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How to ensure better steel connections

Assuring the lowest possibility of risk, misunderstanding, and avoidable costs.

A fresh look at best practice for steel fabricators; from contracts that work for all parties, through to the design and handover and confidence in the ongoing reliability of the steel structure.

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CHAPTER 1

Introduction: Framework is teamwork

This e-book from Symetri looks at steel connections from a fresh perspective. It proposes that structural steel connections are more than simply a matter of connecting beams to beams, and beams to columns. They should represent not just physical and functional perfection, but also how construction professionals connect with each other.

Mutual understanding and collaboration are stronger and more effective when they are brought to bear in the interests of project efficiency. They are weaker if they are driven by self-interest; when contractor/subcontractor contracts are written for the eventual apportionment of blame, rather than in the spirit of shared commitment to the highest quality project outcomes.

Other considerations also come into play. While Eurocode 3: design of steel structures[1] (part 1-8: Design of joints) is the referenced standard, ensuring conformity with it can be a complicated matter if the software selected by a steel fabricator does not directly align with Eurocode requirements.

Ensuring Eurocode conformity

Autodesk's Advance steel 3D structural steel detailing software, helps improve accuracy and reduce time to fabrication, while enabling a more connected BIM workflow.

"Structural engineers and fabricators can use models created in Advance Steel software, Revit software, and Robot Structural Analysis software to quickly export all data necessary and perform pass/fail checks of any joint according to American Institute of Steel Construction (AISC)/Eurocode[2]."

Ready when you are

Do you realise that you may already have Advance Steel within your business, ready to be called into action? If you have access to Autodesk's Architecture, Engineering, and Construction (AEC) Collection, you automatically have Advance Steel. As a compendium of essential BIM tools, the AEC Collection is a deep resource which companies frequently do not explore beyond their most commonly used tools, primarily Revit and AutoCAD.

[1] Eurocode Appplied.com | EN1993: Design of Steel Structures

[2] Autodesk University | Steel Connection Design — Extend Your Advance Steel, Revit, and Robot Structural Analysis Workflow

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CHAPTER 2

The steel fabricator challenge

Everything connects

Better buildings arise from more than the quality of materials used, the smarter technology and software deployed, and the experience, talent and vision of the people who conceive and construct them.

Successful projects don't come about just because the right ingredients are thrown into the mix. They happen because those ingredients are brought together in the right way. They result from understanding—between the many construction professionals involved—of the role that each of them performs, and its dependency on the roles and actions of others.

The stress point

Problems often arise in steel fabrication not through lack of knowledge about processes and materials, stresses and torsions, compressions, loading combinations, pins, plates and point loads…The real stress points may be where you would least expect them to be:

- The many specialists involved in the path from design to erection.
- The changes that need to be made in the evolution of a live project.
- The speed with which the changes have to be made.
- Software interoperability and data loss.
- An occasional lack of clarity about who should take care of what problem, at what point, and with what implications.
- The negative outcomes if things go wrong; costs, profitability, penalties and possibly even legal redress.

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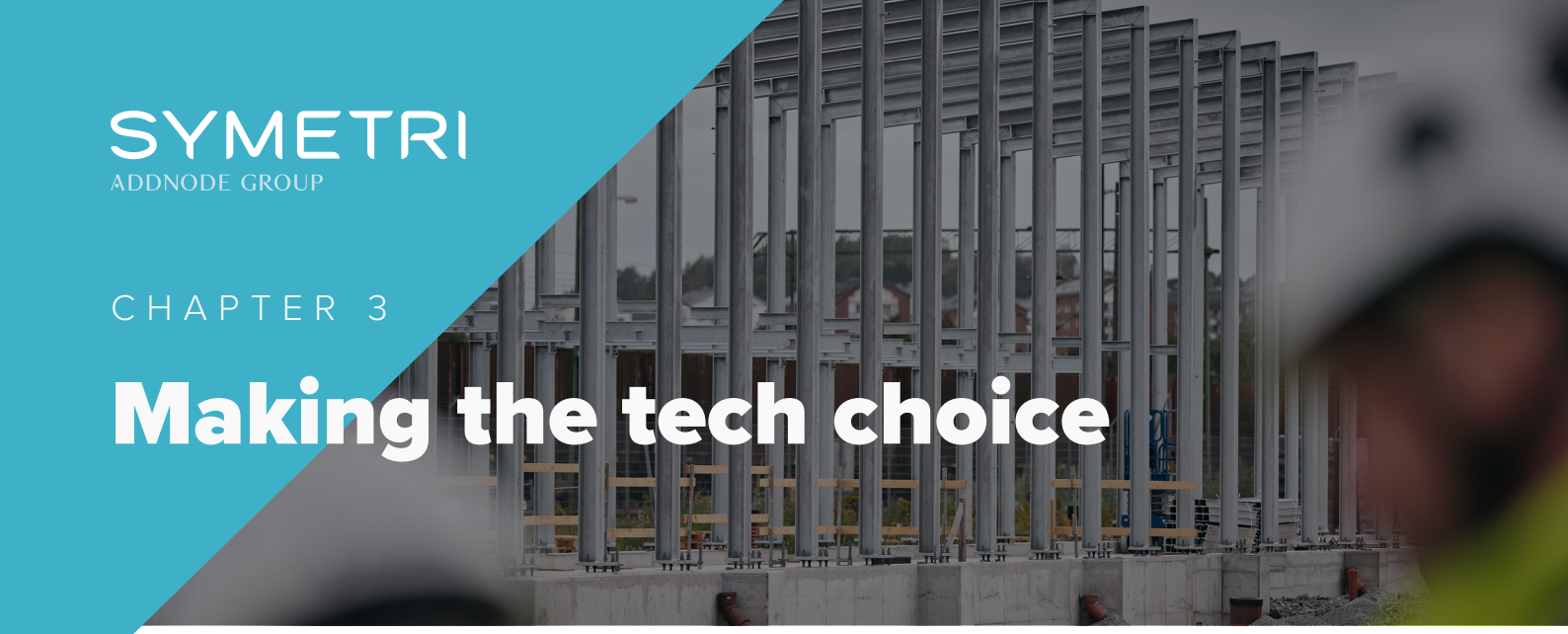

CHAPTER 3

Making the tech choice

The more that architects, structural engineers, contractors, steel fabricators and other subcontractors talk to each other, and the more they share ideas and concerns, the more they mitigate risk, deliver on client expectations, and enhance their own reputations.

Integral to such dialogue—in a digital age and an industry that is continually advancing in its adoption of technology—software solutions help ensure the highest attention to quality and accuracy. They make the connections between design elements while also making the connections between people.

Match the software to the use case

Software that exceeds the purpose you need it for represents unnecessary investment. Indeed, for many companies involved in the everyday business of steel structures—as opposed to the type of structures that break records for their scope and enormity—it's not an investment at all. It's just wasted expenditure.

An appropriate and affordable software solution exists for steel connections for use in commercial, residential, and mixed-use projects based on steel frame structures; from the sheds that now serve the expanding distribution requirements arising from ecommerce, to offices and smaller residential developments.

Always be sure that any software you deploy for steel connections, as well as for working with Revit models, is fit for purpose for the project size and foreseeable business growth; beyond that, and you may well be paying for capabilities you may never require.

Software selection is only part of the challenge, albeit a vitally important part. Collaboration is equally and essentially critical; in terms of digital connections throughout the construction value chain—which sit at the heart of Building Information Modelling (BIM)—and in terms of personal connections.

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CHAPTER 4

Nerves of steel: A fallible contract clause

Steel fabricators are no strangers to re-inventing the wheel. When they receive the framework model from the initial structural engineers, steel fabricators invariably need to set about creating a new model to add the connections to tie all the elements together.

At face value, the practice is sound. The company that specialises in steel fabrication is the best positioned to assess the nature of the connections required.

Somewhere within this process, there's a disconnect

The remodelling itself can take up to 30% of the time allocated for the fabrication task. If potential issues are identified (bearing in mind that they sometimes may not be) then matters need to be clarified with the originators of the master structural model, the structural engineers.

The structural engineers on a project may well offer input in resolving the issue or they may not, if they consider that their part of the project has been responsibly and appropriately completed. If that happens, the idea of then allocating further time to a fix may fall way down on their priority list. They may also point to the contract and politely remind the steel fabricator that they have full responsibility for resolving all matters relating to the implementation of the structural connection design from a steel fabrication perspective.

In other words, resolving any identified issues may not be achieved in a quick phone call, or via a seemingly rational request for a design revision by the structural engineers.

> This has always been the normal run of things; specialist 'A' completes their task and passes the model to specialist 'B' to complete theirs, and so on. As the baton is passed, that's where the margin for slippage exists.

As fabricators add the connections, they also embrace full responsibility and liability for any structural defects that may become apparent as the project progresses. The engineer is long out of the picture. The client awaits the final outcome.

In between, the fabricators know that any subsequent buckling or movement, and the consequences thereof, will bounce back to them, whether in costs, courts, or credibility.

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CHAPTER 5

Small print, big problem

Problems arise when two often-opposing factors collide while the job is in progress:

- Take the weight: As an example, encountering an unworkable aspect in the design, the fabricator shows willingness to fix the issue, work round it, and ensure the project still gets delivered on time.
- Take the blame: The workaround may become complicated and costly. Or, the fabricator may have misinterpreted the design.

Design Responsibility

The steel fabricator challenge is well-summarised in an article in The Fabricator, North America's leading magazine for the metal forming and fabricating industry:

”A fabricator who misreads the design and miscalculates the bid will likely be held to the terms of the contract and bear the consequences in time, cost, and reputation. If the fabricator wins a job that has an unworkable design, through no fault of its own, the company still risks increased costs and lost time. The involved parties might have to resort to drawn-out litigation to recover what is due. Even after all this, a fabricator still can get burned.[3]”

[3] The Fabricator: A smooth structural fabrication project requires a good contract

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CHAPTER 6

The recent past

Across the construction industry, Building Information Modelling (BIM) is bringing specialists together in collaborative workflows, shared models, and greater understanding between architects, engineers, and contractors.

The connected workflow

In bringing the vision of better buildings into everyday practice, BIM has been breaking down silo walls. It's creating a digital open-plan office, where everybody has a far greater understanding of, and sympathy for, the value that's added and the challenges encountered by each specialist preceding and following them in the workflow.

The result is that the work flows better, faster and at lower costs. The outcome is that clients are more fully more satisfied; having enjoyed enhanced confidence through the progress of the project that the 'whole' will be greater than the sum of its parts. In the past these parts were less interwoven, they were more like contributors to a project than co-creators of it.

The present challenge | The Eurocode imperative

Steel fabricators should not be considered as external add-on 'suppliers' to any project. Their role is integral to its success, its safety and its sustainability.

Eurocode 3 defines connections as the "Location at which two or more elements meet. For design purposes it is the assembly of the basic components required to represent the behaviour during the transfer of the relevant internal forces and moments at the connection".

If anything can go wrong, it's eminently possible that right there at the point of connection is where it will go wrong.

In the vastest of projects, this consideration is addressed in design and analysis software specifically designed for the immensity of the task. The cost of such solutions tends to reflect the stature of the projects for which it is intended i.e., big. Yet the cost for major contractors is usually absorbed in the equally stratospheric budget.

Now, for the future

Equally robust solutions exist for fabricators working on construction projects that are the stuff of everyday life, the fabric of society, the steady growth and support of the national economy: domestic and commercial developments, warehousing, shopping centres, local government facilities, healthcare, education, and recreation.

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The BIM context and Design and Build contracts

If the contract pertaining to steel structures appears to offer exposure to the steel fabricator, it is an area that all steel fabricators are advised to pay very close attention to.

BIM is themed throughout with the spirit and a recognition of the value of collaboration. It is not about protectionism, insularity, or self-interest. Indeed, by creating practices that are in the interests—and for the benefit—of all parties, it could be considered as self-interest in its purest form; if all benefit, each party benefits.

Design and build contracts: The single point of responsibility

The ideal contract is one that brings all parties together to work as a fully integrated team, in harmony and shared (collective) interest.

The advantages of design and build[4]

- Single point of responsibility for design and construction.
- Earlier commencement on site.
- Early price certainty.
- Benefit of contractor's experience harnessed during design.

The process of working effectively as a fully integrated team depends on transparency and seamless connection, from design through to handover, and from architect and engineer through to every contractor and subcontractor responsible for bringing ideas to fruition. This approach is the embodiment of BIM:

”The benefits of BIM are through connecting teams, workflows, and data across the entire project lifecycle—from design and engineering to construction and operations—to realise better ways of working and better outcomes.[5]”

[4] Details taken form 'Design and Build procurement Route' at Designing Buildings | The Construction Wiki

[5] Autodesk: What are the benefits of BIM?

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CHAPTER 8

The technology connection

Autodesk Advance Steel sits within the Autodesk AEC Collection. This not only means that you may also have access to it on your computer, but also that it's subject to the benefits that come along with the complete AEC Collection such as easier software and licence management, automatic updates, and the flexibility of shared licences for multi-user access if required.

Advance Steel is interoperable with Revit software and other BIM solutions—supporting a more connected BIM workflow from design through fabrication to construction.

3D modelling tools to accelerate design and detailing

Built on the AutoCAD platform, Autodesk Advance Steel is easy-to-use and comprehensive for structural steel detailing.

It enables you to enhance productivity by accelerating the design process; eliminating the 30% extra time taken up when receiving the structural engineer's model and making additions to it for the steel connections.

Automated connection design

Within the software is an extensive library of intelligent, parametric structural elements, steel connections, and plates. You can also model your own custom elements and connections with intuitive tools.

- Speed time to fabrication by automatically generating shop and general arrangement drawings
- Create bills of material (BOMs)
- Produce DSTV CNC files directly from your designs.

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CHAPTER 9

Six ways to ensure better steel connections

Before connecting the steel, fabricators are well advised to start by connecting the people:

- ✔ Become part of the **connected, collaborative ecosystem** that today's construction value chain has evolved into.
- ✔ Ensure your company's ability and capabilities to work within the **model-centric BIM-driven workflow** where parties share federated models.
- ✔ **Save the extra 30% remodelling time** involved once you receive the engineer's model.
- ✔ Ensure the **seamless coordination** of your design contribution in real-time so that changes are notified to all parties, transparently, visually and digitally.
- ✔ Don't take the blame; eliminate the need for any such reaction by **foreseeing the problems** and additional changes required and making sure that all other parties see them too.
- ✔ Revise those **contracts**.

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About Symetri

At Symetri we support innovative Architecture, Engineering, Infrastruture and Construction companies to optimise their working methods and increase the quality of their projects. Our purpose is to challenge people to work smarter and to turn ideas into new realities that shape a better future.

With a combination of our own IP, best-of-breed technology from our partners and a comprehensive range of services, we enable our customers to build sustainably, maximise efficiency and increase their competitive advantage.

Our services include the provision of software, consultancy, training and support, and we offer a comprehensive range of IT and Document Management solutions. For further information, visit www.symetri.co.uk.

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