The ESG Report

FALL 2008

TRIM CHAINS

Early this year we received an email from Roger Bardwell, P.E. of Hudson Scenic Studio, in which he asked us to discuss overhead lifting with respect to trim chain. Roger asked about a distinction between alloy chain and Grade 30 proof coil chain, specifically if Grade 30 proof coil chain is acceptable for use in a trim chain assembly. In this edition of the ESG Report we'll explore this topic. Thanks Roger for taking time to send us your thoughts and suggestions.

In a typical counterweight rigging lineset, the connection between the batten and the arbor is accomplished by several wire rope lift lines, equidistantly spaced along the batten length. In principal, the equidistant lift line spacing provides uniform support. In reality, when loads are attached to the batten, the wire ropes often stretch enough to create a leveling problem. Imagine a suspended scenery element intended to represent a doorway. If it hangs just slightly off plumb, the result may be visually undesirable, so we need a method to compensate for this. Trim chains attached between the batten and the lift lines are a method to accomplish this.

FORM AND FUNCTION

A trim chain assembly is a short length of chain that can be wrapped around a pipe batten, forming a sling of sorts between the batten and a lift line, allowing the user to compensate for stretch in the lift lines. For our readers who are not familiar with what a trim chain is, we've included a schematic diagram of one (see Figure 1). Trim chain configuration:

- Each end of the load-carrying part of the trim chain is attached to the lift line eye, NOT back onto the chain itself. This is critical to ensure a (correct) double load path through the chain assembly.
- The chain is wrapped 1½ times around the pipe batten. While this does nothing for the load path, functionally it helps keep the batten from rotating.
- One end of the chain is permanently connected into the lift line eye; the other uses a screw pin shackle. This connection is generic and is intended only to illustrate the adjustable nature of the connection. Other connection methods can work.

The trim chain assembly helps compensate for batten deflection, which naturally occurs as loads are added or removed from the batten.

PRACTICAL USE

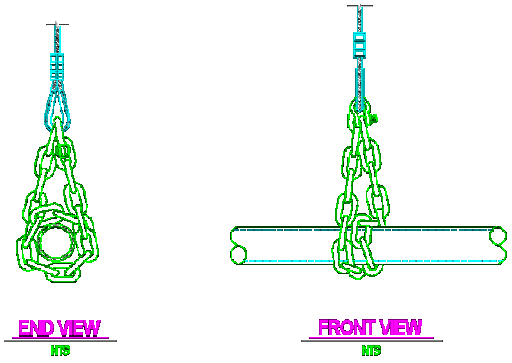
Many methods have been used to level a batten. Many of you are familiar with the classic spring-loaded dog collar snap clip method shown in Figure 2 – which we hope you condemned because, while they might provide a cheap and easy way to quickly make these adjustments, they are inherently unsafe. We say "unsafe" because those clips typically have no load rating – we want a load rating on every component in the tension load path. While snap clips might work in the practical sense, they don't work from the safety perspective. But our article isn't about clips, or even about the entire assembly; it's about the chain itself, and about how the concept of overhead lifting may or may not apply to a trim chain application. Here's where we sift through the available information to dispel a few myths about trim chains and overhead lifting.

OVERHEAD LIFTING

All too often, people get confused by the term "overhead lifting." At first glance, it might be aptly applied to anything suspended overhead, but term overhead lifting is a very explicitly defined term in the chain industry and is applied in very explicit ways. We start with the National Association of Chain Manufacturers (NACM) Welded Steel Chain Specifications, as adopted by the association on 28 September 2005. Section 3.4 of the definitions states, *Overhead Lifting: that process of lifting that would elevate a freely suspended load to such a position that dropping the load would present a possibility of bodily injury or property damage.*

This is a widely recognized specification, but we wanted to know what federal regulations might have to say, so we went to the OSHA website and found a singular reference to the term overhead lifting. It's footnote (1) to Table H-1 – *Rated Capacity (Working Load Limit), for Alloy Steel Chain Slings* as found in 29 CFR 1926.251 (f)(1). The note says, *"Other grades of proof tested steel chain include Proof Coil, BBB Coil and Hi-Test Chain. These grades are not recommended for overhead*

Figure 1



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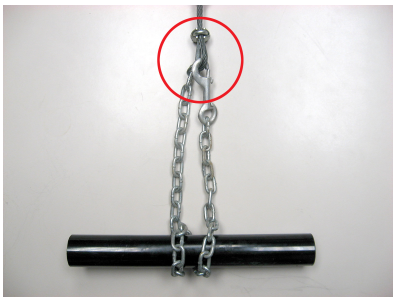
lifting and therefore are not covered by this code." It is interesting to note that OSHA does not define overhead lifting, but that is probably not so important when a precedent definition can be found in other commonly recognized standards.

We know references to the term also appear in several other national standards, but are specifically relevant to chain in such standards as ASME B30.9-2006 *Slings,* ASTM A906/ A906M-02 *Standard Specification for Grade 80 and Grade 100 Alloy Steel Chain Slings for Overhead Lifting.* Those standards pertain only to alloy chain and also use the NACM definition of overhead lifting given above.

FREELY SUSPENDED

The wording is clear; by our interpretation it was carefully written to cover very specific applications wherein the notable wording "freely suspended" must apply. Whether or not something is freely suspended is a critical aspect of determining suitability for a trim chain application, and one that is nearly always overlooked in discussions about trim chains. Understanding the implications of freely suspended is important. By standard definitions, it implies a concept of hanging something in an unrestrained manner or without restriction or limits. We can easily interpret how NACM standards and OSHA regulations are intended to apply to circumstances such as those present on construction sites: a crane lifting a load on a single (freely suspended) cable. This isn't to say that one cannot apply the concepts to other situations, but in the case of trim chain applications the wording can be misleading. This is where interpretation by qualified persons is important to satisfying the requirements of both OSHA and national specifications and standards. All of the standards and regulations we reviewed contain provisions permitting the suitability for a specific application to be determined by the chain manufacturer or by a qualified person (such as a professional engineer).

Figure 2



GRADE 30 PROOF COIL CHAIN

Aside from having a manufacturer's approval, the best way to approach this discussion is by offering a basis for why we think Grade 30 Proof Coil Chain is acceptable, from an engineering perspective.

First, we do not think that a counterweight rigging system constitutes a freely suspended condition. In that application the suspension system is comprised of multiple load sharing elements – the lift lines spaced along a batten – rather than a single load path more commonly associated with a crane on a construction site. Twist in the chain is also an important factor, as a freely suspended load has no way to resist forces that could twist or otherwise rotate a load suspended on a single load-bearing chain or cable. Since a batten is always suspended by more than one lift line, we can eliminate those factors normally associated with freely suspended.

Second, load rated components permit us to evaluate the actual forces based on manufacturer's working load limits, or to calculate allowable stresses based on material properties. The NACM *Welded Link Chain Specifications* requires that proof coil chain be consistently marked along its length which essentially certifies that the chain meets NACM material properties and minimum strength characteristics. This in turn ensures that the manufacturers working load ratings can be relied upon.

Third, the actual working load on any line in a multiple-line counterweight system is considerably lower than the working load limits set by the component manufacturers. This results in design factors far exceeding those normally used in the entertainment industry. The industry standard 1/4" wire rope has an average breaking strength of 7,000 lbs. The accepted minimum design factor of 8:1 (relative to average breaking strength) permits a working load limit of 875 lbs. 5/16" Grade 30 proof coil chain has a working load limit of 1,900 lbs – over twice the allowable working load limit of the wire rope, increased even more by the fact that a correctly configured trim chain assembly results in the loads being supported by a double load path of chain. The NACM specifications require a minimum breaking strength of 7,600 lbs (a 4:1 design factor based on the working load limit), so a typical trim chain assembly represents a minimum design factor of over 16:1 when compared with the actual working load permitted by the wire rope size. The resulting design factor is easily adequate for an 875 lb load.

In discussions with engineering professionals familiar with entertainment environments, there was no safety concern associated with the use of Grade 30 Proof Coil Chain when used in a properly configured trim chain assembly. Destructive testing has proven that the wire rope itself always fails first in a correctly configured assembly.

SAFETY

No discussion about overhead lifting and the suitability of any type of chain would be complete without discussing the overall ramifications of safety. While the typical application described here represents no specific concern, it is only our interpretation of the available information. Each situation should be evaluated on the basis of its own merits and usage limitations. ESG is considered qualified by all applicable standards to make decisions regarding suitability, but that is not to say one cannot or should not use alloy chain, or any other chain having a higher rating – up to and including being rated for overhead lifting as defined by NACM. Practically, alloy chain link dimensions present issues with compatibility of connecting components; the links are simply too small to accommodate a commonly used connection method. Cost is also a consideration, especially when a rigging contractor may require thousands of feet of chain at a per-foot cost difference of several dollars. However, that additional cost might be what it takes to buy peace of mind – a small price to pay for keeping people safe.

Tell us what you think. We're listening.