) applies

Regulation 6 **does not require** work to be carried out to ensure compliance with A3,

BUT

Regulation 4 does apply and **will require** work to be carried out to ensure that, after the work has been completed, the whole building either:

- still complies with A3 if it previously did, or
- it is no more unsatisfactory in relation to A3 if it previously did not.

Apply:

- **Consequence Class 2a** robustness measures to the whole building.

Example 20: 3-storey flats extended to 4-storey flats. Building extended by an additional storey, therefore 'building work' undertaken (see (ii) above). The Consequence Class of the building after the work is the same as it was before. In this example, checks undertaken on the structure indicate that the alteration works will result in a 'material alteration' of the building.

Regulation 5 material change of use category (g) applies

Regulation 6 **does not require** work to be carried out to ensure compliance with A3,

BUT

Regulation 4 does apply and **will require** the 'building work' to be carried out so that it complies with A3. Furthermore, it **does require** checks on the whole structure and **will require** work to be carried out to ensure that, after the work has been completed, the whole building either:

- still complies with A3 if it previously did, or
- is no more unsatisfactory in relation to A3 if it previously did not.

Apply:

- **Consequence Class 2a** robustness measures to the new storey and check that if the existing building previously complied with A3 it still complies after the work, or, if it did not previously comply, the work does not involve alterations resulting in the existing structure being more unsatisfactory in relation to A3.

Example 21: 4-storey flats extended to 5-storey flats. Building extended by additional storey, therefore 'building work' undertaken (see (ii) above). The Consequence Class of the building after completion of the works increases from CC2a to CC2b. In this example, checks undertaken on the structure indicate that the alteration works will result in a 'material alteration' of the building.

Regulation 5 material change of use category (g) applies

Regulation 6 **does not require** work to be carried out to ensure compliance with A3,

BUT

Regulation 4 **does** apply and **will require** the 'building work' to be carried out so that it complies with A3. Furthermore, it **does require** checks on the whole structure and **will require** work to be carried out to ensure that, after the work has been completed, the whole building complies with A3.

Apply:

- **Consequence Class 2b** robustness measures to the **whole building**.

The Consequence Class of the building after the work is higher than it was before. Therefore the robustness measures required for the building as a whole are greater and so potentially it is more unsatisfactory in relation to A3 than before the work was carried out.

Notes:

Examples 18 & 19 are alternative scenarios for conversion to two similar buildings, intended to illustrate the application of Requirement A3 due to building work that respectively will not and will include 'material alteration' of the building.

Examples 19, 20 & 21 are intended to illustrate the application of Requirement A3 due to building work rather than a material change of use. However, the results would be the same if the examples combined a change of use involving categories (a), (b), (g), (h), (i) or (j), such as a warehouse being converted to flats, with the extended number of storeys.

