Risk Mitigation Framework for Urban Cultural Heritage
Case Study of Walled City, Ahmedabad

Project by:

National Institute of Disaster Management (NIDM), New Delhi
in collaboration with
Ahmedabad Municipal Corporation (AMC)

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COORDINATORS

Ms Chandrani Bandyopadhyay
National Institute of Disaster Management (NIDM)

Shri Debashish Nayak
Ahmedabad Municipal Corporation (AMC)

PROJECT TEAM

Ms A. Vijaya, (Consultant)
Dr Rohit Jigyasu (Advisor)
Shri Nikhil Vyas (Project Assistant)

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Mr. Ramesh Kumar
Mr. Shekhar Chaturvedi
Mr. S. K. Tiwari

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(गृह मंत्रालय, भारत सरकार)
National Institute of Disaster Management
(Ministry of Home Affairs, Govt. of India)
5B, I.P. Estate, M. G. Marg, New Delhi - 110 002
nidm
Towards a disaster free India.....
प्रो. संतोष कुमार
कार्यकारी निदेशक
Prof. Santosh Kumar
Executive Director

Preface

The urban landscape in India is a rich mosaic of historic cores, modern built-form and informal settlements. The historic urban cores showcase the origin and evolution of the city and are a repository of traditional construction practices, urban design and community characteristics. Over time, however, with "modernisation," these areas degenerate, leading to either modification of its characteristics or complete redevelopment, resulting in loss of not only the built heritage, but also the traditional cultural practices associated with it.

The 600 year old history of the city of Ahmedabad is mirrored in the architecture, urban design and neighbourhood planning of the Walled City. The urban fabric is a documentation of architectural styles of various periods within an integrated neighbourhood setting called pols. Ahmedabad also has the distinction of effective local governance, with the first Urban Local Body in the country set up here in 1818 AD. A system of underground network of sewerage and electricity has been operational since the 19th century. Despite its antiquity, its distinctive construction features have led the Walled City structures to perform much better in the 2001 earthquake than relatively recent structures. However, the recent spate of commercialization has led to demolition and modification of old buildings, leading to aggravation of risk.

The need for conservation of traditional architecture, urban form and practices has been felt, especially in the context of historic urban cores that regularly face the onslaught of modernization. There is a need to revitalize these areas and plan for their sustainability so that the unique heritage is preserved. This study is a small effort to put Cultural Heritage Risk management of historic urban cores in the perspective of overall risk management. I hope this document will encourage policy makers, practitioners and communities to consider the Cultural heritage of cities as a critical part of holistic disaster risk reduction.

(Santosh Kumar)
New Delhi 2015

अगर उचित है आपदा प्रबंधन, तभी मिलेगा विकास को धन।

डा. सतेन्द्र, भा. व. से.
कार्यकारी निदेशक
Dr. Satendra, IFS
Executive Director

राष्ट्रीय आपदा प्रबंधन संस्थान
(गृह मंत्रालय, भारत सरकार)
5 बी, आई. पी. इस्टेट, महात्मा गाँधी मार्ग, नई दिल्ली - 110002
National Institute of Disaster Management
(Ministry of Home Affairs, Govt. of India)
5B, I.P. Estate, M. G. Road, New Delhi - 110 002

Foreword

The overwhelmingly destructive nature of disasters impacts lives, livelihoods, assest and properties and disrupts the prevalent socio-cultural structures of communities. The loss of cultural heritage that acts as a source of information of the past, a symbol of social identity and pride is often overlooked in the risk reduction acitvities.

A living historic environment, including built heritage and cultural landscapes is more resilient to natural hazard as they manifest traditional knowledge accumulated over centuries of adaptation to the locale. The Bhuj earthquake 2001 and the Kashmir Earthquake 2005 demonstrated the resilience of traditional buildings when relatively modern structures failed. The need of the hour is to understand the significance of cultural heritage in promoting community resilience and integating heritage concerns in plans, policies and programmes aimed towards reducing disaster risks.

The National Institute of Disaster Management (NIDM) and the Ahmedabad Municipal Corporation (AMC) collaborated to prepare a framework for Cultural Heritage Risk Mitigation Planning for the Walled City of Ahmedabad. Though limited in its approach and scope, the study has brought out the vulnerability of this urban cultural heirtage and the framework for planning of urban cores. This study is now placed in the public domain in the hope that it will help in risk mitigation of cultural heritage and will be useful for student, researchers, heritage managers and DRR professionals in various ways.

New Delhi

(Satendra)

फोन / Ph: +91-11-23702445, फैक्स / Fax: +91-11-23702446, ई मेल / E-mail:ed.nidm@nic.in, वेब साईट / Website: nidm.gov.in

About the Project...

The United Nations Educational Scientific and Cultural Organization (UNESCO) defines heritage as "the product and witness of the different traditions and of the spiritual achievements of the past and … thus an essential element in the personality of peoples." The interface between cultural heritage and natural disasters are evident in most high intensity disasters around the world. Countless structures have fallen prey to natural hazards like floods, cyclones, tsunamis, earthquakes etc. As with other vulnerable structures and population, cultural heritage needs to be preserved with a focus on disaster risk mitigation. The Kyoto Declaration 2005 declares that "cultural heritage is a priceless and non-renewable asset and it is our duty to raise awareness and undertake all necessary measures for protection of cultural heritage from disasters." Mitigating disaster risk of cultural properties is an integral part of an overall risk reduction process.

This project is an attempt to study disaster risks in heritage structures in the context of an inner urban core. Sustained for over six centuries, the Walled City of Ahmedabad is replete with rich cultural heritage, both tangible and intangible. Through this study, we have tried to identify both the vulnerabilities and capacities of the heritage structures in the Walled City. This project, though limited in scope, is an effort to underscore the need for concerted action for disaster-resistant conservation and revitalization of the Walled City, with its immense potential, aesthetic value and traditional wisdom.

I hope the planning framework developed by this team would be the fore-runner of many more initiatives for detailed planning and preparedness actions to conserve the heritage in the Walled City of Ahmedabad and other cities from future disasters.

Chandrani

Chandrani Bandyopadhyay
Project Coordinator

New Delhi, 2015

Acknowledgement

This project report is the culmination of efforts by many people, who, with their knowledge, wisdom and interest have motivated us throughout our journey. In this context, we express our deepest gratitude to the people of the Walled City, who have cooperated and extended their support in the best possible way during the surveys.

The Project team would like to convey its gratitude toProf. Santosh Kumar, Executive Director, NIDM, Shri P.G Dhar Chakrabarti, IAS(Retd.) and Dr. Satendra, IFS, former Executive Directors of NIDM for their keen interest in the issue of cultural heritage risk management and conservation. We also thank Shri I.P Gautam, IAS, former Municipal Commissioner of Ahmedabad who agreed to collaborate with NIDM on this project.

We take this opportunity to thank Dr Guruprasad Mahapatra, IAS, former Commissioner, AMC for their support and motivation that enabled the successful completion of the project despite initial difficulties. The team is grateful to Shri P.K. Ghosh, IAS (Retd), Chairman, Heritage Conservation Committee, AMC and Shri Rajesh Kumar Singh, Director (PP), National Disaster Management Authority who took out their valuable time to review the document in great detail and endorse the same. Their valuable inputs have been incorporated in the document in the best possible way. The team thanks Shri M.F. Dastoor, Chief Fire Officer, AMC for sharing his experiences in the Walled City and his staff for their cooperation.

At the end, we express our deepest gratitude to all those unnamed people, who have, directly or indirectly, contributed to this project.

New Delhi

Project Team

The map showing dense urban fabric of the walled city of Ahmedabad
source: Indo - French Report

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Chapter 1.

Introduction

Ahmedabad is located at 23.03°N 72.58°E in Western India at an elevation of 53 metres (174 ft) above mean sea level. The city sits on the banks of the River Sabarmati, in north-central Gujarat and spans an area of 205 km² (79.15 square miles). It is the largest city in Gujarat and the sixth largest in India with a population of 6.4 million (2011). The city was said to be founded by Ahmad Shah in 1411AD, when he shifted the capital from Patan to the banks of the river Sabarmati on ancient site of Ashaval and Karnavati. In its 600 years of continuous history, the city has seen atleast four regimes of power, the independent Sultanate of Gujarat, Mughal dominion, the Marathas and the East India Company. During the British rule, the city established itself as the home of a booming textile industry and also was at the forefront of the Indian Independence movement. Ahmedabad is divided by the river Sabarmati into two physically distinct eastern and western regions, connected by bridges. The western part of the city expanded only during the colonial period. This part of the city houses educational institutions, modern buildings, well-planned residential areas, shopping malls, multiplexes and new business districts centred on roads such as Ashram Road, C. G. Road & Sarkhej-Gandhinagar Highway.

The eastern bank of the river houses the old walled city covering an area of about 5.5 sq km with a population of 3.2 lakhs (census 2001). It boasts of the first Urban Local Body in India, set up in 1818 AD. An efficient underground network of amenities, like electrical network and sewerage has been operational since 1887 AD. The urban fabric is characterized by a neighbourhood setting with tightly packed houses along narrow winding lanes, known as 'Pols". Each pol has a tightly knit homogeneous character, often populated by same families, caste or community, protected by gates and supported with amenities such as wells, Chabutaros for feeding birds etc. Twelve

gates served as entry and exit points to the walled city. All these including the Mosques, tombs, step wells, Jain Derasars, bazaars / Markets, administrative and commercial buildings located in and around the walled city make for a vibrant, though congested area.

Rationale of present study

The city lies in seismic zone III (Bureau of Indian standards). On 26th January 2001, a devastating earthquake struck Bhuj, located more than 300 km away from the city. The impact of the earthquake was such that as many as 50 multi storied buildings collapsed, killing 752 people and devastated the city's infrastructure. The average rainfall in the city is 93.2 cm (36.7 inches) but infrequent heavy torrential rain cause the river Sabarmati to flood. The city has experienced heavy flood situation in the year 1998, 2003, 2004, 2005 and 2006.

Issues like mixed landuse, commercialization, solid waste disposal and vehicular pollution contribute to the vulnerability of the city, especially to fire. The walled city has distinctive construction and indigenously designed features that contribute to make it resistant to earthquake, which was demonstrated in 2001 when the traditional buildings performed better than the new constructions. Minimum casualties were witnessed in the walled city as compared to that in the modern part of Ahmedabad. Post earthquake, people who had moved to newer parts of the city but still retained their houses in the walled city were seen returning. However, this appreciation did not seem to continue for long as unfortunately many traditional buildings have since been modified with new construction materials and designs which have made them unsafe besides altering their architectural character.

Moreover, the walled city has shown decreasing trend in population with large scale out - migration contributing to the degeneration of the area and the old havelis being subjected to apathy and neglect. Multiple ownership issues, legal problems have led to lack of maintenance and disrepair of the buildings. With the out migration

of local population, the residential neighbourhoods are getting commercialized and many houses have been converted into commercial stores or godowns. The buildings that survived have a rare chance to keep their ethnic character intact as due to lack of knowledge and awareness, the building materials are being replaced with mild steel girders, Kota stone in the name of renovation and repair. These changes and introduction of incompatible materials have not only endangered the heritage value but also increased the vulnerability to disasters.

Having witnessed the devastating earthquake of 2001, the walled city heritage structures need to be conserved for which appropriate guidelines for maintenance and preservation of the buildings should be developed. The organic city structure also requires specific preparedness for devastating fires. The Pol or neighbourhood based planning and earthquake resistant features in individual structures have manifested in minimal casualties during the last earthquake despite huge casualties in the 'modern' part of the city. However, in view of the vulnerability in terms of commercialization, combination of unmatched construction elements into heritage structures and maintenance, a comprehensive disaster risk management plan needs to be put in place not only to preserve the area as a unique living place, but also to infuse vitality and sustainability to the walled city.

Aim & Objectives

In view of the heritage significance of the walled city of Ahmedabad, vulnerability of heritage components to various hazards, there is a need to make a comprehensive analysis of the disaster risks and formulate a risk management plan. A project to prepare a Disaster Risk Management Plan framework was thus initiated by the National Institute of Disaster Management (NIDM) and the Ahmedabad Municipal Corporation (AMC). While part I of the project deals with the assessment of vulnerabilities and various risks to the heritage components of the walled city and developing a framework for Disaster Management, part II comprises documentation of traditional

coping practices that contributed to its resilience.

The main objectives of this study are:

- To assess the hazard, risk and vulnerability to the urban fabric of the Walled city.
- To critically analyse the vulnerability of structures, people and facilities.
- To assess the coping capacities and document the traditional coping practices.
- To prepare a framework for Disaster Risk Management for the walled city.
- To suggest measures for future risk reduction and urban regeneration of the Walled City.

Based on comprehensive risk assessment of urban cultural heritage in the Walled City, framework for preparing Disaster Risk Management (DRM) plan is proposed, which aims at reducing risks to unique heritage components (tangible and intangible, movable and immovable) from earthquakes, fires and floods and elaborating different mechanisms of disaster risk reductions viz: adequate mitigation measures, well planned response and post disaster recovery.

Methodology

The project has been executed by NIDM with assistance from the Heritage Cell of AMC. Surveys conducted during the Indo French Collaborative project were used as a base and new data collected through primary surveys. Surveys undertaken by AMC after the 2001 earthquake were referred to and data related to fire hazard was collected from the Fire department of AMC.

Scope & Limitation

The current document only makes preliminary assessment of risks to urban cultural heritage and proposes basic principles and procedures. However these need to be elaborated by responsible agencies. Also specific guidelines for mitigation, response and

recovery from earthquakes, fire and floods need to be prepared by experts on the basis of principles and procedures laid down in this plan. Upgradation of maps and undertaking primary surveys for the entire walled city were not in the scope of present study. A pilot study has been undertaken for Shantinath ni Pol in the Kalupur II ward. More such surveys could not be undertaken due to general disinclination shown by the pol residents to share information about their houses. Common issues and threats faced by the cultural heritage of the walled city have been discussed and vulnerabilities analysed based on a broad reconnaissance and a framework has been developed which would subsequently help in preparation of a disaster management plan.

Stakeholders

The Disaster Risk Management Framework is targeted for various institutions that have stake in the cultural heritage of the Walled City. These mainly include : Cultural heritage institutions responsible for protection of heritage at national and state level (Archaeological Survey of India, Vadodara Circle and Gujarat State Department of Archaeology), Ahmedabad Municipal Corporation responsible for overall management of the Walled City, Residents of traditional houses/Pols in the Walled City etc who would also play major role in the preparation, updation and maintenance of the DRMP.

The project has initiated and paved the way for undertaking actual demonstration projects in future that could explain how the traditional construction materials and techniques offer maximum resistance to the natural hazards. It also gives opportunities for other projects to be undertaken at local level such as incorporating mitigation measures and preparing disaster response plans for each and every Pol as efforts towards achieving a resilient walled city of Ahmedabad.

Chapter 2.

Profile of Walled City of Ahmedabad

2.1 Heritage Significance

The walled city of Ahmedabad comprises of the settlement founded by Ahmed Shah in 1411 AD on the east bank of the Sabarmati river. A roughly 10 kilometre long wall, known to be built by Muhammed Begda still exists in portions along with some towers / bastions and 12 historical gates. The names of gates which designate the various wards at present were perhaps also those of the leading citizens (Jamal-pur, Kalu-pur, Daria-pur etc). The layout of the city is not geometrically composed. The city was originally designed around a central axis from east to west forming a processional route stretching from the Rani no Haziro (tomb of the royal wives) to the Bhadra Fort with the tomb of King (Raja no Haziro), Jami Masjid, Teen Darwaza located in between. The Bhadra fort, the royal castle, occupies the point of highest altitude to the west within the city walls on the banks of the river. The area in front of the palace used to be the Maidan-i-Shah esplanade catering to various activities, which can still be distinguished as it is largely unoccupied by residential neighbourhoods. The lack of neighbourhoods has, however, transformed the area into a commercial hub characterized by heavy traffic, large crowd with different kinds of commercial activities all around. Today, several other streets link the fort and the gates.

Since the inception of Ahmedabad, the population of the town concentrated on trade and crafts. Thus communities grouped together in enclaves known as *"pols"* on the basis of their origins, trade and traditions. In 1871, the number of pols counted were 356. In a 2000 survey, it was found to have increased to 500 leading to a conclusion that the pols were subdivided over time. Muhurat ni Pol is known to be the first pol of Ahmedabad. The houses within the

pols were traditionally built of carved wood and brickwork. Some 10,000 of these houses still remain today, as revealed during the survey done in the year 2000. The traditional houses have developed a system for the collection and storage of rain water in tanks locally known as "tanka", one of the earliest urban water harvesting systems in the country. The "tanka" study reports on the existence of nearly 10000 water tanks in the basement of the houses in the walled city.

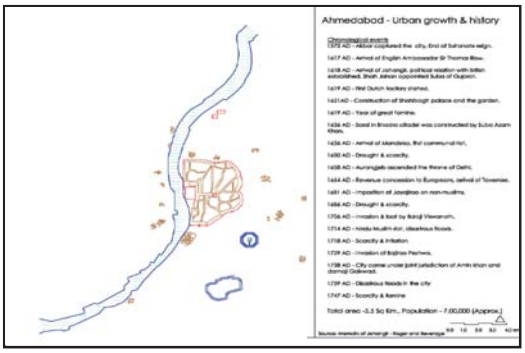
It was during the reign of Ahmad Shah and his immediate successors that the large monuments of the city were built, most of which still form major landmarks in the locality. These buildings not only borrowed stylistically from Hindu architecture, but in many cases elements of pre existing temples were incorporated into these monuments. In addition a multitude of Hindu and Jain temples as well as mosques are found throughout the city. The hydraulic works of the time were also significant. The base of the Jami Masjid served as a reservoir and the 31 hectares of the man made Kankaria Lake outside the walled city still serves as a major recreational area for the entire city.

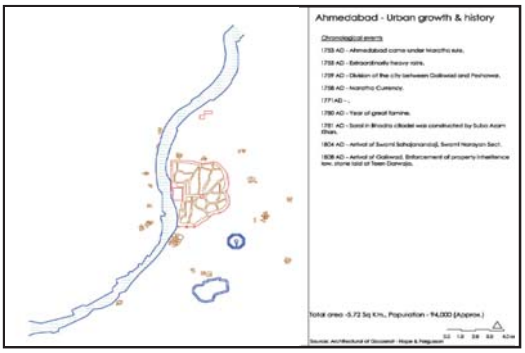
There was no significant development in the city after the end of independent sultanate in 1572 AD, during the Mughal rule and the Maratha occupation until the second half of the 19th century, when the textile industry brought economic growth to the city. Three textile mills were built between 1864 and 1867 and another 80 were built outside the city. Ahmedabad became known as "Manchester of India". The city's association with the freedom struggle and Mahatma Gandhi is also of great significance. In 1915, Gandhiji founded the Satyagraha(Sabarmati) Ashram, which opened an important new phase in the history of the city. In the 1930s, the city became a financial and political base for the Indian National Congress and was at the helm of many great national movements. Apart from the Sabarmati Ashram on the banks of river to the north west of

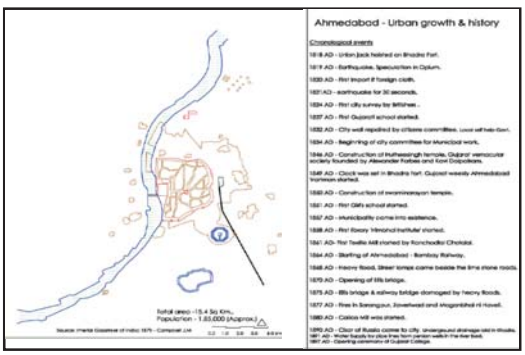
the walled city, many other buildings/ havelis inside the walled city are associated with the Indian Independence movement . After independence, in 1950, Le Corbusier and Louis Kahn were called upon by industrialist families to construct remarkable buildings. Buckminster Fuller built the dome of a shopping centre known as the Calico Dome in the centre of the Walled city.

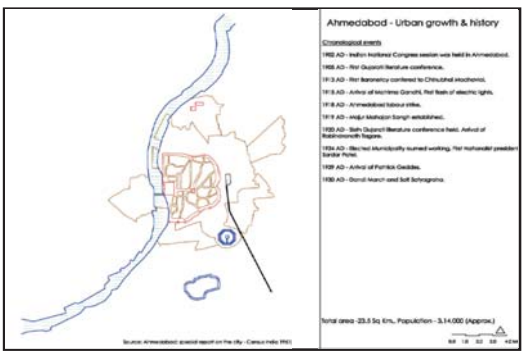
Besides the unique urban character and planning of the city, the tangible Heritage components of the Walled city of Ahmedabad could be broadly listed as -

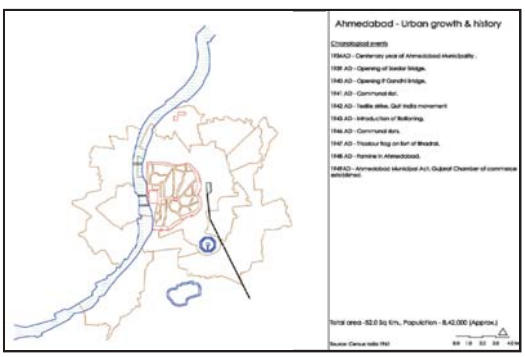
1. **Remaining portions of the city walls with the bastions / towers.**
2. **12 Historical gateways,**
3. **Bhadra Fort and other Muhammedan monuments,**
4. **Several old Hindu and Jain temples,**
5. **Residential neighbourhoods known as "Pols' and its components. 6. Traditional Residential Havelis.**

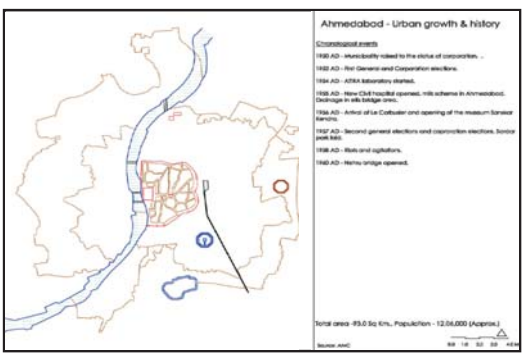






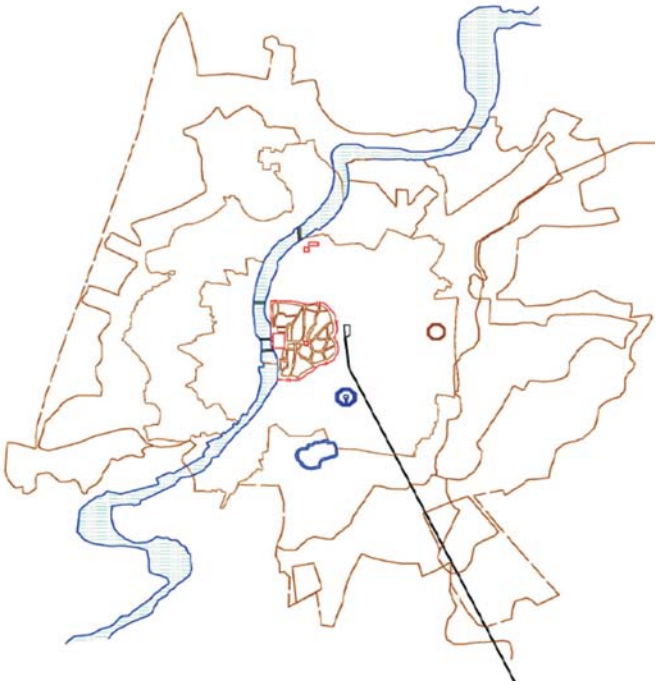






City Evolution - Ahmedabad

Ahmedabad - Urban Growth & History



Ahmedabad - Urban growth & history

Chronological events

1961 AD - Ahmedabad became capital of new state of Gujarat. Lalit kala Academy established .

1962 AD - NID, IIM, School of architecture, Indology, Darpan Academy started.

1963 AD - Arrival of louis khan. Third Corporation elections.

1968 AD - First Multistoreyed building. ISRO space application centre established.

1969 AD - Communal riots.

1970 AD - Capital shifted to Gandhinagar.

1971 AD - School of planning started. Drive in cinema started.

1975 AD - Subhash bridge opened.

1976 AD - AUDA established. Premabhai hall completed.

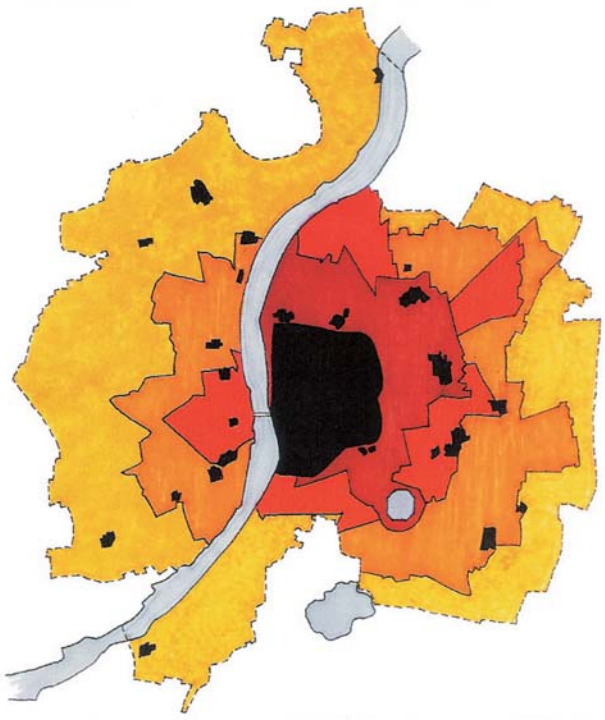
1978 AD - Arrival of R. Buckminster Fuller.

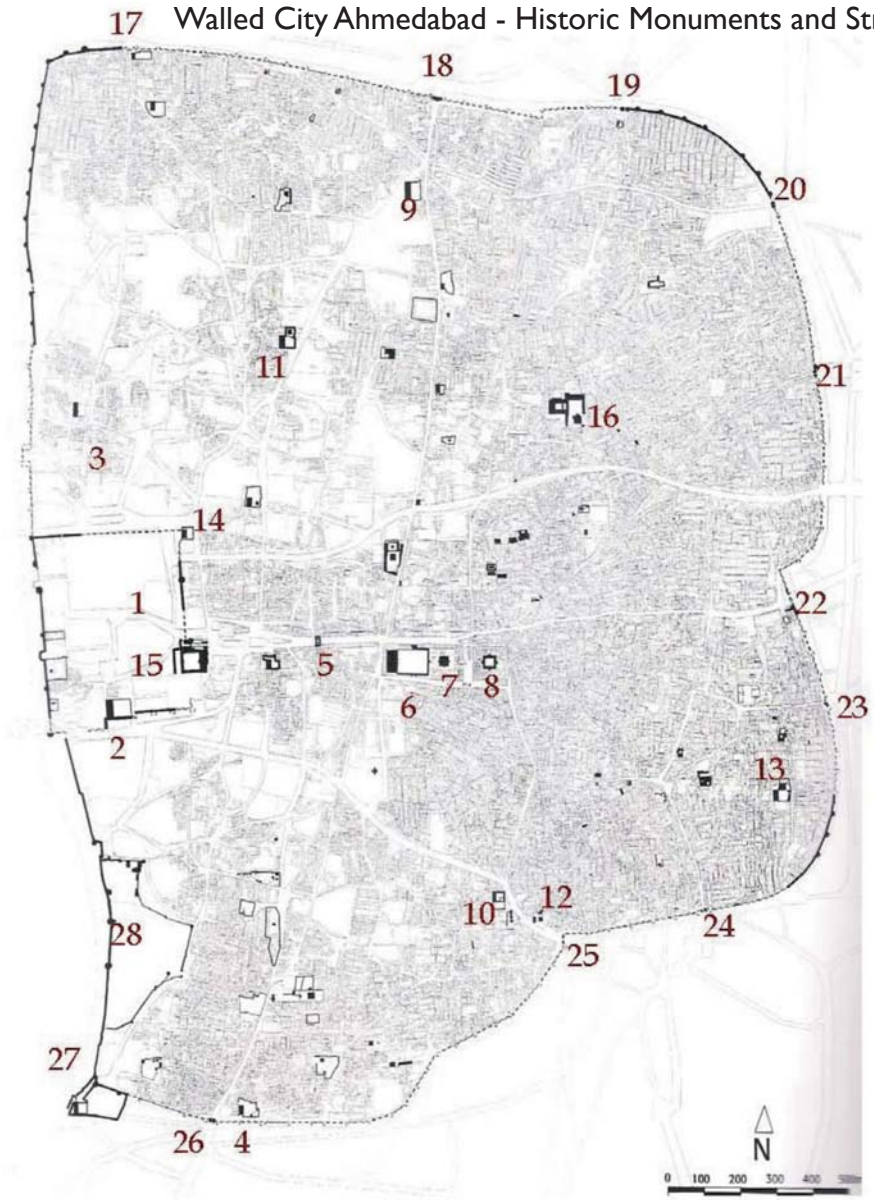
1981 AD - Vasna Barrage Scheme realised.

Total area -271 Sq Km., Population - 23,80,000 (Approx.)

0.0 1.0 2.0 3.0 4.0 km

Source: Ahmedabad urban Complex - AUDA





1. Bhadra Fort (Clock tower and other remains) 2. Mosque of Ahmad shah 3. Mosque of Sayyid Alam 4. Haibat Khan's mosque 5. Teen Darwaja 6. Jami Mosque 7. Tomb of Ahmad Shah 8. Rani ka Hazira 9. Mosque of Qutub Shah 10. Mosque of Dastur Khan 11. Rani Rupavati's mosque 12. Mosque & tomb of Rani Sipri 13. Ek Toda Masjid 14. Sidi Sayyid Mosque 15. Azam Khan's palace 16. Swami Narayan temple 17. Shahpur gate 18. Delhi gate 19. Dariyapur gate 20. Premabhai gate 21. Kalupur gate 22. Panchkuva gate 23. Sarangpur gate 24. Raipur gate 25. Astodia gate 26. Jamalpur gate 27. Khan Jahan gate 28. Gaekward haveli. The bold black line on the periphery shows remains of city wall

2.2. Heritage Components

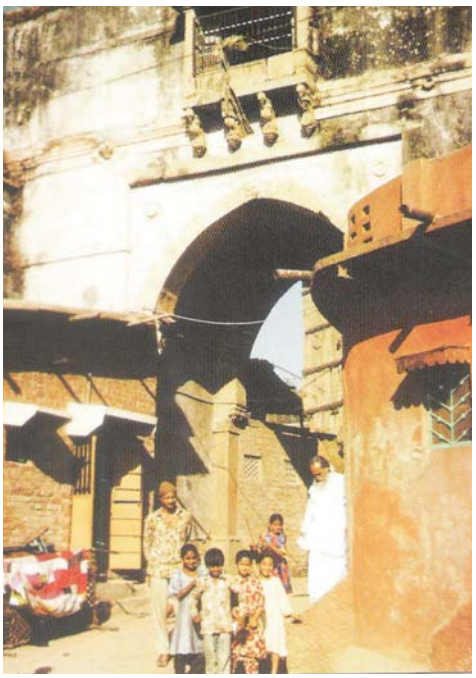
2.2.1. Monuments

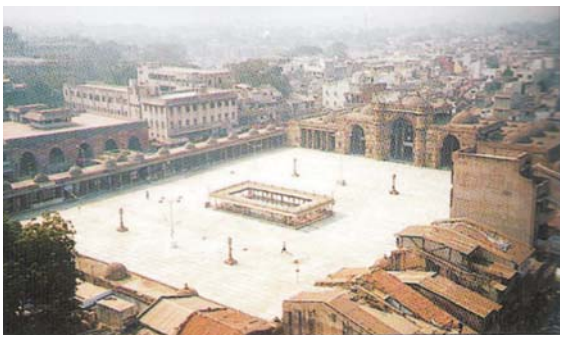
The monuments of Ahmedabad are unique as they combine the indigenous system of construction and decoration by Hindu master craftsmen with the ideas and traditions of Muhammedan rulers. The mosque and tombs are rich in detail; the delicate tracery and ornamental minarets make them most distinctive and finest examples of the Indo - Saracenic style.

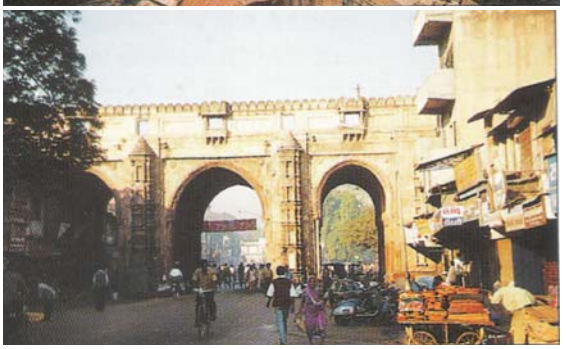
The monuments erected by Sultan Ahmad Shah and his successors are all in stone and some of them have marble pillars. The Bhadra fort is a small square building with several gates, two of which are presently in existence along with two imposing towers. There is no trace of the royal palace complex except the royal mosque; which Ahmad Shah built in 1414AD mostly out of materials brought from the pulled down temples. The interior has entirely Hindu character with pillars and there is not a single arch. The most important monument of this era is the Jami Masjid regarded worldwide as one of the most beautiful mosques in the East. The Jami Masjid has been highly admired for its beautiful architecture and fine adaptation of Hindu design by historians and archaeologists alike The mosque has 260 sandstone pillars entirely of Hindu style and fifteen domes; each dome being supported on eight columns. The central arch is flanked by two minarets, the upper part of which were unfortunately lost to an earthquake in 1819. The minarets originally consisted of four storeys, elegantly proportioned and richly decorated. In common with some other minarets at Ahmedabad, they possessed the peculiarity that when one was shaken it communicated a vibratory motion to the other, though not the slightest tremor or agitation was perceptible in the intervening roof. These minarets represent a wonderful engineering skill in the world. Near the Jami Masjid are the Badshah-ka-Hazira and the Rani-ka-Hazira, which are the

beautiful works of art exquisitely finished to the minutest details. The King's rauza is a massive domed building with a central hall, deep pillared verandahs. The Teen Darwaza to the east of the Bhadra fort is the sole memorial of the Maidan Shahi, which originally formed the grand approach to the Bhadra citadel. A number of other monuments built by the Sultan and his nobles are worthy relics of the glorious period. Rani Rupamati's mosque on Mirzapur road, Rani Sipri's mosque and the tomb near the Astodia gate are exquisite works of art. The upper parts of the minarets of Rani Rupamati's mosque were destroyed by the earthquake of 1819. The Sidi Sayyed Masjid built in 1572 in the north east corner of the Bhadra Fort has the most attractive features in the form of its intricate stone traceries of the arched windows. The gateways are imposing structures. Outside the walled city, there are other significant monuments such as Sarkhej Roza, Kankaria Lake, Shahibagh, Adalaj ni Vav etc. Little is left of the secular architecture of that period. The houses which have been built on the ruins of earlier houses represent the arrangement and decorations of the houses of the Sultanate.

The walled city has numerous Hindu and Jain temples. The Jain temples are so well decorated that they seem like the art of goldsmith. The Hindu temple of Shri Swami Narayana in the Kalupur ward and the Jain temple of Hathisingh outside the walled city are two outstanding examples. 24 monuments in the walled city are protected by the Archaeological Survey of India (ASI).







Left : Bhadra fort, right above - Jama Masjid & below- Tin Darwaja.
Picture source - Indo French report 2001

Ek-Toda Masjid, Panchkua darwaja (right)

Rani Shipri Tomb and Masjid, Raipur ward. near Astodia darwaja

2.2.2. Pols

The walled city of Ahmedabad has a rich architectural and urban character. It is a direct manifestation of the socio economic conditions as exhibited in its compact and climatically responsive housing. The neighbourhoods have a typical morphology with their winding streets that periodically open out to small chowks or squares. Such neighbourhoods are called *"Pols"* inhabited by a community of the same religion, caste or trade and this holds true even today. The houses are grouped together along the interior streets. The dimension of the pols vary ranging from few houses to several hectares. The areas outside of the pols is known as "naka". The limits of the pols facing the roads (outside the pol) are identified by facades onto which small shops have been built but which remain in non pol space. The houses on the border line between pols can be identified by their large plinth structures, blind walls and the small windows on their frontages. There can also be narrow alleys in the space separating two pols. One of the distinguishing features of a Pol is the

arrangement of continuous row houses facing the interior roads. Often, Pols have Khadki, in which houses of the same family or relations are grouped around a private courtyard entered through a gate. The temples and derasars (local name of a Jain temple) have the privilege of being constructed on separate plot, very few independent havelis are found in a pol. A typical pol is characterised by the following features:

•**The Gate -** The entrance gate through which the pol is accessed from the main street. One enters the tranquility of the pol upon passing through the gateway, the width of which normally varies from 12 - 15feet. A steep stairway leads to the guard's quarters located on the upper floor of the gate. To maintain access control, the main doorways are kept closed, only a small wicket gate in one of the leaves allows entry and exit of one person at a time. Not every Pol has gateways.

• **The temple** nearby the entrance of Hindu or Jain pols is the ritual place for puja and daily offerings.

• **The blackboard** onto which are written the dates of the feast days, weddings or other information for the inhabitants the pol bearing witness to the existence of collective life.

• **The bird's feeder or chabutaro**, a pole supporting a platform covered by an awning. The inhabitants bring food here for the birds. The chabutaro is usually crafted out of craved stone or wood or moulded in stucco or plaster. The existence of more recent versions in sheet metal or concrete demonstrates that these practices are still very much alive. The walled city has, today, approximately 100 chabutaros in its pols and streets. It is also common to find 'bird facades" comprising many niches or holes in the blind facades of houses or trays which hang under the roof.

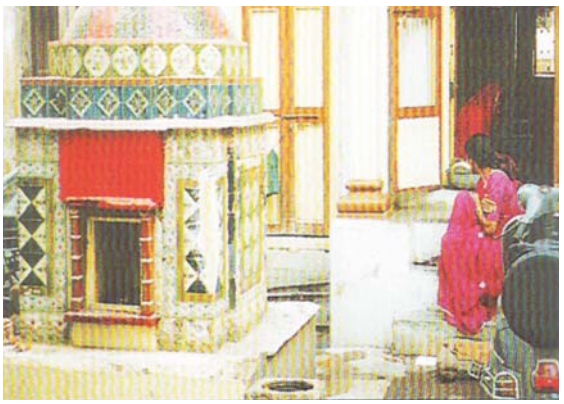
•**Wells**- most of these have been sealed off and their sculpted brim removed due to the lowering of the water tables.

•Water pots atop podiums at the entrance of the pols are kept for thirsty passers-by.

•Pols used to have community toilets as toilets originally did not find a place inside the houses. The community toilets do not exist any more as they are being incorporated inside the houses.

•The streets and small quarters inside the pols are used for ceremonies, feasts and re-unions. The ground is paved with kota stone which have now increasingly given way to asphalt with the arrival of the motorcar.

Sketch showing compact nature of pols & arrangement of plots and the houses inside



Pol features- clockwise (Pol gate, blackboard, temple, kotastone paving, well, Pol gate)

Picture source - Indo French report 2001

A wooden chabutaro in Khadia

2.2.3. Houses

Stylistic evolution

In terms of stylistic evolution of forms of houses, they can be divided into five broad types:

•The 'Indigenous" or "Hindu" idiom from the founding of the city up to the end of 17th century - this category only concerns the monumental buildings. No houses of this period is found in the city.

•The "traditional' idiom from the late 17th century until British dominion - this category groups together facades of carved wood free from any western influence.

•The 'progressive" or "colonial' idiom influenced by new construction from British dominion until independence. This category includes facades which purposely combine elements from both antique and western forms (Corinthian, Gothic) with traditional forms.

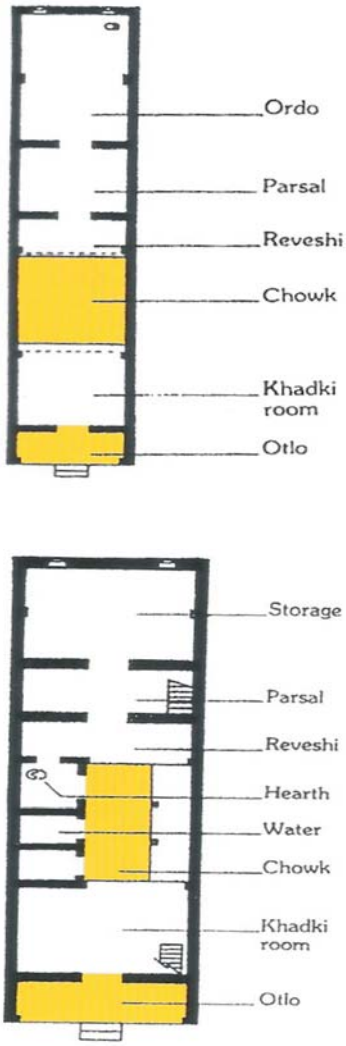
•The "Neo-Progressive" or "Eclectic" expression (from 1920s until 1950)comprises facades free of any traditional elements and which combine stylistic vocabulary borrowed from western architecture, which includes stucco facades or concrete materials.

• The "modern" or "Art deco" expression, from roughly 1940 to about 1960s, this category comprises facades with cement decoration and far less common wood decoration .

The survey conducted in the walled city of Ahmedabad in the year 2000 reveals that 30000 buildings were found to be interesting, 1200 buildings were remarkable and more than 430 buildings have exceptional character irrespective of the style mentioned above.

Description of a typical traditional House

The houses of the walled city have a typically laid out plan form with elaborately decorated facades with projections or windows on the first floor. The richly carved interiors indicate the prosperity and the aesthetic values of the owner. Whether large or small, the



Typical distribution of a traditional house

houses were built against one another with a shared wall. Most of the houses are of limited surface area, narrow and deep. The height of ground floor is usually 2.5 to 3 meters, however it goes up to 4 meters for houses with western influence. The houses consist of two parts with a courtyard in between linked up by passages. As a general rule, the rear portion is higher than the front portion that looks onto the street. Roofs have two slopes with the roof crest running parallel to the street. The rear portion is partly covered by a terrace for the collection of rainwater for storage in the water tank - *'tanka'* in the basement. Access to the house is provided by the *Otlo* which is a place of exchange with the outside world. Most often the door to the house is located in the middle of the facade. When the ground floor is used for commercial purposes or as a workshop or if the house is separated into several dwellings, a second side entrance provides access to the upper storeys.

The first room or *Khadki* opens into the chowk. Air circulation and visibility into the house from the street to the rear building is provided by well - aligned windows. The chowk or central patio which comes after the first entrance room is an open space - with a semi covered space, *Osari*- into which the ground floor rooms are connected as well as those on the upper floors. On one of the sides of the chowk is the room for water, the *paniyaru*, containing the brim of water tank, the *tanku*, or a stone pedestal sealed into the masonry to store the earthern jugs. The kitchen, *Rasodu*, also opens into the chowk as does the prayer room, the puja.

The *parsal* and *ordo* are the rooms in the building behind the osari flanking the chowk. A ladder leads to the upper floors or *Baithak*. Toilets were originally common in the pol or located in the rear portion of the building called

the *chinni.* After the creation of sewage system and piped water supply these were moved to the front facade on the otlo. Roughly 20% of the houses are open spaces.

There are many variations to the standard house plan consisting of the use of an overhanging upper floor, verandha (*loggias*) and different interior divisions. There are also double houses, laid out in symmetric repetition, houses with a carriage gate, these are exceptional and to be found only on large buildings or those dwellings which were built around a central courtyard. There is also a small number of enclosed houses, which comprise several dwellings around a large courtyard.

Typical Pol house

Types of wooden frame structures

Four types of structure predominate, as follows :

1. Bare plumb facade,
2. Facades with overhang of upper floors borne by posts,
3. Facades with cantilever over the ground floor,
4. Facades with cantilever and overhang borne by ground floor posts.

These facades consist of a main frame of teak wood and an inset of either wood or masonry. Irrespective of the type of facade, the transfer of load to the ground is accomplished by the beams and poles onto the stone pedestal formed by the otlo. The wooden elements are arranged in the following fashion:

-the column formed at its base, its shaft and its capital

-a front bracket, a rear corbel, two lateral corbels

-the edge beam

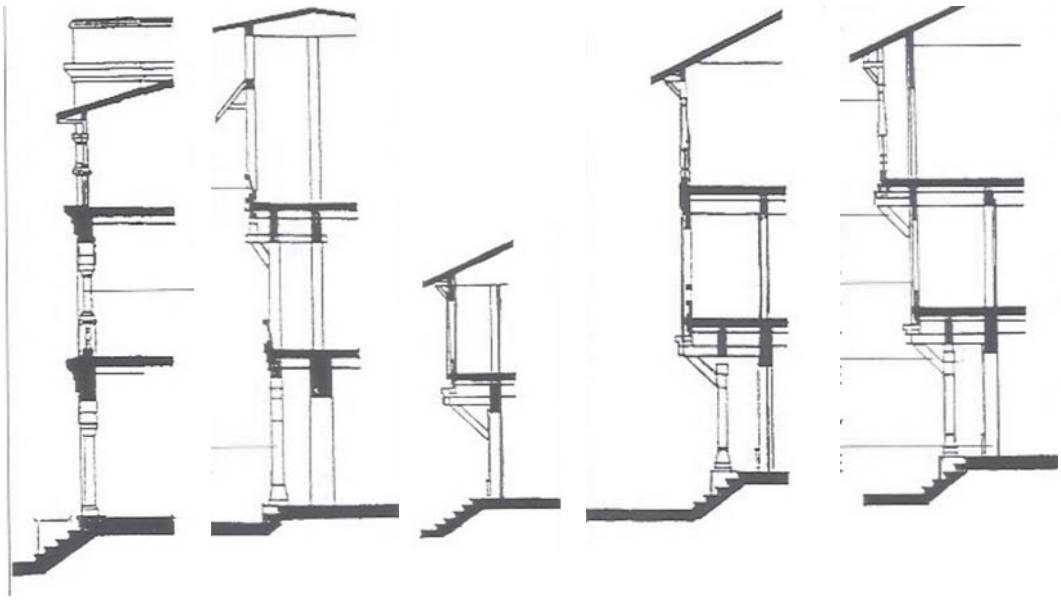
-the floor stud

-added ornaments for decorative purposes.

The facades giving onto the courtyard were designed in the same way as the main facades. They have less decoration and cantilever is either reduced or non existent. Rear facades are in masonry as are the side facades.

Materials

The main materials used in the constructions of old houses are wood, brick. Stone was used less, which was used solely for the basement and the otlo and also as pedestal for posts, and for laying of floors over the wooden structure. The region around Ahmedabad has no forests. Amongst the local wood, Sadad and Mohuao was available, which used in the continuous ties to reinforce the masonry. Teak, which was used primarily in all the building were imported from Daman, Malabar and Burma.



Four major structural types of wooden frame structures
(from L-R) 1. Bare Plumb facade, 2. With overhangs of upper floors borne by columns, 3. With cantilever over the ground floor, 4a & b. With cantilever and overhang borne by ground floor columns

Building Technique

FOUNDATION - Foundation consists of continuous footings made of brick and earthern mortar consisting of clay and a small amount of lime. Foundations are as deep as 2.5 meters and their width varies from wall thickness to twice the thickness of the walls they support.

WALLS- Walls are built of brick masonry with clay and lime mortar. Wall thickness ranges from 35 - 60 centimeters. Facade walls are often reinforced using continuous wood lacing courses bonded by wooden headers. These wall ties which also provided support to beams or floor joists are not always bonded to the cross walls or even the lateral external walls. At the bottom of back facades, a 20 to 30 centimeters additional thickness or strengthening wall forms a plinth and reinforces the masonry from the ground level up to the foundation thereby limiting ground stress and deflecting rainwater run-off outward.

FLOORS- Main beams run parallel to the facade and transfer their load to the shared walls and or to the wood posts. The most widely used wood is teak.

ROOFS- There are two types of roof frames. In the first type, the purlin rests from gable wall to cross wall and from cross wall to cross wall. In the second type, purlins rest upon an intermediate support consisting of a false truss comprising two principal rafters i.e. a tie beam and uprights at a right angle from each purlin. The roof was originally made of small tiles (30x10x5 cm) placed upon ribs or bamboo set in the direction of slope. Only few houses still have the roof tiles, which mostly have been replaced by corrugated sheet or terraces.

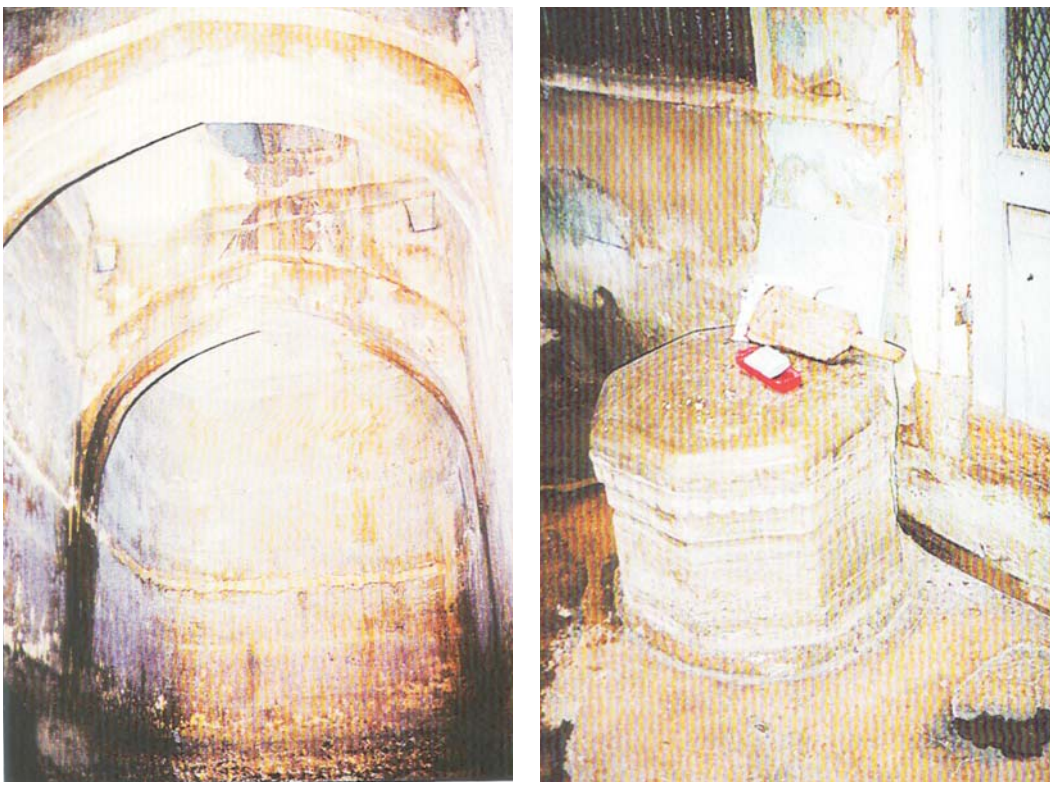
Foundation & wall structure

Picture source - Indo French report 2001

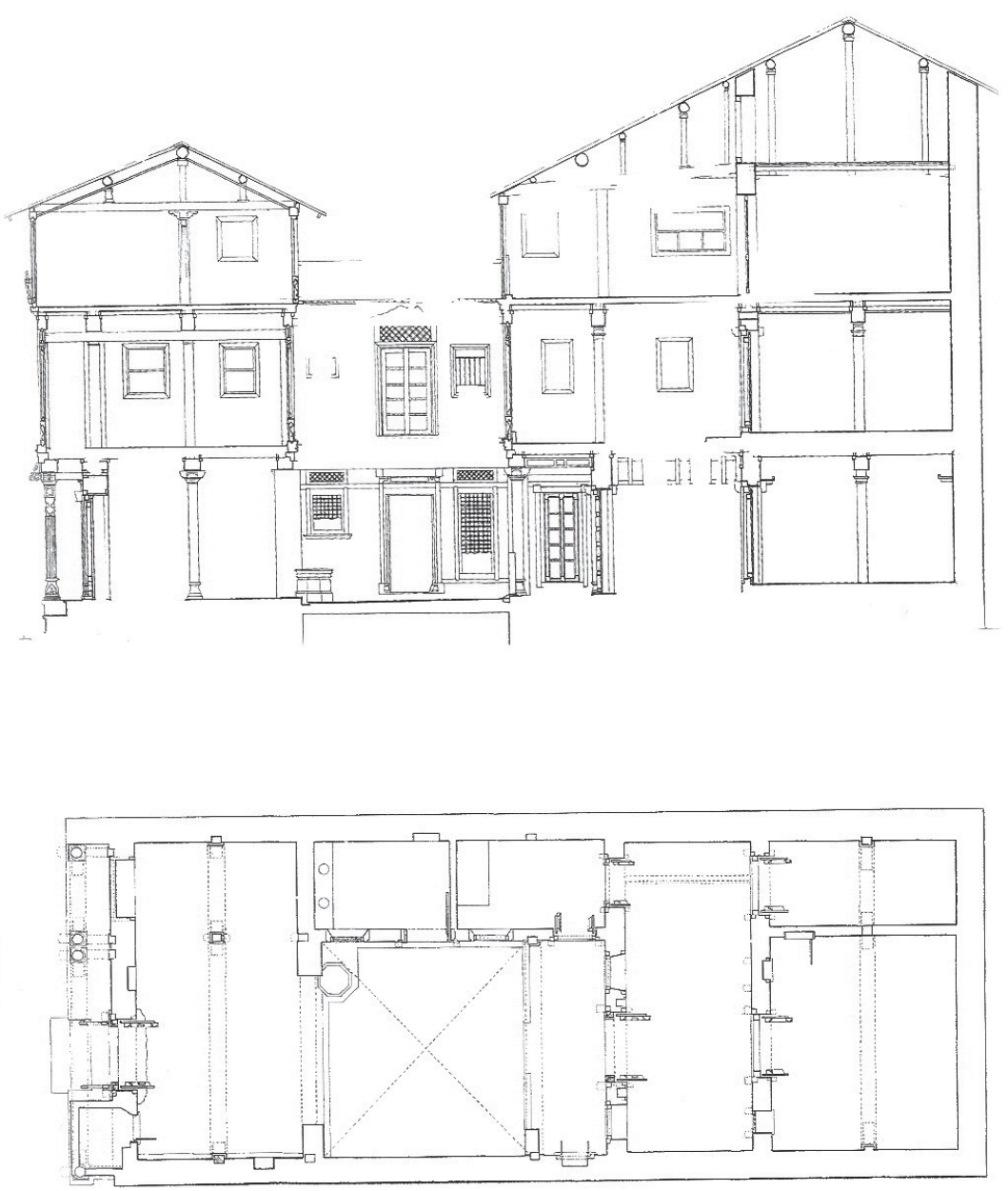
Lacing course with timber within the brick masonry

2.2.4 Water tanks

The underground tanks that gather rain water off the roof are located under the interior courtyard . They are made of masonry and are coated with lime plaster (lime, sand, brick aggregate). Stone arches are used to transfer the load of the posts. The Puja room and the cover of the Tanka share the same space denoting the sense of sacredness which is attached with water. The size of tanka varies from house to house; average storing capacity of a tanka is about 25000 litres. Its height varies from 13 - 15 ft. The shapes don't follow any strict rules. The plan form is usually organic.

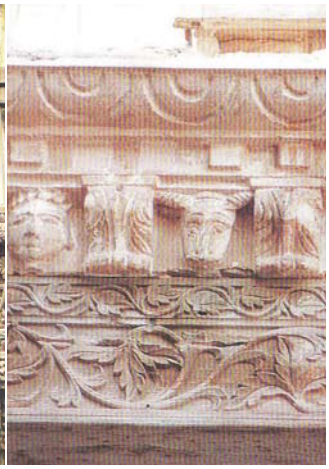


Tanka - interior and the stone cover
Picture source - Indo French report 2001



Plan and cross section of a typical traditional wooden frame house in the walled city

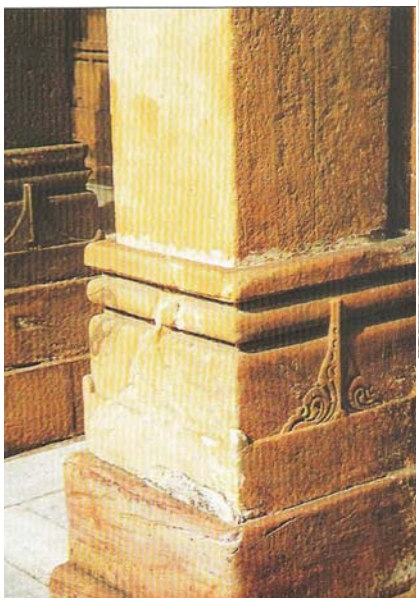
Traditional style



Composite style

Traditional style

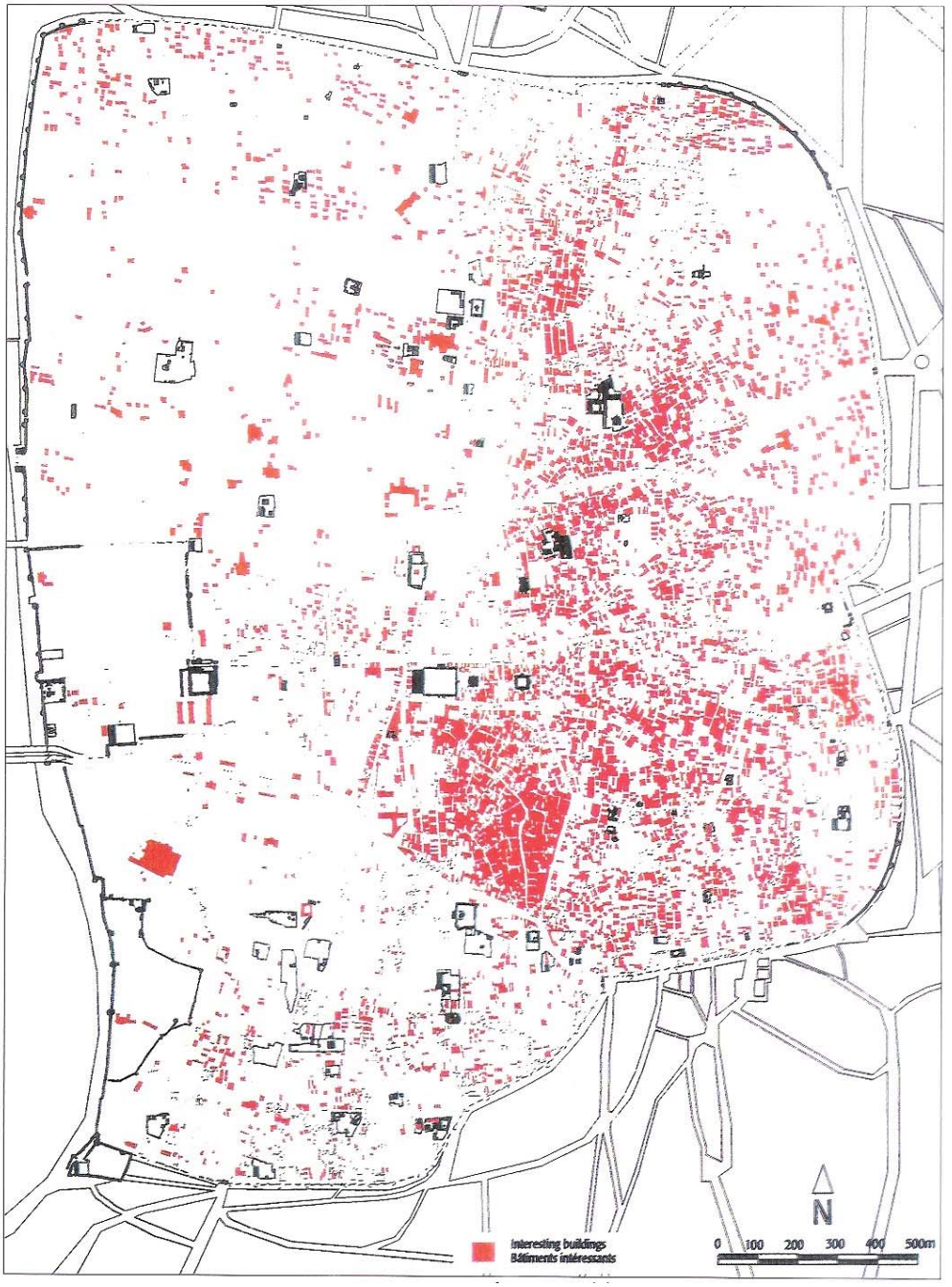
Composite style



Muhammdean style

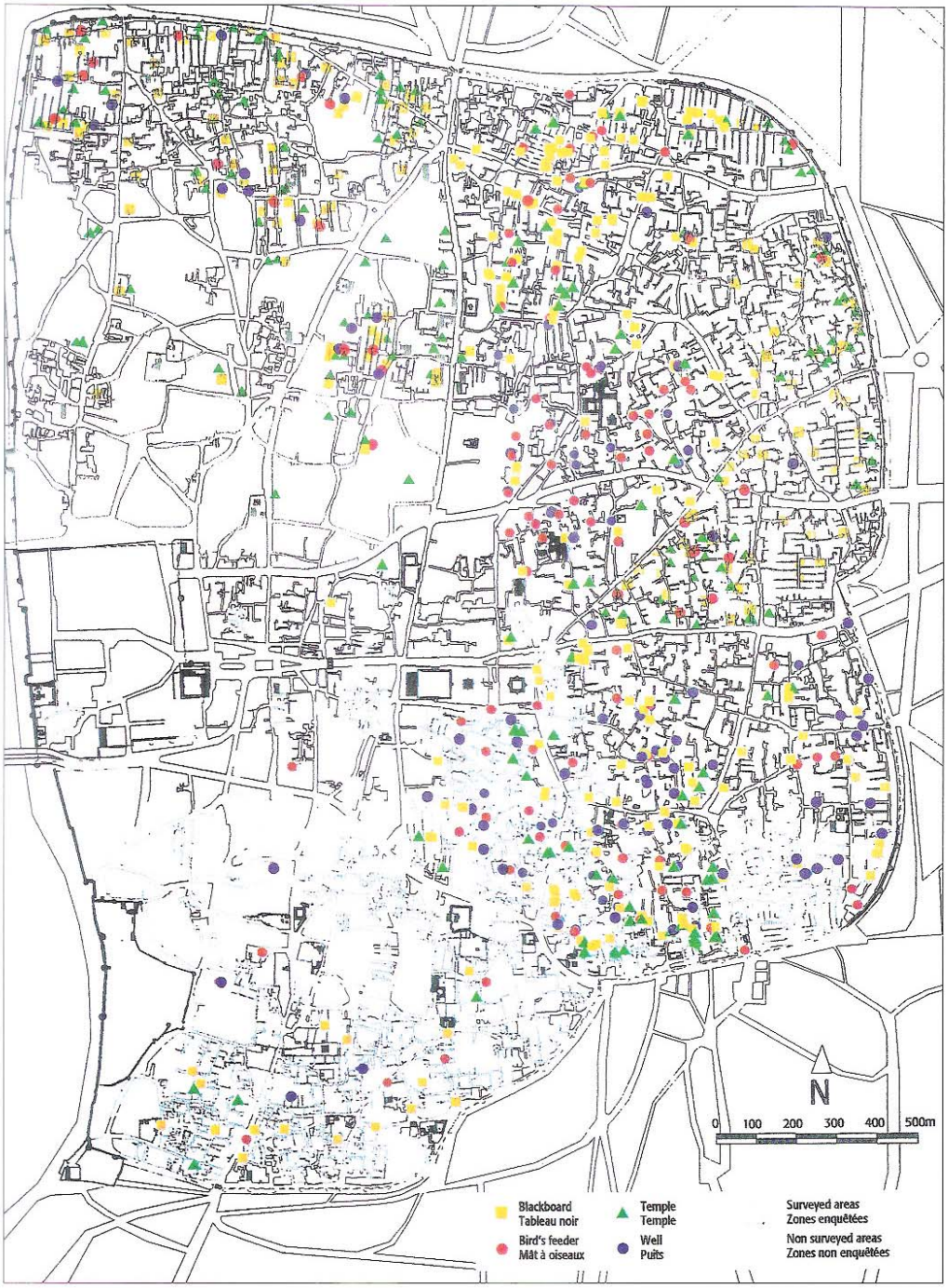
Wood carved houses

Picture source - Indo French Report



10,000 Interesting (heritage) building exist today in the walled city

Map source - AMC Heritage Cell



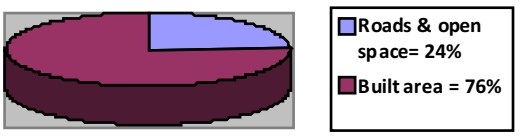
Pol features - map, Map source - AMC Heritage Cell

2.2. Present Scenario

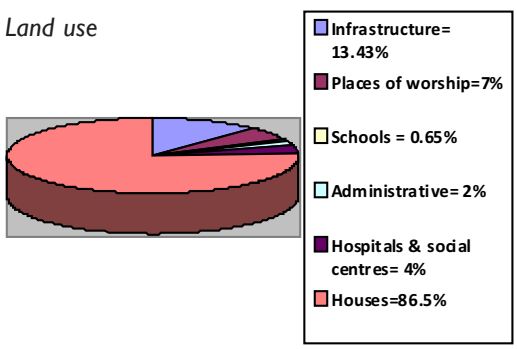
The walled city of Ahmedabad has an area of 7.4 Sq km (549 hectares) 76% of which is covered by the built area. The data below shows the compact nature of the walled city urban fabric.

S no.	Spaces	Surface area in hectares	Percentage of the total
1	Total	549	
2	Roads and open spaces	132	24%
3	Built	417	76%
3a.	Infrastructure	56	
3b.	Places of worship (temples & mosques)	28.7	5.3%
3c.	Cultural & creational (schools & theatres)	2.7	0.5%
3d.	Administrative facility (town hall, post office, police)	8.3	1.5%
3e.	Social facility (hospitals, social centres)	16.2	2.9%
3f.	Housing, shops, offices	361	65.8%

Propartion of Built-up area



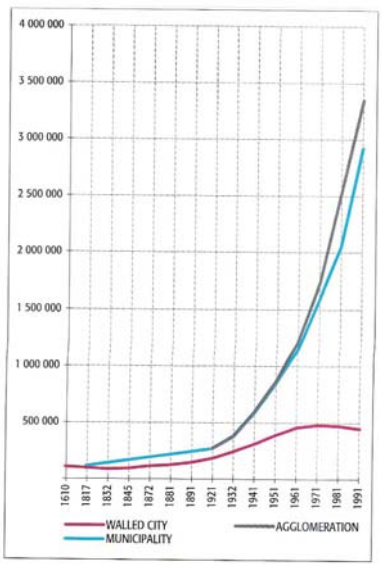
Land use



The 417 hectares of housing blocks comprise 63,000 parcels. With the exception of large plots or those resulting from parcel regrouping for new buildings the average surface area of parcels for houses varies only marginally from 60 to 70 sqmts. These parcels are 5 to 6 meters wide and generally range from 12 to 18 meters in depth.

The walled city shows a trend of decreasing population over the decades. According to the 2001 census data, the walled city has 3.2 lakhs population while 1991 census data shows the walled city population to be 4.39 lakhs. The walled city which accounted for 64% of total population of the Urban agglomeration in 1932 accounted for only 15% in 1991, which indicates major developments outside the city. The average population density in 1991 was 800 inhabitants per hectare., while it exceeded 1400 per hectare in 5 of the 13 wards. The 1824 census revealed 30,000 houses, roughly one half the current 63,000 parcels. The walled city, which was divided into 13 municipal wards until 1990 is now confined to 6 wards. The 2011 census however has shown an increase in population, that has gone up to 3.67 lakh.

Date	Walled city	Municipality	Agglomeration
1610	100000		
1817	88000	120000	
1832	90000		
1845	95000		
1872	117000		
1881	127000		
1891	148000		
1921	185552	274007	274007
1932	244792	382768	382768
1941	314396	591267	595210
1951	393941	837163	877329
1961	459535	1149918	1206001
1971	480735	1585544	1741552
1981	474223	2059725	2548057
1991	439043	2917343	3352849
2001	320000		4525000

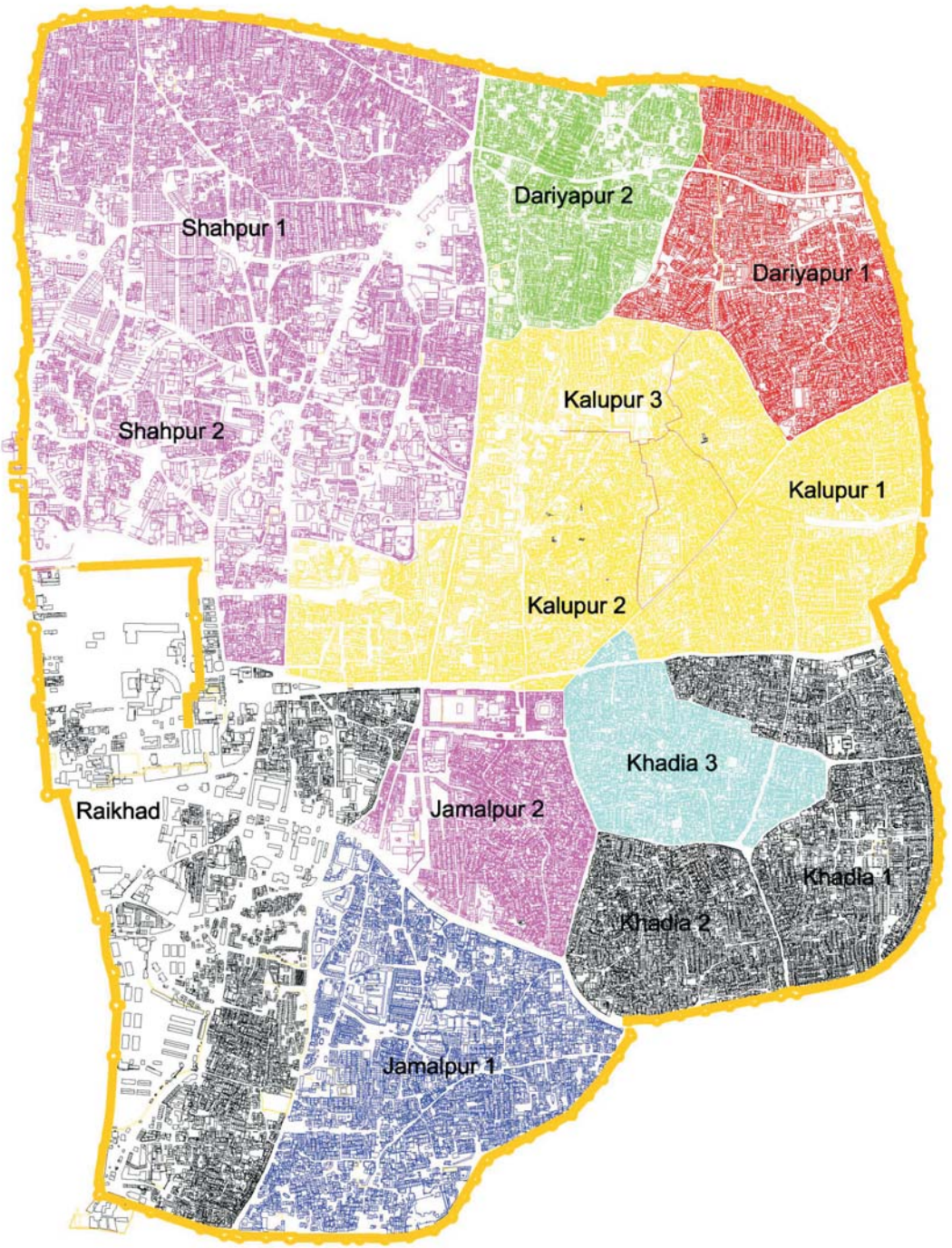


SURFACE, POPULATION, WARDS' DENSITY

WARD	SURFACE (HA)	1932 POPULATION	1932 DENSITY (inhab/ha)	1961 POPULATION	1961 DENSITY (inhab/ha)	1991 POPULATION	1991 DENSITY (inhab/ha)
KHADIA I	33,7	19 738	*586*	34 035	*1011*	23 155	*688*
KHADIA II	18,1	13 844	*764*	25 797	*1424*	29 575	*1632*
KHADIA III	25,9	11 991	*463*	21 548	*832*	20 232	*781*
JAMALPUR I	57,0	27 761	*487*	51 706	*908*	21 109	*371*
JAMALPUR II	28,5	13 355	*469*	23 170	*814*	24 639	*865*
RAIKHAD	98,4	21 157	*215*	41 677	*424*	26 893	*273*
KALUPUR I	25,9	17 960	*694*	31 380	*1212*	37 172	*1436*
KALUPUR II	28,5	18 418	*647*	33 331	*1170*	46 315	*1626*
KALUPUR III	31,1	15 175	*488*	26 198	*843*	49 238	*1585*
DARIAPUR I	33,7	21 884	*650*	43 678	*1298*	29 981	*891*
DARIAPUR II	23,3	17 473	*750*	31 465	*1350*	43 026	*1847*
SHAHPUR I	36,2	20 297	*560*	41 038	*1132*	47 075	*1299*
SHAHPUR II	108,7	25 842	*238*	54 512	*501*	40 633	*374*
TOTAL	549,0	244 895	*446*	459 535	*837*	439 043	*800*

Ward no.	Ward name	Census 1991	Census 2001	Census 2011
1	Khadia	67350	54570	49408
2	Kalupur	68930	61106	53630
3	Dariapur	68733	63081	63664
4	shahpur	63972	62694	68150
5	Raikhad	66738	64646	66855
6	Jamalpur	62687	66536	66246

source - Indo French report 2001 except the bottom right, which is from collector office, Ahmedabad



Ward Map - 13 wards shown in different colours and the wall conjectured. For the extent of city wall surviving today, refer to the heritage significance map.

Chapter 3.

Risk Analysis : Hazard,Vulnerability and Capacity

MAIN HAZARDS & THEIR IMPACTS

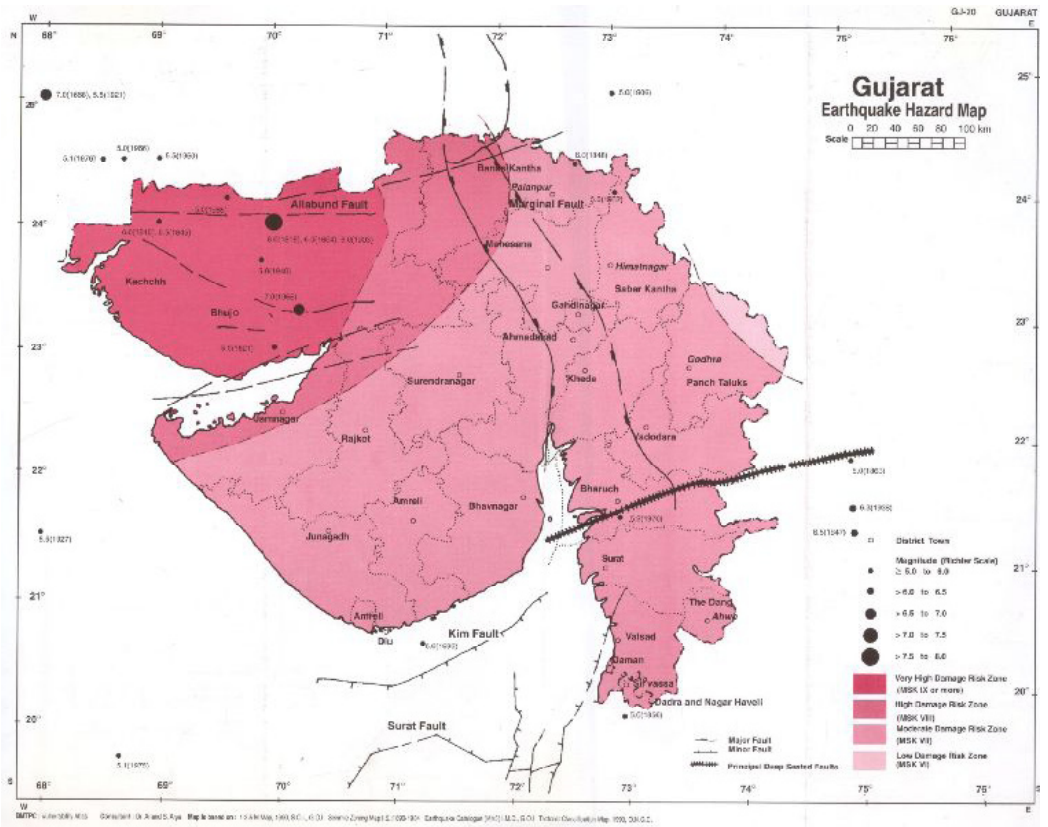
3.1 PAST RECORD

The state of Gujarat has a long history of cyclones, droughts, floods and earthquakes.

Cyclones 1850, 1881, 1893, 1897, 1903, 1917, 1920, 1933, 1947, 1948, 1961, 1964, 1975, 1976, 1978, 1981, 1982, 1983, 1990, 1993, 1996, 1998, 1999
Major Droughts 1987, 1998, 1999, 2000
Floods 1980, 1989, 1991, 1993, 1994, 1996, 1997, 1998
Earthquakes 1819, 1845, 1847, 1848, 1903, 1938, 1956, 2001

While Gujarat coast is prone to cyclones, the recurrent natural calamity which the state repeatedly faces is drought and deficiency of rainfall. The seismic map of Gujarat shows the Kutch region which is in zone V has been classified as the most earthquake prone region. Parts of the several adjoining districts are in zone IV, while others are in zone III. Ahmedabad in zone III has faced the devastating impact of 2001 earthquake.

In Ahmedabad, the most serious hazards in the past, as recorded, were the earthquake of 1819, the floods of 1868, 1875 and 1927, the fire of 1877, the famine of 1899 - 1900, the plague of 1896 to 1907 and 1916 to 1918 and the influenza pandemic of 1918 - 1919. Among other hazards, fires and vehicular accidents have the potential to cause disasters. Other issues like solid waste, vehicular pollution, overlapping of mixed landuse etc contribute to the vulnerability of the city.



Gujarat Earthquake Hazard map. source - Vulnerability Atlas of India (BMTPC).

3.2 EARTHQUAKE

Of all natural hazards, earthquake is recognized as perhaps the most devastating as it strikes without notice. Earthquake is a shaking or trembling of the earth's crust caused by the release of enormous waves of energy due to sudden movement along the fault lines or due to volcanic forces breaking the rock beneath the surface. Ground shaking, landslides and liquefaction are some of the phenomenon associated with such movements. The magnitude of an earthquake is measured on the Richter scale in terms of energy released at its point of origin. Buildings vibrate as a consequence of ground shaking and seismic waves propagate in all directions causing the ground to vibrate at different frequencies. India has been divided into four seismic zones, zone II being the region of lowest activity and Zone

V being the region with highest hazard. Earthquakes with magnitudes in excess of 7.0 occur in the areas of Zone V, which constitutes 12% area of the total area of our country. 26% area lie in Zone III while a large section, around 44% lie in Zone II.

Ahmedabad lies in seismic Zone III at a distance of 370 odd kms from Zone V in Kutch district. The Bombay Gazetteer records that soon after the beginning of the British rule in Ahmedabad (1817 AD), in June 1819 the city suffered from a severe shock of earthquake. The shaking minarets of the Jama Mosque fell and many houses were destroyed. In 1821, 13th August, an earthquake shock lasted for thirty seconds. A slight tremulous motion was enough to swing lamps and rock chairs. Another earthquake was recorded in 1864 (April 29). It is described as a smart shock travelling from south to north, and lasting for 20 seconds with a noise like the rolling of a heavy carriage on a hard road. The high magnitude earthquakes are listed below in the table.

DATE & YEAR	**EPICENTRE**	**MAGNITUDE** (Richter scale)
1668	Sindhu Delta	7.6
June 1819	Great Rann of Kutch	8.0
August13, 1821		
1845	Lakhpat	6.0
29th April 1864		
1903	Great Rann of Kutch	6.0
1904	Great Rann of Kutch	5.8-6.0
1956	Anjar	7.0
January26, 2001	Bhachau	6.9

The recent earthquake occurred on 26th January 2001 at 8:46 am lasting about 45 seconds, recorded 6.9 Richter scale had its epicenter located about 12 km North West of Bhachau town and about 65 kms east of Bhuj. It was an extremely damaging earthquake and the largest seismic event in India in the last 50 years. This earthquake was felt throughout north west India, Pakistan, Nepal and Bangladesh. For the first time, it involved large population of many urban centres, collapse of a large number of multi storeyed buildings and damage to large number of reservoirs and dams in the region. According to the State Government, a total of 13881 persons died and 1.67 lakhs sustained injuries as a result of earthquake while the death loss faced by Ahmedabad district was 755. In Bhuj, a large number of traditional houses were purely load bearing structures made of stone masonry, which were vulnerable to the seismic forces. A large number of erstwhile princely state monuments from the Kutch region were badly affected. The Aina Mahal museum, where the Kutch art and culture were on display sustained major damages whereas the Chhatardi built in 18th century in memory of Lakhpatji turned into rubble.

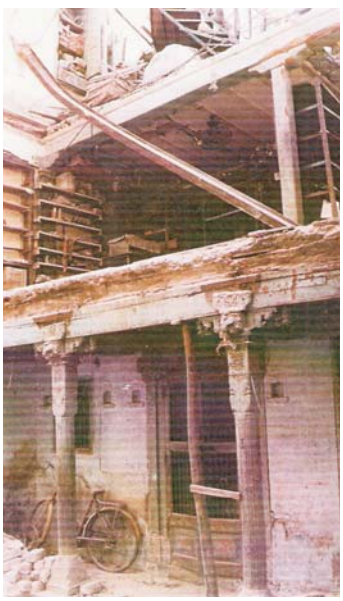
In Ahmedabad, there were cracks in a number of buildings and some of the multi storeyed buildings tumbled down as houses of cards. In Ahmedabad city alone, about 495 persons died and 888 were injured. 73 multi storeyed buildings either collapsed or had to be pulled down for safety rendering 824 families homeless. A new phenomenon was witnessed post earthquake; families who had abandoned their ancestral homes in the walled city and moved to the new areas outside returned since it was found that the walled city suffered far less than the newer part of the city. The traditional wooden houses have inherent qualities of being resistant to the external forces. Apart from some damage to the Bhadra fort, the monuments of the walled city withstood the tremors well and the few houses that were demolished were already in ruins. On a rough estimate, only about 10% of the

buildings were damaged. It appeared that the earthquake had only minor impact as most of the houses that collapsed had already been in an alarmingly unsound condition.

Chhatardi, Bhuj after the earthquake of 2001

Demolished floors (pictures above)

Damaged monuments - Bhadra fort (top picture)



Partial collapse of house

Collapse of upper floors has also damaged the neighbouring house

Damaged house supported with temporary props

3.3. FIRE

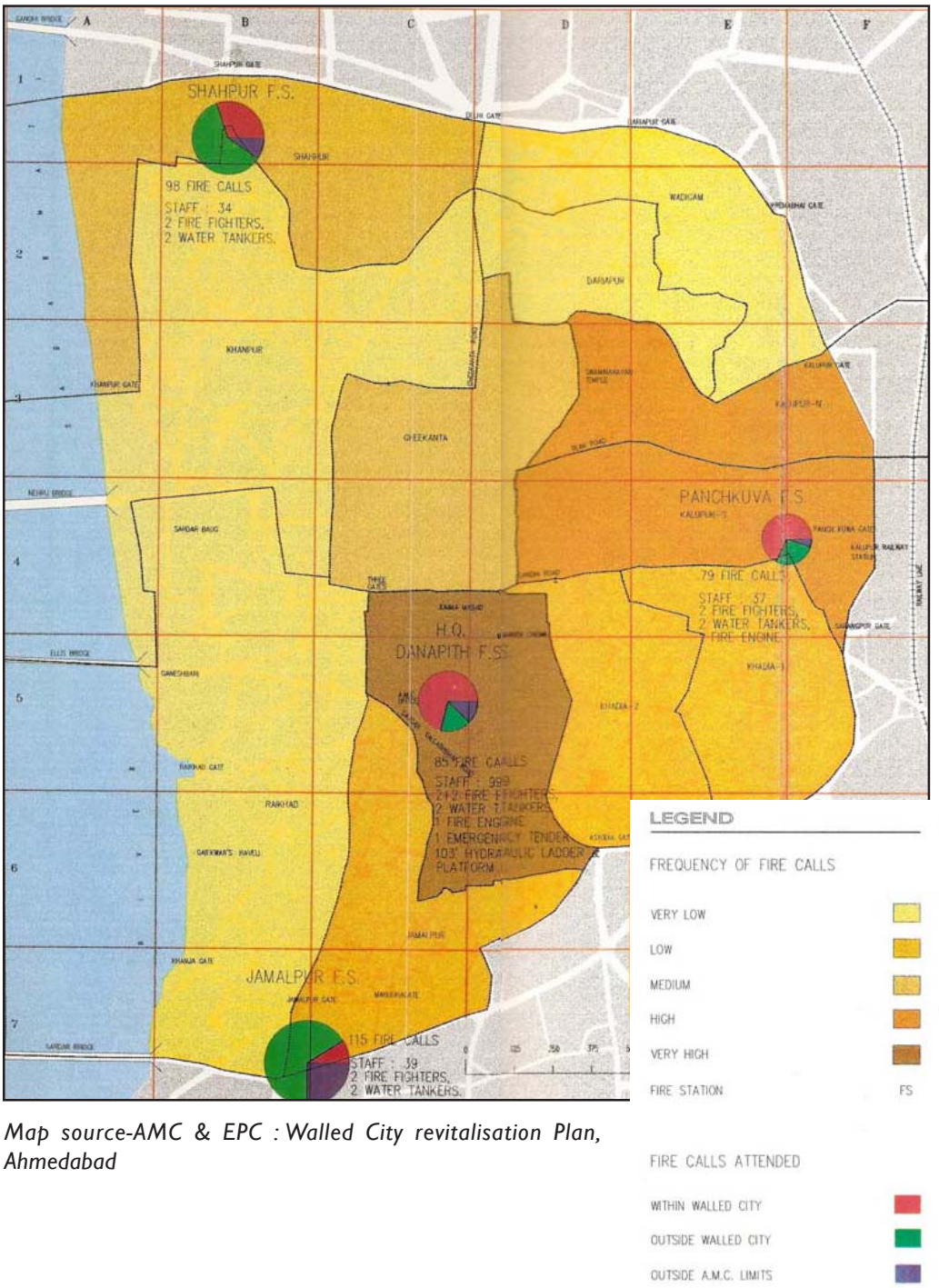
There are historical records about Fires in Sarangpur, Zaveriwad and Maganbhai ni Haveli in 1877. There are four fire stations in the walled city area : Danapith - head quarter, Panchkuva, Shahpur and Jamalpur. The table below gives some details of fire calls over last 4 years.

Year	No. of fire calls	Main reason
2007	28	short circuit & fire in Godowns
2008	27	short circuit & fire in storage materials
2009	86	Short circuit, fire in dustbin, wastage materials, storage, gas cylinder
2010	26	Short circuit, fire in storage materials

Source: Danapith Fire Station, Ahmedabad Fire Service

The fire brigade has a total staff of 530 which includes 62 communication experts, 176 drivers and 278 firemen. The equipment consists of fire fighters, water tankers, ambulance, dead body carrier vans, various types of pumps as well as specialised equipments such as 103 ft. hydraulic ladder, emergency tender with life saving equipments and snorkels.

Existing fire services in Walled City



Map source-AMC & EPC : Walled City revitalisation Plan, Ahmedabad

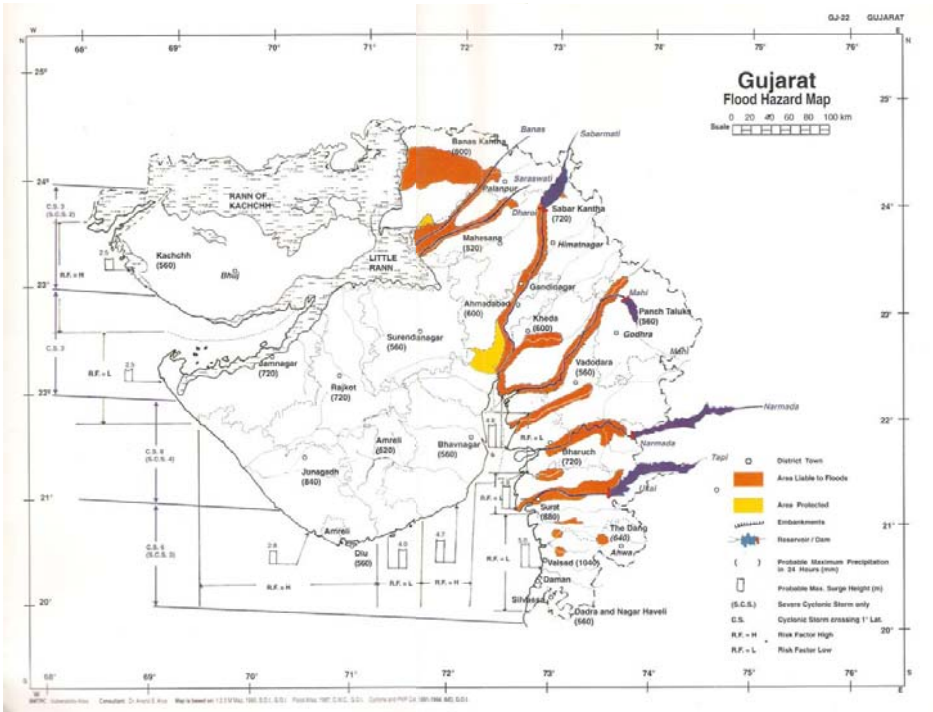
3.4. FLOOD

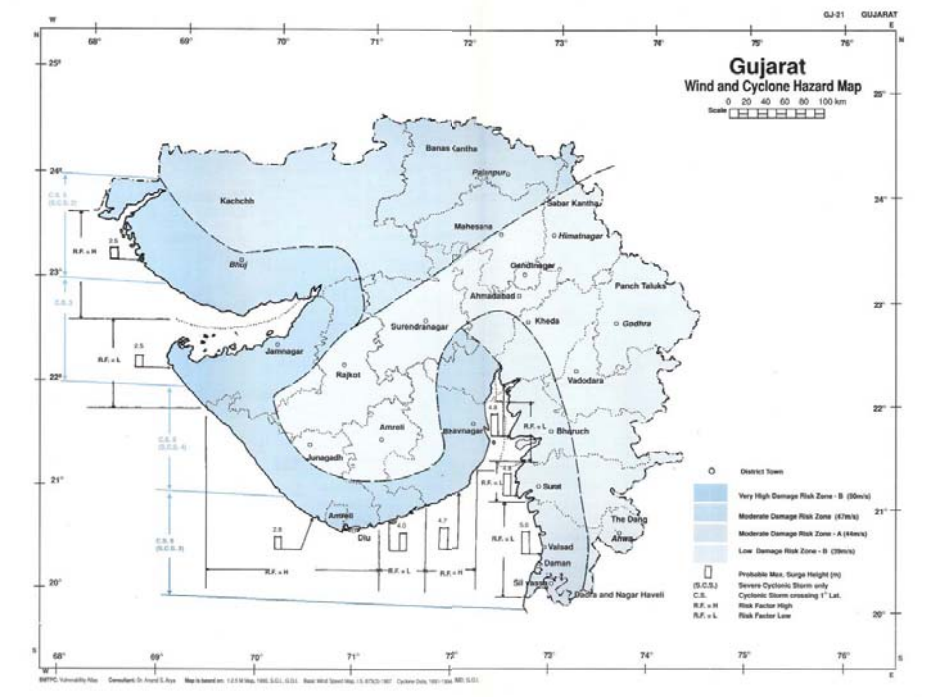
There is record of disastrous flood in 1714, 1739, 1868, 1875 and extraordinarily heavy rains in 1755. However, Ahmedabad has not often suffered from floods.

Opposite the city, the river with a bed about 1550 feet wide, flows during the fair season with a channel of only 375 feet, and leaves between the stream and the city a broad stretch of deep sand rising in mounds in front of the walls. Towards the south west corner, the stream crosses to the left bank and flows close under the city. The chief risk of flooding is from the river bend about 1.5 miles north of the city. This in ordinary years is guarded by the strong wall built along the left bank of the river at the Shahi Baug. In 1714 and 1739 the Sabarmati flooded the city and in 1755 the rain was so heavy that great breaches were made in the city wall. In 1813, the river is said to have risen 18 feet above the summer level. In 1868 there was scarcely any rain till August 10th and then in four days 27" of rain fell. There was no flooding from the river, but the local drainage together with a very strong wind destroyed 9566 houses and movable property assessed at Rs 56070 at that time. In 1875 on the evening of the 21st September, the gauge opposite the city showed the water 5 feet above the ordinary flood level. From that it continued to rise for two days till it stood five feet higher than in 1868 or about 19 feet above the river's ordinary level. The two bridges, the railway bridge about three miles north to the city and the Ellis Bridge constructed in 1870 in the south west were swept away. The flood water forced their way through several of the city gates, made many breaches in the city walls and covered more than a third of the town causing 12 deaths, ruining 3887 houses and destroying property valued at Rs 1,64,590 at that time. The 1875 flood was the highest known at Ahmedabad and lasted for three days.

The average rainfall during the fourteen years ending 1874 was 29.36 inches; the highest fall in any one year being 46.43 inches in 1868 and the lowest 16.85 inches in 1861.

Remaining portion of City wall & bastion in Shahpur towards the river Sabarmati.





Source - Vulnerability Atlas of India (BMTPC),Govt. of India

3.5.VULNERABILITY OF CULTURAL HERITAGE

3.5.1 CHANGING SCENARIO

The walled city of Ahmedabad has emerged as a central business district. This evolution has put enormous pressure on the traditional urban fabric which is constantly transforming to accommodate and adjust to the new land uses, material and transport. There is a slow but steady change in the **land use** from the residential to commercial resulting in the breakdown of the traditional social fabric. The business in the walled city has been transformed to whole sale, which has resulted into transformation of residential buildings into godowns.

The speed and volume of the **traffic** generated by the commercial activities is also responsible for the damage to the character of Walled City. Most of the open spaces in the residential areas are occupied for parking space leading to **congestion**. Ahmedabad is one of the most heavily polluted cities in India and its centre suffers the most. The main source of pollution is derived from the heavy traffic which traverse it. About 150000 people go to work to the walled city on a daily basis. The number of vehicles registered has doubled in the past 10 years. Polluting gases generated from the vehicles adversely affect the timber and stone used in the houses of old city. The actions undertaken thus far by the authorities have simply consisted of widening roads thereby increasing the number of vehicles of all kinds.

The out migration has led to breaking down and conversion of the properties into blocks or insensitive sub division and rented units leading to pressure on infrastructure. The low cost rental residential units further attract in-migration of workers, which ultimately leads to decay in the urban fabric and its social relevance in the walled city. The division of houses into apartments or the introduction of

toilet and sanitary facilities done incorrectly lead to the disfiguring of buildings. The other problems are the misuse of the Rent Control Act and its effects on the collection of the property tax. One can frequently observe a recent trend consisting of subdividing plots involving their separation into sub units of large houses or for the fitting out of small shops especially along the frontage. Conversely, many plots are grouped together to enable new housing development. The ward Shahpur has been totally rebuilt in the form of multi-storey buildings, which houses medium income population, offices and services. There are slum / squatter development and distinguished pockets have been formed in the vicinity of the city wall or in the fringes.

The traditional houses of the walled city are generally of composite nature i.e . load bearing external brick masonry in lime and mud mortar and wooden beams, columns, brackets providing the advantage of framed structure. Timber structures are considered as most earthquake resistant among the traditional forms provided their joints are sound and the timber is not attacked by termites but they are vulnerable to fires. The factors that aggravate the vulnerability of these houses to various hazards are explained below in detail. The city monuments, which are masonry structures, are considered less resistant to earthquake, however, use of good materials, quality of workmanship play a significant role which seems to hold true for the monuments here.

Multistoreyed buildings in Shahpur. The Shahpur Gate is seen surrounded by the tall buildings

3.5.2 Physical Vulnerability

The following factors directly aggravate the physical vulnerability during the time of any hazard.

A. Demolition, Poor quality construction & alteration work -

Demolition performed in a careless way can often cause destabilization of the structure whose stability is provided by the transfer of horizontal loads from one member to another. Similarly, if any reconstruction work or addition of another floor is not carried out sensitively following the original structure and with appropriate materials, it can cause disorders in the structure of the house as well as the neighbouring ones, since the houses share a party wall. There

is a current trend in the walled city to build either entirely or partially with mild steel girders and kota stone slabs This results in loss of inherent qualities of the structure and the basic principle of load distribution and makes not only the house but also the neighbouring houses vulnerable at the time of earthquakes. Poor quality construction has been one of the major factors responsible for heavy damages due to earthquake. Besides the instability, the mild steel members catch fire and easily transmit as they are good conductors of heat.

Construction trend - I section and Kotah stone slabs replace the irreplaceable wooden havelis

B. Sub - division and grouping of plots - The out migration has led to breaking down and conversion of the properties into concrete blocks or insensitive sub division and renting units, which leads to tremendous pressure on infrastructure. The low cost rental small units of residences further attract in-migration of workers, which ultimately leads to decay in the urban fabric and its social relevance in the walled city besides the unreasonable demand for basic infrastructure such as sewage and electricity connections. The data obtained from the fire brigade office Danapith shows maximum number of fire calls due to short circuit, fire in electric pole, distribution boards etc.

C. Diverse ownership- Often, the Pol houses have multiple ownership due to sub - division of same property. Diverse ownership paralyzes initiatives to improve properties and to upgrade seismic resistance because all the parties in the estate cannot agree. Likewise, after a disaster, the same problem affects proposals for repair.

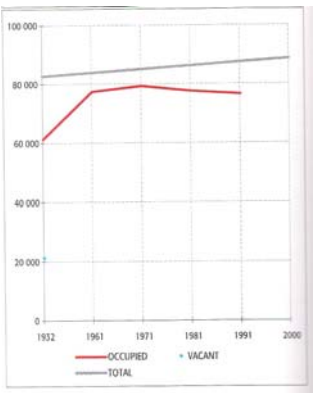
D. Destruction - The most serious threat is destruction which is only increasing day by day. In the absence of public policy in favour of restoration and adaptive re-use of old houses, these are considered as inappropriate and their inhabitants tend to either neglect them or sell them off at low market prices. Insensitive destruction of houses also happens after every monsoon when the owners get sanction from the Municipal Corporation by getting it declared unsafe. While along the main roads destruction of residential houses is rampant, it is also happening inside the residential pols. The destruction of houses has a deteriorating effect on the neighbouring houses, since structurally the row houses behave as a mass and become resistant to the forces of earthquake and to other external forces. Destruction of one or

two houses in the middle cause the loss of the inherent structural stability.

Insensitive destruction of traditional houses a. along the main road b. inside a residential Pol

e. Vacant houses - In the absence of public policy in favour of restoration and adaptation of old houses the residents reglect regular maintenance and upkeep of these properties their Furthermore, rental legislation fail to provide incentives for maintenance or for letting out. The Rent Control Act has proven to be a major set back. Thus a great many dwellings are now vacant. This not only aggravates the problems resulting from lack of maintenance, but also makes the neighbourhood vulnerable to threat like fire in the electric wires, cables, distribution boards etc. A very beautiful Pol like Jada Bhagat ni Pol in Dariapur II ward with highly decorated traditional style wooden facades have atleast 20 houses vacant and abandoned out of its 100 houses.

Occupied Houses



Source - Survey 2001(AMC)

Locked & vacant houses in Jada Bhagat ni Pol

F. Commercialization - One of the most serious threats is the commercialization; not only the Pols near the main market area and main roads i.e. Relief Road and Gandhi Road such as the Mamu Nayak ni Pol, but also the interior residential pols are fast becoming commercialised. Most of the houses facing the road have a shop on the ground floor if not the entire house. This is happening due to cheap rental price and cheap buying price of a house to convert into shops and godowns. The business in the walled city has been transformed to whole sale business, which has resulted in transformation of residential buildings into godowns. The survey shows that there has been high growth for business concerns going from 21,998 in 1961 to 47,882 in 2000. No information is available regarding the size / scale of the businesses. Hence the gradual transformation of the town centre which is losing its resident population in favour of business has resulfed in a very high level of density. Whole sale business of stationary items related to paper, bill

The houses in Shantinath ni Pol facing the main road are either concerted into shops or has atleast one room as shop. Right above - Kankotri shop & below- the shoe market

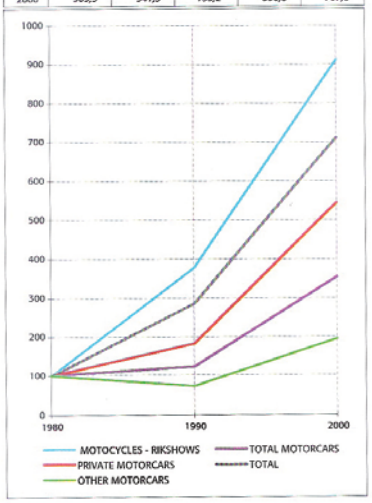
books, wedding cards known as Kankotri are seen in nook and corner along with their godowns. A large shoe market occupies an entire stretch of Kalupur facing outwards, where each house on the outer road has been converted into a shoe shop while the other face of the same house facing the pol is still intact. However, it appears that soon the entire house would become a godown. The godowns with highly combustible material make the structure and occupants extremely vulnerable during the time of fire.

G. Traffic and Congestion- Ahmedabad is one of the most heavily polluted cities of India and the walled city suffers the most. The main source of pollution is derived from the heavy traffic which crosses it. The number of vehicles registered has doubled in the past 10 years. The speed and volume of the traffic mostly generated by the commercial activities is responsible for the damage to the character of the urban fabric besides creating other problems.

Traffice flow and commercialization

EVOLUTION OF THE % OF VEHICLES 1980 - 2000

DATE	TYPE OF VEHICLE				
	MOTOCYCLES RIKSHOWS	PRIVATE MOTORCARS	OTHER MOTORCARS	TOTAL MOTORCARS	TOTAL
1980	100,0	100,0	100,0	100,0	100,0
1990	378,5	182,5	74,4	123,3	286,3
2000	909,5	541,5	193,2	350,8	707,8



Source - Survey 2001(AMC Heritage Cell)

Parking in the open spaces in residential areas leads to congestion. High population density and congestion are factors responsible for heavy damages due to earthquake. Road widening undertaken by the authorities have only increased the number of vehicles. The recent widening of the road leading to Astodia gate brought about the demolition of the buildings which stood on both sides including the historic bastion and the Ganesh Bari, a river side ancient gate.

H. Lack of maintenance - Survey and documentation undertaken by the Ahmedabad Municipal Corporation post the earthquake (2001) revealed that the damaged old houses were already suffering from several decades of neglect and lack of maintenance. The earthquake further accelerated the process of deterioration. The traditional buildings in the walled city initially absorbed the shocks, some later developed serious cracks and some settled precariously. In numerous houses, the joinery in the structure loosened which could collapse causing damage to the inhabitants and their properties. Structures that had already weakened due to water leakage and termites suffered from cracks and in addition, several of the upper floors were partially destroyed due to subsequent addition of poorly designed structures. Several houses which already required work urgently became endangered after the earthquake. Lack of maintenance has also resulted in houses performing poorly during heavy rains. The collapse of one unit could seriously affect the neighbouring house. Slow decay of the structural and decorative timbers and wood carvings gradually result in collapse of buildings. The crown collapse of sewer lines because of the formation of gases which do not get vented through the exhaust pipes lead to blast and causes collapse of structure above in critical cases.

J. Dampness and termite attack - Water seepage due to defective roof, leaking of sanitary installations and capillary action

cause rotting of exposed members such as beam ends and the column bottoms. When teak wood is attacked by moisture, it softens. Termites climb up via columns or masonry and attack floors and roof frames. The termite attack reduces wood member cross section to an insufficient dimension bringing about deformations and load shifting which cause deformation and eventual collapse of the structure. The termite infested weak structures are subjected to sudden collapse during earthquake and heavy rains.

Damage caused by water seepage

wooden members infested by termites

J. Incompatible changes - In spite of the traditional houses being well built with meticulous architecture and suitable to climatic conditions, residents are failing to appreciate the qualities. Improper use of courtyard and closing of openings etc gives rise to the requirement of air conditioning. Window units are often seen precariously settling on the walls. Moreover due to the demands of modern life, the houses are modified without any consideration for the initial structure such as the extensions covering the verandah, balconies, addition of bathrooms, slabs, beams etc.

K. Outdated infrastructure- Ahmedabad is one of the very few cities in India, where the electrical wires and cables are laid underground, so one does not find the wires hanging over head while walking on street. However, insensitive sub division of plots and multiplication of units has led to tremendous pressure on electricity and sewage networks. The data obtained from the

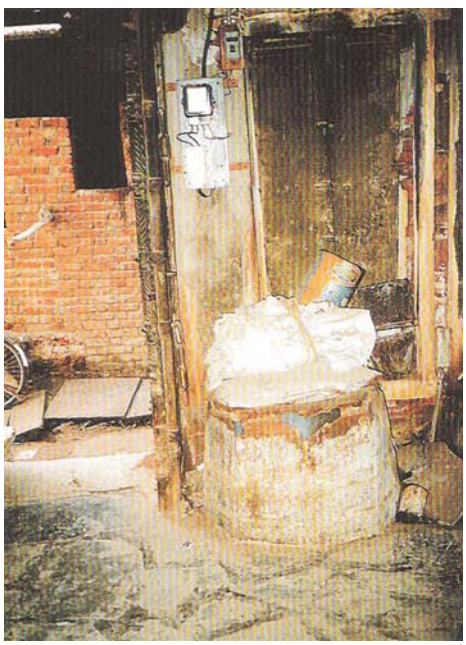
fire brigade office Danapith shows the maximum number of fire calls due to short circuit, fire in electric pole, distribution boards etc.

L. Lack of technical knowledge and incentives for retrofitting and new hazard resistant constructions

Lack of technical knowledge and appropriate advice to the house owners to maintain the traditional houses is a major problem in the walled city. Petty contractors are generally employed to do repair and maintenance works, that ends up in making the structure vulnerable in the event of hazard.

M. Lack of adequate water supply for Emergency response-

Ahmedabad suffers from shortage of water supply. The number of wells, water tanks and artificial lakes are testimony to the efforts undertaken in different periods to offset this shortfall. The underground water level has dropped substantially. The wells which formerly supplied the pols and certain houses are now sealed off. The "tanka" study report reveals nearly 10000 water tanks in the



Sealed off tanka and the well

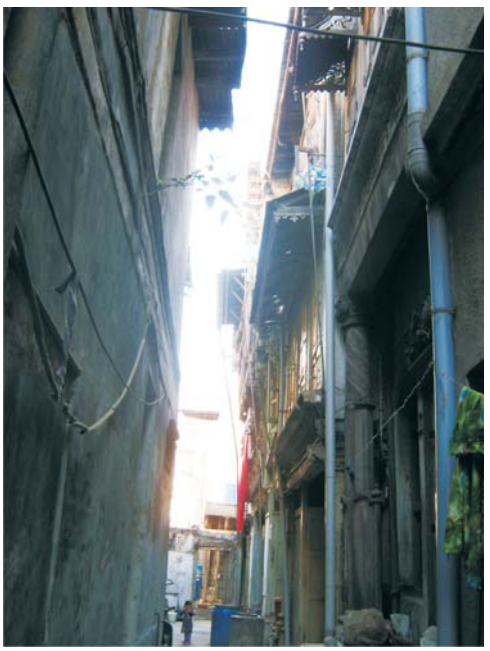
basement of the houses in the walled city, however most of them are sealed. These tanks have not been in use for over fifty years as the British Government had passed an ordinance for their closure fearing that the freedom fighters might use them as hiding places or to make ammunition. However, it is recorded that an order was issued in 1943 to seal them off alleging health reasons. At present, the water supply grid only provides water two hours per day. The reuse of the tanks could serve as secondary source of supply but a distinction would have to be made between drinking water and water for domestic use on the basis of quality.

The water tankers of the Ahmedabad Fire Brigade (AFB) have to go to Dudheswar water works or Bapunagar for refilling. Being limited to 2 hours per day, the municipal supply does not serve the water needs of fire brigade. In the event of a major fire, time is wasted in going to Dudheswar and Bapunagar for water.

N. Inaccessibility of emergency services and for escape-

Accessibility problems are very acute in narrow and deep Pols of

Photo title :



Shahpur and Jamalpur areas like Dhalgarwad, Nagoriwad etc. Encroachments on road and on street haphazard parking also contribute to this problem. Required speeds are difficult to attain in high traffic areas in the walled city, especially during the peak hour. The fire brigade officer shares his experience of narrow alleys in the walled city that sometimes to attend the fire calls, searching for the address takes such a long time that fire is extinguished by the locals by the time the location is found. *(refer street hierarchy map)*

Narrow lanes inside the Pol with the roofs of opposite houses almost touching each other- very clever planning and design to prevent hot sun rays to enter the houses could pose problem during the event of hazard such as fire. In such cases, concerted efforts towards prevention of hazard and use of suitable equipments are imperative.

0. Shortage of Suitable equipments & training for emergency response especially in case of fires

In the absence of preventive approach and increasing the vulnerability by inappropriate transformation of residences into commercial spaces, using unsuitable building materials, the unique urban fabric (dense built form and the narrow roads) make large portion of the walled city vulnerable to damage or destruction by fire, however significant it is in terms of architecture and climatic design. The conventional fire fighting vehicles are too bulky to move with required speeds. Water tankers carrying large quantities of water (upto 10000 litres) and such other vehicles require a minimum clear road of 6 metres to move fast.

While there are four fire stations (Danapith - head quarter, Panchkuva, Shahpur and Jamalpur) in the walled city area, they are not appropriately equipped to handle the specific problems of fighting fire in the walled city. While the fire brigade personnel are

undoubtedly brave and skilled people, often they have no particular expertise in dealing with historic buildings and they may not be aware of the significance of historic elements of that building. At times, relatively unimportant duties are also performed by the same trained staff. This has a somewhat demoralising effect on the Fire Brigade personnel and at the time of event of a hazard the staff might stand unprepared.

P. Lower level of community awareness

Lack of awareness amongst the local community creates panic situation during the event of disaster. Neither is there any involvement of Govt. and Non Govt. organisations in terms of training and generating awareness including mock drills etc.

3.5.3 Social and economic vulnerability

The pols constitute a space of social integration and mutual help, a protected space for family life and especially that of children. When compared to the costs engendered by modern cities, pols are economical because they make use of simple facilities and techniques, which are easily accessible.

Initially each pol was inhabited by a community of the same religion, caste or trade and this still holds true today for some pols for example: Jadabhagat Pol. However, in other pols, due to commercialisation, out migration of residents to areas outside the walled city, intermingling of social groups, influx of industrial labours due to sharp industrial growth resulted in the cohabitation of different class of people. The walled city is losing the resident population which is migrating outside in favour of apartments and modern life style. Commercialisation has caused a very high density in the walled city. All this has resulted into breaking of social cohesion amongst the community in some pols. With breaking up of the social structure, collective means of preparedness and response by the community has weakened

although it is still considerable in some areas.

The Panch system in Pols is slowly disappearing. Although a separate survey in connection to the social and economic status of the walled city was not conducted as part of this report, a general reconnaissance shows that most of the residents are into business or have petty shops inside the walled city.

3.5.4. Misconceptions

The drawbacks of the pols spring from their qualities. Their very structure is sustained due to strong social pressure. The car is not at home here and the image of the pol is not "modern" one.

Overuse and property speculation, be it on a large or small scale, as well as technologically poor 'modern" paradigms lead to the disfiguring of buildings. In addition to these threats, there is excessive structural modification and use of inappropriate materials such as cement etc in traditional buildings. Due to lack of awareness amongst

the general public, traditional buildings are perceived as outdated and weak and symbols of 'backwardness'. The strengths of traditional construction practices is not recognized among the community as well as local building professionals.

3.6. CAPACITY ANALYSIS

Traditional Construction

The walled city has distinctive construction and indigenously designed features that contribute to make them resistant to earthquake, flood and other disasters. This was demonstrated during the earthquake of 2001, when traditional buildings performed better than new constructions. The composite nature of the traditional structures with load - bearing brick masonry and wooden beams and columns provide stability and ductility. Timber structures are considered as most earthquake resistant among the traditional forms. The pure masonry structures are considered less resistant to earthquake, however, the walled city monuments, with the use of good materials, good quality workmanship can be exceptional, which has been proved in the past by experiencing minimum or no damage. The underground water tanks or the 'tankas' in each Pol house should be acknowledged as capacity as they are great source of water during emergency situations.

Skilled crafts people

Significant amount of traditional building knowledge is still possessed by skilled craftspersons. AMC Heritage Cell has list of skilled craftspeople, who are engaged in various restoration and retrofitting works time to time. Their skills are also being upgraded by various training programmes conducted by the heritage cell inhouse and collaborative programmes with other countries.

Institutional capacity

Ahmedabad is among the first few cities in India where the Listing of heritage properties has been undertaken by the Heritage Cell of Ahmedabad Municipal Corporation. In fact, Ahmedabad is the first city to establish Heritage Cell in the Municipal Corporation, which is very active since 1995. Besides

various awareness programmes and research/documentation work, a number of conservation projects are being implemented every year by the Heritage Cell. One of the projects is revitalization of 'Tankas'. As a first step to revive the tankas, an initial inventory was undertaken which revealed nearly 10000 tankas in the walled city. Another such initiative is the design of special fire brigade, which is a small fire engine with a high power pressure pump, since it is difficult for a normal fire engine to enter the narrow lanes of walled city. The Heritage Cell has also procured tubular steel scaffolding sets, which is of great helpduring emergency situations, to support, brace and shore unstable heritage structures.

The List of heritage buildings and specific heritage regulations for the same have been notified in 2007 and made part of the Gujarat Development Control Regulation (GDCR) by the Govt. of Gujarat. As part of the Heritage Regulations, a Heritage Conservation Committee (HCC) has been constituted to advise on different matters of heritage conservation. A separate Heritage Centre is also being established by the Heritage Cell that would be dedicated to technical assistance to the house owners. AMC also has an active and fully functional Disaster Management Cell dedicated to the town.

Community strength

Local administration system known as 'Panch' are still prevalent in some Pols of the walled city. 'Panch' with an elderly respectable citizen as its leader and four other prominent residents as members take the charge of management of the Pol. It looks after various aspects like renting of properties inside the Pol, selling of houses, maintenance of Chabutaros, well, temples and other public structures, garbage disposal etc. Functions of 'Panch'

can be further strengthened to undertake mitigation measures, disaster response and recovery works.

3.7. Disaster Risks to Cultural Heritage

The heritage components of Ahmedabad walled city are at various kinds of risk; they are at the risk in the face of nature's occasional fury, from political and economic pressures, from the daily forces of slow decay and neglect and the vulnerability factors as mentioned in the previous section Assessment of various risks as discussed is given in the table below.

	Aspect of Heritage	**Hazard**	**Vulnerability**	**Capacity**	**Risk**	**Potential Impact**
1	City wall & the bastions	Earthquake Flood	Lack of conservation and strengthening Demolition to give way for new developments Construction above and very near to the walls causing weakening of the masonry walls	Thick masonry walls Recently, the heritage Cell of AMC has started conservation of city walls.	High	Partial collapse and damage to the walls and bastions.
2	Gates	Earthquake, Fire	Freestanding structures due to demolition of city walls. Lack of conservation and strengthening Construction very near to the gates and heavy commercialization near and around every gate.	Adequate sections of masonry to resist earthquake forces.	Medium toHigh	Damage to the structure
3	Monuments	Earthquake,	Lack of appropriate conservation and earthquake resistance strengthening Encroachment and construction very near to the monuments.	Inherent resistance qualities. Good quality materials and high standard of building technique and	Elements such as minarets, parapets are under very high risk	Partial collapse and damage to the structure

	Aspect of Heritage	Hazard	Vulnerability	Capacity	Risk	Potential Impact
			Lack of maintenance plans Lack of fire protection plans, absence of any fire fighting installations	joinery system	High High Risk of theft and vandalism	
4	Market areas	Earthquake, Fire	High density. Lack of standards followed by buildings. Spreading of market due to lack of control in landuse.Lack of fire prevention strategies.		Very high	Loss of life, loss of business. Damage to traditional buildings
5	Pols / neighbour hoods	Earthquake, Fire	High density. Lack of accessibility.Ingress of Commercialization and lack of regulation. Demolition of row houses. Vacant houses. Pressure on infrastructure. Lack of adequate water supply.Subdivision and grouping of plots. Low level of preparedness. non-existence of pol panch and its ways of communication (disappearance of black boards)	social cohesiveness. climatically suitable designed houses.	Very High	Loss of life, loss of assets, full and partial collapse of houses.
6	Chabutaros	Earthquake, Fire, theft	Single standing, wood. Apathy in some pols. Lack of maintenance.	Quality materials and	Medium	Loss of historic component

	Aspect of Heritage	**Hazard**	**Vulnerability**	**Capacity**	**Risk**	**Potential Impact**
			Can be dissembled and easily transported.	techniques, can be reconstructed		& identity
7	Traditional houses	Earthquake, Fire	Lack of maintenance. Insertion of modern amenities. Insensitive additions, alterations causing change in structural inherent qualities. Termite attack and dampness. lack of improved infrastructure. Lack of adequate water storage. Low level of preparedness of occupants.	Climatically suitable designs, Inherent Structural and earthquake resistant elements. Self sufficient infrastructure and service	Very High	Loss of life, loss of assets, full and partial collapse of houses.
8	Wooden facades and other wooden components	Earthquake, Fire	Lack of maintenance. Termite attack and dampness. Loosening of joinery Selling off of wooden components. Lack of skilled craftspersons.	Inherent Structural and earthquake resistant elements.	High	Loss of historic component & identity of the house. Loss of artistic & cultural value.

Chapter 4.
PILOT STUDY - Shantinath ni Pol

Entrance of shantinath ni Pol

4.1. HERITAGE SIGNIFICANCE

Shaninath ni Pol is one of the significant residential Pols located in Kalupur II ward, at the heart of the Walled city. The changing circumstances of the city has also affected the Pol, which, of late, is witnessing new unplanned constructions for commercial purposes. The Pol has been selected for analysis of vulnerability and risk assessment because of its surviving built fabric, which is under influence of insensitive development and in process of gradual disappearance and the residents were cooperative during the survey.

- The Pol is originally a *Jain* Pol as most of the owners belong to the community and there are two Jain Derasars inside the Pol.

- The pol has around 60 houses (distinct survey numbers) with a mix of ground to three storeyed structures. While ground storey structures are confined to the Derasars, the only distinct two storey structure is the nursery school. Most of the houses are either G+2 or G+3.

- The pol has no gate, which opens to the main street of 4.0 meter wide and becomes wider to form a chowk in the middle of the Pol. The chowk is an open square of 14 meters x 14 meters and has stone Chabutara on a raised platform. The main spine street extends to internal streets of 4.0 meter wide on average each, which are paved with kota stone. The main street though has been altered to asphalt. One of the interior lanes (south west direction) is narrower, 2.5 meter wide on average.

- Houses are arranged on either sides of these streets on a row house pattern. Apart from these, the pol has four khadkis with separate gate structures and houses are arranged around the chowk inside. The one on the north

west side has three gates in row opening into chowks surrounded by houses. Most of the row houses have internal chowks (courtyards) and otlas with exception of few houses, which are either altered or sub-divided.

- The houses are of mixed style varying from Composite to Eclectic and art deco style. Houses with pure traditional style is not found, which indicates the pol could be dated as second half of 19th century i.e. AD1850 onwards.

- The Shantinath ni Derasar which is one of the oldest temples with unique embellishments is very popular amongst the Jain population. To the south of the temple is a secret covered passage which opens to Kuwavala no Khancho in Doshivada ni Pol.

- The blackboard at the entrance of the pol is still in use, which is against the wall of house survey no 858.

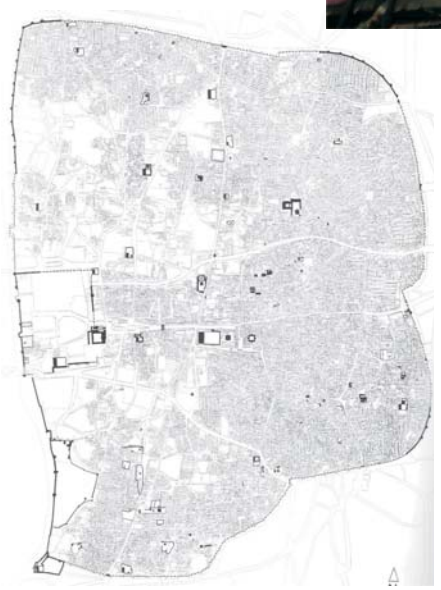
- There is one house (survey no 804,805, 806) which has side facade with many holes in them designed to accommodate birds and which include decorative animal pattern.

- There are seven tankas in the pol including the two, which are inside the chowks of the two Derasars that are functional even now. One tanka in the chowk of extreme north west khadki is used while other four tankas inside the chowks of the individual houses are not used any more.

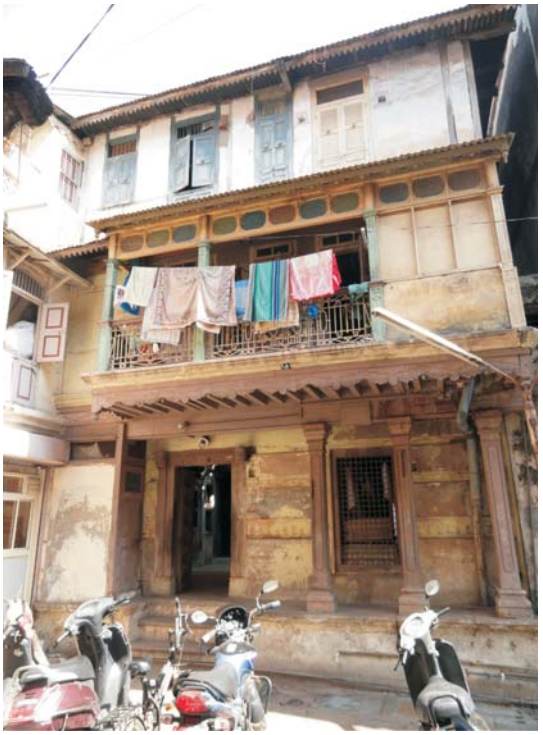
- The carvings on the Plinth, columns, brackets, doors, beams, overhangs, cornices are highly decorative. The building facades have interesting motifs on them.

Stone Chabutra - the alcove inside the raised platform is used to store grains for birds

Location map of Shantinath ni Pol - south of Swaminarayan temple across the Relief road




Vulnerable Elements in Shantinath - ni -Pol
KEY DRG
LEGEND
Ashphalt road
Kota stone paving
Semi open passage
Internal courtyards
Chabutaro
Built
Electric pole
Manhole
0.0 5.0 10.0 25.0 M
DISASTER RISK MANAGEMENT PLAN (DRMP)
FOR THE WALLED CITY OF AHMEDABAD
VULNERABILITY STUDY OF A POL
POL NAME - SHANTINATH NI POL
KALUPUR WARD
DRG. TITLE - POL DATA & DETAILS
SCALE- 1:500
DATE - 30 / 10 / 2010
DRG. NO. - NIDM/AMD/DRM/4
DRG. SOURCE - Heritage Cell, AMC
DRG. EDITED BY - A. VIJAYA
An Initiative of Administrative & Municipal Corporation (AMC)
The National Institute of Disaster Management (NIDM), New Delhi
1. All dimensions are in metres, unless specified otherwise.
2. Copyright of all drawings remain with AMC & NIDM.
Built Area - 3300 Sqmt
Street / Open space - 986 Sqmt.
Total area of the Pol - 4286 Sqmt.



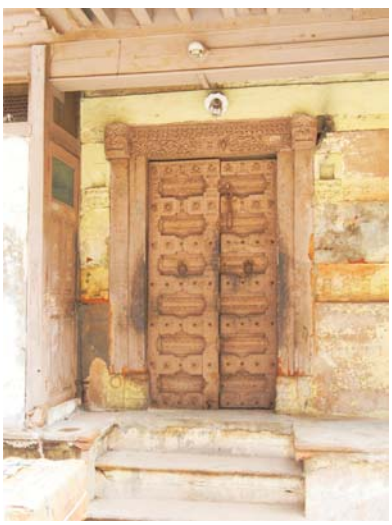
Clockwise - Traditional houses of various styles - Composite, Eclectic and Art Deco

Jain Derasar at the entrance of the Pol

Shantinath ni Derasar inside the Pol

Gate & passage to the khadki, below- door of a house

Unique design of the bracket & blackboard on the wall

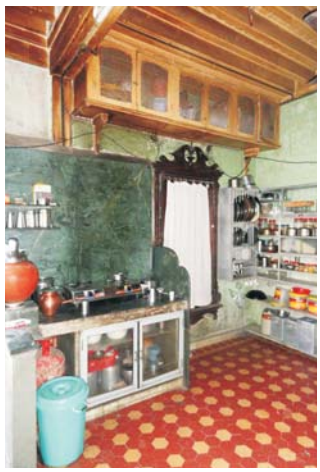


Door of house - eclectic style

Tanka (in working condition) cover in the chowk of khadki

Tanka (not working) cover inside the room

Details of stone plinth and column



Pictures showing interior of house - right - masonry wall with bracing course of wooden members

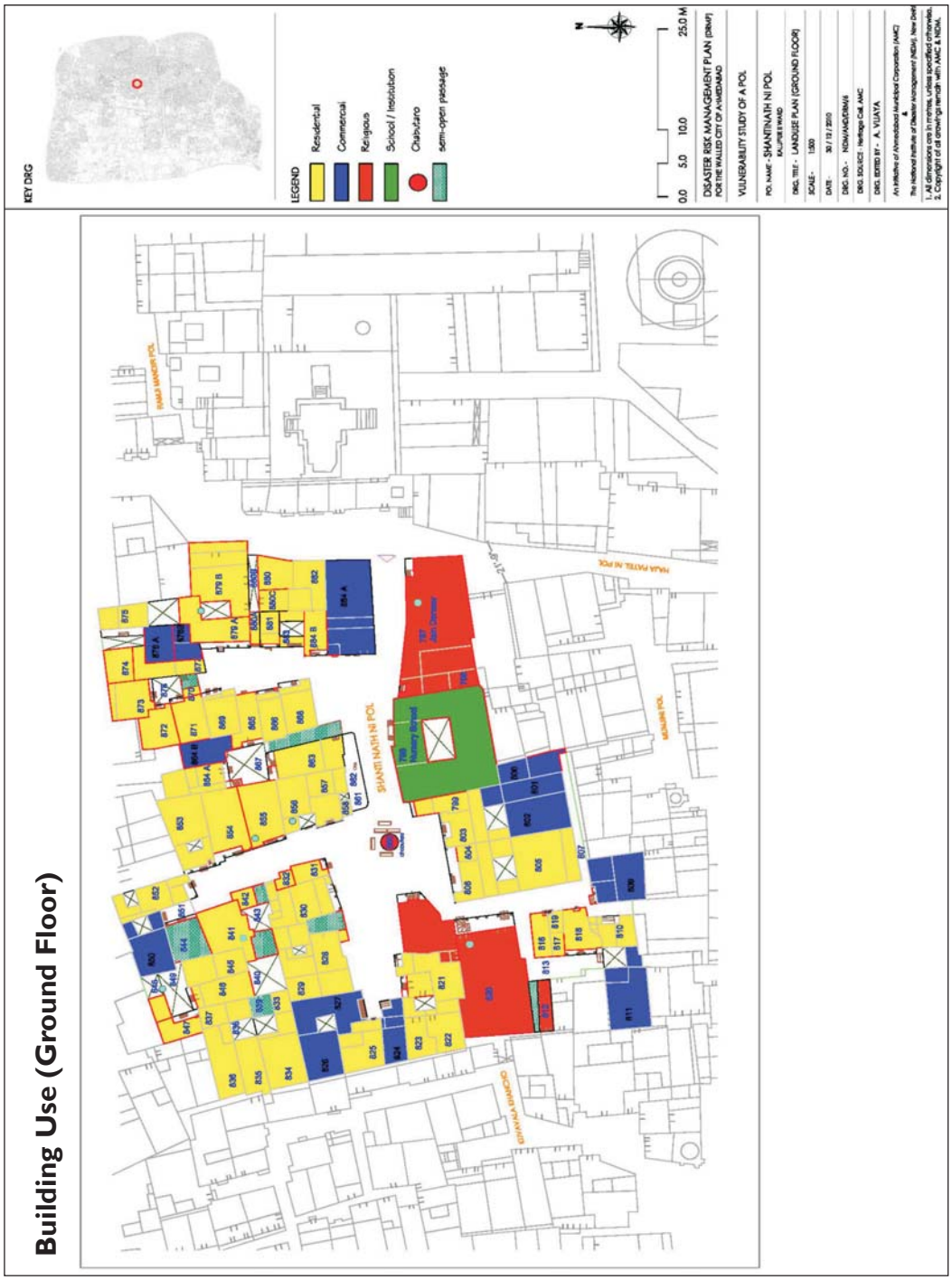
Wooden brackets with intricate & exquisite carvings

Parapet details of gable end

Motifs on cornice mouldings - Eclectic style

Jain Derasar at the entrance of the Pol

Motifs on facade - Composite style


Building Use (Ground Floor)
KEY DRG
LEGEND
Residential
Commercial
Religious
School / Institution
Chabutaro
semi-open passage
N
0.0 5.0 10.0 25.0 M
DISASTER RISK MANAGEMENT PLAN (DRMP)
FOR THE WALLED CITY OF AHMEDABAD
VULNERABILITY STUDY OF A POL
PO. NAME - SHANTINATH NI POL
DWG. TITLE - LANDUSE PLAN (GROUND FLOOR)
SCALE- 1:500
DATE - 30/12/2010
DRG. NO. - NDM/AHD/BMA
DRG. SOURCE - Heritage Cell, AMC
DRG. EDITED BY - A. VIJAYA
An Initiative of Ahmedabad Municipal Corporation (AMC)
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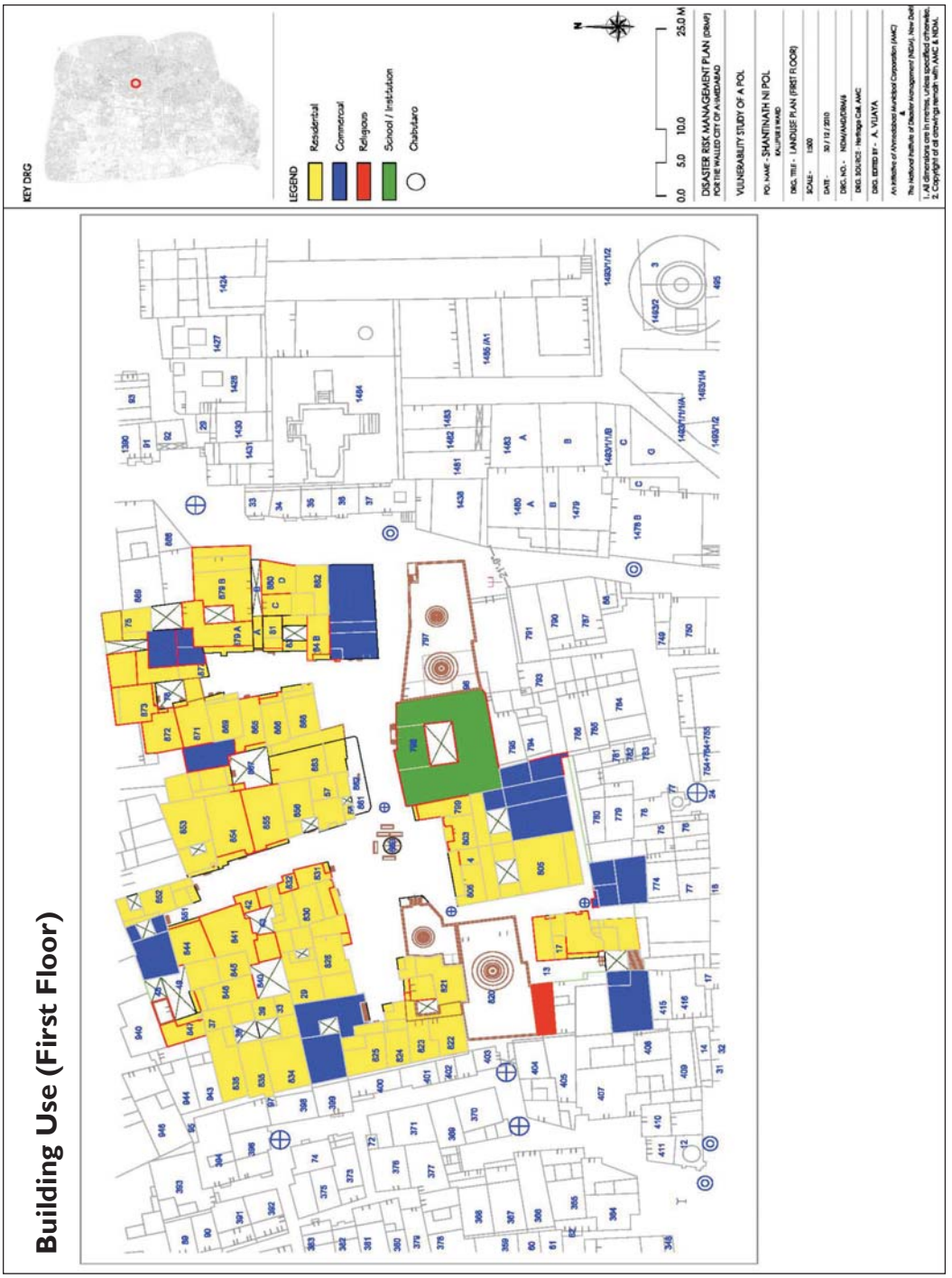
SHANTI NATH NI POL
HALA PATEL NI POL
MOLIMIA POL
GIVANA KHADKI


Building Use (First Floor)
KEY DRG
LEGEND
Residential
Commercial
Religious
School / Institution
Chabutaro
0.0 5.0 10.0 25.0 M
DISASTER RISK MANAGEMENT PLAN (DRMP)
FOR THE WALLED CITY OF AHMEDABAD
VULNERABILITY STUDY OF A POL
PO. NAME - SHANTINATH NI POL
DRG. TITLE - LANDUSE PLAN (FIRST FLOOR)
SCALE - 1:300
DATE - 30/12/2010
DRG. NO. - NDMA/AMD/DRM/8
DRG. SOURCE - Heritage Cell, AMC
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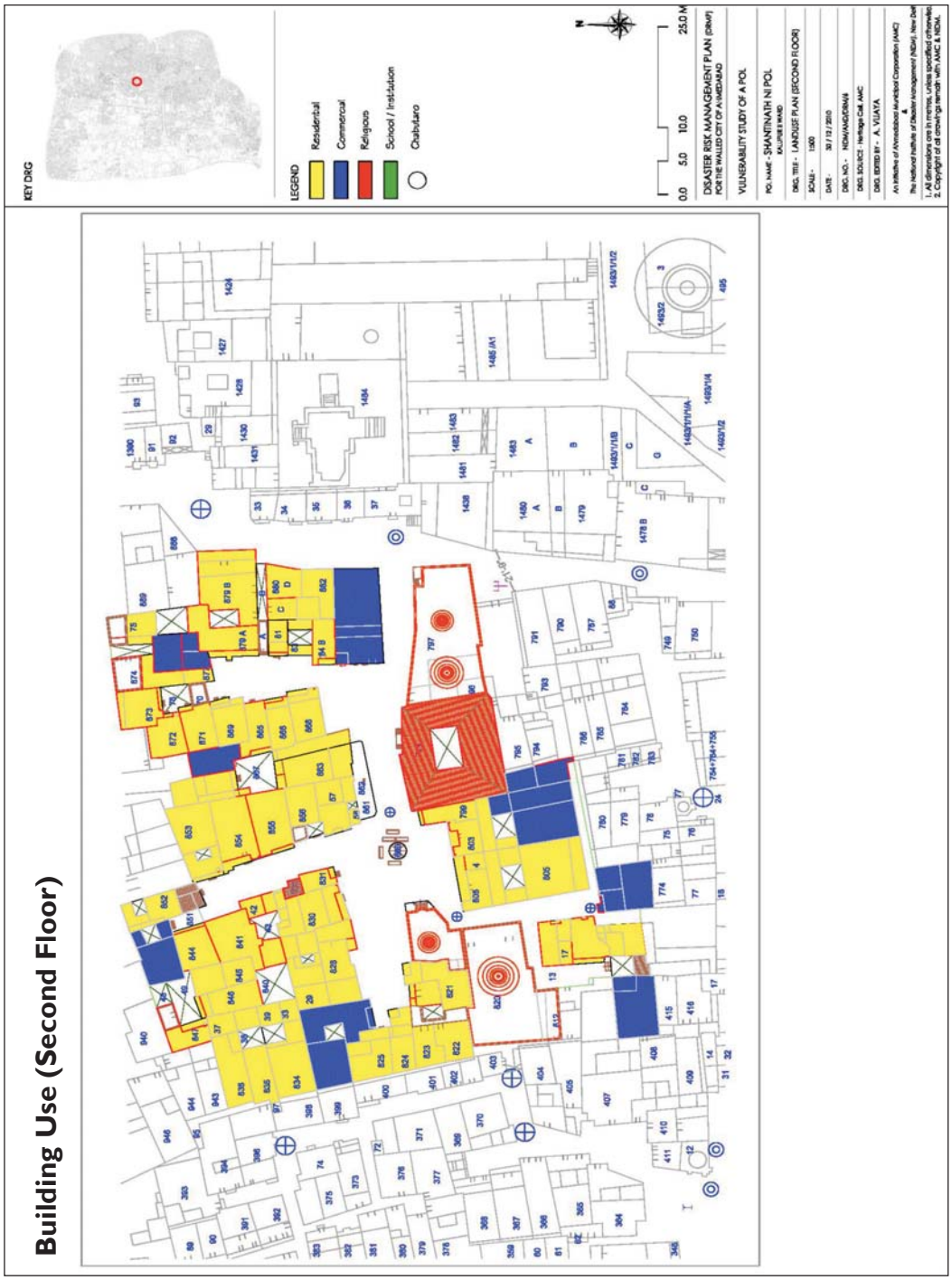
Building Use (Second Floor)
KEY DRG
LEGEND
Residential
Commercial
Religious
School / Institution
Chabutaro
N
0.0 5.0 10.0 25.0 M
DISASTER RISK MANAGEMENT PLAN (DRMP)
FOR THE WALLED CITY OF AHMEDABAD
VULNERABILITY STUDY OF A POL
PO. NAME - SHANTINATH NI POL
DRG. TITLE - LANDUSE PLAN (SECOND FLOOR)
SCALE - 1:500
DATE - 30 / 12 / 2010
DRG. NO. - NDM/AMC/ERM/4
DRG. SOURCE - Heritage Cell, AMC
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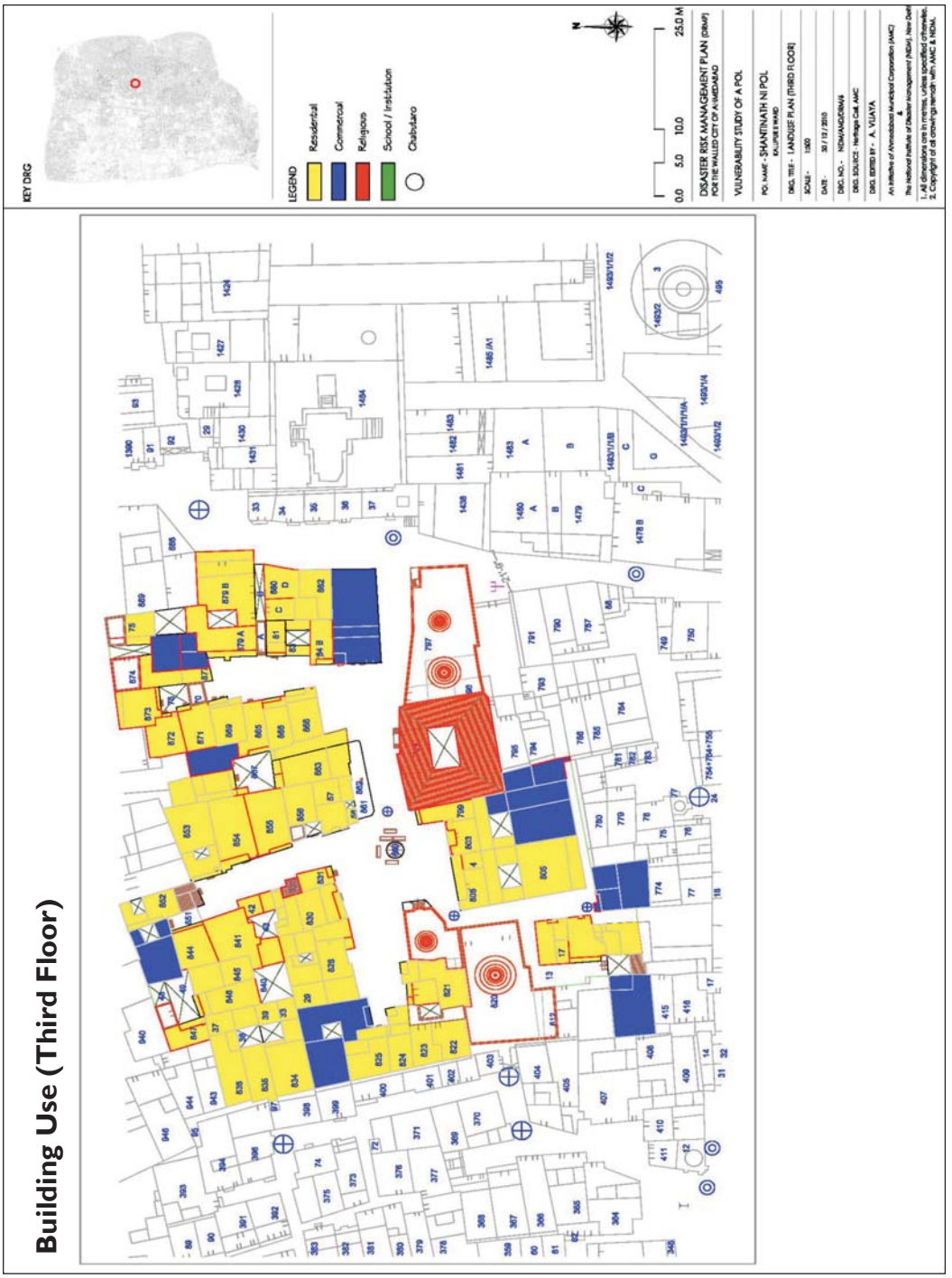
Building Use (Third Floor)
KEY DRG
LEGEND
Residential
Commercial
Religious
School / Institution
Chabutaro
0.0 5.0 10.0 25.0 M
DISASTER RISK MANAGEMENT PLAN (draft)
FOR THE WALLED CITY OF AHMEDABAD
VULNERABILITY STUDY OF A POL
PO. NAME - SHANTINATH NI POL
KALUPUR WARD
DRG. TITLE - LANDUSE PLAN (THIRD FLOOR)
SCALE - 1:300
DATE - 30 / 12 / 2010
DRG. NO. - NDM/AMD/DM/4
DRG. SOURCE - Heritage Cell, AMC
DRG. EDITED BY - A. VIJAYA
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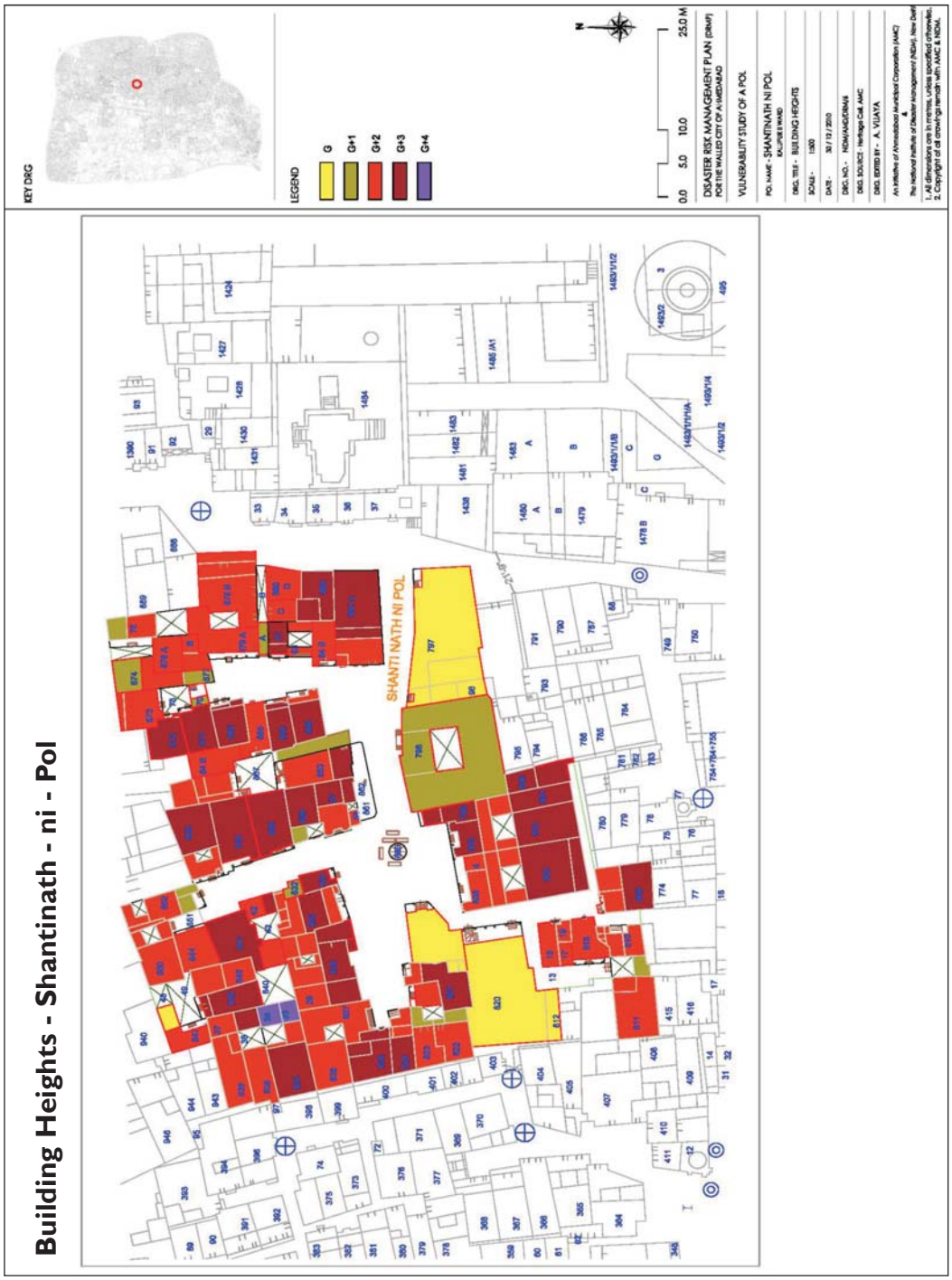

Building Heights - Shantinath - ni - Pol
KEY DRG
LEGEND
G
G+1
G+2
G+3
G+4
0.0 5.0 10.0 25.0 M
DISASTER RISK MANAGEMENT PLAN (DRMP)
FOR THE WALLED CITY OF AHMEDABAD
VULNERABILITY STUDY OF A POL
PO. NAME - SHANTINATH NI POL
DRG. TITLE - BUILDING HEIGHTS
SCALE - 1:500
DATE - 30 / 10 / 2010
DRG. NO. - NDMA/AMD/BHM
DRG. SOURCE - Heritage Cell, AMC
DRG. EDITED BY - A. VIJAYA
SHANTI NATH NI POL

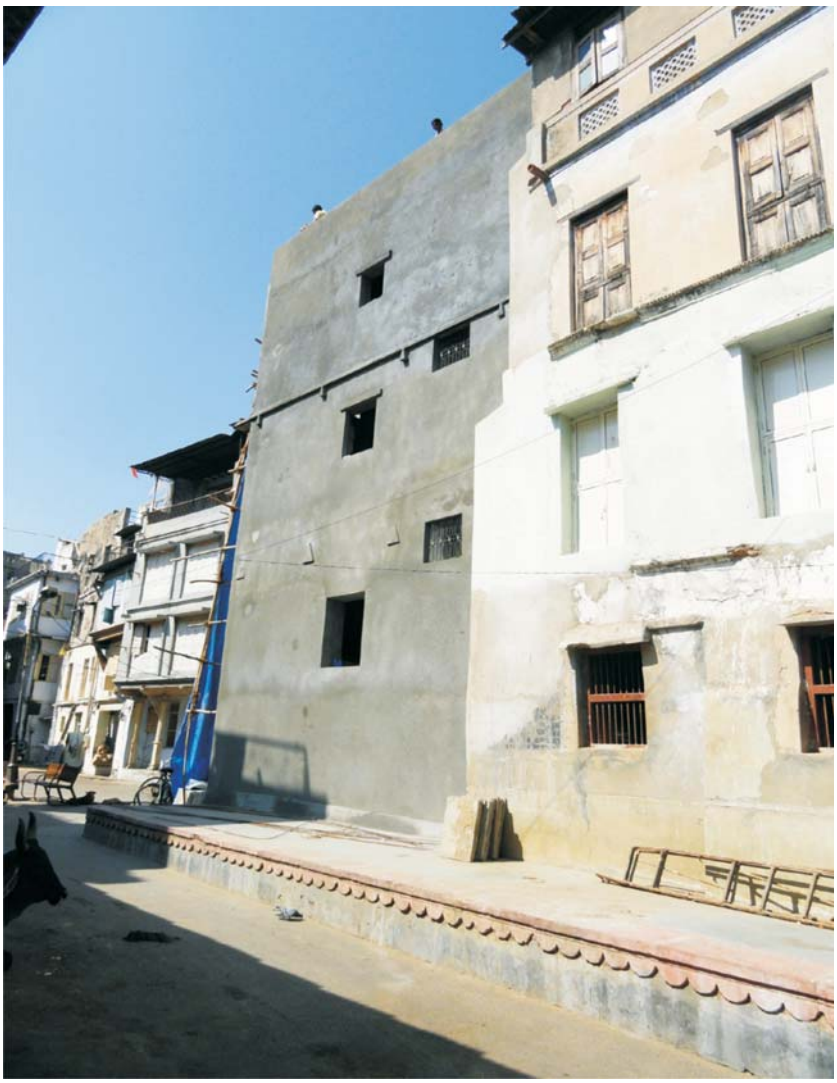
4.2. Analysis of vulnerability to earthquake, fire and floods

A survey was conducted to assess the vulnerability of Pol population to hazards such as earthquake and fire. All households were given a questionnaire to fill up. Abstract of the Information obtained by the survey is given in the appendix 1.

4.2.1. Demolition of traditional houses

Out of the 64 properties, 20 traditional houses have been demolished. The demolition takes place in a very planned manner. For example, the recent demolition of the house with survey no. 857 & 858 was started in July 2010. The Photograph taken in August 2010, did not show any work from the exterior; however, the work was on going in the interior in a discreet manner. After the interior demolition accomplished, new frame in MS girder was erected, following which the exterior too was demolished. The house had the most unique wooden column / bracket with a horse head apt for a corner property.

Photographs taken in Aug 2010

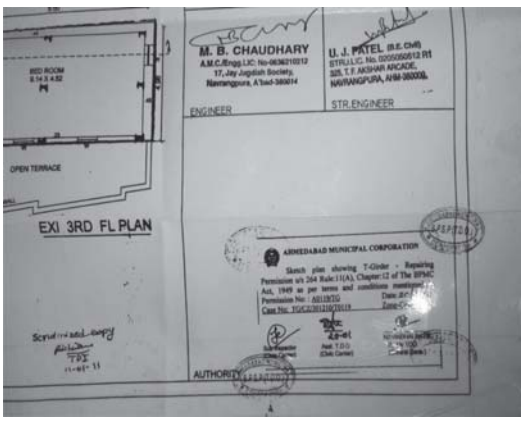


Picture - February 2011

4.2.2. Poor quality construction work

In Shantinath - ni - Pol, out of 50 houses, 22 houses have been found to be either rebuilt or highly altered. The reconstruction and alteration of the buildings have been done without following any minimum structural / building standards, which have replaced the high quality designed traditional construction. General trend has been employing the easy to install MS girders and kota stone flooring.

demolition in progress



Municipal permission

4.2.3. Sub division of Plots and multiple ownership

In the Pol, although grouping of plots/ houses has not taken place, but many of the plots have been subdivided to create small houses. This has not only resulted in the destruction of the original house entity, but also created multiple ownership which further leads to many problems. In some cases, subdivision of the houses in vertical manner has also happened. For example, the house with survey no. 803 has been divided into 6 portions with different owners for the second and third floor which are later additions. All these factors have contributed towards increasing vulnerability to earthquakes due to loss of structural integrity.

Before

Demolition and Reconstruction

Survey no 803 - Multiple ownership

4.2.4. Inaccessibility for emergency escape and rescue

The Pol has four distinct Khadkis, in which series of courtyards are surrounded by many houses. The courtyards are linked by semi-open passages, which have houses above. Some of the Khadki passages have deteriorated and become inaccessible due to absolute lack of maintenance.

Houses on the periphery converted to Commercial use

Damaged khadki entrance - access for 10 households

General trend of alteration to a exquisite wooden carved traditional house

4.3 Summary of Vulnerability Analysis

Number of houses / propertieas (survey nos.)	**Vulnerabilities (factors)**	**Risk to hazards (Earthquake, fire & flood)**	**Impact**
Jain Derasars -2nos	none	low (due to collapse of neighbouring properties)	none
Chabutara-1 no.	none	low	none
School - 1 no	Poor quality construction (MS girders, sections, shed roof and poor infrastructure. Small entrance doorway.	High	Damage to the building. Risk to occupants (children)
Chowks - 12 nos.	Access may be blocked due to collapse of surrounding houses	Medium	
Semi open passages (survey no. 839 & 844)	Semi open spaces and the passages of the khadkis are vulnerable due to lack of maintenance, deteriorated wooden members of the roof and poor quality construction, increased load above the passage.	High	Collapse of roof and the house above. escape route blocked for Khadki population Loss of life of occupants.
Traditional houses (original structures) - 12 nos. (821, 822 & 823, 824, 831, 846 & 847,	Lack of maintenance. Sub division of houses. multiple ownership. Inappropriate methods of insertion of modern	Medium	Damage to the house Partial Collapse of overhangs,

853, 866, 870 & 871, 874/875/ 876A, 879, 882, 883)	amenities and infrastructure. Inappropriate materials such as Thermocol on the ceiling. Survey no.s 846,847 & 853 are well maintained houses, however, they may be vulnerable due to collapse of surrounding houses, which are completely altered. Among these houses, survey nos. 824, & 876 are used for commercial purposes.		Balconies, parapets etc
Moderately altered houses - 12 nos. (809, 810, 818, 833&834, 839, 844, 855, 856, 868, 869, 877, 881)	Inappropriate building additions, especially on the upper floors, which increased load on the original structure. Lack of maintenance Sub division of houses, both vertical and on ground. Among these houses, one property survey no. 809 being used for commercial purposes	Medium	Damage to the house. Partial Collapse of the houses. Injuries and loss of life of occupants.
Rebuilt, Highly altered houses- 22 nos. (799, 800/801/802/803, 804/805/806, 811, 816/817/819, 825, 826/827, 828, 829, 830, 835/836/837 /838, 840, 841, 842, 850, 857, 863, 864A, 864B, 865, 872, 873)	Rebuilt or completely altered using inappropriate materials and technique, such as I sections and kota stone. Among these houses, 6 properties with Survey nos. 811, 800/801 /802, 826/827, 850, 864 and 884 are	High	Complete collapse of houses and endanger the neighbouring houses. Loss of life of occupants and others.

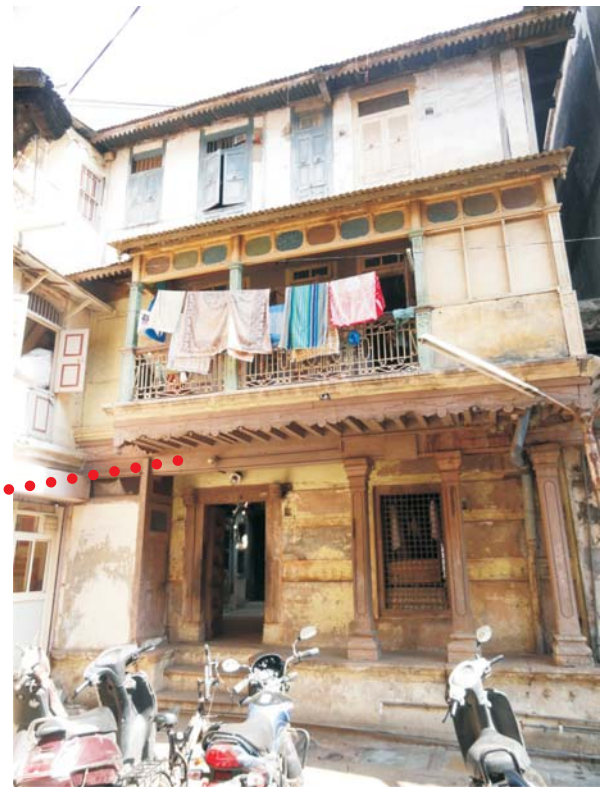
Closed and vacant houses - 2 nos. (survey no. 852, 854). Dilapidated - 1 no. Survey no. 832	being used for commercial purposes and godowns.		

The above analysis reveals that Shantinath ni Pol, popularly recognized as one of the purely residential Pols and which was one of the criteria for selecting for survey in this study, has only 12 houses with original construction still surviving out of the total number of 50 houses. This together with other 12 houses, which are moderately altered do not even count for 50% of total housing stocks in the Pol. Based on the above analysis and samples of detail study of traditional houses in the following chapter and undertaking further public consultation, Mock drills etc, Disaster Risk Reduction Management plan for the Pol could be prepared.

Besides the general survey of the household with the help of questionnaire, another rapid survey for few buildings were done to assess the vulnerability status. A mix of commercial and residential buildings were selected for the same. Some building owners / tenants were reluctant to cooperate and others let us enter inside the houses with a bit of hesitation.

1. Survey no. 879 A & B

Plan - 879A & B.



Front facade - west side

Picture showing construction detail - wooden lacing course in the brick masonry

Open Courtyard

Tanka manhole inside the kitchen

1.	Building details	GF+2, row house area (ground coverage) = 135 Sqmt.
2.	Architectural significance & Components	Traditional house with internal chowk - cantilever borne by ground floor columns. Composite style of construction dating to end of 19th century Part of the row house Tanka under the courtyard. Tin moulded ceiling and tile flooring on the ground floor. old bathroom in the courtyard on the north side. Original Facade, Courtyard with intact wooden members, wooden doors and windows, staircase are the original components
3.	Ownership	Multiple ownership. Ground floor with survey no. 879B is divided into two portions along north south direction. First and second floor with survey no. 879A has been purchased by a family some 15 years ago.
4.	Capacity	Traditional construction and the load distribution mainly intact. Shared walls on north, part south. House opens to both west side (main entry from the Pol) and on the east side towards the main road. Tanka exists, although not working at the moment.
5.	Vulnerability	a. Multiple owners creating different use / handling of the house. b. Change in materials such as false ceiling with thermacoal (combustible material) beneath the wooden joists and planks - on the ground floor rooms. c. Lack of maintenance. d. Tanka non-functional e. Inappropriate additions and alterations on the first floor, such as toilets, RCC beams and columns, balcony (eastern side) overlooking the main road. f. Narrow staircase to the first and second floor. g. Neighbouring commercial property, 876A & B and poorly rebuilt houses.

		h. Free standing wall towards the chindi side (south side) i. Lack of awareness and preparedness.
6.	Risk to Hazards	Medium risks to occupants and the house during earthquake and fire.

Old bathroom inside the chowk on north side, Floor pattern, moulded tin ceiling

Ceiling with thermacoal sheets on ground floor

Wooden column replaced by RCC / brick column

Lack of maintenance

Alteration made on first floor

2. Survey no. 884 A & B Dhavaal Stationery Mart

1.	Building details	GF+3, corner house area (ground coverage) = 92 Sqmt.
2.	Description	The residential building has been converted into a wholesale shop of paper stationery. The plan and form of the building though remains the same as the original building would have been, the interior has been totally reconstructed. The traditional wooden joists, beam roof is replaced by T-girders and kota stone above which a 4" PCC slab is laid. The wooden staircases have been retained for access to the upper storeys. A dumb weight machine helps the paper goods to move up and down. Remains of Tanka can still be seen.
3.	Ownership	Private owner. Part of the same house with survey no.884B has different owner.
4.	Capacity	none

5.	Vulnerability	a. Commercialization of the property and heavy storage of papers and other combustible materials. b. Change in materials such as T- girders and kota stone slab. c. Tanka used as storage. structure dilapidated with broken arches. d. Narrow staircase to the first and second floor. e. Corner house. f. Lack of warning system and preparedness.
6.	Risk to Hazards	High risks to occupants and the house during earthquake and fire.

Storage of paper materials

Interior of the building

View from main road

Tanka used for storage - dilapidated

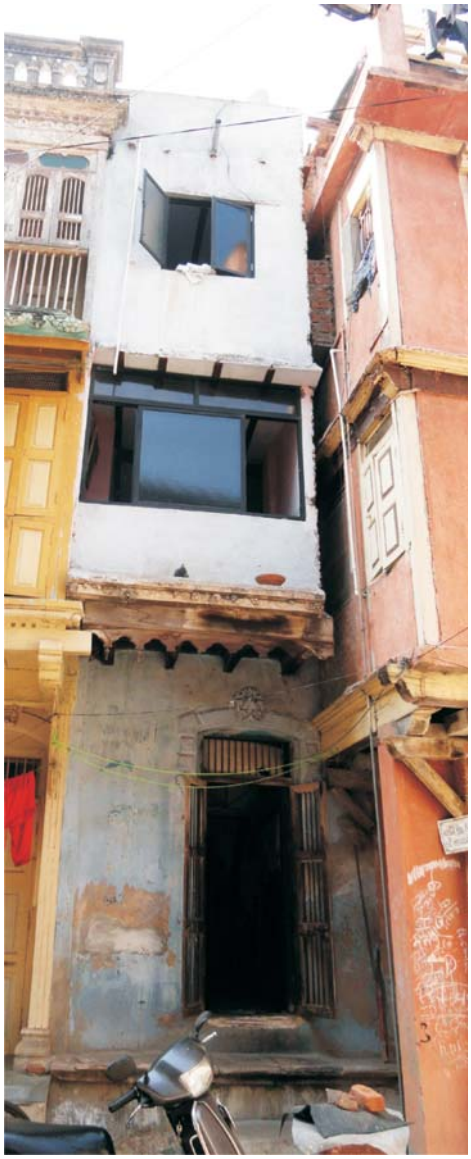
Staircase inside the building

3. Survey no. 798 Nursery School

1.	Building details	GF area (ground coverage) = 208 Sqmt.
2.	Architectural significance & Components	The school was established in 1936, in the open area adjacent to the Jain Derasar, belonging to the Derasar. Since then, the structure which seems to be temporary in nature with bare steel columns, steel truss roof, GI roof supported on channels remains the same with a little alterations here and there. The school houses around 100 students, aged between 4 - 7 year old. A room on the east side, adjacent to the Derasar still has the wooden joists, plank roof and a wooden staircase.
3.	Ownership	Single ownership (Derasar).
4.	Capacity	none.
5.	Vulnerability	a. There is only one small entrance door from the Pol, which is not adequate for escape during the time of any hazard. b. Exposed steel members are highly hazardous during fire. c. adjacent House no. 799, a three storeyed recent addition increases vulnerability.
6.	Risk to Hazards	high risks to occupants, especially the young children during earthquake and fire.

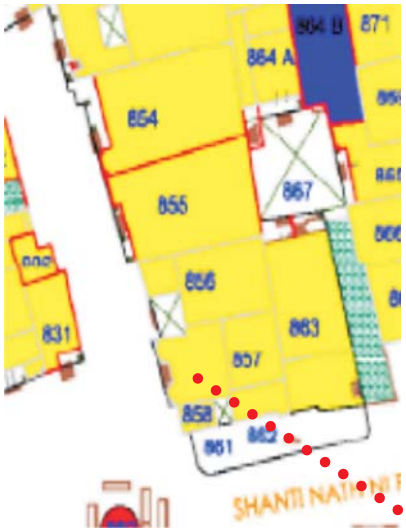
4. Survey no. 865 Residence

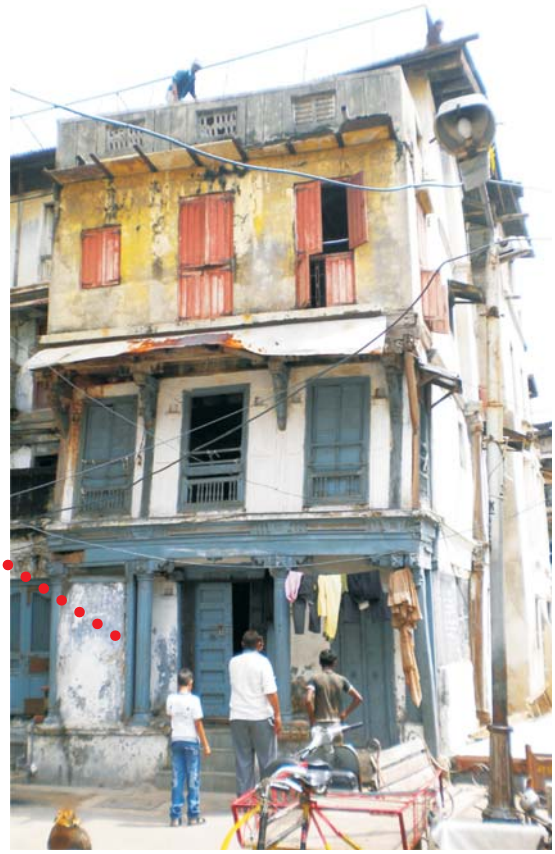
1.	Building details	GF+2, row house area (ground coverage) = 26 Sqmt.
2.	Architectural significance & Components	Originally a single storeyed room of the khadki or its entrance. The house, very narrow in width (only 2.85 meters) might have been a part of the khadki around the internal courtyard of survey no. 867. It has entrance from the street as well as from the chowk. Only the ground floor house (owner - Amit bhai Shah) could be inspected as the upper floor was locked up. There are only two rooms on the GF, which has original con struction of wooden joists plank ceiling. The upper floor (both first and second floor) are new additions to the ground floor. Access to the upper floor is through a staircase entered from the Khadki, which itself is very narrow (only 1.3 meters wide).
3.	Ownership	Multiple ownership. The small house is divided between two owners.
4.	Capacity	None. except that it has access to the wide lane on the east side besides the west side towards the khadki chowk.
5.	Vulnerability	a. Multiple owners creating different use / handling of the house. b. Complete change in materials on the first and second floors such as the iron girders, steel and glass windows. c. Lack of maintenance of the ground floor rooms. Dam aged wooden ceiling. d. Narrow staircase to the first and second floor. e. Neighbouring commercial property, 64B. f. Lack of awareness and preparedness.
6.	Risk to Hazards	High risks to occupants and the neighbours during earthquake and fire.



5. Survey no. 856, 857 & 858
Residence - presently being reconstructed

1.	Building details	GF area (ground coverage) = 42 Sqmt.
2.	Architectural significance & Components	The house was one of the landmarks of the Shantinath ni pol, it had a very prominent horse headed long wooden bracket. The house is being completely reconstructed in steel sections and kota stone. During the survey, it was found that permission was given by AMC on paper, which was duly pasted on the wall. The permission indicated mix use of residence and commercial. However, it is foreseen that the building will be used for full commercial purpose and the permission for mix use was just meant to be on the paper.
3.	Ownership	Single ownership.
4.	Capacity	none. Corner House.
5.	Vulnerability	Commercialization creeping inside the residential pol is hazardous. New construction with steel sections and kota stone increases the vulnerability of the adjacent traditional houses.
6.	Risk to Hazards	Medium risks to occupants and neighbours during earthquake and fire.

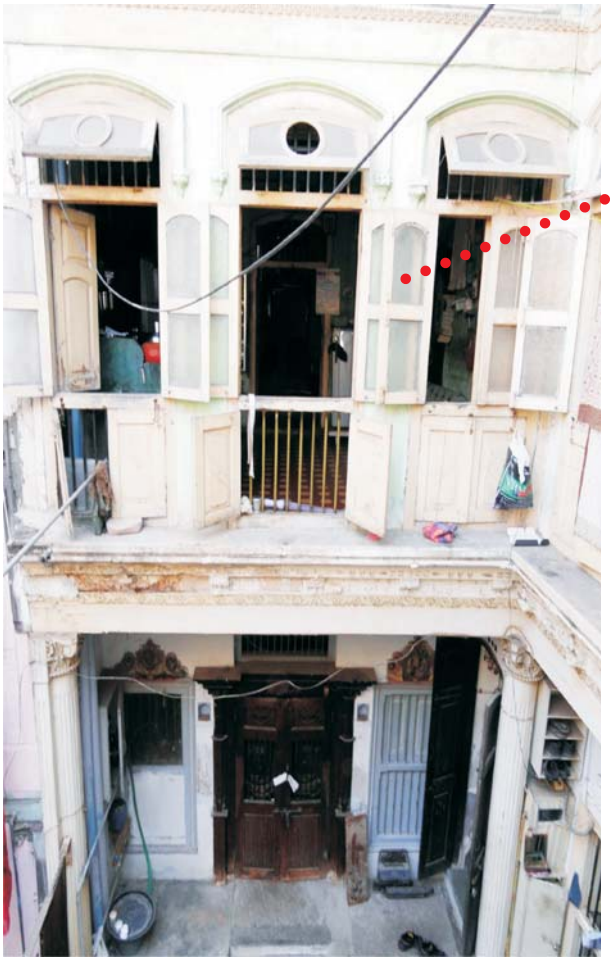


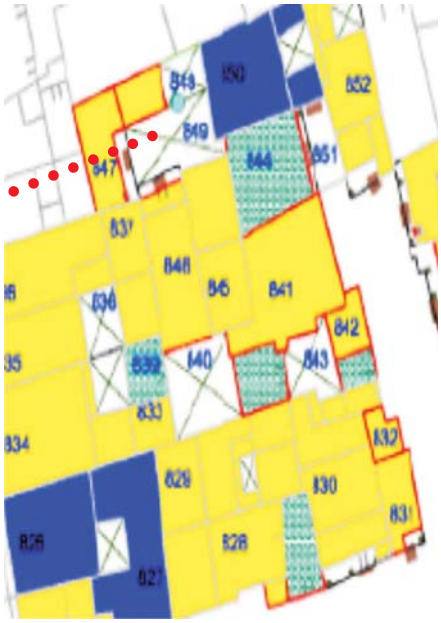


earlier house and now under reconstruction

6. Survey no. 844, 845, 846, 847, 848 & 849 Khadki

1.	Building details	GF+2 area (ground coverage) = 140 Sqmt.
2.	Architectural significance & Components	The khadki is still intact with houses grouped around a chowk. The house no. 846 & 847 still retain the traditional character without any addition or alteration. The house with survey no. 845 has been altered in terms of an additional floor. The chowk has a tanka. Though, the houses are well maintained, the khadki entrance is badly damaged with the wooden beams and joists infested with termite attack. In one corner of this space, a toilet is located, originally common to all houses.
3.	Ownership	Multiple ownership.
4.	Capacity	Traditional construction is still retained. Tanka works.
5.	Vulnerability	Commercialization in one of the neighbouring houses. Damaged entrance portion. Altered houses around the Khadki (no. 845) increases vulner ability. Restricted access and exit.
6.	Risk to Hazards	Medium risks to occupants during earthquake and fire.

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Damaged entrance portion of the khadki

Decorative roof pediment (above)
Wooden staircase, decorative tile flooring (below)

Inappropriate additions and alterations to survey no. 845

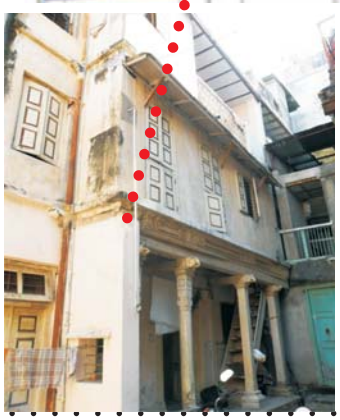
7. Survey no. 811
Commercial / godown

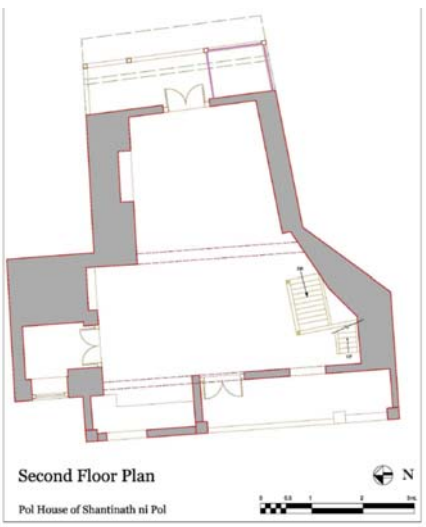
1.	Building details	GF+2 area (ground coverage) = 70 Sqmt.
2.	Architectural significance & Components	The house seems to have divided into two portions: survey no. 810 and 811. The house has undergone several inappropriate alterations and additions. Some rooms on the ground and first floor still have the original wooden joist roof and wooden doors.
3.	Ownership	Single owner.
4.	Capacity	None.
5.	Vulnerability	Commercialization and storage of materials.
6.	Risk to Hazards	Inappropriate additions and alterations. High risks to occupants and the neighbouring houses during earthquake and fire.

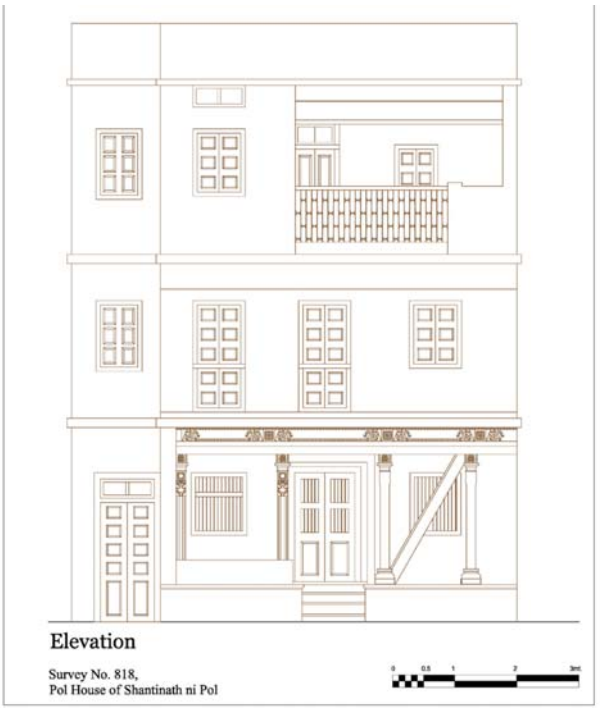

B13
B18
B17
B19
B18
B10
B11
B07

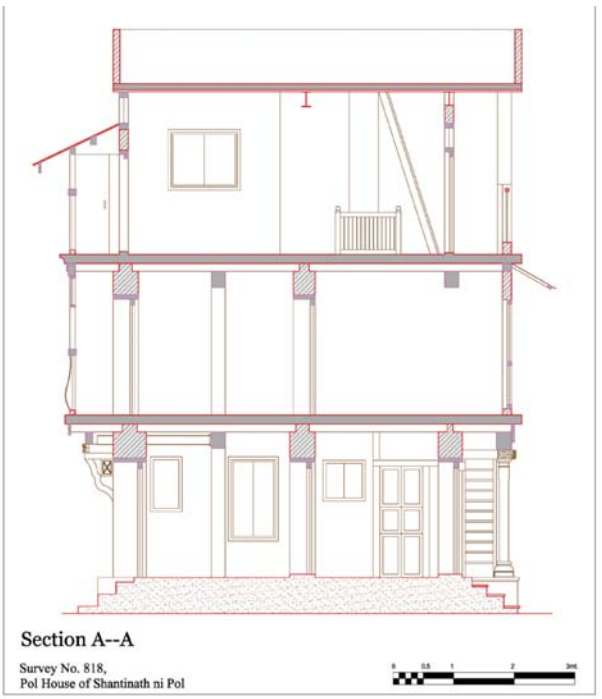
8. Survey no. 818
House

1.	Building details	GF+2 area (ground coverage) = 29 Sqmt.
2.	Architectural significance & Components	The house opens on both sides with prominent facades. The cantilevered first floor on the west side is supported by wooden columns and on the east side by decorative iron brackets. Second floor on the east side seems to be a later addition. The interior has no chowk and there are two rooms on each floor.
3.	Ownership	Single owner.
4.	Capacity	Original construction.
5.	Vulnerability	Inappropriate additions and alterations on the second floor.
6.	Risk to Hazards	Medium - low risks to occupants houses during earthquake and fire.









Drhs of house survey no. 818 - Extensions made on second floor by using steel members.

Chapter 5.

Reducing Disaster Risks to Urban Heritage in the Walled City

5.1 Fundamental Approach of DRM Plan:

A comprehensive disaster risk management policy for the walled city that recognizes heritage components and articulates strategies for mitigation, preparedness, response and recovery needs to be formulated as a pre-requisite for this plan to be effective.

It should establish links with various sectors such as planning, water supply, civil works (PWD) and environment. DRM should also be included in the existing heritage protection and management systems at regional and city level. So, while one the hand DRM systems need to integrate heritage concerns, disaster risk management initiatives should also be an integral part of heritage management systems. This reciprocal two-pronged approach is needed for effective risk reduction.

The approach to disaster risk management planning should help in identifying various technical, human and financial resources needed to prepare, implement and review the plan. The plan at city level should be linked to individual DRM plans at Ward level that recognize specific heritage sites/components in each ward and the nature of hazards to which it is exposed. It would elaborate on the procedures and not just static actions for implementation by various agencies. The Heritage Cell of Ahmedabad Municipal Corporation (AMC), which has been very active in urban conservation of the walled city since more than 15 years, can be made the central agency in this regard.

5.2. Establishment of the Disaster Management Committee for the Walled City

A disaster management committee needs to be established for commissioning the DRM plan. The committee should be assigned with the following tasks:-

- Approval of DRMP and incorporating in the master plan / city development plans.
- Periodic review based on the effectiveness of the plan after implementation and in the light of the experience of an emergency, if any has taken place.
- Coordinate with other agencies and NGOs for activities like generating awareness amongst the citizens, professional training etc.
- Advice, training and monitoring the activities of Disaster Response teams.
- Recognizing the list of heritage buildings and other heritage components of the walled city for their protection from disasters.
- Full access to inventories and detail documentation of historic properties and coordination with responsible heritage management agencies for adequate and timely response and recovery.
- Implement effective mechanisms to reduce vulnerability of heritage of the walled city through unsympathetic / inappropriate additions, alteration, commercialization, poor maintenance, etc.

The composition of the committee is suggested below :

Municipal Commissioner	Chairman
Deputy Municipal Commissioner	Member secretary
Transport commissioner	Member

Joint commissioner of Police (Law & order)	Member
Additional Commissioner of Police (traffic)	Member
Chief Fire Officer, AMC	Member
Chief Executive officer, GSDMA	Member
Director, Medical services	Member
Executive engineer, AMC	Member
Director General, Information & Public Relations	Member
Superintendent Archaeologist, ASI Gujarat Circle	Member
Director, of Archaeology Dept. Gujarat	Member
Chairman, Heritage Conservation Committee	Member
Advisor, Heritage Cell, AMC	Member
Director, Disaster Cell, AMC	Member
Expert Architect (Conservation), Ahmedabad	Member
Director, Centre for Conservation Studies, CEPT	Member
Citizens representative	Member

The expenditure incurred to convene the meeting is to be borne by the AMC commissioner's office until a separate AMC Disaster Management Cell for the walled city is formed and separate fund is allocated by AMC and the Govt. of Gujarat. Alternatively, the existing Disaster Management Cell should be upgraded and made exclusive for the walled city. Another option is to upgrade the Heritage Cell into a multidisciplinary department including the disaster management. This is also appropriate since most of the issues dealt by the Heritage Cell presently are concerned with vulnerability reduction, which is the first step to preparedness of Disaster Management Plan. The Heritage Cell should coordinate and implement the components of DRM Plan.

5.3. Awareness generation & advocacy

Residents should be educated on the importance of historic buildings and their maintenance. Guidelines for house owners and local builders on the correct techniques for maintaining and upgrading buildings, skills and materials needed for maintenance and repair of traditional

buildings, measures and actions for mitigation of damage to the buildings and their habitation should be published. Residents should be made aware about the alternate designs and materials available based on the traditional best practices for repair, maintenance and upkeep of the houses of the Pol. Such alternate designs and data are available with the AMC Heritage Cell based on many restoration works done in the past as well as ongoing. Heritage walk daily conducted by the Heritage Cell is also an important tool to spread awareness and the media should also play an active role.

5.4 Target Group

The plan is targeted for various institutions that have stake in the urban cultural heritage of the Walled City. These mainly include:-

- Cultural heritage institutions responsible for protection of heritage at national and state level (Archaeological Survey of India, Vadodara Circle and Gujarat State Department of Archaeology).
- Ahmedabad Municipal Corporation responsible for overall management of the Walled City
- Residents of traditional houses/Pols in the Walled City

5.5 Main Components of DRM Plan

Risk-preparedness for the heritage components of the walled city of Ahmedabad requires a planning framework, which is divided into following three phases-

1. Pre-disaster Mitigation

2. Emergency Preparedness & Response

3. Post-disaster Recovery & Rehabilitation.

5.5.1 Pre disaster Mitigation Measures

Having identified the heritage significance and the hazard vulnerabilities in the walled city, the preparedness measures should focus on reduction of risks, such as enforcing regular maintenance of the historic properties, use of detection and early warning systems during fire, training and capacity building of both residents and officials / staff to undertake various maintenance and monitoring measures to prevent or mitigate the impact of a disaster. It is important to acknowledge that money invested in seismic or any natural hazard risk reductions will ultimately give a good return in reduced damage and saving lives.

The AMC heritage Cell is the appropriate agency for coordination and implementation of preparedness measures, some of which are outlined below:

1. Listing and Inventory

Ahmedabad is among the first few cities where the listing of heritage properties has already been done by the Heritage cell of Ahmedabad Municipal Corporation. The list comprises of approx. 12000 heritage buildings. However, detailed inventory with photographs and documentation is yet to be completed. Full inventory supported by photographs and photogrammatic records, plans, elevation and sections of all heritage components should be prepared. Duplicate records should be kept in an earthquake and fire resistant building. It is necessary to assemble the following documents in digitised format relating to each heritage building:

a. A detailed architectural description, accurate sketches, graphic records etc on a scale suitable to the dimension of the structure (preferably 1:50 unless it is too large with detailed drawings at 1:20 or 1:10).

b. A detailed file on all previous repairs, maintenance and conversion work.
c. A comprehensive set of black and white and color photographs of archival quality including close ups.
d. Complete and accurate inventories of the movable objects within the structure.
e. For the monuments protected by the Archaeological Survey of India (ASI) and the Dept. of Archaeology of Gujarat detailed archival records should be maintained.
f. Detailed condition assessment of listed buildings should also be made part of the inventory to understand their vulnerability for undertaking effective mitigation measures.

A strong case should be made for using computer based database for listing. Detailed information about the built heritage by means of inventories that describe the cultural values as well as the degree of vulnerability to different hazards should be produced.

2. Preventive Maintenance and Monitoring

The 2001 Gujarat earthquake revealed that well maintained buildings survive much better than those that are poorly maintained. Past experience shows that masonry buildings that are properly maintained even without precautionary strapping or reinforcement has resisted earthquake with minimum damage and sometimes without any damage, whereas the buildings that were poorly maintained or not maintained at all were dislocated or collapsed. Therefore all traditional houses and monuments in the walled city should be periodically inspected, any weaknesses should be remedied as soon as possible. A permanent conservation programme for the heritage buildings including inspection, maintenance and rehabilitation should be established. The soon to be established Heritage Centre (by AMC) or the existing Heritage Cell may be made in charge of such programme.

3. Guidelines for house owners and builders for repair and retrofitting of their houses.

The local community should be made aware of the main reasons for vulnerability of their houses. Guidelines for local builders and house owners on simple and affordable techniques for maintaining, repair and retrofitting of traditional buildings should be formulated and on-site training programmes should be conducted. Community organizations at Pol level should be galvanized to raise awareness of disaster risks and collective preparedness and response in the event of disasters. A Programme for defence of the sociocultural values of the pols and the walled city should be promoted through existing community based organizations / NGOs. Government (AMC) can consider providing some support in the form of subsidies or grants for these activities.

4. Legislation and Land use strategies for risk reduction

Policies and planning strategies should be formulated to reduce vulnerability of the particular hazards such as fire or eliminate their sources. The godowns of whole sale shops in the pols (especially in the residential pols) and the haphazard electrical wiring are a major source of fire, for which preventive measures should be taken. Rapid commercialization and inappropriate additions, alternations to heritage properties as well as poor quality of new constructions in walled city should be controlled through formulation of special regulations and its strict implementation. These special regulations can be made as part of the GDCR Heritage Regulations.

It is recommended that new buildings constructed in mild steel girders and kota stone slabs that make the building and the neighbourhood vulnerable to fire should not be permitted. Systematic verification of the effect of the application of modern building technologies to traditional houses with traditional materials and systems should be

made a necessary procedure, especially concerning behaviour in the event of earthquakes, fires. Not only the verification of alteration made to the individual buildings, but the impact of demolition and new houses should also be verified for its impact on the vulnerability of the entire neighbourhood / Pol.

5. Earthquake Vulnerability and Risk Analysis

Vulnerability analysis of walled city should be made for earthquakes of different intensities and the resulting risks to the heritage components of the area should be assessed. Computer generated models can help in assessing potential damage to each type of heritage component. AMC Heritage Cell can consult experts and structural engineers to undertake such assessments.

6. Capacity Building of Building Professionals

Inspection reports are the basis of good maintenance. Therefore city architects and engineers should be trained in inspection of heritage buildings through a proper understanding of traditional materials, constructions, crafts etc. All professionals involved in the protection and management of heritage buildings and objects need specialized training.

7. Utilizing Traditional knowledge systems for disaster mitigation

Traditional knowledge systems for disaster mitigation may take one of several forms such as the community-based management system like 'Panch system' in the Pols or other indigenous monitoring systems. Investigations have shown that lot of traditional knowledge for disaster mitigation is embedded in historic and traditional buildings. This aspect has been proved in 2001 earthquake due to the higher rate of survival of the traditional houses, which showed how traditional construction techniques often conferred a good earthquake resistance on buildings. Significant amount of this knowledge is still possessed

by skilled craftspersons. Therefore these craftspeople should be engaged in the restoration and retrofitting process and their skills should be upgraded where needed. This would also provide them with livelihood opportunities and thus encourage them to continue to practice their skills. Action is also needed to secure the supply of traditional materials such as timbers, which are becoming more and more difficult to obtain. The list of such skilled craftpeople should be published by Heritage Cell.

In connection to the various causes mentioned in the vulnerability chapter 3.5, detailed studies on the impact of polluting gases generated from vehicles and other sources such as carbon monoxide on the timbers or stone used in the walled city houses or monuments should be commissioned. The study should also recommend remedial or preventive measures. A serious thought should also be given to have a system of monitoring of the quantum of gases generated in the sewer lines and control the accumulation to avoid crown collapse of heritage buildings.

5.5.2. Emergency Preparedness & Response

When an emergency situation befalls a historic property, it is necessary to take rapid action to prevent further loss of historic fabric over and above that initially caused. Following a fire, flood or earthquake, the local emergency services, usually the Fire Brigade is involved. While they are undoubtedly brave and skilled people, often they have no particular expertise in dealing with the historic buildings and they may not be aware of the significance of the historic elements of that building.

However the emergency may itself create new kinds of risk to cultural heritage such as:

- Theft of collapsed or damaged fragments or movable objects

in the property, such as the decorative and carved wooden members - door & window shutters, columns, brackets, beams, joists etc of traditional houses. Even members of the dismantled chabutaros could be lifted easily.

- Flooding may cause contamination through pollution and mould growth in the buildings.
- Insensitive actions by relief agencies or by volunteers (due to lack of awareness), such as pulling down damaged structures of heritage value such as the wooden facades in the name of 'life safety'. During fire control, additional damage to the heritage property may be caused by the water used for extinguishing the fire.
- Risk of making inappropriate damage assessment of heritage property due to a lack of prior knowledge or experience.
- Confusion due to lack of coordination and preparedness.

Therefore emergency response plan for each heritage property, each Pol, market area should be developed by bringing together heritage managers/institutions, emergency response institutions and local residents. The plan should be based on shared understanding of the property, its significance, its condition and its need in disaster situations as well as preparing individuals that can be available on site for assuming appropriate responsibilities during emergency situation.

1. Constituting emergency response team / disaster response mechanism with special consideration of heritage

A competent emergency response team at city level should be formed with members of Municipal Corporation, Fire Brigade, Police department, conservation architect, a structural engineer etc. However volunteers should also be identified from each pols to be part of emergency response team at community level. Panch members of each Pol would be helpful in this exercise. The

emergency response team should have adequate awareness of the nature of a property's heritage qualities and of appropriate means to limit the damage to these qualities during response without compromising human life or safety.

However this would require strengthening coordination between various stakeholders notably those of heritage and emergency response and also key line departments such as electricity and water supply who have a crucial role to play during response.

Constitution of Disaster Response team is suggested below :

Director, Disaster Management Cell, AMC	Chairperson
Advisor, Heritage Cell	Member Secretary
Ward councillor	Member
Fire officer	Member
AMC engineer	Member
Representative of Pol Panch member (on rotation basis)	2 Members
Traditional houses representative	Member
Shop owners (on Rotation basis)	Member
Architect (conservation)	Consultant
Structural Engineer	Consultant
Plumbing, electrical engineer	Consultant
Volunteers	Honorary members

2. Directory of Agencies

A complete and easily accessible directory of responsible persons in various agencies and specific emergency team members including volunteers from local community should be prepared along with list of skilled craftspeople and other skilled persons. A list with contact details of Fire Stations, Police Stations and other relevant institutions should be made. It should also include

the list of equipments each agency possesses. The directory should also be made available on the web site besides printing of hard copies. The AMC Heritage Cell should have such directories made immediately.

3. Evacuation plan

Evacuation plan in the event of an emergency should include escape routes, rescue points, access routes for rescue teams, parkings etc. Evacuation routes for each house and the pol for different hazards should be planned and marked on the map. These routes should be designed in a way that loss of heritage values due to widening of roads or creating new access points is minimal. If possible some refuge areas for salvage of heritage fragments/collections should be identified at secure locations. However it is important to note that mere designing of routes on maps is not effective. It is important for ward level response team to test/practice these on regular basis in cooperation with emergency response agencies.

4.Provision of adequate equipments and infrastructure for emergency response

Risk to infrastructure of roads, drainage, water, gas, electricity, telephones and other installations in each Pol should be assessed and anti-seismic design for these lifelines should be initiated. Since, electricity is often cut off after an earthquake, the Ahmedabad Electricity Company should have an independent source of supply on the premises.

In case of main supply of water is cut and blockage of roads following a disaster, specific arrangements for local supply of water should be made in heritage structures as well as traditional pols. For this purpose, the potential of traditional water system of 'Tankas' should be explored.

For preventing spread of fire, adequate and appropriate number of extinguishers should be installed especially in public heritage buildings

and in large shops and godowns which are highly vulnerable to fire. These should be regularly maintained. Depending on need and available resources, other fire prevention equipment such as smoke detectors and hydrants should also be considered especially in areas that have restricted accessibility. New technologies like 'Mist Technology' should also be made available.

In general, low-cost measures such as a stock of sand or buckets of water can be of great help during emergency situations. Garage and car park sites should be chosen by keeping in mind various emergency operations.

5.Training and Capacity Building for Emergency Response

Training and capacity-building on the use of emergency equipment such as fire extinguishers, and emergency drills in cooperation with external agencies such as fire services should be undertaken on a regular basis. Regular emergency simulation drills, awareness-raising activities, short publications for visitors, etc. should be organised. Training and simulation exercises for enhancing the community's preparedness and response capability to identified risks will simultaneously strengthen and enhance the capacity of the administration to undertake necessary preparedness or evacuation measures. Private sector units, NGOs and other organisation should also be identified to assist in this process.

6. Raising awareness of civic defence agencies

It is crucial that civic agencies in charge of emergency response like the fire brigade, police departments, response forces are aware of heritage structures in the walled city and thus seek advice of responsible heritage agency/professionals before making any final decision regarding demolition of these structures. Of course, these decisions should not compromise on people's basic safety in any way.

The capacity of Police control rooms / police chowkies and hospitals including private nursing homes to respond in emergencies should be improved through adequate training and awareness courses and on site disaster simulations.

7. Damage Assessment

After initial rescue phase is over, inputs of heritage professionals need to be sought for specific damage assessment of heritage structures that would be fundamentally different than contemporary structures. This calls for prior procedural arrangement, where the AMC Heritage Cell prepares special damage assessment forms in advance considering the specific structural, material and architectural nature of heritage structures in the walled city. Local architects and engineers would need to get trained prior to any disaster in using these damage assessment forms. The central control point should be the Heritage Cell, where all of them can report.

8.Developing procedures for immediate protection and repairs

The historic buildings which have been impacted by a disaster will have elements in different states of structural stability. There will be elements which are quite sound and which can remain without immediate action. However, there may be elements especially on the upper storeys such as the parapet walls, railings, pediments, balcony overhangs, chajjas, minarets and other elements which are in dangerous situation and the building professionals, however, sympathetic to the structure must agree to their demolition. There will be elements falling between these two extreme categories. Elements which have to be demolished should be recorded in the best way possible, bearing in mind the dangerous condition of the structure. Any demolition should be carried out with great care ensuring that falling of debris does not cause further damage to other parts of the structure.

Elements such as walls, roofs which do not demand immediate demolition, but which appear unstable should be shored. The decision of demolition or shoring is largely a matter of experience and should be made bearing in mind short term changes such as high winds and the ingress of moisture. Shoring can be constructed from tubular steel scaffolding or timber depending in the availability and situation.

Balconies, overhangs, suspended floors need particular attention, particularly where they have been fire damaged and where reduced sections may exist. Suspended floors may also be seriously overloaded with fallen debris, which, in a fire situation, may be water logged. It will be necessary to examine the floor below before the work to remove fallen debris commences. It should also be remembered that floors, even partially damaged floors, may well be providing useful lateral stability to walls.

The tops of masonry walls may have become dislodged, resulting in a risk of masonry falling onto people below. Such loose masonry should be removed after recording. While great care is needed to ensure that all necessary actions are taken, the professionals involved should take care not to overreact, either by attempting to save dangerous elements or conversely by giving permission for wholesale and possibly unnecessary demolitions. The key word is care; to save as much as possible and in avoiding unnecessary risks. There may be a conflict of interests between removing debris quickly for safety reasons and leaving it undisturbed that it may be recorded properly.

Multidisciplinary conservation team should be employed for immediate weather protection. Suitable materials should be allocated, such as polyethylene sheets, steel / wooden props, tubular scaffolding, mobile cranes, jacks, wire, ropes, steel straps, or chains with all

necessary fittings such as corner pieces, turn buckles, timbers for shoring etc. Having made the building safe in the short term by a combination of demolition, shoring and removal of debris, it will be advisable to consider some longer term weatherproofing of the remaining structure so that, for example, the building can be allowed to dry out slowly and be protected from further damage from the elements of nature. It is also necessary to protect the building from unauthorised entry and from further damage due to vandalism and theft of valuable features. The key word is protection: protection from natural elements and vandalism.

The highest priority following a disaster to a historic building is to get sympathetic building professionals onto the site as soon as possible. These people must be in position to give sound, competent and practical advice and to encourage others to take a positive attitude as an alternate to the obvious solution of demolition. The need for quick, but nevertheless thorough, investigation prior to making decisions regarding shoring dangerous elements, demolition or other actions cannot be overemphasized. Where demolition is unavoidable, such recording as can be done in safety should be carried out and the remains of the structure should be made weather tight and vandal proof as soon as possible. When the emergency repair work starts, light drilling equipment, electrical generator, stainless steel wires, grouting equipment and materials, flat jacks, epoxy resins etc should be made available along with traditional building materials such as stone, brick, sand, brick aggregates, lime mortar, timber and roofing sheets etc.

All the above mentioned guidelines should be included in the plan and followed in case of emergency. This would require training of local building professionals as mentioned previously. AMC Heritage Cell should procure the above mentioned equipments, materials with funding assistance by different corporates under Public Private Partnership (PPP) initiatives.

5.5.3 Post Disaster Recovery and Rehabilitation

After the disaster phase is over, long-term measures need to be formulated to ensure that the property is rehabilitated at the earliest and is protected from future disasters. Lessons learnt from the disaster should help in reviewing existing risk management systems. The following aspects need to be reviewed or be put in place for effective post disaster recovery:

- Procedure for in depth assessment of damage with estimates and cost of restoration and priorities criteria for taking decisions on appropriate interventions should be established.
- Affordable and compatible techniques for structural repairs, restoration and retrofitting of structures should be advocated in the plan. Qualified heritage professionals should be identified for undertaking these.
- Recovery plan should allow for adequate review of policy and legislation regarding cultural heritage and disaster management based on the effectiveness of the plan in the disaster.
- Recovery planning should allow for adequate availability of human resources based on various needs of heritage in post disaster situation.
- Regular discussions with stakeholders and the local community are important for keeping these groups involved during recovery and rehabilitation and for their understanding the importance of restoring the lost cultural heritage values. Therefore procedures for effective engagement of stakeholders in the recovery process including local community should be laid out in the plan.

- Educational and awareness-raising activities.
- Monitoring system for review of the recovery process should be established with clearly designated roles and responsibilities.

Part ii

Traditional Coping Practices in the Walled City

Introduction

Traditional knowledge and management systems have a positive role in disaster mitigation as well as protection. Traditional communities may not know how to respond to a major fire but they may have a specific organization for collective action in responding to a disaster. Natural heritage may also play a significant role as buffers or protection from various hazards, for example the function of mangroves in protection against coastal flooding caused by erosion or tsunami and storm surge. Functioning ecosystems also have increased capacity to store rainfall in soils, plants and wetlands during storms, thus reducing flood risk within the property and downstream of it.

Traditional knowledge systems for disaster mitigation may take one of several forms:

- Indigenous management systems: in Kathmandu valley, Guthi lands are jointly owned by the community for fulfilling various social and religious functions. The returns from these lands provide resources for the maintenance and repair of historic temples, especially after disasters.
- Indigenous monitoring systems: in Shirakawa Village (Japan), the community members share responsibility for going around the village daily to inspect any possible risk of fire. While on inspection they call out reminders of the need to be vigilant.
- Traditional skills and techniques in building construction and periodic maintenance : Analysis of those constructions that had a higher rate of survival in the Kashmir and Gujarat earthquakes showed how traditional construction techniques often conferred a good earthquake resistance on buildings and it was discovered that good-quality traditional constructions survived the devastating earthquakes of 2005 and 2001 respectively. During the Kashmir earthquake, the traditional structures built using local building techniques of Taq (timber laced masonry-bearing wall) and Dhajji Dewari

(complete timber frame with masonry forming panels within the frame), in part or in whole, performed much better than many poorly built 'modern' structures. Although there were many cracks in the masonry in fill, most of these structures did not collapse, thereby preventing loss of life. Also some vernacular constructions such as wooden log houses, and those employing the use of well-laid masonry with through-stones and well-designed arches, trusses, tongue-and-groove joints and balconies resting on projecting wooden joists performed well in the earthquake. Similarly, the traditional dwellings of the earthquake-prone Kutch region in Gujarat, the Bhungas, have also withstood the earthquakes, thanks to their circular form, which is very good at resisting lateral earthquake forces. Moreover, wattle and daub constructions, especially where wood is used as reinforcement for the wall, have proved to be very effective. It is worth mentioning that bhungas are not only earthquake safe, they also demonstrate sensitive understanding of locally available resources, climatic conditions and spatial requirements of people. In fact, all these factors play an important role in the evolution of vernacular architecture at any given place. Many traditional structures in Gujarat built prior to the 1950s have floor joists extending through the rubble stone walls to support the balconies. These types of structures were more successful in stabilizing the walls than those where joists terminated in pockets and performed much better during the 2001 quake.

- Local ecological relationships and indigenous planning systems may also contribute to sustainability and thus prevent disasters such as floods. For example, in Majuli Island in Assam, a large river island with unique local ecology, the vernacular housing in the area using locally available bamboo and constructed on stilts has evolved as a sensitive response to local factors, notably

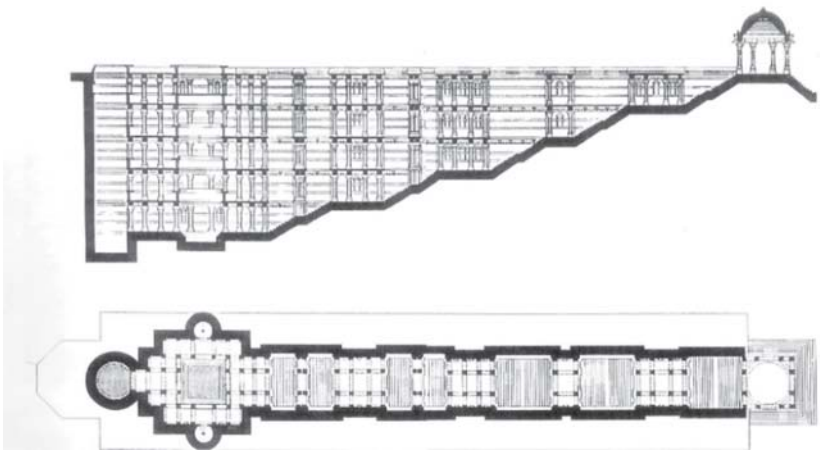
floods that inundate the island on a regular basis. The light bamboo structure enables easy dismantling and relocation, in the event that the area is affected by floods.

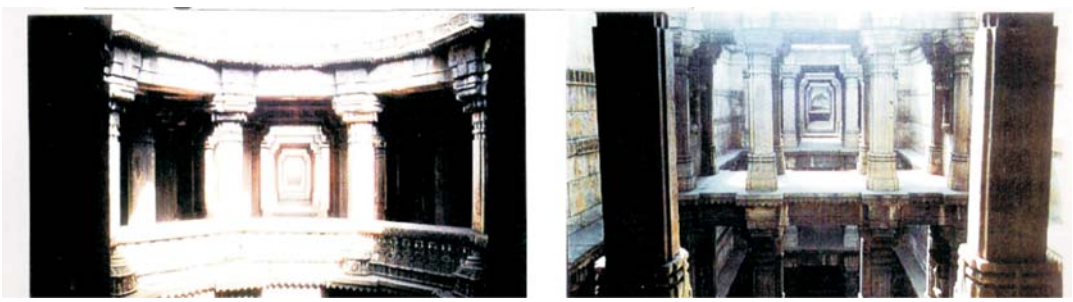
- If such traditional knowledge systems exist, every effort should be made to integrate these into the DRM plan of a heritage property.

The traditional houses in the Pols of the Walled city of Ahmedabad also exhibit certain coping mechanisms, which have been documented and described in this section of DRMP. **It is highly recommended to compile all such traditional knowledge of coping practices in the walled city and articulate such knowledge in the language of modern civil engineering. This is necessary to put that knowledge in proper footing and save them from being ignored as old outdated practices.**

Tanka - traditional water harvesting system

Ahmedabad is part of northern Gujarat which is characterised by semi arid climate. Its urban form and architecture are conditioned by the hot and dry climate and scanty rainfall. Water being a scarce resource assumed sacred connotations and was almost celebrated in the form of magnificent step wells (vavs) and lakes constructed during Solanki and the Sultanate periods. Large tanks built during the Solanki period are still functional, their grand scale and magnificence speak highly of their hydraulic engineering skills. During the Sultanate period several types of structures were built, during which a great degree of perfection was achieved in the construction of Vavs and Tankas used for harvesting rainwater falling on the terrace of any building. The Tankas served in good stead for long time until they

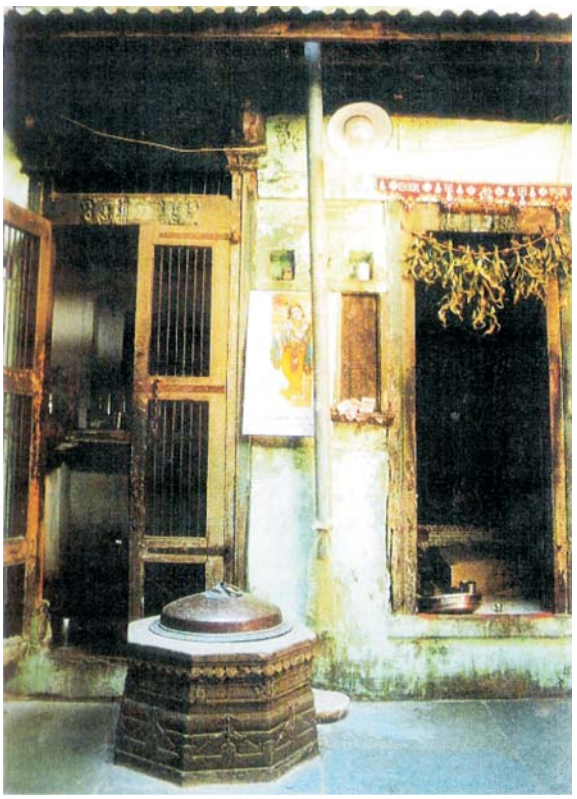


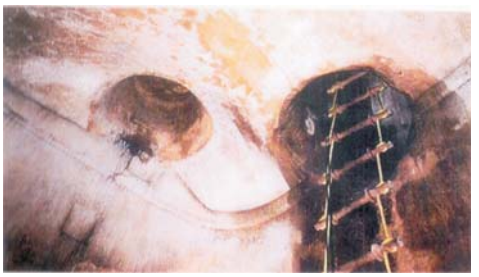


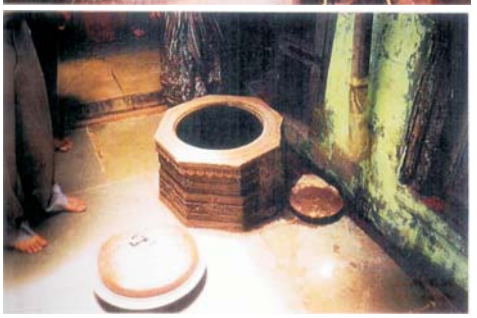
Dada Hari's Vav, Ahmedabad is an elaborate construction to access ground water. Beyond its usual function as a well, it better served as a social institution. It is a place where travellers could rest and refresh themselves.

were dislodged by political intervention and introduction of centralised water supply facility. Excessive dependence on ground water has seriously depleted the aquifers below the city. The municipality tube wells have become ineffective in last few years. Direct rain water harvesting with the help of tanka system will definitely emerge as one of the dependable means for augmenting the water supply. Especially, during the event of hazard such as fire, large amount of water required to douse the fire in the neighbourhood can be obtained from tanka.

Tanka in the courtyard of Pol houses of Ahmedabad is an expression of intimate understanding of nature. The Puja room and the manhole of Tanka share the same space, denoting the sense of sacredness which is attached to water. The portion of the tanka, which is seen in the courtyard is made of monolithic sandstone and profusely

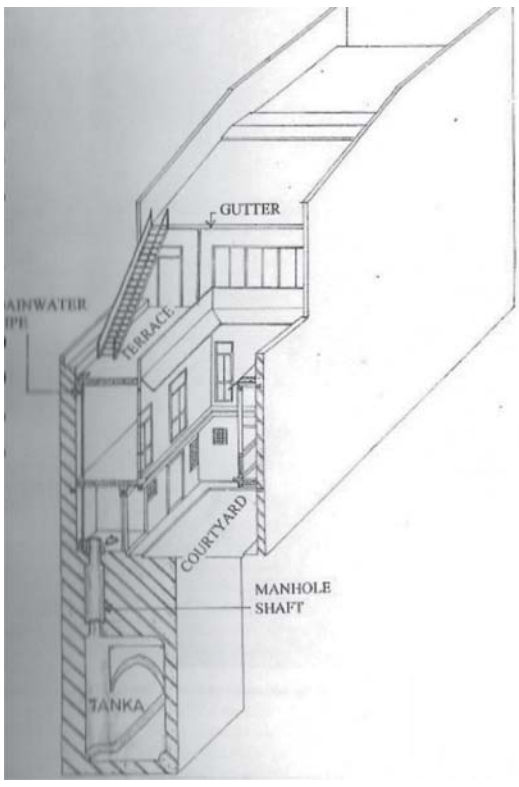


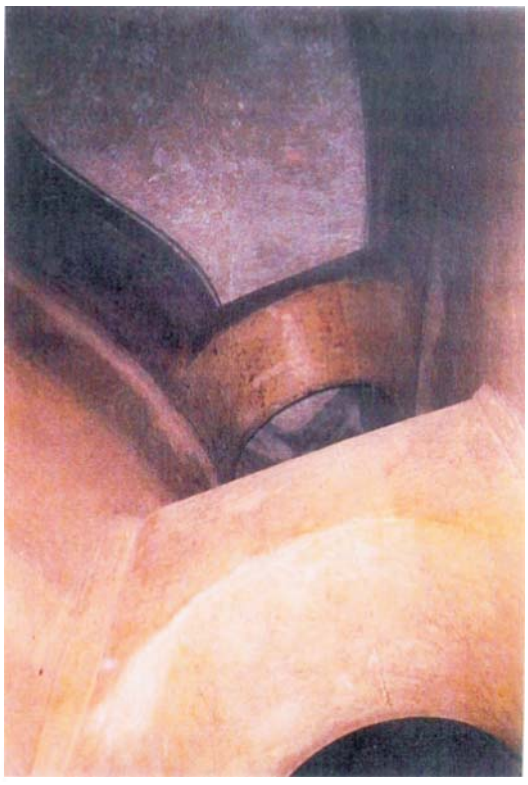




The puja room (room for worship inside the house) and the manhole of tanka share the same space denoting the sense of sacredness which is attached to water

embellished with a lid made of copper. The two and a half feet diameter manhole is 8-10ft. long circular shaft. It leads to a large dark space, where water is stored; the interior is characterised by arches and curvilinear walls. The retaining walls are in brick masonry with thick lime plaster. The floor slopes towards a sump, which lies directly below the manhole. There are other utilitarian elements like niches and brackets as lamp stand and foothold are provided along the manhole shaft. Size of tankas varies from house to house. Average storing capacity of a tanka is about 25000 litres and its height varies from 13 -15ft. Some Tankas have more decorative interiors such chadar / sheet like a water fall, dancing statues etc. In rare cases, a secret room or "chor khana" is located in the walls, which measures approx. 7ftx8ft with a height of 7ft.





Interior of tanka

Principle:

Tanka is based on the principles of in situ collection of rain water as close as possible to the location where it falls. It is one of the most cost effective and hygienic system to store water. The terrace is swept and cleaned before the monsoon by the owners. Rain water falling on the terrace is channelled through a G.I. sheet gutter into a copper pipe which brings down to an open chamber on the ground floor which has two outlets, one takes water into the underground cistern and the other to the waste drain. So water coming down the pipe can also be allowed to escape as storm water. Water from unseasonal rains or early mansoons is allowed to flow out because of the dust and imprifies it contains. The high standard of water quality conforming to international standards is the high point of this system. A small filter is now being added to this chamber, which is a new feature.

The main factors of tanka system are outlined below;

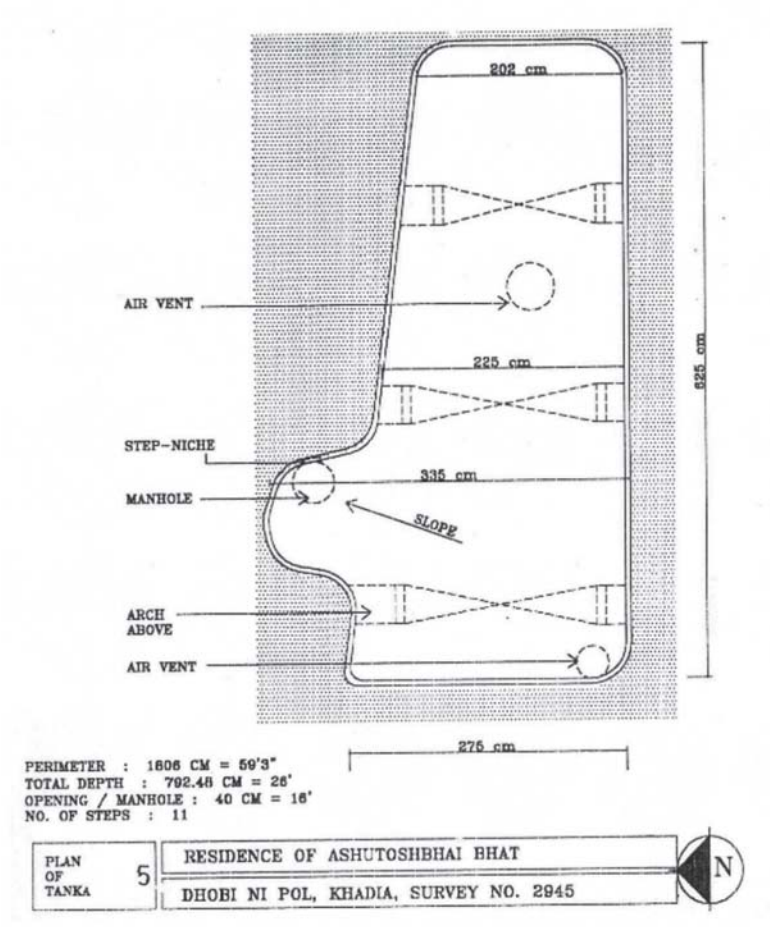
a) The system involves direct collection of rain water so the chances of pollution are minimum.

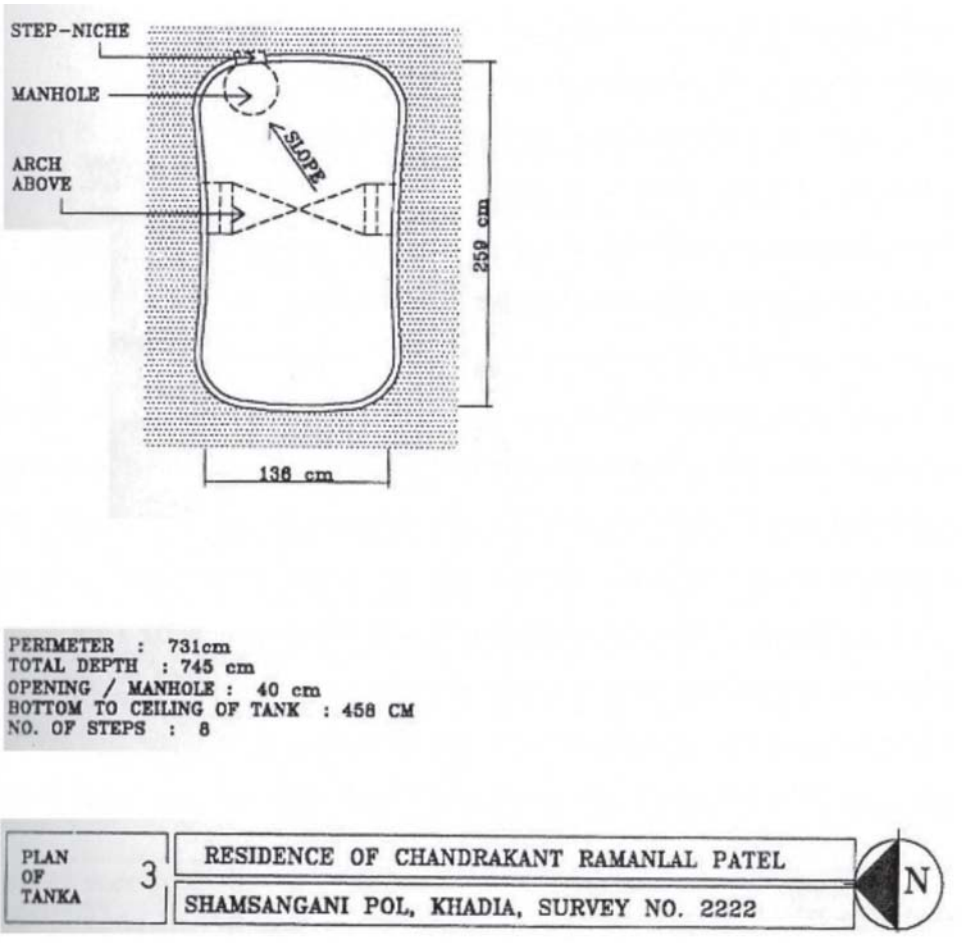
b)The interior of tank is dark, hence lack of light energy stops growth

of chlorophyll containing algae and other microbes. In stagnant water algae is the breeding ground for bacteria, so absence of algae indirectly controls and checks the bacterial growth.

c) Bacterial growth is also controlled by the presence of lime which is used in the construction.

There are also astrological guidelines for storing water. Local calendar divides a year into twelve months, each having two main nakshatras. As per astrological guidelines there are seven odd nakshatras which are considered good for storing water in the tanka. These predictions are said to be based on the fact that during these particular nakshatras, the bacterial and microbial growth is minimum.



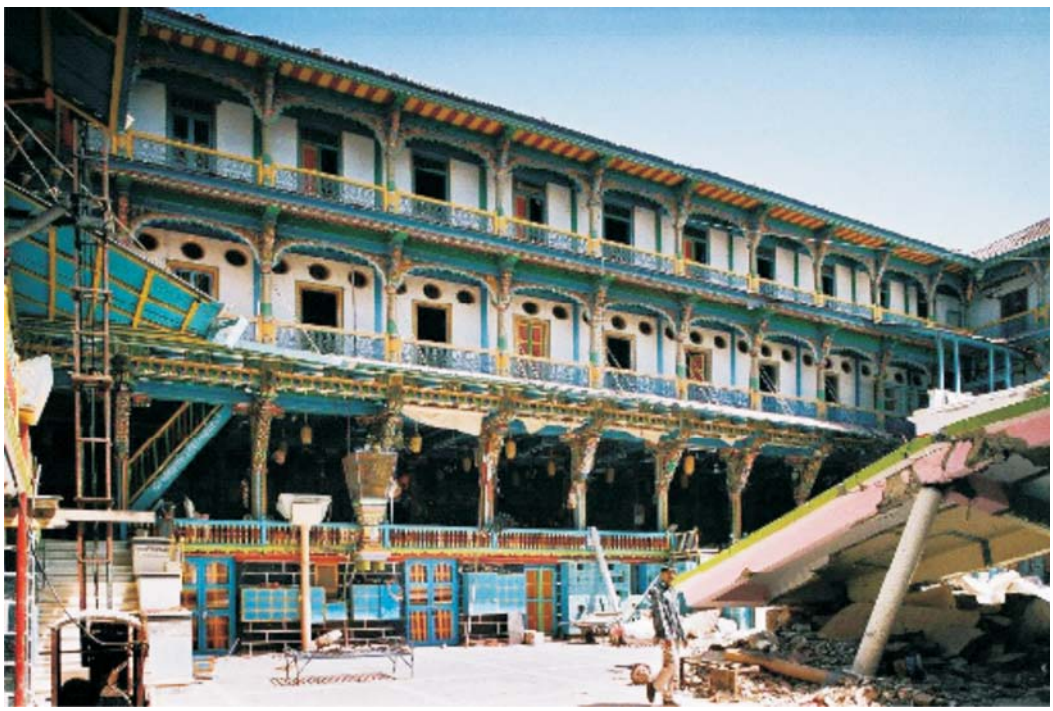


Plans of different types of tankas

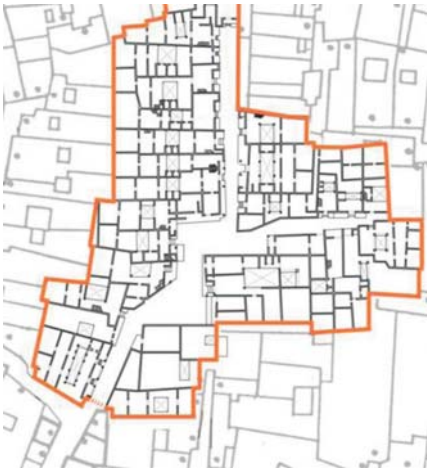
Pol System

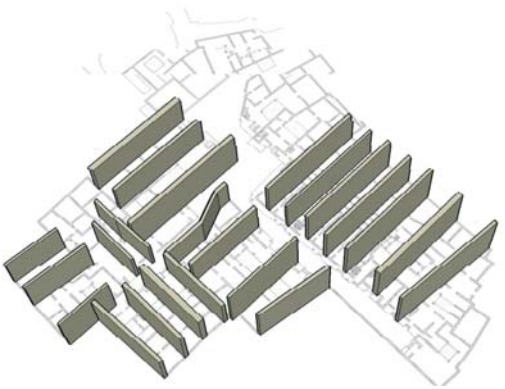
The houses of Ahmedabad have survived several natural calamities that devastated newer parts of the city. There are several lessons to be learnt in the system of making the old city, from plan organization of streets to construction of individual houses. If the indigenous techniques of building are not studied vital information about these would be lost.

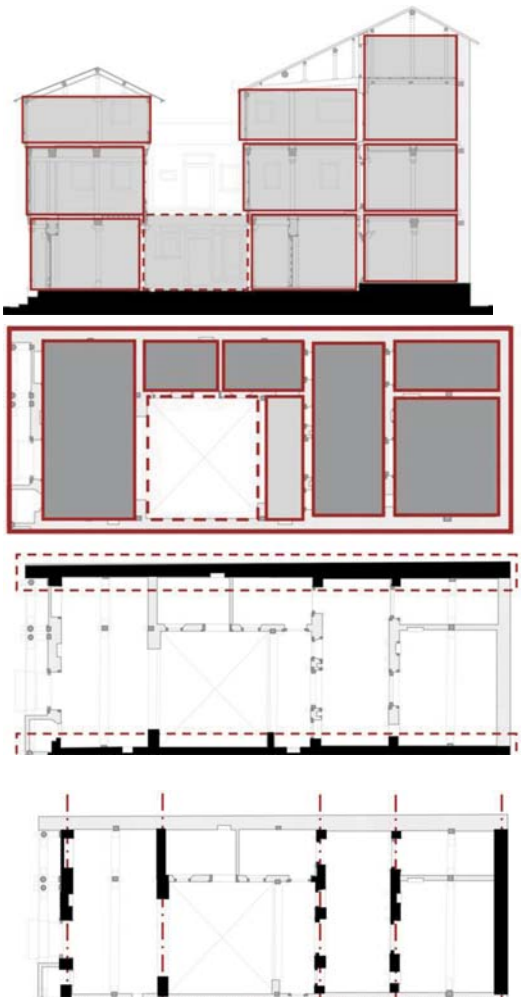
The grouping of houses into a Pol is typical of Gujarat and especially of Ahmedabad. A Pol is made of elementary rectangular units evolved linearly along the street, parallel wall grouping system, with minimum surface area towards the street. Pol behaves as a single structure with floors and roofs acting as diaphragm and interconnection established between adjacent houses. Horizontal Thrust is shared within the cluster of houses that help each other to survive in case of external force such as caused by earthquake.



Swaminarayan temple, Ahmedabad - January 2001







Drawings of Pol (above) and of traditional house

Traditional Houses

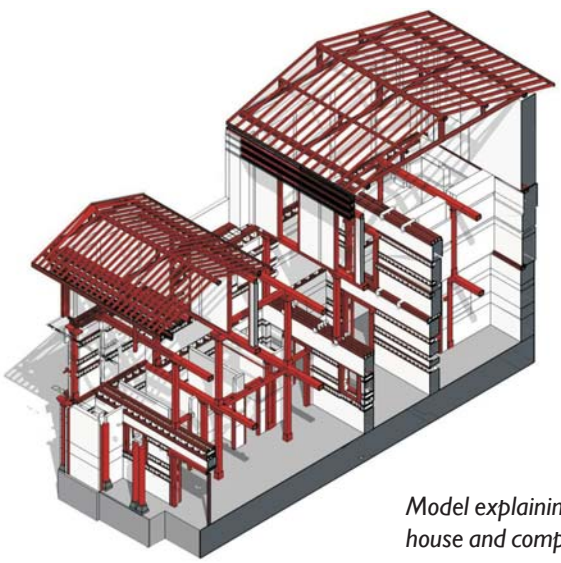
Housing units are narrow, deep and consist of two bodies with courtyard between and linked up by passage ways. The general rule in making these units is that the rear body is higher than the body looking on to the street. Roofs are pitched with the roof-crests running parallel to the street. The rear building is partly covered by a terrace for the collection of rainwater to be stored in the water tank (under the courtyard) known as "tanka". Each aspect of the houses have inherent structural qualities of resistance, which is explained below:

Wall System - The traditional houses have two long parallel walls supported by cross walls at regular intervals that act as a rigid box. Cross walls effectively reduce the length of

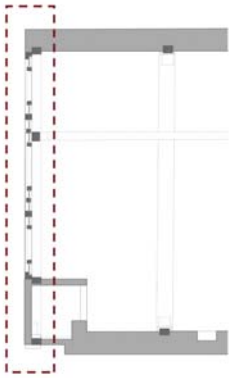
parallel walls and increase strength as their length decreases. Cross walls, acting as shear walls, are capable of resisting all horizontal forces due to their own mass, as well as those transmitted to them during an earthquake.

Plan (Mass distribution and reduction) - The courtyard divided the mass into two parts in the event of earthquake, this difference in the mass distribution is well taken care of by independent flexible wooden courtyard structure between two masses and the lightweight structural system in the upper floors. Increasing openings on the top floor reduces the dead load on the walls below. There is reduction in the size of the elements like column, bracket and walls as the structure rises up, which allows the system to be light in weight, balances the horizontal forces and also helps in reducing the overall mass on top.

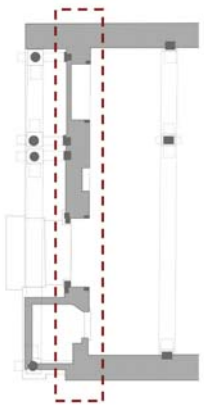
Section - The Pol houses have all walls matching their respective floor layout at every level, which helps the gravitational and horizontal load transmission easily to the foundation. Projecting floor joists make conjunction with brick wall to hold and protect vulnerable masonry against moisture, rain and humidity.



Model explaining construction of traditional house and composition of wooden members



Material - Proportion of wood reinforcement increases as the wall goes up and increases the strength of wall. First floor facade made only by using wood, to reduce load. On the upper floor levels, the number of wooden elements increases, but the elements reduce in size distributing their mass in smaller segments. The top structure becomes flexible enough to move with rest of the mass and allows dissipation of more energy.

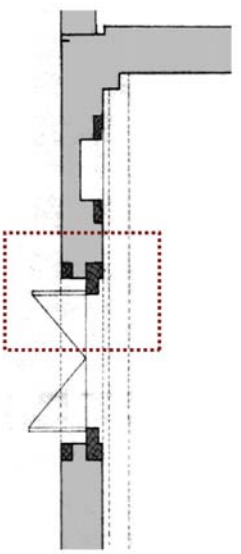


Construction - Heavier walls help to apply compression to brickwork in lower level, and the resultant horizontal forces are taken care of by thick walls. Top parapet with brickwork also helps to hold roof in place and give more compression to the wall below.

Floor elements such as beams, floor joists, floor boards, filler materials are tied together to be capable of exhibiting diaphragm action.

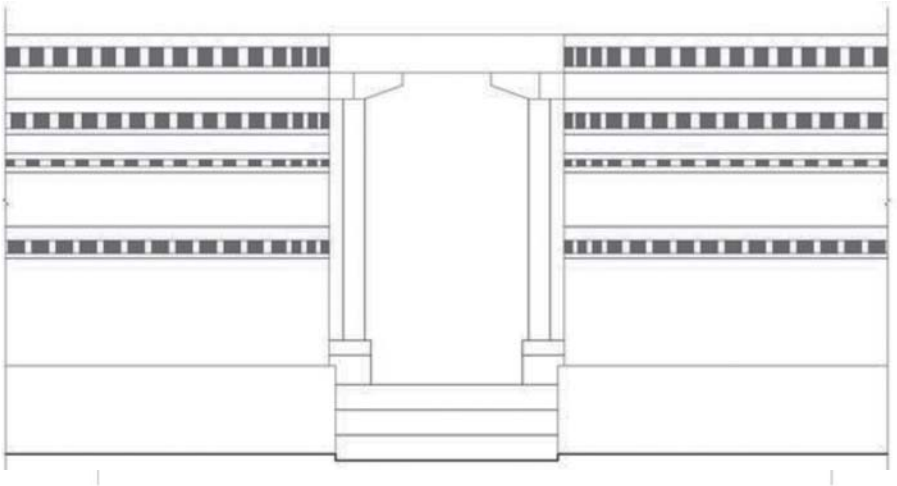
Roof is anchored to the supporting walls and have an arrangement for transferring their inertia forces to the end walls.

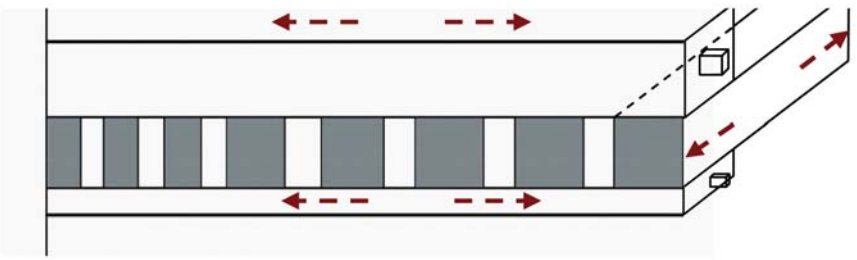
GF part Plan and above - FF



Openings - The openings have two complete frames of timber around to strengthen against lateral forces. Wooden lintel and frame ties the whole door or window and its parts with the wall and takes the load coming from the wall above and transfers it to the wall below. Openings in any storey of the Pol houses have their top at the same level so that a continuous wooden band provided over them including the lintels throughout the building.

Bonding - Bonding timber placed in the wall divide the wall horizontally at intervals reducing wall's effective height. In order to reduce thrust at openings, wooden members reduce in size and increase in number help to dissipate energy. Horizontal timber ties up with attached columns, door and window frames to form a kind of a cage which holds the house together.





Construction Materials

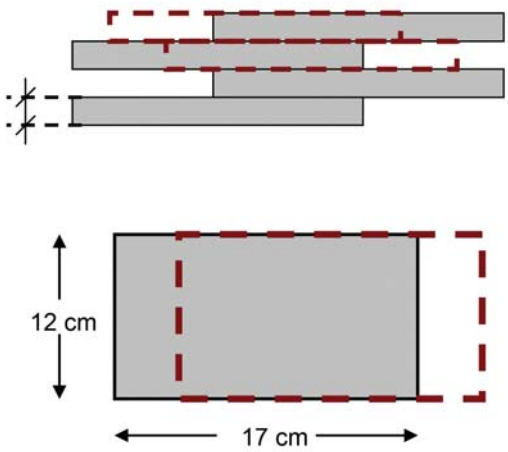
Wood - Timber structures have a well deserved reputation for high resistance to earthquakes, particularly the high strength-to-weight ratio timber. Timber is organic material and its cellulose fibre makes it highly effective to undertake tensile stresses.

Brick - The large flat bricks when placed evenly over each other on well made surfaces produces stability against overturning. The bonding materials used for brick work was made of mixture of mud and cow dung or lime which was adequate bonding material for large sized bricks. The weak mortar perhaps allowed a certain degree of movement and plasticity in total wall.

Stone - In Pol Houses, stone is used to make base for column posts and door frames. Under the earthquake motion, the posts are effectively connected at the top and bottom and the structure can somehow rock to and fro.

Unfortunately, the modern method of analysis fails to determine the seismic adequacy of traditional buildings.

The above elements of traditional coping systems against disasters need to be documented and analysed through scientific tools and methods. Where possible, these should be incorporated in disaster risk management practices for mitigation, response and recovery.



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APPENDIX

Appendix i

1

Survey no. - 796 & 797
Jain Derasar

1. **Ownership** - Trust (religious)
2. **User Type**- Community
3. **Income source** -
4. **Change** - Altered
5. **New Material** - RCC+Brick wall
6. **Total floors**- GF +1
6. **Tanka System** - Tanka works
7. **Any damage** - due to earthquake
8. **Facility/ equipment** - (for emergency) no
9. **Vulnerability** - —
10. **Remarks** - Not at risk

2

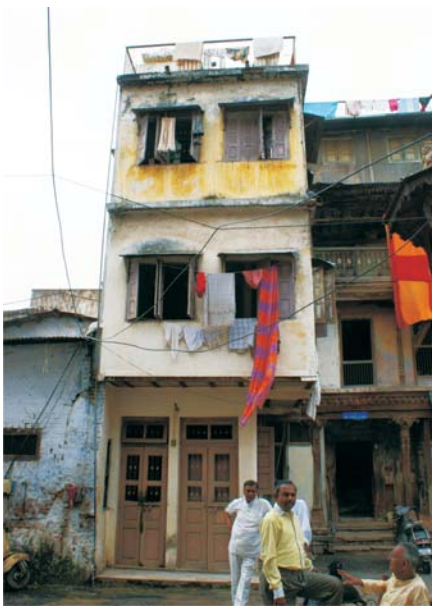
Survey no. - 798
School

1. **Ownership** - Trust
2. **User Type**- Children of age group 4 -8 and teachers (20-60)
3. **Income source** -
4. **Change** - Additions
5. **New Material** - Steel sections+kota stone
6. **Total floors**- GF+1
6. **Tanka System** - No Tanka
7. **Any damage** - due to earthquake
8. **Facility/ equipment** - (for emergency) no
9. **Vulnerability**- Yes. (fire)
10. **Remarks** - Only one access from the street. At risk

3

Survey no. - 799
Residence

1. **Ownership** - Rented
2. **User Type**- Old people-2
   Youth (20-45)- 5
3. **Income source** - Business
4. **Change** - Additions
5. **New Material** - Steel sections+kota stone
6. **Total floors**- GF+2
6. **Tanka System** - No Tanka
7. **Any damage** - No damage
8. **Facility/ equipment** - (for emergency) no
9. **Vulnerability**- Yes.
10. **Remarks** - House created due to subdivision of original property. This portion is completely an extension and rebuilt poorly. At Risk



4a

Survey no. - 800

Residence - Closed

4b

Survey no. - 801 & 802

Residence - partially demolished.
800, 801, 802 - created by dividing original property and completely
altered / rebuilt poorly. At risk category.

4c

Survey no. - 803 (second floor)
Residence

1. **Ownership** - Privately owned
2. **User Type**- Old people-1
   Children (below 10)-1
   Youth (20-45)- 2
3. **Income source** - Job
4. **Change** - Alterations
5. **New Material** -
6. **Total floors**-
6. **Tanka System** - No Tanka
7. **Any damage** - earthquake
8. **Facility/ equipment** - no
   (for emergency)
9. **Vulnerability**- Yes.
10. **Remarks** -

4d

Survey no. - 803 (Third floor)
Residence

1. **Ownership** - Privately owned
2. **User Type**- Old people (above 70)-2
   Youth (20-45)- 3
3. **Income source** - Job
4. **Change** - Alterations
5. **New Material** - RCC + Brick wall
6. **Total floors**-
6. **Tanka System** - No Tanka
7. **Any damage** - earthquake
8. **Facility/ equipment** - no
   (for emergency)
9. **Vulnerability**- highly vulnerable.
10. **Remarks** - Poorly built addition to the original property.
    At risk.

5

Survey no. - 804, 805 & 806

The original house has been sub divided into three survey no.s and completey altered / rebuilt poorly. At risk category.

6 Survey no. - 809
Residence

1. **Ownership** - Privately owned
2. **User Type**- Youth (20-45)- 3
   Single women - 1
   Youth (20-45) - 1
3. **Income source** - Business
4. **Change** - Alterations
5. **New Material** - RCC + Brick wall
6. **Total floors**- GF+2
6. **Tanka System** - No Tanka
7. **Any damage** - earthquake
8. **Facility/ equipment** - (for emergency) no
9. **Vulnerability**- Vulnerable due to new use
10. **Remarks** - At Risk

7

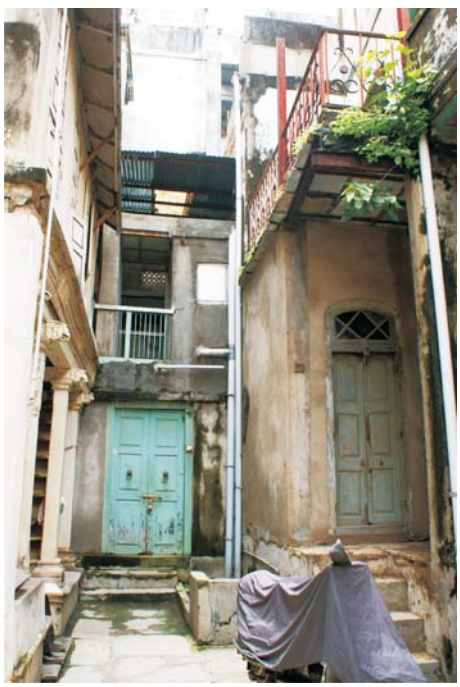
Survey no. - 810
Residence

1. **Ownership** - Privately owned
2. **User Type**- Children (below10)- 3
   Single women - 1
   Youth (20-45) - 1
3. **Income source** - Job
4. **Change** - Additions (2010)
5. **New Material** - RCC + Brick wall
6. **Total floors**- GF+2
6. **Tanka System** - No Tanka
7. **Any damage** - earthquake
8. **Facility/ equipment** - (for emergency) no
9. **Vulnerability**- Due to improper alterations
10. **Remarks** - At risk

8

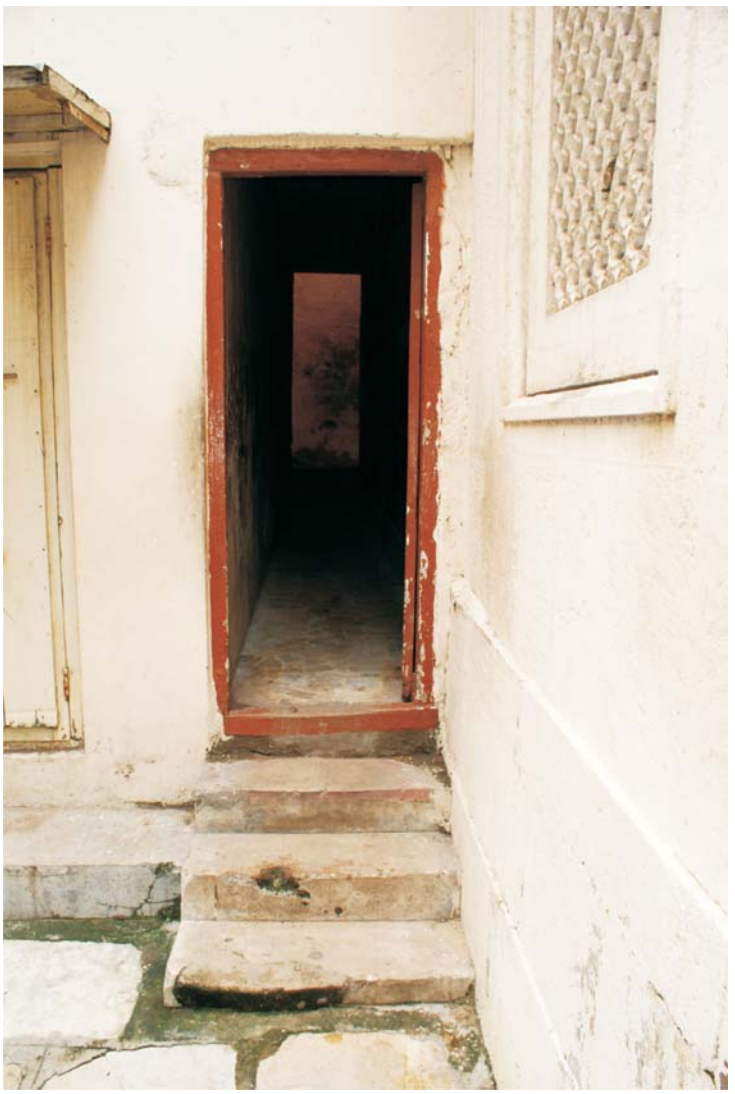
Survey no. - 811
Commercial

1. **Ownership** - Privately owned
2. **User Type**-
3. **Income source** - Business
4. **Change** - Alterations (2000)
5. **New Material** -
6. **Total floors**- GF+1
6. **Tanka System** - No Tanka
7. **Any damage** - No damage
8. **Facility/ equipment** - (for emergency) no
9. **Vulnerability**- Vulnerable due to use.
10 **Remarks** - rebuilt poorly. used as godown. At risk.



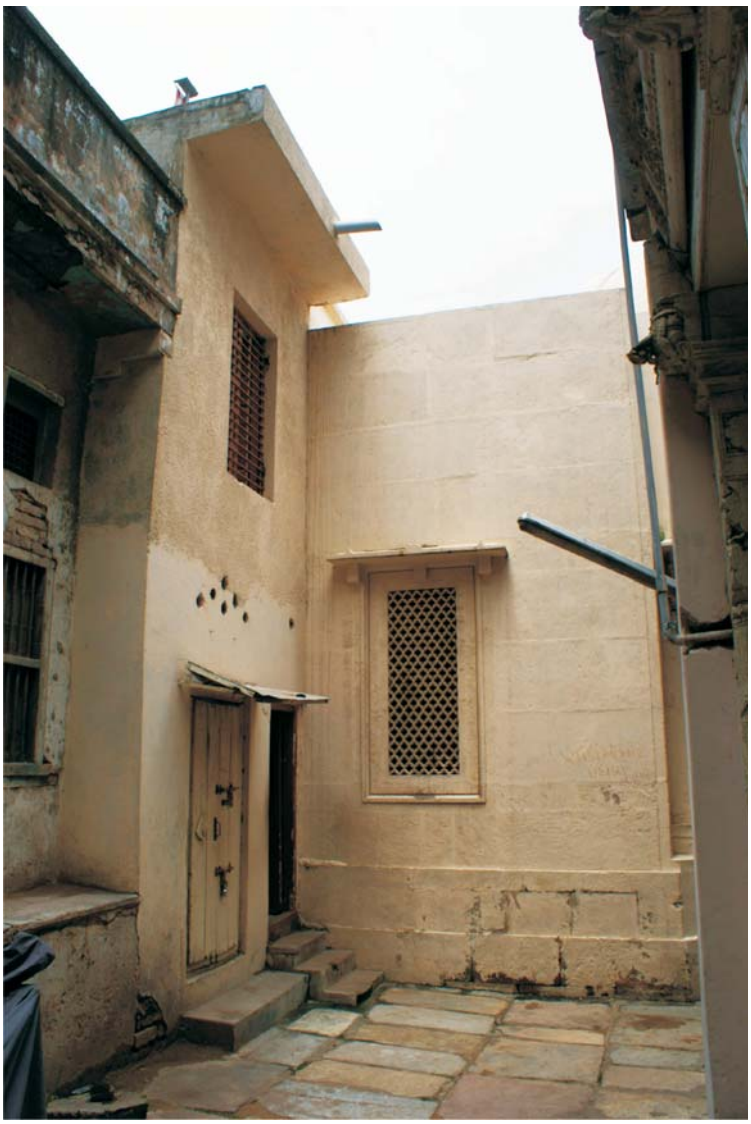
9

Survey no. - 812
Passage



10

Survey no. - 813
Chowk



11

Survey no. - 818
Residence

1. **Ownership** - Privately owned
2. **User Type**- Youth (20-45) - 3
3. **Income source** - Job
4. **Change** - Additions
5. **New Material** - RCC+Brick wall
6. **Total floors**- GF+2
6. **Tanka System** - No Tanka
7. **Any damage** - Earthquake damage
8. **Facility/ equipment** - (for emergency) no
9. **Vulnerability**- Vulnerable due to additions on 2nd floor
10. **Remarks** -

12

Survey no. - 816, 817 & 819
Residence

1. **Ownership** - Privately rented
2. **User Type**- Children (below10)-1
   Youth (20-45) - 3
3. **Income source** - Business
4. **Change** - Altered
5. **New Material** - RCC+Brick wall
6. **Total floors**- GF+2
7. **Tanka System** - No Tanka
8. **Any damage** - No damage
9. **Vulnerability**-
10. **Remarks** - The original house completely altered / rebuilt poorly.

13

Survey no. - 820
Residence

1. **Ownership** - Privately owned
1. **Ownership** - Religious (Trust)
2. **User Type**-
3. **Income source** -
4. **Change** - Altered
5. **New Material** - RCC+Brick wall
6. **Total floors**-
7. **Tanka System** - Tanka (works)
8. **Any damage** - No damage
9. **Vulnerability**-
10. **Remarks** -

14

Survey no. - 821

Residence - disintegrating due to lack of maintenance

15

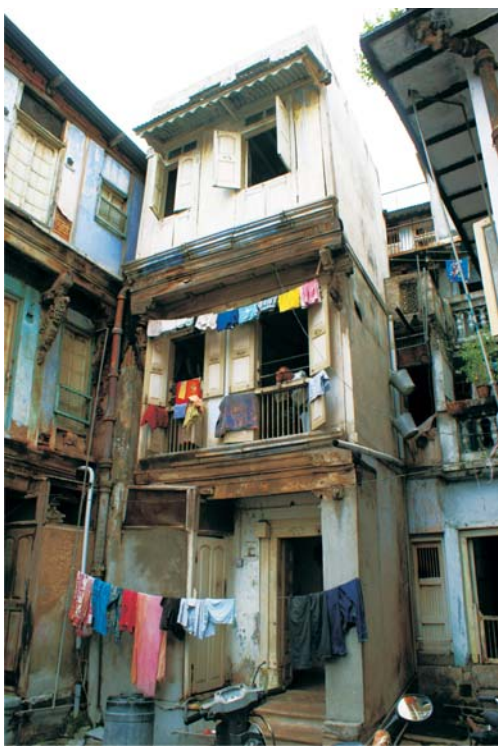
Survey no. - 822 & 823

Residence - disintegrating due to lack of maintenance

16

Survey no. - 824
Residence

1. **Ownership** - Privately owned
2. **User Type**- Old (above70)-1
   Children (below10)-2
   Youth(20-45)-2
3. **Income source** - Business
4. **Change** - No change
5. **New Material** -
6. **Total floors**- GF+2
7. **Tanka System** - No -Tanka
8. **Any damage** - No damage
9. **Vulnerability**- due to lack of maintenance & corner wall.
10. **Remarks** -



17

Survey no. - 825
Residence

1. **Ownership** - Privately owned
2. **User Type**- Children (below10)-1
   Single women - 1
   Youth(20-45)-1
3. **Income source** - Job
4. **Change** - Altered (1998)
5. **New Material** - RCC + brick
6. **Total floors**- GF+2
7. **Tanka System** - No -Tanka
8. **Any damage** - No damage
9. **Vulnerability**- Internal rooms- lack of maintenance.
10. **Remarks** - Facade is rebuilt with extensions and alterations.

18

Survey no. - 826 & 827
Residence

1. **Ownership** - Privately owned
2. **User Type**- Youth(20-45)-2
3. **Income source** - Business
4. **Change** - Additions (2000)
5. **New Material** - RCC+Brick
   steel section +Kota stone
6. **Total floors**- GF+2
7. **Tanka System** - No -Tanka
8. **Any damage** - No damage
9. **Vulnerability**-
10. **Remarks** - Poorly rebuilt without considering the traditional structural qualities.

19a

Survey no. - 828 (Ground Floor)
Residence

19b

Survey no. - 828 (First Floor)
Residence

1. **Ownership** - Privately owned
2. **User Type**- Old (below70)-1
   Youth(20-45)-4
3. **Income source** - Job
4. **Change** - Additions
5. **New Material** - Steel sections+kota stone
6. **Total floors**- GF+3
7. **Tanka System** - No -Tanka
8. **Any damage** - No damage
9. **Infrastructure** - Satisfied
10. **Vulnerability**-
11. **Remarks** - Poorly rebuilt without considering the traditional structural qualities.

20

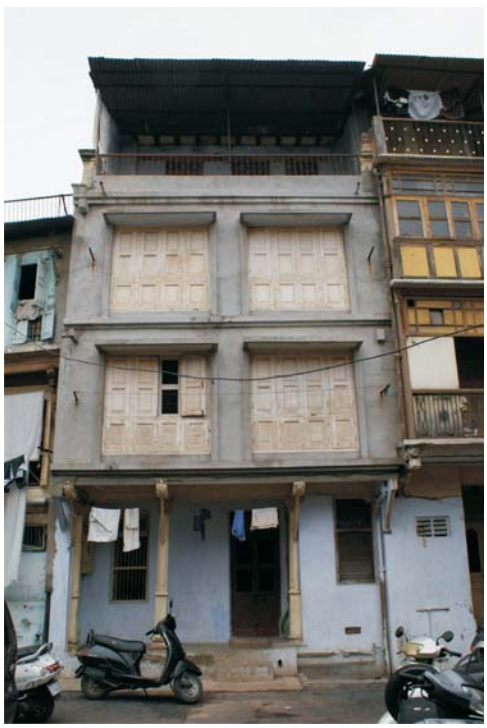
Survey no. - 829
Residence

1. **Ownership** - Privately owned
2. **User Type**- Old (below70)-2
   Youth(20-45)-2
3. **Income source** - Business
4. **Change** - Alterations
5. **New Material** - Steel sections+kota stone
6. **Total floors**-
6. **Tanka System** - No -Tanka
7. **Any damage** - No damage
8. **Infrastructure** - Not Satisfied
9. **Vulnerability**-
10. **Remarks** - Access to & from the house is a major problem.

21

Survey no. - 830
Residence

1. **Ownership** - Privately owned
2. **User Type**- Single woman-1
   Youth(20-45)-2
3. **Income source** - Job
4. **Change** - Additions & Alterations
5. **New Material** - RCC+brick wall
6. **Total floors**- GF+3
7. **Tanka System** - No -Tanka
8. **Any damage** - Earthquake damage
9. **Infrastructure** - Satisfied
10. **Vulnerability**-
11. **Remarks** - Poorly altered with inappropriate materials & technique.



22

Survey no. - 831

Residence - disintegrating due to lack of maintenance

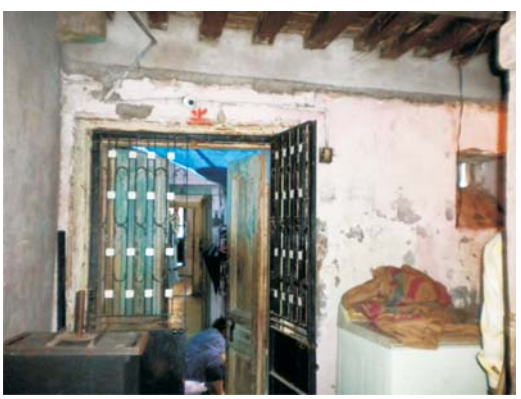
23

Survey no. - 832
Residence

24a

Survey no. - 833 & 834
Residence

1. **Ownership** - Privately owned
2. **User Type**- Children (below10)-1
   Youth(20-45)-6
3. **Income source** - Job
4. **Change** - No change
5. **New Material** -
6. **Total floors**- GF+3
7. **Tanka System** - No -Tanka
8. **Any damage** - Earthquake damage
9. **Infrastructure** - Satisfied
10. **Vulnerability**-
11. **Remarks** - Rear end of the khadki. Escape route is limited.



24b

Survey no. - 839
Residence

1. **Ownership** - Privately owned
2. **User Type**- Old (above70)-1
   Youth(20-45)-4
3. **Income source** - Business
4. **Change** - Alterations (2010)
5. **New Material** -
6. **Total floors**-
7. **Tanka System** - No -Tanka
8. **Any damage** - Earthquake damage
9. **Infrastructure** - Satisfied
10. **Vulnerability**-
11. **Remarks** - Being above the semi open passage, maintenance of this house is crucial.

24c

Survey no. - 834 (Second Floor)
Residence

1. **Ownership** - Privately owned
2. **User Type**- Children (below10)-2
   Youth(20-45)-2
3. **Income source** - Business
4. **Change** - No change
5. **New Material** -
6. **Total floors**- GF+3
7. **Tanka System** - No -Tanka
8. **Any damage** - Earthquake damage
9. **Infrastructure** - Satisfied
10. **Vulnerability**-
11. **Remarks** - efforts to repair is seen. Escape route is limited.

25

Survey no. - 835,836, 837 & 838
Residence

1. **Ownership** - Privately owned
2. **User Type**- Old (above 70) - 2
   Children (below10)-2
   Youth(20-45)-7
3. **Income source** - Business
4. **Change** - Additions
5. **New Material** - Steel section+kota stone
6. **Total floors**- GF+3
7. **Tanka System** - No -Tanka
8. **Any damage** - Earthquake damage
9. **Infrastructure** - Not Satisfied
10. **Vulnerability**- high.
11. **Remarks** - Khadki is highly densed. Access / escape route is very limited.

26

Survey no. - 840 (First Floor)
Residence

1. **Ownership** - Privately owned
2. **User Type**- Youth(20-45)-2
3. **Income source** - Job
4. **Change** - Additions
5. **New Material** - RCC + brick wall
6. **Total floors**-
7. **Tanka System** - No -Tanka
8. **Any damage** - Earthquake damage
9. **Infrastructure** - Satisfied
10. **Vulnerability**-
11. **Remarks** -

27

Survey no. - 841
Residence

1. **Ownership** - Privately owned
2. **User Type**- Old (above 70)-2
3. **Income source** - Job
4. **Change** - Additions (1985)
5. **New Material** - RCC + brick wall
6. **Total floors**- GF+2
7. **Tanka System** - Tanka (doesn't work)
8. **Any damage** - Earthquake damage
9. **Infrastructure** - Satisfied
10. **Vulnerability**-
11. **Remarks** - Poorly rebuilt without considering the traditional structural qualities.

28

Survey no. - 842

Residence - Poorly rebuilt without considering the traditional construction.

29

Survey no. - 843
Open Courtyard

30

Survey no. - 844
Residence

1. **Ownership** - Privately owned
2. **User Type**- Women- 1
   Youth (20-45)-3
3. **Income source** - Job
4. **Change** - Additions (1985)
5. **New Material** - RCC + brick wall
6. **Total floors**- GF+2
7. **Tanka System** - No Tanka
8. **Any damage** - Earthquake damage
9. **Infrastructure** - Not Satisfied
10. **Vulnerability**- Lack of maintenance
11. **Remarks** - also serves as entrance to the khadki.

31

Survey no. - 845
Residence

1. **Ownership** - Privately owned
2. **User Type**- Old- 2
   Youth (20-45)-3
3. **Income source** - Job
4. **Change** - Alterations
5. **New Material** - RCC + brick wall
6. **Total floors**- GF+2
7. **Tanka System** - No Tanka
8. **Any damage** - Earthquake damage
9. **Infrastructure** - Satisfied
10. **Vulnerability**- poor quality construction
11. **Remarks** - only the original wooden entrance door remains

32

Survey no. - 846 & 847
Residence

1. **Ownership** - Privately owned
2. **User Type**- Old (above 70)- 1
   Children (below 10)-1
   Youth (20-45)-4
3. **Income source** - Business
4. **Change** - No change
5. **New Material** -
6. **Total floors**- GF+2
7. **Tanka System** - Tanka works
8. **Any damage** - No damage
9. **Infrastructure** - Satisfied
10. **Vulnerability**-
11. **Remarks** - Vulnerable due to adjacent properties.

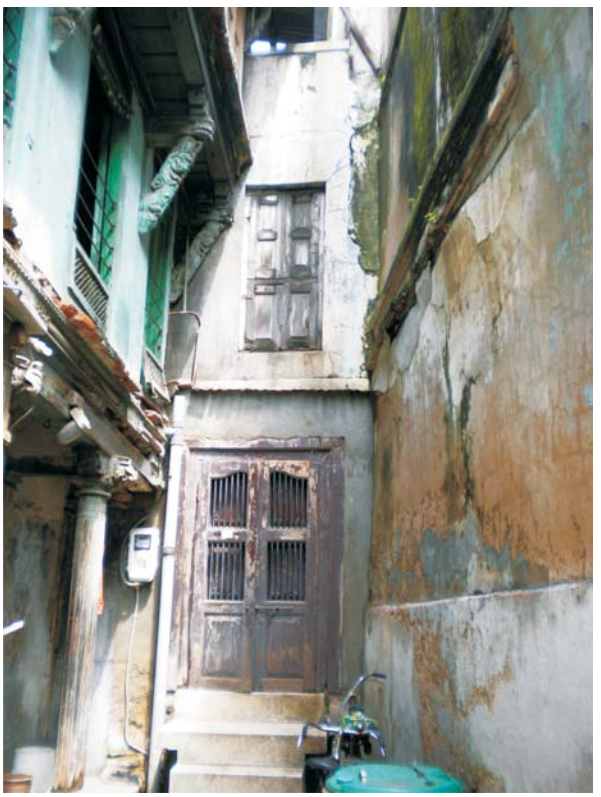
33

Survey no. - 848 & 849
Tanka & the open courtyard

34

Survey no. - 850
Commercial

1. **Ownership** - Privately owned
2. **User Type**- Youth (20-45)-3
3. **Income source** - Business
4. **Change** - Alterations (2010)
5. **New Material** -
6. **Total floors**- GF+2
7. **Tanka System** - No Tanka
8. **Any damage** - Earthquake damage
9. **Infrastructure** - Satisfied
10. **Vulnerability**-
11. **Remarks** -



35

Survey no. - 851
Street

36

Survey no. - 852
Residence - closed

37

Survey no. - 853
Residence

1. **Ownership** - Privately owned
2. **User Type**- Old (above70)-2
   Children (below 10)-3
   Youth (20-45)-4
3. **Income source** - Business
4. **Change** - No Change
5. **New Material** -
6. **Total floors**- GF+2
7. **Tanka System** - No Tanka
8. **Any damage** - No damage
9. **Infrastructure** - Not Satisfied
10. **Vulnerability**-
11. **Remarks** -

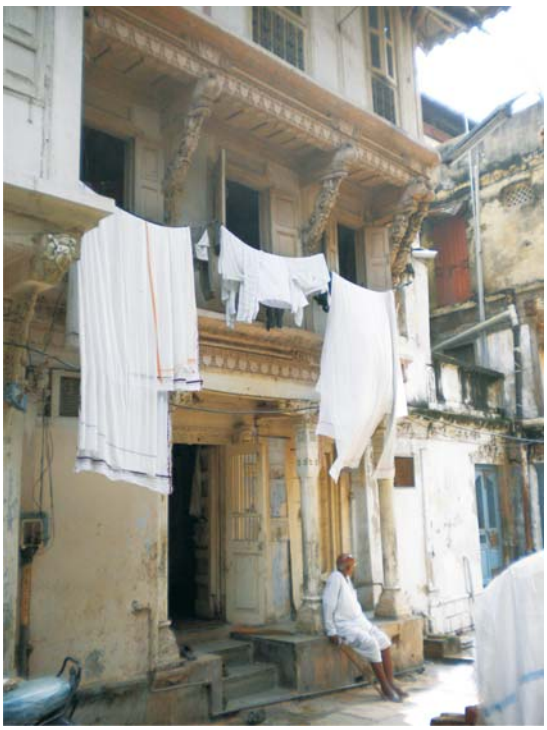
38

Survey no. - 854
Residence - Closed

39

Survey no. - 855
Residence

1. **Ownership** - Privately owned
2. **User Type**- Old (above70)-1
   Children (below 10)-2
   Women- 2
   Youth (20-45)-2
3. **Income source** - Business
4. **Change** - Additions, alterations
5. **New Material** - Steel section+kota stone
6. **Total floors**- GF+2
7. **Tanka System** - Tanka (doesn't work)
8. **Any damage** - No damage
9. **Infrastructure** - Satisfied
10. **Vulnerability**-
11. **Remarks** -



40

Survey no. - 856
Residence

1. **Ownership** - Privately owned
2. **User Type**- Old (above70)-1
   Children (below 10)-2
   Women- 2
   Youth (20-45)-2
3. **Income source** - Business
4. **Change** - Additions, alterations
5. **New Material** - Steel section+kota stone
6. **Total floors**-
7. **Tanka System** - Tanka (doesn't work)
8. **Any damage** - No damage
9. **Infrastructure** - Satisfied
10. **Vulnerability**-
11. **Remarks** -

41

Survey no. - 857 & 858
Under demolition and reconstruction.

42

Survey no. - 859
Plot converted into street

43

Survey no. - 860
Chabutaro

44

Survey no. - 861 & 862
Otla

45

Survey no. - 863
Residence

1. **Ownership** - Privately owned
2. **User Type**- Women- 2
   Youth (20-45)-1
3. **Income source** - Business
4. **Change** - Alterations
5. **New Material** - RCC+brick wall
6. **Total floors**- GF+3
7. **Tanka System** - No Tanka
8. **Any damage** - Earthquake damage
9. **Infrastructure** - Satisfied
10. **Vulnerability**-
11. **Remarks** - Lot of addition and alteration has been carried out on this corner building.

46

Survey no. - 864A
Residence

1. **Ownership** - Privately owned
2. **User Type**- Old (above70)- 1
   Youth (20-45)-4
3. **Income source** -
4. **Change** - Alterations
5. **New Material** - RCC+brick wall
6. **Total floors**- GF+2
7. **Tanka System** - No Tanka
8. **Any damage** - Earthquake damage
9. **Infrastructure** - Not Satisfied
10. **Vulnerability**- High due to limited escape routes, which is through the courtyard and the narrow passage surrounded by 8 houses.
11. **Remarks** -

47

Survey no. - 864B

highly vulnerable and at risk due to inappropriate use and located at the rear end of khadki. Access is limited which is through the courtyard and passage surrounded by 8 houses.

48

Survey no. - 865
Residence

1. **Ownership** - Privately owned
2. **User Type**- Children (below10)- 1
   Youth (20-45)-3
3. **Income source** -
4. **Change** - Additions
5. **New Material** - RCC+brick wall
6. **Total floors**- GF+2
7. **Tanka System** - No Tanka
8. **Any damage** - No damage
9. **Infrastructure** - Not Satisfied
10. **Vulnerability**-
11. **Remarks** - Completely altered exterior. Room on the ground floor has roof with wooden joists and beam-.

49

Survey no. - 866
Residence

1. **Ownership** - Privately owned
2. **User Type**- Youth (20-45)-4
3. **Income source** - Job
4. **Change** - No change
5. **New Material** -
6. **Total floors**- GF+2
7. **Tanka System** - No Tanka
8. **Any damage** - No damage
9. **Infrastructure** - Satisfied
10. **Vulnerability**-
11. **Remarks** - Original structure.

50

Survey no. - 867
open to sky chowk / courtyard

51

Survey no. - 868
Residence

1. **Ownership** - Privately owned
2. **User Type**- Old (above 70)-1
   Children (below10)-1
   Youth (20-45)-2
3. **Income source** - Job
4. **Change** - Cement plaster on walls
5. **New Material** -
6. **Total floors**- GF+2
7. **Tanka System** - No Tanka
8. **Any damage** - No damage
9. **Infrastructure** - Satisfied
10. **Vulnerability**-
11. **Remarks** - Inappropriate repairs and lack of maintenance

52

Survey no. - 869
Residence

1. **Ownership** - Privately owned
2. **User Type**- Women - 2
   Youth (20-45)-4
3. **Income source** - Job
4. **Change** - Altered
5. **New Material** - RCC+brick wall
   Steel section+Kota stone
6. **Total floors**- GF+2
6. **Tanka System** - No Tanka
7. **Any damage** - Earthquake damage
8. **Infrastructure** - Satisfied
9. **Vulnerability**-
10. **Remarks** - Lack of maintenance

53

Survey no. - 870 & 871
Residence

1. **Ownership** - Privately owned
2. **User Type**- Old (above 70)-1
   Children (below10)-1
   Youth (20-45)-2
3. **Income source** - Job
4. **Change** - No change
5. **New Material** -
6. **Total floors**- GF+1
6. **Tanka System** - No Tanka
7. **Any damage** - Earthquake damage
8. **Infrastructure** - Not Satisfied
9. **Vulnerability**-
10. **Remarks** - Lack of maintenance

54

Survey no. - 872
Residence

1. **Ownership** - Private Owned
2. **User Type**- Children (below10)-1
   Youth (20-45)-4
3. **Income source** - Job
4. **Change** - Additions
5. **New Material** - Steel section+kota stone
6. **Total floors**- GF+2
7. **Tanka System** - No Tanka
8. **Any damage** - Earthquake damage
9. **Infrastructure** - Satisfied
10. **Vulnerability**- high
11. **Remarks** - Completely altered and limited access

55

Survey no. - 873
Residence

1. **Ownership** - Privately owned
2. **User Type**- Old (above 70)-2
   Children (below10)-2
   Youth (20-45)-2
3. **Income source** - Job
4. **Change** - Additions
5. **New Material** - Steel section+kota stone
6. **Total floors**- GF+2
7. **Tanka System** - No Tanka
8. **Any damage** - Earthquake damage
9. **Infrastructure** - Not Satisfied
10. **Vulnerability**- High
11. **Remarks** - Completely rebuilt. poor quality construction and limited access

56

Survey no. - 874, 875 & 876A
Residence

1. **Ownership** - Privately owned
2. **User Type**- Old (above 70)-2
   Children (below10)-2
   Youth (20-45)-4
3. **Income source** - Business
4. **Change** - No change
5. **New Material** -
6. **Total floors**- GF+2
7. **Tanka System** - No Tanka
8. **Any damage** - Earthquake damage
9. **Infrastructure** - Satisfied
10. **Vulnerability**- Very high
11. **Remarks** - limited access

57

Survey no. - 876B
Commercial

1. **Ownership** - Privately owned
2. **User Type**- Old (above 70)-1
   Children (below10)-1
   Youth (20-45)-2
3. **Income source** - Business
4. **Change** - Addition
5. **New Material** - RCC+Brick wall
   Steel section + Kota stone
6. **Total floors**-
7. **Tanka System** - No Tanka
8. **Any damage** - Earthquake damage
9. **Infrastructure** - Satisfied
10. **Vulnerability**-
11. **Remarks** -

58

Survey no. - 877
Residence

59

Survey no. - 879 A & B
Residence

1. **Ownership** - Privately owned
2. **User Type**- Old (above 70)-1
   Children (below10)-1
   Youth (20-45)-2
3. **Income source** - Business
4. **Change** - Addition
5. **New Material** - RCC+Brick wall
   Steel section + Kota stone
6. **Total floors**-
7. **Tanka System** - No Tanka
8. **Any damage** - Earthquake damage
9. **Infrastructure** - Satisfied
10. **Vulnerability**-
11. **Remarks** -

60

Survey no. - 880 A, B, C & D
Residence

61

Survey no. - 881
Residence

1. **Ownership** - Privately owned
2. **User Type**- Old (above 70)-1
   Children (below10)-1
   Youth (20-45)-2
3. **Income source** - Job
4. **Change** - Alteration
5. **New Material** -
6. **Total floors**- GF+2
7. **Tanka System** - No Tanka
8. **Any damage** - No damage
9. **Infrastructure** - Not Satisfied
10. **Vulnerability**-
11. **Remarks** -

62A

Survey no. - 882 (Second Floor)
Residence

1. **Ownership** - Privately rented
2. **User Type**- Youth (20-45)- 6
3. **Income source** -
4. **Change** - No Change
5. **New Material** -
6. **Total floors**-
7. **Tanka System** - No Tanka
8. **Any damage** - No damage
9. **Infrastructure** - Satisfied
10. **Vulnerability**-
11. **Remarks** - House subdivided

62B

Survey no. - 882 (Third Floor)
Residence

1. **Ownership** - Privately rented
2. **User Type**- Children (below10)-1
   Youth (20-45)-2
3. **Income source** - Job
4. **Change** - No Change
5. **New Material** -
6. **Total floors**-
7. **Tanka System** - No Tanka
8. **Any damage** - No damage
9. **Infrastructure** - Satisfied
10. **Vulnerability**-
11. **Remarks** - House subdivided

63

Survey no. - 883
Residence

1. **Ownership** - Privately rented
2. **User Type**- Youth (20-45)- 6
3. **Income source** -
4. **Change** - No Change
5. **New Material** -
6. **Total floors**-
7. **Tanka System** - No Tanka
8. **Any damage** - No damage
9. **Infrastructure** - Satisfied
10. **Vulnerability**-
11. **Remarks** - House subdivided

64

Survey no. - 884 & 884A
Commercial

1. **Ownership** - Privately Owned
2. **User Type**- Commercial
3. **Income source** - Business
4. **Change** - Additions & Alteration
5. **New Material** - RCC+Brick wall
   Steel Section + Kota stone
6. **Total floors**- GF+2
7. **Tanka System** - Tanka (doesn't work)
8. **Any damage** - No damage
9. **Infrastructure** - Satisfied
10. **Vulnerability**- Very high
11. **Remarks** - Altered and rebuilt as stationery shop and godown.

Pol Survey Form

S.No- 811

Survey of Shantinath Ni Pol
શાંતિનાથ ની પોળ

Heritage significance: ..... Approx. Year of construction: .....

Questions:

1. Are there any additions / alterations to building? ..... Yes. .....Yes / No
If yes then describe the year of intervention and type of building materials used.
શું તમારા મકાનનાં બાંધકામમાં કોઇ ફેરફાર / ઉમેરો કરેલ છે?..... હા..... હા/ના. જો હા તો ફેરફાર/ ઉમેરો નું વર્ણન અને વર્ષ.

T-Girdir, Kotah stone, Flooring, plastering.
almost 10 years back.

2. What type of ownership of the built structure? મકાનની માલીકીનો પ્રકાર ?

Privately owned ખાનગી માલીકી	Privately rented ભાડૂઆત	Religious ધાર્મિક	Trust/Institute ટ્રસ્ટ/ સંસ્થા	Govt. સરકારી	Other (specify) અન્ય
V					

3. Total number of users of the place. મિલકતનો વપરાશ કરતી કુલ વ્યક્તિની સંખ્યા ?

Old people (above 70 years) વૃધ્ધ (૭૦ વર્ષથી ઉપર)	Children (below 10 years) બાળકો ૧૦ વર્ષથી નીચે)	Sick / Handicap બિમાર/ અપંગ	Youth (Men) 20 to 45 years યુવાન.(પુરૂષ) ૨૦ થી ૪૫ વર્ષ	Single women સ્ત્રી/બહેનો (એકલી રહેતી)	Total કુલ
—	—	—	—	—	—

4. What is your main source of income? આપની આવકનું મુખ્ય સ્ત્રોત: (Commercial activity (Godocon)

Business

5. Infrastructure – supply, issues and level of satisfaction. મુળભૂત સુવિધાતો પુરવઠો. નિર્ગમન અને સંતોષનું પ્રમાણ.

Electricity વીજળી	—
Water supply પાણી	—
Sewerage/ Drainage ગટર	—
Telephone ટેલીફોન	—
Internet ઇન્ટરનેટ	—
Other અન્ય	—

Appendix ii- News paper clippings of house (under reconstruction) in Saudagar ni Pol, Kalupur collapsed in February 2011.

Publication: The Times Of India Ahmedabad;Date: Jan 29, 2011;Section: Front Page;Page: 3

4-storey building collapses in Ahmedabad, 5 dead

Illegal Structure Falls On 5 Houses

TIMES NEWS NETWORK

Ahmedabad: Five people were killed and 20 injured when an under-construction, four-storey building collapsed in Kalupur area of the walled city here on Friday morning.

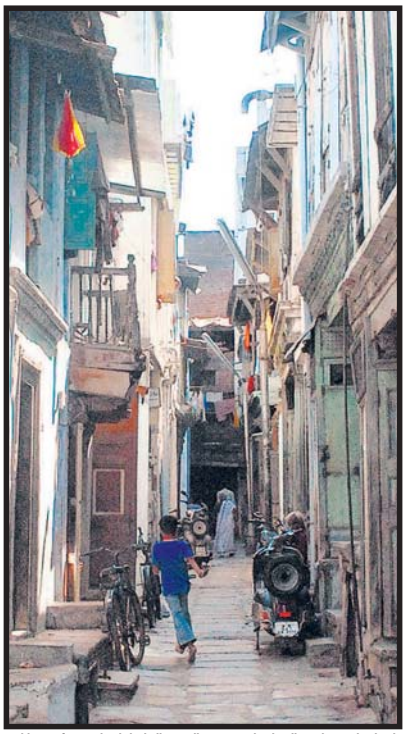
The incident took place at 7.30 am when the building, in lane number 16 of Saudagar ni Pol, collapsed on five adjoining buildings. The building, like many others in the walled city, was illegally raised in just six months. The building collapse created an earthquake-like effect sending tremors till at least 500 metres and forcing residents to come out of their houses.

Altaf Rifai, 36, saw top floor of the illegal building crumble his house. “My wife, two children and I barely managed to come out of my house with some scars, but other families were not that lucky,” he said.

Residents in the area had voiced protest against the large-scale construction activity in their pol. “The building started leaning on one side four days ago. We even approached the builders, Munaf, Hanif, Salim Bata and Salim Mansuri, but like earlier representations they ignored this one and asked us to evacuate the place,” said Sameena Shaikh, 47, a resident of the same lane.

A complaint of culpable homicide has been filed against the absconding builders. The narrow lanes made the rescue operation difficult for officials of the emergency response service. Neighbours and fire brigade officials took victims out of the rubble in makeshift stretchers.

While the builders have fled to escape public ire, a mob attacked their houses in adjoining Haranwali Pol. “Forensic science officials will be called to examine the building quality and we are trying to find the builders,” said M S Bharada, deputy commissioner of police, zone III. AMC has ordered an inquiry by the city engineer and suspended two estate department officials.



Residents of several pols including Mulla Haroon ni Pol, Falka Pol, Karoda ni Pol and Timba ni Pol have signed a legal pact against selling houses to developers or entering into renovation contracts with them

UNITED THEY STAND DIVIDED THEY CRASH

At Saudagar ni Pol, builders' mafia erected illegal structures after forcing residents to sell their houses. But in 'wiser' pols, residents kept them at bay by remaining united under a legal agreement

ZAHID QURESHI & VIPUL RAJPUT

The building collapse in Saudagar ni Pol that left five dead has exposed cracks in the solidarity of families residing here and their resultant exploitation by the builders' mafia. Residents of pols like Karoda ni Pol and Timba ni Pol have guarded themselves against anti-socials by entering into a legal agreement which forbids them from selling their houses to developers or signing renovation contracts with them.

HOW MAFIA OPERATES

AS MANY as six illegal buildings have been constructed in Saudagar ni Pol in the last couple of years. Some of these structures have come up in place of old, dilapidated houses which were either sold to the developers in return for a large sum

TURN TO PAGE 6 ▸▸

SEE ALSO PAGES 3, 4, 5

DAY AFTER THE COLLAPSE

JUST NOTICES, NO ACTION

In 2010, AMC issued notices to around 400 dilapidated buildings in the eastern Ahmedabad. However, no repairs have taken place till now, neither has the corporation taken any steps to secure these buildings

The notice by AMC had asked the owners to repair the buildings. Taking into consideration that on an average four people live in these houses, lives of around 1600 people are at risk.

ANNAGARE MANEK BOSSAN

Several houses in the old city stand on a shaky foundation — quite literally. The incident on Friday where five people lost their lives following the collapse of a building in the congested Saudagar ni Pol has once again drawn attention to this fact.

In 2010, the Ahmedabad Municipal Corporation had identified a total of 400 buildings that were in a dilapidated condition which require immediate repairs. Of the identified buildings, 193 are on the Rath Yatra route. The corporation had also issued notices to these building owners to get their houses repaired and discourage people from gathering on their roofs and balconies.

"Going by the estimate that there are an average four people live in these houses, lives of around 1600 people are at risk.

However, the negligence on the part of the Ahmedabad Municipal Corporation (AMC) coupled with the tussle between owners and tenants have ensured that no repairs are carried out on dilapidated houses.

TWO INCIDENTS IN PAST

IN THE past two, there have been incidents of a house collapsing in Danapur killing two while 16 people lost their lives when Hotel Shakunt in Kalupur fell down.

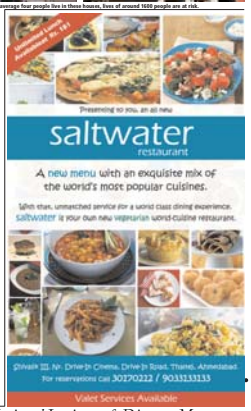
Despite the recurring tragedies, the corporation seems to be happy just issuing notices. But what happens after that doesn't seem to concern the AMC officials.

An AMC official on condition of anonymity said, "A few buildings have been demolished in the past few months while some of them have been demolished by the AMC. However, there are still several houses in the pols that are dangerous for its occupants."

The Saraspur area in the city has 62 dilapidated buildings, which is the highest. Shahpur comes a close second with 32 dangerous buildings.

Despite the notices, no repairs have taken place

In the past, two buildings have collapsed in the old city killing 21 people



TIMES CITY

CITY STUDENTS GATHER TO DEMAND JUSTICE IN AARUSHI CASE | 5

RUSSIAN CLASSIC 'CRIME & PUNISHMENT' CATCHES JAILED COP VANZARA'S FANCY | 5

Corruption spawns illegal buildings in walled city

AMC Crackdown Comes Too Late

Civic Body Received Large Number Of Complaints But No Action Taken

KALUPUR BUILDING COLLAPSE

PLAINTS GALORE

Complaints of illegal construction in different zones of the city, from Jan 1, 2010, to Jan 29, 2011

East	West	South
398	45	44
North	Sabarmati	Old City
51	95	228

AMC sealing drive: CG Road shopowners get reprieve

The association had pleaded that in the last financial year, 34 they had collected only Rs 1.5 crore against a little above Rs 30 crore that would be required for constructing additional parking complex

Residents upset over demolition drive

Bata brothers available to media, not police

They have many tricks to break the law

Injured migratory golden eagle rescued

RARE VISITOR

Injured African steppe migratory eagle, but golden eagle not ruled out

An international appeal for peace through dance

Each bit of intricacy in dance movements was part of a continuous conversation with the audience by the dancer

Appendix iii: Damage Assessment Forms

Source: Fielden B. (1987) "Between two earthquakes. Cultural Properties in seismic zones" ICCROM & Getty Conservation Institute

Inventory of Damage

Damage Assessment Form

Immovable Cultural Property

1. Name of Monument

Reference Number

Century of Construction

2. ☐ Archaeological site
☐ Urban group of buildings
☐ Fortified urban area
☐ Monastery/monasteries
☐ Rural group of buildings
☐ Isolated monument

	12	13	14	15	16	17	18	19	20
Religious monument	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Habitation	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Public building	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Building serving an economic purpose	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Military architecture (fortified)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Ethnological structure	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Building serving a technical purpose	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Monument to the struggle for national liberation	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3. Location

Community
Town
Place
Address
Land register no.
Owner

Overall Floor Space (m^2)

Basement
Ground floor
1
2
3
4
Total

Condition Before Earthquake
☐ Good
☐ Medium
☐ Poor

Category of Monument

Protection Agency

4. Damage Caused by the Earthquake

Destroyed	Heavily Damaged	Damaged	Slightly Damaged	Intact	
☐	☐	☐	☐	☐	Chimney(s)
☐	☐	☐	☐	☐	Covering
☐	☐	☐	☐	☐	Structure
☐	☐	☐	☐	☐	Dome(s)
☐	☐	☐	☐	☐	Vault(s)
☐	☐	☐	☐	☐	Ceiling(s)
☐	☐	☐	☐	☐	Wooden floor structure(s)
☐	☐	☐	☐	☐	Other floor(s)
☐	☐	☐	☐	☐	Bearing wall(s)
☐	☐	☐	☐	☐	Nonbearing wall(s)
☐	☐	☐	☐	☐	Arch(as)
☐	☐	☐	☐	☐	Column(s)
☐	☐	☐	☐	☐	Staircase(s)
☐	☐	☐	☐	☐	Foundations
☐	☐	☐	☐	☐	Belfry/belfries
☐	☐	☐	☐	☐	Minaret(s)
☐	☐	☐	☐	☐	Architectural decoration
☐	☐	☐	☐	☐	Iconostasis
☐	☐	☐	☐	☐	Mural painting(s)
☐	☐	☐	☐	☐	

5. Degree of Danger
☐ Repair feasible
☐ Repair impossible

Status of the Monument
☐ Unchanged
☐ Changed
☐ Not retained

☐ **EMERGENCY ACTION**

6. Outline Plan (at ground level) of the Monument and Principal Dimensions
Photographs and indication of damage (attach plans)

7. Structural Characteristics
Type and quality of building materials and bonding components

8. Description of Deformations and Structural Damage

9. Emergency Action Proposed

- ☐ Total demolition
- ☐ Partial demolition
- ☐ Temporary covering
- ☐ Shoring
- ☐ External scaffolding
- ☐ Internal scaffolding
- ☐ Protection of mural paintings
- ☐ Protection of architectural decoration
- ☐ _____

10. Repair Program Proposed

- ☐ Demolition(s)
- ☐ Chimney(s)
- ☐ Covering
- ☐ Timber Structure
- ☐ Dome(s)
- ☐ Vault(s)
- ☐ Ceiling(s)
- ☐ Wooden floor(s)
- ☐ Other floor(s)
- ☐ Bearing wall(s)
- ☐ Nonbearing wall(s)
- ☐ Arch(es)
- ☐ Columns
- ☐ Piers
- ☐ Beam(s)
- ☐ Staircase(s)
- ☐ Geomechanical exploration
- ☐ Foundation(s)
- ☐ Belfry/belfries, minaret(s)
- ☐ External plastering
- ☐ Internal Plastering
- ☐ Preservation
- ☐ Restoration
- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____

11. Damage Classification and State of Usability of the Building
Defined by the Technical Commission for Damage Assessment in the Socialist Republic of Montenegro.

I. Usable (green)
- ☐ IA – grade 1 – intact except superficial damage
- ☐ IB – grade 2 – no structural damage
- ☐ IC – grade 3 – light structural damage

II. Temporarily unusable (yellow)
- ☐ IIA – grade 1 – structural damage
- ☐ IIB – grade 2 – heavy structural damage

III. Unusable (red)
- ☐ IIIA – grade 1 – very heavy structural damage
- ☐ IIIB – grade 2 – partial destruction
- ☐ IIIC – grade 3 – total collapse

12. Estimated Cost of Repair

1. Value of the building before the earthquake

_____ m^2 x _____ (cost) = _____ total cost

2. Cost of restoring the building to its pre-earthquake condition (structural repair)

_____ m^2 x _____ (cost) = _____ total cost

3. Total cost of repair (consolidation)

_____ m^2 x _____ (cost) = _____ total cost

13. Notes

Members of the Commission

Photographic Coverage

Number of Negatives

Photographer

Copyright Owner

Place

Date

Inventory of Damage

Damage Assessment Form

Movable Cultural Property

1. Name of Object

Reference Number

2. Nature of Object

Century of Construction

	12	13	14	15	16	17	18	19	20
Religious	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Profane	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Ethnological	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Archaeological	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Literary/archives	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Technical	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Object in the struggle for national liberation	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3. Material

- ☐ Metal
- ☐ Wood
- ☐ Fabric/textile
- ☐ Leather
- ☐ Paper
- ☐ Pottery
- ☐ Glass
- ☐ Porcelain
- ☐ Stone
- ☐ Bone
- ☐ Horn
- ☐ Parchment
- ☐ Precious stones
- ☐ _____
- ☐ _____

4. Location

Community

Town

Place

Address

Owner

Condition Before Earthquake

- ☐ Good
- ☐ Medium
- ☐ Poor

Classification Category

Protection Agency

5. Damage Caused by the Earthquake

- ☐ Destroyed
- ☐ Heavily Damaged
- ☐ Damaged
- ☐ Slightly Damaged
- ☐ Intact

6. Degree of Danger

- ☐ Repair feasible
- ☐ Repair impossible

Status of the Object

- ☐ Unchanged
- ☐ Changed
- ☐ Not retained

☐ **EMERGENCY ACTION**

7. Drawing of the Object and Principal Dimensions

Photographs and indication of damage (attach drawings and photographs)

8. Principal Characteristics of the Object

9. Description of Deformations and Damage

10. Emergency Action Proposed

- ☐ Cleaning
- ☐ Dismantling
- ☐ Packing
- ☐ Transport
- ☐ Disinfection
- ☐ Storage
- ☐ Drying
- ☐ Inventory
- ☐ Photographs
- ☐ _____

11. Repair Program Proposed

- ☐ Total preservation
- ☐ Preservation with reconstitution
- ☐ Preservation with restoration
- ☐ _____
- ☐ _____

12. Damage Classification and State of Serviceability of the Object

- ☐ Serviceable
- ☐ Temporarily unserviceable
- ☐ Unserviceable

13. Estimated Cost of Repair

Cost of restoring the object to its previous condition _____

14. Notes

Members of the Commission _____

Photographic Coverage

Number of Negatives _____

Photographer _____

Copyright Owner _____

Place _____

Date _____

Other sample forms

Detailed Building and Site Condition Assessment

Inspection

Inspection date time _____ ☐ AM ☐ PM

Inspector _____

Affiliation _____

Area Inspected
☐ Exterior Only
☐ Exterior and Interior

Page 1 of ___
Final Posting
from Page 2 ☐ **Inspected** ☐ **Restricted Us** ☐ **Unsafe**

Property Description

Building Name _____

Address _____

_____

Number of stories above ground _____ below ground _____

Approx footprint area (square feet) _____

Number of residential units _____

GPS coordinates _____

Type of Construction
☐ Wood Frame ☐ Brick ☐ Boat
☐ Steel Frame ☐ Stone ☐ Other
☐ Concrete ☐ Manufactured

Primary Occupancy
☐ Dwelling ☐ Government
☐ Other Residential ☐ Museum
☐ Public Assembly ☐ School
☐ Emergency Services ☐ Religious
☐ Commercial ☐ Cemetery
☐ Offices ☐ Other
☐ Industrial

Occupied?
☐ yes ☐ no

Repairs begu
☐ yes ☐ no

Owner/Contact In
_____
_____
_____
_____
_____

Potential Hazards

Is it possible to enter the building or site? ☐ yes ☐ no

Is it ***Safe*** to enter the building or site? ☐ yes ☐ no

Comments _____

Electrical	☐ yes	☐ no	_____
Chemical	☐ yes	☐ no	_____
Mold	☐ yes	☐ no	_____
Asbestos	☐ yes	☐ no	_____
Lead	☐ yes	☐ no	_____
Other	☐ yes	☐ no	_____

Significance

				Comments
Does this property appear historic? (older than 50 years)	☐ yes	☐ no	☐ don't know	_____
Is there a sign or plaque?	☐ yes	☐ no	☐ don't know	_____
Do exterior features display a high level of craftmanship?	☐ yes	☐ no	☐ don't know	_____
Do interior features display a high level of craftsmanship?	☐ yes	☐ no	☐ don't know	_____
Is the building located in a neighborhood or district of similar building style?	☐ yes	☐ no	☐ don't know	_____
Does the setting (yard, fencing, garden walls, etc.) make this building unique?	☐ yes	☐ no	☐ don't know	_____

Designation ☐ Nat'l Hist. Landmark/District ☐ Nat'l Register/District ☐ State/Local ☐ Nat'l Register Eligibile ☐ Other...

Identifiable architectural style/features?
Check all that apply.

☐ Colonial: English/French/Spanish	☐ Italianate	☐ Queen Anne	☐ Art Deco/Art Moderne
☐ Georgian	☐ Romanesque	☐ Shingle	☐ Modern/International
☐ Federal	☐ Renaissance Revival	☐ Arts & Crafts/Bungalow	☐ Vernacular/Local Style
☐ Greek Revival	☐ Eastlake	☐ Beaux-Arts	☐ Other
☐ Gothic Revival	☐ Second Empire	☐ Prairie	☐ Don't know

Comments _____

Site Evaluation

			Other/Comments
Topographic	☐ Slope ☐ Steps/Terrace ☐ Walkways	☐ Minor/None ☐ Moderate ☐ Severe	_____
Unique features	☐ Pool ☐ Fountain ☐ Fence	☐ Minor/None ☐ Moderate ☐ Severe	_____
Retaining Walls	☐ Masonry ☐ Stone ☐ Wood	☐ Minor/None ☐ Moderate ☐ Severe	_____
Small Scale Structures	☐ Gazebo ☐ Pergola ☐ Outbuilding	☐ Minor/None ☐ Moderate ☐ Severe	_____
Vegetation	☐ Planting beds ☐ Hedge/Shrub ☐ Tree	☐ Minor/None ☐ Moderate ☐ Severe	_____

Is Archaeological Material Present? ☐ on/eroding from ground ☐ no ☐ unknown ☐ other _____

Does material include bone? ☐ yes ☐ no ☐ unknown ☐ other _____

Comments _____

Developed for FEMA by the NPS National Center for Preservation Technology and Training in collaboration with the Heritage Emergency National Task Force, 9/2005.

Damage Assessment Form
A. IMMOVABLE CULTURAL PROPERTY

	INVENTORY OF DAMAGE	REFERENCE No.
1	NAME OF MONUMENT	

2 — ARCHAEOLOGICAL SITE ○
URBAN GROUP OF BUILDINGS ○
FORTIFIED URBAN AREA ○
MONASTERY/MONASTERIES ○
RURAL GROUP OF BUILDINGS ○
ISOLATED MONUMENT ○

	antiquity	century 12	13	14	15	16	17	18	19	20
religious monument										
habitation										
public building										
building serving an economic purpose										
military architecture (fortified)										
ethnological structure										
building serving a technical purpose										
monument to the struggle for national liberation										

3 — LOCATION
commune _____
place _____
town _____
address _____
land register No. _____
owner _____

OVERALL FLOOR SPACE
basement _____ m^2
ground floor _____ m^2
1 _____ m^2
2 _____ m^2
3 _____ m^2
4 _____ m^2
TOTAL _____ m^2

CONDITION BEFORE EARTHQUAKE
○ good ○ medium ○ poor

CATEGORY OF MONUMENT _____
PROTECTION REGIME _____

4 — DAMAGE CAUSED BY THE EARTHQUAKE

	destroyed	heavily damaged	damaged	slightly damaged	intact
chimney(s)	○	○	○	○	○
covering	○	○	○	○	○
structure	○	○	○	○	○
dome(s)	○	○	○	○	○
vault(s)	○	○	○	○	○
ceiling(s)	○	○	○	○	○
wooden floor structure(s)	○	○	○	○	○
other floor(s)	○	○	○	○	○
bearing wall(s)	○	○	○	○	○
non-bearing wall(s)	○	○	○	○	○
arch(es)	○	○	○	○	○
columns	○	○	○	○	○
staircase(s)	○	○	○	○	○
foundations	○	○	○	○	○
belfry/belfries	○	○	○	○	○
minaret(s)	○	○	○	○	○
architectural decoration	○	○	○	○	○
iconostasis	○	○	○	○	○
mural painting(s)	○	○	○	○	○

Appendix IV: Glossary of relevant disaster management terms

Acceptable risk

The level of potential losses that a society or community considers acceptable given existing social, economic, political, cultural, technical and environmental conditions.

Building code

A set of ordinances or regulations and associated standards intended to control aspects of the design, construction, materials, alteration and occupancy of structures that are necessary to ensure human safety and welfare, including resistance to collapse and damage.

Capacity

The combination of all the strengths, attributes and resources available within a community, society or organization that can be used to achieve agreed goals.

Capacity Development

The process by which people, organizations and society systematically stimulate and develop their capacities over time to achieve social and economic goals, including through improvement of knowledge, skills, systems, and institutions.

Coping capacity

The ability of people, organizations and systems, using available skills and resources, to face and manage adverse conditions, emergencies or disasters.

Disaster

A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources. of services, social and economic disruption and environmental degradation.

Disaster risk

The potential disaster losses, in lives, health status, livelihoods, assets and services, which could occur to a particular community or society over some specified future time period.

Disaster risk management

The systematic process of using administrative directives, organizations, and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster.

Disaster risk reduction

The concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events.

Disaster risk reduction plan

A document prepared by an authority, sector, organization or enterprise that sets out goals and specific objectives for reducing disaster risks together with related actions to accomplish these objectives.

Early warning system

The set of capacities needed to enerate and disseminate timely and meaningful warning

information to enable individuals, communities and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss.

Emergency management

The organization and management of resources and responsibilities for addressing all aspects of emergencies, in particular preparedness, response and initial recovery steps.

Emergency services

The set of specialized agencies that have specific responsibilities and objectives in serving and protecting people and property in emergency situations.

Exposure

People, property, systems, or other elements present in hazard zones that are thereby subject to potential losses.

Hazard

A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.

Land-use planning

The process undertaken by public authorities to identify, evaluate and decide on different options for the use of land, including consideration of long term economic, social and environmental objectives and the implications for different communities and interest groups, and the subsequent formulation and promulgation of plans that describe the permitted or acceptable uses.

Mitigation

The lessening or limitation of the adverse impacts of hazards and related disasters.

Natural hazard

Natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.

Preparedness

The knowledge and capacities developed by governments, professional response and recovery organizations, communities and individuals to effectively anticipate, respond to, and recover from, the impacts of likely, imminent or current hazard events or conditions.

Prevention

The outright avoidance of adverse impacts of hazards and related disasters.

Public awareness

The extent of common knowledge about disaster risks, the factors that lead to disasters and the actions that can be taken individually and collectively to reduce exposure and vulnerability to hazards.

Recovery

The restoration, and improvement where appropriate, of facilities, livelihoods and living conditions of disaster-affected communities, including efforts to reduce disaster risk factors.

Resilience

The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions.

Response

The provision of emergency services and public assistance during or immediately

after a disaster in order to save lives, reduce health impacts, ensure public safety and meet the basic subsistence needs of the people affected.

Retrofitting

Reinforcement or upgrading of existing structures to become more resistant and resilient to the damaging effects of hazards.

Risk

The combination of the probability of an event and its negative consequences.

Risk assessment

A methodology to determine the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability that together could potentially harm exposed people, property, services, livelihoods and the environment on which they depend.

Risk management

The systematic approach and practice of managing uncertainty to minimize potential harm and loss.

Structural and non-structural measures

Structural measures: Any physical construction to reduce or avoid possible impacts of hazards, or application of engineering techniques to achieve hazard resistance and resilience in structures or systems; Non-structural measures: Any measure not involving physical construction that uses knowledge, practice or agreement to reduce risks and impacts, in particular through policies and laws, public awareness raising, training and education.

Vulnerability

The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard.

National Institute of Disaster Management (NIDM)
(Ministry of Home Affairs)
IIPA Campus
I.P. Estate
New Delhi - 110002

National Institute of Disaster Management
(Ministry of Home Affairs, Government of India)
New Delhi - 110002