



lintu

# **TRAFFIC SAFETY AT PEDESTRIAN ZEBRA CROSSINGS**



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Long-term research and development programme for road safety

LINTU-Reports 7B/2007

This report has been published only as an electronic version

LINTU research programme

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Tel. +358 9 720 64264

ISBN 978-952-201-759-8 (electronic version)

Helsinki 2007

Tekijät (toimielimestä: toimielimen nimi, puheenjohtaja, sihteeri) Eero Pasanen Helsingin kaupunkisuunnitteluvirasto Liikennesuunnitteluosasto		Julkaisun laji Tutkimus	
		Toimeksiantaja LINTU-tutkimusohjelma	
		Toimielimen asettamispäivämäärä	
Julkaisun nimi <b>Suojateiden turvallisuus - Traffic safety at pedestrian zebra crossings</b>			
Tiivistelmä Suomalaiset autoilijat noudattavat suojateiden väistämissääntöjä selvästi huonommin kuin kuljettajat esimerkiksi Englannissa, Saksassa tai Ruotsissa. Englannissa ja Saksassa merkitään suojateitä vain vähäliikenteisille kaduille, mikä epäilemättä vähentää houkutusta sääntörikkomuksiin. Sen sijaan Ruotsissa suojatietiheys on edelleen samaa suuruusluokkaa kuin Suomessa, vaikka 1.5.2000 toteutettuun väistämissääntöön täsmennykseen liittyen noin 15 % suojateistä poistettiin. Ruotsissa autoilijoiden suojatiekäyttäytyminen koheni tällä vuosituhannella merkittävästi ja jalankulkijoiden odotusajat lyhenivät ratkaisevasti. Siitä huolimatta tai ehkä juuri siksi jalankulkijoiden suojatieonnettomuudet lisääntyivät. Voidaan epäillä että Ruotsin nykytila, jossa puolet autoilijoista noudattaa väistämissääntöä, on liikenneturvallisuuden kannalta huonoin mahdollinen. Suojatie saattaa Ruotsissa luoda väärää turvallisuuden tunnetta. Suomalainen jalankulkija tietää, ettei sääntöihin ole luottamista. Ruotsissa on nyt entistä kovempi pyrkimys hillitä autojen nopeudet enintään 30 kilometriin tunnissa jalankulkijoiden kadunylityspaikoissa. Ajoradasta korotettu, ilman suojatieraitoja oleva ylityspaikka (gångpassage) yleistyy nopeasti. Ainakin Helsingissä on selvästi turvallisempaa ylittää katu suojatiellä kuin muualla. Ruotsissa saadut päinvastaiset tulokset ovat vähintäänkin hämmäntäviä. Suojatiekäyttäytymisen tarkkailu Helsingissä ja Kemissä vahvisti aikaisempia käsityksiä. Väistämissääntöä noudatetaan sitä huonommin mitä suuremmasta kaupungista tai liikennemäärästä on kyse ja mitä kovempi on suojatietä lähestyvän auton vauhti. Suomessa tuskin voidaan saavuttaa tuntuvasti Ruotsia parempaa autoilijoiden suojatiekäyttäytymistä ilman todella tehokasta, lainsäädännön muutoksia edellyttävää kameravalvontaa. Väistämissääntöön laiminlyöntiä ei pidä hyväksyä, mutta toistaiseksi on alistuttava siihen, että jalankulkijan on viime kädessä itse varmistettava kadunylityksen turvallisuus. Emme voi opettaa lapsille, että tällä kadulla autot pysähtyvät 70:n ja jollain toisella kadulla 20 prosentin todennäköisyydellä. Suomessa ei ole syytä luopua tiheään merkityistä suojateistä. Nykyinen väistämissääntökin on riittävän täsmällinen. Ajonopeuksien hillitseminen on avainasemassa kun halutaan parantaa kadunylityksen turvallisuutta. Ajonopeuksien hillitseminen on yleensäkin kaupunkiliikenteen turvallisuustyön tärkein tavoite. Ellei tätä voida (haluta) saada aikaan valvontaa rationalisoimalla tai varustamalla ajoneuvot älykkäillä, mataliin rajoituksiin reagoivilla nopeudenrajoittimilla, on lisättävä tuntuvasti töyssyjen, korotettujen suojateiden ja vastaavien hidasterakenteiden käyttöä.			
Avainsanat (asiasanat) liikenneturvallisuus, suojatie			
Muut tiedot			
Sarjan nimi ja numero LINTU-julkaisuja 7B/2007		ISBN ISBN 978-952-201-759-8 (verkkojulkaisu)	
Kokonaissivumäärä 46	Kieli englanti	Hinta	Luottamuksellisuus julkinen
Jakaja LINTU-tutkimusohjelma		Kustantaja Liikenne- ja viestintäministeriö	

Författare (uppgifter om organet: organets namn, ordförande, sekreterare)		Typ av publikation	
Eero Pasanen Helsingin kaupunkisuunnitteluvirasto Liikennesuunnitteluosasto		Forskning	
		Uppdragsgivare	
		LINTU-forskningsprogram	
		Datum för tillsättandet av organet	
Publikation (även den finska titeln)			
<b>Trafiksäkerhet vid övergångsställen - Suojateiden turvallisuus</b>			
Referat			
<p>Finska bilförare bryter mot väjningsplikten vid övergångsställen oftare än t.ex. brittiska, tyska eller svenska förare. I England och Tyskland målas övergångsställen endast på lågtrafikerade gator utan trafikljus. Detta minskar otvivelaktigt frestelsen att bryta mot reglerna. Det är lättare att tåla en störning som kommer sällan än en som kommer ofta. Men frekvensen markerade övergångsställen i Sverige är ungefär lika hög som i Finland.</p> <p>Svenska förares väjningsbeteende vid övergångsställen har förbättrats märkbart, och fotgängares väntetider minskat radikalt, under detta sekel - av många orsaker. Trots, eller kanske på grund av, detta har antalet fotgängarolyckor vid övergångsställena ökat. Man kan misstänka att nuvarande situation i Sverige, när hälften av bilisterna följer väjningsreglerna, är den sämsta möjliga i trafiksäkerhetskänseende. I Sverige kan ett övergångsställe skapa en slags säkerhetskänsla. Finska fotgängare vet att de inte kan lita på sina rättigheter. I Helsingfors är det klart säkrare att korsa gatan vid ett övergångsställe än på annan plats. De motsatta resultaten i Sverige är verkligen förvirrande. I Finland verkar vi inte ha någon orsak att avskaffa de täta markerade övergångsställena.</p> <p>Ju större staden eller trafikflödet är och ju högre hastighet annalkande bilar har, dess sämre åtlids väjningsplikten vid övergångsställen. Brott mot reglerna kan inte accepteras, men än så länge måste vi finna oss i att fotgängarna själva måste svara för sin säkerhet när de korsar en gata. Vi kan inte ge barnen rådet att lita på sin rätt, med en 65% sannolikhet här och en 15% sannolikhet där. Sårbara trafikanter är tvungna att akta sig och väja.</p> <p>I Sverige betonar man nu vikten av att minska hastigheten vid övergångsställena till 30 km/h. Antalet plan-skilda övergångar ökar snabbt. Också i Finland borde åtgärder för att minska hastigheten vara centrala i strävan att förbättra fotgängarnas säkerhet.</p>			
Nyckelord			
trafiksäkerhet, övergångsställe			
Övriga uppgifter			
Seriens namn och nummer		ISBN	
LINTU utredningar 7B/2007		ISBN 978-952-201-759-8 (nätpublikation)	
Sidoantal	Språk	Pris	Sekretessgrad
46	engelska		Offentlig
Distribution		Förlag	
LINTU-forskningsprogram		Kommunikationsministeriet	

Authors (from body; name, chairman and secretary of the body) Eero Pasanen Helsinki City Planning Department Traffic Planning Division		Type of publication Research	
		Assigned by LINTU Research Programme	
		Date when body appointed	
Name of the publication <b>Traffic safety at pedestrian zebra crossings</b>			
Abstract <p>Finnish drivers violate the right of way rules at pedestrian zebra crossings more often than drivers, for example, in the United Kingdom, Germany or Sweden. In the UK and Germany, zebra stripes are painted only on non-signalised streets with low traffic volumes. Undoubtedly, this reduces the temptation to violate the rules. However, the density of zebra crossings in Sweden is on about the same high level as in Finland, even though 15 % of zebra crossings were removed in connection to the adjustment of right of way rules in May 2000.</p> <p>During this millennium, the right of way behaviour of Swedish drivers has been remarkably improved and pedestrian waiting times have been radically reduced at zebra crossings. In spite of this or maybe even because of this, the number of pedestrian accidents at zebra crossings has increased.</p> <p>It can be suspected that the present Swedish situation, where half of the drivers follow the right of way rules, is the worst possible scenario from the point of view of traffic safety. Zebra stripes may create a false feeling of safety. Finnish pedestrians know that they can not rely on their rights.</p> <p>Today in Sweden, the importance of reducing speeds to 30 km/h at pedestrian crossings is highlighted. The number of elevated crossings is increasing rapidly.</p> <p>In Helsinki, it is clearly safer to cross a street at a zebra crossing than elsewhere. The reverse Swedish results are quite confusing.</p> <p>Video observations at pedestrian zebra crossings in Helsinki (540,000 inhabitants) and in Kemi (20,000 inhabitants) confirm the earlier findings. The bigger the city and higher the traffic volume or the speed of the approaching car, the worse also the observing of right of way rules.</p> <p>It is hard to believe that Finnish drivers could adopt a better behaviour pattern at zebra crossings than Swedish drivers without effective (municipal) enforcement, at least. Violations must not be accepted but so far we have to submit to the fact that pedestrians themselves should try to ensure their safety when crossing a street. It is not possible to teach children to rely on their rights on one street with a 65 per cent and on another street with a 15 per cent confidence.</p> <p>There is no reason to dump the high density of zebra crossings in Finland. Speed reducing measures are in key position when trying to improve pedestrian safety.</p> <p>In general, speed management is the most important tool for a safer urban traffic. If this is not possible (i.e. wanted) with an effective speed enforcement or with mandatory intelligent speed restricting equipment in vehicles (ISA), the use of physical speed reducing constructions (humps etc.) on central and residential streets must be radically increased.</p>			
Keywords traffic safety, pedestrian zebra crossing			
Miscellaneous			
Serial name and number LINTU Reports 7B/2007		ISBN ISBN 978-952-201-759-8 (electronic version)	
Pages, total 46	Language English	Price	Confidence status Public
Distributed by LINTU Research Programme		Published by Ministry of Transport and Communications	

# Foreword

This study is a part of a long-term research and development programme for road safety (LINTU) financed by the Finnish Ministry of Transport and Communications, Finnish Road Administration and Finnish Vehicle Administration.

Pedestrian accident risks at zebra crossings and elsewhere in Helsinki have been estimated. The results are compared with previous, controversial results from Sweden and Norway. The behaviour of drivers and pedestrians has been observed at zebra crossings in two Finnish cities. Also the present practice with zebra crossings in some European countries is described and a future policy for Finland is suggested.

This study has been made by Eero Pasanen, Helsinki City Planning Department, Traffic Planning Division. This report is available also in Finnish.

In Helsinki 21.12.2007

Juha Valtonen

Senior engineer

Ministry of Transport and Communications

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# 1 Zebra crossings in some countries

## 1.1 Introduction

The density of zebra crossings in the central areas of some European capitals is shown in Appendix 1.

In the city centres of Helsinki, Stockholm, Paris and Brussels there are about 150 zebra crossings per square kilometre. In Amsterdam, the respective number is about 50, in London 6 and in Berlin only one.

This visualises the current practice in these countries. Zebra crossing is a common measure in Finland, Sweden, France and Belgium but a rare facility in Germany and the United Kingdom.

In the United Kingdom – with one of the safest traffic systems in the world – pedestrian safety is not on a good level (Figure 1). However, a comparison of national accident statistics includes many factors of uncertainty. For example, the walking mileage per inhabitant is not known well enough, and the number of pedestrian fatalities depends strongly on the driving speeds. In any case, it is obvious that the big differences between the densities of zebra crossings reflect upon the behaviour of drivers at zebra crossings. It is easier to tolerate a rare than a frequently repeated annoyance.

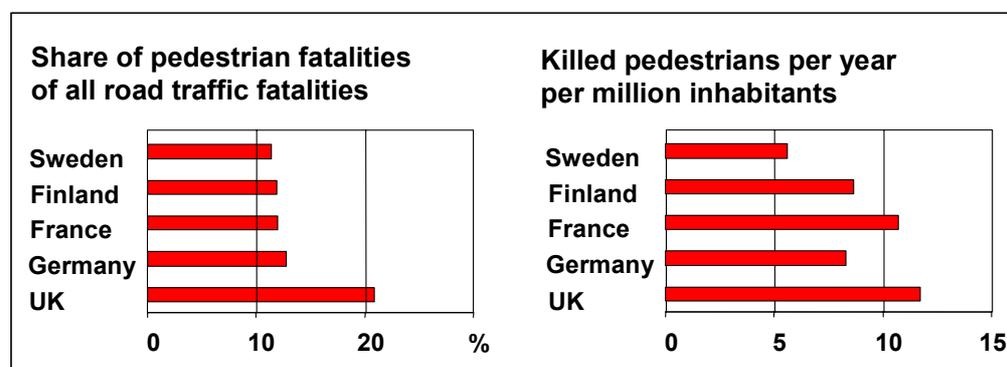


Figure 1: Pedestrian fatalities in some countries.

## 1.2 Finland

Until the end of the sixties, drivers were obligated to give right of way for pedestrians at every imagined continuation of a footpath over a street, even if it was not marked with a sign or with zebra stripes. Zebra stripes were in use but not as common as today.

In 1969, the traffic act ordered (with a change-over period of some years) that a crosswalk (suojatie) must be marked with a sign or/and with white stripes. At present, a crosswalk in Helsinki is always marked with white stripes.

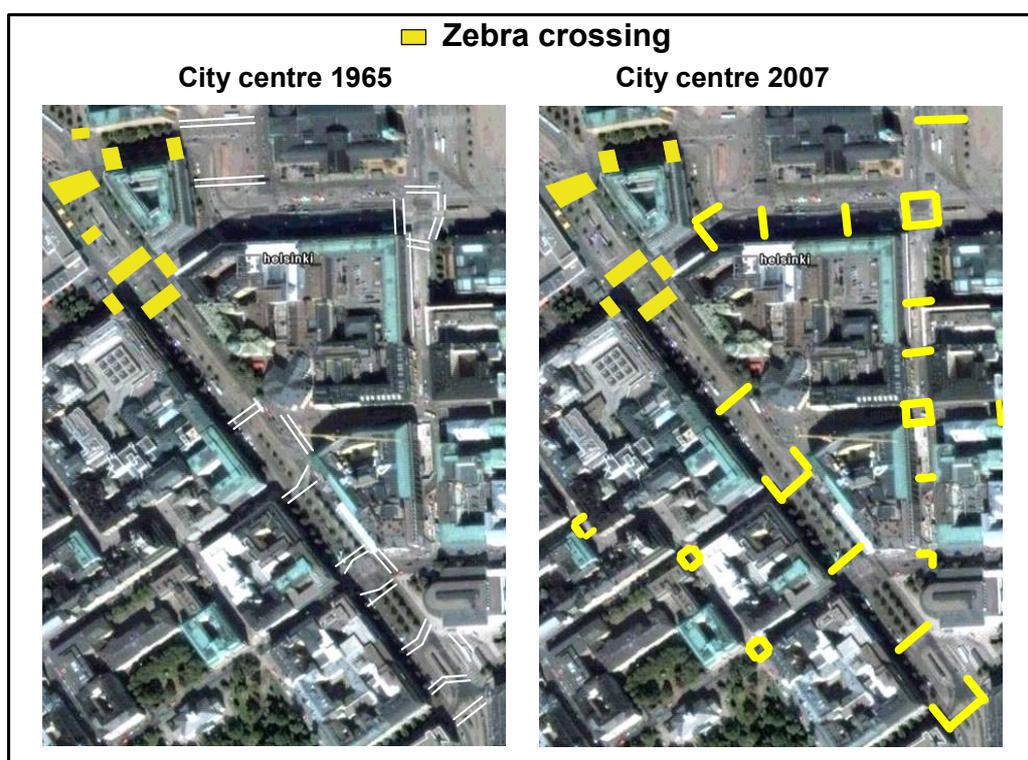


Figure 2: Zebra crossings in the city centre in 1965 and 2007.

Today, there is a zebra crossing at almost every street corner in downtown Helsinki. Also in suburban areas most junctions of main streets and arterial streets are equipped with zebra stripes. All signalised junctions with pedestrian traffic are equipped with zebra stripes (Appendix 2).

In 1969, 59 pedestrians were killed in traffic accidents in Helsinki. Nowadays, the number of fatal pedestrian accidents is only a few per year in spite of the rapid growth of car traffic.

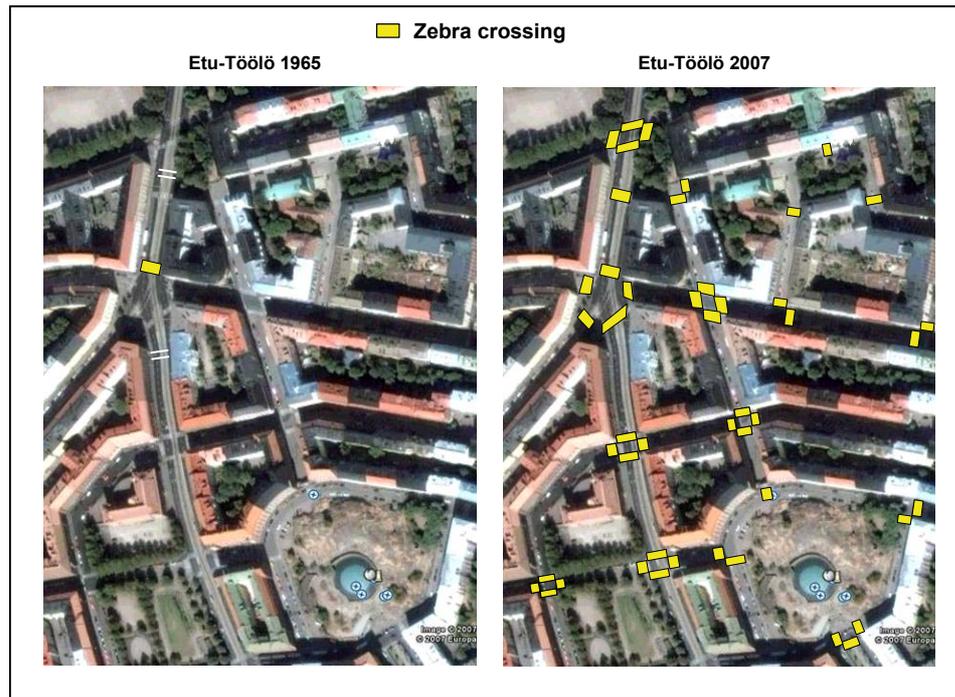


Figure 3: Zebra crossings in a downtown residential area in 1965 and 2007.

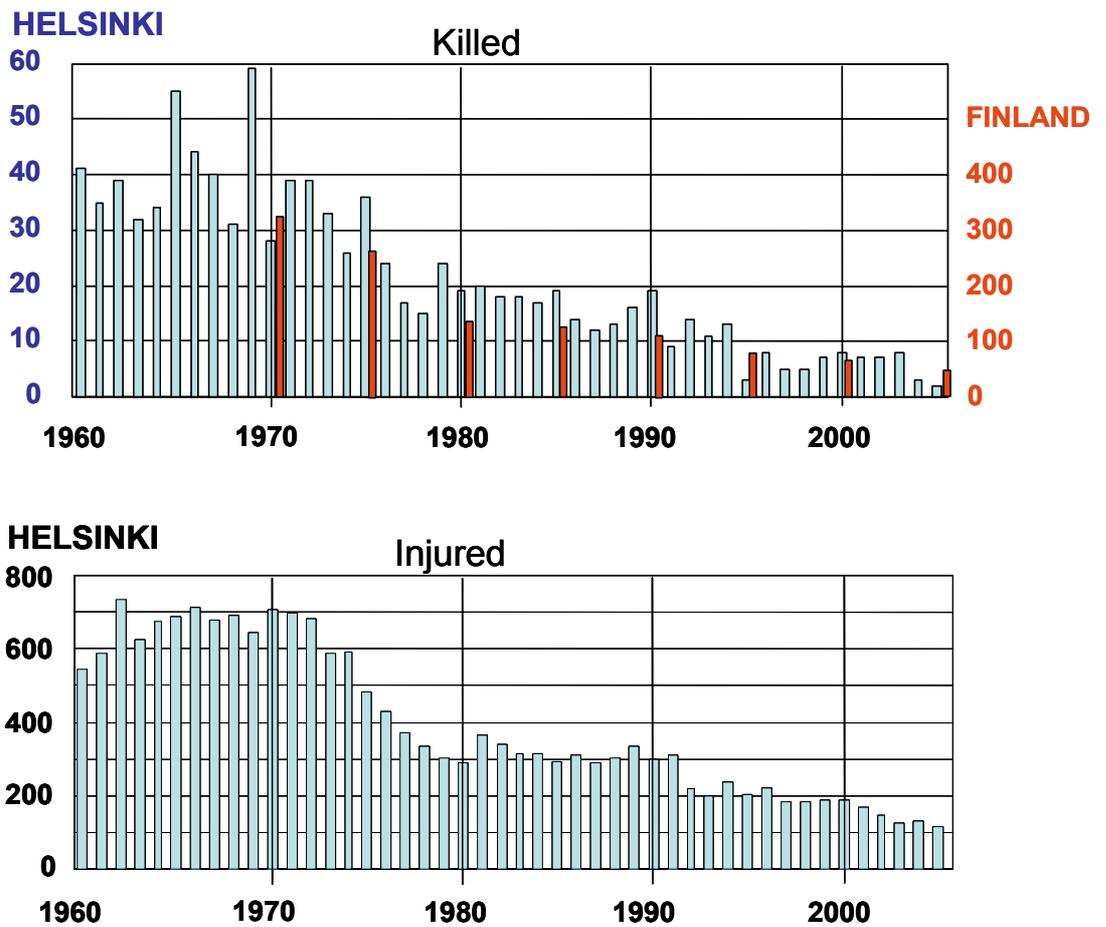


Figure 4: Killed and injured pedestrians in Helsinki in the years 1960-2005.

The radical improvement of pedestrian safety in Helsinki is obviously not caused by painting zebra stripes. We do not even know if zebra stripes have either increased or decreased traffic safety.

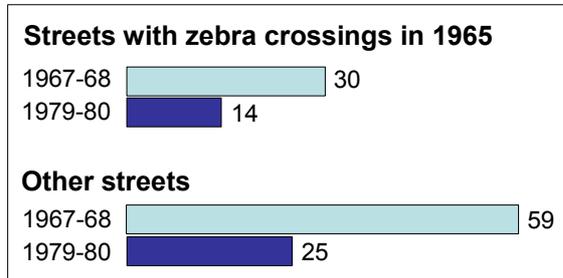


Figure 5: Pedestrian accidents in the city centre in 1967-68 and 1979-80.

More important large scale factors have probably been the introduction of speed limits on highways in 1973 with its reflections on urban streets, the introduction of 40 and 30 km/h speed limits in downtown Helsinki in 1992 and 2004 /10/ and improvements in first aid and other medical activities.

In any case, the differences between European countries arouse some thoughts. Especially the mid-block zebra crossings on busy signalised main streets in Helsinki and in Finland undoubtedly feed nonchalance against traffic rules. Why should I bother to stop for a pedestrian while nobody else stops? If I stop, an overtaking car can hit the pedestrian or the next car behind me collides with my vehicle. In addition, cars drive daily through several signalised crossings, where the white stripes usually do not obligate to do anything. On the other hand, frequent zebra stripes give at least a certain visual message.

## 1.3 Sweden

During the latest years, Finns visiting Sweden have noticed the politeness of Swedish drivers in comparison to Finnish drivers. A respective improvement in Finnish traffic culture is demanded.

A zebra crossing is called in Swedish "Övergångsställe" (a place to cross). The Finnish expression is "Suojatie" (security path), but the right of way rules are of the same kind.

In the late eighties, a Swedish comparison of accident risks at different kinds of crossing facilities showed that a non-signalised zebra crossing is the most dangerous place for a pedestrian to cross a street /2/.

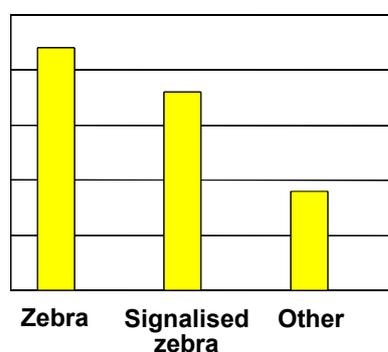


Figure 6: Risks at different types of pedestrian crossings in Sweden /2/.

This result caused a massive public debate. In May 2000, the Swedish right of way rules at zebra crossings were adjusted to underline the driver's responsibilities to yield. In addition, enforcement was increased and about 15 % of zebra crossings were removed /4/.

The share of drivers giving right of way for pedestrians leaped from 20 to 50 per cent. The waiting times of pedestrians were reduced to one third /5/. However, the number of pedestrian accidents at zebra crossings was increased by 15 per cent and the number of rear end injury collisions by 70 per cent /6/.

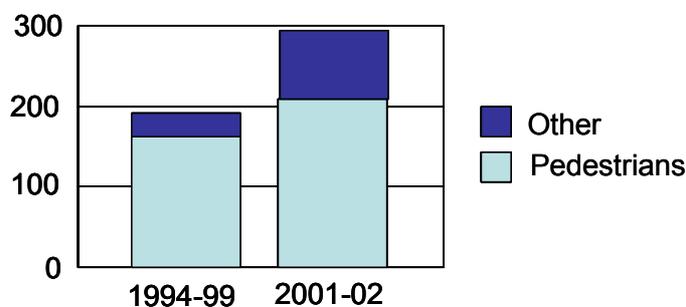


Figure 7: Injured and killed per year in zebra crossing accidents in Sweden before and after the legal reform.

Based on Swedish experiences, one could think that a right of way rule, which still only 50 % of drivers follow, is more dangerous than a rule which

almost nobody follows. Finnish pedestrians know that most drivers violate the right of way rule. It may be that Swedish pedestrians began to trust too much in their rights.

Today in Sweden, the importance of reducing speeds to 30 km/h at pedestrian crossings is highlighted.

The hypothesis is that low driving speeds improve the cooperation (eye contact) between drivers and pedestrians. It is also well known that the reduction of driving speeds strongly reduces the severity of accidents.

The number of elevated crossings has increased considerably.

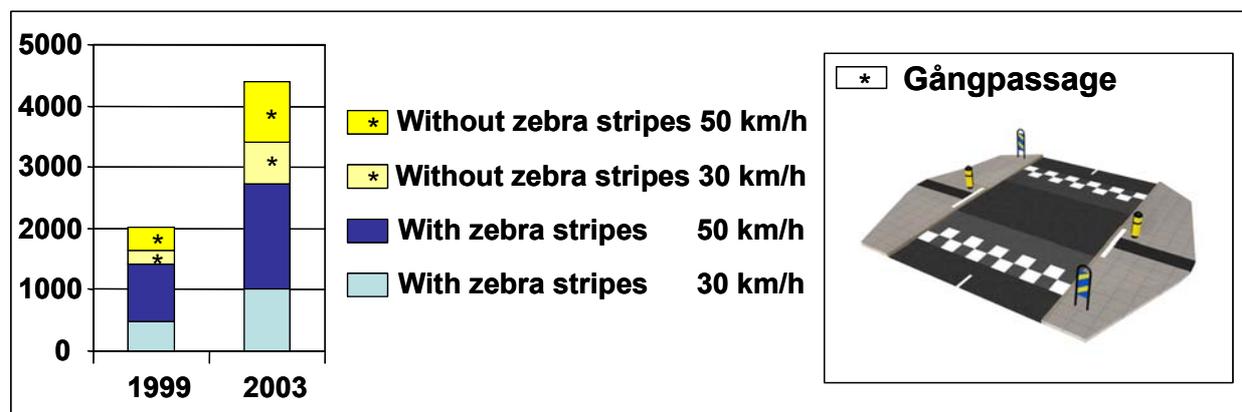


Figure 8: Number of elevated crossings in Sweden in 1999 and 2003.

The new Swedish zebra legislation (1 May 2000) does not differ too much from the Finnish legislation. It orders drivers to give a right of way (väjningsplikt) for pedestrians at a zebra crossing and for pedestrians just about to step on a zebra crossing. The Finnish rule orders drivers to give a free passage (estreetön kulku) for pedestrians. Therefore it is hard to imagine that a corresponding measure in Finland could arise as massive actions and behavioural changes as it did in Sweden.

## 1.4 Germany

In Germany, there used to be zebra crossings (Fußgängerüberweg) at most street corners until someone noticed that pedestrian accidents tend to concentrate on them. For all we know, the number of accidents was not compared to the number of crossing incidents, as was later done in Sweden.

The removal of zebra crossings started in 1955 and continued to the eighties. The present German instructions /7/ do not allow zebra crossings:

- on streets with more than one lane per direction
- if the speed limit is over 50 km/h
- at or close to signalised junctions
- on streets with green waves
- on streets with right of way
- if the traffic volume per peak hour is over 500 vehicles per direction
- if the number of crossing pedestrians is less than 50 or more than 150 per peak hour.

These instructions would forbid most zebra crossings in Helsinki.

In Germany, signalised crossings are equipped with white broken lines (Fußgängerfurt). They do not give any rights for pedestrians and they are not used outside signalised crossings.



*Figure 9: A signalised pedestrian crossing in Germany.*

One could be suspicious of the motives behind the removal of zebra crossings during the years of strong motorisation. It has been even claimed that the operation was the biggest mistake in the history of German traffic planning /8/.

In the nineties, the Federal State of Nordrhein-Westfalen began to increase the number of zebra crossings, after the local state ministry advised to re-evaluate the old sceptical attitude. /9/.

## 1.5 The United Kingdom

Zebra crossings are located only on streets with low traffic volumes (less than 500 vehicles per peak hour in both directions) and never at signalised crossings.

Zebra crossings are equipped with black-and-white poles topped by flashing orange globes. The zig-zag lines before the crossing forbid parking and also overtaking a moving vehicle nearest the crossing or a vehicle which has stopped to give way to pedestrians.

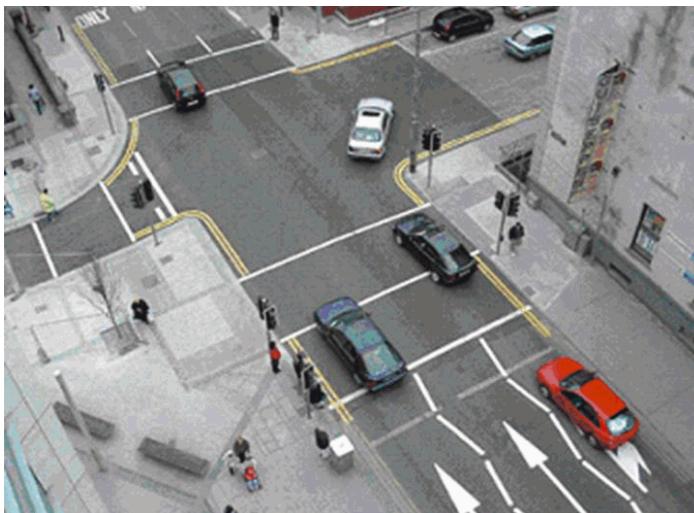


*Figure 10: A British zebra crossing.*

Drivers must give way when someone has moved onto the crossing.

Pedestrians are advised to stop before entering a zebra crossing and to make sure that all traffic has stopped before they use the crossing.

At signalised junctions, the white lines do not give pedestrians any rights. If there are no specific signals for pedestrians, they have to wait for a safe gap in the flow of traffic to cross the street.



*Figure 11: A signalised junction.*

## 1.6 The Netherlands

In the Netherlands, there is no common policy with zebra crossings.



*Figure 12: Zebra crossings and a canalised crossing at a same junction in Eindhoven.*

In the City of Eindhoven, new zebra crossings have not been painted since mid nineties. They are considered to give pedestrians a false feeling of safety. Canalised pedestrian crossings – which do not give any specific rights for pedestrians – are preferred.

Common guidelines for marking pedestrian crossings are under way in Eindhoven /10/.

## 2 Accident risks at pedestrian crossings

### 2.1 Sweden and Norway

Swedish research shows that a zebra crossing is the most dangerous place to cross a street for pedestrians. The Norwegian results were controversial with this finding /3/.

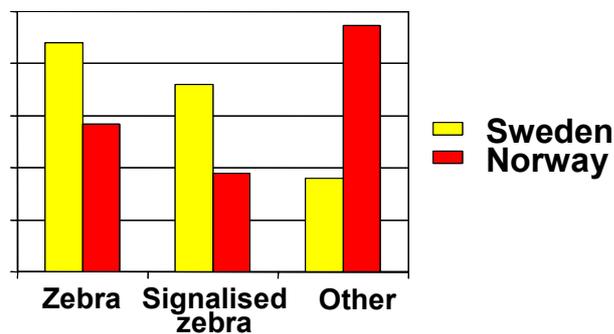


Figure 13: Accident risks at different crossing facilities in Sweden and Norway.

The Swedish explanation was that their sample was larger and that Norwegian drivers probably obey the rules better. Especially the latter sounds odd now that we know that improvements in the right of way behaviour of Swedish drivers has led to an increased number of pedestrian accidents at zebra crossings.

A common belief among Finnish traffic engineers is that the situation in Finland is close to the Norwegian results but there has not been too much research behind this opinion.

### 2.2 Traffic accidents of street crossing pedestrians in Helsinki

In Helsinki, 75 % of pedestrian accidents take place when a pedestrian is crossing a street. Of these accidents, 35 % take place outside zebra crossings. This share is rather independent of the district (part of town).

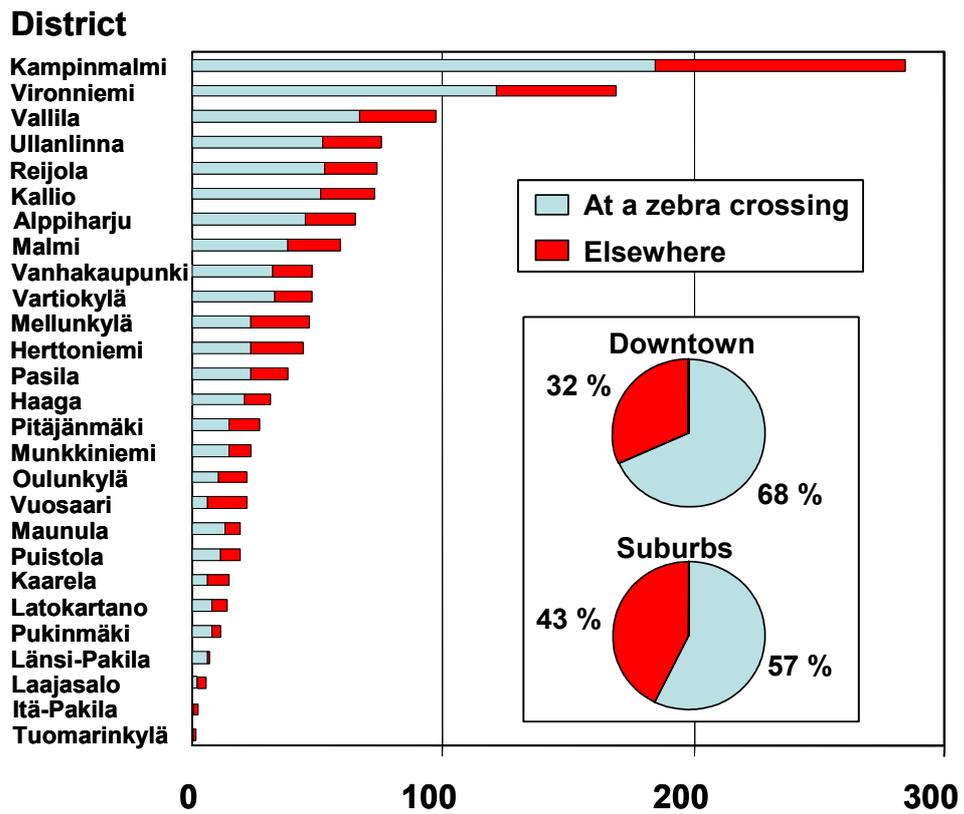


Figure 14: Accidents of street crossing pedestrians in different districts of Helsinki in 1996-2005.

The share of accidents of pedestrians who have crossed a street outside zebra crossings is higher at night than during daytime but the variation is not too dramatic.

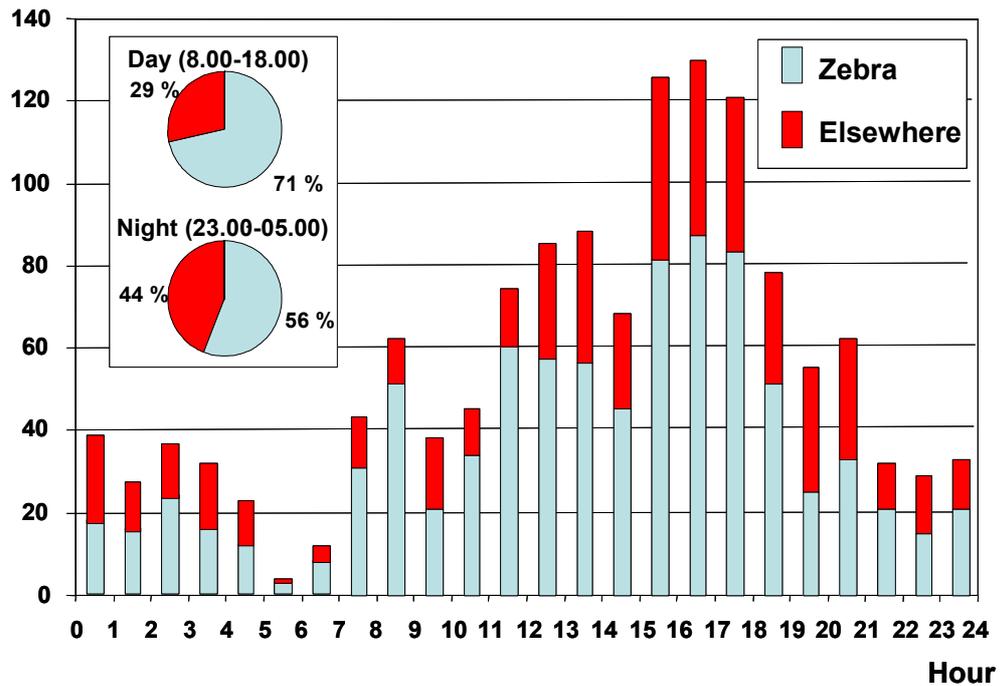


Figure 15: The hourly variation of accidents of street crossing pedestrians in Helsinki in 1996-2005.

It is difficult to estimate the share of pedestrian crossing incidents at and outside signalised crossings. Figure 16 shows the accident distributions if signalised crossings are excluded.

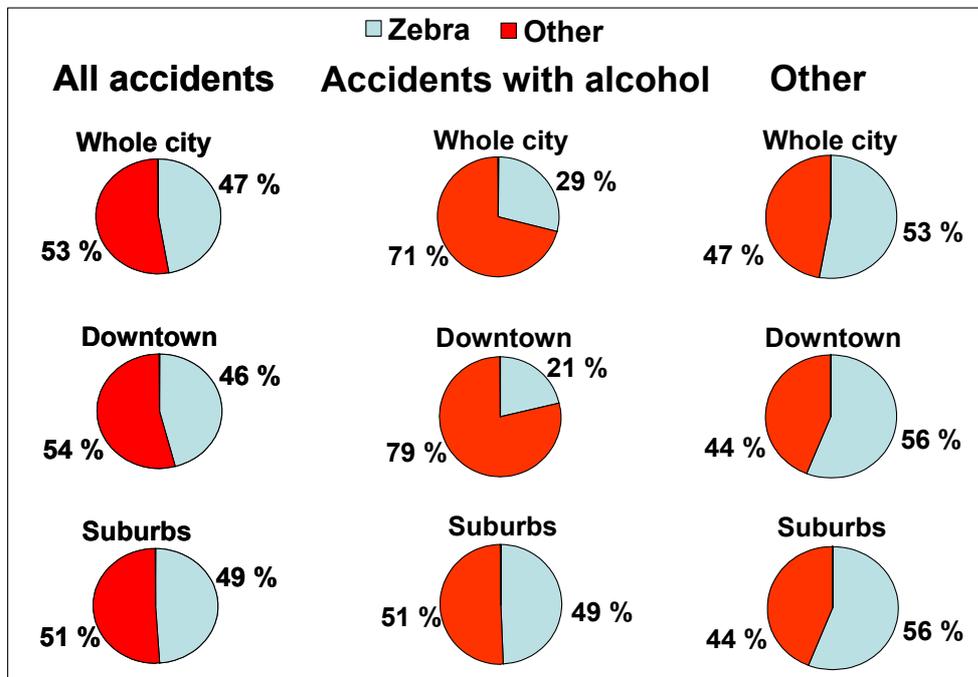


Figure 16: Pedestrian crossing accidents outside signalised crossings.

In alcohol-related accidents, the share of accidents outside zebra crossings is very high in the downtown area. In any case, it can be roughly said that outside signalised crossings slightly over half of accidents of sober street crossing pedestrians take place at zebra crossings.

We do not know the share of pedestrian crossing incidents outside zebra crossings in Helsinki. The next chapter gives some estimates made by different methods.

## 2.3 Pedestrian crossing incidents in Helsinki

### 2.3.1 Aerial calculations

A data set of aerial laser photos with a ground resolution of 5 cm covers all of Helsinki. However, the calculations had to be limited to totally sunny street surfaces where the shadows of pedestrians confirm the identification. In addition, streets without footpaths had to be excluded, because it was impossible to know if the pedestrian was walking along or across the street.

Because of this and the timing of the flights (Sunday), the sample stayed regrettably small (N=49).



Figure 17: Distribution of pedestrian crossing events in suburbs.

Downtown Helsinki was filmed from a helicopter with a high resolution HD video camera. Because of technical problems and strong wind, a complete aerial cover was not reached.

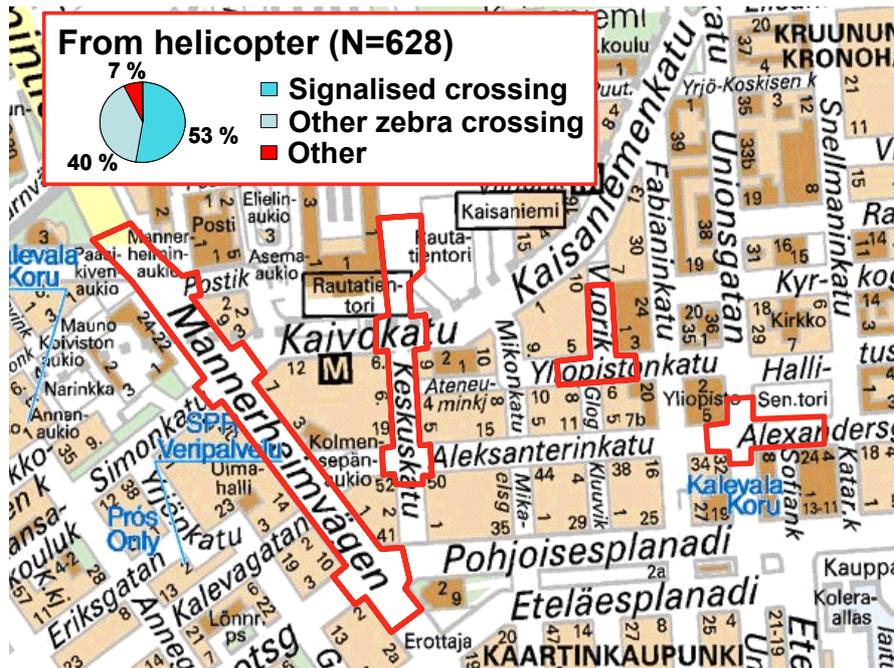


Figure 18: Pedestrian crossing events on streets in the city centre.

### 2.3.2 Ground observations

To count pedestrian crossing incidents at individual streets does not produce any average results. There is no such concept as an average street. The aim of the calculations reported in Figure 19 was to get a view of the variation at different surroundings.

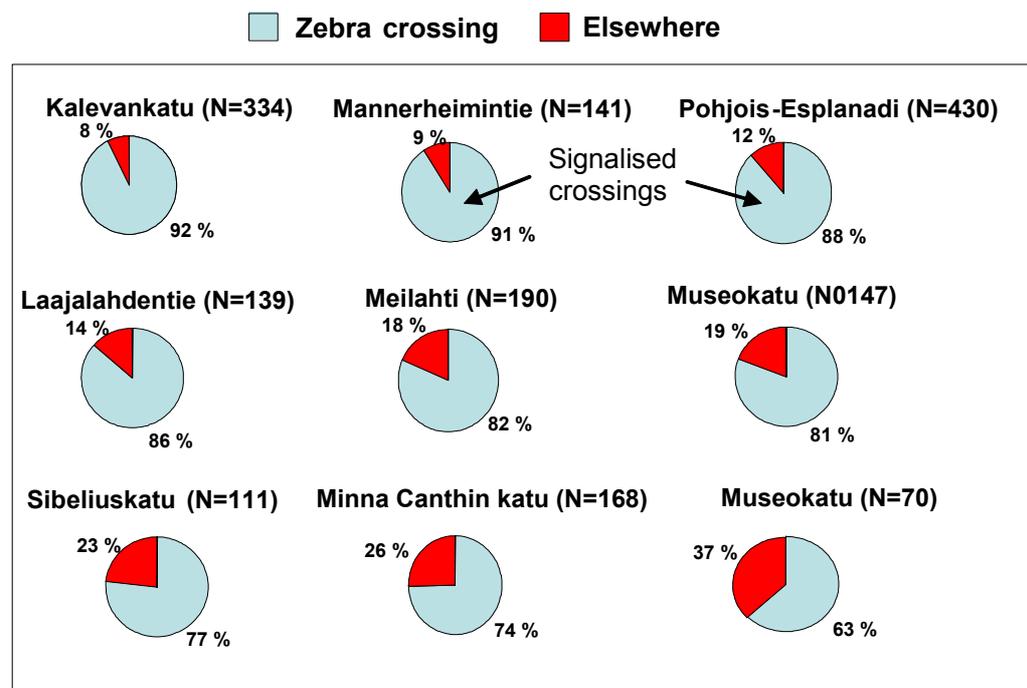


Figure 19: Distribution of pedestrian crossing incidents on individual streets in downtown Helsinki.

## 2.4 Accident risks in Helsinki

Outside signalised crossings, about 55 % of pedestrian accidents in Helsinki take place at zebra crossings. The share of pedestrian crossing incidents at zebra crossings varied between 63 and 92 per cent depending of the place and method of counting. If the average share is estimated roughly to 75 per cent, the risk of crossing a street outside zebra crossings is more than double compared to non-signalised zebra crossings.

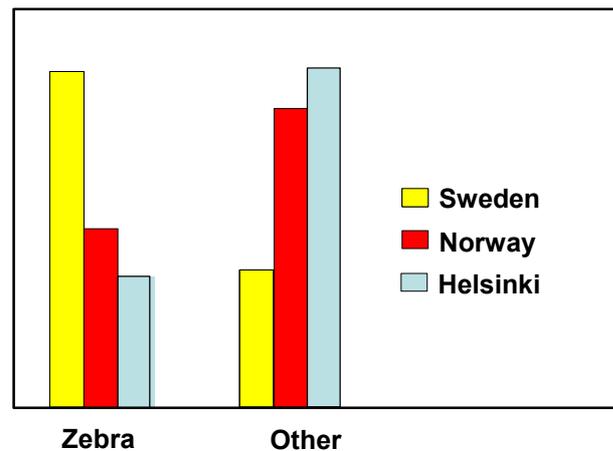


Figure 20: Relative accident risks outside signalised crossings according to calculations in Sweden, Norway and Helsinki.

It is hard to believe that such a big difference really exists between the behaviour of drivers and pedestrians in Nordic countries. There has to be a conflict between the research methods. In any case, it looks that on average in Helsinki it is much safer to cross a street at a zebra crossing than elsewhere

# 3 Right of way behaviour at zebra crossings

## 3.1 Sweden

The proportion of vehicles which stopped for pedestrians increased from 20 to 50 per cent. The proportion has a high degree of co-variation with the number of pedestrians.

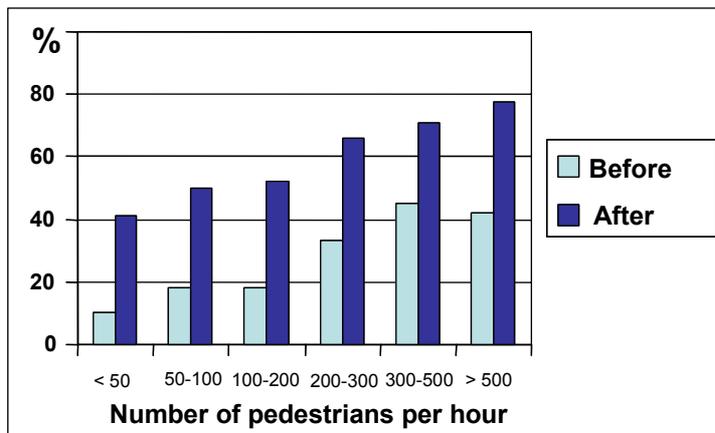
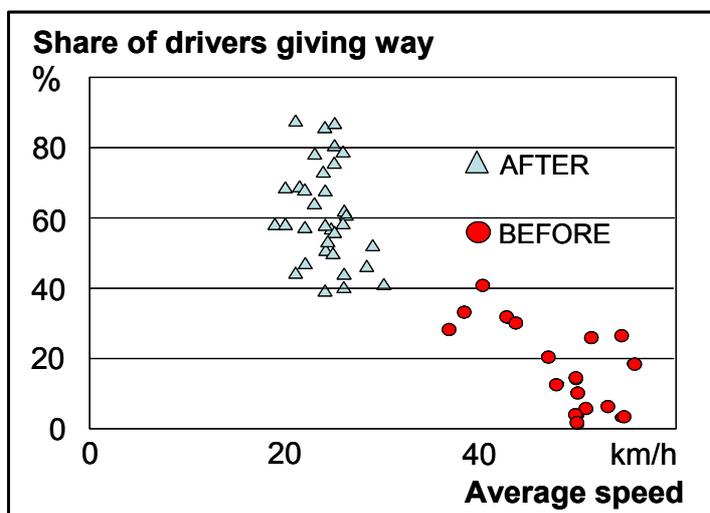


Figure 21: Cars that stopped or adjusted their speed to give way to pedestrians on the crossing (nearest lane) before and after 1 May 2000 /4/.

Before the legal reform in Sweden 1 May 2000, the willingness to give way to pedestrians was studied before and after the construction of speed reducing humps in front of zebra crossings in Stockholm and Örebro. The average  $V^{85}$  speed was reduced from 56 to 30 kilometres per hour. The proportion of drivers giving way increased from 20 to 67 per cent /10/.



## 3.2 Finland

In the late seventies and early eighties, Himanen observed the right of way behaviour at zebra crossings in three Nordic capitals and in two smaller Finnish towns, Lappeenranta (59,000 inhabitants) and Savonlinna (27,000 inhabitants) /1/.

According to Joki /11/ and Arppe /12/ the behaviour of drivers in Helsinki (550,000 inhabitants) and Turku (200,000) inhabitants) was in the beginning of this millennium worse than in Sweden before its legal reform.

<b>Himanen 1981</b>	<b>Car stopped</b>	<b>Pedestrian stopped</b>
<b>Helsinki</b>	6 %	94 %
<b>Stockholm</b>	13 %	87 %
<b>Copenhagen</b>	15 %	85 %
<b>Lappeenranta</b>	29 %	71 %
<b>Savonlinna</b>	61 %	39 %

<b>Matti Joki 2001</b>	<b>Car gave way</b>	<b>Car did not give way</b>
<b>Helsinki</b>	10 %	90 %
<b>Turku</b>	10 %	90 %
<b>Turku</b>	15 %	85 %

<b>Jukka Arppe 2002</b>	<b>Car gave way</b>	<b>Car did not give way</b>
<b>Helsinki</b>	7 %	93 %
<b>Helsinki</b>	12 %	88 %

Figure 23: Right of way behaviour at zebra crossings in some cities.

### 3.2.1 Helsinki

In spring 2007, traffic behaviour at a zebra crossing with a pedestrian refuge on Pasilankatu street was filmed.



Figure 24: Pasilankatu street.

On Pasilankatu street, the traffic volume to the north is about 400 vehicles per hour and about 100 pedestrians cross the street per hour.

In 46 cases the vehicle or the pedestrian had to yield:

- vehicle stopped 1 case
- vehicle slowed down 7 cases
- vehicle did not yield 38 cases

The average speed of those vehicles which did yield was 33 km/h (25 metres before the crossing) and of those which did not yield, 50 km/h.

The longest waiting time at the kerb was 20 seconds and the average waiting time of those who had to wait was 5 seconds.

The digital video footage from Pasilankatu was also analysed with a TrafMon computer programme developed by the Finnish Technical Research Centre (VTT). TrafMon detects and numbers all moving objects and saves their coordinates in a text file 25 times per second. The problem is that the programme gets in trouble with some reflections and with objects too close to each other. This problem is tried to be solved by treating the text files with some logical assumptions but the work is so far uncompleted.

### 3.2.2 Kemi

Kemi is a small town (20,000 inhabitants) in northern Finland. Driving speeds in the city centre are clearly lower and the right of way behaviour of the drivers is much better in comparison to Helsinki.



Figure 25: Pohjoisrantakatu street.

In spring 2007, traffic behaviour at a zebra crossing on Pohjoisrantakatu street was filmed. The traffic volume of the observed direction on Pohjoisrantakatu was about 100 vehicles per hour and the number of pedestrians crossing the street was also about 100 per hour.

In 33 cases the vehicle or the pedestrian had to yield:

- vehicle stopped 5 cases
- vehicle slowed down 16 cases
- vehicle did not yield 12 cases

The average speed (30 metres before the crossing) of those vehicles which did yield was 37 km/h, and of those which did not yield, 44 km/h.

Traffic behaviour was also observed at two zebra crossings on Valtakatu street,

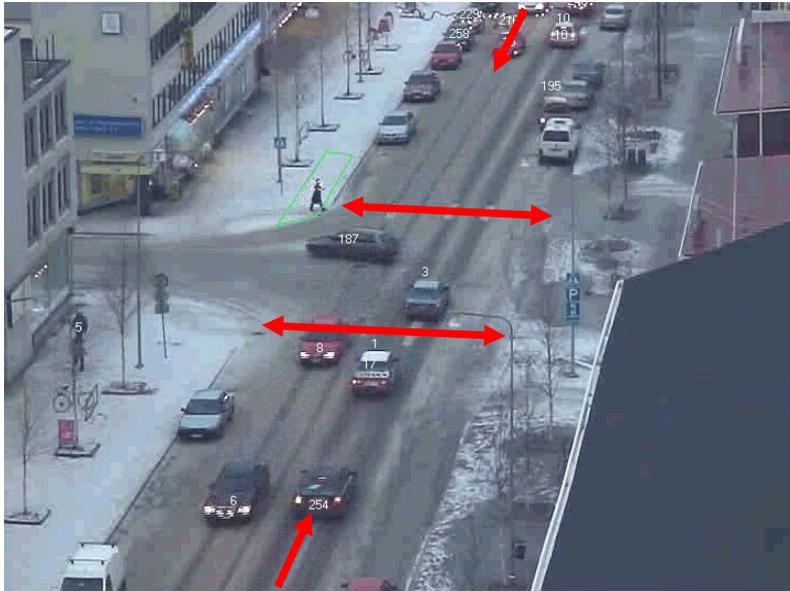


Figure 26: Valtakatu street.

In 40 cases the vehicle or the pedestrian had to yield:

- vehicle stopped 11 cases
- vehicle slowed down 16 cases
- vehicle did not yield 13 cases

The average speed (30 metres before the crossing) of those vehicles which did yield was 27 km/h, and of those which did not yield, 37 km/h.

### 3.3 Conclusions

For several reasons, the measurements in Finland in spring 2007 could not be implemented in the planned scale. In any case, combined with earlier results they showed that drivers' willingness to yield weakens, the bigger the city and higher the traffic volume or the driving speed of the approaching car.

It is quite logical that on busy streets the anxious rhythm and the pressure from the cars behind one's own vehicle affect the behaviour of drivers. It is also clear that the higher the speed, the more unpleasant it is to stop both mentally and physically.

We can not change these facts but the right of way legislation is in force all over the country on all kinds of streets. Should we concentrate on improving the behaviour of drivers — although the Swedish experiences are not too convincing?

It is not possible to teach children in Kemi to rely on their rights with a 65 per cent and in Helsinki with a 15 per cent confidence. It is obvious that we must highlight to pedestrians the importance of watching traffic and taking care of themselves. However, the real challenge for the community is trying to control driving speeds wherever pedestrians and vehicular traffic share the space.

# 4 Driving speeds at zebra crossings

## 4.1 Speed for conditions

”Speed for conditions” is an expression mostly used by opponents of speed limits or speed enforcement. Their idea is that drivers themselves can adjust the speed to the prevailing conditions. This group does not realise that a traffic accident is usually a result of an unexpected sudden event.

The willingness to give way for pedestrians is connected to the driving speed near a zebra crossing and the spot speed at the crossing is obviously connected to the spot speed in previous “free” conditions.

Figure 27 shows spot speeds of individual cars about 60 meters before a zebra crossing and also in front of the crossing. Cars with high ”starting” speeds are shown with red lines and cars with lower starting speeds with black lines. The diagram is based on the material of reference /13/. We can see that a high “starting” speed usually reflects to a high speed also at the critical point for pedestrians.

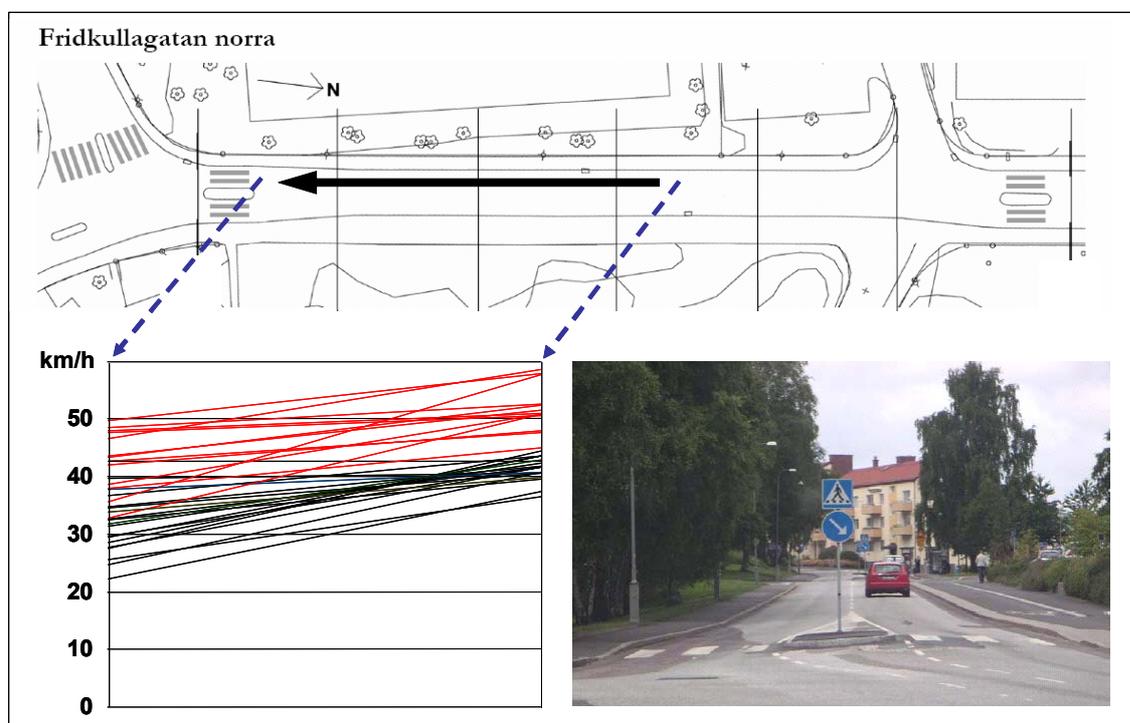


Figure 27a: Driving speeds in "free" circumstances and right in front of a zebra crossing.



Figure 27b: Driving speeds in "free" circumstances and right in front of a zebra crossing.

## 4.2 Speed limits

Low 30 km/h speed limits are common on residential streets all over Europe and they are becoming more common also on the most dangerous business streets.

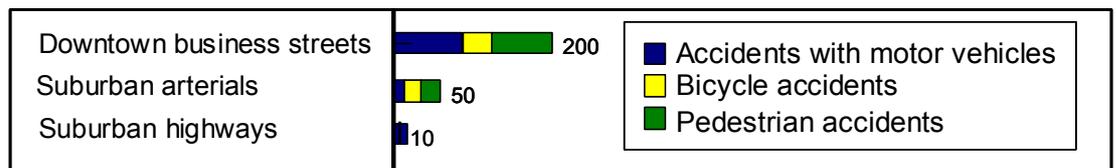


Figure 28: Injury accidents per 100 million vehicle kilometres in Helsinki.

In May 2004, the speed limit was reduced in downtown Helsinki to 30 km/h, also on business streets with traffic volumes up to 30,000 vehicles per day.

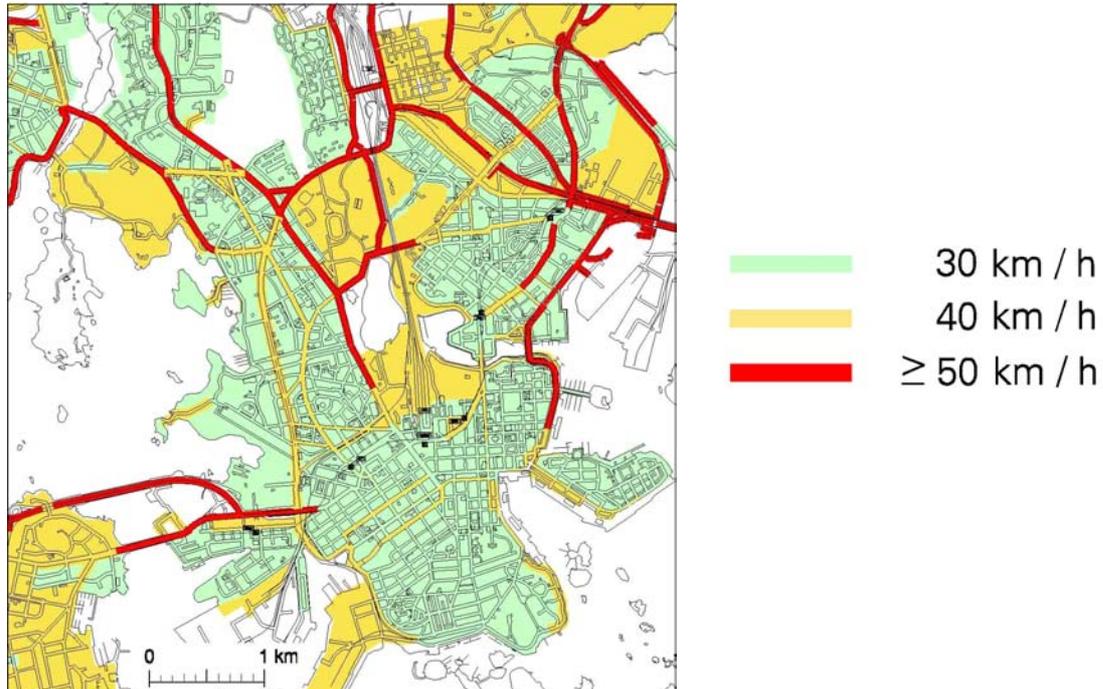


Figure 29: Speed limits in central Helsinki.



Figure 30: Mannerheimintie street

The benefits of the reduction of speed limits in downtown Helsinki were multiple compared to the costs /14/. However, there is still much to do with the compliance with low speed limits. They are not followed even close to elementary schools on schooldays /15/.

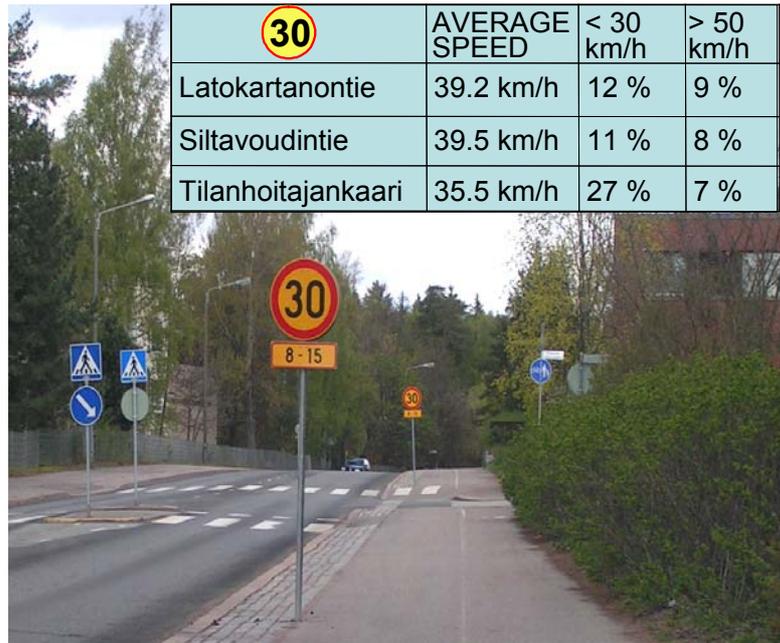


Figure 31: Speed distributions in daytime on three streets, situated close to elementary schools, with flexible speed limits.

For years, the City of Helsinki has done its best for national speed camera legislation, based on owner's responsibility. This would make effective municipal camera enforcement possible. Once again, the subject is under discussion in Finland. If an effective enforcement or more sophisticated restrictive methods like ISA /16/ are delayed too far into the future, the City of Helsinki has to begin to radically increase the use of physical speed reducing measures on streets.

## 4.3 Physical speed reducing measures

### 4.3.1 Suburbs

At present, there are about 1,000 humps or elevated zebra crossings in the City of Helsinki. The Norwegians have built 2,400 humps to a half smaller (population and length of street network) city of Bergen. Most of the humps are situated on residential streets in suburbs.

The citizens in Bergen strongly support the policy with humps and even the local bus company seems to be getting used to the humps. The most common type is a circular hump built of asphalt /17/.

A concrete element with a shape of a cut pyramid treats buses and emergency vehicles with wider axles more gently. A concrete element is rather expensive compared to an asphalt hump but it maintains the exact shape and it can also be equipped with tough reflective warning symbols.



Figure 32: A hump of asphalt in Bergen and the Swedish concrete element (Måsen).

The "Bergen model" in Helsinki suburbs would require a few thousand humps to be constructed on streets with a total length of 210 kilometres.

#### 4.3.2 Downtown

The present humps in Helsinki are mostly located in suburban streets with low traffic volumes. The Swedish City of Gothenburg has introduced elevated pedestrian crossings on a large scale also on more busy downtown streets.



Figure 33: Elevated pedestrian crossings in downtown Gothenburg.

In the late nineties, humps have been the most effective traffic safety measure in Gothenburg. This is partly due to the fact that humps moved traffic from dangerous downtown streets to a safer ring road /18/.

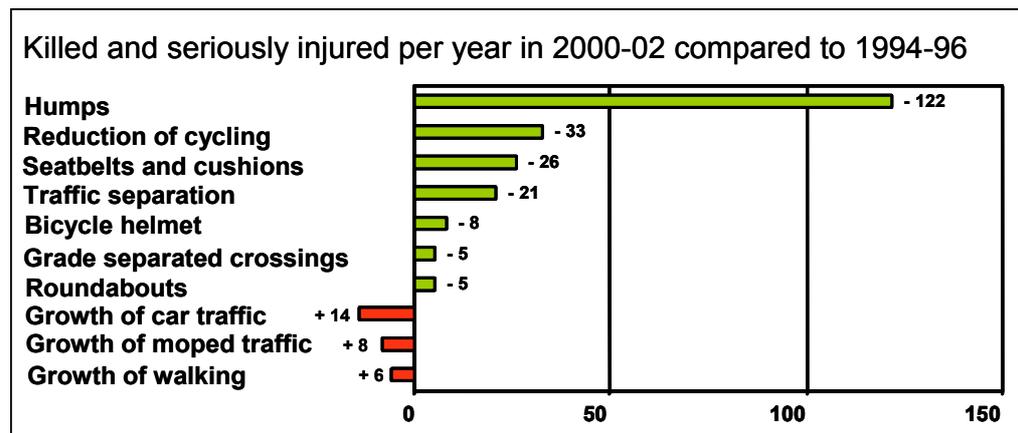


Figure 34: The effect of various factors to traffic safety in Gothenburg from 1994-96 to 2000-02.

The large-scale implementation of the “Gothenburg model” in downtown Helsinki would cost (only) about 3 million euros

#### 4.3.3 Cost-benefits

Figure 35 shows a comparison between the costs of speed reducing measures and more conventional traffic engineering safety measures. The calculation is very rough but it shows the superior cost-effectiveness of humps and other physical speed reducing measures.

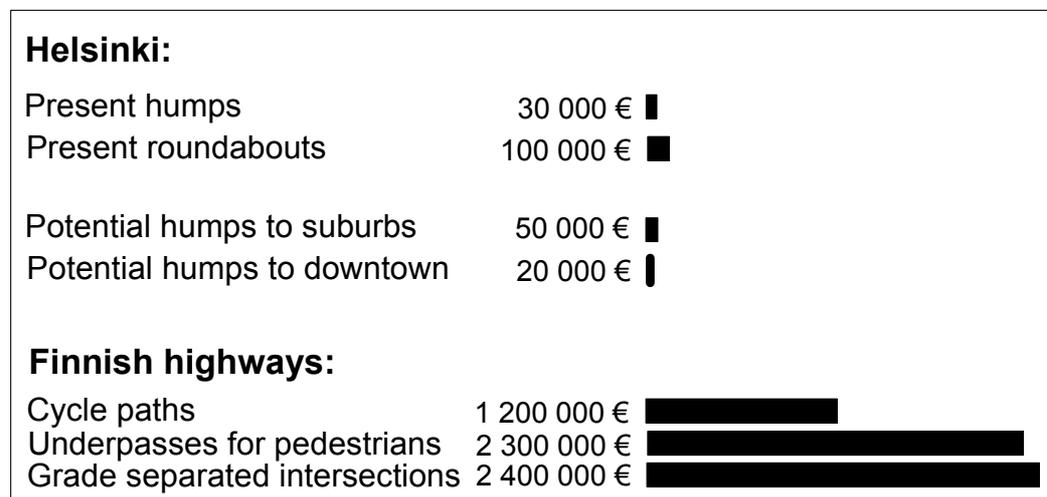


Figure 35: Cost per one prevented injury accident.

## 4.4 Conclusions

The cost-effectiveness of physical speed reducing measures is very high. Traffic safety benefits also exceed the problems caused to winter maintenance or emergency vehicles /19/.

Humps can not be used on streets sensitive to vibration or with a speed limit over 50 km/h. These conditions must be dealt with enforcement. But also on central and residential streets an effective control would, without a doubt, be more pleasant for drivers compared with humps every 50 metres. They should remain at specific locations like schools etc.

## 5 Overtaking at zebra crossings

One of the most dangerous acts in urban traffic is to overtake a vehicle which has stopped in front of a zebra crossing. The Finnish road traffic act clearly forbids this but the rule is violated all the time. To mitigate this, a radically improved enforcement (owner's responsibility) should be introduced.

Another way is to increase safety margins for unexpected events with recessed stop lines. They offer both drivers and pedestrians (especially children) better possibilities to predict the behaviour of each other and to react to the unexpected acts of others.

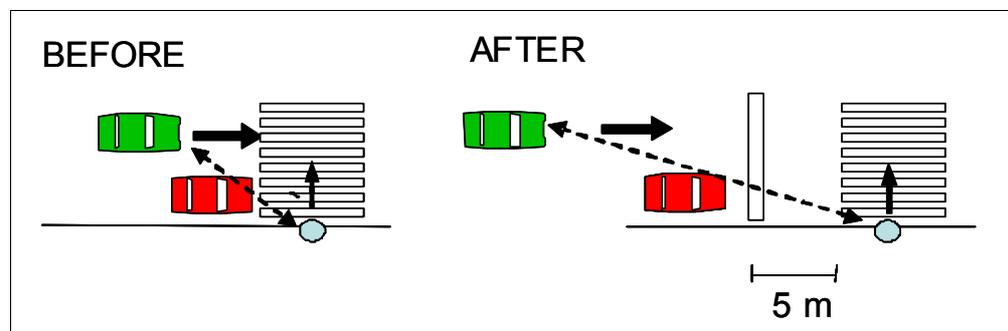


Figure 36: A recessed stop line in front of a zebra crossing.



Figure 37: A recessed stop line at a signalised zebra crossing in Helsinki.

The original idea of a recessed stop line is to give a good visibility to the signals for those drivers who otherwise would have stopped right in front of the pole.

In Finland, signalised crossings are equipped with repeated signals behind the crossing. Helsinki introduced recessed stop lines to increase safety margins in incidents, where a pedestrian is crossing the street against a red light. The video recording of real life pedestrian accidents showed that in every third pedestrian accident at a busy crossing in the city centre there was a left-turning vehicle involved which had stopped. The vehicle “masked” the visibility for the pedestrian and probably also misled the pedestrian to act foolishly.

After the death of a schoolgirl at a signalised zebra crossing (car was driving against red light) in August 2002, almost all signalised crossings in Helsinki have been equipped with recessed stop lines. However, this cheap safety measure can not be used at non-signalised zebra crossings.

Helsinki Traffic Planning Division suggested to the Finnish Ministry of Transport and Communications that the required paragraphs should be added into the Finnish legislation. The Ministry dismissed the proposal by appealing mainly to the international Vienna convention from year 1968

## 6 Conclusions

Swedish research showed that a non-signalised zebra crossing is the most dangerous facility for pedestrians to cross a street. In this millennium, 15 % of zebra stripes have been removed in Sweden.

The original aim of this study was to find out if Finland should once again follow the example of its neighbouring country.

To compare the share of accidents to the share of crossing incidents at zebra crossings and elsewhere is a somewhat doubtful method, when one is trying to find out the effects of zebra stripes. Zebra crossings are usually located at intersections, where other vehicles occupy a part of the perception capacity of drivers. This load does not disappear by removing the zebra stripes.

If a pedestrian is crossing a street outside zebra stripes, he is usually aware of his “outlawry”. This may increase his alertness. On the other hand, he may be drunk or influenced by a sudden impulse more often than an average pedestrian. This would decrease the alertness.

This study showed that in Helsinki it is clearly safer to cross a street at zebra crossings than elsewhere. The Swedish results sound strange. It is hard to believe that traffic behaviour in these two neighbouring countries could differ so much that a zebra crossing is dangerous in Sweden and in Finland a safe facility.

In Helsinki, drivers violate the right of way rules at zebra crossings all the time. There is no reason to compare this bad behaviour to British or German drivers. In these countries zebra stripes are used only at specific locations on streets with low traffic volumes. But also in Sweden, where the density of zebra crossings is on about the same high level as in Finland, drivers obey the rules clearly better than in Finland.

The improved behaviour of Swedish drivers has clearly reduced the waiting times of pedestrians at zebra crossings, which means increased freedom for pedestrians. At the same time the number of pedestrian accidents at zebra crossings has increased. Once again we may be dealing with the fact that freedom and safety are often contrary goals in traffic /1/.

It can be suspected that the present Swedish situation, where half of the drivers follows the right of way rule, is the worst possible one from the point of view of traffic safety.

It is hard to believe that Finnish drivers could adopt a better behaviour pattern at zebra crossings than Swedish drivers without effective (municipal) enforcement, at least. Violations must not be accepted but so far we have to submit to the fact that pedestrians themselves should try to ensure their own safety when crossing a street.

In any case, the following conclusions can be drawn:

- 
- There is no reason to begin to reduce the density of zebra crossings in Helsinki or in Finland on a large scale.
  - The Finnish right of way legislation at zebra crossings is sharp enough.
  - Recessed stop lines should be introduced also in front of non-signalised zebra crossings over multilane streets.
  - Speed management is the keyword to pedestrian safety.

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## Appendix 1: Zebra crossings in the central areas of some European cities

Zebra crossings (—)

Helsinki (● = Railway station)



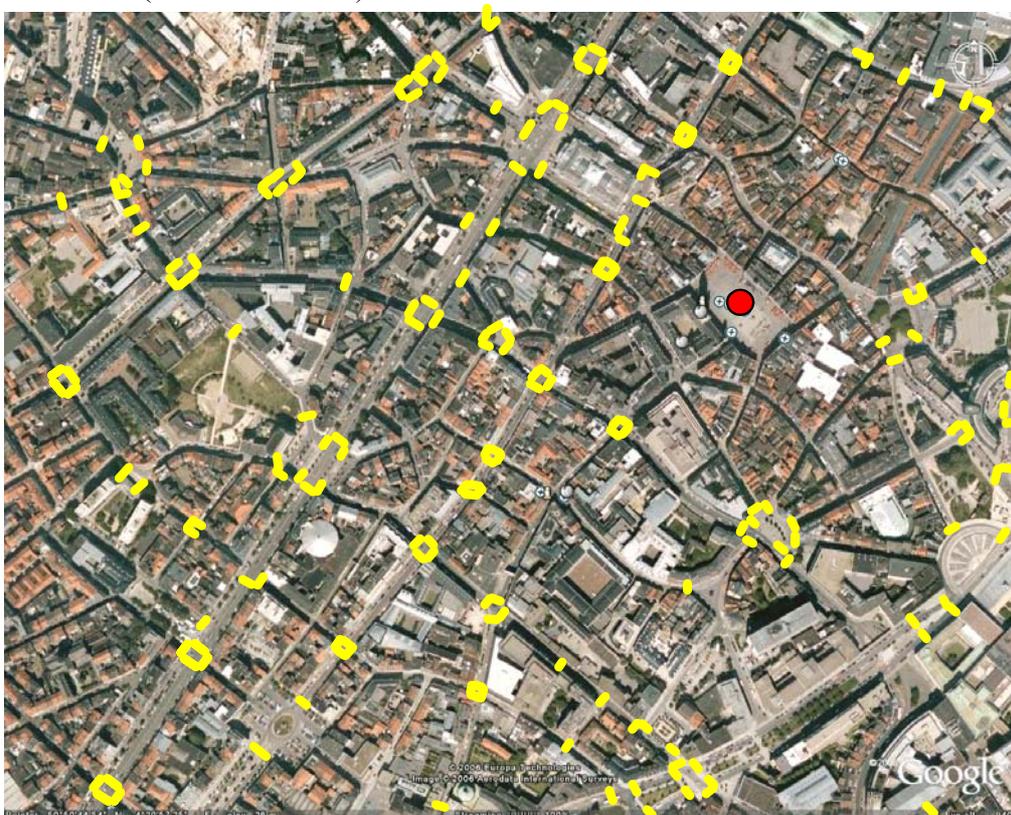
Stockholm (● = Hötorget)



Paris (● = Notre Dame)



Brussels (● = Grand Place)



Amsterdam (● = Central railway station)



London (● = Piccadilly Circus)



Berlin (● = Unter den Linden)



## Appendix 2: Zebra crossings and signalised crossings in the city centre and in a suburban residential area in Helsinki

