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Structural modeling of pneumatic actuators of the string tension at the installation for cutting the raw cellular concrete

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Abstract

In the manufacture of cellular concrete products a string cutting of the raw material before autoclaving is widely used. The quality of cutting which represents the interaction of the string with a moving mass of the raw material is largely determined by the dynamics of the string deflection size Δx especially at the stage of its insertion and withdrawal from the material. So it is very relevant to stabilize Δx through the system of the automatic string tension. The structure of the proposed control system by the pneumatic cylinder, which is used as the power actuating tensioning device, is presented in this paper. The system contains two circuits. The inner circuit is closed by the pressure magnitude in the pneumatic cylinder, while the outer one by the axial force of the string measured with the strain sensor, which is structurally located between the pneumatic cylinder and the string. It is shown that the use of such system increases the service life of the string and reduces deficiencies formed at the string withdrawal from the raw material.

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1. Introduction

The string cutting of cellular concrete products is to force the mass through the matrix of strings. This method is characterized by rather a simple technical implementation, but it has some significant drawbacks associated primarily with the nonstationary properties of the raw cellular concrete. One of the main indicators of the quality of

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cutting is the reduction of deficiencies, i.e. pieces of the raw material “rooted out” the array at the string withdrawal from the product. Therefore, creation of the automatic control system of the raw cellular concrete string cutting, which includes the automatic string tensioning device, is actual.

2. Problem solving

The essential nonstationary rheological characteristics of the raw cellular concrete (the change of parameters of the cellular concrete mix components, the change of composition, the dispersion of values of acuring period interval for a raw cellular concrete in the process of cavitation, etc.) leads to a considerable variation of forces acting upon the string. This is reflected in the structure of the system controllable object (fig.1). Here the input effects are: the pressure P in the string tensioning pneumatic cylinder and the feed rate V_f of the raw material to the string. The operators $A_1 - A_4$ represent the relationship of the input effects with a force of the string tension F_t , a cutting speed V_c of the raw material, a cutting force F_{cut} , an axial force of stretching the string F_{EXT} (from the cutting force) and deflection Δx . Mathematical dependencies and logical operations involved in $A_1 - A_4$ are given in papers (1-4) The output coordinate of the object is the total axial force acting on the string. This force is measured in the controlling system with the strain sensor.

The structure of the synthesized system of automatic control by the string tensioning includes two circuits. The inner circuit is closed by pressure P . The actuating device here is the electromagnetic pneumatic converter, the operation of which is controlled by the regulator R_2 . In the outer circuit, which is closed by the force, the regulator R_1 is used.

The main objectives of the controlling system are to increase the technologic reliability of the cutting process by stabilizing the optimal value of mechanical stresses in the string and providing necessary conditions for automatic program control of the raw material cutting.

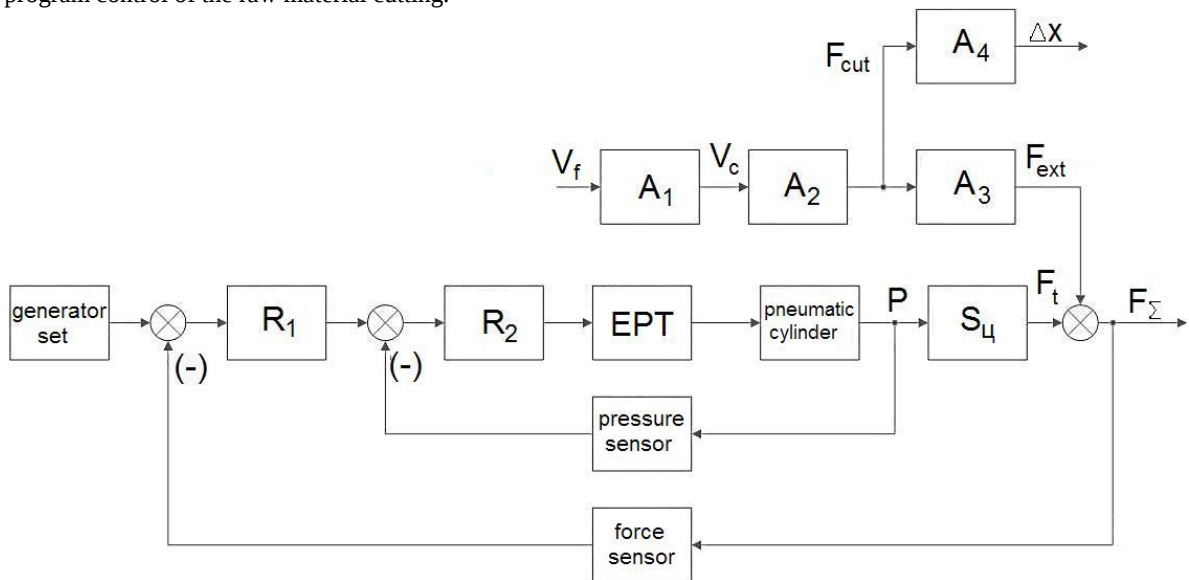


Fig. 1. The structure of the string deflection stabilization system.

3. Results

Created in the software environment MATLAB, the computation model of the developed automatic system to control string tension of the cutting machine used in the manufacture of cellular concrete products, when the dimensions of the raw material are $6,6 \times 1,4 \times 0,66$ m; the string (of 3mm diameter) span length is $L = 1,4$ m; the raw

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