SITE SAFE

STRUCTURAL TIMBER ASSOCIATION

Building solutions in timber

Design guide to separating distances during construction, Part 4

For CLT type frame buildings

Version 1.1 - November 2014

Thanks to KLH and Binderholz for their support

KLH UK

binderholz

tiptop timber

Who is the guidance for?

This is a design guide for design professionals and construction managers for the approach to design appropriate risk mitigation where appropriate for CLT buildings.

The construction applications of structures relevant to this paper are buildings such as houses, flats, schools, sports halls and civic centres.

Product types covered by Category CLT are Cross laminated Timber panels, and other panels made of solid timber elements bonded together to be at least 60mm in the thickness of the panel and where the envelope of the room comprises the same minimum CLT product.

The rooms are constructed using walls and ceilings/floors of CLT and similar products or non-combustible products.

Authoritative guidance

Structural Timber Association (STA,) supported by KLH and Binderholz, have derived an approach to the risk mitigation for a category of building construction named Category CLT.

The STA have worked with the CFOA timber frame working group which includes representation by HSE, NHBC, FBU, LFB, FPA and DCLG to provide industry feedback on the concerns relating to the spread of fire in buildings under construction.

The KLH and Binderholz products have been tested by BRE and witnessed by HSE. The results of the tests have informed and provided data from which the STA have derived a calculation approach which has been peer reviewed. The tables in this guidance are those generated by the STA calculation process.

This guidance is written by Martin Milner for the STA with drawings and artwork by An Ideal World. The work has been technically supported by KLH and Binderholz.

CLT is short for Cross Laminated Timber. There are other forms of solid wood construction which the category referred to as CLT also covers. Products can be tested to show they perform in the same manner as the KLH and Binderholz CLT products used in the development of this guidance.

Image 1 - CLT walls and floors during construction

Transverse planks Longitudinal planks

Figure 1 - CLT product

Image 2 - CLT wall slabs

Image 3 - Multi storey CLT frame

Need to consider off-the-site impacts of construction site fires

For all construction projects, regardless of the material content, an off-the-site risk assessment for buildings is required to satisfy the requirements of HSG 168 and CDM responsibilities. Off-the-site is defined as buildings that fall outside the contractor's responsibility. For timber frame structures, the fire service and the HSE has an increased concern of potential rapid fire spread with consequential life safety risks for persons not involved in the construction project i.e. off-the-site. An off-the-site fire risk assessment is for life safety outside of the contractor's site boundary. The use of safe separation distances from the new build to the existing neighbouring structures is an appropriate method to fulfil the CDM requirements.

An on-the-site fire risk assessment to cover safe escape routes for the Contractor's workforce and site strategies to minimise the opportunity for fire to occur within the site is also required. The use of separation distances can be adopted on the site but this is not a regulatory requirement and such review is outside the scope of this paper.

For the completed building the Building Regulations requirements, and specific client specifications, will address the in-service fire resistance and reaction to fire requirements. These in service fire resistance specifications are outside of the scope of this guidance.

STA Site Safe guidance documents

Design guide to separation distances for timber frame buildings during the construction process V2.1, 2011, Parts 1,2 and 3

Originally released by the STA in 2011 the STA design guide is endorsed by the HSE and CIREG (Construction Insurance Risk Engineering Group). Readers of this guidance should consult the document to understand the background to safe separating distances during the build process. The original design guide introduced 3 categories of timber frame construction:

Part 1 - Background and introduction

Part 2 - Standard timber frame and construction process mitigation process mitigation measures. This section provides separation tables for Category A (standard timber building system) walls, floors and flat roofs.

Part 3 - Timber frame build methods to reduce the separating distances. This section provides separation tables for Category B (reduced fire spread) walls, floors and flat roofs, plus Category C (fire spread resistant) walls, floors and flat roofs.

This guidance, Part 4 - CLT frame build methods to reduce the separating distances

This document compliments the original design guidance by forming Part 4 to include solid wood frame constructions and introduces a new Category CLT (robust internal fire resistant) walls, floors and roofs.

See note on page 2 regarding CLT construction.

STA 16 Steps guidance

The 2014 edition of the STA 16 Steps to fire safety during the construction process has been updated to include Category CLT structures. The 16 Steps guidance deals with on-the-site fire risk mitigation for STA members. This design guide, Part 4, addresses off-the-site fire risk mitigation.

Off-the-site and on the site risk mitigation

Cause of the fire

The cause of the fire and initial growth of the fire is not covered by this guidance and it is assumed that a full fire has developed (for enclosures this is taken as a post flashover condition). The focus of this guidance is radiant heat from the emitter to the receiver.

Safe distances

To determine the safe separating distances for buildings constructed from CLT to neighbouring buildings the following shall has been determined:

1 The acceptance criteria for radiant heat on the receiver i.e. the neighbouring building being considered

2 The emitter radiant heat flux that can be taken from the elevation of the new CLT building being considered

3 The method of calculating the amount of radiant heat flux being received by the elevation of the neighbouring building being considered.

Acceptance criteria for heat transfer to neighbouring buildings

The receiver building can be variable with numerous types of materials, the acceptance criteria is 12.6 $kW.m^2$

It is pointed out however, that the user of this guidance shall consider the safe escape from neighbouring properties of its occupants. The guidance assumes that there are alternative escape routes for persons who are in buildings that fall outside the site boundary. If there is only a single escape route and it is in direct line of the new building, then risk mitigation is required. The use of a 2.5 factor on the tabled values can be adapted, or a fire risk assessment undertaken by a competent person.

Separating distances for robust internal Category CLT fire resistant walls, floors and roofs

Product and building form

The building structure is taken as having the walls, floors, ceilings to floors constructed in CLT. These may be covered with other products including additional fire risk mitigation elements such as non-combustible materials (Euro Class A1 and A2) and insulation materials (see STA Product Paper 2 for FI insulation - references cover rigid foams and mineral wools). The height of the building is not limited, but for practical purposes the tables in this guidance are restricted to 8 storey levels. Outside of these limits you should consult with the building system supplier for advice and or engage a competent fire risk assessment engineer and use of the STA guidance on fire engineering calculations for CLT structures.

Product STA website listing

All products listed on the STA website have been assessed and tested for compliance with the data needed to produce the separating distance tables for each relevant category of structural timber building method. Included in the STA website list are CLT framing systems that have been suitably tested for acceptance in the Category CLT, for use in Part 4 guidance tables.

Separation distances for CLT buildings

The following tables provide safe separation distances for a set of conditions:

Series 1 tables - for average storey heights up to 3m, for example hotels, dwellings and flats

Series 2 tables - for average storey heights up to 4m, for example schools up to three storeys

Series 3 tables - for single storey heights up to 6m and 7m, for example gymnasiums, supermarkets, halls, atrium.

In each of the tables the upper limit of percentage area of openings, emitter length (eL) and number of storeys is given. The number of storeys is the actual number of CLT storeys, which may be less than the building if podium slabs are used. See the following sections for explanations for calculating the emitter length and percentage area of openings.

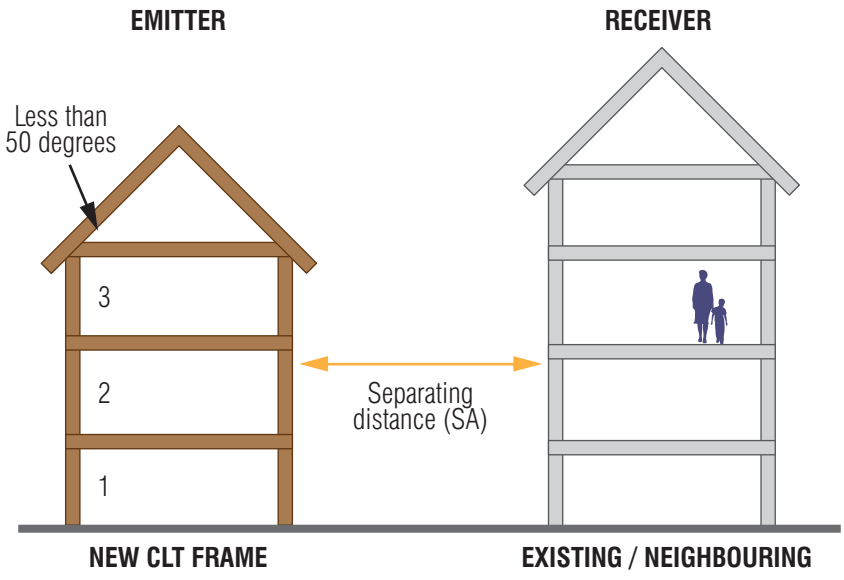


Figure 2 - Separation distance concept in section

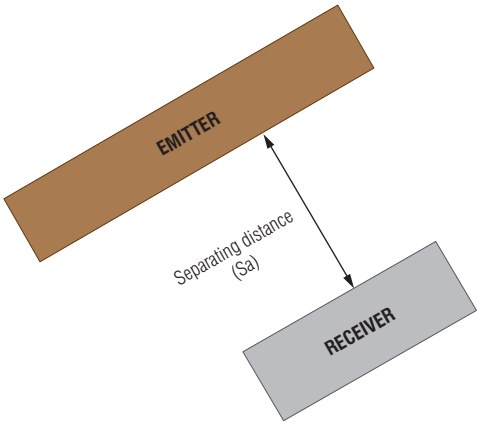


Figure 3 - Separation distance concept on plan

Separation distances tables for Category CLT

The use of these tables assumes that the emitter length has been correctly selected and that the ratio of openings on the elevation being considered has been calculated. See the following section on determining the emitter length and percentage openings. The tables assume also that the façade is vertical and does not slope outwards as such conditions would alter the fire spread and the tables would be invalid.

Note that the separation distance (Sd) is limited to 5m to avoid flame impingement from a façade or opening under wind conditions. When distances closer than 5m are required, then there are to be no openings in the emitter length being considered, or openings are to be temporarily covered using euro class A1 or A2 fire boards.

Separating distances series 1
Buildings with up to 3m average floor to ceiling height

Use of the tables is explained on pages 13-17 of this document. For buildings not included within the tables, a fire engineer should be consulted and a review undertaken.

Number of storeys	Emitter length (eL) in metres					
	≤ 5	≤ 10	≤ 15	≤ 20	≤ 25	≤ 30
1	5.0	5.0	5.0	5.0	5.0	5.0
2	5.0	5.0	5.0	5.6	6.2	6.7
3	5.0	5.0	5.5	6.3	7.0	7.6
4	5.0	5.0	6.0	6.9	7.7	8.4
5	5.0	5.0	6.2	7.1	7.9	8.6
6	5.0	5.1	6.3	7.2	8.0	8.7
7	5.0	5.1	6.3	7.3	8.1	8.9
8	5.0	5.2	6.4	7.4	8.2	9.0

Table 1 - 5% to 20% openings per emitter length and 3m height

Number of storeys	Emitter length (eL) in metres					
	≤ 5	≤ 10	≤ 15	≤ 20	≤ 25	≤ 30
1	5.0	5.0	5.9	6.6	7.1	7.5
2	5.0	6.0	7.3	8.2	9.0	9.7
3	5.0	6.5	7.9	9.0	10.0	10.7
4	5.0	7.0	8.5	9.8	10.8	11.7
5	5.0	7.3	9.0	10.3	11.3	12.3
6	5.0	7.5	9.1	10.5	11.5	12.5
7	5.1	7.6	9.3	10.6	11.8	12.7
8	5.2	7.7	9.4	10.8	11.9	12.9

Table 2 - 20.1% to 30% openings per emitter length and 3m height

Separating distances series 1 cont.../

Number of storeys	Emitter length (eL) in metres					
	≤ 5	≤ 10	≤ 15	≤ 20	≤ 25	≤ 30
1	5.0	7.2	8.7	9.8	10.6	11.2
2	5.7	8.3	10.0	11.3	12.4	13.3
3	6.0	8.8	10.7	12.1	13.3	14.3
4	6.3	9.2	11.3	12.9	14.2	15.3
5	6.7	9.8	12.0	13.7	15.1	16.3
6	6.8	10.0	12.2	14.0	15.4	16.6
7	6.9	10.2	12.5	14.2	15.7	17.0
8	7.0	10.3	12.7	14.5	16.0	17.3

Table 3 - 30.1% to 40% openings per emitter length and 3m height

Number of storeys	Emitter length (eL) in metres					
	≤ 5	≤ 10	≤ 15	≤ 20	≤ 25	≤ 30
1	6.4	9.2	11.1	12.4	13.5	14.3
2	7.1	10.2	12.3	14.0	15.3	16.3
3	7.5	10.7	13.0	14.8	16.2	17.4
4	7.8	11.2	13.6	15.5	17.1	18.4
5	8.3	12.0	14.6	16.6	18.3	19.7
6	8.4	12.2	14.8	16.9	18.7	20.1
7	8.6	12.4	15.1	17.3	19.0	20.5
8	8.7	12.6	15.4	17.6	19.4	20.9

Table 4 - 40.1% to 50% openings per emitter length and 3m height

Separating distances series 1 cont.../

Number of storeys	Emitter length (eL) in metres					
	≤ 5	≤ 10	≤ 15	≤ 20	≤ 25	≤ 30
1	7.6	10.7	12.7	14.3	15.5	16.5
2	8.3	11.7	14.0	15.8	17.3	18.5
3	8.6	12.2	14.7	16.6	18.2	19.6
4	9.0	12.7	15.3	17.4	19.1	20.6
5	9.6	13.6	16.4	18.7	20.5	22.1
6	9.8	13.9	16.7	19.0	21.0	22.6
7	9.9	14.1	17.1	19.4	21.4	23.0
8	10.1	14.4	17.4	19.8	21.8	23.5

Table 5 - 50.1% to 60% openings per emitter length and 3m height

Number of storeys	Emitter length (eL) in metres					
	≤ 5	≤ 10	≤ 15	≤ 20	≤ 25	≤ 30
1	9.0	12.2	14.3	15.9	17.2	18.3
2	9.8	13.3	15.8	17.7	19.3	20.6
3	10.2	13.9	16.6	18.6	20.4	21.8
4	10.6	14.5	17.3	19.5	21.4	23.0
5	11.3	15.5	18.5	20.9	22.9	24.6
6	11.5	15.8	18.9	21.3	23.4	25.1
7	11.7	16.1	19.2	21.7	23.8	25.6
8	11.9	16.4	19.6	22.1	24.3	26.1

Table 6 - 60.1% to 85% openings per emitter length and 3m height

Separating distances series 1 cont.../

Number of storeys	Emitter length (eL) in metres					
	≤ 5	≤ 10	≤ 15	≤ 20	≤ 25	≤ 30
1	8.7	11.3	12.9	14.1	15.0	15.7
2	10.5	13.9	16.3	18.2	19.7	21.0
3	11.0	14.7	17.3	19.3	21.0	22.4
4	11.4	15.4	18.2	20.4	22.2	23.8
5	12.2	16.3	19.3	21.7	23.7	25.4
6	12.4	16.6	19.7	22.2	24.2	25.9
7	12.6	16.9	20.1	22.6	24.7	26.5
8	12.8	17.2	20.4	23.0	25.1	27.0

Table 7 - 85.1% to 100% openings per emitter length and 3m height

Separating distances series 2
Buildings with up to an average of 4m floor to ceiling height

Use of the tables is explained on pages 13-17 of this document. For buildings not included within the tables, a fire engineer should be consulted and a review undertaken.

Number of storeys	Emitter length (eL) in metres					
	≤ 5	≤ 10	≤ 15	≤ 20	≤ 25	≤ 30
1	5.0	6.7	8.1	9.2	8.5	8.9
2	5.1	7.6	9.3	10.5	11.5	12.4
3	5.4	8.1	10.0	11.4	12.5	13.5

Table 1 - 15% to 30% openings per emitter length and 4m height

Number of storeys	Emitter length (eL) in metres					
	≤ 5	≤ 10	≤ 15	≤ 20	≤ 25	≤ 30
1	7.9	11.2	13.4	15.0	15.5	16.4
2	8.5	12.0	14.5	16.3	17.8	19.1
3	8.9	12.6	15.2	17.2	18.9	20.3

Table 2 - 30.1% to 50% openings per emitter length and 4m height

Number of storeys	Emitter length (eL) in metres					
	≤ 5	≤ 10	≤ 15	≤ 20	≤ 25	≤ 30
1	9.2	11.5	13.4	15.0	15.5	16.4
2	10.9	14.2	16.5	18.3	19.7	20.9
3	11.5	15.1	17.7	19.7	21.4	22.8

Table 3 - 50.1% to 100% openings per emitter length and 4m height

Separating distances series 3
Buildings with up to 6m and 7m floor to ceiling height

Use of the tables is explained on pages 13-17 of this document. For buildings not included within the tables, a fire engineer should be consulted and a review undertaken.

Number of storeys @6m	Emitter length (eL) in metres					
	≤ 5	≤ 10	≤ 15	≤ 20	≤ 25	≤ 30
1	5.0	5.6	7.0	7.9	8.7	9.2

Table 1 - 10% to 15% openings per emitter length and 6m height

Number of storeys @6m	Emitter length (eL) in metres					
	≤ 5	≤ 10	≤ 15	≤ 20	≤ 25	≤ 30
1	8.5	12.1	14.5	16.3	17.8	19.0

Table 2 - 15.1% to 40% openings per emitter length and 6m height

Number of storeys @7m	Emitter length (eL) in metres					
	≤ 5	≤ 10	≤ 15	≤ 20	≤ 25	≤ 30
1	5.0	5.0	5.0	5.0	5.0	5.0

Table 3 - 10% to 15% openings per emitter length and 7m height

Number of storeys @7m	Emitter length (eL) in metres					
	≤ 5	≤ 10	≤ 15	≤ 20	≤ 25	≤ 30
1	5.0	6.6	8.3	9.5	10.4	11.2

Table 4 - 15.1% to 20% openings per emitter length and 7m height

Number of storeys @7m	Emitter length (eL) in metres					
	≤ 5	≤ 10	≤ 15	≤ 20	≤ 25	≤ 30
1	9.3	13.0	15.5	17.3	18.9	20.1

Table 5 - 20.1% to 40% openings per emitter length and 7m height

How to use the tables

1 Terminology

Emitter length (eL)

The length of elevation which is taken in the calculations in the separation distance tables.

Vertical fire division

The boundary of the compartment being considered

Fire door (Fd)

A site installed door which provides robustness against fire spread from either side of the compartment. For CLT structures the use of a self-closing 30minute fire door is required.

2 Emitter length to be taken

In any plan arrangement the rooms between CLT walls can be considered to from a vertical fire division.

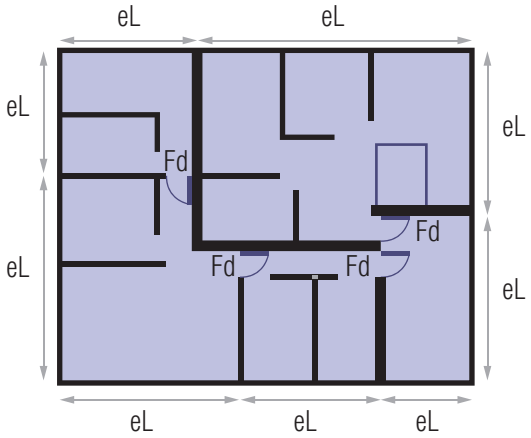


Figure 4 - Emitter lengths of a CLT building

Providing the rooms are closed off by fire doors (Fd), the worst case emitter length is the room width or the width of enclosure to the fire door.

3 Building heights

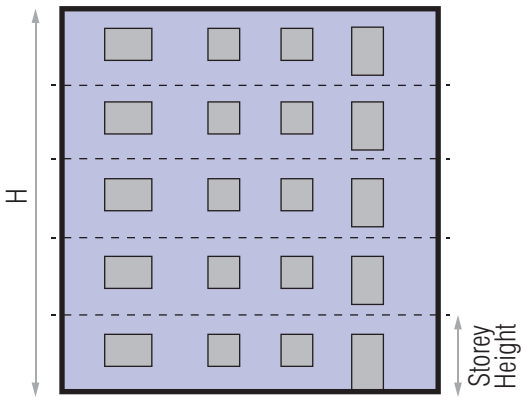


Figure 5 - Building height

The building height is taken as the height from lowest level of timber construction up to the eaves, or height of the roof if the slope is 50 degrees or more (for example a mansard roof). If the storey heights vary the average storey height is to be used in the tables.

4 Percentage opening

This is taken in the façade elevation being considered, over the full height and within the emitter length being considered. The percentage of window or doors i.e. openings is calculated as follows:

Emitter length (eL) x building height (H) = effective area (EIH)

Area of openings (AO)

Level 1- AO1

Level 2- AO2 etc

Total area of openings = sum of each level $\sum^{n} AOi$

Percentage of openings (PO) = (AO/ELH) x 100 = PO %

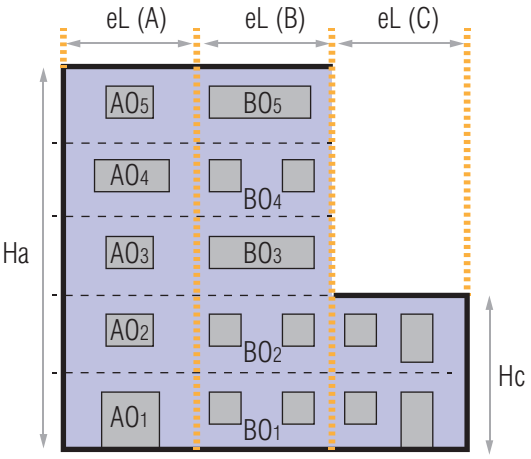


Figure 6 - Building opening areas per zone

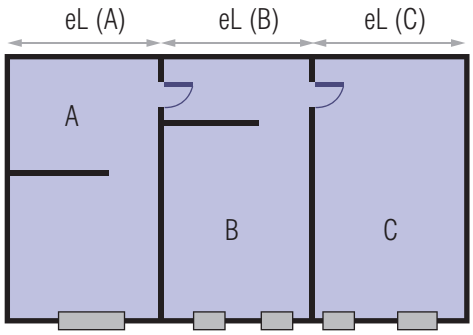


Figure 7 - Building plan diagrammatic zones

In figure 6 and 7 there are three zones shown diagrammatically, which are determined by the emitter lengths A, B and C.

$\sum^{n} AOi \text{ zone } A = AO_1 + AO_2 + AO_3 + AO_4 + AO_5$

From which the percentage of openings per zone $(PO) = (AO/ELH) \times 100 = PO\ \%$

5 To calculate the Site Safe separating distances

Using the eL, H and PO for each zone of the building the separating distance (Sdi) per zone is taken from the appropriate table.

Each zone is checked as shown in Figure 8 and 9. If any of the zones have a separating distance greater than the actual distance between the new build and the existing building then additional risk mitigation measures are required.

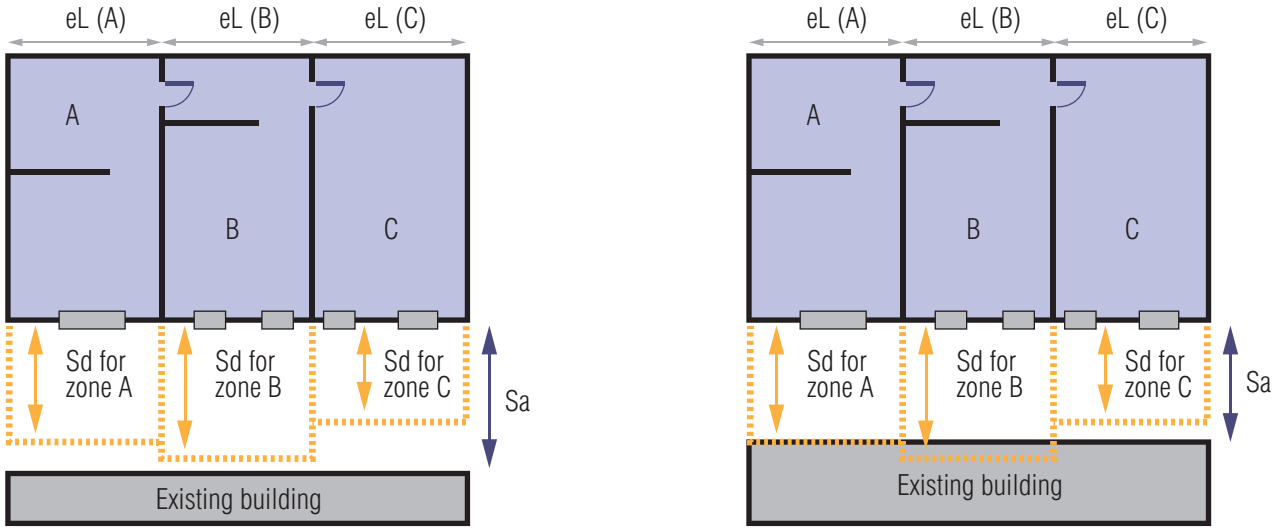


Figure 8 - Diagrammatic view of checking the safe separation distances from building to building

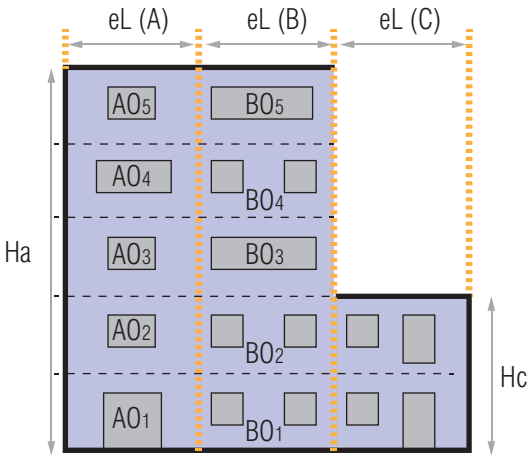
6 Additional risk mitigation measures

If the calculated separation distances (Sd) is greater than the actual separation distance (Sa) then the following can be carried out.

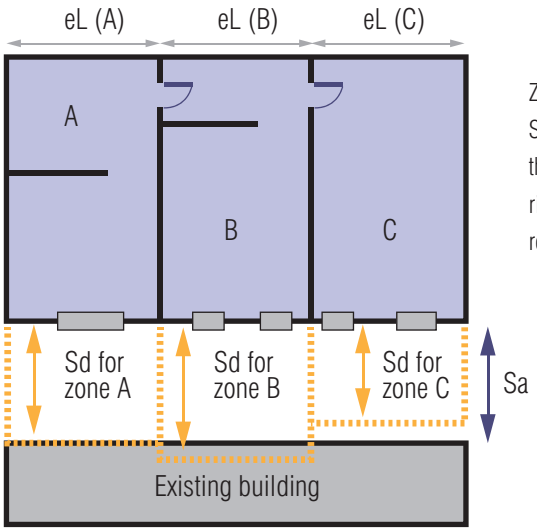
1 Change the design - with location or number of effective story heights

2 Incorporate additional walls (temporary) to reduce the emitter length (eL)

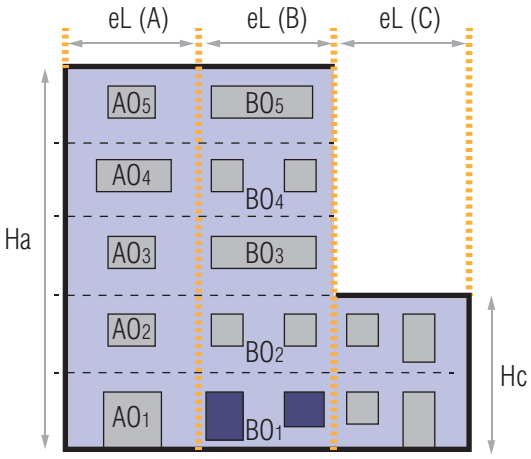
3 Reduce storey heights by covering the openings in the affected elevations and associated emitter lengths; covering to be Euro Class A1 (9mm min) or A2 boards (12mm min) or to STA listed products. The remaining storey heights checked for compliance with Sd < = Sa.



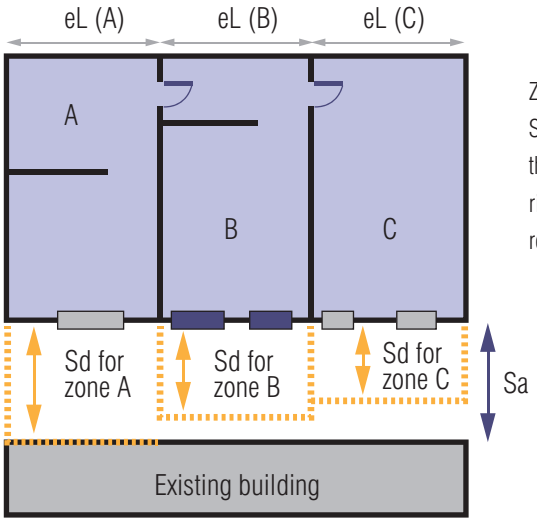
Elevation of building before covering windows



Plan of building before covering windows



Elevation of building with zone B lower ground level with windows covered



Plan of building with windows covered on ground floor

Figure 9 - Example for risk mitigation to cover windows

7 Cladding the external elevation

The separation tables assume that externally, the façade is exposed timber or exposed rigid foam of mineral wool insulation material (FI1, FI2 or FI3 - see STA Product Paper 2). Where other insulation materials are used these are to be reviewed by a fire engineer to check if the product requires fire breaks to avoid horizontal fire spread; as this can increase the emitter length assumed in this guidance.

If non-combustible cladding is fixed to the frame elevation, this will provide a robust resistance against a façade fire. If there is no opportunity for a façade fire then the safe separation distances can be determined by assuming that the building comprises of a single storey for the relevant emitter length; assuming that the cladding is to be for the full height of the building and over the relevant emitter width being considered.

8 Closed off windows as a risk mitigation measure

Closed off windows are to be installed prior to the floor or roof being installed, in accordance with the safe separation distance calculations at the stage of construction. For example, if you have a single storey building then the windows are closed after the walls are erected.

The fixing of the closed off windows is to be appropriate for the material and to achieve required fire robustness. Nails at 150mm centres or screws at 300mm centres are a minimum requirement .

If you have a four storey frame that requires windows closed off on the lower floor to make the frame an effective three storey, then the windows do not need to be closed off until the fourth storey walls are erected. This assumes of course that three storey frame has adequate separation distances without risk mitigation.

If windows are opened during the building process and during the day the contractor shall undertake a risk management review and produce a work-method statement to ensure that the risk of fire spread is minimal and that the reinstatement of the opening takes place before the end of the work shift.

The closing off of windows does not need to stop smoke and is a secure fit with gaps no greater than 25mm.

9 Closed windows that can be removed

If windows are closed off during the construction process, then the time to remove them is when the internal wall fire protection is installed.

10 Holes and penetrations in fire compartmentation walls

If holes are created in either the walls or floors that form the fire compartmentation, they are required to be filled with temporary fire stopping material which can only be removed following a work permit arrangement. The fire stopping can be mineral wool of at least the thickness of the material being penetrated.

11 The importance of robust fire doors

Fire doors are to be a minimum 30 minute fire door with automatic closer. Doors must not have gaps around them and are not to be left open.

Copyright

Limitations of the guidance

The design guidance provided is present by the STA based on current knowledge and experience of CLT type structures. The tables have been reviewed by HSL and the HSE and represent current thinking on the fire behaviour of CLT type structures. Further research and work may result in changes to these tables. Users of the tables do so without liability to the STA or its authors. Users should consult with fire engineers should they require specific designs for their project.

CLTSDG/v1.1/1114

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