MODAL SPACE - IN OUR OWN LITTLE WORLD by Pete Avitabile

Illustration by Mike Avitabile

Can the shaker stinger have any effect on the FRF measurements? Let's take a look at this.

When performing shaker tests, there should be concern when connecting the shaker to the structure under test. Many times I have found that there are misconceptions in regards to this type of shsker testing when used for the development of frequency response functions for a modal test. Often times people are familiar with base excitation shaker testing when used for qualification of equipment due to some simulation of actual loads or for conducting qualification testing in accordance with some specification. Modal testing is a little different than these types of qualifications tests.

Rather than directly conneting the test structure to the shaker armature, there is a long slender rod, referred to as a quill or stinger, that is placed between the shaker and the test structure. The intent of this stinger is to provide axial excitation along the length of the rod to the structure while providing very little lateral stiffness to the structure under test. Figure 1 shows a typical shaker test set up configuration for illustration.

Now I could spend a lot of time to discuss all of the different situations that could possibly exist but there is not enough room here to discuss all the possible scenarios. At best, I can probably illustrate some typical testing situations that must be considered and show some possible frequency response function measurement distortions that could result from an inappropriate test set up with the shaker and the stinger.

Case A: Let's consider the effect of bending of the shaker stinger during a test. Remember the intent is to provide only input excitation along the length of the stinger and to minimize any bending of the stinger. Two thngs can happen when the stinger bends. The stinger can impart a rotational load which is not measured by the force gage; remember that the force gage expects to see only uniform compressive or tensile loads and any moment will distort the force gage reading as well as impart a moment into the structure that is not measured as a rotational load. Also, the stinger can introduce rotational stiffness into the structure under test which is not really part of the structure's dynamic characteristics. Figure 2 shows a measurement where the shaker excitation was applied at different elevations to a simple structure. Clearly, there is an effect on the measured frequency response functions. This should be checked at the preliminary stages of test set up.

Case B: Now consider the situation where the alignment of the shaker relative to the test structure is not set up properly. This is similar to the case above in that the is a bending contribution that the shaker imposes on the measurement set up. Figure 3 shows measurement distortions resulting from shaker misalignment. Care should be exercised in aligning the shaker.

Case C: Another consideration is related to the length of the shaker quill in the test set up. Again the measurements in Figure 4 show that there can be differences in the measurements obtained. Preliminary testing should be performed to understand if this effect is important or not.

Case D: Finally, the type of stinger used can also have an effect on the measurements obtained. Figure 5 shows the effects resulting from different stingers used and should be checked at the start of testing.

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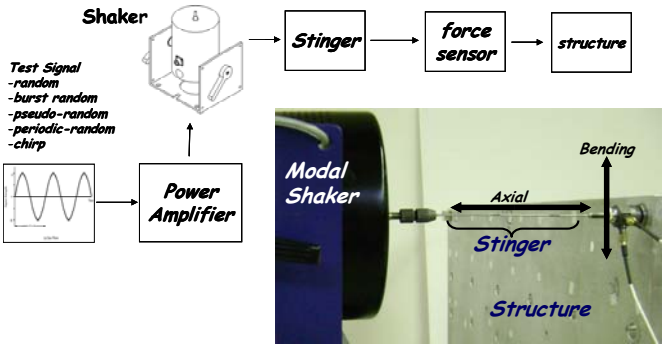

Figure 1 – Typical Modal Test Shaker Set Up Arrangement

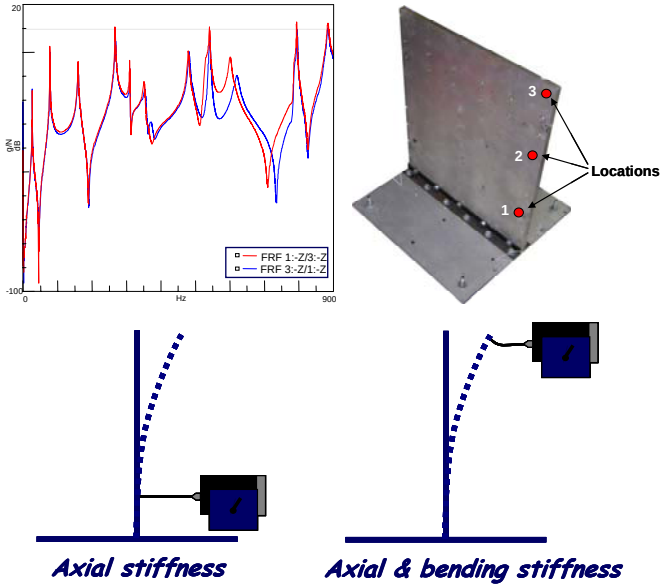

Figure 2 – Stinger Bending Effects

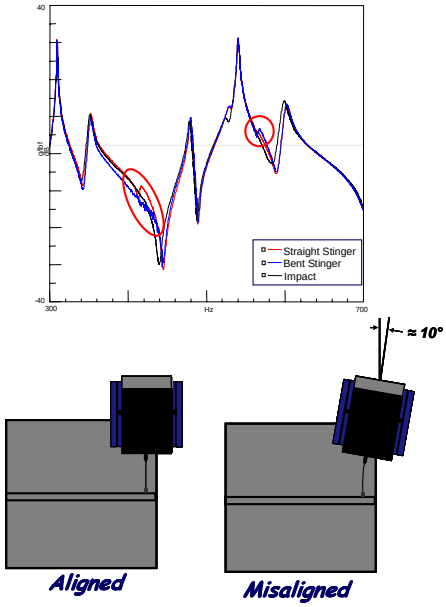

Figure 3 – Stinger Misalignment Effects

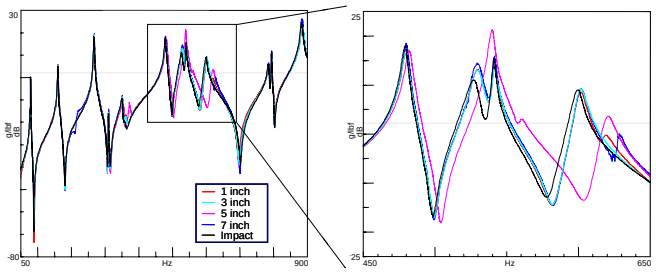

Figure 4 Stinger Length Effects

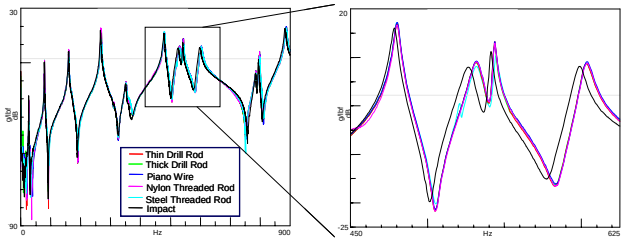

Figure 5 Stinger Type Effects

So in all the cases shown there is clearly an effect of the stinger on the results obtained. Whether it be the position of the shaker/stinger on the structure, the skewed alignment to the structure, the length of the stinger or type of the stinger, there can be an effect of the bending of the stinger that affects the measured frequency response function.

Care must be exercised in the test set up. Unfortuantely there is not one clear cut answer as to which stinger configuration will provide the optimal results. This is heavily dependent on the structure under test and the frequency range of interest. However, it is very important to try different scenarios to assure yourself that the best possible frequency response measurements are being acquired for the configuration eventually utilized for the test.

I hope this explanation helps you to understand that you need to be very careful when performing shaker tests and that the stinger can have a significant effect on the overall results.. If you have any other questions about modal analysis, just ask me.

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