

Analysis and Optimization of various parameters in Dot peen marking

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ABSTRACT

Due to the increasing demand of faster production, the need of technology for faster marking machines and marking techniques has developed to a greater extent. Markmate Pneumatic machine of Marks Pryor is a machine used for quiet, efficient and fast marking using the technique of dot peen marking. This paper focuses on effects of change in the parameters of Markmate Pneumatic machine for the improvement of utility and efficiency of the machine which will eventually lead to better marking. Pin angle for penetration is kept constant and parameters like marking pressure and sample materials are changed turn by turn to provide optimum results for each material. The results are checked and verified by using appropriate optimization technique using Minitab.

Keywords: Marking, Markmate Pneumatic, Dot Peen Marking, Stylus Pin System, Minitab

ARTICLE INFO

Article History

Received: 26th April 2017

Received in revised form :
26th April 2017

Accepted: 29th April 2017

Published online :
3rd May 2017

I. INTRODUCTION

This paper analyses the effects of various parameters of dot peen marking on various materials using an appropriate optimization technique. Dot marking technology also called dot peen marking, stylus pin system or micro-percussion marking consists in indenting series of dots into materials to form human readable alphanumeric identification, logos and 2D Data Matrix codes. These systems are well known in the aerospace industry for extremely high quality of marks but also appreciated by many other industrial customers for their robustness and reliability.

It requires compressed air supply and powered by a standard 240 volt electric source. The system is a single marking system used for all requirements of materials.

The separate controller protects the electronics from the mechanical shock loading generated in the marking head and large high contrast LCD screen give users clear control over the marking operation without the need for a separate PC. The controller also provides connectivity options through RS232 serial and digital I/O ports. 55, 100, 160 mm lengths are available in stylus. Solid carbide, sharp point and mini-stress tipped styli are available.



Fig 1: Markmate Pneumatic (Dot peen marking machine)

II. RESEARCH STATEMENT

There are various applications of dot peen marking right from automobile to aeronautical industry. The application can be from indicating part number to as precise as engraving matrix codes. According to the application the life of the marking needs to be different and it depends on

depth of marking. Till date there was no data available with vendors regarding indentation pressure to depth relation for various materials. Therefore this paper focuses on changes in depth of indentation due to change in pressure on various materials and further deriving a relation between pressure and depth for various materials.

III. OBJECTIVES

- Optimization of various results obtained through experimentation.
- Identifying the different materials on which dot peening is done.
- Studying the various pressures required for indentation.
- Understand the effect of variation of pressures and materials in dot peen marking.
- Calculating the different depths.
- Optimization of various results obtained through experimentation.

IV. SCOPE

- To generate and store data in tabular form regarding dot peen marking on various materials.
- Optimum depth identification for post machining processes like painting. The coats should not cover the indents making them invisible.
- Increased life of depths and reduction in overall energy consumption to generate the same effect.

V. ADVANTAGES

- Exact depth identification and creation on different materials.
- Effects on depths due to different pressures for optimised depth.
- Process will become easy.
- Standardisation of data.
- Cost savings.



Fig 2: Dot peen marking

VI. METHODOLOGY

- Study of Markmate pneumatic dot peening machine
- Selection of plate materials
- Selection of a pin
- Actual experimentation
- Experimental readings (Depth and pressure)
- Analysis of readings
- Study of various optimization techniques

- Selection of appropriate optimization techniques
- Optimization
- Approval
- Preparation of data book
- Final Project Report

VII. STRUCTURAL ANALYSIS

With the help of ANSYS software theoretical deformation can be calculated.

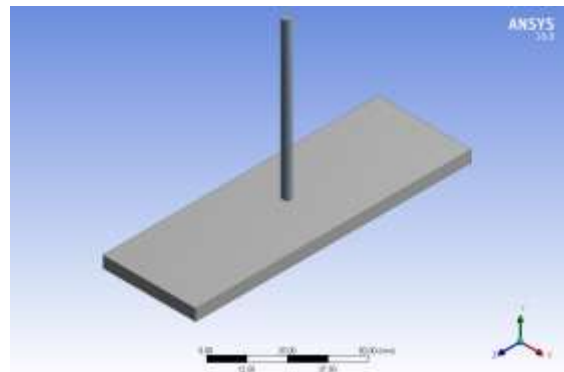


Figure 3: Plate and tool model

A CAD model of plate, tool is imported and analysis is done in ANSYS workbench software.

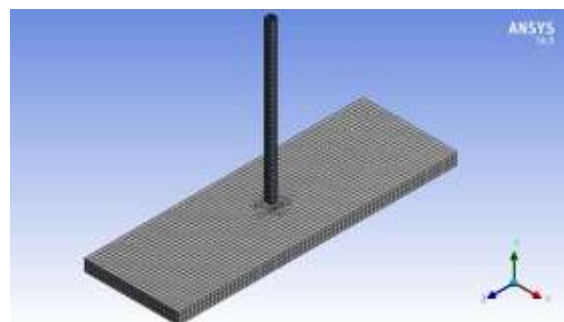


Figure 4: Meshing of the plate

The above figure shows the meshing of plate in ANSYS.

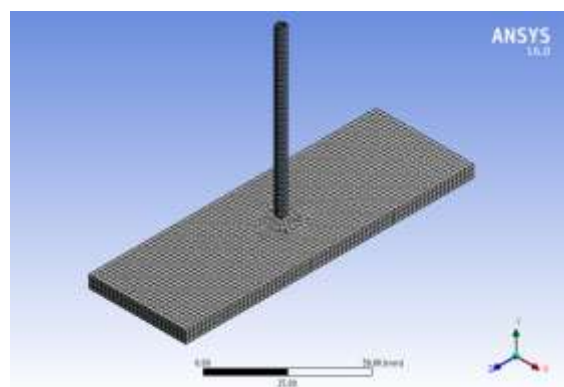


Figure 5: Meshing at centrally acting point

The above figure shows the centrally acting point on the plate in ANSYS.

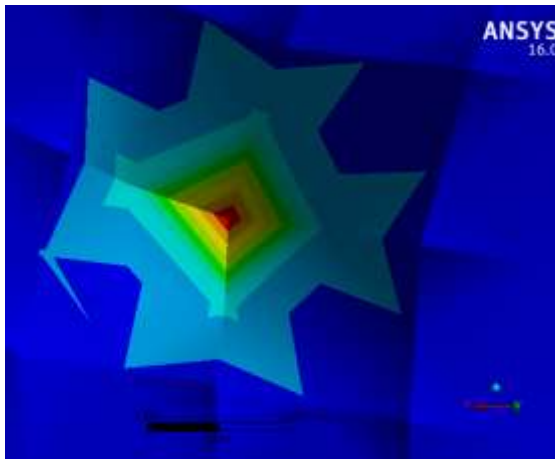


Figure 6: Total deformation at the point

Deformation after dot peen marking is shown in the above figure with maximum deformation at the centre shown in red colour. The deformation decreases away from the centre.

VIII. VALIDATION

Minitab, originally intended as a tool for teaching statistics, is a general - purpose statistical software package designed for easy interactive use. Minitab is well suited for instructional applications, but is also powerful enough to be used as a primary tool for analysing research data.

Terminologies:

ANOVA:

Analysis of variance (ANOVA) tests the hypothesis that the means of two or more populations are equal. ANOVAs assess the importance of one or more factors by comparing the response variable means at the different factor levels. The null hypothesis states that all population means (factor level means) are equal while the alternative hypothesis states that at least one is different.

To perform an ANOVA, you must have a continuous response variable and at least one categorical factor with two or more levels. ANOVAs require data from approximately normally distributed populations with equal variances between factor levels. However, ANOVA procedures work quite well even if the normality assumption has been violated, unless one or more of the distributions are highly skewed or if the variances are quite different. Transformations of the original dataset may correct these violations.

GENERAL LINEAR MODEL:

Use General Linear Model to determine whether the means of two or more groups differ. You can include random factors, covariates, or a mix of crossed and nested factors. You can also use stepwise regression to help determine the model. You can then use the model to predict values for new observations, identify the combination of predictor values that jointly optimize one or more fitted values, and create surface plots, contour plots, and factorial plots.

MULTI-VARI CHART:

A multi-vari chart is a graphical representation of the relationships between factors and a response. Use a multi-vari chart to present analysis of variance data in a graphical form especially in the preliminary stages of data analysis to view data, possible relationships, and root causes for variation. Multi-vari charts are especially useful in understanding interactions.

Minitab draws multi-vari charts for up to four factors. The chart displays the means at each factor level for every factor.

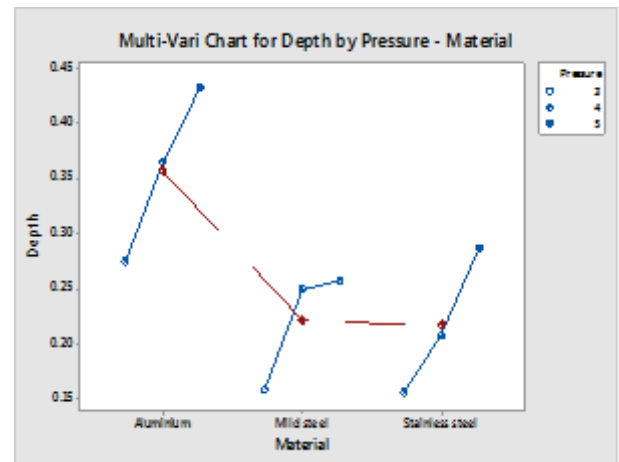
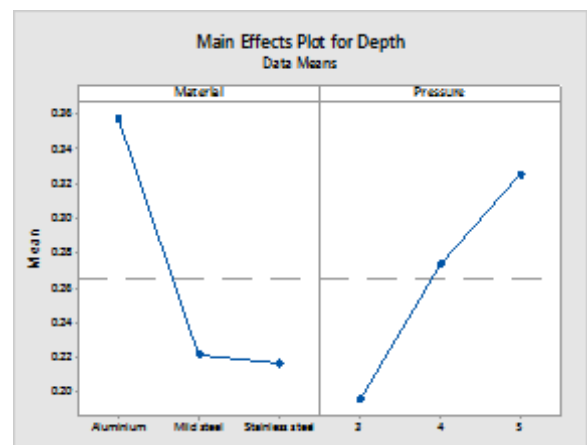


Figure 7: Multi - Vari chart for depth by Pressure – Material

The above is a Multi – Vari chart for depth by Pressure Material. Following observations are done from the chart:

- Depth of indentations is highest in aluminium at 5 bar pressure.
- Depth of indentations is lowest in stainless steel at 5 bar pressure.
- The depth of indentations increases with increase in pressure.



The above is a Main Effects plot. Following are the observations done:

- Between the groups variation is more.
- Mean depths of all materials are shown with respect to pressure.

IX. CONCLUSION

- Dot peen marking does not damage the materials structure at right choice of pressure and pin size.
- Depth of indentations increase with increase in pressure.
- Dot peen marks are clearer and more readable than the laser ones.
- Dot peen method is environmentally friendly and does not harm the environment; no chemicals are used in this marking method.

X. ACKNOWLEDGEMENT

We have great pleasure & immense satisfaction in presenting this paper. We express our deepest sense of gratitude & thanks to our guide Prof. U. C. Agashe for his consistent guidance, inspiration and sympathetic attitude throughout the project work and also thankful to our in-company guide Mr. Bharat Kokatnur.

We are also thankful to all staff members of Mechanical department. We are highly obliged to Dr. S. N. Mali, Principal, Sinhgad Institute of Technology and Science, Narhe, Pune, who has been a constant source of inspiration and also thankful to our friends for their support and encouragement.

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