White Paper

Why choosing Energy Absorbing SlowStop® Bollards is Superior to Embedded Steel Bollards for Construction Projects.

Introduction

This paper intends to outline why choosing Surface Mount Energy Absorbing Bollards is superior to traditional deeply embedded all steel pipe bollards (also referred to as concrete filled tubes or CFT) for both new construction and renovations.

Design Stage

Placement of appropriate building and utility protection bollards at the design stage of a construction project is subject to uncertainties and changes that occur throughout the project. Understanding traffic patterns is often difficult during the early stages of building design without detailed owner input. Anticipating how semi drivers utilize space can be unpredictable and difficult to enforce. Embedded bollards, once placed, are not easily changed nor moved, leading to construction change orders. To properly design and place embedded bollards, a complete site soil study should be undertaken to understand necessary depths and perhaps required foundations. For a renovation project, this may be nearly impossible if the surface is already covered.

A surface mounted solution provides for a clean sheet approach where appropriate guarding can be placed at virtually any stage of design/build without significant impact to cost because installation takes place anywhere on the concrete surface. Additions only require additional product, without core-drilling and backfilling. This approach can be included in sustainability efforts for green architecture efforts due to the reduced materials use, especially carbon-intensive concrete.

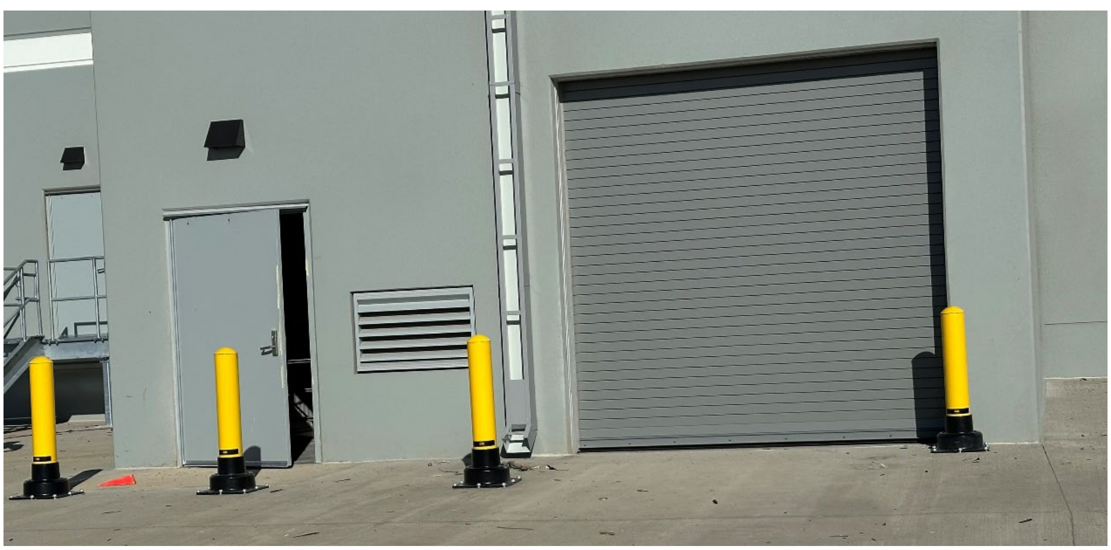

Figure 1 - Surface Mount Rebounding Bollards

Planning and Installation

Site preparation prior to concrete pour is required at embedded bollard location if the contractor is to avoid costly concrete sawing and coring after site concrete work is complete. This requires accurate and complete site planning prior to laying foundations by the contractor. Alternately, coordination with the concrete contractor to form access points is done with added forming, labor, and planning. The practice of installing bollards prior to concrete pour also complicates final pour and sealing as the bollards need to be worked around.

Figure 2 - Greenfield Bollard Installation

Post-foundation embedment is even more costly, requiring saw cutting of concrete, excavation, and back-filling, all beyond the cost of the embedded bollard pipe itself.

Figure 3 - Core Drilling

Installation of concrete filled tubes is multi-step process often requiring multiple trades prior to completion. Concrete cutting, excavation, backfilling, concrete fill, and finally painting may all occur at different times by different crews. This can turn a seemingly simple task into a multiple day effort.

With surface mount energy absorbing bollards, installation can occur at any time prior to substantial completion at a fraction of the cost and effort, by a single crew. This type of bollard is also easily moveable, whereas once an embedded bollard is constructed, removal is costly and there is typically no re-use of materials.

Figure 4 - SlowStop Fire Hydrant Protection

Performance

It is important to understand the failure modes of embedded bollards and their relationship to the installation process. When a bollard is hit, the concrete edge of the installation, not the steel bollard itself, typically fails first. This is due to the leverage created by the bollard acting as a class one lever, pivoting around the fulcrum provided by the ground. The failure of the concrete edge is often predictable but difficult to precisely describe due to the complex nature of the impact.

Figure 5 - Common Concrete Damage

Factors such as the strength of the materials, substrate behavior, and the depth of the bollard influence the bollard's performance and failure modes. While steel bollards are generally strong, it's the concrete surrounding the bollard that needs to withstand the impact forces. The depth of the bollard and the characteristic of the substrate also plays a role. For a proper understanding, a soil study would need to be completed in addition to concrete specifications. This can be costly and time-consuming.

The stress-strain curves and finite element analysis (FEA) can be used to predict failure points and assess the behavior of the bollards under different impact scenarios. However, the real-world behavior of the system is more complex than these predictions due to the dynamic nature of vehicle crashes and the interplay of various factors.

A further complication of embedded pipe bollard is corrosion at the base due to the impermeable nature of the surrounding concrete. This often leads to a corrosion-based weakening at exactly the point of maximum stress during impact. Shear failure often occurs quickly at this point should this occur. Once corrosion has begun, replacement of the pipe bollard is again time-consuming and costly, often leaving a compromised safety device in place.

Crash-rated bollards are specifically designed to withstand high-speed impacts without failure. However, in certain situations where flexibility is desired to prevent severe accidents, bollards that bend or yield under impact may be preferred. The strength and effectiveness of bollards depend on proper installation, understanding the failure modes, and considering the specific characteristics of each site.

An energy-absorbing bollard has specific design features to actively absorb and dissipate energy, which can contribute to a different, more predicable set of failure modes and performance characteristics.

These bollards are engineered to yield or deform in a controlled manner, thereby reducing the severity of the impact on both the bollard and the vehicle.

In summary, the performance of an embedded bollard varies based on installation, characteristics, behavior, and failure modes, while an energy-absorbing bollard is designed with specific mechanisms or materials to absorb and dissipate energy during an impact.

Cost

In general, a new embedded pipe bollard installation in the 6" class will run between $800 and $1200 or more per bollard, depending on local conditions. See the addendum to this paper for a detailed analysis. On large construction projects, these costs are often hidden or buried in larger concrete, parking lot, or fencing contractor bids, however they can easily be reduced with the advent of new surface mount rebounding technology.

A surface mount bollard of equivalent strength in this class takes less than 30 minutes each to install, using common tools. All product materials are provided, and virtually no waste needs to be disposed, creating a known and reliable pricing model at the lower end of the embedded model.

Summary

Surface Mount Energy Absorbing (SlowStop®) Bollards offer significant advantages over traditional embedded steel pipe bollards for construction projects as follows:

- Design Flexibility: Due to their surface mount design, SlowStop Rebounding Bollards provide a simple drop-in design process for building and utility protection.
- Installation Ease: The installation of surface mount bollards is simpler, requiring only common tools and minimal site preparation, significantly cutting both time and cost compared to embedded bollards, without complex site preparation.
- Performance and Safety: Due to the engineered and tested nature of rebounding bollards, safety can be improved over standard embedded concrete filled pipe bollards.
- Cost: SlowStop Rebounding Bollards provide a known, competitive pricing structure that in many circumstances provides a savings to the owner, especially when considering the overall management of a project and allowance that need to be made for embedded pipe bollards. Reduced materials offer sustainability advantages.

In conclusion, energy-absorbing bollards not only present a safer and more adaptable solution for traffic and pedestrian safety in construction but also contribute to substantial savings in both installation and maintenance costs over the lifecycle of the project.

Addendum – Cost Analysis

The cost of installing an embedded 6-inch diameter bollard can vary based on numerous factors including location, materials, labor rates, and specific requirements for the installation. Below is a detailed cost analysis based on general industry standards and insights from web sources:

Material Costs:

1. **Steel Pipe Bollard:**
   - **6" Schedule 40 Steel Pipe**:
     - A 96" length (42" above ground, 54" below ground for stability) might cost approximately $199 to $220 each, depending on local prices and whether it's primed or painted.
2. **Concrete:**
   - **Concrete for Footing:** For an 18-inch diameter hole, roughly 42-48 inches deep, you might need about 0.30 cubic yards per bollard. At $200-$225 per yard, this would cost approximately $60 to $67.50 per bollard.
3. **Additional Materials:**
   - **Rebar**: Small amount for reinforcing the bollard, around $5-$10 per bollard.
   - **Sonotube or Cardboard Form** (if used): About $30-$35 each.
   - **Anchor Bolts or Rebar for Embedding**: Usually minimal cost, but included in the estimate for thoroughness.

Labor Costs:

- **Labor for Installation**:
  - This includes cutting asphalt or concrete, digging the hole, setting the bollard, pouring and finishing concrete, and cleanup. For one bollard, labor can range significantly; for a single installation, expect:
    - **Preparation and Excavation**: If done by two workers for half a day, at $500/day each, that's $500 total for labor for one bollard.
    - **Setting and Finishing**: Similar labor cost, assuming careful work is needed for alignment and finishing.

Equipment Costs:

- **Rental or Use of Machinery**:
  - Small excavators or augers might be needed. For a small project, rental costs might be negligible if you include them in a broader context, but for individual bollards, consider:
    - **Rental Cost**: Approximately $100 to $300 for the necessary equipment for the day.

Miscellaneous Costs:

- **Transportation/Delivery**:

    - If you're purchasing from a supplier, delivery fees could range from $50 to $150, depending on distance and volume.
- **Waste Disposal**:
    - Removal of asphalt or concrete cuttings, around $50 if not managed by the main contractor.

Total Estimated Cost:

- **Materials**:
    - Steel Pipe: $220
    - Concrete: $67.50
    - Rebar/Reinforcement: $10
    - Sonotube: $35
    - Total: $332.50
- **Labor**:
    - Assuming 1 day for 2 workers at $500/day each: $500
- **Equipment Rental**:
    - $200 (if renting for just this job)
- **Miscellaneous**:
    - $100 (average of delivery and waste disposal)

Grand Total for One Bollard: Approximately **$1,132.50**

This estimate can vary widely based on:

- Location (urban vs. rural, state regulations, etc.)
- Bulk purchasing discounts
- Whether you have your own equipment or need to rent
- If the installation is part of a larger construction project where some costs might be distributed differently.

For projects involving multiple bollards, economies of scale might reduce the per-unit cost due to bulk discounts on materials, more efficient use of labor, and equipment. These are rough estimates, and getting quotes from local contractors would provide the most accurate figures.

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