INFLUENCE OF ENVIRONMENTAL FACTORS ON THE TECHNICAL CONDITION OF LIVESTOCK BUILDINGS

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Abstract

Livestock buildings are constantly exposed to environmental factors that influence their durability, safety and functionality. The specific environment of livestock farms is characterized by high humidity, temperature variations, the presence of aggressive gases, manure and biological agents, which contribute to the progressive degradation of building materials. The paper analyzes the main mechanisms of deterioration of structures used in livestock farming, with an emphasis on concrete and reinforced concrete elements. The effects of chemical, physical and mechanical aggressions are presented, as well as their manifestations on livestock buildings. The necessary measures to prevent degradation and to increase the service life of buildings intended for livestock farming are also highlighted.

Key words: *livestock buildings, concrete, durability, environmental factors, corossion, structural degradation*

INTRODUCTION

Livestock buildings are an essential component of modern agricultural infrastructure, providing the necessary conditions for animal production processes [1, 2].

Shelters for cattle, swines, poultry and other breeds must provide optimal microclimate conditions, structural safety and functionality throughout the entire period of operation [3, 4, 5].

In figure 1 are presented different types of farm layouts [6].

Fig. 1 Types of farm layouts. a) single building, b) identical large buildings placed in parallel, c) three-sided layout, d) scattered buildings.
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Compared to other construction categories, livestock buildings are exposed to particularly aggressive environmental conditions [7].

The permanent presence of humidity, manure, gases resulting from biological processes and temperature fluctuations favour the occurrence of complex degradation processes [8, 9].

In recent decades, the development of intensive animal husbandry technologies has led to increased demands on the sustainability of constructions and reduced maintenance costs [10, 11, 12].

Under these conditions, knowledge of the degradation mechanisms and factors that influence the technical condition of livestock constructions becomes an essential condition for their efficient design and operation [13, 14, 15].

MATERIAL AND METHOD

The current paper was carried out by analyzing and adapting concepts related to the degradation of concrete structures under the action of environmental factors, in order to apply them to livestock buildings.

The main categories of aggressions affecting the structural elements of modern farms were studied, namely:

- chemical aggressions;
- physical aggressions;
- mechanical aggressions;
- corrosion processes;
- manifestations of structural degradation.

The analysis aimed to identify sources of damage specific to the livestock environment and highlight measures to prevent and limit their effects on constructions.

RESULTS AND DISCUSSIONS

The action of environmental factors on livestock constructions

The durability of livestock buildings is directly influenced by the characteristics of the environment they operate in.

High humidity, the presence of ammonia, carbon dioxide, sulfites and other compounds resulting from manure fermentation create conditions favourable to the degradation of materials [16].

In the case of constructions made of concrete and reinforced concrete, deterioration processes are influenced both by the quality of the materials used and by exploitation conditions.

Chemical attack on concrete elements

Carbonation of concrete

One of the most common degradation processes is the carbonation of concrete.

Carbon dioxide present in the atmosphere and in animal housing spaces penetrates the pores of the concrete and reacts with the alkaline compounds of the cement [17].

As a result of these reactions, the pH of the concrete drops significantly, reducing the protective capacity of the metal reinforcement.

Over time, this phenomenon leads to corrosion and the detachment of the protective layer from the concrete [18].

The process is accelerated in livestock buildings with insufficient ventilation and high humidity.

Sulphate attack

Animal manure, wastewater, and certain types of soil can contain high concentrations of sulphates [19].

These compounds react with the hydration products of cement and generate expansive substances that cause cracking and degradation of concrete.

Sulphate attack is commonly encountered in manure storage areas, drainage channels, and wastewater collection basins.

The action of nitrogen compounds and ammonia

Fermentation of manure produces ammonia and other aggressive substances that attack both metal elements and concrete structures [20, 21].

In insufficiently ventilated spaces, high concentrations of ammonia accelerate corrosion processes and reduce the lifespan of installations and structural elements.

Physical aggression

The action of freeze-thaw cycles

Water that penetrates the pores of building materials increases its volume through freezing, generating significant internal pressures.

Repeated alternating freeze-thaw cycles produce:

- cracks;
- peeling;
- material detachment;
- reduction of structural strength.

This phenomenon is frequently encountered in unheated buildings, outdoor platforms, and elements directly exposed to climatic factors [22, 23].

Shrinkage due to humidity variations

Changes in environmental humidity cause dimensional variations in concrete and other building materials.

Evaporation of water causes contractions that generate internal stresses and promote the appearance of cracks. These defects constitute entry points for aggressive agents and accelerate degradation processes.

The action of high temperatures

Fires represent one of the most severe forms of physical aggression against livestock buildings.

High temperatures affect the strength of concrete and reinforcement, causing deformations, cracks and loss of load-bearing capacity of structural elements [24, 25].

Mechanical aggression

Wear and tear caused by animals and machinery

In livestock farms, floors and building elements are constantly subjected to mechanical action generated by the movement of animals and machinery.

These stresses produce:

- abrasion;
- superficial wear;
- material detachment;
- damage to the protective layer.

The phenomenon is accentuated in areas of heavy traffic and in feed handling areas.

Erosion

Water used for sanitation and cleaning can carry solid particles that cause wear on concrete surfaces.

Erosion is commonly found in drains, gutters, and wastewater collection facilities [26].

Overload

The use of heavier equipment than those provided for in the design can lead to excessive deformations and structural cracks.

These effects reduce the safety of exploitation and accelerate degradation processes.

Manifestation of degradation in livestock buildings

The main defects observed in livestock farms are:

- cracks and fissures;
- peeling of concrete;
- detachment of the coating;
- efflorescence;
- corrosion of reinforcement;
- infiltration;
- deformation of structural elements;
- degradation of floors.

The appearance of these defects is the result of the simultaneous action of several environmental factors and represents an indicator of reduced construction durability [27].

Corrosion of reinforcements

Reinforcement corrosion is one of the most serious forms of degradation of reinforced concrete structures [28].

The penetration of moisture and aggressive substances through cracks or porous concrete promotes the oxidation of reinforcement.

Corrosion products occupy a larger volume than the original metal and generate stresses that lead to the detachment of the concrete.

In livestock buildings, this process is accelerated by the presence of nitrogen compounds, ammonia and salts.

Measures to increase the sustainability of livestock buildings

To reduce degradation and increase the service life, the following measures are recommended:

- use of concrete with reduced permeability;
- choosing materials resistant to aggressive environments;
- protection of metal elements against corrosion;
- achieving efficient ventilation;
- proper collection and disposal of manure;
- waterproofing of exposed surfaces;
- carrying out periodic inspections and repairs;
- monitoring the technical condition of the constructions.

CONCLUSIONS

Environmental factors have a significant influence on the technical condition and durability of livestock buildings.

Humidity, aggressive gases, manure, temperature variations and mechanical stress contribute to the progressive degradation of materials and structural elements.

Chemical, physical and mechanical aggressions act simultaneously and can generate complex damage processes, manifested by cracks, exfoliation, corrosion and reduced resistance of constructions.

Applying appropriate construction solutions, using resistant materials and implementing efficient maintenance programs are essential conditions for ensuring the sustainability of modern livestock farms and reducing long-term operating costs.

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