Design, arrangement of rig floor tugger derrick sheave blocks change as drilling goes deeper

By Jeff Shepard, GlobalSantaFe Corp

THE DESIGN AND arrangement of derrick sheave blocks used with rig floor tuggers is important to the safety of rig floor personnel. The use of snatch blocks in the derrick to suspend rig floor tugger lines has been and is still common practice. Typical snatch block design allows for one of the cheek plates to be easily disengaged and swiveled out of the way to allow quick reeving of the wire rope on and off the sheave. Their light weight also allows for easier handling by personnel suspended by a riding belt. Snatch block design safety factors have also traditionally provided an adequate margin of safety as long as their safe working load was equal to or greater than the tugger capacity. However, on larger, high-capacity rigs used to drill deeper wells, there has been an increase in loading on derrick sheave blocks because:

Trends on high-capacity, larger rigs used to drill deeper wells have changed design requirements for derrick tugger sheaves and their arrangement in the derrick.

• Higher-capacity equipment and tools have resulted in a dramatic increase in tugger capacity;

• Increased use of top drives and footage of tubular goods that occupy the setback area has severely reduced the working space inside the derrick, which has increased the risk of snagging tugger lines on traveling equipment; and

• Restrictions are being imposed on man-riding operations to ensure safe operations.

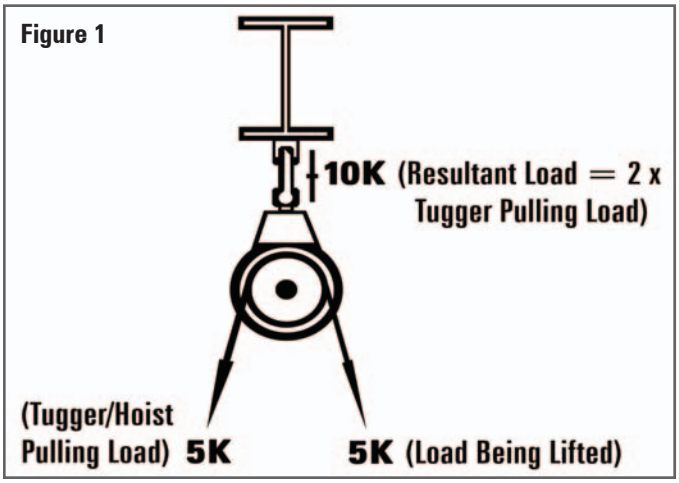
Because of these trends, design requirements for derrick tugger sheaves and their arrangement in the derrick have changed. In addition, the resultant load must be considered when selecting derrick sheave blocks as illustrated in figure 1.

WORST-CASE LOADING SCENARIO

The worst-case loading scenario is incurred when the working end of a tugger line is snagged while the traveling blocks are coming down and the tugger brake is set. In this case, the forces exerted on the line can exceed the breaking strength of the wire rope. The resultant load on the sheave block can amount to twice the breaking strength of the wire rope if the sheave block does not fail first and fall to the rig floor.

Even if this does not occur, it is still possible that the pad-eye securing the sheave block to the derrick structure, as well as the derrick structure itself, could fail under this scenario. Therefore, pad-eyes used to attach tugger sheave blocks to the derrick should be designed to AISC (American Institute of Steel Construction) standards so that the rated load of the pad-eye is twice the stall pull rating of the tugger. The derrick structure that the pad-eye is attached to should also be analyzed to ensure the derrick member has sufficient strength to withstand these loads.

Figure 1



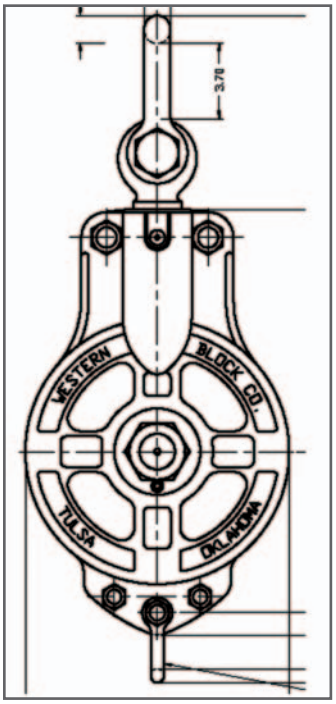


Figure 2: Full-Sided Cargo Block

When the tugger – and the tugger wire – and derrick sheave block is viewed as a system, the preference is that the wire rope should be the weaker link under this scenario. By selecting a tugger wire rope that will break before damage is done to any other part of the system, it can be replaced with confidence that expensive and time-consuming inspections and replacement of sheave blocks and pad-eyes will be avoided.

However, the wire rope breaking strength must still exceed the maximum pulling force of the tugger. For example, if a 5-ton Western Type Cargo Block that has a 5-to-1 safety factor based on the resultant load of 10 tons is selected, it can theoretically withstand a resultant load of 50 tons without damage. To ensure the wire rope will break before sheave block damage is incurred, it must have a breaking force that is less than 25 tons but more than the tugger stall pull rating. Wire rope selected to break between these two limits would then be considered optimum.

In any case, there is a growing need for higher capacity sheave blocks with improved design safety factors. For this reason, Full-Sided Cargo Blocks (figure 2) are replacing conventional snatch blocks because of the following features:

• Higher strength materials allow higher load capacities to choose from and preserve the safety factor of these sheave blocks at 5-to-1 against the resultant load;

• 4 bolts secure the cheek plates, providing improved protection from the cheek plates disengaging from the sheave block assembly;

• Built-in swivels prevent twisting the sheave block while in service;

• Anti-friction bearings are installed on the shaft as well as the swivel to provide improved reliability and longer service life;

• An additional shackle can be fitted to the bottom of the sheave block for the attachment of a safety line without having to weld on pad-eyes;

• Sheave diameters of these sheave blocks are larger than conventional snatch blocks, which allow for increased wire rope life;

• Tight clearances between the sheave and the cheek plates prevent the wire rope from jumping off the sheave and incurring damage;

• Sheave pins are held in place with heavy duty nuts that are secured with set screws;

• Easy, quick visual inspection will reveal whether retaining devices such as split pins, R-pins, grub screws, or lock wire on all fasteners are missing or damaged.

If the design of the system guarantees that the wire rope will break first in the event of an overload, the safety sling for the sheave block assembly will not have to be sized to catch the sheave block and the tugger line at high loads. This is an important consideration because in most cases, safety slings simply cannot be large enough to withstand the high loads that are generated by stopping a falling sheave block at high line loads.

In fact, if the system is designed to ensure that the tugger wire rope will break first, it could be argued that there is no need for a safety line. However, a safety line is still recommended to prevent the sheave block from falling while it is being rigged on and off its derrick attachment. In this case, it only needs to be designed to catch the sheave block.

SUBSTITUTE 'WEAK LINK'

Finally, to reduce the risk of tugger wire rope failure with this arrangement, a substitute "weak link" is recommended to be fitted to the working end of the tugger wire. This could be a length of soft line with red or yellow "flags" attached that could alert the driller that the tugger line has been snagged by the traveling equipment. This would be affixed to the rig floor at all times and would be disconnected from the end of the tugger wire when the tugger in use.

A substitute "weak link" can be fitted to the working end of the tugger wire. It could be a colored, visual "flag" to indicate a line snag.

The design and arrangement discussed above should reduce the risk to rig floor personnel due to overloading. However, this increase in safety cannot be realized without a complete inspection and maintenance program. To allow quick and efficient visual inspections, all pins and fasteners used in derrick sheave blocks and safety sling assemblies – including all shackles, swivels, and other loose gear – should be fitted with retaining devices, such as cotter (split) pins or locking wire (cotter pins are preferred) to prevent such pins and fasteners from coming loose and allowing objects to fall to the rig floor. Such retaining devices shall be clearly visible from the outside without requiring any disassembly to facilitate easy visual confirmation that such devices are not damaged, deteriorated or missing.

Lubrication of the sheave block and swivel bearings should also be scheduled based on the sheave block manufacturer's recommendations or by historical experience.

In addition, an ongoing third party inspection and replacement of the rig floor tugger wire rope and loose gear such as shackles and swivels should be established. Regular nondestructive testing of the pad-eye used to secure the sheave block to the derrick, including its weldment and adjacent structure, should be performed by a qualified third party at regular intervals and immediately after an overload incident occurs. Finally, set intervals should be established to replace the derrick sheave blocks before they wear out with spare units that have been overhauled.

With a sound design basis and an adequate inspection and maintenance plan, safety incidents involved with this equipment can be greatly mitigated and move us forward to becoming an injury-free industry.

This article is adapted from a presentation made at the IADC Lifting and Mechanical Handling Conference & Exhibition, held 11-12 April in Houston.