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# What can be Learned from the Design Philosophy of American Highway

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**Abstract:** As with the development of the society, people demand higher on the comfortability of highway driving, which requires more emphasis on feelings of users when designing highways. Comparing with China, American highway designing lays more stress on the accordance with surroundings both culturally and naturally with more flexible designing standards. Those design standards and philosophies are worth studying.

**Key words:** American highway; Design philosophy; Environment; Route

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## 1 Introduction

America's highway transportation is one of the most advanced around the world. With highway network plan being made in 1940s, a large number of highways were constructed during the 1950s. After more than 70 years of construction, American highway surpassed others not only in distance, but also in the design concepts and geometric designing methods resulting in high level of integration, good view and low accident rate. The author participated in an international highway design project abided by American standards and examined by international consultant. During which the author gained a certain degree of understanding of American highway design philosophy and would like to share them in this work.

## 2 Basic Concept

American highway design believes that uniqueness exists in every project and its location, and multiple factors such as natural and cultural environment, community form, needs of highway users should all be taken into account. In the National Highway System Designation Act, the U.S. Congress highlighted that a design for new construction or reconstruction of a highway on the National Highway System may take into account the constructed and natural environment of the area; and the environmental, scenic, aesthetic, historic, community, and preservation impacts of the activity except for adequately serving the existing and planned future traffic of the highway in a manner that is conducive to safety, durability, and economy of maintenance. To meet various requirements from different areas towards highway design, the US highway has been paying attention to public involvement and the comprehensive application of different subjects. Local residents and related communities in the area are able to take part in the designation no matter the project is in planning phase and developing phase, which let designers be well informed of their travel demands, natural or cultural heritages needing preservation and other specific factors.

During detailed designing phase, designers would work with a team formed by professionals from different fields including landscape architects, area designers, eco designers, scholars or artists, creating a highway blending into the environment perfectly instead of merely satisfying travel needs.

As is mentioned, the landscape design is of great importance during detailing designing phase since it acts as the most obvious part for the users. It would be better-looking to unify plants, lightings, pavements or even safety rails with surroundings. These details could improve the overall image of the highway and increase the comfortability of drives.

## 3 Categorization of Highways

US highways are divided into 3

categories according to the function: arterials, collectors and local roads. (see in Chart 3.1) The function level of a road should be confirmed before starting a design project according to existing traffic system along with the long-term transportation plan.

**Table 1 Classification of American Highway**

| Function system | Services |
|---|---|
| Arterials | Have certain entries and exits; offer uninterrupted and high-speed traffic; provide best service. |
| Collectors | Collect arterials and local roads; offer relatively low-speed and mid-distance traffic; provide general service. |
| Local Roads | Mainly offer low-speed traffic between urban and rural areas as well as residential areas. |

Once the level has been confirmed, the designated speed range could be determined with other parameters such as plane grade, longitudinal slope and form of cross sections. However, according to A Guide to Achieving Flexibility in Highway Design Revision published by AASHTO (American Association of State Highway and Transportation Officials), the geometric design of highway could choose parameters with flexibility even though the category has been determined. At the same time, the functions would change with surrounding environment and society, which requires parameters meeting the long-term plan.

**4 Route design**

Route design is the key of the whole project, choices like directions, parameters and combinations of basic line shapes would act as decisive factors of investment control, construction, operation and maintenance. It is necessary to choose compatible parameters to make the route smooth-going, continuous and blending into surroundings instead of pursuing high-standard parameters for a good-looking route or a safely-operating project.

A Policy on Geometric Design of Highways and Streets by AAATHO (shortly referred to as "The Policy") is recognized as national universal standards for American highway design. The Policy does not match specific numbers with key parameters such as circle curve radius, longitudinal grade and vertical curve length, instead, it calculates based on different occasions

$$R_{\min} = \frac{V^2}{127(0.01e_{\max} + f_{\max})}$$

and gives recommended value. Then the designers could choose feasible values under different circumstances.

For instance, The Policy believes that minimum radius of plane route depends on maximum superelevation (emax) and maximum friction coefficient (fmax) under different designed speed (V) and gives the equation:

According to the Equation, The Policy recommends the minimum radius under different designed speed.

As for parameters corresponding only with designed speed such as spiral curve length, the recommended value is usually low in the safe range, making it more flexible for designers to set parameters.

Although The Policy is not compulsory for all states, all highway design standards point out that some parameters directly or indirectly come from The Policy, and generally choose the mid or the lower limit. Thus the designers could select reasonable parameters according to current technical, natural and cultural conditions.

**5 Cross Section Design**

American highway design adopts relatively flexible philosophy in the cross section design, considering safety and feelings of users when driving as important criteria. The recommended driveway width range in The Policy is 2.7m to 3.6m without particular designation according to speed, the exact value depending on the designed speed and traffic flow. Likewise, The policy only gives recommended range for the width of the median and road shoulder, all designed parameters should be set under comprehensive consideration of traffic safety, capacity and surroundings.

In order to reduce the harm brought by errant vehicles, The Policy recommended that the width of lateral clearance of highway should be more than 3.0m, which could provide space for errant cars to slow down in emergency so as to prevent huge damage as well as reduce the possibility of secondary damage.

The joints of cross sections should be arcs rather than polylines, which could stabilize the roadbed and reduce the damage caused by accident. The arc joint could also meet the visual needs of highway users and make it easier for the ecological treatment of side slope and median, improving appearance and integrating the highway with surrounding environment.

**6 Over-standard Design**

Although there is high flexibility in the choice of parameters, occasions happen when minimum standard still cause huge environmental impact or high expense on construction, and it is the time using over-standard design. When the highway belongs to US National Highway System, over-standard design projects have to be discussed and authorized to carry out. Issues that should be considered are:

(1) Project cost and environment impact when abiding by standard;

(2) Whether the functions of highway will be influenced when lowering standard;

(3) The compatibility with other highways in the area when lowering standard;

(4) Traffic safety influence under over-standard design.

**7 Conclusion**

American highway design lays more stress on surrounding cultural and natural environment, attempting to blend into the surroundings. Thus, designers are offered enough space under highway standard as long as they meet safety prerequisites. Also, they are allowed to conduct over-standard design, making it more flexible when designing highways. Comparatively speaking, China's highway standards are more specific, more convenient for designers to choose the exact value. Nevertheless, this would lead to a higher attention on standards rather than conditions of natural and cultural environment, causing insufficient integrity with surroundings.

We should learn from American design philosophy and pay more attention to the relation among highway, people and the nature, making the highway safer, better-looking, and more comfortable for the users.

**References**

[1] AASHTO, A Policy on Geometric Design of Highways an Streets [S].2004.
[2]Li Haifeng, Dai Dongchang, Guan Changyu, etc. The Flexibility of American Highway Design[M]. Beijing: Transport Planning and Research Institute, 2006: 61-77.
[3] Tan Hongxia. Shallow Arguments on Differences of China's and U.S. Highway Geometric Design [J]. Engineering Construction and Design, 2003,11.
[4] Zhang Xing. Comparative Study of Technical Parameters in Domestic and Abroad Route Design[D], [Master's Degree Thesis]. Xi'an: Changan University, 2011.
[5] Wu Yanling, Wang Zhuoya, Liu Wei. Inspiration of Highway Design in China from American Highway Design Ideas [J]. COMMUNICATIONS STANDARDIZATION, 2008, 02/03.