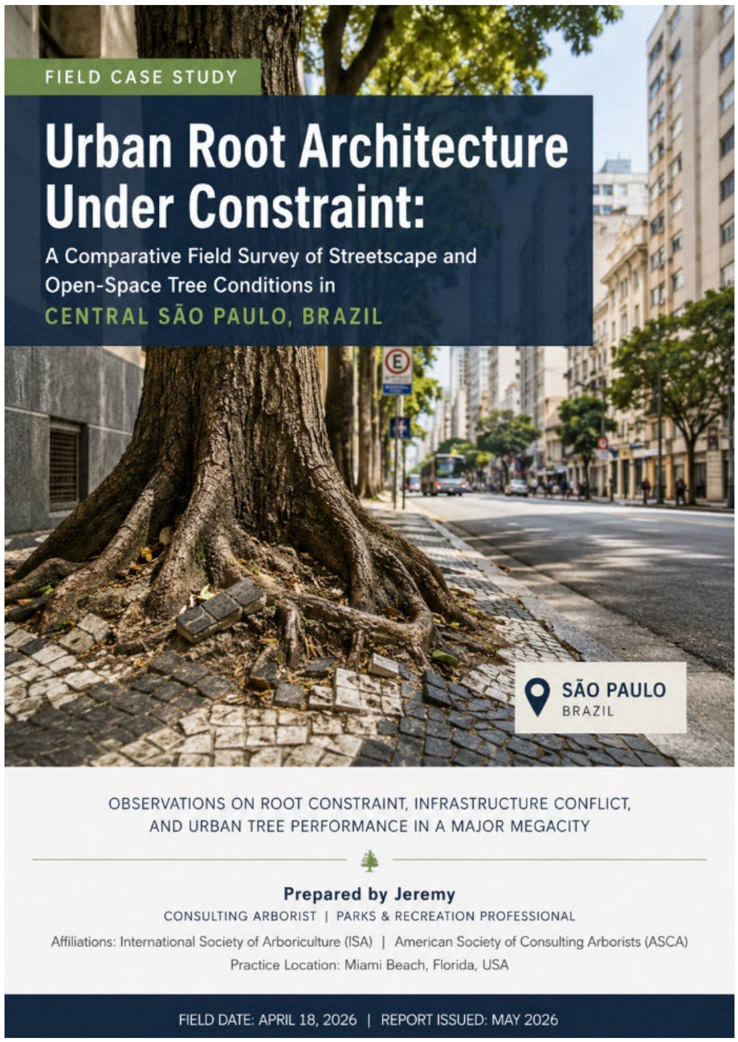
FIELDCASESTUDY

Urban Root Architecture Under Constraint:

A Comparative Field Survey of Streetscape and Open-Space Tree Conditions in Central São Paulo, Brazil



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Executive Summary

This case study serves as Volume I of the International Urban Root Architecture Series. Volume II, completed in Warsaw, Poland in July 2026, extends the comparative framework into a temperate European urban environment. The study extends an ongoing line of comparative international research conducted by the author on root intrusion in constrained streetscapes versus opengrown park specimens. São Paulo offered an exceptional study site: a megacity with more than 650,000 inventoried street trees and approximately 2,000 documented street-tree failures annually, concentrated in the verticalized historic core where this fieldwork was performed (Locosselli et al., 2024).

The author photographed and assessed mature streetscape specimens within sidewalk planting cells of approximately 0.5 to 1.0 m² of exposed surface area, situated against high-rise façades, retaining walls, and curb edges. Observations consistently revealed buttressed and surface-rooted growth, severed and re-emergent woody roots, infill repair work in adjacent pavers, and root-collar deformation indicative of mechanical constraint. Findings align with the international peer-reviewed literature documenting that restricted soil volume, impervious surfacing, and repeated sidewalk reconstruction are leading drivers of root-related tree failure and infrastructure conflict in dense urban environments (Randrup et al., 2001; D'Amato et al., 2002; Locosselli et al., 2024).

The professional purpose of this trip was to gather comparative international field data to inform consulting practice in Miami Beach, where similar conflicts between mature trees and dense urbanized streetscapes are an active concern for property owners, public works, and risk-management stakeholders. This document, together with the author's public-facing dissemination on LinkedIn (Appendix B), constitutes the deliverable of that field research.

1. Purpose and Professional Justification

The author maintains an active consulting arboriculture practice based in Miami Beach, Florida, with a focus on tree-infrastructure conflict assessment, risk evaluation, and management of mature canopy in dense coastal urban environments. South Florida's combination of subtropical climate, aggressive species (e.g., Ficus spp., Roystonea spp., Bursera simaruba), narrow streetscape easements, and high-value adjacent infrastructure creates a professional environment in which root-architecture assessment is a recurring and economically material concern.

Comparable conditions exist in many global megacities, but ground-level photographic and observational data on root constraint patterns is generally not available from secondary sources at the level of detail required for client-facing consulting work. The purpose of this trip was therefore to:

- Conduct first-person photographic field documentation of mature street-tree root systems in a comparable subtropical urban core (São Paulo, Brazil).
- Compare observed conditions in narrow constrained sidewalk pits to those of trees with greater rooting volume in adjacent open spaces.

- Generate case-study material suitable for use in client reports, professional society contributions, and public dissemination through LinkedIn.
- Build a repeatable case-study framework for application to subsequent international fieldwork (next planned site: Poland, July 2026).

This document, the author's timestamped photographic record, and the corresponding LinkedIn publication (Appendix B) collectively establish the professional and business basis for the field activity.

2. Site and Setting

Fieldwork was conducted on April 18, 2026, within the central districts of São Paulo, Brazil. The relevant area corresponds broadly to the Sé Regional Administration, comprising eight historic central districts (Sé, República, Bom Retiro, Santa Cecília, Consolação, Bela Vista, Liberdade, and Cambuci). These are among the oldest and most verticalized neighborhoods in the city and have been independently identified in the peer-reviewed literature as a tree-failure hotspot relative to the rest of São Paulo (Locosselli et al., 2024).

Key site characteristics observed during fieldwork include:

- Mid- and high-rise residential and mixed-use buildings flanking narrow sidewalks.
- Sidewalk surfacing predominantly comprised of small-format granite pavers and the iconic Portuguese black-and-white wave-pattern pedra portuguesa.
- Tree wells of small surface area (typically a single paver-frame opening) cut into otherwise continuous impervious surfacing.
- Streetscape-scale trees including mature broadleaf specimens (likely Tipuana tipu, Ficus spp., and similar large-canopy taxa common to the São Paulo street inventory) and royal/imperial palms (Roystonea spp.).
- Visible historic infill repair using brick, mortar, and replacement pavers around root flares.
- Adjacent open viaduct and elevated streetscape conditions providing comparison points to constrained pit specimens.

3. Methodology

Methodology was qualitative, observational, and photographic, consistent with field reconnaissance practice rather than a formal quantitative study. The approach was designed to generate comparative case material rather than statistically representative data.

For each subject tree, the author:

- Recorded location and contextual photography showing the tree, its planting pit, and the surrounding built environment.
- Photographed root flare, surface roots, and observable root-collar conditions.

- Photographed adjacent pavement, curb, and sidewalk conditions to record evidence of rootinduced displacement, prior repair, or infill work.
- Noted approximate planting pit dimensions, surrounding surface treatment, and proximity to building façades or retaining walls.
- Captured timestamped EXIF data on each image (preserved in the original digital files) to establish field-presence chronology.

The selected specimens are illustrative rather than exhaustive. They were chosen for their clear visual representation of common constraint patterns rather than as a random sample of the central São Paulo inventory.

4. Field Observations

Plate 1 — Streetscape canopy in dense vertical context

Plate 1. Mature broadleaf streetscape specimen, central São Paulo. Note canopy compressed against multi-story façade, overhead utility congestion, and minimal sidewalk pit at base.

This first specimen illustrates the canopy-scale outcome of a constrained streetscape: a tree of significant vertical reach forced into asymmetric crown development between a high-rise façade and overhead utility infrastructure. While the photograph is principally a canopy view, the relevant point for root assessment is that large, water- and nutrient-demanding crowns of this character must be supported by root systems that, in this site context, have access only to a small surface opening and whatever sub-pavement soil volume the original tree well permits. The peer-reviewed literature has long established that the lateral root spread of an open-grown tree is on the order of 38 times the trunk diameter at maturity (Day & Wiseman, cited in DeepRoot, 2025); The visible planting aperture is clearly insufficient to provide that volume independently; the extent and quality of usable rooting volume beneath the surrounding pavement were not investigated.

Plate 2 — Severe root-flare exposure and pit overflow

Plate 2. Exposed buttress and surface roots overflowing a sub-meter pit, with brick and mortar infill marking prior pavement repair work.

Plate 2 is the diagnostic image of this study. The buttress and structural surface roots have completely exceeded the original pit and are in active mechanical contact with the surrounding paver field. Brick-andmortar infill is visible on multiple sides of the pit, indicating that this site has been the subject of repeated reactive maintenance rather than design-stage accommodation. The condition shown corresponds closely to what Locosselli et al. (2024) describe as root-collar constriction by sidewalk surfacing, which their analysis of 456 documented failures in central São Paulo identified as one of the three principal predictors of street-tree failure, alongside poor wood condition and drastic pruning. Approximately 14% of root failures and 11% of trunk failures in that dataset were associated with constricted root-collar conditions of this general type.

Plate 3 — Linear constraint between retaining wall and pavement

Plate 3. Mature trunk wedged into the linear gap between a stone retaining wall and granite paver field, with effectively no surface pit.

Plate 3 documents an even more extreme constraint geometry: a mature trunk has been retained in place as a stone retaining wall and adjacent paver field have been built up around it on both sides. The available rooting cross-section at grade is reduced to a narrow linear seam. This kind of post-hoc accommodation is characteristic of older central districts where mature trees predate the most recent generation of pavement and wall construction. From a consulting perspective, this represents the most severe root-space and infrastructure constraint observed during the field day: the tree is providing canopy services but its root system has no plausible engineering path to a soil volume commensurate with its mature crown, and the immediately adjacent built infrastructure is unforgiving.

Plate 4 — Curb-edge encroachment and structural deformation

Plate 4. Buttressed root mass overflowing the pit, deflected by the curb edge, with painted curb line distorted by years of incremental displacement.

Plate 4 demonstrates the classic curb-edge confrontation. The structural root mass has clearly continued to add girth against the curb, and the painted curb line is bent and deflected as a record of years of incremental displacement. This is the visible manifestation of the international literature on rootpavement conflict: damage to curbs, sidewalks, and roads from expanding roots is documented across North America, Central and South America, and Europe (Randrup et al., 2001). Importantly, that literature is not unanimous on the direction of causation. D'Amato et al. (2002) and others have proposed that the more favorable moisture and temperature regime under sidewalk slabs actively recruits root growth toward the pavement, rather than roots merely encountering it incidentally; the brick-infill pattern visible in Plates 2 and 4 is consistent with that mechanism.

Plate 5 — Royal palm in confined façade-edge planting

Plate 5. Royal/imperial palm (Roystonea sp.) at Edifício Tunis, planted directly against the building façade with minimal at-grade rooting allowance.

Plate 5 shows a contrasting form: a tall single-stemmed palm in a similarly constrained planting position. Palms differ fundamentally from broadleaf trees in root architecture — they produce a fibrous root mass of consistent diameter rather than expanding secondary woody roots — and so they are commonly specified for constrained urban positions where buttressing trees would cause structural damage. The professional implication, transferable directly to Miami Beach practice, is that palm placement is genuinely lower-risk for adjacent hardscape, but only as a first-order proposition: storm loading, water demand, and root-plate stability remain consequential considerations even where pavement-lifting risk is reduced.

5. Discussion: Patterns of Constraint

Synthesizing the field observations against the peer-reviewed literature, four reinforcing patterns emerged across the central São Paulo study area:

5.1 Soil volume is the limiting variable

The conditions observed are textbook illustrations of the principle that mature tree health is governed by available rooting volume more than by any other single site variable. The Dutch literature established decades ago that mature poplars require on the order of 50–60 m^3 of rootable soil for optimal growth (Schoenfeld & Van de Burg, cited in Kopinga, 1991). The pits observed in central São Paulo offer perhaps a small fraction of that volume at the surface, with sub-pavement extension dependent on whatever noncompacted substrate happens to exist below the paver bedding. International work in Singapore and elsewhere has demonstrated that engineered solutions — structural cells, structural soils, and biocharamended load-bearing substrates — meaningfully outperform conventional pits, in roughly that performance order (Yusof et al., 2018).

5.2 Sidewalk replacement is itself a stressor

The brick-and-mortar infill visible in multiple plates indicates a maintenance cycle in which roots heave pavement, pavement is replaced, and adjacent roots are severed in the process. Long-term work in Minneapolis–Saint Paul on Acer platanoides, Celtis occidentalis, Gleditsia triacanthos, and Tilia spp. has shown measurable reductions in basal area increment in trees adjacent to replaced sidewalk panels relative to controls more than three meters away (Johnson, Giblin, and colleagues, summarized at UF/IFAS Gulf Coast REC, 2025). The implication is that the visible repair scars in São Paulo are not just cosmetic — they are likely correlated with reduced subsequent vigor in the trees they surround.

5.3 Root-collar constriction is a leading failure predictor in this exact city

The most directly relevant published evidence to the present case study comes from the recent collaborative work of researchers at the University of São Paulo (USP), the Federal University of São Paulo (UNIFESP), and partner institutions, who analyzed 456 documented tree failures within the same Sé Regional Administration in which this fieldwork was conducted. Their regression analysis identified wood condition, sidewalk-induced root-collar constriction, and drastic pruning as the three leading predictors of failure, with constricted root collars associated with a meaningful share of root and trunk failures specifically (Locosselli et al., 2024). The plates above are representative field evidence of precisely those constriction conditions.

5.4 Verticalization compounds the problem

A separate São Paulo study found that the average height of surrounding buildings and the age of the district were the strongest predictors of street-tree failure across the city as a whole, with failure rates roughly twice the city average in the most verticalized districts (Locosselli and colleagues, 2022). The plates documented here are explicitly within that verticalized core: the canopies are growing in windtunneled, light-restricted, pollution-loaded urban canyons in addition to occupying constrained pits. Root limitation does not act in isolation; it interacts with above-ground stressors that the same trees are simultaneously experiencing.

6. Comparative Context: Street Pits vs. Park and Open-Space Conditions

The thematic core of this research line is the contrast between trees in narrow streetscape pits and trees with access to open-space soil volumes. The empirical literature on this contrast is more nuanced than the intuitive picture suggests, and a responsible consulting case study should reflect that nuance.

On one hand, the soil-water and growth literature is consistent with the intuitive expectation. Comparative monitoring in Copenhagen, for example, has shown that water-retention capacity in street planting pits is substantially lower than in adjacent park soil, and that street-pit moisture is depleted rapidly after rainfall or irrigation, with a corresponding reduction in stem-area increment (LindseyRandrup and colleagues, summarized in ISA Arboriculture & Urban Forestry, 2007). The 17-year Brooklyn comparison of CU-Soil sidewalk installations against an adjacent tree-lawn demonstrated that engineered soil systems can approach tree-lawn performance, but only with deliberate design — not as a default outcome (Grabosky and Bassuk, summarized 2016).

On the other hand, recent work has begun to question the assumption that park trees are uniformly better off than street trees in all climates and contexts. A semi-arid Mediterranean comparative study published in 2026 found that street trees in some contexts experienced more stable hydraulic status than nearby park trees during prolonged dry periods, attributing the result to anthropogenic shielding effects (irrigation runoff from adjacent surfaces, reduced direct radiation in narrow canyons) (Urban Forestry & Urban Greening, in press, 2026). The takeaway for consulting practice is not that park-like conditions are unimportant — they remain a robust positive predictor of growth and longevity in temperate and humid subtropical climates — but that the comparison is climate-specific and should not be applied uncritically.

Within the central São Paulo study area observed in this field day, the operative comparison is between the constrained pit conditions of Plates 1–5 and the verifiably superior rooting conditions available in São Paulo’s 130 municipal parks and squares, which support large-canopy specimens at densities and dimensions plainly unattainable in the verticalized streetscape. The author’s direct field photographs from the Viaduto Glicério overpass area (Appendix A) illustrate the streetside extension of this contrast at the urban-corridor scale.

7. Relevance to Practice in Miami Beach and South Florida

The transferability of these observations to Miami Beach practice is direct. South Florida's combination of subtropical humid climate, narrow public rights-of-way, mature aggressive-rooting taxa (notably Ficus spp.), and high-value adjacent property creates root-infrastructure conflicts that resemble those of central São Paulo more closely than they resemble those of the temperate North American cities most often cited in the standard references. Specific points of relevance include:

- Pit-overflow conditions of the type shown in Plates 2 and 4 are routinely encountered in Miami Beach assessments and warrant the same diagnostic interpretation: high probability of rootcollar constriction, prior reactive repair, and elevated long-term failure risk.
- The international literature's emphasis on soil-volume engineering — structural cells, structural soils, and similar approaches — is directly applicable to South Florida streetscape redesigns and should be raised proactively with municipal and private clients during pre-construction phases.
- The São Paulo verticalization finding has obvious analogs along Miami Beach's denser corridors and should be considered when assessing the cumulative stress load on mature street trees in those settings.
- Where palm species are appropriate to design intent and storm-loading conditions, their fundamentally different root architecture (Plate 5) does provide a genuinely lower-risk option for hardscape interfaces, consistent with longstanding South Florida specification practice.

8. Conclusions and Future Field Work

The central São Paulo field day produced a coherent, internationally consistent, and practice-relevant set of observations on root architecture under constraint. The observed conditions — buttressed root flares overflowing sub-meter pits, repeated brick-and-mortar pavement infill, curb-edge deflection, and trunk wedging into linear gaps between walls and pavers — are precisely the conditions that the peer-reviewed literature identifies as predictors of failure and infrastructure conflict, and they are specifically supported by recent peer-reviewed work conducted in the same São Paulo districts.

This case study will serve as the first comparative datum in an ongoing international series. The next planned site is Poland in July 2026, which will offer a temperate-zone European comparison contrasting with the subtropical South American conditions documented here. Subsequent reports in this series will follow the same structure: site characterization, field methodology, photographic plates, peer-reviewed contextualization, and Miami Beach practice relevance.

10. Scope & Limitations statement

This document is an observational field case study prepared for professional education and comparative reference. It is not a site-specific tree risk assessment, engineering opinion, or condition assessment of any individual tree. Observations and interpretations are limited to conditions visible during the field investigation.

10. References

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