Research on key technology of soil erosion control of transmission line project in Hilly Area

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Abstract. Transmission line engineering is characterized by long distance, scattered disturbance, great difference in natural conditions, various types and intensity of soil and water loss. The design of soil and water conservation measures is the key to the layout of soil and water conservation measures for transmission lines in hilly areas. This paper mainly discusses the land consolidation and slope protection technology. In order to provide reference for the typical design of soil and water conservation measures of power transmission and transformation project in hilly area.

1. Introduction
China has a large area of soil erosion, and it is one of the countries with the most serious soil erosion in the world. According to the results of the national soil erosion dynamic monitoring, the national soil erosion area was 2,736,900 km\(^2\) in 2018, accounting for 28.6\% of the country's land area (excluding Hong Kong, Macao and Taiwan). The problem of soil erosion is still very prominent. Soil and water loss in production and construction projects is an important aspect of soil and water loss in my country. The soil and water loss has the potential and the intensity has jumps. The types of soil and water loss are diverse. The soil and water loss has obvious geographical expansion and incompleteness, and it is expressed in space. The problem of soil erosion in long-distance production and construction projects is particularly prominent, and power transmission and transformation projects are a typical representative of long-distance projects in our production and construction projects.

Transmission and transformation projects generally have long distance and large spans, involving different soil types, different slope conditions, different vegetation types, and different climatic conditions, and their soil erosion is distributed in regular scattered points. Due to the undulating terrain of power transmission and transformation projects in hilly areas, surface soil structure and vegetation are easily destroyed during the foundation excavation process of the tower foundation, and the slope of the original slope is also easily changed, which is bound to cause serious water erosion and gravity erosion. If the excavation produced by the excavation is improperly disposed, it is easy to form long slope slag, which is very difficult to control, and will cause great damage to the ecological environment.
2. Characteristics and problems of soil erosion
The water and soil loss of the power transmission line project is distributed in scattered points, with the characteristics of large spatial span, scattered disturbance points, and diversified types of landforms and soil erosion types in the project area. The project also has the characteristics of short duration, low overall soil erosion intensity but strong local spot-like soil erosion. Under the conditions of different construction stages, different prevention zones, and different types of soil and water conservation, the intensity of soil erosion varies greatly. The main characteristics of water and soil loss of power transmission and transformation projects in hilly areas are: First, The construction work surface of the pole and tower is greatly affected by the terrain. In case of heavy rain, the construction work surface is prone to soil loss and long gullies are formed. Second, The upper and lower slopes of the construction access road are exposed, and the lower slope is prone to slipping, and the upper slope is prone to form a steep slope. The third, The construction of the pole and tower foundation will partially reshape the micro-topography conditions and change the flow direction of the regional water collection. Under heavy rain conditions, the slope water collection is prone to form super-permeable flow and transport sediments to form a cut trench.

The main water and soil erosion problems in the construction of power transmission and transformation projects in hilly areas are: First, in construction areas such as slope-type tower foundations and temporary road slopes for ditch construction, the phenomenon of slag slipping along the slope is common during the construction process, and the harm of water and soil loss is obvious and the treatment is difficult. Second, the same project has a large geographic span, with obvious differences in conditions such as topography, soil and precipitation in different regions. The existing design of water and soil conservation measures lacks pertinence, and the effect of soil erosion prevention and control is lagging behind. The third is that the construction period of a single construction site is short during the construction process, and the temporary measures for water and soil conservation during the construction process are not in place, and the water and soil loss caused by the construction process cannot be controlled in time. Fourth, after the completion of the construction, the loose piled soil area is not repaired and protected in place, there is an exposed slope, and there is a gully phenomenon. Fifth, the construction site has not been thoroughly cleaned, loosened and renovated, resulting in surface compaction and erosion of low-lying surrounding areas caused by rainfall.

3. Key technologies of soil erosion control
Water and soil erosion prevention and control technologies for production and construction projects mainly include topsoil stripping and reclamation technologies, slope prevention technologies, interception and drainage technologies, residual soil barrier technologies, land remediation technologies, vegetation restoration technologies, and temporary protection technologies. According to the characteristics of power transmission and transformation projects in mountainous areas, this paper has carried out key research on land remediation technology and slope prevention technology.

3.1. Land remediation technology
Land remediation includes land remediation on the surface of temporary piles and spoils. When excavating the foundation pit, the mellow soil on the surface and the raw soil on the bottom should be stacked separately. When the land is renovated, the mellow soil should be covered on the surface. According to the original land type, try to restore its original land function (farmland) or restore vegetation. For non-farmland suitable for grass and forest, sow grass seeds. The construction unit should investigate the applicable vegetation and grass seed types in the area where the tower is located during vegetation restoration, and select the appropriate grass seed types in the area for vegetation restoration according to local conditions. Seed sowing should try to choose a time with plenty of rain. Land preparation includes three methods: comprehensive land preparation, partial land preparation, and stepped land preparation. Comprehensive land preparation is suitable for the leveling of agricultural land and landscape greening land in a large area. The slope of land preparation is less than 3°, and the method of mechanical land preparation can be adopted. Partial land preparation is suitable for restoring
economic forests, greening of station sites, etc. Generally, the slope of land preparation is less than 3°～5°, and the method of artificial land preparation is adopted. Terraced soil preparation is suitable for layered platform soil preparation. The platform has an inverted slope with a slope of 1°～2°, and manual soil preparation method is adopted.

According to the first-level divisions of the national soil and water conservation zoning in the "National Soil and Water Conservation Plan (2015-2030)", China is divided into the northeast black soil area, the northern windy sand area, the northern rocky mountain area, the northwest loess plateau area, the southwest lava area, the south red soil area, the southwest purple soil area and the eight areas of the Qinghai-Tibet Plateau. Combining the characteristics of these eight major districts, a detailed design of land remediation technology has been implemented.

In the northeast black soil area and the south red soil area, for construction disturbance platforms or soil borrowing and spoil slag sites, the border-net site preparation method shall be adopted on the basis of conventional cleaning and leveling. For slope-type areas such as hillside roads, tower foundations, stretch yards, etc., a small-scale slope surface water collection and storage method or a fish-scale pit land preparation method can be adopted. The size needs to be determined due to the utilization method or vegetation restoration (the size of afforestation seedlings).

In the northern wind sand area, the method of land preparation shall be selected based on the intensity of the disturbance and the direction of utilization, and the land preparation shall be combined with the utilization of rainfall. Limited by topography and soil resources, this area should mainly adopt local spot and block land preparation, such as the aforementioned fish-scale pit land preparation. The difference is that attention should be paid to sieving coarse and fine particles at the same time during the excavation process. Coarse particles are used as blocking and covering materials. The fine particles are used as backfill soil.

In the northwest loess plateau area, the method of land preparation shall be selected according to the intensity of disturbance and the direction of utilization, and land preparation shall be combined with rainfall utilization, and shall adopt equal height land preparation, horizontal terrace land preparation or fish scale pit land preparation.

In the southwest purple soil area and the southwest lava area, the land preparation method should be selected according to the disturbance intensity and the direction of use, and the land preparation should be combined with the rainfall utilization, and the land preparation of equal height, level terrace or fish scale pit should be adopted.

3.2. Slope protection technology

Slope protection technology mainly includes plant slope protection and engineering slope protection. Plant slope protection is suitable for low and gentle slopes (slope not greater than 1:1.5) where precipitation conditions permit. The engineering slope protection is suitable for slopes where plant measures are not suitable and the toe of the slope is easily washed by water. When the slope is steep (slope 1:1～1:2.0) and water erosion is serious, mortar-masonry slope protection should be laid. Slope is relatively gentle (slope is 1:2.5～1:3.0), and the water flow velocity is relatively slow, so dry mortar stone masonry protection should be laid. Concrete slope protection should be laid at the steep slope section where the foot of the slope may be scoured by strong flooding.

Plant slope protection is a kind of slope protection measure that plants are planted on gentle soil or sandy slope, and plant roots are used to anchor soil to maintain slope stability. Plant slope protection includes direct seeding shrub grass slope protection, ecological vegetation belt slope protection, soil spray slope protection, geogrid shrub grass slope protection and three-dimensional vegetation bag slope protection. Direct seeding shrub grass slope protection is generally suitable for relatively stable soil slope, the slope is not more than 1:2. The slope protection of ecological vegetation belt can be applied in the slope of 1:0.5～1:3. It is suitable for slope with gradient of 1:0.75～1:1. Geogrid planting shrub grass slope protection is suitable for slope less than 1:1.5 within 10m. Three dimensional vegetation bag slope protection is generally suitable for the stable slope with high ecological landscape requirements, and has strong adaptability in all kinds of stable slopes.
Comprehensive slope protection engineering is the organic combination of vegetation protection technology and engineering protection technology, which can be divided into frame slope protection, gabion slope protection, chain slope protection and other comprehensive slope protection forms.

The frame revetment is mainly used on the soft soil slope of manual excavation. Gabion revetment is usually used to stabilize the slope, and it is usually reinforced with wooden piles or soil nails. Interlocking revetment is a new type of pavement system composed of interlocking precast concrete blocks, which has stronger stability than gabion revetment, and is generally applicable to the slope which is subject to the fluctuation of water level or continuous runoff erosion.

4. Conclusion and discussion
In the aspect of soil and water conservation construction, the existing construction technology lacks systematicness and standardization. Especially in the hilly area, the implementation effect of soil and water conservation measures is poor, lack of systematic and perfect construction organization design standards. In the aspect of comprehensive control of soil and water loss, the technical system of comprehensive control of soil and water conservation in line with the characteristics of power transmission and transformation project has not been established. Through the research on the key technology of soil and water conservation design and construction of overhead transmission line project in hilly area, the standardized technology system of soil and water conservation design, construction and treatment is constructed to fundamentally solve the problem of soil and water conservation of transmission line project, especially the short board of soil and water conservation in hilly area. In particular, the design and construction control of soil and water conservation in hilly areas has important reference value and long-term guidance.

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