ADHESION AND FRICTION OF A METAL-POLYMER MATRIX COMPOSITE PILLAR

Turgay Eray[a*], Mithat Can Özin[a], İlker Murat Koç[a], Bilsay Sümer[b],
*erayt@itu.edu.tr
[a]Istanbul Technical University,
Dept. of Mechanical Engineering, Beyoğlu, 34437, Istanbul, Turkey
[b]Hacettepe University,
Dept. of Mechanical Engineering, Beytepe, 06800, Ankara, Turkey

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Damping; Composite pillar; Adhesion; Friction

INTRODUCTION

Tribological characteristic of elastomeric pillars such as adhesion strength has been shown to be altered via making a composite pillar by adding soft or hard material on the tip of the pillars [1,2] or a composite body with a stiff core and compliant shell [3].

This study investigates the change of mechanical properties of composite pillars by considering the contribution of homogenously distributed additive particles. Adding a homogenous metal particle inside a polymer matrix with different ratios results in a change in the stiffness and damping characteristics of the pillar which is likely to permit adhesion and friction properties to be tuned accordingly in the viscoelastic interface.

The previous works focuses on composite pillars made by adding another material on the tip surface or laminating different layers on the body of the pillar while this study deals with composite pillars made out of almost homogenously distributed additive materials in a composition of cured PDMS.

EXPERIMENTAL PROCEDURE

Internal damping mechanism of a composite pillar with fixed-free boundary conditions is identified via harmonic base excitation for different mass ratios of the materials. This procedure targets to reveal the contribution of additive particles to internal damping, which is obtained via frequency response function of composite pillars by using half bandwidth method.

Composite pillars are slidden on a smooth surface to observe the effect of mass ratio of additive particles to PDMS on the frictional damping. Contact between composite pillars and the surface is obtained under different sliding velocities and normal load which is chosen to be less then Euler critical buckling load of the corresponding composite pillars.

Two customized experimental set-up are built. In the first set-up as depicted in Fig.1, internal damping of a pillar is identified. The set-up consists of an electrodynamic shaker to provide excitation to observe structural response of a composite pillar, an accelerometer to measure the base excitation amplitude and a laser vibrometer to measure the displacement/velocity of a composite pillar to obtain the structural response of the pillar and the internal damping [4].

In the second set-up frictional damping of a composite pillar is obtained by laterally loading of the composite pillar in a frictional sliding contact under various normal load and sliding velocities.

a)

b)

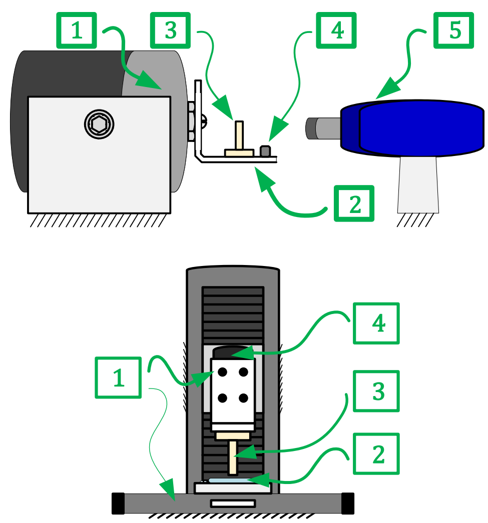

Fig.1 Drawing of the first experimental set-up (a) 1-Shaker, 2-Base, 3-Composite pillar, 4-Accelerometer, 5-Laser vibrometer, (b) 1- Motorized stage, 2- Smooth surface, 3-Composite pillar, 4- Force sensor.

REFERENCES

[1] Fischer, S. C., Arzt, E., & Hensel, R. (2016). Composite Pillars with a Tunable Interface for Adhesion to Rough Substrates. ACS Applied Materials & Interfaces.

[2] Balijepalli, R. G., Fischer, S. C., Hensel, R., McMeeking, R. M., & Arzt, E. (2017). Numerical study of adhesion enhancement by composite fibrils with soft tip layers. Journal of the Mechanics and Physics of Solids, 99, 357-378.

[3] Minsky, H.K. & Turner, K.T. (2015). Achieving enhanced and tunable adhesion via composite posts. Applied Physics Letters, 106(20), p.201604

[4] Akay, A., & Carcaterra, A. (2014). Damping Mechanisms. In Active and Passive Vibration Control of Structures (pp. 259-299). Springer Vienna.