

## Crash tests to evaluate the design of temporary traffic control devices for increased safety of cyclists at road works

*Anna Niska, Jan Wenäll and Jones Karlström*

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**Background:** In Sweden many cyclists are injured in single-bicycle crashes and some of these occur in connection with road works. These crashes lead, not only to minor injuries but also to severe injuries and even fatalities. Not all bicycle crashes, least of all those occurring in parks and suchlike, are entered in the Strada (Swedish TRaffic Accident Data Acquisition) accident database, which makes it hard to gauge the magnitude of the problem posed to cyclists by road works. In an earlier study for the period between 2007 and 2012, we identified, through Strada, 288 bicycle crashes relatable to road works. The majority, 90 per cent, occurred in urban areas, and the most common causes were: cyclists falling when encountering cables, hoses, pipes etc. laid across the cycle path; loose gravel, stones or dirt from the road works; high and/or unmarked edges; large potholes, ditches or other irregularities. In addition, we found that cyclists were also injured by the temporary traffic control devices put out to warn or protect the road users, for example by getting stuck with handlebars in fences or falling when hitting road signs. The conclusion was that there is a need for increased knowledge on how to adapt marking and fencing material as well as diversion routes for cyclists, both for increased accessibility and to reduce the risk of injuries.

Following up this earlier study, VTI has now started a new research project funded by the Swedish Transport Administration. The purpose of this project is to provide a platform for knowledge exchange between ongoing initiatives regarding cyclists at road works and to gather and synthesize knowledge from these. By simulating bicycle crashes in the VTI crash safety laboratory and performing field studies, this project will also give the bases for how temporary traffic control devices should be dimensioned and designed for cyclists. The project will also contribute with input to develop the road keepers' regulations and guidelines on how to handle cyclists at road works. To secure that the results from the project will be applied it is also included to develop educational materials and plans for enhancing the knowledge within the road construction sector.

**Aim:** This paper will present the results from the first part of the project including simulated bicycle crashes in the VTI crash safety laboratory. The purpose is to give input on dimensions and design features of temporary traffic control devices regarding the risk of injuries among cyclists.

**Method:** Through literature studies and contacts with road owners and contractors, knowledge is gathered concerning current guidelines and present-day procedures in connection with road works on or near cycle paths. Adjustments of current guidelines and requirements for temporary traffic control devices is discussed in workshops with manufacturers, suppliers, road authorities and contractors. Design parameters that need to be taken into consideration, such as falling height, angles and forces, are elaborated on through simulations of bicycle crashes in the VTI crash safety laboratory. These simulations are conducted using a Hybrid II 50th percentile crash test dummy, with acceleration measurements in the head, placed in the saddle of a bicycle. Besides the acceleration measurements, the tests are documented with several video cameras at different angles, including high-speed video cameras, to be able to study the falling motion in detail. Several crash scenarios are tested at different speeds and angles etc.

**Results:** The results will include slow motion pictures describing falling patterns that will give input on how temporary traffic control devices should be dimensioned and designed to reduce the risk of injuries among cyclists. Adjustments of current guidelines and requirements will be discussed regarding the view from manufacturers, suppliers, road authorities and contractors.

**Conclusions:** The paper will elaborate on current guidelines and present-day procedures in connection with road works on or near cycle paths and how they may conceivably affect cyclists in terms of accessibility, comfort and safety. In particular, the design of temporary traffic control devices will be examined.