

SELECTION OF SOME TECHNICAL ISSUES FOR RURAL ROAD CONSTRUCTION IN JIANGSU PROVINCE

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ABSTRACT

In order to reach a challenging goal for rural road construction in the Jiangsu Province of China, some technical issues related to road construction should be settled. This paper starts by confirming the principles used for the selection of a technical classification for rural roads based on an intensive investigation done in Jiangsu, a province of China with a high density of roads. Second, the appropriate applications of pavement structures are examined. Third, some technical parameters related to the composition of pavements are discussed, such as horizontal alignment, vertical alignment, transverse sections and the height of the subgrade. These solutions to the technical problems with regard to low-grade rural roads will have a great influence on rural road construction in other regions of China.

Keywords: Rural road, Rural highway, Technical standard, Technical index

1. INTRODUCTION

In order to develop the economy and improve the living standards of the people in rural areas in China, the Chinese government decided to step up rural road construction. The Department of Transportation timeously issued the newly revised *Technical Standard of Highway Engineering* in March 2005 to improve the classification of roads and related technical parameters for the extensive and rapid development of road construction. The Standard classifies roads into five categories, namely Expressway, Grade One, Grade Two, Grade Three and Grade Four. However, it does not deal specifically with the rural roads (including unclassified roads) that link counties, towns and villages — the three levels of administration in rural areas in China. Because these rural roads amount to about 50% of the total 1.8 million kilometres of Chinese roads, it was necessary to do practical research to develop a functional classification and detailed technical parameters for these roads. It is planned to build 40 000 km of rural roads in Jiangsu Province in the next 3 to 4 years. In order to reach such a strenuous goal, some technical issues related to rural road construction (particularly for roads between townships and administrative villages) should be settled.

2. CHOICE OF TECHNICAL GRADE FOR THE RURAL ROAD

For easy construction of a rural road, as well as relative consistency between the technical indices of road construction, the technical criteria for rural road construction in Jiangsu Province should principally adhere to *JTG B01—2003 Technical Standard of Highway Engineering* issued by the Communication Administration of China. Based on the field surveys of rural road construction conducted in Jiangsu, the following stipulations were established: (1) roads between counties and towns shall principally adopt technical indices as for Grade Two or above (district with developed economy and heavy traffic flow), as

<hr/> Surface: cement concrete slab 15 – 18 cm <hr/> Old roads: with clay-bound macadam or crushed gravel surface (levelled and compacted)	<hr/> Surface: asphalt concrete 3 – 5 cm <hr/> Base: lime-flyash-stabilised macadam 15 – 20 cm <hr/> Old roads: with clay-bound macadam or crushed gravel surface
(3) rebuilt cement concrete pavement (one lane)	(4) rebuilt asphalt pavement (one lane)

Figure 1. Typical pavement structures for roads between towns and villages.

4. SOME OPTIONAL TECHNICAL PARAMETERS FOR THE RURAL ROAD

4.1 Minimum Length of Straight Line

The alignment of the road is based on the existing natural conditions, and routes must be harmonised with the geological conditions rather than adopting straight horizontal routes or continuous curves (Ministry of Communications, People’s Republic of China, 2004). Generally, it is reasonable to specify that the minimum length (in m) of straight line between same-direction adjacent curves shall be no less than six times the design speed (in km/h), and the minimum length (in m) of straight line between reverse curves shall be no less than twice the design speed (in km/h). The lines in Figure 2 are determined according to the driver’s visual response, as well as psychological endurance. The route takes into account the geological conditions, surface features and natural landscapes, and the optical illusion. (As Figure 2 shows, the length of straight route section, as judged by human eyes, must differ visually if the inclination where the ends of the straight route section and straight lines meet varies). The authors suggest that the following adjustments can be made to the length of the straight route between same-direction adjacent curves and reverse curves when the horizontal route of a rural road with a design speed of 20 km/h is determined. When α , the angle of turn of same-direction adjacent curves or reverse curves (rural roads do not have transition curves) connected to a straight line, is equal to or less than 30° , then L, the length of straight line between same-direction adjacent curves, shall be set at $5.5 V$ (m), and that between reverse curves shall be $1.8 V$ (m). If α exceeds 30° , then L, the length of straight line between same-direction adjacent curves, shall be $5.5 V$ to $6.0 V$ (m), and that between reverse curves shall be set at $1.8 V$ to $2.0 V$ (m) (see Figures 3 and 4)



(1) Straight lines a, b, c are of the same length (2) Straight lines a, b are of the same length

Figure 2. Illustration of the optical illusion.



Figure 3. Same-direction adjacent curves and their angle of intersection.

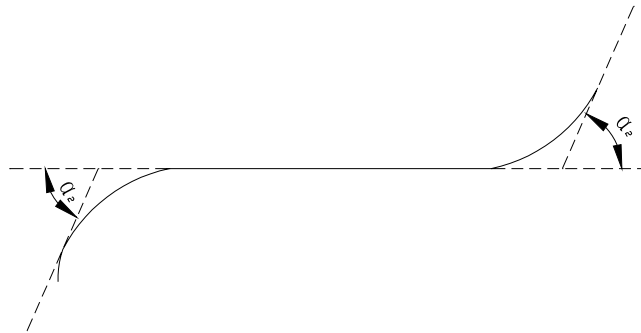


Figure 4. Reverse curves and their angle of its intersection.

4.2 Design of Vertical Section

Smooth road alignment in harmony with natural features is better than alignment necessitating much excavation and filling with priority being given to a straight-line appearance. This avoids the destruction of the linear ecological environment due to the construction of roads and is beneficial to nature conservation, or to construction, or saves on the engineering cost, maintenance cost and labour cost (Ministry of Communications, People's Republic of China, 2004). Obviously, when the vertical section is designed, the principle of accommodating natural topography is more important for the construction of rural roads. But when the natural features change, the upgrades and downgrades of some linear road sections may have to be altered. The situation easily induces incorrect judgments on the part of drivers in moving vehicles about the real road conditions, i.e. it may produce optical illusions, which are especially obvious to drivers on rural roads with one lane or double lanes. According to related research results (Yuan and Cheng, 2002), the following measurements are applicable to road sections whose horizontal alignment is a straight line and whose vertical alignment is a concave vertical curve with an antero-posterior difference in gradients of tangent lines of more than 10%: Vertical poles with alternating bright red and white and gradually changing height can be set up at the edges of the road shoulders on both sides of the road. Figure 5 shows details of the location of the poles. The diameter of the vertical poles is 25 cm, and their lengths vary from 90 to 190 cm, with the buried depth being 50 cm and the length of the red and white portion being equal to or less than 20 cm. The maximum height of the vertical pole located at the grade-change point of the concave vertical curve is 140 cm, and the minimum height of the vertical pole located close to the middle of the straight-grade section connecting the vertical section with one end of the concave vertical curve is 40 cm. The distance between neighbouring vertical poles is 250 cm and the difference in height between neighbouring vertical poles can be calculated from the following formulae:

$$h = \frac{140 - 40}{n} \quad (4-1)$$

$$n = \left[\frac{L'}{2.5} \right] + 1 \quad (4-2)$$

$$L' = \frac{L}{2} + \frac{l}{2} \quad (4-3)$$

In these formulae, L is the length of the vertical curve, l (including l_1 and l_2) is the length of straight-grade section connecting both ends of the vertical curve, and $\left[\frac{L'}{2.5} \right]$ is the integral part of $\frac{L'}{2.5}$. The number of vertical poles located on one side of the grade-change point of the vertical curve (including the grade-change point) can be calculated from the formula:

$$n = \left[\frac{L'}{2.5} \right] + 1 \quad (4-4)$$

The setting up of red-and-white vertical poles at the edges of road shoulders on both sides of concave vertical-curve road sections of rural roads (with one lane or double lanes) located in beautiful natural environment not only makes drivers feel safe, but also adds an attractive human landscape to a beautiful natural environment.

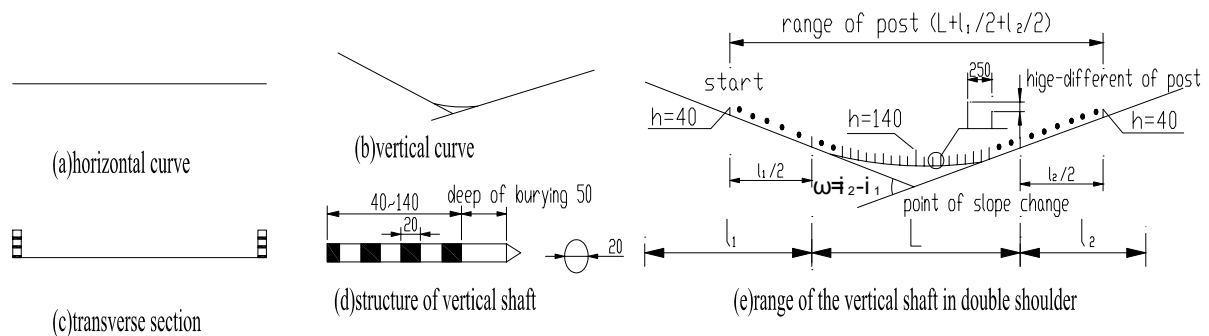


Figure 5. Vertical poles and their location within the concave vertical-curve sections.

4.3 Cross-Section

4.3.1 Width of Lane and Road Shoulders

The traffic composition and the external dimensions of the vehicles moving on the roads are important determining factors in the geometric design of roads (Ministry of Communications, People's Republic of China, 2004). The results of the survey indicated that the traffic flow on most rural roads is composed of a variety of different vehicles. The main vehicles for villagers are: bicycles, motorcycles, electro-tricycles, etc., and the main load-bearing vehicles are: 'walking tractors', light trucks, minibuses, medium-duty trucks and a tiny minority of heavy-duty trucks. Based on the above findings, combined with the related regulations in the Standard, the researchers of the supervisory group have made the following suggestions. For cement concrete pavement, the pavement width of one-lane rural roads should be 3.5 m or 4.0 m (this is increased to 4.5 m or 5.0 m in areas with a more developed economy), each with a road shoulder width from 0.50 m to 1.5 m respectively (hard shoulders are assumed). For asphalt pavement, the pavement width of one-lane rural roads should be from 3.5 m to 5.0 m.

4.3.2 Height of Subgrade

In view of the particular usage of rural roads (such as mixed traffic and densely covered farmlands on both sides of the roads), the subgrade of rural roads should be low fill with a proper height, H , controlled to within 0.50 m (as shown in Figure 6).

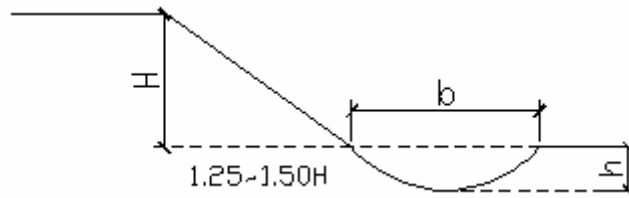


Figure 6. Height of embankment, high wall slope and shape of side ditch.

4.3.3 Side Slope and Side Ditch of Embankment

To ensure the stability of the side slopes of the embankment and to reduce the amount of land covered by roads, the side slope value should be controlled between 1:1.25 and 1:1.50 (Yuan and Cheng, 2004) to give drivers on the side slope of the embankment a better visual effect. The arc line for the side ditches should be closely related to the side slopes of the embankment, as shown in Figure 6, where the values h and b should be no less than 40 cm and 60 cm respectively.

5. OTHER CONSIDERATIONS

Apart from the above technical parameters related to the construction of rural roads, there are some other undeterminable technical considerations that are extremely important for the construction of rural roads. For example, the reasonable location of a drainage system is closely related to the construction of rural roads, greening of plants and the protection of the natural ecological environment, etc. The researchers of the supervisory group believe such aspects should be kept very much in mind during the construction process of rural roads. The best protection measure for a lasting and stable natural ecological environment is to reduce interference with and destruction of the environment by rural roads as far as is at all possible.

6. CONCLUSIONS

The principles used for the selection of a technical classification for rural roads have been confirmed, based on an intensive investigation done in Jiangsu Province. The relevant uses of pavement structures have been discussed, as well as various technical parameters related to the composition of pavements. Some technical issues established in this paper act as a beneficial supplement to *The Technical Standard of Highway Engineering* stipulated by the Ministry of Communications of China. In particular, the technical details related to the construction of low-grade roads (such as rural roads) offer significant guidance not only for the construction of roads in the vast rural areas of Jiangsu Province, but also for the construction of rural roads in other provinces, cities and municipalities of China.

7. REFERENCES

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