REINFORCEMENT OF DEEP EROSION SECTORS WITHIN THE BRATIA HYDROGRAPHICAL BASIN, CONTRIBUTIONS TO TEN IMPROVEMENT OF THE METHODOLOGY OF DESIGNING ON THE SEISMIC CALCULATION OF THE WALLS IN THE GABIONS

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Abstract
The hereinafter work regards the problem of the ecological rehabilitation of the damaged lands due to the late years' floods on Bratia River which resulted in serious erosions of the river's bank and associated with the high level of instability of the water course have endangered the dwellings, agricultural lands, communication routes, etc. Among the works covered by study the gabion walls have a significant weight. Individual gabions are boxes or mattresses used in the hydro technical arrangement works as structure elements in the shape of blocks.
They are filled with rocks or stones and from their horizontal or vertical connection large size works result, forming a flexible low cost long lasting monolithic structure, with a long operation time. Gabion banks' protection has the advantage of high permeability which eliminates the suppression effect of the infiltration water which damages the concrete structures. This high permeability acts as a self drainage system reducing the hydraulic load of the phreatic water. The gaps between the stones filling the gabions diminish the drainage effect and the waves' actions so that the entire structure is airy and require no additional drainage works. A methodology of seismic calculation of the gabion walls is presented as the designing technologies don't explicitely refer to the effects of the seismic actions on the gabion walls.
We have adopted from the international specialty literature a methodology able to solve the problem of stability of the gabion support walls as well as verifications by structural calculations of the stability of the hydro technical structure. The stabilizing forces opposing the sliding of the support wall are the friction, cohesion, passive pressure and anchoring forces. The methodology described in the present work ensures the structures a high reliability. During the operation period the gabions require no maintenance works. The advantages of the gabions result from their use as modular systems.

Key words: hydrographic basin, support wall, protection dam, gabion wall

1. INTRODUCTION

The main objective is the works of reshaping-recalibration of the Bratia river bed and strengthen the bank with a view to strengthening the damaged hydrotechnical network and the river banks affected by the erosion processes, to protect social and economic objectives within the hydrographic basin.
The damaged hydrographic network is 6.1 km long, amounting to 10% of the total length of the river network and is affected by beds and banks erosion, slopes destruction and unconsolidated alluvial deposits.

2. RESULTS AND DISCUSSION

Among the works covered by our study, the gabion walls have a great weight; individual gabions are boxes or mattresses used in the construction of hydrotechnical arrangements as construction elements in the form of blocks. They are filled with rocks or stones, and linking them horizontally and vertically result in large works, forming a flexible low cost long lasting monolithic structure. The bank protections using gabions have the advantage of having a high permeability, eliminating the effect of infiltration water underpressure, which damages concrete structures; this high permeability acts as a selfdrainage reducing the hydraulic load of the phreatic water[1]. Gaps between the rocks filling the gabions dissipate the leakage energy and waves action, the entire structure is airy and does not require additional drainage works.

Gabions' flexibility allows structures adaptation to compression of the foundation earth and ensure a long operating time.

During the gabions operation time, fine particles of soil are deposited in the gaps between stones, favoring the installation of natural vegetation. This way a permanent, natural, well assimilated in the environment structure is built up.[2]

During the operation period the gabions require no maintenance works.

The advantages of the gabions also result from their use as modular systems.

Gabions are reliable, efficient, modern construction elements, with wide possibilities for use in hydrotechnic constructions, although they set a higher weight per sqm of land than the concrete work.

As the design methodology doesn't explicitely refer to the effects of seismic action on the walls of gabions, we adopted from the international literature a methodology that can solve this problem:

The static force S_a, an increment of it ΔS_a and inertial forces S_i are taken into consideration.

The increment (increase) of the static force (Δsa) is given by:

$$\Delta S_a = S_a^{'} - S_a$$

S_a - static pressure

$$S_a^{'} = \bar{S}_a \cdot A,$$

$$A = \frac{\cos^2(\alpha+\theta)}{\cos^2\alpha \cdot \cos^2\theta}$$

$$\theta = arctgC$$

C-coefficient of seismic intensity having the following values:

- 0.04 in areas with low seismic activity
- 0.07 in areas with average seismic activity
- 0.10 in areas with high seismic activity [3]

$\bar{S}_a$ - (pushing) force calculated on the basis of:

$$\bar{\alpha} = \alpha + \theta$$

$$\bar{\varepsilon} = \varepsilon + \theta$$

(α positive for forces pointing to external side of the wall)

This increase of the pushing force occurs at a distance from the wall.

Horizontal inertial force is calculated by: $S_i = cw$

c – coefficient of seismic intensity

w – weight of wall in gabions

Structural calculations

1. Checking the resistance to sliding is compared to the horizontal plane. Specific for the gabions walls is that the stabilizing forces (F_s) opposing the sliding are the friction forces (fN) and the cohesion forces (cB) on the sliding surface, the passive pressure passive (S_p) to the wall basis and the anchoring forces (S_s) to the upper wall: $F_s = fN + cB + S_p\cos\delta + S_s$

Some of these components may be missing, depending on the type of gabion wall and the actual conditions of the site.

Normal force N is the sum of vertical forces perpendicular to the sliding surface, ie soil weight, the weight of the wall, the vertical component of force of the earth, overload and possible seismic action.

The friction coefficient is:

$f = tg\varphi$, f= 0,64 concrete foundation

The force establishing the slide for weight walls is:

$$F_i = [S_a \cdot \cos(90+\delta-\beta)]\cos\alpha$$

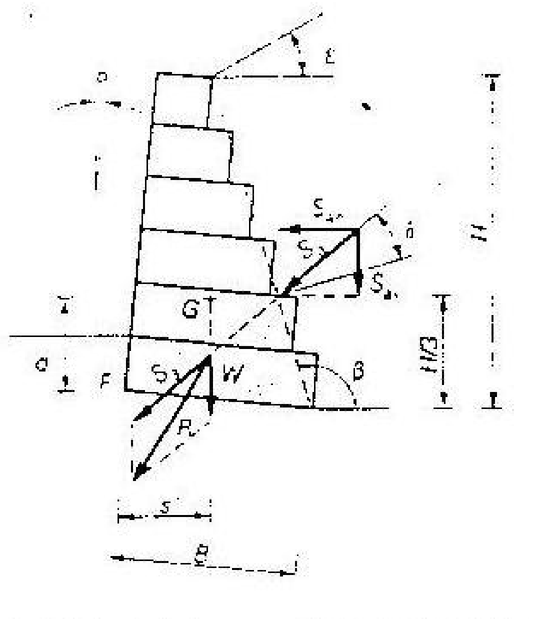
For walls with increased foundation:

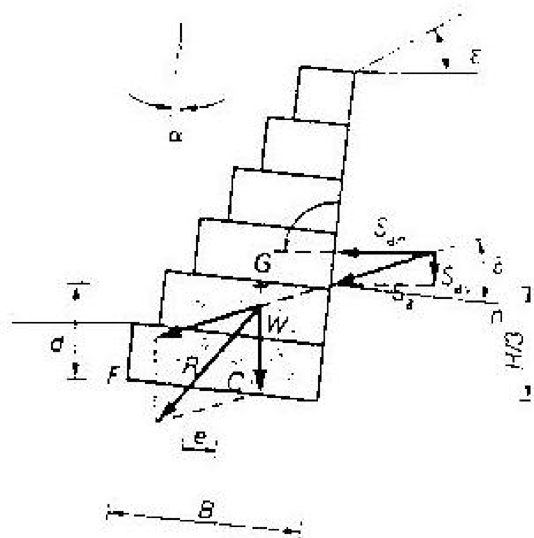
$$F_i = (S_a\cos\delta)\cos\alpha$$

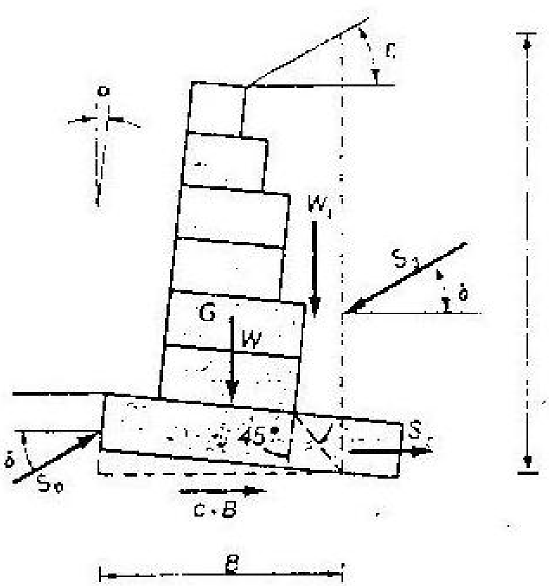
The slideproof coefficient is:

$$\eta_s = \frac{F_s}{F_i} \geq 1,3$$

The passive force upstream, S_p, may be neglected.







2. Checking resistance to collapse

The collapse time is defined by:

$$M_i = S_{ah} \cdot d$$

and the reset time M_s is:

$$M_s = W \cdot s' + W_t \cdot b + S_{av} \cdot s$$

w - structure weight

wt - weight of dislocated soil plus a certain reload

S_{ah} / S_{av} - pressure's horizontal and vertical components including seismic pressure.

d=H/3 –B sin α ,without overload

$$d = \frac{H}{3}\left(\frac{H + 3pd\gamma_t}{H + 2pd\gamma_t}\right) - b\sin\alpha$$ with overload

$p_0 \cos\gamma_t$ weight of the soil

$s' = X_g \cos\alpha + Y_g \sin\alpha$

($X_{g,} Y_g$ - weight cartesian coordinates of the wall inrelation to the origin in point F

$$s = B\cos d - \frac{H}{3}\left(\frac{H + 3p_d\gamma_t}{H + 2p_d\gamma_t}\right)\frac{1}{\tan\beta}$$

b- distance from the dislocated soil centre of gravity to point F

Crash safety factor is $\eta_t = \frac{M_s}{M_i} \geq 1,5$

5. CONCLUSIONS AND RECOMMENDATIONS

Stability of support walls is checked by structural calculations to determine stability of the hydrotechnical construction.

Stabilizing forces opposing the sliding of the support wall are friction, cohesion, passive pressure and anchorage forces. The methodology described in the paper ensures greater reliability of the construction using it.

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