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The Evaluation of Debris Flows Influence on the Pass through Type Debris Flow against Construction

Goga Chakhaia[a*], Eduard Kukhalashvili[b], Robert Diakonidze[c], Nugzar Kvashilava[d], Levan Tsulukidze[e], Shorena Kupreishvili[f],Tamriko Supatashvili[g], Irina Khubulava[h]

[a,b,c,d,e,f,g,h]*Tsotne Mirtskhulava Water Management Institute of Georgian Technical University*

Abstract

In the article is presented the pass through type debris flow against construction, builts at the surrounded by the flow principle, has been implemented theoretical researches for evaluation debris flow influence on that. As a result of our implemented calculation, in a condition of specific access, established, a numerical value of current loads on the cylinder form elements at the debris flow impact on the link debris flow. Results of the above calculation provide the basis for considering this construction potentially effectively debris flow against construction.

Key words: Construction; debris flow; theoretical calculation.

1. Introduction

Recently, as a result of global warming running on the Earth significantly changed climate on the various continents, because frequent heavy rains caused floods, intensified the process of melting glaciers, erosion and debris flows, landslides and debris flows and glacial debris flow processes, as a significant threat to the ecological imbalance in the influence zone of the population, under the risk are safety functionality of strategy importance transport corridor and energetic objects, the country's economy is suffering.To accomplish the formation of the frequency of natural disasters, Georgia is not an exception, In this respect the example of on the basin of the river Kabaki (the tributary of the river Tergi) the large-scale natural disaster which took place on 17 May 2014.

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* Corresponding author.

Particularly, in the catchment basin of the river Kabaki, as a result of melt glacier Devdoraki, formated debris flow with high 20-25 meter, which locked bed of the river Tergi and dead 7 human, has destroyed military motor-road 500 meters in length, of the strategic importance road connecting Russia-Georgia-Azerbaijan-Armenia, Rendered inoperative 2 pipeline of Russia and Armenia with diameter 200, and 750 through Georgia, leaving a long cut off gas supplies to Armenia. After blocking river Tergi basin by debris flow, under the threat turned out to be lower in elevation under construction Darial HPP hydraulic structures [1, 2]. Also, it is important, that, in the section of formation debris flow arose new vulnerability areas, which may cause the formation of repeated debris flow, what more can do much damage as Georgia and the South Caucasus countries.

The above-mentioned circumstances, due to various genesis debris flow activated in debris flow nature river catchment basin in Georgia, there should be implement debris flow against resources saving measures, for minimizing ecological risks [3, 4, 5, 6, 7 , 8, 9, 10].

2. Materials and methods

For this purpose, we have developed, resources saving through type debris flow against construction, built on base of surrounded principle of power [11], which consist checkerboard pattern knotted cylindrical elements, which are metal pipes with the metal axis, fulls of inert mass of riverbed, which have been fitted with tires, they are fixed on Reinforced concrete base(see Figure 1, 2, 3, 4).

Among the elements of the scheme of through type debris flow against construction, developed by us:(1)metal pipe, (2) tyres, (3) metal axis, (4) angled bar for connecting metal pipe and metal axis, (5) ropes for fixing on the river bed slope cylindrical elements component of the debris flow against construction, (6) ropes clamps, (7) anchors for attach ropes clips on the river bed slopes, (8) reinforce for attach anchors on the river bed slopes, (9) metal angled bar, for connection cylinder elements of the construction to each other, (10) inert mass placed in the tube, (11) slopes of river bed, (12) the building of reinforced concrete foundation.

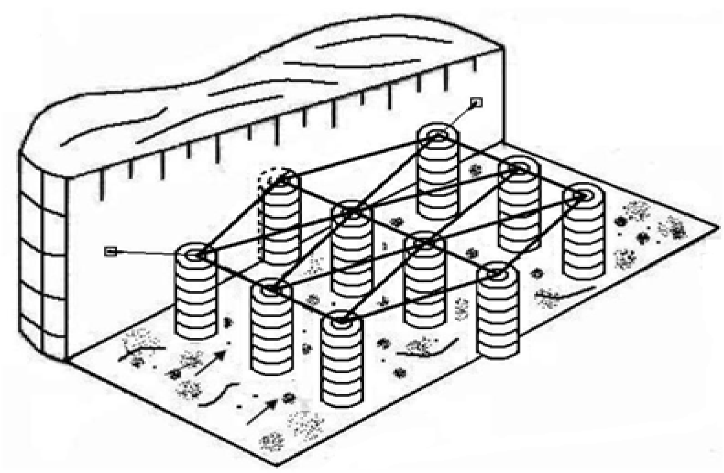

Figure 1: General view of the through type debris flow against construction

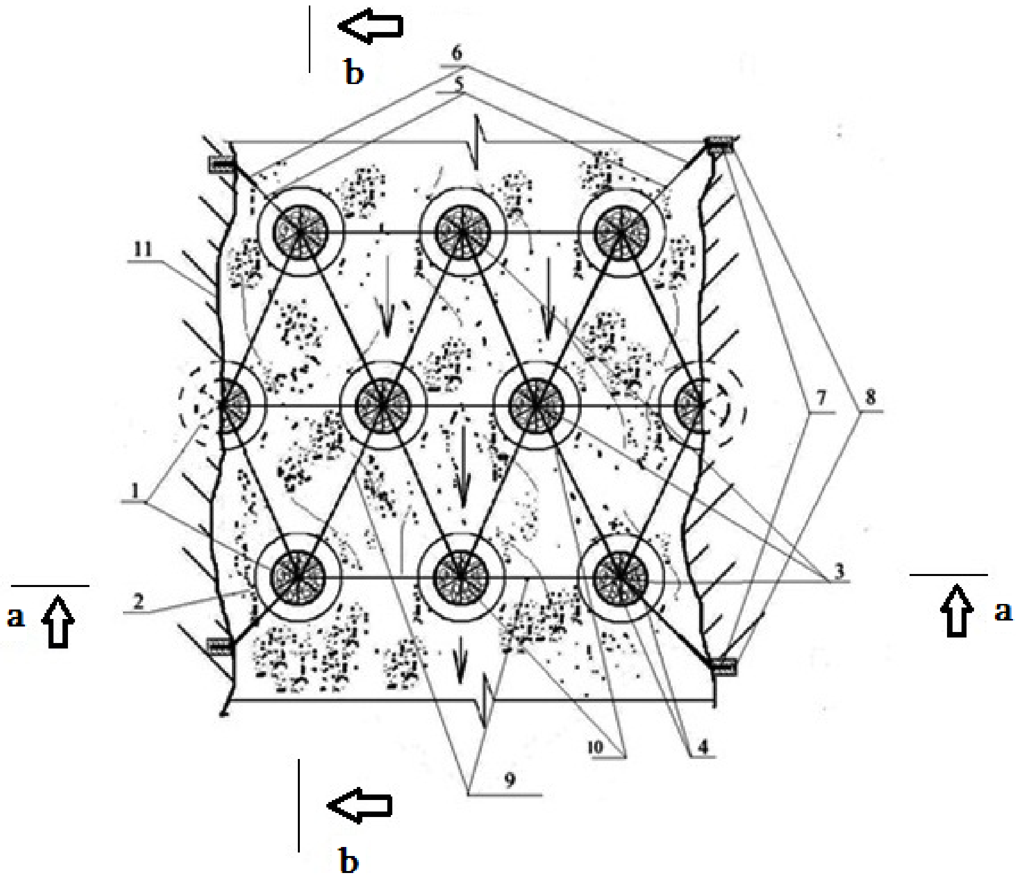

Figure 2: Plan of the through type debris flow against construction

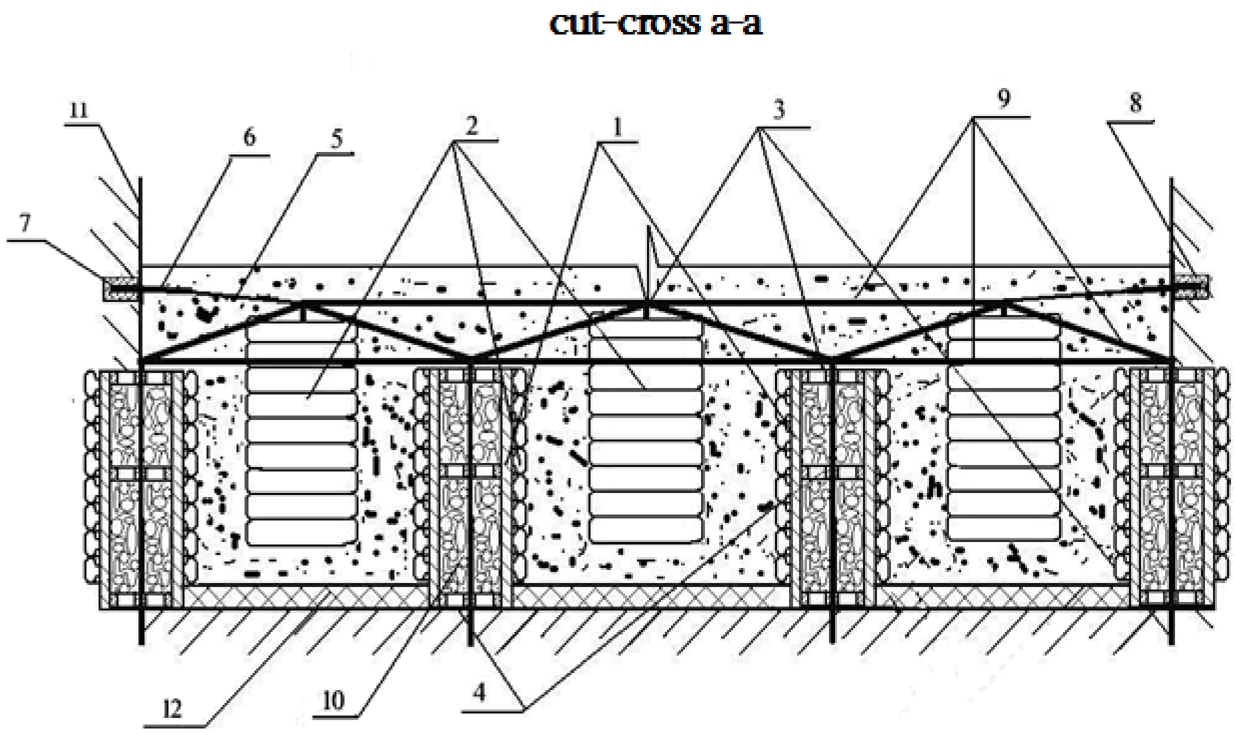

Figure 3: Front view of the construction (from the tailrace)

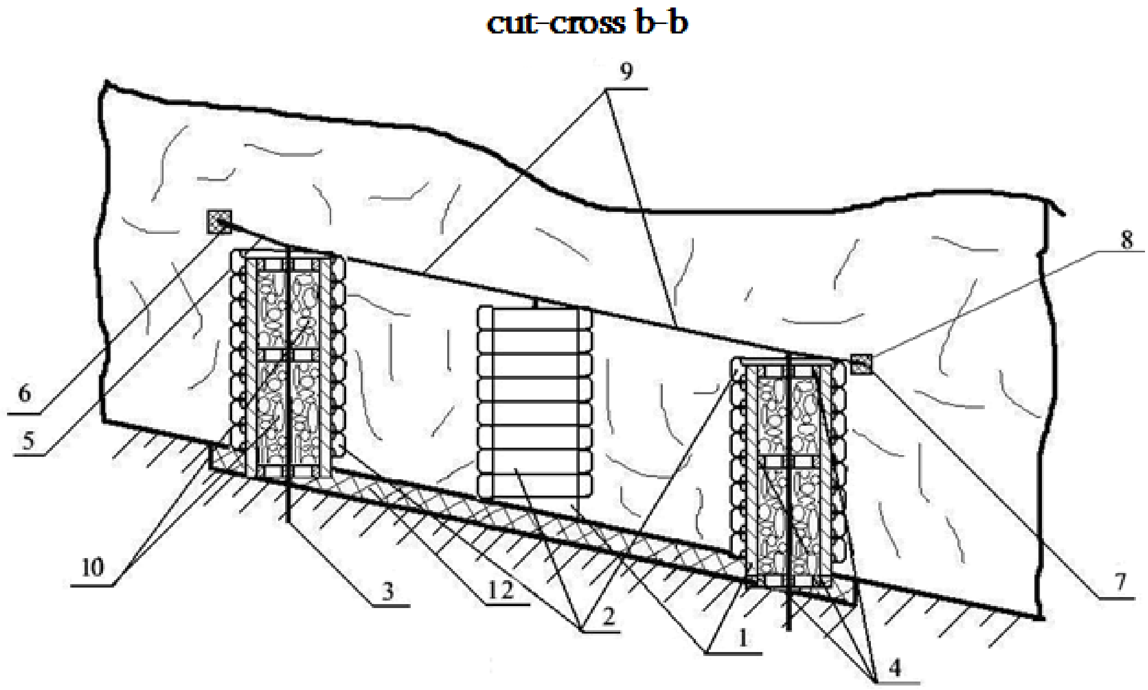

Figure 4: The view of the construction site

For assessment of cohesive debris flow impact on the above noted through type debris flow against construction it is given follow calculation with specific assumptions [12]:Initially, it should be noted, that distance between rows of cylinder elements of our construction L=10 m, because, due to lack of L, in calculation is not provided energy losses in the length of the debris flow during debris flow through from I row to II row of the construction cylinder elements. Deaf building case, when construction creates to bed base 90^0 corners, debris flow power impact on the construction is equal:

$$\mathrm{P} = \mathrm{K}_1 \frac{\gamma \cdot Q^2}{g \cdot \omega}, \qquad (1)$$

Where, K_1 – is experimental coefficient;

γ – debris flow volume weight kg/m^3;

g – gravity acceleration (m/s ^{2});

ω – Live sectional area of m^2.

Due to model of flow motion is received meaning of K_1 [5].

$$\mathrm{K}_1 = 1{,}5 \cdot \left[\cos\alpha \cdot tg\varphi + \frac{h_0}{2 \cdot H} \cdot \left(\frac{1-\sin\varphi}{\cos\varphi}\right)\right], \qquad (2)$$

Where h_0 – connectivity equivalent to the height;

φ – internal friction angle;

H – height of debris flow ;

α –inclination of bed.

Taking into account the above indicates, calculating formula of size of debris flow attacking force on the construction has follow view:

$$\text{P} = \frac{1{,}5 \cdot \gamma \cdot \omega \cdot v^2}{g} \cdot \left[\cos\alpha \cdot tg\varphi + \frac{h_0}{2 \cdot H}\left(\frac{1-\sin\varphi}{\cos\varphi}\right)\right], \qquad (3)$$

Meaning of debris flow attacking force on the construction It is the cross-cutting function of capacity. Therefore, in the first place, calculation takes place on the analogical deaf construction, which considering, force of linkage debris flow impact on the construction, when is given characteristics of bed and flow, so when width of debris flow bed B=20m, flow height H=5 m, Flow rate V = 5 (m/s), Volumetric mass of 2000 kg/m ^{3}, Internal friction angle – 300 and inclination of duct 0.2.

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

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

Because our suggested construction is though, off road coefficient calculating with formula:

$$\text{K}_2 = \frac{\omega_{\text{through}}}{\omega} \quad \text{an} \quad \text{K}_2 = \frac{(B - n \cdot d) \cdot H}{B \cdot H} = 1 - \frac{n \cdot d}{B};$$

Where ω_{through}–through area between cylinder elements in construction row;

n –amount of cylinder elements in construction row, In our case, due to the structures of the construction $n = 3$.

d – diameter of cylinder elements, so

$$\text{K}_2 = 1 - \frac{3 \cdot d}{20} = 1 - 0{,}15d; \ \text{K}_2 = 1 - 0{,}15d, \ \text{wherefore} \ d = \frac{1 - \text{K}_2}{0{,}15};$$

As for, on the first row of through construction, as attracting force current on the every next row, compare to deaf construction, in case of various assumptions (total 5 access, m=1,…,5), as by percentage, also partially functionality

$$\frac{P_{m \text{ deaf}}}{P} = f\,(K_2);$$

I access K_2 = 0,8; then

$\frac{P_{1 \text{ deaf}}}{P} = 20\,\% = 0{,}2$; but

$P_{1 \text{ deaf I row}} = P \cdot 0{,}2$ =5 962,5 · 0,2=1 192,5 k.n.

$$d_1 = \frac{1-0{,}8}{0{,}15} = 1,(3)$$

In case of diameter of cylinder shape elements of through type debris flow against construction 1, (3) m, after impact of debris flow at the first row elements o the construction, residual attract force on the second row elements of the construction $P_{1 \text{ residual I row}}$ is equal:

$P_{1 \text{ residual I row}}$ =P–$P_{1 \text{ deaf I row}}$=5 962,5 – 1192,5=4 770 k.n.,

but $P_{1 \text{ deaf II row}}$=$P_{1 \text{ residual I row}}$ • 0,2 = 4 770 • 0,2 = 954 k.n.

after the impact of debris flow at the second-row elements o the construction, residual attract force on the third-row elements of the construction $P_{1\text{residual II row}}$ is equal:

$P_{1 \text{ residual II row}}$ = $P_{1 \text{ residual I row}}$ – $P_{1 \text{ deaf II row}}$ =4 770 – 954 = 3 816 k.n.,

but $P_{1 \text{ deaf III row}}$= $P_{1 \text{ residual II row}}$ • 0,2 = 3 816 • 0,2 = 763,2 k.n.

Finally will recieve:$P_{1 \text{ residualIII row}}$ =$P_{1 \text{ residualII row}}$ – $P_{1 \text{ deaf III row}}$ =3 816– 763,2= 3 052,8 k.n.

From above calculation seem, that in the case of diameter of cylinder shape elements of through type debris flow against construction 1, (3) m, the initial force of the debris flows front P=5 962,5 k.n. impacted on the construction, decreases after through the construction approximately twice ($P_{1 \text{ residual III row}}$ =3 052,8 k.n.).

II access $K_2 = 0{,}6$ then,

$\frac{P_{2\ deaf}}{P} = 40\,\% = 0{,}4$, but

$P_{2\ deaf\ I\ row} = P \cdot 0{,}4$ =5 962,5 · 0,4=2 385 k.n.,

$$d_2 = \frac{1-0{,}6}{0{,}15} = \frac{0{,}4}{0{,}15} = 2,(6)$$

In case of diameter of cylinder shape elements of through type debris flow against construction 2,(6) m after impact of debris flow at the first row elements o the construction, residual attract force on the second row elements of the construction $P_{2\ residual\ I\ row}$ is equal:

$P_{2\ residualI\ row} = P - P_{2\ deaf\ I\ row}$ =5 962,5 – 2 385 =3 577,5 k.n.,

but $P_{2\ deaf\ II\ row} = P_{2\ residualI\ row}$ • 0,4 = 3 577,5 • 0,4 =1 431 k.n.

after impact of debris flow at the second row elements o the construction, residual attract force on the third row elements of the construction $P_{2\ residual\ II\ row}$ is equal:

$P_{2\ residual\ II\ row} = P_{2\ residualI\ row} - P_{2\ deaf\ II\ row}$ =3 577,5–1 431= 2 146,5 k.n.,

but $P_{2\ deaf\ III\ row} = P_{2\ residualII\ row}$ • 0,4 = 2 146,5• 0,4 = 858,6 k.n.

Finally will recieve: $P_{2\ residuaIII\ row} = P_{2\ residuaII\ row} - P_{2\ deaf\ III\ row}$ = 2 146,5–858,6=1 287,9 k.n.

From above calculation seem, that in case of diameter of cylinder shape elements of through type debris flow against construction 1, (3) m, initial force of the debris flow front P=5 962,5 k.n. impacted on the construction, decreases after through the construction approximately 4,6-times and equal : $P_{2\ residual\ III\ row}$ =1 287,9 k.n.

III access $K_2 = 0{,}4$ and,

$\frac{P_{3\ deaf}}{P} = 60\,\% = 0{,}6$, but

$P_{3\ deaf\ I\ row} = P \cdot 0{,}6$ =5 962,5 · 0,6=3 577,5 k.n.

$$d_3 = \frac{1-0{,}4}{0{,}15} = \frac{0{,}6}{0{,}15} = 4{,}0$$

In case of diameter of cylinder shape elements of through type debris flow against construction 4 m, after impact of debris flow at the first row elements o the construction, residual attract force on the second row elements of the construction $P_{3\ residual\ I\ row}$ is equal:

$P_{3\ residualI\ row}$ =P– $P_{3\ deaf\ I\ row}$ =5 962,5 – 3 577,5 =2 385 k.n.,

but $P_{3\ deaf\ II\ row}$= $P_{3\ residualI\ row}$ • 0,6 = 2 385 • 0,6 =1 431 k.n.

after impact of debris flow at the second row elements o the construction, residual attract force on the third row elements of the construction $P_{3\ residual\ II\ row}$ is equal:

$P_{3\ residualII\ row}$ = $P_{3\ residualI\ row}$ – $P_{3\ deaf\ II\ row}$ =2 385 –1 431= 954 k.n.,

but $P_{3\ deaf\ III\ row}$= $P_{3\ residualII\ row}$ • 0,6 = 954• 0,6 =572,4 k.n.

Finally will receive: $P_{3\ residualIII\ row}$ =$P_{3\ residual\ II\ row}$ – $P_{3\ deaf\ III\ row}$ = 954 –572,4=381,6 k.n.

From above calculation seem, that in case of diameter of cylinder shape elements of through type debris flow against construction 1, (3) m, initial force of the debris flow front P=5 962,5 k.n. impacted on the construction, decreases after through the construction approximately 15,6-times $P_{3\ residual\ III\ row}$ =381,6 k.n.

<u>IV access</u> $K_2 = 0,2$ and,

$$\frac{P_{4\ deaf}}{P} = 80\,\% = 0,8$$, but

$P_{4\ deaf\ I\ row}$= $P \cdot 0,8$ =5 962,5 · 0,8=4 770 k.n.

$$d_4 = \frac{1-0,2}{0,15} = \frac{0,8}{0,15} = 5,(3)$$

In case of diameter of cylinder shape elements of through type debris flow against construction 5 (3) m, after impact of debris flow at the first row elements o the construction, residual attract force on the second row elements of the construction $P_{4\ residual\ I\ row}$ is equal:

$P_{4\ residual\ I\ row}$ =P– $P_{4\ deaf\ I\ row}$ =5 962,5 – 4 770 =1 192,5 k.n.,

but $P_{4\ deaf\ II\ row}$= $P_{4\ residual\ I\ row}$ • 0,8 = 1 192,5 • 0,8 =954 k.n.

after impact of debris flow at the second row elements o the construction, residual attract force on the third row elements of the construction $P_{4\ residual\ II\ row}$ is equal:

$P_{4\ residual\ II\ row}$ = $P_{4\ residual\ I\ row}$ – $P_{4\ deaf\ II\ row}$ =1 192,5 –954= 238,5 k.n., but $P_{4\ deaf\ III\ row} = P_{4\ residual\ II\ row} \cdot 0{,}8 = 238{,}5 \cdot 0{,}8 = 190{,}8$ k.n.

Finally will receive: $P_{4\ residual\ III\ row} = P_{4\ residual\ II\ row} - P_{4\ deaf\ III\ row} = 238{,}5 – 190{,}8 = 47{,}7$ k.n.

From above calculation seem, that in case of diameter of cylinder shape elements of through type debris flow against construction 1, (3) m, initial force of the debris flow front P=5 962,5 k.n. impacted on the construction, decreases after through the construction approximately 125 - times $P_{4\ residual\ III\ row} = 47{,}7$ k.n.

V access $K_2 = 0$ and,

$\frac{P_{5\ deaf}}{P} = 100\,\% = 1{,}0$, but

$P_{5\ deaf\ I\ row} = P$

$$d_5 = \frac{1-0}{0{,}15} = 6,(6)$$

3. Results

After through debris flow against construction (third row) connection between residual attacking force and changeable diameter of cylinder shape elements of construction. It is presented follow functional dependence $d_n = f(P_{n\ residualIIIrow})$, where amount of assumptions change into 1-5 points (see Figure 5).

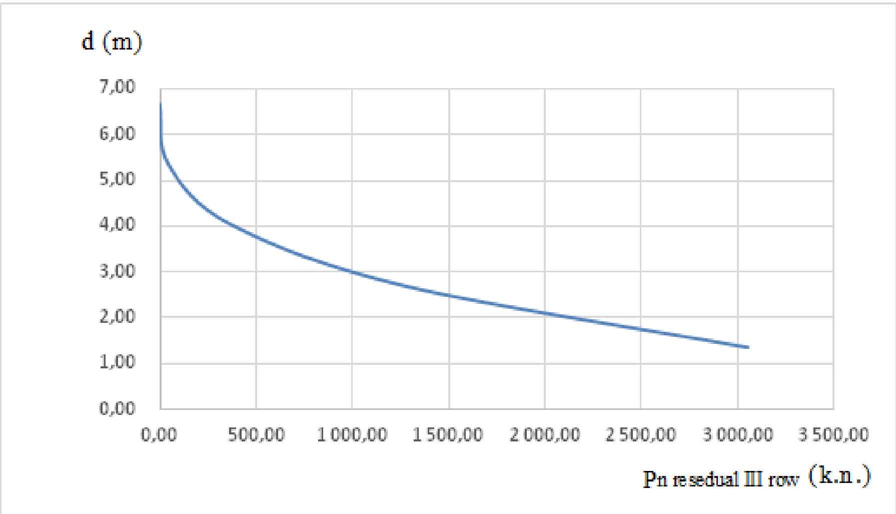

Figure 5: The functional defendence between changeable diameter of cylinder shape elements and residual attacking force of debris flow after pass through type debris flow **against** construction

After pass through type debris flow against construction, active force on the cylinder element of construction (deaf section), to changeable diameters of cylinder shape of construction is equal:

d_1=1,(3) in case $P_{1\ deaf}$=P –$P_{1\ residualIIIrow}$ =5 962,5– 3 052,8=2 909,7 k.n.;

d_2=2,(6) in case $P_{2\ deaf}$ =P –$P_{2\ residualIIIrow}$ =5 962,5– 1 287,9=4 674,6 k.n.;

d_3=4,0 in case $P_{3\ deaf}$ =P –$P_{3\ residualIIIrow}$ =5 962,5– 381,6=5 580,9 k.n.;

d_4=5,(3) in case $P_{4\ deaf}$ =P –$P_{4\ residualIIIrow}$ =5 962,5–47,7=5 914,8 k.n.;

d_5=6,(6) in case $P_{5\ deaf}$ =P –$P_{5\ residualIIIrow}$=5 962,5– 0=5 962,5 k.n.

According of received values draw graph of follow functional dependence d_n=f($P_{n\ deaf}$), where n changes within 1-5 (see Figure 6).

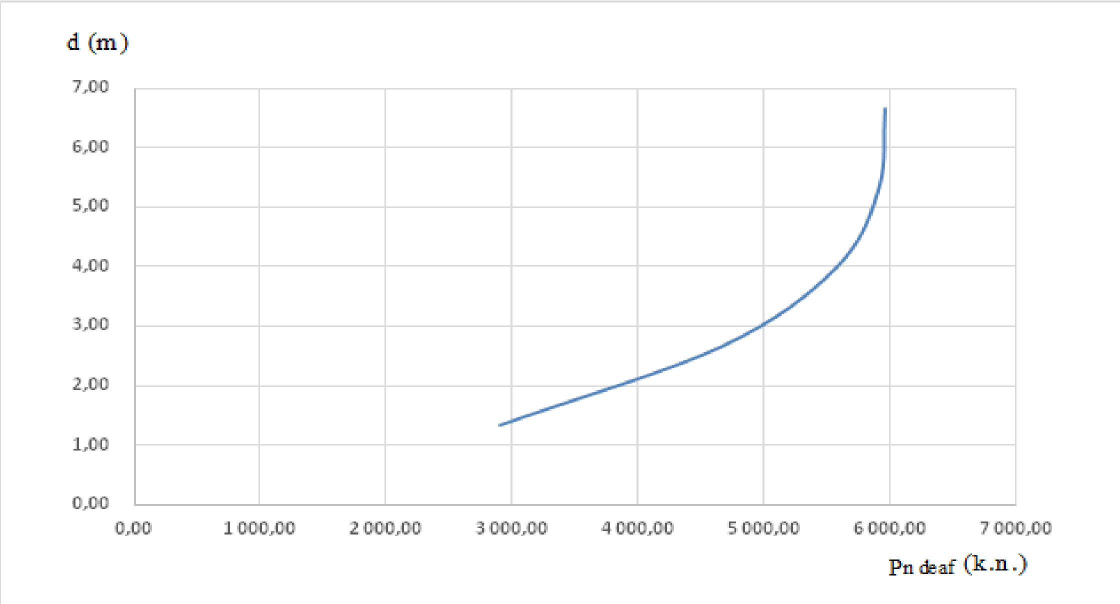

Figure 6: The functional defendence between changeable diameter of cylinder shape elements and residual attacking force of debris flow action on the deaf section of the construction after pass through type debris flow **against** construcion

4. Conclusion

Thus, from the report implemented for describe influence of linkage debris flows on the through type debris flow against construction, seen thatconstruction is effective measure for defence to the debris flow, because in condition of fourth access power of debris flow decrease by 125-times, that indicate effectivity of construction and therefore its introduction is perspective. From the calculations implemented for describe influence of linkage debris flow on the through type debris flow against construction seem, that construction is effective engineering measures for a fight against debris flow and its implementation is perspective, because in the condition of these assumptions its reflectivity characteristic is satisfactory and is accepted with taking into account engineering practice.

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