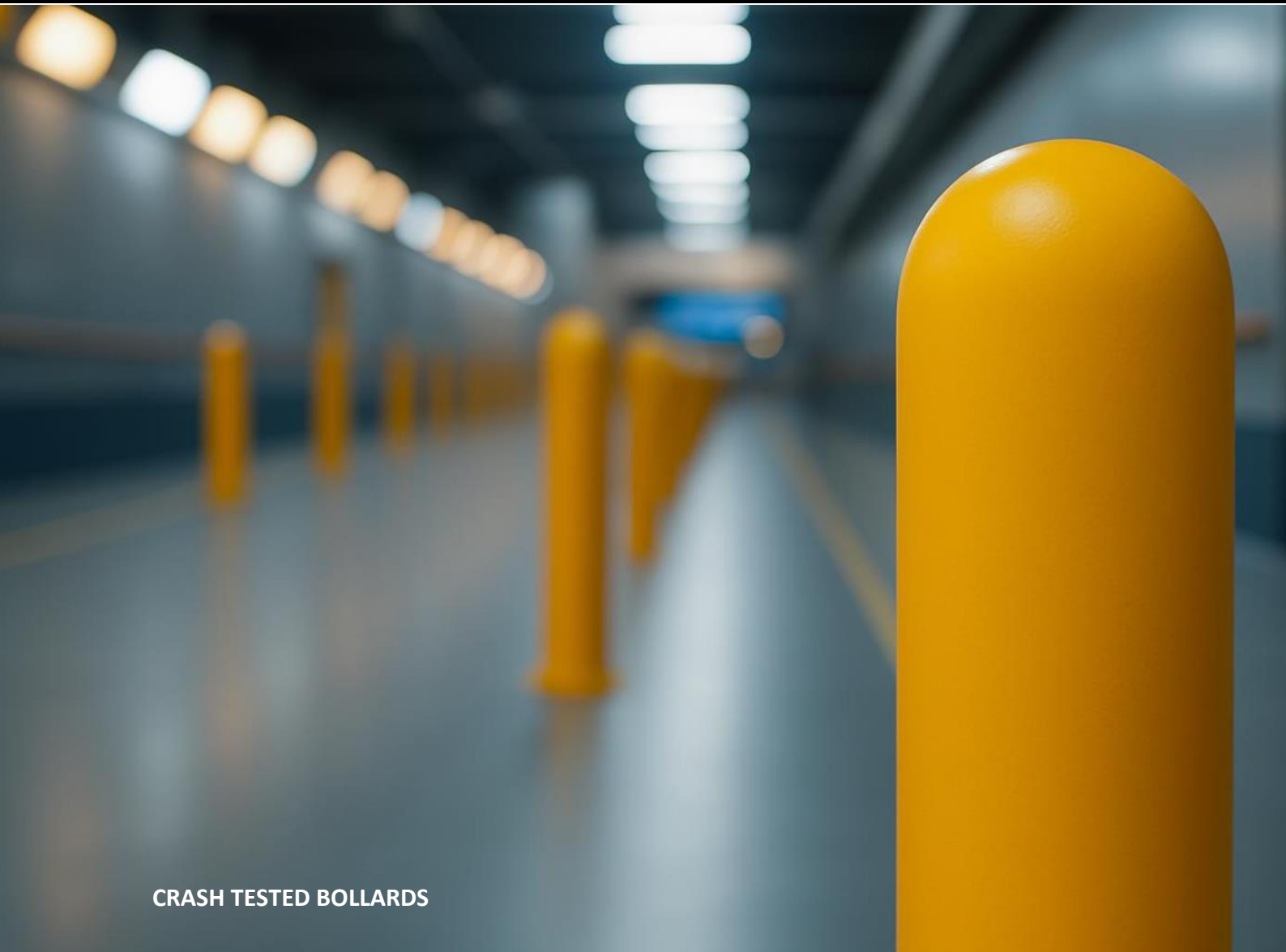




ZERO CIVIL

ZERO WASTE TECHNOLOGIES



CRASH TESTED BOLLARDS

"A genuinely transformational change is needed to move away from approaches that amount to a coping mechanism to one that proactively fixes the problem once and for all".

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What Happens in a Crash?

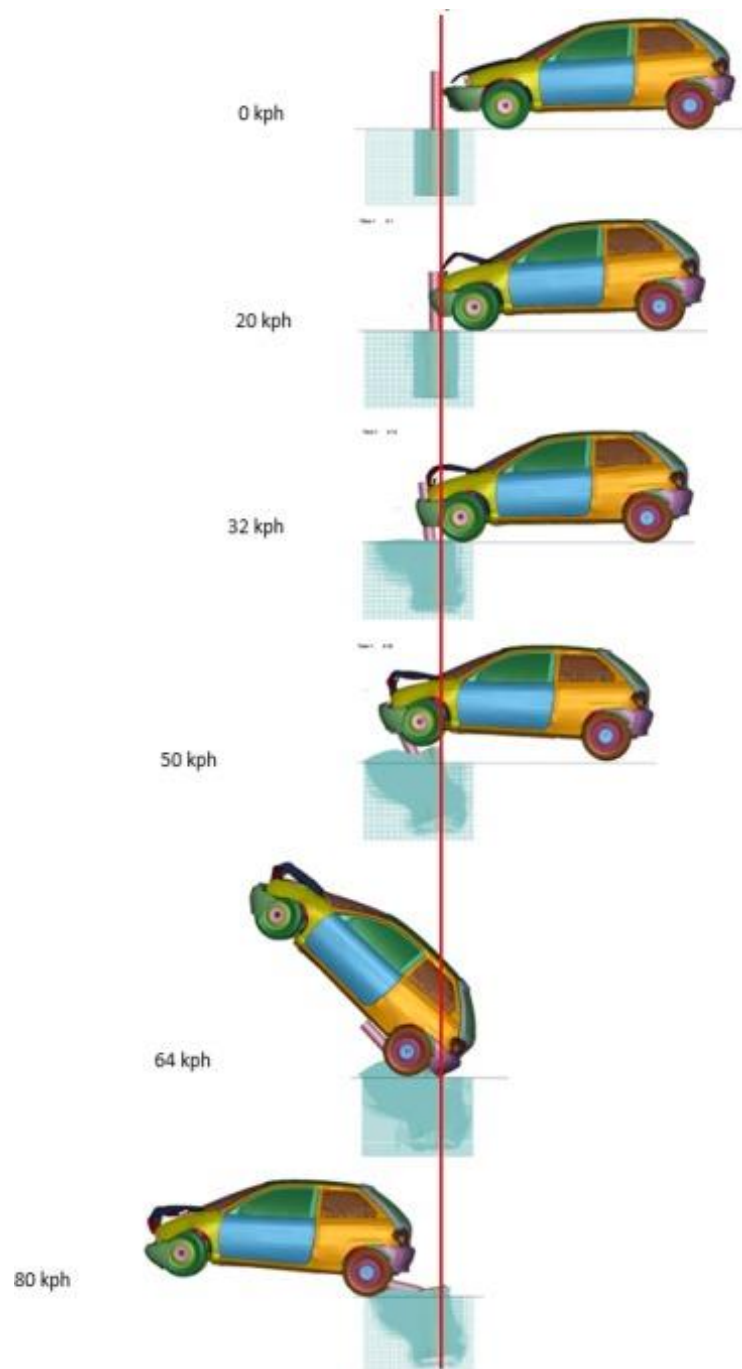
Solid inground bollards have been the mainstay of the industry for decades, but in recent times with more pedestrians and vehicles on our roads there is a growing concern for the safety factor when designing bollards.

When a car hits something that doesn't give, the impact energy has only a few places to go:

1. The car deforms hard (front end crush), then
2. The vehicle can ride up the bollard as the front suspension collapses and the contact point climbs, then
3. The car can pivot and launch (you see the nose lift → car rotates → wheels leave ground). That's the "projectile" effect that is not suitable for urban environments.

For a bollard to resistant impact, it requires some form of shock absorbing mechanism. There are currently two options

- Energy Absorbing Bollards– Crash tested to effectively prevent forward movement of a vehicle. Must be replaced following vehicle impact.
- Impact Recovery Bollards – Crash tested to effectively absorb impact force and protect surrounding footings, reducing maintenance costs



All bollards have an element of risk and whilst many prefer bollards with greater energy absorption capabilities, product developers often choose a balance between containment capacity, energy absorption and practicality, realising that higher containment will cost more, and greater energy absorption will often require a more complex and less practical system.

It is recognised that there are situations where Impact Recovery Bollards may be more appropriate (such as low speed zones, car parks and situations where the majority of impacts would be side glances).

Australian Standards state it is necessary to clearly define the purpose of a bollard installation.

The purpose of a bollard installation.

Bollard selection requires an understanding of the bollard requirements and objectives and the site conditions. According to the Austroads Safety Barrier Assessment Panel there are four main categories of bollards:

1. Bollards crash tested to AS/NZS 3845.2:2017 - **EAB**
2. Bollards crash tested, but not to AS/NZS 3845.2:2017- **IRS**
3. Bollards that are not crash tested
4. Bollards for security purposes

Choosing the Right Bollard for Each Location

Energy Absorbing Bollards are often specified where vehicle impact protection is required. That does not mean every bollard on a site needs the same level of containment. The appropriate system depends on the vehicle risk and the outcome required at each location.

For a carpark with a 10 km/h speed limit, a high-speed "road safety device" bollard (which are engineered for 50–70 km/h impacts) are generally an over-specification. Instead, the focus shifts to low-speed asset protection, compliance with parking standards, and vehicle impact recovery. Depending on whether your goal is rigid asset protection or preventing damage to vehicles, you have a couple of standard approaches for Australian car parks:

Each location should be assessed against the expected vehicle, impact speed and angle, people or assets behind the bollard, and the relevant test evidence.

Choose the bollard for the risk

- An Energy Absorbing Bollard is designed and crash tested for **vehicle impact protection** when containing an errant vehicle is the objective.
- In car parks and loading areas where routine low-speed clips are the main problem, the Impact Recovery Bollard is designed to **deflect and recover**, with a replaceable resistance core for more severe impacts.
- The appropriate choice depends on the vehicles, speeds, direction of likely impact, people exposed and required outcome

Example — A vehicle turning corner

Trucks turning through a tight corner may glance the bollards on a corner. If the site assessment identifies these glancing contacts as the main risk, an Impact Recovery Bollard may offer a more practical solution.

If the site assessment identifies a credible risk of direct impact into the shopfront or pedestrian area, an EAB may be the better choice for containment.



Crash Tested bollards that absorb impact force

Energy Absorbing Bollards (EAB): for vehicle containment. Energy Absorbing Bollards are intended for locations where containing an errant vehicle is the priority. EABs were previously recognised under AS/NZS 3845:1999 Test Level 0, involving a 1,600 kg car at 50 km/h.

- Test 21062-01: Reported containment of a 1,600 kg vehicle at 51.9 km/h in a soil installation. The vehicle's calculated impact energy was 166.3 kJ.
- Test 21062-02: Reported containment of a 1,615 kg vehicle at 62.5 km/h with a concrete slab at the surface. The vehicle's calculated impact energy was 243.4 kJ.
- The test reports, installation requirements and current road authority acceptance should be reviewed for the proposed site. Repairs to the bollard and foundation after an impact should also be considered.

Contact SafeSystemEngineering@roads.vic.gov.au for guidance.

Impact Recovery Bollards - suitable for carparks with speeds up to 10km/hr. Impact Recovery Bollards were crash tested demonstrating crash worthiness for speed zones up to and including 10 km/hr and were evaluated for structural adequacy, occupant risk and vehicular response.

- Structural adequacy: Bollard and surrounding foundations remained in good working condition following multiple impacts.
- Occupant risk : The bollard cushions the impact force as it deflects. In the recorded low-speed impacts, the bollard deflected by approximately 20 degrees, and the driver showed no adverse response. This controlled deflection is intended to make the collision less abrupt than striking a rigid bollard.
- Where a solid bollard can become a projectile- the Impact Recovery Bollards remain firmly seated in the footing following severe impact.
- Vehicle response: In the recorded low-speed impacts, the vehicle met resistance at the bollard and the driver reversed away. The bollard remained anchored and returned upright.
- Note: IRS Bollards shown below were impacted by a very large truck – Outcome: Bollards remained firmly planted in footing. Foundations and bollard system remained reusable following impact. You can see the scuff marks on the footings from repeated impacts (bollards have been repainted following severe impact). NB: Ground covers are available to cover scuff marks.



Comparison EAB & IRS

Feature	Impact Recovery Bollard	Energy Absorbing Bollard
Primary Design Purpose	Manage frequent, low to moderate speed vehicle impacts (e.g., car parks, shopping centres)	Stop high-speed vehicles (e.g., roadways, perimeter security)
Typical Impact Type	Side-glancing or minor front-on hits	Severe front-on collisions
Deflection Capability	Deflects up to 20 degrees on impact, self-recovering to upright position	Crushes on impact (polystyrene or sacrificial components); bollard needs replacement
Upon Impact	Self-recovering — no parts need replacing after typical impacts	Single-use — full or partial replacement needed after any major impact
Material Strategy	Advanced polymer casing + rubberized recovery rings + steel resistance core	Steel casing + polystyrene crash core, designed to collapse
Vehicle Damage Risk	Lower — flexible casing and energy absorption reduce damage to vehicles	Higher — rigid structures crush on impact causing significant vehicle damage
Maintenance Costs	Very low — system survives most impacts without replacement	High — replacement needed after moderate to high impacts
Best Applications	Car parks, shopping centres, urban street furniture — frequent minor bumps	High-speed road barriers, perimeters — rare but severe impacts
Cost Effectiveness	Extremely high for locations with frequent light impacts	Lower — high replacement and maintenance costs

Site specific evaluation

Selection depends on the site:

Bollard specifications may require a system to prevent unauthorised vehicle access, remain anchored after impact, avoid creating hazards, and limit damage to nearby infrastructure. A site-specific assessment should identify which outcomes are essential and which outcomes offer the greatest benefit.

Assess the site:

- Vehicles and speeds: Consider the vehicles that can access the area and their credible *impact speeds*, not only the posted speed limit.
- Impact conditions: Consider whether a vehicle could strike the bollard head-on or at an angle, and the space available for vehicle movement and bollard deflection.
- People and assets: Identify pedestrians, occupied areas and infrastructure behind the bollard, and the consequences if a vehicle passes it.
- Installation and maintenance: Check the foundation requirements, inspection needs and likely repair work after an impact.

In a car park where minor vehicle contact or glancing impacts are the greater identified risk, the IRS offers a self-recovery option for low speed impacts and fast recovery for high speed impacts. In recorded low-speed impacts, it deflected by approximately 20 degrees, remained anchored and returned upright.

Maintenance and Durability

The Bollard Impact Recovery System, when combined with the Extra Heavy Duty resistance core, dual compression rings, and ZERO WASTE Foundations, is engineered to withstand and absorb substantial impact forces.

- **Energy Absorption Capacity:**

The Impact Recovery System can absorb impact energy through deflection, deformation of the Impact Recovery Rings, and outer casing flexibility. The remaining energy is transferred into the reinforced footing and subgrade without dislodgement.

Maintenance & Durability: Review component durability, impact resilience, and inspection requirements outlined in [AS/NZS 3845.1:2015](#). Is the road safety barrier or device likely to be complex or difficult to install, maintain, repair and/or dismantle?

The site assessment should consider how each bollard is installed, inspected and repaired, as well as its performance during an impact. A system selected for vehicle containment may involve replacement of energy-absorbing components after a significant impact. If its foundation is damaged, concrete removal and reconstruction may also be required.

The Impact Recovery System is designed for a different maintenance outcome:

- Low-speed impacts: The bollard can deflect and return upright. This occurred in the recorded vehicle impacts.
- Impacts beyond the recovery range: The resistance core can bend and be replaced. The bollard casing, ground socket and foundation can be retained if inspection confirms they remain serviceable.
- Repeated contact: Retaining a serviceable foundation can avoid excavation, reduce disruption and reduce material use compared with rebuilding a damaged footing.

At a location subject to frequent glancing contact, these repair outcomes may offer a substantial whole-of-life benefit. They must be weighed against any requirement for tested vehicle containment.

A bollard badly impacted just twice a year would cost around \$200,000.00 to maintain over the life of the development, (\$1,500 bollard + \$500 min. footing removal and replacement = \$2,000 per event. Two replacements a year for 50 years, equate to around \$200,000 per location, excluding traffic management and disposal.)

When badly impacted the Impact Recovery Bollard can be replaced quickly and efficiently without disturbance, or major cost, greatly improving the safety and reliability of these bollards

- Preventing infrastructure damage by absorbing and redirecting energy, rather than resisting it rigidly
- Engineered to withstand repeated low- to medium-speed impacts without dislodging the footing
- Self-recovering post-impact — reducing call-outs
- Using ZERO WASTE ground sockets to anchor the resistance core, which eliminates concrete breakage or subsoil disturbance

Energy Absorbing Bollards (EAB)

Energy Absorbing Bollard, were crash tested in accordance with AS/NZS 3845.2 demonstrating crash worthiness for speed zones up to and including 60 km/hr

Bollard:
150 mm diameter Steel
1450 mm Length
Weight 67.5 kg

Footing:
Installed in solid asphalt.
700 mm width concrete footing
1000 mm below ground
Reinforced using reo cage

Vehicle
Passenger vehicle weighing 1600kg.
Impact Speed 60km/hr



Outcome:

Bollards deflected to a maximum of 45 degrees upon impact demonstrating they were capable of preventing an errant vehicle from entering an area.

The impact absorbing cushion crushed and required replacing. Meets Australian Crash Barrier Standard AS/NZS 3845:1999 (60 km/h).

OPTIONS

By increasing the depth of the footing with a reinforcing reo cage bollards can control errant vehicles weighing up to 2270kg



The “impact absorbing” nature of the bollards results in vehicles being brought to a complete stop, protecting people and assets from errant vehicles

[VIEW VIDEO](#)

Impact Recovery Bollards (IRB)

Impact Recovery Bollards crash tested in accordance with AS/NZS 3845.2 demonstrating crash worthiness for speed zones up to and including 10 km/hr

Bollard:

165 mm diameter Steel
5 mm wall thickness
800 mm height

Footing:

Installed in solid asphalt.
300 mm width concrete footing
350 mm below ground

Vehicle

Passenger vehicle weighing 1600kg.
Impact Speed 10km/hr



Outcome:

Bollards deflected and self-recovered following multiple impacts at low speed demonstrating no reduction in capacity to recover.

At low speed the bollard deflected up to 20 degrees at which time the driver was aware of hitting the bollard and reversed off- allowing the bollard to self-correct.

OPTIONS

When using 650 mm footings you can install and Extra Heavy Duty resistance core, reducing the incidence of the core bending upon high impact.



The “impact absorbing” nature of the bollards results in vehicles “bouncing” off the bollard without damage to either the vehicle or bollard.

[VIEW VIDEO](#)

Footings Tested 10 – 110 kmph

ZERO WASTE Foundations have been tested to withstand high speed impact and remain in good working condition, preserving the surrounding paving and foundations

Safe & Secure

Bollards secured using the ZERO WASTE Foundations are secured using friction which ensures they remain secure and well aligned.

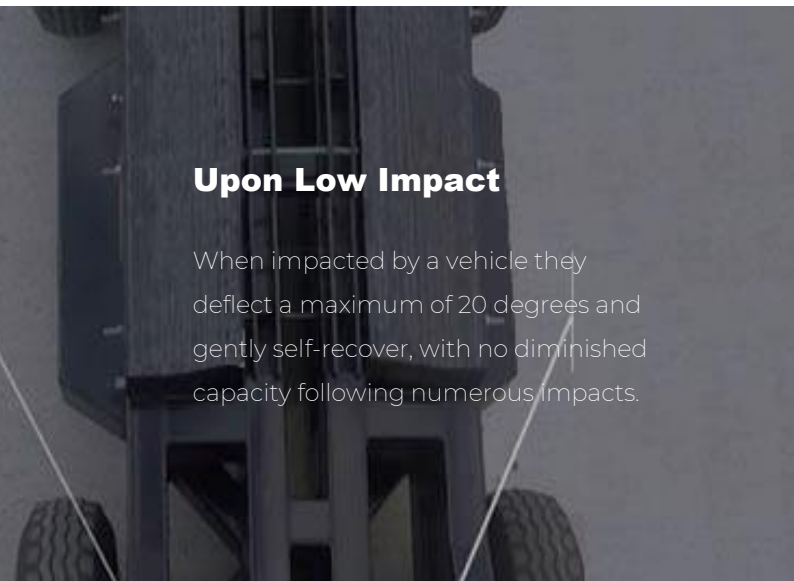
FOOTINGS BOTH LABORATORY AND INSITU IMPACT TESTED 10 - 110 KMPH

Upon Low Impact

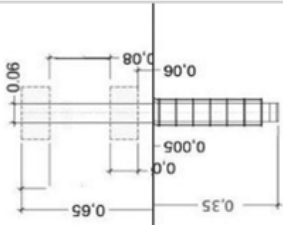
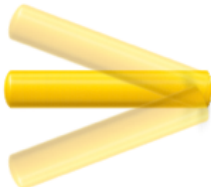
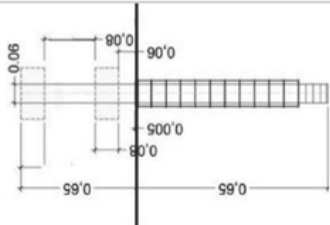
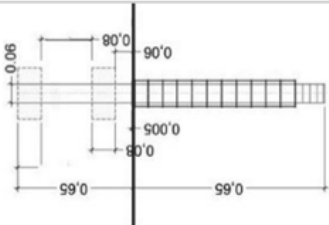
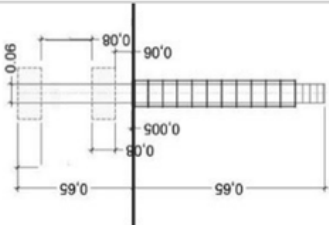
When impacted by a vehicle they deflect a maximum of 20 degrees and gently self-recover, with no diminished capacity following numerous impacts.

Upon Severe Impact

When severely impacted the resistance core bends allowing the bollard to fold but not be dislodged- preventing any further forward movement of the vehicle and enabling fast reinstatement



Impact Charts

BOLLARD		INSTALLATION	BOLLARD REUSABLE	FOOTINGS REUSABLE
		INGROUND 350 MM IMPACT RECOVERY MEDIUM RESISTANCE Advanced Polymer 150 Ø 1200L (350 mm depth) Suitable for low speed zones such as carparks. 350 mm footing suitable for areas with existing concrete footings to provide stability to concrete base and protect against dislodgement. Rather than “flexing” the bollard has a shock absorbing core that allows bollard to deflect up to 20 degrees and slowly recover from low to medium speed impacts and glances (no maintenance). Footings and bollard are reusable following even severe impact.		
		INGROUND 650 MM IMPACT RECOVERY HIGH RESISTANCE Advanced Polymer 150 Ø 1200L (650 mm depth) Suitable for low to medium speed zones such as carparks. 650 mm footing suitable for areas with no existing concrete footings (free standing footing). Rather than “flexing” the bollard has a shock absorbing core that allows bollard to deflect up to 20 degrees and slowly recover from low to medium speed impacts and glances (no maintenance). Footings, and bollard are reusable following more severe impacts and glances (such as utility vehicles)		
		INGROUND 650 MM XHD IMPACT RECOVERY MOST RESISTANT Advanced Polymer 150 Ø 1200L (650 mm depth Extra Heavy Duty Resistance Core provides 150% greater resistance to bending upon impact from a vehicle) Suitable for medium to high impact from large passenger vehicles and utility vehicles. Rather than “flexing” the bollard has a shock absorbing core that allows bollard to deflect up to 20 degrees and slowly recover from low to medium speed impacts and glances (no maintenance). Footings and bollard are reusable following severe impacts (such as utility vehicles).		

When a passenger vehicle hits the Impact Recovery Bollard

1. First: The Impact Recovery Rings compress, absorbing energy and reducing the peak impact force.
2. Then: The vehicle bumper contacts the internal Resistance Core directly.
3. Because the core is only 300 mm tall, and secured into solid concrete, it acts almost like a solid stump — it won't flex much. NB: The shorter a post, the greater the resistance to bending.
4. Vehicle structure (especially the bumper and front undercarriage) would hit and climb slightly up the post.
5. At this low height, the post could:
 - Bend or buckle if too weak.
 - Shear off at ground if footing is inadequate.
 - STOP the vehicle if post and footing are strong enough.

In most instances it will cause the vehicle to get “trapped” or “caught” — the front underside of the car would dig into or ride up over the post, stopping it abruptly.

Question	Answer
Do the impact recovery rings help?	Greatly reduce peak force
Will a 60 mm × 5.5 mm Core stop a car?	Possible, but NOT crash-tested. Above 10kmph
Will the car get trapped?	Highly likely — it would snag under the bumper and stop.

-
- A short heavy-gauge post CAN stop a passenger vehicle, especially helped by the energy-absorbing impact Recovery Rings.
 - But cannot guaranteed compliance at 165.4 kJ unless extensively tested. We can conduct FEA assessment to provide evidence of this. As this bollard is designed for carparks, and we are currently developing a High Impact Bollard, we shall not be conducting actual in situ testing for this product

Impact Resistance IRS

As shown here, a light walled (2.3 mm) signpost can prevent forward movement of a vehicle.

The heavy gauge Resistance core provides around 2 x the resistance of a 2.3 waled post and the Extra Heavy Duty Resistance Core provides another 150% increase in resistance against bending.

MRWA Sign Structural Design Guidelines. 4.3.3. state If the speed limit of the road is greater than 80 km/h the post should not exceed 2.9 mm wall thickness (as anything higher is not considered frangible)



As shown here- even if post does bend the car will become impaled on the resistance core, preventing any further forward movement of the vehicle.

1. Low speed

Parking lots

When a vehicle impacts a bollard at relatively low speed, the Impact recovery Rings will compress allowing the bollard to deflect up to 20 degrees and slowly self-recover

2. Medium speed

Roads 60 KM Zone

When a vehicle impacts a bollard at relatively High speed the resistance core will initially deflect elastically and if there is sufficient momentum and energy in the errant vehicle, the post's bending strength will be exceeded, leading to plastic deformation concentrated near the top of footing as the bollard bends over and the resistance core will need replacing

3. High speed

Freeways 110 KM Zone

When a vehicle impacts a post at High speed, the same happens as a vehicle travelling at medium speed.

Bollard Type	Install / Detail	*	Speed*	What actually happens
Surface Mount – Standard	Bolted to slab, no socket	≈ 1 kJ	≈ 4 km/h	Cosmetic only. Bolts bend, pull out or slab chips. Offers almost zero real protection.
In-ground Galv steel	140–165 Ø in 400 mm footing	≈ 3 kJ	≈ 7 km/h	Survives trolley/very slow nudge. A light car hit will crack/rotate footing and need replacement.
In-ground 165 Steel – concrete filled	165 Ø, fully filled, 400 mm footing	≈ 4 kJ (no real gain)	≈ 8 km/h	Stiffer but <i>more brittle</i> . Energy goes straight into the footing. Post and footing usually stuffed; concrete fill also traps moisture → rust + ugly stains.
In-ground 150 mm Poly – partial fill	150 Ø polymer with concrete plug from ~150 mm above ground down into footing	≈ 6 kJ	≈ 10 km/h	Flexible poly absorbs the hit; the localised plug adds toughness at ground line. Good for low-speed carpark impacts but still not a “security” or highway system.
Impact Recovery 3.5 mm – Surface Mount	3.5 mm steel/poly core on base plate with Impact Recovery Rings	≈ 10 kJ	≈ 13 km/h	Bollard deflects, car usually stops or rides up, and the bollard self-recovers. Footing and slab generally reusable.
Impact Recovery 3.5 mm – In-ground	3.5 mm core in 350 mm socket, 400 mm footing + Rings	≈ 15 kJ	≈ 16 km/h	Designed for shopfronts/carparks. Takes a decent low-speed hit, post recovers, footing survives with minimal damage.
Impact Recovery 5.5 mm – In-ground (Xtra HD)	5.5 mm core in 650 mm deep socket + Rings	≈ 25 kJ	≈ 21 km/h	High-duty option. Handles serious low-speed impacts (drive-through/parking lane stuff-ups) with limited permanent set. Bollard and foundation remain reusable.
Crash-tested Energy-Absorbing Bollard	Certified to AS/NZS 3845.2 / security standard	100–150+ kJ	≈ 40–50 km/h	Designed and crash-tested to stop a vehicle at specified speed and mass. Bollard deforms sacrificially. Used for hostile-vehicle mitigation & high-risk sites.
Indicative Energy Before Failure. Speed* of Passenger vehicle				

THE COSTS ARE NOT ONLY FINANCIAL

DISTURBANCE

UNDERGROUND SERVICES

SILICOSIS



The “impact absorbing” nature of the Impact Recovery Rings reduces the risk of injury to driver and vehicle occupants considerably, protecting both the bollard and the expensive footings for the entire lifespan of the development overcoming the problem of repeatedly replacing concrete foundations , which is not only costly, resulting in tonnes of concrete waste over the next 100 years, but it also creates ongoing disturbance and risk of pedestrian injury.

OUR CITIES ARE IN A CONSTANT STATE OF DECLINE

GROWING DAMAGE GROWING WASTE GROWING CONSUMPTION

DESIGNED
TO FAIL

GROWING
INCREASINGLY
COSTLY TO
MAINTAIN

We have designed our cities to fail and concrete to be “single use”.

With hundreds of thousands of bollards, barriers, signposts and roadside items in our cities, the damage and subsequent carbon waste has led to unprecedented consumption of concrete (now considered the world's most dangerous material) and each year the damage and costs continue to grow