in which the structure operates. Therefore, when calculating the temperature stresses in asphalt concrete layers on a rigid basis should take into account the heated structure or cooled and in what temperature range the deformation occurs.

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CONVERT PAPER CARD IN A DIGITAL TERRAIN MODEL

The issue of converting paper cartographic material into a digital model of the area today is quite relevant given:

– the problem of rapid damage to paper media during use;

– convenience and speed of transfer of cartographic material in digital format between users;

– rapid development of computer-aided design tools.

Over time, corporate and municipal funds of cartographic materials, which are in paper form, are erased, aged and become unusable. A fairly simple and reliable way to save sometimes invaluable cartographic materials is to turn them into digital terrain models.

When digitizing existing paper cartographic material, it is mandatory to preserve the following data [1]:

– graphic accuracy – it is necessary to ensure the preservation in the raster map of all the details of the original paper card (if the paper card has a graphic accuracy of 0.2 mm, it is advisable to scan with an expansion of at least 500 dpi so that the pixel size is approximately 0.1 mm;

– general information – the name of the map area and settlements located on its area, nomenclature and legend of the map, etc .;

– structural information – a description of the relationships between different objects;

– metric information – existing coordinate systems and coordinates of situation points;

– syntactic information – a description of the relationships between points;

– semantic information – characteristics of the properties of the object.

Conversion of cartographic material into a digital terrain model that meets the above requirements can be performed using modern software packages «Autodesk Civil 3D», «Autodesk Map 3D», «MapInfo», «Pythagoras», «Digitals», «GeoniCS», «Credo» and others. In the following, we will consider the sequence of converting paper cartographic material into a digital terrain model in the Credo software package with examples of complex geometry of situational objects and the need to edit a digital terrain model.

The basis for building a digital model of the area on the existing paper cartographic material is a raster substrate, which is created by scanning a paper map with subsequent processing in the software Transform. This software package allows [2]:

– scan various cartographic documents, including documents whose size exceeds the size of the scanner;

– adjust the transparency of individual fragments of raster images;

– move the fragments relative to each other;

– correct nonlinear distortions of raster material due to deformation of the source document, scanning error and other factors;

– perform topographic binding of raster fragments in different coordinate systems;

– rotate raster fragments to any angle and cut their dimensions;

– combine (stitch) several raster fragments into a single raster field, in a single coordinate system, as a result of the transformation of fragments;

– export individual fragments or all raster fields to software packages Credo, Mapinfo, Arcview, PHOTOMOD, etc.

To start developing raster material, you need to scan existing paper cartographic material with an extension of at least 500 dpi, with any color depth (black and white, monochrome, color) directly in the Transform program, or anywhere else with the extension BMP, GIF, TIFF (GeoTIFF) , JPEG, JPEG2000, PNG, CRF, ECW, RSW, etc.

For the most part, the size of existing paper cartographic materials exceeds the size of the scanner, so the cartographic material is divided into several sheets with a subsequent combination. To combine the fragments, it is necessary to specify the reference points (anchor points) at which the transformation and binding of the raster to the coordinate system [2]. Reference points are divided into absolute and relative. Absolute points are points with known coordinates (grid intersections, extreme points of the frame, points of geodetic substantiation and just characteristic points of the raster with known coordinates) [2].

Points are set by the user in the coordinate system set by him (longitude / latitude or flat rectangular coordinates. Relative points are additional points for which coordinates are not specified (set on each of the adjacent fragments in the area of overlap in characteristic places

of the image: wells, line intersections, individual trees, etc.). Usually such points are used to eliminate in the process of transformation cases when the contours of the fragments do not match. The minimum number of points for transformation - two, the maximum – is not limited). The stitched and processed raster in the * .bmp format with the subsequent loading in the Credo software package is stored.

Before you start building a digital terrain model based on the downloaded raster material, you need to study the terrain. Choose a horizontal, the height of which we know, and enlarge the image so that it was convenient to work with. Consistently moving along the horizontal image, it is necessary to circle its structural line, completely repeating its image on the raster. This stage of work is extremely responsible, because the accuracy of the obtained digital terrain model depends on the quality of its execution. After completion of construction of a structural line on the chosen horizontal it is necessary to specify value of a height mark of the given horizontal. Upon completion of the stroke of all horizontals from the raster substrate is built directly digital terrain model with a preliminary indication of the parameters of the surface.

The reflection of the created relief may not coincide with the horizontals on the substrate. Most often, this is due to incorrect determination of the height marks of points and horizontals. The created surface can be modified and adjusted with surface editing commands.

In the Credo system, all data can be created and stored in various projects and layers. It is advisable to place the digital model of the situation in a separate project from the digital terrain model.

Each type of situational objects can be placed in separate layers. The structure of the layers can be linear or hierarchical.

All components of the digital situation model in the Credo software package are built from the so-called thematic objects that are part of a special classifier [3]. All elements of the situation are divided into point, linear and planar objects [3].

To construct a point element of a situation, you must select its exact location and select the appropriate thematic object with the required semantic properties from the classifier dialog box.

To construct a linear element of the situation, you must first construct the geometry of the linear symbol, according to its location and shape on the raster substrate, and then select the necessary semantic properties and captions to the symbol from the classifier.

Construction of planar symbols of complex shape is divided into two stages. First, it is necessary to construct a geometric contour of the planar symbol according to the image on the raster substrate. After constructing the contour of the planar element of the situation from the classifier, select the appropriate semantic properties and captions to the symbol.

The sequence of conversion of paper cartographic material of any size into a raster substrate with subsequent processing and assignment of a coordinate system is considered. The sequence of construction of the digital terrain model and the situation on the basis of the previously created raster substrate is given.

The considered sequence of works is rather simple and allows to save and without aging and damage to store paper cartographic materials. In addition, this approach allows designers to use computer-

aided design systems in solving any problem in the presence of source data in the form of a paper map, which will greatly simplify the complexity of work, reduce its time and improve the quality of design results.

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URBAN AND TRANSPORT PLANNING

The rapid developments that the world is witnessing in all aspects of life, especially after the industrial and technological revolution, have led to the emergence of new challenges related to the environment, which in turn have been reflected in the called ecological, green, and sustainable cities. Cities are responsible for about 80% of global emissions of carbon and greenhouse gases and account for about 75% of energy consumption worldwide. The share of energy demand for transport purposes is about 20% of energy consumption worldwide, and transport operations are responsible for