Effects of traffic calming schemes in Denmark

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Abstract

The traffic problems on main roads passing through town and village centres are mainly caused by traffic passing without consideration to inhabitants and local traffic, with speed considerably higher than the limit. This has led to many accidents, large problems with risk perception, environmental problems and a great local interest for improvements. The Danish Road Directorate decided to implement traffic calming schemes in several Danish towns which were appropriate to the towns and the defined problems, also including economy. The traffic calming schemes should be effective, the visual appearance satisfactory and the measures should adapt to the local urban and traffic environment. Safety should be improved and the number of accidents reduced. COWI has assisted the Danish Road Directorate with the evaluation of the traffic calming schemes in 21 towns. This paper presents the results of a before-and-after study of traffic calming schemes in Denmark. The general result of the traffic calming schemes was a reduction in the average traffic speed by 10 km/h. In towns with new roundabouts the average speed was reduced by 15 km/h. In some towns the average speed was reduced by 30-40% (17-26 km/h). Reduction in traffic speed by each of the different means (e.g. gateways, roundabouts including mini-roundabouts, pedestrian refuges and central refuge islands for narrowing the carriageway, chicanes, road humps, including flat topped humps) is also presented in the paper. The paper concludes that by investing approximately 0.3 - 0.4 mill. £ per km in small urban areas, positive effects can be obtained on traffic safety, risk perception, and the environmental quality of the area.

1 Introduction

During the 1980's the Danish Road Directorate started to carry out systematic attempts to rebuild main roads leading through urban areas following the principle that the traffic should be passing with consideration to inhabitants and local traffic. These roads were called environmentally adopted through-roads (traffic calming schemes). The results were encouraging but the costs relatively high due to a complete reconstruction of the road profile.

During the early 1990's the Danish Road Directorate once again focused on traffic problems in small urban areas where traffic often passed through without consideration to inhabitants and local traffic, and with a speed considerably higher than the limit. The traffic calming schemes were primarily financed under an employment scheme financed by the Federal Government, and they were also part of an action plan prepared by the Danish Traffic Safety Commission.

Several small Danish towns were selected for the implementation of traffic calming schemes by the Danish Road Directorate in co-operation with the counties. These towns were characterised by many accidents, large problems with risk perception, environmental problems and considerable local interest for improvements.

The main objectives were to improve traffic safety and to reduce risk perception using limited expenses. Additionally, the visual appearance of the roads should be improved. The means to reduce the problems were a number of connected spot improvements instead of a complete reconstruction of the whole length of road. Subsequently the implementation of the traffic calming schemes effects should be assessed. This paper presents the main results of a before-and-after study of the traffic calming schemes in Denmark. COWI has assisted the Danish Road Directorate with the evaluation of traffic calming schemes in 21 Danish towns (Mertner, Jørgensen, Rosbach & Wellis[1], Mertner & Jørgensen[2], Jørgensen & Rosbach[3]). The evaluation included the different measures and their effect, primarily on speed. This included both an evaluation of the reduction in average speed through the towns and an assessment of reduction in traffic speed by each of the different measures.

2 The Planning and Implementation Process

It was considered important that local authorities and representatives from the local area should be involved in the preparation of the projects.

The representatives were typically people from citizen societies, trade and industries, schools, police and municipalities.

During a number of meetings in each town the problems were identified and the potential measures discussed. The outlined projects were discussed in the working groups and the results were presented at citizen meetings.

In most cases the presented projects were supported. In a few cases there were some disagreements on the presented projects which resulted in some revision of the projects.

Even though a few of the presented traffic calming schemes had to be changed, the experience with this method for planning and implementation of traffic calming schemes is positive. The dialogue with local representatives made it possible to adapt the measures to the local urban and traffic environment, and the projects had large local support.

3 The Towns

Generally the towns are rather small with a population between 200 and 2000. The urban through-roads are typically 1 km long. The traffic flow is between 800 and 13,000 vehicles per day, typically 4,500 to 5,000 vehicles per day. Approximately one third of the towns had four to nine personal injury accidents during a five-year period, the remaining towns had fewer.

The road profiles were very different from town to town, but they were typically a wide carriageway and none or only few facilities for cyclists and pedestrians.

In most cases the traffic problems in the towns were caused by too high speed. Often the visibility was poor and it was often difficult for vulnerable road-users (including pedestrians, cyclists, children, elderly people and people with impaired mobility) to cross the roads safely. The towns were characterised by fast and heavy traffic, and a poor visual appearance.

The towns described in this paper were all along main roads, but it is envisaged that similar projects could be implemented on roads in large cities with the same effect.

4 The Traffic Calming Schemes

The traffic calming schemes are very different in extent and measures, and therefore naturally also in costs.

In nearly all the implemented projects the entries and exits of the towns are emphasised by gateways of a very different nature. Some of the gateways consist of only surface treatments or central refuge islands while other gateways have special side features or consist of a combination of central refuge islands and chicanes with special over-run areas, special surface treatment and planting.

A variation of different measures has been used on the road stretches ranging from different kinds of central refuge islands and chicanes, ordinary roundabouts and mini-roundabouts (with over-run island), flat topped road humps and formation of squares.

There has been some experiments with the design of central refuge islands and chicanes. Some are designed to facilitate over-run by using lowered kerbs. Different materials have also been used ranging from traditional sett pavings and granite stones to marked concrete and surface treatments.

In most cases the conditions for the cyclists have been improved. Not always by traditional cycle tracks due to lack of space or lack of funds, but in some towns by divided or shared tracks, or cycle lanes. As an experiment narrow cycle lanes have been introduced in some towns.

Often planting has been used to define the carriageway, to create a visual effect of narrowing the carriageway, to define changes in the carriageway and to improve the overall environment.

In many cases different kinds of maintenance work were also included - typically new street lighting, strengthening of the road and new surface dressing.

5 Assessments of Effects

The assessments of effects are primarily based on a before-and-after study of the speed in the towns. In all towns the speed profile has been measured and in approximately half the towns the speed has also been measured at specific points. The speed profile is measured by a "measure car" which follows randomly chosen vehicles and register results every 50 m. Curves for the speed profile are drawn up similar to those illustrated in Figure 1 and 2.

Apart from the effect on speed the cost of the projects has been estimated. Additionally the anticipated savings in traffic accidents and changes in environmental conditions were assessed

The projects were very different in the before situation in terms of project measures and therefore also in the after situation. Nearly all

projects consist of a combination of several measures and the effect of each individual measure is difficult to assess.

6 Reduction of Average Speed in the Towns

The average traffic speed has been reduced in all towns, though with very different results. Towns with new roundabouts seem to have the lowest average speed. The reductions are ranging from 5% to 40%, and the average reduction in traffic speed is 10 km/h. In comparison, the first attempts with traffic calming schemes in Danish towns in the 1980's showed reductions in traffic speed between 10-15% (Vejdirektoratet[4-6]), which is similar to later Norwegian experiences (Statens Vegvesen[7]).

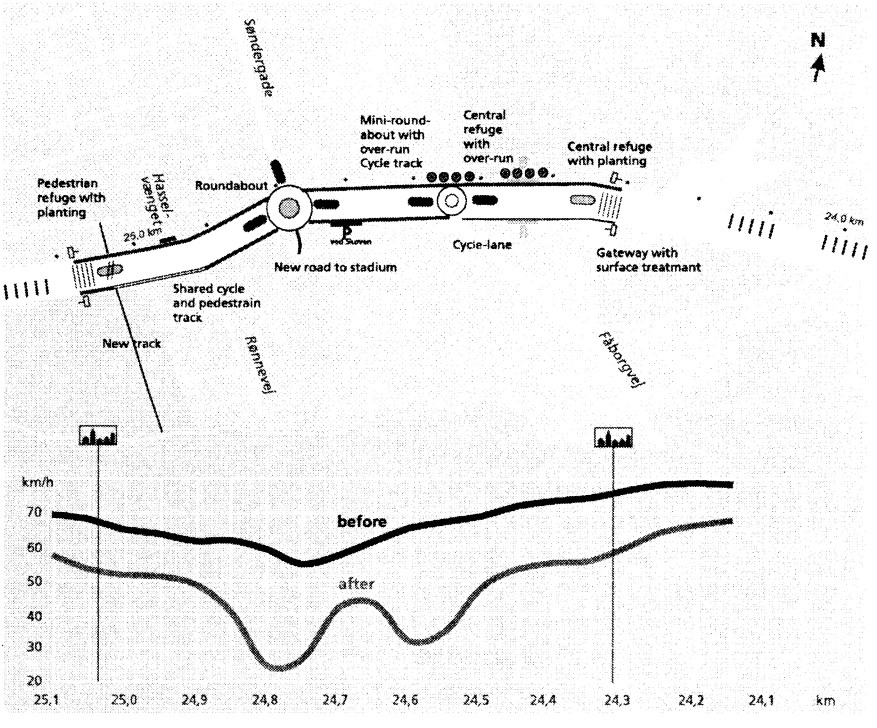

Figure 1 The speed profile before and after a traffic calming scheme for a town with an ordinary roundabout and a mini-roundabout with over-run area.

The typical changes in speed profiles with corresponding sketches are shown in Figure 1 and 2 for a town with roundabout and gateways, and a town with central refuge islands and gateways. At the gateways (urban zone signs) the average speed has been reduced by 10-15 km/h. The lower speed level is kept or decreases further towards the town centre where the difference between the before and after speed is typically 5 km/h. In towns with new roundabouts there is a significant reduction in speed at the roundabout and some of the reduction seems to be maintained throughout the town.

When the speed level has been reduced, there has naturally also been a decrease in the number of vehicles exceeding the speed limit (generally 50 km/h) between the urban zone signs. In most of the towns though, more than 40% are still driving too fast. In a few of the towns only 2-20% are exceeding the speed limit which is probably due to roundabouts, flat topped humps and measures lying closely together.

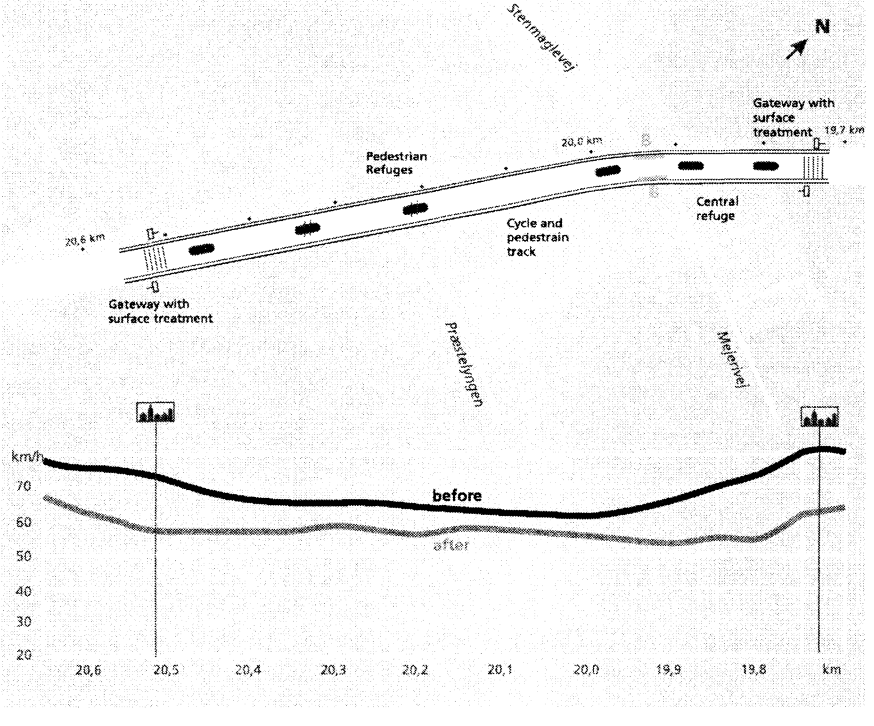

Figure 2 The speed profile before and after a traffic calming scheme for a town with central refuge islands.

An essential source to both safety and risk perception problems is the fast driving motorists. It is therefore important to know how the traffic calming schemes have influenced this group of drivers compared with the average group.

In Figure 3 the average speed profiles before and after the traffic calming schemes are illustrated. The average speed profile has been reduced by 10 km/h at the gateways and approximately 5 km/h in the centre of the towns. The effect is larger in towns with roundabouts and this effect is generally kept throughout the town (approx. 12 km/h).

The fastest driving vehicles (Figure 3 shows the 15% fastest) have almost the same tendency as the average, though, in towns with roundabouts the decrease in the speed (approx. 15 km/h) has been larger than for the average driver.

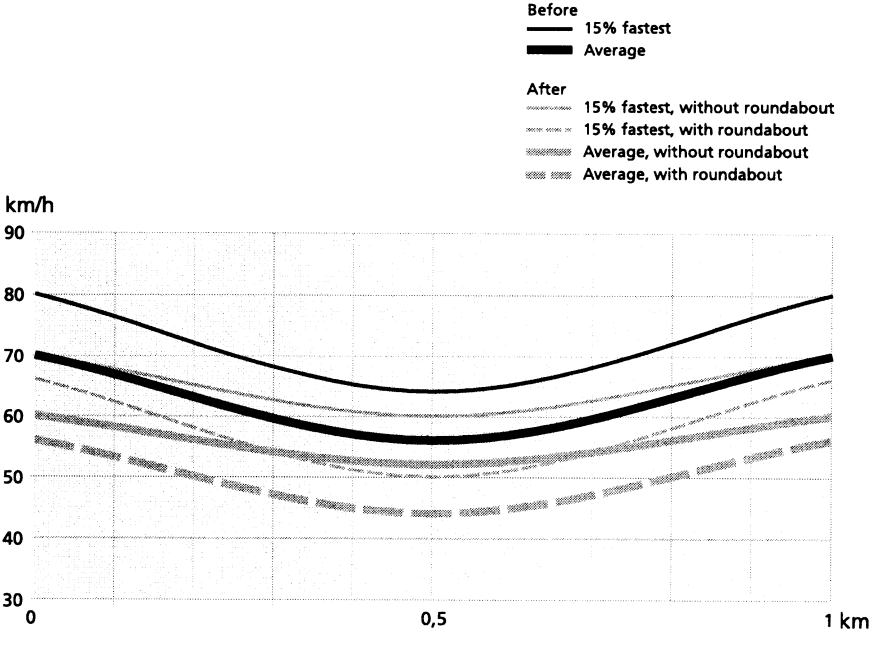

Figure 3 Calculated average speed profiles for the 21 towns before and after the traffic calming schemes.

This means that generally the traffic calming schemes have not reduced the dispersion in the speed significantly, but in towns with roundabouts the dispersion has been reduced for the fastest drivers.

The above assessments of the changes in the speed profile were based on average values from all the towns. The before and after speed was measured specifically at the gateways and in the centre of the towns. The assessment of the decrease in speed for the average driver and the 15% fastest drivers showed significant variations from town to town, but as indicated above the largest reduction in the speed of the fastest drivers generally occurred in towns with roundabouts.

7 Reduction of Speed at the Measures

The effects of the different measures have also been assessed although the results are not explicit. The measures used have different designs, are combined with other measures in different ways and the before situations were very varied.

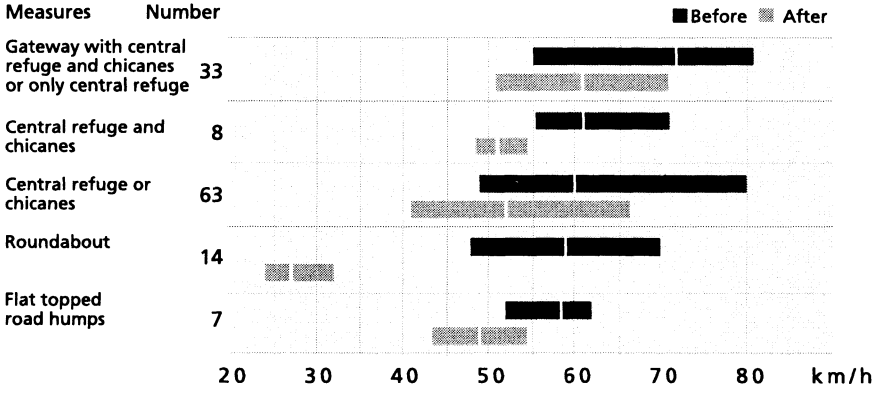

Figure 4 The reduction of speed at the various measures. The length of the bars indicate the dispersion of the analysed measures. The vertical white lines indicate the average situation before and after the measures

The number of each measure included in the analysis is also shown in Figure 4. It shows that refuges have been used in 33 gateways, the before speed varies between 55 km/h and 80 km/h and the after speed has been reduced to 50 km/h - 70 km/h. The reduction in speed varies significantly from gateway to gateway and apparently there is often no direct

coherence between reduction in speed and the specific design of the measure, though wider central refuge islands (4.0-4.5 metres) tend to have the largest effect on speed. The vertical lines in Figure 4 indicate the average speed in the before and after situation. The average reduction in speed at the gateways is 10 km/h.

Similarly the effects and dispersion may be assessed for the other measures. They generally all have a decrease in the average speed of 10 km/h. Only the roundabouts are significantly different.

Roundabouts are very effective measures to reduce speed, and it makes no difference whether they are traditional roundabouts or mini-roundabouts. The speed has generally been reduced by 30 km/h at the roundabouts. This effect gradually decreases 100-250 metres from the roundabout depending on the usage of other measures. However, it seems that some effect (5 km/h) is kept throughout the town.

8 Other Results

The following presents other experiences and anticipated effects of the traffic calming schemes.

8.1 Traffic management

During the planning process problems with access and the inconvenience for heavy vehicles were discussed. This resulted in some revisions of the detailed project and also during the implementation. An effective traffic calming scheme undoubtedly effects heavy vehicles more than small. But for both type of vehicles the additional time consumption is very limited - only between 3 and 31 seconds for the average driver which is equal to 13.1 seconds/km. This is very little compared to the total trip.

In some of the towns special arrangements have been made for special vehicles by using over-run areas and kerbs, removable signs, etc. After the first period most people are now satisfied with the driving conditions through the towns.

8.2 Costs

The total costs for construction and simultaneously operation and maintenance work were between 0.3 and 0.8 mill. £ per km - with an average of 0.4 mill. £ per km. Towns with new roundabouts are generally the most expensive projects.

An average of 0.06 mill. £ per km was spent on operation and maintenance work such as new surface or new street lighting. In some

towns the street light was part of the traffic calming schemes and therefore included in the construction costs.

8.3 Traffic safety and risk perception

Effects on traffic safety can only be assessed over a 3-5 year period after the finalisation of the projects. A preliminary assessment of the reduction in personal injury accidents has been made on the basis of the reduced speed. On the basis of these figures the number of personal injury accidents is expected to decrease by 15-80% in each town or by an average of about 40%. Additionally a reduction in accidents is expected due to specific measures targeted to vulnerable road users e.g. cycle tracks or junctions with many accidents, e.g. roundabouts. The evaluation of traffic calming schemes in Denmark in the 1980's (Vejdirektoratet[4-6]) showed a reduction in personal injury accidents between 44 and 67%.

The risk perception along the roads or for crossing the roads depends on the traffic volume, speed, tracks and carriageway width. Especially speed is considered an important factor. It is assumed that the risk perception has been improved due to reduction in speed in all towns and the construction of tracks and pedestrian refuges.

8.4 Energy consumption, air pollution, vibrations and noise

The environmental factors are influenced by speed, design, surface dressing etc. The traffic calming schemes all change these elements. Experience from Denmark (Vejdirektoratet[4-6]) and Norway (Statens Vegvesen[7]) shows marginal changes in vehicle emissions of different chemicals and a minor reduction in energy consumption. The traffic calming schemes are not expected to cause significant local changes on these elements.

A reduction of the traffic speed will lead to a reduced noise level. But this may be compensated by accelerations and decelerations, braking, uneven road surfaces conditions etc. The final effect on noise is not easily described.

In one town there were many complaints about noise after the implementation of a new roundabout, and measurement of noise was carried out. The conclusion was, however, that the noise level was lower than before the traffic calming scheme, and there were not more frequent peaks at the roundabout than at other places in the town.

8.5 Operation and other experience

The general impression is that the projects have improved the visual appearance of the towns, and in most towns the citizens declare themselves satisfied with the projects. In a few towns there has been some complaints regarding specific measures, primarily regarding noise problems, but also problems with parking and delivery of goods have been raised.

Setts have been torn loose on over-run areas in some towns, and some problems with operation and increased operation costs have also been raised - e.g. regarding snow clearance.

In almost half of the towns the traffic calming schemes have resulted in improvements on other roads and tracks financed by the municipalities and the inhabitants have improved their buildings and front gardens.

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