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Noor Zaman Khan, Arshad Noor Siddiquee, Zahid A. Khan

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## Proposing a new relation for selecting tool pin length in friction stir welding process

Noor Zaman Khan\*, Arshad Noor Siddiquee, Zahid A. Khan  
Department of Mechanical Engineering, Jamia Millia Islamia (A Central University), New Delhi,  
India

### Abstract

In this paper, an empirical relation to determine tool pin length for a specific set of Friction Stir Welding (FSW) parameters such as base material thickness, tool shoulder diameter, tool pin diameter and tool tilt angle is derived and proposed. The effectiveness and suitability of the proposed relation was verified through FSW experiments. Tool pin length was obtained from the relation and FSW of dissimilar aerospace grade aluminium alloys (AA7475 and AA2219) was performed. Three welds were made: one using the FSW tool with the pin length obtained from the proposed relation; second with the pin length smaller and third with the pin length greater than that obtained from the proposed relation. Subsequently, the three welds were compared and it was found that the tool having pin length obtained from the proposed relation resulted in smooth surface morphology and proper material mixing with good consolidation of flowing material at the bottom of the joint. Value of pin length smaller than that obtained from the proposed relation resulted in heavy flash due to larger plunge depth. Value of pin length larger than that obtained from the proposed relation resulted in surface cracks along with insufficient mixing and lack of bonding at the bottom of the joint due to insufficient plunge depth. Joint fabricated with optimized pin was characterized by mechanical testing, microstructure and fractography.

**Keywords:** Friction stir welding; Aluminium; Plunge depth; Pin length; Microstructure.

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\* Corresponding Author. Tel.: +91-011-26985176  
E-mail address: noor\_0315@yahoo.com

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