Prognostics and Health Management Technology of Mechanical Structure Under Fatigue Load

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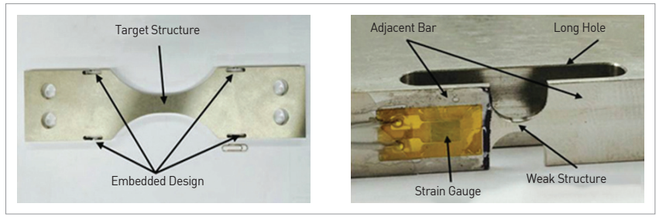
Embedded structural design and sensing technology for predicting remaining useful lifetime (RUL) of a mechanical structure under fatigue loading



Client / Market

- National Infrastructure (bridge, tunnel, dam) monitoring and safety diagnosis company
- Machinery asset monitoring at cargo handling machine and heavy construction equipment rental company
- Machine structure with unpredictable model–based fatigue limit due to corrosion environment
- Improvement of machine structure with over–applied safety coefficient due to uncertainty and deviation of future loads

Necessity of this Technology

- The existing model–based prediction method for predicting the fatigue life of mechanical structures essentially involves the following three error sources– uncertainty of materials properties, unknown future loading condition and the modeling error itself by simplification.
- Model–based life prediction using the fatigue property is difficult when the structure is affected by corrosive environment and variable random loading.
- Prediction of remaining life is difficult for a used machine structure with unclear use history or loads exceeding the permitted weight.
- It is useful for a machine structure that switched from preventive maintenance to condition–based maintenance to reduce the operational expenses.
- With this technology, second damage in the system can be prevented and the golden time can be secured in case of a big disaster.

DESIRED PARTNERSHIP

Technology Transfer | Licensing | Joint Research | Other

TECHNOLOGY READINESS LEVEL [TRL]

Research, basic explanation | Project concept or idea development | Technology idea verification | Prototype development | Trial product production/ evaluation in similar environment | Pilot field demonstration | Development and optimization of commercial model | Commercial product demonstration | Mass production and initial market launch

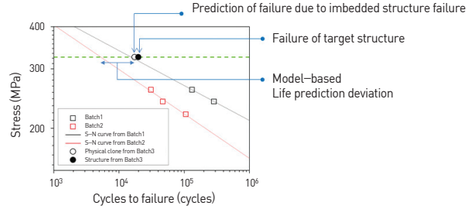
Technical Differentiation

- It is a fatigue limit prediction technology with additional processing or attachment of an embedded structure that interlocks the target structure mechanically. It can be called as a mechanical fuse for fatigue damage accumulation.
- It is a new concept fatigue failure prediction device that can be applied random loading and corrosive environment.
- A non–model–based sensor that monitors the health of the structure was developed.

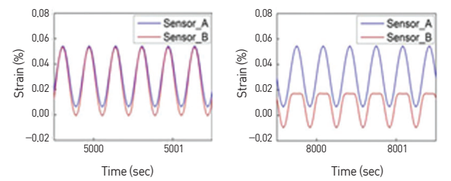
Excellence of Technology

- To prove the superiority to existing model–based life prediction technique, an experiment with a 316 L stainless steel structure with a constant amplitude fatigue loading was conducted, and the failure was predicted at 86% point of the entire life. (with existing model–based prediction, there is a 25 to 280% error)
- It can be applied also for random fatigue loading.
- It can be applied regardless of material property deviation and corrosive environment.

Comparison with Existing Model–Based Prediction Method



Signal Change of Strain Sensor before and after failure of Embedded Structure for failure prediction



Prediction method (Batch #)	Prediction method (Batch #) (In reality, failure after 19,800 cycles)	Life prediction error
Model–based life prediction (Batch 1)	15,900 cycles	4,900 cycles (19.7%)
Model–based life prediction (Batch 2)	5,240 cycles	14,600 cycles (73.5%)
Failure predicting embedded–structure–based prediction	17,400 cycles	2,400 cycles (12.1%)

Current Intellectual Property Right Status

PATENT

- Fatigue Failure Prediction Apparatus of Mechanical Structures (KR1718131)

KNOW–HOW

- Fatigue load–linked structure design technology considering machinability
- Failure prediction structure sensing and signal processing technology
- Failure prediction timing control technology