Grain Elevator Collapse

A 1.4-million-bushel grain storage and distribution center located in the Midwestern United States experienced structural failure and collapse during a summer storm with 60+ mph winds (Figure 1). Although originally built with only five grain bins and a single grain elevator tower, additional grain bins, grain elevator towers, and an elevated horizontal conveyor system with support towers were added over the years to increase capacity and provide the means to move the grain to and from trucks and trains and between grain bins and the dryer (Figure 2). The collapse resulted in complete loss of the elevator and conveyor systems as well as damage to the grain bins and dryer.

Engineers working for other parties opined that the collapse had been caused by weld defects in the newest grain elevator tower. RRJ was retained to evaluate the credibility of this opinion. This assignment included review of project documents, examining the condition of tower members and connections that had been retained by the owner's consultant, and analyzing the as-designed and as-built load cases for the elevator tower in question as well as the conveyor system and two adjacent towers.

RRJ found that the existing conditions of the towers differed substantially from the original design. The newest grain elevator tower, which was designed to be freestanding, had been erected with unplanned connections to an existing horizontal conveyor. By analyzing the relative stiffness of the new tower, adjacent conveyor support towers, and the elevated conveyor structure, RRJ found that the load resistance of the newer tower was more than twice that of the adjacent towers. The connection of the new tower to the conveyor, in conjunction with the tower's relatively high stiffness, significantly increased the loads the structure would need to resist during a wind storm. These loads had not been considered by the other consultants. Additionally, after reviewing the project documents and examining retained tower base connection components, it became apparent that some of the older towers exhibited severe precollapse member and connection distress. Corrosion had completely failed the welded connections at the base of one tower and ground settlement had caused rotation of the concrete base of another. These conditions, which affected the stability of the older towers, also had not been considered.

The added information brought forth by RRJ’s investigation resulted in a favorable outcome for our client and demonstrated the benefit of performing a thorough investigation.

- Kurt R. Hoigard, P.E., SECB
- George R. Mulholland, S.E., P.E.