

Cost versus Value -

The role of the Consulting Structural Engineer

2012 President of the Institution of Structural Engineers, John Nolan brings a very special combination of career experiences to his year in office. A Chartered engineer who has worked as a labourer, contractor's engineer, consulting engineer, business owner, property developer and client, John is extremely well placed to challenge consulting engineers on the conundrums of 'Cost versus Value'.

Based on his recent Inaugural Address, he provides an insight into the experiences that shaped him as an engineer, drawing on observations from his own business life and offers some practical suggestions and solutions for both engineers and the Institution who support the profession.



Personal background

Having passed the 11 plus examination I was accepted by St Philips Grammar School in Edgbaston. There I made some great friends, played a lot of sport and found myself leaving with what I later realised was a great education. My first job on site was during the Christmas holidays when I reached my 15th birthday. It was legal then. I was employed as a general labourer by a local firm on a 16 storey block of flats near Saltley Gas Works (Fig. 1). I have vivid memories of that site as I almost managed to get myself killed on a number of occasions during the three weeks that I was there. Building sites in those days were seriously "macho" places where the concept of Health and Safety hadn't yet been invented and where the younger guys in particular would compete with each other to see who would take the biggest risks and the older guys would encourage this! I'm embarrassed to record that on one occasion I raced another lad from top to bottom of the building down the outside of the scaffolding! Thank goodness lunatic behaviour like that is no longer tolerated. Management too would often take short cuts in those days. I vividly remember tripping on the 16th floor scaffolding and because of the absence of toe boards losing a wheelbarrow and its contents over the side, luckily nobody was underneath! That period was also memorable for a huge explosion at Saltley Gas Works. I was working on the roof at the

time and was blown off my feet by the blast!

From that point on, during every school and university holiday I worked on site doing a variety of labouring jobs including pipe laying, concreting, hod carrying and, in the year I left school, piling the foundations for the major motorway intersection that became known as Spaghetti Junction (Fig. 2). That piece of road has had lots of problems over the years but I am pleased to say that these don't appear to have included the foundations - although I did have my doubts!

What did I learn from these experiences? Well obviously how physically hard and

sometimes dangerous working on a building site can be and how difficult it is to achieve the construction tolerances when you are cold and wet and up to your ankles in mud. Having said that, the great sense of achievement you get from creating your part of the project is absolutely fantastic. I have nothing but admiration for those men and women who turn our designs into reality. Given how difficult their job is I am convinced that we should all be making every effort to generate designs that can be substantially assembled off site in factory conditions so that site work is kept to an absolute minimum and is as simple as possible.



Figure 1 Saltley Gas Works with flats in background © Alamy



Figure 2 Spaghetti Junction, Birmingham
© Alamy

Figure 3 Fond memories of North Wales



Figure 4 Tenby Electrical. A redevelopment of the former Lucas HQ site

Figure 5 The NatWest Tower (now Tower 42)
© Stockphoto

It doesn't need to be as difficult for them as we often make it. Anyone who thinks building to 1/2mm tolerance is possible should try measuring their desk to that level of accuracy. Too often designers and contractors work in isolation, neither taking advantage of the other's knowledge and experience. I wonder whether the Institution has a role to play breaking down this "silo" mentality?

Apart from the money and the experience the other huge positive from this hard manual work was that I became much fitter and stronger than I would have otherwise been and I suspect that this had a bearing on me being invited to join Moseley Rugby Club during the summer I left school. I am still involved with the club to this day. There is a strong possibility that I played against last year's President, Roger Plank around that time, but neither of us remember it.

After school, with my A-levels under my belt I headed for Lanchester Polytechnic (now Coventry University) to do a sandwich degree in Civil Engineering, with every

intention of becoming a contractor. My rugby commitments meant that I stayed in Birmingham and commuted every day to Coventry. In hindsight, possibly because most of the lecturers had spent time in industry, the course was very practically based and clearly targeted at providing us with the skills to make us useful the day we graduated, whether we started work on site or in the design office. I am eternally grateful for the efforts of the excellent staff, led by Jack Cain, who were always very generous with their time.

Lanchester arranged for my 15 month sandwich placement to be with a civil engineering consultant in Birmingham called Sir Herbert Humphries and McDonald who specialised in sewerage and sewage treatment works and were involved in some structural projects. They were a very busy practice at the time and were very supportive of me, giving me quite substantial sections of projects to design and detail from day one. Those were the days before computers had reached the design office

when engineers used slide rules and log tables and were expected to draw their own designs. Marvellous training! One particularly memorable experience was designing, detailing then acting as assistant RE on a rural sewerage and sewage treatment works project in a village called Loggerheads in North Wales. There was a pub opposite the site and I've always appreciated the sign outside (Fig. 3). They must have seen me coming!

A couple of weeks after I came back from North Wales I got married to my wife Valerie and soon after returned to Lanchester for my final year. This coincided with Valerie's final year at teacher training college in Birmingham. Unfortunately, I managed to get quite badly injured in my first rugby match after the wedding and was unable to play for the remainder of the season. The upside to this was that without the rugby commitments Valerie and I were able to devote all of our time to studying for that year and I surprised myself and my lecturers with how much my work improved.



I had just finished a part time Masters degree in Structural Engineering



Formative Career

I graduated in 1974 but due to an IRA bomb threat the graduation ceremony was cancelled. I was finally presented with my certificate in 2010 when the university realised that my year had missed out.

By 1974 the boom times of the 1960's had faded away to be replaced by the "Winter of Discontent" and the "Three Day Week" with a rolling programme of power cuts. My first recession! I was fortunate to get a job with RM Douglas Construction, now part of Interserve, again in Birmingham. I thought I was going on site, but when I turned up for work I was sent to the design office because of my previous design experience. I was delighted because still wishing to be a contractor I thought that it would be great

to get my design experience for the "Civils" out of the way early. I am not sure I had even heard of our Institution back then.

At that time Birmingham and the West Midlands were still centres of industry and most of the projects I worked on were heavy industrial such as extensions to Patent Shaft and Round Oak Steelworks and a number of the Lucas car component factories. Sadly, despite the investment, these factories closed down and later in my career I was involved in new developments on those sites including Tenby Electrical (Fig. 4). I was also seconded to subsidiary companies British Lift Slab and Rapid Metal Developments to help out when they had design peaks. This gave me the opportunity to work on the NatWest Tower (now Tower 42) in London (Fig. 5), several slip formed silos and a number of Lift Slab system buildings including multi storey car parks and a large hospital block in Australia. Many of you will have heard of the Pipers Row car park collapse which effectively sounded the death knell for this extremely cost effective form of construction, whereby all of the slabs were cast one on top of the other on the ground and then jacked up the columns to their final position. In my opinion the collapse was caused by construction and maintenance problems and not by the system.

Douglas were a great training company and used to regularly give in-house lectures by directors and senior management for their trainee engineers and other technical staff. I remember a particular talk by the late Mike Manzoni who was MD at the time, who turned up with samples of different building materials and asked us what they cost when fixed. I remember being embarrassed by how weak my knowledge was when I was rightly asked: "How can you advise someone on design and construction if you don't know the comparative cost of the materials and methods you are using?" He also brought home to us how much over ordering and waste added to the cost of a contract.

After several years in the design office I was transferred to site for my "Civils" experience and spent the hottest summer on record roasting in a hut on the roof of Lucas HQ acting as estimator on their small works term appointment. By the time I had finished I did know what things cost! Years later I advised on the redevelopment of that site, and I am pleased to say that it was for the construction of a modern factory. I moved from there to senior engineer on an industrial site for Slough Estates and from there, to the Austin car factory at Longbridge where I was sub-agent on the construction of a new office block and extension to the engine works.

Given the infamous state of the industrial

relations at that plant, which I was horrified to see at first hand, it was no surprise when it eventually closed down. Since then we have assisted in the redevelopment of the site.

When that project completed I returned to the design office and assisted the RMD engineers with the R&D work on a new formwork system for speedy construction of in-situ concrete, medium rise, housing called "Roomform" which I understand is still in use. Having sampled the delights of contracting and design I concluded that my preference had changed to design and that if I wanted a career in design I should move to consultancy; a move that was given impetus by the desire of RMD that I should go to Iraq to teach their engineers how to use the "Roomform" system. However, I decided to remain in the UK and seek alternative employment.

It was fortuitous that about that time I had already taken the "Civils" and our Chartered Membership exam and managed to pass both. I had also just finished the last module of a part time Masters Degree in Structural Engineering at Warwick University. This comprised two evenings a week and one full time weekly module over three years and provided the privilege of being taught cutting edge structural engineering by the a superb Warwick team led by Gold Medal winner Roger Johnson and former Vice President David Anderson with guest lecturers such as Past President David Nethercot and the polymath RH Wood. Unfortunately Warwick no longer run this course, but given the fee pressure now placed on undergraduates I wonder whether a split degree with a full time Bachelors qualification topped up with a part time Masters course might be a more affordable model for the future education of our engineers.

I moved to a firm of consulting engineers called Farebrother and Partners in Edgbaston as an Associate to replace a chap called Roger Plank who had just passed his CM exam and gone off to be a university lecturer!

Older members will remember that this was about the time that we were changing over to "limit state" design and my new boss Jim Farebrother was greatly concerned that this was making the design process too unwieldy and expensive. He'd turn in his grave if he could see the Eurocodes! I assisted him and Michael Little of Kenchington Little in the writing of an Institution handbook to try to simplify the process. I understand that it is still available from the Institution Bookshop.

Farebrother's were one of the preeminent structural consultants in the Midlands at that time and as such provided experience

designing a huge variety of building structures. However the project I remember best is the collapse of limestone workings under a factory estate in the Black Country causing progressive settlement of 25mm a day and resulting in a differential settlement of 1.2m across one portal framed building. The processes in this building were too expensive to move out so I was tasked with keeping the building open and safe. Hand analysis could not keep up with the rate of movement so I modified an elastic programme to carry out a quasi elastoplastic analysis of the frame. For several months we had a rolling cycle of survey one day, analyse in a computer bureau in London the next (there were no PCs then), and reporting on findings on day three. We managed to keep the building functional all the way through the movement and when it stabilised we strengthened and refurbished it for ongoing use.

It was during this time that Hilary the first of our three children was born. She was soon to be followed by her siblings Ruth and Ciaran, giving us the delight of three children under the age of four.

Business Ownership

After four years at Farebrother's I left to set up Nolan Cameron Taylor with three partners and jointly ran the Birmingham office. From small beginnings, by the time I left that practice ten years later, we had grown it to several hundred strong and it had evolved into Cameron Taylor Bedford with seven offices. It is now part of URS.

Coming from a contracting background I always had a great affinity with 'design and build', and as a consequence much of our workload was with contractors. We were also lucky to meet McDonald's when they arrived in the country, particularly as this was in the middle of the early 1980's recession.

One thing I am particularly proud of from that time is the contribution we made in value engineering the now ubiquitous McDonald's "drive-thru" down to a third of the cost and a third of the construction time of the traditionally built design. We did this by standardising the design to a structure that could be factory engineered and fitted out, transported to site in 6no 3m by 12m modules and founded on prefabricated foundations. This concept has since saved hundreds of millions of pounds worldwide. The downside was that we effectively engineered ourselves out of a job!

I left CTB in late 1992 and set up Nolan Associates with my wife Valerie in early 1993. At that time the recession was just starting to ease and we were fairly quickly joined by the bulk of my former staff. The

Figure 6 Euro Packaging UK Ltd warehouse, Birmingham. An 11 storey apartment block could fit inside this structure

Figure 7 Brindley House, Birmingham



vast majority are still with us. I would like to take this opportunity to thank them all - and particularly my co-directors led by Andy Williams - for their great loyalty and support over the years. It's easy to lead when the team is of the highest quality!

The team grew steadily over the years reaching about 60 by 2007 when we made the decision to sell to a public company called Erinaceous, who were keen to build up a building consultancy division. It would be disingenuous to say that money wasn't a factor in that decision, but I can honestly say that after 15 years of a rising market it struck us that the end to that cycle was overdue and jobs would be more secure in an organisation that had several client divisions.

This turned out to be wishful thinking when a year later Erinaceous was the first high profile property industry company to go bust, heralding the start of the recession and putting all those jobs at risk. Within a week we bought the assets of the business from the administrator and entered the battle for survival that the recession became. Unfortunately we weren't able to save all of the jobs, but with the benefit of across-the-board salary sacrifices we have been able to keep the core of the team together. Examples of some of the work undertaken by Nolan Associates include: a 33m to underside of haunch warehouse in Birmingham (Fig. 6). This project represents one of the largest warehouses in the UK - Birmingham Air Traffic Control came onsite to check that it didn't interfere with the airport's flight path!; Brindley House - a former BT Exchange in Birmingham (Fig. 7); the temporary spectator stands for the 2012 Paralympic tennis in London (Fig. 8); the former Qualifications and Curriculum Development Agency (QCDA) offices in Coventry (Fig. 9) and Calthorpe House in Edgbaston, Birmingham (Fig. 10).



Figure 8 2012 Paralympic tennis stand (temporary structure)

Figure 9 QCDA offices, Coventry



I mentioned earlier that we had always had an affinity with contractors and this proved to be very valuable building up Nolan Associates as when working for them on D&B projects it established our reputation with our developer client base. Over the years we have worked on the complete spectrum of building projects from Airports to a Zoo and nearly everything in between. I am pleased to say that we are still commissioned to design industrial units



Figure 10 Cathorpe House, Birmingham

Figure 11 Recycling miles of telecommunications cables at Global Cable Recovery

Figure 12 Power generators supplying the National Grid at Green Frog Power



and that once more they are a growing proportion of our workload. In these tough economic times, value engineering contractors' tenders has again become a significant part of our turnover.

By way of finishing this autobiographical section, I should also mention that in 2003 I became one of the founders of a property company called Antringham Developments and in 2010 I became chairman of Global Cable Recovery (Fig. 11) which specialises in recovering and recycling redundant terrestrial and sub sea cables. Last year I became a director of Green Frog Power (Fig. 12).

Formative years of involvement with the Institution

I am embarrassed to say that other than taking the Chartered Membership exam and going to technical meetings I had very little involvement with the Institution in the early part of my career. For those of you who

are wondering how I came to be elected as your President I can reveal that it all came about because I was a member of our office team that won the Midlands Branch (now Regional Group) quiz. I was making up the numbers! The organiser, Tony Strong, who is a stalwart of the Group came up to me afterwards and pointed out to me that I had received a lot from the Institution but hadn't put much back and wasn't it about time that I did! He suggested that I should put myself forward for election to the Branch Committee. I didn't know how to say no and was duly elected. There was a shortage of willing candidates at the time! The following year I was asked if I would consider standing as Branch Junior Vice Chairman as there were no other candidates, but not to worry because it wouldn't involve a big time commitment! You might be starting to notice a pattern here! This of course lead to the start of my exposure to HQ and various committees and panels such as the

Professional Conduct Committee and the Health and Safety Panel and then, as Branch Chairman, member of Council.

Prior to then I had a view of the Institution as London-centric, but I was delighted to discover that it really was the sum of the Branches and Divisions and that London was just the most convenient location for the HQ of a worldwide organisation. I became a Member of Council just as we were reorganising the management structure of the Institution and setting up the Executive Board. Keith Eaton who was Institution Secretary at the time asked me if I would allow my name to go forward for election to that Board and once again, lacking the ability to say no, I agreed and was duly elected by Council; so much for "not a big time commitment". I'm making this sound like a chore, but truly it has been the opposite - it has been incredibly rewarding. The Institution has evolved enormously since then and I consider myself honoured to have been able to play a small part in that.

Cost versus Value

The traditional role of the Institution has unashamedly focussed on technical engineering and design competencies together with the competencies demanded by our examinations. This is of course the essential component of our purpose as an Institution to promote safety and competence in structural engineering for public benefit.

Structural engineers however offer far more to the construction process and as I started to reflect on my experiences as a contractor, consultant, property developer and client it became clear to me that we have a tremendously important role in the area of "cost versus value". As an Institution we should take the opportunity to raise our profile in this arena too, since it impacts on safety; quality; sustainability; project viability and not least, the standing of engineers as part of the modern project team. This provided the focal point of my inaugural address (and this article) and I am grateful for the encouragement I have been given by several past presidents to tackle this theme.

Firstly, some observations based on my personal experience and I acknowledge that this is predominantly UK focussed. One of the very real benefits of belonging to this organisation is that we are a "Global Institution for a Global Profession". It will therefore be one of my personal ambitions during my year as President to understand how these issues are tackled internationally and see how the Institution can inform and facilitate the sharing of best practice opportunities.

The conundrum

In my opinion, compared to other professions most of us sell our services at far too low a cost and this can have a detrimental effect on the value we generate for society, our clients, our staff and shareholders.

It is one of the rules of Professional Indemnity Insurance that an engineering practice is not insured if it works directly for a company in which one of its partners has a significant shareholding. As a consequence Nolan Associates cannot work directly for Antringham Developments and hence I get the chance to use the services of other consultants. Often I am delighted with their product but, sadly, occasionally I am disappointed. If I am disappointed it will either be because the concept design was not cost effective or the structural and civil elements were over designed, or worse still, both.

I mentioned that in recent times Nolan Associates has gained a significant proportion of its turnover from value engineering contractors' tenders. We often find savings in excess of 10% of the value of the project. If you calculate on the basis of these elements comprising between 20% and 40% of the value of a project, this can result in as much as 25% to 50% design wastage in the elements that are under our control. This is clearly wrong for a number of reasons: firstly, we have no right for our generation to be wasting physical resources that later generations will need; secondly, on state sector projects we have no right to be saddling future generations with servicing and paying off the associated increased debt; thirdly, the embedded carbon in the development will be significantly greater than it needs to be and finally, it could put the financial viability of the project at risk. To give you a perspective on this in the good old days when banks were still funding developments they required the development appraisal to show a minimum of 15% return on the project cost. It would be a rare deal indeed that could afford to carry the cost of 25% let alone 50% structural waste. As you can see these numbers dwarf the scale of the fees that we can charge. As a developer I believe that screwing down the professionals' fees is counterproductive, but if I am paying a fee I expect value for money. I certainly don't want to be paying for over design which wastes money and the Earth's resources, but equally I don't want to be a hostage to fortune to a contractor's value engineering skill and subsequently, have to second guess the extent to which the bid has been reduced to secure the project!

Why does over design occur?

I have asked myself why does over design of this magnitude happen and what can we do

Figure 13
London 2012
Olympic Velodrome
(Structural
Engineers:
Expedition
Engineering)



about it? In my opinion there are a number of reasons:

The improvement effect

It is almost always possible to improve on somebody else's design, the really hard work is involved in producing the initial concept, but we shouldn't rest on our laurels once we have done so and value engineering should be part of the concept and the ongoing design process.

The form of contract

On design and build projects where the design consultants are novated to the contractor, a reluctance to design to the bone is understandable when there is a risk that the contractor will look to recover the cost of any mistakes from the consultant. Clearly a contingency sum is needed, but it is important that all contingency figures are out in the open and not hidden in the design.

Inadequacy in the education and training of some engineers

Midlands, my Regional Group, runs a concept design course for graduates to prepare them for the CM exam. I occasionally help out with this. Some of the candidates are excellent and a credit to themselves, their educators and their companies, but some are not as strong and their education looks seriously deficient. As you may know, the Institution has a task group preparing guidance to assist the universities in this area and now has an

annual Academics Conference which I hope will also help. We do have some marvellous engineering faculties doing great work in this area, but I am not convinced that this is universal.

I mentioned earlier that when I worked for contractor RM Douglas their graduate training programme included work on the cost of building materials and alternative methods of construction. As a profession I believe that we often think that this is solely the province of the QS and don't equip ourselves with the cost knowledge to enable us to evaluate the relative cost effectiveness of the structural options available. Additionally I am concerned that the advent of the sophisticated computer software that we now use has in some cases become a barrier to training and understanding of structural performance and some engineers have become little more than data managers.

I am conscious that there is a lot to be crammed into our CM exam but wonder whether we could look into asking our candidates to display more knowledge in the area of the cost effectiveness of their proposals.

Unqualified designers

In my opinion our seven hour CM exam with the requisite training and interview that precede it is the "gold standard". If you haven't passed that, you haven't proven, at least to my satisfaction, that you have attained the knowledge and skill



© Figure 14
An exterior shot
of the Velodrome

level that society has a right to expect of the people responsible for designing their structures. Unfortunately UK law allows anyone to aggrandise themselves with the title “structural engineer” irrespective of whether or not they have the appropriate qualifications to support that designation and most clients do not understand our qualifications nor do they check to see that their structural team leader has them. Given that over 60% of candidates fail our exam in any year, one wonders where these people earn a living and what alternative qualifications they may have attained.

Reduction of services and expansion of “contractor designed and detailed” elements

Not to put too fine a point on it, some of the fee bidding that has gone on recently is suicidal. In recent months I have heard of structural consultants bidding as low as 0.6% and an entire project team offering their services for 2.6%! When I have enquired further it appears that the organisations concerned often excluded almost everything except the foundations and external works. This is in nobody’s best interest. If you are divorcing yourself from the bulk of the structure how can it be optimised? Indeed if we are reducing our service to this level there is a risk that the client might decide to put the entire project out as “contractor designed” elements and attempt to get away without our services altogether. Who will then take responsibility for the structural design performance of the entire building? Even more concerning I have heard of a case where a young engineer was instructed by his boss to only design the worst case slab, beam, column and foundation and use those sizes throughout a development. This obviously generates an overdesign for some of the structure, but more worryingly, runs the risk of a potentially catastrophic under design if the engineer makes the wrong choice.

I wonder how many of our Members have lost their jobs because their employer has reduced their service and fee level? In my opinion this action has massively increased the effect of the recession on our membership.

We have recently been asked by a contractor to review a high rise city centre project where a client had an end user in place and had obtained planning but couldn’t get the costs remotely near the level where the project was financially viable. The client had dispensed with his design team and as a last hope had asked the contractor if he could value engineer the scheme to provide the accommodation required within budget. We were asked to help.

Virtually the entirety of the structure was “contractor designed”. We were rather surprised to find a structural layout that necessitated five transfer decks! It didn’t take a great deal of architectural adjustment to get rid of four of them. Additionally three levels of underground car parking beneath the building was rationalised to one level outside the building. On another recent tender the engineer specified 11m deep piles for a 4 storey building where the site investigation revealed mudstone at only 1.2m deep! That was the second similar occurrence in a month!

The split between design and detailing

I am sure that I am not alone in owing a huge debt of gratitude to the technicians who helped to train me in my earlier career. Like army NCOs carrying their raw Second Lieutenants it is, in my opinion, the experienced technicians that lead the young graduates towards good practice in terms of structural and building details. Nowhere is this more important than in reinforced concrete. In recent times particularly in larger organisations, we have seen a tendency towards “offshoring” rc detailing. In my opinion this regularly results in an oversimplification of design and an over provision of reinforcement. Regularly, we see tenders with reinforcement in flat slabs stated as an area of steel in each direction top and bottom throughout. Often you can see this as the product of the maximum moments in the slab generated by finite element software set to default settings which some of the software suppliers openly admit are conservative. On several occasions we have redesigned and detailed slabs like this saved 50mm in their depth and halved the reinforcement quantities! What disappoints me most about this is that a very quick hand calculation and knowledge of detailing would have revealed the waste. Similarly on columns and cores, it doesn’t take a lot of experience to realise that if you provide the same structural sizes and reinforcement details from top to bottom of a high rise building you will get more and more wasteful as you go up the building. If you compound this by over design at the base you can

combine unnecessary cost with reduced value due to the reduction in floor area. I am not sure that the client would approve!

Method of Prequalification and Procurement

State sector projects in the UK are required to be procured by way of the Official Journal of the European Union (OJEU). I may be biased on this subject because we rarely win work this way but it is my opinion that this pre qualification route has little to do with whether or not the practice has the appropriate skills and experience and much more to do with how skilled it is at filling in pre qualification forms. I have never seen one yet that mentions cost effective design, or value for money, but when you interrogate the bid scoring you will almost invariably see the highest amount of points awarded to the “competitiveness” of the fee. As a UK taxpayer I am appalled at the waste that this bureaucratic nonsense is generating.

State and private sector clients also often fail to understand and define the schedule of services they require from us and very often some of us are guilty of not mentioning how little work we will be doing for the minuscule fee we are tendering and conveniently ignore the effect that this will have on the cost of the project.

Failure of the Engineer to make the case for cost effective design

As I travel around I am often struck by the convoluted shapes of some of the modern buildings and stadia that I see. I admire the great skill of the structural engineers involved solving the problems set for them by the architect helping them achieve their new masterpiece. Many of these buildings are marvellous additions to our environment and are rightly acclaimed, the new Olympic Velodrome (Figs. 13 and 14) is a great example. However, in my opinion, many more are different for the sake of being different and add little except cost to the environment and the project and often compromise the usability of the space within. To paraphrase Paul Morrell, the UK Government Chief Construction Adviser, “just because we can doesn’t mean that we should” I know of several cases recently where projects have been put into administration because the client couldn’t afford to build them even though the buildings had been almost fully pre let. In the end, in the private sector it is the clients’ responsibility to control their projects and they stand or fall by the cost of their schemes, but when it comes to the public sector I believe that we have a responsibility to society to do our best to achieve best value for money.

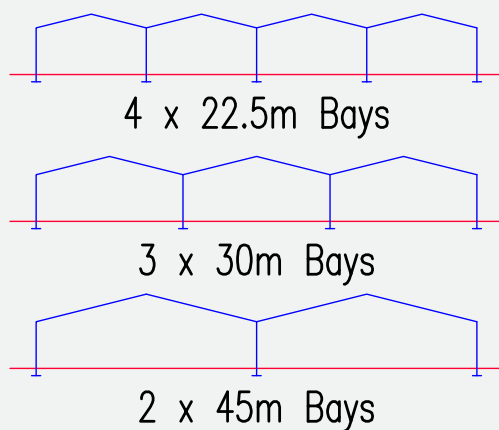
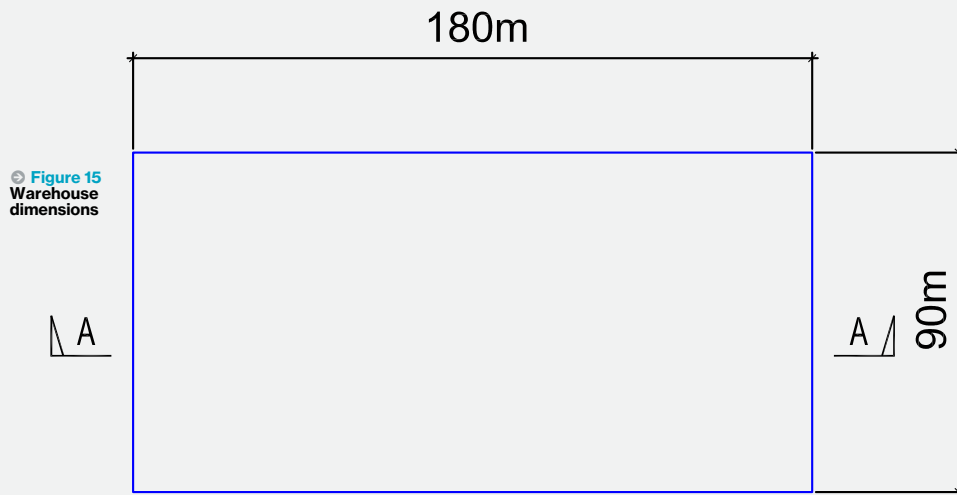
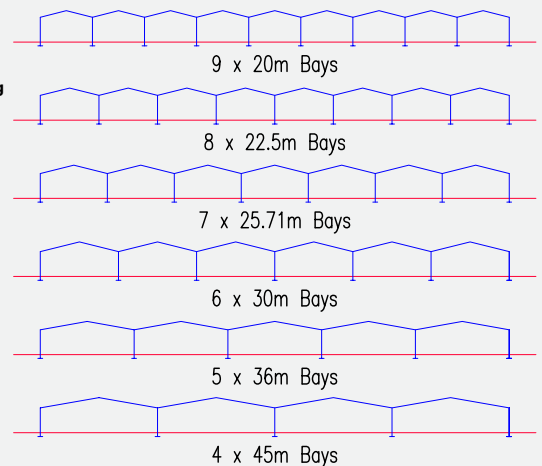


Figure 17 Portals running longitudinally



The design optimisation process – a simple example

For the benefit of those engineers who may wish to use this article to better inform clients and project managers as to the complicated nature of the design optimisation process, I thought that it might be of value if I briefly described the design decision making process involved in optimising the cost of a comparatively simple building such as a 9m to underside of haunch warehouse 90m wide by 180m long with no internal drainage manholes allowed (Fig. 15). To simplify the process I will presume that there is no internal craneage or unusual restrictions on column centres and will ignore the offices and dock levellers which would probably be present in reality. I will also presume that ridge height is restricted to 12m and that we are founding on 6m of granular fill with a safe bearing pressure of 50kN/m² contaminated with heavy metals overlaying competent mudstone. In short, the sort of building and ground conditions that regularly occurs in the West Midlands, but simpler than a typical question in our CM Exam.

By experience, at the moment, in Britain, a portal framed steel structure with cold rolled purlins and a profiled metal deck roof is likely to be most cost effective; elsewhere trusses or other forms of construction might be more cost effective so the first design decision is:

What is the optimum geometry for the frame? Minimum roof pitch for the roof sheeting is 6° so that could define the minimum rafter slope but clearly the portals can span transversely transversely (Fig. 16) or longitudinally (Fig. 17). Spanning transversely the geometry of 4 x 22.5m, 3 x 30m or 2 x 45m spans all work as do 6m, 7.5m, 9m and 10m grids and the removal of alternate internal columns is also an option, some 24 alternatives. Similarly, spanning the portals longitudinally the geometry of 9 x 20m span portals through to 4 x 45m spans all work as do all the grid spacings previously mentioned and again the opportunity to remove alternate internal columns, providing a further 48 alternatives totalling at least 72 portal frame options. If you always put your steelwork out to fabricator design, how do

you know which combination is optimal? Clearly, a structural engineer experienced in steelwork design will be able to narrow down the options considerably but I reckon you might have to run possibly as many as 16 combinations to find the optimum. That is, of course, until you consider base fixity. The steelwork fabricator will generally prefer to fix the column bases to minimise column weight but this can throw considerable moments into the foundations and greatly increase their size. Given the aforementioned weak ground and the cost of cart-away and tipping contaminated materials, it is clear that a balance needs to be made between the optimal superstructure design and the optimal substructure design.

What is the optimal foundation design?

Given the weak contaminated ground, I think that most experienced structural engineers would recognise the need to minimise the base sizes and would therefore wish to keep the loads from the superstructure to a minimum and would also wish to strengthen the ground with some form of ground treatment such as vibroflotation, dynamic

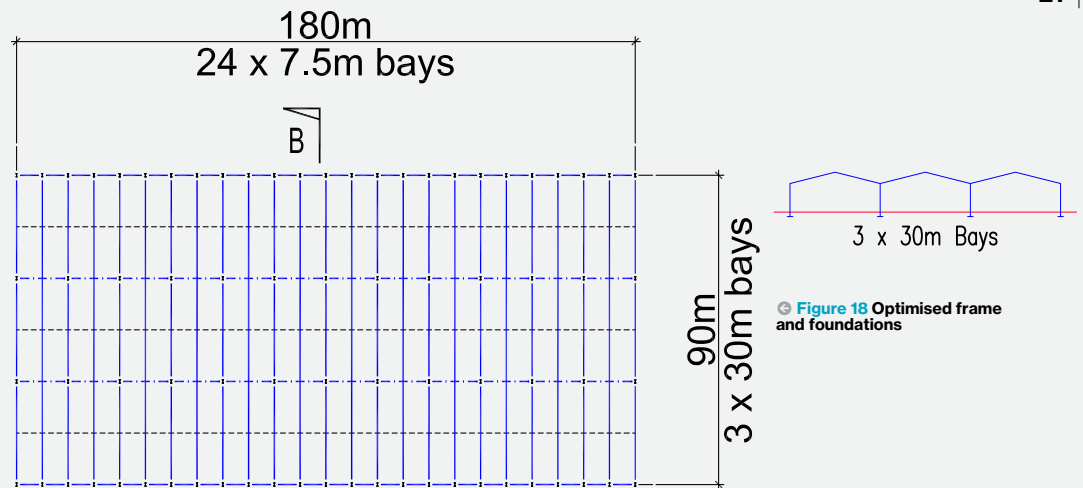


Figure 18 Optimised frame and foundations

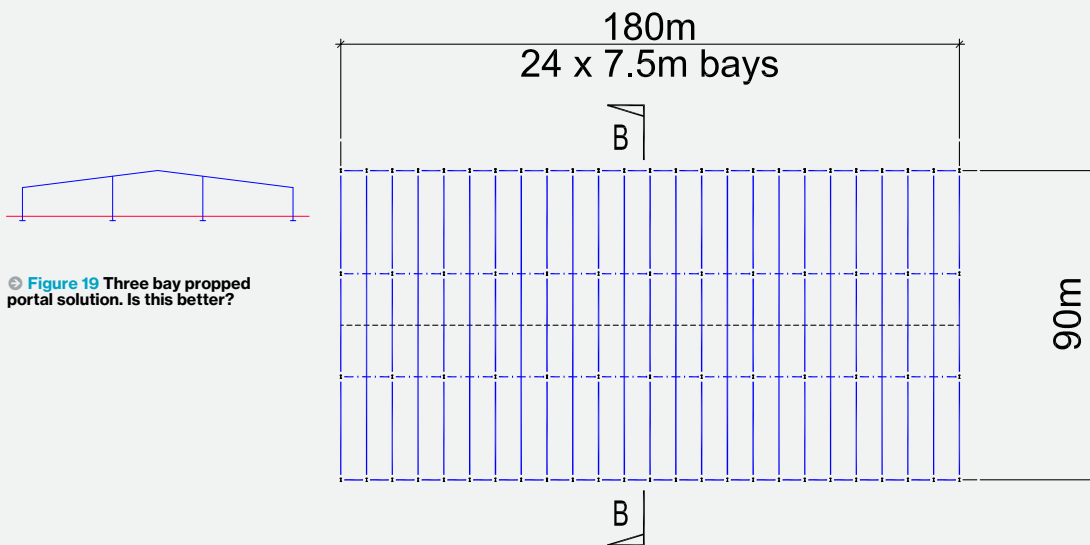


Figure 19 Three bay propped portal solution. Is this better?

compaction or piling. Vibroflotation and dc are relatively cheap but would probably require larger base sizes than pile caps and then which is likely to be cheaper, mass concrete or reinforced concrete bases? It might also be the case that if piled foundations are chosen you might find that in optimising the pile sizes and numbers you might have some spare capacity which could be used to provide greater base fixity to the stanchions and hence reduce the weight of the steel frame.

Have we optimised the building cost?

Let's presume that we did our own steel frame design and came up with an optimised frame 3 x 30m portals wide and 24 x 7.5m bays long on optimised foundations comprising mass concrete pads on vibro treated ground and these elements have been fine tuned with each other (Fig. 18). Have we optimised the building cost? The honest answer is that we still don't know. What I haven't discussed so far is the drainage. The layout we have come up with has four gutters, which are the most expensive and problematic elements of the

roof covering and all of them need drains which are also expensive, particularly given the cost of carting away contaminated material. I mentioned earlier that we weren't allowed any internal manholes. This precludes longitudinal drains beneath the slab. Of course we could use four runs of siphonic drainage the length of the building with a drain at one end picking them up, or we could have a series of drains running transversely across the building picking up the internal down pipes running into a collector drain down one side.

If we found the optimal solution for the drainage and the optimal solution for the frame from the above would we have optimised the cost of the building? Possibly, but is there a better holistic solution? Is there a frame solution which could minimise the cost of the drainage without adding too much to the cost of the structure? What about a three bay propped portal (Fig. 19) with rafters reduced to 2 deg pitch, to keep the building volume the same and the height within the allowed figure, with standing seam sheeting to compensate and with an external gutter on either side, as having only external

gutters allows us to nearly halve the design rainfall on the roof? We can only find out by doing the design to enable it to be costed!

What I hope that this exercise shows is that in order to find the optimal value design for a building, even a comparatively simple shed like the one I have described, there is need for a great deal of design input and access to up to date costing information. This time costs money and needs to be paid for. Screwing us down on fees is counterproductive! It is highly unlikely that a structural engineer who has been forced to take a reduced brief for a reduced fee will find the optimum cost for the building. Indeed, I would argue that of all the building design professionals, we have the greatest knowledge of how the building fits together and hence we have the potential to generate the best value. I would ask any client or project manager reading this to remember that in order to do this we need to be adequately recompensed and the extra value generated can be considerably greater than the cost. You certainly won't get it if you are only prepared to pay 0.6%! So what should be done?

Public Sector

Two years ago, Paul Morrell challenged the Institution to provide leadership and guidance on enabling building professionals to analyse carbon usage in construction projects. We rose to that challenge and the resulting publication can now be purchased from the Institution Bookshop. I will be sending Mr. Morrell a copy of this article and challenging him to provide national guidance to state sector clients and their project managers on the simplification of OJEU documentation and in particular the need for emphasis on the value of a track record in cost effective design when assessing the design professionals. I will also ask him why it is that private sector clients usually spend much less than 10% of the project value prior to start on site and state sector clients often spend more than 25%.

Private Sector

Can we do more to help clients understand the value of what Engineers can do for them? I think so. Several years ago, Past President Bob McKittrick authored *Engaging Structural Engineers – a Guide for Clients*. In my opinion its contents are still relevant today as far as the UK market is concerned. I would like this guide to be made more widely available and intend inviting a worldwide task group of Institution members to review its appropriateness for international audiences (plural since one solution will probably not cover all market conditions). To date, the publication has only been available in the members-only area of the Institution website, since it was originally aimed as a guide for engineers to share with their clients, I would prefer it to be freely accessible to the public. I know from our web forum that some of our members think that this document is a bit unwieldy for domestic clients, so I am delighted that as part of the 2012 business plan, it is intended to prepare a guide specifically aimed at the domestic client and what they should expect when engaging a Chartered structural engineer.

Education of our Young Engineers

The Institution has set up a task group to provide assistance to academia with regard to industry's requirements. Initially this is UK focused however it does I am sure mirror issues in other parts of the Institution world and I have high hopes for its output. In addition, in recent months I have been invited to speak at two Regional Group meetings putting forward my views as a practitioner on the standard of education our civils graduates receive from the universities. Listening to the academics speak, there seems to be a view that, over time, we have



Figure 20 Institution HQ, 11 Upper Belgrave St, London

steadily crowded our courses with more and more topics which may, potentially, have taken time away from the most important core subjects. We need to understand the pressures that are leading to these changes and as appropriate ensure we tackle them. I am involved with the education project and am keen to contribute in any way I can to discussing the issues with other stakeholders, such as other Institutions, the JBM and the Engineering Council.

PI Insurance

We are not a trade or lobbying organisation but there does seem to me to be something intrinsically wrong with the British system when it appears that in essence the majority of Chartered engineers are effectively subsidising those consultants who seem intent on devaluing our service. Arguably, more imaginative treatment by insurers will ultimately drive up professional standards, which is entirely within the remit of this Institution to pursue. Accordingly, I intend taking the opportunity to find out how this is done internationally and see if there are exemplars that can be used to promote discussion with the insurance industry. Surely it must be in the best interests of the insurance industry to require that all structural projects are managed by a Chartered Structural Engineer?

Consultancy

The CDM regulations require that we provide sufficient man hours for the task. Clearly this is not possible at some of the fee levels being quoted and clearly this level of fees is insufficient to optimise value. I would ask the senior management of all practices to review the appropriateness of their pricing policy. I would also suggest that they review the drawings and calculations for one or two of their most recent projects as if they were the client. Would they be happy if they were paying for the project

with their own money? I also suggest that they should carry out a review of the default settings on their software to confirm that they are not inadvertently over-designing. In order to distance ourselves from those who call themselves structural engineers but do not have our qualifications I urge those of you who are Chartered Structural Engineers to describe yourselves as such on stationery and when introducing yourselves and your profession. I see that Simon Pitchers already does this on the credits to his television programme.

The Institution

We ask a lot of those sitting our Chartered Membership exam. However, in the context of an ever-changing world, I would be pleased if the Examinations Panel would consider the emphasis we place on value for money.

In our Structural Awards programme we have an excellent showcase on a wide range of project types. The creation of a new category for "cost-effectiveness" or an enhancement of the evaluations we make in the existing categories would be most welcome and allow us to demonstrate, very publicly, the value that is created by structural engineers.

Registration has proven to be effective in Scotland in ensuring that projects are supervised by adequately qualified and experienced structural engineers. Your Institution is actively pursuing Registration in England and Wales.

A final thought

I asked one of my client friends why it was that we were often treated as a commodity and not given credit for the value we can create. His view was that as a profession we undersell ourselves and fail to explain the magic of what we do. Well fellow magicians, I suggest we get out there and put that right! ■