Computer technology of designing of optimum road constructions made of local materials

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Abstract. This article considers the principles of formation and support of the database management system (DBMS) in design of optimum road designs made of local road-building materials. The principle of multilevel representation of information bases, which are connected by relational communications, is the basis for design. Databases contain separate information files on administrative or territorial regions of area or the region, technical parameters of highways, soil and geological conditions and also data on the available road-building materials of the region and their specific expense. Contact between the separate DBMS files is kept constantly by means of the uniform codifier. Management of databases is carried out by the AD application program written in the FoxPro language, allowing one to run for search of optimum roadbed designs depending on the area of construction, technical category of the road and type of soil of a roadbed with their subsequent check on durability.

1. Introduction
On the basis of the executed research in the field of design and construction of roadbed of the Volgograd region made of local low-strong stone materials (including chalk), hardened soil, metallurgical slag, eliminations of crushing of crushed stone, soil of the increased density and the soil reinforced by geosynthetic materials, authors developed the management system database (DBMS). The purpose of the DBMS is increase in efficiency of use of local road-building materials in constructions of roadbed on highways of regional value taking into account road and climatic and economic conditions of construction and also creation of information databank of rational constructions.

2. Relevance
Constant growth of intensity of traffic up to 7-13% a year, increase in thrust transport loads up to 10 t and more, limited financing of road construction require optimization of the most expensive element of the road – roadbed. Growth of cost of construction, change of traditional suppliers of materials, require to more widely use local construction materials and secondary production of the industry [1,2].

Traditionally process of constructing of roadbed is based on a construction choice from a row of normative documents [3-8], standard taking into account recommendations, and their binding to local conditions. At the same time only natural factors, road-building materials and their physic-strengthening characteristics are considered. Availability of local materials and accounting of an environment allow to develop personal constructions of roadbed on the basis of standard projects [9].
The road constructions, which well proved in use from a row of personal, pass into discharge traditionally applied in this region. The accumulated experience of use of local materials in case of design and construction of highways allowed to develop regional directories of constructions of roadbed over time. Such directories were developed for regions of Russia, Ukraine, Belarus, Central Asia. Regional directories represent to the engineer more wide choice of full-strength and economic constructions of roadbed. It is reached due to wide use in constructive layers of local materials and waste of the industry.

Primary benefits of the existing directories of roadbed are:
- systematization of constructions on groups depending on technical category of the road, design load, required elastic modulus of roadbed;
- accounting of local materials and their physic-strengthening characteristics in case of their use in different constructive layers;
- accounting of an environment and field of design.

However, the regional albums of optimum constructions of roadbed [1, 10] developed on a paper basis 20-25 years ago became outdated and can't be used in practice of design.

Transition to computer-aided design of roadbed assumes creation of the electronic regional album of optimum constructions of roadbed from local stone materials presented in the form of a relational database [11-14] that will provide automated access to them in the course of computer design.

3. Structure of the file of the database

The principle of multilevel representation of information bases, which are connected by relational communications, is the basis for designing of optimum road constructions [15-21]. As a part of the database management system separate information files on administrative or territorial areas of area or the region (RAION.DBF file), to technical parameters of highways (TITUL.DBF file), to soil and geological conditions (GGY.DBF file), the database on local road-building materials of the region (DSM.DBF file), on a specific consumption of road-building materials on a construction of 1 sq.m. of roadbed (RASXOD.DBF file), the database of standard designs of roadbed from local materials are provided (DO.DBF file).

Contact between the DBMS separate files is kept constantly by means of the single codifier. Management of databases is carried out by the AD application program written in the FoxPro language. For the organization of fast search in the DO.DBF, TITUL.DBF, RAION.DBF, GGY.DBF files, in the course of loading of the program AD module indexation of data with forming in the working folder of the index files KOD_DO.IDX, KOD_T.IDX, KOD_RA.IDX, KOD_GGY.IDX is made.

Database is provided by the following interdependent files:
- DO.DBF and KOD_DO.IDX – the database and the index file of constructions of roadbed made of local materials.
- TITUL.DBF and KOD_T.IDX – the database and the index file of technical parameters of highways of the region.
- RAION.DBF and KOD_RA.IDX – the database and the index file location of a designed project in the region.
- GGY.DBF and KOD_GGY.IDX – the database and the index file of soil-geological conditions of the region.
- PEREM.DBF – the database for temporal data storage.
- DSM.DBF – the database on local road-building materials of the region.
- RASXOD.DBF – the specific expenditure of road-building materials on 1 sq.m. of roadbed.

The databases DSM.dbf, RASXOD.DBF which are connected with the DO.DBF file by the system of codifiers (fig. 1 – fig. 3) belong to the DBMS main files.

List of code names:
- KOD_T – code of technical category of the road;
- TK – technical category of the road;
• NPR – traffic load, cars/days;
• KOD_RA – code of the region of a construction;
• RAION – region of a construction;
• KOD_DO – code of roadbed;
• H1…H5 – thickness 1 … 5 layers of roadbed
• MAT1…MAT5 – materials 1 … 5 layers of roadbed;
• R_M1… R_M5 – specific material consumption 1 … 5 layers of roadbed;
• ED_IZM1, ED_IZM5 – material consumption units of measure;
• the maximum quantity of constructive layers – 5;
• the specific consumption is given in 1 sq.m. of roadbed.

The DSM.dbf database – local road-building materials

| KOD_DO | DSM | MESTO |
|--------|-----|-------|
| 1      | Crushed stone F 40-80 E = 350 MPa from sedimentary rocks | Frolovsky pit of the Volgograd region |
| 5      | Dense fine-grained asphalt concrete type B brand 2 E = 3200 MPa | The asphalt concrete plant from crushed stone of the Pavlovsk pit of the Voronezh region |
| 6      | Black crushed stone E = 900 MPa prepared in installation on ACMP | The asphalt concrete plant from crushed stone of the Zhirnovsky pit of the Rostov region |
| 7      | Sand of average fineness without impurity of clay and dusty particles of E = 100 MPa | Local sand of the Oryol pit |

Figure 1. Structure of the File of the database of local road-building materials.

The Rasxod.dbf database – the specific material consumption

| KOD_DO | DSM | ED_IZM | RASXOD |
|--------|-----|--------|--------|
| 1      | Crushed stone 3rd class of durability of F 40-80 mm | cubic meter | 1.00 |
| 3      | 60/90 construction bitumen | ton | 0.5 |
| 3      | Mineral powder | cubic meter | 0.38 |
| 3      | Sand of average fineness | cubic meter | 1.55 |

Figure 2. Structure of the File of the database of specific consumption of materials.
The DO.dbf database – designs of roadbed made of local materials

Figure 3. Structure of the File of the Database of Standard Designs of Roadbed made of local materials.

Database management is exercised by means of the menu, provided in fig. 4 which consists of the following modules:

![Menu of management system database of constructions of roadbed made of local materials.](image)

Figure 4. Menu of management system database of constructions of roadbed made of local materials.

Forming and support of the information database – filling, fixed updating and adjustment of data on administrative or territorial and geographical areas of area and the region, soil and hydrological conditions of the allocated areas of the region, technical characteristics of highways, local and imported road-building materials and semifinished products, the specific material consumption for a construction of constructive layers of roadbed. The regional album of optimum designs of the roadbed calculated on IRC 218.046-01 is made on the basis of the created data arrays.

The flowchart DBMS of roadbed made of the local materials AD is provided on figure 5.
Figure 5. Structure of AD DBMS.
Search of a construction of roadbed in the set conditions is intended for the choice of one or several constructions of roadbed made of local materials on the specified search signs. As signs of search of optimum designs in the "AREA and SERVICE CONDITIONS" module are specified: region of a construction, soil and hydrological conditions and technical category of the road. In case of accomplishment of the choice of a design in the "CHOICE OF THE CONSTRUCTION OF ROADBED" module the system makes filtering the database of the DO.DBF file and offers the user the constructions of roadbed made of local materials.

In case of lack of designs the system gives the message "Constructions of Roadbed for the Specified Conditions Are Absent". After the choice of the construction of roadbed listing of results is made for their further check on durability (according to IRC 218.046-01) in the program for calculation of roadbed of nonrigid type, with possible subsequent adjustment of thickness of constructive layers and comparison with alternative options at the integrated construction cost (one-off costs) or the given costs.

4. Inference
For increase in efficiency of computer-aided design of roadbed the shell program is developed for guiding of a relational database of the regional constructions of roadbed made of local construction materials. The AD application program is developed in the FoxPro language, allows to run for search of constructions of roadbed depending on the region of construction, technical category of the road and type of soil of a roadbed with their subsequent check on durability (according to IRC 218.046-01 in the program for calculation of roadbed of the nonrigid RODON type) and possible adjustment of thickness of constructive words.

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