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The Assessment of the Debris Flow Influence on the Debris Flow against Stepped Barrage Containing of Semi Cylinder Shape Elements

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Abstract
In the article is purposed debris flow against stepped barrage containing semi cylinder shape elements and the theoretical researches conducted to assessment debris flow influence on it.
In the conditions of the specific assumptions it has been found number values of action loads at the semi cylinder shape elements of the construction at the influence of debris flow.
The results of the calculating gives basis that proposed construction consider as the effective debris flow against construction.

Keywords: debris flow, barrage, surrounded by flow, through coefficient

Introduction
From the natural ddisaster running on the Earth recently, with the flood and landslide processes, special place has also debris flow phenomena of erosion-landslide genesis, that cause human casualties, destruction of infrastructure facilities and economic damage.
In Georgia as in whole world, especially active is debris flows phenomena, that is very serious problem for country, because significant part of the country is in the debris flows area [1, 2, 5, 6].
Based on the above is necessary to work out effective measures to manage of debris flows [3, 7, 8].

The main part
To manage of debris flows, has been worked out the debris flow against stepped barrage containing with semi cylinder shape elements**,** theoretical studies were carried out with for assessment debris flow influence [4].
The debris flow against stepped barrage containing with semi cylinder shape elements is presented with four figures: fig 1 – The general view of construction fig.2 - The above view of construction; fig.3 – cut a-a on the fig. 2; fig. 4 – cut on the fig. 2.

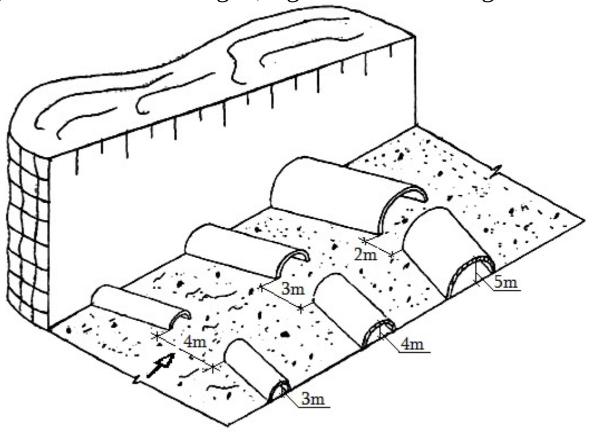


Fig 1.

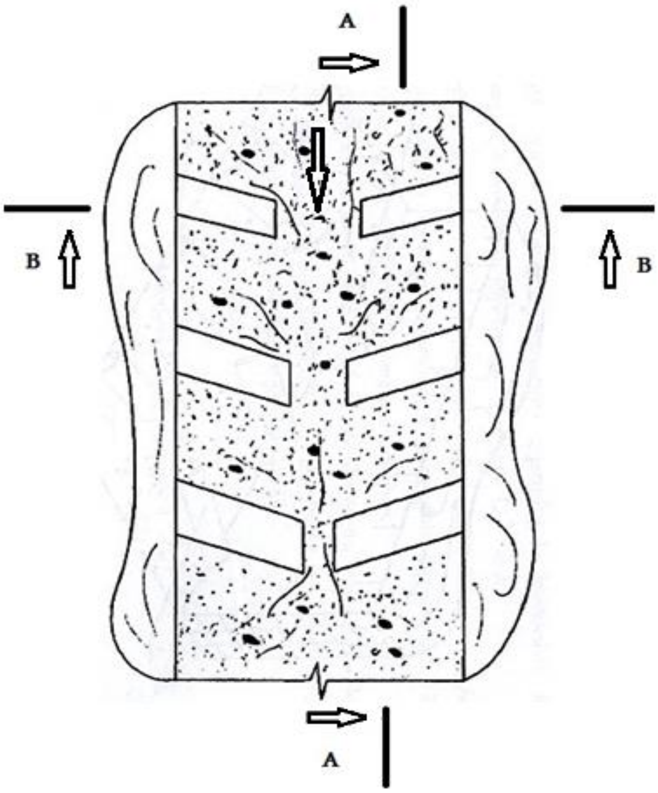


Fig 2.

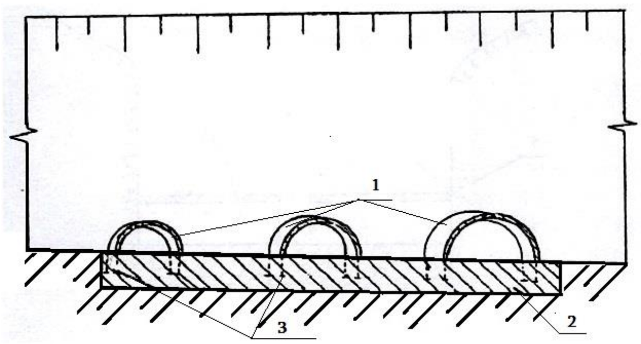


Fig 3.

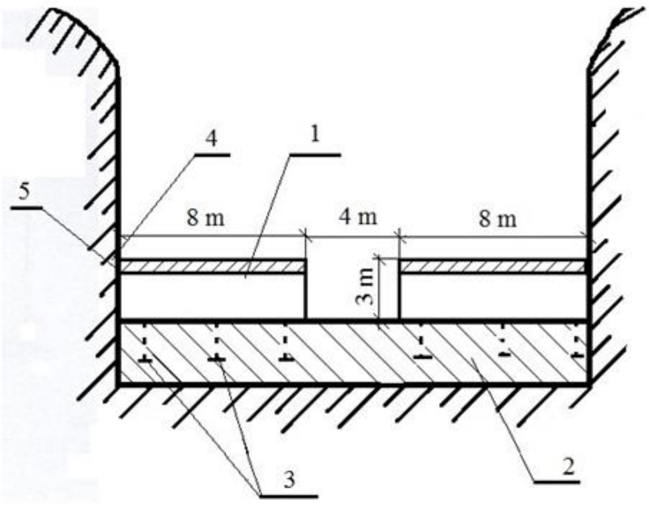


Fig. 4.

Debris flow against stepped barrage is containing with semi cylinder shape elements1, which separately is pinned concrete foundation 2, with anchors 3, and with hollow bases 4 affixed to the banks of the river bed 5 with blunt α angle toward debris flow movement, the radius of curvature of the elements are increasing, and distance between steps elements is decreasing towards debris flow movement.

The semi cylinder shape elements of the debris flow against stepped barrage may made of reinforced concrete, or metal bottles.

The working principle of debris flow against stepped barrage is containing with semi cylinder shape elements is follow: during the moves of debris flow in the river bed, the debris flow energy extinguish on the first step 1 of the construction containing half cone-shaped part arch hollow elements causes the location of the construction in the river bed, particularly, the cylinder elements of the construction is located with blunt α angle towards debris flow movement, because during debris flow influence at the first step of the construction changes of debris flow part direction and collision to the flow motion to direction of bed center from right and left side, also extinguish of kinetic energy of the debris flow has place during the surrounded by flow on the next steps of the construction, that finally causes debris flow energy extinguish.

It should be noted, that distance between small bases of the barrage elements are decreasing, so is increasing its width towards debris flow movement, that also causes debris flow energy extinguish.

The size of steps elements of debris flow against stepped barrage**,** their amount and location in the river bed will choose by taking into account of debris flow hitting force and river natural-topographical conditions.

For assessment influence of linkage debris flow on the debris flow against stepped barrage is containing with semi cylinder shape elements there is follow calculation with specific assumption [9, 10].

Initially, it should be noted, that semi cylinder shape elements of construction are located by 3 row. The distance between the row is L=10 m, because L is small, in the calculation is not taking into acount loss of debris flow energy on the lengh during throw the debris flow from I row of truncated half cone-shaped elements to III row.

The calculating formula of hitting force of debris flow on the construction is follow:

$$P = \frac{1,5 \cdot \gamma \cdot \omega \cdot V^2}{g} \cdot \left[\cos\alpha \cdot tg\varphi + \frac{h_0}{2 \cdot H}\left(\frac{1-\sin\varphi}{\cos\varphi} \right) \right] \qquad (1)$$

Where γ – The volume mass of the debris flow kg/m^3;

V – The speed of debris flow vawe motion (m/sec);

g – The acceleration of mass force (m/ sec ^{2}) ;

ω – The area of live cut of riverbed m^2;

h_0 –The equivalent height of linkage;

φ – The angle of inside friction;

H – The height of debris flow;

α – The inclination of river bed.

For calculation of hitting force of linkage debris flow on the construction introducing follow characteristics of debris flow and bed: width of debris flow bed B=20 m (m/sec), height of debris flow H=5 (m), speed of motion of debris flow wave V=5 (m/sec), Volume weight γ =2000 kg/m^3, internal friction angle $\varphi = 30^0$ and inclination $i = 0{,}2$.

By taking into account above conditions value of hitting force of linkage debris flow on the construction is equal:

$$P = \frac{1{,}5 \cdot \gamma \cdot \omega \cdot V^2}{g} \cdot \left[\cos\alpha \cdot tg\varphi + \frac{h_0}{2 \cdot H}\left(\frac{1-\sin\varphi}{\cos\varphi}\right)\right] == \frac{1{,}5 \cdot 2000 \cdot 20 \cdot 5 \cdot (5)^2}{9{,}81} \cdot \left[0{,}978 \cdot 0{,}577 + \frac{4}{2 \cdot 5} \cdot \frac{1-0{,}5}{0{,}866}\right] = 5962{,}5\ K.n.$$

Because our construction is through off road coefficient is calculated by the following formula:

$$Kn = \frac{\omega\ through\ n\ row}{\omega}, \quad (2)$$

where $\omega_{hrough\ n\ row}$ – occupied area by debris flow from outflow on the truncated half cone-shaped elements exist in the construction row;
$n$construction – is row number of truncated half cone-shaped elements.
The debris flow hitting containment of construction elements is equal:

$$K_n^I = \frac{\omega\ deaf\ n\ row}{\omega}, \quad (3)$$

Where $\omega_{deaf\ n\ row}$ – is area of frontal protection of the truncated half cone-shaped elements exist in the construction row (area of the elements protection is trapezoid area;

The calculations for I row of construction

Through coefficient $K_1 = \frac{\omega\ through\ I\ row}{\omega} = \frac{52}{100} = 0{,}52\ m^2$,
Where $\omega_{hrough\ I\ row} = \omega - \omega_{deaf\ Irow} = 100-48 = 52\ m^2$;
$\omega = B \cdot H = 20 \cdot 5 = 100\ m^2$;
$\omega_{deaf\ I\ row} = S_1 + S_2 = 24+24 = 48\ m^2$,

where S_1 and S_2 – is areas of the frontal protections of the left and right truncated half cone-shaped elements exist in the construction I row.
$S_{1\ I\ row} = a_{1\ I\ row} \cdot b_{1\ I\ row} = 3 \cdot 8 = 24\ m^2$;
$S_{2\ I\ row} = a_{2\ I\ row} \cdot b_{2\ I\ row} = 3 \cdot 8 = 24\ m^2$;

Where $a_{1\ Irow}$ and $b_{1\ Irow}$ – $a_{2\ I\ row}$, $b_{2\ Irow}$ is large and small sides of the rectangular shape projection of the semi cylinder shaped I and II elements exist in the construction I row.
The hitting force of the linkage debris flow action on the of semi cylinder shaped both elements exist in the construction I row is equal:
$P_{deafIrow} = P \cdot K_1^I = 5962{,}5 \cdot 0{,}48 = 2862$ k.n.,

Where

$$K_1^I = \frac{\omega\ deaf\ 1\ row}{\omega} = \frac{48}{100} = 0{,}48.$$

After through I row of construction residual hitting force of linkage debris flow is equal:
$P_{residual\ Irow} = P - P_{deafIrow} = 5962{,}5 - 2862 = 3100{,}5$ k.n.

The calculations for II row of construction

Through coefficient $K_1 = \frac{\omega through\ II\ row}{\omega} = \frac{32}{100} = 0{,}32 m^2$,
where $\omega_{through\ IIrow} = \omega - \omega_{deaf\ IIrow} = 100-68 = 32\ m^2$;
$\omega = B \cdot H = 20 \cdot 5 = 100 m^2$.
$\omega_{deaf\ IIrow} = S_{1\ IIrow} + S_{2\ IIrow} = 34+34 = 68\ m^2$,

where $S_{1\ IIrow}$ and $S_{2\ IIrow}$ – is areas of the frontal projections of the left and right truncated half cone-shaped elements exist in the construction II row.
$S_{1\ IIrow} = a_{1\ IIrow} \cdot b_{1\ IIrow} = 4 \cdot 8{,}5 = 34\ m^2$;
$S_{2\ IIrow} = a_{2\ IIrow} \cdot b_{2\ IIIrow}\ 4 \cdot 8{,}5 = 34\ m^2$;

Where $a_{1\ IIrow}$, $b_{1\ IIrow}$, $a_{2\ IIrow}$, $b_{2\ IIrow}$ – is large and small sides of the trapezoid projection of the truncated half cone-shaped elements exist in the construction II row.
The hitting force of the linkage debris flow action on the of semi cylinder shape both elements exist in the construction II row is equal:
$P_{deaf\ IIrow} = P_{residual\ Irow} \cdot K_2^I = 3100{,}5 \cdot 0{,}68 = 2108{,}34$ kn,

Where

$$K_2^I = \frac{\omega\ deaf\ II\ row}{\omega} = \frac{68}{100} = 0{,}68.$$

After through II row of construction residual hitting force of linkage debris flow is equal:
$P_{residual\ IIrow} = P_{residual\ Irow} - P_{deaf\ IIrow} = 3100{,}5 - 2108{,}34 = 992{,}16$ kn.

The calculations for III row of construction

Through coefficient $K_3 = \frac{\omega through\ III\ row}{\omega} = \frac{10}{100} = 0{,}1\ m^2$,
Where $\omega_{through\ IIIrow} = \omega - \omega_{deaf\ IIIrow} = 100-48 = 52\ m^2$;
$\omega = B \cdot H = 20 \cdot 5 = 100\ m^2$.
$\omega_{deaf\ IIIrow} = S_{1\ III\ row} + S_{2\ III\ row} = 45+45 = 90\ m^2$,

Where $S_{1\ IIIrow}$ and $S_{2\ IIIrow}$ – is areas of the frontal projections of the left and right truncated half cone-shaped elements exist in the construction III row.
$S_{1\ IIIrow} = a_{1\ IIIrow} \cdot b_{1\ IIIrow} = 5 \cdot 9 = 45\ m^2$;
$S_{2\ IIIrow} = a_{2\ IIIrow} \cdot b_{2\ IIIrow} = 5 \cdot 9 = 45\ m^2$;

Where a1 $_{IIIrow}$ and b1 $_{IIIrow}$ – is large and small bases of the trapezoid projection of the truncated half cone-shaped elements exist in the construction III row.
The hitting force of the linkage debris flow action on the of semi cylinder shape both elements exist in the construction III row is equal:
$P_{deaf\ IIrow} = P_{residual\ IIrow} \cdot K_3^I = 992{,}16 \cdot 0{,}9 = 892{,}94$ k.n,

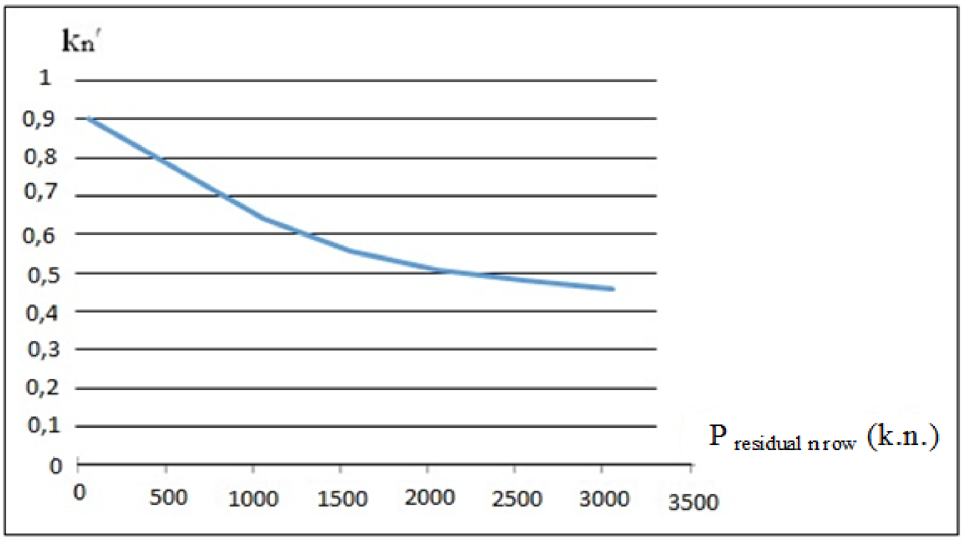
Where

$$K_3^I = \frac{\omega\ deaf\ III\ row}{\omega} = \frac{90}{100} = 0{,}9.$$

The hitting force of the linkage debris flow action on the of semi cylinder shape both elements exist in the construction III row is equal:
$P_{residual\ IIIrow} = P_{residua\ IIIrow} - P_{deaf\ IIIrow} = 992{,}16 - 892{,}94 = 99{,}22$k.n.

Connection between the containment coefficient of debris flow hitting on the debris flow against stepped barrage and residual force after through stepped barrage elements is presented by follow functional independence. $K_n^I = f(P_{residual\ n\ row})$, (see. Graph 1).

$K_1^I = 0{,}48$ in case $P_{residual\ I\ row} = 3100$,k.n;
$K_2^I = 0{,}68$ in case $P_{residual\ III\ row} = 992{,}16$ k.n;
$K_3^I = 0{,}9$ in case $P_{residual\ IIrow} = 99{,}22$ k.n.



Grap 1: Connection between the containment coefficient of debris flow hitting on the debris flow against stepped barrage containing with semi cylinder shape elements and residual force after through stepped barrage elements

The results

From the calculation implemented for describe influence of linkage debris flow on the presented debris flow against stepped barrage containing with semi cylinder shape elements, seem, that construction is effective engineering measure for against debris flow, because initial force of debris flow influence on the construction P=5962,5 k.n., after through of construction decrease approximately 5962,5÷99.22≈60- times, that indicate to effectively of construction.

Conclusion

Due to above mentioned may be concluded, that presented debris flow against stepped barrage containing with semi cylinder shape elements is effective, relative easy for implementation and economy construction by technical point of view, that gives basis for its implementation in practice.

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