CHARACTERIZATION OF SUBSIDENCE LAND RECLAIMED BY HYDRAULIC DREDGE PUMP IN CHINESE COAL MINES[1]

by

Zhenqi Hu, X.Y. Chen, Q.L. Li, J.L. Hu and Y.P. Ding[2]

Abstract With the excavation of coal from underground, the severe subsidence often results, which causes huge losses of cultivatable lands. In China, a simple but practical reclamation technique ---- Hydraulic Dredge Pump (HDP) is being used in subsidence land reclamation. But the characteristics of reclaimed land by this sort of technique has not been studied so far. This research was conducted on two field plots to ascertain whether soil amelioration treatments are necessary in the reclaimed land. Plot I was reclaimed land by using of the HDP method, Plot II was adjacent undamaged farmland. The main soil physical and chemical properties were tested for comparison between the two plots. The result showed that this sort of reclaimed land was reconstructed land which had higher clay content. Its surface was hardened and impervious. Cracks was found in the land. Moisture content of the reclaimed land was very high, which was about 1.5 to 2.5 times as much as that of farmland. The infiltration was much slower than that of farmland. But the bulk densities of the two plots were not tremendously different. The soil fertility analysis proved that the reclaimed land was poorer than that of farmland. Therefore, the soil amelioration treatments of the reclaimed land are needed for achieving reclamation success. Also, the reclamation process of the HDP technique was introduced in this paper.

Additional key words: soils, subsidence, reclamation technique, hydraulic dredge pump, soil properties, wetlands, underground coal mine

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[2]Zhenqi Hu is an assistant professor, Department of Mining Engineering, China University of Mining and Technology, Xuzhou, Jiangsu, P.R. China; X.Y. Chen is a senior engineer, Dept. of real estate management, Pingdingshan coal mine bureau, Pingdingshan, Henan; Q.L. Li, J.L. Hu and Y.P. Ding are the head of Land management office for suburban district of Pingdingshan city, 169 construction road, Pingdingshan, Henan, P.R. China

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Introduction

In China, 96% of the coal is produced by underground mines. The underground coal mining has caused a large amount of lands to subside, which has led to farmland losses and caused severe conflicts between farming and mining. According to statistics, the subsidence lands due to coal mining are more than 13,300 hectares each year. Half of this acreage is located in the plain area, which consits of prime farmlands (Sun and Li 1990). This situation makes the subsidence land reclamation become an urgent task for our country.

The HDP is a set of machines for earthwork, which includes a high-pressure pump, hydraulic giants (water syringes), a slurry pump, two electric machines, two float bowls, some steel and plastic pipes, etc. It is widely used in excavating fish ponds, dredging rivers or irrigation ditches, building river banks, etc. The basic principle of the reclamation method is that using the HDP machine, simulating the natural water erosion and turning the mechanical and electrical power into hydraulic power for digging, transporting and filling of soils (see Figure 1). The procedures are: (1) excavating soils by use of hydraulic giants with high-pressure and high speed water produced by high pressure pump, which makes the soils become slurry; (2) transporting the slurry to the subsidence trough to be filled through transportation pipes by use of the slurry pump; (3) leveling the reclaimed land by manual work or dozers. This method has many advantages such as: the equipment is simple, the cost is low, the operation efficiency is high and the operation is convenient and not affected by weather.

In the ccmprehensive treatments for subsidence lands due to coal mining, the method of reclaiming lands by Hydraulic Dredge Pump (HDP) called "digging deep to fill shallow" is being used in our country. This reclamation method destroys the original soil profile and results in the formation of a new rooting medium. The characteristics of land reclaimed by this technique have not been studied. This study characterized the reconstruct soils reclaimed by HDP so that the improving treatments for the new soil and the HDP method could be found.

Material and Methods

The experiment site is in the subsidence area of the 8th mine of Pingdingshan coal mine bureau, Pingdingshan, Henan province. The subsidence lands were about 31.3 hectares. Among these damaged land, 14.1 hectares were filled by water because of the high ground water level. The maximum subsidence depth was about 2.3m. At the end of October 1991, about 6.7 hectares of land were reclaimed by HDP method. No other treatments were done on the reclaimed lands. Soil samples were taken in April, 1992. And an adjacent undamaged farmland with wheat was also chosen for comparison.

The soil condition reclaimed by HDP will directly affect the reclamation effectiveness. This study described following properties of the reclaimed soil: (1) soil profile, (2) soil bulk density (3) soil porosity, (4) moisture content, (5) infiltration, (6) organic matter and some macronutrient contents.

Results and Discussion

Soil profile characterization

The excavated soil pits revealed that the reclaimed soil lacked topsoil and distinct horizontal layers. Instead, the reclaimed soil was a mixture of original topsoil and subsoil from adjacent area. It was easy to recognize that clay and moisture contents were very high, and the surface was the hardened and imperious soil. The thickness of the reclaimed soil was about 60-85cm. Underlying the reclaimed soil was the original soil profile. Undamaged farmland had an average of 15cm of topsoil and distinct

horizontal layers. The upper layer of the farmland soil was darker than the underlying layers as well as the reclaimed soil because of the accumulation of organic matter. The granular structure dominated the topsoil of farmland, while the platy and subangular blocky structure were noted in the reclaimed soil.

Soil bulk density and soil porosity

Table 1 shows the average bulk density and porosity of sampled soils. Due to the high clay contents of the reclaimed soil, the top soil was easy to be hardened. Thus, the bulk density at the depth of 0-20cm was larger than that of undamaged soil, and the porosity at the same depth was lower than that of undamaged soil. The underlying soil on reclaimed sites had similar bulk density and porosity to the undamaged soil. The values of bulk density and porosity of the reclaimed soil were not extreme enough to severely restrict plant growth.

Soil moisture content

The soil moisture content is the important factor affecting the plant growth. Numerous other soil properties depend very strongly upon moisture content (Hillel 1982). The results listed in table 1 showed that the moisture content of the reclaimed soil was very high, which was about 1.5 to 2.5 times as much as that of farmland. Thus, the moisture content was the main factor restricting plant growth in the reclaimed soil. The high moisture content mainly came from the high clay content of the soil and the HDP method itself. Therefore, the drainage for the superfluous water in the reclaimed soil is the key to making the reclamation successful. And, the establishment of drainage system should be one of procedures of the HDP operation.

Infiltration

As the reclaimed soil had high moisture content and clay content, the infiltration should be lower than that of farmland. The tested results by single ring method (see Figure 2) revealed that the infiltration rate at the one hour point of the farmland was about 6 times as much as that of the reclaimed soil, which were 0.0033cm/sec and 0.0006 cm/sec respectively. The result might lead to the severe erosion and nutrient losses in the reclaimed soil.

Organic matter and other nutrients

The Organic Matter content (OM) is one of the important fertility factors. Reclaimed soil had much lower organic matter content than farmland soils (see Figure 3). The distribution of organic matter content along the vertical soil profile was also different between the two kinds of lands: the upper layer (0-20cm) of the farmland soil had higher OM content than the underlying layer (20-40cm), which is the typical characteristics of agricultural soil; but in the reclaimed soil the upper layer (0-20cm) had similar OM content to the underlying layer (20-40cm), some time the upper layer had lower OM content than the underlying layer. The difference in the distribution of OM content revealed that the HDP reclamation method led to the mixture of original soil layers, and some time the original underlying layer was covered on the the original upper layer. Therefore, the poor characteristics was produced by the HDP method itself. Some improvements for the HDP method are needed.

Soil nutrient levels for the soil samples as shown in table 2. The reclaimed soil had quite lower contents of total nitrogen, total phosphorous and rapidly available nitrogen than the farmland soil. The contents of rapidly available phosphorous and potassium of the reclaimed soil were also lower than that of the farmland soil. Thus the reclaimed soil had much lower comprehensive fertility than that of farmland soil. The amelioration treatments of the reclaimed soil are

necessary.

Conclusion

Based on the findings of this research, the following conclusions can be made.

1. The soil profile examination showed that the reclaimed soil by use of HDP resulted in a massive structure soil, which was the mixture of original topsoil and subsoil, and had high clay content and no district horizontal layers.

2. The analysis of soil physical properties of the reclaimed soil indicated that the bulk density and porosity were nearly ideal for plant growth. However, the moisture characteristics of the reclaimed soil was the most severe factor restricting plant growth because of the high moisture content (almost close to saturate) and slow infiltration. Therefore, the establishment of drainage system is the key to making the reclamation successful and should be one of procedures of the HDP operation.

3. The soil fertility assessment indicated that the reclaimed soil was very poor, and the amelioration treatments are necessary.

4. Although the HDP reclamation technique is a practical method for subsidence land reclamation in China, it produces a very poor soil. Thus, the improvements of the technique itself are needed, especially the replacement of topsoil should be one of procedures of the HDP operation.

Reference

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Table 1. The results of soil bulk density, porosity and moisture content

type of soil	depth (cm) 0-20	20-40	40-60	60-80
	Bulk density (g/cm^3)			
undamaged	1.16	1.55	1.56	1.49
reclaimed	1.32	1.46	1.49	1.37
	Porosity (%)			
undamaged	56.2	41.5	41.1	43.8
reclaimed	50.2	44.9	43.8	48.3
	Moisture content (%)			
undamaged	13.8	14.0	15.5	14.3
reclaimed	26.3	35.5	38.4	31.3

Table 2. Some macronutrient contents

type of soil	depth (cm)	total N (%)	total P (%)	apidly available nutrients N (ppm)	P (ppm)	K (ppm)
farmland	0-20	0.107	0.167	87	14.1	112.5
	20-40	0.066	0.130	47	3.7	95
reclaimed	0-20	0.042	0.091	25	2.7	97.5
	20-40	0.042	0.098	27	1.4	95

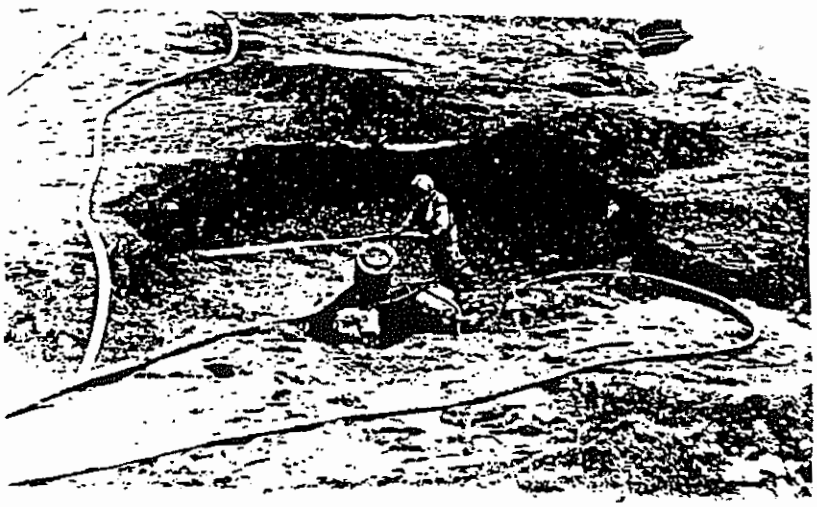

Figure1. The reclamation operation by use of the hydraulic dredge pump in Chinese subsidence trough

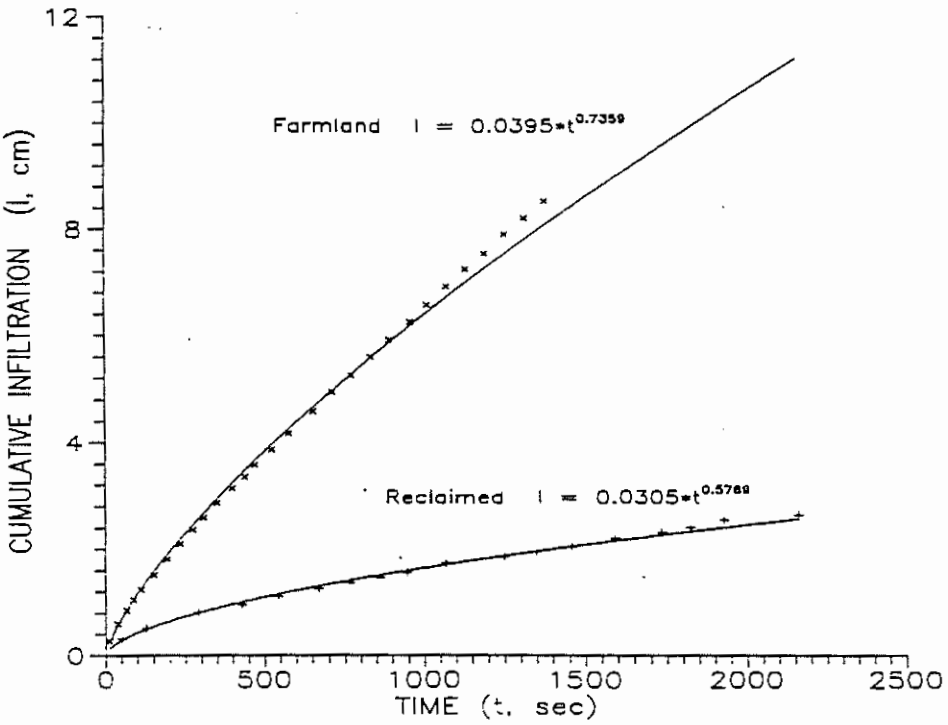

Figure 2. Comparison of infiltration between farmland soil and reclaimed soil

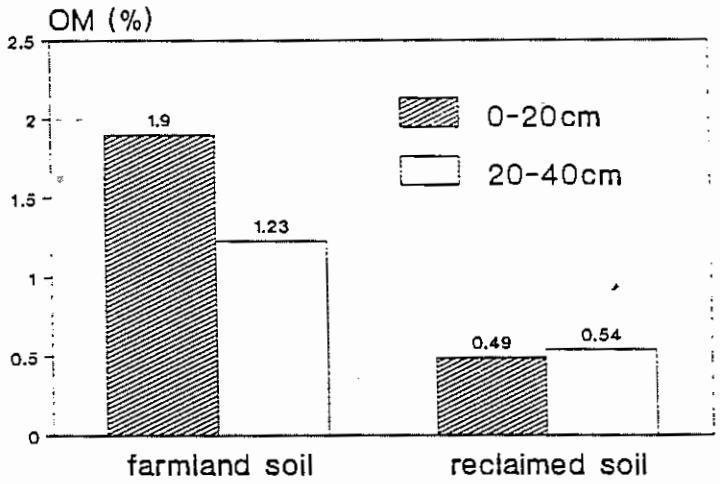

Figure 3. Organic matter content