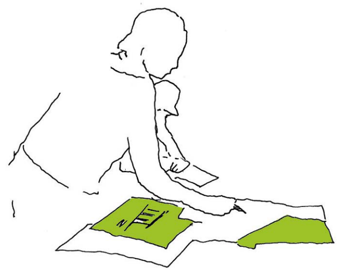
*‘BACK TO SCHOOL’

Disaster Preparedness and Response Workshop

Chamoli, Uttarakhand

India 2008



participants working on the main structure of the shelter

Architecture Sans Frontieres-UK

SEEDS INDIA

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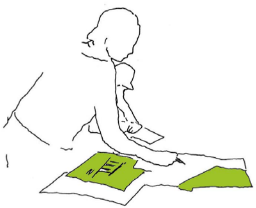

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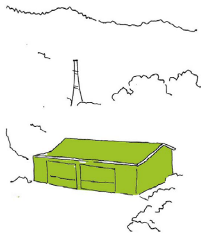

EXECUTIVE SUMMARY

The 'Back to School' Disaster Preparedness and Responses workshop took place between the 15th and the 29th June 2008, in Chamoli, Uttarkhand (India). It was jointly organised by Architecture Sans Frontieres – UK and SEEDS (Sustainable Environment and Ecological Development Society) India.

As 60% of India's land area could face moderate to severe earthquakes, the project scenario for the workshop was based in an area where the built environment is extremely fragile and the ability to prepare and effectively respond to earthquakes is currently inadequate.

Participants: engaged in the collection of data about different technologies and the availability and costs of materials in the area; assessed humanitarian standards for intermediate shelter; investigated the local culture using well established PRA (Participatory Rural Appraisal) techniques; developed a design for an intermediate shelter; procured the necessary materials; built the shelter with the assistance of local masons and labourers; and as a separate project designed the requirements to adapt the existing school building into an immediate shelter through an investigation of basic retrofitting techniques for earthquake resistant construction.

The brief was ambitious and the context in which the scenario was based broadly introduced the majority of issues development practitioners have to engage with when working in a post disaster scenario. Physical and mental exhaustion, diarrhoea and food fatigue, the heat, dangerous working conditions, frustration with communication difficulties, time and cost constraints, difficulties in finding suitable materials, cultural differences, a complex site, and group dynamics all contributed towards a very real learning environment in which participants had to work.

The workshop was a steep learning curve for all participants, as their skills, patience and resourcefulness was tested at every stage. The challenging process meant that the sense of achievement at the end was all the more real. The shelter designed and built during the workshop should be seen as a prototype, and the document, as an evaluation of the process and outcome. The 'Back to School' report explains how and why decisions were made, and how with hindsight and more experience they may be approached differently.

Melissa Kinnear, ASF-UK General Manager.

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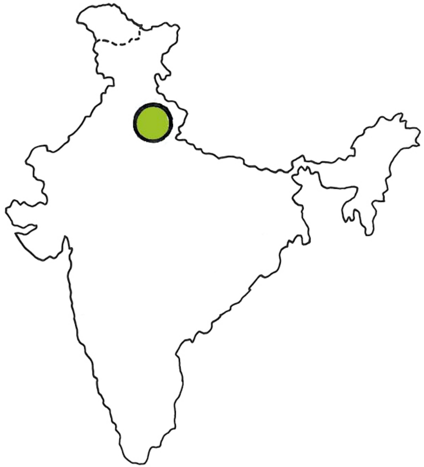


INTRODUCTION

The 'Back to School' Disaster Preparedness and Response workshop took place between the 15th of June and the 29th of June, 2008, in Chamoli, Uttarakhand (India). It was jointly organised by Architecture Sans Frontieres-UK and SEEDS (Sustainable Environment and Ecological Development Society).

SEEDS is a non-profit voluntary organization working to make vulnerable communities resilient to disasters. SEEDS adopt a multi hazards locally based approach seeking to empower communities through awareness generation, training and action. Founded in 1994 by a group of students and pedagogues of the School of Planning and Architecture, New Delhi, SEEDS comprises young professionals drawn from various development related fields.

Architecture Sans Frontières - UK (ASF-UK) is a registered charity [no. 1123786.] Through workshops, grassroots activities and lecture programmes the organisation promotes ethical practice, particularly in poverty habitats. ASF-UK trains built-environment professionals to be more relevant to the agenda of development, and - by supporting networks with local partners - helps to build organisational capacity.

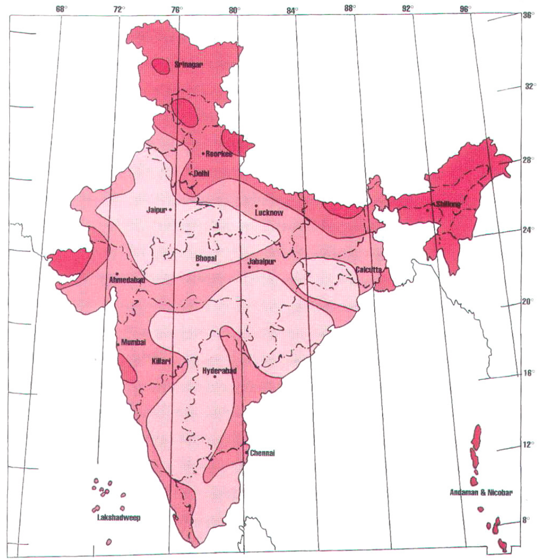
ASF-UK and SEEDS were supported by Gomti Prayag Jan Kalyan Parishae, a local NGO based in the village of Bhakunda. This NGO, founded in 1982, runs projects concerned with water supply, family planning, networking and capacity building and the Mountain Forum Himalaya, as well as 25 (nursery) schools in the region. In addition, Christian Aid generously donated 50,000 rupees to SEEDS that was used in aid of this project.

This report has been compiled by ASF-UK in collaboration with SEEDS.

RATIONALE

India's high earthquake risk and vulnerability is evident from the fact that about 60 per cent of India's land area could face moderate to severe earthquakes. During the period 1990 to 2006, more than 23,000 lives were lost in India due to six major earthquakes, which also caused enormous damage to private and public infrastructure. The occurrence of several devastating earthquakes in areas hitherto considered safe indicates that the built environment in the country is extremely fragile and the ability to prepare and effectively respond to earthquakes is inadequate. During the 1990s Uttarakhand witnessed two major earthquakes - the Uttarkashi earthquake of 1991, and the Chamoli earthquake of 1999. These were followed by the Gujarat earthquake in 2001 and Jammu & Kashmir earthquake in 2005.

The majority of casualties were caused primarily by the collapse of buildings. However, similar high intensity earthquakes in the United States and Japan have not caused such enormous loss of lives as the structures in these countries are built with structural mitigation measures and earthquake resistant features.



Zone V: Very High Damage Risk Zone
Zone IV: High Damage Risk Zone
Zone III: Moderate Damage Risk Zone
Zone II: Low Damage Risk Zone

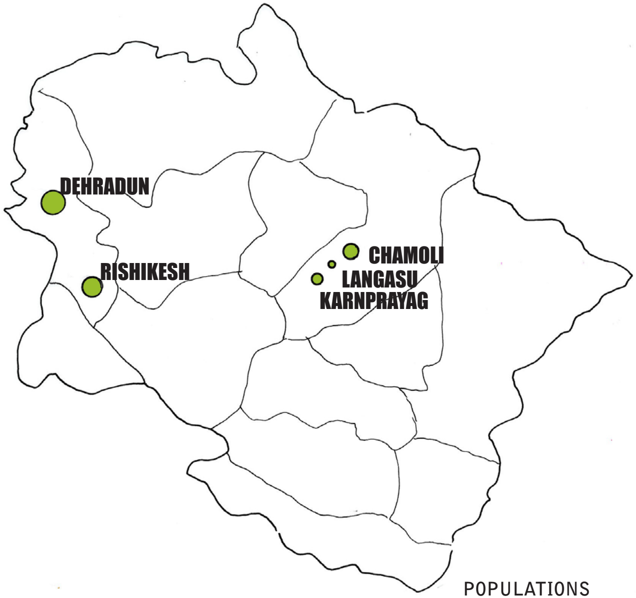
map of India showing relative earthquake risks (source: Building Materials and Technology Promotion Council, Government of India, 2006)

PROJECT SCENARIO

There has been a moderate earthquake in the Chamoli area and houses, schools and public infrastructure have been damaged. This is a hilly region and the climatic condition
here is quite cold in comparison to the plains. Nearly 500 families have lost their houses. ASF-UK/SEEDS have been asked to provide Interim shelter to these families within 50 days as the weather is getting worse by the day.

The Interim shelters provided to all the affected people need to be technically sound because of the threat of aftershocks in the area. The shelter should also be locally acceptable to the community taking into consideration tradition and lifestyle. The idea is to provide shelter that could eventually be converted incrementally into permanent shelter. While the Interim shelters are being constructed, existing schools could be used as short-term communal emergency shelters, and would need to be strengthened for this purpose.

The ASF-UK/SEEDS team will need to conduct a study of the local area and availability of different resources like materials and manpower, in order to provide efficient and appropriate shelter.



POPULATIONS	
Rishikesh	59,671
Karnprayag	6,976
Langasu	336

a map of the state of Uttarakand indicating the key cities, towns and villages that we visited

OBJECTIVES + OUTPUTS

• To study the local area in terms of built, natural, socio-economic and cultural environment
• Design of an Interim shelter module that is based on local materials and skills, is suited to local conditions, is quick to erect, and meets humanitarian standards of relief
• Construct one interim shelter unit as a prototype, with an aim to leave it with the local school for its own use later
• Design the technology for converting the interim shelter into permanent shelter
• Design a proposal for upgrading the host school for future needs as emergency shelter and as a model school

• Documentation of the different design options for interim shelter
• Prototype of interim shelter
• Design proposal for upgrading host school as a model school and emergency shelter
• Lessons learned workshop at the end of the project duration

the existing school building (right) next to the Patwari office, the site is situated behind the school

BRIEF

Study Area

The study area for this project will be around Langasu village in Uttarakhand state of India, which experienced an earthquake in 1999. Almost 100 people lost their lives in the Chamoli district. This area is quite vulnerable in terms of seismic activities and there is the possibility of a future earthquake in the range.

Activities

• Data collection of different technologies available in area and humanitarian standards from secondary sources
This activity will be focused on collecting different data such as building technologies, material, and evolution process diversification in the region from secondary sources. This can be taken up as preparation activity before coming to India. For humanitarian standards the SPHERE Standards may be referred (www.sphereproject.org)
• Finalisation of design and technology to be used for proposed interim shelter
This activity will be focused on preparation of a design for an interim shelter and toilet for one family in a hilly region. The design can be finalised looking to different aspects of shelter design like architectural, structural and earthquake resistant elements. Design of the toilet will be based on local culture and availability of water in the area.

• Estimation and requirement of materials to be used for interim shelter & toilets
After finalisation of the design of the shelter and toilet, estimation based on the design and material to be used for the construction can be finalised based on the collection of data from different sources locally.
• Construction of the interim shelter and toilet at project site
Once the team arrives in India, construction of the shelter and toilet can be done based on the design of the shelter. To carry out this activity, required technical manpower such as carpenters and/or masons will be sourced locally. The prototype will be eventually left with the local school for use as an additional classroom.

• Study and documentation of the host school, and preparation of plans for its upgrading
The host school will have to play the role of an emergency shelter in future disasters, and also operate as a school in normal times. The ASF-SEEDS team will assist the local NGO in preparing plans for upgrading the school to meet this need.

• Documentation of the different activities
This activity will be running parallel with all the different activities. At the end of the project a complete report should be prepared with the outcome of the project and lessons learned from project activities.

• Lessons learned workshop with different stakeholders
At the end of the project a half day workshop will be organised with different stakeholders including local government people, NGOs and technical agencies involved in construction works. This will be an opportunity for sharing of experience and to see how the ideas can be developed for disaster management strategies during different emergency situations.

• Designing of permanent shelter based on the design of interim shelter
The team staying behind will carry out a follow-up activity of documenting local traditional construction practices from the disaster reduction point of view, and formulating guidelines for permanent shelter reconstruction in the area.

Budget

SEEDS will provide a lump sum amount of 50,000 INR (Indian rupees) for materials and manpower to be used for construction of shelter and toilet prototype. This amount has been kindly donated to SEEDS by Christian AId.

WORKSHOP PROCESS

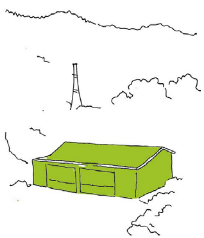
The **ASF-SEEDS** team set up office briefly in the Gomti Prayag Jan Kalyan Parishae offices close to Langasu Village on 17 June 2008. The team looked briefly at the history of the area, with specific reference to the high possiblity of a future earthquake happening in the very near future. To achieve the workshop brief the team was split into four groups each focusing on one of the four main requirements of the brief:

1.

The village/social had to understand the **CONTEXT** and how the community lives and works for the interim shelter design.

2.

The materials group had to research the availability and costs of **LOCAL RESOURCES**, including materials and labour.



3.

The school group had to research and design the **SCHOOL RETROFIT** to upgrade the school to perform as an interim shelter and a model school for the area.

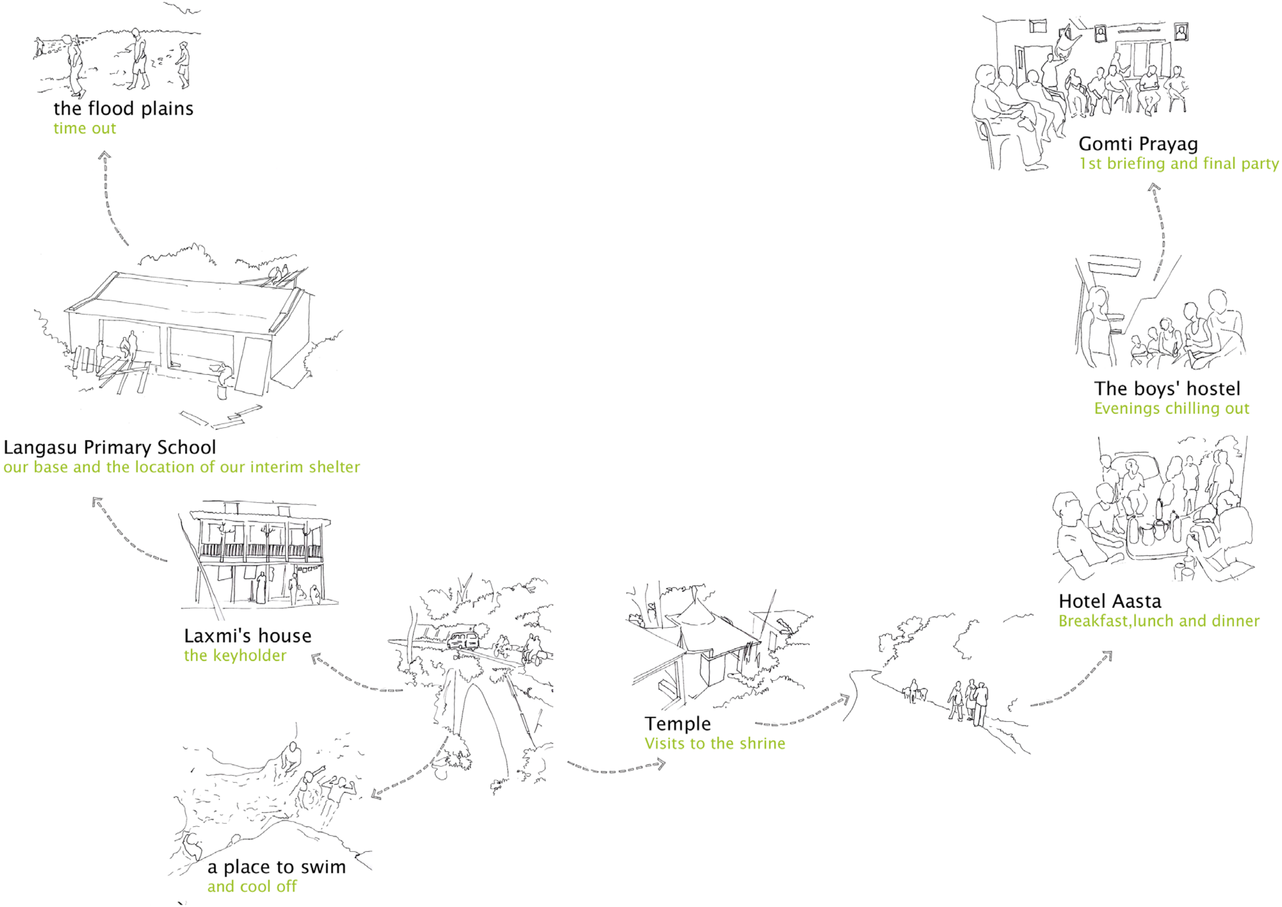
4.

The **SHELTER DESIGN** group were tasked with clearing the site for construction, and using any data collected by the other groups to design the interim shelter.

The groups had two and a half days to do the research required to successfully implement the build programme. Once the basic information had been collated groups 1,2 and 4 then came back together to finalise the design of the interim shelter and start construction on site. Group 3 continued to work on the school retrofitting proposal.

a particapant with local children taking time out on the flood plains close to the site

THE COMMUTE


the flood plains
time out
Langasu Primary School
our base and the location of our interim shelter
Laxmi's house
the keyholder
a place to swim
and cool off
Temple
Visits to the shrine
Hotel Aasta
Breakfast,lunch and dinner
The boys' hostel
Evenings chilling out
Gomti Prayag
1st briefing and final party

2.

CONTEXT

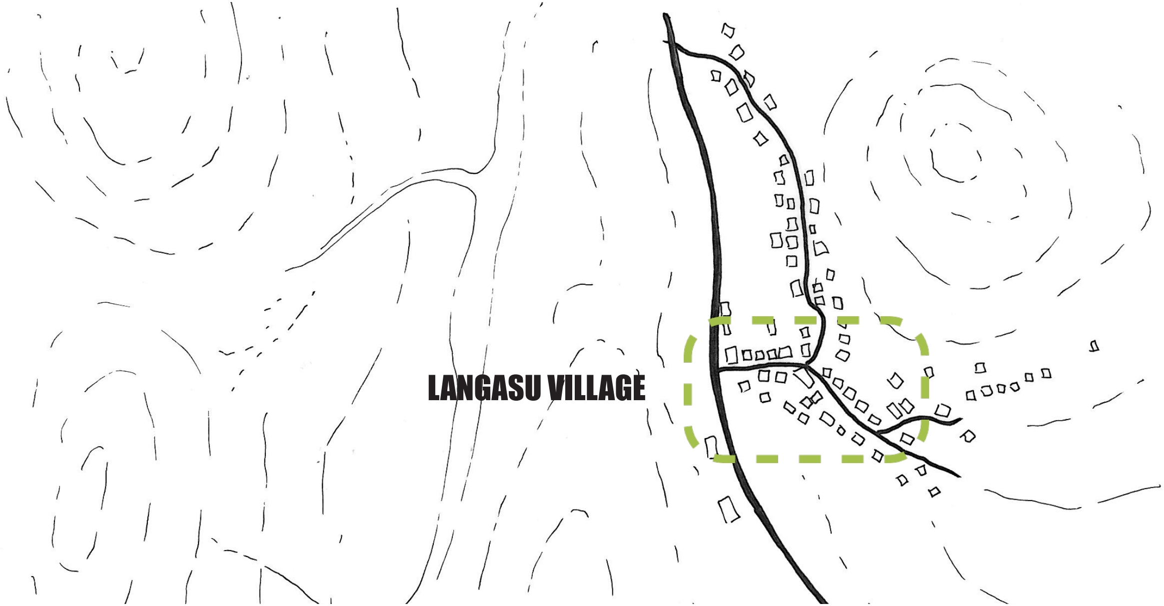
The social and cultural research group focused on gathering information from the Langasu Village community. The group consisted of four architecture students and an Indian Social Work student who was able to translate conversation from Hindi to English. Through visits to the village and conversations with members of the community the group was able to start to build rapport.

Information was mainly gathered through semi-structured interviews and direct observation. The objective was to understand how people live, the materials and techniques they employ to build their houses and the heirarchy of space.

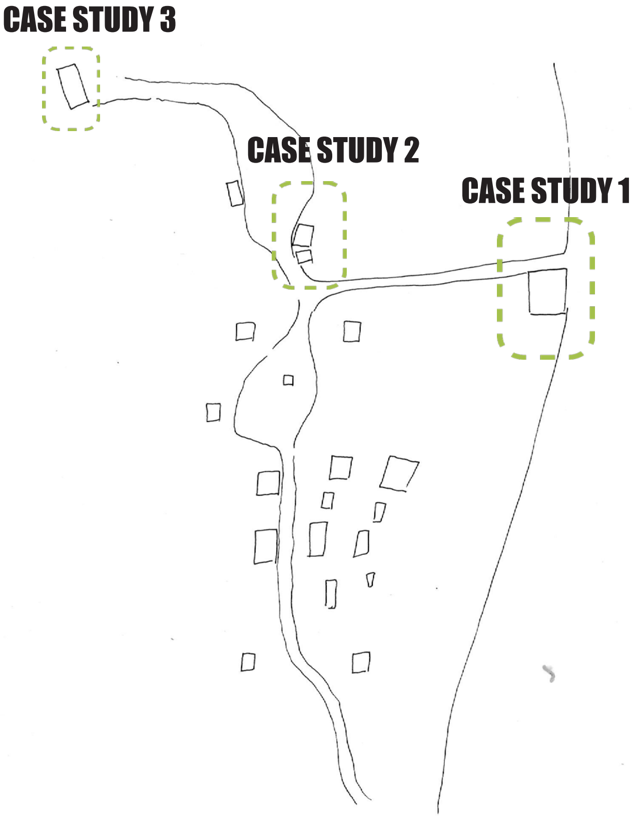
It was important to establish the impact of the previous earthquake in 1999 (Chamoli), the extent of damage caused and the capacity to rebuild.

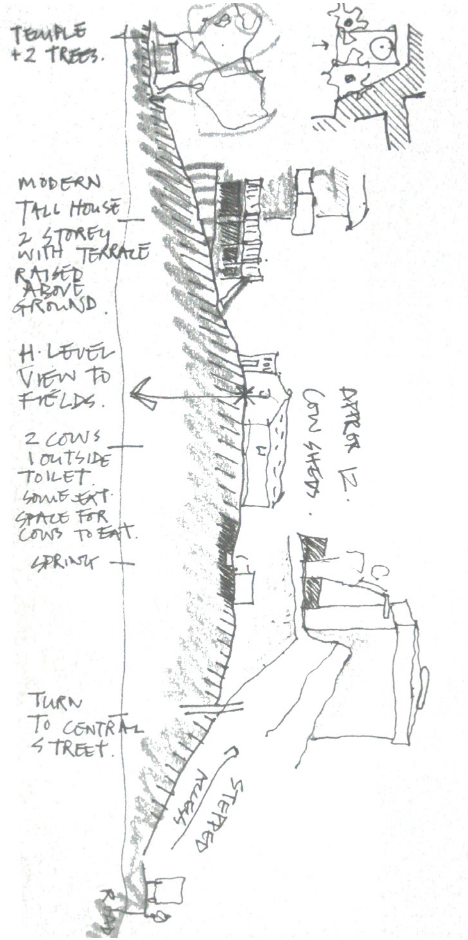
Through regular feedback sessions with the other groups questions could be asked and clarified. With further time a wider range of Participatory Rural Appaisal techniques could be used with the community to understand social and cultural patterns further.

view towards Langasu village



main road leading to Langasu village


CASE STUDY 3
CASE STUDY 2
CASE STUDY 1


TEMPLE +2 TREES.
MODERN TALL HOUSE 2 STOREY WITH TERRACE RAISED ABOVE GROUND.
H. LEVEL VIEW TO FIELDS.
2 COWS 1 OUTSIDE TOILET
SPACE FOR COWS TO EAT.
SPRING
COW SHEDS
TURN TO CENTRAL STREET.

local children writing their names next to a sketch by one of the participants

INTERVIEWS

Semi-structured interviews and observation were used in the information gathering process. The following questions were asked:

- How big is your family?
- How long have you lived here?
- What do you grow? Is it seasonal? What happens at other times of the year?
- How do you respond to changes of climate?
- What is your educational background?
- Do your children go to school? if so, where?
- Where do you cook/clean/wash/keep animals?
- When was the house built?
- Who built it? and how?
- What construction details have been used in house construction?
- What influences the style and size of openings?
- Did it survive the last earthquake?
- Is it still possible to build in the same way?
- How would you chose to build differently?
- What did you do after the last earthquake?
- What happened to your livestock?

meeting local women returning from the fields

local children watching a participant sketching their village

CASE STUDY 1
Jayanti Devi

Jayanti Devi is in her 70s and has been living in the house that we visited for over 50 years. The house was built by a previous generation. She is currently living alone, but has 12 children, all educated, (11 girls and 1 boy) from two marriages. Since marrying her children have lived in their respective homes, but visit her during holidays. Currently she has four grandchildren staying for the school vacation.

She owns land but is too old to farm it herself and employs labourers to do so. They take half the produce as payment. She is also too old to take care of animals. During the 1999 earthquake she was scared by the shaking and slept outside on the verandah for a month afterwards. The house withstood the earthquake and minor cracks were repaired.

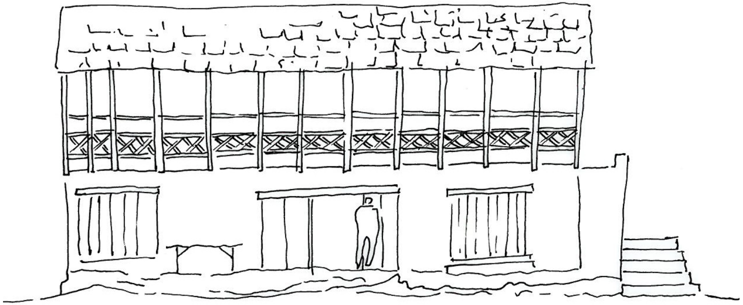
The kitchen is inside and has both a gas cylinder and stove. The gas is used in the summer and the stove in the winter as it provides more heat. The roofspace was once used as a store, but is now used as a guest room when more people stay with her.She is running the house on her pension from the government (2000 rupees).

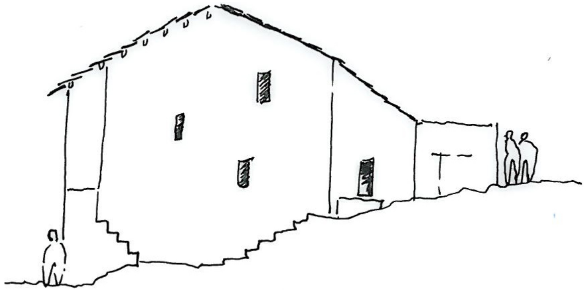
Direct Observation:

The house has two storeys (not including the roofspace) with shops on the ground floor on the road side. Due to the slope of the site the main entrance is at first floor level at the back of the building. A bedroom feeds off the entrance space on the left and the hall leads through to the verandah at the front of the building over the shops. All other spaces are accessed from the verandah.

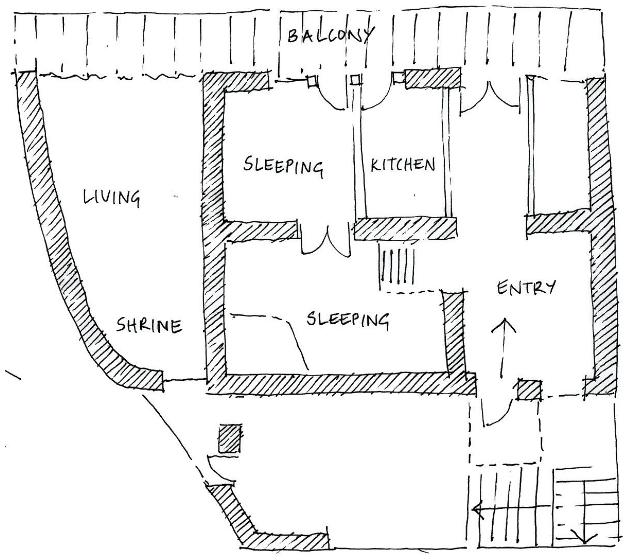
When we arrived Jayanti Devi was washing clothes on the roof terrace at the back of the building.

Jayanti Devi on her balcony with three of her grandchildren

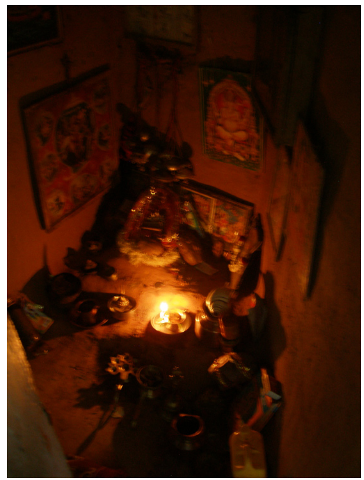




Elevations of Jayanti Devi's house



Plan of Jayanti Devi's house



a shrine within the living room

the balcony used for circulation

two grandchildren in one of the sleeping spaces

Jayanti Devi's roofspace for drying clothes

CASE STUDY 2
M P Nagwal

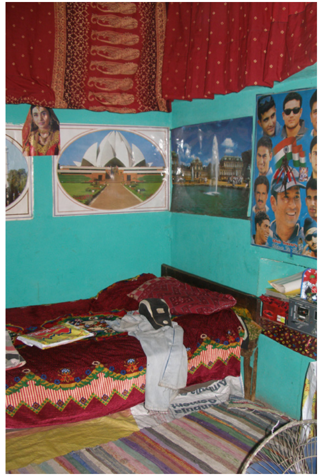
M P Nagwal's house was built by local masons and carpenters under his supervision in 40 days. It uses modern construction techniques and a concrete roof, as although this is more expensive he explained that it required less maintenance.

He explained that the problem with traditional construction is that the timber roof beams which rest on stone walls expand in the summer and contract in the winter causing cracking. The concrete flat roof can also be used for drying.

His rice and wheat harvests are stored in a locked wooden trunk which he sleeps on at night. He explained that the shrine is used for prayer twice a day.

Direct Observation:

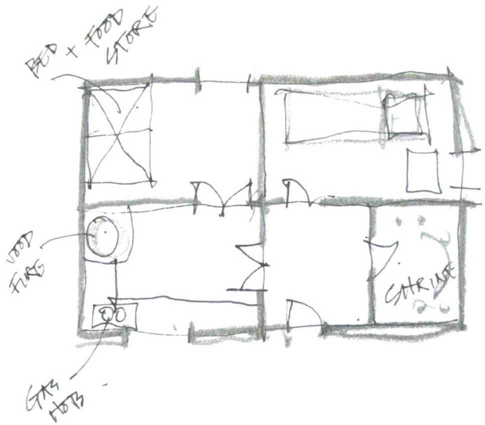
The house has four rooms which are all accessed from the entrance hall. The rooms include a shrine, bedroom, kitchen, store/bedroom.



M P Nagwal's store and bed and his wife's bedroom

M P Nagwal's cooking equipment

the house from the exterior showing the concrete stairs to access the roofspace



Plan of M P Nagwal's house

CASE STUDY 3

P. B Sati

The house is 16-17 years old and before it was built the family lived in the building that is now used as a cowshed. There are 9 occupants in the house spread across three generations. The three youngest go to a local government school.

In case of an emergency the cattle would be taken with the family, as they are considered to be as important as the children. The house withstood the last earthquake and any cracks have been repaired.

The doors are low traditionally as the house is considered as a holy place and bending over to enter is a sign of respect.The kitchen is inside and the toilets are outside, as is traditional in this area. Food waste is given to the animals or used to make compost and plastic waste is burnt.

Direct observation:

This is one of the larger homes in the village with a satellite dish, small solar panel and anti-mosquito device on the roof.

a satellite dish on the roof

the verandah - a place to meet

plants drying on the roof before they can be turned into rope

open space in front of their house

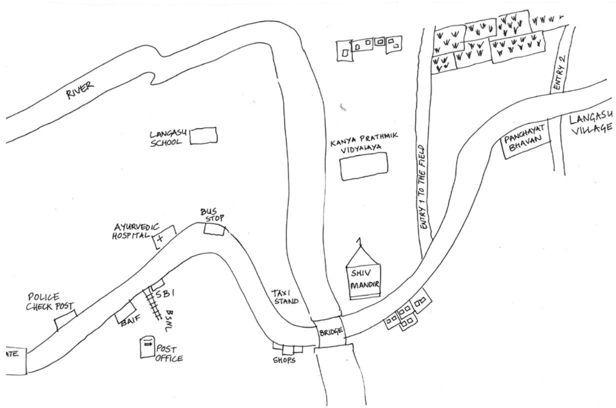
PRA TOOLS

The Indian Social work students used Participatory Rural Appraisal tools (PRA) as an alternative to interviewing to gather information.

Participatory techniques can be implemented in a variety of ways and can be divided into four main categories:

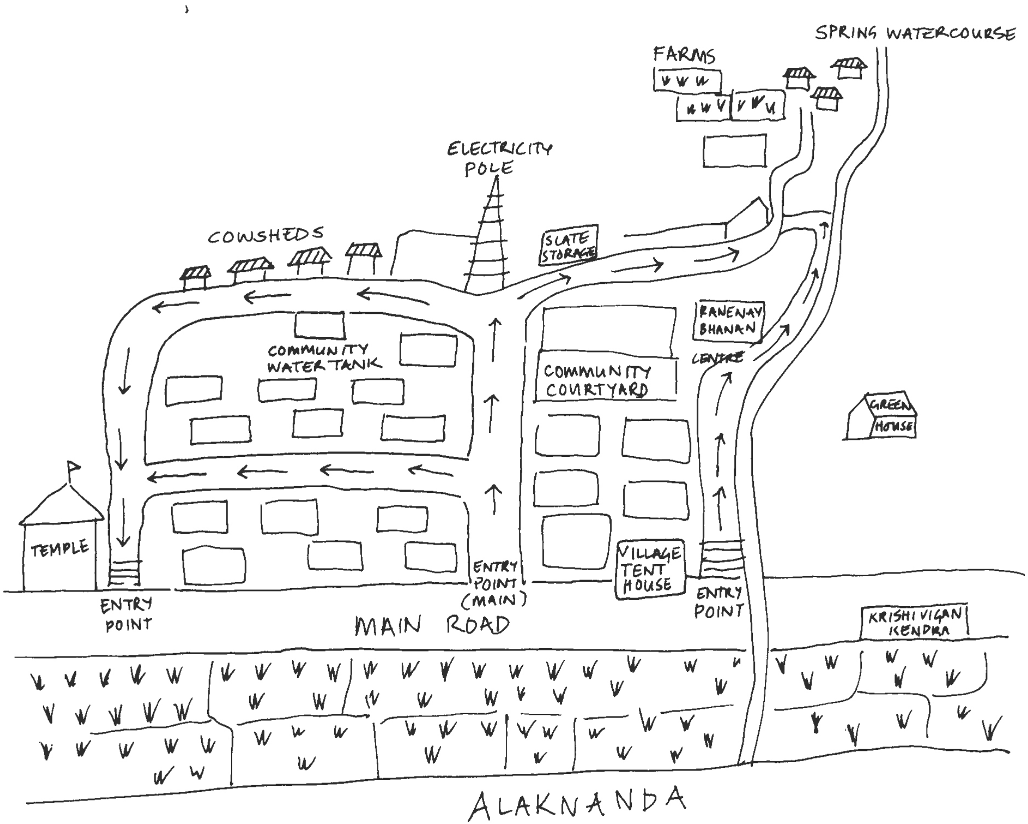
Group dynamics, e.g. learning contracts, role reversals, feedback sessions
Sampling, e.g. transect walks, wealth ranking, social mapping
Interviewing, e.g. focus group discussions, semi-structured interviews, triangulation
Visualization e.g. venn diagrams, matrix scoring, timelines

The social work students focussed on mapping with small groups within the community to further understand the heirarchy of space, social dynamics and priorities and the geography of the area.



Map of the area surrounding Langasu village

A girl drawing her home in Langasu village



Map of Langasu village drawn in collaboration with members of the community

FINDINGS

Through the case studies, and meeting other people within the village, the context group were able to start to develop an understanding about how people live and how houses are built within the village. The houses the group saw were all of a permanent nature; traditionally constructed from stone and more recently built/rebuilt with concrete. This typology was immediately at odds with the notion of an interim shelter and the need for rapid construction and lightweight/demountable materials.

Questions were asked to ascertain how the community have coped with emergency situations in the past, and how expectations of an interim shelter would differ from those of permanent accommodation. From the information that we gathered we understood that in an emergency animals would be taken alongside children, cooking would still take place indoors and families could share sleeping accommodation.

Design qualities;

•Shrine in a portion of room/whole room facing north.
•Storage for grain and possessions – high level or under beds.
•Mango leaves at entrance to make building smell good. •Shoes removed at entrance
•Lower door height so person lowers their head as a sign of respect.
•Cooking on gas during summer months and a stove during the winter.

women and children in the village

3.

LOCAL RESOURCES

As the structure was intended to serve as a prototype of an earthquake resistant shelter, part of the brief was to ensure that all necessary materials and tools could be acquired locally. This would enable the local population to easily reproduce the structure in an emergency situation.

The market research group investigated the local resources that were available at village, town and city level.

Locations

Langasu (village)

The following information on basic construction materials was gathered from a local building site:

Sand –	could be dug from down by the river and carried by local women to site for 11 rupees/50kg bag.
Cement –	2 brands in the area – obtained from Langasu for approx 285 rupees/bag
Gravel –	from a site 5km down river. 26 rupees/ft3.
Bricks –	2000 units for 5000 rupees
Steel -	reinforcement bars available locally, in large quantities 45 rupees/kg

Karnprayag (town)

In Karnprayag, the local resources group visited the market to find out more about specialised building components:

CGI sheets –	8ft x (3ft-25cms) – 425 rupees 12ft x (3ft-25cms) – 780 rupees
Mosquito net -	1m x 1m – 95 rupees
PVC pipes –	4in diameter – 8 rupees/ft 8in diameter – 15 rupees/ft
Connections -	10 – 15 rupees
Glass –	plain - 35 rupees/ft2 frosted - 22 rupees/ft2
plywood –	9mm waterproof 8′ x 4′ – 2400 rupees 9mm non – waterproof– 8′ x 4′ – 1100 rupees (available in (1.5,3.0,4.5,7.5) mm) Thick plywood block board 55 rupees/ ft2(door – 6′ x 3′) [double door – (6′ x 2′)x2]

The local furniture shop in Karnprayag lacked in variety of materials and because of the limited size of the business prices were relatively high.

Simli (town)

As Karnprayag did not have a timber merchant, ironmonger or steelworker, the group visited a third town, Simli, to enquire after primary building materials. Simli, a town about 6km past Karnprayag, did have a timber merchant. who quoted a price of 960 rupees/ft3, with an additional 400 – 700 rupees for transportation.

Rishikesh (city)

Most of the timber available in Karnprayag was sourced in Rishikesh and the group considered purchasing all materials in Rishikesh, which in spite of higher transportation costs would still be more cost-effective. However, a carpenter in Langasu met the group and indicated that he could obtain all necessary timber locally for a reasonable price, which seemed the preferable option.

Materials

Timber

With a limited overall project budget of 50,000 rupees, and relatively high costs for timber, most of the project budget would be spent on timber. TImber was sold at a price per cubic foot, but there did not appear to be any standardisation for the dimensions of timber beams and columns. Timber planks were cut to different sizes in the furniture shop itself, which seemed to be common practice in the area.

Concrete

Another main construction material for the shelter was concrete, to be used for foundations and the ground floor slab. Gravel was ordered from a local gravel pit owned by Jagdamba, located near Kaleshwar Temple. 50ft3 of gravel was ordered but only 40ft3 arrived on site after a days delay at a price of 1600 rupees. Sand was collected by the participants from the river bed; a total amount of 25ft3 was needed. The cement (12 bags) was ordered from the secretary of the school, Khatri, who also owned a local hardware shop.

Tools

Tools were originally borrowed from Khatri's hardware store as well, but eventually had to be bought. These included four spades, a pick-axe, two sickels, a hoe and five hammers.

Challenges faced on site

1. The site was located about 10-12m below the level of the road, and could only be reached by uneven steps. All materials had to be carried down to site by hand.
2. There was no water on site; the nearest tap was situated at the top of the steps next to the road. A drainage channel ran along the front of the school which was diverted for the mixing of concrete.
3. The gravel arrived a day late, which meant that laying the foundations had to be delayed, and the amount delivered did not correpsond to the amount agreed in advance, which meant that a second delivery was needed. In addition, the quality of the gravel consisted of large pieces of aggregate which resulted in a weaker concrete strength.
4. The cement arrived in stages
5. The sand had to be collected by participants because the local women who usually collect it were busy on another job
6. Tools were limited and of poor quality.

Improvements to method

The team could have been more efficient with time if they had spoken to the local carpenter first, but this was difficult to predict in an unfamiliar area.

There were difficulties in translation, and misunderstandings as a result. It took time to establish reasonable prices to pay, and calculate quantities needed. A closer working relationship with Gomti Prayag, may have helped in obtaining materials and advice.

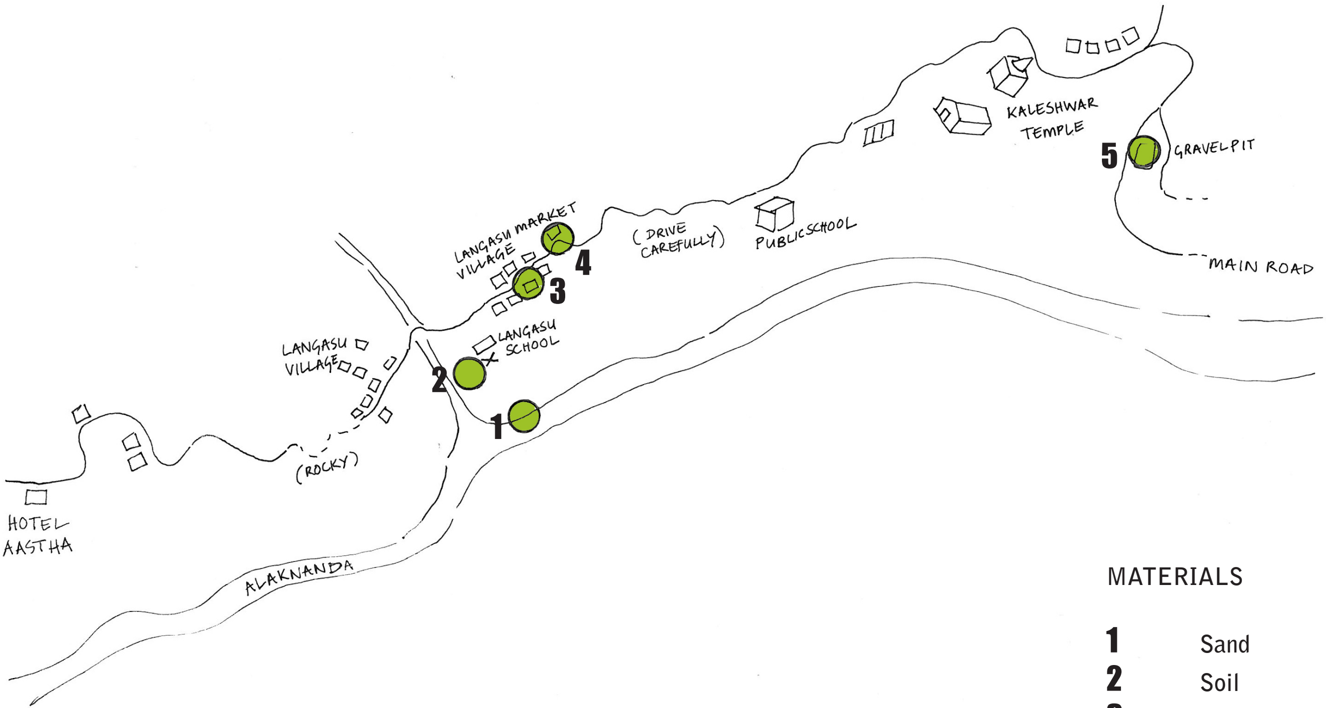
local gravel pit

the local carpenter at work

the materials used for making the concrete: cement, sand and gravel

the hand-drill used for the construction of the shelter

an engineer from SEEDS India in conversation with a timber merchant in Simli

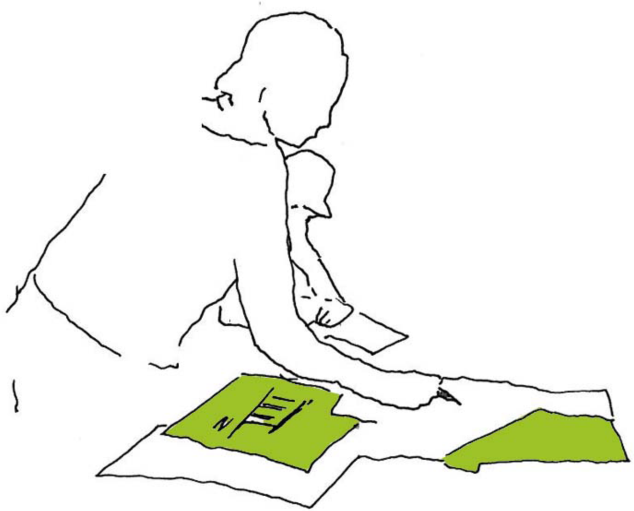


MATERIALS

1	Sand
2	Soil
3	Timber
4	Cement
5	Gravel

map showing the locations of key materials used in the construction of the shelter

4.



SHELTER DESIGN

Using the information gathered by the context research group as well as the local resources research group, the aim of the Shelter Design group was to develop a design for an intermediate shelter module that would be based on local materials and skills, suited to local conditions and traditions, quick to erect, and met humanitarian standards of relief.

This intermediate shelter was to be constructed by all participants as a prototype of an appropriate post-earthquake shelter for the local population. In addition, the shelter was to be used on a temporary basis as an additional classroom for the local primary school.

The Shelter Design group furthermore was responsible for initial site preparations which included removing vegetation where necessary, removing boulders where they would obstruct foundations, and levelling the ground. The group developed a design that attempted to include all aspects mentioned previously. This design went through 3 phases: a conceptual stage, a 'construction drawing' stage and a final design stage.

Reviews with the other three groups, with the local carpenter and with an engineer from SEEDS led to a constant development of the design. In addition, the design had to be adapted a number of times in order to take into account time, material and budget restrictions.

DESIGN DEVELOPMENT_CONCEPT

The following aspects were considered in the development of a conceptual design of the shelter

participants overviewing the site

Site conditions

The available site posed several different challenges. Loose soil, the presence of several very large boulders and a substantial slope meant that the foundations of the shelter had to be carefully considered.

Climate

The climate in Uttarakhand is hot and humid in summer, and cool in winter, with temperatures dropping to about
5 degrees C in winter. Heavy rainfall can be expected in the monsoon period. Accordingly, the design needed to allow for good cross-ventilation, shading, protection from driving rain and wind, and insulation for winter periods. Finally, the openings needed to be covered with mesh to keep mosquitoes out.

Earthquake resistance

In order to make sure that the shelter would be earthquake resistant, in particular considering possible aftershocks, the following elements were taken into account: strong reinforced corners; proper foundations; use of lightweight materials such as timber; appropriate joints (flexible/hinged/fixed); ringbeams at plinth, sill and ceiling level; cross-bracing (for instance by means of steel wires); a square, compact plan; a sIngle-storey design and small window and door openings.

Available materials and skills

Based on findings from the local resources group (see Section 3_Local Resources), and observations from the context research group, the following information on the local use of building materials was gathered:

bamboo - available but not widely used

steel - available but not easily adaptable, connections depend on having a welder

stone and slate - traditional building material but too permanent for intermediate shelter

bricks - traditional building material, but too permanent for intermediate shelter

concrete - widely used modern construction material, considered to be easily maintainable, generally allows for possible future extension upward

corrugated galvanised iron (CGI) sheets - lightweight, widely used for roof construction, easily acquired

Family size

Initially, the average family size was considered to be around 7, based on research by the context group, with each household consisting of parents and 4-5 children, with grandparents living elsewhere. However, after further research, this number was reduced to an average of 5 people per household.

Humanitarian relief standards

Based on the standards provided by the Sphere Standard Guidelines, a minimum space requirement of 3,5m2 per person has been taken as a guideline.

However, as described in the Sphere Standards for Humanitarian Relief, shelter should provide not only a means of immediate survival, but also security, personal safety, human dignity and privacy, protection from the climate, enhanced resistance to ill health and disease, coping strategies, self-sufficiency and self-management. Therefore, it was important to carefully consider the design, its immediate and wider context, local culture and traditions and the construction methods.

Local culture and traditions

A number of traditional elements came out of the social and cultural research, e.g. the presence of a shrine in the north/east corner of house, and the use of low door openings as a sign of respect. For more information, see Section 2_Context.

Livelihoods and possessions

Research of the local context showed that secure storage for harvest (high up or underneath bed) was an important aspect in the traditional layout of houses in the region, as well as ample amounts of shelves and cupboards for general storage. In addition, an allocated space for livestock (preferably covered) seemed an indispensable part of housing design.

Adaptability

Inherent to the nature and purpose of an intermediate shelter, it was important that the shelter would be easily adaptable, so that it can be made more permanent or be extended as more resources become available. Hence, the use of flexible materials such as timber and a simple open plan that could be divided or extended into different spaces, depending on the specific needs of the inhabitants.

Time and budget restrictions

Because of the limited available budget and time, it was important to keep the design simple and economic, and to make sure that materials could be used as efficiently as possible.

Additional use as classroom

The brief included the use of the shelter as a temporary classroom. This meant that the design of the shelter should be suitable as a classroom space: hence, a large open space, a verandah to spill out onto and low windows would have to be considered in the design.

collaboration in the design phase

DESIGN DEVELOPMENT_CONCEPT

Conceptual stage

In the initial, conceptual stage, information gathered by the context group and the local resources group was used to come up with a sketch design for the shelter which was explored through a series of drawings that showed a general layout of spaces and an initial idea for a structure.

As shown, the conceptual design incorporates a double pitched roof, with large overhang on all sides, to protect the shelter from rain. The gap in between the two sections of roof lets light and fresh air into the shelter. A verandah provides shade and coolth, and allows for better ventilation. Prevailing wind in the area comes from the south-west, so openings are facing that direction in order to maximise ventilation.

The shelter makes use of a simple timber frame structure, which is lightweight, easily available, quick to erect and relatively cheap. In addition, two damaged steel electricty posts that were found on the way to site have been incorporated into the roof structure (see photograph on this page).

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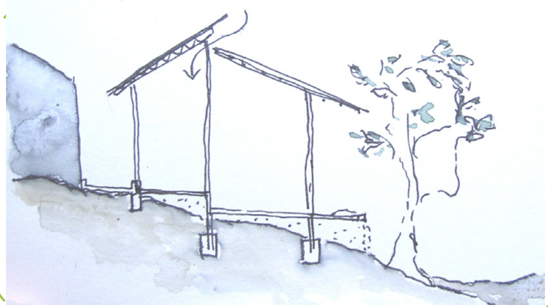
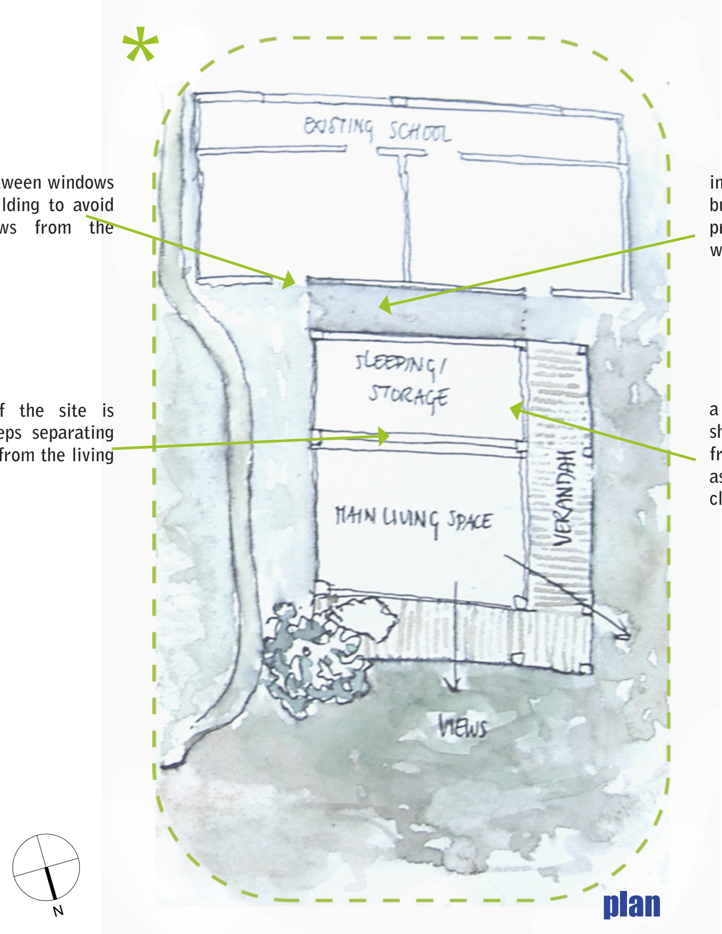


section

steel telephone post found next to the site the shelter is placed in between windows of the existing school building to avoid blocking light and views from the classrooms

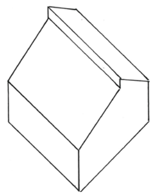
the height difference of the site is mediated by a set of steps separating the sleeping/storage area from the living area



plan

in between the shelter and the school building a concrete drainage channel provides an area for collecting rain water for washing and laundry

a verandah runs along two sides of the shelter to provide shade and protection from wind and rain. It can also be used as break-out space for the temporary classroom

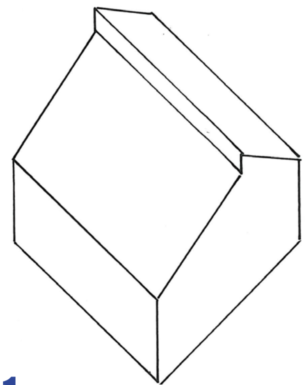


axo

DESIGN DEVELOPMENT _ ROOF

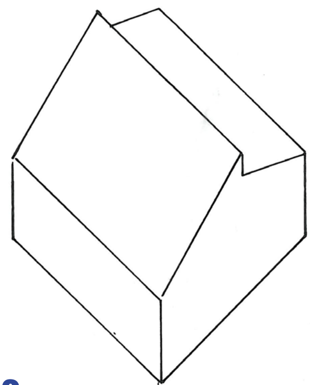
In the process from conceptual to final design, the roof - an important element in the climatic conditions of Uttarakhand - has undergone the most profound changes. Five different design stages can be identified:

concept



1.

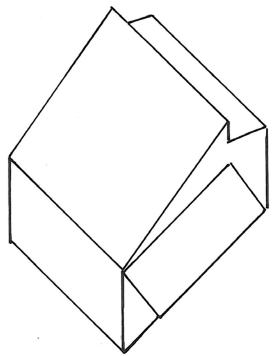
Double-pitched roof with a north-facing clerestory window



2.

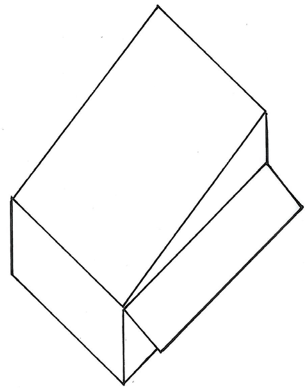
Double-pitched roof with a south-facing clerestory window to allow for more light and ventilation (prevailing south-west wind).

construction drawings



3.

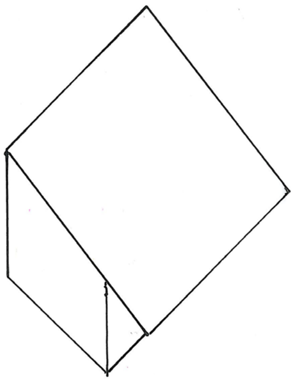
Double-pitched roof with a separate verandah roof to reduce construction costs



4.

Mono-pitched roof with a separate verandah roof to further reduce construction costs and time

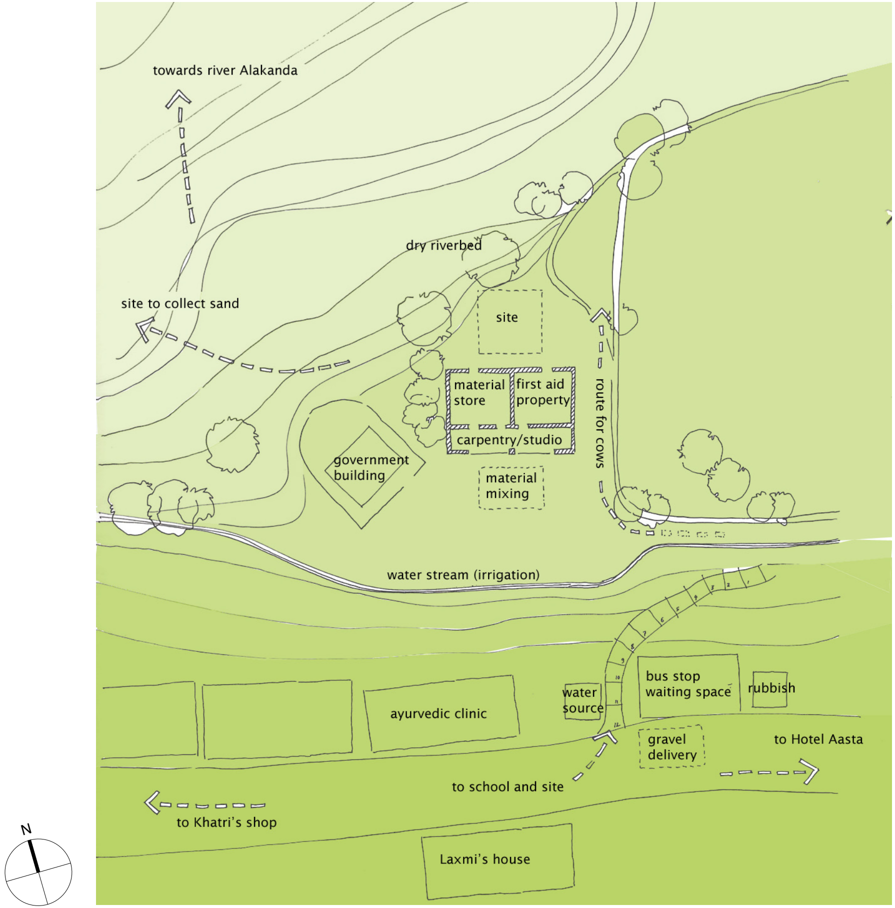
final design



5.

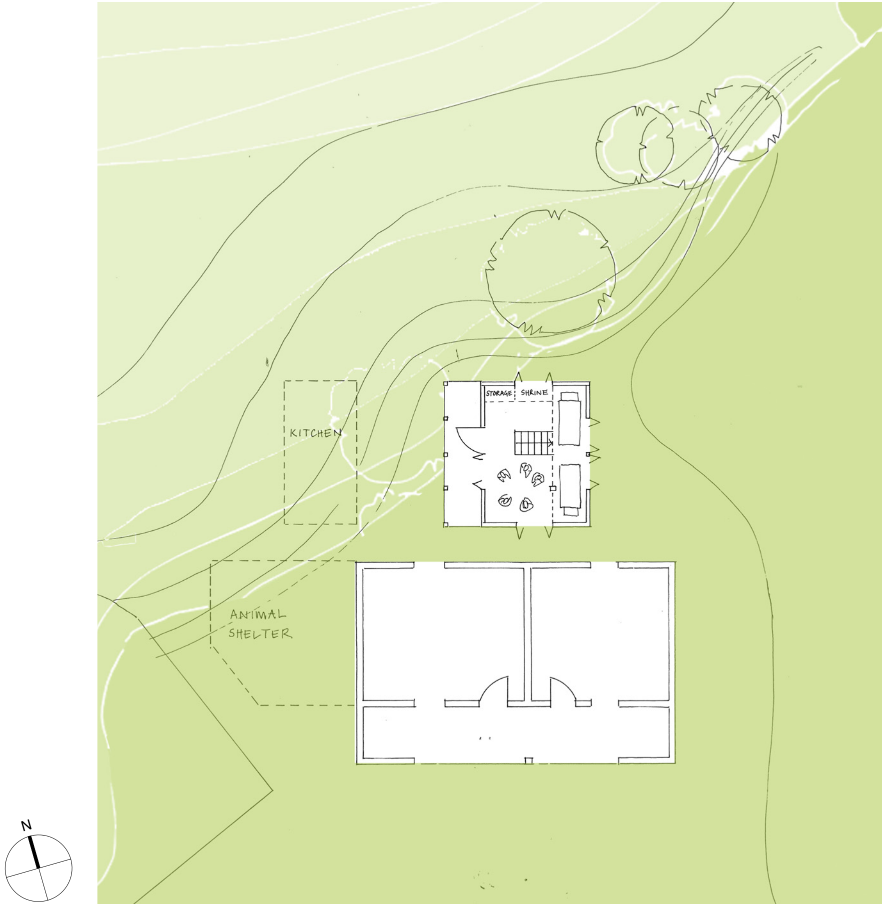
Mono-pitched roof extended over the verandah to reduce construction costs and time even more

SITE SET-UP



plan of the site set-up and use of site during construction period

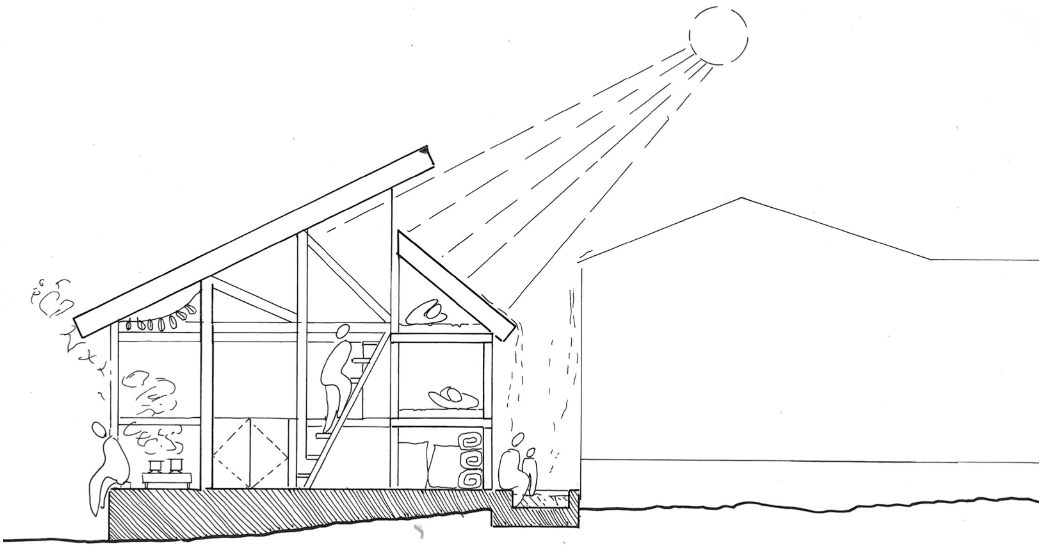
PLAN



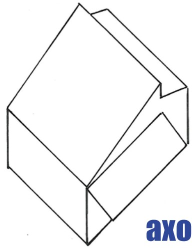
plan of the school building and shelter

CONSTRUCTION DRAWINGS

Based on the conceptual design of the shelter, a series of construction drawings was developed in order to figure out dimensions, calculate how many materials were needed, and what the overall cost would be. The opening between the two roof sections has been turned 180 degrees to maximise the amount of sunlight entering the shelter. The level difference between living and sleeping space has been taken out of the design and a sleeping platform design and a sleeping platform constructed for protection and extra storage. And finally, the steel roof member has been removed from the design because of ownership issues.



SECTION
construction drawing



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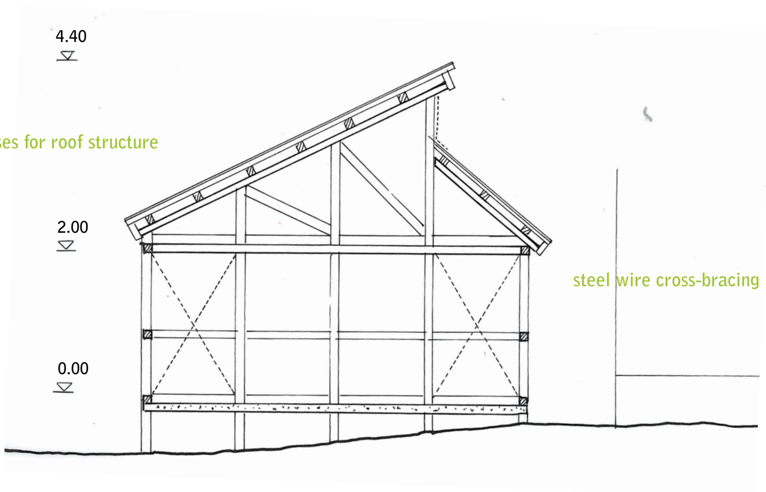
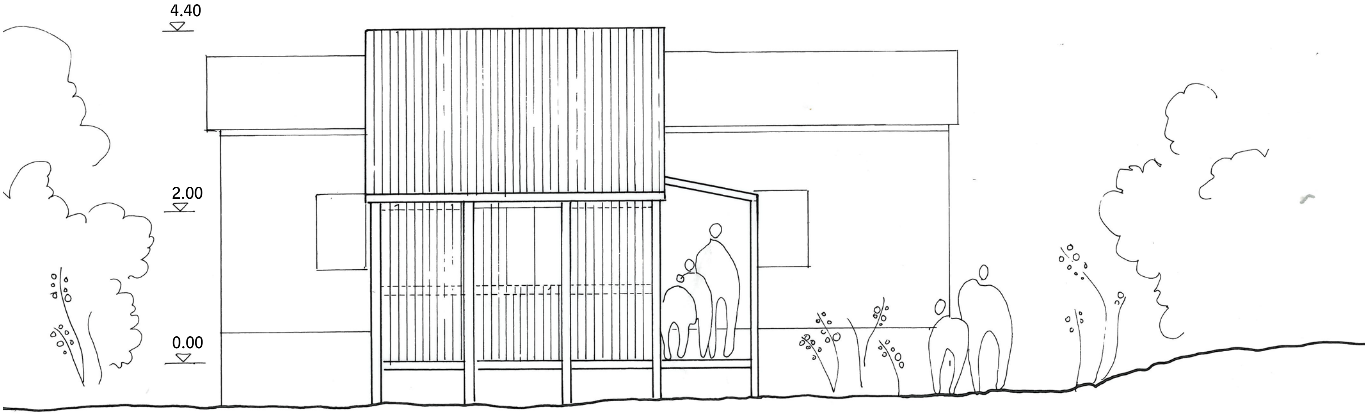
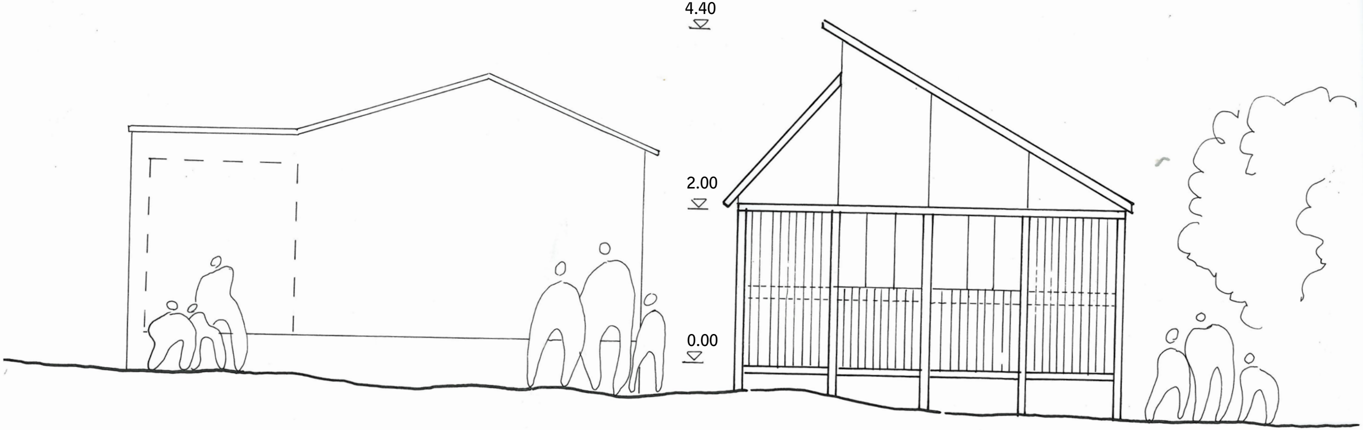


NORTH ELEVATION
construction drawing

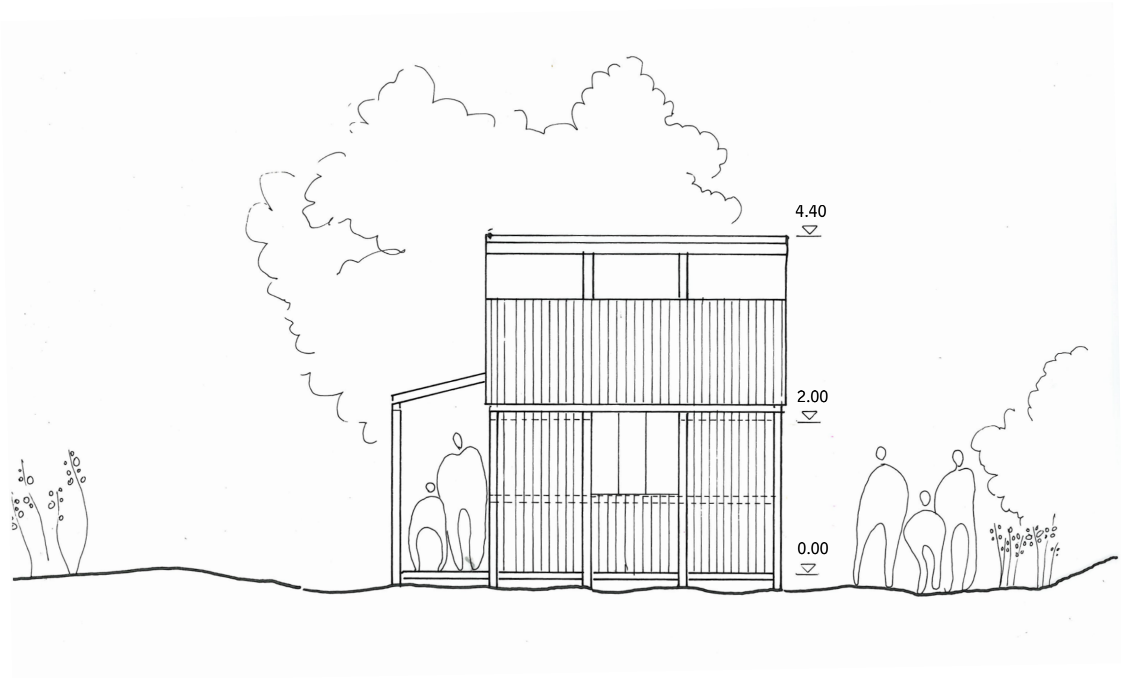


EAST ELEVATION

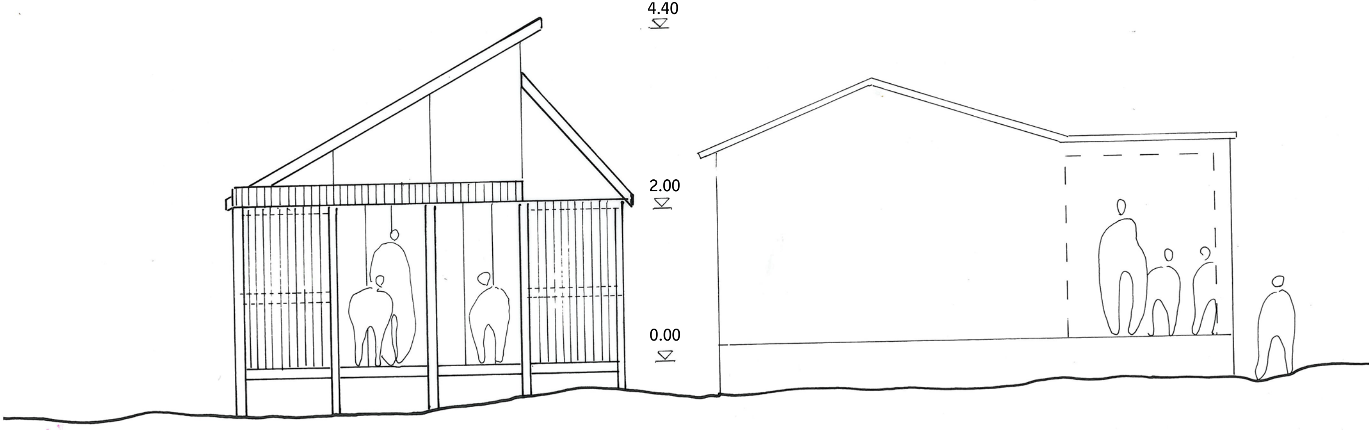
construction drawing



SOUTH ELEVATION
construction drawing



WEST ELEVATION
construction drawing



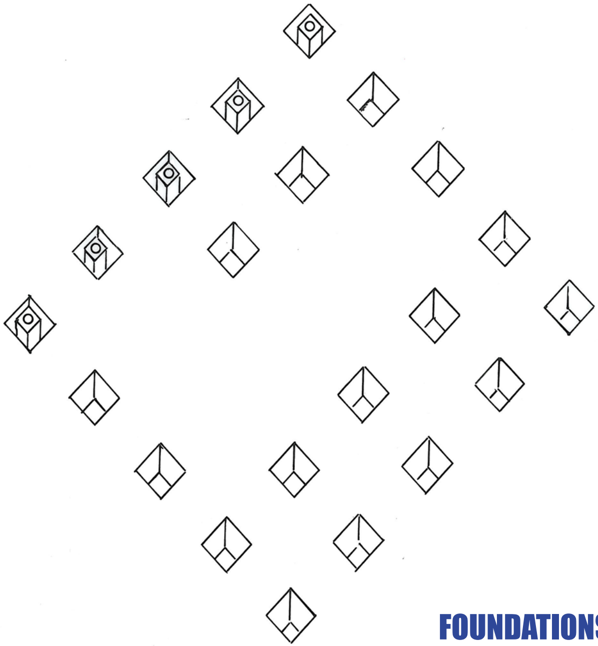
FINAL DESIGN

For the final design, the construction drawings were adapted to reduce costs and construction time. The main change was the shape of the roof: from a staggered double-pitched roof with separate verandah roof to a monopitch roof continuing over the verandah. The truss structure of the roof had to be simplified to economise the design, and the sleeping platform was taken out of the design for the same reason.

preparing the foundations

AXONOMETRIC
final design

Foundations were constructed out of old oil tins that were bought off a local resident. The lid was cut off these tins, a piece of PVC pipe was inserted, and concrete was poured into the can around the pipe. Timber posts could then be inserted into the PVC pipes and were thus relatively protected from rotting. A few timber posts with a larger section were cast into concrete that was poured into holes protected with aluminium sheets since they did not fit the tin cans or PVC pipes (see picture overleaf).



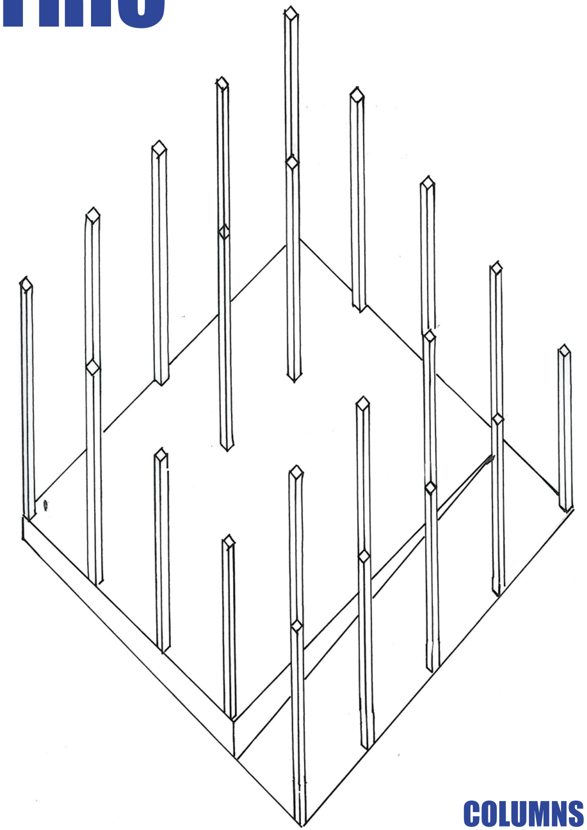
FOUNDATIONS

casting the large timber sections into concrete foundations

AXONOMETRIC

final design

Two different sections of timber post were used: 75mm and 100mm. They were placed in a grid at 1.25m centres around the edge of the main structure and along the verandah. In addition, two posts were placed in the centre of the space. A simple plumb line was used to ensure their verticality.

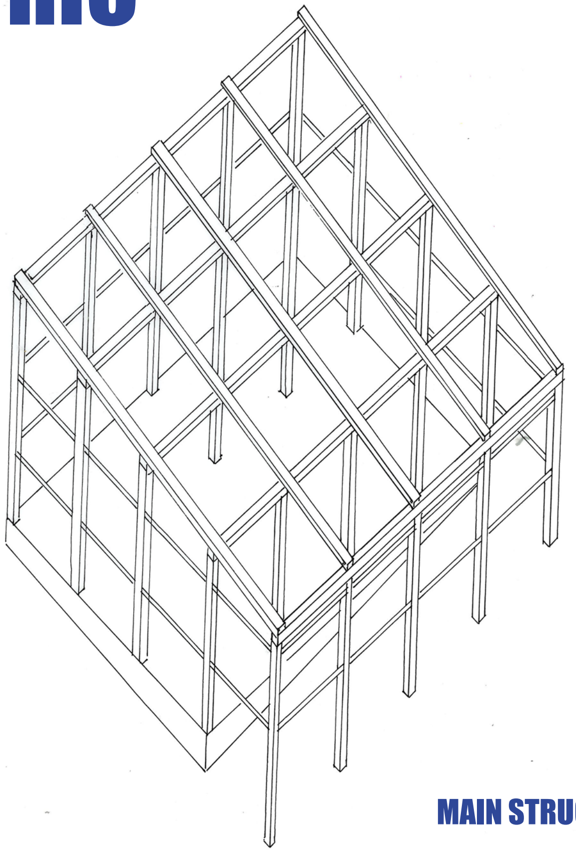


COLUMNS

two participants constructing the roof structure

AXONOMETRIC
final design

The main structure consisted of the vertical timber posts, smaller horizontal timber members and a simple roof structure of joists and battens.
As no screws or bolts were available, all joints were nailed together.

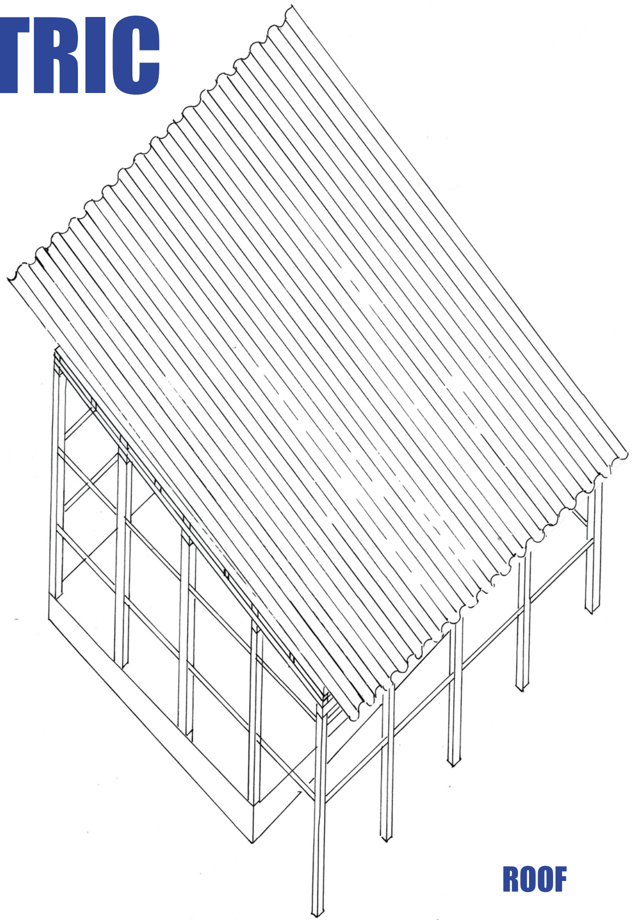


MAIN STRUCTURE

interior of the shelter with partly finished roof

AXONOMETRIC
final design

The roof was constructed out of corrugated galvanised iron sheets that were nailed to the roof structure. They were laid with a large overhang at each of the four sides of the structure to protect the shelter from rain. In addition, each of the sheets overlapped the previous one considerably to prevent leakages through the roof.



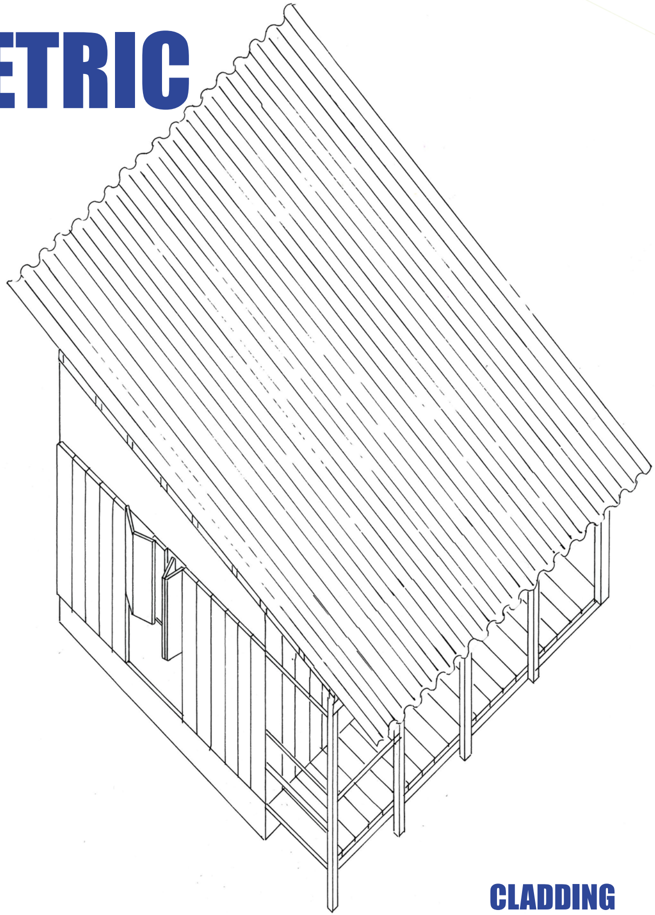
ROOF

the verandah clad with vertical timber planks and mesh windows

AXONOMETRIC
final design

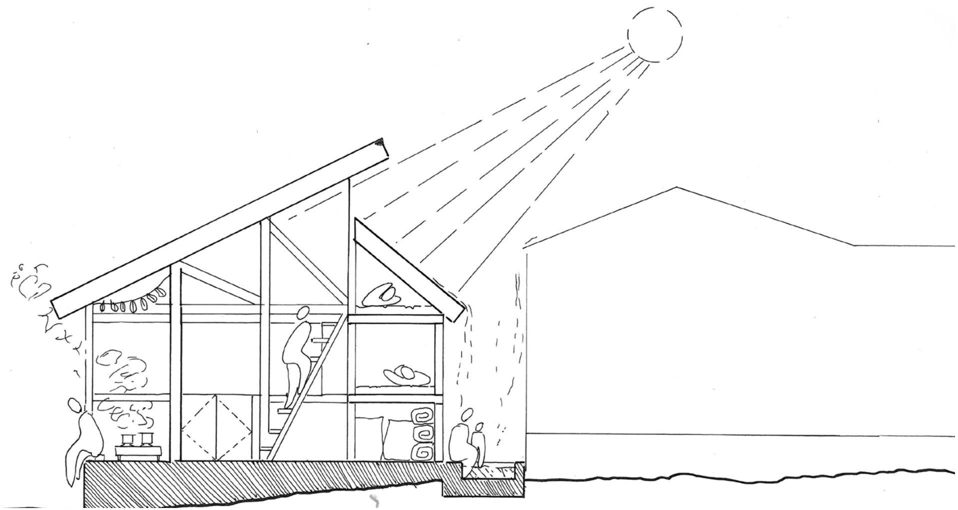
The structure was clad using a combination of plywood sheets that were nailed to the timber columns and battens and a series of thicker planks that were nailed vertically to the columns and battens.

The openings were covered with mesh to stop mosquitoes getting into the shelter, and windows were covered with double-leaf hinged shutters that were nailed to the window frames.



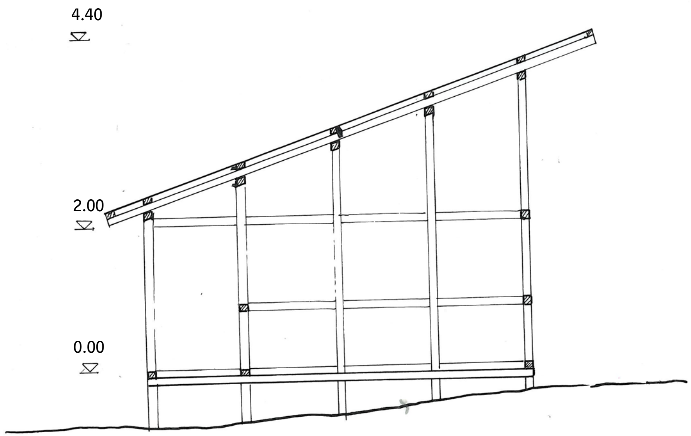
CLADDING

FINAL DESIGN

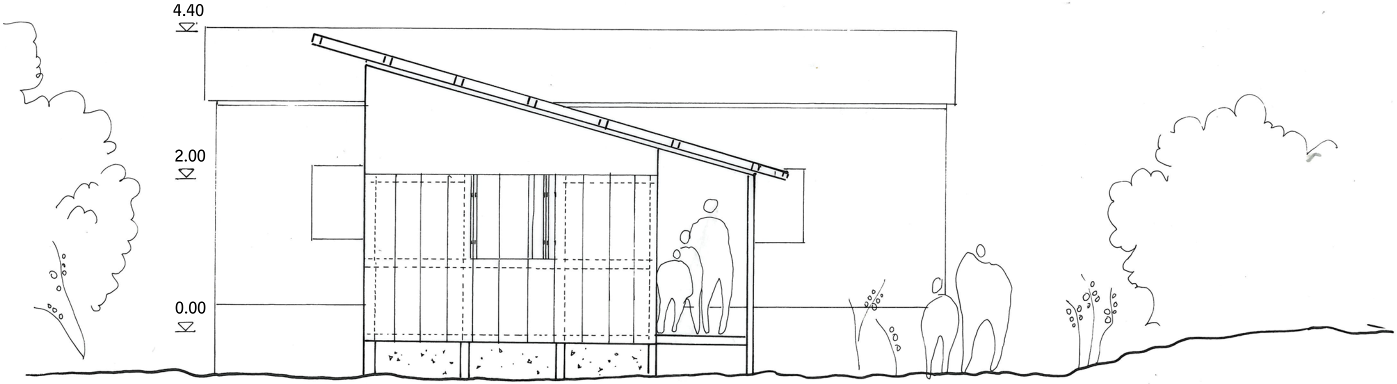


SECTION

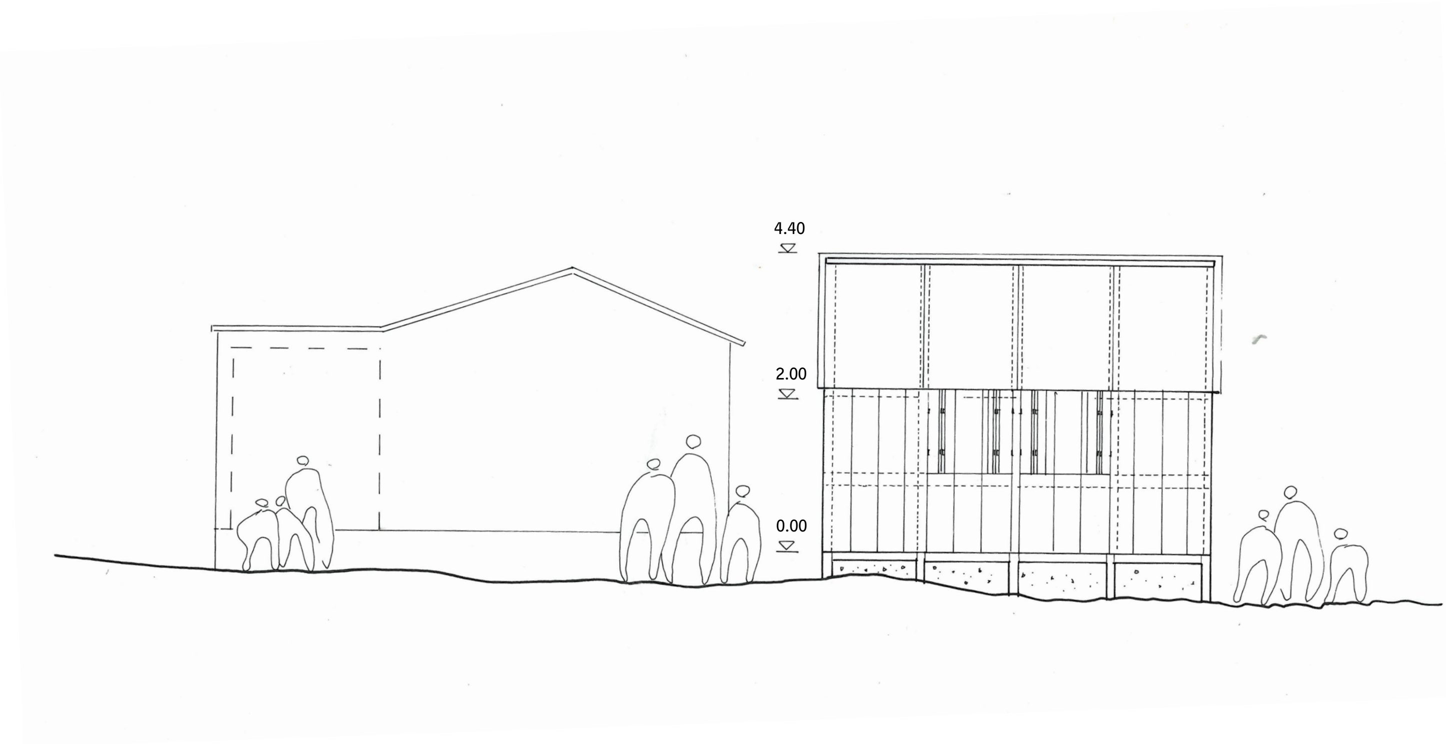
final design



NORTH ELEVATION
final design

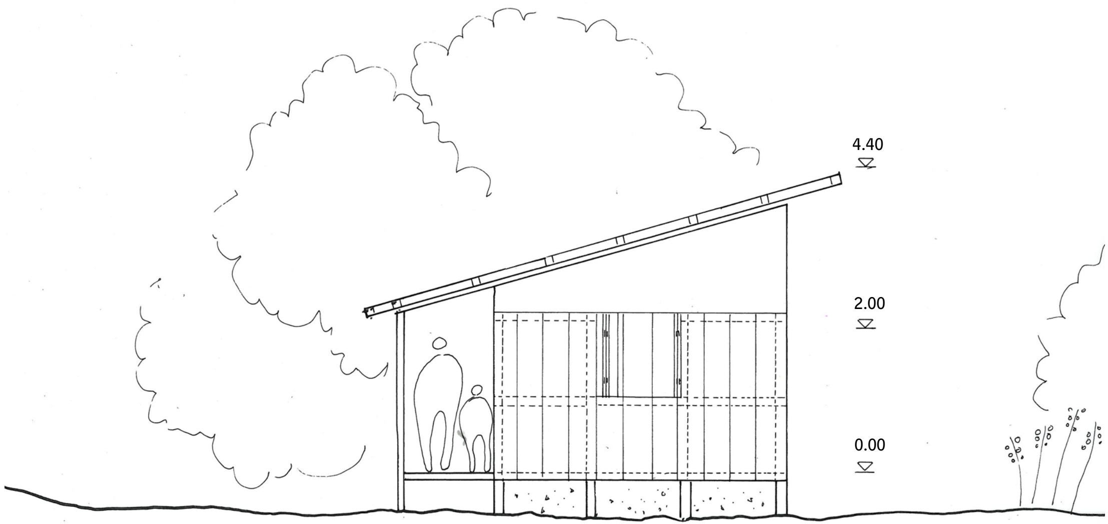


EAST ELEVATION
final design

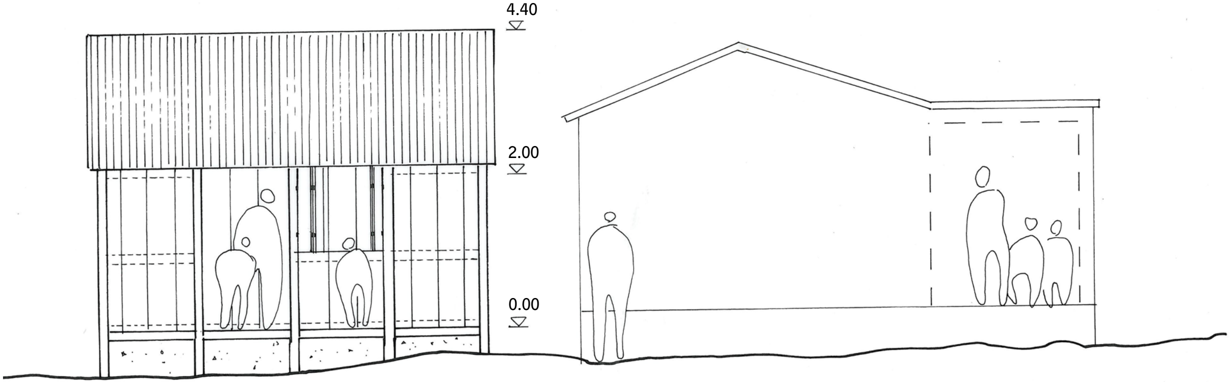


SOUTH ELEVATION

final design



WEST ELEVATION
final design



Cutting timber planks for the cladding

Fixing the cross battens to the posts

5.

LEARNING OUTCOMES

The learning outcomes from this workshop can be classified in several different categories, and range from general organisational issues to observations on the local community to specific problems related to the context that the workshop took place in.

General

In general, participants experienced learning on a design level, on implementation and construction, and on a social level. The close link that existed in the project between designing, finding resources and having to construct the shelter meant the design had to constantly be redeveloped and redesigned.

Local community

In spite of the high risk of earthquakes as discussed in the first section, the local community does not seem very afraid of earthquakes. In fact, there is a wide gap between real and perceived risks. Some villagers seem to have a rather fatalistic attitude: "If I have to die in this earthquake, I will"; but also: "We're a god-fearing community, nothing will happen to us". In general, it seems like people do not really have the time or energy to be too concerned about earthquakes. This of course makes disaster prevention and risk reduction more difficult. Therefore, it would be good to raise awareness and promote IEC: information, education and communication.

Site

The site that the participants were presented with was particularly difficult due to the slope, large boulders, loose soil, rubbish and vegetation. In addition, there turned out to be some ownership issues: the construction of the shelter on the site behind the existing school building was in fact an 'illegal' encroachment. An official hand-over meeting with the district magistrate, however, once the building was finished, gave the project a 'seal of approval' from the local authorities.

These conditions are a good example of the fact that real-life situations are never perfect, and that moving from a simulation into an actual project requires a certain degree of creativity and flexibility.

Construction and design process

In the construction of the shelter, several problems were encountered. The design was intended to be built with the help of a mason and carpenter, however the latter dropped out for unclear reasons, so a new carpenter had to be found. Neither of the two craftsmen really got involved in the development of the design, mainly because there simply was not enough time to work together and work through the design, which was further hindered by language barriers. As a result, it was not possible to make full use of their skills and local expertise. In addition, it would perhaps have been useful to have an Indian architecture student or engineering student on the design team, which would have greatly helped the communication as well.

Because of the limited availability of (and information on) materials, the design had to be adapted several times to take into account different timber sections, less materials than originally planned for, and different construction techniques, such as joints. The carpenter who was involved with the project did not have much experience building houses, and there was not enough time to empower him to collaborate on the project to build a better building.

This less-than-perfect working relation with the carpenter probably also influenced the budget. If there had been a chance to properly communicate with the carpenter, to go through every single drawing and really explain the purpose of the building, it would have been possible to cost the design more appropriately and change the design accordingly. Then, when the cost eventually came in over budget the design could have been value engineered accordingly.

Organisation

Throughout the process it became clear that the different groups were not structured enough: the groups did not have a clear enough idea of what they were supposed to be doing. Tasks and roles should have been divided more clearly, and there was not enough communication between the group doing the context research and the groups involved with the design and construction; more percolation of information would have helped the efficiency of the construction and the appropriateness of the design, with a hopefully more informed design as a result.

In addition, if a better rapport had been established with the local community, this would have also influenced the appropriateness of the design and construction: more people would have become involved in the building process, which would have made the construction more efficient and which would have given the local community a stronger sense of ownership.

On a more general level, a control desk and a Gantt chart would have been useful, to keep track of how construction was progressing. Having a Gantt chart would have also helped with the efficiency of the construction process, as time was wasted waiting for materials that had to be delivered. If more time had been spent on 'building an organisation' initially, this could have saved time and money.

Difficulties encountered

As further described in the Challenges section, there were a number of difficulties in the process that the participants encountered. Most of these, although not all, were directly related to the immediate context in which the project took place. One main issue which has been mentioned before was the difficulty in communication. Both in terms of communicating the design (the carpenter for instance was not able to read our construction drawings, a scale model might have been a more appropriate tool), and in communicating with the local community in general and people on site. Quite often, things got lost in translation. In addition, a very tight schedule and budget placed an extra strain on the process, with participants often being too tired for proper feedback sessions.

Conclusion

However, in spite of all these challenges that were encountered, many positive learning outcomes were mentioned during the feedback session that was held at the end of the workshop. Conditions were close to those experienced in 'real-life' situations. The extent of the brief was particularly interesting, with the additional use of the shelter as temporary classroom. People in particular mentioned the benefits of the close link between designing, resourcing materials and constructing the shelter and the richness that comes with working in a very different cultural context to one's own.

FROM DESIGN TO CONSTRUCTION

Change in the design/future additions

A number of changes that were made to the design have been mentioned in section 4_Shelter Design. Here, some of these changes are explained, as well as those elements that were designed but left out in the final construction due to time or budget restrictions.

Some changes were made because of research outcomes by context group and local resources group. For instance, the average family size, and thus necessary size of shelter, was reduced from 7 to 5 after further research.

Additions/changes that would improve the final design of the shelter that was built:

1. Proper cross-bracing by means of steel wire

2. Better junctions, such as between the column/roof beam. In the final construction, these joints had to be nailed together because of a lack of screws or bolts.

3. The truss that was included in an early stage of the design to support the roof would have been particularly good for earthquake resistance; this had to be taken out of the design because of the limited budget.

4. The roof should perhaps be double-pitched: this would mean less problems with wind lifting off the roof, and be structurally more sound. However, a monopitch roof was chosen for time and budget reasons.

5. A double skin with insulation (wool, sand etc.) should be introduced inbetween the walls to make the shelter winterproof.

6. The shelter should ideally be painted to improve termite resistance and protection from the elements - the local NGO Gomti Prayag has offered to take this on .

7. A sleeping platform with storage underneath should be added for increased security/safety. Other internal additions include furniture, a cooking area and the shrine mentioned in the Context section.

8. Access to site should be improved, with respect to its role as Interim shelter. Currently the site is very inaccessible, this would only get worse in a post-earthquake situation.

9. The material delivery could have been managed more effectively to ensure that materials arrived when they were needed, and in the quantities specified.

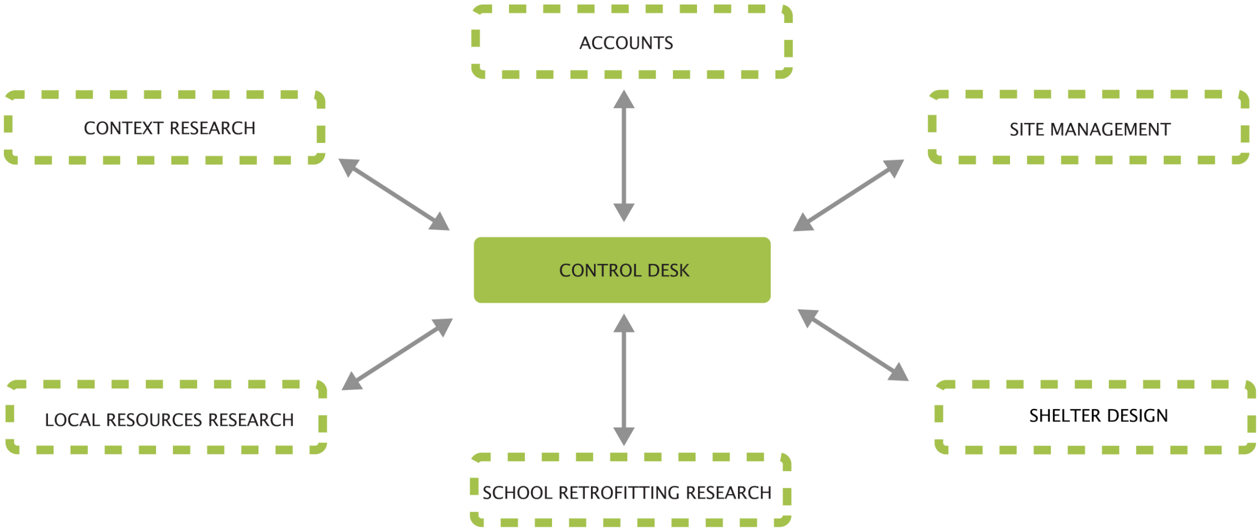
10. If it had been realised at an earlier stage the extent to which the design was over budget more ply could have been used instead of the timber planking for the cladding.

11. The span of the roof could have been reduced in order to use the sizes of timber available more efficiently.

12. The hinges and bolts for the window shutters could have been designed differently to accommodate the irregularities of the thickness of the timber planks if this had been known in advance.

ORGANISATION

improved structure



CHALLENGES


local protests about road safety


pilgrims on bikes


boulders


dehydration

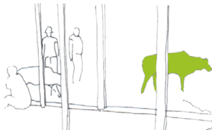

the sun


the food


carrying equipment


the tools


working at height

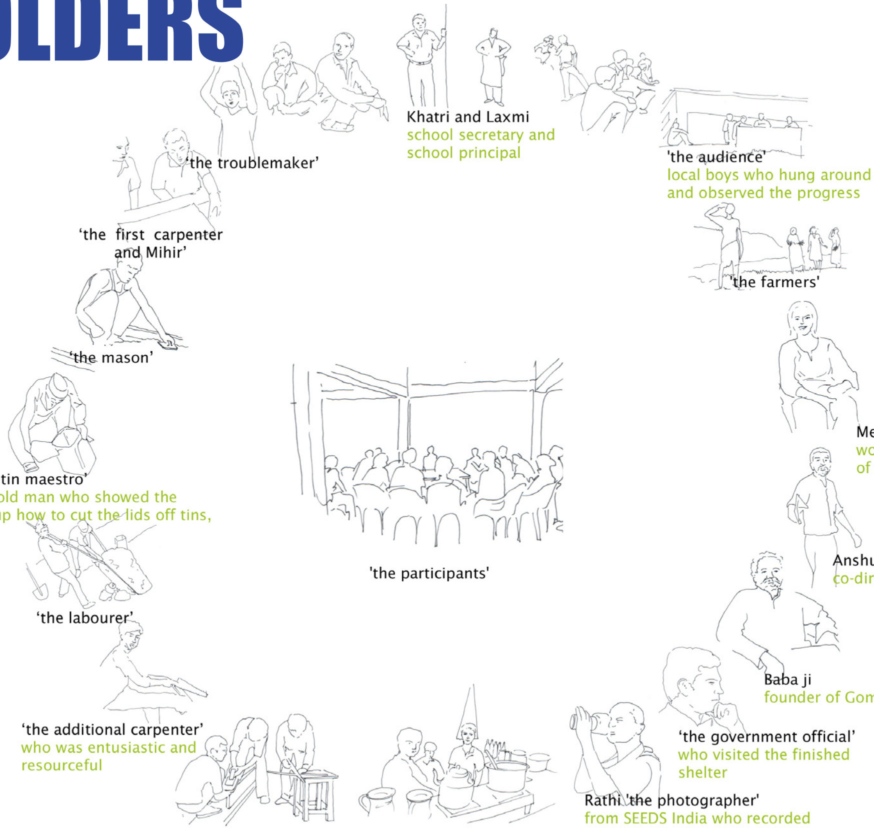

passing cows


danger on the road


group dynamics

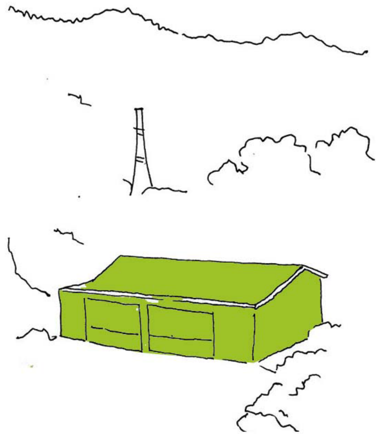

working relationships

STAKEHOLDERS



Many different people were involved in the project, all of whom contributed in their own particular way

post-its with participants' expections that were written down at the start of the workshop



SCHOOL RETROFIT

Retrofitting of the existing school building

The school has been chosen as a place that could be used as an immediate shelter after an earthquake. In order for the building to be used in this way, it needs to be able to withstand the loads an earthquake would put upon it.

A survey of the school showed that the building needed building work to achieve this level of stability in event of an earthquake. Identified weak points were the corners, the column on the south facing side, and the openings in the walls for doors and windows. All of these points need retrofitting.

Once this is achieved, the school could serve as a model example of an earthquake-resistant structure

existing school building seen from across the yard

EXISTING SITUATION

School facilities

• 2 classrooms: 4.2 x 5m each plus a verandah approx 10 x 1.8m
• 80 students between 5 and 15 years
• 8 classes
• All students have the same timetable. In winter between 10am and 4pm, in summer 7.30am - 12am.
• In winter, some lessons are taken outside as it is warmer and lighter in the sun
• Lessons take the format of students gathering on the floor and being taught as a group by the teacher
• Resources for the lesson are blackboards and chalk, and exercise books and pens that the students
bring to lessons
• There is no toilet. There is a tap a short walk from the school building, and the concrete irrigation channels that run around part of the perimeter of the site where students can wash their hands.
• There is little need for storage. Food is not provided, there is not a school store of materials/books and there is no library.
• Only a small amount of daylight enters the classrooms and there is no electricity so no artificial light
• At the front of the school (south side) is a yard used for playing but it cannot be built upon because of an ownership issue.
• At the north side (back) of the school is a previously farmed field site with unstable soil and large boulders. This is currently overgrown and on a slope.
• The school does not seem to be used as a hub for the community. There are no large sports events, plays etc. that take place. The social and cultural group suggests there is more of a private focus on family life in Langasu.

Restrictions

• site - can only really be built upon on top of existing building due to ownership issues of the rest of the site
• access - main access to site is poor from sloping stairs that would not necessarily remain standing after an earthquake if left as is. Access from other direction means crossing a river - easy if able-bodied, not carrying anything. Otherwise hard.
• existing building - extension must not undermine the structural integrity of existing structure, so a suitable construction system must be chosen.
• community - certain materials/construction techniques are favoured in the village as they are seen to be of higher quality/fit in better with the aspirations
of the people in the village. Eg concrete has become the most common construction material in the village. This should be kept in mind in order to have a design sensitive to the social context and local availability of materials.
• earthquake - if this is to be an example school, construction techniques must be chosen that can withstand the loads of an earthquake to E-rating.
• climate - very hot summers, cool winters, heavy rain -> need for control over amounts of daylight and solar gain entering classrooms, as well as ventilation.

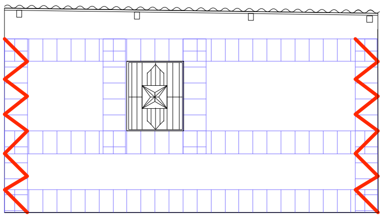
Requirements

• to provide extra teaching space to more comfortably accommodate at least the 80 existing pupils and preferably nearer to 120 (this will be particularly essential if a neighbouring school closes)
• to create an arrangement of spaces that can be used both for teaching and also for an immediate shelter and community gathering/aid point post earthquake: an immediate shelter for 7 days and then perhaps an intermediate shelter for a few families until it reopens as a school
• to provide some more basic facilities - toilets, water.
• all built to withstand earthquakes

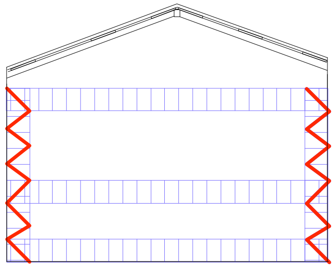
local mason explaining the brick bonds of the existing school building

RETROFITTING PROPOSAL

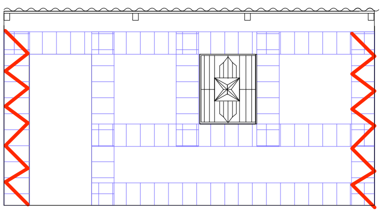
Internal Elevations 1:200 [Classroom 1]



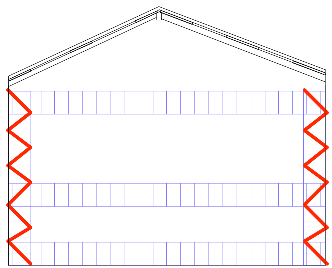
Elevation A



Elevation B

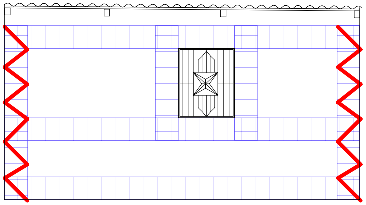


Elevation C

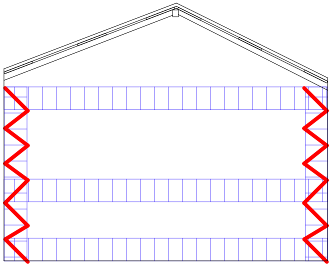


Elevation D

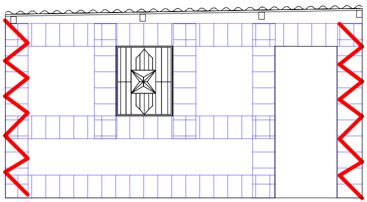
Internal Elevations 1:200 [Classroom 2]



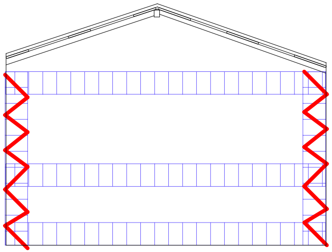
Elevation E



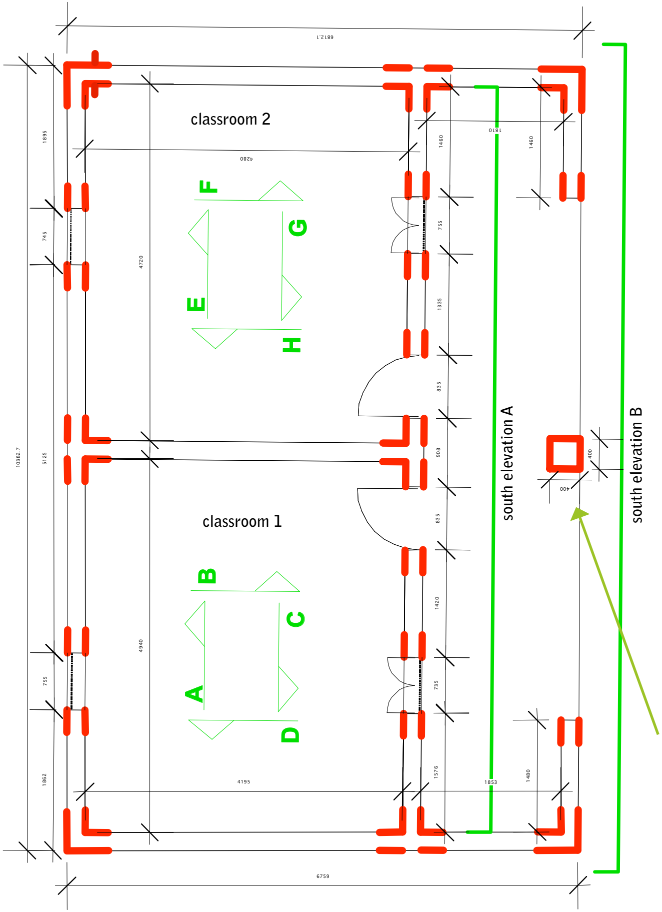
Elevation F



Elevation G



Elevation H



Plan of school showing placement of vertical reinforcement

Plan and south elevation A

Vertical reinforcement and 'through' bonds

'Through bond' elements in wall tie inner and outer belt placed at 1000mm centres and at a 500mm stagger.

Method

Remove bricks in order to create a through hole being careful not to damage the rest of the wall.

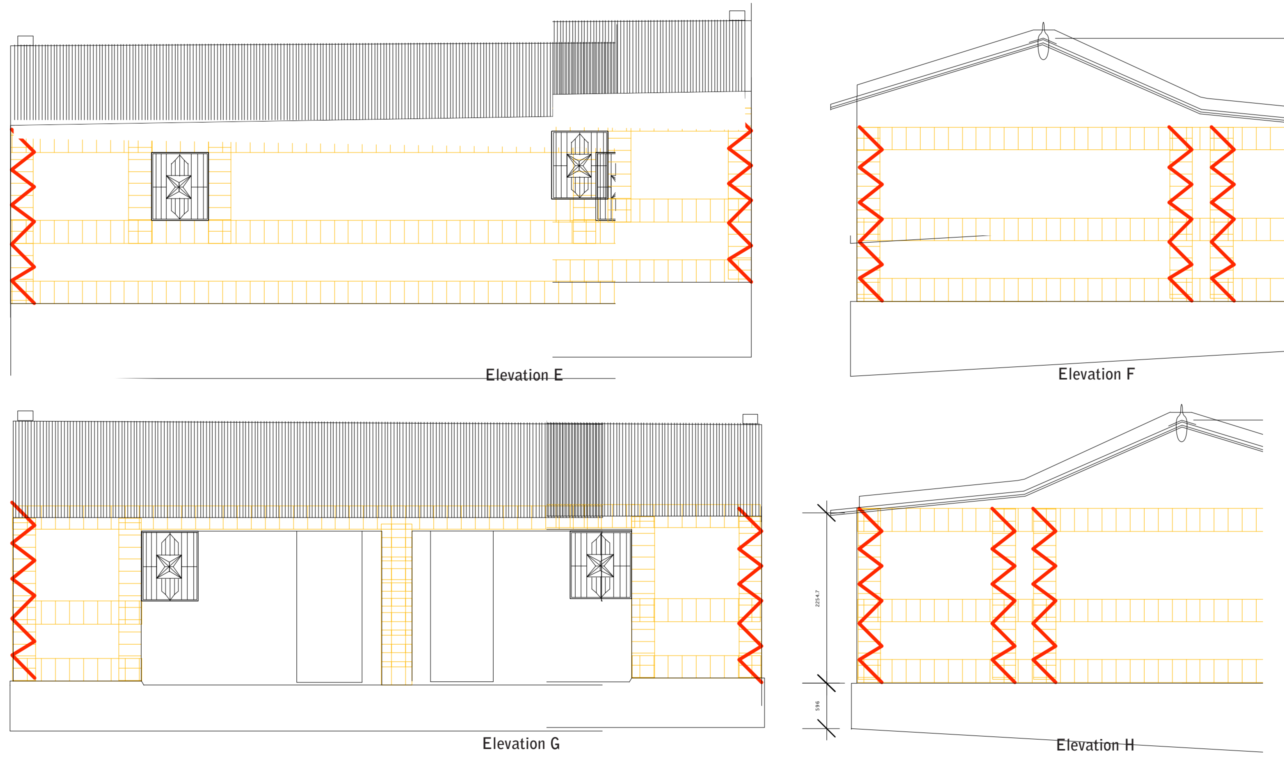
Fix a wooden board on one side of the wall temporarily. Pour concrete of 1:2:4 (cement:sand:aggregate) mix into the hole from the other side to half the depth of the hole.

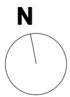
Place 10mm diameter hooked mild steel bar in hole and then completely fill the hole with concrete.

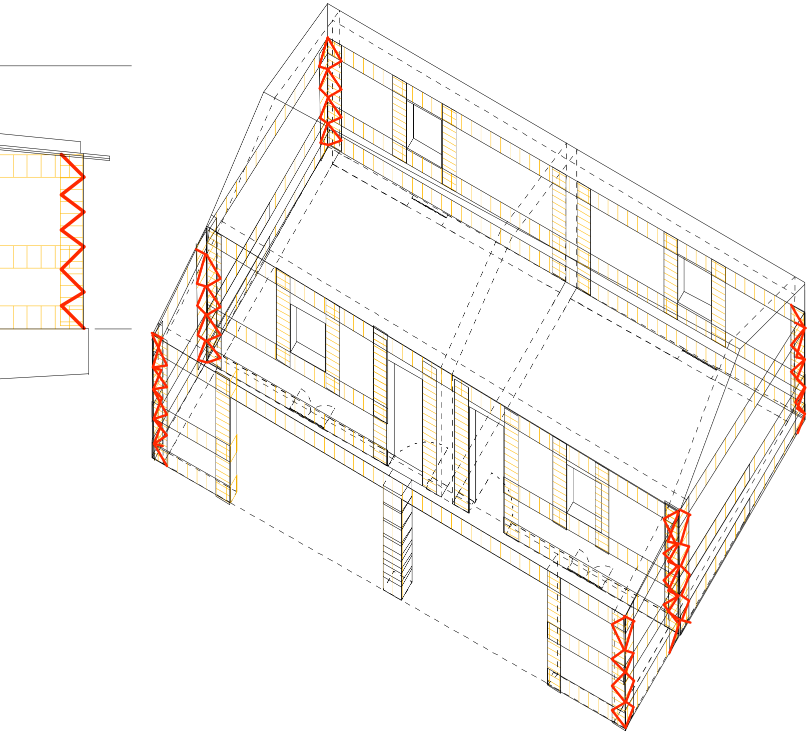
Cure for a minimum of 10 days by sprinkling water on the exposed surfaces of both sides

Note: column to be wrapped entirely from bottom to top in reinforcing mesh.

External Elevations 1:200







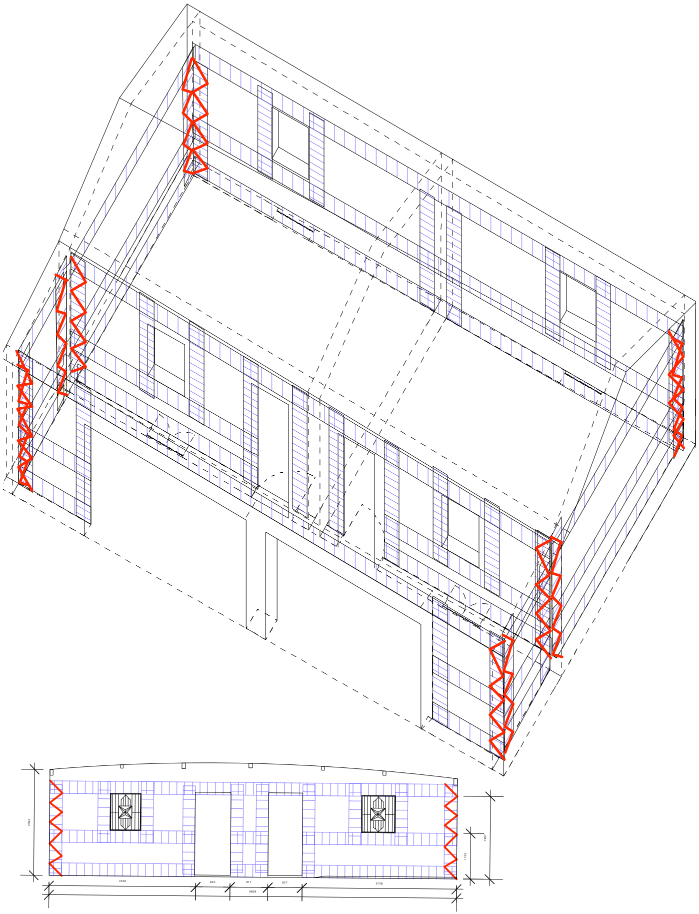
axonometric drawing showing vertical seismic belts(not to scale)

Vertical seismic belt at corners

Vertical reinforcement is required at corners. The width of this belt should be 150mm on each side of the corner.

The reinforcement should be started 300mm below plinth level and continued into the highest horizontal seismic band.

Recommended reinforcement is wire girder.



axonometric drawing and south elevation A showing seismic belts(not to scale)

seismic belts

Seismic belts are to be provided on all walls on both sides above lintels, at plinth level and around openings.

Use 300mm width belt of weld mesh with wires 30mm apart.

Installation of seismic belts:

1. Remove plaster
2. Clean plaster
3. Wet surface
4. Apply neat cement slurry and plaster first coat of 10-12mm thickness and roughen its surface.
5. Fix the mesh with 150mm long nails with large heads at 450mm centres while plaster is still green. Make sure that mesh is nailed internally and externally to 'through' elements (see retrofit plan) where they occur.
6. Apply a second coat of plaster of 15-20mm thickness so that steel as minimum cover of 12mm.

Weld mesh must be a continuous belt - a minimum overlap of 300mm is required when joining two pieces of mesh.

site strategy

Proposed site strategy for use in an emergency situation when the school building has been suitably retrofitted.

CREDITS

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Project credits:

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Picture credits:

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Andrew Edwards	p. 13, 25(2), 29 (3), 37.
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Katarina Dubravcova	p. 22, 27, 33(2), 43(1), 64, 66, 70, 72, 95.
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Rachel O'Grady	p. 18.
Sam Clark	p. 21, 24, 25(1), 28, 29 (2), 30, 31, 33(3), 42(2).
Sarah Ernst	p. 29(1), 33(1&4), 34, 51, 81, 91.
Hannah Price	p. 43 (2).

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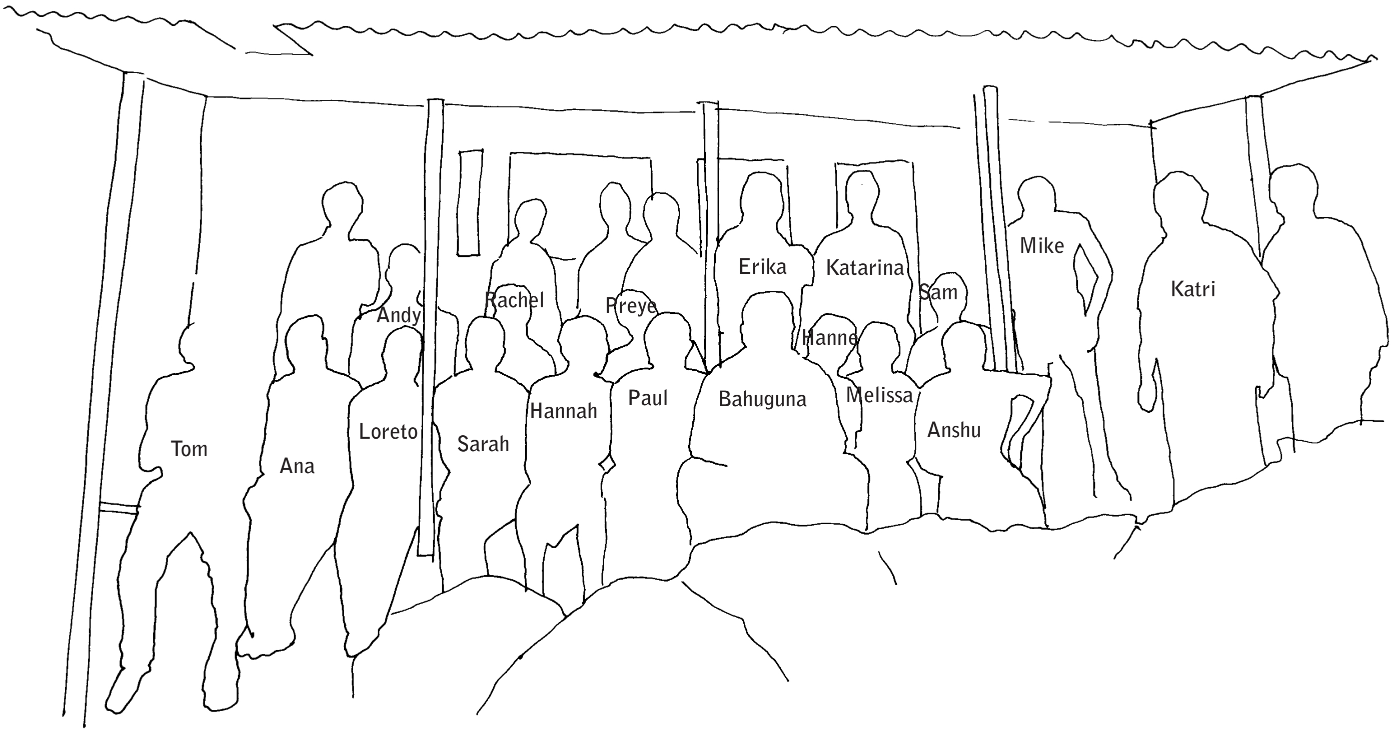

all those involved on the verandah of the nearly finished shelter


MIRACLE
KNIGHTS

architecture sans frontières
UNITED KINGDOM

SEEDS INDIA