MULTI-OBJECTIVE PARAMETER OPTIMIZATION OF FABRIC ADHESIVE BONDING: A CASE STUDY OF PANEL BONDING

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DECLARATION

I declare that this is my own work, and this thesis/dissertation does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other University or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text. I retain the right to use this content in whole or part in future works (such as articles or books).

Signature: Date:2025.06.10

The above candidate has carried out research for the master's thesis under my supervision. I confirm that the declaration made above by the student is true and correct.

Name of Supervisor: Dr. J.R. Gamage

Signature of the Supervisor: Date: 10/06/2025

ACKNOWLEDGEMENT

Undertaking the writing of this thesis has been one of the most pivotal academic challenges I have encountered. The completion of this study would not have been possible without the dedicated support, remarkable patience, and insightful guidance of the professionals enumerated below.

First of all, I would be extremely grateful to **Dr. J.R.Gamage,** Senior Lecturer of the Department of Mechanical Engineering, University of Moratuwa, Who, despite his many other academic and professional engagements, committed to the role as my research supervisor, was a strength for me. I was inspired and motivated by his wisdom, knowledge, and commitment to the uppermost standards.

Finally, my sincere thanks to the **Mr.Dulanjana Tharindu** whose expertise in managing laboratory equipment was crucial for my experiments. Their patience and readiness to assist at all times have left a profound impact on the completion of my project.

ABSTRACT

Bonding strength and stretchability are two key parameters that define the quality of an adhesive-bonded fabric. However, there is a lack of studies on parameter optimization focusing on achieving multiple objectives. This study examines the optimization of adhesive bonding parameters in knitted fabric applications, focusing on achieving the highest bonding strength and stretchability. Four key process factors were analyzed using Taguchi experimental design. They are adhesive weight, distance between glue dot lines, press time, and curing time. The research aimed to identify the optimal levels for these factors to maximize the performance of polyurethane-based reactive hot melt adhesives (PUR).

The experimentation was conducted using an L27 orthogonal array. The bonding strength and stretchability were analyzed through the application of signal-to-noise (S/N) ratios, general Linear model, and ANOVA. The analysis discovered different optimum values for each factor when strength and stretchability were considered separately. The S/N ratios for both responses were normalized, and a composite S/N ratio was calculated.

The results reveal the optimum process parameters for achieving a balanced adhesive bond for the selected parameters. The study highlights the importance of balancing process parameters to meet the practical requirements of the textile industry, ensuring both durability and flexibility in bonded fabrics. The findings contribute to the existing knowledge base of adhesive bonding in knitted textiles and provide practical recommendations for industrial applications.

Keywords: Adhesive bonding, Design of experiment, Taguchi method, PUR bonding

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LIST OF ABBREVIATIONS

Abbreviation	Description
PUR	Polyurethane-based reactive hot melt adhesives
DOE	Design of Experiments
PCC	propylene carbonate
ANOVA	Analysis of Variance
SN ratio	signal-to-noise ratios
HB	higher the better
LB	Lower the better
GA	Genetic algorithms
DF	Degrees of freedom
Adj SS	adjusted sums of squares
Adj MS	adjusted mean squares
CAD	Computer-Aided Design
GSM	grams per square meter
MDI	Methylenediphenyl diisocyanate
DMDEE	dimorpholinodiethyl ether
PU	Polyurethane
PA	Polyamide
PO	Polyolefin