The influence of control processes in structural engineering

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The Paper brings a breath of fresh air to the subject of control processes in building construction. I imagine that for reasons of continuity with existing literature, the Author has concentrated on actual structural failure and so-called structural safety. This latter term must be classed as one of the ill-conceived concepts referred to in § 1. Papers dealing with safety often consist of discussions of criteria such as number of deaths/population of dwellings/year or numbers of structural failures/populations of buildings/year. The size and nature of the populations chosen and the definitions of structural failure are chosen arbitrarily, and even if the analysis of the safety data is rationalized and refined, its only effect can be the modification of factors used in element design through the codes of practice. The real problem facing the construction industry is the failure of large populations of buildings. Consider, for example, the collapse of Ronan Point and the consequent immensely expensive survey and modification of many similar blocks, or the failure of two beams in the roof of the Stepney school swimming pool followed by a nationwide search for other beams containing high alumina cement. These are just two examples from a long list of failures where, in economic terms, minor local failure has generated large consequential costs in survey, renovation and repair costs throughout the whole population of similar buildings, i.e. those related by a common construction material, form, design, contractor or other factor. One concept that must therefore be considered *vis-à-vis* the control of building quality is the stability of building populations.

63. The Author's analysis of control processes relates principally to problems of the individual structure. However, just as thin shells and slender columns with their single optimized load-carrying mechanisms are very efficient in material usage but at the same time prone to instability failure, so large populations of buildings defined by a common feature are efficient in design and construction costs but very unstable if that common feature becomes suspect. Unfortunately, the control systems discussed in the Paper are frequently administered at national and international levels and automatically institute uniformity in large building populations. Thus regulatory systems which are beneficial for individual buildings can be, in themselves, deleterious for the populations of such buildings. However, as every designer knows, there is no unique solution to the problems posed by his clients. The size of building populations can be controlled by encouraging variations in control procedures which maintain satisfactory standards within any one population, but generate different means of attaining these standards for different populations and so permit the variety of solutions essential for stability.

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Structural safety is indeed an ill-conceived concept, lacking adequate definition even within the profession. A preliminary attempt at anchoring this concept was made in the Paper using the notion of expected loss; a more refined approach might employ utility theory, but even then subjective limitations are difficult to quantify in terms useful to the profession.

65. The approach to structural safety that is currently fashionable—that of determining partial factors for use in codes of practice—cannot account for all variations and errors that may occur. I agree that regulatory systems administered through codes could produce the opposite effect to that desired. The thrust of the Paper, however, was not with this type of control, but rather with that administered through competent design checking, field inspection and so on, which should, in the broadest sense, be concerned with whether or not the transformation from project requirement to project implementation had been done competently, i.e. to within the contemporary standards of the profession. It is important to recognize in this regard that simply ensuring that the rules are obeyed does not in itself constitute adequate control; particularly in design checking, there are many matters of concept which are not covered (and cannot be covered) by codes which are vitally important to a structural project. Both of the examples quoted by Mr Armer are in this category.

67. It is unavoidable that codes of practice are at national levels and that by virtue of their transitory nature they are erroneous in some respects. The control exercised in this way may well lead to the problem of failures of populations of structures mentioned by Mr Armer. The consequences of code errors should be considered as part of the process of evaluating the worth of a code and the degree to which it should circumscribe the actions of designers and others. It may well be that present codes are too restrictive—either directly by regulation or indirectly through economic pressure. Nevertheless, it would be unreasonable to expect code writers to foresee every possible use to which their code might be put. In the end it is each individual designer's professional task to ensure that he understands what the code he is using is about, and that the code is relevant to his objectives. It is with the degree to which this is done that the Paper is principally concerned.