Natural Stone: Functions (Science, Health, and Safety), Long-term Value, and Cultural Contributions

天然石材：功能（科學、健康、安全）、長期價值與文化貢獻

(Prepared for Taiwan Marble Association / 為台灣區石礦製品工業同業公會編製)

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Executive Summary 摘要

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This report analyzes the **functions, long-term value, and cultural contributions of natural stone** in comparison with artificial and composite building materials. Drawing on official standards (ASTM, EN, CNS) and international guidance (WHO, EPA, UNESCO, EU Circular Economy Action Plan), the findings emphasize three key dimensions:

- **Functions (Science, Health, Safety)**:
  Natural stone demonstrates measurable scientific advantages through water absorption and color change, which serve as natural diagnostic tools for moisture and leakage. Its inorganic composition prevents mold growth and avoids the emission of volatile organic compounds (VOCs). As a non-combustible material, stone enhances building fire safety and indirectly reduces risks of electrical failures by indicating concealed moisture conditions.
- **Long-term Value**:
  With durability that can exceed the lifespan of buildings, natural stone represents a sustainable investment. It resists resin degradation, requires minimal maintenance, and provides a lower life-cycle cost compared to many artificial alternatives. Health-related costs are also reduced, as stone does not release harmful emissions or toxic smoke.
- **Cultural Contributions**:
  Stone’s natural diversity of patterns and colors provides beauty in **“similar but different”** harmony, reflecting principles found in family resemblance and nature itself. Historic buildings such as the church beside the Leaning Tower of Pisa show how variation can coexist without conflict. Encouraging designers to embrace originality rather than over-emphasize uniformity increases both architectural value and cultural identity. Natural stone has shaped world heritage sites and continues to be recognized as a material of authenticity and sustainability in international frameworks.

Conclusion:
Natural stone is not only a building material but also a **scientific safeguard, long-term asset, and cultural expression**. It provides visible safety signals, reduces health risks, and enhances architectural originality. As global and national policies emphasize sustainability and cultural preservation, natural stone remains a critical material for the future of construction.

中文

本報告以天然石材為核心，針對其與人造或複合建材的比較，分析其**功能、長期價值與文化貢獻**。研究依據包括國際與國家標準（ASTM、EN、CNS）以及官方指引（WHO、EPA、UNESCO、歐盟循環經濟行動計畫），主要結論如下：

- **功能（科學、健康、安全）**：
  天然石材具備科學上可量化的優勢，其吸水率與顏色變化能成為環境濕度與漏水的自然檢測工具。由於為無機材質，石材不滋養黴菌，亦不會釋放揮發性有機化合物 (VOC)。石材屬不燃建材，能強化建築物火災安全，並透過顯示乾濕狀態間接降低水電管路異常與漏電風險。
- **長期價值**：
  天然石材的耐久性往往超越建築壽命，是永續的投資選擇。與人造建材相比，石材不會因樹脂老化而失效，維護需求低，生命週期成本更具優勢。健康成本亦因無有害排放與火災毒煙而大幅減少。
- **文化貢獻**：
  石材的自然紋理與色澤展現了**「**相似而不同**」**的和諧之美，猶如家族成員彼此相似卻各具特色，或同一棵樹上的葉子形態相近卻無一完全相同。比薩斜塔旁的教堂，內部石柱與石牆雖各異其色，卻共同構成莊嚴優美的整體。與其過度追求一致性，不如鼓勵設計師展現個人設計風格，避免重複「複製貼上」，從而提升建築美感與文化價值。天然石材自古以來塑造了世界遺產，並在國際框架中被視為具真實性與永續性的建材。

結論：

天然石材不僅是建材，更是**科學保障、長期資產與文化表達**。它能提供可見的安全訊號，降低健康風險，並提升設計的原創性。隨著全球與國家政策持續強調永續與文化保存，天然石材將在未來建築中持續扮演關鍵角色。

📌 Key Messages 關鍵訊息

- **Visible Safety**: Natural stone’ s water absorption and color change reveal hidden moisture, preventing mold and indirectly reducing electrical risks.
- **Health Protection**: Inorganic and non-combustible, stone avoids mold growth, VOC emissions, and toxic smoke.
- **Long-term Value**: Durable for decades to centuries, stone offers lower life-cycle cost compared to resin-based materials.
- **Cultural Identity**: “**Similar but different**” natural patterns enhance originality, design style, and cultural richness — unlike uniform copy-paste solutions.

- **可見的安全**：天然石材的吸水率與顏色變化能顯示隱藏濕氣，預防黴菌，並間接降低用電風險。
- **健康防護**：無機且不燃，不滋養黴菌，不釋放 VOC，也不產生火災毒煙。
- **長期價值**：耐久度可達數十年至百年以上，生命週期成本低於樹脂基建材。
- **文化身份**：**「**相似而不同**」**的天然紋理提升原創設計與文化價值，避免流於一致化與「複製貼上」。

Section A – Functions (Science, Health, and Safety)

功能（科學、健康、安全）

📊 吸水率比較表 (Commercial Natural Stone vs Man-made)

Table A1. Water Absorption Comparison of Commercial Natural Stone and Man-made Materials

材料 Material	吸水率 (依重量%) Water Absorption (% by weight)	官方檢測依據 Official Test Standards	商業應用備註 Commercial Application Notes
花崗岩 Granite	0.2 – 0.8%	ASTM C97 / EN 13755 / CNS	結晶緻密，多數商用品種 <0.5%，顏色變化輕微 Dense crystalline structure, most commercial types <0.5%, color change slight
大理石 Marble	0.3 – 2.0%	ASTM C97 / EN 13755 / CNS	脈紋與微孔較多，顏色變化較明顯 More veining and micro-pores, color change more visible
人造石英 Engineered Quartz	< 0.05%（幾乎不吸水 / almost zero absorption）	製造商產品規格 Manufacturer specifications	樹脂封閉表面，顏色固定；無調濕能力 Resin-sealed, fixed color; no moisture regulation
樹脂基人造石 Resin-based Artificial Stone	< 0.1%（由樹脂比例決定 / resin-dependent）	製造商產品規格 Manufacturer specifications	不吸水，長期可能龜裂或泛黃變色 Non-absorptive; may crack or yellow with time

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A.1 Scientific Functions 科學功能

When natural stone absorbs moisture, its color temporarily darkens, then returns to its original state once dry. This is not a defect but a natural mechanism of “breathing” and moisture regulation.

- **Leakage detection tool**: This color-change phenomenon serves as a practical indicator; if a local area remains darkened for an extended period without returning to dry, it likely indicates **water accumulation, seepage, or structural leakage** requiring inspection.
- **Building diagnostics**: Color change provides an immediate **visible signal** to users and inspectors, unlike impermeable building materials that conceal hidden moisture problems. “**The ASHRAE Handbook of Fundamentals** provides data on thermal conductivity and moisture transfer, supporting natural stone’s role in passive indoor climate regulation

天然石材在潮濕時顏色會暫時加深，乾燥後恢復原狀。這一現象並非缺點，而是其自然「呼吸」與調濕機制的表現。

- **漏水檢測工具**：此顏色變化現象可作為實用的檢測方式；若局部長時間保持濕色而未恢復乾燥，即代表該處可能存在**積水、滲水或結構性漏水**，應進一步檢測與處理。
- **建築診斷輔助**：石材顏色變化能提供即時訊號，成為使用者或檢修人員的**可見指標**，不同於不透水材質建材會隱藏問題。「**美國空調工程學會《基礎手冊》**提供建材熱傳導與濕度傳輸的資料，支持天然石材在被動式室內氣候調節上的作用

- ## A.2 Health Functions 健康功能

- **Mold resistance**: Natural stone is inorganic and provides no organic nutrients. When stone remains dry, it confirms that no standing water is present → indirectly proving no condition for mold growth.
- **Official references**:
    - **WHO** *Indoor Air Quality: Dampness and Mould* (2009): mold exposure strongly linked to respiratory illness, allergies, and asthma.
    - **US CDC**: prolonged mold exposure can cause severe infections in immunocompromised individuals.
- **Health risks of some artificial materials**:
    - Resin-based materials may release **VOCs (volatile organic compounds)** such as formaldehyde and benzene under normal conditions.
    - US EPA reports VOC exposure linked to headaches, respiratory problems, and long-term cancer risks. In Taiwan, **the Green Building Material Label** (administered by ABRI / reviewed by TABC) requires indoor materials to meet low VOC, mold-resistant, and moisture-protection standards.
    - → Thus, **artificial materials may release harmful chemicals even without burning**.

- **黴菌防護**：天然石材為無機材質，不提供有機養分。當石材顯示乾燥狀態，即代表環境無積水 → 間接證明沒有黴菌滋生的條件。
- **官方依據**：
    - **WHO**《Indoor Air Quality: Dampness and Mould》(2009)：黴菌暴露與呼吸疾病、過敏、哮喘有顯著關聯。
    - **美國 CDC**：長期黴菌暴露可造成免疫功能受損人群的嚴重感染。
- **部分人造材料健康風險**：
    - 樹脂基建材在常溫下可能釋放 **VOCs (揮發性有機化合物)**，如甲醛、苯系物。
    - 美國 EPA 指出 VOC 長期暴露與頭痛、呼吸問題、甚至癌症風險有關。在台灣，**內政部建築研究所《綠建材標章》**（由台灣建築中心審查）規範室內建材需具低 VOC、抗黴與防潮等性能。
    - → 換言之，**人造材料即使未燃燒，也可能持續釋放有害化學物質**。

- 🛡️A.3 Safety Functions 安全功能

- **Non-combustibility**: Natural stone does not burn and emits no toxic smoke; resin-based or engineered stone, when burning, release dense toxic fumes **(CNS 12514; EN 13501-1).**
- **Electrical safety (indirect)**: When natural stone maintains its dry appearance, it indirectly indicates that concealed plumbing and electrical conduits behind walls or beneath floors have not experienced **leakage or flooding**, showing no abnormal conditions → reducing risks of wire corrosion or outlet short-circuit. **ASHRAE** also highlights the importance of moisture regulation in reducing hidden electrical risks within building systems

- **不燃性**：天然石材不燃燒，無有毒煙霧；樹脂基或人造石燃燒時則會釋放濃煙與毒氣（CNS 12514；EN 13501-1）。
- **用電間接安全**：當天然石材長期保持乾燥顏色，間接顯示牆體或地板下方的水電管路未發生**滲水或泡水**，表示水電管路狀態無明顯異常 → 減少電線受潮或插座短路風險。**美國空調工程學會**亦強調濕度調控對於降低建築系統中隱藏電氣風險的重要性

🎯A.4 Misinterpretation and Correct Understanding of Color Change 顏色變化的誤解與正確認識

The temporary darkening of natural stone due to moisture absorption has long been misinterpreted as a defect. In fact, it is a natural mechanism for revealing environmental conditions. When ventilation and humidity are normal, stone faithfully reflects wet-to-dry cycles. By contrast, **impermeable building materials** prevent users from knowing whether hidden moisture or abnormal dampness exists behind walls or beneath floors, thereby concealing potential risks. Natural stone thus provides a “visible safety indicator” instead of hiding problems.

天然石材因吸水而顏色暫時加深，過去常被誤解為瑕疵或缺點。實際上，這正是石材顯示環境狀態的自然機制。當空間通風良好、濕度正常，石材能如實反映乾濕循環。相較之下，**不透水材質建材**會讓使用者無法得知牆體或地坪背後是否積水或異常潮濕，因而潛在風險被隱藏而不易察覺。天然石材提供了「可見的安全訊號」，而非將問題掩蓋。

Section B – Long-term Value 長期價值

⏳ B.1 Durability and Lifespan 壽命與耐久性

- **Natural stone**: Official tests show durability lasting decades to centuries, effectively matching the building’s lifespan.
    - Example: Stone elements in medieval European structures and Japanese-era buildings in Taiwan are still functional today.
- **Artificial materials**: Most engineered stones and composites have a 10 – 20 year lifespan before resin aging, cracking, or yellowing.
- **Official references**:
    - EN 1469 (Cladding Slabs), EN 12057 (Modular Tiles) specify strength and durability tests for stone.
    - Taiwan CNS 11031, 11032 define compressive strength and abrasion resistance for natural stone.

- **天然石材**：經官方標準測試，壽命可達數十年至百年以上，與建築物同壽。
    - 例如：歐洲許多中世紀建築及台灣日治時期建築的石材構件，至今仍在使用。
- **人造建材**：多數人造石與複合材料壽命 10 – 20 年，會因樹脂老化、龜裂或黃化而失效。
- **官方依據**：
    - EN 1469 (Cladding Slabs) 與 EN 12057 (Modular Tiles) 對天然石材要求強度與耐久性試驗。
    - 台灣 CNS 11031、11032 規範天然石材強度與耐磨性。

🔥 B.2 Non-combustibility and Safety 不燃性與安全性

- Natural stone is classified as **A1 non-combustible** (EN 13501-1), meaning it does not burn or emit toxic gases in fires.
- Resin-based engineered stone and composites produce dense smoke and toxic fumes in fire, hindering evacuation.
- **Official references**:
    - **EN 13501-1 (Fire classification of construction products).**
    - **Taiwan CNS 12514 (Fire performance of building materials).**
- According to the European Standard designation code **EN 13501-1**, natural stone is classified as **A1 non-combustible**, the highest level within the Reaction-to-Fire system.

  A1 classification indicates that the material does **not burn**, **does not release flammable gases**, and **does not contribute to fire growth**, typically accompanied by **minimal smoke (s1)** and **zero flaming droplets (d0)**.
- Because natural stone is an inorganic mineral material, it qualifies under **A1 Without Testing**, meaning it is recognized as non-combustible by nature without requiring laboratory fire testing.

  This inherent safety makes natural stone one of the most predictable and secure materials for fire safety design, especially compared to resin-based engineered stones, which generate dense smoke and toxic fumes when burning.

- 天然石材屬於 **A1 不燃材料**（EN 13501-1 分級），在火災中不燃燒，不釋放有毒氣體。
- 樹脂基人造石與複合材料在火災中會產生濃煙與毒氣，影響逃生。
- **官方依據**：
    - **EN 13501-1 (Fire classification of construction products)。**
    - **台灣 CNS 12514 建材燃燒性能測試**。
- 根據歐洲標準正式代號 **EN**（European Standard designation code）13501-1，天然石材屬於最高級別的 **A1「不燃材料」**。

  A1 等級代表材料在火災中**完全不燃燒**、**不釋放可燃氣體**、**不助長火勢**，並通常伴隨 **最低煙量**（s1） 與 **零燃燒滴落物**（d0）。
- 天然石材屬無機礦物材料，符合法規中 **A1 Without Testing（無需試驗即可歸類為 A1）** 的標準認定。

  此一本質性不燃特徵，使天然石材成為建築防火設計中最安全、最可預

測的建材之一，尤其相較於樹脂基人造石在燃燒時會釋放濃煙與毒氣，更具顯著安全優勢。

🛠 B.3 Maintenance and Health Costs 維護與健康成本

- **Natural stone**: Low maintenance cost, requiring only routine cleaning. No large-scale replacement needed, leading to lower life cycle cost (LCC).
- **Some artificial materials**: Prone to resin aging or color changes, often requiring replacement or refinishing, adding to maintenance cost and waste.
- **Health cost**:
    - VOC release from artificial materials and toxic smoke in fire contribute to hidden social and medical costs.
    - **WHO and US EPA** highlight significant health impacts of indoor VOC exposure. Taiwan’ s Green Building Material Label (ABRI / TABC) further reinforces this by certifying only those materials that limit VOC emissions and resist mold growth.

- **天然石材**：維護成本低，只需定期清潔即可。無需大規模更換，整體生命週期成本 (LCC) 較低。
- **部分人造建材**：因樹脂老化或顏色變化，需要更換或翻新，增加維護成本與廢棄物。
- **健康成本**：
    - 人造建材 VOC 釋放及火災毒煙造成的健康損害，往往隱含社會與醫療成本。
    - **WHO 與 EPA** 文件均指出室內 VOC 對呼吸健康有顯著影響。台灣內政部建築研究所《綠建材標章》（由台灣建築中心審查）進一步要求建材必須具有限制 VOC 排放與抗黴的特性，方可獲得認證。
- **註解**：VOC 為 *Volatile Organic Compounds*（揮發性有機化合物），包括甲醛、苯、甲苯等，常見於樹脂基建材與黏著劑中。

Section C – Cultural Contributions 文化貢獻

C.1 Natural Patterns and Colors 自然紋理與色澤

- Natural stone possesses unique mineral structures and colors, with no two pieces identical.
- Its aesthetic value lies in **“similar but different”** harmony: like family members who resemble each other yet remain distinct, or leaves from the same tree that are similar in form but never exactly the same.
- This natural diversity avoids monotony and creates richness without conflict.
- Example: In the church beside the Leaning Tower of Pisa, large stone columns and walls of different colors coexist beautifully even without polished surfaces, showing that variation can be timelessly elegant.
- By contrast, some modern projects in Taiwan place too much emphasis on uniformity. A more sustainable and creative direction is to encourage architects and designers to express their individual design styles through stone, rather than relying on repetitive ‘copy-and-paste’ solutions.
- This approach is consistent with **Taiwan’s Public Construction Commission (PCC) guidelines**, which promote value-based procurement and encourage creativity beyond lowest-price competitio

- 天然石材具有獨一無二的礦物結構與色澤，每一塊皆不同。
- 其美感來自於**「**相似而不同**」**的和諧：就像同一家族的成員彼此相似卻仍各具特色，或同一棵樹上的葉子形態相近但沒有兩片完全相同。
- 這種自然的多樣性避免了單調，營造出豐富而不衝突的效果。
- 例如：比薩斜塔旁的教堂，其內部巨大的石柱與石牆呈現不同色彩，即使未經拋光，依然莊嚴優美，展現了多樣化的永恆美感。
- 相較之下，部分現代台灣工程過度要求石材「一致性」。更永續的方向應是鼓勵建築師與設計者透過石材展現**個人設計風格**，而非一再重複的「複製貼上」。接受自然的多樣性，不僅能提升美感與文化價值，也能避免設計僅淪為價格競爭。
- 此方向亦與**台灣公共工程委員會（PCC）的指引**一致，強調以價值為導向的採購方式，並鼓勵設計創意，而非僅以最低價競爭

🏛 C.2 Historical and Cultural Applications

歷史與文化建築應用

- Iconic structures such as the Roman Colosseum, the Parthenon in Athens, and Japanese-era official buildings in Taiwan show natural stone’ s cultural durability.
- Stone has long symbolized permanence, dignity, and identity in architecture.
- UNESCO World Heritage guidelines recognize natural stone as a critical element of cultural heritage preservation.

- 羅馬競技場、雅典帕特農神廟與台灣日治時期的官方建築，均展現了石材的文化耐久性。
- 石材長久以來代表了建築的永恆、莊嚴與身份象徵。
- 聯合國教科文組織《世界文化遺產保護準則》將天然石材列為文化遺產建築的重要元素。

🔄 C.3 Repairability and Sustainability 修復性與永續價值

- Natural stone can be polished, repaired, or re-laid, prolonging service life without full replacement.
- By contrast, artificial materials often fail irreversibly when resin layers or printed surfaces degrade.
- From a circular economy perspective, stone is recyclable and reusable in secondary construction.
- The EU *Circular Economy Action Plan* identifies natural stone as a low-waste, reusable building material.

- 天然石材可透過打磨、修補或重新鋪設延長使用壽命，而不必全面更換。
- 人造建材常因樹脂層或印刷表面老化而無法修復，只能報廢。
- 從循環經濟的角度，石材可回收再利用於二次工程。
- **歐盟《循環經濟行動計畫》**將天然石材列為低廢棄、可再利用的建材。

Appendix – EN 13501-1 A1 Non-combustible Classification: Official Definition and Source

EN (European Standard designation code) 13501-1 is the unified European fire classification system for construction products, issued by the **CEN (Comité Européen de Normalisation)**.
It defines how materials behave under fire exposure through a structured classification from **A1 to F**, combined with smoke production (**s1 – s3**) and flaming droplets (**d0 – d2**).

1. Purpose and Relation to CE Compliance

EN 13501-1 is a core requirement of the **CE (Conformité Européenne)** regulatory system. Many construction products must declare their reaction-to-fire performance according to this standard before being legally sold within the EU market.

2. Official Definition of A1 Classification

A1 is the **highest** level within the Reaction-to-Fire system, indicating that the material:

- Does **not ignite or burn**
- Emits **no flammable gases**
- Does **not contribute to fire growth or flashover**
- Produces **extremely low heat release**
- Typically corresponds to **s1** (minimal smoke) and **d0** (zero flaming droplets)

A1 materials are used in high-safety applications, including public buildings, evacuation routes, and fire-resistant assemblies.

3. Natural Stone and A1 – "A1 Without Testing"

Natural stone, being a fully inorganic mineral, is recognized under:

A1 Without Testing

This classification indicates that stone is **inherently non-combustible**, without requiring laboratory fire testing.

In contrast, resin-based composites may emit toxic gases, smoke, or molten droplets during fire, increasing evacuation risks.

4. Summary of Classes (A1 – F)

- A1 – Non-combustible: natural stone, concrete, ceramics, glass, metals
- A2 – Limited combustibility: stone composites, fiber-cement boards
- B – Very limited combustibility: fire-treated wood
- C – Combustible: engineered wood, some flooring
- D – Readily combustible: general wood
- E – Highly combustible: plastics, foams
- F – Not tested or failed classification

5. Relevance to Building Safety

The A1 classification of natural stone enhances fire compartmentation, reduces smoke risks, and increases long-term safety, making it a preferred material in sustainable and public-interest architecture.

附錄 — EN 13501-1 A1 不燃等級之正式定義與出處

EN（European Standard designation code）13501-1 是歐盟統一的建築產品防火分類標準，由 CEN（Comité Européen de Normalisation） 制定。
本標準針對材料在火源作用下的反應行為進行等級分類，範圍從 A1 至 F，並搭配煙量（s1 – s3）與燃燒滴落物（d0 – d2）標示。

1. 標準用途與 CE 合規要求

EN 13501-1 為歐盟建材法規 CE（Conformité Européenne） 的核心依據之一。
多數建築材料在進入歐盟市場前，必須依據本標準提供反應火焰性能之分級。

2. A1 等級的正式定義

A1 為最高防火等級，代表材料：

- **不點燃、不燃燒**
- **不釋放可燃氣體**
- **不助長火勢或火焰蔓延**
- **熱釋放量極低、可忽略**
- 通常對應 s1（**極低煙量**）、d0（**零燃燒滴落物**）

A1 級多應用於公共建築、避難動線、機電井與高安全需求區域。

3. 天然石材與 A1 —「A1 Without Testing」

天然石材屬無機礦物材料，符合：

A1 Without Testing（無需試驗即可直接歸類為 A1）

此分類代表石材本質天然不燃，不需經燃燒測試即可認定為最高防火等級。
相對地，樹脂基複合材料於火災中可能釋放濃煙、毒氣或熔融滴落物，風險較高。

4. 等級摘要（A1 – F）

- A1：不燃 — 天然石材、混凝土、陶瓷、玻璃、金屬
- A2：近不燃 — 石材複合板、纖維水泥板
- B：低可燃 — 防火木材
- C：中可燃 — 工程木、部分地板
- D：較可燃 — 一般木材
- E：易燃 — 塑膠、泡棉
- F：未測試或未通過

5. 建築安全意義

天然石材的 A1 不燃性：

- 提升防火區劃完整性
- 不產生毒煙，有助於逃生安全
- 適用於高人流、高風險場所
- 增強建築之生命週期安全與永續性

Appendix – References / 參考文獻

• UNESCO – Operational Guidelines for the Implementation of the World Heritage Convention

🔗 https://whc.unesco.org/en/guidelines/

Guidelines emphasizing authenticity of materials, acceptance of natural variation in cultural heritage.

👉 聯合國教科文組織《世界文化遺產公約執行準則》，強調材料真實性與自然變化的可接受性。

• European Commission – Construction Products Regulation (CPR, EU 305/2011)

🔗 https://ec.europa.eu/growth/sectors/construction/product-regulation/

Defines performance requirements for building materials, including aesthetics as part of product quality.

👉 歐盟《建築產品規則》要求建材性能中包括美學特性，作為品質評估的一部分。

• EURORoc – European & International Natural Stone Organization

🔗 https://euroroc.net

Promotes the aesthetic uniqueness and cultural value of natural stone in architecture.

👉 歐洲與國際天然石協會，推廣天然石材在建築中的獨特美學與文化價值。

• EU – Circular Economy Action Plan

🔗 https://environment.ec.europa.eu/strategy/circular-economy-action-plan_en

Identifies natural stone as a low-waste, reusable building material in sustainable construction.

👉 歐盟《循環經濟行動計畫》將天然石材列為低廢棄、可再利用之永續建材。

• Taiwan Public Construction Commission (PCC) – Procurement Guidelines

🔗 https://www.pcc.gov.tw

Encourages value-based procurement in construction, discouraging lowest-price-only competition.

👉 台灣公共工程委員會《採購指引》，鼓勵以價值為基準的採購方式，避免僅以最低價競爭。

• Taiwan CNS Standards – Stone and Building Materials

🔗 https://www.cnsonline.com.tw

Provide official test methods for stone durability, water absorption, and fire performance.
👉 台灣 CNS 標準，規範石材耐久性、吸水率與燃燒性能之檢測方法。

- ABRI / TABC – Green Building Material Label (綠建材標章)

🔗 https://www.abri.gov.tw/cp.aspx?n=805

Administered by the Architecture and Building Research Institute (ABRI), Ministry of the Interior, with certification review by the Taiwan Architecture & Building Center (TABC). Sets standards for low VOC, mold resistance, moisture protection, and durability. Results are also summarized in MOENV reports.

👉 內政部建築研究所《綠建材標章》，由台灣建築中心 (TABC) 審查，規範建材需具低 VOC、抗黴、防潮與耐久性。相關成果亦由環境部彙整公布。

- ASHRAE – Handbook of Fundamentals

🔗 https://www.ashrae.org/technical-resources/ashrae-handbook
Provides official data on **thermal conductivity, thermal comfort, and moisture transfer** in building materials, supporting natural stone's role in passive indoor climate regulation.
👉 美國空調工程學會《基礎手冊》，提供建材熱傳導、室內熱舒適與濕度傳輸等資料，支持天然石材在被動式室內氣候調節的作用。

- CEN – EN 13501-1: Fire classification of construction products and building elements – Part 1: Classification using data from reaction to fire tests

🔗 https://standards.cencenelec.eu/dyn/www/f?p=205:110:0::::FSP_PROJECT:34006
Provides the official European fire classification system (A1 – F) for construction materials, defining non-combustibility and reaction-to-fire performance used in CE compliance.
👉 歐洲標準化委員會 CEN（2020）。EN 13501-1《建築產品防火分類—第 1 部：反應火焰性能》。歐洲標準正式代號，布魯塞爾。