

The safety of roundabouts and traffic lights in Belgium



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0. Introduction

In some ten years, roundabouts have spread all over Europe and even throughout the world. The Americans also have imported this type of crossroads but, for once, they followed the movement instead of starting it.

Three reasons have contributed to this quick growth : a good mark on safety point of view, a progressive cut in the sizes and a central space available for the decoration.

If the French architect Eugène Hénard created the idea of roundabout from the beginning of the 20th century, the British first had the idea of roundabout as we know it now. The priority to the "ring" was tested in the late fifties to be widespread in 1996. In the late seventies, the French discovered the roundabout again and, from the on, the roundabout got a worldwide reputation in the late eighties and nineties.

Some years after that flooding wave in our country, it's interesting to stop for a while, to assess these roundabouts and to compare them with the French roundabouts and with the traffic lights.

1. Definitions

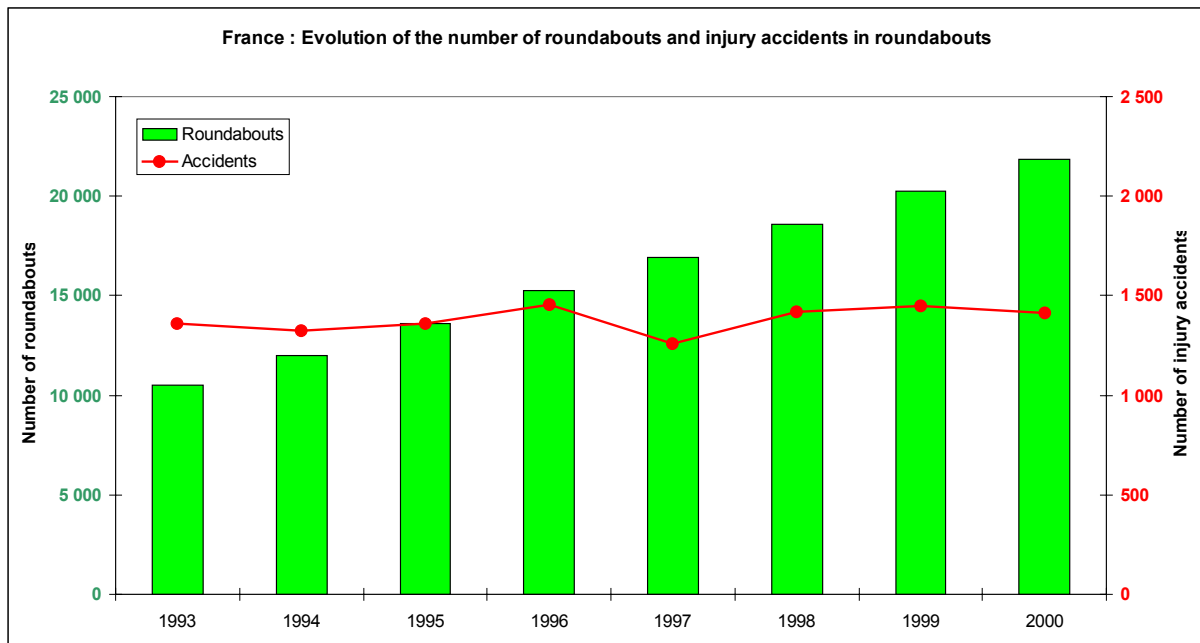
The generalization of the priority to the ring was accepted in the Highway Code in October 1997.

The French Highway Code defined the roundabout and generalized the priority to the ring in May 1984. The word "crossroads with roundabout" indicates a place or crossroads made of a central island (impossible to cross) surrounded by a one-way road at right to which some other roads arrive and forecasted by specific roadsigns.

In 1995, the concept of "crossroads with roundabout" was increased to crossroads with a central island possible to cross it in some circumstances (in cities, 50 km/h roads, less than 24 m outer island, less than 15 cm at the base of the central island).

2. Evolution of the number of roundabouts

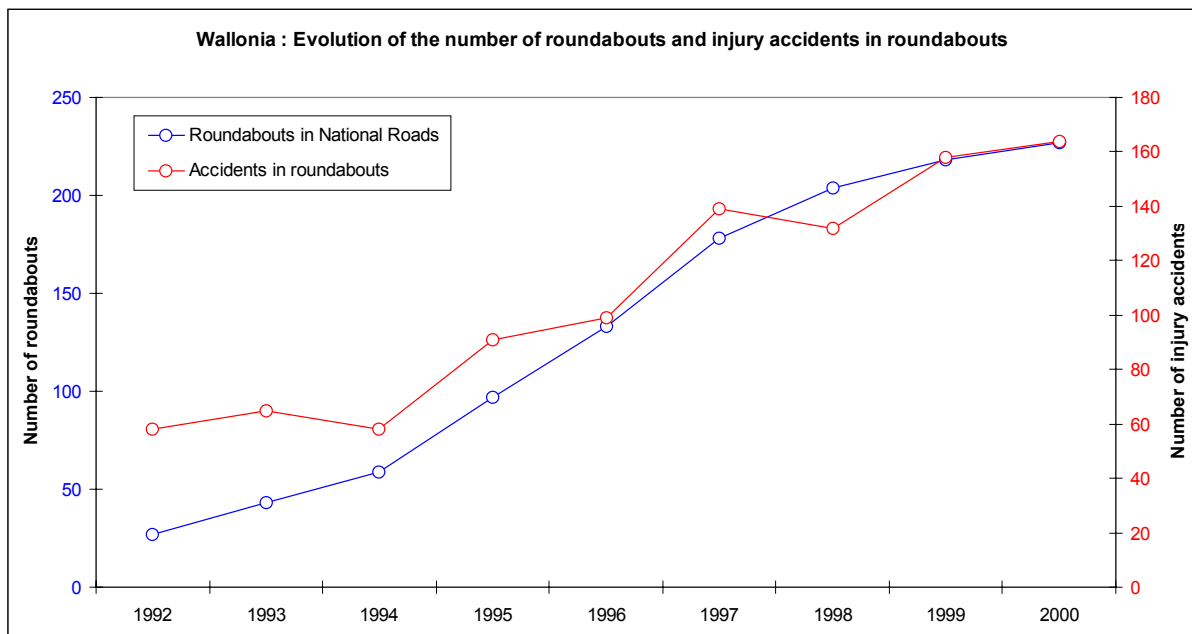
Almost 12 000 roundabouts were built-up in France in 1994 and about 22 000 roundabouts in 2000. In comparison, the United Kingdom counted approximately 8000 roundabouts in 1996.



source : CETE of the West; assessment from the 1994 census

In Walloon Region, nearly 500 roundabouts were counted at the end of the year 2000 and about 230 on the national roads.

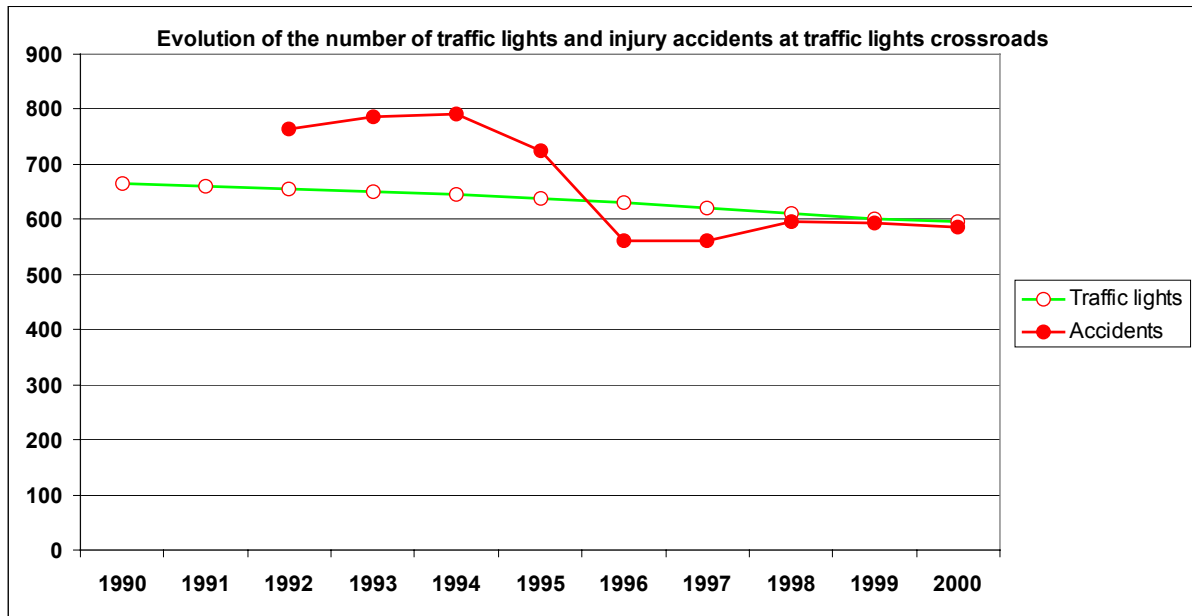
The roundabouts "fashion" spread through the country in the years 1995, 1996 and 1997. In the meantime, the accidents in roundabouts have increased since 1995 but not in same proportion. In ten years, the number of roundabouts is nearly ten times higher and roundabouts accidents double.



Number of roundabouts every year on the 31st of December

Taking into account the difference of the inhabitants number and the road system length, there are twice as many roundabouts in France as in Walloon Area.

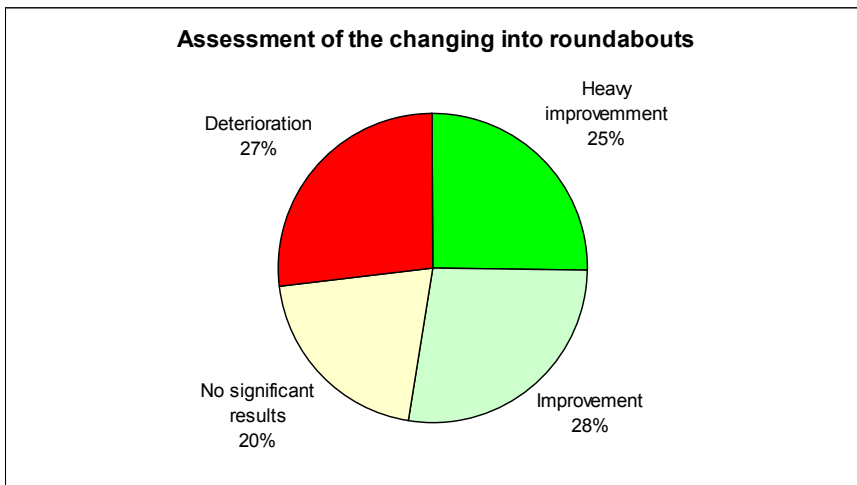
3. Evolution of the number of crossroads with traffic lights



A part of the traffic lights have been transformed into roundabouts.

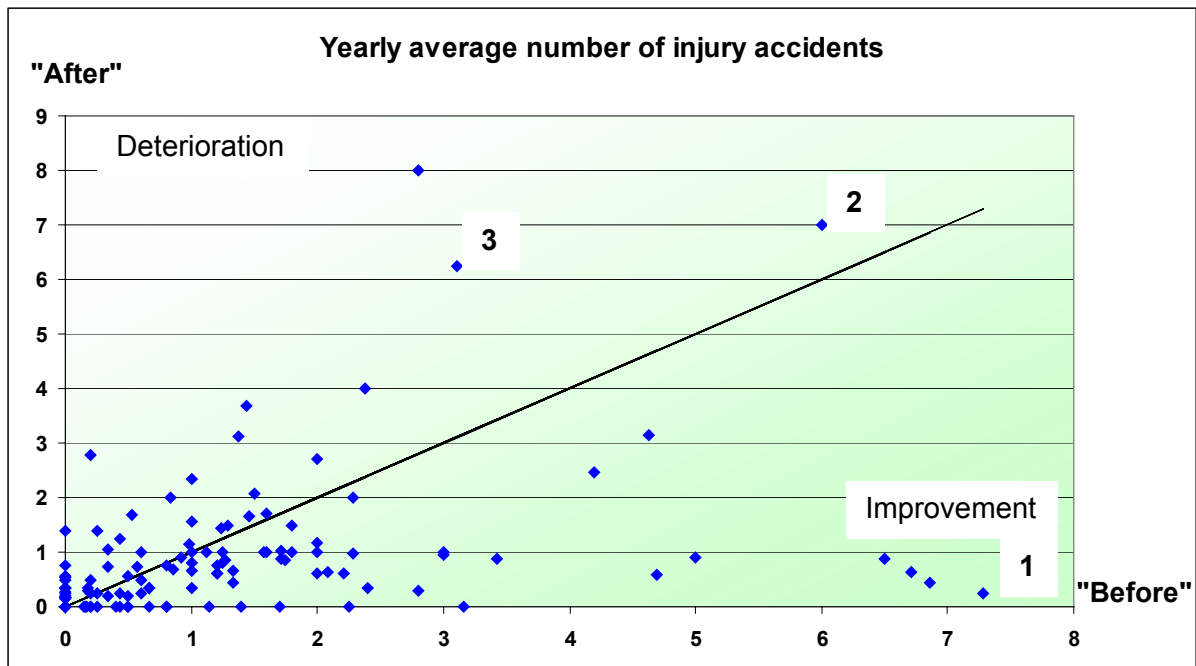
4. Before-After comparison

122 crossroads were analysed during the years 1992-2000 for the before-after approach.



Heavy improvement : more than 50 % of injury accidents reduction

In terms of road accidents, 53 % of the transformations clearly improve the safety situation. On the other hand, the results aren't significant for 20 % and they are worse than before for 27 %.



Some spots stand out but it's important to remember that statistical dubiousness is high for a individual case.

The site nr 1 (# N90-N922 on Floreffe) had high unsafety before its modification because more than 7 injury accidents per year were noted at this crossroad. After the built-up of the roundabout in 1996, the injury accidents were rare.

About 6 injury accidents per year were established on the site nr 2 (# N90-R3 on Charleroi) before bone-shaped roundabouts. Afterwards, we approximately count 7 injury accidents per year, that is to say no improvement and no deterioration.

On the site nr 3 (# Chêne du Bû - N58 on Mouscron), safety conditions are deteriorated seeing that we have 6 injury accidents per year after against 3 per year before.

The comparison "before and after roundabout" of the 122 studied crossroads achieve a 42 % decrease of the injury accidents and a 48 % decrease of the serious accidents. However, the environment has a big effect on the results. The reduction is only 15 % in urban intersections but 46 % in suburbs and even 50 % in open country.

On the same period 1992-2000, the accidents diminish about 15 % in other crossroads.

Environment	Before			After			Reduction	Nbr #	AADT	Injury Acci. / year AADT=10000
	Accidents	month	Acci. / year	Accidents	month	Acci. / year				
Open country	226	2 411	1,122	103	2 224	0,556	- 50 %	45	10 200	0,545
Suburbs	379	2 421	1,879	199	2 361	1,009	- 46 %	45	19 915	0,507
Urban	132	1 700	0,928	109	1 660	0,788	- 15 %	32	15 870	0,496
Total	736	6 532	1,352	411	6 245	0,789	- 42 %	122	15 271	0,516

: abbreviation of crossroads; AADT : Annual Average Daily Traffic

Environment	Before			After			Reduction	Nbr #	AADT	Serious Acci./year TJMA=10000
	Serious Accidents	month	Serious Acci. / an	Serious Accidents	month	Serious Acci. / an				
Open country	87	2 411	0,431	33	2 224	0,178	- 59 %	45	10 200	0,175
Suburbs	81	2 421	0,399	49	2 361	0,249	- 38 %	45	19 915	0,125
Urban	36	1 700	0,254	19	1 660	0,137	- 46 %	32	15 870	0,086
Total	203	6 532	0,373	101	6 245	0,194	- 48 %	122	15 271	0,127

: abbreviation of crossroads; AADT : Annual Average Daily Traffic

These significant decreases point out the importance of the road infrastructure and its conception.

In a road project, the conception of the crossroads is primordial (kind of crossroads, traffic management, ...).

These substantial decreases of accidents are nevertheless lower than decreases achieved in other studies or countries.

France

- The comparison before-after put in service of 100 roundabouts in Haute-Garonne showed a reduction of more than 60%, that it is a matter of the accidents or victims. (1)
- The different studies before-after taken in France by the SETRA (1981,1983,1986), the city of Quimper (1983), the regional direction of the equipment of the Loire Atlantic (DDE 44, 1992) and the CETE of the West (1996) obtain superior reductions up to 66% accidents.
- A study of 2002 concerning 55 roundabouts of the department of the Loire Atlantique constructed during the period 1979 to 2000 arrive to a reduction of more than 88% physical accidents. (2)

Australia

- In 1995, Peter Adams, engineer in the city of Sydney, announced a reduction of 71% on 13 Australian roundabouts. (3)

U.S.A.

- Researchers of the Ryerson Polytechnic University and the University of Maine studied 24 intersections to the United States. The study found a 76% decrease in injury accidents and a reduction of 90% fatal accidents or incapacity injuries. (4)(5)
- The roads administration of the Maryland obtained a reduction of 88% injury accidents on 8 roundabouts constructed between 1993 and 1998. (6)

Denmark

- The Danish obtained a reduction of the bodily accidents of 53% in urban site and of 84% in rural site. (7)

The Netherlands

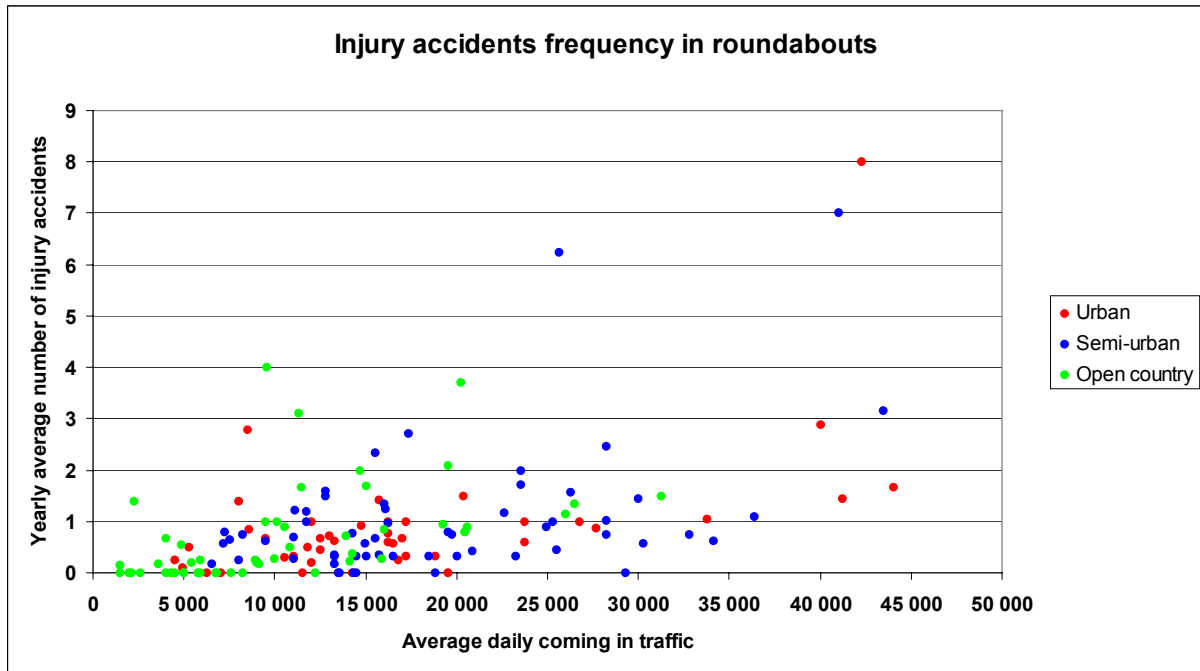
- Schoon and van Minnen of the SWOV studied the transformation of 181 conventional crossroads (traffic lights or stop signal) in roundabouts and achieve a reduction of 71% bodily accidents. (8)

Nevertheless, the common road safety in Belgium is not far from being disastrous. While taking account of the factors such as demography and the roads and motorways network development, the road safety in Belgium reach the lower positions of Western-Europe. (9)

The reduction of the accidents is strongly different according to the type of users. On one hand, it is important for the cars and generally also for the pedestrians. On the other hand, for the motorbikes, the moped and the bicycles, the reduction is clearly the least. The pedestrians take advantage of the decrease of the speeds of the vehicles. On the other hand, for the motorbikes and the mopeds, a roundabout constitutes a difficulty because turns to cross it. The place of the bicycles, their visibility and the living together with the cars and the trucks sometimes raise problems.

The reduction also differs according to the collision type but that is treated in the types of accidents in the following pages.

5. Accidents frequency in roundabouts



Environment	Nbr. #	Inj. Acci.	month	Inj. Acci. / year	Inj. Acci. / year AADT=10000	Serious Acci.	month	Serious Acci. / year	Serious Acci. / year AADT=10000	AADT
Open country	49	117	2 560	0,548	0,527	38	2 560	0,176	0,169	10 401
Suburbs	59	272	3 519	0,926	0,488	64	3 519	0,218	0,115	18 973
Urban	43	196	2 753	0,854	0,502	32	2 759	0,139	0,082	17 013

: abbreviation of crossroads; AADT : Annual Average Daily Traffic.

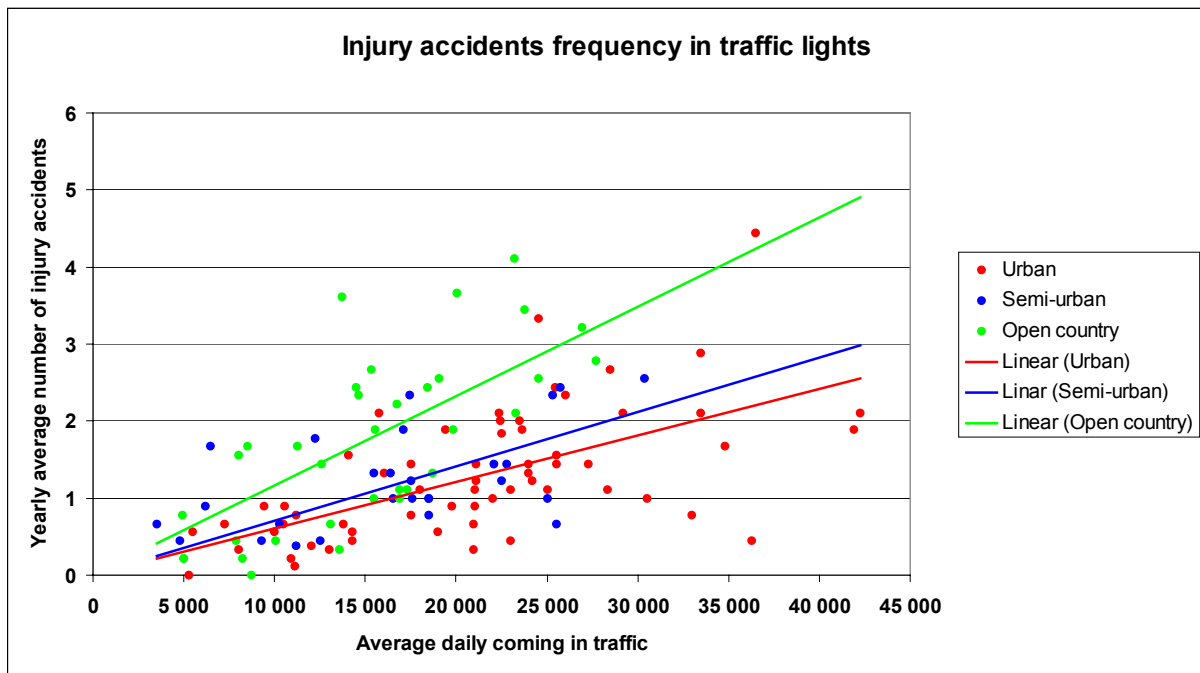
The 151 studied roundabouts totals 736 years of accidents observations.

Environment	1 Injury Accident for	1 Serious Accident for	Injury Accidents / 10 ⁶ veh.
Open country	6,9 millions of vehicles	22 millions of vehicles	0,14
Suburbs	7,5 millions of vehicles	32 millions of vehicles	0,13
Urban	7,3 millions of vehicles	45 millions of vehicles	0,14

The environment has not any influence on the accidents frequency but well on their seriousness. In open country, the frequency of serious accidents is twice as high as in urban environment. This can be explained by the speeds of approaching roundabouts. The analysis of the Swedish roundabouts shows well the importance of general and local speed on the accidents frequency. This one can simply be doubled and increased fourfold according to the general speed of 50 km/h, 70 km/h or 90 km/h. (11)

The three-leg roundabouts presenting less conflict points have therefore a accidents frequency lightly inferior (-15%) than a four-leg roundabout. An other characteristic having a considerable influence is the number of traffic lanes in the ring. In Sweden, the two-lane rings see their increased frequency of about 20% in comparison with the one-lane rings.

6. Accidents frequency at crossroads with traffic lights



Environment	Nbr. #	Inj. Acci.	month	Inj. Acci. / year	Inj. Acci. / year AADT=10000	Serious Acci.	month	Serious Acci. / year	Serious Acci. / year AADT=10000	AADT
Open country	34	533	3 672	1,740	1,139	131	3 672	0,428	0,280	15 272
Suburbs	27	301	2 916	1,237	0,743	59	2 916	0,243	0,146	16 635
Urban	61	708	6 588	1,290	0,609	114	6 588	0,208	0,098	21 184

: abbreviation of crossroads; AADT : Annual Average Daily Traffic.

The 122 studied traffic lights totals 1098 years of accidents observations.

Environment	1 Injury Accident for	1 Serious Accident for	Injury Accidents / 10 ⁶ veh.
Open country	3,2 millions of vehicles	13 millions of vehicles	0,31
Suburbs	4,9 millions of vehicles	25 millions of vehicles	0,20
Urban	6,0 millions of vehicles	37 millions of vehicles	0,17

The environment strongly influences the accidents frequency. In open country, the frequency doubles for the injury accidents and triple for the serious accidents.

The frequency of accidents is correlated to the traffic entering.

7. Comparison between roundabouts and traffic lights

Difference of accidents frequency between traffic lights and roundabouts :

	Injury Accidents	Serious Accidents
Open country	+ 116 %	+ 66 %
Suburbs	+ 52 %	+ 24 %
Urban	+ 21 %	+ 25 %

The roundabouts confirm their safety reputation. In urban environment, the traffic lights have a superior accidents frequency from 20 to 25% to the roundabouts. In open country, the accidents frequency at the traffic lights is practically twice as high as the one in the roundabouts.

These significant differences between traffic lights and roundabouts are also noted in France, in Norway and in other countries.

Traffic lights / Roundabouts

France	Norway (12)	The Netherlands (8)	Australia (3)
+ 100 %	+ 60 % à + 100 %	+ 30 %	+ 100 %

For the defence of the traffic lights, in the studied sample of the 151 roundabouts and 122 traffic lights totalling 1834 observation years, the frequency of the killed victims is one death for more or less 250 millions of entering vehicles as well for the traffic lights as the roundabouts.

Besides, sometimes, the transformation of traffic lights in roundabouts doesn't improve or even degrades the safety of the crossroad. For example, the transformation in Flanders of 16 traffic lights in roundabouts give an increase of almost 25% of accidents. (13)

8. Comparison with France

The comparison between countries is difficult because the census level of the injury accidents is not the same.

Nevertheless, according to the different studies that we previously realized, one can evaluate that the census level of the injury accidents in France is less than factor 2 in comparison with Belgium.

If one takes into account the level difference of census of the injury accidents, we achieve :

Roundabouts	Injury Accidents / year AADT=10000	Injury Accidents / year AADT=10000
France (1), (14), (15)	0,24	de 0,165 à 0,4
Walloon Region	0,50	de 0,48 à 0,52

AADT : Annual Average Daily Traffic

The accidents frequency in the Walloon roundabouts is about twice as high as the one in the French roundabouts.

Several explanations can be looked for or advanced. As roads administrators, we only focus on the infrastructure aspect or geometry of the roundabouts.

a) Some roundabouts are not only circular. One can find double, oval, in forms of bones or of bean and even of rectangular form roundabouts.

b) The Walloon roundabouts are often too wide for fear of traffic capacity problem.

c) The Walloon roundabouts have some characteristics in comparison with the French roundabouts. These specificities are all negative for the security and already have been raised at the time of preceding studies.

Raised specificities of the Walloon roundabouts :

- by-pass presence (direct way of turn-to-right)
- frequent entries of 2 lanes
- two-lanes rings
- ring width generous
- few reductions of the profile to one lane in upstream of the roundabout for the roads to 2+2 lanes

Nevertheless, the frequency of killed victims in Walloon Region seems to be comparable to France. One notes 1 death for more or less 250 millions of entering vehicles. However, the weak number of deceased victims makes the frequency and the comparison difficult.

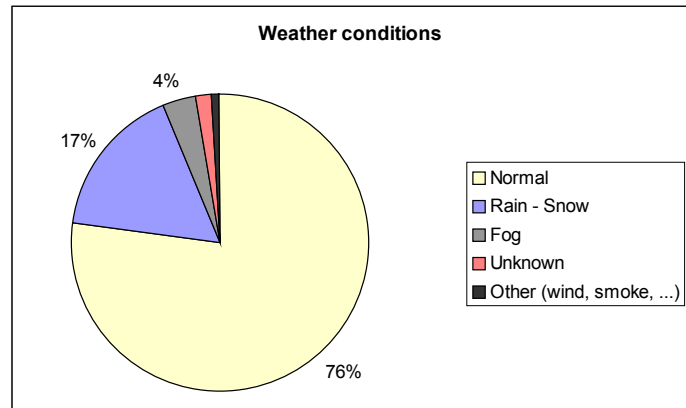
9. Characteristics and types of accidents in roundabouts

Statistics have been realized from physical accidents between 1992-2000.

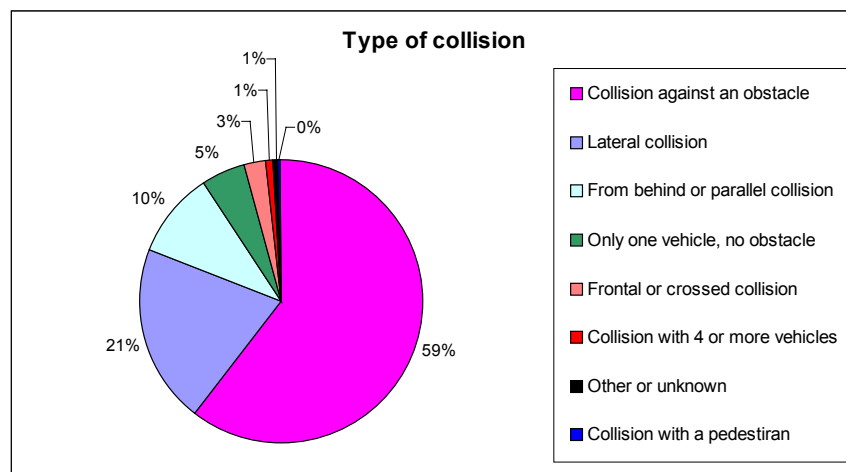
Open Country (356 accidents)

According to the data of the Royal Meteorological Institute, precipitations are observed during about 13 to 14% of time*. Besides, the accidents in rain or snow weather in the roundabouts in open country represent 16,8%. Rain has therefore comparatively less influence on the accidents frequency in the roundabouts.

* average of the 7 weather stations in Walloon Region (Bierset, Chièvres, Elsenborn, Florennes, Gosselies, St-Hubert, Spa) during the period 1992-1998



If 31% of accidents happen on a humid or wet road, nevertheless, this percentage remains inferior to the average on the roads out town (34%).



The pedestrians being rare in the open country, the collisions with a pedestrian are exceptional. More than half collisions (59%) are collisions against an obstacle. If the central islands and dividing islands are the most frequently hit type of obstacles, they are followed by the lighting posts. The establishment of the lighting posts is important on pain of damaging the safety rather than improving it. The numerous collisions against an obstacle are notably signs of bad perceptions of approaching the intersections or the sign of too high speed approaches.

Motorbikes (7,9%) and mopeds (5,3%) represent 13,2% of accidents what is more than their deal in the traffic. A roundabout constitutes a difficulty for motorbikes and mopeds considering the "turns" to cross it. On the other hand, the motorbikes tend to cut through it and slow down less than the 4 wheels vehicles. The trucks are implicated in 7,9% accidents what is proportional to their importance in the traffic.

A real drunkenness or a positive check are mentioned in near of 21% accidents what is more than an average (11%) on the non built-up roads. If the roundabouts doesn't "provoke" the accidents with the drivers under the influence of alcohol, they tend to "crystallize" there rather than elsewhere. Alcohol impairs the driving capacity rather than the respect of the rules.

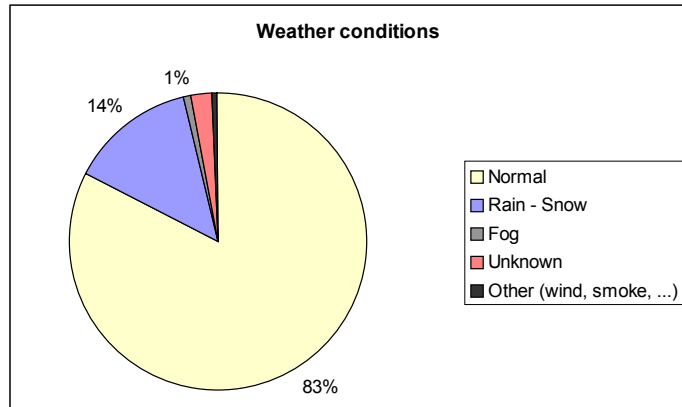
Effectively, this high rate of accidents in the presence of alcohol has not raised in the traffic lights intersections.

53% of accidents occur during the night. Obscurity is not definitely the first cause but this is the sign of misfit speed, of bad perceptions of approaches, of drivers under the alcohol influence, etc. The roundabout and its approach must not surprise the driver but well awaken his attention and incite him to slow down to negotiate it without any damage.

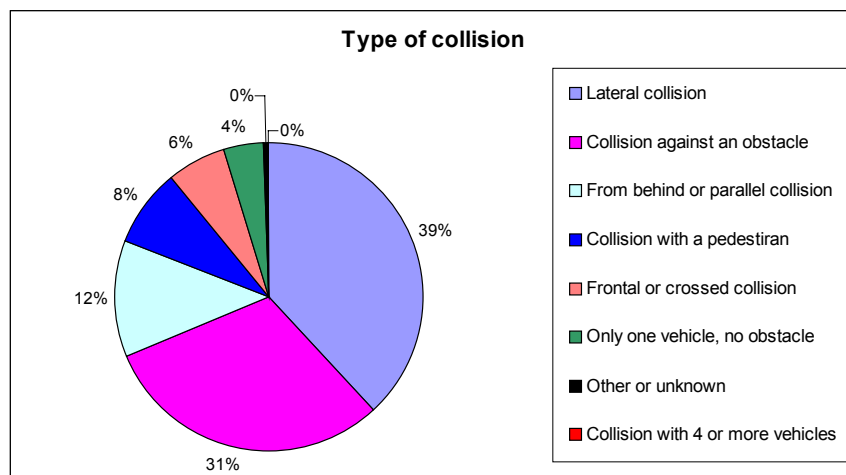
Built-up area (1219 accidents)

Rain is mentioned in 13,7% of accidents in roundabouts in town. Compared to the duration of precipitations observed by the RMI*, about 13 to 14% of time, rain has little effect on the accidents frequency in the roundabouts. That means that rain does not raise hardly visibility problems.

* Royal Meteorological Institute



Only 25% of accidents take place on a humid or wet road. This is significantly less than the average on the roads in town (29%). Comparatively, low speeds in roundabouts diminish the braking problems on wet ground.



The collisions type is modified in comparison with the open country. In town, the most frequent collisions are linked to the refusal of the priority. Nevertheless, The obstacles remain an important element in the collisions (31%). After the traffic islands, the lighting posts are the most frequently hit type of obstacles. The establishment of the lighting posts is important on pain of damaging the safety rather than improving it. The collisions with a pedestrian represent about 8,5% of collisions. Generally, the pedestrians take advantage of not very high speeds of vehicles near the roundabouts.

The motorbikes (7,4%) and the mopeds (18,3%) are implicated in 25,7% of accidents what is more than their deal in the traffic (2 to 3%). A roundabout constitutes a difficulty considering the "turns" to cross it.

The bicycles are implied in 7,4% accidents. The place of the bicycles, their visibility and the living together with the cars and the trucks sometimes raises problem.

A real drunkenness or a positive check are mentioned in 12,4% of accidents what is very high in comparison with an average of 11% on the numbered roads in town. Alcohol impairs the driving capacity rather than the respect of the rules such as the traffic lights.

In roundabouts, 38,6% accidents happen during the night, the average being about 31% in town.

The accidents types

In 1990, the CETE of the West studied 202 injury accidents happened in 179 urban roundabouts. These accidents have been classified in 16 types to make obvious the common points. (16)

The three most represented types of accidents are the following :

1) Priority refusals (36,6 %)

If we can quote the habitual factors of alcohol, speed and the non-respect of the signalisation, we also can quote : two-lanes entries, entries too tangential and lacks of visibility due to the vegetation on the dividing islands.

2) Control losses on the ring (16,3 %)

One finds a surprising number of accidents with mopeds and motorbikes. They are due to a too high speed and sometimes to an oil, petrol or gravels presence. For the 4 wheels vehicles, one also notes the small radius in oval roundabouts.

3) Control losses at the entry (11,4 %)

Night accidents of single vehicle, often linked to speed and sometimes to alcohol. These accidents are often material. When aggressive obstacles are on the trajectory, they are then bodily and sometimes lethal.

The others types of accidents are less numerous. The final recommendations are :

- legibility of the intersection
- avoid the two lanes entries and way out except for a notorious need of capacity
- separate the entry and the way out with a dividing island
- avoid tangential entries and too big radius
- avoid exit radius too squeezed
- avoid oval roundabouts.

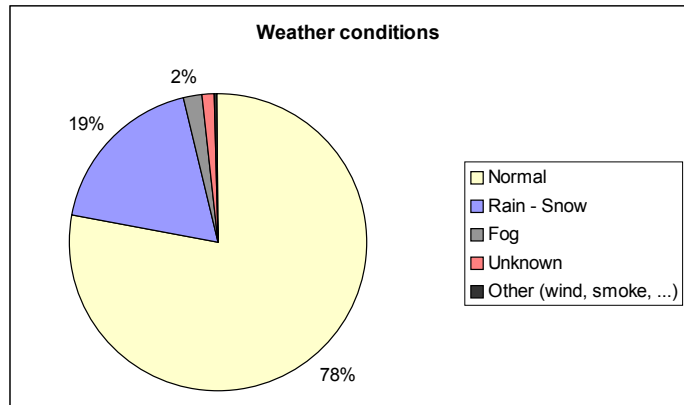
The analysis on our data achieve to similar results. Nevertheless, the French analysis is based on more precise data on the sequence of the accidents, this is the reason we prefer to taking it.

10. Characteristics and types of accidents at crossroads with traffic lights

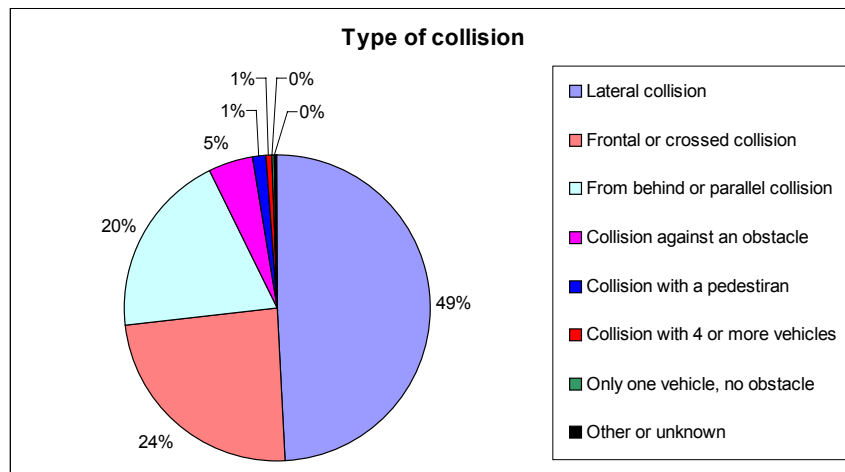
Open Country (1397 accidents)

Rain is mentioned in 18,7% of accidents in the intersections with traffic lights out of town. As precipitations are present during 13 to 14% of time (RMI*), rain has therefore a consequent effect on the accidents frequency in traffic lights intersections. Rain will raise notably a visibility problem in traffic lights intersections.

* Royal Meteorological Institute



A humid or wet road is mentioned in 36,4% of accidents. This is lightly more than the average on the roads out of town (34%).



The pedestrians being rare in open country, the collisions with a pedestrian are comparatively rare and represent 1,4% of collisions.

The accidents implicate 2 vehicles or more in the big majority of the cases. The lateral collisions are the most frequent followed by the frontal collisions and by the back.

In nearly of 56% of accidents, one of the vehicles turns left.

The red lights crossing at quotes in 29% of accidents.

According to realized measures in Toulouse, 2,9% of crossings of traffic lights take place during the red phase. This percentage climbs to nearly of 10% at night about 4 h. in the morning.

1% of crossings are red lights trespassings when the opposite traffic lights are green and the risk maximum. (17)

The motorbikes (2,3%) and the mopeds (3,5%) are implicated in 5,8% of accidents, the bicycles in 1,6% and the trucks in about 7% accidents.

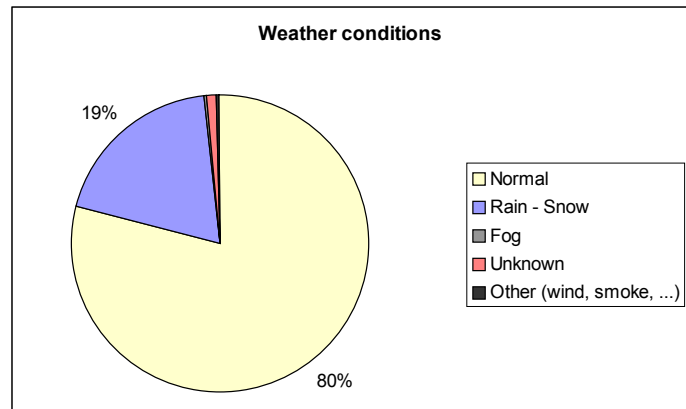
A real drunkenness or a positive check are mentioned in 9,2% of accidents that is less than the average 11% roads out of town. Apparently, alcohol impairs little the respect of the rules at the traffic lights.

31,5% of accidents occur at night.

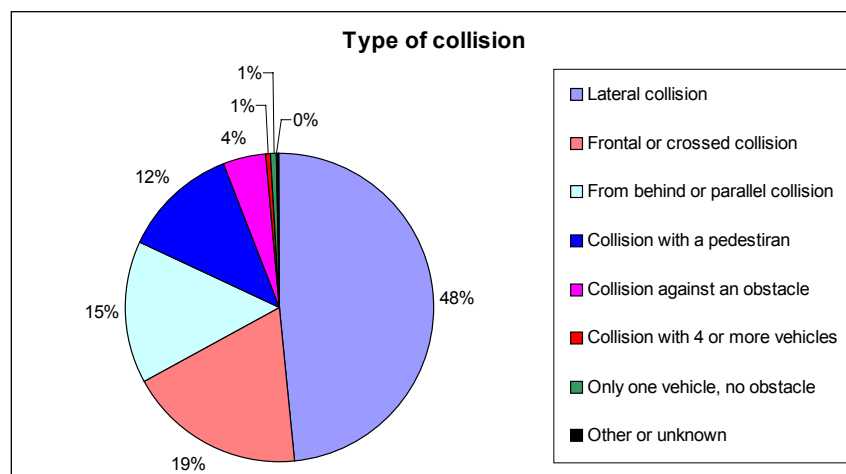
Built-up area (4018 accidents)

Rain is mentioned in 19,2% of accidents in the traffic lights intersections in town. As the RMI observations, it rains during about 13 to 14% time, rain has therefore a consequent effect on the accidents frequency in traffic lights. Rain will raise a real visibility problem in traffic lights intersections.

* Royal Meteorological Institute



A humid or wet road is mentioned in 31 % of accidents. This is lightly more than the average on the roads in built-up area (29 %).



Collisions with a pedestrian account for 12,3 % of accidents.

In a large majority, the accident implicated 2 vehicles or more. The lateral collisions are the most frequent after the frontal collisions and by the back collisions.

In nearly 46 % of accidents, one of the vehicles turns left.

The red lights crossing (when they're red) is quoted in 1 accident out of 3.

According to measures taken in Toulouse, 2,9% of crossings of traffic lights happen during the red phase. This percentage climbs to nearly of 10% at night at about 4 in the morning.

1% of crossings occur at red phase just when the opposite traffic lights are green and the risk maximum. (17)

The motorbikes (4,2 %) and the mopeds (13,2 %) are implicated in 17,4 % of accidents, the bikes in 3,5 % et the trucks in 4,5 %.

A real drunkenness or a positive check are mentioned in 10,3 % of accidents, what is near the average 11% roads out of town.

36 % of accidents occur at night.

11. Crosswalks

In open country a specific installation can't be isolated around roundabout. One can only have it, following a verge. In suburban zone, we could create ways for the pedestrians on one or several parts of a roundabout. In urban environment, the establishment of a crosswalk on each of the parts of the roundabout is better to avoid the pedestrians to cross through the centre of the roundabout.

The position of a crosswalk is very important to guarantee a good security level for the pedestrians.

On the way in, the beginning of the crosswalk must be situated between 2 and 5 m from the line "yield". (2 m for the smaller urban roundabouts; 5 m for the bigger ones)

On the way out, the cars don't feel obliged to stop and the pedestrian doesn't know if the vehicle is leaving the roundabout. Nor to block the ring, the crosswalk should be far enough to place a car. The crosswalk should be marked farther than in the way in : between 3 and 10 m according to the traffic.

The sidewalk edges should be lowered and a "waiting place" should be created in every dividing island. The crosswalk marking stop near the dividing island. There's no marking on the dividing island.

(A – p. 52, 53, 65 et 66, B – p. 89, C – p. 177 et 178)

12. The bicycles : cycle tracks ?

The study Schoon et van Minnen in the Netherlands (8) is concluded with these words : A separated cycle track is wished if the traffic intensity is at least 8000 vehicles a day and if the bikes number is "significant". For fewer vehicles and bikes, no measure is to be taken without turning down the cycle track in some cases.

Different countries have got similar results and follow these conclusions. (18)

A specific installation can't be isolated around a roundabout. It's only acceptable when continuing a cycle track along the roads. (C – p. 179)

For the roundabouts with a radius inferior to 22m, it's suggested not to mark a cycle track around the ring because the speed of the cyclists and the vehicles is not really different and the car drivers don't want to overtake the cyclists. The interruption of the cycle track should be foreseen at about 15 m before the "yield" sign.

For the radius being higher than 22m, there should be a cycle track marking on the ring itself because the cyclist is in danger because of the higher speed of the vehicles. (C – p. 180)

13. Principal planning elements

Principal Planning Elements (B–p.69)

- prefer a simple installation
- rule out any aggressive obstacle
- give the road user a good view when approaching the roundabout
- oblige the user to a certain "way"
- control if the planning capacity is satisfactory
- avoid too big planning elements
- not hesitate to make the central island rather small in urban environment

Fuller recommendations are available in the French report and in the references A, B, C.

14. Choice of types of crossroads

Motorways and Express ways

On the motorways, only the made uneven crossroads and the semi-crossroads (way in, way out) are authorized. In principle, it's the same with the express ways except the roundabout at the end of installation.

Ordinary Roads

In open country, the basic crossroads are the simple crossroads (stop – yield – priority of right). When the turning left traffic becomes more important, a turning left way improves the safety of this movement. We'll think of a roundabout when the side-traffic is rather important or in case of safety problems. The setting of traffic lights should be avoided in open country.

In urban and semi-urban situation, several kinds of crossroads are often compatible. Defining the installation aims and their priorities in act will help to choose the most appropriate type of crossroads.

The series of simple crossroads (stop – yield – priority of right) is considered as the basic installation without any peculiar problem.

The roundabout will be suggested when the side traffic is important and in case of safety problems. More safety and the advantages of a roundabout in speed limit are especially interesting in the following cases :

- urban or sub-urban intersections with numerous islands
- city way in crossed by an important trunk road

The choice for traffic lights intersection can be made if :

- it's necessary to manage and control the traffic in regulated zone (co-ordinated crossroads, blocked intersections);
- it's too difficult for pedestrians to cross;
- you must take into account the priority of public transport, especially on bus lanes;
- you control the "queues" near a level crossing or a quick way;
- you meet an urban intersection with heavy traffic, you should choose traffic lights crossroads.

While the traffic lights intersections doesn't allow to master the speed when it's green and it's useless in off-peak periods, the roundabout obliges the drivers to slow down at any time. This characteristic of the roundabout must avoid building too successive and too near roundabouts.

In addition, the use of the roundabout at intersection where the traffic "main road / secondary road" is completely and cannot be compared, is not very logical for the main road and can lead to disfunction. If the main traffic is ten times as high as the secondary traffic, the roundabout is certainly not good way.

15. Conclusions

Roundabouts have given a feeling of safety at many intersection, particularly in open country. Considering the high safety level in a roundabout, they will probably spread over our road network.

In open country, traffic lights should be forward replaced by roundabout for safety reason. In urban zone, traffic lights and roundabouts work differently and are complementary.

As for the type of accidents, in the in open country roundabout, we can see people not remaining in control of their vehicles and collide against obstacles.

In urban zone, lateral collisions and refusals to give way are the most frequent. If the rain and wet road don't apparently have any influence on the accidents frequency in roundabout, on the other hand, they both have great influence on traffic lights crossroads. The accidents frequency increases about 40 % in raining weather.

The comparison between the Walloon roundabouts and their French or foreign counterparts is particularly disappointing as well for the degree of improvement brought by the transformations in roundabouts as their accidents frequency.

Safety level of the Walloon roundabouts is practically twice lower. That indicates the numerous lacks in their creation. These problems could be summed up like this :

- complex installation
- too aggressive obstacles
- general over-proportioned

Thanks

Thanks to all people who have contributed to the making of this report and particularly to Mr B. Guichet of the CETE of the West for his kind contribution.

Sources

For the physical accidents the National Institute of Statistics is responsible for the collection and the broadcasting of the basic data.

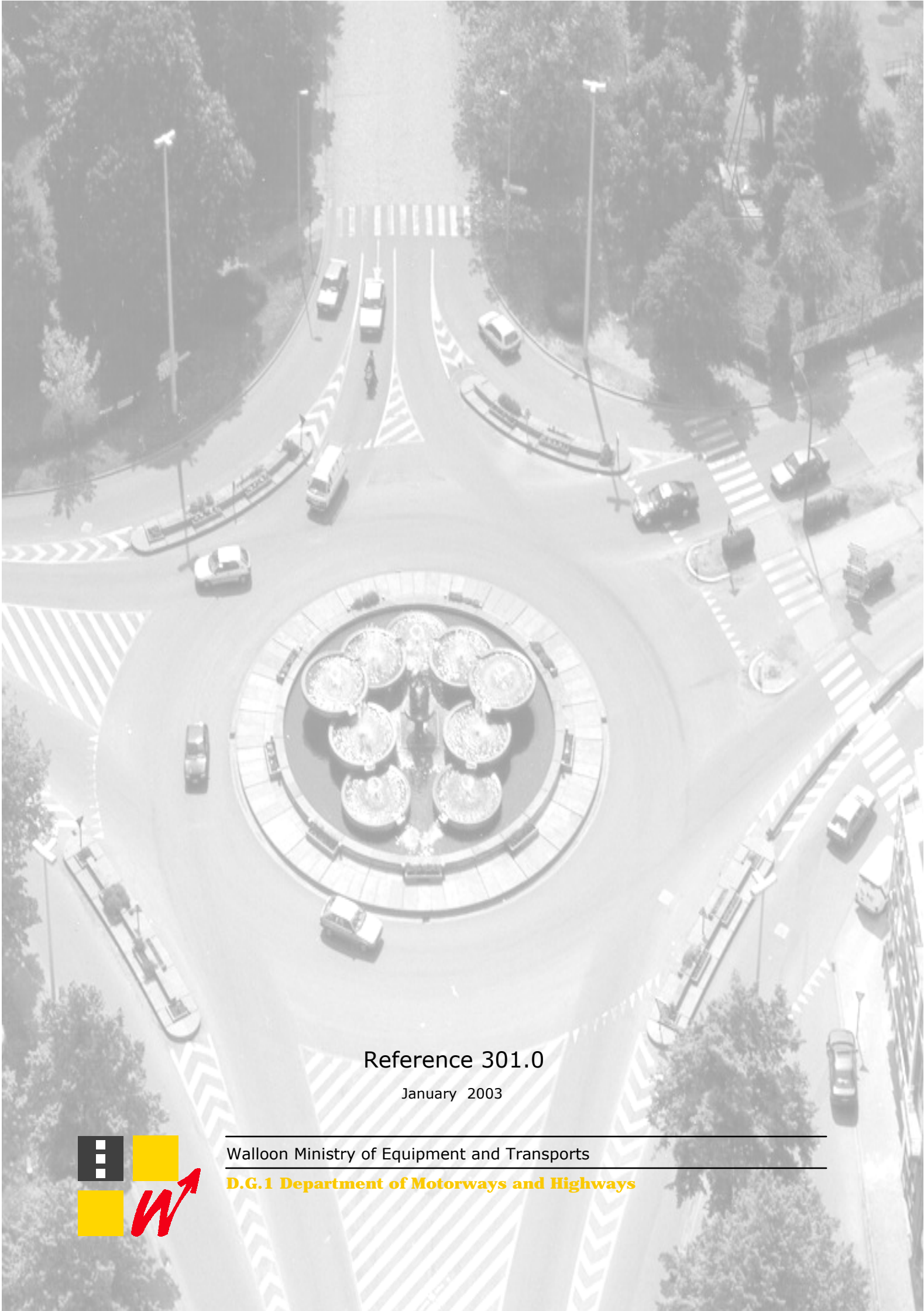
For the traffic data, the MET itself realizes the measures campaigns.

Bibliography

1. D.R.E. Midi-Pyrénées – "100 Giratoires en Haute-Garonne : Gain de sécurité", D.R.E. Midi-Pyrénées, 1994, Toulouse
2. GER-Sécurité Routière – "Routes départementales – Efficacité des opérations de sécurité", DDE44 & Conseil Général - Loire Atlantique, July 2002, Nantes
3. Adams P. – "Traffic signals and roundabouts : Are they really safer ?", Roads & Transport Research, ARRB, vol 4, n° 4, pg. 88-100, December 1995, Victoria
4. Insurance Institute for Highway Safety – "Roundabouts", Status Report, vol.35, n° 5, p1-3 & 6, Mai 2000, Arlington
5. Persaud B. N, Retting R. A., Garder P. E., Lord D. – "Crash Reductions Following Installation of Roundabouts in the United States", Insurance Institute for Highway Safety, March 2000, Arlington
6. Maryland State Highway Administration - Office of Traffic and Safety – "Maryland Roundabout Safety Experience", FHWA, October 2001
7. Jørgensen E., Jørgensen N.O. – "Traffic Safety at Danish Roundabouts – Constructed after 1985", VTI Konferens, n° 4A, part 5, 1996, Linköping, Sweden
8. Schoon C., van Minnen J. – "The Safety of Roundabouts in The Netherlands", Traffic Engineering and Control, March 1994, vol. 35, n° 3, pg. 142-148, London
9. M.E.T. – "La Route en Wallonie : Trafic et Sécurité - 2000", M.E.T., October 2002, Namur
10. Dagersten A. – "Roundabouts in Switzerland and Sweden, Thesis 72", Departement of Traffic Planning and Engineering, Institute of Technology, University of Lund, 1992, Lausanne
11. Brüde U., Larsson J. – "What roundabouts design provides the highest possible safety ?", Nordic Road & Transport Research, August 2000, vol. 12, n° 2, pg. 17-21, Linköping, Suède
12. Gjaever T. – "Application, Design and Safety of Roundabouts in Norway", Actes du Séminaire "Giratoires 92", October 1992, pg. 83-92, Nantes
13. Walraevens P. – "Evaluation des interventions en matière de technique de circulation routière", L.I.N., Bruxelles (unpublished)
14. Alphand F., Guichet B. – "La sécurité des carrefours giratoires en milieu urbain et péri-urbain", CETUR, January 1992, Bagneux
15. Guichet B. – "Modélisation des accidents dans les carrefours giratoires interurbains", CETE de l'Ouest, 2000, Nantes (unpublished)
16. Guichet B. – "Typologie des accidents dans les giratoires urbains", Actes du Séminaire "Giratoires 92", October 1992, pg. 145-151, Nantes
17. ZELT – "Détection des franchissements de rouge sur 13 entrées de 5 carrefours de la ZELT", CETE de l'Ouest, June 2001, Toulouse
18. Brüde U., Larsson J. – "The safety of cyclists at roundabouts : A comparison between Swedish, Danish and Dutch results", VTI meddelande 810A, 1996, Linköping, Sweden
19. AIPCR – "Audits de Sécurité Routière", AIPCR - PIARC, 2001, Paris

References

- A. M.E.T. – "Vade-mecum pour la conception des carrefours giratoires", M.E.T., October 1999, Namur
 - B. SETRA – "Aménagement des carrefours interurbains sur les routes principales – Carrefours plans", SETRA, December 1998, Paris
 - C. CERTU – "Guide – Carrefours urbains", CERTU, January 1999, Lyon
 - D. CERTU – "Giratoires en ville, mode d'emploi", CERTU, January 2000, Lyon
 - E. CERTU – "Guide – Les mini-giratoires, textes et recommandations", CERTU, December 1997, Lyon
 - F. M.E.T. – "Règlement du gestionnaire de voirie", M.E.T., Namur
- Girawal[®] – Software for the roundabout capacity, CERTU, 2000, Lyon - Adaptation of Girabase[®] to Walloon environment



Reference 301.0

January 2003



Walloon Ministry of Equipment and Transports

D.G.1 Department of Motorways and Highways