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Types of Coastal Bridge Supports

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ABSTRACT: The article describes the main types of coastal bridge support. For this reason, the design of the coastal support, the base of which is concave, is recommended. The definition of the area of the concave base of the coastal support by mathematical expressions is considered.

KEYWORDS: Shore support, concave, abutment, piling, earthquake resistance, sector, segment, ground.

I. INTRODUCTION

Bridge supports are divided into coastal ones, as indicated in Table 1. Supports are needed to transfer vertical and horizontal loads from the weight of spans, 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-monolithic or prefabricated). Having appeared at the dawn of bridge construction, massive supports are still used today on bridges over large rivers during intensive ice-moving and in other difficult conditions; pile supports − structures consisting of one or more rows of piles connected on top by a nozzle (crossbar), on which the superstructures are installed [1-3].

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 drift, as well as for overpasses. In the 60-70s, various types of pile supports appeared and quickly gained recognition among builders: columnar, in which the main load-bearing elements are reinforced concrete posts that are joined on top by a nozzle (crossbar) resting on the foundation, and leafless 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 reinforced concrete slab of solid cross-section. Hollow supports are designed as concrete (without vertical reinforcement) or reinforced concrete with non-stressed or tensioned 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. Non-bulk abutments are currently used mainly in urban environments, often in combination with longitudinal retaining walls that limit the size of the embankment in plan; bulk - located in the body of the cone. Such abutments are now the main type of structures that allow you to use the most effective technical solutions-pile and rack supports. The disadvantage of loose abutments is an increase in the length of the bridge by the part of the cone that is overlapped by the spans [4-5].

II. MAIN PART

The table shows four types of shore support:

1) An array of coastal support (with sloping wings or in the form of a retaining wall);
2) Prefabricated pile or rack type abutment (single row);
3) An abutment in the form of a lezhnevoy support;
4) Prefabricated pile or rack type abutment (double row or gantry).

In this case, basically, the shore support should perceive the active ground pressure (E_a) arising from the oscillatory force of the rolling stock and transmit it to the base, as well as ensure the safe operation of the structure.

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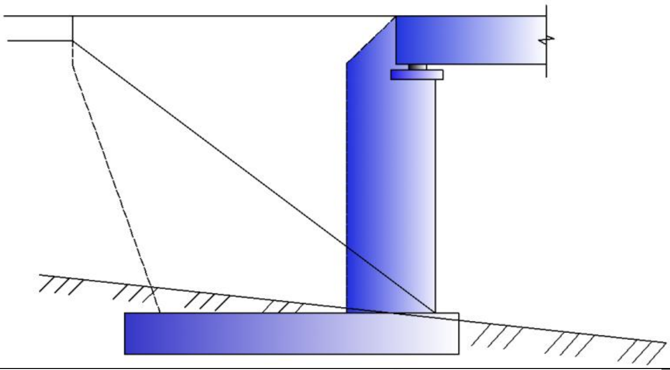
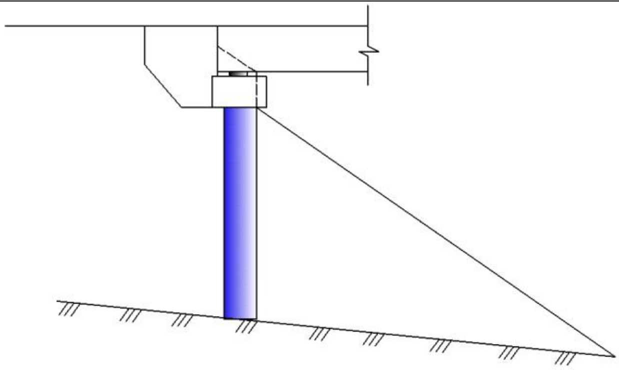
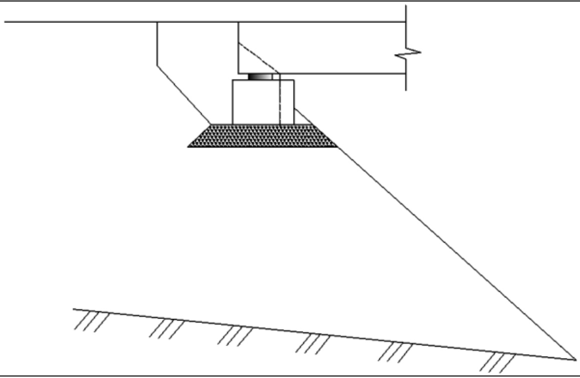
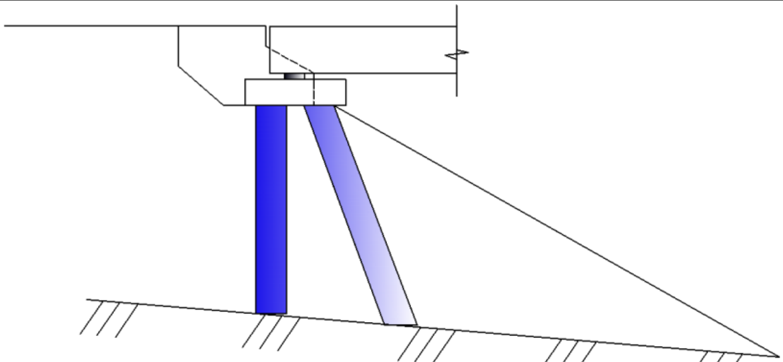
Table 1

Types of shore supports	
Massive shore support (with sloping wings or in the form of a retaining wall)	
Prefabricated pile or rack type abutment (single row)	
An abutment in the form of a lezhnevoy support	
Prefabricated pile or rack-type abutment (double-row or gantry)	

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III.RESULTS

An increase in the service life of the structure of the above-mentioned shore support is achieved by reducing the amount of deformability by repaying the acting forces by making a design change. The positive aspects of the coastal support, which changed the design appearance, are shown below:

1. Coastal bridge supports should be designed with buttresses, as in the construction of retaining walls-Fig. 1. This design is especially effective in earthquake-prone areas of construction, since part of the active seismic ground pressure reduces the impact on the structure. This reduces the weight of the structure, which leads to savings in concrete and rebar. Also, the seismic inertial forces are reduced, which are directly proportional to the weight of the structure according to the static theory of earthquake resistance. These structural changes significantly increase the overall dynamic rigidity of the bridge support, which is necessary for high-speed train traffic and increases the earthquake resistance of the structure.

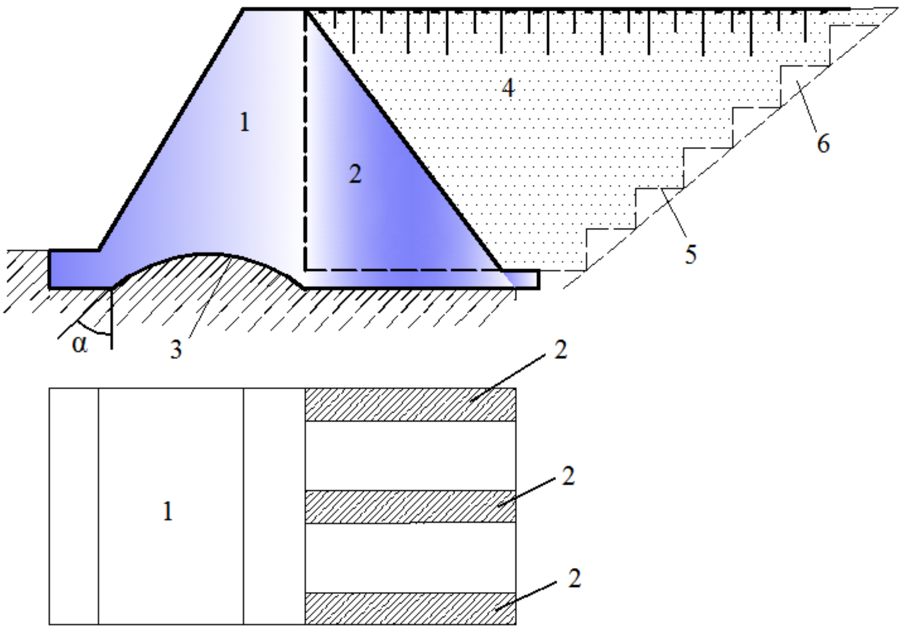

Fig. 1.The design of the coastal bridge support with buttresses and a concave support part at the base
1-retaining wall, 2-buttresses,
3-the concave support surface of the retaining wall,
4-the roadbed, 5-ledges, 6-the mass of the landslide soil.

2. The concave support part of the foundation sole increases the resistance of the bridge support against possible horizontal shear. In addition, the contact area of the 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 is reduced [2].

When the base of the shore support is concave, 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 Figure 2:

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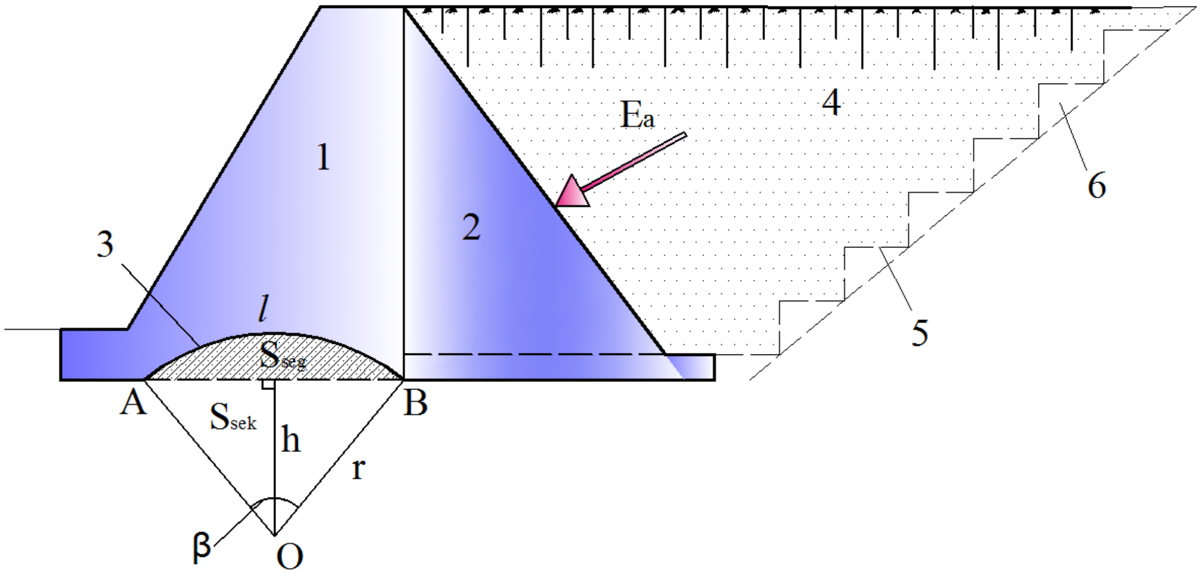

Fig. 2. Calculation of the area of the additional section of the concave base shore support with ground 1-retaining wall, 2-buttresses,3-the concave support surface of the retaining wall,4-the roadbed, 5-ledges, 6-the mass of the landslide soil,

E_a - 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:

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

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

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

Where:
r – circle radius;
β – central corner;
S_{AOB} – the area of the triangle in the sector;
π =3,14.

IV. CONCLUSION

From the calculations, it follows that the area of the segment is equal to the concave part of the coastal support. Hence, in a concave support, the friction area is (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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