The climate change crisis demands radical change by all. How must structural engineers respond to the challenge?

The Climate Emergency has driven us to a critical moment in human history. We are currently at a unique point in time where we are aware of the damage that we are causing whilst still having the opportunity to significantly alter our future environment. Engineers have an opportunity as well as a responsibility to play a major role in this change.

In the past, it may have been argued that society would not have been willing to accept radical engineering solutions or risks to the status-quo, but that is now changing. Public opinion is shifting so rapidly that engineers need to move quickly to provide the solutions which the public, and therefore our clients, are now willing to accept. If we do not, then engineers will be responsible for impeding the worlds progress on climate change.

Some argue that environmental legislation is the only solution that can enable rapid change within the Construction Industry. However, in other comparable activist movements such as Suffrage, Civil Rights and LGBT Rights, public opinion has always preceded legislation and not vice versa. Therefore, we cannot wait for governments to provide the solution. We need to be offering our clients the information and the options to make the right choices for the environment now.

We also need to be wary of making mistakes when acting quickly. In the early 2000's diesel cars were heralded as the future of environmentally friendly transport. They produced less CO_2 per km and were branded as "efficient". Consequently, their numbers rose dramatically. We now know that the other pollutants released by burning diesel have extremely harmful effects on the environment and on ourselves, and there are now several schemes planned to scrap diesel powered vehicles in major cities across the UK. This initially narrow-minded response, even with good intentions, must not be repeated by engineers dealing with The Climate Emergency today.

In order to produce truly sustainable solutions, we must first acknowledge the work that has been done and then build on this with innovative ideas to ensure that we are providing holistic and balanced answers.

Our initial actions may be summarised by these key points:

- We must use less material and make the material we use do more.
- We must understand and increase the transparency of our carbon values and share our data throughout the industry.
- We must question industry norms and use theory and reason to design our structures, instead of regulation.

As well as these tangible goals we need to be more radical in our ideas, to inspire others, and be willing to adapt and stay up to date. If our society shifts as quickly as we need it to, the information which we base our initial decisions on will quickly become outdated.

Using Less Material

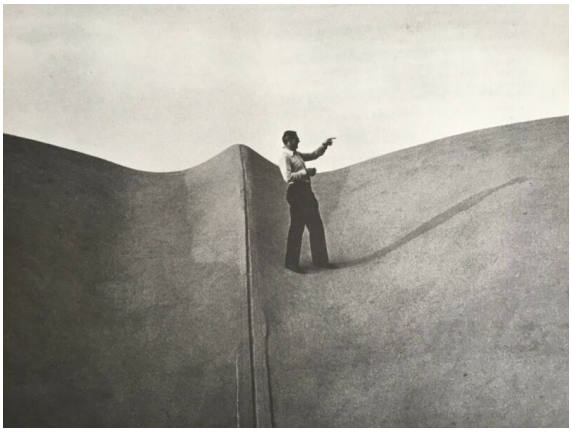
To use less material we must design more efficiently, but even this statement raises questions about what we mean by efficiency:

- Can we design every element in our structures to a utilisation ratio of 1.0?
- Can the cross sections of our elements be varied to more accurately correspond to the loads that they carry?
- Is the span, column spacing, and decking type that we specify enabling the most efficient use of materials?
- Can we extend the lifespan of our buildings and do we even need to build in the first place?

These questions need to be considered and justified on every project, to keep them in our minds and ourselves accountable.

However, there is also a broader sense in which we can reduce our materials through our approach to design. In my opinion, the greatest designs are always those in which materials serve multiple purposes. This requires thought and co-ordination, but when achieved successfully, the products are simple and efficient.

In 1965 Heinz Isler combined his practical and theoretical knowledge of construction to ensure that his concrete roof structures did not crack, therefore omitting the requirement for waterproofing. He achieved this through compression in his shell structures (Figures 1 & 2) and through pre-stressing in flat roofs. The designs were carried out without the aid of computers and the resulting structures were simple to understand, efficient in terms of materials and many of them were selected on the grounds of their cost. He used one of these structures as his offices for 40 years without defect. Which engineers would take such risks in today's climate?

Figures 1 & 2. Heinz Isler's compression shells: Dudingen Sports Centre, Switzerland

The collaboration between suppliers and engineers is another area which needs to be improved to promote efficiency. Suppliers need to become more willing to adapt to different situations and engineers need to be more willing to help them, even if it is not within the strict confines of their responsibility. An example of this would be combining cladding modules onto primary structure, therefore removing the need for superfluous secondary steelwork.

In some instances, this collaboration may blur the lines of responsibility, but I believe that our concept of responsibility needs to change as well. We are all responsible for climate change and we cannot deal with vast problems through contractual arrangements. We need to create a more collaborative environment, and by working together we can create simpler more efficient structures where responsibility for success is shared between parties.

In a modern example, Practice Architecture used timber & hempcrete cassettes to create Flat House in Cambridgeshire (Figure 3), where the cassettes were used as the structure of their building as well as the insulation and the internal finish. If we can make our materials do more, then the complexities of the project are shifted towards the skill of the designer and away from a complex combination of products.

Figure 3. Flat House by Practice Architecture, Cambridgeshire

Transparency of carbon figures and data

Regulations, CE markings and FCS certifications are useful procedures for promoting minimum standards in design and of materials. However, they can also be used to shield engineers from requiring a full understanding of where our materials come from. I suggest that we should question those who supply our products and delve deeper into the source of the materials which are used in our structures. This role is typically left to the contractor, but by expanding our breadth of influence we can have a greater role in choosing which products should be used and therefore improve the sustainability of our projects.

Another method of improving transparency in our carbon values is to use more local products. The value of this is in increasing the transparency of the supply chain. As the supply chain gets longer, this information becomes more clouded and contentious. This does not necessitate the exclusion of globally produced products, which can be produced more efficiently on scale, but their use should only be based on a sound knowledge of the supply chain needed to create them.

We also need to be aware of more than just the figures. For instance, GGBS and Fly ash may be useful ways to reduce the value of carbon in concrete, but they are produced by heavily polluting industries and are a finite resource. We need to be careful that we do not build a future construction model with reliance on materials which will not last.

Most importantly, we must build material databases of all of our buildings. There will be further debates about the best method for standardising our carbon accounting, but this should not be an excuse to delay the process of material cataloguing. This resource, combined across the industry, will be a vital tool for informing future decisions to determine the areas in which the largest impacts can be made.

Questioning norms

Our industry is built on a set of norms which benefit construction convenience and cost, but now that carbon has become such a driving force it is time to revisit their necessity. Some questions may include:

- Do we require 50mm blinding across a whole site?
- Do we require rebar spacing of 200mm to accommodate the average foot size?
- Do we require top reinforcement in every slab?
- Are the Eurocodes loading requirements suitable for every building?

In many instances, questioning norms will require us to return to first principles to justify our deviations from industry standards, but this will promote a greater understanding of the structures we design and will in itself generate simpler solutions more adaptable to their surroundings and favouring quality of design over speed.

The recommendations above suggest a general shift in the role of an engineer. We need to increase the breadth of our expertise in construction methods, supply chains and carbon values. We need to work more closely with other disciplines, but also take on more responsibility and become better generalists to achieve a more holistic approach to design.

It is easy to be overwhelmed by the amount of work to do, but when we look at the inefficiencies in our industry there are also grounds for hope. There is an enormous amount of room for improvement and as engineers we have an opportunity to make a significant impact. Our duty is to make the most of this opportunity and to inspire other to do so as well.

Word Count: 1490