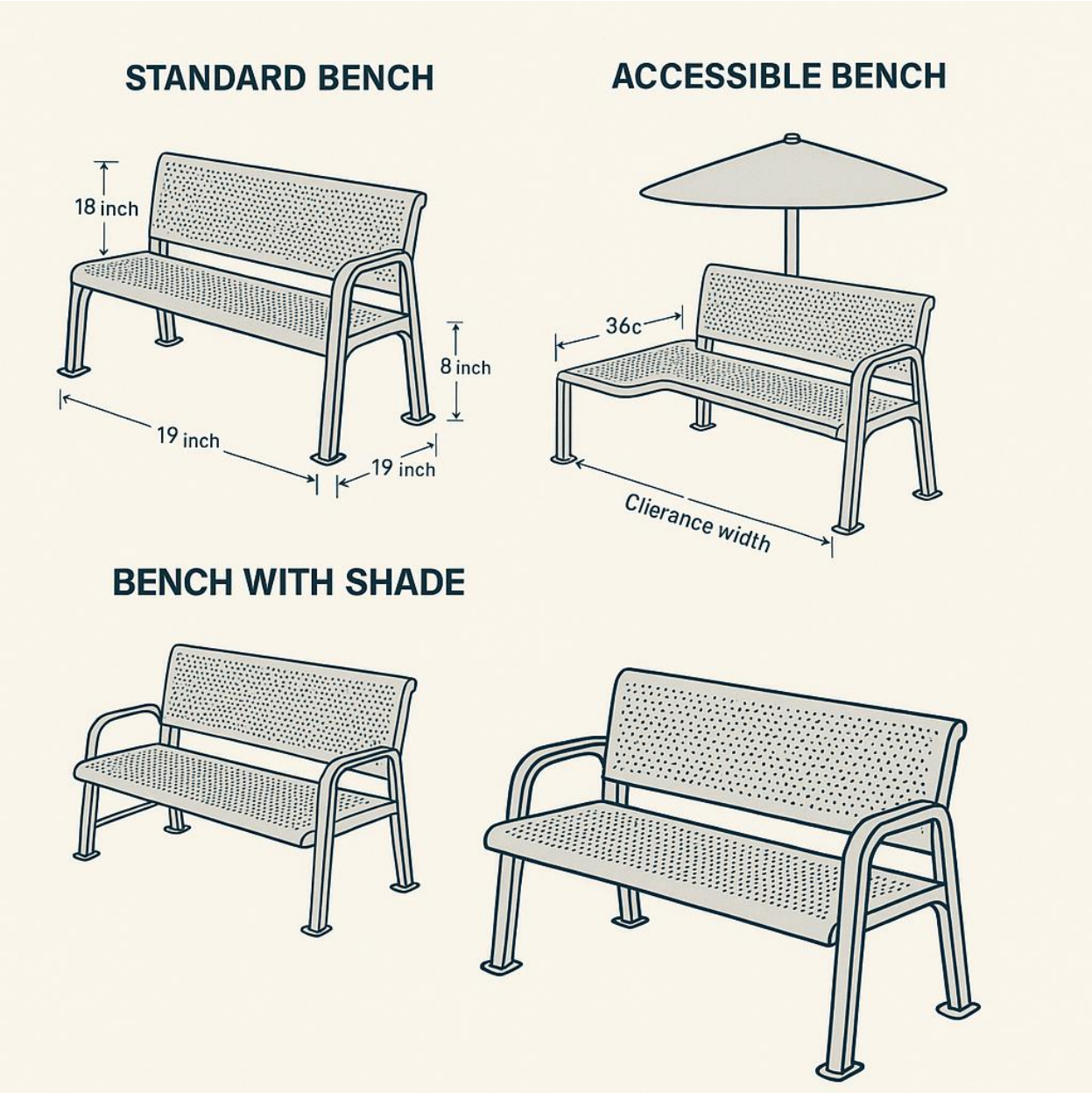
REDESIGNING PUBLIC BENCHES FOR UNIVERSAL ACCESSIBILITY AND CLIMATE ADAPTATION



Executive Summary

Public seating is an essential element in urban design, yet traditional benches often fail to accommodate users with diverse physical needs or to endure varying environmental conditions. This case study explores the process of redesigning public benches to ensure

universal accessibility and climate resilience. Drawing from ergonomic principles, anthropometric data, and climate-adaptive material choices, a conceptual design was developed using CAD software. The proposed model enhances comfort for the elderly, individuals with mobility impairments, and users in both hot and rainy environments. The report outlines design rationale, modelling methods, and proposed improvements based on simulated feedback.

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1. Introduction

Urban furniture plays a key role in public life by promoting inclusivity, rest, and social interaction. Among these elements, public benches are common yet often underdesigned in terms of universal accessibility and environmental adaptation. Most existing benches lack features to support elderly users, wheelchair integration, or resilience against heat and moisture. This study proposes a redesign focused on functionality, comfort, and durability, while aligning with contemporary design standards and global urban needs.

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2. Problem Identification

Three major shortcomings in conventional public benches were identified:

- **Ergonomic Barriers**: Height, lack of armrests, and poor back support hinder usability for older adults and persons with disabilities.
- **Material Limitations**: Traditional wood or metal benches absorb heat or corrode in wet climates, affecting longevity and user comfort.
- **Lack of Modularity**: Fixed designs do not allow space for wheelchair users or adaptable placement in diverse public environments.

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3. Literature Review

A review of standards and prior studies revealed that:

- According to the ADA (Americans with Disabilities Act), inclusive seating must offer proper seat height (17–19 inches) and support aids.

- Biophilic design encourages the use of thermally neutral and tactile materials to improve urban seating experience.
- Studies in Copenhagen, Toronto, and Singapore emphasized that shade elements and climate-resistant coatings increase usage duration and reduce maintenance.

Sources:

- Steinfeld, E. & Maisel, J. (2012). *Universal Design: Creating Inclusive Environments*
- ADA Accessibility Guidelines (2023)
- Rahman et al. (2020), *Urban Design and Heat Resilience in Public Spaces*

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4. Design Objectives

The redesign focused on the following goals:

1. **Accessibility**: Include armrests, optimal height, and partial backrest curvature.
2. **Climate Resilience**: Use perforated thermoplastic-coated steel with anti-corrosive base.
3. **Modular Form**: Provide detachable extensions for wheelchair side space and umbrella-mountable slots.

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5. Design Process

The design methodology included:

- Sketching initial concepts based on ergonomic datasets (5th to 95th percentile).
- Creating 3D CAD models in SolidWorks with three variants: standard, accessible (with transfer space), and shaded.
- Material selection using Autodesk Material Library, focusing on non-metallic coatings and moisture-repellent laminates.
- Stress and heat retention simulations using FEM tools.

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6. Modelling and Simulation

Key dimensions in the model:

- Seat Height: 18 inches
- Depth: 19 inches
- Backrest Angle: 100° from seat
- Armrest Height: 8 inches from seat level
- Clearance Width for wheelchair side: 36 inches

Simulations showed:

- Load-bearing of up to 200 kg without deformation (steel support model)
- Surface temperature reduction of 8°C in sun-exposed areas using ventilated mesh

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7. Evaluation and Improvements

User testing via virtual reality walkthroughs and heat-mapping simulations suggested:

- Users preferred a gently curved seat edge to reduce thigh pressure
- Umbrella mounts were better received when placed to the rear-left or rear-right
- Color choice impacted surface temperature; lighter shades reduced retained heat

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8. Conclusion

The proposed design effectively addresses the dual goals of accessibility and climate adaptation. Integrating ergonomic support, durable materials, and flexible extensions allows the bench to serve a wider public. This case study demonstrates how inclusive design can enhance urban comfort while reducing environmental wear.

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9. References

- ADA Accessibility Guidelines. (2023). U.S. Department of Justice.
- Steinfeld, E., & Maisel, J. (2012). *Universal Design: Creating Inclusive Environments*.
- Rahman, S., Wong, M.S., & Li, T. (2020). *Climate-Responsive Urban Furniture*.
- Autodesk Material Library (Accessed 2025).
- SolidWorks Design Manual. (2024).