DETAILED DRAWINGS:

WHAT SHOULD THE ENGINEER BE LOOKING FOR?

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The engineer, the contractor and the draughtsman all should have important reasons why detailed drawings should be correct .In addition to purely financial considerations, the engineer so that his structure will perform satisfactorily, the contractor so that his artisans can efficiently and correctly manufacture the steelwork in the works and that the steel will be erected quickly and accurately and the draughtsman so that he can satisfy his client and keep getting more work from his clients.

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BACKGROUND ISSUES

The advent of the 3D detailing package (Boucad, Strucad and Tekla amongst others) has created an enormous problem for design engineers who must accept responsibility for structural correctness of connections and detailed drawings done by others on his projects in that he now is presented with a box file of detailed drawings that he is expected to go through, check, markup and accept as being structurally correct.

Just the sheer volume of paper is intimidating for the engineer. In any case why on earth would the engineer want to look at each and every connection or gusset plate or for that matter each shaft of steel with its drilling details? The only exception to the rule of not looking at each and every piece small drawing would be where full penetration welds are required and the weld preparations should be shown on the piece small components to ensure that the preparations do get cut into the components. Hopefully the engineer can limit himself for most simple structures (without full penetration welds) to then only looking at the "assembly" drawings (usually prefixed with a letter before the drawing number for easy identification).

However what follows applies equally as well to hand drawn details - the structural issues are largely the same. It is just the number of drawings that differs.

Before suggesting what the contractor should instruct the draughtsman to ensure he prepares drawings that suit the contractors favourite methods of fabrication and what the engineer should look for and when in the drawing process he should look for when it comes to checking the drawings, let's step back a bit and get to basics. Might I add that a whole lot of issues can be prevented by having a round table discussion between the engineer, the contractor and the detailer before the detailing actually commences.

What is the engineer's responsibility? Well he has to ensure that his design is correctly interpreted by the contractor, that all the contractors structural decisions (setting out points, connection design, number, type and size of bolts, size of welds, weld consumables, etc) will result in a structure that conforms to his design so that he can sign off the structure on completion.

The engineer certainly has no responsibility for the dimensional accuracy of the drawings but of course would be very counterproductive if he noticed errors without passing on the information to the contractor.

WHAT THE ENGINEER SHOULD LOOK FOR WHILE THE "WIRE DIAGRAM IS BEING CREATED"?

For some time now, SAISC has been advising engineers that the best time to do over view checking is whilst the contractor draughtsman is actually setting up the wire diagram of the structure. At this point in time it is easy to check that the dimensional layout is correct but more importantly that setting out points (SOP's) are in the correct places for diagonal items such as bracings, internal members of trusses/ lattice work and so on.

Based on a recent bad experience it is necessary that the draughtsman draws the floor when viewed from the top down (if it is, as one would usually expect that it is a requirement for the tops of floor beams all to be at one level) and not upside down - which can and will lead to expensive rectification. (There might of course be a specific situation where the engineer needs the bottom of the floor to be level and if this is the case, it is unusual, and thus the engineer should make big effort to pass on this unusual requirement to the draughtsman.)

Clearly it is necessary for the engineer to ensure that every component he has called up and obviously requires does get detailed in the wire diagram to ensure it gets built into the structure. In another bad experience recently a crane structure with latticed crane columns was built without the top diagonal member of the crane columns (actually from the bottom of the crane girder to the house leg) resulting in all sorts of movement and loosening of the bolts.

MATERIAL SIZE AND GRADE ISSUES

The engineer must also ensure that the section size called up on his drawing is exactly what the detailer calls up. It is not unusual for the detailer to just automatically call up the most commonly used section from a serial size (e.g. 406UB178x54) without paying close attention to the actual mass called up (say 406 UB 178x67). The consequences of calling up a lighter than the designed for profile are obvious i.e. we could have a structural failure. Calling up a heavier profile will of course just cost the client more money if the error is not noticed down the line.

Just as important at the early stage is to ensure that the correct grade of steel is called up. This can be quite important in the interim situation where Grade 350WA beams are called up and used, but due to non-availability of grade 350WA plates, the contractor decides to use grade 300WA for the connection plates. In principal there is absolutely nothing wrong with this as long as the connections are correctly designed.

Other items where the material grade could differ from the design drawings might be in Cold formed items (purlins and girts) which might be out of commercial quality coil, a 300MPa equivalent yield, or an even higher grade such as pre-galvanised Metsec.

Thus it is important that the material grade is called up clearly on both piece small parts and can be shown on the assembly drawing in the table of components what grade each component is made from.

WELDING ISSUES

Equally important is that the correct class of welding consumables are called up on the drawing (E7018 or similar are recommended to be compatible with 350WA steel). For that matter draughtsmen are notorious for not showing any or all welding information on their detailed drawings. So it is necessary to look for weld types and sizes (making sure that they call up the leg length size of the welds required by AWS and not the throat size of a fillet weld as the Euro Norm specs call for). Due to the lack of knowledge of draughtsmen and work shop boilermakers in general about welding it is very important that in particular correct details of weld preparations are shown in detail for all full penetration welds (or even partial penetration welds).

In this regard, draughtsmen often omit to show where shop welded splices are to be executed. These splices are typically required when lengths of steel available are too short for the finished component. Splice welds should be full penetration (complete joint penetration in AWS terms) welds and thus require the correct weld details to be successfully executed, remembering the rule of thumb gap should be a 60° opening groove for most complete joint penetration welds, this may go down to 45° in some cases, a root opening and step should also be shown. Weld testing requirements should also be called up on the detailed drawings where applicable.

Great care must be exercised in checking weld symbols when shown on drawings. Once again it is easy to mix up the symbol for fillet and penetration welds - the former being a closed triangle and the latter being an open triangular symbol. The SAISC therefore advises engineers to ask for a short description of what weld is required to be called up on the detailed drawings (such a 5mm CFW (continuous fillet weld) or CJP (complete joint penetration weld commonly, but loosely, called a full pen butt weld FPBW).

DETAILING ISSUES RELATING TO BOLTS AND WASHERS

It is necessary for the draughtsman to ensure that the correct class grade of bolts is called up for each connection.

SAISC has for some time been recommending the following simple rules to help ensure that the wrong class grade (the worrying one would be lower strength) of bolts do not get inserted into a connection:

1. Grade 4.8 bolts should only be used for "minor connections" such as purlin and girt connections, handrails, stair treads and the like. To prevent the grade 4.8 bolts going into a hole intended for the grade 8.8, we recommend that only 16 diameter grade 4.8 should be used, and that grade 8.8 bolts should be from 20 and 24mm diameter bolts.
2. Class Grade 8.8 20 and 24 diameter should be used for all typical structural connections
3. Friction grip or other non-slip connections should be used when the good design practice calls for this type of connection. The use of this type of connection must be clearly shown on all relevant drawings (including erection drawings).

When it comes to non-slip or friction grip connections it is important that the correct information is called up on the detailed drawings. In the case of the former the correct diameter of the holes should be called up (i.e. zero tolerance on holes (rare), 0.2mm oversize holes or 0.5mm oversize holes. In addition, the thread should not normally be in the holes so great attention must be paid to the length of the bolt ordered. In the case of the latter the condition of the faying surface and any special treatment must be clearly called up on piece small drawings and on assembly drawings. Common surface preparations for faying surface include for shot blasted and protected till bolting is executed, shot blast and clean immediately before bolting and in the case where corrosion plays an important role, inorganic zinc rich primer paint (this and only this paint) has similar friction attributes as a shot blasted surface and may be applied to the faying surfaces.

Finally engineers and draughtsmen are reminded of the benefits to the contractor by taking advantage of standardisation of the lengths of bolts offered by allowing the 25mm protrusion permitted by SANS 2001-CS1 (see pages 6.12 and 13 of the "Red Book").

Once again the draughtsman has a responsibility to ensure that washers, where required, are always called up on the drawings and or bolt lists.

To remind readers the main requirements for the use of washers are as follows:

1. Hardened washers are required under the turning component of friction grip connections.
2. Washers are required to be used with all "oversize" holes i.e. slotted holes or bigger diameter.
3. It is good practice to use washers on all previously corrosion protected surfaces

"End of part one: Watch this space for part 2 in our next issue where the article will continue to look at specific forms of construction but will also cover some good practice thoughts for designers".

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