ENGINEER

international scientific journal

SPECIAL ISSUE

E-ISSN
3030-3893
ISSN
3060-5172

A bridge between science and innovation

TOSHKENT DAVLAT TRANSPORT UNIVERSITETI

Tashkent state transport university

ENGINEER

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E-ISSN: 3030-3893

ISSN: 3060-5172

SPECIAL ISSUE

24-april, 2025

engineer.tstu.uz

MUHAMMADAMIN KABULOVICH TOHIROVNING TAVALLUDINING 80 YILLIGIGA BAG‘ISHLANGAN "SAMARALI QURILISH MATERIALLARI, KONSTRUKSIYALARI VA TEXNOLOGIYALARI" MAVZUSIDAGI XALQARO ILMIY-AMALIY KONFERENSIYASI ILMIY ISHLARI TO‘PLAMI

Toshkent davlat transport universiteti Rossiya Arxitektura va qurilish fanlari akademiyasining akademigi, O‘zbekiston Respublikasida xizmat ko‘rsatgan yoshlar murabbiysi, texnika fanlari doktori, professor **Muhammadamin Kabulovich Tohirovning tavalludining 80 yilligiga** bag‘ishlangan **"Samarali qurilish materiallari, konstruksiyalari va texnologiyalari"** mavzusidagi xalqaro ilmiy-amaliy konferensiya ilmiy ishlari to‘plami chop etildi.

Muhammadamin Kabulovich kompozitsion qurilish materiallarining polistrukturaviy nazariyasini rivojlantirishga ulkan hissa qo‘shgan olimdir. 1995-yilda Muhammadamin Kabulovich Rossiya Arxitektura va qurilish fanlari akademiyasining (RAASN) xorijiy a’zosi etib saylangan, bu esa ularning qurilish materialshunosligi sohasiga qo‘shgan ilmiy hissasining xalqaro miqyosdagi e’tirofi bo‘ldi. Ular o‘z ilmiy faoliyati davomida 6 ta monografiya, 200 dan ortiq ilmiy maqola va 25 ta ixtiroga mualliflik guvohnomasi yaratganlar.

Ushbu konferensiyaning asosiy maqsadi – qurilish materialshunosligi, bino va inshootlarni loyihalash hamda qurilish sohasidagi zamonaviy ilmiy tadqiqotlar natijalarini muhokama qilish, shuningdek, muhandislik ta’limini takomillashtirish yo‘llarini aniqlashdir.

Konferensiyada O‘zbekiston Respublikasi hamda xorijiy mamlakatlarning oliy o‘quv yurtlari va ilmiy-tadqiqot institutlari olimlari, shuningdek, muhim ilmiy tadqiqot natijalariga ega bo‘lgan ishlab chiqarish vakillari o‘z ilmiy ishlari bilan ishtirok etdilar.

"Samarali qurilish materiallari, konstruksiyalari va texnologiyalari" mavzusidagi xalqaro ilmiy-amaliy konferensiyaning asosiy yo‘nalishlari quyidagilardan iborat:

1. **Resurs va quvvatni tejaydigan qurilish materiallari va texnologiyalari** – zamonaviy ekologik va iqtisodiy talablarni qondirishga qaratilgan innovatsion yechimlar.
2. **Bino va inshootlarning qurilish konstruksiyalari, zamonaviy hisoblash va loyihalash usullari - muhandislik** va texnologik yechimlarni takomillashtirish yo‘nalishlari.
3. **Arxitektura va shaharsozlik** – estetik va funksional jihatlarni uyg‘unlashtirgan zamonaviy loyihalar yaratish.
4. **Zamonaviy muhandislik ta’limi tizimini takomillashtirish** – kelajak mutaxassislarini yuqori malakali darajada tayyorlash uchun ta’lim jarayonini modernizatsiya qilish.

Mazkur konferensiya ilmiy hamjamiyatning turli vakillarini bir joyga jamlab, qurilish materialshunosligi sohasidagi zamonaviy muammolar va istiqbollarni muhokama qilish uchun qulay platforma vazifasini bajardi.

Experimental investigation of load-bearing capacity of three-layer panels with insolation layer based on rice crete

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Abstract: This article presents the results of full-scale experimental testing of wall panels based on rice crete made with rice husk as the organic filler. The panels are designed as three-layer structural elements, with rice crete forming the middle insulating layer and self-compacting lightweight reinforced concrete forming the outer structural layers. The aim of the study is to evaluate the strength, crack resistance, and deformation characteristics of such panels under static vertical load. The experimental tests were conducted on panels of actual dimensions, using standard procedures. The load-deformation behavior, crack formation, and failure mechanisms were analyzed. The results confirm the potential use of these panels in low-rise energy-efficient and earthquake-resistant buildings.

Keywords: energy efficient; three-layer reinforced concrete structures; concrete strength; contact interlayer; heat-insulating materials; multilayer structures; agricultural waste

1. Introduction

Modern construction trends are increasingly oriented towards the use of environmentally friendly, energy-efficient, and cost-effective building materials. One such promising direction is the development of lightweight concretes using agricultural waste. Rice crete, a composite made from mineral binders and organic fillers (such as wood chips, straw, or rice husk), is gaining popularity due to its good thermal insulation, lightweight, and environmental sustainability. [1-5,8]

Three-layer reinforced concrete panels are becoming a key element in modern construction due to their ability to provide high strength characteristics while reducing heat transfer. In recent years, special attention has been paid to the use of innovative materials to increase the energy efficiency of such panels. One of these materials is rice crete, which is a wood-cement composite with excellent thermal insulation properties and low density.[7]

2. Research methodology

Studies conducted by Ivanov I.I. and Petrov P.P. (2023) showed that rice crete significantly reduces the thermal conductivity of building elements, which is consistent with the results of foreign studies. For example, Jones and Kaplan (2021) confirmed in their study that rice crete concrete can improve the thermal characteristics of buildings with a minimal increase in their mass, which makes it an ideal material for multilayer structures.

Important foreign studies also confirm the prospects of using multilayer panels with rice crete. In the work of Fang and Wang (2020), an integrated approach to the design of three-layer reinforced concrete panels, including various insulating materials such as rice crete, was studied. Studies have shown that such panels are highly resistant to temperature fluctuations and can significantly improve the energy efficiency of buildings in various climatic conditions.[1, 9-11]

On the other hand, Sidorov A.A. and Kuznetsov V.V. (2024) found that rice crete not only preserves, but also improves the mechanical properties of three-layer panels, especially under dynamic loads. These conclusions are supported by research by Smith and Lee (2019), which showed that rice crete panels exhibit high strength and durability, especially in earthquake-prone regions. Moreover, the work of Brown and Taylor (2020) has shown that rice crete layers can effectively resist the formation of cracks in reinforced concrete structures, which significantly increases their service life.[11-15]

Another important aspect is to take into account the climatic conditions when designing such panels. Smirnov D.D. and Lebedev E.E. (2023) noted the need for a detailed analysis of the influence of climatic conditions on the performance characteristics of panels with rice crete. These conclusions are supported by the research of Garcia and Rodriguez (2018), who analyzed the use of rice crete panels in European countries and found that this material can be successfully used in various climatic conditions, providing high energy efficiency and durability of structures.[16-20]

The hypothesis:The hypothesis of this study is that the use of rice crete concrete as a thermal insulation layer in three-layer reinforced concrete panels will significantly improve their thermal performance and at the same time preserve or improve their mechanical properties.

In accordance with the technology described above, panels of ricecrete mixture on rice husk with dimensions of 2500x400x250 mm were manufactured. The number of ricecrete mixture batches adopted for the manufacture of panels was 4. The specific pressure of panel molding was 0.26 MPa. Before testing the panels, the control destructive load was determined using the formula in accordance with paragraph 2.4.2 of GOST 8829 (Precast reinforced concrete structures and products. Test methods for assessing strength, rigidity and crack resistance).[24-27]

$$q_{cr} = \frac{c}{m} q_{cal} \quad (1)$$

where c is the coefficient taken according to Table 1 of the specified GOST as equal to 1.8. m is the coefficient of the operating conditions of the structure, taken as equal to 0.75. $q_{расч}$- is taken as equal to the standard value of the static component of the wind load ($q_{н}^{c}$).

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Although according to KMK 2.01.07 (Standards design. Loads and impacts) the wind load on buildings and structures should be determined as the sum of static and dynamic components, only the static component of the load was taken into account. The dynamic component caused by pulsations of the velocity pressure is taken into account only when calculating structures with a period of natural oscillations of more than 25 sec (masts, towers, chimneys, etc.) and multi-story buildings more than 40 m high, etc.

$$q_{cal} = q_n^c = q_o kc \qquad (2)$$

According to map 3 (Zoning of the Uzbekistan territories by wind pressure) of the specified building codes, the Tashkent region belongs to region 3. Therefore, we take q_n^c= 0.45 MPa, K = 1, C = 1.4.

Thus: $g_{\text{расч}}$= 0.45 · 1 · 1.4 = 0.63 MPa. Consequently, the control destructive load is equal to:

$$q_{cr} = \frac{c}{m} q \frac{c}{n} = \frac{1{,}8}{0{,}75} \cdot 0{,}63 = 15{,}1\ MPa \qquad (3)$$

The strength of the panels was assessed using the safety factor (C).

$$C = \frac{m \cdot q_r}{q_{cal}} \qquad (4)$$

where m = 0.75; q_{cal}= 15.1 MPa; q_{r}= 41 MPa

The purpose of the work:The purpose of this study is to develop and experimentally substantiate three-layer reinforced concrete panels using rice crete concrete as an insulating layer. As part of the work, it is planned to evaluate the effect of rice crete on the thermal and mechanical characteristics of the panels, determine the optimal parameters for their design and develop recommendations for their use in various climatic conditions.

Axes:

X-axis: Labeled as *f, mm* — presumably representing the deflection of the structural element in millimeters.

Y-axis: Values range from 5 to 45, with no explicit unit indicated; however, based on context, it can be assumed that the quantity represents load, possibly in kN or kgf.

Three curves are labeled as P-1, P-2, and P-3 — according to the diagram below the graph, these correspond to different measurement points for deflection along the span of the beam:

P-1 and P-3 — located at the edges of the middle span section,

P-2 — located at the center of the span.

The schematic below the graph illustrates the positioning of the displacement meters:

The beam, with a total length of ℓ, is divided into four equal segments (ℓ/4).

Displacement meters are installed at positions ℓ/4, ℓ/2, and 3ℓ/4.

The test rig for the panels is shown in Figure 50. Simultaneously with the panels, the deflection and strength characteristics of ricecrete were determined on samples manufactured simultaneously with the panels: cubes measuring 100x100x100 mm, prisms measuring 100x100x400 mm. The tests showed that the ratio of the prismatic strength to the cubic strength for ricecrete is 0.73. The initial modulus of elasticity is 680 MPa, the prismatic strength is 1.15 MPa, and the ricecrete grade is 15. The panel test results are given in Table 1 .

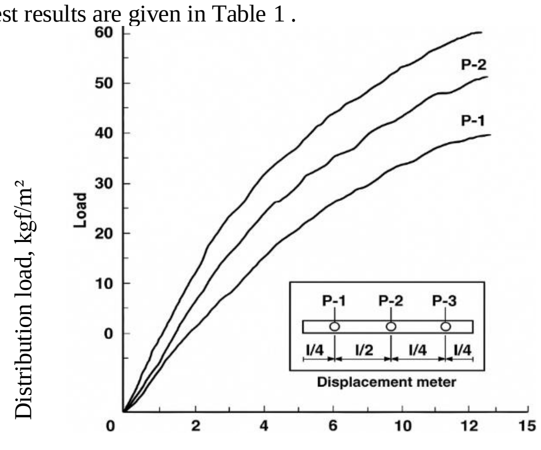

Fig. 1. Change in deflection of panel 1 due to the action of a uniformly distributed load

Table 1

Results of testing panel

Breaking load, MPa		Safety margin $\frac{q_o}{q_k}$	Deflections (f) under load, mm			f / l ratio under load		
Calculation control sample (q_k)	Actual (q_o)		normative: Acceptable	normative: actual	Maximum	normative: acceptable	normative: actual	Maximum
13.3	36	2.7	15	1.15	13.6	$\frac{1}{200}$	$\frac{1}{2400}$	$\frac{1}{212}$
	44	3.3		1.51	12.4		$\frac{1}{1910}$	$\frac{1}{230}$
	44	3.3		1,12	15.3		$\frac{1}{2270}$	$\frac{1}{188}$

Tests have shown (Table 1) that the strength of the panels exceeds the calculated control values several times (from 2.7 to 3.3). Under the action of the standard load, their rigidity does not exceed the permissible value, i.e. the deflection (*f*) is less than 15 mm, and the ratio of the deflection to the calculated one (*l*) does not exceed *l* /200.

Thus, the panels meet the requirements for enclosing structures in terms of strength and rigidity and can be used as wall material. [28-30]

3. Conclusion

The results confirm that rice husk-based arbolite can be effectively used as an insulating core material in three-layer wall panels. The combination of arbolite and reinforced concrete layers provides both structural strength and thermal performance.

The experimental findings support the following conclusions:

- The panels demonstrated good composite behavior,

especially when anchorage and surface treatment were optimized.
- The load-bearing capacity (75–80 kN) is sufficient for low- to mid-rise buildings.
- The deflection limits were within acceptable ranges for structural wall elements.

However, certain limitations were identified:
- The interface between arbolite and concrete remains a potential weakness, requiring improved treatment methods.
- Cyclic and dynamic load testing are recommended for seismic application validation.

The study demonstrated the structural potential of three-layer wall panels using rice husk arbolite as the core layer. These panels meet basic strength and deformation criteria, offering an environmentally friendly alternative to traditional concrete walls. Their light weight and thermal insulation capacity make them suitable for energy-efficient and seismic-resistant construction.

Further research is required to optimize the interface bonding and evaluate long-term performance under environmental loads.

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