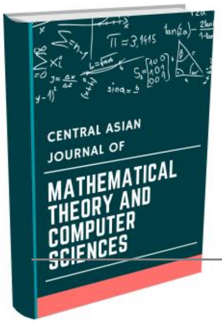

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Constructions of Coastal Supports of Railway Bridges

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Abstract

The article analyzes the main types of structures of coastal supports and provides a justification for the friction area of coastal supports with the soils of the base and structures with high shear resistance using mathematical expressions.

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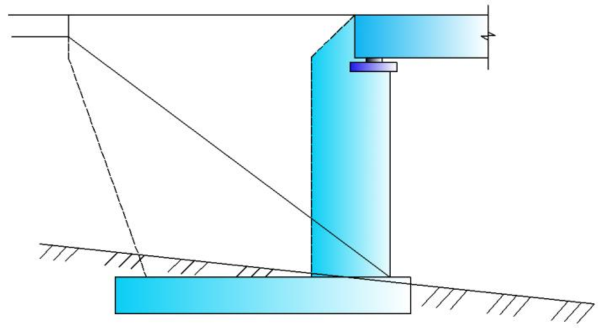
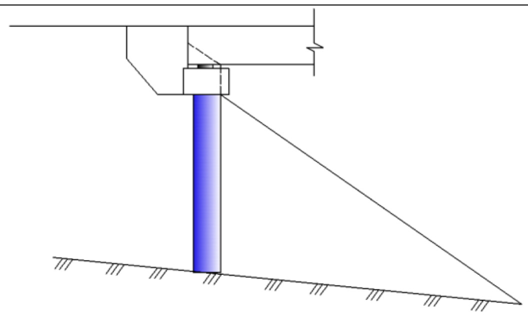
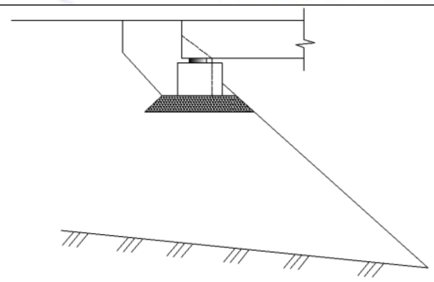
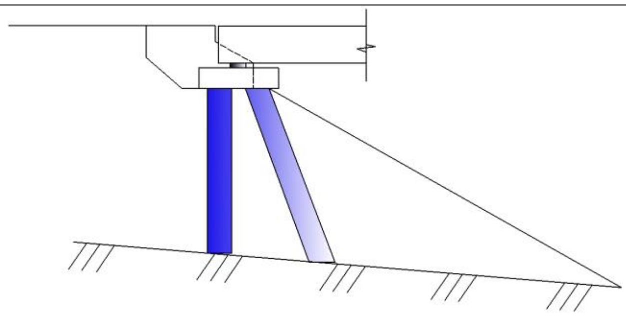
INTRODUCTION

Bridge supports are divided into coastal ones, indicated in Table 1. Supports are needed to transfer vertical and horizontal loads from the weight of superstructures, mobile load, wind, etc. to the ground of the base. By design, the supports can be classified as follows: massive supports − stone, rubble concrete, concrete (monolithic, prefabricated or prefabricated). Having appeared at the dawn of bridge construction, massive supports are still used today on bridges over large rivers during intensive ice runs and in other difficult conditions; pile supports are structures consisting of one or more rows of piles connected on top by a nozzle on which superstructures are installed [1].

Pile supports made of wooden and metal piles are widely used for temporary bridges. With the development of piling technology, such supports began to be constructed from reinforced concrete piles and used for permanent bridges over small watercourses in the absence of ice passage, as well as for overpasses. This made it possible to give some constructive solutions to ensure the stability of the roadbed on the slope and the expediency of strengthening the bulk part with piles [2].

In the 60s and 70s, varieties of pile supports appeared and quickly gained recognition among builders: columnar, in which the main bearing elements are reinforced concrete pillars joined on top by a nozzle resting on the foundation, and grillless ones made of shell piles with diameters of 1.6 m or more or bored piles; hollow supports made of monolithic concrete or closed concrete blocks, mainly of rectangular cross-section, installed on a foundation of any type and combined on top with a reinforced concrete slab of solid cross-section. Hollow supports are designed as concrete or reinforced concrete with non-stressed or stressed reinforcement. Depending on the location of the approach embankment in the cone, the abutments are divided into: non-bulk, in which the sole of the cone does not go beyond the front face of the abutment [3]. Loose abutments are currently used mainly in urban conditions, often in combination with longitudinal retaining walls that limit the size of the embankment in plan; loose abutments are located in the body of the cone. Such foundations are now the main type of structures that allow the use of the most effective technical solutions − pile and rack supports. The disadvantage of the bulk abutments is an increase in the length of the bridge to the part of the cone overlapped by the superstructures [4].

Table 1.Types of coastal supports

Massive coastal support (with sloping wings or in the form of a retaining wall)	
Prefabricated pile or rack-type abutment (single row)	
The mouth in the form of a lezhnevoy support	
Prefabricated pile or rack-type abutment (double row or gantry)	

The active pressure (E_a) that affects the shore support of the bridge increases, creating the possibility of deep ground shift [5]. Shore supports are used to interface the bridge with the approach embankments (Fig. 1).

Fig.1. Construction of the shore support of the operated bridge

As is known, the coastal support of bridges often receives significant residual deformations along the vertical and horizontal planes during operation, which complicates the operation of the structure and requires additional costs to ensure normal conditions for moving transport [6].

The dynamic stiffness of the sub-grade, which is interrupted at the coastal bridge support, is significantly reduced and depends on the rigidity of the bridge span and the interface with the bridge support [7].

To reduce the impacts listed above in the structures of coastal bridge supports, the following design solutions are proposed, which reduce the amount of deformations and increase the service life of the structure. The methods of calculating the stiffness of the track depending on the modulus of elasticity of railway tracks and coastal bridge supports are clarified in order to ensure the elastic operation of the railway on the transition sections [8].

The embankment in front of the shore support of the bridge fluctuates under the influence of seismic and vibrodynamic forces [9].

RESULTS

The concave support part of the foundation sole increases the resistance of the bridge support from possible horizontal shear. In addition, the contact area of concrete and the ground of the base increases. The angle α of force transfer to the ground of the base increases by 15-20%, which reduces the amount of stress in the ground and the thickness of the compressible layer, i.e. the sediment of the structure decreases [10].

With the concave base of the coastal support, the friction force increases, which ensures its stability. From a mathematical point of view, the increase in the friction surface during the design of the concave base of the shore support is shown in Fig. 2:

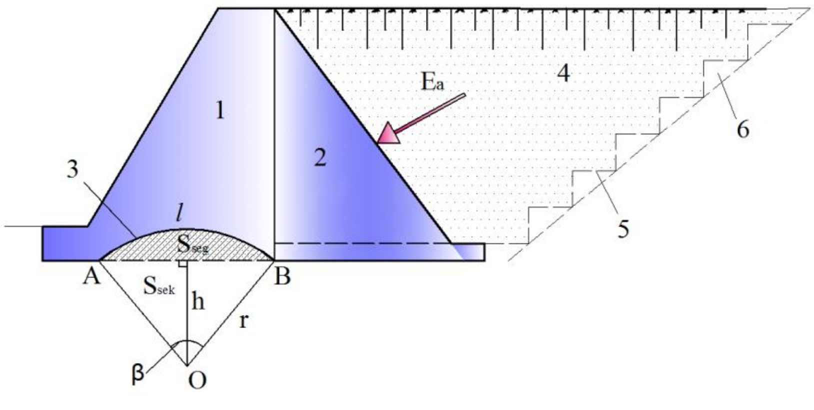


Fig.2. Calculation of the area of an additional section of the concave base of a coastal support with soil

1-retaining wall, 2-buttresses, 3-concave support surface of the retaining wall,

4-roadbed, 5-ledges, 6-landslide ground mass, Ea- active ground pressure

The concave support is divided into a circular sector and a segment. The area of the sector is determined by the following expression:

$$S_{sek} = \frac{\pi r^2 \beta}{360^0}, \qquad (1)$$

The area of the segment is determined by the following expression:

$$S_{seg} = \frac{\pi r^2 \beta}{360^0} - S_{AOB}, \qquad (2)$$

where

r – circle radius, (m);

β – central corner;

S_{AOB} – the area of the triangle in the sector, (m^2);

π =3,14.

CONCLUSION

It follows from the calculations that the area of the segment is equal to the concave part of the coastal support. Consequently, in a concave support, the friction area (S_seg) increases by 10-15% than in a support whose base consists of a straight line. This allows you to increase the service life.

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