The Missing Link between Colonial Jack Arch Roofing and Indigenous Construction Practices in India

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ABSTRACT

This research critically examines the hybridization of the Jack Arch roofing system within the context of colonial India, where British engineering intersected with indigenous construction traditions. While Jack Arches are often treated as purely colonial imports, this study argues for a more nuanced understanding of their localized adaptation. The research identifies a gap in architectural historiography, where the Jack Arch is seldom recognized as a culturally negotiated outcome shaped through collaboration and necessity. By analysing archival engineering manuals and Public Works Department records, this paper reveals how local craftsmen modified imported engineering practices using vernacular materials such as hand-moulded bricks, lime mortar, and region-specific construction logic. These adaptations not only improved the climatic suitability and cost-effectiveness of the system but also established a new architectural language that merged colonial structural rationalism with indigenous craftsmanship. The study uses a comparative framework to contrast Jack Arches with traditional roofing systems such as Madras Terrace, bamboo thatch, and stone slabs evaluating them through parameters like thermal performance, construction skill, durability, and cost. In doing so, it offers evidence of a conscious and regionally grounded architectural transition during the colonial era. The findings underscore the relevance of these hybrid systems in both heritage conservation and the development of sustainable, resource-efficient architecture in present-day India.

Key words: Jack Arch, colonial construction, indigenous techniques, hybrid architecture, British India, vernacular adaptations, architectural conservation.

INTRODUCTION

The architectural landscape of colonial India was shaped by a dynamic interplay between imported technologies and indigenous knowledge systems. Among the many structural innovations introduced by the British, the Jack Arch roofing system emerged as a prominent feature in railway quarters, administrative buildings, and institutional structures due to its fire resistance, structural efficiency, and cost-effectiveness. Traditionally viewed as a colonial imposition, the Jack Arch system has seldom been studied as a product of

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collaboration or adaptation. This research challenges the dominant narrative by examining how Jack Arches were not merely transplanted but transformed engineered with local materials like hand-moulded bricks and lime mortar and implemented by skilled Indian craftsmen whose vernacular expertise shaped its final form. While literature on colonial infrastructure has documented the spread of European engineering methods, limited attention has been given to the regional improvisations and hybrid techniques that emerged through this cultural and technical exchange. the study identifies a critical gap in architectural historiography, the absence of focused analysis on Jack Arch systems as culturally negotiated constructs rather than standardized colonial forms. Through a comparative investigation of historical documentation and conservation efforts, this paper aims to uncover the pluralistic evolution of the Jack Arch in India. In doing so, it contributes to broader conversations around heritage, sustainability, and the revaluation of intermediate technologies in postcolonial built environments. to investigate the hybrid evolution, spatial use, and conservation challenges of colonial jack arch roofing systems in India by uncovering their indigenous adaptations, regional variations, and current architectural relevance. Critically investigate how the British-introduced Jack Arch roofing system was adapted, modified, and hybridized through the integration of indigenous Indian construction materials, climate-responsive techniques, and craftsmanship thereby reframing it not as a mere colonial imposition, but as a collaborative and regionally evolved architectural form. this paper focuses on the evolution and transformation of the Jack Arch roofing system in India during the British colonial period. It examines the architectural, material, and cultural adaptations that occurred when this British engineering technique was implemented in the Indian context. The study is limited to the analysis of archival documentation, engineering manuals, and comparative assessments of traditional Indian roofing systems, excluding detailed regional case studies or primary fieldwork. It places emphasis on understanding the Jack Arch not merely as an imported structural form, but as a hybridized system that absorbed indigenous influences and construction practices. The paper does not aim to provide structural calculations, restoration blueprints, or region-specific building surveys, but rather seeks to contribute a theoretical and historical framework for recognizing intermediate colonial technologies as part of India's architectural heritage.

HISTORICAL BACKGROUND

The Jack Arch roofing system was first developed in 18th-century Europe as a fireproofing solution for industrial floors and roofs. Characterized by shallow masonry arches spanning between parallel iron or steel beams, the technique gained popularity during the Industrial Revolution for its fire resistance, load-bearing capacity, and structural economy (Fletcher, 1905). The system was introduced to colonial India by British engineers in the mid-19th century, particularly through infrastructure projects under the Public Works Department (PWD). Sir George Buchanan's *Treatise on Civil Engineering in India* (1859) detailed the technical specifications of Jack Arches, promoting them as suitable alternatives to timber structures in institutional and infrastructural buildings across India. These included railway quarters, government offices, and military barracks (Buchanan, 1859; Metcalf, 1989). Despite their advantages, the use of Jack Arches in

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India required significant adaptation. Imported materials such as steel joists and Portland cement were expensive and often inaccessible in remote regions. Moreover, the diverse climatic zones of the Indian subcontinent from humid coastal areas to arid interiors posed challenges to unmodified European construction techniques (Sahapedia, 2020; Sohoni, 2021). To address these challenges, Indian masons and craftsmen began modifying the Jack Arch using locally available materials such as hand-moulded bricks and lime-surkhi mortar. Traditional knowledge systems informed decisions on thermal performance, waterproofing, and structural resilience. These adaptations allowed the system to meet regional climatic demands and reduced dependency on expensive imports (INTACH, 2010; ASI, 2015–2020). Thus, in India, the Jack Arch evolved from a standardized colonial technology into a hybrid architectural solution shaped by material pragmatism, environmental responsiveness, and indigenous agency.

Evolution of the Jack Arch Roofing System

18th Century Europe (1780s) Jack Arches first developed in Europe, particularly in Britain, as a fire-resistant structural system for industrial floors and roofs. Constructed using shallow brick arches set between iron or cast-iron beams.

Source: Yeomans, D. T. (1992). *The Trussed Roof: Its History and Development*. Scholar Press. 19th Century Industrial Revolution (Europe) (1830s–1850s) Widespread use of iron I-beams and brick vaults in mills, warehouses, and factories across Britain. (Addis, B. 2007). Phaidon Press. 1859 - Sir George Buchanan's *Treatise on Civil Engineering in India* describes the use of Jack Arch systems for colonial buildings, praising their structural efficiency and fire resistance. (Buchanan, G. 859). Mid–Late 19th Century Arrival in India (1850s–1870s) British engineers introduce Jack Arches into Indian colonial architecture, especially in railway infrastructure (stations, workshops, staff quarters), barracks, and public works. (Arif, M. K. 2019). (1870s–1890s) Indian adaptations emerge: Locally made bricks replace imported ones.Lime mortar is used instead of Portland cement due to availability and climate performance. (Davies, P. 1985). Early 20th Century Vernacular Adaptations 1900s–1920s -Jack Arch construction popularized in worker and institutional housing, such as those by Tata Steel (TISCO) in Jamshedpur. Adaptations for Indian climate (e.g., drainage for monsoons, improved thermal performance) (Lang, J., Desai, M., & Desai, M. 1997). 1930s–1940s Transitional hybrids: Jack Arches combined with Madras terrace roofing for climate control and durability. (Tillotson, G. 1989). Post-1947 post-Independence India 1950s–1980s -Decline in usage due to the rise of RCC (Reinforced Cement Concrete). Architect Laurie Baker explores low-cost construction techniques including Jack Arch-inspired methods. (Baker, L. 1991). 1990s–2010s -Conservation efforts by INTACH and ASI focus on preserving early 20th-century Jack Arch buildings in cities like Kolkata, Chennai, and Bangalore. (INTACH, 2005). Contemporary (2020s–Present) Renewed architectural interest in Jack Arches for: Sustainable construction**,** vernacular hybrid technologies & academic curricula in heritage conservation and climate-resilient architecture Encouragement of documentation, thermal efficiency analysis, and revival

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for low-income housing. (Nair, J. 2021).

Construction Of Typical British Jackarch Roofing

The British procedure for the construction of jack arches, developed in the 19th century during the Industrial Revolution, was primarily intended to provide fireproof, durable, and load-bearing floor and roof systems for industrial and colonial buildings. The process began with the placement of cast iron or wrought iron joists, typically spaced 3 to 4 feet apart, which acted as the structural frame and springing point for the arches. Wooden centering or shuttering was then temporarily erected between these joists to form the underside curvature of the jack arch. This centering could be supported either from the joists or independently from the floor below, but it was essential to ensure that the joists were not overloaded during construction.The jack arches themselves were constructed by laying burnt clay bricks on edge using lime mortar (1:3) or cement mortar (1:4). The arches were usually shallow and segmental in shape, and the bricks were sometimes cut or tapered to maintain uniform joints and curvature. Once the arches were keyed at the crown to lock them in place, the spandrel spaces or haunches between the arch and the top flange of the joists were filled using lime concrete, rubble, or broken brick aggregate in lime mortar. Over this, a leveling course of lime concrete, approximately 75 mm thick, was laid to prepare for the final floor or roof finish, which could be brick tiles, stone slabs, or timber battens depending on the building's function.Curing was a critical step, where the structure was kept moist for 7–10 days before gradually removing the centering to allow the load to transfer to the arches. This technique was especially favored for its fire-resistant qualities, making it ideal for textile mills, warehouses, railway stations, and colonial structures in India and other British territories. The system combined the modular strength of iron with the availability and economy of brick and lime, making it suitable for adaptation in different climates and regions. Historical sources such as *The Builder journal (19th century UK)*, and colonial Public Works Department manuals provide detailed documentation of these techniques, which later influenced Indian construction practices and standards like IS: 2541–1974.

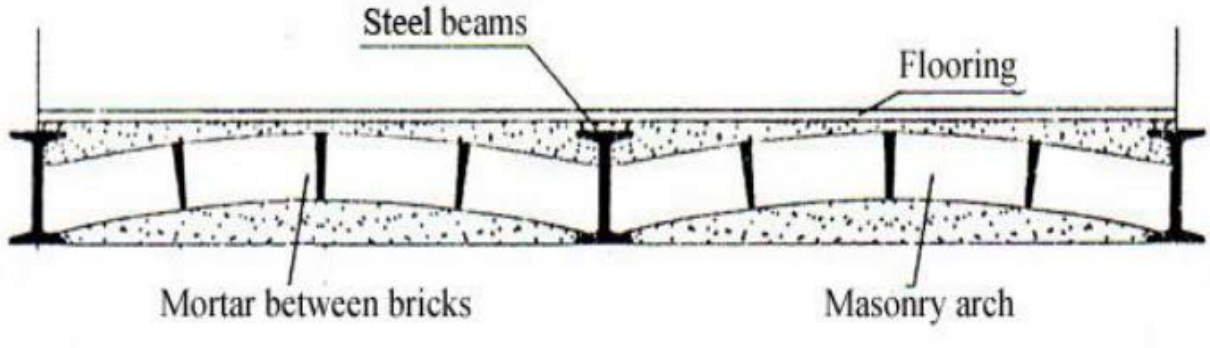

Fig1: A typical form of jack arch slab and its details

Construction Of Indegenous Jack Arch Roofing In India

Construction of Jack-Arches The construction of jack-arches begins with the erection of centering, which is

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essential to support the arch work placed between joists. This centering must be smooth and conform accurately to the required curvature. It may be supported either from the joists themselves or independently from the floor below, but it must not bear upon any tie rods. Temporary supports can be provided to the joists to prevent sagging during the arch construction process. Brickwork for the Jack Arch Bricks, as prepared according to the specified standards, are laid on edge in a cement mortar mix not leaner than 1:4 (cement: sand by volume), or an equivalent lime mortar. These bricks spring from the bottom flange of the joists and form the arch over the centering. Joints at the bottom shall not exceed 10 mm in thickness. Once the brickwork is laid, it should be kept moist for curing and allowed to set for a minimum of 10 days before any concrete is laid over it. The centering used for jack-arches is eased after 7 days if constructed with cement mortar, and after 10 days if constructed with lime mortar, just before the laying of lime broken brick aggregate concrete. Laying of Lime-Concrete After the arch has adequately hardened, a layer of lime-broken brick aggregate concrete is laid. This concrete mix typically follows the ratio of 1:2+ (slaked lime: broken brick aggregate by volume). Alternatively, a mix of lime, pozzolanic material, and fine aggregate in the ratio of 1:1:1 may be used, following the standards outlined in IS:2541-1974 or as detailed in Appendix B. This mixture is spread to an initial thickness of 75 mm over the crown of the arch. The concrete is then compacted using wooden rammers weighing no more than 2 kg, reducing the consolidated thickness to approximately 60 mm. Further compaction is achieved through hand beating using wooden hand beaters until the surface becomes firm and the beater bounces off without leaving an impression. Workers must beat the surface lightly, in rhythm, while moving forward in closely arranged rows. During this process, the surface is kept moist by sprinkling lime water mixed with sugar solution or herbal solutions like KADUKAI (Hararh) or jaggery-GUGAL mixtures. Traditional Additives for Compaction Traditional compaction practices include using herbal and natural additives. For instance, in northern India, a sugar solution is made by mixing around 3 kg of jaggery and 1 kg of Bael fruit in 100 litres of water. A solution of KADUKAI or HARARH is prepared by breaking the dried nuts into pieces and soaking them in water with 200 g of jaggery, using 60 g of KADUKAI or HARARH per 40 litres of water for 10 m^2 of work. The mixture is brewed for 12 to 24 hours before use. Alternatively, jaggery and GUGAL are soaked in water (50 g each in 40 litres of water per 10 m^2 work) to form another effective compaction aid. Finishing and curing if the surface becomes uneven and water pools during compaction, it must be pricked and fresh concrete added and consolidated again to ensure evenness. Finally, the surface is cured by regular sprinkling of water and is allowed to harden for no less than six days before any flooring or roofing finish is applied**.** The *culturally and materially negotiated transformation* of Jack Arch roofing into a hybrid architectural form shaped by indigenous craftsmen, local materials, and contextual performance needs. It includes use of vernacular materials like lime-surkhi mortar, hand-moulded bricks, shell lime, and admixtures, integration with local craftsmanship and techniques (e.g., modifications in arch rise, bonding patterns), climatic adaptation, such as enhancing thermal comfort in hot/dry or humid regions, construction improvisations, such as combining Jack Arch logic with Madras Terrace finishes.

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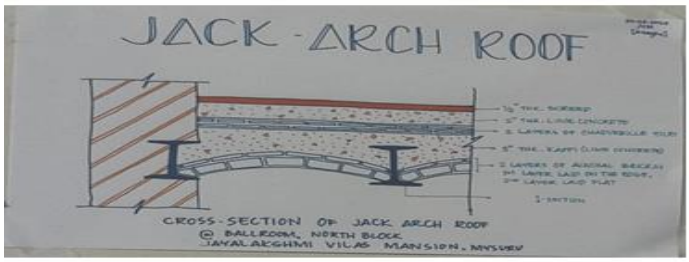
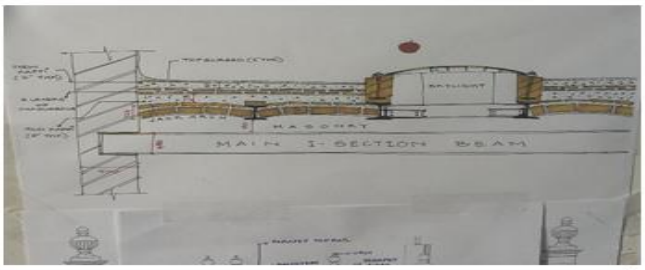
Case studies on Indian Context Jayalakshmi Vilas Mansion, Mysore

Fig(1) : View of Jack arch roof

Fig (2) skylight on the jackarch



Fig(3): Detail of jackarch



Fig(4): Detail of jackarch

The Jayalakshmi Vilas Mansion, built in 1901–1905 by Maharaja Chamaraja Wodeyar IV near Kukkarahalli Lake in Mysuru, is a grand example of classical European architecture in South India. While its design is visibly colonial evident in its Ionic/Corinthian detailing and arched porticos it also features a jack-arch roofing system, particularly noticeable in its iconic grand ballroom. Structural & Material Characteristics, Jack-Arch Roof Structure The ballroom boasts a 40-foot-high ceiling formed by shallow brick jack arches spanning between iron or timber joists, supporting a glass-panelled dome. Local Materials & Craftsmanship Despite its European formal design, the roofing reflects indigenous material use Hand-moulded regional bricks, likely produced locally, shaped and assembled by Mysuru masons accustomed to arch vault work. Lime-based mortar, used instead of cement, enhanced compatibility with native bricks and the humid climate. Glass skylights, possibly imported but stored in locally fabricated iron frames, then embedded over low brick arches and waterproofed using indigenous sealing techniques Roof Integration The jack-arch base allows natural light through skylights while holding waterproofing layers and concealing structural elements. The adaptation demonstrates how colonial structural logic (arch spans, iron supports) and vernacular roofing tradition (brick vaulting, plaster finishes) merged seamlessly. In Jayalakshmi Vilas, the missing link is the material-cultural synthesis The palace's roof melds colonial structural intent (fireproofing, load distribution) with local craftsmanship and materials (brick vaulting traditions of Mysuru). The ballroom’s custom skylight assembly resting on jack-arched brick vaults exemplifies how British engineering cherry-picked indigenous execution methods, resulting in a hybrid form a colonial shell animated by local substance. Interpretation The Jayalakshmi Vilas Mansion’s roofing system doesn’t simply replicate a colonial template it reinterprets and actualizes it through regional expertise. This amalgamation validates your thesis: colonial technology was hybridized through indigenous traditions, and the missing link is that collaborative intersection made visible in this building’s roof.

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Fig(5): view from physics block

Fig(6): view from physics block

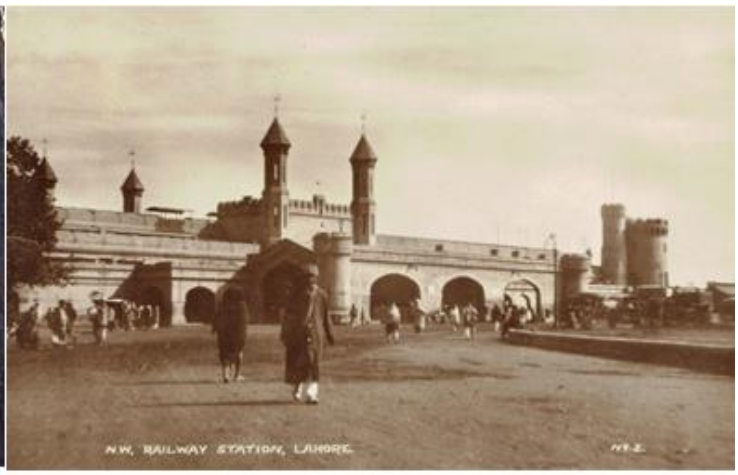
Fig(7): view from physics block

British Residency , Koti Hyderabad

Constructed: 1803–1805 under Lt. Samuel Russell of the Madras Engineers, commissioned by British Resident James Achilles Kirkpatrick. Style, Neo-Palladian, designed to be Hyderabad's version of the "White House" Current State: Adaptively reused as the Koti Women's College; conserved in a multi-decade project led by the World Monuments Fund and ASI Composite Structural Roof Although originally specified with iron joists and cement, the actual implementation used locally available lime and mud mortar, hand-pressed bricks, and teakwood beams, as confirmed by heritage surveys. Situated in a hot, hazy urban climate with monsoon rains, jack-arched roofs were lime-finished and topped with waterproof terrace layers, blending colonial arched systems with Madras Terrace functionality.

Lahore (Now Pakistan) – Railway Quarters & Barracks (1900–1940)

Fig(8)View of the Jack arch roofing



Fig(9) View of the Railway building

Historical Context Between 1900 and 1940, Lahore was a vital node in British India's expanding railway network. As the headquarters of the North-Western Railway (NWR), Lahore saw rapid development of

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Railway quarters for officers and staff, Military barracks and armories & Support infrastructure like workshops and storehouses. British engineers prioritized cost-effective, durable, and fireproof construction, making Jack Arch roofing a key architectural feature in this infrastructural wave. Jack Arch Roofing System: Colonial Intent The railway quarters were standardized using, Segmental brick arches spanning between cast iron or rolled steel I-beams, Fireproof ceilings that protected against heat and combustion hazards from coal-burning stoves and Minimal timber use due to termite risk and scarcity in Punjab. Plans were often drawn in regional public works offices following the British PWD manuals, with input from engineers based in Lahore's engineering school and NWR headquarters, Indigenous Adaptation: Materials & Methods Despite colonial standardization, Lahore's builders made numerous local modifications, resulting in a hybrid construction system, Materials Used Hand-pressed Punjabi bricks (larger and more porous than British bricks), moulded locally in kilns near Wagah and Kasur. Lime-surkhi mortar, widely used in Punjab, composed of Slaked lime Burnt brick powder (surkhi) Sometimes mixed with organic additives like guggal resin or molasses to improve water resistance. Plaster finishes composed of lime, mud, and natural oils to improve internal insulation and reduce hairline cracks in vaulted ceilings. Construction Techniques Variable arch spans: Adjusted on site depending on available brick size and spacing of beams. Reinforcement with tie rods was sometimes introduced in longer spans a local innovation not standard in British jack arch design. Roofs were covered with lime concrete and china mosaic to prevent water seepage during the monsoon. Climatic & Cultural Performance Lahore's hot semi-arid climate required durable roofing that could Withstand high summer temperatures (often >45°C) Resist monsoon damage and humidity-related decay Provide passive cooling in staff housing the indigenous lime mortar and plastering allowed for thermal inertia, reducing indoor heat load while remaining permeable enough to prevent moisture buildup. The Jack Arch system in Lahore became a cultural-technical hybrid structured by British logic, but materially and climatically governed by Punjabi traditions. The "missing link" here is the vernacularisation of British construction, where Indian masons worked within structural constraints but localized every material and finish. Colonial blueprints became skeletons animated by indigenous labor, craft, and climatic intelligence.

Comparison With Other Indigenous Roofing

Traditional Indian roofing systems exhibited deep environmental intelligence and regional adaptation. Their comparison with the adapted Jack Arch system underscores the architectural negotiation between imported engineering and indigenous practice. **Madras Terrace** Widely used in Tamil Nadu; this system consisted of timber joists overlaid with brick-on-edge courses and lime plaster. It offered moderate thermal comfort but required significant maintenance, *particularly in coastal* climates where waterproofing frequently failed. The heavy reliance on timber made it susceptible to decay and termite damage, limiting long-term performance (Sahapedia, 2020).

Bamboo and Thatch Roofs Common in Bengal and northeastern India, these roofs used flexible, low-cost materials suited to high rainfall. They performed well thermally due to low thermal mass but were highly perishable, requiring frequent replacement. While environmentally sustainable, they lacked structural longevity and were mainly confined to vernacular domestic buildings (Hardy, 2007). Stone Slab Roofing Used in arid regions like Rajasthan, large stone slabs were laid over beams to form robust, thermally stable robust,

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thermally stable roofs. These systems performed excellently in dry climates and were nearly maintenance-free. However, the roofs were heavy, expensive to construct, and limited in design flexibility, requiring skilled stonemasonry (Venu, 2010). **Hybrid Jack Arch System** the Jack Arch, as adapted in colonial India, combined British structural logic with local materials such as hand-molded bricks and lime mortar. Supported by steel or iron joists, it offered excellent fire resistance, reduced reliance on timber, and required less maintenance than Madras Terrace roofs. Unlike stone slabs, it allowed wider spans, and unlike thatch, it was permanent. Its adoption represents a pragmatic vernacularizing of colonial building systems (Buchanan, 1859; INTACH, 2010). **Kerala** Timber Roof (Sloped Mangalore Tile Roof) In Kerala and parts of coastal Karnataka, the sloped Mangalore tile roof emerged as a significant adaptation to monsoon-heavy environments. These roofs were constructed using seasoned timber rafters and clay tiles arranged on steeply pitched frames, enabling efficient rainwater runoff. The integration of ventilated attic spaces also facilitated passive cooling in humid tropical climates. This roofing system embodied a synthesis of local timber craftsmanship and colonial-era tile-making technologies. Patra (Leaf Roof) In the tribal belts of Odisha and Central India, Patra roofs composed of large sal or palmyra leaves tied over bamboo frameworks were widely used. Extremely lightweight and biodegradable, these roofs were ideal for temporary or seasonal dwellings, reflecting ecological sensitivity and the nomadic traditions of the communities that built them. Chhajja Roof Extension (Overhanging Eaves) Chhajja roof extensions, found across North India in Mughal and Indo-Islamic architecture, consisted of overhanging eaves supported by elaborately carved stone or timber brackets. These provided critical shading and rain protection and were often incorporated into larger terrace systems, demonstrating a blend of ornamentation and function. Brick Vaulted Roofs (Pre-Colonial & Islamic Influence) Another pre-colonial form, brick-vaulted roofing, was prevalent in Mughal-era structures across regions such as Delhi and Awadh. Built using burnt brick and lime mortar arranged in arches or domes, these roofs embodied advanced masonry techniques and represented a structural precursor to the Jack Arch. They were commonly seen in mosques, caravanserais, and public baths. Mud and Reed Roofs In the arid regions of Gujarat and Rajasthan, particularly in vernacular circular dwellings like the Bhunga, roofs were built from mud and reed. These structures were thermally insulative, offering protection from extreme desert heat, and often incorporated dome-like forms for stability and spatial efficiency. Slate Roofing In Himalayan regions such as Himachal Pradesh and Uttarakhand, slate roofing was common. Flat slate tiles laid over wooden rafters created steeply pitched roofs capable of withstanding snow loads. These roofs not only performed exceptionally well in cold climates but also made use of locally quarried stone and skilled craftsmanship. These varied roofing systems highlight the ingenuity of traditional Indian builders in negotiating environmental challenges through material and structural innovation. Against this rich backdrop, the localized Jack Arch system can be understood as one among many regionally adapted responses to evolving architectural demands during the colonial period.

Table 1: Comparative Analysis between other traditional roofing systems

Roofing System	Region	Materials Used	Structural Logic	Climate Suitability	Construction Skill Required	Durability	Maintenance Needs	Source
Jack Arch (Hybrid)	Pan-India (Colonial Sites)	Brick voussoirs, lime mortar, iron/steel joists	Shallow arches between steel beams	High thermal mass; dry/hot regions	Moderate (trained masons)	High	Low	Buchanan (1859); INTACH (2010); ASI (2015–2020)
Madras Terrace	Tamil Nadu, Andhra Pradesh	Timber joists, brick bats, lime plaster	Layered flat roof	Moderate; vulnerable to humidity	High (traditional masons)	Medium	High (frequent plastering)	Sahapedia (2020)
Bamboo & Thatch	Bengal, Northeast India	Bamboo, palm leaves, rope	Lightweight, flexible framing	Excellent for rainfall; poor in heat	Low (vernacular skills)	Low	High	Hardy (2007)
Stone Slabs	Rajasthan, Karnataka	Stone slabs on wooden or stone beams	Post-and-slab spanning	Ideal for arid zones	High (stonemasonry)	High	Low	Venu (2010)
Mangalore Tile Roof	Kerala, Coastal Karnataka	Timber rafters, clay tiles	Sloped rafter-based structure	Excellent for monsoons; ventilated	High (carpentry)	Medium	Moderate	Sahapedia (2020)
Leaf (Patra) Roof	Odisha, Chhattisgarh	Palm or Sal leaves over bamboo framing	Light, temporary over bamboo frame	Moderate rain protection	Low (tribal/vernacular)	Very Low	Very High	Hardy (2007)
Brick Vaulted Roofs	North India (Mughal areas)	Burnt bricks and lime mortar	Vaulted arches or domes	Stable across climates	High (vault specialists)	High	Medium	Metcalf (1989); INTACH (2010)
Slate Roofs	Himachal, Uttarakhand	Slate tiles, timber battens	Pitched roof with overlapping tiles	Excellent for snow and rain	High (hill construction)	High		

This comparative overview illustrates the pluralism and ingenuity of India's roofing traditions. The hybrid Jack Arch system occupies a unique middle ground: it bridges colonial structural rationalism with local material logic. Its relative permanence, structural resilience, and adaptability made it distinct from more ephemeral or climate-specific vernacular systems. While traditional roofs emphasized local resource use and craftsmanship, the Jack Arch offered a structurally efficient and low-maintenance alternative that was modified through indigenous knowledge. This nuanced comparison repositions the Jack Arch not as a foreign import but as an assimilated architectural technology shaped by cross-cultural dialogue.

CONCLUSION

This study concludes that the Jack Arch roofing system, far from being a simple instrument of colonial construction, evolved into a sophisticated hybrid form through its engagement with the Indian subcontinent.

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The paper has demonstrated that its transformation was driven by the pragmatic ingenuity of local craftsmen, who adapted British engineering with regional materials, vernacular building logic, and a deep understanding of climate. The use of hand-moulded bricks, lime-based mortars with traditional additives, and integration with other roofing finishes were not minor alterations but fundamental reinterpretations that created a new, culturally embedded architectural language. By tracing this evolution, this research challenges the dominant historiography of colonial architecture, replacing the narrative of a one-way transfer of technology with a more nuanced story of collaboration, adaptation, and indigenous agency. The Jack Arch thus represents a crucial "missing link" connecting imperial structural rationalism with the material and environmental realities of India. The implications of this re-evaluation are twofold. First, it enriches our approach to heritage conservation, urging us to recognize and preserve these hybrid systems as unique testaments to a shared architectural past. Second, and perhaps more urgently, it provides a valuable precedent for contemporary sustainable design. The adapted Jack Arch serves as a time-tested example of climate-responsive, low-carbon building that prioritizes local resources and craftsmanship model directly relevant to the architectural challenges of today. Ultimately, the Jack Arch is a powerful metaphor for architectural dialogue: a structure built from both blueprints and experience, embodying a confluence of empire and ecosystem.

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