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Short Communication

Utilization of Design of Experiment for Two-Body Abrasive Wear Assessment of Thai Silk Fabric

Surapol Raadnui*

Machinery Health Monitoring & Tribology Laboratory, Department of Production & Robotics Engineering, Faculty of Engineering King Mongkut's University of Technology North Bangkok (KMUTNB), Bangkok, Thailand

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***Corresponding author:** Surapol Raadnui, Machinery Health Monitoring & Tribology Laboratory, Department of Production & Robotics Engineering, Faculty of Engineering King Mongkut's University of Technology North Bangkok (KMUTNB) 1518 Pracharaj 1 Road, Bang-Sue, 10800, Bangkok, Thailand

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Abstract

The study of friction and wear characteristics in general engineering materials has been an area of extensive research over the past few decades. However, limited studies have explored the tribological properties of silk fabrics. This study specifically examines the two-body abrasive wear behaviour of Thai silk fabric. The research evaluates the effects of key wear factors, including applied load, sliding speed, and abrasive media grain size, on the wear performance of silk fabric specimens.

Experimental Design and Methodology

A reciprocating abradant sheet testing machine was used to conduct the wear experiments. This machine enables controlled variation of multiple wear parameters in accordance with a designed experiment approach. The operational mechanism is illustrated in Figure 1.

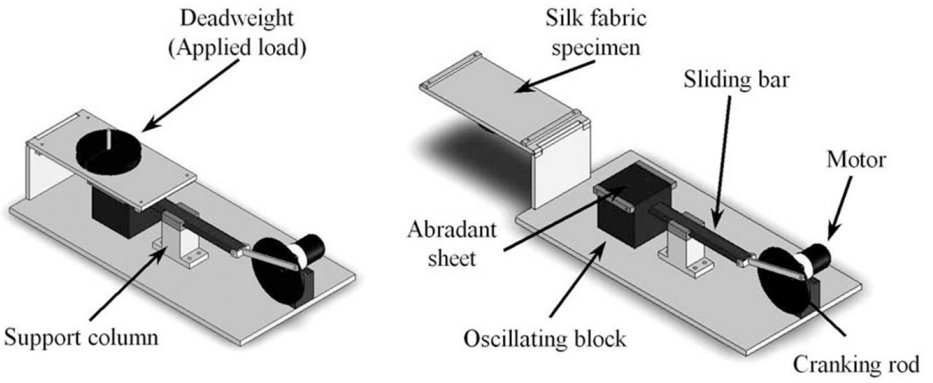

Figure 1: Exploded view of test apparatus.

Test apparatus and procedure

The testing apparatus comprises a fixed rectangular plate equipped with edge clamps to secure the silk fabric specimen. The surface of the plate is designed to prevent specimen slippage. Load application is achieved by placing an appropriately selected deadweight at the designated pin atop the plate. The reciprocating block, to which the abradant sheet is affixed, oscillates at a rate of 30 to 60±5 double strokes per minute, with a stroke length of 20±2mm. Clamps on either side of the block hold the abradant sheet securely. The machine is equipped with a resettable counter to monitor the number of cycles and speed during the test. The drive

system consists of a motor-driven cranking rod linked to a sliding bar via a connecting pin. During operation, the silk fabric specimen moves back and forth over the abrasive sheet. Adjustments to the vertical and horizontal alignment of the specimen and abradant sheet allow for control of stress intensity. A full factorial Design of Experiments (DOE) was employed to systematically investigate the effects of wear variables [1], with the experimental setup details summarized in Table 1.

Table 1: Independent wear variables and their levels and dependent weight losses.

Run Order	Applied Load (g)	Reciprocating Speed (rpm)	Abrasive Media No.	Weight loss (mg)
1	100	100	# 1200	48
2	300	120	# 1200	125.1
3	100	120	# 600	520.4
4	100	120	# 1200	98.2
5	300	120	# 600	100.5
6	300	100	# 1200	45.7
7	300	100	# 600	200.3
8	100	100	# 600	48.4

Experimental Results and Analysis

Figures 2&3 present the primary and interaction effects of independent wear variables (applied load, abrasive media grain size, and speed) on the weight loss of silk fabric specimens. Results indicate that applied load is the most significant factor influencing wear, with higher loads resulting in greater weight loss [2]. Additionally, both abrasive grain size and speed contribute to wear behaviour, where coarser abrasives and higher speeds generally lead to increased material removal. Notably, interaction effects were observed; for example, at higher loads, the influence of abrasive grain size was more pronounced. These findings align with prior research on the wear characteristics of Thai silk fabrics and highlight the effectiveness of DOE in analyzing multiple variable effects in tribological studies.

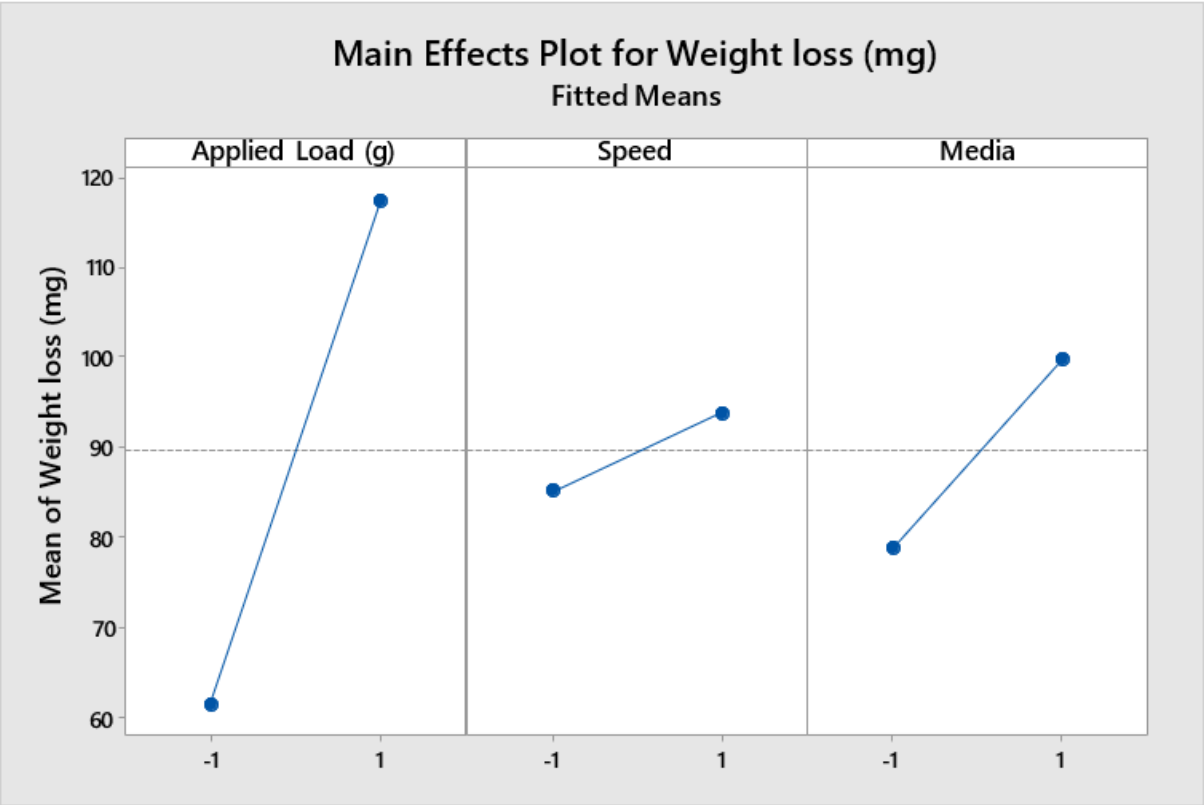

Figure 2: Main effects of independent wear variables on weight losses.

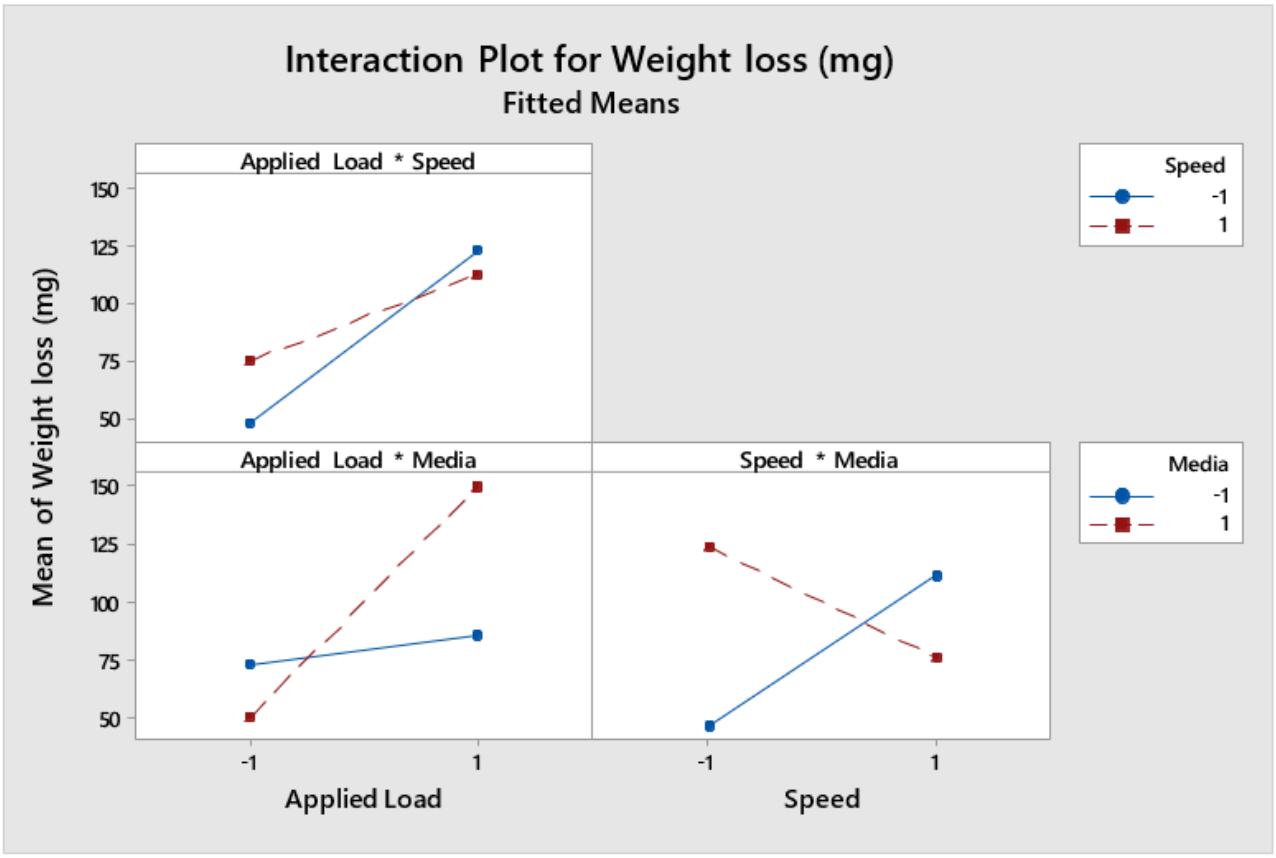

Figure 3: Interaction effects between independent wear variables on weight losses.

Conclusion

Based on the experimental findings, the following conclusions can be drawn regarding the abrasive wear resistance of Thai silk fabrics:

A. The primary wear factors-applied load, abrasive grain size, and speed-have a significant impact on the two-body abrasive wear performance of silk fabrics.

B. Increasing the applied load and using coarser abrasive grains substantially elevate weight loss, indicating a strong interaction effect between these two factors.

These results contribute valuable insights into the tribological behaviour of silk fabrics and demonstrate the utility of a DOE-based approach in analyzing wear mechanisms.

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