Mini-strips for Limited Access Peening Intensity Measurements

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Abstract

The Almen strip as described in SAE J442 is widely used for measurement of peening intensity. There are some applications, however, where the strip size is too large for the intended measurement area. A sub-size strip can be used in those applications. This paper will dscribe the procedures for affixing and measuring this strip and how to correlate the Mini-strip arc height readings to the standard size Almen strip.

Keywords: Intensity, correlation, mini-strip, shaded strip

Introduction:

The Almen Mini-strip was developed by Electronics Incorporated to provide a means of more accurately verifying the shot peening intensity in areas that are inaccessible with standard size Almen strips and holders. (Figure 1) The Almen Mini-strips also provide a faster and more accurate method of intensity verification as compared to the use of shaded strips. This article will define the process of using the Mini-strips, the associated accuracy and limitations.

Experimental Method

The intent was to determine the effectiveness and repeatability of the Mini-strip and establish the conditions and limits for which it may be used. All tests were performed in a specially designed blast cabinet with a rotary table capable of peening 26 Almen strips in the same test. The Mini-strips were mounted onto the Almen holders, next to the Almen strip, using double sided tape. (Figure 2)

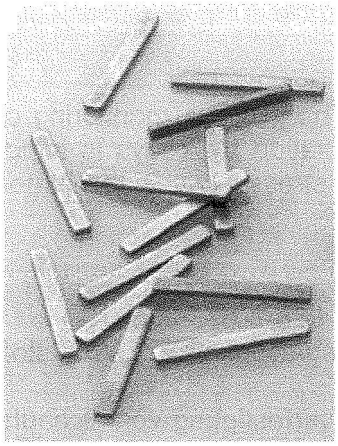

Fig. 1 Mini-strips

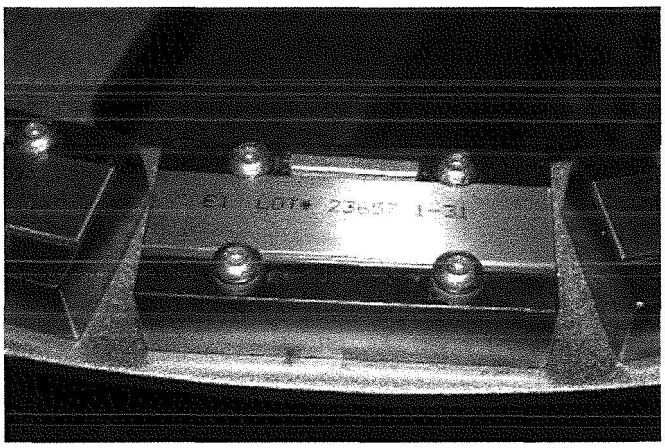

Fig. 2 Almen strips, Mini-strips mounted on Almen holders on the rotary table.

The strips were then peened using two sets of conditions. One was to generate saturation curves for both the Almen strips and the Mini-strips and the other was to peen multiple strips at T1 times to compare the resultant arc heights and distributions. Prebow compensation was employed on all of the tests in order to accurately determine the change in arc height. The arc heights of the Almen strips were measured using an Electronics Incorporated TSP-3 Almen gage (Figure 3) and

the Mini-strips were measured using a special TSP-M Mini-strip gage (Figure 4) designed by Electronics Incorporated.

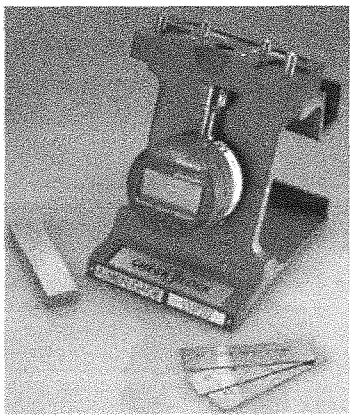

Fig. 3 TSP-3 Almen Gage

Fig. 4 TSP-M Almen gage

Experimental Results:

The first data sets were compiled by generating saturation curves using Almen "A" strips and Mini "A" strips. The target intensities for comparison were chosen as 12A (Figure 5) and 16A (Figure 6) in order to work in the mid-ranges of the Almen A strip.

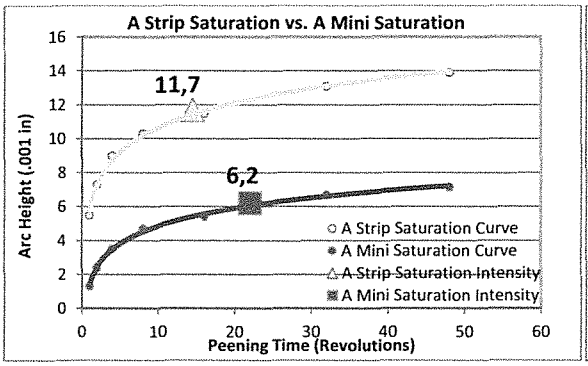

Fig. 5 Comparison of saturation curves for Almen and Mini-strips at 12A Intensity.

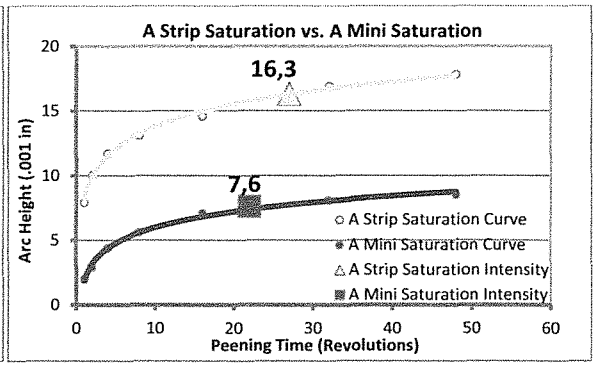

Fig. 6 Comparison of saturation curves for Almen and Mini-strips at 16A intensity.

The charts confirm that the performance of the "A" Mini-strip is comparable to the standard Almen strip but with reduced arc heights. They also verify that the response of the "A" Mini-strip is consistent with the Almen strip throughout the range of peening times.

The second comparison was performed using the Almen "N" strip and the corresponding "N" Mini-strip. (Figure 7) This set of data resulted in the same characteristics as the "A" strip tests as the curves exhibited a similar profile and the ratio of the intensities was of the same magnitude as the "A" strips.

The second phase of testing involved determining the relative performance of the "A" Mini-strip to the Almen "A" strip over a range of intensities. For this data, multiple Mini-strips and Almen strips were peened concurrently at T_1 times for intensities of 3A, 6A, 12A, 16A, and 20A and the mean values of the arc heights plotted to display the relationship. (Figure 8)

The resultant graph shows a linear relationship of the Mini-strip as compared to the standard Almen strip under this set of conditions.
The final phase of this analysis was to evaluate the repeatability of the performance of the Mini-strip as compared to the standard Almen strip, in particular, to test the consistency of the arc heights of Mini-strips when multiple pieces are peened at the same time. The following graphs (Figures 9, 10, 11, & 12) represent multiple strips, both "A" and "N", peened to T_1 times for intensities of 6A, 12A, 6N and 12N.

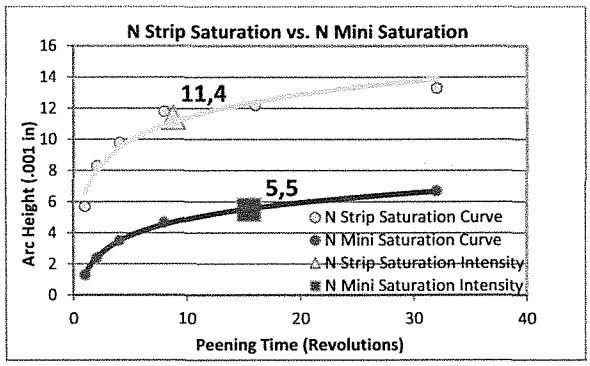

Fig. 7 Comparison of saturation curves for Almen and Mini-strips at 11N Intensity.

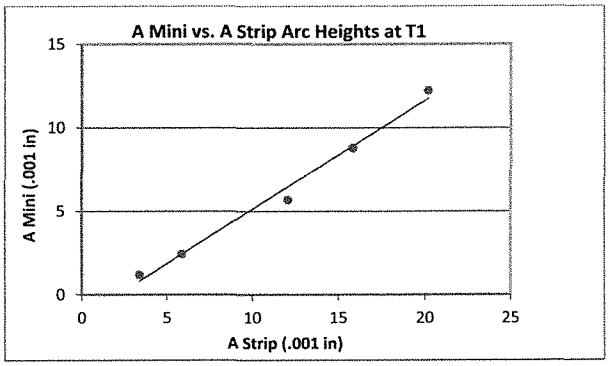

Fig. 8 Plot of T_1 arc heights of "A" Mini-strips vs Almen "A" strips

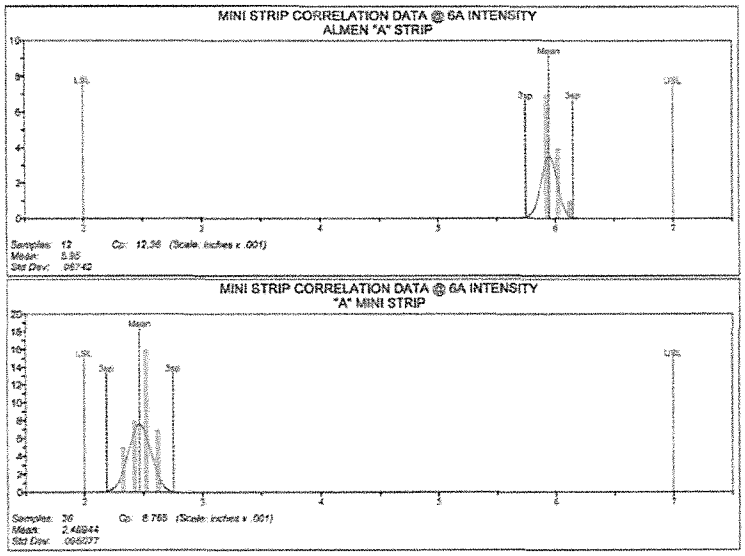

Fig. 9 Histograms for "A" Mini-strips and Almen "A" strips at a 6A intensity.
The distribution for the Mini-strips is consistent with the Almen strips, exhibiting a Standard Deviation of .095 and a total range of .0003 in.

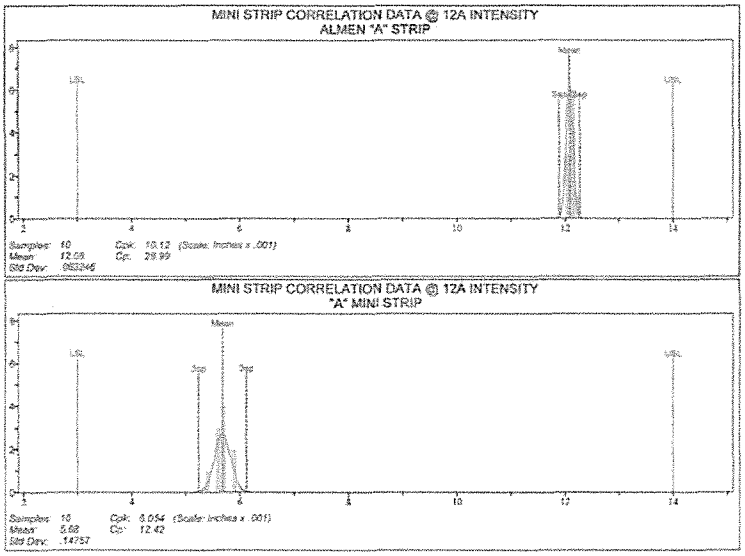

Fig. 10 Histograms for "A" Mini-strips and Almen "A" strips at a 12A intensity.
The distribution for the Mini-strips is consistent with the Almen strips, exhibiting a Standard Deviation of .147 and a total range of .0005 in.

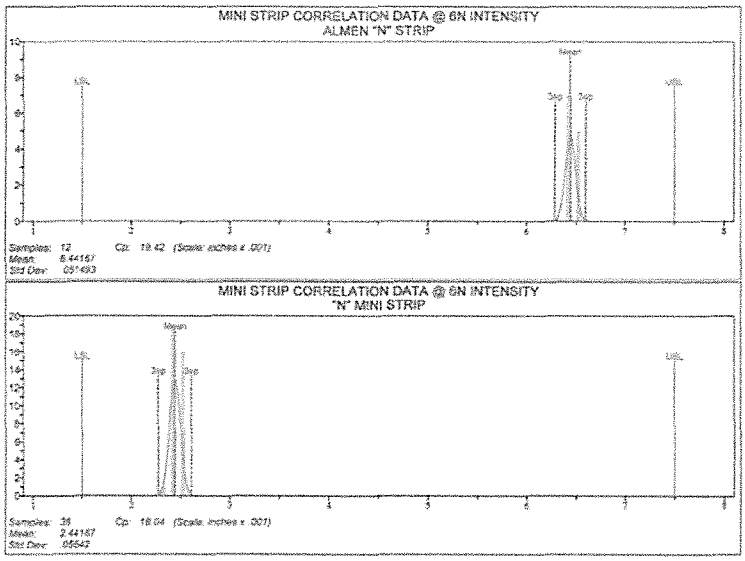

Fig. 11 Histograms for "N" Mini-strips and Almen "N" strips at a 6N intensity.
The distribution for the Mini-strips is consistent with the Almen strips, exhibiting a Standard Deviation of .095 and a total range of .0002 in.

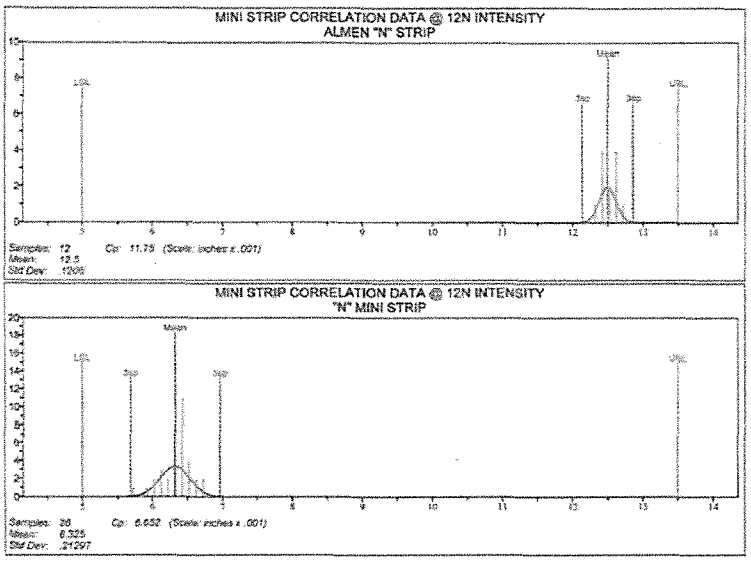

Fig. 12 Histograms for "N" Mini-strips and Almen "N" strips at a 12N intensity.
The distribution for the Mini-strips is greater than the Almen strips, exhibiting a Standard Deviation of .213 and a total range of .0009 in. This may be the upper limit for the "N" Mini-strip.

Discussion and Conclusions

The above evaluations of the "A" and "N" Mini-strip verify that these sub-sized strips can be effective tools for the measurement of peening intensity in applications where the standard Almen strip is too large for the intended measurement area. The application shown in the following photograph (Figures 13 & 14) is an excellent example of the use of the Mini-strip. It is a representation of a lance peening operation, with a special fixture made to mount the Mini-strip on the bore of the test piece. The Mini-strip is mounted to the fixture with double sided tape and, when the fixture is bolted to the test piece, it provides an improved representation of the internal surface to be peened as compared to what could be provided by a standard size Almen strip.

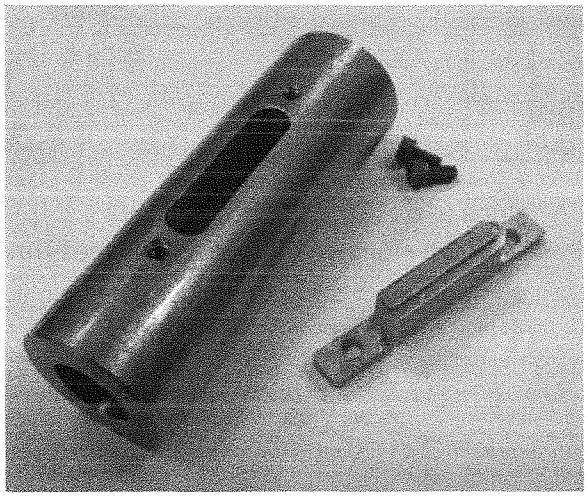

Fig. 13 Mini-Strip mounted to fixture.

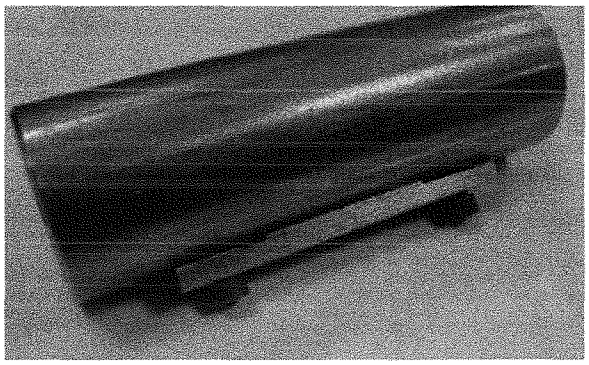

Fig. 14 Mini-strip and fixture fixed to test piece.

The size of the Mini-strip and the ease of mounting and measurement also provide a method of measuring peening intensity that is more effective and easier to use than shaded strips.

While tests indicate that the Mini-strip can be used practically and effectively in many applications, there are some considerations that were observed during testing that should be applied.

1. All of the tests were performed using double sided tape. Other methods of fastening the strip, such as using rubber cement, may be used but, testing at EI have found the tape to be the most effective and convenient.
2. When operating at low intensities, where the maximum arc height of the Mini-strip is less than .003 inches, is not recommended. Since the total range of the arc height is so small, any minor change or error in measurement can result in a significant change in the saturation curve.
3. Operating at higher intensities, where the Mini-strip has an arc height of greater than .007 inches, the variation in the arc height measurement increases. This is a result of the fact that the strip, as it arcs, is also pulling away from the contact surface.
4. From the tests that were completed, the conclusion is that the practical range for using the Mini-strips, as equated to the standard Almen strip, would be 6N to 12N for the "N" strip and 6A to 15A for the "A" strip. This range, however, may be extended depending on the peening application and the method of fixing the Mini-strip.
5. All of the tests were performed with a 90 degree nozzle orientation. As the nozzle angle decreases from 90 degrees, there will be a tendency to cause the strip to separate from the surface.

Testing of the Mini-strips will continue at Electronics Incorporated to develop better definitions of the conditions and limits of the performance as well as the methods of mounting. The results of the extensive testing that has already been completed, however, confirm that the Mini-strip is a viable tool for the measurement of peening intensity.

Acknowledgments
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