



Road aesthetic adaptation to its surroundings

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ABSTRACT

The position of a roadway in space is univocally defined by its horizontal and vertical alignment. Visual faults, arising as a result of unsuccessful combination of horizontal and vertical road alignment, affect the perspective of a road and control the drivers' capability to estimate the speed they could achieve, the provided oversight, and the drivers' deduction of their route. The picture of the driver's position in space could help to construct an aesthetically good road, which will pleasantly affect people circulating on it or observing the landscape on which the road is weaving. Aesthetic issues of a road (planting, retaining walls construction, form of noise walls and bridges) are discussed in connection to measures to be taken by engineers and architects. Comments concerning the proper combination of horizontal and vertical road alignment are made aiming the aesthetically pleasant, adapted in the environment, relaxed during driving and safe road alignment. Actions and measures for the vegetated areas around the roadway are proposed bearing in mind aesthetics.

Keywords: road design, visual impacts, aesthetics, alignment in space, adaptation

1. INTRODUCTION

Aesthetics, considered as a scientific-philosophical category, researches and studies -at all levels- the development determinisms and laws of shaped relations between man and the objective reality. These relations are called aesthetic relations. The aesthetic relations are a human process, are an attribute that man acquired through his historical and social evolution and it is the result of the reflection of the objective reality in his conscience [1].

Proper aesthetic design permits the introduction of positive visual impacts to highway building or improvement projects. This aspect is complementary to the efforts for the protection of existing natural or manmade visual resources as well as the goal to conform to adjacent landscapes. Large roadway elements such as bridges, retaining walls, and noise walls, can greatly affect roadway appearance [2]. When a highway is being designed, it is important to bear in mind that landscape influences the road and vice versa. The road architecture is influenced -among other issues- by economic interests, the construction techniques, legislation, and landscape ecology or even by the historic heritage [3]. All the above mentioned features should be taken into consideration as a whole, in order to produce an integrated view of the quality of the road.

The ancient Greek philosophers and art critics were of the first to describe the relationship between the visual experience and the aesthetic pleasure. This strong association has been demonstrated in social science and design literature [4-7]. Though other senses have also an aesthetic effect, sight dominates the aesthetic experience of landscapes [8]. On the other hand, the movement through the landscape is a complex experience which cannot be fully captured by a single, static view. Thus, the valid representation of the landscape's visual quality is a methodological question in dealing with visual impact assessment [9].

2. DRIVERS PERCEPTION AND BEHAVIOR

A basic prerequisite for highway studies is to offer an alignment corresponding to the expectations of drivers and creating a uniformly drawn roadway. The expectations of drivers are shaped through various experiences and they have a significant consequence in the driving because they increase the driver's readiness to correspond in road's requirements. A road with

uniform speed environment that corresponds to the expectations of drivers is desirable so that are avoided the abrupt changes in the speed of movement with result the guarantee of a safe road environment. The use of design speed as it is currently determined and used by the researchers does not lead to the required uniform fluctuations of the speed of movement and usually the design speed is lower than the desirable speeds.

In 1987, Taylor and his colleagues demonstrated that driving information is mostly obtained from the outside environment [10]. The decisions made by drivers are highly influenced by the landscape along the roadsides. The influence could be either positive or negative results. Nature scenes have positive influence on driver behavior, because natural settings have an optimal level of complexity to be appealing [11]. Aesthetics is a desired outcome of the road design in parallel with safety. Landscape may contribute to both ensuring a safer driving, while being compatible to the roadway surroundings [12, 13]. Drivers seeing natural roadside views show lower levels of stress or frustration compared to those viewing built settings [14].

Carefully landscaped roadside edges having enough features to be interesting make the drive experience more pleasant than the highway option, contributing on the other hand to higher degrees of attentiveness [15]. In such a way, the increased quality of visual aesthetic and increased attention may indicate a positive influence on improvement in driver safety. Appropriate landscaping and planting has also a psychological effect of reducing driving speed [16]. Streets with landscaped centre strip or median planting may alter driver's perception of lane width and, therefore, reduce driving speeds.

3. AESTHETICS OF RETAINING WALLS AND SLOPES

Both retaining walls and slope configuration constitute a means of reformation of outdoor spaces having great importance from a static view as well as an aesthetic impact. A nice appearance of these massive natural or artificial elements makes them compatible to the terrain crossed by a highway and other adjacent structures. The aesthetic result must be reached for all reinforced slopes and visible retaining walls taking into consideration criteria of functionality and cost effectiveness. A set of requirements from the aesthetics point of view are the carefully designed wall face and the selection of its material, the appropriate finish of the surface in terms of its pattern, texture and color, the shaping of the terminals and the top profile. Referring to the height of retaining walls aesthetics play a role, especially when other

features and qualities (seismic risk, bearing capacity, long-term durability, current practice, etc.) are warranted.

Relaxation of the semi rock soil cohesion could potentially result in slippage or depression of the slope requiring preventive retaining measures to balance the pressures and retention of soil masses. The option was to construct a concrete wall reinforced with buttresses whose slope varies following the configuration of the side of the natural slope. So, the array of supports penetrates with mildness in the artificial terrain offsetting their inhibitory action. This technical interference is shown in Fig. 1. The concrete structure with the mild breaking of its inclination is open to mentalization beyond its technical function, i.e. it looks like a sculpture artefact that resonates with the intimate moments of the soil or the erosive runoff of waters and the subsequent landslides event. The work resembles a votive work recalling the harsh and daring act of digging to build the mountain road.



Fig. 1 A concrete retaining wall in the Aliakmon River area, West Macedonia, Greece, having buttresses with varying slope [17]

Roadside slopes need to be planted; thus irrigation conduits must be provided wherever possible. Design undertaken to improve appearance of retaining walls including provisions for planting and irrigation will render an outcome of visual softening. The blending to the surrounding areas will be achieved in a natural manner. High continuous walls are not desirable and stepping must be implied. Between the steps plantings may be provided. It is usually difficult to provide a soil at the wall face suitable for growing plants and being adequate in meeting engineering requirements (drainage characteristics, compressibility,

strength). In some cases, it could be attempted to have plantings (grasses, small plants, or vines) on facings with welded wire.

4. AESTHETICS OF BRIDGES

Bridges are elements of the rural and natural landscape easily noticeable by road users. In order to be thought as part of the whole scenery and not intruders, an effort should be made to reduce their size and screen them in the surroundings (hiding effect). In the case of large bridges or long overpasses it is not suitable to hide them the landscape [18]. If a bridge is made simple and elegant, as much as possible, then it can complement the existing natural landscape or an urban setting [19]. A third way to give a bridge special emphasis is to make it stand out in the landscape coming in contrast to it. Figure 2 shows a bridge on the Kosynthos River, Xanthi, Northern Greece.



Fig. 2 Bridge at Kosynthos River, Xanthi, Greece, contrasts and stands out in the landscape

The external shape or appearance of a bridge relates to the bridge type, the way different parts are arranged, and the order or rhythm of elements to create an overall visual impression. Specifically, the form of an elegant bridge is influenced by its simplicity, the consistency and unity of its design, the symmetry or asymmetry of its elements, their proportionality, rhythm and order, and their detailed structure. Harmonic combination of these details may lead to good looking bridge solutions.

In rural settings, bridge complexity should be minimized, since it attracts the eye and compete with views of the landscape. A simple bridge form outlines the landscape and provides an aesthetically pleasing contrast with the natural textures of the scenery. Minimal facets and simple shapes provide a good landscape contrast. It is also essential to highlight the primary visual elements (dock and parapet) of a bridge, while reducing the road furniture to a minimum. Generally, dark landscape tones should be contrasted by light colors such as plain concrete.

When the scenic value of the area is high, the built and natural environment should be visible through the bridge, the landscape should be allowed to dominate the view, and views from the bridge must be maximized in order to establish milestones and landmarks on the route, improve the interest of road users and make drivers more alert and aware of their surroundings.

Water always forms a horizontal plane and a bridge skewed to that plane may appear incompatible, adding needless complexity. If bridges could not take a horizontal form due to differing levels either side of the water mass, then the location of the bridge should be fine-tuned.

5. AESTHETICS OF NOISE WALLS

Noise barriers in the form of earth berms, high vertical walls, or a combination of the two are designed to reduce the loudness of traffic flows. These solid constructions are built between the street and residence buildings, offices, shops, or public buildings. They cannot completely eliminate all traffic noise and are most effective within 60 m of a roadway, usually the first row of homes. Besides being more natural in appearance, earth berms reduce noise more (~3 dB) than vertical walls of the same height due to their tops that are soft and relatively broad [20]. Although noise barriers do not require much space, they may have height restrictions due to structural requirements or aesthetic considerations [21].

Noise barriers can be built out of wood, stucco, concrete, masonry, metal, insulating wool, and other materials, having varying absorption coefficients, α (0 for fully reflective to 1 for fully absorptive materials). It is desirable for absorption coefficients to be better than 0.8 at frequencies which are significant in the traffic noise spectrum. On highways involving other concrete structures it may be economical to use in-situ concrete to construct noise barriers. Different techniques could be used in constructing noise barriers (precast planks in H shape or

linked at various angles). Concrete noise barriers benefit from low-maintenance, but are relatively expensive.

Wooden noise barriers are manufactured using frames of wooden joists and sound-insulating planking of suitable thickness. Their face to the side of noise is constituted of eels and their interior is filled with thermo-welded polyester fibers that have unlimited life duration and are not influenced by the atmospheric conditions. They are ideal whenever the harmonic incorporation of the barriers to natural environment is required. Landscaped barrier systems, including living barriers of willow or similar woody plants may also be aesthetically attractive.

People walking on sidewalks or driving down the streets are better oriented if the noise barriers are manufacture of various materials and transparent panels are incorporated at eye level. Transparent materials reflect noise allowing light pass to areas which will be placed in the noise wall's shadow if it is constructed using opaque materials. Plastics have for a long time been used in absorbent panels, apart from their existence in transparent panels. They have the disadvantage of becoming brittle after a prolonged exposure to sunlight, especially those manufactured with polyethylene. They are also vulnerable to fire and could easily be damaged by vandalism actions.

Galvanized metal sheets usually comprise the external side of noise walls while the internal side is constructed with perforated metal sheets. The color of the metallic parts of a noise barrier could be in a wide chromatic range; green is the most calming for drivers. As a fill material, sound absorbent materials are selected. The panel spans would be larger –hence fewer supports are required- if aluminum is used, since it has high strength value taking into account it is lightweight.

6. INTEGRATION OF A MOTORWAY IN THE LANDSCAPE

The surrounding landscape should constitute a guide for plantings, making the integration of the road to it feasible and creating to the traveler a sense that is part of the landscape he crosses (Fig. 3). For example, when forestall vegetation dominates then more trees must be planted, while in open landscapes less trees must be planted. The planting has to be asymmetric with different tree masses which must be in harmony and equilibrium with the existing volumes and not rows of trees which signal the road from a long distance and differentiate it against the landscape.



Fig. 3 Road to Komnina, Xanthi adapted to the landscape

Biodiversity of planted or preserved vegetation provides food and shelter for small mammals and song birds. Because grasses and forbs have deep and fibrous root systems, they increase the strength of the slope and prevent erosion. By protecting plants, endangered species are also protected. Grasses growing on the land and slopes around transportation infrastructure capture much of the precipitation before it hits the ground and being absorbed by it. The run off is better absorbed by the deep roots. Therefore, rainfall picks up less fertilizers, agricultural run-off, etc. Roadway features, such as concrete median barriers, paved shoulders, and extended vegetation clear zones represent safety related design elements.

Highway infrastructure, such as landscaped edges, grassed shoulders, vegetated medians, other landscape elements within 10 m of the edge of the driving lanes, is associated with all the above mentioned issues and in harmony with existing surrounding development and nature [22]. To enhance road beauty, guidelines for planting should include measures and actions like:

- Roadside vegetation is designed or maintained to accomplish specific goals of sight-distance, clear view of obstructions, erosion control, and aesthetics.
- Plants are not planted where they may obstruct driver visibility, sightlines, or signs.

- On frontage roads, at least 1 m clear space between the back of curb and any area to be maintained is allowed for maintenance personnel.
- In intersection areas, plant use is limited to low-growing species.
- Plants are not placed near merging lanes.
- Landscape improvements do not create unsafe conditions for motorists or maintenance personnel.

For the integration of scenic beauty of roadside vegetation into its management programs, it is necessary to record the opinions and preferences of road users who are the actual targets of all roadside beautification plans [23, 24]. This information would be helpful in analyzing the current status of roadside vegetation in the public eyes and for determining the broad grounds for its effective management.

7. CONCLUSION

Aesthetics are hard to handle. For an aesthetically excellent road design, engineers have to bear in mind multiple issues, as avoiding locating sharp horizontal curves at or near the top of a crest vertical curve or at the low point of a sharp vertical curve, designing horizontal and vertical curvature to be as flat as possible in the area of intersections to allow for proper sight distance, formatting a pleasant facing in retaining walls or selecting the best fitting materials for noise walls.

At points where horizontal and vertical curves converge, the horizontal curve must be longer than the vertical one. It is preferred to have only one vertical curve in the space where the horizontal curve extends. It is also desirable to have a road designed providing on tangent alignment a tangent grade. If a curve breaks the sight distance in either the vertical or horizontal alignment, then there is no requirement for a tangent maintained for a long distance.

The ideal alignment extends between control points without unnecessary curvature in the middle section. However, driver's boredom may cause problems when extremely long tangents are provided by the designer of the roadway.

In order to ensure the most effective harmonization of horizontal and vertical road alignment, a multidisciplinary planning and design team is suggested to be involved in all engineering phases of a highway project.

With ever increasing use of roads for transportation in modern life, the roadside vegetation has become one of the major elements of the roadside environment which people experience on a frequent basis. In the past, the engineering and traffic related issues in construction and management of roads and their vegetation were given the highest importance and the ecological issues were neglected by the highway authorities.

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