# THE UNIVERSITY OF CONNECTICUT

## Civil & Environmental Engineering

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**Master’s Thesis Defense**

**Department of Civil & Environmental Engineering**

**University of Connecticut**

**10:30 aM – THURSDAY, NOVEMBER 14TH, 2019**

#### IPB 315 B (Innovation Partnership Building- 159 Discovery Dr, Storrs, CT 06269)

***Advisory Committee:***

Prof. Kim Jeongho (Major Advisor)

Prof. Wei Zhang (Associate Advisor)

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**A UNIVERSAL RELATION FOR MIXED-MODE FRACTURE OF DENTAL INTERFACES USING THE BRAZIL-NUT-SANDWICH TEST**

In recent times, there has been an increase in the use of bi-materials in many engineering applications. These bi-materials present the advantage of combining the positive attributes of different materials in a single structure. On the other hand, it raises concerns about interface fracture. Often times, cracks develop at the interface (between the two materials) and propagates over time due to internal stresses and external loads, which results in the ultimate collapse of the structure. To be able to develop reliable bi-material systems, a comprehensive knowledge of interface fracture is required. In the dental field, a number of tests have been developed to evaluate the fracture toughness of bi-material interfaces. Out of the numerous tests invented, the sandwiched Brazil-nut specimen has proven to be the most reliable. This is due to its ability to measure the interfacial fracture toughness along the entire range of mode mixities (from mode I to mode II). In this present work, a finite element analysis of the sandwiched Brazil-nut disc is used to evaluate the interfacial fracture toughness of bi-material dental structures. The goal is to develop a design map to help dental professionals determine the fracture toughness of three common dental material combinations (zirconia-resin, glass ceramic-resin, and porcelain-resin). ABAQUS is used for the finite element analysis and validation of the numerical model is done using similar models in existing literature. The study revealed that interface fracture toughness is influenced by a number of factors including, the size of the crack, the loading angle, degree of mismatch in mechanical properties of the materials, and the location of the crack path. Based on the finite element results, a formula/ design map is developed to predict the fracture toughness of the three common dental material combinations. The results for fracture toughness predicted by the formula correlated well with the numerical prediction.