By Erik Viker

Things fall down unless we take steps to prevent them from doing so. In the theatre, we suspend scenery, lighting instruments and curtains overhead, depending on top-quality hardware and equipment to guarantee safety and efficiency. This article may familiarize the reader with rigging components commonly used in the theatre, but cannot substitute for reliable training and personal responsibility. Theatre practitioners should be thoroughly trained by reputable experts in the field before using rigging materials, as it is important to understand the basic structural design properties of any material used for rigging scenery or lighting equipment. Rope, cable, chain and fasteners all have a certain breaking strength, the average force at which the material fails. A safety factor (usually one-fifth to one-tenth of breaking strength) must be applied to any rigging equipment or hardware used; for example, if the breaking strength of a certain rope is one thousand pounds, its working load limit might be two hundred pounds. Trustworthy rigging hardware manufacturers clearly mark working load limits on their products or provide the information at purchasing.

Common Rigging Hardware

An anchor shackle is a U-shaped steel bow with a removable pin (often threaded for secure attachment) engineered to provide substantial strength for overhead rigging applications. For example, the ¼-inch screw pin anchor shackle manufactured by the Crosby Group has a working load limit of half a ton. Shackle drawbacks include their potentially inconvenient two-part construction and the need to carefully align all loads. To make certain the shackle’s full strength is available, the load direction must run through the pin and the curve of the bow section, rather than sideways, which places strain on the “arms” of the shackle.

A locking link (or Quick-Link) resembles a chain link with a gap on one side closed by a threaded sleeve. Although locking links are frequently used for light loads due to their convenient one-piece design and self-orienting shape, many theatre technicians believe locking links are not as trustworthy as shackles.

In some cases, turnbuckles can be used to easily level a scenery piece. Turnbuckles are usually steel frames around two threaded eyebolts, which can be lengthened or shortened by turning the frame. The turnbuckle is attached to one end of the lifting line of the scenery rigging, becoming part of the total line length needed to fly the scenery piece.

Carabiners, steel loops with spring-loaded latches often secured with an additional threaded sleeve, originated as rock-climbing gear and have become popular for quick rigging applications. Only use versions rated for overhead lifting, as carabiner-shaped key chains are common, but cannot support even minimal loads.

Steel nuts and bolts often are used to secure chain around a pipe or other fastener, especially in permanent or semipermanent installations. Nuts and bolts used for rigging should be of the same hardened steel variety, Grade Five or higher, identified by radiating diagonal lines on the bolt head and curved lines on the nut.

Rope, Cable and Chain

Trim chain refers to short lengths of chain often used to connect scenery to batten pipes for flying purposes. Only fused link chain should be used for overhead rigging. Grade 3 proof coil chain is commonly employed as trim chain, as the ⅜-inch size has a working load limit of about 800 pounds. Chain allows lengths of each line to be adjusted individually in single chain link increments. Chain may be fastened with shackles, locking links or hardened steel bolts. Avoid using spring-latch “dog clips” or other hardware not rated for load-bearing purposes.

Wire rope is frequently used to suspend scenery from fly system battens. The variety known as 7 x 19 aircraft cable (manufactured with seven strands of nineteen wires each) is common in the theatre and is available with black powder coating to make it less visible from a distance. Aircraft cable of the 7 x 19 variety that is ¼-inch in diameter has a
working load limit of about 240–300 pounds, depending on manufacturer and type.

Rope has been used in theatre rigging for countless decades and comes in many varieties, sizes and strengths. It is important to know the working load limit of any rope used in the theatre. Although *manila rope* is inexpensive and strong enough for many rigging applications, it tends to leave tiny splinters in unprotected hands and wears out more quickly over time than do other ropes. *Synthetic ropes* such as StageSet X (a very strong braided rope with a polyester core) and Multiline II (a twisted three-strand rope) are increasingly popular for lifting, static rigging and general theatre work. At 3/8-inch diameter, manila rope has a WLL of about 650 pounds, compared to 2,300 pounds and 1,175 pounds for StageSet X and Multiline II, respectively.

Several basic knots and hitches can meet most rope rigging needs in the theatre, with the *clove hitch* and the *bowline* being two of the most versatile. Remember, a knot reduces rope strength by approximately 50%, and a hitch reduces rope strength by about 25%. The *Backstage Handbook* by Paul Carter (Broadway Press) offers helpful knot tying diagrams for many common theatre knots.

Cables, ropes or chains can be attached to scenery with D-rings, "hanging irons" or eye bolts. Hardware attached to scenery should be fastened by bolting entirely through the scenery framing structure (not with drywall or wood screws). If eyebolts are used, they should be the forged-closed variety. Even simple masking curtains or fabric drapes need careful planning before flying them overhead. Never underestimate how heavy fabric can be, especially the thick velour used for masking curtains. Ensure that soft goods are attached to supporting structures such as scenery battens with an adequate number of ties. Most professionally sewn theatre curtains include grommets and ties every twelve inches along the upper hem, which is reinforced with jute or vinyl webbing. Most often #4 black cotton tie line (or trick line) is used for this and many other light-load applications, but care should be taken when using tie line in the theatre because it has essentially the same strength as a shoelace and may not be rated for load-bearing purposes by manufacturers.

*Swaging sleeves* are copper or stainless steel oval tubes crimped onto the doubled-over end of aircraft cable to form closed loops, usually enclosing steel support channels called *thimbles*. A thimble
keeps the swaged cable from kinking too sharply, which would reduce the cable strength. After swaging, a “go-gauge” measuring the resulting sleeve thickness is applied to each sleeve to make sure it has been adequately crimped. If correctly applied with a swaging tool, the copper sleeve results in a connection only slightly less strong than the original cable and creates an end loop suitable for shackles or other hardware attachment. An alternative method for making end loops in wire rope is the wire rope clip or cable clip, a U-shaped bolt with two hex nuts holding a saddle engineered to grip the cable. Ideally, wire rope clips are installed with a torque wrench to ensure adequate torque on each nut and should be applied carefully to clamp the saddle to the load-bearing or “live” side of the termination loop.

Polyester slings often are used to suspend lighting trusses or other heavy equipment overhead in conjunction with wire rope or chain. Slings have working load limits upward of 2,000 pounds, depending on the configuration in which they are used. Reliable products include the SpanSet Stagesling and the Tuflex Roundsling. Of course, novice riggers should consult experts before attempting to work with such heavy loads.

Rigging Systems

Some of the hardware and equipment described here can be used to install static or dead-hung scenery in your theatre where no scenery movement is necessary or when simple masking is required. Many theatres are equipped with counterweight rigging systems comprised of flown battens of Schedule 40 steel pipe held up by wire rope lift lines running over an arrangement of overhead sheaves (pulleys). Each batten is counterweighted by an arbor, a vertical rack holding removable steel weights, which is raised or lowered by a rope control line to move the batten and any attached scenery. Some of the hardware described in this article may be used to fasten scenery to counterweight battens, but only technicians who have been thoroughly instructed in their use should operate counterweight-rigging systems. The Stage Rigging Handbook by Jay O. Glerum (Southern Illinois University Press) provides extensive information about the complexities of counterweight-rigging systems, and several theatrical equipment companies such as Sapsis Rigging Inc. offer seminars on rigging system operations. Any time rigging requires work where no railings exist to prevent a fall, use a fall arrest device such as the CMC ProTech rigger’s harness or the DBI crossover full body harness.

Even experienced riggers should never work alone, and it is best to have another technician check your work before putting any rigging into service.

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