



Impact Recovery Systems

REDUCING DAMAGE FROM VEHICLE- BOLLARD IMPACTS

WHITE PAPER

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ABSTRACT

Bollards are short vertical posts, usually made of steel, typically used to prevent access and to protect pedestrians and assets from vehicle collision damage. In so doing, vehicles (and their passengers) that impact bollards face damage (and injury) due to the collision, as well as damage to the bollard structure itself. A new bollard system, known as SoftStop® in Europe and SlowStop® in the United States, solves this problem by allowing the bollard to give slightly upon collision, greatly reducing the maximum impact forces felt by both the colliding vehicle and the bollard system itself.

BOLLARD APPLICATIONS

Bollards are used in a myriad of applications, for one of several purposes:

- Equipment Protection
- Utility Protection
- Building Protection
- Access Restriction
- Pedestrian Safety

One needs only to keep a sharp eye to see bollards around us every day. In parking lots, driveways, and drive-thru lanes, bollards are used to protect buildings, teller machines, utilities such as gas meters, electrical equipment and fire hydrants, handicap parking signs, gate entry keypads, and to restrict access to undesired areas. In factories and warehouses, bollards are important for protecting pedestrians as well as guarding storage racks and capital equipment from fork truck collisions.

Other industries which find a heavy use of bollards include automated car wash facilities, self-storage facilities, gas stations and convenience stores, propane dispensing, and parking garages, among others.

THE PROBLEM

Foundation mounted bollards are typically installed in one of two ways. The first, least expensive way, is with a plate mounted bollard. These bollards are steel pipes welded to a flat steel plate that can be anchored to a hard surface using concrete anchors. This method of installation is quick and inexpensive, requiring the installer to drill four to eight holes in the concrete and bolt down the bollard with expansion or screw anchors.



The downside to this installation method, when used with a rigid bollard, is that the anchors are generally not strong enough to withstand anything more than a minor collision. The plate anchors often are pulled up and possibly the plate bends, leaving a post which leans and is no longer able to properly serve its purpose. Plate mounted bollards often require constant maintenance and replacement.

The second method for installing bollards involves using a longer steel pipe and burying a portion of it deep in the ground. This method gives the bollard far more strength than surface mounted, however it can be very expensive to install if the surface is concrete and already poured. Installation in this case requires coring a hole in the surface using an expensive diamond bladed coring saw. These machines and their blades are expensive and require water cooling, creating a mess during



installation. Once the concrete is cored and the bollard is in place, the hole must be backfilled with concrete to secure the bollard. For added strength, these bollards are often filled with concrete, as well. Though the bollard pipe itself is relatively inexpensive, this installation method is costly and time consuming.



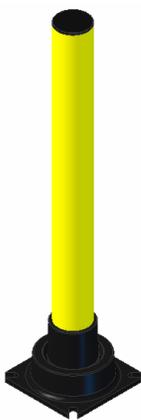
Although very strong, there are significant disadvantages to core installations. Most importantly, there is no give to this system upon impact. Though desired in high security applications, any vehicle impacting such a bollard will be significantly damaged and its passengers at risk of injury. Loads carried by fork trucks can also be thrown given the jarring impact likely to occur. Further, the bollard or its foundation can be damaged by such an impact, again leaving a tilted and less effective barrier requiring costly maintenance to correct. Often

the steel bollard itself is beyond repair and must be replaced with an entirely new bollard.

Another disadvantage of this type of installation is that it is a permanent installation with little flexibility for movement. In factory applications, equipment is often moved and rearranged. Bollards used to protect equipment or storage racks which are core-installed are not easily moved. The concrete surrounding the bollard must be broken out and the large remaining hole filled, leaving a factory floor full of unsightly patches. If the bollard itself is reusable after removal, the entire expensive installation process is started over at the new location.

Some designs have been created to attempt to solve these problems through the use of plastic or spring loaded bollards, however these designs suffer from a lack of strength. If the plastic is of insufficient stiffness, the entire function of access denial is lost. On the other hand, very stiff plastic designs have had difficulty with long term durability. Minor collisions tend to wear away at such devices, and in outdoor applications UV degradation becomes a concern.

REVOLUTIONARY NEW DESIGN

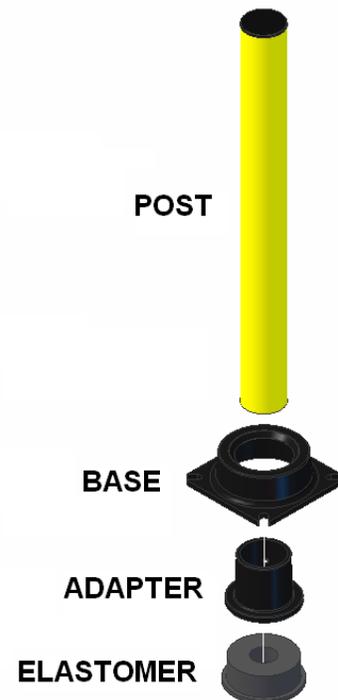


Designed and patented by Belgian inventor Gerard Wolters as SoftStop® in Europe, the SlowStop® Bollard system is a unique design which solves many of the problems associated with traditional foundation mounted bollards. Simply put, the SlowStop® system uses a compressed rubber base to act as an energy absorbing mass. This elastomer allows the bollard to tilt slightly when impacted, in the range of 20° from vertical, then return upright while still stopping the colliding vehicle.

The SlowStop® design consists of four major pieces:

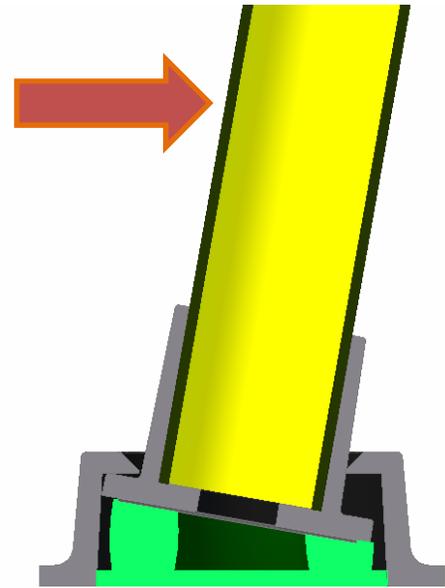
- Elastomer
- Base
- Adapter
- Post

This system is anchored to concrete using concrete anchor screws. These anchors affix the base component over the adapter, which pre-compresses the elastomer against the ground. The base and adapter pieces are made of a special ductile cast iron, which makes the pieces less brittle than typical cast iron, and also has a very low (-40°) brittleness



temperature. The steel pipe which serves as the bollard post is a typical steel pipe inserted into the adapter. In the US, standard ANSI schedule 40 pipe is used to give the end user the flexibility to weld fencing using standard components if necessary. Concrete fill is not required inside the bollard pipe, though is permitted. In fact, sign posts can be inserted into the post and concrete filled in place.

Upon collision, the pipe and adapter are allowed to tilt within the base, forcing the adapter to further compress the elastomer in the direction of the impact. The elastomer absorbs much of the energy of the impact and lengthens the deceleration time of the vehicle. The elastomer is of sufficient strength to then rebound, usually pushing the vehicle away from the bollard and returning to an upright position. The tilt of the pipe is limited to approximately 20° at which point the bollard will become rigid.



SlowStop Bollards® are designed in a variety of sizes, each of which is appropriate for various expected collision speeds and masses. Further, they are



available with modular connectors which can be used to create fencing and guards out of multiple base units. By using multiple base units, the ultimate strength of the rebounding bollard unit can be increased.

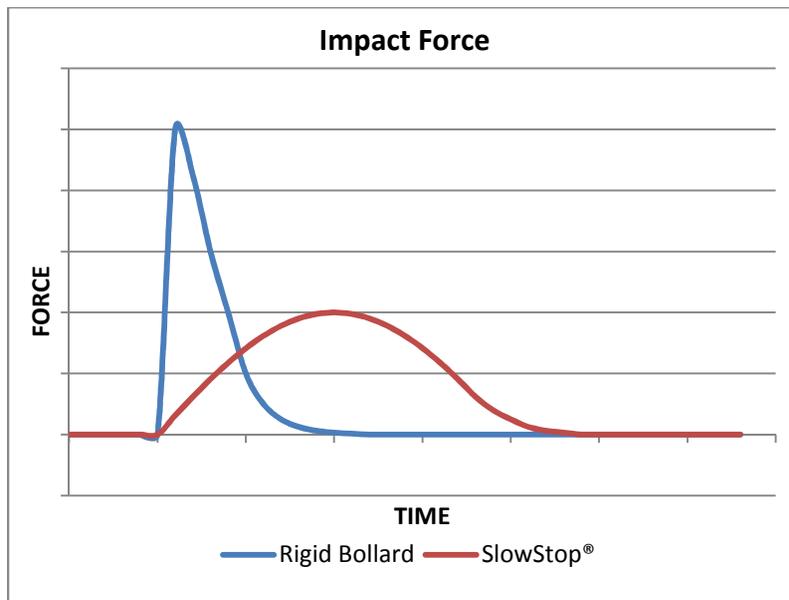
PERFORMANCE ADVANTAGES

SlowStop® Bollards utilize the much simpler method of surface installation, greatly reducing installation costs, while maintaining the flexibility to move

bollards as conditions warrant. This is accomplished without the normal disadvantage of lack of strength, as the elastomer within the bollard system greatly reduces the maximum impact forces applied to the base anchors.



This is because deceleration of an impacting vehicle is much less severe than during an impact with a rigid bollard. Energy is transferred to the elastomer instead of directly to a rigid post. The chart show below demonstrates the difference in impact forces felt by impacting vehicles between a rigid bollard and the SlowStop® Bollard system.



This leads directly to the most important advantages of the SlowStop® Bollard



system and that is the reduction of damage to both offending vehicles and to the bollard system itself. Direct damage to vehicles is reduced due to the reduction of peak impact force seen by the vehicle. Not only will this avoid damage to the vehicle, but also the

chance of injury to a passenger is likewise reduced. In the case of a fork lift in a factory or warehouse, the chance of a thrown load is also reduced, avoiding the potential for bystander injury and stock loss.

Finally, damage to the bollard and its foundation is reduced. Because the post is constructed of Schedule 40 steel pipe, it maintains its strength, but because of its forgiving nature, much less force is transferred to the foundation. This simplifies and eliminates maintenance while preserving an aesthetically pleasing facility.



LIMITATIONS

SlowStop® Bollards must be installed on concrete, as an asphalt surface is not of adequate strength to anchor the bollard system. Considering the replacement costs of damaged bollards, however, it may be cost effective to pour a concrete pad and eliminate years of costly maintenance and asphalt repair. As previously mentioned, each bollard is sized for expected loads in terms of mass and speed. Should that limitation be exceeded, it is possible to break a component of the SlowStop® system. Most likely that involves the post, adapter, or base. Fortunately, the SlowStop® system is modular and easily repaired. Posts can be replaced by loosening several set-screws, removing and replacing, and re-tightening the set screws. Adapter and Base components can be replaced by carefully removing the concrete screw anchors and replacing the component.

CONCLUSION

The SlowStop® Bollard system is a revolutionary new product which solves many of the problems involved with bollard collisions as well as installation and maintenance issues. Damage to vehicles, passengers, vehicle loads, and the bollards themselves is greatly reduced due to the absorption of impact energy by an elastomer hidden within the base of the bollard. This elastomer allows the bollard to tilt when impacted and return upright afterward. SlowStop® Bollards are quick and inexpensive to install, flexible as they are easily moved, and simple to maintain should there be the need. Safety fencing and barriers are easily created using modular connectors, avoiding the need to weld pipe together.

Further information can be found at www.slowstop.com or by calling Impact Recovery Systems at 1-800-736-5256 (210-736-4477).