

Disaster Recovery and Build Back Better
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Lecture – 31
Guidance to DRR

Welcome to the course; disaster recovery and build back better, my name is Ram Sateesh, I am Assistant Professor in Department of Architecture and Planning, IIT Roorkee. Today, we are going to discuss about guidance to DRR; Disaster Risk Reduction so, here today in this lecture what I tried to do is I tried to compile at least showcase, different kinds of manuals or which is providing some guidance.

It could be a thumb rule guidance, it could be dos and don'ts, whatever you call it but it is showing some guidance; guidance to what, guidance to whom and guidance to which context so, when we say guidance to whom, this could be for the people who are working on the shelter practices whether it is an architect, whether it is a civil engineer, whether; so basically there is a group of built environment professions involved in the shelter recovery especially, in the humanitarian context.

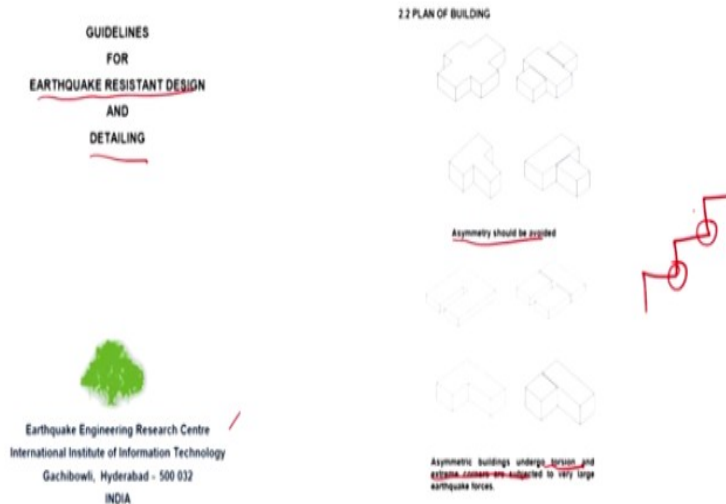
And the second aspect is; it is talking about certain principles of do's and don'ts, you know what to do and what not to do which is better, it's a very generic principles which is showing, it is not specific to the site but it will actually show some guidance to people working either on hilly areas or floodplain areas or an earthquake-prone area so, it is sometimes it is also specific to a disaster.

So, this particular manuals earlier, they were too technical to work on it and but as the time moved on, the visual aspect has improved quite a lot and because it has to reach to the common man, the most of the target group population who were often affected by the disasters, they are probably from the vulnerable areas especially, from the remote rural areas where you hardly get any technical manpower.

So, how this kind of guidance can show and these manuals can show your direction for the layman even to understand that what to do and what not to do and how to do, I will be showing a few guidelines and which has been developed by different agencies and what are

the focus lights on and how they have tried to demonstrate and what is that they are trying to give an information or to a guidance to the shelter makers.

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Now, for example, this was an a kind of guidelines which have been developed for earthquake resistant design and detailing and this has developed by ERC which is the Earthquake Engineering Research Centre, International Institute of Information Technology, this is where the IIIT in Gachibowli, Hyderabad have worked and they have also set up some lab on it and they have worked on the simulations part of it.

And finally, they have concluded with various evidence-based analysis, they try to develop a small manual about to you know, which gives the kind of thumb rules for example, how it will inform the built environment professionals for instance, in architects or a civil engineer who is constructing the housing. When we talk about very basic form of house compositions, planning of a house or a dwelling here, we follow certain elements of architecture and we follow certain principle; we apply the principles of okay.

And then we compose basically, what we try to do is we compose and in this composition process what in terms of the earthquake nature is concerned so, they are recommending that try to avoid the asymmetrical compositions in an earthquake-prone areas and because these asymmetric buildings undergo torsion and extreme corners are subject to very large earthquake forces.

So, obviously if you are talking about wings and keeping many officers in the building's obviously, there is a tendency that you know, there will be tendency, that these corners can break because most of the damages which we have noticed in the past earthquakes, they mostly occur in the corners, so that is where they try to suggest, try to avoid the asymmetrical buildings forms.

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Some of the other guidelines, which they talk on the site selection you know, so when you are constructing something for building try to avoid the sufficient away from the steep slopes okay and also in many cases what they do is; when you are cutting down and filling the soil especially, the filled up soil try not to make the foundations in this because that is going to have an implication that you know, it might come down and the whole load will collapse, there is a possibility that the building may collapse at the time of earthquake.

Because the forces it cannot be very much stabilized because of that fill soil and the shape of the building, they also suggest that very slender building should be avoided so, they also talk about the ratio, height and breadth should be less than four and also the inverted pendulum type buildings are unstable so, they always go with a kind of pyramidal type so the load is distributed and whereas, here it becomes difficult the more height you are going up, it becomes difficult.

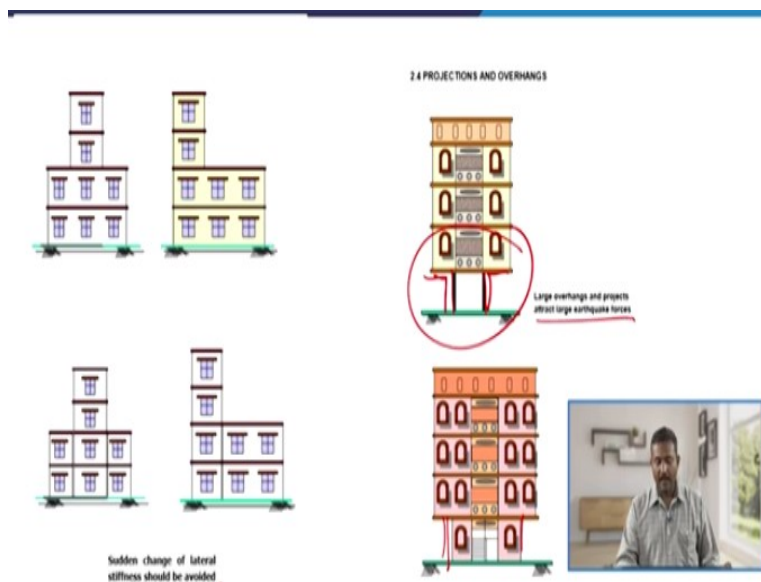
And there is also the wind movement, there is also the lateral forces which are actually applied on to the whole structure and how it can resist for instance, in Hyderabad is called we call as; nickname is a kind of Malkpet Bhuj, it's a kind of tall tower which has been built in a

place called Malkpet and you can see that 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 almost, 1, 2, 3, 4, 5, 6, 7, 8, 9 and with the ground floor G plus 9 floors and look at the volume of the building and look at the height and breadth of the building whether, in and also look at what is on the adjacent sides.

If some slight movement happens now, you can see that the next building is also coming on the similar heights so now, when certain towers are not considering and they are not leaving any setbacks and they are not leaving out any proportions you know how the proportions with the height and breadth has to work and this is where despite of the building regulations on what we have, the building bylaws, the permissible limits yes, he is going within that permissible limit.

But is it really worth enough and whether it can resist that earthquake forces during the time of an event so, these are all some mismatches between what the building by-laws permits and what the earthquake guidance is telling so, there is a consensus, there should be a consensus between the bylaws and as well as the structural measures which the guidance manual suggests.

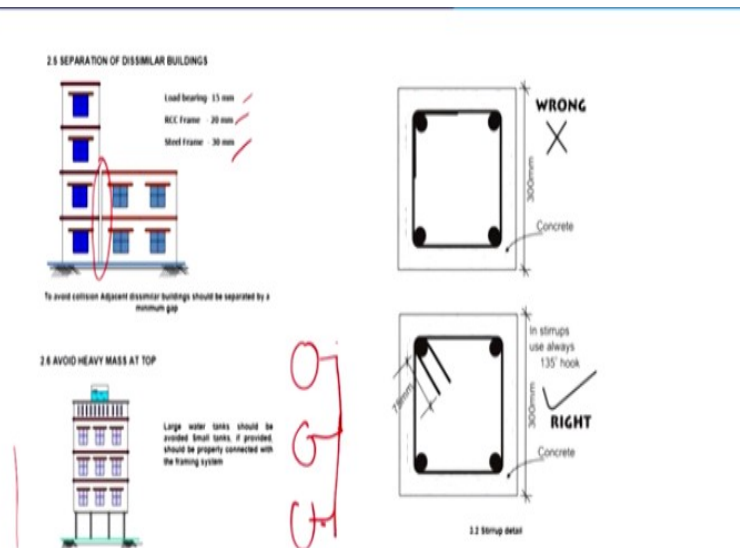
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And similarly, when we say about the sudden change of lateral stiffness should be avoided so, when you are talking about the you know, when we are improving the height so, you should not you know increase it, so that the sudden change of this lateral stiffness because it has to avoid this but otherwise, there is a chance of collapsing similarly, and the projections and overhangs.

So, now just on the two stilts, the whole building has been collapsed so, this is very unstable you know and so you need to have some kind of support system that is how in order to have this kind of large overhangs and then you are keeping load over a load and it may collapse that's what it says, large overhangs and projects attract large earthquake forces.

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Similarly, the separation of dissimilar buildings so, when you are talking about the two different buildings at least, you need to; if it is a load-bearing structure, you should have about 15 mm and if it is RCC frame, it should be have 20 mm and if it is a steel frame, it is about 30 mm so, at least this much gap should be left because in order to avoid the collision between these are dissimilar buildings and that should have a minimum gap.

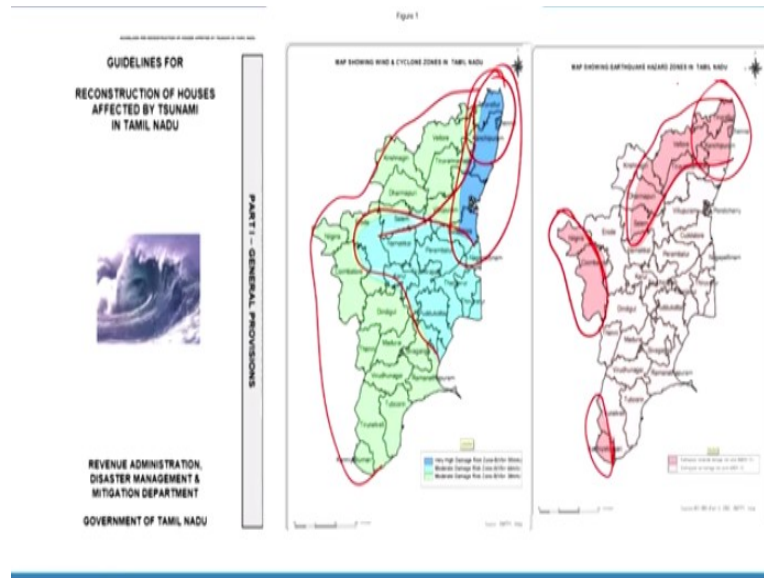
Also, we should try to avoid the heavy mass at the top because normally, in the previous building culture, what they do is they try to build the overhead tanks at a heavy volumes but then during the movement you know that is where it can also give a load and it can also can be a cause of that particular you know, when the movement is happening obviously, it can bring instability in that whole structure.

So, that is why what the advice is you can have instead of a large tank, what you can do is you can have a smaller tanks and the water distribution system could be connected, so that at least on that note you will not get any load aspects into it also, these technical manuals also talks about the even the type of reinforcement, the connection details you know so, for

example, they will talk about when we say the one foot beam or that is where the reinforcement.

Basically, how even the stirrups, how the clear cover has to be done so, you know the stirrup details will also have been given as guidance, how to mould them how to consider and what to do and what not to do.

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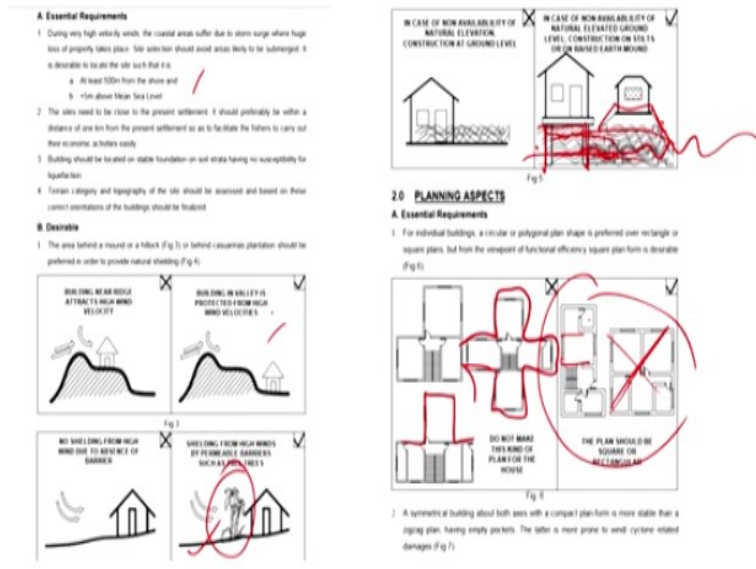
So, after the Tsunami, government of Tamil Nadu and with the help of Revenue Administration Disaster Management and Mitigation Department, they have also developed certain guidelines of reconstruction of houses affected by tsunami in Tamil Nadu. I will show you a brief about what is there in the guidelines and like that, I will keep discussing about various guidelines.

Now, they also talk about the you know, the cyclone zones; the wind and cyclone zones, for instance, this is the most high damage risk zone which is more towards the Chennai and this is the moderate and this is much more beyond the cyclone aspect but whereas, in the earthquake if you look at it that is where this zone is more of an earthquake vulnerable zones.

Also, the hilly areas about the Nilgiris and a little bit of the Kanyakumari and the part of Kerala, where the Western Ghats are also meeting at some point near Nagercoil and other places so, these are developed so but one has to look at when you see these kind of maps, they should not look that in an isolated manner, you have to also consider the multi hazard prone aspect.

So, at the same district, it might be a cyclone like for instance, if you look at this, it is also a cyclone-prone, it is also an earthquake hazard zone, so in that way, one has to look from that perspective.

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And similarly, they also talk about the CRZ regulations, the implication of the CRZ, which is a coastal regulation zone implication like they talk about at least 500 meters from the shore and plus 5 meters from the main sea level so, you know they also talk about because if you don't raise it, either you improve the height of the plinth of the building, so that if the water comes there is a tsunami then or you raise the plinth, so that at least this will be taken care of.

And similarly, there is about the desirable conditions when you talk about building near a ridge attracts high wind velocity but buildings and valley is protected from a high wind, I think, in this case, I would also bring a counter aspect of it, it is also depends on where how the make-up of the hill and the landscape is all about because even in sometimes, imagine if you have an another hill that becomes a tunnel effect you know, so in that way the wind will get channelled much fiercerful.

So, no shielding from high wind due to absence of barrier because that is where you need to talk about the landscape, you know, how we can promote the landscape, so that it can actually reduce the velocity of wind and can have a control mechanism over there and as I discussed you as an earlier report, which talks about the planning requirements of what kind of plan forms, don't make an asymmetrical plans.

And also, you know, don't have too many offsets you know here, this is like too many, so symmetrical but still it's too many offsets in it but then either try to make more of a defined shape because that is where you can even have a diagonal bracings, you can have some kind of support system so, it will; it is at least bound to a; this plan should be square or rectangular, if it is rectangular then you need to have a kind of intermediate support systems into it.

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4.0 Quality control

- The construction as well as curing should be done only with good quality of water
- The PCC in foundation of 1:4:8 should be made over well-compacted soil
- The cement mortar not leaner than the minimum grade 1:6 should only be used for construction of brick work (Fig 25)

Fig 25

DO NOT USE CEMENT AND SAND RATIO OF LESS THAN 1:6

USE ONLY THE SE MORTAR MIXES:
CEMENT 1: SAND 4
CEMENT 1: LIME 3: SAND 3

- Aspect Ratio of the building (Length to Width ratio of the building) should not be greater than 3
- Ornamental architecture involving zigzag corners, vertical or horizontal cantilever

Fig 26

- In case of loading a group of buildings, a wider arrangement should be chosen in reference to the span building (Fig 26)
- Row houses creates wind tunnel effects
- The building should be oriented in such a manner that the shorter span length of the wall faces the sea (Fig 26)
- Corner walls of the building facing the wind direction
- Interior walls of the building facing the wind direction

Fig 27

- Reinforcement bars should be properly detailed i.e. bent with proper hooks at ends of the beams and bands with adequate anchorage
- The thickness of band should be not less than 75mm with 2 rods of 10 mm diameter and tied with properly detailed hooks / bends

Now, asymmetric buildings with empty pockets are more vulnerable to damage because don't leave these empty pockets, we tried to fill that and that is where these are more stable you know, the symmetric buildings are more stable and also when we say about the row house planning; the row house planning also creates wind tunnel effects because the moment your house is one step to another, next to the shore and then it channels the wind and that is where it can damage the edges of the walls or the corners.

So, that is where you can even you know, now even the zigzag planning avoid wind tunnel effect right, so how actually, you can actually see about, how you can actually, give a little bit of vastness and then reduce it so, the zigzag pattern as well can have some control, it depends on how you are actually orienting it and similarly, the long phase of the building facing the wind direction.

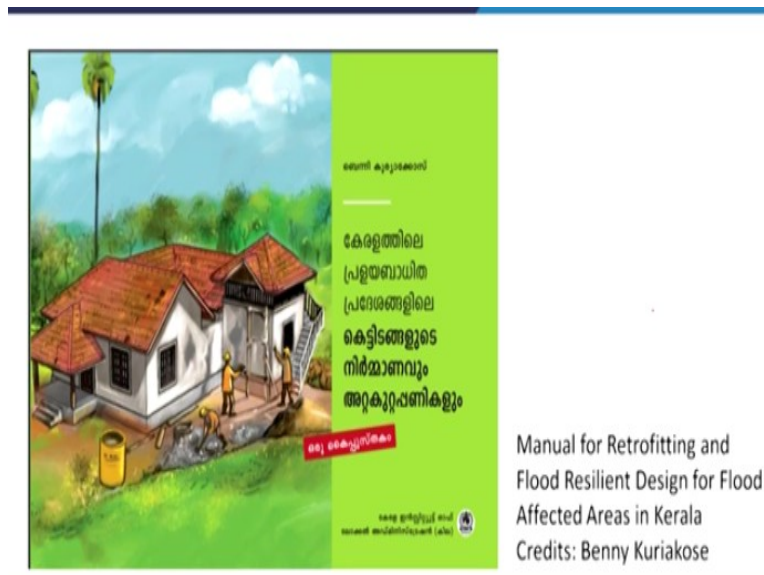
In fact, if you ever visit in the coastal villages of Tamil Nadu and the coastal areas; most of the times your short phase is of the building is facing the wind direction and whereas, in

horizontal phase because that is where they have less number of openings and either that, if they are facing that side and they will have less number of openings and otherwise, if they mostly they orient so, the whole building pattern is like you have the seashore and you have these.

So, the building's; the shorter side will face the seaside, so that is how they are oriented and similarly, in terms of the; this particular manuals also talk about the quality control. In terms of quality control, it is also talks about the material, what are the ratios we have to include. So, when we say about do not use cement and sand to be less than 1:6 okay, 1:6, so for 1 cement and 6 part of the sand.

So, you should not make use of the combination of this mortar not less than 1:6, either it is recommended to use 1 sand, 1 cement and 6 sand or 1 lime with 3 sand or 1 cement, 3 lime and 9 sand, so this is a kind of mortar mixes which normally guidelines do recommend and at the end of the day, all these are coming from the proper IS code but these are only a thumb rules.

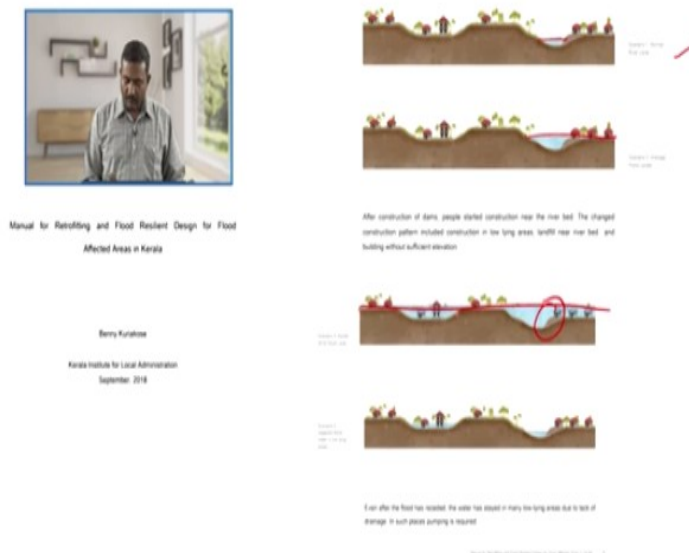
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And many of these manuals, when they are published in English, it becomes very hard how a local mason can understand it, so that is where a recent efforts have been done by architect Benny Kuriakose after the recent Kerala floods. So, what he did was he developed a manual for retrofitting and flood resilient design for flood-affected areas in Kerala. So, the Malayalam version is already printed and the English version is on the process.

But still, I could show you some images of what his work and it was very diagrammatic and really illustrative work. He looks into the before coming into the solutions, he actually explains the situation of how the causes you know, this is a very important aspect of developing any guidance, so one has to understand the consequences of these disasters and especially, what are the causes; root causes for it.

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And whether it is the form of orientation, whether it is the type of construction, whether it is a citing out you know, so this all for instance, here, you have these normal setup where you have the river level and all of them have built on the top, on the mountains and then the average flood level in case, it might have reached here but then because, after the construction of dams, people started construction near the riverbeds, they change.

Because they know, that the water is not coming very frequently, that is how they started coming down and they even started you know, constructing the houses near the riverbeds, so that is where you can see that in 2018, the Kerala flood have almost submerged 3/4th of the houses even on the top but even after the flood process still certain because you see that when this kind of images have formed, even after the this low-lying areas are still leftover with the water and that is what creating some endemic and epidemic diseases which are spreading.

And that is even much bigger disaster okay, so it takes so much time and also there are the water has stayed back even after you know because even after the flood and even after the rescue process still in being the same story in Kashmir, the water has stayed back and because the main issue is lack of proper drainage systems, the Chennai floods it is the same

because that is where the planning situation, the service infrastructure orientation has to be addressed.

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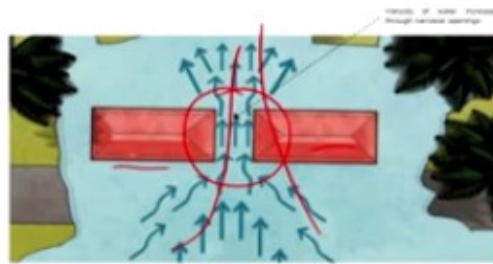


Then, when the water keeps coming into these areas obviously, there is also an aspect of; there is a difference in water levels for instance, the amount of water it enters and the amount of water outside, this is almost 8 cars, you know the load which is coming of the 8 cars worth of load which is pushing this wall and this difference in water level you know creates the pressure on the wall you know, this difference is creating the pressure.

And that is how there is a major scope that this wall might collapse right because there is two forces; one is a smaller force, one is a bigger force and it is pushing, it's almost about 8 cars and then obviously, that balance is missing and even the water so, it takes out the topsoils, the moment the topsoils are going out because the foundation we are talking about maybe a 1000 mm.

And obviously, this can loosen and this can change the soil conditions and movement beneath, so in that way, there is a possibility that these houses may collapse, so that is what we have seen in those videos.

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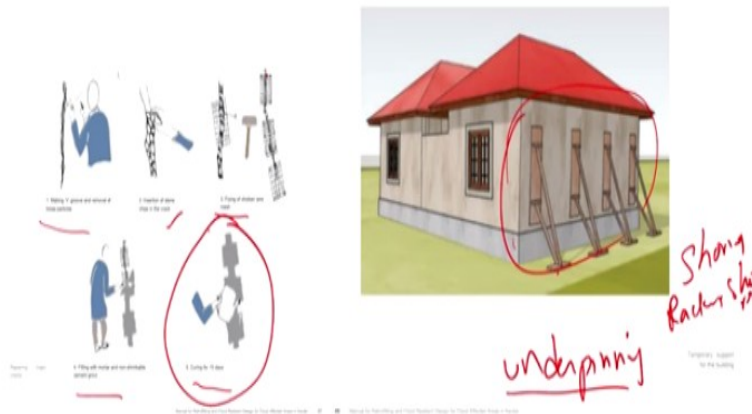


2.2.2 Velocity of Floodwater

When a certain volume of water moves through narrower areas, the velocity of water flow increases intensifying the damage further.

Also, the velocity of the flood water because the moment you are keeping the same thing what the other manual of the tsunami is talking, the moment you are making these row houses like this that is where this is going to create the pressure you know, intensify because that is where the it's a kind of bottleneck process so, the water and then it affects this whole damaged process both the walls and also it can affect the foundations.

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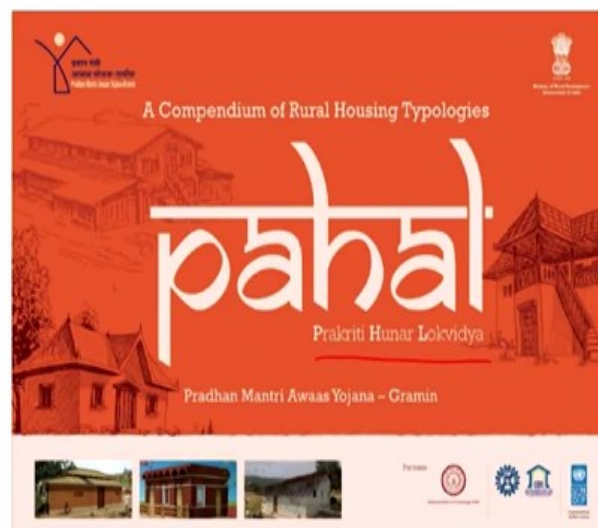
So, these are a few glimpses of the reasons but there are many other which he have explained in this manual and in fact, how to retrofit these things because there are some solutions not only the causes for these aspects but you also have to talk about the solutions so, for instance when we say about solutions, how to retrofit it, what are the techniques one can use.

For example, in architecture we might have studied shoring and you might have studied about raking shores and you might have studied about underpinning so, these are various techniques which we learn from our architecture building construction subject but then this is one, where you really apply it because this is where, in order to protect this wall and during the restoration process, you need to apply these shores.

So, that you need to give a kind of temporary support until the restoration is done or retrofitting is done. Now, there are different ways of; he explains different scales of these cracks for instance, if it is a smaller crack what to do is; we making a V groove and removal of loose particles, then insertion of stone chips, so there is a Gelatin technique sort of thing, you keep the stone chips and then, then fixing a chicken wire mesh all along and then filling with the mortar and non-shrinkable cement grout.

So, in that way curing it for 15 days, the curing is most important part you know, everyone ignores this curing part, it is only not just only the plaster part of it so, these are some few techniques which he comes up with you know how to retrofit these things.

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And then till now, we have spoken about we have discussed our discussion about the giving the manuals and guidance from a very disaster focus, whether it is an earthquake focus, whether it is a tsunami focused and it is a flood focused but in Benny Kuriakose, we have observed that these are being translated in the local language which and illustrated more in a diagrammatic manner explaining the cause and the reason for it and the impact of it.

So, there is an issue, there is a cause and there is an impact and as a result of this, how we can deal with this as a solution you know, what are the very different ways we can deal, so that is how these manuals have been framed but then when we talk about the manuals or the guidance yes, we do understand the show a broader picture of it but then, what about whether it is a State Government of Tamil Nadu whether it is engineering structures GSD, MA where is a Gujarat State Disaster Management Authority which have issued some manuals for retrofitting the buildings or reconstruction.

But the state; whole state is very diverse, it has its own regions, it has its own unique geological and geographical and topographical conditions, it has unique landscape; is a very diverse landscape, if you take Gujarat state, you have the desert part of it; you have the Banni grasslands part of it. Similarly, in Tamil Nadu you have the coastal Tamil Nadu; you have the Nilgiris, as a mountainous place.

So, one has to understand that each state is been sub-categorized by different cultural geographies, which is not only the geography but they also vary with the cultures, the moment culture comes into it, it can talk, it is reflected in the building practices whether it is a type of construction, whether it is an alignment of a house, whether it is the dwelling typology and their belief systems.

So, that is where and there has been an effort by the Ministry of Rural Development and Government of India where they have issued a compendium of rural housing typologies of 13 states, this is called Prakriti Hunar Lokvidya under the Pradhan Mantri Awas Yojana Gramin scheme, this has been compiled as a kind of compendium of different rural housing technologies.

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And UNDP and CBRI and IIT Delhi and they have all been partners of technical institutions, they have already covered Assam, Chhattisgarh, Himachal, Jharkhand, Manipur Orissa, Rajasthan, Tripura, Uttar Pradesh, West Bengal so, I will just show you, I will not show you everything but I will show you one state how there; what is the pattern they have try to address.

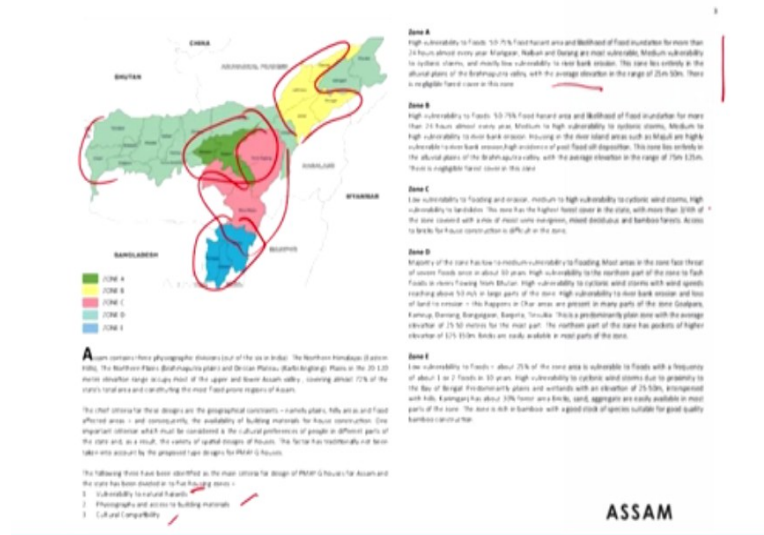
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First of all, the design of the manual itself is the important thing when you are developing a guidance, for example, this is a zone A, this is how the coding is worked so now, it says UPA 01, UP is Uttar Pradesh, A is what is the zone and within the zone, you might have 2, 3 typologies, so that is where the typology number. So, for example when you say, the state name and then zone; 1, 2, 3, 4, 5, like that.

So, this could be done by ABCDE zone and then within the zone, you have 1, 2, 3, 4 typology, this is how it has been organized and how one can read this document.

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I will show you one example of it, for example, you take the Assam state where you have the zone A is here and the zone B okay and the zone C which is towards the Bangladesh and the Manipur side of it and you have the zone D and zone E, so this is how and they are all classified by vulnerability to natural hazards, physiographic and access to building materials and the cultural compatibility.

So, here, they have even described what actually this zone A comprises of in the high vulnerability especially to floods and what kind of floods they are talking about, what kind of riverbank erosions, they are talking about and you know, it is also talking about what kind of elevations and the forest cover, so that's how the descriptions of each zone has been given.

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ZONE-A

The classification zones in Assam is based on vulnerability to natural hazards

- High vulnerability to floods, 10-15% Flood hazard area and likelihood of flood occurrence for more than 24 hours almost every year. Mangrove, natural and flowing are most vulnerable.
- Medium vulnerability to cyclonic storms which are vulnerability to river bank erosion.

Resilience Available

There is high concentration of brick kilns.

- Hand bricks are also a viable alternative due to presence of thermal power plants.
- Handlooms are used extensively for carpeted wall paper, minimal purchase with of hand plastered bamboo qalis and bamboo post in public portions of walls.

Zone A has one typology AS-A01

AS-A01 **Side view**

This design responds to the brick masonry houses with 3" walls which are the most common PMM-G design followed in greater area of the Brahmaputra valley.

Recommendations for built form		
Plan issue	Notes	Real World
The design responds to the brick masonry houses with 3" walls	High three storey	Highly not
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The design responds to the brick masonry houses with 3" walls which are the most common PMM-G design followed in greater area of the Brahmaputra valley.

Recommendations for construction systems	
Component	Recommended Specifications
Foundations	• vertical footing of 12" x 12" concrete and 2" x 6" brick beam. Full brick masonry in 1:4 cement mortar 60 grade lean soil is considered per m ² concrete foundation. The brick load is distributed over the brick area, so as to provide a good foundation for masonry construction.
Walls	• A plaster coat has been recommended to protect the brick work. This is required because high thickness of construction is allowed with of medium to low bearing capacity.
Floor	• vertical footing of 12" x 12" concrete and 2" x 6" brick beam. Full brick masonry in 1:4 cement mortar 60 grade lean soil is considered per m ² concrete foundation.
Roof system	• Sloped roof.
Roof structure	• 10" x 10" rafters and 10" x 10" purlins are provided in concrete with 2" x 4" brick. Roof is additionally supported with bamboo strong bamboo in place of high timber section.
Roof insulation	• None. Concrete masonry floor 2" thick on brick for setting. Bamboo concrete masonry foundation.

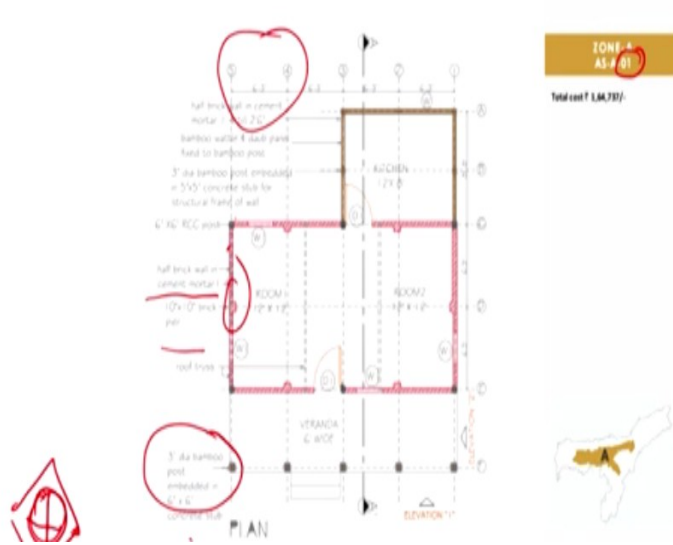
ASSAM

Then in the zone A, where we talk about, here, this is the zone A and it is based on the high vulnerability and medium vulnerability cyclonic storms and mostly, low vulnerability riverbank erosion, so here, this particular typology, this is a typology of a house where they try to document it and this response to brick masonry houses with three-inch walls which are most common.

And because it is an effort how one can validate these rural housing typology which are already existing you know, so how structurally one can validate how, so that earlier whatever the rural technology exists, they try to ignore it and they try to give their own uniform and standardized solution but this is an effort, how we can bring that local character still and how we can validate those techniques.

Now, it says about the plinth; the high plinth design and a sloped roof, it also talks about the foundations and the wall, wall finish, plain roof structure and the floor and it's all talking about the recommended specifications of it.

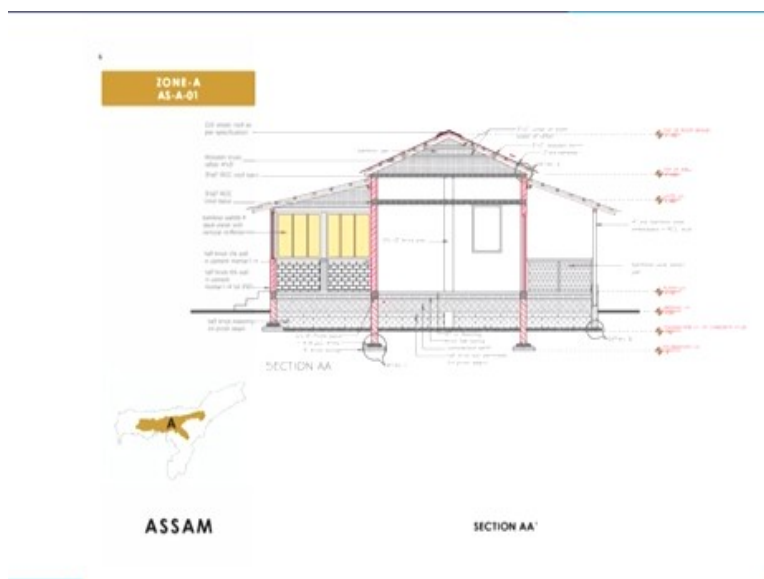
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Then, a typical dwelling unit like this is a zero-one, this is one typology and you can even think about you know, the how the basic dimensions, which are existing and how one can actually understand that 6 foot 3 inches because the span between 6 foot 3 inches and that is how a framed structure could be also thought of and here, you can see the half brick wall in cement mortar is 1:4.

And whereas, if it is a brick pier; 10 inches by 10 inches brick pier and for each this is a 6 feet 3 inches span you are getting and also 3 inch diameter, bamboo post embedded in concrete slab so, basically, you have the concrete and then this is a bamboo post which has been embedded with it that acts like a reinforcement so, this is a basic understanding of the plan forms of it.

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And then, it goes back to the heights and you know, the material components in it so, how the wooden purlins works, how the collar beam works you know so, how the brick foundations you know, how they have to so, it gives the more technical details of how one can construct in this format.

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Cost Estimate for ZONE-A Design 01

Sl. No.	Item	Unit	Quantity	Rate	Amount
1	Excavation	m ³	100	100	10000
2	Brick soiling	m ²	100	100	10000
3	PCC	m ²	100	100	10000
4	Brickwork foundation	m ²	100	100	10000
5	Brickwork about plinth	m ²	100	100	10000
6	Concrete	m ³	100	100	10000
7	Reinforcement steel	kg	100	100	10000
8	GCI sheet	m ²	100	100	10000
9	Door	nos	100	100	10000
10	Window	nos	100	100	10000
11	Cement	kg	100	100	10000
12	Plaster	m ²	100	100	10000
13	Labour	nos	100	100	10000
14	Material	nos	100	100	10000
15	Transportation	nos	100	100	10000
16	Contingency	nos	100	100	10000
17	Profit	nos	100	100	10000
18	Grand Total				180000

Cost Breakup

Item	Cost (INR)
Room	1,10,000
Kitchen	15,000
Veranda	15,000
Total	140,000

ASSAM

Then, comes to the cost estimate, you know the cost estimate for zone A, design one so, when we talk about cost estimate, it covers excavation, brick soiling, PCC, brickwork foundation, brickwork about plinth, concrete, what is the ratio we are talking about 1:1.5:3 always it's a multiple of the aggregates and the reinforcement steel truss and then GCI sheet and door, window cement and plaster.

So, in that way they have been composed with you know how much it is going to cost per room, kitchen, veranda and total is this much and how do they calculate it, when you talk about this is where the integration of quantity, pricing and specification will come into the picture also, one will have to understand the labour rates of that region, if it is a Delhi area you have to talk about the list analysis of rates you know, DSRs.

And if it is a CPWD agency, then you have to analyse, that at least there are different ways how one can get these rates, whether it is a labour rate, whether it is a material rate, whether it is a steel rate, if it is one ton how much steel it is working, it is brickwork how much brickwork is costing and for this amount of brickwork, how much labour is worked out so this whole thing is a kind of a cost break up.

So that at the end you are able to come up with some kind of guidance from 1 lakh 64,000 one is able to get this kind of house, right so, in that way, this is giving you a detailed version of what to do and how we can bring these rural typologies into the mainstream practice.

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http://www.world-housing.net/wp-content/uploads/2011/08/Dhajji_English.pdf

Similarly, there are efforts in Pakistan in countries like Pakistan, there have been a guidebook for technicians and artisans, they call it as artisans. Like in India, also in Himachal and as well as in Uttarakhand, we have the Dhajji wall constructions where it can go of the one and two storey earthquake-resistant houses, where you have the timber frames and the embedded whether it is a stone embedded, whether it is cobbles or pebbles, whether is a flint filling it so, they have developed the technical manuals of doing this Dhajji constructions.

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Pattern	Timber in (ft)	Number of nails (all sizes)
A	3.75	100
B	3.29	88
C	3 to 4	100 to 120
D	3.85	108
E	3.04	94
F	3.25	78

- Walls can be subdivided in various ways. The strength of the finished wall depends on the quality of connectors and the number of bracing boards.
- Nail sizes
 - 6" nails to connect the main frame elements (4" x 4").
 - 4" nails for 2" boards (use 2 nails at each end)
 - 3" nails for 1" boards.
- Don't save money on nails. Whenever two pieces of timber meet, connect them with nails.

And also, the retaining walls if you are constructing in these hilly areas, what are the methods one has to approach in constructing the retaining walls and especially how, what are the principles we apply in subdividing these Dhajji wall constructions because there is a timber studs and which are embedded within the stone gabions sort of thing or it could be mud-plastered as well.

So, this is where they even talk about the nail sizes, they even talk about the spacings to it you know and now, here 1 inch by 4 inch you know, there even talking about the length of studs, the dimensions of the studs, the volume of the squares you know now, some of the technical details which has been given some guidance to these local carpenters or the artisans who are going to work on these Dhajji wall constructions.

So, I mean this is a brief about these manuals of course, there are many manuals in different, different languages but I try to show you from the Indian context and probably Pakistan I covered so, this is good enough for an architects to look into some kind of thumb rules for a low-cost housing as well and one has to understand that giving it in the local language, how this particular technical information can reach to the common man and the layman to understand it, is one of the important objective of these manuals.

I hope you are familiar with these manuals now and the guidance, thank you very much.