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On the draft of antiseismic construction standards in the Republic of Armenia

E. E. Khachian
Armenian Earthquake Engineering Research Institute, Yerevan, Armenia

ABSTRACT: Today in the Republic of Armenia the building is conducted on the base of USSR Antiseismic construction standards SNIP II=7-81. The results of Spitac Earthquake and the new data in the sphere of engineering seismology which were received during last years revealed voids in earthquake engineering. The new regional codes on seismic building for the Republic of Armenia are developed by the specialists of Armenian Earthquake Engineering Research Institute. The main concepts and quantitative parametres of new codes for the determination of seismic design forces are given in this report.

1 SEISMIC DANGEROUS ZONES IN THE REPUBLIC OF ARMENIA

In the Republic of Armenia the buildings and constructions are designed in accordance with seismic effect. The degree of seismic dangerous in each region is determined by maps of seismic zoning and faultswhich are developed by specialists of Armenian Academy of Sciences. The earthquake intensity is evaluated by peak-level lateral acceleration of soil.

1.1 Earthquake Engineering is conducted according to four zones in increasing consequence. The peak values of lateral acceleration of soil according to zones are shown at Table1.

Table 1. The peak value of soil acceleration

Seismic zones	1	2	3	4
Soil accelegation sm/sec².	300	350	400	450

The peak value of soil acceleration in vertical direction is assumed =3/4 of lateral acceleration.

1.2 The soil categories of building sites. In seismic dangerous zones 1-4 the building sites are divided into 3 maincategories 1, II, III and subcategory IIIa. The structural description and dynamic characteristics of soils are given at Table 2.

Table 2. Soil categories.

Category	Soils	Velocity spread of shear-waves V_s m/sec	The period of microvibrations of surface layer T_o per second
I	Rocky	$V_s > 800$	$T_o < 0,25$
II	Semi-rocky	$500 < V_s < 800$	$0,25 < T_o < 0,5$
III	Mellow	$200 < V_s < 500$	$0,5 < T_o < 0,7$
IIIa	Granular Weak clayey Saturated	$V_s < 200$	$T_o > 0,7$

Peak values of soil acceleration (Table 1) for building sites with the category - IIIa are multiplied by the coefficient 1, 2 regardless of the number of seismic dangerous zone.

2 THE VALUES OF SHEARING SEISMIC FORCES

2.1 While determining the values of shearing seismic inertial forces the design scheme of buildings and constructions is assumed as a weight - less girder stiffly installed in the ground carrying its lumped mass and making vibratory motion in one of the main axes of its symmetry. The design value of shearing seismic force S_{ki} which corresponds to i - from of free vibrations of buildings or constructions is determined by formula

$$S_{ki} = Q_k K_c \beta_i \eta_{ki} \qquad (1)$$

where Q_k - is the load (weight) causing inertial force, accepted as lumped at the point k, K_c - nondimensional coefficient of seismicity showing the ratio of pek soil acceleration for given zone to the soil acceleration according to table 2.

Table 2. Values

Zone	1	2	3	4
Value K_c	0,3	0,35	0,4	0,45

Nondimensional dynamic coefficient β_i corresponding to i-form of free vibrations has the following values.

For the 1 category of soils

$\beta_i = 1 + 7{,}5\,T_i$ when $0 < T_i < 0{,}2$

$\beta_i = 2{,}5$ when $0{,}2 < T_i < 0{,}4$

$\beta_i = 1{,}35\,T_i^{-2/3}$ when $T_i > 0{,}4$

For the II category of soils

$\beta_i = 1 + 5\,T_i$ when $0 < T_i < 0{,}3$

$\beta_i = 2{,}5$ when $0{,}3 < T_i < 0{,}55$

$\beta_i = 1{,}65\,T_i^{-2/3}$ when $T_i > 0{,}55$

For the III and IIIa category of soils

$\beta_i = 1 + 3{,}75\,T_i$ when $0 < T_i < 0{,}4$

$\beta_i = 2{,}5$ when $0{,}4 < T_i < 0{,}7$

$\beta_i = 2{,}0\,T_i^{-2/3}$ when $T_i > 0{,}7$

The periods of free vibrations T_i (in sec.) are determined by methods of structural mechanics. For some buildings the period of the first form of vibrations is recommended to determine by the following empirical formulaes:

$T_i = 0{,}042\,n$ -for masonry buildings

$T_i = 0{,}045\,n$ -for large panel buildings

$T_i = 0{,}085\,n$ -for framed reinforced concrete buildin.

$T_i = 0{,}058\,n$ -for frame braced reinforced concrete buildings

$T_i = 0{,}1\,n$ -for metal multistoreyed buildings

where n - is the number of storeys. The periods of the second and third forms of free vibrations are accepted: $T_2 = 0{,}35\,T_i$, $T_3 = 0{,}2\,T_i$. Nondimensional coefficient η_{ki}, depending on ordinate forms of free vibrations and the values of lumped loads is determined by formula

$$\eta_{ki} = \frac{x_{ki}\sum_{i=1}^{n} Q_j x_{ji}}{\sum_{j=1}^{n} Q_j x_{ji}^2} \qquad (2)$$

where x_{ki} is the displacement (amplitude) of k point of the construction during its free vibrations by i - from. In accordance with higher forms of vibrations the design values of shearing forces, bending moments, normal and circumferential stresses in constructions from seismic loads are determined by formula

$$N_p = \sqrt{\sum_{i=1}^{\nu} N_i^2}$$

where N_i is the values of forces and stresses in given section caused by seismic forces according to i-form of vibrations by formula (1), ν - is the number of the forms of vibrations taken into consideration. For buildings and constructions with approximately equal distribution of stiffness and mass over their height the number of assumed forms of vibrations is equal to 3; if the value of the first form of vibration $T_i > 0{,}4$ s; and when $T_i < 0{,}4$ s only the first form of vibration is taken into consideration.

2.2 The calculated value of design stresses according to formula is multiplied by coefficient K_1 where the admitted damages are taken into consideration during the earthquake.

Table 4. The values of the permitted damages coefficient.

Constructive solutions of	Value k_1
Metal constructions	
framed	0,30
frame braced	0,35
Reinforced concrete constructions	
framed	0,40
frame braced	0,45
with carrying large-panel walls	0,50
with carring cast-in-place walls	0,55
Masonry constructions	
of complex structure	0,60
of large-block structure	0,65
masonry regular-shaped constructions	0,70

2.3 For buildings and constructions, where the damage is connected with heavy results of the values of stresses according to formula (3) is multiplied by coefficient K_2. The values are given at table 5.

Table 5. The values of the coefficient k_2.

The function of buildings and constructions	
1. Big and medium stations, theaters, cinemas, airports, stadia, commercial, centres	1,30
2. Schools, kindergardens, nurseries, hospitals, institutions	1,25
3. Energy and water-supply systems, Police and Fire stations, communication centres, Banks, the Republic, urban, regional administrative buildings	1,20

2.4 For buildings and constructions with the main form of vibration period $0,1 < T_i < 0,6$, the forces (3) are multiplied to the interaction coefficient "Soil-Construction" k_3:

for soils of II category

$$k_3 = 1,2 - 0,2\, T_i^{-1/2}$$

for soils of III and IIIa category

$$k_3 = 1,2 - 0,25\, T_i^{-1/2}$$

For soils of the I category regardless of the value T_i and soils of the II, III and IIIa category $k_3 = 1$ when $T_i > 0,6$.

3 VERTICAL SEISMIC EFFECTS

3.1 Vertical component of seismic effect. It is necessary to take into consideration the vertical component of seismic effect when lateral and till-up cantilever structurs, frames, arches, trusses, spatial floors of buildings and constructionsare designed with span for more than 24 metres and also when the stability of buildings and foundations, their overturning and slippage are calculated. The value of vertical seismic forces is calculated by formula (1) and forces - by formula (3). Besides the value of seismic coefficient K_c is taken from table 3, multiplying them by 0,75, the value β_i is determined by above mentioned formulae according to the period of vertical free vibrations. The interaction coefficient $k_3 = 1$.

3.2 Strength analyses of bearing walls of masonry buildings, wall panels of large-panel buildings, stiffening diaphragms must be done with simultaneous effect of static lateral and vertical seismic forces. Vertical seismic load is assumed = $0,75\, K_c Q_3$, where Q_3 is the value of vertical static load influenced on a given element.

3.3 Strength analyses of columns in framed buildings is done on the base of simultaneous effect of lateral and vertical static and seismic forces. The influence of vertical seismic component is determined by increasing of normal (longitudinal) forse N statically effected on $0,75\, K_c N$. The design bending moments in columns are increased additionally for more than 10%.

3.4 Additional vertical distributed load to $1,5 \cdot 0,75\, K_c q$ should be designed for floor slabs and beams, where q - is a normative distributed static load.

4 TORSIONAL SEISMIC EFFECTS

While designing shearing and vertical forces of buildings and constructions it is necessary to take into consideration torsional effects from rotatory motions of soil about its vertical axis and from mass and stiffness of buildings where their centres do not coincide. The value of design torsional moment M_k level of K - storey is determined by formula:

$$M_k = P_k(e_k + e) \quad (4)$$

where P_k is the value of shearing force on the level of k -storey, e_k is the actual eccentricity between the mass centre and the centre of stiffness of e_k -storey, e - is the additional design value of eccentricity from rotatory movement of the soil accepted according to the period of the main form of horeisontal vibrations and the categories of soils:

For buildings and constructions with $T_i < 0{,}5s$:

e = 0,03 b for the soils of the I category
e = 0,06 b for the soils of the II category
e = 0,08 b for the soils of the III and IIIa categories

For buildings and constructions where $T_i > 0{,}5s$.

e = 0,02 b for soils of the I category.
e = 0,04 b for soils of the II category
e = 0,05 b for soils of the III and IIIa categories

where b is the size of k-storeyed building the direction of which is perpendicular to the action of shearing forse P_k in the plane.

REFERENCES

Building Codes and Rules,SNIP II-7--81, Moscow,1982. (in Russian).
Uniform Building Code, 2311-2312 USA, 1988 Edition.
Basic concepts of Seismic Codes.Vol.1 The International Assosiation for Earthquake Engineering, 1980.
N.N.Newmark, E.Rosenblueth. 1980.Fundamentals of Earthquake Engineering. Moscow. (in Russian).
Sh.Okomoto, 1980. Introduction to Earthquake Engineering. Moscow. (in Russian).
E.E.Khachian, 1991,Some aspects of Earthquake Engineering Standartization. Building mechanics and structural analysis.Vol.4, pages 61-67. (in Russian).
E.E.Khachian, M.G.Melkumian,1990, Earthquake Resistance of framed reinforced concrete buildings.In the book "Earthquake Engineering constructions", "Nauka", Moskow.