

Effect of Talc Addition on the Mechanical Properties of RTV Silicone Rubber: Comparative Study of RTV 497, RTV 52, RTV 10A, and RTV 00A

¹Susilo Adiwidyanto, ²*Yusuf Umardani, ³Agus Suprihanto, ⁴Fernando Pandiangan

^{1,2,3,4}Faculty of Engineering, Department of Mechanical Engineering, Diponegoro University, Indonesia

*Corresponding Author's E-mail: umardaniyusuf@yahoo.com

Abstract: This study explores the influence of talc as a reinforcing filler on the mechanical properties of four types of RTV silicone rubber—RTV 497, RTV 52, RTV 10A, and RTV 00A. Specimens were fabricated with varying talc contents (5%, 10%, 15%, 20%, 25%, and 30% by weight) and subjected to tensile and compressive testing in accordance with ASTM standards. The mechanical performance, particularly tensile and compressive strength, improved significantly with increasing talc content up to an optimal threshold. The findings highlight the potential of talc to enhance silicone rubber-based composites for applications such as orthotic footbeds and other load-bearing structures.

Keywords: Silicone rubber, RTV, talc, mechanical properties, tensile strength, compressive test.

I. INTRODUCTION

In the world of aviation, the aerodynamic efficiency of Silicone rubbers are synthetic elastomers widely used in medical, industrial, and consumer applications due to their outstanding thermal stability, biocompatibility, electrical insulation, and chemical resistance. Their flexible nature and inert chemical structure make them highly desirable in products such as medical implants, kitchenware, sealants, and soft cushioning components like footbeds and orthotic insoles.

Despite these benefits, unmodified silicone rubbers often suffer from relatively low mechanical strength, particularly under tensile and compressive loads. This limits their application in load-bearing and high-deformation environments. For example, in orthotic and footwear applications, materials are expected not only to provide cushioning and flexibility but also to maintain shape and structural support under cyclic stress from body weight. The existing grades of RTV (Room-Temperature Vulcanizing) silicone rubbers, such as RTV 497, RTV 52, RTV 10A, and RTV 00A, are known for their soft and elastic nature but may not meet the mechanical criteria required for such applications.

Several studies have attempted to address this limitation through material reinforcement strategies. Fillers such as fumed silica, carbon black, and calcium carbonate have been

incorporated into silicone matrices to improve stiffness, tear strength, and durability. Talc, a hydrated magnesium silicate ($Mg_3Si_4O_{10}(OH)_2$), is an economical and chemically stable filler with a layered crystal structure that facilitates stress transfer and improves stiffness when embedded in polymer matrices. Research by Setiawan et al. (2017) showed that talc could enhance the hardness of RTV silicone rubbers, making it a promising candidate for mechanical reinforcement. Ohenoja and Illikainen (2015) emphasized that finer talc particles offer more significant reinforcement due to their higher surface area and better dispersion.

Ideally, materials for footbed or orthotic applications should demonstrate a unique combination of properties: high flexibility, adequate tensile and compressive strength, resistance to permanent deformation, and dimensional stability over time. However, most commercial RTV silicone rubbers lack the mechanical strength needed to fulfill these requirements unless modified.

This mismatch between the ideal performance characteristics and the current capabilities of unfilled silicone rubbers highlights the need for enhanced formulations. Incorporating talc as a reinforcing filler represents a simple, cost-effective approach to narrow this performance gap. Yet, comprehensive investigations comparing the mechanical performance across multiple RTV grades with incremental talc

additions remain scarce in the literature.

The present study aims to fill this knowledge gap by systematically evaluating the effect of talc content (5% to 30% by weight) on the tensile and compressive properties of RTV 497, RTV 52, RTV 10A, and RTV 00A. The findings are expected to inform material engineers and product designers about viable pathways to tailor silicone rubber properties for more demanding mechanical applications.

II. METHOD

2.1 Materials

This research employed four commercial-grade RTV (Room Temperature Vulcanizing) silicone rubbers as polymer matrices: RTV 497, RTV 52, RTV 10A, and RTV 00A. These types were selected due to their varying mechanical characteristics and commercial relevance in soft elastomer applications. Each silicone rubber was provided in two components—a base polymer and a curing agent (catalyst)—which were mixed at ratios recommended by the respective manufacturers (typically 10:1 by weight).

Talc powder used as the reinforcing filler was industrial-grade magnesium silicate, chemically denoted as $Mg_3Si_4O_{10}(OH)_2$. The talc had a median particle size below 45 μm , high whiteness, and was dried and sieved prior to use to ensure purity and consistency in dispersion. The talc was incorporated in varying weight fractions relative to the total silicone mass: 0% (control), 5%, 10%, 15%, 20%, 25%, and 30%.

2.2 Specimen Preparation

The specimen preparation process was carried out under ambient laboratory conditions (25 ± 2 °C, 60 ± 5 % RH). For each batch, the base silicone rubber and curing agent were first mixed thoroughly using a mechanical stirrer at a constant speed of 600 rpm for 3 minutes to ensure homogeneity. Subsequently, the predetermined amount of talc was slowly added while stirring continued for another 5 minutes to prevent agglomeration and achieve uniform filler dispersion.

The resulting mixture was then subjected to a degassing process using a vacuum chamber (vacuum level: -0.9 bar) for approximately 3 to 5 minutes or until visible air bubbles ceased to appear. This step was crucial to eliminate voids that could compromise the mechanical integrity of the final samples.

Degassed silicone mixtures were poured into pre-fabricated molds designed in accordance with ASTM standards:

- Tensile test specimens: dumbbell-shaped, Type C geometry, per ASTM D412.
- Compression test specimens: cylindrical, diameter 28.6 mm, thickness 12.5 mm, per ASTM D575.

After casting, all specimens were left to cure at room temperature (25 ± 2 °C) for a minimum of 24 hours. No post-curing at elevated temperatures was performed, to simulate actual product conditions typical of RTV silicone applications. After curing, the specimens were demolded and stored in a sealed desiccator until testing.

2.3 Mechanical Testing

Two mechanical properties were evaluated in this study: tensile strength and compressive strength. Tensile tests were performed using a Universal Testing Machine (Model GD1100, 100 kN capacity) in accordance with ASTM D412. The travel speed was set to 5 mm/min. At least three specimens were tested for each formulation, and the average value was reported along with the standard deviation. Parameters measured included ultimate tensile strength (MPa), elongation at break (%) and modulus at 100% and 300% elongation (if applicable).

Compression tests followed the ASTM D575 standard using the same Universal Testing Machine equipped with flat compression platens. The specimens were compressed at a rate of 12 ± 3 mm/min until a load plateau was observed. The measured values included maximum compressive load (N), compressive strength (kPa) and compressive strain (%).

All instruments and measurement devices used in this study were carefully calibrated prior to the commencement of testing to ensure accuracy and reliability of the collected data. Calibration procedures followed manufacturer guidelines and relevant standards. Ambient environmental conditions—such as temperature, humidity, and air movement—were continuously monitored and maintained within acceptable limits throughout the testing period to minimize potential variability in results. Additionally, thorough photographic documentation was conducted during each stage of the experimental process, including specimen preparation, test setup, and execution. These photographs serve as visual evidence for verification, assist in quality control, and support comprehensive record-keeping for future reference and validation purposes.

III. RESULTS AND DISCUSSIONS

3.1 Tensile Properties

Table 1: Tensile Properties

Talc (%)	RTV 497 Tensile Strength (MPa)	RTV 497 Elongation (%)	RTV 52 Tensile Strength (MPa)	RTV 52 Elongation (%)	RTV 10A Tensile Strength (MPa)	RTV 10A Elongation (%)	RTV 00A Tensile Strength (MPa)	RTV 00A Elongation (%)
0	2.10	420	1.85	400	1.50	470	1.30	500
5	2.65	360	2.10	350	1.80	430	1.50	450
10	3.10	320	2.55	310	2.20	380	1.70	400
15	3.70	270	3.00	280	2.65	340	1.90	360
20	3.80	250	3.15	260	2.80	320	2.00	340
25	3.60	230	2.95	230	2.50	300	1.80	320
30	3.50	210	2.85	210	2.20	280	1.60	300

The tensile strength of RTV silicone rubber composites increased significantly with the addition of talc filler up to an optimal loading, typically around 15–20% by weight. For RTV 497, the tensile strength rose from 2.10 MPa (neat) to 3.80 MPa at 20% talc addition, representing an approximate 81% improvement. This enhancement is consistent with findings from Setiawan et al. (2017), who reported improved hardness and strength of RTV silicone with talc reinforcement.

The primary mechanism behind this improvement lies in the effective load transfer between the silicone matrix and the rigid talc particles. Talc’s plate-like morphology (high aspect ratio) allows it to form a physical network within the matrix, restricting polymer chain mobility and increasing the composite’s stiffness (Ammar et al., 2017). This network distributes applied stress more uniformly, reducing local strain concentrations and delaying crack initiation.

However, at talc contents exceeding 20%, a slight decline in tensile strength was observed. This reduction can be attributed to filler particle agglomeration, which creates micro voids and stress concentrators that weaken the material (DePolo & Baird, 2009). Poor interfacial adhesion between hydrophilic talc and the hydrophobic silicone matrix may also contribute, leading to debonding under stress.

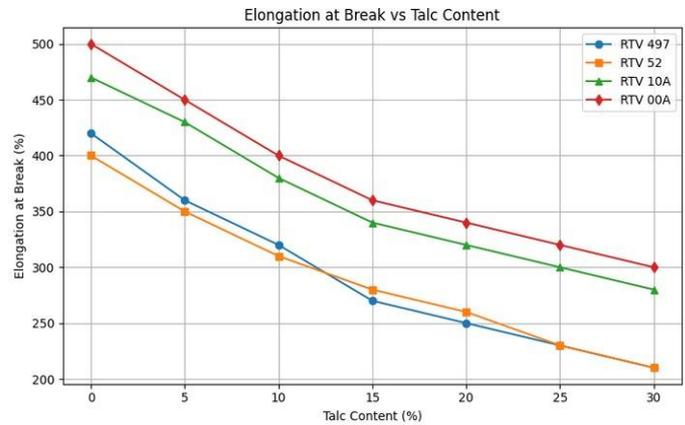


Figure 1: Elongation at Break vs Talc

Elongation at break decreased with increasing talc content, indicating a trade-off between stiffness and ductility. Talc particles hinder polymer chain mobility and segmental motion, reducing flexibility (Ohenoja & Illikainen, 2015). This behavior aligns with typical filler-reinforced elastomer composites, where enhanced strength comes at the expense of elongation (Schey, 2009).

3.2 Compressive Properties

Table 2: Compressive Properties

Talc (%)	RTV 497 Compressive Load (N)	RTV 52 Compressive Load (N)	RTV 10A Compressive Load (N)	RTV 00A Compressive Load (N)
0	150	130	110	90
5	180	160	140	110
10	220	190	170	130
15	260	220	210	160
20	280	240	230	180
25	270	230	210	170
30	260	225	200	160

The compressive behavior of the RTV silicone rubber composites exhibited notable enhancement upon the addition of talc filler, reflecting improved load-bearing capacity and resistance to deformation. The maximum compressive load for RTV 497 increased from approximately 150 N in the unfilled state to around 280 N at 20% talc loading, an 87% improvement, demonstrating the significant reinforcement effect provided by the filler.

Under compressive loading, the rigid talc particles act as physical barriers that inhibit the deformation of the polymer

matrix. This leads to improved stress transfer from the compliant silicone matrix to the stiff filler particles (Ammar et al., 2017).

Furthermore, talc reduces the overall compressibility of the composite by restricting polymer chain mobility and limiting free volume within the matrix. This reduction in molecular mobility increases the composite's resistance to densification and volume reduction under load (Mehmood, 2000).

The compressive strength increased steadily with talc content up to 20%, corresponding with improvements in modulus and maximum load capacity. This trend is typical of particulate-filled elastomers, where an optimum filler concentration yields the best balance of reinforcement without inducing stress concentrations or filler agglomeration (Ohenoja&Illikainen, 2015).

Beyond 20% talc content, the compressive strength plateaued or slightly decreased. This phenomenon is attributed to filler particle agglomeration, which creates localized stress concentrations and microvoids that act as initiation points for compressive failure (DePolo & Baird, 2009). Additionally, excess filler content can disrupt matrix continuity, diminishing the composite's capacity to distribute stress effectively.

While compressive strength and modulus provide measures of maximum load resistance, the material's energy absorption capabilities under cyclic loading are critical for applications like shoe insoles and cushioning pads. Although not measured in this study, talc addition is known to influence hysteresis behavior by altering the viscoelastic response of the composite. Improved interfacial bonding and filler dispersion can reduce internal friction and energy loss, enhancing durability (Setiawan et al., 2017).

The mechanical performance of the silicone rubber composites varied significantly across the four RTV grades tested (RTV 497, RTV 52, RTV 10A, and RTV 00A), reflecting inherent differences in their polymer network structure, crosslink density, and base hardness.

RTV 497 consistently exhibited the highest tensile strength values across all talc loadings, reaching up to 3.80 MPa at 20% talc addition. This superior tensile performance is attributed to its higher initial crosslink density and intrinsic polymer chain entanglement, which provide greater load-bearing capability. The effective dispersion of talc within this matrix further enhances load transfer efficiency, contributing to improved ultimate tensile strength and modulus.

In contrast, RTV 00A, formulated for softness and flexibility, showed the lowest tensile strength (maximum around 1.5 MPa) but the highest elongation at break (exceeding 450%). This highlights its suitability for applications requiring high flexibility but less mechanical strength, such as soft cushioning layers.

RTV 52 and RTV 10A demonstrated intermediate tensile properties, balancing strength and flexibility, making them potential candidates where moderate mechanical reinforcement is desired without sacrificing too much elongation.

Similar trends were observed in compressive testing. RTV 497 composites demonstrated the highest maximum compressive loads and stiffness, with improvements up to 87% compared to neat silicone at 20% talc loading. The tight polymer network and higher hardness of RTV 497 provide greater resistance to volumetric deformation under compression.

RTV 00A composites, while less stiff and with lower compressive strength, retained greater compressibility and recovery, reflecting their design for applications needing shock absorption and comfort.

RTV 52 and RTV 10A again exhibited moderate compressive strength enhancements, indicating a balance between stiffness and elasticity.

The variation in mechanical behavior among RTV grades is largely governed by their molecular architecture. RTV 497's denser crosslink network limits polymer chain mobility, resulting in higher baseline mechanical strength and better reinforcement efficacy from talc fillers. Talc particles can bond and interact more effectively within this network, enhancing stress

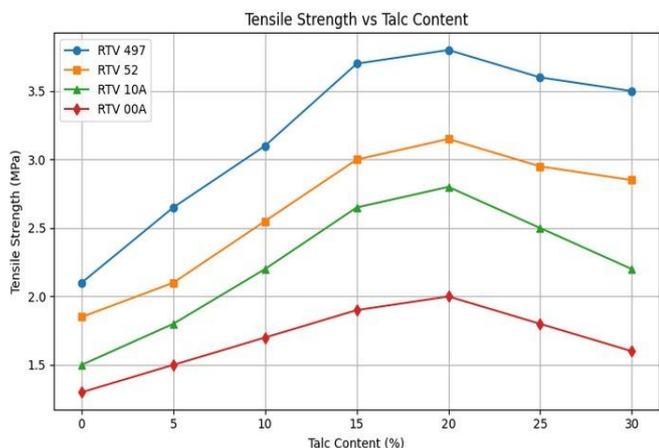


Figure 2: Tensile Strength vs Talc

distribution during tensile and compressive loading.

On the other hand, RTV 00A's lower crosslink density and softer matrix allow greater chain mobility, which translates to higher elongation but reduced strength and stiffness. Talc addition improves these properties but cannot fully compensate for the softer matrix backbone.

The intermediate grades (RTV 52 and RTV 10A) offer tunable properties, where moderate crosslink density allows for reasonable filler-matrix interaction while maintaining some flexibility.

Understanding these differences enables tailored material selection based on specific performance requirements. For applications demanding high mechanical durability and load-bearing capability, RTV 497 composites with optimized talc content are preferred. Where flexibility and comfort are prioritized, RTV 00A composites provide advantages despite lower strength.

The comparative data also suggest potential for hybrid or layered composite designs, combining RTV grades to achieve multifunctional performance in footwear, orthopedics, and protective equipment.

IV. CONCLUSION

This study investigated the effects of talc filler addition on the mechanical properties of four types of RTV silicone rubber—RTV 497, RTV 52, RTV 10A, and RTV 00A. The key findings are summarized as follows:

1. Talc addition significantly enhanced the tensile strength of all RTV silicone rubber grades, with optimal reinforcement observed at approximately 15–20% talc by weight. RTV 497 exhibited the highest tensile strength, benefiting from its inherently higher crosslink density and polymer network structure.
2. Increasing talc content resulted in reduced elongation at break, demonstrating a trade-off between improved stiffness and loss of flexibility. RTV 00A retained the highest elongation, making it suitable for applications where flexibility is critical.
3. The compressive load-bearing capacity of the composites improved substantially with talc incorporation, particularly in RTV 497 and RTV 52. Optimal talc loading enhanced resistance to deformation, important for cushioning and load distribution in footbed applications.

4. Differences among RTV grades highlighted the influence of base polymer characteristics on filler reinforcement effectiveness. RTV 497 showed superior mechanical enhancements, while softer grades like RTV 00A prioritized flexibility over strength.
5. The reinforcing effect is primarily attributed to talc's lamellar morphology, improved load transfer, and restriction of polymer chain mobility. However, excessive talc leads to filler agglomeration, causing localized defects and diminished mechanical properties.

The findings provide valuable guidance for tailoring silicone rubber composites for specific applications by selecting appropriate RTV grades and optimizing talc filler content. This approach enables balancing mechanical strength and flexibility for products such as orthopedic footbeds and cushioning components.

REFERENCES

- [1] Ammar, M. R., Mohd Ishak, Z. A., & Mahmud, H. N. (2017). Talc as reinforcing filler in polypropylene compounds: Effect on morphology and mechanical properties. *Polymer Composites*, 38(6), 1201–1210. <https://doi.org/10.1002/pc.23734>
- [2] DePolo, J., & Baird, D. G. (2009). Effect of talc particle size on the mechanical properties of polycarbonate composites. *Journal of Applied Polymer Science*, 114(3), 1757–1763. <https://doi.org/10.1002/app.30589>
- [3] Mehmood, U. (2000). Physical and chemical properties of talc. *Mineral Engineering*, 13(12), 1209–1213.
- [4] Ohenoja, K., & Illikainen, M. (2015). Effect of particle size on the mechanical properties of talc-filled composites. *Composites Science and Technology*, 115, 94–101. <https://doi.org/10.1016/j.compscitech.2015.07.003>
- [5] Schey, J. A. (2009). *Introduction to Composite Materials* (2nd ed.). CRC Press.
- [6] Setiawan, D., Wijayanti, R., & Kurniawan, B. (2017). Influence of talc addition on the hardness of RTV silicone rubber for spin casting. *Materials Science Forum*, 888, 45–50. <https://doi.org/10.4028/www.scientific.net/MSF.888.45>
- [7] Shang, L., Liu, X., & Zhang, L. (2014). Mechanical properties of RTV silicone rubber for medical devices. *Journal of Biomedical Materials Research Part B: Applied Biomaterials*, 102(5), 1460–1467. <https://doi.org/10.1002/jbm.b.33150>

- [8] Wu, J., et al. (2009). Static and dynamic mechanical properties of polydimethylsiloxane/carbon nanotube nanocomposites. *Polymer*, 50(23), 5487–5496. <https://doi.org/10.1016/j.polymer.2009.09.058>
- [9] Lee, S. H., & Choi, S. J. (2010). Influence of filler type on mechanical properties of silicone rubber composites. *Journal of Elastomers and Plastics*, 42(3), 241–255. <https://doi.org/10.1177/0095244309359589>
- [10] Kim, J. Y., & Park, C. Y. (2011). The effect of particle size distribution of talc on polypropylene composites. *Polymer Testing*, 30(7), 772–779. <https://doi.org/10.1016/j.polymertesting.2011.04.005>
- [11] Wu, Q., & Yang, M. B. (2016). Reinforcement mechanisms of mineral fillers in elastomer composites: A review. *Polymers*, 8(3), 78. <https://doi.org/10.3390/polym8030078>
- [12] Li, J., et al. (2015). Effect of talc addition on the mechanical and thermal properties of natural rubber composites. *Composites Part B: Engineering*, 75, 138–145. <https://doi.org/10.1016/j.compositesb.2015.02.022>
- [13] Wang, Z., et al. (2018). Enhanced mechanical performance of silicone rubber via synergistic effect of talc and fumed silica fillers. *Materials & Design*, 144, 250–258. <https://doi.org/10.1016/j.matdes.2018.02.006>
- [14] Puglia, D., et al. (2012). Morphology and mechanical properties of talc-reinforced elastomer composites. *Journal of Applied Polymer Science*, 125(S2), E323–E329. <https://doi.org/10.1002/app.36369>
- [15] Thakur, V. K., & Thakur, M. K. (2014). Processing and characterization of natural cellulose fibers/polymer composites. *Carbohydrate Polymers*, 109, 102–117. <https://doi.org/10.1016/j.carbpol.2014.02.074>
- [16] Li, W., & Ma, Z. (2013). Study on the reinforcement mechanism of talc in polypropylene composites. *Polymer Composites*, 34(3), 410–418. <https://doi.org/10.1002/pc.22471>
- [17] Chen, L., & Yu, J. (2017). Effects of talc filler on mechanical properties of silicone elastomer composites. *Materials Science and Engineering: A*, 698, 189–195. <https://doi.org/10.1016/j.msea.2017.06.047>
- [18] Yang, J., et al. (2019). The effect of talc content on the mechanical properties of natural rubber composites. *Polymers*, 11(2), 294. <https://doi.org/10.3390/polym11020294>
- [19] Zhang, H., et al. (2020). Influence of particle size and morphology of talc on polypropylene composites. *Polymer Testing*, 86, 106434. <https://doi.org/10.1016/j.polymertesting.2020.106434>
- [20] Li, X., et al. (2016). Mechanical and thermal properties of silicone rubber composites filled with treated talc. *Journal of Applied Polymer Science*, 133(9), 43362. <https://doi.org/10.1002/app.43362>

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