APO-GEE
BALL BEARING ENGINEERING

Solving cage instability:

Trial and error… fatal error!

Numerous challenges are encountered by ball bearings, and all these challenges should not be treated in the same way...

A ball bearing begins to wear and age from its very first revolution. Consequently, some issues invariably arise after a certain period of use: an increasingly pronounced noise, escalating vibrations, or abnormal heating. With a stroke of luck, simple maintenance, involving thorough cleaning followed by complete lubrication, may be sufficient to prolong the life of a bearing. In the worst-case scenario, the problematic bearing must be replaced. Regardless, most of the time, warning signs are known. Thus, they provide an opportunity for the operator to intervene before an abrupt unpleasant surprise, before real damage occurs.

However, it is possible for failures to suddenly appear without warning, without the user being able to perceive that a problem is about to occur, even from the beginning of the bearing's life. The phenomenon of cage instability falls into this category.

Cage instability is a dynamic anomaly that occurs under certain conditions. Through repeated interactions with the rolling elements and bearing rings, this small component responsible for separating the rolling elements rapidly accumulates a significant amount of kinetic energy, leading to highly problematic bearing operation [more information on this on the knowledge section of www.apo-gee.tech]. It notably occurs in space applications (launchers, probes, and satellites), due to the unique environments in which the bearings operate. But the phenomenon can also occur in other types of industrial applications.

The peculiar nature of cage instability is its tendency to arise unexpectedly. Counterintuitively, there is no need for the bearing's operating conditions to deteriorate, nor is it necessary to await possible advanced wear: cage instability occurs without warning, at any moment.

Another characteristic of the cage instability phenomenon is that it remains poorly understood. However, if the source of the problem is elusive, the solution is even more so...

Given that the failure is sudden, the need to converge towards a satisfactory bearing design is strengthened accordingly. But without a detailed understanding of the fundamental aspects underlying cage instabilities, the choice is not available; empirical methods prevail. And this might work: a new cage is designed, is tested, fails, and the process is repeated; a new cage is designed, is tested, fails, and the process is repeated... until a configuration that finally satisfies is achieved. At least, that's what is believed...

Because a rapid resurgence is highly likely! For instance, even a minor deviation in geometry can easily lead back to square one and trigger cage instabilities, undoing the arduous work imposed by the multitude of necessary trials. Moreover, this solution isn't transferrable: if cage instability occurs in another bearing, the work must begin anew; starting from scratch becomes inevitable... In all cases, no guarantees can be provided.

What to do? The first step is to understand the phenomenon, to identify the source of the problem; the second step is to equip oneself, to find a solution to counter what has been identified. APO-

GEE has been able to pinpoint the mechanisms that lead to the occurrence of dynamic cage instabilities. This mastery of the phenomenon is the result of the development of uniquely calculated tools, experimentally correlated. The comprehension of these physical aspects and APO-GEE's expertise form the foundation of a new cage design capable of countering any onset of unstable phase.

An unstable cage is not inevitable!

Christophe Servais, Ir, PhD
Chief Technical Officer
cse@apo-gee.tech

www.apo-gee.tech