EFFECT OF SHOT SIZE ON PEENING INTENSITY FOR LOCAL PEENING

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Industrial Summary

The results are reported of tests in which saturation curves were obtained for local peening and for uniform peening, under otherwise identical test conditions. In addition to using standard Almen strips, non-standard strips, designed to emphasize the differences arising between local peening and uniform peening, were employed. A range of shot sizes was explored. Results indicate that the conventional method of specifying the required peening intensity is not generally applicable where local peening is involved, and the localized peening of the Almen strip is advised in such instances. Guidance as to the selection of the correct size of shot for local peening is given.

Introduction

The time of peening a surface is decided by selecting a specified arc height from saturation curves obtained by peening standard Almen strips. Saturation curves are the relationship between the Almen Arc height and the time of peening for a given set of parameters such as stand off, shot size and material, air pressure and type and shape of nozzle. The time necessary to produce saturation on a test strip is defined as the time required to produce a specified arc height at which doubling of the exposure time will not increase the arc height by more than 10%. However, the saturation curves must be obtained by peening the strip uniformly, which is achieved by providing relative movement between the nozzle and the test strip. There may be service situations where the peening is required in a localized region only, which is achieved by directing the nozzle in the air blast system at the region to be peened: the peening of unwanted regions may be avoided by masking with rubberized tape [1]. However, the question arises as to whether or not the saturation time determined by the standard method will be applicable to local peening. To investigate this aspect it was decided to study the effects of local peening on saturation curves.

Experimental work

Pneumatic shot peening equipment with the syphon induction method of
shot aspiration was designed and fabricated [2]. The laboratory experimental equipment was intended for clean jobs which would not contaminate the steel shots used. Several designs of nozzles were evolved, tested and characterized with the shot peening equipment [3]. A sketch of the equipment with details of the nozzle is given in Fig. 1.

During preliminary tests on a standard Almen strip, A, it was discovered that the coverage increased slowly with the time of peening if the peening was localized. In these tests the strips were locally peened with the nozzle directed at the centre of the strips and without any relative movement between the nozzle and the samples, for 30, 45, 60, 75 and 90 s, using S-280 shots. It was found that the coverage gradually increased on both sides of the centre.

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**Fig. 1.** Equipment used for the shot peening tests.
of the strip as the peening time increased. In comparative tests, the shots were caused to strike uniformly over the gauge length by moving the test strip a small distance, to and fro, relative to the nozzle. The saturation curves for these two cases are shown in the lower part of Fig. 2. It can be seen from this figure that there was a decrease in the arc height after 75 s peening time in the case of locally peened samples, whereas no such decrease was observed in case of uniformly-peened samples.

To emphasize the difference between the saturation curves for uniform and localized peening it was decided to use strips of carbon steel of greater length, lesser thickness and lesser hardness than the standard Almen strips. 1-mm thick strips of Carbon steel (0.12% C, 0.03% Si, 1.5% Mn, Max 0.04% P, S) having a hardness of 123 BHN, elongation 25%, UTS 34—46 kgf/mm² (33.3—45.1 MPa), and with a gauge length of 90 mm were used in this experimental study.

The high pressure air — maintained at a nozzle inlet pressure of 0.5 MPa — was obtained from a pressure vessel which was fed by a two-stage air compressor. The peening of a specimen was controlled through a manual valve, and in the case of uniform peening the specimen holder was oscillated by means of an eccentric mechanism which completed four oscillations in five seconds. The arc height was measured by an LVDT displacement gauge provided with a digital indicator.
Results and discussion

Figure 2 shows the saturation curves for 90-mm gauge length Carbon-steel strips, shot peened locally by shots varying in size from S-170 to S-330. The smaller shots, while initially causing a lesser deflection for the same exposure, result in a flatter curve after the saturation time is reached. (The same figure, as stated earlier, shows the saturation curves for a standard Almen strip with uniform and localized peening with S-280 shots.) Figure 3 shows the saturation curve for 90-mm gauge length Carbon-steel strips under spot-peening and uniform-peening conditions with S-170 shots, whilst similar curves with S-280 and S-330 shots are shown plotted in Figs. 4 and 5, respectively.

From these figures it can be seen that the 90-mm strips, though longer than standard Almen strips, result in saturation curves of the same geometrical nature as those of standard Almen strips under uniform peening conditions. However, the strips peened locally show a higher arc height for the same time of peening. This situation continues until a point is reached where the curve of localized peening begins to droop. It is also seen that the time after which drooping begins decreases with increasing shot size. It is interesting to note that the portion of the curve after the saturation point has been reached extends parallel to a similar portion in the curve for uniform peening, until the drooping occurs.

It is evident from Figs. 3, 4 and 5 that if the saturation curve for uniform peening is to be used for establishing the desired intensity for peening a sur-

![Graph](image-url)

Fig. 3. Saturation curves for the spot- and the uniform-peening of 1.0-mm thick, 90.0-mm gauge-length strips: stand-off 70 mm, pressure 0.5 MPa, nozzle bore 5.0 mm, shots S-170.
face, the saturation curve for localized peening will represent the condition of over-peening. Conversely, knowing that the situation for spot peening exists, the saturation curve for uniform peening will not be a suitable choice. Further, definition of the time of saturation in the case of spot peening may not be a feasible proposition. However, a comparison of the three spot-peening curves in Figs. 3, 4 and 5 would suggest that if the saturation curve con-
tains a sufficiently long region between saturation and drooping, it may perhaps still be used for deciding upon the desired arc height within the conventional definition. In such an event the time of saturation will be lower than that determined by the uniform-peening curve. For example in Fig. 5 the uniform-peening curve overestimates the time for saturation by 16% with 17% lesser arc height.

It was observed that the shot-peened strips under spot-peening conditions began to show surface erosion from the point of drooping, and for large-size shots, the central region of the strip had sunk under the action of the shot stream: this obviously was the reason why the arc height showed a drop after a particular period of peening under spot-peening conditions. The surface erosion removes the surface layer—which is under compressive stress—and thus effects stress relieving, with resultant reduction of the arc height.

Conclusions

The conventional method of specifying the desired arc height is not applicable in situations where localized peening is required. In such a case the arc height must be defined by the localized peening of the Almen strip. In localized peening the shot size for establishing a saturation curve should be chosen such that the saturation curve does not begin to droop at up to twice the saturation time: if this happens then the shot is over-size.

References