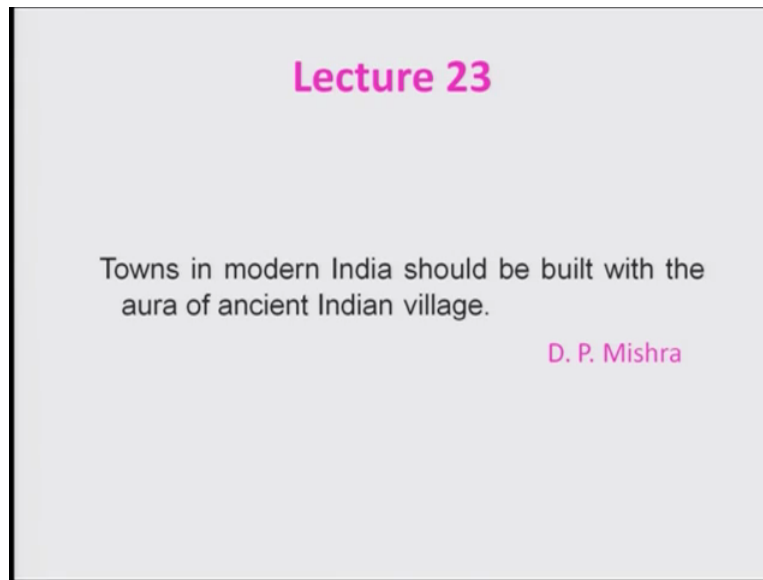


**Introduction to Ancient Indian Technology**  
**Professor D. P. Mishra**  
**Department of Aerospace Engineering**  
**Indian Institute of Technology Kanpur**  
**Module 5**  
**Lecture No 23**

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Let us start this lecture with a thought process. “Towns in modern India should be built with the aura of ancient Indian village”. Sustainability is today is the budge word, but it was prevailed in ancient Indian village. So, therefore we should have that and we will let us recall that what we had learnt in the last lecture, we basically looked at rural housing. And of course before that agriculture and textile and today we will be talking about the urban housings and town planning in ancient India. And let us look at what are the problems with the modern town planning and buildings? And we can look at whether we can get some solution from this ancient Indian town planning or not.

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**What are Problems with Modern Town planning & Buildings?**

- Maintaining the internal temperature by mechanical cooling and heating
- *Modern Buildings Consume More Energy.*
- Waste Water Management
- Lack of Greenery
- Higher level Carbon footprints
- Road Safety
- Crime management

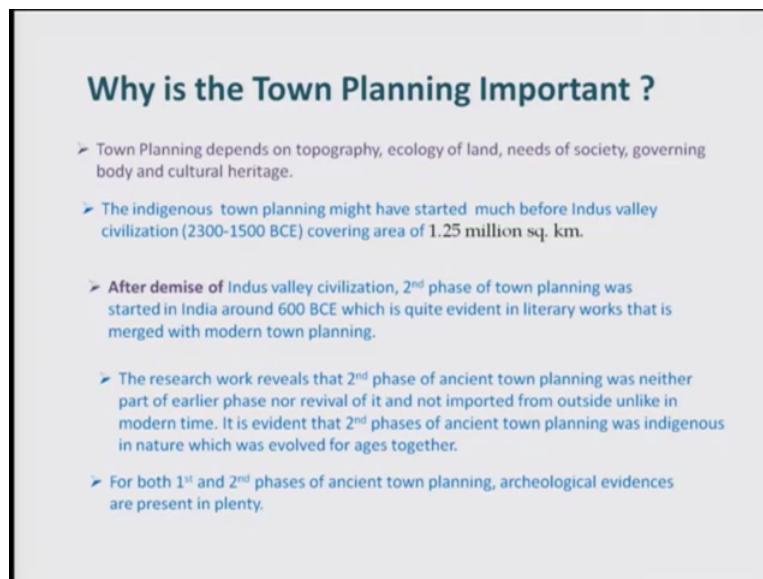
**What are the Crisis of Sustainability ?**

- ⊕ Global warming and environmental pollution
- ⊕ Over-exploitation of natural resources
- ⊕ Depletion of fossil fuels and resources

So, as we know that it is very difficult now-a-days to keep the temperature in the house at comfortable level. So, for maintaining the internal temperature and also humidity, we will have to use mechanical cooling and heating system for which we will have to use lot of energy in modern buildings. Beside this waste water management is a big hassle in modern town so also we do not have greenery means where we can store this greens and of course most of modern and complex life we are living. Actually if you look at we are living a very complex life in modern days as a result we have higher level of carbon foot prints, and road safety is a big problem particularly in India where around 400 or more people are dying per minute in this country due road accidents. And criminal activities going on at an alarming rate in this place and so also management of crime is a very big challenging problem in modern days.

So, what are the crises of sustainability? If you look at global warming is a thing what we feel every now and then. And beside this we are encountering the environmental pollution, over exploitation and utilization of natural resources. As a result there is a depletion of natural resources and so also fossil fuel.

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### Why is the Town Planning Important ?

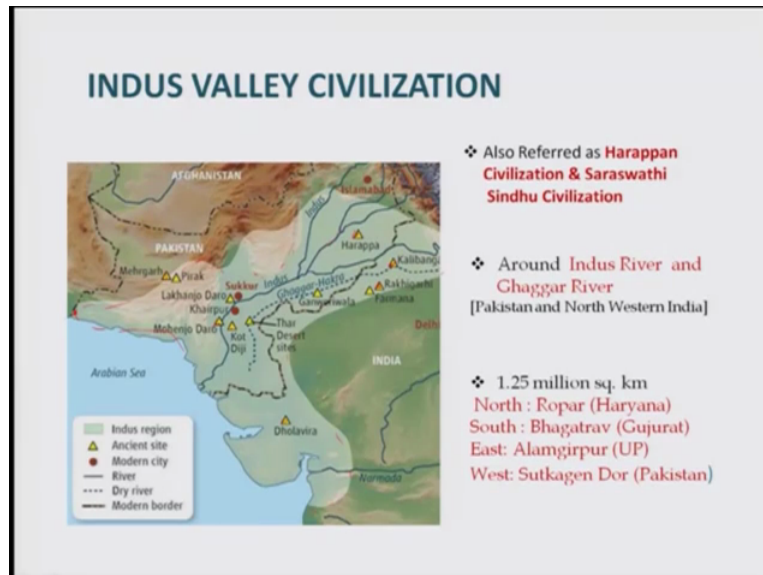
- Town Planning depends on topography, ecology of land, needs of society, governing body and cultural heritage.
- The indigenous town planning might have started much before Indus valley civilization (2300-1500 BCE) covering area of 1.25 million sq. km.
- After demise of Indus valley civilization, 2<sup>nd</sup> phase of town planning was started in India around 600 BCE which is quite evident in literary works that is merged with modern town planning.
- The research work reveals that 2<sup>nd</sup> phase of ancient town planning was neither part of earlier phase nor revival of it and not imported from outside unlike in modern time. It is evident that 2<sup>nd</sup> phases of ancient town planning was indigenous in nature which was evolved for ages together.
- For both 1<sup>st</sup> and 2<sup>nd</sup> phases of ancient town planning, archeological evidences are present in plenty.

So, therefore it is very important to have a town planning and we will see why we need to have proper town planning such that we can lead a very good life. Because the town planning depends on topography, ecology of land and the needs of the society not the greed's of society or greed's of you know certain people you know market forces which we are now what you call encountering, and governing body and cultural heritage that is important. But today most of the towns are being established and without much planning it is just going on particularly in this country and we are not taking care of neither the ecology nor the you know our cultural heritage and other things. So, indigenous town planning might have started much before in Indus Valley Civilization what we are calling now-a-days Saraswati river civilization which was around 2300-1500 BCE covering an area of covering an area of 1.25 million square kilometer is a very big you know area.

And of course after the demise of Indus Valley Civilization there was a 2<sup>nd</sup> phase of town planning in ancient India around 600 BCE, which is quite evident in literary works and that is merged with the modern town planning, because there is a going on till today. And of course in modern time we are just taking the ideas from the western countries and then implementing without thinking. And the research work reveals that 2<sup>nd</sup> phase of town planning was neither part of earlier phase, earlier phase I mean basically the Indus Valley Civilization, nor the revival of it nor it was imported from outside unlike in modern time. It is basically was developed indigenously which was evolved for ages together. And if you look at for both 1<sup>st</sup> and 2<sup>nd</sup> phases of ancient town planning, the archeological evidences are

present in plenty to establish that those are quite good and also what you call indigenous in nature.

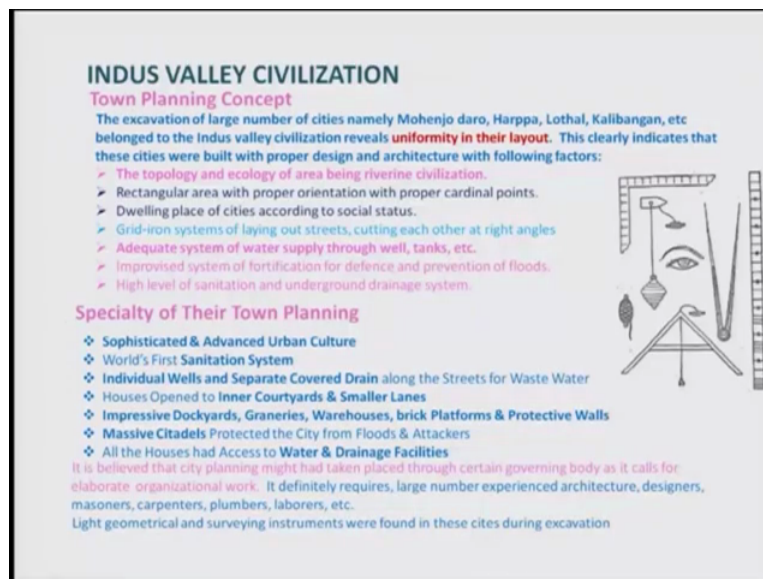
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And Indus Valley Civilization if you look at, it was basically in these areas these are the rivers Indus Rivers and then Ravi rivers and there is a Ghaggar river, which is a dry almost. And these are the spots if you look at this yellow colour spots like Rakhighari, Kalibnagan, Harappa, and then your the Kot Diji and Mohenjodaro, Mehargarh and Dholavira and there are several other places where you can have this Indus Valley Civilizations you know this regions if you look at this is the region what I am saying it goes to some other portion of Haryana also. Present Haryana there is a place known as Ropar region; this region belongs to that what you call Indus Valley Civilization. And now-a-days we call it Saraswathi-Sindhu Civilization as I mentioned earlier. And this civilization was you know located around Indus River as I told and Ghaggar, Pakistan and also North Western India.

And if you look at this 1.25 million square kilometer is basically north side it is in Ropar in present day it is called Ropar in Haryana and earlier name was Ropar and which is not shown in this map. And South, the Bhagatrav which is in Gujarat somewhere which is also not shown here in this figure and Alamgirpur UP, which is near Meerut this place and in the Western side, this is Sutkagen Dor, which will be nearby this place Sutkagen Dor so, it was a quite a big area where this civilizations were there as per the excavation by Archeological Survey of India.

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**INDUS VALLEY CIVILIZATION**

**Town Planning Concept**

The excavation of large number of cities namely Mohenjo daro, Harappa, Lothal, Kalibangan, etc belonged to the Indus valley civilization reveals **uniformity in their layout**. This clearly indicates that these cities were built with proper design and architecture with following factors:

- The topology and ecology of area being riverine civilization.
- Rectangular area with proper orientation with proper cardinal points.
- Dwelling place of cities according to social status.
- Grid-iron systems of laying out streets, cutting each other at right angles
- Adequate system of water supply through well, tanks, etc.
- Improvised system of fortification for defence and prevention of floods.
- High level of sanitation and underground drainage system.

**Specialty of Their Town Planning**

- ❖ Sophisticated & Advanced Urban Culture
- ❖ World's First Sanitation System
- ❖ Individual Wells and Separate Covered Drain along the Streets for Waste Water
- ❖ Houses Opened to Inner Courtyards & Smaller Lanes
- ❖ Impressive Dockyards, Graneries, Warehouses, brick Platforms & Protective Walls
- ❖ Massive Citadels Protected the City from Floods & Attackers
- ❖ All the Houses had Access to Water & Drainage Facilities

It is believed that city planning might had taken place through certain governing body as it calls for elaborate organizational work. It definitely requires, large number experienced architecture, designers, masoners, carpenters, plumbers, laborers, etc.

Light geometrical and surveying instruments were found in these cites during excavation

And Town planning concept if you look at is basically in various if you look at the excavation of large number of cities namely Mohenjo daro, Harappa, Lothal, Kalibangan, etc, basically belonged to the Indus Valley Civilization. And this if you look at it is having uniformity in their layout that means there was a basically a planned town planning and and this clearly indicates that these cities were built with proper design and architecture with the following factors. These factors are basically if you look at the topology and ecology of area being riverine civilization. Of course most of the earlier civilization were riverine means by the side of river and unlike in modern times. And rectangular area with proper orientation with proper cardinal points that means there will be a point around which the cities will be growing.

And dwelling place of cities according to social status, of course not all the places but in some places. And grid iron systems of laying out streets, cutting each other at right angles and today if you see that you will not find that kind of thing. And adequate system of water supply through well and tanks etc, because water is very important for life so, therefore always a provision were being made for the water and improvised system of fortification for defense and prevention of floods. And high level of sanitation and underground drainage system you could you know find in the excavation sites of Indus Valley Civilization.

And specialty of their town planning and it was basically, Sophisticated and Advanced Urban Culture, and it is claimed that the Indus Valley Civilization was having the world's first Sanitation system. Individual wells and separate covered drainage over the streets for waste water and today we have seen that there are several drains that do not have really cover in the

our country at this moment. And houses opened to Inner courtyards and smaller lanes so that you can really go and then do that. And impressive Dockyards, granaries and ware houses and brick plat forms and protective walls. And massive citadels were available at that time to protect the city from floods and attackers, all houses had access to water and drainage facilities.

And besides this it is believed that city planning might had taken place through certain government agency as it calls for elaborate organizational work because the city was planned in a very organized manner therefore somebody should be there to have that city planning. And if the city was really being planned and developed, then naturally there will be large number of experienced people like architecture, designers, masoners, carpenters, plumbers and laborers etc, must be there. That means there is a system which was prevailed at that time. And light geometrical and surveying instruments were found in these cities during excavation, like what I have shown here like this is a compass kind of things and these are the some balance systems and of course the threads and there is a kind of a stand for this thing for putting this balance for surveying purposes, this instrument is used for surveying and also labeling purposes.

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**Indus Valley Civilization**  
**Development of Cities**

- ❑ Cities grew out of earlier villages that existed in the same locality for < 100 yrs
- ❑ Grew in its size & density that might be surrounded by several small towns & big villages
- ❑ The cities might be interlinked by trade & commercial activities, social relations, etc
- ❑ Large land areas for agriculture, rivers & forests and rural communities, surrounded each city

**CLASSIFICATION OF TOWNS**

- Small villages / hamlets : 0 – 10 hectares
- Large towns : 10- 50 hectares
- Cities : 50 hectares

1 Hectare = 10,000 m<sup>2</sup>

CITY	SIZE IN HECTARES	POPULATION
MOHENJODARO	200	35-41000
HARAPPA	150	23500
GANWERIWALA	80	
RAKHIGARHI	80	
DHOLAVIRA	100	
REHMAN DEHRI	22	12000

So, Indus Valley Civilization if you look at there is a development of cities, it is believed that cities grew out of villages that existed in the same locality may be for around 100 years. And it grew in its size and density that might be surrounded by several small towns and big villages. The cities might have interlinked by trade and commercial activities and social


relations etc, and large land areas for agriculture, rivers, forests and rural communities were surrounding the each city, that means that, this agriculture and rivers and also forests at the time forest used to give the products which will be useful for the day to day life. And which is a part of their city particularly outskirts kind of things may be and which is the need of the hour also like that means each city should be self-sustainable and we can learn from this.

And if you look at classification of towns the small villages or hamlets around 0 to around something 10 hectares and large towns 10 to 50 hectares and cities around 50 hectares, and 1 hectare is around something 10,000 meter square. And if you look at these are the cities which were there in Indus Valley Civilization that Mohenjodaro is around 200 hectares in size and people were around something 35 to 45,000 people were living this estimation. And Harappa was 150 hectare in size, 23,500 people were living at that time. And similarly all others of course the Rakhigarhi and then Ganweriwala around 80 hectares in size. Of course, Dholavira was a little larger around 100 in size and Rehman Dehri is a smaller you know you can say it is a town kind of things which is something 12,000 people were living. So, these are of course in a size based on that they have come up with some population I would like kind of things.

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## HARAPPA

- It is extended over a circuit of **6 km** on left bank of river Ravi in the Punjab province of Pakistan.
- **23000** population in around 150 Ha
- This city might had been developed earlier during the Kot Diji phase, i.e., **2800-2500 BC**



➤ Earliest city covered an area of **25 Ha**.

➤ It became a **centre for trade networks** extending from **Baluchistan and Afghanistan** to the **west of the seacoast in the south**.

➤ Towns were built over **raised mud brick platforms**.

The high mound at Harappa is surrounded by a massive mud brick city wall with large square ramparts.

One of these **eroding ramparts** is visible through the underbrush that now covers the site. The flags mark the tomb of a Muslim saint was visible.

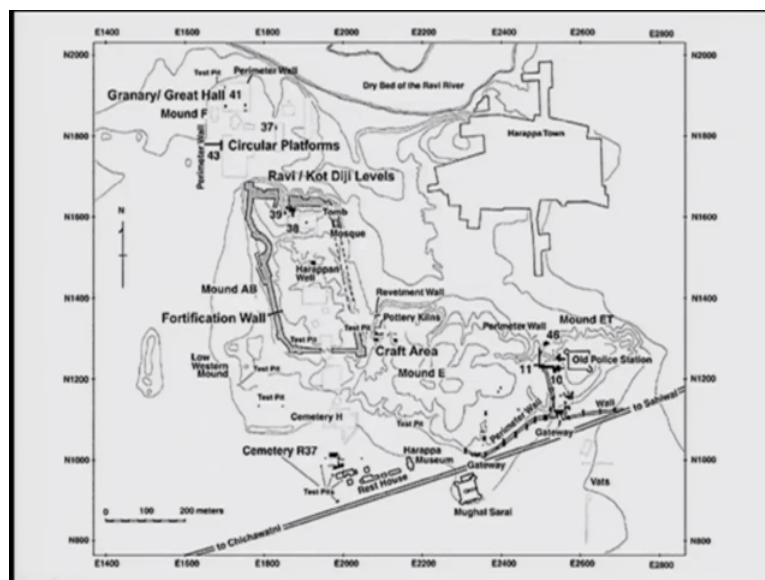
So what will be doing, will be basically looking at Harappa Civilization and topology kind of things. If you look at the Harappa, is basically nearby this place which is Ravi, by the side of Ravi River and it is an extended over a circuit of 6 kilometers on the left bank of river Ravi in the Punjab province of Pakistan, Pakistan of course the new name today, earlier it was a part



of India. And around 23,000 people were living in that area and the city might have been developed earlier during the Kot Diji phase, maybe 2800-2500 BC. And earliest city coverage of an area of 25 hectare Later on might have you know grown to the larger in size. And it became a center for trade networks extends to Baluchistan and Afghanistan. Afghanistan is here in this region might have spread and west sea coast in the south and towns were built over the raised mud brick platforms.

And the high mound at Harappa is surrounded by a massive mud brick city wall with a large square ramparts. And of course these are the things you know what people could see even today and because the remaining are there and today of course that you know you can see that other things like a tomb of Muslim saint you know you can today see that because after that people have a you know use that portion also.

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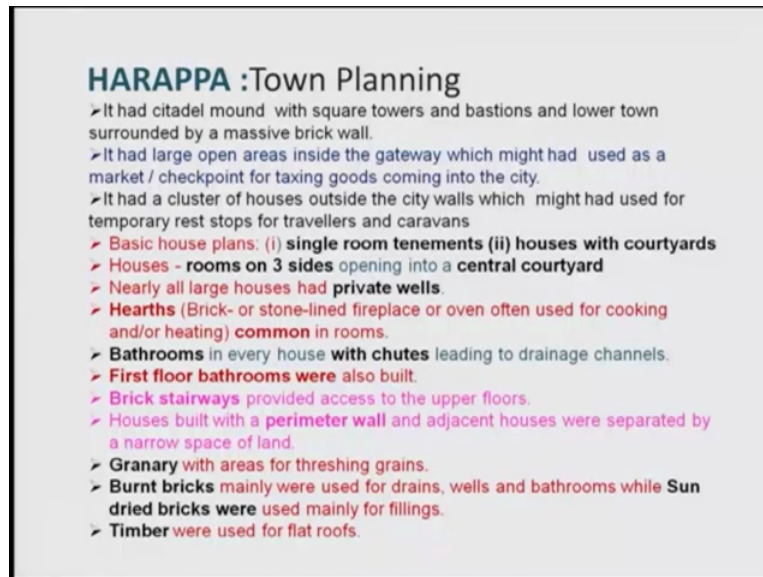
So, if you look at this is the what you call excavated lay out what people got in that region, you can see that is the mound area they have classified in various areas, there is a fortification here and there is a Harappan well in this region. Of course, later on people might have built this mosque later on and a tomb, and this region is basically Ravi and Kot Diji and there is a circular platform here and this we call is a mound F which is granary and for storage space for the grains. And this area is basically might be the place where king or the administrator might be staying in this region, and this is the Harappan town. And this is the river Ravi and of course, now it is a dry bed. And if you look at people got also some pottery clans here,



evidence of pottery clan and they are thinking that mound E is the craft area and there is a cemetery in this region.

And of course, there is a perimeter wall various walls remnants of the walls they could see from various regions and I mean they have excavated these regions and they have located several remaining of the structures.

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**HARAPPA :Town Planning**

- It had citadel mound with square towers and bastions and lower town surrounded by a massive brick wall.
- It had large open areas inside the gateway which might have been used as a market / checkpoint for taxing goods coming into the city.
- It had a cluster of houses outside the city walls which might have been used for temporary rest stops for travellers and caravans
- **Basic house plans:** (i) **single room tenements** (ii) **houses with courtyards**
- Houses - **rooms on 3 sides** opening into a **central courtyard**
- Nearly all large houses had **private wells**.
- **Hearths** (Brick- or stone-lined fireplace or oven often used for cooking and/or heating) **common** in rooms.
- **Bathrooms** in every house **with chutes** leading to drainage channels.
- **First floor bathrooms** were also built.
- **Brick stairways** provided access to the upper floors.
- Houses built with a **perimeter wall** and adjacent houses were separated by a narrow space of land.
- **Granary** with areas for threshing grains.
- **Burnt bricks** mainly were used for drains, wells and bathrooms while **Sun dried bricks** were used mainly for fillings.
- **Timber** were used for flat roofs.

So, if you look at this Harappan Town Planning had a citadel mound with square towers and bastions and lower town as I told are as I had shown you earlier that surrounded by massive brick walls and it had large open areas inside the gateways which might have been used as a market or check point for taxing goods coming into the city, these are all hypotheses or a kind of things what people have made. And it had clusters of houses outside the city walls which might have been used for temporary rest stops for travelers or caravans. If you look at basic house plans; is a single room tenements and houses with courtyards. Even if you look at when we discuss about rural housing courtyards were earlier a part of rural housing and houses if rooms on 3 sides opening into a central courtyard.

Nearly all large houses had private wells, that means if it is a large house, the person must be rich so therefore is having their personal well for water. And people found also the Hearths like may be brick or stone lined fire place, which was might be used for the cooking purposes or people says that it is for the Poojas also and for Yagnas, and for maybe another things will be heating and it was common in every rooms. And bath room in every house with a chutes leading to drainage channels that means the water will be going out to the channels for

drainage. And first floors of bathrooms were also built, that means bathrooms were also built on the first floor. And there is a brick staircase was provided as access to the upper floors because there is a two storey houses what people have conjectured.

And houses built with perimeter wall and adjacent houses were separated by a narrow space of land. Unlike today all are houses are you know joined together in most of places. And granary with the areas of threshing grains which will see as you go along see some of pictures. Burnt bricks mainly were used for drains and wells and bathrooms while Sun dried bricks were used mainly for fillings. Timbers were used for flat roofs like I had shown you earlier that culture of having you know flat roofs with the timber and mud might be there at that time and which is still there today in this country, particularly in rural areas.

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**HARAPPA: Architecture**

- ❖ Building materials - **mud bricks and baked bricks, wood and reeds.**
- ❖ The average size of the bricks was **7 x 12 x 34 cm (for houses)** and **10 x 20 x 40 cm** for the city walls. the larger bricks have a standard ratio of **1:2:4**.
- ❖ **Mud brick, baked brick & wood or stone** were used for the **foundation and walls** of the houses.
- ❖ The **doors ,windows** were made from **wood and mat**.
- ❖ House **floors -hard-packed earth**
- ❖ **Bathing areas and drains** - baked **brick and stone**.
- ❖ **Roofs** with wooden beams covered with **reeds and packed clay**.
- ❖ **Largest buildings** made entirely of wood.
- ❖ **Windows** – shutters & lattice work

**Architecture : Large Public Structures**

- **Large Buildings** -Administrative /Ritual Structures.
- **Access Routes** **are** Provided Thoroughfare from One Area to Another.
- **Markets and Public Meetings** Held in **Large Open Courtyards**.
- **Houses and Public Buildings** **Grouped with Shared Walls and Formed Larger Blocks & Accessed by Wide Streets**.
- **Most Houses** had **Private Baths &Toilets as Well as Private Wells**.

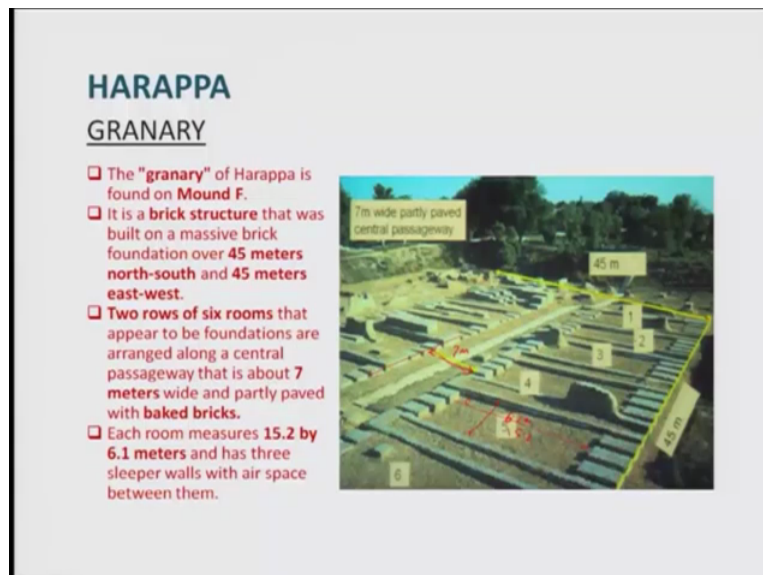
Harappan Architectures if you look at the building materials wise, they were using mud bricks, baked bricks, mud means basically it is a dried sun dried bricks and wood and reeds. Average size of bricks were found to be 7 into 12 into 34 centimeter 7 will be height and then this is the width and this is the length 34 centimeter and 10 into 20 into 40 centimeter for city walls and larger bricks have also standard ratio of 1 is to 2 is to 4, so if we have to look at this is the ratio is 1 is to 2 is to 4.

And mud bricks, baked bricks and wood or stone were used for the foundation of walls of the houses. Doors, windows were made from the wood and mat, house floor were made out of hard-packed-earth or the soil basically. And even in rural areas we do use today particularly for the in the houses of poor man. For bathing areas and drains, baked bricks and stones were

used, roofs with wooden beams covered with the reeds and packed clay as I told that it was being used earlier days. Largest buildings made entirely of wood, what people are anticipating I am really concerned whether how they could say this because wood might not be there, ok and windows the shutters or the lattice work were being used.

Architecture for the large public structures if you look at, large buildings were meant for administrative and ritual purposes and access routes are provided throughout from one area to another, and markets and public meetings were held in large open courtyards. Houses and public buildings were grouped with shared walls and formed larger blocks and were accessed by wide streets. And most houses as I had mentioned earlier had private baths and toilets as well as the Private Wells.

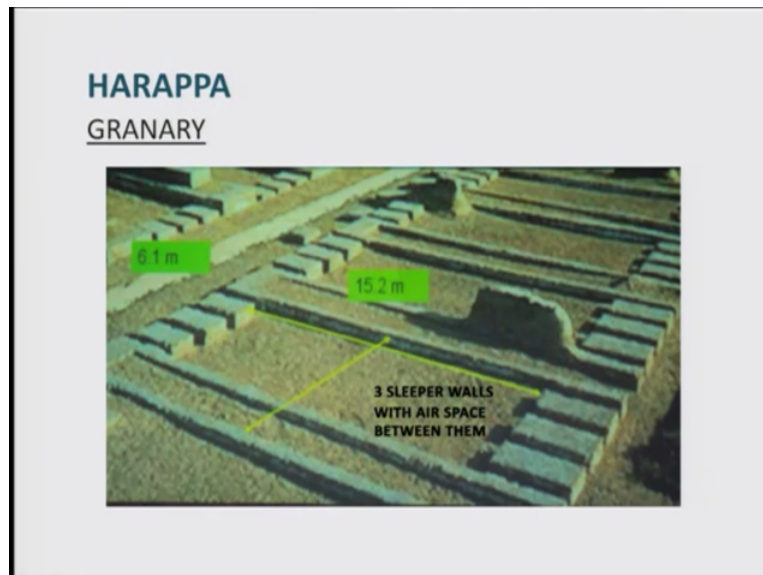
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Let us look at the granary, If you look at granary of Harappa is found in Mound F as I had shown you earlier and it is a brick structure that was built on a massive brick foundation over 45 meters north-south and 45 meters east-west. If you look at this is the north-south can region 45 meters this side and 45 meters this side which is not shown and which is quite a huge structure wise. Two rows of six rooms that appear to be the foundations these are shown like 1, 2, 3, 4, 5, 6 these are all rooms of which will be 7 meters wide I will show may be in the next figure, partly paved with the baked bricks. If you look at this two rows of there is a one row of 6 rooms, this is one row and there is another rows here right, 12 rooms are there. And in between there is a road, this is the road which is around 7 meters wide apart and which was paved with the baked bricks.

Each room measures around 15.2 meter length, this house will be around something 15.2 meters and 6.2 meters wide width kind of things and of course it has three sleeper walls with air space between them. If you look at, this one wall here the other wall is here and the other wall is here, this space will be for the air. Or this is known as the air space.

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So, if you look at question arises why this air space is being provided at that time? May be for what you call maintaining the temperature as it is a granary may be temperature will be affecting, the quality of the grain being stored. So, therefore it might be given and this can also be utilized even modern days and more research is required for that. So, with this I will stop over here and thank you very much and then we will discuss more things in next.