Educator Insights: A Journal of Teaching Theory and Practice
Volume 01, Issue 08, August 2025
brightmindpublishing.com
ISSN (E): 3061-6964

ON A CYLINDRICAL BODY IN A NONLINEAR MEDIUM PLANE SHOCK WAVE EFFECT

Kamil Atabayev
"Candidate of Physical and Mathematical Sciences",
Professor, Andijan State Technical institute

Abstract
In this article, the effect of one-dimensional waves on a non-deformable moving cylinder located in the ground is studied. The environment model is taken as a grunt [1]. The article defines the kinematic parameters of the cylindrical structure and the stresses generated around the cylinder. According to this model, the relationships between stress and deformation obtained based on experience are assumed to be homogeneous during loading and unloading, that is, the environment is nonlinear. The problem is reduced to a Cauchy problem based on suitable initial conditions. The results of the issue will be presented in the next article.

Introduction

The effect of seismic waves on underground structures is one of the most urgent and important issues. If these structures are cylindrical, then underground metro, oil, water and gas pipelines are one such example. Cylindrical underground devices are the most common structures in practice.

Ensuring their strength, integrity and stability is of great importance in construction. Many scientists from Uzbekistan have dealt with such issues. [2, 3, 4, 5, 6, 7].

Setting the issue. Let the shock wave front arrive at the cylinder along the OX axis at the time of initiation, i.e. at t=0. In the considered problem, we accept the condition of adhesion, that is, the displacements of any point attached to the cylinder and the points touching it are equal to each other.

For the medium in which the cylinder is located, we obtain the following relations obtained based on experiments such as [1]:

Educator Insights: A Journal of Teaching Theory and Practice
Volume 01, Issue 08, August 2025
brightmindpublishing.com
ISSN (E): 3061-6964

$$\lambda(\varepsilon,\varepsilon_i)=\alpha_1-\alpha_2\varepsilon-\frac{2}{9}(\beta_1+\beta_2\varepsilon_i),\quad G=\frac{1}{3}(\beta_1+\beta_2\varepsilon_i) \tag{1}$$

This is for fine-grained sands: $\alpha_1=18\cdot10^2\,kg/sm^2$, $\alpha_2=82\cdot10^3\,kg/sm^2$, $\beta_1=42\cdot10^2\,kg/sm^2$, $\beta_2=18\cdot10^4\,kg/sm^2$

The voltage behind the shock wave front $X_x=-P_0$ $((P_0>0-const)$ and its speed $D=const)$ let it be
In this case, the following relations are valid for the shock wave.

$$\begin{cases}\rho_1(D-V_x)=\rho_0 D\\ \rho_0 DV_x=-X_x\\ \rho_0=\rho_1(1+u_x)\end{cases} \tag{2}$$

If $X_x=-100\frac{кг}{см^2}$, $\rho_0=200\frac{кг\cdot c^2}{м^4}$ if, then $D=545\frac{м}{c}$, $V_x=9{,}17\frac{м}{c}$, $\rho_0=203{,}42\frac{кг\cdot c^2}{м^4}$ will be equal to it is appropriate to work on this problem, i.e., the effect of the wave on the cylinder, in the cylindrical coordinate system. The displacements in the radial and transverse directions behind the shock wave front will have the following form:

$$\begin{aligned}u(r,\theta,t)&=-10^{-2}\cdot1{,}682[(r_0+r)\cos\theta-Dt+r_0]\cos\theta;\\ \upsilon(r,\theta,t)&=-10^{-2}\cdot1{,}682[(r_0+r)\cos\theta-Dt+r_0]\sin\theta;\end{aligned} \tag{3}$$

Particle velocities are determined by the following formulas:

$$\dot{u}=V_x\cos\theta,\quad \dot{\upsilon}=V_x\sin\theta$$

To create the equations of motion of the environment, we cover the plane along the radial and perpendicular lines from the origin of the coordinate with rectangles with imaginary curves. The radii of concentric circles are determined as follows: r_0+r_k in this $r_k=\frac{2k-1}{2}\cdot\Delta r$, $(k=1,2,...\Delta r=\frac{b-r_0}{n_1}$, b fictitious outer radius).

We define polar angles as follows.

$\theta_s=\frac{2s-1}{2}\cdot\Delta\theta$ ($\Delta\theta$-are angles corresponding to curved elements). It is optional after it (r_0+r_k,θ_s) the equations of motion of the elements are drawn up. The stresses on the four sides of the centers of the resulting elements are written based on finite differences. The resulting tensions $\sigma_{rr}[r_0+k\cdot\Delta r,\theta_s]$, $\sigma_{r\theta}[r_0+r_k,s\cdot\Delta\theta]$, $\sigma_{\theta\theta}[r_0+r_k,s\cdot\Delta\theta]$, $\sigma_{r\theta}[r_0+k\cdot\Delta r,\theta_s]$ expressions are not given here because they are complicated. Since the problem is symmetrical, it is appropriate to work on it and the field.

Educator Insights: A Journal of Teaching Theory and Practice
Volume 01, Issue 08, August 2025
brightmindpublishing.com
ISSN (E): 3061-6964

The mass of isolated elements $m_{k,s}$ - we get the following system of differential equations in the radial and tangential directions:

$$m_{k,s}\ddot{u}_{k,s} = -\theta_{rr}\left[r_0 + \Delta r(k-1), \theta_s\right]\left[r_0 + \Delta r(k-1)\right]' \Delta\theta + \sigma_{rr}\left[r_0 + \Delta r, k/\theta_s\right]\cdot$$
$$\cdot\left[r_0 + \Delta rk\right]\Delta\theta - \sigma_{r\theta}\left[r_0 + r_k, (s-1)\Delta\theta\right]\Delta r\cos\frac{\Delta\theta}{2} + \sigma_{r\theta}\left[r_0 + r_k, s\Delta\theta\right]\Delta r\cos\frac{\Delta\theta}{2} - (4)$$
$$-\theta_{\theta\theta}\left[r_0 + r_k, (s-1)\Delta\theta\right]\cdot\sin\frac{\Delta\theta}{2} - \sigma_{\theta\theta}\left[r_0 + r_k, s\Delta\theta\right]\Delta r\sin\frac{\Delta\theta}{2}$$

$$m_{k,s}\ddot{\upsilon}_{k,s} = -\sigma_{\theta\theta}\left[r_0 + \Delta r(s-1), \Delta\theta\right]\Delta r\cos\frac{\Delta\theta}{2} + \sigma_{\theta\theta}\left[r_0 + r_k, s\Delta\theta_s\right]\cdot$$
$$\Delta r\cos\frac{\Delta\theta}{2} - \sigma_{r\theta}\left[r_0 + (k-1)\Delta r, \theta_s\right]\left[r_0 + (k-1)\Delta r\right]\Delta\theta + \sigma_{r\theta}\left[r_0 + k\Delta r, \theta_s\right]\cdot$$
$$\Delta r\cos\frac{\Delta\theta}{2} - \sigma_{r\theta}\left[r_0 + (k-1)\Delta r, \theta_s\right]\left[r_0 + (k-1)\Delta r\right]\Delta\theta + \sigma_{r\theta}\left[r_0 + k\Delta r, \theta_s\right]\cdot$$
$$\cdot(r_0 + k\Delta r)\Delta\theta + \sigma_{\theta\theta}\left[r_0 r_k, (s-1)\Delta\theta\right]\Delta r\sin\frac{\Delta\theta}{2} + \sigma_{r\theta}\left[r_0 + r_k, s\Delta\theta\right]\Delta r\sin\frac{\Delta\theta}{2}$$

For a cylinder of mass M, we construct its equation of motion:

$$M\ddot{u}_0 = \frac{2\pi r_0}{n_1}\sum\left\{\sigma_{rr}\left[r_0, \theta_i\right]\cos\theta_i - \sigma_{r\theta}\left[r_0, \theta_i\right]\sin\theta_i\right\} \qquad (5)$$

In this $u_0(t)$ is the displacement of the center of mass of the cylinder along the axis; - the number of divisions of a circle with a radius.

Within the boundaries of the cylinder, i.e

$r = r_0$ the following conditions are met:

$$u_{k,s} = u_0\cos\theta_s, \quad v_{k,s} = -u_0\sin\theta_s$$

$r_0 \le r \le b$ in the field, the movements of particles in the cylinder and system are expressed by equations (4) and (5). $r = b$ va $0 \le \theta \le \arccos\left((Dt - r_0)/b\right)$: $u_{k,s} = v_{k,s} = 0$ will be. If $\arccos\left((Dt - r_0)/b\right) \le \theta \le \pi$ and in the field σ_{rr}, $\sigma_{r\theta}$, $\sigma_{\theta\theta}$ voltages are calculated by incident wave formulas. The system of equations created in this way is closed. The initial conditions are defined based on conditions (3) behind the front, and they are zero in front of the front.

Educator Insights: A Journal of Teaching Theory and Practice
Volume 01, Issue 08, August 2025
brightmindpublishing.com
ISSN (E): 3061-6964

References

1. Х.А.Рахматулин, А.Я.Сагомонян, Н.А. Алексеев.Вопросы динамики грунтов. 1964 г., Изд.МГУ
2. Т.Р.Рашидов, Г.Х. Хожиметов. Сейсмостойкость подземных трубопроводов. Ташкент, 1985г.-152 с.
3. Б.М.Мардонов. Волновые процессы в упругих насыщенных средах. Ташкент, ФАН, 1991г. -200 с.
4. Т.Р. Рашидов. Динамическая теория сейсмостойкости сложных систем подземных сооружений. Ташкент.Фан 1973 г
5. И.И. Сафаров Колебания и волны в диссипативно неоднородных средах и конструкциях. Ташкент. ФАН 1992, 250 с
6. М.Т Уразбаев. Сейсмостойкость упругих и гидроупругих систем Ташкент., 1966,-254с
7. А.А Ильюшин, Т.Р.Рашидов. О действии сейсмической волны на подземный трубопровод. Изв АН Уз ССР, серия техн. наук, 1971, №1, с.37-42.
8. Yusupova Rano, U Asadillo, M Go‘zaloy Heat-conducting properties of polymeric materials. Universum: технические науки, 29-31
9. Yusupova Ranakhon Kasimdjanovna. Analysis of IP Sustainability and Efficiency Coefficiency. Middle European Scientific Bulletin 23. 217-221
10. Yusupova Ranakhon Kasimdjanovna Optimization of the performance of the torsion device with a ball nozzle International scientific abd practical conference 5 (Issn 2181-153) 673-677
11. Study of mechanical damage of paddy (rice) during drying in the device B Bekkulov, R Aliyev, T Rakhmonkulov, K Atabayev, R Yusupova, ...
E3S Web of Conferences 510, 02003
12. Advantages and disadvantages of compact yarn devices on spinning machines. RK Yusupova Educational Research in Universal Sciences 2 (2), 458-466
13. ДАЛЬНЕЙШЕЕ СОВЕРШЕНСТВОВАНИЕ ТЕХНОЛОГИИ ПРОИЗВОДСТВА КРУЧЕНОЙ НИТИ Ш Рузматов, РК ЮсуповаНовости образования: исследование в XXI веке 2 (20), 292-299
14. УСОВЕРШЕНСТВОВАНИЕ УСТРОЙСТВА КРУТИЛЬНОЙ МАШИНЫ РК Юсупова JOURNAL OF INNOVATIONS IN SCIENTIFIC AND EDUCATIONAL RESEARCH 6 (3), 163-171

15. Джалилов М. Л., Хаджиева С. С., Иброхимова М. М. Общий анализ уравнения поперечного колебания двухслойной однородной вязкоупругой пластинки //International Journal of Student Research. – 2019. – №. 3. – С. 111-117.
16. Джалилов, М. Л., Хаджиева, С. С., & Алижонова, Х. (2024). КОЛЕБАНИЯ КУСОЧНО-ОДНОРОДНЫХ ДВУХСЛОЙНЫХ ПЛАСТИН. Новости образования: исследование в XXI веке, 2(20), 248-254.
17. Каюмов У. А., Хаджиева С. С. НЕКОТОРЫЕ РЕКОМЕНДАЦИЙ ПО ПРИМЕНЕНИЮ ПОРОШКОВЫХ СПЛАВОВ ПРИ ВОССТАНОВЛЕНИИ ДЕТАЛЕЙ СЕЛЬСКОХОЗЯЙСТВЕННОЙ ТЕХНИКИ СПОСОБАМИ ПЛАЗМЕННОЙ НАПЛАВКИ И НАПЫЛЕНИЯ //The 4th International scientific and practical conference “Science and education: problems, prospects and innovations”(December 29-31, 2020) CPN Publishing Group, Kyoto, Japan. 2020. 808 p. – 2020. – С. 330.
18. Khadjieva S. S. VIBRATIONS OF PIECE-HOMOGENEOUS PLATES //Educational Research in Universal Sciences. – 2023. – Т. 2. – №. 2. – С. 488-496.
19. Хаджиева С. С. ОПРЕДЕЛЕНИЕ СТАБИЛЬНОСТИ ВАЛОВ В МАШИНОСТРОЕНИИ //Научный Фокус. – 2023. – Т. 1. – №. 7. – С. 446-453.
20. Хаджиева С. С. СОВРЕМЕННЫЕ КОМПОЗИЦИОННЫЕ МАТЕРИАЛЫ //Научный Фокус. – 2023. – Т. 1. – №. 1. – С. 1574-1580.
21. Хаджиева С. С., Алижонова Х. ВИДЫ ДЕФОРМАЦИЙ И ПРОЦЕСС ОБУЧЕНИЯ ИМ СТУДЕНТОВ //Новости образования: исследование в XXI веке. – 2023. – Т. 2. – №. 13. – С. 354-356.