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# THEORETICAL STUDY OF THE VIBRATION OF CHAIN NETWORKS


## TURDALIYEV VOXIDJON

Professor, Namangan State Technical University, Namangan, Uzbekistan
Phone.: (0597) 335-9339, E-mail.: vox-171181@mail.ru

## AKBAROV ABDURAXMON

Doctoral student, Namangan State Technical University, Namangan, Uzbekistan
Phone.: (0897) 216-6692, E-mail.: abduraxmonakbarov77@gmail.com
*Corresponding author

## TOYCHIEVA MAJUDA

Researcher, Namangan State Technical University, Namangan, Uzbekistan


**Abstract**: The article presents the results of theoretical studies of oscillations of the free branch of the chain of a chain transmission with a variable interaxial distance. In the studies, the free branch of the chain was isolated separately and studied as a single-mass mechanical system. As a result of the studies, an equation of motion of the free branch of the chain was compiled and, based on the numerical solution, the laws of change and graphical dependence were constructed.

**Keywords:** Chain, free branch, motion, vibration, length, angle, equation, sprocket, weight, force, spring, tensioning roller.

**Introduction.** A chain drive is a type of mechanical transmission in which energy (mechanical motion) is transmitted from a driving shaft to a driven shaft (or shafts) by means of a flexible link (chain) meshing with the teeth of the driving and driven sprockets [1]. The simplicity of the structure of chain drives, high efficiency, absence of slippage compared to belt drives, small overall dimensions, constant number of gears, ease of adjustment and replacement, and the ability to transmit motion to several shafts other than the driving shaft ensure their wide application in technological machine drives. At the same time, chain drives are used as the main transmission in all areas of mechanical engineering due to their ability to transmit high-value power, flexibility, large center distance, and ease of maintenance and installation [2]. In recent years, based on technical and technological innovations, a number of resource-saving transmission designs have been developed, and their unique kinematic and dynamic characteristics have been created.

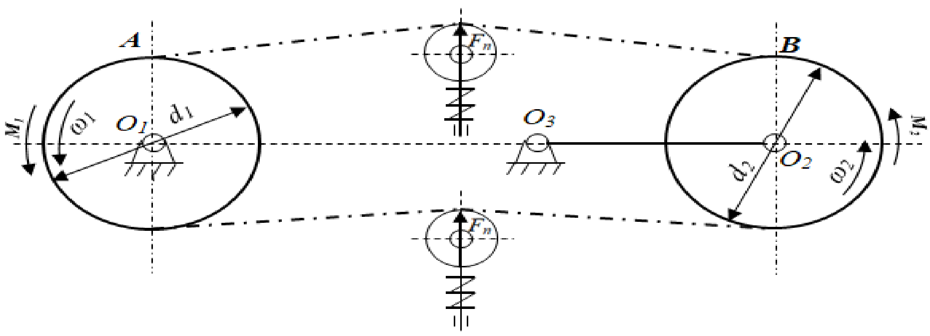



**Figure 1.** Chain transmission scheme with variable distance between axles

As is known, the main factor determining the performance of chain transmissions is the resistance of chain elements to wear. In addition to natural wear in chain transmissions during operation, changes in the extension and angle of engagement are observed as a result of vibration or shaking. This, in turn, leads to a decrease in the tensile strength and uneven distribution of loads on the chain links [3]. Therefore, it is important to reduce the vibration of the free links of the chain transmission chain.

**Methodology.** We will study the vibrations of the free link of a variable pitch chain drive shown in Figure 1. In order to simplify the research, we will isolate the AB part of the chain link separately (Figure 2).

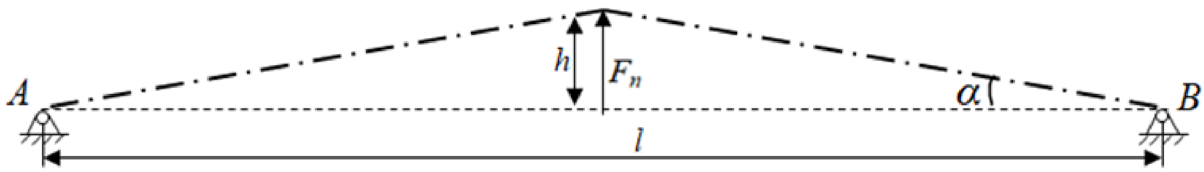



**Figure 2.** Free link of the chain (section AB)

To study the oscillations of the free network of the chain shown in Fig. 2, we consider it as a one-problem mechanical system.

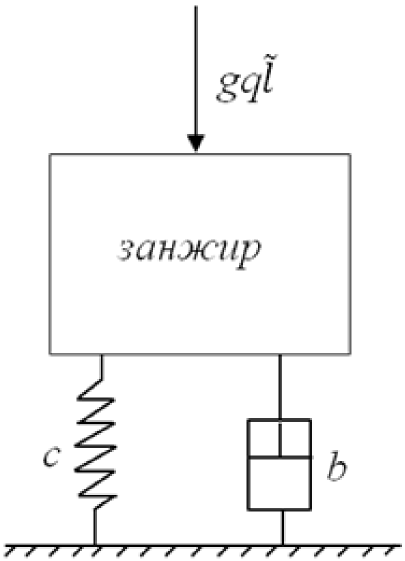



**Figure 3.** Calculation scheme

According to the calculation scheme presented in Fig. 3, we will construct the equation of motion of the free network of the chain

$$q \cdot l \cdot h'' = g \cdot q \cdot l - ch - bh', \qquad (1)$$

where $q$ is the mass of the chain per meter of length; $l$ is the free length of the chain; $g$ is the free fall velocity; $c$ is the density; $b$ is the absorption coefficient; $h$ is the height;

(1) Dividing both sides of the equation by $ql$, we obtain

$$h'' + \frac{b}{ql} h' + \frac{c}{ql} h = g \quad (2)$$

To simplify equation (2), we introduce the following notation

$$A = \frac{b}{ql} \qquad B = \frac{c}{ql} \qquad \Delta_0 = 4B - A^2 \quad (3)$$

Taking into account (3), we write equation (2) as follows

$$h'' + Ah' + Bh = g \quad (4)$$

The characteristic equation of the left part of equation (4) is as follows

$$y^2 + A \cdot y + B = 0 \quad (5)$$

We solve equation (5) and determine its roots

$$y_{1,2} = \frac{-A \pm \sqrt{A^2 - 4B}}{2} = \frac{-A \pm i \cdot \Delta_0}{2} \quad (6)$$

Since the roots of equation (5) are complex numbers, according to [4], we write the following using Euler's formula,

$$h(t) = e^{-\frac{A}{2}t} \cdot \left( c_1 \cos \frac{\Delta_0 t}{2} + c_2 \sin \frac{\Delta_0 t}{2} \right) \quad (7)$$

Since the equation (2) is a non-homogeneous linear differential equation with constant coefficients of the second order, we define its particular solution as a constant number as follows

$$\bar{h}(t) = D \quad (8)$$

We can find the value of D by substituting expression (8) into equation (2)

$$D = \frac{g}{B} \quad (9)$$

Using the above expressions (7) and (9), we write the general solution of equation (2) as follows

$$h(t) = e^{-\frac{A}{2}t} \cdot \left( c_1 \cos \frac{\Delta_0 t}{2} + c_2 \sin \frac{\Delta_0 t}{2} \right) + \frac{g}{B} \quad (10)$$

Using equation (10), we determine the integral constants $c_1$ and $c_2$ at $t$=0, subject to the conditions $h(0)=0$ and $h'(0)=0$. According to the given condition

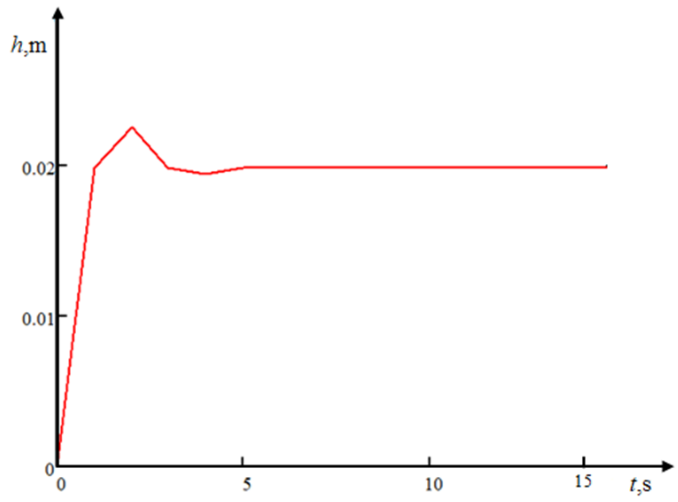
$$c_1 = -\frac{g}{B} \qquad c_2 = \frac{Ac_1}{\Delta_0} = \frac{-Ag}{\Delta_0 B} \quad (11)$$

Taking into account the defined integral constants $c_1$ and $c_2$, then equality (10) can be written as follows

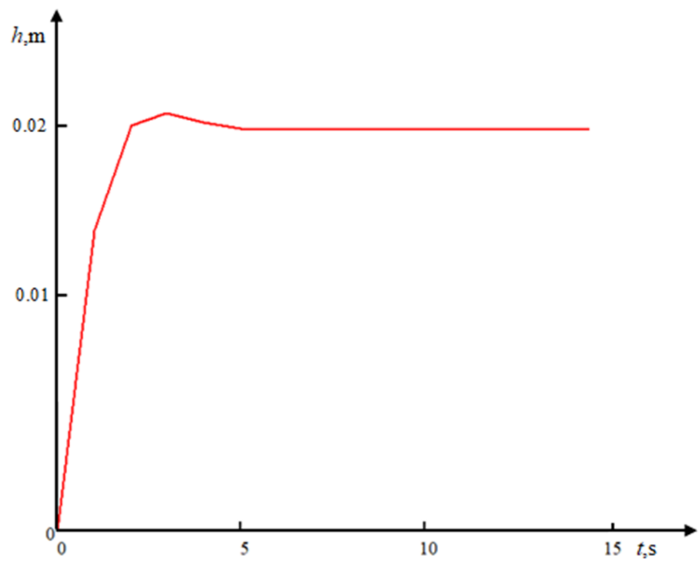
$$h(t) = e^{\frac{-bt}{2ql}} \cdot \left( \frac{b \cdot g \cdot q^2 \cdot l^2}{c \cdot \left(4cql - b^2\right)} \cdot \sin\left( \left( \frac{b^2 - 4cql}{q^2 l^2} \right) \cdot \frac{t}{2} \right) - \frac{gql}{c} \cdot \cos\left( \left( \frac{b^2 - 4cql}{q^2 l^2} \right) \cdot \frac{t}{2} \right) \right) + \frac{gql}{c} \quad (12)$$

**Results.**To determine the oscillation laws of the free chain network, we perform the numerical solution of equation (12) using the Microsoft Office Excel program with the following parameter values, namely $b$=3 Ns/m, $g$=9,81m/c$^2$, $q$=1,5 kg/m, $t$=(0÷15) s, $c$=(350÷750) N/m, $e$=2,7.

Figure 3 shows that when the spring constant is c=350 N/m, the vertical oscillation amplitude of the free chain link is 0.023 m, and its damping period is 5.4 seconds. When the spring constant is $c$=550 N/m and $c$=750 N/m, the vertical oscillation amplitude of the free chain link is 0.028 m and 0.042 m, respectively, and their damping periods are 5.1 seconds and 4.8 seconds, respectively.




*а*

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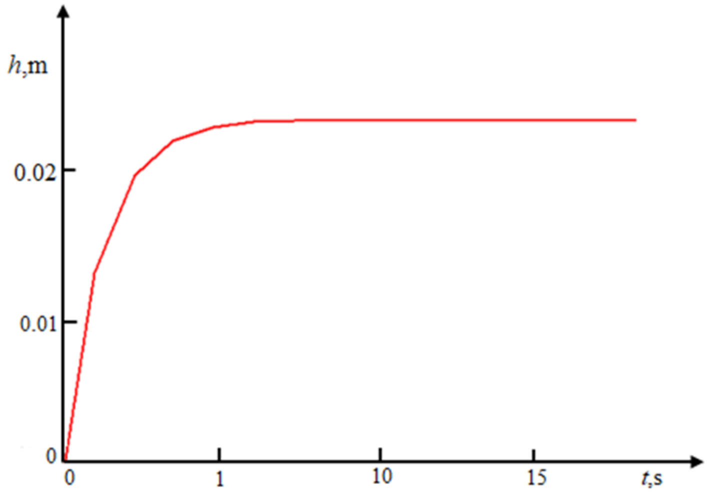


*в*

*а*- *c* = 350 N/m; *б*-*c*=550 N/m; *в*-*c*=750 N/m

**Figure 3. Oscillation laws of chain free network**

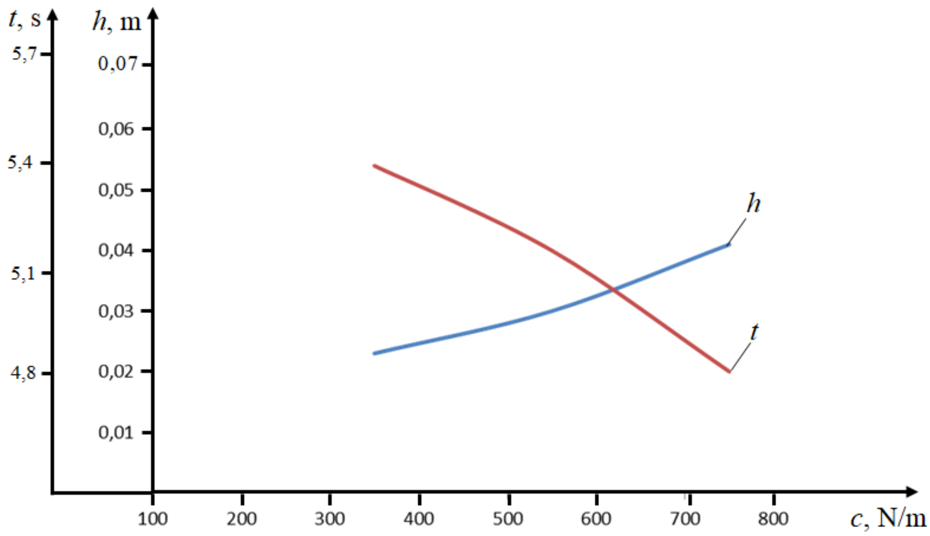


**Figure 4.** The graph of dependence of the vibration coverage and damping period of the free network of the chain in the vertical direction on the coefficient of elasticity of the spring

Figure 4 shows that with an increase in the stiffness coefficient of the spring in the tensioning device, the amplitude of the oscillations of the free chain link in the vertical direction increases in a curvilinear pattern. However, it can be observed that with an increase in the stiffness coefficient of the spring in the tensioning device, the oscillation periods of the free chain link in the vertical direction decrease in a curvilinear pattern.

**In conclusion**, it can be said that the oscillations of the free chain links in chain transmissions cannot be positively assessed. Because the oscillations of the chain lead to their departure from the sprockets, acceleration of the wear processes and increased noise. Since the distance between the axles in the chain transmission under study is variable, gaps appear in the chain links during operation, which increases the acceleration of vibrations. Therefore, the spring in the tensioning device requires a high coefficient of inertia.

## References

**1. Скорюнов А.А.** Механика специальных роликовых цепных передач с внутренним зацеплением: Дис. канд. тех. наук. – Москва, 2015. – 156 с.

**2. Краснов А.А.** Развитие основ проектирования систем транспортирования нитей и тканей текстильных машин как механизмов с гибкими звеньями: Дисс. докт. тех. – Иванова, 2010. – 357 с.

**3. Турдалиев В.М, Акбаров А.И, Ўлмасов С.А.** Расчет натяжение в ведущей ветвицепицепной передачи с переменным межосевым расстоянием // Проблемы механики. – Тошкент, 2024. – №2. – С. 48 –53.

4. http://mathemlib.ru/books/item/f00/s00/z0000027/st238.shtml.

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