



ON THE IMPACT OF SILICA AND BLACK CARBIDE IN IMPROVING THE ANTI-VIBRATION OF THE RUBBER BLENDS BASED ON NATURAL RUBBER (NR) AND STYRENE BUTADIENE RUBBER (SBR)

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ABSTRACT

This paper presents some results on the survey of the impact of silica and black carbide on the mechanical – physical properties and vibration resistance of the rubber blended on natural rubber (NR) and synthetic styrene butadiene rubber (SBR), for application in manufacturing diesel engine mounts. Based on this research, the article also introduces some results in building up anti-vibration rubber and the process of diesel engine mounts manufacture. Development of the method to test the vibration resistance of the diesel engine mounts has initially resulted in some good results such as the natural frequencies are lower than 20 Hz and the damping factor is higher than 10.

Keywords: anti-vibration rubber, engine mounts.

1. INTRODUCTION

Engine mount is a typical anti-vibration product made from rubber [6]. The engine mount is designed to link the engine and the vehicle body. It must achieve a vibration reduction effect (avoiding resonant frequencies) while reducing the impact force on the chassis as well as displacement to the lowest level. In order to meet these requirements, manufactured rubber must achieve elastic characteristics and mechanical properties that ensure the bearing is stable enough for a long time. To increase the life of the product, it is necessary to increase the durability of the rubber, reduce the hardness and hence the resonant frequency, increase the anti-vibration resistance for the support. Factors affecting the hardness of the rubber are network density, powdered content, plasticizers, reinforcing agents, etc. In this paper, we present some results on the impact of filler (carbon black and silica) to vary the shake resistance of NR and SBR/NR blend.

2. EXPERIMENT

2.1. Materials, chemicals

The materials for the study include:

- Anti-vibration rubber bearing on NR basis.
- Anti-vibration rubber pillow on SBR/NR blend.
- All kinds of materials and chemicals for making anti-vibration rubber pillow include:
 - + Natural rubber, RSS1 (Vietnam).
 - + Styren butadien rubber, SBR 1502 (Korea).
 - + Promoters (M, D), Activator (ZnO, Axitstearic), fillers (carbon black N330, SiO₂), anti-aging substances (4020, RD), etc. are the basic chemicals used in rubber industry.
 - + Silica made in Vietnam with the parameters as indicated in Table 1 [4].

Table 1. Specification of the made silica in the study.

No	Specifications	Unit	Results
1	Content SiO ₂	%	≥ 86
2	Specific weight	g/cm ³	0.10-0.25
3	Moisture at 105 ⁰ C	%	3-5
4	Loss on heating at 1000 ⁰ C	%	8-14
5	pH of suspension 5%		6.5-8
6	Left on 325 mesh sieve (dry sieve)	%	≤ 12
7	Total Chlorine	%	≤ 0.22
8	Private surface	m ² /g	> 110

2.2. Measurement methods, measurement standards

- Fabrication of mechanical samples according to TCVN 1592: 2007, manufacture of chemical samples according to TCVN 4855: 2008 by cutting and grinding machines;
- Rubber hardness testing according to TCVN 1595-1: 2007 with LX-A (China);
- Tensile strength testing according to TCVN 4509: 2006 with UT-2080 (Taiwan);
- Elongation test when pulled out according to TCVN 4509: 2006 with UT-2080 (Taiwan);
- Check compression deformation according to TCVN 5320-1: 2008 at 70⁰C in 24 h.
- Check th level of aging according to TCVN 2229: 2007 at 70⁰C in 96 h.
- Vibration test according to ASTM E756-05 [3] Vibration Exciter - i230, IMV Corporation, Japan).

2.3. Application and rolling process, product vulcanization

During the study, we found the blend of natural rubber with styrene butadiene rubber was very good for anti-vibration characteristics. NR deformation, which can generate high heat when working due to large molecular weight [1]. Mixing NR and SBR will increase the mechanical strength of the system, especially the resilience. On the other hand, these two types of rubber have molecular structure, polarization and have the same vulcanization system, so it is easy to mix. In some experiments, we chose the basic rubber base as shown in Table 2.

Table 2. Experimental rubber composition.

No	Chemical name	Ratio (phr)
1	Natural rubber RSS1	100
2	ZnO	5.0
3	Axit Stearic	3.0
4	anti-aging substance RD	1.0
5	anti-aging substance 4020	0.4
6	Parafin	0.3
7	SiO ₂	5.0
8	Flexon	6.0
9	S	2.2
10	Promoter M	0.5
11	Promoter D	0.5
	<i>Additional Element</i>	
12	SBR/NR blend	80/20
13	Carbon black N330	43.5/49/54
14	SiO ₂	5.0

Product shape

The rubber mount is made in the following form (Figure 1) [2]:

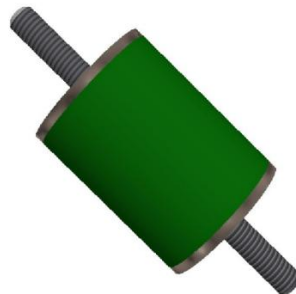


Figure 1. The rubber mount.

Product manufacturing process

The rubber rolling process is carried out on two-axis rolling machine. Incubation of the product on a sample curing vessel with a pressure of 30 tons, a temperature of 142 °C to 145 °C and a retention time of 25 to 30 minutes.

3. RESULTS AND DISCUSSION

3.1. Effect of carbon black and silica content on the hardness, tensile strength and vibration resistance of NR

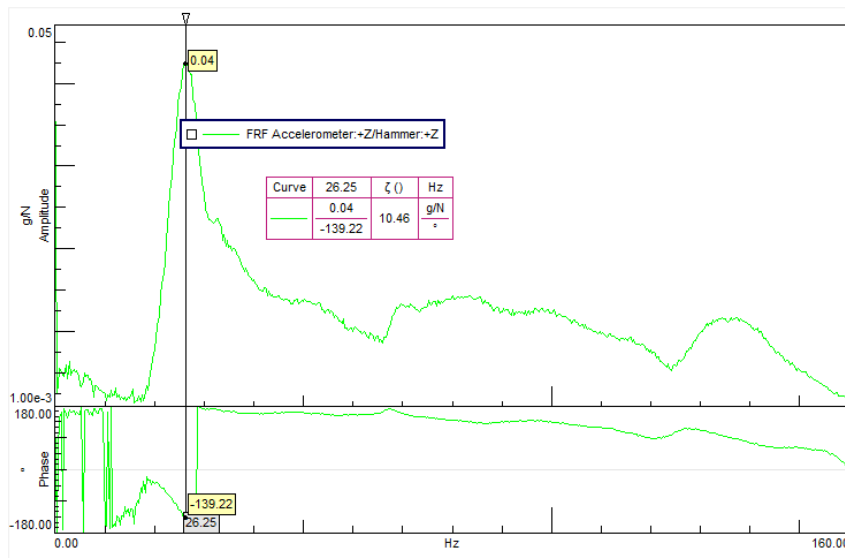


Figure 2. Vibration measurement results of the rubber sample by Vibration Exciter - i230.

Table 3. Physicochemical and anti-vibration properties of NR with carbon black content of 43.5/49/54 phr.

No	Specifications	Content of carbon black N330 (phr)		
		43.5	49	54
<i>I Physicochemical properties</i>				
1	Hardness, Shore A	64	67	71
2	Tensile strength, MPa	23.62	24.04	23.35
3	Elongation, %	637.6	626.9	608.1
<i>II Anti-vibration properties</i>				
4	Resonant frequency, Hz	18.86	22.94	25.94
5	Damping coefficient	9.21	9.12	9.04
6	Distortion rate, kN/m	107	124	145

Results of physicochemical properties and vibration parameters of rubber when changing the content of carbon black is presented in Figure 2 and Table 3.

Table 3 shows that carbon black affects the physicochemical properties of NR. When the carbon content is increased, the hardness, tensile strength increases and elongation decreases, which is consistent with the law. In this case, carbon black acts as the reinforcement powder for NR. However, increasing the carbon black content also reduces the damping coefficient, increasing the distortion rate which reduces the vibration resistance of the NR. On the other hand, when the amount of carbon black increases the resonant frequency, this is not good for the engine mounts because we need to reduce the resonant frequency to the lowest, the farther away from the operating frequency range of the engine is good.

Results of physicochemical properties and vibration parameters of rubber when changing the content of carbon black with 5 phr silica is presented in Table 4.

Table 4. Physicochemical and anti-vibration properties of NR with content of 43.5/49/54 phr and 5 phr silica.

	Specifications	Content of carbon black N330 (phr) + silica 5 (phr)		
		43.5/5	49/5	54/5
<i>I</i>	<i>Physicochemical properties</i>			
1	Hardness, Shore A	66	68	72
2	Tensile strength, MPa	23.75	23.11	22.65
3	Elongation, %	696.5	625.4	586.9
<i>II</i>	<i>Anti-vibration properties</i>			
4	Resonant frequency, Hz	19.24	23.75	26.25
5	Damping coefficient	10.21	9.89	10.46
6	Distortion rate, kN/m	113	132	158

Table 3 and 4 show that, when 5 phr of silica is added, the physicochemical properties of the material are negligible, but the damping coefficient increases by more than 10%, the Distortion rate to decrease. This can be said, 5 phr silica enhanced anti-vibration of the NR.

3.2. Effect of carbon black and silica content on the hardness, tensile strength and vibration resistance of NR/SBR blend

The results of the research on blends based on NR/SBR of other authors [5] have been reported to produce blends with good physicochemical properties (Table 5), the ratio between NR and SBR in the interval 80/20 is suitable, the other components and technological mode are intact to investigate the effect of carbon black and silica on physicochemical properties and vibration resistance of this material on the blend.

Table 5. Physicochemical and anti-vibration properties of NR/SBR blend with carbon black content of 43.5/49/54 phr.

	Specifications	Content of carbon black N330 (phr)		
		43.5	49	54
<i>I</i>	<i>Physicochemical properties</i>			
1	Hardness, Shore A	66	68	71
2	Tensile strength, MPa	24.90	22.02	21.67
3	Elongation, %	583.1	586.7	500.4
<i>II</i>	<i>Anti-vibration properties</i>			
4	Resonant frequency, Hz	20.15	24.23	26.11
5	Damping coefficient	10.05	10.38	9.92
6	Distortion rate, kN/m	119	146	160

As the carbon black content increases, hardness, physicochemical strength increase, resonant frequency and distortion rate increase. Compared with Table 3, it is found that the physicochemical and vibration resistance of NR/SBR blend is higher than NR.

Results of physicochemical properties and anti-vibration parameters of SBR/NR blend change in carbon black with 5phr silica are presented in Table 6.

Table 6. Physicochemical and anti-vibration properties of NR/SBR blend with carbon black content of 43.5/49/54 phr and 5 phr silica.

	Specifications	Content of carbon black N330 (phr) + silica 5 (phr)		
		43.5	49	54
<i>I</i>	<i>Physicochemical properties</i>			
1	Hardness, Shore A	66	69	71
2	Tensile strength, MPa	22.55	22.69	21.45
3	Elongation, %	582.0	599.1	534.6
<i>II</i>	<i>Anti-vibration properties</i>			
4	Resonant frequency, Hz	20.88	25.89	27.15
5	Damping coefficient	11.78	12.01	11.92
6	Distortion rate, kN/m	125	153	169

Comparing the results between Tables 5 and 6, we found that the physicochemical properties of the NR / SBR blend did not change much with 5phr of silica. On the anti-vibration

feature, the resonant frequency is not significantly increased, only the damping coefficient and the distortion rate are relatively large.

From the results, it can be seen that the carbon black content increases the hardness, strength and NR/SBR blend, but it also increases the resonant frequency and deformation of the rubber. While 5 phr of silica does not significantly affect the physicochemical properties of the rubber, it does increase the damping coefficient of the rubber (more than 10 %). Based on the requirements for the manufacture of engine mounts, it is possible to select the appropriate single component, optimizing the technical specifications.

4. CONCLUSION

Based on the study, the followings have been figured out:

A number of important technical specifications of vibration resistant rubber have been surveyed, measured and evaluated. These measurements are the basis for self-study and manufacture of anti-vibration rubber pillows for products such as engine mounts.

Measurement of carbon black and silica impact on physicochemical properties and vibration resistance of rubber samples, with 5 phr of silica, increased the damping coefficient by more than 10 % increases the resonant frequency.

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