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SUBSTANTIATION OF RULES FOR SETTING OF RETAINING PROTECTIVE BUILDINGS AGAINST LANDSLIDE ON HIGHWAYS IN MOUNTAINOUS AREAS

O. Tymchenko, T. Asst.,
Kharkov National Automobile and Highway University

Abstract. The grounding of choice of necessary construction of retaining protective buildings and their location on landslide areas is carried out. It has been noted that the efficiency of protective measures is provided on condition of landslide process development studying, the geological structure of the sliding dangerous territory, the form and conditions of the glide surface and studying of the water-bearing horizons.

Key words: retaining building against landslide, landslide and sliding dangerous territory, choice of protective building.

ОБОСНОВАННЫЕ ПРИНЦИПЫ НАЗНАЧЕНИЯ УДЕРЖИВАЮЩИХ ПРОТИВООПОЛЗНЕВЫХ СООРУЖЕНИЙ НА АВТОМОБИЛЬНЫХ ДОРОГАХ В ГОРНОЙ МЕСТНОСТИ

О.Н. Тимченко, ассист.,
Харьковский национальный автомобильно-дорожный университет

Аннотация. Предложены принципы назначения удерживающих противооползневых сооружений на автомобильных дорогах в горной местности. Проведено обоснование выбора необходимой конструкции удерживающих противооползневых сооружений и их место расположения на оползнеопасных территориях. Обоснованы основные принципы назначения сооружений инженерной защиты.

Ключевые слова: удерживающее противооползневое сооружение, оползневая и оползнеопасная территория, выбор защитного сооружения.

ОБҐРУНТОВАНІ ПРИНЦИПИ ПРИЗНАЧЕННЯ ЗАТРИМУЮЧИХ ПРОТИЗСУВНИХ СПОРУД НА АВТОМОБІЛЬНИХ ДОРОГАХ У ГІРСЬКІЙ МІСЦЕВОСТІ

О.Н. Тимченко, асист.,
Харківський національний автомобільно-дорожній університет

Анотація. Запропоновані принципи призначення затримуючих протизсувних споруд на автомобільних дорогах у гірській місцевості. Проведено обґрунтування вибору необхідної конструкції затримуючих протизсувних споруд та їх місце розташування на зсувонебезпечних територіях. Обґрунтовані основні принципи призначення споруд інженерного захисту.

Ключові слова: затримуюча протизсувна споруда, зсувна та зсувонебезпечна територія, вибір захисної споруди.

Introduction

In mountainous areas highway designing is related to the necessity of paring of sliding dangerous slopes, construction of access roads for road-building machinery conveyance, and designing of protective measures. Practice shows that even after accurate calculation the designed and built construction against landslide is able to become deformed till the complete loss of the

bearing strength. It is related to the irrational choice of protective measures against landslide.

Analysis of publications

Prevention of landslide processes will allow to avoid enormous charges in comparison with liquidation of their consequences. Therefore arrangement and analysis of protective engineering measures against landslide were conducted on highways in mountainous areas. Much scientists have studied the problems of forecasting of development of landslide processes, calculation of slope stability and they were engaged in the decision of problems of stabilizing of sliding dangerous territory. Trere are M.N. Gol'dshteyn, N.N. Maslov, K.O. Gulakyan, M.D. Krucik, E.P. Emel'yanova [1–5].

The aim and formulation of a problem

The aim of the article is to substantiate the rules of setting of protective measures against landslide on highways in mountainous areas.

The choice of engineering protective buildings is carried out in view of the degree of responsibility and value of the protected territories, buildings and constructions, their structural and operating features [6]. At the same time there was analyzed the possibility of the use of engineering protective buildings as structural elements of buildings and constructions to be placed on the sliding dangerous territory.

Substantiation of rules for setting of retaining protective buildings against landslide

The choice of necessary construction of retaining buildings against landslide and their location on sliding dangerous territories is carried out on the basis of analysis and account of [7]:
– features of slope territories – landslide or sliding dangerous;
– results of complex engineering researches within the limits of sliding dangerous territories or in the zones of landslide occurrence;
– forecasting of possible changes of natural conditions caused by natural or anthropogenic factors, changes of setting and state of the protected objects;
– estimations of materials of research works and design executed for the choice of effective protective constructions against landslide;
– experience of designing, construction and exploitation of objects of engineering protection;
– information concerning local building conditions, climatic features, the presence of open pits of building materials and natural resources;
– requirements for systematic observations over the state of highway territory and for work of engineering protective buildings during highway construction and exploitation;
– the choice of setting places of control and measuring devices, observation pits, setting of sensors, posts, geodesic plugs and other devices necessary for supervision during highway construction and exploitation after the development of landslide processes influence on retaining engineering buildings;
– rules of technical exploitation of engineering protective buildings and organization of technical exploitation service work.

The basic principles of engineering protective buildings designing are as follows:
– reliability (the ability of the building to take loads during all the life length without dislocation of normal service of protected buildings or areas);
– speed of construction (the protective building must be built in the shortest time especially on landslide territories);
– economy (the protective buildings to be designed in real conditions must have the least cost among all the analyzed variants);
– maximal use of retaining capacity of grounds subjacent to landslide masses;
– the wide use of modern technologies, equipment and mechanisms, achievements in the field of soil mechanics and foundation engineering during highway designing and construction [6].

The estimation of the modern state of existent buildings, highways, communication systems is carried out on the basis of reliable information in relation to the exposed deformations on the protected areas of highways before the beginning of engineering protective buildings designing.

The estimation of economic and ecological value of the territory and perspectives of its use is carried out as well. Information concerning executed protective measures against landslide and existent engineering protective buildings, their state, necessity and possibility of their repair, reconstruction is analyzed.

Retaining buildings against landslide are referred to basic buildings of the protective complex against landslide on highways the construc-

tions of which is carried out on the basis of reasonable engineering calculations, technical and economic comparison of options of various designs with other constructions against landslide.

The expedience of their application is grounded by the following [4]:
– the stability of the slope during construction of buildings gradually increases;
– large volumes of earthworks are excluded that is especially important for city and mountainous conditions;
– the technology of piles pitching of large diameters allows to almost completely mechanize the construction process;
– the vertical elements of retaining buildings against landslide, bending members, can be used as foundations of buildings of different function after stabilization of the slope.

On landslide territories it isn't allowed to apply retaining buildings against landslide if on the basis of experimental works on engineering-geological researches the glide surface or the zone of the disorganized horizon was not defined accurately.

Use of retaining buildings on the sliding dangerous territory (highway sections in mountainous areas) is caused by the existence in the slope of such engineering and geological elements which can't be engaged in landslide shift and in which retaining constructions cannot be reliably set up. Thus, on the basis of calculations performed it has been confirmed that the stability coefficient does not go down below the standard on any glide surfaces passing under the lower ends of retaining elements. Calculations are carried out in view of the possible changes of hydrogeological conditions and other sliding factors changing within a certain time limit.

Experimental researches showed that the ordinate of landslide pressure on the fixed retaining building increases in the wide range of landslide shift practically in proportion to the value of landslide soils motion [8].

The reduction degree of landslide pressure depends on the value of structural durability of the soil. At change of landslide pressure from zero to the maximal value it is possible to assume that the soil works as Vinkler's elastic circle when the dependence of pressure from the value of landslide soils motion is next to the linear one. The value of efforts caused by landslide soils on

the elements of the retaining building can be obtained by multiplication of rigidity coefficient of the soil on the value of motion of the landslide massif located before the building.

If the building is rigid under pressure of landslide soils it only turns. The value of such shifts can be determined according to the following equation

$$y = \delta(a + bx), \qquad (1)$$

where y – moving of the rigid building element; δ – the value of landslide soil shift.

For landslides of sliding or other types of landslides at small power of the deformation zone the calculated scheme of the rigid single-row retaining building against landslide is presented in fig. 1.
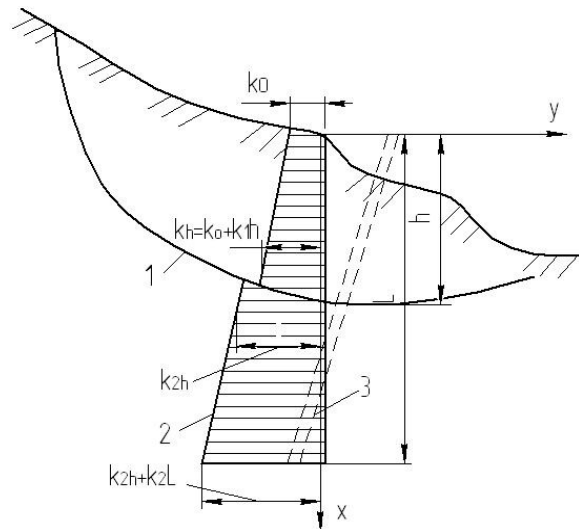

Fig. 1 The scheme of work of the single-row retaining building: 1 – glide surface; 2 – distributions coefficient of rigidity for landslide and standing grounds; 3 – vertical element of the rigid retaining building

Coefficients a and b (for δ=const) are determined on the basis of solving of the system of equations describing the balance of the retaining element:

$$\int_0^h (1 - ma - mbu)\varphi_1(u)du - \int_h^L (a + bu)\varphi_2(u)du = 0;$$

$$\int_0^h (x - u)(1 - ma - mbu)\varphi_1(u)du - \qquad (2)$$

$$-\int_h^L (x - u)(a + bu)\varphi_2(u)du = 0,$$

where $\varphi_1(x)$, $\varphi_2(x)$ – the functions characterizing rigidity of soils depending on the depth of x within the limits of landslide block and below the glide surface in the horizontal direction.

For this calculation scheme the following formulae can be applied

$$\varphi_1(x) = k_0 + k_{1x}; \varphi_2(x) = k_{2h} + k_{2x}.$$

Here in k_0 and k_h – the horizontal rigidity coefficient of soil at the level of daily surface and near the glide surface within the limits of landslide soils;

k_{2h} and k_{2L} – the same near the glide surface and at the depth of immersion of vertical retaining elements within the limits of resistant rock below the glide surface;

h – the depth to the shift surface on the area of construction of retaining buildings against landslide;

L and b_1 – the depth of immersion of the vertical elements of retaining buildings against landslide and their cross value;

m – the coefficient taking into account the stability degree of landslide soils directly adjoining the retaining building from the local side: $m = 2$, if the coefficient of stability of the indicated soils of the landslide slope is equal 1,5 or more. If the coefficient of stability of the landslide blocks adjoining the building is next to zero or is not guaranteed, then $m = 1$. In all other cases the value of m is undertaken according to the linear extrapolation depending on the coefficient of stability of the indicated soils.

Conclusions

Retaining buildings against landslide in the system of protection against landslide in many cases (mountainous area, city building, etc.) are the unique buildings the application of which allows to fix a soil slide area or to increase stability of a slope on the sliding dangerous territory.

Retaining buildings against landslide are applied in that case when it is not possible or economically expedient to increase stability of a slope by means of its diminishing of the gradient or by other more economical methods of fixing. Retaining buildings are intended for fixing of landslides of sliding, rock fall or run developing in slopes where strong and resistant rocks underlay lower than the shift surface or deformation zone in which retaining elements can be reliably established. Protective buildings against landslide

are applied for fixing of landslide masses slowly displaced or on sliding dangerous slopes where landslide shifts are absent during designing, however, construction of new objects requires increase of stability degree of slopes up to the standard sizes.

Retaining buildings are also applied in cases when within a possible slope destruction prism they design a large weight building setting, slope cutting, etc.

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