Verulam

Topics of importance openly discussed

Send letters to...
All contributions to Verulam should be submitted via email to:
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Contributions may be edited on the grounds of style and/or length by the Institution's publishing department.

Basements and site investigations

One of our regular correspondents, Simon Pole, has concerns about the construction of domestic basements. Simon seeks other views, especially on the lack of site investigations.

I write to express my concerns about the shortcuts being taken by our members with regard to domestic retrofit basements, most typically in the wealthier London suburbs.

In particular, I would like to highlight the frequently encountered omission of site-specific geotechnical investigations. During my role checking hundreds of such schemes each year on behalf of neighbours and their party wall surveyors, I would estimate that approximately two-thirds of engineering submissions exclude a site-specific soil report. Members claim that geology maps are sufficient, together with general knowledge of similar projects in the general vicinity, often a mile away or more.

I do not imagine members would skimp on other deep excavation projects or indeed the specification of soil testing and foundation design for most projects. So it is a worry that we appear to be skimping on what some might perceive as formulaic or empirical design for domestic basements, where there are so many risks and so many concerned and interested parties involved.

We know that reinforced concrete underpinning can be a complicated matter, often not necessarily constructed by particularly experienced site operatives. There are, of course, complexities associated with temporary propping, control of groundwater and bulk excavation, working in dangerous confined spaces, etc. We also know that most neighbours are extremely nervous about the safety and risk of damage to their valuable homes. In summary, a lot of people are relying on our profession to provide good advice.

We know that most designs are safe and strong and only rarely pose problems once built. Most problems are either health and safety-related or govern the level of damage which might occur to neighbouring properties if the works are not carried out properly.

This requires the design engineer to be proactive in the specification of method statements and temporary works, including the treatment of groundwater.

The party wall process is primarily concerned with understanding 'the manner in which the works will be executed'. In other words, how will the work be carried out safely and without unnecessary inconvenience and damage to neighbouring properties?

The geotechnical profession is at a loss to know why our profession is skimping in these areas. I suspect our professional indemnity insurers would be even more concerned if they were aware of the practice. In practical terms, good party wall surveyors will not agree party wall awards until their advising engineer is satisfied with the developer's proposals. That should, in my opinion, include a site-specific soil report, together with construction method statements and temporary works designs.

We know there is pressure on professional fees, scope of service, etc., but we do need to make comprehensive proposals to our clients so they can be assured of a professional service and one which meets the practical needs of party wall surveyors and the safety needs of the contractor. We know that basements are normally expensive luxuries and can add significant value. The cost of a soil investigation is a fraction of the project cost, so apart from some early disruption to households, there are few excuses not to do a proper job.

To say that we are guessing the ground condition and will improvise when on site is too late in the process, dangerous and, frankly, unprofessional in my opinion.

I would be interested to know what other members think.

"I DO NOT IMAGINE MEMBERS WOULD SKIMP ON OTHER DEEP EXCAVATION PROJECTS OR INDEED THE SPECIFICATION OF SOIL TESTING AND FOUNDATION DESIGN FOR MOST PROJECTS"

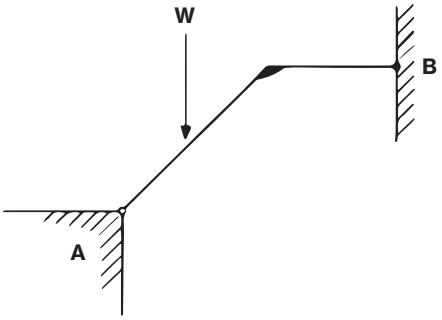
There is a tendency for us to concentrate on the structural engineering skills needed for major projects. However, a very large number of our members are engaged in the less glamorous (but still essential) work of small building extensions and the increasing market of adding basements. Anyone involved in such work will appreciate it can be really tricky (especially in execution) and a review of the press will reveal some spectacular collapses. Simon asks for other views.

More on brainteasers

In the January and February letters, we published an exchange between Bill Harvey and Martin Ashmead regarding the 'And finally...' brainteasers. In short, Bill was dubious of the value of these puzzles and emphasised the role of stiffness rather than concentrating on equilibrium and forces, while Martin was aghast at engineers' inability to draw bending moment diagrams and set a problem for readers. Bill has

now written in again. To refresh your memories, we replicate the problem below, before presenting Bill's latest response.

Ignoring the self-weight of the cranked member and any secondary stresses, mark on the diagram the directions of the vertical and horizontal reactions.



It's basically the ladder problem, but is it?

The ladder problem thinking process begins with the ladder rotating towards the wall until it makes contact. Until contact is made, there can be no vertical force at the top. Once it is made, the vertical reaction is produced by friction, which requires a small vertical displacement but also a horizontal force. The horizontal force needs a reaction, so we have to have friction at the base. So the reactions are both inclined and the three forces have to meet at a point or we won't have rotational equilibrium.

Here, though, we have a pin at each end, so with no consideration of secondary effects, the problem is essentially a beam with two vertical reactions. One would be happier with a roller at one end or the other to remove the secondary effects. With a (horizontal) roller at A, we have the beam solution because the reaction at A must be vertical. With a vertical roller at B, the reaction there must be horizontal and the force at A must be W vertically and inclined to meet force W where its line cuts the horizontal through B.

However, you aren't really allowed to ignore secondary effects. If we start with the beam solution, the members will bend and the shape means the ends will push outwards generating horizontal force. The structure is actually statically indeterminate and cannot be solved without considering stiffness. If there are horizontal forces as well as vertical, the three external forces must again meet at a point, but that point can (at least theoretically) be anywhere on the line of W.

Like all indeterminate structures, this is highly sensitive to fit and, as Jacques Heyman would tell us, the effect of the boundary conditions is likely to cause similar stresses to the applied loads.

Which brings me back to the previous point. Unless the horizontal beam in the October 2017 question is stiff enough to hold the nodes at nominally the same spacing as the feet, the moments at the base are a function of the stiffness of all the members and of the foundations. They cannot be derived by simple statics. Drawing the nodes closer together in the deflected shape implies that the beam is not so stiff.

You cannot have your bun and your halfpenny. Either the members are sensibly rigid axially or we have to allow for the fact that they aren't. In the May 1982 question [reproduced above], the members would have to be sensibly rigid in bending when compared with the stiffness of the foundations. The bulk of the foundations means that is unlikely.

Well that's a bit complicated. At the end of the February contribution, Verulam posed their own question, which was: *First of all, readers should check they have the 'correct' answer. Then they should ask themselves (i) what difference would it make if the axial stiffness of the cranked member was considered; and (ii) what difference would it make if the upper support was not infinitely stiff in the horizontal direction? Finally, given the response to these two points, what would a safe model be for designing a practical structure?*

Firstly, Martin's poser is statically determinate and correct if the supports at A and B are infinitely stiff in the horizontal direction. Under that assumption, the bending moment at the top beam crank has tension at the top. However, if the support at B is free to move laterally (infinite flexibility), there is no horizontal reaction at B and the bending moment at the crank fully reverses with tension on the bottom. Hence (as Bill might argue), in reality all structures have some flexibility and the real stresses depend on that.

A lesson here is that the direction of the bending moment is critically dependent on an assumption about support stiffness. How that is idealised produces a very significant shift in the stress. So in modelling this structure in a real project, designers would have to be very careful and cater for a range of uncertainty. Against Bill we might argue that even this simple puzzle can yield profound insights into real structural behaviour. Is honour satisfied on both sides?

"LET'S HAVE MORE VIDEOS LIKE THIS TO PROMOTE OUR PROFESSION"

Promoting the profession to all

Finally, we have more encouraging words from regular contributor, David Brett.

The Institution's latest YouTube video on 'Why become a structural engineer?' is a huge step forward in helping to promote our profession to young people – particularly young women.

The only women in our profession when I was a young engineer were usually foreign nationals. Very few girls in the UK even thought about studying engineering. When I was a postgraduate at Imperial College, there were around 3000 men, and only about 30 women.

We now have our second female President, so are well on the way to showing that a career in structural engineering is open to all.

Congratulations to all concerned with this initiative. Let's have more videos like this to promote our profession – particularly to students in secondary schools who are deciding on which subjects to study for their GCSEs and A-levels.

Perhaps it's worth pointing out to those regional groups that are providing careers advice to schools that there are a number of YouTube videos about structural engineering that might be useful in presentations. As David writes, a profession open to all.

AND FINALLY...

Answer to April's question

A) There can be no horizontal reaction in the right-hand column. Therefore, there is no horizontal reaction in the left-hand column. Therefore, neither column can bend.
B) There can be no horizontal reaction in the right-hand column. Therefore, there is no horizontal reaction in the left-hand column. Therefore, neither column can bend.
C) There can be no horizontal reaction in the right-hand column. Therefore, there is no horizontal reaction in the left-hand column. Therefore, neither column can bend.
D) Correct.