# Innovative Fiber Reinforced Elastomeric Isolation Devices

**Pablo Castillo, Andreas Pürgstaller, Eftychia Apostolidi, Konrad Bergmeister, Alfred Strauss**

*University of Natural Recourses and Life Sciences, Vienna, Austria*

**Contact:** eftychia.apostolidi@boku.ac.at

## Abstract

In the last years fiber reinforced elastomeric bearings (FREBs) acting as isolation devices have begun to replace bearings with steel reinforcement. To understand the behaviour of FREBs under seismic loads it is essential to investigate their relevant mechanical properties, effective shear modulus and equivalent damping ratio. The experimental investigation yielded some discrepancies between collected data and expected behaviour of the bearings. In order to investigate that disagreement, a numerical simulation approach focusing on capturing the visco-hyperelastic behaviour of the elastomeric material has been investigated. In addition, a method for the calibration of the material model is presented and validated. Moreover, the influence of vertical load, horizontal deflection, number of elastomeric and reinforcement layers and support type on the mechanical properties will be discussed.

**Keywords:** fiber reinforced elastomeric bearings, laminated rubber bearings, seismic isolation, nonlinear numerical model.

## 1 Introduction

Seismic isolation devices and in particular elastomeric bearings were widely used in the past in bridge engineering, with a further use extension in damping of vibrations induced in buildings. Elastomeric bearings consist mainly of alternating rubber and steel layers, bonded together through vulcanisation. In the most recent experimental and theoretical studies there is a tendency towards the development of fibre reinforced elastomeric bearings (FREBs). Carbon or glass fibre reinforcement leads to much lighter bearings and it generally facilitates the production, as large sheets can be manufactured and then cut to the size of interest, thus reducing also the manufacturing cost. This reduction would enable the use of basis seismic isolation systems in applications where currently they are not cost-efficient. [1], [2]. Among the advantages of elastomeric bearings is to sustain very high vertical loads with a simultaneous flexibility in the horizontal direction, a fact that enables the structure to perform large lateral deformations caused by strong ground motions [3].

A further novelty lately introduced in the production of elastomeric bearings is the discarding of the thick steel end plates, used so far for fixing the bearing to the structure. The resulting elastomeric bearings, called unfixed bearings, show unique behaviour when high horizontal displacements are imposed to the system. This behaviour is developed in two phases: a) First the rollover deformation is observed and occurs when the upper and lower contact layers of the isolator are detached from the supports of the structural system, increasing the energy dissipation capacity of the isolator. b) For even higher lateral displacements, a so called stable rollover deformation occurs, leading to the overall increase of the isolator's horizontal stiffness [4], [5]. Stable rollover deformation can



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