Research on the measurement of static friction force of bamboo root soil

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Abstract. Root soil maximum static friction play as an important parameter to measure the effect of soil reinforcement.Accurate measurement of it has the higher application value and research significance. this paper takes the bamboo root bamboo developed as the researching object ,and uses a self-made device to simulate the condition of natural soil ,adopts the tension gauge measurement method to implement experiments. These experiments measure following factors: the maximum static friction of bamboo root - soil under the factors of the self weight stress, water content , depth, root depth, root diameter of different soil. Analyzes the impact of the above on root soil interface friction. The results show that: the maximum static friction of bamboo root - soil interface becomes higher with the increasing of soil depth and root depth. The relationship between maximum static friction and root diameter, soil depth is approximately power function .Under the same soil depth, In contrast to 32.7% moisture content of the soil, the maximum static friction of bamboo root - soil is greater when the moisture content of the soil is 23.5%

Introduction

Plant root system has a wide application in the field of environmental protection, which is effective in enhancing the soil strength and improving soil stability, preventing and controlling soil erosion. Root soil interface friction characteristic is an important factor affecting the effect of soil reinforcement. The static friction between the root and soil can reflect the stand or fall of roots and soil interface friction characteristics. Generally, the soil dry density, soil bulk density, moisture content, soil self weight and other factors are related to the root system. Accurate measurement of it has the higher application value and research significance

Xiao guang Liu[1-9] adopts the method of directly applied load of different species tree studied the effect of root diameter on the friction properties of the root soil interface and the relationship between the maximum drawing force and displacement of the pulled up roots ,He used the method of heavy loads to ground the soil in burying the root system analyzed the Pullout load influenced by root diameter. Liwen Zheng [10-12]by study on the woody plants such as root pulling resistance and the role of slope reinforcement established the mechanics model. Get the pull-out force is the root of the plant and friction force of interaction between rock and soil mass in the vertical direction, But none of the above research directly reveal the relationship bamboo roots and soil interface friction performance. This article selects the root cluster of more developed bamboo root system as the research object. with tension meter measuring method to pull-out tests for bamboo root directly .Simulation in the condition of natural soil bamboo root soil friction performance relationship, Analyzed The influence on root force friction in different soil depth, different soil depth, and different soil self weight stress .To explore the bamboo roots and soil interface friction performance provide important theoretical basis.

Materials and methods

Subjects for bamboo 1 ~ 2 years old cluster bamboo root system. Experimental root system using artificial mining In order to reduce the damage to the root system of the operating tools, the

whole layer was dug out Select the skin in good condition and fresh root, applied properties of parameters measured

Test equipment

Testing equipment mainly includes homemade root pull-out device and root buried device, The pull device is composed of a measuring pull meter and a root holding device. The Buried device has simple structure, and easy to install.

(a) Front view (b) Vertical view

Fig.1 Device of root buryried

Test method

Firstly: select the fresh root which skin in good condition and straight, length is more than 12 cm, Finally, according to the measured soil needs To fill in the root buried device, controlling force measurement meter horizontal uniform moving to be measured root once the root system is pulled, recorded the number of the tension gauge immediately ,It Is the maximum static friction force of the root under this moisture content.

Test data processing

(1)Soil moisture content (Q_m)

$$Q_m = \frac{m_t - m_s}{m_s} \tag{1}$$

m_t—Wet soil sample quality

m_s—Dry soil sample quality

(2) Soil bulk density (γ)

$$\gamma = \frac{m_t}{V(1+Q_m)}$$

Ring knife model is 100 cubic meters, (2)

γ—Soil bulk density per unit g/cm3

m_t—wet soil sample quality unit g

V—cm3; Ring unit cm3

Q_m—Soil moisture content

(3)Soil gravity stress(σ_{sz})

$$\sigma_{SZ} = \gamma_1 h_1 + \gamma_2 h_2 + \gamma_3 h_3 + \cdots\cdots = \sum_{i=1}^{n} \gamma_i h_i \tag{3}$$

σ_{sz}—Any depth Z effective vertical gravity stress of soil, unit kpa;

n—Soil depth in the range of z;

γ_i—I layer soil bulk density;

h_i—I layer soil thickness;

Results and analysis

Control force measurement meter horizontal uniform moving to be measured root ,Once the root system is pulled ,recorded the number of the tension gauge immediately

Select the soil that moisture content is 23.5% By the formula (2) to calculate the soil bulk density of 1.12 g/cm3;Calculated by the formula (3) the different layers of soil gravity stress shown in the table below:

Table 1.The dead weight stress of root distribution layer

Soil layer (cm)	10	20	30	40	50
Self weight stress (kpa)	1.09	2.19	3.29	4.39	5.48

Relationship between static friction and soil depth

From table1, it can be known that the difference of soil depth influence on tension of the root .Different soil depth of soil self weight stress is also different

Therefore, the gap of the soil particles is different, so the tensile force is different also. And with the increase of soil depth.

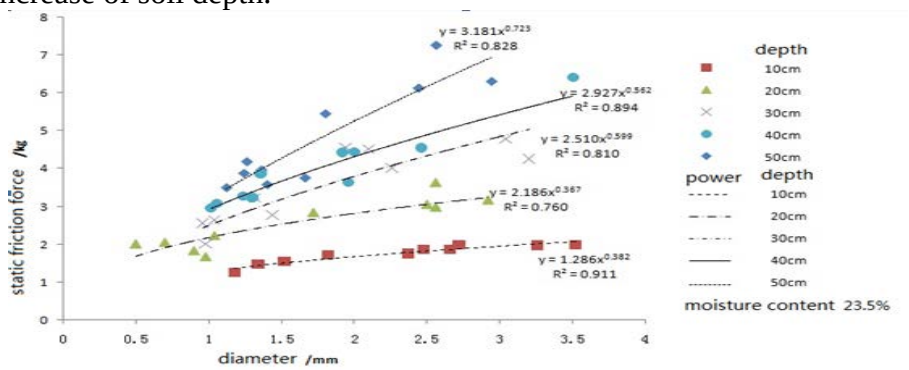

Fig.2The relation curve among each soil depth ,roots diameter and static friction force under the 23.5% moisture content, soil bulk density 1.12g / cm3

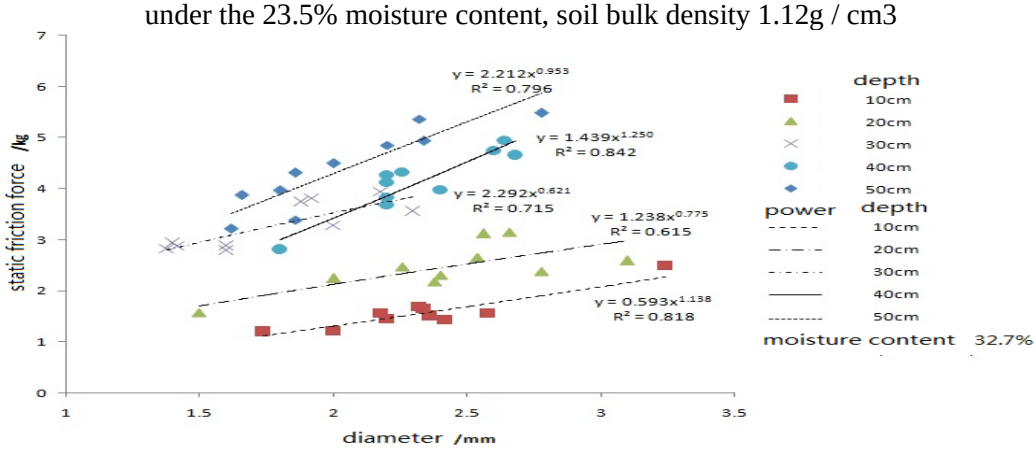

Fig.3The relation curve among each soil depth ,roots diameter and static friction force under the 32.7% moisture content, soil bulk density 1.12g / cm3

From Figure 3, figure 2,Under the same soil depth, the static friction force increases with the increase of root diameter, and the friction force and the diameter of the root system satisfy the power function, that is $F = kR^a$ .Analysis of the reason is that the greater of the root diameter, the greater the contact area between the root and soil .According to soil pressure can learn, Under the same condition, the soil pressure of per unit area is fixed. Therefore, with the increase of contact area, the static friction of the root will increase as well ,In the case of similar root diameter, the static friction of the soil increased with the increase of soil depth ,Analysis of the reason .By the formula (3) to know the soil gravity stress increases with the depth. Root pressure of per unit area will great.

The relationship between static friction and water content,

The same Roots buried depth ,8cm,The different soil moisture content, Soil particles dispersion degree is different also. High moisture content of soil particle dispersion degree is greater than low soil moisture content, The greater the degree of soil particle dispersion .The smaller the relative forces between particles. So the low degree of soil moisture content the static friction force is larger.

From the image above, In the same depth the root-soil static friction decreases with the increase of soil water content. Analysis The soil moisture content increases with the decrease of soil self weight stress, With the decrease of the vertical pressure, the pressure of the soil particles is weakened, the particle spacing is enlarged, and the particles are arranged in a loose, and the soil and the root contact are more loose. So the friction will be reduced

Conclusions

Based on different soil bulk density, soil moisture content, soil depth, root buries depth influence on static friction of bamboo root ， research and analysis come to the following conclusions.(1)The maximum static friction force of bamboo root is different with the depth of soil and the buried depth, The maximum static friction force is a power function relationship between the root diameter and the depth of the soil, and the correlation coefficient is higher.(2)In the same Soil depth and root buried depth ,the maximum friction force will greater with the bamboo root diameter increases. (3)Under the same soil depth, In contrast to 32.7% moisture content of the soil, the maximum static friction of bamboo root - soil is greater when the moisture content of the soil is 23.5%.

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