MECHANICAL ANALYSIS OF ORBIT TRACKING
MOVEMENT OF FEED SYSTEM IN LARGE
SPHERICAL RADIO-TELESCOPE *

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Abstract: The curve equation and its mechanics analysis of suspended-cable under the
condition of end load are given. Then on the basis of it, the mechanical analysis of
suspended-cable system for large spherical radio-telescope is studied, and procedures of
the control for the orbit tracking movement of the line feed in large spherical radio-
telescope are given. The validity of the results mentioned above is confirmed by means
of computer simulations.

Key words: curve equation of suspended-cable; suspension mechanics; large spherical
radio-telescope; orbit tracking movement; control

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Introduction

Suspension mechanics is the application of classical mechanics in suspension system. In
these years, with technology developing, more and more requests are put forward. The
mechanics analysis of feed system in LSRT (large spherical radio-telescope) and the control
of tracking movement are the practical applications of suspension mechanics[1].

Constructing a new LSRT was put forward by the international experts of chronometers
and antennas at Kyoto meeting in 1993, so Chinese experts work actively to make
international chronometers construct this LSRT in Guizhou[2], China. According to Karst
physiognomy in Guizhou, they bring forward many ideas, one of which is that line feed
resource is supported by six suspended cables having large span and its scan movement is
achieved by the actions of servosystem to suspended cables, such as relaxing, expanding,
drawing and unlocking.

Suppose the settled points of suspended cables on the ground are A, B, C, D, E and F;

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their corresponding crunodes of suspended cables and the feed resource are \( a, b, c, d, e \) and \( f \); point \( O \) is the focus of feed. In order to obtain the expected purpose of observation, the axis of feed makes an angle of \( \alpha \) degree with vertical line through the focus, and rotates around this line with definite angular velocity, shown in Fig. 1. When tracking and observing one planet, to assure the definite space position of feed, the length of six suspended cables must be controlled strictly, and the tension of these cables must be adjusted. The length of cables is changed, so support forces of these support points on the ground are changed too. To confirm the length and tension of the cables, mechanics analysis of feed system must be made.

To realize the results above, it is necessary to make tracking movement and control of suspended-cables system. So should exact space position of feed be obtained, it is necessary to analyze mechanically feed system and study the control of tracking movement in LSRT. Many experts engage in studying these problems, but reports are not satisfying so far. So it is essential to develop the study in this area.

Curve equation of suspended cables in suspension system on which heave objects hung, and mechanics analysis are given in this paper. On these bases, mechanics analysis of feed system and control of orbit tracking movement in LSRT are done, using methods of kinematics and dynamics of rigid body that does compound movement. The methods of controlling orbit tracking movement and its steps are given too. The example validates the theory in this paper and the correctness and feasibility of the methods.

But it is needed that wind power is not considered here, because work space of feed is lower than the ground around, LSRT is settled in low basin, so-called karst physiognomy.

1 Structure Hung Heavy Body on One End

Limp cable, whose line density is \( \rho \), whose length is \( L \), hangs between two points \( A \) and \( B \), whose horizontal range is \( X_0 \), and joints with them. Point \( A \) is a sliding hinge which can glide along plumb plane up and down. These points and glide axis are on the same plane. The forces acting on point \( A \) are horizontal force \( H \) and the weight of heavy body, \( W \). Acceleration of gravity is \( g \). It is supposed \( a = H/(\rho g) \).

In the coordinates shown in Fig. 2, equations following are obtained:

\[
Y' = \sinh\left( \frac{X}{a} + \arsh\left( \frac{W}{H} \right) \right),
\]

\[
Y = a \left\{ \cosh\left[ \frac{X}{a} + \arsh\left( \frac{W}{H} \right) \right] - \left[ \left( \frac{H^2 + W^2}{H^2} \right)^{0.5} \right] \right\}.
\]

So the height of suspended cable, \( h \), the length \( L \), horizontal force \( H_b \) and perpendicular force \( F_B \) on point \( B \) are as follows:

\[
h = a \left\{ \cosh\left[ \frac{X_0}{a} + \arsh\left( \frac{W}{H} \right) \right] - \left[ \left( \frac{H^2 + W^2}{H^2} \right)^{0.5} \right] \right\},
\]