Central Reserve / Median Safety Barriers

Rethinking VRS Selection

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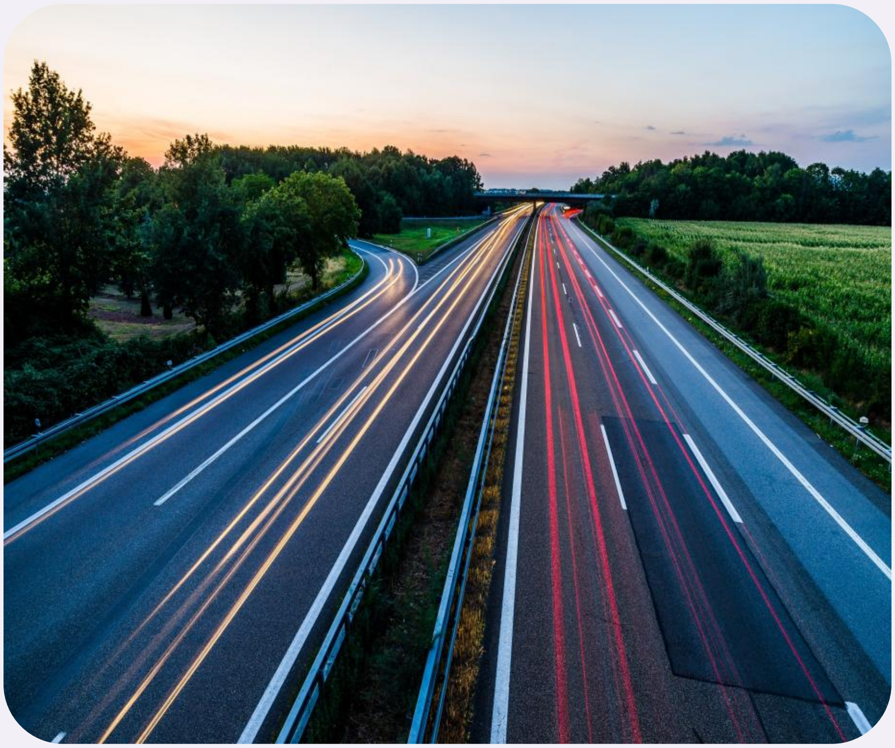


1 Executive Summary

There is a longstanding perception within the highways industry that concrete barriers are inherently safer and more suitable than steel barriers for central reserve applications on high-speed roads. However, modern vehicle restraint systems should be assessed on measured performance rather than material type alone.

2 How Did the Misconception Arise?

Much of this view stems from Highways Agency Interim Advice Note (IAN) 60/05, published before the organisation became National Highways as they are now known. This IAN was later superseded by TD 19/06 and incorporated into the Design Manual for Roads and Bridges (DMRB). IAN 60/05 required that, from 2005 with immediate effect, new central reserve barrier installations on motorways with an annual average daily traffic flow of 25,000 vehicles per day should be rigid concrete safety barriers. The stated aim was to improve health and safety outcomes, particularly by reducing maintenance interventions and exposure for road workers.

Later, TRL Published Project Report PPR279, issued in 2007, which examined the whole-life costs and performance of median safety barriers. The study compared the non-proprietary systems commonly used at the time, including Wire Rope Safety Fence (WRSF), Tensioned Corrugated Beam (TCB), Open Box Beam (OBB), Double Rail Open Box Beam (DROBB), Vertical Concrete Barrier (VCB) and Higher Vertical Concrete Barrier (HVCB).

More recently, National Highways published a press release in March 2022 stating that “The steel central reservation is being replaced with a more modern, concrete barrier, which is even stronger than the metal ones and helps to significantly reduce the risk of vehicles crossing over from one carriageway to another”.

It is important to note that, regardless of whether a Vehicle Restraint System (VRS) is steel or concrete, both should be assessed against the same relevant test standard, such as EN 1317 for UK applications. Consequently, systems achieving the same containment, working width and impact severity classification as a result of dynamic impact testing should be considered equivalent in terms of their declared performance characteristics.

3 The Findings

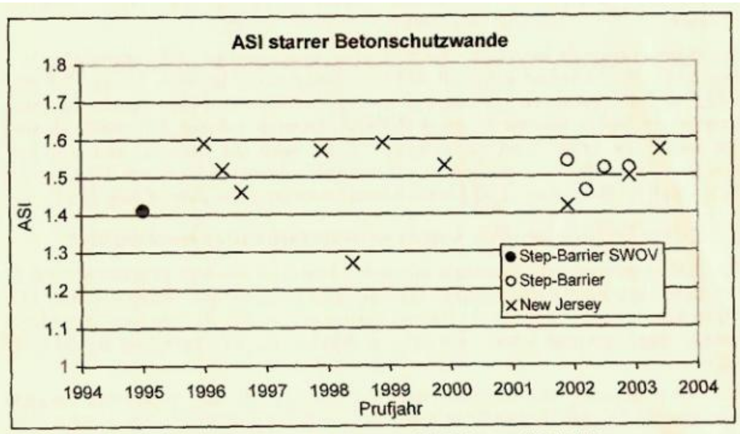
An independent study conducted by Business Strategy Group (BSG) for the Vehicle Restraint Maintenance Authority (VRMA) in 2006, which has never been made publicly available and was circulated exclusively within the VRMA, concluded that the rationale underpinning IAN 60/05 was fundamentally flawed (Davies and Pearson, 2006).

Their keynote summary stated:

"**BSG has investigated the issue raised by Highways Agency IAN 60/05 and finds that the facts do not support the new performance requirement to install rigid concrete barrier in the median of motorways set out in that document. Indeed, it is clear that a change to rigid concrete median barrier is neither cost effective nor in the interests of safety for the travelling public, for whom the HA has a duty of care**" (Davies and Pearson, 2006, pg.1).

The study also included a series of whole-life cost comparisons for different Vehicle Restraint System (VRS) configurations. In the scenarios assessed, Concrete Safety Barrier (CSB), Vertical Concrete Barrier (VCB), and Higher Vertical Concrete Barrier (HVCB) systems were shown as having higher whole-life costs than the alternative solutions considered.

A further key element of the investigation was an analysis of the Acceleration Severity Index (ASI) performance of various concrete barrier systems over time. The accompanying figure 1 below illustrates the ASI results against the year of testing. Of the fifteen tests reviewed, only one achieved an ASI value below 1.4, the threshold required for Impact Severity Level B.



Source: BSG reproduction of chart dated 4/11/04 in BASt letter of 21/12/04

Figure 1

Accompanying this, BSG was provided with a copy of a letter dated 21/12/04 from Herr Dr Klöckner of the German Federal Highway Research Institute (BASt). The letter responded to claims that the introduction of a new Impact Severity Level C classification was unnecessary because an in-situ concrete protection wall with a step-barrier profile was reportedly capable of achieving Impact Severity Level B performance (Davies and Pearson, 2006).

However, the evidence showed that only a single test result approached the Level B requirement. The test referred to in the letter was the concrete dutch-step barrier, promoted by Britpave, highlighted above in Figure 1 as 'SWOV'. This test was conducted before the introduction of EN 1317 in 1998 and recorded an ASI value of 1.41, which exceeds the maximum threshold for ASI B classification (≤1.4). It was only because of an amendment to EN 1317, which introduced a provision allowing values to be rounded to one decimal place, that this result could be classified within the lower impact severity category.

The TRL report suggested that concrete barriers offered lower whole-life costs due to their durability, reduced maintenance requirements and reduced likelihood of crossover accidents. The M25 case study investigated within the document identified no fatal casualties associated with impacts into concrete barriers, while serious injury rates were comparable with steel systems. On this basis, the report determined that concrete barriers were generally the most cost-effective option over a 50-year design life (Williams, 2007).

However, nearly **two decades later**, it is important to consider these findings in their historical context.

The highways sector has evolved significantly since 2007. The systems assessed in PPR279 were legacy, non-proprietary solutions, and the report's conclusions were based on the technology, materials and performance standards available at that time.

In addition, only **12.7%** of the M25 network assessed within the study consisted of concrete barrier, compared with **87.3%** for the steel vehicle restraint systems. This disparity in installation lengths means the accident and casualty data should be viewed with an appropriate level of caution.

Similarly, the historical durability advantage often attributed to concrete barriers has narrowed considerably. Modern galvanising technologies, enhanced corrosion protection systems and improved manufacturing processes can now deliver steel barrier service lives in excess of 50 years, depending on the environmental conditions and maintenance strategy adopted. Notably, Brackmore offers approved systems, both proprietary and non-proprietary, utilising advanced specialised coatings, offering significant reductions in carbon while preserving the full BS EN 1317 safety performance.

4 Considerations When Specifying Concrete Barriers

While concrete systems undoubtedly have a role to play in certain applications, they also present several challenges that should be considered during the design process:

- More difficult to provide emergency and maintenance access through the central reserve.
- Reduced visibility through the median compared with open steel systems.
- Can restrict wildlife movement across transport corridors.
- Typically require more substantial foundations.
- Less suitable for locations with weak or soft ground conditions due to their weight.
- Often require longer minimum installation lengths to achieve the desired performance.

- Require larger plant and equipment during installation.
- Typically contain higher embodied carbon footprint per metre installed, depending on the system type, foundation design, transport distances and construction methodology – see system EPD information for clarification.
- May require costly utility diversions, drainage modifications and relocation of existing services - costs that were not fully considered within the original PPR279 analysis.
- Limited access to services underground such as drainage or cabling.
- May require relocation or replacement of existing lighting columns to accommodate the concrete barrier; in some locations, steel solutions may offer greater flexibility where sufficient space is available.

5 Why Modern Steel Barriers Have Their Place

Today's high-containment steel vehicle restraint systems provide designers with a far wider range of options than were available when PPR279 was published.

Key advantages of modern steel systems include:

- ✓ Lower initial installation costs in many applications.
- ✓ Faster and easier emergency access, with required sections more suited for temporary removal.
- ✓ Improved access and less danger posed to maintenance teams during installation due to the lack of requirement for lifting at height, use of mechanical aids and overall component mass/size.
- ✓ Greater flexibility and controlled deflection during impacts, helping to manage occupant forces.
- ✓ Lower risk of vehicle rollover where high-centre-of-gravity vehicles are involved.
- ✓ Easier modification, relocation or extension during future network upgrades.
- ✓ Improved visibility across the central reserve.
- ✓ Reduced dependency on substantial foundations.
- ✓ Smaller installation plant requirements and reduced construction disruption.
- ✓ Lower risk of expensive utility and drainage diversions.

- ✓ Lower embodied carbon in many applications.
- ✓ Easier replacement of damaged components without major reconstruction.
- ✓ A wide range of proven high-containment steel systems are now available that can achieve containment levels historically associated with concrete barriers.

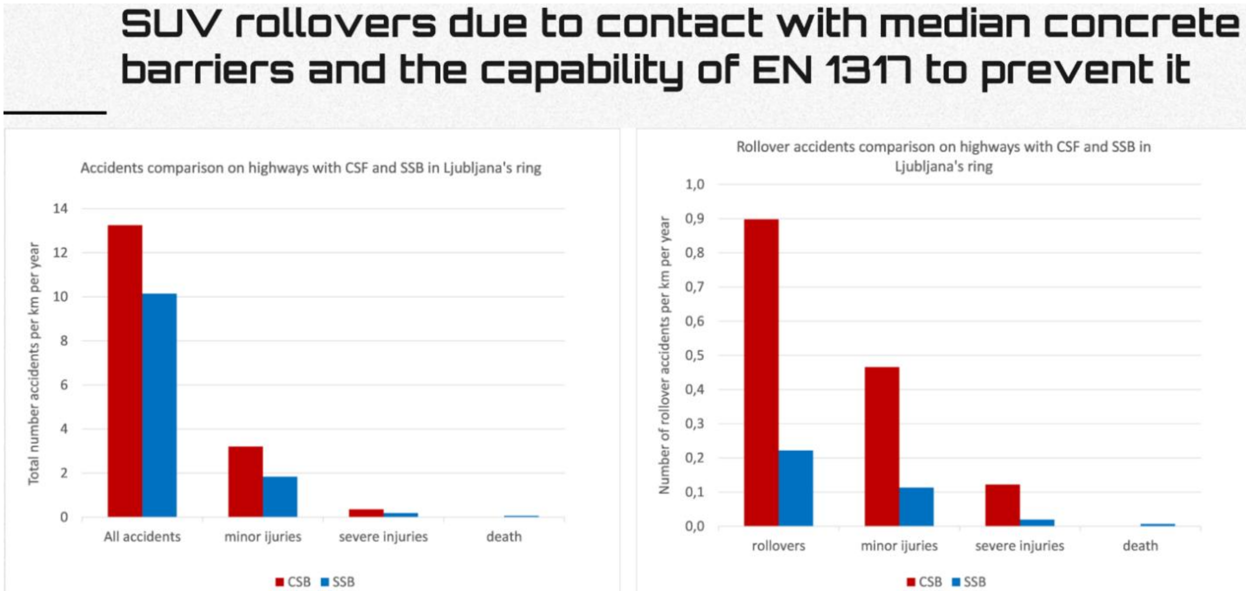
6 Supporting Studies

A separate study, conducted by Jovan Trajkovski and presented by AISICO, investigated the interaction between median concrete barriers and SUV rollover incidents, while also evaluating the extent to which the EN 1317 testing regime adequately considers and addresses this risk (Trajkovski and Kunc, n.d.).

The report, which is publicly available, highlights concern regarding vehicle rollover behaviour when more modern vehicles, such as SUVs, impact rigid concrete barriers, particularly where vehicle geometry and centre of gravity may influence post-impact stability.

One of the most compelling findings presented is a comparison of accident and rollover rates per kilometre per year on the Ljubljana Ring Road. Note the Ring Road is approximately **29.1 km (18.1 miles) long** on the outer ring, with approximately one third of its length having concrete safety barrier installed – demonstrating a high concentration of incidents for this section.

The data suggests that, although concrete barriers can be effective in preventing cross-median incursions, they may be associated with a higher proportion of rollover accidents, where a vehicle tips onto its side or roof during a collision, than steel safety barriers in the conditions studied. This is an important reminder that barrier selection should not be based solely on containment performance or whole-life cost. It should also consider vehicle stability, occupant risk, maintainability and the real-world performance of different barrier types under modern traffic conditions. Road user safety should remain the primary consideration.



*CSB – Concrete Safety Barrier

*SSB – Steel Safety Barrier

7 Myth vs Reality

Myth	Reality
Concrete barriers are always safer.	Safety performance is determined by tested EN 1317 classifications, not material type alone.
Steel barriers cannot achieve high containment.	Modern steel systems are available in high-containment configurations.
Concrete barriers always provide lower whole-life costs.	Cost effectiveness depends on maintenance, installation, carbon, access requirements and site constraints.
Concrete barriers are always the preferred solution for motorways.	Current standards specify performance requirements, with material selection depending on scheme requirements.

8 The Key Takeaway

The debate should no longer be framed simply as steel versus concrete. Instead, designers should select the most appropriate solution for the specific site conditions, performance requirements and whole-life objectives of each scheme, including safety, carbon, cost, access, maintenance and repair strategy.

Modern high-containment steel vehicle restraint systems can deliver performance comparable to concrete barriers while offering advantages in accessibility, adaptability, constructability, visibility and maintainability, as well as lower whole-life costs and a reduced carbon footprint in many applications.

For schemes where steel systems are the most appropriate solution, Brackmore, formerly Hill & Smith VRS, offers a range of high-containment guardrail systems suitable for a wide variety of applications, with advanced specialist coating options available designed to enhance durability, extend service life and minimise maintenance requirements.

As technology continues to evolve, specifying the right solution should be based on current performance data and project-specific requirements rather than assumptions formed nearly twenty years ago.

9 Current Standards and Design Requirements

The BSG study argued that IAN 60/05 conflicted with the principle of the Construction Product Directive where a performance criterion is specified rather than prescribing a single material type (Davies and Pearson, 2006).

As such, designers should always refer to the latest DMRB guidance when selecting and implementing Vehicle Restraint Systems on the high-speed road network. For applications where compliance with **CD 377** is not a mandatory requirement, the guidance should nevertheless be followed wherever feasible as industry best practice, ensuring robust and consistent design outcomes.

The English National Application Annex states that, for safety barrier provision within the central reserve of **existing roads**, a minimum containment level of H1 should be specified (Clause E/3.8 onwards). Notably, this requirement does not prescribe the use of a rigid barrier, defined as a safety barrier that exhibits no measurable dynamic deflection when tested in accordance with BS EN 1317-1 and BS EN 1317-2. The requirement for a rigid barrier applies only to **new roads** with a predicted two-way annual average daily traffic (AADT) greater than or equal to 25,000 vehicles/day, as set out in Clause E/3.4 onwards (National Highways, 2025).

In summary, vehicle restraint system specification should be performance-led, evidence-based, and tailored to the risks, site constraints, and operational requirements of each individual project, rather than being driven by a prescriptive preference for a particular barrier type.

10 Sources

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