



SSC

sustainable shelter construction

SSC A series of practical guidance on
Sustainable Shelter Construction

SUSTAINABLE SHELTER CONSTRUCTION – AN OVERVIEW

Sustainability is the practice of using resources in a way that meets current needs without compromising the ability of future generations to meet their own needs, and contains environmental preservation, social justice and economic viability.

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01 | Introduction

This guideline outlines a comprehensive approach to sustainable shelter construction, integrating environmental, social, and economic principles to achieve resilient and enduring structures. It emphasizes balancing resource efficiency, community needs, and long-term viability to address both immediate and future challenges.

Environmental sustainability focuses on reducing waste, optimizing energy use, and preserving ecosystems through responsible material choices and low-impact designs. Social sustainability ensures shelters are culturally appropriate, inclusive, and designed to promote well-being. Economic sustainability prioritizes durable, cost-effective designs that lower long-term operational costs while supporting local economies.

Resilience and disaster risk reduction are essential, incorporating hazard-resistant designs to mitigate risks from natural disasters such as floods and earthquakes. Health and safety measures ensure adequate ventilation, sanitation, and structural integrity to protect occupants. Long-term solutions emphasize adaptability and smooth transitions from temporary to permanent housing, ensuring sustainable living conditions over time.

This approach promotes collaboration, combining traditional and innovative techniques while minimizing the carbon footprint of construction. By focusing on these core principles, the design and construction of shelters can harmonize with the environment, foster resilience, and support sustainable development.

02 | Comprehensive Sustainability

Sustainable shelter focuses on six interconnected aspects to create safe, resilient, and enduring structures. Environmental sustainability emphasizes resource efficiency and minimizing ecological impact. Social sustainability ensures inclusivity, addressing community needs and social equity. Economic sustainability emphasizes affordability, financial feasibility, and long-term investment. Health and safety prioritize well-being, with attention to secure, hazard-resistant environments. Resilience and disaster risk reduction involve designing for adaptability and preparedness against natural hazards. Long-term solutions ensure shelters remain functional, adaptable, and sustainable across generations. Together, these principles foster shelters that balance human, environmental, and economic needs for present and future generations.

Long-term solutions

integrate temporary shelters into broader plans for transitioning to permanent, sustainable housing.

Health and safety

prioritize adherence to safety standards and the promotion of hygiene, sanitation, and ventilation to protect occupants from hazards and diseases.

Resilience and disaster risk reduction

focus on hazard-resistant shelter design and community education to enhance preparedness and long-term resilience.



Environmental sustainability

involves minimizing resource consumption, reducing waste, enhancing energy efficiency, and designing low-impact solutions to preserve ecosystems and natural habitats.

Social sustainability

prioritizes community participation, cultural sensitivity, and accessibility to create inclusive and empowering shelter solutions.

Economic sustainability

emphasizes cost-effectiveness, support for the local economy, and durability to maximize resources and minimize long-term costs.

03 | The Dilemma of Manufactured Building Materials

Manufactured building materials like steel, concrete, and aluminum are essential in modern construction due to their strength, durability, and adaptability. Their properties support innovative designs, large-scale projects, and structural performance. At the same time, their production processes are energy-intensive, contributing significantly to carbon emissions and environmental degradation. This creates a complex challenge: the need to reconcile their outstanding structural advantages with their considerable ecological footprint. Solutions lie in advancing sustainable production methods, optimizing resource use, and exploring alternative materials that maintain performance standards while reducing environmental impact, ensuring the balance between progress and sustainability in construction practices.



Cement Plant (Foto © Tasiacenturystocks)

Cement

Cement is a fundamental ingredient in modern construction, primarily in making concrete.

Its versatility, strength, and durability make it a go-to material for various structures, from bridges to skyscrapers. Cement's ability to withstand environmental factors ensures longevity in construction projects.

The production of cement is energy-intensive and contributes significantly to global CO2 emissions. Over-reliance on cement can also lead to unsustainable construction practices and habitat destruction.



Cement Bricks



Roofing with CGI-Sheets

Corrugated Galvanised Iron Sheets

Corrugated iron sheets are durable and lightweight materials commonly used for roofing and walls in urban and rural areas. They are cost-effective and weather-resistant but can amplify heat and noise without insulation, are prone to rust without treatment, and raise environmental concerns due to mining impacts.

Tarpaulins

Tarpaulins, typically made from plastic or canvas, are versatile waterproof sheets used for emergency shelters, material covers, and site protection. Their lightweight and durable nature suits various applications, but non-biodegradable versions contribute to pollution, and prolonged UV exposure can degrade their effectiveness over time.

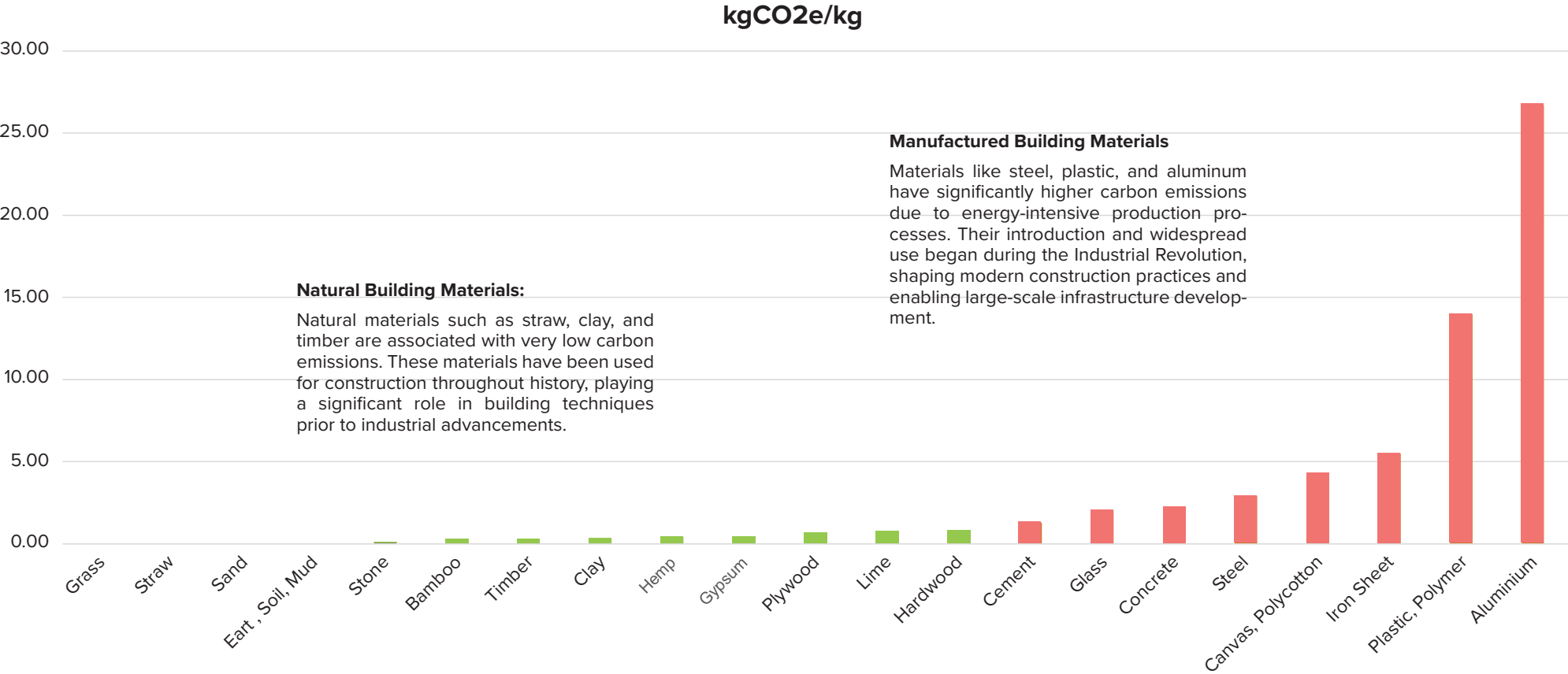
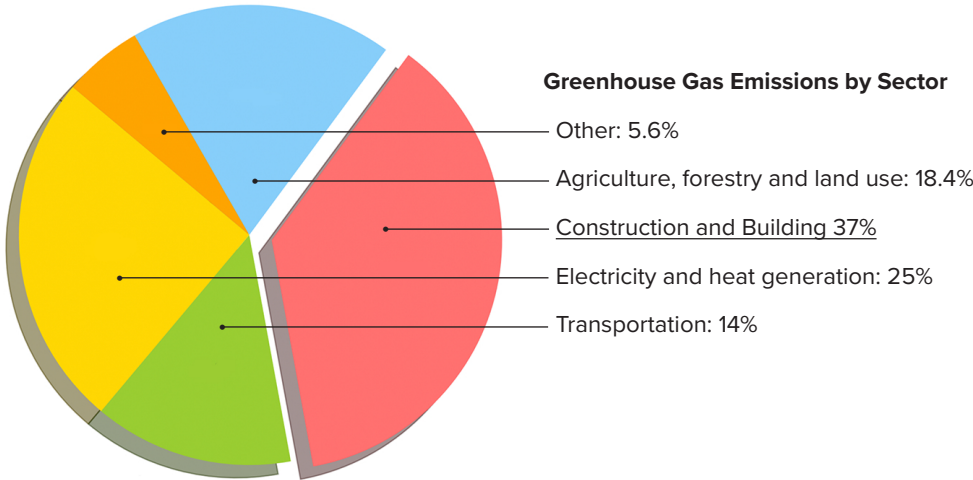


Tarpaulins for Roofs and Walls

04 Embodied Emissions

Embodied emissions represent the greenhouse gas emissions generated during the production, transportation, and assembly of building materials. This **graphic** highlights the significant contribution of the construction and building sector, accounting for 37% of global greenhouse gas emissions, alongside other major sectors such as electricity and heat generation, transportation, and agriculture.

The **bar chart** underscores the varying carbon intensities of materials, ranging from low-impact options like grass, straw, and timber to high-impact materials such as cement, steel, and aluminum. By prioritizing low-carbon materials and practices, the construction industry can play a pivotal role in reducing global emissions and fostering sustainability.



05 Sustainability in Vernacular Construction

The widespread use of industrially manufactured materials in modern construction has brought significant ecological challenges, including high carbon emissions, resource depletion, and environmental degradation. In contrast, vernacular architecture, rooted in traditional practices, offers a more sustainable alternative.

By **relying on locally sourced materials and adapting to the specific climatic and cultural context**, these structures minimize environmental impact while maximizing harmony with their surroundings. Vernacular designs reflect the ingenuity of communities in addressing local needs, integrating efficient resource use, climate adaptation, and cultural symbolism. Exploring these traditions can inspire innovative, sustainable approaches to contemporary building practices.



Multi-level adobe dwelling, Taos Pueblo, Taos New Mexico United States (Foto © J.B. Burke)

Solar Gain and Sunlight Control

The windows of the Taos Pueblo dwellings in New Mexico are small and often irregular in shape, designed to minimize heat loss in winter and keep interiors cool in summer. These modest openings reflect the practicality and resourcefulness of traditional adobe construction in response to the harsh desert climate.

Rainwater Management

The architecture of traditional houses considers the local precipitation patterns. Roofs, gutters, and drainage systems are designed to efficiently collect and manage rainwater.



Traditional water harvesting techniques in the Thar desert (Foto © VillageSquare)

Thermal Comfort

Climate influences the design of traditional houses to achieve thermal comfort. For example, in hot climates, houses may feature shaded courtyards, thick walls, and high ceilings to promote airflow and reduce heat gain.



Old wooden house with grass insulation

Developed Appearance

In a modern implementation near Santa Fe, New Mexico, adobe bricks and clay plaster were used to take advantage of the thermal properties of clay. The chimney and the roof gutters reflect the climatic variations of the region.



New Adobe Construction, Santa Fe, New Mexico, (Foto © Daniel Schwen)

Disaster Resilience

Traditional building techniques often incorporate solutions to hazards such as earthquakes, floods and windstorms, with features such as timber bracing for flexibility, elevated foundations for floods and wind-resistant construction.



Traditional Bhattar Construction, Pakistan, Foto © T. Schacher

06 Participatory Approach

Involvement throughout the Shelter Project Cycle

The Shelter Project Cycle is a comprehensive framework that emphasizes the involvement of the targeted community throughout each stage of the process. From the initial **assessment** phase, the community's input is vital in identifying needs, priorities, and available resources. During the **design and planning** stage, local knowledge and preferences shape solutions that are both culturally appropriate and sustainable. In the **implementation phase**, active participation fosters ownership, skill-building, and resilience. Continuous **monitoring and evaluation** involve the community to ensure the project remains adaptable and effective. **Capacity-building** initiatives further empower local stakeholders to maintain and improve their shelters. Finally, the project is **handed over** to the community, ensuring long-term sustainability through their full engagement and ownership.



Exit Strategy & Handover

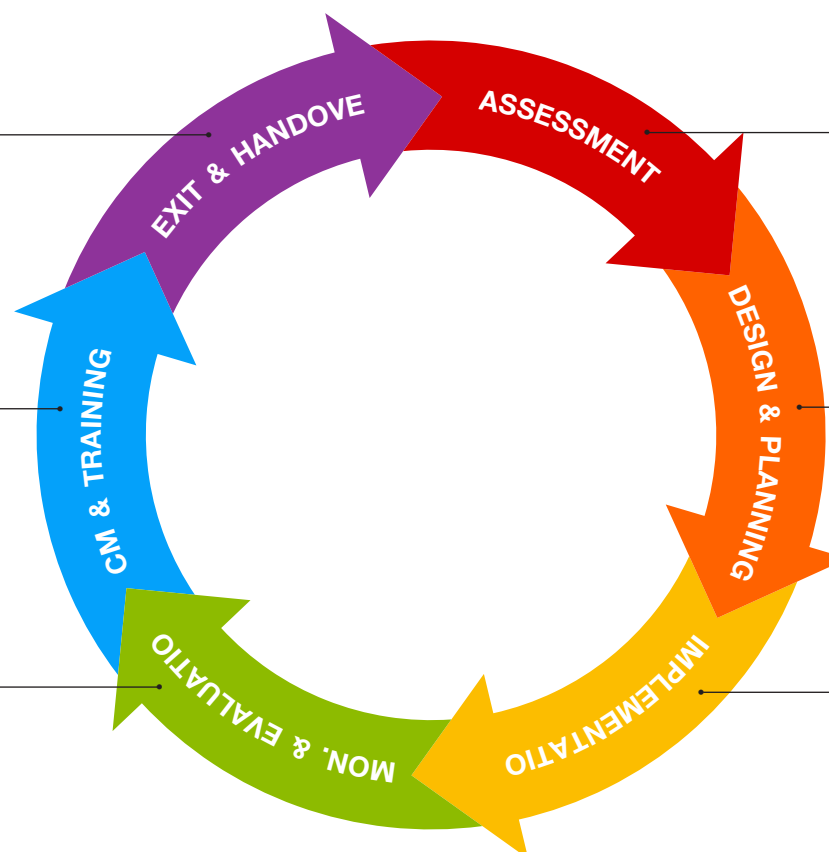
When transitioning out of the program, ensure beneficiaries are well-equipped to manage and maintain their shelters. Engage them in discussions about the future and sustainability.

Capacity Building & Training

Training sessions empower beneficiaries with skills and knowledge about shelter maintenance, disaster risk reduction, and more. This fosters resilience and independence in the community.

Monitoring & Evaluation

Periodic feedback from beneficiaries is vital for course correction. They can point out what's working and what isn't. Feedback boxes, community meetings, and participatory evaluations can facilitate this.



Assessment Phase

During the initial assessment phase, engage beneficiaries to understand their needs, vulnerabilities, capacities, and priorities. This can involve surveys, focus groups, and individual interviews.

Design & Planning

Involve beneficiaries in co-designing shelter solutions. This ensures culturally relevant, sustainable, and context-specific interventions. Workshops and community meetings can be platforms for this collaboration.

Implementation

Encourage beneficiary-led construction and setting up of shelters. This builds ownership and can also provide local employment opportunities. Training sessions can be organized to impart necessary skills.

07 Natural Construction Materials

Durable shelter construction methods are organized by **material and technique**. Timber-based methods include timber frame with cladding, wattle and daub (wood combined with clay or mud), and Dhajji, a timber-laced design adapted for seismic resilience. Bamboo Construction relies on bamboo, valued for its flexibility, strength, and rapid renewability. Earth Construction involves techniques such as compressed earth blocks (CEB), interlocking stabilized soil blocks (ISSB), and adobe, all utilizing a mix of soil, clay, and natural fibers.

Stone Construction features traditional masonry practices like Bhattar, where stone is the primary building material.

These materials are either renewable or finite. Renewable materials, including timber, bamboo, and adobe, can be replenished sustainably. Finite materials, such as those used in fired clay structures, cement-based blocks, compressed earth, and quarried stone, are limited and require mindful resource management to reduce depletion and environmental strain.

Earth/Clay

Earth and clay are abundant, natural materials used in adobe, cob, and rammed earth construction. They offer high thermal mass, regulating indoor temperatures efficiently. These materials are low-cost, fire-resistant, and recyclable. However, they require stabilization with lime or cement in wetter climates to improve durability and reduce erosion.

Bamboo

Bamboo is a rapidly renewable material used in structural frameworks, flooring, and scaffolding. Its high strength-to-weight ratio makes it an excellent alternative to timber and steel. Found in tropical and subtropical regions, bamboo grows quickly and absorbs CO₂, but it requires proper treatment to resist insects, fungi, and moisture.

Straw/Grass

Straw and grass are lightweight, renewable materials often used in construction for insulation, roofing, and straw bale walls. They provide excellent thermal performance, reducing heating and cooling needs. Readily available in agricultural areas, they are biodegradable and low-cost but require proper sealing to prevent moisture and pest issues.

Wood

Wood is a versatile and durable building material used for structural framing, flooring, and cladding. Sourced from forests, it offers strength, flexibility, and aesthetic appeal. Sustainably managed timber ensures environmental responsibility. However, it requires treatment for fire resistance and protection against pests and decay to extend its longevity.

Aggregates

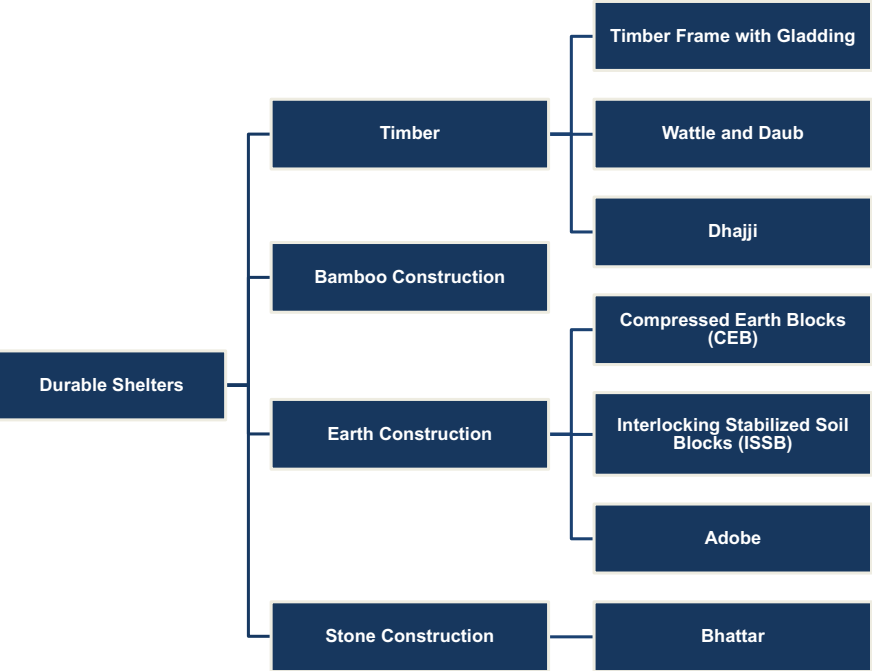
Aggregates, such as sand, gravel, and crushed stone, are vital for creating sturdy foundations, roads, and drainage systems. They enhance stability and durability in construction projects. Commonly sourced from quarries and riverbeds, aggregates are cost-effective and versatile. However, their extraction can lead to environmental degradation, necessitating responsible mining and recycling practices.



08 Local Construction Techniques

Constructing with natural materials is a crucial approach to reducing environmental impact while ensuring durable and resilient shelter solutions. Techniques such as wattle and daub, compressed earth blocks (CEB), and interlocking stabilized soil blocks (ISSB) demonstrate the versatility and strength of earth-based methods. Similarly, renewable resources like bamboo and timber, when combined with thoughtful design, provide sustainable alternatives to energy-intensive materials such as steel and concrete.

Using locally sourced materials not only lowers the carbon footprint but also enhances cost-efficiency and adaptability to local climates. Earth construction methods like adobe or CEB offer excellent thermal insulation, while bamboo and timber ensure flexibility and renewability. By integrating these traditional and natural materials into modern construction practices, professionals can create structures that meet housing needs while promoting environmental sustainability.



Main Construction Material for Durable Shelters

Material and Craftsmanship

The use of locally available materials in combination with the skills of local artisans ensures sustainability, cost efficiency and resilience. This synergy strengthens the knowledge of the community, minimizes the environmental impact and promotes cultural identity. Traditional techniques optimize material efficiency while promoting self-reliance and pride in local heritage.



Transitional Bamboo Shelter, UNHCR

Transporting Knowledge

The inclusion of traditional building techniques increases resilience to natural disasters by drawing on the adaptive knowledge acquired over generations. Local methods that are tailored to specific ecological challenges ensure the structural stability and safety of the community.



New Bhatar (Stone, Timber) Construction, Pakistan, (Foto © T. Schacher)

Community empowerment

Using locally sourced materials such as laterite to create Interlocking Stabilized Soil Blocks (ISSB) can empower communities by creating sustainable livelihoods and fostering self-reliance. For example, initiatives that involve training community members to make these environmentally friendly bricks not only provide an affordable and environmentally friendly building material, but also challenge traditional gender roles and empower marginalized groups. By equipping individuals with skills and knowledge, such projects build resilience, improve economic opportunities, and strengthen the social fabric of the community.



Produced on the site: ISS-Blocks after curing

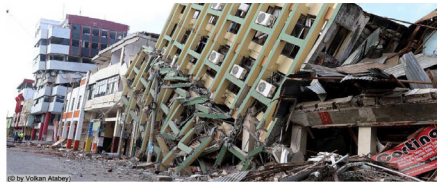
09 Resilience and Disaster Risk Reduction

A key factor in sustainable shelter design is **ensuring physical resilience against external forces**. These forces can be climatic, such as flooding, heavy rain, storms, extreme heat, or cold, or they may stem from geological events like earthquakes and landslides. Enhancing a structure's durability begins with **selecting an appropriate site and incorporating environmental considerations into the construction process**. Traditional architectural solutions often evolved in response to these natural pressures, providing time-tested methods of protection.

The four main natural hazards:



Landslides



Earthquake



Storm



Flood

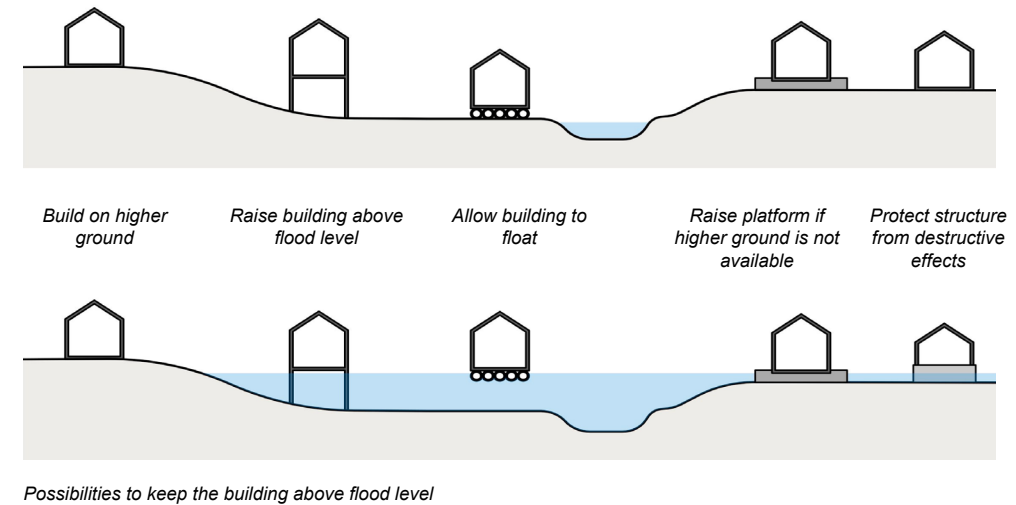
Achieving resilience against natural hazards involves **reinforcing structures** to withstand external forces such as earthquakes and storms.



New Dhajji (Stone, Timber) Construction, Pakistan, (Foto © T. Schacher)

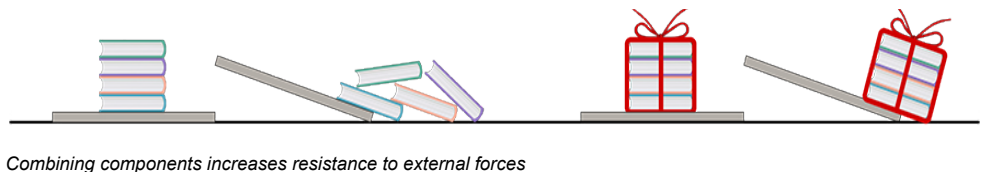
Strategies for Flood-Resilient Structures

Flood resilience in building design aims to mitigate damage through a combination of location and structural adaptations. Key approaches include situating buildings on higher ground, elevating structures above anticipated flood levels, and incorporating floating mechanisms where feasible. In cases where neither relocation nor elevation is practical, constructing raised platforms or protective barriers can safeguard the structure. These strategies collectively reduce the destructive impact of floodwaters and enhance long-term sustainability in flood-prone areas.



Strategies for Earthquake-Resilient Structures

Enhancing earthquake resistance involves reinforcing various building materials and techniques. The fundamental principle is to create a strong, interconnected structure that can flexibly absorb seismic forces. This requires securely connecting all parts of the building while minimizing the size and mass of components that could detach or collapse. These measures help distribute stress evenly, reducing structural damage and ensuring greater safety during seismic events.



10 Health and Safety

Health and safety are fundamental aspects of sustainable housing construction, ensuring that the built environment protects and promotes the well-being of its occupants. This includes adhering to **structural safety standards, minimizing hazards and improving indoor air quality, hygiene and sanitation**. Proper planning and design can mitigate risks such as fire, disease transmission and structural failure, while promoting comfort and resilience in both everyday and emergency situations.

Effective health and safety measures go beyond building materials and techniques. They include **site selection, ventilation, insulation and the integration of water and drainage systems**. By considering these elements, emergency shelters become safer and healthier places for communities to live.



Foto © UNHCR

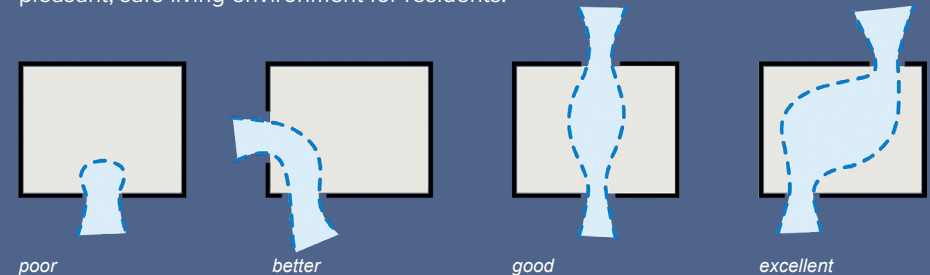
Health and safety as basic requirements for dignified living

Structural integrity

Strong foundations, reinforced beams and secure roofs prevent collapse from natural forces like earthquakes and windstorms and ensure stability, longevity and protection from structural failure over time.

Ventilation and air quality

Proper ventilation systems and breathable materials promote air circulation and reduce pollutants, moisture and mold indoors. This improves respiratory health and creates a pleasant, safe living environment for residents.



Hygiene and sanitation

Access to clean water, sanitation and proper drainage prevents the spread of disease. Integrated systems improve hygiene and health by effectively disposing of waste and providing safe access to water supplies.

Fire protection

Fireproof materials, controlled cooking areas and planned emergency exits protect against fire hazards. These measures reduce the risk of injury, prevent deaths and ensure quick and safe evacuation in emergencies.

Thermal comfort and insulation

Insulated walls, floors and roofs stabilize internal temperatures by protecting against extremes of heat and cold. This reduces energy consumption, improves comfort and prevents temperature-related health issues.

Protection from external hazards

Careful site selection and hazard-resistant construction reduce vulnerability to natural hazards such as flooding and landslides. Proper design ensures that the shelter remains safe even under adverse environmental conditions.

Safety from toxic materials

Non-toxic building materials minimize exposure to harmful substances such as volatile organic compounds, lead and asbestos. Choosing safe materials improves air quality, prevents chronic health problems and ensures the safety of workers during construction.

GENEVA TECHNICAL HUB

The Geneva Technical Hub (GTH) has been established to improve the lives of refugees, internally displaced persons and their host communities by enhancing the quality of technical programming in disaster risk reduction (DRR), energy, environment, shelter/housing, settlement planning, water, sanitation and hygiene.

GTH brings together Swiss academia and expert practitioners to tackle complex technical problems, share learnings, and find solutions that can be applied in diverse UNHCR operational contexts.

