

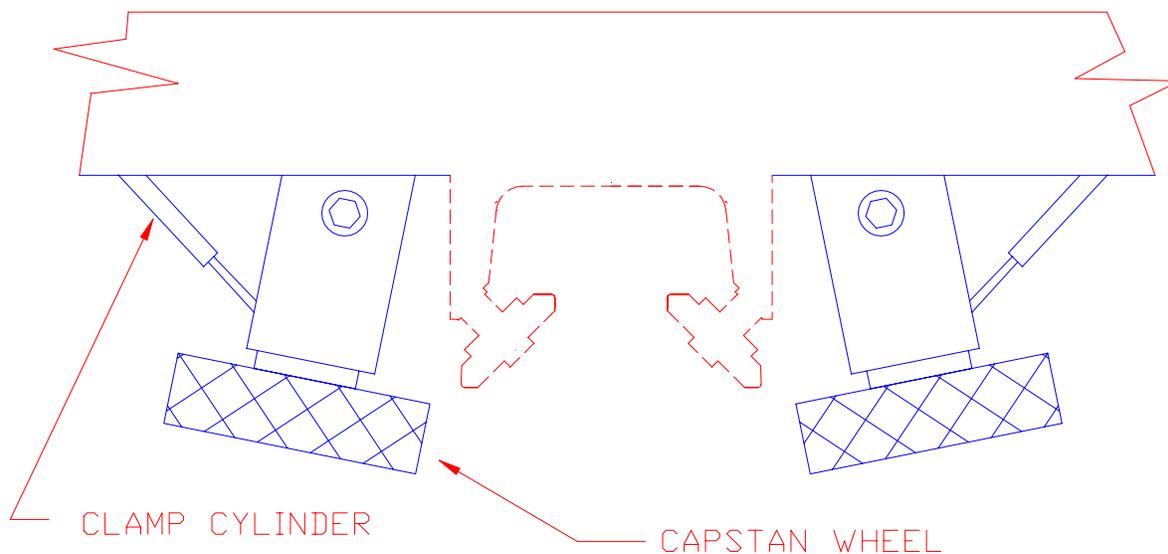
TECHNICAL
BRIEF

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TTM CAPSTAN SYSTEMS

During the normal operation of a Quickchange[®] Moveable Barrier System the QMB[®] barriers can migrate longitudinally due to topographic and mechanical forces. For example, barrier will tend to migrate down a hill, and will tend to migrate to some extent around curves. This is caused by gravity, by rolling resistance within the machine as the barrier passes over the conveyor system and to some extent by the springs and/or pusher plates contained in the hinge assemblies.

To counteract this tendency, TTM machines are equipped with a capstan system. This capstan system consists of a motor, two pumps, two large rubber "capstan" wheels mounted under the machines and a set of controls.



By proper utilization of the capstan system the forces of gravity, mechanical resistance and the springs can be overcome and the wall can be held in a constant longitudinal position. If the capstan system is not utilized properly or not utilized at all it is possible to build up excess barrier in valleys between hills and develop compressive forces within the barrier wall or to develop excess tension in the wall at the top of hills and at either the entrance or exit of a curve. It is therefore important that the operators understand how to use the capstan system.

An important and integral part of the capstan system is the marking of the barrier and the road so that it is possible to tell in which direction if any the barrier is migrating. When a wall is deployed for this first time, a set of reference marks are placed on the barrier. This typically consists of a vertical line 1 foot long 1 inch wide, on the lower part of the barrier, located in the middle of the barrier and corresponding line on the ground, perpendicular to the barrier, approximately one foot in length and an inch wide.

At the same time the barrier is typically numbered with a reference number indicating it's distance from the beginning of the wall or some known reference point. Typical spacing of these reference marks and reference barriers is approximately a tenth of a mile, but all key geometric points such as beginning and ending of curves, are also marked. In difficult locations (multiple curves, S-curves, tight radii, etc.) it is generally beneficial to make these marks at half-tenth mile increments. A typical set of reference marks might read 1.5, 1.55, 1.6, 1.65, 1.7, 1.8, etc., depending on the geometry of the specific road course. These reference marks allow accurate evaluation of wall condition and migration (or movement). The wall should typically be held to within 12 to 18 inches of original position.

The monitoring of this movement and compensation with the capstan system is one of the most important duties of the operators. It should be noted that the purpose of the capstan system is not to move the wall to make major corrections, but rather to maintain the wall in the neutral stable position as it was originally deployed.

Detailed, site specific instructions (or scripts) for appropriate use for the capstan are developed by the on site Barrier Systems Inc. representative during startup and training for each deployment. This initial "script" is then modified by the operators as they monitor any movement of the wall and make adjustments accordingly.

More detailed specific instructions on the operation and use of the capstan system are included in the Systems Operation Manual. It cannot be over emphasized that one of the most important duties of the operators is the use of the capstan system in conjunction with the barrier migration marks to control and monitor the migration of the wall.