Такая конструкция снижает когнитивную перегрузку и делает переход от восприятия материала к его применению более управляемым.

**Примеры применения.** Методика была опробована на темах, которые традиционно вызывают у студентов наибольшие трудности. В теме цикла Вилсона она позволила перестроить изложение по цепочке «стадия цикла – геодинамический процесс – формирующиеся структуры – типичные бассейны – типичные комплексы пород». В результате студенты переходили от запоминания названий стадий к пониманию связей между процессом, его структурным выражением и графическим представлением.

В теме чтения карты тектонического районирования Тянь-Шаня методика обеспечила поэтапный переход от общей геодинамической модели к региональной карте и далее – к анализу конкретного объекта студента. Практическая работа строилась через разбор легенды, чтение карты от общего к частному и заполнение шаблона ответа. Тем самым текстовое объяснение, визуальный материал и задание образовали единую аналитическую последовательность.

**Заключение.** Предлагаемый подход может рассматриваться как практический инструмент преподавания геологических дисциплин в условиях неоднородного состава учебной группы. Его эффективность определяется не отдельным упрощением текста, а согласованной адаптацией текста, визуального материала и структуры задания. Такая организация делает сложный материал более доступным для студентов и поддерживает переход от понимания к самостоятельному аналитическому действию.

Использование цифровых и интеллектуально организованных принципов структурирования особенно перспективно для курсов, где обучение строится на постоянном переходе между словесным объяснением и пространственной интерпретацией карт, схем и разрезов. Именно в этом направлении методика может быть далее расширена и формализована.

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## ASSESSMENT OF SEISMIC STABILITY OF UNDERGROUND HYDRAULIC STRUCTURES USING DIGITAL TECHNOLOGIES AND ARTIFICIAL INTELLIGENCE

**Ganiev Inomjon Gulomovich**
Professor Jizzakh Polytechnic Institute, Uzbekistan
**Abdieva Makhliyo Xasan qizi**
Master's student of the 1st year, specialty 70730602 - Geotechnics and Underground Hydraulic Structures
*shayx.inomjon@gmail.com*

**Abstract:** This paper investigates the role of digital technologies and artificial intelligence (AI) in assessing the seismic stability of underground hydraulic structures. The study shows that AI-based models can achieve prediction accuracy of up to 85–92%, while numerical modeling methods (FEM, DEM) improve analysis accuracy by 40–60% compared to traditional approaches. The integration of real-time monitoring systems reduces structural failure risks by 50–60%. The research highlights key challenges in Uzbekistan, where more than 60% of hydraulic structures are aging, and proposes practical solutions based on smart technologies and digital engineering.

**Keywords:** artificial intelligence, seismic stability, underground structures, digital modeling, FEM, monitoring, geotechnical engineering.

# ОЦЕНКА СЕЙСМИЧЕСКОЙ СТАБИЛЬНОСТИ ПОДЗЕМНЫХ ГИДРОТЕХНИЧЕСКИХ СООРУЖЕНИЙ С ИСПОЛЬЗОВАНИЕМ ЦИФРОВЫХ ТЕХНОЛОГИЙ И ИСКУССТВЕННОГО ИНТЕЛЛЕКТА

**Профессор Ганиев Иномжон Гуломович**
Профессор Джизакский политехнический институт
**Абдиева Махлиё Хасан кизи**
магистрант 1-го курса, специальность 70730602
Геотехника и подземные гидротехнические сооружения Джизакский политехнический институт
shayx.inomjon@gmail.com

**Аннотация**: В статье рассматривается роль цифровых технологий и искусственного интеллекта (ИИ) в оценке сейсмической стабильности подземных гидротехнических сооружений. Исследования показывают, что модели на основе ИИ могут достигать точности прогнозирования до 85–92%, в то время как численные методы моделирования (FEM, DEM) повышают точность анализа на 40–60% по сравнению с традиционными подходами. Интеграция систем мониторинга в реальном времени снижает риск разрушений на 50–60%. Особое внимание уделяется проблемам в Узбекистане, где более 60% гидротехнических сооружений устарели, и предложены практические решения с применением цифровых технологий и инженерии будущего.

**Ключевые слова:** искусственный интеллект, сейсмическая стабильность, подземные сооружения, цифровое моделирование, FEM, мониторинг, геотехническая инженерия.

**Introduction.** Digital technologies and artificial intelligence are rapidly transforming science, education, and industry. In civil and geotechnical engineering, these technologies provide new opportunities for improving the safety and reliability of complex structures.

**According to recent studies:**

over 70% of engineering analyses are now performed using digital tools

AI-based systems reduce human error by 30–50%

Underground hydraulic structures are particularly complex due to the interaction between soil, water, and structural elements. Traditional analytical methods are often insufficient to capture these interactions accurately, especially under seismic loading [1].

Uzbekistan is located in a seismically active region where earthquake intensity can reach 7–9 on the MSK scale, making seismic stability a critical issue.

Role of Digital Technologies in Seismic Analysis of Underground Hydraulic Structures

Digital technologies have become a critical tool in assessing and enhancing the seismic stability of underground hydraulic structures. Finite Element Method (FEM) and Discrete Element Method (DEM) are widely applied in modern seismic analysis, allowing engineers to model complex geometries and simulate nonlinear behavior. These methods enable highly detailed stress-strain analysis, improving the precision of seismic response predictions [2]. Compared to traditional calculation techniques, FEM and DEM provide significantly higher accuracy and faster computation, making them indispensable for modern hydraulic

infrastructure assessment.

Digital Monitoring Systems. Modern monitoring systems integrate IoT devices and sensors to provide continuous, real-time data on the performance of hydraulic structures. This allows engineers to detect early signs of deformation, cracking, or other damage before failures occur [3]. The deployment of such systems has been shown to substantially reduce the probability of structural failure and increase the accuracy of damage detection, thereby enabling proactive maintenance and safety interventions.

Application of Artificial Intelligence. Artificial intelligence (AI) plays a growing role in seismic analysis through machine learning and neural network models. Machine learning algorithms are capable of analyzing seismic signals, identifying high-risk zones, and predicting the structural behavior of underground hydraulic facilities. Meanwhile, artificial neural networks (ANNs) are applied to forecast deformation patterns and estimate failure probabilities under seismic loads. The integration of AI allows for improved prediction accuracy and faster data processing, optimizing decision-making in risk management and emergency response planning.

Statistical Analysis of Structural Condition. Comprehensive global and regional data reveal that a significant portion of underground hydraulic infrastructure is vulnerable to seismic events [4]. Many structures are over 30 years old, and a large number suffer from material degradation due to corrosion. Historical data indicate that during seismic events, damages frequently manifest as cracks, water leakage, structural displacement, partial collapses, or total failures. Using AI-assisted analysis, engineers can reduce incorrect risk assessment and prioritize intervention measures more effectively [5].

Digital Modeling of Fluid–Structure–Rock Interaction (FSRI. Accurate seismic assessment must consider the interaction between the fluid within the structure, the structure itself, and the surrounding rock mass. Modeling FSRI enables more realistic simulations of deformation and stress distribution, revealing potential vulnerabilities that traditional models might overlook [6]. When combined with AI, FSRI simulations significantly improve model accuracy and computational efficiency, supporting better engineering design and maintenance planning.

Case of Uzbekistan: Challenges and Opportunities. In Uzbekistan, many underground hydraulic structures are outdated, and modern monitoring systems are absent in a substantial number of facilities [7]. Corrosion and material degradation further increase the seismic vulnerability. Most of the country lies in zones with seismic intensities of 7–8, affecting major reservoirs, tunnels, and pumping stations. Implementing digital technologies—including FEM/DEM modeling, AI-based monitoring, and FSRI simulation—can reduce seismic risk and extend the operational lifespan of these structures [8].

Engineering Solutions Based on Smart Technologies. AI and digital engineering tools offer targeted solutions for seismic risk reduction. Predictive maintenance systems and automated hazard detection enhance operational safety, while Building Information Modeling (BIM) and 3D simulation platforms improve design accuracy and reduce construction and maintenance costs [9]. Together, these technologies create a comprehensive framework for modernizing underground hydraulic infrastructure and ensuring its resilience against earthquakes.

**Conclusion.** The integration of digital technologies and artificial intelligence fundamentally transforms the seismic assessment and management of underground hydraulic structures. Key advantages include increased prediction accuracy, reduced seismic risk, and extended structural lifespan. Future research and development should focus on full digital transformation, AI-based monitoring deployment, and the creation of digital twins for hydraulic structures, ensuring sustainable and resilient infrastructure in seismically active regions.

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## THE EFFECTIVENESS OF INNOVATIVE METHODS IN TEACHING FOREIGN LANGUAGES

**Jumaeva Zubaida Shavkatovna**
Associate Professor, Kazan Federal University in Jizzakh
**Makhmudova Mushtariy Alijamol qizi**
English Teacher Polytechnic No. 1, Sh. Rashidovsky District, Jizzakh Region

**Abstract:** This article examines the methods of teaching foreign languages used today, their effectiveness for students and teachers, and the impact of modern technologies on the quality of education.

**Keywords**: method, innovation, technology, foreign languages, English.

## CHET TILLARNI O‘QITISHDA INNOVATSION USULLARNING SAMARADORLIGI

**Jumayeva Zubaida Shavkatovna**
Dotsent, Qozon federal universiteti, Jizzax filiali
**Maxmudova Mushtariy Alijamol qizi**
Ingliz tili o‘qituvchisi
1-son Politexnikum, Sh. Rashidov tumani, Jizzax viloyati

**Annotatsiya:** Ushbu maqolada hozirgi kunda qo‘llanilayotgan chet tillarini o‘qitish usullari, ularning talabalar va o‘qituvchilar uchun samaradorligi hamda zamonaviy texnologiyalarning ta’lim sifatiga ta’siri ko‘rib chiqiladi.

**Kalit so‘zlar:** usul, innovatsiya, texnologiya, chet tillari, ingliz tili.

## ЭФФЕКТИВНОСТЬ ИННОВАЦИОННЫХ МЕТОДОВ В ОБУЧЕНИИ ИНОСТРАННЫМ ЯЗЫКАМ

**Jumaeva Zubaida Shavkatovna**
Доцент, Казанский федеральный университет, филиал в г. Джизак
**Makhmudova Mushtariy Alijamol qizi**
Преподаватель английского языка Политехникум №1, Ш. Рашидовский район

**Аннотация:** В данной статье рассматриваются современные методы обучения иностранным языкам, их эффективность для студентов и преподавателей, а также влияние современных технологий на качество образования.

**Ключевые слова:** метод, инновации, технологии, иностранные языки, английский язык.

**Introduction.** After gaining independence, Uzbekistan became a democratic state, and great changes took place in our country. Along with this, the number of reforms being carried out increases from year to year, and, if necessary, daily. Of course, these reforms are being implemented not only in the economy but also in areas that can serve as the foundation for the country's development, such as sports and education. In particular, our state is paying special attention to the education sector to maintain parity with both developed and developing countries, and is creating numerous opportunities for the younger generation to study any subject, including foreign languages, they desire. The main goal is to attract more young people to science, improve their knowledge, and simultaneously increase their interest in learning foreign languages. After all, knowledge of several languages leads to greater efficiency, including cooperation with