UDC 625.72

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DATABASE FOR FLEXIBLE PAVEMENTS DESIGN IN THE REPUBLIC OF VIET NAM

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Statement of the problem. The problem of information in ensuring flexible pavements designing automation of Vietnam is discussed. We need to analyze the essential parameters in the diagram analysis of Vietnam's highway pavements. The main purpose of the study is providing the design parameters of soils with the practical surveys to find out the database for calculating highway pavements.

Results. Probabilistic models obtained in the distribution laws enable to distribute the database for highway flexible pavements calculation. The calculated values of the parameters, soil moisture content are obtained with different levels of reliability.

Conclusion. The results of statistical analysis processing will provide the parameters of soft soil of Vietnam. These parameters will be used for Vietnam's flexible pavements design.

Keywords: flexible pavements, automated design, computer-aided design, database, distribution laws.

Introduction

In developing transport systems anywhere in the world a focus is made on improving a design and reliability of roadways as major transport arteries. Road surfacing is the most costly construction element of a roadway. Its strength is primarily due to that of the base. In calculating road surfacings the most hazardous condition of a structure is generally selected, which commonly corresponds with excessive wetting of the base [1]. In order to design non-rigid road surfaces special software is employed, which constitutes automatized design systems. Modern software allows a user to create information on database road construction materials and soils in order to perform calculations. Filling databases with comprehensive, scientifically valid data is a current issue. One of the approaches to addressing it is dealt with in the paper.

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1. Information models for designing road pavements. This process takes a few consecutive stages: construction, strength calculations of a road structure, technical and economic consideration of the options [2]. Due to the complexity of strength calculations and variety of construction solutions designing road pavings currently employs special systems of computer-aided design (CAD) [3]. Based on the general theory of systems of computer-aided design by A.V. Bukhtoyarov, a scheme for designing non-rigid road pavings using local road construction materials was proposed [4]. In order to create databases for designing non-rigid road pavings for the Republic of Vietnam this scheme was altered as shown in Fig. 1.

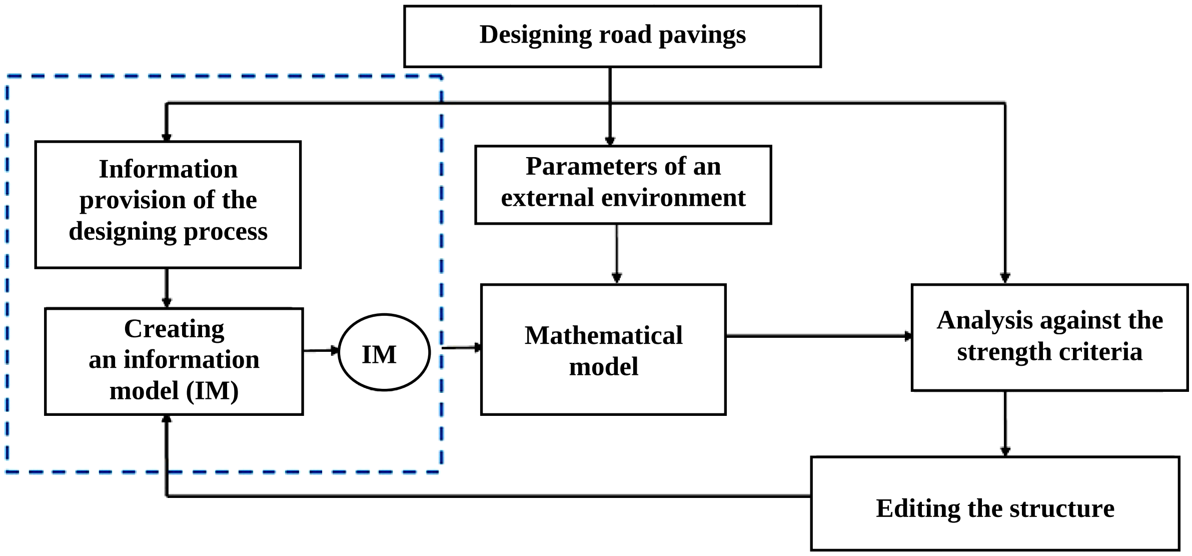

Fig. 1. Scheme for creating an information model for designing non-rigid road pavings

The highlighted information block consists of three scheme elements. Information provision of designing is necessary databases, information and reference materials making up information provision of designing road paving. Creating an information model involves selection based on the analysis of an information base of a subset of construction options for road pavings meeting the parameters of an external environment (road category, calculation loads and weather conditions). The initial construction options for road paving accepted for designing are an information model (IM) which is calculated and checked against different strength criteria.

Current software complexes for computer-aided design of roadways contain one for designing road pavings. *CREDO* RADON *RU* software for calculating non-rigid road pavings. It was originated using methods of the modern strength theory for calculations involved in designing road pavings [1]. Calculations are automatised in accordance with the guidelines of the

Russian Federation and international regulations [2] that were employed for developing those for road pavings of the Republic of Vietnam. The software can be used for developing catalogues and albums of typical solutions in designing road pavings. It allows the user to create information bases to perform calculations according to road construction materials and vehicles. A material base enables one to create information models for subbases of an operating layer, construction layers of road pavings and geosynthetic materials.

2. Calculation characteristics of an operating layer of the subbase. According to the previous research, Vietnam is most occupied by swamps with weak soils, particularly in the mouths of large rivers. The Mekong delta with a road network is very flat and crossed with a wide array of rivers and canals. There are five areas with different weak soils [5]. Weak soils such as clayey silt, *sandy-argillaceous*, semisolid soil, sandy clay.

In calculating road pavements, resistance of soils to external loads is evaluated using the modulus of elasticity or deformation. Water-thermal mode of the base changes throughout the year. So does the modulus of elasticity and deformation of the subbase. The major calculation parameters of physical and mechanical properties of the subabse which are used in strength calculations of road pavements are the following:

- elasticity modulus $E_{гр}$, MPa;
- Poisson ratio $\mu_{гр}$;
- angle of internal friction $\varphi_{гр}$, degrees;
- specific adhesion $C_{гр}$, MPa.

Calculation characteristics mainly depend on a design humidity which is determined during the least favorable season when the subbase is excessively wet. If for Russia it is the springtime and deflection calculations of soils are performed for high spring temperatures, the analysis of the climate of Vietnam showed that it gets the maximum rainfall in summer and spring (227 mm in July, 273 mm in September and 277 mm in October). These months are marked by high temperatures [6]. Design characteristics of soils can be identified as shown in tables specified in the guidelines [2], but this data has limited applications and can only be used individually for complex designs. It can rely on the results of special experiments conducted as part of engineering research.

3. Experimental research and processing of the results. A study of physical and mechanical properties of soils on road pavements of the Mekong Delta in the Cần Thơ province of the Republic of Vietnam was conducted on a roadway 60 Cha Ving-Ben Che (km 1010 + 109 – – km 1013 + 209). 72 soil samples were tested.

On a sample area the subbase consisted of six base layers: semisolid or solid soil, clayey silt, *sandy-argillaceous and solid clay.*

Three characteristics were investigated: an average water content W, %, liquid limit W_L, %, rolling limitation period W_P, %. A relative humidity of a soil used in designing was given by the formula

$$a = \frac{W}{W_L}. \quad (1)$$

The results of the study of the properties of soils show that the humidity of a soil, liquid limit, rolling limitation period change considerably.

A statistical processing of the experimental data on a water content of *sandy-argillaceous soils was performed using the known method* [7].

Based on the analysis of a histogram in Fig. 2, it was assumed that a water content is random in relation to the Weibull distribution which is generally the following:

$$F\left(w\right) = n \cdot \mu^n \cdot (w - c)^{n-1} \cdot e^{-\mu^n \cdot (t-c)^n}, \quad (2)$$

where w is a random variable; c is a parameter of a position determining the position of the beginning of a distribution in relation to the reference point; μ is the scale parameter; n is the shape parameter.

The probability of that was checked against the Pearson criterion X^2:

$$X^2 = \sum_{m=1}^{i} \frac{(m_i^* - m)^2}{m_i}, \quad (3)$$

where m_i^* are experimental frequencies; m_i are theoretical frequencies.

Using the calculations and special tables, experimental and theoretical frequencies and probability were determined. The results of the calculations are presented in Table 1.

Table 1

Results of statistical processing of experimental data on a water content of soils

Scales	Theoretical frequencies	Experimental frequencies	Theoretical frequencies	Theoretical frequencies (probability)
40—45	5	0,125	6,2	0,155
45—50	11	0,275	10,2	0,255
50—55	7	0,175	9,8	0,245
55—60	9	0,225	6,8	0,17
60—65	6	0,15	4	0,1
65—70	2	0,05	2,2	0,06

A distribution histogram and theoretical curve of a water content are in Fig. 2.

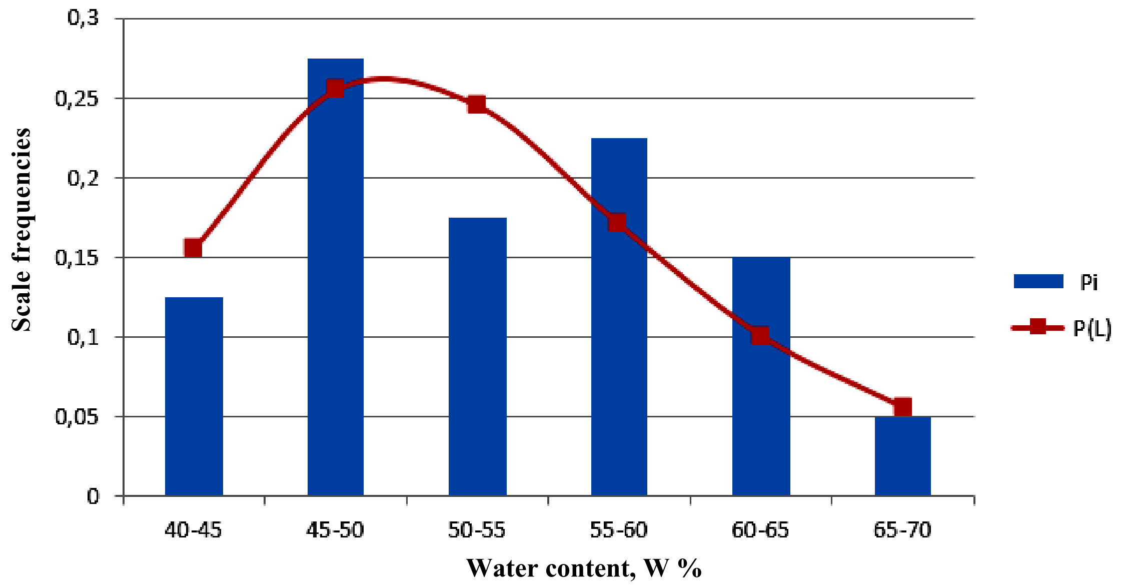

Fig. 2. Distribution histogram of water content P_i

and balancing theoretical curve of the Weibull distribution P_L

In order to see whether experimental data is part of the Weibull distribution, the Pearson criterion X^2 was used with a significance level of 0,01.

The calculations using Formula (3) showed that the Pearson criterion is $X^2 = 2{,}9$.

The probability table for the Pearson distribution at $X^2 = 2{,}9$, number of degrees of freedom $N = 4$ and significance level α = 0,1:

$$P(X^2, Ч) = P(2{,}9; 4) = 0{,}557 > 0{,}1. \qquad (4)$$

Thus the assumption of a random variable being part of Weibull distribution is not denied.

Using the theoretical distribution, the limits of confidence ranges of the random variable were identified for different confidence probability. The calculation results are shown in Table 2.

Therefore it can be argued that with the probability of 95 % water content of *sandy-argillaceous* soils in this area is no less than 42,65 % and no more than 63,85 %.

Table 2

Confidence ranges of water content of sandy-argillaceous soils in the Mekong delta

Confidence probability P, %	Mutual confidence range for water content of soils, %
95	$42{,}65 < W < 63{,}85$
90	$44{,}38 < W < 62{,}12$

Similarly the experimental data for the liquid limit W_L and rolling limitation period W_P were calculated. These random variables were also identified using the Weibull distribution. The results of processing are shown in Fig. 3, 4 and Table 3, 4.

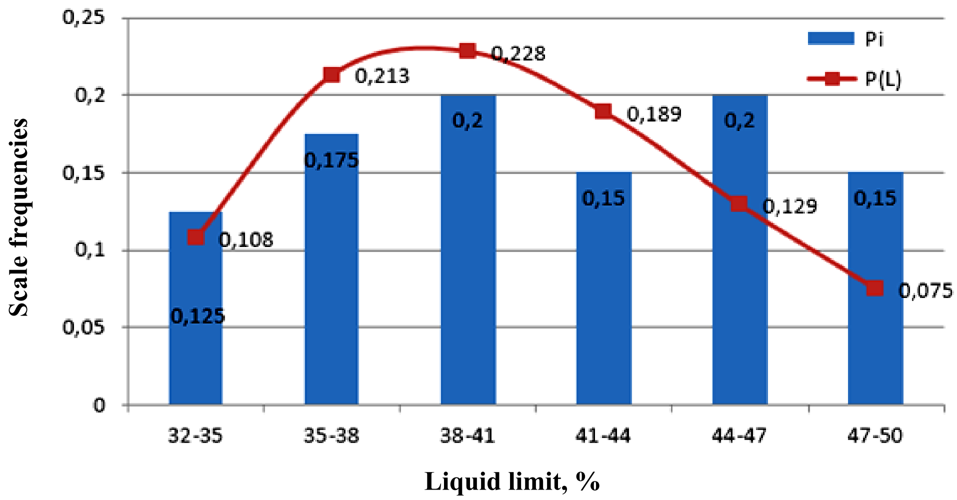

Fig. 3. Distribution histogram of the liquid limit P_i
and balancing theoretical curve of the Weibul distribution P_L

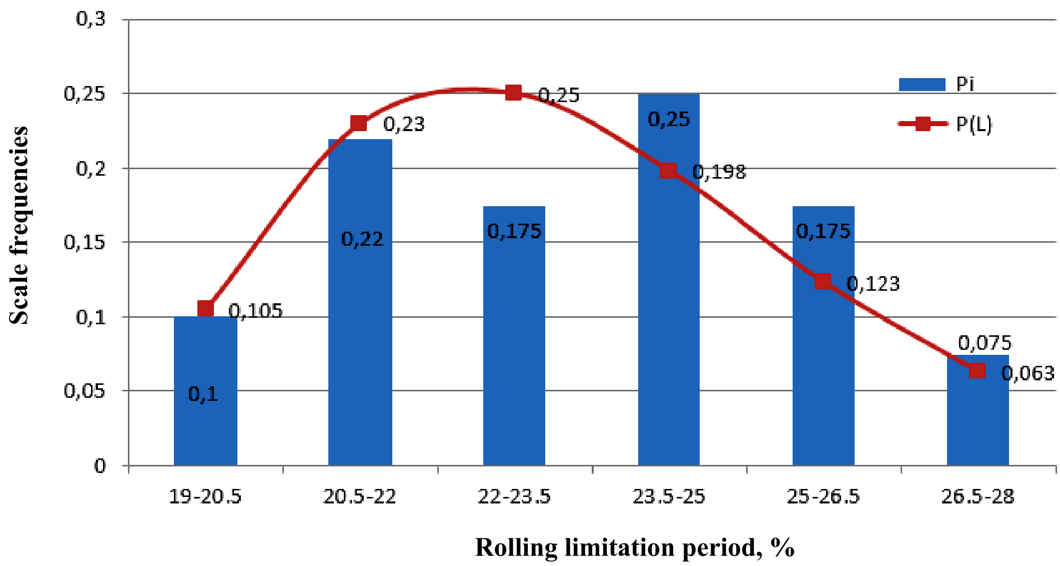

Fig. 4. Distribution histogram of the rolling imitation period *Pi*
and balancing theoretical curve of the Weibull distribution P_L

Thus it can be argued that with the probability of 95 % the liquid limit of *sandy-argillaceous soils in this area is no less than* 33,85 % and no more than 48,61 %.

Table 3

Confidence ranges of rolling limitation period of sandy-argillaceous soils in the Mekong delta

Confidence probability *P*, %	Mutual confidence range of the rolling limitation period of soils, %
95	$33,85 < W_L < 48,61$
90	$35 < W_L < 47,5$

Table 4

Confidence ranges of rolling limitation period of sandy-argillaceous soils in the Mekong delta

Confidence probability *P*, %	Mutual confidence range of the rolling limitation period of soils, %
95	$19,87 < W_P < 26,83$
90	$20,44 < W_P < 26,26$

Therefore with the probability of 95 % a rolling limitation period of sandy-argillaceous soils is no less than 19,87 % and no more than 26,26 %.

The obtained data allow one to create a database of subbases of an operating layer for designing non-rigid road pavements of the Republic of Vietnam.

Conclusions

1. We have examined information provision of computer-aided design of non-rigid road pavements of the Republic of Vietnam. Features of modern software for computer-aided design of road pavements have been investigated.
2. Based on the analysis of features of the soil of the Mekong delta, its water content was concluded to be a major consideration for research. The results of special engineering experiments have been shown to be crucial for calculation data.
3. According to the statistical processing, the distribution and confidence ranges of water contents of soils, liquid limit and rolling limitation period of sandy-argillaceous soils were obtained and checked against the Pearson criterion.
4. The results of the study are helpful in creating a database for soils of an operating layer for designing non-rigid road pavements of the Republic of Vietnam.

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