

M. D. Van Horn (BSME), M. Keefe, and Y. Duan (PD)

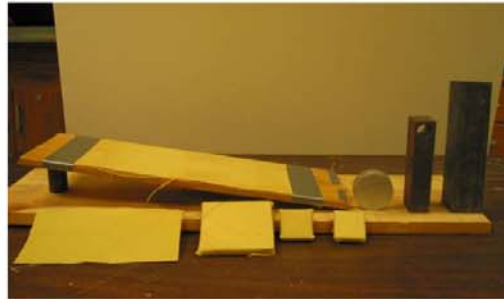
University of Delaware • Center for Composite Materials • Department of Mechanical Engineering

OBJECTIVES

Measure the coefficient of friction (COF) between Kevlar fabric layers

- Basic sliding test
- Wrapped plates in servohydraulic machine

BASIC SLIDING TEST



Basic sliding test setup for measuring the coefficients of friction between layers of Kevlar fabric

CHARACTERIZING THE FABRIC LAYER TO LAYER FRICTION

Possible factors that affect the COF

- Force
 - 0.53 lbs
 - 3.24 lbs
 - 9.84lbs
- Area
 - 4 x 4 (in)
 - 1.25 x 1.25 (in)
- Yarn orientation
 - 0 deg
 - 45 deg



TESTING LAYER TO LAYER FRICTION

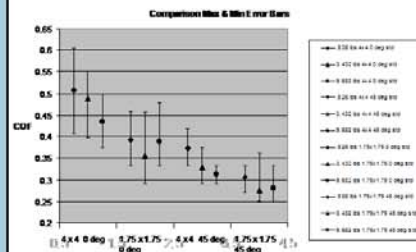
When the block begins sliding, the ramp height is recorded

The COF is calculated for

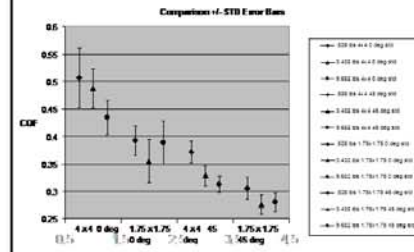
- Three weights
- Two orientations
- Two areas



TESTING RESULTS



TESTING RESULTS

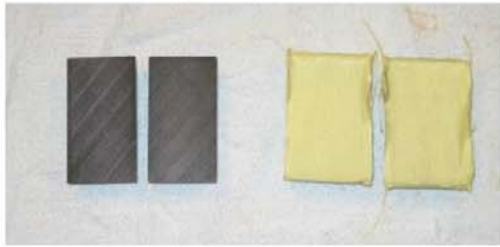


SERVOHYDRAULIC (INSTRON) MACHINE



Two steel plates wrapped in Kevlar fabric
 A strip of Kevlar fabric was pulled through
 The top grip is firmly clamped
 The bottom grip is clamped using a known torque

REFINEMENT OF TEST



Problem

Knurled grips induced rough testing surface of the Kevlar fabric

Solution

Smooth thin plastic card inserted as backing for the Kevlar fabric

TESTING

The Instron machine pulls the Kevlar fabric strip at 10 mm/min

Variables

Clamping force

Different torques yielding different clamping forces

Fabric contact area

Different grips

Yam orientations

Fabric wrapped in grip

0 deg

45 deg

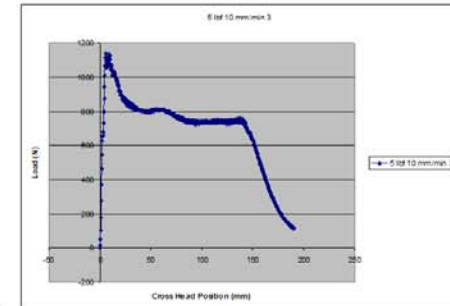


PRELIMINARY TESTING RESULTS

5 lb-f torque applied to the bottom grip

The initial peak load corresponds to a static friction

The constant load at large displacement corresponds to a sliding friction



FUTURE TESTING

Continue changing torques
Minimum of three tests per torque

Area
Repeat torque tests on a smaller area grip

Yam orientation
0 deg
45 deg

CALCULATIONS

Calculations

Use Instrumentation and/or calculation to determine the clamping forces relative to the applied torques

A coefficient of friction can then be calculated through

$$\mu = \frac{F_{\text{Instron}}}{F_{\text{Clamping}}}$$

CONCLUSIONS

The COF of Kevlar fabric layers depend on all the three variables (force, area, yam orientation)

The COF between Kevlar fabric layers is not a constant value. Depending on testing conditions, the COF may vary between 0.28 and 0.51

The force appears to be the smallest factor that affects the COF; however, the yam orientation is the largest one

ACKNOWLEDGEMENTS

- CMT

We gratefully acknowledge the support of Army Research Laboratory (ARL) and the Center for Composite Materials at University of Delaware (UD-CCM) during this research and the help from Dr. Travis Bogetti, Dr. Bryan Cheeseman, and Dr. Brian Powers.