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Goga Chakhaia
Nugzar Kvashilava
Levan Tsulukidze
Zurab Lobzhanidze
Shorena Kupreishvili
Tamriko Supatashvili
Irakli Kvirkvelia
Irina Khubulava
Sophio Gogilava
Tsotne Mirtskhulava Water Management Institute of Georgian Technical University Ave. I chavchavadze, Tbilisi, Georgia

Correspondence:
Goga Chakhaia
Tsotne Mirtskhulava Water Management Institute of Georgian Technical University Ave. I chavchavadze, Tbilisi, Georgia

The assessment of debris flow influence on the debris flow against stepped barrage

Goga Chakhaia, Nugzar Kvashilava, Levan Tsulukidze, Zurab Lobzhanidze, Shorena Kupreishvili, Tamriko Supatashvili, Irakli Kvirkvelia, Irina Khubulava, Sophio Gogilava

Abstract
In the work is purpose debris flow against stepped barrage, on which is implemented theoretical research foe assessment of debris flow influence.
As a result of calculation, in the condition of concrete assumptions, has been established number value of operating loads on the truncated half cone-like structure elements of the construction during linkage debris flow influence.
The results of the above calculations give basis that purposed construction consider as effective debris flow against construction.

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

Introduction
Due to abundant sediments caused climate changes running on the Earth have become more frequent various natural disasters: floods, debris flow. Landslide and other, which negative influence on the environment is significant. Georgia is not an exception, because here is especially active debris flows, which is a very serious problem for country, because 29 % from country territory is in spread of debris flow. Debris flow formation often accompanied human victim, destroy of various infrastructure [1, 2, 5, and 6].
Based on the above is necessary to work out effective engineering ecological measures of debris flow manage for minimize negative results of the debris flow [3, 7, 8].

The main part
For this purpose, has been developed the debris flow against stepped barrage**,** theoretical studies were carried out with for assessment debris flow influence [4].
The debris flow against stepped barrage 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.

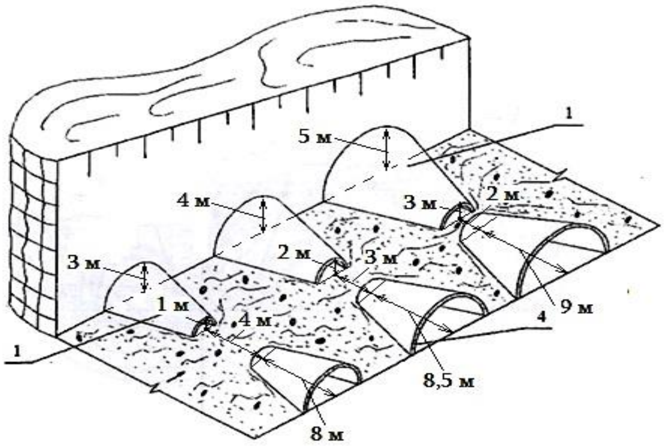


Fig. 1

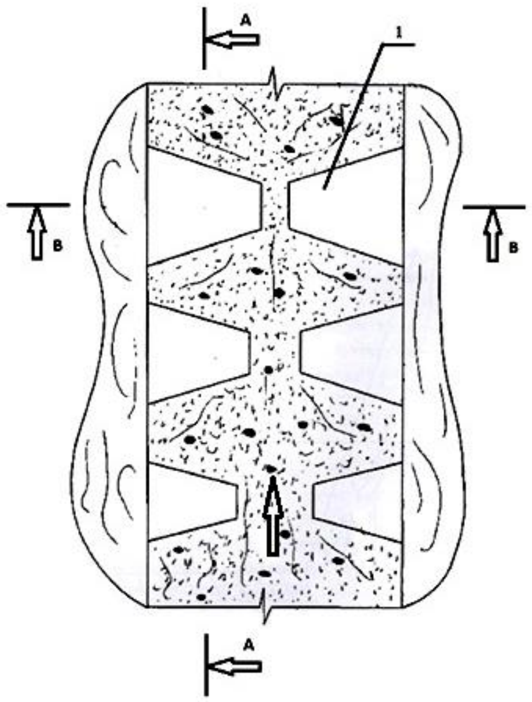


Fig. 2

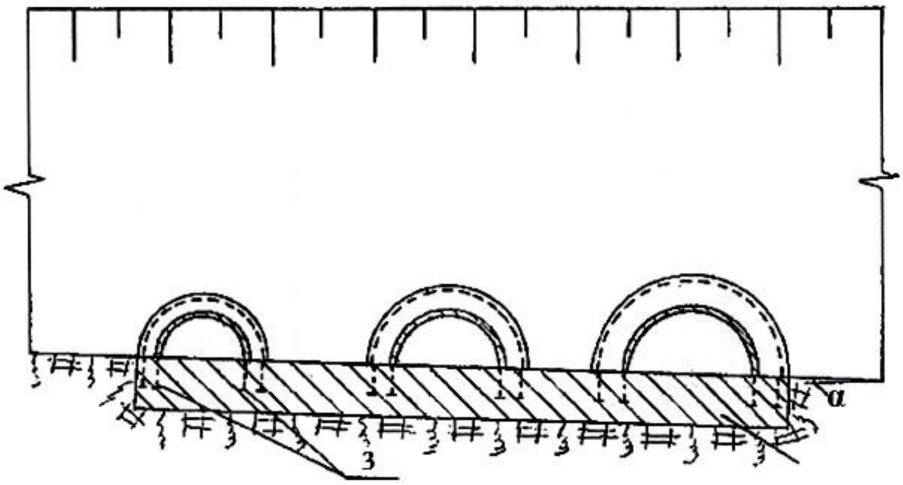


Fig. 3

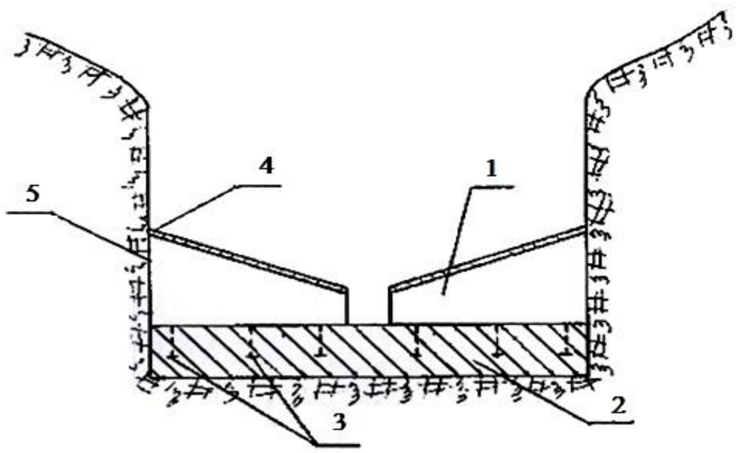


Fig. 4

The debris flow against stepped barrage contain truncated half cone elements 1, which are separately mounted concrete foundation 2, anchors 3, while large bases 4 the banks of the river bed 5. The radius of elements curvature increase, and distance between the step elements decrease to direction of debris flow motion.

The working principle of the debris flow against stepped barrage is follow: the debris flow energy extinguish on the truncated half cone-shaped part arch hollow composite elements on the construction steppes leads plot the layout of the building, particularly during the influence of debris flow on the first step of the construction becoming change of debris flow part direction and motion flow to direction of bed center from right and left side construction surrounded by a stream flowing into the collision, the same process goes on further steps of the construction, which ultimately leads to extinguish of debris flow energy. It should be noted that distance between the small bases of the barrage elements decrease, so increasing the width of the structure elements to direction of debris flow, it 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 above mentioned construction there is follow calculation with specific assumption [9, 10].

Initially, it should be noted, that truncated half cone-shaped elements of construction are located by 3 rows. 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:

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

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:

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

$$= \frac{1{,}5 \cdot 2000 \cdot 20 \cdot 5 \cdot (5)^2}{9{,}81} \cdot \left[0{,}978 \cdot 0{,}577 + \frac{4}{2 \cdot 5} \cdot \frac{1-0{,}5}{0{,}866}\right] = 5962{,}5 \mathrm{kn.}$$

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

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

Where ω $through\ n\ row$ – 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:

$K_n^I = \frac{\omega\ deaf\ n\ row}{\omega}$, (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 $K_1 = \frac{\omega through\ \mathrm{I}\ row}{\omega} = \frac{68}{100}$ =0,68 m^2,

Where

$\omega_{hroughIrow} = \omega - \omega_{deafIrow}$=100-32=68 m^2;
ω =B·H =20·5 =100m^2;
$\omega_{\ deaf\ I\ row} = S_1 + S_2$=16+16=32 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.

$S_1 = \frac{a1+b1}{2} \cdot h = \frac{1+3}{2} \cdot 8$=16m^2; $S_2 = \frac{a1+b1}{2} \cdot h = \frac{1+3}{2} \cdot 8$=16m^2,

Where a1 და b1 – is large and small bases of the trapezoid protection of the truncated half cone-shaped elements exist in the construction I row.

The hitting force of the linkage debris flow action on the of truncated half cone-shaped both elements exist in the construction I row is equal:

$P_{deafIrow} = P \cdot K_1^I$ =5962,5· 0,32=1908kn;

where $K_1^I = \frac{\omega\ deaf\ 1\ row}{\omega} = \frac{32}{100}$=0,32.

After through me row of construction residual hitting force of linkage debris flow is equal:

$P_{residual\ Irow} = P - P_{deafIrow}$=5962,5-1908= =4054,5 kn.

The calculations for II row of construction

Through coefficient $K_1 = \frac{\omega through\ \mathrm{II}\ row}{\omega} = \frac{49}{100}$ =0,49m^2,

Where

$\omega_{throughIIrow} = \omega - \omega_{deafIIrow}$=100-51=49 m^2;
ω =B·H =20·5 =100m^2.
$\omega_{\ deaf\ I\ I\ row} = S_1 + S_2$=25,5+25,5=51 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 II row.

$S_1 = \frac{a2+b2}{2} \cdot h = \frac{2+4}{2} \cdot 8{,}5$=25,5m^2; $S_2 = \frac{a2+b2}{2} \cdot h = \frac{2+4}{2} \cdot 8{,}5$=25,5m^2,

Where a1 და b1 – is large and small bases of the trapezoid protection 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 truncated half cone-shaped both elements exist in the construction II row is equal:

$P_{deafIIrow} = P_{residualIrow} \cdot K_2^I$ =4054,5·0,51==2067,8 kn,

Where

$K_2^I = \frac{\omega\ deaf\ II\ row}{\omega} = \frac{51}{100}$=0,51.

After through II row of construction residual hitting force of linkage debris flow is equal:

$P_{residualIIrow} = P_{residualIrow} - P_{deafIIrow}$= =4054,5-2067,8=1986,7 kn.

The calculations for III row of construction

Through coefficient $K_3 = \frac{\omega through\ III\ row}{\omega} = \frac{28}{100}$ =0,28 m^2,

Where

$\omega_{through\ IIIrow} = \omega - \omega_{deaf\ III\ row}$=100-72=28 m^2;

ω =B·H =20·5 =100 m^2.

$\omega_{deaf\ III\ row}$ =S_1+S_2=36+36=72 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 III row.

$S_1 = \frac{a3 + b3}{2} \cdot h = \frac{3+5}{2} \cdot 9$=36 m^2;

$S_2 = \frac{a3 + b3}{2} \cdot h = \frac{3+5}{2} \cdot 9$=36 m^2,

Where a1 და b1 – is large and small bases of the trapezoid protection 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 truncated half cone-shaped both elements exist in the construction III row is equal:

$P_{deaf\ IIrow} = P_{residual\ IIrow} \cdot K_3^I$ =1986,7· 0,72= =1430,4 kn,

Where $K_3^I = \frac{\omega\ deaf\ III\ row}{\omega} = \frac{72}{100}$=0,72.

The hitting force of the linkage debris flow action on the of truncated half cone-shaped both elements exist in the construction III row is equal:

$P_{residualIIIrow} = P_{residualII\ row} - P_{deaf\ I\ I\ I\ row}$=1986,7--1430,4 =556,3 kn.

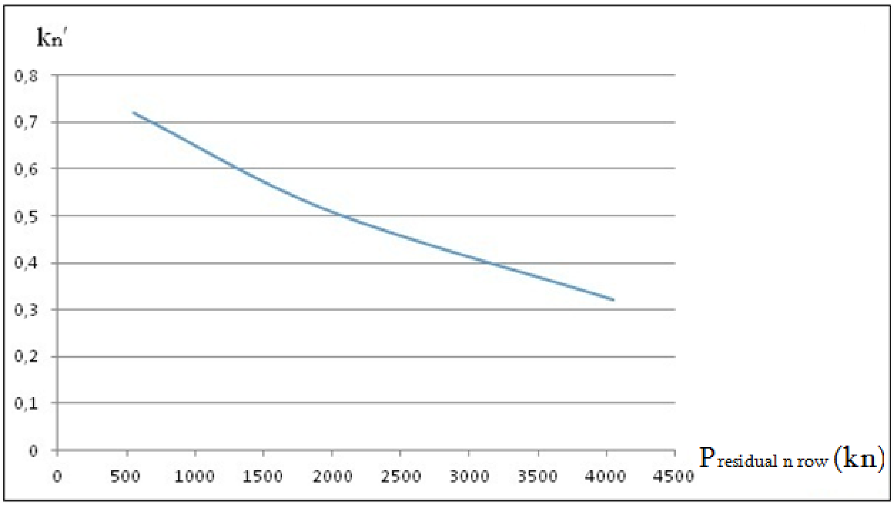
Connection between the containment coefficient of debris flow hitting on the debris flow against stepped barrage and residual force after through stepped barrage elements is presented by follow functional independence.

K_n^I=f($P_{n\ residual\ III\ row}$), (see. Graph 1).

K_1^I=0,32 in case $P_{residual\ I\ row}$ =4054,5 kn;

K_2^I=0,51 in case $P_{residual\ IIIrow}$ =1986,7 kn;

K_3^I =0,72 in case $P_{residualIIrow}$ =556,3 kn.



Graph. 1 Connection between the containment coefficient of debris flow hitting on the debris flow against stepped barrage 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, seem, that construction is effective engineering measure for against debris flow, because initial force of debris flow influence on the construction P=5962,5 kn, after through of construction decrease approximately 5962,5÷556,3≈11- times, that indicate to effectivity of construction.

Conclusion

It should be noted, that technical-economical characteristics of debris flow against stepped barrage is high, because using of barrage is possible without crash and durably, which excludes the additional costs of its repair.

Due to above mentioned may be concluded, that presented debris flow against stepped barrage effective, relative easy for implementation and economy construction by technical point of view. On the base of above mentioned may be say, that introduction of presented debris flow against stepped barrage is perspective.

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