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THE USE OF SPRINGS IN PREFABRICATED STRUCTURES TO OPTIMIZE THE PERFORMANCE OF STRUCTURAL ELEMENTS

Abstract. This article will provide a general overview of springs, their types, and their most important applications in civil engineering, including how springs have contributed to enhance structure and building structural performance.

Keywords: spring, vibrations, mounting springs, prefabricated buildings, passive installation system.

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ИСПОЛЬЗОВАНИЕ ПРУЖИН В СБОРНЫХ КОНСТРУКЦИЯХ ДЛЯ ОПТИМИЗАЦИИ РАБОТЫ КОНСТРУКТИВНЫХ ЭЛЕМЕНТОВ

Аннотация. В этой статье будет представлен общий обзор пружин, их типов и их наиболее важных применений в гражданском строительстве, в том числе то, как пружины способствовали улучшению конструкции и характеристик строительных конструкций.

Ключевые слова: пружина, вибрации, монтажные пружины, быстровозводимые здания,монтаж пассивной системы.

1. Introduction

Mounting springs – springs that are pre-compressed at the factory, used to transformable elements from transport to design position during installation. Compressed mounting springs can be found in a high-tech building module as prefabricated buildings.

The spring is one of the most important parts in mechanisms that have been used in any industry for more than a century. In modern industry, springs used in several technologies to perform multiple functions, the features are similar to each other. The type of springs is chosen according to their purpose in buildings to reduce vibrations caused by earthquakes or vehicle movement, etc., to improve the durability and safety of the building. In prefabricated buildings, the spring is a zero-energy precision tooling and control element that can be used in passive installation systems to speed up the mounting process. [1]

2. Types of springs and their general applications

1-Compression springs. This type of spring is the most common and is used in almost all areas of production and moving parts. The main difference between varieties of this type is the ultimate compressive load and the ultimate tensile load.

Additional features include the following:

- Diameter;
- Pressure height;
- Height at rest

This type of spring finds its application in assembly process in construction, mining, petrochemical, industrial and many other fields.

2- Tension springs. This variety is widely used in machine tools. The main function of compression springs is to reduce the load on hydraulic systems. With lifting traction or shock-pressing processes, this spring contributes to a softer and easier return of the mechanism to its original state. As well as dynamic dampers to reduce the impact of earthquakes on buildings [2].

They are evaluated according to the following characteristics:

- length;
- shape (conical, cylindrical, conical);
- number of turns;
- The diameter of the wire;
- The presence or absence of closing rings, which are installed at the ends of this spring.

3-Bending spring – used to transfer elastic deformations with minor changes in the geometric dimensions of the spring or spring package (springs, Belleville springs). They have a variety of simple shapes (torsion bars, retaining rings, elastic clamps, relay elements, etc.) [3].

4-Torsion springs are a special type of spring that strongly resist rotating forces known as torque. There can be two types:

- torsion – a torsion bar
- helical springs working in torsion

This type of spring finds its application in in clothespins, in mousetraps and in stationery hole punches.

3. Material and class of springs

The material of the springs, it is preferable to use carbon steel because of its good resistance to high temperatures, and it is suitable for use, especially in the conditions of Iraq. Other materials, such as stainless steel, are widely used for making springs; bronze springs are used in the electrical industry because the material has good electrical conductivity and corrosion resistance; and graphite Epoxy is used in high strength springs, such as leaf springs and drawn carbon wire, where low-temperature resistance and low stress are required [4].

Springs can be divided into classes according to GOST 13764, which characterizes the loading mode and endurance; defines the basic requirements for materials and manufacturing technology (See Table 1).

Table 1

Springs grades

Spring class	Type of springs	Loading	Endurance N F established fail-safe operating time, cycles	Inertial collision of coils
I	Compression and extension	Cyclic	$1 \cdot 10^7$	Not available
II	Compression and extension	Cyclic and static	$1 \cdot 10^5$	Not available
III	Extension	Cyclic	$2 \cdot 10^3$	Allowed

4. Research studies on the applications of spring technology in construction

Many practical investigations upon that usage of springs in civil engineering, which are considered zero-energy elements, were given by a number of researchers. They've been employed as vibration dampening components in earthquakes and transportation, as well as fastening elements that assist speed up the installation procedure of structural parts.

V. A. Smirnov proposed to use a mass-spring system to reduce vibration caused by the movement of metro trains, which are sources of increased vibration, which is transmitted over the ground to buildings located at a distance of up to 40 m from the tunnel axis, and spreads along this, often exceeding the normalized sanitary and hygienic requirements or mechanical safety requirements [5] (See Fig. 1).

V. S. Semenov, T. V. Veremenko developed solutions to reduce seismic loads on buildings and structures, in terms of what they proposed to use a spring absorber as a dynamic absorber, with which it is attached to the protected object. Dynamic vibration dampers are considered to be one of the most effective SPHCs capable of suppressing steady state forced vibrations of structures under monoharmonic disturbance (See Fig. 2).

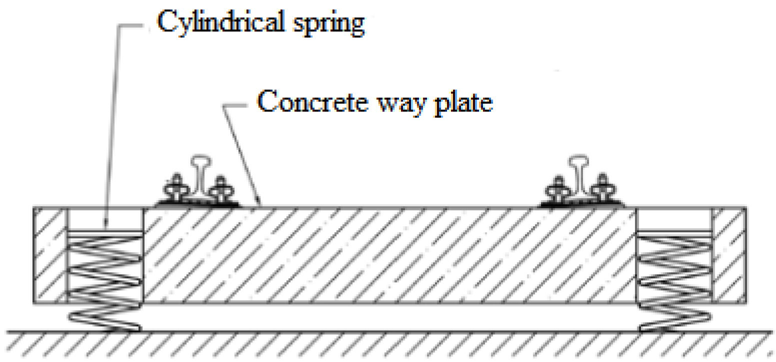

Fig. 1. "mass-spring" system

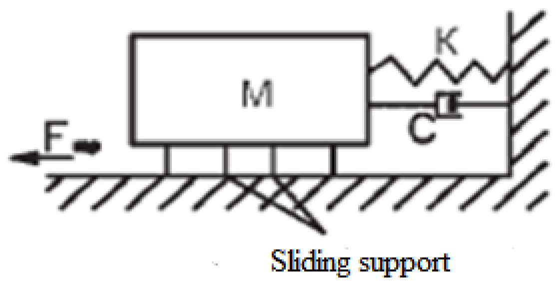

Fig. 2. System with dynamic vibration dampers "spring type"

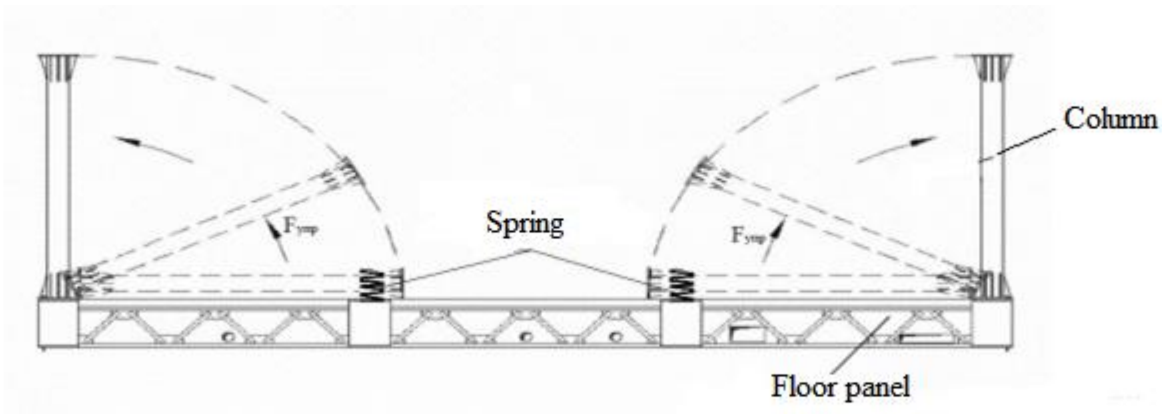

Fig. 3. The mechanism of using a spring to speed up the installation of columns

The spring damper consists of a massive block, which rests on the floor of the building through sliding supports, and steel springs placed between the block and the supporting structures of the building or special stops. The advantage of passive vibration damping systems is high reliability, constant readiness for operation, simplicity of design and operation, and no energy consumption [6].

Also, the spring was used in the technical solutions of prefabricated buildings and structures by Sychev S. A.

S. A. Sychev has presented a detailed description of the elements of the volumetric units, where the spring was used to accelerate the installation of reinforced concrete columns connected to the floor, from its horizontal position to the vertical installation position. For the first time, the principle of transforming steel-concrete columns and the outer wall fencing of the module into the design position is considered, which makes it possible to reduce the installation time by 25 % compared to a building made of three-dimensional blocks (See Fig. 3).

On the other hand, by using a spring to install the elements, the column is installed vertically instead of using a crane to install it, and this reduces the number of times the crane is used to install the elements, which can greatly reduce the transportation cost of shipping modules of prefabricated buildings by 50 % [7, 8].

Conclusion

Construction is a vast and fast-paced industry with a never-ending variety of projects, each requiring thousands of various components to complete a given task. From big projects to smalls. Assembly springs, which are considered assembly mechanisms, accessories, and precision control components that require zero energy, are used to assist in the installation of structure elements such as panel and column in prefabricated buildings, to minimize dynamic vibrations imposed on structures due by earthquakes or vehicle movement, and other situations where springs can be employed to safeguard the structure and improve its design life.

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