The Detroit Hoist Gear Brake

The term ***Load Brake*** *has a long history and refers to various brake designs used in hoisting applications. The term is also used in industry specifications like CMAA and HMI. The perception of the usefulness and functionality of* ***load brakes*** *is largely determined by opinions based on prior experiences with traditional load brake designs. Obviously, the strongest opponents to* ***load brakes*** *are manufacturers of hoists that don't have* ***load brake*** *options. Most negative publications are obviously written to discredit the benefits of load brakes for the purpose of boosting sales for non-load brake hoists. Non-load brake hoists have been and remain the standard in the hoisting industry.*

Actually, many negative publications are true, when describing traditional load brakes with a pawl and ratchet design, combined with a screw type axial actuation. The inherent design problems of these conventional load brakes start with having small diameter friction surfaces and low coefficients of friction, while operating in oil. This requires high friction pressure to provide the torque to stop or decelerate a load from full speed. The high pressure leads to wear and the need for adjustment and maintenance. The pressure is typically created by the angle of a screw thread, internal to the load brake adjacent gear. The higher the required pressure, the lower the required angle. The lower the angle, the higher the screw-thread friction and therefore the slower the actuation and release speed of the load brake. The low thread angle is comparable with the functionality of a worm gear-set and therefore is subject to fatigue and failure under high pressure. Such failure will cause a breach in the hoist gear train and can result in freefall of the load. The low thread angle and high thread friction can also create thread lock and in turn will require peak motor torque to release the load brake, therefore rendering traditional load brakes poorly suitable for 'Variable Frequency Drive' controlled hoists.

As long as load brakes are not failsafe and as long as they require maintenance they will remain a poor choice for hoisting. In addition, the slow action of traditional load brakes and their limited torque to stop a load immediately, does not qualify them as holding brakes but merely as a "mechanical control braking means", according to CMAA. Nevertheless, using the principle of a torque differential between gears to mechanically actuate a brake, especially in a pure gravity application like hoisting, can be an excellent solution if it is executed correctly.

The ***Detroit Hoist Gear Brake*** *is applying the same principle of a torque differential between gears but that is where the similarities to conventional load brakes end. Most importantly, the* ***gear brake*** *stops the load immediately and therefore qualifies as a holding brake. The brake torque automatically adjusts to the actual load and the design factor for the brake is 150% based on full load conditions. The brake is engaged through chrome-finished ball bearings operating above 95% efficiency. They allow for instant actuation and release of the oil immersed Kevlar Composite dual friction clutch. The clutch operation is based on an oil shear principle. In contrast to motor brakes, the* ***gear brake*** *does not require adjustment or maintenance, it simply requires periodic oil changes. The locking mechanism consists of a multi element backstop with up to 37 locking elements to ensure even load distribution and to prevent wear. The back-stop* *engages instantly and locks within 1° of rotation. All back-stop components are carburized, induction hardened and precision ground. All friction surfaces engaged by the Kevlar composite friction clutch and all bearing surfaces engaged by the chrome finished ball bearings are ionitrided. The* ***gear brake*** *shaft is ground within .0005" and the bore of the adjacent first gear is honed within .0005". The unique design of all our* ***gear brake*** *components reduces the stresses mostly to compression, which makes our brake virtually failsafe, where conventional load brakes with an internal screw thread design are subject to wear and structural failure.*

The acceptance of squirrel cage motors as "inherent regenerative controlled braking means" by the governing agencies CMAA and HMI seem to qualify hoists with squirrel cage brake motors to be as safe as load brake hoists. This could only be argued if a load brake failure would result in a breach within the gear train since load brake hoists still have brake motors in addition to the load brake. Motor brakes can fail as well due to either lack of adjustment or maintenance and due to failure of brake components such as splines, shafts and actuators. Most importantly though, any regenerative controlled braking through a squirrel cage motor only works with current supplied to the motor which requires the manual pushbutton to be maintained during the entire braking process, otherwise the load will drop when the motor brake fails.

The ***Detroit Hoist Gear Brake*** *provides a much safer solution than conventional load brakes and squirrel cage brake motors alone. The* ***gear brake*** *engages just as fast as motor brakes and it stops the load instantly. Therefore it qualifies as a holding brake. The* ***gear brake*** *can't fail resulting in a breach within the gear train due to its inherent component design principle. And most importantly, every* ***Detroit Hoist Gear Brake*** *is monitored by* ***VFD and PLC Controls*** *that* ***monitor two important brake functions****:*

1) Monitoring the proper rotational speed of the rope drum. *The speed is controlled by a PLC that monitors pulse count input from a bearing encoder connected to the rope drum. If the speed of the drum would exceed the equivalent programmed synchronous speed of the motor then the PLC controlled VFD will either decelerate the motor to a stop or it will maintain minimum speed until the low limit position is reached. The program choice is based on customer preference and application specifics.*

2) Monitoring the load brake condition by measuring the energy generated by the descending load through the VFD. *This is achieved by comparing the AC current on the DC bus of the VFD with the limit setting for the VFD dynamic braking output. The squirrel cage hoist motor will act as a generator and send AC current to the DC bus of the VFD if it receives rotational energy from the load upon the motor shaft when lowering a load. The* ***gear brake*** *is designed to prevent that load energy from reaching the motor and the VFD monitors that dynamic condition. If the* ***gear brake*** *should lose even a little torque, resulting in slower braking, then the motor would generate enough energy for the VFD to detect and indicate the condition with a specific dynamic braking fault. The dynamic braking output of the VFD is always connected to a small dynamic braking resistor and the dynamic braking output is set to 2%. This is the energy leak threshold of the* ***gear brake****. The VFD monitors the braking speed of the* ***gear brake*** *and* *if the braking speed is not maintained then the energy leak can exceed the programmed threshold of 2% dynamic braking and the VFD will trip with a specific fault code. At this point the dynamic braking can be raised to 5% which is still less than 50% of the resistor capacity and the hoist will operate as normal. The VFD trip though should be the trigger to schedule a hoist inspection and it may indicate the need for an oil change or other conditions responsible for the delay in* ***gear brake*** *speed. The new* ***Detroit Hoist Gear Brakes*** *have been in service since 2011 and have not yet required any dynamic braking adjustments or inspections.*

The Detroit Hoist Conclusion for Hoist Brakes

Obviously, the least safe solutions for a hoist braking system would be a traditional design load brake without feedback controls or a contactor hoist with just a squirrel cage brake motor. Both can fail due to over-torque or continuous wear with the potential of freefall of the load. Without PLC/VFD controlled speed and brake torque monitoring it seems questionable that the "inherent regenerative controlled braking means" of a squirrel cage motor can provide braking redundancy because it is instantly disabled when power is cut from the motor just by releasing the pushbutton. The braking system of squirrel cage brake motors becomes much more sophisticated when used with VFD Vector Controls, speed sensors and dynamic braking through resistor banks or line voltage regeneration. Such braking systems do not use the motor brake to decelerate or stop the load, leaving the brake in a virtually unused condition, eliminating the most common cause of motor brake failure, which is wear and lack of maintenance.

Therefore, a failsafe ***gear brake*** *combined with a squirrel cage brake motor, monitored by PLC and VFD Vector controls with speed sensor input, is a superior solution for a hoist braking system and it is a* ***Detroit Hoist Standard****.*

Detroit Hoist *believes that it is the responsibility of the manufacturer to provide the best design options for their products but the final decision for choosing a hoist braking system ultimately remains with the customer.*