STABILITY OF BUILDINGS AND STRUCTURES RESEARCH: ANALYSIS OF EXISTING DESIGNS, MATHEMATICAL METHODS, AND MODELS

Makhmudov Said Makhmudovich,. Askarova Mukhlisa,Bakhromjon

Professor
Tashkent University of Architecture and Civil Engineering (Uzbekistan),
a researcher,
Andijan Institute of Construction and Economics (Uzbekistan)

Abstract: The aim of the research is to determine the risks of building destruction by developing a mathematical model and algorithms for studying the stability of buildings on soils with a heterogeneous structure.

Key words: Algorithm, soil, groundwater, liquefaction, stability, heterogeneity, model, construction, destruction, earthquakes.

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In order to determine the type of deformations that occur, it is important to examine the problem of modeling structures and structures. According to the information that is currently accessible, processes of groundwater return to their former channels have been observed over the past few decades as a result of an increase in groundwater and reservoir water. This explains the soil liquefaction that occurred in the Japanese city of Niigata in 1964, which caused huge house collapses and water to flow everywhere. A brand-new 13-story building in Shanghai collapsed in 2009 as a result of carelessness during construction and ground inquiry. The building was constructed on unstable soil with a clay surface, as it came out afterward.Buildings and structures fell as a result of inadequate understanding of the soil conditions.

Folded regions, which are indicative of inclined soil formations, are constantly developing. High-rise building complexes are constructed not only at the bottom of hills but also on incline slopes with heterogeneous soils. However, Uzbekistan continues to build high-rise structures with an increasing number of stories, and the underground portions of these structures extend farther into the ground, approaching in some areas filtration-water-saturated soils.

The problem of creating models for the strength, devastation, and stress-strain state of the soil massif of a layered and heterogeneous structure is important from a scientific perspective. The stability of buildings being built cannot always be predicted using preliminary experimental investigations of the surface local soil lithology. In light of this, it is imperative to study them using cutting-edge mathematical modeling and computer technology, as well as the fundamental laws of mechanics of a deformable solid body, along with the development of new failure criteria for anisotropic soils and a software program for analyzing the strength of the foundation. Building regulations do not currently give enough consideration to the impact of tectonic compression of sediments and rocks near the earth's surface. It is well known that the value of the tectonic force's horizontal component rises directly as the depth grows. In order to properly understand the stress-strain state, it is necessary to consider the impact of tectonic forces as well as hydrostatic forces related to the water saturation of the soil and pore pressures.

Ansys is an example of well-known software that is currently available but is costly and requires lengthy user training. In light of this, it is clear that it is necessary to create a domestic software product, a mathematical model, and algorithms that will enable you to research the strength of the earth during the planning phase of building construction. Поэтому данное научное исследование является актуальным.

The study's goal is to develop a mathematical model and algorithms for analyzing the stability of structures on soils with an uneven layered structure, as well as a software tool for calculating the likelihood that a structure will collapse.

In order to accomplish this, a mathematical model of a soil massif in contact with the underground portion of a buried foundation of a layered inhomogeneous structure was created. The boundaries of the computational area were "cut out" of an infinite half-plane to provide justification for their existence.

A mathematically described algorithm has been created to regulate the stability of the "heterogeneous soil-foundation-building" system. [2,].

In order to solve the problems of determining stability and destruction under the action of geostatic, gravitational, hydrostatic, and tectonic forces, a set of programs for multivariate studies of the stress-strain state of a system consisting of a building, a foundation, and a soil base have been developed. Additionally, algorithms based on the GKKlein method, matrix algorithms for computer simulation, have been created for a mathematical model of a soil base layered inhomogeneous structure. Various natural forces operating on a system made up of a building (construction), a foundation, and a soil base are represented by algorithmic formulas.

Using a software program, patterns of stress concentration formation and a zone where soils in touch with foundations are destroyed are established, resulting in the tilting and collapse of buildings and structures.

Calculations show the regularities of different soil foundation deformed states and cellar floor deformed states under the influence of the geostatic force. It is examined how the stress-strain condition of the "heterogeneous base, foundation, and building" system affects the gravitational load. The stress-strain state is then examined while accounting for the tectonic force operating on the structures' underground, buried portions. Separately, hydrostatic loads brought on by water saturation in the underground portion of structures and the impact of wind load on the overall stress-strain state acting on the ground parts of structures are examined. The complex impact of all the listed forces is investigated, followed by a look at the stress-strain state. Diagrams and drawings depict the destruction zones close to the foundation soils based on the analysis of the calculation results that identify the areas where stress concentrations develop.

A composite beam resting on a heterogeneous foundation is used in this study to model the system "building-foundation-heterogeneous foundation" [3]. The subsequent duties were accomplished concurrently:

A composite beam is unhinged and presented as distinct independent beams in order to address issues. In the conventional setup, each beam is viewed as a simulated beam that is loaded with unknown forces R0, R1 and R2 that occur at the cut spots, as well as a distributed load q(x) (the dead weight of the building framework and foundation). In this instance, the upper face of the simulated beam is brought under the self-weight of the building framework and the foundation.

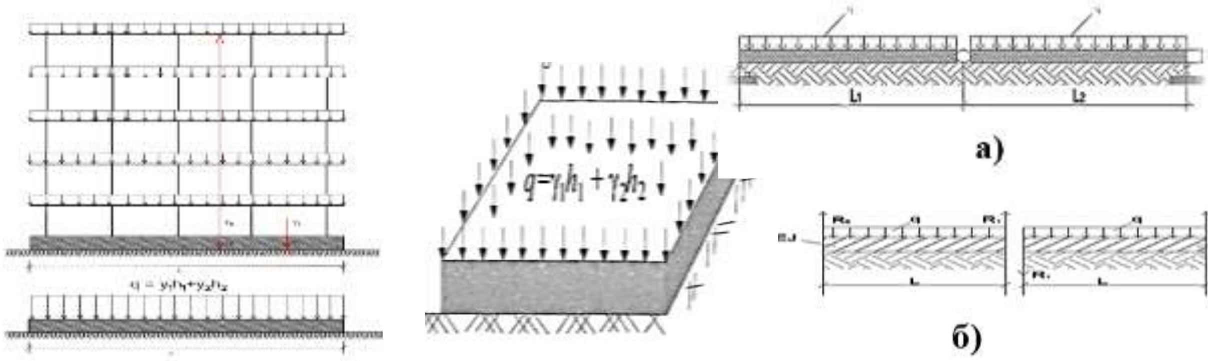


Figure 1. Design schemes of the simulated beam lying on an inhomogeneous foundation.

(a-given scheme; figure b-calculation scheme;);

Here q(x) = $y_1h_1 + y_2h_2$ – self-weight of building structure and foundation

The continuous inhomogeneous medium model of soil foundation, or medium in which the modulus of deformation changes with depth in accordance with a power law, is currently capturing the interest of many researchers. G.K. Klein created a technique for beam calculations on an uneven soil base whose deformation modulus varies in accordance with the law for the first time:

$$E = E_m Y^m \; ; \tag{1}$$

Here E - soil deformation modulus, m-coefficient of soil heterogeneity.

The solution of the problem under consideration is reduced to establishing the law of distribution of reactive pressures of bases *P(x)* on the basis of a system of three equations.

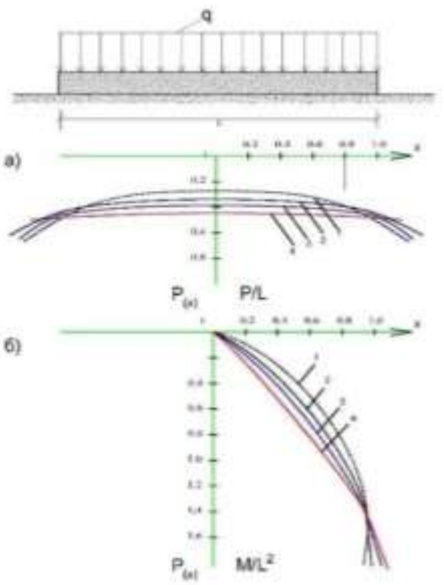
1. The first of these is the differential equation for beam bending

$$\frac{d^4W}{dx^4} = \frac{l^4}{EJ}[q(x) - \mathrm{p(x)}]; \qquad (2)$$

here W - beam deflection; EJ - beam bending stiffness

2 .The second equation expresses the precipitation of a heterogeneous base, according to G.Ya. Popov, has the form:

$$V(x) = \frac{al}{\pi E_m l^m} \int_{-1}^{1} \frac{p(s)ds}{(x-s)^m}; \qquad (3)$$



3. The third equation is the contact condition of the beam surface with the base, which is expressed by the identity:

$$\mathrm{W(x)=V(x)}; \qquad (4)$$

In addition to the above equations (2), (3) and (4), the beam equilibrium conditions and the boundary conditions of the problem under consideration must be satisfied.

Figure 2. Base jet pressure diagrams

According to T.Sh. Shirinkulov[4], we are searching for the desired function *P(x)*, satisfying the aforementioned equations, in the shape of a number of Gegenbauer polynomials, i.e.:

$$p(x) = \frac{1}{\sqrt{(1-x^2)^{1-m}}} \sum_{t=0}^{\infty} A_i \, C_i^{\frac{m}{2}}(x); \qquad (5)$$

Here $C_n^{\frac{n}{2}}(x) -$ the Gegenbauer polynomial

The following results are produced when the stress-strain state of the "building-foundation-heterogeneous base" system is calculated using a simulated beam situated on an inhomogeneous base.

Diagrams of the reactive pressure of the bases were constructed based on the study findings and taking into account formula (2) with the coefficient of soil heterogeneity m=0, m=0.25, m=0.5, and m=0.75. Thus, when accounting for m=0.25, m=0.5, and m=0.75, the reactive pressure of the base plot at m=0 deviated considerably from the plot of the reactive pressure of a homogeneous base, with a decline at the edge of the simulated beam and an increase in the center of the beam.

Conclusion.

1. With the study of current techniques for evaluating the stability of buildings and the deformability of soil massifs under different conditions, a review of collapses and destructions occurring in Uzbekistan and overseas was conducted.
2. The study's findings indicate that there are no solved issues for figuring out the stress-strain and pre-fracture states of the soil base of buildings with layered inhomogeneous structures and various natural laying angles.
3. For the mathematical model of the object under study, which consists of a building and a foundation in a heterogeneous soil base, an algorithm has been created.

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