As regards the safety of the standard concrete barrier, the obvious benefit was the important reduction in cross median accidents. On the other hand the damage to passenger cars established during crash tests has been proved in real accidents, particularly on roads with high speed traffic.

So we believe that concrete barriers can be placed on all the highways with limited speeds. But in the other cases, according to the characteristics of the road and the traffic, the assessment may be different. Therefore, it does not seem possible to foresee a systematic safety gain with regard to standard barriers.

Acknowledgments

These studies were conducted by the "Institut National de Recherche dans les Transports et leur Securite" (INRETS) under contract with the French Transportation Ministry, through the instrumentality of the "Service d'Etudes Techniques des Routes et Autoroutes" (SETRA) which has responsibility for road regulations in France.

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MOTORCYCLE IMPACTS WITH GUARDRAILS

by Robert Quincy, Dominique Vulin and Bernard Mounier, Institut National de Recherche sur les Transports et leur Securite, (INRETS), France

Abstract

Although we note few motorcycle accidents with guardrail impacts, one frequent concern of motorcyclists is the exaggeration of risk due to the presence of guardrail.

A study has been done in order to specify the real hazard of these accidents in different areas: rural highways and urban highways. The most important problem remains on the urban highways: the accidents with guardrail impacts represent one third of motorcycle injury accidents and lead to the third of the fatalities. The most common crash happens in curves, often with the motorcyclist falling down and knocking his head into the guardrails posts.

A guardrail with two beams was designed and tested in order to avoid the posts motorcyclists impacts. Tests were performed with a dummy ejected from a sled. The deceleration levels registered on different parts of the dummy were acceptable. Tests with cars were conducted to confirm this model.

Introduction

In France, during 1984, motorcycles were involved in 4.8% of all vehicle accidents that resulted in fatalities or injuries. These accidents with motorcycles caused 820 fatalities and 18,939 injuries, that is to say, respectively, 7.1% and 6.7% of the whole.

About 80% of these accidents occur in an urban environment, but the most serious accidents are located in open country (50% of the fatalities). The rate of fatalities by user involved is the highest for motorcycles (10.4% fatalities by motorcyclists involved).

Although it is not important from a statistical point of view, one frequent concern of motorcyclists is the exaggeration of risks due to the presence of safety barriers. The development of traffic barriers for passenger cars and heavy trucks has brought about an increase in the number of lateral obstacles which can be dangerous to motorcycles.

Considering the barrier locations, motorcycle crash problems come up mainly on urban highways, and to a lesser extent on national roads in some particular sections. We have, therefore, tried to characterize these accidents on the two types of motorways.

Motorcycle Accidents on Rural Highways

This study covered three years and 940 km of highway (A6, A7 and A9 highways) equipped for 100% of its length with median barrier and for 40% of its length with roadside guardrail(1).

The tabulation of motorcycle accidents for 1980-82 is given in Table 1.

	Overall	Motorcycle	% Motorcycle
Accidents	12,361	283	2.3%
Injuries	4,382	206	4.7%
Fatalities	439	19	4.3%

Table 1 - Motorcycle Highway Accidents

The motorcycle accidents have been divided into four main types (Table 2).

	Accidents N	Accidents %	Injuries N	Injuries %	Fatalities N
Fell off alone on road	90	31.9	69	33.5	2
Crashed into another vehicle	109	38.5	79	38.3	9
Ran off road without guardrail impact	57	20.1	35	17	0
Ran off road with guardrail impact	27	9.5	23	11.2	8

Table 2 - Motorcycle Accident Typology

The accidents are divided in about one-third increments between fell off alone on the road, crash into another vehicle and ran off the road accidents. About 10% of the motorcycle accidents led to barrier impacts, and it was only in that case when the severity was very important. Guardrails behave clearly, then, as dangerous obstacles, even more dangerous than impacts with other vehicles.

Guardrail Accident Typology

Tables 3 and 4 distribute the accidents according to their site conditions.

	Accidents	Injuries	Fatalities
Standard roadway section	18	10	7
Exit area	8	12	1
Toll-bar	1	1	0

Table 3 - Accident Site Categories

	Accidents	Injuries	Fatalities
Median barrier	13	8	6
Roadside guard-rail	5	2	1

Table 4 - Distribution in the Standard Roadway Section

We notice that a disproportionally high number of accidents occur in exit areas owing to the corresponding low number of "motorcycles x km". This is certainly linked to the presence of low radius curves reached at an excessive speed. But the severity seems lower than for accidents along a standard roadway section.

Considering these standard sections the severity is higher for median barriers than guardrails. This can be explained by the closeness of the guardrail and the importance of the impact speeds.

Urban Motorways

A study was carried out for two years (1978-79) on motorway sections located in the Paris area (Table 5). The total length of the sections studied was about 70 km. Median barriers were constructed on 100% of the length and roadside guardrail on 62% of the length. These sections included 28 access roads and seven interchange areas. These motorways were made up of six or eight lane divided roads and the speed was limited to 70-80 km/h on almost the entire length.

	All vehicles	Motorcycles	% Motorcycles
Fatal plus injury	651	134	21
Injuries	1,031	169	16.7
Fatalities	25	6	24

Table 5 - Urban Motorway Accidents

We notice that in these urban areas the percentage of motorcycle accidents is significant. This is mainly due to the traffic importance of small motorcycles. The severity of motorcycle accidents is more significant than the average.

	Accidents	Injuries	Fatalities
All motorcycle accidents	134 (1)	169	6
Barrier impacts (first impact)	38	51	4

Table 6 - Accidents with Barrier Impacts

(1) In 21 cases a guardrail was impacted after a vehicle impact.

This table shows, again, the severity of impacts against barriers which represented 28% of the motorcycle accidents but two-thirds of the corresponding fatalities.

Site Categories

These accidents were divided in the following way:

In median	32%
Along roadsides	14%
At access roads	54%

Whereas exit and access roads represent only 5% of the roadway length.

Impact Circumstances - Crash Condition

The 38 barrier impacts can be divided in the following way.

- Road sliding and barrier impact: 13 cases 34%
  (with users on the motorcycle)

- Pavement sliding and barrier impact: 9 cases 24%
  (users ejected during sliding)

- Barrier impact without sliding: 16 cases 42%

We notice than in more than half of the cases, there was sliding of the motorcycle before impact, and further analysis showed that the severity was higher when the users were ejected.

Study on Barrier taking into Account Motorcycle Protection

Our aim was to reduce the aggressiveness of a metal beam standard guardrail. We developed two designs. In the first one we added a lower beam near the ground to prevent post impact and an upper beam to the existing guardrail. In the second design we removed the upper beam considering the accident data, and we reduced the lower beam stiffness in order to make the fitting easier.

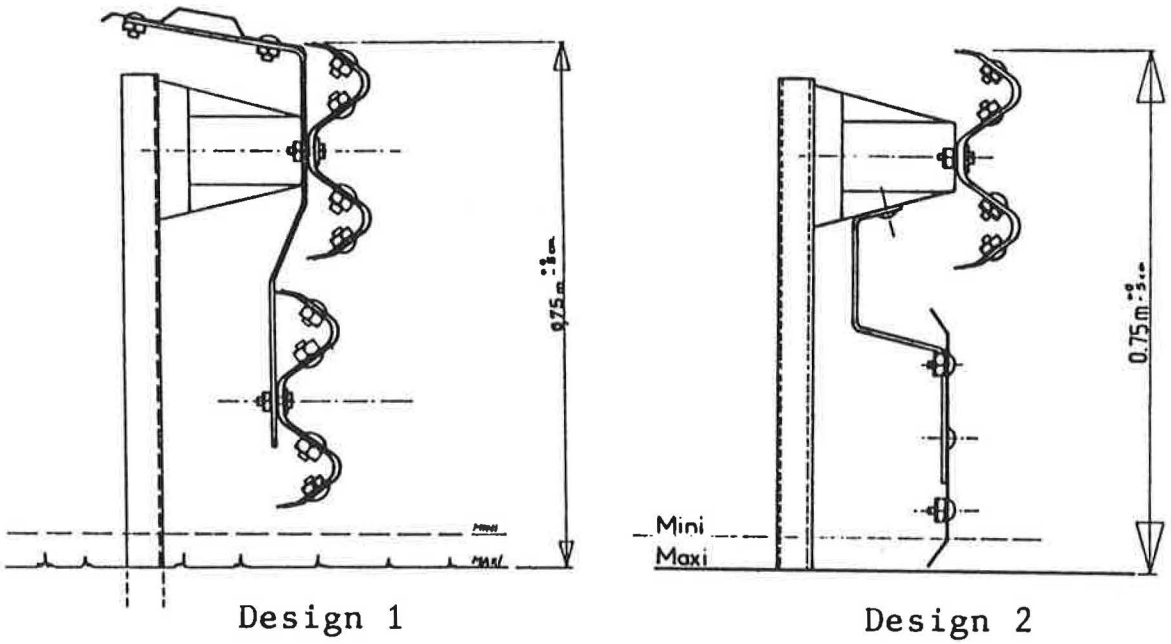

FIGURE 1 - Guardrail with Motorcycle Protection

The accident investigation showed that when the barrier post was impacted the head injuries were the most numerous and the most severe. The impact often happened after the motorcycle slid along the ground.

In our test configuration the dummy was on a platform lying on its back with its head forward. Just before impact, the platform was stopped and after 2 m sliding on the pavement the dummy impacted the barrier at a 30° angle.

Three tests were conducted at a 55 km/h impact speed and 30° angle, two with the first design and one with the second one. Moreover, a comparative test on concrete median barrier was performed.

Test No.	Device	Impact Speed km/h	Angle	Head acceleration at 3 ms (g)	Head acceleration HIC
504	G2R/1	55	32	66	325
506	G2R/1	55	32	40	175
566	G2R/2	54,5	30	80	365
505	Concrete barrier	55	30	110	110

Table 7 - Dummy Test Results

As shown in Table 7 the accelerations and the HIC criteria were lower than the limit values, so motorcycle restraint is good.

At this time, the motorcycle barrier is approved for use by the French Transportation Ministry and some roadside highways are equipped with it, but we don't have sufficient accident data to conduct an evaluation.

Conclusion

On rural highways, the hazard of motorcycles impacting a barrier is not important as it represents less than 1% of all accidents and less than 2% of the corresponding fatalities. We noticed a concentration of impacts on access roads and interchanges but this also corresponds to a lower severity.

On urban or suburban motorways motorcycle impacts against barriers represent about 6% of all the injury accidents and 16% of fatalities. Moreover half of these accidents occur on access roads and interchanges.

On this basis a pre-study was conducted to determine the best metal rail envelope to improve metal beam guardrail. We concluded that in critical accident areas we could assign 50% of the guardrail cost to its improvement.

Acknowledgments

These studies were conducted by the "Institut National de Recherche sur les Transports et leur Securite" (INRETS) under contract with the French Transportation Ministry, through the instrumentality of the "Service d'Etudes Techniques des Routes et Autoroutes" (SETRA) which has responsibility for road regulations in France.

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VEDYAC: A TOOL FOR ROADSIDE SAFETY HARDWARE RESEARCH, by Tom Heyer, Stichting Wettenschappeliuk Onderzoek Verkeersveiligheid, (SWOV), Netherlands

Introduction

The VEDYAC model is a mathematical computer-model and, as such, a further developed and more generalized model than the first extensive computer model MAMIAC that originated about 1972.

MAMIAC was specifically developed for simulations of collisions of (passenger) cars with steel guard rail barriers. To that end it contains an extensive (finite-element) model for guard rail barriers and a simplified vehicle model with only one deformable side, but with a wheel suspension system that is very detailed in character.

That model was not very efficiently programmed and can only be run on an IBM-mainframe computer.

Experience with MAMIAC was favorable. In spite of the high costs of the large computer, it still was very much cheaper than full scale testing. That has been the reason that SWOV has continued the development of mathematical models.

Certain conditions have been set for the new VEDYAC-model (VEDYAC = Vehicle Dynamics And Crashdynamics): the applicability should be enlarged while lowering the operation costs considerably.