



Technical Guidance Document TGD-021-6

Structural Guidelines Disproportionate Collapse, Horizontal Tie, Vertical Tie and the Requirements in the Building Regulations

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1. INTRODUCTION

1.1 Purpose of this Document

- (a) This document provides guidance to Design Teams and School Authorities on structural issues relating to disproportionate collapse, horizontal tie, vertical tie and the requirements in the Building Regulations TGD Part A 2012.

1.2 Application of these Guidelines

- (a) The guidelines are applicable to all Educational Facilities.
- (b) Other Relevant Guidance Documents
- (c) The following guidelines should be read in conjunction with the Building Regulations Part A 2012 and Eurocodes including IS EN 1991-1-7.

1.3 Definitions

- (a) For the purpose of this document the term School Authority means the Board of Management or other body legally entrusted with the management of the School.
- (b) A Design Team refers to all the professional advisors engaged by the School Authority for the project.

1.4 Further Information

- (a) For further advice on these or any other matter, please contact:

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2. TECHNICAL GUIDANCE

2.1 Introduction

- (a) All buildings must be designed in accordance with the relevant Eurocodes IS EN 1990 -1999, and in accordance with the current Building Regulations Technical Guidance Documents (TGD) Parts A - M.
- (b) Building Regulations TGD Part A 2012 is to be implemented from 1st July 2013 and has been updated from the previous version in relation to designing for disproportionate collapse to be consistent with the Eurocodes
- (c) Transitional Arrangements; This document applies to works, or buildings in which material changes of use takes place, where the works or the change of use commence or take place, as the case may be, on or after 1 July 2013. Technical Guidance Document A - Structure, dated 1997 also ceases to have effect from that date. However, the latter document may continue to be used in the case of works, or buildings in which a material change of use takes place where the works or the change of use commence or takes place, as the case may be, before 30 June 2013.
- (d) All buildings must be designed to accommodate unforeseen or accidental actions in such a way as to prevent the extent of any resulting collapse being disproportionate to the cause of the collapse.
- (e) Buildings should be designed so that they are robust, which is defined in IS EN 1991-1-7 - Accidental Actions as “ the ability of a structure to withstand events like fire, explosions, impact or the consequences of human error, without being damaged to an extent disproportionate to the original cause.”
- (f) All buildings are divided into different categories or consequence classes in both of IS EN 1991-1-7 and Building Regulation TGD Part A 2012, which should be referenced for further details.
- (g) Educational buildings are categorised as follows:
 - (i) Consequence Class 2A: Single storey educational buildings.
 - (ii) Consequence Class 2B: Educational buildings greater than single storey but not exceeding 15 storeys.

2.2 Recommended Strategies

- (a) **Existing Buildings**
 - (i) In the case of material alterations or changes of use of existing buildings, the guidance should be applied in a pragmatic way to ensure the necessary robustness is achieved in a cost-effective manner with minimum modifications to the building. In particular, the application of guidance intended for application to new work to existing buildings without full considerations of the alternatives may be unduly restrictive or impracticable. Buildings of architectural or historical interest are especially likely to give rise to such circumstances. In these situations, alternative approaches based on the principles contained in the document may be more relevant and should be considered.
- (b) **New Buildings**
 - (i) Recommended strategies to ensure that buildings are sufficiently robust to sustain localised failure without a disproportionate collapse are as follows:

(ii) **Class 2A buildings:**

- 1st Provide effective horizontal ties, or effective anchorage of suspended floors to walls, for framed and load bearing wall construction as defined in the codes and standards.

(iii) **Class 2B buildings:**

There are three methods by which the robustness requirements may be satisfied for Class 2B buildings and for the avoidance of disproportionate collapse:-

- 1st Provide effective horizontal ties, together with effective vertical ties in all supporting columns and walls for framed and load bearing wall construction as defined in the Eurocodes and Irish National Annex Building Regulation Part A 2012.
- 2nd Check that upon the notional removal of a supporting column or a beam supporting one or more columns or any nominal section of load bearing wall (one at a time in each storey of the building) that the building remains stable and that the area of floor at any storey at risk of collapse does not exceed 15% of the floor area of that storey or 100 m², whichever is smaller, and does not extend further than the immediate adjacent storeys.
- 3rd Where the notional removal of such columns and sections of walls (or beams supporting one or more columns) would result in an extent of damage in excess of the above limit, then such elements should be designed as key elements.

As with existing buildings, it is anticipated that the Designer will consider the alternative approaches based on the principles contained in such a manner as to meet the standard required in a practical cost-effective manner. In the case of buildings of load-bearing wall construction, the notional removal of a section of wall, one at a time, is likely to be the most practical strategy to adopt.

It is possible to mix methods within the same building, i.e. a building may generally satisfy the tying method but deal with local areas that do not satisfy the tying method by applying the notional removal or key element methods. The designer must still ensure that the structure is horizontally robust in both directions, which is generally achieved by providing horizontal ties.

2.3 Horizontal and Vertical Ties

- (a) The requirements for horizontal and vertical ties are given in IS EN 1991-1-7, A.5 and A.6.
- (b) Most traditional masonry receives its stability by being buttressed and by being load bearing.
- (c) Lateral bending resistance in the transverse direction can be boosted by incorporating bed joint reinforcement and this might be used as an emergency span system to justify wall survival.
- (d) The traditional cellular plan form of masonry structures offers inherent robustness if all the vertical and horizontal elements are interconnected and if sensible traditional practice with regard to wall end returns is deployed.
- (e) Where sufficient vertical loading is available, shear or frictional resistance can be relied upon to provide the horizontal tie force. However the provision of the complementary vertical ties can be practically difficult and can only be achieved within masonry voids if the wall has a minimum thickness of 150mm. As an alternative, discrete concrete columns (ties) can be formed in the wall space. The use of full storey height steel straps or steel sections (e.g. wind posts) as vertical ties is also possible.
- (f) Whatever the form of vertical ties used, they must be taken down to the foundations and securely fixed there, or alternatively taken down to a level below which the vertical elements can be shown to function as key (protected) elements. Vertical ties must be effectively restrained horizontally at each floor level.
- (g) Robustness can therefore be achieved by various methods which will satisfy the relevant Eurocodes, the building regulations and the Architects and Engineers requirements.
- (h) The risk level and accidental actions that should be considered when undertaking the structural design of a building for disproportionate collapse should be in accordance with the recommendations of I.S. EN 1991-1-7 or the method set out in the Irish National Annex (Building Regulations TGD Part A 2012). Other additional material specific requirements may be outlined in I.S. EN 1992-1-1 to I.S. EN 1996-1-1 and I.S. EN 1999-1-1. Any reference to Eurocodes must be taken to include the relevant Irish National Annex (Building Regulations TGD Part A 2012).