GUIDELINES FOR **FLOOD RESILIENT HUMANITARIAN SHELTERS**

GENEVA TECHNICAL HUB

Co-convened by

UNHCR The UN Refugee Agency

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
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Swiss Agency for Development and Cooperation SDC

AUTODESK FOUNDATION

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01 | INTRODUCTION

1.1 Goal and Impact

The increasing frequency and intensity of climate-related disasters, particularly floods, pose significant risks to displaced persons living in temporary shelters. Flooding is one of the most prevalent climate risks faced by refugee and IDP camps, severely threatening the safety and well-being of already vulnerable populations.

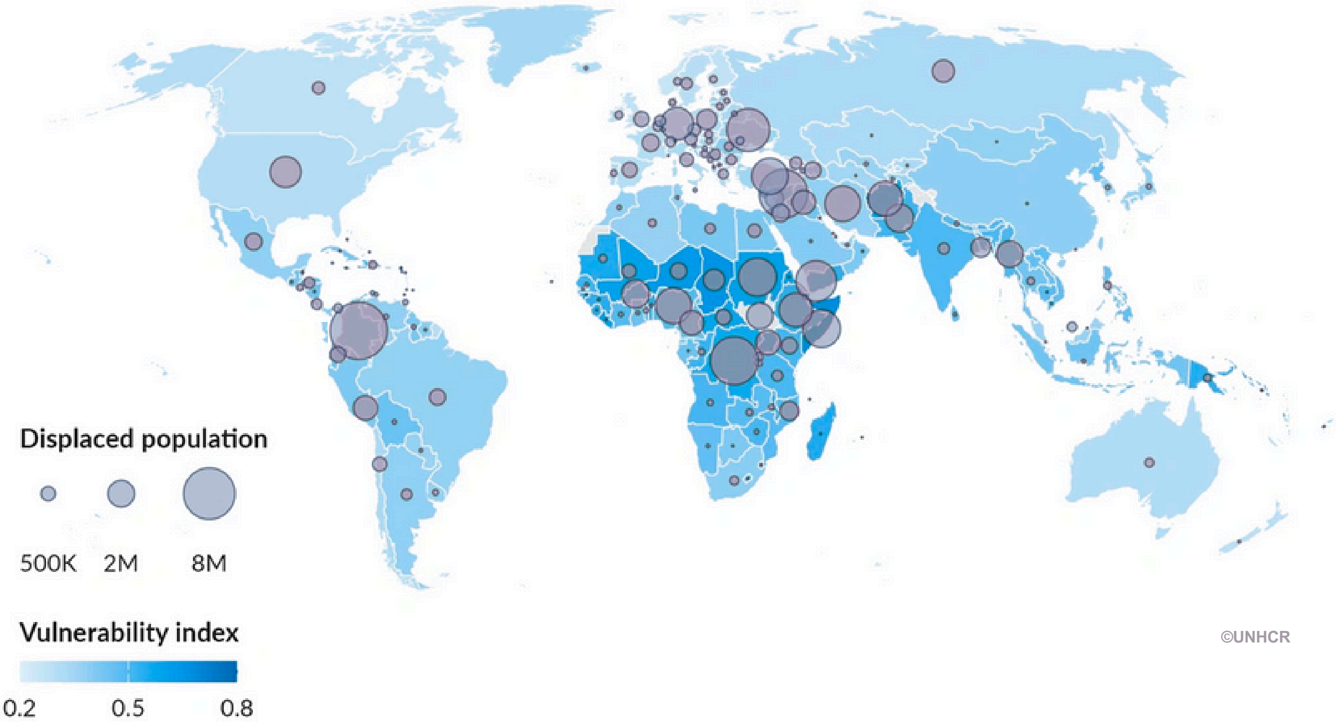
This guideline is focused primarily on enhancing flood resilience in shelter design, addressing the urgent need for shelters that can withstand such hazards. By equipping shelter officers with comprehensive templates, best practices, and construction techniques, it aims to reduce the risks of injury, loss of life, and further displacement due to flooding.

In alignment with UNHCR's Strategic Framework for Climate Action (2024-2030), the guidelines will also address other climate risks, including heatwaves, sandstorms, cyclones, and hurricanes. These additional sections ensure that shelters are designed to provide comprehensive protection against a variety of extreme weather events, fostering resilience and sustainability in humanitarian shelter provision.

1.2 Challenge: Converging Crisis

GEOGRAPHICAL OVERLAP

Displacement areas often overlap with regions highly vulnerable to climate change. Many displaced populations reside in areas with high climate risk, such as Sub-Saharan Africa, South Asia, and the Middle East. These regions frequently experience extreme weather events, including floods, droughts, and hurricanes, all worsened by climate change. Coastal areas face rising sea levels and stronger storms, while arid regions endure prolonged droughts. This geographical overlap amplifies risks, as displaced populations not only flee environmental disasters but also face challenges finding safe stable shelter in similarly climate-vulnerable regions.



1.3 Shelter Resilience Gap

THE IMPACT OF INADEQUATE FUNDING

Flooding is one of the most devastating climate-related hazards affecting refugee camps, particularly those located in low-lying areas or near water bodies. Flooding can destroy shelters, contaminate water supplies, and disrupt essential services like healthcare, education, and food distribution, worsening the already fragile conditions for refugees.

In regions like Cox's Bazar, Bangladesh, where monsoon rains cause severe flooding, poor drainage systems and deforestation worsen the situation, leading to waterlogging and landslides. Floods also block access to humanitarian aid and lead to the spread of waterborne diseases, such as cholera and diarrhea. UNHCR stresses flood-resistant shelters, improved drainage, and flood mitigation measures, including building dykes, to protect refugee populations from these damaging effects.

02 | FOUNDATIONAL RESEARCH

2.1. Impact of Climate Change and Crisis on Refugees

The UNHCR has pinpointed 22 countries where the impacts of climate change will be most intense by 2030. These nations, which include regions like the Eastern Horn of Africa, Afghanistan, Bangladesh, Ecuador, and Honduras, are significantly affected by both conflict and climate change. Together, they account for 52% of all internally displaced persons, 24% of all stateless individuals, and 28% of all refugees (UNHCR, 2024). The UNHCR has recognized the critical need for climate action and sustainability, as outlined in its Strategic Framework for Climate Action and Operational Strategy for climate resilience. These initiatives emphasize protecting displaced populations from the increasing frequency and severity of extreme weather events, such as floods, droughts, and storms. (UNHCR, 2020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FLOODS AND VULNERABILITY IN REFUGEE CAMPS

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Recent research indicates that without significant action to combat climate change and reduce disaster risks, by 2050, 200 million people will need aid annually due to its effects (UNHCR, 2024). The intersection of these impacts with conditions in refugee camps underscores the urgent need for climate-resilient shelter solutions. These should be designed to withstand hazards but also to enhance the overall resilience of displaced populations, aligning with the UNHCR's second pillar of climate action and sustainability.

EXTREME WEATHER CONDITIONS/STORMS CAMPS

Extreme weather conditions, including storms, hurricanes, and cyclones, pose a significant threat to refugees, particularly in camps located in coastal or tropical regions. These weather events can cause widespread destruction, tearing apart shelters, uprooting trees, and disrupting services. Refugee camps, which are often constructed with temporary and makeshift materials, are particularly vulnerable to the high winds and heavy rains associated with storms. For example, in the aftermath of Cyclone Idai in 2019, refugee camps in Mozambique experienced severe damage, with many shelters being destroyed and access to aid being severely hindered (UNHCR, 2019).

To enhance resilience against extreme weather conditions, humanitarian organizations have been focusing on strengthening shelter designs, improving early warning systems, and training refugees in disaster preparedness. For instance, in the Philippines, where typhoons frequently occur, the UNHCR has been working to implement storm-resistant shelters and establish community-based disaster risk reduction programs to better equip refugees to respond to extreme weather events. (UNHCR, 2021) These initiatives are crucial in reducing the vulnerability of refugee populations to the devastating impacts of storms and other extreme weather conditions.

2.2. Existing Shelter Designs

In humanitarian aid contexts, various shelter designs are employed to accommodate displaced persons. These designs vary in durability, cost, and adaptability to different environmental conditions.
According to the Shelter Design Catalogue by UNHCR, several key shelter types are widely used:

- Global Shelter Designs
- Emergency Shelter Designs
- Transitional Shelter Designs
- Durable Shelter Designs

EMERGENCY | TRANSITIONAL | DURABLE

COMPARATIVE ANALYSIS OF EXISTING SHELTER DESIGNS

UNHCR Family Tent: Emergency Shelters

- ⊕ Easily transported and quickly assembled, providing immediate relief at low-cost
- ⊖ Limited Climate Adaptation: Basic structures not equipped to handle severe weather events.
- ⊖ Low Durability: made from lightweight materials vulnerable to extreme weather.

Bamboo mats: Transitional Shelters

- ⊕ Offers more stability than emergency shelters and provides more comfort.
- ⊕ Can be upgraded or repurposed for longer use.
- ⊖ More resilient than emergency shelters but still vulnerable to harsh weather conditions.
- ⊖ More expensive and requires materials - challenging

Non-reinforced masonry: Durable Shelters

- ⊕ Built with strong materials, designed to withstand extreme weather events like floods, hurricanes, and extreme temperatures.
- ⊕ Can be tailored to local climate and cultural needs
- ⊖ Suitable for extended stays, offering stability and comfort.
- ⊖ High cost, complex logistics, and unsuitable for rapid post-disaster deployment

2.3. Case studies for different geographical contexts

This chapter on foundational research concludes with findings from two case studies, chosen based on the size of displaced populations, the regions' vulnerability index (see Figure 1), and the frequent occurrence of floods. Insights from meetings with field officers in refugee camps on the impact of climate change, particularly floods, on displaced populations. These insights highlight community vulnerabilities, the challenges faced, and potential sustainable solutions to mitigate environmental risks and enhance shelter resilience.

2.3. Case studies for different geographical contexts

he Dadaab refugee complex in northeastern Kenya, established in 1991 for Somali refugees, expanded in 2011 with 130,000 more arrivals. Comprising Dagahaley, Ifo, Hagadera, and Ifo 2, the complex has faced ongoing challenges from droughts and floods.

The El Niño rains of 2023-2024 caused severe flooding, especially in Ifo 1 and Ifo 2, displacing 20,000 households. Farms in Dagahaley and Hagadera were also damaged, leading to significant crop and poultry losses

In 2006, torrential rain and floods displaced around 13,000 refugees from Dadaab camps. By 2023, the El-Nino event caused unprecedented rainfall, affecting nearly 25,000 people. This increasing frequency and intensity of floods underscore the urgent need for climate-resilient shelter designs in the camps.

Insights from the Field officer:

Peter Maloba, an officer from Dadaab refugee camp, shared valuable insights into flood management and mitigation efforts. Key measures include early warning systems, rapid assessments with the Kenya Red Cross, and response efforts like evacuations, distribution of essential items, and WASH (Water, Sanitation, and Hygiene) initiatives.

Temporary solutions like building dykes were used but had adverse effects on host communities, leading to their removal because they caused floods upstream. A more inclusive planning is recommended for future plans.

Challenges stem from the camp's location in low-lying areas, making it highly susceptible to flooding. Potential long-term solutions include relocating camps to higher ground, building permanent shelters using Interlocking Stabilized Soil Blocks (ISSB), elevating shelters, and improving drainage systems. Utilizing locally available materials remains essential for shelter construction.

Despite progress, further collaboration with the government and host communities is crucial to develop sustainable solutions for both refugee and host population

Refugee Camps in Idlib and Aleppo, Syria:

Syria is experiencing one of the world's most severe internal displacement crises, with 7.2 million IDPs as of 2023, second only to Sudan. The ongoing civil war, especially in Idlib and Aleppo, has displaced over 2 million people, many living in informal camps. Extreme weather events, such as heavy rain, snowstorms, and the Türkiye earthquakes of 2023, have worsened conditions, leading to repeated displacement and shelter destruction. In 2021 alone, floods and storms displaced 79,000 people. These challenges highlight the urgent need for durable shelters that can withstand both cold and wet conditions.

Insights from the Field officer:

Elias Hadjar, an officer at the Aleppo refugee camp, shared key insights into the camp's structure and infrastructure efforts. The camp consists of self-built mud, brick, and stone houses, well-suited for year-round conditions. However, inadequate drainage and sewage systems pose challenges during occasional floods, with residents often taking refuge on roofs.

Efforts to improve infrastructure include integrating sewage and drainage systems, upgrading outdated canals with underground polyethylene pipes, and adjusting local slopes to control water flow. Roof drainage systems have also been installed to mitigate flooding risks. The focus remains on enhancing existing systems to manage water flow and accommodate the growing population.

03 | CONSTRUCTION TECHNIQUES

3.1. Site Considerations and Modifications

This chapter provides an overview of the construction techniques necessary for building flood-resilient shelters. It outlines key methods for adapting shelters to protect them from floodwaters and extreme weather conditions.

The first step in site preparation is conducting a thorough assessment of the area to identify flood-prone zones. Areas with a history of flooding, or those designated as flood zones in local or regional planning documents, should be avoided. Proper site selection is crucial to ensuring the effectiveness of these construction techniques.

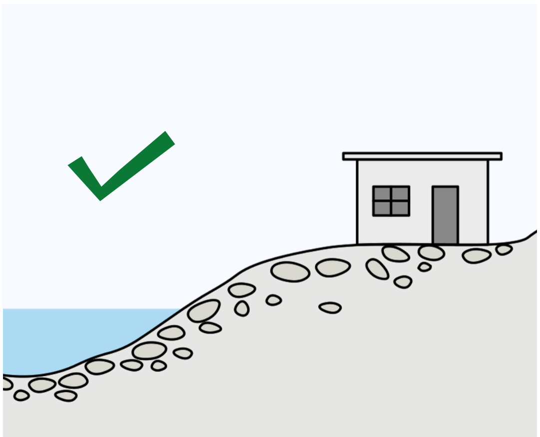
Site Selection Criteria

CONSIDER HIGHER GROUND:

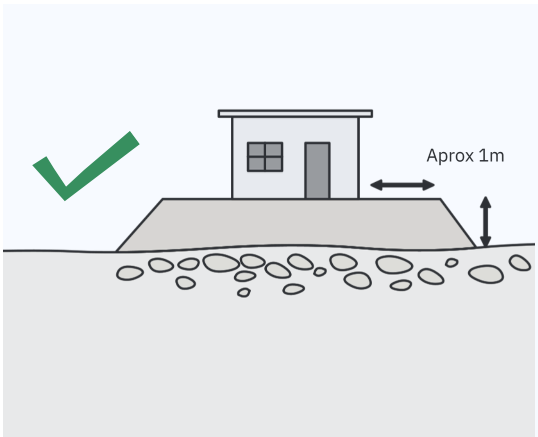
Prioritize selecting sites on higher ground to naturally avoid floodwaters. In cases where higher ground is not available, constructing elevated platforms can help mitigate flood risks. Assess the site's topography to ensure proper drainage and minimize water accumulation. Where possible, incorporate community knowledge on historical flood patterns to select the most suitable areas for shelter placement, further reducing the risk of flooding.

CHECK LIST SITE SELECTION CRITERIA

- [ ] Spot flood zones
- [ ] Seek Higher Ground
- [ ] Avoid Riverbeds
- [ ] Steer Clear of Slopes
- [ ] Away from the Sea
- [ ] Watch for Flash Floods
- [ ] Avoid Fresh Landfills



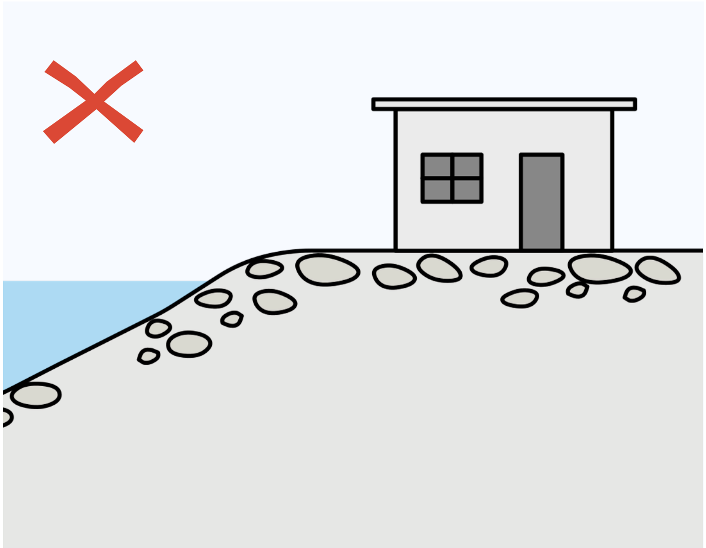
Build on higher ground.



Raise platform if higher ground is not available.

AVOID LOW-LYING RIVERBEDS:

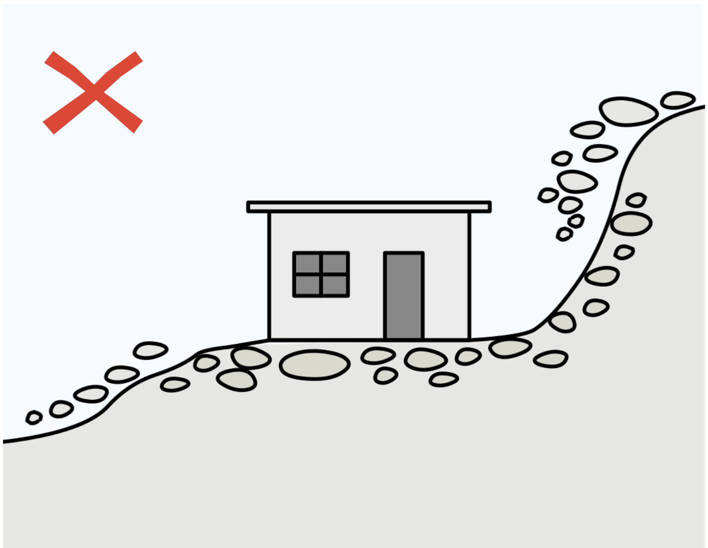
Do not construct shelters in low-lying areas, such as riverbeds, where water tends to accumulate and flow during heavy rainfall. These areas are particularly vulnerable to flash floods.



Avoid low laying river beds.

AVOID VALLEYS:

Do not build shelters in valleys, where water naturally flows and collects during heavy rainfall, increasing the risk of flash floods. In addition, valleys often have poor natural drainage, which can exacerbate flooding issues during the rainy season.



Avoid low laying river beds.

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Landslides triggered by heavy rain

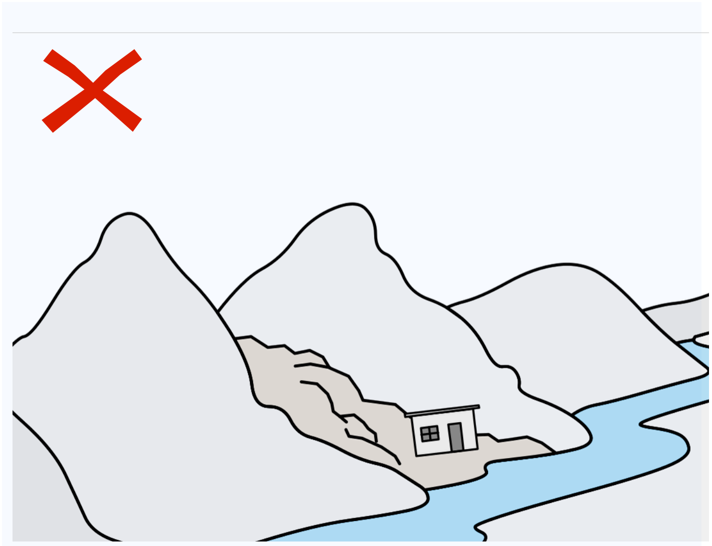
AVOID BUILDING TOO NEAR THE SEA:

Coastal areas are at risk of flooding from storms and tsunamis. Building too close to the shoreline increases the risk of shelters being affected by high tides, storm surges, or tsunamis.

Don't build too near the sea:
storms and tsunamis can flood the area

STAY CLEAR OF FRESH LANDFILLS:

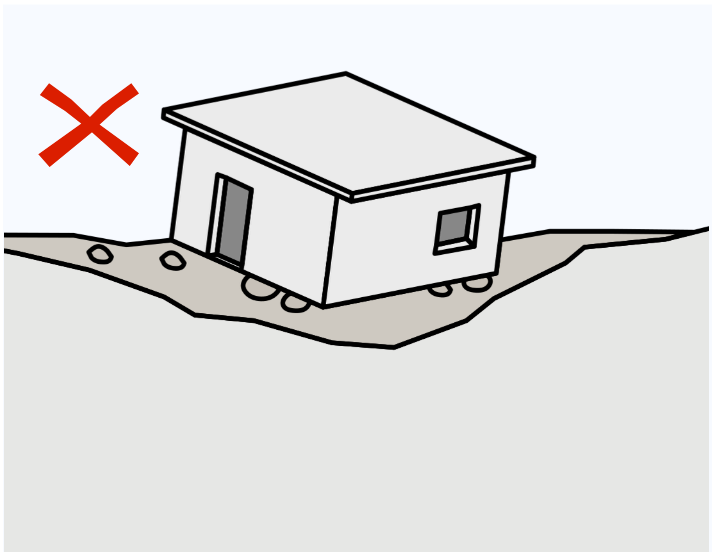
Assess the risk of flash flooding, even in areas not typically prone to it. Sudden, heavy rainfall can lead to unexpected floods. Ensure shelters are not located near potential or known flash flood paths.



Avoid low laying river beds.

STAY CLEAR OF FRESH LANDFILLS:

Fresh landfills are unstable and can be prone to subsidence and waterlogging. Avoid building on recently filled land as it may not have compacted adequately to support the weight of a shelter.



Don't build on fresh landfills

3.2. Shelter Adaptations

3.2.1. ARCHITECTURAL ADAPTATIONS

The general rule for reducing flood risk to shelters is to build them on higher ground, away from flood-prone areas. However, this is not always feasible due to land availability constraints. As a result, a combination of architectural and structural adaptations is necessary to mitigate flood damage to buildings and other assets located in vulnerable areas.

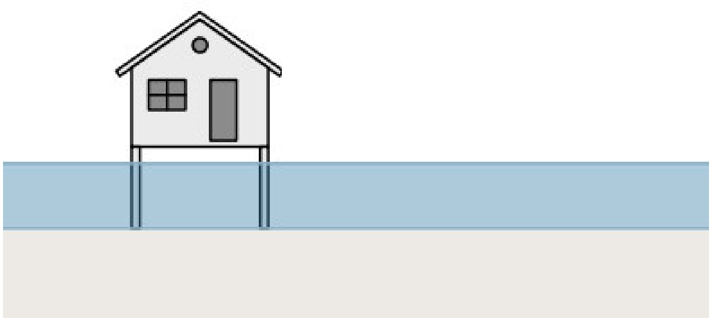
CHECK LIST ARCHITECTURAL ADAPTATIONS

- [ ] Elevated Shelters
- [ ] Raised Platforms
- [ ] Amphibious Construction
- [ ] Consolidated shelters:
    - Dry Floodproofing
    - Wet Floodproofing

1.ELEVATED SHELTERS

One of the most effective ways to protect shelters from flooding is to elevate them above the expected flood level. Usually 1 and 1.5m above the ground depending the historical flood levels in the specific area with an additional height added for safety. This involves raising the entire structure on stilts or piers, which allows floodwater to flow beneath the building without causing damage.

While effective for flooding, elevated shelters are not suitable in earthquake-prone areas due to the instability that elevated structures may present during seismic activity. The foundation design must also ensure stability against both water flow and potential erosion.



Elevation: Raise the building above the flood level.

2. RAISED PLATFORMS

In situations where higher ground is not available, constructing a raised platform is another effective flood mitigation strategy. Platforms can be built from compacted earth, concrete, or other durable materials that can support the weight of the shelter and withstand water pressure.

The platform should be elevated above the highest recorded flood level in the area. Platforms can be built to various heights depending on the flood risk and local conditions. This approach helps to keep the shelter dry and protects it from minor flooding.

The platform must be designed to ensure proper drainage and prevent water from pooling around the shelter. Additionally, the materials used should be resistant to water damage and erosion.

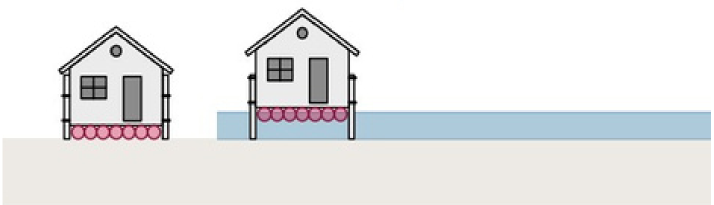
Elevation: Raise Platform if higher ground is not available.

3. AMPHIBIOUS CONSTRUCTION/FLOATING SHELTERS

Amphibious construction or floating shelters are designed to float on the water's surface, rising with the water level during floods. These structures are anchored to the ground to prevent them from drifting away but are built with buoyant foundations that allow them to rise and fall with changing water levels.

Floating shelters are particularly useful in areas where flood waters are expected to rise gradually and remain elevated for extended periods. This method involves constructing shelters on buoyant platforms or pontoons that provide stability and prevent capsizing.

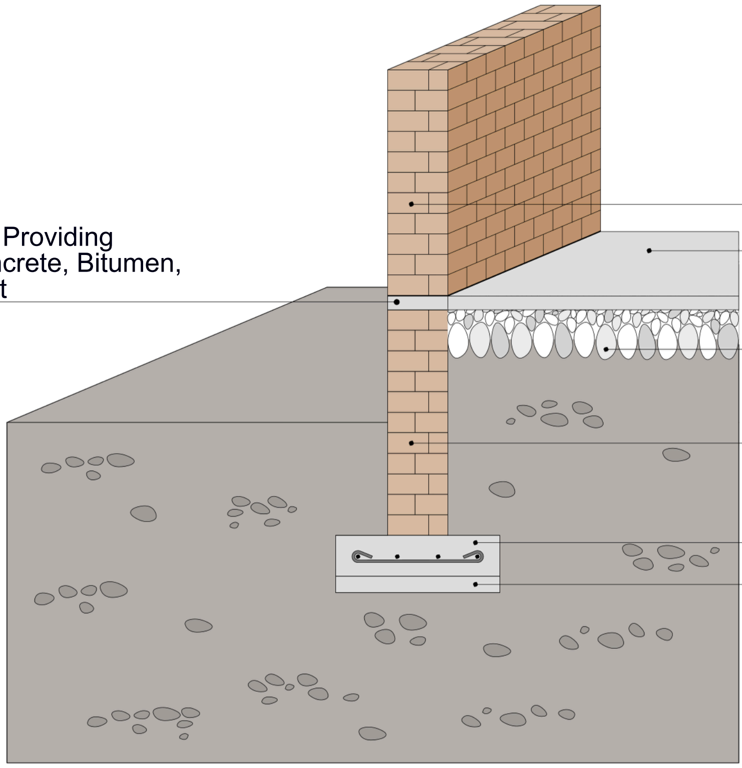
Amphibious construction requires careful planning and engineering to ensure stability and safety. This approach is less effective in areas prone to rapid flooding or strong water currents, which could destabilize the floating structures.



Floating House: Allow the house to rise with the rising water level.

3.3. Water barriers and sealing techniques

STEP BY STEP GUIDE OF CONSTRUCTION A FLOODWALL



1. **Lean Concrete Layer:** Pour a layer of 50mm lean concrete over the compacted soil to form a level and stable sub-base.
2. **Reinforced Concrete (RC) Strip Foundation:** Construct a reinforced 100mm concrete foundation to provide a strong and durable base for the floodwall.
3. **Foundation Wall Construction:** Build a foundation wall on the RC strip foundation to start the vertical structure of the floodwall.
4. **Damp Proof Course (DPC) Installation:** Apply a Damp Proof Course layer on top of the foundation wall to prevent moisture penetration
5. **Placing Large Stones Vertically:** Position large, round stones vertically without mortar on top of the DPC layer to enhance stability and flood resistance.
6. **Second Lean Concrete Layer:** Pour another layer of lean concrete over the stones to create a smooth surface for brick masonry.
7. **Brick Masonry Construction:** Build the brick masonry wall on top of the lean concrete layer to complete the floodwall.
8. **Finishing and Waterproofing:** Apply a waterproof coating to protect the floodwall from water damage. Conduct a final inspection and establish a maintenance plan to ensure the floodwall's effectiveness over time.

3.4 Materials and Supply chain

MATERIALS SELECTIONS

Materials used in shelter construction must be durable, flood-resistant, and locally available to ensure easy access and cost efficiency.

- **Flood-Resistant Materials:** Concrete, treated wood, and steel are durable against water but have high environmental and energy costs. While they reduce repair needs, their sustainability and long-term impact should be carefully considered.
- **Locally Available Resources:** Using locally sourced materials reduces transportation costs and lead times, ensuring the community can maintain and repair shelters with available resources.
- **Sustainable Materials**: Incorporate eco-friendly materials, such as bamboo or recycled materials, to reduce the environmental footprint of shelter construction.

COMPARATIVE ANALYSIS OF MATERIALS

Plastic Sheet

- ⊕ Consistent material quality
- ⊕ Waterproof
- ⊕ Low cost
- ⊖ More resilient than emergency shelters but still vulnerable to harsh weather conditions.
- ⊖ Short lifespan
- ⊖ Becomes brittle in cold weather

Bamboo

- ⊕ Positive environmental impact
- ⊕ Suitable in hot climate (provided proper ventilations)
- ⊕ Durable and strong when well treated and maintained
- ⊖ Untreated: vulnerable to insects, rot and fire.
- ⊖ Not suitable in cold climates

Bricks - mud

- ⊕ Very durable when well maintained
- ⊕ Good fire resistant
- ⊕ Regulates temperature and humidity
- ⊕ Non- toxic material
- ⊖ Sensitive to rain and wind when insufficiently protected
- ⊖ Production needs good weather conditions

SUPPLY CHAIN MANAGEMENT

Efficient supply chain management ensures the availability of necessary materials, reducing delays in construction and shelter reinforcement.

- **Supplier Partnerships:** Establish long-term partnerships with reliable suppliers who can consistently provide quality materials, especially during emergencies or peak demand.
- **Local Supply Chains:** Prioritize local suppliers to shorten supply routes and decrease dependency on distant sources that may be disrupted by natural disasters or geopolitical events.
- **Stockpiling Essential Materials:** Maintain a stockpile of critical materials, such as flood-resistant coatings, structural reinforcements, and sandbags, to enable quick response during flood events.

3.5 Other Climate-Risk Mitigation Measures

In addition to flood risk, shelters must be designed to withstand other climate-related hazards, such as heatwaves, sandstorms, cyclones, and hurricanes. Addressing these risks requires a combination of architectural design, material selection, and structural adaptations to ensure resilience under different conditions.

GENERAL SITE CONSIDERATIONS

Site selection plays a crucial role in enhancing the overall resilience of shelters to climate risks. The location should be chosen based on a comprehensive risk assessment, taking into account the area's vulnerability to multiple hazards.

- **Wind Patterns:** In areas susceptible to strong winds or cyclones, it's important to avoid locations with excessive wind exposure, such as open plains or coastal areas. Natural windbreaks, such as hills or vegetation, can offer protection.
- **Proximity to Resources:** The site should be close to essential resources like water and energy supplies while also being accessible to transportation routes for emergency supplies.

1. HEATWAVES RESILIENCE

Heatwaves are becoming increasingly common in many regions, and shelters must be designed to maintain internal comfort in extreme heat conditions. Key adaptations include: green roofs can contribute to thermal comfort.

- **Cross Ventilation:** Designing shelters with windows and openings on opposite sides allows for natural airflow, reducing indoor temperatures without the need for mechanical cooling. Louvered windows or adjustable vents can enhance ventilation control.
- **Thermal Efficiency:** Using materials with high thermal mass (e.g., concrete or brick) can help regulate internal temperatures by absorbing heat during the day and releasing it at night.
- **Envelope Insulation:** Proper insulation in walls, roofs, and floors can significantly reduce heat transfer, keeping shelters cooler in hot conditions. Insulation materials such as reflective roofing, insulating panels, or green roofs can contribute to thermal comfort.
- **Shading:** External shading devices, such as overhangs, pergolas, or trees, help block direct sunlight, reducing the amount of heat entering the shelter

2. SANDSTORMS RESILIENCE

Heatwaves are becoming increasingly common in many regions, and shelters must be designed to maintain internal comfort in extreme heat conditions. Key adaptations include:

- **Sealed Openings:** Windows, doors, and ventilation systems must be sealed to prevent sand from entering. Use weatherstripping and tightly fitted frames for windows and doors.
- **Wind-Resistant Roofing:** Roofs should be designed to resist strong winds and prevent the accumulation of sand. Sloped roofs are more effective than flat roofs in reducing sand buildup.
- **External Barriers:** Vegetation barriers or windbreaks, such as trees or fences, can help reduce the impact of wind and sand on shelters.
- **Durable Exterior Materials:** Walls and roofs should be made from durable materials that can withstand erosion from sand and wind, such as reinforced concrete, steel, or treated wood.

3. CYCLONES AND HURRICANES RESILIENCE

Cyclones and hurricanes present significant structural challenges, including extreme wind speeds and heavy rain. Designing shelters with structural integrity and secure foundations is crucial to ensure their resilience.

- **Reinforced Structural Systems:** The structural framework should be reinforced with materials such as steel or reinforced concrete to resist the forces generated by high winds and debris impact.
- **Strong Foundations:** Deep foundations, such as reinforced concrete footings or piles, help anchor the shelter and prevent it from being uprooted during extreme wind events.
- **Wind-Resistant Roofs:** Roofs should be securely anchored to the shelter's walls using hurricane clips or straps to prevent uplift. Hip roofs, which have fewer edges exposed to wind, are generally more resistant to wind damage than gable roofs.
- **Impact-Resistant Windows and Doors:** Windows and doors should be made from impact-resistant glass or fitted with shutters to protect against flying debris.
- **Storm Shutters and Barricades:** Temporary storm shutters or barricades can be installed over windows and doors to provide additional protection during hurricanes or cyclones.

04 | CAD TEMPLATES FOR FLOOD-RESILIENT SHELTERS

This chapter gives an overview of CAD templates and guidelines needed for designing flood-resilient shelters. It highlights important structural elements, material choices, and construction methods that help protect shelters during floods.

These templates are designed to be used globally, ensuring shelters can not only address immediate disaster needs but also adapt to future climate challenges.

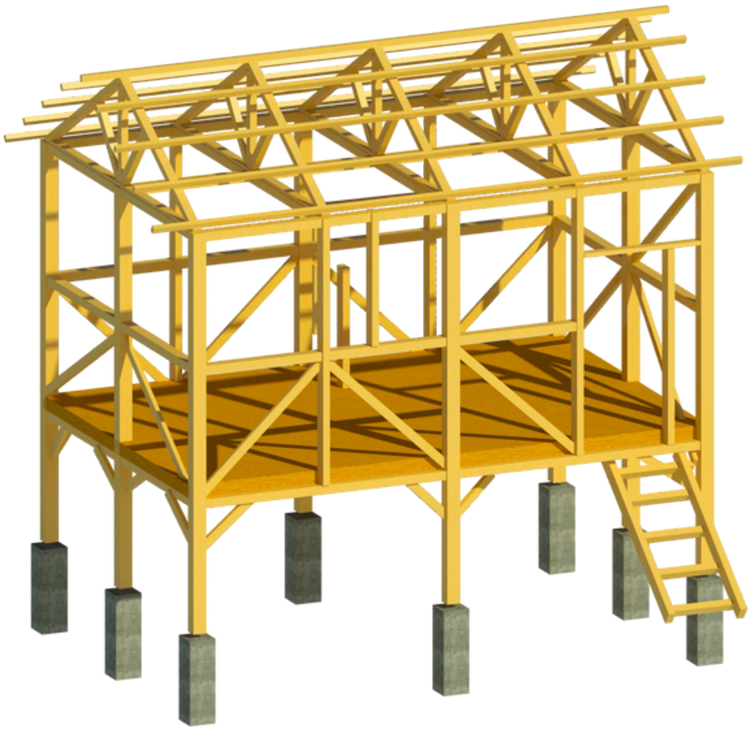
The designs include single and twin elevated shelters on stilts, as well as shelters built on raised platforms for better flood protection.

4.1 Single Elevated Shelter
3D Structure

Shelter Design Overview:

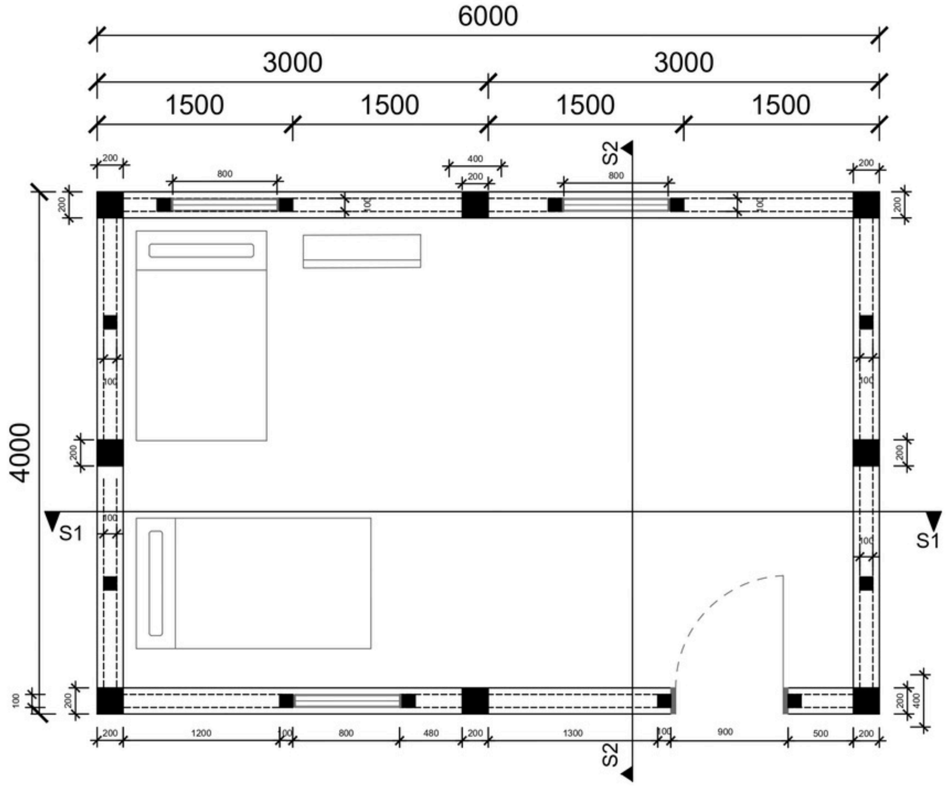
- This shelter features a **gable frame structure**, designed to efficiently drain water and protect against harsh weather.
- The shelter is built on an elevated platform, **raised 1.5 meters** above ground to prevent flood damage. This height can be adjusted based on local flood risks and terrain conditions, ensuring adaptability to different environments.

- The frame is constructed from locally available materials, such as **timber or wood**, making it cost-effective and easy to maintain.
- For added stability, the shelter's columns are encased in **concrete, embedded 1 meter below ground** to provide resistance against flooding and heavy rainfall, reinforcing the shelter's durability.

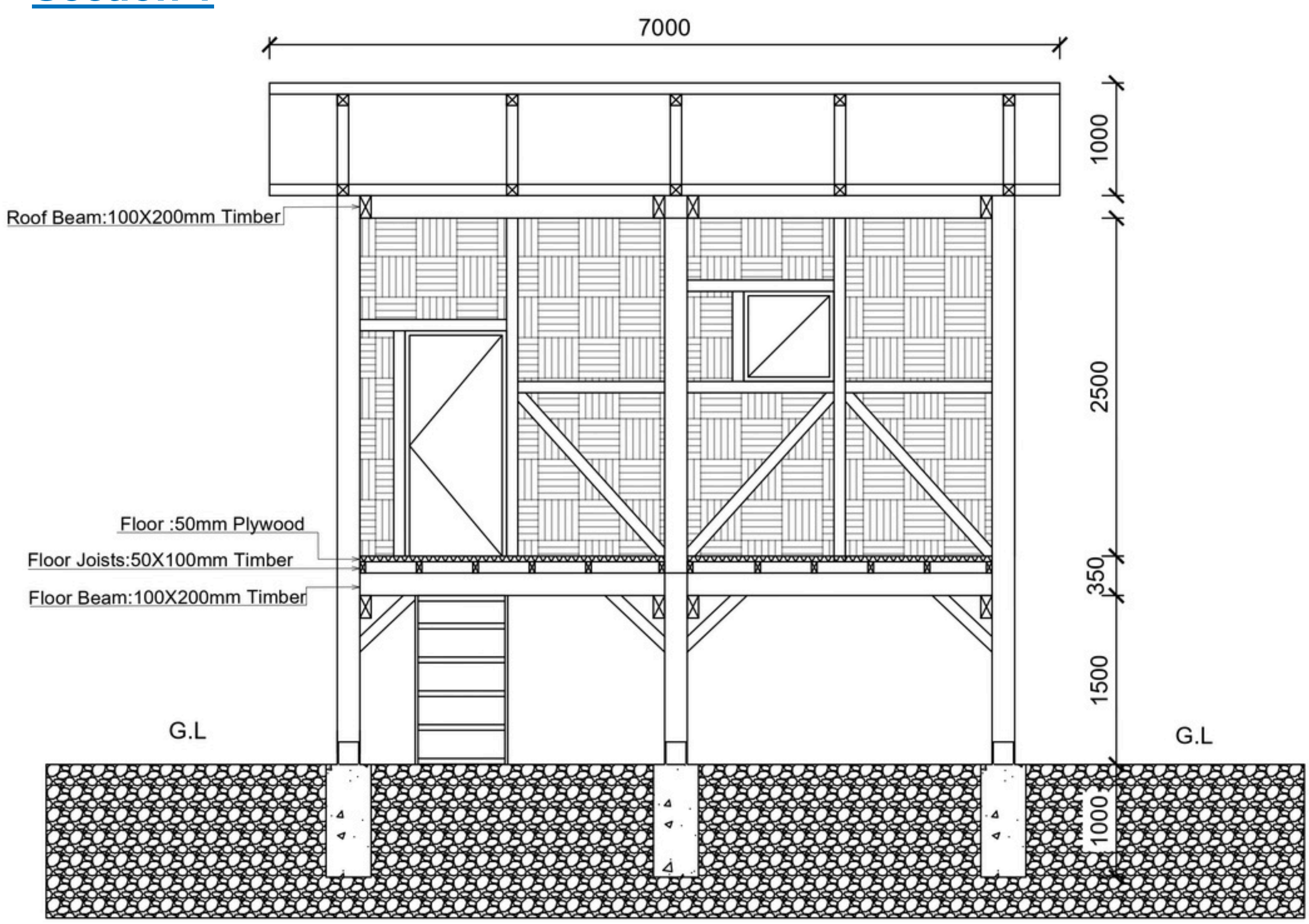


CAD Drawings

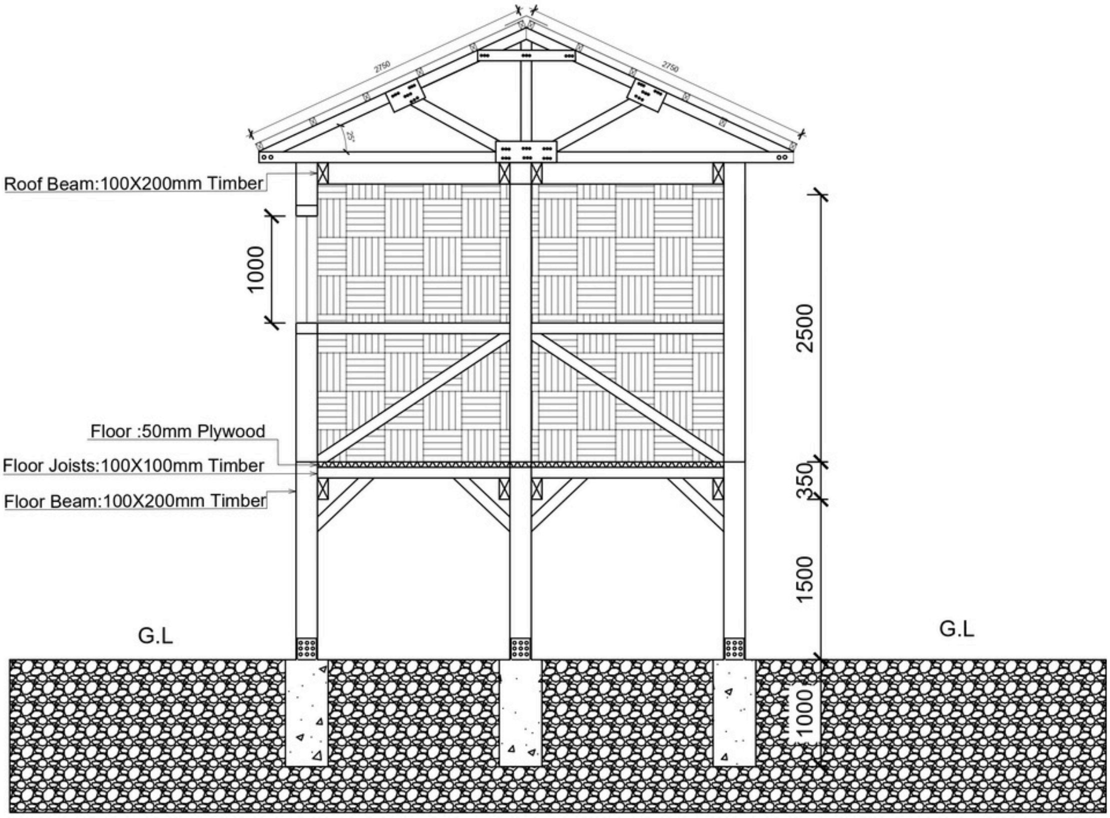
Floor Plan



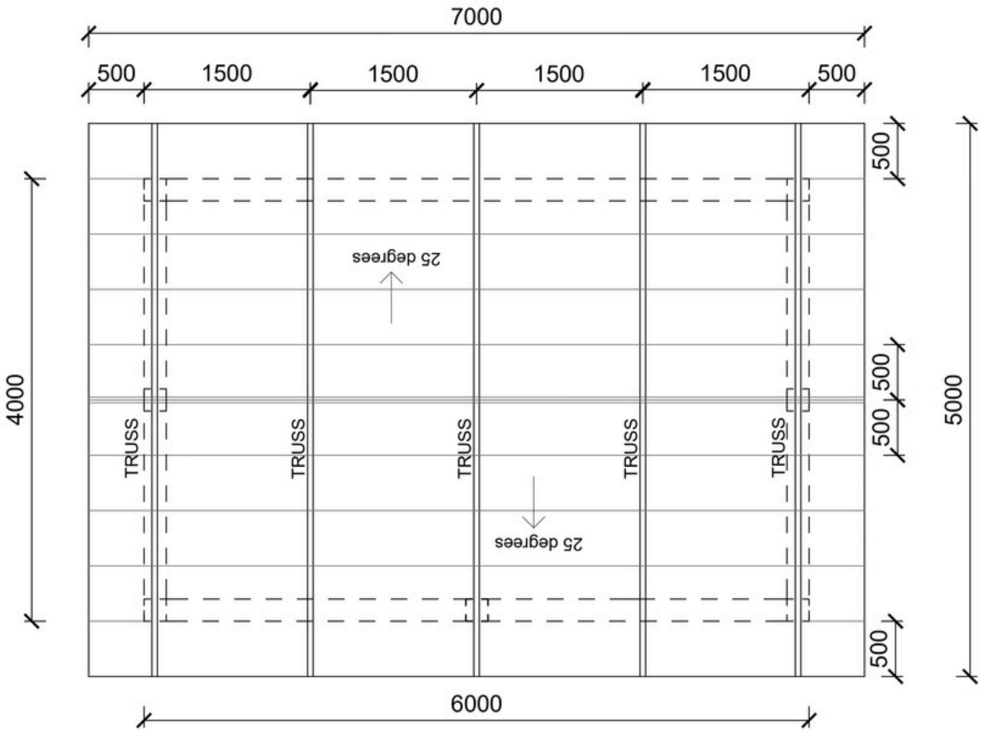
Section 1



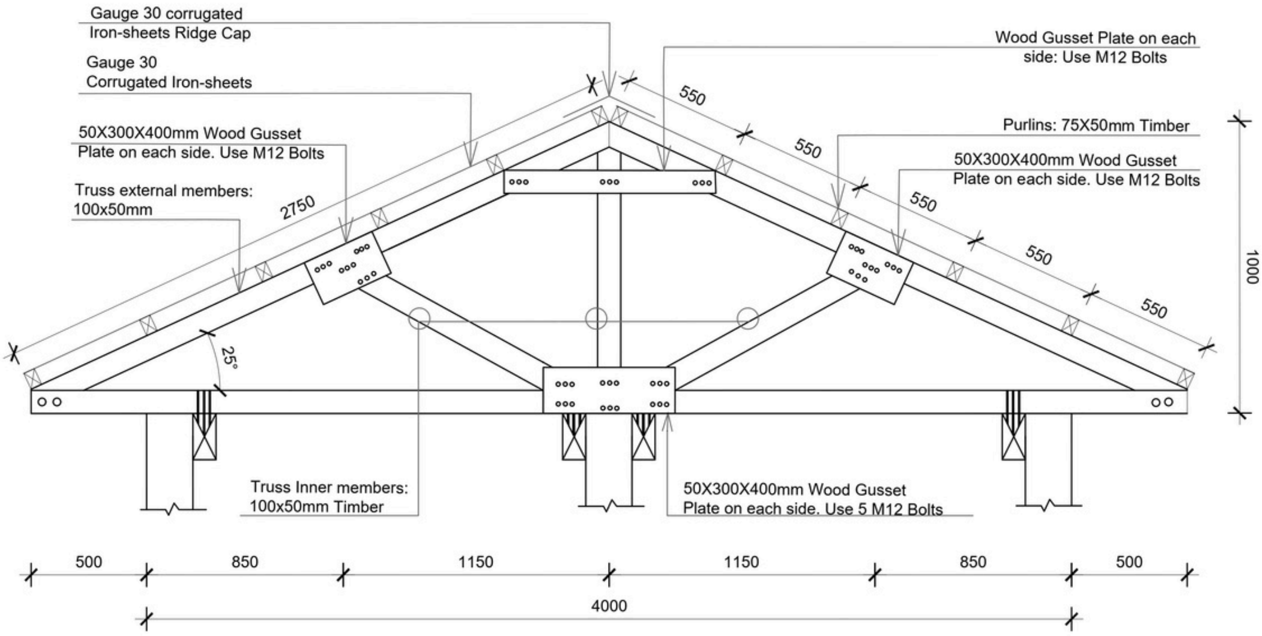
Section 2



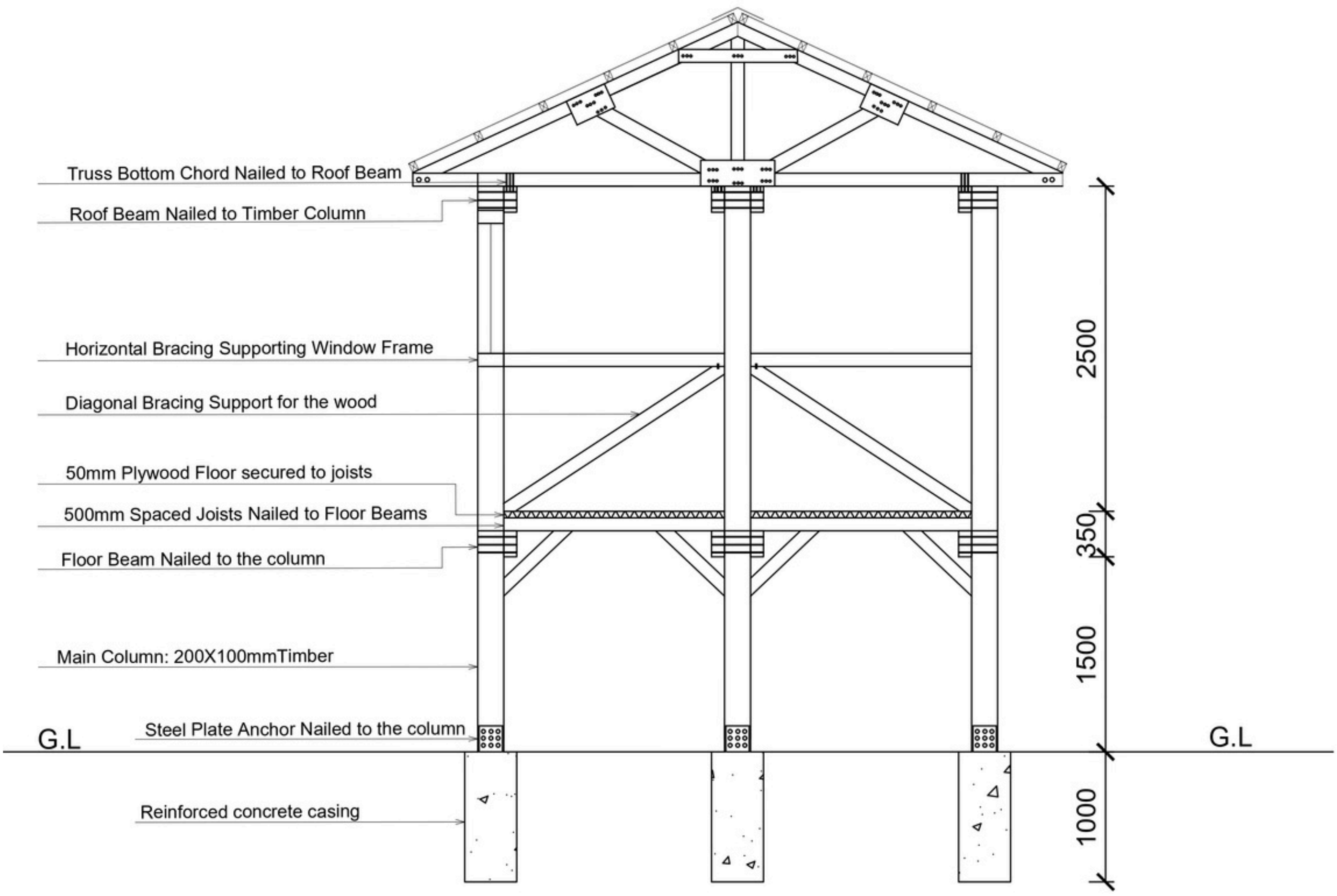
Roof Plan



Typical Truss Detail



Joint Connection



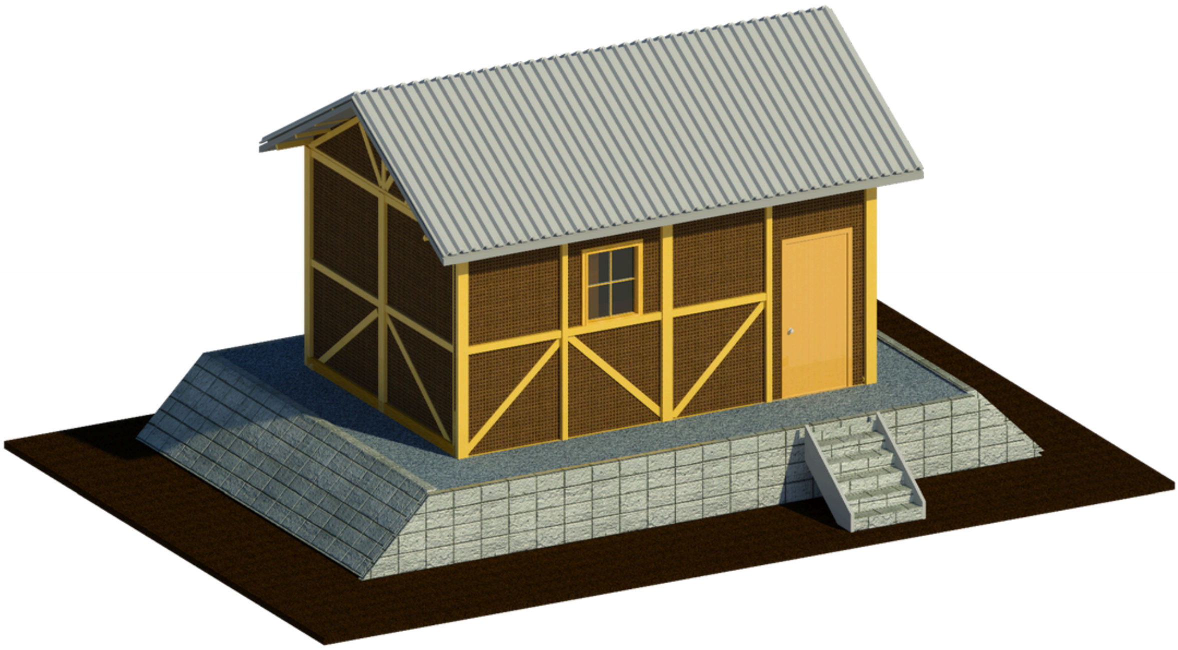
Bill of Quantities
Single Elevated Shelter

	Item	Specification	Unit	Quantity
1	Concrete foundation	Earthworks and 0.5m Excavation	m3	2.0
2	FoundationEarthworks and 1m Excavation	0.4mx0.4m Cement ratio mix 0.45:1:2:4	m3	4
3	Anchor plates	Steel Plates 400mmX180mm	Pieces	3.2
4	Timber columns	4m Pretreated Timber 200x200mm	Pieces	8
5	Floor beams	6m Pretreated Timber 100x200mm	Pieces	8
6	Floor Joists beams	4m Pretreated Timber 50x100mm	Pieces	8
7	Flooring	1.2x2.4m Plywood sheets covering 24m2	m2	24
8	Diagonal column bracing	1m Pretreated Timber of 100x50mm	Pieces	9
9	Diagonal wall bracings	1.8m Pretreated Timber 100x50mm	Pieces	16
10	Walls	Woven Bamboo mats	Pieces	10
11	Vertical wall bracings	2.5m Pretreated Timber 100x50mm	Pieces	50
12	Horizontal wall bracings	2m Pretreated Timber 100x50mm	Pieces	4
13	Door	1mx2m Timber door panel	Pieces	6
14	Windows	1mx800mm Timber panel	Pieces	1
15	Roof beams	6m Pretreated Timber 100x200mm	Pieces	3
16	Truss	4m Pretreated Timber 100x50mm	Pieces	8
17	Purlins	7m Pretreated Timber 50x75mm	Pieces	20
18	Corrugated Iron roofing sheets	0.9mX3m sheets covering 35m2	Pieces	10
19	Bolts, washer and nuts	50mm diameter; bolts 10cm long	kg	3
20	Nails	10-11cm and Roofing nails(Umbrella type)	kg	7

MATERIAL SUBSTITUTIONS BASED ON LOCAL AVAILABILITY:

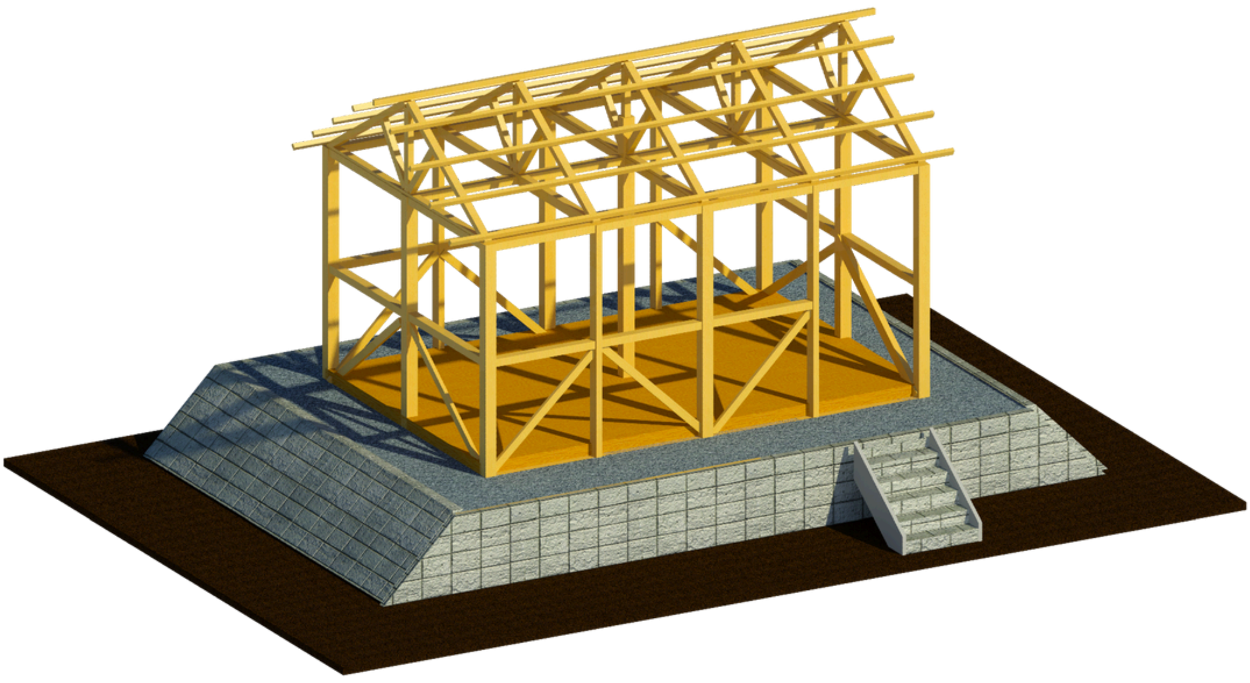
1. **Timber Substitution:** Substitute timber with locally sourced, pretreated wood for structural elements. In other cases use treated bamboo poles for columns, beams, trusses, and bracings where timber is unavailable.
2. **Walls:** Where Bamboo matts are unavailable, use tarpaulin sheets (provided by UNHCR) for wall cladding or mud/ clay bricks if available.
3. **Roofing:** Use tarpaulin sheets with bamboo mats or thatch as a temporary roofing solution when iron sheets are not accessible.
4. **Flooring** Plywood Alternatives: Use bamboo planks, locally available wood, or compacted earth as substitutes for plywood flooring.

4.2 Shelter on a Raised Platform



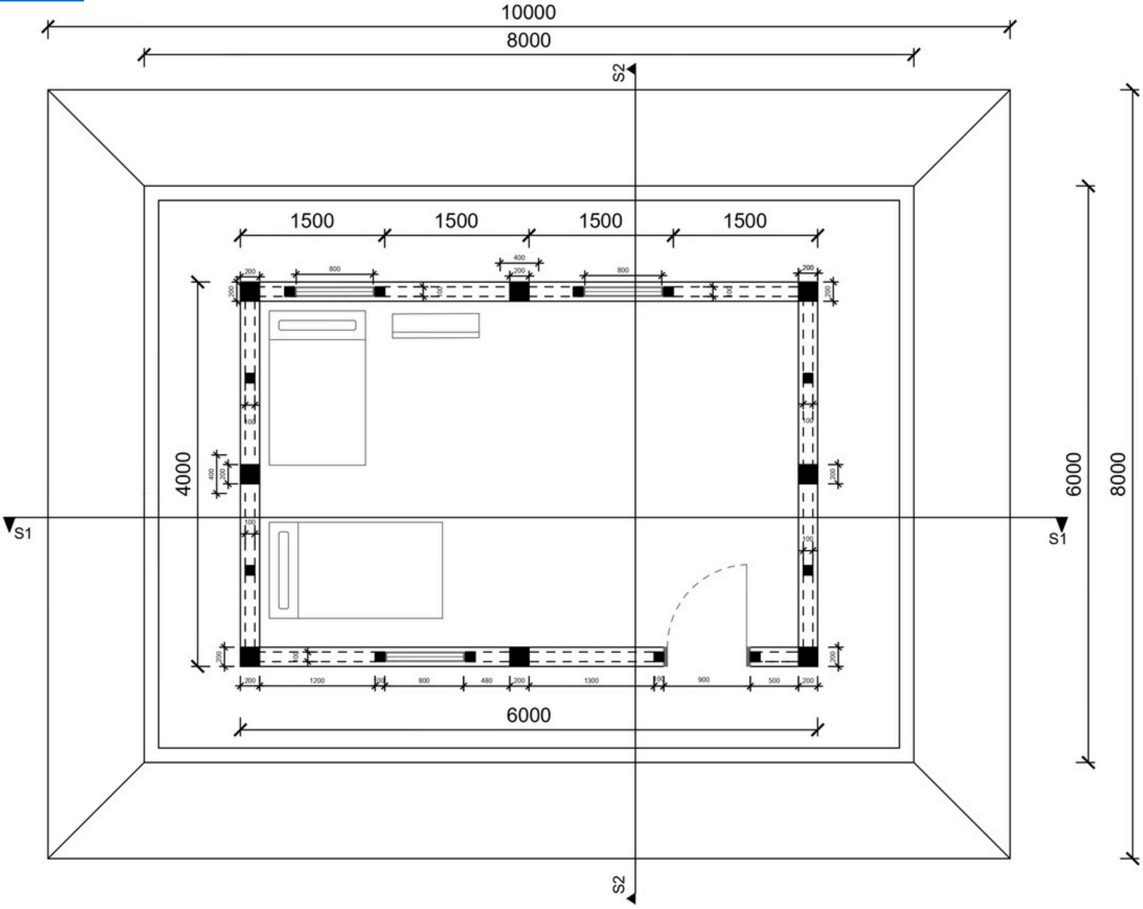
Shelter Design Overview:

- This shelter also features a **gable frame structure**, designed to efficiently drain water and protect against harsh weather.
- The shelter stands on a raised platform, **1 meter** above ground, to prevent flood damage. This height can be modified based on local flood risks and terrain.
- The platform comprises compacted earth, reinforced with **rocks and stones angled at 45 degrees** to pad the walls and ensure stability.
- The frame is constructed from locally available materials, such as **timber or wood**, making it cost-effective and easy to maintain.
- For added stability, the shelter's columns are encased in concrete and **embedded 0.5 meters below ground**, offering strong resistance to flooding and ensuring durability.

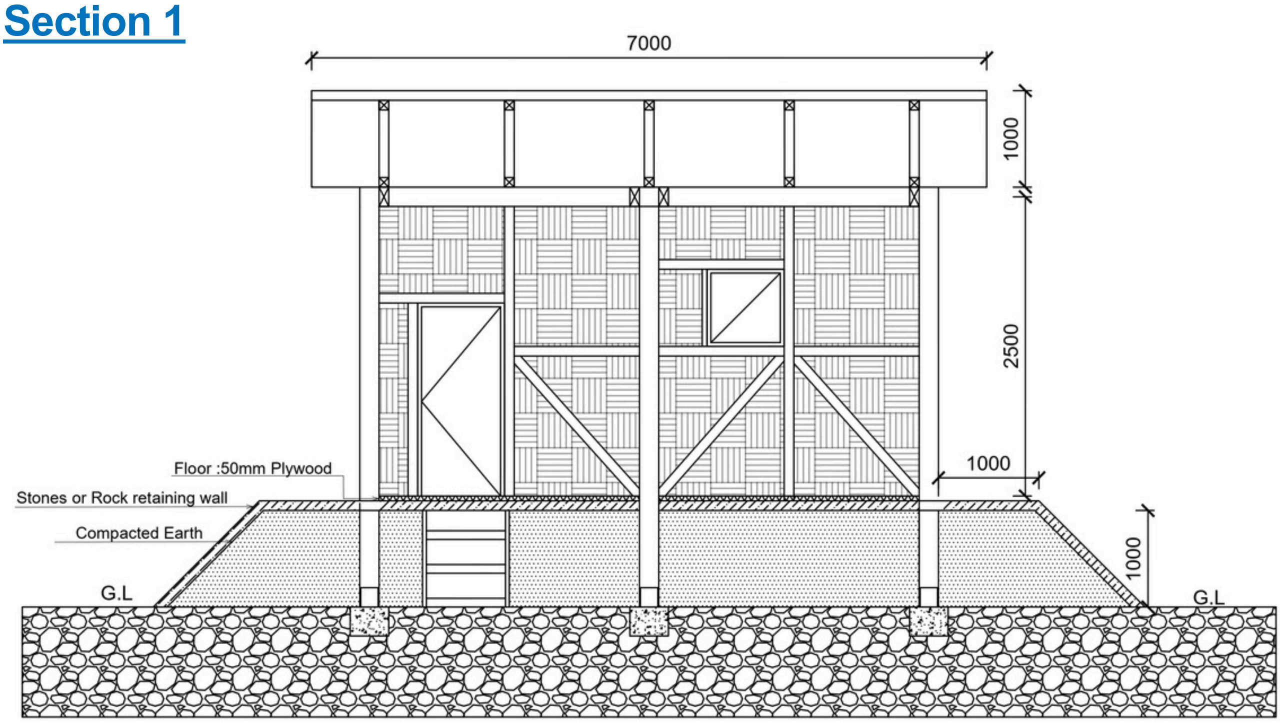


CAD Drawings

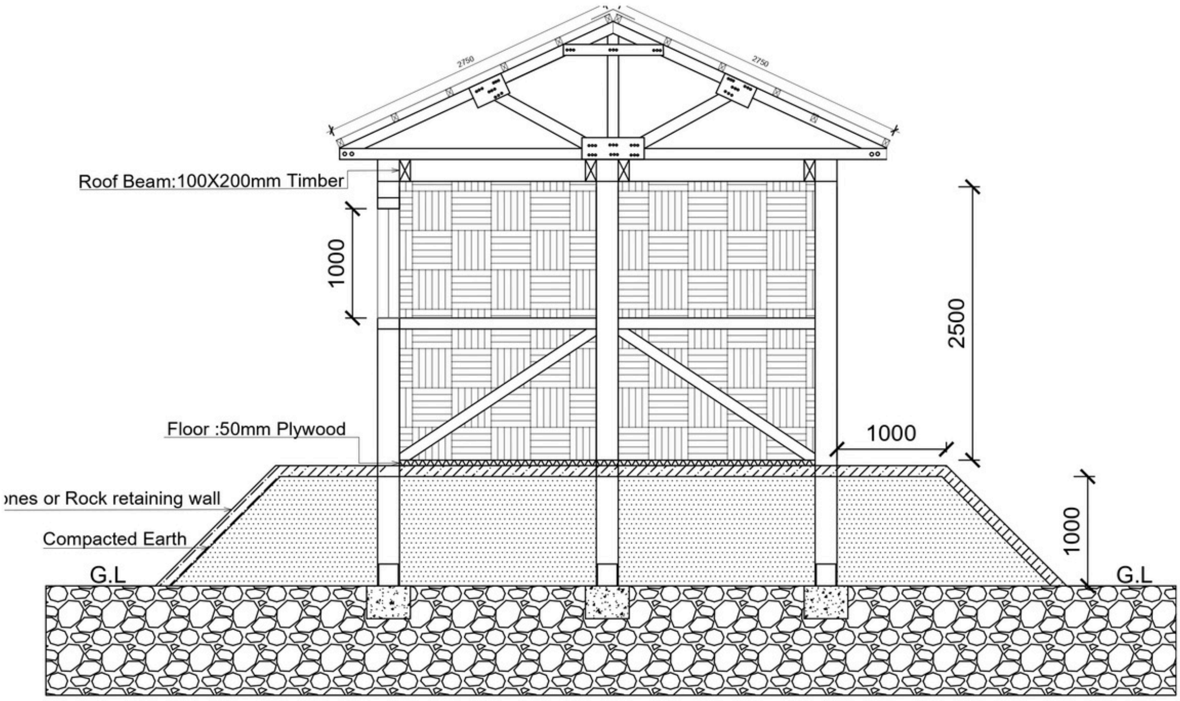
Floor Plan



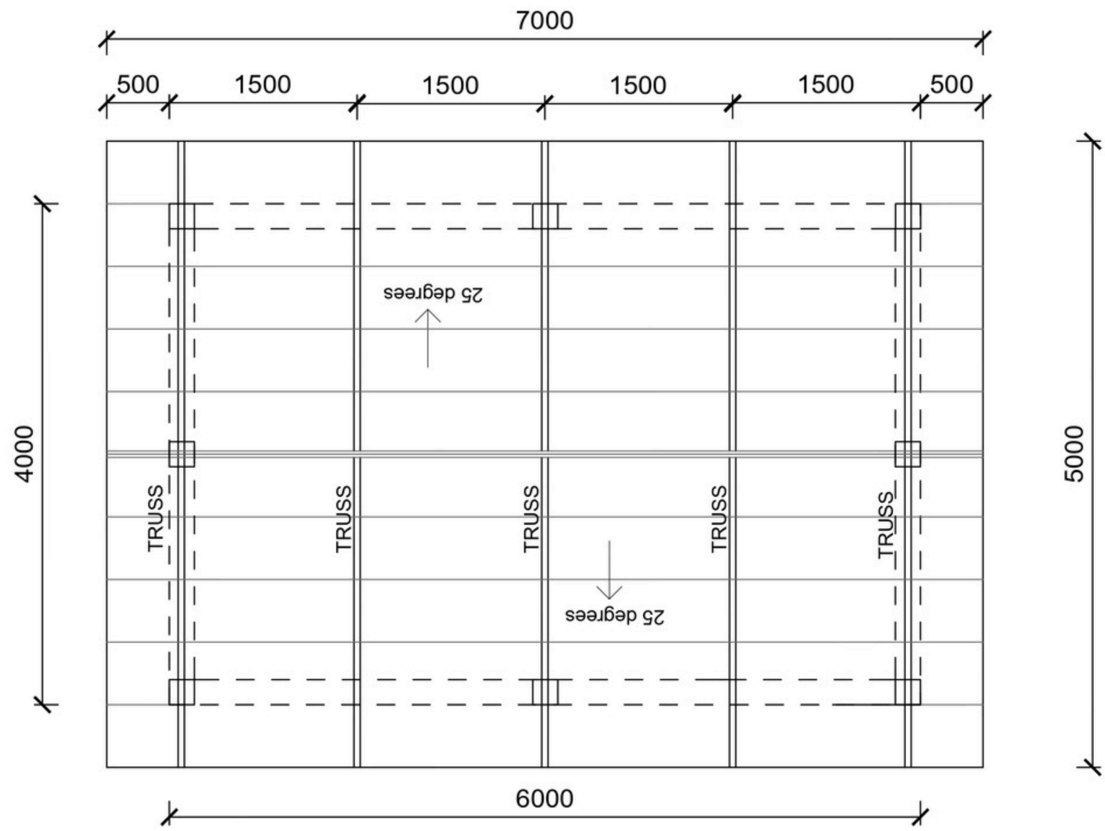
Section 1



Section 2



Roof Plan



Bill of Quantities
Shelter on a raised platform

	Item	Specification	Unit	Quantity
1	Concrete footing	Earthworks and 0.5m Excavation	m3	
2	Foundation	0.4m x 0.4m Cement ratio mix 0.45:1:2:4	m3	2
3	Anchor plates	Steel Plates 400mmX180mm	Pieces	3.2
4	Timber columns	4m Pretreated Timber 200x200mm	Pieces	8
5	Raised Platform	Compacted earth,1m above ground		8
6	Retaining wall	100mm thick rocks or stones 45°		72
7	Floor beams	6m Pretreated Timber 100x200mm	Pieces	1.5
8	Flooring	1.2x2.4m Plywood sheets covering 24m2	m2	8
9	Diagonal wall bracings	1.8m Pretreated Timber 100x50mm	Pieces	9
10	Walls	Woven Bamboo mats	Pieces	10
11	Vertical wall bracings	2.5m Pretreated Timber 100x50mm	Pieces	50
12	Horizontal wall bracings	2m Pretreated Timber 100x50mm	Pieces	4
13	Door	0.9mx2m Timber door panel	Pieces	6
14	Windows	0.8x0.8m Timber panel	Pieces	1
15	Roof beams	6m Pretreated Timber 100x200mm	Pieces	3
16	Truss	4m Pretreated Timber 100x50mm	Pieces	8
17	Purlins	7m Pretreated Timber 50x75mm	Pieces	20
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19	Bolts, washer and nuts	50mm diameter; bolts 10cm long	kg	3
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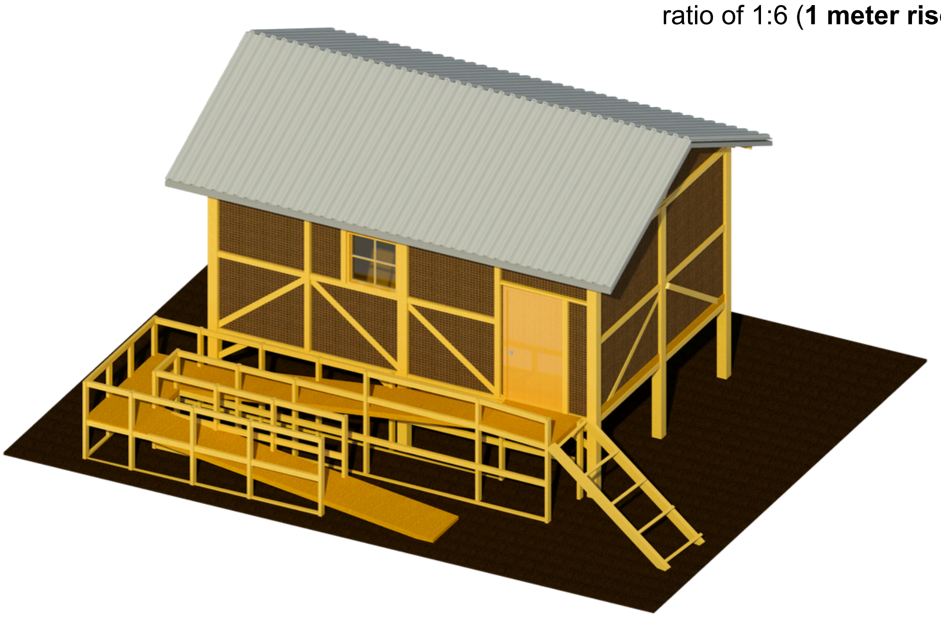
MATERIAL SUBSTITUTIONS BASED ON LOCAL AVAILABILITY:

1. **Timber:** Use locally sourced, pretreated wood for structural elements. If timber is unavailable, substitute with treated bamboo poles for columns, beams, trusses, and bracing.
2. **Walls:** In the absence of bamboo mats, utilize UNHCR-provided tarpaulin sheets for wall cladding or opt for mud/clay bricks if available.
3. **Roofing:** When iron sheets are inaccessible, use tarpaulin sheets combined with bamboo mats or thatch as a temporary roofing solution.
4. **Flooring:** Replace plywood with bamboo planks, locally available wood, or compacted earth.

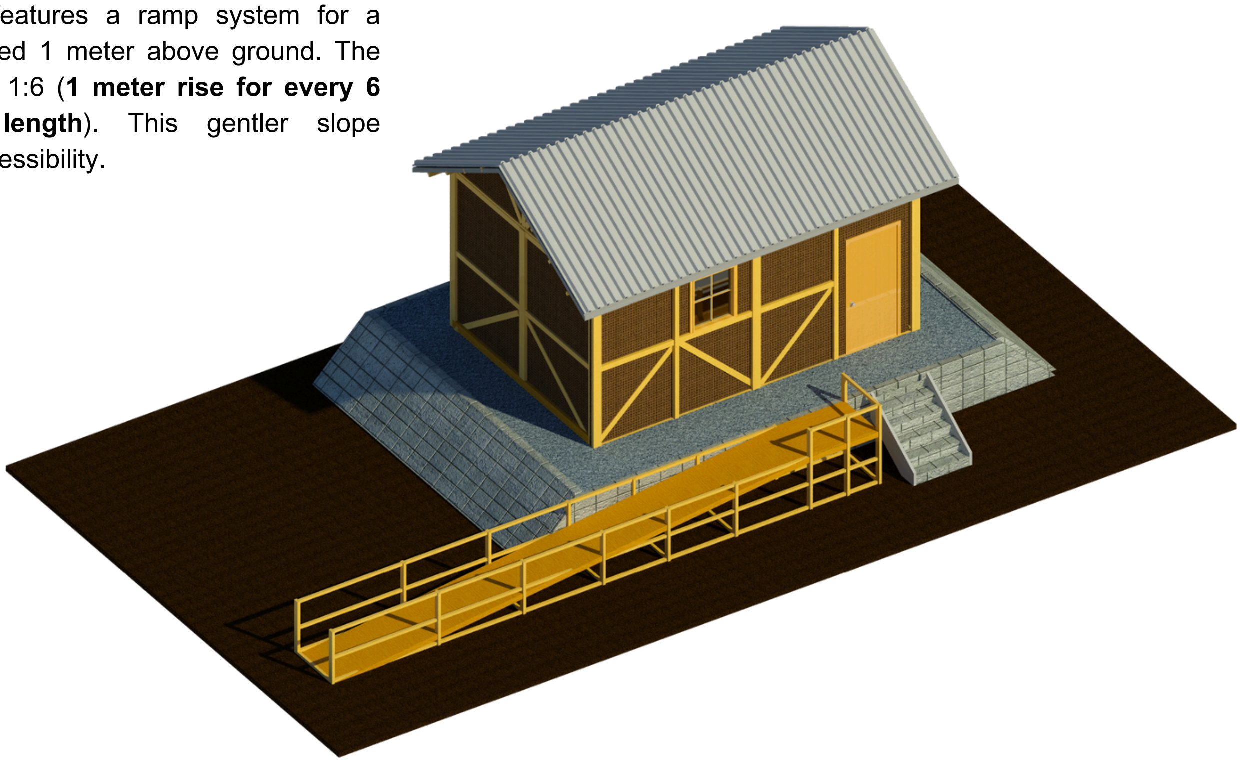
INCLUSIVE SHELTER DESIGNS WITH RAMP SYSTEMS FOR DISABLED ACCESSIBILITY

The two shelter designs can be modified to ensure accessibility and inclusivity for disabled individuals within refugee communities. They are exceptional options for refugee households that include people with disabilities.

Single Elevated Shelter:
This shelter includes a ramp that accom-modates a height difference of 1.5 meters from the ground level. The slope ratio of 1:6 (**1 meter rise for every 6 meters of length**).



Shelter on Raised Platform:
The design features a ramp system for a shelter elevated 1 meter above ground. The slope ratio of 1:6 (**1 meter rise for every 6 meters of length**). This gentler slope enhances accessibility.



05 | CONCLUSIONS AND RECOMMENDATION

5.1 Key Takeaways

INCREASED CLIMATE RISKS: Refugee and internally displaced persons (IDP) camps are increasingly vulnerable to climate-related disasters, particularly floods. These hazards threaten the safety, health, and stability of displaced communities.

FLOOD-RESILIENT SHELTER DESIGN FOCUS: The guidelines prioritize flood-resilient shelter solutions, emphasizing architectural and structural adaptations to reduce flood impact, such as elevated platforms, floodproofing techniques, and reinforced materials.

MULTI-HAZARD CONSIDERATIONS: The document aligns with the UNHCR's 2024-2030 Strategic Framework for Climate Action by addressing not just floods but also heatwaves, cyclones, sandstorms, and hurricanes, providing a comprehensive approach to climate resilience in shelter design.

COMMUNITY INVOLVEMENT AND LOCAL MATERIALS: Local sourcing of materials and inclusive planning involving host communities is highlighted as essential for sustainability. These practices reduce logistical challenges and improve community ownership.

CHALLENGES IN LOW-LYING CAMP AREAS: Camps like Dadaab in Kenya and Aleppo in Syria face persistent environmental and infrastructure challenges due to poor drainage and proximity to flood-prone zones. Key insights from field officers underline the need for early warning systems, drainage improvements, adaptive infrastructure and relocations.

ADVANCED CONSTRUCTION TECHNIQUES FOR FLOOD RESILIENCE: A key focus is on elevating shelters above flood levels or constructing them on raised platforms to allow water to flow underneath. Elevated structures (on stilts or piers) and platforms made from compacted earth offer essential protection from flooding. These strategies are especially crucial where higher ground is unavailable, ensuring the shelters remain dry and intact during extreme weather events.

5.2 Recommendations for Humanitarian Agencies and Stakeholders

STRENGTHEN COORDINATION WITH HOST COMMUNITIES AND GOVERNMENTS:

Inclusive flood management plans are essential to avoid adverse impacts on host communities, especially in cases where flood barriers or dykes can displace water to upstream areas, as experienced in Dadaab camps. Engaging local communities and governments ensures better site selection, shared access to drainage infrastructure, and improved water flow management. Collaborative planning can also minimize tensions between refugee populations and host communities by avoiding unintended environmental consequences.

INVEST IN DURABLE MATERIALS AND LOCALLY ADAPTED DESIGNS:

Using locally available, flood-resistant materials reduces costs and ensures easier access to construction resources. For instance, Interlocking Stabilized Soil Blocks (ISSB) offer strong, durable structures and can be sourced from local soil, promoting sustainability. Such materials also help shelters withstand multiple hazards, including heavy rains, floods, and strong winds. Additionally, integrating vernacular designs that reflect local construction knowledge improves the cultural appropriateness and resilience of shelters.

INCORPORATE LONG-TERM CLIMATE RISK MANAGEMENT:

Humanitarian agencies must go beyond short-term emergency responses by embedding climate risk management strategies into every stage of shelter design, construction, and site planning. This means anticipating future climate trends—such as increasing flood frequencies, rising temperatures, or more intense storms—and incorporating these risks into long-term planning.

ESTABLISH ROBUST MAINTENANCE AND CAPACITY-BUILDING PROGRAMS:NT:

Refugees and host communities should receive training on shelter maintenance and disaster preparedness to strengthen their capacity to respond to emergencies without external aid. Such programs should cover the cleaning of drainage systems, roof repairs, and the deployment of temporary flood barriers like sandbags. Building community-led maintenance teams can also foster self-reliance and create employment opportunities within refugee settings, improving shelter longevity.

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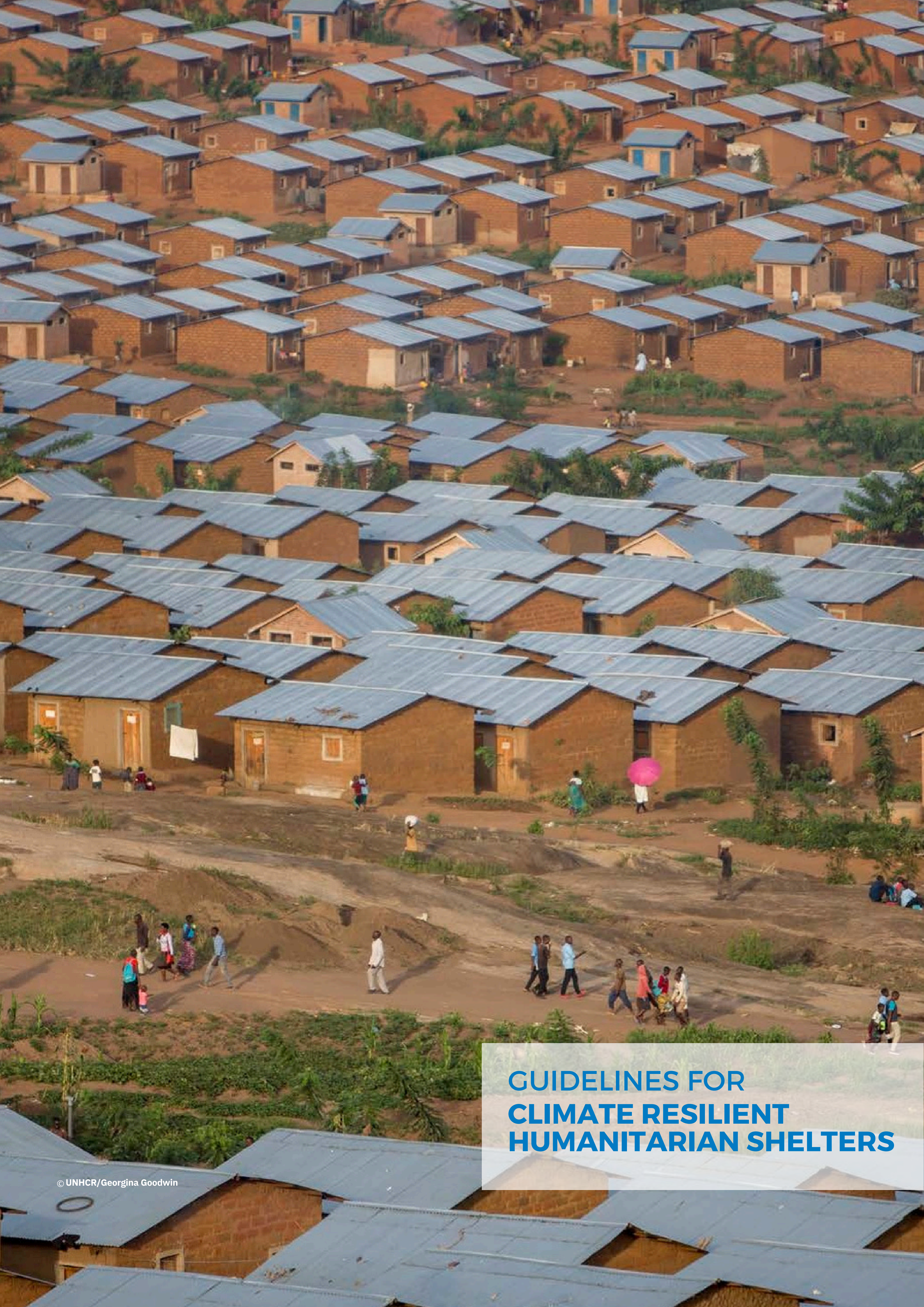

GUIDELINES FOR
CLIMATE RESILIENT HUMANITARIAN SHELTERS

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