Validation of Our Model for Isotropic Materials

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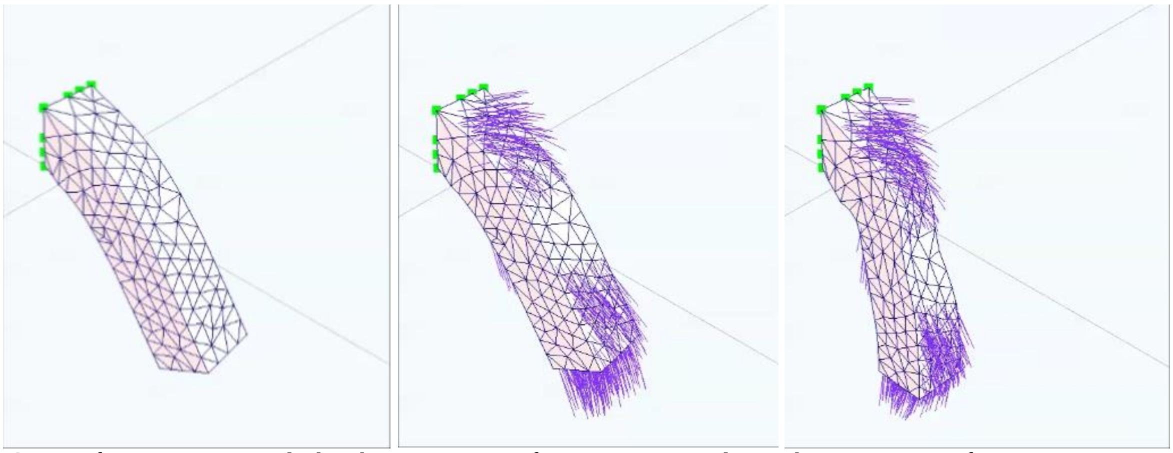
1 Visual Comparison

In this complementary note, we show that isotropic materials can be dealt with as a special case by our *fiber incorporated model*; the same deformation results by the existing *isotropic FEM model* can be reproduced by our model. In Figure 1a, the deformed result of an isotropic rectangular bar under gravity is represented by the tetrahedral mesh computed by the existing CLFEM model. In Figure 1b, the fiber field is generated for the isotropic material by our new model, which reserves the same deformation of the tetrahedral mesh. The same deformation processes can be viewed in the accompanying video, which further validates the correctness of our method.

In contrast, we can redefine the fiber in the same FEM model for an anisotropic material to view its effect. Figure 1c shows the deformed results of a transversely isotropic material under gravity (with smaller stretching resistance along the fiber directions), which clearly illustrate the different fiber field from that in Figure 1b and the different tetrahedral mesh from those in Figures 1a and 1b.



a. CLFEM for isotropic material b. Fiber incorporation for isotropic material c. Fiber incorporation for anisotropic material
Figure 1. **Validation of the correctness of the fiber incorporated models with the existing CLFEM model**

See the accompanying animation video "*Validation Isotropic Material.mp4*" for dynamic comparison.

2 Quantitative Comparison

For isotropic materials, the mechanical response is independent of directions in the material space; thus theoretically, the local frame transformations in our model will not affect its behavior, and should produce exactly the same results, i.e. displacement field $\boldsymbol{u}$. To validate this, we give a quantitative comparison of the two models in Figures 1a and 1b. The bar model in Figure 1a has 311 vertices (1039 elements), with 20 fixed vertices; that is, the degree of freedom is 873. We compare the displacement field $\boldsymbol{u}_1$ and $\boldsymbol{u}_2$ of the two simulations in ***equilibrium*** state, using the square difference formula, $diff := \sum_i \left(u_{1_i} - u_{2_i}\right)^2$. The computed difference is only 3.95795e-012 which can be well ignored in modelling, resulting in the same $\boldsymbol{u}_1$ and $\boldsymbol{u}_2$. Thus, we have quantitatively validated the correctness of our fiber incorporated model for the special case of isotropic material.