



GOVERNMENT OF
PAKISTAN

PEOPLE
SAFER PLACES
RESILIENT COMMUNITIES
A PROSPEROUS PAKISTAN

RESILIENT INFRASTRUCTURE STRONGER COMMUNITIES SUSTAINABLE FUTURE

PREPARE | BUILD | ADAPT | THRIVE



NDMA PAKISTAN

NATIONAL DISASTER MANAGEMENT AUTHORITY

SAFER PAKISTAN • STRONGER COMMUNITIES



EARTHQUAKE
RESILIENT



FLOOD
RESILIENT



LANDSLIDE
RESILIENT

*A Safer
Pakistan
Our Shared Future*



DISASTER
RESILIENT
COMMUNITIES



SMART
INFRASTRUCTURE



SUSTAINABLE
SOLUTIONS



INNOVATIVE
DESIGN



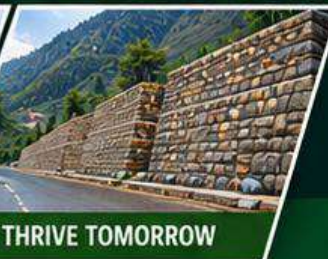
FASTER RECOVERY
STRONGER FUTURE



PREPARE TODAY



BUILD RESILIENCE



THRIVE TOMORROW



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DISASTER RESILIENCE
FOR A STRONGER PAKISTAN

Disaster Resilient Infrastructure Models

DRIM



Aerial view of the complete DRIM at NDMA Headquarters

DRIM

17 Region-Specific Disaster-Resilient Infrastructure Models

Displayed at NDMA Headquarters, Islamabad

17 Resilient Models	4 Regional Categories	Overall Geographical Coverage	40-60% Time Saving	15-45% Cost Saving
Flood, Earthquake, Landslide	Hilly (H), Plain (P), Hilly & Plain (HC), Plain & Coastal (PC)	Punjab, KP, Sindh, Balochistan, GB, AJ&K	Faster construction	Value Added

NDMA Pakistan
IA&PD Wing,

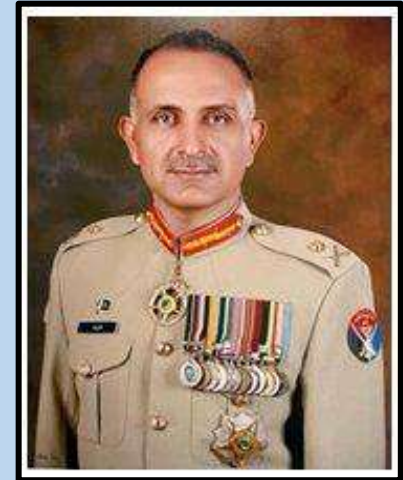
CHAIRMAN'S MESSAGE

Pakistan stands at a critical juncture in its battle against disasters. As one of the world's most disaster-prone nations, we have witnessed the devastating impact of earthquakes, floods, and landslides on our communities particularly on the homes and infrastructure of our most vulnerable citizens. The recurring cycle of disaster and reconstruction has inflicted immeasurable human suffering and economic loss upon the people of Pakistan.

It is within this context that the Disaster Resilient Infrastructure Models (DRIM) initiative represents not merely a construction showcase, but a transformative national commitment. The geographical breadth of DRIM is equally significant. From the earthquake-prone mountain valleys of Gilgit-Baltistan, AJK and Khyber Pakhtunkhwa to the flood-ravaged plains of Sindh and the riverine Punjab, from the coastal communities of Balochistan to the peri-urban settlements of Khyber Pakhtunkhwa. DRIM addresses Pakistan's hazard exposure with region-specific, hazard-responsive solutions.

I commend the Infrastructure Advisory & Project Development (IA&PD) Wing of NDMA for their tireless dedication in bringing this initiative to life.

It is my sincere hope that DRIM will serve as both inspiration and practical guidance helping policymakers allocate resources more effectively, enabling engineers to design with resilience in mind, and empowering communities to build homes that will protect their families for generations to come. Pakistan's path to a safer, more resilient future begins with how we build today.



Lt. Gen Inam Haider Malik HI(M)
Chairman, NDMA

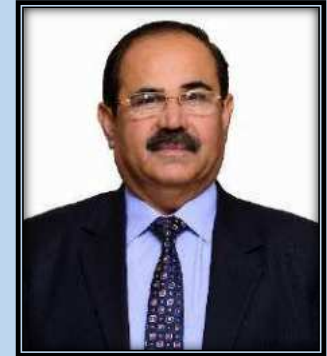
EXECUTIVE DIRECTOR (IA&PD) MESSAGE

The increasing frequency and intensity of disasters in Pakistan underscore the urgent need to strengthen the resilience of our infrastructure and communities. The **Disaster Resilient Infrastructure Models (DRIM)** initiative reflects NDMA's commitment to promoting safer, smarter, and more sustainable construction practices that can withstand the country's diverse hazard landscape.

DRIM showcases practical, hazard-specific infrastructure solutions tailored to the unique geographical and climatic conditions of Pakistan. From earthquake-resistant housing to flood-resilient structures, these models demonstrate how resilient design can protect lives, reduce economic losses, and support sustainable development.

I extend my sincere appreciation to the leadership of NDMA and my team whose dedication and expertise made this initiative possible. I hope this initiative inspires greater collaboration and encourages all stakeholders to embrace resilient infrastructure as a cornerstone of Pakistan's sustainable future.

Together, we can build safer communities, protect future generations, and create a stronger, more resilient Pakistan.



Saleem Raza
Executive Director (IA&PD), NDMA

Infrastructure Advisory & Project Development (IA&PD) Team

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TABLE OF CONTENTS

DRIM – DISASTER RESILIENT INFRASTRUCTURE MODELS

DESIGNING RESILIENT COMMUNITIES • BUILDING A SAFER PAKISTAN

1

INTRODUCTION

START



An overview of DRIM initiative and its vision for a resilient Pakistan.

2

PURPOSE & RATIONALE OF DRIM



- 2.1 Background Need
- 2.2 Core Purpose

3

DRIM MODEL CATEGORIES & SHOWCASE



3.1
Hilly Region
Models
(H1–H5)



3.2
Plain Region
Models
(P1–P4)



3.3
Plain / Coastal
Region Models
(PC1–PC2)



3.4
Hilly / Plain
Region Models
(HP1–HP5)

6

COST & SPEED SAVINGS ANALYSIS



Evidence-based analysis of cost efficiency and reduced construction time using DRIM models.

5

COMMUNITY BENEFITS



Stronger, safer and more resilient communities through locally adapted infrastructure.

4

PAKISTAN REGIONAL COVERAGE MAP



Geographical spread of DRIM models across all provinces and regions.

7

CONCLUSION



Key takeaways and the way forward towards a disaster resilient Pakistan.

FINISH



RESILIENT INFRASTRUCTURE



SAFE COMMUNITIES

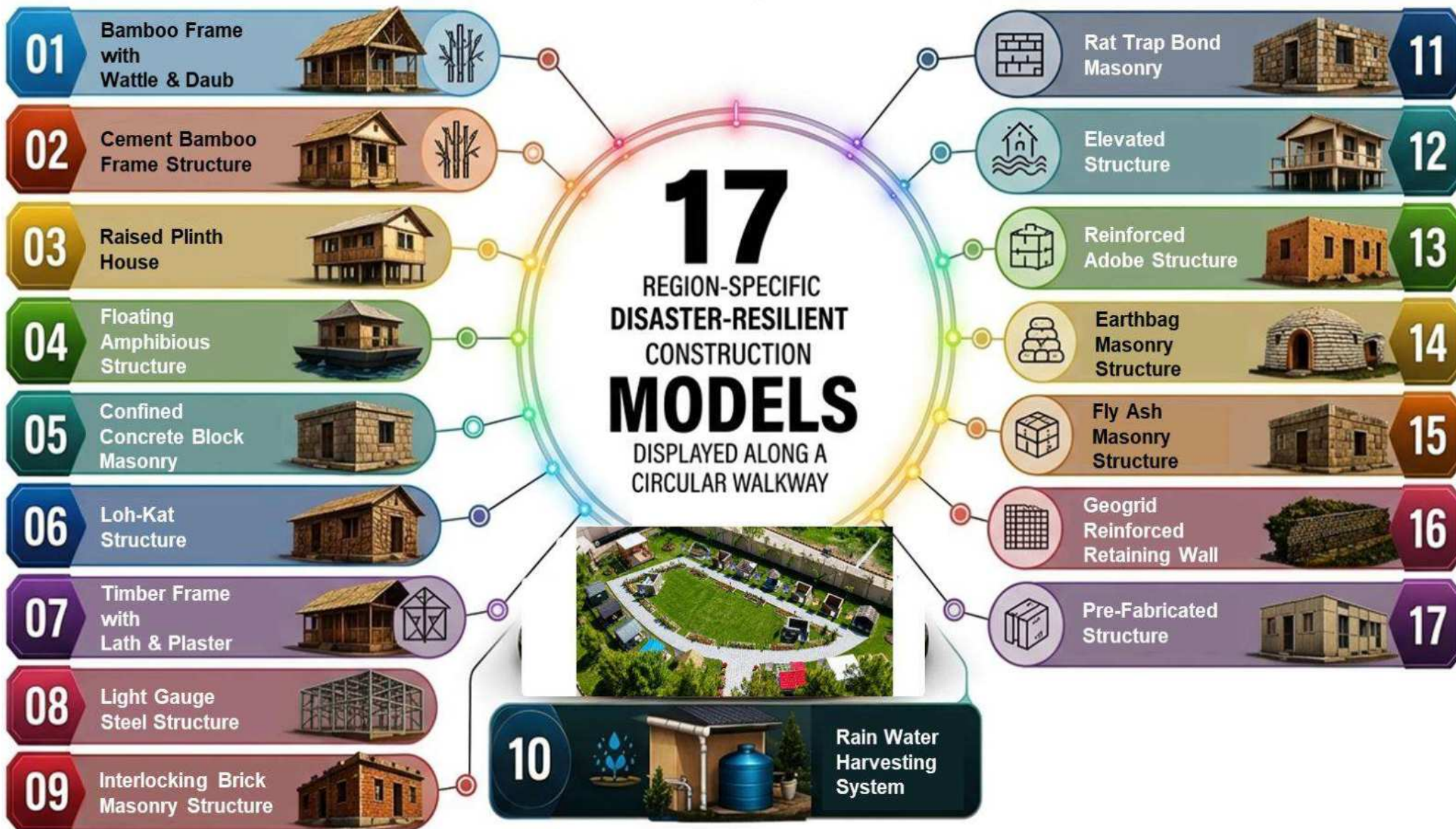


SUSTAINABLE FUTURE



STRONGER PAKISTAN

1. Introduction: Pakistan's Disaster Landscape & the DRIM Response



**REDUCING
DISASTER RISK**
Building safer
communities



**PROTECTING
COMMUNITIES**
Empowering local
resilience



**STRENGTHENING
INFRASTRUCTURE**
Building back stronger



**ENSURING
SUSTAINABILITY**
Green. Resilient. Inclusive



**ENHANCING
RESILIENCE**
Prepared today. Resilient
Tomorrow

2. PURPOSE & RATIONALE OF DRIM

4th Most Vulnerable Country to Climate Change	80K+ Deaths — 2005 Earthquake	\$30B Losses — 2022 Floods	Rs 822+ Million Losses — 2025 Floods
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2.1 Background Need

Conventional housing in Pakistan is generally not designed to withstand natural disasters. Repeated flood and earthquake events have destroyed hundreds of thousands of homes, displacing millions of citizens and inflicting enormous economic losses. Key drivers that necessitated the DRIM initiative include:

- Recurrent disasters exposing systemic vulnerabilities in conventional housing stock
- Absence of region-specific, hazard-responsive design guidance for communities
- High reconstruction costs following each disaster event
- Low awareness among communities, local contractors, and masons of safer building practices

The proposed infrastructure models serve as a practical, educational, and policy-support tool, demonstrating how region-specific, disaster-resilient housing can significantly reduce vulnerability and strengthen community resilience across Pakistan

2.2 Core Purpose

Showcase Hazard-Responsive Design

Demonstrate housing designs tailored to specific hazards and regions — earthquake-prone and flood-affected zones — providing visual and physical proof that safer construction is achievable.

Promote Economical Resilience

Prove that disaster-resilient construction does not require expensive imported materials or specialized labor. Each DRIM model uses locally available materials and can be built by trained community members.

Serve as Educational & Policy Tool

Physical models provide clear, intuitive visualization for policymakers, international donors, local engineers, academia, and village-level communities — transforming abstract engineering concepts into accessible demonstrations.

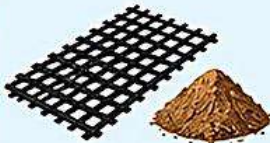
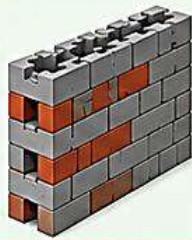
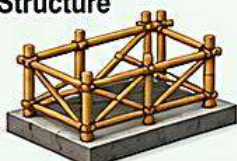
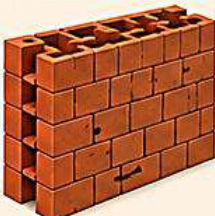
Support Low-Cost Housing Solutions

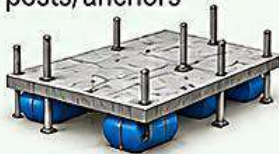
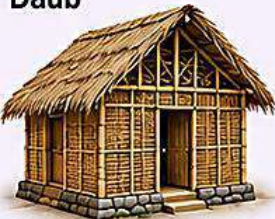
By integrating locally sourced materials such as bamboo, earthbags, adobe, timber, and fly ash bricks, DRIM offers cost-effective alternatives that communities can replicate without dependence on external supply chains.

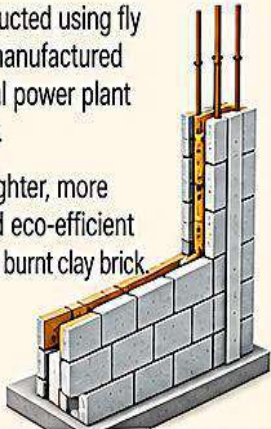
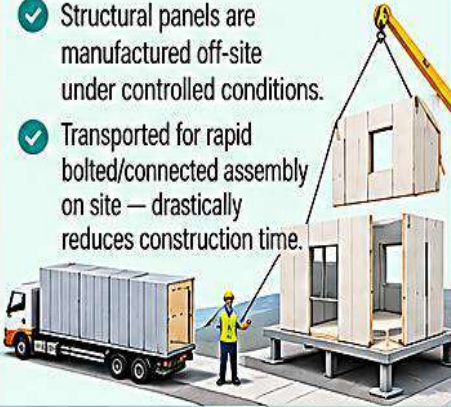
3. DRIM MODEL CATEGORIES

Code	Model Name	Hazard Focus	Key Materials	Construction Standard / Technique	Cost Saving	Time Saving
H1	Confined Concrete Block Masonry 	 Earthquake	 Concrete blocks, RCC confining columns/tie-beams at corners & openings	 Confined masonry: load-bearing block walls confined by vertical RC tie-columns and horizontal tie-beams cast after wall construction, providing ductility and preventing brittle collapse	 Moderate	 Moderate
H2	Loh-Kaat Timber House Structure 	 Earthquake	 Timber logs (horizontal), stone/masonry infill	 Traditional Loh-kaat technique: interlocking horizontal timber log framework forming a lattice, infilled with stone/Mud or rubble masonry — flexible frame absorbs seismic energy	 Low–Moderate	 Moderate
H3	Timber Frame with Lath and Plaster 	 Earthquake	 Timber studs/frame, wooden laths, mud or lime plaster	 Lightweight timber stud frame clad with closely spaced wooden laths, finished with lime plaster skin reduces seismic mass while maintaining thermal comfort	 Low	 High
H4	Earthbag Masonry Structure 	 Earthquake	 Polypropylene bags filled with local soil, barbed wire between courses	 Earthbags filled with on-site soil are stacked in courses, tamped, and stabilized with barbed wire for inter-course	 Very High (~55%)	 Moderate
H4A	Earthbag Flood Resilient Model 	- Built on raised plinth or stilts - Waterproof plaster/lime render - Elevated openings & drainage provision		Raised foundation & flood-resistant finishes protect from water ingress; drainage channels reduce flood impact	 High Savings	 High Savings
H4B	Earthbag Earthquake Resilient Model 	- Barbed wire reinforced layers - Vertical rebar at corners & openings - Ring beam at roof level		Reinforced corners & ring beam improve ductility and lateral strength; flexible walls resist seismic forces	 High Savings	 Moderate Savings



Code	Model Name	Hazard Focus	Key Materials	Construction Standard / Technique	Cost Saving	Time Saving	Illustration
H5	Geogrid Reinforced Retaining Wall 	Landslide / Earthquake 	Compacted soil/aggregate fill, geogrid reinforcement layers, facing units 	Layered soil reinforced with horizontal geogrid sheets at set vertical intervals, forming a stable slope/retaining structure resisting slope failure and lateral earth pressure 	 Moderate	 Moderate	
P1	Interlocking Brick Masonry 	Earthquake 	Cement-stabilized interlocking bricks (mortarless or minimal mortar) 	Bricks manufactured with interlocking keys/grooves are dry-stacked or laid with minimal mortar, self-aligning courses that speed construction and improve wall uniformity 	 Moderate	 High	
P2	Cement Bamboo Frame Structure 	Earthquake 	Bamboo culms as structural frame, cement-sand plaster/mortar skin, wire mesh 	Bamboo poles form the primary structural frame (posts & bracing), wrapped with wire mesh and cement plaster to form a composite panel — lightweight, low-cost, locally sourced 	 High (~40%)	 High	
P3	Raised Plinth Flood Resilient House 	Flood 	RCC/masonry raised plinth, standard superstructure above flood level 	Floor level is raised on an elevated plinth (masonry/RCC) above historical flood levels, keeping living space above inundation while foundation remains conventional 	 Moderate	 Very High (~60%)	
P4	Rat Trap Bond Masonry 	Earthquake 	Standard bricks laid on edge in cavity bond pattern 	Bricks are laid on edge to create a cavity within the wall thickness, reducing wall thickness 	 High (15–25% bricks)	 Moderate (~20%)	

Code	Model Name	Hazard Focus	Key Materials	Construction Standard / Technique	Cost Saving	Time Saving	Illustration
PC1	Elevated Flood Resilient House 	Flood / Storm Surge 	RCC stilts/columns, elevated timber or RCC floor deck 	Entire habitable structure is elevated on RCC or timber stilts/columns above design flood/surge level, allowing floodwater to pass beneath the structure unobstructed	 Moderate	 High	
PC2	Floating Amphibious Structure 	Flood 	Buoyant hollow foundation (floatation base), guide posts/anchors 	Structure rests on a buoyant foundation platform that rises with rising floodwater along vertical guide posts, then settles back on its footprint once water recedes	 Moderate	 High	
HP1	Reinforced Adobe Brick Structure 	Earthquake 	Sun-dried mud/adobe bricks, internal reinforcement (bamboo/timber/steel mesh), lime stabilizer 	Traditional adobe (sun-dried mud brick) walls are internally reinforced with bamboo splints, timber, or wire mesh to overcome adobe's brittleness and improve seismic ductility	 High	 Low–Moderate	
HP2	Bamboo Frame with Wattle and Daub 	Earthquake 	Bamboo lattice frame, mud/clay daub infill, straw binder 	Woven bamboo lattice (wattle) is fixed to a bamboo frame and coated both sides with a mud-clay-straw mix (daub) — lightweight, flexible and seismically resilient	 High	 High	

Code	Model Name	Hazard Focus	Key Materials	Construction Standard / Technique	Cost Saving	Time Saving	Illustration
HP3	Fly Ash Masonry Structure 	Earthquake 	- Fly ash bricks/blocks (industrial by-product) - Standard mortar 	- Walls constructed using fly ash bricks manufactured from thermal power plant by-products. - Offering a lighter, more uniform, and eco-efficient alternative to burnt clay brick 	 Moderate-High	 Moderate	
HP4	Light Gauge Steel House Structure 	Earthquake 	- Cold-formed light gauge steel (LGS) - Frame members - Screw/bolt connections 	- Prefabricated cold-formed steel C- and Z-sections assembled into wall panels, floor joists, and roof trusses on site. - Connections using bolted/screwed connections — minimal on-site labor. 	 Moderate	 Very High	
HP5	Pre-Fabricated House Structure 	Earthquake 	- Factory-manufactured wall/floor/roof panels - Bolted site connections 	- Structural panels are manufactured off-site under controlled conditions. - Transported for rapid bolted/connected assembly on site — drastically reduces construction time. 	 Moderate	 Very High (~60%)	



4. REGIONAL COVERAGE OF DRIM

Introduction

- Pakistan is highly vulnerable to natural disasters such as frequent floods, earthquakes, landslides & extreme weather
- Traditional construction practices often fail under disaster risks
- DRIM promotes a preventive approach rather than reactive disaster management

Purpose

- It's purpose is to show how houses & community structures can be built to better withstand natural disasters
- Provides practical examples of safer construction techniques
- Aims to significantly reduce the impact of future disasters

Hilly Region



Protecting infrastructure through seismic-resistant designs

Plain Region



Stronger, affordable houses with better thermal insulation

Plain/Coastal Region



Flood-resistant designs using elevated/floating structures

Hilly/Plain Region



Modern solutions suitable for both hilly/plain areas

BENEFITS



15% - 40%
Cost Saving

Construction emphasize locally available materials



40% - 60%

Faster Construction

Systems like Timber Frames or Pre-Fabricated structures emphasize modern, efficient construction techniques



Easy Build-Up

Techniques are kept simple so that locals can adopt these without complex technology or Skills



Sustainability

DRIM promotes standardized, environment friendly practices that are easily replicable across different regions of country

H1 — CONFINED CONCRETE BLOCK MASONRY

Hilly Region Model (Earthquake Resilient)



CONFINED CONCRETE BLOCK MASONRY

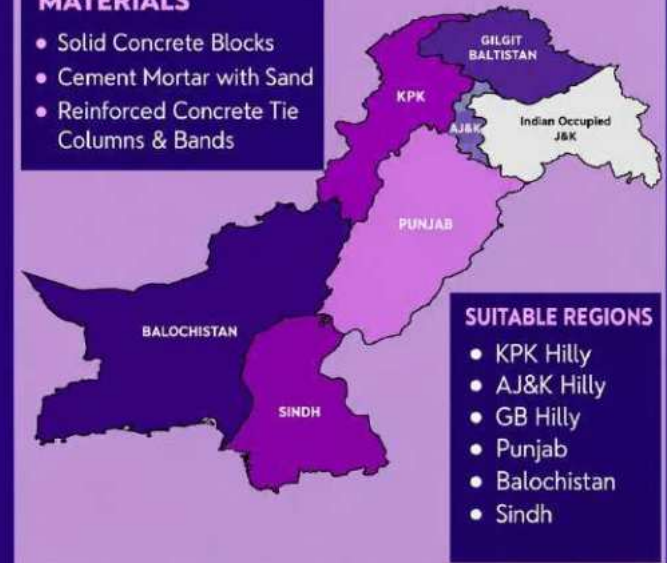
SALIENT FEATURES

- ✓ Higher Lateral Resistance against Seismic Loads
- ✓ Improved Seismic Performance
- ✓ Higher Structural Stability & Strength
- ✓ Better Crack Control
- ✓ Suitable for Low to Mid-Rise Buildings

MATERIALS & REGIONS

MATERIALS

- Solid Concrete Blocks
- Cement Mortar with Sand
- Reinforced Concrete Tie Columns & Bands



H1 — Confined Concrete Block Masonry Structure displayed at NDMA Headquarters, Islamabad

RESILIENCE FEATURES OF CONFINED CONCRETE BLOCK MASONRY



STRONG ROOF STRUCTURE

Timber truss and sturdy framing provide flexibility and stability, allowing the roof to withstand seismic forces during an earthquake.



DURABLE ROOFING MATERIAL (EARTHQUAKE RESILIENT)

Lightweight metal sheet roofing reduces seismic load on the structure, minimizes risk of collapse, and remains secure during ground shaking while providing long-term durability.



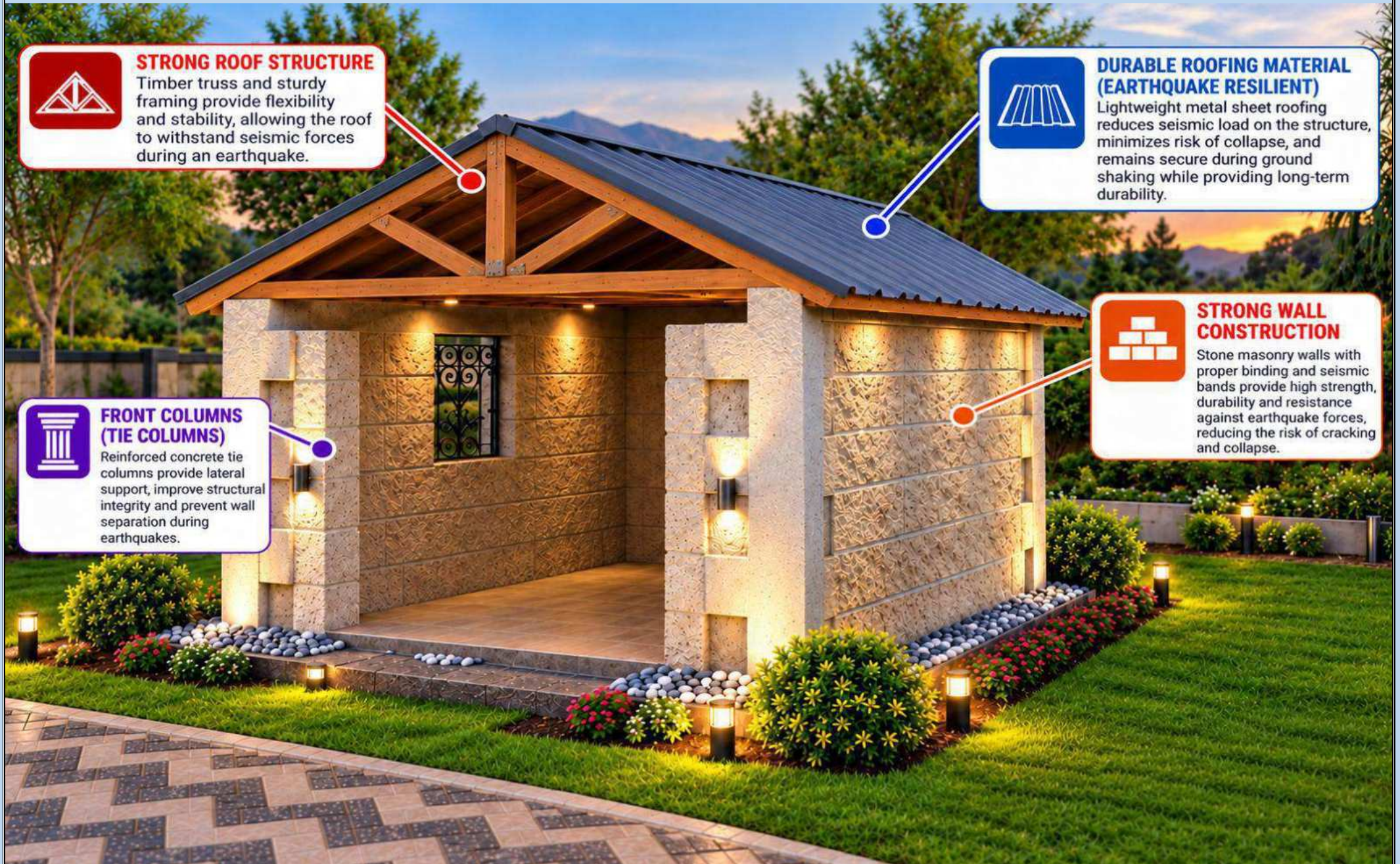
FRONT COLUMNS (TIE COLUMNS)

Reinforced concrete tie columns provide lateral support, improve structural integrity and prevent wall separation during earthquakes.



STRONG WALL CONSTRUCTION

Stone masonry walls with proper binding and seismic bands provide high strength, durability and resistance against earthquake forces, reducing the risk of cracking and collapse.



H2 — LOH-KAAT TIMBER HOUSE STRUCTURE

Hilly Region Model (Earthquake Resilient)



LOH-KAAT TIMBER HOUSE STRUCTURE

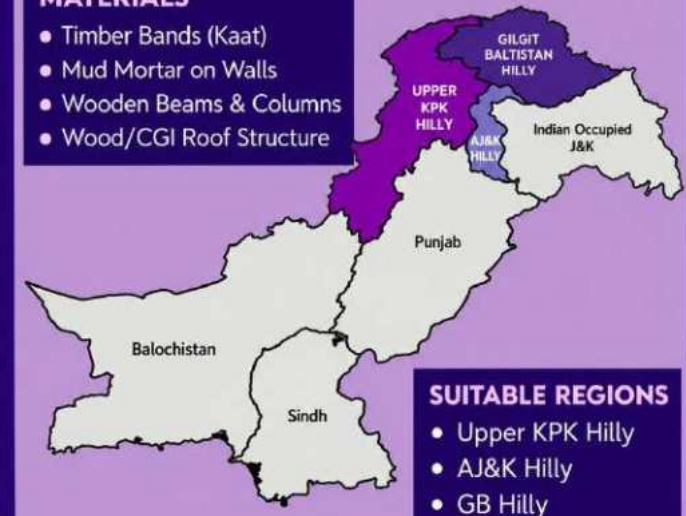
SALIENT FEATURES

- ✓ Timber Frame Improves Earthquake Resistance
- ✓ Flexible Wooden Bands reduces Wall Cracking
- ✓ Use of Timber reduces overall Structural Weight
- ✓ Cost-Effective, Use of Local Materials
- ✓ Good Thermal Performance maintains Temperature

MATERIALS & REGIONS

MATERIALS

- Timber Bands (Kaat)
- Mud Mortar on Walls
- Wooden Beams & Columns
- Wood/CGI Roof Structure



SUITABLE REGIONS

- Upper KPK Hilly
- AJ&K Hilly
- GB Hilly

H2 — Loh-Kaat Timber House Structure displayed at NDMA Headquarters, Islamabad

RESILIENCE FEATURES OF LOH-KAAT TIMBER HOUSE STRUCTURE

STRONG ROOF STRUCTURE



Timber truss and strong roof framing provide high stability and resistance against seismic loads and strong winds.

LIGHTWEIGHT ROOFING MATERIAL



Lightweight roofing reduces overall dead load, improving seismic performance and reducing the risk of roof collapse.

TIMBER FRAME CONSTRUCTION



Timber post-and-beam frame enhances flexibility and ductility, allowing the structure to absorb and dissipate seismic energy.

EARTH / LIGHTWEIGHT INFILL WALLS



Earthen or lightweight infill walls reduce structural weight while providing good thermal performance and durability.

STRONG CONNECTIONS AT JOINTS



Proper connections between timber elements improve structural integrity and resistance to lateral forces.

H3 — TIMBER FRAME WITH LATH AND PLASTER

Hilly Region Model (Earthquake Resilient)



TIMBER FRAME WITH LATH AND PLASTER

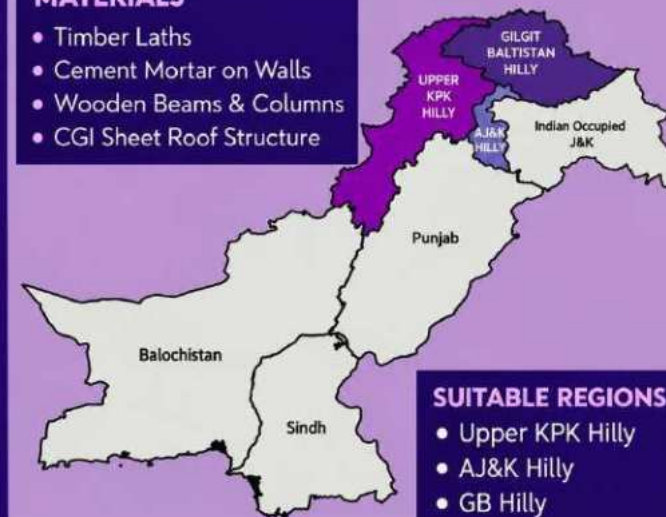
SALIENT FEATURES

- ✓ Timber Frame improves Earthquake Resistance
- ✓ Flexible Wooden Laths reduces Wall Cracking
- ✓ Cost-Effective, Uses Locally Available Material
- ✓ Good Thermal Performance in Cold Climates
- ✓ Light Weight Frame, Rapid Construction Technique

MATERIALS & REGIONS

MATERIALS

- Timber Laths
- Cement Mortar on Walls
- Wooden Beams & Columns
- CGI Sheet Roof Structure



SUITABLE REGIONS

- Upper KPK Hilly
- AJ&K Hilly
- GB Hilly

H3 — Timber Frame with Lath and Plaster Structure displayed at NDMA Headquarters, Islamabad

RESILIENCE FEATURES OF TIMBER FRAME WITH LATH AND PLASTER

STRONG ROOF FRAMING WITH TRIANGULATION



Triangulated roof framing provides stability, distributes loads evenly and enhances resistance to seismic forces and high winds.

LIGHTWEIGHT ROOFING MATERIAL



Lightweight roofing reduces overall dead load on the structure, improving seismic performance and safety.

LIGHTWEIGHT & DURABLE WALL PANELS



Lightweight wall panels reduce structural load while providing durability, seismic resistance and weather protection.



H4 — EARTHBAG MASONRY STRUCTURE

Hilly Region Model (Earthquake/Flood Resilient)



EARTHBAG MASONRY STRUCTURE

SALIENT FEATURES

- ✓ Uses Locally Available Soil or Stone Dust
- ✓ Excellent Earthquake Resistance
- ✓ Use of Simple Materials reducing Construction Cost
- ✓ Eco-friendly and Low-carbon Construction Technique
- ✓ Good Thermal Insulation maintains Indoor Temperatures

MATERIALS & REGIONS

MATERIALS

- Polypropylene Bags
- Local Soil (Compacted)
- Steel Bar on Layers
- RC Lintels & Bands

GILGIT BALTISTAN
KPK
PUNJAB
Balochistan
Sindh
Indian Occupied J&K

SUITABLE REGIONS

- KPK Hilly
- AJ&K Hilly
- GB Hilly
- Punjab
- Balochistan
- Sindh

H4 — Earthbag Masonry Structure displayed at NDMA Headquarters, Islamabad

RESILIENCE FEATURES OF EARTHBAG MASONRY STRUCTURE



RCC BOND BEAM

RCC bond beam on top ties the walls together, improves stability and provides resistance against seismic forces and lateral loads.



REINFORCED LINTEL

RCC/Timber lintel above the opening distributes loads and prevents cracking.



REINFORCED DOOR FRAME

Timber/Bamboo/Steel door frame securely anchored to the bond beam and plinth, resisting earthquake and lateral forces.



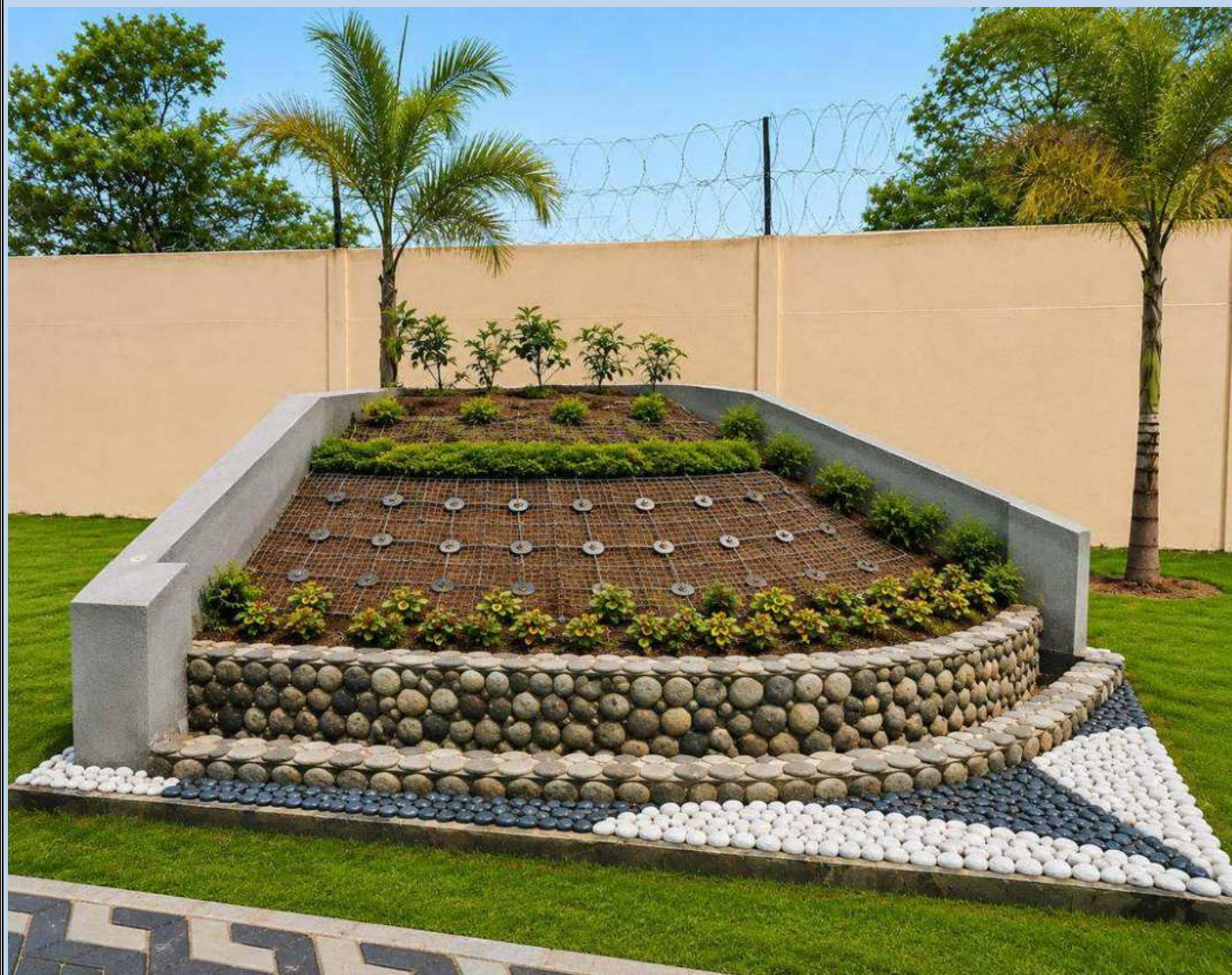
INTERLOCKING BAGS

Bags are placed in an interlocking pattern with proper offset, enhancing wall strength, load distribution and seismic performance.



H5 — GEOGRID REINFORCED RETAINING WALL STRUCTURE

Hilly Region Model (Landslide Resilient)



GEOGRID REINFORCED RETAINING WALL STRUCTURE

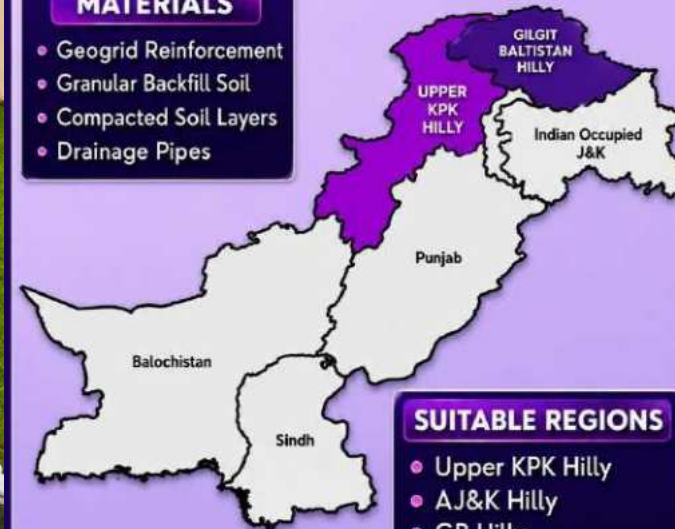
SALIENT FEATURES

- ✓ Reinforced Soil Structure using Geogrid Reinforcement
- ✓ Prevents Soil Erosion and Slope Failure
- ✓ Quick and Easy Construction
- ✓ Cost-effective compared to Conventional Concrete Retaining Walls, Strong Slope Stabilization

MATERIALS & REGIONS

MATERIALS

- Geogrid Reinforcement
- Granular Backfill Soil
- Compacted Soil Layers
- Drainage Pipes



SUITABLE REGIONS

- Upper KPK Hilly
- AJ&K Hilly
- GB Hilly

H5 — Geogrid Reinforced Retaining Wall Structure displayed at NDMA Headquarters, Islamabad

RESILIENCE FEATURES OF GEOGRID REINFORCED RETAINING WALL STRUCTURE

SLOPE STABILIZATION WITH VEGETATION



Vegetation on the slope helps bind the soil, reducing erosion and improving slope stability during heavy rains and seismic activity.

EROSION CONTROL MATTING / GEOGRID



Geogrid with soil and vegetation prevents soil erosion, enhances slope stability and withstands heavy rainfall and tremors.

REINFORCED RETAINING SIDE WALLS



Reinforced concrete side walls retain the soil mass, resist lateral pressure and prevent slope failure during earthquakes and heavy rainfall.

VEGETATIVE COVER & PLANTING



Plants and shrubs reduce surface runoff, absorb water and enhance soil strength while preventing erosion.

STONE / RIPRAP RETAINING WALL



Stone retaining wall provides high strength, durability and flexibility to resist seismic forces and prevent erosion and collapse.



P1 — INTERLOCKING BRICK MASONRY STRUCTURE

Plain Region Model (Earthquake Resilient)



INTERLOCKING BRICK MASONRY STRUCTURE

SALIENT FEATURES

- ✓ Reduced Mortar Usage (Hollow Bricks)
- ✓ Improved Seismic Performance (Bands | Rebars)
- ✓ Cost-Effective Locally Available Material Usage
- ✓ Better Load Distribution
- ✓ Faster Construction

MATERIALS & REGIONS

MATERIALS

- Cement, Sand Mortar
- Hollow Bricks
- Steel Rebars (12mm)
- Concrete for Plinth, Lintel, & Roof Bands

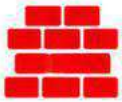


SUITABLE REGIONS

- KPK
- Punjab
- Balochistan
- Sindh

P1 — Interlocking Brick Masonry Structure displayed at NDMA Headquarters, Islamabad

RESILIENCE FEATURES OF INTERLOCKING BRICK MASONRY STRUCTURE



STRONG BRICK MASONRY WALLS

Properly laid brick masonry walls with good quality bricks and mortar provide strength, durability and thermal comfort.



RCC LINTEL & ROOF BAND

Reinforced concrete lintel and roof band tie the walls together, improving stability and preventing wall separation during seismic events.



LIGHTWEIGHT ROOF SYSTEM

Lightweight RCC roof reduces overall dead load on walls, improving seismic performance and overall structural safety.



P2 — CEMENT BAMBOO FRAME STRUCTURE

Plain Region Model (Earthquake Resilient)



P2 — Cement Bamboo Frame Structure displayed at NDMA Headquarters, Islamabad

CEMENT BAMBOO FRAME STRUCTURE

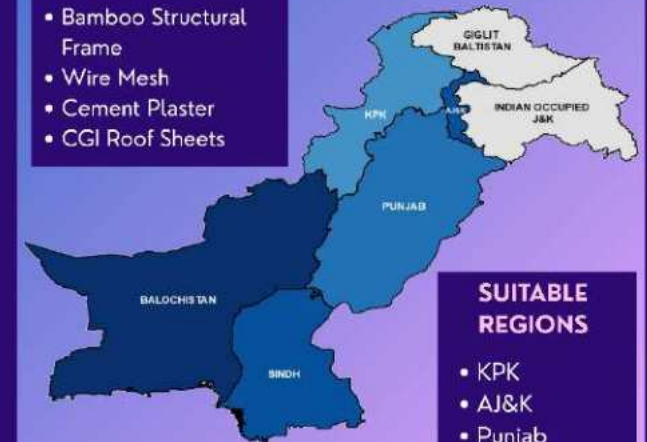
SALIENT FEATURES

- Improved Earthquake Resistance Lightweight Frame
- Crack Control with Wire Mesh Reinforcement
- Cost-Effective and Suitable for Low-Income Housing
- Uses Locally Available Bamboo with Enhanced Lifespan
- Faster Construction compared to Brick Masonry

MATERIAL & REGIONS

MATERIALS

- Bamboo Structural Frame
- Wire Mesh
- Cement Plaster
- CGI Roof Sheets



SUITABLE REGIONS

- KPK
- AJ&K
- Punjab
- Balochistan
- Sindh

RESILIENCE FEATURES OF CEMENT BAMBOO FRAME STRUCTURE

LIGHTWEIGHT ROOF STRUCTURE



Lightweight bamboo roof reduces overall load on the structure and improves seismic performance.

STRONG ROOF FRAMING



Bamboo framing provides flexibility and ductility, allowing the structure to withstand earthquake forces.

REINFORCED WALL WITH PLASTER



Reinforced masonry wall with plaster finish improves strength, durability and resistance to weather and impacts.

STRONG COLUMN & CONNECTIONS



Bamboo columns and strong lashings at joints provide stability and enhance the structure's resistance to lateral forces.



P3 — RAISED PLINTH FLOOD RESILIENT HOUSE

Plain Region Model (Flood Resilient)



RAISED PLINTH FLOOD RESILIENT HOUSE

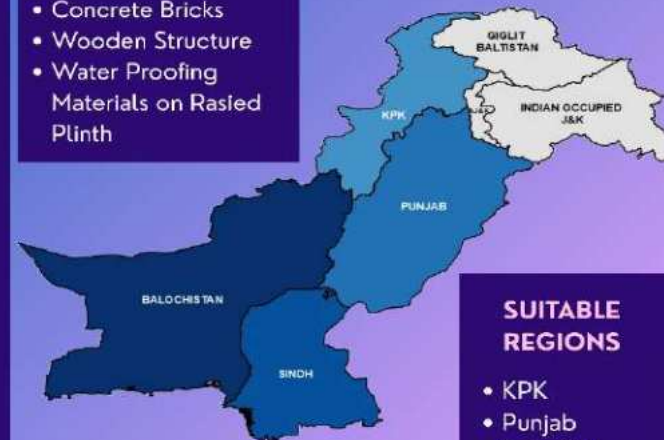
SALIENT FEATURES

- House Built on an Elevated Plinth Foundation
- Protects Living Areas from Floodwater Entry
- Strong Foundation to Resist Water Pressure
- Damp Proof Flooring to Prevent Moisture Damage

MATERIALS & REGIONS

MATERIALS

- Concrete Bricks
- Wooden Structure
- Water Proofing Materials on Raised Plinth



SUITABLE REGIONS

- KPK
- Punjab
- Balochistan
- Sindh

P3 — Raised Plinth Flood Resilient House displayed at NDMA Headquarters, Islamabad

RESILIENCE FEATURES OF RAISED PLINTH FLOOD RESILIENT HOUSE



LIGHTWEIGHT THATCH ROOF

Lightweight thatch roof reduces load and allows easy replacement after flood damage. The wide overhang protects walls from heavy rain and minimizes water seepage.



STRONG ROOF STRUCTURE

Thatch roof supported by strong bamboo/wood framing provides flexibility and resilience during floods, allowing the structure to withstand high winds, heavy rainfall and water pressure.



FLOOD RESILIENT WALL PANELS

Lightweight and flexible wall panels (bamboo/wood or fibre panels) are water-resistant, reduce water absorption and can withstand temporary inundation, enabling quick drying and repair after floods.



P4 — RAT TRAP BOND MASONRY STRUCTURE

Plain Region Model (Earthquake Resilient)



RAT TRAP BOND MASONRY STRUCTURE

SALIENT FEATURES

- Bricks placed on Edges (Cavity Formation)
- 15-25% Brick Saving compared to Conventional Bond
- Reduced Cement & Mortar Consumption
- Improved Thermal Insulation
- Lighter Wall Weight

MATERIALS & REGIONS

MATERIALS

- Burnt Clay Bricks
- Cement Mortar, Sand
- Steel Bars (If Seismic Reinforcement in Cavity with Concrete)
- RCC Lintel & Roof Bands

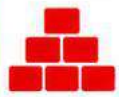


SUITABLE REGIONS

- KPK
- Punjab
- Balochistan
- Sindh

P4 — Rat Trap Bond Masonry Structure displayed at NDMA Headquarters, Islamabad

RESILIENCE FEATURES OF RAT TRAP BOND MASONRY STRUCTURE



REINFORCED LINTEL / ROOF BAND

Reinforced concrete lintel band ties the walls together, improving stability and resistance to seismic forces.



CONFINED MASONRY WALLS

Brick walls with strong confined edges provide high strength, ductility and prevent collapse during earthquakes.



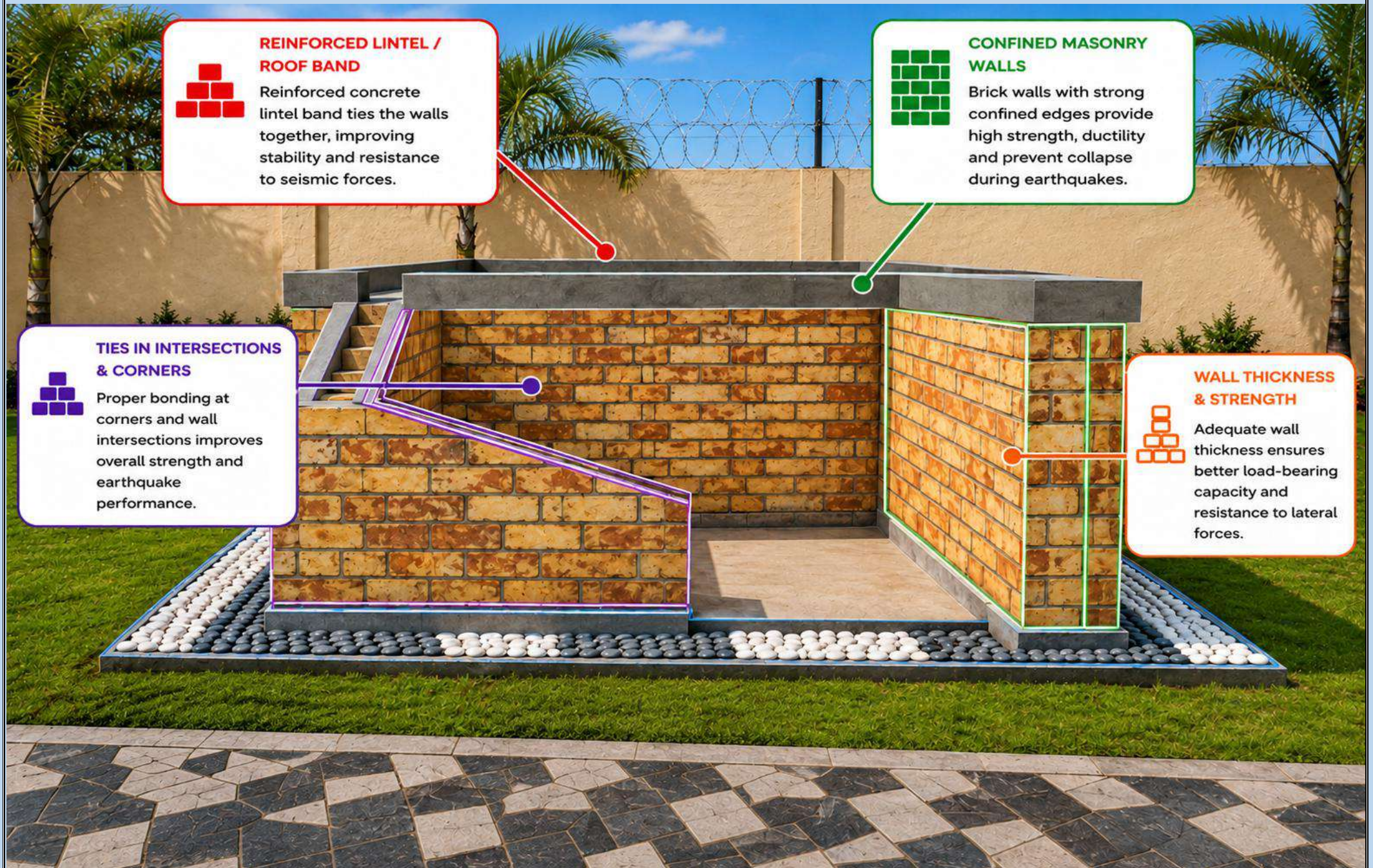
TIES IN INTERSECTIONS & CORNERS

Proper bonding at corners and wall intersections improves overall strength and earthquake performance.



WALL THICKNESS & STRENGTH

Adequate wall thickness ensures better load-bearing capacity and resistance to lateral forces.



PC1 — ELEVATED FLOOD RESILIENT HOUSE STRUCTURE

Plain / Coastal Region Model (Flood Resilient)



ELEVATED FLOOD RESILIENT HOUSE STRUCTURE

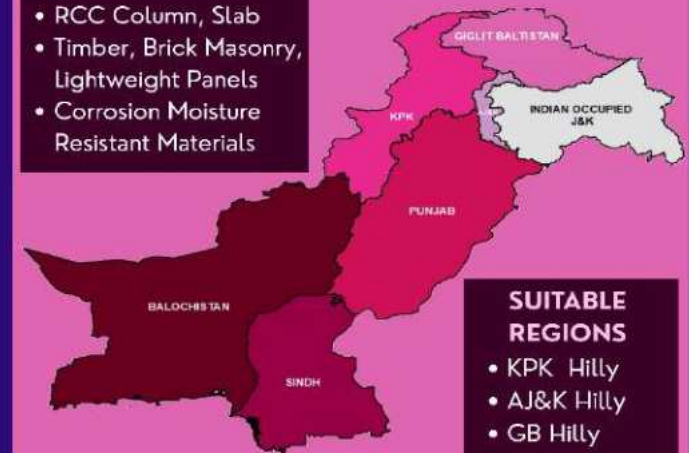
SALIENT FEATURES

- Elevated Design significantly reduces Damage during Seasonal Flooding
- Strong Columns provide Stability & Protect the Structure from Water Impact
- Raised Flooring improves Air & Prevent Dampness

MATERIALS & REGIONS

MATERIALS

- RCC Column, Slab
- Timber, Brick Masonry, Lightweight Panels
- Corrosion Moisture Resistant Materials



SUITABLE REGIONS

- KPK Hilly
- AJ&K Hilly
- GB Hilly
- Punjab
- Balochistan
- Sindh

PC1 — Elevated Flood Resilient House Structure displayed at NDMA Headquarters, Islamabad

RESILIENCE FEATURES OF ELEVATED FLOOD RESILIENT HOUSE STRUCTURE



FLOOD RESILIENT ROOF WITH OVERHANG

Lightweight roof with wide overhangs helps keep rainwater away from walls, reduces leakage and protects the structure during heavy rains and floods.



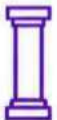
LIGHTWEIGHT & DURABLE WALL PANELS

Lightweight, water-resistant wall panels resist moisture, dry quickly after flooding and provide long-term durability in flood-prone areas.



RAISED CONCRETE FLOOR SLAB

Reinforced concrete slab provides a strong and stable platform above flood levels, keeping the structure and belongings safe from floodwater.



REINFORCED CONCRETE COLUMNS

Strong concrete columns provide vertical strength and stability, keeping the structure elevated above expected flood levels and resisting water flow and debris impact.



ELEVATED FOUNDATION

Elevated concrete pedestals keep the building above floodwater, reduce the risk of inundation, allow water to flow freely underneath and improve overall resilience.

PC2 — FLOATING AMPHIBIOUS STRUCTURE

Plain / Coastal Region Model (Flood Resilient)



FLOATING AMPHIBIOUS STRUCTURE

SALIENT FEATURES

- ✓ Structure automatically rises with increase Water Level
- ✓ Minimizes Permanent Flood Damage
- ✓ Light Weight Superstructure reduces Load on System
- ✓ Damp Proof Flooring to prevent Moisture

MATERIALS & REGIONS

MATERIALS

- Sealed Plastic Drums
- Timber, Light-weight Bamboo Structure
- Steel Frame Only
- RC Frame, Steel Frame



SUITABLE REGIONS

- Sindh (Flood Prone)
- South Punjab
- Balochistan Coastal

PC2 — Floating Amphibious Structure displayed at NDMA Headquarters, Islamabad

RESILIENCE FEATURES OF FLOATING AMPHIBIOUS STRUCTURE



SLOPED ROOF FOR RAINWATER RUNOFF

Steeply sloped roof quickly drains rainwater, preventing leakage and reducing the risk of water accumulation.



STRONG BAMBOO FRAMING

Bamboo provides high strength, flexibility and ductility, allowing the structure to withstand high wind and flood forces.



BAMBOO WALLS

Lightweight yet strong walls are more flexible and perform better during floods. They dry quickly after inundation, reducing long-term damage.



ELEVATED FLOOR LEVEL

Raised platform keeps the living space above floodwater, preventing water ingress and minimizing damage to household items.

FLOATATION SUPPORT (BARRELS)



Sealed HDPE barrels provide buoyancy, helping the structure to float during severe floods and reducing the risk of collapse.

HP1 — REINFORCED ADOBE BRICK STRUCTURE

Hilly / Plain Region Model (Earthquake Resilient)



REINFORCED ADOBE BRICK STRUCTURE

SALIENT FEATURES

- Improved Strength with Cement or Lime Stabilization
- Reinforcement Controls Cracking during Earthquakes
- Good Thermal Performance reduces Indoor Heat
- Simple Construction and Local Labor can Execute
- Use of Local Materials for Construction of Bricks

MATERIALS & REGIONS

MATERIALS

- Stabilized Adobe Bricks
- Cement | Lime Stabilization
- Wire Mesh Reinforcement
- RCC Bands & Lintels



SUITABLE REGIONS

- KPK
- GB
- AJ&K
- Punjab
- Balochistan
- Sindh

HP1 — Reinforced Adobe Brick Structure displayed at NDMA Headquarters, Islamabad

RESILIENCE FEATURES OF REINFORCED ADOBE BRICK STRUCTURE



EARTH / RAMMED EARTH WALLS

Thick earthen walls provide excellent thermal comfort, high mass for stability and resistance against lateral seismic forces.



RING BEAM / LINTEL BAND

Continuous lintel band ties all walls together, distributing loads evenly and preventing wall separation during earthquakes.



REINFORCED OPENINGS

Properly framed door opening improves structural integrity and reduces stress concentrations.



HP2 — BAMBOO FRAME WITH WATTLE AND DAUB

Hilly / Plain Region Model (Earthquake Resilient)



BAMBOO FRAME WITH WATTLE AND DAUB

SALIENT FEATURES

- Cost-effective and Locally Available Materials
- Flexible Structure with Good Earthquake Performance
- Lightweight System reduces Seismic Forces
- Environmental-friendly & Low Carbon Footprint
- Good Thermal Insulation, Easy Repair and Maintenance

MATERIALS & REGIONS

MATERIALS

- Bamboo Poles Frame
- Split Bamboo Strups (Wattle)
- Mud mixed with Straw (Daub)
- Wooden Strips Roof



SUITABLE REGIONS

- KPK
- GB
- AJ&K
- Punjab
- Balochistan
- Sindh

HP2 — Bamboo Frame with Wattle and Daub displayed at NDMA Headquarters, Islamabad

RESILIENCE FEATURES OF BAMBOO FRAME WITH WATTLE AND DAUB



LIGHTWEIGHT ROOFING

Bamboo and thatch roofing are lightweight, reducing seismic load and risk of collapse.



STRONG BAMBOO FRAMING

Bamboo frame provides high strength, flexibility and ductility, allowing structure to sway and absorb earthquake energy.



FLEXIBLE CONNECTIONS

Rope lashings at joints allow movement and dissipate seismic forces without breaking.



MUD / EARTH WALLS

Thick earthen walls provide thermal comfort and high mass, improving stability and resisting lateral forces.



HP3 — FLY ASH MASONRY STRUCTURE

Hilly / Plain Region Model (Earthquake Resilient)



HP3 — Fly Ash Masonry Structure displayed at NDMA Headquarters, Islamabad

FLY ASH MASONRY STRUCTURE

SALIENT FEATURES

- Recycled Material Bricks with Uniform Size
- High Compressive Strength & Durability
- Better Thermal Performance as compared to Clay Brick
- Utilize Industrial By-product Fly Ash
- Cost-effective Construction

MATERIALS & REGIONS

MATERIALS

- Fly Ash Bricks
- Cement Mortar
- Reinforced Concrete Bands & Lintels



SUITABLE REGIONS

- Sindh Plains
- Punjab Plains
- KPK Plains
- Balochistan Plains

RESILIENCE FEATURES OF FLY ASH MASONRY STRUCTURE



FLY ASH BRICK MASONRY WALLS

Fly ash bricks are durable, low-permeability and flood-resistant, offering enhanced strength and stability during floods.



REINFORCED CONCRETE LINTEL & ROOF BAND

Provides structural integrity and distributes loads evenly, resisting earthquake and flood forces.



HP4 — LIGHT GAUGE STEEL HOUSE STRUCTURE

Hilly / Plain Region Model (Earthquake Resilient)



LIGHT GAUGE STEEL HOUSE STRUCTURE

SALIENT FEATURES

- High Strength to Weight Ratio, Overall Light-weight
- Rapid Construction with Steel Sections
- Good Earthquake Performance due to Ductility
- Termite Proof and Rot Resistant Structure
- Easy to Expand, Modify or Repair

MATERIALS & REGIONS

MATERIALS

- Galvanized Steel Sections
- PVC Sheathing
- Lightweight Roofing Sheets



SUITABLE REGIONS

- KPK
- GB
- AJ&K
- Punjab
- Balochistan
- Sindh

HP4 — Light Gauge Steel House Structure displayed at NDMA Headquarters, Islamabad

RESILIENCE FEATURES OF LIGHT GAUGE STEEL HOUSE STRUCTURE

1 LIGHTWEIGHT ROOFING SHEETS



Corrugated steel sheets are lightweight, non-combustible and reduce dead load, minimizing risk during earthquakes and high winds.

2 LIGHT GAUGE STEEL ROOF FRAMING



Galvanized steel trusses and purlins provide high strength-to-weight ratio and excellent seismic performance.

4 WALL SHEATHING (PVC / CEMENT BOARD)



Lightweight, non-combustible wall panels provide racking resistance and protect against weather and moisture.

5 LIGHT GAUGE STEEL WALL FRAMING



Cold-formed steel sections offer excellent strength, ductility and stability during earthquakes.

7 BASE ANCHORAGE



Steel frame anchored to foundation for uplift resistance and lateral stability.

8 CORROSION PROTECTION



Galvanized steel sections provide long-term durability and protection against corrosion in harsh environments.

HP5 — PRE-FABRICATED HOUSE STRUCTURE

Hilly / Plain Region Model (Earthquake Resilient)



HP5 — Pre-Fabricated House Structure displayed at NDMA Headquarters, Islamabad

PRE-FABRICATED HOUSE STRUCTURE

SALIENT FEATURES

- Light-weight Structure Improves Seismic Performance
- Minimal Site Labor required, Rapid Construction
- Easy to Transport, Assemble & Modify
- Sustainable & Cost Effective, Disaster Resilient Design

MATERIALS & REGIONS

MATERIALS

- Precast Sandwich Panels
- Insulated Wall & Roof Panels



SUITABLE REGIONS

- KPK
- GB
- AJ&K
- Punjab
- Balochistan
- Sindh

RESILIENCE FEATURES OF PRE-FABRICATED HOUSE STRUCTURE

1

EPS SANDWICH PANEL ROOFING



Lightweight EPS sandwich roof panels provide thermal insulation, reduce seismic load and ensure fast installation.

2

EPS SANDWICH PANEL WALLS



EPS sandwich wall panels are lightweight, non-combustible, weather resistant and provide excellent thermal insulation.



RAINWATER HARVESTING TANK SYSTEM

Roof Catchment, Filtration & Domestic Water Supply — Working Principle, Benefits and Home Construction Guide

Rainwater harvesting (RWH) is the planned collection, filtration and storage of rooftop runoff for reuse, instead of letting it discharge as uncontrolled stormwater. With falling groundwater tables and increasingly erratic monsoon rainfall across Pakistan, a simple roof-fed harvesting and filtration tank illustrated below offers an affordable, low-maintenance source of secondary water at the household scale.



Roof-catchment rainwater harvesting and multi-layer filtration tank, with clean-water outlet tap



RAINWATER HARVESTING AT HOME

**SIMPLE STEPS
BIG IMPACT**



- ✓ SAVE WATER
- ✓ REDUCE FLOOD RISK
- ✓ CLEANER ENVIRONMENT
- ✓ A BRIGHTER TOMORROW

1 CLEAN YOUR ROOF

Keep the roof clean so the collected water is safe to use.



- Remove leaves, dust and debris.
- Clean the roof at least 2–3 times a year (before rainy season).

2 INSTALL GUTTERS

Fix gutters along the roof edge to collect rainwater.



- Use readily available PVC or GI gutters.
- Make sure gutters are slightly tilted towards the downpipe.

3 INSTALL DOWNPIPE WITH FILTER

Bring the water down and remove dirt before it enters the tank.



- Fix a PVC pipe from gutter to ground.
- Install a simple mesh filter to stop leaves and dirt.
- Clean the filter regularly.

4 BUILD A STORAGE TANK

Use a brick, block or plastic tank to store the clean water.



- Use a plastic water tank or build one with bricks/blocks and cement.
- Keep the tank on a strong, level base.
- Use a tight-fitting lid to keep it clean and safe from mosquitoes.

5 ADD OVERFLOW PIPE

Let extra water flow out safely when the tank is full.



- Fix an overflow pipe near the top of the tank.
- Direct it to a soak pit or garden area.
- This prevents flooding and saves extra water in the ground.

6 USE THE STORED WATER

Use the collected water for daily needs.



- Use the water for gardening, cleaning, or other non-drinking purposes.
- If needed for drinking, do proper boiling or additional treatment.

7 KEEP IT CLEAN & MAINTAIN

Regular care keeps the system working well.



- Clean the roof, gutters and filter regularly.
- Remove dirt from the tank 1–2 times a year.
- Check for leaks and repair if needed.

8 ENJOY THE BENEFITS

A simple system for a safer, more resilient home.



- Saves water and money.
- Reduces surface flooding.
- Provides water during dry periods.
- Helps create a cleaner and greener Pakistan.

SMALL ACTIONS. BIGGER RESILIENCE.

HARVEST RAINWATER – BUILD A SAFER TOMORROW

MODEL SUMMARY

HAZARD APPLICABILITY & CONSTRUCTION SPEED



CONSTRUCTION SPEED

Percentage faster compared to conventional practice



FASTER

% time savings



SAFER
COMMUNITIES



SUSTAINABLE
SOLUTIONS



COST
EFFECTIVE



FASTER
RECOVERY

5. COMMUNITY BENEFITS

How DRIM Directly Serves Pakistan's Vulnerable Communities

DRIM is fundamentally a community-centric initiative. Its design principles, material choices, and deployment strategy are all oriented toward delivering direct, measurable benefits to vulnerable communities across Pakistan.



5.1 ENHANCED SAFETY & DISASTER RESILIENCE

The most direct community benefit is the **reduction of disaster-related deaths, injuries, structural damage, and displacement**. Earthquake-resilient models provide improved seismic performance, structural stability, and lateral resistance, while flood-resilient models reduce floodwater intrusion and protect families during inundation events.

5.2 EMPOWERMENT OF LOCAL COMMUNITIES

Resilient construction approaches strengthen community self-reliance by:

- Developing a **locally trained workforce** capable of constructing and repairing homes.
- Reducing dependency on **external technical assistance and prolonged government intervention** after disasters.
- Retaining economic benefits through **local labour and material procurement**.
- Promoting a **culture of safe construction** and transferring practical knowledge across generations.

5.3 ENVIRONMENTAL & THERMAL BENEFITS

Several resilient construction systems provide environmental and climate-adaptation benefits:

- **Fly Ash Masonry:** Utilizes industrial by-products, supporting resource-efficient and lower-waste construction.
 - **Bamboo Frame with Wattle & Daub:** Provides good thermal insulation, helping maintain comfortable indoor temperatures.
 - **Loh-Kaat & Timber Frame Structures:** Can provide suitable thermal performance for **cold mountainous climates**.
 - **Low-Carbon Construction:** Greater use of local, renewable, recycled, and low-impact materials supports broader **environmental sustainability objectives**.
-

6. COST & SPEED SAVINGS ANALYSIS



COST & SPEED SAVINGS ANALYSIS

QUANTIFIED BENEFITS ACROSS DRIM MODELS



COST SAVINGS
15-40%
ACROSS ALL MODELS

TIME SAVINGS
20-50%
FASTER CONSTRUCTION

#	DRIM MODEL	ESTIMATED COST SAVINGS	ESTIMATED TIME SAVINGS	#	DRIM MODEL	ESTIMATED COST SAVINGS	ESTIMATED TIME SAVINGS
1	 Rat Trap Bond Masonry	15-25%	20-35%	9	 Reinforced Adobe Brick	20-30%	25-40%
2	 Earthbag Masonry	20-30%	25-40%	10	 Geogrid Reinforced Retaining Wall	20-30%	25-40%
3	 Cement Bamboo Frame	25-35%	30-45%	11	 Raised Plinth Flood Resilient House	15-25%	20-30%
4	 Bamboo Frame with Wattle & Daub	25-40%	30-50%	12	 Elevated Flood Resilient House	15-25%	20-30%
5	 Loh-Kaat Timber House	20-30%	25-40%	13	 Floating Amphibious Structure	20-30%	25-40%
6	 Timber Frame with Lath & Plaster	20-30%	25-40%	14	 Pre-Fabricated House	25-35%	30-50%
7	 Interlocking Brick Masonry	15-25%	20-30%	15	 Light Gauge Steel House	25-35%	30-45%
8	 Confined Concrete Block Masonry	25-35%	30-45%	16	 Fly Ash Masonry	15-25%	20-30%

WHY DRIM MODELS MATTER

Rs PKR ↓
REDUCES
CONSTRUCTION
COSTS
Up to 40%

⌚
FASTER
CONSTRUCTION
TIME
Up to 50%

🏠
ENHANCES
DISASTER
RESILIENCE

🌿
PROMOTES
SUSTAINABILITY
& LOCAL
MATERIALS

👥
IMPROVES
COMMUNITY
SAFETY &
LIVELIHOODS



DRIM models can reduce construction costs by up to **40%** and accelerate construction by up to **50%** while maintaining disaster resilience, sustainability, and community safety.



BUILDING A RESILIENT PAKISTAN
SMARTER • STRONGER • SUSTAINABLE



LOCAL SOLUTIONS
FOR LOCAL NEEDS



LOWER COSTS
BETTER VALUE



STRONGER
COMMUNITIES



RESILIENT
FUTURE

DISASTER-RESILIENT INFRASTRUCTURE

From Hazard Exposure to Resilient Infrastructure



STRATEGIC INFRASTRUCTURE



Transport Power Dams & Water Telecom

COMMERCIAL INFRASTRUCTURE



Industrial Ports & Terminals Airports Markets

RESIDENTIAL INFRASTRUCTURE



Housing Settlements Multi-Storey Buildings Community Facilities

HYDRAULIC INFRASTRUCTURE



Irrigation Water Supply Drainage & Sewerage Storage



RESILIENCE PRIORITIES



Structural & Seismic Safety



Flood / Scour Protection



Slope & Debris-Flow Protection



Fire Safety & Safe Evacuation



Climate-Resilient Planning & Design



REDUCE VULNERABILITY • PROTECT ASSETS • MAINTAIN SERVICES • STRENGTHEN COMMUNITIES

Disasters Impacting High Rise Strategic Infrastructure

EARTHQUAKE

GLOF

FLOOD

URBAN FIRE



EARTHQUAKE



Structural Collapse of Buildings



Damage to Bridges and Overpasses



Failure of Lifelines and Utilities



Service Disruption and Casualties



GLOF



Sudden Floods from Glacial Lake Outburst



Destruction of Dams, Bridges and Roads



Severe Impact on Downstream Facilities



Threat to Communities and Critical Assets



FLOOD



Inundation of Roads and Infrastructure



Damage to Buildings and Public Facilities



Disruption of Power, Water and Transport



Economic Loss and Public Health Risks



URBAN FIRE



Rapid Spread in High Rise Buildings



Damage to Structures and Critical Assets



Evacuation and Risk to Human Life



Service Disruption and Recovery Delays

STRATEGIC INFRASTRUCTURE | BUILDING RESILIENCE FOR PAKISTAN

VULNERABILITY

>

RESILIENCE

HAZARD	DAMAGED / COLLAPSED STRUCTURES			RESILIENT MEASURES TO BE ADOPTED		
 FLOODS	 Bridge Scour & Undermining	 Road Washout	 Building Inundation	 Scour Protection for Bridges	 Raised & All-Weather Roads	 Flood-Resilient Buildings (Elevated Design)
 EARTHQUAKES	 RC Building Collapse	 Masonry Wall Failure	 Bridge Pier Damage	 Seismic-Resistant Design (Ductile Detailing)	 Confined Masonry with Bands & Ties	 Seismic Isolation Bearings for Bridges
 GLOFS	 Bridge & Culvert Blockage	 Debris Flow Damage	 Sediment Deposition & Building Damage	 Debris/Sediment Barriers & Check Dams	 Improved Drainage & River Training	 Slope Stabilization & Retaining Structures
 URBAN FIRE	 RC Frame Fire Damage	 Factory/Shop Fire Loss	 High-Rise Fire Spread	 Fire-Resistant Construction (Concrete & Steel)	 Fire Detection, Alarms & Safe Exits	 Emergency Exits & Safe Assembly Areas

HAZARD

DAMAGED / COLLAPSED STRUCTURES

RESILIENT MEASURES TO BE ADOPTED



FLOODS



Mall Parking Flooding



Shop Inundation



Road & Access Damage



Flood Barriers & Watertight Entrances



Elevated Utilities & Critical Systems



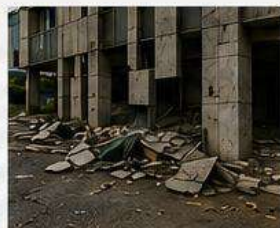
Permeable Pavements & Proper Drainage



EARTHQUAKES



High-Rise Building Damage



Façade / Cladding Failure



Parking Structure Collapse



Seismic-Resistant Frames & Bracing



Flexible Façades & Secure Connections



Seismic Joints in Parking Structures



GLOFS



Retail Complex Debris Impact



Road Blockage by Debris



Foundation Scour



Debris Deflection Systems & Retaining Walls



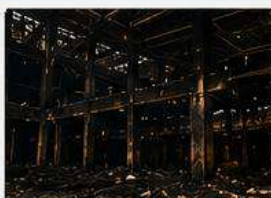
Clear Drainage Corridors & Culverts



Slope Protection & Retaining Structures



URBAN FIRE



Shopping Mall Fire



Market/Shop Fire



Office Building Fire



Sprinkler Systems & Fire Suppression



Fire-Rated Doors & Compartments



Safe Evacuation Routes & Fire Exits

HIGH-RISE BUILDING MODELS

Understanding Structural Behavior
Under Seismic Forces

STRUCTURAL SYSTEMS

Tuned Mass Damper · Base Isolation · Shear Wall · Diagrid ·
Outrigger & Belt Truss

SEISMIC RESPONSE

Decouples ground motion from superstructure; cuts sway
by 30–50%

MODEL DEMONSTRATION

Physical simulator showcasing earthquake-resilient high-
rise configurations

RESILIENCE CONTEXT

Pakistan highly vulnerable to earthquakes — advanced
structural systems reduce damage



STRUCTURAL SYSTEMS

Tuned Mass
Damper

Base
Isolation

Shear Wall
System

Diagrid
System

Outrigger &
Belt Truss

Central Core
System

Energy
Dissipation

HIGH-RISE BUILDING RESILIENCE

TUNED MASS DAMPER (TMD)

—• SMART ENGINEERING FOR STABLE HIGH-RISE STRUCTURES •—

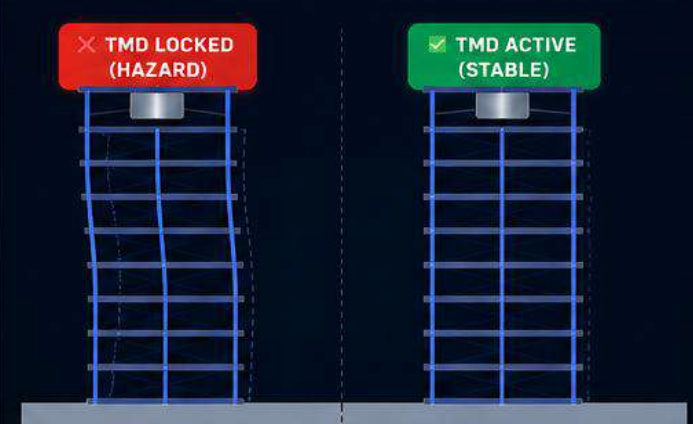
ENGINEERING BENEFITS

-  **REDUCES SWAY UP TO 40%**
Cuts wind- and quake-induced sway by up to 40%.
-  **IMPROVES OCCUPANT COMFORT**
Enhances comfort in supertall towers.
-  **NO ADDED STIFFNESS NEEDED**
No added stiffness needed elsewhere in the frame.
-  **WORKS CONTINUOUSLY**
Works continuously, not just during rare extreme events.

ACTUAL ENGINEERING DEMONSTRATION



INTERACTIVE STRUCTURAL SIMULATION



ENGINEERING LIMITATIONS

-  **CONSUMES VALUABLE TOP-FLOOR SPACE**
Requires significant space and adds roof mass.
-  **MUST BE RE-TUNED WHEN CHANGES OCCUR**
Performance depends on correct tuning if building mass or use changes.
-  **LOCKING OR FAILURE REMOVES BENEFIT**
If locked or damaged, the TMD provides no effect at all.
-  **HIGH-PRECISION COMPONENTS NEED CARE**
High-precision cables and shocks add maintenance cost.

REAL-WORLD APPLICATIONS



TAIPEI 101
Taipei, Taiwan
World's largest TMD (660 ton)



SHANGHAI TOWER
Shanghai, China
Reduces wind and vibration



CITIC TOWER
Beijing, China
Improves comfort and stability



BURJ KHALIFA
Dubai, UAE
Enhances stability in extreme winds

ENGINEERING FACT

-  TMD acts like a pendulum that moves out of phase, absorbing energy and reducing building motion.
-  Works for both wind and earthquake loads.
-  A small system with a big impact on safety, comfort and performance.

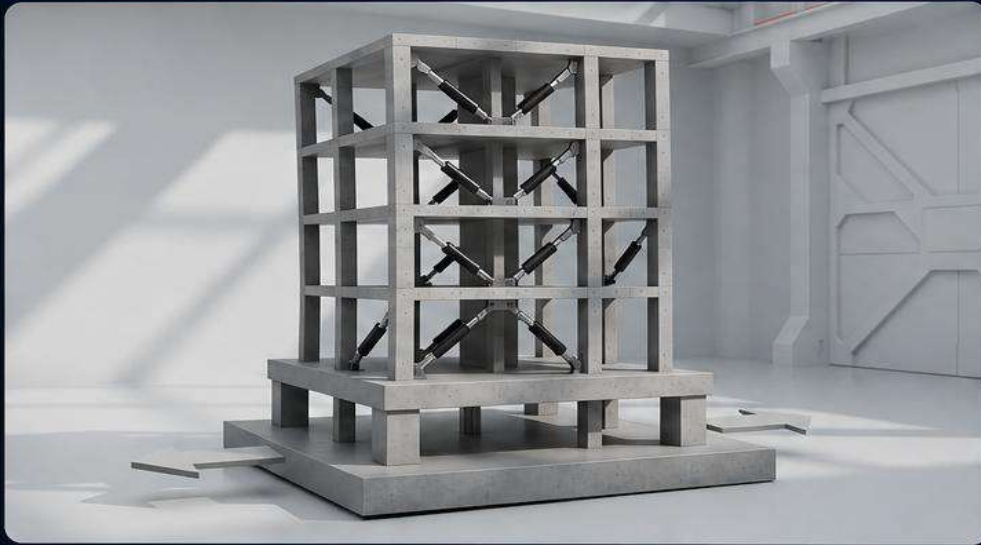
HIGH-RISE BUILDING RESILIENCE

ENERGY DISSIPATION SYSTEM

ENHANCING STABILITY. ABSORBING ENERGY. PROTECTING STRUCTURES.

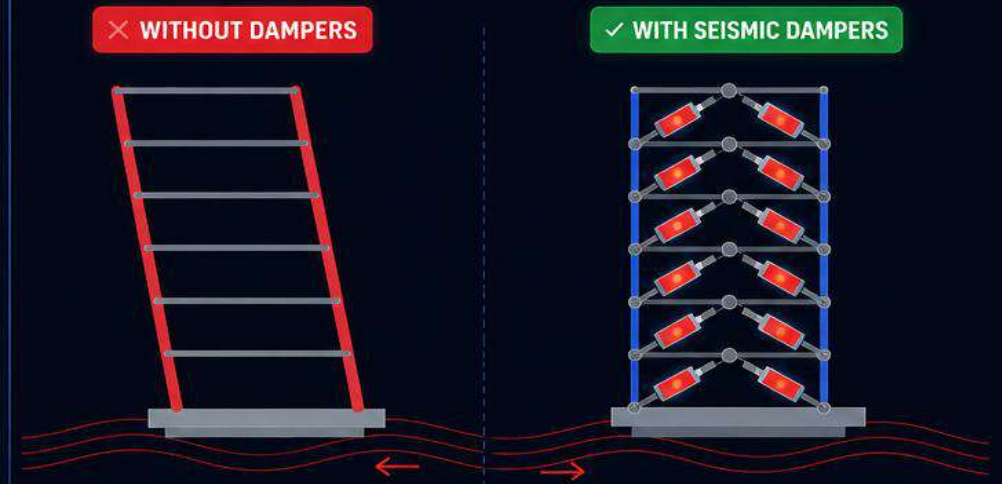
ACTUAL ENGINEERING DEMONSTRATION

● PLAYING



INTERACTIVE STRUCTURAL SIMULATION

● COMPARISON ON



ENGINEERING BENEFITS

-  **ABSORBS & DISSIPATES ENERGY**
Reduces seismic and wind forces on the structure.
-  **IMPROVES STRUCTURAL SAFETY**
Limits drift and displacement, reducing damage risk.
-  **ENHANCES PERFORMANCE**
Maintains stability and functionality during extreme events.
-  **REDUCES REPAIR & DOWNTIME**
Minimizes structural damage and maintenance cost.

ENGINEERING LIMITATIONS

-  **HIGH INITIAL COST**
Installation and devices can be expensive.
-  **REQUIRES SPACE**
Needs adequate space for installation and access.
-  **REGULAR INSPECTION NEEDED**
Periodic maintenance is essential for optimal performance.
-  **DESIGN DEPENDENT**
Effectiveness depends on correct design and placement.

REAL-WORLD APPLICATIONS

			
TAIPEI 101 Taipei, Taiwan	SHANGHAI TOWER Shanghai, China	BURJ KHALIFA Dubai, UAE	ONE WORLD TRADE CENTER New York, USA
Uses tuned mass damper for wind load control.	Reduces wind vibration for occupant comfort.	Enhanced stability in extreme wind conditions.	Improves structural resilience and safety.

ENGINEERING FACTS

-  Energy dissipation systems absorb and dissipate dynamic energy through controlled deformation.
-  Works for both earthquake and wind-induced loads.
-  A key solution for modern high-rise and critical structures.

HIGH-RISE BUILDING RESILIENCE

OUTRIGGER & BELT TRUSS SYSTEM

— ENHANCES STABILITY. REDUCES SWAY. STRENGTHENS HIGH-RISE STRUCTURES. —

ACTUAL ENGINEERING DEMONSTRATION

PLAYING

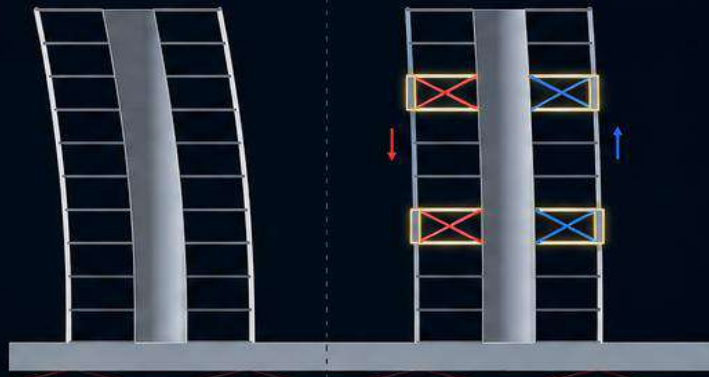
Outrigger and Belt Truss System



INTERACTIVE STRUCTURAL SIMULATION

✗ CORE SWAYS
UNCOUPLED

✓ ENGAGED
OUTRIGGER TRUSSES



ACTIVE STRUCTURAL COMPONENTS

- ✓ Central Concrete Core
- ✓ Perimeter Columns
- ✓ Outrigger Trusses **ACTIVE**

ENGINEERING BENEFITS

- REDUCES SWAY**
Outriggers connect the core to perimeter columns, reducing lateral movement.
- IMPROVES STABILITY**
Transfers loads to the building perimeter for greater stiffness.
- ENHANCES SAFETY**
Controls drift and improves structural resilience during earthquakes and wind.
- INCREASES STRENGTH**
Belt trusses act like a "strong belt", resisting overturning moments.

ENGINEERING LIMITATIONS

- ADDS COMPLEXITY**
Requires careful design and precise detailing.
- HIGHER CONSTRUCTION COST**
Additional materials and skilled labor increase cost.
- ARCHITECTURAL CONSTRAINTS**
Outriggers occupy space, which may affect usable floor area.
- DESIGN DEPENDENT**
Effectiveness depends on proper placement and structural configuration.

REAL-WORLD APPLICATIONS



TAIPEI 101
Taipei, Taiwan
Outrigger system at multiple mechanical floors.



SHANGHAI TOWER
Shanghai, China
Uses outrigger to reduce wind induced sway.



BURJ KHALIFA
Dubai, UAE
Outriggers enhance lateral stability and structural efficiency.



PETRONAS TOWERS
Kuala Lumpur, Malaysia
Belt trusses connect towers for added stiffness and safety.

ENGINEERING FACTS

- Outriggers are most effective when placed at 1/3 to 2/3 height of the building.
- Can reduce top displacement by up to 30–50%.
- Essential for ultra-high-rise buildings above 50–60 stories.

HIGH-RISE BUILDING RESILIENCE

DIAGRID STRUCTURAL SYSTEM

STRENGTH • STABILITY • EFFICIENCY

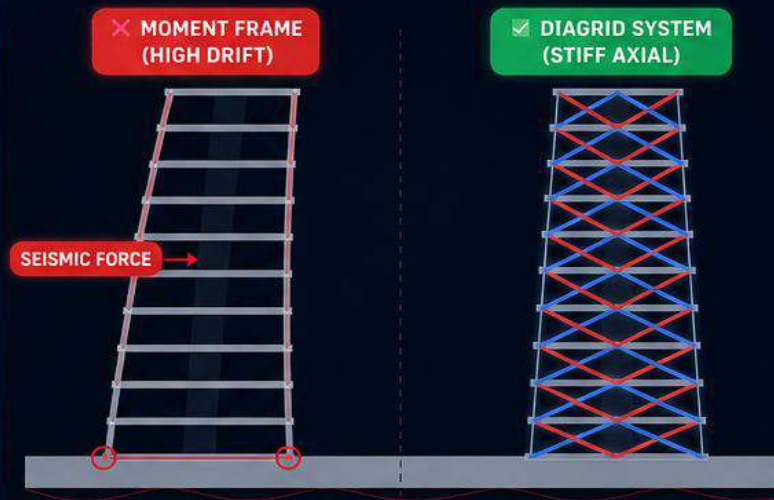
ACTUAL ENGINEERING DEMONSTRATION

PLAYING



INTERACTIVE STRUCTURAL SIMULATION

COMPARISON ON



ACTIVE STRUCTURAL COMPONENTS

- ✓ Joint Node Plates
- ✓ Ring Girders
- ✓ Diagrid Members **ACTIVE**

ENGINEERING BENEFITS

- HIGH STRENGTH & STIFFNESS**
Triangular action provides excellent lateral stiffness.
- REDUCES DRIFT**
Effectively limits sway and improves stability.
- INCREASES LOAD CAPACITY**
Axial load path enhances overall structural capacity.
- MATERIAL EFFICIENCY**
Uses less material with higher performance.

ENGINEERING LIMITATIONS

- COMPLEX GEOMETRY**
Requires specialized design and skilled fabrication.
- HIGHER COST**
More complex connections and node details.
- DIFFICULT MODIFICATIONS**
Changes or openings are difficult after construction.
- CONSTRUCTION CHALLENGE**
Requires precise alignment and temporary support.

REAL-WORLD APPLICATIONS



HEARST TOWER
New York, USA
First high-rise with diagrid exterior.



30 ST MARY AXE
London, UK
Diagrid structure for stability & efficiency.



AL HAMRA TOWER
Kuwait City, Kuwait
Diagrid system resists wind & seismic loads.



COCOON TOWER
Tokyo, Japan
Combines diagrid for strength & aesthetics.

ENGINEERING FACTS

- Diagrids work on axial forces, minimizing bending moments.
- Can reduce lateral drift by up to 30–60%.
- Ideal for high-rise buildings and towers.
- Enhances structural resilience to seismic and wind loads.

HIGH-RISE BUILDING RESILIENCE

SHEAR WALL SYSTEM

STRENGTH • STABILITY • SEISMIC RESISTANCE

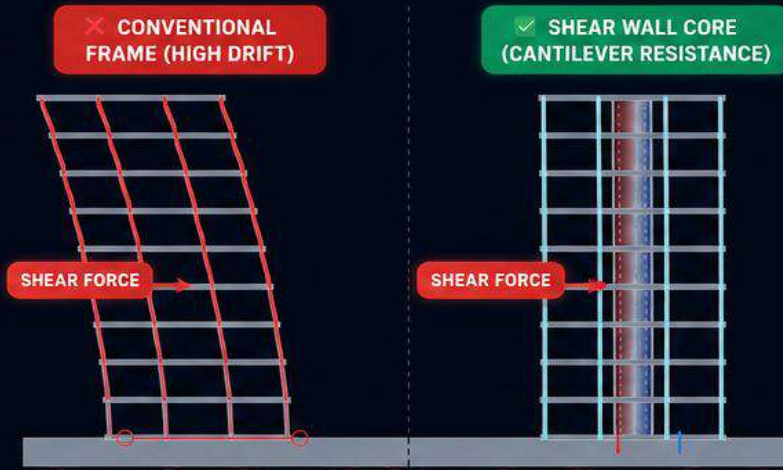
ACTUAL ENGINEERING DEMONSTRATION

PLAYING



INTERACTIVE STRUCTURAL SIMULATION

COMPARISON ON



ACTIVE STRUCTURAL COMPONENTS

- ✓ Vertical Rebar
- ✓ Fixed Base Anchor
- ✓ Concrete Core Wall **ACTIVE**

ENGINEERING BENEFITS

- HIGH LATERAL STRENGTH**
Resists wind and seismic forces effectively.
- MINIMIZES DRIFT**
Reduces lateral movement for safer structures.
- INCREASES STIFFNESS**
Provides high stiffness and improves stability.
- SPACE EFFICIENCY**
Combines structure and partition in one element.

ENGINEERING LIMITATIONS

- ARCHITECTURAL CONSTRAINTS**
Limits window/door openings and layout flexibility.
- HIGHER CONCRETE & STEEL**
Requires more material and skilled labor.
- DIFFICULT MODIFICATIONS**
Hard to alter after construction is completed.
- ADDS DEAD LOAD**
Increases overall building weight.

REAL-WORLD EXAMPLES



BURJ KHALIFA
Dubai, UAE
Central core shear walls provide exceptional lateral stability.



JOHN HANCOCK CENTER
Chicago, USA
Shear wall core ensures stability against wind and seismic loads.



TAIPEI 101
Taipei, Taiwan
Reinforced concrete core walls resist typhoon and seismic forces.



MARINA BAY SANDS
Singapore
Core walls provide strength and stiffness for tall towers.

ENGINEERING FACTS

- Shear walls resist lateral forces through in-plane shear action.
- Can reduce lateral drift by up to 50–70%.
- Essential for mid-rise to high-rise buildings.
- Provide both strength and serviceability in one system.

HIGH-RISE BUILDING RESILIENCE

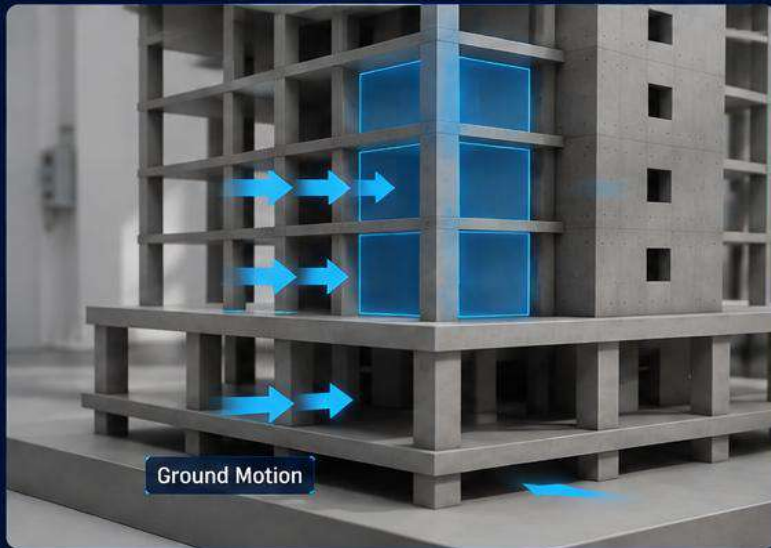
CENTRAL CORE SYSTEM

THE STRENGTH WITHIN. STABILITY AROUND.



ACTUAL ENGINEERING DEMONSTRATION

PLAYING

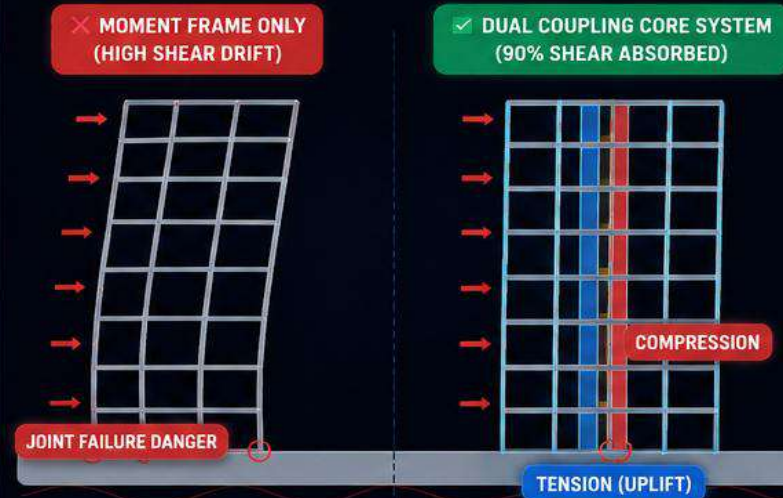


Ground Motion



INTERACTIVE STRUCTURAL SIMULATION

COMPARISON ON



ACTIVE STRUCTURAL COMPONENTS

- ✓ Coupling Beams
- ✓ Floor Interaction
- ✓ Twin Concrete Piers **ACTIVE**



ENGINEERING BENEFITS



MAXIMUM STRENGTH

Core provides high stiffness and strength.



REDUCES LATERAL DRIFT

Central core resists most seismic and wind forces.



IMPROVES STABILITY

Enhances overall structural stability and safety.



EFFICIENT FLOOR SPACE

Keeps perimeter column-free for flexible layouts.



ENGINEERING LIMITATIONS



HIGH CONSTRUCTION COST

Requires more materials, skilled labor and time.



DESIGN COMPLEXITY

Needs detailed analysis for core and coupling beams.



LIMITED ARCHITECTURAL FLEXIBILITY

Core location can restrict open floor planning.



HEAVY STRUCTURE

Increases overall building weight and foundation load.



REAL-WORLD EXAMPLES



BURJ KHALIFA
Dubai, UAE

Central core with outrigger system for maximum stability.



TAIPEI 101
Taipei, Taiwan

Core system resists typhoons and seismic forces.



ONE WORLD TRADE CENTER
New York, USA

Reinforced concrete core ensures strength and safety.



PETRONAS TOWERS
Kuala Lumpur, Malaysia

Central core with coupling beams for lateral stability.



ENGINEERING FACTS



Central cores resist up to 70–90% of lateral loads.



Can reduce top floor drift by up to 50–70%.



Ideal for high-rise buildings above 30+ stories.



Provides both strength and stiffness in one system.

HIGH-RISE BUILDING RESILIENCE

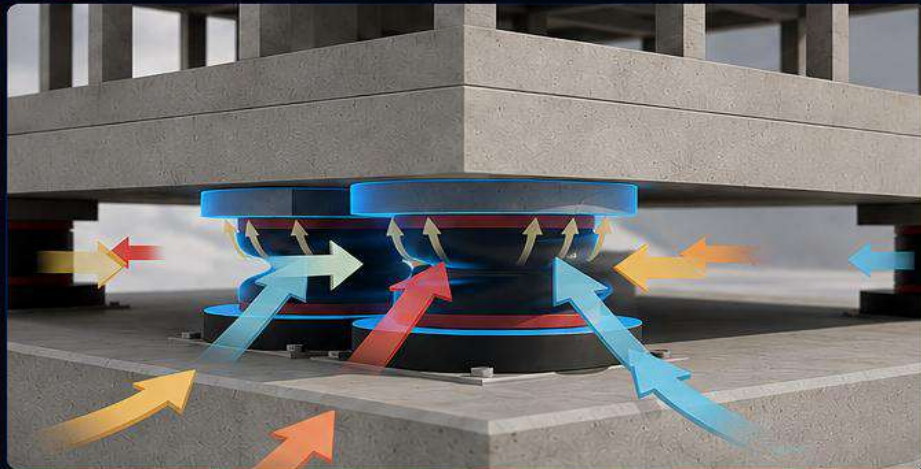
BASE ISOLATION SYSTEM

ISOLATE. ABSORB. PROTECT.



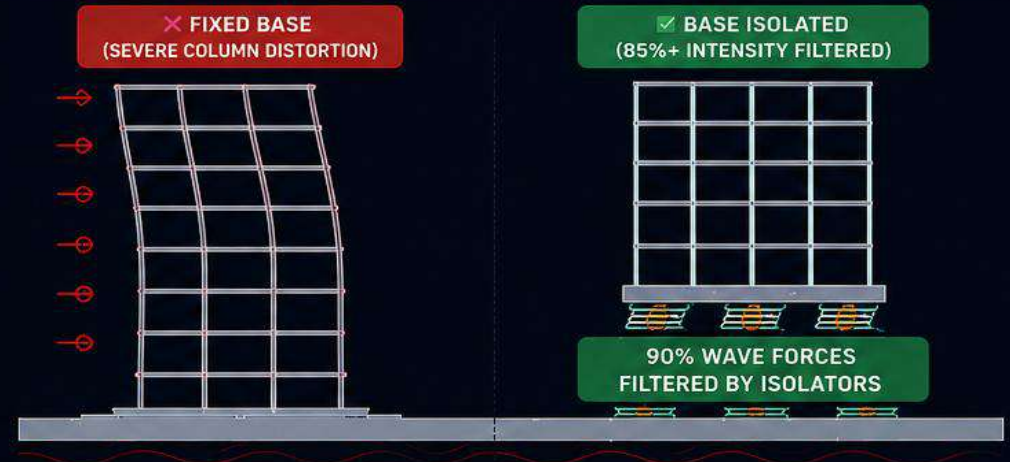
ACTUAL ENGINEERING DEMONSTRATION

PLAYING



INTERACTIVE STRUCTURAL SIMULATION

COMPARISON ON



ENGINEERING BENEFITS



REDUCES SEISMIC FORCES
Filters earthquake energy, reducing forces transmitted to the structure.



PROTECTS STRUCTURE
Minimizes damage to columns, beams and non-structural components.



IMPROVES OCCUPANT SAFETY
Limits acceleration and enhances comfort.



ENABLES CONTINUITY OF USE
Buildings remain functional after strong earthquakes.



ENGINEERING LIMITATIONS



HIGH INITIAL COST
Increases material and installation cost.



INCREASED BASE DISPLACEMENT
Requires larger separation gaps and access.



SENSITIVE TO MAINTENANCE
Needs periodic inspection and bearing replacement.



NOT IDEAL FOR LOW-RISE
Less effective and not cost-efficient.



ENGINEERING FACTS



Reduces base shear by up to 70–90%.



Increases fundamental period of the structure.



Isolators decouple the structure from ground motion.



Common isolators: Lead Rubber Bearings, HDRBs, Friction Pendulum.



REAL-WORLD EXAMPLES



NEW ZEALAND PARLIAMENT
Wellington, New Zealand

Base isolated in 1980s, performed well in earthquakes.



CHENGDU XINHUA HOSPITAL
Chengdu, China

Seismically isolated using LRBs for high safety and functionality.



KEY TAKEAWAY



Base isolation protects lives, reduces damage and ensures buildings stay operational when it matters most.

THE WAY FORWARD

RESILIENT INFRASTRUCTURE FOR A SAFER, STRONGER TOMORROW

RESILIENT
INFRASTRUCTURE
STRONGER
COMMUNITIES
SUSTAINABLE
FUTURE



Scale Up

DRIM & High-Rise Infrastructure

Scale up **DRIM** initiatives and integrate resilience in **high-rise** and large-scale infrastructure across all provincial and district levels.



Resilient
Public Facilities



Seismic & Flood
Resilient High-Rise
Buildings



Resilient
Transport Networks



Safe & Functional
Critical Infrastructure



Train & Certify

Build Skills for Resilient Infrastructure

Establish capacity building programs on **DRIM** and **high-rise infrastructure** for all relevant stakeholders.



Training for
Engineers & Builders



Certification &
Standards Compliance



Technical
Guidelines & Toolkits



Awareness for
Communities



Policy Integration

Mainstream DRIM & High-Rise Resilience

Incorporate **DRIM** and **high-rise** resilience into national building codes, land-use planning and disaster recovery frameworks.



Updated
Building Codes



Risk-Sensitive
Land Use Planning



Resilient Approvals
& Enforcement



Public-Private
Collaboration

BUILDING
BACK
BETTER
HIGHER
STRONGER
TOGETHER

SAFE CITIES
RESILIENT
COMMUNITIES
PROSPEROUS
PAKISTAN



PEOPLE-CENTRED



CLIMATE RESILIENT



INCLUSIVE GROWTH



SUSTAINABLE



DISASTER RESILIENT



NDMA PAKISTAN

NATIONAL DISASTER
MANAGEMENT AUTHORITY

PLANNED TODAY PROTECTED TOMORROW

TOGETHER FOR A SAFER FUTURE



DISASTER
RESILIENT



COMMUNITY
FOCUSED



SUSTAINABLE
SOLUTIONS



SMART &
INCLUSIVE
INFRASTRUCTURE



FASTER
RECOVERY



STRONGER
PAKISTAN

IA&PD WING

INFRASTRUCTURE ADVISORY &
PROJECT DEVELOPMENT WING



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