Metallic utility poles, light poles, and mast arms are intermittently damaged by vehicle collision. In many cases the vehicular impact does not cause immediate failure of the structure, but induces localized damage that may result in failure under extreme service loadings or can promote corrosion within the damaged region. Replacement of these poles is costly and often involves prolonged lane closures, service interruption, and temporary loss of functionality. Therefore, an in situ repair of these damaged structures is required.

This thesis examines the failure modes of damaged metallic poles reinforced with externally-bonded fiber reinforced polymer (FRP) composites. Several FRP repair systems were selected for comparison, and a set of medium and full-scale tests were conducted to determine the critical failure modes. The material properties of each component were experimentally determined, and then combined into a comprehensive model capable of predicting global response.

Four possible failure modes are discussed: yielding of the unreinforced substrate, tensile rupture of the FRP, compressive buckling of the FRP, and debonding of the FRP from the substrate. It was found that simple linear, bilinear, and trilinear stress/strain relationships accurately describe the response of the composite and substrate components, whereas a more complex bond-slip relationship is required to characterize debonding. The constitutive properties were then incorporated into MSC.Marc, a versatile nonlinear finite element program. The output of the FEM analysis showed good agreement with the results of the experimental bond-slip tests.