Scenario Buildings' Simulation in the Complex Security Tasks

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Abstract: This article was performed within the Russian State tasks MSUCE project "Methodology of ideas, design and verification of energy-efficient engineering systems conventionally abstract objects (on formal models of buildings)". In this article the method of use of scenario modeling techniques in the evaluation of complex safety of buildings. The methods of process modeling of the microclimate of buildings , electricity and water supply.

Introduction

Engineering systems of buildings (constructions) during operation are subjected to the load, typically a finite number of significant factors. These factors can be dependent on the person, or independent, predictable or random [1-5]. Obviously, some of them, such as extreme heat, strong wind, and the like, represent a real danger to humans. It is also undeniable that human security in such cases depends on the ability of engineering systems to provide sufficient resistance to foreign factors. For engineering systems of buildings could provide such resistance, they are already at the design stage should be based on the required resource (additional battery power, tanks of water for the needs of fire suppression etc.).

Discussion

The upper ones define the main engineering problem in general terms: determination of the optimal amount of resources engineering systems. If we assume the possibility of simultaneous exposure to all hazards, measures to ensure an acceptable level of safety will require more than substantial costs at all stages of the life cycle of the building (construction). At the same time, if you are designing a priori exclude the possibility of simultaneous action of several factors, or to neglect any of them, the consequences can lead to situations that threaten the life and health of people.

Obviously, a reliable way of forming reliable sets of influencing factors is the scenario creation. So, for any object on the basis of statistical data and expert estimates, with known probability delineate the range of scenarios of emergency

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situations that may arise in the course of its operation. Under emergency is a situation - the set of system's conditions (construction site's), fixed some indignation, causing unpredictable change the actual functional and/or technical characteristics of the building (construction) and/or items that violate the steady state of the construction object [4,5]. For example, for an arbitrary building a set of scripts may contain, for example, caused by fire due to faulty wiring, flooding, explosion of domestic gas, the destruction of the bearing and enclosing structures due to land subsidence or other geo-ecological changes and so on. Any of these scenarios will meet, as a rule, the original set of requirements for resource engineering systems.

Come back to the classification. Calculation and emergency situations are characterized by predictable and unpredictable change the actual functional and/or technical characteristics, as well as preservation or violation of the steady state of the construction object, respectively. The emergence of computational situations and assumes, as a rule, accordingly, is taken into account at the design stage of a building (constructions), i.e, characterizing the situation as a settlement, the engineer defines the parameters of the steady state of the object so that the occurrence of a settlement of the situation did not lead to any significant change or dynamics of such changes in the required extent offset by a corresponding control (or a particular sequence of control actions) of the original system, operating in the engineering and equipment construction site. It is said, however, does not determine the fact that any abnormal situation, in turn, is a consequence of unpredictable disturbances. The main role has just the second part of the determination. In practice, the class predicted perturbations of a steady state construction projects is very small. On the other hand, economically, and on a number of other important criteria, including the timing of construction, the objective necessity of conformity of a building or structure to a specific functional purpose, etc., obviously unjustified is the design and construction of the object so as to reduce the class of contingencies to empty, i.e., in fact, by making it part of the class settlement. Current design practice "close eye" on many abnormal (by definition) the situation in force, for example, objectively low likelihood of occurrence, a significant increase in cost and construction time in the event the design and creation of the appropriate "compensation" systems, etc.

Thus, the calculated and emergency situations are not clearly defined concepts. At the design stage of a building or structure engineer should seek a reasonable compromise in the construction of classes of situations, considering the above factors and the objective constraints. As practice shows, this becomes a major problem, the solution of which determines totally the efficiency of the design process. Moreover, the real dynamics of the changing characteristics and operating conditions of the system may, in some cases, to transform the settlement of the situation in abnormal and vice versa.

In practice, the functional design of control systems of buildings (constructions) is proposed to divide disturbances, or otherwise provoking the calculated and contingencies, as follows:

- ordinary;
- likely;
- possible;

- the exceptional (extraordinary).

It is appropriate to give now the definition of ***the steady state*** of the construction object, which should manage in further reasoning. ***The steady state*** construction project is a condition in which the actual features and specifications of the building (construction) and its elements correspond to the possible values of the invariant in this system), and the dynamics of their change does not involve violations of invariance in the estimated future [4,5].

Omitting relevant formal definition of "sustainability", will focus only on one important aspect of the analysis which extends the classical declarative representations about sustainability in Cybernetics in terms of existing mathematical grounds (for example [9]). We are talking about the dynamics of changes of system parameters. The main idea is that in the context of the stated problem, the stability of the system cannot and should not be defined solely by her instant, arbitrarily considered by the state. In other words, ***if probable foreseeable sequence of changing system's states or arbitrary sets of system's parts may lead to the invariance violation of some observable characteristics, such condition may not be considered sustainable.*** The theoretical basis of such assumptions is the ability to evaluate:

1) probability of the assumed sequence of transitions;

2) amount (or degree) visibility of this sequence is the essence of the time period (or number of selected discrete stages of evaluation of the system state), during which the specified sequence may be initiated and/or completed.

The next step is determining the amount of resources sufficient engineering systems of the building for an adequate response to emergency situation, and ensuring the safety of people and material values. Such calculation complexity must take into account the dynamics of the process. This is due to the consistent development of scenarios: for example, from the auxiliary heating system prior to flooding wiring and subsequent fire. Such calculations are invited to perform with the use of specially developed mathematical models of engineering systems of buildings (structures).

The mathematical model constructed in accordance with the modular principle. So, created the model has a set of blocks:

- the water supply system;
- thedrainage system;
- the ventilation system;
- the air conditioning system;
- the heating system, etc.

Each system in turn contains blocks corresponding to its functional nodes. So, block heating system contains blocks:

- the heat exchanger ETC;
- the supply pipeline;
- the radiators;
- the return line, etc.

Accordingly, each of the next block, if necessary, includes the blocks of the lower level. At the lowest level are the basic blocks of nodes of engineering systems, such as a block heater first heated in the air-conditioning system. The modeling of the operation of these blocks is based on the description of transfer functions' processes, according to the theory of automatic control methods. For example, the block temper heater contains transfer functions "influence of coolant flow in the coil of the first heating temperature and the influence of the coolant flow in the heater preheating the relative humidity of the air."

During and upon completion of the modeling process guided by the principles outlined can monitor the effect as a separate external factors or parameters of engineering systems of interest to the designer of the indicators and the impact on these indicators of the totality of the factors stipulated in the simulated scenario.

In Fig.1 as an example, shows a plot of the effect of the number of people staying in a room on the relative humidity.

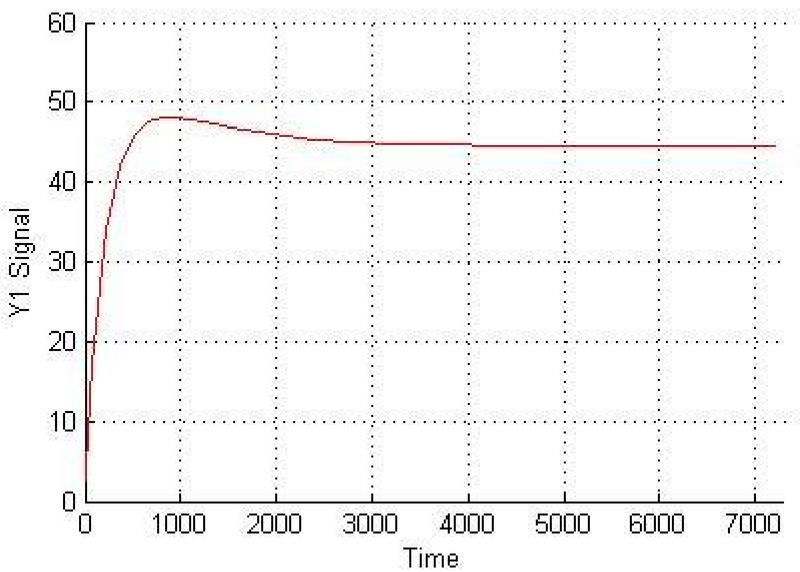

Fig. 1. The influence of the number of people in the room at a relative humidity

Generally to simulate any scenario, the input of the mathematical model it is necessary to enter the architectural parameters of a building or structure, the physical parameters of engineering systems, climatic parameters, the location of the object and the parameters of the microclimate, which must be maintained in each room in the passing of expect script.

Upon completion of the modeling process designer provides data on the number of resources required engineering systems for adequate compensation of the influence of external factors. These resources include both consumable values (water, heat, electricity, etc.), and characteristics of the fences, emergency tanks and so on.

After, the receiving data on required resources for a successful response for each scenario, it is necessary to establish the optimal amount of resources, because the provision of readiness' 100% to respond to a worst case scenario can greatly increase the cost of construction.

This assessment can be conducted using the mass service theory's methods.

The operation of any system of mass service consists in performing inflowing stream requirements or applications. Requests are coming one after another in some totally random moments in time. Service applications continue for some time, after which the channel is released and is again ready for receiving the next request. Each queuing system, depending on the number of channels and their performance has an established bandwidth that allows more or less successfully to cope with the influx of applications in the manner described.

In this case, the application must understand the impact of various factors on the object, and under the maintenance - engineering systems to compensate these effects.

The response of engineering systems at the flow of the factors described each scenario in terms of the theory of mass service is represented as a random process with a countable set of states and continuous time.

Thus, methods of the theory of mass service allow us to determine the necessary amount of resources engineering systems for effective response at all possible scenarios with a given reliability. Reliability is determined by the security requirements for different buildings), while the probability of whether a scenario is determined on the basis of statistics and expert estimates.

In summary, scenario simulation of buildings and structures allows the design stage to thoroughly assess the conditions of the object from the point of view of integrated safety and to determine the optimal engineering solutions that respond to emergency situations with the required reliability [1-8].

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