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**Multiple joined prestressed orthotropic layers under large strains.** (English) Zbl 1423.74134  
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Summary: A compressible orthotropic nonlinear elastic material model is developed, for which a number of exact analytical solutions are possible for large deformations. The exact solution for the problem of bending of the compound beam with prestrained layers is obtained for large deformations using this model of elastic materials. The solution is obtained using the theory of superposition of large strains. Numerical results are shown. The nonlinear effects and the effects of anisotropy are investigated.

**MSC:**

74B20 Nonlinear elasticity

**Keywords:**

nonlinear elasticity; superposition of large strains; bending of multilayer beam; compressible orthotropic materials; exact solution; preliminarily strained layers

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**References:**

- [1] Ahamed, T.; Dorfmann, L.; Ogden, R. W., Modelling of residually stressed materials with application to AAA, *Journal of the Mechanical Behavior of Biomedical Materials*, 61, 221-234, (2016)
- [2] Dai, K.; Shaw, L., Finite-element analysis of effects of the laser-processed biomaterial component size on stresses and distortion, *Metallurgical and Materials Transactions A*, 34, 1133-1145, (2003)
- [3] De Pascalis, R., The semi-inverse method in solid mechanics: Theoretical underpinnings and novel applications, (2010), Universit'e Pierre et Marie Curie and Universit'a del Salento Paris, Salento
- [4] (Fu, Y. B.; Ogden, R. W., (2001))
- [5] Green, A. E.; Adkins, J. E., Large elastic deformations and non-linear continuum mechanics, (1960), Clarendon Press Oxford · [Zbl 0090.17501](#)
- [6] Jiang, Y.; Wang, Q., Highly-stretchable 3d-architected mechanical metamaterials, *Scientific Reports*, 6, 34147, (2016)
- [7] John, F., Plane elastic waves of finite amplitude. Hadamard materials and harmonic materials, *Communication on Pure and Applied Mathematics*, 19, 309-341, (1966) · [Zbl 0139.43401](#)
- [8] Johnson, B. E.; Hoger, A., The use of a virtual configuration in formulating constitutive equations for residually stressed elastic materials, *Journal of Elasticity*, 41, 177-215, (1995) · [Zbl 0857.73007](#)
- [9] Karpenko, V. S.; Vershinin, A. V.; Levin, V. A.; Zingerman, K. M., Some results of mesh convergence estimation for the spectral element method of different orders in FIDESYS industrial package, *IOP Conference Series: Materials Science and Engineering*, 158, 1, 012049, (2016)
- [10] Lekhnitskii, S. G., Theory of elasticity of an anisotropic elastic body (holden-Day series in mathematical physics), (1963), N.Y., Holden-Day
- [11] Levin, V. A., Theory of repeated superposition of large deformations: elastic and viscoelastic bodies, *International Journal of Solids and Structures*, 35, 2585-2600, (1998) · [Zbl 0918.73026](#)
- [12] Levin, V. A.; Taras'ev, G. S., One variant of the model of a viscoelastic body at large deformations, *Soviet Applied Mechanics*, 19, 7, 615-618, (1983) · [Zbl 0539.73041](#)
- [13] Levin, V. A.; Zubov, L. M.; Zingerman, K. M., An exact solution for the problem of flexure of a composite beam with preliminarily strained layers under large strains, *International Journal of Solids and Structures*, 67-68, 244-249, (2015)
- [14] Levin, V. A.; Zubov, L. M.; Zingerman, K. M., An exact solution for the problem of flexure of a composite beam with preliminarily strained layers under large strains. part 2. solution for different types of incompressible materials, *International Journal of Solids and Structures*, 100-101, 558-565, (2016)
- [15] Lin, W. J.; Iafrazi, M. D.; Peattie, R. A.; Dorfmann, L., Growth and remodeling with application to abdominal aortic aneurysms, *Journal of Engineering Mathematics*, 109, 113-137, (2018) · [Zbl 1408.74038](#)
- [16] Lurie, A. I., Nonlinear theory of elasticity, (1990), North-Holland Amsterdam · [Zbl 0715.73017](#)
- [17] Mitsuhashi, K.; Ghosh, S.; Koibuchi, H., Mathematical modeling and simulations for large-strain j-shaped diagrams of soft biological materials, *Polymers*, 10, 715, (2018)

- [18] Ogden, R. W., Non-linear elastic deformations, (1984), Ellis Horwood Limited Chichester · [Zbl 0541.73044](#)
- [19] Pierson, H. O., Handbook of chemical vapor deposition, (1999), Noyes Publications New York
- [20] Popovich, A. A.; Sufiarov, V. S.; Borisov, E. V.; Polozov, I. A.; Masaylo, D. V.; Grigoriev, A. V., Anisotropy of mechanical properties of products manufactured using selective laser melting of powdered materials, Russian Journal of Non-Ferrous Metals, 58, 4, 389-395, (2017)
- [21] Rausch, M. K.; Kuhl, E., On the effect of prestrain and residual stress in thin biological membranes, Journal of the Mechanics and Physics of Solids, 61, 1955-1969, (2013)
- [22] Rivlin, R. S., Large elastic deformations of isotropic materials. V. the problem of flexure, Proceedings of the Royal Society of London A, 195, 463-473, (1949) · [Zbl 0036.24901](#)
- [23] Rivlin, R. S., Large elastic deformations of isotropic materials. VI. further results in the theory of torsion, shear, and flexure, Philosophical Transactions of the Royal Society London A, 242, 173-195, (1949) · [Zbl 0035.41503](#)
- [24] Rodriguez, E. K.; Hoger, A.; McCulloch, A. D., Stress-dependent finite growth in soft elastic tissues, Journal of Biomechanics, 27, 4, 455-467, (1994)
- [25] Truby, R. L.; Lewis, J. A., Printing soft matter in three dimensions, Nature, 540, 371-378, (2016)
- [26] Truesdell, C., A first course in rational continuum mechanics, (1972), Baltimore, Maryland
- [27] Ungor, E. E., Deformations and motions in compressible non-linear elasticity, (2009), Rice University Houston, Texas
- [28] Zubov, L. M., On yaumann derivative for the second-rank tensor. higher education news, Natural sciences, 2, 27-30, (1976), North-Caucasus Scientific Center of Academic Insitution

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