Treatment of the Modern Management Mechanism of the Debris Flow Processes Expected in the Mletiskhevi

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***Abstract*—**The work reviewed and evaluated various genesis debris flow phenomena recently formatted in the Mletiskhevi, accordingly it revealed necessity of treatment modern debris flow against measures. Based on this, it is proposed the debris flow against truncated semi cone shape construction, which elements are contained in the car's secondary tires. its constituent elements (sections), due to the possibilities of amortization and geometric shapes is effective and sustainable towards debris flow hitting force. The construction is economical, because after crossing the debris flows in the river bed, the riverbed is not cleanable, also the elements of the building are resource saving. For assessment of influence of cohesive debris flow at the construction and evaluation of the construction effectiveness have been implemented calculation in the specific assumptions with approved methodology. According to the calculation, it was established that after passing debris flow in the debris flow construction (in 3 row case) its hitting force reduces 3 times, that causes reduce of debris flow speed and kinetic energy, as well as sedimentation on a certain section of water drain in the lower part of the construction. Based on the analysis and report on the debris flow against construction, it can be said that construction is effective, inexpensive, technically relatively easy-to-reach measure, that's why its implementation is prospective.

***Keywords*—**Construction, debris flow, sections, theoretical calculation.

I. Introduction

FROM the natural disasters that occur in Georgia, special attention is paid to erosion and landslide genesis debris flow phenomena. There are 3000 debris flows in Georgia, which is about 29% of the country's territory [1], [6]. Debris flows threaten the population, the risk of strategic mental health: bridges, transport mains, water and energy objects, church monasteries and other cultural monuments [14], [15].

The debris flows are created with special frequency in the waters of the Mletis Khevi watershed basin tributary of river Aragvi River in the Dusheti municipality [17]. As a result of intensive exogenous processes (soil erosion, landslade) catastrophic debris flow processes are created, which threaten the village Mleta population, tourist routes, Mleti St. George Church, motorway and bridge, prevent the normal function of Tbilisi water supply - Zhinvali water reservoir [18], because the debris flow mass formed in the Mletis khevi ravine meets the river via the river Aragvi River in the Zhinvari water reservoir, the quality of the water reservoir is deteriorating and its useful volume decreases within the short period of time, thus restricting Tbilisi water supply [13].

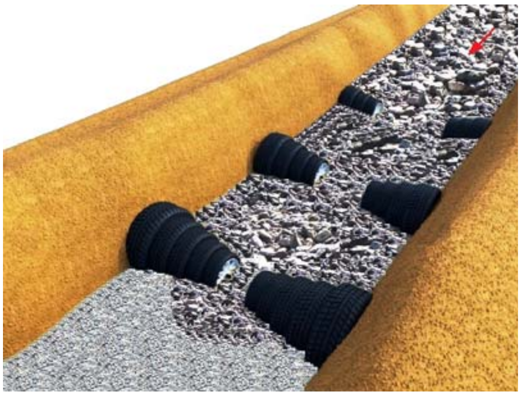

Fig. 1 General view of the Debris Flow against Construction

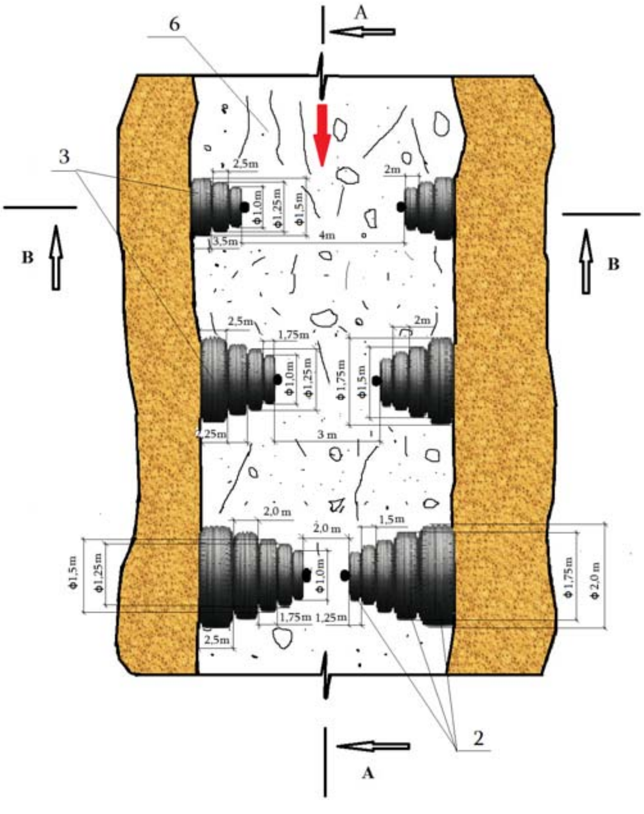

Fig. 2 Plan of the Debris Flow against Construction

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Based on the above, for the effective management of the expected debris flow events in Mletiskhevi [1], [2], there is purposed snapped half cone shape debris flow against new construction with stepped elements, containing with secondary tires (see Figs. 1-4).

The debris flow against construction is represented by four figures: Fig. 1 – The general view of construction; Fig. 2 – Plan of the construction; Fig. 3 – Cut A-A on Fig. 2; Fig. 4 – cut B-B on Fig. 2.

The debris flow against truncated semi cone shape construction with stepped elements represents sections from tire (Fig. 4 - 2) of vehicles with disc (Fig. 4 - 1), which consist of horizontally, located righteous flow direction, burned half of the semicolon shaped paired from the elements placed on the banks of the bed with great bases (Fig. 4 - 3). The tire of the structure half fixed in the debris flow bed vertically with their working surface and the hollow body is filled with inert materials (Fig. 4 - 4) and one of the final divisions in the discs dividing the metal axis (Fig. 4 - 5) is in the shore of the bed (Fig. 4 - 6), and second end on the base of bed (Fig. 4 - 7) on the concrete base (Fig. 4 - 8) with anchors (Fig. 4 –9). At the same time, dimension of the sections increases in debris low (Fig. 4 - 10) movement direction and thus the distance between the elements of the sections is reduced.

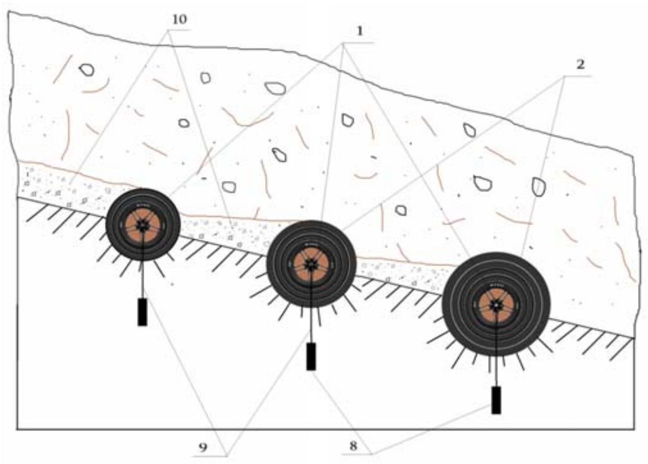

Fig. 3 Front view of the construction (cut-cross A-A)

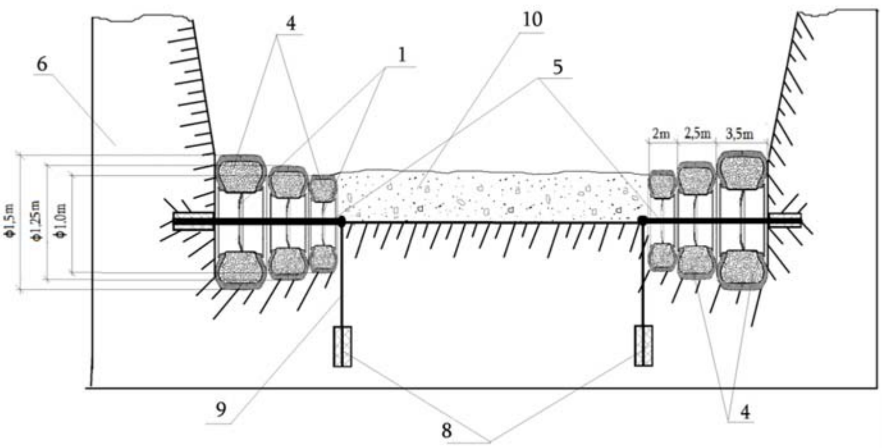

Fig. 4 The view of the construction site (cut-cross B-B)

The specification of the debris flow against truncated semi cone shape construction with stepped elements is the following: the debris flow energy extinguish significantly determines the shape of elements of the construction [8], [10], 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 [3], [4]. It should be noted that distance between the small bases of the barrage elements decreases, so increasing the width of the structure elements to direction of debris flow that creates more resistance; it also causes debris flow energy to extinguish [5]. Filling the hollow elements of the construction with inert material and fixation of both end of the axis of the tire discs increases the stability of the construction [7], while the elastic properties of tires reduce the dynamic loads on it, which greatly increases the reliability of the construction [9].

The sizes of the elements of the debris flow against truncated semi cone shape construction with stepped elements, their amount and location in the bed will be selected according to hitting force of debris flow by taking into account the natural-topographical conditions of the river [12], [16].

II. Materials and Methods

In order to determine the efficiency of the proposed debris flow construction with specific assumptions and identical loads, calculations are made by our approved methodology [19], [20]: The calculating formula of hitting force of debris flow on the construction is:

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

where γ : The volume mass of the debris flow kg/m^3; V: The speed of debris flow wave 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.

It should be noted that value of hitting force of debris flow is a function of its transparency, therefore, first of all calculation happens at the analogy deaf construction [11], with consideration of it, force of cohesive debris flow acting at the construction is:

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

where the width of the debris flow bed B = 20 m; Height, H = 5 m; The speed of debris flow wave motion V = 5 (m/sec); Volume share γ = 2000 kg/m^3; Internal friction angle φ = 30^0; Inclination of debris flow $i = 0{,}2$.

Because the construction is permeable, the pass-through coefficient is calculated by:

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

where $\omega_{through\ n\ row}$: The occupied area by debris flow outstretched over the elements with rectangles shaped frontal projection in the line of construction; n: The number of elements of the structure.

The containment coefficient of debris flow hitting at the construction elements is equal to:

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

where $\omega_{deaf\ n\ row}$ is the sum of front-line projections of 2 elements with the form of rectangles (the area of the projection of elements is the sum of the area of rectangles).

The Calculation Made for the I Order of Construction

The Off-road coefficient is $K_1 = \frac{\omega through\ I\ row}{\omega} = \frac{79{,}25}{100} =$ 0,7925 m^2 where $\omega_{through.\ I\ row} = \omega - \omega_{deaf\ I\ row}$ = 100-20,75 = 79,25 m^2; ω = B·H = 20·5 = 100m^2. $\omega_{deaf\ I\ row} = S_{1\ I\ row} + S_{2\ I\ row}$ = 10,375+10,375 = 20,75 m^2, where $S_{1\ I\ row}$ და $S_{2\ I\ row}$ is the first line of frontal projection elements of the rectangle shaped elements on the left and right sides of the structure.

$S_{1\ I\ row} = a_1\times b_1+a_2\times b_2+a_3\times b_3$ = 3,5×1,5+2,5×1,25+2,0×1,0 = 10,375m^2;

$S_{2\ I\ row} = a_1\times b_1+a_2\times b_2+a_3\times b_3$ = 3,5×1,5+2,5×1,25+2,0×1,0 = 10,375m^2;

where: a_1, b_1; a_2, b_2; a_3, b_3 are accordingly the width and length of the first line rectangle shape (frontal projection) of the structure.

The impact force of the debris flow acting on the first two elements of the construction is equal to:

$P_{deaf\ I\ row} = P \cdot K_1^I$ = 5962,5 · 0,2075 = 1237,22 k.n.,

where $K_1^I = \frac{\omega\ deaf\ 1\ row}{\omega} = \frac{20{,}75}{100} = 0{,}2075$.

After passing the first line of construction, the residual force of the cohesive debris flow is:

$P_{residual\ I\ row} = P - P_{deaf\ I\ row}$ = 5962,5-1237,22 = 4725,3 k.n.

Calculations Made for the II Order of Construction

The Off-road coefficient is $K_1 = \frac{\omega through\ II\ row}{\omega} = \frac{76}{100} =$ 0,76 m^2 where $\omega_{through.\ I\ row} = \omega - \omega_{deaf\ I\ row}$ = 100-24 = 76 m^2; ω = B·H = 20·5 = 100 m^2. $\omega_{deaf\ I\ I\ row} = S_{1\ I\ Irow} + S_{2\ I\ I\ row}$ = 25,5+25,5 = 51 m^2 where $S_{1\ I\ I\ row}$ და $S_{2\ I\ I\ row}$ is the second line of frontal projection elements of the rectangle shaped elements on the left and right sides of the structure.

$S_{1\ I\ I\ row} = a_1\times b_1+a_2\times b_2+a_3\times b_3+a_4\times b_4$ = 2,5×1,75+2,25×1,5+2,0×1,25+1,75×1,0 = 12,0m^2;

$S_{2\ I\ I\ row} = a_1\times b_1+a_2\times b_2+a_3\times b_3+a_4\times b_4$ = 2,5×1,75+2,25×1,5+2,0×1,25+1,75×1,0 = 12,0m^2

where: a_1, b_1; a_2, b_2; a_3, b_3; a_4, b_4 are accordingly the width and length of the second line rectangle shape (frontal projection) of the structure.

The hitting force of the cohesive debris flow on the both elements of the construction of the rectangle shaped elements exist in the second row of construction is:

$P_{deaf\ I\ I\ row} = P_{residual\ I\ row} \cdot K_2^I$ = 4725,3 · 0,24 = 1134,0 k.n.;

where $K_2^I = \frac{\omega\ deaf\ II\ row}{\omega} = \frac{24}{100} = 0{,}24$.

After passing the second line of construction, the residual force of the cohesive debris flow is:

$P_{residual\ I\ I\ row} = P_{residual\ I\ row} - P_{deaf\ I\ I\ row}$ = 4725,3 -1134,0 = 3591,0 k.n.;

Calculations Made for the III Order of Construction

The Off-road coefficient is $K_3 = \frac{\omega through\ III\ row}{\omega} = \frac{71{,}5}{100} =$ 0,715 m^2 where $\omega_{through.\ III\ row} = \omega - \omega_{deaf\ III\ row}$ 100-28,5 = 71,5 m^2; ω = B·H = 20·5 = 100 m^2. $\omega_{deaf\ III\ row} = S_{1\ III\ row} + S_{2\ III\ row}$ = 14,25+14,25 = 28,5 m^2 where $S_{1\ I\ I\ I\ row}$ და $S_{2\ I\ I\ I\ row}$ is the second line of frontal projection elements of the rectangle shaped elements on the left and right sides of the structure.

$S_{1\ III\ row} = a_1\times b_1+a_2\times b_2+a_3\times b_3+a_4\times b_4+a_5\times b_5$ = 2,5×2,0+2,0×1,75+1,75×1,5+1,5×1,25+1,25×1,0 = = 14,25 m^2,

$S_{2\ III\ row} = a_1\times b_1+a_2\times b_2+a_3\times b_3+a_4\times b_4+a_5\times b_5$ = 2,5×2,0+2,0×1,75+1,75×1,5+1,5×1,25+1,25×1,0 = = 14,25 m^2, where: a_1, b_1; a_2, b_2; a_3, b_3; a_4, b_4; a_5, b_5 are accordingly the width and length of the third line rectangle shape (frontal projection) of the structure.

The hitting force of the cohesive debris flow on the both elements of the construction of the rectangle shaped elements exist in the third row of construction is:

$$P_{deaf\ I\ I\ I\ row} = P_{residual\ I\ I\ row} \cdot K_3^I = 3591{,}0 \cdot 0{,}285 = 1023{,}4 \text{ k.n.};$$

where $K_3^I = \frac{\omega \text{ deaf III row}}{\omega} = \frac{28{,}5}{100} = 0{,}285$.

After passing the third line of construction, the residual force of the cohesive debris flow is equal:

$$P_{residual\ I\ I\ I\ row} = P_{residual\ I\ I\ row} - P_{deaf\ I\ I\ I\ row} = 3591{,}0 - 1023{,}4 = 2567{,}6 \text{ k.n.};$$

The connection between containment coefficient of debris flow hitting at the construction elements and the residual force of the cohesive debris flow after passing the stepped elements of construction is presented as functional dependence K_n^I = f($P_{residual\ n\ row}$) (see Fig. 5):

$$K_1^I = 0{,}2075 \text{ in case } P_{residual\ I\ row} = 4725{,}3 \text{ k.n.};$$

$$K_2^I = 0{,}24 \text{ in case } P_{residual\ II\ row} = 3591{,}0 \text{ k.n.};$$

$$K_3^I = 0{,}285 \text{ in case } P_{residual\ III\ row} = 2567{,}6 \text{ k.n.}$$

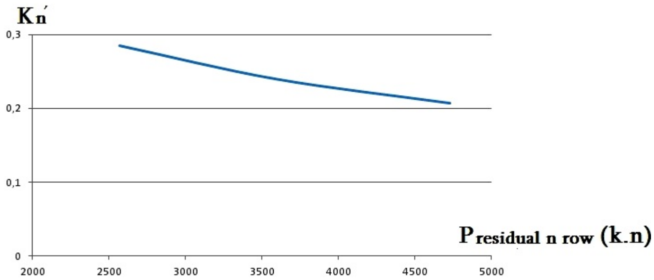

Fig. 5 The connection between containment coefficient of debris flow hitting at the construction elements and the residual force of the cohesive debris flow after passing the stepped elements of construction

III. Results

From the calculation implemented for describe cohesive debris flow influence at the debris flow against truncated semi cone shape construction with stepped elements, it seems that construction represents effective engineering measure for fight with debris flows, because the initial force P = 5962,5 k.n. of the debris flow acting on the construction after passed construction reduced approximately 2,3 times, which indicates the efficiency of the building.

IV. Conclusion

It should also be noted that the technical-economic indicators of the proposed debris flow against construction is high, because of the use of secondary, written materials used for its construction, while the operation is possible and long lasting without crash, which reduces additional costs for its repairs.

Depending on the circumstances mentioned above we can conclude that proposed debris flow against construction is effective, cheap, technically relatively easy to implement technology, therefore, its implementation in the Mletiskhevi basin is promising

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