has a strong scientific component but its practitioners must have some feel for what is going on in a structure and also be aware of the considerable limitations of their 'calculations'. There are two hazards to using a computer: one is its spurious accuracy (12 decimal places immaculately printed out do not mean that the structure acts as assumed or that the loads entered bear any relationship to the real loads); the other, more subtle, is that the user is at risk of becoming subservient to the machine by losing the basic skills necessary for its correct use.

Having started with a slide-rule and passed to calculator and then computer, I consider myself very fortunate to be one of the dwindling band of engineers who really appreciate what a marvellous thing the computer is. However, this appreciation comes only from having done calculations by hand and thereby getting 'the seat of my trousers' calibrated. A friend, a physics lecturer, gave his class the problem of estimating the mass of the earth. One student presented the answer 64 000t, and never flickered an eye: it had come out of his computer and he had not the mental resource even to see that it was preposterous.

Given that we have generations of young people who do not know their simple multiplication tables or are able to tell a noun from an adjective, I am beginning to wonder whether we are not producing structural engineers who do not even know the basic laws of statics. How many, I wonder, could work out the reactions to a simply supported beam; or (a little more taxing) to a continuous beam; or (really sweaty) the deflection of a cantilever beam allowing for the rotation of the column to which it is fastened? As for deflected shapes ...

I would like to link this concern to another that I have inveighed upon before in this column: CPD. When we have been irrelevantly compared to the legal and medical professions, I have suggested that the governing bodies for these groups should be finding ways of making it easier for their hardworking members to keep up-to-date rather than faffing about mouthing empty management-speak and building pointless box-ticking bureaucracies to appease politicians and tabloid headline writers. Our own Institution could perhaps set an example by doing this themselves: we are supposed to be practical people, after all. For example, leaflets could be prepared on a range of topics from, say, the above-mentioned laws of statics, elementary moment distribution (invaluable for training purposes), deflected shapes, right through to clear, worked examples of how to use the latest Codes, etc. I would have found such guidance invaluable in my early years. Further, the idea could be used to involve members by enclosing drafts of such leaflets with *The Structural Engineer*, with an invitation for suggestions and criticisms.

The buzzword, I think, is 'empowerment'.

There have been previous attempts to get members to submit simple design guides on a range of topics for publication, and no doubt such contributions would still be most welcome. Are there any volunteers?

As regards computer use, some awareness regarding the approximate answers to be expected is a very necessary safeguard against misuse or unwarranted trust in unlikely results. However, that need predated the advent of computers. The problem is now greater because computers are used to solve problems that were insoluble by longhand method, making it harder to be aware of realistic answers. With or without computers one still has to pose the right questions, and that may be the hardest part when innovating.

On the issue of CPD Mr Bowden has followed up his recent letter(2 May 2000) with one to the Council, so we may hear more on this in due course.

The system as described does not seem to depart significantly from proposals many years ago, at that time aimed for use in the UK, which foundered on the inability to find the insurance cover demanded by the then Department of the Environment (now DETR).

Everyday risks

Denis Camilleri has written from Malta:

The recent Concorde crash questions the safety of airline transport (15). It has been considered as very safe, safer than smoking (40) or walking beside a road (20). It was classified as safe as travelling by car (15). The riskier activities are rock climbing (4000) and travel by helicopter (500) and motorcycle (300).

The classification of risk is obtained from the fatal accident rate or FAR no. (Kletz), indicated bracketed above: the higher the number, the greater the risk exposure. It is defined as the risk of death/100 million h of exposure to the activity. It is approximately the same as the probable number of fatalities from 1000 people working-lives, each taken at 100 000h (Hambly).

'Tolerable risk' is deemed to be 1:1000 for workers FAR 50

'Very low risk' is deemed to be 1:10 000 for the public FAR 1

'Minimal risk' is deemed to be 1:100 000 for nuclear power plant FAR 0.1

'Negligible risk' is deemed to be 1:1000 000 representing the annual risk of death from fire in a home FAR 0.01

'Insignificant risk' is deemed to be 1:100 000 000 representing the annual risk of death from a contaminated landfill FAR 0.001

Decisions have to be taken on the degree of risk to which an activity is exposed. To quote from Wood & Grant's viewpoint (*The Structural Engineer*, 18 July 00): 'Would we not be better off spending money on reducing health problems from high known risks, as opposed to moving soil around the country to remove a perceived risk to health which probably does not exist to any significant level?' Where does the Concorde disaster leave airline travel?

Mr Camilleri highlights a major problem, resulting from the refusal by Governments to address risks on any logical basis. The immediate, normally excessive, reaction to a failure which achieves widespread publicity delays and often blocks a more rational approach which might have been achieved, given more thinking time. Concorde is now grounded, apparently ignoring the very remote likelihood of the alleged cause of the damage being repeated and the many years of safe flying previously provided by it.

There have been proposals for an officially supported Hazards Committee (see 'Risk analysis: uses and abuses', The Structural Engineer, 20 October 1998) which would be asked to advise on disproportionate risks. Reference to it of disasters such as Concorde would at least give Governments time to think and might avoid the worst cases of over-reaction. It is unfortunate that we are constantly told of the need to carry out risk analysis for matters related to safety, but yet there is a dearth of well-defined cost benefit analysis. Even when one is competently set up, the resulting action may bear little resemblance to the recommended levels of safety. The fear of litigation causes a hugely disproportionate overspend on safety right through the construction industry and impinges on other desirable actions such as wider training, greater consideration of design options or construction methods, and other forms of welfare. It is becoming ever harder to introduce innovation and, in the long run, the only victims are the general public, who are denied its potential benefits.

What comments from members?

Emails can be sent to Verulam via: reynolds@istructe.org.uk

Letters should be kept as short as possible, since space is limited: the longer the letter, the greater the likelihood of it being cut or held over for a future issue

Queries, comments, correspondence, and curiosities . . .

Aspects of safety

David Quinion, who previously wrote on this issue on 2 January and 6 March, addresses more recent responses to his letters and writes:

The comments of Alastair Forsythe and Stan Lawrence persuade me to react. Everyone is required by HANDSAW to exercise responsibility for their own safety as well as that of others who could be affected by the actions being undertaken. Most contractors have been training their staff and operatives in safe practices for some decades.

An accredited quality management system refers both to the safety of construction as well as employing appropriately trained and experienced personnel. The system is the control procedure for assuring and demonstrating conformity to that contractor's operational requirements and thus the provision of sufficient and competent supervision for the work entailed. Accidents unfortunately occur when personnel are distracted, and when they try to save time or money by taking risks, the nature of which they do not appreciate, or which arise from most unlikely circumstances.

I do not contend that the QM system can avoid all safety problems but experience has shown me that its use does reduce the chances of personnel perversely departing from prescribed good practices.

The suggestion that accidents be referred to as 'incidents' alarms me. An incident can be any event whereas an accident is specifically a mishap or unexpected event. Site personnel have been continually taught to avoid accidents whereas I doubt that they would regard references to incidents in the same way. It is clearly desirable that the requirements and instructions to site personnel from engineers, architects or the contracting employers be expressed in familiar, clear and unambiguous terms.

Some supervisors wish only to receive instructions in writing whereas others will accept some verbally. Some require instructing only at the start of the day whereas others require a mid-day reminder. Supervisors and operatives expect consistent standards to be applied from site to site using appropriate materials and equipment to achieve similar results and enable them to work efficiently. Specifiers must remember the needs of those who actually do the work on site.

I perceive a growing move to rename too many activities and operational techniques almost as re-inventions, which is confusing. I suspect that in so doing the track records of past experience are ignored or just not explored!

Both Alistair Forsyth and Stan Lawrence have also written again. Stan Lawrence has drawn on the recent catastrophic building collapse in Jerusalem and wonders whether our Institution should do more to draw attention to procedures which might reduce such tragedies.

Alistair Forsyth has referred Verulam to a news item regarding the potential threat of accidents to rail from road bridges with inadequate barriers (*New Civil Engineer, *14 June 2001). A second letter drew attention to a description of a crash on a motorway which caused a mini-van to run into and extensively damage a barrier between the highway and a railway line. This had been erected because of a perceived threat to the railway. He continues:

There are two aspects to note. Firstly, with respect to the quantifying risk of incident, the question now in my mind is just how many times, throughout the UK, do motorways and railways cross or run parallel to each other? Secondly, with respect to preventing incidents, it is interesting to note someone felt there was danger and did something about it. If the barrier was badly damaged, the absorption of energy this implies presumably prevented the minibus from ending up on the line in the path of the next train.

He also accepts that

You cannot read what is reported without thinking about the costs involved and their 'economic viability'. However, it is not reasonable to ignore the situation. Clearly the subject needs to be addressed and, where deemed appropriate, preventive measures taken.

Few would argue that efforts must be made to minimise deaths and injuries from accidents – or incidents. The problem of determining priorities remains. If one considers the current chaos on the railway, should new lines be built ahead of new signalling systems and/or automatic braking? Should a higher standard be required for the track? Should more trains be demanded to reduce overcrowding? Should they be faster? Are level crossings acceptable? Should barriers separate trains from travellers at stations, as they do on London's Jubilee Line? The stark reality is that by far the greatest number of accidents and deaths on the railways result from trespass. Next problem – does this suggest impenetrable barriers between track and adjoining land? Undoubtedly we cannot afford all of them, even for just the railways! Which would add most to safety? Which would best assist the greater economic viability, then be able to pay for more safety measures? A tangled web indeed!

D. Camilleri has some suggestions for making choice more rational. He writes

With reference to correspondence in the 19 June issue on the subjects of the nature of reasonable care, whether economic factors should be given more weight for accident reduction and what then is a reasonable cost for achieving this, the following could throw some light.

A number of different measures can be used to express estimated risk. These include individual mortality rates, societal mortality rates, fatalities per million, loss of life expectancy and death per unit measure of activity.

The setting of tolerability thresholds requires a baseline against which comparisons may be made. Maximum tolerable individual risk is deemed to be 1 in 1000 (FAR 50) for workers or voluntary activities involving economic benefits or other profits, for which a higher risk may be considered as acceptable. For somebody subjected to an involuntary or unnatural risk, from which he has no benefits at all, the target is substantially lower at 1 in 10 000 (FAR 1) for the public, classified as 'very low' risk. For those living close to a nuclear plant or near a transport route used for dangerous materials, receiving no profit whatsoever, the target is set at 1 in 100 000 (FAR 0.1). These limits for individual risks are defined as just tolerable and a minimal level below which further action to reduce risks may not be required. Between these levels, it depends on how much safety society really needs and what it is prepared to pay for that level, if society insists.

The social acceptance of risk to human life is often presented as an F-n-curve. Two levels of acceptance are plotted. In the upper level the risk is considered not acceptable and below the lower level the risk is considered negligible. In the area in between, risk-reducing measures should be considered and judged on an economic basis known as the ALARP principle (As Low As Reasonably Practicable).

The F-n-curve method does not take into account the economic consequences. In a market economy it is not the concern of the state or of the law to maximise the benefit of the single actors. Everybody is responsible for himself. Therefore the law does not care about damages which are suffered by the risk owner himself, but it wants to prevent damages caused by the risk owner to someone else. Therefore, only the externalised damages are relevant for the law. The internalised damages are, in principle, not a legal problem.

Risks are acceptable if the cost of further risk reduction measures would be higher than the monetarised risk reduced by these measures. The following figures in million Euros per life saved were applied in a 'risk based regulation' project:

- Category 1: voluntary risk exposition, e.g. dangerous sport: no compensation/life saved.
- Category 2: direct individual benefit, e.g. car driving: 2.75 Euros/life saved.
- Category 3: individual benefit, e.g. working conditions: 6.70 Euros/life saved.
- Category 4: involuntary/no direct benefit, e.g. vicinity to dangerous installation: 13.5 Euros/life saved.

The above values are to be treated with reservation, as it is considered difficult, unethical and even impossible to make a valuation of human lives. The value of life appears to be assessed differently according to geography and the level of social development. The integration of economic losses and human safety needs further attention with the QLI (Quality Life Index) approach seeming to be promising.

Peter Phillips, an architect, is concerned about past attempts to improve safety in construction, which he regards as having failed. He writes:

The CDM Regulations were introduced in the UK about 6 years ago as a result of a European Directive which was, as usual, overzealously interpreted by our civil service. Not long after they were introduced, an Association of Planning Supervisors (APS) was set up to represent the new specialty that the regulations created. Since then it has regularly advertised (in *Building Design* at least) to ratchet up both its own self-importance and the scope of any future revisions to the regulations. Its latest advert (*BD* 25 May 2001) should send alarm bells ringing in the construction professions as its calls for planning supervisors to be given an enhanced relationship with clients in the new Approved Code of Practice, currently being revised by the Government. Most worrying was its wish to see planning supervisors being given a pivotal role in advising clients on the competence of consultants, and by inference their selection.

It is obvious where all this is heading – to a completely separate profession with more power, statutory registration, an enlarged APS, and of course more bureaucracy. With a fairly sympathetic ear of Government it could very easily happen.

But what would all this achieve? Government statistics recently revealed that building site accidents had increased significantly over the last 5 years, the very period during which the CDM regulations had been in operation. Those with a vested interest, like the APS, use the increase to justify even more CDM regulation, but another interpretation could be that the whole philosophy of CDM has failed and should therefore be scrapped or substantially simplified. That is what I believe, and I think many others do too.

The health and safety lobby, like so many self-appointed single-interest groups, has become too influential in this country and has resulted in much bad legislation and fear of litigation which does not reflect the views or interests of the silent majority. The recent saga of Norwich City Council wanting to fell a row of conker trees because children might hurt themselves is an example of how ridiculous health and safety has become in the UK.

If the construction industry does not do its own lobbying now to counteract these pressure groups, we will be lumbered with more of this dreadful CDM regulation. I would like to gauge the opinion of all the main construction professionals with a view to lobbying our respective institutes, and readers are asked to log on to a newly created website on the issue: www.users.globalnet.co.ukl–peterfphillips) to comment and/or offer help in gathering support.

What do members think? What would improve on the CDM Regulations?

F. C. Beale has reacted to the SCOSS report and comment regarding it (*The Structural Engineer *3 July 2001). He notes the conflict identified between the aims to improve efficiency and attention to rigorous checks and is concerned that, as part of this, site experience is shrinking, no longer being a compulsory requirement for Chartered Engineers in the Institution of Civil Engineers and having never been demanded by our Institution. He continues:

Over the years the result has been supervision by Civils people with virtually none by Structurals. Now the long-term effect of abandonment by the Civils is taking effect, with supervision effectively by specialists who go from contract to contract rather than keeping supervision within a consultancy with knowledge of bad practice operating from site to office to detailers.

It has always been anathema for consultants etc. to wash their dirty linen in public. Now resident engineers have to bottle up their experience so knowledge does not spread to the people who need it.

Is this a further example where specialisation detracts from the broader knowledge important in good engineering design? Members may wish to comment.

Historic slip-forming?

Rod Gibbons has found a reference to an interesting 1935 construction:

An article I have found in a magazine from 1935 describes a church hall at Frinton-on-Sea in Essex, built using 'a new method of reinforced concrete construction'. It is a single-storey RC cavity wall construction with encased steel stanchions to receive the roof beams.

We are told of a patented shuttering system (by Wheeler & Son, East Bergholt), one board wide which moved upwards at the rate of 0.25 in. every three minutes, all round the building. The lifting used mechanical jacks on vertical iron pipes, operated by 'a boy who travels round the whole work continuously'. The concrete mix was semi-dry, shovelled into the shutter by hand and tamped down.

A photograph shows a roughly rectangular building, somewhat larger than a badminton court, with a flat roof. Is it still there? When was slipforming invented and when do we think it was first used in Britain? Can it be that Frinton, a town not often associated with technological advances, will have to rethink its image?

Do members know of an earlier use of slipforming?

Shear and asymmetrical loading

Ralph Simons has reacted to Stuart Alexander's letter (Verulam, 19 June 2001)

Mr. Alexander's reminder regarding shear arising from asymmetrical loading is, as you say, useful, but higher shear values at midspan can also be obtained if the loading on point loads is reduced.

Consider two point-loads on a simply supported beam positioned in the two half-spans. If the load at one position is reduced or eliminated (i.e. no live load at that point), the shear between the loads will have a greater value than with both points fully loaded. The same result applies of course to all loading cases where there are point loads positioned about the centre of the span.

Might this be considered analogous to the conditions of loading for continuous beams specified in clause 3.2.1.2.2 of BS 8110: *Part 1*: 1985 which states that it is normally sufficient to consider all spans loaded with maximum design loads or alternate spans loaded with maximum and minimum loads? Taken to its extreme, the point loads on one half of the span should be considered fully loaded (1.6DL + 1.4LL) with the point loads on the other half considered as 1.6DL only. As Mr. Alexander points out, this is only significant for the design of openings in the beam positioned near the middle of the span but there could be a considerable increase in the Vierendeel moment generated by the shear force. However, the reduction in moment at or near the centre of the beam also results in a reduction of the axial forces in the sections above and below the opening.

A new tie?

The debate on status (Verulam, 5 June 2001) has brought comment from the Institution's Chief Executive, Keith Eaton.

Both as a fellow of the Institution and as its Chief Executive and Secretary, I follow with interest the correspondence in this column, ranging as it does over a very broad canvas.

I normally resist the temptation to offer comments on every subject raised, but I do wish to respond to Andrew Mahaffy's remarks concerning the Institution tie. You may recall that he referred to it as a 'thin polyester appendage last revised in the 1970s'.

Whilst the design has been changed more recently than that, and beauty may be said to be in the eye of the beholder, I do have sympathy with his view. In fact I have already been investigating this matter.

I suspect that whatever new designs are introduced in due course, they will not be to everyone's taste, but we will certainly try to come up with a tie which will be worn with pride by our (male) members.

Please provide an option of silk or polyester!

Emails can be sent to Verulam via: reynolds@istructe.org.uk

Letters should be kept as short as possible, and preferably clearly typed. Illustrations cannot be redrawn: please ensure they are suitable for publication.