Structures health monitoring and prognosis

What is the situation?

Network Rail's structures asset portfolio is substantial; the budget for management and renewal of structure assets within Control Period 5 (2014-2019) is circa £2bn. There are few if any single organisations in the world that are responsible for the management of a portfolio of this size and age. This includes approximately:

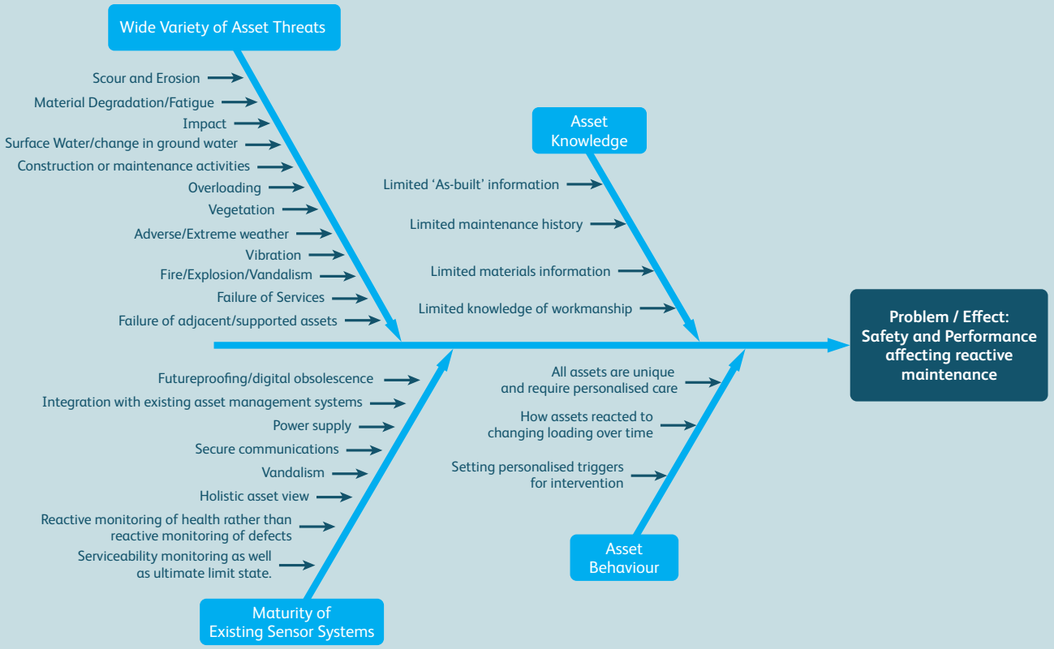
- 28,000 bridges range from modest rural utility bridges to complex multi spanned structures such as the Forth Rail Bridge
- 22,000 retaining walls, many of these significant structures in their own right 15 metres or more high
- 1400 footbridges
- 22,000 culverts
- 200 miles of coastal defences
- Over 100,000 ancillary structures, including masts, lighting columns and signal posts.

The majority of these assets were built over a hundred years ago before the advent of modern design codes. Their longevity, construction form, size and failure mechanisms have led to a perception of robustness that in many cases may not exist. Early structures were typically constructed from masonry, cast iron or wrought iron. Early steel was introduced at the turn of the twentieth century. For these older assets there are no records linking their performance with the loading that they carried or were designed for. Neither is there reliable information on original construction form, maintenance history, materials and workmanship from that era, so we are faced with a great many uncertainties.

Condition inspections of structures assets rely heavily on data collected by examiners in the field. Many of the data sets collected are subjective creating incomparable, and sometimes unreliable, data sets. This limits the extent to which asset condition and potential failure can be accurately determined. The recording of condition data could also be seen only as recording a proxy for loss in structural capability.

Routine capability assessment of structures is normally limited to bridge assets and undertaken on an 18 year rolling cycle. Assessments are traditionally complex, expensive and time consuming.

Analysis of causes



Priority problems

Specific priority problems

- Better understanding of asset threats – how can these be predicted? What are measureable precursors?
- How do we determine the size, material and history of elements not currently visible?
- How do we better understand individual asset behaviour?
- Development of sensor technology with a lifespan and maintenance requirement congruent with the assets they are monitoring.

Related goals

- Greater understanding of asset portfolio allowing engineers to make better and more timely decisions
- Improved reliability of data
- Increased asset availability

Scope

The scope of the challenge is to explore how a holistic system for the overall health monitoring and prognosis of structures assets can be developed.

The scope covers new and novel methods for structural assessment, data collection, analysis and intervention.

Specific research needs

To address this challenge it is expected that research and development activities will need to address the following aspects:

- What remote structural health checks are required to individual assets that are to be supported by a holistic remote monitoring system?
- How can serviceability of a structure be remotely monitored?
- How can structural capability be calculated instantly on the receipt of new data from the field?
- How can structure condition data be remotely captured efficiently, reliably and repeatedly?

Expected impacts and benefits

- Improved asset knowledge supporting greater asset availability to customers
- Reduced volume of performance affecting reactive maintenance
- Lower whole life cost through more effective and efficient maintenance
- Improved workforce safety through reduced requirements for site visits.