REPORT

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STRMTG

SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS

Annual report on the fleet, traffic and tramway operating events

– Year 2018

– evolution 2009 – 2018

Technical department for ropeways and guided transport systems (STRMTG)

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INTRODUCTION

The purpose of this report is to present the results from the use of the national database of tram events for 2018, as well as the developments in accidentology over the last ten years. This database is populated by declarations of accidents provided by operators.

The “tram” term covers systems on rails and rail-guided systems on tyres (mechanical guidance).

The statistical analysis is not intended to make a comparison between networks or present a classification based on safety levels. The differences of the configurations, in terms of number and traffic of road crossings, as well as in terms of the urban structure would make such a comparison meaningless.

On the other hand, a comparative analysis of the accidentology of the various predefined and codified urban layouts, and its evolution over the period 2009-2018 is one of the main subjects of the report.

The possible deviations of this report with respect to the graphs of the previous reports will be clarified if required; they emerge from the verifications that the operators and STRMTG carry out with respect to the continuous data so as to ensure constant reliability.

The codification principles were updated in 2018 through the “Codification des lignes de tramway” guide but could not undergo specific analyses on the date of this report, with all the networks being unable to complete the updating of the codification of their network.

A new version of the report will be produced in the first half of 2020 to incorporate this new data.

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1 - Reminder on the database construction

1.1 - Data concerning events

The database of tram events contains the following main information for the events:

- Network identification (city + line)
- Type of event, based on a predefined list of undesirable events
- Details of the event, mainly for the passenger events and collisions between trams and details of the third party if need be
- Temporal position (date and time)
- Geographical situation (lane V1/V2, location of event via the section number)
- Configuration of the site of the event, using a predefined coding system
- Environment of the event (adhesion, degraded mode of operation, visibility, etc.)
- Bodily injuries (victims) for the passengers and third parties, material consequences and derailment following collision with a third party, duration of disruption of operation
- Circumstances of the event (summary of event, behaviour of the third party, aggravating factors, etc.)
- Record of system parameters (according to driver's statement or data from tachymetric system, tram number)
- Police report and intervention of emergency services (yes/no)
- Analysis by the operator and action taken (investigation in progress, planned modification, action plan,etc.)

1.2 - Description of the networks via the codification of tram lines

The tram event database contains information on description of tram networks by means of codification data.

The codification consists of describing the various tram line configurations in order to create a descriptive database common to all the lines. It thus makes it possible to analyse events on all networks according to the characteristics of the sites where they occur, the comparison of the configurations between them and the identification of the most accident-prone configurations.

The latter thus allows characterising the following configuration categories:

- Station
- On-street/off-street section
- Pedestrian/cycle crossing
- Crossroads intersection:
  - Simple junction
  - Turns to
  - Roundabouts or roundabout with traffic lights
  - Resident's access
  - Starting of general traffic section
  - Other intersection

For the intersections, detailed traffic signals are available for each configuration: static signals, light signals on close position of the tracks or before the conflict zone, etc. The possible presence of visual masks and ease of identification of the tram track are also new codified information.

Detailed principles of the new codification can be found in the guide “Codification des lignes de tramway” available on the STRMTG website. It should be noted that the latter corresponds to the modification of the coding figures carried out in 2018, and whose changes are being integrated into the networks.

The transfer of the data of codification according to the new guidelines could not be carried out on the date of drafting this report, as the data usedis that of the networks codified based on the previous “Codification des lignes de tramway, nouvelle édition 2010” guide.

1.3 - The adopted principles and definitions

1.3.1 - Operators' declarations.

In 2017, the criteria for the declaration of passenger events and the classification of the victims associated to the events have been specified, in order to standardise the practices.

Thus, a passenger event corresponds to any event reported at the handrail taking place in the rolling stock, at the interface with the doors, or at the interface between the platform and the track (excluding collision).

In this report we present the operating events for the last 10 years; the configuration-wise event analyses can be analysed for a different time period.

/! *It is recommended to specify that the evolutions of declaration of the operators in 2014 and 2017 impact the graphs presenting the victims of the events and the passenger events; the analysis of data evolution should be taken with precaution.*

1.3.2 - Victims

Since 2017, in the database of the tramway events, a victim (person involved in the event and who does not get through unharmed) is counted if there is intervention or request for intervention of emergency services or if there is proof provided of medical care. The person is then listed as minor injury, serious injury or fatality, if the information is available.

Definitions of serious injuries and fatalities (accepted and used within the European Union):

- Seriously injured = duration of hospitalisation more than 24 hours.
- Fatal = death within the 30 days following the event.

These statistical elements about the nature of the victims obviously remains dependent on the information available and “being brought to the knowledge” of the tram operator.

1.3.3 - Panels of networks

In this report, we distinguish , particularly for the graphs of the ratios of events and collisions at 10,000 km, the “pure STPG” networks from the mixed networks.

This is a linguistic device to allow easy identification of tram networks built and commissioned fully in accordance with the STPG decree (safety of guided public transport systems) of 2003.

In practice, the “pure STPG” networks are those put in commercial operation from 2006 (included) and possibly having had line extensions.

In addition, the “mixed” networks are those put in commercial operation before 2006 and may have had extensions authorised in accordance with the STPG Decree or previously.

The “pure STPG” networks represent the following part of the production elements:

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Km	15,1%	15,2%	19,0%	21,0%	23,9%	26,1%	26,1%	25,6%	25,1%	25,0%
Journeys	14,5%	14,4%	16,3%	18,7%	20,1%	21,4%	21,6%	21,1%	20,9%	20,9%

Table 07d

1.3.4 - Serious events and severe victims

By convention and in accordance with the profession, serious events correspond to one of following criteria:

- serious physical consequences: fatality or serious injury or more than 5 victims,
- significant material damage (including for the third party) or derailment of the tram,
- derailment during commercial operation in a zone shared with third-parties.

Severe victims represent the sum of the injured persons and fatalities.

1.3.5 - Signalling of conflict

In the next part of the report, special analyses are carried out according to the signalling of conflict between the tram and the road vehicles.

The codification describes the signalling of conflict for a simple junction, resident's access, starting of general traffic section, another intersection. It pertains to the car/tram conflict. This signalling is called “crossing sign” for “turn left/right” road crossings and “entrance signs” for “roundabouts/roundabouts with traffic lights”.

In addition, the “upstream” signs manage the car/car conflict then possibly the car/tram conflict. It is set up at the “roundabouts/roundabouts with traffic lights” and “turn left/right” road crossings. For the roundabouts, this signalling is called “entrance signs”.

2 - Fleet and traffic of the tramnetworks

2.1 - Analysed tramnetworks and 2018 production data

The tramnetworks of the table below are taken into account for the analysis of accident rates.

Urban areas	Type	Nb of lines	Mkm	Mjourneys	Opening	Remarks
Angers	Tram on rails	1	0,89	10,05	25/06/2011	
Aubagne	Tram on rails	1	0,16	2,26	01/07/2014	
Bâle St Louis	Tram on rails	1	0,12	0,77	01/12/2017	Swiss network extension in France
Besançon	Tram on rails	2	1,12	8,6	01/09/2014	
Bordeaux	Tram on rails	3	6,94	96,77	20/12/2003	
Brest	Tram on rails	1	1,05	10,50	23/06/2012	
Clermont-Ferrand	Tram on tyres	1	1,01	16,65	13/11/2006	
Dijon	Tram on rails	2	2,11	24,72	02/09/2012	
Grenoble	Tram on rails	5	5,28	55,05	05/09/1987	
Le Havre	Tram on rails	2	1,12	11,39	12/12/2012	
Le Mans	Tram on rails	2	1,92	18,85	14/11/2007	
Lille	Tram on rails	2	1,51	11,21	04/12/1909	
Lyon	Tram on rails	5	5,17	92,85	18/12/2000	
LyonRX	Tram train	1	1,15	1,51	09/08/2010	
Marseille	Tram on rails	3	1,57	24,93	01/06/2007	
Montpellier	Tram on rails	4	5,43	66,32	01/07/2000	
Mulhouse	Tram on rails	4	1,16	15,00	12/05/2006	including a “Tram-train” line
Nancy	Tram on tyres	1	1,04	10,35	28/01/2001	
Nantes	Tram on rails	3	5,44	73,89	07/01/1985	
Nice	Tram on rails	2	1,44	33,79	26/11/2007	line 2 in 2018
Orléans	Tram on rails	2	2,32	22,70	24/11/2000	
Paris / IdF	Tram on rails Tram on tyres	6 2	11,53	302,18	06/07/1992	
Reims	Tram on rails	2	0,98	14,03	16/04/2011	
Rouen	Tram on rails	2	1,40	18,85	16/12/1994	
Saint-Etienne	Tram on rails	3	1,52	20,98	01/01/1881	
Strasbourg	Tram on rails	6	6,25	72,25	26/11/1994	
Toulouse	Tram on rails	2	1,54	12,86	11/12/2010	
Tours	Tram on rails	1	1,29	17,43	01/09/2013	
Valenciennes	Tram on rails	2	1,22	4,37	03/07/2006	
29 urban areas		74	73,67	1071,11		

Table 01g

network, new line or extension line opened at the end of 2017 or 2018

Please note:

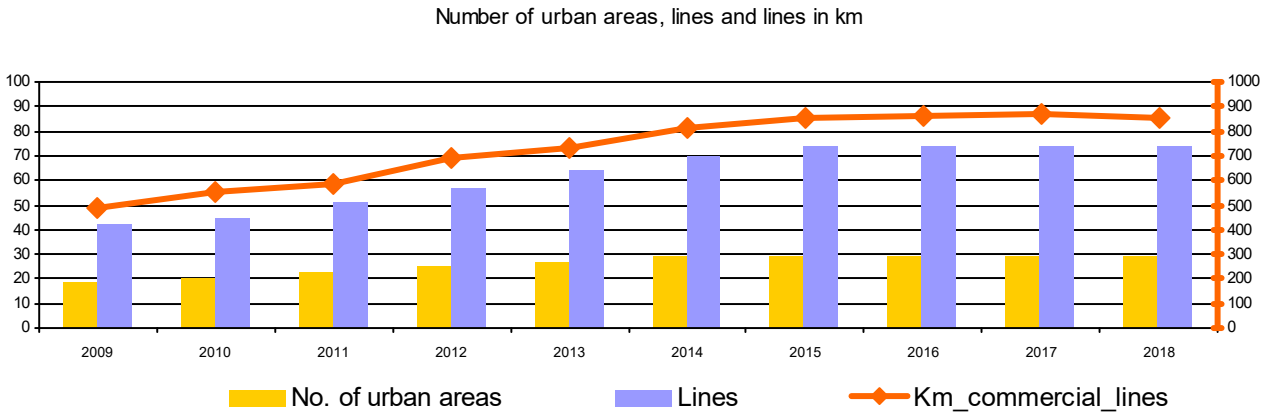
Caen	Tram on tyres	2	--	--	18/11/2002	Network not operated in 2018

2.2 - Table of rolling stock in operation on the networks at the end of 2018

Urban area	Manufacturer	Model	umber of tram
Angers	ALSTOM	CITADIS 302	17
Aubagne	ALSTOM	CITADIS 202	8
Besançon	CAF	Urbos 3 – 3 modules	19
Bordeaux	ALSTOM	CITADIS 302	12
Bordeaux	ALSTOM	CITADIS 402	92
Brest	ALSTOM	CITADIS 302	20
Clermont-Ferrand	TRANSLOHR	STE4	23
Dijon	ALSTOM	CITADIS 302	33
Grenoble	ALSTOM	CITADIS 402	50
Grenoble	ALSTOM	TFS	53
Le Havre	ALSTOM	CITADIS 302	22
Le Mans	ALSTOM	CITADIS 302	34
Lille	BREDA	VLC	24
Lyon	ALSTOM	CITADIS 302	73
Lyon	ALSTOM	CITADIS 402	19
Lyon	STAEDLER	Tango	6
Marseille	BOMBARDIER	(stretched out)	26
Montpellier	ALSTOM	CITADIS 302	27
Montpellier	ALSTOM	CITADIS 401	30
Montpellier	ALSTOM	CITADIS 402	30
Montpellier	ALSTOM	TFS	1
Mulhouse	ALSTOM	CITADIS 302	27
Mulhouse	SIEMENS	Avanto	12
Nancy	BOMBARDIER	TVR	25
Nantes	ALSTOM	TFS	45
Nantes	BOMBARDIER	Incentro	33
Nantes	CAF	Urbos 3 – 5 modules	12
Nice	ALSTOM	CITADIS 302	13
Nice	ALSTOM	CITADIS 402	15
Nice	ALSTOM	CITADIS 405	12
Orléans	ALSTOM	CITADIS 301	22
Orléans	ALSTOM	CITADIS 302	21
Paris / IdF	ALSTOM	CITADIS 302	105
Paris / IdF	ALSTOM	CITADIS 402	46
Paris / IdF	ALSTOM	TFS	35
Paris / IdF	TRANSLOHR	STE3	15
Paris / IdF	TRANSLOHR	STE6	28
Reims	ALSTOM	CITADIS 302	18
Rouen	ALSTOM	CITADIS 402	27
Saint-Etienne	ALSTHOM / VEVEY	MR_SET1	15
Saint-Etienne	ALSTHOM / VEVEY	MR_SET2	20
Saint-Etienne	CAF	Urbos 3 – 5 modules	16
Strasbourg	ALSTOM	CITADIS 403	62
Strasbourg	BOMBARDIER	Eurotram	42
Toulouse	ALSTOM	CITADIS 302	24
Tours	ALSTOM	CITADIS 402	21
Valenciennes	ALSTOM	CITADIS 302	30
TOTAL			1360

2.3 - Evolution 2009-2018

2.3.1 - Systems in operation

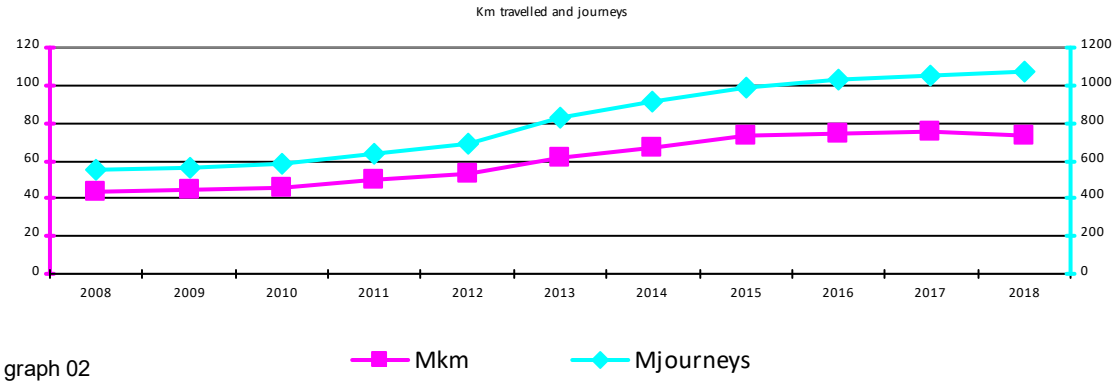


graph 01b

The trams in operation in 2018 are present in 29 urban areas and represent 74 commercial lines including 70 tram on rails and 4 tram on tyres lines. The fleet tends to stabilise over the last 3 years even if some extensions have been commissioned. Please note that, since 2008, the number of commercial lines has nearly doubled, and that the km representing the length of these lines has increased by 80%.

The major event in the fleet in 2018 was the closing of the Caen network for transformation into a tram on rails.

2.3.2 - Production data



graph 02

The number of journeys has more than doubled since 2008 and are once again increasing: note that the number of journeys now exceeds a billion journeys for the 3rd year.

Conversely, the kilometres travelled are stable for the past years.

3 - Events

3.1 - Overall data for 2018

The number of events declared by the operators and reported in the national database is 2509 for the year 2018; the table below gives the breakdown of the number of events and victims per category of event, according to the list of undesirable events.

Event Type	No. of evt	Total victims	Total seriously injured persons	Total fatalities
Fire Explosion	9	0	0	0
Panic	0	0	0	0
Electrocution	0	0	0	0
Derailment	15	0	0	0
Passenger event	1042	542	9	0
Collision between trams	0	0	0	0
Collision with obstacle on track	40	1	0	0
Collision with third parties	1369	385	27	7
End of track event	7	4	0	0
Other events	27	6	0	0
	2509	**938**	**36**	**7**

Table 03b

For 2018, please note the 7 events declared End of track events (12 in 2017, 5 in 2016, 6 in 2015) and the 15 Derailment/splitting point events (10 in 2017, 8 in 2016, 5 in 2015).

3.2 - Remarks concerning the events

3.2.1.a - Fire - explosion

9 fire explosion events were declared in 2018 (6 in 2017) but did not result in any victims:

- 8 events related to brakes applied with emission of smoke,
- emission of smoke in the tram.

3.2.1.b - Derailment/splitting point/off-rail

15 derailment, splitting point or off-rail events have been declared in 2018 (9 in 2017) but did not result in victims:

- three derailments at the exit of a single track, before arriving at the station, relating to an incorrect switch point position,
- a derailment during the running of a crossover, linked to an incorrect switch point position,
- five derailments during a turn back manoeuvre (two on the line, three at the station),
- a trailing with incorrectly positioned switch point,
- a derailment on a frog at very low speed,
- a tram went off the rail following the presence of objects in the groove of the rail,

- a tram went off the rail following the presence of ice,
- two trams went off their rails, following defect.

The increase in the number of derailments is focused on a network for which investigations are underway.

3.2.1.c - Passenger event

This event category is the subject of a detailed analysis of victims later in the report, chapter§4 - Victims.

3.2.1.d - Collision between trams

No event in 2018 (7 in 2017).

3.2.1.e - Collision with obstacle on track

40 collisions (42 in 2017) with obstacles on the track of different types: trolleys, garbage cans, barrier (construction site or not), site pipes, metal or concrete studs, cobblestones, wooden pieces, iron bars, etc. There is 1 slightly injured third party.

3.2.1.f - Collision with third parties

The analysis of this category is more detailed in chapter §5 The passenger events of this report.

7 fatal events occurred in 2018 (4 in 2017) that are all collisions with pedestrian third parties: 4 on pedestrian crossing, 2 in on-street/off-street section, 1 at the station.

Please note that a pedestrian death is caused by an act of suicide.

3.2.1.g - Other events

27 other events (34 in 2017) resulting in no serious victims.

Most of the events are of the following nature: vandalism, catenary hanging, breaking of stay ropes, collisions of third party with tram system infrastructure, etc.

The phenomenon of “tram surfing” is seen again (1 event).

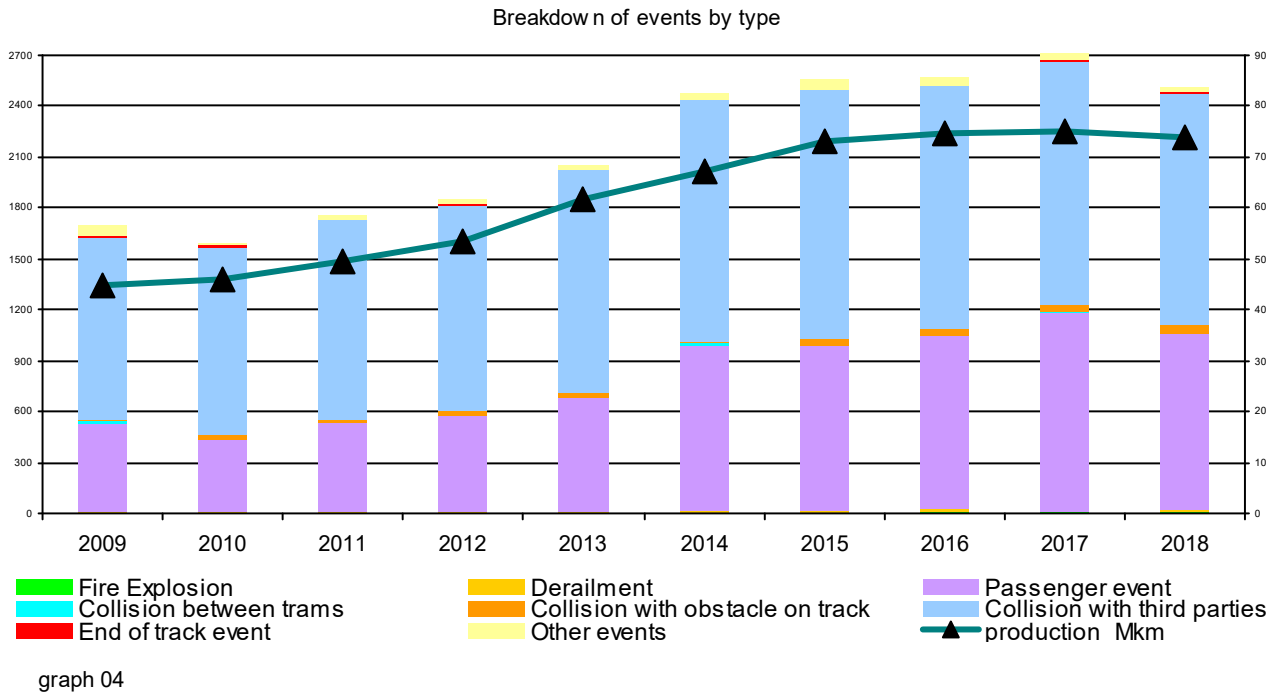
3.2.1.h - End of track event

7 track end stops overruns (12 in 2017), of which two involved the unexpected movement of a tram and one can be explained by the hypovigilance of the driver, with 4 passengers being slightly injured.

3.3 - 2009-2018 evolution

3.3.1 - Breakdown by type of event and evolution of travelled km

The graph below shows the evolution of the number of events over the 2009-2018 period, with breakdown per category, and shows the evolution in the number of travelled km at the same time.



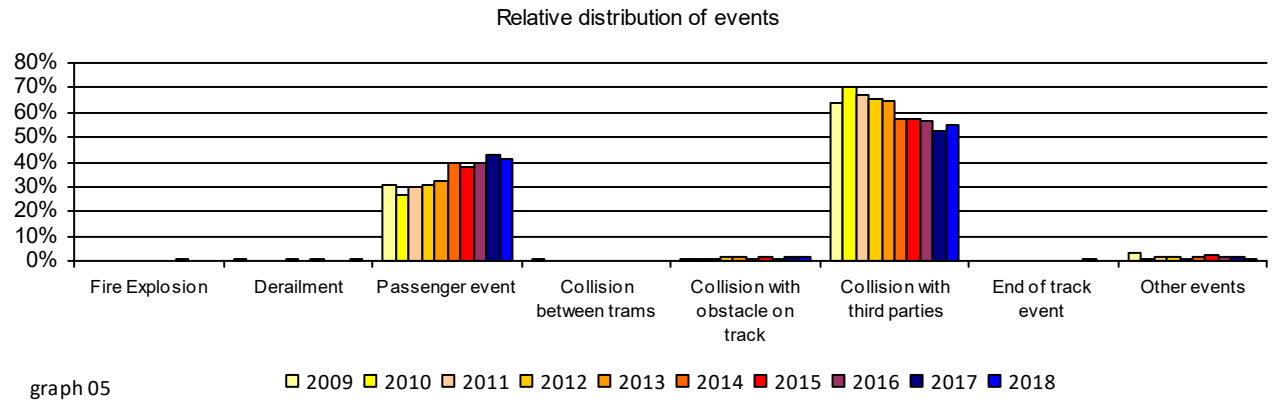
graph 04

In 2018, we noted a significant decrease in the number of reported events.

Collisions with third parties always show the highest share of events.

3.3.2 - Evolution of the share of events by event type

The graph below shows the evolution of the relative proportion of each event type over the 2009-2018 period, with breakdown per type.



graph 05

Over the period, we observe an increase in the proportion of passenger events and a decrease in the proportion of collisions with third parties. The proportion of the other types of events remains very low.

There are several explanations put forward by the operators concerning the evolution of the proportion of passenger events:

- Observation of a trend of the passengers holding on less frequently to the gripping devices present in the trams in view of a smoother ride in the trams, unlike buses.
- Tendency to claim for compensation
- Observation of an increasingly ageing clientele (considering the accessibility of trams).
- Increase in travel by soft modes (walking/ cycling) leading to emergency braking to avoid collisions and resulting in passengers falling.

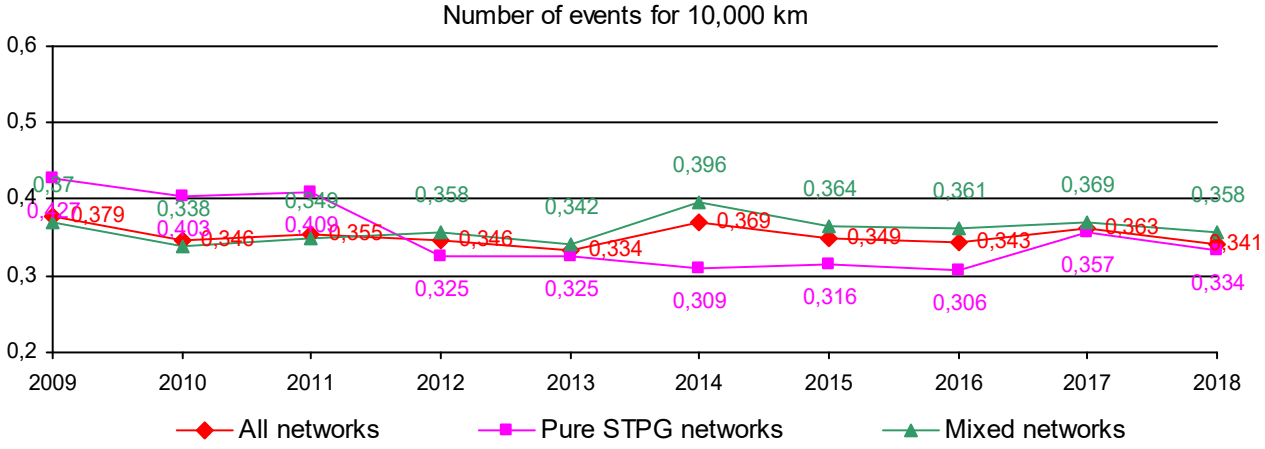
This being the case, the majority of severe victims are from collisions with third parties (See 4.2.4.b Evolution of the proportion of severe victims according to the events).

3.4 - Monitoring of events indicators

3.4.1 - Events per 10,000 km travelled

The number of events per 10,000 km is a common indicator of accident used by tram and bus networks operators. The evolution of this indicator is represented in the graph below.

With respect to the analysis report of events declared covering the 2006-2015 period, we have used the comparison between the mixed networks, opened before the STPG Decree of 2003, and the “pure STPG” networks opened fully in accordance with the STPG Decree *(see 1.3 - The adopted principles and definitions).*



graph 07b

We observe that the ratio of events with 10,000 km for the “pure STMG” networks was clearly below that of the mixed networks between 2014 and 2016. This trend is not confirmed in 2017 or in 2018 and seems to be related to the change in the reporting procedures of passenger events.

3.4.2 - Comparison with buses

As a guideline, we were able to get the bus accident rate data for 5 typical tram networks. The events taken into account for buses are almost the same as those for trams, mostly collisions with third parties and passenger events. We get the “events for 10,000 km” ratio below for the 5 considered networks:

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018
Bus	0,80	0,80	0,79	0,73	0,67	0,75	0,68	0,65	0,68
Tram	0,39	0,39	0,34	0,34	0,42	0,38	0,39	0.39	0.37

Table 06_e

The tramway maintains a ratio to its advantage, in comparison with the bus.

4 - Victims

4.1 - 2018 data - All events

The table below provides details for the events of 2018, the breakdown of the number of victims per category according to the event type. A total of 938 victims has been recorded, significantly decreased as compared to the previous year.

Table 03a

Event	Total Victims	% victims	Third-Party Slightly Injured	Third-Party Severely Injured	Third-Party Fatality	Passenger Slightly Injured	Passenger Severely Injured	Passenger Fatality
Fire Explosion	0	0%	0	0	0	0	0	0
Panic	0	0%	0	0	0	0	0	0
Electrocution	0	0%	0	0	0	0	0	0
Derailment	0	0%	0	0	0	0	0	0
Passenger event	542	57,8%	0	0	0	533	9	0
Collision between trams	0	0%	0	0	0	0	0	0
Collision with obstacle on track	1	0%	1	0	0	0	0	0
Collision with third parties	385	41,0%	232	27	7	119	0	0
End of track event	4	0%	0	0	0	4	0	0
Other events	6	0,6%	2	0	0	4	0	0
Totals	**938**		**235**	**27**	**7**	**660**	**9**	**0**

Please note the proportion of passenger victims in the victims of collision with third parties: they constitute 30% of the victims of collision. This figure is higher with respect to previous year (27% in 2017).

The collisions with third-parties are more severe than the passenger events as the former reports 34 severely injured victims (including 7 fatalities) per 1368 collisions with third parties compared to 9 passenger severe victims (no fatality) per 1042 passenger events.

4.2 - Evolution 2009-2018

4.2.1 - Table of evolution of the victims by level of severity

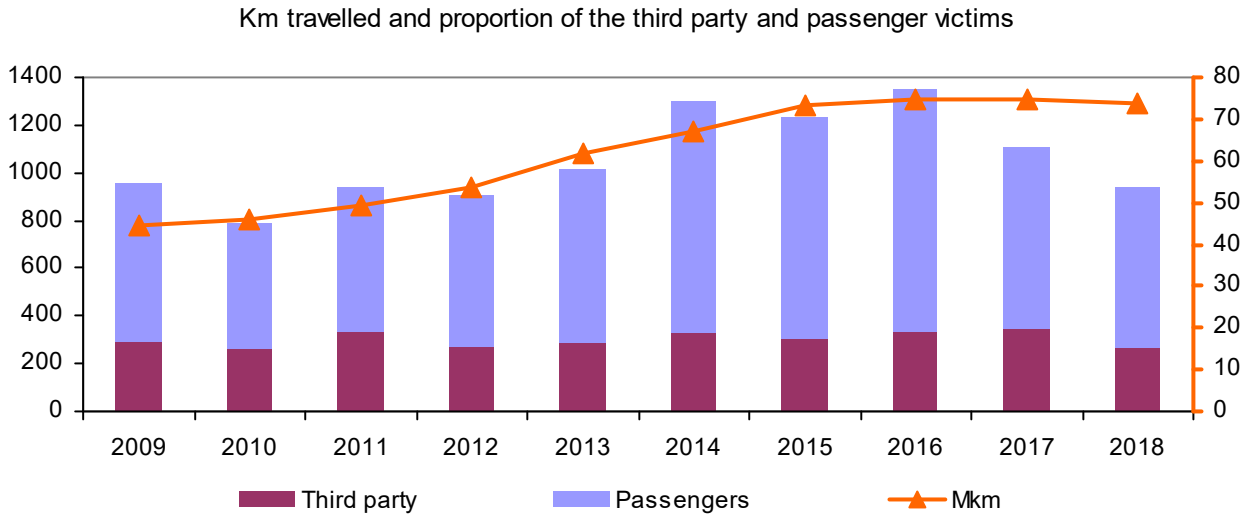
Year	Events	Victims	Seriously injured	Fatalities	Mjourneys	Mkm
2008	1694	819	38	5	552,53	43,43
2009	1695	958	23	6	567,17	44,77
2010	1586	789	32	9	584,58	45,85
2011	1762	941	44	2	636,36	49,58
2012	1851	908	33	3	690,36	53,55
2013	2057	1011	33	6	829,85	61,66
2014	2480	1300	44	6	908,65	67,22
2015	2555	1230	41	5	989,74	73,27
2016	2566	1346	57	7	1025,35	74,77
2017	2714	1103	66	4	1055,55	74,87
2018	2509	938	36	7	1072,63	73,75

Table 03e

Please note the significant decrease in the number of seriously injured persons in 2018.

4.2.2 - Passenger and third party victims

The graph below shows the evolution of the number of third party and passenger victims over the 2009-2018 period, third party and passenger victims.



graph 22

The passenger victims still represent the greatest proportion of victims (see explanations put forward in 3.3.2. concerning the passenger events).

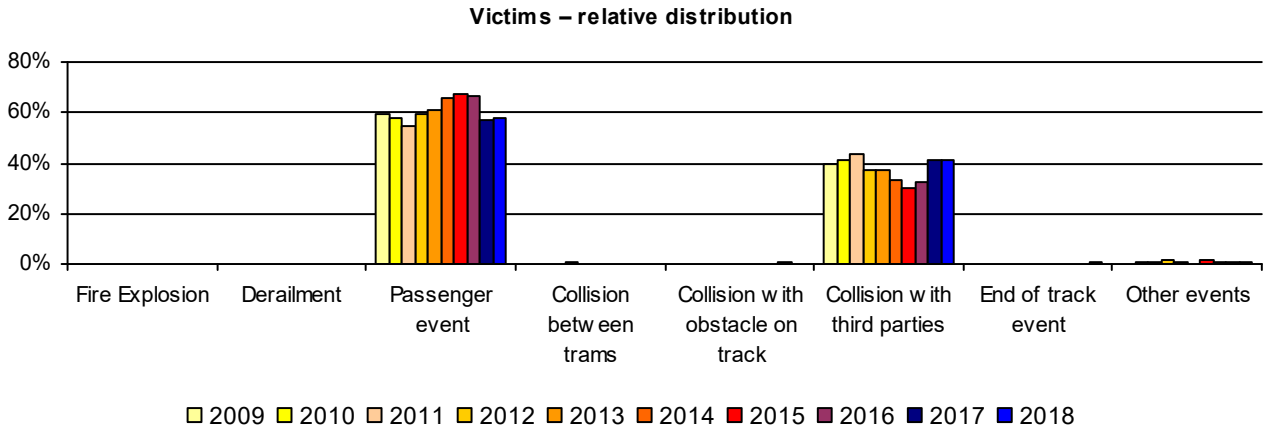
/!\ Following the change in the reporting procedures (refer to 1.3 - The adopted principles and definitions), the number of passenger victims has notably fallen since 2017.

Please note the significant decrease in the number of third party victims in 2018.

We would like to emphasise that the significant increase in distance (km) travelled over the past 10 years has not resulted in an increase in the number of victims of collisions with third parties.

4.2.3 - Evolution in the proportion of victims according to the type of event

The graph below shows the change in the relative proportion of victims during the 2009-2018 period with a breakdown according to the event type.



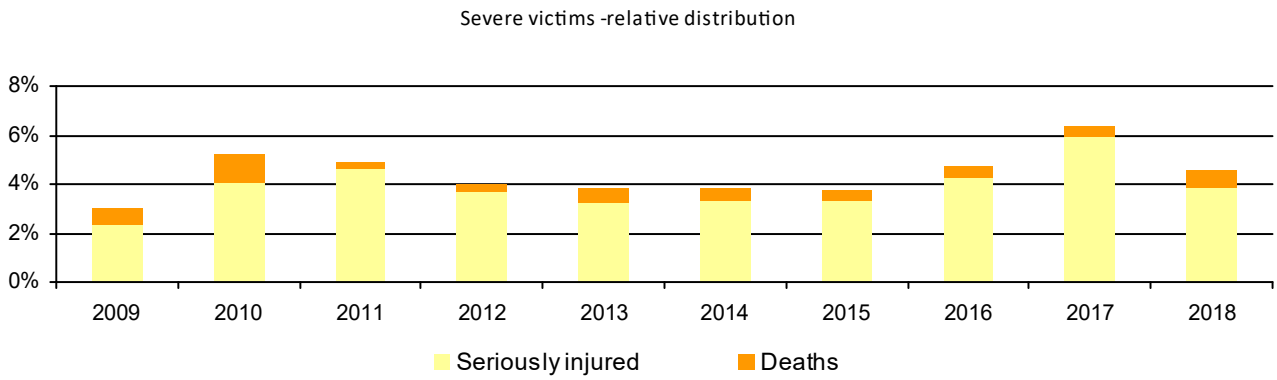
graph 23

/!\ Following the change in the reporting procedures (refer to 1.3 - The adopted principles and definitions), the proportion of passenger victims has fallen since 2017.

4.2.4 - Severe victims

It is to be recalled that the severe victims comprise severely injured individuals and fatalities *(refer to 1.3 The adopted principles and definitions).*

4.2.4.a - Evolution of the proportion of severe victims

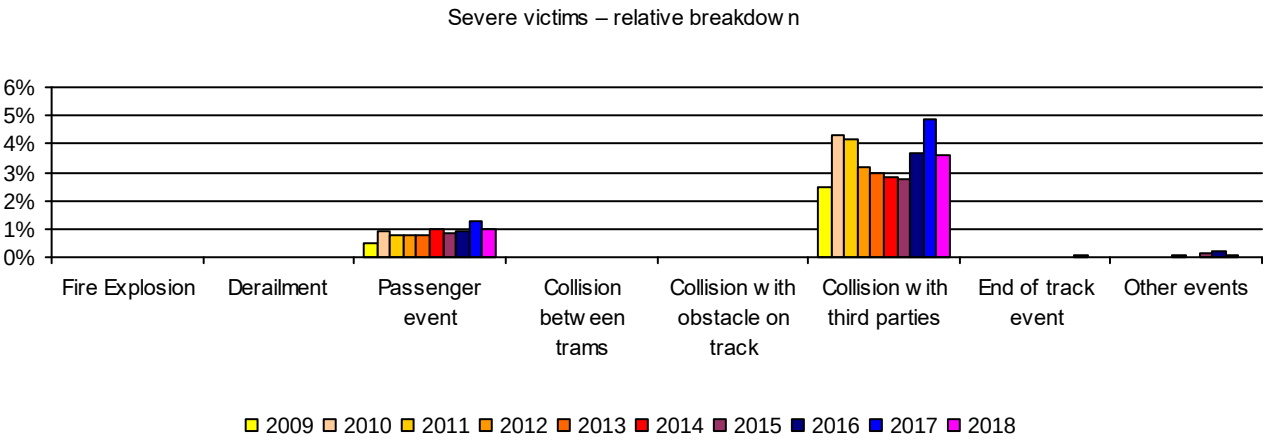


graph 25

After a significant increase in the previous year, the proportion of serious victims comes back, in 2018, to a level of the same scale as over the entire period – approx. 4% victims. This indicator remains to be monitored during the next reports.

It should be remembered that the statistical elements about the nature of the victims remain dependent on the information available and brought to the knowledge of the tram operator.

4.2.4.b - Evolution of the proportion of severe victims according to the events



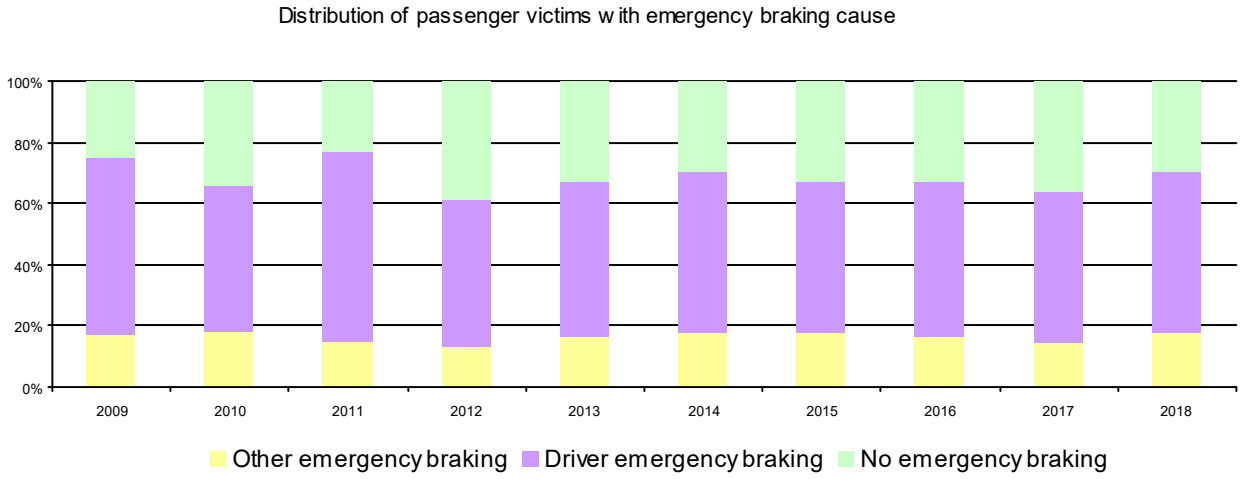
graph 24

Collisions with third parties remain the type of event generating the most severe victims. The significant increase observed in 2017 is not confirmed for 2018.

4.2.5 - Changes in the proportion of passenger victims related to the emergency braking

The graph below shows the evolution, over the 2009-2018 period, of the proportion of the passengers victims associated to the cause of the emergency braking (tram driver or other).

The events taken into account are collisions with a third party and the events of passengers falling in the tram.



graph 26

Over the observed period, 2/3 of the victims are related to an event with an emergency braking. We do not observe any particular trend concerning the evolution of the proportions based on the cause of the emergency braking.

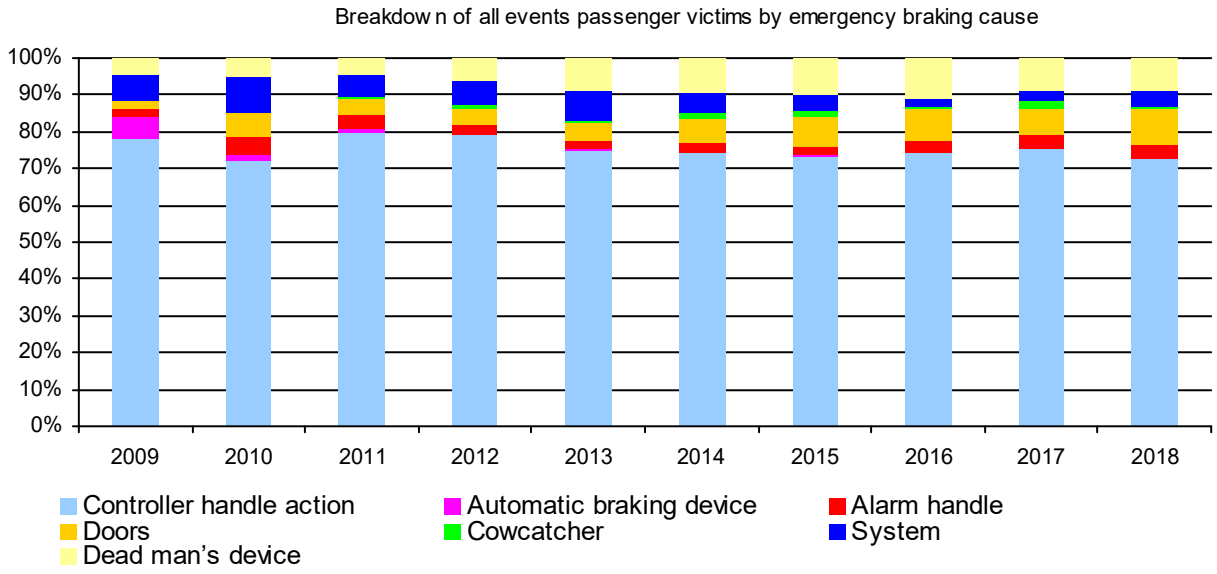
4.2.6 - Evolution of the proportion of passenger victims according to the nature of the emergency braking

It is interesting to provide details about the distribution of passenger victims, depending on the nature of the emergency braking, for all the events. Nevertheless, it is important to highlight that this analysis remains dependent on the clarification provided by the operators in their reporting.

The database can have seven categories of emergency braking that are reported:

- Controller handle action: includes all the emergency braking by the tram driver and initially caused by traffic in urban areas. For the most part, it pertains to the actions made actively by tram drivers and designed to avoid a collision with third parties.
- Automatic braking device: some networks with specific configurations have “automatic braking device of trains” for example in tunnels or on single track. The networks with this device have been in commercial operation since 2008. The largest number of emergency braking occur during the testing period (one to two years after the commissioning).
- Alarm Handle: refers to the device available to passengers; this device is only active when tram is leaving the station.
- Doors: is the emergency braking caused by opening doors, either because of travellers (forcing) or due to maladjustment of doors’ system.

- Cowcatcher: related to emergency braking caused by the detection of obstacle on the line and causing the falling of the cowcatcher device.
- System: denotes the technical malfunctions encountered on the rolling stock and causing an emergency braking. The operators' declaration do not enable their nature to be defined accurately.
- Dead man's device: corresponds to the absence of activation of the dead man's switch by the driver, resulting in emergency braking when the time-out is exceeded.



graph 27

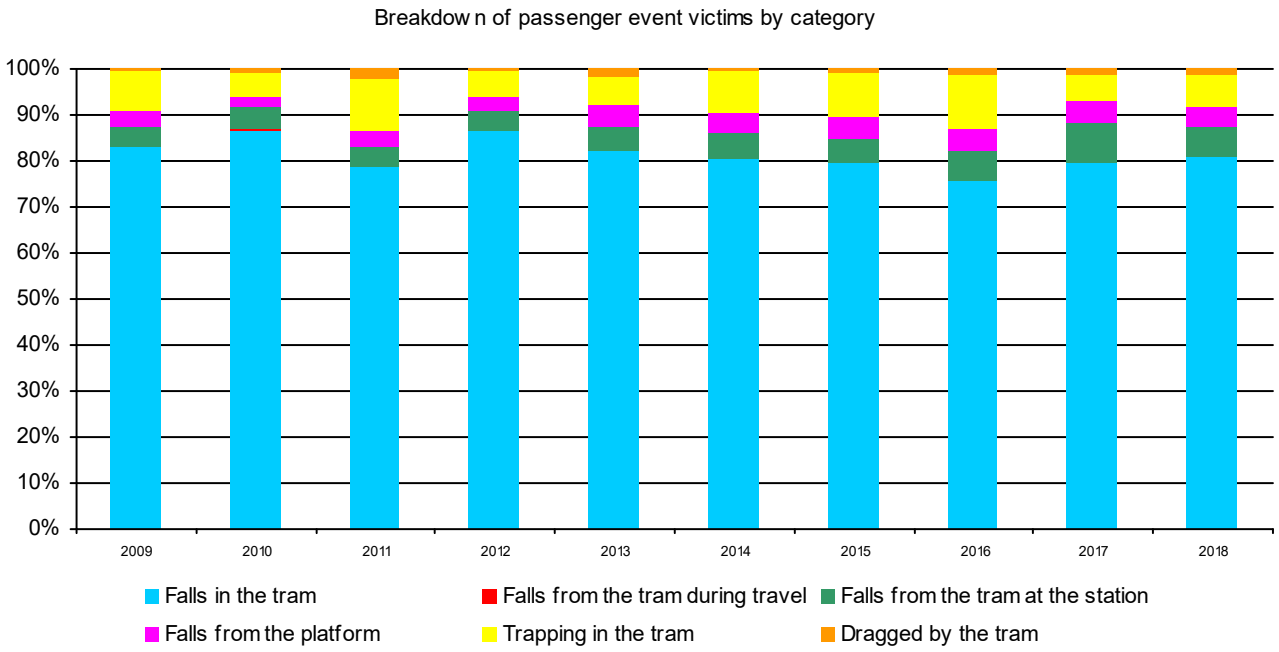
The proportion of the Doors emergency braking victims is to be correlated with a network reporting its passenger events since 2014 .

Concerning the proportion of the dead man's device emergency braking victims, we cannot observe the effects of the STRMTG recommendations of 14 February 2017 relating to the alert related to the triggering of the emergency braking of the dead man's device function because 90% of the victims concern networks that have not yet deployed the modification of rolling stock on the dates of the events concerned.

Additionally, the proportion of severe victims related to an emergency braking (all EB together) amongst all passenger victims is very low, lying between 0% and 1.5 % during the period 2009-2018 (0.8 % in 2018). By removing the "operator action" emergency braking, this proportion falls to a value between 0% and 0,56% (0% in 2018).

4.2.7 - Evolution of the proportion of victims of passenger events per category

The graph below shows the evolution over the 2009-2018 period in the proportion of passenger victims per passenger event category.



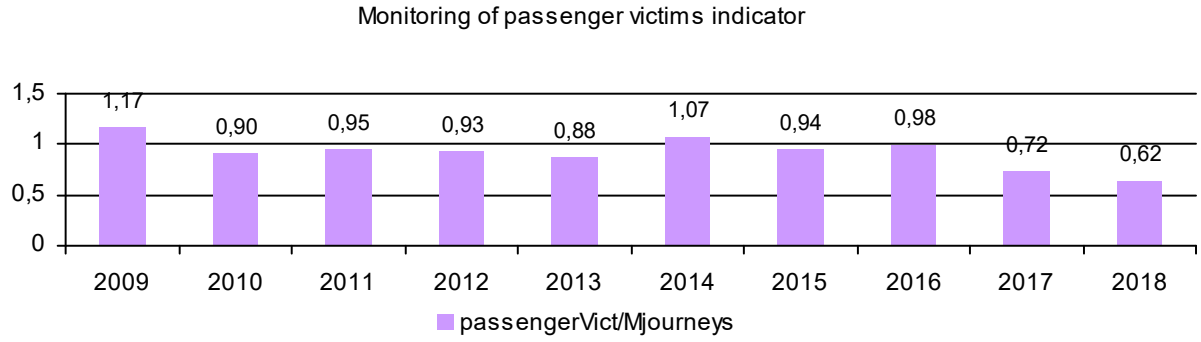
graph 15b

We observe that falling in the train remains the main cause of the victims of passenger events: the proportion of the victims related to a fall in the train has varied slightly over the last 10 years.

The trappings in the tram and the associated victims, which had significantly increased till 2016, have now come back to an average level.

4.3 - Other monitoring of victims and events indicators

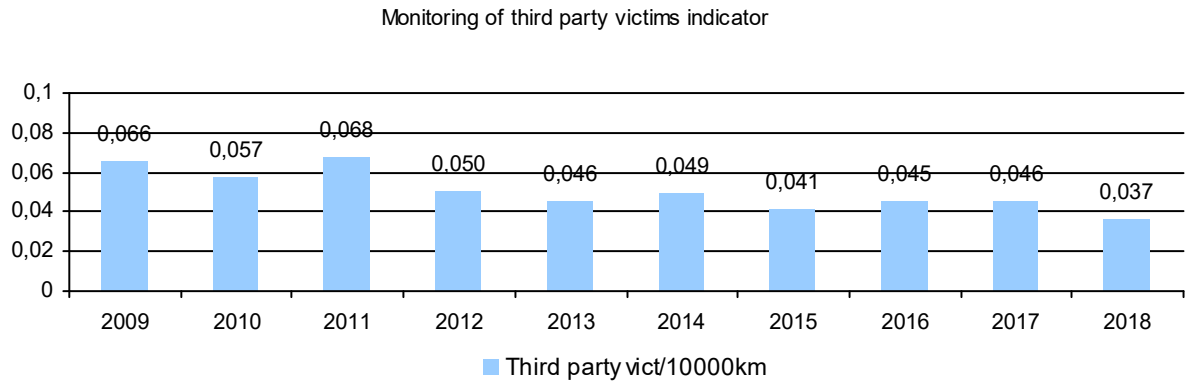
4.3.1 - Passenger victims per 1 million journeys



graph 30e

The indicator of the passenger victims per million journeys has reduced for 2018, in connection with the decrease in the number of passenger victims.

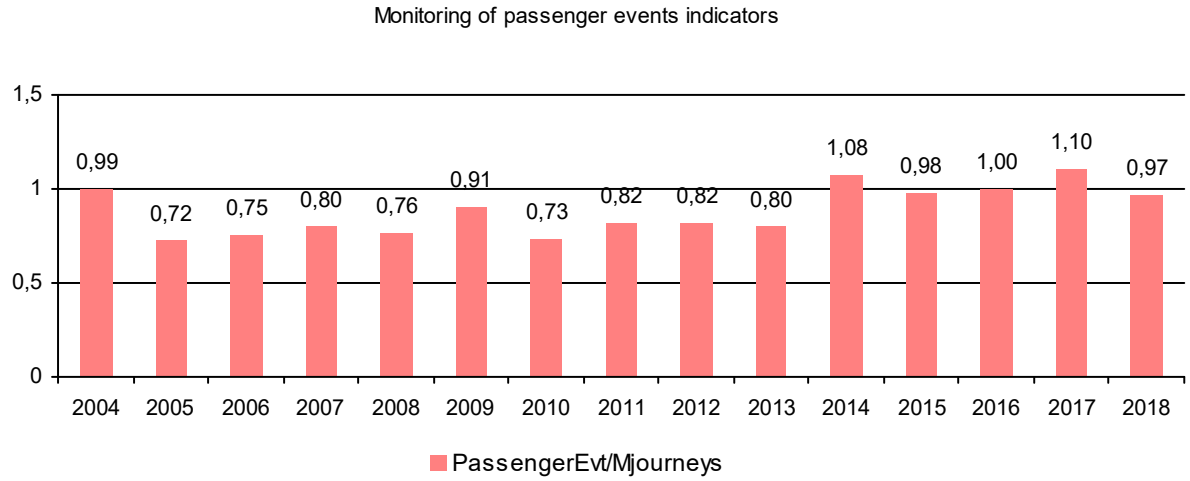
4.3.2 - Third-party victims per 10,000 km



graph 30d

The indicator of third-party victims per 10,000 km is overall declining over the last 10 years.

4.3.3 - Passenger events per 1 million journeys



graph 30f

The indicator of the passenger events per million journeys is observed to be increasing since 2014, in correlation with a network reporting its passenger events.

5 - The passenger events

/!\ For the passenger events, the main difference observed between the number of passenger events and the number of passenger victims since 2017 can be explained by the change of reporting procedures (refer to 1.3 - The adopted principles and definitions).

The passenger events for which no specification is provided in their declaration are identified as “non-specified”.

5.1 - Evolution 2009-2018

5.1.1 - Breakdown of the passenger events by specification

Passenger accident subtype	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Falls in the tram	413	358	401	468	521	732	699	686	813	732
Falls from the tram during travel		1			1	1			1	2
Falls from the tram at the station	25	24	29	27	35	54	54	69	95	89
Falls from the platform	19	11	19	19	30	45	45	47	51	36
Trapping in the tram	52	28	65	44	43	117	107	144	131	120
Dragged by the tram	3	3	8	4	12	7	9	10	12	10
Not specified	2	2		4	22	25	55	69	60	53
TOTAL	514	427	522	566	664	981	969	1025	1163	1042

Table 100_c

The declared passenger events predominantly pertain to the falls in the tram, mainly following a braking to avoid a collision. The trappings in the tram remain to be monitored.

5.1.2 - Breakdown of the victims of passenger events by specification

Passenger accident subtype	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Falls in the tram	473	393	405	466	488	667	617	630	459	410
Falls from the tram during travel		1			1	1			1	1
Falls from the tram at the station	26	23	23	22	31	46	42	56	50	32
Falls from the platform	19	10	18	17	28	36	36	38	29	23
Trapping in the tram	49	24	59	30	37	76	75	99	31	35
Dragged by the tram	3	3	11	3	10	5	6	10	8	6
Not specified	2	2		3	24	23	48	59	47	35
TOTAL	572	456	516	541	619	854	824	892	625	542

Table 100_d

We observe that the victims of the passenger events are essentially concerned by falls in the train.

5.1.3 - Breakdown of the severely injured victims of passenger events by specification

Passenger accident subtype	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Falls in the tram	1	6	5	6	5	8	7	8	4	3
Falls from the tram during travel	0	0	0	0	0	0	0	0	1	0
Falls from the tram at the station	2	0	1	1	0	0	0	0	4	2
Falls from the platform	0	0	0	0	2	4	2	0	0	0
Trapping in the tram	1	0	0	0	0	0	0	0	0	2
Dragged by the tram	1	1	1	0	1	1	1	2	4	2
Not specified	0	0	0	0	0	0	0	2	1	0

Table 100_e

The severely injured victims of passenger events are divided between the falls in the tram, falls during passenger exchange, and being dragged by the tram. In 2018, the severely injured victims of passenger events represent less than 2% of the victims of this type of event.

6 - Collision with third parties

6.1 - 2018 data

6.1.1 - Number of collisions and victims by type of third-party

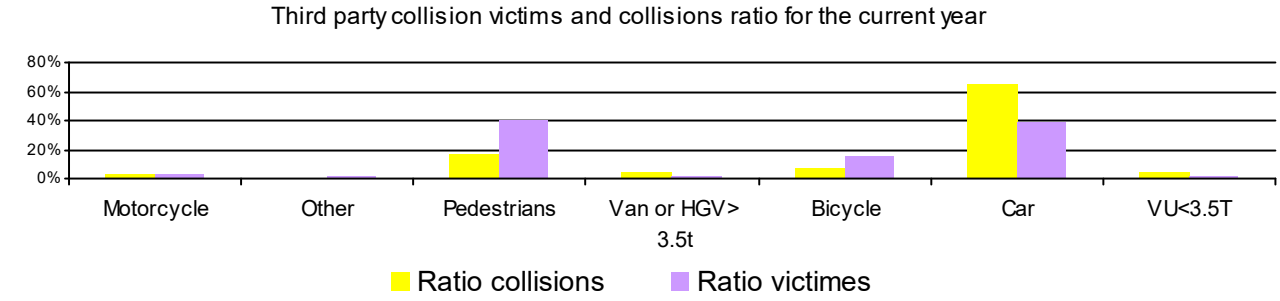
	Third party							
	Motorcycle	Other	Pedestrians	Public transport or HGV>3.5t	Bicycle	Car	Van <3.5t	Passengers
Collision with third parties	38	8	229	49	94	883	66	
Victims	6	4	107	2	40	104	2	114

Table 18_a

With 1368 events in 2018, collisions with third parties represent 54.3% of all reported events (2516 events).

As regards the victims of collisions with third parties, 379 in number, they are divided into 265 third party victims (27.6% of all events victims) and 114 passenger victims (12.3% of all events victims) for 943 victims in total.

6.1.2 - Ratio of collisions and third party victims of collisions by type of third party



graph 40

Collisions with private cars account for vast majority of cases; **collisions with pedestrians, which are far fewer, however, causes the largest number of victims.**

6.2 - Evolution 2009-2018

6.2.1 - Breakdown of collisions according to third parties

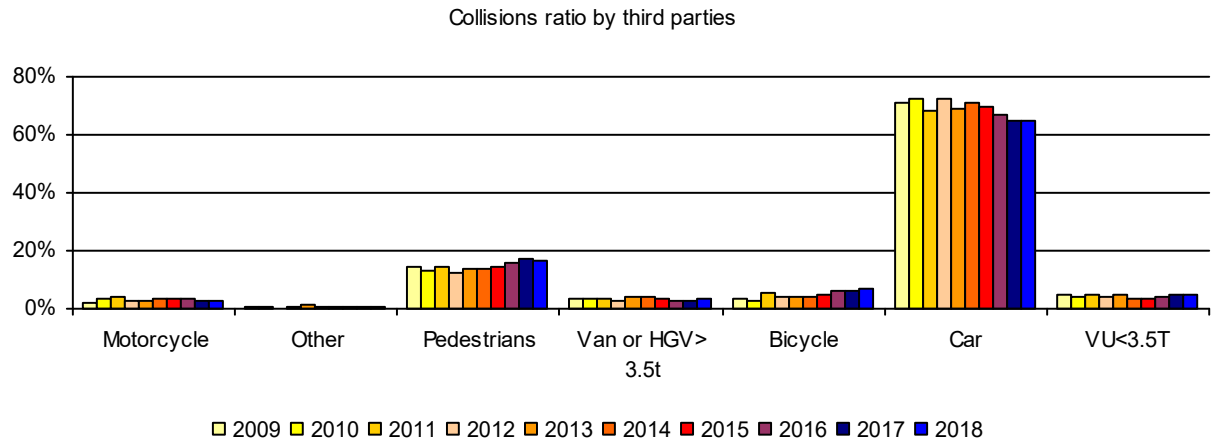
6.2.1.a - Table of data

Third party	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Motorcycle	26	41	45	35	38	47	54	49	37	38
Other	7	8	4	7	14	5	14	10	11	8
Pedestrians	154	148	169	153	183	198	209	230	251	229
Public transport or H	36	35	40	35	55	55	48	43	43	49
Bicycle	39	31	62	50	56	63	72	87	94	94
Car	763	808	806	883	911	1004	1027	964	933	883
Van <3.5t	54	47	54	54	64	48	48	56	68	67
TOTAL	**1079**	**1118**	**1180**	**1217**	**1321**	**1420**	**1472**	**1439**	**1437**	**1368**

Table 19_f

Overall, the number of collisions with third parties has significantly decreased for 2018. As regards collisions with pedestrians, their rate seem to be falling; this point remains to be monitored over the next few years.

6.2.1.b - Evolution of the proportion of collisions according to third-parties



graph 41

The distribution of the collisions according to the third parties presents an insignificant global variation over the analysed period.

6.2.2 - Third party victims of collisions

6.2.2.a - Table of data

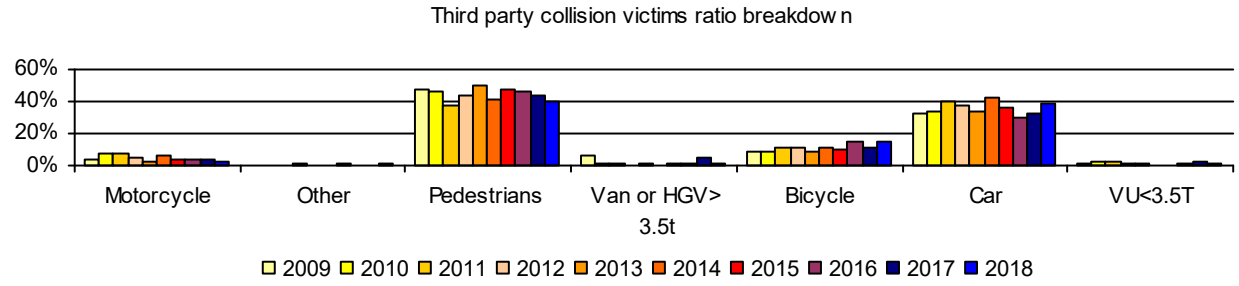
Third party	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Motorcycle	12	19	24	14	7	19	12	13	12	6
Other	1	1	0	2	1	0	2	1	1	4
Pedestrians	137	120	125	115	138	134	139	154	148	107
Public transport or H	19	3	5	1	4	2	3	6	18	2
Bicycle	24	22	39	29	25	35	28	51	37	40
Car	94	88	132	97	94	139	104	101	109	104
Van <3.5t	4	8	8	2	5	0	1	4	10	3
TOTAL	**291**	**261**	**333**	**260**	**274**	**329**	**289**	**330**	**335**	**266**

Table 19_g

For 2018, there is a decreasing number of victims like the number of collisions. In 2017, the number of victims of the “Public transport or HGV > 3.5t” category is associated to a tram/bus collision.

The pedestrian victims have fallen substantially for 2018, a trend to follow in the years to come.

6.2.2.b - Evolution of the proportion of victims of collisions according to the third-party



graph 42

The proportion of “pedestrian” victims has significantly lowered since 2015. Nevertheless, this category remains the most vulnerable to collisions and represents on average close to half the third party victims of collisions. Conversely, the proportion of “bicycle” victims has increased slightly for 2018.

6.2.3 - Third party severely injured victims of collisions

6.2.3.a - Table of data

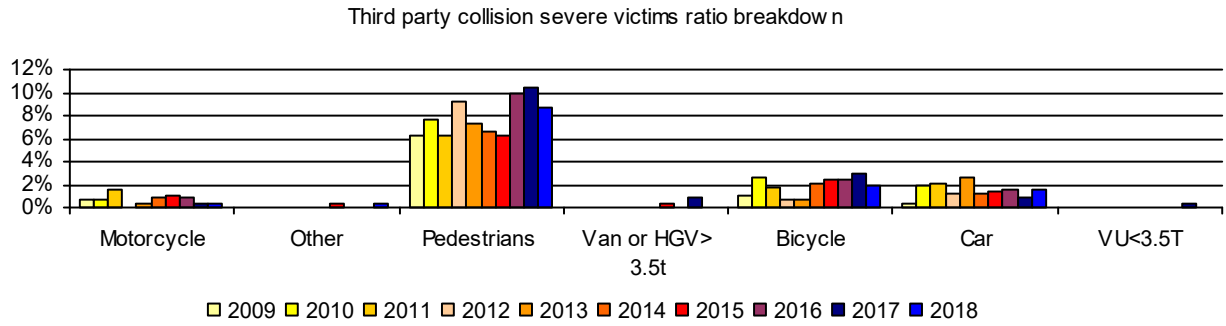
Third party	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Motorcycle	2	2	5	0	1	3	3	3	1	1
Other	0	0	0	0	0	0	1	0	0	1
Pedestrians	18	20	21	24	20	22	18	33	35	23
Public transport or H	0	0	0	0	0	0	1	0	3	0
Bicycle	3	7	6	2	2	7	7	8	10	5
Car	1	5	7	3	7	4	4	5	3	4
Van <3.5t	0	0	0	0	0	0	0	0	1	0
TOTAL	**24**	**34**	**39**	**29**	**30**	**36**	**34**	**49**	**53**	**34**

Table 19_i

This table confirms the vulnerability of pedestrian third parties that represent the majority of the severely injured victims of collisions with third parties.

For 2018, we underline, as before, a significant decrease in the number of serious pedestrian and bicycle victims, a trend to follow for future years.

6.2.3.b - Evolution of the proportion of third-party severe victims of collisions according to the third-party



graph 43

The proportion of serious pedestrian and bicycle victims fell again in 2018.

6.2.4 - Passenger victims of collisions

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Third party collisions passenger victims	88	66	79	80	104	106	86	111	123	119
Number of third party collisions	1079	1118	1180	1217	1321	1420	1472	1439	1437	1369
%	8,2%	5,9%	6,7%	6,6%	7,9%	7,5%	5,8%	7,7%	8,6%	8,7%

Table 19_h

We observe an increase in passenger victims of collisions in 2017 and 2018, without a marked trend over the period.

6.2.5 - Data on the causes of collisions with third parties for motorised third parties

The main cause of collisions with a third-party is non-compliance with signals by the motorcyclist and cyclist third parties.

We later find the prohibited manoeuvres on the platform, and the encroachment of the platform by third parties, that mostly results in only material consequences**.**

6.2.5.a - Disrespect for traffic signals by motorised third parties, bicycles and trams

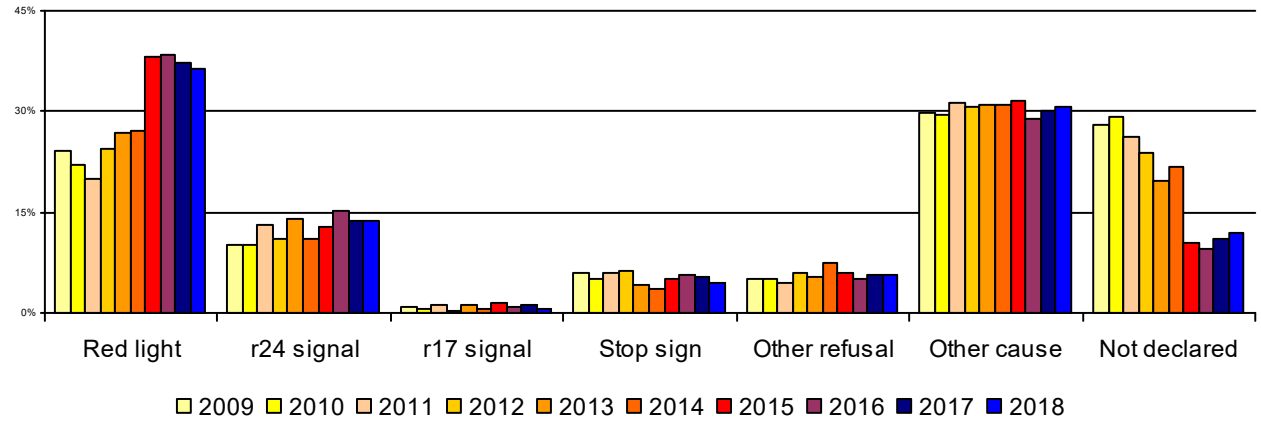
The graph below shows the ratio of the number of collisions with a third-party to the disrespect for traffic signals by motorised third parties, bicycles and by comparison, the tram driver.

The “other refusal" category takes account of the C20c, the give-ways and also the case of a crossroads in degraded mode where the traffic lights signals are in flashing amber.

The other causes pertain to events that are not related to traffic signals. The details about the breakdown of these events is given in the graph below.

The signals concerned for the tram driver are R17 traffic lights (see §9 Appendix – Main road signals).

Collisions with third party – disrespect for traffic signals and other causes

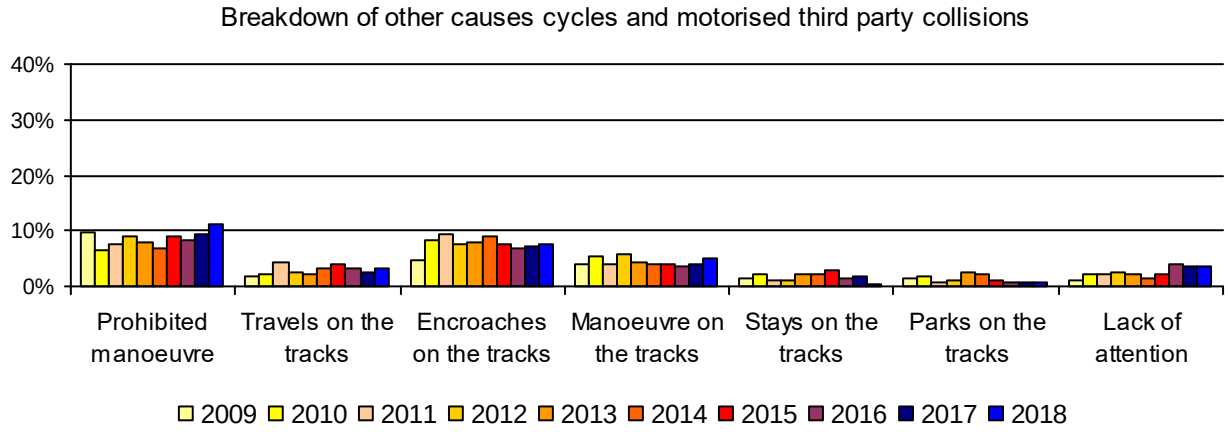


graph 29b

We observe a marked increase in the proportion of red lights crossed since 2015. This can be explained by a better quality of declaration by the operators.

6.2.5.b - Other causes for bicycles and motorised third parties

In addition to the previous graph, the graph below provides a representation, for the collisions that are not related to traffic signals, of the ratio of the number of collisions with third party that are related to the behaviour of the bicycle and motorised third parties. This mainly concerns the prohibited movements, U-turns, encroachment of the platform, etc.



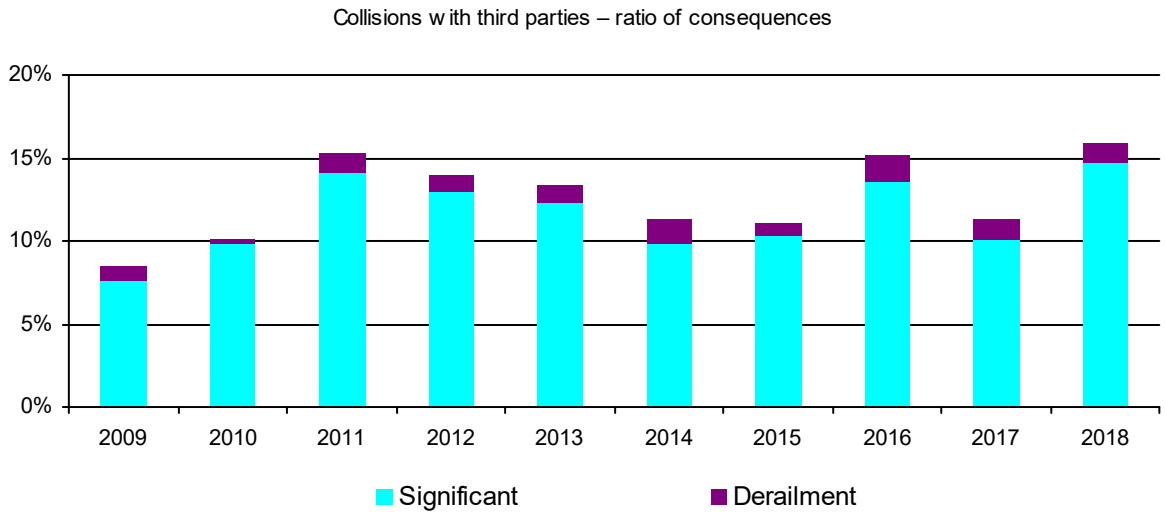
graph 46b

We observe that the main causes of collisions with a third-party, which are not related to the disrespect of conflict signalling, pertain to prohibited operations and encroachment of the platform (when the track clearance of the trams is occupied by third-party vehicles), and are increasing for 2018. No specific trend observed over the period.

6.2.6 - Material consequences of collisions with third parties – derailment

The graph below illustrates the material consequences of collisions with third-party: significant damage for third parties as to/for the system, and/or the tram derailment.

Since the 2017 report, only the collisions with motorised vehicles have been taken into account.



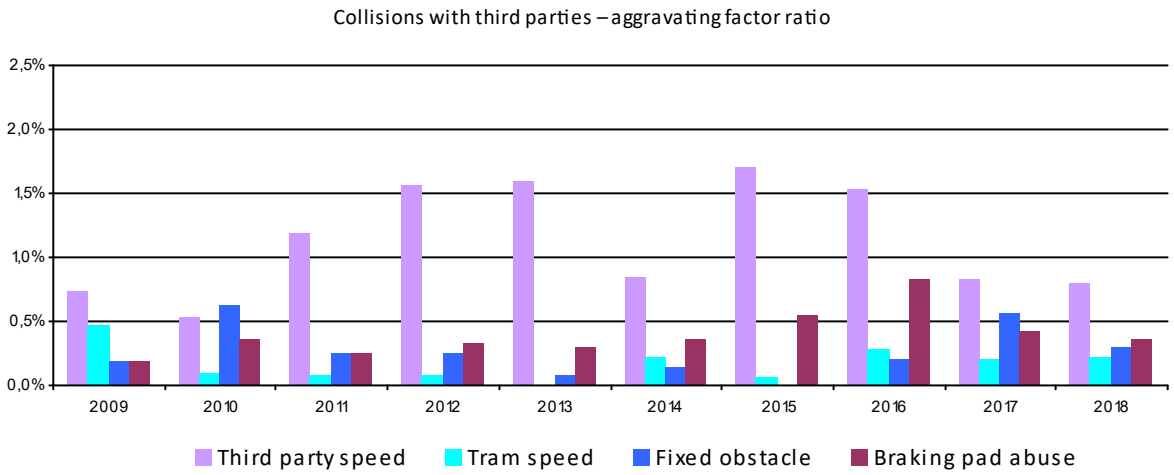
graph 48

The proportion of important physical impact remains below 15%. The decrease observed in 2017 is not confirmed in 2018.

The proportion of the derailments following a collision with a third party involving a car comes to 1.2 % in 2018.

6.2.7 - Aggravating factors

The graph below shows the repartition of aggravating factors according to the assessment of the operators in the collisions with third parties.



graph 49

Aggravating factor	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Braking pad abuse	2	4	3	4	4	5	8	12	6	5
Fixed obstacle	2	7	3	3	1	3		3	8	4
Tram speed	5	1	1	1		3	1	4	4	3
Third party speed	8	6	14	19	21	12	25	22	12	11

Table 92_f

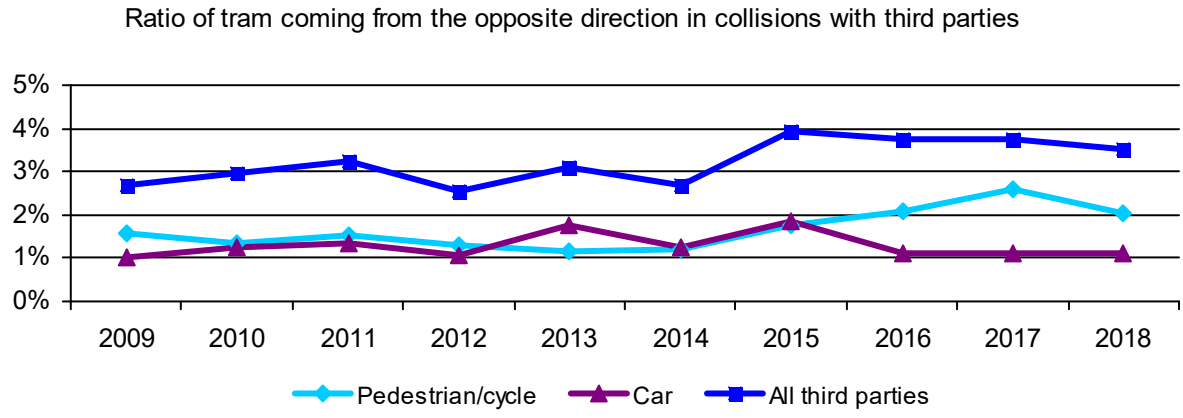
Four categories of aggravating factors have been identified:

- Third-party speed: corresponds to a speed assessed as excessive in view of the declaration of the tram driver and if it aggravated the consequences of the collision
- Tram speed: similarly, the tram speed is considered to be excessive when it significantly exceeds the maximum speed of the considered area or that of the instructions to be followed in view of the event scenario
- Fixed object: pertains to the collisions whose consequences have been aggravated by the third party being caught between the obstacle and the tram
- “Braking pad abuse”: means the practice of using the magnetic brake pads instead of an emergency braking. This practice extends time and braking distances, thus leading to higher speed of tram when striking third parties.

Collisions with third parties for which an aggravating factor has been identified is a very small part of overall collisions.

6.2.8 - Opposite direction tram

The graph below shows the proportion of collisions with third parties whose circumstances appear to involve a tram coming from the opposite direction while crossing a first tram.

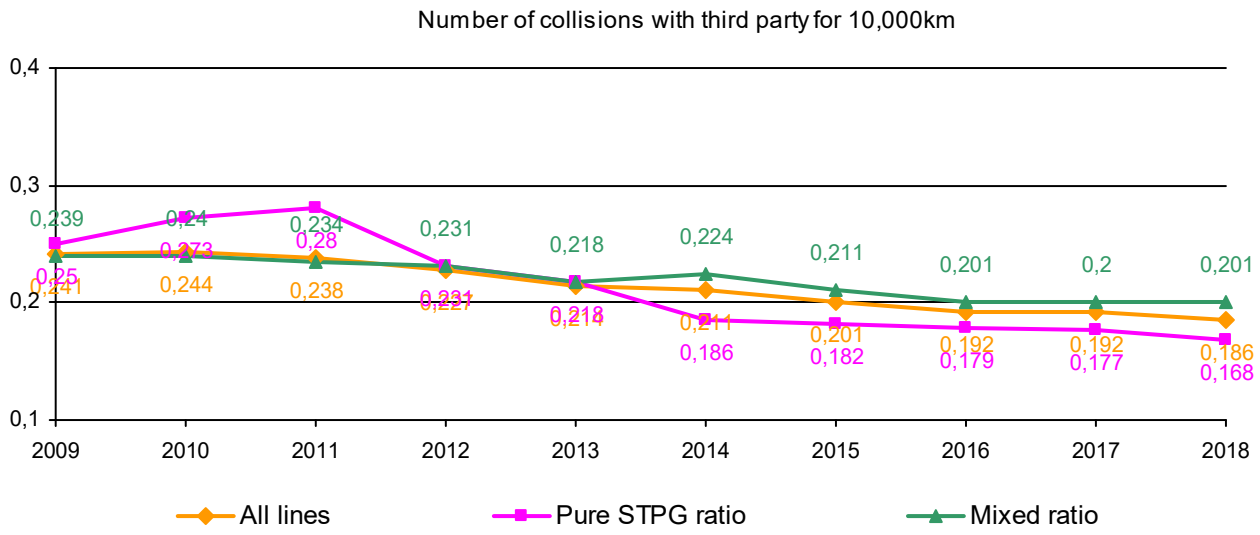


graph 47

With a ratio that is stable since 2015, it is an indicator that must be observed, although it represents a small proportion of collisions with third-parties, with an increase in the common core line operations (predominantly corresponding to the city-centre) and active modes.

6.3 - Monitoring of collisions indicators

6.3.1 - Collisions per 10,000 km travelled



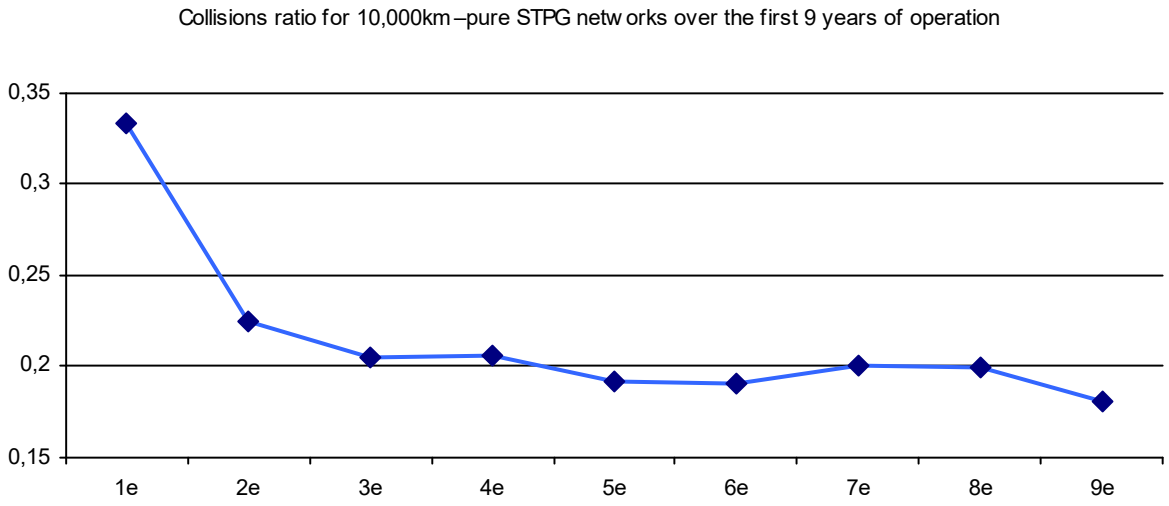
graph 08

For the indicator of the number of collisions with third parties per 10,000 km travelled, the general trend remains downward. It is important to note a more significant decrease, mainly since 2014, of the ratio of collisions per 10,000 travelled km for the “pure STPG” networks (the lowest ratio since 2006).

6.3.2 - Collisions at the beginning of operating

Some STPG lines now have a number of years of operation exceeding 10 years in 2018. We found it interesting to observe the rate of collisions at 10,000 km of “pure STPG” networks in the first 9 years of operation.
This graph is scalable and takes into account the start-of-operation data for all the networks concerned.

In order to determine this ratio, we have considered the date of the event and the date of opening of the section. As regards the production in km, it is always the complete year production that is used. As these two elements of information are not on the same temporal base, this rate is to be considered as an estimate.



graph 09c

For the first five years of operation, it appears that the ratio of the collisions at 10,000 km, after a significant decrease in the first three years, slightly increases in the following year to again decrease and then become stable, approx. decreasing by half overall in total as compared to the first year of operation.

As a reminder, the 2018 average ratio of the number of collisions at 10,000 km for the pure STPG networks is 0.168.

7 - Analysis of configurations

The codification of lines allows describing the present configurations on the tram networks and as a result analysing the breakdown of events according to the different configurations. The codification defines nine types of configurations: station, on-street/off-street section, pedestrian/cycle intersection, and six types of road intersection with the tram platform.

The road intersections with turning movement and the roundabouts/roundabouts with traffic lights present from the origin the most unfavourable configuration vis-à-vis accidentology. In the next part of the report, there will be a special focus on these intersections.

Please note that, the distinction between roundabouts (without the tram, the intersection works like a conventional roundabouts with give-way signs and priority to the ring) and roundabouts with traffic lights (even in the absence of tram, all the conflicts between road vehicles are managed by traffic lights) is done by selecting the "R11v" type for the entrance light signal of the roundabout/ roundabouts with traffic lights.

In addition to the types of configuration, our objective sought with the codification is to describe the characteristics of the configurations, in order to identify the parameters of the most accident-prone places, particularly for the intersections.

7.1 - Panel of the sections

	Configuration	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
	Station	892	920	956	1038	1201	1312	1419	1448	1482	1458
	On-street/off-street section	3004	3092	3180	3575	4174	4598	4994	5113	5235	5206
	Pedestrian cyclist crossing	3699	3826	3925	4336	5199	5707	6245	6415	6535	6443
Intersections	Simple junction	464	466	473	518	586	626	663	680	698	676
	Turns to	1003	1051	1079	1178	1406	1557	1716	1774	1795	1781
	Roundabout	132	136	145	164	174	179	187	189	186	182
	Roundabout with traffic lights	33	33	33	35	45	51	52	52	52	50
	Resident's access	270	279	296	311	381	413	453	458	460	452
	General traffic section entry	26	26	27	54	66	77	80	81	86	89
	Complex junction	301	307	318	343	394	421	472	482	500	500
	TOTAL	9824	10136	10432	11552	13626	14941	16281	16692	17029	16837

Table 30_f

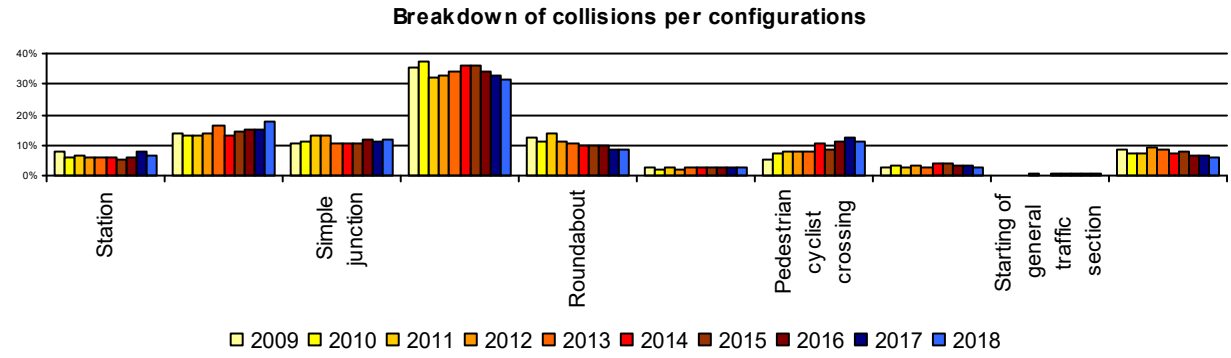
The table shows the number of sections (by codification category) in operation on 31 December of the year under consideration over the last 10 years. The most represented sections are the pedestrian/cycle intersections and the on-street/off-street sections. Amongst the road crossings, those with turning movements (the turn left/right) are highest in number, followed by the road junctions of the type “simple intersection”.

In 2018, following the closing of the Caen network, the overall number of active sections (“in operation”) was decreasing.

7.2 - Evolution 2009 - 2018

Events considered in this chapter are collisions with a third-party.

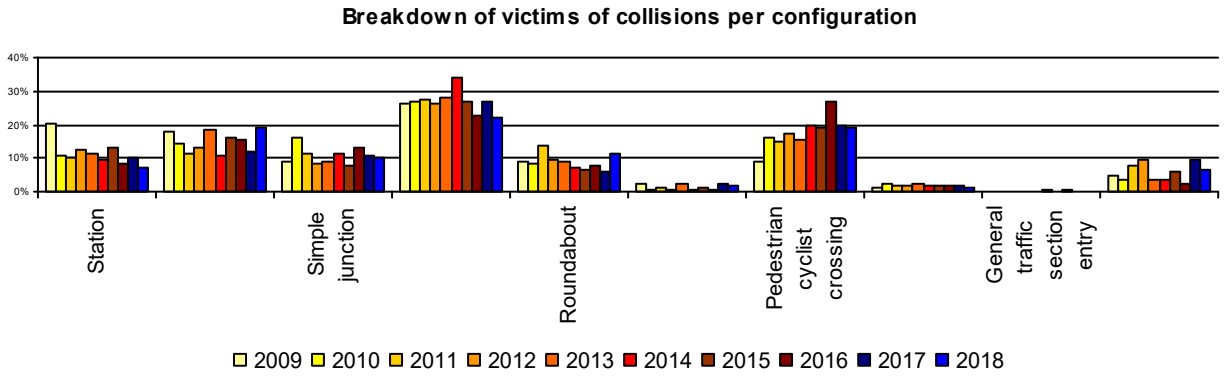
7.2.1 - Evolution of the proportion of the number of collisions according to the configuration



graph 50

Collisions with third parties occur in majority in turn left/right junctions, on-street/off-street sections, simple crossings followed by at the roundabouts. The proportion of the pedestrian/cycles intersections tends to noticeably increase over the period. There is no marked trend for the other types of intersection.

7.2.2 - Evolution of the proportion of victims of collisions according to the configuration

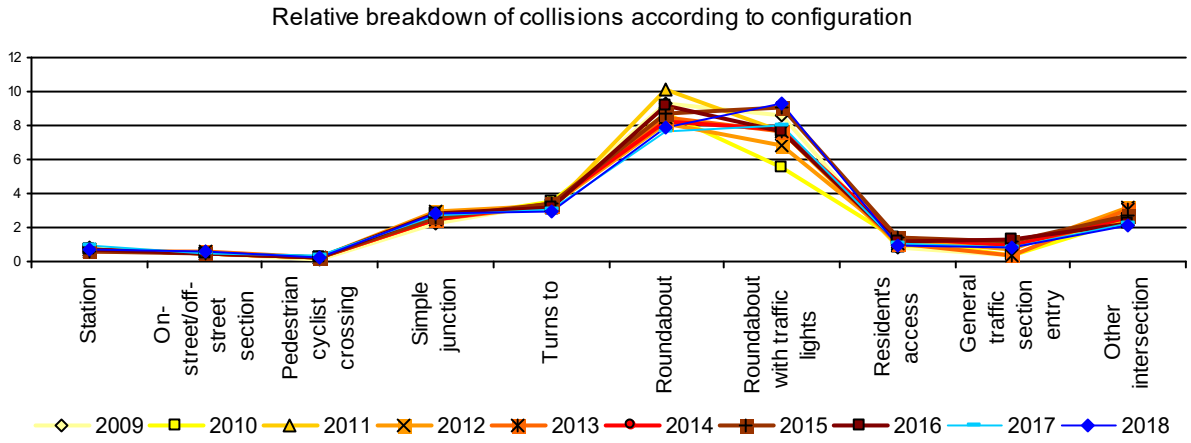


graph 51

All the victims of collisions with a third party are taken into account in this graph (third party and travellers).

The upward trend in the proportion of collisions at the pedestrian/cycle intersections is confirmed by that of the victims.

7.2.3 - Estimated risk



graph 52

The estimated collision risk corresponds to the ratio between the relative proportion of the collisions for each type of intersection, with the relative proportion of the number of intersections for each type of intersection.

We observe that the estimated collision risk of the roundabouts and roundabouts with traffic lights clearly remains above the other intersections over the entire period. However, the estimated risk reaches its lowest value over the last 2 years.

7.2.4 - Historised and active sections

7.2.4.a - Definitions

The **"active"** sections correspond to the sections in service with their present configuration, while the **"historised"** sections correspond to those before change of configuration or those that are deleted/abandoned.

This convention is used to ensure the monitoring of accident rates according to the development of the urban environment of the tram during its life. This is mainly the case of road crossings or pedestrian crossings whose characteristics have been modified: geometry, traffic signals or other components. The codification thus allows the conservation of historical configurations.

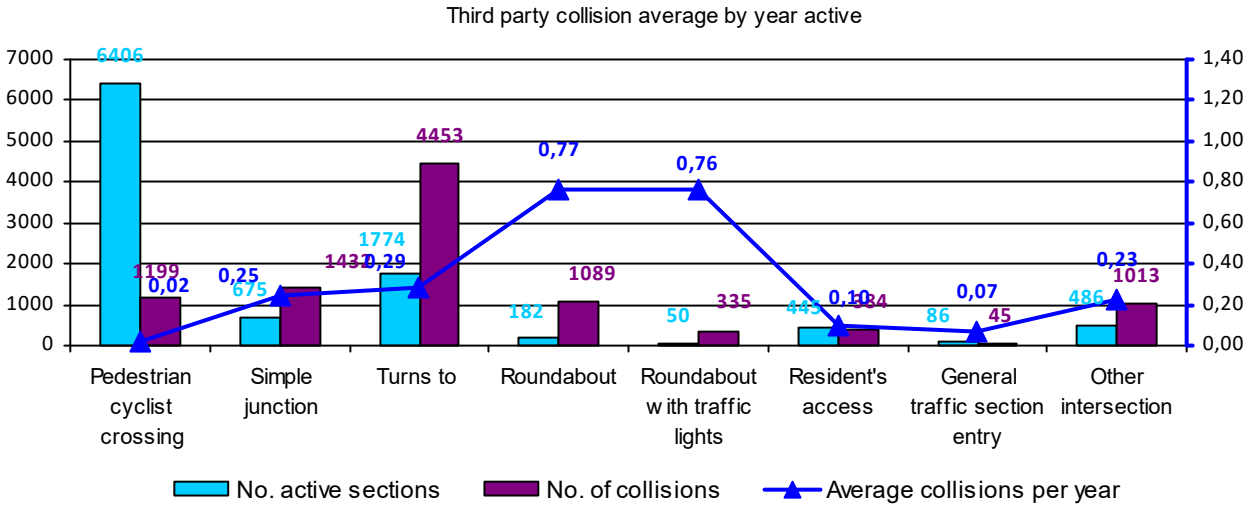
The collisions are taken into account over the 2008-2018 period (11 years) and the active sections on the networks at the end of 2018.

7.2.4.b - Average of the number of third party collisions by year and by type of active configuration

The graph below represents the following data:

- left scale: number of sections and collisions with a third-party allocated to these sections

- right scale: curve of the average number of collisions per year and per type of intersection



graph 54b

We observe a significant quantitative difference between the numbers of the different intersection types.

In addition, the trend for the average of the number of collisions per year is the same as the one observed in graph 52 (estimated risk) presented in §7.2.3.

7.2.4.c - Comparison of average number of third-party collisions per year

For the section panel that has been historised in the database since 2007 and according to the category of intersection, the table below indicates the number of logged sections, the yearly average number of collisions for the logged sections, as well as the yearly average number of collisions for the active sections.

ype of intersection	Number of "logged" intersections	No. of associated collisions	Average collisions per year by configuration on "logged" sections	Average collisions per year by configuration on active sections
Pedestrian cyclist cro	325	48	0,02	0,02
Simple junction	119	191	0,50	0,25
Turns to	133	372	0,60	0,29
Roundabout	111	396	1,28	0,77
Roundabout with traff	6	15	0,63	0,76
Resident's access	31	48	0,24	0,10
General traffic sectior	2	0	0,00	0,07
Complex junction	37	51	0,38	0,23

Table 200_a10_a11

This table allows us to see that the "number of collisions per logged configuration" ratio is higher than the one for the current configurations. This will globally demonstrate (for the data for which the sample size is sufficient) a certain effectiveness of the changes implemented over the tram networks. **In the following part of the document, the impact of signalling is analysed for the roundabouts and roundabouts with traffic lights. For a purpose of good understanding, a description of the different types of signs and light signals can be found at §9 Appendix – Main road signals.**

7.3 - Roundabouts and roundabouts with traffic lights

Events considered in this chapter are collisions with a third party over the 2008-2018 period (11 years) and the active sections at the end of 2018.

It should be noted at the beginning that we have not been able to analyse the possible link between the average rate of events per year, size parameters of roundabout and roundabouts with traffic lights, width of the ring and the number of entrance lanes, and the road traffic volumes, in the absence of traffic data.

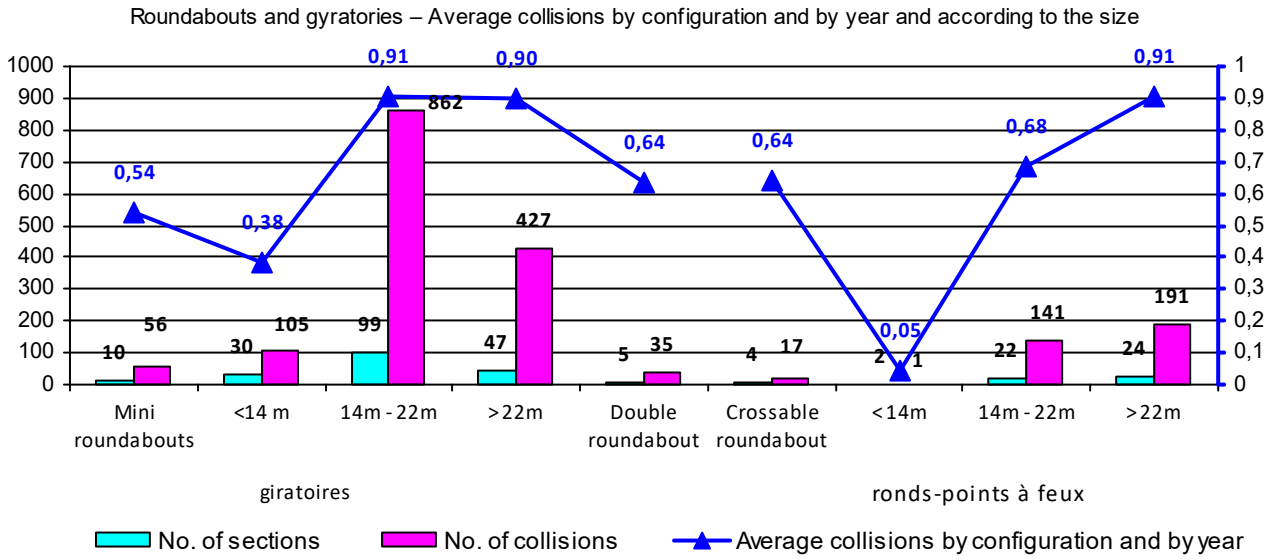
The average collision figures per year represent the average of the number of collisions observed for the configuration, divided by the number of observation years of the configuration.

7.3.1 - Average collision ratio for all the roundabouts and roundabouts with traffic lights

In the graph below, the roundabouts are divided into five main categories according to their size, and the roundabouts with traffic lights are divided into four categories.

At the start, we observe the low number of mini roundabouts and double roundabouts, as well as for the roundabouts with crossable central island and size < 14m.

For these categories, **the values of the statistical analyses should be interpreted carefully**.



graph 90a

We observe that the average of the number of collisions by configuration and by year for the roundabouts becomes higher for the roundabouts with radius > 14m.

However, comparing some combinations according to this single criterion of size remains irrelevant due to the impact of other criteria in the database (for example: entrance signs).

We observe that the average rate of the “14-22m” category is close to that of the “more than 22m” category; today, it seems necessary to understand this result. In the current study on roundabouts, carried out jointly by STRMTG/CEREMA, the influence of the radius of the roundabout in the “14-22 m” category will be observed, which may lead, if necessary, to deduct two relevant sub-categories.

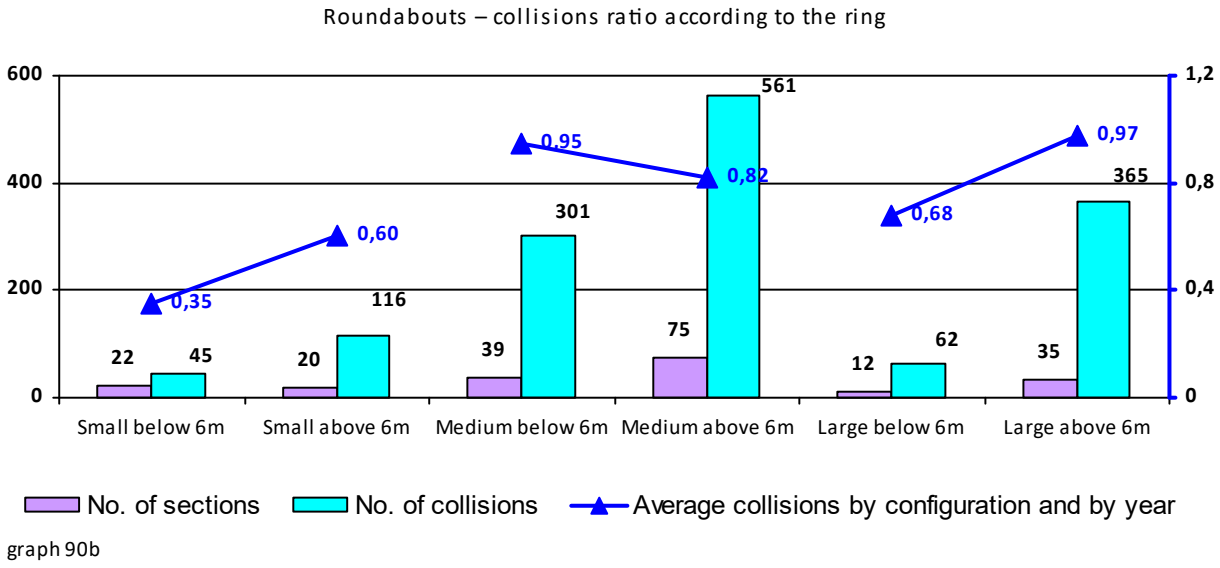
We will provide details in the following paragraphs about the influence of the width of the ring and the number of entrance lanes for the roundabouts, with a breakdown by roundabout size, as well as the influence of the entrance sign and crossing sign (and their evolution), for roundabouts and roundabouts with traffic lights.

7.3.2 - Impact of the geometry for roundabouts

The criteria of the width of the ring and the number of entrance lanes are only analysed for the roundabouts as the sample relating to the roundabouts is very low.

The graphs below represent the impact of the width of the ring and the number of entrance lanes for the roundabouts classified into three “families” according to size: small roundabouts (R<14m), medium-sized roundabouts (14m<R<22m) and large roundabouts (R> 22m).

7.3.2.a - Width of the ring

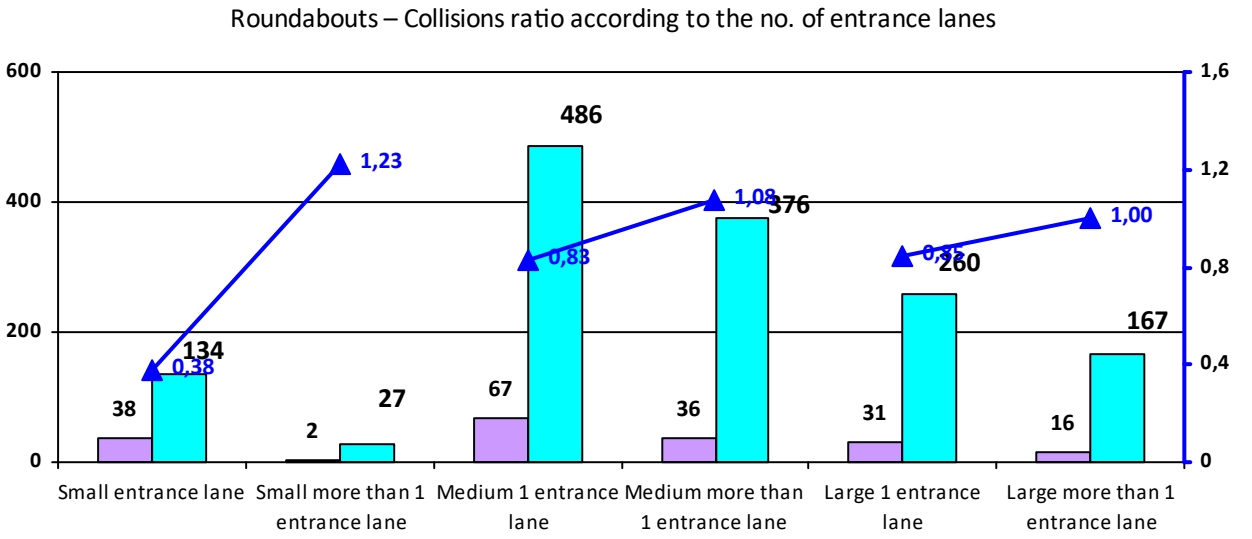


graph 90b

The lowest ratios are observed for the small and big roundabouts whose ring width is below 6 m. However, for the medium-sized roundabouts, the lowest ratio is observed for the roundabouts whose ring width is above 6 m.

We also observed that the small roundabouts have the lowest ratios.

7.3.2.b - Number of entrance lanes



graph 90c

Whatever the size of roundabouts, the lowest ratios are found with roundabouts having a single entrance lane. Beyond the configuration itself, this could be explained in part mainly by the traffic data, as the dimensioning of the number of entrance lanes of the roundabout can be connected to this data.

7.3.2.c - Conclusion

The results shown in the graphs above notably demonstrate that small roundabouts have lower ratios in terms of collisions with third parties. This ratio globally decreases as the width of the ring becomes smaller or the number of entrance lanes reduce. **This seems logical because such a geometry limits the traffic and speed near the platform.**

7.3.3 - Impact of traffic lights for roundabouts

In the following, the concept of "reinforced signalling" means more than 2 signals per crossing.

As the codification of the roundabouts has been fully verified in 2015, we are committed to understanding the impact of the evolutions of the sections for the upstream (entrance) (ES) and crossing (CS) signalling. For this, we have determined the following 10 categories:

Category	No. of sections	ES_earlier	CS_earlier	ES_present	CS_present
cat0	127	unchanged	unchanged	unchanged	unchanged
cat1	26	Nothing or static	R24	Nothing or static	R24 reinforced
cat2	1	Nothing or static	R24 reinforced	R24 reinforced	R11j
cat3	28	R11j	R24	Nothing or static	R24 reinforced
cat4	2	R11j	unchanged	R24	unchanged
cat5	1	unchanged	R11v	unchanged	R24
cat6	1	R11j	R24	R11j	R24 reinforced
cat7	1	R11j	R24	R24	R24 reinforced
cat8	1	Nothing or static	R11j	Nothing or static	R11v
cat9	1	Nothing or static	Nothing or static	Nothing or static	R24
cat10	1	Nothing or static	R11j	Nothing or static	R24 reinforced

Table 09 – Signalling evolution category

This made it possible to observe the roundabouts in greater detail by distinguishing between the sections without any evolution in signalling and those that have had an evolution in signalling.

7.3.3.a - The roundabouts whose signals did not change

The roundabouts concerned are those of category 0: this means that the roundabouts may have undergone a change in codification but without any change in the traffic lights.The other changes often pertain to the visibility conditions (visual mask or visibility of the tram track).

The summary table below shows the overall results for the sections in this category. For each crossing and upstream signal configuration, we recalled the number of active sections at the end of 2018, and the average of the number of collisions by configuration and by year, over an observation period of 11 years.

The boxes in red correspond to configurations for which the samples are the most important.

	Sig. Entrance					
Crossing sign	Nothing or static		R11j		R24	
Nothing or static	3	0,89	8	0,49	3	0,15
R1	1	2,18				
R24 simple	19	0,91	1	0,18		
R24 reinforced	35	0,54			1	
R11v simple	26	0,76	8	0,77		
R11v reinforced	4	1,01				
R11j simple	2	0,27	5	0,69		
R11j reinforced	2	0,73	1			

Table 210_a6

We note the following:
- A variety of configurations making a detailed statistical analysis difficult (e.g. by including the size of the roundabout).
- for the roundabouts without light signalling upstream, the ratio obtained with “R24 reinforced” signalling for crossing sign (0.54 collisions by configuration and by year on average) is lower than the one with R11v simple (0.76 collisions by configuration and by year on average) or the R24 simple for crossing sign (0.91 collisions by configuration and by year on average).

7.3.3.b - The sections whose signalling has changed

The table below presents the following data for the roundabouts of category other than 0 and whose number is statistically significant:

- the number of sections concerned (validity of the sample) that are active at the end of 2018,
- the average of the number of collisions per configuration and per year, before and after the modification of signalling, over an observation period of 11 years.

Categ.	No. of sections	Sig. before(entry + crossing)	Avg. before	Sig. after (entry + crossing)	Avg. after
cat1	26	nothing or static + R24 simple	1.52	nothing or static + R24 reinforced	1.11
cat3	27	R11j + R24 simple	0.70	nothing or static + R24 reinforced	0.90

Table 210_b

We can therefore analyse the categories 1 and 3 that pertain to the roundabouts whose upstream signalling has been changed to have no light signalling, and whose crossing sign has been changed to “R24 reinforced” in place of “R24 simple”.

For category 1, we observe that the ratios obtained with an “R24 reinforced” signalling for crossing sign enables a lowering of the average of the collisions per year, in comparison with the initial average with "simple R24" for crossing sign.

Conversely, for category 3 that only concerns a single tram network, the setting up of reinforced R24 did not lead to the decrease of the average of the collisions per year over the observed period, in comparison to the initial average with “simple R24” for crossing sign. It is recommended to carry out a more detailed analysis of this category to understand the provided results and mainly with respect to those observed in the last year (not taking into account the same observation period). This point will be examined during the update of the report scheduled for the first half of 2020.

7.3.4 - Impact of traffic lights of the roundabouts with traffic lights

The table below shows the overall results for the roundabouts with traffic lights whose signalling has not changed. For each crossing signal configuration, we recalled the number of active sections at the end of 2018, and the average of the number of collisions by configuration and by year, over an observation period of 11 years.

The boxes in red correspond to configurations for which the samples are the most important

Sig. Entrance	Crossing sign	No. of sections	Evt average per year
R11v	Nothing or static	11	0,60
R11v	R24 reinforced	4	0,65
R11v	R11v simple	17	0,61
R11v	R11v reinforced	7	1,51
R11v	R11j	12	0,57

Table 210_c

It appears that in the case of roundabouts with traffic lights, there is no trend that particularly emerges as the samples are small. It seems that having a light signalling for crossing sign does not improve ratios.

We did not carry out an analysis of the sections with a modification in signalling insofar as only two sections were affected with 5 events over the entire period.

It should be noted however that these elements should be treated with caution since they do not take into account the local context and in particular the road traffic data.

7.4 - Turn left/right - Impact of traffic signs type

Events considered in this chapter are collisions with a third party over the 2008-2018 period (11 years) and the active sections at the end of 2018.

As the verification of the codification of the “turn left/right” is completed at the end of 2017, with the active collaboration of the operators, the reliability of the data for this configuration allows us to carry out an analysis of the accidentality.

For this, in order to refine the analyses related to this category for better understanding of the risk associated to the turn left/right manoeuvre, we have taken into account only those collisions for which the third-party (car, van or public transport) in question was reported to be carrying out this operation.

Over an observation period of 11 years, this leads to retaining only 2395 collisions among the 4579 that occurred on this type of intersection; for others, the manoeuvre given is "go straight" or was not filled in.

The table below shows the overall results of the possible configurations in “turn left/right”, grouped into upstream and crossing signalling; for each of them, we have recalled the number of active configurations and the average of the number of collisions per year.

The boxes filled in red correspond to configurations for which the samples appear to be sufficient enough (more than 30 configurations) to be able to make relevant analyses.

	Sig. Crossing									
Sig. Upstream	Nothing or static		R11v		R24		R24_barriers		Other	
Nothing or static	92	0,17	54	0,17	75	0,21	21	0,00	15	0,17
R11v	1142	0,10	42	0,30	75	0,17	17	0,01	7	0,08
R11v_dedicated	37	0,25	8	0,32	4	0,06				

Table 210_a7

Overall, we observe the following items:

- the ratio obtained in configurations without upstream and crossing signalling is quite low (0.17). These configurations are for much configurations with lateral track layout having a street crossing the platform giving access to general residential areas with low traffic.

- the configurations without upstream signalling have a similar ratio with R11v (0.17) or with R24 (0.21) with crossing; they generally correspond to the crossings with low traffic.

- the ratio with the upstream R11v signal is very favourable when there is no crossing signalling (0.10). These configurations correspond to road crossings in which no other vehicle is permitted to pass during the tram phase, which enables obtaining a better ratio.

- we also note that configurations with **upstream R14 signals do not give a very good ratio and confirm the comments of the National technical instruction for road safety on the difficulty for the user to understand it well.**

8 - Conclusions

8.1 - Constant factors

- The events related to the behaviour of third parties are in the majority (collision with third parties and passenger events – falling in the tram).
- The occurrence of severe victims is higher during collisions with third party with respect to passenger events.
- The “roundabout”, “roundabouts with traffic lights” and “turn left/right” configurations present the highest estimated collision risk.

8.2 - Reasons for satisfaction

- The decreasing trend for number of collisions at 10,000 km for all networks.
- The advantageous comparison for the tramway of the number of collisions at 10,000 km with respect to the bus, on a significant sample of 5 networks.
- The low proportion of aggravating factors, including fixed objects and tramway speed, in collisions with third parties.
- The decrease in the number of pedestrian victims of collisions with a third party, trend to be monitored for 2019.

8.3 - Confirmations

- The proportion of the "opposite direction tram" is low in the accidentology: around 4% of collisions. This indicator remains to be monitored in the future even if the trend is stable.
- The proportion of severe passenger victims, related to an emergency braking (all EB together) for all the passenger victims remains low.
- With regard to roundabouts, the following points are confirmed, even if the traffic levels are not known, for the "average number of collisions per year by category" ratio:
  - on the geometry: the ratio is lower for small roundabouts (radius less than 14 m).
  - for the signalling: the ratio obtained for the roundabouts without upstream light signalling , and with no changes in terms of signalling, is lower with a “reinforced R24” crossing sign with respect to signalling with “simple R24”.

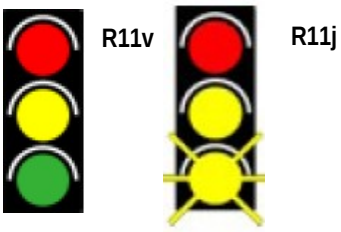
8.4 - Analysis of “turn left/right”

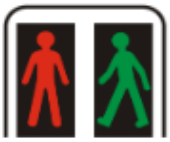
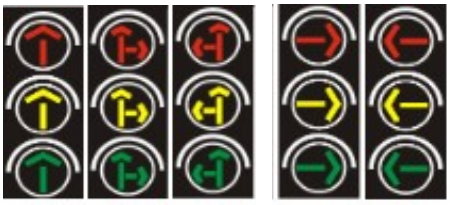
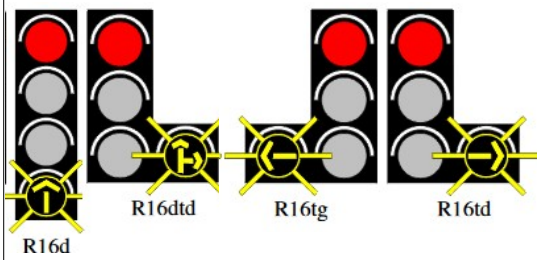
- The road crossings where no vehicle is allowed to pass during the tram phase have the lowest ratio of the “average number of collisions per year by category”. This confirms the effectiveness of "full red" during a tram phase.
- The configurations with upstream R14 signals do not give a very good ratio and confirm the comments of the National technical instruction for road safety.

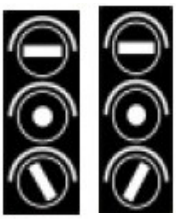
8.5 - Remaining cause of concern

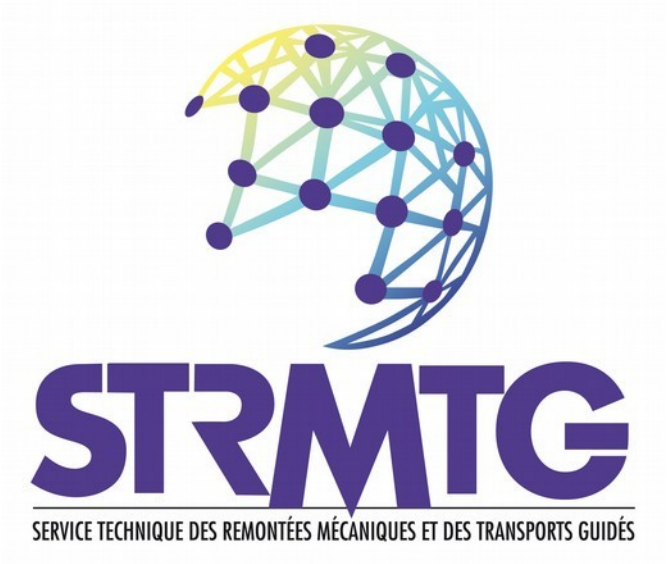
- The most significant proportion of the number of fatalities related to collisions with a third party in 2018, which are all pedestrians, despite a decrease in the number of severe pedestrian and cycle victims in 2018, and representing approx. 10% of the third party victims of collisions.

9 - Appendix – Main road signals

Type of signal	Name of signal	Number NATIONAL TECHNICAL INSTRUCTION FOR ROAD SAFETY	Representation
Priority signs	Give way – Position sign	AB3a	
	Stop sign – Position sign	AB4	
Mandatory signs	Trams only	B27b	
Information signs	Trams crossing (position sign)	C20c	
Warning signs	Trams crossing ahead (advanced sign)	A9	
Intersection traffic light signals	Intersection signals	R11	

Type of signal	Name of signal	Number NATIONAL TECHNICAL INSTRUCTION FOR ROAD SAFETY	Representation
Intersection traffic light signals	Intersection pedestrian signals	R12	
	Three-colour modal signals	R13b	
		R13c	
	Directional signals	R14	
	Anticipation signals with flashing arrows	R16	
	Public transport signals	R17	

Type of signal	Name of signal	Number NATIONAL TECHNICAL INSTRUCTION FOR ROAD SAFETY	Representation
	Public transport directional signals	R18	
Other traffic light signals	Flow control signals	R22	
	Public transport line crossing - pedestrian/cyclist signals	R24	
	Public transport line crossing	R25	



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