Verulam

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Topics of importance openly discussed

Invisible connections in the Leadenhall Building

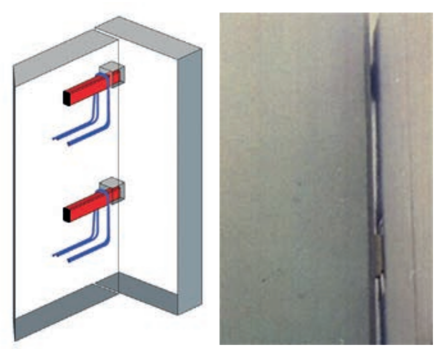
Cliff Billington adds detail to a recent paper on the Leadenhall Building.

The article on the Leadenhall Building (April 2018) was an excellent description of the design processes involved in simply getting the building to stand up at all. On a building of this scale, technical problems, and the need for novel solutions, cascaded right down to component level and an example of this was the precast core walls.

Although not required for the purposes of stability, the core walls still formed stairwells and lift shafts, and thus needed full integrity. Because of the need to maintain predetermined load distribution, many of the walls could not be directly supported off adjacent steelwork. The alternative was to support some wall panels off others, but this had to be done 'invisibly'. Although the panels were cast using lightweight concrete, the loads to be transferred were considerable, as some panels were over 7m tall. As well as the self-weight of the precast panels, additional loads resulted from staircases and the superimposed loads on them, supported from the panels.

As a specialist in precast concrete connections, I worked with the design team to find a way forward. The solution was to use TSS telescopic connectors. These are proprietary items, generically termed 'invisible connections', more usually used to support precast stair landings (www.invisibleconnections.co.uk/). By casting them into the edge of the wall panels, a structurally adequate support was created to transfer the load from one panel onto the adjacent panel, which was in turn supported by steelwork. Having the TSS connectors projecting into a recess gave considerable tolerance, which in turn allowed accurate alignment of the panels to each other.

Once grouted in, the result was a totally invisible connection, satisfying both engineering and aesthetic requirements, as well as being fully fireproofed. It was an excellent example of thinking outside the box to achieve an elegant and efficient solution.



Sharing good ideas with readers is one of our aims, and one of a designer's skills is to know what the market can provide. So, thanks to Cliff for this contribution.

Innovation in engineering

Peter Debney critiques a couple of points made in the recent debate over innovation.

I welcome the recent articles and discussion on innovation in the construction industry and broadly agree with all the points raised. There are a couple that I will offer an adjustment to.

The first is the theory of punctuated equilibrium from Paul Millett's letter to Verulam (March 2018). In my experience of running genetic algorithms (i.e. evolutionary optimisations), I have found that the routines do experience periods of accelerated change between long periods of very little progress. This happens naturally whenever some member of the optimisation 'population' has stumbled upon something much better than what has gone before. This change rapidly spreads through the generations, being refined as it goes, generating a fast improvement in the solution. This happens without any catalyst or change in the environment and seems to be a natural feature of evolutionary algorithms and, by inference, of natural evolution.

The second is Paul's statement that, 'Optimisation is therefore the enemy of innovation'. This is only true when you conflate optimisation with refinement. Good optimisation should both 'exploit' and 'explore': exploit to refine the ideas that we have already; and explore new options that might overtake our current best solution.

Some optimisation methods, such as gradient methods, can only exploit. In the right situations, they are extremely efficient, but they suffer badly when there is more than one solution for them to choose from. Evolutionary methods, on the other hand, can be very good at exploring multiple solutions, if you can keep them from 'premature convergence'. They are notoriously slow though, not unlike the construction industry in adopting new ideas...

The more you observe evolution in nature, the cleverer it seems – and optimisation is remarkable.

Retaining building control records for posterity

Ian Anderson, a former building control officer, adds his personal experience to this discussion.

Further to Timothy Salmon's comments on the above in Verulam in February, I would like to add my experiences. When I worked for an outer London borough, we had access to all the historical building control records back to the early 20th century. These did prove useful on a number of occasions.

Following a fire in a major department store not far from the town hall, I was called after the fire brigade had put the fire out to look at a particular beam that was still on the move off its bearing padstone as it contracted after the fire. It did eventually stop in a safe place, such that a repair could help secure it. The rear of the building proved rather more contentious as the concrete first floor was supported on three post-tensioned beams. Each beam comprised three precast sections post-tensioned together. The drawings were of some assistance then.

On another occasion, the upper front wall of a parade of three terraced shops opposite the town hall was found to have separated from the party wall between two of the shops. The building control drawings proved useful in assessing the building. After diverting traffic, and bracing the whole frontage with a temporary scaffold against the cobblestoned road surface under the existing blacktop (which the wall settled against later in the day!), the wall could safely be demolished and reconstructed. The defect was only picked up by consulting engineers doing a routine examination of the upper floors above the shops, which were not used for storage, etc.

Some of the many through-lounge and loft conversions that passed my desk also would prove interesting for any later house owners, as some designs included flitched beams which at best were questionable and at worst were unsafe.

At the time, two admin managers questioned the need to keep building control records if older than seven years. Their main reason seemed to be to gain space, without considering what would be lost for ever. We structural engineers objected when we found out the plans and managed to stop the planned cull, along with the building control officers who also looked at old records from their duties encompassing dangerous structures. I hope we succeeded long term.

It seems to me that this limit of access on data protection grounds is a misnomer when the original owners are probably long gone. If people are that worried, remove names.

Surely Ian is right about data protection? The records prove most useful when altering buildings after many years. And given today's facilities for electronic storage, can space saving really be a valid argument? (Older records can be digitised at little cost.) Digital storage, as well as saving space, provides for efficient and rapid retrieval (thereby saving cost).

Basements and site investigations

Steve Lieske lends his support to a recent letter (Verulam, April 2018) which urged proper site investigations for all basement extensions.

New basements to existing buildings are generally complex, involving both underpinning and retaining structures. Accordingly, the ground (and groundwater) conditions are paramount.

A client decision on a site investigation is required. But until you start digging (this applies to ALL projects!), you don't know what you will find. It is best to dig early, but the client (having been so advised) must decide.

Anyone who has been involved in digging around older structures will be well aware that surprises abound. So, Steve's advice is well founded. Proceed with caution and be prepared to react to revealed conditions.

Concrete detailing using the strut-and-tie method

Melvin Hurst gives us feedback on a previous letter on concrete detailing.

I was interested to read Daniel Parker's contribution in Verulam on concrete detailing using the strut-and-tie method (February 2018), since I have recently come across it in connection with the detailing of end-blocks in prestressed concrete members.

I was familiar with the provisions of BS 8110 and BS 5400 for detailing transverse reinforcement to resist the bursting, or splitting, forces induced by the concentrated load of a single prestressing anchorage, but although the codes made passing reference to the problems associated with two or more anchorages within an end-block, they didn't describe exactly how to treat them.

However, when I was designing a footbridge with six anchorages, my attention was drawn to the detailed provisions in the AASHTO bridge code (*LRFD Bridge Design Specifications,* 8th edition), which explained clearly how to determine the amount of transverse reinforcement required to resist the forces, and precisely where to place the links. The basis of the method, clearly explained in the guide to the code, is the strut-and-tie method.

An important general point here is that, as in much of structural engineering, overall design adequacy strongly depends on detailing adequacy. This is as true of concrete as it is of every other material. Thanks to Melvin for highlighting a useful source of guidance (AASHTO is a US code).

Water entrapment in hollowcore concrete floors

Sean Lightowler seeks feedback on a particular problem with precast flooring units.

Following the recent article in *The Structural Engineer* (April 2018) on this topic, I wondered if fellow members and suppliers could comment on their experience of the issue of water trapped in the hollow cores. It is an issue that does not generally create problems in my experience, but a recent project has generated some discussion.

During the construction phase, it is common for rainwater to enter the hollow cores, and to be 'trapped' once the topping is applied and the building is made weathertight. Towards the end of construction, as the structure begins to 'dry out', it is sometimes necessary to drill the cores at the mid-span of the units with a small bit in order to release the water previously trapped. In my experience, once this has been undertaken, it has not needed to be repeated.

On a recent scheme, however, there have been numerous times during a 24-month period whereby hairline cracks have formed in the exposed soffit of the unit and water has been released, damaging the finishes.

The contractor does not believe that there is an underlying issue, but that manufacturing issues such as camber, a 'rough, uneven' finish to the core, and even interstitial condensation are to blame, rather than water ingress from an alternate source.

Any feedback on this issue would be gratefully received.

Has anyone else had similar experiences?

Are we overcomplicating design?

Finally, we have some praise from Bob Wilson for a recent Technical Guidance Note, along with a gripe about the complexity of modern codes and calculations.

May I commend Chris O'Regan for his Technical Guidance Note about concrete bored piles (March 2018). Not only does he try to make sense of the complexity of Eurocode 7, but he has managed to do a neat, short(ish) calculation!

In doing this he has, in my view, opened up and exposed the huge complexities of these Eurocodes. I am over 80 years old (and some will say too old and outdated and I should hang up my slide rule!) and I find the Eurocodes a real pain in the neck! How are we supposed to read (pronounce) 'q suffix b;k', even if we could remember what it stood for! It is a new language!

And where did Chris get the supposed pile diameter from (750mm diameter), or the 25m depth of pile? This information seems to have appeared out of the blue like so many examination questions. As a procedure for checking a presumed construction, I do not fault it, but we seem to be missing the concept design. What is basically wrong with a FoS = 3, like in the 'old days'?

Have we degenerated into doing these calculations just because 'we can do them'? I have been reading my new copy of Malcolm Millais' book, *Building Structures*, and have found what I believe to be a relevant quotation, from Professor Leroy Emkin: 'Real structural engineers can create models of complex structural systems, perform appropriate analyses on such simplified models, and create designs that can be constructed that are safe, reasonably economical, and functional.' Have we ceased to be such structural engineers?

Well, Bob makes his point strongly and you probably can just design on a big safety factor if you want to. But modern codes offer more complex routes for those who want to put in more design effort in the hope of achieving more economy. That trend started in older British codes (again with contemporary criticism). While you may save construction costs if you 'get it right', designers do need to be careful not to get lost in complexity and miss the obvious.

AND FINALLY...

Answers to June's question

A) Incorrect. The frame receives equal pressure on both sides as the water height is equal. This bending moment diagram corresponds to a frame receiving water pressure from the left side that is far greater than from the right side.

B) Incorrect. The frame receives equal pressure on both sides as the water height is equal. This bending moment diagram corresponds to a frame receiving water pressure from the right side that is a little greater than from the left side.

C) Correct. The frame is in perfect balance horizontally as it receives equal water pressure on both sides. Pascal's law states that water pressure is a function of water height, not extent.

D) Incorrect. The frame receives equal pressure on both sides as the water height is equal. This bending moment diagram corresponds to a frame receiving water pressure from the left side that is greater than from the right side.