Athens Journal of Architecture 2026, 12: 1-37
https://doi.org/10.30958/aja.X-Y-Z

Heavy Lightness: A Comparative Study between Álvaro Siza's Portugal Pavilion and Oscar Niemeyer's Casa das Canoas

*By Salvatore Rugino**

This contribution examines the concept of "heavy lightness" in architecture through a comparative analysis of Álvaro Siza's Portugal Pavilion (1998) and Oscar Niemeyer's Casa das Canoas (1953). While focusing on these two paradigmatic reinforced concrete works, the study situates the phenomenon within a broader historical trajectory extending from classical antiquity to contemporary practice. The research employs a comparative and multidisciplinary approach, integrating technical-constructional analysis, morphological survey, and phenomenological assessment of spatial experiences. The analysis reveals how distinct design strategies—Siza's structural subtraction and Niemeyer's morphological transformation—achieve phenomenologically convergent effects of perceived lightness. Particular attention is devoted to the technical specificities of each work, including the cable-suspended concrete roof of Siza's pavilion and the continuous curved surfaces of Niemeyer's residence. The conclusion positions "heavy lightness" as a critical category for understanding twentieth-century and contemporary architecture, capable of reconciling technical innovation, poetic sensibility, and sustainability.

Keywords: *heavy lightness, Álvaro Siza, Oscar Niemeyer, reinforced concrete, spatial perception, tectonic culture*

Introduction

The concept of "heavy lightness" constitutes one of the most fascinating and complex topics in the history of architecture, representing a paradox inherent in the capacity to transfigure dense materials through technical innovation and design intelligence into an experience of suspension and equilibrium. At its ontological foundation, "heavy lightness" designates a designed condition of phenomenological contradiction: a building's actual structural mass — measurable, gravitationally determined, materially irreducible — is systematically counteracted by a constellation of spatial, structural, and perceptual strategies, so that the observer experiences the material not as inert weight but as suspended, dynamic, or dematerialized presence. The contradiction is not resolved but held in productive tension: matter remains fully present and structurally legible, yet its gravitational character is phenomenologically neutralized[1].

*Adjunct Professor, Department of Civil, Environmental, Architectural Engineering and Mathematics (DICATAM), University of Brescia, Italy.

1. The concept of phenomenological neutralization of gravitational character draws on by Merleau-Ponty M (1945), *Phénoménologie de la perception*. Paris: Gallimard [Eng. trans.: *Phenomenology of Perception*, trans. D. Landes, London: Routledge, 2012], particularly Part II, "The World as

This distinguishes "heavy lightness" from mere visual illusion or decorative lightening — the mass is not concealed, but transfigure[2]. At the operational level, the category identifies three distinct but interacting registers of design intervention. of load-bearing elements — through cantilevers, cable systems, shell geometries, or the suppression of intermediate supports — so that structural weight is redistributed in ways that visually negate the logic of gravity[3]. The second is morphological transformation: the metamorphosis of mass through continuous curvature, plastic fluidity, or formal dynamism, whereby the building's volume appears not to compress the earth beneath it but to emerge from or hover above it[4]. The third is luminous dematerialization: the calibrated modulation of natural and artificial light across concrete or masonry surfaces, which dissolves the perception of material thickness and density into vibration, reflection, and atmospheric diffusion[5].

These three registers may operate independently or, in the most powerful instances, simultaneously and synergistically. At the disciplinary level, "heavy lightness" functions as a comparative framework with transhistorical reach, capable of identifying, across radically different architectural languages and historical periods, the specific design operations through which matter is phenomenologically transfigured[6]. It is therefore neither period-specific nor style-dependent. The Gothic flying buttress, Brunelleschi's pietra serena grid, Borromini's undulating walls, and Niemeyer's continuous curved surfaces all instantiate the category through technically and formally distinct means, yet are unified by the same operative ambition: to ensure that built matter, while preserving its physical and structural integrity, offers itself to perception as something other than weight[7].

Perceived." See also Zumthor P (2006) *Atmospheres: Architectural Environments, Surrounding Objects*. Basel: Birkhäuser, pp. 17–24.

2. The distinction between concealment and transfiguration is grounded in Frampton K (1995) *Studies in Tectonic Culture*. Cambridge, MA: MIT Press, pp. 1–27; and Semper G (1989) *The Four Elements of Architecture and Other Writings*, trans. H.F. Mallgrave and W. Herrmann. Cambridge: Cambridge University Press, for the foundational distinction between structure and cladding (*Bekleidung*) underpinning modern debates on material honesty and perceptual transformation.

3. On tectonic suspension as structural and expressive category, see Engel H (1997) *Structure Systems*. Stuttgart: Hatje Cantz, pp. 234–267. For cable-suspended concrete, see Balmond C (2002) *Informal*. Munich: Prestel, pp. 309–343. See also Rice P (1994) *An Engineer Imagines*. London: Ellipsis, on the relationship between structural economy and spatial poetry.

4. Morphological transformation through curvature is theorized in Forty A (2004) *Words and Buildings: A Vocabulary of Modern Architecture*. London: Thames & Hudson, pp. 149–173. For its instantiation in Niemeyer's work, see Underwood D (1994) *Oscar Niemeyer and the Architecture of Brazil*. New York: Rizzoli, pp. 88–124. The philosophical implications of formal dynamism are explored in Deleuze G and Guattari F (1994) *What Is Philosophy?* trans. H. Tomlinson and G. Burchell. New York: Columbia University Press, pp. 163–200.

5. On luminous dematerialization and light in the phenomenology of concrete surfaces, see Pallasmaa J (2005; expanded ed. 2012) *The Eyes of the Skin: Architecture and the Senses*. Chichester: Wiley, pp. 45–52; Plummer H (1987) *Poetics of Light*. Tokyo: a+u; and Holl S (1996) *Intertwining*. New York: Princeton Architectural Press, pp. 11–40.

6. The transhistorical comparative approach draws on Colquhoun A (1981) *Essays in Architectural Criticism*. Cambridge, MA: MIT Press, pp. 129–144; and Rowe C and Koetter F (1978) *Collage City*. Cambridge, MA: MIT Press, for the transhistorical persistence of spatial types.

7. On the Gothic flying buttress, see Mark R (ed.) (1993) *Architectural Technology up to the Scientific Revolution*. Cambridge, MA: MIT Press, pp. 89–134. On Brunelleschi's *pietra serena* grid, see Battisti E (1981) *Filippo Brunelleschi*. Milan: Electa, pp. 45–98. On Borromini's walls, see

This transhistorical applicability is precisely what confers upon "heavy lightness" the status of an analytical category rather than a period concept or a stylistic label[8]. Critically, the category also presupposes an active observer: "heavy lightness" is not a property of the object alone, but an intersubjective phenomenon arising at the intersection of designed space and embodied perception[9]. It belongs, therefore, to the tradition of architectural phenomenology — from Bachelard's "spiritualization of matter" [10] and Norberg-Schulz's "apparent gravity" [11] to Pallasmaa's multisensory ambiguity[12] and Böhme's "atmospheric architecture"[13] — while simultaneously maintaining a structural and technical grounding that prevents it from dissolving into pure aesthetics. It is this dual anchorage — in measurable tectonic reality and in lived phenomenological experience — that makes "heavy lightness" a genuinely operative category: one that can orient both the critical reading of existing works and the design intelligence of new ones[14]. Far from being a twentieth-century invention, this dialectic has traversed architecture from classical antiquity to contemporary practice, manifesting itself in diverse formal and technical solutions united by the same aspiration: to transcend the apparent limits of matter in order to create spaces that elevate the human spirit[15].

The historical depth of this phenomenon is evident in numerous canonical examples that demonstrate how each epoch has sought, with the technical and cultural means at its disposal, to resolve the contradiction between structural

---

Portoghesi P (1967) *Borromini: Architettura come linguaggio*. Milan: Electa, pp. 112–167. On Niemeyer's curves, see Comas CED (2010) *Oscar Niemeyer: Curves of Irreverence*. New Haven: Yale University Press, pp. 23–67.

8. The distinction between an analytical category and a period concept is developed in Panofsky E (1955) *Meaning in the Visual Arts*. Garden City, NY: Doubleday, pp. 1–31; and Eisenman P (1984) The End of the Classical. *Perspecta* 21: 154–173.

9. The intersubjective constitution of architectural experience is theorized in Böhme G (2017) *Atmospheric Architectures*. London: Bloomsbury, pp. 12–29; Seamon D (2024) Architecture and Phenomenology. In: Lu D (ed.) *The Routledge Companion to Contemporary Architectural History*. London: Routledge, pp. 1–14; and Relph E (1976) *Place and Placelessness*. London: Pion, pp. 1–56.

10. Bachelard G (1948) *La terre et les rêveries de la volonté*. Paris: José Corti, particularly ch. IX, "La dureté, le dur et le durci," pp. 214–247. See also Bachelard G (1958) *La poétique de l'espace*. Paris: PUF [Eng. trans.: *The Poetics of Space*, trans. M. Jolas, Boston: Beacon Press, 1969].

11. Norberg-Schulz C (1979) *Genius Loci: Towards a Phenomenology of Architecture*. New York: Rizzoli, pp. 14–23. See also Norberg-Schulz C (1988) *Architecture: Meaning and Place*. New York: Rizzoli, pp. 34–56.

12. Pallasmaa J (2005; expanded ed. 2012) *The Eyes of the Skin: Architecture and the Senses*. Chichester: Wiley, pp. 10–30. See also Pallasmaa J (2009) *The Thinking Hand: Existential and Embodied Wisdom in Architecture*. Chichester: Wiley, pp. 87–112.

13. Böhme G (2017) *Atmospheric Architectures*. London: Bloomsbury, pp. 87–104. For the original formulation, see Böhme G (1993) Atmosphere as the Fundamental Concept of a New Aesthetics. *Thesis Eleven* 36: 113–126.

14. The dual function of an operative category is argued in Moneo R (1978) On Typology. *Oppositions* 13: 22–45; and Gregotti V (1996) *Inside Architecture*, trans. P. Ghirardo and E. Ghirardo. Cambridge, MA: MIT Press, pp. 34–58.

15. On the transhistorical trajectory of the weight-lightness dialectic, see Frampton K (1995) *Studies in Tectonic Culture*, cit., pp. 1–27; Giedion S (1941; rev. ed. 1967) *Space, Time and Architecture*. Cambridge, MA: Harvard University Press; Banham R (1960) *Theory and Design in the First Machine Age*. London: The Architectural Press, pp. 320–330; and Rykwert J (1996) *The Dancing Column: On Order in Architecture*. Cambridge, MA: MIT Press, pp. 1–45.

necessity and aspiration to lightness. The Caryatids of the Erechtheion on the Athenian Acropolis (421–406 BCE) perhaps represent the first and most eloquent manifestation of this tension: the female figures appear to support the entablature effortlessly while maintaining a graceful and natural pose, transforming lithic weight into human presence and structural support into choreographic gesture.

Figure 1. *Porch of the Caryatids, Erechtheion, Acropolis of Athens (421-406 BCE). The Female Figures support the Entablature, transforming Lithic Weight into Choreographic Gesture*
Source: S. Rugino.

Gothic architecture brought this research to even more radical consequences. The slender columns, flying buttresses, and ribbed vaults of the great medieval cathedrals literally dissolved the massive Romanesque stone walls into luminous screens, transforming the sacred edifice into a cage of light where matter seemed to volatilize into pure spiritual transcendence. The flying buttresses, in particular, represent a masterpiece of constructive intelligence: by rendering explicit on the exterior the system of thrusts and counterthrusts that sustains the nave, they liberate the interior from all structural encumbrance, permitting almost entirely glazed walls that negate the very perception of mural mass.

In the Florentine Renaissance, Filippo Brunelleschi (1377–1446) elaborated subtler but no less effective strategies. The small columns that "disappear into the walls" in his architectures — visible in the Old Sacristy of San Lorenzo (1421–1428), the Pazzi Chapel (1429–1461), and the Ospedale degli Innocenti (1419–1427) — represent an operation of refined perceptual ambiguity: the gray *pietra serena* of the

architectural members stands out against the white plaster of the walls, creating a visual grid that articulates space without oppressing it. The load-bearing elements are not hidden but sublimated into a geometric design of such purity as to appear almost two-dimensional, as if the architecture were a spatial theorem rather than a material construction.

The dome of Santa Maria del Fiore (1420–1436), with its self-supporting double shell and hidden wooden chains, represents the culmination of this research: an enormous mass of brick that seems to rest with impossible lightness on the octagonal drum, defying both gravity and the constructive conventions of the time.

Figure 2. *Filippo Brunelleschi, Dome of Santa Maria del Fiore, Florence (1420-1436). The Brick Mass seems to rest with Impossible Lightness on the Octagonal Drum*
Source: S. Rugino

Italian Mannerism of the sixteenth century explored the weight-lightness tension through deliberate structural inversions and visual paradoxes that questioned Renaissance certainties. In Michelangelo's Laurentian Library (1524–1559), the columns of the *ricetto* do not support but are supported, set into wall niches that invert the traditional relationship between support and load; the corbels beneath the paired columns project without anything to bear; the staircase seems to flow downward like petrified *lava*.

Figure 3. *Michelangelo,* Ricetto *of the Laurentian Library, Florence (1524-1559). The engaged Columns Set within recessed Niches Reverse the conventional Hierarchical Relationship between Structural Support and Load*
Source: S. Rugino

Giulio Romano, in Palazzo Te in Mantua (1524–1534), inserted triglyphs that slip out of place and keystones that appear to yield, creating an architecture of disquiet where apparent stability is constantly threatened. These "licenses" were not errors but sophisticated reflections on the conventionality of architectural languages and the possibility of manipulating the perception of weight through design.

The dissolution of corners in many seventeenth-century buildings represents a further chapter in this history. Francesco Borromini (1599–1667), in works such as San Carlo alle Quattro Fontane (1638–1641) and Sant'Ivo alla Sapienza (1642–1660), bent walls into continuous undulations that eliminate every angular caesura, transforming the traditional mural box into a pulsating organism where interior and exterior, concave and convex, interpenetrate in perpetual movement. Matter seems

to lose its rigidity to acquire an almost organic fluidity, anticipating by three centuries the plastic experimentations of reinforced concrete.

Figure 4. *Francesco Borromini, San Carlo alle Quattro Fontane, Rome (1638-1641). The walls inflect into continuous undulating surfaces, anticipating the formal plasticity achievable with reinforced concrete*
Source: S. Rugino

Guarino Guarini (1624–1683), in the Chapel of the Holy Shroud in Turin (1668–1694), stratified arches and ribs in a vertiginous ascending spiral where each element seems to float above the one beneath, dissolving the perception of weight into pure luminous geometry.

The visionary engravings of Giovanni Battista Piranesi (1720–1778), particularly the *Carceri d'invenzione*, brought this dialectic to its theoretical extreme: impossible

architectures where conventional structural relationships are abolished. His visions profoundly influenced subsequent architectural imagination.

These precedents establish "heavy lightness" as a longue durée theme in Western architectural culture, a red thread connecting apparently distant experiences unified by the same aspiration: to ensure that matter, while preserving its physical presence and actual weight, offers itself to perception as suspended, dynamic, potentially volatile. With the advent of reinforced concrete in the twentieth century, this millennial aspiration found not its origin — as has often been erroneously claimed — but a renewed and more radical possibility of expression, thanks to the technical characteristics of a material capable of working simultaneously in compression and tension, spanning previously unthinkable distances with minimal thicknesses, assuming any form that formwork can contain.

The theoretical foundation of "heavy lightness" draws upon the phenomenological reflections of French philosopher Gaston Bachelard (1884–1962), who spoke of a "spiritualization of matter" in his seminal work *La terre et les rêveries de la volonté* (1948). For Bachelard, matter[16] is never inert objectivity but always dreamed substance, imagined, transformed by the consciousness that inhabits it; architecture becomes authentic only when the physicality of the environment is experienced as an imaginative and memorial dimension, when walls cease to be mere boundaries to become membranes between inside and outside, between body and world, between present and memory.

This "overcoming" of material limits — which Bachelard investigates through the images of stone, cave, and crystal — resonates profoundly with what Italian writer Italo Calvino (1923–1985) defined as "lightness of thought" in his *Lezioni americane* (1988). For Calvino, lightness is not superficiality or evasion but the capacity to grasp the complexity of reality while maintaining a dynamic and non-oppressive equilibrium with matter; it is the quality of Perseus who defeats Medusa by avoiding looking at her directly, reflecting her in his polished shield. "My working method has more often than not involved the subtraction of weight", writes Calvino; "I have tried to remove weight, sometimes from people, sometimes from heavenly bodies, sometimes from cities; above all I have tried to remove weight from the structure of stories and from language". This subtraction does not eliminate substance but transfigures it, rendering it bearable, habitable, poetic[17] — exactly what the architecture of "heavy lightness" pursues with respect to built matter.

In recent years, reflection on architectural phenomenology has experienced renewed interest, with studies that reread the relationship between body, light, and matter as the central nucleus of spatial experience. In particular, recent contributions on the phenomenology of light demonstrate how the articulation of concrete surfaces and envelopes can transform structural weight into a perceptual condition

16. Bachelard G (1994) *La terra e il riposo. Un viaggio tra le immagini dell'intimità*. Milano: Red Edizioni.

17. Calvino I (1988) *Lezioni americane: Sei proposte per il prossimo millennio*. Milano: Garzanti, p. 7.

of suspension, confirming the centrality of the theme of heavy lightness in contemporary debates on architectural "atmosphere"[18].

The technological revolution of reinforced concrete represented an epochal turning point in this millennial history: it liberated architecture from traditional structural constraints — the pure compression of stone, the limited free span of wood, the modular rigidity of iron — enabling forms and spaces previously literally unthinkable and drastically redefining both constructive practice and the very perception of dwelling. Reinforced concrete, born from the encounter between the compressive resistance of cementitious mortar and the tensile resistance of steel bars, created a hybrid, almost alchemical material capable of behaving statically as a single monolithic body while combining the properties of two radically different substances.

As Swiss-American historian Sigfried Giedion (1888–1968) demonstrated in his monumental work *Space, Time and Architecture: The Growth of a New Tradition* (1954), reinforced concrete[19] is not simply a new building material but the foundation of a new conception of space: it permits the construction of structures that openly defy gravity through cantilevers, brackets, self-supporting curved surfaces; it enables formal continuity between horizontal and vertical elements, between walls and roofs, between interior and exterior; it dissolves the perception of material heaviness into a new spatial experience — dynamic, fluid — where the boundary between structure and envelope, between bearing and borne, becomes increasingly labile. Le Corbusier's "five points of a new architecture" (pilotis, roof garden, free plan, ribbon window, free façade) — all made possible by reinforced concrete — represent the codification of this perceptual revolution: the building rises from the ground, walls are freed from their load-bearing function, interior space flows without interruption.

British architectural historian Reyner Banham (1922–1988), in *Theory and Design in the First Machine Age* (1960), further elaborated how modern materials[20] — reinforced concrete, steel, glass — fundamentally altered the relationship between structure and expression, between constructive truth and formal appearance. For Banham, the architectural twentieth century is marked by the unresolved tension between the ethics of "structural honesty" — showing what the building is —a nd the temptation of "formal freedom" —making the building what one desires. Reinforced concrete exacerbates this tension because it is a material that can be molded into any form: it can feign the lightness of a sail or the heaviness of a bunker, can imitate stone or metal, can hide its structure or exhibit it brutally. This almost infinite versatility has opened the field to experimentations that have made "heavy lightness" no longer an exception or a tour de force but an ordinary design possibility, accessible to anyone who can master the language of concrete. From Auguste Perret to Pier Luigi Nervi, from Félix Candela to Eero Saarinen, from

18. Liu Q (2024) *Architectural Phenomenology: Past, Present and Future Direction*s. Architectural Studies 18(1), pp. 1–23.

19. Giedion S (1954) *Spazio, tempo ed architettura. Lo sviluppo di una nuova tradizione*. Milano: Hoepli.

20. Banham R (1960) *Theory and Design in the First Machine Age*. London: The Architectural Press.

Tadao Ando to Zaha Hadid, the history of twentieth-century and contemporary architecture can be read as a continuous exploration of the possibilities offered by this protean material to conjugate mass and lightness, weight and suspension, terrestrial gravity and celestial aspiration.

In this context of renewed expressivity of reinforced concrete, architects Álvaro Siza Vieira (b. 1933) and Oscar Niemeyer (1907–2012) represent two emblematic but distinct approaches to the dialectic between weight and lightness, two voices that have been able to decline in profoundly personal ways the challenge of transfiguring built mass into an experience of suspension and levity. Both developed their practice in countries of Latin culture — Portugal and Brazil respectively — characterized by a critical and creative appropriation of European modernism, filtered through local sensibilities, specific climatic conditions, and rooted constructive traditions. This common belonging to a "creative periphery" of modernism — distant from the canonical centers of Paris, Berlin, or Chicago — allowed both architects to elaborate original languages, free from functionalist orthodoxy while remaining faithful to the fundamental principles of architectural modernity.

Álvaro Siza, trained in the tradition of the Porto School under the guidance of Fernando Távora, manifests what Kenneth Frampton has defined as "critical modernism" or "critical regionalism": an approach that combines the rationalist rigor[21] of the European legacy with the Mediterranean and Atlantic culture of Portugal, simultaneously drawing upon local constructive tradition and international avant-gardes. His architecture arises from a patient dialogue with context — topographic, climatic, cultural — which translates into works where geometric rigor is never abstract but always rooted in the specific place. The apparently simple geometries of his plans and sections actually conceal complex mediations between functional requirements, site constraints, routes, and landscape views. The weight of concrete, in Siza's hands, dissolves not through structural virtuosity or formal acrobatics, but through proportional purity, millimetric calibration of openings, masterful control of natural light that sculpts interior surfaces, transforming them into vibrant screens. As Rafael Moneo has observed, in Siza's work "mass dissolves in perceptual experience"[22] not because it is denied or hidden, but because it is sublimated into a higher order where each element finds its necessity.

Siza's training at the Escola Superior de Belas Artes do Porto in the 1950s exposed him to an intellectual environment that rejected both nostalgic provincialism and uncritical importation of international models. Távora, his teacher and later colleague, maintained that modernism should be intimately linked to local cultural and technological identity: it was not about applying prefabricated formulas but reinventing modernity from the concrete conditions of building in Portugal. This lesson has profoundly permeated Siza's work, which has always rejected both formalism for its own sake and reductive functionalism, seeking instead a synthesis where form emerges from the patient resolution of specific problems. His approach to reinforced concrete reflects this philosophy: the material is never brutally

21. Frampton K (1995) *Studies in Tectonic Culture: The Poetics of Construction in Nineteenth and Twentieth Century Architecture*. Cambridge, MA: MIT Press, pp. 298-334.

22. Moneo R (2004) *Theoretical Anxiety and Design Strategies in the Work of Eight Contemporary Architects*. Cambridge, MA: MIT Press, p. 199.

exhibited nor dissimulated under cladding, but treated with a sobriety that exalts its intrinsic qualities — plasticity, the capacity to assume any form, the possibility of creating continuous surfaces that modulate light.

Oscar Niemeyer, by contrast, represents a "tropical modernism" that radically transformed the European rationalist grammar into a plastic, sensual, and profoundly original vocabulary. Trained at the Escola Nacional de Belas Artes in Rio de Janeiro in Lúcio Costa's atelier — himself a privileged interpreter of Le Corbusier in Brazil — Niemeyer absorbed the principles of international modernism but subjected them from the outset to a metamorphosis that rendered them unrecognizable. Where European rationalism privileged the right angle, the modular grid, serial repetition, Niemeyer introduced the free curve, the organic form, the sculptural gesture. "It is not the right angle that attracts me", he famously declared, "nor the straight line, hard, inflexible, created by man. What attracts me is the free and sensual curve, the curve I find in the mountains of my country, in the sinuous course of its rivers, in the waves of the sea, in the body of the beloved woman"[23].

This poetic declaration should not be misunderstood as mere aestheticism: the Niemeyerian curve is always structurally motivated, derived from the intrinsic possibilities of reinforced concrete to assume forms that other materials would not allow. Niemeyer's "tropical modernism" celebrates the formal freedom guaranteed by concrete not as caprice but as an appropriate response to the Brazilian climate (curves create shadows, deflect winds, collect rain), to local culture (the baroque sensuality of colonial churches, the fluidity of music and dance), to the landscape (Rio's mountains, the coastal curves, luxuriant vegetation). His works do not impose themselves on context but dance with it, establishing formal resonances that render architecture an integral part of the natural and cultural landscape.

The search for lightness in Niemeyer assumes radically different characters from that of Siza. Where the Portuguese architect pursues lightness through subtraction — eliminating everything non-essential until reaching an almost ascetic purity — Niemeyer obtains it through transformation: mass is not reduced but metamorphosed, rendered fluid, dynamic, apparently in movement. His buildings do not seem to weigh upon the earth but to emerge from it like geological or vegetal formations, or to hover above it like winged creatures. Columns attenuate until becoming almost filiform, roofs curve like sails swollen by wind, walls undulate like sand dunes. Reinforced concrete, in his hands, loses all connotation of heaviness and rigidity to acquire an almost liquid quality, as if it had been poured into forms and then solidified at the instant of maximum dynamism.

An illuminating comparison can be drawn between the two architects through their relationship with Le Corbusier, a tutelary figure for both but interpreted in diametrically opposed ways. Siza absorbed from the Swiss-French master especially the compositional discipline, proportional rigor, attention to the promenade architecturale, developing them in a direction of increasing essentiality and contextual rootedness. Niemeyer, who collaborated directly with Le Corbusier on the project for the Ministry of Education in Rio de Janeiro (1936–1943) and the plan for the

23. Cfr. in C.E.D. Comas, *Oscar Niemeyer: Curves of Irreverence*, Yale University Press, New Haven 2010, p. 45.

United Nations in New York (1947), instead grasped the freer and more poetic component — that of Ronchamp and Chandigarh — bringing it to consequences that Le Corbusier himself might not have imagined. If Siza represents the "Apollonian" legacy of modernism — order, measure, proportion — Niemeyer embodies its "Dionysian" aspect — formal inebriation, sensuality, transcendence of limits.

This comparative research between Siza's Portuguese Pavilion, realized for the 1998 World Exposition in Lisbon, and Niemeyer's Casa das Canoas, built in 1953 in the mountains above Rio de Janeiro, analyzes two moments of synthesis of the respective design philosophies, two works that condense in paradigmatic form decades of research on the transfiguration of weight into lightness. The choice of these two case studies is not arbitrary: both works represent culminating points in the trajectories of their respective authors, moments when technical and conceptual maturity permits the achievement of results of particular expressive intensity.

The Portuguese Pavilion is distinguished by its large suspended roof of approximately 3,000 m² — one of the largest reinforced concrete slabs ever realized without intermediate supports — sustained solely by two thin longitudinal walls placed 65 meters apart. This apparently impossible configuration creates an emblematic volume of extraordinary emotional power, a covered public space where the mass of concrete seems literally to vanish in the perception of an "artificial sky". The roof, with its slightly curved catenary profile and thickness varying from 20 centimeters at the center to 90 centimeters at the supports, offers itself to the gaze as a veil stretched between two mural wings, visually denying its structural weight while unequivocally affirming its material presence. The effect is that of a suspension of perceptual judgment: the observer knows that surface weighs thousands of tons, yet sees it as suspended, almost floating in air. It is precisely in this gap between rational knowledge and sensory perception that "heavy lightness" manifests itself in its purest form.

The pavilion was commissioned from Siza to represent Portugal at Expo '98, dedicated to the theme of oceans — a symbolically charged occasion for a country whose historical identity is indissolubly linked to maritime navigation and discoveries. Siza responded to this representative challenge not with explicit iconography but with an architecture that evokes the sea through purely spatial means: the suspended roof recalls a sail swollen by wind, but also the water's surface seen from below, or a clouded sky that protects without oppressing. Conceived to host institutional events and ceremonial representations, the covered plaza of the pavilion has become over time one of Lisbon's most vital public spaces, demonstrating how "heavy lightness" can generate architectures capable of taking deep root in the life of the city.

Casa das Canoas, built over forty years before Siza's pavilion, exemplifies with equal eloquence Niemeyer's capacity to dissolve traditional boundaries between load-bearing structure, architectural envelope, and interior space, generating an environment that appears sculpted from matter rather than simply constructed from assembled elements. The residence, designed by Niemeyer as his personal residence, is situated on a hillside site in the São Conrado district of Rio de Janeiro with views of the Serra dos Órgãos, and Niemeyer masterfully exploited this topographic condition to create a building that seems to emerge organically from

the mountain landscape. The curved reinforced concrete walls do not simply delimit spaces but model them as a ceramist models clay, creating fluid environments where it is impossible to distinguish where structure ends and envelope begins.

The domestic programv—vspaces for living, bedrooms, services — is completely reinvented through spatial fluidity: environments are not juxtaposed boxes but intercommunicating cavities, separated by walls that never reach the ceiling or that curve to create niches, alcoves, unexpected expansions. Natural light, filtered by ample glazing that frames the landscape, penetrates interior spaces creating chiaroscuro effects that change continuously during the day, animating curved surfaces with a play of shadows in perpetual movement.

Despite evident differences in scale and program — a national representative pavilion versus a private residence, a monumental public space versus an intimate dwelling, a state commission versus a private commission — both works offer paradigmatic insights into how "heavy lightness" operates as a critical category for understanding and interpreting twentieth-century and contemporary architecture. The differences themselves are illuminating: they demonstrate how the dialectic between weight and lightness is not tied to a specific scale or particular typology, but transversally traverses the entire field of architecture, manifesting itself with equal intensity in public monument and private house, in the space of collectivity and that of domestic intimacy.

The comparison between the two works also reveals how "heavy lightness" is not a replicable formula but a problem to be resolved each time in a specific way, through design strategies that depend on site conditions, functional program, available technologies, and the author's expressive intentions. Siza and Niemeyer arrive at phenomenologically convergent resultsv—vboth create spaces where reinforced concrete transcends its material heavinessv—vbut through radically different paths: subtraction and essentiality for Siza, transformation and metamorphosis for Niemeyer. This divergence of methods and convergence of results suggests that "heavy lightness" is a potentially transversal category of architectural experience, one that appears applicable across different formal languages and scales, and recognizable by the peculiar perceptual quality of the space it produces — a space where matter, while fully present, seems to have transcended its gravitational limits.

Literature Review

The Dialectic between Heaviness and Lightness in Architectural History

The dialectical relationship between weight and lightness represents one of the most complex and enduring theoretical nodes in architecture. Its roots extend to the classical tradition articulated by Marcus Vitruvius Pollio (c. 80–15 BCE), who established the equilibrium between *firmitas* (structural solidity) and *venustas* (aesthetic beauty) as essential for architectural quality. This equilibrium, however, remained relatively static until the twentieth century, conditioned by traditional technologies and materials such as stone and brick.

The French poet and philosopher Paul Valéry (1871–1945), in his 1921 essay *Eupalinos ou l'Architecte*[24], introduced a crucial distinction between "physical weight" and "perceptual weight", anticipating the importance of perceptual psychology applied to architecture. For Valéry, the architectural work manifests its maximum potency when it renders a heavy mass as "heaviness without weight" — a formulation that prefigures contemporary phenomenological approaches.

The Norwegian architectural theorist Christian Norberg-Schulz (1926–2000), in *Genius Loci: Towards a Phenomenology of Architecture* (1979), developed[25] this duality by emphasizing "apparent gravity" — that perceived by the inhabitant — as one of the distinctive phenomenological characteristics of modern architecture. He clearly distinguishes between merely physical weight and dynamic, subjective weight, demonstrating how design capacity resides precisely in manipulating this second dimension through spatial, material, and luminous strategies.

The Finnish architect and theorist Juhani Pallasmaa (b. 1936), in *The Eyes of the Skin: Architecture and the Senses* (2005; expanded edition 2012), has deepened the theme of multisensory perception, highlighting how the perceived lightness of reinforced concrete derives from a complex sensory ambiguity[26]: although the material proves heavy to the touch due to its rough surface, it can appear visually light thanks to its form and the effect of light. This dual nature of the material broadens the understanding of heaviness as a complex and engaging experience.

More recently, Pallasmaa has developed these themes in "The Atmospheric Sense" (2019), emphasizing the role of peripheral perception in architectural experience, and in *Rootedness: Reflections for Young Architects* (2024), where he articulates the necessity of an architecture founded on ethical responsibility and reconnection with the environment.

The French anthropologist Marc Augé (1935–2023) introduced the concept of "fluid density" to describe a new dimension of architectural spaces realized with heavy materials that, through design, achieve experiences of lightness and aerial flow, characterized by fluid and dynamic spatial traversal. The British-American architectural historian Kenneth Frampton (b. 1930), in his influential *Studies in Tectonic Culture* (1995), has provided essential theoretical frameworks for understanding how material expression and structural logic combine to produce architectural meaning, distinguishing between "tectonic" (frame-based) and "stereotomic" (mass-based) approaches to construction[27].

The German philosopher Gernot Böhme (1937–2022) provided a fundamental contribution to the phenomenological understanding of architectural space through the concept of "atmosphere". In *Atmospheric Architectures: The Aesthetics of Felt Spaces* (2017), Böhme articulates how atmosphere—understood as "tuned space" — constitutes the primary modality through which we perceive built environments. This perspective enriches the understanding of "heavy lightness" as a phenomenon that operates in the atmospheric sphere, where the perception of weight is not an objective property but a diffused quality of felt space.

24. Valéry P (2011) *Eupalinos o l'architetto*. Milano-Udine: Mimesis.
25. Norberg-Schulz C (1997) *Genius Loci. Paesaggio ambiente architettura*. Milano: Electa.
26. Pallasmaa J (2007) *Gli occhi della pelle. L'architettura e i sensi*. Milano: Jaca Book.
27. Frampton K (1995) *Studies in Tectonic Culture*, cit.

Within the twentieth century, particular attention merits the exploration of contradictory relationships between non-load-bearing elements and transparent materials such as glass, a dialectic that has produced some of the most significant reflections on the nature of "heavy lightness" in architecture. A central figure in this research is James Stirling (1926–1992), British architect and 1981 Pritzker Prize laureate, who developed an architectural language founded on the tension between weight and transparency, positioning himself in open opposition to orthodox modernism. The Engineering Building at Leicester (1959–1963), designed with James Gowan, constitutes the emblematic example of this approach: massive volumes in red brick, evocative of Victorian industry, are counterposed to glazed surfaces inclined at 45 degrees that seem to defy gravity. The contrast between opaque towers and transparent classrooms is deliberately strident, as the architect seeks not harmony but exalts the dialectic between opposites, thus anticipating the strategies of critical postmodernism. Stirling's legacy resides precisely in having demonstrated that the weight-lightness relationship can be explored not only through structural lightening, as in the works of Nervi or Candela, but also through the provocative juxtaposition of materials with opposite qualities, transforming the contrast itself into an expressive instrument.

The Portuguese Tradition and the contribution of Álvaro Siza

The work of Álvaro Siza is solidly positioned within the constructive tradition of the "Porto School", a movement rooted in the capacity to conjugate international modernism with a Mediterranean and Atlantic cultural identity, developing a dialectical and critical relationship with Modernism. This school expresses an architecture profoundly rooted in context, yet simultaneously open to global influences. Siza, together with prominent figures such as Fernando Távora (1923–2005) and Eduardo Souto de Moura (b. 1952), promotes a "rooted modernism" that surpasses passive acceptance of functionalist canons, reinterpreting innovation in local terms and valorizing the design culture and constructive traditions of the territory.

Kenneth Frampton defines this poetics as a virtuous synthesis between the rigor typical of Northern Europe and the plasticity characteristic of Southern Europe, where the structural component is not mere technique but translates into a poetic language capable of expressing technological authenticity and aesthetic quality.

A crucial but often neglected influence on Siza's approach to "heavy lightness" is the work of Antoni Gaudí (1852–1926), the visionary Catalan architect whose research on structural form represents one of the highest peaks of constructive innovation between the nineteenth and twentieth centuries. Siza himself has acknowledged this debt on numerous occasions, stating with particular eloquence that from Gaudí he learned that "plumbing, steel tubes and stone could dance, as if levitating". This declaration reveals a profound understanding of what makes Gaudí's work so singular: the capacity to make the heaviest materials — stone, brick, iron — appear endowed with an internal dynamism that makes them appear

in perpetual movement, suspended in an equilibrium that defies conventional expectations about architectural stasis.

The recognition of this debt connects Siza's research on lightness to a broader and more ancient Mediterranean tradition of organic and expressive structural form, extending well beyond the rationalist legacy typically associated with the Porto School. Gaudí represents the antithesis of rationalism, yet his architecture, inspired by nature and organic forms, is founded on a rigorous structural logic in which every curve responds to the flow of forces. In his works, stone and brick are transfigured into forms that evoke waves, bones, geological formations: weight is exhibited in the materiality of surfaces but simultaneously negated by the dynamic form that seems to animate inert matter.

This lesson did not escape Siza, who operates in an antithetical formal register: where Gaudí is exuberant, Siza is sober; where Gaudí accumulates, Siza subtracts. Yet they share a profound sensibility: the awareness that architecture is not mere construction but the creation of spatial presences capable of evoking emotions, memories, moods — and that materials can transcend their physical nature through the intelligence of form.

The theme of "heavy lightness" pervades Siza's work beyond the Portuguese Pavilion. Casa Cardoso (1988–1994) in Moledo exemplifies his capacity to integrate heavy concrete volumes with the landscape through careful positioning and proportioning. Casa Beires (1973–1976) in Póvoa de Varzim demonstrates early explorations of how geometric manipulation can visually lighten massive forms. The residential ensemble in The Hague (1984–1988) shows his ability to create urban monuments that seem to float despite their substantial mass. The Galician Center of Contemporary Art in Santiago de Compostela (1988–1993) masterfully resolves the apparent contradiction between the granite-clad mass that responds to the historic context and the luminous, weightless quality of its interior spaces. These works collectively reveal a sustained investigation into how design intelligence can transcend material heaviness.

The recent monograph *Before/After: Álvaro Siza Duccio Malagamba* (Phaidon, 2024) documents twenty projects from Siza's career, confirming the persistence of his research on lightness through minimalist forms and masterful control of light.

The Spanish architect and theorist Rafael Moneo (b. 1937) explicitly describes this duality as a tension between *gravitas* and *levitas*, using the expression[28] "transparent density" to define Siza's capacity to create walls and roofs that, rather than oppress, liberate space, generating a new spatiality within apparent heaviness. The Italian architect and critic Vittorio Gregotti (1927–2020) emphasizes how this quality of lightness does not translate into a decorative presence or mere functionalist architecture, but rather represents the manifestation of a conception of architecture as the art of building and as a complex experience, where technique and poetry are profoundly interwoven[29].

28. Testa P (1996) *The Architecture of Álvaro Siza*. Porto: Faculdade de Arquitectura da Universidade do Porto.

29. Gregotti V (1996) *Dentro l'architettura*. Torino: Bollati Boringhieri.

The Poetic-plastic Modernity of Oscar Niemeyer

Oscar Niemeyer represents another pole of the fusion between weight and lightness in architecture, with a contribution of primary importance in the context of Brazilian and international modernism. He profoundly influenced twentieth-century architectural culture by advancing a poetic and sculptural use of reinforced concrete. His training at the Escola Nacional de Belas Artes in Rio de Janeiro, in the atelier of Lúcio Costa (1902–1998) — himself a collaborator of Le Corbusier — favored the emergence of a "tropical modernism" adapted to Brazilian climate and culture.

The French architectural historian Yves Bruand (b. 1926), in *Arquitetura Contemporânea no Brasil* (1981), identified in Niemeyer[30] the capacity to liberate concrete from its intrinsic gravity through the fluidity and continuous geomorphy of his surfaces, transforming it from rigid constructive matter into plastic material in movement. This transformation makes Niemeyerian architecture a sort of three-dimensional dance, in which form defies the laws of gravity and becomes emotional and symbolic experience.

The Greek-American architect and critic Stamo Papadaki (1906–1992), in *Oscar Niemeyer: Works in Progress* (1950)[31], and Brazilian curator Lauro Cavalcanti[32] emphasize the sculptural, almost baroque dimension of Niemeyer's work, where structure becomes form and form becomes spatial experience, creating environments that seem to possess what has been defined as "choreographic structure", where architecture directs fluidly modulated space as in a choreography. The Brazilian-Argentine architect and historian Roberto Segre (1934–2018)[33], in *Arquitetura Contemporânea no Brasil* (1999; previous edition 1986)[34], indicates Casa das Canoas as an example of equilibrium between formal research and functionality, demonstrating the poetic transformation of everyday programs into occasions for spatial innovation.

Critical Comparisons and Future Research Directions

Despite evident analogies in both architects' capacity to transform material weight into a perceived experience of lightness, the literature that directly relates Álvaro Siza and Oscar Niemeyer remains surprisingly limited. Much of the available scholarship tends to privilege approaches of a stylistic, formal, or biographical nature, neglecting a deeper analysis of the sensory and phenomenological dimension that significantly characterizes their respective design poetics. Both authors share, albeit through different formal languages, a profound interest in constructing a spatial experience that transcends the mere materiality of architecture, triggering perceptual dynamics that border on lyricism.

30. Bruand Y (1981) *Arquitetura Contemporânea no Brasil*. São Paulo: Perspectiva.

31. Papadaki S (1950) *Oscar Niemeyer: Works in Progress*. New York: Reinhold.

32. Cavalcanti L (2007) *When Brazil Was Modern: A Guide to Architecture 1928–1960*. New York: Princeton Architectural Press.

33. Underwood D (1994) *Oscar Niemeyer and the Architecture of Brazil*. New York: Rizzoli.

34. Segre R (1999) *Arquitetura Brasileira Contemporânea*. Rio de Janeiro: Viana & Mosley.

Roberto Segre has highlighted important points of contact between the two masters[35], emphasizing their common ability to transfigure apparently crude materials — first among them reinforced concrete — into veritable instruments of poetic expression. According to Segre, this capacity manifests itself through profoundly different design strategies, but equally effective in generating an architecture in which physical mass is sublimated into spatial lightness. Other scholars, such as Portuguese architectural historian Ana Tostões (b. 1959)[36] and Spanish-Catalan architectural theorist Josep Maria Montaner (b. 1954), have contributed to broadening the discourse by highlighting the existence of reciprocal influences and both architects' belonging to a sort of shared tectonic tradition, founded on the capacity to conjugate constructive rigor and expressive freedom in the treatment of reinforced concrete.

However, significant gaps remain on both theoretical and methodological planes. In particular, there is a notable absence of systematic analysis of the perceptual and cognitive processes that permit the experience of "lightness" beyond simple reduction of mass or weight. There also lacks an analytical apparatus capable of exhaustively and comparatively relating design strategies that — despite their apparent distance — converge in constructing a profoundly engaging and sensitive spatial experience. A further deficiency concerns the absence of a structured definition of "heavy lightness" as an autonomous critical category, equipped with interpretive and design instruments capable of orienting the reading of contemporary architecture. The present research proposes to fill these gaps, offering a comparative and in-depth reading of the two case studies, with the objective of revealing possible syntheses between constructive technique, aesthetic quality, and sensory perception of space.

Methodology/materials and Methods

The investigation of the phenomenon of "heavy lightness" in architecture is based on a multidisciplinary approach of a qualitative and comparative nature, which centers on the comparison between two emblematic works: the Portuguese Pavilion designed by Álvaro Siza and Casa das Canoas realized by Oscar Niemeyer. This integrated method surpasses simple descriptive analysis to structure itself as an articulated dialogue between technical, spatial, and phenomenological dimensions, with the objective of unveiling the complexity and richness of this concept.

The analysis develops across three closely connected and complementary levels. First, a technical-constructive study aims to deepen understanding of the structural solutions adopted, the materials employed, and the technological innovations that characterize the works, enabling a rigorous evaluation of constructive and functional modalities. In parallel, a theoretical-critical analysis frames the concept of heaviness and lightness in its multiple historical, cultural, and philosophical aspects, in order to comprehend its value and implications in the broader context of architectural modernity.

35. Montaner JM (2014) *Del diagrama a las experiencias, hacia una arquitectura de la acción*. Barcelona: Gustavo Gili.

36. Tostões A (2015) *Modern Architecture in Africa: Angola and Mozambique*. Zurich: Park Books.

Finally, a phenomenological evaluation dedicated to the perceptual and spatial experience generated by the buildings takes into consideration sensory aspects and the relationship between observer and architecture. The comparison between the two works is conducted according to four explicit analytical criteria. The first criterion concerns structural parameters: span-to-thickness ratios, load-path configurations, and the presence or absence of intermediate supports—factors that allow quantification of the structural "economy" through which perceived lightness is achieved. The second concerns spatial parameters: the ratio between built mass and void, the hierarchy of enclosure, and the relationship between scale and program, which determine the experiential amplitude of the spaces produced. The third concerns material and surface parameters: surface texture, colour, and the modulation of natural light on concrete surfaces, all of which condition the haptic and visual register of the observer's encounter with matter. The fourth criterion—perceptual parameters—constitutes the most epistemologically complex of the four, since it addresses qualities of architectural experience that are irreducibly subjective yet methodologically tractable through a combination of phenomenological analysis, critical reception, and direct observation. Within this research, perceptual parameters are operationalized across three interrelated dimensions.

The first is the quality of suspension: the degree to which a structure appears to defy gravitational logic in the observer's experience—whether through the visual negation of load-bearing elements, the perception of mass as floating or tensioned rather than resting, or the cognitive dissonance between known structural weight and perceived weightlessness.

The second is spatial fluidity: the capacity of the architectural interior to generate a sense of continuous, uninterrupted movement through space—the absence of hard boundaries, the dissolution of corners, the interpenetration of zones—which produces an experience of lightness not in the vertical (gravitational) sense but in the horizontal (spatial) sense.

The third is atmospheric continuity: the perceived dissolution of the boundary between interior and exterior, between structure and landscape, between built matter and natural environment—drawing on Böhme's concept of atmosphere as "tuned space"[37] and Seamon's notion of "environmental wholes"[38], treating the building not

37. Böhme G (2017) *Atmospheric Architectures: The Aesthetics of Felt Spaces*, trans. A.-Chr. Engels-Schwarzpaul. London: Bloomsbury, pp. 12–29. The concept of "tuned space" (*Stimmungsraum*) was first introduced in Böhme G (1993) Atmosphere as the Fundamental Concept of a New Aesthetics. *Thesis Eleven* 36: 113–126. Atmosphere is defined not as a property of subject or object alone but as a diffused quality of felt space pervading the environment and experienced prior to any cognitive act of perception. See also Griffero T and Tedeschini M (eds.) (2019) *Atmosphere and Aesthetics: A Plural Perspective*. Cham: Springer.

38. Seamon D (2024) Architecture and Phenomenology. In: Lu D (ed.) *The Routledge Companion to Contemporary Architectural History*. London: Routledge, pp. 1–14. Seamon distinguishes three modalities through which buildings operate as places: "lived worlds" (the taken-for-granted environmental background of daily life), "architectural atmospheres" (the affective tonality a building generates), and "environmental wholes" (the integrated perceptual unity of a place experienced as greater than the sum of its parts). The third modality is directly operative in the analysis of both case studies. Seamon's approach is grounded in Merleau-Ponty M (1945) *Phénoménologie de la perception*. Paris: Gallimard [Eng. trans.: *Phenomenology of Perception*, trans. D. Landes, London: Routledge, 2012] and Relph E (1976) *Place and Placelessness*. London: Pion.

as an isolated object but as a field condition[39] that extends perceptually beyond its physical limits[40].

Together, these three dimensions of the perceptual criterion are assessed through systematic cross-referencing of: a) primary sources—architects' writings and interviews expressing design intentions; b) critical literature—independent scholarly descriptions of spatial experience; and c) direct observation, where accessible. This triangulated approach confers sufficient methodological rigour to the perceptual criterion without reducing lived experience to numerical data. Taken together, the four criteria provide a replicable comparative framework that enhances the transparency and reproducibility of the analysis.

It is appropriate to recognize the intrinsic difficulties of a comparison between works of radically different scale and program: the Portuguese Pavilion is a public architecture of national representation, conceived to host official ceremonies and large gatherings, with a roof covering approximately 3,000 m²; Casa das Canoas is instead a private residence of contained dimensions, designed for the domestic life of a single family. This programmatic and dimensional asymmetry, far from constituting a limitation, represents precisely the heuristic value of the comparison: it permits verification of how the weight-lightness dialectic is articulated across different scales and functions, revealing transversal design principles that transcend typological contingencies. The comparison does not aim to establish formal equivalences, but to identify common phenomenological strategies in the use of reinforced concrete as expressive matter.

The initial phase of the research is characterized by a systematic documentary analysis that includes theoretical texts, technical documents, specialized bibliographic references, and academic studies focused on the evolution of reinforced concrete, its structural morphology, and the phenomenology of architectural space. Particular attention is directed to studies that deepen the relationship between perceived lightness and the materiality of concrete, providing a solid critical foundation for interpreting the realizations. The research draws upon original sources including the engineering documentation of the Portuguese Pavilion and published interviews with both architects regarding their design intentions.

For the Portuguese Pavilion, the technical-structural analysis utilized engineering documentation published by Cecil Balmond and the Arup team, including specifications on the cable system and the in-situ casting process.

---

39. Allen S (1999) Field Conditions. In: *Points + Lines: Diagrams and Projects for the City*. New York: Princeton Architectural Press, pp. 90–103. Allen argues that field thinking displaces the traditional focus on individual form in favour of the relational logics that organize elements across a surface or volume. Though his formulation is primarily urban in orientation, its epistemological premise—that architecture can be understood as a distributed perceptual condition rather than a self-contained artifact—applies directly to the atmospheric dimension of both case studies examined here.

40. See Pérez-Gómez A (2006) *Built upon Love: Architectural Longing after Ethics and Aesthetics*. Cambridge, MA: MIT Press, particularly his discussion of architecture as the construction of a "horizon of meaning"; and Pallasmaa J (2005; expanded ed. 2012) *The Eyes of the Skin: Architecture and the Senses*. Chichester: Wiley, pp. 45–52, where peripheral and haptic perception are shown to extend the body's spatial awareness beyond the visual field. Both accounts converge in suggesting that the experiential boundary of a building is phenomenologically wider than its tectonic boundary—a condition that "heavy lightness" exploits by designing for the dissolution of material edges.

Descriptions of the spatial experience derive from direct observations conducted on-site, only for the Lisbon Pavilion, and from existing critical literature, particularly studies from the "Critical Monumentality" project on Siza's works in the context of the Polis program. For Casa das Canoas, given lesser documentary accessibility, the analysis was based predominantly on monographic publications dedicated to Niemeyer, available photographic documentation, and the architect's own theoretical writings regarding the relationship between form and structure. It is necessary to acknowledge that the absence of direct access to original design archives constitutes a limitation of the research, partially compensated by the richness of available secondary literature.

David Seamon (2024), in his systematization of the phenomenological approach to architecture in *The Routledge Companion to Contemporary Architectural History*, has distinguished three modalities through which buildings operate as places: "lived worlds", "architectural atmospheres", and "environmental wholes". This framework offers tools for understanding how "heavy lightness" manifests itself simultaneously across all three levels.

Subsequently, a careful morphological and structural analysis proceeds through examination of plans, sections, and elevations, analyzing the dimensional and compositional characteristics of the works. The relationships between solids and voids, load-bearing elements and spatial elements are examined, placing particular emphasis on the function of structural elements such as walls, columns, and roofs in architectural space. These analyses permit clarification of the technical strategies that suggest a sensation of lightness in otherwise massive structures.

In parallel, an in-depth material analysis focuses on the materials used, finishing techniques, and surface treatments applied to reinforced concrete structures, dwelling on surface textures and especially on the interaction between matter and ligh — a fundamental element for the perception of lightness. A comparison is also conducted between the constructive processes employed in the Portuguese Pavilion and the casting techniques present in Casa das Canoas, also considering the dimension of material memory, with matter's capacity to evoke sensations and memories profoundly rooted in local cultures.

The phenomenological analysis phase privileges the experiential aspect, combining available photographic documentation, testimonies from the authors, critical reviews, and behavioral studies on how users perceive space. The specific perceptual dimensions investigated—suspension, spatial fluidity, and atmospheric continuity—are assessed through the triangulated methodology detailed in the analytical criteria above.

To conduct an exhaustive comparison, various analytical tools and parameters are adopted: measurement and comparison of structural proportions (thicknesses, dimensions, free spans, and surface curvatures); study of constructive techniques (post-tensioning, continuous casting, and surface finishing); evaluation of spatial experience, with analysis of the presence of suspended environments or significant voids; and assessment of atmospheric qualities and continuity or dissolution between interior and exterior. Photographic documentation and graphic representations permit visualization and comparison of the effectiveness of applied lightening strategies and the perceptual rendering of surfaces under different light conditions. The

relationship with context is a fundamental criterion, with a comparison between works that highlights contrasts between public monumentality and landscape mimesis or residential fluidity.

The criteria for case study selection are based on three fundamental principles: technical innovation, theoretical relevance, and cultural impact. The choice of works benefits from the availability of technical and critical documents that permit in-depth analysis and meaningful comparison. The approach is essentially qualitative and interpretative, concentrating on the sensory, cultural, and phenomenological depth of the research, beyond quantitative data, with the awareness that the interpretative nature and partiality of data impose limitations that must be addressed in the future through more objective instruments such as advanced structural simulations and neuroscientific studies on users' perceptual responses.

Results

The Portuguese Pavilion by Álvaro Siza: Structural Configuration and Tectonic Conception

The Portuguese Pavilion represents one of the most audacious realizations of contemporary architecture in reinforced concrete. Its principal structure consists of a rectangular roof measuring 65 × 45 meters (2,925 m²) whose technical realization requires careful clarification. Contrary to initial appearances that might suggest prefabrication, the roof was cast in situ using a complex system involving steel cables. The project's responsible engineer, Cecil Balmond of Arup, confirmed that the concrete was cast on-site and that, critically, "it was not a pre-stressed structure" in the conventional sense: the pre-tensioning of the cables served primarily to give them form rather than to induce compression in the concrete[41].

41. C. Balmond, *Informal*, Prestel, Munich 2002, pp. 309-343. The chapter dedicated to the Portugal Pavilion documents the entire engineering process of the roof. On p. 319, Balmond, at the time Deputy Chairman of Arup and head of the Advanced Geometry Unit, describes the greased-sheath cable system that allows the concrete to 'ride' the cable rather than bond to it, and recounts how the collaboration with Siza led him to abandon the initial steel solutions in favour of a concrete 'drape'. For the Italian account of the design process,cfr. C. Balmond, "La linea che scorre", *Domus* 854, 2004, p. 75; further documentation in *a+u Architecture and Urbanism*, Special Issue, novembre 2006, e *El Croquis* 95, 1999.

Figure 5. *Álvaro Siza Vieira, Portuguese Pavilion. The Concrete Canopy (65×50 m span, 20 cm thick) is suspended in a Catenary Curve between Two Portal Frames*
Source: S. Rugino

This technical distinction is essential for understanding the achievement of "heavy lightness" in the pavilion. The roof hangs in catenary form between two portals, suspended by cables that are embedded in the concrete slab. The variation in roof thicknes — from 20 cm at the edges to 90 cm at the supports — responds both to structural criteria (optimal distribution of stresses) and to expressive requirements, accentuating the perception of thinning toward the edges and conferring lightness to the structure. The longitudinal curvature, with a deflection of 87 cm, provides the necessary rigidity to resist wind and asymmetric loads, while simultaneously contributing to the visual impression of a suspended fabric.

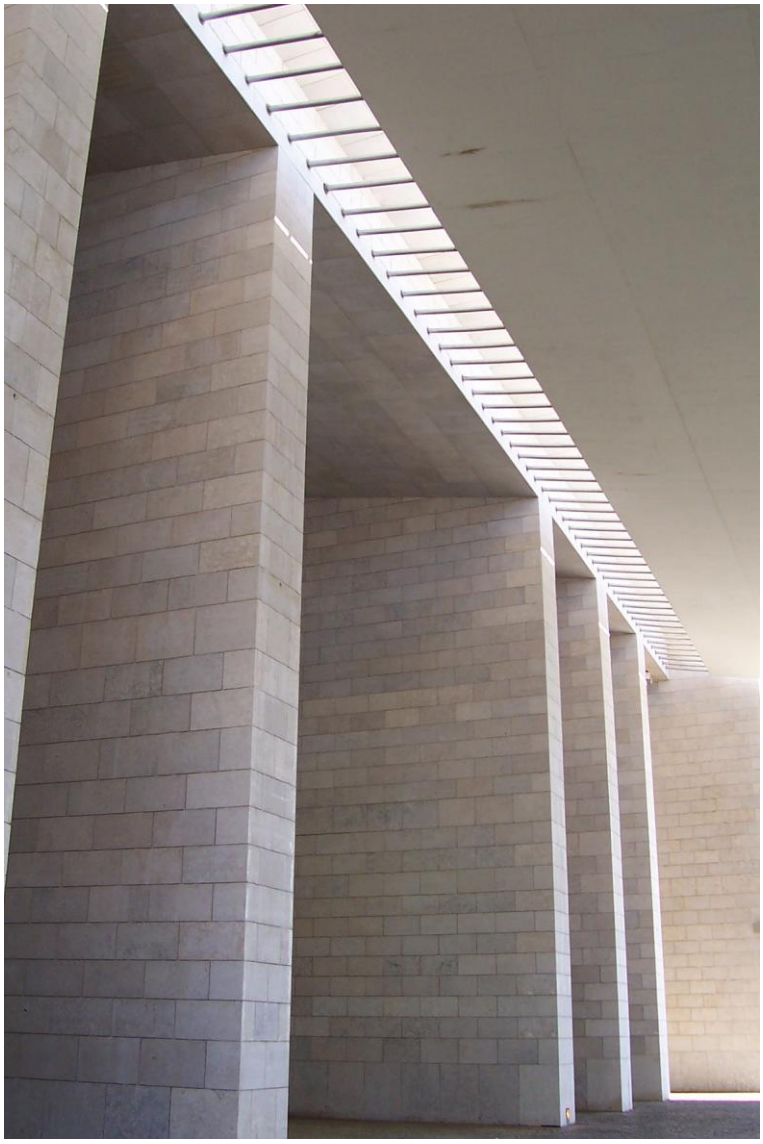

Figure 6. *Portuguese Pavilion, Detail of the Roof-portico Junction. The 45° Bevel Optically Cuts the Structural Thickness, Accentuating the Perception of Structural Slenderness*
Source: S. Rugino

The vertical load-bearing structure consists of only two parallel longitudinal walls, placed 45 meters apart and having variable thicknesses from 30 cm at the base to 60 cm at the top. Beyond their load-bearing function, these walls integrate technological systems such as rainwater drainage. The absence of intermediate columns is made possible by the effectiveness of the cable suspension system and the roof's curvature. This creates an interior space free of almost 3,000 m², known as a "suspended void" — a condition that transforms structural weight into an exceptional experience of lightness.

From a material perspective, the concrete of the roof retains the imprints of the wooden formwork used during construction, with a surface texture that recalls the grain of Portuguese maritime pine, contributing to humanizing the material's

hardness. The cement used is white Portland with calcareous aggregates, and the variation in its coloration produces a visual dematerialization effect that changes with lighting, reinforcing the impression of lightness. It is important to note that a significant portion of the concrete is lightweight and non-structural, further contributing to the visual effect of weightlessness while reducing the actual mass.

The load-bearing walls present differentiated finishes: externally the texture is rough, leaving the imprint of in-situ casting, while internally the surface is polished. This choice accentuates the contrast between the anchoring function of the walls and the suspended, protective function of the roof, creating a sort of expressive tension between earth and sky. Natural light assumes a central role, reflecting and diffusing in ways that further dematerialize the structure. The roof acts as a calibrated reflective surface, modulating light and creating a system of multiple reflections that uniformly illuminates the area below without generating sharp, oppressive shadows. The 45° chamfer of the structural edge optically cuts the roof's thickness, accentuating its perceived thinness. The combination of wooden texture and raking light generates an effect of "luminous vibration" that renders the surface alive and dynamic.

Figure 7. *Portuguese Pavilion, underside of the Roof Structure. The Texture of the Maritime Pine (*Pinus pinaster*) Formwork combined with raking Light Produces a "Luminous Vibration" Phenomenon*
Source: S. Rugino

Finally, the pavilion inserts itself into the urban and landscape context as an autonomous object but also as an urban device that creates a covered public space—an "aerial plaza" protected and open simultaneously, establishing an intense

relationship with the Tagus River and the surrounding landscape. The visual tension between the apparent lightness of the roof and its actual material presence creates what might be defined as a "controlled disproportion" — the structural mass seems to defy expectations, generating wonder rather than unease.

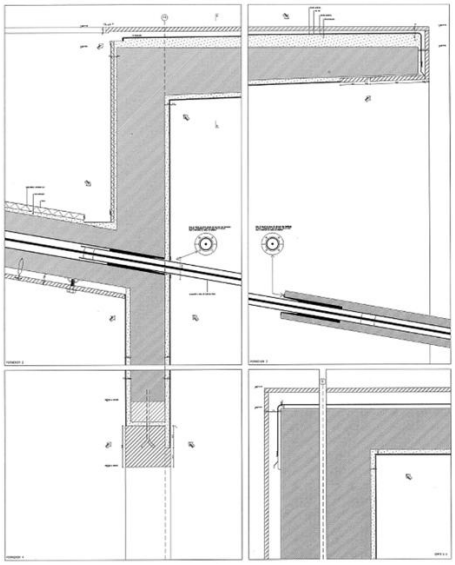

Figure 8. *Portugal Pavilion, Cross-section. Structural System Scheme showing Steel Cables embedded within the Concrete Slab*
Redrawn from: El Croquis 95 (1999), pp. 114-141

Casa das Canoas by Oscar Niemeyer: Structural Configuration and Stereotomic Conception

Casa das Canoas constitutes a significant example of Niemeyer's sculptural design approach, where traditional distinctions between load-bearing structure and envelope dissolve into a spatial continuum characterized by curved surfaces. The development occurs across two levels connected by a staircase that is simultaneously a structural and distributive element.

Figure 9. *Oscar Niemeyer, Casa das Canoas. The curved roof Canopy Integrates Harmoniously with the Mountainous Landscape of the Serra dos Órgãos Mountain Range*
Redrawn from: Domus 302 (1955)

The load-bearing structure combines circular reinforced concrete columns (30 cm diameter) in a modular grid with curved load-bearing walls that define the envelope and internal distribution simultaneously. The columns absorb vertical loads, while the curved walls perform the role of bracing and resistance to horizontal forces. The continuous casting technique applied to the perimeter walls eliminates joints, creating monolithic surfaces that accentuate plastic continuity, contributing to a sense of fluidity and lightness.

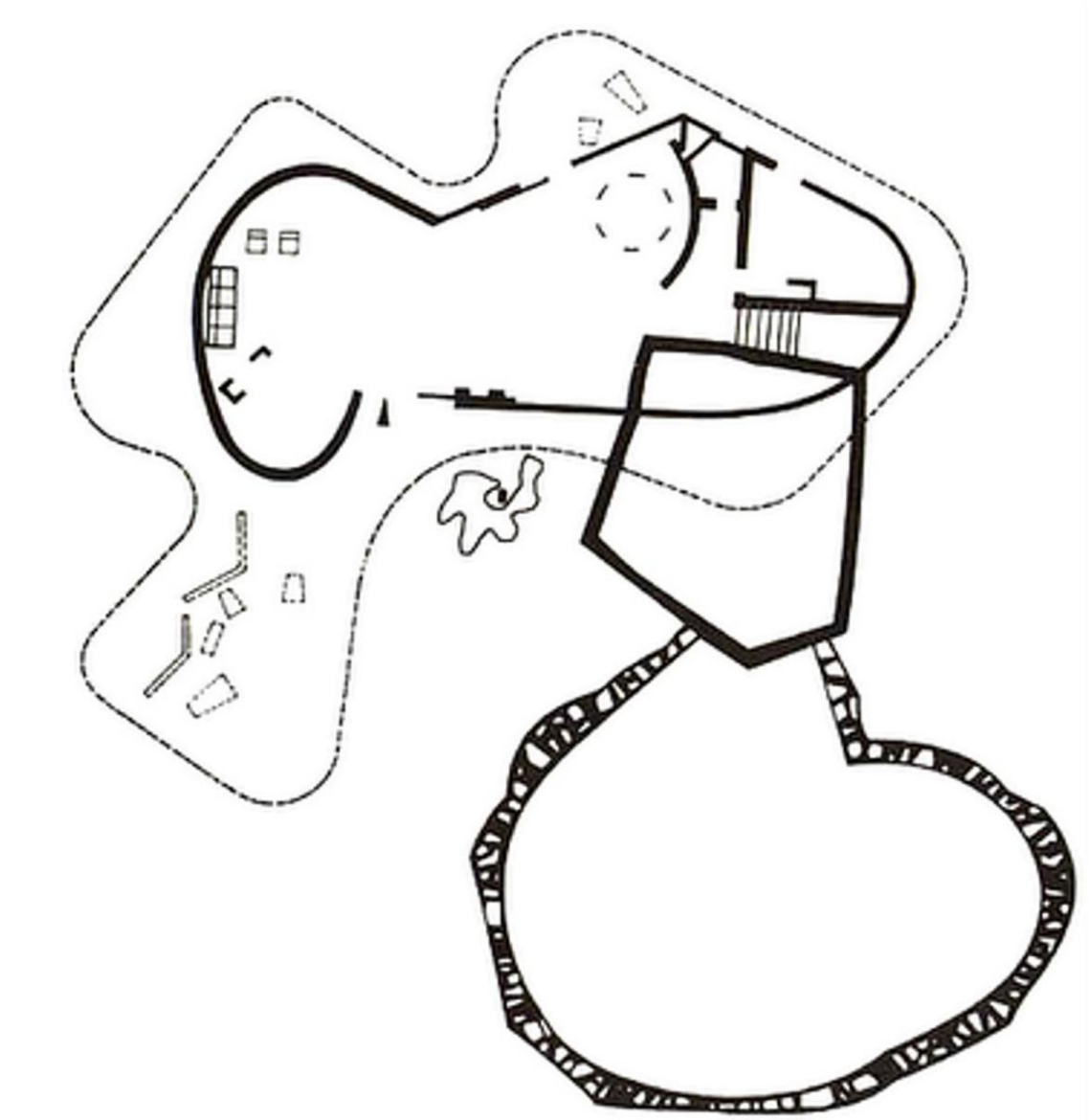

Figure 10. *Oscar Niemeyer, Casa das Canoas. Plan. The Circular Columns and curved Walls Simultaneously define Structure and Circulation*
Source: architectuul.com

The curved walls, executed in cast-in-place reinforced concrete, are veritable structural sculptures that combine function with aesthetic virtuosity. They transform what could be mere elements of spatial delimitation into the experiential core of the house, fluid surfaces that unfold through space, converting material heaviness into a perception of dynamic lightness.

The material treatment shows refined modulation: the polished surfaces of external walls, obtained with metal formwork, also respond to climatic requirements, facilitating water runoff and contributing to thermal comfort through solar reflection. Conversely, the columns maintain a rough texture that emphasizes their

structural function, establishing a tactile hierarchy that communicates the logic of forces.

***Figure 11**. Oscar Niemeyer, Casa das Canoas. Interior View of the Living Room: The Natural Rock Penetrates the Domestic Space, dissolving the Boundary between Architecture and Landscape. The Extensive glazing and Circular reinforced Concrete Column define a Spatial Continuum between Interior and Exterior*
Source: architectuul.com

Natural lighting plays a fundamental role, with ample glazed surfaces that frame the surrounding landscape and carefully designed solar control through orientations and screening. The curvature of internal walls modulates light, generating diffused illumination that eliminates sharp shadows, while zenithal light on the staircase creates a "luminous chronometer" that marks spatial time during the day.

The landscape integration of the Casa is marked by morphological mimicry, with curved forms that echo those of the surrounding hills, dissolving the sharp separation between built and nature and using the white color of concrete as an element of contrast and harmony with tropical vegetation. Unlike Siza's public monumentality, Niemeyer proposes an intimate and domestic experience where lightness becomes an integral part of daily life.

Comparative Analysis: Convergences and Divergences

The structural strategies implemented to generate the sense of lightness differ substantially but converge in the perception produced. Siza's Pavilion utilizes a "structural subtraction", minimizing built supports to the essential to create a large suspended void: the reduction to the minimum of load-bearing elements — only two longitudinal walls supporting a roof of almost 3,000 m² — produces what we might define as a "tectonic suspension", where space is born from the recognizable assembly of few clearly readable structural elements. By contrast, Niemeyer applies a "morphological transformation", effecting a metamorphosis of mass into plastic forms through an integrated system in which columns and curved walls merge into a unitary continuum: this "stereotomic fluidification" generates a space that appears carved from a continuous mass, with total plastic fluidity.

Figure 12. *Álvaro Siza Vieira, Portuguese Pavilion. Strategies of "Heavy Lightness": The "Tectonic Suspension" of the Portugal Pavilion"*
Redrawn from: S. Rugino

The relationship with gravity further evidences this polarity: Siza founds lightness on suspension and void, with large masses that seem to levitate thanks to controlled disproportion between structural weight and spatial perception; Niemeyer fluidifies matter, modeling space as crystallized and dynamic movement where structural complexity is accompanied by uninhibited spatial fluidity. Both

strategies, though radically different in formal premises, converge in producing analogous phenomenological effects, revealing a set of recurrent perceptual conditions associated with the generation of perceived lightness within this comparative frame: spaces with dimensional excess relative to load-bearing elements, use of light to dematerialize surfaces, and integration between technical constraints and formal language.

The temporal experience proposed is comprehensively different: Siza's is contemplative, suspending time, while Niemeyer's is dynamic, marking movement and perception through spatial sequence and light management. On the scale level, Siza's Pavilion addresses public and monumental space, creating a collective experience of lightness. Casa das Canoas proposes a more intimate and domestic experience, where lightness becomes an integral part of daily life. These scalar differences, far from undermining the comparison, illuminate how "heavy lightness" adapts to different programmatic and social requirements while maintaining its essential phenomenological character.

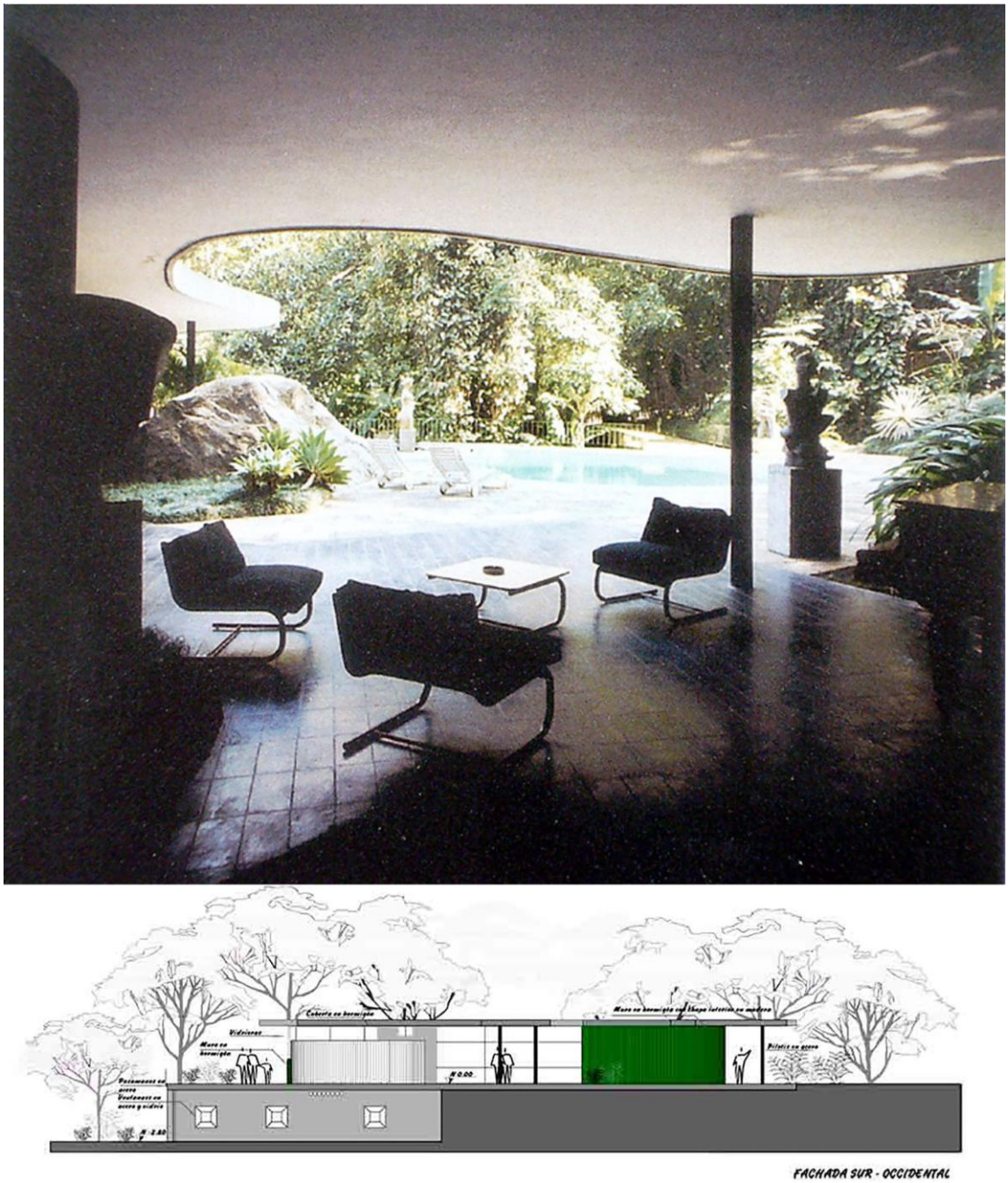

Figure 13. *Oscar Niemeyer, Casa das Canoas. Strategies of "Heavy Lightness": The "Stereotomic Fluidification" of Casa das Canoas*
Redrawn from: S. Rugino

Discussion

The present investigation has highlighted how "heavy lightness", while evoking Oriental suggestions in its formulation, actually constitutes a central theme profoundly rooted in aesthetic and design reflection throughout historical periods.

The expression, apparently oxymoronic, describes a dialectical tension between opposites — mass and suspension, gravity and lightness — that is concretized in numerous significant works from antiquity to the present day. This is not a simple perceptual game or a technical expedient aimed at astonishment, but a veritable aesthetic and conceptual category that finds its most authentic expression in the conscious use of different building materials across epochs, with reinforced concrete representing only its most recent and perhaps most dramatic manifestation.

"Heavy lightness" manifests itself fully when rough and powerful materiality is not dissimulated but rather exalted, in dialogue with sensations of suspension, dynamism, or visual delicacy. In this sense, reinforced concrete architecture is not only a constructive means but a philosophy of building capable of fusing structural solidity and expressive intensity in an only apparently perceptual contradiction, as demonstrated by Le Corbusier's late-career works, through Tadao Ando's minimalist poetry, to Peter Zumthor's material intensity, in which concrete becomes an instrument for poetic essentiality.

The comparative study between the Portuguese Pavilion and Casa das Canoas has revealed how the two design strategies identified in the analysis—though radically different in formal premises—converge in producing analogous phenomenological effects. Thus emerge a set of recurrent perceptual conditions, consistent across the two cases examined: spaces with dimensional excess, use of light to dematerialize surfaces, and integration between technical constraints and formal language.

A central aspect that emerged is the "controlled disproportion" between structural mass and spatial perception, as in Siza's Pavilion, where the imposing weight of the roof contrasts with an impression of suspension, or in Casa das Canoas, where structural complexity is accompanied by uninhibited spatial fluidity. This disproportion does not transmit precariousness but generates constructive wonder that renders architecture an aesthetic and contemplative experience. "Heavy lightness" is thus interpreted as a philosophy of design and construction, a paradigm that surpasses the dichotomy between matter and form, technique and poetry, function and aesthetics, configuring architecture as a critical space of synthesis in which apparently irreconcilable opposites find equilibrium.

The design experience is nourished by a dialogue between technical rigor and aesthetic sensibility, transforming every structural element — beam, column, slab — into a narrative instrument capable of communicating spatial, symbolic, and emotional values. This vision finds confirmation in experiences from brutalism to poetic minimalism, where the contradiction between heaviness and lightness dissolves into active harmony. Contemporary works demonstrate that no unique formula exists, but diversified strategies aimed at a superior equilibrium between materials, structures, and space, with technology as an enabler of increasingly refined controls over structural performance and perceptual qualities.

In a context of global environmental crisis, "heavy lightness" also assumes ecological valence: reducing materials and weights becomes an ethical imperative and sustainable strategy, with the use of innovative low-impact materials, renewable energies, and efficient resource management. New frontiers include smart materials, adaptive structures, 3D printing, and artificial intelligence applied to design, introducing a temporal and plastic dimension capable of responding to changing

conditions. The current challenge is to expand this paradigm by integrating it with emerging technologies and environmental urgencies, maintaining alive the relationship between technique and poetry, innovation and tradition, weight and lightness.

On the technological front, recent developments in the field of ultra-high-performance concrete (UHPC) offer new possibilities for sustainable "heavy lightness". Recent studies (Fan et al., 2024; Amran et al., 2022) demonstrate how UHPC enables thinner structural sections with superior performance, significantly reducing CO_2 emissions in the life cycle compared to conventional concrete.

Conclusions

The concept of "heavy lightness" in architecture represents one of the most complex and fascinating questions of the discipline, a critical category that transcends simple technique to embody itself as a philosophy of building and phenomenological strategy. The transformations of twentieth-century and contemporary architecture find in this dialectic between mass and perception one of the principal design drivers and frameworks for critical reading. This research has demonstrated that "heavy lightness" is not a mere decorative effect or apparent contradiction, but a true design philosophy that unites technical innovation and poetic distinction, generating spaces in which the dialectical tension between dense materiality and perceived lightness produces experiences of high aesthetic and functional quality. The material element is transfigured into a sensitive and narrative subject, manifesting itself primarily as a perceptual phenomenon: the massive matter of reinforced concrete is transposed through constructive and visual strategies into an experience of suspension, lightness, and spatial purity, mediated by light, finishes, transparency, and voids around structural elements.

The analyses conducted on the Portuguese Pavilion and Casa das Canoas confirm how Siza's constructive rigor and Niemeyer's formal plasticity represent two complementary declinations of the same aspiration: to transform the massiveness of reinforced concrete into an experience of lightness. Technical innovations in reinforced concrete constitute the basis of these experiences: post-tensioning, suspension by cables, shell structures, and tensile structures permit thin elements with large free spans while maintaining resistance and stability; structural optimization reduces thicknesses and functionally distributes load-bearing elements, while minimization or disappearance of supports increases the effect of suspension and lightness; innovative materials such as cross-laminated timber, aerogel, and high-performance composites further favor sustainability with high energy performance and low environmental impact.

The original contribution of this study resides in the systematic articulation of "heavy lightness" as an operative critical category. The two strategies identified — tectonic suspension and stereotomic fluidification — have both proven effective in producing the perceptual negation of weight, suggesting the existence of phenomenological invariants transversal to different architectural languages.

The research limitations include the absence of direct access to design archives, which prevented analysis of decision-making processes during design; the lack of empirical investigations on user perception through neuroscientific methodologies or structured questionnaires; and the focus on only two case studies, which limits the generalizability of conclusions. Moreover, the comparison between works of different scale and program, though methodologically justified, requires caution in extending results to other architectural typologies.

Future research perspectives suggest extending the analysis to other masters of reinforced concrete (Tadao Ando, Zaha Hadid, Peter Zumthor) to verify the validity of proposed categories; integrating empirical methodologies from environmental psychology to measure perceptual responses; studying the implications of "heavy lightness" for sustainability in light of UHPC technologies that permit thinner sections with equal performance; and historical investigation of pre-modern precedents of the concept, from Gothic to Mannerism, for a more complete genealogy of the weight-lightness dialectic in architecture.

References

Amran, M., et al. "Recent Trends in Ultra-High Performance Concrete (UHPC)." *Construction and Building Materials* 352 (2022).

Allen, S. *Points + Lines: Diagrams and Projects for the City.* New York: Princeton Architectural Press, 1999.

Augé, M. *Nonluoghi: Introduzione a una antropologia della surmodernità.* Milano: Elèuthera, 1992.

a+u Architecture and Urbanism. Special Issue, November 2006.

Bachelard, G. *La terre et les rêveries de la volonté.* Paris: José Corti, 1948.

Bachelard, G. *La poétique de l'espace.* Paris: Presses Universitaires de France, 1958. English translation: *The Poetics of Space*, trans. M. Jolas, Boston: Beacon Press, 1969.

Bachelard, G. *La terra e il riposo: Un viaggio tra le immagini dell'intimità.* Milano: Red Edizioni, 1994.

Balmond, C. *Informal.* Munich: Prestel, 2002.

Balmond, C. "La linea che scorre." *Domus* 854 (2004).

Banham, R. *Theory and Design in the First Machine Age.* London: The Architectural Press, 1960.

Battisti, E. *Filippo Brunelleschi.* Milan: Electa, 1981.

Böhme, G. "Atmosphere as the Fundamental Concept of a New Aesthetics." *Thesis Eleven* 36 (1993): 113–126.

Böhme, G. *Atmospheric Architectures: The Aesthetics of Felt Spaces.* London: Bloomsbury, 2017.

Bruand, Y. *Arquitetura Contemporânea no Brasil.* São Paulo: Perspectiva, 1981.

Calvino, I. *Lezioni americane: Sei proposte per il prossimo millennio.* Milano: Garzanti, 1988.

Cavalcanti, L. *When Brazil Was Modern: A Guide to Architecture 1928–1960.* New York: Princeton Architectural Press, 2007.

Collovà, R. "Una piazza coperta." *Lotus International* 99 (1999).

Colquhoun, A. *Essays in Architectural Criticism: Modern Architecture and Historical Change.* Cambridge, MA: MIT Press, 1981.

Comas, C.E.D. *Oscar Niemeyer: Curves of Irreverence.* New Haven: Yale University Press, 2010.

Croset, P.A. *Álvaro Siza, Scultura Architettura.* Milano: Skira, 1999.

Curtis, W.J.R. "Intervista ad Álvaro Siza." *El Croquis* 95 (1999).
De Llano, P., and Castanheira, C., eds. *Álvaro Siza: Opere e progetti.* Milano: Electa, 1995.
Deleuze, G., and Guattari, F. *What Is Philosophy?* Translated by H. Tomlinson and G. Burchell. New York: Columbia University Press, 1994.
Domus. "Ritorno a Casa das Canoas, la residenza di Oscar Niemeyer." *Domus* 302 (1955).
El Croquis. Álvaro Siza 1995–1999. No. 95 (1999).
Fan, J., et al. "Sustainable Reinforced Concrete Design: UHPC in Life-Cycle Structural Performance." *Engineering Structures* 316 (2024).
Figueira, J., and Neiva, A., eds. *What Is Needed: Mostra sull'architettura portoghese 1974–2023.* Lisboa: Fundação Calouste Gulbenkian, 2024.
Fleck, B. *Álvaro Siza.* London: E & FN Spon, 1999.
Forty, A. *Words and Buildings: A Vocabulary of Modern Architecture.* London: Thames & Hudson, 2004.
Forty, A. *Parole e edifici: Un vocabolario per l'architettura moderna.* Bologna: Pendragon, 2004.
Frampton, K. *Studies in Tectonic Culture: The Poetics of Construction in Nineteenth and Twentieth Century Architecture.* Cambridge, MA: MIT Press, 1995.
Futagawa, Y. *GA Residential Masterpieces 28: Oscar Niemeyer – Casa das Canoas, Casa Cavanelas.* Tokyo: A.D.A. Edita, 2019.
Giedion, S. *Spazio, tempo ed architettura: Lo sviluppo di una nuova tradizione.* Milano: Hoepli, 1954.
Gregotti, V. *Dentro l'architettura.* Torino: Bollati Boringhieri, 1996.
Griffero, T., and Tedeschini, M., eds. *Atmosphere and Aesthetics: A Plural Perspective.* Cham: Springer, 2019.
Holl, S. *Intertwining.* New York: Princeton Architectural Press, 1996.
Liu, Q. "Architectural Phenomenology: Past, Present and Future Directions." *Architectural Studies* 18, no. 1 (2024).
Malagamba, D., and Siza, Á. *Before/After: Álvaro Siza.* London: Phaidon, 2024.
Mark, R., ed. *Architectural Technology up to the Scientific Revolution.* Cambridge, MA: MIT Press, 1993.
Merleau-Ponty, M. *Phénoménologie de la perception.* Paris: Gallimard, 1945. English translation: *Phenomenology of Perception*, trans. D. Landes, London: Routledge, 2012.
Mindlin, H. *Modern Architecture in Brazil.* New York: Reinhold, 1956.
Moneo, R. "On Typology." *Oppositions* 13 (1978): 22–45.
Moneo, R. *Theoretical Anxiety and Design Strategies in the Work of Eight Contemporary Architects.* Cambridge, MA: MIT Press, 2004.
Moneo, R., et al. *Álvaro Siza: Tutte le opere.* Milano: Electa, 2006.
Montaner, J.M. *Del diagrama a las experiencias, hacia una arquitectura de la acción.* Barcelona: Gustavo Gili, 2014.
Norberg-Schulz, C. *Architecture: Meaning and Place.* New York: Rizzoli, 1988.
Norberg-Schulz, C. *Genius Loci: Paesaggio ambiente architettura.* Milano: Electa, 1997.
Pallasmaa, J. *Gli occhi della pelle: L'architettura e i sensi.* Milano: Jaca Book, 2007.
Pallasmaa, J. *The Thinking Hand: Existential and Embodied Wisdom in Architecture.* Chichester: Wiley, 2009.
Pallasmaa, J. "The Atmospheric Sense." In Griffero, T., and Tedeschini, M., eds., *Atmosphere and Aesthetics: A Plural Perspective.* Cham: Springer, 2019.
Pallasmaa, J. *Rootedness: Reflections for Young Architects.* Hoboken: Wiley, 2024.
Papadaki, S. *Oscar Niemeyer: Works in Progress.* New York: Reinhold, 1950.
Panofsky, E. *Meaning in the Visual Arts.* Garden City, NY: Doubleday, 1955.
Pérez-Gómez, A. *Built upon Love: Architectural Longing after Ethics and Aesthetics.* Cambridge, MA: MIT Press, 2006.

Plummer, H. *Poetics of Light.* Tokyo: a+u, 1987.
Portoghesi, P. *Borromini: Architettura come linguaggio.* Milan: Electa, 1967.
Relph, E. *Place and Placelessness.* London: Pion, 1976.
Rice, P. *An Engineer Imagines.* London: Ellipsis, 1994.
Rowe, C., and Koetter, F. *Collage City.* Cambridge, MA: MIT Press, 1978.
Rykwert, J. *The Dancing Column: On Order in Architecture.* Cambridge, MA: MIT Press, 1996.
Seamon, D. "Architecture and Phenomenology." In Lu, D., ed., *The Routledge Companion to Contemporary Architectural History.* London: Routledge, 2024.
Segre, R. *Arquitetura Brasileira Contemporânea.* Rio de Janeiro: Viana & Mosley, 1999.
Siza, Á. *Scritti di architettura.* Edited by A. Angelillo. Milano: Skira, 1997.
Siza, Á. *Expo '98: Pavilhão de Portugal.* Lisboa: Parque Expo, 1998.
Siza, Á. *Immaginare l'evidenza.* Roma-Bari: Laterza, 1998.
Semper, G. *The Four Elements of Architecture and Other Writings.* Translated by H.F. Mallgrave and W. Herrmann. Cambridge: Cambridge University Press, 1989.
Testa, P. *The Architecture of Álvaro Siza.* Porto: Faculdade de Arquitectura da Universidade do Porto, 1996.
Tostões, A. *Modern Architecture in Africa: Angola and Mozambique.* Zurich: Park Books, 2015.
Tzonis, A., and Lefaivre, L. *The Grid and the Pathway.* Cambridge, MA: Harvard University Press, 1984.
Underwood, D. *Oscar Niemeyer and the Architecture of Brazil.* New York: Rizzoli, 1994.
Valéry, P. *Eupalinos o l'architetto.* Milano-Udine: Mimesis, 2011.
Vidler, A. *Warped Space: Art, Architecture, and Anxiety in Modern Culture.* Cambridge, MA: MIT Press, 2000.
Wang, W. *Álvaro Siza: Figures and Configurations, Buildings and Projects 1986–1988.* Cambridge, MA: Harvard University Graduate School of Design, 1988.
Zevi, B. *Saper vedere l'architettura.* Torino: Einaudi, 1950.
Zumthor, P. *Atmospheres: Architectural Environments, Surrounding Objects.* Basel: Birkhäuser, 2006.