Accelerometer Mounting

Accelerometers play a central role in providing vibration signals used in the diagnostics of gears, bearings, reciprocating compressors, and many other machines. While the sensor system often receives much attention during procurement and installation, too little consideration is sometimes given to the machined surface that will be receiving the transducer. This article provides an overview of the mounting requirements and describes methods to check existing installations, and to correct any problems that are found. The article focuses on permanently installed transducers; however many of the concepts apply to portable systems as well.

Mounting Requirements

Proper accelerometer mounting begins by evaluating the environment in which the transducer will be installed. This checklist includes some important factors to consider:

- **Ambient and Surface Temperatures**: All accelerometers have a fixed temperature range over which they can operate reliably. Both the ambient and surface conditions must be within this range over all operating regimes of the monitored machine.

- **Electrical Isolation**: Accelerometer designs vary. So if the accelerometer is to be installed on electrical equipment, it is important to consult the accelerometer datasheet to confirm that the internal electronics have sufficient isolation from sensor casing. In situations where the accelerometer does not have sufficient isolation, an isolation adaptor may be installed. Note that installation of an adaptor can alter the frequency response of the accelerometer system and this must be accounted for in adaptor selection.

- **Weather**: Accelerometer systems installed outdoors generally need protection from the elements. Usually this protection takes the form of a housing that installs around the accelerometer and allows the accelerometer case to connect directly to the machine case. Figure 1 shows an example of the Bently Nevada housing #43212 that allows such a mounting.

- **The Machined Surface**: This feature has a significant effect on accelerometer performance. In order for the accelerometer system to faithfully report the machine vibration, the mechanical mounting surface must be flat, clean, and perpendicular to the mounting stud. The finish and mounting requirement for most accelerometers are quite high. Figure 2 shows an example of the finish and machining tolerances for the 330400 and 330425 accelerometers. To maintain the required perpendicularity tolerance a combination drill
and spotface tool or a piloted counterbore tool may be used. These are available commercially, however some modification may be required. For example, the piloted counterbore tool part number 3102A37 from McMaster-Carr* comes with a 6.35 mm (0.25 in) pilot. This pilot must be turned down to 5.54 mm (0.218 in) to fit into the ¼"-28 tap drill hole. The 0.813 μm (32 μin) RMS Total Indicated Runout (TIR) surface finish can be obtained by placing emery cloth between the spotfacing tool and surface to provide a final polish.

- **Thread Lubrication and Transducer Torque:** All threaded accelerometers will have thread lubrication and torque requirements. These requirements must be followed exactly to avoid a poor transducer response or damage to the transducer. The torques frequently have low values (on the order of 3 N·m or 30 in-lbs) so an appropriate torque wrench must be selected. Generally, thread locking compounds should be avoided; however, if locking compound is used, care must be taken to ensure it contacts only the threads of the transducer. Any locking compound that seeps into the area between the transducer and the machine surface during installation and torquing lifts the transducer from the surface as it cures and expands. This lift results in higher effective torques that can damage the transducer and reduce signal response.

*FIGURE 1:* Weather Resistant Accelerometer and Housing Assembly. Note that the base of the housing has a circular hole that allows the protected accelerometer to be mounted directly to the surface of the machine casing.
Figures 2 and 3: Accelerometer and housing mounting details.

**Figure 2:** Accelerometer and housing mounting details.

**Figure 3:** Example of contact area check on accelerometer.
Verifying Proper Installation

For any given installation it can be difficult to quantitatively determine if the features meet the tolerances called for in the accelerometer manual. One method of verification that has proven to be reliable in the field is to apply a thin layer of soft machinist’s blue (or transfer blue) to the machine surface. The accelerometer is threaded into the hole until it contacts the surface, no more than finger tight. Then the accelerometer is removed from the mounting and the amount of bluing agent that transferred from the surface to the accelerometer can be observed. Figure 3 shows an example of this method. The bluing covers approximately 80% of the accelerometer which is acceptable. A good installation will have a contact area of at least 80% and more is desirable.

Correcting an Improper Installation

Minor defects, such as incomplete threads or burs on the machine surface, can usually be fixed quickly once they are identified. Systemic machining defects, such as a rough or warped surface or a surface not perpendicular to the threaded hole, are more difficult to correct. The following process has proven to be effective for correcting these types of machining problems.

The most difficult part of repairing or renewing the surface under the accelerometer is making sure that the tooling face remains perpendicular to the centerline of the tapped hole. To ensure perpendicularity, the process and tooling in Figure 4 is used.

First, a chamfer is machined at the surface using a conical de-burring tool. This ensures that the chamfer is concentric with respect to the intersection of the tapped-hole centerline to the surface. Once the chamfer is complete, a guide pin with a radiused end is threaded into the hole. The guide has a diameter slightly larger than the nominal thread size. This ensures that the radius contacts the chamfer at a single line. The pin will be held concentric and parallel to the centerline of the tapped hole. With the pin in place, tooling can be inserted over it to repair or renew the mounting surface while maintaining acceptable tolerances for perpendicularity.

Surface Correction Example

A 2 in x 2 in (~5 cm x 5 cm) steel beam used for modal testing provides a good illustration of the effectiveness of an improved accelerometer mounting surface. Figure 5 shows the guide pin threaded into the hole on the 2”x2” steel beam.
FIGURE 5: GUIDE PIN THREADED INTO STEEL BEAM. MACHINING TOOL MARKS AND A SMALL AMOUNT OF “FIRE-SCALE” PITTING ARE VISIBLE.

FIGURE 6: SLEEVE TOOL AND EMERY CLOTH, IN PLACE ON THE GUIDE
The next step in the process is to install a machining fixture over the guide. Since this installation needed correction to the surface finish, emery cloth and a sleeve-style tool (with perpendicular end) were installed over the guide. More aggressive correction might warrant the use of a counterbore tool, which has been machined to fit over the guide pin. Figure 6 shows the sleeve tool and emery cloth arrangement. The tool was turned by hand to polish the surface.

Working from coarse (80 grit) to fine (600 grit) abrasive removed most of the pits from the mill scale and noticeably improved the surface finish of the steel bar (Figure 7). Visually, it appears that the surface has been smoothed and evened out.

Vibration Measurements – Before and After Surface Correction

The modal testing beam was simply supported at each end. The accelerometer was installed in the vertical orientation on the beam, and the beam was excited with an impact hammer. Vibration samples were collected before and after the correction of the accelerometer mounting surface, and the results were compared.

The lower plot in Figure 8 shows the transfer function (TF) obtained prior to the surface correction as the gray line and after the correction as the blue line. The TF magnitude for both lines shows a large peak at 2.7 kHz, which is very close to the predicted value of 2.8 kHz for the first bending mode of the beam. The second mode of the beam is predicted to be 8.1 kHz. The gray line shows two peaks below this value, but no distinct peaks above 8 kHz.

The upper plot in Figure 8 shows the coherence function (CF), which is an indication of the relationship between the frequency content in the accelerometer and the impact hammer. The gray (before correction) line shows good agreement only to about 6.5 kHz, which is below the estimated second mode response of the beam. With the surface finish corrections (blue line), the CF is stable out to about 8.5 kHz, which is far enough to allow the accelerometer to accurately capture the second mode response.
The TF for the corrected surface clearly shows a peak at 8.3 kHz, which is very close to the predicted value of 8.1 kHz. In this case, polishing the surface enabled accurate measurement of the second mode of the beam, although it had been unable to be measured with the original rough mounting surface.

**Conclusion**

This article provides methods for checking and improving accelerometer installations. Ensuring that the installation matches the specifications for a given accelerometer results in a faithful representation of the vibration at the machine. This, in turn, allows for improved condition monitoring and earlier detection of machinery malfunctions.

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