# ABSTRACT

Glass Fiber Reinforced Polymer (GFRP) rebars are becoming a new substitute for traditional steel rebars in concrete structures. Today, most GFRP rebars are used in the construction of bridges, airports, or offshore projects due to its higher strength to weight ratio compared to steel rebars, non-corrosive, non-magnetic, and non-electromagnetic nature. Developments towards understanding the behavior and performance of GFRP rebars has allowed engineers to design infrastructure using GFRP rebars. A significant outcome is recently published ACI440.11-22 which allows the utilization of GFRP rebars for RC construction.

With the demand of new construction projects wanting to retrofit and extend existing infrastructures, GFRP has become an appealing material to use to because of its superior qualities compared to traditional steel rebars. With the advent of post-installed rebar technology, an improved and non-invasive solution was developed to provide connection between existing and new structure. Post-installed rebars are installed in existing structures to provide a starter rebar to connect the reinforcement from new structure to the existing structure. However, the use of high-strength epoxy for post-installed rebar connection is often governed by minimum requirements due to low strength steel rebars. This leads to a greater number of post-installed rebars required to transfer the required forces from new to the existing structure. In addition to that, corrosion of post-installed rebar can cause a significant degradation in its performance, especially in post-installed connections because of non-monolithic nature of the connection. Therefore, post-installed GFRP rebars can provide an alternate to post-installed steel rebars due to its high strength, and non-corrosive nature which can influence the performance of post-installed steel rebars. Unfortunately, there is limited research that has investigated how GFRP behaves in the post installed state. With the material properties of GFRP being more flexible comparatively to steel, there is doubt that GFRP would behave the same way as steel in the post installed state.

The goal of this work is to develop an equivalence in terms of equivalent bond-strength that GFRP rebars provide under different conditions and compare that with the equivalent bond-strength that steel rebars provide under similar conditions. AC 308 provide a systematic framework to establish and qualify an equivalence between cast-in steel rebars and post-installed steel rebars. However, no such framework is available to establish an equivalence for post-installed GFRP rebars and no research is available in literature to suggest any equivalence. Proving an equivalence

between steel and GFRP rebars under post-installed conditions as well as cast-in conditions can benefit in terms of utilizing GFRP rebars instead of steel rebars. This would also help in reducing overall carbon emission in nature resulting from steel rebar manufacturing.

To establish an equivalence between steel and GFRP rebars under realistic boundary conditions, pull-out tests were performed on cast-in and post-installed GFRP and steel rebars. The tests were performed based on a modified framework of AC308 that utilize block specimens to perform tests on rebars close to a corner at very large embedment depth. The depths that were used to investigate the material were 5D, 10D, 20D, and 35D. Additional lengths of 10D and 20D were tested in this work to check the influence of embedment depth on bond-performance. Having this variety of embedment depths ensures a complete understanding of the bond strength. In addition to the different embedment depths, different adhesives were used as well to get an understanding of how the bonding agent influences the overall strength of a rebar. The adhesives that were used in this experiment were PURE 220 and AC 100+. The main difference between these bonding agents is that PURE 220 is an epoxy-based adhesive compared to AC 100+ which is an acrylic based adhesive.

The test program utilized in this experiment was able to measure these different parameters and their influence on the bond strength of the GFRP and steel rebars. With fiber glass being weak in the transversal direction of the fibers, the traditional way to grip using hydraulic grip jaws and conduct a pullout test was not an option. So, a new gripping system had to be made to ensure that local failure do not occur at the grip location and an accurate measurement can be made to reflect the true strength of the GFRP rebar connection.

This thesis walks the reader through the test program, results, and takeaways of the experiment in depth. Finally, the thesis shows how GFRP is comparable to steel and how the different design parameters can influence the overall bond performance of the rebars.