

ASSESSMENT OF THE EFFECTIVE PERFORMANCE OF SAFETY BARRIERS AND PREPARATION OF THE UPGRADE PLAN WITH PRIORITY ACTIONS

THE ANFISA CIRCULAR ISSUED LAST DECEMBER TO ALL ROAD OPERATORS DRAWS ATTENTION TO THE NEED TO PREPARE PROGRAMS AND INITIATIVES TO ASSESS THE EFFICIENCY OF SAFETY BARRIERS AND TO DRAFT REDEVELOPMENT PLANS WITH RELATED PRIORITIES FOR INTERVENTION, IN ORDER TO PROGRESSIVELY ADAPT THE STANDARDS OF SAFETY BARRIERS

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The legislation currently governing the performance and use of safety barriers in Italy is closely linked to Ministerial Decree 223 of 1992. Over the course of the following 30 years, regulations (including Ministerial Decree 2367 of 2004), circulars, and directives have been issued that have made some changes and provided clarifications, but in the most significant aspects, Ministerial Decree 223 has remained substantially unchanged.

Much progress has been made in these 30 years, both in Italy and in Europe. Today, we acknowledge that what was unthinkable in the early 1990s. Although this knowledge has yet to be used to radically revise the contents of the 1992 regulation, it has gradually focused attention on certain aspects, including the actual performance of barriers in situ compared to those tested. The problem is now widely known: can a barrier in situ provide performance substantially similar to that observed during laboratory crash tests?

To answer this question, which has a significant impact on road safety, several studies over the last ten years have essentially arrived at a shared conclusion: besides exceptional cases, barriers in situ never perform in the same way as barriers subjected to crash tests.

There are several reasons for this: the ideal characteristics of test laboratories, which are difficult to replicate on-site, the mechanical characteristics of the materials used in the barrier, and the mechanical and geometric characteristics of the supports. Finally, the physiological deterioration in the performance of barriers and supports should not be overlooked.

ABSTRACT

The need for road operators to progressively upgrade the performance characteristics of the safety barriers on their infrastructure is reiterated in an ANFISA circular sent to all operators last December. The drafting of upgrading plans and related intervention priorities requires a complex process that ensures objectivity in choices and is based on a validated procedure. The ARES method allows the operator to arrange a safety barrier redevelopment plan with intervention priorities, in accordance with the requirements of the ANFISA circular.

Furthermore, in many of the installations carried out over the last 30 years, the actual performance of the barriers in place was not taken into account, with projects limited to prescribing the use of a specific barrier distinguished by destination, containment class, and an operating width.

All these circumstances have led to the installation of many devices that are unable to meet the required performance standards; consequently, road infrastructure operators need



1. H3 class side edge barrier with double longitudinal element

to assess the performance of the barriers installed on their network and establish appropriate upgrading criteria.

The principle was recently re-proposed by ANFISA, the National Agency for the Safety of Railways, Road and Motorway Infrastructure, in a circular sent to all operators last December. In this communication, ANFISA, in reiterating the fundamental role played by restraint systems in protecting vehicles in derailment conditions, as well as in protecting structures, infrastructure and related users, confirms, as already clarified by MIT Directive No. 3065 of 25 August 2004, that there is no obligation to apply Ministerial Decree 223/92 and to replace any barriers that do not meet the requirements set out in the technical instructions attached to the same Decree. However, the communication calls on the managing bodies to comply with the tasks assigned by Article 14 of the New Highway Code regarding the control of the technical efficiency of the road and road appurtenances, including all restraint systems.

To this end, for ANFISA, it is absolutely essential that all operators, in accordance with a specific programme also related to budgetary constraints, take planned and systematic action on the network to achieve adequate levels of protection, while also progressively improving the overall safety of road infrastructure.

All operators are therefore required to adopt programmes and initiatives to verify and monitor, along the road network under their responsibility, the efficiency and maintenance conditions of restraint systems, defining, on the basis of this knowledge and where such conditions are not acceptable, specific requirements plans to be updated annually and aimed at the progressive adaptation of the systems, according to priority criteria resulting from a risk assessment extended to the network under management.

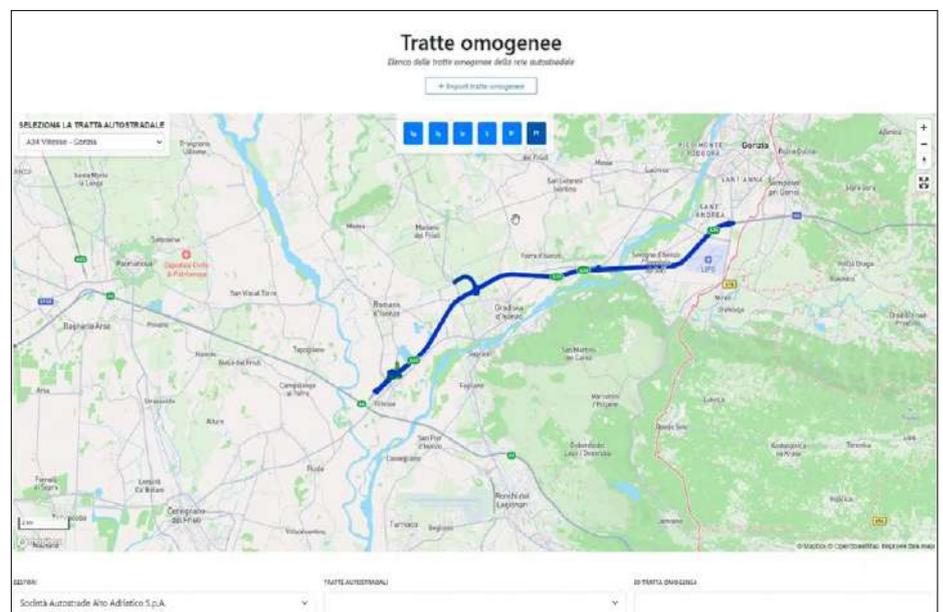
Drafting redevelopment plans requires precise knowledge of the performance of the restraint systems installed along the network under the responsibility of an operator, in order to objectively determine:

- the actual performance of the devices, and determine any inadequacy with respect to regulatory requirements;
- in the event of inadequacy, the level of risk of each section in order to determine the priorities for intervention;
- the interventions necessary to restore the devices to efficient working order.

To address this complex and multifaceted task, AISICO Srl, with the support of Progetti e Servizi Srl, developed the ARES method (Assessment Road Equipment Safety), a leading European company in the field of road safety. This method allows managing bodies to assess the actual performance characteristics of road safety barriers and to equip themselves with a system for the integrated management of restraint devices. Through a platform, the method enables the preparation of a plan for upgrading the restraint systems with intervention priorities, in accordance with the requirements of the ANFISA circular.

THE ARES METHOD

The method examines partial or total sections of road networks, dividing them preliminarily into homogeneous sections, each characterised by the same type of barrier and support.



2. Ares WebApp - View of a motorway section



3. Mo.Ma.S - High-Performance Vehicle

The characteristics of the different types of devices present on the network and the geometric characteristics of the supports are acquired using a suitably equipped High Performance Vehicle, capable of detecting not only the types of devices present, their state of repair and their geometric characteristics, but also the geometric characteristics of the support and any obstacles located in the vicinity of the device.

Based on the survey, each device is registered, and after examining the available documentation, each device is assigned the essential characteristics required by standard EN1317 (containment level, operating width, dynamic deflection and vehicle intrusion).

For all systems for which it is not possible to obtain the essential characteristics due to a lack of documentation, an Artificial Intelligence system assigns presumed values for the essential characteristics to any barrier.

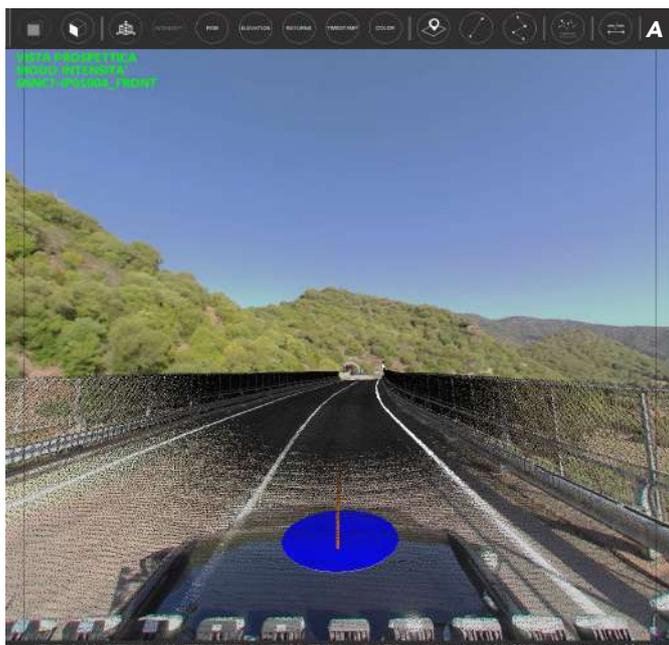
The mechanical characteristics of the supports are determined through typological dynamic testing campaigns using the THOR dynamic impactor, in accordance with the provisions of the technical document UNI/TR11785.

INTRINSIC PERFORMANCE OF THE BARRIER

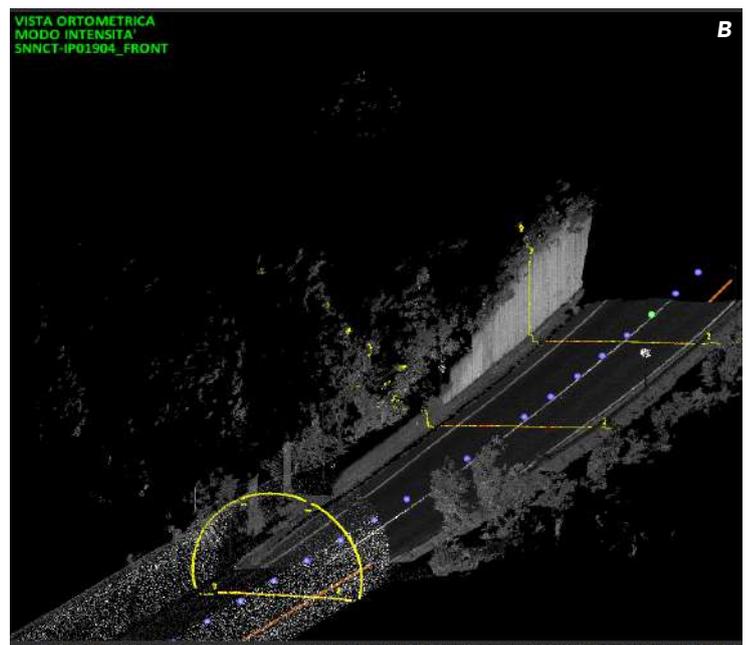
The performance that each device is capable of providing depends on its containment class, geometric characteristics and state of maintenance. In the event of deviation from the theoretical nominal values, the decay of each parameter is calculated using decay curves, defined by algorithms developed using finite element numerical analysis in accordance with UNI EN 16303, and validated by experimental tests.



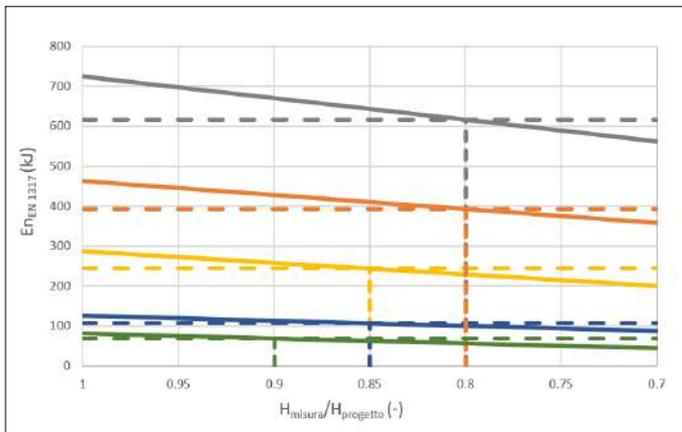
4. THOR - Dynamic Testing



5A and 5B. Survey results with High-Performance Vehicle (A).



Road cross-section surveys with a high-performance vehicle (B)



6. Graph of energy loss as height varies for class H2 barriers

These three parameters define a Maintenance Index, which accounts for the device's intrinsic performance. The intrinsic characteristics of the barriers must be supplemented by the characteristics of the support, defined by a Support Index. Again, the decay in the performance of barriers in the case of supports that do not comply with those used during the tests that led to their certification is determined using algorithms defined with finite element numerical simulations and validated by experimental tests.

The weighted combination of the two indices defines a Performance Index that represents the actual value of the device's containment capacity.

DEVICE INSTALLATION CONDITIONS

Other factors that influence the level of suitability of a device are the conditions in which the device is installed. In fact, even if a barrier is intrinsically valid, it may not be suitable, for example, due to the presence of obstacles behind it that may interfere with the operating width determined during testing with heavy and light vehicles, due to obstacles that interfere with vehicle intrusion, or due to the geometric characteristics of the supports. The presence of obstacles, their frequency and the geometric dimensions of the supports, appropriately weighted, define an Installation Index that represents the adequacy of the condi-



7A and 7B. Example of a device with oxidation

tions surrounding the device to allow the barrier, in the event of an impact, to behave in a similar manner to how it behaved during the tests that led to its approval or certification.

Compared to the Performance Index, which requires interventions on the barrier or on the mechanical characteristics of the support, a deficient Installation Index does not necessarily require interventions on the barriers but could, for example, require interventions on the obstacles or on the dimensions of the supports.

OVERALL OPERATION OF THE DEVICE

The Performance Index and Installation Index, appropriately weighted, define an Operation Index, which identifies the overall capacity of the device to guarantee performance in line with the requirements of the standards. Each homogeneous section is characterised by a Functionality Index value. Devices that require adjustment are those with a Functionality Index below a defined threshold value. The threshold value, or acceptability limit, has been determined based on analytical and statistical assessments and is such that it does not significantly reduce the level of road safety.

REDEVELOPMENT PLAN AND INTERVENTION PRIORITIES

Thanks to the ARES platform, which stores all the data collected by the system, it is possible to draft a redevelopment plan and establish intervention priorities.

In fact, for each homogeneous section, it is possible to predict the maximum interventions that can be carried out and verify whether these planned interventions allow the device to meet the acceptability criteria. Furthermore, for each type of intervention, it will be possible to establish a cost using a price list containing all the unit costs of the foreseeable interventions. Therefore, it will be possible to define at a general level the necessary adaptation interventions and the related overall costs for each homogeneous section.

In order to define the priorities with which the various interventions must be carried out, it will be necessary to take into account not only the Functioning Index but also other factors which, although they do not affect the need to adapt the device,

defined exclusively by the Functioning Index, nevertheless affect the general safety of the road and therefore the advisability of carrying out a given intervention sooner or later.

These parameters include, for example, the purpose of the device, such as the roadside; the engineering structure or the traffic divider, which have different levels of risk; the characteristics and volumes of traffic, which affect the probability of an accident occurring; the authorisation status of the device (EC certification, type

approval or other); finally, the cost of individual interventions, with the aim of prioritising interventions which, at the same cost, are capable of making a longer stretch of road safer.

The Functioning, Destination, Traffic, Authorisation and Cost indices, when appropriately weighed, assign a value to each homogeneous section: the lower the value, the more critical the situation and the more urgent the need for intervention. The list of all sections that need upgrading, ordered according to increasing index values, provides the Intervention Priorities. Each section is also marked with an estimated amount necessary to implement the upgrade; therefore, the operator can schedule interventions based on available financial resources.

SAFETY WITH REGARD TO LIGHT VEHICLES

The procedure mentioned above, which only takes into account the behaviour of the barrier with regard to heavy vehicles, is combined with the interventions necessary to make the road network safe for light vehicles, whose safety is generally compromised by other factors, such as terminals, fixed obstacles, tunnel entrances, overpass piers, etc.



8. Presence of PMV within the operating width of the device

In this case, the priority of intervention is determined by the frequency with which these specific points are present within each homogeneous section.

CONCLUSIONS

Many road devices along national networks are unable to perform as intended and therefore require various types of adaptation work, ranging from a simple realignment to a replacement of the barrier. To address the problem in a systematic manner, it is necessary to have a tool that allows the operator to make objective choices about the interventions and their priorities, within the available resources, keeping in mind that a redevelopment plan necessarily takes place over a long period of time and that, for this reason, it is

necessary to define the risk of each intervention in order to give priority to those that allow to secure the most dangerous sections first. The risk is that interventions are planned on subjective grounds, for example, due to an accident or a report, making it difficult to justify why that intervention was prioritised over other, more urgent ones.

ARES was developed precisely to address this need, allowing objective criteria to be used to define where interventions are actually necessary and the priorities with which to carry them out, taking into account the actual performance capabilities of the barriers and all the conditions that determine, on the one hand, the need to carry out adaptation interventions and, on the other, the priority with which to carry them out.

The list of intervention priorities allows the operator to objectively plan the most urgent annual interventions, based on available resources, thus optimising them and postponing to subsequent years those interventions for which the necessary financial coverage is not currently available.

Intervento	COSTO	QTA	TOTALE
Fornitura e posa in opera di nuova barriera metallica su rilevato con rimozione della barriera preesistente (euro/m), Classe H1	156,29 €	127 (m)	20.102,83 €
TOTALE			20.102,83 €

Intervento	COSTO	QTA	TOTALE
Fornitura e posa in opera di nuova barriera metallica su rilevato con rimozione della barriera preesistente (euro/m), Classe H2	156,29 €	127 (m)	20.102,83 €
TOTALE			20.102,83 €

9. Entry of adaptation interventions and definition of costs

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