Appendix 6: Damage Types

This section presents some of the common types of damages that can occur on FRP decks, and provides visual information on the appearance of these damages.

1. Punch Through. This is defined as a local failure mode where the deck section immediately beneath the wheel load cannot absorb any more energy, thus fails in one or more sections. The failure can be spontaneous (i.e., explosive) or gradual (i.e., slow relaxation). Typically, composite bridge decks are built with large factors of safety such that if the facesheet is thick enough to prevent facesheet crippling or delamination first, punch through is the primary mode of failure.

Figure 6-1 shows a typical test setup for deck testing with a single wheel load between girders.

![Figure 6-1. Test Setup for Single Wheel Load.](image)

Figure 6-2 shows the punch through failure of the cellular sections of the sandwich deck beneath the wheel load.
A close inspection of the affected area in Figure 6-3 shows little indication of the extent of the damage.

Cutting through the top facesheet reveals just how extensive the damage is as seen in Figures 6-4 and 6-5.
However, it has been demonstrated that this type of damage is repairable as the following sequence of repair steps show (Figures 6-6 through 6-9).
Figure 6-6 Damaged Section Cleaned and Prepped.

Figure 6-7 Replacement Patch Added.
Figure 6-8 Facesheet is Rebuilt.

Figure 6-9 Repair is Completed.
2. **Facesheet Delamination and Buckling** Delamination is typically classified as a separation of plies within the facesheet laminate, but can also occur at the boundary layer between facesheet and core if a distinction is prominent. Buckling occurs when the facesheet snaps through, but can recover flatness.

Figure 6-10 shows a four-wheel test configuration of an early MMC deck. Figure 6-11 shows the failed surface of the deck. Note the facesheet wrinkles circled in yellow. When the load was removed, the surface flatness recovered to near flat, and dimpling was discernable. Multiple facesheet failure modes are seen in Figures 6-12 and 6-13.
Figure 6-12 Facesheet Delaminations and Buckling at Max Load.

Figure 6-13 Tearing of Core Leading to Facesheet Buckling.
Example of facesheet delaminations taken from a foam-filled sandwich deck is shown in Figure 6-14, and examples of how facesheet thickness drives failure modes for deck are shown in Figures 6-15 through 6-17.

Figure 6-14 Delaminated Side Wall of Salem Bridge Deck.

Figure 6-15 Foam Sandwich Deck Failure Under Line Load.
Figure 6-16 Example of Thin Facesheet Crippling on Foam Sandwich Deck

Figure 6-17 Example of Debonding of Thick Facesheet from Core.