In this paper we study the deformation and durability of the cylindrical shell on the basis of the underlying. The elastic foundation model by Vlasov-Leont’ev is taken as a basis for the model building. To account for the deformation of the rheological base the author has used the integrated form of the viscoelastic deformation law. The resulting resolving equations are presented in increments according to the V.V. Petrov method of the successive perturbation parameters.

**Keywords:** basic problems, calculation, viscoelastic, deformation, durability, construction.

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The social and economic changes in Russia have affected all aspects of society life including the construction industry. All participants in construction process became the quite real entities. The modern project is based on three managers: architect, designer and geotechnician. Earlier understanding of this fact by a project manager will provide the more perfect geotechnical component of a design solution, the more reliable a projecting building, the safer technologies of its construction for surrounding buildings. The list of basic problems for modern city construction includes tight construction deadlines, aspiration to arrange an underground space under construction spot and yard space, increase of loads onto base.

Their successful solution can only be ensured by use of the modern geo-technologies adapted to the engineering-geological conditions of city, as well as by use of the latest tools for calculation the “building-foundation-base” system. The geotechnical norms TCN 50-302-96 directly require to consider the joint work of constructions’ bearing structures with their base and correctly to model their joint work.

This paper presents a variant of techniques to solve this problem of the joint calculation for base and elements. Boundary conditions – the simple support. Equation of state in increments:

\[ \Delta \sigma_x = E_{ii} \Delta e_{ii} + \Delta h_{ii} \epsilon_{ii} \quad (i, j = 1, 2, 3). \]

In tackling the used mathematical modeling of static viscoelastic structural elements. You must have the equilibrium equations, boundary conditions, and equation of state relations for the equation of state parameter changes on the parameters of the external process.

The approach is based on an extensive literature review of current damage concepts included in current mechanistic-based design procedures, soil permanent deformation laboratory data. Design outputs are compared in terms of reliability and thickness using these design procedures. It is shown that the provides higher reliability values compared to the probabilistic procedure. All the existing subgrades fail distress reliability such as rutting and top down cracking reliabilities. Currently uses a single load P value to deal with variability associated with subgrade strength design. Is used to generate full scale subgrades response and performance data for development and verification of subgrades design criteria. The physical properties of subgrades structures significantly influence both the response of the subgrades to applied loads and the long-term performance. It is, therefore, of the utmost importance that full scale test subgrades be constructed with uniformity in material properties, layer thicknesses, and other considerations for which non-uniformity might result in nonrepresentative and nontypical behavior and failures. Current mechanistic-based design methods for the design of subgrades use vertical strain criteria to consider foundation rutting.

A considerable number of measurements of the physical properties test basis were made at all stages of construction and after construction was completed. The measurements were made for three purposes: construction quality control, construction acceptance, and material characterization. The material characterization tests were performed to provide information for theoretical modeling and were not related to construction and contractual requirements. The material characterization tests were performed to provide information for theoretical modeling and were not related to construction and contractual requirements. Tests were conducted on the subgrade materials, base subbase, and surface layers. For a basis of model building we take the model of elastic foundation, Vlasov – Leont’ev [2] (Fig.1).

Here: \( u(x, y, z) = 0 \); \( v(x, y, z) = 0 \); Increments of displacements of points:

\[
\begin{align*}
\Delta u(x, z) & = \sum_{i=1}^{m} \Delta U_i (x) \cdot \varphi_i (z) \quad (i = 1...m); \\
\Delta w(x, z) & = \sum_{k=1}^{n} \Delta W_k (x) \cdot \psi_k (z) \quad (k = 1...n),
\end{align*}
\]

The unknown functions \( \Delta U_i \), \( \Delta W_k \); and – dimensionless \( \varphi_i (z) \), \( \psi_k (z) \).

The resolving equations:

\[
\begin{align*}
\frac{\partial^2}{\partial x^2} \left( D * \frac{\partial^2 W'}{\partial x^2} \right) & + \frac{E \cdot k \cdot \Delta W'}{1 - \nu^2} \frac{R^2}{R^2} - \sum_{i=1}^{n} \left[ E \cdot \Delta W'_i \right] \\
\sum_{i=1}^{n} \int_{0}^{L} \left[ \varphi_i dz \right] \Delta W'_i & = \Delta p.
\end{align*}
\]

Here [1]:

\[
\begin{align*}
\nu_x &= 0.5 - E / E_0 \cdot (0.5 - \nu), \quad E_0 = E / (1 - \nu^2), \\
\nu_y &= \nu / (1 - \nu),
\end{align*}
\]

Elastic modulus – \( E \), \( D* \), \( E* \) – Volterra integral operators.
The theory of hereditary creep includes all the theories based on rheological models. Condition of reliability \( \varepsilon \leq \varepsilon_{\text{destriv.}} \) (\( \varepsilon \) – deformation). To solve this problem apply the variational method of Bubnov-Galerkin, the calculation is performed on small intervals of time.

\( L \) = length of casing 5 m, the wall thickness \( h = 0,4 \) m, the shell radius \( R = 3 \) m, Poisson’s ratio \( \nu = 0,35 \). Displacement graphics element (curve 1), 2 – the base layer are shown in Fig. 2.

Plots of the stresses and strains of the middle surface of the shell are shown in Fig. 3. Taking into account nonlinear properties (curve 1) significantly affect the results of the numerical calculation [3, p.4].

References:
1. Petrov V.V. Construction of a model of the non-uniform basis at a varied level of earth waters. Interuniversity scientific collection. - Saratov., SSTU, 2000., pp. 6-10.
2. Petrov V.V. Dimensional model of non-linear deformable heterogeneous basis. Interuniversity scientific collection. – Saratov, SSTU, 2007., pp. 6-12.
3. Artamonova E.N. On the design of slabs on the non-uniform basis. - Moscow., INGN; 2012., p. 4.

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Fig. 1. Model of elastic foundation

Fig. 2. Displacement curves

Fig. 3. Stresses and strains