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A convenient designation for the optimal hydraulic cross-section of "Rectangle-V" shaped drainage canal of viscous debris flow

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## A Convenient Designation for the Optimal Hydraulic Cross-section of "Rectangle-V" Shaped Drainage Canal of Viscous Debris Flow

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**Abstract:** Debris flow is one of the geo-hazards in the west mountain area of China. It occurs suddenly with short duration and intensive erosion and silt. As its collapsing force is extremely strong, debris flow often erode and silted rail ways, highways, stations, towns, factories, mining areas and water conservancy establishments. It severely rejected the continuance development of economic construction of mountain area. Therefore, it cries for prevention of debris flow to ensure the continuance development of economic of mountain area. The "Rectangle –V" shaped drainage canal of debris flow, as its simply engineering configuration, convenient construction and relative fewer land use, is one of the most-widely used engineering measures in debris flow prevention in the west mountain area in China. The cross-section shape and sizes of the "Rectangle –V" shaped drainage canal are the important parameters in the designation. How to choose the shape and sizes of the "Rectangle –V" shaped drainage canal so that let it has the optimal drainage capacity is rarely revolved before. This paper chooses the "Rectangle –V" shaped drainage canal to analysis the designation of the optimal hydraulic cross-section.

The optimal hydraulic cross-section of drainage canal refers that the passage area of cross-section ($A$) is minimum or the hydraulic radius ($R$) is maximum when the values of inside section longitudinal gradient ($J$), roughness coefficient ($n$) and design discharge ($Q$) are fixed. That is let the minimum $A$ to drain the design discharge $Q$. The characteristic sizes of "Rectangle –V" shaped drainage canal under optimal hydraulic condition are confirmed by the width B and depth H of the cross-section.

Assuming the size parameter is $F = H / B$, while H is slurry depth and B is width of the

drainage canal, and it can be deduced as $F=\frac{\sqrt{1+I_C^2}-I_c}{2}$ ($I_c$ is the transverse slope coefficient and it is the absolute value of $I_C=2\triangle H/B$ ) under the optimal hydraulic condition. The cross-section configuration parameter of "Rectangle –V" shaped drainage canal (S) is defined as the ratio of wetted perimeter (P) to hydraulic radius(R), and it can be deduced as $S=8\sqrt{1+I_C^2}-4I_C$ under the optimal hydraulic condition. It indicated that F and S are only related to the transverse slope coefficient $I_c$ under the optimal hydraulic condition.

The equation of the "Rectangle –V" shaped cross-section sizes has been deduced by assuming the discharge Q, bottom longitudinal slope J and the grain composition of debris flow are known. Calculating the hydraulic radius of "Rectangle –V" shaped drainage canal when drainage viscous debris flow, there is

$$R=0.23\frac{Q^{3/7}}{\left[S^6C_v^{\ 2}(D_{50}J)\right]^{1/14}}$$

Where $C_v$ is volumetric ratio of silt concentration and it can be confirmed by field investigation; $D_{50}$ is the grain size which is smaller than 50% on grading curve (mm) and it can be confirmed by field sampling analysis.

Then calculating the optimal hydraulic depth and width of "Rectangle –V" shaped drainage canal:

$$W=\frac{SR}{I_CF+\sqrt{1+I_C^2}}$$

$$H=\frac{SI_CFR}{2I_CF+2\sqrt{1+I_C^2}}$$

Take Mozi gully, a first - order distributaries in the right upper Min River after "5.12" earthquake as an example, this paper designed the optimal cross-section of the drainage canal of viscous debris flow.

Compared to the actual designation methods, the result of this paper can confirm the shape and the sizes of "Rectangle –V" shaped drainage canal of viscous debris flow. And the calculated result is the only confirmed value, while the calculating method is convenient and efficient and can be adapted to the actual engineering.

**Key words:** Optimal hydraulic cross-section; "Rectangle-V" shaped drainage canal; viscous debris flow