Design of wound vegetation restoration measures for upper and lower reservoir connecting road project of pumped storage power station in northwest cold and arid regions

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Abstract: Taking a pumped storage power station in the northwest cold and arid regions as an example, this paper summarizes the construction technology and method of wound vegetation restoration in the upper and lower reservoir connecting road project of pumped storage power station in the northwest cold and arid regions, as well as the system of measures including the selection of suitable plants, the design of soil covering engineering, the design of plant measures and the construction technology. The soil covering engineering and plant measures were designed according to different wound types. The soil preparation of the Yurian pit and the ridge outside the pit were constructed with planting bags, arbor and shrubs were planted inside the pit, Picea asperata Mast. was selected for arbor and Juniperus sabina L. for shrubs, and forest vegetation blanket was used on the upper slope with a gentle slope, and shrubs and grass seeds were mainly planted with Poa annua L., Stipa capillata L. and Artemisia frigida Willd. The above vegetation restoration measures were designed. It greatly reduces soil and water loss in the reservoir area, improves vegetation coverage in the reservoir area, and enriches plant diversity, making the wound surface of the upper and lower reservoir connecting road of pumped storage power station gradually restore to the natural environment plant community state before the destruction.

1. Introduction

Water conservancy and hydropower project is a comprehensive development project, the construction of water conservancy and hydropower project often has a serious impact on the natural ecological environment in the construction area, especially the local vegetation. In the process of construction, ecosystem degradation and frequent soil and water loss may occur in the construction area, which will endanger the sustainable development of the region [1]. Pumped storage power station is the inevitable product of the development of the industry to a certain stage, and its safety, flexibility, adaptability and economy are getting higher and higher [2]. Pumped storage power station is developing rapidly across the country [3]. Pumped storage power station has a large disturbance surface, trees are cut down, grasslands are destroyed, and a large number of exposed slopes are formed [4]. Vegetation restoration is the most important part in the ecological restoration of engineering wound surface [5]. Vegetation restoration is the use of self-recovery ability supplemented by artificial measures to improve and beautify the damaged engineering wounds [6].

The excavation of land occupied by the power station and wound surface will directly cause damage to vegetation and other biological resources, destroy native vegetation, aggravate soil erosion, reduce the living environment of animals and plants, and endanger the normal ecological system. It is very difficult to restore the vegetation of the formed project wound, which has a serious impact on the ecological environment of the project area [7]. Vegetation restoration can improve soil physical properties and increase soil microbial biomass and activity through the effects of plant underground roots and litter [8].

2. Overview of the study area

The project area is located in Zhongshan Canyon area, which has a typical temperate continental climate. The average annual temperature of the project is 6.3 °C, the extreme maximum temperature is 41.5 °C, and the extreme minimum temperature is -37.0 °C. ≥ 10°C active accumulated temperature 3574.6 °C; The annual average evaporation was 1419.6 mm. The average annual precipitation is 265.1 mm, and the average annual relative humidity is 61%. Such climatic conditions are suitable for drought-tolerant and cold-tolerant plant species. With the increase of altitude, the regional soil has a more obvious vertical distribution. The construction area of Fukang pumped storage Power Station project is located at an altitude of 1540 ~ 2400m, and the soil types are mainly gray brown forest soil and mountain meadow grassland soil. Soil organic matter content is higher, which is conducive to the growth of shrub and grass vegetation.
The soil in the slope management area is poor, and the soil consists of diluvial and landslide aggregates, gravel and soil, and part of the surface contains plant root soil. After the slope vegetation is disturbed and destroyed, the soil grass cover (sod) for vegetation growth for a long time is either completely destroyed, the bedrock is exposed, or the stone slag is buried, which directly restricts the process of vegetation restoration and succession.

Affected by topography, soil, elevation and rainfall, there are spruce forests in the upper reservoir area of the project, the shrubs are mainly Xinjiang juniper, and the vegetation coverage is about 60%. In the lower reservoir area, the main shrub is Xinjiang cedar, scattered spruce, poplar and other trees, and the vegetation coverage is about 50%.

3. Project wound surface distribution

The construction of the upper and lower storage connecting road of pumped storage power station requires a large amount of excavation along the slope, which forms a large number of excavation faces, and the excavation slag falls to the lower side slope of the embankment, which covers and encroaches on the grassland and destroys the grassland ecosystem on the hillside. The soil quality of the slope is mainly gravel and rock. A total of 26 slope control points are designed for vegetation restoration. Through reasonable selection of suitable plants and vegetation restoration technology, the ecological environment of the control area and the surrounding ecological environment can be coordinated, The summary table of governance points is as Table 1.

<table>
<thead>
<tr>
<th>Slope number</th>
<th>Stake mark</th>
<th>Floor space (ha)</th>
<th>Original land use type</th>
<th>Altitude (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>K0+426</td>
<td>0.37</td>
<td>Bushland</td>
<td>1692</td>
</tr>
<tr>
<td>2</td>
<td>K3+825</td>
<td>0.85</td>
<td>Forest land</td>
<td>1817</td>
</tr>
<tr>
<td>3</td>
<td>K3+749</td>
<td>0.42</td>
<td>Forest land</td>
<td>1836</td>
</tr>
<tr>
<td>4</td>
<td>K3+678</td>
<td>0.17</td>
<td>Forest land</td>
<td>1847</td>
</tr>
<tr>
<td>5</td>
<td>K3+460</td>
<td>0.65</td>
<td>Forest land</td>
<td>1820</td>
</tr>
<tr>
<td>6</td>
<td>K3+368</td>
<td>0.22</td>
<td>Grass land</td>
<td>1918</td>
</tr>
<tr>
<td>7</td>
<td>K4+915</td>
<td>0.31</td>
<td>Forest land</td>
<td>1892</td>
</tr>
<tr>
<td>8</td>
<td>K4+832</td>
<td>0.24</td>
<td>Bushland</td>
<td>1890</td>
</tr>
<tr>
<td>9</td>
<td>K6+709</td>
<td>0.08</td>
<td>Bushland</td>
<td>1995</td>
</tr>
<tr>
<td>10</td>
<td>K7+554</td>
<td>0.94</td>
<td>Bushland+Grass land</td>
<td>2021</td>
</tr>
<tr>
<td>11</td>
<td>K9+025</td>
<td>0.54</td>
<td>Forest land</td>
<td>2103</td>
</tr>
<tr>
<td>12</td>
<td>K9+150</td>
<td>1.36</td>
<td>Forest land</td>
<td>2125</td>
</tr>
<tr>
<td>13</td>
<td>K9+352</td>
<td>0.69</td>
<td>Bushland</td>
<td>2104</td>
</tr>
<tr>
<td>14</td>
<td>K9+480</td>
<td>1.09</td>
<td>Bushland</td>
<td>2135</td>
</tr>
<tr>
<td>15</td>
<td>K2+872</td>
<td>0.25</td>
<td>Bushland+Grass land</td>
<td>1809</td>
</tr>
<tr>
<td>16</td>
<td>K4+511</td>
<td>0.65</td>
<td>Forest land</td>
<td>1864</td>
</tr>
<tr>
<td>17</td>
<td>5#Road</td>
<td>0.50</td>
<td>Forest land+Grass land</td>
<td>1918</td>
</tr>
<tr>
<td>18</td>
<td>6#Road</td>
<td>0.09</td>
<td>Forest land</td>
<td>1920</td>
</tr>
<tr>
<td>19</td>
<td>6#Road</td>
<td>0.28</td>
<td>Forest land</td>
<td>1897</td>
</tr>
</tbody>
</table>

4. Design requirements

The excavation of the road connecting the upper and lower storehouses of pumped storage power station leads to the decrease of vegetation coverage, soil quality and ecological environment. The design should be based on the natural conditions along the connecting road, ecological environment and other conditions reasonable design, at the same time to meet the principles of suitable for trees, multi-level greening, and coordination with the surrounding environment, to form a unified and perfect landscape.

5. Key techniques of slope vegetation restoration

5.1. Selection of suitable plants

Reasonable selection and allocation of plants is one of the preconditions for the development of community in the direction of positive succession [9]. Different plants have different genetic characteristics, and their adaptability to environmental conditions is different [10-11]. Rational utilization of suitable plants is the most critical factor in the process of slope vegetation restoration. Selecting suitable plants is the key to successfully restoring slope ecosystems and ensuring the long-term effectiveness of plant communities [12]. Therefore, in the process of suitable plant selection, the principles of suitable place and tree, species diversity, native species priority and importance to the status and role of species in community succession should be followed. Grasses such as bluegrass, stipa, Artemisia were reasonably selected, the ratio was 4:4:2, the dosage was 30g/m²; Bush, rosebud, Spiraea chinensis, 36 plants /m²; Spruce, golden elm, birch and other trees.

5.2. Slope finishing and soil covering engineering design

Slope land consolidation and cover soil mainly include site leveling and restoration planting soil. Among them, the site leveling is the whole land preparation in the area of sowing grass seeds, and the land preparation in the area of planting shrubs is fish scale pit. The return planting soil thickness is 10 cm. When the engineering wound is located on the upper slope, forest vegetation blanket is used to treat the slope. The specific engineering design is shown in Table 2.
<table>
<thead>
<tr>
<th>Serial number</th>
<th>Slope number</th>
<th>Land regulation</th>
<th>Soil covering works</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1#, 3#, 4#, 5#, 6#, 7#, 8#, 9#, 10#, 12#, 13#, 14#, 15#, 16#, 17#, 18#, 19#, 20#, 23#, 24#</td>
<td>The area of seeding grass seed is fully prepared, and the area of planting shrubs is fish scale pit prepared</td>
<td>The average thickness of soil cover is 10 cm according to the elevation of the original landform. Soil improvement should be carried out during soil cover to facilitate the growth of vegetation.</td>
</tr>
<tr>
<td>2</td>
<td>21#, 22#, 25#</td>
<td>In the area of seeding grass seeds, the area of planting shrubs is prepared by the fishscale pit, and the slope foot of the fishscale pit should be anchored by steel when the planting bag is constructed outside the preparation</td>
<td>The average thickness of soil cover is 10 cm according to the elevation of the original landform. Soil improvement should be carried out during soil cover to facilitate the growth of vegetation.</td>
</tr>
<tr>
<td>3</td>
<td>2#, 11#, 26#</td>
<td>The forest vegetation blanket is used to treat the upper slope surface. A trench with a width and height of 20×30 cm is dug at the top of the slope surface 20 cm from the edge of the slope, and one end of the forest blanket is buried in the trench at the top of the slope, and then the soil is compacted and then rolled from top to bottom.</td>
<td></td>
</tr>
</tbody>
</table>

5.3. Design of plant measures

The design of plant measures follows the principle of "restoring grassland to grassland, woodland to woodland, combining engineering measures with plant measures".

5.3.1. Lower slope

The slope is prepared by the fishscale pit (the ridge outside the fishscale pit is constructed with planting bags), shrubs are planted, and grass seeds are mixed in the planting bags to restore vegetation. The shrubs were selected according to the site conditions of the project area. Earth ball seedlings were selected for juniper Cypress in Tianshan Mountains, and the crown width was 60 ~ 80cm. The fish scale pits are arranged in the shape of "goods", the spacing of the rows is 2×3m, the specifications are 0.8m long diameter, 0.5m short diameter, and 0.5m deep pit. The small fish scale pit is shown in Figure 1.

5.3.2. Lower slope

The slope is prepared by the fishscale pit (the ridge outside the fishscale pit is constructed with planting bags), trees are planted, and grass seeds are mixed in the planting bags to restore vegetation. The tree species were selected according to the site conditions of the project area, and the soil ball seedlings were selected for spruce; Fully lignified, no drying phenomenon; The seedling height is 80 ~ 100cm. The fish scale pits are arranged in the shape of "goods", the spacing of the rows is 2×4m, the specifications are 1.0m long diameter, 0.6m short diameter, and 0.6m deep pit. The large fish scale pit is shown in Figure 2.

5.3.3. Upper side slope

The forest vegetation blanket is used, and the forest blanket is tightly combined with the slope with anchors. The 10 cm long kid is cut out on the blanket, deep to the bottom. Plant the shrub between the bottom layer and the growth layer, the anchor spacing is 1×1 m, and the bottom layer of the adjacent two rolls of blankets is overlapped by 15 cm at the overlap, which should also be fixed with anchors. The shrubs were selected according to the site conditions of the project area. Planting method: 3 holes per square meter, plum blossom arrangement, 3 plants per hole, an average of 9 plants /m². The ratio of bluegrass, stipa and Artemisia cold was 4:4:2, and the seed amount was 30g/m². The forest vegetation blanket is shown in Figure 3.
6. Implementation and effect analysis

6.1. Construction Technology

The implementation process of wound vegetation restoration of upper and lower reservoir connecting road project mainly includes the following key technical processes: land preparation, base fertilizer application, fish scale pit land preparation, planting engineering and maintenance engineering.

6.1.1. Land preparation

The planting soil is required to use loam or sandy loam, and the clay or sandy soil should be improved to meet the particle composition standard of loam or sandy loam. The planting soil layer must be connected with the underground soil layer to keep the soil capillary through the upper and lower, to keep the water and air connected up and down, and the thickness of the soil layer required for planting shrubs and trees is 40 cm and 50 cm.

6.1.2. Spread base fertilizer

Spread cattle and sheep manure and add 300kg/mu granular bactericide for pile retting. The dosage should be controlled at about 10cm. After fertilization, ploughing should be carried out once about 30cm deep, so that the fertilizer and soil are fully mixed, so that the fertilizer and soil are integrated.

6.1.3. Fish scale pit preparation

The fish scale pit is arranged in a "quality" font. The size of the large fish scale pit is 1.0m in length, 0.6m in short diameter, and 0.6m in depth. The size of the small fish scale pit is 0.8m in length, 0.5m in short diameter, and 0.5m in depth. In addition, the fish scale pit should be "three light and one hard" (after cutting slope light, table light, front light, ridge along the hard), with planting bag encircling code solid.

6.1.4. Planting engineering

Before planting, it is necessary to check the size and depth of the foundation pit and the size of the soil ball, and then first put the topsoil at the bottom of the pit, the loose thickness of about 15cm, and then sow the appropriate amount of organic fertilizer. Cover the fertilizer with 5~10cm of topsoil so that the roots do not touch the fertilizer. Then the bare root plant is placed in the center of the tree pit, and the soil around and above the tree pit is backfilled and then tamped down and pressed tightly. When the backfilling reaches half the depth of the root system, the plant is lifted slightly to make the seedling roots stretch, and after stepping firmly, the remaining soil is filled and then stepped again.

6.1.5. Maintenance engineering

Regular irrigation and fertilization, weed removal, pest control, garbage removal, topsoil protection.

6.2. Construction of forest vegetation blanket

6.2.1. Clean the site and level the slope

The slope should be cleaned to remove stones with unstable foundations to prevent falling rocks from endangering the safety of labor and equipment in the subsequent construction process. The undulating areas should be slightly leveled, and the areas with large pits on the slope should be repaired.

6.2.2. Laying forest blanket and anchorage

Dig a trench 20cm wide and 20cm high from the top of the slope, bury one end of the forest blanket into the trench at the top of the slope, compact the soil, and then roll it from top to bottom. The distance between the anchors is 100cm×100cm. There is a overlap of 15cm at the bottom of the overlap between the two adjacent rolls of blankets, which should also be fixed with anchors. If the slope is uneven, it is necessary to add one or more small anchors at the lowest place to ensure that the forest blanket is tightly integrated with the slope.

6.2.3. Plant trees and shrubs

Cut a 10cm slit in the blanket, deep above the bottom layer. The trees and shrubs were planted between the bottom layer and the growing layer, and the planting density was 9 plants/m².

6.3. Effect of vegetation restoration

Due to the special area of the project and the long cold season, the vegetation restoration construction period will be carried out from May to June. Generally, seeds will germinate from 7 to 15 days after the completion of the construction, and the maintenance period will be 50 days. Sprinkler irrigation water is used to keep the soil moist, promote the germination and rapid growth of plant seeds, and improve the vegetation coverage of the project wound surface. Two months after the completion of the construction, the vegetation coverage of the slope reached more than 75%, forming a stable community structure.

7. Discussion and Conclusion

Surface vegetation is an important part of the ecosystem. Once it is destroyed, vegetation, as a medium of energy and material circulation, will naturally fail to develop the energy and material circulation of the ecosystem normally. In recent years, pumped storage power stations have developed rapidly. During the construction of hydropower stations, vegetation protection issues have not been well managed, vegetation ecological issues have not received
due attention, and even have been directly ignored by hydropower station contractors. Vegetation restoration in hydropower project areas plays a crucial role in the surrounding environment, such as: The vegetation ecological restoration carried out in Xiaolangdi in 1995 was very successful and played an effective role in improving the ecological environment around the project area [13].

The construction of large-scale water conservancy and hydropower projects has a large disturbance area and a long construction period, which will inevitably lead to a large amount of vegetation destruction, aggravated soil erosion and deterioration of the ecological environment [14], especially in the northwest cold and arid regions, where the ecological environment is fragile. The design of vegetation restoration measures is related to the improvement of the ecological environment in the construction area [15]. The wound vegetation restoration design of the upper and lower reservoir connecting road project of the hydropower station puts forward the classification of engineering wounds, the selection of suitable plants, the design of plant measures, the construction and effect analysis, and verifies the feasibility of the restoration technical system through continuous practice on the site. In order to provide a reference basis for the vegetation restoration of engineering wound in similar areas.

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