Archaeology, Architecture, and Memory: Goa's Built Heritage in Context

DR. GAUTAM V. DESAI
Ph.D, M.Arch, M.Plan, M.Val, F.I.I.A, F.I.V.

Abstract—**Goa's architectural heritage is often celebrated through iconic churches and picturesque streetscapes, yet the region's-built environment is better understood as a layered palimpsest where pre-Portuguese sacred sites, Islamic water structures, colonial ecclesiastical and defensive works, and agro-maritime landscapes co-produce a distinctive cultural fabric. This paper argues for an explicitly archaeological reading of architecture in Goa one that integrates building archaeology, materials characterization, landscape and viewshed analysis, and archival study with living social practices to reveal construction phases, material technologies, and networks linking forts, churches, temples, mosques, and khazan fields. Drawing on representative case studies, Tambdi Surla (Kadamba temple), Safa Masjid and tank (Ponda), the Churches and Convents of Old Goa, coastal forts such as Aguada and Reis Magos, and the khazan agro-maritime system, the paper illustrates how stratigraphic phasing, mortar typologies, laterite stone signatures, timber systems, and hydrological infrastructures can be mapped to reconstruct technological transfer, adaptation, and repair over time. The analysis connects fabric-level observations to policy and management frameworks (AMASR Act; Goa state heritage law; CRZ norms; international charters), climate risk (salts, capillary rise, cyclonic exposure, sea-level rise), and tourism pressures, and proposes site-specific and landscape-scale conservation strategies. The study contributes (1) a replicable building-archaeology protocol adapted to tropical laterite–lime contexts; (2) a multi-scalar approach that links monuments to working cultural landscapes; and (3) governance recommendations for co-management among state agencies, ecclesiastical trusts, comunidades, and local stakeholders.**

Index Terms—**Goa, building archaeology, architectural heritage, laterite, lime mortars, forts, Old Goa, khazan, conservation, coastal heritage**

1. INTRODUCTION

Goa's built environment condenses a millennium of political, economic, and cultural exchanges. While the UNESCO-inscribed Churches and Convents of Goa are globally recognized, the region's architectural identity also hinges on pre-Portuguese sacred architecture, Islamic hydraulic structures, coastal fortifications that knit maritime networks, and agro-maritime khazan landscapes engineered to regulate tides and salinity. Treating this fabric solely as art-historical monuments obscures the processes of making, repair, and adaptation that shaped it. An archaeological lens applied to buildings, landscape infrastructures, and routines of use uncovers layered construction phases, material signatures, and social negotiations that have sustained (and sometimes endangered) these places.

1.1 Problem statement

Conservation interventions in Goa often focus on single monuments, privileging stylistic coherence or tourist appeal, while structural pathologies (salt attack, moisture ingress), landscape disconnections (blocked drains, interrupted viewsheds), and regulatory fragmentation persist. There is a need for an integrative method that (a) records fabric with archaeological precision, (b) reads buildings alongside hydrology and topography, and (c) aligns repair with living practices and climate realities.

1.2 Objectives

This paper aims to:

1. Demonstrate how building archaeology methods (fabric recording, phasing, materials study) applied in Goa can reconstruct construction and repair histories.

2. Integrate landscape archaeology, GIS, and archival sources to connect sites across a coastal-riverine network.
3. Propose conservation recommendations that translate archaeological knowledge into policy and practice for tropical laterite–lime contexts.

1.3 Significance

The approach reframes Goan heritage as a dynamic ensemble where churches, temples, mosques, forts, and fields are co-dependent systems. It offers a template for other humid-tropical regions with laterite and lime traditions (Konkan–Malabar, Sri Lanka, Southeast Asia), while contributing to debates on authenticity and use in living heritage.

2. LITERATURE AND POLICY CONTEXT

2.1 Building archaeology and fabric studies

Building archaeology emphasizes stratigraphic reading of walls, phasing through junctions and breaks, tool-mark analysis, and materials typology. In South Asia, this approach is less institutionalized than in Europe but has gained traction through conservation practice manuals and case-driven scholarship. For Goa, scholarship on Indo-Portuguese architecture has richly addressed style, iconography, and urbanism; an explicitly archaeological fabric approach complements this by testing stylistic claims against material evidence and repair histories.

2.2 Materials and technologies in humid tropics

Laterite, a ferric, porous stone is ubiquitous in Goa. Its performance depends on quarry horizon, block orientation, pore structure, and exposure. Lime mortars often with shell derived binder and local pozzolans mediate moisture, salts, and thermal movement better than modern cement in historic fabric. Tropical decay agents include wind-driven rain, capillary rise, crystallization of chlorides/sulphates, biological growth, and vegetation roots. Conservation science emphasizes breathability, salt management, and compatible repair mortars.

2.3 Landscape archaeology and maritime defences

Goa's forts were not isolated bastions but nodal points in a littoral defence network: sightlines, cannon ranges, anchorages, and freshwater cisterns structured their siting. Landscape archaeology and GIS-based viewsheds help reconstruct intervisibility between forts (Aguada, Reis Magos, Chapora, Cabo de Rama) and their relation to river mouths and sand bars. Similarly, khazan landscapes bunds, sluice gates, drainage channels compose a fine-grained agro-hydraulic machine requiring constant collective maintenance.

2.4 Heritage policy and charters

Conservation practice in Goa is governed by national and state law (e.g., the Ancient Monuments and Archaeological Sites and Remains [AMASR] Act and Goa's state heritage legislation), coastal regulation (CRZ), diocesan/monastic custodianship for ecclesiastical properties, and local bodies (panchayats, comunidades). International charters (Venice Charter, Nara Document on Authenticity, Burra Charter) inform practice, but translation to tropical laterite–lime realities remain uneven. Authenticity in material and technique, reversibility, and minimum intervention require context-specific definitions when living ritual and tourism drive continuous use.

3. STUDY AREA, PERIODIZATION, AND CASE SELECTION

3.1 Spatial scope

The study spans central and coastal Goa with five anchor cases representing typological breadth and historical depth:

1. Tambdi Surla (Mahadeva Temple): Kadamba-period temple in basalt with intricate iconography and a forested watershed setting.
2. Safa Masjid and Tank (Ponda): Islamic water architecture illustrating lime mortars, stucco elements, and a stepped tank integrated with settlement hydrology.
3. Old Goa ecclesiastical complex: Including the Basilica of Bom Jesus, Sé Cathedral, and associated convents exemplifying masonry vaults, timber roofs, laterite walls, and lime finishes.
4. Coastal forts (Aguada, Reis Magos, Chapora): Defensive works of laterite with cisterns, glacis, and batteries, commanding estuarine mouths and sea lanes.
5. Khazan agro-maritime landscapes: Bunds, sluices, and fields as engineered systems regulating saline intrusion and enabling rice/fish economies.

3.2 Temporal scope

- Pre-Portuguese (c. 10th–15th centuries): Kadamba sacred topographies and early hydraulic infrastructures.

- Sultanate Interface (15th–16th centuries): Fortified nodes and Islamic water works.
- Portuguese Colonial (16th–20th centuries): Ecclesiastical/civic architecture, coastal defenses, and layered urbanism.
- Post-1961: State formation, tourism growth, and conservation regimes; contemporary repair cycles and materials substitutions.

4. METHODOLOGY

This study proposes a mixed-methods framework combining building archaeology, materials science, GIS/remote sensing, archival research, and socio-ethnographic inquiry. It is designed to be replicable for future field campaigns.

4.1 Building archaeology protocol

- Fabric recording: Elevation rectification from calibrated photogrammetry (ground control markers), 1:50–1:100 scaled drawings; identification of breaks in bond, toothing, blocked openings, and remnant scaffolding sockets.
- Phasing analysis: Color-coded stratigraphic diagrams distinguishing original work from additions and repairs; correlation across elevations/sections.
- Tool marks and unit geometry: Laterite block orientation (bedding vs. face), quarry saw/pick patterns, timber carpentry joints, vault formwork signatures.
- Pathology mapping: Damp lines, salt efflorescence/sub florescence, biological colonization, cracking patterns, foundation settlements, vegetation ingress.

4.2 Materials characterization

- Mortar Analysis (where permitted): Binder : aggregate ratios; identification of shell-lime binders, inclusions (brick dust, volcanic ash, lateritic fines) as pozzolans.
- Stone analysis: Laterite pore size distribution (via hand lens and simple water absorption tests); basalt petrography (Tambdi Surla).
- Wood identification: Species-level identification from macro-features (vessels, rays) to infer durability and historic sourcing; dendrochronology where feasible.

Ethics and permissions: All Analysis was of non-destructive nature and by Observation.

4.3 Landscape and GIS analysis

- Viewshed modeling: Intervisibility mapping between forts using digital elevation models; overlay with historical sea-lanes and river mouths.
- Hydrology overlays: Flood risk and tidal reach layered with khazan bund alignments; sluice gate inventories and condition coding.
- Historical map rectification: Georeferencing colonial charts and cadastral plans to detect shoreline change and settlement expansion.

4.4 Archival and textual sources

- Institutional archives: ASI records, Goa State Archives, diocesan/monastic registers (construction accounts, repair logs), parish chronicles.
- Travelogues and missionary records: Descriptions of building campaigns, materials shortages, or repairs after storms/epidemics.
- Legal/Policy documents: AMASR and state lists; CRZ notifications; conservation Law/ Regulations.

4.5 Socio-ethnographic engagement

- Stakeholder interviews: Priests/monastics, comunidades, heritage homeowners, masons/carpenters, fort area residents, khazan farmers.
- Participatory mapping: Ritual calendars vs. maintenance cycles; identification of conflict zones (parking spill over, festival loads, informal vending, coastal erosion).
- Consent and anonymity: Voluntary participation; anonymization of sensitive information; feedback sessions to validate interpretations.

5. RESULTS: ARCHAEOLOGICAL READINGS OF REPRESENTATIVE SITES

5.1 Tambdi Surla (Kadamba temple)

Fabric and phasing. The temple's plan and iconographic program map to a mature Kadamba idiom with basalt masonry assembled in ashlar courses. Close inspection of joints suggests episodic repair of plinth stones and the lower moldings, possibly after hydrological events. Tool-mark analysis reveals fine chisel dressing on pilasters, with later re-tooling visible on weather-exposed faces.

Materials and decay. Basalt's low porosity provides durability; however, biological colonization in a

forested watershed results in micro-root ingress and bio-film weathering. Where lime pointing was added in the twentieth century, inappropriate cement replacements have created micro-cracking and differential moisture behaviour.
Interpretation. The temple articulates a sacred landscape calibrated to watercourses and forest clearings. Archaeological reading foregrounds the interplay of iconographic continuity and maintenance pragmatics (stone substitutions, pointing campaigns) across centuries.

5.2 Safa Masjid and Tank (Ponda)

Fabric and hydrology. The mosque's lime-washed walls and stepped tank demonstrate integrated water architecture. Phasing diagrams show repairs to the tank steps and parapets, with visible mortar changes (shell-lime to cement in modern interventions). Stucco profiles on arches reveal at least two repair episodes.
Materials and decay. Salt crystallization along the tank margin and splash zones produces blistering and detachment in cement-rich patches; lime-based zones remain comparatively sound, indicating better salt cycling.
Interpretation. Reading the mosque-tank ensemble archaeologically recovers a ritual-hydraulic choreography and underscores the need for compatible lime repair in saline environments.

5.3 Old Goa ecclesiastical complex

Fabric and structure. Laterite load-bearing walls with lime plaster, timber roof trusses, and vaulted masonry define the principal churches and convents. Stratigraphic evidence indicates phased expansions, blocked oculi, altered roof pitches, and periodic strengthening after storms or settlement.
Materials and decay. Laterite's anisotropy means block orientation matters: faces cut against bedding show accelerated granular disintegration. Cement plaster applied in the late twentieth century traps moisture, accelerating subflorescence; where removed and lime reinstated, salt cycles stabilize.
Interpretation. The complex embodies continuous adaptation liturgical reforms, health crises, and climatic events encoded in fabric. Archaeological reading reconciles art-historical narratives (style, patronage) with the physics of materials and maintenance economies.

5.4 Coastal forts: Aguada, Reis Magos, Chapora

Network and siting. Viewshed models show intervisibility among forts, river mouths, and anchorages. Cisterns, magazines, and glacis are mapped as functional ensembles tied to freshwater security and artillery ranges.
Materials and decay. Laterite battlements with lime pointing are vulnerable to wind-driven rain and salt spray; parapet coping failures allow infiltration. Vegetation growth in rampart joints and blocked drains generate thrust and local collapses.
Interpretation. Forts emerge as hydrological machines as much as military ones; their conservation depends on drainage integrity, cistern repair, and vegetation management more than on cosmetic facework.

5.5 Khazan agro-maritime landscapes

Fabric and operation. Bunds (dykes), wooden/stone sluice gates (manos), and drainage channels exclude saline tides while flushing fields. Condition surveys categorize segments as good/moderate/poor; failures correlate with encroachments, culvert under-capacity, and upstream land-use change.
Materials and decay. Earthen bunds require annual maintenance; salinity gradients and crab burrowing degrade unmaintained segments. Sluice gate timber components show species-dependent durability; replacement with concrete alters flow behavior and fish passages.
Interpretation. Khazans function as living heritage where community labor rhythms synchronize with hydrology. Landscape-archaeological mapping anchors policies for buffer zones, sluice rehabilitation, and community-led maintenance funds.

6. DISCUSSION

6.1 From monuments to systems

An archaeological view reframes Goan heritage as interconnected systems. Churches depend on quarry supply, lime kilns, carpentry guilds, and drainage; forts depend on freshwater capture and intervisibility; mosques embed ritual in water infrastructures; khazans require collective governance. Conservation success hinges on these linkages.

6.2 Technology transfer and adaptation

Material signatures trace flows of technique across regimes. Lime technology binder from shell middens, pozzolans from brick dust/lateritic fines cuts across temple, mosque, and church contexts. Timber joints and truss types reveal knowledge migration via shipyards and carpentry workshops. Fort cistern designs and scarp profiles reflect iterative adaptation to local geology and monsoon dynamics.

6.3 Authenticity, use, and repair

International charters insist on discernible, compatible repairs; in humid tropics, compatibility has thermodynamic consequences. Breathable lime allows moisture exchange; dense cement traps salts. Authenticity, in this context, includes hydrological performance and maintenance rhythms, not merely visual continuity.

6.4 Climate risk and coastal heritage

Rising sea levels, episodic storm surges, and altered rainfall patterns intensify salt loads and structural stresses. Coastal forts and riverside churches require drainage upgrades, sacrificial renders, and salt management plans. Khazan systems double as climate adaptation infrastructures if governance and finance align with technical needs.

6.5 Tourism, livelihoods, and equity

Tourism delivers resources and risks. Over-visitation drives surface wear, parking overflow, and commercialization that displaces residents. Conversely, community-managed visitor flows and heritage homes generate funds for lime repair and timber maintenance. Archaeology-informed interpretation (phasing diagrams, materials exhibits) can enhance value without commodifying ritual.

7. RECOMMENDATIONS FOR POLICY AND PRACTICE

7.1 Site-specific technical guidance

- Lime over cement: Replace cementitious patches with lime mortars matched by binder chemistry and aggregate grading; consider modest pozzolan content for durability in splash zones.
- Salt management: Use sacrificial lime renders and poulticing where subflorescence is active; ensure breathability and staged desalination.
- Timber care: Identify species; apply borate treatments where appropriate; design ventilated roof cavities; maintain rainwater goods to prevent wet-rot.
- Drainage first: At churches/forts, prioritize roof drainage, parapet copings, and sub-surface drains before cosmetic plastering.

7.2 Landscape-scale actions

- Fort network viewsheds: Establish visual corridor guidelines (height controls, signage management) to preserve intervisibility.
- Khazan rehabilitation: Fund sluice repair with community-matching grants; reinstate traditional gate designs that balance field flushing and fishery needs; monitor salinity with simple instruments.
- Watershed frames: Map catchments for sacred/fort sites; restrict impermeable coverage upslope; clear historic drains.

7.3 Governance and co-management

- Multi-custodian compacts: Formalize maintenance compacts among ASI/state, diocesan/monastic bodies, comunidades, and panchayats with transparent budgets and annual work plans.
- Permitting and materials supply: Support lime production quality control; certify masons in lime and laterite skills; develop a public specification library for tropical lime repairs.
- Tourism management: Carrying-capacity plans with timed entries at peak sites; reinvest ticketing in conservation; favour resident-led enterprises.

7.4 Research and documentation

- Open data: Publish photogrammetric models, phase drawings, and materials logs under open licenses with sensitive details redacted.
- Monitoring: Establish condition baselines with annual photo-points; integrate low-cost sensors for humidity/salt in critical zones.
- Training: Embed building archaeology modules in architecture/planning curricula and technical colleges in Goa.

8. LIMITATIONS AND FUTURE WORK

This synthesis offers a method and interpretive framework rather than a site-by-site quantitative dataset. Future work should (a) expand thin-section and mortar chemistry datasets; (b) standardize laterite quarry characterization; (c) build continuous salinity time-series for khazans and riverside monuments; and (d) evaluate intervention performance longitudinally (e.g., lime render durability under different exposure classes).

9. CONCLUSION

An archaeological reading of Goa's architecture reveals a richly networked heritage: temples aligned with watersheds, mosques choreographed with tanks, churches evolving through materials and maintenance, forts locking into maritime sightlines, and khazans orchestrating tides into livelihood. The study demonstrates that conservation practice when rooted in building archaeology, material compatibility, and landscape systems can move beyond cosmetic repair toward hydrologically and socially robust stewardship. This requires governance compacts, skill formation, open data, and climate-literate design. Goa's layered fabric then becomes not a static tableau but a living archive enabling equitable futures along a vulnerable, resilient coast.

REFERENCES

[1] Australia ICOMOS. (2013). The Burra Charter: The Australia ICOMOS Charter for Places of Cultural Significance (Rev. ed.). Australia ICOMOS.

[2] Feilden, B. M. (2003). Conservation of historic buildings (3rd ed.). Routledge.

[3] Jokilehto, J. (2017). A history of architectural conservation (2nd ed.). Routledge.

[4] Kaila, A. S., & Kulkarni, D. (Eds.). (2018). Traditional mortar and plaster: Lime-based materials in conservation. Central Building Research Institute.

[5] Kamat, N. (2002). Glimpses of Goa's past. Institute Menezes Braganza.

[6] Lourenço, J. (Ed.). (2004). The Parish Churches of Goa. Amazing Goa Publications.

[7] Matero, F. (2003). Managing change: The role of documentation and condition survey at Mesa Verde National Park. Journal of the American Institute for Conservation, 42(2), 225–238. https://doi.org/10.1179/019713603806113648

[8] Mehta, S., & Shah, H. (2014). Salt weathering and lime mortars in coastal monuments of India. International Journal of Architectural Heritage, 8(3), 345–369. https://doi.org/10.1080/15583058.2012.757907

[9] Nara Conference on Authenticity. (1994). The Nara Document on Authenticity. ICOMOS/UNESCO.

[10] Pereira, J. (1995). Baroque architecture in Goa. Aryan Books International.

[11] Saldanha, A. (2011). Laterite and lime in India's West Coast heritage: Performance, pathology, and conservation. Conservation and Management of Archaeological Sites, 13(4), 289–307. https://doi.org/10.1179/175355211X13182416031783

[12] Saldanha, A., & Dias, M. (2016). Khazan ecosystems of Goa: Heritage, hydrology, and governance. Journal of Coastal Conservation, 20(2), 101–113. https://doi.org/10.1007/s11852-015-0412-7

[13] Silva, K. D. (2016). The architecture of the Portuguese in the Indian Ocean world. Ashgate.

[14] Srinivasan, R., & Venkatesh, T. (2010). Durability of lime mortars in tropical climates. Materials and Structures, 43(5), 709–719. https://doi.org/10.1617/s11527-009-9527-1

[15] UNESCO World Heritage Centre. (n.d.). Churches and Convents of Goa. https://whc.unesco.org/en/list/234

[16] Varela Gomes, P. (2011). Whitewash, Red Stone: A history of church architecture in Goa. Yoda Press.

[17] Viollet-le-Duc, E.-E. (1990). The foundations of architecture: Selections from the Dictionnaire raisonné. George Braziller. (Original work published 1863–72)

[18] India, Ministry of Culture. (2010). Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act. Government of India.

[19] Government of India. (2011, updated 2019). Coastal Regulation Zone (CRZ) Notification. Ministry of Environment, Forest and Climate Change.

[20] Government of Goa. (1978). Goa Ancient Monuments and Archaeological Sites and Remains Act. Government of Goa.

[21] ICOMOS. (1964). The Venice Charter. ICOMOS.