REPORT TITLE: **ERAD Sub-Frame Bush Testing**

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DATE	28/03/22	28/03/22	28/03/22

1. Title

1.1. ERAD Sub-Frame Bush Testing.

2. Objectives

2.1. Measure the stiffness of four e-rad mounts bushes on a used subframe.

2.2. Measure the stiffness of one e-rad mount bush on a new subframe.

3. Conclusions

3.1. The stiffness of the five mount bushes tested are shown in Table 1.

3.2. The stiffness values of all tested bushes were within the manufacturer specification for new bushes of: 500 ±10% N/mm.

Table 1 - Bush Stiffness Summary

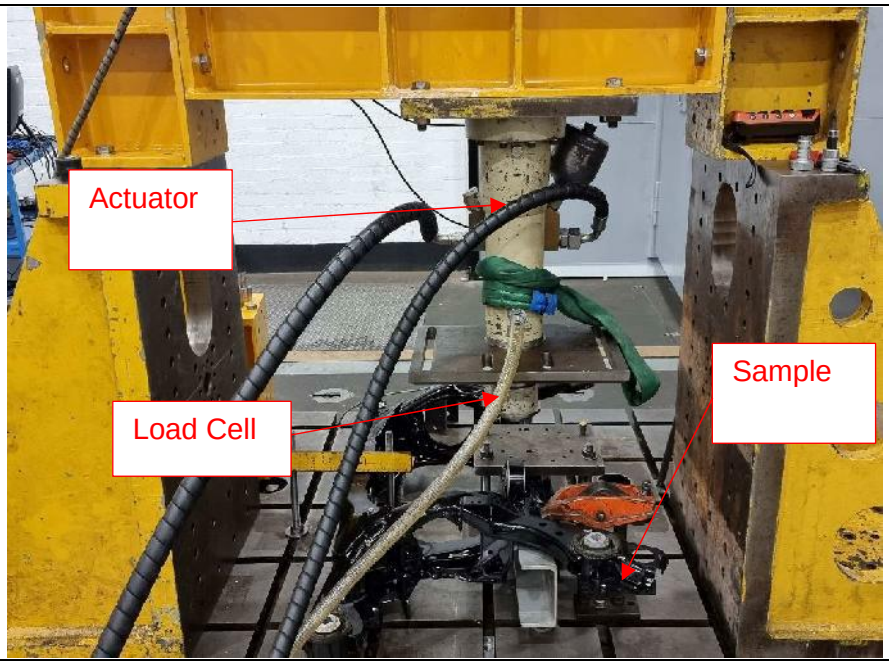
Subframe Type	Bush Name	Stiffness (N/mm)
New	3B	519.5
Used	1A	462.6
Used	1B	505.5
Used	1C	501.2
Used	1D	516.4

4. Test Method

4.1. Testing required five bushes (four on a used subframe and one on a new subframe) to be subjected to a load input of approximately ±10kN at an input rate of 12mm/min in order to obtain a corresponding stiffness value.

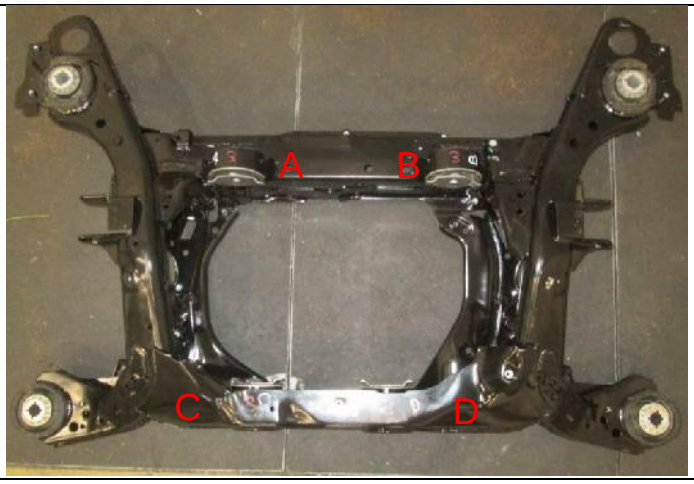
4.2. To apply this load a servo-hydraulic actuator, in displacement control was used to output a ramped input signal. The actuator was suspended directly above the sample as shown in Figure 1. The sample was clamped down to the bedplate to prevent any frame movement during the test. A load cell was used to return load feedback from the bush during the cycle.

Figure 1 - Rig Setup



4.3. The bushes were named with the convention shown in Figure 2. The used bush was labelled as subframe 1 and the new subframe was labelled as 3.

Figure 2 - Bush Naming Convention



4.4. The load was applied to the centre of the bush using a clevis and stepped shaft arrangement. This set up is shown in Figure 3 for A and B tests and Figure 4 for C and D.

Figure 3 - A and B Bush Load Application

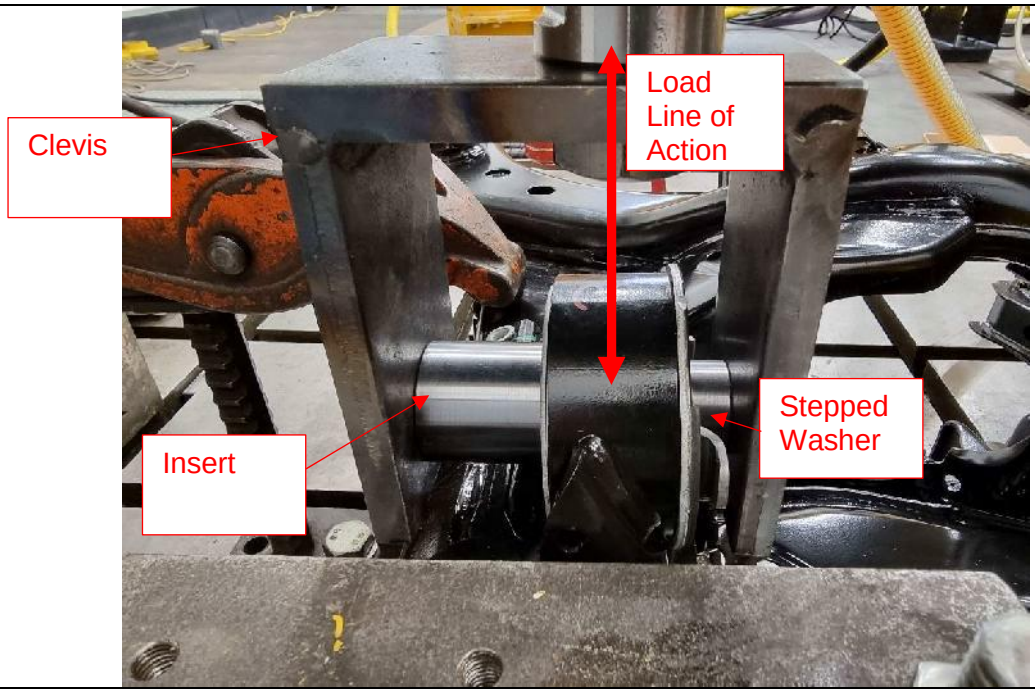
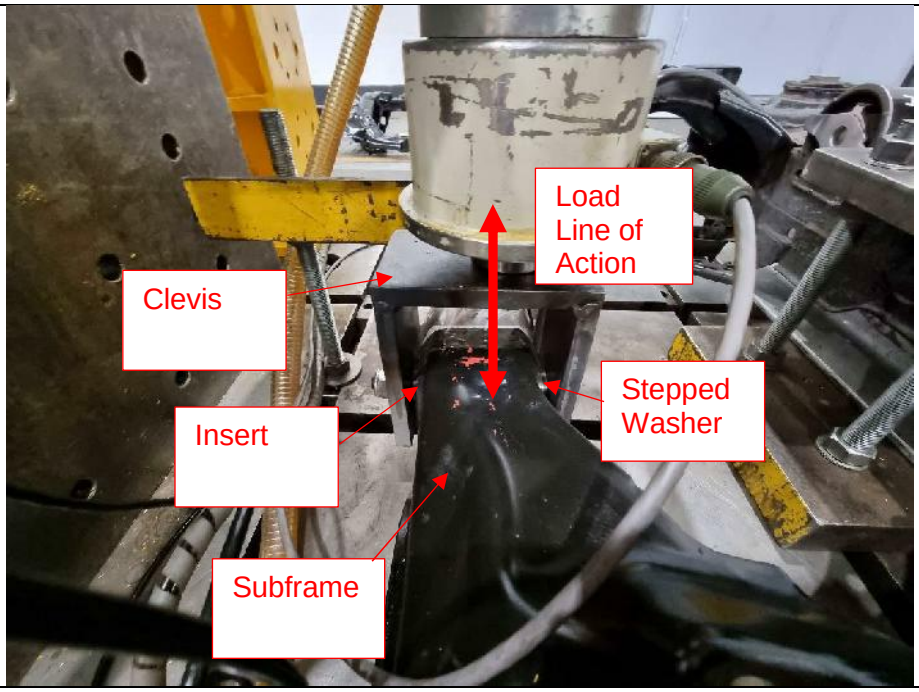


Figure 4 - C and D Bush Load Application



5. Results

5.1. To obtain the stiffness of the bush, a gradient for the load vs displacement graph was needed. A section was taken from -3mm to 3mm for all bushes to obtain the stiffness value in the elastic region of the mount.

5.2. The new subframe was tested and produced the following Load vs Displacement graph in Figure 5. The load and displacement data beyond the bounds of the elastic region were then removed to produce the Load vs Displacement graph in Figure 6. A trendline was formed from the data and the gradient of this line was the stiffness of the bush.

5.3. This process was used for the bushes on subframe 1. The Load vs Displacement and truncated stiffness graphs for those bushed are shown in Figures 7-14 with a direct comparison to subframe 3.

5.4. Post-test, the subframe bushes were inspected for cracks in the rubber. The results of those bush inspections are available in Appendix A.

Figure 5 - 3B (Load vs Displacement)

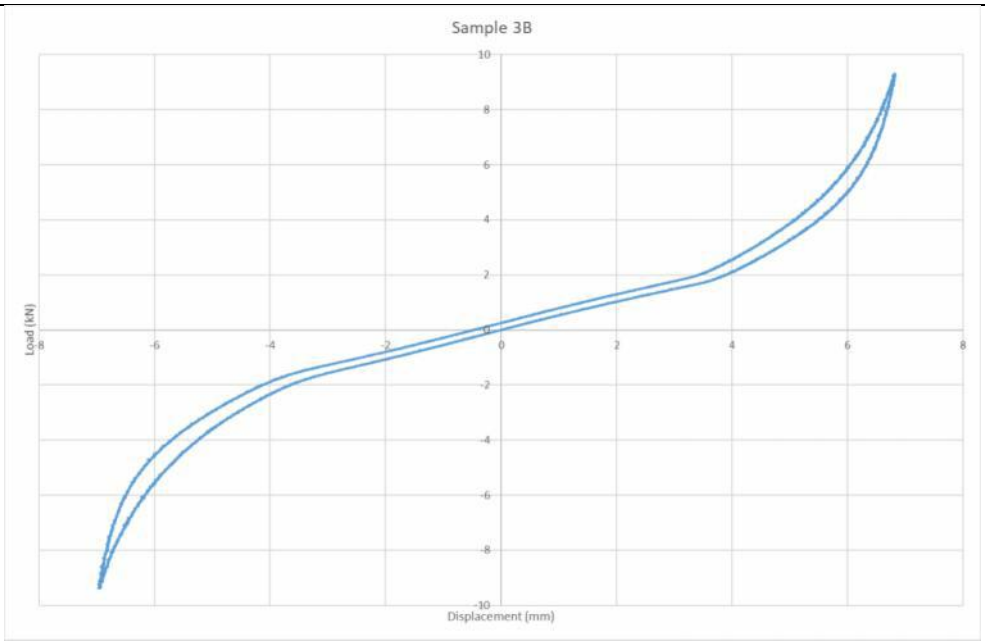


Figure 6 - 3B Filtered Data (Load vs Displacement, -3mm to 3mm)

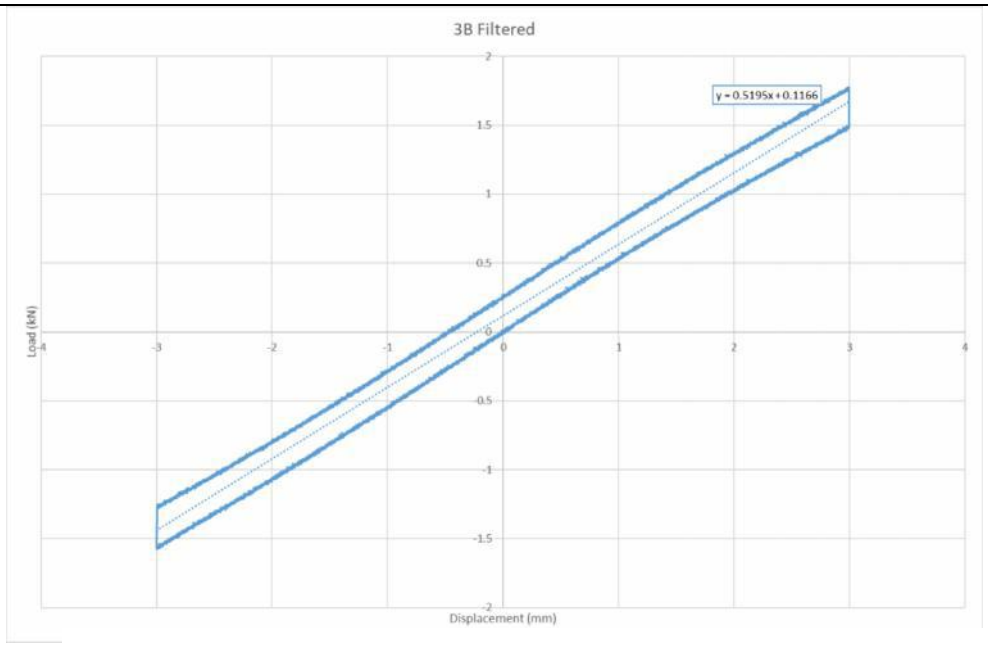


Figure 7 - 1A vs 3B (Load vs Displacement)

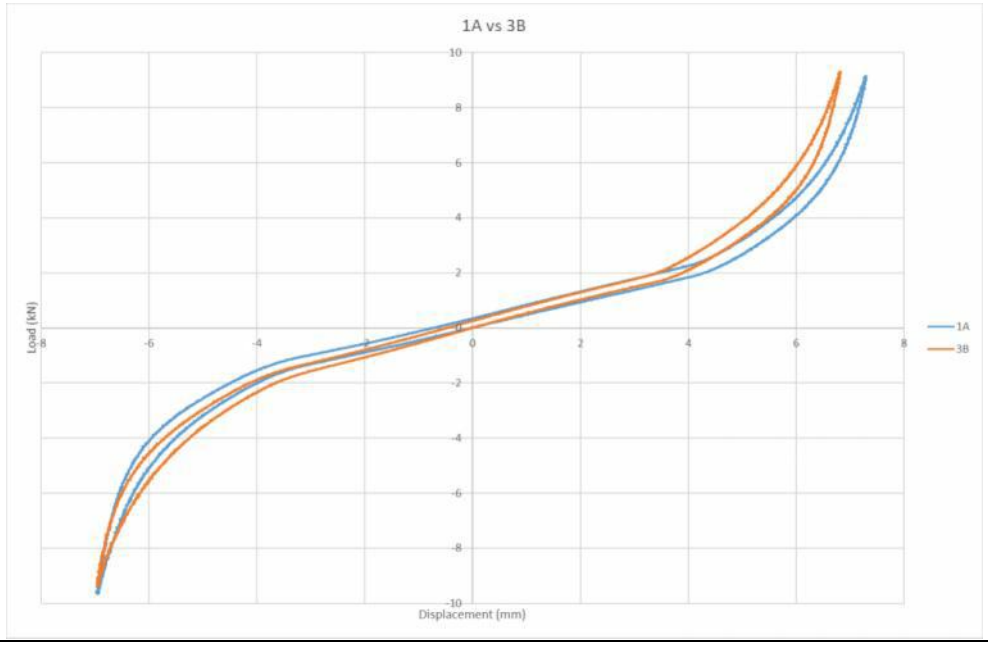


Figure 8 – 1A vs 3B (Load vs Displacement, -3mm to 3mm)

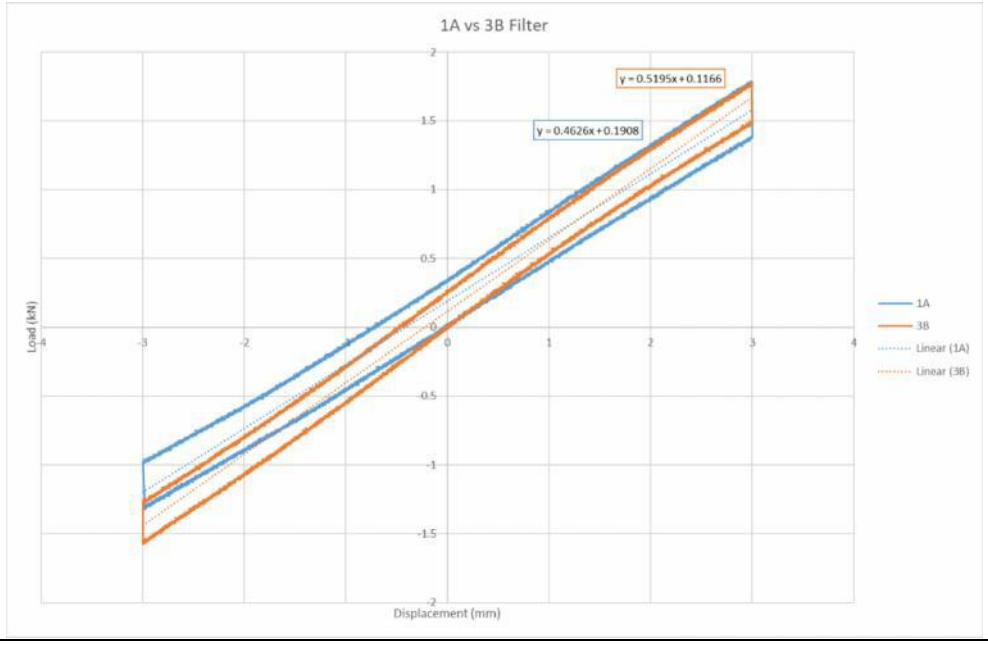


Figure 9 - 1B vs 3B (Load vs Displacement)

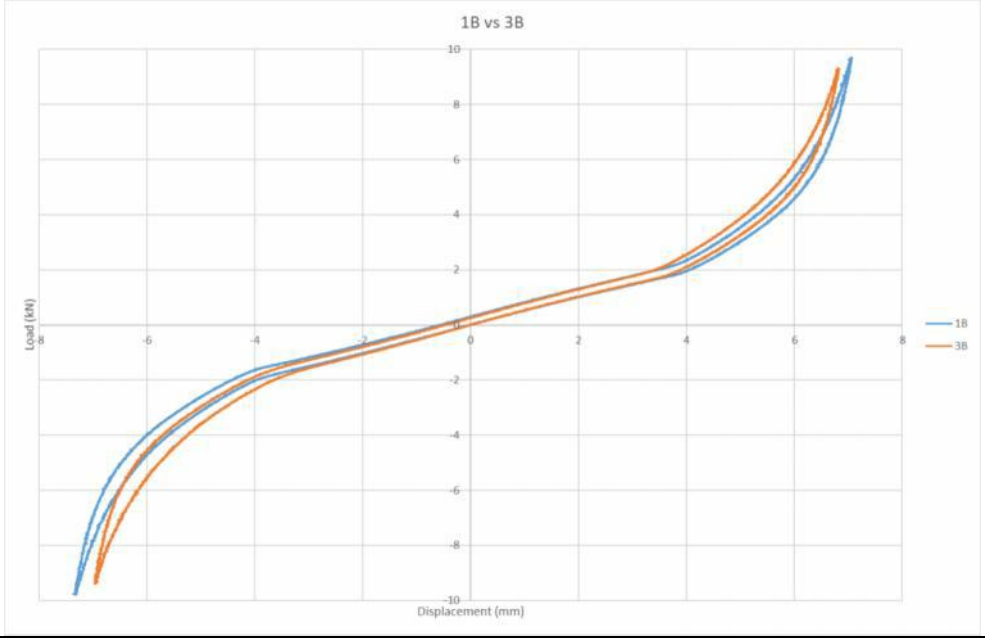


Figure 10 - 1B vs 3B (Load vs Displacement, -3mm to 3mm)

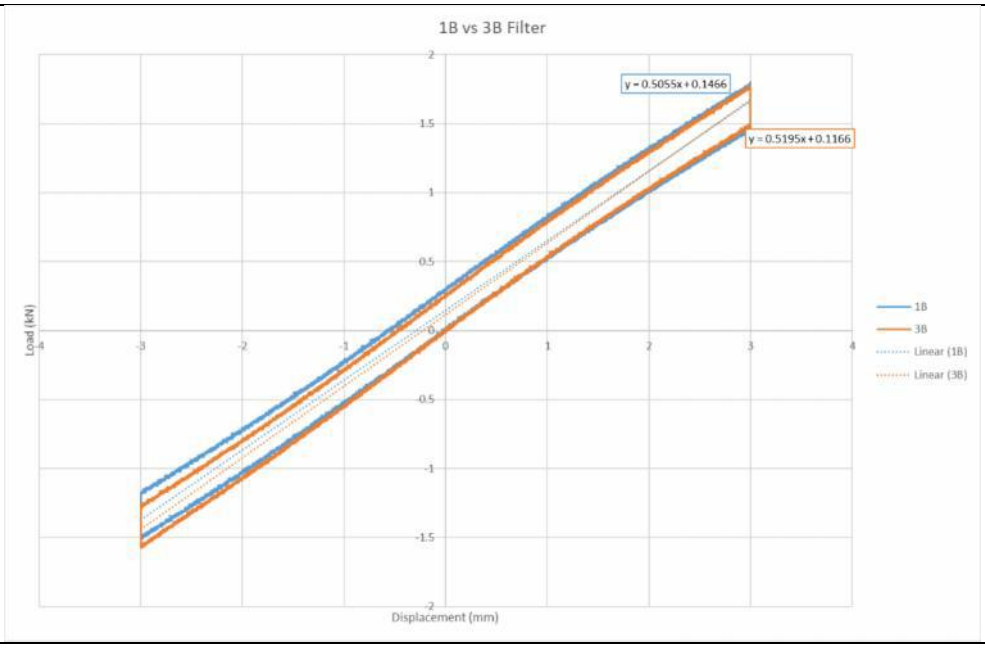


Figure 11 - 1C vs 3B (Load vs Displacement)

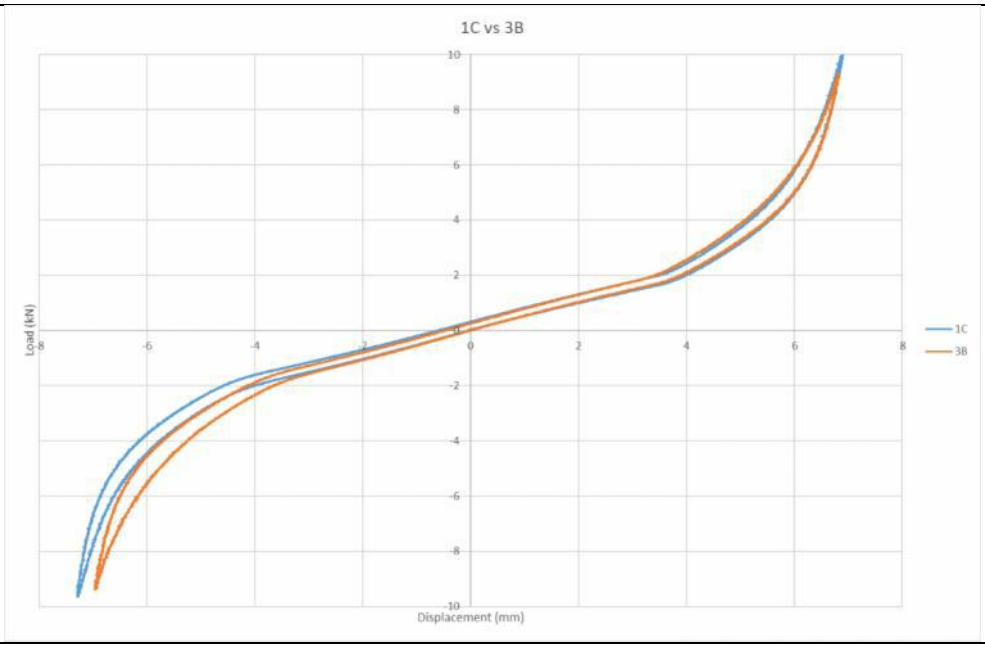


Figure 12 - 1C vs 3B (Load vs Displacement, -3mm to 3mm)

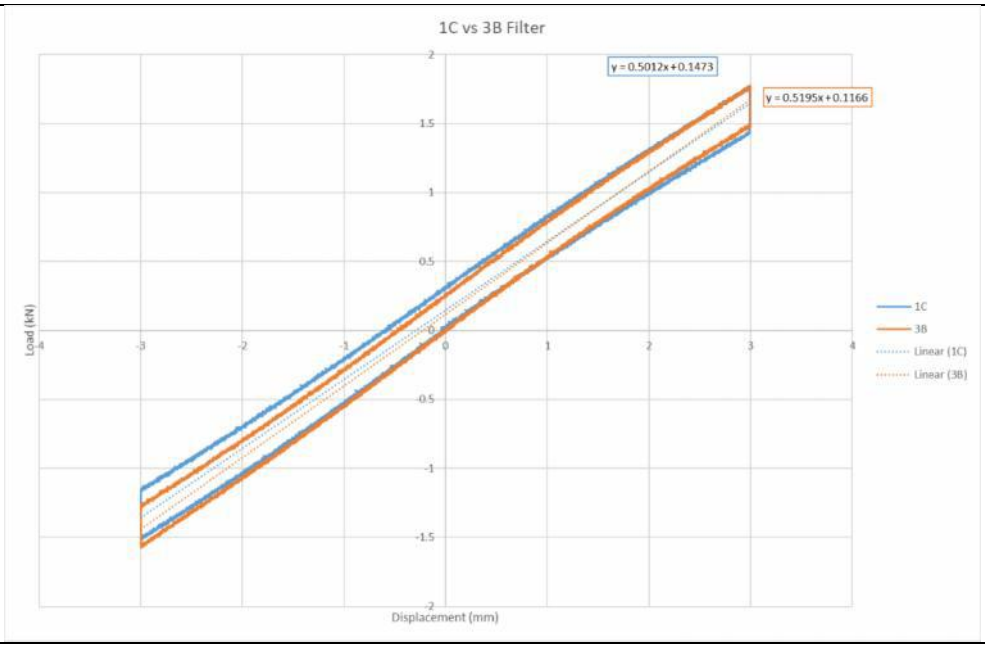


Figure 13 - 1D vs 3B (Load vs Displacement)

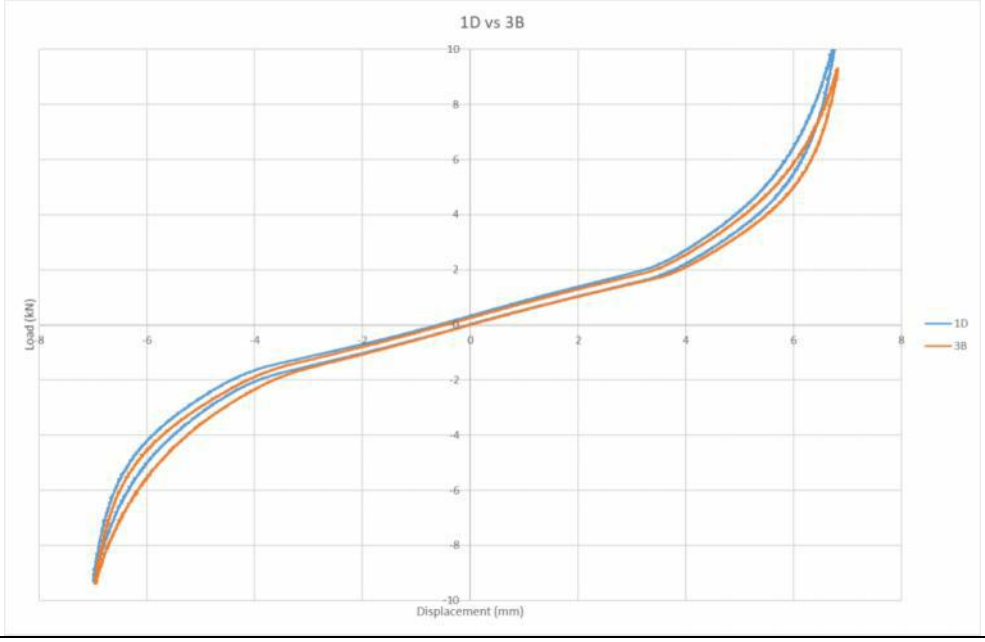
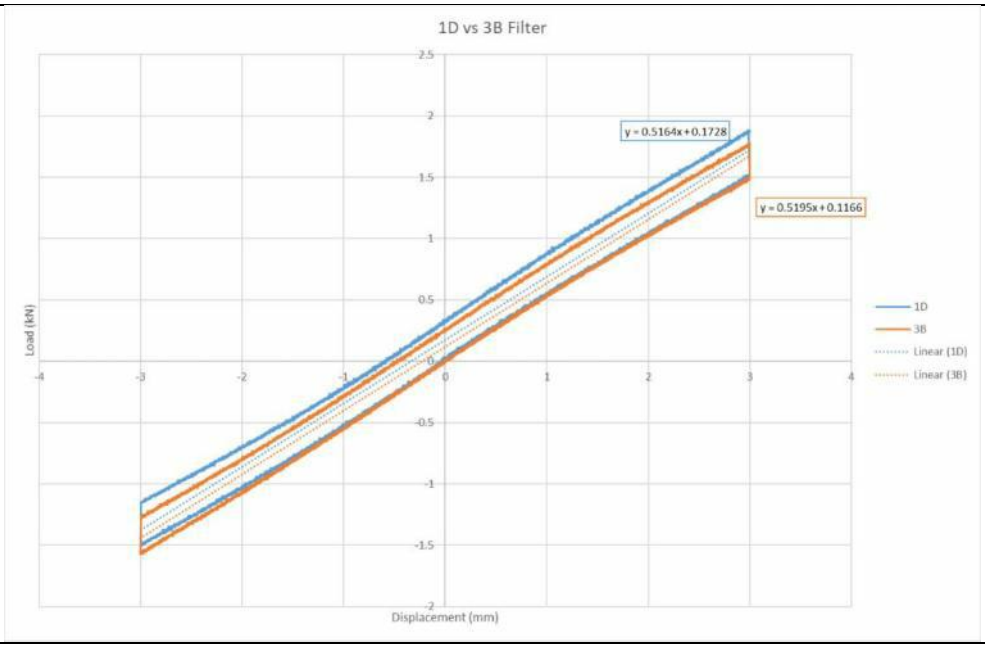


Figure 14 - 1D vs 3B (Load vs Displacement, -3mm to 3mm)



5.5. The stiffness of the tested bushes are shown in Table 2.

Table 2 - Bush Stiffness

Bush Name	Stiffness (N/mm)
3B	519.5
1A	462.6
1B	505.5
1C	501.2
1D	516.4

6. Discussion of Results

6.1. The stiffness of the 4 bushes on the used subframe and the bush on the new subframe were within the new production part stiffness specification of 500N/mm ± 10%. This criteria was specified by Boge, the bush manufacturer.

6.2. The older subframe bushes exhibited rubber cracks during post-test inspections. The same cracks were not visible on the new subframe bush.

7. Test Equipment

7.1. Test equipment shown in Table 3.

Table 3 - Test Equipment Used

Item	Stock Number	Calibration Due Date
Data Logger	MDS014	23/08/22
25kN Rated Schenck Load Cell	LDC048	07/09/22
25kN Schenck Actuator	TRD194	26/07/22
Zwick K7500 Controller	CON124	26/07/22

8. Test Period

Table 4 - Key Phases

Key Phases	Date
Parts Arrival	02/03/22
Rig Design Approval	15/03/22
Test Start	16/03/22
Test Completion	17/03/22

Appendix A – Subframe Bush Crack Inspection

Figure 15 – 1A Bush Investigation

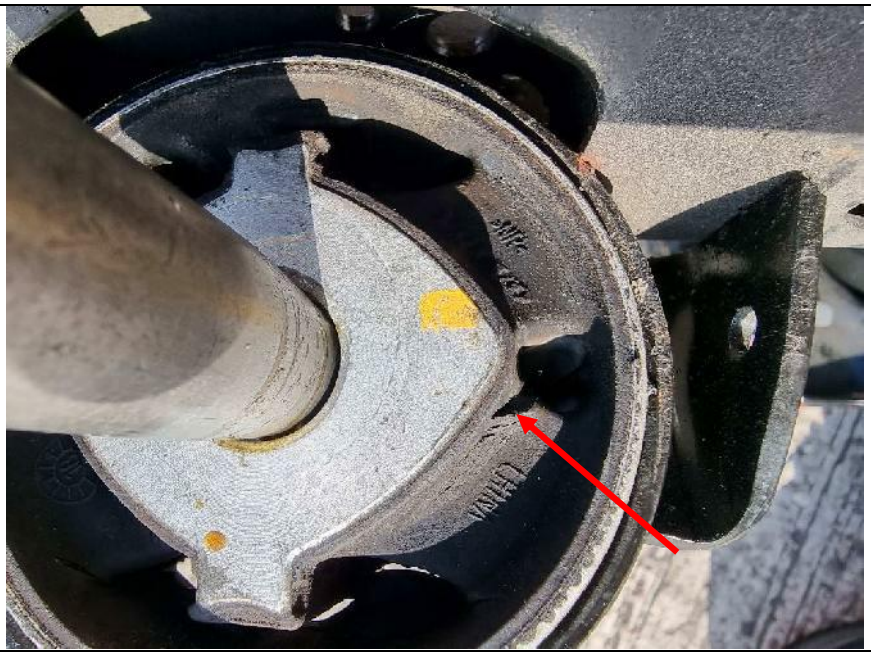


Figure 16 – 1A Bush Investigation

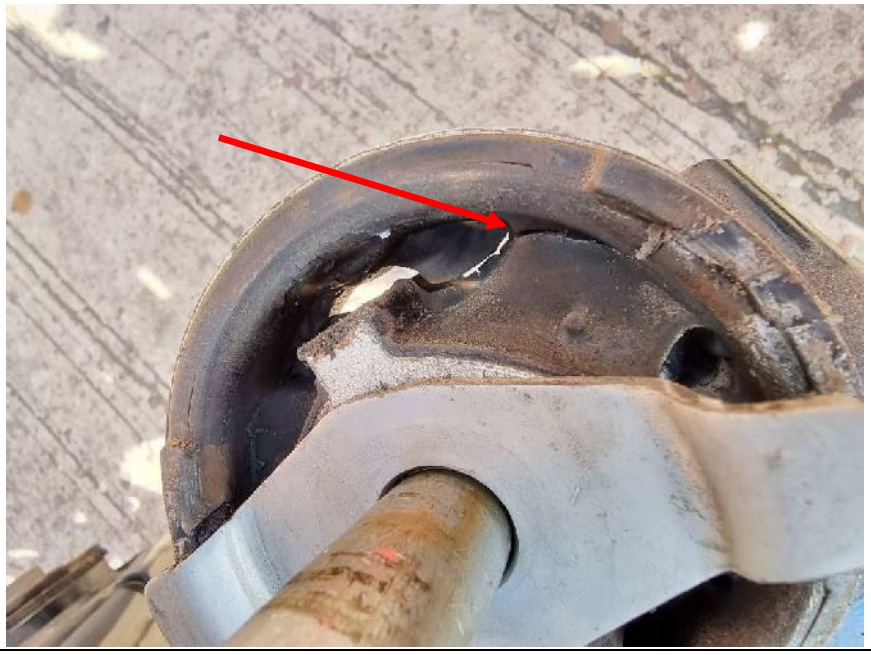


Figure 17 – 1B Bush Investigation

Figure 18 – 1B Bush Investigation

Figure 19 – 1C Bush Investigation

Figure 20 – 1C Bush Investigation

Figure 21 – 1D Bush Investigation

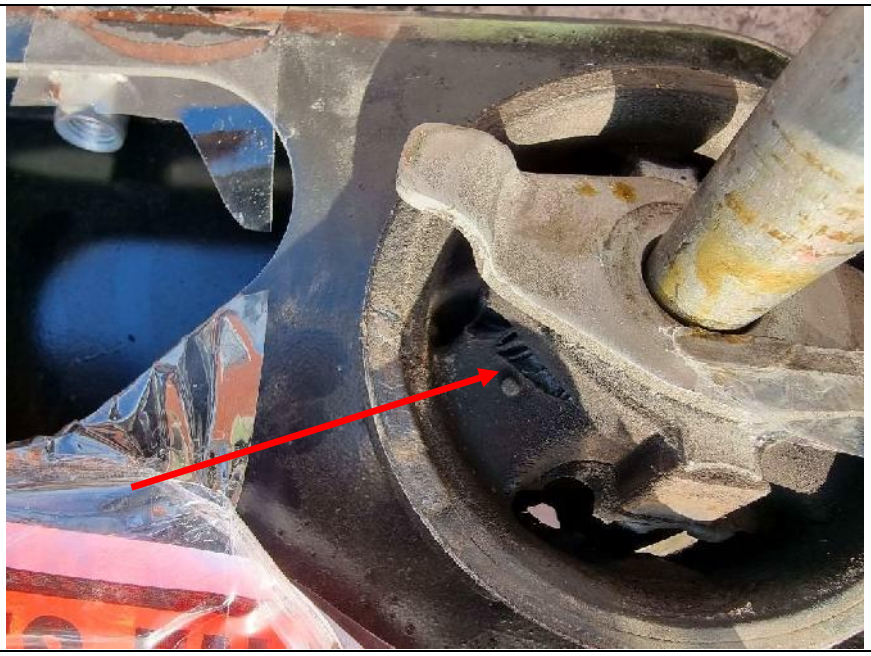


Figure 22 - 1D Bush Investigation

Figure 23 - 3B Bush Investigation

Figure 24 - 3B Bush Investigation

---------- END OF TEST REPORT ----------

Customer Satisfaction

In order to ensure that the service that we provide is of the standard required by our customers, we welcome any feedback on the testing or calibration services provided.

Should you wish to make any comments or provide feedback and improvements, please do not hesitate to contact the Operations Director, [redacted] ([redacted]@[redacted].com) or your sales contact.

Your answers will be treated in the strictest confidence.

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