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Computational Analysis of Loading Rate Dependent Damage in Biomimetic Layer-by-layer Structures

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Layer-by-layer structures are common in natural. They not only provide robust bonding between different biological units but also serve as shielding for cracks and damages. To learn from nature, researchers endorse layer-by-layer structures for man-made biomedical materials and devices. This study is to explore failure mechanism of layer-by-layer biomimetic structures in light of providing guidance for the design of crack-resistant biomimetic structures. Viscosity induced loading rate effects were incorporated into a non-linear finite element analysis (FEA) framework to assist the in-depth understanding of the evolution of damage in polymeric biomaterials which are reinforced by nano-size inorganic particles. Contact damage is evaluated in both macro- and nano- scales to provide comprehensive understanding upon the failure mechanism of biomimetic structures under contact loading. The computational results are compared and validated with experimental evidence.

Keywords: Biomimetic, layer-by-layer, finite element analysis, loading rate effect, crack-resistant design