



Aga Khan Agency for Habitat

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Safe Housing  
and  
Resilient Communities

*Rural Habitat Development by  
Aga Khan Agency for Habitat India*

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# Foreword

Aga Khan Agency for Habitat (AKAH) India works to ensure that poor people live in physical settings that are as safe as possible from the effects of natural disasters; that residents who do live in high-risk areas are able to cope with disasters in terms of preparedness and response; and that these settings provide access to social and financial services that lead to greater opportunity and a better quality of life. With a mandate to tackle issues related to improving habitats and resources, AKAH India works to improve human habitats, particularly safe housing design and earthquake-resistant construction, village planning and natural hazard mitigation, water supply and sanitation, and improved indoor living conditions, mainly for rural communities. The Rural Habitat Development Program (RHDP) is such an initiative undertaken in rural Saurashtra of Gujarat.

RHDP has evolved over a period of time into a tested model to improve the quality of life of the individual and the community through a safe and green houses and habitat program. RHDP has improved the resilience of the physical habitats of the vulnerable communities along with building resilience within the community and the larger ecosystem. This has resulted in a model of sustainable and green development which is inclusive, participatory, futuristic and replicable.

We hope to scale up the initiative to many more regions and evolve it further into a more comprehensive program which can cater to the entire continuum of habitats, from rural, rural and periurban to urban, and enhance the resilience in human settlements.

Head – Planning and Building  
Aga Khan Agency for Habitat, India

# 01

## The evolution of the Program





**S**ince 1991, **Aga Khan Agency for Habitat, India** (AKAH India) has been working to improve the built environment including housing and sanitation, services and infrastructure and the larger environment.

Post the earthquake at Bhuj (Gujarat) in 2001, which clearly exposed the vulnerability in our built environment, AKAH India actively participated post disaster reconstruction of houses. This enabled AKAH to develop the capacity to build its capacity to address the needs for safe housing and habitat. AKAH India thereby embarked on a mission to address the need for safe, resilient and healthy housing and habitat for the most vulnerable rural communities of Gujarat.

This led to the genesis of a scientific, participatory and resilient housing program called the **Rural Habitat Development Program** in Northern and Southern Saurashtra in Gujarat.

The evolution of the Rural Habitat Development Program took over 6 years.

The Rural Habitat Development Program was first piloted in 2012 at Jivapar (Jamnagar) and then scaled up in multiple location of Northern and Southern Saurashtra, demonstrating multiple typologies of safe housing and evaluating the same with respect to people's preferences, acceptance and affordability to ensure safety and resilience in the built habitat. This process of evolution needed the adoption of a scientific process of defining the needs.

# RHDP Timeline

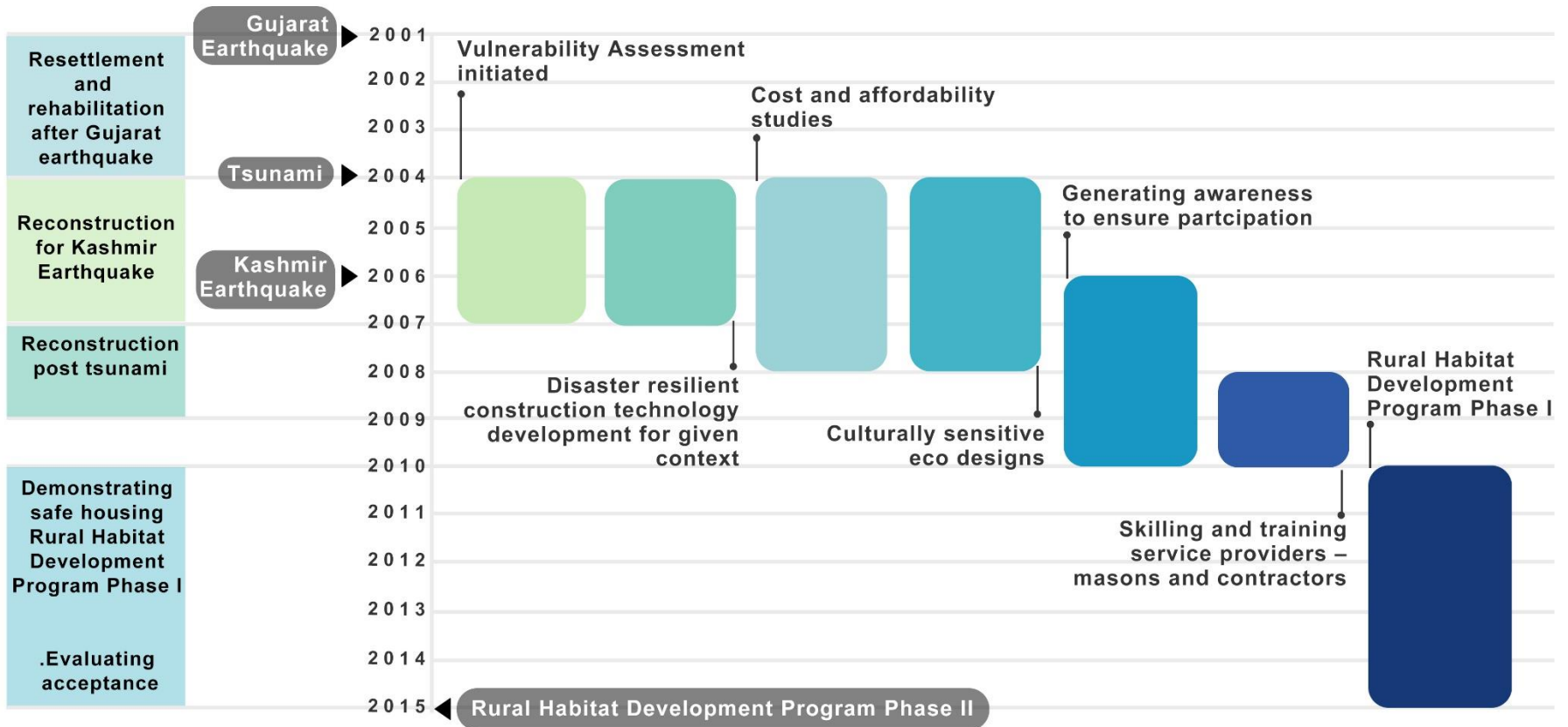


Fig 1.1

As the first step, an assessment methodology was developed with the help of experts to identify structural vulnerabilities and incorporated into a rapid diagnostic tool. This facilitated rapid assessment of structural vulnerabilities in the physical habitats and classification of the structures into three categories of vulnerability - high, medium and low, before the planning for the necessary mitigations. Large scale assessments and access studies were undertaken to develop a comprehensive understanding of needs of the regions in the areas of operation. Based on the findings, the next step was to define the right approach - technology and methodology, to ensure resilience in the housing. The mitigation measures planned were reconstruction and redevelopment of the highly vulnerable structures, which could not be repaired or retrofitted, while the moderately vulnerable structures were identified for repairs through use of latest technologies.



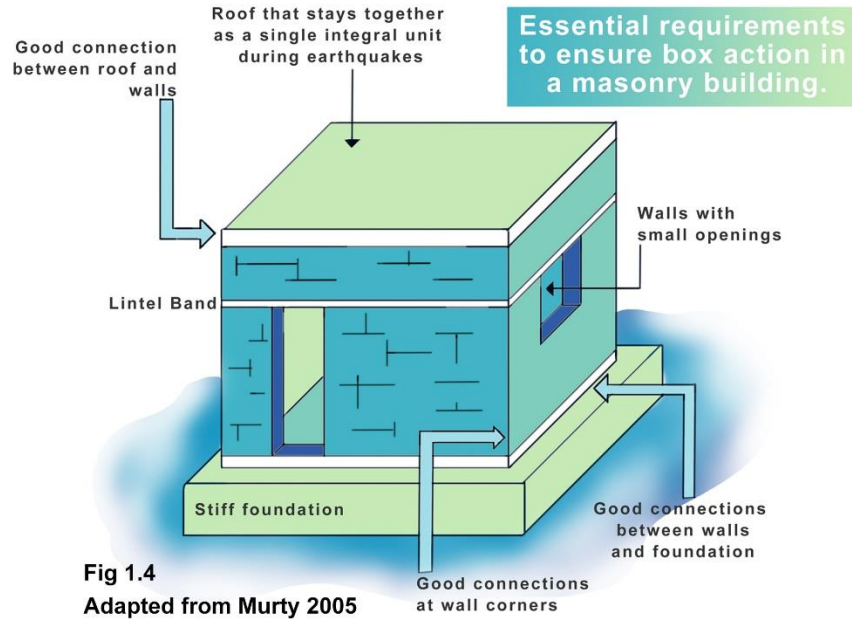
Fig 1.2



Fig 1.3

As a second step towards addressing the need for safe housing, AKAH India engaged with policy think tanks and research groups to define a disaster resilient housing construction and repair methodology for rural housing which adapted to the local risks and natural hazards, practices, preferences, availability of materials and the gaps and needs identified in the local construction sector. This also took into consideration the skills available in the local service providers for the sector.

The two subsequent disasters, the tsunami in 2004 and the earthquake in Jammu and Kashmir in 2006, which caused large scale destruction resulted in AKAH India's participation in the post disaster reconstruction and rehabilitation. This further enhanced the capacity of the teams to understand risks and vulnerabilities and tailor-make solutions based on the vulnerability



**RHDP Timeline**



**Fig 1.5** Chitravad (2016)







To ensure adoption and participation it was necessary to ensure that proposed housing designs retained the identity of the owner and the culture of the place it was sited on since as articulated by the famous architect and founder of Environment Behaviour Studies, Amos Rapoport who said “*house form is not simply the result of physical forces or any single causal factors, but is the consequence of a whole range of socio-cultural factors seen in their broadest terms*”. Hence, existing house layouts and local material supply chains were studied, and disaster resilient features, bio climatic modifications and eco- design principles incorporated into the same to ensure the bridging between the cultural, social and ecological relationships. Green design principles of low emissivity in materials, maximizing space utilization, ensuring energy efficiency through design, onsite water recharge were integrated into the designs. A passive designing approach was adopted where the user and the project team jointly defined the need and layout preferences and this were adopted as project brief to design alternative solutions. This ensured integration of identity and tailoring of specific needs which increased acceptability by the end user.



Fig 1.8 Chitradav (2018)

Daylight levels shown in section

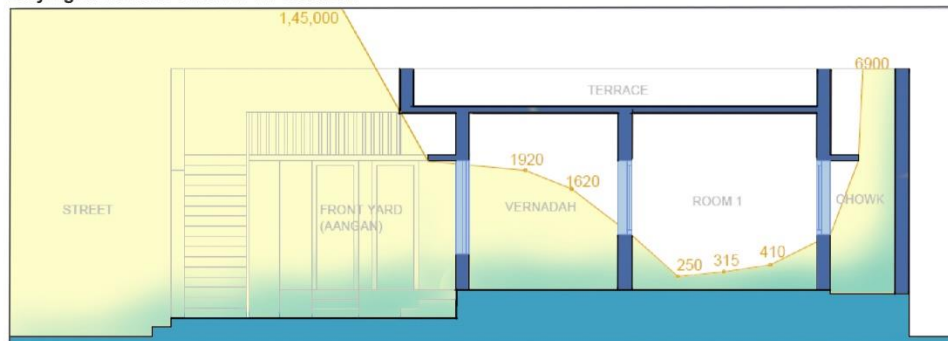


Fig 1.9

Wind flow within the case study dwelling

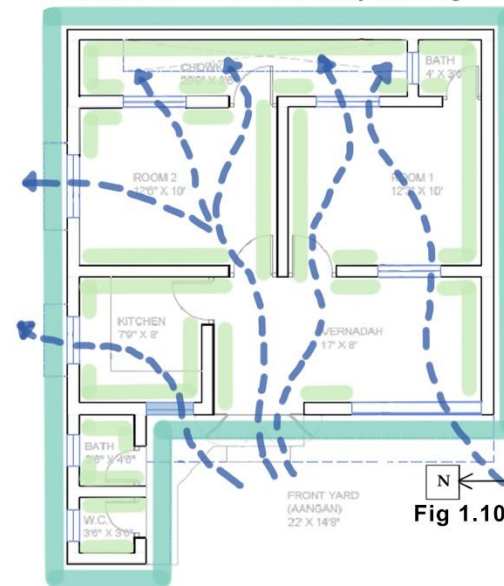


Fig 1.10

RHDP Timeline



Fig 1.11

Participation was identified as the key parameter for success. This required that the identified communities were aware of their vulnerabilities to realize the need for safe housing. Awareness and mobilization sessions were undertaken in various settlements over a period of time. Tools included videos, group discussions by community leaders and experts, developing table top models of houses, community level awareness sessions with open discussions where women were encouraged to voice their views, pilot demonstrations of typologies and designs etc. Counselling support was provided to feasible fund plans and budgeting. To ensure informed decisions the design principles and benefits of safe resilient and healthy housing to quality of life were explained.



Fig 1.12 Chitravad\_Aashiyana (2016)

Building the capacity to deliver required collaboration with local service providers. AKAH India not only built up skills within its own team through experts but embarked upon a skilling initiative for local contractors and mason. Skilling was undertaken through classroom and practical training sessions followed by on the job training during construction of houses to ensure adoption and demonstration of good practices. These certified contractors and masons were then supported to ensure that they could reach out for clarification and help as they spread their practices. Refresher trainings ensured that their newly acquired technical knowledge was sustained.

RHDP Timeline

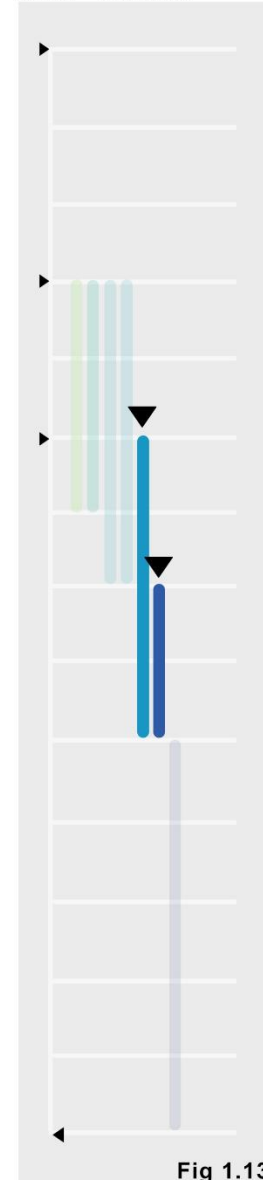


Fig 1.13

AKAH India adopted the approach of establishing proof of concept of the various components of Rural Habitat Development Program to the community through demonstrative projects in different settlements in the identified regions. These **pilot houses** were fully funded through grants provided by multilateral agencies as well as trusts. Low rise group housing for EWS families were demonstrated in Jivapar (Jamnagar, 2012) Surendranagar (Surendranagar, 2014) Babra and Amreli (Amreli, 2015) helped establish the concept of shared resources and ease of living, increasing **access to housing through cross subsidization and community stewardship**.

**Individual resilient housing** construction was demonstrated in Chitravad where sloping roof and bamboo tensile members were introduced to reduce the cost of safe housing. However, evaluation of beneficiary acceptance revealed a evolving preference for flat roof to the traditional sloping roof which and greater preference of individual housing to group housing in rural areas. A total of 50 houses in Saurashtra and over 80 houses in other regions were constructed during this period.

The **second phase of Rural Habitat Development Program**, which evolved over time and was launched in 2015 in three settlements of Chitravad, Sangodra and Haripur of Gir Somnath district in Southern Saurashtra. This was then extended to nine more settlements (Virpur - Gir Somnath District, Amrapur - Junagadh District, Kenedipur - Junagadh, Maliya Hatina - Junagadh, Lathodra - Junagadh, Gangecha - Junagadh, Nani Khodiyar - Junagadh, Zinzuda - Junagadh, Bhalchhel - Junagadh).

The success of the program was clearly seen when requests for design and construction management support were received from less vulnerable sections of the society. The trained contractors further spread the awareness and ensured **adoption of the good construction practices** in their other projects. Thus, a change in local construction practices and techniques ensured that the objectives of the program were sustained over time.



Fig 1.14



Fig 1.15



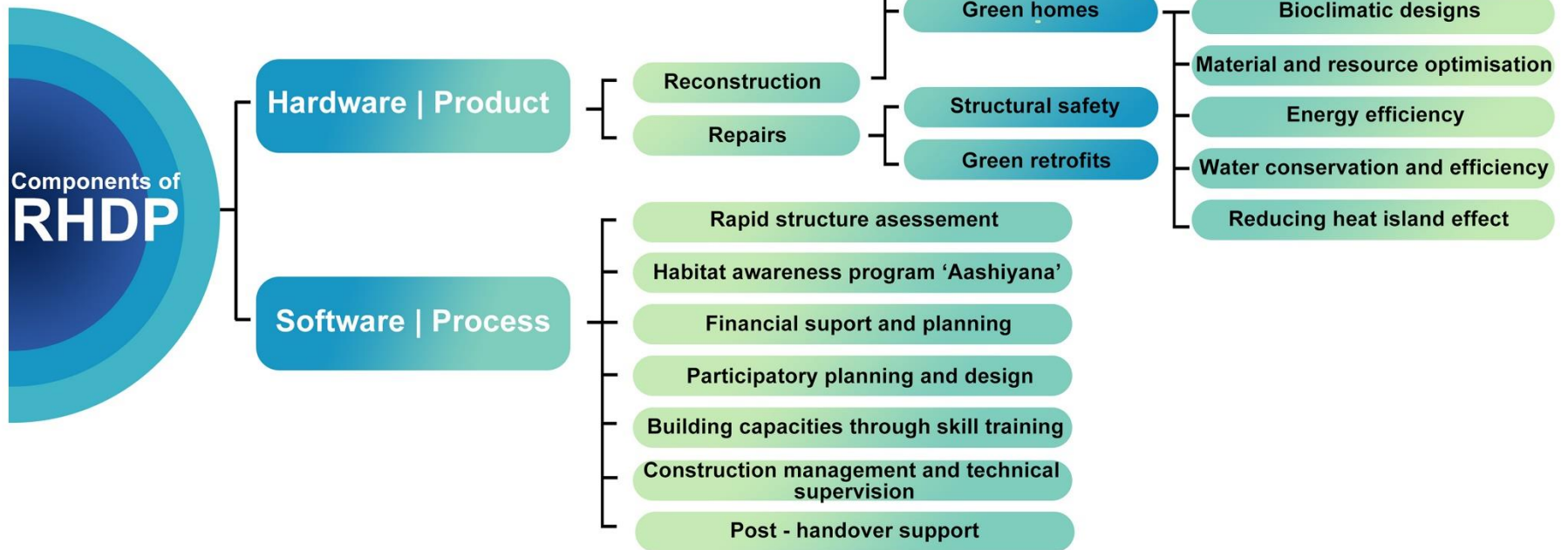


Fig 1.16 Components of Rural Habitat Development Program

# 02

## The context





The districts of Saurashtra Division in Gujarat include Amreli, Bhavnagar, Botad, Dwarka, Gir Somnath, Junagadh, Rajkot, Jamnagar, Morbi and Porbandar.

The region forms a rocky tableland fringed by coastal plains with a central part made up of an undulating plain broken by hills and considerably dissected by various rivers that flow in all directions. It has abundant natural resources, varied topography, soil, climate and hydrology. Saurashtra region is surrounded by Arabian Sea on the south and south-west; Gulf of Kutch on northwest, Gulf of Khambhat and North Gujarat on the east.

The region is fairly well served by road and broad gauge railway lines. Saurashtra region has a well-connected road network.

Rajkot as a center of the region is connected with all the major locations within and outside the state via National Highway 8A, State Highways and District roads.

All the districts of the region are connected with a **single diesel Broad Gauge line** except Amreli. Rail linkage provides connectivity to ports and port led industries.

Ports in Saurashtra like Pipavav, Navalakhi, Mundra, Bhavnagar and Okha are connected with broad-gauge rail network. The airports at Porbander, Diu, Rajkot, Jamnagar and Bhavnagar make the region accessible by air.

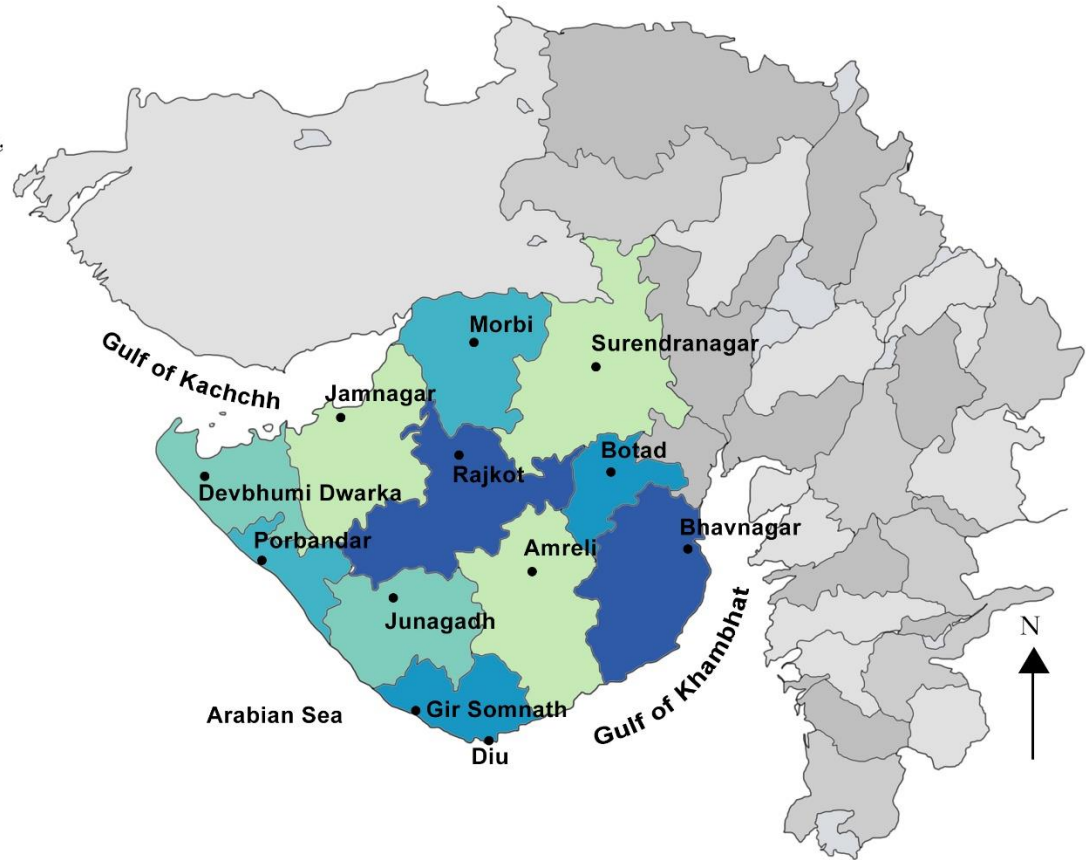


Fig 2.1 Map of Saurashtra

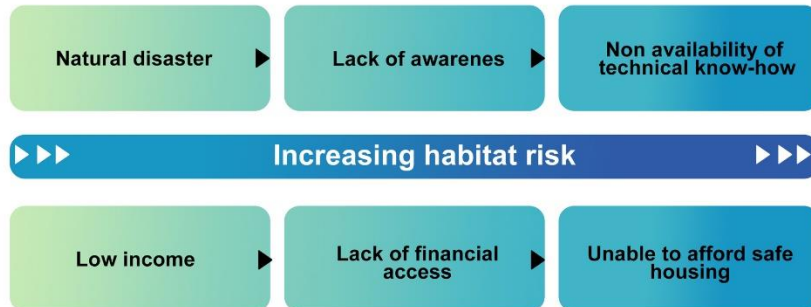
The Saurashtra region is exposed to multiple natural calamities including **earthquake, cyclone, flood, drought, and extreme heat**.

The disruption caused in this region has been because of earthquakes. The region is sited upon a formation of **sedimentary rocks** and **partly of volcanic rocks**.

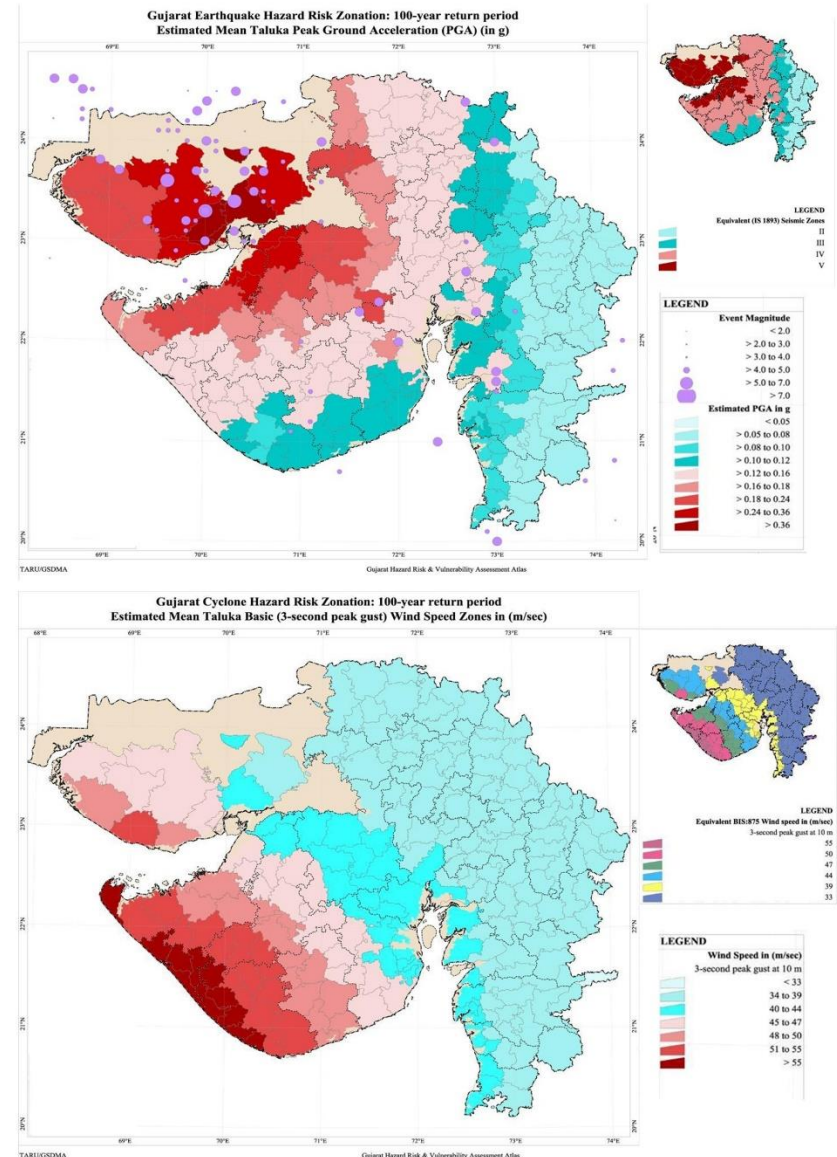
Gujarat is located in the “**Himalayan Collision Zone**” -where Indo-Australian tectonic plate slides under Eurasian plate-causing active fault lines beneath.

Southern Saurashtra is prone to not only earthquakes of **MSK VII** but also **cyclones** with significantly high wind speeds.

Since unmortared rubble, stone and mud masonry with thatched, tiled and or stone roofs have dominated the housing fabric, the hazards have not only had disastrous effect on physical safety of people but also impacted livelihoods and the economy making a dep impact on the quality of life of vulnerable communities.



**Fig 2.3 Factors increasing risks in human settlements of Southern Saurashtra**



**Fig 2.2 Earthquake and Cyclone hazard risk zonation of Gujarat**

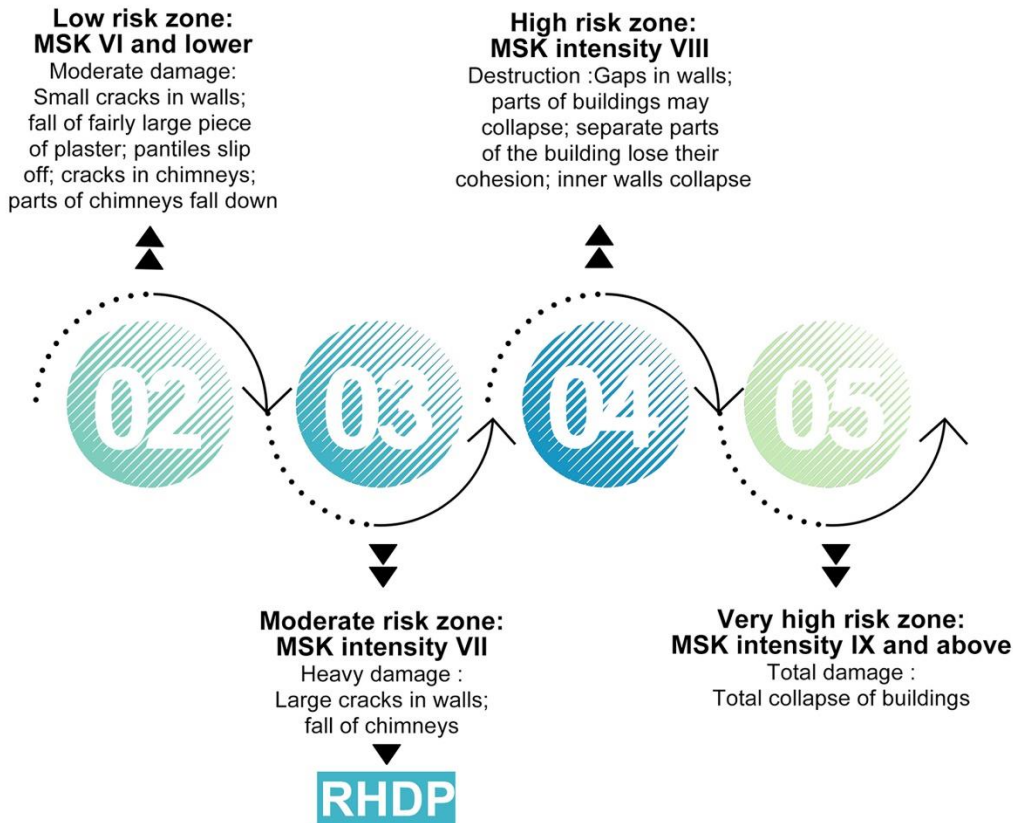


Fig 2.4 Seismic zones and risk classification, India

The **Medvedev–Sponheuer–Karnik scale**, also known as the MSK or MSK-64, is a **macroseismic intensity scale** used to evaluate the severity of ground shaking on the basis of observed effects in an area of the earthquake occurrence.

## MSK VII - Damage to structures:

In single instances there are landslips of roadway on steep slopes; cracks in roads are visible; seams of pipelines are damaged; and cracks in stone walls appear.

**Post earthquake in 2001** of medium intensity in the region, almost all the houses in southern Saurashtra also exhibited **structural distress**

**Some critical reasons for the vulnerability in physical space were identified as:**

01. The quality of construction was very poor and most of the structures were non- engineered.
02. There was lack of awareness among various stakeholders about the seismic risk;
03. There was inadequate enforcement of earthquake-resistant building codes
04. There was lack of knowledge and training in disaster resilient construction methodologies in local engineers, contractors and masons;
05. There was absence of earthquake-resistant features in non-engineered construction lack of adequate preparedness and response capacity among various stakeholder groups



The villages surrounding Gir are in a state of fragile relationship with the natural habitat and surrounding ecosystem in Southern Saurashtra. There has been a change in the territorial preference of lions towards the Greater Gir area due to increased availability of food and water in the surrounding villages. Harsh climatic conditions and lack of food has also led to animal attacks on humans in some parts of the region. Thus the migration of lion population in the human inhabited areas has increased the man-animal conflict in the region.

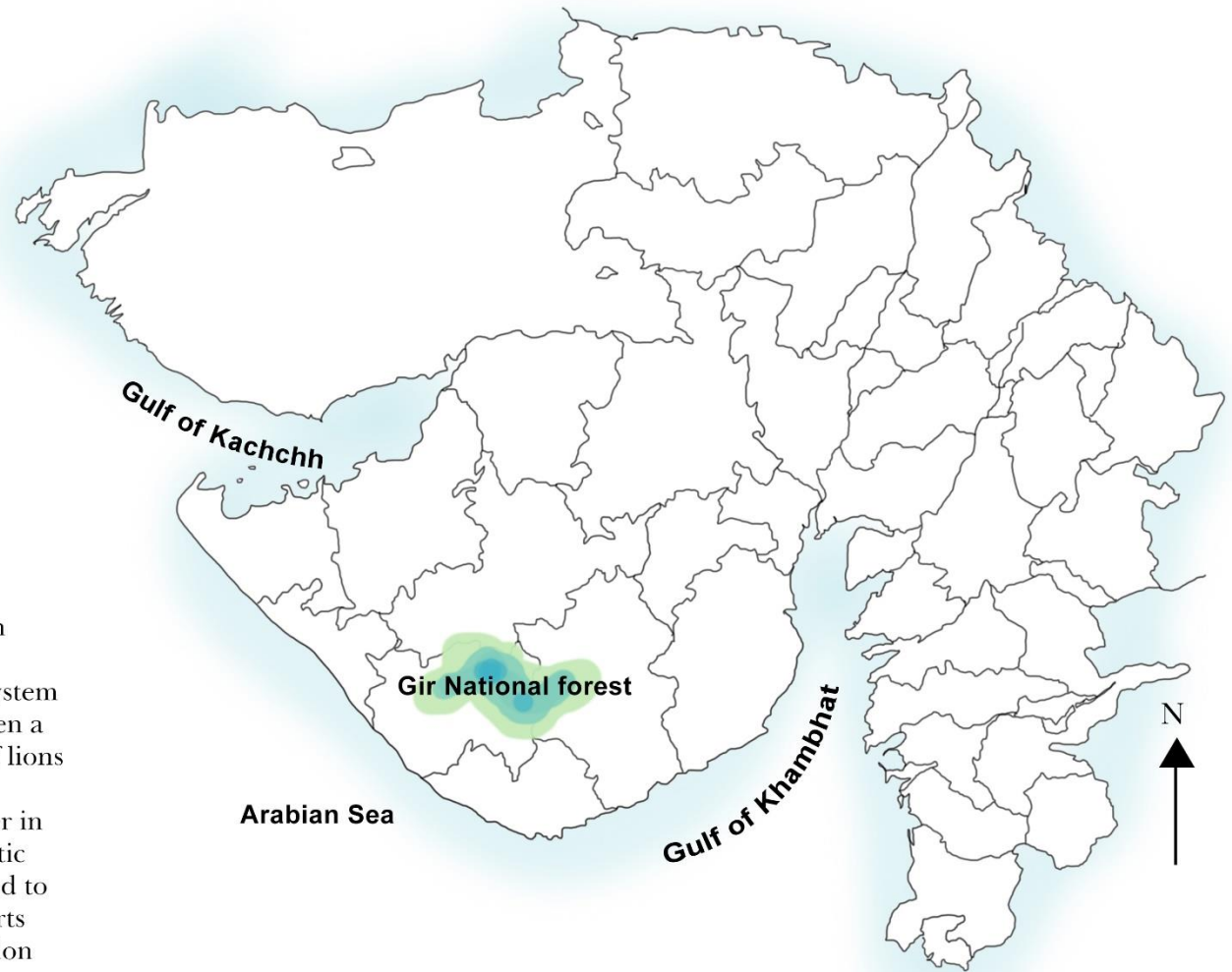


Fig 2.5

## Water supply

The main source of water supply for most villages are local rivers like the Hiran river and wells tapping groundwater. The water supply system generally consists of elevated water tanks and dug wells and handpumps. The water is supplied to all the habitations on alternate days for an hour through a piped water system in most villages. Each household has developed its own storage facility through which they managed to get water throughout the day. Water supply for irrigation is through check dams and individual borewells.

## Sanitation

Most households have individual toilets and wash facilities with lined or unlined pits. A lot of households undertake washing of utensils and clothes in the open standposts with water flowing out of houses onto walkways. There is no provision of drains along the streets resulting in this wastewater accumulation in low lying areas or at some undulating street patches. During the monsoon, the situation worsens as the rainwater from all over the village gets accumulated on these low lying areas

## Waste management

Solid waste management is a key issue in most villages. The door to door waste collection does not exist and the dumping of the waste on open areas (on village periphery or vacant plots inside the village) is a common practice here. The segregation of dry and wet waste is not followed by most of the people and thus the waste remains untreated. The increase in the use of plastic and its open disposal is becoming harmful for grazing cattle. The households with farming as a major occupation use wet waste to feed stray/ owned cattle or dump in the farms for composting. The practice of burning the dry waste (mainly plastic) in the courtyards/ streets is also a common practice.

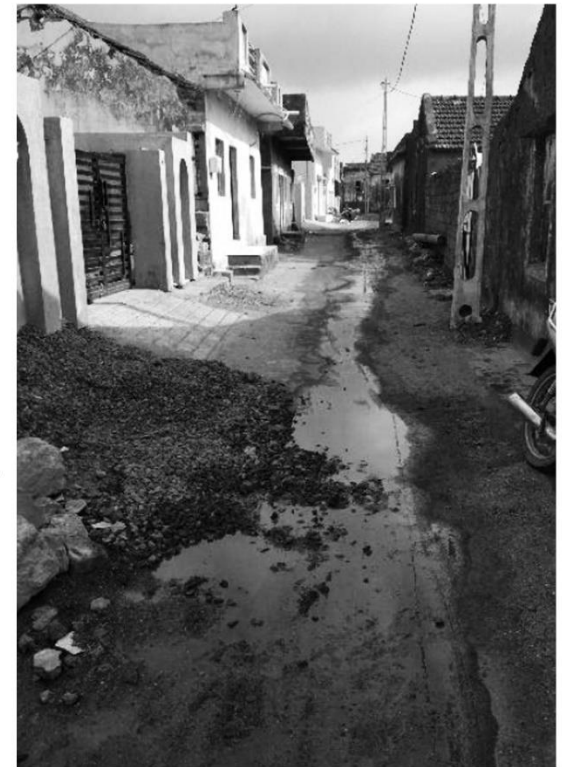


Fig 2.6 Water on streets\_Chitravad (2017)



Fig 2.7 Waste dumping\_Chitravad (2019)

**Open dumping and water accumulation on low lying areas**



The region, today, exhibits a **mix of new and old houses** with ground and one storied height. These houses are closely organized with connecting narrow lanes. The some surviving old structures are majorly constructed with **traditional materials** like bela stones, with very high compressive strength, locally available and bio climatically suitable for the region, and have sloping terracotta tiled roofs. However new houses built by people who could afford to reconstruct show a clear preference for the use of cement blocks/bricks and cement for walls and concrete for construction of flat roofs.

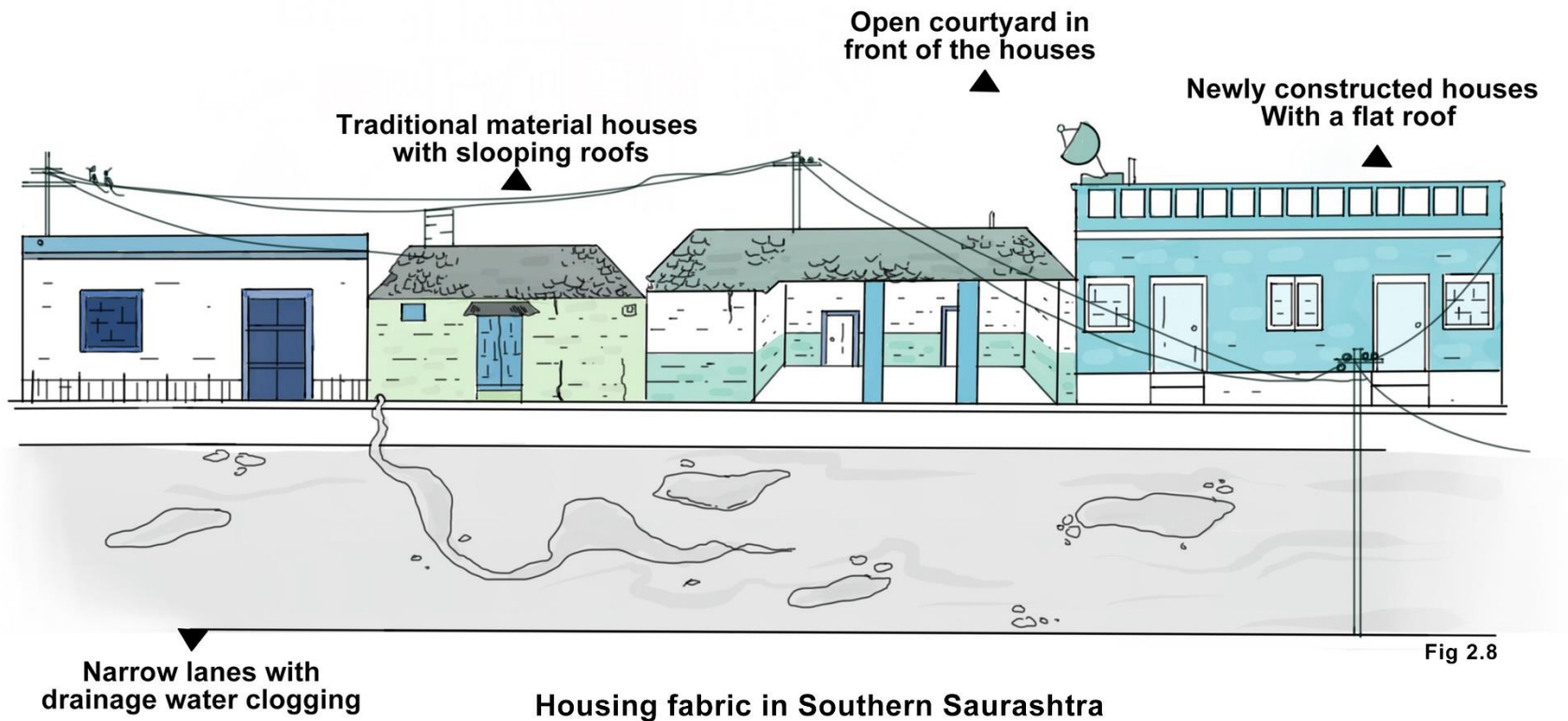


Fig 2.8

- Due to the **dislodging of rubbles and stones during tremors** the vulnerability of the safety of the residents was compromised due to falling rubble, walls and sometimes collapse of part or whole structure. Vertical and diagonal cracks during tremors due to improper corner bonding were seen widely.
- Due to the **improper laying of mangalore tiles** for sloping roofs which requires skilled workmanship for proper finish, tiles were often **dislodged during cyclones resulting in leakages and seepages**.
- For newer constructions with blocks/brick, cement and concrete, absence of adequate foundation, tie beams, corner bonding, adequate and proper use of steel, and improper casting of RCC roofs have resulted in similar and in some cases more severe structural vulnerability and unsafe living conditions.



Fig 2.9 Dislodging of rubble and stones\_Chitravad (2017)



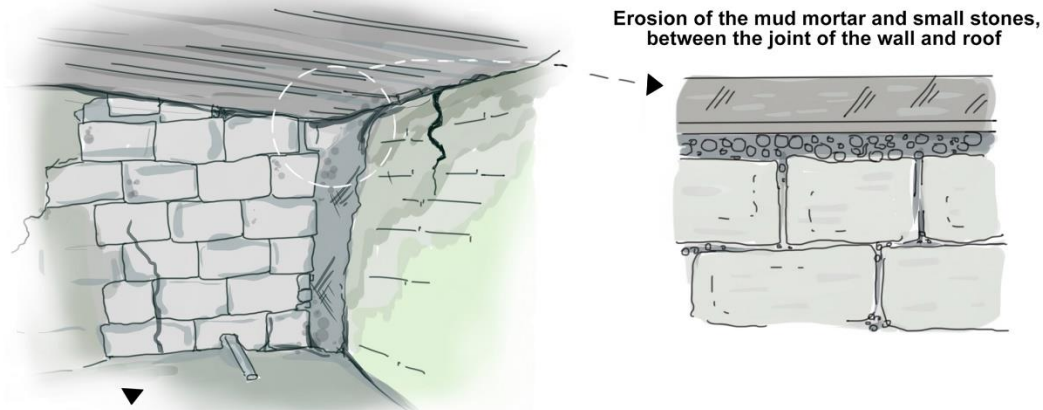
The traditional housing structures with non-mortared loose rubble masonry and mud mortared stone often resulted in severe financial burden due to need for frequent repair and maintenance and sometimes reconstruction. Some of the **traditional and newer construction practices which increased structural vulnerability** were:

- **Poor foundation** in most of the structures leading to structural vulnerability during medium tremors frequenting the region.
- Wide usage of **random rubble** and **mud mortar for walls** resulted in leakages during cyclones and monsoons leading to the mud mortar dropping off from the wall which in turn causes seepage, unhealthy living conditions and structural deterioration.



Fig 2.10 Dislodging of rubble and stones\_Chitravad (2015)

Fig 2.11



The layout with **open courtyard** in the front of the house which is surrounded by high compound walls provide **multi use space** for family gathering, sleep outs during summer nights, many household activities and safe space for livestock, well protected from wild animals foraging in from the nearby Gir forest. Most of the houses have **secondary entrances** which open directly onto lanes with further provisioning offer community level 'otla' or small community level congregation spaces.

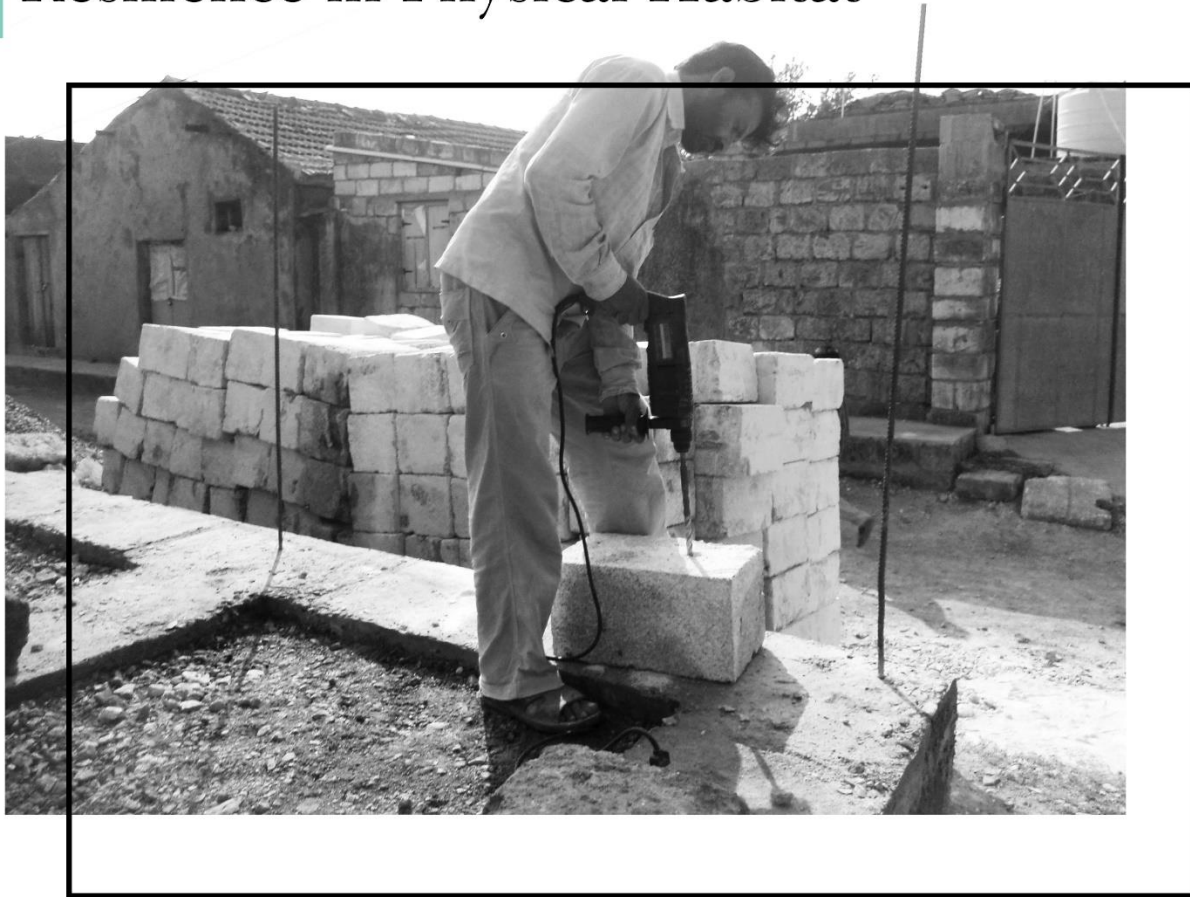
Fig 2.12





03

## Resilience in Physical Habitat





# Rapid assessment of structures

Approach adopted for developing resilience in the physical space and the residing community:

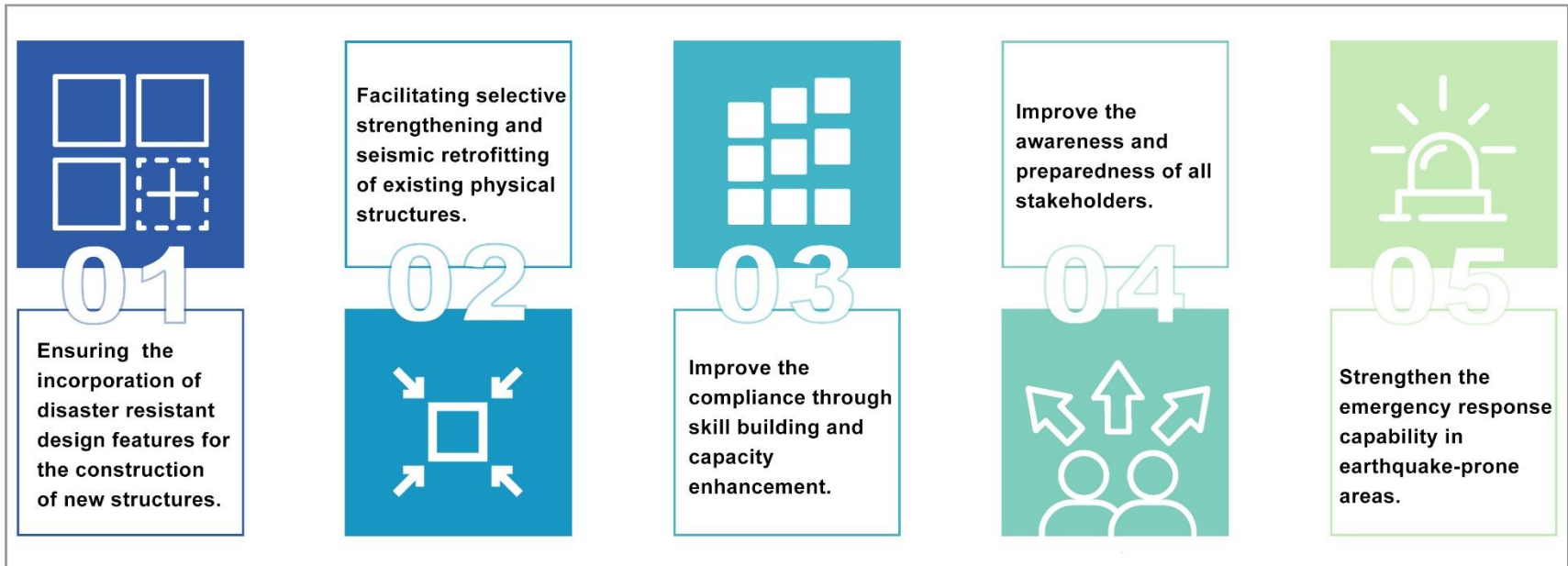


Fig 3.1 Approach adopted for physical resilience

The Rural Habitat Development Program by AKAH India has envisioned a resilient housing construction and improvement of the region through participatory housing reconstruction and repair with each house serving as not only a safe place to live in but a demonstration of disaster resilient construction technology and a training ground for the local service providers in the construction space. Each new construction was also the medium for generating awareness in the wider community towards larger habitat issues affecting quality of life.

## A rapid assesement was undertaken to identify the structural vulnerabilities in the region

01. Developing inventory of existing built environment
02. Assessing inventory of construction through rapid structure diagnosis tool
03. Prioritising vulnerable structures
04. Developing seismic retrofitting measures
05. Undertaking retrofitting to strengthen vulnerable structures

Fig 3.2 Rapid assessment of structures

An assessment of structural vulnerabilities that had emerged in the housing structures in the region post the Bhuj earthquake were first assessed in 2003 and 2004. Though the region had not suffered critical damage during the earthquake in 2001, being in seismic zone II I and away from the epicenter, structural vulnerabilities which could lead to unsafe living conditions could be seen. A more structured assessment undertaken through the tool which was subsequently developed –Rapid Structural Diagnosis, a visual assessment tool to be used by a pre-trained technical team.

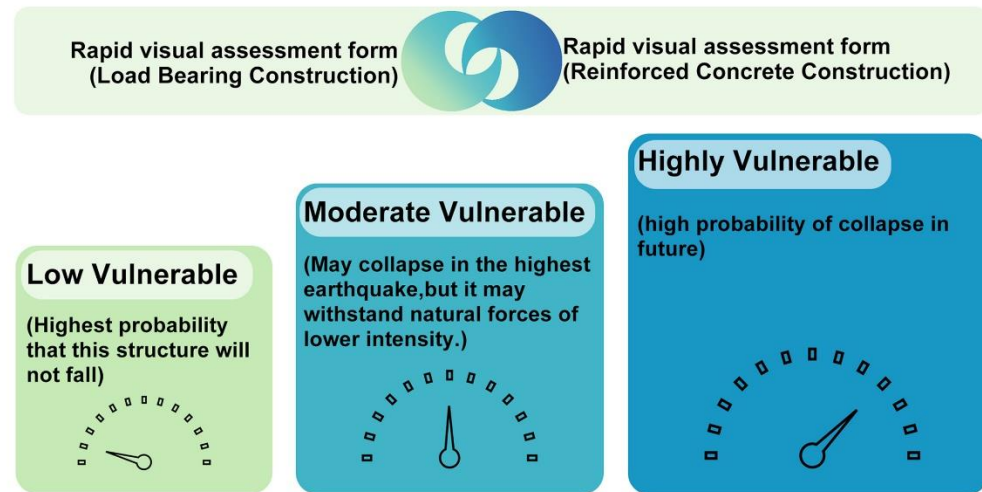


Fig 3.3 Structural vulnerability classification

Eventually over a 219 housing structures were identified as moderately vulnerable and highly vulnerable structures in the three villages were the Rural Habitat Development Program was initiated.

The missing links in the vernacular construction were identified as absence of strong foundation, raised plinths, symmetrical construction and cantilever, ductility, proper binding and connection between structural systems of the housing units.

# Reconstruction of highly vulnerable houses

The process adopted for reconstruction of highly dilapidated structures is as follows:

## ► Defining the need:

01. **Documentation** of the **existing house** to ensure existing activities and functionality are recorded by the field project team.
02. Land **ownership documents** are scrutinized and verified and documented for record.
03. **Joint definition of user needs** is undertaken, and all family members are encouraged to participate in the process to ensure the definition is inclusive and meets current and future needs.
04. The architect makes **alternative plans (3 options)** addressing the needs and ensuring the quality of life parameters are met.
05. The **plan is finalized** with the user and signed approval of the user is taken to ensure agreement to the next stage.



Fig 3.4 Housing conditions, Gangecha village (2019)

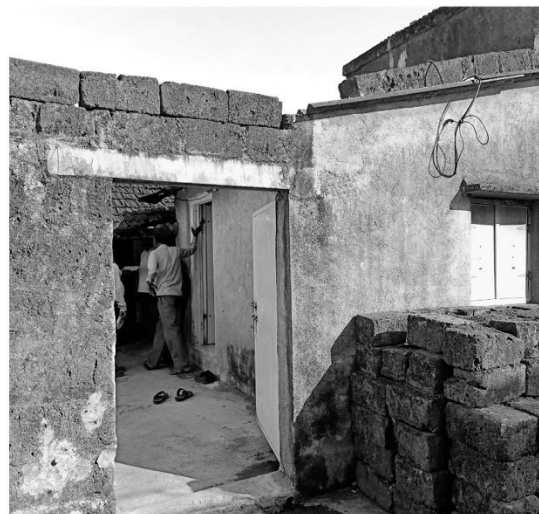


Fig 3.5 Housing conditions, Gangecha village (2019)



Fig 3.6 Housing conditions, Gangecha village (2019)



## Resilient construction features



Fig 3.7 Foundation\_Chitravad (2018)



Fig 3.8 Corner reinforcement\_Chitravad (2018)

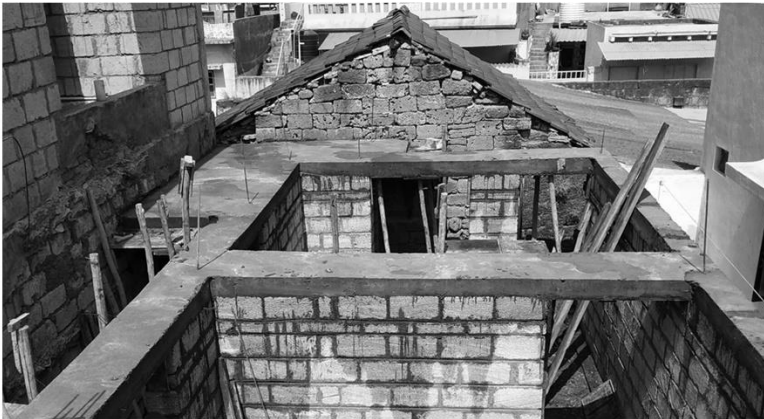
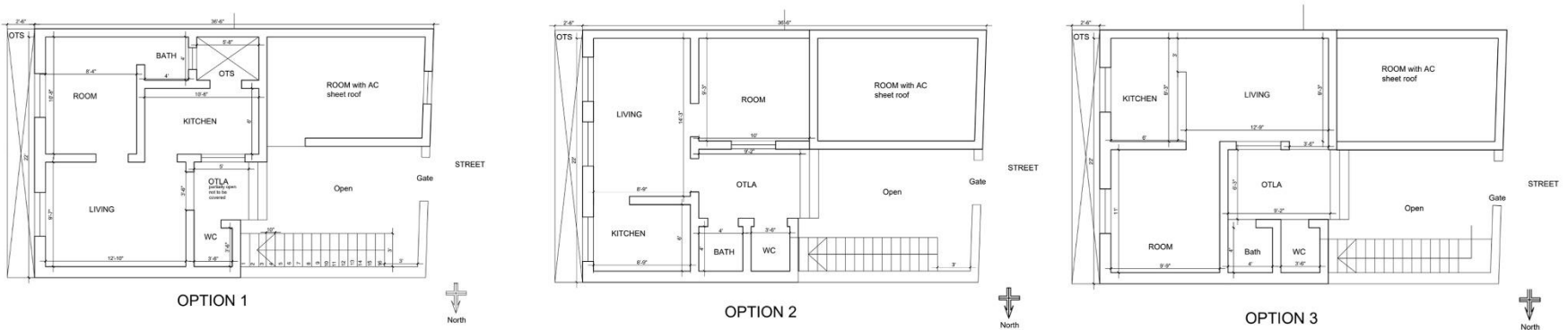


Fig 3.9 Lintel\_Chitravad (2018)



Fig 3.10 Slab\_Sangodra (2018)

**Fig 3.11**  
**Three alternative designs options for the same structure.**



## ► Planning and Design:

06. The finalized plan is reviewed and further refined. Lighting and ventilation, circulation and universality of design to ensure unhindered movement, interior layouts and electrical and plumbing layout are incorporated by the architect.
07. Structural design ensures optimized and strong foundation, raised plinths, corner ductility and reinforcement, reinforcement in opening, buttressing of long walls, plinth lintel and roof beams with reinforcements. Structural details to ensure connections between structural systems – foundation, plinth, walls and roofs are carefully incorporated. Value engineering is undertaken to ensure cost effectiveness, reduced emissivity and green construction by structural engineer.
08. Working drawings of architectural and structural designs are made by inhouse architect and engineer.



**Finalised design**  
**Fig 3.12**



## ► Construction management:

09. **Estimation of construction cost** is shared with the beneficiary
10. **Funding plan** is discussed and fund flow is agreed upon to ensure quick construction. Documentations needed for the subsidized components is undertaken and necessary approval of the funders taken through a predefined process.
11. **Identification of the contractor** is done by the beneficiary based on the recommendation by the project team. Pretrained contractors and masons are given preference.
12. **Inventory of quality material suppliers** and recommended **brands** for cement and steel are shared with the beneficiary. Alternative palette for interior finishes are recommended to the user as per users preference and purchase capacity.
13. Regular **site supervision**, material quality monitoring and on job training is undertaken by trained supervising engineers. Certification of materials, inventory management, proper stacking, workmanship, adequate curing and other details are ensured.
14. A **three stage quality assurance and quality control protocol** is adopted. Regular site supervision through trained site supervisors is further monitored intermediate checks and visits by the project manager who also is present during beam and slab constructions. Regular **weekly reports** including photographs of predecided critical elements are sent to the structural engineer and architect. Intermittent monitoring visits by the designing team and team head ensures that quality assurance and control standards are strictly adhered to.
15. **Site safety** is given utmost importance. The contractor is mandated to ensure that safety jackets and safety helmets are available for its masons and laborers.

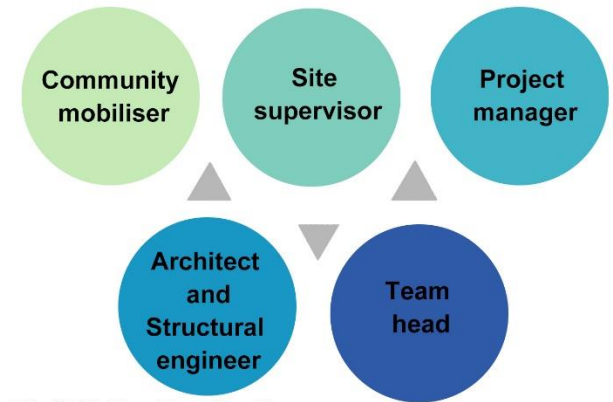


Fig 3.13 The Housing Team



Fig 3.14 Mandatory use of helmets and jackets for all personnel



# Repair and Retrofit of moderately vulnerable houses

Repair and retrofit are undertaken for structures identified as moderately vulnerable due to factors like:

01. Developing leakage or seepage of water into the structure resulting in deterioration of materials
02. Developing of minor nonstructural or structural cracks with potential of increase in future

Critical components for repair of moderately vulnerable structures includes **waterproofing** to prevent leakage and further deterioration of the structure, **roof water downspouts**, **adequate plastering of walls** and ceiling to prevent seepage of water and corrosion of reinforcement, **repair of cracks** with appropriate technology including stitching, meshing and grouting etc., **corner reinforcement** and **tying of structural elements** through meshing, bracing if required in short sections or buttressing of long span walls.

**The process adopted for repair of moderately vulnerable structures includes:**

01. Identification of structural stress through detailed inspection of the structure
02. Identification of the repair methodology and explaining the same to the house owner
03. Supporting the owner in cost estimation
04. Training the mason identified for repair by the owner on site.
05. Technical supervision the repair work till completion of work



Fig 3.15 Sealing of crack Chitrad (2019)



Fig 3.16 Using steel mesh for structural strengthening Chitrad (2019)



Fig 3.17 Treating the cracks before re-plastering Chitrad (2019)

# Training local service providers

The role of training service providers in the local sector was a **critical success parameter** to ensure the achievement of objectives set out for the Rural Habitat Development Program.

In order to ensure that there is availability of trained masons and contractors in all parts of the region, AKAH India initiated a **construction skill training program**.

By certifying the participating contractors and masons through its own certification process, AKAH India provided a **market of skilled contractors and masons** to house owners who could access, negotiate and appoint them for their constructions and repair.

Continuous interaction between Beneficiary, Masons and AKAH team during the process of construction and repairs.

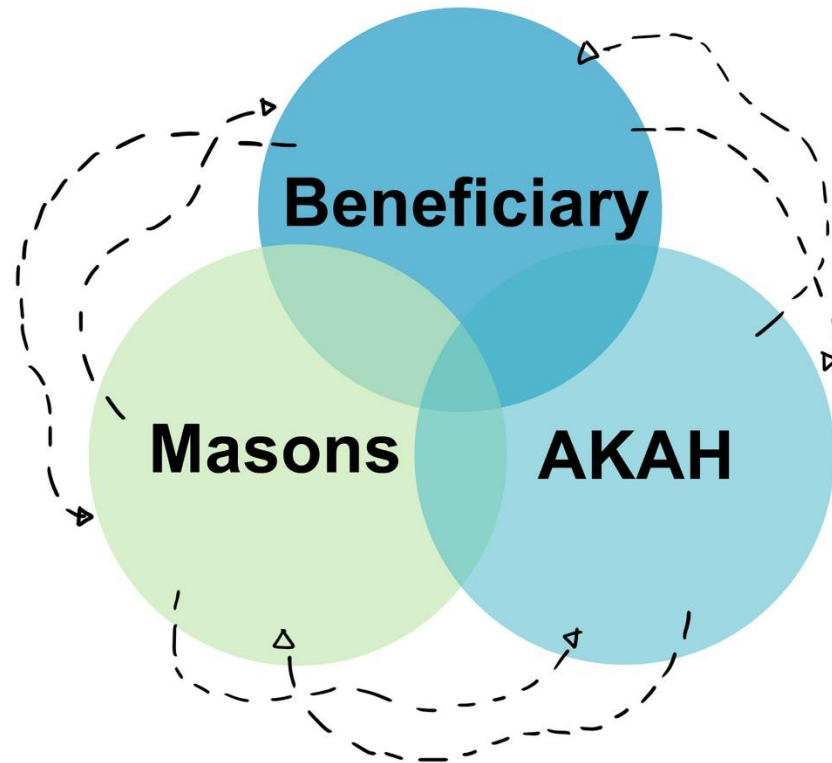


Fig 3.18 A partnership approach in housing delivery

## Three training mediums were used for training of masons:

**01 Classroom teaching** through use of models, audio visual mediums like drawings, videos, whiteboards etc, discussions and query addressal. **Access to experts** in such informal setup helps in building strong relationship between the trainer and the trainees and helps better communication. Vendors and suppliers of materials and fixtures have been encouraged to participate in such classroom training.

- a. Bite-sized, vernacular language training and informal training setups helps in better absorption of the information and knowledge.
- b. Disaster resilient features and their significance, are discussed.
- c. Various repair methodologies and their outcomes are shared.
- d. Electrical layout and plumbing layout, jointing, use of right products and fixtures help in addressing the gaps in associated services.
- e. Right materials need for using branded and quality products, material selection and certification are addressed during the trainings.
- f. Estimation, quoting for work, documentation and recordkeeping are taught.



Fig 3.19 Mason technical training indoor session\_Chitrad (2019)



## 02

**Practical training** in a yard to demonstrate

- a. Right use of construction equipment,
- b. Bar bending and reinforcement, estimation of steel length and cutting of steel to reduce wastage,
- c. Mixing proportions and methodologies to ensure right mix and reduce wastage, etc.
- d. On the Job training on mixing of mortar, laying of stones, corner overlaps, corner reinforcement, good practices in plastering, casting, curing etc.



Fig 3.20 Mason training on Beam reinforcement bending, as a part of on-site practical session\_Chitradvad (2017)

## 03

**Soft skilling** is an integral part of the entire skilling process where knowledge is imparted on making accurate calculations, factoring in contingencies and making good estimates and bids, accounting and record maintenance, documentation and applying for government projects. **Informal federations and networks are created** to ensure that members can help each other in quick resolution of queries, support during crises, share acquired knowledge on technologies and products and thus form an informed workforce.



Fig 3.21 Mason making Polymer Modified Mortar\_Chitradvad (2019)

**Safety trainings** are mandatory component of each training module.

Safe practices in handling of materials, scaffolding, use of safety helmets, and jackets, common accidents and precautions, first aid and role of coworkers etc are discussed in detail and recommended for mandatory adoption in AKAH projects.

---

The construction skilling has not only benefited the projects undertaken but also helped the local masons and contractors to upgrade their skills, apply the same in other projects as well as bid for larger projects.

Some masons have built in their own practices as contractors and thus new enterprises have emerged.

Vendors and suppliers have benefitted through increase in customer base and trust in products



Fig 3.22 Mason training\_Chitravad (2019)



# Quality assurance and quality control

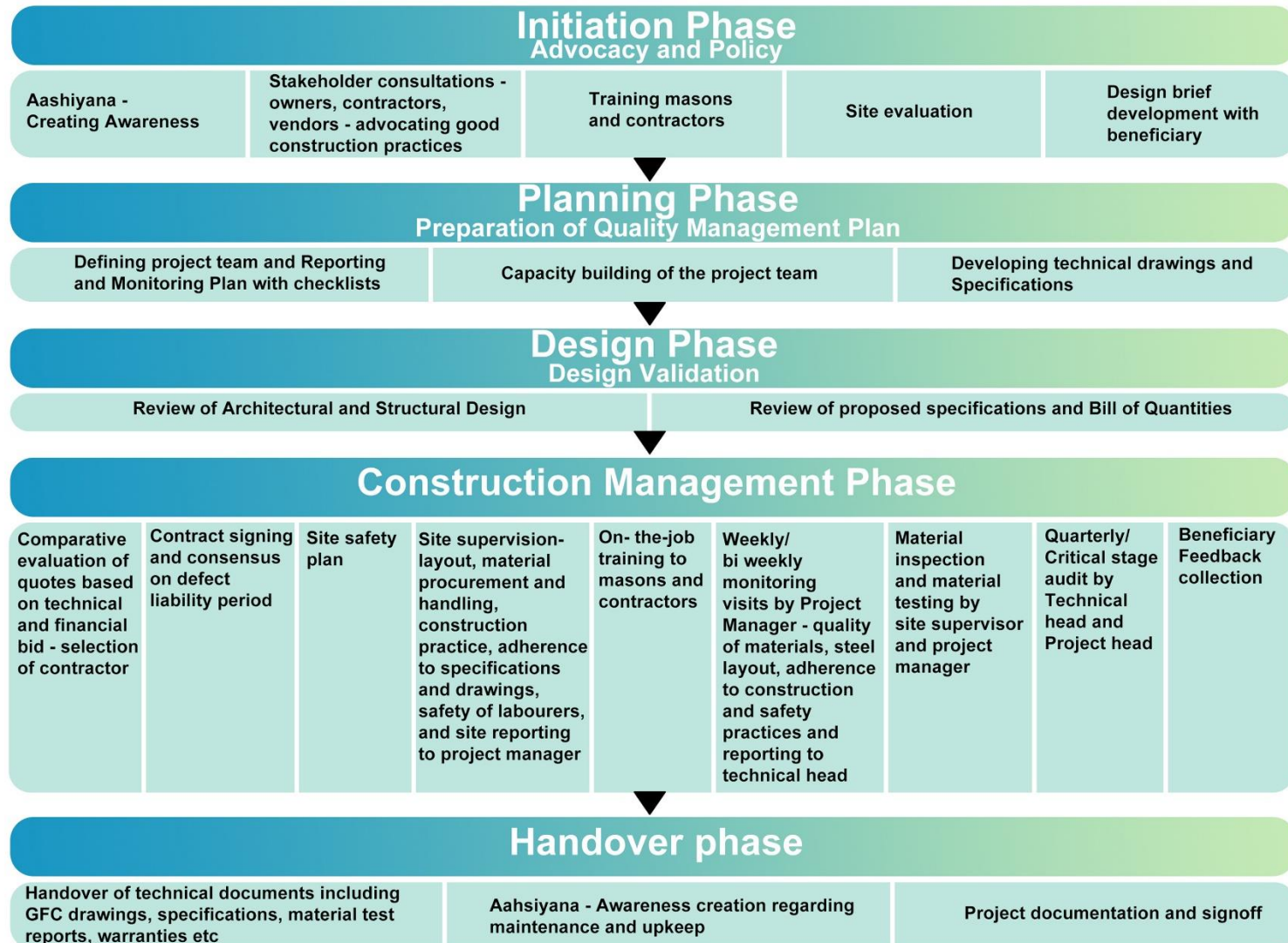


Fig 3.23 Ensuring quality in housing construction



# Green Homes

Resilience in housing is factored in not only structural safety but also resilience features for the changes in climate and the need for **resilience from climate change parameters** like heat waves, excessive precipitation, water and energy stress and increasing conflicts with the local ecosystem.

Rural houses were hence conceptualized to factor in traditional construction practices, cultural preferences as well as sustainable development parameters to ensure a **green development**.

01. Bioclimatically suitable design for green homes
02. Material and resource optimization
03. Energy efficiency
04. Water conservation and efficiency,
05. **Reducing heat island effect through cool roof tops**

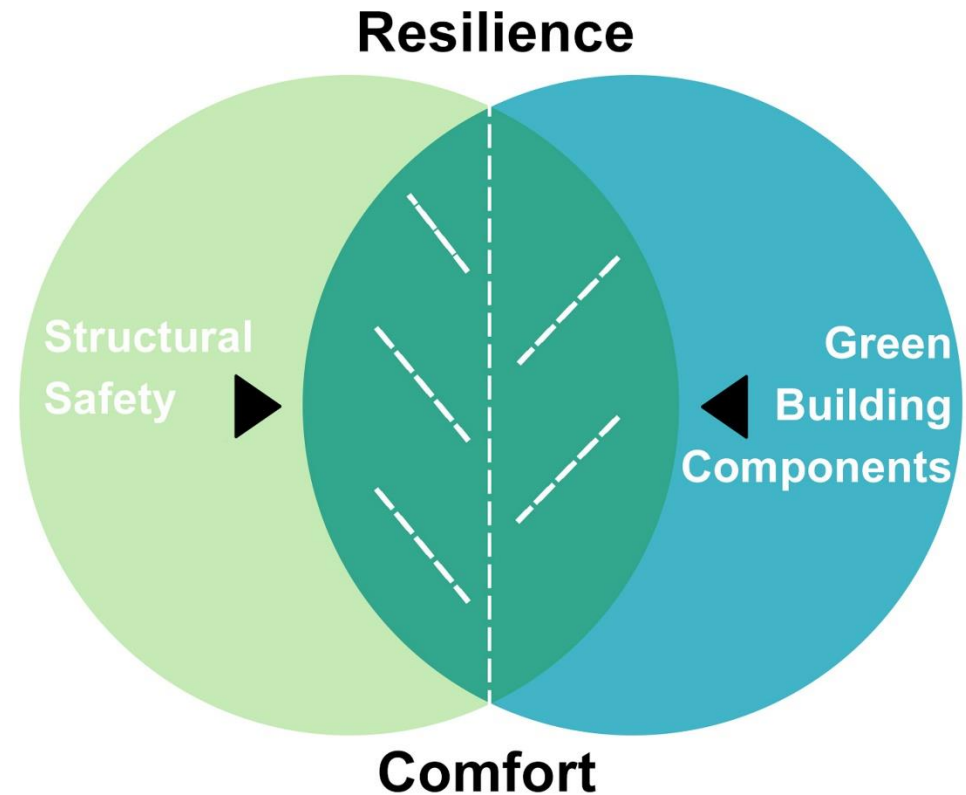


Fig 3.24 Adapting to Climate Change

# 01 Bioclimatically designed green homes factor in many eco design features in its form and fabric.

Bioclimatically suitable design features including orientation based on sun path, optimising daylight and ventilation, ease of circulation and pervious open courtyards.

**Design feature 1:** Orientation of the house to reduce heat gain from the west through provision of deep verandah

**Design feature 2:** Optimizing daylight penetration by ensuring adequate windows and provision of chowks

**Design feature 3:** Provisioning for natural ventilation through open to sky elements built into the design to provide cross ventilation in most rooms

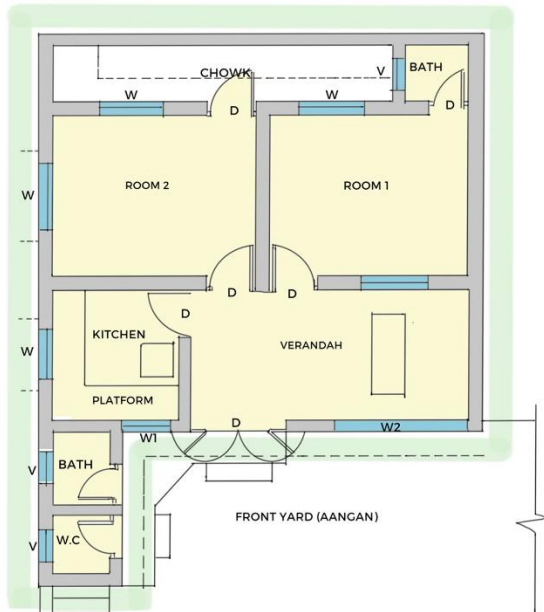


Fig 3.25 Bioclimatic design feature: Orientation



Fig 3.26 Design feature 2\_Chitravad (2016)

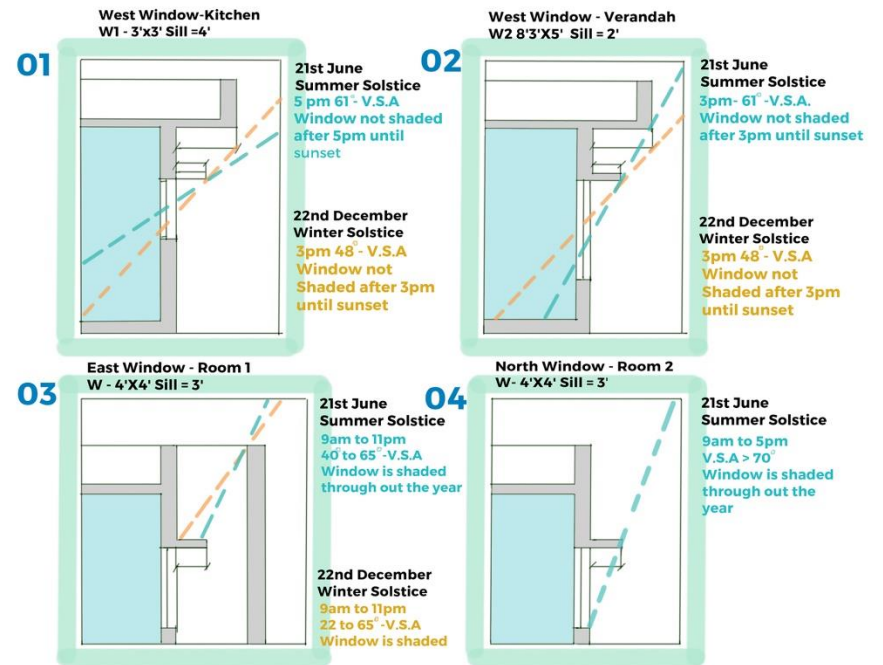


Fig3.27 Bioclimatic design feature 3: Optimizing daylight and heat ingress

Fig 3.30 Open to sky spaces allow heat to escape  
Chitravad (2016)



Fig 3.31 Cross ventilating spaces Chitravad (2016)



Fig 3.32 Daylighting through larger windows Chitravad (2016)



**Existing house plan with sloping roof**

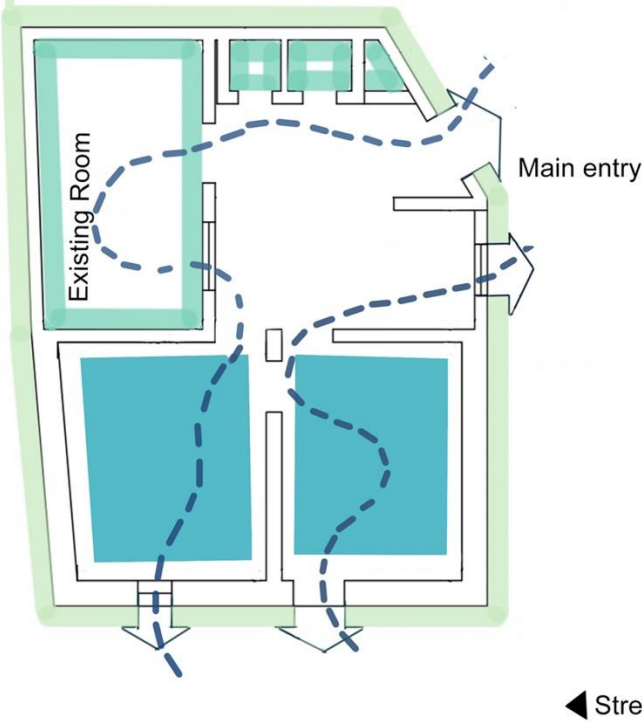


Fig 3.28 Existing housing without ventilation

**New house plan by AKAHI with terrace**

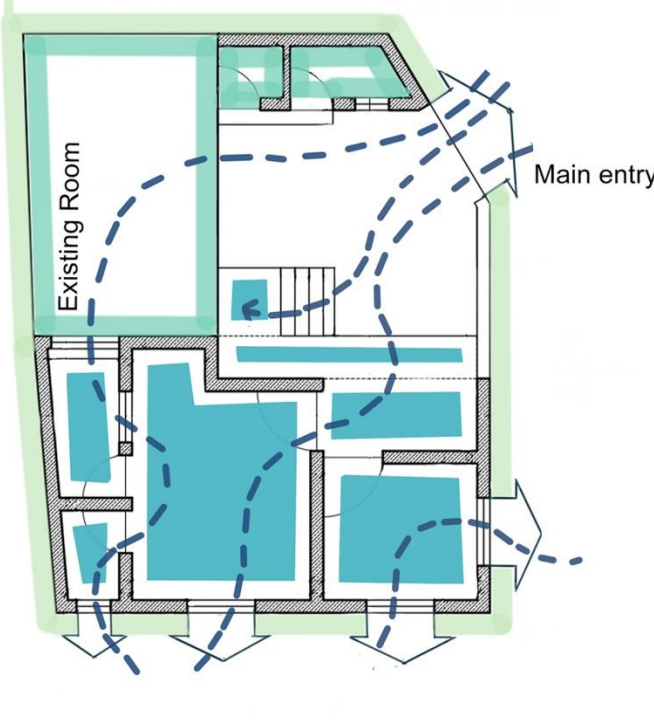


Fig 3.29 Bioclimatic design: Internal lighting and ventilation through Open to Sky space, cross ventilation and larger windows



## Kitchen ventilation :

### Case study

As observed in some of the houses, the construction was planned in a way which allowed the owners to maximise the floor area. This resulted in the house having only one front with open space, restricting the ventilation. During reconstruction of one such house, AKAH intervened to show the importance of leaving open space on the rest three fronts of the house as well, and suggested a design accordingly. The beneficiary was unimpressed by this suggestion and was stringent on sticking to the conventional way. AKAH attempted to convince the beneficiary's family to adopt the suggested design. However, all the family members except the wife of the beneficiary did not see any value in this proposition. The wife later raised the point that leaving more space will result in better ventilation throughout the house, which is crucial for spaces like kitchen. Eventually convinced by the importance of natural lighting and ventilation, the family arrived on the same page and agreed to proceed with the design as per AKAHs guidelines.



Fig 3.33 Ventilated kitchens reduce internal pollution\_Chitravad (2018)

## 02 Material and resource optimization help reduce emissions and provide green home comfort.

**Optimization Feature 1:** Using debris from demolished house for plinth filling and plinth protection and Reusing stones from the demolished house for construction of walls and boundary walls

**Optimization Feature 2:** Use of locally available stones as building blocks.

**Optimization Feature 3:** Ductile reinforcement in corner stones with overlap to optimize use of reinforced concrete



Fig 3.34 Reusing debris  
Optimization feature 1



Fig 3.35 Use of locally available stones  
Optimization feature 2



Fig 3.36 Optimizing the use of concrete - Ductile reinforcement inserted in cornerstones \_Optimization feature 3



# A

**Energy efficiency features in green rural houses** could be incorporated through design and recommendation for use of energy efficient electrical fixtures. Through generation of awareness and facilitation support, government subsidies for Solar PV rooftop systems could be accessed for some homes.

- a. Energy efficiency through **optimized natural daylighting** through layout and window design and use of shading devices.
- b. Energy efficiency by **harnessing clean energy**

**Fig 3.37 Harnessing clean energy - training masons on solar rooftop installations Chitravad (2018)**



**Fig 3.38 Jivapar (2013)**



**Fig 3.39 Optimizing daylighting\_Jivapar (2013)**





# B

**Water conservation** and efficiency has been incorporated into the way of life through recommendation of water harvesting through soakpits with biofilters to harvest grey water and roof rainwater.



Fig 3.40 Soakpits with biofilters for grey water  
Chitravad (2019)

# C

The effect of **heat island** has been effectively mitigated through cool roof tops and use of china mosaic with high reflective index.



Fig 3.41 Cool Roof application  
Sangodra (2019)

## Case study:

Our old house built by my grandfather was more than 70 years old. We used to face several problems. Water would enter our houses during the rainy season. Water would rise up from the ground during monsoons and make the floor wet. WE would often fall sick due to the dampness inside during the rainy months. The house would just not dry up enough. During summers, sleeping indoors at night was difficult and we would sleep in the courtyard at night to catch the breeze. We were scared of leopards entering and attacking us at night. The asbestos roof would make the house very hot in the afternoons.

In our new house water doesn't come in anymore. The rooms are cleaner, brighter and dry. We no longer need to switch on lights during daytime. We can do a lot of activities inside the house. Moreover, the mud flooring in our previous home was difficult to clean and caused mosquitoes and flies to infest our living space. The new floors and rooms are easy to clean and maintain, which also leaves us with more time for other activities.

Fig 3.42 Before



Fig 3.43 After (2019)



# 04

## Resilience in Social Habitat





## Transformation in habitat - Building social resilience

**A socially resilient housing program focuses not only on physically safe spaces but a healthy, sustainable, inclusive development which enhances economic well being, creates cohesive communities and builds stewardship for society and environment.**

# Social Principles adopted for building community resilience

## 01 Participation- focus on people rather than assets

- Building identities and economic well being through spaces
- Generating ownership for assets through participation within households
- Women and Children are encouraged to participate in decision taking
- Developing accountability for healthy practices



Fig 4.1



Fig 4.2

## 02 Inclusion - integrating communities



Fig 4.3 Senior citizen and single women with access to housing

- Creating identities for the left outs
- Building dignity through living spaces,
- Encouraging cohesion through community spaces



Fig 4.4 Community gathering in either courtyard/ opla

## 03 Sustainability - impacting beyond housing

- Green homes and responsible living practices,
- Promoting healthy and socially responsible behavior,
- Impacting housing market forces – building sustainable capacities and knowledge
- Sustainable settlement development - environmental awareness and stewardship



Fig 4.5 World Environment Day campaign



Fig 4.6 A row of new houses and clean streets



Fig 4.7 Mason training



Fig 4.8 Aashiyana in school



# Building dignity and resilience – integrating the excluded into the community

## Case study:

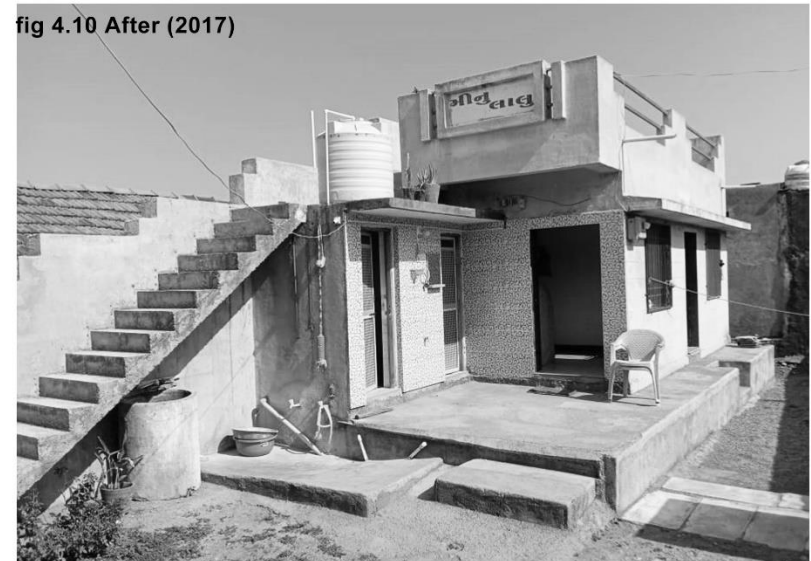
The Rural Habitat Development Program claimed that a safe house not only provided physical safety but also social dignity to its beneficiary. The case of a transgender who was identified as a beneficiary in the program clearly proves the claim.

An impoverished community member who was also a transgender was identified for support under the program by the community leaders. Unable to find any employment, the identified community member was dependent completely on donations and support from others for survival. This necessitated moving around from one settlement to another, a feeling of helplessness, instability and exclusion. The shelter in the village was in a state of disrepair and added to the physical and mental vulnerability and hopelessness. Community leaders identified this case for support, the RHDP team soon tried to engage with the intended beneficiary. Persistence and sensitive mobilization by the team generated trust. This helped in accessing financial support from the larger community including the larger transgender community. Visits by the team and the facilitation by community leaders promoted inclusion and feeling of belonging. Upon project completion, the beneficiary started residing in the new house, and eventually also found a job nearby. Being settled and stable, social interaction increased. A dignified life became possible.

Fig 4.9 Before



fig 4.10 After (2017)





# Creating identity in the community through housing

## Case study:

A widowed mother and her daughter lived in a single room tenement. The mother earned her livelihood as a tailor. The single room served as her workspace as well as the living space. Quality of living space and privacy was severely compromised. The new housing design proposed a verandah for customer engagement. Additional workspace was created through partitioning of the existing space. The addition of a veranda and the necessary partitions provided the house with the required segregation of working space and private space reducing disruption and intrusion due to customer walk-ins.

Fig 4.11 Before



Fig 4.12 After (2015)



## Process adopted

▶ 01. Generating awareness

▶ 02. Identifying needs and vulnerabilities

▶ 03. Mobilising

▶ 04. Financial planning

▶ 05. Improving access through subsidies

▶ 06. Beneficiary selection

▶ 07. Training and building capacities

## Process adopted for social resilience

### 01 Generating awareness Aashiyana: Community awareness programs

Aashiyana a **Community awareness programme** to raise awareness on need for **structural safety** in housing and its impact on **quality of life, role of community** in a habitat and its **environment** and need for stewardship.

**Steps undertaken for community awareness include:**

1. Context based habitat issues are carefully assessed by the team
2. These issues are highlighted within the community
3. Sessions on role of safe housing, importance of building maintenance and repairs are undertaken.
4. Session on habitat based issues like waste water, roads, solid waste management and other environment-related issues are discussed.
5. Awareness around climate change, energy efficient products, water conservations, solid liquid waste management, etc.

Fig 4.13 Process adopted to ensure resilience in the social structure

A calendar for continual awareness generation is developed and multiple contacts with the community is maintained through informal gatherings. **AV presentations, skits, focus group discussions** are undertaken and children focused activities are organized on multiple occasions in late evenings, public holidays and other community events.

Aashiyana helps in generating a need for better quality of life, willingness to participate in upgradation of habitat, environmental stewardship and ownership into the process. It helps in **developing a trust** within the community and open the door for more intensive engagement

**02** Identifying vulnerabilities – structural and socio economic, and selection of intended beneficiaries through collaboration with multiple stakeholders

**03** Mobilising identified beneficiaries

**04** Facilitating financial planning

**05** Improving access through subsidies in stages

There are multiple stakeholders like community leaders, influencers and donors and community based organisations who aid in the process of selection of beneficiaries. These stakeholders help not only in identifying the beneficiaries but also in ensuring inclusion, verification, transparency, mobilisation, arbitration during disputes and linkages with donors and filling gaps in case of crisis.

Fig 4.14 Aashiyana\_Chitrad (2016)



Fig 4.15 Involving multiple stakeholders from the community helps increase transparency and accountability





| 1 <sup>st</sup> Stage<br>Plinth level completion      | 2 <sup>nd</sup> Stage<br>Room slab                    | 3 <sup>rd</sup> Stage<br>Post completion of entire construction |
|---|---|---|
| <b>30%</b><br>of payment                              | <b>45%</b><br>of payment                              | <b>25%</b><br>of payment  |
| Level of completion documents submission and approval | Level of completion documents submission and approval | Level of completion documents submission and approval           |
| Bank transfer   | Bank transfer   | Bank transfer   |

Fig 4.16 Access to subsidy improves access to safe housing

Fig 4.17 Difference in cost of construction of local houses versus RHDP houses



## 06 Beneficiary selection plays a critical role in meeting the objectives

- Rapid structural diagnosis identifies the level of vulnerability of a structure. Highly vulnerable structures are identified for reconstruction and moderately vulnerable for repair.
- A multiple stakeholder selection committee selects the beneficiaries based on the structural need assessed and the economic vulnerability.
- The selected beneficiaries are asked to produce their income certificate by the local organisation.
- Verification of income certificate by the committee ensures zero error and complete transparency.
- An agreement is signed between the beneficiary and Aga Khan Agency for Habitat, in the presence of witnesses, detailing the commitment by the beneficiary to adherence to the construction methodology and quality standards recommended by AKAH and the amount and stages of subsidy payout committed by AKAH to the beneficiary.
- The project transcends to the next stage of design and approval of layout by the beneficiary followed by structural designing and construction.
- The cost of a new house ranges from 4,00,000/- to 5,00,000

Beneficiaries from LIG/ EWS are given 75% financial assistance on the unit cost by the program ,and

Beneficiaries from MIG will be given 50% of financial assistance

Whereas people from HIG are not given any financial assistance in reconstruction, but AKAH provides technical assistance free of charge in the form of planning and designing of the unit.

## 07 Training and building capacities – equipping local service providers with skill and knowledge

# Role of mobilization in reaching the proposed outcome.

## Case study 01:

The survey had led to the identification of a house which looked particularly vulnerable. The owner and the condition of the house met all the criteria established for beneficiary selection. When approached with the proposal for reconstruction of the house the same was rejected by the houseowner.

Two years later, the house owner approached Aga Khan Agency for Habitat with a request for support in reconstruction of his house. Post a quick verification and documentation, the construction was initiated. However, at the second stage of construction, the beneficiary showed unwillingness to continue with the disaster resilient construction methodology promoted by AKAH. This was against the initial agreement between AKAH and the beneficiary. Intense mobilisation by multiple stakeholders was initiated and finally the work was resumed and completed as per the quality standards promoted by Aga Khan Agency for Habitat.



Fig 4.18 Before

Fig 4.19 After (2018)



## Case study 02:

Post the selection of a beneficiary through the same process, the project advanced in its next stage. Careful analysis of all the essential parameters led the architect and the technical team to design alternative layouts. This plan was then approved, and the construction was about to commence as scheduled. However, the initial procedure came to a halt as the client expressed his disagreement over the proposed structural design. The beneficiary refused to accept the structural safety elements proposed by AKAH and opted to undertake the local construction styles instead. This led to dispute and multiple attempts to remobilise failed. The intended beneficiary claimed the first installment of the subsidy based on the stage of construction reached. However the dispute was resolved and the committee disapproved the payment due to the deviation from the initial agreement.



# 05

## Resilience in the Ecosystem



# Sustainable settlements: Resilient habitats, communities and ecosystem

To focus on improving the current condition of the villages and meet the basic quality of life needs of all the residents – safety and security of persons and their possessions, housing, water, sanitation, electricity, roads, transport and communication facilities, livelihoods, education and health facilities AKAH India initiated a habitat approach in its interventions by focusing not only on building of physical and social resilience but an environmental stewardship to ensure a sustainable development. This would ensure that the Rural Settlement could transform itself into a Progressive Rural settlement with qualitative features such as social integration, peace, harmony and a sense of community coexistence in its ecosystem could be further enhanced.



Fig 5.1 Sustainable settlements need conducive environment for progressive growth

# Village Development Planning

AKAHI undertook comprehensive master planning to develop a model village plan for Chitrad. The approach was largely based on integrating the participatory planning process with local Panchayat Raj Institutions and community in addressing the needs for habitat planning. The purpose was to identify and prioritize development issues of the village and develop such mechanisms which encourage active community participation and effective utilization of local resources in resolving the development issues in short, medium, and long term perspectives.



Fig 5.2 Process adopted for Village Development

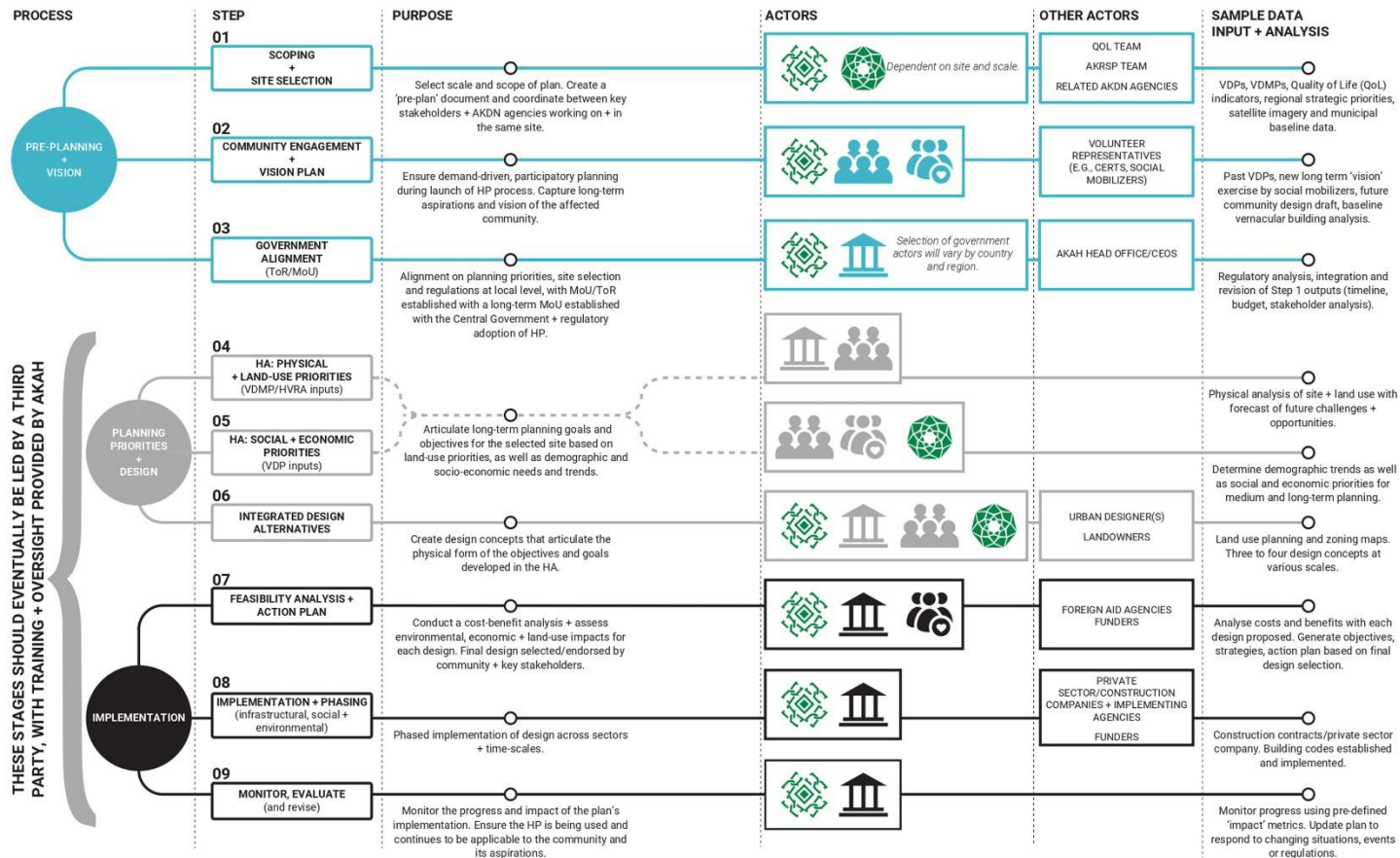






Fig 5.3 Participatory rural appraisal and planning Jivapar (2014)

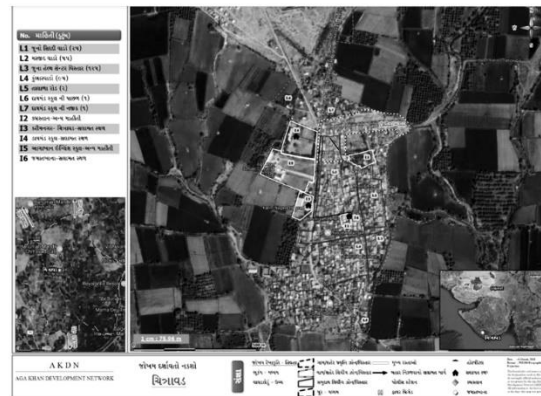


Fig 5.4 Chitradav Map

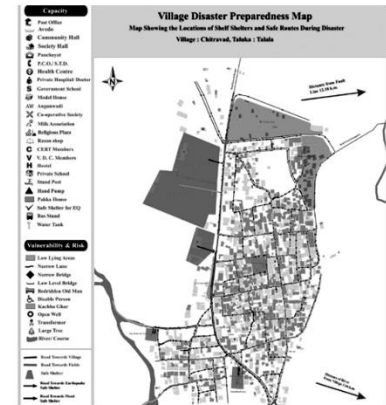


Fig 5.5 Village disaster preparedness map



Fig 5.6 Recharge bore well drilling Chitradav (2019)

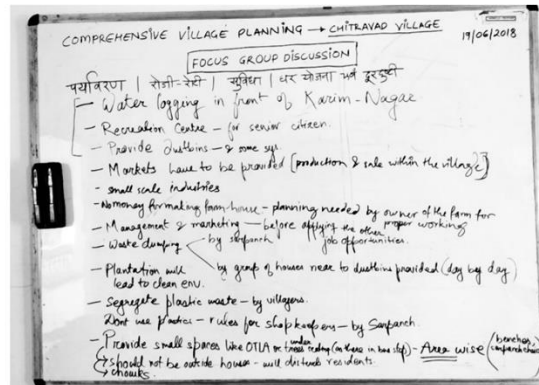


Fig 5.7 Comprehensive village planning notes



Fig 5.8 Recharge bore\_Chitradav (2019)

# Environmental Upgradation and Biodiversity Conservation

To reduce man animal conflict, improve the safety of communities and the wildlife it lives with, with funding support from the Prince Sadruddin Aga Khan Fund for the Environment a program was launched in 10 villages of the district which were in the periphery of the Wild life Reserve of Gir. Multiple interventions in finding practical solutions to reduce man animal conflict through participatory rural appraisal, generating awareness and pride towards the adjoining natural heritage and wildlife reserve, the Gir National Park which is the only living habitat for the Asiatic lion, and supporting the forest department in building partnership with the community for conservation and preservation of the same were undertaken.

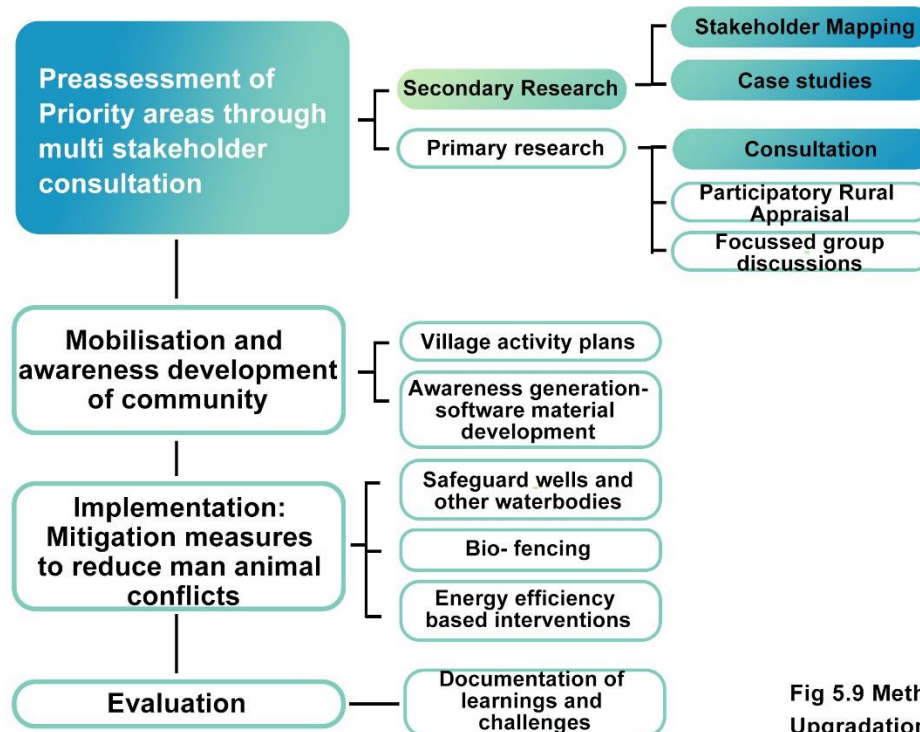


Fig 5.9 Methodology adopted for Environmental Upgradation and Biodiversity Conservation project





**Fig 5.10 Participatory rural appraisal Sangodra (2019)**



**Fig 5.11 Participatory planning is critical to ensure ownership and partnership in the development planning.**



**Fig 5.12 Community gathering\_Shirvan (2019)**



**Fig 5.13 Shirvan (2019)**



**Fig 5.14 Construction of fencing, covering wells and building sanitation units to reduce man animal conflict**



**Fig 5.15 Bhalchhel (2019)**



# Building Environmental Consciousness and Stewardship

A consciousness towards the environment and the ecosystem through creation of awareness within children, elders and community leaders, through folk plays, competitions in schools, campaigns and tree plantation drives and developing cadres, champions and advocates of environment and has helped in developing environmental stewardship within the community at large. This has led to an awareness towards the ecosystem and the environment which the community lives in and a movement towards sustainable living.

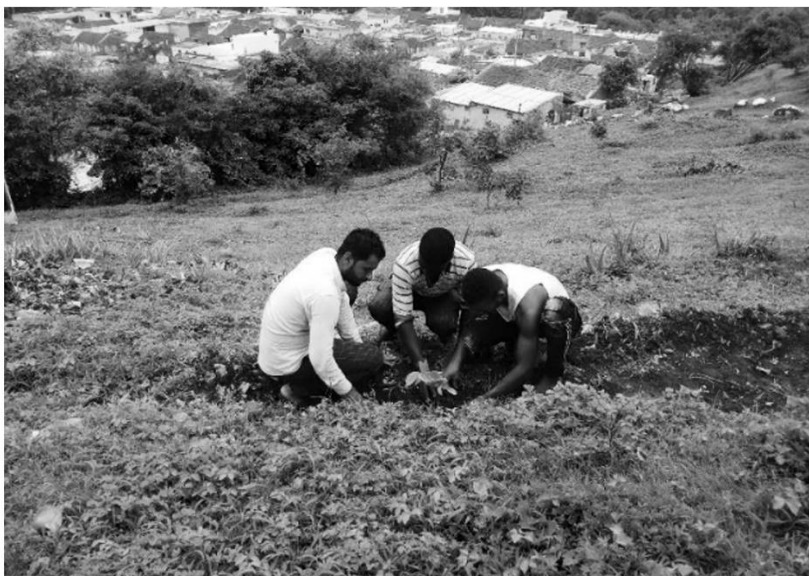


**Fig 5.17 Competitions with children encourage engagement with habitat issues and innovative ideas and solutions Chitravad (2019)**

**Fig 5.16 Gir Mitra-are environment ambassadors in the community**



**Fig 5.18 Campaigns and marches to raise awareness on environmental issues\_Chitravad (2019)**



**Fig 5.19 Planting of trees to revive the ecosystem balance (2019)**



**Fig 5.20 Folk plays help are effective communication and awareness tool\_Chitradad Diamond High School (2019)**

# Program milestones

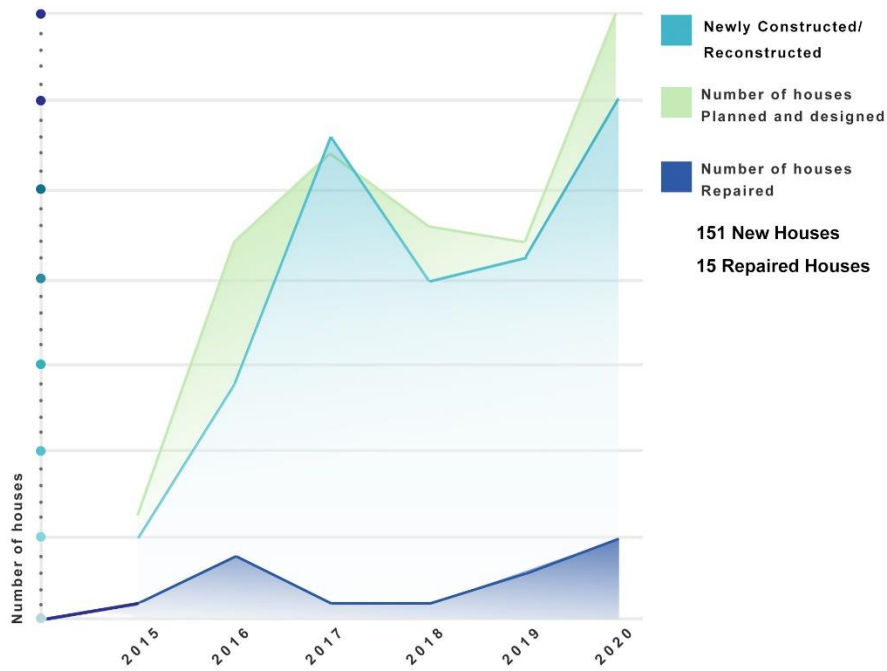


Fig 5.21 Program Milestones and achievements

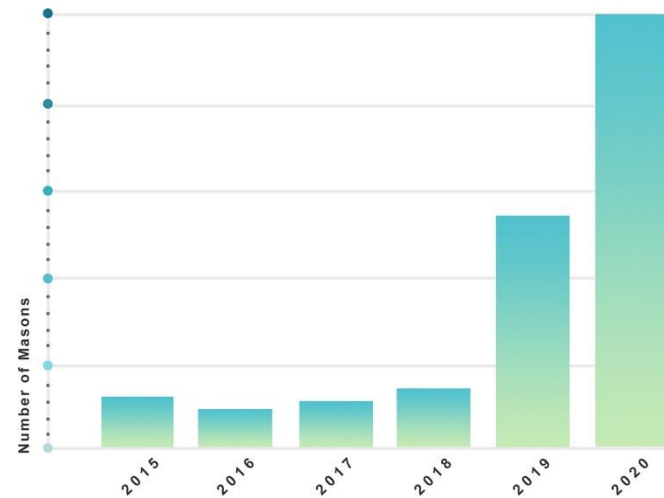


Fig 5.22 Skilling of Masons



# Beneficiary Testimonials

January 2020 for on-going construction projects

## Owner: Elderly Couple

Location: Kenedipur (January 2020)

I am 90 years old. I look forward to living in this house when done, with my wife. My old house had mud tiles and the roof would leak. There wasn't enough light during daytime. The new house under construction looks strong and the team visits quite often to check the quality. I think in this house there will be more airy and lighted. I am looking forward to my new house.



## Owner: Elderly lady and her middle-aged son

Location: Kenedipur (January 2020)

The new house is nicely designed and when we move into it with our new furnitures we will feel very good. The work by AKAH India is excellent and all team members Mansur Vadsariya (Community mobiliser), Harsukh Solanki (project Engineer), Malik Mithani (Project Supervisor) keep coming to site and ensure that our all our suggestions are included, they always take our feedback. We are satisfied with the quality of work and are certain that this new house will make us very happy and healthy.



## Owner - Middle aged couple

Location: Kenedipur (January 2020)

The new house looks very nice and livable. Our old house made us feel unsafe, as through it would collapse anytime, the floor would always feel damp and the wooden support in the roof would keep collapsing during heavy rains and then the house would flood and become unlivable. The old was very small and I would feel suffocated inside. The new house has enough windows for light and air. The way the windows and doors are designed and located we will get more oxygen, we shall definitely be healthier.



## Owner: Single lady with aged parents

Location: Amrapur (January 2020)

The house we lived in was in a bad condition and we would feel that during monsoon or earthquake the house might fall down. Water would often drip from the roof, Wooden supports were infested with termites and the heat was unbearable inside the house during summer. But now seeing the new house construction, we feel very happy as we could never imagine that people like us who earn so less can also live in houses like this. I am very happy with the quality of work and the support I have received.



## Owner: Aged couple and daughter

Location: Virpur (January 2020)

We are very excited about our new house. We used to sit on our beds to stay dry and wait for water to subside in our house during rains. The raised plinth and the strong construction in our new house will now keep us safe. The team of supervisors and engineers visit very often and we send them daily photographs over phone and thus work on our new house is going very well.



## Owner: Young working lady with aged parents

Location: Virpur (January 2020)

I feel very hopeful and at peace as I see the house come up, my parents can now live safely and comfortably. All our community members also appreciate the work being done by AKAH India for community welfare. Harsukhbhai, Bhaveshbhai and Mansurbhai continuously support us and undertake regular visits to check the construction. The design of the house which was provided after many discussions with me and my parents was very good and I am very happy with it.





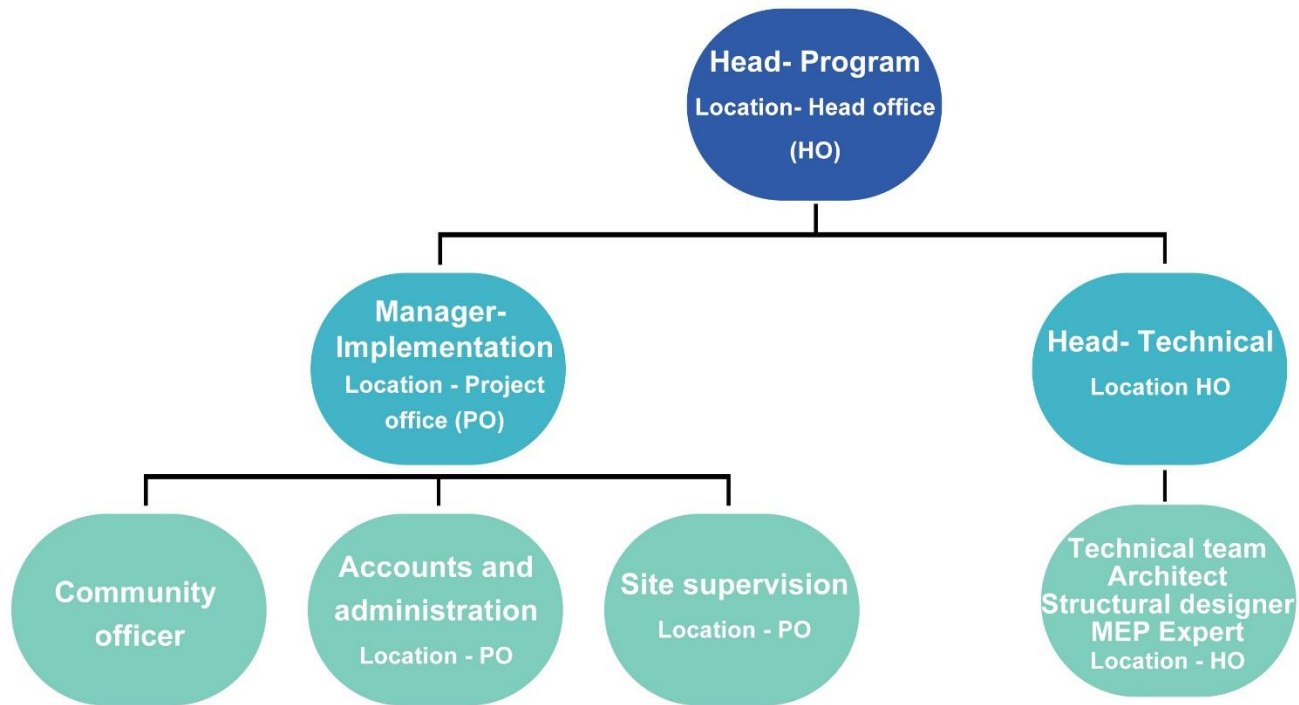


Fig 5.23 Project team

# Team Testimonials

## Malik Mithani

### Project Supervisor - Construction

When we started work, there weren't many takers. As some of the houses started taking shape, they had more faith in us. When people started living in their new houses and started experiencing a new life which they could not have dreamt of before, they gave us their blessings and that gave us the strength to work against all obstacles and continue with our mission.



## Bhavesh Bamaniya

### Project Supervisor - Construction

I would like to thank AKAH for giving me the opportunity to engage in such meaningful work. I have learnt a lot through this project. The most important thing is this project has given us the opportunity to work where there is need and that gave a deep sense of satisfaction.



## Sana Dharani

### Program Manager – Housing and Habitat Development

As an Architect when I see happy families residing in their safe homes, I feel accomplished that through my education I could make a difference to people's lives. I have learnt that a home is not just a means of shelter, but it can change the social status of the family and outlook of the community. I feel motivated by the fact that I am part of someone's dream house.



## Harsukh Solanki

### Project Manager – Rural Habitat Development Program

I have worked with the government and non-government organizations in several projects for rural development work and I have been working with AKAHI since 2006 in many projects. The success of the RHDP Project has given me a deep sense of satisfaction and pride because this is a project in which we work for safe and secure housing which is every person's dream. I could feel that I was a part of someone's life and making a difference, helping them find security and happiness, and this motivated me to give my all and do my best work.





## Sucharita Roy

### Head of Planning and Building Department

They say the home is where the heart is. These houses are more than a physical space, it ensures security, identity, dignity and new opportunities for its residents. I am proud to have been working with this team who have dedicatedly and passionately supported people to build happy homes where the heart can live with pride.



## Mansurali Vadsariya

### Project Office – Community development and administration

Working in the RHDP project has given me a lot of happiness because for those people who have been living in poor houses, these new houses have made very positive changes in their quality of living and their status in the society. We can now clearly see the successful impact of this project on their lives. This gives me a sense of satisfaction and pride.



# Mahmadfiroj Kureshi

## Engineer - Structures

RHDP is a great program to provide safe housing to the needy people. This is the best service of AKAH India and I feel satisfied and emotionally touched after meeting beneficiaries giving blessings and appreciation for the work. I feel the quality of work is because of the regular visits and monitoring.



# Salim Vanzar

## Senior community Officer

I have learnt a lot about the culture of rural communities and their expectations, while working with the team from the initial phase of the project. Personally, I feel that real India is in its villages and it makes me happy that AKAH India is providing a secured and healthy environment in rural areas. Seeing the beneficiaries excitement and happiness after getting good quality habitat I feel very satisfied with my work here.



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  - 2.9 Dislodging of rubble and stones\_Chitrad (2017)
  - 2.10 Dislodging of rubble and stones\_Chitrad (2015)
  - 2.11 Formation of cracks on wall due to tremors
  - 2.12 Structural vulnerabilities exhibited in traditional structures
  - 2.13 Moisture on walls\_Amrapur (2018)
  - 2.14 Open Courtyard\_Chitrad (2016)



- 3.1 Approach adopted for physical resilience
- 3.2 Rapid assessment of structure
- 3.3 Structural vulnerability classification
- 3.4 Housing condition, Gangecha village(2019)
- 3.5 Housing conditions, Gangecha village (2019)
- 3.6 Housing conditions, Gangecha village (2019)
- 3.7 Foundation Chitrad (2018)
- 3.8 Corner reinforcement Chitrad (2018)
- 3.9 Lintel Chitrad (2018)
- 3.10 Slab\_Sangodra(2018)
- 3.11 Three alternative designs options for the same structure
- 3.12 Finalised design
- 3.13 The Housing Team
- 3.14 Mandatory use of helmets and jackets for all personnel
- 3.15 Sealing of cracks Chitrad (2019)
- 3.16 Using steel mesh for structural strengthening Chitrad (2019)
- 3.17 Treating the cracks before re-plastering Chitrad (2019)
- 3.18 A partnership approach in housing delivery
- 3.19 Mason technical training indoor session Chitrad (2019)
- 3.20 Mason training on beam reinforcement bending as a part of on site practical session Chitrad (2017)
- 3.21 Mason making polymer modified mortar Chitrad (2019)
- 3.22 Mason training Chitrad (2019)
- 3.23 Ensuring quality in housing construction
- 3.24 Adapting to Climate Change
- 3.25 Bioclimate design feature: Orientation
- 3.26 Design feature 2 Chitrad (2016)
- 3.27 Bioclimate design feature 3\_Optimizing daylight and heat ingress
- 3.28 Existing housing without ventilation
- 3.29 Bioclimate design: Internal lighting and ventilation through open to sky spaces, cross ventilation and larger windows
- 3.30 Open to sky spaces allow heat to escape Chitrad (2016)
- 3.31 Cross ventilating spaces Chitrad (2016)
- 3.32 Daylighting through larger window Chitrad (2016)
- 3.33 Ventilated kitchens reduce internal pollution Chitrad (2018)
- 3.34 Reusing debris Optimization feature 1
- 3.35 Use of locally available stones Optimization feature 2
- 3.36 Optimizing the use of concrete- Ductile reinforcement inserted in cornerstones Optimization feature 3
- 3.37 Harnessing clean energy- training Masons on solar rooftop installation Chitrad (2018)

- 3.38 Jivapur (2013)
- 3.39 Optimizing daylighting\_Jivapar (2013)
- 3.40 Soaking with biofilter for grey water Chitravad (2019)
- 3.41 Cool roof application Sangita (2019)
- 3.42 Before
- 3.43 After
  
- 4.1 Image
- 4.2 Image
- 4.3 Senior citizen and single women with access to housing
- 4.4 Community gathering in either courtyard/otla
- 4.5 World Environment Day campaign
- 4.6 A row of new houses and clean streets
- 4.7 Mason training
- 4.8 Aashiyana in school
- 4.9 Before
- 4.10 After (2017)
- 4.11 Before
- 4.12 After (2015)
- 4.13 Process adoption to ensure resilience in the social structure
- 4.14 Aashiyana\_Chitravad (2016)
- 4.15 Involving multiple stakeholders from the community helps increase transparency and accountability
- 4.16 Access to subsidy improves access to safe housing
- 4.17 Difference in cost of construction of local houses versus RHDP houses
- 4.18 Before
- 4.19 After (2018)
  
- 5.1 Sustainable settlements need conducive environment for progressive growth
- 5.2 Process adopted for Village Development
- 5.3 Participatory rural appraisal and planning Jivapar (2014)
- 5.4 Chitravad map
- 5.5 Village disaster preparedness map
- 5.6 Recharge bore well drilling Chitravad (2019)
- 5.7 Comprehensive village planning notes
- 5.8 Recharge bore Chitravad (2019)
- 5.9 Methodology adopted for Environmental upgraded and Biodiversity Conservation project
- 5.10 Participatory rural appraisal Sangodra (2019)

- 5.11 Participatory planning is critical to ensure ownership and partnership in the development planning
- 5.12 Community gathering\_Shirvan (2019)
- 5.13 Shirvan (2019)
- 5.14 Construction of fencing, covering wells and building sanitation units to reduce man animal conflict
- 5.15 Bhalchhel (2019)
- 5.16 Gir Mitra- are environment ambassador in the community
- 5.17 Competition with children encourage engagement with habitat issues and innovative idea and solutions Chitavad (2019)
- 5.18 Campaign and marches to raise awareness on environment issue\_Chitavad (2019)
- 5.19 Planting of t trees to revive the ecosystem balance (2019)
- 5.20 Folk plays help are effective communication and awareness tool\_Chitavad Diamond High School (2019)
- 5.21 Program Milestone and Achievement
- 5.22 Skilling of Masons
- 5.23 Project Team





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