HUDCO's Role and Contribution in Disaster Preparedness and Mitigation

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Introduction

Human settlements are frequently affected by natural disasters – earthquakes, floods, hurricanes, cyclones, landslides – which take a heavy toll on human lives, destroy buildings and infrastructure and have far reaching economic and social consequences for communities. The vulnerability of human settlements to natural disasters is continuously rising due to the concentration of population and economic activities in large urban agglomerations and the precarious situation of low-income settlements in both urban and rural areas

Enormous efforts are being made throughout the world to overcome the problems of natural hazards. However in this decade of the International Decade for Natural Disaster Reduction (IDNDR) of the UN, with around only 79 days left for the next millenium a lot more needs to be done in this direction. Even the well-developed countries like USA and Japan have suffered from severe disasters in the recent past. But with an *integrated approach to Regional Development Planning with community participation and integrated approach to disaster mitigation*, these countries have been able to reduce the impact of unexpected disasters to a great extent, over a period of time. In addition, these countries are ***continuously engaged in collecting the data/ information, undertaking research on development of disaster prevention and mitigation techniques and creation of an awareness among the masses through series of actions, training and education.*** Most of the developed countries are still continuously engaged in strengthening their disaster management capabilities in the form of short term and long term strategies in this International Decade for Natural Disaster Reduction (IDNDR)

The Indian Scenario

Based on the size of the problem in India where 59% of its area is vulnerable to one or multiple hazard, an approach for any disaster mitigation programme needs to be conceived at ***three levels i.e. individual, community and national.*** Efforts have to be from multidisciplinary teams w.r.t disaster preparedness in terms of pre-disaster initiatives as well as post disaster rehabilitation. Adequate measures need to be taken at the **developmental planning stage of the new habitat/ township and strengthening/retrofitting measures for the existing structure/ building in order to safeguard lives and properties.**

Disaster Preparedness

This would cover series of initiatives related to preparedness and prevention and protection to minimise loss of life/property. The success of disaster preparedness is entirely dependent on the following strategies

- risk assessment and degree of efficiency
- forecasting, warning and prediction to be given based on scientific database on occurrence of impending disasters
- appropriate tools for speedy communications and use of technologies for information flow and evacuation
- imparting public awareness on how to respond in pre-disaster situations
- introduction of land use controls, building byelaws and their monitoring
- preparedness and contingency plans at local and national levels
- structural mitigation

The evacuation and sheltering of 'likely to be affected persons/belongings' has been successfully organised with increasing degree of efficiency over the years. This is more successful now in most cases of flooding and cyclone disasters. In the case of earthquakes and landslides, we are still not able to make predictions well in advance that could result in timely warning. However, adequate and quick timely response to symptomatic events can help to a large extent.

Cyclone Shelter

In the cyclone prone coastal areas, the frequency of occurrence and prevalent ecosystems demand provision of alternative to living on the coastline during the cyclone and the subsequent flooding. The fishermen community whose bread and butter is dependent on living nearest to the sea does not like to move permanently to the distant places. In India, a coastline of 3000 kms is affected every year by cyclones and flooding

Therefore, one of the successful means to evacuate and shelter the people likely to be affected, by cyclones include designing and constructing special multi-purpose cyclone resistant community relief shelters, for providing safe and secure accommodation. The cyclone relief shelters can take care of population ranging from 50 to 300 people (men, women and children). This should be located at relatively elevated areas, to be protected from floods and also with proviso for community kitchen, ensuring water supply, sanitation, battery operated electric supply, and in some cases, helipad landing facility on roof for relief supply, etc.

The structures are provided of particular shapes, which are able to withstand extreme cyclonic storms due to aerodynamic effects. Further, a new initiative has been taken to develop a low cost, anti-cyclone core unit for each family designed to provide for secure deposit of personal belongings, during cyclones in the existing villages. When the families evacuate, the personal belonging can be stored in the anti cyclone core unit located in base villages. This would help to resume economic activity and livelihood soon, on return.

Protection of Sea Front

Sea coast protection is done by building coastal revetment to avoid sea erosion, construction of earth bunds and the development of "shelter plantation" all along the coast line to provide a buffer or cushion against the onslaught of high speed cyclonic storms of 150 to 250 Km/hour. The shelter protection plantation belt of Casuarina trees which are fast growing and recyclable have substantially helped to protect the human settlements built on the leeward side. Other than this, regulatory controls for keeping new settlements at a distance away - say 200 to 500 meters away from coastline is also considered to be a precautionary measure.

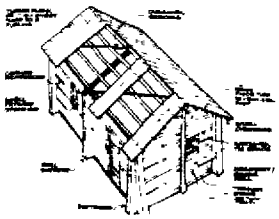
Structural Mitigation in Seismic Zones

In addition to the various measures that can be covered under pre-disaster activity, another major initiative that can be taken is to ensure the least amount of damages at the time of occurrence of a the natural disaster.

Structural mitigation is required in all disaster prone zones, it represents important possible solution to

reducing the losses in earthquake situations. This can be done by providing appropriate strengthening of the structure and providing disaster resistant features in housing and building construction programmes as per codal provisions to be taken up in different vulnerable areas. However, this can succeed only if the local building regulatory media through building byelaws insist on these features during building application

For incorporation of disaster resistant structural features in the buildings, the country is divided into seismic zones of various intensity based on a recently compiled 'Vulnerability Atlas' developed by the BMTPC. The buildings coming under seismic zone no III, IV & V should receive special attention. Accordingly, for important buildings IS - 1893 and NBC provide for strengthening measures in seismic zones. Similarly IS 875 provides for structural strengthening against high winds The ABCDE of cyclone protection housing are.



A - Anchorage
B - Bracing
C - Connection
D - Detailing
E - External Environment

Codes for structural mitigation could be of invaluable use for normal housing and for structures which are constructed by people or what is generally called 'non-engineered' buildings. The level of technology inputs have to be left at a workable level by giving the earthquake resistant construction features for walling roofing. foundation, doors and windows fixing etc. using local materials like mud, stone, steel, cement, concrete, roofing material etc. The information of how to effectively use local materials for disaster resistant construction would need to be widely disseminated by providing graphical interpretation through **Do's and Don'ts** brochures. Various Indian Standard Codes and the National Building Code provide substantial guidance for the same.

The large amount of coastal housing done over the last decade with various cyclone resistant features have been able to withstand the vagaries of natural disasters well

Post-Disaster Activities

In India, presently the awareness and spread of implementation of pre-disaster initiatives is yet to be widely used and in this situation the importance of quick response in post disaster situations becomes very important. Most common problems faced by the population during and after such disasters are

i. Damages to houses and other man made structures
ii. Blocking of Roads
iii. Occurrence of fire
iv. Land slides and rock falls causing damages or blockade
v Damage to communication facilities
vi Failure/Dislocation of essential services like water supply, electricity
vii Bodies buried under debris
viii Panic and rumor problems
ix. Depression in morale of the affected population
x Disruption of law and order and vandalism of public and private properties
xi Lack of presence of emergency shelters
xii. Disposal of human dead bodies, cattle and animals
xiii. Lack of immediate and sufficient first aid treatment to injured.
xiv Spread of disease and epidemics
xv. Family separation requiring reunion and psychological trauma
xvi. Evacuation and emergency camping
xvi. Rehabilitation of destitute persons

Many of the above problems can be eliminated or minimised by pre-disaster planning and preparedness, some are taken care of by relief work and emergency aid while others are of a type that need a more permanent solution in the post disaster period.

Immediate Post-Disaster Assistance

This covers efforts for rescuing and providing shelter in either the various relief shelters already constructed earlier or in the makesnift shelter through evacuation of public asset buildings like schools, community centres, other community asset buildings including places of worship, etc. as done in Tamil Nadu, Orissa and Kerala. Removal of the damaged elements of the structures including debris and recovering people who are either injured or deceased also is a very major task that has taken place during the Uttarkashi, Latur and Jabalpur Earthquake. The challenge of building on the upper hill regions of the Himalayas is not only of strengthening. It is also of building in the shortest possible time to provide provision for extreme weather conditions and protection from wild animals which prowl such areas.

Reconstruction/Rehabilitation Programme

After the immediate relief is provided to the victims of natural disasters the next step is to start a reconstruction and rehabilitation programme. And the foremost activity is assessing the extent of damages to the houses/buildings. Based on the quick assessment done by the Central Govt / State Govt. special team of the damage, an overall package for the reconstruction/rehabilitation/repair work for the various housing and building and infrastructure work can be taken up.

HUDCO has played a very major role in the reconstruction/ rehabilitation/repairs and renewal programme of houses/ buildings which are either fully or partially damaged through the natural disaster like earthquake, cyclone, flood, sea erosion and land slides Some of the salient features on earthquake reconstruction are given in Table 1. Further, retrofitting covering strengthening of partially damaged buildings and reconstruction in original site is also becoming relevant.

Apart from above it was realised that most important requirement was to build the capacities of the local taskforce and communities who are the first to be able to take necessary pre-disaster as well as post disaster actions in the wake of disasters HUDCO has endeavoured to do so with its network of 553 building centres in the country. The beneficiaries getting training in Building Centres go to the field and further implement the cost effective and disaster resistant technologies

As most of the non-engineered structures, especially housing, is built by people themselves through petty contractors, it was recognised that an effort was required to translate codal provisions to a simplified local language, which could be understood by local communities This initiative was taken by HUDCO by disseminating on information using local materials and technology through brochures on **Do's** and **Don'ts** in the local language. HUDCO has also been sensitizing mixed groups of professionals on the benefits and options of preparing built environment to mitigate impacts of disaster through its training programmes on disaster mitigation at HSMI

HUDCO's Role in Disaster Mitigation in India

HUDCO has been on the forefront of disaster mitigation efforts in India. It has played a very major role in the reconstruction/rehabilitation/repairs and renewal/

retrofitting programme of houses/buildings which are either fully or partially damaged through the natural disaster like earthquake, cyclone, flood, sea erosion and land slides HUDCO has been actively associated in the rehabilitation work for the gas victims of Bhopal, earthquake rehabilitation in Uttarkashi, Latur & Jabalpur, re-housing flood victims of Mewat in Haryana and the cyclone-affected people of Andhra Pradesh

HUDCO, as a techno-financing institution, is involved in a variety of efforts towards mitigation - prior, during and post-disaster. *The **three P's Prevention, Preparedness and Protection** are the keys to the pre-disaster action which is not complete without understanding and estimating actions which are post-disaster covering the efforts for emergency operation including search and rescue, relief and rapid damage assessment, post-disaster planning, physical reconstruction including efforts of social and economic rehabilitation.*

HUDCO, being the only techno-financial institution in housing, has been playing an important role, not only in financing the Housing and Urban Development programmes in disaster affected areas but also looking into the socio-economic and technology aspects of such projects. Mitigation of the consequences and over coming natural disaster situation with the least possible social and economical cost requires corresponding **legislation giving the possibility for long-term and integrated planning along with mobilisation of trained personnel with due scientific, technical, economic and administrative preparation.**

In total, HUDCO has financed the construction of a total of **7,32,267 dwelling units** with a cumulative project cost of **Rs. 807.69 crores** with a HUDCO loan amount of **Rs. 497.41 crores.**

HUDCO has so far assisted for rehabilitation of 72,158 Dwelling Units for victims of Earthquakes at a project cost of Rs.120 crores and with a HUDCO loan assistance/KfW grant of Rs.106 crores in the country.

HUDCO nas been assisting for providing shelter for reconstruction of houses for cyclone victims. HUDCO has so far assisted for rehabilitation of more than **2,37,232 Dwelling Units** in cyclone affected areas at a total cost of **Rs.291.37 crores** with HUDCO loan assistance of **Rs.194.89 crores**. In addition, for the recent cyclone and flood in Andhra Pradesh, HUDCO has offered a package of assistance to the extent of **Rs.190 crores** for reconstruction, repairs and rehabilitation programmes

In addition, HUDCO has also given assistance for rehabilitation of **4,30,083 Dwelling Units** for victims of flood affected areas at a project cost of **Rs. 396.64 crores** with a HUDCO loan assistance of **Rs.215.02 crores.**

HUDCO's Role in Latur

At 3.56 a m. on the 30th of September 1993 an earthquake measuring 6 4 on the Richter Scale with its epicentre near Killari village in Latur district resulted in the death of 7,928 people and injuring more than 16,000 people. This earthquake devastated 52 villages and nearly 27,000 houses and supporting infrastructure, other than this around 1,90,000 houses suffered damage of various degrees in 2,500 villages across 11 districts of the Marathwada region. Infrastructural facilities worth over Rs 4000 Millions was damaged and the estimated property lost was to the extent of Rs 1,1821 Millions.

The construction programme undertaken by HUDCO for 4 villages in Maharashtra for rehabilitation of these earthquake victims is an example of post disaster planning and reconstruction including the social and economic aspects. Construction of **1319 houses** in the four villages of Chincholi- Tapse, Utka , Tungi and Tembhi as taken up. The housing was financed through an overseas grant of **Rs. 20 crores** from the government of FRG and the KfW. It also established **10 building centres** in the affected areas.

HUDCO also provided training and technical suppor through its building centres for promotion of cost effective and appropriate earthquake resistant technology. For creation of an awareness among the technical personnel and general public, HUDCO published 4 brochures in simple and vernacular languages with simple graphics for different types of buildings/houses prevailing in the area with an emphasis to appropriate, cost effective and earthquake resistant technologies for repair retrofitting/strengthening of damaged structures and new construction to be taken up in future, also as a step for LONG TERM APPROACH for disaster mitigation.

Further, retrofitting covering strengthening of partially damaged buildings and reconstruction in original site is also becoming relevant. HUDCO's efforts for retrofitting in Tembe Village in Latur District is a good example on this count. Further, the much needed technology transfer would have to be imparted for people affected by natural disaster through the field level technology transfer centres including production centres

On the conclusion of the Maharashtra Government Programme for Rehabilitation of Latur earthquake victims, HUDCO was awarded a shield for its services towards the rehabilitation of the affected victims by His Excellency the Governor of Maharashtra

The Case of Jabalpur

The tragedy in Jabalpur

More recently tragedy befell the town of Jabalpur and neighboring areas in Madhya Pradesh in the wee hours of May 22, 1997 in form of a massive earthquake, resulting in the loss of 32 lives, injuring hundreds and destroying thousands of houses and causing major damage to other properties. Having an intensity of 6 1 on the Richter scale, the epicenter of the earthquake was located about 35 kilometers south of the Jabalpur town in a village called Kosamghat.

According to the survey conducted by HUDCO, about 8500 houses had been razed to the ground of which 6000 were in urban areas and 2500 in the rural areas. Besides an estimated 55,000 Houses were fully or partially damaged requiring Reconstruction or major repairs Of these, 25,000 were houses in the rural areas and 30,000 in the urban areas HUDCO involvement in rehabilitation efforts in Jabalpur range from financing, training, and information dissemination.

HUDCO offered to extend a loan package of Rs. 144 crores for the rehabilitation work at the lowest interest rates of 9% for EWS category and at 13 per cent for LIG category under which the majority of the affected persons fall.

Other than assistance through its loan financing mechanism HUDCO also is actively involved in developing the old and the new structures in the region so that in case such a mishap reoccurs the damage to life and shelter will be far less.

The existing construction system in Jabalpur did not take into account the earthquake resistant features for foundations, walling roofing and other elements as was clearly visible from the extent of damages suffered by the buildings The need for introducing earthquake resistant features in the reconstruction of houses wa recognised and HUDCO promised to provide necessary

technical inputs in the form of brochures indicating **"Do's & Don'ts"** in Hindi to be widely disseminated. For the effective implementation of these technologies HUDCO simplified these technical documents. These brochures have been brought out in association with Building Materials and Technology Promotion Council (BMTPC) and the MP Government, under the overall guidance of Dr AS Arya, an internationally renowned earthquake-engineering expert The brochures are in Hindi for wider and better dissemination among the people of the affected area These include guidelines for construction of earthquake resistant houses using bricks (for predominant urban applications), using mud (for predominant rural applications) as also for repairs/ strengthening/ retrofitting of buildings and mud houses. The technical brochures on retrofitting were infact the first of its kind ever brought out in such a simple form.

Recognising the urgent need to create awareness and to train the local artisans in the cost-effective earthquake resistant technologies, HUDCO launched an comprehensive training programme The training programmes included training for master artisans, who could subsequently train other local artisans to propagate the technologies as also exclusive training to the supervisors and engineers of the implementing agencies especially for the engineers of Rural Engineering Services, DRDA, PWD, MPHB, JDA, Municipal Corporation, Builders, Architects etc

With a long term view to transfer technologies and training of local artisans, HUDCO nas sanctioned 5 Building Centres to be located in Jabalpur, four in rural area and one in urban area, with total grant amounting to Rs 1 crore. Each of the Building Centers could receive a maximum grant of Rs 20 lakhs. HUDCO would also give assistance for putting up five model houses of various sizes in each of the five Building Centres, which will give appropriate information and guidance to the local population

HUDCO has so far sanctioned Rs 57.97 crores for the construction of 7424 housing units and repair/ retrofitting of 12733 units in Jabalpur and nearby affected areas.

HUDCO in association with the MP State Apex Cooperative Bank, have jointly organised more than **80 camps** covering most of the affected villages in an effort to educate the affected citizens about the simple loan application procedures.

Rehabilitation of Gas Victims in Bhopal

On the stillness of the night of the 2nd of December 1984, the capital city of Madhya Pradesh, Bhopal was affected by a grave tragedy Many lives were lost and more than 3000 families became shelterless due to a fatal gas leakage from the Union Carbide Plant. This unfortunate incident has left a permanent dent on the minds of not only the affected people but also citizens in Madhya Pradesh, all over India and the world. The Government of India in a effort to relieve the hardships of the affected people decided to provide them with a housing away from the location of the Union Carbide Plant.

In response to a request from the Madhya Pradesh Government, HUDCO took on the challenge to design the houses for the beneficiaries who were in ill health and could not climb to upper floors. It decided to provide a "low rise high density development with traditional cluster planning". In this scheme houses were planned around a community courtyard to encourage social bondage among the beneficiaries **2071 houses** were constructed which had a project cost of **935.36 lakhs** in which HUDCO's loan assistance was **692.67 lakhs**. This scheme was very well received by the beneficiaries and the larger community It received the "Excellence in Architecture" award from the Indian Institute of Architects in 1990 and was selected as one of the best five projects for the World Habitat Award in 1992 Besides technical assistance, the required financial assistance was also provided by HUDCO

Conclusion

Based on its experience HUDCO has for some time now been strongly advocating countrywide action for disaster mitigation It believes that only the institution of a efficient **Techno-legal and a Techno-financal regime** could ensure that all the new buildings constructed in the regions prone to natural calamities would have adequate protection measures before the local bodies accord any statutory clearance to it. These features would incur an additional expenditure of only about two-percent of the total cost of the building. However, incorporation of such technological features in the buildings would considerably help minimize the extent of damage in the event of natural calamities like earthquake, cyclone and floods. It would therefore be seen HUDCO nas been in the development both facets of application of natural disaster mitigation programmes i.e as a **pre-disaster activity** and the second as **a post-disaster activity** wherein the elements that contribute to the mitigation of damages in both the situations can have substantial relevance for reduction in loss of properties, human beings and animals

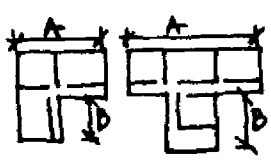
Recently the Government of Maharastra as a follow up of the Maharastra Emergency Earthquake and Rehabilitation Programme has take up the important and ambitious plan to formulate and implement a Maharastra Disaster Mitigation Plan. For this purpose a it had recently convened a international workshop in which all stakeholders in this process were present to contribute towards the preparation of this state plan which is based on the accumulation of District Disaster Mitigation Plans. This indeed is a positive step in the right direction, which needs to be supported and followed by all other states in India.

TABLE 1

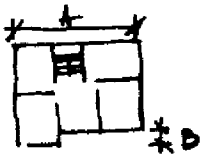
CATEGORY OF DAMAGE	EXTENT OF DAMAGE	REMEDIAL MEASURES
Slight non- Structural Damage	Fine cracks in plaster fall of small pieces of plaster.	Building need not be vacated Only architectural repairs needed.
Moderate Structural Damage	Small cracks in walls, fairly large pieces of plaster, slates slip off, cracks in chimneys, fall	Building need not be vacated. Architectural repairs required to achieve parts of chimney's durability.
Heavy Structural Damage	Large and deep cracks in walls, chimneys fall Load carrying capacity of the building is partially reduced.	Building needs to be vacated and reoccupied only after structural restoration and seismic strengthening
Severe Structural Damage	Gaps in walls, parts of buildings may collapse. separate parts of building lose cohesion and show relative movement, inner walls collapse Approx. 50 per cent of the main structural elements fail.	Building has to be vacated Either the building has to be demolished or extensive structural restoration and seismic strengthening work has to be undertaken.
Collapse	Total collapse of building	Clearing site and reconstruction

Dont's ☒	Do's ☑

BRICK CONSTRUCTION
PLANNING



B:A > 0·2



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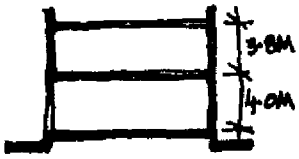
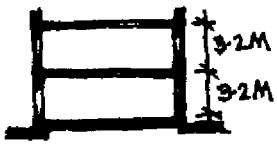
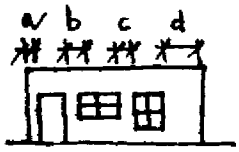


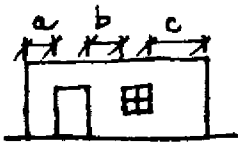
HT. OF EACH STOREY > 3·2M



HT. OF EACH STOREY < 3·2M

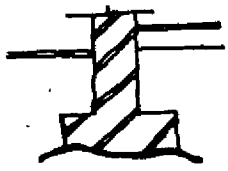


a, b, c, d < 0·6M

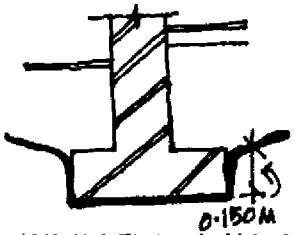


a, b, c > 0·6M

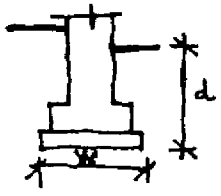
FOUNDATIONS



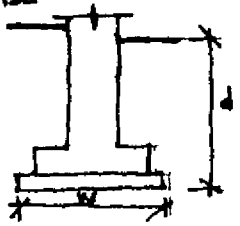
FOUNDATION ON ROCKY BASE



FOUNDATION ATLEAST 0·150 M INSIDE ROCKY BASE

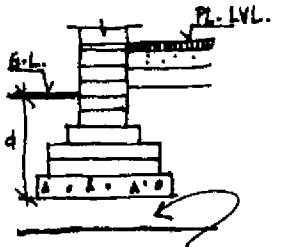


d < 0·5M
W < 0·75M IN SANDY / MOORUM SOIL

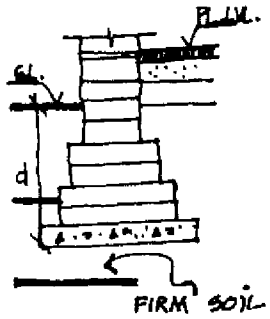


d > 0·5M, W > 0·75M IN SANDY / MOORUM SOIL

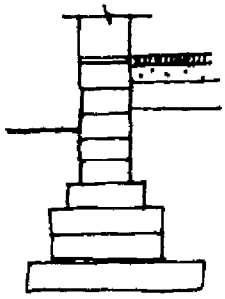
Dont's ☒	Do's ☑



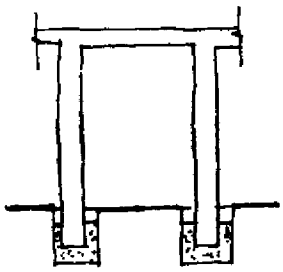
FOUNDATION RESTING ON BLACK SOIL WHERE DEPTH OF SOIL LESS THAN 1·2 M



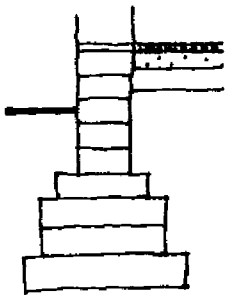
FOUNDATION DEPTH TO BE MORE THAN 1·2M IF BLACK SOIL DEPTH IS 1·2M OR LESS



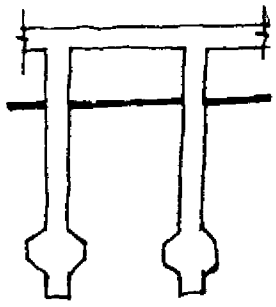
AVOID NORMAL FOUNDATION WHERE DEPTH OF BLACK SOIL IS BETWEEN 1·2 M AND 2·0 M.



USE PEDESTAL PILES WHERE DEPTH OF BLACK SOIL IS BETWEEN 1·2M AND 2·0 M



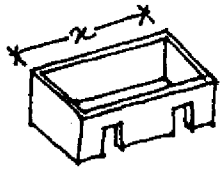
AVOID NORMAL OR PEDESTAL FOUNDATIONS WHEREVER DEPTH OF BLACK SOIL IS MORE THAN 2·0M



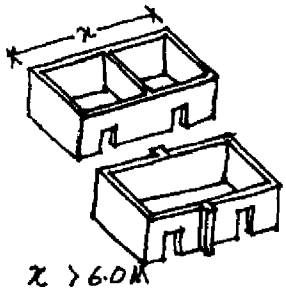
USE UNDERREAMED PILES WHEREVER DEPTH OF BLACK SOIL IS MORE THAN 2·0 M.

Dont's ☒	Do's ☑

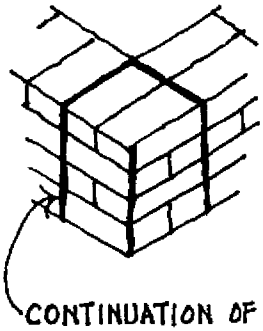
WALLS



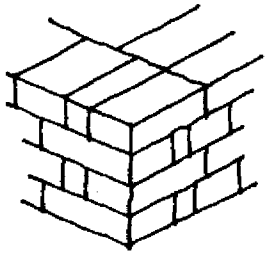
$x > 6.0M$



$x > 6.0M$
USE CROSSWALLS OR PILASTERS

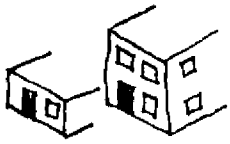


CONTINUATION OF VERTICAL JOINTS IN COURSES

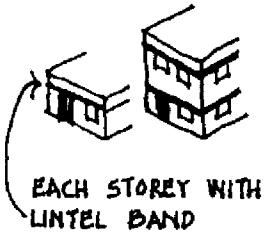


ALWAYS DISCONTINUE VERTICAL JOINTS IN EACH COURSE

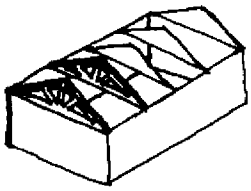
ROOFS



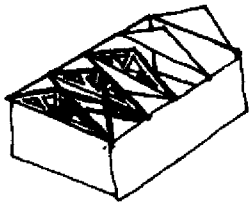
EACH STOREY WITHOUT LINTEL BAND



EACH STOREY WITH LINTEL BAND



TRUSSES WITHOUT BRACINGS IN SLOPED ROOFS



USE BRACINGS AT BOTTOM CHORD AND IN PLANE OF SLOPE OF TRUSSES.

Dont's ☒	Do's ☑

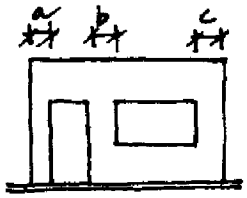
MORTAR

MORTAR —
CEMENT : SAND ~ 1:9

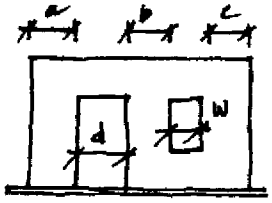
MORTAR —
A. CEMENT : SAND ~ 1:6
B. LIME : SAND ~ 1:3
C. CEMENT : LIME : SAND ~ 1:2:9

MUD CONSTRUCTION

PLANNING

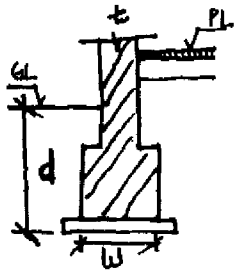


$a, b, c < 1.2M$

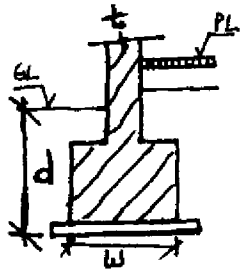


$a, b, c > 1.2M$
$d, w < 1.2M$

FOUNDATIONS

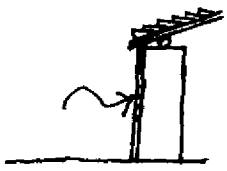


$t < 1.5 \times w$
$d < 0.5M$

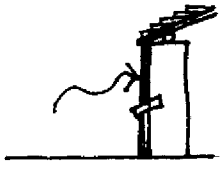


$t \geq 1.5 \times w$
$d > 0.5M$

WALLS

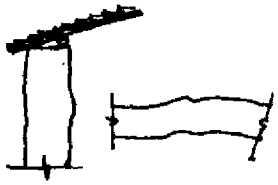


DO NOT PLASTER THE OUTER SURFACE OF AN EXTERNAL WALL WITH PLAIN MUD PLASTER

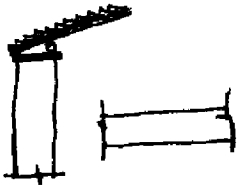


PLASTER THE OUTER SURFACE WITH WATER PROOF MUD PLASTER MIXED WITH 2% BITUMEN CUTBACK

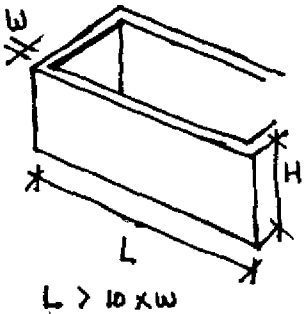
Dont's ☒	Do's ☑



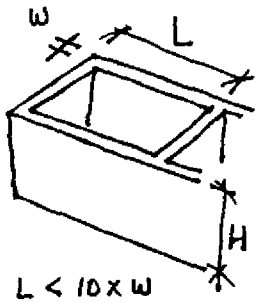
CROOKED/MISALIGNED WALLS IN LENGTH/ HEIGHT



MAINTAIN THICKNESS OF WALL. USE A STONE SLAB/WOOD PLANK OVER THE WALL.

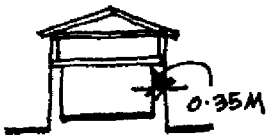


L > 10 x W
H > 8 x W



L < 10 x W
H < 8 x W

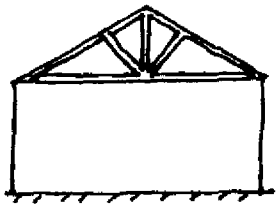
HOUSE MORE THAN 1½ STOREY HIGH. GROUND FLOOR WALLS LESS THAN 0·35M THICK.



HOUSE TO BE 1 OR 1½ STOREY HIGH. GROUND FLOOR WALLS AT LEAST 0·35 M THICK.

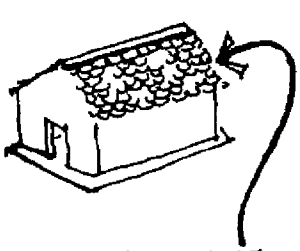
ROOFS

GABLE WALL WITH-OUT GABLE BAND

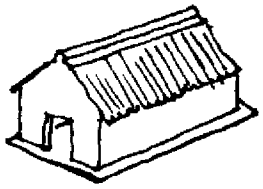


GABLE WALL WITH GABLE BAND

Dont's ☒	Do's ☑



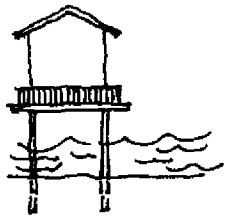
HEAVY AND LOOSE ELEMENTS ON THE ROOF.



LIGHT WT. MATERIAL LIKE SHEETS AS ROOFING MATERIAL. TIE ALL ELEMENTS TOGETHER AND WITH WALL SUITABLY.

FLOOD PRONE AREAS

IN NON-AVAILABILITY OF NATURAL ELEVATION — CONSTRUCTION AT GROUND LEVEL

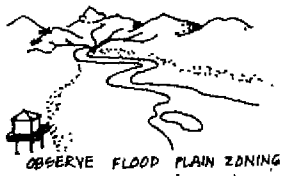


BUILD ON STILTS TO ELEVATE THE BUILDING.

BUILDING AT LESS THAN MINIMUM SAFE DISTANCE FROM COASTLINE

BUILDING AT 'SAFE' DISTANCE FROM COASTLINE.

RESIDENTIAL/ IMPORTANT BUILDINGS IN FLOOD PLAIN OF RIVER



OBSERVE FLOOD PLAIN ZONING

PROJECTIONS HINDER FREE FLOW

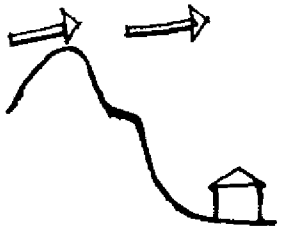
NO PROJECTIONS ARE BEST

Dont's ☒	Do's ☑

CYCLONE RESISTANT HOUSING

PLANNING

BUILDING ON RIDGE ATTRACTS HIGH WIND VELOCITIES

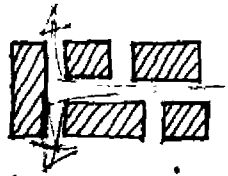


BUILDING IN VALLEYS PROTECTS FROM HIGH WIND VELOCITES

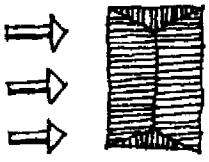
NO SHIELDING OF BUILDING FROM HIGH WIND

SHIELDING OF BUILDING FROM HIGH WIND BY TREES

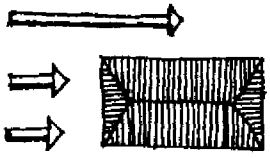
ROW PLANNING CREATES WIND TUNNEL EFFECT



ZIG ZAG PLANNING AVOIDS WIND TUNNEL EFFECT



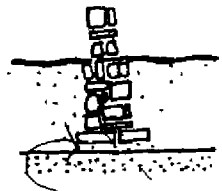
LONG FACE OF BUILDING FACING WIND→EXERTS GREATER PRESSURE



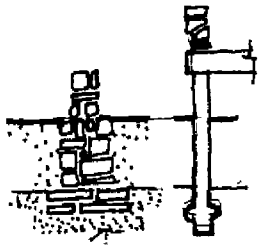
SHORTER FACE OF BUILDING FACING WIND — LESS PRESSURE IS EXERTED.

Dont's ☒	Do's ☑

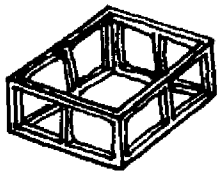
FOUNDATIONS



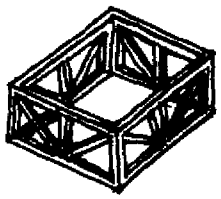
SHALLOW FOUNDATION OVER LOOSE SOIL CAN CAUSE SETTLEMENT



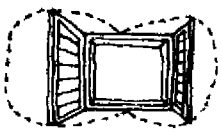
ADEQUATE DEPTH OF FOUNDATIONS, TO REACH FIRM SOIL IS DESIRABLE



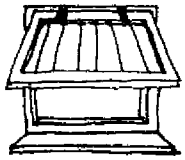
FRAMED STRUCTURE WITHOUT CROSS-BRACING IS VULNERABLE



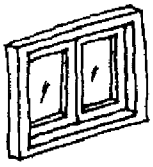
FRAMED STRUCTURE WITH CROSS BRACING IS MUST



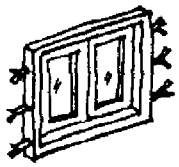
SELF-OPENABLE WINDOW (SIDE HUNG)



SELF CLOSING WINDOW (TOP HUNG) IS DESIRABLE



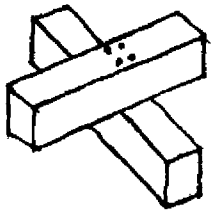
INADEQUATE ANCHORAGE OF DOOR & WINDOW FRAMES.

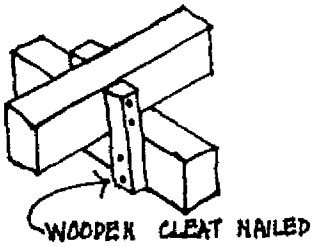


ADEQUATE ANCHORAGE OF DOOR AND WINDOW FRAMES.

Dont's ☒	Do's ☑

ROOFS - JOINTING DETAILS





FLOODS - JOINTING DETAILS