

Development of Safe Impact Performance Vehicle Parapets for Bridges

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Summary

In 1998 the European Committee for Standardization (CEN) published the first two parts of Standard EN 1317 under the general title Road restraint system. The published sections specified the requirements and methods for full-scale impact tests on safety barriers.

The safety barrier generally used in Finland on bridges, the standard vehicle parapet of the Finnish Road Administration (Finnra), did not conform to the standard according to the arranged full-scale impact tests. Thus began the development process described in this article.

The new Finnish standard safety barriers to be used on bridges, Finnra H2 vehicle parapets, were successfully developed with the chosen method to adequately conform to Standard EN 1317. The costs of increasing the safety of vehicle parapets in Finland have been estimated as equaling the savings in accident costs.

Keywords: Safe, impact, accident, collision, vehicle, parapet.

1. Introduction

In 1998-1999 Finnra arranged full-scale impact tests consistent with Standard EN 1317 for its standard vehicle parapet. The aim was to prove that the vehicle parapet generally used in Finland at the time satisfied the requirements of the standard. The unsatisfactory impact performance revealed by the tests led to the development process and doctoral thesis described in this paper; the objective was to produce new domestically utilized vehicle parapet alternatives conforming to the standard.

The developed structures' analyses and impact tests were carried out in 2000-2004. Subsequently the drawings of new Finnish standard vehicle parapets have been updated and the publication "Vehicle parapets" (Finnish Road Administration 2006), consisting of a design manual and quality requirements for vehicle parapets to be used in Finland, has been released as a result of the development project. The standard drawings, publication and doctoral thesis are available on the Internet: <http://www.tiehallinto.fi/sillat> and <http://webhotel.tut.fi/library/tutdiss/show.php?id=34>.

2. Object Setting

The new Finnish standard vehicle parapet types, to be used on the main roads, were named Finnra H2 vehicle parapets. The objectives for their development were defined to be containment level H2, narrow construction, aesthetically pleasing and open structure with finished details, high enough to protect bicycle and pedestrian traffic, and able to withstand small impacts without notable damages.

One way to achieve a new higher containment level vehicle parapet would be to develop a massive structure and improve its ability to withstand light vehicle collisions by equipping it with energy absorbing devices. The result would be a heavily built and expensive structure. A more economic and aesthetically pleasing, light and open structure can however be achieved by designing a structure whose frame bends adequately, but is strong enough to resist breakage. In the latter case, the design task is more challenging. A heavy vehicle collision requires a rigid structure with high strength, while the requirements of a light vehicle collision are the opposite: the narrow target is somewhere in the middle. The need to withstand small impacts, snow clearance, etc. without notable damages also complicates the balance between structural rigidity and strength requirements.

3. Developed Containment Level H2 Vehicle Parapets

According to Standard EN 1317, the impact performance of safety barriers is tested by full-scale impact tests where actual vehicles collide with a full-size safety barrier construction. Besides full-scale testing, the utilization of computer simulation is increasing as its ability to simulate reality has improved and costs have fallen. The analysis method used to develop the new Finnish standard vehicle parapet types was a combination of calculation analyses, full-scale impact tests (Fig. 1) and the experiences gained from the process.

The new, containment level H2, standard vehicle parapets reach 1.2 m above the road surface. The parapets consist of solid steel bar posts spaced 2.0 meters o/c., a rail and a cold-rolled U-profile as a handrail. The 2-pipe rail is normally used because of aesthetic and openness requirements. Alternatively, a uniform open section rail can also be used, but with a lower pipe rail below the handrail to prevent a heavy impact from a car against the post. The alternative structure is meant for small bridges whose parapets, for the sake of consistency, should match the other roadside safety barriers.



Figure 1: On left, impact of car weighing 937 kg against Finnra H2 vehicle parapet with 2-pipe rail at 104 km/h impact speed and 20° angle. On right, impact of bus weighing 13.12 tons at 81 km/h impact speed and 19.1° angle. (Courtesy of Helsinki University of Technology)

4. Conclusion

Although the new Finnish standard vehicle parapet types conforming adequately to Standard EN 1317 were successfully developed for domestic use, structures conforming to the standard could also be used in other countries in the future. Correspondingly, vehicle parapets other than the Finnra structures – conforming to the European standard and suitable for Finnish conditions – could also be used in Finland. According to an accident cost-effect analysis carried out, the investment per year due to the implementation of the new standard vehicle parapets is quite small, and most of any invested money would be recovered through saved accident costs. Most importantly, the number of injuries will be reduced, along with the high risks related to the severe consequences of accidents involving public transport vehicles.