THE NEW GUIDING SYSTEM OF NATIONAL EXPRESSWAY NETWORK IN CHINA

Huixue Liu, Feng Yang, Zhiyong Sun, Yucai Song
Research Institute of Highway, Ministry of Transport, China
Hx.liu@rioh.cn

ABSTRACT

With the rapid construction of infrastructure in China, an interconnected expressway network has been formed. By the end of 2009, the total length of expressway has reached 65,100km, nearly 85% of which belongs to national expressways. Because constructed by sections and by different authorities, the guiding system gradually becomes unsuitable for the motorists' travel across the network. Many problems come forth, such as "One expressway with many names, guide sign messages without consistency and hierarchy, overload messages, shortage of service-related information", etc. To settle these issues, ministry of transport of China decides to carry out "project of naming and numbering national expressway network" from March 2007. Through unremitting efforts including relative research and design of pilot project, the new guiding system has been formed until now. The new system is characterized by "digitalizing information, networking information, systematization, human oriented layout, standardization". It is proved that the new guiding system can improve the travel efficiency, enhance the traffic safety, and serve the motorists better than ever.

1. INTRODUCTION

1.1. Background

In Dec. 2004, *National Expressway Network Plan* was approved by the state council, which is composed of 7 radial routes from Beijing, 9 vertical routes from north to south, and 18 horizontal routes from east to west. The total length is 85,000km. From 1988 to the end of 2009, the mileage of expressway open to traffic has changed from zero to 65,100km in mainland China, and 7 provinces has reached over 3,000km. The expressway network has taken effect, and plays a more and more important role in national economy and social development.

But due to the mode of sectional construction and sectional management at the early building phase of expressway, the naming of routes was decided by the sectional names of origin and destination. Taking Beijing-Tibet expressway for example, it was named Badaling expressway, Jingchang expressway in Beijing municipality, Jingzhang expressway, Danla expressway in Hebei province, Huji expressway, Hubao expressway in Inner Mongolia autonomous region, etc. Under the new circumstances of networked expressway, this kind of naming mode with obvious localism would bring about a series of problems, such as "one expressway with many names, guide sign messages without consistency and hierarchy, overload messages, shortage of service-related information", etc. These issues are inconvenient for the cross-boundary travel of the public, unsuitable for the requirement of highway networking and information management. To some extent, The function and service level of national expressway network was affected.

1.2. Main tasks

To settle these issues, ministry of transport of China decided to carry out "project of naming and numbering national expressway network" from Mar. 2007. Professional standard *Naming and Numbering Rules of National Expressway Network* was issued on Jul.3, 2007. Accompanying with the issuance of the *Technical Guidelines for the*

Replacement of National Expressway Network Related Traffic Signs on sep.26, 2007, the new guiding system of national expressway network was put forward. At the same time new guide sign design drawings of pilot project of G2 (Beijing-Shanghai Expressway) Beijing-Tianjin-Tanggu section were done and finally constructed in Dec.2007. After that, national standard *Road Traffic Signs and Markings* (GB5768-2009) and professional standard *Specification for Layout of Highway Traffic Signs and Markings* (JTG D82-2009) were both implemented, which fully absorbed the new guiding system.

2. NEW GUIDING SYSTEM

Aimed at solving the existing problems, the new guiding system was put forward on the basis of the study result of motorists driving behaviours including their information requirements and process procedures. The new system absorbed not only the advice of experts from home and abroad, but also the related standard and specifications of the developed countries.

The new guiding system consists of route direction signs, roadside information direction signs, roadside facilities direction signs, tourist attractions direction signs, and related notification signs used to publicize the name and number of national expressway and safety driving prompt signs.

2.1. Route direction signs

Route direction signs are used to provide the expressway users with the messages from origin to destination, including 4 main information of the route number, place names to be reached, travel direction, and distance to the destination, etc.

2.1.1 *Classification*

Route direction signs can be divided into the following kinds:

(1) Entrance guiding signs, including entrance advance signs, entrance destination and direction signs, name and number signs.

Entrance guiding signs would guide motorists to enter the expressway smoothly. Control cities or other important cities should be chosen as the direction information. Entrance guiding signs should be installed according to the road, traffic condition and requirements of traffic management.

(2) Travel confirmation signs, including destination and distance signs, name and number signs.

Travel confirmation signs are used to make motorists conscious of their routes and directions. Destination and distance signs should provide with long, medium and short distance destination information.

(3) Exit advance and exit signs, including exit advance signs, exit signs, destination and direction signs, etc.

Exit advance signs would provide the motorists with crucial information for them to leave or keep driving along the route. Route number and related 1-2 destination information should be supplied in these signs.

2.1.2 *Layout sequence*

Based on the analysis of motorists driving process, the route direction signs should be laid out in the following sequence so as to match their expectancy and reduce their reaction time.

Entrance advance signs→Entrance destination and direction signs→Name and number signs→Destination and distance signs (or next exit signs, decided by the distance of interchanges)→Name and number signs (subject to the distance of interchanges)→Exit advance signs→Exit signs→Destination and direction signs.

The information of related route direction signs should keep consistent and continuous.

2.2. Roadside information direction signs

2.2.1. Expressway start and end signs

Because there exists great difference in the aspects of geometric condition, traffic composition and roadside facilities between expressway and conventional highway, it is necessary to lay out expressway start and end signs. But when one expressway connects another expressway (including urban expressway), the expressway end advance signs may be cancelled, and the end signs could be simplified.

2.2.2. kilometre and hectometre signs

Kilometre signs should be installed in median or both side of the expressway. The number of kilometres should be counted in the whole country basis. The location where the hectometre signs are installed should be convenient for the use of motorists when needed. The number of kilometres should also be appeared in the hectometre signs.

2.2.3. Keep distance signs

When the distance of interchanges is greater than 10km, and motorists tend to drive faster, keep distance signs may be installed to warn motorists potential dangers. The quantity of such signs should be controlled so as to avoid the side effect to other important signs.

2.3. Roadside facilities direction signs

Such roadside facilities as service areas, parking lots, toll stations, etc. should be supplied with direction signs. In order for the motorists to choose appropriate service area, the advance signs of the next 2 or 3 service facilities should be installed.

2.4. Tourist attractions direction signs

In order to meet the leisure and tourism requirements of the public, tourist attractions of 4A and above level may be provided with direction signs. The famous tourist attractions, which may generate huge traffic flows, may be used as name of destinations.

2.5. Notification signs

Because the motorists are unfamiliar with the new guiding system, notification signs are used to publicize the name and number of national expressway. Moreover, notification signs may be used to remind the motorists of some safety driving rules.

3. IMPLEMENTATION CONCEPTS AND PRINCIPLES

3.1. Implementation Concepts

The project of naming and numbering national expressway network is not simple change of route name, but rather characterized by “digitalizing information, networking information, systematization, human oriented layout, standardization”. The project is based on the geometrical and operational characteristic of national expressway network, and aimed at providing the public with safe and convenient service.

3.1.1 Digitalizing information

Information digitalization contributes to the efficiency of information transfer of traffic signs. Number of highways (including expressway, national, provincial, and county highway) defines the guiding characteristic and geographic direction of every highway. When used as messages of traffic signs, the quantity of destinations can be limited and the format of traffic signs can be simplified. Number of national expressway has its own meaning. 1-digit number means the 7 radial routes from Beijing, 2-digit odd number means vertical routes from north to south, 2-digit even number means horizontal routes from east to west. Exit number means the distance from the exit location to the origin place. By the widespread use of such information, this project provides the public with simple and efficient

messages, and avoids the instance of “one expressway with many names” and “overload messages”, etc. Figure 1 is an example.

Figure 1 - Example of digitalizing information

3.1.2 Networking information

The highway network should be treated as a whole object, and the layout of traffic signs should be overall planned. The information should be changed from the destination names to the route number (or name) incorporated with destination names. Traffic signs in specific sections should be laid out on the basis of network. The information in traffic signs should embody the relation of different routes and sections so as to guarantee the uniform, reasonable, and orderly (Figure 2). Besides, the information between the expressway and conventional highway should be responded each other so as to play a big role in traffic volume adjustment and emergency rescue.

Figure 2 - Example of networking information

3.1.3 Systematization

Systematic and hierarchical characteristics should be reflected when choosing the messages of traffic signs. The information of guide signs should meet the requirements of continuity and consistence in order for the motorists to receive complete and interconnected information on time. Figure 3 is an example showing the main guide signs between two interchanges.

By using systematic method, traffic signs should also be coordinated in both function and forms with such facilities as traffic markings, traffic supervision and control facilities, etc.

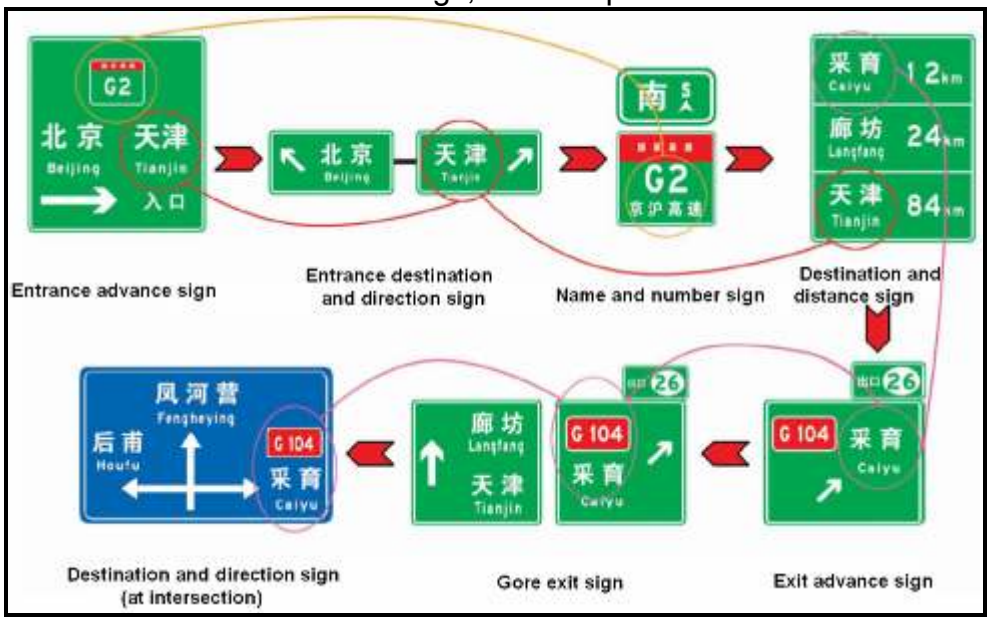


Figure 3 - Example of information systematization

3.1.4 Human oriented Layout

Physiological and behaviour characteristics of motorists are the basis of layout of traffic signs. Factors of vision, information needs, information processing procedure, expectancy, and reaction time of motorists should be respected. For an example, motorists unfamiliar with the adjacent network should be focused. Information needs of long, medium and short distance users should be considered. Besides, overload messages should be avoided because of the limit of information processing capability.
Moreover, graphic signs reflecting the basic profile of junctions may be widely used to guide the motorists to choose the right route. Figure 4 is an example.

Figure 4 - Example of graphic signs

3.1.5 Standardization

By adhering to the work programme of “Unified arrangement, unified standard, regulated layout”, the project of naming and numbering national expressway network received better result of uniformity and normalization.

3.2. Implementation Principles

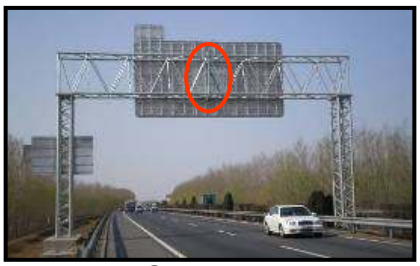
3.2.1. Scientific and rational

Based on the implementation principles of “scientific, rational, and aesthetic”, the present standard was complemented. In 1986, the national standard *Road Traffic Signs and Markings* was established for the first time, when there was no expressway in mainland China. In 1999, the standard was revised, when the length of expressway was 11605km. But the network wasn’t formed and the expressway was built section by section. In order to solve the existing problems of traffic signs, “scientific, rational, and innovative” principle had to be used and the latest research results in the field of traffic sign layout and legibility in China and advanced countries such as America, Japan and Germany, etc.

3.2.2. Economical

The economical principle should be used so as to reduce the cost of engineering. For an example, the former support should be fully used (Figure 5 a). In some sections where it will be expanded in the near future, the support structure should be specially designed in order to be utilized after expansion (Figure 5 b).

a) The scheme of replacement of sign panels and utilization of the former support



b) Support structure design considering the expansion requirement

Figure 5 - The design scheme of sign support

4. MAIN CONTRIBUTIONS

4.1. Name and number signs of national and provincial expressway are put forward, aimed at confirming the route of the users.

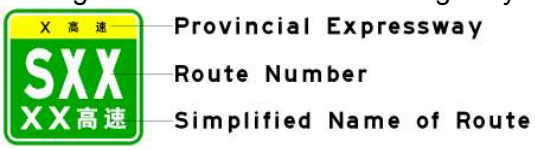
4.1.1 Function

As stated before, the route number determines the guiding characteristics and defines the geographical direction of every expressway. Under the circumstances of expressway network, motorists have to transfer their driving routes frequently, and need to confirm their driving directions. Such work will be done by the name and number signs.

4.1.2 Sign format

In national standard of GB5878-1999, number signs of national, provincial and county conventional highway were put forward, but there was no number signs of expressway. In professional standard of JTG A03-2007, the name and number of main routes, connecting routes, parallel routes and ring routes of national expressways are stipulated. In order to reflect the information above correctly, obviously and legibly, the simple and aesthetic schemes are put forward as illustrated in figure 6.

a）National expressway: The red strip representing “National Expressway” in accordance with the number sign of national conventional highway



b）Provincial expressway: The yellow strip representing “Provincial Expressway” in accordance with the number sign of provincial conventional highway

Figure 6 – Name and number signs of expressway

4.1.3 Layout

The name and number signs (Figure 7) should be laid out at the start of expressway, and suitable location entering the main routes. These signs may be laid out repeatedly if the distance of interchanges is too long.

a）Single route

b）Combined routes

Figure 7 – Illustration of name and number signs of expressway layout

4.2. Directional signs are put forward, convenient for the users to identify their travel direction.

The numbers of national expressway network are arranged on the basis of orderly rules. For examples, 2-digit odd numbers refer to the north-south bound, 2-digit even numbers refer to the east-west bound, directional information may be supplementary to control cities along the route. In some countries, directional signs are used for the guide of entrance of expressway. By referring to the pilot experience of Beijing municipality in China and

foreign countries, the directional signs are put forward and widely used (Figure 8). The directional signs are often laid out with the name and number signs.

a）Combined with name and number signs

b）Auxiliary signs showing the travel direction in combined routes

Figure 8 - Directional signs in China

4.3. Arrangement rules of kilometre and hectometre signs are put forward, convenient for the users to identify their present location.

4.3.1. Kilometre signs

Kilometre signs (Figure 9 a) are arranged on the national basis, that is to say, the radial routes start in Beijing, the vertical routes start from the north origins, and the horizontal routes start from the east origins.

The advantage of this scheme is to stress the entity and continuity of national expressway network, and convenient for the users to locate their positions.

4.3.2. Hectometre signs

On the basis of the sign format of the national standard, the numbers of kilometres are added in the hectometre signs (Figure 9 b). When emergency incidents happen, it is easy for the motorists to locate their accurate positions.

a）Kilometre signs

b）Hectometre signs

Figure 9 - Illustration of kilometre and hectometre signs

4.4. Exit numbering rules of expressway are clearly indicated, and the locations of exit number signs are adjusted.

In order to confine the quantity of destination names of exits, interchanges should be numbered. The exit numbers should appear in the exit advance signs (including exit signs). There are two method of exit numbering: The first is used in America, Canada, etc, which uses the number of kilometres of exit locations as exit numbers; the second is used in Japan and Europe, etc, which uses continuous numbers as exit numbers. The advantage of the first method is that the exit numbers needn't be changed when interchanges are added, and motorists can calculate their travel distance and determine their distance to the destinations. The advantage of the second method is that the motorists can have continuous driving feelings. Considering the construction of highway network isn't finished, the first method is used (Figure 10).

Figure 10 - Exit numbers of expressway in China

4.5. Information of exit advance signs focuses on the main messages of route number (or name), destination name, geographic direction and distance, etc.

As exit guiding signs, exit advance signs play an important role in realizing the safe and convenient transfer. In order to embody the relation of highways, route number (name) information shall be focused. The travel direction can be indicated when the direction is very clear. The destination names can be chosen by the class of interchanges. For interchanges formed by expressways, names of control cities should be chosen. For interchanges formed by conventional highways, names of important places should be chosen. Figure 11 is an example.

a) Interchange formed by expressways b) interchanges formed by conventional highways

Figure 11 – Illustration of exit advance signs

4.6. Multiple exits advance signs of urban area are put forward which are convenient for the motorists to choose their nearest exit.

With the rapid development of urban area and the extension of expressway network, there often exist many exits for a city, which need the traffic signs to inform the motorists to choose their nearest exits and avoid detouring. By referring to the international expertise, multiple exits advance signs of urban area (Figure 12) are put forward with the suitable adjustment of relative guide signs.

Figure 12 - Multiple exits advance signs of urban area

4.7. Information of destination and distance signs meets the requirements of long, medium and short distance users, reflecting the hierarchy of information.

By providing the destinations ahead, destination and distance signs (Figure 13) play an important role in the new guiding system. 3 lines are often used, and the key point is how to choose the three destinations.

Because undertaking cross-boundary and high-volume transportation tasks, the national expressway network has its user composition of not only medium and short distance, but also long distance users. In choosing the name of destinations, the short, medium and long distance information shall be chosen: The most important information such as capital of province and autonomous region and municipality shall be acted as long distance destinations, arranging in the third line and keeping relatively fixed. The destination which can be reached through the next interchange shall be acted as the short distance information. Other important destination other than that appears in the first line shall be chosen as the second line information, such as city of deputy provincial level and prefectural level. If no above information exists, relative route numbers may be chosen as needed.

Figure 13 – Illustration of destination and distance sign

4.8. Some sign formats are improved and perfected, graphical signs are recommended. By doing so, traffic signs become an important element of beautifying the expressway.

Except for the name and number signs of national and provincial expressway which have been chosen on the basis of many schemes, the pattern of advance signs of service areas and parking lots has been beautified. The colour of those signs is adjusted and the representative symbols have been improved and are easier to recognize and distinguish (Figure 14).

a）Advance signs of continuous service areas and parking lots

b）Advance sign of service area

Figure 14 – Illustration of advance signs of service facilities

In order to improve the transportation efficiency, the toll collection mode in China has been changed from conventional manual mode to combination mode of manual mode and electronic toll collection mode (ETC). Toll gate and toll gate advance signs representing the toll collection mode are added (Figure 15).

Figure 15 - Illustration of toll gate advance and toll gate signs

Graphic signs can clearly show the profile of the interchange to be reached, and directly guide the motorists to choose their exact driving routes. So the graphic signs are recommended for the complicated interchanges or sections (Figure 4).

5. IMPLEMENTATION EFFECT

At the end of 2010, the project of naming and numbering national expressway network finished. From the feedback of expressway users, it is widely recognized that the new guiding system is clear, simple, and aesthetic, and reflects the relations of highways and characteristics of cross-boundary and high-volume transportation. The new system is easy for the motorists to transfer routes and plan their journey.

At the same time, the motorists are unfamiliar to the new names and numbers of expressways because the project is based on 45,000km expressway that are already open to traffic. At the early stage, it is necessary to widely publicize the new system by different means. Figure 16 is an example of Beijing.

Figure 16 – Illustration of notification signs
publicizing the name and number of national expressway

CONCLUSIONS

Aimed at solving the existing problems of traffic signs formed in the extension of expressway network, the new guiding system is put forward by referring to the domestic and international experience and latest research results. The new system sticks to the concepts of “Digitalizing information, Networking information, Systematization, Human oriented layout, Standardization” and principles of “Scientific and rational, Economical”. The delivered schemes are adaptable to the development of network, and focus on the reasonable selection of guide messages. It is proved that the new guiding system can improve the travel efficiency, enhance the traffic safety, and serve the motorists better than ever.

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