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Effect of Joint Types Between Metallic Material and Elastomer Material Used for Vibration Isolation on Isolation Performance and Dynamic Properties

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***Abstract*–** Elastomer materials can be jointed using various connection types with metallic parts. Removable connections (with screws, nuts, etc.), adhesive and vulcanization methods are some of them. In this work, it is investigated that how joint between one type of elastomer called silicone and aluminum using adhesive and vulcanization process affect dynamic properties and vibration isolation performance and results are compared. Modal tests are performed for investigation and comparation.

Keywords–Vibration isolation, elastomer material behavior, modal test, natural frequency, vibration transmissibility

I. Introduction

Vibration isolation is an engineering problem which is encountered by especially military application, many industrial application and many situations in life. If the vibration isolation is not used where a structure is exposed to vibration, it is possible that the structure can be damaged in terms of mechanic, electric, optic, etc. [5]. There are many solution for vibration isolation problem. Wire rope, elastomer mounting and industrial vibration isolator which can be determined according to application area are some solution types.

. Elastomer materials which are affected by temperature, load frequency, load amplitude, chemical content and filler material about material behavior are nonlinear material type. Mechanical and dynamic properties of these materials are affected by applied boundary conditions as well as load conditions and load shapes about vibration isolation. It means joint types between elastomer material and mechanical parts for vibration isolation affect vibration isolation performance. [6].

There are many papers that mention about joints between elastomers and metals[1]. In this work, silicone which is one type of many elastomer materials is used. Silicone materials which show thermally more stable behavior than the others have successful mechanical properties. They are utilized with different hardness values as a vibration isolation material[3,4].

Adhesives demonstrate hyperelastic material behavior and they made an elastic connection between metals and elastomers[2]. Vulcanization is a kind of heat treatment process. Elastomers which are semi-finished or pastry cast to the metal by means of molding. They are provided to joint metal using heat press and special prescription. Covalent connection is created between metal and elastomer. It is also called cross-link[1]. This document explains how change dynamic behavior and vibration transmissibility of the system which have adhesive and vulcanization joint between metals and elastomers.

II. Materials and Method

In this work, silicone and aluminum materials are used. Silicone's goal is to isolate an avionic unit from vibration loads and connected to unit by means of two aluminum metals and their interfaces.

Two methods were applied for metal-silicone joint. First one is adhesive connection. Before this method is applied, both silicone and metals joint faces are cleaned with related chemicals. After that, silicone rubber adhesive called Sil-Poxy is glaired joint faces and silicone and metals are bonded by applying prestress. In order to finish process, they are waited for curing like said in the adhesive prescription.

Second method is vulcanization. Face cleaning is also critical and impotant in this process, too. Semi-finished silicone is cast to the metals by means of molding and needed heat treatment prescription is applied for connection. After that, cross-links are occurred between silicone and metals. Heat treatment prescription can change according to the hardness of silicone[1]. After this process, joint between silicone and metals is happened. This joint is demonstrated at Fig. 1 for both methods.

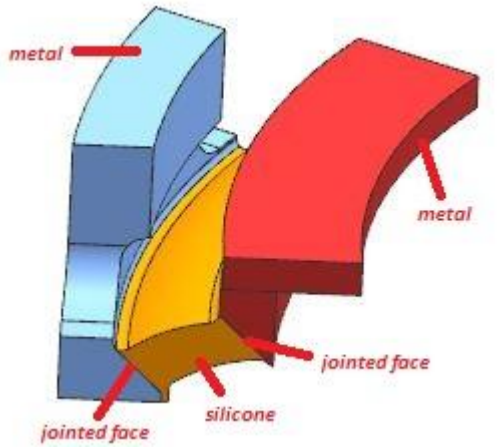

Fig. 1 3 D model of jointed assembly

Effects of two joint methods is observed by modal tests on dynamic properties and isolation performance of avionic unit. Free-free boundary condition is occured for these tests. Test setup is showed at **Fig. 2.**

Fig. 2 Test Setup

4 jointed assembly, 1 avionic unit, 1 fixture, one flexible rope, 1 modal shaker, 4 three dimentional and 4 one dimensional acceloremeters, 1 computer, 1 LVDT machine and 1 power supplier are used in these modal tests. In order to manage test and observe test results, LMS software is used. Jointed vibration isolation assemblies are positioned over the avionic unit with equal interval. This assembly connected to fixture is mounted to crane by a flexible rope. Harmonic loads are applied to the assembly by stringer of modal shaker. These tests are happened between 20-300 Hz. Tests are repeated with various loads

III. RESULTS

Test results dependent to load amplitudes are shown at Tablo 1 for adhesive case.

Tablo 1. Test results for adhesive case

Load Amplitude(N)	Natural Frequency(Hz)	Transmissibity
1	91,8	12,3
2	91,8	12,1
3	91,4	11,9
5	90,5	11,2
10	88,4	10,1
30	81,2	7,3
50	77,3	6,5
75	73,9	6,2
100	71,4	5,9

Test results dependent to load amplitudes are shown at Tablo 2 for vulcanization case.

Tablo 2. Test results for vulcatization case

Load Amplitude(N)	Natural Frequency(Hz)	Transmissibity
1	131	11,1
2	131,4	10,8
3	131	10,6
5	130,2	10,3
10	126,3	8,7
30	116,1	6
50	110,1	5
75	105	4,4
100	100	4,1

IV. DISCUSSION

Test results for natural frequencies dependent to loads are shown at Fig. 3.

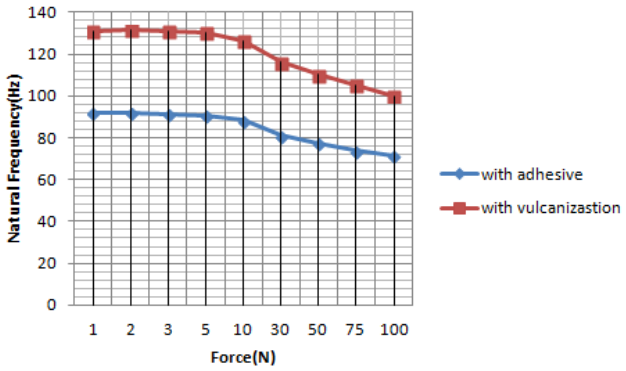

Fig. 3. Natural Frequencies based on Loads

Test results for transmissibilities dependent to loads are shown at Fig. 4

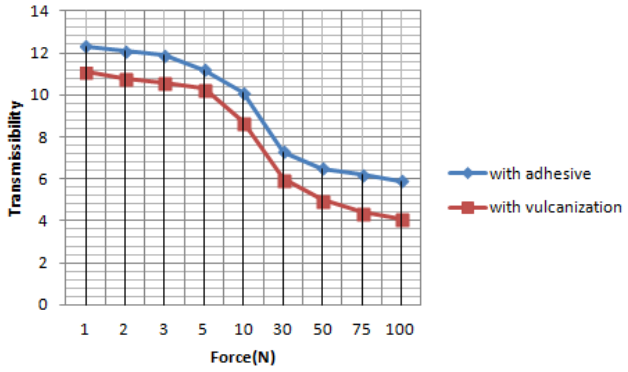

Fig. 4. Transmissibilities based on Loads

As seen clearly at Fig. 3 and Fig. 4, joint metods between elastomer and metals are effective on dynamic properties and vibration transmissibilities. So, at vulcanization joint, natural frequencies of the system are higher nearly %40-45 according to adhesive joint. Similarly, transmissibities of isolators are lower nearly %10-30 according to adhesive joint.

V. CONCLUSION

Even if they are seen same and have same interfaces, joint types change the boundary conditions contact forces between elastomer and metals are different. Consequently, this work showed that types of joints between elastomers and metals change dynamic properties of the system and transmissibility seriously.

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