DETAILS OF INTERESTING CLAIM

No: DOIC 57

<u>Type of Insurance:</u>

Industrial All Risk

<u>Description of damaged item:</u>

Wheat Silo Collapse

Cause of Loss:

(4) Other internal causes

Claim Cost:

Not available.

Description of Incident and Loss Prevention Measures initiated:

A 32-m steel silo collapsed. The diameter of the silo was 18 m. The silo had a volume of about 8,000 m³ and held around 5,800 tons of wheat. It had been part of a row of eight similar silos before the accident. The silo was of fully welded design, and the plate thickness varied between 15 mm at the base and 6 mm at the top.

The silo fell against an empty grain silo, and then they both collapsed against a third silo. Silo 1 and the empty silo were totally destroyed, and the third was seriously damaged. The collapse of Silo 1 was caused by plates buckling in an area where the thickness was 10 mm.

At the time of the damage, the silo was about 97% full. To check the quality of the wheat, samples were run out of the bottom of the silo and then returned to the top. During this process, a high-level warning occurred. Sampling was temporarily stopped in accordance with established routines, but after an hour the alarm ceased and sampling was restarted.

Possible causes of the collapse have been investigated with the following conclusions:

- The base plating has been checked and shows no deviation from normal structural tolerances and no subsidence.
- Material samples were taken from the silo walls and tested. The test results show that the steel has normal values for steel of SS1412 quality.

- There was no sign of ‘prebuckling’. Buckling was initiated at a height that excluded collision damage. Ventilation on neighbouring silos was open, so it was also likely to have been open on this silo, which means that inward buckling due to vacuum is not a probable cause.
- On the inside of the silo walls there were some original white paint marks remaining from the time of its construction. This indicates that in most cases discharge has taken place without large frictional forces being developed against the silo walls, and that discharge has taken place via ‘core flow’.

None of the above damage mechanisms seems likely in this case. Instead, the collapse may have been due to biological activity.

Inside the silo, several temperature gauges set in a circle of about half the radius of the silo hang from cables fixed to the silo top. According to the recorded data, temperature conditions in the silo varied considerably.. The lowest temperature, less than freezing, occurred at the top of the silo. The highest temperature was 30ºC.

The variations in temperature indicate that there has been a centre of biological activity, which can cause asymmetrical discharge due to grain forming into lumps, and can also generate moisture that migrates towards the external walls. Asymmetrical discharge increases the risk of buckling, and moisture at the external walls can create a rough surface to which the grain can freeze. Computer calculations show that the risk of freezing on the silo walls is small in normal winters if the wall insulation is dry and unbroken. If the insulation is locally wet or torn, the risk of freezing increases considerably and causes asymmetrical discharge conditions with a consequent increased risk of buckling. The positions with low temperatures indicate that local freezing did in fact occur. Of all the possible causes of damage checked, it would therefore appear that local freezing is the most likely explanation.

Loss prevention measures:

- The usable volume of the remaining silos on the damage site has been restricted.

- The calculation checks for safety against buckling and subsequent collapse should be made on older silos.

- The conditions inside the silo should be monitored and subjected to adequate checks.

<u>Outline the interesting or unusual aspects of this claim or problems experienced during settlement:</u>

The progress of the collapse, which took some time, showed typical buckling behaviour. The steel wall buckled but did not tear. When buckling started, the tensile stresses in the steel in the buckling zones were greater than the elastic limit of the steel, and deformation occurred.

The silos were constructed in 1975 and were designed in accordance with the regulations that applied at the time. In the past decade, the conditions for calculating silo loadings have changed several times due to accidents that had occurred.

The silos are designed for dry granular materials, with central filling and discharge. During discharge, there is friction between the material and the silo walls, as well as between the individual grains themselves. Two loading cases can be calculated, for either smooth or rough walls. For the rough-wall case, friction is considerably higher. Friction means that the walls will bear a large part of the vertical load when the silo has a height greater than the diameter. Design must be carried out so that the silo walls do not buckle.

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