

Construction Industry Council CDM Guidance for Designers

Designing to make management of hazards associated with erecting steelwork easier

Technical Guidance Note

T 20.002

INTRODUCTION

1. Designers can play a major part in making it easier to manage the hazards associated with erecting steel.
2. Erecting steelwork can expose workers to several of the hazards that it is necessary, under law, to protect them from. On site, this is a contractor's duty, but designers can help by giving priority to measures, which will reduce workers exposure to these hazards.
3. Designers should be aware that the state-of-the-art in erecting steelwork is changing. Increasingly, it is being erected using MEWPs and designers should be aware of how this might affect their design – see 8(j).
4. This guidance note makes designers aware of some of these issues.

HAZARDS ASSOCIATED WITH ERECTING STEELWORK

5. The erection of steelwork requires people to work on partially complete structures, usually at height. In addition, they are often exposed to the hazards associated with:
 - a) Working close to machines, eg: cranes;
 - b) Unplanned work, eg: remedial processes, could expose them to health hazards; and
 - c) Programme delays, which could mean that different trades are working close to others, eg, under or above.
6. Therefore, the hazards associated with erecting steel structures and working on the associated temporary works may be summarised as including:
 - a) Temporary instability;
 - b) Falls from height – people and objects;
 - c) Lifting components [exacerbated by site constraints];
 - d) Handling loads; and
 - e) Collapse of temporary works equipment and other equipment.

WHAT DESIGNERS SHOULD DO

7. Designers should give consideration to measures, which will either remove or lessen these hazards.

Designing to minimise the chances of temporary instability

8. Usually, steelwork is erected piece by piece. Therefore, at any time there is a chance for frame instability. However, the risk of instability can be reduced by some fairly simple measures, which include:
 - a) Providing bracing between the first two bays to be erected, to form the basis of a braced erection;
 - b) Checking all steel members for assumed erection loads. Particularly vulnerable members include:
 - i) Long-span [slender] members – also see 8 g);
 - ii) Floor beams, especially when they are part of a composite system, due to:

- Stacks of profiled steel forms;
 - Torsional effects of placing pc panels on one side of the flange;
 - Concrete discharged in a heap;
 - Other foreseeable storage;
- iii) Roof beams, especially portal rafters, for stacks of profiled roofing assembly materials;
- c) Providing bracing, which is symmetrical;
 - d) Ensuring that plan bracing connects into vertically braced bays;
 - e) Designing columns as free-standing cantilevers during erection, to resist short-term erection loads, eg: working wind loads [$V_s = 18$ m/s], ladder lateral forces, etc. meaning that pinned columns, ie, two bolt connections, may not be adequate;
 - f) Ensuring that design effective lengths can be achieved by assumed construction techniques;
 - g) Ensuring that slender members can resist the compression imposed by lifting slings, ie, the component of the sling forces. If there are restrictions on sling angle inform the contractor to allow him to design the lifting points;
 - h) Considering worker fall protection loads, see 12;
 - i) Designing bases for portal and arch-type structures to resist the lateral thrusts developed at their base;
 - j) If MEWPS are to be used, their loads on the partially erected structure must be accounted for.
9. Having carried out these checks, designers should act as follows:
 - a) For 8 a) and b) inform the contractor about your assumptions and erection load allowances – how much, applied where;
 - b) For 8 c) & d) if lateral stability is by other means, eg: diaphragm action of floors or cladding, or by shear cores or when symmetry cannot be achieved, inform the contractor;
 - c) For 8 e) – 8 g) inform the contractor about any design assumptions, to allow him to develop his method of erection;
 - d) For 8 h) inform the contractor about any members, which may not be used for this purpose;
 - e) For 8 i) tell the contractor what the forces are.

Designing to reduce the hazard of falling from height

10. Falls from height can occur off any unprotected edge. Designers should give consideration to measures, which would protect workers from this hazard, by reducing the time they have to spend at height and by designing in provisions for worker protection.

11. To reduce the time workers spend at height, designers could:

- a) Design to maximise prefabrication, eg, portal frames to be erected flat and lifted to vertical;
- b) Limit the number of bolts in connections;
- c) Minimise components, eg, purlins;
- d) Design buildings with fewer members;
- e) Use pc floor construction in preference to profiled steel forms, which need bolting down;

12. Operatives are most vulnerable when the steel is ready to receive following on components, eg: pc floor units, profiled steel formwork, roof assemblies, etc, which create an advancing unprotected leading edge. Therefore, designers should consider providing some means for attaching collective protection and PPE. For example, designers could:

- a) Design in parapets at the eaves, which could act as temporary guard-rails;
- b) Provide holes in column flanges at 2.1m above floor steel level for anchorage of lanyards, capable of resisting 15 kN;
- c) Specify the provision of anchorage points in follow on components, eg: pc units, profiled steel forms;
- d) Ensure that the steel members can resist the loads from safety net anchorages: 4.5 kN, 6 kN, 4.5 kN at 2.5m crs, and specify net anchorage components;

13. In addition, access to the place of work at height, should, wherever possible, be provided by permanent staircases, which have been designed for construction loads [possibly as free-standing structures].

14. To assist erectors making connections at height, designers should consider the provision of seating cleats, pre-attached to columns.

15. Where steel sections are to be connected to other materials, eg, concrete, the brackets for this connection should be installed while constructing the other component, eg, cast into the concrete. This could be more of a problem in existing buildings.

16. To prevent falls through roofs, designers should only specify non-fragile assemblies, in which all the components are non-fragile. [This would also mean that removal of components for maintenance would not render the remaining assembly non-fragile]. Non-fragile assemblies are defined in ACR[M]001:2000.

17. Where the steelwork is to support horizontal lifelines, designers should consult experts about the magnitude of forces that may have to be resisted.

Designing to reduce hazards with lifting

18. To facilitate the lifting of members, designers should:

- a) Consider the space requirements for cranes;
- b) Consider the provision of lifting points and specify these as an item for the fabricator to design;
- c) Design members to resist loads from lifting points, eg: sling component loads;
- d) Where necessary, ensure that the spacing of purlins allows for the largest component to be lowered down through them with sufficient clearance;
- e) State on the drawings, the maximum piece-weight to be lifted and its location [to allow a contractor to size a crane – see also 14 a)];

Handling loads

19. This problem occurs mainly, though not exclusively, on refurbishment projects, where, due to the situation of the work, eg: inside an existing building where cranes cannot be used, operatives are often required to manhandle steel members into position. To facilitate this, designers should minimise the weight of the steel member by:

- a) Designing beams with splices, to allow:
 - i) piece-meal installation of the beam, and
 - ii) Manoeuvring in limited spaces;
- b) Replacing one section with two, eg: 2 × RSCs instead of a single UB;

20. In addition, members should be detailed with site constraints in mind. For example, where members have to be transported through corridors, their length should be compatible with manoeuvring them around corners – see 19 a) ii).

21. Erection tolerances should be taken into account when detailing members for fabrication. This is more of a problem in existing buildings into which steel sections are being installed. In these circumstances, a detailed survey of the building should provide the necessary dimensional accuracy. Designers should also be aware that erection tolerances for other materials are different.

22. When connecting steel to other materials, it is likely that fin type connections will pose less of a handling problem than end-plate type connections.

23. It should be possible to lift members that are to be installed vertical hanging vertically.

Designing to reduce the hazard with temporary works and other equipment

24. Temporary works equipment [TWE] needs to be stabilised – see Technical Guidance Series T 20.006 Temporary Works Equipment. Designers should consider the provision of members, which could be used to attach TWE. For example:

- a) Cladding side rails could be designed to carry the lateral loads that could be applied by attaching scaffold ties: 10 kN;
- b) Eaves beams could be designed to carry lateral loads that could be applied by attaching mobile towers to them: 3 kN;
- c) Profiled steel forms and supporting steel beams should be designed to carry the concentrated leg loads that could be applied by a mobile tower: 6 kN;

25. The ability of members to support loads from fall arrest devices being brought into use should be checked and any members that are not strong enough to support these loads highlighted **unambiguously**.

26. Ladders can apply lateral loads up to 1kN where they are supported at the top.

27. In order to allow a contractor to design temporary supports, designers should provide sufficient information, to ensure that a contractor has a clear understanding of stability concepts.

28. On industrial type of buildings, much of the steelwork is erected from MEWPs. Therefore, designers should ensure that there is space around the building perimeter, to accommodate these machines.

29. In addition to designing to make erection safer, designers should give consideration to designing to minimise maintenance, to reduce the exposure of workers to health and safety hazards when carrying out maintenance.

USEFUL REFERENCES

Erectors manual BCSA Publication No 16/93

National Structural Steelwork Specification for Building Construction BCSA Publication No 1/89

BS 5531 Safety in erecting structural frames

HSE Guidance Note GS 28 parts 1 –4 [HSE]

SCI Publication 178 Design for Construction