

Analysis of the typical small watershed of warping dams in the sand properties

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Abstract. Coarse sediment with a particle size greater than 0.05mm is the main deposit of riverbed in the lower Yellow River, the Loess Plateau is one of the concentrated source of coarse sediment, warping dam is one of the important engineering measures for gully control. Jiuyuangou basin is a typical small basin in the first sub region of hilly-gullied loess region, twenty warping dams in Jiuyuangou basin was selected as research object, samples of sediment along the main line of dam from upper, middle to lower reaches of dam fields and samples of undisturbed soil in slope of dam control basin were taken to carry out particle gradation analysis, in the hope of clearing reducing capacity on coarse sediment of different types of warping dam through the experimental data. The results show that the undisturbed soil in slope of dam control basin has characteristics of standard loess, the particle size are mainly distributed in 0.025~0.05mm, and the 0.05mm particle size of Jiuyuangou basin of loess is an obvious boundary; Particle size of sediment in 15 warping dam of Jiuyuangou basin are mainly distributed in 0.031~0.05mm with the dam tail is greater than dam front in general. The separation effect of horizontal pipe drainage is better than shaft drainage for which particle size greater than 0.05mm, notch dam is for particle size between 0.025~0.1 mm, and fill dam is for particle size between 0.016 ~ 0.1 mm, they all have a certain function in the sediment sorting.

1 Introduction

Nearly 50% of the silt in the river channel of the lower reaches of the Yellow River is coarse sediment with a particle size > 0.05mm, the main channel sediment and coarse sediment particle size greater than 0.05mm over 70%. Coarse sediment is the main source of sediment in the main lower reaches of the Yellow River [1]-[3], Jiuyuangou basin is a source of one of the coarse sand in the middle reaches of the Yellow River [4], The warping dam is one of the main maintain soil engineering measures in the basin [2]-[4], It plays an important role in reducing sediment deposition in the lower reaches [5]-[9]. Sediment in 15 warping dams of Jiuyuangou dam sample through the probe hole method [10], At the same time, the original soil sampling in the dam control basin, then particle gradation analysis of samples, the difference of different types of silt Engineering Dam in Jiuyuangou dam to clear sediment sorting, in particular, the separation difference between coarse sediment with a particle size greater than 0.05mm. On the transformation of warping dam structure in the future, extend the dam of the deposition period and service life, all have a positive effect.

2 The Study Area and The Sampling Method

2.1 The Study Area

Jiuyuangou watershed's a ditch that is located middle and downstream area in the middle reaches of the Yellow River's Wuding River on the left bank. Jiuyuangou watershed is The typical small watershed about first sub region of Loess Hilly Region. Channel section is in a V shape. The main channel length is Eighteen km. Average gradient of the channel is 1.15%, gully density is 5.34 km/km², sea level elevation is 820-1180m, the catchment area is 70.10km². Jiuyuangou watershed is extremely severe erosion area.

2.2 The Sampling Method

Selection twenty dams in Jiuyuangou watershed (refer with: Table 1), along the line of dam in middle thread of channel, upstream, midstream and downstream of the layout of a sampling point, in the upstream, midstream and downstream of the layout of a sampling point, through the adjustable length of Luoyang shovel sampling, common deep 2m, the weight of each sample is about 0.5kg, and control of basin slope sampling dam, sampling once per 0.05m, common deep 0.15m.

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Table 1. The Main Sampling Jiuyuangou Watershed Check Dam Situation

Name of the dam	Basin unit Watershed	Type of dam	control area of watershed (km ²)	Drainage works	Influence of upstream dam
Weijiayan 3# dam	Hejiagou	Small dam	0.85	Nothing	no
Hejiagou 2# dam	Hejiagou	Key dam	1.69	Aven	yes
Hejiagou 1# dam	Hejiagou	Small dam	0.11	Nothing	no
Weijiayan 1# dam	Hejiagou	Small dam	0.16	Nothing	yes
Laolimo dam	Maliangou	Medium dam	1.36	Horizontal pipe	yes
Maliangou key dam	Jiuyuangou	Key dam	2.43	Horizontal pipe	yes
Haojialiang dam	Xiyangou	Key dam	2.69	Horizontal pipe	yes
Xiyangou Mizoguchi dam	Xiyangou	Key dam	2.43	Spillway	yes
Xiyangou Village front dam	Xiyangou	Medium dam	1.81	Horizontal pipe	yes
Tanyangou dam	Xiyangou	Gap dam	0.29	Nothing	no
Mazhangzui dam	Lijiazhai	Key dam	0.99	Horizontal pipe	no
Fanshan dam	Lijiazhai	Medium dam	2.16	Aven	no
Beitagou dam	Wangmagou	Small dam	0.19	Nothing	no
Guandigou 3# dam	Wangmagou	Small dam	0.12	Aven	no
Guandigou 2# dam	Wangmagou	Small dam	0.2	Nothing	no
Guandigou 4# dam	Wangmagou	Medium dam	0.41	Aven	no
Wangbogu 2# dam	Wangmagou	Small dam	0.17	Aven	no
Nianyangou 4# dam	Wangmagou	Small dam	0.21	Nothing	no
Sdzui 2# dam	Wangmagou	Small dam	0.59	Aven	no
Guandigou 1# dam	Wangmagou	Medium dam	1.11	Aven	yes

3 Analysis of Grain Size of Original Loess in Jiuyuangou Watershed

Table 2 shows that the Jiuyuangou watershed of loess gives first place to silt particles (0.05~0.005mm). The change range of the soil mass percentage of fine sand (>0.05mm) percentage of the silt size is 17.3 ~ 36%, the change value is 18.7%. The change range of the soil mass (0.05~0.005mm) percentage of the silt particle size is 47 ~ 62.2%, the change value is 15.2%. The clay is 12.8 to 23.8%, the change value is 11%. The

difference between the maximum and the minimum of the content of different particles is close.

The differences of average content of different sizes of Jiuyuangou watershed of loess in great. The average value of the soil mass (>0.05mm) percentage of fine sand particle size is 27.6%. The silt (0.05~0.005mm) is 55.5%. The clay (<0.005mm) 17%. In Jiuyuangou watershed of loess in silty soil, followed by sand, clay is again. The average soil mass percentage of 0.05~0.01mm particle in silt is 46.4%. The average soil mass percentage of 0.01 ~ 0.005mm is 9.1%. The coarse silt is more than 5 times that of the fine silt soil, and has the main characteristics of the standard loess.

Table 2 Analysis results of particle gradation of undisturbed soil in Jiuyuangou basin

Sampling point of original loess in Dam control basin	The particle size of soil mass less than a particle size (mm)		
	>0.05mm	0.05-0.005mm	<0.005mm
Gejia gou Dam	27.8	56.6	15.6
Wangmao gou Menhu lu Dam	36.0	47.3	16.7
Wangmao gou Shujing Dam	25.0	62.2	12.8
Weijiayan 3# dam	28.3	50.0	21.7
Hejia gou 2# Dam	30.8	54.0	15.2
Hejia gou 1# Dam	20.4	61.3	18.3
Xiyangou dam	24.4	58.5	17.1
Haojialiang dam	35.4	47.0	17.6
Maliangou dam	20.2	56.0	23.8
Lao li mao dam	28.7	58.4	12.9
Ma zhang zui dam	25.3	57.5	17.2
Fanshan dam	32.6	52.9	14.5
Xia qiao gou 3# dam	28.8	55.6	15.6
Xia qiao gou 2# dam	32.3	54.0	13.7
Xiang ta gou dam	17.3	60.6	22.2
minimum value	17.3	47.0	12.8
Maximum value	36.0	62.2	23.8
Average value	27.6	55.5	17.0

4 The Analysis of Different Types of Engineering Dam Sediment Particle

According to the particle size analysis results(refer with: Table 3), the silt dams that the average particle size's in front of the dam is less than the dam tail in Jiuyuangou Watershed are seventeen, 81% of the total number; the silt dams that the average particle size's in front of the dam is close to the dam tail are three, 15% of the total number; the silt dams that the average particle size's in

front of the dam staggers distribution in the dam tail and intermediate are one,5% of the total number. Therefore,the one silt dams will be get rid of the sampling analysis.

Table 3 Particle gradation analysis of sediment from 15 sampling warping dam in Jiuyuangou basin

Dam name	position	The particle size of soil mass less than a particle size (mm)			
		<0.001	0.001~0.025	0.025~0.050	>0.050
Xi yan gou cun qian dam	The front of the dam	4.71	55.59	25.06	14.64
	Dam tail	3.14	32.46	32.77	31.63
Hao jia liang dam	The front of the dam	3.02	33.01	30.21	33.76
	Dam tail	3.12	29.77	28.28	38.83
Xi yan gou gou kou dam	The front of the dam	3.69	40.88	30.8	24.63
Tan yang gou dam	The front of the dam	3.5	36.24	31.92	28.34
Ma lian gou dam	The front of the dam	3.27	33.12	30.23	33.38
	Dam tail	2.92	26.83	30.65	39.61
Lao li mao dam	The front of the dam	3.36	42.91	30.36	23.36
	Dam tail	3.52	39.42	29.44	27.62
Ma zhang zui dam	The front of the dam	4.15	47.41	28.64	19.81
	Dam tail	3.21	35.31	30.5	30.99
Fan shan dam	The front of the dam	4.32	48.75	27.11	19.82
	Dam tail	3.98	43.23	28.61	24.18
Bei ta goui dam	The front of the dam	4.38	57.63	25.64	12.35
	Dam tail	3.17	32.59	33.36	30.88
Guan di gou 3# dam	The front of the dam	4.4	60.25	24.63	10.71
	Dam tail	3.01	30.42	33.43	33.15
Guan di gou 2# dam	The front of the dam	4.5	55.88	23.88	15.74
	Dam tail	3.69	37.03	29.48	29.8
Guan di gou 4# dam	The front of the dam	4.21	56.57	26.55	12.67
Wei jia yan 3# dam	The front of the dam	3.67	36.22	28.6	31.51
	Dam tail	3.31	31.1	28.27	37.33
He jia gou 2# Dam	The front of the dam	4.67	55.02	25.08	15.24
	Dam tail	3.8	40.63	28.3	27.27
He jia gou 1# Dam	The front of the dam	3.89	40.97	27.98	27.15

Sediment's size in front of the dam about Jiuyuangou Watershed's the 20 silt dams > 0.05mm and > 0.10mm,particle size volume arithmetic average percent respectively 22.41% and 3.07%, Sediment's size in the dam tail > 0.05mm and > 0.10mm,particle size volume

arithmetic average percent respectively 32.07% and 4.89%. Jiuyuangou Watershed's the average particle size distribution curve about in in front of the dam and the dam tail is Figure 1. According to the particle size analysis results, the coarse sadiment size of Jiuyuangou Watershed's silt dam concentrats mainly in 0.05mm.

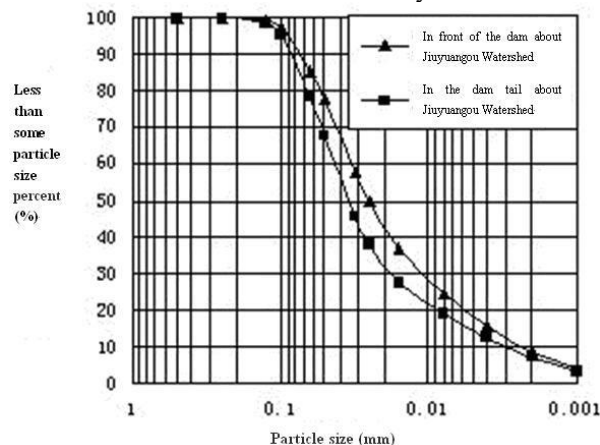


Figure 1 Average sediment grading curve in front of the dam and the dam tail about Jiuyuangou Watershed

According to the particle size analysis results(refer with: Table 3), in addition to tanyanggou que kou dam and xiyangou goukou dam, the average grain size distribution curve of the remaining 17 warping dams in the sediment of the display in front of the dam is located below the dam end curve curve shows that the average grain size of sediment in front of the dam is less than the tail dam (refer with: Figure 2). The proportion of sediment particle size at 0.031mm ~ 0.001mm, the drainage dam is greater than no drainage dam. The proportion of sediment with a sediment particle size larger than 0.05mm, the drainage dam is less than no drainage dam. The proportion of sediment particle size at 0.05mm ~ 0.031mm, no drainage dam and drainage dam is basically the same. Thus it can be seen,In front of the dam, the drainage dam is greater than no drainage dam in separation of coarse sediment with a particle size larger than 0.05mm (refer with: Figure 3).

At the front of the dam, the difference of sediment sorting is mainly because there is no drainage engineering dam for the upstream flood carrying sediment basically is retaining, the sediment concentration flood after the dam can not be discharged in time, the fine sediment carried by the flood is fully deposited, the drainage dam project is through the shaft or horizontal pipe part of the late deposition of fine sediment transported downstream. Therefore, sand in front of the drainage dam is crude than the no drainage dam.

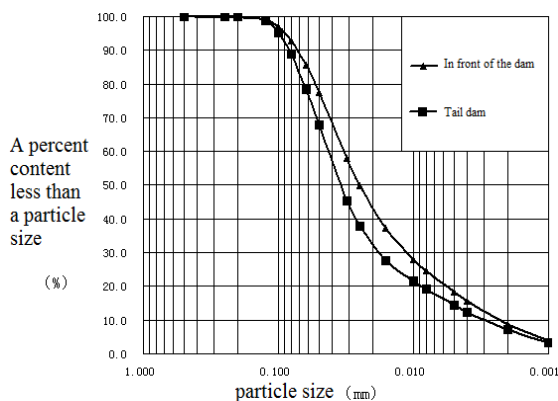


Figure 2 Average particle gradation curve of sediment from dam front and tail of 13 warping dam

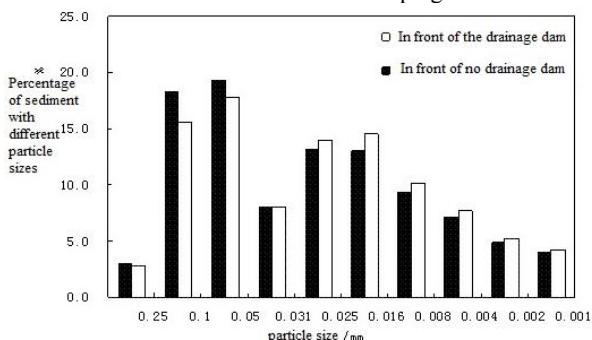


Figure 3 Variation in proportion of different particle size of sediment from dam in front of warping dam with drainage works and no drainage works

The proportion of grain size of mud and sand in front of the tanyangou dam from 0.025mm to 0.001mm, lower than the original soil in front of the dam. The proportion of particle size in 0.1mm ~ 0.025mm, the front of the dam is larger than the original soil. The proportion of sediment particle size from 0.25mm to 0.1mm, lower than the original soil in front of the dam. So, in front of the tanyanggou dam, on the particle size in 0.1mm ~ 0.025mm has a certain role in the sediment sorting. The proportion of sediment in the mud and sand grains in the front of the xiyangou goukou dam from 0.1mm to 0.016mm, the front of the dam is larger than the original soil. The proportion of sediment particle size from 0.016mm to 0.001mm and 0.25mm to 0.1mm, Lower than the original soil in front of the dam. So, the silt filled dam has a certain sorting effect on the 0.1mm ~ 0.016mm sediment in the upper reaches.

Table 4 shows that the particle size is greater than 0.05mm of sediment, horizontal pipe dam drainage optimal separation effect.

Table 4 Proportion sorting of sediment in different types of warping dam

The type of dam engineering	$d_{yu}(\%)$		$d_{yuan}(\%)$		$d_{yu}/d_{yuan}(\%)$	
	$d>0.05$ mm	$d>0.1$ mm	$d>0.05$ mm	$d>0.1$ mm	$d>0.05$ mm	$d>0.1$ mm
Drainage pipe drainage	26.0	4.4	21.9	3.5	118.7	125.7
Shaft drainage	20.7	3.5	21.2	3.5	97.6	100.0
No drainage	23.0	4.2	24.8	5.5	92.7	76.4

project						
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Explain: d_{yu} is the arithmetic mean of the percentage of the sediment particle size greater than 0.05mm and 0.1mm in dam
 d_{yuan} is the arithmetic mean of the percentage of the sediment particle size greater than 0.05mm and 0.1mm in basin of Original loess

5 Conclusion

First, Jiuyuangou undisturbed soil particle size was mainly distributed in 0.025 ~ 0.05mm, the coarse silt is more than 5 times the fine silt, with standard features of loess; warping dams in sediment particle size mainly distributed in 0.031 ~ 0.05mm.

Second, At the end of the dam, there is little difference in the average particle size of silt in the dam drainage project dam and no drainage project dam. In front of the dam, dam separation effect is better than coarse sand dam drainage engineering for particles of size greater than 0.05mm without drainage engineering. The dam dam is better than vertical drainage drainage sorting horizontal coarse sediment particle size is greater than 0.05mm of the tube.

Third, the tanyanggou dam has certain sorting effect on the sediment with particle size ranging from 0.1mm to 0.025mm. The silted xiyangou goukou dam has certain sorting effect on the sediment with particle size from 0.1mm to 0.016mm.

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