

ANALYZING METAL FAILURE:

CONTACT FATIGUE

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“CYCLIC LOADING” TAKES A TOLL ON METAL PARTS

Fatigue...Every person has felt it. It is typically the result of many stresses being placed on a person over time, with the result being that they feel tired and weak. Fortunately, in people, fatigue tends to be a temporary condition.

Metal parts—even those made from strong, durable metals like stainless steel—can also experience fatigue, and from a similar source: the repeated application of pressure. In materials science, this is referred to as “cyclic loading,” and it results in what is known as “contact fatigue.”

Contact fatigue is one of four main forces that can damage metal assets. The other three are:

CORROSION

In corrosion, a refined metal converts to a more chemically stable form, like a sulfide or oxide. This process, which can be caused by exposure to a corrosive chemical, for example, typically takes place over time.

ABRASION

Abrasion is the removal of material from a surface by mechanical actions like rubbing, scratching, or scuffing, such as when two metal parts repeatedly come into contact with one another.

EROSION

When a surface is struck repeatedly or continually by liquids or gasses in motion, the particles of those substances can remove material from the metal object. Cavitation, which is the formation of small vapor-filled cavities in a liquid, also can cause erosion.



Fortunately, there is a simple step that metal part designers, manufacturers, and users of metal parts and devices can take to minimize or prevent contact fatigue and the other causes of metal failure. In doing so, they help ensure that those assets last longer and with less loss of functionality.

This is the final guide in a series of four on how applying advanced coatings like chromium to metal parts and devices can provide a remarkable level of protection. Specifically, it covers contact fatigue: what it is, where it commonly occurs, and how to prevent it.

Reacting to contact fatigue is not an effective business strategy. A much better approach is to be proactive and coat parts with a substance that makes them more resistant to stress.

UNDERSTANDING CONTACT FATIGUE

Contact fatigue differs from structural fatigue in that it results from different forces and has no endurance limit. Typically, it is caused by localized stress when curved surfaces are in contact under normal load conditions. It is commonly found on ball bearings and roller bearings, but it can also occur on gears, valvetrain components, rails, and gear couplings.

Sometimes referred to as rolling contact fatigue, surface contact fatigue, or pitting fatigue; this condition can occur in any scenario in which repeated, localized rolling or sliding contacts occur and the surface contact pressure is greater than 1 GPa (gigapascal). In addition to the amount of load experienced, the degree of damage is affected by the properties of the materials involved (including any nonmetallic inclusions they contain), the presence or absence of lubricants, and conditions on the two surfaces. The biggest influence is base metal strength.

As contact fatigue occurs, cracks develop that ultimately result in pitting on a metal surface. In the case of bearings, the pitted surface prevents them from rolling smoothly and they become noisy. If the contact fatigue is not addressed, catastrophic failure can occur.

Consequently, any part or device that can be subject to contact fatigue—like bearings, valve lifter cams and rollers, and many others—should be inspected regularly for signs of pitting or other damage. And just as importantly, the surfaces on those parts and devices should be coated to protect them from damaging forces.



UNCHECKED CONTACT FATIGUE IS VERY COSTLY

Because there is no endurance limit associated with this type of fatigue failure, components subjected to high contact loads in the presence of rolling or sliding are all at risk for contact fatigue. Businesses that do not take steps to protect those components and extend their fatigue life face several potential consequences, including:

UNNECESSARILY HIGH REPLACEMENT COSTS

When bearings and other parts begin to deteriorate due to contact stress, they must be replaced, and the replacement cycle is much shorter in unprotected parts.

INCREASED DOWNTIME

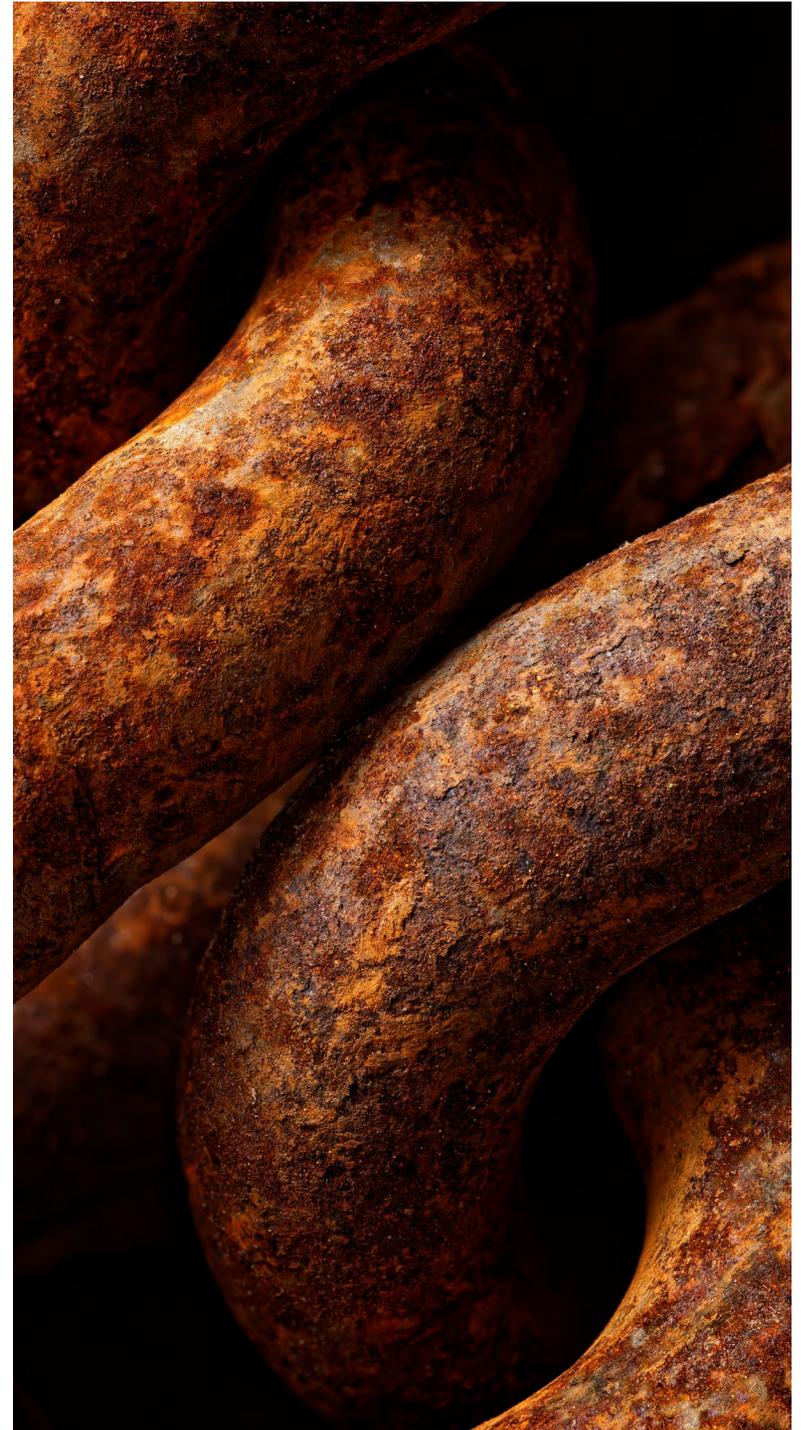
The catastrophic failure of parts can bring work to a sudden halt, and that downtime can cause a significant drop in revenue.

DECREASED QUALITY

Particularly in precision applications, pitted bearings or other parts can cause a device or system to operate less effectively and produce substandard output.

LOST BUSINESS AND OPPORTUNITIES

Issues like downtime and poor quality can not only drive away existing customers, but the damage to a company's reputation can make it difficult to attract new ones.



GETTING AHEAD OF CONTACT FATIGUE

Reacting to contact fatigue is not an effective business strategy. A much better approach is to be proactive and coat parts with a substance that makes them more resistant to stress.

Advanced chromium coatings serve that purpose especially well. The hardest metal, chromium, can be applied to parts in extremely thin layers. It provides effective defense even at deposits as low as .000050”

There are various chromium formulations for different purposes. Armoloy's advanced chromium coatings are:

THIN DENSE CHROME (TDC)

When a project involves extreme precision and tight tolerances, this coating is ideal.

DIAMOND CHROME

Also known as XADC, this material has a hardness of up to 98Rc and absolute atomic adhesion.

HYBRID COATINGS

Bi-Protect is a coating that combines electroless nickel with an overlay of Armoloy TDC or XADC.



HAVING THESE COATINGS APPLIED TO CRITICAL COMPONENTS PROVIDES MANY ADVANTAGES. FIVE OF THE MOST IMPORTANT BENEFITS ARE:

1. Enhanced durability

Chromium-coated items resist cracking and pitting, which means a company's replacement expenses are lower.

2. Increased productivity

When metal parts have to be replaced less frequently, fewer stoppages are required and more work gets done.

3. Improved functionality

Smooth-rolling bearings mean more effective operations in whatever device or system they are a part of.

4. Protection within design specs

Because chromium can be effective in extremely thin layers, parts can be coated and still fall within design specifications.

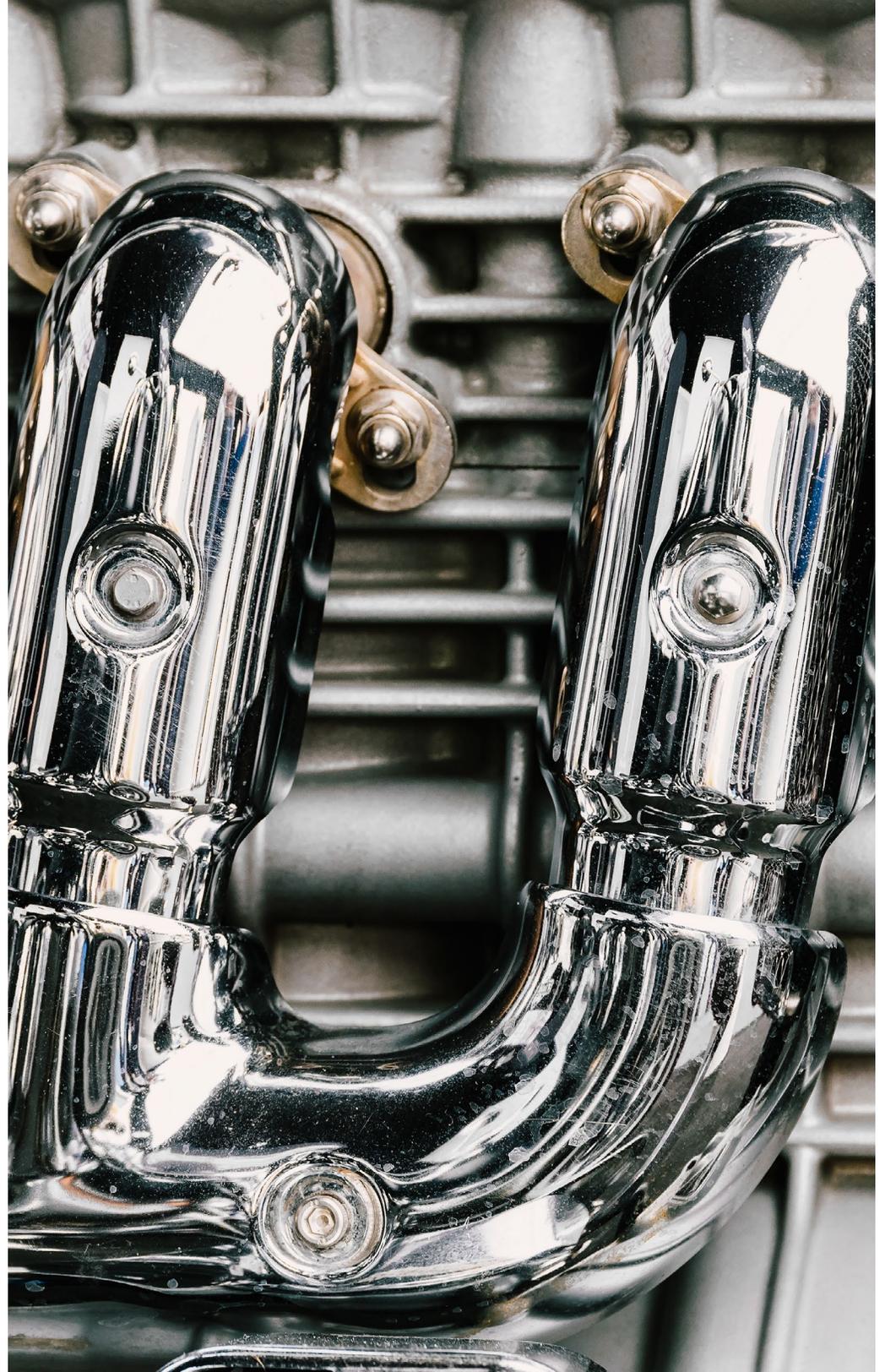
5. Increased customer retention

Companies that put out a high volume of high-quality work make their existing customers happy and get the attention of prospective customers.

DESIGNING PARTS AND PRODUCTS WITH PROTECTION IN MIND

Advanced chromium coatings can be applied to existing parts that have no coating to immediately elevate their level of protection from contact fatigue and other conditions that can lead to metal failure. However, it is often more effective to design parts and products with the application of a coating being the final step in the manufacturing process. That way, the items are shielded from damage right from the start.

Armoloy's coating experts frequently work with designers and manufacturers to determine the best coating for a particular application. This can include applying the selected coating to proof-of-concept items during the development phase so that the coated item can be tested and its design fine-tuned if appropriate.





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A licensee of the Armoloy Corporation, Armoloy Southeast has been in operating since 1995 in its original location in Sumner, SC.

Providing a full range of Thin Dense Chrome surface coatings, Armoloy Southeast serves the greater manufacturing community in the Southeastern United States, as well as many customers in the international market.

Armoloy Southeast works in concert with the chemistry lab and innovation center at the Armoloy Corporate headquarters located in DeKalb, IL, which allows us to address and engineer solutions to the most difficult coating challenges. Armoloy is often the first place customers in the nuclear power, aviation, food-manufacturing, and other sectors turn to for solutions to “impossible” coatings challenges.

Armoloy Southeast is ISO 9001:2015 certified.

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