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Assessement of Debris Flow Influence on the Lattice Type Debris Flow against Construction

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

[a,b,c,d,e,f,g,h]*Tsotne Mirtkhulava Water Management Institute of Georgian Technical University Ave. I chavchavadze 60, Tbilisi, 0179, Georgia*

[a] *Email: gogachaxaia@mail.ru*

[b] *Email: nugzarkvashilava@mail.ru*

[c] *Email: robertdia@mail.ru*

[d] *Email: levanitsulu@mai.ru*

[e] *Email: zurablobjanidze@mail.ru*

[f] *Email: shorena_12@mail.ru*

[g] *Email: tamunasupatashvili@gmail.com*

[h] *Email: khubulavai@yahoo.com*

Abstract

In the work is purpose lattice type debris flow against construction built on the depreciation principle, on which implemented theoretical research for assessement of debris flow influence. As a result of implemented calculation, in the condition of specific assumptions, istablished number value of rectangular structure lattice elements of the operating loads of construction during of cohesive debris flow influence on the construction. Results of above calculations given basis, that purpose construction considered potentially effective debris flow against construction.

Keywords: debris flow; lattice; construction; off-road ratio.

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* Corresponding author.

1. Introduction

Natural-destructive geomorphological phenomena debris flow, as for many countries of World, so for Georgia is vey serious problem, because 29 % of the country is in coverage zone of debris flow. The formation of debris flow often accompanied the human loss, destroyed of various infrastructures [1,2].

Due to above is necessary treatment of effective engineering ecological measures for debris flow manage and negative results minimize.

2. The main part

For this purpose, has been developed, lattice type debris flow against construction built on the depreciation principle on which implemented theoretical research for assessement of debris flow influence.

The lattice type debris flow against construction represented by four figures: Figure 1 – The general view of construction; Figure2 The above view of construction; Figure3 – cut A-A on the Figure 2; Figure 4 – cut B-B on the Figure 2.

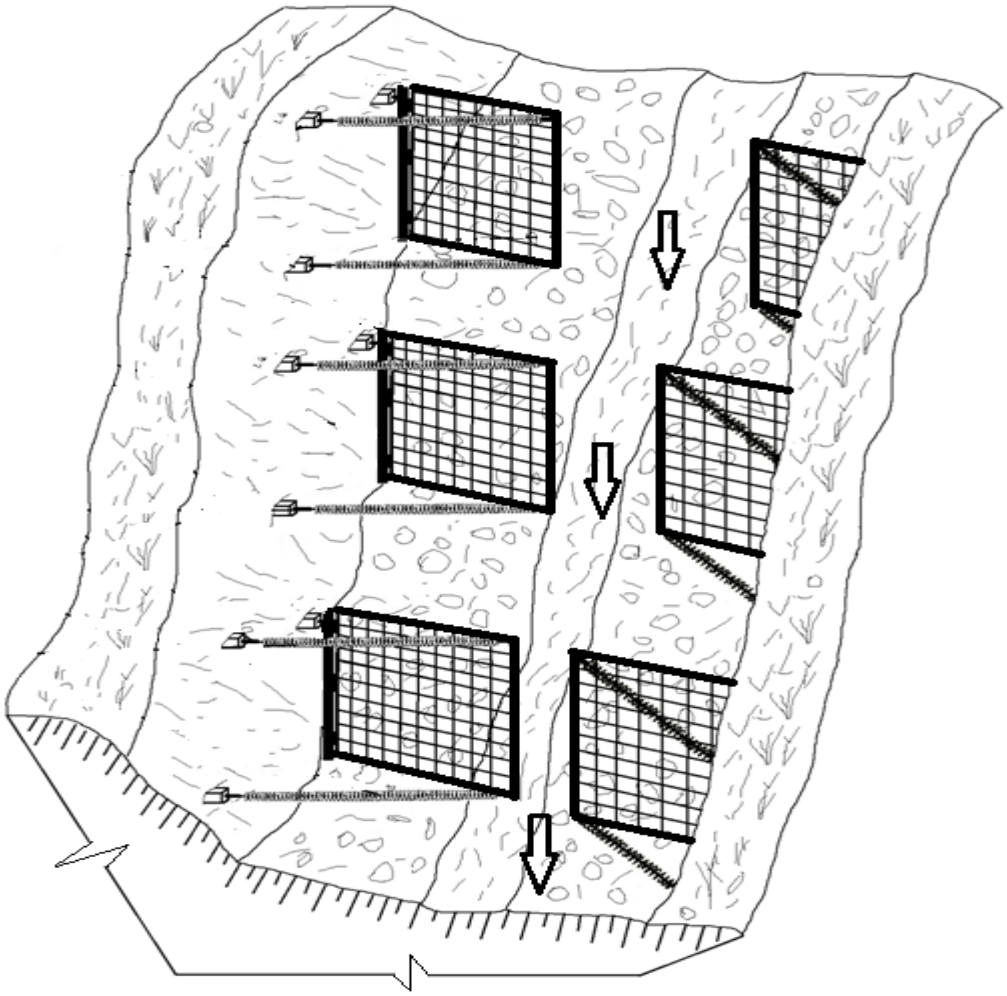

Figure 1

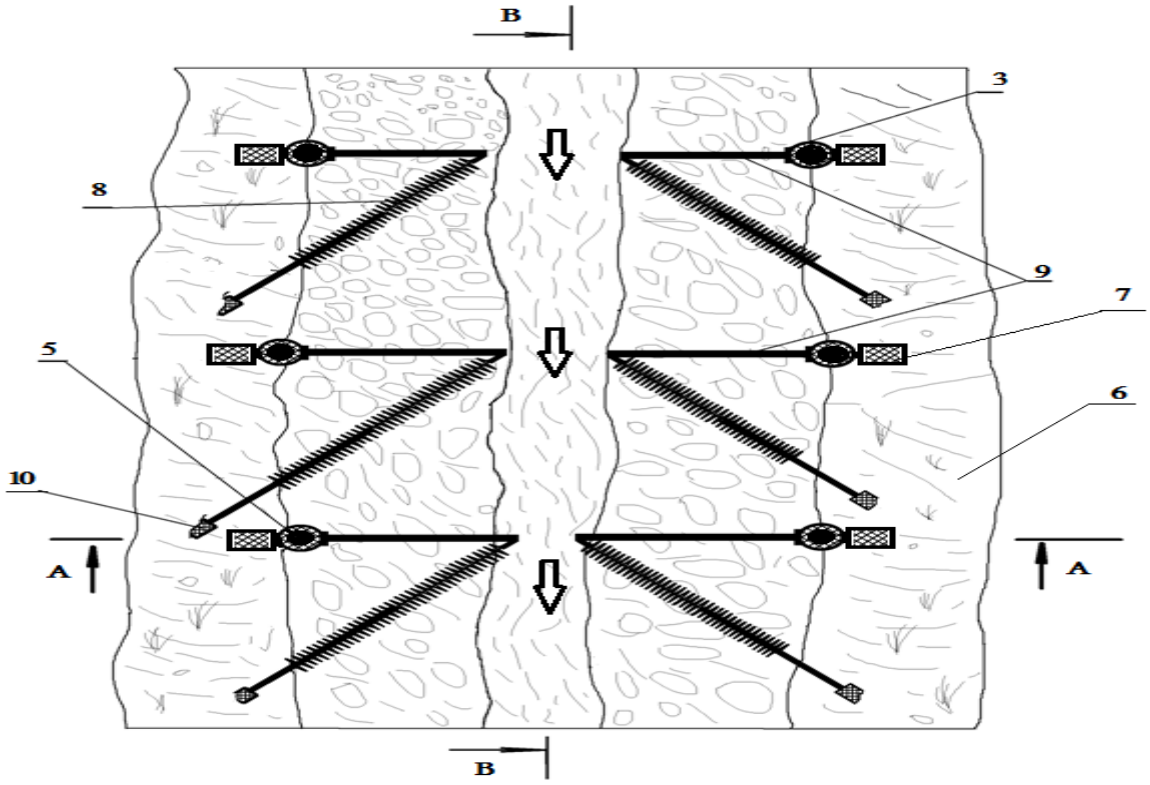

Figure 2

Cut A-A

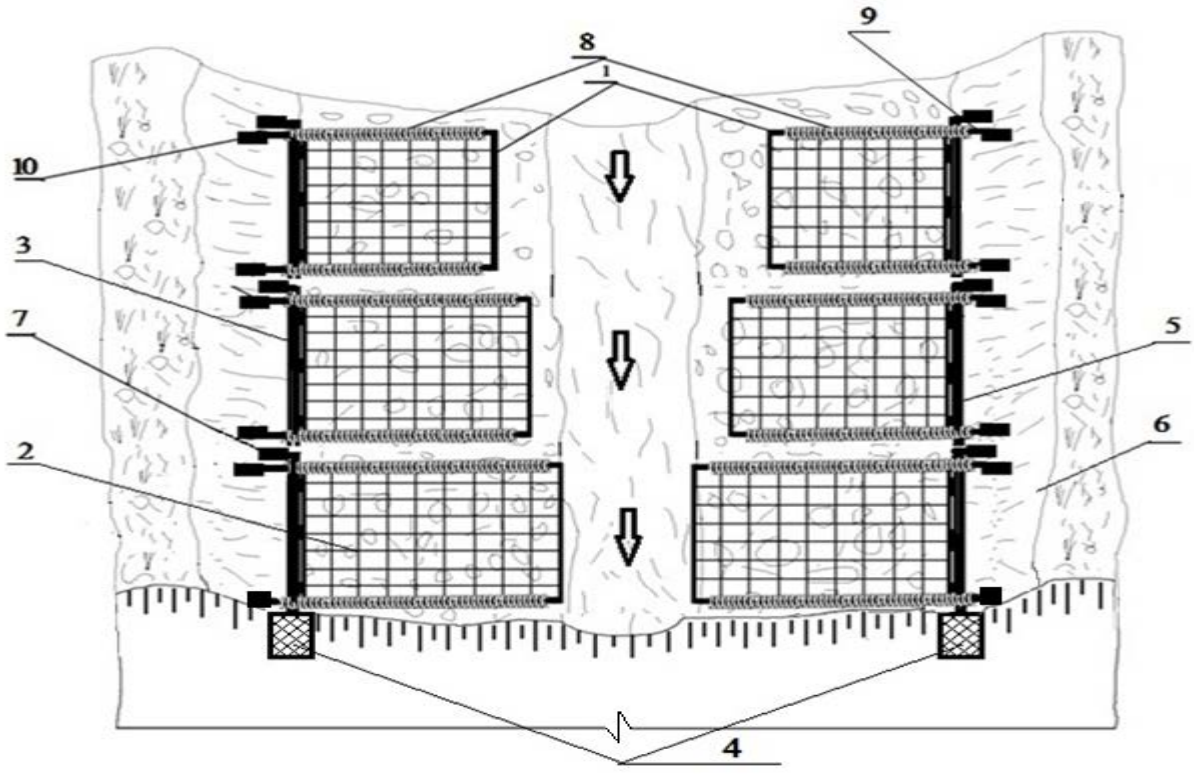

Figure 3

Cut B-B

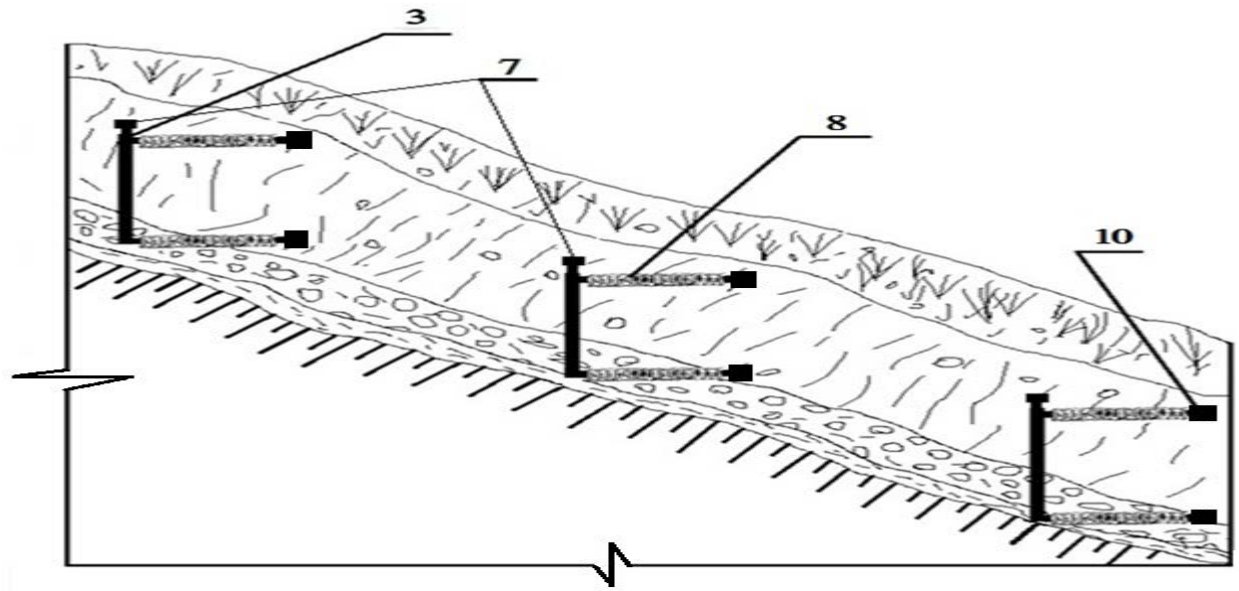

Figure 4

The debris flow against consruction contain: the lattice elements (2) inserted in the rectangular shape frame (1), which is connected pillars of metal pipes (3), which loosely inserted in the concrete base (4) on the metal column (5), metal columns on the river bed embankment (6); attached are the concrete sleepers (7); metal springs attached to rectangular shape frame (8) fixing guide (9) and concrete lining it for fixing spring(10).

The size of elements of the lattice type debris flow against construction, their amount and location in the bed will select by taking into account of debris flow hitting and natural topographical condition of river[3;4;5].

The working principle of the debris flow against construction is follow: during influence of debris flow on the rectangular shape lattice element (2) of construction to extangnish of energy leads amortization properties metal springs (8) yoked to rectangular shape frame. Sizes of rectangulat shape lattice elements increase to direction of flow motion, that also promote to extangnish of kinetic energy of debris flow[6;7;8].

For assessement influence of linkage debris flow on the above mentioned construction there is follow calculation with specific assumption [9,10; 11; 14]:

Initially, it should be noted, that rectangular shape lattice elements of construction consist of 9 vertical and 6 horizontal located metal armature, which in this case are located in 3 rows. The distance between rows L=10 m, because due to lack of L , in the calculation is not taking into acount loss of debris flow energy on the length debris flow through from I row to III row of construction.

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

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

where γ – volume weight of debris flow kg/m ^{3};

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

g – gravity acceleration (m/sec^2);

ω – living cut area of the bed m^2;

h_0 – Connectivity equivalent to the height;

φ – Internal friction angle;

H – height of debris flow;

α – bed inclination.

For calculation of hitting force of linkage debris flow on the construction introducing follow charachteristics 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 attacting force of linkage debris flow on the construction is equal:

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

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

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

$$K = \frac{\omega_{through}}{\omega} \quad (2)$$

Where $\omega_{through}$ – The sum of the void areas of rectangular shape lattice elements existing in the construction row plus through space exist between the elements.

What about hitting force action on the first row of through construction, as on the every next row, in the various assumptions condition (sum 4 assumption, m = 1…….4) as by percentage, so partially as functional independence [12;13].

$$\frac{P_m}{P} = f\,(K) \qquad (3)$$

I assumption K = 0.8, area of deaf part of rectangular shape lattice elements:

$$\omega_{deaf} = 186d_{1I} - 108d^2_{1I}; \qquad (4)$$

Where d_{1I} – is in case of I assumption diameter of armature of rectangular shape lattice elements I row consisting;

186 – is sum of length of metal armatures consisting of rectangular shape lattice elements existing in construction row;

108 – The sum of adhesion knot metal armatures consisting of rectangular shape lattice elements existing in construction row.

$$\omega_{through} = \omega - 186d_{1I} + 108d^2_{1I}, \qquad (5)$$

Where ω – is area of living cut (width bed B=20 (m), heitgh of debris flow is H= 5 (m), in this case ω=100 m^2 .

I row

The through coefficient of the construction before open I row lattice elements is equal:

$$K = \frac{\omega_{through\ open}}{\omega} = \frac{\omega - 186d_{1I} + 108d^2_{1I}}{100} = 1\text{-}1.86d_{1I} + 1.08d^2_{1I} = 0.8\,. \qquad (6)$$

From where we received independence:

$$1.08d^2_{1I} - 1.86\,d_{1I} + 0.2 = 0 \Rightarrow d_{1I} = 0.115 \text{ m}. \qquad (7)$$

The distance between the rectangular shape lattice elements consist of I row of construction before the open is 4m.

The hitting force of debris flow on the rectangular shape lattice elements consist of I row of construction before the open (debris flow to construction elements create angle 90^0) is equal:

$$P_{1\ deaf\ I\ row} = P \cdot 0.2 = 5962.5 \cdot 0.2 = 1192.5 \text{ kn}. \qquad (8)$$

And after through I row of construction residual hitting force equal:

$$P_{1\ residual\ I\ row} = P - P_{1\ deaf\ I\ row} = 5962.5 - 1192.5 = 4\ 770\ kn. \quad (9)$$

If I row rectangular lattice elements of the construction $\alpha=45^0$, then after opening frontal weidth sum for both elements of construction will be:

$$\sum b=8\cdot\cos45^0+8\cdot\cos45^0\approx11,3\ m. \quad (10)$$

The distance between rectangular lattice elements of construction will be:

$$l= B-\sum b = 20 - 11.3 = 8.7\ m. \quad (11)$$

The area of deaf part of th I row rectangular shape lattice elements will be:

$$\omega_{deaf} = 2\cdot6\cdot5.65\ d_{1I} + 2\cdot9\cdot5\ d_{1I} - 108\ d^2_{1I} = 7.8 + 10.4 - 1.4 = 16.8\ m^2. \quad (12)$$

And area of through part of construction after open lattice elements will be:

$$\omega_{after\ through\ open} = \omega - \omega_{\ deaf}=100-16.8=83.2\ m^2. \quad (13)$$

Therefore through coefficient after open of I row lattice elements of construction is equal:

$$K^I = \frac{\omega_{after\ through\ open}}{\omega} = \frac{83.2}{100} = 0,832. \quad (14)$$

The hitting force of debris flow after open of I row lattice elements of construction is equal:

$$P_{1\ after\ deaf\ open.\ I\ row} = P_{1\ residual\ I\ row} \cdot \frac{\omega_{deaf}}{\omega} = 4770\cdot0.168 = 801.4\ kn. \quad (15)$$

And after through I row of construction residual force will be:

$$P_{1finally\ residual\ I\ row} = P_{1\ residual\ I\ row} - P_{1\ after\ deaf\ open\ \ I\ row} = 4770 - 801.4 = 3968.6\ kn. \quad (16)$$

II row

The distance between II row rectangular lattice elements of construction is 3 m; because instead of $186d_{2I}$ will be $192d_{2I}$, fom where receive diameter of metal armature consist of lattice elements:

$1.08d^2_{2I} - 1.92d_{2I} + 0.2=0 \Rightarrow d_{2I}=0.(1)$ m.

The hitting force of debris flow on the rectangular shape lattice elements consist of II row of construction before the open is equal:

$P_{1\ deaf\ II\ row} = P_{1\ finally\ residual\ I\ row} \cdot 0.2 = 3968.6 \cdot 0.2 = 793.72$ kn.

And after through II row of construction residual hitting force equal:

$P_{1\ residual\ II\ row} = P_{1\ finally\ residual\ I\ row} - P_{1\ deaf\ II\ row} = 3968.6 - 793.72 = 3174.88$ kn.

If II row rectangular lattice elements of the construction $\alpha=45^0$, then after opening frontal weidth sum for both elements of construction will be:

$\sum b = 8.5 \cdot \cos 45^0 + 8.5 \cdot \cos 45^0 \approx 12$ m.

The distance between rectangular lattice elements of construction will be:

$l = B - \sum b = 20 - 12 = 8$ m.

The area of deaf part of th II row rectangular shape lattice elements will be:

$\omega_{deaf} = 2 \cdot 6 \cdot 6d_{2I} + 18 \cdot 5d_{2I} - 108d^2_{2I} = 8 + 10 - 1.3 = 16.7\ m^2$.

And area of through part of construction after open lattice elements will be:

$\omega_{after\ through\ open} = \omega - \omega_{deaf} = 100 - 16.7 = 83.3\ m^2$.

Therefore through coefficient after open of II row lattice elements of construction is equal:

$$K^I = \frac{\omega_{after\ through\ open}}{\omega} = \frac{83.3}{100} = 0{,}833.$$

The hitting force of debris flow after open of II row lattice elements of construction is equal:

$$P_{1\ after\ deaf\ open\ II\ row} = P_{1\ residual\ II\ row} \cdot \frac{\omega_{deaf}}{\omega} = 3174.88 \cdot 0.167 = 530.2 \text{ kn.}$$

And after through II row of construction residual force will be:

$P_{1\ finally\ residual\ II\ row} = P_{1\ residual\ II\ row} - P_{1\ after\ deaf\ open\ II\ row} = 3174.88 - 530.2 = 2\ 644.68$ kn.

III row

The distance between III row rectangular lattice elements of construction is 2 m; because instead of $192d_{3I}$ will be $198d_{3I}$, fom where receive diameter of metal armature consist of lattice elements:

$1.08d^2_{3I} - 1.98\ d_{3I} + 0.2 = 0 \Rightarrow d_{3I} = 0.107$ m.

The hitting force of debris flow on the rectangular shape lattice elements consist of III row of construction

before the open is equal:

$P_{1\ deaf\ \ III\ row} = P_{1\ finally\ residual\ \ II\ row} \cdot 0.2 = 2644.68 \cdot 0.2 = 528.94$ kn.

And after through III row of construction residual hitting force equal:

$P_{1\ residual\ \ III\ row} = P_{1\ finally\ residual\ \ III\ row} - P_{1\ deaf\ \ III\ row} = 2644.68 - 528.94 = 2115.74$ kn.

If III row rectangular lattice elements of the construction $\alpha=45^0$, then after opening frontal weidth sum for both elements of construction will be:

$\sum b=9\cdot \cos 45^0+9\cdot \cos 45^0\approx 12,7$ m.

The distance between rectangular lattice elements of construction will be:

$l= B-\sum b = 20 - 12.7 = 7.3$ m.

The area of deaf part of th III row rectangular shape lattice elements will be:

$\omega_{deaf} = 2\cdot 6\cdot 6.36d_{3I} + 18.5d_{3I} - 108d^2_{3I} = 8.17 + 9.63 - 1.24 = 16.6\ m^2$,

And area of through part of construction after open lattice elements will be:

$\omega_{after\ through\ open} = \omega - \omega_{ყრუ}=100-16.6=83.4\ m^2$.

Therefore through coefficient after open of III row lattice elements of construction is equal:

$$K^I = \frac{\omega_{after\ through\ open}}{\omega} = \frac{83.4}{100} = 0,834.$$

The hitting force of debris flow after open of III row lattice elements of construction is equal:

$P_{1\ after\ deaf\ open\ \ III\ row} = P_{1\ residual\ \ III\ row} \cdot \frac{\omega_{deaf}}{\omega} = 2115.74 \cdot 0.166 = 351.2$ kn.

And after through III row of construction residual hitting force equal:

$$P_{1finaly\ residual\ \ III\ row} = P_{1\ residual\ \ III\ row} - P_{1\ after\ deaf\ open\ \ III\ row} = 2115.74 - 351.2 = 1764.54 \text{ kn.}$$

Finally, after through III row rectangular shape lattice elements hitting force of debris flow decrease ≈ **3.4 times.**

II assumption K = 0.6.

Through coefficient $K = \frac{\omega_{\text{through open}}}{\omega} = \frac{\omega - 186d_{1II} + 108d_{1II}^2}{100} = 1\text{-}1.86d_{1II} + 1.08d_{1II}^2 = 0.6.$

From where receive independence:

$1.08d^2_{1II} - 1.86d_{1II} + 0.4 = 0 \Rightarrow d_{1II} = 0.272$ m.

I row

The distance between the rectangular shape lattice elements consist of I row of construction before the open is 4m.

The hitting force of debris flow on the rectangular shape lattice elements consist of I row of construction before the open (debris flow to construction elements create angle 90^0) is equal:

$P_{2\ deaf\ I\ row} = P \cdot 0.4 = 5962.5 \cdot 0.4 = 2385$ kn.

And after through I row of construction residual hitting force equal:

$P_{2\ residual\ I\ row} = P - P_{2\ deaf\ I\ row} = 5962.5 - 2385 = 3577.5$ kn.

If I row rectangular lattice elements of the construction $\alpha = 45^0$, then after opening frontal weidth sum for both elements of construction will be:

$\sum b = 8 \cdot \cos 45^0 + 8 \cdot \cos 45^0 \approx 11{,}3$ m.

The distance between rectangular lattice elements of construction will be:

$l = B - \sum b = 20 - 11.3 = 8.7$ m.

The area of deaf part of th I row rectangular shape lattice elements will be:

$\omega_{deaf} = 2 \cdot 6 \cdot 5.65d_{1II} + 2 \cdot 9 \cdot 5d_{1II} - 108d^2_{1II} \approx 35$ m^2.

And area of through part of construction after open lattice elements will be:

$\omega_{\text{after through open}} = \omega - \omega_{deaf} = 100 - 35 = 65$ m^2.

Therefore through coefficient after open of I row lattice elements of construction is equal:

$K^I = \frac{\omega_{\text{after through open}}}{\omega} = \frac{65}{100} = 0.65.$

The hitting force of debris flow after open of I row lattice elements of construction is equal:

$P_{2\ after\ deaf\ open\ \ I\ row} = P_{2\ residual\ I\ row} \cdot \frac{\omega_{deaf}}{\omega} = 3577.5 \cdot 0.35 = 1252.13$ kn.

And after through I row of construction residual force will be:

$P_{2\ finally\ residual\ \ I\ row} = P_{2\ residual\ I\ row} - P_{2\ after\ deaf\ open\ \ I\ row}$ 3577.5 - 1252.13 = 2325.37 kn.

II row

The distance between II row rectangular lattice elements of construction is 3 m; because instead of $186d_{2II}$ will be $192d_{2II}$, fom where receive diameter of metal armature consist of lattice elements:

$1.08d^2_{2II} - 1.92d_{2II} + 0.4 = 0 \Rightarrow d_{2II} = 0.24$ m.

The hitting force of debris flow on the rectangular shape lattice elements consist of II row of construction before the open is equal:

$P_{2\ deaf\ \ II\ row} = P_{2\ finally\ residual\ \ I\ row} \cdot 0.4 = 2325.37 \cdot 0.4 = 930$ kn.

And after through II row of construction residual hitting force equal:

$P_{2\ residual\ \ II\ row} = P_{2\ finally\ residual\ \ I\ row} - P_{2\ deaf\ \ II\ row} = 2325.37 - 930 = 1395.3$ kn.

If II row rectangular lattice elements of the construction $\alpha = 45^0$, then after opening frontal weidth sum for both elements of construction will be:

$\sum b = 8.5 \cdot \cos 45^0 + 8.5 \cdot \cos 45^0 \approx 12$ m,

The distance between rectangular lattice elements of construction will be:

$l = B - \sum b = 20 - 12 = 8$ m.

The area of deaf part of th II row rectangular shape lattice elements will be:

$\omega_{deaf} = 2 \cdot 6 \cdot 6d_{2II} + 18 \cdot 5d_{2II} - 108d^2_{2II} = 17.28 + 21.6 - 6.22 = 32.7$ m^2.

And area of through part of construction after open lattice elements will be:

$\omega_{after\ through\ open} = \omega - \omega_{deaf} = 100 - 32.7 = 67.3$ m^2.

Therefore through coefficient after open of II row lattice elements of construction is equal:

$$K^I = \frac{\omega_{after\ through\ open}}{\omega} = \frac{67.3}{100} = 0.673.$$

The hitting force of debris flow after open of II row lattice elements of construction is equal:

$P_{2\ after\ deaf\ open\ II\ row} = P_{2\ residual\ II\ row} \cdot \frac{\omega_{deaf}}{\omega} = 1395.3 \cdot 0.327 = 456.3$ kn.

And after through II row of construction residual force will be:

$P_{2finally\ residual\ II\ row} = P_{2\ residual\ II\ row} - P_{2\ after\ deaf\ open\ II\ row} = 1395.3 - 456.3 = 939$ kn.

III row

The distance between III row rectangular lattice elements of construction is 2 m; because instead of $192d_{3II}$ will be $198d_{3II}$, fom where receive diameter of metal armature consist of lattice elements:

$1.08d^2_{3I\ I} - 1.98d_{3II} + 0.4=0 \Rightarrow d_{3II}=0.23$ m.

The hitting force of debris flow on the rectangular shape lattice elements consist of III row of construction before the open (debris flow to construction elements create angle 90^0) is equal:

$P_{2\ deaf\ III\ row} = P_{2\ finally\ residual\ II\ row} \cdot 0.4 = 939 \cdot 0.4 = 375.6$ kn.

And after through III row of construction residual force will be:

$P_{2\ residual\ III\ row} = P_{2\ finally\ residual\ II\ row} - P_{2\ deaf\ III\ row} = 939 - 375.6 = 563.4$ kn.

If III% row rectangular lattice elements of the construction $\alpha=45^0$, then after opening frontal weidth sum for both elements of construction will be:

$\sum b=9 \cdot \cos45^0+9 \cdot \cos45^0=12.7$ m.

The distance between rectangular lattice elements of construction will be:

$l= B-\sum b = 20 - 12.7 = 7.3$ m.

The area of deaf part of th III row rectangular shape lattice elements will be:

$\omega_{deaf} = 2 \cdot 6 \cdot 6.36d_{3II} + 18.5d_{3II} - 108d^2_{3II} = 17.55 + 20.7 - 5.71 = 32.5$ m^2,

And area of through part of construction after open lattice elements will be:

$\omega_{after\ through\ open} = \omega - \omega_{deaf}=100-32.5=67.5$ m^2.

Therefore through coefficient after open of III row lattice elements of construction is equal:

$$K^I = \frac{\omega_{\text{after through open}}}{\omega} = \frac{67.5}{100} = 0.675.$$

The hitting force of debris flow after open of III row lattice elements of construction is equal:

$P_{2\ \text{after deaf open III row}} = P_{2\ \text{residual III row}} \cdot \frac{\omega_{deaf}}{\omega} = 563.4 \cdot 0.325 = 183.3$ kn.

And after through III row of construction residual force will be:

$P_{2\ \text{finally residual III row}} = P_{2\ \text{residual III row}} - P_{2\ \text{after deaf open III row}} = 563.4 - 183.3 = 380.1$ kn.

Finally, after through III row rectangular shape lattice elements hitting force of debris flow decrease ≈**15.7 times.**

III assumption K =0.4

Through coefficient $K = \frac{\omega_{\text{through open}}}{\omega} = \frac{\omega - 186d_{1III} + 108d_{1III}^2}{100} = 1\text{-}1.86d_{1III} + 1.08d_{1III}^2 = 0.4.$

From where receive independence:

$1.08d^2_{1III} - 1.86d_{1III} + 0.6 = 0 \Rightarrow d_{1III} = 0.43$ m.

<u>I row</u>

The distance between the rectangular shape lattice elements consist of I row of construction before the open is 4m.

The hitting force of debris flow on the rectangular shape lattice elements consist of I row of construction before the open (debris flow to construction elements create angle 90^0) is equal:

$P_{3\ \text{deaf I row}} = P \cdot 0.6 = 5962.5 \cdot 0.6 = 3577.5$ kn.

And after through I row of construction residual hitting force equal:

$P_{3\ \text{residual I row}} = P - P_{3\ \text{deaf I row}} = 5962.5 - 3577.5 = 2385$ kn.

If I row rectangular lattice elements of the construction $\alpha=45^0$, then after opening frontal weidth sum for both elements of construction will be:

$\sum b = 8 \cdot \cos 45^0 + 8 \cdot \cos 45^0 \approx 11.3$ m.

The distance between rectangular lattice elements of construction will be:

$l= B-\sum b = 20 -11.3 \approx 8.7$ m.

The area of deaf part of th I row rectangular shape lattice elements will be:

$\omega_{deaf} = 2\cdot6\cdot5.65d_{1III} + 2\cdot9\cdot5d_{1III} - 108\ d^2_{1III} \approx 29.15 + 38.7 - 20 \approx 48\ m^2$.

And area of through part of construction after open lattice elements will be:

$\omega_{after\ through\ open} = \omega - \omega_{deaf}=100-48=52\ m^2$.

Therefore through coefficient after open of I row lattice elements of construction is equal:

$$K^I = \frac{\omega_{after\ through\ open}}{\omega} = \frac{52}{100} = 0.52.$$

The hitting force of debris flow after open of I row lattice elements of construction is equal:

$P_{3\ after\ deaf\ open\ I\ row} = P_{3\ residual\ I\ row} \cdot \frac{\omega_{deaf}}{\omega} = 2385 \cdot 0.48 = 1144.8$ kn.

And after through I row of construction residual force will be:

$P_{3\ finelly\ residual\ I\ row} = P_{3\ residual\ I\ row} - P_{3\ after\ deaf\ open\ I\ row} = 2385 - 1144.8 = 1240.2$ kn.

II row

The distance between II row rectangular lattice elements of construction is 3 m, because instead of $186d_{2III}$ will be $192d_{2III}$, fom where receive diameter of metal armature consist of lattice elements:

$1.08d^2_{2III} - 1.92d_{2III} + 0.6 = 0 \Rightarrow d_{2III} = 0.4$ m.

The hitting force of debris flow on the rectangular shape lattice elements consist of III row of construction before the open (debris flow to construction elements create angle 90^0) is equal:

$P_{3\ deaf\ II\ row} = P_{3\ finelly\ residual\ I\ row} \cdot 0.6 = 1240.2 \cdot 0.6 = 744.12$ kn.

And after through II row of construction residual force will be:

$P_{3\ residual\ I\ I\ row} = P_{3\ finelly\ residual\ I\ row} - P_{3\ deaf\ II\ row} = 1240.2 - 744.12 = 496$ kn.

If II row rectangular lattice elements of the construction $\alpha=45^0$, then after opening frontalweidth sum for both elements of construction will be:

$\sum b=8.5\cdot \cos45^0+8.5\cdot \cos45^0\approx12$ m.

The distance between rectangular lattice elements of construction will be:

$l= B-\sum b = 20 -12 \approx 8$ m.

The area of deaf part of th II row rectangular shape lattice elements will be:

$\omega_{deaf} = 2\cdot 6\cdot 6d_{2III} + 18\cdot 5d_{2III} - 108d^2_{2III} = 28.8 + 36 - 17.28 = 47.5$ m^2.

And area of through part of construction after open lattice elements will be:

$\omega_{after\ through\ open} = \omega - \omega_{deaf} = 100-47.5=52.5$ m^2.

Therefore through coefficient after open of II row lattice elements of construction is equal:

$$K^I = \frac{\omega_{after\ through\ open}}{\omega} = \frac{52.5}{100} = 0.525.$$

The hitting force of debris flow after open of II row lattice elements of construction is equal:

$$P_{3\ after\ deaf\ open\ II\ row} = P_{3\ residual\ I\ I\ row} \cdot \cdot \frac{\omega_{deaf}}{\omega} = 496 \cdot 0.475 = 235.6 \text{ kn.}$$

And after through II row of construction residual force will be:

$P_{3\ finelly\ residual\ II\ row} = P_{3\ residual\ I\ I\ row} - P_{3\ after\ deaf\ open\ II\ row} = 496 - 235.6 = 260.4$ kn.

III row

The distance between III row rectangular lattice elements of construction is 2 m; because instead of $192d_{3III}$ will be $198d_{3III}$, fom where receive diameter of metal armature consist of lattice elements:

$1.08d^2_{3III} - 1.98d_{3III} + 0.6=0 \Rightarrow d_{3\ III}=0.32$ m.

The hitting force of debris flow on the rectangular shape lattice elements consist of III row of construction before the open (debris flow to construction elements create angle 90^0) is equal:

$$P_{3\ deaf\ III\ row} = P_{3\ finelly\ residual\ II\ row} \cdot 0.6 = 260.4 \cdot 0.6 = 156.24 \text{ kn.}$$

And after through III row of construction residual force will be:

$P_{3\ residual\ I\ II\ row} = P_{3\ finelly\ residual\ II\ row} - P_{3\ deaf\ III\ row} = 260.4 - 156.24 = 104.16$ kn.

If III row rectangular lattice elements of the construction $\alpha=45^0$, then after opening frontalweidth sum for both elements of construction will be:

$\sum b=9\cdot \cos 45^0+9\cdot \cos 45^0=12.7$ m.

The distance between rectangular lattice elements of construction will be:

$l= B-\sum b = 20 - 12.7 = 7.3$ m.

The area of deaf part of th III row rectangular shape lattice elements will be:

$\omega_{deaf} = 2\cdot 6\cdot 6.36d_{3III} + 18\cdot 5d_{3III} - 108d^2_{3III} = 29 + 34.2 - 15.6 = 47.6$ m^2.

And area of through part of construction after open lattice elements will be:

$\omega_{after\ through\ open} = \omega - \omega_{deaf}=100-47.6=52.4$ m^2.

Therefore through coefficient after open of III row lattice elements of construction is equal:

$$K^I=\frac{\omega_{after\ through\ open}}{\omega}=\frac{52.4}{100}=0.524.$$

The hitting force of debris flow after open of III row lattice elements of construction is equal:

$P_{3\ after\ deaf\ open\ II\ row}= P_{3\ residual\ II\ row}\cdot\frac{\omega_{deaf}}{\omega}= 496\cdot 0.475 = 235.6$ kn.

$P_{3\ after\ deaf\ open\ III\ row} = P_{3\ residual\ I\ II\ row}\cdot\frac{\omega_{deaf}}{\omega}= 104.16\cdot 0.476 = 49.58$ kn.

The hitting force of debris flow after open of III row lattice elements of construction is equal:

$P_{3\ finelly\ residual\ III\ row} = P_{3\ residual\ I\ II\ row} - P_{3\ after\ deaf\ open\ III\ row} = 104.16 - 49.58 = 54.6$ kn.

Finally, after through III row rectangular shape lattice elements hitting force of debris flow decrease ≈ **109 times.**

IV assumption K = 0.2,

Through coefficient $K = \frac{\omega_{through\ open}}{\omega}=\frac{\omega-186d_{1IV}+108d^2_{1IV}}{100}=1\text{-}1.86d_{1IV}+1.08d^2_{1IV}=0.2.$

From where receive independence:

$1.08d^2_{3VI} -1.86d_{3IV} + 0.8=0 \Rightarrow d_{3\,IV}=0.8(3)$ m.

I row

The distance between the rectangular shape lattice elements consist of I row of construction before the open is

4m.

The hitting force of debris flow on the rectangular shape lattice elements consist of I row of construction before the open (debris flow to construction elements create angle 90^0) is equal:

$P_{4\ deaf\ I\ row} = P \cdot 0.8 = 5962.5 \cdot 0.8 = 4770$ kn.

And after through I row of construction residual hitting force equal:

$P_{4\ deaf\ open\ I\ row} = P - P_{4\ deaf\ I\ row} = 5962.5 - 4770 = 1192.5$ kn.

If I row rectangular lattice elements of the construction $\alpha=45^0$, then after opening frontal weidth sum for both elements of construction will be:

$\sum b=8\cdot\cos45^0+8\cdot\cos45^0 \approx 11.3$ m.

The distance between rectangular lattice elements of construction will be:

$l= B-\sum b = 20 - 11.3 = 8.7$ m.

The area of deaf part of th II row rectangular shape lattice elements will be:

$\omega_{deaf} = 2\cdot6\cdot5.65d + 2\cdot9\cdot5d - 108d^2 = 56.5 + 75 - 75 = 56.5\ m^2$.

And area of through part of construction after open lattice elements will be:

$\omega_{after\ through\ open} = \omega - \omega_{deaf}=100-56.5=43.5\ m^2$.

Therefore through coefficient after open of I row lattice elements of construction is equal:

$$K^I = \frac{\omega_{after\ through\ open}}{\omega} = \frac{56.5}{100} = 0.435.$$

The hitting force of debris flow after open of I row lattice elements of construction is equal:

$P_{4\ deaf\ I\ row} = P_{4\ residual\ I\ row} \cdot \frac{\omega_{deaf}}{\omega} = 1192.5 \cdot 0.565 = 673.8$ kn.

And after through I row of construction residual force will be:

$P_{4finally\ \ residual\ I\ row} = P_{4\ residual\ I\ row} - P_{4\ deaf\ I\ row} = 1192.5 - 673.8 = 518.7$ kn.

II row

The distance between II row rectangular lattice elements of construction is 3 m; because instead of $186d_{2IV}$ will

be $192d_{2IV}$, fom where receive diameter of metal armature consist of lattice elements:

$1.08d^2_{2VI} - 1.92d_{2IV} + 0.8=0 \Rightarrow d_{2\,IV}=0.(6)$ m.

The hitting force of debris flow on the rectangular shape lattice elements consist of II row of construction before the open (debris flow to construction elements create angle 90^0) is equal:

$P_{4\ deaf\ II\ row} = P_{4\ finally\ residual\ I\ row} \cdot 0.8 = 518.7 \cdot 0.8 = 415$ kn.

And after through II row of construction residual force will be:

$P_{4\ residual\ II\ row} = P_{4\ finally\ residual\ I\ row} - P_{4\ deaf\ II\ row} = 518.7 - 415 = 103.7$ kn.

If II row rectangular lattice elements of the construction $\alpha=45^0$, then after opening frontalweidth sum for both elements of construction will be:

$\sum b=8.5\cdot \cos45^0+8.5\cdot \cos45^0\approx12$ m.

The distance between rectangular lattice elements of construction will be:

$l= B-\sum b = 20 -12 \approx 8$ m.

The area of deaf part of th II row rectangular shape lattice elements will be:

$\omega_{deaf} = 2\cdot6\cdot6d + 18\cdot5d - 108d^2 = 48 + 60 - 48 = 60$ m^2.

And area of through part of construction after open lattice elements will be:

$\omega_{after\ through\ open} = \omega - \omega_{deaf}=100-60=40$ m^2.

Therefore through coefficient after open of II row lattice elements of construction is equal:

$$K^I = \frac{\omega_{after\ through\ open}}{\omega} = \frac{40}{100} = 0.4.$$

The hitting force of debris flow after open of II row lattice elements of construction is equal:

$P_{4\ after\ deaf\ open\ II\ row} = P_{4\ residual\ II\ row} \cdot \frac{\omega_{deaf}}{\omega} = 103.7 \cdot 0.6 = 62.2$ kn.

And after through II row of construction residual force will be:

$P_{4\ finally\ residual\ II\ row} = P_{4\ residual\ II\ row} - P_{4\ after\ deaf\ open\ II\ row} = 103.7 - 62.2 = 41.5$ kn.

III row

The distance between III row rectangular lattice elements of construction is 2 m; because instead of $192d_{3IV}$ will be $198d_{3IV}$, fom where receive diameter of metal armature consist of lattice elements.

$1.08d^2_{3IV} - 1.98d_{3IV} + 0.8=0 \Rightarrow d_{3IV} =0.6$ m.

The hitting force of debris flow on the rectangular shape lattice elements consist of III row of construction before the open (debris flow to construction elements create angle 90^0) is equal:

$P_{4\ deaf\ III\ row} = P_{4\ finally\ residual\ II\ row} \cdot 0.8 = 41.5 \cdot 0.8 = 33.2$ kn.

And after through III row of construction residual force will be:

$P_{4\ residual\ III\ row} = P_{4\ finally\ residual\ II\ row} - P_{4\ deaf\ III\ row} = 41.5 - 33.2 = 8.3$ kn.

If III row rectangular lattice elements of the construction $\alpha=45^0$, then after opening frontalweidth sum for both elements of construction will be:

$\sum b=9\cdot \cos45^0+9\cdot \cos45^0=12.7$ m.

The distance between rectangular lattice elements of construction will be:

$l= B-\sum b = 20 - 12.7 = 7.3$ m.

The area of deaf part of th III row rectangular shape lattice elements will be:

$\omega_{deaf} = 2\cdot6\cdot6.36d + 18\cdot5d - 108d^2 = 45.8 + 54 - 39 = 60.8$ m^2.

And area of through part of construction after open lattice elements will be:

$\omega_{after\ through\ open} = \omega - \omega_{deaf}=100-60.8=39.2$ m^2.

Therefore through coefficient after open of III row lattice elements of construction is equal:

$$K^I = \frac{\omega_{after\ through\ open}}{\omega} = \frac{39.2}{100} = 0.392.$$

The hitting force of debris flow after open of III row lattice elements of construction is equal:

$$P_{4\ after\ deaf\ open\ III\ row} = P_{4\ residual\ III\ row} \cdot \frac{\omega_{deaf}}{\omega} = 8.3 \cdot 0.608 = 5.05 \text{ kn.}$$

And after through III row of construction residual force will be:

$P_{4\ finally\ III\ row} = P_{4\ residual\ III\ row} - P_{4\ after\ deaf\ open\ III\ row} = 8.3 - 5.05 = 3.25$ kn.

Finally, after through III row rectangular shape lattice elements hitting force of debris flow decrease ≈**1835 times.**

What about condition than K=0 that is absurd, because in the construction every time is through space (4 m, 3m, 2m) and if put in the above independence K=0 under the radical received negative, it is completely legal.

Connection between debris flow changeable dimeters and construction of the after through III row rectangular lattice elements of the debris flow against comstruction and received residual hitting force is follow functional independence $d_{3n}=f(P_{n\ finally\ residual\ III\ row})$,

where n- number of assumptions changes I-IV border (see Figure 4:)

$d_{3\ I}=0{,}107$ in case $P_{I\ finally\ residual\ III\ row}=1764{,}5$ kn.;

$d_{3\ II}=0{,}23$ in case $P_{II\ finally\ residual\ III\ row}=380{,}1$ kn.;

$d_{3\ III}=0{,}32$ in case $P_{III\ finally\ residual\ III\ row}=54{,}6$ kn.;

$d_{3\ IV}=0{,}6$ in case $P_{IV\ finally\ residual\ III\ row}=3{,}25$ kn.

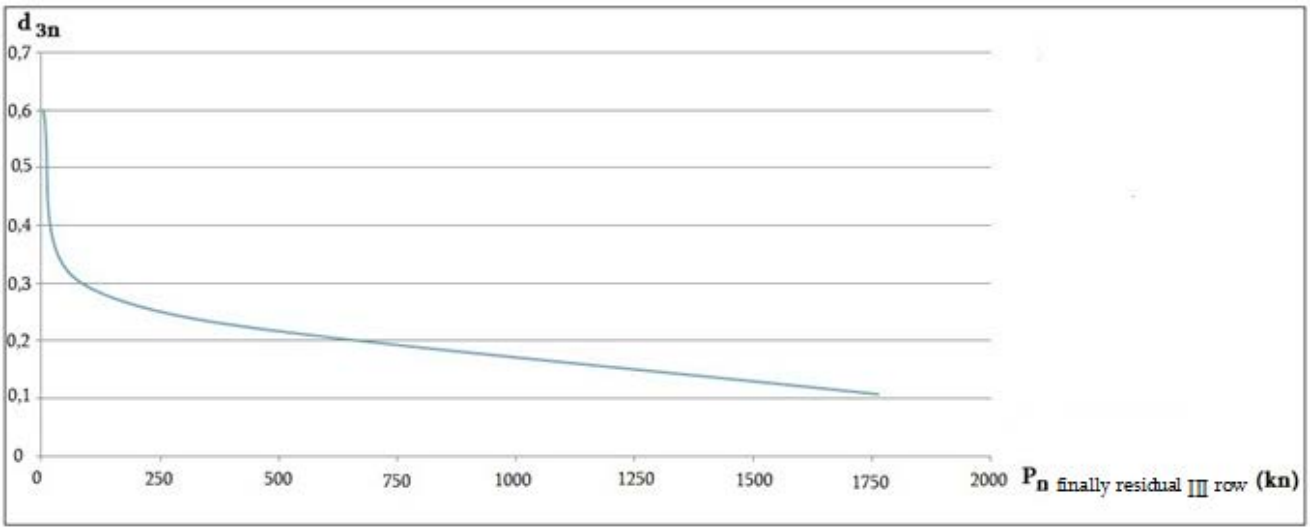

Figure 4: functional independence between between debris flow changeable dimeters and construction of the after through III row rectangular lattice elements of the debris flow against comstruction and received residual hitting force

4. The result

From the calculation implemented for describe influence of linkage debris flow on the debris flow against lattice type construction, that construction is effective ingeneering measures of fight, because in forth assumption condition hitting force value of debris flow action on the construction decrease **1835-**times, that indicate

effectiveness of construction.

5. Recommendations

The technical economical charachterisitics of the offered construction is high, because using of thie building is often possibale without accident and long time, that avoid additional costs for its restavration, that caused to prepare recommendation for implementation of its in practice.

6. Conclusion

The most amount from existing classical debris flow against construction need cleaning after throw of debris flow and it is connected to costs, some of them is not stable against of debris flow for their geometrical shape, many from them is non economical due to their expensive materials, and our offered the lattice type debris flow construction is effective, relative easy implemention by technical point of view and economic structure, which is why the introduction of perspective.

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