双荚决明不同弯曲程度单根抗拉变形特性

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摘 要：【目的】在西南喀斯特地区，植物根系大多以弯曲形态存在，而以往研究多选取均匀顺直的根系，对于弯曲根抗拉特性还不得而知，弯曲根力学特性的研究有助于揭示根系固土机制。【方法】为探究不同弯曲程度根系固土的力学性能，揭示其固土护坡机理，以五年生边坡绿化树种双荚决明为研究对象，采用单根拉伸试验，探讨弯曲根抗拉变形特性。【结果】1）双荚决明不同弯曲程度根系的抗拉力和抗拉强度均表现为顺直根>微弯曲根>弯曲根，极限延伸率为弯曲根（29.26%）>微弯曲根(21.15%)>顺直根（12.14%）。2）双荚决明弯曲根拉伸变形过程复杂多样，其应力-应变曲线主要分为单峰型和多峰型，单根以前置、弹性变形，塑性变形，屈服及根皮撕裂五个阶段来抵抗变形，较顺直根多一个前置阶段，此阶段应力产生一定值后才会产生应变，应力截距范围为 0.03~5.7MPa。顺直根受力初期，其应力随应变增长较快，在弹性变形阶段呈“上凸型”，弯曲根在弹性变形阶段呈“下凹型”，应力随应变增长较慢，表现为弯曲根系固土护坡的“缓冲性”。3）双荚决明弯曲根的初始受力位移与弯曲程度呈正相关关系；表现为弯曲根受力变形时比顺直根多分担一部分土压力，这部分力的大小直接受弯曲程度影响。弯曲根的初始受力位移均小于弯曲部分根长，即弯曲根未被拉直就产生了抗拉力；弯曲形态为弯曲根的拉伸储存了部分预应力，当发生浅层滑坡时，由弯曲部分先释放力，表现出弯曲根固土护坡的“前置性”。【结论】双荚决明弯曲根的抗拉变形过程与顺直根有较大差异，且表现出较顺直根更优的护坡特性，本研究结果为弯曲根固土力学性能评价提供参考意义。

关键词：双荚决明；弯曲程度；抗拉特性；应力-应变；前置性

Tensile deformation characteristics of single root with different bending degree of Cassia bicapsularis

Abstract：【Objective】In the southwest Karst areas, most of the plant roots exist in the form of bending. The previous studies mostly selected uniform and straight root systems, but the tensile characteristics of bending roots are unknown. The mechanical properties of bending roots could helps to reveal the root soil solidification mechanism.【Method】The 5 - year - old slope greening tree species Cassia bicapsularis was used to explore the mechanical properties of solid soil with different degrees of bending and reveal the mechanism of slope protection of solid soil. 【Result】1) The tensile force and tensile strength of C. bicapsularis root system under different degrees of bending were shown as straight roots > slightly bending roots > bending roots, and the ultimate elongation was bending root (29.26%) > slightly bending roots (21.15%) > straight roots (12.14%). 2) The tensile deformation process of C. bicapsularis bending root was complex and diverse, and its stress-strain curve was mainly divided into monomodal and multimodal type. The single root was used preposition, elastic deformation, plastic deformation, yield and root bark tearing five stages to resist deformation, and one more preposition than the straight root. The strain will be generated after the stress at this stage produces a certain value, and the stress interception range is 0.03 ~ 5.7 MPa. In the early stage of force on straight roots, the stress increased rapidly with strain, and was "convex" in the stage of elastic deformation, while the bending root was "concave" and the stress increased slowly with strain, which is manifested as the "buffering" of slope protection of solid soil in the bending root system. 3) The initial force displacement of C. bicapsularis bending root was positively correlated with the degree of bending; It was manifested as a part of the

soil pressure shared by the bending root when deformed by force than the straight root, and the magnitude of this part of the force was directly affected by the degree of bending. The initial force displacement of the bending root was less than the length of the bending part, that was, the tensile force was generated before the bending root was not straightened; The bending form was that the stretching of the bending root stores part of the prestress, and when a shallow landslide occurs, the force was released first by the bending part, showing the "preposition" of the bending root to consolidate the soil slope. 【Conclusion】The tensile deformation process of C. bicapsularis bending root was quite different from the straight root, and it showed better slope protection characteristics than the straight root. The results of this study provide reference significance for the evaluation of mechanical properties of bending roots.

Key words: Cassia bicapsularis ; bending degree; tensile properties; sress-strain; preposition