International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048
Volume 7, Issue 5, pp 250-253, May-2023
https://doi.org/10.47001/IRJIET/2023.705032

Study of the Characteristics of the Elasticity of Silicone Rubber Composites RTV 10 and RTV 52 with Talc Reinforcing Powder

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***Abstract* - Insole made of silicone rubber material is capable of dampening heel strike during walking and running activities due to its high elasticity. To meet specific requirements, the elastic properties of silicone rubber can be modified by using it as a composite material by adding talc powder as a reinforcing agent. This study examines the elasticity characteristics of silicone rubber RTV 10 and 52 mixed with talc ranging from 5% to 35%. The testing is conducted by compressing specimens to a certain depth, and then measuring the compressive force and dimensional changes of the specimens. The test results indicate that the higher the percentage of added talc, the lower the change in diameter and the higher the compressive force.**

Keywords: elasticity, silicone rubber-talc composite, heel strike.

I. INTRODUCTION

Sports such as walking and running are highly popular activities. During walking and running, the feet are subjected to shock loads from supporting the body weight. The distribution of load on the feet is influenced by factors such as BMI (Rodrigo et al., 2013), gender (Periyasamy et al., 2011), the contact area of the foot sole (Chuckpaiwong et al., 2008), and the type of activity (Rodgers, 1988). For example, when standing upright, the rear foot/heel region of both feet bears 60% of the body weight (Chia et al., 2009). However, during walking and running, heel strike occurs, resulting in a load of up to 70% of the body weight on one foot in the rear foot area (Giddings et al., 2000). This can lead to foot injuries.

To address this issue, one approach is to develop shoe insoles with soft materials that can absorb impact loads during walking and running activities. Shoe insoles have been proven to reduce heel pain. Thick insoles and extra padding can alleviate pain while standing and walking (Cheung and Zhang, 2005). Contoured insoles are more effective than flat soles in reducing localized peak pressures (Tsung, et.al., 2003). High elasticity is required for shoe insole materials to effectively absorb shock loads. One such material used for insoles is silicone rubber, which is a biocompatible polymer. Therefore, it is commonly used as a material for shoe insoles.

The elastic properties of silicone rubber cause it to deform laterally when subjected to compressive loads. Consequently, when silicone rubber is used as an insole material, it deforms laterally upon heel strike, resulting in pressure on the shoe and discomfort in the foot sole. To address this issue, it is necessary to modify the elastic characteristics of silicone rubber by incorporating reinforcing powders. The chosen powders should also be biocompatible to avoid causing skin sensitivity reactions. Talc is one of the powders that can be used. This study investigates the influence of adding talc powder on the elastic characteristics of silicone rubber.

II. METHODOLOGY

The silicone rubber materials used were RTV 10 and RTV 52. The variations of talc addition were 5%, 10%, 15%, 20%, 25%, and 30%. The mixing process was carried out by stirring for 10 minutes. To remove trapped air, the mixture was placed in a pressure vessel for vacuum processing.

The mixture was then molded into cylindrical molds with a diameter of 30 mm and a thickness of 20 mm for 24 hours. The testing of elastic characteristics was conducted by compressing the test specimens to a specific depth (d). Compression testing was performed using the DME 220H compression testing machine with a maximum compression force capacity of 5000kg. Figure 1 illustrates the compression testing machine used.

The applied compression force and the change in diameter at the center of the specimen were measured and recorded. The depth of compression (d) was varied at 2mm, 4mm, 6mm, and 8mm. The schematic diagram of the elastic characteristics testing is shown in Figure 2.

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Figure 1: The DME 220H compression testing machine

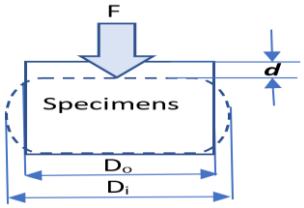

Figure 2: The schematic diagram of the elasticity testing of silicone rubber-talc composite

III. RESULTS & DISCUSSION

Table 1 shows the compression test results for silicone rubber RTV 10-talc composites with variations in talc addition percentage ranging from 5% to 30%. Generally, as the depth of compression increases, the values of D_i (change in diameter) and compression force also increase. The lowest D_i value is obtained at a compression depth of 2mm, while the highest D_i value is observed at a compression depth of 8mm.

Table 1: Compression test results for silicone rubber RTV 10-talc composite

% Talc	*d* (mm)	D_i (mm)	*F* (kg)
5	2	42.96	37.55
	4	51.74	242.53
	6	61.12	2470.12
	8	71.18	2850.43
10	2	38.43	18.76
	4	44.36	65.72
	6	62.24	518.37
	8	62.37	3131.98
15	2	36.56	21.79
	4	40.12	66.21
	6	53.22	343.47
	8	66.45	2360.81
20	2	34.12	24.77
	4	40.98	86.60
	6	53.56	551.91
	8	72.42	2940.31
25	2	34.62	23.75
	4	42.14	85.29
	6	54.18	564.03
	8	76.71	3039.56
30	2	34.14	25.65
	4	42.52	91.37
	6	57.44	568.64
	8	74.66	2943.97

Figure 3 illustrates the graph showing the relationship between D_i values and compression force F with talc percentage. As seen in Figure 3a, as the talc percentage increases, the D_i values generally decrease. This indicates that the elasticity of the silicone rubber RTV 10-talc composite decreases with increasing talc percentage. It is known that talc acts as a reinforcing agent in silicone rubber. Therefore, higher talc percentages added to the silicone rubber composite make it stiffer or increase its modulus of elasticity.

However, at a compression depth of 8mm, the opposite trend is observed, where higher talc percentages result in increased D_i values. This may be due to the lateral forces generated during compression, causing the bond between silicone rubber and talc powder to break. This is supported by the significant compression force observed at a depth of 8mm, which remains relatively constant as shown in Figure 3b.

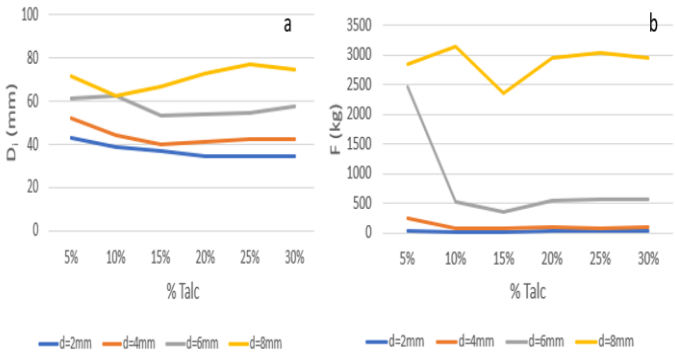

Figure 3: The influence of talc percentage on a) Di values and b) compression force F for silicone rubber RTV 10

Table 2 presents the compression test results for silicone rubber RTV 10-talc composites with variations in talc addition percentage ranging from 5% to 30%. Generally, the D_i values for compression depths of 2mm, 4mm, 6mm, and 8mm tend to

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remain relatively constant, as shown in Figure 4a. This is in contrast to the behavior of silicone rubber RTV 10, where the D_i values tend to decrease with increasing compression depth. The relatively constant D_i values are attributed to the strong bond between talc powder and silicone rubber RTV 52, as indicated in Figure 4b. This suggests that the addition of talc does not significantly affect the modulus of elasticity. However, there is an anomaly observed for a compression depth of 8mm, where the D_i values do not form a regular pattern. This anomaly may be attributed to the presence of air voids within the specimens.

Table 2: Compression test results for silicone rubber RTV 52-talc composite

% Talc	*d* (mm)	D_i (mm)	*F* (kg)
5	2	35.62	29.40
	4	41.40	104.93
	6	40.14	592.78
	8	70.17	2792.68
10	2	32.20	20.91
	4	35.11	46.59
	6	41.67	134.33
	8	43.68	537.56
15	2	34.52	23.43
	4	42.18	80.27
	6	55.65	504.21
	8	76.84	2970.46

% Talc	*d* (mm)	D_i (mm)	*F* (kg)
20	2	34.12	31.27
	4	39.16	90.80
	6	43.83	328.45
	8	65.54	1476.22
25	2	34.14	24.09
	4	38.16	56.71
	6	42.67	172.75
	8	52.78	700.05
30	2	33.33	26.09
	4	37.74	65.57
	6	43.62	228.63
	8	54.58	1047.27

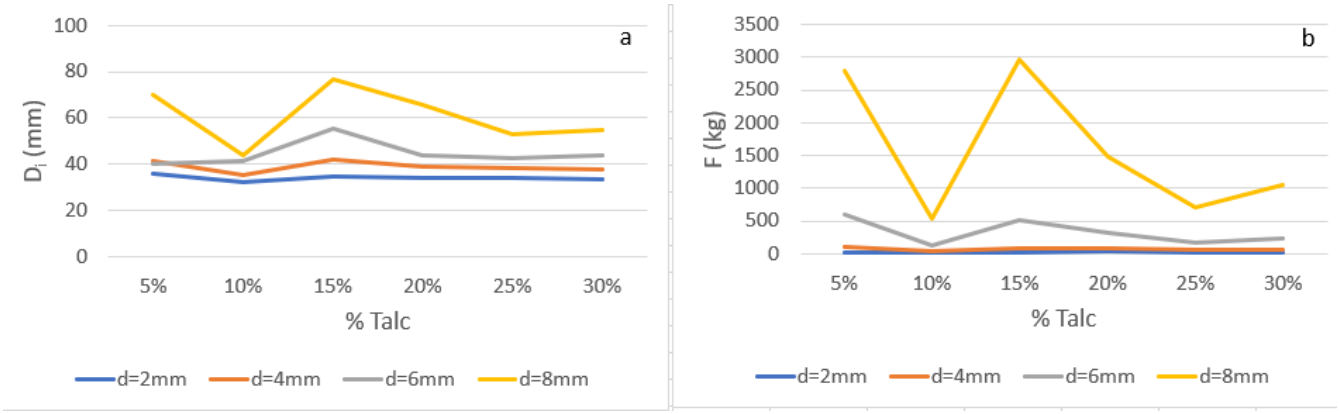

Figure 4: The influence of talc percentage on a) Di values and b) compression force F for silicone rubber RTV 52

IV. CONCLUSION

The addition of talc to silicone rubber RTV 10 and RTV 52 exhibits different characteristics. Silicone rubber RTV 10, which is more elastic compared to silicone rubber RTV 52, can have its elasticity modified by adding talc. On the other hand, the elasticity characteristics of silicone rubber RTV 52, which is harder, are not significantly influenced by the addition of talc. Therefore, silicone rubber RTV 10 offers advantages as a material for shoe insoles because its elasticity can be easily modified by adding talc in certain percentages to meet specific requirements.

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Citation of this Article:

Yusuf Umardani, Susilo Adi Widyanto, Agus Suprihanto, "Study of the Characteristics of the Elasticity of Silicone Rubber Composites RTV 10 and RTV 52 with Talc Reinforcing Powder" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 7, Issue 5, pp 250-253, May 2023. https://doi.org/10.47001/IRJIET/2023.705032

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