FEATURES OF SEASON RESTRICTED ROADS' DESIGNING IN AREAS OF MINING FACTORIES UNDER CONSTRUCTION

Marina Romanenko

Saint Petersburg Mining University, 199106 Saint Petersburg; m.romanenko@geo-sz.ru

ABSTRACT. The article focuses on the question of season restricted roads' studying. In difficult geological, hydrological and climatic conditions of northern countries, such as Russia, Finland, Sweden, Norway, Canada, USA (Alaska), the basis of transport infrastructure is season restricted roads. The problem of season restricted roads' designing is still unresolved, which makes it difficult to maintain and operate such sites. The aim of research is advanced technology of season restricted roads' designing for their further title registration. This technology gives opportunity of first-ever defining possible changes of roads' boundaries by results of field measurements of physical and mechanical soil properties. The technology is developed with the application of similar stationary sites' rules, and also takes into account features of season restricted roads' existence in space and time. The main research objectives are: economic importance definition of season restricted roads; uncovering geographical and climatic conditions, providing possibility of road's functioning; reviewing the methodological approach of their accounting and systematisation. The research is carried out on the basis of information about the location of season restricted road's baselines, and also using the results of monitoring studies of highway service's department. To identify the possible location of roads a buffer zone's model is presented.

Keywords: mining regions, transport infrastructure, season restricted roads

ХАРАКТЕРИСТИКИ НА ПРОЕКТИРАНЕ НА СЕЗОННИ ПЪТИЩА В РАЙОНИ, КЪДЕТО СЕ ИЗГРАЖДАТ МИННИ ПРЕДПРИЯТИЯ

Марина Романенко

Санктпетербургски минен университет, 199106 Санкт Петербург

РЕЗЮМЕ. Статията се фокусира върху изучаването на сезонни пътища. В сложни геоложки, хидроложки и климатични условия в северните страни, като Русия, Финландия, Швеция, Норвегия, Канада, САЩ (Аляска), основата на транспортната инфраструктура са сезонните пътища. Проблемът с проектирането на сезонни пътища все още не е решен, което затруднява поддържането и експлоатацията на такива обекти. Целта на изследванията е усъвършенствана технология за сезонно ограничени пътища, предназначени за по-нататъшната им регистрация. Тази технология дава възможност за първоначално определяне на възможните промени на границите на пътищата чрез резултати от полеви измервания на физични и механични свойства на почвата. Технологията е разработена с прилагането на правила на подобни неподвижни обекти и също така отчита особеностите на съществуването на сезонни пътища в пространството и времето. Основните цели на научните изследвания са: определяне на икономическо значение на сезонните пътища; разкриване на географски и климатични условия, осигуряващи възможност за функциониране на пътя; преглед на методологичния подход на тяхната отчетност и систематизация. Изследването се извършва въз основа на информация за изходното местоположение на сезонните пътища, както и резултатите от мониторинговите проучвания на отдела за обслужване на магистрали. За идентифициране на възможното местоположение на пътищата е представен моделът на буферната зона.

Ключови думи: минно-добивни райони, транспортна инфраструктура, сезонни пътища

Introduction

Transport infrastructure is one of the most important elements on which development of the economic conditions of mining regions directly depends. Therefore, the most important problem of such areas is to provide all conditions for successful roads designing, their construction and operation.

Environmental features (climate, relief, soil properties) define roads` classification depending on the functioning mode: constant and season restricted. Season restricted roads with the base of snow, ice and frozen soil function only from October to March. They are common for many countries which have difficulties in the access to their northern regions: Canada, Finland, Estonia, Iceland, Norway, Russia, Sweden and USA (Nassiri et al., 2015).

Both kinds of roads (constant and season restricted) are complex engineering constructions in the form of linear objects. On the one hand, season restricted roads represent the way of certain direction which location changes every season. On the other hand, they have features of real estate items as they are inseparably linked to the ground surface, and their movement without disproportionate damage to appointment is impossible. In both cases season restricted roads require immediate strategic decisions concerning their construction and operation (Navratil, Frank, 2008).

Today the question of territory planning while designing such sites in difficult geological and climatic conditions is one of the most difficult in the field of civil engineering, geodesy and land management.

Main exposition

Easement areas of any road consist of land plots that determine location of the site's structural elements and road constructions. In other words, easement area represents the

borders of transport road. Formation of land plots under roads' construction includes not only land management works, but also actions, the result of which is creation of the site with new legal status (Kostyrchenko et al., 2016). The main difficulty is allocation of land plots for season restricted roads, because of their changing location during the seasons of the year.

The aim of research

The isolated regions of Northern countries are hard-to-reach areas with poorly developed infrastructure. In difficult geological, hydrological and climatic conditions of northern regions the basis of transport infrastructure are season restricted roads (Yukari et al., 2017). The extent of seasonal roads of such territories is comparable to federal highways as development, arrangement and operation of mineral deposits demand delivery of large-size loads and the equipment.

The aim of research involves advanced technology of designing work's development for seasonal roads' registration. This technology gives opportunity of first-ever defining possible changes of seasonal roads' boundaries by results of field measurements of physical and mechanical soil properties. Basic research tasks: to define specifics of season restricted roads as real estate items; to expose the need of registration of research sites taking into account distribution of their structure in time; to rank the factors defining physical and mechanical soil properties according to the extent of their influence on season restricted roads' location; to develop regression model of easement area's width depending on the extent of influence of indicated factors; to develop the technology of spatial basis' construction allowing to solve problem of season restricted roads' registration in view of their changing location.

Main thesis of the research

The research is carried out on the basis of information about the location of the season restricted roads' baselines, and also using the results of the monitoring studies of highway service's department. From the point of view of legal systems, the formation of land plots for such highways as typical linear sites is wrong. The algorithm for designing works of the object of seasonal operation has to consider distribution in space and time of a number of indicators which define location of such sites (Fig. 1).

As a result it is possible to note a divergence of lines that is connected with the site's specifics of seasonal existence. It can be explained with the changing location of a site depending on climatic conditions, topographic features, hydrogeological characteristics of the territory (Pavlov, 2010).

The creation of the image of the average line was carried out by the method of perpendiculars on points whose location is determined by extreme seasonal lines. It is necessary to obtain the first indicator – deviation of each line, from the drawn average line.

Knowledge of position of the average line in the presence of communication of indicators of certain physical characteristics with coordinates of each point can be used for forecasting the position of border lines in the set buffer zone. Each point corresponds to certain results of the studied indicators.

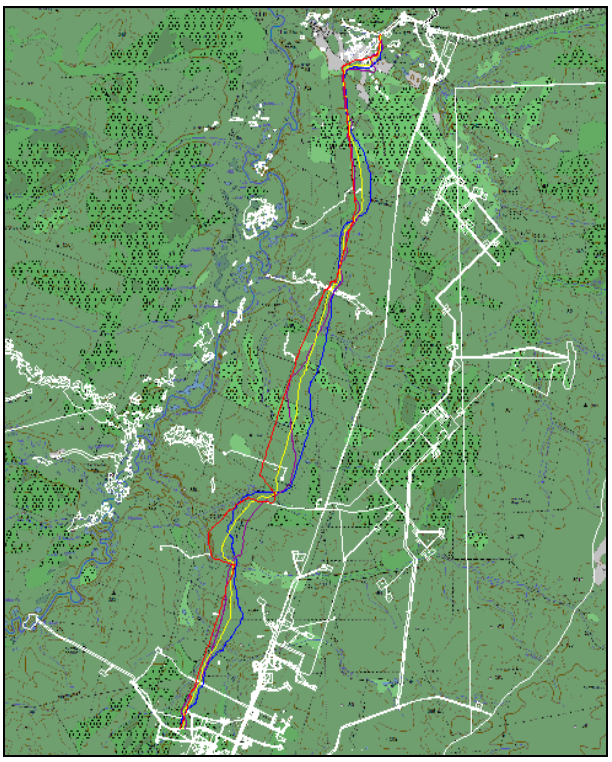

Fig. 1. The winter highways' lines with reference to the cartographic image of metric scale 1:200 000 and to the cadastral plan of the territory: the red colour indicates the line of 2016–2017 years, purple – 2011–2012, blue – 2007–2008, yellow – middle line

Field research on values of the indicators have been received by a testing laboratory of the State Highway Service in November 2007, 2011 and 2016. We need to determine them by carrying out an analytical research of each lines' groups with a binding to the values of their deviation. So far, the distribution of indicators of zones is only an assumption, its scientific justification is possible by a clustering method. Each point of three seasonal lines is characterised by the following signs:

- frozen ground depth, cm;
- snow density, g/cm³;
- time of soil freezing at the average air temperature: -10ºC, hours.

These observations need to be broken into "k" number clusters. Parameters should be considered with average line and should be spread out in clusters (groups). The main aim of statistical research is to find out dependence between deviations on points of lines of different seasons and physical parameters. For future clustering it is offered to establish the following zones:

- zone of maximum divergence;
- zone of average divergence;
- zone of minimum divergence.

The term "divergence" offers to designate distance between points of extreme axes regardless of a season (Skvortsov et al., 2005). The result of research for lines of the highway for the season 2011–2012 is set as an example. It is obvious that such research has been conducted for each of the seasonal lines (Fig. 2).

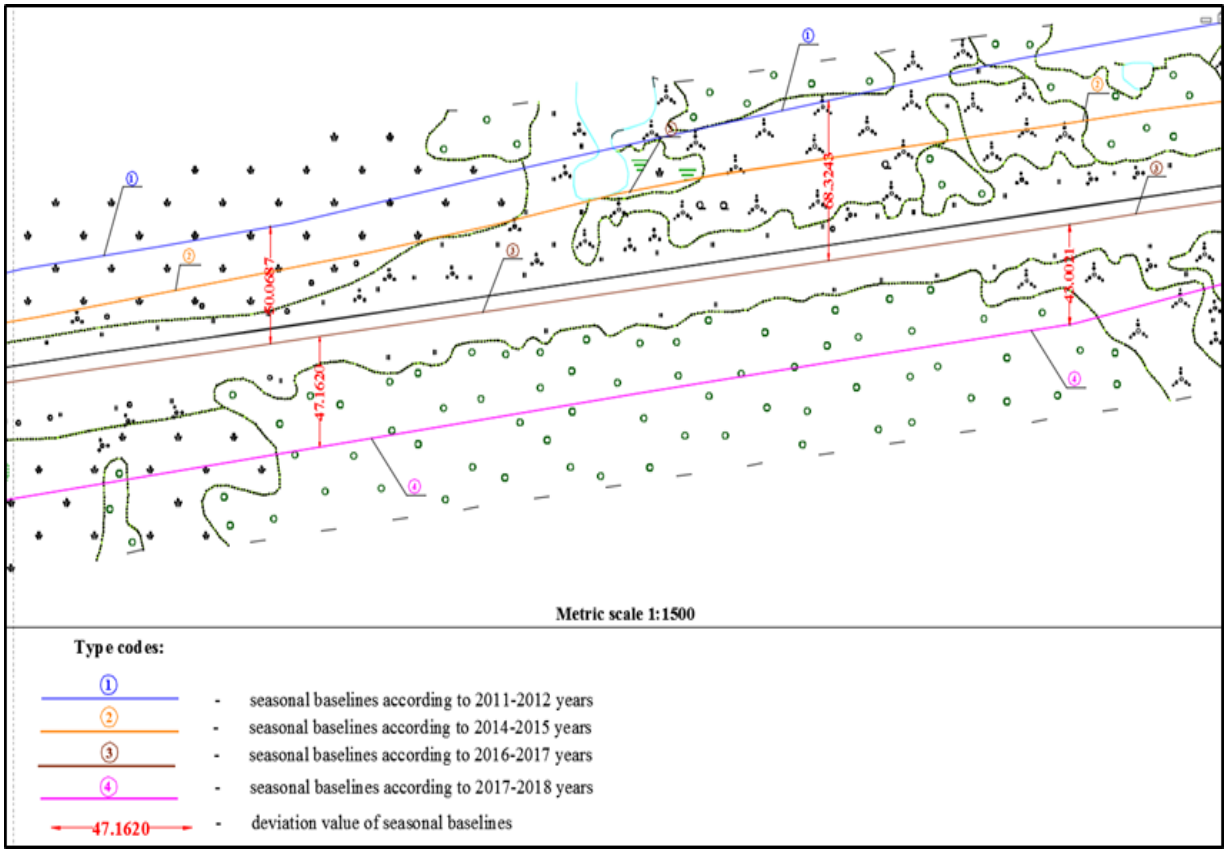

Fig. 2. Result of carrying out of analysis for the roads' seasonal baselines according to 2011–2017 years

The distribution of indicators' values is uneven. Certain groups and classes are obviously allocated. The following conclusions can be made: with the increase of the frozen ground depth, the divergence of lines also increases. As the snow density decreases, the divergence of lines increases. The maximum divergence of lines is in the zones, which have minimum time of soil freezing. Thus, the revealed dependence is logical and can be used for subsequent clustering of the indicators.

The result of cluster analysis is clear division of zones of divergence into three groups. Having information about the coordinates of points for each zone, it is possible to indicate them on the territory (Fig. 3).

The initial stage of the work is the construction of an exact image of the winter highway's baseline by seasons using geodetic survey data. As a result, we can note the divergence of the axes, which is related to the specificity of the site of seasonal function.

Then the middle line, built up by offset method due to the points of seasonal baselines, is determined. It is necessary to obtain the first indicator – the deflection of each baseline from the central one. Using the value of such deflection (with reference to other investigated indicators), it will be possible to explain and predict the location of the site in the future season.

Achieved major results

Knowledge of the position of the central baseline in accordance to these physical indicators can be used to predict the position of the winter highway for the next season. Therefore, an analytical study was carried out for each of the seasonal axes (on the slide as an example for one of them), as a result of which groups were identified. The result of the cluster analysis was a clear division of the zones of divergence into three groups. Having information about the coordinates of points for each zone, they can be indicated on the territory.

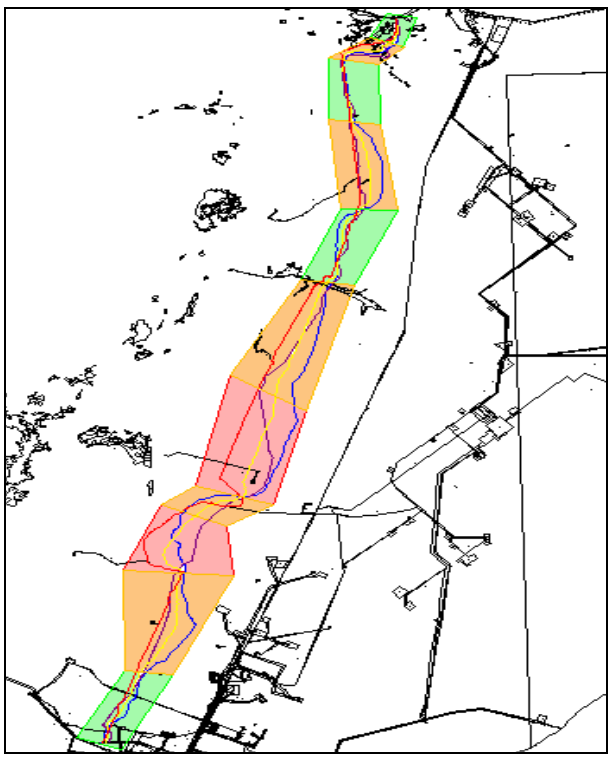

Fig. 3. The territory zones of lines' divergence
1, zone of the maximum divergence (marked with pink color); *2*, zone of the average divergence (marked with orange color); *3*, zone of the minimum divergence (marked with green color)

In addition, the location of the seasonal function site is affected not only by climatic and hydrological, but also by geological factors. That's why we need to take into account the natural features of the territory for cadastral work. All the stages of research are the framework for the algorithm of work for winter highway's cadastral registration. The algorithm is sustainable and requires knowledge of the distribution of a number of indicators in space and time.

Conclusion

The practical importance of research consists in the advanced algorithm of designing and land planning works of constant and seasonal highways. All presented milestones for the study are framework for such algorithm implementation, which requires knowledge of distribution in space and time of a number of indicators which define existence of such sites. It confirms the need of natural indicators' accounting. They can be designed only with the use of knowledge of laws of statement of similar stationary sites and taking into account features of existence in space and time.

Besides, another result of research is the creation of the buffer zone that defines borders of possible site's location for future seasons. The established zone will allow to keep account of such sites, and, secondly, will allow to avoid overlapping (most often, with forested land, royalty-based lands, and sometimes territories of Arctic Indigenous Peoples), the legal disagreements and other local questions caused by features of use and development of the territory.

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