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Discussions about Traffic Safety Measures Using Traffic Calming Devices in Japan

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Abstract: In Japan, the number of traffic accident fatalities is tending to fall, but the proportion of pedestrian and cyclist is high. So the Ministry of Land, Infrastructure, Transport and Tourism has decided to strongly support traffic safety on residential roads and has studied measures to promote it. This paper reports on the discussions about how using traffic calming devices can improve traffic safety, and the measures that will be put into action as a result of discussions. The discussions began with a survey of the attitudes of municipalities toward their traffic calming installations and the state of their actual installations, and the problems of installation were clarified and discussed. Then the content of measures such as enacting installation standards or using big data were discussed.

Keywords: Traffic Safety, Traffic Calming, Residential Road, Hump, Narrowing, Chicane

1. INTRODUCTION

1.1 Background

The number of traffic accident fatalities is about 4,000 (2015), which shows a decline to about 1/4 of the number at its peak level. But the percentage of fatalities of pedestrians and cyclists is higher than in other industrialized countries, and half of fatalities of pedestrians and cyclists killed by in crushes within 500m of the victims' homes. Therefore, the measures to control speed and restrict through traffic on residential roads are being taken. In particular, priority is placed on reducing driving speed, because if the collision speed is 30km/h or lower, the death rate is sharply reduced in Japan.

1.2 Goals

The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) enacted "The Technical Standards for Installing Humps, Narrowings and Chicanes" in March 2016, in order to encourage the installation of humps, narrowings, and chicanes, which effectively reduce driving speed. The standards set general technical matters related to the installation of humps, narrowings, and chicanes (below referred to as, "traffic calming devices") to reduce vehicle speed. This paper reports on the background to the enactment of the technical standards and efforts to take traffic safety measures on residential roads.

2. BACKGROUND TO TRAFFIC SAFETY MEASURES ON RESIDENTIAL ROADS

Figure 1 shows the background to traffic safety measures on residential roads in Japan. Traffic safety measures for residential roads have been introduced as measures such as creating Safe Pedestrian Areas (from 2003), introducing zone 30 (from 2011), and carrying out emergency joint inspections of school commuting streets (from 2012). In 2001, "Road Structure Ordinance" was revised in Japan, in this revise it is positioned that the installation of traffic calming devices on roads in residential districts in order to control the speed of automobiles as necessary.

Figure 1. Background to traffic safety measures on residential roads

3. SURVEY OF THE STATE OF INSTALLATION OF TRAFFIC CALMING DEVICES

3.1 Survey of Attitude towards Installation amongst Municipalities

In spite of "Road Structure Ordinance" was revised, installation of traffic calming devices has been not sufficiently taken. Because of this, in 2014, to clarify the reasons for the lack of installation of traffic calming devices, MLIT carried out a questionnaire survey about the state of installation of traffic calming devices and challenges faced when installing them to all municipalities in Japan (about 1700 municipalities).

Figure 2 shows the results of answers by municipalities to the question: have you actively considered installing traffic calming devices or taking other speed control measures when studying traffic safety measures for residential roads?.

Only 3% of the municipalities answered, "We tend to actively study this matter.", while others tend to place priority on the study of measures other than traffic calming devices. (road indications, colored pavement, etc.).

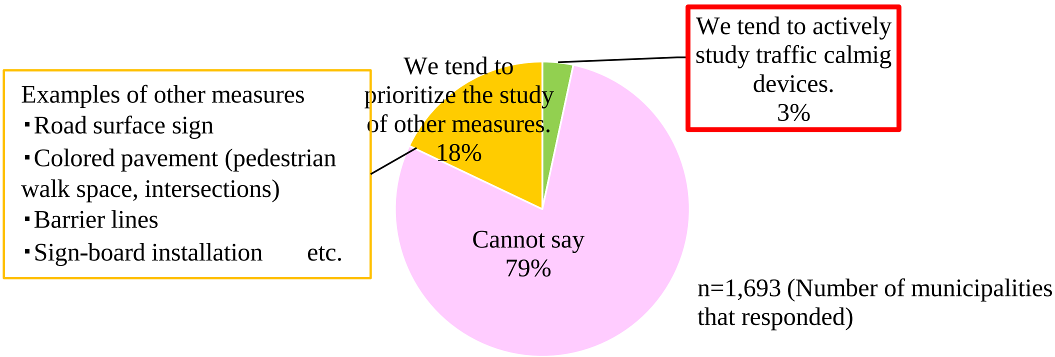


Figure 2. State of introduction of traffic calming devices.

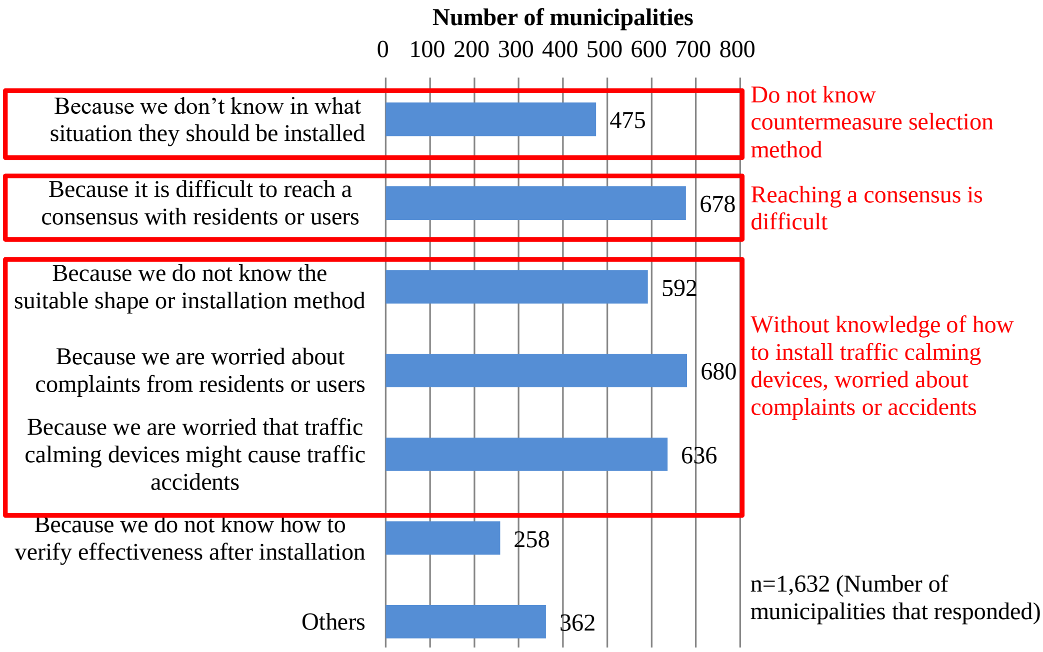


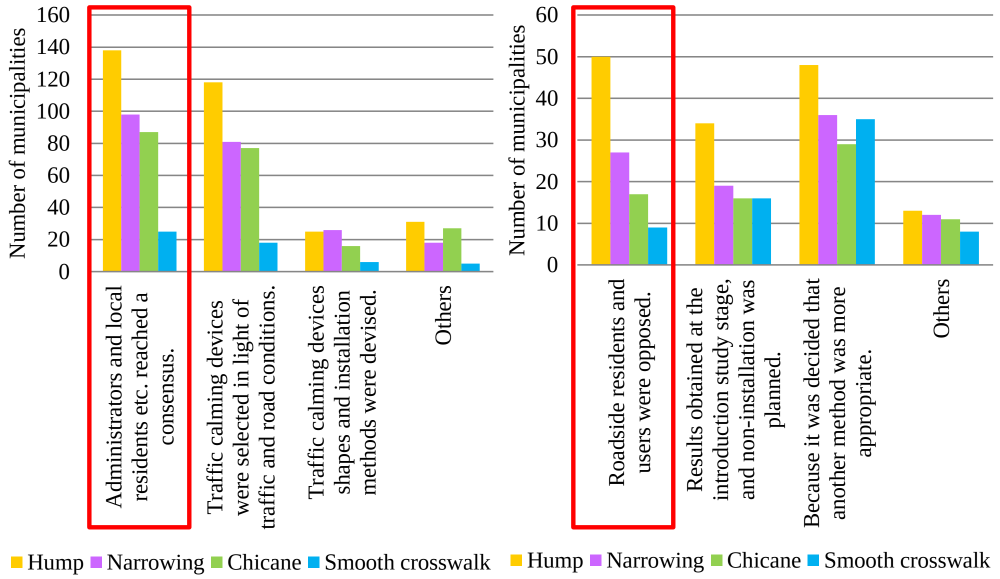
Figure 3. Reasons for difficulty of studying installations of traffic calming devices. (multiple answers permitted).

Figure 3 shows the results of asking respondents why it is difficult to study the installation of traffic calming devices in municipalities who answered either "We tend to prioritize the study of other measures." or "Cannot say" in Figure 2.

They answered as their reasons for not installing traffic calming devices "We do not know how to select measures", "It is difficult to reach a consensus." and "we do not know how to install them."

Figure 4 shows reasons they install traffic calming devices (see Fig. 4(a)), and reasons for not installing traffic calming devices after having studied their introduction (see Fig. 4(b)).

Many municipalities answered that they did not install them because of opposition by roadside residents or users. This means that the importance of reaching a consensus to install traffic calming devices.



Number of municipalities that answered: Hump (n= 250), Narrowing (n= 158), Chicane (n=165), Smooth crosswalk (n=40)

Number of municipalities that answered: Hump (n= 134), Narrowing (n= 91), Chicane (n=71), Smooth crosswalk (n=66)

(a) Reasons for installing traffic calming devices (b) Reasons for not installing traffic calming devices

Figure 4. Reasons for installing or not installing traffic calming devices (multiple answers permitted)

Figure 5 shows the content of opposition of reasons why roadside residents or users were opposed as shown in Figure 4(b). It is revealed that many were opposed to particularly hump's installation because of the noise and vibration humps would cause.

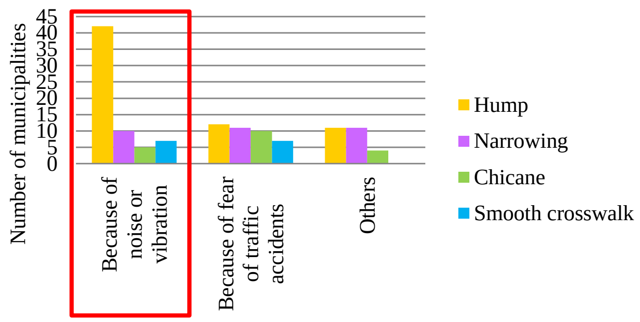
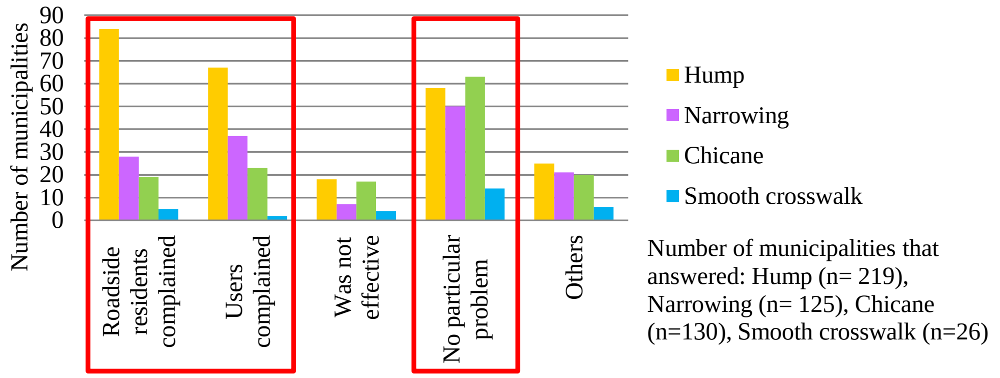


Figure 5. Opposition by roadside residents, users etc. (multiple answers permitted)

Figure 6 shows the state of occurrence of problems after installation of traffic calming devices. While many municipalities received no complaints, there are complaints by roadside residents or users about noise and vibration by humps or the danger of accidents caused by narrowings or chicanes. A possible explanation for these complaints is that the shapes of traffic calming device were not suitable.

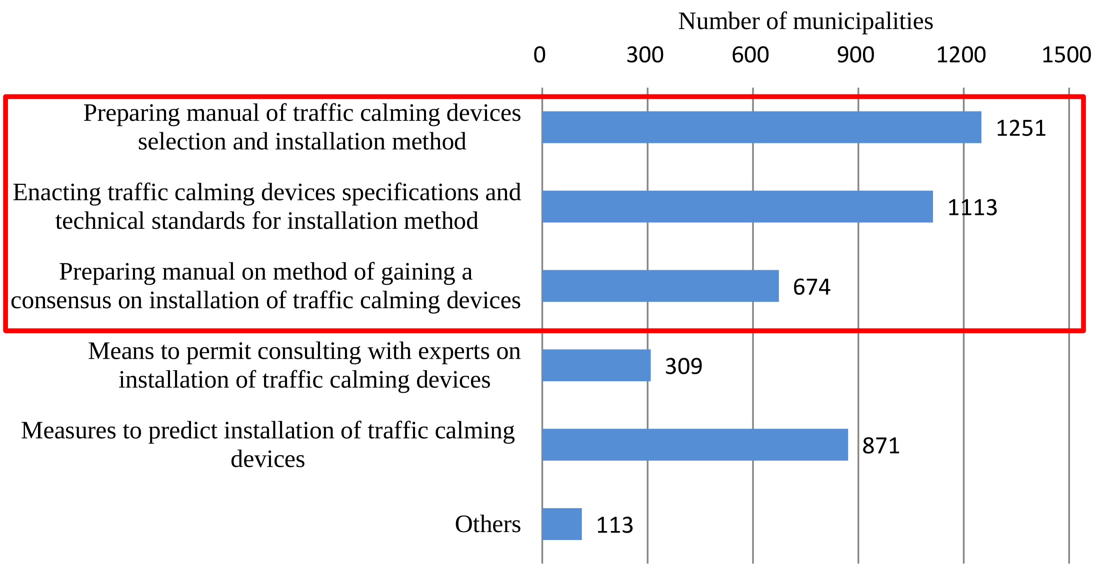


Major contents of complaints
(Humps):・Cause noise and vibration
(Narrowings, Chicanes): ・There is danger of traffic accidents occurring
・It is difficult for vehicles to meet and pass or to leave and enter roadway.

Figure 6. State of occurrence of problems after installation (multiple answers permitted)

The results of the survey have revealed that reasons why municipalities have not aggressively studied the installation of traffic calming devices are: not understanding measure selection methods, not knowing how to install them, difficulty of forming a consensus (complaints and opposition by roadside residents or users), etc.

Another result of this survey, many municipalities have reported that preparing traffic calming devices selection and installation method manuals would be a good way to simplify the study of the installation of traffic calming devices. (see Fig. 7).



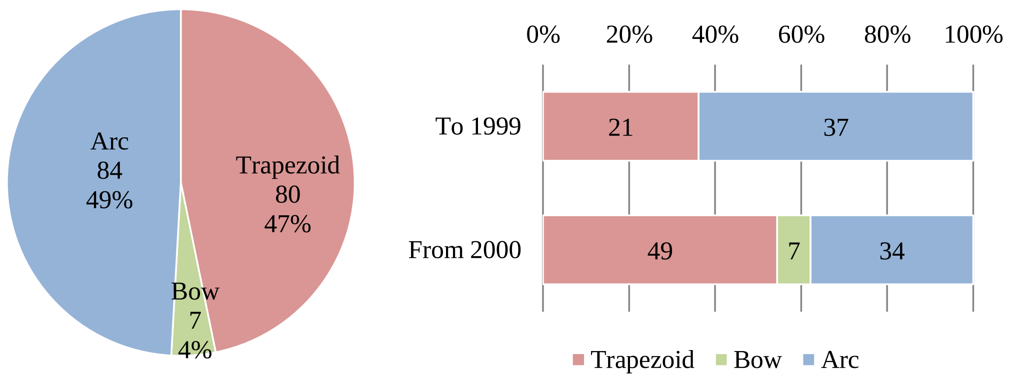
n=1,672 (Number of municipalities that responded)

Figure 7. Methods of simplifying the study of installation (multiple answers permitted)

3.2 Survey of State of Installation by Municipalities

To clarify the actual condition of the installation of humps, in 2013, MLIT conducted questionnaire survey to all municipalities. In this survey, 151 municipalities reported the information of humps they installed. They answered about one or some shapes of hump, if there were many different shapes of humps in one municipality. The survey totally gathered information of 171 humps.

Figure 8(a) shows percentages by shape of the collected cases, revealing that many humps are arcs or trapezoids. Examining the humps by year of installation, shows that although in cases after 2000, the percentage of arc shaped humps fell, but they are still used (see Fig. 8(b)). Arc-shaped humps are tend to cause noise and vibration because the connections of the hump and roads surface are discontinuous. In this reason, it is assumed that these humps encourage road-side residents and users to feel that vibration and noise are problems.



(a) Hump shapes n = 171

(b) Hump shapes by installation year n = 148
(excluding 23 locations where installation year is unknown.)

Figure 8. Shapes of humps in the collected cases

Figure 9 shows the results by height of totaling cases of installation of humps that were collected. Although most are humps shorter than 10cm, humps with various heights (ranging from 1 to 20cm) are used.

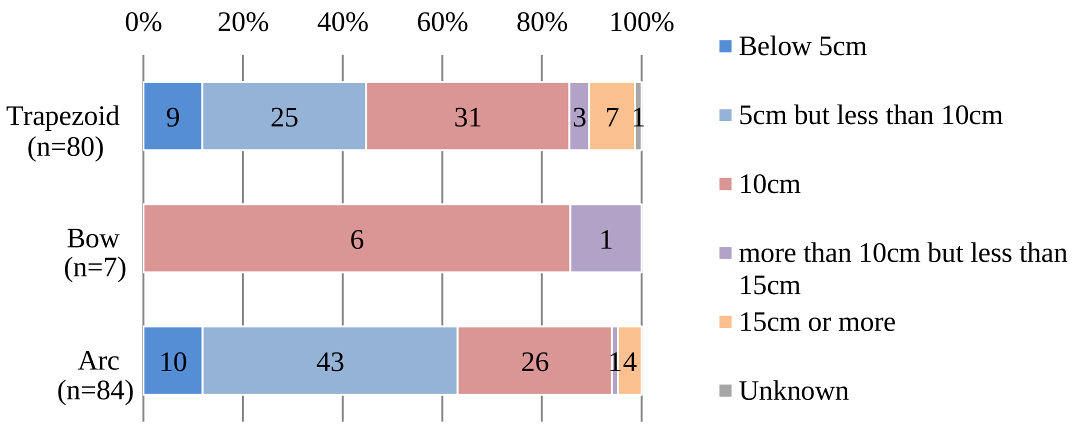
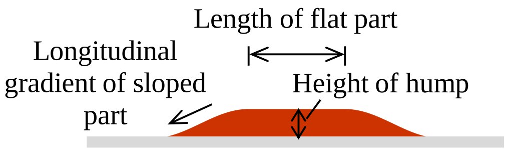
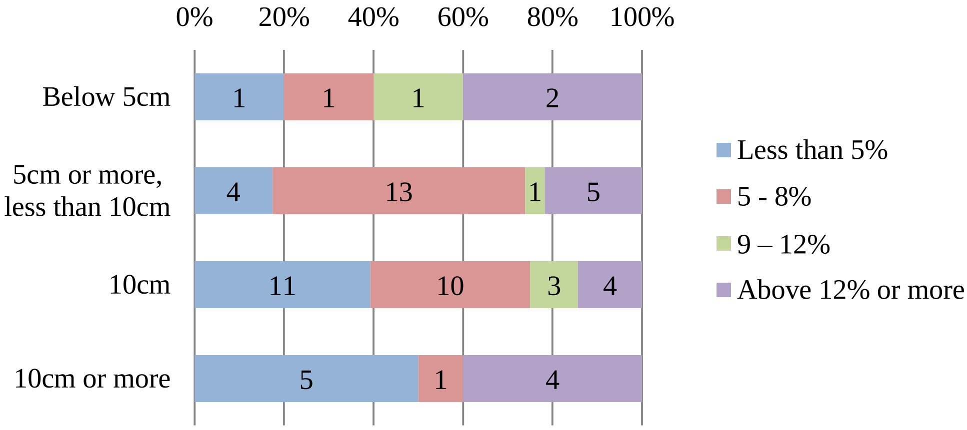


Figure 9. Height of humps

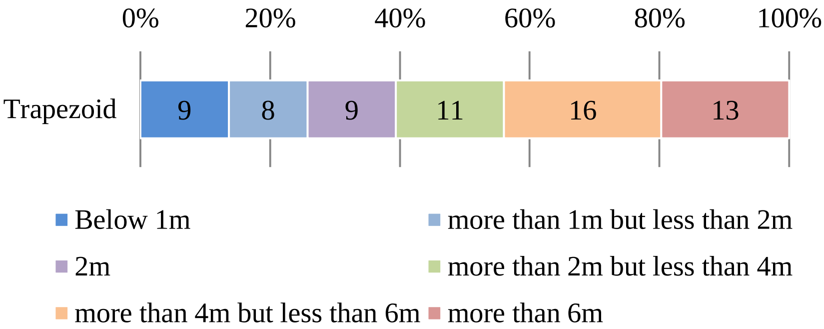
Figure 10 shows the results of the structures of trapezoidal humps. Regarding the longitudinal gradient of the slope, 30% to 40% of the humps have steep slopes that exceed 8% (see Fig. 10(b)). The length of the flat parts of the humps varied (see Fig. 10(c)).



(a) Typical shape of trapezoidal hump



(b) Longitudinal gradient of sloped part by height (n=66)
Except 14 locations where trapezoidal hump gradient is unknown.



(c) Length of flat part (uninterrupted flow section)(n = 66)

Figure 10. Structure of trapezoid humps

3.3 Problems Revealed by Surveys

The results of survey of attitude towards installation revealed problems such as, [1] they do not know how to select appropriate measures, [2] they do not know how to handle traffic calming devices, and [3] it is difficult to form a consensus. And survey of state of installation humps by municipalities revealed that various shapes of hump had been adopted including inappropriate shape such as arc shape in japan. It shows that in order to make it easier for municipalities to study the installation of traffic calming devices, selection and installation method manuals should be provided.

4. STIDY OF MEASURES USING TRAFFIC CALMING DEVICES

4.1 Forming a Study Committee and Points Discussed

Based on such background circumstances, in 2014 MLIT set the following three points to be discussed and formed the Study Committee on Traffic Calming Devices.

(Discussion point 1) Concept of the selection of a residential road measure method

(Discussion point 2) Concepts of planning and designing traffic calming devices for residential roads

(Discussion point 3) Promoting understanding of the installation of traffic calming devices.

The study of measures for residential roads includes clarifying challenges etc. by a survey of present conditions, enacting a plan, taking measures then evaluating the measures. The measures for residential roads include not only traffic calming devices but many others such as traffic regulation and constructing sidewalks, but this study set its scope at the promotion of measures using traffic calming devices (see Fig. 11).

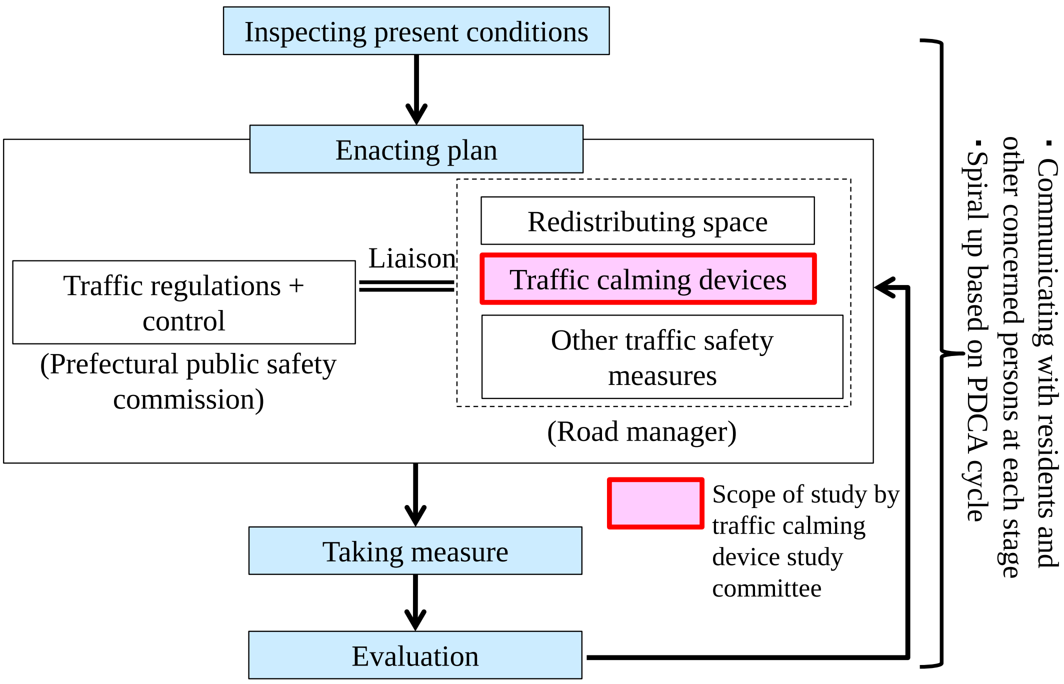


Figure 11. Flow chart of a study of measures for residential roads

4.2 (Discussion Point 1) Concept of the Selection of a Residential Road Safety Measure Method

To present concepts of the selection of measures, first of all, basic policies concerning the installation of traffic calming devices were discussed, and it was shown that traffic calming devices are installed to ensure safe travel by pedestrians and by cyclists, and that their installation does not obstruct the smooth flow of traffic.

And in order to install effective traffic calming devices, roads described by 1) to 5) below were set as the scope of traffic calming devices, and as necessary traffic calming devices are installed while considering conditions along the roadside.

1) Roads where pedestrian and bicycle accidents occur often
2) Roads where automobiles travel at high speed

3) Roads with heavy through traffic
4) Roads where drivers often do emergency braking
5) And other roads where installation of humps is considered to be necessary by the community.

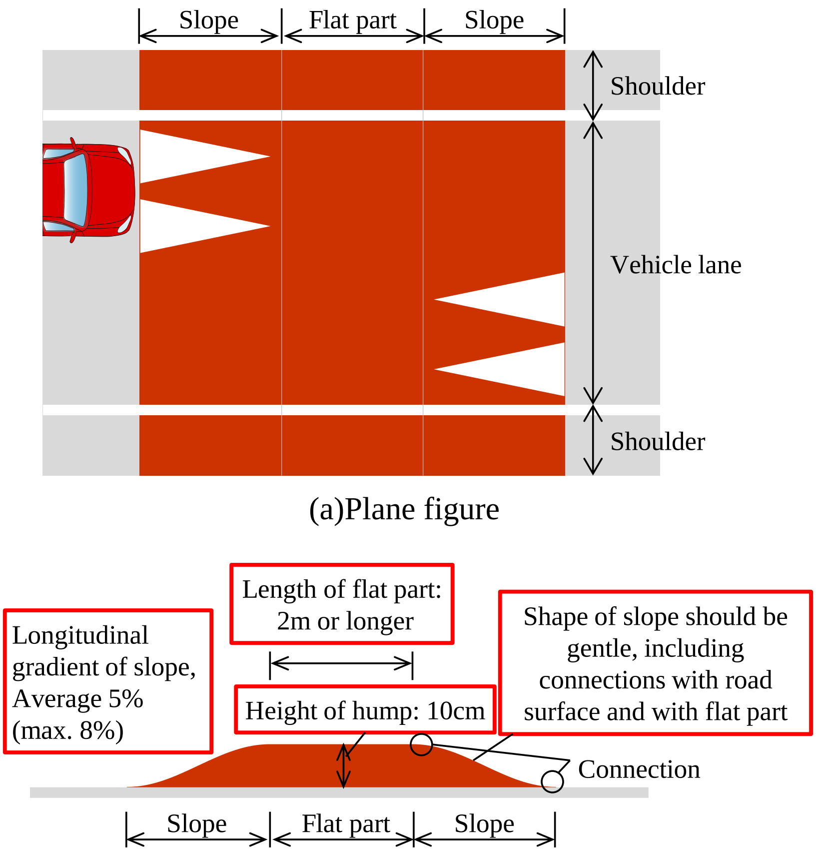
It was shown that in order to conduct a study to install traffic calming devices to keep traffic from switching to other residential roads, when installing traffic calming devices, the planned area should be set and the installation locations and types of traffic calming devices should be planned.

4.3 (Discussion Point 2) Concepts of Planning and Designing Traffic Calming Devices for Residential Roads

As stated in part 3, one reason given for the failure of traffic calming devices to accept is that municipalities lack know-how concerning the handling of traffic calming devices. For this reason, the standard structure was discussed and presented in order that installations be done so they effectively reduce driving speeds.

4.3.1 Humps

The structure of a hump is set according to the height of the hump, longitudinal gradient of its slopes, shape of its slopes, and length of its flat part. Then the structure for cases where it can adequately reduce the vehicle speed faster than 30kkm/h was shown (see Fig. 12). The following is a description of this structure.



(b) Longitudinal section

Figure 12. Structure of humps

1) Standard height of humps is 10cm.

The height of humps has been set so they can effectively reduce speed and prevent any chance of contact between the vehicle body and the hump. The effect of 10cm hump was confirmed by experiences. In addition other cases are reported that confirming speed reduction at height of 10cm for example by Kamada et al. (2014).

2) The standard longitudinal gradient of the slope is an average of 5%, and a maximum of 8%.

It has been considered important that the longitudinal gradient of the slope be inclined so that it does not create anxiety about danger while still effectively restricting speed. It is confirmed that the hump with average of 5% and a maximum of 8% slope satisfies these conditions. According to the Japan Society of Traffic Engineers (1996), humps with an average gradient of the slope of 10% or more may obstruct normal movement of automobiles. And it is set in order to consider movement of pedestrians and wheel-chair users etc., the access standards for roads in the Cabinet Order Establishing Standards for the Structure of Roads Necessary for Smooth Travel indicate longitudinal gradient of 5% or less, and when unavoidable, 8% or lower.

3) The shape of the slope is considered to be gentle, including its connections with the road where the hump is installed and with the flat part.

If the connection between a hump and a road surface is discontinuous, noise and vibration occur. This shows that the shape that restricts noise and vibration is a gentle connection. It is confirmed the hump with 1)-4) shape hardly causes the noise and vibration.

4) The length of the flat part is a standard 2m or more.

The shorter the flat part, the more effectively it reduces speed, but the gap between the road surface and vehicle is narrowed. So, the standard length of the flat part is 2m or more as the length that prevents any possibility of contact of the vehicle body with the hump and reduces traveling speed.

4.3.2 Narrowing

It shows that the structure of a narrowing (Figure 13) is set according to the width of narrowest lane. Its width is intended to adequately slow down vehicles as they pass through this part, and it is considered appropriate for the standard to be 3m that allows automobile with the maximum width to pass through. This is based on the fact that the width of an automobile capable of passing through is not greater than a width which is 0.5m narrower than the road, and on the stipulation by the Cabinet Order on Vehicle Restriction that the maximum width of an automobile is 2.5m. It is also assumed that if the width of automobiles that pass through is limited in relation to traffic regulations, it could be installed so that it is even narrower than 3m.

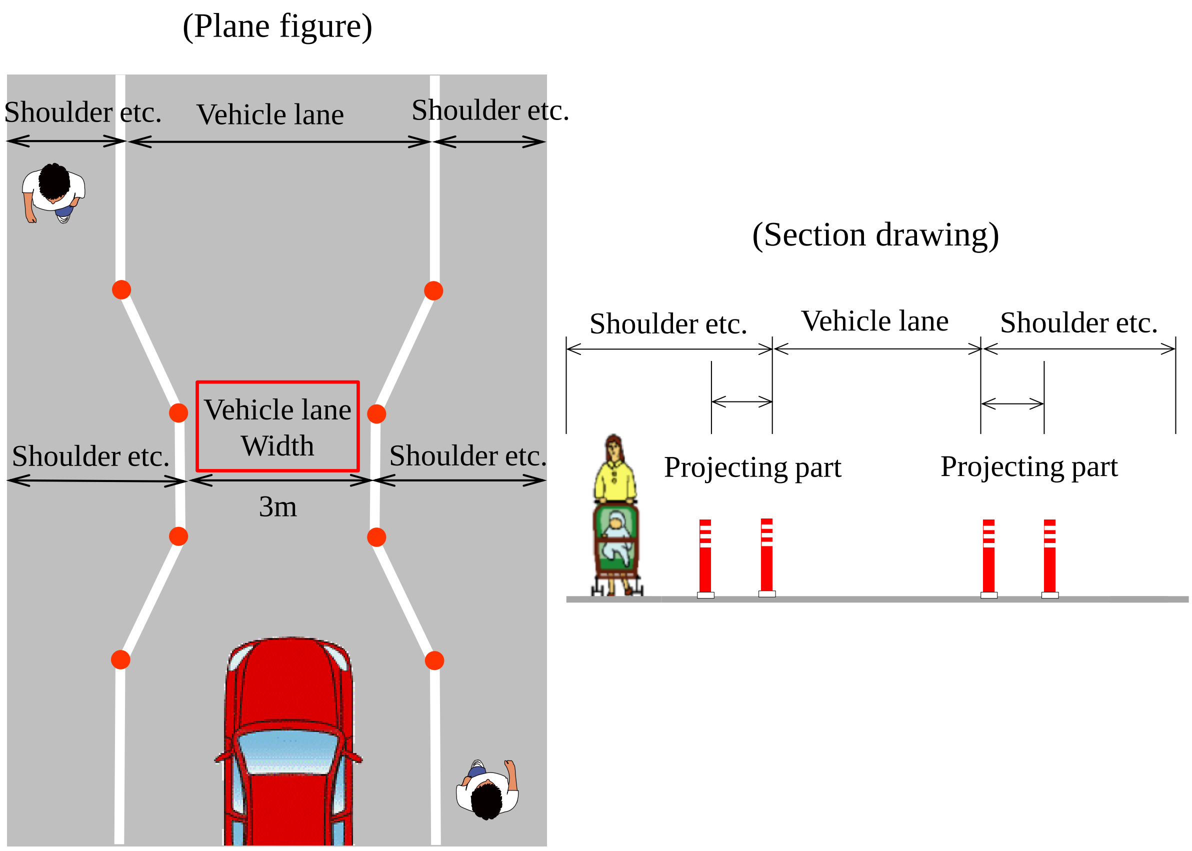


Figure 13. Structure of a narrowing

4.3.3 Chicane

For a chicane, performance is defined as, "a structure that permits the passage of normal automobiles and adequately lowers the speed of small automobiles passing the location." Chicanes feature a variety of shapes according to lane width and road alignment, so methods of confirming the speed reduction effectiveness for normal automobiles based on vehicle tracks etc. are presented, and used to set various structures at installation time.

4.3.4 Execution and maintenance

Materials, execution method, maintenance related items were discussed.

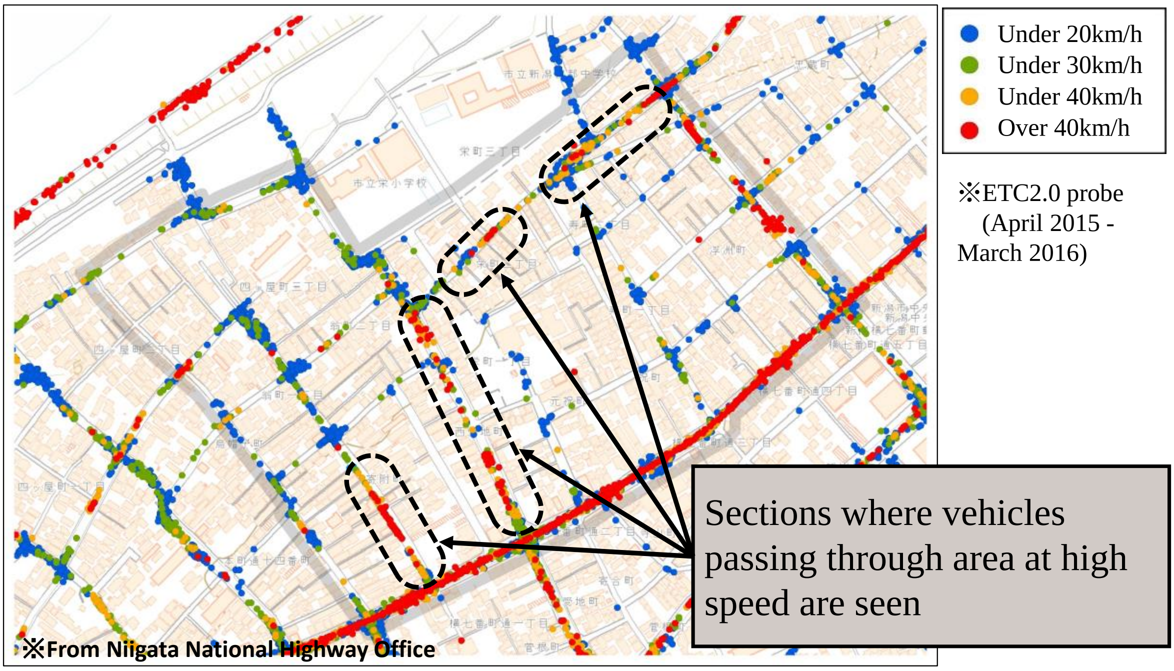
It is required that materials be durable and permit safe transit through the location. Maintenance requires visual inspections by people performing daily patrols, and prompt repairs when safety of transit through the location is not ensured. And at the same time, direction to keep records of installed traffic calming devices are also presented.

4.4 (Discussion Point 3) Promoting Understanding of the Installation of Traffic Calming Devices

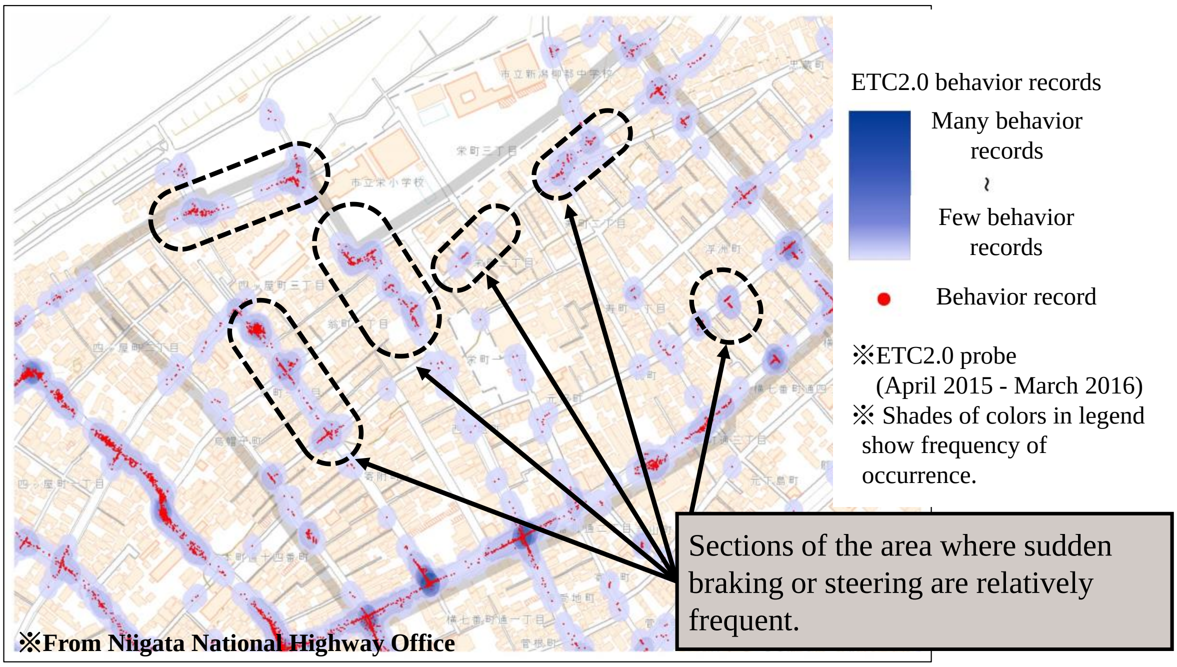
In order to smooth the process of reaching a consensus regarding the installation of traffic calming devices, building a system of maintaining contacts with interested persons and using big data to visualize information were discussed.

To construct a system of maintaining contacts with interested persons, using a system to promote traffic safety on school commuting roads that are conducted separately and using the good offices of academic experts to support measures were presented.

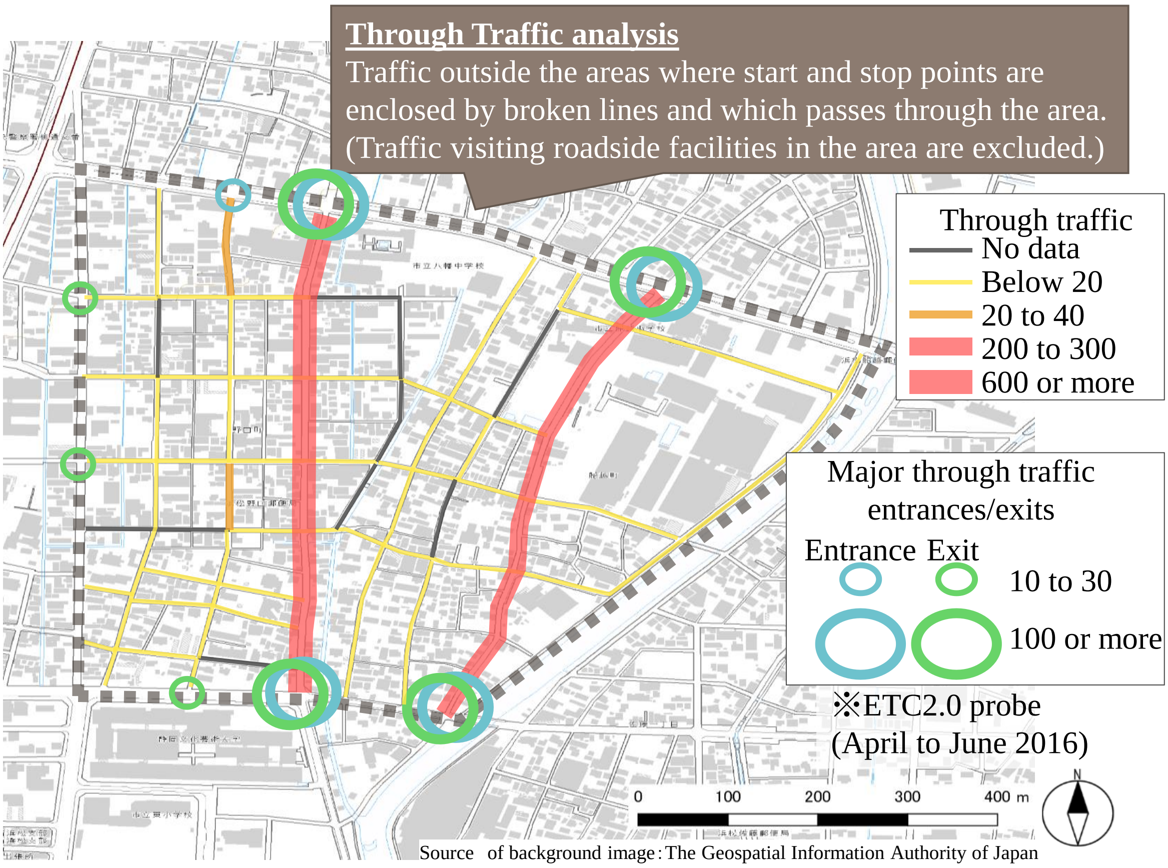
By using ETC2.0 probe data (floating car data) and accident data, Visualizing information at each stage—clarifying the present situation, enacting plans, and evaluating countermeasures—was discussed. Specifically using ETC2.0 probe data can be efficiently visualized, such as analyzing traveling speed, showing locations where emergency behavior occurs, and illustrating routes of through traffic, (Fig. 14).



(a) Example of traveling speed analysis



(b) Example of analysis of locations
where emergency behavior (sudden braking or steering) occurs



(c) Example of analysis of routes of through traffic

Figure 14. Examples of analysis using ETC2.0 probe data

5. CONCLUSIONS

Based on the present study, MLIT enacted "Technical Standards for Installing Humps, Narrowings and Chicanes" in March 2016. In addition, the designation of dangerous locations on residential roads, and proposal of plans for the installation of traffic calming devices have already been carried out by analyzing ETC2.0 probe data. At this time, individual municipalities have designated areas for priority implementation of these measures, and by December 2016, about 250 of these areas were presented.

And MLIT has lent portable humps with standard shapes shown in 4.3.1 as one measure to promote road safety measures. Municipalities can predict the effectiveness of measures to select methods which will be more highly effective by carrying out trial installation of the portable humps on roads. And this can also deepen residents' understanding of the measures so that it is possible to smoothly obtain a consensus.

At the same time, studies are carried out regarding measures other than humps, narrowings and chicanes, in combination with ETC2.0 probe analysis in order to expand future tools for traffic safety measures.


Figure 15. View of trial installation of portable humps

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