



National
Operational
Guidance

Hazard

Unstable or collapsed structure



NFCC
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Hazard - Unstable or collapsed structure

Hazard Knowledge

Structural collapses occur because of a loss of stability, where the basic shape and integrity of the structure is significantly changed through being subjected to a combination of forces. As the altered structure or shape is less capable of supporting the imposed forces and loads, it continues to change until it finds a new shape that is more stable.

Structures may become unstable or collapse due to:

- Construction or demolition work
- Derelict or deteriorated condition, including previous fire related damage
- Involvement in a transport collision
- Substandard or unregulated construction or modification
- Exemption from, or non-conformity with, building regulations
- Operational activity such as moving or cutting structural elements
- Severe weather conditions, such as flooding, heavy snow or high winds
- Shock due to severe impact or explosion

Inherent design defects can cause weaknesses to parts of a structure, which may subsequently fail if stresses are applied, such as severe weather conditions or abnormal loading by heavy machinery. A building under demolition or renovation may collapse if critical load-bearing walls or floors are removed without considering the effects on the other structural elements.

Substandard materials used in construction, or poor workmanship during the construction phase, can result in a building that is substantially weaker than intended. This increases the likelihood of collapse should the building be exposed to additional forces.

Some non-building or temporary structures can become unstable due to a combination of potential causes that render the environment hazardous to fire crews operating within or nearby.

Structures may fail for various reasons, such as insufficient strength to take the weight or force of a load or possibly through secondary collapse. People may be at risk if they are on, in under or attached to an unstable or collapsed structure. Loads or forces applied to the structure, directly or indirectly, may worsen the instability or progress a collapse. This could include rescue loads and the use of equipment.

Elements of structure, [floors](#), [walls](#), ceilings, ancillary items, fixtures and fittings can partially collapse. Partial collapse can follow on from the collapse of lightweight or decorative features.

If partial collapse is not controlled, it may increase the potential for falling debris and secondary or structural collapse.

Lightweight or fragile structural features may collapse, including non-structural elements; for example roof coverings, [false chimneys](#) and glazing.

False chimneys do not form part of the structural fabric of the building, can be a considerable weight and are only supported by roof timbers. If roofing timbers or lightweight trusses fail, they may collapse through the roof. False chimneys are not suitable as an anchor for working at height, as they may not be able to support any additional weight.

Collapse may not be limited to the structure itself, as scaffolding or cranes, for example, may be at risk of damage or collapse.

Moving or cutting [structural elements](#) during operational activity can have an impact on the stability of a structure.

The way and speed in which elements of construction distort or fail depend on the type of structure and how construction materials have been used or combined. There may be varying stages or severity of instability or collapse. A structural collapse may occur without warning, giving people little or no time to escape.

In a collapsed structure casualties may be located in voids or spaces, or be trapped under debris. The type of structure can provide some indication of the way it has collapsed, and the location of potential voids or spaces.

For more information on construction methods and materials see [BRE building supplementary information](#).

Patterns of collapse

Collapse patterns can be categorised as internal, external or total collapse.

Internal collapse	
Pancake or progressive collapse	Structural failure causes a floor to fall horizontally onto the floor below. The added weight may cause that floor, and subsequent floors, to fail and fall to a lower level, although not always to ground level. Pancake collapse can be mistaken for total collapse.
Lean-to collapse	Where one supporting wall fails, resulting in the roof or floor hinging on the remaining wall creating a triangular void.



V-shape collapse	Usually occurs when the centre support is compromised, and the floor or roof collapses and settles in the shape of a V. Triangular voids may be formed under the V-shape.
A-frame or tent collapse	The floor is no longer supported at the outer edges, but remains supported on internal walls or structures, forming an A-shape.
External collapse	
90° collapse	This is when the wall drops away from the building at a 90 degree angle. Debris will spread as the wall hits the ground.
Curtain fall collapse	Much like a curtain cut loose at the top; walls collapse straight down and create a rubble pile near their base.
Inward/outward collapse	Walls crack horizontally in the middle. The top half usually falls inwards and the lower half outwards.
Total collapse	This is the most severe form of structural failure and occurs when all the floors have collapsed to the ground or basement level and all walls have collapsed onto the floors.

Partial or structural collapse may create other physical hazards such as

- Unstable or fragile surfaces
- Exposed structural members
- Sharp edges
- Heavy dust loads making atmospheres irrespirable
- Damaged utilities
- Unsafe cabling or wiring



Control measure - Cordon control: Unstable structures

Control measure knowledge

The hazard area for an unstable structure that may undergo partial or structural collapse needs to take into account:

- Construction materials
- The height and type of the structure
- Severe weather conditions, such as flooding, heavy snow or high winds
- The potential for damage to surrounding structures and infrastructure

In the UK, a [portal or rigid frame](#) construction is designed for inward collapse – in a fully developed fire a basic single storey structure may be expected to collapse within 30 minutes. Portal frame structures are generally designed so that they collapse within their own footprint.

Cordons may need to consider the potential collapse of scaffolding and tower cranes. On a construction site they could collapse outside the existing hoarding or site boundary. For further information see the hazard: [Scaffolding](#).

Glass (glazing) or other flat panels falling from height may travel (plane) significant distances from a structure, particularly in windy conditions.

Specialist advice may be required from local authority building control teams, structural engineers or urban search and rescue tactical advisers.

Strategic actions

Fire and rescue services should:

- Make arrangements with other agencies to establish the type and level of response they can provide if specialist advice is required
- Ensure personnel are aware of the specialist advice available

Tactical actions

Incident commanders should:

- Evaluate and monitor the potential footprint of collapse and debris

- Consider seeking specialist advice when defining the hazard area for a potential collapse



Control measure - Assess and monitor structural stability

Control measure knowledge

An appropriate understanding of structure design and construction materials, is required to assess and monitor an unstable or collapsed structure. This will include identifying:

- Age, design and condition of the structure
- Structural materials and construction methods

All aspects of the structure, the actions taken and the efforts made to distribute applied loads should be considered. An assessment of the unstable or collapsed structure should be made to determine the hazard area and, because of risks such as secondary collapse or falling debris, it should be monitored while personnel are working within the hazard area.

An unstable or collapsed structure should be assessed at the earliest opportunity. Although the initial assessment can be carried out by first responders, it may be necessary to seek specialist advice.

Specialist advice and monitoring may be available from local authority building control teams, structural engineers or urban search and rescue (USAR) tactical advisers.

Signs of collapse may include:

- Cracks in walls
- Sagging floors or floors deflecting from wall
- Displaced columns
- Dropping arches
- Bulging walls
- Buckling columns or beams
- Unusual noises coming from the structure

The minimum number of personnel should be committed to the hazard area, especially if assessment or monitoring indicates the potential for further collapse. Emergency procedures should also be in place, which can be initiated if required.

If safe routes are identified they should be marked, and exposed elements or other hazards should be marked or clear.

Strategic actions

Fire and rescue services should:

- Establish arrangements with appropriate agencies to provide structural advice, assessment and monitoring
- Ensure personnel are aware of local or national arrangements and the specialist advice available

Tactical actions

Incident commanders should:

- Identify the age, design and condition of the structure
- Identify the type of structural materials and construction methods
- Assess and continuously monitor the structure for signs of collapse
- Ensure that competent personnel assess and monitor the suitability of the structure for working in the hazard area
- Consider the stability of surrounding structures and the wider area before and during operational activity
- Ensure that minimum number of personnel work in the hazard area
- Have emergency procedures in place for unstable or collapsed structures
- Consider appointing an external safety officer to monitor structural stability



- Consider requesting structural advice, assessment and monitoring from appropriate agencies