Applying of soft rock to control Mu Us sandland: A case study of Yulin City

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Abstract. In order to alleviate the contradiction between people and land, improve the quality of cultivated land and the ecological environment of the land, this paper studied the sand-fixing characteristics of soft rock by indoor experiments and promoted the field. The results showed that the complementarity of the soft rock and sand in the particle size composition, the two had mixed with the composite soil to form a good particle size distribution, increased the grain roughness, and had a sand-fixing effect, improved the porosity of the sand at the same time. The increasing of the content of clay increased the water retention and water retention of the sand and reduced wind erosion. Based on this sand-fixing mechanism, the practical application of arsenic sand-fixing in Daji Khan Village, Yuyang District, Yulin City had been carried out by means of soil-body reconstruction project of soft rock and sand, water, road and forest supporting projects, and the control effect is remarkable.

1. Introduction
As of 2014, China's desertified land area was 2,611.6 million km², accounting for 27.20% of the total land area, of which the wind-eroded desertified land area was 1,286,300 km², accounting for 69.93% of the total desertification land in the country [1]. In December 2015, the State Forestry Administration announced the fifth "China Gazette on Desertification and Desertification", saying, "Land desertification and desertification are the most serious ecological problems in China." The 13th Conference of the Parties to the United Nations Convention to Combat Desertification adopted the Ordos Declaration, which recognizes that desertification, land degradation and drought are major challenges to global sustainable development and can cause and exacerbate environmental, economic and social problems, such as Poverty, poor health, lack of food security, loss of biodiversity, lack of water, reduced ability to withstand climate change, and forced migration. According to the IPCC Fifth Assessment Report, extreme weather events such as drought, floods and abnormal high temperatures have occurred frequently in the past decade, and the safety of human living environment is being challenged [2]. Therefore, ensuring the sustainability of ecosystem functions and services and desertification control are critical to food security and sustainable development [3]. This paper analyzed the key sand-forming factors in the Mu Us Sand land, and used the widely existing soft rock to fix the sand, and the technology was practiced to provide a feasible method for the ecological improvement of the sand and promote the scientific and technological progress in the field of land remediation.
2. Project area overview

The project area is located in Daji Khan Village, Xiaoji Khan Township, Yuyang District, Yulin City. Yuyang District (E109°28′58″-109°30′10″, N38°27′53″-38°28′23″) is located in the northwestern part of Shaanxi, between 1206-1215m above sea level, on the southern edge of the Mu Us Desert, uncertain In the middle of the river. It is a typical mid-temperate semi-arid continental monsoon climate zone with uneven spatial and temporal precipitation, dry climate, short winter and summer, four distinct seasons, abundant sunshine, windy and dry in spring, and cool and humid in autumn. The annual average temperature is 8.1 °C, the accumulated temperature of ≥10 °C is 3307.5 °C and the duration is 168d. The annual average frost-free period is 154 days, the annual average precipitation is 413.9mm, and the 60.9% rainfall is concentrated in 7-9 months. The annual maximum rainfall is 695.4mm, the smallest is 159.6mm; the maximum daily precipitation is 141.7mm. The average annual sunshine hours are 2879h, and the percentage of sunshine is 65%. The total annual radiation is 145.2 kcal/cm² [4].

3. Soft rock sand fixation key factor

3.1. Soft rock and sand structure complementary

The strontium soft rock is a rock interbedded layer composed of soft rock, sand shale and argillaceous soft rock, widely distributed in the Mu Us sandy land. It has low diagenesis, high degree of weathering and high content of secondary minerals (montmorillonite and illite) [5], the particle size distribution range is 0.317-709.0μm, the sand, silt and clay content are 19.57%, 72.94% and 7.49%, respectively. The particle size is mainly concentrated in the finer sticky particles, the venting pores are less. 7.84%. The sand-sand soil has no structure, the particle size distribution ranges from 0.564 to 2000.0 μm, and the sand, powder and clay content are 91.39%, 5.51% and 3.10%, respectively. The particle size is mainly concentrated in the coarse sand segment, and the venting pores are larger. It is 26.50% (Table 1). It can be seen that the particle size composition of the two has obvious complementarity. After the soft rock is crushed into a certain particle size and mechanically mixed with sand, the defects of the particle size composition of the two materials are changed, the particle size composition range is enlarged, the texture is improved, and a good structure is formed, and the complex formation is formed. With soil, the aggregate content increased by 9.84%. Li Yurui et al. studied the sand-fixing effect and microscopic mechanism of the soft rock and sand compound farmland. It was found that the introduction of the silt and clay enhanced the interaction between the soil particles and bonded with the sand to improve the sandy soil. The agglomeration characteristics form a soil structure with certain stability [6].

| Table 1 Comparison of soft rock and sand properties |
|-----------------------------------------------------|
| Soil type                                                | Soft rock | Sandy soil |
| Particle size ratio (%)                                  |           |            |
| Sand                                                  | 19.57     | 91.39      |
| Silt                                                  | 72.94     | 5.51       |
| Clay                                                  | 7.49      | 3.10       |
| Texture                                                | Sandy loam soil | Sand |
| Structure                                              | Granular massive layered | No structure |
| Capillary porosity (%)                                  | 44.94     | 26.33      |
| Density degree                                        | Close together | Loose |
| Saturated hydraulic conductivity (mm min⁻¹)             | 0.07      | 7.10       |

3.2. Soft rock and sand holding water retention characteristics

The water absorption, water storage and water retention properties of the soil are the key factors for improving the ecological environment and preventing wind and sand. The soft rock is loosely cemented when it is dry, and it expands rapidly when it meets water. It has good water retention and
water retention. Sandy soil has good water permeability under dry and wet conditions, and water retention is poor. It can be seen from Table 3.1 that the porosity of the soft rock capillary is 44.94%. Although the porosity is very high, due to the high proportion of fine particles in the grain size distribution of the soft rock, the intergranular pores are small, and the saturated hydraulic conductivity is very small, only 0.07mm Min⁻¹, so the ventilation and water permeability is poor. However, due to the large intergranular pores of sand, the porosity of the capillary is low, only 26.33%, the capillary action is weak, the water retention is poor, the saturated hydraulic conductivity is as high as 7.10 mm min⁻¹, and the venting permeability is strong. Therefore, the soft rock and sand are mixed in different proportions to form a compound soil, and the different proportions (0:1, 1:5, 1:2, 1:1, 2:1, 5:1, 1:0) are obtained. The water characteristic curves of soft rock and sand compound soil were studied. It was found that the effective water variation range in the compound soil ranged from 3.17% to 8.37%, which showed an increasing trend with the increase of soft rock content (Fig. 1). It indicates that the soft rock and sand have good water retention performance after mixing, and the effective water increases with the increase of the content of the soft rock. The soft rock plays a role of “small reservoir” in the sand. Zhang Xingchang et al. studied the water absorption and water retention results of an appropriate amount of soft rock improved aeolian sandy soil [7].

![Fig. 1 Curve of soil moisture characteristics of different proportions](image)

4. Engineering practice

4.1. Land leveling project

Before the development of the project area, there is high and low undulating sand with a relative height difference of more than 20m. Land leveling mainly adopts the method of track bulldozer bulldozing leveling. At the same time, according to the location of fields and roads, the line is laid out. The center line of roads is laid out. The side line of roadbed and the footline of slope of field slope are laid out to control the position around the fields. Then, according to the earthwork drawing, the balance line of excavation and filling is designed and marked, and each small field is used as a construction unit. Bulldozer is used to push the sand dunes in the field to design elevation. According to the topography, the slope of the long side of the field is controlled within 2‰, and the slope of the broad side is controlled within 5‰. A total of 1,438,300 m³ of earthwork is moved to form 28 regular rectangular fields, 85 acres of a single field. The land flatness and slope of the plots all meet the relevant technical requirements for uniform irrigation [8].
4.2. Soil Reconstruction Engineering
After the completion of the land leveling project, the soft rock and sand cementation works were carried out. Firstly, 152,200 m³ of soft rock was transported from outside the project area to cover evenly on the flattened field. Secondly, the project area was sampled and examined. The thickness of the plough layer of soft rock reached 10 cm on average, and the mechanical matching artificial soft rock was used. The crushing is carried out to ensure that the size of the soft rock block is 2-4cm; again, the rotary sander is used to mix the soft rock and the sand to ensure uniform mixing; finally, the soil-forming particles are effective under physical, biological and farming conditions, cemented to form a good agglomerate structure.

4.3. Supporting engineering
4.3.1. Irrigation Engineering. According to the hydrogeological structure of the project area, the location, shape and area of the affected or temporarily occupied land parcels, combined with the actual local irrigation conditions, the habits of the people pouring land, and the relevant standards of irrigation technology, the technicians will be surveyed to determine the new drilling wells. Location, quantity, 17 new eyes of agricultural machinery wells in the entire demonstration project.

4.3.2. Power Engineering. The power distribution room foundation is treated by the method of sedimentation of raw sand water. The masonry is brick-concrete structure, the roof is prefabricated floor, and the prefabricated floor is hoisted with 1t electric hoist. The construction of the power grid project will be carried out after the completion of the land leveling, and actively cooperate with the power department, and carry out the whole construction according to the requirements of the power department regulations, regulations, standards and construction specifications. The entire demonstration project erected 2569m of 10kV line, buried 12389m of 0.4kV line, and installed 2 sets of 160kVA transformer.

4.3.3. Road Engineering. Road subgrade construction is combined with the construction of field. When field is leveled, the subgrade soil should be compacted when the road foundation is filled. When the subgrade is the excavation section, the compaction thickness of the subgrade is 0.3m. The production roadbed can be laminated without any layering, and only after the surface of the road surface is flattened, the surface of the roadbed after rolling should be flush with the surface of the field. The road construction of this project shall be carried out according to the “Technical Regulations for the Construction of the Subgrade of the Yulin-Jingbian Expressway Sand Area”. The road is graded and built with 890 m road connecting roads, 2 14212 m main roads (gravel pavement), 5 19134 m roads (gravel pavement), and 9 4800 m production roads (soil roads).

4.3.4. Forest Network Engineering. The entire demonstration project was planted along the periphery of the project area and on both sides of the main road to plant poplar, cutting head and sand willow. The selection of the trees is the standardized seedling base, with the use, timely forestation. The tree of is select the material nearby and plant it at the right time. After the implementation of the project, the management of the seedlings will be carried out by a special person. After the planting, the water will be watered twice a month. When the drought is over, the number of watering will be increased in a timely manner.

Fig.2 Rehabilitation effect chart
5. Conclusion
Facing the major problems of sand development and utilization in ecological management, combined with the widely distributed soft rock in Mu Us Sandland, using the complementary characteristics of soft rock and sand, it is found that the combination of the two has the effect of wind and sand fixation, forming a reconstructed soil. After the land consolidation project, this reconstructed soil has been effectively applied. As of November 2017, the use of this technology has cumulatively added 100,000 mu of cultivated land in Yuyang District, Yulin City, Shaanxi Province, bringing significant economic benefits to the local area. The comprehensive benefits of society and ecology have effectively solved the balance of cultivated land occupation and compensation in Shaanxi Province.

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