Effect of different types of fillers on properties of natural rubber latex foam

G.T. Krunarathna, N. S. Withanage
Faculty of Animal Science and Export Agriculture, Uva Wellassa University of Sri Lanka

and

D.G. Edirisinghe
Rubber Research Institute, Rathmalana, Sri Lanka

Introduction

Natural Rubber Latex Foam (NRLF) is a cellular rubber, which is made directly from centrifuged latex with 60 % dry rubber content and it gives a cushioning effect for a wide range of applications such as mattresses, pillows, cushions, upholstery, carpet backing and shoe arches. If there is a possibility of replacing a certain amount of natural rubber latex in these products, while maintaining the expected physico mechanical properties by incorporating another low cost material (filler), it would reduce the cost of production. Therefore a study was conducted to develop different natural rubber latex foam by incorporating five types of commercially available mineral fillers in five different loading levels. Fillers can stiffen the rubber phase of the foam. Therefore comparable load bearing characteristics can be obtained at higher expansion with the incorporation of filler (Blackley, 1966). There by material cost can be decrease.

Methodology

Samples were prepared by incorporation of talc, dolomite, calcite, 50:50 blend of dolomite and calcite and china clay as filler materials. Each of these fillers was incorporated in NR latex foam at 5 phr, 10 phr, 15 phr, 20 phr and 25 phr loading levels.Latex foam was prepared using a batch technique. The foam preparation was carried out in a Hobart type planetary mixer.
To develop twenty five different foams all of these were replicated three times and they were arranged in Complete Random Design. Indentation hardness index, compression set, tensile strength and density properties of the test samples were compared against the reference sample which was prepared without incorporating fillers.

Results and discussion

Hardness of the compound increases with the increase of calcium carbonate filler loading up to 20 phr and it decreases beyond this filler loading. The increase in hardness may be due to fillers acting as hardening agents in rubber compounds and uniform filler distribution in the rubber phase. At higher filler loadings beyond 20 phr, the decrease in hardness is probably a result of aggregation of calcium carbonate.

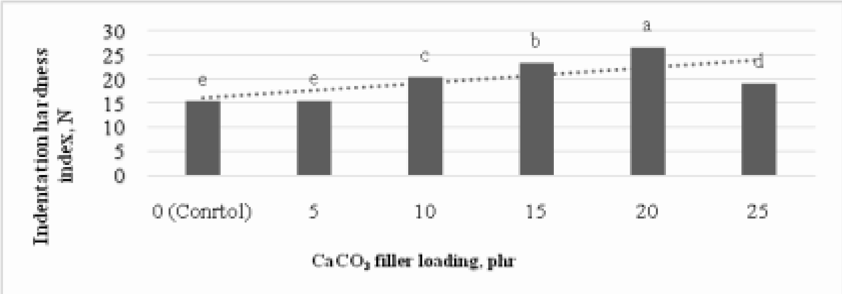

Figure 01. Variation of Hardness of NRLF with $CaCO_3$ Filler Loading Levels

Increasing the filler loading in foam compound simultaneously increases the mass of the compound, while having an equal volume. Therefore, density of the compound is increased along with the calcium carbonate loading.

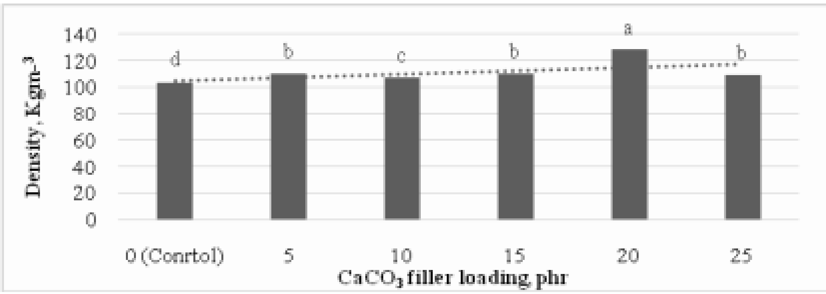

Figure 02. Variation of Density of NRLF with $CaCO_3$ Filler Loading Levels

The gum compound shows the lowest compression set due to better recovery after the force on the test piece is released and can be attributed to more rubbery nature of the compound. However, addition of filler causes to reduce the rubbery nature of the compound. Therefore, filler loaded compounds show a lower recovery after the force on the test piece is removed.(Ramasamy *et al.*, 2013)

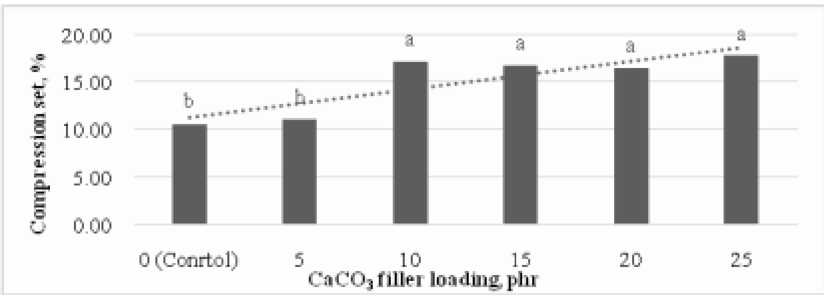

Figure 03. Variation of Compression set of NRLF with $CaCO_3$ Filler Loading Levels

Calcium carbonate, which is known to be a non-reinforcing(particle size more than 5000 nm)filler. Therefore calcium carbonate has poor dispersion in the rubber matrix. Therefore, the reinforcement given by calcium carbonate to the compound is less, which eventually results in low tensile strength.

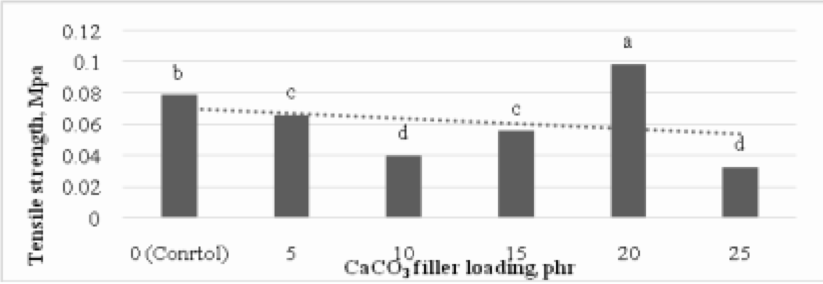

Figure 04. Variation of Tensile Strength of NRLF with $CaCO_3$ Filler Loading Levels

Testedphysico mechanical properties of all fillers which are comparable with the reference are summarized in Table no 01.

Table 01. Tested Physico Mechanical Properties of all Fillers against Control

	Hardness (N)	Density (kgm^{-3})	Compression set (%)	Tensile strength (Mpa)
Reference (control)	15.3	103.3	10.60	0.079
Calcite - 5 phr	15.5		11.10	
Talc - 10 phr	15	102.9		0.055
Dolomite - 10 phr	11.9			0.079
Calcite + Dolomite 5 phr	15.4		12.36	0.084
China Clay 20 phr			12.00	0.085

Conclusions

The compression set and the indentation hardness index of foam which contains 5 phr of calcite was comparable with those of the reference foam made without any filler. Density, tensile strength and indentation harness index of the foam which was loaded with 10 phr of talc was comparable with those of the reference foam. Moreover, the tensile strength and indentation hardness index of the foam which was loaded with 10 phr of dolomite was comparable with those of the reference foam. Further, hardness, compression set and indentation hardness index of the foam which contain 5 phr of 50:50 blend of dolomite and calcitewas comparable with those of the reference, whilst the foam containing 20 phr of china clay exhibited similar compression set and tensile strength to those of the reference foam. Also the results indicate that, upto 20 phr filler loading level, most of the required properties could be maintained in all filler types.

References

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