and no coating. The remaining panels in Fig. 4 were subjected to both types of ammunition. As shown in Figs. 5 to 7, three other UHPC panels (P1-2.7-0, P1-2-0.34, and P2-2-0) were selected to report their ballistic behavior.

Panel P1-2.7-0, made with Batch 1 UHPC, had a 2.7-inch thickness without coating. It exhibited a crater diameter of 1.75 inches and a DOP of 0.8 inches when subjected to 5.56 rifle FMCJ (Fig. 5). Panel P1-2-0.34, also from Batch 1 UHPC, had a 2-inch thickness with a 0.34-inch coating. It showed a crater diameter of 2.5 inches and a DOP of 1.1 inches under the same ammunition (Fig. 6). Although there was no full penetration, its back face had severe cracks. Compared to Panel P1-2.7-0, the coating improved ballistic resistance as anticipated, even though the extent of damage in P1-2-0.34 appeared to be more severe. Panel P2-2-0, made with Batch 2 UHPC, had a 2-inch thickness without coating. It exhibited a crater diameter of 1.5 inches and a DOP of 1.26 inches under 5.56 rifle FMCJ (Fig. 7). Compared to P1 panels made with Batch 1 UHPC, P2 panels with Batch 2 UHPC containing 4% steel fibers showed substantially improved ballistic resistance.

Fig. 3 UHPC panels placed in the field prior to testing

Fig. 4 UHPC panels after testing

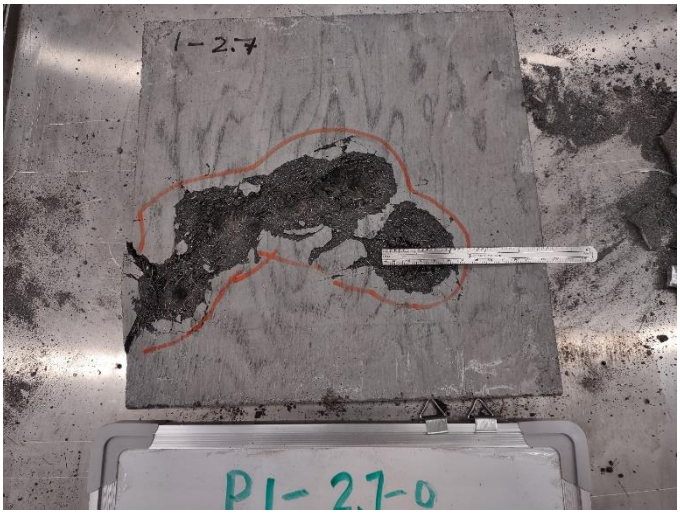

Fig. 5 Panel P1-2.7-0 after testing – front face

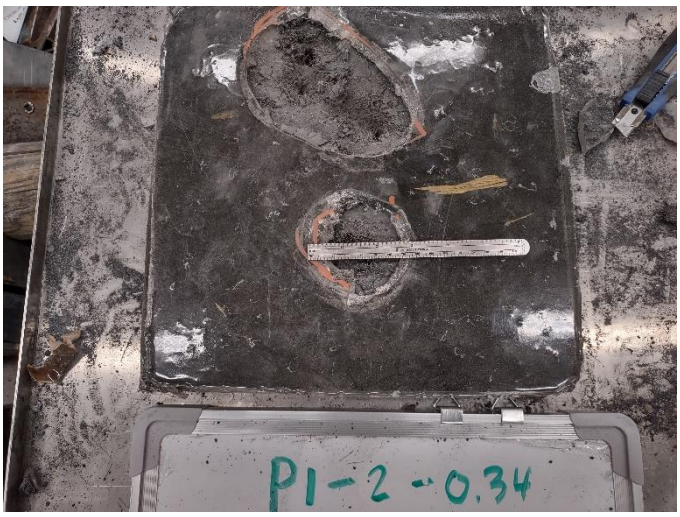

Fig. 6 Panel P1-2-0.34 after testing – front face

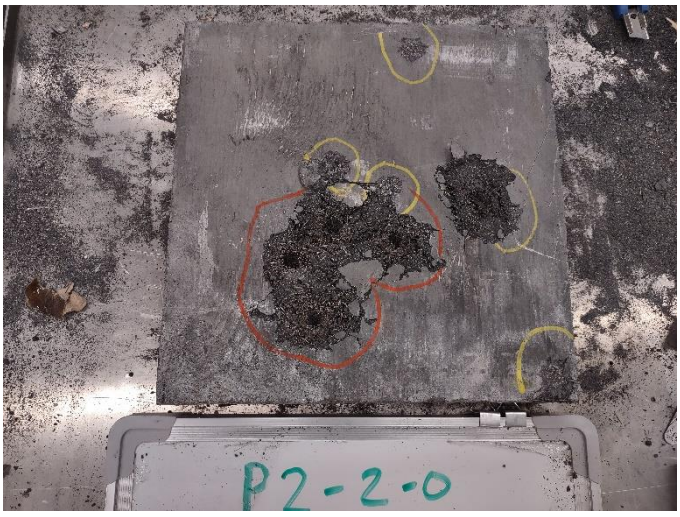

Fig. 7 Panel P2-2-0 after testing – front face

4. CONCLUSIONS

Numerous UHPC panels were made and field tested to evaluate their ballistic behavior against 9 mm FMCJ with lead core and 5.56 rifle FMCJ with lead core ammunition. By measuring the crater diameters and penetration depths, it was found that increasing the steel fiber dosage from 2% to 4% in UHPC mixtures substantially enhanced ballistic resistance. The polyurea coating, when applied at a meaningful thickness, also improved ballistic resistance. Although adding polyurea complicates fabrication, it can reduce panel thickness, which minimizes weight, eases construction, and lowers the need for heavy equipment during installation. The field test results provided valuable data to calibrate and validate the numerical analysis, which will be conducted in the next research phase.

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