

A NEW CONCEPT OF LANDSCAPE DESIGN IN HIGHWAY CONSTRUCTION

DEJUN GONG¹, HUA XIE², XUEJUN XU², XINSHA FU² and HAIFENG LI²

¹Institution of Highway Computer-Aided Design, Changsha University of Technology, Changsha, China. E-mail: gongdejun@hotmail.com

²College of Traffic and Communication, South China University of Technology, Guangzhou, Guangdong, China. E-mail: xh316@163.com

ABSTRACT

Roads in China have developed dramatically since the 1990s, evolving into an extensive system of interconnected freeways. Lessons learned during this evolution indicate that the landscaping of highways is as important as their safety. In the past decade, highway aesthetics and the striving for harmony between highways and nature has attracted many specialists to improve the landscaping of highways. However, no criteria or operational regulations for the design of highway landscapes have been introduced in China. This paper therefore presents a new concept of highway landscape design that integrates highway planning, design, operation and landscaping during the lifecycle of a highway.

First, some elements of highway landscaping are summarised. Next, six models of highway landscaping, emphasising highway alignment, pavement and side slopes, highway structure and subsidiary facilities along the highway corridor, which may be applied to the design of highway landscapes, are presented. The conception and implementation method, which integrates highway planning, design, operation and landscaping by means of GIS tools and computer software into the whole lifecycle of a highway is discussed in detail. Finally, the prospects for applying landscape design in highway construction are examined. It is fascinating to see how the trails and paths of days gone by have evolved into today's landscape design which aims to maintain the scenery and environmental quality for the future.

Keywords: Highway construction, Landscape design, Landscape element and model

1. REVIEW OF THE LANDSCAPE

The highway (road) system has dramatically changed the landscape in China. The early 1990s saw the growth of cities and the rise of public transport. The later 1990s saw the growth of suburban superhighways and the increased use of motor vehicles. With the development of the highway system, more and more attention has been paid to highway landscape design, and the landscape of highways is as important as their safety. Highway aesthetics and striving for harmony between highways and nature has attracted many specialists to improve the landscape of highways.

In the USA, until the early 1950s, engineers typically understood how to incorporate the highway into the landscape because they worked in multi-disciplinary teams with landscape architects or had training in sympathetic layout and construction. By the late 1950s, the Bureau of Public Roads (BPR), the American Society of Landscape Architects and the Highway Research Board (now the Transportation Research Board) emphasised that basic

highway design, layout, planning and construction were as important aesthetically as the added details, minor structures and landscape planting, and that the road should be integrated into the land it crossed.

The landscape architect seeks to obtain the most functional, economical and aesthetic results in physical land planning. The structure, the principles and outlines of highway landscaping are known and Zhiyong He (2003) advocated highway landscape design that is in harmony with nature and that should be integrated into highway planning, design and construction.

Engineers collaborate with the landscape designer at an early stage of the project and endeavour to use the road construction process creatively to achieve high-quality new landscapes in the countryside (see 3 highways website).

Landscape architects are constantly developing new tools and techniques to make roadways more compatible with the landscape and communities. Recent developments include widely used computer-based visualisation techniques, visual quality and visual preference assessment methods, and the development and enforcement of legislation, policy and guidance. Currently, numerous multi-disciplinary teams, inter-agency collaborations and public-private partnerships are being guided by landscape architects, including those implementing highway projects designed to respect their context or place.

In recent years, the development of the Geographic Information System (GIS) has made timely temporal and spatial information accessible. Moreover, its capability of spatial analysis and presentation makes it a useful tool for studying landscape spatial structure and for landscape change analysis.

The integration of landscape ecology and GIS into landscape design will probably become the main focus of research in future, but the following key issues should be dealt with as effectively as possible:

- Describe the content of a broad landscape corridor according to landscape theories.
- Present the models of the highway landscape, which should be in harmony with the highway geometrics and aesthetic design, and which should be conducive to highway landscape design.
- Define the tasks and requirements in each stage of the highway landscape design.

Based on these objectives, this paper presents a new concept of highway landscape design that integrates highway planning, highway design, operation and landscaping during the highway's lifecycle. The following sections present the elements of highway landscaping and six models of highway landscapes, followed by a discussion of the design concept and recommendations for applying landscape design in highway construction.

2. ELEMENTS OF HIGHWAY LANDSCAPES

All the types of scenery that road users could experience along the highway are elements of highway landscapes. That the elements are varied and their contents are abundant is an important characteristic of highway landscapes. It involves detailed consideration of the following four factors: the scenery of highway construction, the landscape of facilities along highway corridor, distant views, and some uncertain factors.

2.1 Scenery of Highway Construction

Highway alignment, highway structural design, road materials, side slopes, the highway cross-section and the organisation of their space constitute the 'scenery of highway construction'. The colour of the asphalt and the type of road materials used, for example, can greatly affect highway landscape, but they may be specified only in a few travel areas due to the high cost of construction. Different side slope treatments, such as planting grass and paving the facing wall, have various effects on the highway landscape. Along the travelled way, the reasonable allocation of proportions to roadways, median strips, walkways, and so on, is extremely important for a pleasing highway landscape, particularly in urban areas. The alignment of the highway can give a pleasant impression to road users, and what is more, the rise and fall of the alignment also influence road users to appreciate the landscape. Highway alignment therefore has a basic function in highway landscaping. Furthermore, the whole usage of space in the highway has a pivotal effect on the highway landscape.

2.2 Landscape of Facilities Along the Highway Corridor

The facilities along a highway corridor include various road signs, advertisement boards, vacant land (such as parks and rivers) and some buildings apart from the highway itself (parking lots, toll plazas, etc.).

2.3 Distant View

Distant view can be divided into two types: natural landscape and cultural landscape. Natural landscapes may contain mountains, oceans, lakes, forests, etc. Cultural landscapes may contain elements such as clock towers, city walls, historical sites, etc.

2.4 Other Diversification Factors

The indispensable diversification factor is human beings. The activities of man influence the highway landscape and may even enrich it.

Moreover, highway landscapes change with time. From spring to winter the distinctive highway landscape brings different agreeable prospects to road users; from day to night various pleasant landscapes could also be enjoyed.

3. THE MODELS OF HIGHWAY LANDSCAPES

It is advisable to integrate the construction of highway landscapes into the planning, design and construction of a highway, with all the elements of highway landscapes taken into account fully. In accordance with general highway design, this paper sorts highway landscaping into six models, each of which could be easily integrated into the planning, design and construction of a highway, thus effectively accomplishing highway landscape design. The six models are described below.

3.1 The Model of Highway Alignment

The alignment of a highway is the foundation of the whole highway landscape design and its characteristics impact on the quality of the whole landscape design. The alignment of a highway should be in harmony with the terrain, surface features, geology and geographical environment, and should be combined with the settings and layouts of bridges, tunnels, intersections and various facilities along the highway. Furthermore, it should be in line with the theory of sustainable development as far as possible.

The highway alignment landscape model is applied in the stage of planning and preliminary design. The designer can carry out a visual analysis and evaluate the alignment landscape of the highway in advance so as to set up a highway alignment landscape model.

The main factors that should be considered while setting up a highway alignment landscape model are as follows:

- The alignment should meet the standards of highway design and the requirements of security.
- Every effort should be made to avoid dullness in the alignment so that road users receive the best visual effect. (Here 'road users' refers to both drivers and passengers).
- The alignment should be adapted to the local natural environment. This will reduce the destruction of the natural landscape during construction to the greatest possible extent and may even enrich the natural landscape.
- The overall arrangement should be in accordance with the local topography. Furthermore, alternation between curving and straight-line highway landscapes should also be taken into consideration to enrich the highway alignment landscape.

3.2 The Model of Pavement and Side Slopes

The pavement and side slope landscape model consists of comparing the proportions allocated to the road cross-section, considering the character and colour of the pavement materials and the close-up design of the side slopes. Zhiyong (2003) asserts that "road users always move in a certain direction. As the vehicle speeds up, both the driver and passengers are increasingly less able to have head movement. Instead, their attention would be directed to the lane and side slopes". Therefore, further investigation into the road lane and side slope view can ensure the safety of road users and give them better views.

The following factors should be considered when using the pavement and side slope landscape model:

- The median strip should be planted with shrubs, small trees or grass, which are anti-dazzle, dust-resistant and tolerant of strong sunlight. The anti-dazzle and shielding angle of the median strip must be within 8° to 15° and the height must be limited so as not to obstruct the road users' sight and to guarantee road security. (Investigation shows that the best average height is between 1.8 and 2 m).
- The side slope view, especially in cuttings, is very visible to road users, so the form of the side slopes should be changed as often as possible. For example, flowers and trees can be planted on the upper slopes to increase the rate at which the view changes, as well as to absorb the noise and lessen driver fatigue.

3.3 The Model of Highway Construction

The highway construction landscape model mostly applies to the landscape design of bridges, tunnel entrances and cloverleaf junctions.

The following factors should be considered while setting up the highway construction landscape model:

- While designing a bridge landscape, the designer should think carefully about the type of bridge structure, the colour it is to be painted, the lighting, the entrance and exit signs, the surrounding natural views, etc.
- The features of a cloverleaf junction landscape should fully represent local culture and be in harmony with the natural environment. It is recommended that grass should be planted along with shrubs and trees; this arrangement will not obstruct but direct the drivers' view, reduce soil erosion and beautify the road view.

- The landscape of the tunnel entrance should be in harmony with the surrounding trees and mountains. Large trees at the entrance should help road users to adapt smoothly to the environment in the tunnel, and prevent the exhaust gases of vehicles from circulating in the tunnel. Pictures of local features could be painted on both sides of the tunnel entrances, to enrich the tunnel entrance landscape.

3.4 The Model of Subsidiary Facilities Along the Highway Corridor

The subsidiary facilities landscape model covers various buildings, sightseeing platforms, parking lots, toll plazas, lighting, guardrails, various traffic signs, traffic administration facilities and so on. The function, aesthetics and the reasonable distribution of facilities should be well thought over to provide road users with an environment that is comfortable and secure.

3.5 The Model of Highway Greening

Directing sight and enriching the road view are the main tasks of highway greening landscape design, which includes the distant-view design of slopes and the landscape design of the areas where highway alignment changes in an obvious way. The former type of design, say planting trees at a T-junction and along the outside of a curve, plays a role in directing sight, while the latter type of design is aimed at enriching the road view and co-ordinating the natural landscape with the artificial view along the road.

3.6 Other Landscape Model

The other landscape model deals mainly with the landscape of the future and various other factors. As the rivers, springs, waterfalls, lakes, oceans, beaches, ancient temples and courtyards along the highway corridor could not be easily changed, thought should be given as to how to integrate them into the overall highway landscape design so as to fully include the local colour of a particular highway and give a special, memorable aesthetic impression to road users.

4. THE CONCEPT OF INTEGRATING LANDSCAPES INTO THE WHOLE LIFECYCLE OF THE HIGHWAY

The concept of using Geographic Information Systems (GIS) to quantify the landscape design and using the six models to analyse the road landscape is illustrated in Figure 1. Highway engineers collaborate closely with the landscape designers at the early stage of a highway project, such as project planning, and endeavour to achieve beautiful new landscapes along highway corridor during road construction process.

Planning phase: In this stage, land planning and design for extensive areas and large-scale developments commences with an overall master plan containing drawings and written analyses of existing and required facilities, plans for future management and development, and construction priorities and programme information. Such a master plan is usually composed of land-use and other basic information maps, area or general site plans for future development, and narrative reports.

The macro-effect of the road network planning should be considered. It consists of the highway alignment landscape model and other landscape models. Ways of integrating the local scenery into the highway landscape should be investigated so as to improve the highway landscape. For instance, if there were to be a stretch of virgin forest or a cluster of historical sites of high archaeological value in the planning area, or if any damage to the natural landscape would threaten some endangered species or some historical and cultural

legacies, then the planning departments should commit themselves to fully protecting these natural resources and historical legacies during road construction.

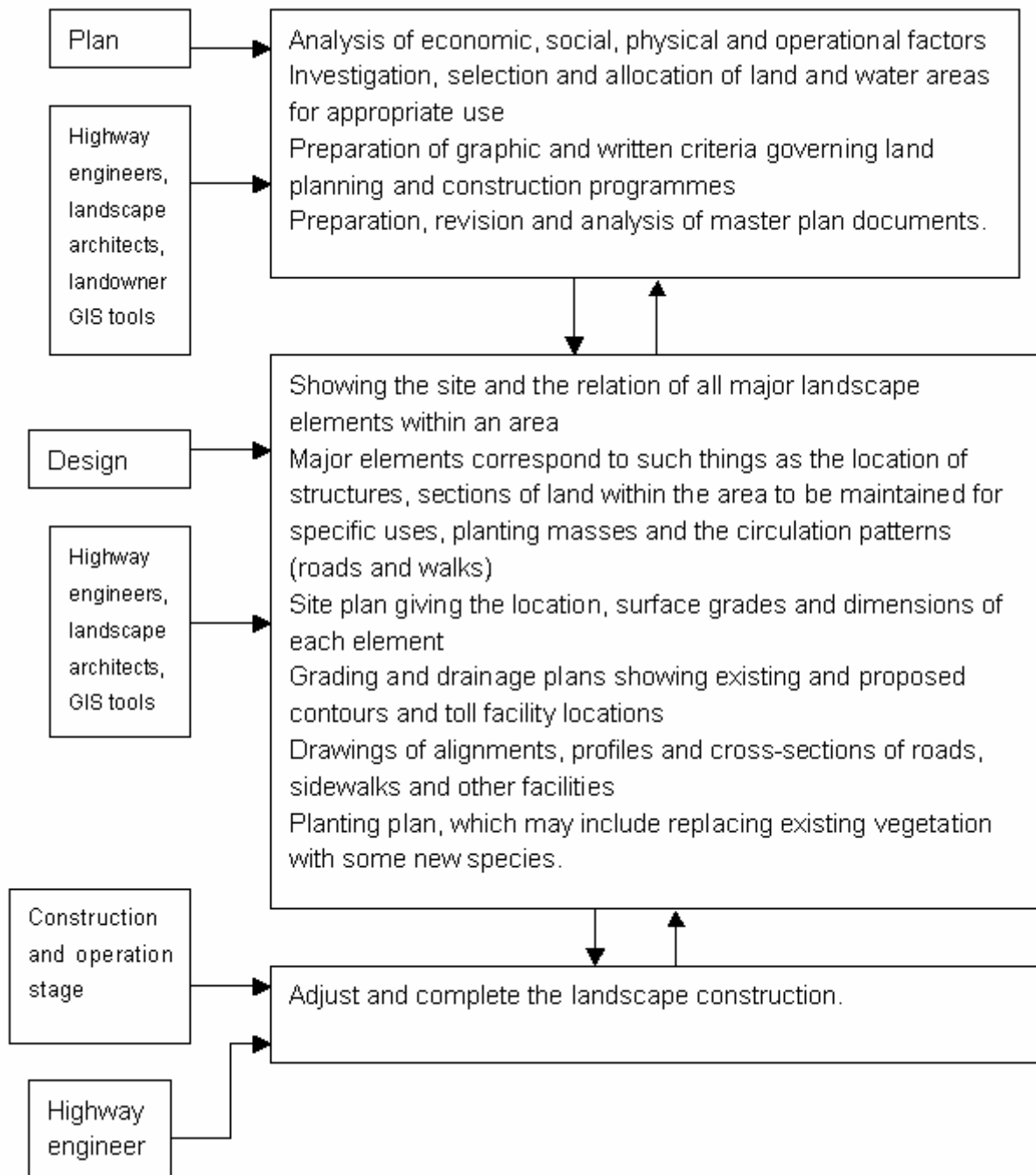


Figure 1. Design flow diagram of highway landscapes.

Design phase: The highway alignment landscape model and the other landscape model are firstly properly considered, then the highway construction landscape model, the pavement and side slope landscape model and the landscape model of subsidiary facilities along the highway corridor are also considered. The road alignment scheme is pivotal to the engineering design and is the foundation of subsequent designs, and it plays a fundamental role in landscape design. The geographical features and topographical forms along the alignment, such as archaeological and historic sites, rivers, streams, forests, distant views, mountains, oceans, lakes, natural patterns of the land, etc., should be properly thought about. Whether the way in which the alignment of a highway links with a city is reasonable, and whether it is in harmony with the original natural landscape or

man-made views should be carefully appraised. Thereafter, the detailed schemes, such as structure of subsidiary facilities scheme, and the greening design scheme, are designed, compared and chosen. Naturally, the designer's imagination and creativity are also indispensable here.

Construction and maintenance phase: Adjust and complete the landscape construction, particularly with regard to greening style and complementary subsidiary facilities, and also attend to the newly built surrounding structures.

This paper summarises and analyses the exciting subject of highway landscape design, and then integrates the construction of highway landscapes into three stages: highway planning, design and construction. Although the aims and tasks of each stage are separate, they are also closely related to each other.

This relationship can be described as follows:

- Despite the different objectives of each stage, they are all aimed at creating a better highway landscape and environment.
- Despite the different tasks of each stage, they ultimately aim at an effective highway landscape with pleasing views .
- The tasks of each stage are sequential and closely related to the whole of the highway's service life, i.e. the quality of works completed at a previous stage will have a great impact on the following stage.
- Common basic information is needed at every stage, including civil engineering techniques, road planning and landscape aesthetics.

5. CONCLUSIONS AND RECOMMENDATIONS

In this paper, the features and models of highway landscapes are analysed in detail, then a new concept of highway landscape design, which integrates highway planning, design, operation and landscapes into the highway's service life is presented.

The recommendations for the application of landscape design in highway construction are:

- Commission an appraisal of a broad landscape corridor before alignment begins to be fixed from an engineering viewpoint. Such an appraisal would not only identify aspects of the landscape that could be damaged by road construction, but would identify local landscape characteristics and seek opportunities for landscape development and management which could arise out of the road project.
- Work closely with landscape architects, ecologists and archaeologists throughout the design process in developing a preferred alignment for a new road or the widening of an existing one; be prepared to place a high value on environmental factors, even if it proves difficult or impossible to price them in purely financial terms.
- Where appropriate, look for ways of widening the 'road corridor' to ensure proper integration of landforms, woodlands, hedges, ponds and other features of landscape value, including wildlife habitats; look for opportunities to create significant new features adjoining the road, even if they are not required primarily to reduce the impact on the environment.
- Look for opportunities, in partnership with other landowners or authorities, to improve the landscape of the wider 'zone of impact' visible from or associated with the road, thus improving the view from the road and using the process of road construction to 'put something back' into the landscape.
- Ensure that the design of structures and use of material are sensitive to local landforms and establish a 'sense of place'.

- Establish landscape budgets where necessary for the upgrading of existing roads, as well as for ensuring adequate financial provision for landscaping work related to new roads.
- Using GIS and quantitative indices of landscape structure to evaluate the effects that a proposed highway design may have on the landscape is a feasible and effective approach, which is useful for planning landscapes and studying such designed areas in future.

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