Reinforced Masonry Structure

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Technology:
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AIT-S, Thailand

Load Bearing Structure: Historical Monuments, Historic Settlements and Traditional Buildings

Traditional Buildings in Rural and Remote Areas

Experts View: All those structures and early constructed frame structure buildings are weak from the earthquake

Many of these buildings and structures will be collapsed and hundred thousands of people will be died and injured, if big earthquake happens

GORKHA EARTHQUAKE, 25th APRIL 2015

Modern houses as well as these types of traditional houses in the rural areas have been collapsed during the earthquake

GORKHA EARTHQUAKE, 25th APRIL 2015

Damage in historic settlements and traditional buildings :
Patan, Bhaktapur, Sankhu, Bungamati, Harisiddhi and other

GORKHA EARTHQUAKE, 25th APRIL 2015

Modern Buildings

GORKHA EARTHQUAKE, 25th APRIL 2015

*Nearly **500,000** houses were destroyed and more than **250,000** houses were partially damaged*

TABLE 1.1: NUMBER OF HOUSES DAMAGED[8]

	Low Strength Masonry	Cement Mortared Masonry	Reinforced Concrete	Total
Fully Damaged	474,025	18,214	6,613	498,852
Partially Damaged	173,867	65,859	16,971	256,697

Around 95% of Low Strength Masonry Houses were fully damaged

Perception:
Traditional construction technology (load bearing) is weaker than the frame structure

Why all monuments and traditional buildings are not collapsed? would they have collapsed in same manner even if there were no earthquake?

What are the reasons behand that?

GORKHA EARTHQUAKE, 25th APRIL 2015

Destruction pattern in load bearing Structures

1. Lack of Structural integrity

- Lack of bands at various levels like; **sill**, **lintel** or **gable**.
- Due to lack of proper bonding in masonry load bearing wall, **out of plane collapse** was more commonly observed in Kathmandu valley and other settlements

Fig: Out of plane collapse in traditional masonry buildings

GORKHA EARTHQUAKE, 25th APRIL 2015

An overview of destruction pattern

1. Lack of Structural integrity

Fig: Damage at corner walls due to lack to corner stitching

Pc : ***Observed Damage Patterns on Buildings during 2015 Gorkha (Nepal) Earthquake*** NSET

GORKHA EARTHQUAKE, 25th APRIL 2015

An overview of destruction pattern

1. Lack of Structural integrity

Fig: Corner failure

Fig: Out of plane collapse

Pc : ***Observed Damage Patterns on Buildings during 2015 Gorkha (Nepal) Earthquake*** NSET

GORKHA EARTHQUAKE, 25th APRIL 2015

An overview of destruction pattern

2. Bonding materials

(Mud used for bonding bricks in a wall)

Fig : Failure of masonry units due to lack of proper bonding material

Gorkha earthquake – 25th April 2015

An overview of destruction pattern

3. Load path discontinuity

- Wall built above projections result in discontinuity of load path
- Masonry buildings up to six stories have been found while max. limit is 4 !
- Lack of implementation of building codes & bylaws

Other damages and causes

- Shared walls and wall thickness
- Inclined foundation and soil problems
- Heavy roofs (roof tiles)
- Age of buildings
- Pounding and progressive failures
- Improper modification of buildings
- Lack of periodic and proper maintenance

GORKHA EARTHQUAKE, 25th APRIL 2015

An overview of destruction pattern

Experience:

Damages of traditional houses vs frame structure houses

- More causalities
- Difficult in debris management

RECONSTRUCTION - GORKHA EARTHQUAKE

ISSUES/CHALLENGES

- Construction of permanent, strong, earthquake resilient, environment friendly and sustainable house by using local material and technology
- Construction of traditional houses to ensure our cultural heritage and local and ethnic identity
- Construction of mass houses in different areas in a short period.

PREFERENCE

- Construction of permanent, strong, earthquake resilient, environment friendly, sustainable and cost effective houses by using locally available building materials
- Maximum utilization of local skill/knowledge or involvement of local people for the construction of houses: development /use of simple construction technology
- Local employment generation

GORKHA EARTHQUAKE-25th April 2015

Big Question ?

Is it possible to address such issues/challenges and build earthquake resilient buildings from our local materials with local technology (load bearing system)?

Alternate Technology

1. **Bamboo**

2. **Prefab**

Alternate Technology

3. Earth Bag Construction

4. Rammed Earth Construction

Alternate Technology

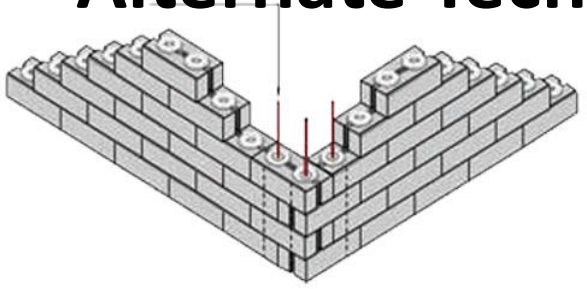
Soil Cement Stabilized Brick)

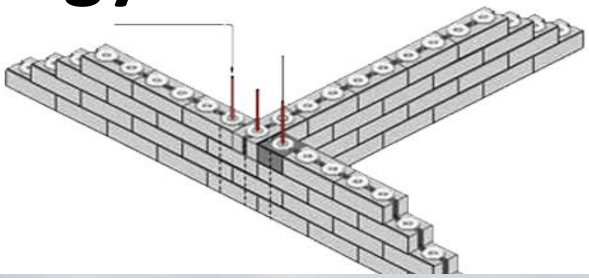
Alternate Technology

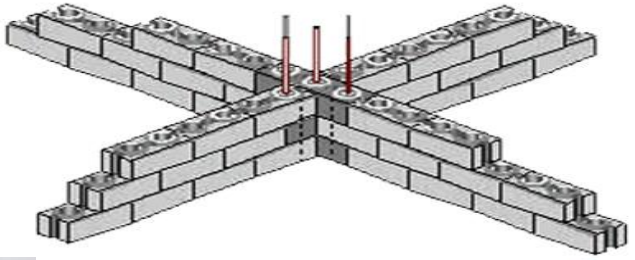
Soil Cement Stabilized Brick)

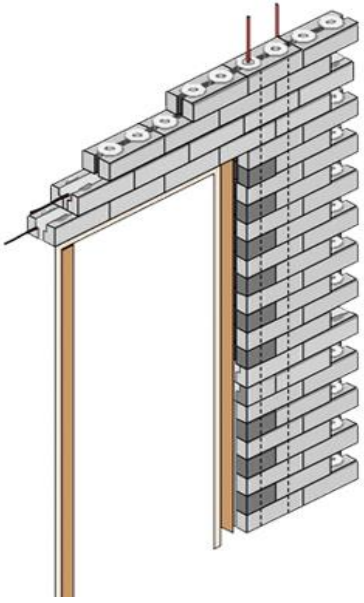
RECONSTRUCTION - GORKHA EARTHQUAKE

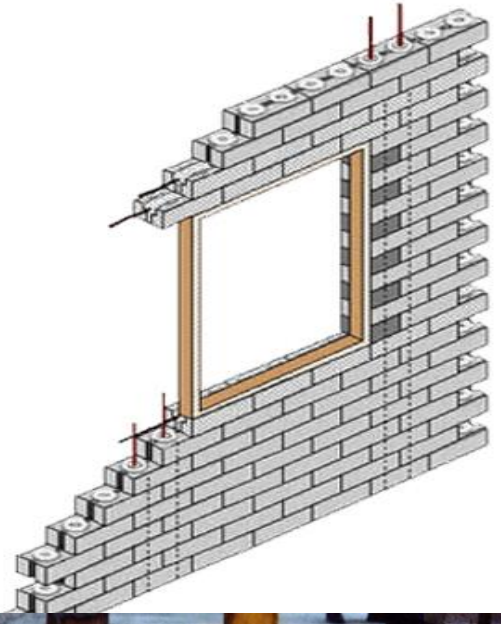
Alternate Technology : Habitech Building Technology:





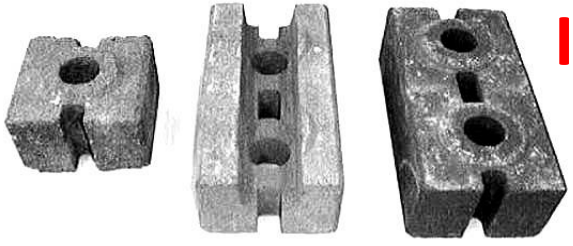






Reinforce Masonry Structure

Interlock Soil Cement Bricks



हेविटेक भवन निर्माण प्रविधि

"स्थायी, दिगो एवं भूकम्प सुरक्षित भवन निर्माणको पुर्ण समाधान"

- स्थानीय सामग्री तथा शिपको प्रयोग गरी स्थायी एवं भूकम्प सुरक्षीत भवनहरु (आवास, शिक्षण तथा स्वास्थ संस्था आदि) निर्माण गर्न ।
- गाँउघरको मौलिकता झल्कने घरहरुको पुनः निर्माण गर्न ।
- स्थानीय रोजगारीमा टेवा पुऱ्याउन ।

समृद्ध समाजको स्थापनामा
सही पुननिर्माण आजको आवश्यकता

इनोटेक नेपाल प्रा. लि.
(नेपाल ह्याबिटेक सेन्टर)
इनोटेक ट्रेडिंग प्रा. लि.
भूस्पर्श कन्स्ट्रक्सन प्रा. लि.
खुमलटार, ललितपुर, नेपाल
(०१-५५३२३२३)
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“Habitech Building Technology”

Habitech Center, AIT consulting, AIT Thailand has developed “Habitech Building Technology” which is similar to our traditional building construction system with more improvements specially rebar in the strategic location of walls “Reinforce Masonary Structure”

Technology is very useful for the construction of 1-2 storey permanent, earthquake resilient, environment friendly, sustainable, cost effective houses in any rural/remote areas where such materials are available:

- Stone, soil, cement, sand, chips (pea gravel), rebar, wood, metal pipe, GI sheet, or other local roofing materials

KEY ATTRIBUTES OF HABITECH SOLUTION

- Less carbon footprint due to lower transportation requirements
- Uses natural soil as a major ingredient in the bricks
- No need to burn during production, hence no pollution
- Low wastage

- Uses locally available soil
- Can be constructed by local unskilled labor with little training
- Generates local employment

- Is Earthquake safe due to use of horizontal and vertical reinforcement in strategic point
- High resistance to wind, hurricanes and floods

- Weather resistant/Suitable for all climatic conditions
- High compressive strength
- No maintenance
- Cement base

- Faster and quicker construction
- Uses a simple technique and equipment for the production of bricks
- Modular and no need to cut
- Interlocking bricks make it easy to construct due to its self-alignment technique

- Produced at the site and near the site – low transportation cost
- Use of local unskilled labour and need less skilled labour compared to conventional construction methods
- Lower use of cement and sand as compared to traditional methods
- No plastering or very thin plastering
- No wastage/no cutting required
- Eliminates concrete beam, columns, lintels and form work

“Habitech Building Technology”

Habitech Building Components

Interlocking Blocks	Concrete Door Frame	Concrete Window Frame	Concrete Joist	Concrete Pans	Concrete Stringer & Tread	MCR Tiles	Sanitary Unit
for Walls	for Walls	for Walls	for Floors	for Floors	for Staircase	for Roofing	for Toilet

Equipment are simple and light so production unit can establish at any places

Manual Brick Production Press

Major Components

Cement Pan production machine

RCC Joist production machine

“Habitech Building Technology”

Material for the building components

1. Foundation: Stone/Brick/RCC
2. Wall: CSEB interlock bricks with provision for rebar
3. Intermediate Slab for two storey house: concrete joist + cement pan or any other locally available material
4. Door/Window : concrete window frame or various options
5. Staircase: Prefab concrete stairs/ Metal/ Wooden etc.
6. Roof : MCR tile or local roofing system for slope roof or concrete joist and cement pan for flat roof

“Habitech Building Technology”

Soil Cement Stabilize Interlock Brick instead of burnt brick for wall

Regular Brick 15 X 30 X 10 cm

Half regular Brick 15 X 15 X 10 cm

Half U-shaped Brick 15 X 30 X 10 cm

U-shaped Brick 15 X 30 X 10 cm

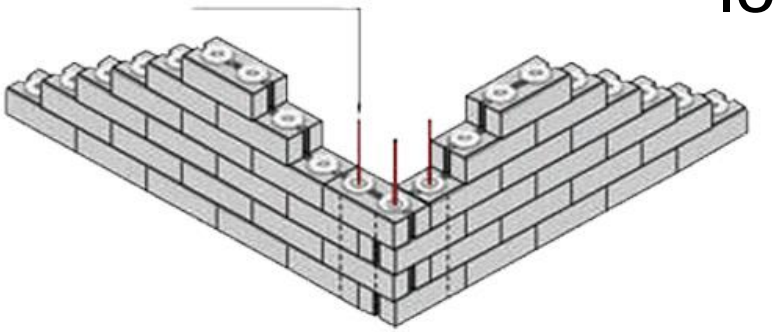
RCC joist and cement pan instead of wooden material for flat roof or intermediate floor if 2 storey building

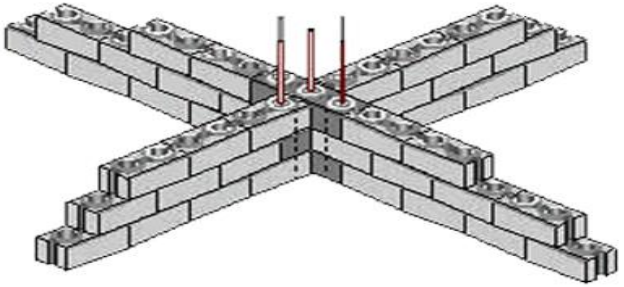
“Habitech Building Technology”

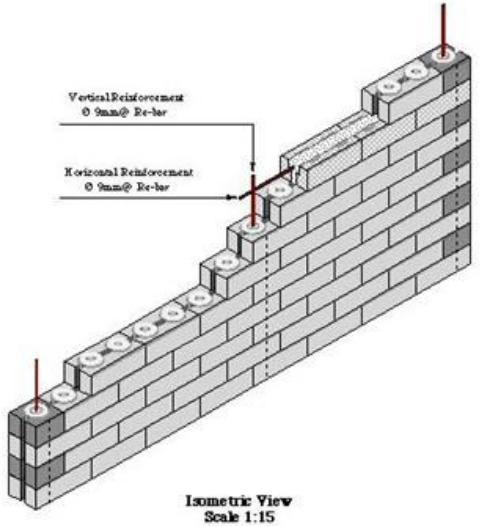
Technology is so simple that local people with or without construction skill/knowledge can easily construct earthquake resilient house by providing 5-7 days training

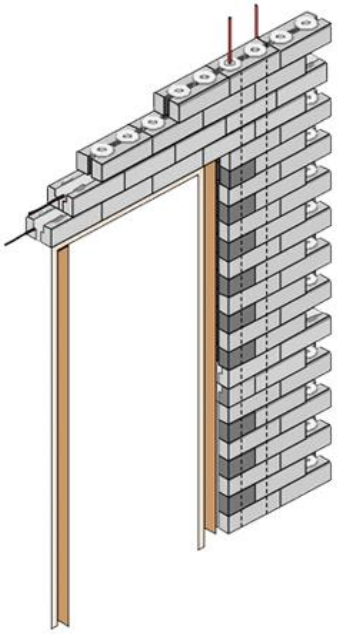
“Habitech Building Technology”

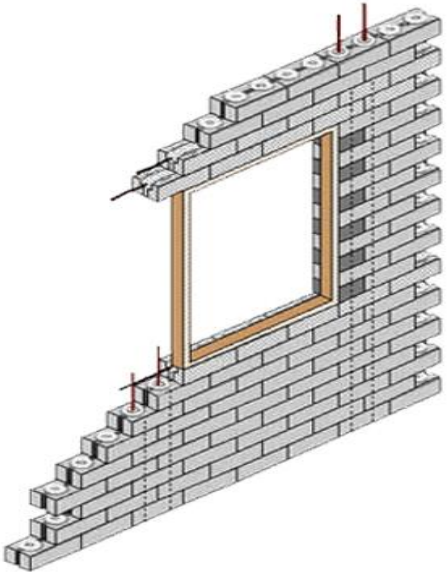
Reinforce Masonry Structure: permanent, environment friendly, earthquake resilient wall with rebar in each strategic location of building

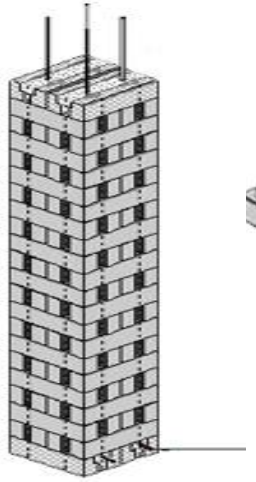


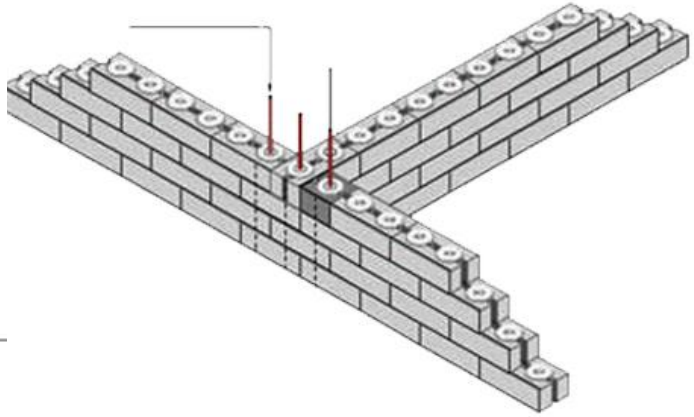


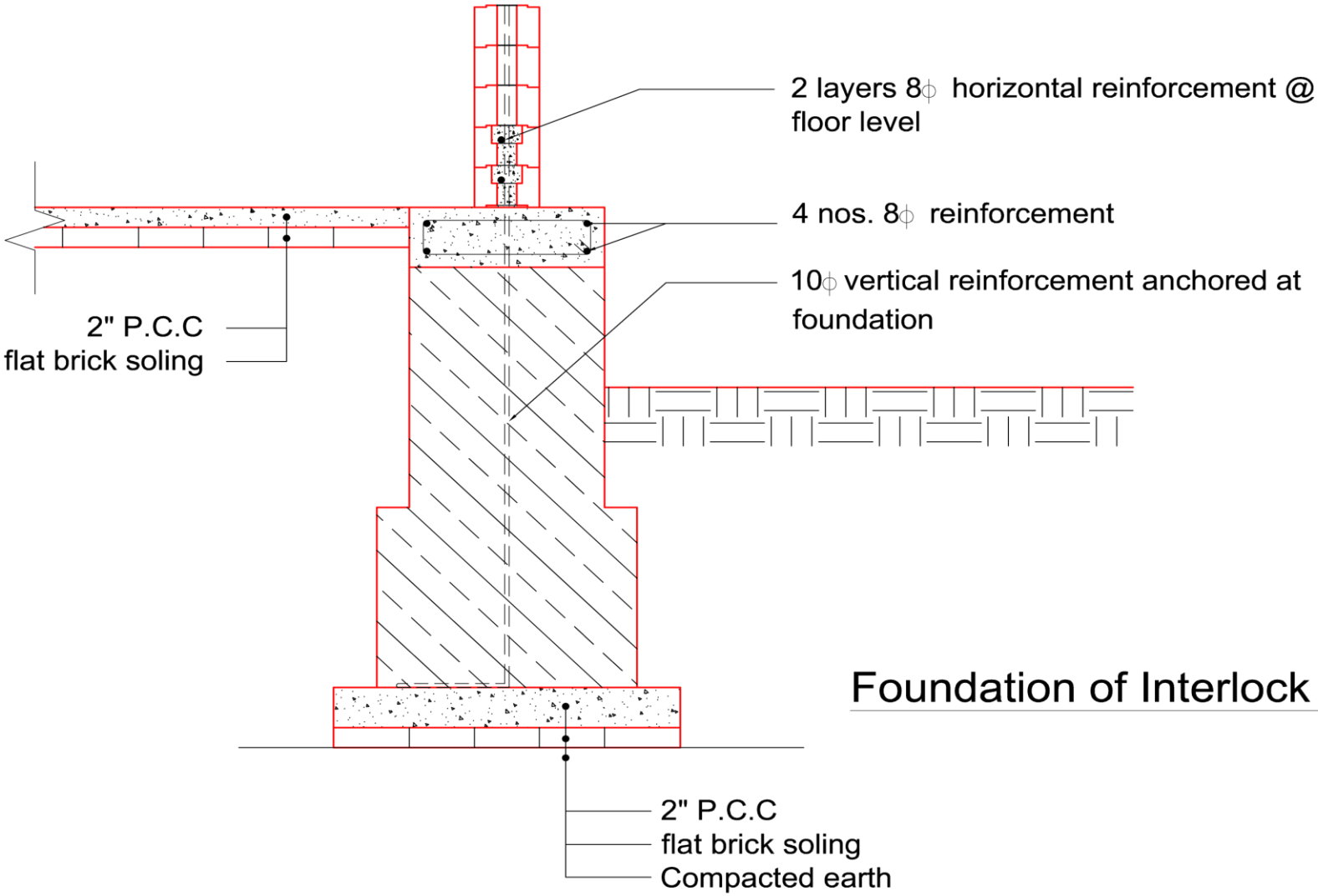












Foundation of Interlock system

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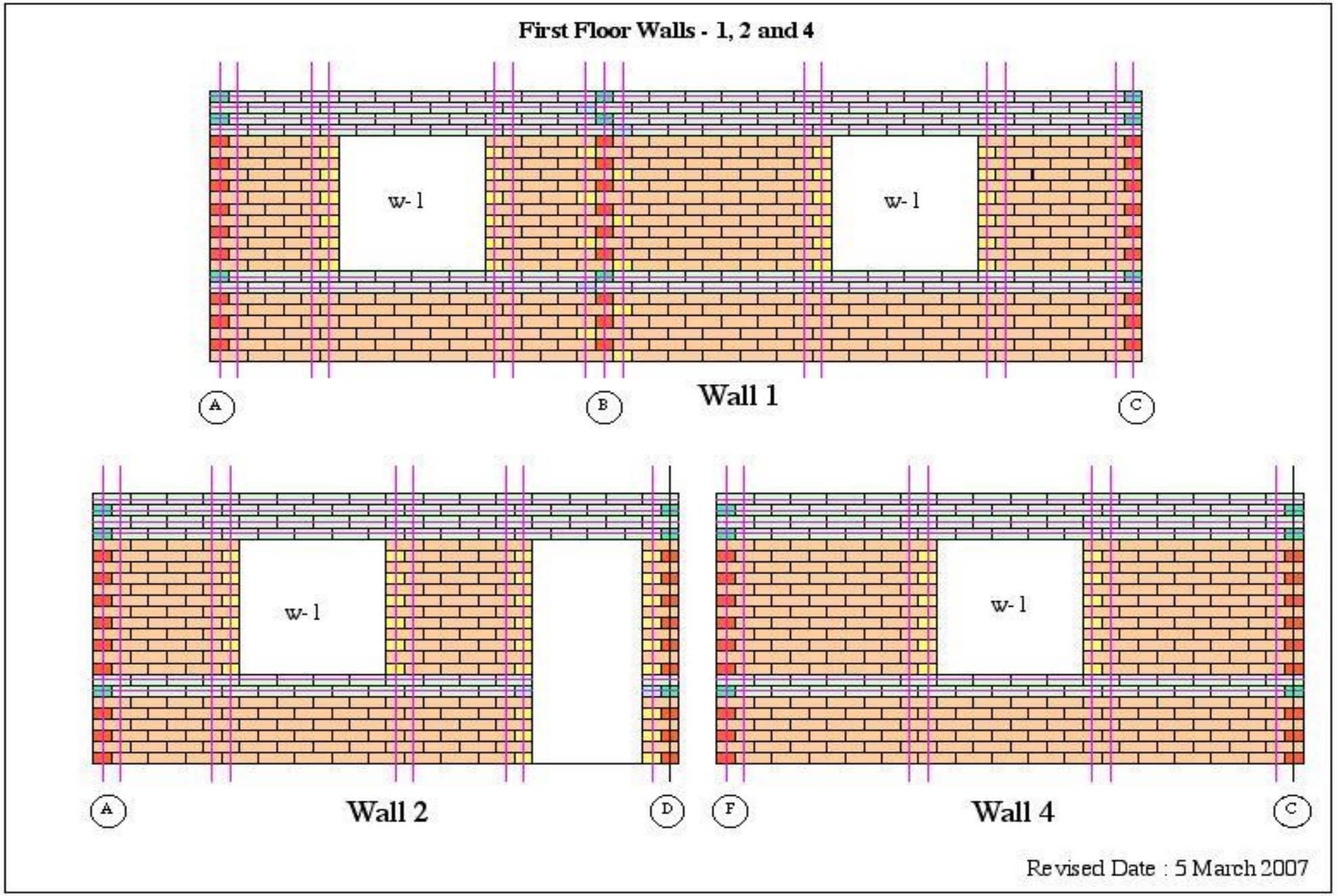
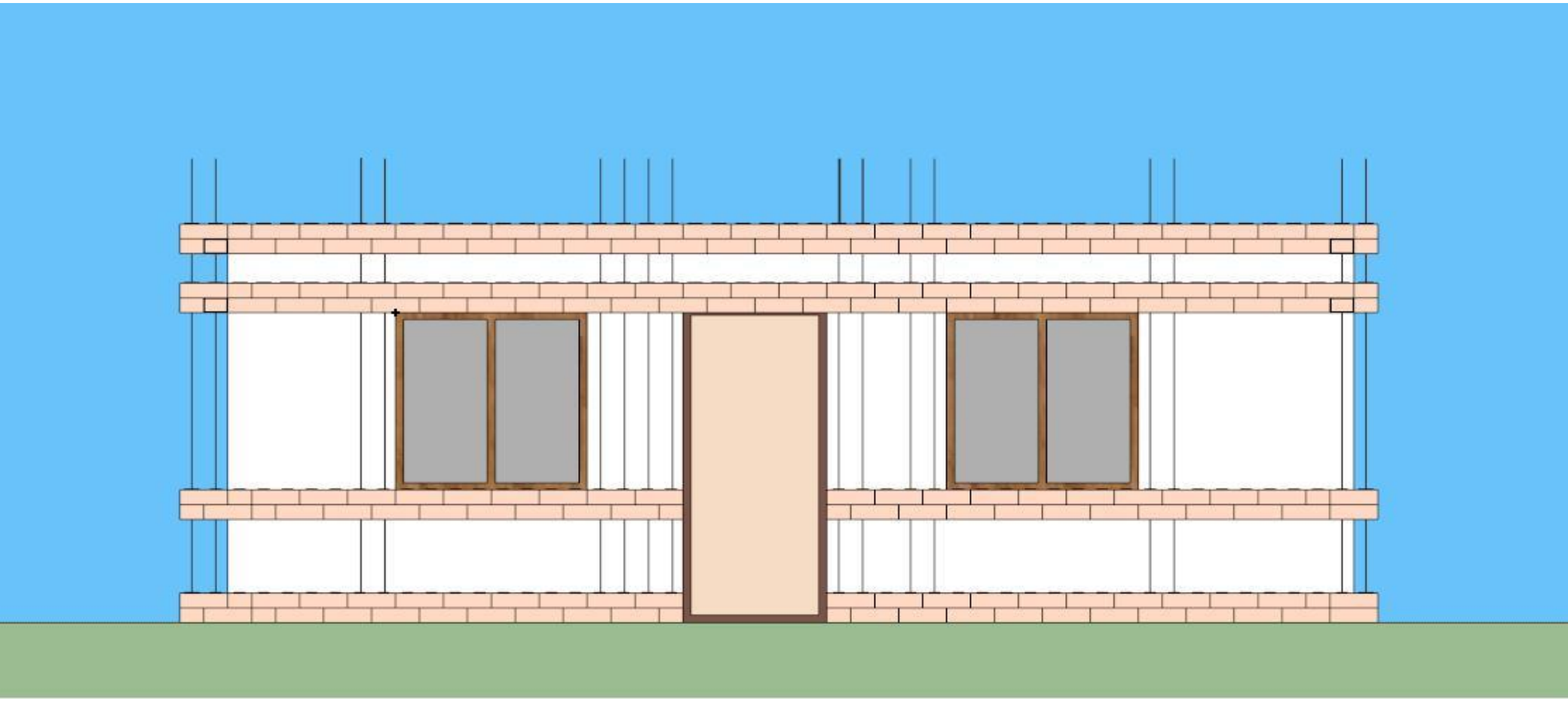
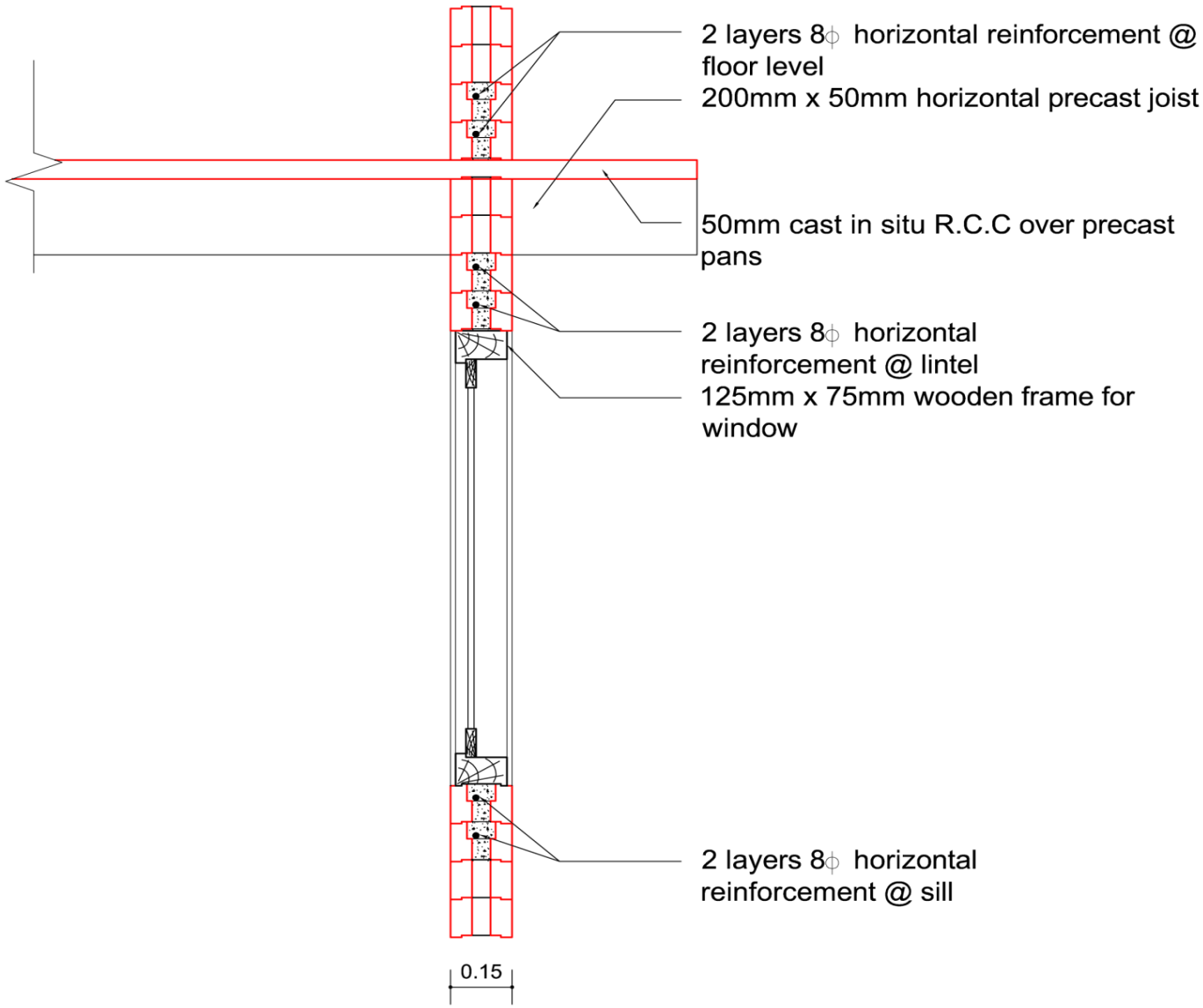


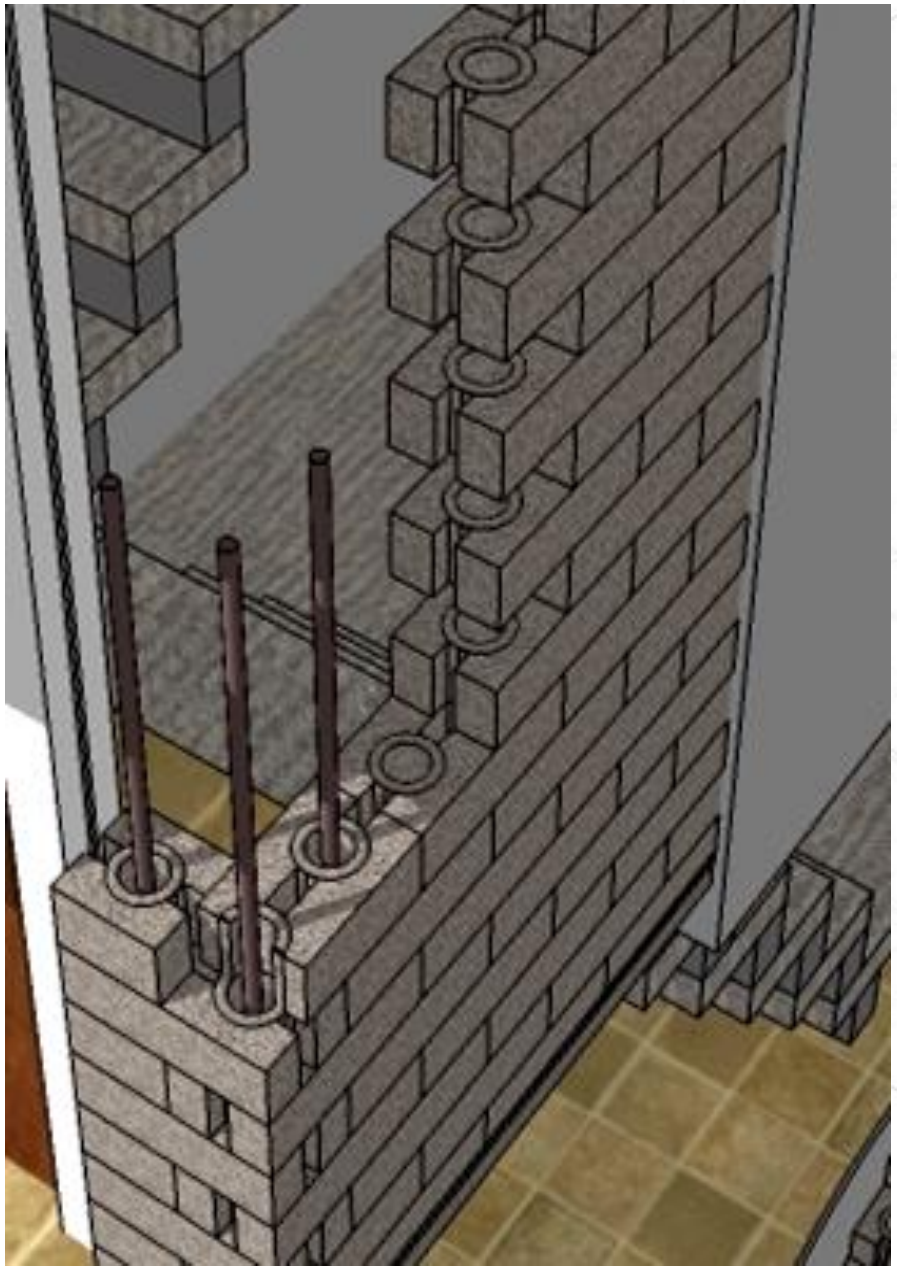


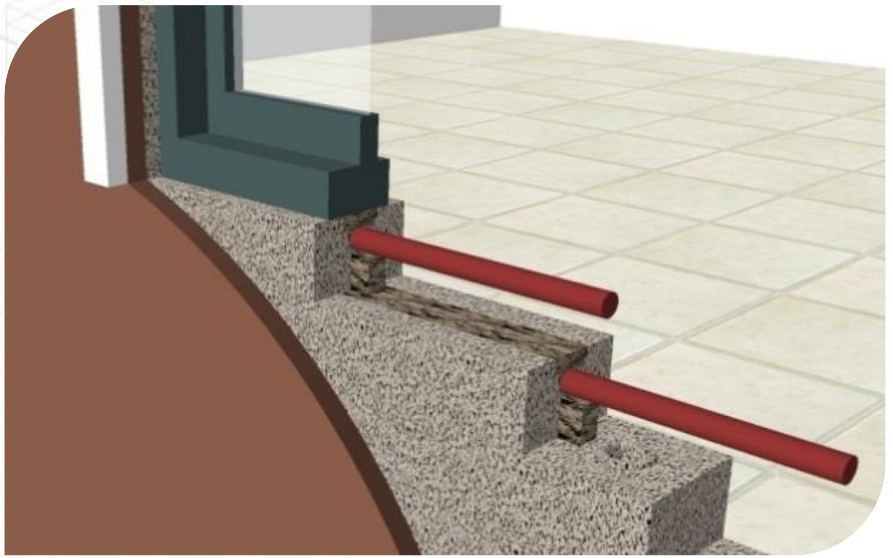
VERTICAL AND HORIZONTAL REINFORCEMENT IN A TYPICAL INTERLOCK BLOCK WALL



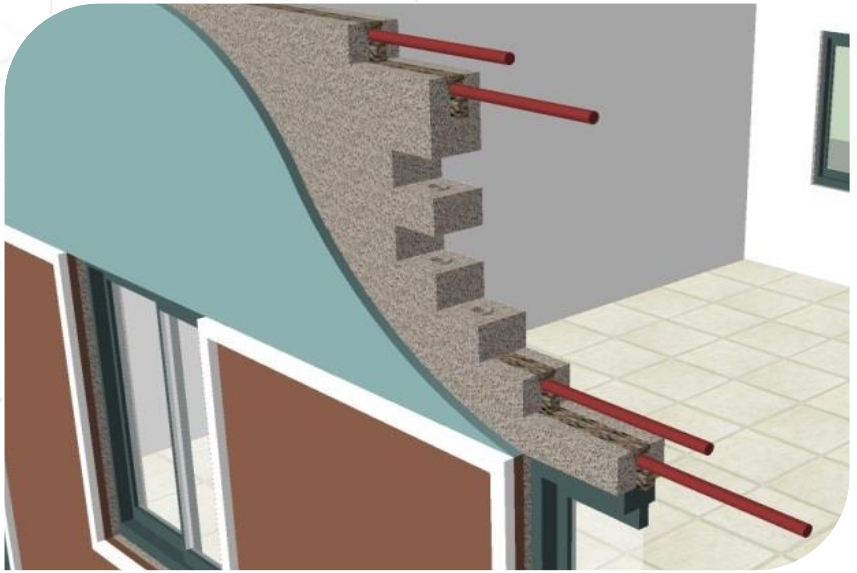
Lintel and sill band details

U-channel interlocking bricks with horizontal reinforcement

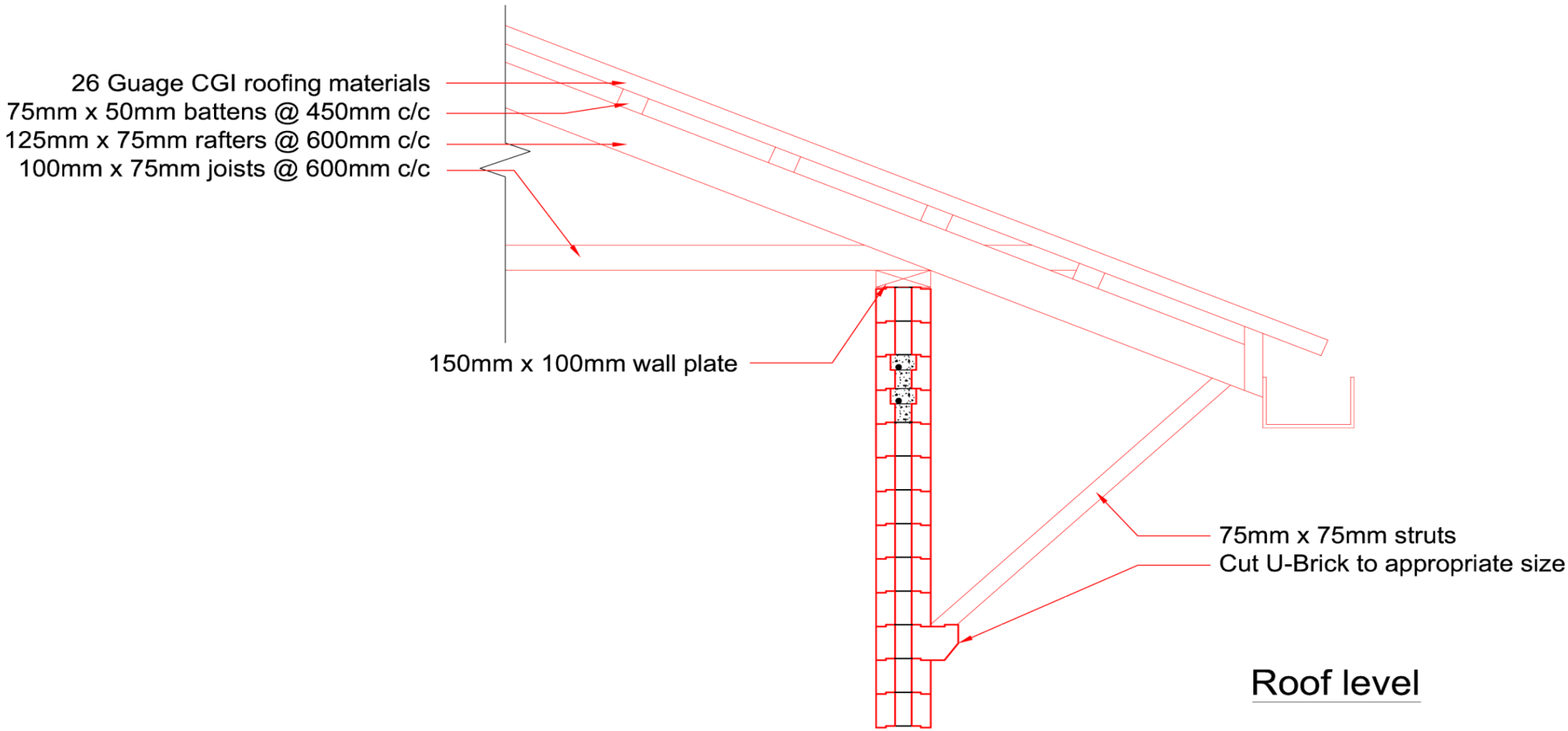




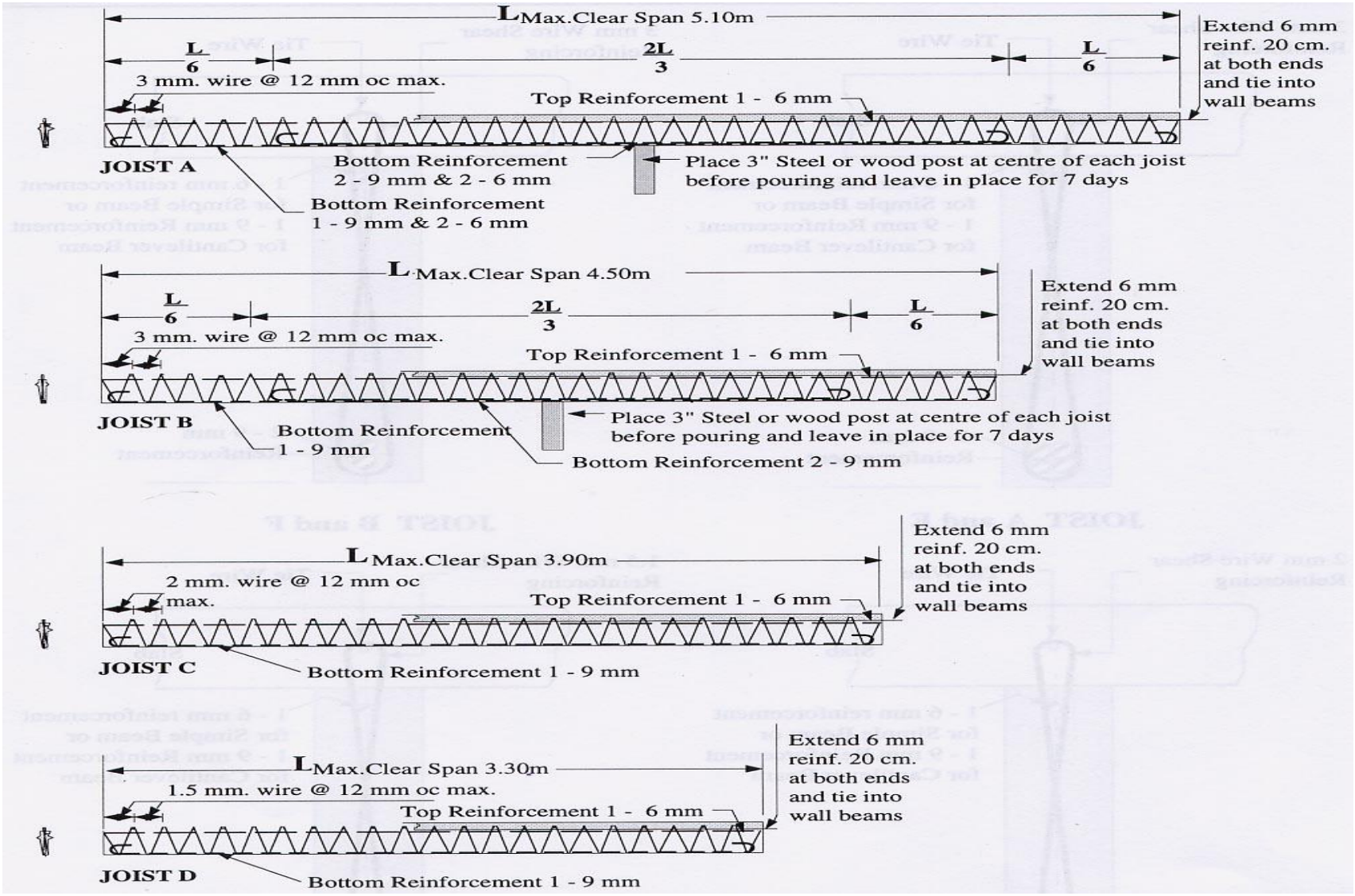
Sill level Detail



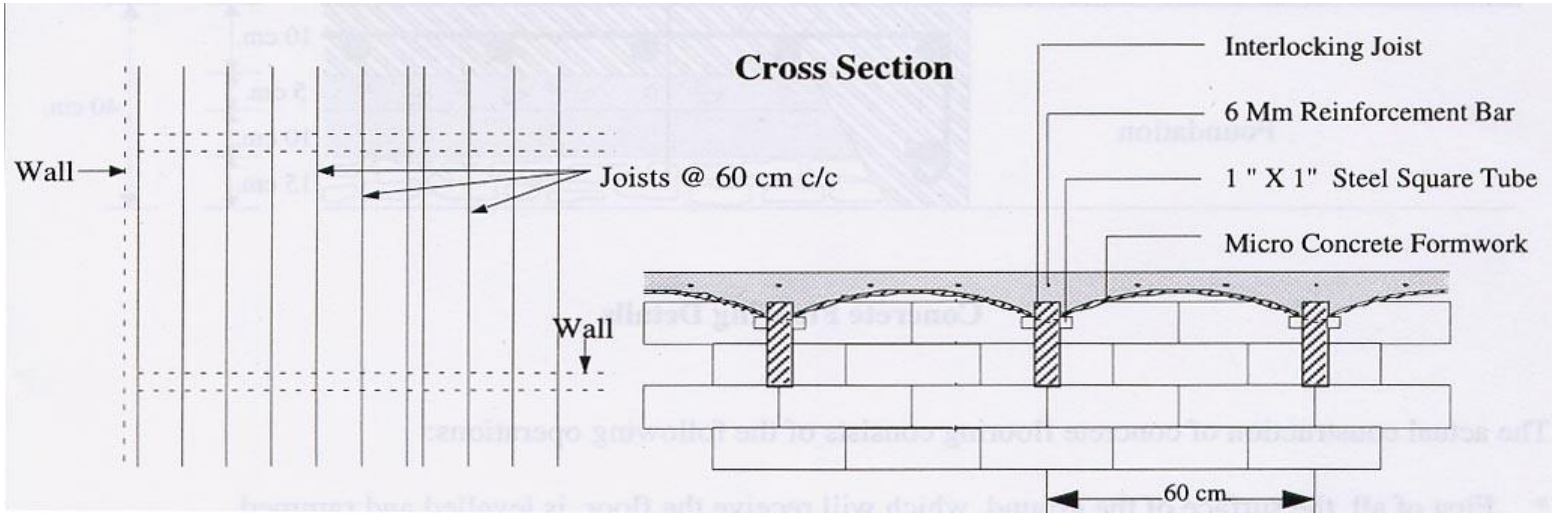
Lintel level Detail


26 Guage CGI roofing materials
75mm x 50mm battens @ 450mm c/c
125mm x 75mm rafters @ 600mm c/c
100mm x 75mm joists @ 600mm c/c
150mm x 100mm wall plate
75mm x 75mm struts
Cut U-Brick to appropriate size
Roof level

Concrete Joist



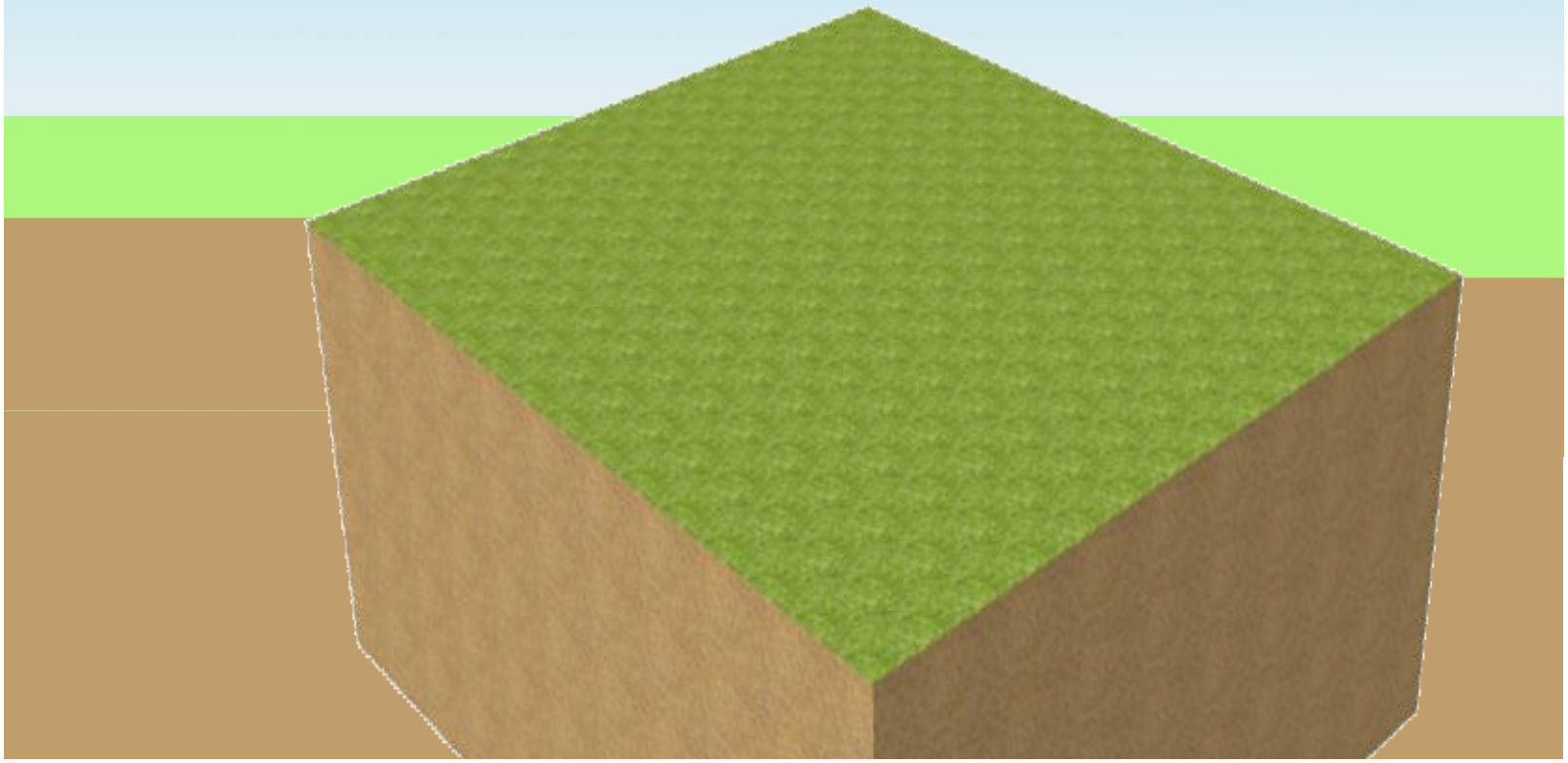
Intermediate floor or Flat roof



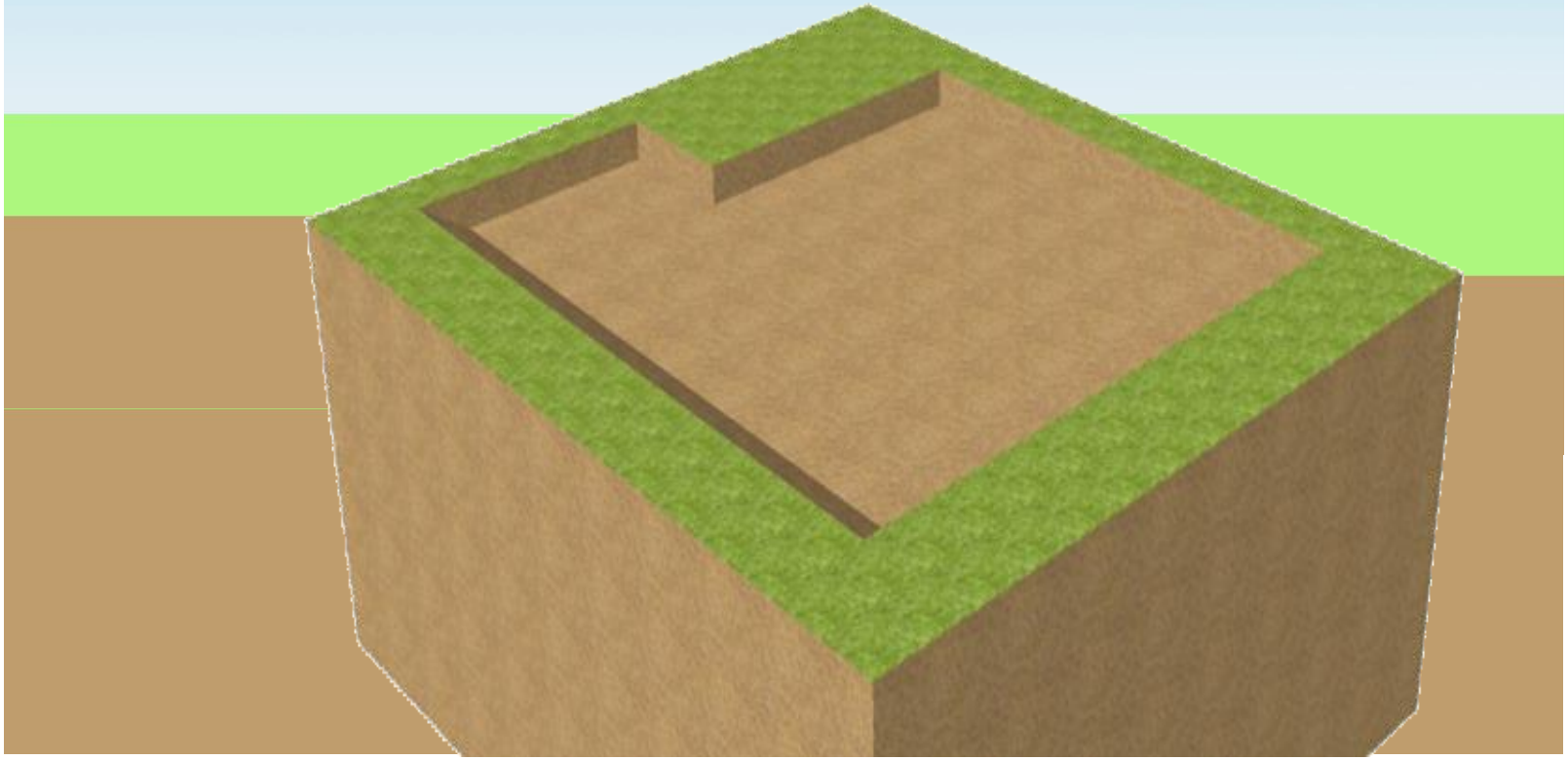
Intermediate floor or flat roof

Habitech Building Solution

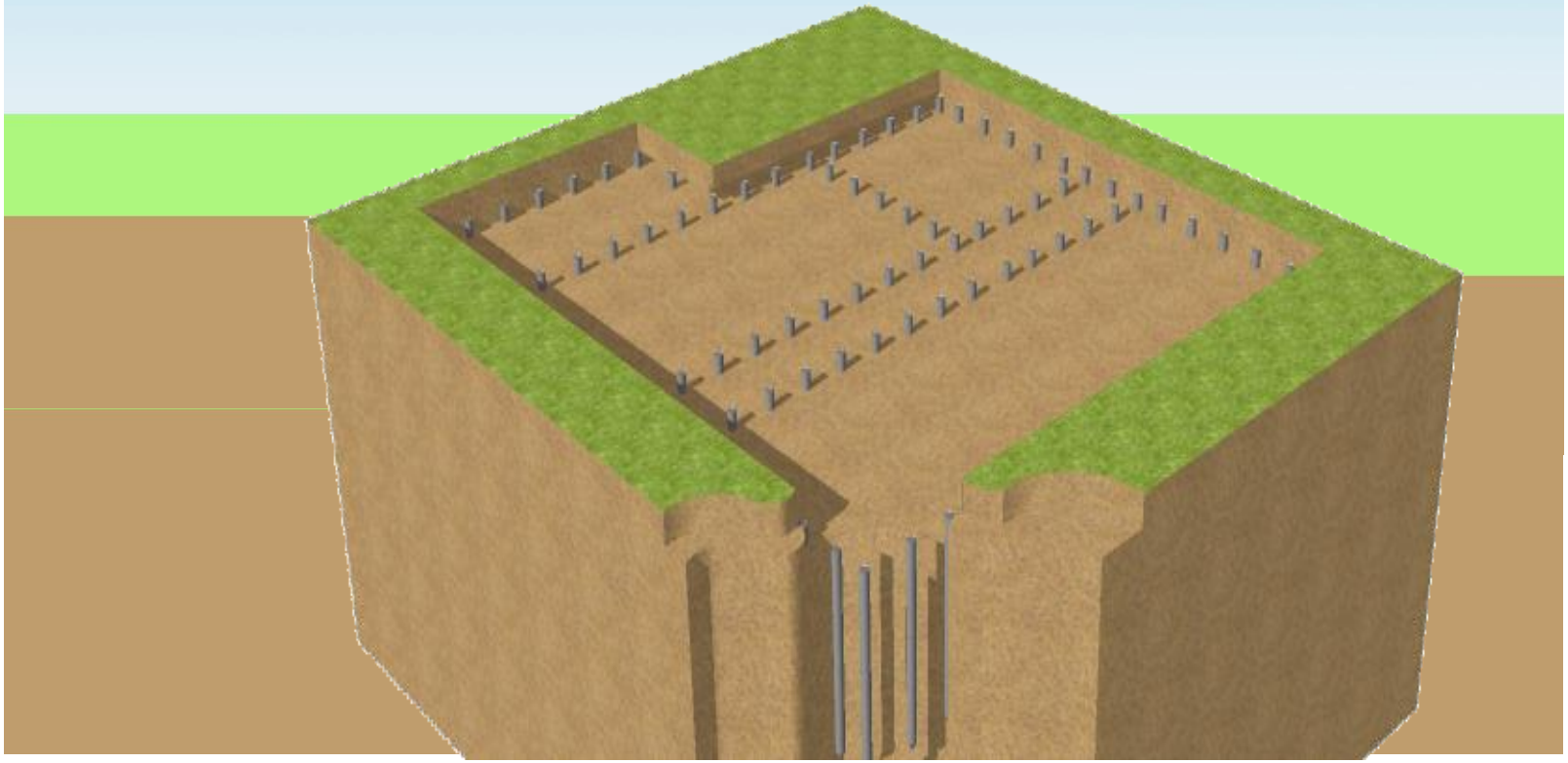
- Site



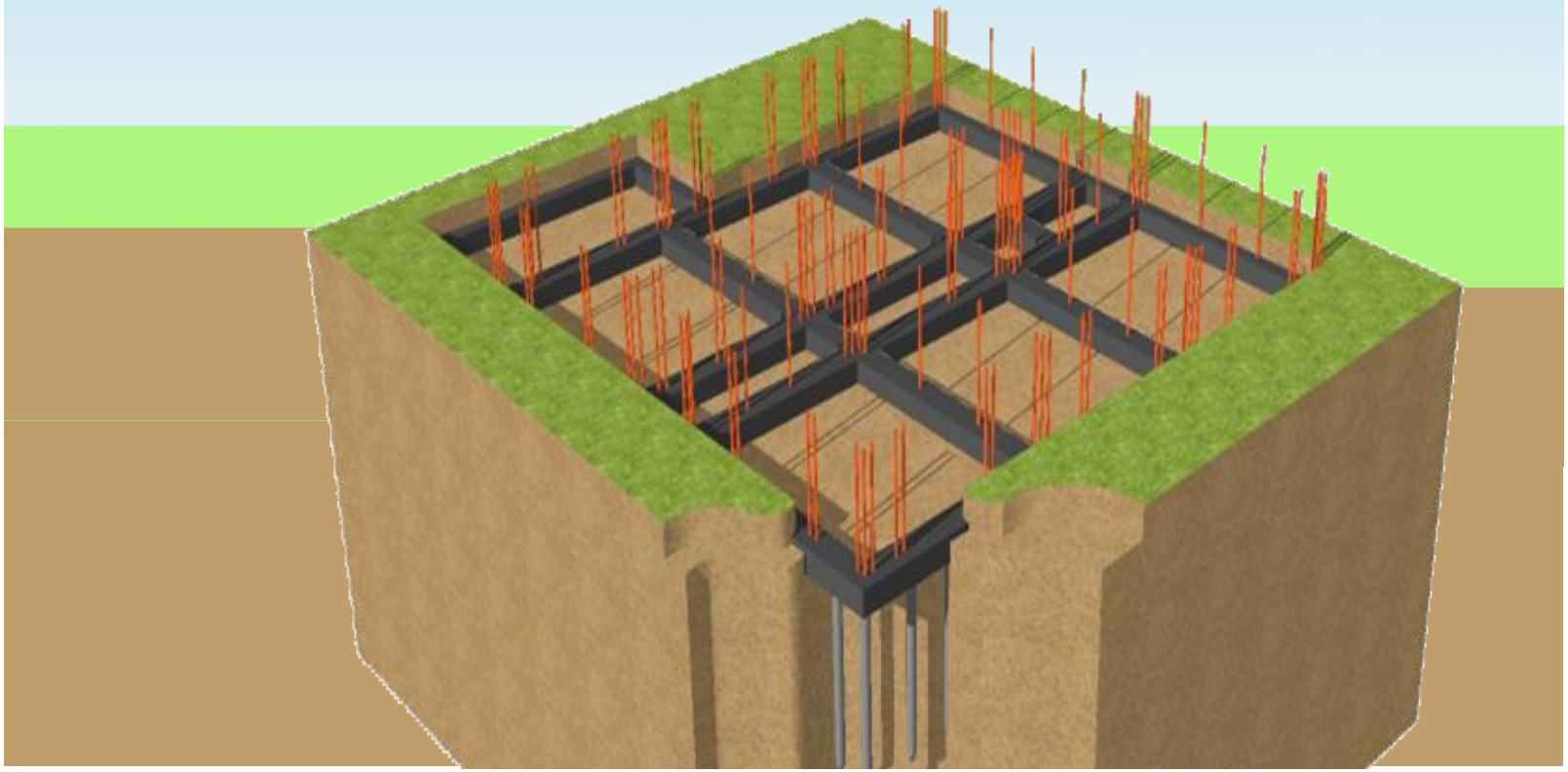
- Excavation



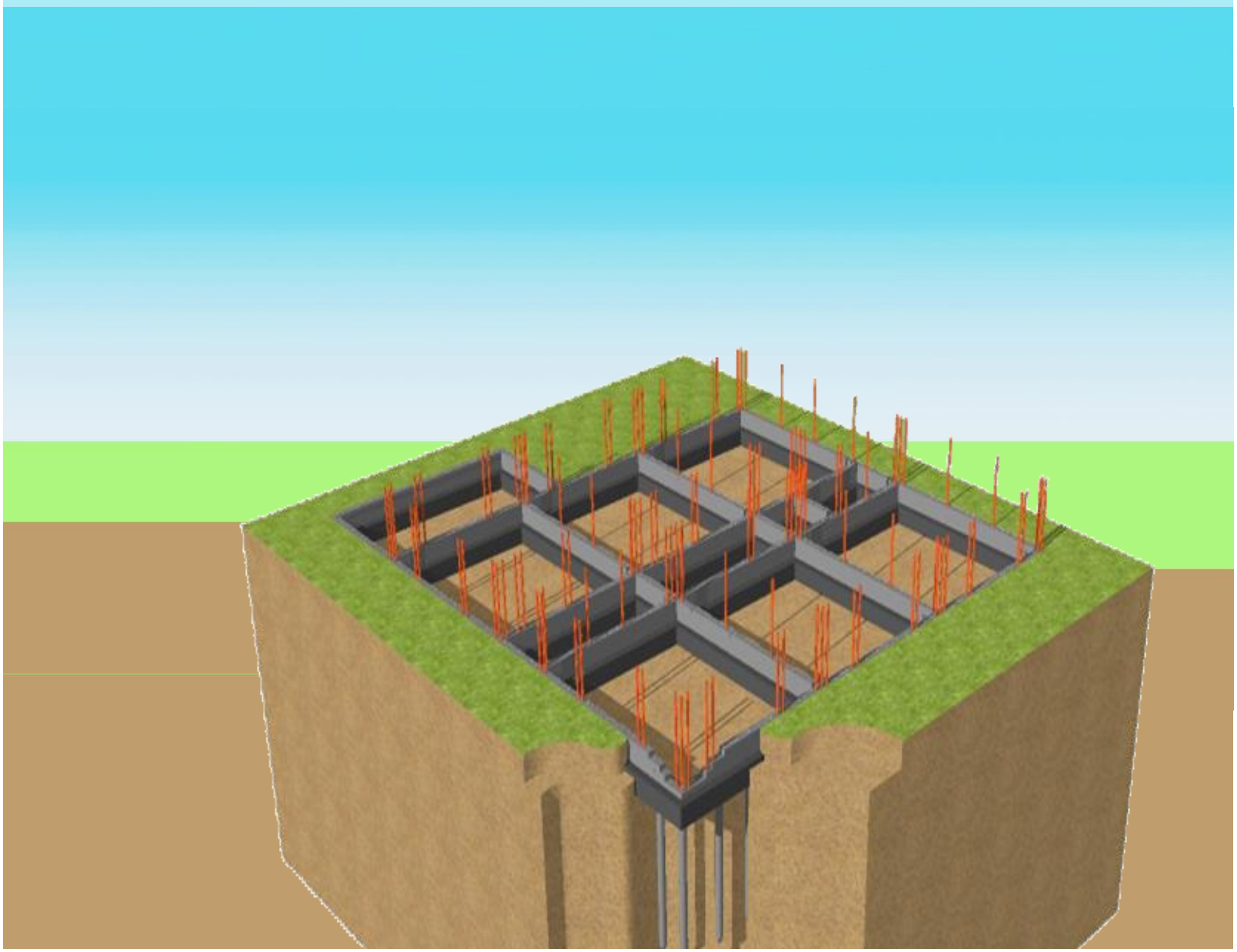
- Foundation (soil type)
  - Strip
  - Pad — Shallow
  - Raft
  - Pile — Deep



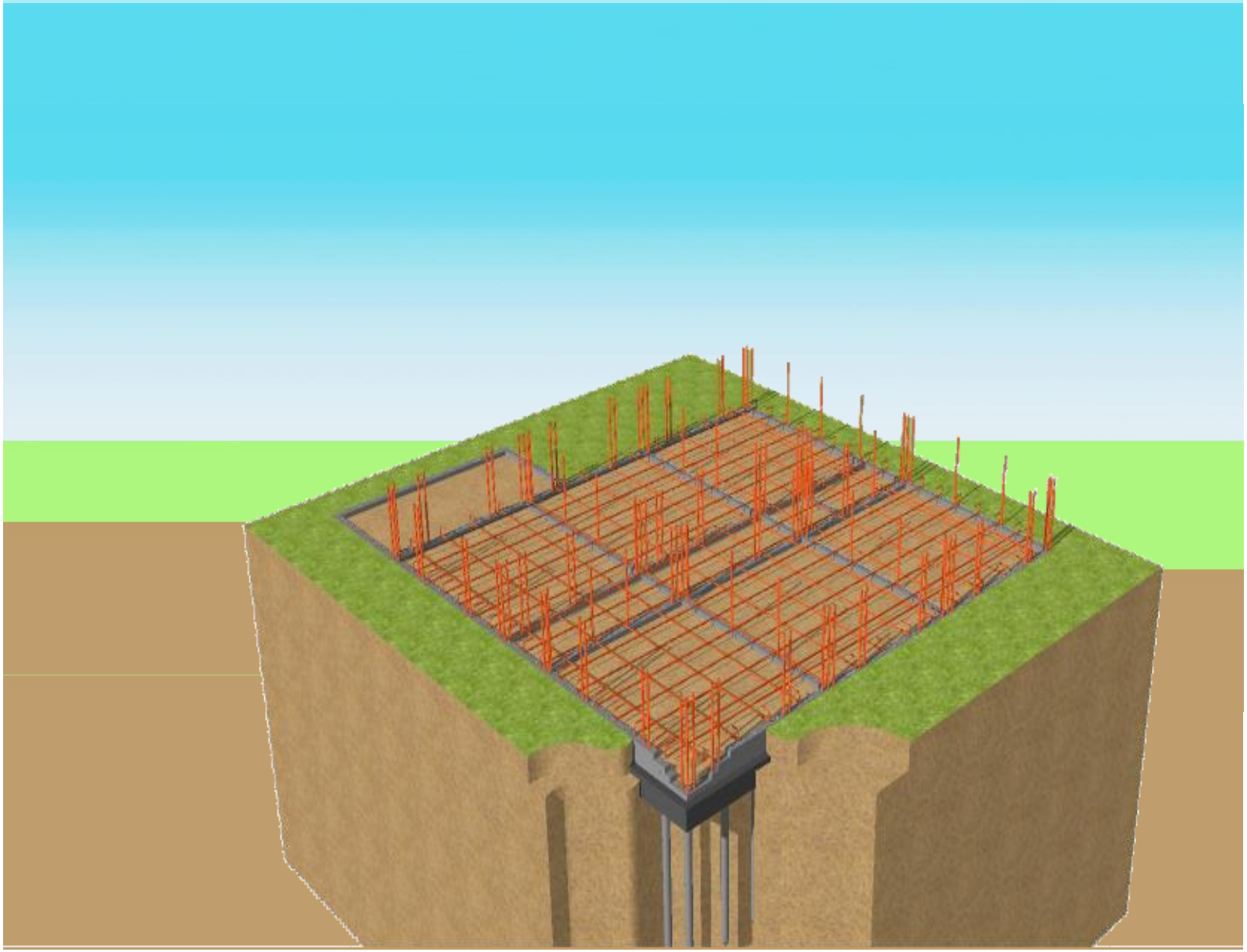
- Foundation



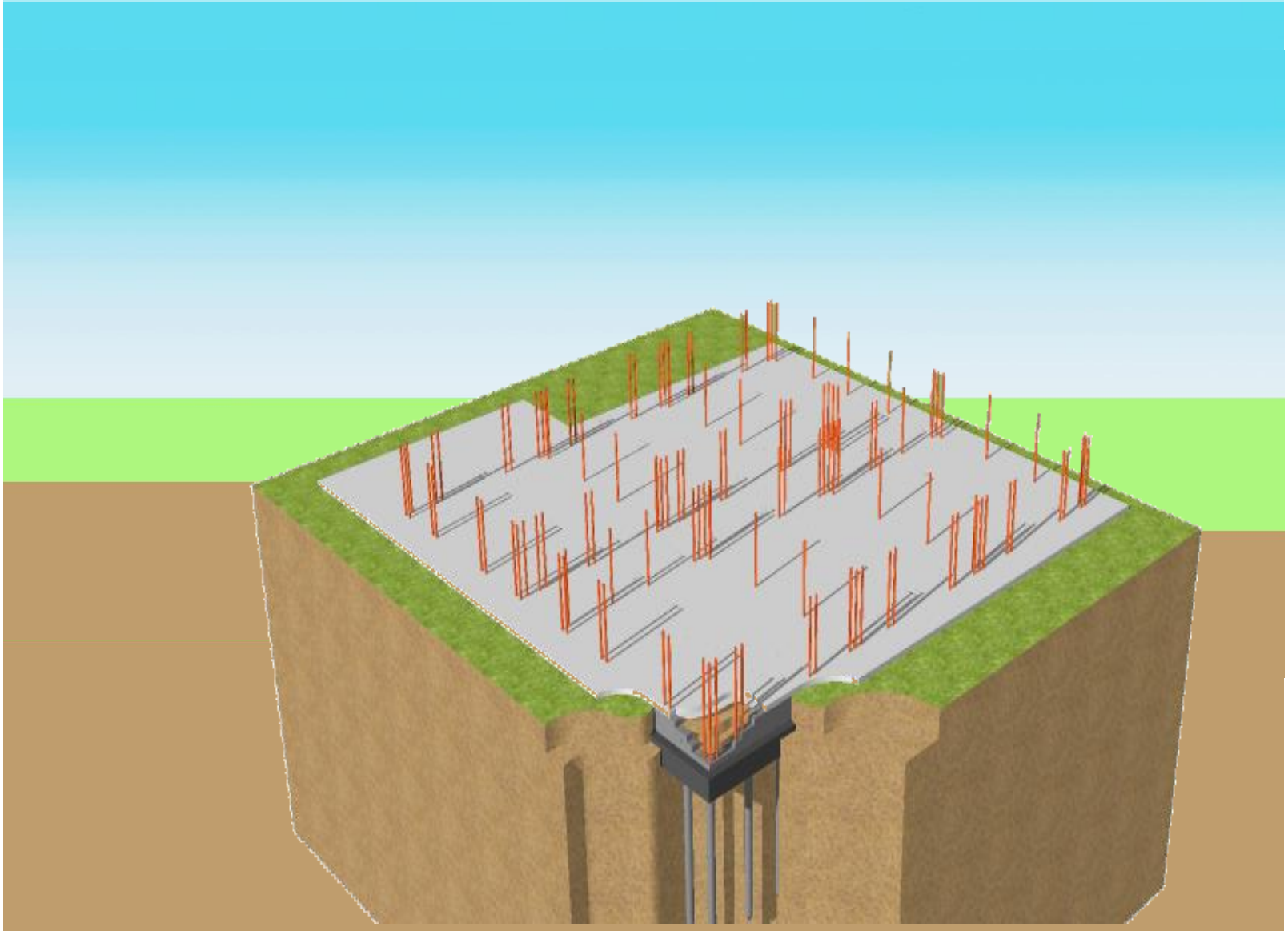
- Tie beam



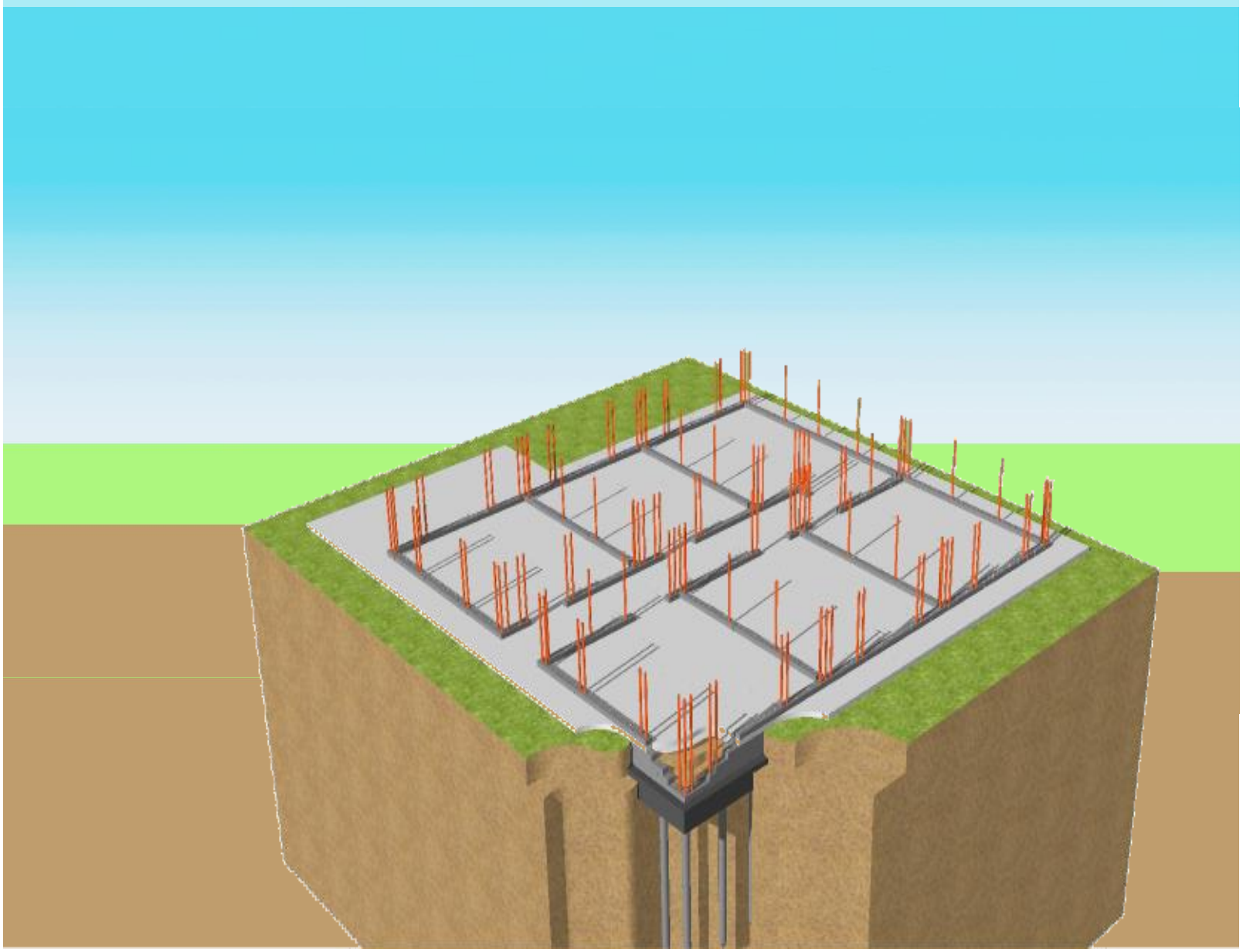
- Vertical Reinforcement & Sand Compaction



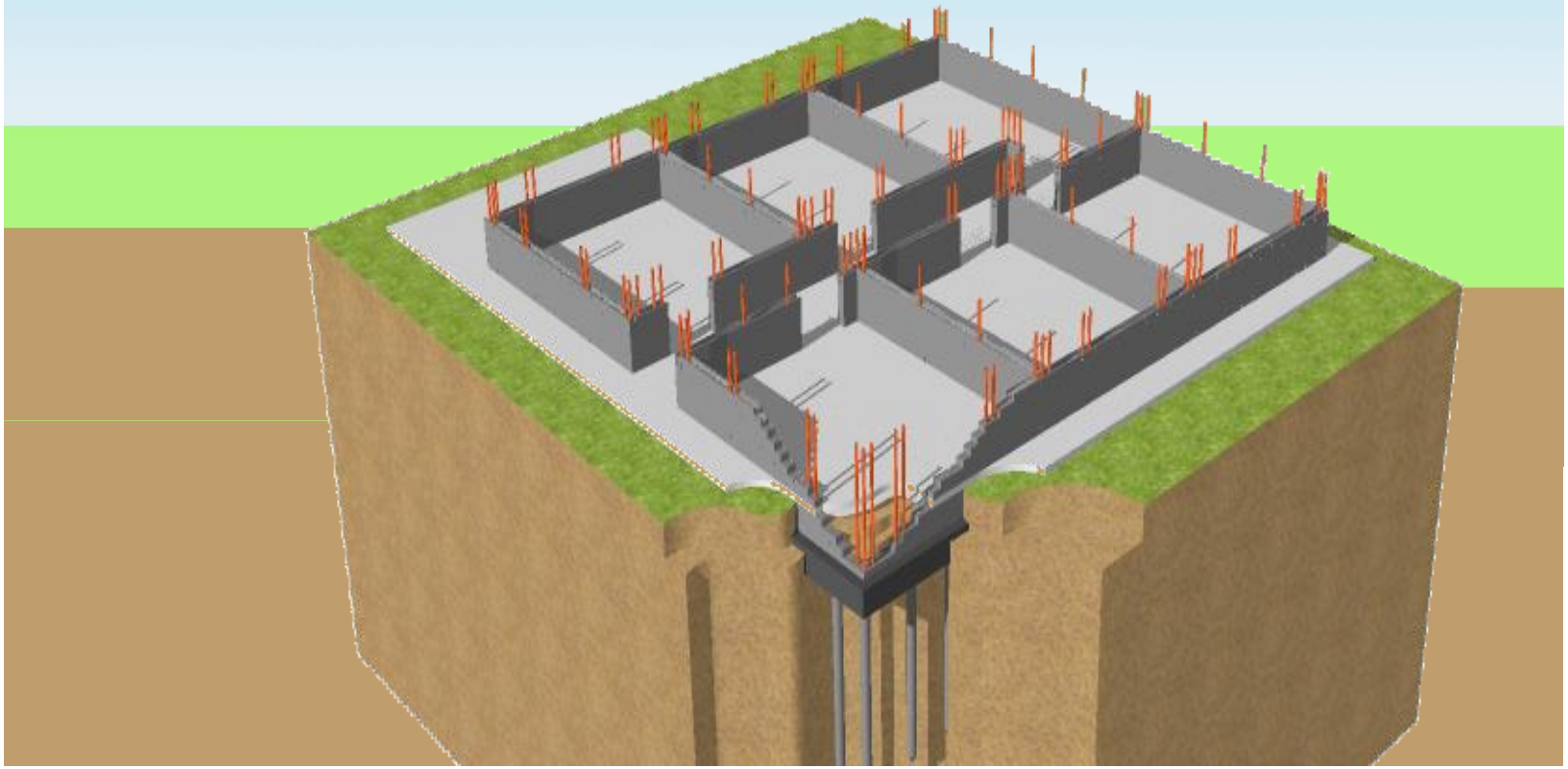
- Damp proofing
- Plain cement concrete floor



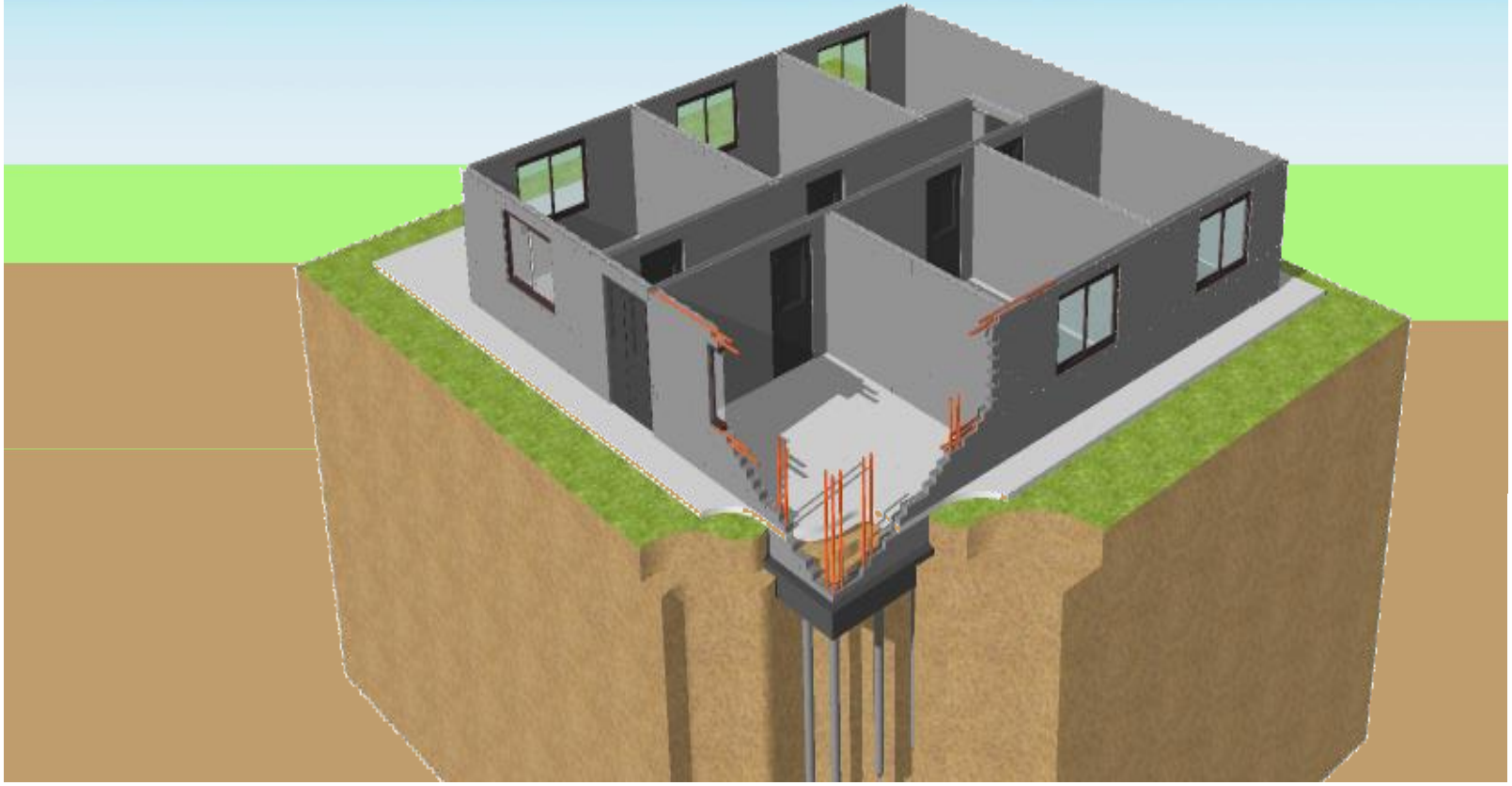
- First layer brick



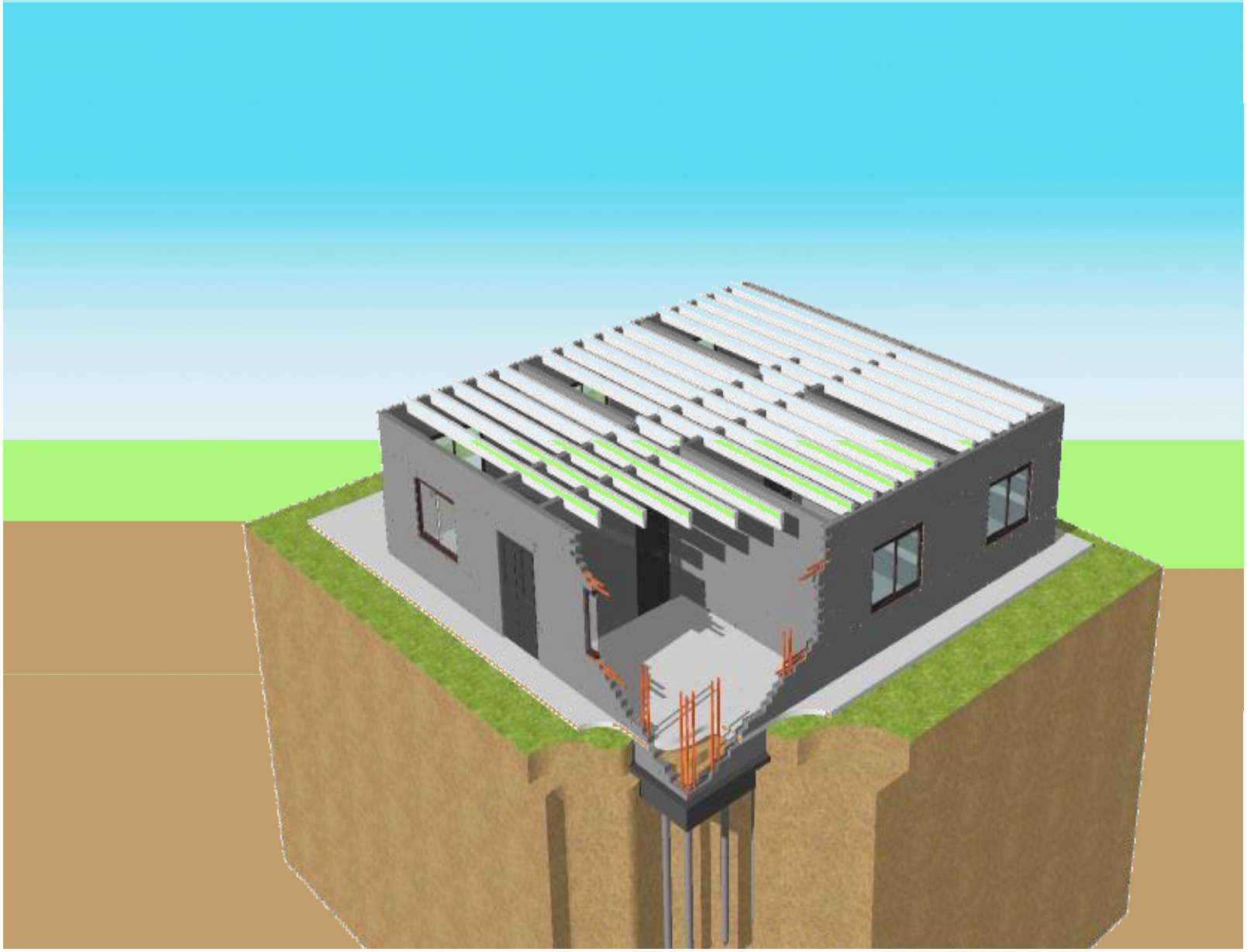
- Wall construction



- Wall construction



- Flat Slab – Joist Placement



- Flat Slab – Micro-concrete Pan & Rebar Placement

- Flat Slab – 1” cast-in-situ concrete slab
- Above Floors are constructed in same manner as ground floor

Habitech Building Solution

“Habitech Building Technology”

Technology to preserve the cultural heritage and local and ethnic identity of our settlements

Vernacular Designs With Interlock Bricks

Vernacular Designs With Interlock Bricks

“Habitech Building Technology”

Rebuild to ensure our cultural heritage and local and ethnic identity

“Habitech Building Technology”

Construction of mass houses in short period of time through “Self-Help Approach”

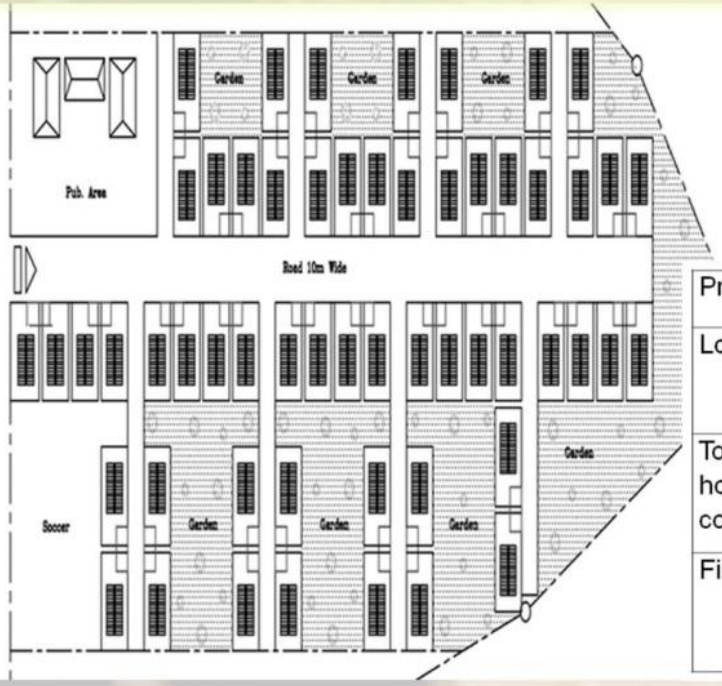
Major features/characteristic of “Self Help Approach”:

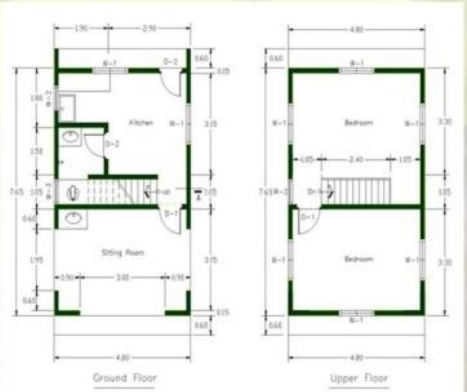
- Use of Local Resource: material and skill
- Cost Reduction
- Quality Assurance
- Employment Generation

“Habitech Building Technology”

Post- Tsunami Reconstruction Project: An example of “Self Help Approach”

TSUNAMI HOUSING (THAILAND)
- AN EXAMAPLE OF HABITECH CENTER, AIT-C
- (SUPPORTED BY EU & ROTARY)





Project Period	2007/2008	Plot size	120 sq.m
Location	Ban Nam Khem Village, Phang Ngha Province, Thailand	Area of the house	74 sq.m (2 storey)
Total number of houses and community center	56/1	Wall construction	Interlock bricks
Financial support	European union: 32 and Rotary: 24	Project completion time	10 months

“Habitech Building Technology”

Local tsunami victims : trained and building their own house

“Habitech Building Technology”

A Glance of Completed Rehabilitation Settlement

Can our own new settlement be like this?

“Habitech Building Technology”

Sanagaun, Saankhu Reconstruction Community Housing Project: “Self-Help Approach”

Sanagaun after Gorkha Earthqauke 2015

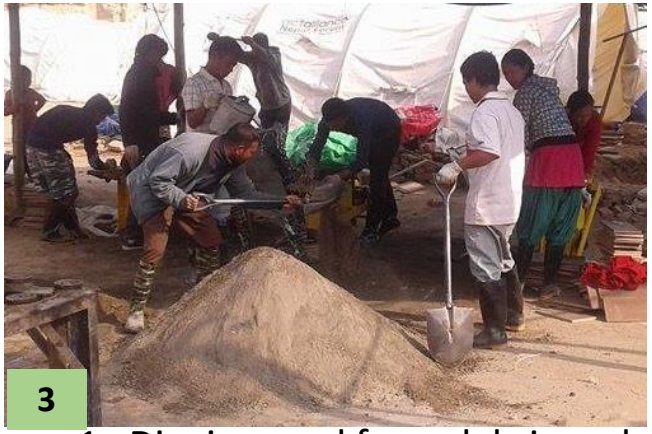
Proposed reconstruction of Sanagaun with habitech interlocking bricks

COMMUNITY PARTICIPATION: "Self-Help Approach"

Sanagaun, Saankhu Reconstruction Community Housing Project

1

2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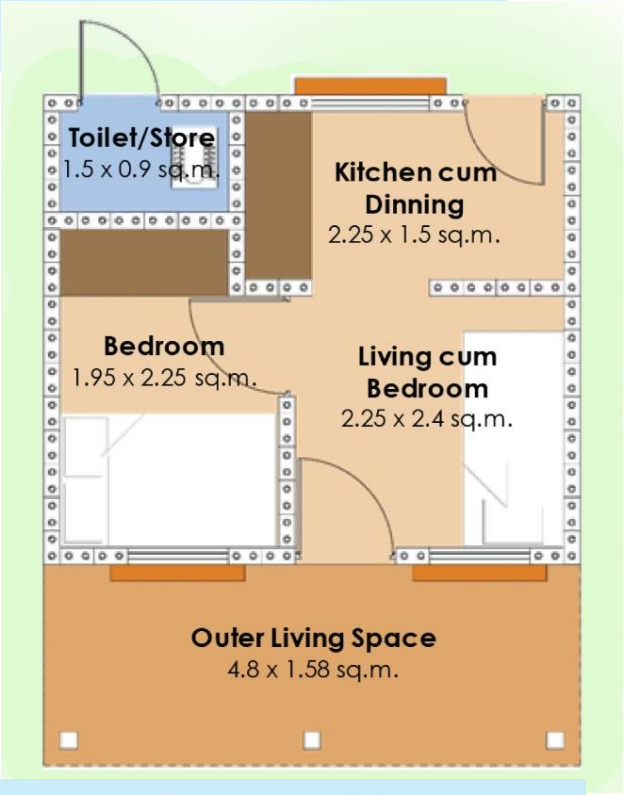
5

1. Digging mud from debris and demolished houses for brick production
2. Refining sand
3. Preparation of mixer for interlock brick
4. Hand Pressed bricks being checked for precision
5. Stacking of brick after production
6. Further curing of bricks for 21 days

6

Reconstruction Project, Fulbari Gaun, Lalitpur

Financial Support:	MOM-Habitech Center, AIT-C
Project Location:	Fulbari Gaun, Mahalaxmi Municipality, Ward No. 4
Technical Support:	Innotech Nepal Pvt. Ltd (Habitech Nepal Center)
Total No. of Houses:	25 Nos.



Usage area: 20 sq. m (215 sq. ft.)
Roof: Sloped
Spaces:

Habitech CENTER BUILDING SYSTEM

AIT Asian Institute of Technology

Reconstruction Community Project in Mustang, Nepal

“Habitech Building Technology”

Houses using Interlock Bricks in Nepal (Pre Earthquake)

Residence, Gokarna

Office, Imadol, Lalitpur

Office,Khumaltar, Lalitpur

“Habitech Building Technology”

Houses using Interlock Bricks (Post Earthquake)

Mickey’s International School , Jhamsikhel, Lalitpur

Residence, Khumaltar, Lalitpur

Residence, Matathirtha, Kathmandu

Residence, Khumaltar, Lalitpur

T H A N K Y O U

Iswar Joshi

Urban Planner, Land and Housing Developer/Architect

Chairman: Innotech Nepal Pvt. Ltd. (Nepal Habitech Center)

Contact:9851064699

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