Considerations for Safe Handling of Roll Neck Bearings

This paper will discuss proper lifting procedures for mill roll neck bearings as both complete assemblies and as individual components. Bearing standard and optional design features to facilitate safe handling are introduced. Standard lifting device design configurations are also discussed, together with relevant industry design standards. The objectives of this paper are to improve roll shop safety and awareness, reduce handling damage to the chock and bearing components, and reduce lost-time injuries by raising awareness on the dangers of using legacy lifting devices and educating on proper fixture designs and lifting techniques.

The bearings used on roll necks come with a wide variety of features to improve their performance in the mill environment. But commonly overlooked in mill design are features to improve bearing handling and safety. Bearings in the roll shop are typically handled with legacy fixtures and lifting tools, and these long-standing methods can vary by location. Also, mill operators are often resistant to change, which further contributes to the continued use of legacy lifting devices.

Lifting industry standards were first created in 1916 as a result of growing safety concerns. They evolved to include safety provisions for a multitude of equipment types. While legacy tools and methods tend to be simple and get the job done, mills frequently lack the bearing and chock features that allow efficient — and, most importantly, safe — use of the tools, or that allow compliance with the design, construction and marking requirements specified by the lifting industry’s standards.

This paper provides an overview of legacy lifting devices, features that should be considered in chocks and bearings for safe handling, new designs for lifting fixtures, and an overview of the standards that control lifting fixture design and make it compliant with U.S. Occupational Safety and Health Administration (OSHA) safety standards.

Figure 1

Cup backface backing without a relief for lifting device in unsealed (a) and sealed bearings (b).

This article is available online at AIST.org for 30 days following publication.
Discussion

The handling of bearing products is typically not considered in the original equipment design of chocks and specification of components. Typically, the backing shoulder in a chock is a non-interrupted shoulder that contacts the bearing outer ring face. Lifting tools may be unable to engage the bottom face of the cup when installed in the chock, making removal of the bottom cup difficult (Fig. 1).

This limited contact becomes an even greater concern when using sealed roll neck bearings. The use of a sealed bearing assembly requires that, to prevent damage to the seal, the lifting tool must be able to reach out to an even larger diameter to lift against the cup backface and avoid contact with the face of the seal.

Fig. 2 shows a selection of lifting devices that are in use today in roll shops around the world. Hook lifters are a reasonable solution for lifting single bearing races because they can capture either the bore of the inner ring or the outside of an outer ring for stacking an assembly prior to installation into a chock.

Eyebolts and lifting chains are a proven method for lifting bearing assemblies that use a pin-type cage construction, as the cages are already threaded for eyebolts.

These tools should be evaluated during the design review phase of a mill upgrade, since features for bearing handling can easily be added when chock modifications are already in the plan — thus reducing the cost of implementing safe handling features.

The two lifting devices that commonly appear in bearing manufacturers’ catalogs for use in lifting assemblies are shown in Fig. 3: the three-legged and the sliding-foot fixture. The three-legged fixture maintains concentricity of the bearing components for installation and removal of an entire assembly, depending on the assembly configuration and the length of the foot design of the fixture. The sliding-foot fixture may be designed for lifting entire assemblies, and may be used primarily as a disassembly fixture because it does not force alignment of the bearing races.

Bearing Features to Aid in Lifting: Type TQO and 2TDIW — With proper training and minimal special equipment, smaller bearing products can be lifted by hand and easily assembled. But as bearings become larger, the need for lifting fixtures and handling tools is greatly increased because of the bearings’ weight and size, and the space available to lift the bearing races and/or entire assemblies.

Sliding-foot lifting fixtures engage the bottom row of the bearing assembly. Adding a relief in the chock shoulder provides clearance for the foot to properly engage the face of the outer ring for removal of the entire bearing assembly at once, as shown in Fig. 4. This lifting configuration allows the bearing assembly to be stacked outside the chock and removes the potential for raceway damage, such as nicking the race and rollers during installation. Note that sliding-foot
fixtures require a top sliding-foot plate to force alignment of the double cones. Limitations to this lifting configuration include overhead crane capacity, availability of a proper lifting device, or availability of machined reliefs in the chock to allow for the feet to engage the bottom row. Such limitations reinforce the need to evaluate existing handling practices during mill upgrades, as more than chock modifications may be necessary to improve the mill’s procedures.

When less than the entire assembly is lifted, additional bearing features may aid in lifting and removal.

The options for removing individual races are many, so consult with the bearing supplier about adding a specific feature that fits with the current available lifting fixtures, or consider a new lifting device made to the standards discussed later in this paper.

Fig. 5 shows some representative design features that may be added to bearing components to improve the ease and safety of lifting individual bearing components. For example, tapped holes in the face of the bearing race allow for eyebolt and chain lifting of components. Blind holes in the bore of the double-row inner ring allow the use of turnbuckle-style lifting devices. Grooves in the bore of the double-row inner ring allow the use of sliding-foot lifting devices.

Contact the bearing manufacturer before considering lifting features. Depending on the bearing design, adding lifting features may compromise the bearing’s integrity.

**Bearing Features to Aid in Lifting: Type TQIT and TQITS** — Tapered bore four-row tapered roller bearings (type TQIT/TQITS) are used only at the backup roll position, and therefore are larger in size. Using bearings of this type and size in manufacturing requires the use of pin-type cages, where two machined steel rings are used in conjunction with steel pins that pass through the center of the rollers. This method of roller retention allows the cage rings to be threaded for use with eyebolts and standard lifting chains to properly engage the eyebolts (see Fig. 7). The outer races are not typically supplied with tapped holes for lifting them individually, and should be lifted with the inner rings. The steps used to lift the inner and outer rings together are shown in Fig. 6. This lifting process eliminates the need for lifting holes in the bearing outer races.

**Bearing Features to Aid in Lifting: Four-Row Cylindrical Bearings** — Four-row cylindrical bearings come in one of two basic construction types: finger-type cage or pin-type cage (as shown in Fig. 8). The finger-type cage style is available on smaller bearings, which can typically be lifted by hand and assembled with standard tools and proper training. For pin-type cages, the lifting procedure is similar to the TQIT- or TQITS-type bearings, where the outer rings are lifted out of the housing using eyebolts installed in the cage rings, allowing the roller complement to lift the outer race out of the housing. The inner races are typically press-fit on the roll and do not require separate handling at roll changes.
Lifting Fixture Design Standards — Safety has been a concern in the lifting industry since 1916, when an eight-page “Code of Safety Standards for Cranes” was prepared by an American Society of Mechanical Engineers (ASME) committee. Meetings, discussions and improvements on this code took place from 1916 to 1943, with the involvement of multiple organizations including ASME, the American National Standards Institute (ANSI), the American Standards Association (ASA), and the U.S. Department of Labor and Industry.

In 1943, the ASA B30.2-1943 Code was published, and included safety provisions for a multitude of equipment types. Throughout the following years, the ASA B30.2-1943 format was changed so that different equipment types could be addressed in different volumes. The B30.2 code evolved into the current ASME B30 Standard. B30.20 was first published in 1985 as a separate volume of the ASME B30 Standard.

The industry has also expressed a need for a comprehensive design standard for below-the-hook lifting devices that would complement the safety requirements of ASME B30.20. A design task group was created in 1997 that evolved into the BTH-1 Standards Committee in 1999. The first edition of the BTH-1 Standard was published in 2006.

Today, the two ASME standards that govern the lifting industry are BTH-1-2017 and B30.20-2018.

BTH-1 provides minimum structural and mechanical design and electrical component selection criteria for below-the-hook lifting devices. The provisions in this standard apply to the design of new
or modification of existing lifting devices. BTH-1 addresses only design requirements. The design criteria set forth are minimum requirements that may be strengthened at the discretion of the lifting device manufacturer or a qualified person.

Lifting devices designed to the BTH-1 standard must comply with ASME B30.20, “Below-the-Hook Lifting Devices.” B30.20 offers comprehensive provisions that apply to the marking, construction, installation, inspection, testing, maintenance and operation of below-the-hook lifting devices: structural and mechanical lifters, vacuum lifters, close-proximity and remotely operated lifting magnets, scrap and material handling grapples, and clamps.

In simple terms, ASME states that a below-the-hook lifting device is “a device used for attaching a load to a hoist. The device may contain components such as slings, hooks, and rigging hardware…” Bearing lifters fall into the category of below-the-hook lifting devices.

Custom-built below-the-hook lifting devices like bearing lifters are very common. These lifting devices are built for picking and moving a very specific load, taking into consideration its size, shape, center of gravity, etc. Manufacturers can partner with the customer to develop completely new devices from scratch, or may modify an existing product design for the customer’s specific lifting needs.

Conclusions

There are many bearing configurations used for supporting roll neck loads, where each load may have a unique lifting configuration and sequence. Improving handling practices for roll neck bearings both improves safety and reduces handling damage, which leads to improved service life and reduced safety incidents. Often, adding features to the bearings or chocks to facilitate lifting fixtures can greatly improve the safety and efficiency of the lifting process. Mill upgrades and new chock orders are perfect times to evaluate existing practices and include these features as necessary.

Guidelines for designing below-the-hook lifting devices were first published in 2006. Any existing lifters that pre-date this publication are not designed to current standard requirements. Evaluating roll shop procedures and practices helps guide users to specific lifting device styles. With updated design standards, new lifting tools may be incorporated to improve worker safety and reduce handling damage to vital components of the mill machinery.

References


Did You Know?

SSAB Launches Strenx® 1100 Plus for Stronger and Lighter Lifting Equipment

SSAB has introduced a new grade of hot-rolled strip grade designed for applications that require welded joints, particularly lifting equipment.

Part of the 1,100 MPa range of Strenx performance steels, Strenx® 1100 Plus brings advances in weld seam strength that are ideal for the lifting sector. This new steel grade gives customers and end users lighter yet stronger equipment that can reach farther, increase payload and improve fuel economy. Strenx 1100 Plus is designed to help boost overall performance and productivity.

Traditionally, weld seams can represent weak links in the highest grades of structural steels such as S1100 and S900. But with Strenx 1100 Plus, such weld weaknesses are virtually eliminated because the strength, elongation and impact toughness properties of the welded area meet the minimum guarantees of the base material.

The optimal combination of strength and toughness of the welded and heat-affected area offers a major benefit to the design engineering process. The design can be based on the same minimum static strength for the entire application, depending on the design rules. It is ideal for lifting equipments and advanced structures that require matching strength in the welds. Strenx 1100 Plus is designed for the applications that require welded joints.

Strenx 1100 Plus offers the following benefits:

• An exceptionally clean steel and a precisely controlled production process means consistently high quality and predictable results.
• Guaranteed flatness, thickness and bendability.
• Tight tolerances.
• The recommended heat input interval is very wide.
• Strenx 1100 Plus does not require any pre-heating when welded.
• Optimal combination of strength and toughness in the welded area and heat-affected zone.