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EFFECT OF REINFORCEMENT FIBER LENGTH ON THE MECHANICAL BEHAVIOR OF BIOMIMICKED COMPOSITES

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ABSTRACT

Biomimicked composites have shown to be effective in reducing risk factors associated with the resistance of buildings against earthquakes. A significant amount of work is needed to determine what factors are critical in toughening composites used for homes, office buildings and other human dwellings. The effect of carbon fiber length on the mechanical properties of biomimicked composites was investigated. Composites made of cement, polymer and carbon fiber were fabricated in layers similar to the layering scheme of nacre and tested for toughness to determine the effects of fiber length. Preliminary results show an increase in the the strength of the composites with the fiber length. However, the effect is more pronounced on the increase in the fracture energy showing a linear relationship with the carbon fiber length..

KEYWORDS: Biomimicking, Fracture energy, Dynamic Shear Stress, Deflection, Strength

INTRODUCTION

Affordable housing usually means dwellings that lack many characteristics of expensive buildings including resistance to earthquakes. This is especially true for third world countries, where houses are made from mud and locally available inexpensive materials. Each year many lives are lost across the globe due to earthquakes and other disasters that cause dynamic shear failure of structures. The number of fatalities can be reduced by toughening of materials used in construction of houses and other human dwellings. One simple solution is biomimicking. Nacre, bone and tooth are naturally tough materials made of brittle ceramics and natural polymers. Of these, nacre can be easily mimicked to toughen structural composites. This is achieved by layering brittle construction materials such as concrete, plaster or clay with natural or synthetic polymers such as animal glue. Research has shown that this simple scheme significantly increases the toughness of brittle materials. The smallest improvement in the toughness can help many lives by delaying the collapse of buildings and allowing the inhabitants to exit the buildings during the earthquakes.

While biomimicking is a viable method of toughening of structures, it is not practical with the conventional laborious construction practices. It requires robotic layering of hard and soft phases, in situ. The construction material should be compatible with 3D printing such that the costs can be reduced to a minimum. While concrete lacks tensile strength, reinforcement is needed to make it applicable to construction. Inserting steel rebars in concrete is not compatible with current 3D printing technology, however, use of extrudable carbon fiber is. Incorporation of natural and synthetic fibers in an extrudable paste with a 3D printer allows fabrication of biomimicked housing with desirable resistance against earthquakes. Further, it allows application of new designs such as open and closed cell foam, lattice block, and sandwich structures that lighten up the weight. To develop tough biomimicked