Tests Reveal That All Grid Couplings **Aren't the Same**

SUMMARY

Grid couplings are common in a variety of industries and applications because they are able to operate under extreme conditions and handle high levels of torque. There are several brands of grid couplings and they all appear to be identical. However, third party tests discussed in this paper show a wide range of results measuring the performance and durability of Falk®, Dodge®, and Lovejoy® branded grid couplings. These results demonstrate that there can be a significant impact on the uptime and production on your system, plant or mine by the brand of grid coupling that is selected must withstand the high impact and cyclical stresses that commonly occur.

None of us like downtime. Whether you design, build, operate or maintain plants and equipment, you know how frustrating it can be when a critical component fails and stops production.

Couplings are components that are often overlooked amidst the mix of machinery found within a typical mine or industrial operation. However, while couplings may represent a minor portion of the overall system cost, choosing the correct coupling, and in some cases the correct coupling brand, can define the productivity of the entire facility.

Grid couplings are flexible couplings typically used to connect motors, engines and gear boxes to rotating equipment. For nearly 100 years, grid couplings have provided the critical link between power and machine.

Because grid couplings strike a balance between torque capacity and price, they are recognized as the standard in many industries. Their torsional flexibility is ideal for applications with high vibratory and impact loads, including mixers, fans, compressors and pumps used in water, power, mining, steel, cement, chemical, food processing, and pulp and paper facilities.

The torsional softness of grid couplings is also desirable for belt conveyors, cranes and hoists used in mines, ports, bulk transportation hubs and power plants. These are some of the most demanding applications in the world, and the coupling selected must withstand the high impact and cyclical stresses that commonly occur.

All of the grid couplings currently on the market appear to have adopted the same product design. Some manufacturers even claim to have interchangeable parts. However, it can't be assumed that all grid couplings will perform to the same level.

Material selection, product design, manufacturing processes and quality controls can significantly impact how long a grid coupling is able to stand up to the high stresses inherent to mining and heavy industrial applications. Poor design and manufacturing can severely limit a coupling's life.

CAUSES OF EARLY COUPLING FAILURE

Grid couplings can fail under a variety of circumstances, all of which involve increased levels of wear or stress on the coupling components. Wear is typically caused by alignment or lubrication problems, while increased levels of stress are the result of impact or vibratory loads created by driving or driven equipment, or from shaft misalignment.

Shock or impact loads are most common in conveying or mixing applications, such as when bulk material is introduced to the system.

Vibratory loads are present in any application; however, they are most pronounced in high-speed applications such as pumps or compressors. Vibratory loads can slowly grow to extreme levels as other system components wear, particularly bearings.

Misalignment, both parallel and angular, can bend and stress grid elements as they rotate with the shaft. Misalignment can be caused by installers of the equipment, maintenance personnel or shifting equipment and foundations. Because it is nearly impossible to perfectly align

How It Works:

A grid coupling consists of two hubs, a grid element, cover and seals. The hubs transmit torque through teeth that engage the grid element, while the cover and seals protect the grid element and lubrication. The grid element is arguably the most critical part of the coupling as it absorbs misalignment and vibration, providing torsional softness.

rotating equipment, misalignment is present to some degree in every coupling installation.

Impact and vibratory loads should be considered when sizing and selecting a coupling, but it's difficult to predict every condition that the system will encounter. Inevitably, a coupling will be exposed to loads exceeding its design limits as the overall system ages and wears. Manufacturers place limits on the amount of misalignment allowed for their products. While no one plans for their equipment's misalignment to exceed these requirements, it happens quite often.

Knowing that shock loads, vibration and misalignment are key factors in grid coupling failure, it is possible to simulate these factors in test situations to measure the performance of each grid coupling brand.

ALL COUPLINGS ARE NOT CREATED EQUAL

To quantify differences in performance, product cycle testing was conducted on grid couplings sold by three major brands. Simulating the shock loads and misalignment that cause high stresses within a grid coupling during operation, the tests were designed to produce comparative results of coupling durability and stress resistance.

Two separate tests were performed on grid coupling products: a reverse torque test and an operating under misalignment test.

The reverse torque test was performed on a static test stand that uses a pneumatic cylinder to apply torque in both positive and negative directions. The test stand permitted only minimal variation in misalignment between product samples. All couplings were installed per the manufacturers' instructions and within the specified shaft alignment range.

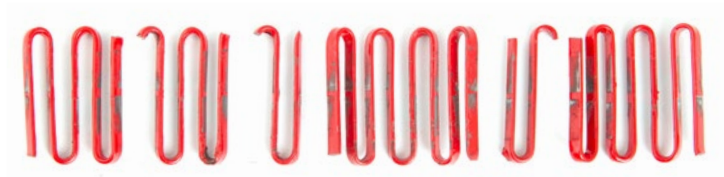

Reverse torque test stand

All coupling manufacturers specify the same maximum torque capacity for a given coupling size and use very similar naming conventions. To accelerate the tests, 220 percent of the maximum torque, or 2,904 inch-pounds, was applied to the model 1030 couplings tested. Failure was determined by pausing the test, removing the cover of the coupling and inspecting the hubs and grid elements for cracks or other significant damage. Two samples of each of the three manufacturers' products were tested until failure or 400,000 cycles were reached.

TABLE 1 — Cycle Test Results of the Six Samples Tested

Brand	Cycles on Test Stand	Type of Failure
Falk (Sample #1)	400,000	None
Falk (Sample #2)	400,000	Grid Failure
Lovejoy (Sample #1)	30,000	Grid Failure
Lovejoy (Sample #2)	20,000	Grid Failure
Dodge (Sample #1)	100,000	Grid Failure
Dodge (Sample #2)	70,000	Grid Failure


Lovejoy grid element after 30,000 cycles


Dodge grid element after 70,000 cycles

Falk grid element after 400,000 cycles

Table 1 shows the wide range of results for the six samples tested. The worst performing coupling sample lasted fewer than 20,000 cycles, while the best performing coupling did not fail within the 400,000 cycle limit.

The failure mode is consistent between all failed test samples: the grid element cracked and fractured. While grid couplings may continue to operate with a crack or fracture in the grid element, note the proliferation of fractures in the Dodge and Lovejoy samples. Once removed for inspection or equipment maintenance, grid elements in this condition require replacement.

OPERATING WITH A FRACTURED GRID ELEMENT

Although it failed at 30,000 cycles, the Lovejoy sample #1 was tested through 400,000 cycles to determine the effects of a fractured grid on coupling performance.

While the coupling continued to transfer torque, the broken grid element increased backlash in the coupling, causing the grid element to wear on the tooth surfaces and gap-side edges of each tooth. The wear and metal burrs on the tooth edges will,

The Falk Steelflex Coupling survived **100 million** cycles without failure

After 400,000 test cycles, Falk Steelflex hub shows no wear with smooth, machined surfaces.

Competitive hub shows pitting on teeth and burrs on tooth edges from broken grid element.

Continued use with broken grid elements will lead to complete destruction of hub teeth.

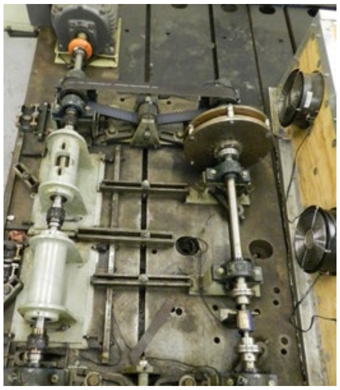
in turn, damage the grid element. As a result, both the grid element and hubs now need to be replaced. It is recommended that the grid elements be replaced at the first signs of damage to avoid damaging the hubs. This is accomplished by removing the cover and replacing the fractured grid element. No machinery needs to be moved in the process.

Waiting until grid elements completely disintegrate and the coupling no longer transmits torque will significantly damage the hubs. This typically requires moving machinery in order to slide the damaged hubs off the shafts. Considerable time and money can be saved by maximizing the life of the grid coupling hubs. This is accomplished by performing regular inspections and replacing damaged grid elements.

SIMULATING REAL-LIFE ALIGNMENT CONDITIONS

The second test, operating under misalignment, was designed to simulate coupling performance under real-life alignment conditions. While all grid coupling manufacturers specify a shaft alignment range, misalignment outside this range is often present due to human error or natural settling of equipment or equipment foundations.

For test purposes, parallel misalignment of 0.5 degrees, or twice the recommended misalignment, was used in an attempt to accelerate the tests. While the reverse torque test stresses the grid element axially (about the shaft axis), the operating under misalignment test stresses the grid element axially and radially (perpendicular to the shaft axis).



Operating under misalignment test stand

TABLE 2 — Cycle Test Results of the Three Samples Tested

Brand	Start/Stops	Cycles on Test Stand	Failure Mode
Falk	18	100,000,000	None
Lovejoy	7	320,000	Grid Fracture
Dodge	7	320,000	Grid Fracture

Torque in steady state during the test was 1,790 inch-pounds while torque peak at start-up was 2,700 inch-pounds. Peak torque occurred after every inspection. Couplings were rotated at 3,558 rpm until failure or 100 million cycles were reached.

The Falk® Steelflex® Coupling survived 100 million cycles without failure while the other two brands failed after less than 325,000 cycles each. Once again the grid elements were pushed beyond their limits and fractured; however, these high levels of misalignment are not uncommon in real applications. These fractured grid elements should also be replaced to minimize hub tooth damage.

Lovejoy grid element after 320,000 cycles

DURABLE COUPLINGS LOWER MAINTENANCE COSTS

Because grid couplings are used in some of the world's most demanding applications, they are constantly subjected to high levels of stress. They must run continuously while enduring both shock and vibratory loads from the machinery to which they are connected as well as flexing caused by shaft misalignment.

Selecting or specifying grid couplings that demonstrate high resistance to shock, vibration and misalignment stress can significantly reduce repair and maintenance costs and thereby lower total cost of ownership. While they may not be a significant portion of the initial system price, selecting the right coupling can be the difference between uptime and downtime.

While many grid couplings look the same, product cycle testing conducted in a controlled laboratory environment confirms that they do not perform to the same level. In fact, there can be a difference in performance of up to a factor of 20.

Maximizing uptime and keeping costs down is the key to improving bottom-line results. Choosing the most durable grid couplings for use in your facility helps to lower total cost of ownership and ensures that your operation remains as productive as possible.

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