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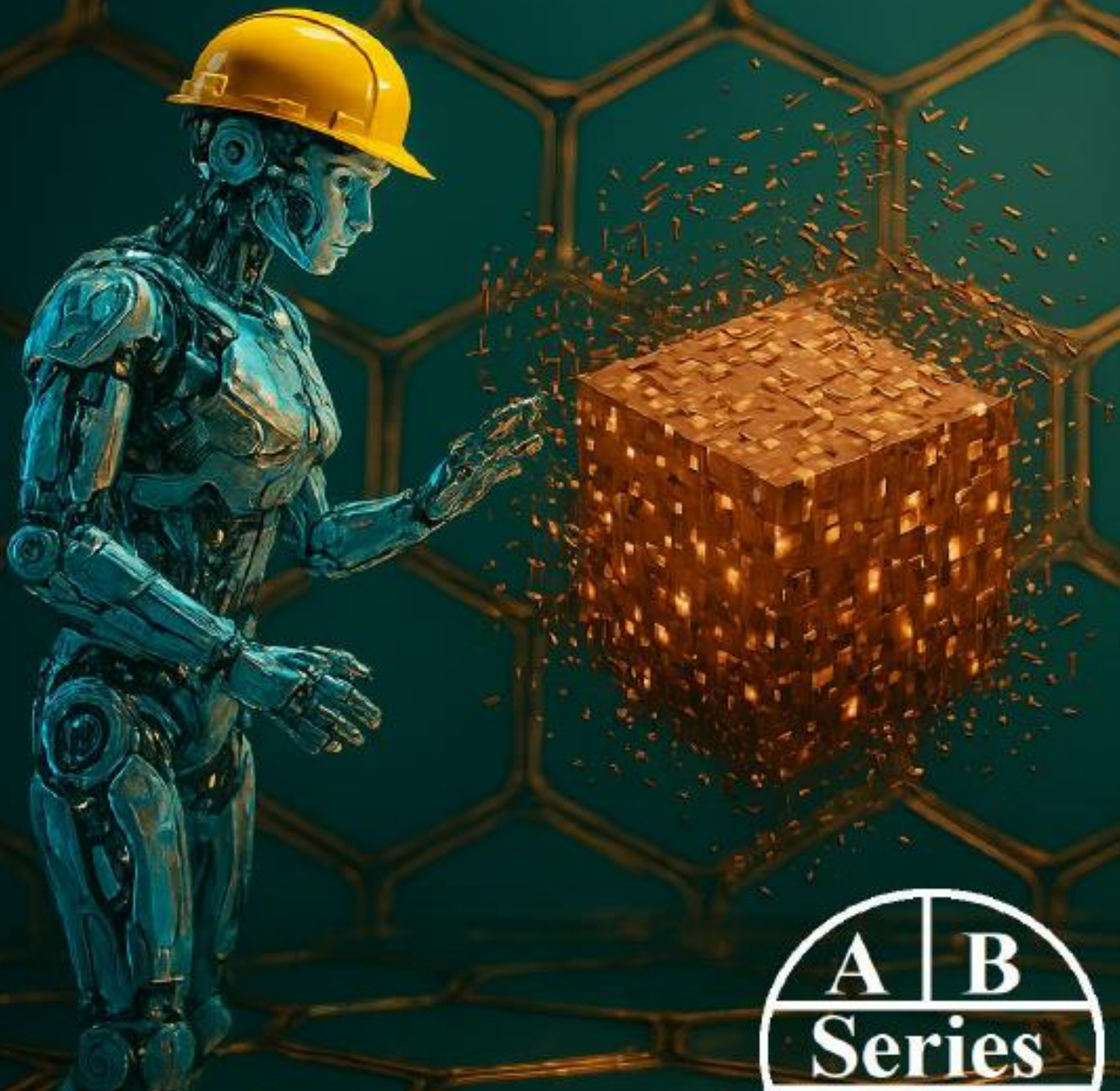

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INNOVATIVE TECHNOLOGIES IN CONSTRUCTION SCIENTIFIC JOURNAL (ITC)

TAHRIRIYAT| EDITORIAL

NON-AUTOCLAVED AERATED CONCRETE WITH IMPROVED PERFORMANCE USING COMPLEX MINERAL AND ORGANOSILICON ADDITIVES

Erdanov Nodirbek Ibragimovich

Abduqayumov Farrux Otabek o'g'li

Abstract. *This article presents the development results of non-autoclaved aerated concrete (NAAC) with enhanced performance properties. To improve water resistance and durability, an organosilicon water repellent was combined with mineral additives. Partial substitution of quartz sand with ground river sand, along with the incorporation of microsilica, helped optimize the aggregate particle size distribution and boost strength characteristics. A novel NAAC composition with a density of 500–550 kg/m³ and compressive strength of 4.8–5.0 MPa, not previously reported in the literature, is introduced. The article also includes comprehensive test results covering frost resistance, water absorption, and microstructural analysis.*

Key words: *non-autoclaved aerated concrete, water repellent, microsilica, modifiers, pore structure*

Introduction

Modern construction places high demands on energy-efficient wall materials, including aerated concrete. Non-autoclaved aerated concrete (NAAC) reduces production energy costs and carbon emissions, but its performance characteristics are inferior to its autoclaved counterparts. Low energy consumption is a particularly pressing issue. water resistance , increased water absorption and insufficient frost resistance .

A promising direction for solving them is the use of:

- mineral additives of the pozzolanic type (microsilica);

-organosilicon water repellents;

- pore structure modifiers;

-optimized granulometric composition of the filler due to partial replacement of quartz sand with ground river sand.

Main part

Source materials

-Portland cement M500

- Quartz sand (30% of total sand)

- Ground river sand (70% of total sand, fraction < 0.5 mm)

- Microsilica (5% of cement weight)

- Aluminum powder (gas-forming agent , 0.1% of the cement weight)

-Organosilicon water repellent (0.5% of the cement weight)

- Polycarboxylate superplasticizer (0.6% of the cement mass)

-Water (water-cement ratio 0.45)

Research methods

- Compressive strength - according to GOST 10180

-Density - according to GOST 12730.1

- Water absorption - according to GOST 12730.3

- Frost resistance - freeze/thaw cycles according to GOST 10060

-Microstructure - using scanning electron microscopy

Curing period of samples: 28 days under normal conditions (temperature 20±2°C, humidity 95%).

Table 1

Developed composition

No.	**Component**	**Content per 1 m³ of mixture**
1	Cement M500	250 kg
2	Quartz sand	150 kg
3	Ground river sand	350 kg
4	Microsilica	12.5 kg
5	Aluminum powder	0.5 kg
6	Organosilicon water repellent	1.25 kg
7	Polycarboxylate superplasticizer	1.5 kg
9	Water	112.5 l

The added polycarboxylate superplasticizer (0.6% of the cement mass) ensured the required workability of the aerated concrete mixture while maintaining a stable pore structure. The measured flow rate (cone flow) was 180–190 mm, indicating good workability of the mixture.

The viscosity of the system was estimated using a rotational viscometer at a shear rate of 20 s^{-1}, and the dynamic viscosity value was obtained about 220–250 mPa s , which is optimal for uniform distribution of gas bubbles without them floating up or sticking together.

The average linear shrinkage of the samples after 28 days of hardening did not exceed 0.4 mm/m, which is due to the use of microsilica , acting How additional nucleating center , and an organosilicon water repellent that slows moisture evaporation. These additives reduced the risk of cracking during drying.

Tests showed an increase in compressive strength to 4.9–5.0 MPa at a density of 520 kg/m^3. The reasons for this are:

- denser structure matrices thanks to microsilica (pozzolanic effect) activities »);

-more even distribution of pores;

- reduction of capillary porosity under the influence of a water repellent.

The frost resistance grade has been increased to F50 due to:

-reduction of the number of open capillary pores

-increasing the water-repellent properties of cement stone

-higher degree of hydration (formation of CSH phases)

Pressure tests (according to GOST 12730.5) showed an increase in water resistance from W2 (control) to W4 for the new composition. This associated with hydrophobization contact areas where organosilicon compounds form a thin film that prevents moisture penetration .

At the microstructure level, the following processes can be distinguished:

Microsilica - works as a pozzolanic additive, reacting with hydroxide calcium ($Ca(OH)_2$), forming Additional CSH gels fill the pores and reduce the capillary

permeability of the cement stone. SEM shows a more uniform distribution of hydration products and a reduction in the number of large pores.

Ground river sand —due to its higher specific surface area and varied particle morphology—improves compaction of the aggregate skeleton. As a result, segregation is reduced, the mixture becomes more homogeneous, and the gas pore structure becomes more stable.

An organosilicon water-repellent agent forms a thin hydrophobic film around the porous walls at the microstructural level, reducing capillary absorption and blocking water ingress. Microstructural analysis reveals this as a lower proportion of open pores and reduced water contact with the inner surface of the cement paste.

Polycarboxylate plasticizer - disperses cement particles , reducing water demand and increasing fluidity , which contributes to better stabilization of the gas phase and uniform distribution of bubbles throughout the volume of the mixture.

Studying microstructures non-autoclave aerated concrete

To study the microstructure of the aerated concrete under study, a scanning electron microscope was used at a magnification of ×500 and ×2000.

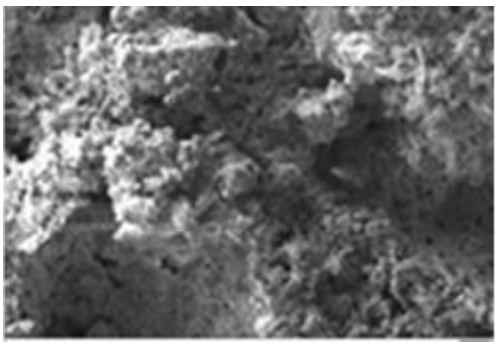

Fig . 1. Control sample Day 7

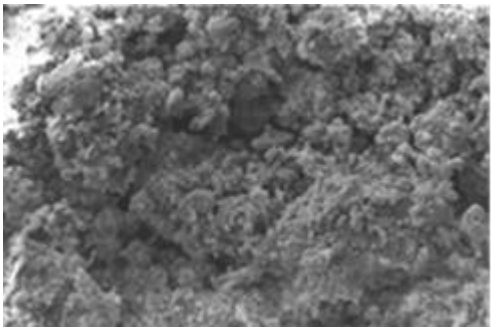

Fig. 2 Sample with the addition of microsilica and water repellent on the 7th day

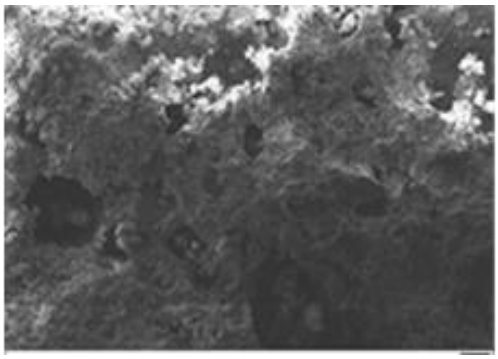

Fig. 3 Control sample 28th day

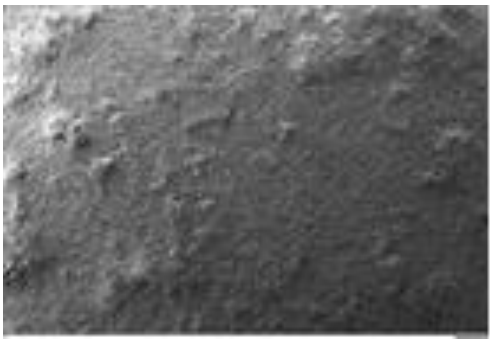

Fig. 4 Sample with the addition of microsilica and water repellent on the 28th day

In Fig. 1, the control sample shows a pronounced porous structure with a developed system of capillary channels 100–200 μm in diameter, which are predominantly open and interconnected. The cement stone exhibits uneven compaction and a significant number of voids around the gas pores.

In Fig. 2 , samples with microsilica and a water-repellent agent exhibit a denser contact zone due to the formation of CSH phases in the presence of microsilica . The walls of the gas pores appear smoother, the pores have more uniform sizes of 50–100 μm, and the number of open channels is significantly smaller.

In Fig. 3, individual crystals of Ca $(OH)_2$ are visible, the level of binding of hydration products is low, and the formation of needle-shaped crystals of ettringite is visible in the pores .

Figure 4 shows a high degree of pore filling with CSH gel phases; residual pores are less pronounced, the structure is more continuous, and cracking is minimal. The surfaces of the sand particles are covered with a thin hydrophobic layer, as evidenced by reduced capillary water absorption .

Thus, the addition of microsilica provides an additional pozzolanic reaction, reducing the amount of calcium hydroxide and increasing the proportion of calcium silicate hydroxides , while the water repellent forms a protective film on the capillary

channels. This comprehensively reduces permeability and increases frost resistance of aerated concrete.

Table 2

Material property test results

No.	**Property**	**Control composition**	**New line-up**
1	Average density, kg/m³	550	520
2	Compressive strength, MPa	3.6	4.9
3	Frost resistance, grade	F25	F50
4	Water absorption , %	38	28
5	Water resistance, brand	W2	W4
6	Mixture fluidity, mm	165	185
7	Viscosity, mPa s	270	240
8	Linear shrinkage, mm/m	0.6	0.4
9	Thermal conductivity, W/ m K	0.13	0.12

Increasing the microsilica dosage to 7–10% increases strength due to the formation of additional calcium hydrosilicates and compaction of the pore structure. Further increases above 10% are impractical due to reduced workability and excessive water consumption.

Conclusion

The combined use of microsilica , organosilicon water repellents, and ground river sand has enabled the development of a new non-autoclaved aerated concrete composition with improved rheological properties, high strength, reduced shrinkage, and increased water resistance. The contribution of each component to the material's microstructural organization is confirmed by research and testing of its physical and mechanical properties. These solutions have enabled the creation of aerated concrete with potential for use in energy-efficient construction in challenging climates.

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HUMANISM AND SOCIAL JUSTICE IN THE POETIC VISION OF ZULFIYA

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Abstract. This article examines the manifestation of humanism and social justice in the poetic worldview of *Zulfiya Isroilova*, one of the most influential voices in twentieth-century Uzbek literature. Her lyrical works represent a rare synthesis of emotional sincerity and moral strength, where poetry becomes both a mirror and a tool of ethical transformation. Zulfiya's verses reflect the universal struggle for dignity, equality, and compassion — values that transcend time, gender, and nationality.Through her poetic language, Zulfiya created a spiritual space where humanity, fairness, and empathy form the foundation of moral consciousness. She saw poetry not merely as an aesthetic endeavor but as a moral responsibility — a way to give voice to the voiceless and to celebrate the sanctity of human life. Her poetic world consistently advocates for social harmony, condemns injustice, and elevates the inner beauty of the human spirit. The article explores how Zulfiya's humanistic philosophy intertwines with her advocacy for women's rights, education, and social progress. Her poems portray the individual as a bearer of collective responsibility and moral light. In the broader context of Uzbek literature, Zulfiya's creative vision stands as an enduring symbol of moral courage and artistic sincerity — a legacy that continues to inspire readers to seek truth, empathy, and justice.

Keywords: Uzbek literature**,** humanism**,** social justice**,** moral philosophy**,** women's emancipation**,** spiritual ethics**,** cultural identity**,** literary legacy**,** compassion**.**

Introduction

The poetic legacy of **Zulfiya Isroilova (1915–1996)** represents a profound synthesis of artistic beauty and moral consciousness. Her works embody not only the lyrical essence of Uzbek culture but also its deepest ethical aspirations. As a poet, thinker, and moral voice of her generation, Zulfiya elevated poetry beyond aesthetics — transforming it into a means of social reflection, justice, and compassion. Emerging during a century of ideological and cultural upheaval, Zulfiya's poetry became a moral compass for her people. In an era marked by political transformation and gender inequality, she redefined the role of women in literature and society. Her voice, soft yet unyielding, resonated with a belief in **the sanctity of human life and the pursuit of justice**. Through her verses, Zulfiya spoke not only for herself but for all who yearned for dignity, fairness, and emotional freedom. Her poetry is deeply rooted in the **humanistic traditions of Eastern philosophy**, especially the ethical principles found in the works of Alisher Navoi and other classical thinkers. Yet, she also drew inspiration from the global humanist movement — affirming that moral ideals such as equality, compassion, and justice belong to all of humanity. In Zulfiya's worldview, the poet carries a sacred duty: to awaken empathy and to give voice to the silent sorrows of the oppressed. One of the most remarkable features of Zulfiya's poetic thought is

her ability to blend **personal emotion with collective moral consciousness**. Her lyrical "I" is never isolated; it reflects the heartbeat of an entire community. Each poem carries within it a dialogue between the poet and her nation, between the individual and the universal. Through this harmony, Zulfiya transforms private experience into a moral act — where beauty becomes truth, and truth becomes justice. Her commitment to **social justice** is especially evident in her portrayals of women's struggles and triumphs. She celebrated the intelligence, strength, and moral courage of women — not as a feminist slogan, but as a moral necessity. In her poetic vision, every woman symbolizes the moral backbone of society, a guardian of purity and compassion. Zulfiya's belief in education, equality, and self-respect for women mirrored her conviction that social justice begins with moral awakening. Zulfiya's humanism also extended beyond gender; it embraced the entire human condition. Her empathy reached across social boundaries — to the poor, the forgotten, the suffering. She condemned oppression not through anger, but through tenderness; her protest was lyrical, her defiance graceful. In this way, Zulfiya crafted a poetics of justice — one that uses beauty as resistance, and love as liberation. Today, her work remains a cornerstone of **modern Uzbek moral thought and literary aesthetics**. Her poems continue to inspire discussions about human dignity, equality, and the spiritual development of the nation. In a world where materialism often overshadows morality, Zulfiya's voice reminds us that poetry, at its purest, is an act of conscience — a bridge between the beautiful and the just.

Artistic and Moral Analysis

Zulfiya Isroilova's poetry stands at the intersection of beauty and conscience, where humanism becomes both the foundation and the destination of artistic expression. Her creative world is shaped by a belief that **art must serve humanity** — not by preaching, but by touching the heart, refining the spirit, and awakening the moral sense within each reader. Through lyrical imagery, rhythm, and emotional sincerity, Zulfiya transformed the private act of writing into a public act of compassion. Her humanism is not abstract philosophy; it is lived experience. In her verses, Zulfiya speaks of people who work, love, and suffer — everyday individuals whose worth is measured not by power or wealth, but by their integrity. She celebrates those who create, nurture, and heal — mothers, teachers, and workers — portraying them as moral heroes of society. Her poetic language dignifies their labor, turning the ordinary into the sacred. A key dimension of Zulfiya's humanism lies in her **vision of justice**. For her, justice is not confined to the courtroom or political sphere; it begins in the soul. Her poetry suggests that social harmony can only emerge when individuals live with honesty, empathy, and a sense of shared responsibility. In poems written during the post-war period, Zulfiya's words became a moral appeal for peace — not just as the absence of conflict, but as the presence of equality and understanding. She viewed inequality as a moral wound that art must heal. Through soft rhythm and vivid metaphor, Zulfiya spoke against oppression, ignorance, and prejudice — yet she did so with the gentleness of a mother, not the anger of a rebel. Her rebellion was one of **compassion**, her protest a form of **moral tenderness**. This emotional discipline made her poetry accessible and universal, resonating across generations. One of the most

powerful aspects of her poetic philosophy is her portrayal of **women as agents of justice and humanity**. Zulfiya rejected the reduction of women to passive symbols of beauty or sacrifice. Instead, she presented them as thinkers, creators, and moral educators. In her view, a woman's role in society is not merely biological or domestic — it is spiritual and intellectual. She often wrote about mothers whose patience and faith sustain the moral fabric of the nation, transforming their love into a form of social strength. Zulfiya's imagery of nature also reflects her belief in moral balance. In her poems, the blossoming of a flower is a metaphor for spiritual growth, and the coming of spring symbolizes moral renewal. The beauty of the natural world serves as a reminder that harmony is the natural state of both earth and human conscience. When injustice disrupts that harmony, the poet's voice acts as a force of restoration. Her moral sensitivity is inseparable from her artistic craft. Zulfiya's choice of words, her balanced rhythm, and her calm tone all mirror her ethical worldview. She rejected the harsh rhetoric of ideology in favor of the quiet strength of truth. Her verses are free of bitterness — instead, they invite readers into reflection. This **ethical subtlety** is what gives her poetry its timeless power: it instructs without lecturing, moves without demanding, heals without wounding. In the broader frame of Uzbek literature, Zulfiya's artistic humanism became a **moral bridge between tradition and modernity**. She drew from classical ethics — humility, compassion, gratitude — and reinterpreted them for a society seeking renewal. Her moral ideals are deeply Uzbek, yet universally human. She believed that the worth of a nation lies not in its wealth or politics, but in its conscience. Today, her poetry continues to echo in classrooms, literary circles, and public ceremonies — reminding people that art has a moral duty: to elevate the soul and protect the dignity of all human beings. Zulfiya's poetic humanism remains a guiding light for those who believe that justice without love is hollow, and beauty without conscience is meaningless.

Conclusion

The poetic vision of **Zulfiya Isroilova** embodies one of the most profound moral and artistic achievements in modern Uzbek literature. Her poetry stands as both a song of beauty and a testament of conscience, reminding humanity that the purpose of art is not only to delight, but to heal, enlighten, and unite. Zulfiya's work reveals that the soul of poetry is the soul of humanity itself — it breathes through compassion, justice, and truth. Her humanism is deeply rooted in her cultural and spiritual identity. Drawing inspiration from the moral traditions of the East, Zulfiya transformed those values into a living ethical practice through her art. She believed that poetry must awaken moral awareness in the reader — not through preaching, but through the power of feeling and sincerity. Her verses carry an invisible moral pulse: they teach kindness without command, they call for fairness without confrontation. Zulfiya's notion of **social justice** transcends the boundaries of ideology. For her, justice begins not in laws but in the human heart. She envisioned a society where empathy is the foundation of strength, and equality is born out of mutual respect. Through her portrayal of women, workers, and ordinary citizens, Zulfiya elevated the forgotten and gave dignity to the humble. Her poems serve as a spiritual call to recognize the sacredness of every human life. As an artist, Zulfiya proved that beauty and morality are inseparable. The aesthetic

perfection of her verse mirrors her ethical balance — harmony in sound reflecting harmony in soul. Her calm, meditative rhythm mirrors her belief in peace; her clarity of expression mirrors her moral honesty. She used the tenderness of words as a tool of reform, proving that love is stronger than violence and that empathy is the truest form of resistance. Even decades after her passing, Zulfiya's voice remains urgently relevant. In a world still struggling with injustice, inequality, and moral decay, her poetry offers a timeless remedy — to return to the essence of being human. Her art reminds us that justice cannot survive without mercy, and that mercy is the highest form of human strength. In the final measure, Zulfiya Isroilova's poetic vision stands as a living bridge between **beauty and justice, art and ethics, heart and humanity**. Her words continue to illuminate the moral landscape of Uzbek culture and resonate far beyond its borders. Through her legacy, Zulfiya affirms a truth as old as poetry itself: that the greatest art is not only written in ink, but in the conscience of those who live it.

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TALABALARDA SHAXSIY QADRIYATLARNI RIVOJLANTIRISHDA AKSIOLOGIK YONDASHUVNING PSIXOLOGIK-PEDAGOGIK ASOSLARI

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Chirchiq davlat pedagogika universiteti

ANNOTATSIYA. Ushbu maqolada talabalarda shaxsiy qadriyatlarni shakllantirish jarayonida aksiologik yondashuvning mohiyati, uning psixologik va pedagogik asoslari keng yoritiladi. Qadriyatlarning shakllanishi, talabaning shaxsiy rivoji, pedagogik muhit va psixologik omillarning o‘zaro ta’siri, ta’lim jarayonida qadriyatlarga yo‘naltirilgan integrativ metodlarning ahamiyati ilmiy asosda tahlil qilinadi. Tadqiqot natijalari ta’lim jarayoniga aksiologik yondashuvni keng joriy qilish bo‘yicha taklif va metodik tavsiyalarni o‘z ichiga oladi.

KALIT SO’ZLAR: Aksiologiya, qadriyatlar tizimi, shaxsiy qadriyatlar, ta’lim jarayonida qadriyatlar, aksiologik yondashuv, talaba shaxsi rivoji, psixologik-pedagogik asoslar, kompetensiyalar, kasbiy qadriyatlar, o‘quv faoliyati, pedagogik monitoring, shaxslararo munosabatlar.

KIRISH (INTRODUCTION). Globallashuv va axborot oqimining keskin ortishi sharoitida yoshlarning dunyoqarashi, ijtimoiy faolligi va ma’naviy barkamolligini shakllantirish dolzarb masalalardan biridir. Talabalik davri shaxsning hayotiy pozitsiyasi, qadriyatlar tizimi, kasbiy va ma’naviy yo‘nalishlari shakllanadigan bosqich bo‘lgani sababli, ta’lim jarayonida aksiologik yondashuvni qo‘llash zarurati kuchayib bormoqda. Aksiologik yondashuv (qadriyatshunoslik yondashuvi) — shaxs rivojida qadriyatlarning markaziy o‘rinda turishini ta’minlaydigan metodologik yondashuv bo‘lib, ta’limning ma’naviy,
ijtimoiy va psixologik funksiyalarini uyg‘unlashtiradi. Bu yondashuv talabaning nafaqat bilim olishini, balki uning ichki dunyosi, ma’naviy-axloqiy qarashlari va hayotiy maqsadlarining shakllanishini qo‘llab-quvvatlaydi.
Ushbu tadqiqotning maqsadi — talabalarda shaxsiy qadriyatlarni rivojlantirish jarayonida aksiologik yondashuvning psixologik-pedagogik asoslarini ilmiy jihatdan tahlil qilish va amaliy metodik yechimlarni ishlab chiqish[1-6].

METODLAR (METHODS). Tadqiqotda quyidagi metodlar qo‘llandi:

- Nazariy-tahliliy metod – aksiologiya, psixologiya, va pedagogika yo‘nalishidagi asosiy ilmiy manbalar o‘rganildi.
- Struktural tahlil – qadriyatlarning psixologik tuzilmasi va ularning ta’lim jarayonidagi funksiyalari tahlil qilindi.
- Diagnostik metodlar – talabalar qadriyatlar tizimini aniqlash uchun so‘rovnoma, test va kuzatishlar o‘tkazildi.
- Pedagogik eksperiment – qadriyatga yo‘naltirilgan metodlar joriy qilindi va samaradorligi baholandi.
- Statistik metodlar – natijalar matematik qayta ishlanib, umumlashtirildi[7-8].

NATIJALAR (RESULTS). Qadriyatlar shakllanishining psixologik omillari. Tadqiqot talabalar qadriyatlar tizimining shakllanishi quyidagi psixologik omillarga bog‘liqligini ko‘rsatdi:

- Motivatsiya — talabaning o‘qish, kasbiy o‘sish va jamiyatdagi o‘rniga bo‘lgan munosabati qadriyatni anglash darajasiga ta’sir qiladi.
- O‘zini anglash — shaxsning o‘zini baholash, o‘z imkoniyatlarini bilishi ma’naviy qadriyatlarning barqaror shakllanishini ta’minlaydi.
- Emotsional barqarorlik — stressga chidamlilik, ijobiy psixologik fon talabaning ijtimoiy qadriyatlarga nisbatan munosabatini belgilaydi.
- Ijtimoiy-madaniy muhit — oila, do‘stlar, o‘qituvchilar ta’siri asosiy rol o‘ynaydi.

Aksiologik yondashuvning pedagogik asoslari. Pedagogik jihatdan aksiologik yondashuv talaba shaxsiga yo‘naltirilgan ta’lim falsafasi bilan bog‘liq. U quyidagi tamoyillarga asoslanadi:

- Ma’naviy tarbiya va ta’limning integratsiyasi.
- Talabaning mustaqil fikrlashi va refleksiyasini qo‘llab-quvvatlash.
- Dars jarayonida hayotiy vaziyatlar, bahs-munozaralar, loyiha ishlari orqali qadriyatlarga ta’sir ko‘rsatish.
- Pedagogning kommunikativ madaniyati va shaxsiy namunalari asosiy omil bo‘lib xizmat qiladi.

Ta’lim jarayoniga qadriyatga yo‘naltirilgan metodlarni joriy etish. Tadqiqot davomida quyidagi metodlarning yuqori samaradorligi kuzatildi:

- Interfaol metodlar: debat, “aqliy hujum”, rol o‘ynash.
- Refleksiv metodlar: kundalik yuritish, shaxsiy maqsadlarni rejalashtirish.
- Ijtimoiy loyihalar: ekologik aksiyalar, xayriya ishlari, volontyorlik.
- Mentorlik instituti: murabbiy talabaning ma’naviy rivojiga yo‘naltirilgan shaxsiy yordam ko‘rsatadi.

Eksperimental guruhda:

- ijtimoiy faollik 30% ga,
- mas’uliyat darajasi 22% ga,
- kasbiy motivatsiya 17% ga oshganligi qayd etildi.

MUNOZARA (DISCUSSION). Olingan natijalar shuni ko‘rsatadiki, talabalarda qadriyatlar tizimi tabiiy shakllanmaydi, balki pedagogik va psixologik ta’sirlar orqali ongli ravishda rivojlantiriladi. Aksiologik yondashuv ta’lim jarayonini insonparvarlashtirish jarayoniga xizmat qiladi.

Talabalarda ma’naviy qadriyatlarni rivojlantirish quyidagi ijobiy o‘zgarishlarga olib keladi:

- jamiyatga moslashuvchanlik oshadi;
- ijtimoiy mas’uliyat kuchayadi;
- kasbiy etikaga amal qilish shakllanadi;
- shaxsiy maqsadlar aniq va real bo‘ladi.

Pedagogik jarayon esa qadriyatlarga yo‘naltirilgan muhit bilan boyitilganda, ta’lim mazmuni yanada samarali bo‘ladi.

XULOSA (CONCLUSION). Tadqiqot shuni ko‘rsatdiki, talabalarda shaxsiy qadriyatlarni shakllantirishda aksiologik yondashuvning psixologik-pedagogik

asoslari chuqur ilmiy mazmunga ega bo‘lib, uni ta’lim muassasalarida keng joriy etish zarur.

Quyidagi takliflar ishlab chiqildi:

1. Ta’lim jarayonini qadriyatlarga yo‘naltirilgan metodlar bilan boyitish.
2. Pedagogik psixologiya asosida talabalarning individual qadriyat xaritasini yaratish.
3. Ma’naviy tarbiya, shaxsiy rivoj va kasbiy o‘sishni uyg‘unlashtiruvchi integrativ kurslarni joriy etish.
4. O‘qituvchilarning aksiologik kompetensiyasini rivojlantirish. Maqola talabalarda shaxsiy qadriyatlarni shakllantirish bo‘yicha ilmiy-amaliy yechimlarni o‘z ichiga oladi va ta’lim sohasida qo‘llash uchun amaliy ahamiyatga ega.

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TO‘RLI TUZILMALARNI HISOBLASH MODELINI SHAKLLANTIRISH

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Annotatsiya. Ushbu maqolada to’rli konstruktsiya-bir qatlamli armaturalangan panellarning hisoblash modeli shakllantirilgan, ko’chish orqali muvozanat tenglamasi keltirilgan.

Kirish. Musatahkamligini va foydalanish muddatini oshirish, material sarfini kamaytirish, plitalar va qobiq konstruksiyalarining ishchi parametrlarini kuchaytirish ularni qurilish, mashinasozlik va energetika sanoatida qo‘llash samaradorligini oshirishning eng muhim shartlaridir [1-5].

Ko‘p qatlamli plitalar va qobiqli tuzilmalar ularning konstruksiya shakllari, ishlab chiqarish texnologiyalari, ish sharoitlari va ishlatiladigan materiallarning fizik-mexanik xususiyatlarida sezilarli o‘ziga xos xususiyatlarga ega. Plitalar, panellar va qobiq konstruktsiyalarini loyihalash bilan bog‘liq ko'plab masalalar bunday tuzilmalarning kuchlanganlik-deformatsiyalanganlik holatini (KDH), mustahkamligi va ustivorligini o‘rganishni o‘z ichiga oladi.

Anizotrop, shuningdek izotrop qatlamli plastina va qobiqlar nazariyasi S.A.Ambartsumyan , N.A.Alfutov, V.V.Bolotin, Ya.M. Grigorenko, E.I. Grigolyuk, S.K.Golushko, G.M.Kulikov va boshqa olimlar asarlarida ishlab chiqilgan. Ko'p qatlamli armaturalangan qobiqlarning mustahkamligini hisoblash usullari, hamda qobiqlar masalalarining sonli yechim algoritmlari [1] da keltirilgan. Monografiyada [2] anizotrop jismlarni hisoblash masalalariga bag'ishlangan bo‘lib, unda anizotrop qobiqlar nazariyasining asosiy tenglamalari, har xil turdagi konstruksiyalarning KDH va tebranishlarini aniqlash ko‘rib chiqiladi. Korolev V.I. [3] elastik va elastik-plastik deformatsiyalar ostida plitalar va qobiqlarning mustahkamligi va ustivorligini hisoblash usullari keltirilgan.

Annin B.D. [4] maqolada uch o‘lchovli elastiklik nazariyasini masalalarini ikki o‘lchovli muammoga — plitalar va qobiqlar nazariyasiga — qaytarish usullariga bag'ishlangan tadqiqotlar sharhi keltirilgan. Bunada muallif Ikki yondashuv: kinematik va kuch gipotezalaridan foydalanish va uch o'lchovli elastiklik nazariyasi yechimlarini funksiyalarning to'liq tizimiga kengaytirish ko'rib chiqiladi.

Pshenichnov T.I. [5]da o‘z navbatida yupqa elastik to‘rli qobiqlar va plastinalar nazariyasi hamda ularning texnikadagi qo‘llanilishi yoritilgan. Asosiy e’tibor bir qatlamli va uch qatlamli konstruktsiyalarga qaratilgan bo‘lib, ularning to‘rlari sterjen tizimlari ko‘rinishida bajarilgan. Chegaraviy masalalar yechimida analitik va sonli usullardan foydalanilgan.

Elastiklik va plastisiya nazariyasi masalalarini algoritmik yechish masalalari, sterjenlar va qobiq plitalari birinchi marta akademik V.K. Qobulov va uning shogirdlari va izdoshlari tomonidan yanada rivojlantirildi. T. Bo‘riev o‘z ishlarida deformatsiyalanuvchan qattiq jism mexanikasining chegaraviy masalalarni yechishning matematik modellari va sonli usullarini, shuningdek, fazoviy tuzilmalarni va murakkab sxemalar panellarini, materiallarning haqiqiy

xususiyatlarini hisobga olgan holda loyihalashni avtomatlashtirish uchun ishlab chiqdi [6] .

Shuni ta'kidlash kerakki, plitalar va qobiqlar nazariyasida chegaraviy masalalarni yechishning eng keng tarqalgan usullari chekli ayirmalar usuli, chekli elementlar usuli va sonli integrallash usulidir.

Masalaning qo'yilishi. To'rli tuzilmalar uchun hisoblash modelini ishlab chiqishda panel plastinka konstruktsiyasi hisoblanadi. Bir qatlamli panel yupqa plitadan va ikki qatlamli tekis armaturalangan karkasdan iborat deb qaraladi. Yassi karkas va yupqa plita uchun holat tenglamalarini keltiramiz [5].

Masalaning yechilishi. Plastinka uchun holat tenglamasi quyidagicha yoziladi:

$$\begin{aligned} T_{11}^{(0)} &= E^{(0)}h\left(\varepsilon_1+\nu\varepsilon_2\right)/\left(1-\nu^2\right), \qquad M_{11}^{(0)} = -D\left(\chi_1+\nu\chi_2\right) \\ T_{22}^{(0)} &= E^{(0)}h\left(\varepsilon_2+\nu\varepsilon_1\right)/\left(1-\nu^2\right), \qquad M_{22}^{(0)} = -D\left(\chi_2+\nu\chi_1\right) \\ T_{12}^{(0)} &= T_{21}^{(0)} = E^{(0)}h\varepsilon_{12}/2\left(1+\nu\right), \qquad M_{12}^{(0)} = M_{21}^{(0)} = -D\left(1-\nu\right)\tau \end{aligned} \tag{1}$$

Armatura karkasi uchun x o'qi bilan bo'ylama armatura $\varphi_1 = 0^0$ *va* y o'qi bilan $\varphi_2 = \pi/2$ bo'ladi. Armatura holati tenglamasini aniqlash uchun quyidagi munosabatlardan foydalanamiz [5]:

$$T_{11}^{(1)} = C_{11}\varepsilon_1 + C_{12}\varepsilon_2 + C_{16}\omega - \sum_{i=1}^{n} s_i c_i \chi_i',$$

$$T_{22}^{(1)} = C_{12}\varepsilon_1 + C_{22}\varepsilon_2 + C_{26}\omega + \sum_{i=1}^{n} s_i c_i \chi_i',$$

$$T_{12}^{(1)} = C_{61}\varepsilon_1 + C_{62}\varepsilon_2 + C_{66}\omega + \sum_{i=1}^{n} c_i^2 \chi_i',$$

$$T_{21}^{(1)} = C_{61}\varepsilon_1 + C_{62}\varepsilon_2 + C_{66}\omega - \sum_{i=1}^{n} s_i^2 \chi_i',$$

$$\begin{aligned} M_{11}^{(1)} &= -\left[\left(D_{11}+K_{11}\right)\chi_1 + \left(D_{12}-K_{12}\right)\chi_2 + \left(2D_{16}-K_{16}\right)\tau\right], \\ M_{22}^{(1)} &= -\left[\left(D_{21}-K_{21}\right)\chi_1 + \left(D_{22}+K_{22}\right)\chi_2 + \left(2D_{26}+K_{26}\right)\tau\right], \\ M_{12}^{(1)} &= \left(D_{61}-K_{61}^{(1)}\right)\chi_1 + \left(D_{62}+K_{62}^{(1)}\right)\chi_2 + \left(D_{66}+K_{66}^{(1)}\right)\tau, \\ M_{21}^{(1)} &= \left(D_{61}+K_{61}^{(2)}\right)\chi_1 + \left(D_{62}-K_{62}^{(2)}\right)\chi_2 + \left(D_{66}-K_{66}^{(2)}\right)\tau, \end{aligned} \tag{2}$$

$$M_{1s}^{(1)} = -\sum_{i=1}^{n} I_i^0 c_i \chi_i^0, \qquad M_{2s}^{(1)} = \sum_{i=1}^{n} I_i^0 s_i \chi_i^0,$$

To'rli plitaning panjaralarida (armaturada) kuchlar va momentlarni aniqlaymiz. Sterjenlarning bosh markaziy o'qlaridan biri panelning o'rta yuzasiga normal yo'nalishiga mos keladi deb hisoblanadi.

Sterjenlarda paydo bo'ladigan kuchlar va momentlarning deformatsiya tarkibiy qismlariga bog'liqligi quyidagi ko'rinishga ega [5]:

$$\begin{aligned} N_i^* &= E_i F_i \varepsilon_i^*, \qquad M_i^* = -E_i J_{1i} \chi_i^*, \\ G_i^* &= -E_i J_{2i} \chi_i^0, \quad H_i^* = G_i J_{3i} \tau_i^*, \\ Q_i^* &= -\nabla_i M_i^*, \quad S_i^* = -\nabla_i G_i^*, \end{aligned} \tag{3}$$

Ko‘rib chiqilayotgan panel uchun sterjen deformatsiyasi, egriligi va buralishi quyidagi shaklga ega :

$$\varepsilon_1^* = \varepsilon_x = \frac{\partial u}{\partial x} - z_i \frac{\partial^2 w}{\partial x^2}; \quad \chi_1^* = -\frac{\partial^2 w}{\partial x^2}; \quad \tau_j^* = -\frac{\partial^2 w}{\partial x^2}; \quad \tau_j^* = -\frac{\partial^2 w}{\partial x \partial y};$$

$$\varepsilon_2^* = \varepsilon_y = \frac{\partial v}{\partial y} - z_i \frac{\partial^2 w}{\partial y^2}; \quad \chi_2^* = -\frac{\partial^2 w}{\partial y^2}; \quad \chi_j^* = -\nabla_i \psi_i;$$

$$\chi_1^0 = -\nabla_1 \psi_1 = \frac{\partial \psi_1}{\partial x}; \quad \chi_2^0 = -\nabla_2 \psi_2 = -\frac{\partial \psi_2}{\partial y};$$

$$\psi_1 = -\delta + \frac{\omega}{2} = \frac{\partial v}{\partial x}; \qquad \psi_2 = -\delta - \frac{\omega}{2} = -\frac{\partial u}{\partial y}; \qquad (4)$$

Natijada quyidagilarni olamiz: $\chi_1^0 = \frac{\partial \psi_1}{\partial x} = \frac{\partial^2 v}{\partial x^2}; \quad \chi_2^0 = -\frac{\partial \psi_2}{\partial y} = -\frac{\partial^2 u}{\partial y^2}$

Shuni ta’kidlaymizki ψ va δ [5] formulalar bilan aniqlanadi :

$$2\psi = -2\delta + \omega \cos 2\varphi + (\varepsilon_2 - \varepsilon_1)\sin\varphi; \quad \delta = \frac{1}{2}\left(\frac{\partial u}{\partial y} - \frac{\partial v}{\partial x}\right);$$

$$\omega = \frac{\partial u}{\partial y} - \frac{\partial v}{\partial x}; \quad \mathrm{x}_i^0 = -\nabla_i \psi_i; \quad \left(\nabla_i = c_i \frac{\partial}{\partial x} + s_i \frac{\partial}{\partial x}\right), \quad c_i = \cos\varphi_i; \quad s_i = \sin\varphi_i \qquad (5)$$

Ko‘chishlardagi muvozanat tenglamalarini olish uchun mos keladigan chegara shartlariga ega bo‘lgan kuchlarda to‘rli plitalarining ko‘ndalang egilish tenglamalaridan foydalanamiz [2]:

$$\frac{\partial T_{11}}{\partial x} + \frac{\partial T_{21}}{\partial y} + X = 0 \qquad \frac{\partial T_{22}}{\partial y} + \frac{\partial T_{12}}{\partial x} + Y = 0$$

$$\frac{\partial^2 M_{11}}{\partial x^2} + \frac{\partial^2 M_{12}}{\partial x \partial y} + \frac{\partial^2 M_{21}}{\partial x \partial y} + \frac{\partial^2 M_{22}}{\partial y^2} + Z = 0 \qquad (6)$$

(1) va (2) munosabatlardan foydalanib, biz kuchlar va momentlarni siljish orqali aniqlaymiz:

$$T_{11} = T_{11}^{(0)} + T_{11}^{(1)}, \quad \ldots \quad , \quad M_{11} = M_{11}^{(0)} + M_{11}^{(1)}$$

Masalan,

$$T_{11} = \left[\frac{E^{(0)}h}{1-v^2} + \frac{(E_1^{(1)} - E^{(0)})F_1}{a_1} + \frac{(E_1^{(2)} - E^{(0)})F_2}{a_2}\right]\frac{\partial u}{\partial x} + \frac{vE^{(0)}h}{1-v^2}\frac{\partial v}{\partial y} -$$

$$-\left[\frac{(E_1^{(1)} - E^{(0)})F_1}{a_1} z_1 + \frac{(E_1^{(2)} - E^{(0)})F_2}{a_2} z_2\right]\frac{\partial^2 w}{\partial x^2};$$

$$T_{12} = \frac{E^{(0)}h}{2(1+v)}\frac{\partial v}{\partial x} + \frac{E^{(0)}h}{2(1+v)}\frac{\partial u}{\partial y} - \left[\frac{(E_2^{(1)} - E^{(0)})\mathrm{J}_2^{(1)}}{a_1} + \frac{(E_2^{(2)} - E^{(0)})\mathrm{J}_2^{(2)}}{a_2}\right]\frac{\partial^3 v}{\partial x^3}$$

\- (7)

$$M_{11} = -\left[D + \frac{E_1^{(1)} - E^{(0)}}{a_1}(\mathrm{J}_{10}^{(1)} + z_1^2 \mathrm{F}_1) + \frac{E_1^{(2)} - E^{(0)}}{a_2}(\mathrm{J}_{10}^{(2)} + z_2^2 \mathrm{F}_2)\right]\frac{\partial^2 w}{\partial x^2} - Dv\frac{\partial^2 w}{\partial y^2}$$

$$M_{12} = -\left[D(1-v) + \frac{(G_1^{(1)} - G^{(0)})}{a_1}\mathrm{J}_p^{(1)} + \frac{(G_1^{(2)} - G^{(0)})}{a_2}\mathrm{J}_p^{(2)}\right]\frac{\partial^2 w}{\partial x \partial y}$$

(7) ni hisobga olgan holda, siljishlardagi muvozanat tenglamalarini (6) qayta yozamiz:

$$K_{11}\frac{\partial^4 w}{\partial x^4}+K_{12}\frac{\partial^4 w}{\partial x^2\partial y^2}+K_{13}\frac{\partial^4 w}{\partial y^4}+z=0$$

$$K_{21}\frac{\partial^4 u}{\partial y^4}+K_{22}\frac{\partial^3 w}{\partial x^3}+K_{23}\frac{\partial^2 u}{\partial x^2}+K_{21}\frac{\partial^2 v}{\partial x\partial y}+K_{25}\frac{\partial^2 u}{\partial y^2}+x=0 \qquad (8)$$

$$K_{31}\frac{\partial^4 v}{\partial y^4}+K_{22}\frac{\partial^3 w}{\partial y^3}+K_{33}\frac{\partial^2 v}{\partial x^2}+K_{34}\frac{\partial^2 u}{\partial x\partial y}+K_{35}\frac{\partial^2 v}{\partial y^2}+y=0$$

Differensial tenglamalar sistemasini (8) vektor ko'rinishida ifodalanishi [7] da keltirilgan.

$$A\frac{\partial^4 U}{\partial x^4}+B\frac{\partial^4 U}{\partial x^2\partial y^2}+C\frac{\partial^4 U}{\partial y^4}+D\frac{\partial^3 U}{\partial x^3}+E\frac{\partial^3 U}{\partial y^3}+F\frac{\partial^2 U}{\partial x^2}+J\frac{\partial^2 U}{\partial x\partial y}+I\frac{\partial^2 U}{\partial y^2}+Q=0 \qquad (9)$$

Ko'chishlarni chegaraviy shartlari ifodalanadi Masalan,

$$\left[-\bar{a}_1\frac{\partial u}{\partial x}-\bar{a}_2\frac{\partial v}{\partial y}+\bar{a}_3\frac{\partial^2 w}{\partial x^2}+P_{11}\right]\delta u\big|_x=0,\left[-\bar{a}_4\frac{\partial u}{\partial y}-\bar{a}_5\frac{\partial v}{\partial x}+\bar{a}_6\frac{\partial^3 w}{\partial y^3}+P_{21}\right]\delta v\big|_x=0$$

$$\left[\bar{a}_7\frac{\partial^2 w}{\partial x^2}+\bar{a}_8\frac{\partial^2 w}{\partial y^2}+M_{11}^{(p)}\right]\delta\frac{\partial w}{\partial x}\Big|_x=0,\left[\bar{a}_7\frac{\partial^3 w}{\partial x^3}+(\bar{a}_8+\bar{a}_9)\frac{\partial^3 w}{\partial x\partial y^2}+P_{31}\right]\delta w\big|_x=0 \qquad (10)$$

Burchak panellarida siljishlardagi to‘plangan kuchlar quyidagicha ko‘rinishda bo‘ladi:

$$\left[\bar{a}_9\frac{\partial^2 w}{\partial x\partial y}+M_{21}^{(p)}\right]\delta\frac{\partial w}{\partial y}\Big|_x\Big|_y=0;\quad\left[\bar{b}_9\frac{\partial^2 w}{\partial x\partial y}+M_{12}^{(p)}\right]\delta\frac{\partial w}{\partial x}\Big|_x\Big|_y=0 \qquad (11)$$

(9) differensial tenglama, (10), (11) chegara shartlarini hisobga olgan holda, Bubnov-Galerkin usuli va chekli ayirmalar usuli yordamida yechiladi.

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PROBLEMS IN THE CLASSIFICATION OF DISK-SHAPED GALAXIES' HALOS

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Abstract: This paper presents the result of a quantitative assessment of the ratio of the halo mass to the total mass of stars is given. We classify galactic halos into five classes based on the ratio of the mass of the halo and the total mass of the stars. According to our catalog, 28% of disk galaxies have low-mass halos, 23% are moderately massive, 20% are semi-massive, 13% are massive, and 16% are supermassive.

Keywords: *disk galaxies, disk subsystem, halo, dark matter halo, halo classification*

Halo classification varies significantly depending on the cosmic web type. Halos are classified as knot, filament, sheet, and void halos based on the eigenvalue decomposition of the velocity shear tensor. The peculiar velocities of a fixed number of neighboring halos determine the velocity field, and the spatial derivatives are calculated using a kernel borrowed from smoothed particle hydrodynamics. This classification scheme is used to study halo clustering as a function of web type for halos with masses greater than 10^{11} $M_{\odot}$. It is found that knot halos exhibit a positive bias, filament halos exhibit a negligible bias, and void and sheet halos exhibit an an tibias, regardless of halo mass. Our results indicate that the mass dependence of halo classification is rooted in the composition of web types as a function of halo mass. A significant fraction of knot-type halos for halo masses of $2\times10^{13}M_{\odot}$ leads to a positive bias. Filament-type halos predominate at intermediate masses, 10^{12} -10^{13} $M_{\odot}$, resulting in an unbiased classification. The large contribution of plate-type halos at low halo masses $\lesssim10^{12}$ $M_{\odot}$ generates smoothing [1].

The dynamical signatures left by baryons on dark matter halos during formation are studied using the Very Large Scale Simulations, a set of advanced, high-resolution cosmological hydrodynamic simulations. The study [2] examines in detail the influence of feedback on the orbits of dark matter particles, stars, and subgalaxies, analyzing model runs without feedback, with feedback from stars, and with feedback from supermassive black holes. In the central regions of the galactic halo with virial masses of approximately $6 \times 10^{13} \div 7 \times 10^{11}$ $M_{\odot}$ at z = 0, the influence of several key parameters, such as mass, redshift, and dynamical state, on the orbital composition (relative fractions of different orbit types) of these galactic halos is investigated. The results of spectral analysis of the orbital abundances of these models are compared, and the change in the fraction of box, tube, and irregular orbits is quantified. Orbits turned out to be dominant in the orbital structure of halo dark matter in cosmological simulations. There is no correlation between the fractions of box orbits and the fractions of central baryons. While radiative cooling reduces the fraction of box orbits, the implementation of strong feedback leads to the same orbital distribution as in the case with dark matter alone. The orbital composition described by stellar particles

turned out to be strikingly similar to the orbital composition of dark matter particles, suggesting that either they have forgotten their dynamical history or that the star-bearing subhalos are not significantly offset from the main distribution. The orbital composition of the subhalos is generally consistent with the particle distributions observed in the outer regions.

Results of quantitative analysis and halo classification by mass. The catalog contains barless spiral galaxies (62%), transitional spiral galaxies (24%), and spiral galaxies with very pronounced bars (14%). It should be noted that low-mass halos are most common in this catalog. The histogram (Fig. 1) shows that 49 galaxies have a halo mass to total stellar mass ratio of Mh/M* = 0-3, while the remaining galaxies have Mh/M* = 4-10. Several galaxies with very large halo masses, Mh\M*~100, are also found. A new estimate [3,4] of galaxy masses is presented based on radial velocities and distances measured for approximately 100 faint blue horizontal branch stars. The authors' study aims to reduce the uncertainty in the measured galaxy masses by increasing the number of objects in the halo and at the center of galaxies at distances less than 30 kpc with measured radial velocities from U-B photometry. These samples include blue horizontal branch stars in the field, as well as fainter main-sequence stars with surface gravity, which are primarily blue lost field stars. To classify these blue horizontal branch stars, precise photometry and spectra were obtained. This paper describes methods for identifying pure samples of blue horizontal branch stars in a manner that is efficient in terms of required telescope time. High-signal spectra of stars in the classification are used to evaluate the reliability of the two methods and quantify the signal-to-noise ratio requirements. First, the authors reconsidered the hydrogen line width-to-color ratio as a classifier (here called the D0.15-color method). The second method is new and compares the shapes of the Balmer lines. Using this method (here called the width-shape scale method), there is no need for color or spectrophotometry. Using the equivalent Ca II and K line width as an additional filter, they found that it is possible to reproduce the Λ-classification using both their methods. In a sample of stars with strong Balmer lines equivalent to a width of Hγ>13Å [equivalent to the color range $0 <= (B-V)_0 <= 0.2$], BHB halo stars can be reliably separated from blue trailing halos. For spectroscopy (i.e., for both classification methods), the minimum required continuum signal-to-noise ratio is 15 Å-1. The $D_{0.15}$ (B-V) color method requires a color ratio accurate to 0.03 mag. Quantum halos are defined as systems with a predominant multi-body structure and large radii compared to the sizes of classically resolved regions. Dimensionless universal scaling plots of the dependence of radii on the binding energies of two- and three-particle systems have been constructed to characterize and classify halo states [5-10]. Both short-range and long-range interactions are taken into account, and molecular, atomic, and nuclear states are plotted on a single graph. Specific two- and three-particle systems, including Efimov states, are discussed.

Based on the above results, we decided to classify halos by their masses. The histogram in Fig. 1 shows that five classes can be roughly distinguished based on the ratio of halo mass to the total mass of stars: low mass, moderately massive, semi-massive, massive, and supermassive halos (see Table 1).

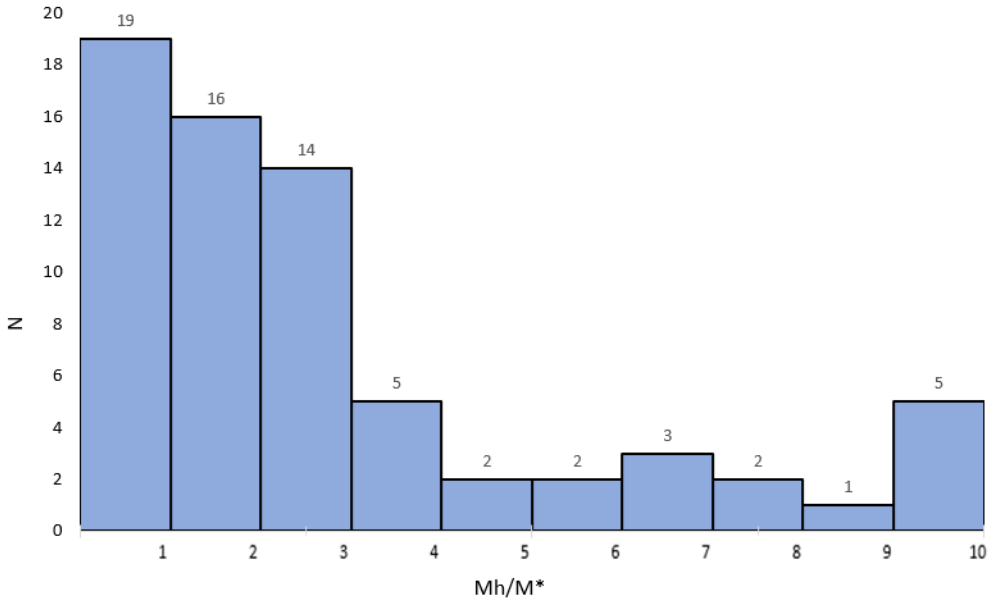

Fig. 1. Quantitative assessment of the halo mass ratio to the total mass of stars.

Table 1. Halo Classification

Classes	Class names	Number of galaxies	M_h/m_*	Average halo outer radius (kpc)	Most characteristic galaxy type
I	Low-Mass	19	≤1	30	SO, SAB
II	Moderately Massive	16	1÷2	50	SAB
III	Semi-Massive	14	2÷3	45	SA
IV	Massive	9	3÷6	15	SA, SB
V	Supermassive	11	6 <	10	SB

In our catalog, 28% of disk galaxies have low-mass halos, 23% moderately massive, 20% semi-massive, 13% massive, and 16% supermassive. The first class includes halos whose masses are less than or approximately equal to the total mass of the stars in the galaxy ($Mh/M* \leq 1$). These galaxies also include lenticular galaxies and barless galaxies with varying degrees of spiral arm twist. The next class (moderately massive) has halos for which $Mh/M* = 1 \div 2$ and an outer average halo radius of approximately 16 kpc. In the third class (Table 1), the halo mass is twice or more the total mass of the stars. The next class (moderately massive) has halos for which $Mh/M* = 1 \div 2$ and an outer average halo radius of approximately 16 kpc. In the third class (Table 2.3), the halo mass is twice or more the total mass of the stars. These galaxies most often harbor prominent bars. The table also shows that semi-massive halos are found in galaxies with SB bars and the Sa, Sb, Sc, and Sm morphological subtypes (Table 2.1). Furthermore, the average outer radius of semi-massive halos varies around 35 kpc. In the following classes (massive and supermassive), the halo radius varies from 45 kpc to 55 kpc, indicating that both dense and voluminous halos are found between massive halos. Massive halos are also more common in galaxies without bars and twisted spiral arms.

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ASETONITRIL MOLEKULASINING TEBRANMA HARAKAT SPEKTRLARI

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Annotatsiya: Kombinatsion va infraqizil spektroskopiya metodlari yordamida uglevodorodlar turkumiga mansub bo'lgan metill guruhiga kiruvchi asetonitril molekulasi tarkibidagi atomlararo vodorod bog'lanishlarining qonuniyatlari chastotaning 0-3500 sm^{-1} oralig'ida tadqiq qilindi. Kvant-kimyoviy hisoblashlar asosida asetonitril molekulasining strukturaviy modeli yaratildi.

Tayanch so'zlar: kominatsion sochilish, spektr, atsetonitril, qutblanuvchanlik, infraqizil spektr.

Molekulalarning tebranma spektrlari qonuniyatlarini yorug'likning kombinatsion sochilish (KS) va infraqizil (IQ) yutilish spektrlari yordamida o'rganish, suyuq moddalardagi molekulalararo ta'sirlashuv natijasidagi relaksatsion jarayonlarni tahlil qilishda asosiy metodlardan hisoblanadi. Bu spektrlar yordamida relaksatsion jarayonlarning mikro va makro parametrlarini aniqlash muhit tuzilishi to'g'risida kerakli ma'lumotlarni olish imkoniyatini beradi.

Suyuqliklardagi molekulalararo ta'sirlashuv molekuladagi atomlararo bog'lanish qonuniyatlarini o'zgarishiga sabab bo'ladi. Jumladan, tebranma spektrlarning kengayishiga ham olib kelishi mumkin. Agarda bu jarayonning yashash vaqti nisbatan katta bo'lsa, molekulaning tebranma harakati bilan bog'liq bo'lgan spektrning chastotasini o'zgarishga olib keladi. Ushbu vaqt, ichkimolekulalar tebranishining relaksatsiya vaqtidan sezilarli darajada katta bo'lib, suyuqliklarda bir necha o'n pikosekunddan oshmaydi [1-4].

KS va IQ spektrlarning qonuniyatlari qattiq jismlarda yaxshi o'rganilgan bo'lib, optik spektrlarning namoyon bo'lish mexanizmlari to'g'risida ham aniq ma'lumotlar mavjud. Jumladan, dioksid kremniy plenkasida IQ spektrlari olinib, optik spektrlarning hosil bo'lish mexanizmlari tahlil qilingan [5]. IQ spektroskopiya metodi yordamida polivinil plenkalarida vodorod bog'lanish qonuniyatlari o'rganilgan [6].

Ushbu soha bo'yicha chop etilgan ilmiy ishlarning tahliliga asosan shuni alohida qayd qilish lozimki, qattiq jismlardan farqli o'laroq suyuq moddalar tarkibidagi kuchli molekulalararo ta'sirlashuv kuchlari mavjudligini e'tiborga olsak, ayniqsa, murakkab strukturaga ega bo'lgan molekulalarning xossalari va sturukturasi bugungi kungacha mukammal o'rganilmagan. Mavjud molekulyar nazariyalar imkoniyatlari ham chegaralangan. Hatto ayrim ilmiy tadqiqot ishlarining natijalari ham bir-biridan keskin farq qilib, KS va IQ spektrlarning namoyon bo'lish mexanizmlariga turlicha yondoshilgan.

Yuqoridagilarni e'tiborga olgan holda ta'kidlash lozimki, kondensirlangan muhitlardagi molekulalararo ta'sirlashuv kuchlari hamda murakkab strukturaga ega

bo‘lgan molekulalarning optik spektrlarining qonuniyatlari tabiatini o‘rganish zamonaviy spektroskopiyaning dolzarb yo‘nalishlaridan hisoblanadi.

Ushbu ilmiy tadqiqot ishi suyuq asetonitril – C_2H_3N molekulasining tebranma harakati bilan bog‘liq bo‘lgan optik spektrlarning namoyon bo‘lish qonuniyatlarini KS va IQ yutilish spektrlari yordamida tadqiq qilishga bag‘ishlangan.

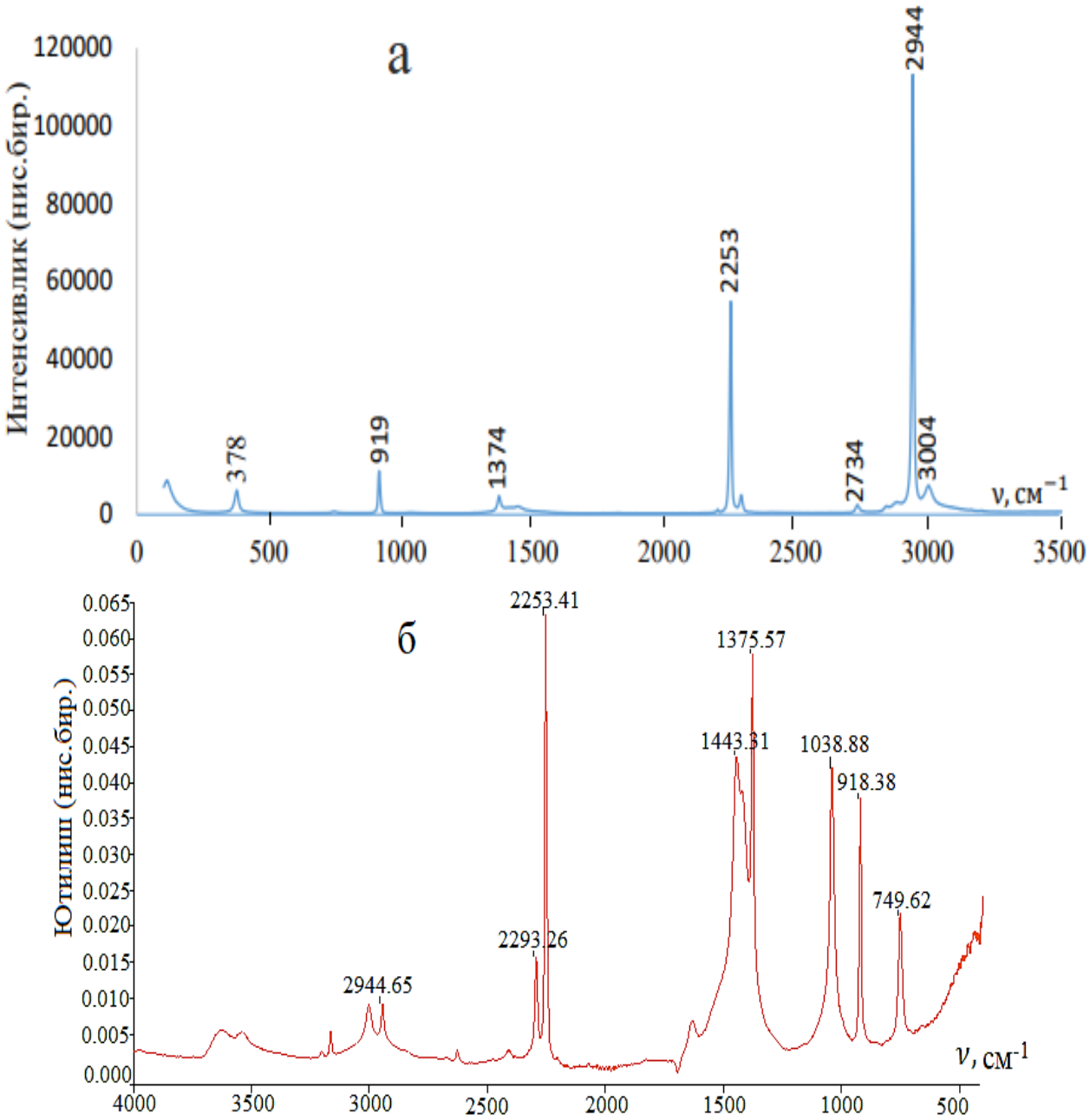
KS va IQ spektroskopiya bir-birini to‘ldiradigan metod hisoblanadi. Agarda elektromagnit to‘lqin nurlanishi ta’sirida molekulaning qutblanuvchanligi o‘zgarsa KS faol, molekulaning dipol momenti o‘zgarganda esa IQ faol hisoblanadi. Atom bog‘lanishlarining tebranishlari xar ikkala spektrda ham kuzatiladi, lekin bu spektrlar intensivliklari bilan farq qiladi (1-rasm).

Ko‘p atomli molekulalardagi tebranma spektrlarning namoyon bo‘lish qonuniyatini tahlil qilish murakkab hisoblanadi. Chunki, atomlar bir vaqtni o‘zida bir nechta tebranishlarda ishtirok etadi. Molekulaning ichidagi atomlarning harakati murakkab jarayon hisoblanib, nochiziqli molekula N ta atomdan tashkil topgan bo‘lsa, tebranma erkinlik darajalari soni 3N-6 ga teng bo‘ladi. Tebranma erkinlik darajalari miqdori molekulaning xususiy tebranishlar soniga teng bo‘ladi. Ushbu har bir xususiy tebranishlar o‘zining xususiy chastotasiga ega. Yutilish esa ma’lum bir chastotalar oralig‘ida sodir bo‘lib, IQ spektrlarni hosil qiladi. IQ spektrlarning qonuniyatlariga qarab, valent tebranishda molekulaning tebranishlari atomlarining bog‘lanish yo‘nalishi bo‘yicha atomlar orasidagi masofani o‘zgarishiga olib keladi. Deformatsion tebranishda esa atomlar orasidagi masofa o‘zgarmas bo‘lib, atomlar orasidagi burchaklarni o‘zgarishiga sabab bo‘ladi.

1-rasmda asetonitril molekulasi uchun chastotaning 0-3500 sm^{-1} diapozondagi KS va 4000-400 sm^{-1} diapozondagi IQ yutilish spektrlarining umumiy ko‘rinishi berilgan.

KS va IQ spektrlarining chastota bo‘yicha taqsimot qonuniyatlarining tahlili shuni ko‘rsatadiki, KS va IQ spektrlarining soni bir-biridan farq qiladi va ularning intensivliklarining absolyut qiymatlari ham turlicha. Yuqorida qayd qilinganidek, KS spektrlarining intensivligi molekulaning qutblanuvchanligining o‘zgarishi bilan bog‘liq bo‘lib, IQ spektrlarda esa molekulaning dipol momentining o‘zgarishi bilan bog‘liq bo‘ladi.

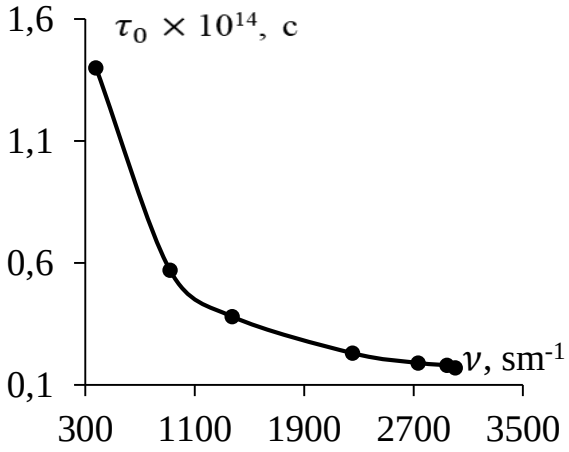
KS spektrini C – H tebranishi bilan bog‘liq bo‘lgan spektral intervalni ko‘rib chiqamiz. Asetonitril molekulasi uchun C-H tebranish bilan bog‘liq bo‘lgan 7 ta spektr kuzatilgan bo‘lib, ularning chastotalari 378, 919, 1374, 2253, 2734, 2934, 2944, 3004 sm^{-1} qiymatlarga to‘g‘ri keladi. Quyi chastotalarga to‘g‘ri kelgan KS spektrlari (378, 919 sm^{-1}) asetonitrilning aylanma-chayqalma harakati bilan bog‘liq. Asetonitril molekulasining tebranma harakati bilan bog‘liq qonuniyatlarini hamda spektrlarning namoyon bo‘lish mexanizmlari to‘g‘risida tegishli ma’lumotlar olishda molekulaning potensial chuqurlik balandligining (molekulaning faollashuv energiyasi) qiymatlarini bilish katta ahamiyatga ega.



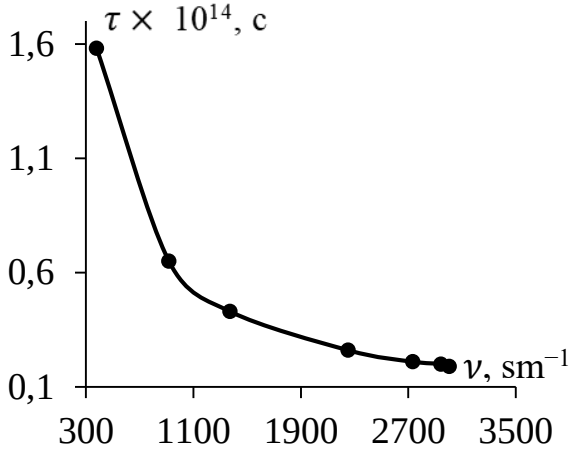
1-rasm. Asetonitril molekulasining tebranma harakati bilan bog‘liq bo‘lgan KS va IQ spektrlari: a-KS, b-IQ yutilish

Bu energiya kattaligini aniqlashning bir nechta usuli mavjud bo‘lib, yarim emperik metod bilan hisoblash mumkin. Unga asosan potensail chuqurlik balandligini o‘zaro tebranishda bo‘lgan molekulalarning bir-biri bilan itarilish hisobiga hosil bo‘lgan energiya farqiga teng deb qarash mumkin. Ushbu energiya C-H bog‘lanishning energiyasiga proporsional bo‘lib, uning qiymatini bilgan holda vodorod bog‘lanishga tegishli bir qator mikroskopik parametrlar hisoblandi. Jumladan, Ya.I.Frenkel nazariyasini qo‘llash asosida H-bog‘lanishning yashash vaqti $\tau = \tau_0 \exp(U/kT)$ tenglamadan nazariy hisoblandi. $\tau_0 = \frac{1}{2\pi\nu c}$ ga teng bo‘lib, molekulaning tebranish chastotasini xarakterlovchi vaqt, ν – molekulaning tebranish chastotasi (1-rasmdagi KS spektriga tegishli intensivlikning maksimal qiymatiga to‘g‘ri kelgan chastota). U – C-H bog‘lanishning energiyasi.

Asetonitril molekulasiga tegishli turli xil KS spektrining chastotalari uchun molekulaning tebranish vaqti va H-bog‘lanishning yashash vaqtlari 2,3-rasmlarda keltirilgan.



2-rasm. Asetonitril molekulasi uchun tebranish vaqtining tebranish chastotasiga bog‘liqligi



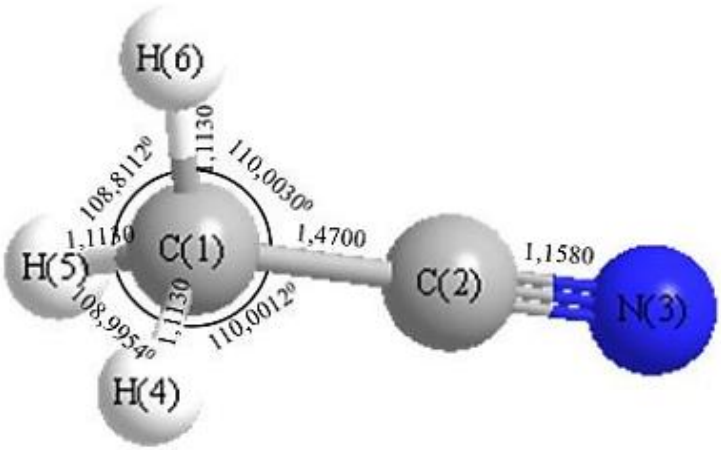
3-rasm. Asetonitril molekulasi uchun H-bog‘lanishning yashash vaqtini tebranish chastotasiga bog‘liqligi

3-rasmda qayd etilgan qonuniyatni tahlili shuni ko‘rsatmoqdaki, tajribada kuzatilgan KS spektri intensivligining maksimal qiymatlariga to‘g‘ri kelgan molekulaning tebranish chastotasini oshib borishi bilan asetonitril molekulasining C-H bog‘lanishi bilan bog’liq bo‘ladigan tebranishlarning yashash vaqti kamayib borishi kuzatildi. Jumladan, $1{,}58 \times 10^{-14}$ s dan $0{,}19 \times 10^{-14}$ s gacha kamayib borgan.

1-rasmdagi KS va IQ spektrlar asetonitril molekulasidagi C-H bog‘lanishga tegishli valent tebranishlarning chastotalari bir-biridan farq qiladi. Masalan, KS spektridagi chastotaning 1374 sm^{-1} qiymatga to‘g‘ri kelgan spektr IQ spektrda 1375,57 sm^{-1} ga teng bo‘lib, 1,57 sm^{-1} qiymatga siljigan. KS va IQ spektrlardagi ushbu farq kichik bo‘lganligi sababli C-H tebranishlar bir jinsli hamda barqaror qonuniyatga ega degan xulosaga kelish mumkin. Spektrlarning intensivliklari esa bir-biridan keskin farq qilib, IQ spektr intensivligi KS spektridan bir necha barobar katta qiymatni qabul qiladi. Demak, IQ spektr faol bo‘lib, molekulaning dipol momentini o‘zgarishi bilan bog‘liq.

Asetonitril molekulasi uchun tajribada aniqlangan KS spektri asosida kvant-kimyoviy hisoblashlar olib borilib, molekulaning konformatsiyasi HF/6 – 31G Xartri-Fok usuli yordamida kompyuterda modellashtirilib, atomlarning bog‘lanish uzunliklari (angstremda, Å) va ular orasidagi fazoviy burchaklar aniqlandi (4-rasm).

Ushbu usul yordamida olingan natijalar molekulalar tarkibidagi atomlar orasidagi masofalar va burchaklar qiymatlari asosida aniq maqsadga yo‘naltirilgan kimyoviy moddalarni sintez qilishda, termodinimik kattaliklarni hisoblashda, molekulalarning erkinlik darajalari bo‘yicha qutblanuvchanlik koeffitsientini nazariy hisoblangan qiymatlarini topishda qo‘llanishi mumkin.



4-rasm. Asetonitril molekulasi uchun kvant-kimyoviy hisoblashlarga asoslangan strukturasidagi atomlarning bog‘lanish uzunligi va ular orasidagi burchaklar

Olingan natijalarga asosan, KS spektrini namoyon bo‘lishida C-H bog‘lanishlarning o‘rni alohida ekanligi hamda yorug‘likning KS spektri yordamida H-bog‘lanishi kuzatiladigan moddalarda ushbu bog‘lanishning yashash vaqti, energiyasi hamda molekulaning tebranish chastotasini xarakterlovchi vaqt aniqlandi va ularni nazariy yo‘l bilan hisoblash metodikasi tavsiya qilindi.

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ASSESSMENT OF THE TECHNICAL CONDITION OF ARTIFICIAL CONSTRUCTIONS

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Abstract. This article provides guidelines for the maintenance of artificial structures, the timing of current, periodic, and special inspections, assessment of the technical condition of structures based on the results of inspections and tests of artificial structures, assessment of throughput, load-bearing capacity, traffic safety, durability, as well as traffic and pedestrian movement regimes, and recommendations for repairs if necessary.

Key words: artificial structures, storage, current inspection, periodic inspection, special inspection, inspection and testing of artificial structures, conductivity, load-bearing capacity, durability assessment.

Аннотация. В данной статье приведены сроки хранения искусственных сооружений, проведения текущих, периодических и специальных осмотров, оценка технического состояния по результатам обследования и испытаний искусственных сооружений, оценка пропускной способности, несущей способности, безопасности движения, долговечности, а также инструкции по режиму движения транспорта и пешеходов и рекомендации по ремонту при необходимости.

Ключевые слова: искусственные сооружения, хранение, текущий осмотр, периодический осмотр, специальный осмотр, обследование и испытание искусственных сооружений, оценка пропускной способности, несущей способности, долговечности.

Introduction. During the maintenance of artificial structures, regular current, periodic, and special inspections are carried out, safe movement is organized along them at any time of the year, cleanliness is maintained, and the preservation of the artificial structure is ensured during periods of rapid water flow and avalanches, natural disasters.

Routine inspection of structures is carried out by bridge (tunnel) masters within the following timeframes: wooden bridges, ferry crossings, overpasses - at least once a quarter; metal, reinforced concrete, and stone bridges and pipes - at least once every six months; solid welded steel and reinforced steel-reinforced concrete span structures - at least once a month in winter, and when the air temperature is below -20°C - daily, and tunnels - once a month.

The next current inspection of bridges and pipelines is carried out after the passage of flood waters and ice roads; small bridges and pipelines are additionally inspected after heavy and prolonged rains, when the water flow level may rise; in artificial irrigation areas, water pipelines and siphons are inspected before the start of irrigation, once a month during irrigation, and also after their completion.

Fig. 1. Inspection and testing of the artificial structure

Bridges and overpasses are inspected after floodwaters or earthquakes with a magnitude of more than 5, as well as after the repair of the structure (Fig. 1).

Special inspection and load testing of the structure are carried out by bridge testing organizations within the following timeframes: wooden bridges - periodically once every 5 years, other bridges and pipes - once every 10 years. Based on inspections and tests, work plans for the maintenance and repair of artificial structures are drawn up.

Based on the results of inspections and tests, an assessment of the technical condition of the structure is carried out, which should include an assessment of the functional and consumer properties of the structure, i.e., throughput, load capacity, traffic safety, durability, as well as instructions on the mode of movement of vehicles and pedestrians and recommendations for further operation and, if necessary, repair.

Materials and methods. In accordance with ShNQ 3.06.07-23 “Ko‘priklar va quvurlar. Tekshirish, sinash va diagnostika qilish qoidalari” based on the results of assessing the technical condition by individual characteristics, a general point assessment of the technical condition is established, and the bridge structure is assigned to one of the six categories of technical condition.

The category of excellent technical condition includes bridge structures that meet all the requirements of regulatory and design documentation, taking into account the prospects for the development of vehicles and the road network.

The category of good technical condition includes bridge structures in which all main structures are in good working order, while the values of one or more parameters of the technical condition of the bridge structure may not fully comply with those established by current regulatory documents, but under certain operating conditions, the main functional characteristics of the bridge structure are not violated.

The category of satisfactory technical condition includes bridge structures, the main functional characteristics of which are partially disrupted, but all the main structures are in working order, the safe passage of all vehicles moving at speeds not lower than those established by economic considerations is ensured, and the difficulties that may arise for vehicle traffic are only short-term. Measures for the repair of structures in a satisfactory technical condition are organized in a planned manner.

The category of unsatisfactory technical condition includes bridge structures whose main structures have significant defects in load-bearing capacity, safety, and durability. A bridge structure, the technical condition of which is assessed as unsatisfactory, is capable of performing only partially the required functions, normal operation is disrupted, but it is currently unlikely that a critical failure will occur, as a result of which one or more main structures will transition to the limiting state of the first group and lead to an accident. The safety of the operation of structures with this technical condition assessment can be ensured by traffic regulation with road signs. The introduction of traffic restrictions disrupts their normal functioning (Fig. 2).

Structures whose technical condition is assessed as unsatisfactory must first be repaired, overhauled, or reconstructed.

Fig. 2. Bridge structures in which an accident may occur during operation

The category of technical condition unsuitable for normal operation (or pre-accident) includes bridge structures that have a condition unsuitable for normal operation or a pre-accident condition, in which an accident may occur if adverse impacts continue. This category also includes structures that cannot guarantee the safe passage of vehicles by introducing various traffic restrictions through the installation of road signs, which require mandatory regulation of the operating mode, for example, a ban on movement along lanes, the introduction of reversible traffic, etc. Bridge structures included in this category require urgent restoration and repair measures.

This category of technical condition is assigned to bridge structures, the main structures of which, as a rule, have dangerous defects in load-bearing capacity, safety, and durability.

For pre-emergency facilities, a special regime of control measures, up to and including daily inspections, may be established.

The category of emergency technical condition includes bridge structures that have signs of emergency, indicating the possibility of loss of stability, destruction, or collapse of a structure or part of a structure, or where the first group of limiting conditions has already occurred. Emergency technical condition is assigned to bridge structures with significant defects in the main load-bearing structures that preclude the operation of the bridge structure until its elimination. If the emergency condition of the bridge structure is detected, it is required to immediately stop traffic.

Main regulatory and technical documents: ShNQ 2.05.03-12 “Ko‘priklar va quvurlar”, ShNQ 3.06.07-23 “Ko‘priklar va quvurlar. Tekshirish, sinash va diagnostika qilish qoidalari” GOST 33161-2014 “Avtomobil yo‘llaridagi sun’iy inshootlarda diagnostika va pasportlashtirishdan o‘tkazishga qo‘yiladigan talablar”.

Results and discussion. Recommendations for post-bridge operation should include a list of urgent measures necessary for the continued safe operation of the bridge and considerations on the overall long-term maintenance strategy.

These include: restoration of damaged barriers and railings, if the damage is dangerous for vehicles and pedestrians; closing cracks and deep holes in the pavement of the roadway and sidewalks; limiting the movement of vehicles by mass, speed, and intervals between them to the extent that traffic safety is ensured on the bridge. The long-term operational strategy should be built on a feasibility study based on optimizing the costs of current bridge maintenance and additional capital investments for its repair or reconstruction. In this case, the following alternative methods are usually considered:

• “zero option” - no repair measures will be carried out until the bridge is completely destroyed;

• cosmetic repair - minor defects and damage are eliminated in order to ensure operation in a short time before the planned more serious overhaul;

• repair or overhaul - restoration of the design level of functional consumer properties and extension of service life for a sufficiently long period (up to 25 years);

• reconstruction or complete replacement of the structure - achieving compliance of the level of functional consumption characteristics with modern requirements and extending the full-service life of the bridge to the standard value (for span structures - up to 80 years).

It should be noted that the choice of a specific bridge maintenance strategy is not always determined by the specified criteria calculated for this bridge. If the goal of reconstruction of a transport route is set, these criteria are determined for the entire group of bridge structures located on this route.

Assessment of the technical condition of bridge structures, development of recommendations for their operation and repair requires high qualifications from the executors. This work should be carried out by a specialized organization that has the appropriate license. At the same time, it is necessary to distinguish the attitude towards defects and damage during the design and construction of a new bridge and the operation of the constructed structure.

The attitude towards defects and damage in operating structures should be built based on purely pragmatic considerations, taking into account the need, possibility, labor intensity, and cost of their

repair, and comparing these costs with the damage that could be caused to the structure if they were not repaired.

The main tasks of maintaining water pipelines are to ensure their normal operation, prevent the occurrence of defects in the embankment and on the roadway above it, as well as directly in the pipelines themselves, and eliminate minor damage (Fig. 3). During the maintenance of water pipelines, it is necessary to monitor the condition of structures and materials (metal, reinforced concrete), the condition of protective coatings and waterproofing joints and connections, as well as the condition of slopes, pipe heads, inlet and outlet channel embankments and supports.

Fig. 3. Assessment of the technical condition of water pipelines

Water pipes are cleaned of debris and silt in the summer, and snow and ice in the winter. In winter, all pipes at the entrances and exits must be covered with log mats and shields to prevent snow from entering the pipe. In watercourses, holes are left in the shields for warm days. In the event of small attenuating deposits or displacement of pipe joints, defective joints are closed, and the pipe chute is leveled with concrete. The gaps between the joints in the joints are sealed with resin packing, then with a hard cement mortar. Cracks and fractures in concrete and brick masonry are patched.

In water pipelines operating under pressure, it is necessary to ensure complete waterproofing of the joint joints, as well as reliable fastening of the outlet channel. Pipeline repairs are recommended to be carried out during the summer season. With the development of large deformations (stretching of pipes, vertical displacement of joints) and failure of heads and individual joints, their reassembly or replacement is carried out. Such pipes must be temporarily reinforced with frames, supports, circles, etc., before repair work is carried out.

In the event of signs of waterproofing failure (multiple leaks), formation of cracks with soil spills into the pipe cavity, they are repaired by sealing the cracks with polymer materials using sealants, polymer-cement compositions, or cement compositions.

The scope of monitoring work is determined by the program, compiled in accordance with the requirements of the project, regulatory documents, and this set of rules. The following content of the monitoring program is recommended:

- purpose of monitoring;
- system of measurement frequency and timing of work;
- main characteristics of the monitoring object;
- analysis of monitoring tasks, materials of observations and inspections;
- a list of types of work, parts, and structural elements requiring measurements;
- monitoring tools used, the procedure for their placement in building structures;
- measuring instruments, instruments, equipment used, the procedure and place of their installation, the procedure for measurements;
- procedure for conducting instrumental measurements;
- methodology for processing measurement data and analysis of results;
- measures to ensure the use of structural elements for installing sensors, stamps, and taking readings;

• measures to ensure the protection of installed sensors, stamps, and devices from damage, vandalism, and theft;

• list of reporting documents, deadlines for their submission.

The Program additionally indicates:

• defining the concepts of "safe situation" and "dangerous situation," introducing their boundary conditions;

• provide control (project) data on all parameters. If monitoring is not planned at the operational stage, this data should depend on the stages of the work being carried out;

• formation of requirements for the timeliness of the information received;

• formation of requirements for units of measurement, identification, availability and content of information received, stored, used, and transmitted;

• determine the procedure for taking actions when obtaining information, the values of which fall under the concept of "hazardous situation";

• determination of methods for storing data and accessing archives.

Conclusion. Assessment of the technical condition of artificial structures is of fundamental importance in ensuring the strength, operational reliability, and safety of structures. Studies show that the integrated use of visual control, testing, monitoring systems, and digital modeling makes it possible to accurately determine the real technical condition of the structure.

Based on the assessment results, the residual resource of the structure, the intensity of degradation processes, and the necessary repair strategy are determined. Regular diagnostics based on regulatory requirements serve to identify structural hazards early, reduce the probability of accidents, and increase economic efficiency. Therefore, a scientifically based assessment of the technical condition is the most important factor in the long-term and safe operation of artificial structures.

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