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A Maintenance-Free Splice for Belt Bucket Elevators

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Summary

The application of belting for bucket elevator service is a small part of a giant industry. In the U.S. alone, elevator belting is less than 5% of the total material handling belting sold for industrial applications. Although it is a small amount, it plays an important role in specialized applications such as the manufacture of cement. This article will explore some of the basic options of bucket elevator belting and will examine in detail the critical aspects of belt splices.

1. Introduction

Belt bucket elevators are normally constructed with either a fabric carcass belting or steel cable belting. The fabric carcass (usually polyester or nylon) is preferred because of:

a) lower initial cost,
b) bolt retention characteristics,
c) ready availability.

Steel cable belting is used for its:

a) high load capacity,
b) lower stretch properties.

Regardless of belt construction, the elevator can perform only as reliably as the splice joining the belt ends together.

The polyester (synthetic) carcass with PVC covers is used when the temperature of the material handled is less than 200°F. Temperatures of 200—400°F require specially compounded rubbers for the cover material. Belting of the single-ply construction, with its interwoven construction, provides superior fastener retention.

Particularly for bucket elevator service, belting with a fabric carcass possesses one undesirable characteristic — elongation or stretch. Depending on the carcass material and type of weave, stretch can vary from 2% to 3.5%. On a 200 ft tall elevator, this can mean removal of up to 14 ft of belting before stabilization. The design of the elevator takeup must minimize resplicing and permit removal of as much belting as possible, usually 4—5 ft with each resplicing. Removal of this initial stretch through resplicing demands the splice be of simple construction for quick replacement.

Steel cable belting is used to minimize stretch, provide load ratings in excess of 1,200 piw*, and, for certain high temperature applications. For a 200 ft tall elevator, the total belt elongation should not exceed 1% or 4 ft of growth. A properly designed elevator will allow for this growth and not require resplicing.

2. Common Belt Bucket Elevator Splices

The four most common splices used in belt bucket elevators are:

1. the oil well splice (Fig. 1),
2. the segmental clamp (Fig. 2),
3. the European clamp (Fig. 3),
4. the butt strap (Fig. 4).

1. The oil well splice (Fig. 1) is for thin, light-duty, fabric elevator belts, commonly referred to as industrial duty elevators. For this type of splice, belt ratings are reduced as much as 50%.

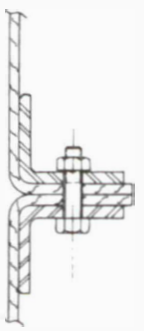

Fig. 1: Oil well clamp

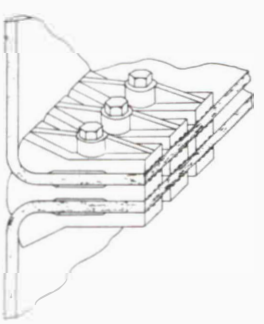

Fig. 2: Segmented clamp

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* pounds per inch of belt width

2. The segmental clamp splice (Fig. 2) is used on heavy duty fabric belts up to 1,200 piw rating. The segments can be varied in quantity to match a standard belt width. When using this type of splice, the belt ratings are reduced as much as 60 %.
3. The European clamp splice (Fig. 3) is used on both fabric belting and steel cable belting. This splice is varied in cross-section to match belting thickness. It can be modified to accommodate steel cable belting by providing a trough to contain the exposed ends of the cable, which are "cast in" (babbitted) to aid in restraining the belt. Reduction of fabric belt rating would be proportional to the cross-sectional area of belting removed for fastener holes. For a fabric belt 20 in. wide with 18 in. wide buckets and a B8 punching with 5/16″ dia. fasteners (seven 3/8″ dia. holes), the working load would be reduced 7 x 0.375 divided by 20 = 0.131 or 13.1 %.
4. The butt strap splice (Fig. 4) is common for fabric belts and recommended for high tension service by many belting manufacturers. This splice is most difficult to install and requires precise positioning of the fasteners in the strap material. It is not uncommon for this splice to require as much as 40 hours to install.

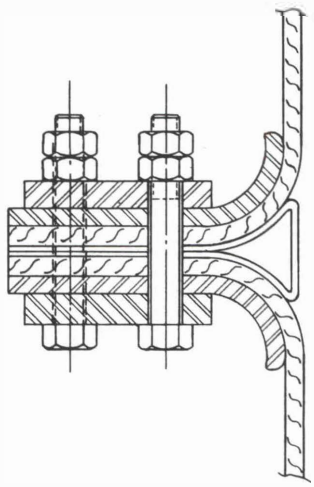

Fig. 3: European clamp

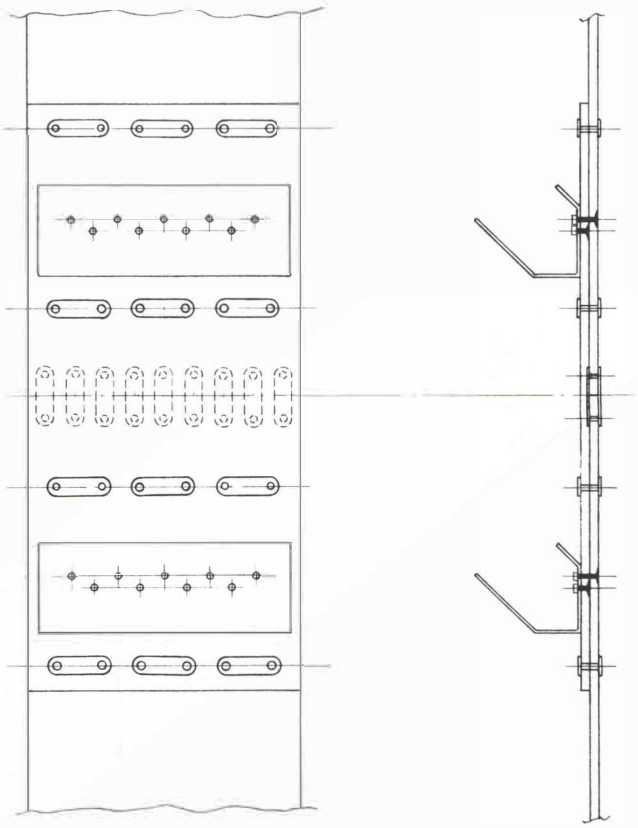

Fig. 4: Butt-strap splice

A distinct disadvantage of the butt strap splice is the shear force which is induced in the fasteners by the double thickness of (strap and main) belting passing over the head pulley. The cyclic nature of this load creates a potential fatigue problem with the fasteners.

The clamp type splices are subject to fatigue failure of the primary fasteners unless a disciplined maintenance program is followed to inspect and retorque the fasteners. This is essential due to cyclic loads which precipitate fatigue failure of the clamp fasteners.

For continuous process industries, such as the manufacture of cement, the frequent maintenance of belt splices is costly. During startup of a new system or replacement with a new belt, it may be necessary to resplice two or three times to remove initial stretch in a fabric belt.

3. The REX Splice

In response to problems with some belt elevator splices used in the belting industry, the Conveying Equipment Operation of Rexnord Inc. began a development program to design a splice which would meet the reliability requirements of the cement industry and, at the same time, permit the use of conventional fabric belting.

The program began with an evaluation of the splices used in the belting industry. The butt strap splice was not desirable because of its complexity and length of time required for installation. The clamp type designs provided the appealing features of compactness and ease of installation.

Variations of the three common clamp type splices were fatigue tested. The splices were subjected to a load variation from 45 piw to 1,000 piw, as is typically experienced within an elevator going from the bottom to the top. All demonstrated the same weakness, a premature fatigue failure of the clamp fasteners. Failures initiated in as few as 5,000 load cycles, which corresponds to 110 hours actual operation for a 200 foot center elevator.

By incorporating design principles used in the construction of their rugged cement mill elevator chains, Rexnord has developed a splice (Fig. 5) which does not subject the fasteners to the cyclic loads therein, eliminating the fatigue failures.

4. Operating Experience

The REX splice was tested with the same 45 piw to 1,000 piw load variation as the clamp splices. No failure was experienced, either in belting or the splice fasteners. The tests were terminated after the equivalent of 7.6 years operation for a 200 foot elevator.

In addition to testing at Rexnord, the splice has been successfully tested at a major belting manufacturer. This test was to determine the splice flexing ability and was run over two 20 inch diameter pulleys while under tension. The splice endured more than 3.4 million flexes. Both the splice and the belt were in good condition at the termination of the test. The results indicated that fabric belting and the REX splice operate successfully together and should provide good service in mill-duty applications. The REX splice was recently commissioned in a 193 ft tall belt elevator at a cement plant in California. The unit has 30 in. wide buckets and a capacity of

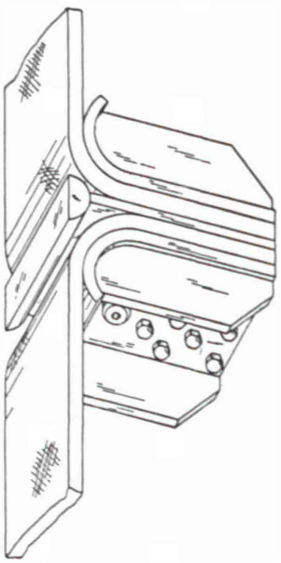

Fig. 5: REX splice

over 14,400 ft³/h of raw meal. Another cement plant on the East Coast recently began operation with a 192 ft tall belt elevator handling 135 t/h of mill product.

The REX splice is designed for quick resplicing (4 to 6 hours maximum) that can be done by two men with common tools. The splice is compact, does not extend beyond the bucket lip. It is designed to reuse bucket bolt holes in fabric belting to minimize holes in the belt. Most importantly, the REX splice has been designed to eliminate maintenance for the life of the belt.

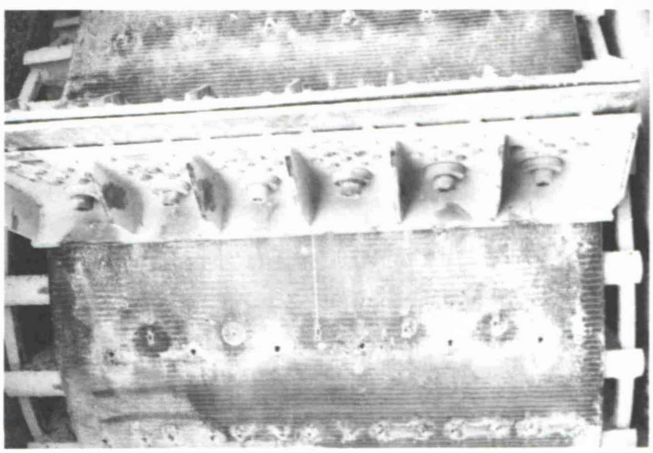

Fig. 6: REX splice installed in a cement mill bucket elevator (Patent applied for)