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THE METHODOLOGICAL BASIS OF DETERMINING THE OPERATION CONDITION OF A ROAD FOR ITS TECHNICAL EXPERTISE

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ABSTRACT

Carrying out a technical examination of a cost estimate of a section of a highway is based on its certain technical and functional state. Different methods are used to establish the operational state. The expert method is the simplest, most affordable and, with strict adherence to the technique, provides high reliability. The essence of this method is the subjective consideration of situations from which one or more optimal ones should be selected.

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Introduction. There is now a real need for an instrument through which the road industry can be assessed. The existing methods of assessment of buildings and structures practically do not have practical methods for solving this problem [1]. The assessment of the object of transport construction requires the conversion of the qualitative state of the object into a quantitative estimate. This qualitative assessment is based on the Qualimetry, the field of science, including the notion of quality indicators [2].

The main objective of the road condition assessment is to determine the range of groups and levels of state indicators for a certain period of time. For example, the road model that is being operated can be presented at three levels in two groups of indicators: Road maintenance and construction, drainage and landscaping (Fig.1).

Various methods are used to establish operational condition: Experimental, numerical and expert [2]. Of the three methods for determining the state of the assessment object, experimental and numerical is reliable. In most practical cases, it is not possible to fully use the above-mentioned methods in monetary valuation due to a number of objective circumstances. Therefore, an expert method has been widely used to carry out this procedure. The expert method is based on the analysis of the opinions of highly qualified experts.

The expert method is the simplest, most accessible and with strict adherence to the methodology provides high reliability. The essence of this method consists in subjective consideration of situations from which one or more optimal should be chosen. The higher the qualification of experts, the higher the reliability of the evaluation.

The reliability of the results obtained is greatly enhanced if the assessment of the state of the object is based on the opinions of some highly qualified experts. The processing of the results of the

group examination provides a reasonable solution. On the basis of the method of expert evaluation it is possible to define the nomenclature of indicators; to set weightlessness factors; to certify the state of the object; to determine the best options of alternative solutions.

Level				
0	1	2		
K_k	Performance indicators	P_{14}	Evenness	B_1 P_1
			Roughness	B_2 P_2
			Solidity	B_3 P_3
			Width of the carriageway	B_4 P_4
			Cross slope	B_5 P_5
	Road construction, water drainage, landscaping	P_{15}	Road marking	B_6 P_6
			Fencing	B_7 P_7
			Road signs	B_8 P_8
			Stopping, landing sites and car pavilions	B_9 P_9
			Landscaping	B_{10} P_{10}
			Construction of surface drainage	B_{11} P_{11}
			Water pipes	B_{12} P_{12}
			Regulated structures	B_{13} P_{13}

Fig. 1. The qualitative property model of the state is qualitative: K_k – is a complex indicator of the state of the evaluation object, P_i is the value of the i -th indicator of the qualitative state of the evaluation object, and B_i is a level factor of the weight of the property.

The most common in the expert evaluation is the ranking method, in which the state of the object is assessed by a number of properties that are located in the order of their advantage $N_1 > N_2 > N_3, K, N_n$. The assessment of each of them is based on the expected dependence expert $K_i = f(N_i, b_i)$. If the indicator N_i is better than the N_{i+1} indicator, it is awarded the highest rank (degree). As a result of the pair comparison, it is possible to make the best series of properties.

The method of direct evaluation is used when comparing a number of properties and when quantifying absolute indicators in a given interval. Based on the object status indicators, a certain interval of numerical values is set, which must be evaluated. In this case, the expert should be a highly qualified specialist in this field, specifically in road construction. Otherwise, there may be significant errors in the expertise. For example, the condition of the road surface should be assessed according to the measure of cracks. Objective evaluation by this method is possible only when the expert clearly represents the physical essence, causes of cracks, as well as the influence of their sizes, shapes and places of their concentration, conditions of work of the covering and road construction as a whole.

Thus, all methods of expert evaluation are based on the superiority of one property over another. In more complex cases of evaluation, elements of the theory of quantitative measurements should be applied – to quantify how much one property is more important than another.

The credibility of the expert assessment depends on the number of experts. In this connection, the task arises of selecting a minimum number of specialists, which provide the greatest objectivity and reliability of evaluation at the minimum cost of examination. The selection of experts depends on their qualifications. Thus, when evaluating the same products of specialists with a higher degree of argumentation, it is necessary about 3 times less than with a low one.

Research results. In view of these difficulties, the method of first-hand evaluation can be simplified, and the quantitative evaluation by absolute criterion can be replaced by the absolute criterion. The scale of qualitative assessments allows to take into account all degrees of difference. The value range of this property is set to the equivalent number of points 1 ... n. The accuracy of the quantitative evaluation of experts is set. The method of direct scoring is very convenient and should be further widely used in determining the cost of road transport facilities, taking into account their technical level and operational condition.

The most common problem that arises in expert evaluation is the determination of weighting factors. One of the methods that are often used to calculate the weighting of a particular property is the

cost, which is based on the assumption that there is a proportional relationship between the weight of the property and the value [3]. However, when determining the condition of the road surface, for example, it is very difficult to distribute the cost of increasing separately only equity, roughness, durability, since during repairs these properties are improved simultaneously.

As a result of expert interviews, for example by questionnaire method, each of them receives the initial data (assessment) in the table (table 1). In addition, the average estimate by experts of general middle classes determines the group weight coefficients for each property of the object. The coefficient of the i -th property of this group is determined by the formula:

$$B'_i = \frac{\frac{1}{n} \sum_{j=1}^n N_{ij}}{\frac{1}{m} \sum_{j=1}^m \sum_{i=1}^n N_{ij}} \quad (1)$$

where N_{ij} – i -th property, is evaluated j -th; m – number of parameters in the group; n – number of experts.

Each group must comply with the terms and conditions: $\sum_{i=1}^m B'_i = 1$.

After a similar determination of the weighting factors for each group (Figure 1, Table 1), the level factors of each property are calculated. For example, the importance of property 1, the road surface plane, the complex assessment of the road area is calculated for level 0 (Fig. 1) as $B_1 = B'_{14} \cdot B'_1$, and the weight of the properties 9 (stop, landing sites and car pavilions) – $B_9 = B'_{15} \cdot B'_9$ and etc. for another properties. The results of the calculation of the weighty level factors are presented in Table 1, it is necessary to observe the conditions: $\sum B_i = 1$ и $B_i < B'_i$.

Table 1. Determination of weightlessness factors according to expert's estimates

Object properties	Assessment of experts					Average estimate	Sum of average estimates	The group weight factor of the property	The weighting factor of the indicator	The level factor of the property weight
	1	2	3	4	5					
1	80	75	70	100	80	81	343	0,24	0,58	0,14
2	90	80	80	75	80	81		0,24		0,14
3	100	90	95	100	95	96		0,28		0,16
4	45	50	45	55	50	49		0,14		0,08
5	40	45	40	30	25	36		0,10		0,06
6	100	100	100	100	100	100	408	0,25	0,42	0,10
7	80	80	80	85	85	82		0,20		0,08
8	85	80	80	80	85	82		0,20		0,08
9	40	35	45	40	40	40		0,10		0,04
10	50	40	40	35	40	41		0,10		0,04
11	20	20	20	20	25	21		0,05		0,02
12	20	20	20	25	20	21		0,05		0,02
13	15	25	25	20	20	21		0,05		0,02

Based on the results obtained, you can define a weighted average complex indicator:

$$K_K = \sum_{i=1}^m P_i \cdot B_i. \quad (2)$$

where P_i – the value of the i -th indicator of the qualitative state of the object of evaluation, B_i – the level factor of the property weight.

The mathematical model of the state of the road will look like this:

$$K_k = 0,14(P_1 + P_2) + 0,16P_3 + 0,08P_4 + 0,06P_5 + 0,1P_6 + 0,08(P_7 + P_8) + \\ + 0,04(P_9 + P_{10}) + 0,02(P_{11} + P_{12} + P_{13}). \quad (3)$$

Some of the quality indicators are visually identified [2], others by appropriate measurements. The value of the valuation of the road section is adjusted by a coefficient.

Conclusions. The method of expert evaluation is now particularly relevant. This is due to the desire to take into account as many factors as possible affecting the operational condition of the road, in particular, the water-thermal regime. The validity and ease of practical use of this method allows to minimize the risks in errors of experts in carrying out technical expertise, provided that they are taken into account the average assessment.

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