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A PROCEDURE TO TEST THE SAFETY LEVEL OF ROAD DESIGN ELEMENTS

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ABSTRACT

Since 1992, 'Sustainable Safety' has been the leading road safety concept in the Netherlands. The main objective of a sustainably safe road transport system is to reduce the number of traffic casualties to only a fraction of the current annual number. The most important ways to achieve this are to prevent latent errors in the traffic system as much as possible, and to let road safety depend as little as possible on individual road user decisions.

The four main principles for road design are:

1. functionality;
2. homogeneity;
3. recognizability/predictability;
4. forgivingness.

The fifth Sustainable Safety principle, 'State awareness' (by the road user), involves the ability to assess one's task capability to handle the driving task and has no direct effect on road design.

The first principle, functionality of the traffic system, is important to ensure that the actual use of the roads is in accordance with the intended use. For this reason, each road or street may only have one function: flow, access or distribution. The second principle, homogeneity, is intended to avoid large differences in speed, direction, and mass by separating transport modes and, if that is not possible or desirable, by making motorized traffic drive slowly. The third principle should result in a design (of the road and its environment) which promotes the recognizability of the road categories, and therefore the predictability, of the traffic situations that may occur. In this way, undesirable traffic situations can be acknowledged and avoided in time. The fourth principle is intended to limit injury severity by a forgiving road environment.

Each principle has been specified into a set of requirements for road design. To test these requirements, the Sustainable Safety Test was developed. The requirements can be tested during various design phases (from the planning phase to the reconstruction phase). In essence, the Sustainable Safety Test compares each indicator of a planned or existing situation with the test criteria. The result of the Sustainable Safety Test consists of calculated percentages that indicate which proportion of the road length (or which proportion of the intersections) meets the various sustainable safety requirements.

Recently EuroRAP (European Road Assessment Programme) launched another type of test: the Road Protection Score (RPS). The RPS test focuses on a set of criteria, which specifically relate to the safety of a car driver; the Sustainable Safety Test also takes into account the safety of other road users. The present paper will discuss the differences and similarities between both tests.

The Sustainable Safety Test was applied several times: in research projects (e.g. evaluation of zones with a 60km/h speed limit, evaluation of main roads in a city), and in several design stages of a planned light rail track in a medium-sized city. The RPS test was applied to national roads and to a share of the provincial roads.

If a road (design) meets the sustainable safety requirements, and thus scores a high percentage on the Sustainable Safety Test, this does not automatically mean that from now on there will be no more crashes. Fulfilling the requirements means that the road design meets the most important safety conditions. The same applies to the criteria of the RPS test. How the requirements and criteria are linked to crash patterns and to crash types is a subject of research.

INTRODUCTION

It is generally accepted that a journey should be fast and safe. It is less clear how fast and how safe, and at what price. At the national level we provide some clarity by setting goals and targets for the how and the price, but at the regional and local level the clarity is less. At the level of road networks, traffic models are used to calculate levels of traffic flow, accessibility, and safety. This is much more difficult, however, at the level of road sections and intersections. At that level, the road designer attempts to transfer the goals and targets from the higher levels to a specific road section or intersection. Is this a well-nigh impossible task? As far as the actual design is concerned, there are indeed many unanswered questions for every design. In practice it always comes down to yet another design that has a strongly traditional character and which combines objectives, wishes, and preconditions of various natures.

Is it really possible to arrive at traffic engineering designs which, already during the (re)design phase, provide a better understanding of the extent to which a contribution is made to traffic flow, accessibility, and safety? If the answer is yes, the designer can come to a better balance between flow, accessibility, and safety. If the answer is no, either knowledge should be improved to arrive at a 'yes', or the designer will be forced to use his expertise as the main input.

At all times the designer must weigh the possible effects of external wishes and goals against the three traffic goals. There should be clarity, for the designer and for others involved, about the choices in a design and the effects on the balance between flow, accessibility, and safety. This is necessary because the designer always needs to makes choices, often implicitly, during the creative process which designing just is. However, participants, joint deciders, and those responsible must be able to see what the choices were; all inputs and outputs of the design must be clear for all design phases. Preferably, this should be quantitative information that must provide sufficient understanding of the consequences of the design to be carried out for all relevant safety aspects.

SUSTAINABLE SAFETY

Since 1992, the concept 'sustainably safe traffic' (Koornstra et al., 1992; Wegman & Aarts, 2006) has been used in the Netherlands. The main objective of a sustainably safe road traffic system is to reduce the number of traffic casualties to only a fraction of the current annual number. What a sustainably safe traffic system must precisely look like has been worked on by many researchers, policy makers and practitioners.

One of the first issues, categorization of the road network, was studied by a national working group of experts (CROW, 1997). They formulated requirements for each road category. The present paper will take these requirements as a starting point.

Wegman & Aarts (2006) proposed a quality assurance system, which, besides organizational elements, should comprise reviewing elements for road infrastructure, both for existing roads as well as for the different phases of road design. The instruments described in this paper can possibly contribute to such a system.

It is of great importance for a sustainably safe traffic system that for each of the different road categories road users know what behaviour is required of them and what they may expect from other road users. This should be supported by optimising the recognizability of the road categories.

The main concepts in relation with the infrastructure in a sustainably safe traffic system are:

- Functionality,
- Homogeneity,
- Recognizability and predictability,
- Forgivingness.

The functionality of the traffic system is important to ensure that the actual use of the roads conforms to the intended use. This has been worked out by dividing the road network into three categories: through roads, distributor roads, and (residential) access roads. Each road or street may have only one function; for example, a distributor road may not have any direct dwelling access.

The homogeneity is intended to avoid large differences in speed, direction, and mass by separating traffic types and, if this is not possible or desirable, by making motorized traffic drive slowly.

The third principle entails the predictability of traffic situations. The design of the road and its surroundings should increase the recognizability, and therefore the predictability, of the traffic situations that may occur. Undesirable traffic situations can thus be acknowledged and avoided in time. Finally, if a crash cannot be avoided, the fourth principle is meant to prevent a serious outcome of the crash.

Functional Requirements

The national working group that was mentioned above drew up so-called functional requirements for each principle (CROW, 1997).

Functionality
The requirements for the principle 'Functionality' are:

- Largest possible residential areas;
- Minimal part of the journey along unsafe roads;
- Journeys as short as possible;
- Shortest and safest route should coincide.

Functionality requirements according to Sustainable Safety are especially intended to make an individual road user choose a safe route, for himself and also for others. That is why a journey should not go through a residential area. Nor is it desirable to drive along an unsafe road too long. A large residential area is safe for internal traffic; too many intersections with the surrounding through roads are avoided. An area that is too large leads to too much internal traffic; one that is too small leads to too many intersections with the surrounding through roads.

Recognizability and predictability
The principle 'Recognizability and predictability' has the following requirements:

- Prevent searching behaviour;
- Make road categories recognizable;
- Limit the number of possible types of design and make them uniform.

The homogeneity requirements aim at orderly traffic surroundings: unification of measures, road signs and signposting. According to Sustainable Safety the limitation of the number of road categories makes the largest contribution to recognizability. It then follows that there are large differences between the categories, and within each category the differences are small.

Homogeneity and Forgivingness
The requirements for the principles 'Homogeneity' and 'Forgivingness' are:

- Avoid conflicts with oncoming traffic;
- Avoid conflicts with intersecting traffic;
- Separate vehicle types;
- Reduce speed at potential conflict locations;
- Avoid obstacles alongside the carriageway.

These requirements are mainly based on crash analyses. Many crashes could be prevented by making certain conflicts impossible and by separating different vehicle types. Crash severity decreases considerably with lower speeds and obstacle-free zones.

There is no direct link between the requirements and the traffic characteristics or between the requirements and the infrastructural elements. Designers should be able to 'translate' these requirements into their design variables, traffic situations, and design elements. In addition, someone who wants to test the layout of an existing situation must be able to understand the link with the Sustainably Safety requirements. A so-called Sustainable Safety Test supports the designer or road authority by processing the input data and carrying out the test.
Of all the listed Sustainable Safety requirements, the national, regional and local governments only agreed upon the application of a system of alignment marking (a requirement for recognizability) on all national roads in 2010 and on all other roads in 2015 (Min. V&W, 2009). The other requirements

have not yet been part of such a national agreement. However, each road authority can set its own goals for applying the other requirements.

DESCRIPTION OF METHODS

Sustainable Safety Test

Goal of the Sustainable Safety Test

The designer or road authority can use the Sustainable Safety Test as an instrument to determine whether planned or existing infrastructural traffic facilities meet the Sustainable Safety requirements that were listed above.

Design of the Sustainable Safety Test

The Sustainable Safety Test is a software program that has been developed to test all the earlier mentioned requirements. Testing of the requirements can take place during various design phases. The application of the test is also possible for existing roads and streets (phase '0'):

0. Existing roads and streets;
1. After making the road network plan;
2. After overall working out of parts of the plan;
3. After detailed working out;
4. Some time after opening;
5. Before maintenance and reconstruction.

Design variables per Sustainable Safety requirement

Two types of design variables can be distinguished: the traffic and travel variables belong to one type, and the other type consists of traffic infrastructure variables. In the first planning phase very little will be known about the actual traffic and travel variables, but models can be used to provide an indication. In the fourth and fifth phases and in existing situations, the actual traffic and travel variables can be observed. In all phases, there will be sufficient knowledge about the traffic infrastructure.

Indicators

The indicators were selected to indicate which variables and features are important for the testing the Sustainable Safety requirements. The indicators for each requirement are given in Table 1. The indicators were selected on the basis of literature review and expert opinion (Van der Kooi & Dijkstra, 2000).

Necessary data / Measuring and observation methods

The Sustainable Safety Test requires much data concerning variables, indicators, and features. This data can be obtained by making use of existing measuring and observation methods.
The Sustainable Safety Test uses various data which we (may) assume the road authority has available. While applying the test, it may become apparent that other or adapted data is required. We recommend, if practically possible, to check the presence and type of the necessary data beforehand.
The following types of data are important for the phases:

- Research data (traffic model; phase 1)
- Plans (section studies, design drawings; all phases)
- Measurement data (speeds, road lengths, traffic volumes; phase 1/2/4/5/0)
- Observation data (surveys, registration number studies; phase 1/2/4/5/0)

Menus have been made for data input; they show if the data entered is correct and mutually consistent. The data input is done for every road section and intersection within an area or along a route.

TABLE 1 Indicators for the Sustainable Safety requirements

	Requirement, according to CROW (1997)	Indicators
1	Realization of as many connected residential areas possible	• area and shape • number of dwellings • trip generation • maximum traffic volumes • daily deliveries
2	Minimal part of the journey along unsafe roads	• number of category transitions per route • risk per (part of a) route • distances between intersections
3	Journeys as short as possible	• length of fastest route divided by straight line distance
4	Shortest and safest route should coincide	• overlap of shortest (in time) and safest route
5	Avoid searching behaviour	• presence and locations of signposting • indication of ongoing route at each intersection • street lighting at intersections
6	Make road categories recognizable	• presence and type of alignment marking • presence of area access roads • presence of emergency lanes • obstacle-free distances • presence of bus and/or tram stops • specific design features for each type of intersection • speed limit • colour and nature of road surface • presence and transverse position of bicycle, moped, and other 'slow traffic'
7	Limit the number of possible types of design and make them uniform	• number of structurally different intersection types • number of different crossing types (for cyclists and pedestrians) • number of transitions from one category to another • number of different priority regulations (per route)
8	Avoid conflicts with oncoming traffic	• degree of protection from oncoming traffic
9	Avoid conflicts with intersecting traffic	• degree of protection from intersecting traffic • number of potential conflict locations
10	Separate vehicle types	• degree of protection from motor vehicles for bicycle, moped, and other 'slow traffic'
11	Reduce speed at potential conflict points	• degree of speed reduction per potential conflict location
12	Avoid obstacles alongside the carriageway	• presence and dimensions of profile of free space, obstacle-free zone, and plant-free zone • presence of bus and tram stops, break down facilities and parking spaces

Testing criteria

On what basis can one determine the extent to which a route or an area meets the Sustainable Safety requirements? In the previous steps all relevant variables and features were used as input for each road section. This happens based on the indicators derived for each requirement. Whether an indicator sufficiently answers to the Sustainably Safety requirements depends on the Sustainable Safety criterion. Over the past years, it has been determined for each road category which criteria the variables and features must meet in a sustainably safe traffic system. National working groups, consisting of practitioners, scientists and policymakers have formulated these criteria (Infopunt DV, 1999, 2000; CROW, 2002a/b/c). These testing criteria are divergent by nature, sometimes on a metric scale, sometimes on an ordinal or nominal scale. These criteria were incorporated in the Sustainable Safety Test.

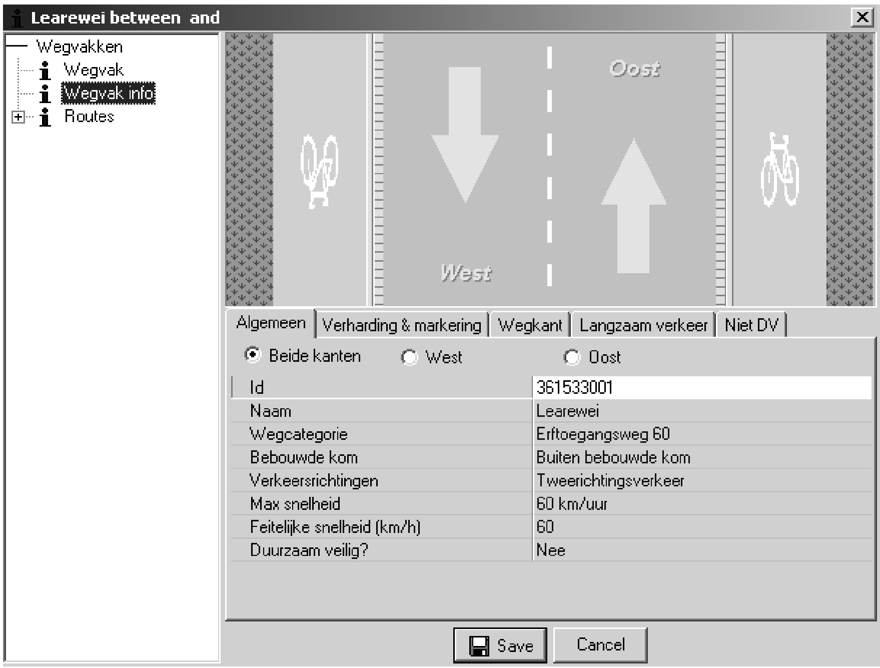

FIGURE 1 Input screen for a road section.

Differences between the set of requirements and the design or existing situation

In essence, the Sustainable Safety Test compares each indicator for a planned or existing situation with the testing criteria. This means that for road sections one can investigate which proportion of the total road length and which share of the intersections meet the Sustainable Safety criteria. The testing can be done for road categories, for intersection types and for selected routes.
The final result of the Sustainable Safety Test consists of percentages that indicate which proportion of the road length or which proportion of the crossroads meets the various Sustainable Safety requirements.

Relationship with crash reduction

If a traffic facility meets the Sustainable Safety criteria, and thus scores a high percentage in the Sustainable Safety Test, this does not automatically mean that from that moment on there will be no more crashes. Some of the requirements can be directly related to crashes: the requirements regarding homogeneity and forgivingness will most likely prevent crashes which deal with the conflict types involved. On rural roads, around 30 percent of all serious crashes are related to conflicts with intersecting traffic, while more than 30% of the serious crashes are with obstacles alongside the carriageway. Therefore, meeting the requirements related with these conflict types will probably have large safety benefits. However, this depends on the safety effects of the design elements that are selected: for example, improving the surface of shoulders and widening the shoulder (or removing obstacles) will have considerable effects on the number of crashes.
The requirements for functionality and for recognizability/predictability are assumed to have a relationship with crash prevention. Until now there has hardly been any 'hard evidence' for the size and impact of this relationship.

Road Protection Score (RPS)

The European Road Assessment Programme (EuroRAP) includes a method to produce a score for the passive safety of each road section. This score, called Road Protection Score (RPS), can be compared with the scores of other road sections. The RPS focuses on the road design and the standard of road-based safety features (Lynam et al., 2004). The concept 'protection' is used to mean protection from severe injury when collisions do occur (secondary safety).

The road characteristics used are speed limit, median treatment, hard obstacles or barriers (type and placement), road site areas (cut and embankment), junctions and intersections (type and access). The classes or values for scoring each road characteristic are given in Table 2.
According to OECD (1999), three crash types are responsible for about 75% of all fatal and serious crashes on major roads in rural areas. The three types are single vehicle run-off-the-road crashes, head-on 'meeting' crashes and crashes at intersections (Table 3). The scores for each crash type are based on a family of relative risk curves (Figure 2) reflecting the speed limit for traffic on the road and the potential variations in road design characteristics relevant to that crash type. The minimum relative risks for the RPS rating are based on the speeds at which car occupants can be expected to survive an impact in a car with a high EuroNCAP rating: 70 km/h or below for head-on crash protection, and 50 km/h for intersection crashes. These impact speeds are usually lower than the actual driving speeds at the moment a conflict will occur that leads to the crash.
The relative risks roughly vary with the cube power of the ratio of the speeds according to the power function of Nilsson (1982). The current RPS considers only car occupants. An extension to the RPS is envisaged to include a fourth important crash type: crashes involving vulnerable road-users (VRU), but this requires further development in the future.

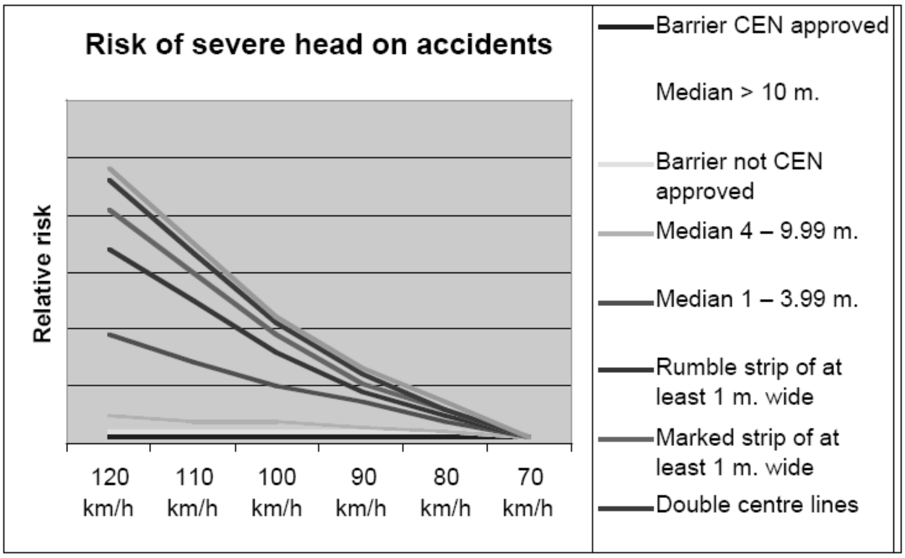

FIGURE 2 Example of EuroRAP's relative risk curves, i.e. relative risk to be involved in a frontal collision and be killed or seriously injured, as a result of the speed limit at different types of separation of driving directions (Lynam et al., 2004).

At present, the main RPS (v1.0) is based on separately scoring the protection provided in relation to three main crash types. These scores are then combined into an overall score of one to four stars (Lynam et al., 2004) which is weighted in proportion to the average occurrence of three crash types across a range of European countries (Denmark, France, Hungary, Switzerland, Sweden, and Britain) (Table 3). The distribution of the crash proportion between the three types, however, differs according to the nature of the road network and the traffic patterns in each country or even per road type within a country.

The RPS scoring process (version 1.0) is roughly described in Lynam et al,. (2004), but a new version (v2.0) which scores both protection and crash likelihood measures (elements of primary and secondary safety), has been introduced since the end of 2009. In this new version the weighting factors to scale the three main crash types are replaced by calibration factors. Complementary to road characteristics which reflect the protection, crash likelihood characteristics like speed, lane width, shoulders, curvature, delineation, overtaking and traffic volume will be inspected as well. (EuroRAP, 2009)

TABLE 2 The classes or values that are used for the scoring of each road characteristic to obtain the RPS (v1.0) during a drive-through inspection (Castle et al., 2007)

Road characteristics	*Classes/values*
Speed	50, 60, 70 etc.
Barrier (placement)	Right, left, middle etc.
Barrier (CEN approved)	Yes/No
Median (width)	0-4 metres, 4-10 metres etc.
Hard obstacle point/stretch (distance)	0-3 metres, 3-7 metres etc.
Hard obstacle point/stretch (placement)	Right, left, etc.
Side area cut (placement)	Right, left etc.
Side area embankment (placement)	Right, left etc.
Side area embankment (type)	Gentle, steep
Junctions (not signalized)	3 of 4 arms with or without left turn lane
Junctions (signalized or roundabouts)	Traffic lights, roundabouts
Intersection merging	Long/short
Intersection access	Yes/No

TABLE 3 Weighting factors used by the RPS (v1.0) to scale the three main crash types (without VRU) These factors are based on the average frequency of occurrence in six EU-countries: Denmark, France, Hungary, Switzerland (OECD, 1999), Sweden and Britain (Lynam et al., 2004)

Three main crash types	Frequency	RPS-weighting factors
run-off road	32%	43%
head-on impacts	24%	31%
severe side impacts at intersections	19%	26%
Total	76%	100%

How does RPS fit into the functional requirements of Sustainable Safety?

RPS mainly focuses on forgivingness and on homogeneity. Four out of twelve Sustainable Safety requirements (Table 1) match the characteristics used in RPS: avoiding conflicts with oncoming traffic, with crossing traffic, reducing speed at conflict points, and avoiding obstacles. These requirements have a strong relationship with severe crashes. RPS does not give outcomes to match the other requirements regarding functionality and recognizability/predictability.

APPLICATIONS OF BOTH METHODS

Sustainable Safety Test

'Zone 60' in rural areas

Roads in rural areas are being converted into traffic zones with a speed limit of 60 km/h. These roads should meet a number of specific requirements regarding marking (only edge marking) and facilities at intersections (raised intersection). Thirteen newly transformed areas were selected for application of the Sustainable Safety Test (Henkens, 2006) to evaluate the 'after' conditions of the zones. Almost all requirements appeared to be met. Only a limited number of improvements were needed to gain a satisfactory outcome of the test. However, obstacle-free zones and speed reducing elements at intersections were hardly implemented.

Light Rail through the city of Leiden

A new light rail system is being developed, connecting a few urban areas with the city of Leiden. The light rail system is planned to go through the inner city that is usually crowded with cyclists and pedestrians. Mixing these vulnerable road users and light rail vehicles in a safe way is a major concern of the city council. Therefore, the design was tested by applying the Sustainable Safety Test in phases

2 and 3 (VIA, 2006). The test was adapted to some extent in order to focus on the requirements for homogeneity, mainly to prevent serious conflicts between light rail vehicles and vulnerable road users. This procedure led to many alterations to the original design.

RPS trials in the Netherlands

The Royal Dutch Touring Club ANWB initiated three RPS trials in the Netherlands. The main road network of the province of Zuid Holland (South Holland) was inspected in 2005. In 2007, both the main road network of the province of Utrecht and the national main road network were assessed. The national main road network of the Netherlands consists of motorways (speed limit 100 or 120 km/h) as well as main roads (roads with a speed limit of 100 km/h, mostly without physical separation of driving directions). The results of the trials are given in Table 4. The differences between the two provinces regarding the shares of 2- and 4-star roads are remarkable. These differences were not only unexpected, nor has an explanation been found yet. It must be examined whether this is caused by differences in posted speed limit, by the mix of urban and rural roads or by the characteristics of the network such as the proportion of single and dual carriageway assessed.
The two provinces do not yet use the RPS as a policy instrument, but the national government aims at having brought all 2-star roads to a 3-star level in 2020 (Min. V&W, 2009).

TABLE 4 RPS (v1.0) scores for the Dutch provinces of Utrecht (2007) and Zuid Holland (2005) and for the National main road network (2007), expressed in percentages of the road length involved

	Two stars (in %)	Three stars (in %)	Four stars (in %)	Total road length (km)
Province of Zuid Holland (2005): main roads, including service roads	17	51	31	751 (100%)
Province of Utrecht (2007): main roads	41	52	7	312 (100%)
Province of Utrecht (2007): main roads, including service roads	42	39	18	405 (100%)
National Main Roads (2007)	1	27	72	5,583 (100%)

Province of Utrecht

Vlakveld & Louwerse (2009) analyzed the relationship between severe injury rate and the RPS (v1.0) of the main road network of the province of Utrecht. The average severe injury rate seems to decrease when the number of stars increases. However, the main road network of Utrecht is rather small which means that the number of casualties is also quite small. Therefore, a final conclusion about the validation of the RPS method in the Netherlands cannot yet be drawn.

Switzerland

Other results of a validation study are available from Switzerland, where 1,500 km 'Hauptstrassen' (main roads not being motorways) were assessed in 2006 (Baumann, 2007). A comparison between crash rates and five years of crash data (1997 - 2002) shows that there appears to be a relationship (statistically weak, however) between crash rates and RPS (v1.0) scores for high values (i.e. RPS > 3.5). For lower ratings, the dispersion in the figures was too high to find any relationship.

Sweden and the United Kingdom

Results of validation studies are also available from Sweden (Lynam et al., 2004). The Swedish comparison of 9,000 kms of road with crash data (for three years) shows that the crash rates are lower for routes with better RPS (v1.0) rating. It was also concluded that the match for the individual crash types is best for run-off ratings and least good for intersection ratings. There was no good fit for roads

in urban areas, because the EuroRAP RPS does not take vulnerable road users into account and because at low speeds the model assumes that restrained car occupants in a 4- or 5-star EuroNCAP rated car will avoid severe injury. The model in its current form is therefore not intended to distinguish satisfactorily between road types at very low posted speed limits.
The overall pattern is similar to comparisons made with UK data of 2006 - 2007 (Castle et al., 2007). About 7,000 kms of road were surveyed. For all roads together there is a decrease in crash rate when the RPS (v1.0) scores increase. Castle et al. (2007) also analyzed the relationship between crash rates and RPS stars for different road types (motorways and A-roads, subdivided into dual and single carriageway road sections). The authors state that the RPS generally distinguishes between roads of poorer and better quality, but they also remarked that for both dual carriageway and mixed carriageway A-roads the number of crashes was too small to draw a statistically valid conclusion.
Validation studies of the renewed RPS (v2.0) have not yet been published although the US studies described below use the car-component part of the International Road Assessment Programme model (iRAP) which is identical in structure to RPS (v2.0).

United States

In Iowa and Washington, star ratings were compared with corresponding crash rates. Therefore, approximately 4,800 kms of rural and urban roads of various types were scored using the RPS-method of the U.S. Road Assessment Program (usRAP), which, as stated above, is slightly different version with a rating of 1 to 5 stars.
Harwood et al. (2010) concluded that there is strong evidence that crash rates for road sections increase as RPS (version usRAP) decrease at two-lane undivided highways, four-lane undivided highways, and four-lane divided non-freeways. This trend was also observed for head-on crashes at two-lane undivided highways, for run-off-road crashes at two-lane undivided highways and six-lane divided freeways, and at two-lane undivided highways in Washington only, and for junction crashes at two-lane undivided highways and four-lane undivided non-freeways. The good correspondence of the RPS crash rates with the US data is likely to be due to a result of the large size of the samples being assessed.
According to Harwood et al. (2010), in general relationships could not be clearly demonstrated for freeways because the design characteristics of freeways are to a large extent uniform, which means that not enough different star classes could be identified.

CONCLUSIONS, RECOMMENDATIONS AND DISCUSSION

Sustainable Safety Test

The various safety requirements identified in Sustainable Safety are probably not all equally important for crash reduction. Some requirements can be expected to have a stronger relationship with crash prevention than others do. The Sustainable Safety Test should be provided with weights for each requirement so that the relative contribution to crash prevention can be expressed.

Data is necessary for describing each safety requirement: an inventory of this data is usually necessary.

The quality of the results of the Sustainable Safety Test depends on the linking of the formulated safety requirements with all relevant parts of the designed or existing traffic facilities.

Hardly anything is known about the effect of requirements for functionality and recognizability/predictability on the size and impact of crash prevention.

The results of applying the Sustainable Safety Test show the difference between the safety levels according to Sustainable Safety on the one hand, and the current or planned safety levels on the other hand. The current or planned safety levels tend to be of a lower safety standard than the safety levels

according to Sustainable Safety. This means that the thresholds in the test were not met by current or planned facilities.
It would be interesting to find out how much safety gain can be attained theoretically by raising the existing infrastructure to the level of the requirements.

Road Protection Score (RPS)

The RPS focuses on the road design and the standard of road-based safety features. The concept 'protection' is used as protection from injury when collisions do occur (secondary safety). Because the RPS rates only part of the overall risk in the transport network, it is therefore to be expected that the match between RPS and crash rates will be partial and less than complete.

The minimum relatively risks for the RPS rating are based on the speeds at which car occupants can be expected to survive an impact in a car wit a high EuroNCAP rating: 70 km/h or below for head-on crash protection, and 50 km/h for intersection crashes.
An extension to the RPS is envisaged for protection against crashes involving vulnerable road-users.

The RPS is mainly focused on forgivingness and also on homogeneity. Four out of twelve requirements (as formulated for Sustainable Safety) are in agreement with the characteristics used in RPS.

The weighing of scores by using average crash data from several countries obviously discards the differences between these countries regarding the nature of the road networks, the road categories, and the design features. It would be better to weigh the scores by using crash data from the region or country the scores have been calculated for.

Both methods

Both the Sustainable Safety Test and the Road Protection Score (RPS) score specific road design elements that are expected to be related to road safety. There is some overlap in the road elements that are considered in the two methods; however, these elements are scaled in different ways. Both methods pay attention to homogeneity of the road traffic and to forgiving road environments. The Sustainable Safety Test has strong roots in the Dutch Sustainable Safety vision, and therefore pays attention to the predictability of the road environment and to the function of road categories in the road network. Therefore a test for the Netherlands would preferably be a combination of both tests, aiming at an input of the best elements of each test.

The European Union has launched the directive on road infrastructure safety management (EP&C, 2008). The Sustainable Safety Test and the Road Protection Score (RPS) fit into this directive with respect to two instruments: road safety audit and road safety inspection. Originally these instruments are of a qualitative nature. Incorporating both tests, or incorporating a combination of these tests, will result in instruments with quantitative aspects.

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