Statistical Design, Analysis, and Inference in Resistance Welding Research

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Abstract

Statistics has been successfully applied in many engineering fields, including welding. In contrast to the conventional one-factor-at-a-time approach, it provides a means to simultaneously deal with problems of multiple input variables. A good statistical design can use as few runs as possible to gain as much information as possible. Statistical analysis and inference can be used to identify important factors and their interactions, and to provide models that can be used for predicting results or consequences, and for in-depth understanding of the physical processes involved. An example is the application of statistics in resistance welding research, in which statistics has been used for analyzing the influence of welding parameters on weld quality, expulsion limits, etc.

The physical systems studied in resistance welding research usually contain input variables (often called factors, such as welding current, time, and electrode force) and output variables (called response, such as the strength of welds or indication of expulsion). The objective of investigation of such systems is to study how the changes of input variables inference the output by use of experiments. The experimental observations (in numerical values) are called *data*. Statistics is a useful tool in providing insight by means of data. In statistics, the study of data is usually divided into three steps:

(i) Data collection: It involves the statistical design, to produce good and representative data, for input variables.

(ii) Statistical modeling and data analysis: At this stage, probabilistic models and analyses are used to explore the relationship between input variables and responses.

(iii) Inference/decision making: It links the statistical models developed and the original objective of the investigation, and draws conclusions and an accompany statement of confidence.

In this work, statistical design, analysis, and inference for resistance welding are demonstrated on two types of data: continuous response and categorical response. For each type of data, advanced statistical tools for the three steps are presented and discussed with practical applications as examples.