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# Finite Element Modeling of Clinching Process for Joining Dissimilar Materials

M. Eshteyah, M. Hrairi, M. S. Dawood, A.K.M Mohiuddin

Department of Mechanical Engineering, International Islamic University Malaysia

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**Abstract.** Clinching is one of the important new joining techniques, in which two plate metal parts are locally plastically deformed by mechanical interlock. Clinching is a mechanical joining method by using simple tools that consist of a punch, a die, and a blank-holder. The shapes of these tools are the most important parameters that control the final geometry of the clinch joints which in turn strongly affect the strength and quality of the final joint. In this study, finite element simulations are carried out to investigate some of the difficulties regarding the optimization of the process parameters, and major expected geometric parameters that will influence the strength, joinability, and the quality of the joint.

## Introduction

Joining dissimilar materials, such as aluminum and steel is practiced in various industries from automotive, railway vehicles, and truck manufacturing to computer and furniture fabrication. Traditionally, resistance spot welding is the prevailing connection technology for several industries' constructions. Due to technical issues, problems, cost, time, pollution, and other reasons, industries have begun to shift from traditional joining methods to mechanical joining methods such as clinching (often called mechanical interlock connection process). The clinching joining method has become a popular alternative to conventional resistance spot welding due to the rising use of several materials, which are hard or impossible to be joined by welding. Until the 1980s the technology was not widely used in industry [1]. Just in recent years has the interest in the use of clinching joining increased in industry, as clinching was successfully implemented to complement or even replace other joining techniques such as spot welding [2]. In the clinching process, two sheets of metal are joined using at most a die and a punch. The clinching joining consists of two principal actions, forming and drawing, that cause the creation of the interlock between the sheet's metal layers. During the process, the sheets are plastically deformed; the punch is moved with the required force depending on the thickness and the strength of the materials to be joined, whereas the die is fixed during the process. Furthermore, the size of the tools and friction coefficient are some of the major factors that influence the clinching joint [3].

Regrettably, this process is still early in its development despite rapid advances in recent years; it requires much more research to achieve the point where accuracy, high quality, and optimal strength of the joints become comparable to industry standard. In order to be adopted on a larger scale, some aspects of the process need to be further studied and clarified. It is impossible to achieve this goal without a complete understanding of the mechanics and relevant parameters. Therefore, this article explores the use of the finite element (FE) method to predict and optimize the main parameters that affect the clinching process.

## Clinching Forming

Single-step clinching is the most commonly used clinching method in automotive joining operations. The process sequence is illustrated (Fig. 1) in four steps:

1. The punch and blank holder move downward, the work pieces are clamped and fixed by spring force of the blank holder.