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Article

# Assessing Roadside Hybrid Energy Absorbers Using the Example of SafeEnd

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**Abstract:** A combination of crash cushion and end-terminal, hybrid energy absorbing devices have been in use worldwide for a few years already. They include SafeEnd, a system Poland has recently introduced. Some road authorities have raised concerns as regards the operating conditions of the devices and how they work together with safety barriers. The objective of this research is to clarify the concerns and answer the following questions: (1) Can SafeEnd devices be used as hybrid devices and combine the roles of end-terminal and crash cushion placed before an obstacle? (2) What should be the rules for installing crash cushions at diverging roads and at the start of an off-ramp? The article presents characteristics of SafeEnd devices, defines the doubts raised by road safety auditors, discusses the results of field and numerical tests of the devices and explains the design principles for interchange ramps where crash cushions are required. The study results have helped to answer the research questions: SafeEnd devices fulfil the role of end-terminal and crash cushion, it is possible to make them more visible and principles have been defined for how the devices should be used at road interchanges. Further research should help to define general principles of deploying road restraint systems such as crashworthy terminals, crash cushions or hybrid devices.

**Keywords:** road safety; road restraint system; crash and numerical tests



**Citation:** Budzynski, M.; Jamroz, K.; Jelinski, L.; Bruski, D.; Pachocki, L.; Baginski, G. Assessing Roadside Hybrid Energy Absorbers Using the Example of SafeEnd. *Materials* **2022**, *15*, 1712. <https://doi.org/10.3390/ma15051712>

Academic Editor: Diego Maria Barbieri

Received: 31 January 2022  
Accepted: 22 February 2022  
Published: 24 February 2022

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## 1. Introduction

Roadsides are critical to road safety management. Roadside hazards represent one of the main causes of fatal accidents [1–3]. One of the ways to manage road safety is to use energy absorbers that prevent vehicles from running off the road [4,5].

Energy absorbers that act as crash cushions and end-terminals have been in use for a few years worldwide. The devices are designed to shield road barrier terminals and protect objects in the clear zone. Recently introduced in Poland, the energy absorber SafeEnd (SE) is an example of such devices. Some road authorities, however, have been raising concerns over their use as an energy absorber. Road authorities mainly object to the fact that:

- The SE system is not certified as a crash cushion,
- The SE is connected to barriers at interchange ramps in a way that increases the deflection of safety barriers from road edge; the result is that the barrier may be hit at more than 20 degrees which may increase the risk of barrier penetration and hitting an obstacle.

The article presents the results of research and SE operation analyses. It also looks at the possibilities and principles of using the devices as hybrid energy absorbers. Answers have been formulated to the research question: ‘Can SE devices be used as hybrid devices fulfilling the role of both an end-terminal, barrier terminal and crash cushion placed before an obstacle?’.