Nondestructive Damage Evaluation

NDE System by Ensyso and Sensuron

In close collaboration with NASA, Sensuron developed compact fiber optic sensing systems that can provide continuous strain measurements. One major challenge facing the development of prominent nondestructive damage evaluation (NDE) tools has been a lack of fine spatial resolution from sensors. Sensuron's advanced fiber optic sensing platforms resolve this issue with spatial resolution down to 6.3mm. Ensyso developed set of rational procedures that can lead to reliable relationships between damage indices and measurable response parameters. The procedures are based on fundamental mechanics and, therefore, are applicable to arbitrary structures. Ensyso's (NDE) expertise combined with Sensuron's advanced FOS technology offers a fully automated continuous health monitoring tool where local damage detection is possible through the use of global vibration information. By bringing Ensyso's and Sensuron's technologies together, a complete NDE system is developed, which could serve as the most prominent NDE algorithm that exists in the market.

Damage may conveniently and accurately be expressed in terms of local decreases in the flexural stiffness of structural members. These decreases cause singularities in the measured strain profiles, which may then be used to detect the location and estimate the extent of

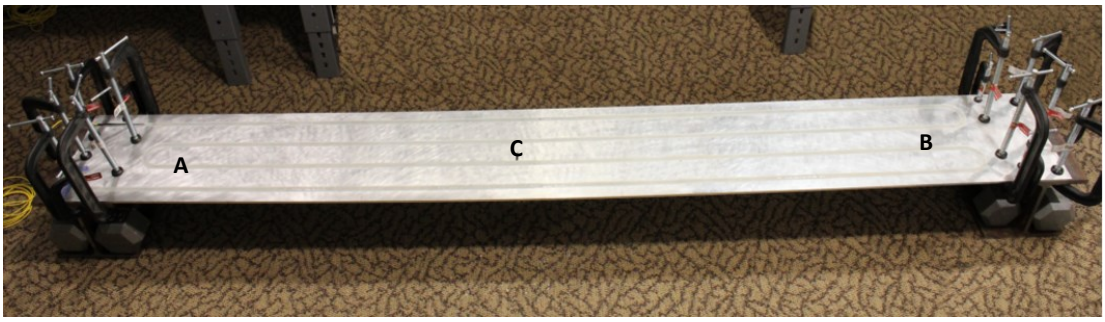

Figure 1. The test article instrumented with fiber is shown above. The severity of the inflicted damage is an 8.3% reduction in the moment of inertia. The location of the damage is indicated by the letter "C."

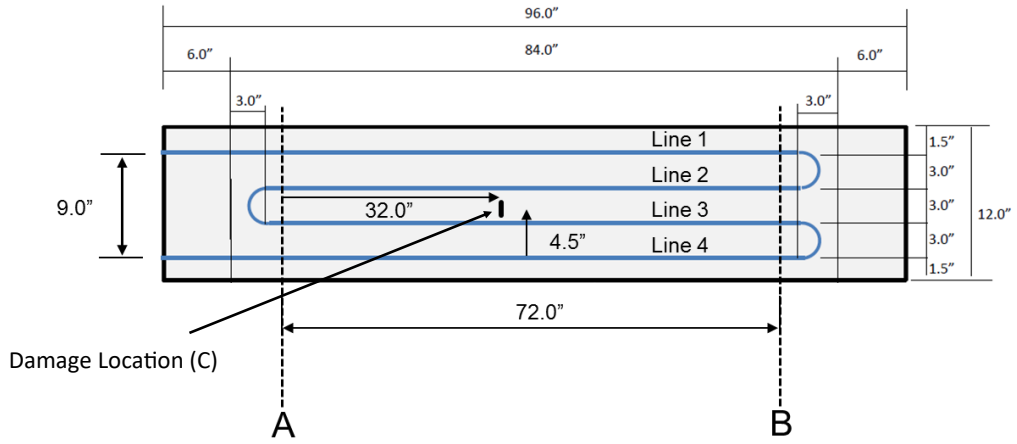

Figure 2. The image above is a drawing of the test article indicating the fiber layout and location of the damage.

damages that reveal themselves as structural discontinuities.

In short, the technique uses pre- and post-damage ambient strain measurements collected from a relatively dense sensor layout provided by the FOS platform to:

- Detect the existence of damage.
- Determine the location of damage.
- Quantify the severity of damage with very high accuracy irrespective of the size of the inflicted damage.

Benefits of the NDE System

The proposed capabilities of the NDE system go far beyond currently available NDE techniques by providing the following benefits:

- The methodology is applicable to a wide variety of structures and sub-systems encountered in practice. This provides the potential to evaluate the health of large scale structures as well as any local defects in pipes.
- There is no need to measure the applied load for accurately detecting damage since ambient vibration data could be used. This feature is particularly attractive for continuous health monitoring of large structures where excitation can not be imposed.
- There is minimal post-processing required since dynamic strain measurements are used directly to detect damage.
- The methodology could be used either for global or local damage detection provided that defects alter the measured response quantities. Large scale structures typically experience a significant amount damage prior to revealing any information regarding the location of damage at the presence of a coarse sensor layout. This will no longer be an issue as near-continuous vibration information is now available with this NDE system. The system provides a practical alternative to local damage evaluation, such as eddy current, radiography, magnetic particle, etc., currently used in the civil, mechanical and oil & gas industries over the past few decades for locating defects in critical components.
- With the use of a dense sensor layout at a relatively low cost, a fully automated continuous health monitoring tool is now available where local damage detection is possible through the use of global vibration information.

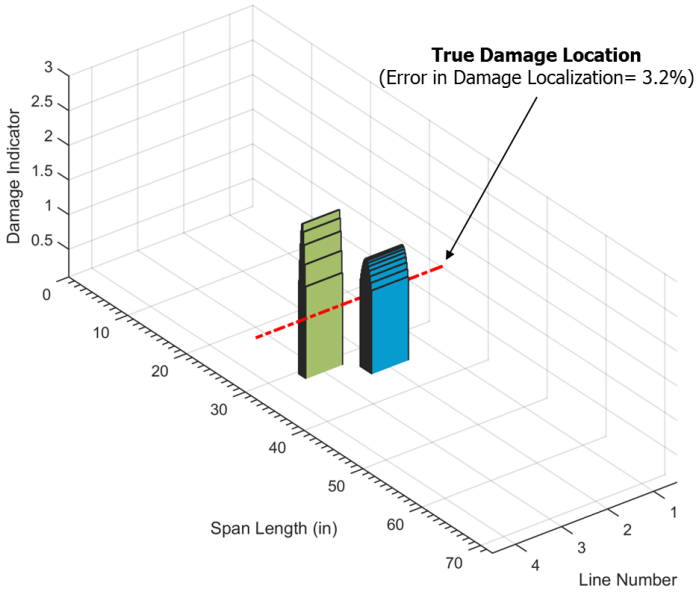

Figure 3. The figure above shows the damage localization of the NDE system compared to the known location.

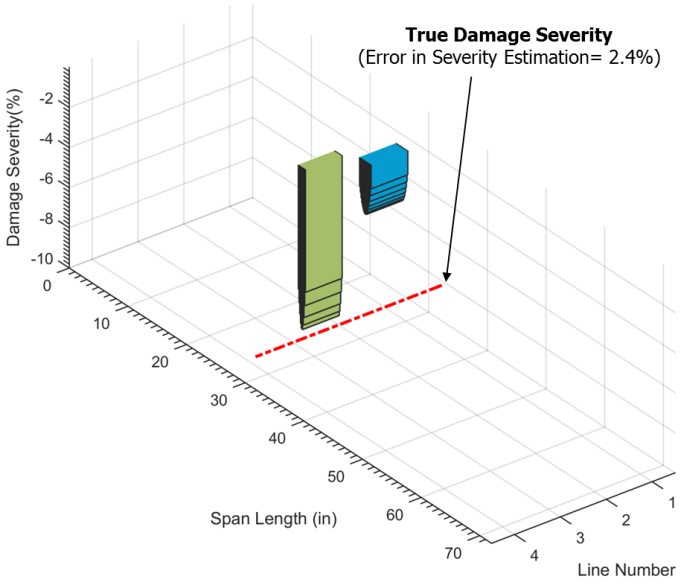

Figure 4. The figure above shows the damage severity of the NDE system compared to the known severity.