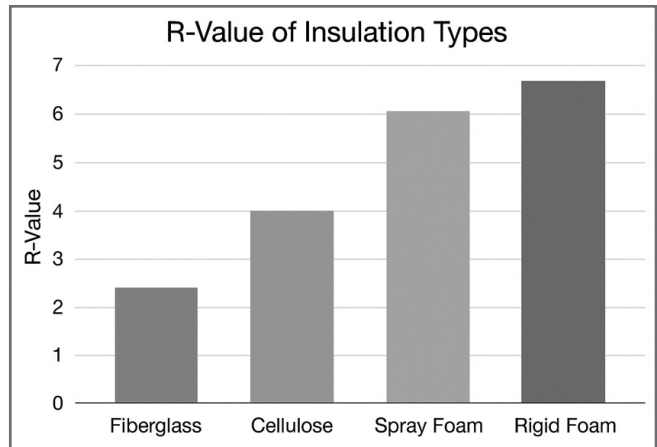
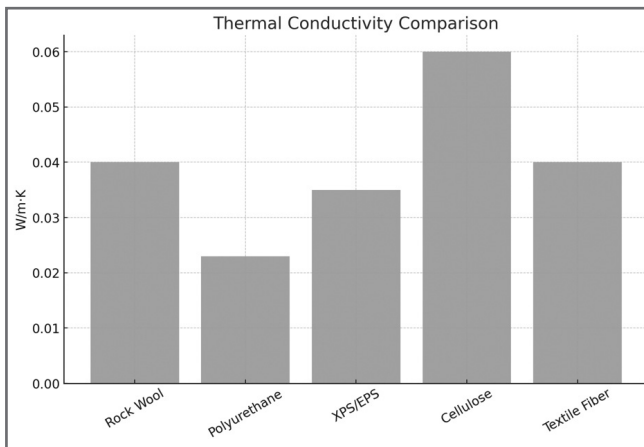


3. Types of Thermal Insulation Used in Sports Facilities

Insulation Type	Material	Features	Application
Rock Wool	Basalt	Fire-resistant, soundproof	Multi-purpose halls
Polyurethane (PU)	Polymer	Lightweight, high efficiency	Swimming pools
Polystyrene (XPS/EPS)	Petroleum derivatives	Moisture resistant	Flooring
Cellulose	Recycled paper fibers	Eco-friendly	Walls/Ceilings
Textile Insulation	Polyester, cotton, recycled fibers	Recyclable	Small halls



for heating and cooling. Benefits include:

- *30–50% reduction in energy costs
- *Improved thermal comfort for athletes
- *Reduced greenhouse gas emissions
- *Enhanced efficiency of HVAC systems

Applications in various areas of sports facilities:

- *Fitness halls
- *Swimming pools and humid areas

*Multi-purpose halls and volleyball/ futsal courts

*Athlete dormitories

Scientific notes:

*Rock wool has a porous fibrous structure, low thermal conductivity, and high sound absorption.

*Polyurethane, due to its closed-cell structure, offers high thermal resistance and is suitable for humid environments.

4. Methods for Testing Thermal Insulation

1. Thermal Conductivity Test

*Standard: ASTM C518

*Measures heat transfer through the sample (W/mK)

2-R-Value Test (Thermal Resistance)

*Standard: ASTM C168

*Determines resistance to temperature flow ($\text{m}^2\cdot\text{K}/\text{W}$)

3-Fire Reaction Test

*Standard: ISO 1182 / ASTM E84

*Evaluates flammability, flame

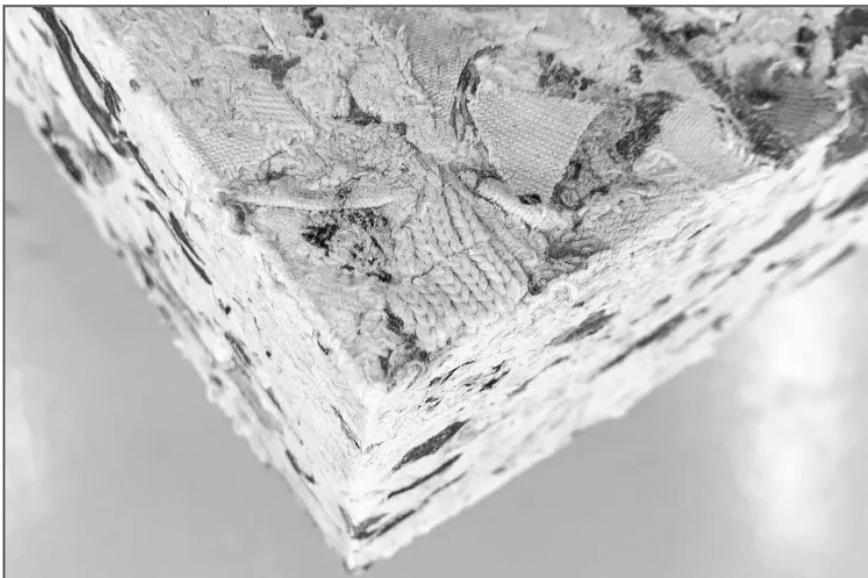
Test	Purpose	Standard	Sample	Output
Thermal Conductivity (λ)	Heat conduction	ASTM C177/C518, ISO 8302	100×100 mm plate	$\text{W}\cdot\text{m}^{-1}\cdot\text{K}^{-1}$
Thermal Resistance (R)	Layer resistance	ISO 6946	Layer/panel	$\text{m}^2\cdot\text{K}\cdot\text{W}^{-1}$
Compressive Strength	Mechanical behavior	ASTM C165/C67	Cube/cylinder	MPa/kPa
Water Absorption	Moisture resistance	ASTM C272/C209	Specified surface	% wt
Water Vapor Transmission (MVTR)	Vapor permeability	ASTM E96	Disk sample	$\text{g}\cdot\text{m}^{-2}\cdot 24\text{h}^{-1}$
Fire Test	Flame/smoke spread	ASTM E84 / EN 13501-1	Sample plate	Flame spread, Smoke index
Thermal Cycling	Long-term performance	Project-specific	Heat/humidity cycles	λ change, R-value
Sound Absorption	Echo reduction	ISO 354	Spherical/flat sample	$\alpha(f)$ (0–1)
Density / Porosity	Physical property	-----	Sample	$\text{kg}\cdot\text{m}^{-3}$ / %



Dr. F Nayeb Morad



Thermal Insulation in Sports Facilities to Recycled Textile Bricks



Abstract

Sports facilities, as centers of high human occupancy and energy consumption, play a critical role in mitigating environmental impacts. High energy demand in gyms and sports halls, due to heating, cooling, and proper ventilation requirements, leads to increased operational costs and greenhouse gas emissions.

One effective approach is the use of standardized thermal insulation combined with recycling textile waste into sustainable construction

materials such as bricks.

Recent studies show that thermal insulation can reduce energy consumption by 30–50% while improving athletes' thermal comfort. Moreover, converting discarded textiles into bricks and building blocks significantly reduces the use of natural resources and enhances structural durability.

This paper introduces different types of thermal insulation, testing methods, the use of recycled fibers in construction, environmental

impacts of these technologies, and provides a framework for designing green sports facilities.

1. Introduction

With the growth of organized sports and the increasing number of gyms, energy consumption in these facilities has become a significant environmental challenge. Research indicates that sports halls consume up to 20% more energy than typical office buildings, particularly in swimming pools and multi-purpose halls. Implementing thermal insulation and using recycled materials can reduce costs and minimize environmental impacts. In developed countries, green gyms employing rock wool, polyurethane, and fiber-reinforced bricks have achieved 40–50% energy savings and reduced CO₂ emissions by up to 30% (Smith & Patel, 2021).

2. The Role of Thermal Insulation in Sports Facilities

Proper insulation minimizes heat transfer, reducing energy demand

Material	STC Range
Rock Wool	45-50
Polyurethane Foam	30-35
Recycled Textile Fibers	40-43

7.2. Sound Transmission Loss (STC) Test

To reduce the transmission of noise between adjacent rooms (e.g., gym hall to dormitory or classroom), the Sound Transmission Class is measured using ASTM E90.

Procedure:

*A sound source is placed in one room, and a receiving microphone in the adjacent room.

•Transmission loss at various frequencies is recorded.

•The STC value is calculated from the averaged frequency-dependent loss.

Approximate STC ranges:

Conclusion: A hybrid configuration combining rock wool + recycled textile fiber layers provides optimal performance for high-noise sports facilities.

8. Mechanical and Thermal Stability Testing for Textile-Reinforced Bricks



Prior to upcycling sports textile waste into construction blocks, mechanical and thermal properties must be validated.

8.1. Compressive Strength Test

*Standards: ASTM C109 / ISO 604

*Required minimum compressive strength: 10–15 MPa

Finding: Bricks reinforced with polyester fibers show up to 20% higher compressive strength than conventional bricks.

8.2. Thermal Stability Test for Fire Performance

*Standard: ASTM D573

*Evaluates fiber degradation, melting point, and fire reaction behavior.

Materials with Best Performance: Polyester and acrylic fibers, especially when modified with flame-retardant additives, show superior fire stability.

Scientific Summary

Key outcomes of the extended testing:

*Insulation selection must consider acoustics + humidity + durability, not only R-value.

*A hybrid system of rock wool and recycled textile fibers yields optimal acoustic–thermal performance in high-density gyms.

*Recycled textile-based bricks provide lightweight, eco-friendly, thermally stable, and mechanically

enhanced construction materials for green sports buildings.

9. Conclusion and Outlook

Applying standardized thermal insulation and converting textile waste into construction materials can transform sports facilities into low-energy, sustainable, and green environments. Future directions include:

*Development of recycled bricks with nanomaterial additives for enhanced strength

*Integration of solar energy systems with thermal insulation

*Global standardization for green sports facilities

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spread, and smoke production

4- Moisture Absorption Test

*Standard: ISO 062–2011

*Determines water absorption and suitability for pools and humid spaces

Suggested figure: Comparison of R-values and thermal conductivity of different insulation types

5. Using Recycled Textiles to Produce Bricks

Production Process:

1-Collect textile waste (t-shirts, towels, sportswear)

2-Shred and mix with mineral additives

3-Compress and shape into bricks or refractory blocks

Benefits:

*15–20% reduction in building weight

*Increased stress and crack resistance

*30% reduction in soil and natural resource usage

*Natural thermal and acoustic insulation

Suitable fibers: Polyester, cotton, acrylic, spandex

Quantitative analysis: Studies indicate that fiber-reinforced bricks have thermal conductivity of 0.2–0.3 W/mK and can save up to 30% of energy compared to traditional bricks.

6. Advanced Thermal and Acoustic Testing for Insulation in Sports Facilities

Due to the thermal–acoustic nature of sports environments, especially fitness halls, weightlifting areas, and

swimming facilities, the evaluation of insulation materials must examine not only heat resistance but also acoustic performance. Therefore, a comprehensive testing system that addresses durability, thermal stability, humidity sensitivity, and sound insulation is necessary for the selection of optimal materials.

6.1. Wet Thermal Resistance Evaluation

In high-humidity environments, such as pools and spa-equipped gyms, moisture absorption may reduce insulation performance by up to 40%. The wet thermal resistance test is performed based on ASTM C739 or ISO 15148.

Procedure:

*Samples are conditioned in a humidity chamber (RH > 90%).

*Thermal resistance is measured using a Heat Flow Meter apparatus.

*The change in R-value before and after moisture exposure is calculated.

Relevance for Sports Facilities:

XPS and polyurethane foams demonstrate superior performance in wet environments compared to rock wool, whose conductivity increases noticeably with moisture uptake.

6.2. Thermal Cycling Test

Sports centers experience daily and seasonal temperature fluctuations due to varying occupancy, ventilation loads, and HVAC system schedules. The thermal cycling test is conducted according to ASTM C1026.

Procedure:

*Samples are cycled between temperatures of 10°C and 70°C for

30–100 cycles.

*Cracking, delamination, and changes in thermal conductivity are evaluated.

Findings: Polyurethane foam and cellulose-based recycled insulation show minimal decreases in performance after cyclic exposure.

7. Acoustic Testing of Insulation Materials in Gymnasiums

Noise levels in sports halls may generate stress, reduce performance, and affect social interactions among athletes. Therefore, acoustic properties must be considered in addition to thermal resistance when selecting insulation for sports construction.

7.1. Sound Absorption Coefficient Test

This test is conducted in accordance with ISO 354 or ASTM C423.

Procedure:

*The insulation sample is mounted in a Reverberation Room.

*Decay of acoustic energy and reverberation time (RT) are measured.

*Absorption coefficients are determined at critical frequencies (250–4000 Hz), relevant to voice noise, music, and equipment impacts.

Results:

*Rock wool shows high absorption at low frequencies, which are dominant in weight drops and equipment impact.

*Recycled textile fibers (polyester, cotton) provide better absorption at speech and music frequency ranges.



Australian apparel makers slash inventory to 5-year low

Australia's clothing, footwear, and accessories manufacturers slashed inventory levels by 64.7 per cent to \$53,588 in the third quarter (Q3) of 2025, down from \$151,967 in the previous quarter, according to new data from Unleashed.

The sharp reduction marks the lowest stock position in more than five years, while profit margins strengthened by 8.19 per cent as firms prioritised leaner, efficiency-driven operations. Sales fell from \$460,175 to \$253,268 quarter on quarter (QoQ) as the sector navigated challenging consumer conditions, yet the aggressive destocking strategy delivered substantial margin improvement. Lead times also improved significantly, falling to 18 days from 33 days in Q2, close to the prior-year benchmark of 17 days and slightly above the national manufacturing average of 16 days. The shift signals a return to operational normality after prolonged disruptions, Unleashed said in a press release. The destocking move aligns with a broader manufacturing trend across Australia, where firms have shifted away from pandemic-era buffer building in favour of lean



inventory strategies to protect profitability and liquidity. Nationally, small and micro manufacturers increased quarterly sales by 9 per cent to \$625,400 while expanding profit margins by 3.2 per cent. "In spite of cautious consumer spending, spiking energy prices and high labour costs, Australian small and micro manufacturers have been adapting and thriving," said Jarrod Adam, head of production and distribution at Unleashed. "Manufacturers have found pockets of demand and capitalised on them. The real story is operational awareness; firms have focused on growing revenue and expanding profitability without tying up capital in excess stock. That's a fundamental shift in mindset from the pandemic era of buffer building." The report also compared

performance across the UK and New Zealand, concluding that Australian operations are leading on efficiency. Average stock on hand across industries fell to \$311,200 in Q3 from \$462,735 in Q2. Purchasing of raw materials also declined sharply, down 34.9 per cent to \$339,371, reinforcing the shift towards disciplined, data-driven inventory control. "The sheer velocity of the Q3 pivot is remarkable," added Adam. "Lead times down 36 per cent, stock down 33 per cent, purchasing down 35 per cent, yet margins up nearly 4 percentage points. This is what disciplined inventory management looks like when manufacturers have real time data and the confidence to act on it." "It's been a tough eighteen months, particularly for retailers, but we're now seeing a modest recovery in market demand for the first time, which is hugely encouraging," said Tim Deane, owner at Norsewear, a New Zealand clothing manufacturer that markets across Australia and New Zealand. "We need a sector-wide strategy to lower energy costs and better implement the use of technology to improve productivity." fibre2fashion.com