Abstract:

When adopting the European Standard for road restraint systems EN1317, France faced the need to adapt its National Guidelines in order to allow anti-falling load systems to be qualified and used on its territory. The original French bridge parapets and anti-falling load systems were formerly covered by the Guideline called “Barrières de sécurité pour la retenue des poids lourds: Barrières de niveau H2 ou H3”. This document is describing the National bridge parapet BN4 usually used on the French bridges on which an additional screen was used to contain possible falling loads.

In a research report “Mise au point des dispositifs de retenue par simulation de chocs”, numerical simulations were used to assess the performance of the BN4 barrier on which a screen to contain falling loads has been added.

This article proposes a procedure to be possibly adopted for any bridge parapets tested according to a Performance Standard such as EN1317 (or NCHRP350 or MASH) on which an anti-falling load would be installed. That procedure is including simulations that prove an acceptable level of reliability of the numerical models by comparing the simulations results with the real crash tests of the reference barrier without the additional anti-falling load screen. Then, a simulation of the heavy vehicle carrying a load able to fall during the impact on that barrier on which the anti-falling load screen would be added would be realized to check the performance of that anti-falling load system.

Keywords: safety barrier, bridge parapet, EN1317, MASH, NCHRP350, anti-falling load
1. Situation before EN1317 for anti-falling load systems in France

The concern of the anti-falling load protection has been of high importance in France since the years 1975. Indeed, in the research report (1) is describing the real crash test made at the time on the first anti-falling load system in France.

The goal of developing that device was to raise the level of protection for the cases below:
- Roadways with intense HGV traffic or special features of a high-risk area to third parties.
- Roadways with high risks of falling of toxic barrels that could pollute the area.
- ...

The first system has been developed to be installed on a common French Bridge parapet called BN4 (public non-proprietary system) and has been tested with a 7.2 tons truck. The truck had a 8 tons coil on its trailer. The speed of impact was 60km/h and the angle of impact was 20°.

[Figure 1. First BN4 with an anti-falling load system tested in 1975 (1).]

2. Situation with EN1317 for anti-falling load systems placed on common bridge parapets in France

With the appearance of EN1317 (3), bridge parapets had to be qualified with test conditions that are different than the ones defined before. Indeed, depending on the considered bridge parapet and its containment level according to EN1317, it has to contain heavy vehicles with masses from 10 tons up to 38 tons. Unfortunately, EN1317 is not covering the case of bridge parapet on which an anti-falling load system would be installed. Due to that, a research report (2) has been released by the research organization for the roads in France called SETRA in 2004. That report aimed at proposing an anti-falling load system that would be suitable to be used on the common BN4 bridge parapet used in France. The BN4 system was supposed to pass EN1317 and the goal was to qualify the anti-falling load that would be installed on it.
As the will was to increase the mass of the impacting coil, it was proposed to qualify the performance of that anti-falling load screen using Finite Element Simulations. The simulation performed was an impact of a coil of 11840 kg impacting at 60km/h with an angle of 20° on the anti-falling load system with a height of 1.95m from the ground as illustrated below.

![Figure 2. Simulation of a coil impacting the BN4 barrier with an anti-falling load system (2).](image)

After some iteration, the research report is proposing solutions for anti-falling load systems to be installed on National French bridge parapets (such as BN4) that pass the impact conditions described in this chapter. This was done relying on simulation results. The following picture shows an installation of one system in France.

![Figure 3. Installation of an anti-falling system for which the performance has been determined by Finite Element Simulation (2).](image)

### 3. Performance qualification procedure proposal for anti-falling load systems

Since the appearance of EN1317, bridge parapet designs tend to be owned by manufacturers more and more and not by road authorities. This is answering the will of the European Commission that products are characterized using the same standard all around Europe so that manufacturers could sell it once being CE marked. To be CE marked, a bridge parapet has to pass two crash tests defined in EN1317.

As many bridge parapets have been and are still developed in Europe, there is a need for regulating the qualification of bridge anti-falling load systems that could be placed on top of them and which could have very different designs.

With the increasing reliability of simulation and, in a similar way that what has been done for the BN4 system, this article proposes to rely on Finite Element Simulations to assess the performances of such systems. This article proposes that the anti-falling load system should be used on a tested bridge parapet (tested according to an international performance standard such as EN1317). Then, that bridge parapet should be modelled and the heavy vehicle impact should be reproduced by simulation following the TR16303 document (4). This would guarantee a sufficient level of reliability for the simulation models.

Then, using the same parameters from the calibrated models, a new simulation would be made with an impact of a truck carrying a detached load to qualify the bridge parapet with the anti-falling load system attached to it. The following picture illustrates such possible simulation.
Figure 4. Illustration of a simulation of an impact of a truck carrying a detached coil against a bridge parapet (tested according to EN1317) on which an anti-falling load system has been installed.

4. Conclusions

This article shows first how anti-falling systems were tested in France for the French bridge parapets including the BN4 system. It also shows the evolution of the testing procedure switching from real crash tests to simulations. With EN1317, numerous new bridge parapets are appearing on the European soil and the need for a performance qualification procedure has been highlighted. Finally, a proposal using Finite Element Simulation is made for qualifying those structures that would be placed on tested barriers.

5. References

(1) DDE de la Moselle, “Barriere normale en acier avec écran anti-chute”, 1975
(2) SETRA, “Mise au point des dispositifs de retenue par simulation de chocs”, 2004
(3) “EN1317”
(4) “TR16303”
(5) SETRA, “Barrières de sécurité pour la retenue des poids lourds : Barrières de niveau H2 ou H3”, 1999