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SEISMIC RESISTANCE OF AVALANCHE–PROOF AND STONE-PROOF GALLERIES

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Abstract: The article considers the definition of the state of the avalanche protection gallery under seismic impact and avalanches.

Keywords: Avalanche protection gallery, seismic, oscillation, arching, snow avalanches.

INTRODUCTION

The railway transport of the Republic of Uzbekistan carries freight and mass passenger traffic both within the republic and in interstate traffic. Uninterrupted operation of railroads is extremely important.

For the Republic of Uzbekistan with rapidly developing high-speed train traffic and the possible impact of seismic forces on complex engineering structures such as Railways, it is necessary to ensure reliable operation of the road in this complex combination of loads [1].

One of the strategic directions of the development of public railway transport is the organization of heavy traffic, including with increased axial loads [2].

The mountainous regions of Uzbekistan are being drawn into the sphere of economic activity. In addition to the development of oil production, mining and energy industries. But development of mountain areas is associated with the need to take into account the danger of natural-destructive phenomena inherent in the mountains and in the first place - snow avalanches and rockfalls [3].

Sections of the railroads of Uzbekistan in the mountainous terrain are exposed to the impact of static rockfall, and more often to the impact of single stones of different sizes. Especially active is the impact of rockfall during earthquakes, and operated railroads in mountainous areas are located in zones of 8-9-point seismicity [4].

When an earthquake occurs and the speed of traffic increases, longitudinal, transverse, and vertical vibrations are created on the roadbed [5].

Currently, a large number of separate works (more than 300) are devoted to the issues of soil pressure on retaining walls and other fences, the presentation and analysis of which would require a multi-volume work [6].

Unfortunately, accidents and destruction of building structures, buildings and structures, including transport structures, have recently become commonplace, as evidenced, for example, by the results of the analysis conducted by the authors of the works [7].

Surveys of the consequences of many earthquakes suggest that avalanche protection galleries, which are built in very difficult terrain and geological conditions, are damaged during 6-point earthquakes, and during 7-point earthquakes are often out of order or require large capital investments for reconstruction.

Analysis of the actual data on the survey of the consequences of destructive earthquakes shows that the intensity of the earthquake depends on the engineering-geological, hydrogeological and geomorphological structure of the area [8].

The problem of assessing the influence of train dynamics on the stressed state of the subgrade becomes particularly difficult in connection with the organization of high-speed traffic [9].

MAIN PART

The low resistance of galleries to dynamic loads (such as seismic loads) can be explained not only by the fact that little attention has been paid to these engineering structures so far, but also by the fact that they were in an extremely complex stressed state during operation. There are many internal and external forces acting on these structures. Therefore, during an earthquake, it is often enough a relatively small impact to damage this structure. As studies and analysis of the consequences of earthquakes show, the main cause of destruction is the different dynamic stiffness of the gallery across the cross section: on the one hand, the high stiffness of the retaining wall wedged into the ground, on the other hand, the sufficient flexibility of the column and the ledgers. Since the floor beams are supported by these elements, they undergo small movements on one side and large movements on the other. Of course, there are many other causes of damage to the galleries, but this is one of them with a total length of 714 m. It is clear from the design of the gallery (Fig. 1) that the nodes connecting the floor slabs do not take into account seismic forces and freely rest on the retaining wall and on the ledgers. Similar designs of girder bridges have a series of developed knots for seismic areas both in our country and abroad. In addition, retaining walls are designed to be massive with conventional foundations, not unlike non-seismic walls. It is also known that massive retaining walls are poorly resistant to earthquakes and require large amounts of concrete and labor.

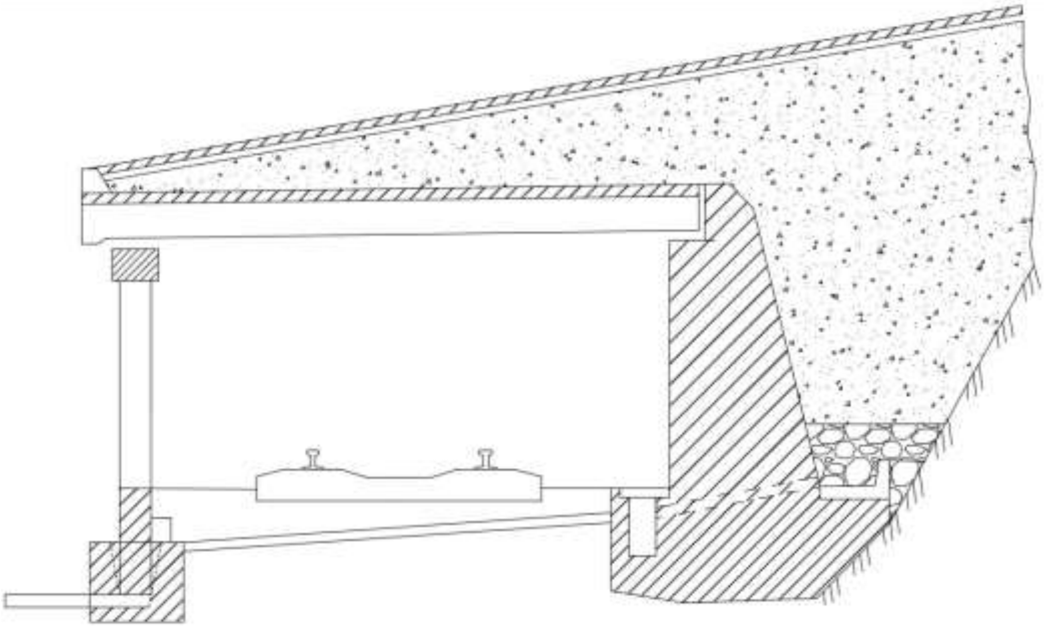

Fig. 1. Cross section of the avalanche protection gallery

Basically, all experimental studies are carried out on models using a seismic platform and a centrifugal modeling machine based on the "Theory of similarity of solid deformable bodies" by academician A.G. Nazarov using the "Installation for reproducing dynamic effects on underground structures", senior scientist Teshabaeva Z.R., as well as using natural structures of bridges of various constructions [10].

As the results of modeling studies have shown, thin-walled retaining walls with buttresses are the most earthquake-resistant of the existing structures. The advantages of these retaining walls can be explained by their relatively low dead weight and considerable flexibility. The main reason, however, is the buttresses, which provide significant dynamic stiffness and great traction with the ground. As can be seen from the seismic platform experiments, the effect of increasing the seismic resistance is obtained by increasing the ground pressure on the buttresses. The buttresses are pinched bilaterally by the soil (Fig. 2), which, in turn, holds the entire retaining wall in place. This restraining force depends on the magnitude of the seismic action.

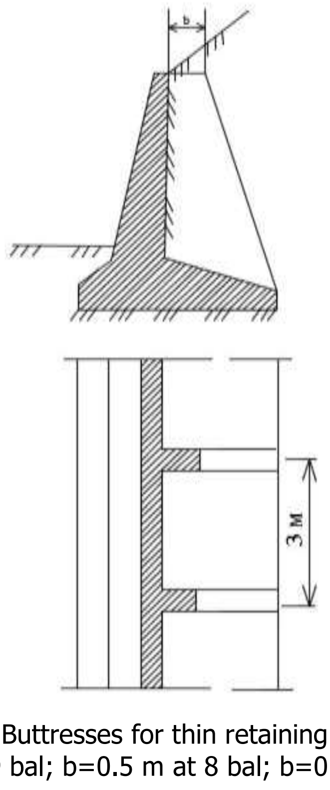

Fig. 2. Buttresses for thin retaining walls::
b=1.0 m at 9 bal; b=0.5 m at 8 bal; b=0.3 m at 7 bal.

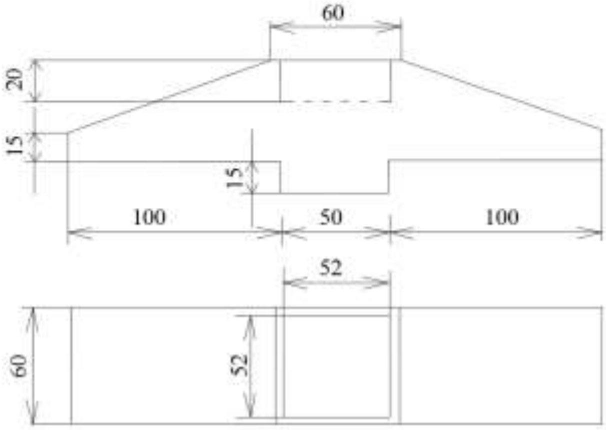

Fig. 3. The foundation for the column

A positive effect in such galleries is the increase of the zone of soil involved in joint oscillations with the retaining wall due to the buttresses. This increases the overall stability of the retaining wall. It is also important that the consumption of concrete in such retaining walls is much less than in solid retaining walls, and a prefabricated version is possible, which makes them preferable in high altitude conditions.

To increase the seismic resistance of the gallery, a connection along the contour is necessary, which can be achieved by installing reinforcement along the concrete floor with embedding in the foundation of the columns and the upper retaining wall. This measure will prevent the foundation and columns from collapsing, which was often the cause of damage to the gallery on steep slopes. The metal consumption is very small and depends on the number of columns.

Experiments allow us to recommend prefabricated foundations for columns (Fig. 3). In seismic areas under the action of dynamic loads they are more stable for a number of reasons. First, they have a relatively low dead weight compared to solid foundations. Next, they have a much larger support part of the soil (foundation). And finally, they are more malleable under dynamic loads, i.e., they allow some deformations without collapsing.

The connection nodes of the floor slab with the supporting parts are of great importance: with the transoms and retaining walls. In the upper part of the support on the retaining wall, it is recommended to make openings in the diaphragm for the plate rib (Fig. 4). This prevents possible lateral displacement of the plates and limits longitudinal displacement. In addition, this design solution increases the dynamic stiffness of the structure as a whole, which will also contribute to the earthquake resistance of the gallery.

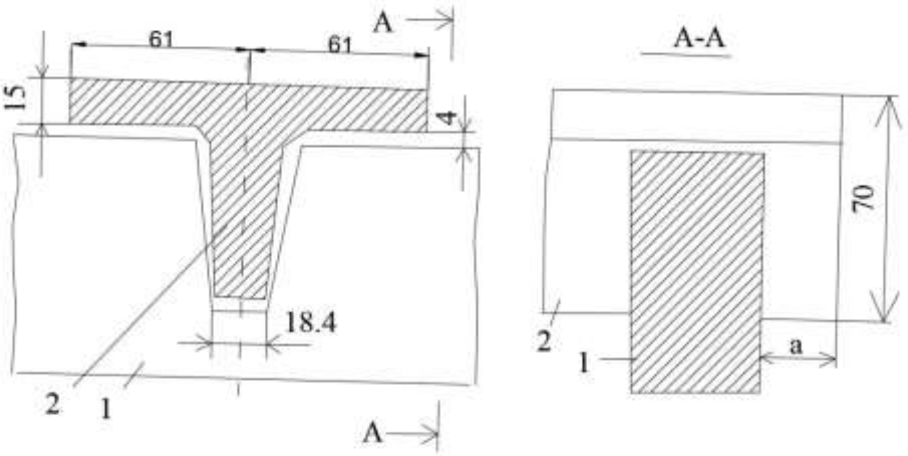

Fig. 4. The node of the floor slab resting on the retaining wall:
1 - retaining wall, 2 - floor slab:
a=0,3 m at 9 bal; a=0,2 m at 8 bal; a=0,1 m at 7 bal;

As the initiated theoretical and experimental studies of seismic resistance of road galleries show, it is more correct to solve this problem as a whole, not breaking it down into separate elements, because it is necessary to take into account the spatiality of the structure and the fact that its stability depends additionally on the design of foundations, soil conditions and the slope slope inclination, on which the gallery is located.

Engineering seismometric stations should be installed on the existing Frunze-Osh road gallery and on the Osh-Khorog road gallery under construction. These stations will make it possible to judge the dynamic parameters of the galleries, their behavior during possible earthquakes depending on the intensity of their manifestation in the section of the engineering structure, the degree of slope gradient, ground and hydrological conditions, and will also allow comparing baseline data depending on the structural changes that are planned in the new galleries under construction.

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