

Guest editorial comment

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Research on real concrete structures—risks and benefits

An apple fell on Isaac Newton's head. From this ordinary event a great mind fashioned a set of simple laws that have been at the foundations of science and engineering ever since.

The intellectual process whereby a simple observation of a reproducible event, through hypothesis to theory and to law, has equally been at the centre of the development of science and engineering for the past quarter of a century. We call this process The Scientific Method.

The value of the deductive process, whereby particular behaviour is deduced from a general law is at the centre of this advance. This journal has at its heart the mission of publishing the results of original work, of theory and experiment in the fields of concrete material and engineering science. Such research is usually economical, sparing in its use of experiment but unstinting in the intellectual rigor that follows this experimentation. We find much to admire in this process, the economy of effort and resource and the simplicity of the conclusions that we draw from it. Indeed, researchers are often suspicious of a complex explanation of an observed event. It is often seen as 'not possible' for such explanations, if correct, to be so complex. More simple and elegant solutions must have been missed. Such is the power of elegant solutions and explanations that experimenters have, on occasions, wittingly and unwittingly proclaimed a theory without having carried out sufficient experiment to justify it.

Without doubt the deductive process is valuable, and it is right that our journal should rely upon work produced in this way.

A problem does arise from our difficulties in applying simple theory to the complex structural arrangements that we construct. Our powers of analysis are often incapable or too cumbersome to use rigor in structural design. We can understand all of the laws of creep in laboratory experiment but find it difficult, impossible or unnecessary to apply them to a complete structural arrangement. We use simple models or design substructures to get over this difficulty. This process is safe and usually conservative, in some cases extremely so.

Often this reserve of strength or of serviceability

comes from the structural continuum surrounding the substructure that is modelled or it comes in global structural effects that are excluded from the simple local model. Membrane effects in slabs are a typical example where great reserves of strength and reductions in deformation are observed coming from restraint offered by surrounding structure.

The engineer is obviously interested in these boundary effects, particularly if economies can be made, and studies in this area are clearly worthwhile. The process of study of these effects and their incorporation into a design is, nevertheless, deductive.

Remember, the deductive process concerns inference from the general to the particular; it is a reliable, economical process that is at the heart of engineering and scientific advance. There is a rather different process, that of induction, reasoning for the particular to the general. In this case, rather than the saying, deductively, 'it works everywhere, therefore it works here', we say, inductively, 'it works here, therefore it works everywhere'.

Inductive research can be seductive. In the example of the complex effects in a structural continuum or in a complex material problem which may be beyond analysis, the idea of an inductive approach can be compelling. Take for example the effect of membrane actions previously mentioned. A real structure would be tested and the 'true ultimate strength' compared with an elastic-plastic analysis. The difference may be a factor of 2, and may be put down to membrane compressions not considered in the analysis. The inductive approach would tempt us to say that true ultimate strengths are twice that predicted by an elastic-plastic analysis—everywhere.

Most engineers would not make such an assumption, but the idea would nevertheless be implanted and could be used to justify a situation where a degree of under-strength is found in a design.

Induction is particularly useful where individual experiments are expensive or time-consuming and therefore cannot be developed, repeated or otherwise assessed. It is nevertheless inherently dangerous.

We are seeing an interest in experiments on real structures on the basis that advances in knowledge of structural performance can now best come from com-

plete structures rather than simple models. Real structures have other advantages: they are large, they may be built specifically as 'demonstration projects' and attract commercial funding. They are part of the marketing budget and are not just technical. If research can be devised to learn from these structures, then this too must be 'a good thing'.

The risks are great, the process is inductive. Re-

search on real structures cannot be repeated and validated, and may always have an undefined area of applicability.

This journal is not against research on real structures but doubts value for money, and is concerned that results so obtained are understood to come from a limited context unless they are supported by further research to ensure their generality.