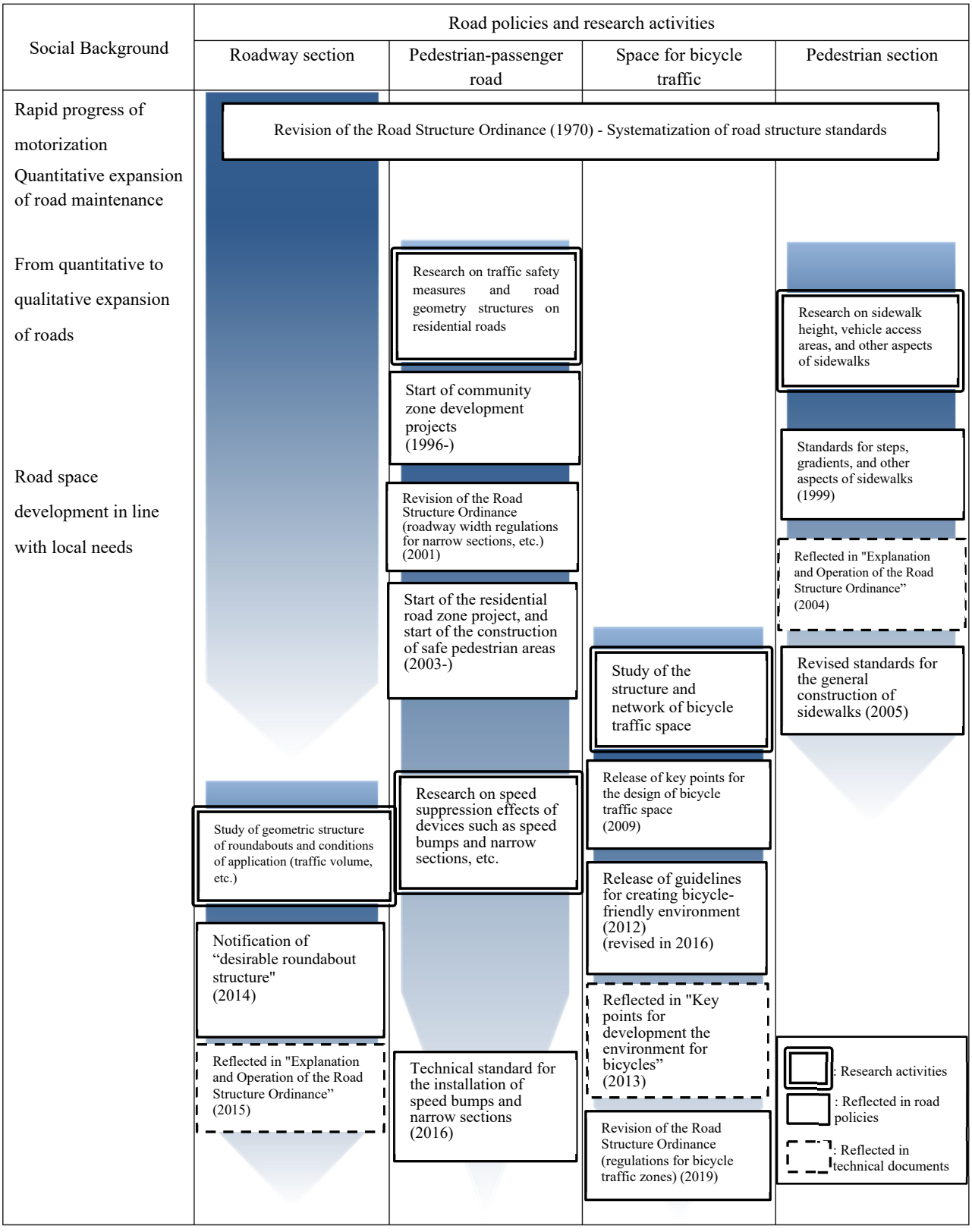
Geometric structure of roads that responds to changing social demands

1. Outline of Studies and Activities



(1) Social needs and policy trend

Establishing geometric structural standards for roads is extremely important for road planning and design. The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) has been revising the road geometric structure standards as needed and appropriately to meet the changing needs of society and road users. The first Road Structure Ordinance was enacted in 1958, and its revision in 1970 systematized the road structure standards leading up to the present. At that time, Japan's main focus was to keep up with the rapid progress of motorization, and the quantitative development of roads was focused on ensuring the smoothness of automobile traffic. Subsequently, in 1982, the Road Structure Ordinance was revised with an eye to qualitative enhancement of roads instead of quantitative expansion. Since then, with social changes, such as the aging society, support for social participation of the disabled, reduction of environmental burden, and frequent natural disasters, there has been a growing demand for road space that enables smooth, safe, and comfortable use by various user groups, such as pedestrians and cyclists, and is disaster resistant.

(2) Outline of research and activities

The National Institute for Land and Infrastructure Management (NILIM) has conducted research on sidewalk sections, roads shared by pedestrians and vehicles, bicycle traffic spaces, and roundabouts, and has contributed to the formulation of standards for road geometric structures that meet users' needs through the development of technical standards based on research results.

① Research on the width of sidewalks and other aspects

With the aging society and the spread of ideas to support the social participation of the disabled, the importance of barrier-free roads has been emphasized. It has also become necessary to properly define the width, gradient, and steps of sidewalks. Therefore, the NILIM conducted surveys and research on the height of sidewalks relative to the roadway and the geometric structure of vehicle access areas.

② Research on speed control of automobiles on roads shared by pedestrians and vehicles

The policy shifted from road maintenance that prioritized automobiles to road maintenance that took into account the safety and convenience of various users, including pedestrians. Under such circumstances, there was a growing need to provide safe and comfortable road space while utilizing the existing road stock. The MLIT has thus promoted the development of community zones and residential road zones. In preparation for the development of this policy, the NILIM conducted surveys and research on the geometric structure and other aspects of residential roads from the perspective of measures to control vehicle speeds and countermeasures against passing traffic.

③ Study on bicycle traffic space network and space design

Against the backdrop of growing health and environmental awareness, bicycles have been attracting attention as a means of transportation in recent years. On the other hand, Japan has allowed bicycles on sidewalks since the 1960s as a countermeasure against the rapid increase in traffic accidents involving bicycles and automobiles. However, accidents involving pedestrians have become an issue, and there has been a demand for the development of a safe space for bicycle traffic. Therefore, the NILIM has conducted research on network planning for bicycle traffic space and on spatial design.

④ Research on roundabout applicability conditions, etc.

Roundabouts are intersections that can ensure smooth traffic flow by applying traffic rules that give priority to the ring road. Roundabouts can reduce accidents by reducing the number of intersections between vehicles. Furthermore, based on the experience of the Great East Japan Earthquake, where intersections with traffic lights did not function because of power outages, roundabouts have attracted attention as a disaster-resilient traffic handling method because they do not rely on traffic control with traffic lights. Therefore, the NILIM has conducted research on traffic capacity (applicable conditions) related to roundabouts and on geometric structures.

2. Main Research Results

(1) Research on the width of sidewalks etc.

Mounted-up sidewalks, while making pedestrians feel safer, also create a slope in the sidewalk, making it more difficult for the elderly and disabled to pass. Therefore, experimental verification of the height of the mount-up sidewalks and the structure of the vehicle access areas were conducted to find the appropriate sidewalk width, height, gradient, etc.

Based on the results of this research, the technical standards were revised in 1999 to include provisions for sidewalk height, longitudinal slope, etc. and the introduction of a semi-flat sidewalk. In 2005, the technical standards were further revised to include height regulations for semi-flat sidewalks and the provision of wider flat areas at vehicle access points.

Figure 1 Semi-flat sidewalk

(2) Research on speed control of automobiles on roads shared by pedestrians and vehicles

Starting with the community zone development project in 1996, the residential road zone project and other projects were promoted as projects that combined speed control and device installation in residential and urban areas to implement area-wide safety measures. The NILIM investigated the effects of installing physical devices, such as speed bumps, narrow sections, and chicanes, and relocation of the outer lane of the roadway on reducing vehicle travel speeds and vehicles passing through an area. It then derived appropriate features for these devices, for example height and shape for a speed bump.

Based on the results of these studies and research, the Road Structure Ordinance was revised in 2001 include standards for physical devices, such as speed bumps and narrow sections. In 2016, a technical standard was developed that specifies the installation plan and geometric structure of the physical devices.

Figure 2 Example of the installation of a narrow section on a road shared by pedestrians and vehicles

(3) Study of bicycle traffic space network and space design

Since around 2007, the NILIM began conducting research on the structure of bicycle traffic space and intersection design methods and compiled the results in 2009 as *Key Points for Designing Bicycle Traffic Space*. The NILIM also conducted research on the concept of selecting bicycle network routes, the form of developing space for bicycle traffic (bicycle paths, bicycle lanes, roadways shared with vehicles), and spatial design methods (size and location of arrows) for traffic zones shared by bicycles and vehicles.

Based on the results of these surveys and research, the guidelines for creating a safe and comfortable environment for bicycle users (formulated in 2012, revised in 2016) were compiled. In addition, the 2019 revision of the Road Structure Ordinance provides for new bicycle traffic lanes.

Figure 3 Experiments on arrow indication
(On a road on the premises of the NILIM)

(4) Research on roundabout applicability conditions etc.

Around 2011, research on roundabouts was initiated at the NILIM. Vehicle headway times and inflow gaps were measured from a driving survey on the test road, and the results were used to estimate them in a traffic flow simulation. In this way, traffic volumes suitable for the introduction of roundabouts were studied. The results showed that it is desirable to use roundabouts at intersections with less than 10,000 vehicles per day, and so on. Based on the results of driving tests on test roads with varying roundabout structures (center island, apron, roadway, and shoulder shape) and measurements from social experiments, a study was conducted on the desirable geometric structure.

Based on the results of these studies and others, a notice was issued to regional development bureaus and other organizations in 2014 regarding the conditions for creating roundabouts and desirable geometric structures. The same information was also included in the Explanation and Operation of the Road Structure Ordinance (2015 edition).

Figure 4 An experiment on suitable traffic volume for using roundabouts

3. List of related reports and technical documents

(1) Technical Note of NILIM No. 52. pp. 160-161, No. 117 pp. 176-177, and No. 185 pp. 142-143.
(Safer road traffic environments in the elderly society)
http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn0052pdf/ks0052008.pdf etc.
(2) Technical Note of NILIM No. 253 pp. 118-119, No. 335 pp. 142-143, No. 411 pp. 136-137, and No. 470 pp. 124-125
(Measures and effects of improving road space suitable for pedestrians)
http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn0253pdf/ks025319.pdf etc.
(3) Technical Note of NILIM No. 1006 pp. 81-82, and No. 1037 pp. 65-66
(Study on effective planning and design of bicycle traveling space)
http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn1006pdf/ks100610.pdf etc.
(4) Technical Note of NILIM No. 813 pp. 16-17, No. 858 pp. 14-15, and No. 913 pp. 12-13
(Review of efficient measures for improving road functions by flexibly setting road geometrical design standards)
http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn0813pdf/ks081306.pdf etc.

4. Future Outlook

The past two decades have been a period of research on the geometric structure of roads with a particular focus on the road space for nonmotorized user entities, such as pedestrians and bicyclists, to solve local problems. Meanwhile, although road maintenance has been conducted, there remains a situation in which the level of service that each road should demonstrate, such as the travel speed of automobiles and the safety of daily life, is insufficient. This is partly due to the fact that, in planning the road network, there is a mix of low-speed arterial roads and daily life roads with a lot of passing traffic due to insufficient differentiation of the geometric structure of each road (road passability and accessibility to roadside facilities) so that each road can play a different role according to its type. The study on roundabouts also took into account some of these road network configurations and discussed intersection structures on lower-standard roads. In the future, it is important to again focus on automobile traffic and continue research to determine the geometric structure according to the configuration of the road network and the nature of the traffic that each individual road should carry.