Innovation and Networking for Fatigue and Reliability Analysis of Structures – Training for Assessment of Risk

The effects of SHM system parameters on the value of damage detection information

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Introduction

- Structural Health Monitoring (SHM) strategies and measurement techniques have been well developed.
- However, there are often too many sensors and several may be incorrect.
- There is an urgent need for understanding the effectiveness of different sensor configurations.

Methods

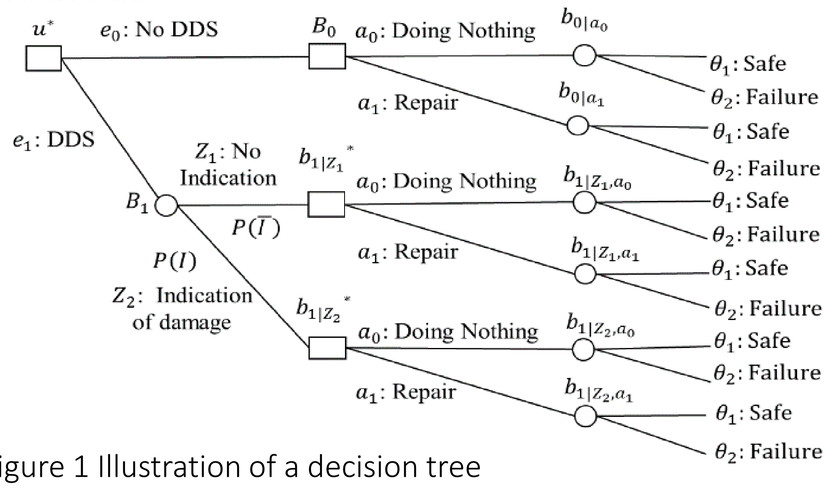

Figure 1 Illustration of a decision tree

- A value of information (VoI) analysis comprising a decision tree analysis, structural probabilistic models, consequences analysis as well as benefit and costs analysis associated with monitoring results through its service life.

Example

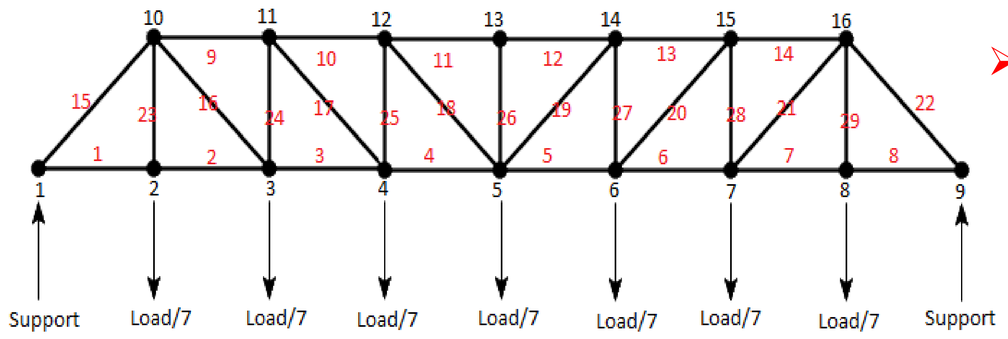

Figure 2 Pratt truss bridge girder

- The Damage Detection System (DDS) is implemented on the truss bridge in a particular year and the monitoring lasts for one year.
- Two scenarios of sensor configurations are modeled, shown in Table 1

Table 1 Sensor Configuration

	Number of sensors	Sensor Node location
Base scenario	3	12,13,14
Scenario (a)	1	13
	3	11,12,13
	5	11,12,13,14,15
	8	11,12,13,14,15,4,5,6
Scenario (b)	3	4,5,6
		2,5,8
		2,3,4
		11,13,15

Results

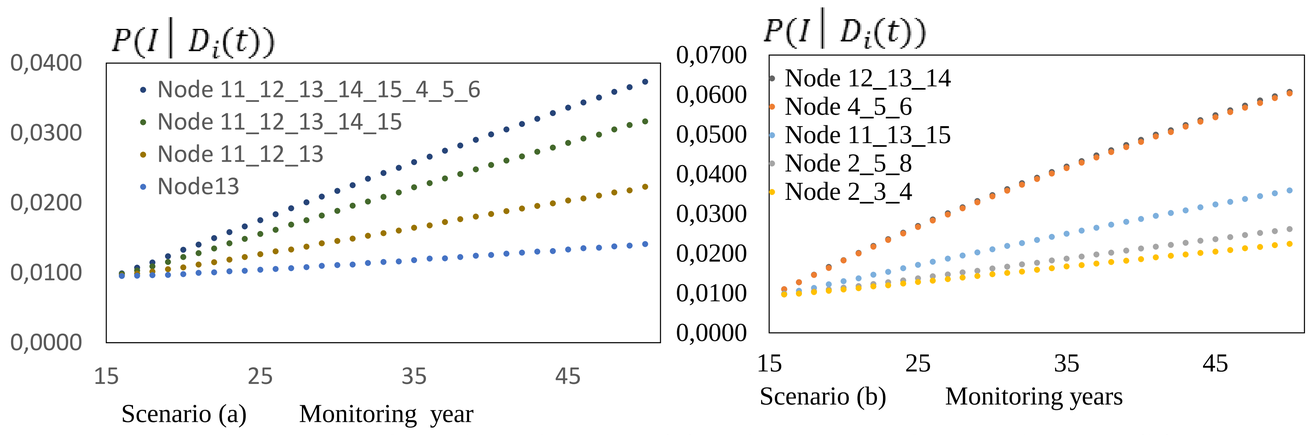

Figure 3 PoI with changes of number of sensors (a) with changes of sensor location (b)

- More sensors, higher probability of damage indication (PoI) will be.
- The closer the sensor location is to the weakest components 11 and 12, the larger the PoI will be.

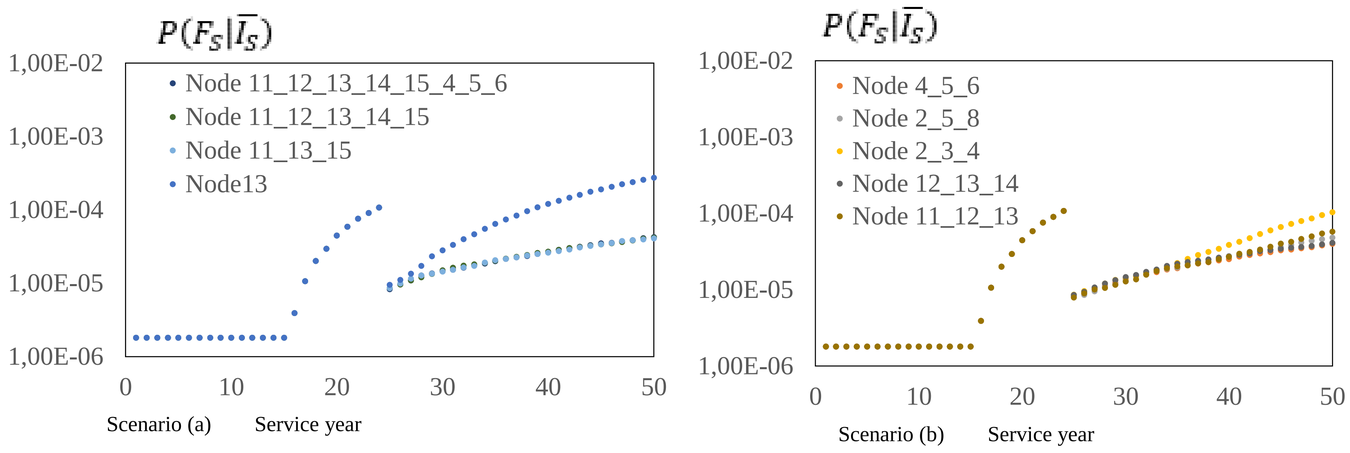

Figure 4 Updated probability of failure when implementing DDS at year 24 with different sensor location (a); with different number of sensors (b)

- More sensors, much lower the updated probability of failure will be than the case with only one sensor.
- The closer the sensor location is to the weakest components 11 and 12, the lower the updated probability of failure will be.

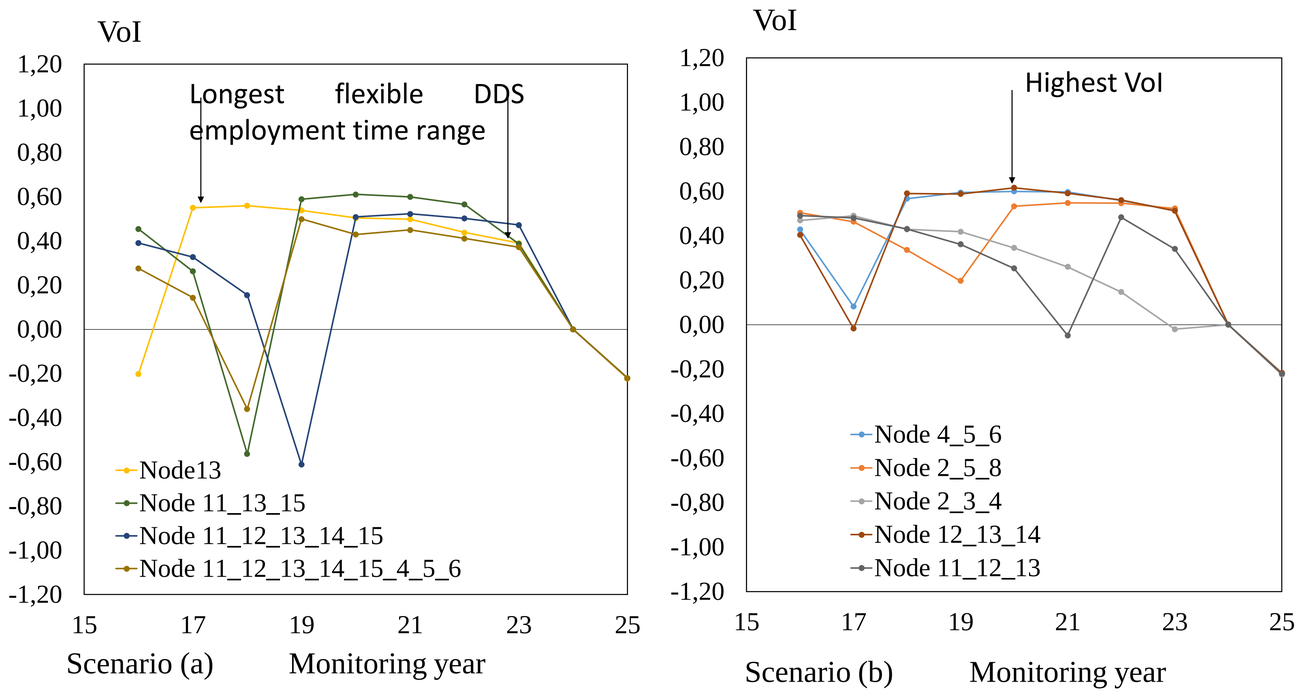

Figure 5 VoI with different sensor locations before year 25 (a); with different number of sensors (b)

Conclusion

- One sensor system provides a high value of information for the longest flexible DDS employment time range.
- Only specific sensor locations near the highest utilized components lead to a high value of information.
- This study only analyzed a finite set out of many possible sensor configurations.

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MARIE CURIE ACTIONS

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