Short Paper on an interesting case of damage
Machinery Insurance
Prepared for IMIA

Cement mill – Cracks in the mill ends

This case of damage was investigated to decide if repair-welding is a sufficient solution when the ends of a cement mill start to crack and are in danger of breaking. To ensure that the damage is repaired reliably, the cause of the damage must be investigated and weld seams examined carefully.

During a routine inspection of a cement mill, the owner of the cement plant noted that one of the cement mills was damaged. Severe cracks were found in the feed and discharge areas (inlet and outlet) of the cylinder ends of the mill. The crack at the outlet end already had progressed for almost 270° of the circumference, and there was a danger of the end breaking apart. This would have resulted in a substantial business interruption loss in addition to the material damage.

In order to avoid interrupting mill operations for too long and thus causing a major loss, the owner considered how to do a repair of the damage quickly. So he decided to weld the worst cracks in the outlet end. However the question was whether this spontaneous temporary repair would last or whether additional repair was necessary or even the ends would have to be replaced. The insurer had already been informed of the damage and engaged an independent research institute to investigate the cause of the damage and examine the weld seams.

What has caused the damage?

First of all the operating history of the mill had to be studied, which had been built in Eastern Europe at the end of the 1990s. This mill had already been previously operated in other countries, so that it had been erected and dismantled several times. For the erection at the owner’s plant, assembly lugs were welded onto the cylinder ends and then removed afterwards. A possible explanation was that the cracks originated at the weld points of the lugs.

The institute carried out a number of tests, including a chemical analysis of the material and ultrasonic and hardness tests. They found that the material of the end covers was equivalent to the cast steel GS-20Mn5. The difficulty involved in processing or repairing this kind of material is that hard spots may form in the material if exposed to very hot temperatures, as in the case of welding without prior

heat treatment. This cast material needs to be preheated to a temperature of 250°C before welding work can start, but when the welding was done, the material could only be preheated to a temperature of 150°C. Hard spots consequently formed in the immediate vicinity of the weld seams. This must have happened when the assembly lugs were welded on, because the cracks started exactly where the lugs had been (see Fig. 2 below). The possibility that further cracks would develop from the provisional repair could therefore not be ruled out completely.

Rectification of the damage

The research institute's recommendation was to grind out the cracks in the cylinder end and repair-weld them, but this was only to be seen as a temporary repair measure. The mill ends would have to be replaced without doubt. In the interests of maintaining operations until the new mill ends became available for replacement, the weld areas were examined every week for further signs of cracking.

The new cylinder ends were delivered eighteen months later and immediately installed.

The loss

The loss finally came to about US$ 800,000. This amount included the costs of the material damage and the additional cost of shifting operations to a nearby factory for the duration of the welding operations. If owner and insurer had not acted so quickly, the damage could have been much more extensive, and the loss could have reached a two-digit million US$ mark. The results of the detailed examination of the weld seams and the investigations into the cause of damage made it possible to rectify the damage in an optimum and permanent manner.

Cement mill

The cement mill subject of the loss described in this article is a ball mill and consists of a horizontal cylinder, closed at both ends by heavy cast walls (Fig. 1). In order to feed the mill continuously with cement clinker and to withdraw the powdered cement afterwards, inlet and outlet shafts are built into the ends and these also form the mill bearings. The cylinder is lined with steel plates and filled with steel balls (grinding media) of various sizes. During operation, cement clinker that has been baked in the rotary kiln is fed into the mill through the input shaft. The cylinder rotates at approximately 15 rpm, with the result that the clinker is ground into cement powder by the impact and friction of the grinding media.

Schematic diagram of a cement mill

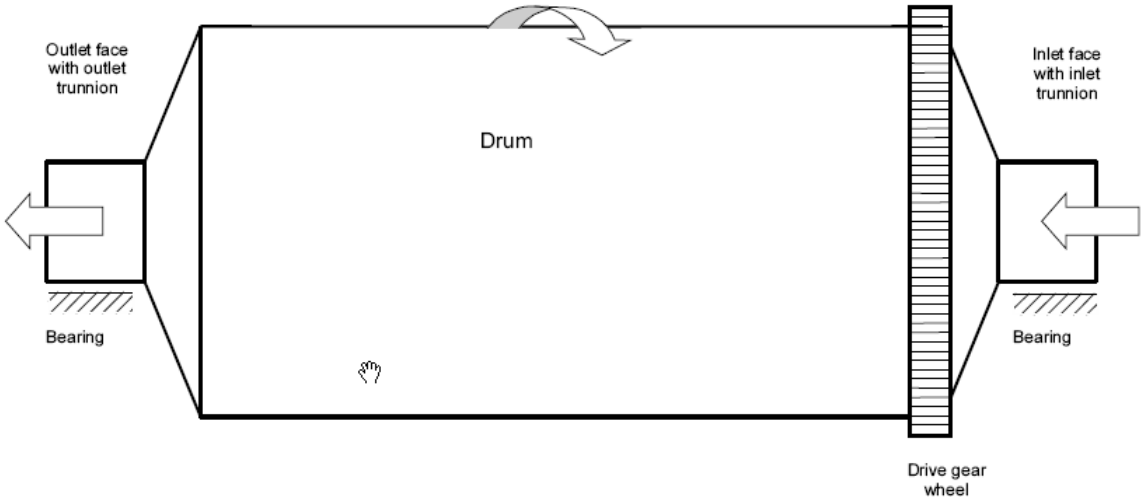

Figure 1: Schematic diagram of a cement mill

Source: Allianz Centre for Technology, Ismaning

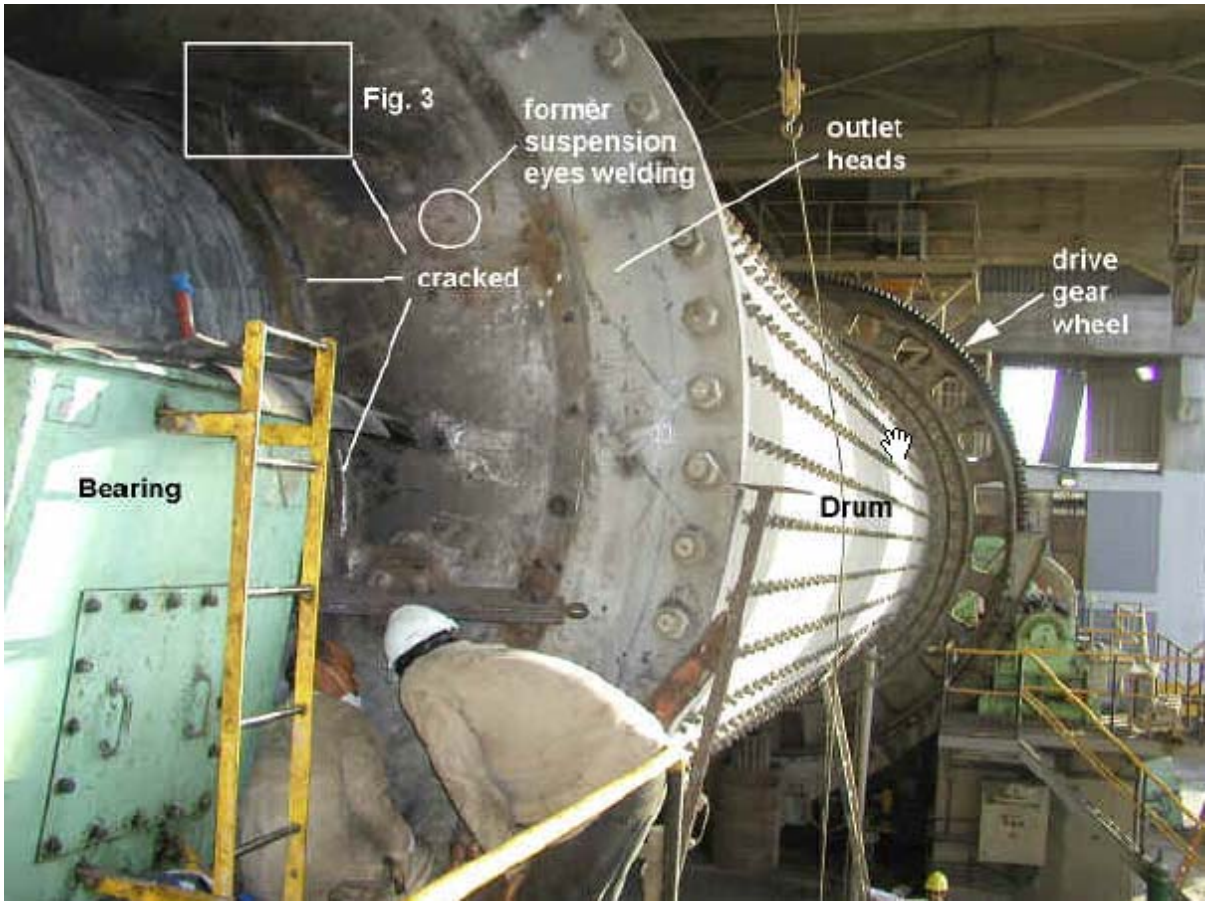

Figure 2: Tube mill with broken outlet head

Source: Allianz Centre for Technology, Ismaning

Experts examining the cracks in the outlet end of the cement mill.

Figure 3: Outlet head; cracks are being repaired

Figure 4: Outlet head viewed from inside the drum

Inside the mill, the crack structure of almost 270° around the outlet shaft is clearly identifiable.

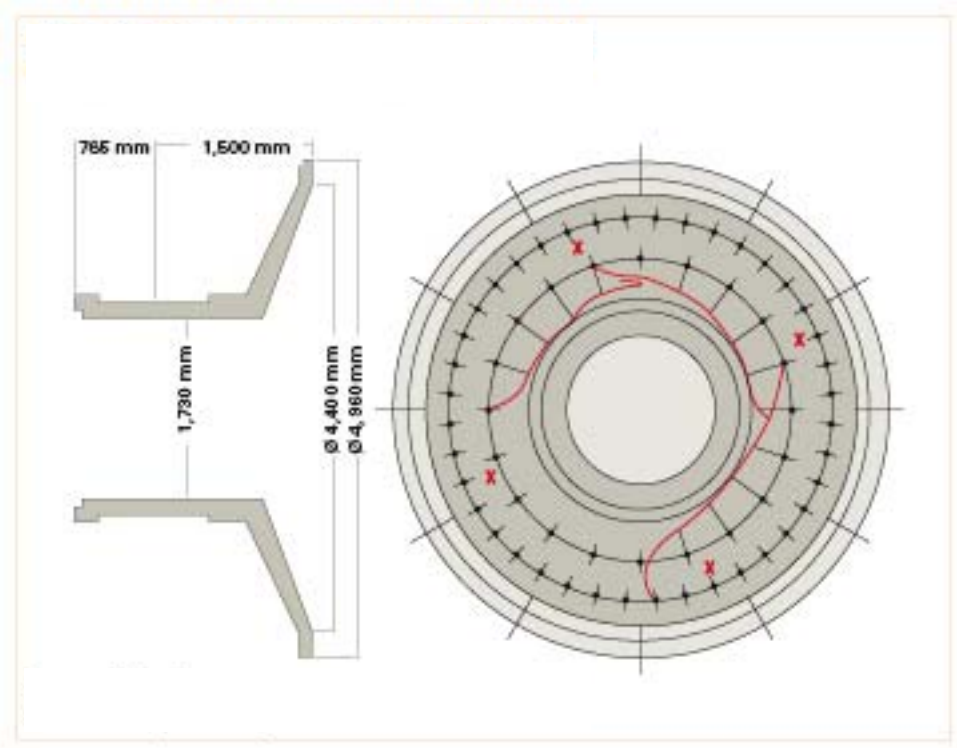

Figure 5: The locations of the assembly lugs (suspension eyes) with the crack propagation of approximately 270°

Source: Allianz Centre for Technology, Ismaning

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