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Failure Analysis of Grain Bins

By

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Structural failure of grain bins occur for a variety of reasons. When a failure does occur, the loss can be substantial. Several thousands of bushels of grain can be damaged, let alone the cost of a grain bin. The following are examples of bin failures and ideas on what to look for when analyzing a failure.

Figure 1

Figure 1 is a view of buckling of a side wall of a grain bin. This happened during a wind storm when the bin was empty. Many bin designs rely on the bin being full to generate hoop tension in the side wall. This keeps the bin round, thereby maximizing the resistance to wind loads. In some designs, side wall stiffeners are under-designed, causing side wall failures at very low wind loads.

Figure 2 is a view of a roof failure on a grain bin. This occurred from excessive fan pressure generated during forced ventilation in the winter. The lower air intakes on the bin were clogged by frost, resulting in a high negative pressure inside the bin and collapse of the roof. It is not unusual for ventilation to generate sufficient pressure to cause a grain bin roof to fail. Figure 3 is a view of another bin roof failure due to winds clocked at 90 MPH. The fans were not operational but the bin was nearly full. Wind deflections on a grain bin roof often tend to depress the roof on the windward side and lift the roof on the leeward side.

Figure 2

Figure 3

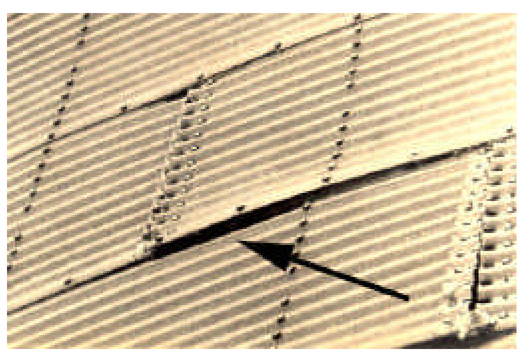

Figure 4

Figure 4 is a view of a failed side wall in a large bin. Close inspection of the side wall indicated that the bolts were loose. Tests indicated break away torque readings well below the manufacturer's recommendations. This is a result of deficient construction of the bin. Figure 5 is a view of a deformed internal side wall stiffener resulting from improper bolt torque.

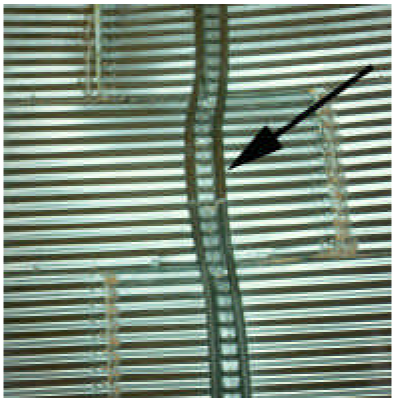

Figure 5

Figure 6

Figure 6 is a view of a side wall of a bin that buckled due to side unloading. A chute was cut in the side of the bin for side discharge which placed an unsymmetrical and damaging load on the bin. Most manufacturers discourage side discharge for this reason.

Computerized structural analysis can be used to determine the adequacy of a grain bin design. Figure 7 shows a computer representation of a grain bin roof structure. Roof strength calculations

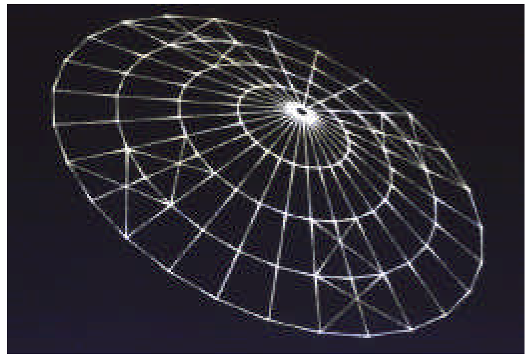

Figure 7

are performed using the finite element method, a structural analysis technique pioneered by the aircraft industry in the 1950's to design aircraft. The computer analysis allows analysis of complex loadings and structural shapes that could not be analyzed by conventional hand calculations. This analysis helps differentiate between a structural failure due to a design problem and a structural failure due to severe environmental loads.

It is desirable to arrive at the scene as soon as possible for data gathering. In many instances the location or configuration of the bin after the event is altered in order to salvage the crop in the bin. Weather conditions, grain moisture content, method of unloading and service history of the bin are examples of data helpful in the failure analysis.

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