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Foreword

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The first two decades of this century have seen a number of high-profile and, in every sense, tragic bridge collapses. However, apart from headline-grabbing failures such as the I-35W bridge in Minneapolis (MN, USA) in 2007 and Morandi (Polcevera) Bridge in Genoa (Italy) in 2018, most collapses go almost unnoticed in the contemporary whirl of instant media and transient news.

Sadly, however, at the time of writing, some statistics suggest that since the start of the millennium and across the globe, there have been 123 significant bridge collapses that have claimed at least one life. Perhaps more sobering is the thought that those collapses have accumulated a total death toll of almost 1000 fatalities (Wikipedia, 2019).

While there are bound to be particular issues associated with each of these – including extended legal proceedings that often prevent or delay the publication of investigations – it is worth reflecting on the causes of collapse in broad terms. Why does a structure fail? There are just five reasons: it has either not been designed, constructed, maintained or operated correctly or it has been subject to external or environmental forces that had not been envisaged by the designer. It is seldom just a single cause, but more likely a combination of any number of these that slowly erode any factor of safety in design loads or material characteristics.

The simple safeguard to prevent collapses is investment: in terms of money, systems and people. In an age of austerity, infrastructure maintenance budgets have fallen at the same time as demand has increased. Often against the better judgement of bridge managers, decision makers may defer planned maintenance, if only for a year or two, but this in turn leads to an increase in reactive maintenance and a further consequential reduction in the available maintenance budget.

But how do we measure the full extent of neglected maintenance? It is almost impossible to monitor the overall condition of a national bridge stock, with many thousands of bridges of various ages, forms and degrees of deterioration. A few countries have a national bridge database. The USA is one of those, and categorises its bridges in four categories, the lower two of which sound almost frightening: 'structurally deficient' and 'functionally obsolete'. In 2017, it was reported in the *Washington Post* (Lu and Keating, 2017) that out of a total of just over 600 000 bridges, there were 130 000 in at least one of these categories (Washington Post). Alarmingly, 200 million trips per day are taken across bridges that have been categorised as structurally deficient. And yet this issue is regularly reported in the media with statements such as 'We are the United States of Deferred Maintenance… We spend, borrow and patch' (Friedman, 2010). It has even been alleged that the I-35W collapse was partly attributable to a policy of planned deterioration as structurally deficient bridges attract additional federal funding (LePatner, 2010). Current estimates used within the media are that the maintenance backlog will take 80 years to be completed at current spend rates (Lou and Griggs, 2019).

And yet it is not just a problem in the USA. After the Polcevera Bridge collapse, national media sought facts from their own countries: in Italy, it was acknowledged that some 300 bridges could be 'unsound'; in France, 840 bridges were described as being 'at risk of collapse'; in Germany, only 12·5% of bridges were 'in good condition' (Gordon, 2019).

Underlying all possible failure causes, however, is the performance of engineers: our profession is responsible for the cradle-to-grave life of all bridges. Media reports of 'engineering ignorance' (Hansford and Lynch, 2010) need to be robustly refuted, illustrating the facts of underinvestment. What is really needed is sufficient financial headroom to allow our profession to invest in the capacity and capability to ensure that those in the profession are enabled to inform infrastructure owners and operators of their liabilities. Whether client, consultant or contractor, underpinning all engineering decisions is the concept of competence. The outcomes from the investigations and inquiry into the Grenfell Tower fire in London in June 2017 will inevitably see a dramatic demand for all professionals to be able to demonstrate they are competent to do their job – a fact already identified in the recent Institution of Civil Engineers report *In Plain Sight* (ICE, 2018).

Fundamental to sound bridge management is the inspection process. From an inspection report, plans are made for interventions to ensure the bridge's longevity, decisions are taken on priorities and risk analyses are performed to review the impacts of progressive deterioration and many other consequences. And yet, any inspection is, to a certain extent, not only subjective but also totally reliant on the competence of the inspector. That competence must be tested and proven, and be subject to independent verification. There have been too many examples of defects simply being recorded as 'historic' (as was the case with the I-35W) with no-one sufficiently competent in the whole bridge management process to challenge that sort of comment. Both the USA and the UK have recognised this shortcoming, with bridge inspector certification schemes now in place (Lantra, 2019).

So, all of us engaged in bridge management and maintenance, responsible for the lives of the travelling public with their implicit trust that we are doing our job properly, must also demonstrate and prove we are competent. We must strive for investment in people as well as budgets and we must prove our competence, eradicate complacency and justify the confidence of our customers.

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