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基于分数阶导数的磁流变弹性体参数模型

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THE PARAMETER MODEL OF MAGNETORHEOLOGICAL ELASTOMERS BASED ON FRACTIONAL DERIVATIVE

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摘要

磁流变弹性体宏观力学行为是基体粘弹性和磁致模量变化的综合反映,建立能够准确模拟其力学特性的参数模型是设计磁流变弹性体装置所必需的。因此,该文利用建立粘弹性材料参数模型的VFD(粘弹性分数阶导数)元件及弹簧元件与表述磁致效应的非线性弹簧元件,建立了磁流变弹性体的磁致粘弹性参数模型,分析了频率、磁场强度和分数阶数对该模型动态性能的影响,结果表明该模型能够反映磁流变弹性体磁致效应对其力学性能的影响,且该模型仅需少量参数就能在较宽频率范围内更好地模拟真实的试验性能。

关键词: 磁流变弹性体 参数模型 磁致效应 VFD元件 磁致模量

Abstract:

The macro-mechanical behavior of magnetorheological elastomers is the comprehensive reflection of both the matrix viscoelastic and the change of magnetic modulus. It is necessary to establish the parameter model for designing magnetorheological elastomers devices, which can accurately simulate the mechanical properties. In the paper, the magnetic viscoelastic parameter model of magnetorheological elastomers is established using the VFD (Viscoelastic Fractional Derivative) element, spring element and the nonlinear spring element related to the magnetic effect. Then, the effects of frequency, magnetic field strength and the influence of fractional order to the dynamic properties of the model are analyzed. The results show that the model can reflect the magnetic effect of the magnetorheological elastomers on the mechanical properties, and only a few parameters will be able to simulate the true experimental properties successfully within a wide frequency range.

Key words: magnetorheological elastomers parameter model magnetic-induced effect VFD element magnetic-induced modulus

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[1]

[1] Jolly M R, Carlson J D. The magnetoviscoelastic response of elastomer composites consisting of ferrous particles embedded in a polymer matrix [J]. Journal of Intelligent Material Systems and Structures, 1996, 7: 613－622.

[2]

[2] Davis L C. Model of magnetorheological elastomers [J]. Journal of Applied Physics, 1999, 85(6): 3348－3351.

[3]

[3] Shen Y, Golnaraghi M F, Heppler G R. Experimental research and modeling of magnetorheological elastomers [J]. Journal of Intelligent Material Systems and Structures, 2004, 15: 27－35.

[4]

[4] 李卓, 徐秉业. 粘弹性分数阶导数模型的等效粘性阻尼系统[J]. 清华大学学报(自然科学版), 2000, 40(11): 27－29. Li Zhuo, Xu Bingye. Equivalent viscous damping system for viscoelastic fractional derivative model [J]. Journal of Tsinghua University (Science and Technology), 2000, 40(11): 27－29. (in Chinese)

[5]

[5] Meral F C, Royston T J, Magin R. Fractional calculus in viscoelasticity: An experimental study [J]. Commun Nonlinear Sci Numer Simulat, 2010(15): 939－945.

[6]

[6] Rand R H, Sah S M, Suchorsky M K. Fractional Mathieu equation [J]. Commun Nonlinear Sci Numer Simulat, (2009), doi: 10.1016/j.cnsns. 2009. 12. 009.

[7]

[7] Adolfsson K, Enelund M, Larsson S. Adaptive discretization of fractional order viscoelasticity using sparse time history [J]. Computer methods in applied mechanics and Engineering, 2004(193): 4567－4590.

[8]

[8] 孙海忠, 张卫. 分数算子描述的粘弹性材料的本构关系研究[J]. 材料科学与工程学报, 2006, 24(6): 926－930. Sun Haizhong, Zhang Wei. Study on constitutive relation of viscoelastic material described by fractional operator [J]. Journal of Material Science & Engineering, 2006, 24(6): 926－930. (in Chinese)

[9]

[9] 沃德 I M. 固体高聚物的力学性能[M]. 徐懋, 漆宗能, 等, 译. 北京: 科学技术出版社, 1988. Ward I M. Mechanical properties of solid polymers [M]. Translated by Xu Mao, Qi Zongneng, et al. Beijing: Science and Technology Press, 1988. (in Chinese)

[10]

[10] 张先舟. 磁流变弹性体的研制及其机理研究[D]. 安徽:中国科学技术大学, 2005. Zhang Xianzhou. The study on preparation and mechanism of magnetorheological elastomers [D]. Anhui: University of Science and Technology, 2005. (in Chinese)

[11]

[11] 余淼, 严小锐, 夏永强. 基于链化模型的磁流变弹性体磁致效应影响因素分析[J]. 功能材料, 2009, 40(8): 1263－1266. Yu Miao, Yan Xiaorui, Xia Yongqiang. Analysis on influencing factors of MR elastomer magneto-induced effect based on chain-like model [J]. Journal of Functional Materials, 2009, 40(8): 1263－1266. (in Chinese)

[1] 汪 强;王进廷;金 峰;张楚汉. 结构-地基动力相互作用的实时耦联动力试验[J]. , 2011, 28(2): 94-100,.

[2] 刘志久;徐 建;尚守平;王贻荪. 任意形状埋置基础滑移振动复合集总参数模型[J]. , 2010, 27(12): 174-178,.

[3] 范让林;吕振华;刘 立;朱茂桃. 液阻悬置节流盘的作用机理[J]. , 2009, 26(3): 229-234.

[4] 杜修力;赵 密. 基础频响有理近似的稳定性和识别：连续时间的集中参数模型[J]. , 2009, 26(12): 76-084,.

[5] 刘志久;尚守平;徐 建;王贻荪. 任意形状基础滑移振动复合集总参数模型[J]. 工程力学, 2007, 24(12): 0-075,.

[6] 马怀发;陈厚群;周永发;黎保琨. 大坝混凝土试件三维细观力学并行计算研究[J]. 工程力学, 2007, 24(10): 0-079.

[7] 侯兴民;廖振鹏;黄浩华. 动力基础频域响应分析[J]. , 2003, 20(4): 122-127.

[8] 刘平;李琪. 基底隔震建筑的剪切梁动力模型[J]. , 1998, 15(3): 90-97.

[9] 王元汉;刘琼. 双参数弹性地基板的边界配置法[J]. , 1996, 13(3): 69-77.

[10] 王海 刘伟庆 王曙光 杜东升 李昌平. 基于Chebyshev复多项分式的地基集总参数模型研究[J]. 工程力学, 0, (): 0-0.

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