E.2-4 Development of tree crown survey systems

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Abstract

For pushing forward the researches on tropical forest crown, we have developed the light weight portable observation system. The system allows us to move around and work inside the crown with minimum environmental disturbance. For this system we are using light weight alloy, FRP, and newly developed materials such as carbon fiber and polyamide fiber; all of which have the characteristics of light weight and high strength. The system consists of the horizontal section, and up and down section. The horizontal moving section is a suspension bridge made of light weight, high tension Kevler fiber rope. By the results from installing tests, it shows enough stability and safety. After further efforts for lightening the total weight and making the price low, we believe it can be versatile for actual observation works. The vertical sections have unique square cross-section structure made by four carbon fiber ropes, light weight alloy frame, and FRP steps. The ropes are suspended by a deck frame made of light weight alloy which is attached to the upper portion of tree trunk. The installing test for this section also shows that the system has high strength and stability in spite of its light weight, as well as safe and efficient observation works. According to an actual installing test for both horizontal and vertical sections, we found the system gave almost no disturbance on forest floor, and little damage on the tree trunk. Accordingly, we can say the system is useful, and environmental acceptable for the tropical forest crone observation. Another development has been done for observations on structures and phenomena on forest crown surface.. We developed a balloon and a remote control system to take aerial photographs in low altitude. Using the system, we made some actual observation on the forest crown.

Key Words

Tree Climbing, Canopy Walk, Observtion Sytem, Low Altitude Aerial Photograph

Introduction

In a tropical rain forest, the ecological elements such as plants, birds, animals and insects or biological activities such as photosynthesis, respiration and flowering mainly distribute and occur in the height of tree crown layer. So it is inevitable for any party who would attempt correct samples and data in a tropical rain forest to adopt some system that can access easily to the height. The purpose of this study is to provide those parties such a system, by which they can climb and walk around easily and safely in a crown layer or observe the upper surface of a crown (Fig 1).

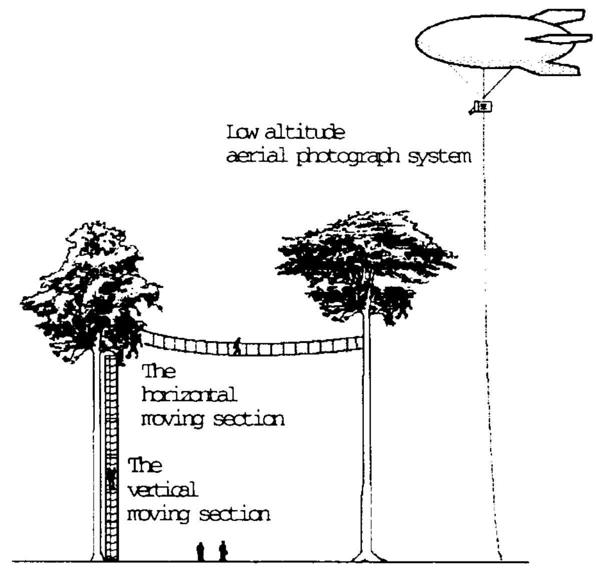

Fig.1 Concept of the system

Method and Result

(1) The horizontal moving section

The horizontal moving section is a suspension bridge made of light weight, high tension Kevler fiber rope (Fig.2). The section can be divided into two units which lengths are 8m and 7m. Therefore, normal installation of two units totals to 15m, however, only one unit can be installed. The width of bottom area is 70 cm, and the height of side wall is 140 cm respectively. These areas are covered with Kevler fiber nets. In the bottom area structure, there are two FRP pipes fixed in each 50 cm. The pipes work not only as structural member, but as walking steps. The upper 40 cm portion of both side walls can be opened for the sample collection and observation works. The windows is removable in each 2m by opening zippers. Both sides of bridge are supported by two light weight alloy beams that attached to the support trees by fabric belts.

In order to evaluate the strength and stability of the horizontal section, we measured the main rope tensions, and mid-span deflections in various load conditions. At no load condition, the main rope tension was 70 kgf, and mid-span deflection was 415 mm. The variation of tension, and mid-span deflections when one to eight adults was boarding are summarized in Figure 3. The results show (1) most of load was supported by lower ropes, (2) even the eight adults boarding condition, the safety factor in main ropes is about 11, which we think safe enough for this purpose.

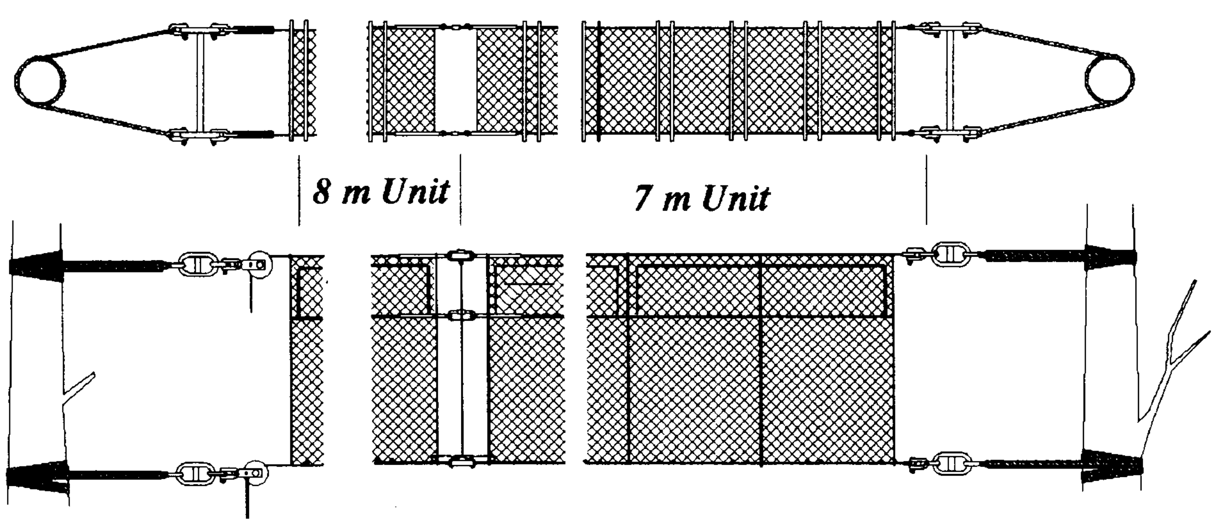

Fig.1 The horizontal moving section

The deflection value in lower main ropes that supports the walking steps was stabled within 600 mm to 700 mm. Therefore we can say the bridge has enough rigidity and stability for walking on. For investigating stability in every condition, we conducted the tests by doing hard action such as leaning out upper half of our body out of bridge, falling down on the bridge, and running fast. In every case, we had feeling of high stability and enough rigidity. There was no remarkable twist in whole bridge body.

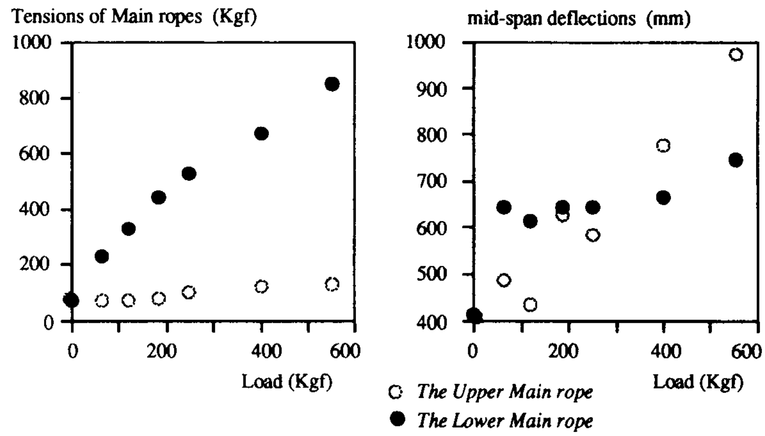

Fig.3 The tension and the deflection of the main ropes

In summer 1993, actual installation for both horizontal and vertical sections was conducted at the height of 11m from the ground level in the arboretum at FFPRI (Fig.7). The installation was done by 5 men's 1 day work, and dismantle was done by less than 2 person's 1 day work. Because of its good stability, and high side wall, all person boarding the system gave no complain about the fear height.


Fig. 4 The horizontal moving section set on the canopy

After further efforts for lightening the total weight and making the price low, we believe it can be versatile for actual observation works.For the problem remained, we must find out the durability and stability under strong wind conditions.

(2) The vertical moving section

The vertical moving section seems as an emergency staircase set outside a tall building (Fig 5). The four corner pillars of the 'staircase' are CFCC cables, and FRP steps are build between those pillars as ladders (Fig. 6). The vertical distances between steps are 50 cm. Those pillars and ladders are united in each 4 m length and will be linked up to the needed length (height).The highest hanging light alloy frame that is slung from the stem by fabric belts has a standing deck and removable hand rail. The grid floor plate of the standing deck can open upward to perform as a hatch. The connecting frame that connects each unit has sockets at both of upside and downside of each 4 corner. At the height of every or any connecting frame, you can sling tightly them to the tree stem, by which the weight and the load can be dispersed to each points (Fig 7). The CFCC rope has connecting knots at each terminal which has been sleeved by steel pipes, and with an interval of ladder steps, also has 7 knots sleeved by light alloy pipes.

We made 3 units, and in an experimental installtion, we set the units to a 17m high Tulip tree. The height we found at the top of the deck has been about 14m high from the ground surface. It took 5 people's 2 days work to build, 3 people's 1 day work to remove. At the test we found no problem in the stability and strength of the construction As for climbing up and down or working on the system, swinging and vibration was very small and rapid to stop. A typhoon with extraordinarily strong winds struck the site while it was set on the tree, but there occurred no damage to the system nor to the tree.

Before an application of the system to actual research works, there needs a small improvement of simplifying the CFCC's knots at the ladder position.

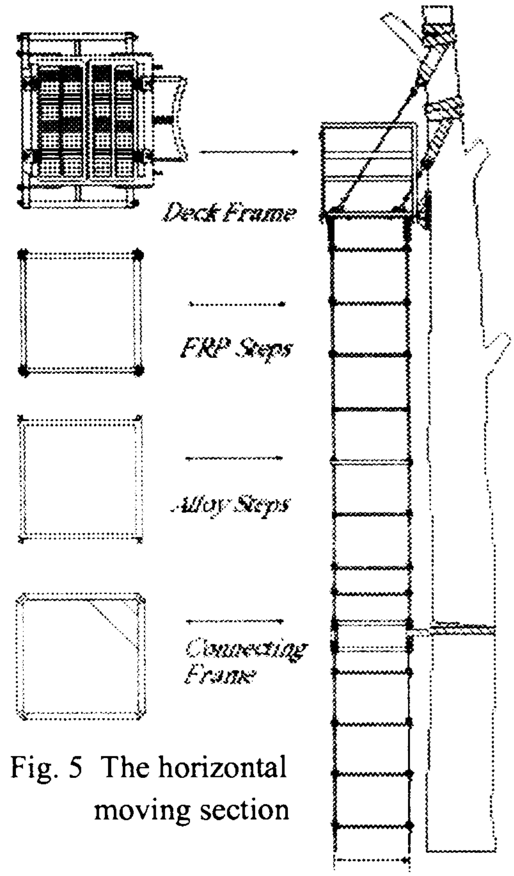

Fig. 5 The horizontal moving section

(3) Low altitude aerial photograph system

To observe crown surface structure such as gap distribution or clusters of leaves, efflorescence of tall trees, or other phenomena occurring on the crown surface, we planned to develop easy and low cost observation system. At the beginning we tested radio controlled model helicopter to find some difficulty of high cost, risk to fall and crash, needs for special operator and engineer. So we planned to develop alternative.

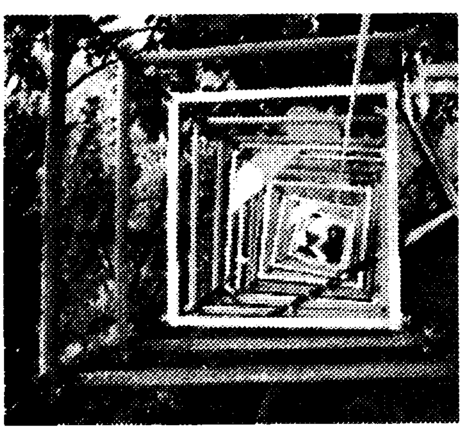

Fig. 6 Inner view of the horizontal moving section

Fig. 7 Slinging the connecting frame to the stem