Disproportionate Collapse: Platform Timber Frame Construction

What Is Disproportionate Collapse?

Disproportionate Collapse is the ability of a building to withstand collapse disproportionate to the cause, if limited accidental damage, or failure to part of the structure, occurs.

Should a localised area of the building be accidentally damaged and cannot be relied upon for support, the remaining structure of the building (floors and structural walls) will need to have the ability to retain the buildings structural integrity.

The Regulations

It is a requirement under the current UK Building Regulations (England, Wales and Scotland) that all buildings comply with a minimum level of robustness. Within the UK building regulations there is a specific reference to Disproportionate Collapse. In essence, although worded slightly differently from each other, they state that

"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."

The Approved Documents give a mixture of prescriptive and performance based guidance for common building situations and makes numerous references to framed buildings such as concrete and steel framed buildings, but NOT timber frame buildings.

As timber frame construction is not specifically referenced in the building regulations and as there is no obligation on the designer to adopt any particular solution contained in any of the approved documents, the route for timber frame designers is to adopt alternative methods.

The Methods For Timber Frame

Platform timber frame is a lightweight building process, comprising wall and floor components mechanically fixed to each other, which under accidental damage is known to be robust and have significant capacity to span over gaps caused by accidental damage. This was demonstrated by tests carried out on the BRE/ TRADA TF2000 six storey timber frame building in 1998 which concluded that…

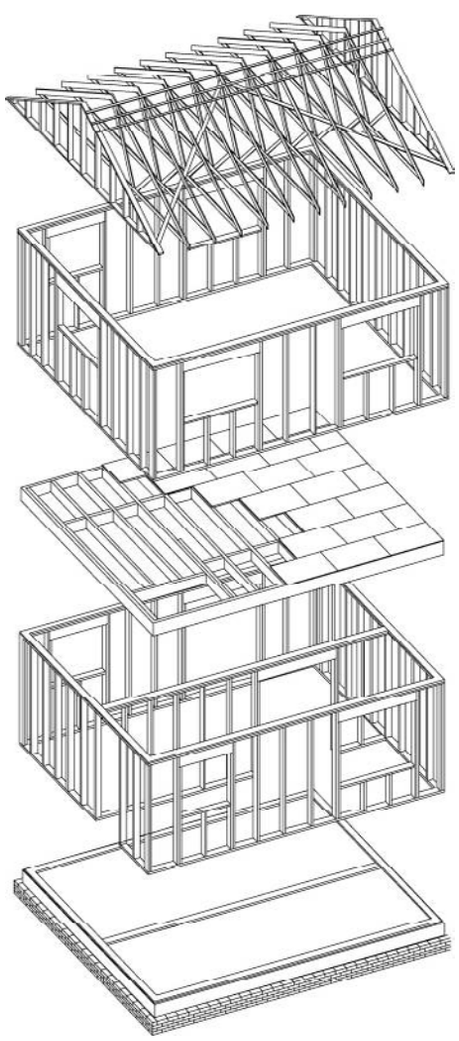
"Timber frames designed and built correctly are robust against disproportionate collapse".

Unlike other structural concepts, buildings falling outside the scope of platform cellular layouts (post & beam or portal frames), platform timber frame relies on the full diaphragm action of the floors to transfer horizontal forces to an evenly distributed layout of load bearing walls, which provide both vertical support and horizontal load resistance.

The timber frame designer should provide a robust connection at each and every junction as part of the normal design process. While these timber frame junctions have a calculated strength, it is known that once the building is completed additional strength is achieved in the framing – undefined system strength – which is greater than the sum of the parts.

The Disproportionate Collapse requirement is to be met by an appropriate choice of measures and the means of achieving this is open to limited interpretation based upon risk management principles and each application should be considered on its merits.

The building regulations have classified buildings into 4 classes according to building type and risk and provided suggested approaches to meeting the requirements.



Platform Timber Frame
(Courtesy TRADA Technology)

Simpson Strong-Tie®, Winchester Road, Cardinal Point, Tamworth, Staffordshire, B78 3HG | Telephone: 01827 255600 | Fax: 01827 255616 | Visit: www.strongtie.co.uk

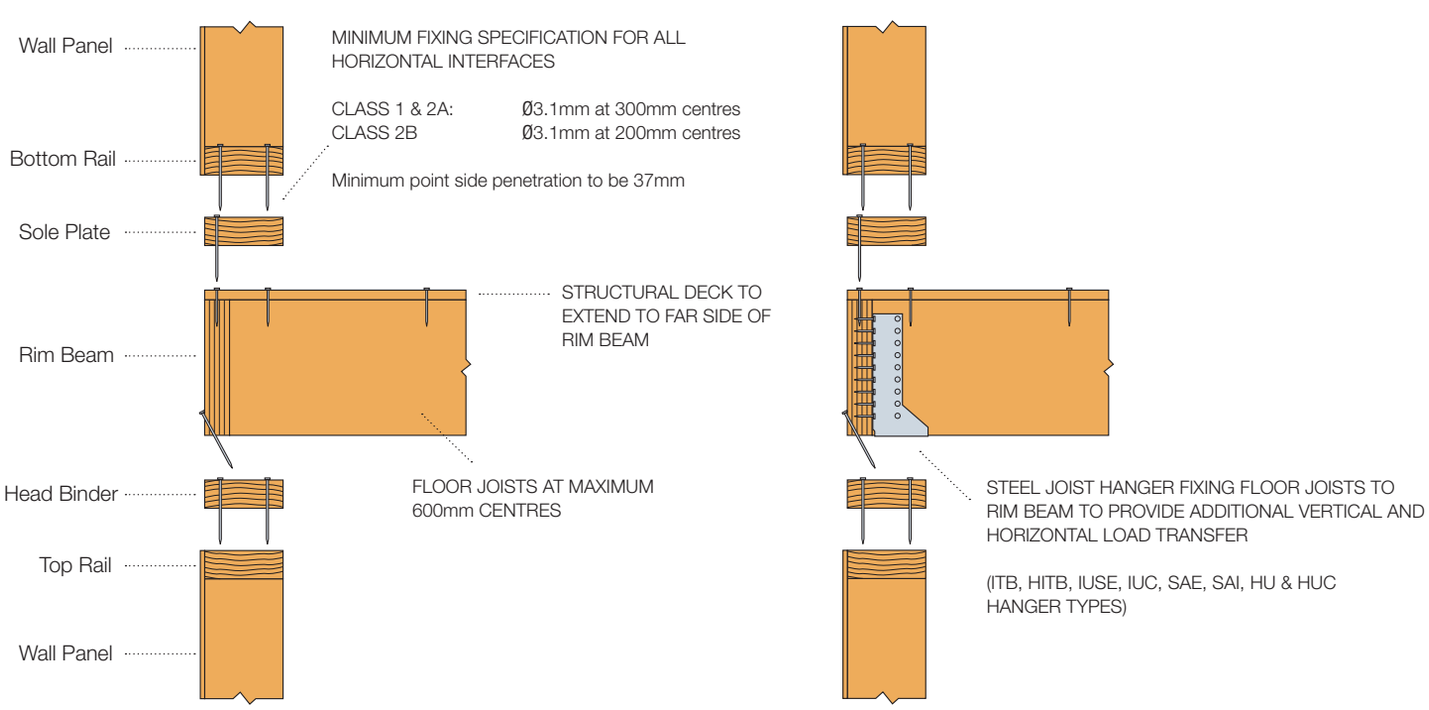
Disproportionate Collapse: Platform Timber Frame Construction

Several documents reviewing the requirements and providing suggested approaches to meeting the requirement have been published, noticeably a Technical Bulletin[1] and Guidance Document[2] published by the UK Timber Frame Association. Information detailed within these documents forms the basis for the following:

Risk Category	Timber Frame Building Usage Type	Risk Design Check	Product
Class 1	Single occupancy buildings from 1 to 4 storeys Detached houses, bungalows, terrace houses, town houses	**Platform:** No additional requirements above normal design processes and specification. **Other:** Horizontal tying forces at each junction to be checked for normal wind loadings.	Standard hangers used in timber frame construction

Risk Category	Timber Frame Building Usage Type	Risk Design Check	Product
Class 2A	5 storey single occupancy houses Hotels, flats, apartments, offices and other residential buildings not exceeding 4 storeys Single storey educational buildings	**Platform:** Provide effective horizontal ties, or effective anchorage of suspended floors to walls, using common proven details. **Other:** Check for an accidental horizontal effective tying force of 5 kN/m of supported wall.	ITB HITB IUSE IUC SAE SAI HU HUC

Typical Connection Details for Risk Category 2A are as illustrated below:



Note:
The hangers listed above are examples of hangers that may be suitable. It is the designer/engineers responsibility to check for suitability.
Please refer to our current technical catalogue C-UK10 for hanger capacities.

Simpson Strong-Tie®, Winchester Road, Cardinal Point, Tamworth, Staffordshire, B78 3HG | Telephone: 01827 255600 | Fax: 01827 255616 | Visit: www.strongtie.co.uk

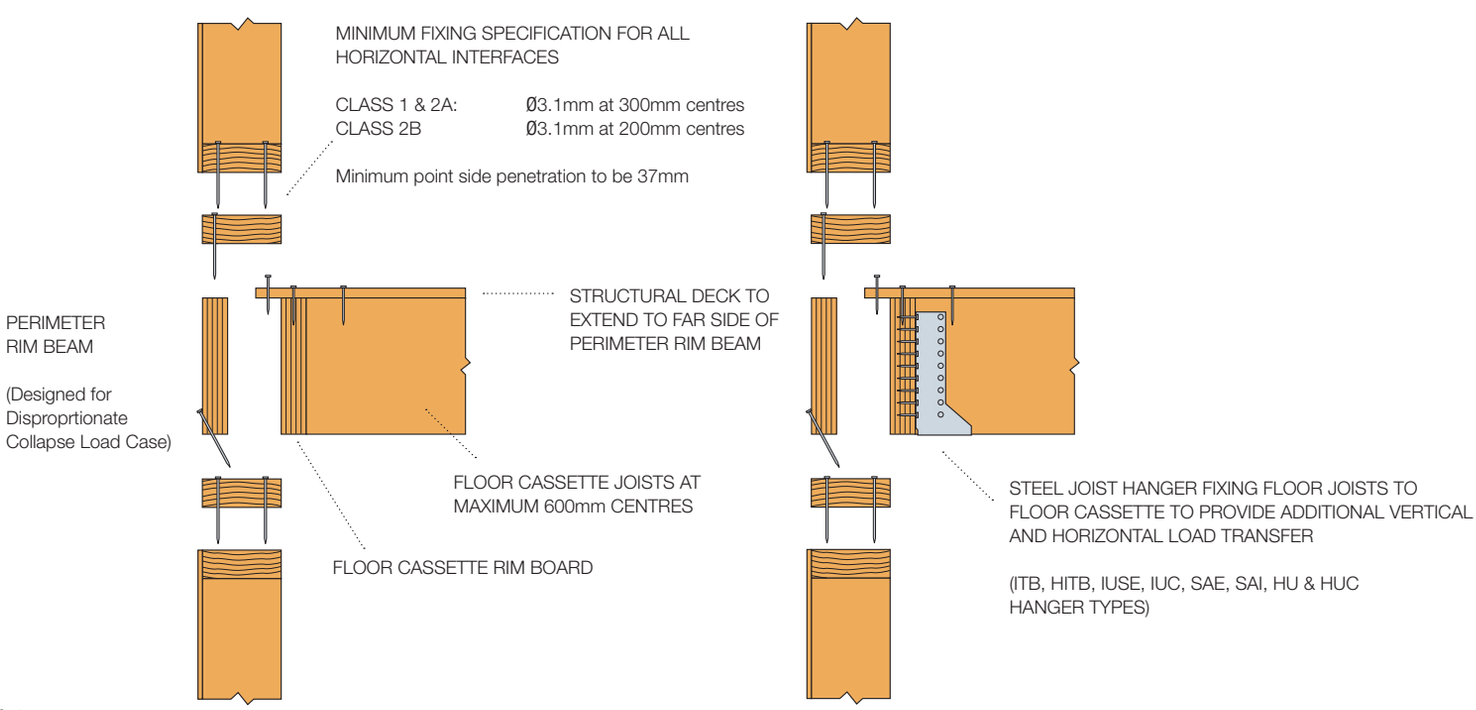
Disproportionate Collapse: Platform Timber Frame Construction

Suggested Design Procedure

- Horizontal loads resisted by the floor deck extending across the joist and connecting onto the rim beam. If required, additional loads can be transferred directly from the joist to the wall / rim beam via a steel joist hanger.
- Anchorage of floors to walls is achieved with sufficient nailing density at the interfaces between the floor platform and wall panels (lower and upper).

Risk Category	Timber Frame Building Usage Type	Risk Design Check	Product
Class 2B	Hotels, flats, apartments, offices and other residential buildings greater than 4 storeys but not exceeding 8 storeys	**Platform:** Provide effective horizontal ties, together with effective vertical ties. Bridging - check on the notional removal of load bearing elements. Key element design to be used when notional removal is not practical. **Other:** Check for an accidental horizontal effective tying force of 7 kN/m of supported wall. Bridging - check on the notional removal of load bearing elements. Key element design to be used when notional removal is not practical.	ITB HITB IUSE IUC SAE SAI HU HUC CC CCC CCT ECCLL

Typical Connection Details for Risk Category 2B are as illustrated below:

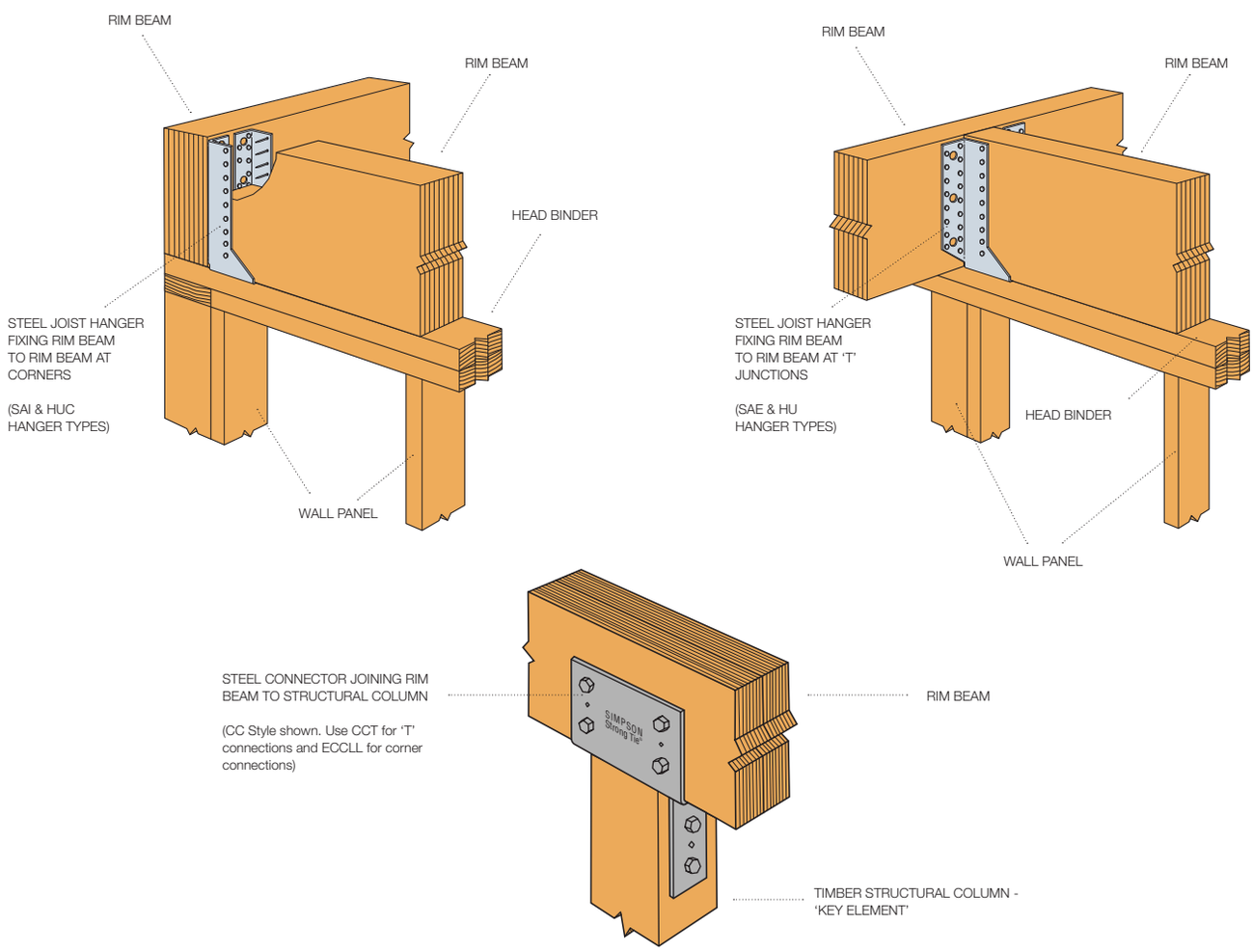


Note:
The hangers listed above are examples of hangers that may be suitable. It is the designer/engineers responsibility to check for suitability.
Please refer to our current technical catalogue C-UK10 for hanger capacities.

Simpson Strong-Tie®, Winchester Road, Cardinal Point, Tamworth, Staffordshire, B78 3HG I Telephone: 01827 255600 I Fax: 01827 255616 I Visit: www.strongtie.co.uk

Suggested Design Procedure

- Vertical loads resisted by direct bearing of floor joists onto wall panels or by using steel joist hangers connecting the floor joists to the wall / rim beam.
- Horizontal loads resisted by the floor deck extending across the joist and connecting onto the rim beam. If required, additional loads can be transferred directly from the joist to the wall / rim beam via steel joist hangers.
- Bridging – the notional removal of load bearing elements requires the provision of a continuous engineered timber rim beam at every floor level. Structural continuity is achieved as the rim beam acts as a 'bridging element' when spanning between points of vertical load restraint (internal load bearing walls or 'key elements').
- Key Element, such as a column in a length of wall, is an alternative design approach which is not related to notional removal. The design of the column is for 34 kN/m^2 in any horizontal direction.



Risk Category	Timber Frame Building Usage Type	Risk Design Check	Product
Class 3	Stadiums, sports grounds or buildings subjected to high frequency of loading (i.e. crowd accumulation)	Designer to carry out a risk assessment and decide upon a suitable method.	

Further information and guidance on Disproportionate Collapse can be found in the following publications:

[1] UKTFA Technical Bulletin 3 - Design Guidance for Disproportionate Collapse – March 2005 Martin Milner – Chiltern Clarke Bond
[2] UKTFA Structural Guidance for Platform Timber Frame – May 2008
[3] UKTFA – Code of Practice for Engineered Wood Products 1st Edition – Jan 2007
[4] NHBC Technical Guidance Note – Requirement A3 – Disproportionate Collapse

Simpson Strong-Tie®, Winchester Road, Cardinal Point, Tamworth, Staffordshire, B78 3HG I Telephone: 01827 255600 I Fax: 01827 255616 I Visit: www.strongtie.co.uk