SID

Upwardly fragile

The CDM regulations require designers to think about the hazards associated with erecting structures. It pays to be aware of the risks, and include ways of minimising them in your project.

When a structure is being erected, contractors will by definition be working on something that is partially completed. This poses significant risks – including those associated with instability and working at height.

Other hazards include working close to machines, like cranes, and potential exposure to health hazards like corroded steel. And it goes without saying that if a project gets delayed, there is a danger of multiple trades working in close proximity to each other, and getting in each others' way.

This guide considers the risks in turn, focusing on:

- **Temporary instability**
- **Falls from height**
- **Lifting (use of cranes)**
- **Working on or near fragile materials**
- **Handling heavy or unwieldy materials**
- **Collapse of temporary works equipment**
- **Danger to adjacent structures**

Temporary instability

Part-built structures can become unstable for a variety of reasons. Designers should be aware of these risks, and take account of them in their specification.

Omission of temporary works
If a design is unusual, and standard erection practice is not sufficient to maintain stability, there is a risk of instability. Examples of designs that could be vulnerable without the addition of temporary works include:

- **Those featuring slender rafters, which require additional bracing until the roofing is fixed**
- **Portal frames where the cladding contributes to sway stability**
- **Long-span members, where bracing is required until another one is connected. This happens on some bridge beams**

When the part-built structure is inherently unstable
This can occur in a number of cases:

- **If the structure is stabilised by other (remote) parts of the permanent works, such as shear walls, shear cores or adjacent structures**
- **If provision for lateral stability is either by unsymmetrical bracing, or dependent on other members, like cladding, that are added later**
- **If the structure is subjected to significant loads during construction, which may not have been anticipated by the designer. Examples of such circumstances include a complete roof being lifted, or timber floors that are supported on 'green' masonry walls being loaded too soon**
- **If a member has inadequate seating on another member while the structure is being built, because erection tolerances add up unfavourably. This could happen when pre-cast slabs are used on narrow flange beams, for example, or when purlins sit on main rafters. It could also happen when beams sit on corbels**
- **If members in isolation cannot sustain normal erection loads – for example, pinned base columns under lateral loads from ladders, or long-span beams and trusses**

Premature removal of temporary supports
This usually occurs when a structure appears to be complete, but actually requires more work. This could happen when composite beams and panels that support 'green' concrete are removed prematurely. It could also happen when portal frames or guying systems are removed before the structure is secure.

What designers can do
It is ideal if the designer can eliminate the risk of temporary instability when developing a project. As a minimum, though, you should:

- **Advise the contractor about the existence of these hazards**
- **Inform the contractor of the assumptions made in the design, especially relating to design forces like construction loads and portal base horizontal thrusts**

Falls from height

It is impracticable to eliminate the risk of falls from height during the erection of a structure. Even so, designers can play a part in minimising the hazard by specifying features that protect contractors when they are working at height.

It is against the law for construction workers to adopt precarious positions during the erection of a structure. So they should not straddle unattached beams, for example, or work towards an open edge. Although the responsibility for this lies with the contractor, designers can help to limit exposure to such hazards. For example, you can:

- **Contact suppliers of temporary edge protection and integrate their products into your design**
- **Incorporate points for anchor lines, or safety nets, to be attached to the structure**
- **Be aware of construction and manufacturing tolerances, so that components do not need vigorous manhandling while slung at height. Examples include the installation of PC slabs on steelwork, or of steel beams between columns**
- **Specify a good quality sub-base for ground slabs, so that mobile platforms can be constructed for the erection of the building envelope**
- **Remove the need for some work at height – for example, by doing away with sag bars for purlins**

More guidance on working at height can be found in CON307 **Fall prevention by design.**

Lifting (use of cranes)

Central to this issue is awareness of the conditions under which a crane could overturn or collapse. Accepting that it is not always possible to restrict the weight of building materials, you should nonetheless give consideration to the following in your design specifications:

- **Cranes need room to work. So avoid heavy lifts or large lifting radii on congested sites**
- **The radius of a lift has an impact on the weight that can be lifted. Even a moderate weight can create a lifting hazard if it is lifted over a large radius. You should always consult with a crane supplier when your design requires such a lift**
- **It is helpful to know the weight of building components. Make sure you provide the contractor with this information**
- **It is essential to know where a load's centre of gravity is located – especially if it is not in the middle. Make sure contractors have this information prior to lifting materials**
- **Materials that incorporate lifting points are easier to handle on site**
- **Cranes need good foundations. If it is not possible to construct a good quality sub-base that bears the weight of the crane, you should try not to specify components that require heavy lifting**
- **The wind on exposed sites can create a significant hazard when lifting with a crane**
- **Long-span large-section beams have a significant momentum when they start to swing – make sure there is sufficient room for this movement in your design**

For further advice about lifting with cranes, see CON302.1 **Crane information.**

Working on or near fragile materials

This problem relates primarily, though not exclusively, to roof work. Designers should only specify non-fragile roof components and assemblies, as defined by the Advisory Committee for Roof Safety (ACR). See CON308 **Roof working** for more guidance.

The non-fragility criteria can be applied to other assemblies in your design, thereby reducing the risk of contractors and maintenance workers falling from height.

Handling heavy or unwieldy materials

Think about the materials you specify in your design. Always opt for the lightest and most easily-manoeuvred components available. For example:

- **Use light concrete blocks or bricks instead of heavy ones. Where heavy blocks are unavoidable – for example, in buildings where the acoustics require heavier materials – specify half-size blocks to reduce the difficulty of handling them. Further information is given about this in CON309 Concrete blocks**
- **Where steel sections have to be lifted into place manually, consider using composite members like back-to-back channels or angles instead of I-beams. Further information is provided in MTN501 Refurbishment**

If it is not possible to replace heavy items with lighter alternatives, be sure to tell the contractor about their weight. You should also investigate whether mechanical installers are available for such components, so as to minimise the hazards associated with moving them. Examples of such equipment include machines that install heavy glazing, and concrete kerbs.

You also need to remember that even light components can be difficult to handle. This is especially likely if they have an unusual shape, or if their centre of gravity is off to one side.

You should consider the ease of handling of any building materials you specify, and make sure contractors know of any potential problems with them.

Collapse of temporary works equipment

Although it is not necessarily your responsibility to design temporary works, it pays to incorporate elements into your project that can be used to stabilise them. You could, for example, provide tying points for the scaffolds. For further advice about temporary works, see CON306 **Temporary works.**

Risk to adjacent structures

There may be occasions on which the erection of your building poses a hazard to adjacent structures. This might restrict the construction methods that can be used on your project, and you need to factor such restrictions into your design.

For example, it may be unacceptable to specify processes that generate considerable noise and vibration on structures near to a hospital. Similarly, excavation may not be possible near to canals or other watercourses. And the use of cranes will be limited by the height and location of adjacent structures.

Useful resources

BS 5531: 1988 Safety in Erecting Structural Frames
Erectors' Manual: A Guide to Health and Safety in Steel Erection
(BCSA publication no 16/93)
National Structural Steelwork Specification for Building Construction
(BCSA Publication no 1/89)
The BCSA is the national association for the steel construction industry.

See elsewhere on SID:

MTN501 Refurbishment
CON306 Temporary works
CON307 Fall prevention by design
CON308 Roof working
CON309 Concrete blocks
CON302.1 Crane information