

BOLTLESS BUT TENACIOUS

How many bolts are required to support a curtainwall? Recent observations of a high-rise building in the Southeast demonstrated the redundancy of curtain wall systems. On this building, major interior renovations of several floors revealed that multiple curtain wall anchorages had loose or missing bolts. The number of similar conditions found warranted an investigation of the anchorages on the remaining finished floors. The owner of the building had initially planned to create an inspection opening through the original gypsum wallboard at each mullion anchorage to check for loose or missing bolts. This procedure would have required a significant investment of time and money due to the disruption in normal building activities and required asbestos abatement. In contrast, the authors implemented a non-destructive inspection technique using a flexible fiberscope, which minimized disruption to normal business operations and eliminated the need for asbestos abatement. Approximately 2000 anchorage locations were inspected using this non-destructive technique, requiring less than 5 minutes on average per location.

A primary pattern of loose or missing bolts was discovered on alternating floors, with a secondary pattern of loose or missing bolts at the column lines. Approximately 25 percent of total anchorages had loose nuts, 5 percent had at least one bolt missing, and 2 percent had both bolts missing. The loosening of these bolts may have been caused by one or more of the following factors. First, the majority of loosened connections were located at mullion splices, indicating that this discontinuity was a significant factor. Second, locations behind the columns were difficult to install, even with all interior finishes removed, leading to the secondary pattern of loose or missing bolts at the columns. Third, the elevations of the curtain wall facing the prevailing wind directions were the most affected, suggesting that wind played a role in the connection loosening. Fourth, the split-lock washers utilized on the bolts did not prevent the nuts from loosening.

Despite the somewhat synergistic effect of these factors, no areas of the curtain wall had experienced localized failures. However, the authors observed large cyclical deflections in one corner of the building during a windstorm. Surprisingly, building occupants reported that the curtain wall (framing and glass) typically moved in and out during high wind events. To restore the intended load path and mitigate the probability of localized curtain wall failure, all loose connections were repaired with improved locking stainless steel hardware.