Business Practice Notes

No. 17: Provision of appropriate levels of information to steelwork contractors/fabricators

The Business Practice Note series has been developed by the Institution's Business Practice and Regulatory Control Committee to provide guidance on aspects of running a practice and project management.

Matt Byatt clarifies the duties and responsibilities of structural engineers involved in building projects requiring structural steelwork.

Introduction

In the UK, it is good practice for building projects involving structural steelwork to be specified in accordance with the *National Structural Steelwork Specification for Building Construction* (NSSS)[1], which will often form part of the building contract documentation. Section 1 of the NSSS provides checklists setting out what information should be provided to the steelwork contractor, with differing requirements according to how the design responsibilities have been allocated.

The NSSS also refers to BCSA Publication No. 45/07 *Allocation of Design Responsibility in Constructional Steelwork*[2], which offers further guidance for identifying and exchanging detailed design information on building projects and incorporates tabulated responsibility matrices to assist in the procurement of steelwork both prior to and following the appointment of a steelwork contractor. Publication 45/07 is primarily designed as a supplement to or detailed explanation of Tables 1.1 and 1.2 of the NSSS, but can be used independently.

Nonetheless, there have been, and continue to be, many instances of confusion and miscommunication within construction projects as to who will be providing what information and when, particularly in respect to structural steelwork. This often causes considerable time and financial implications and may pose safety risks in respect of both permanent and temporary stability.

The purpose of this Business Practice Note is to highlight and clarify the structural engineer's duties and responsibilities, as well as to give guidance as to best practice to ensure a smooth transfer of information.

Allocation and communication of design responsibility

Communication and clarification are imperative. The project structural engineer should clearly convey what information they will and will not be providing. This should be consistent with their agreed brief and appointment (see *Business Practice Note No. 2: Fee proposals – assumptions (and exclusions)*[3]).

There are several aspects of a structural steel design that may, subject to agreement, be included or excluded from the structural engineer's brief. If parts of the structure are to be designed or detailed by others, the project structural engineer should clearly identify this.

However, the project structural engineer must maintain overall responsibility for the stability of the building, or structure, even if certain aspects of the design are assigned to third parties, or specialist contractors, and must clearly identify the requirements for overall stability.

BS 5950-1:2000[4] cl. 2.1.1.2 states that: *'The designer who is responsible for the overall stability of the structure should be clearly identified. This designer should ensure the compatibility of the structural design and detailing between all those structural parts and components that are required for overall stability, even if some or all of the structural design and detailing of those parts and components is carried out by another designer.'*

The Institution of Structural Engineers *Manual for the design of building structures to Eurocode 1 and Basis of Structural Design*[5] cl. 1.4 states that: *'One engineer should be responsible for the overall design of a structure, including stability, and should ensure the compatibility of the design and details of parts and components even where some or all of the design and details of those parts and components are not made by the same engineer.'*

It is also important to remember that the designer with overall responsibility for the building/structure cannot dispose of their legal obligations under the Construction (Design and Management) Regulations 2015[6] (CDM 2015) and that one obligation is for the project structural engineer to provide information for the pre-construction phase plan.

In Scotland and Jersey, the Structural Engineers Registration (SER) procedures ensure that, in most cases, the design should be complete prior to receiving the warrant or certificate of design. It also needs to be demonstrated that the design has been checked (to the appropriate level). Reference should be made to the appropriate category of

"THE PROJECT STRUCTURAL ENGINEER MUST MAINTAIN OVERALL RESPONSIBILITY FOR THE STABILITY OF THE BUILDING"

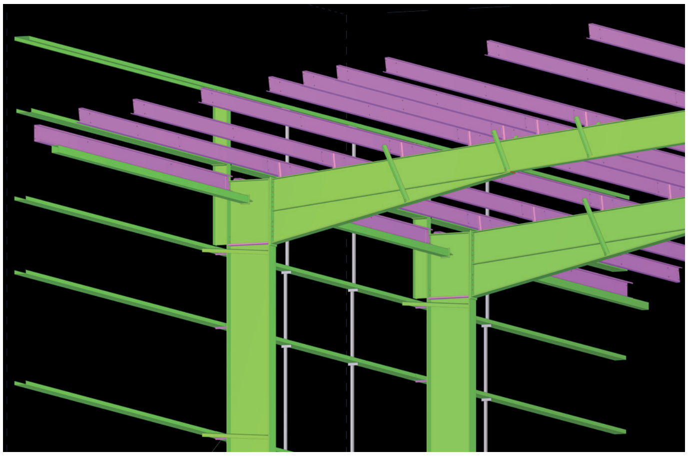

Figure 1
Frame designer must ensure that haunch moment connections can be achieved within constraints

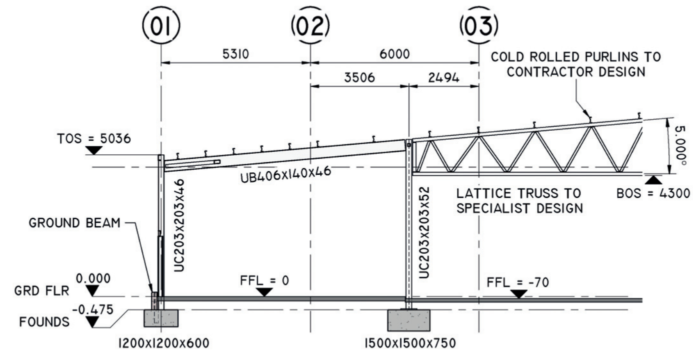

Figure 2
Truss design requires clear allocation of responsibility

the structure being designed (Category 1, 2a, 2b, or 3) and the extent of checking that is required[7,8]. If the SER system is followed, then the issue of misunderstandings, liability and contractual responsibility should be diminished significantly.

Notwithstanding any of the above, it is important that the project structural engineer clearly communicates who will be responsible for the various aspects of the project's structural design and detailing, e.g. design allocation, setting-out of the structure, levels, roof pitches, cold-rolled design, secondary 'non-structural' elements, pre-cambering, measured surveys.

Secondary steelwork and cladding

Secondary steelwork – both hot-rolled and cold-rolled elements – needs to be clearly defined within the structural engineer's output, along with clarity as to who will be responsible for designing it, how it imposes loading, whether and where it is expected to provide restraint to the primary structure, and where it can be accommodated. Coordination is essential when different parties are designing different elements that ultimately need to work together to provide the structural framework.

The main structure needs to take account of the cladding system being used and, as such, its design and connections to the primary and secondary structure should be resolved in good time. As elsewhere, clarity needs to be provided at the outset of the project as to who will be responsible for the design and detailing of the cladding.

Steel connection design

In the UK, it is common practice for steel connections to be excluded from the structural engineer's appointment and passed over to the steel fabricator. This can be acceptable practice, but it is vital that information is clearly conveyed to the fabricator, prior to their appointment, such that they can price and programme the implications of this important aspect of the overall design.

Clarity must be provided as to where responsibility lies for the design of all connection types, including steel-to-steel, steel-to-masonry, steel-to-concrete, base plates and holding-down bolts. Structural engineers should bear in mind that the default assumption of many UK steel fabricators is that they will only be responsible for the design of steel-to-steel connections.

If the connections are to be designed by a different party from the designer of the structural members/frame, then it is the duty of the member/frame designer to pass across all relevant information that is needed to design the connections. This will include shear forces, moments, torsions and axial loads, all of which must be clearly provided along with their appropriate directions and critical combinations. Disproportionate collapse tying forces, as a separate load case, should also be clarified by the frame designer at this stage.

The steel grades and sub-grades should also be clearly stated. Guidance on selecting the sub-grade is given in SCI Publication SCI-419 *Brittle fracture: Selection of steel sub-grade to BS EN 1993-1-10*[9] for quasi-static structures and in SCI Technical Report ED007 *Selection of steel sub-grade in accordance with the Eurocodes*[10] for fatigue structures.

It is also important to clearly state whether the connection forces are ultimate (factored) or working (unfactored) loads. Design codes and project-specific requirements should be clearly identified and communicated.

If the project structural engineer has an expectation for the steel connection types (such as full-depth end plates, fin plates, flexible end plates), these should be clearly stated with the issue of the connection loading information.

The structural engineer who designed the members/frame must also ensure that the designed elements can transfer the required forces at the point of the connections. It is unacceptable for the fabricator to be provided with connection forces that locally exceed the capacity of the members being connected. In the case of haunch moment connections (Figure 1), typically within portal frames, the frame designer must ensure that the connection can be achieved using the members specified and within the constraints of allowable haunch depths and lengths. If haunches have, or have not, been anticipated within the steel frame design, this should be clearly stated along with the limitations in both haunch size and position.

In particular, the project structural engineer should provide information on connections subject to architectural requirements and ensure that the connection forces provided are compatible with the stiffness of the connection assumed in the analysis.

Where connection designs are to be carried out by the steel fabricator, details of the proposed connections, along with supporting design calculations, should be submitted back to the project structural engineer for consideration and approval, prior to manufacture. Calculations should be clearly cross-referenced to the structural frame such that locations can be determined without ambiguity.

In trusses, particularly using

hollow sections, checking joint resistances is the truss designer's responsibility (Figure 2). They are not to be considered as simple connections. The ability of the component members to transfer the forces and moments at node positions, without extensive and expensive stiffening, is a vital part of the truss design. Reference can be made to the International Committee for Research and Technical Support for Hollow Section Structures (CIDECT) for further advice on this topic.

All information must be passed to the steel fabricator/ connection designer in a clear and unambiguous format; and provided in sufficient time to allow the design and details to be accommodated without detriment to the steel contractor's design and detailing programme. This timescale must allow sufficient time for the connection details and designs to be reviewed, commented upon and approved by the structural engineer who maintains overall responsibility for structural stability.

Within the EU, the project structural engineer must ensure that the Execution Class has been clearly stated, is correct and is relevant to the use of the building, to facilitate CE marking of the steel.

Assumptions

The structural engineer must clarify what has been assumed within their design and how this information will be communicated to other package or element designers and detailers.

Pre-cambering, particularly of long-spanning elements/ trusses, must be clearly defined and the implications of the pre-cambering on the fabrication process should be fully communicated and understood between the steel fabricator and project structural engineer. Kick-out forces at supports must be considered and the requirements for fabrication should be agreed prior to commencement of manufacture.

If the type of structure being designed necessitates non-standard construction or fabrication tolerances, this must be clearly identified prior to the appointment of the steel fabricator. It must also be stated how this will be measured and reported. An example of this would be 'top down' construction with king posts.

When designing elements within a steel-framed structure, the structural engineer should fully consider the effect of any elements that will likely need to be offset or displaced from an idealised centre-line analysis of the structure. Typically, this should include items such as bracing offsets and nodes, or eccentrically located members incurring torsional forces.

Avoiding pitfalls

Box 1 lists a selection of considerations that the structural engineer should be aware of and design for to avoid problems occurring.

Communication between structural engineer and steelwork contractor/ fabricator

As with so much in construction, communication is vital to ensuring a smooth-running and safe project delivery. Therefore, prior to commencement of the fabrication process (including design and detailing), the project structural engineer should:

- clearly communicate to the steel fabricator what information will be provided by whom and when
- clearly brief the steel fabricator on any critical or unusual conditions or expectations of the design
- provide timely and appropriate responses to requests for information (RFIs) and technical queries (TQs)
- review the steelwork contractor's drawings and design and clarify upfront whether they will be 'approved' or simply 'commented upon'.

Subject to any contractual restrictions, direct and regular communication between consultant, contractor and fabricator can be extremely helpful in resolving any issues quickly, effectively and efficiently. However, this should always be backed up with written confirmation of the agreed outcome[11].

Acknowledgements

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This note has been prepared by Matthew Byatt CEng, FIStructE, Eur Ing on behalf of the Institution of Structural Engineers' Business Practice and Regulatory Control Committee.

Members are reminded that they should always comply with the legislation of the region in which they are working and should be aware of any jurisdictions specific to that region.

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BOX 1. CONSIDERATIONS FOR STRUCTURAL ENGINEER TO AVOID PROBLEMS OCCURRING

- **Clearly communicate any client or project-specific vibration and natural frequency limitations, project-specific deflection limits or requirements to other parties carrying out frame or element design.**
- **Consider the potential for fatigue, particularly when the elements or the whole structure will be subjected to moving or varying loads, along with any requirements for bolted connections where slip may be detrimental to the performance of the structure.**
- **Ensure that designed members can be safely and economically connected together.**
- **Consider complex nodes, minor axis moments and torsions.**
- **Consider temporary stability during installation. This is particularly relevant in respect to temporary moments in base connections, force reversals during transportation or lifting, and torsion during the installation of precast concrete planks.**
- **Design software is an engineer's tool; it does not provide a foolproof intelligent answer! Ensure that member releases are correctly modelled, consider unwanted secondary effects, be aware of the use of floor plates as diaphragms, and check restraints. Sense-check the output. View the deflected form, moment diagrams and load paths. If it looks wrong, it probably is wrong!**
- **Consider the ready availability of specified steel sections, particularly where small quantities are to be used and on relatively quick programmes. For example, some universal beams and hollow sections can be limited in availability or designated rolling only.**

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