Structural Integrity Associates, Inc.®

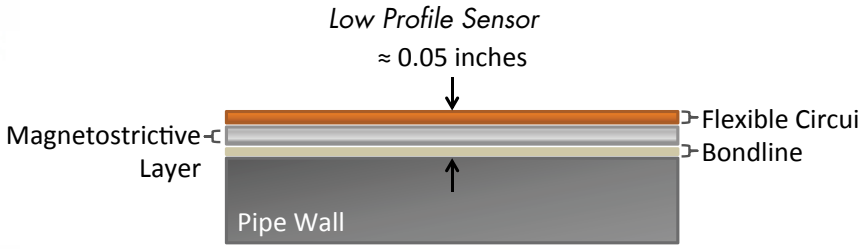
Guided Wave Magnetoelastic Focusing (MEF) Technology

Structural Integrity Associates, Inc. (SI), in cooperation with their strategic ally FBS, Inc., are uniquely able to offer a new guided wave focusing technology for permanent or temporary installation that is based on the magnetostrictive principle. Most standard guided wave tools use pressure-coupled piezoelectric (PZT) materials to generate a guided wave in a pipe wall. The magnetostrictive technique uses a magnetostrictive material that is bonded (either permanently or temporarily) to the surface of the pipe. A current-carrying coil is then used to cause perturbations of a bias magnetic field in the magnetostrictive material, which subsequently causes mechanical vibrations to be transferred into the pipe wall.

Advantages to the Magnetostrictive Approach

1. **Distributed Surface Loading** - Compared to the point loading of piezoelectric tools, the magnetostrictive approach results in distributed loading over the entire pipe circumference at the sensor location, which results in purer mode generation and a significantly decreased near field length; approximately 1ft compared to 3ft to 5ft for conventional PZT tools. This can be advantageous for areas such as wall penetrations or casing entrances, where there is not a sufficient amount of real-estate to place a collar such that the near field does not extend into the penetration or casing, yet the penetration or casing area must still be inspected.

2. **Small Footprint** – A typical magnetostrictive sensor requires no more than 2" of axial space on the pipe and has a profile of < 1/4". In some special cases, up to 4" of axial space may be required depending on the required functionality of the collar.



3. **Structural Health Monitoring (SHM) Capability** – Because the MEF sensors require a strip of magnetostrictive material to be bonded to the pipe, the technology naturally lends itself for use as a SHM sensor. By leaving the strip on the pipe, subsequent data sets from the same sensor can be acquired and compared to the original baseline data set to allow data trending over time. Functioning in an SHM mode to look for changes in the data over time allows for the detection of smaller defects and the interrogation of more complex geometries than can be obtained from a single data set alone and in many cases the test range can be increased.

4. **Improved Sensitivity** – Tests performed with MEF sensors have demonstrated the ability to detect < 1% CSA reductions in laboratory conditions, which is far superior to the ~3% CSA sensitivity achieved with standard guided wave tools on the same test pipe. This improved sensitivity can be attributed to the better SNR achieved by the surface loading attributes discussed previously. The detection of even smaller CSA reductions is possible when used in the SHM mode of operation.

5. **Cost Effective** – Because the magnetostrictive technology does not incorporate costly piezoelectric materials, the sensor collars can be manufactured more easily, with fewer parts, and at a significant cost savings when compared with other permanently installed monitoring systems.

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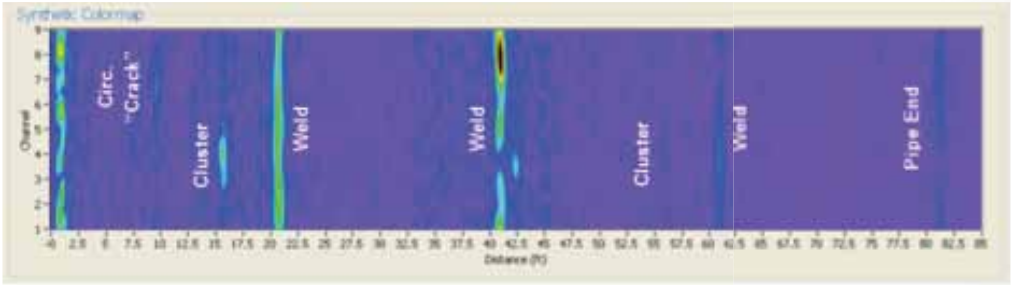
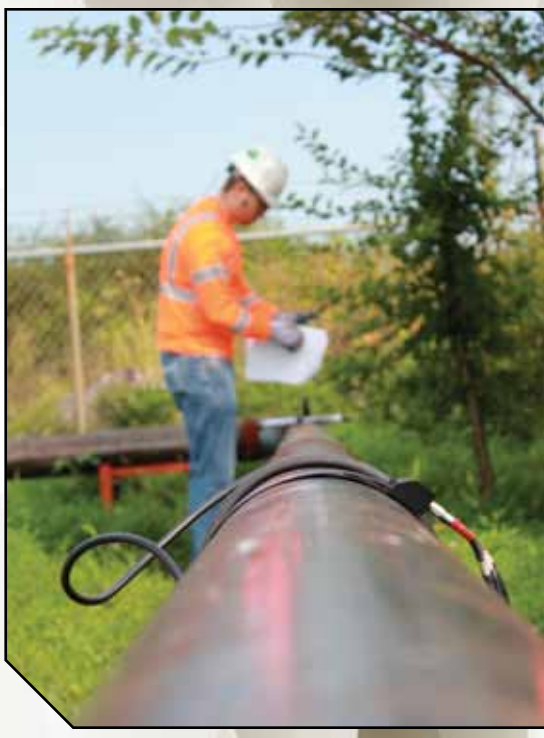
Integrated with Structural Integrity PowerFocus™ guided wave system, the MEF sensor concept has significant advantages over traditional magnetostrictive methods in that it allows for the phased excitation and segmented reception of guided waves, making flexural mode analysis and guided wave focusing possible. The image below shows an example Total Focal Scan™ result obtained with the MEF technology. It is observed that each defect is clearly identified at the correct axial and circumferential location in the pipe. Estimating the circumferential extent of a defect is critical in determining the severity of said defect as a defect concentrated to a small circumferential location is more critical to the operability of the pipe than a defect of the same CSA that is distributed over a large circumferential area.

Ultimately, the MEF sensor technology, integrated with the PowerFocus™ guided wave inspection unit and software, allows Structural Integrity to offer another value-added technology to their clients at a lower cost than traditional permanently installed guided wave tools, making permanently installed solutions more accessible to a wider range of our clientele.



Pipe "image" generated using the Total Focal Scan™ capability of the PowerFocus™ system with the MEF sensor.



ADVANTAGES:

- *Volumetric inspection and/or monitoring*
- *Low-profile sensor*
- *Improved efficiency and sensitivity through surface loading*
- *Lower cost than alternatives*
- *Potential for trending of growth rate through monitoring*
- *Reduced near field*

APPLICATIONS:

- *Cased and non-cased piping segments at road/rail/river crossings,*
- *Above-ground insulated or inaccessible piping,*
- *Buried piping,*
- *Pipeline inspection for corrosion under insulation,*
- *Pipeline inspection for touch point and crevice corrosion (such as corrosion under supports),*
- *Weld location determination, and*
- *Permanently installed monitoring.*

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