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THE DEVELOPMENT OF THE NATIONAL LEGAL FRAMEWORK ON THE BASES AND FOUNDATIONS FOR BUILDINGS AND STRUCTURES DESIGN

The main document of the regulatory framework for the bases and foundations of buildings and structures design is DBN V.2.1-10-2009 (with Amendments No. 1 and No. 2). For the replacement of existing DBN it is proposed to develop a system of regulatory documents that will include DBN V.2.1-10:201X «Bases and foundations of buildings and structures. Main provisions» and standards for its development. The project provides the principles (general provisions) and requirements regarding the design, construction and reconstruction of bases and foundations for the buildings and structures of all types and classes of consequences (responsibility). The attention is focused on the peculiarities of foundations calculations according to design features and interactions with the base and various depth foundation design.

***Keywords:** bases, foundations, buildings, structures, class of consequences (responsibility), design, construction.*

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РОЗВИТОК НАЦІОНАЛЬНОЇ НОРМАТИВНОЇ БАЗИ З ПРОЕКТУВАННЯ ОСНОВ І ФУНДАМЕНТІВ БУДІВЕЛЬ ТА СПОРУД

Основним документом нормативної бази стосовно проектування основ і фундаментів будівель та споруд є ДБН В.2.1-10-2009 (зі Змінами № 1 і № 2). На заміну існуючого ДБН запропоновано розробити систему нормативних документів, що включає ДБН В.2.1-10:201Х «й ряд стандартів у його розвиток. У проекті наведено принципи (загальні положення) і вимоги до проектування, будівництва й реконструкції основ і фундаментів будівель та споруд усіх видів і класів наслідків (відповідальності). Акцентовано увагу на особливості розрахунків фундаментів за конструктивними особливостями й умовами взаємодії з основою, проектування фундаментів різної глибини закладання.

***Ключові слова:** основи, фундаменти, будівлі, споруди, клас наслідків (відповідальності), проектування, будівництво.*

Introduction. At present, most of the territories without any significant ground surface gradients, with usual geological conditions and without dangerous geological processes have been built up. It led to reduction of vacant territories with favorable conditions for construction and the need to design and erect new construction sites on areas with difficult engineering and geological conditions and in zones influenced by dangerous geological processes.

These areas are characterized by the significant gradients of ground surface elevations, the possibility of landslide processes activation, the high levels of groundwater standing, the difficult engineering and geological conditions, the presence of soils with specific properties etc.

The National regulatory framework of Ukraine concerning the bases and foundations design for buildings and structures includes a set of codes and standards on the bases and foundations design for buildings and structures in ordinary and difficult geological conditions and for zones with dangerous geological processes influences.

At present, the document DBN V.2.1-10:2009 with Amendments No. 1 and No. 2 is the main component of the Ukrainian codes and standards system concerning the bases and foundations design for buildings and structures in various engineering and geological conditions.

The bases and foundations of buildings and structures shall be designed considering the implementation of Technical Regulation on Construction Products, Buildings and Structures requirements [1].

The Minregion of Ukraine entrusted the Research Institute of Building Constructions to develop the new building standards for this field, which should meet the modern requirements to the development of construction standards and comply with the science development level and technology basis for the construction industry.

The first draft DBN V.2.1-10-201X «Bases and foundations for buildings and structures. Main provisions» was developed to supersede the document DBN V.2.1-10:2009 and its Amendments No. 1 and No. 2 [2 - 4]. For the new standards draft elaboration, a working group was organized. It included leading experts from design, production, research institutions and universities of Ukraine in the field of geotechnics.

Analysis of recent sources and publications. The issues of the bases and foundations design for buildings and structures for the usual and difficult geological conditions, as well as for the zones influenced by dangerous geological processes, the methods of bases strengthening and the constructive solutions for the buildings and structures foundations have been addressed in a number of codes and standards, including DBN V.2.1-10 with its Amendments No. 1 and No. 2, DBN V.1.1-45, DSTU-N B V.1.1-39, DSTU-N B V.1.1-40, DSTU-N B V.1.1-41, DSTU-N B V.1.1-42 and DSTU-N B V.1.1-44 [2-10].

Identification of unsolved issues in the problem under consideration. The existing complex of regulations and standards on designing the bases and foundations of buildings and structures does not provide the full possibilities for designing at the present-day level.

The document DBN V.2.1-10-2009 and its Amendments No. 1 and No. 2 were adopted rather long ago, so it is necessary to revise some of their provisions, which are outmoded and do not comply with the modern practice of bases and foundations designing for buildings and structures.

DBN V.2.1-10-2009 Amendment No. 1 contains the following improvements to the regulatory act text: Subsection 8.5 «Piles and pile foundations» was added; Annex Б was supplemented with terms and Annex Н «Calculation determination of piles bearing capacity based on the ground base properties» and Annex П «Calculation of piles and pile foundations by bases deformations» were added. But the additions given in Amendment No. 1 require refining the terms and calculation requirements and should be transformed into an appropriate standard DSTU-N «Guidelines on the design of piles and pile foundations». The principles of the piles bearing capacity determination based on the static tests data should be revised as well.

DBN V.2.1-10-2009 Amendment No. 2 contains the following improvements to the regulatory act text: items 4.20-4.22 were added to Section 4, items 5.13-5.18 were added to Section 5, Subsection 7.3 item 7.3.3 was set out in a new wording, items 8.3.5-8.3.7 were added to Subsection 8.3, and Annex P «The features of designing a base strengthened with soil cement piles» and Annex C «Stages and sequence of works on the structures erection for the buried and deep foundations and basement-foundation parts» were added. Besides, the text was subject to improvements as follows: 22 changes were made in various sections; 21 changes were introduced into Annex A; 2 changes were introduced into Annex B; 4 changes were introduced into Annex Д and one change was made in Annex Ж. But the additions presented in Amendment No. 2 relate to some improvements to the sections of DBN V.2.1-10 and references replacement in Annex A «List of regulatory documents cited in the Norms». Amendment No. 2 to DBN V.2.1-10-2009 should be converted into two new standards, namely, DSTU-N «Guidelines for shallow foundations design» and DSTU-N «Guidelines for deep foundations design» that should single out barrettes as individual elements of deep foundation structures with an increased bearing capacity, which are arranged using the technology of «ground walls» according to DBN V.1.1-46:2016.

The implementation of new DBN V.2.1-10:201X «Bases and foundations of buildings and structures. Main principles» and standards for its further development will allow updating the complex of regulatory documents on the design of the bases and foundations for civil engineering and production works, including buildings and facilities with basement floors, as well as for underground and buried buildings and structures designed for undeveloped territories and densely built-up areas, normal and complicated engineering geological conditions or the zones subject to hazardous geological processes influences.

Research objectives. The DBN V.2.1-10:201X code is developed to significantly improve the existing national construction standards [2-4] and bring them into conformity with the current needs and state of the legal framework of Ukraine and with international codes in the field of designing the bases and foundations of buildings and structures, as well as to ensure the norms continuity in respect of modern principles of such items designing. The code will be the main component of the system of codes and standards that establish mandatory requirements to the design of bases and foundations of buildings and structures and are intended for the use at all stages of the life cycle of construction objects [5 - 10].

The development of the DBN V.2.1-10:201X «Bases and foundations of buildings and structures. Main principles» first draft is carried out according to the DBN A.1.1-2-93 requirements.

Main material and results. The DBN V.2.1-10:201X first draft provides the general provisions and requirements for the design, construction and reconstruction of the bases and foundations of the buildings and structures of all types and classes of consequences (responsibility) and contains the basic requirements for bases engineering preparation design, the engineering surveys composition, environmental requirements to the buildings and structures bases and foundations design.

This code will be applied for designing the bases and foundations for new objects, as well as in the reconstruction and enhancement of objects in service.

The choice of the foundation types and strengthening means for the bases of buildings and structures should be based on technical and economic comparison of options and on engineering calculations, should consider the urban planning requirements and the requirements as to the environment protection and the rational use of land resources, and should ensure the territories stability and reliable trouble-free work during the estimated service life of the designed objects.

Calculations of bases, as well as of buildings and structures should be performed for the first (strength) and second (deformation) groups of limit states at the time of construction and operation of objects.

The DBN V.2.1-10:201X code was developed with the use of a parametric method, which is based on the goals and objectives hierarchy and widespread in the European Union countries and many others. The parameters include goals, bases and foundations functional requirements and criteria that the buildings and structures should meet. Parametric norms define the normative act purpose, and declare in the general form the basic principles (provisions) for achieving this purpose. They do not regulate the specific calculation methods, technologies, materials or products; therefore the various aspects of their application are not described.

The parametric method used in DBN V.2.1-10:201X envisages the determination of the bases and foundations parameters that ensure the safety, functionality and reliability of buildings and structures during operation. The national standards provide the basic rules ensuring the implementation of the basic principles (provisions) specified in the State Building Regulations.

The structure of the system of codes and standards on the design of bases and foundations for buildings and structures for the ordinary geological conditions of Ukraine is shown in the Fig. 1.

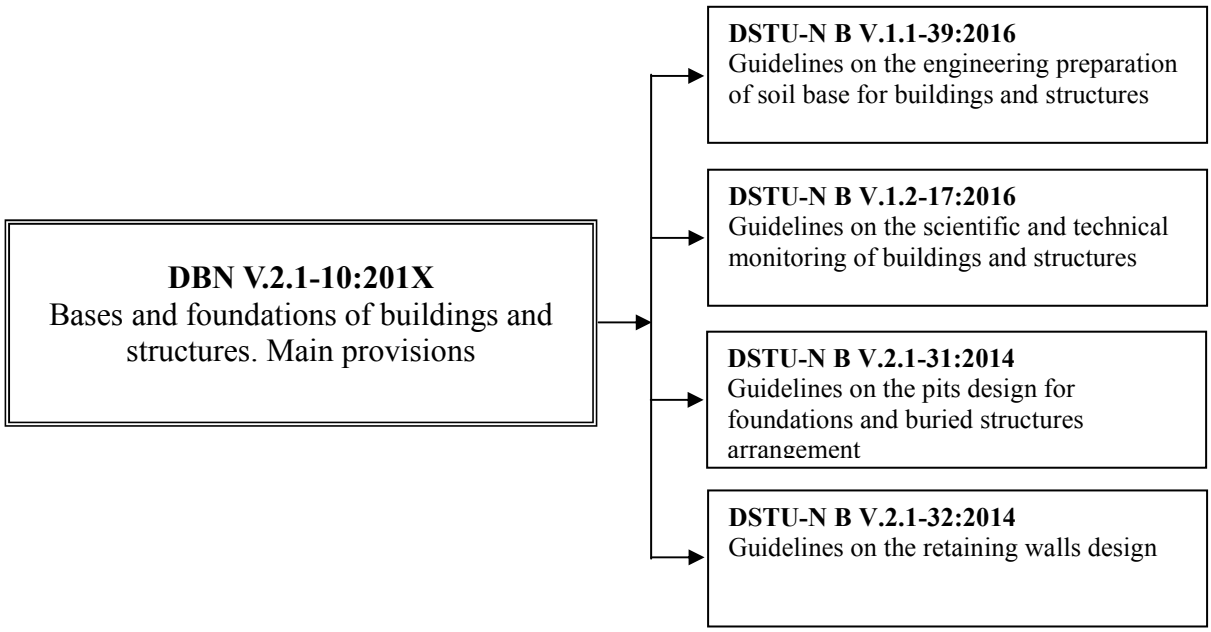

Figure 1 – The structure of codes and standards system of buildings and facilities bases and foundations design in the ordinary geological conditions

The structure of the system of codes and standards on the bases and foundations design in difficult geological conditions is shown in Fig. 2.

In Ukraine the areas of territories subject to dangerous geological processes and quantities of landslides and transitions of previously stable slopes (declivities) into the category of landslide hazard slopes permanently increase, resulting in the increase of geological risks of those territories development and emergency situations occurrences.

The structure of codes and standards system on the bases and foundations design for buildings and structures in zones influenced by dangerous geological processes is shown in Fig. 3.

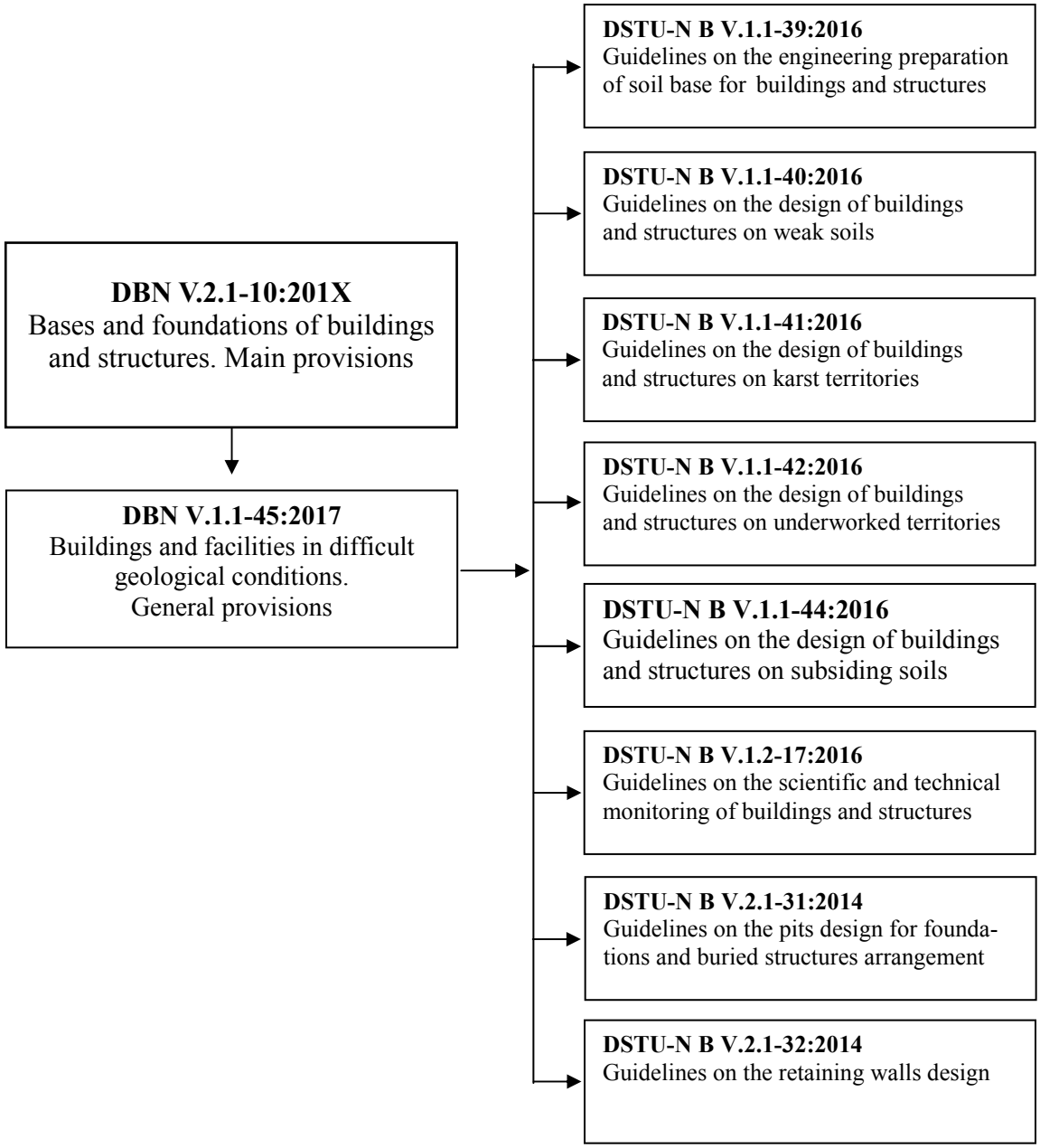

Figure 2 – The structure of codes and standards system on the design of bases and foundations for buildings and structures in the difficult geological conditions

In Fig. 4 the proposals for the DBN V.2.1-10:201X provisions development by means of the elaboration of additional standards on the foundations design for the buildings and structures of various purposes are shown.

In the DBN V.2.1-10:201X draft it is stated that the bases and foundations design for buildings and structures, and the choice of the foundation type/design and the method for bases preparation (if necessary) should be carried out taking into account the following data:

– the results of engineering surveys for construction in compliance with DBN A.2.1-1-2008. For structures with considerable consequences (CC3) the presence of geopathic zones should be taken into account;

– the data characterizing the purpose, as well as the structural and technological features of a building, loads acting on the foundation and the conditions of their operation;

– the feasibility study of alternate technical solutions for the basement-foundation section.

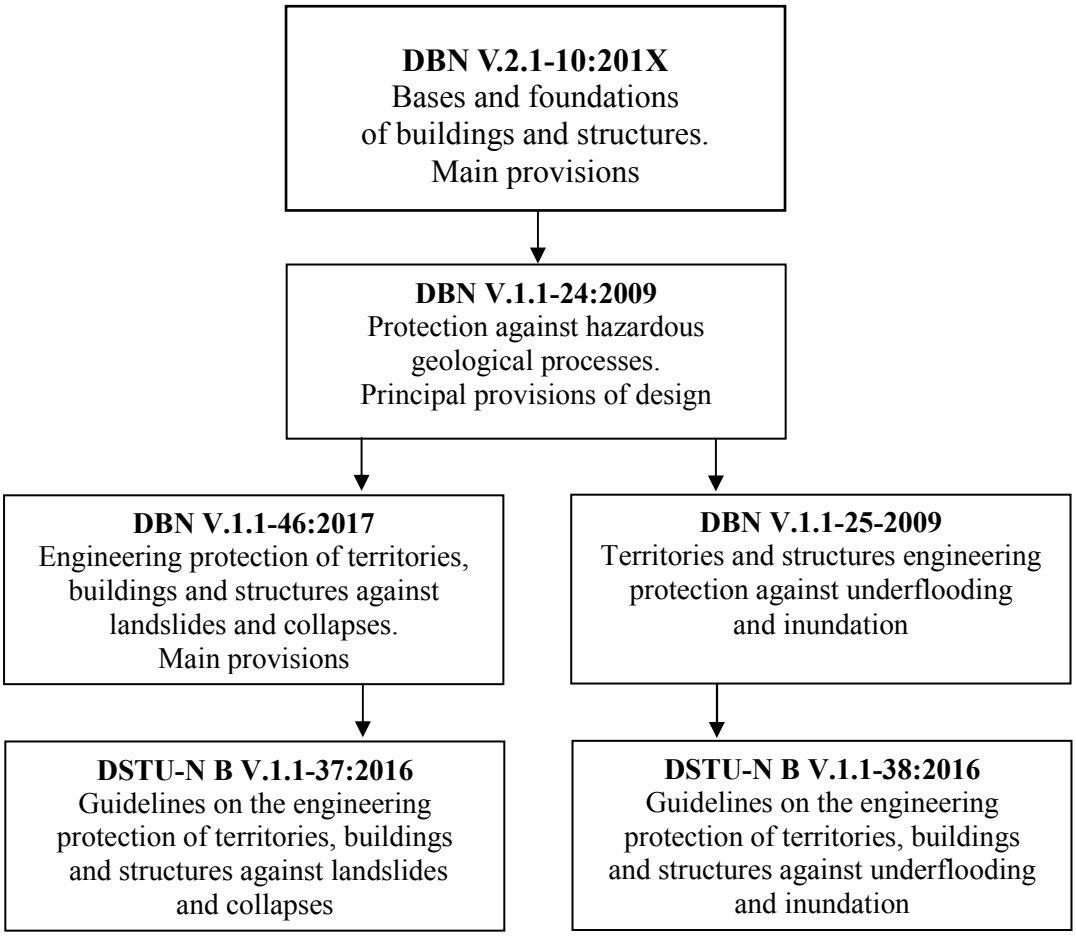

Figure 3 – The structure of codes and standards system on the bases and foundations design for buildings and structures in zones with dangerous geological processes influences

The design should ensure the most comprehensive use of the bearing capacities and deformability of base soils, as well as of the physical and mechanical properties of foundations and substructures materials.

All types of bases and foundations should meet the following requirements concerning:

– safety;

– serviceability;

– life duration (excepting the special cases specified for temporary buildings); and

– some additional requirements defined by the terms of reference on the buildings and structures design.

The bases and foundations should be designed with ensuring the implementation of the above mentioned requirements by the assignment of the following aspects: characteristics of the foundation materials and base soils; coefficients of reliability; loads and actions types; calculation schemes corresponding to the actual behavior of bases and foundations at the various stages of building construction and operation; structural, technological and operational requirements; and values of limit deformations (deflections, maximum and non-uniform settlements and rolls).

If the base design deformation under difficult engineering geological conditions exceeds the limit values or if the base bearing capacity is insufficient, the measures should be foreseen for the deformations negative influence mitigation.

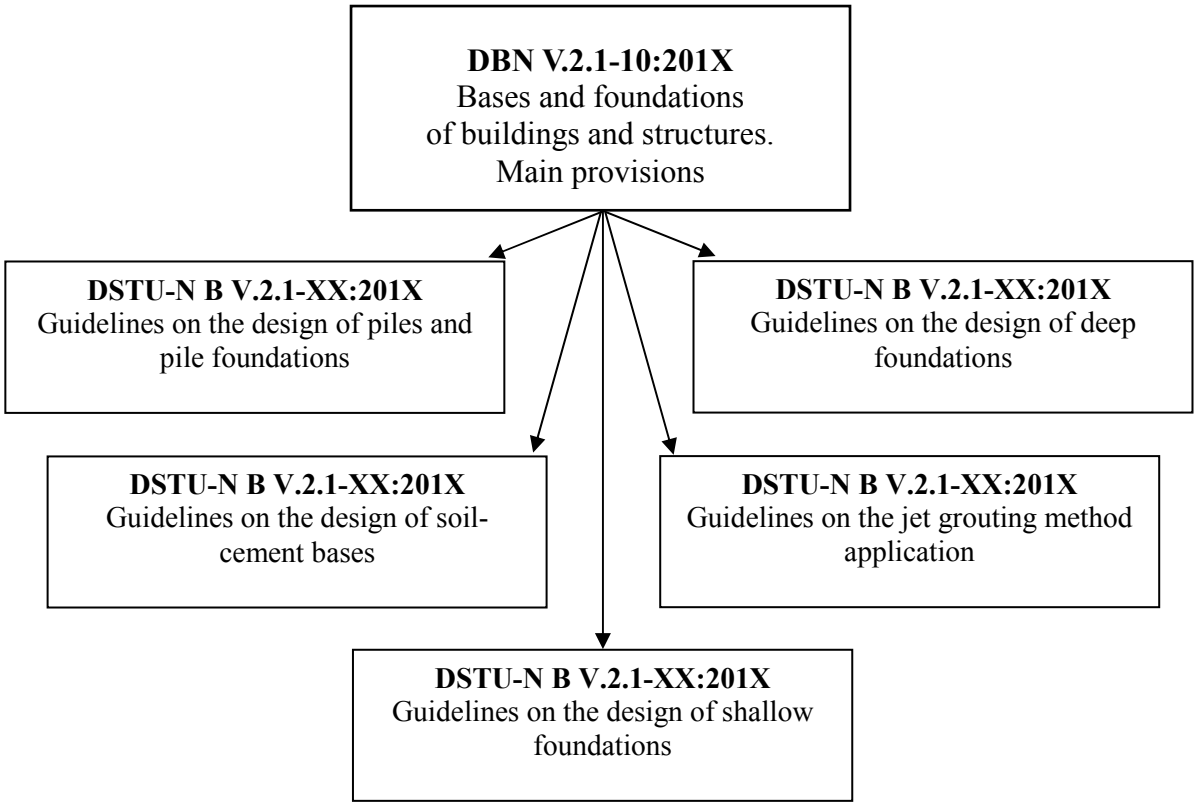

Figure 4 – The DBN V.2.1-10:201X provisions development proposals concerning the foundations design for the various purpose buildings and structures

When designing bases and foundations, it is necessary to envisage the cutting of fertile soil layer with the later using it for the regeneration (reclaiming) of disrupted or inefficient agricultural lands or for the building area planting with trees.

The bases and foundations should be designed based on the initial data necessary for the selection of foundations type, structure, depth and dimensions; the natural engineering preparation of a base or the arrangement of an artificial base; forecasting of buildings and structures bases and foundation deformations over time, making the decisions as to the environment preservation (protection); and the development of engineering measures for territory protection against hazardous geological processes.

The bases and foundations designing should include the computationally substantiated selection of the following data with taking into account the complexity category of geological conditions (DBN A.2.1-1-2008) and buildings and structures consequences class (DBN V.1.2-14-2009):

– the type of base, structures, materials and depths of foundations;

– engineering measures for the reduction of bases deformations influence on buildings operational qualities and the environmental protection ensuring.

The foundations and basement-foundation parts should be calculated as a building part according to the properties of base soil (natural or artificial) and its structures materials. The foundations analysis by the base soil properties should be carried out for two groups of limit states as follows:

a) the first group concerns the bearing capacity (strength and stability);

b) the second group concerns such deformations as settlements, rolls and horizontal displacements, and here the parameters of contact surface deformations in cases of their predicted occurrence in the difficult engineering geological conditions should be taken into account.

The foundations analyses for the first group of limit states are carried out in the cases, when the vertical and/or horizontal loads, including seismic or dynamic ones, act on the building; a building is located near a declivity or on a slope; a base is composed of rock or poor-bearing soils with specific properties or steeply dipping layers; a foundation works for pull-out, as well as in all circumstances, when calculations by base deformations are performed during a non-linear stage.

The foundations analyses for the second group of limit states are carried out in all cases based on the condition of the building or facility combined action with a base. The fundamental principles of bases and foundations calculations having a long history of their evolution and numerous practical applications are preserved in the new standards.

The calculations of foundations according to their structures materials should be carried out with respect to the actions of static and (or) dynamic loads from the structures resting on them; influences of the base non-uniform deformations; in the cases of their predicted occurrence in the difficult geological conditions and under the dynamic or seismic actions transmitted by the base, for the limit states of:

a) the first group, when the foundation materials strength is considered according to the requirements of concrete, reinforced concrete and masonry structures designing; and

b) the second group, when the deformations non-uniformity and cracks initiation or opening in reinforced concrete foundations are considered according to the reinforced concrete structures design requirements.

The buildings and structures calculations by base deformations should be carried out depending on the condition of their combined action. Calculations by bases deformations are carried out from the following condition

$$S \le S_u, \tag{1}$$

where S is a common deformation of the base and building determined by the calculation, mm;

S_u is a limit value of base and building common deformation, mm.

The foundations calculation by the bases bearing capacity is carried out to ensure their bases strength and durability, as well as to prevent displacements along a bottom or foundation overturning. The base failure scheme to be accepted at attaining the base limit state should be admissible in static and kinematic aspects for this influence and this design of a foundation or building.

The foundations calculation by the bases bearing capacity is carried out based on the following conditions

$$\sigma \le \sigma_u \text{ (in general) or } F \le \gamma_c F_u / \gamma_n, \tag{2}$$

where $\sigma = F/bl$, Pa;

σ_u is a stress corresponding to the base bearing capacity limit, Pa;

F is a design load on the base, N;

F_u is a force of base limit strength; the vertical component of the force of the base limit strength, N_u, N;

γ_c is a service conditions factor, which is accepted as follows for: sands, excepting dust sands, as $\gamma_c = 1.0$; dust sands and clayey soils in a stabilized state as $\gamma_c = 0.9$; clayey soils in a non-stabilized state as $\gamma_c = 0.85$; and rocky soils, including unweathered rocks and low-weathered rocks, as $\gamma_c = 1.0$; weathered rocks as $\gamma_c = 0.9$ and strongly weathered rocks as $\gamma_c = 0.8$;

γ_n is a safety factor by responsibility (importance coefficient) determined depending on the consequences class of an object in compliance with ДБН В.1.2-14-2009;

b and l are the dimensions of foundation faces in a plan view (width and length), m.

The limit strength force of a base composed of soft soils in a stabilized state should be determined in view of the requirement that the relation between normal and tangential stresses along all sliding surfaces, which corresponds to the base limit state, obeys the following dependence:

$$\tau = \sigma \, tg \, \varphi_I + c_I, \tag{3}$$

where φ_I and c_I are the design values of an angle of internal friction and soil unit cohesion, respectively.

It is allowed, when appropriate, to calculate the bases stability using the graphical analytic methods (with circular cylindrical or broken sliding surfaces), if:

a) base is irregular in depth and area;

b) surcharging of the base from the different sides of the foundation is different and the intensity of the larger of them exceeds $0.5R$;

c) building is located on a slope or near a declivity;

d) non-stabilized state of the base soils can occur.

In all cases, when the foundation is affected by horizontal loads, and the base is composed of soils in a non-stabilized state, the foundation should be calculated for shear along a bottom.

The foundation calculation for shear along the bottom is determined by the following condition

$$\Sigma F_{s,a} \leq (\gamma_c \Sigma F_{s,r})/\gamma_n, \tag{4}$$

where $\Sigma F_{s,a}$ and $\Sigma F_{s,r}$ are sums of the projections on the sliding plane of design forces that displace and hold, respectively, which are determined considering active and passive pressures of the soil on the lateral faces of the foundation.

If bearing capacity of natural soil bases is insufficient, it is necessary to perform their engineering preparation by improving their properties at the place of their occurrence to the required level or by their strengthening with arranged in them bearing or draining structural members of soil and other materials in compliance with DSTU-N B V.1.1-39 [5].

To improve the properties of soils in place of their occurrence it is possible to apply their mechanical (surface and deep) or physical compaction, as well as mechanical or chemical stabilization.

To strengthen the soil bases it is possible to apply the following engineering measures:

– replacement of poor-bearing layers with soils having higher mechanical characteristics;

– draining of water-saturated soils by means of drains from natural and/or artificial materials;

– bases squeezing by temporary embankments, including those with the arranged drains;

– mixing of poor-bearing soils with cement or other binder solutions;

– reinforcement of soil bodies with (stiff and/or having constrained stiffness) structural members;

– reduction of the bases lateral expansion under loading by means of bases enclosing with permanent sheet-pile or pile walls.

For the conservation of buildings durability and the elimination of the accelerated wear of reinforced concrete structures in watered environment the water protection designing for bases, underground engineering structures, buried structures, underground-foundation parts and foundations is performed. Requirements for water protection should be developed taking into account the following influences of water:

– the temporary ones due to atmospheric precipitation infiltration, underflooding by high waters or accidents at water conduits, and

– the permanent ones due to the presence of soil moisture or ground waters.

To prevent the penetration of ground water in buildings, structures and construction sites protected from flooding, it is possible to use the grout curtains arranged by the injection method or the method of trench walls. They are the most efficient when they reach watertight soils or soils of low permeability with the factor of permeability not exceeding 2x10-2 m/day.

The complex of activities on the protection of the bases and foundations of cultural heritage monuments should be executed within the framework of a special program. The geotechnical research program may be an independent document or a part of a comprehensive program of scientific and restoration research of the monument, which is elaborated for the development of monument conservation projects and the implementation of urgent works on its preservation. The program of the integrated investigations of the technical condition, as well as a plan of measures for the protection of the bases and foundations of landmarked buildings should be agreed upon by the executive authority responsible for the cultural heritage protection.

During designing the bases, foundations and underground or buried structures the engineering surveys should be carried out in accordance with DBN A.2.1-1-2008 in order to assess the engineering and environmental conditions on the territory (site) of construction (reconstruction) and forecast their possible changes.

The composition and scope of engineering and environmental surveys should be sufficient for obtaining information necessary for drawing the conclusion about the territory environmental safety during the construction. The deterioration of the environmental situation, which must be taken into account during the design, may be caused by the changes in the conditions of building development, hydrogeological processes and the technical solutions of construction objects.

The design must contain the engineering solutions necessary for the conservation, protection or improvement of the ecological situation on the site of construction and adjoining territory.

The design should envisage the measures for the prevention or protection of the construction zone and object against the negative impacts of:

– contaminated soil layers - clearing or removing and transfer to agreed burial sites;

– toxic gases (radon) - creation of delayer barriers (screens) and arrangement of ventilated crawl spaces for removing gas and preventing its transfer to living premises,

– contaminated soil and surface waters - construction of dams, grout curtains, water protection walls, sediment basins etc.

If necessary, the following measures should be envisaged: karst control, landslide control, water proofing, protection against dynamic actions and toxic substances, compliance with environmental safety during the construction at waste disposal sites and on man-made waste; and the solution of issues of contaminated soil dumps and preservation of the fertile layer and green plantations.

Scientific and technical support is necessary for complex objects of construction or re-construction (with basements exceeding one floor, located in conditions of high density areas, having a specific structural scheme, high-rise ones, potentially dangerous, unique, religious and monuments); for specific geological, hydro-geological, ecological conditions and complex terrain; and for structures in the zones of new construction (reconstruction) influences (risks) or in areas where dangerous geological processes are possible.

Monitoring is a component of scientific and technical support. It is carried out at the stage of designing and construction, as well as during reconstruction and conservation of the buildings of significant consequences (CC3) – in all cases and of the buildings of CC2 – in difficult geological conditions, on densely built-up areas and in zones influenced by new construction or rebuilding.

Monitoring at the stage of construction and operation according to the functional profile of a building should include the visual-instrumental field observations and surveys (including geodetic control) of structures, bases, territories, as well as the hydrogeological and ecological observing system, and analysis of the results.

Conclusions. Thus, the elaboration and subsequent use of DBN V.2.1-10:201X «Bases and foundations of buildings and structures. Main provisions» will allow more reasonable carrying out the design of bases and foundations for buildings and facilities, increasing the reliability and safety of objects due to the application of new standards, and bringing the practice of designing the bases and foundations of buildings and structures in accordance with modern requirements.

The developers of the new national building codes invite Ukrainian specialists in geotechnics to take part in the further improvement of the DBN draft and will be grateful for careful considerations and proposals.

References

1. *Технічний регламент будівельних виробів, будівель і споруд. Постанова Кабінету Міністрів України від 20.12.2006. № 1764.*
   Tehnichniy reglament budivelnih virobiv, budivel i sporud. Postanova Kabinetu Ministriv Ukrayini vi 20.12.2006. № 1764.
2. *ДБН В.2.1-10:2009. Основи та фундаменти споруд. Основні положення проектування [Чинні від 2009-07-01]. – К. : Мінрегіон України, Укрархбудінформ, 2009. – 104 с. – (Державні будівельні норми).*
   DBN V.2.1-10:2009. Osnovi ta fundamenti sporud. Osnovni polozhennya proektuvannya [Chinni vid 2009-07-01]. – K. : Minregion Ukrayini, Ukrarhbudinform, 2009. – 104 s. – (Derzhavni budivelni normi).
3. *ДБН В.2.1-10:2009. Основи та фундаменти споруд. Основні положення проектування. Зміна № 1. [Чинні від 2011-07-01]. – К. : Мінрегіон України, Укрархбудінформ, 2011. – 55 с. – (Державні будівельні норми).*
   DBN V.2.1-10:2009. Osnovi ta fundamenti sporud. Osnovni polozhennya proektuvannya. Zmina № 1. [Chinni vid 2011-07-01]. – K. : Minregion Ukrayini, Ukrarhbudinform, 2011. – 55 s. – (Derzhavni budivelni normi).
4. *ДБН В.2.1-10:2009. Основи та фундаменти споруд. Основні положення проектування. Зміна № 2. [Чинна від 2012-07-01]. – К. : Мінрегіон України, Укрархбудінформ, 2012. – 18 с. – (Державні будівельні норми).*
   DBN V.2.1-10:2009. Osnovi ta fundamenti sporud. Osnovni polozhennya proektuvannya. Zmina № 2. [Chinna vid 2012-07-01]. – K. : Minregion Ukrayini, Ukrarhbudinform, 2012. – 18 s. – (Derzhavni budivelni normi).
5. *ДБН В.1.1-45:2017. Будівлі і споруди в складних інженерно-геологічних умовах. Загальні положення [Чинні від 2017-07-01]. – К. : Мінрегіон України, Укрархбудінформ, 2017. – 48 с. – (Державні будівельні норми).*
   DBN V.1.1-45:2017. Budivli i sporudi v skladnih inzhenerno-geologichnih umovah. Zagalni polozhennya [Chinni vid 2017-07-01]. – K. : Minregion Ukrayini, Ukrarhbudinform, 2017. – 48 s. – (Derzhavni budivelni normi).
6. *ДСТУ-Н Б В.1.1-39:2016. Настанова щодо інженерної підготовки ґрунтової основи будівель і споруд [Чинна від 2017-04-01]. – К. : Мінрегіон України, Укрархбудінформ, 2009. – 80 с. – (Державний стандарт України).*
   DSTU-N B V.1.1-39:2016. Nastanova schodo inzhenernoyi pidgotovki gruntovoyi osnovi budyvel i sporud [Chinna vid 2017-04-01]. – K. : Minregion Ukrayini, Ukrarhbudinform, 2009. – 80 s. – (Derzhavniy standart Ukrayini).

7. *ДСТУ-Н Б В.1.1-40:2016. Настанова щодо проектування будівель і споруд на слабких ґрунтах [Чинна від 2017-04-01]. – К. : Мінрегіон України, Укрархбудінформ, 2017. – 72 с. – (Державний стандарт України).*
DSTU-N B V.1.1-40:2016. Nastanova schodo proektuvannya budivel i sporud na slabkih gruntah [Chinna vid 2017-04-01]. – K. : Minregion Ukrayini, Ukrarhbudinform, 2017. – 72 s. – (Derzhavniy standart Ukrayini).
8. *ДСТУ-Н Б В.1.1-41:2016. Настанова щодо проектування будівель і споруд на закарстованих територіях [Чинна від 2017-04-01]. – К. : Мінрегіон України, Укрархбудінформ, 2017. – 96 с. – (Державний стандарт України).*
DSTU-N B V.1.1-41:2016. Nastanova schodo proektuvannya budivel i sporud na zakarstovanih teritoriyah [Chinna vid 2017-04-01]. – K. : Minregion Ukrayini, Ukrarhbudinform, 2017. – 96 s. – (Derzhavniy standart Ukrayini).
9. *ДСТУ-Н Б В.1.1-42:2016. Настанова щодо проектування будівель і споруд на підроблюваних територіях [Чинна від 2017-04-01]. – К .: Мінрегіон України, Укрархбудінформ, 2017. – 72 с. – (Державний стандарт України).*
DSTU-N B V.1.1-42:2016. Nastanova schodo proektuvannya budivel i sporud na pidroblyuvanih teritoriyah [Chinna vid 2017-04-01]. – K .: Minregion Ukrayini, Ukrarhbudinform, 2017. – 72 s. – (Derzhavniy standart Ukrayini).
10. *ДСТУ-Н Б В.1.1-44:2016. Настанова щодо проектування будівель і споруд на просідаючих ґрунтах [Чинна від 2017-04-01]. – К. : Мінрегіон України, Укрархбудінформ, 2017. – 68 с. – (Державний стандарт України).*
DSTU-N B V.1.1-44:2016. Nastanova schodo proektuvannya budivel i sporud na prosidayuchih gruntah [Chinna vid 2017-04-01]. – K. : Minregion Ukrayini, Ukrarhbudinform, 2017. – 68 s. – (Derzhavniy standart Ukrayini).

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