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Creating new technically stable building structures from composite materials

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Abstract. This article discusses the creation of sustainable "viable" structure and facility construction from composite nanomaterials that have the properties of preserving original forms and recovering when internal and external loads are applied to them. The necessary requirements for the manufacture and operation of the composite nanomaterials are also presented. Modern design and construction in a cramped urban environment, the creation of territorial planning for a "vial" sustainable complex implies a paradigm of attitude towards nature, which introduces a system of new problems that were not always considered in the past: the quality of the environment; conservation of resources; social equity; control over emissions of pollutants; health of the population, etc. All of this requires a deliberate development of public consciousness and new ideas, which is emphasized by.

The emergence of new composite nanomaterials that are more resistant to changes in natural and climatic conditions (temperature, subsidence, seismic, ice, etc.) and which preserve and restore the forms of shell structures under the influence of static and dynamic loads, including seismic loads, allows to solve the tasks at hand.

When considering seismic phenomena, the following processes are determined: tectonic; volcanic; denudational. The most significant and solvable process nowadays is denudation, which is associated with karst failures, mountain landslides, dynamic impacts during various works that occur near the earth's surface and, possibly, their amplitude decreases with depth, and the penetration depth corresponds to the wavelength, they occur after the S waves and their propagation velocity is less.

Various means can be used to prevent and forecast them. For example, when creating soil-filled structures an anchor shell is placed at their base, taking on the load from surface and acoustic waves, as well as those occurring in the form of *L* or *R* waves.

All measures for seismic protection are divided into active, aiming at reducing their magnitude and passive, aiming at improving the seismic stability of objects. We are currently developing principles for the design and construction of seismic resistance of the structure: reducing their mass, i.e. using light and strength-effective rational forms; ensuring the conditions for plastic deformations in their elements upon possible overloads, possible plasticity, i.e. due to plastic deformations, seismic energy is absorbed and

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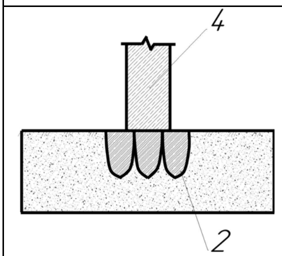
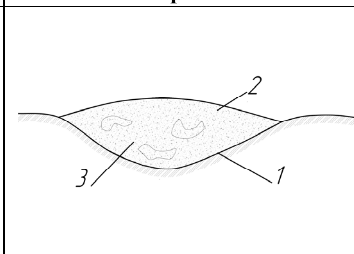
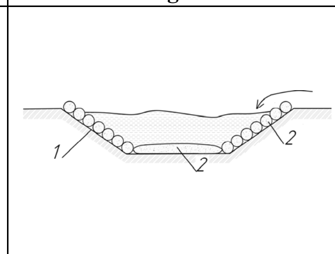
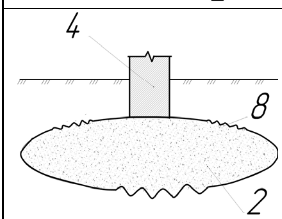
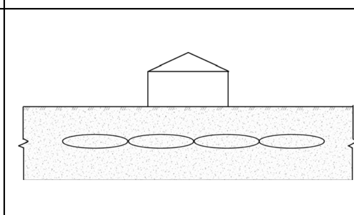
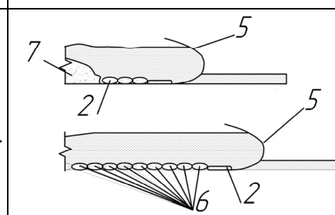
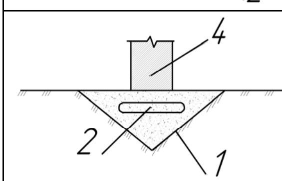
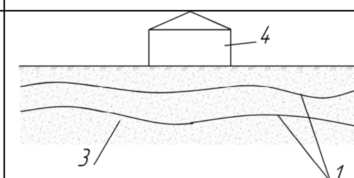
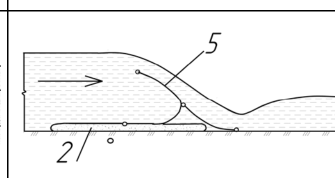
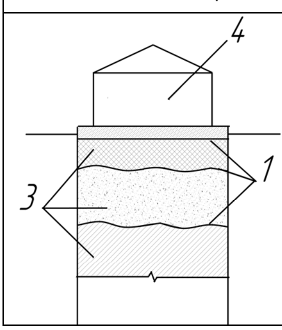
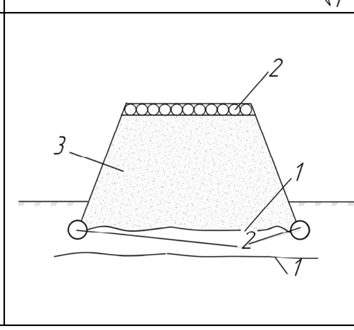
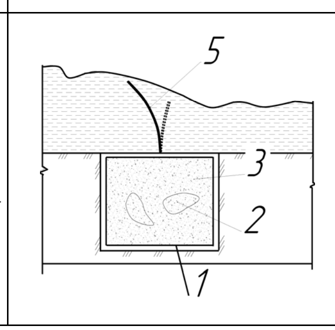
oscillations are dampened, also, the structural system is reorganized, allowing one element to slide relative to another (Table 1)

We carried out theoretical and experimental studies of the technical solutions presented in Table 1 to prevent seismic impacts on human activity and environment, whereby the periods of natural oscillations of buildings and structures were determined during the elastic stage of structure deformation, taking into account their characteristics [1-5].

Table 1. Technical solutions for the safety of inhabited buildings

Strengthening foundations	Protection against man-made impacts	Protective structures during emergencies
		
		
		
		

1 – geosynthetic material; 2 – primer-filled envelope; 3 – priming; 4 – base of buildings; 5 – membrane cable-stayed dams; 6 – curable casings; 7 – mudflow; 8 – damper.

During the theoretical justification of the structure parameters, the calculated values of transverse and longitudinal forces, bending moments, normal and tangential stresses Np from seismic actions under the condition of their static action. When carrying out research and design, we can mainly take into account surface acoustic waves, that is, L and R waves that occur near the earth's surface and the amplitude of their soil movement decreases with depth, with the depth of penetration being approximately equal to the wavelength. When determining the location of the construction of the facility, take into account the antiseismic measures, taking into account the maps of seismic intensity, taking into account the responsibility of the structure (A, B, C). One of the main design rules takes into account the change in the intensity of soil vibration as a function of its elastic properties (density-, humidity P% consistency, etc.). In this case, Np is determined from the dependence:

$$N_p = \pm\sqrt{\sum_{i=1}^{n} N_i^2} \tag{1}$$

where N_i – is the value (forces, moments, voltages, displacements) caused by seismic loads corresponding to the i-th mode of vibration, n is the number of vibration modes.

The conditions for choosing the bases of buildings should correspond to reliability and safety:

$$T_1 > 1,5T_0 \;\; or \;\; T_1 < T_0$$

where T_1 is the period of the first form of free oscillations of structures T_0 – the period of free oscillation of the soil sequence determined by the dependence:

$$T_0 = \frac{4H}{V_s} \cdot V_s = \frac{E}{\sqrt{2\rho(1+\nu)}} \tag{2}$$

where H is the total thickness of the soil strata in m; E – modulus of deformation of soil, $\frac{kN}{m^2}$; ρ – density of soil, $\frac{kN}{m^3}$

Then the movements in the shell structures can be determined from the following relationship:

$$T = f(\Phi, N_1, N_2, N_p, A, t, \lambda) \tag{3}$$

where Φ – the form of a shell soil-filled structure, which is calculated by the formula: $y = \left(1 - \sqrt{1 - \frac{\sin^2\varphi}{K^2}}\right) \cdot h$, where φ – the angle of internal oil-filler friction, in degrees; K – elliptical modules. N_1, N_2 – internal and external loads, kN; A – properties of the composite nanomaterial that meets the natural and climatic conditions of the operation of structures $A = f(E, \sigma, G, S)$, where E – Young's modulus $E = \frac{\sigma}{\varepsilon}$, $\sigma = E\varepsilon$, where ε – relative elongation shear modulus, Pa; $G = \frac{\tau}{\gamma}$; λ – recovery energy, J; t – life cycle of the structure, S – instantaneous strength which is determined by the Arrhenius relation, $\ln S = \ln S_0 - k''te\frac{Q}{F}$, where S_0 – initial strength; Q – activation energy; F – reaction energy; k'' – includes constants k and k' and is a function of the concentration of substances, as well as their nature; k' – constant characterizing the defect size; k – constant depending on material $k = f(\varepsilon_x, \varepsilon_y)$, where ε_x and ε_y – coefficients of relaxation of the composite material in time.

The components of the composite nanomaterial have a clear border between them, however, when manufactured the inhomogeneous continuous material should be in a heterophase system that preserves the individuality of each of the components. The matrix is the most important element of the composite, because it distributes the acting stresses along the material, while ensuring a uniform load on the fibers and redistributing it when it breaks down. Therefore, requirements are directed towards it during manufacture and operation [5-15].

Specific methods are presented for the technological manufacture conditions of composites with the ability to perform when designed, giving it characteristics that will meet the requirements: high stability under changing natural and climatic conditions; high specific strength; ergonomics and preservation of the specified parameters, etc. For operation conditions the following should be taken into account: physico-mechanical and physico-chemical properties; temperature; resistance to the environment; strength characteristics under shear loads; loading of the composite in directions that differ from the orientation of the fibers, including cyclic loads (including seismic loads) this will help to ensure ecological safety and reliability of the entire structure as a whole, that is, to consider the previously carried out theoretically and experimentally, in-situ study of soil-filled soil-cured membrane, ground-reinforced and similar structural elements in solving the problem of the integrity of the system, appears as one of the aspects of emergence, i.e. system approach, which regards the functioning of the system as the interaction of elements as a single dynamic technical system, as their ordered existence as a whole and not reducing to the properties of individual elements. For example, the developed technical solutions in which all the above-mentioned structural elements function, interact in the engineering protection system, from floods, mudflows and the like. [1, 19-21].

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