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**Elżbieta MACIOSZEK**[1]

# ROUNDABOUTS IN JAPAN – SURVEYING, PROBLEMS AND ISSUES

**Summary**. A roundabout is not a popular intersection type in Japan. Vehicular traffic at most road crossings are controlled by traffic lights. This article comments upon a survey of Japanese roundabouts along with their numerical characteristics concerning, among other aspects, the location of roundabouts in specific areas where the surrounding is managed in different ways (that is, urban area, suburban area, residential area, etc.). Moreso, the location of roundabouts in specific regions and prefectures, classification of roundabouts according to the number of legs, outer diameter, etc. The survey in question was conducted as part of a project entitled "Analysis of the applicability of the author's method of roundabouts entry capacity calculation developed for the conditions prevailing in Poland to the conditions prevailing at roundabouts in Tokyo (Japan) and in the Tokyo surroundings" financed by the Polish National Agency for Academic Exchange.
**Keywords:** roundabouts, traffic engineering, transport.

## 1. INTRODUCTION

According to numerous scientific papers, roundabouts offer numerous advantages making them attractive in terms of transport and traffic management solutions compared to other

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intersection types of junctions. Some major advantages resulting from the use of roundabouts include [1, 3, 7, 9, 10, 14, 16]:

- significant reduction of vehicle speed when passing through the roundabout. The smaller the roundabout's outer diameter, the greater the reduction
- increased flow capacity and smoothness of traffic at the roundabout compared to other types of intersections
- less time wasted by vehicle drivers at roundabout entry legs compared to the time wasted by drivers at other intersections, which in turn translates into lower fuel consumption, reduced environmental pollution and lower costs involved in crossing the intersection
- slowing down the vehicular traffic under conditions of considerable overloading of roundabout entry legs. When roundabouts are congested, this prevents traffic from being completely halted, causing rapid growth of vehicle queues, while it only slows traffic down in a considerable manner

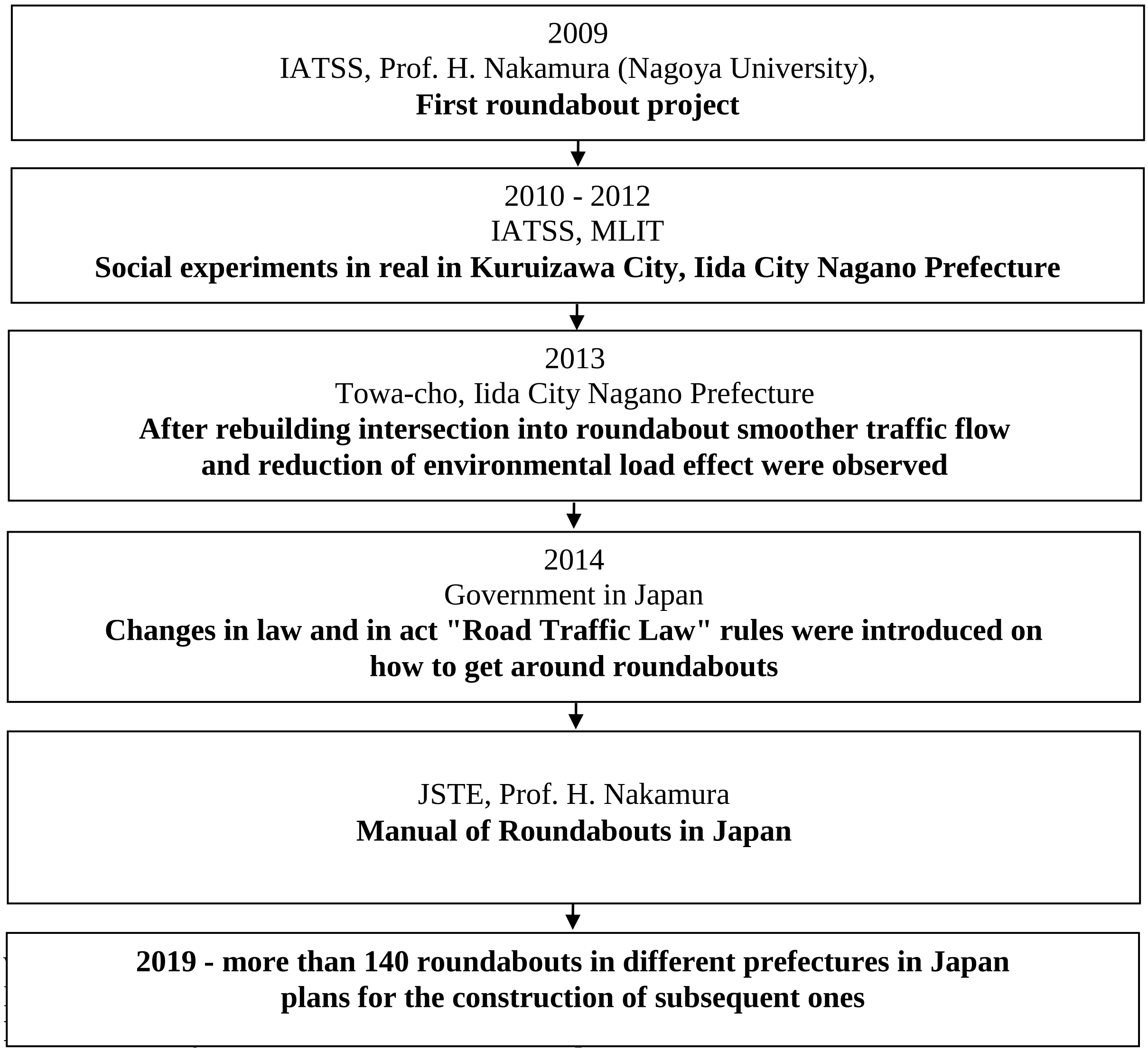
Roundabouts have become an attractive solution, especially when dealing with large streams of left-turning vehicles at entry legs. They are very often the elements, which put the terrain architecture into proper order. It is for the said advantages of roundabouts that they have been extensively designed and built in the USA as well as in many European countries since the beginning of the 20$^{th}$ century. The first roundabout in the USA was designed in 1905 by W. P. Eno (it was the Columbus Circle in New York City). The first European roundabout was La Place de L'etoile designed by E. Henard in 1905 and built in Paris. Both of these roundabouts are still operational. In Japan, on the other hand, the first roundabout was not commissioned until 2012.

As stated in [8], in 2013, the Japanese Ministry of Land, Infrastructure, Transport and Tourism established a body officially known as the Roundabout Study Committee, whose main objective was to determine traffic characteristics of intersections that could be converted into roundabouts (considering the characteristics of the given road, the specificity of traffic in Japan and the related technical challenges). Their findings before the introduction of roundabouts in Japan was the behaviour patterns of road traffic participants at different times of the year, aimed to determine changes in the drivers' behaviour while driving on roads of differing pavement conditions (dry, wet, snowy). These studies were the test component preceding the implementation of roundabouts in the cold and snowy regions, for example, Hokkaido [15]. This training ground and the results provided by traffic flow simulators were used to determine suitable conditions for the operation of roundabouts as well as to develop adequate roundabout designing methods. Some of the first roundabouts built in Japan include the following:

- 2012, Karuizawa, Nagano Prefecture – 6 non-signal-controlled intersections were converted into roundabouts
- 2013, Yaizu, Shizuoka Prefecture – 2 intersections were converted into roundabouts
- 2013, Moriyama, Shiga Prefecture – 2 intersections were converted into roundabouts

According to [11], there were 38 functional roundabouts in Japan in 2014, and 49 in 2015, while according to [6], there are currently ca. 140 of them across 32 Japanese prefectures. Roundabouts are primarily sited in residential districts as well as in suburbs and further on in urban areas. Fig. 1 provides a timeline of the activities performed while introducing roundabouts in Japan. 1.

Since Japan is an earthquake-sensitive country, the intersections where no traffic lights are required offer an additional advantage of being able to pass traffic through without obstructions even after earthquakes, which greatly facilitates any potential evacuation and rescue operations (as opposed to the popular signal-controlled intersections). The literature of this subject mentions further proposals concerning the conversion of existing intersections into roundabouts (for example, the proposal to redevelop 2 intersections in the vicinity of Tokyo Bay, which according to the authors will contribute to fostering sustainable development in the Tokyo Bay area [4]).




JSTE - Japan Society of Traffic Engineering

Fig. 1. Timeline of activities related to the introduction of roundabouts in Japan
Source: own research based on [5, 11, 12]

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This article comments upon a survey of Japanese roundabouts along with their numerical characteristics concerning, among other aspects, the location of roundabouts in specific areas where the surrounding is managed in different ways (for example, urban area, suburban area, residential area, etc.). The location of roundabouts in specific regions and prefectures, classification of roundabouts according to the number of legs, outer diameter, etc. The survey in question was conducted as part of a project entitled “Analysis of the applicability of the author’s method of roundabouts entry capacity calculation developed for the conditions prevailing in Poland to the conditions prevailing at roundabouts in Tokyo (Japan) and in the Tokyo surroundings” financed by the Polish National Agency for Academic Exchange.

## 2. CHARACTERISTICS OF JAPANESE ROUNDABOUTS

Japan is a left-hand traffic country, which makes drivers using the main circulatory roadway move clockwise. There are very few roundabouts in Japan compared to European countries or the USA (according to [13], there are ca. 140 roundabouts in the whole of Japan). Moreover, all the roundabouts surveyed are single lane junctions. It is not a popular type of intersection in Japan, and consequently, every newly built roundabout was initially perceived rather negatively by the local community. Not until public consultations were conducted and people were instructed on how to make proper use of roundabouts (these being conducted primarily in schools) did the reception of roundabouts among the general public change.

Roundabouts in Japan are typically designed for junctions of moderate traffic volume. Considering their siting, most of them are located in residential areas (64%), followed by suburban areas (17%) and urban areas (12%). Fig. 2 provides a breakdown of roundabouts according to location.

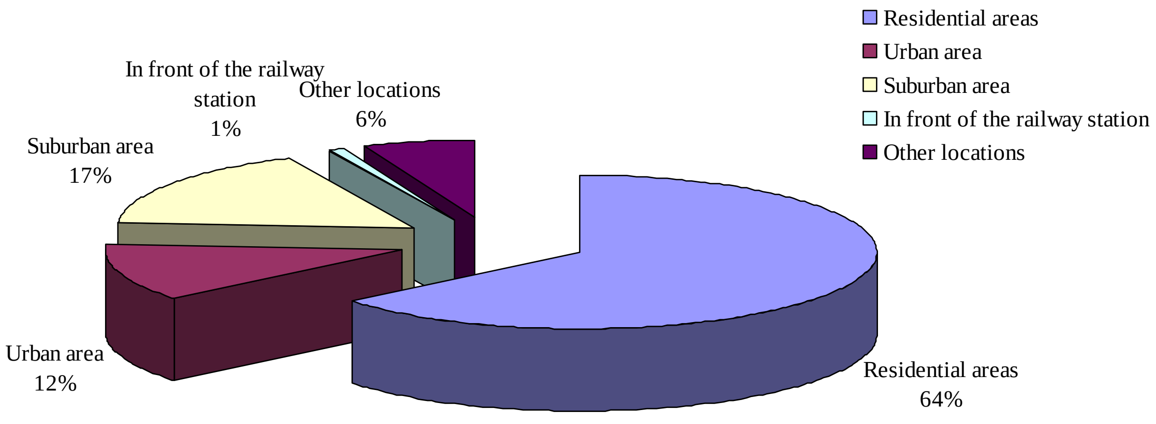


Fig. 2. Classification of roundabouts according to location
Source: own research based on [13]

The percentage share of roundabouts in a breakdown into regions and prefectures are shown in Fig. 3 and Fig. 4.

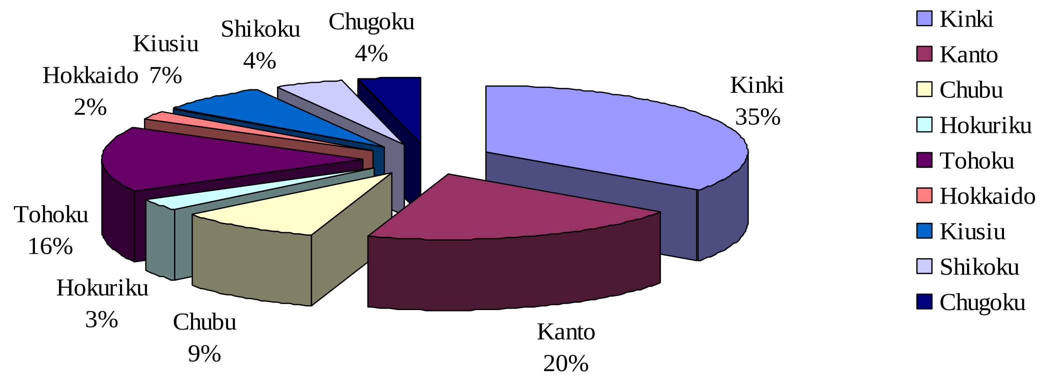


Fig. 3. Roundabouts in individual regions of Japan
Source: own research based on [13]

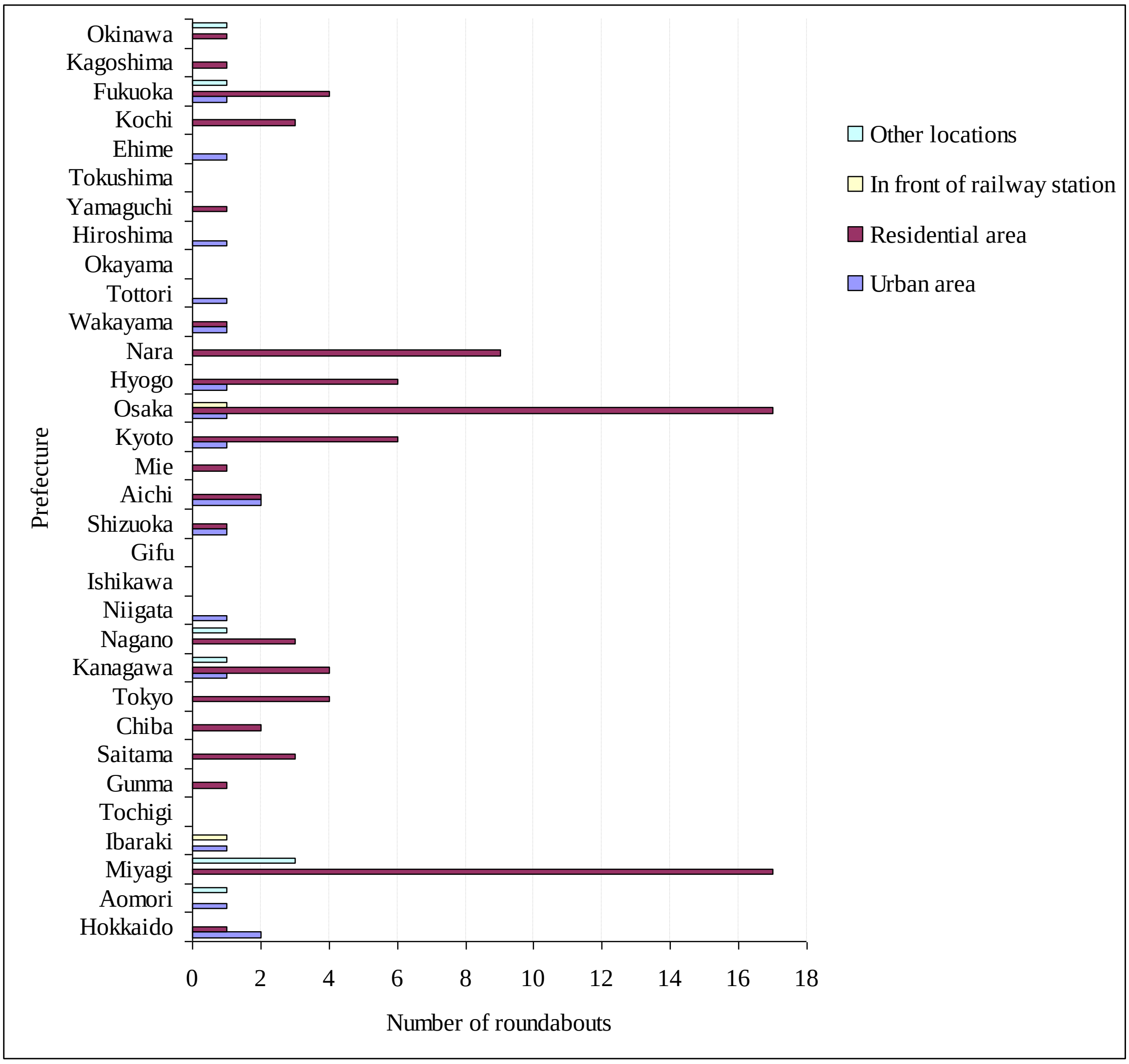


Fig. 4. Roundabouts in individual prefectures of Japan including specific locations ( urban area, residential area, in front of railway stations, other location)
Source: own research based on [13]

Fig. 3 implies that most of the roundabouts, that is, 48 intersections (35%), are found in the Kinki region, followed by the regions of Kanto with 28 (20%) and Tohoku with 22 (16%). Fig. 4 shows that the prefectures of Osaka and Miyagi have the highest number of roundabouts, with 20 roundabouts each. There are also prefectures where only one roundabout has been built so far (for example, Gunma, Nigata, Mie, Tottori, Yamaguchi, Tokushima and Ehime). According to the data provided in [13], there are merely 4 roundabouts in Tokyo. However, given the traffic organisation system applied, only one of them may be called a proper roundabout. The remaining ones are intersections with circular traffic and a central island, and they function as squares shared by the pedestrian traffic, as the infrastructure elements which enable turning back or generate circular traffic, however, they lack the characteristics of roundabouts (for example, no proper entry leg marking, parking allowed or a bus stop in the main roadway). The data provided in Fig. 4 also confirms the fact that the largest number of roundabouts is located in residential areas.

Figures 5 and 6 provide a breakdown of roundabouts according to their outer diameter and number of legs. Fig. 5 implies that a decided majority of roundabouts in Japan are ones which have their outer diameters ranging at $13m \le D_z < 27m$, and they account for as much as 43% of all operational roundabouts in Japan, and those whose outer diameters range at $27m \le D_z < 46m$, accounting for 38% of all Japanese roundabouts (where $D_z$ is the outer roundabout diameter). According to the Polish roundabout design guidelines, these intersections are classified in respect of their outer diameter under the following categories [2]:

- mini-roundabouts: $D_z < 22m$
- small roundabouts: $26(22)m \le D_z \le 40(45)m$
- medium-size roundabouts: $41m \le D_z \le 65m$
- large roundabouts: $D_z > 65m$

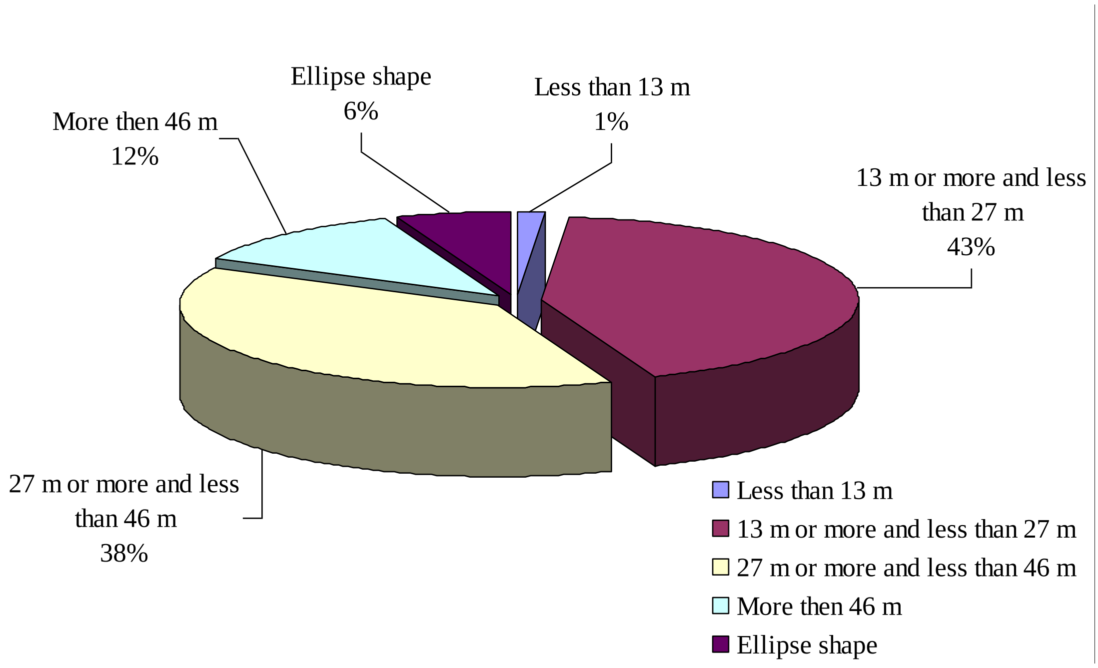


Fig. 5. Breakdown of roundabouts according to the outer diameter
Source: own research based on [13]

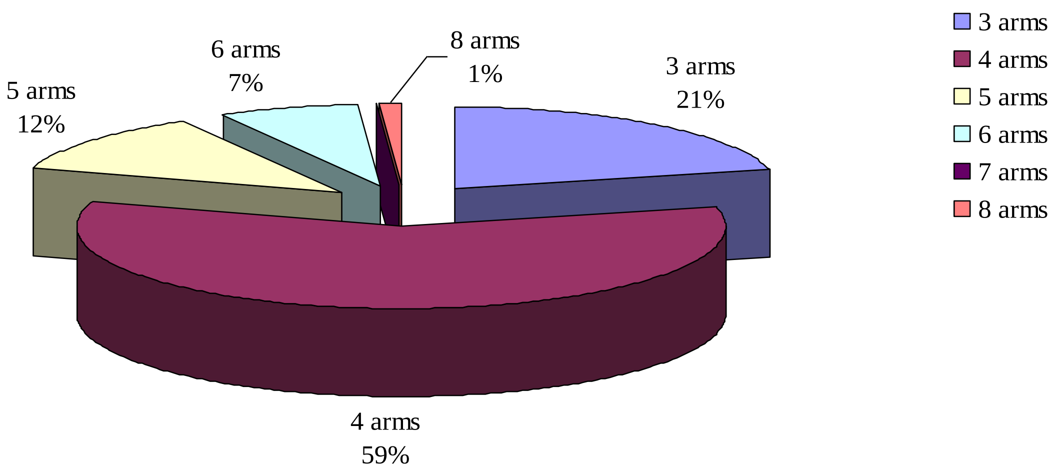


Fig. 6. Breakdown of roundabouts according to the number of legs
Source: own research based on [13]

Having compared the outer diameters of Japanese roundabouts with the values specified in the Polish roundabout design guidelines, it would be noticed that most of the roundabouts currently in operation in Japan might be classified as mini, small and medium-sized. There are also roundabouts which feature non-circular central islands – namely elliptical in eight of them.

An analysis of the data provided in Fig. 6 implies that 59% of roundabouts feature four entry legs, while 21% of them are three-leg intersections, and these two groups constitute the majority of roundabouts in Japan. However, there are two roundabouts in Japan with as many as eight entry legs. Fig. 7 implies that the outer diameter of one eight-leg roundabout ranges at $13m \leq D_z < 27m$, while that of the other $27m \leq D_z < 46m$. Roundabouts of such a considerable number of entry legs are not recommended in Polish conditions. The fact that a circular junction has been designed and built at a point of intersection of so many roads may probably be due to the fact that roundabouts have only been designed since 2012 in Japan in the absence of detailed guidelines on how to design roundabouts and the lack of experience in designing them.

Fig. 8 provides a breakdown of roundabouts according to the category of the intersecting roads. It is evident that most roundabouts are located in urban areas since both the entry and exit roads are predominantly city roads (82%). Where the roundabouts are situated at an intersection of prefecture roads and city roads (9%), they have been designed (still in a significantly smaller number) for suburban areas.

## 3. CONCLUSIONS

This article comments upon a survey of Japanese roundabouts and provides their numerical characteristics. Even though roundabouts are not particularly popular in Japan, their number has been systematically growing over recent years. The attitude of the general public towards roundabouts is slowly changing, and according to this publication [13], the reception is becoming increasingly positive (results of a questionnaire study show that 52% of those surveyed (259 out of 502 respondents) claimed that once the intersection had been converted into a roundabout, traffic conditions improved, which implies improvement in the overall perception of roundabouts). Nevertheless, still as much as 26% of those surveyed considered the traffic conditions to have deteriorated after the conversion. The opinion on the worsening of conditions in the roundabout vicinity is mainly attributable to cyclists, whose share in the road traffic in Japan is significant.

**Acknowledgements.** This research was financed by the Polish National Agency for Academic Exchange as a part of the project within the scope of Bekker Programme "Analysis of the applicability of the author's method of roundabouts entry capacity calculation developed for the conditions prevailing in Poland to the conditions prevailing at roundabouts in Tokyo (Japan) and in the Tokyo surroundings".

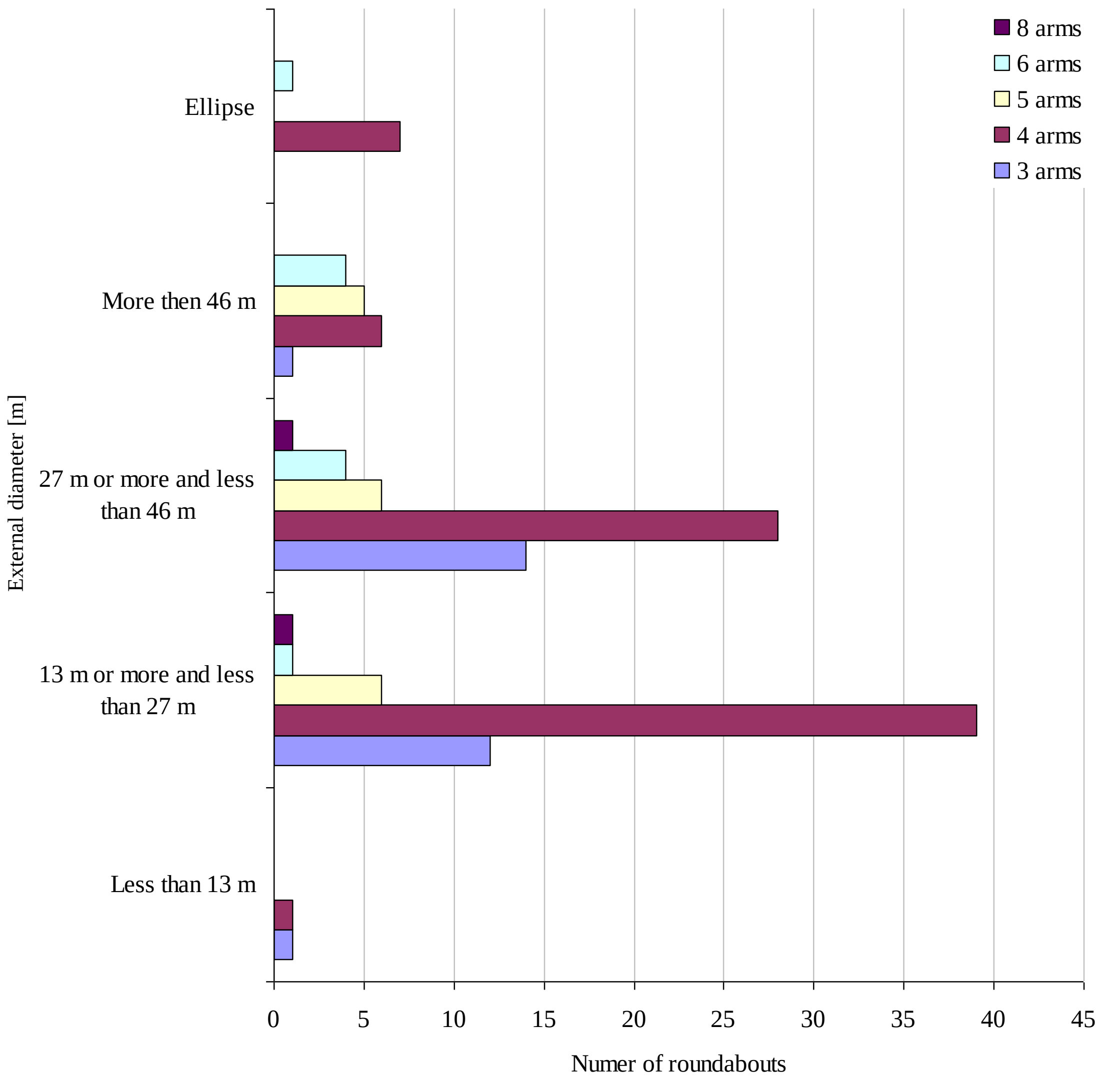


Fig. 7. Breakdown of roundabouts according to the number of legs and the outer diameter
Source: own research based on [13]

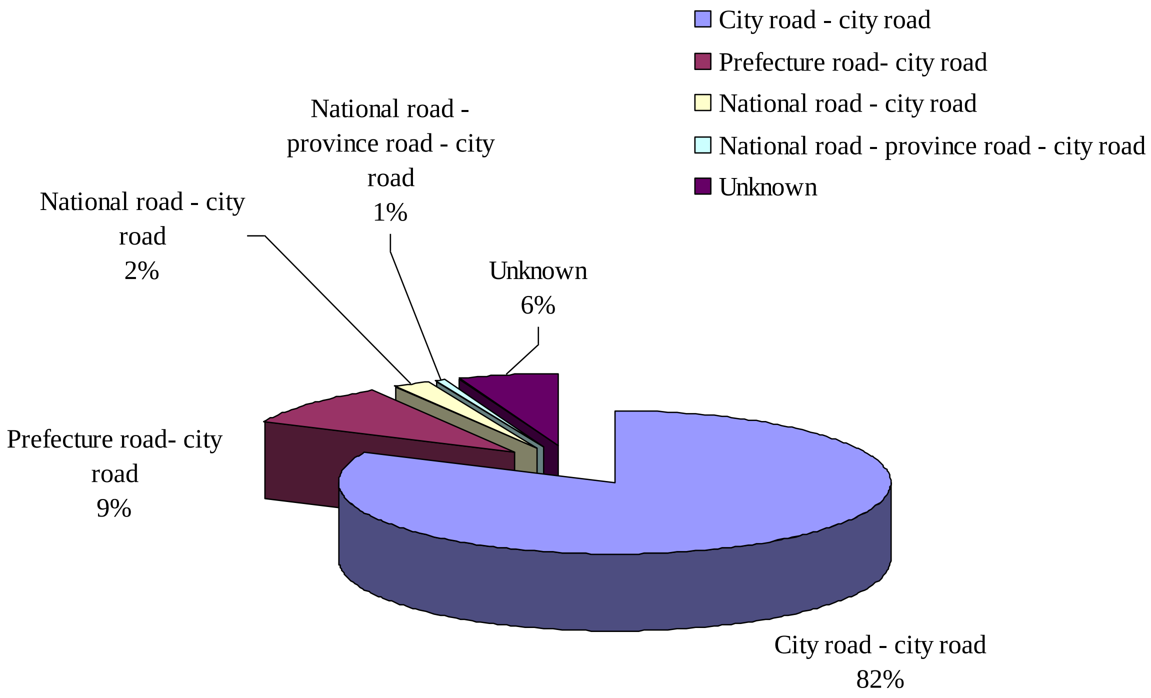


Fig. 8. Breakdown of roundabouts according to the category of intersecting roads
Source: Own research based on [13]

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