Elastomeric Draft Gear Reduces Coupling Forces

John F. Deppen
Director, Engineering
End-of-Car Systems
Amsted Rail
3420 Simpson Ferry Road; Camp Hill, PA; USA

Summary: A traditional draft gear uses friction to absorb energy, which is an inefficient mechanism, and is often constrained to absorbing forces much lower than the strength of the undercarriage of the railcar. In addition, these devices typically have low spring rates and free slack; all of which contribute to higher coupling forces and minimal protection to the freight car.

In heavy haul applications, certain types of freight cars that are normally equipped with conventional draft gears to protect car structure from coupling impact and in-train forces will experience lower coupler forces and accelerations by using elastomeric draft gears. One of these systems, the Twin-Pack®, is an elastomeric design that has greater capacity to absorb coupling and in-train shocks. This device has a stiffer spring rate, less slack, and an optimized stroke; all of which contribute to lower coupling forces, which is important for longer equipment life in heavy haul service.

Over-the-road train tests, yard impact studies, and sophisticated computer simulations have provided real-world data that there are lower forces and accelerations present with an elastomeric draft gear equipped train than for a conventional friction draft gear equipped train.

INTRODUCTION

The Amsted Rail Twin-Pack™ draft gear system uses an elastomeric compound (Key-Gard™) to manage coupler forces and energy. Although a departure from past multi-component designs, it is interchangeable with them in new and existing applications. By eliminating the conventional separate draft gear housing, yoke and follower, it virtually eliminates slack and reduces weight by 270 lbs per car set. By reducing the number of components, it promises to reduce the frequency and cost of maintenance and replacement and improve fuel savings.

Through its ability to manage coupler forces and energy in a different way than conventional draft gears, it reduces high levels of marshaling and in-train forces that cause excessive stress to the car body. The Twin-Pack™ gear utilizes non-linear elastomer pads as the cushioning media in both buff and draft. Rather than friction damping, energy absorption is accomplished through hysteresis within the elastomer pads. In addition to the high energy absorption capability, this allows a very smooth, and reliable action, in all impact and temperature situations.

Unlike conventional draft gear designs, that have identical performance in both buff and draft, Twin-Pack’s unique design allows for separate buff and draft performance. This capability creates the opportunity to tune the device for both yard and in-train performance.

Twin-Pack™ is Approved under M-901G draft gear specification and has been successfully used in many services and markets since 2001. Key-Gard™ elastomer has been in freight and passenger service since 1950 and is used exclusively in all OEM locomotive draft gears and other applications.
DESIGN REQUIREMENTS

The energy management objectives for any end-of-car device are to protect the car structure and sensitive lading from coupling impacts and in-train forces. A draft gear must perform two key functions; control high buff impacts encountered in marshalling yard operations and limit high coupler forces (buff and draft) caused by train action.

Typical Marshalling Yard Operation

Conventional 'steel-friction' draft gear designs use a system of steel wedges and plates, compressed against each other to absorb energy (via friction). There are many limitations with this approach. The most notable is the characteristic 'stick-slip' which is a result of the friction elements undergoing a series of hold-and-release cycles.

![Typical Marshalling Yard Operation](image1.png)

In train/train-action forces

The result is a reduction in efficiency and contributes to another liability...the inability to handle coupler forces higher than 300k-lb. Forces in excess of 300k-lb (~4 mph) become 'over-solid' forces that in-turn must be absorbed by the carbody. The stiff carbody spring rate creates a high resultant coupler force.

Another important limitation is the negative effect of lubricants on the friction elements. Moisture, dirt, rust and scale will act as lubrication and in-turn diminish the ability to absorb energy. The elastomeric properties of Key-Gard™ are not affected by these factors and results in an efficient energy absorption curve.

At 300k-lb coupler force, a standard steel-friction draft gear has exhausted all available travel and can no longer absorb impact energy; Twin-Pack still has capacity.

IMPACT PERFORMANCE

In buff impacts, the Twin-Pack™ gear's elastomeric pads are worked in series. The pads inside the yoke offers 1-1/4 travel and the pads at the rear of the yoke allows 2" travel for a combined gear travel in buff of 3-1/4". The results of this arrangement show that Twin-Pack™ is more effective than a typical steel friction draft gear in limiting the high peak buff impact forces and avoids the solid gear 'steel-on-steel' impact and thus limits the level of buff impact forces. Also, the Twin-Pack™ impact speed v. coupler force relationships shows less scatter than the steel friction gear when the; R-squared ~ 1.
IMPROVED TRAIN ACTION

Standard steel-friction draft gear systems travel 3-1/4" in buff and 3-1/4" in draft. While 3-1/4" may be adequate to protect the car structure during yard impacts, it is not necessary for in-train operation when the relative car velocities are ~2 mph. As a result, the extra draft gear travel can become contribute to higher in-train forces.

It has been shown thru extensive industry analysis and over-the-road testing, that approximately 1-1/4" of travel is adequate to attenuate in-train shocks and that travels greater than this could result in high coupler forces.

In draft movements, the Twin-Pack™ gear’s internal yoke pads are worked alone and gear travel is 1-1/4". The rear pads expand to remain tight between the yoke and the rear follower plate. This offers two improvements over traditional designs. First, draft travel is substantially reduced for improved train action performance. Second, the rear follower is maintained tight against the rear stop eliminating high impact loads when cycled from draft to buff.

OVER-THE-ROAD TEST RESULTS

An over-the-road test was conducted to compare in-train forces of train equipped with steel-friction draft gears to one equipped with Twin-Pack™. The train was a 120 car unit coal train that operated from the Powder River Basin in Wyoming to Mingo Junction in Ohio; 3,280 round-trip miles. Three instrumented cars, located at positions #1, #60 and #90 collected coupler force, draft gear travel, car body accelerations, GPS and velocity. The testing started in January'07 and concluded in Dec'07.

Under contract by Amsted Rail, the Transportation Technology Center Inc. (TTCI) conducted the testing and the data analysis was performed by National Research Council of Canada (NRC-CNRC).
CONCLUSION

The integral draft gear, yoke and follower Twin-Pack™ draft system provides benefits to the car owners by reducing longitudinal forces associated with yard impacts and in-train operations. Using the proven Key-Gard™ elastomer technology, it has been shown that lower coupler forces will be realized in both yard impacts and in-train operations. The key elements in achieving these savings are a reduction in slack, smooth operation, stiff-spring rate and hysteresis of the elastomer pads.