

Daily Level of Service on Low-Volume Roads in Finland

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Some of the findings of the Finnish maintenance research program are described as well as the principles of the maintenance quality standards and road condition standards that the Finnish National Road Administration (FinnRA) has established on the basis of the program. The paper describes how FinnRA has implemented the results of the studies in low-volume road maintenance. To evaluate the daily level of service provided to road users, FinnRA established a monitoring and evaluation system that has been in use for 7 years. The paper also includes brief overviews of the responses to Finnish opinion polls concerning the level of service on low-volume roads and the results derived from the monitoring and evaluation process.

The Finnish National Road Administration (FinnRA) is responsible for Finland's highway network of 76 900 km. That network contains a variety of roads, from six-lane freeways to gravel roads. Low-volume roads account for a high percentage of the total highway mileage managed by FinnRA. The amount of low-volume highways with average daily traffic (ADT) below 200 vehicles is 34 000 km, or 44 percent of the total highway length. Gravel roads constitute 29 000 km of the low-volume roads. The entire network is divided into six maintenance categories based on traffic volumes. The classifications are shown in Table 1.

Most of the low-volume roads within FinnRA's responsibility belong to maintenance Category III. In addition, Finland has 120 000 km of "private roads," most of which are low-volume roads and will remain gravel surfaced.

LOW-VOLUME ROADS AND COST EFFICIENCY

The maintenance costs of the low-volume network during recent years has accounted for 25 percent of total highway expenditures. However, the driven vehicle mileage on the low-volume highway network is only 7 percent of total vehicle mileage. Therefore, maintenance costs of low-volume highways per driven vehicle kilometer are much higher than those of main highways. That is why it is very important to attempt to optimize the daily level of service on low-volume roads. Optimizing the daily level of service involves optimizing the maintenance cost with the benefits enjoyed by the driver, while simultaneously ensuring that the majority of the road users are satisfied with the level of service provided.

MAINTENANCE RESEARCH PROGRAM

During the last decade, an extensive maintenance research program was completed in Finland. The program

TABLE 1 Maintenance Classifications

Category	Traffic volume
Super divided	Freeways
I Super	ADT > 6000
I	ADT 1500-6000
II	ADT 200-1500
III	ADT < 200
IV	Pedestrian and Bicycle Paths

included numerous studies of highway maintenance topics. On the basis of the research program, condition standards for defining an appropriate level of service for different maintenance categories and a system for monitoring the daily level of service were established. In addition, a public opinion poll was conducted on the level of service provided for travelers. The maintenance items that were rated the most important in the public opinion poll were the proper timing of snow removal and an adequate standby system during the winter. Other factors rated important were the need for adequate antiskid treatment on main highways, the desire for smooth pavement, and the desire for dustless and smooth gravel roads.

EVALUATION SYSTEM

To evaluate the daily level of service on highways, FinnRA has developed a monitoring and evaluation system. In the system, the daily level of service of any road can be placed into one of five classes (daily serviceability indexes). Each class has a written description and pho-

tographs of the required driving surface. The classification numbers or serviceability indexes are as follows: Level 1 = poor, Level 2 = fair, Level 3 = satisfactory, Level 4 = good, and Level 5 = excellent.

Quality standards have been established for both winter and summer maintenance. In the winter maintenance system, three variables are used to assign the level: slippery condition, snow condition, and smoothness. The descriptions of serviceability Indexes 2 and 3 for winter maintenance are provided in Table 2.

Four variables are used to assign the levels for summer maintenance of gravel roads: smoothness, firmness of the surface, dust, and cross-sectional profile. The descriptions of serviceability Indexes 2 and 3 for summer maintenance are provided in Table 3.

COST-EFFICIENCY STUDIES

According to the Finnish studies, the maintenance cost differences between various daily levels of service (indexes) were very high. For example, the winter maintenance costs in service Level 2 (Index 2) were \$250/km and in service Level 3 (Index 3) \$700/km.

FinnRA used calculations of user costs in road traffic for cost optimization. FinnRA has studied road user costs and publishes an annual cost report. Road user costs have three components: vehicle, time, and accident costs. The cost components also describe the consequences that affect the use of vehicles. The user costs are calculated for an average vehicle. An example of the cost calculations is shown in Figure 1, according to which winter maintenance level or serviceability Index 2 was the lowest point of the road user and mainte-

TABLE 2 Daily Level of Service for Gravel Road Winter Maintenance

Level of service/variable	Level of service, class 2	Level of service, class 3
SLIPPERY CONDITIONS * Skid number (Friction coefficient) * Road surface texture	0,15-0,25 Dry ice or snow path	0,25-0,30 Coarse ice or snow path in cold weather
SNOW CONDITIONS * Depth of dry frozen snow * Depth of thawing snow * Depth of slush * Drifting snow	< = 50 mm < = 40 mm < = 30 mm Drifting or a moderate layer of snow at the road edges, driving speed must sometimes be reduced	< = 30 mm < = 25 mm < = 20 mm Intermittent drifts on the road, driving speed has to be reduced in some cases
SMOOTHNESS * Depth of ruts * Other roughness	< = 30 mm Plenty of worn spots or disturbing holes, driving speed must be reduced in some places	< = 20 mm Smooth surface, possible unevenness does not disturb driving

TABLE 3 Daily Level of Service for Gravel Road Summer Maintenance

Level of service/variable	Level of service 2	Level of service 3
SMOOTHNESS * Roughness * Potholes * Bumps	360-400 cm/km Surface uneven due to potholes Bumps marked with traffic signs. Driving speed must be reduced due to unevennesses, potholes and bumps	320-360 cm/km Minor potholes Minor bumps. Bumps and potholes can be avoided, driving speed must be reduced in some cases
FIRMNESS OF THE SURFACE	Some amount of loose gravel	Mostly even and firm
DUST	Very dusty	Moderately dusty
CROSS-SECTIONAL PROFILE	Minor changes in the cross-sectional profile	The road surface has generally maintained its shape

nance costs for gravel roads. The corresponding curve of the costs for summer maintenance of gravel roads was quite similar. However, the total cost curve was quite flat and there was no distinct cost minimum.

As a result of the cost-efficiency studies, winter and summer maintenance levels for low-volume roads (maintenance Classifications II and III) have been established. For winter maintenance, the serviceability index mean value should be higher than 2, and for summer maintenance the serviceability index mean value should be 3.4 for maintenance Class II (ADT > 200) and 2.8 for maintenance Class III (ADT < 200). This corresponds to a fair or satisfactory level of service on the evaluation scale.

MONITORING LEVEL OF SERVICE

In the monitoring system, the road network is divided into several monitoring route alternatives. The evaluation date, time, and route are selected by random sam-

ple. In the evaluation process, the maintenance quality control inspector assigns a number from 1 to 5 to each of the variables to be evaluated for every kilometer. The variables are mainly evaluated visually using reference photographs.

During the winter, slipperiness is measured with a skid tester. During the summer, roughness can be measured with a small Finnish device, "Roadman," that measures the international roughness index. When the monitoring system was established, the level of winter service was monitored on low-volume roads once or twice per month and the level of summer service once per month.

The final level of service (serviceability index) is determined by the worst value of the variables. According to extensive studies, the most influential factor determining the level of service on low-volume roads has been snow conditions for winter maintenance and smoothness for summer maintenance.

MONITORING RESULTS AND MAINTENANCE PROGRAM

As a result of the cost-efficiency study and the evaluation data, the trend has been to increase funding for main highways and decrease funding for low-volume roads. However, feedback and complaints from road users have shown that on the road user's scale, the serviceability indexes corresponding to the cost optimum are too low. The same result was derived from the last opinion survey conducted by FinnRA in 1989-1990. Using the scale on which 4 equals very poor and 10 equals excellent, the condition of gravel road surfaces was rated by the drivers between 4.9 and 6.0. The corresponding numbers for main highways were from 6.4 to 7.2.

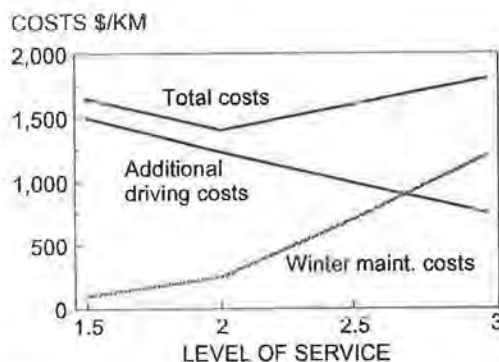


FIGURE 1 User and winter maintenance costs for gravel roads, ADT 150.

Those who live in the country and drive on low-volume roads daily expect that satisfactory level of service on highways is a basic service that should be available to all. In their opinion the responsibility for providing that level of service belongs to the Finnish society. They feel that as taxpayers they have the same rights as those living in urban areas.

Feedback and complaints have had such an influence that the level of service on low-volume roads during the last 2 years has been higher than the cost optimum. The mean value of the evaluated winter level of service has been around 3. The mean value of the summer level of service has been 3.2 to 3.4 on the roads with ADT < 200 and 3.5 to 3.6 on the roads with ADT > 200. In FinnRA's current maintenance program, the goal is to maintain the current daily level of service on low-volume roads in the future.

CONCLUSIONS

According to the experiences derived from the evaluation process, it is quite easy to achieve and exceed the target level of service on gravel roads. If routine winter and summer maintenance operations are carried out normally, results will be adequate. It has not been mandatory for the highway districts to monitor the daily level of service on low-volume roads during the last 2 years because the evaluation process is quite expensive. Some districts have monitored the summer level of service on low-volume roads, but no one has monitored the winter level of service. However, one of FinnRA's objectives is to provide a good winter level of service on main highways, and it is monitored once a week in every highway district.