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MECHANICS OF HYDRAULIC STRUCTURES

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Annotation. The article contains some information about the history of the appearance of ancient hydrotechnical structures in our country, some information, and a statement of concepts. Also, the classification of the tasks performed by these hydrotechnical structures is indicated in several paragraphs. At the same time, the content of hydrotechnical structures that have the importance of blocking water, concepts about dams, and how they are built are clearly explained. At the same time, the article shows examples of structures that are important for collecting and storing water.

Key words: importance of hydrotechnical structures, methods of construction of conical dams and dams, simple ponds, lock ponds, shell

INTRODUCTION

Water science and hydrology have ancient roots in Uzbekistan. Irrigated agriculture existed in our country 6000 years before the new era. In the second half of 4000 BC and the beginning of 3000 BC, rivers were blocked and irrigation canals were made from them. Since 2000 BC, large massifs were irrigated in the Surkhandarya oasis, Fergana valley, LowerAmudarya and Zarafshan rivers. Zang in South Uzbekistan, Bozsuv and Salor in the Tashkent oasis, Old Angor and Tuyatortor in the Samarkand oasis, Shahrud and Romitanrud in Bukhara, Kirqqiz and other canals were dug in the 1st-4th centuries AD.

It is known that several measures are currently being implemented in the Republic of Uzbekistan to ensure the reliable and safe operation of water reservoirs. In particular, for the purpose of ensuring the safe and reliable operation of facilities using the Talimarjon reservoir, the field observation studies carried out on the current condition of the monitoring and measuring devices installed to determine shifts and subsidence are of great importance. Therefore, developing measures to ensure the safe and reliable operation of facilities using the Talimarjon reservoir is one of the urgent issues.

The Talimarjon reservoir is located in the city of Talimarjon, Kashkadkaryo region, and was built for the purpose of extending the Karshi gorge. The Talimarjon Reservoir is a type of reservoir filled with water from the Amudarya using a cascade of KMK pumps. The Talimarjon Reservoir is a large hydrotechnical facility in Kashkadarya region. It was put into full operation in 1985. Tallimarjon Reservoir is filled with water from the Karshi main canal for 6 months in the autumn and winter season. Length: 14 km, width: 5.5 km, average height: 19.8 m, coastline length: 36 km, area 77.4 km^2, total volume 1.53 billion m^3, useful working volume, 1.4 billion m^3. The complex of main structures of Tallimarjon reservoir includes 1 and 2 earthen dams, pumping station, inflow and outflow channel, drainage, It consists of a pumping station. Water is raised to a height of 26.6 m through powerful electric pumps. The Talimarjon Reservoir is one of the most important hydrotechnical structures in our country. It is of great importance in providing water in Asia. Because this reservoir receives water from KMK as a reserve in the winter season, and in the event of a water shortage during the growing season, 360 m^3/sec from the water outlet facility. to remove water and serve to eliminate such a problem. Therefore, proper organization of operation service, timely maintenance of this hydrotechnical facility is the guarantee of safe and reliable operation of this facility, which is a disaster for our country. Its projected water supply is 1525 million m^3, the surface area according to the normal wetted surface (NDS) is 77.35 km^2. The developed reserve in the Karshi desert supplies the lands with water. During the irrigation season, the water collected in the reservoir is able to transfer water to the main channel of Karshi 360 m^3/sec. is supplied through a water dispenser.

So, in the time of the ancient irrigators, the experts knew the general geographical aspects of the area, such as the geological-tectonic structure, hydrology and hydrogeological aspects of the area where the dam is to be built from the engineering point of view. But Khanbandi, Gishtband, and perhaps Abdullakhanbandi (only 2-3 m of its wall on the right side of the stream is preserved now) ceased to function due to the muddy filling of the reservoir bowl. Kaltepa, Katta Tepa forts, which have enjoyed the water of the reservoir for about a hundred years, and the surrounding fields have become ruins. Because the ancient engineers, who masterfully solved the construction of the dam, could not find a solution to the problem of the structure becoming unusable due to the reservoir bowl being filled with mud. Although this problem can be solved in modern reservoirs using some methods (for example,

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removing the mud with heavy equipment excavators or moving the sunken rocks with the help of flotation devices), there are still no measures to complete this task. the risk of silting the reservoir bowl is not eliminated. This problem can be alleviated only by the correct selection of the area where the structure is being designed. Therefore, it is useful to re-familiarize with the structure of ancient water reservoirs in order to have as much impact on the environment as possible, safety and continuous operation of the water reservoirs formed behind the modern dams to be built.

Most of the elements of engineering structures should be power calculation, can be reduced to tray calculation schemes. A shell is a body bounded by curved surfaces, the two dimensions of which are small compared to the distance between them (thickness ±). The arrangement of points equidistant from both surfaces of the shell is called a single surface. The load acting on the shell is also assumed to be and has symmetry properties. However, the forces for such a shell along the arc of the inner circle do not change and depend only on the measured current radius or arc length. It is much more difficult to determine the load distribution for symmetric shells. The calculation scheme for an axisymmetric shell can be used to calculate many building structures, boilers, reservoirs, etc.

The problem of calculation of shells is solved in the simplest way when it can be assumed that the load that appears when the shell is constant in thickness, as a result of which the bending of the shell is lost.

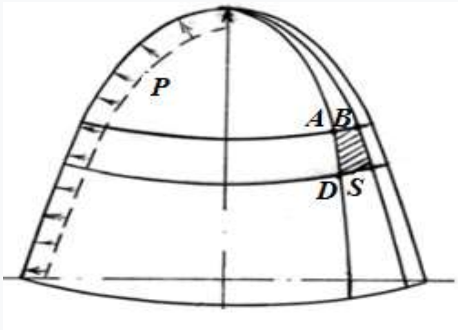

Figure 1 Shell loading diagram

QThe shell calculation is based on the following assumptions:

1. The shell is thin-walled, that is; $\frac{\rho_{min}}{t} \geq 20$ where ρ_{min} are the main radii of the smallest curvature;
2. in particular, the pressure changes in the meridian direction when the power is sufficiently accumulated;
3. in particular, there are no sharp changes in curvature in the meridian;
4. the supporting devices of the shell are such that the supporting forces are directed tangentially to the meridian.

Let us cut an element from the shell between two infinitely close meridional and two infinitely close circular sections (Fig. 2) and show the stresses acting on its faces (Fig. 3).

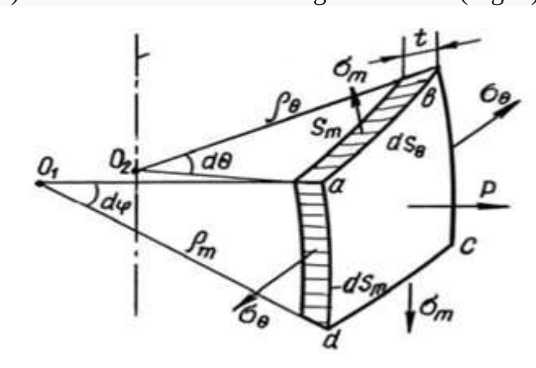

Fig. 2 Loads acting on the faces of the shell element

Due to the symmetry of the shell and load on the side faces of the elements ad and bc, corresponding to the meridian planes, the tangential stresses are zero, only normal loads are called s, circular loads.

According to the law of coupling of tangential stresses, the tangential stresses along the sides a b and c d are also zero; along these edges only normal stresses σ_mm, called meridian loads, act. Therefore, the faces of the element, on which only the normal stresses act, and the tangential ones are zero, are called principal faces.

In addition to the indicated stresses, the shell element a b c d will have a load in the form of pressure P perpendicular to the surface.

-a d and c d faces also have equal force circumferential stress in the corresponding face area - $\sigma_\theta t dS_m$,

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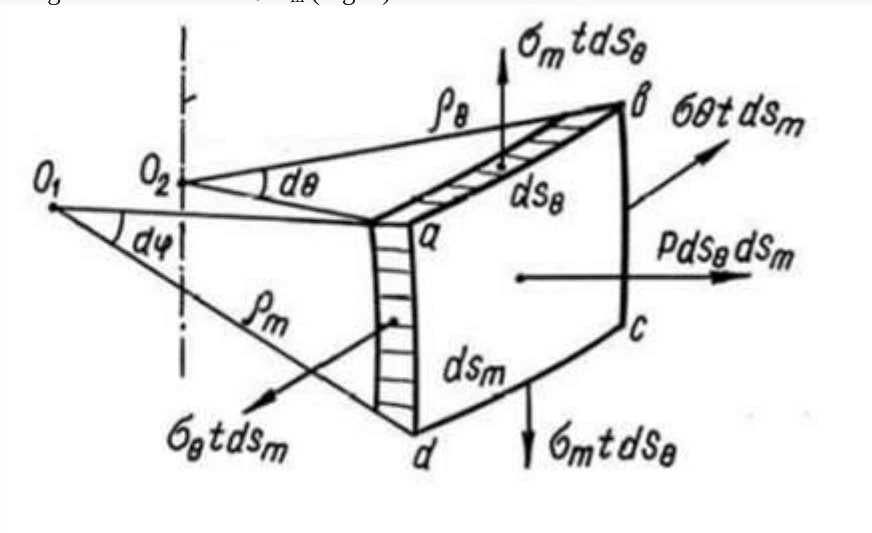
-the forces acting on faces a b and c d are equal to the product of the meridional stress in the area of the indicated faces - $\sigma_m tdS_m$.
The internal pressure gives the force $PdS_\theta dS_m$ (Fig. 4)



Effects of forces on the faces of the shell element

To construct the balance equations, we consider two cases of the element in the circular and meridian direction (Fig. 5, a, b).

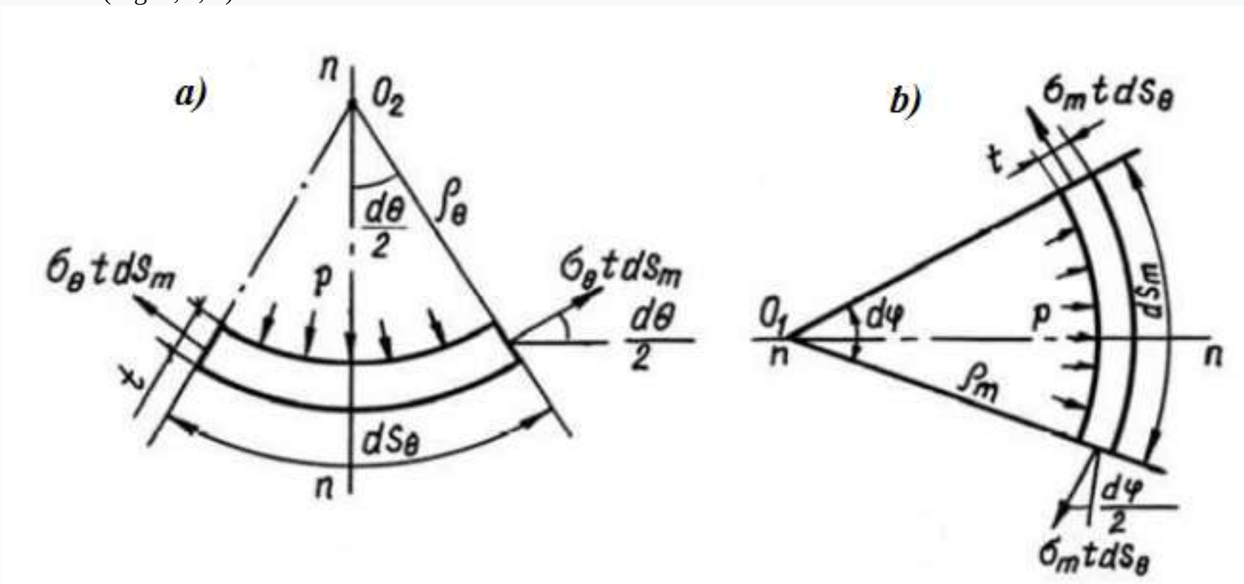


Fig. 5 We consider the equilibrium condition for the element a b c d in the form of equality n-n

$\sum n = 0 \mathrm{Pd}S_\theta dS_m - 2\sigma_m tdS_\theta \sin\frac{d\varphi}{2} - 2\sigma_\theta tdS_m \sin\frac{d\theta}{2} = 0$ (1)

For small angles $\sin d\varphi = d\varphi;\ \sin d\theta = d\theta.$

(1) The formula takes the following form

$\mathrm{Pd}S_\theta dS_m - 2\sigma_m tdS_\theta \frac{d\varphi}{2} - 2\sigma_\theta tdS_m \frac{d\theta}{2} = 0$ (2)

By definition, the arc differences are:

$dS_\theta = \rho_\theta d\theta; dS_m = \rho_m d\varphi \quad d\theta = \frac{dS_\theta}{\rho_\theta}; d\varphi = \frac{dS_m}{\rho_m}.$ (3)

Substituting 3 and 2 into equation, we get:

$\sigma_m tdS_\theta \frac{dS_m}{\rho_m} + \sigma_\theta tdS_m \frac{dS_\theta}{\rho_\theta} = PdS_\theta dS_m$(4)

(4) If we divide the left and right sides of equation by $dS_m\ tdS_\theta$,

$\frac{\sigma_m}{\rho_m} + \frac{\sigma_\theta}{\rho_\theta} = \frac{P}{t}$ (5)

Formula (5) is called Laplace's equation. This is the equation to determine the principal stresses σ_m and σ_θ in the main thin-walled shell. However, we need two equations to determine the two unknown voltages. The second equation includes only the meridional stress σ_m, , the case where the balance of the section of the shell cut by the normal section of the cone is taken into account (Fig. 6).

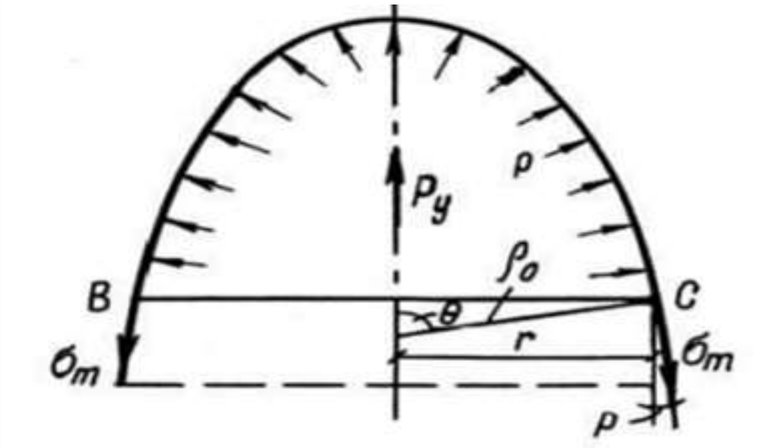


Figure 6. Conical shell

Since the intensity of the pressure in the upper section, the shell along the cross-section considered BC is constant and, based on the theorem on the projection of pressure forces, is uniformly distributed along the surface, on the axis, the result of this pressure is equal$P_y = \rho\pi r^2$

Projecting all the forces onto the shell axis, we get:

$$P_y - \sigma_m t\pi r \cos(90^\circ - \theta) = 0, \quad \rho\pi r^2 - \sigma_m t\pi r \sin\theta = 0$$

$\sigma_m = \frac{\rho r}{2t\sin\theta}$, $\rho_0 = \frac{r}{\sin\theta}$. $\sigma_m = \frac{P\rho_0}{2t}$ (6) $P = \frac{\sigma_m \cdot 2t}{\rho_0}$ (7)

Substituting the expression (7) into the Laplace equation (5), we get $\sigma_\theta \sigma_m$ through the circumferential stress:

$\frac{\sigma_\theta}{\rho_\theta} + \frac{\sigma_m}{\rho_m} = \frac{\rho_m \cdot 2t}{t\rho_\theta}$.(8)

After changing the equation (8) (we multiply the left and right parts of the equation by ρ_θ), we get:

$\sigma_\theta + \sigma_m \frac{\rho_\theta}{\rho_m} = 2\sigma_m$, here $\sigma_\theta = \sigma_m\left(2 - \frac{\rho_\theta}{\rho_m}\right)$.

As mentioned above, the stresses σ_m and σ_θ are fundamental.

The third principal stress directed perpendicular to the surface of the shell P . In thin-walled shells, σ_m and σ_θ are always significantly greater than p, that is, the value of the third principal stress can be neglected compared to σ_m and σ_θ, i.e., the calculation is zero. Depending on the state of the material, the appropriate strength theory should be used:

According to force theory III :$\sigma_k^{III} = \sigma_1 - \sigma_3 \leq \sigma_k$

According to IV force theory :$\sigma_k^{IV} = \sqrt{\sigma_1^2 + +\sigma_3^2 - \sigma_1\sigma_3} \leq \sigma_k$

Cylindrical shell

The cylindrical shell points far enough from the bottom. Find σ_m and σ_θ (Figure 7 a)

The solution. Let's consider the balance of the section of the cylindrical shell (Fig. 7, b):

$$\sum y = 0; \quad \sigma_m 2\pi Rt - \rho\pi R^2 = 0; \; \sigma_m = \frac{\rho R}{2t}$$

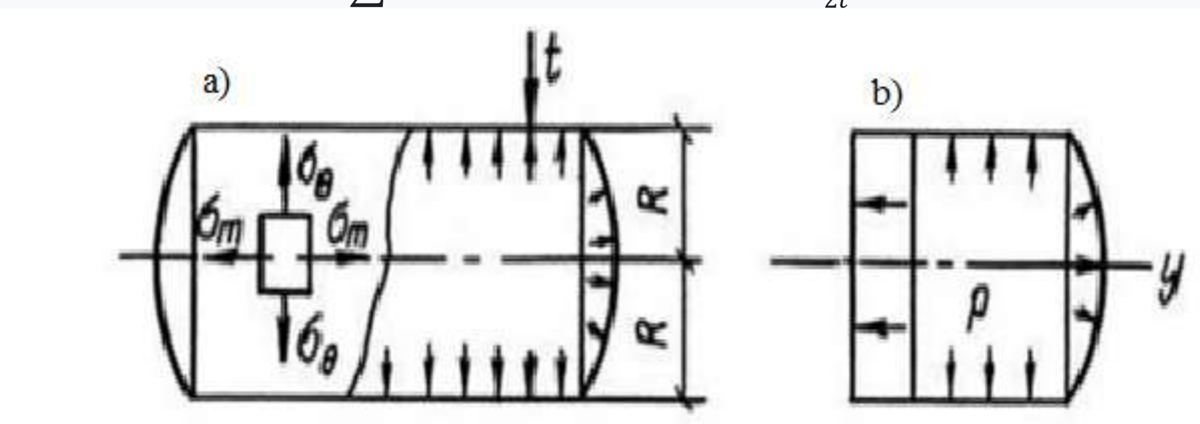


Figure 7. Cylindrical axisymmetric shell and its calculation scheme

In a cylindrical shell, ρ_θ = R, $\rho_m = \infty$, because the meridian. a straight line. Thus, from Laplace's equation (5):

$$\frac{\sigma_\theta}{R} = \frac{P}{t}, yok \; \sigma_\theta = \frac{\rho R}{t}$$

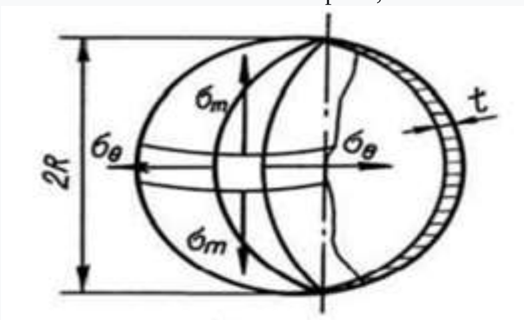
In a cylindrical shell, the circumferential stress is twice as much as the meridian.

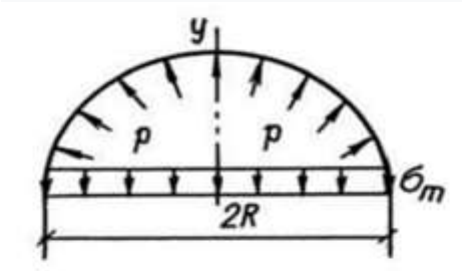
At the same time, near the junction of the shell with the base, the state of stress is momentary due to the meridian break, and it is not possible to determine σ_m and σ_θ using the obtained formulas.

The main part of the water management facilities operating in our republic is managed by the water management organizations under the jurisdiction of the Ministry of Water Management of the Republic. Amudarya and Syrdarya, which are the sources of water supply to them, are transboundary rivers. The article presents information about the drainage base station, its functions and current status, located at PK 75+00, the first dam of the Talimarjon reservoir. Also, the shortcomings identified as a result of observations and details on their elimination are given.

An example. A spherical shell of radius R and thickness t is subjected to internal pressure $\sigma_m$and σ_θ.

The solution. For a spherical shell, under the conditions of complete symmetry, $\rho_m = \rho_\theta = R$. Cut the shell in half and look at the balance of the parts, one of them





(Fig. 8). (Fig. 9).

$\sum y_i = 0,\ \ \sigma_m 2\pi Rt - \rho\pi R^2 = 0, (9)\ bu\ erda\ \ \sigma_m = \frac{\rho R}{2t}.$

Substituting the expression (9) into the Laplace equation (5), we get:

$\frac{\sigma_\theta}{R} + \frac{\rho}{2t} = \frac{P}{t},\ \ \sigma_\theta = \frac{\rho R}{2t}$

It is natural that the main purpose of building ordinary ponds is to maintain water reserves for consumption for a long time without compromising their quality, this type of hydrotechnical constructions can be divided into main and additional parts conditionally. The main part is the water storage bowl, the perfection of which depends on the geographical location (mountains and plains) and the structural structure of the ground (sand, silt, etc.). Due to this condition, it can be additionally enriched with building materials.

This process requires three things:

- when the amount of water absorption on the basis of the pool is high;
- when there is a risk of water quality deterioration;
- when decoration work is optional.

Conclusion. Village ponds are mainly dug on the basis of ordinary soil without additional raw materials. Therefore, when the foundation of the pool had to be dug in sandy soil, the pool was filled with muddy water several times to reduce the amount of seepage. In the areas where the soil is scattered, after the foundation of the newly dug pool was thoroughly leveled with the help of animals such as horses, donkeys, and oxen, in some cases water was filled directly into the structure without this event.

It is natural that the main purpose of building modern ponds is to preserve water reserves for consumption for a long time without compromising their quality, this type of hydrotechnical structures can be conditionally divided into main and additional parts.

The additional parts of the ponds are the beds surrounding the base on all four sides, but raised 0.5–1 m above the water horizon, 3–4 m wide margin couches, bars, and a fence along the shore. -trees are understood. One of the practical importance of the sofa is to prevent it from spreading around when the water level rises, and the second is protection, that is, to prevent the accumulation of rainwater and waste water from flowing into the pool.

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