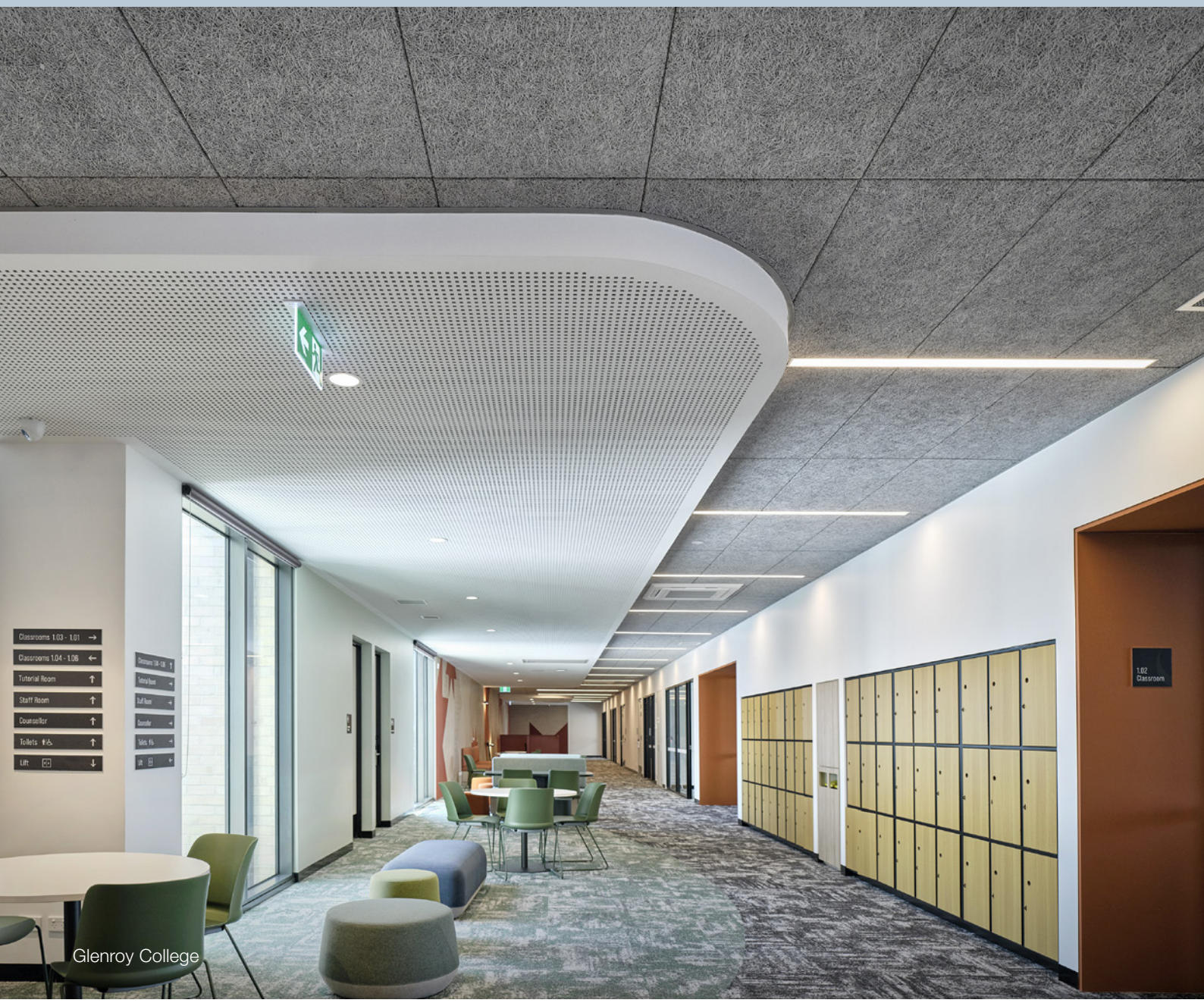
OPTIMISING CEILING DESIGN FOR LEARNING ENVIRONMENTS

ACOUSTIC, LIGHTING, THERMAL AND SEISMIC CONSIDERATIONS



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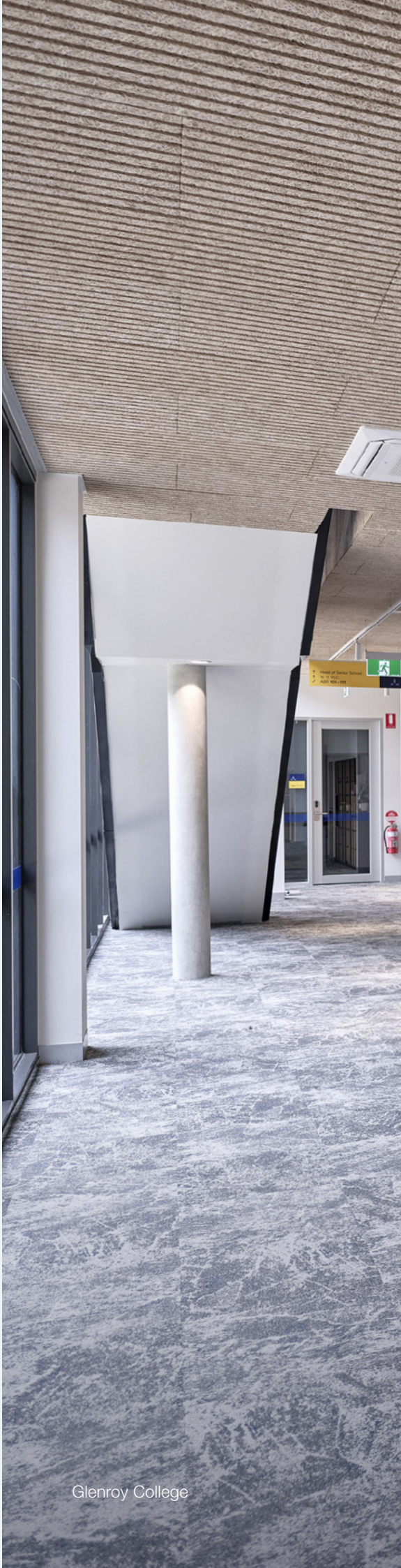
Unlike a one-size-fits-all approach, tailored ceiling systems allow architects and designers to optimise acoustics, lighting, air quality and durability based on the specific demands of different learning areas.

INTRODUCTION

As Australia's population is projected to grow from 27.1 million in March 2024 to 31.3 million by 2034–35,[1] the demand for high-quality educational facilities will continue to rise. Schools must not only accommodate increasing student numbers but also provide environments that support engagement, well-being and academic performance. While key architectural elements such as layout, facade design and material selection often take centre stage, ceilings also play a vital role in shaping effective learning environments through their impact on acoustics, lighting, safety, and comfort.

This whitepaper aims to provide architects and designers with a comprehensive understanding of the role of ceilings in diverse and high-performing educational environments. It will explore best practices and innovative solutions in ceiling design, covering key considerations such as acoustic control, lighting integration, air quality management, seismic compliance, safety and sustainable materials.



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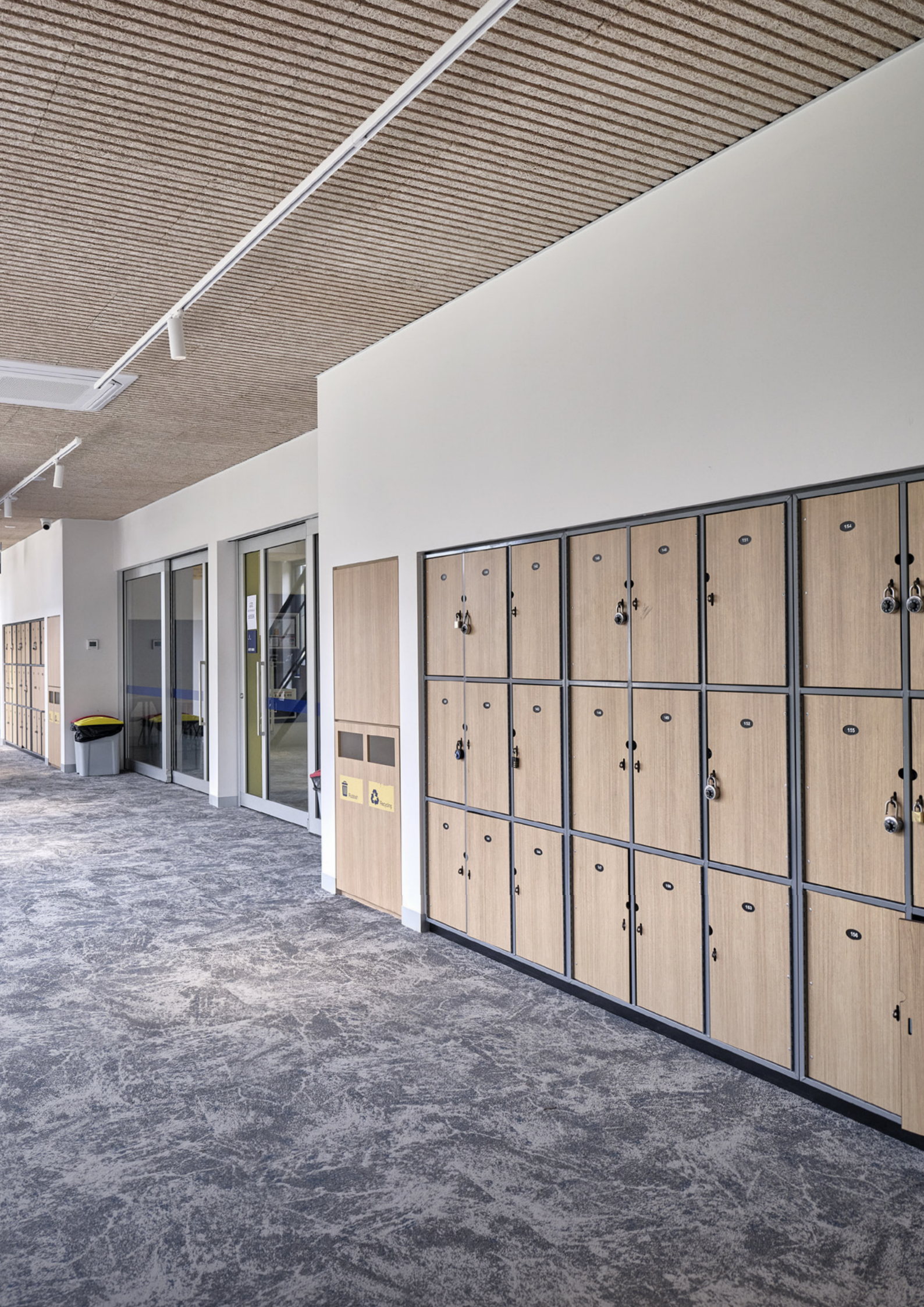

ROLE OF CEILINGS IN TEACHING AND LEARNING

Ceiling design plays a critical role in shaping educational environments, directly impacting students' ability to focus, engage and retain information. A well-designed ceiling reduces noise disruptions, minimises cognitive fatigue and enhances speech intelligibility by controlling reverberation and background noise. Additionally, thermal comfort and indoor air quality are improved by ceiling systems that regulate temperature and support integrated lighting and ventilation. Reflective surfaces optimise natural and artificial light, while aesthetic elements create a stimulating and engaging atmosphere that fosters creativity and learning. A holistic ceiling design balances acoustic, visual and thermal comfort, ensuring an optimal educational setting that enhances both student well-being and academic performance.

Research underscores the significance of ceiling design in improving student performance and well-being. Studies note that the incorporation of ceiling and wall absorbers or diffusers can enhance speech perception, reading ability and cognitive attention by reducing reverberation times.[2]

Similarly, a systematic review of lighting conditions in learning spaces found that optimising natural light through ceiling design contributes to improved student outcomes.[3] Furthermore, there is a demonstrated correlation between improved classroom air quality and better student performance, attendance and overall health.[4]

Ceiling designs for schools must be adaptable and support long-term operational efficiency. Ceiling systems should allow for easy access to services, facilitating upgrades, and repairs as learning needs evolve. Additionally, ceiling designs must comply with relevant Seismic Design standards to ensure structural integrity and occupant safety during an earthquake. Durable, low-maintenance materials with moisture and stain resistance ensure ceilings remain clean, hygienic and cost-effective, particularly in high-traffic areas such as cafeterias, restrooms and science labs.

MANAGING ACOUSTICS THROUGH CEILING DESIGN

Ceilings play a critical role in absorbing, diffusing and blocking sound, which directly impacts students' ability to focus and teachers' ability to communicate effectively. A strategic approach to ceiling selection incorporates materials and systems tailored to the specific acoustic needs of different learning spaces.

The selection of ceiling systems must align with the function of each space within an educational facility. For example:

- In classrooms, where speech clarity is paramount, a suspended acoustic ceiling system with high NRC (Noise Reduction Coefficient) tiles is recommended to minimise sound reflections, ensuring students can clearly hear instructions.
- Libraries and study areas, designed for quiet, focused activities, require materials that prevent sound from traveling across the space. A suspended ceiling with NRC-rated ceiling tiles featuring an acoustic backing, effectively controls noise levels and reduces reverberation.
- Collaborative and multipurpose spaces, such as assembly halls and open-plan learning environments, require a balance between sound absorption and diffusion. Additional acoustic treatments, such as baffles and clouds, may be needed to help reduce echoes particularly in high-ceiling spaces

Specialised ceiling systems play a crucial role in mitigating sound transmission in educational environments. Suspended Grid and Concealed Ceiling Systems can be designed to support heavier loads created by acoustic solutions for ceiling systems, including additional insulation, acoustic tiles, and panels. Additionally, product solutions like perimeter acoustic seals at ceiling-to-wall junctions can further reduce sound leakage and improve overall acoustic isolation.

What is Noise Reduction Coefficient?

Noise Reduction Coefficient (NRC) is a rating that measures how much sound a material absorbs, preventing it from reflecting back into a space. NRC values range from 0 to 1, where:

0 NRC means the material reflects all sound (no absorption); and

1 NRC means the material absorbs all sound (complete absorption).

For example, an NRC of 0.70 indicates that the material absorbs 70% of the sound energy and reflects 30% back into the space.

NRC is commonly used to evaluate the acoustic performance of ceiling tile in various environments.

LIGHTING AND VISUAL COMFORT

High-reflectance ceiling materials, particularly those with a high Light Reflectance Value (LRV), help distribute daylight more effectively throughout a space. Suspended ceilings with high-LRV ceiling tiles reflect natural light deeper into classrooms, minimising reliance on artificial lighting and reducing energy costs.

To supplement natural light, integrated ceiling lighting solutions help maintain even illumination throughout classrooms and study areas. Suspended ceiling grids with integrated LED lighting panels eliminate dark spots and ensure a uniform distribution of light, creating a well-balanced visual environment. Recessed lighting solutions, embedded within ceiling panels, provide glare-free illumination, which is particularly beneficial in settings where students need to focus for extended periods, such as classrooms and libraries.

Direct/indirect suspended lighting fixtures offer a combination of ambient and task lighting without creating glare, making them well-suited for flexible learning spaces where different lighting levels may be required for various activities.

What is Light Reflectance Value?
Light Reflectance Value (LRV) is a measure of how much visible and usable light a surface reflects when illuminated by a light source. It is expressed as a percentage on a scale from 0 to 100, where:

- 0 represents absolute black (absorbing all light); and
- 100 represents pure white (reflecting all light).

What is a good LRV for ceilings?
For ceilings in educational environments, a high LRV (typically 60-100) is recommended to maximise daylight penetration and distribution.

Using high-LRV ceiling materials helps distribute natural and artificial light evenly across a room, reducing shadows and improving visual comfort. In learning spaces, this contributes to better energy efficiency, reduced eye strain and a more engaging environment for students and educators.

THERMAL COMFORT AND INDOOR AIR QUALITY

Several key factors influence a ceiling's ability to regulate temperature and air movement, including ceiling height, configuration, material selection and insulation properties. Higher ceilings and open-plenum configurations can facilitate better air circulation, especially in large spaces such as gymnasiums and auditoriums. The use of high thermal mass materials can help regulate indoor temperatures by absorbing and slowly releasing heat, reducing fluctuations that may cause discomfort.

Proper integration of HVAC components within ceiling systems is essential for maintaining consistent temperature distribution and preventing air stagnation. Suspended ceilings with integrated air diffusers help distribute conditioned air evenly, reducing the risk of hot and cold spots that can impact student comfort and concentration. Drop-in ceiling grids provide a practical solution for housing HVAC ductwork, diffusers and air returns, ensuring an unobstructed airflow path. These configurations enhance overall energy efficiency by optimising ventilation and reducing the workload on heating and cooling systems.

The selection of sustainable ceiling materials can directly impact both indoor air quality and environmental sustainability. Ceiling tiles made from low-emission materials reduce exposure to airborne toxins, making them particularly beneficial in early childhood learning environments where children are more sensitive to pollutants. Additionally, materials with recycled or biodegradable content contribute to green building initiatives while maintaining high indoor air quality standards.

In spaces with fluctuating humidity levels—such as science labs, food technology rooms and bathrooms—moisture-resistant ceiling panels and antimicrobial grid systems help prevent mould growth and material degradation, ensuring long-term durability and a healthier indoor environment.


Penola Catholic College

SEISMIC CONSIDERATIONS

In Australia's National Construction Code (NCC), the "Importance Level" classification system categorises buildings based on the potential risk to human life and property in the event of structural failure. Schools are classified as Importance Level 3 buildings due to their role as critical infrastructure where large numbers of people congregate. This classification requires enhanced seismic performance to ensure occupant safety and maintain functionality in the event of an earthquake.

In accordance with AS1170.4 "Earthquake Actions in Australia", all commercial buildings in Australia must account for seismic design, ensuring both structural and non-structural components can withstand earthquake forces. Ceilings, partitions, walls and fixtures such as lighting, ductwork and fire suppression systems require specific seismic considerations, with lightweight steel framing necessitating structural assessment for each project.

AS/NZS 2785:2020 "Suspended ceilings - Design and installation" provides guidance on seismic design for suspended ceilings. Key updates include seismic restraint methods, clearance requirements and interaction with adjacent components. The standard also clarifies partition wall restraint, specifying that partitions should not be fixed to ceilings unless the ceiling is designed for restraint and that walls must be independently braced to the soffit to prevent ceiling collapse during seismic events.

A holistic ceiling design balances acoustic, visual and thermal comfort, ensuring an optimal educational setting that enhances both student well-being and academic performance.

TAILORED CEILING SYSTEMS FOR DIVERSE LEARNING SPACES

Himmel and Rondo provide an extensive range of ceiling grid systems and acoustic products designed specifically for educational settings. Their offerings include impact-resistant tiles, antimicrobial surfaces, suspended grid frameworks and high-performance acoustic panels that support a healthy, durable, and well-regulated indoor environment. These systems are not only designed to meet strict compliance standards but also empower architects and designers to deliver learning spaces that foster concentration, safety and long-term performance.

Key product solutions

Ceiling Grid Tiles and Panels

- **Ecophon Ceiling Tiles** – High-performance glasswool acoustic ceiling tiles (e.g., Ecophon Advantage and Focus ranges) designed for superior speech intelligibility and noise control in classrooms and study areas.
- **Troldtekt Panels** – Wood wool acoustic ceiling panels that provide excellent sound absorption with a natural aesthetic, ideal for multipurpose spaces and libraries. The Rondo 64mm Wide Furring Channel and Clip Fixing System, used in conjunction with Troldtekt screws has been specifically designed to ensure simple and accurate installation of Troldtekt panels.
- **Martini dECO Collection** – Decorative acoustic wall and ceiling panels designed to reduce reverberation and enhance visual appeal in dynamic learning environments.
- **Ecophon Hygiene Meditec A & Hygiene Performance A** – Fully encapsulated, particle-resistant ceiling tiles for educational spaces that require regular disinfection or cleaning, including science labs and food technology rooms.

Ceiling systems

- **DUO® Exposed Grid Ceiling System** – An engineered exposed grid system designed for quick assembly on-site. It features fully tested seismic designs that meet code requirements, making it a reliable choice for collaborative spaces and open learning environments.
- **DONN® Exposed Grid Ceiling System** – A widely used exposed grid system, available in 24mm and 15mm face grid in white or black colour options, providing architects and designers with aesthetic flexibility while ensuring seismic stability and acoustic performance.
- **DONN® Exposed Healthcare Grid Ceiling System** – A specialised antimicrobial ceiling grid system, designed for hygienic applications in areas such as science labs, food technology rooms and restrooms.
- **XPRESS® Drywall Grid Ceiling System** – A lightweight, fast-installing drywall ceiling system designed for flush plasterboard ceilings, bulkheads and boxed soffits. It is suitable for seismic, acoustic and fire-rated applications.
- **KEY-LOCK® Suspended Ceiling System** – A Concealed Suspended Ceiling System designed to produce a high-quality structure for a flush or featured finish to plasterboard ceilings.


University of South Australia

Ceiling selection guide for educational spaces

School Area	Key Considerations	Recommended Ceiling Systems
Classrooms	Acoustics, lighting optimisation, air quality, thermal comfort	Suspended acoustic ceilings with NRC tiles, integrated HVAC, low-VOC materials (e.g., Ecophon Advantage A, DUO® Exposed Grid Ceiling System)
Libraries and study Zones	Noise management, lighting for focus, ventilation	Sound-absorbing suspended ceilings, fabric-covered ceiling panels (e.g., Troldtekt Panels, Martini dECO Collection, DUO® Exposed Grid Ceiling System)
Science labs and creative spaces	Flexibility, acoustics, lighting adaptability, air quality and safety	Modular ceiling systems, ventilation-integrated ceilings, moisture-resistant tiles suspended grid ceiling systems (e.g., Ecophon Hygiene Performance A, DONN® Exposed Healthcare Grid System, KEY-LOCK® Concealed Suspended Ceiling System)
Multipurpose and Sports Facilities	Noise control, durability, integrated lighting and HVAC	Suspended acoustic system with impact-resistant acoustic panels (e.g., Troldtekt Panels, Donn® Exposed Grid Ceiling System)
Cafeterias and bathrooms	Hygiene requirements, germ control, moisture resistance	Antimicrobial DONN® grid with antimicrobial ceiling tiles (e.g., Ecophon Hygiene Meditec A, DONN® Exposed Healthcare Grid System)

Seismic ceiling design by Rondo

All schools in Australia must incorporate seismic ceiling design to ensure safety and compliance with Australian Standards. Rondo manufactures and supplies industry-leading wall and ceiling systems, which are specifically designed to resist seismic loads.

Rondo's seismic product and design solutions were developed through the use of Australian standards, comprehensive in-house and third-party testing, and extensive research into the latest seismic developments.

Seismic design solutions are available for across the Rondo, concealed and exposed grid range including: Rondo KEY-LOCK® Concealed Ceiling System, Rondo Duo® Exposed Grid Ceiling System, Donn® Exposed Grid Ceiling System, Xpress® Drywall Grid Ceiling System and GRIDLOK® Bracing System. Depending on the room size and seismic loads, Rondo engineers design either a perimeter fixing or plenum bracing option for your Rondo Ceiling System, so that the seismic forces are adequately transferred to the structure.

For large open areas, your Rondo Ceiling System is restrained by evenly distributed braces in the plenum space, with sliding connections to all perimeters. To brace your ceiling system, Rondo offers access to a range of GRIDLOK® bracing components that speed up installation versus traditional back-bracing methods.

University of South Australia

References

1 https://population.gov.au/publications/statements/2024-population-statement

2 https://link.springer.com/article/10.1007/s40857-023-00291-y

3 https://www.researchgate.net/publication/387464180_Improvement_of_student_performance_based_on_the_lighting_conditions_of_learning_spaces_A_systematic_review_analysis

4 https://www.researchgate.net/publication/339315678_The_relationships_between_classroom_air_quality_and_CHILDREN'S_performance_in_school

All information provided correct as of May 2025

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