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Editorial

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Forensic Engineering is defined by the US National Academy of Forensic Engineers as '…the application of the art and science of engineering in matters which are in, or may possibly relate to, the jurisprudence system, inclusive of alternative dispute resolution' (see http://www.nafe.org). This legally-based definition is extended by the American Society of Civil Engineers to become

> Forensic engineering is the application of engineering principles to the investigation of failures or other performance problems. Forensic engineering also involves testimony on the findings of these investigations before a court of law or other judicial forum, when required. Failures are not all catastrophic, such as when a building or bridge collapses, but include facilities or parts of facilities that do not perform as intended by the owner, design professional, or constructor. (see http://www.asce.org/forensic-engineering/forensic-engineering).

This latter definition includes the concept of 'learning from failure' and the purpose of legal redress in forensic engineering cases on complex structures almost invariably relates to the provision of remedial measures to achieve the design life or performance, or to recouping the cost of a replacement structure. It is therefore clearly important for engineering practice to implement learning from failure and to then incorporate the knowledge gained in designing against failure. Increased knowledge of the factors affecting performance issues for complex structures in 'extreme' environments (involving, for example, either corrosion or temperature excursions) is eventually captured in updates or revisions to published design code or recommended practice documents that are issued by regulatory or national bodies; for example, DNV or ISO.

An area of forensic engineering that is currently of significant global importance relates to achieving increased sustainability for human consumption, either through provision of renewable energy devices (e.g. wind turbine generators, which may be either offshore or land-based) or via recycling (e.g. city waste composter facilities). Over the last few years, the author has acted as an expert witness in several high value court cases that have dealt with structural reliability issues for large-scale rotating composters or offshore wind farms. Typical initial design lives are around 20 years for such expensive structures, but with an expectation of life extension as operating experience increases. In the case of composter facilities which operate at 55–60°C with a highly corrosive internal environment, there do not seem to be any relevant codes covering their design, and arguments around reliability then invoke design standards or codes developed for other categories of structure that operate in corrosive environments; for example, offshore. Operating experience may then indicate that the provisions in such codes are unduly conservative, as the design conditions are, in fact, somewhat different. For offshore wind turbine generators, documents covering recommended structural design practice do exist and, as this is an area of emerging operational experience, these may be subject to regular updating or amendment. A significant part of the legal argument in such cases may revolve around the applicability and responsibility for any changes made to relevant codes since the date of the particular design standards that were contractually specified.

The present issue of *Forensic Engineering* is therefore focused towards the topic of ensuring reliability of structures in complex environments. In such cases, codes of practice may still be evolving and design necessarily involves an optimised balance of capital cost (which is likely to be highly important in winning a contract) against through-life cost. This balance should take into account any remedial measures that may be required and that might arise from incomplete knowledge of variations in the operational environment, compared with the state of knowledge on which the current codes were based. In terms of forensic engineering, the latter point regarding the knowledge base underlying the code and assumptions or conclusions drawn from that knowledge are particularly important, as latter versions of a code may state that this aspect of operation should be considered without defining why it has become known to be important. Condition monitoring may then become highly important to cost-effective operation.

The content list therefore includes a case study by Zhou *et al.* (2015), which deals with failure of reinforced-concrete foundations of onshore wind turbine towers under extreme weather conditions and recommends changes to the design of the bond between the circular steel tubes of the tower and the reinforced-concrete foundations. These recommendations are similar to those contained in amendments made to DNV-OS-J101 regarding the possibility of slippage in the grouted connections between the transition piece and the monopile from offshore wind turbine foundations.

The issue of different design standards is a factor in the paper dealing with an example of failure of holding down bolts (Kog, 2015). Bolts are implicated in many structural failures, even though their design should be relatively straightforward, and this case study highlights a case of incompatible nut and bolt thread forms possibly involving procurement from different countries with different standards.

The next paper by Donchev *et al.* (2015) considers the estimation of temperatures reached in different parts of fire-damaged buildings, which is a primary factor in condition assessment and hence remedial measures.

A Discussion article on the use of systems dynamics in managing assets through-life (Thurlby and Rimell, 2015), and a Briefing paper on statistical pattern-recognition-based structural health monitoring (Balsomo and Betti, 2015) are also included. These are intended to highlight issues around objective monitoring of structural health issues and pattern-based recognition of 'damage-sensitive features' that allow damage state identification to be performed on a computerised basis, and the potential of increasing operational performance and decreasing costs through changes to asset management strategy policy.

Structural health monitoring is an area of significant attention for the engineering design community and this issue will hopefully be of considerable interest.

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