Introduction to Ancient Indian Technology.
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Lecture-30.

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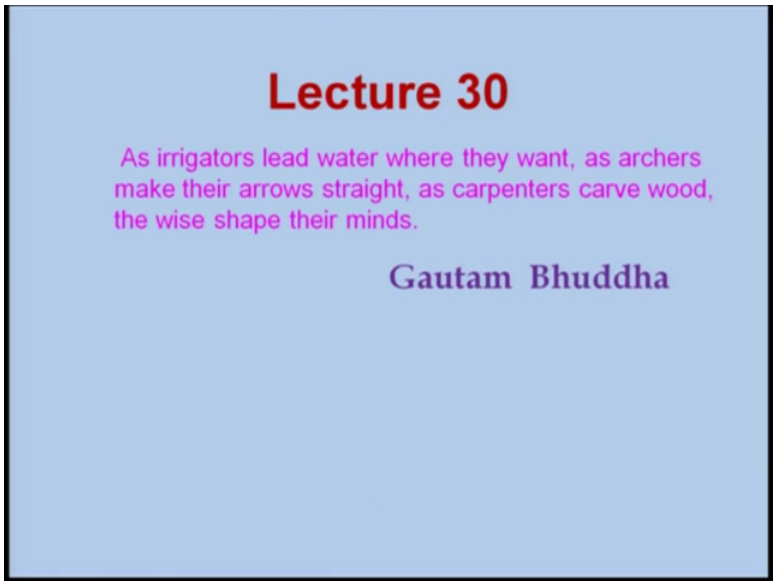

Let us start this lecture with a thought process from Gautama Buddha who says `As irrigators lead water where they want, as archers make their arrows straight, as carpenters carve wood, the wise shape their minds'.

If you recall that in the last lecture, we basically discussed about the ancient irrigation system which were different in the various regions of this country. And unlike in the modern days where we are using the same canal and then dam systems for irrigations. And we need to learn from that that each region will have different way of water conservations and also the water irrigation systems. And we also looked at various reservoir systems which were very huge and were built by joining the rivulets in a very what you call nice ways that it will not harm the people around them.

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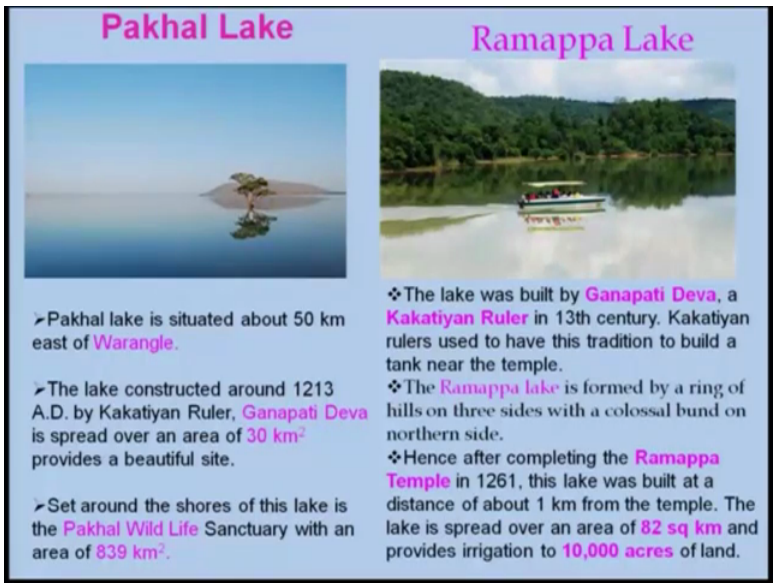

So, today we will be discussing about more reservoirs, let us look at Pakhal lake which is basically situated around 50 kilometres east of Warangal. And you might be knowing that Warangal is very basically the capital of the Kakatiyan Ruler Ganapati Deva who is around 1213 built this lake which is artificial nature in the area of around 30 kilometres and it provides a very beautiful site. And of course there is a Pakhal Wild Life sanctuary around this lake which is covering around 839 kilometre square area, it is a very huge.

So, from the environmental point of view this is the great things what we have still kept and it will be good to have such kind of water bodies for the betterment of the environment. And let us look at another lake which is quite old that is Ramappa Lake and this was again built by the same king Ganapati Deva of Kakatiyan dynasty around 13th century. He was very much interested in having to build a tank near the temple and that temple is basically Ramappa temple which was built around 1261.

And the lake was built at a distance about 1 kilometre from the temple. And lake is spread over an area of 82 square kilometer and provides irrigation to 10,000 acres of land. So, this was a tradition of the medieval king and also before that we had seen that they were very much concerned about the water conservation and also water preservations for the users. And it was around the temple not only the temple also in cities they were making that.

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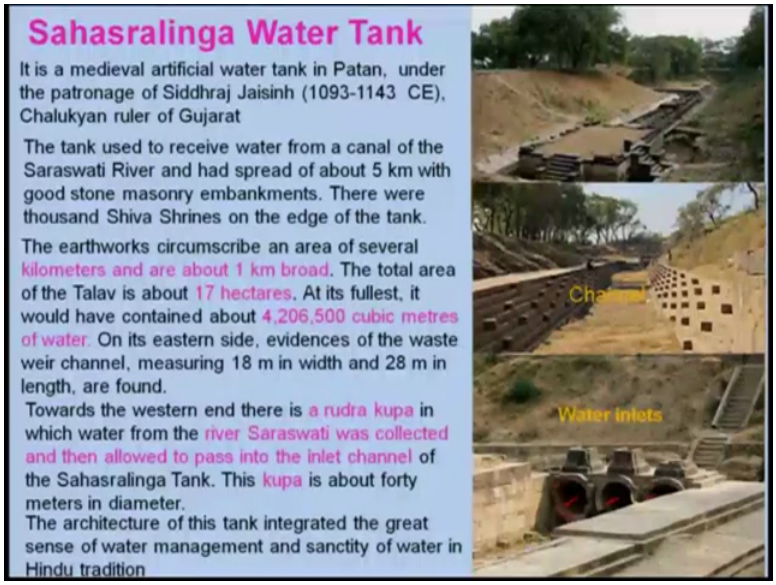

And let us look at another very interesting water tank that is Sahasralinga as its name indicates you might be thinking lingam is basically Shivaling and that is a lot of you know small small temples order of you know 1000 temples were there around this tank. And again it is a medieval artificial water tank in Patan, under the patronage of Siddhraj Jaisinh around 1093-1143 CE who is a Chalukya Ruler of the Gujarat.

The tank built by him was basically receiving water from Canal of Saraswathi River and this canal had spread about 500 kilometres with good stone masonry embankments. And as I told earlier there were thousand Shiva Shrines on the edge of this tank. And if you look at like some of the pictures I have shown here, like these are the canals which are having and these channels are having if you look at these are all brick stone cladded kind of things and there is a also the water inlets these are all water inlets which will be coming out kind of things, there is staircase.

And this earth work circumscribes an area of several kilometres and the width maximum width may be around something 1 kilometre. And total area of this tank, water tank is around 17 hectares, it is a very huge. It is estimated that when it is full it would have you know contained around something 42, 06,500 cubic meters of water. On the eastern side there is an evidence of waste weir channel measuring around 18 meter width and 28 meter in length.

On the western side there is a very huge temple for Shivji and which was built with the around I think 64 columns of made of stones, now it is in dilapidated condition. And towards the western side there is a rudra kupa; kupa means basically well in which water from from

the river Saraswathi was collected first and then the water will be allowed to pass into the inlet channel of Sahasralinga tank. And this kupa is about 40 mtrs in diameter. It is quite a huge well they had built.

The architecture of this tank integrated the great sense of water management and sanctity of water in Hindu tradition. Because we always consider water to be divine, therefore you should use it sparingly and also conserve it, that is the message what we should get from this and it was a tradition of our country and also our way of life if to consider the all these natural things as divine. So, unlike in modern time when we misuse it, abuse them profusely.

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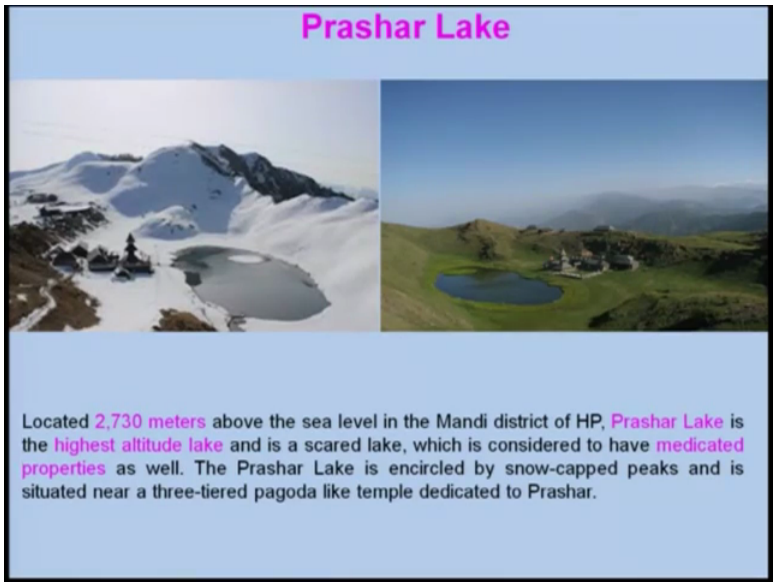

So, let us look at the Prashar lake which is a basically ice clad mountain areas in Mandi of district of Himachal Pradesh and this lake of course is known as natural one this one is known as Prashar lake and during ice it will be there and there is a temple here you know a pagoda type temple, three tiered pagoda like temple and dedicated to Prashar. And this is a natural lake what people have used and let me just emphasize that earlier days our you know, people were finding out the natural place of storing water which is much easier, I had emphasized and also gave several example how they used to join the rivulet which is coming from the mountains and also the make the dams as less as possible unlike in the modern time where people use what you call dams in a mechanical or the brutal way without really thinking much.

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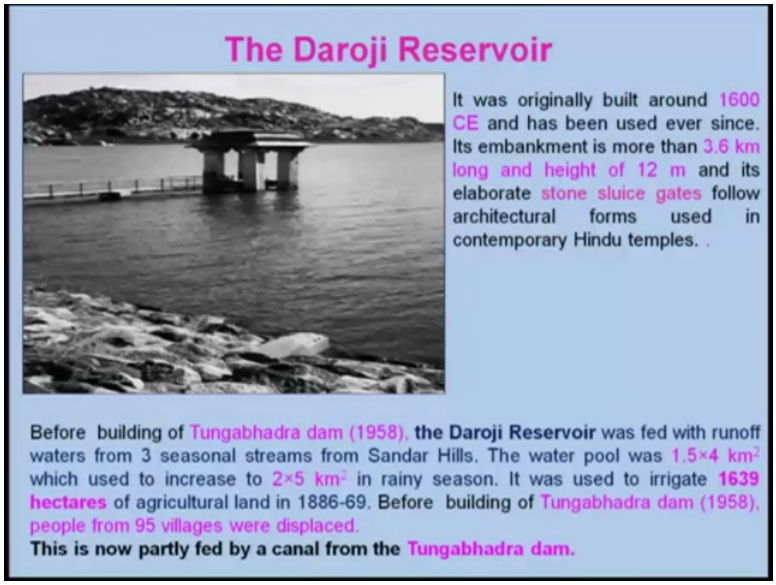

Let us consider the another reservoir that is Daroji reservoir and it was basically originally built around 1600 CE that is common era, has been used ever since it has been built and the figure I have shown here which is of course today it is not in good shape. Its embankment is more than 3.6 kilometre long and height of around 12 m , it had a elaborate stone sluice gates I mean which is shown here, one of them is shown here this is, there will be a sluice gate through which you can control the water and it is having architectural of the Hindu temple, contemporary temple kind of things.

Unfortunately this was being used by the people local people before the building of Tungabhadra dam in 1958, because this Daroji Reservoir was fed with runoff water from 3 seasonal streams from Sandar Hills. As I told earlier that they were collecting you know these streams and then making reservoirs together. And water pool is around 1.5 into 4 kilometre square which used to increase to 2 into 5 kilometre square in rainy season.

It was used to irrigate around 1639 hectares of agriculture land in around 1886-69 as per the record of British government. During the building of Tungabhadra dam people from 95 villages were displaced. And this Daroji Reservoir they have kept but they are merely fed from a canal from this Tungabhadra dam. So, therefore the naturality of this Daroji Reservoir is lost in the process and that is the beauty of our ancient reservoir system being built.

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Now, let me talk about a little bit about how the water being managed in the forts of you know ancient India. Because people were having these forts for protecting themselves and guarding them. And one example I will take only and water harvesting in the fort of Chittor, Rajasthan, you might be knowing the that Chittor is a very famous, it was been captured by several people and the Rajputs had a registered and also recaptured this fort several times starting from Khalil's to Akbar periods. And therefore lots of stories are around this Chittor fort but later and it is one of the largest forts of India. And it is has been declared as a UNESCO heritage being a largest and then very beautifully designed.

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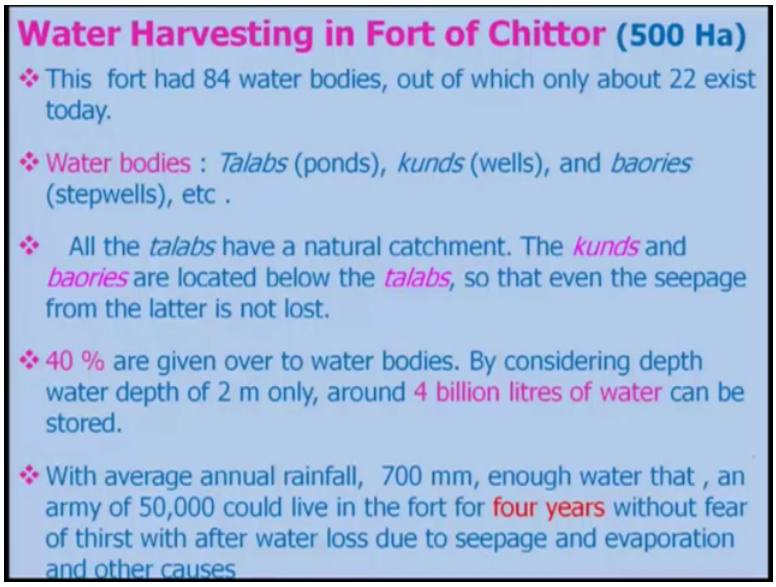

Let us look at from the water harvesting point of view. It is having 500 hectares of land which was devoted for harvesting water. What people had found out something this fort was having 84 water bodies, out of which only about 22 exist today. Today means may be 20 years back or 10 years back I do not know, right.

And water bodies basically consists of ponds, wells and step wells, right. And as the, these ponds have natural catchment areas they always find out natural way of doing the thing. And the wells and the baories, baories means basically step wells located below these ponds such that the seepage will not be lost. If there is a water seepage is going down and it will be store there.

40 percent of this you know land were given over to the water bodies. That was the design what they were using. Today we are not concerned about that whenever we are making a home or a buildings we should have open space for the water particular rain water to seep into the you know ground and then we can use it. By considering the depth of water around 2 m only around 4 billion liters of water can be stored. With this water you know if rainfall is around 700 mm of the height and army of 50,000 could live in the fort for 4 years. That means one seasonal rain can last for you know 4 years to meet the needs of 50,000 people. And of course by considering the water losses due to seepage and evaporation other things, right.

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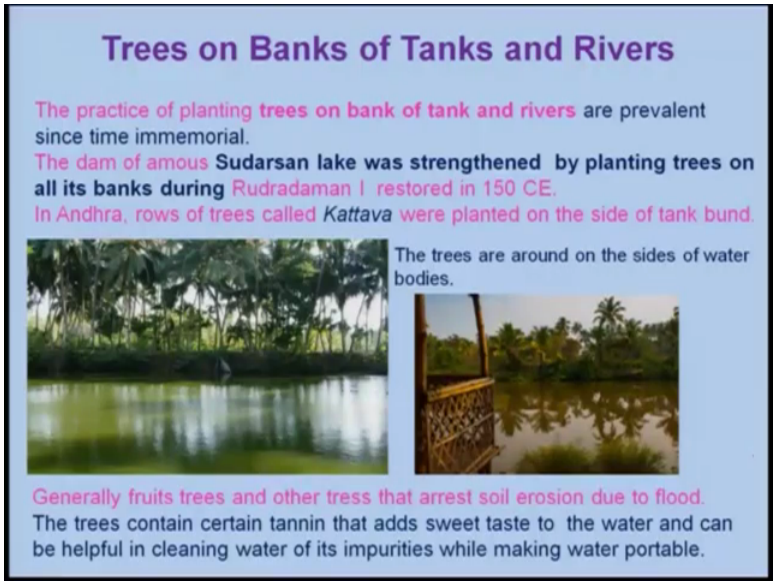

So, if you look at the design of the fort and other things where considering the water need of the people and also future anticipation, that was a good thing we can learn from this kind of

you know studies. And it is whenever there is a tank or the water reservoirs, even the embankment in the rivers there were people were planting the trees. And this practice of planting trees on the bank of tank and rivers were there since time immemorial, because trees and other things are part of our lives. And if you recall the famous dam of Sudarshan Lake was strengthened by planting trees on all its banks during the Rudradaman 1 which was restored in 150 CE.

In Andhra, the rows of trees called Kattava were planted on the side of tank bund, bund means embankment. And not only in Andhra other places people do I could recall there is a one book written by `Aaj bhi khari hai talab' by Mr. Anupam Mishra who just passed away, who was one of the pioneers in what you call in revoking the traditional knowledge for water conservations and he has done wonderful work and we should go through that and learn and then apply those things in our day to day life also.

So, if you look at these are the pictures which I have shown the lot of trees around that. This is the pond and similarly of course these are from I have taken from South. This culture is still remaining in the south but unfortunately it is receding at an alarming rate. Generally fruit trees and other trees which are you know needed and also that arrest the soil erosion due to the flood or the you know being planted. Certain trees contain certain amount of tannin that adds sweet taste to the water and can be helpful in cleaning of water of its impurities while making water potable.

So, those knowledges you know which a part of our Ayurveda and other things can be utilized for water purification and also adding the sweet taste to the water. So, it is a win-win situation kind of having which will make strengthen the earthen embankment and also it will add the you know some kind of a chemicals which will be helpful for the, natural chemicals which will be helpful for what you call put make the water potable.

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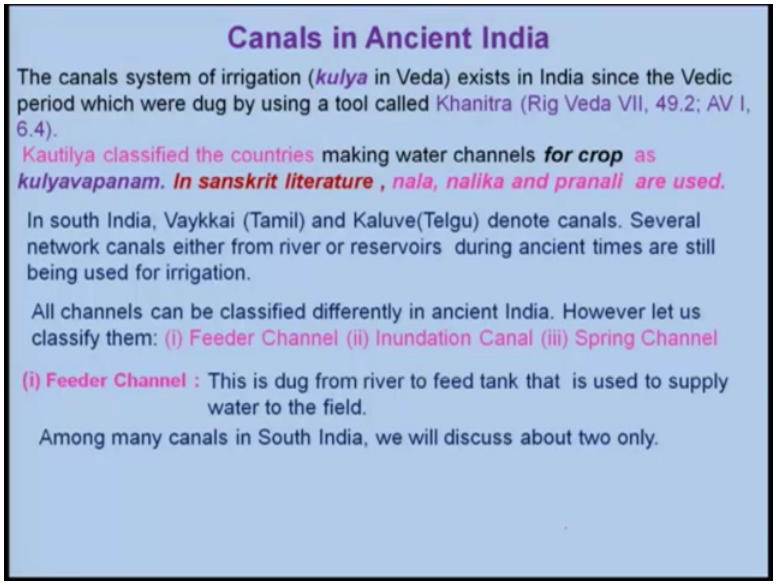

So, we had a very brief discussion about canal just to prove that how the various different kinds of irrigation system were used in ancient India, different parts of the country, it's not the same system. But now we will discuss a little about canal systems in ancient India. Canal system of irrigation which is basically known as `Kulya' in Veda exists in India since Vedic period and which were dug using a tool Khantira is basically a tool which is used to do it artificially. It is not only in the Vedic period, even like Indus Valley Civilization we are having canal systems and which I had shown you earlier a diagram for that.

Kautilya who is the basically author of Arthashastra classified the countries making water channels for crop as a kulyavapanam. In Sanskrit literature, nala, nalika, pranali are used for the words for canals. In South India, the Vaykkai in Tamil and Kaluve in Telugu denote canals. Of course the pronunciation might be distracted by me, pardon for that. And several networks of canals either from the river or reservoirs during ancient times are still being used for irrigation even in recent time.

And all channels broadly can be classified into 3 categories which were One is Feeder channel; other is Inundation channel and Spring channel. So, Feeder channel is basically, this is being used to feed water from the river to the tank and so that also it can to the field, right and this is done artificially. And among many canals in South India, we will discuss about two only because you know that due to the paucity of time.

And during Pallava period Parameshwaravarman dug canal from river Palar to feed the Parameshwara tataka basically, it is a reservoir near the Kanchipuram. Rajaraja Chola around

985-1013 AD dug canal from river Kaveri to feed the tank near village around 10 miles away from Tiruchirapalli which is being used even today. So, these are the 2 examples I have taken just to elastrate that the feedal canals were there in ancient time.

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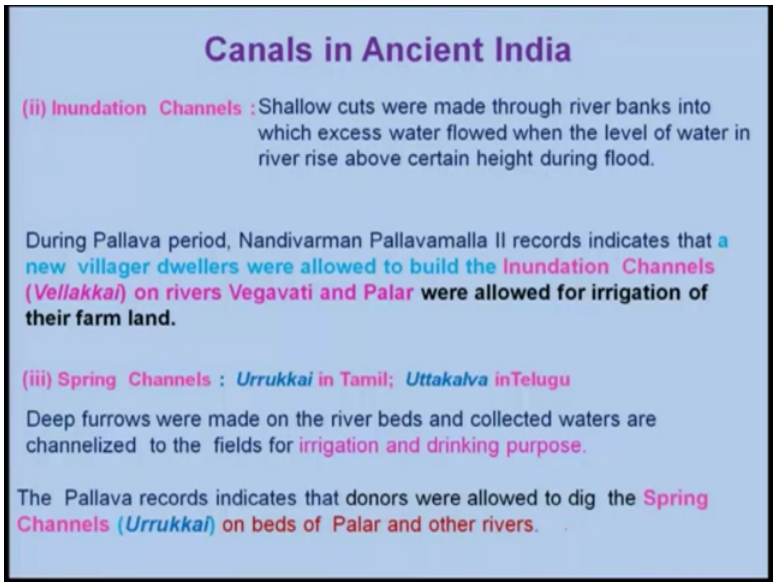

And Inundation channels we have seen in the last lecture that about how it was being used in Bengal and it was studied by British engineer during what you call British era. And generally the shallow cuts were made through the river banks into which excess water flowed when the level of water in river rise above certain height during flood, that we have seen earlier.

And during Pallava period Nandivarman Pallavamalla II records indicates that a new villager dwellers were allowed to build Inundation channels what they call it as a Vellakkai in Tamil on rivers Vegavati and Palar were allowed for irrigation of their farm land. They were allowed to do that and that means there will be some provision for them to do not all people will go and have a Inundation channel, so, otherwise it will create anarchy in that.

And the Spring channel which is in Tamil known as Urrukkai and Uttakalva in Telugu. So, deep furrows were made on the river beds and collected waters are channelized to the fields for irrigation and drinking purposes also. These are a smaller one but the Inundation channel will be spreading across the whole field so that is silt will be taken from the rivers to the field which will be acting like fertilizers during the Inundation. They will be allow flood to go; basically that is idea in Inundation channels.

And Pallava records indicate that donors were allowed to dig the Spring channels - Urukkai on the beds of Palar and other rivers. That means you know like a people were donating the

money for that and for the general purposes. And that kind of attitude is very important that means they are taking care of their group of people.

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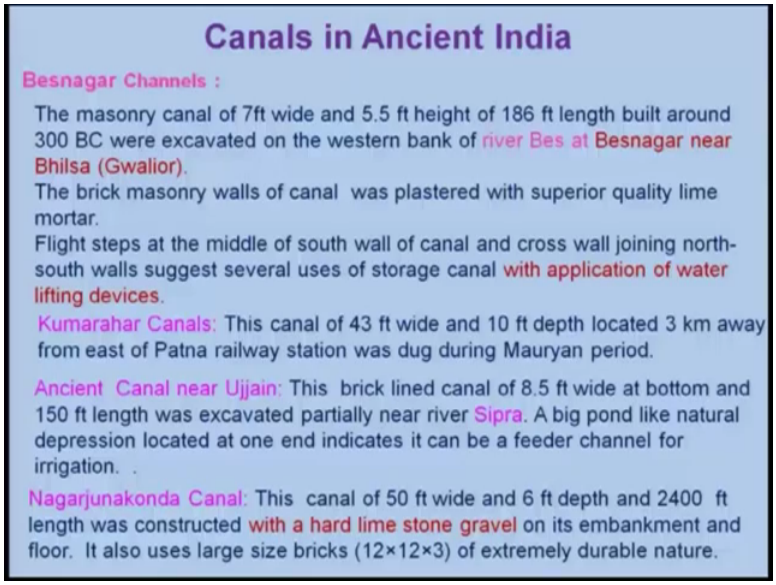

The Canals in Ancient India: If you look at like will be looking at another kind of Besnagar channels which is a in the river what you call masonry canal of 7 ft wide and 5.5 feet height of length of 186 feet built around 300 BC which was excavated on the western bank of river Bes at Besnagar near Bhilsa in Gwalior. These are of course a you know historical data which is there.

And brick masonry walls of canals was plastered with superior quality of lime mortar. If you look at the water is passing through that, that means it should not you know dissolve with the water which one the lime, lime should not be dissolved in the water therefore it should be very hard enough like your cement and other things modern days that it should be remain intact with the flow of water on its surface.

The flight steps at the middle of south wall of canal and cross wall joining the north-south wall suggest several uses of storage of water with the application of lifting devices. Water lifting devices I won't be discussing. But there are lot of evidence water lifting devices were being used in our country and using various lever system and even water wheel was being you know used in ancient time.

So, Kumarahar canals: And this canal of 43 feet wide and 10 feet depth located 3 kilometres away from the east of Patna railway station was basically dug during the Mauryan period. It is a very old kind of canals. And the Ancient canal near Ujjain: This brick line canal of 8.5

feet wide at the bottom and 150 feet length was excavated partially near the river Sipra. People also found out a big pond like a natural depression located at one end which indicates that it can be a feeder channel of irrigation. I mean which goes back to something you know very ancient time.

And Nagarjunakonda Canal: which was of 50 feet wide and 6 feet depth and its length is around 2400 feet was constructed with hard lime stone gravel on its embankment and the floor. But today we do not know how to make this hard lime stones in local manners. Of course you may get something from the company but this knowledge is not with the people they are rather with the company. It also uses large size bricks of extremely durable natures. And that shows that you know they were having lot of technologies which were available at that time.

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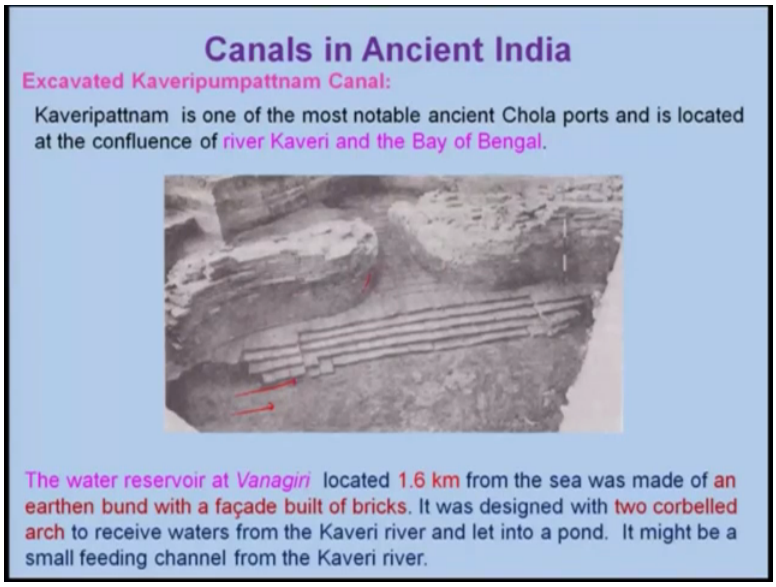

So , let us look at Kaveripumpattanam canal which was excavated in recently and this is one of the most notable ancient Chola ports and which is located at the confluence of river Kaveri and the Bay of Bengal. This is nearby the sea which is still being used. this is the canal systems and this is the water which is passing through from the Kaveri. And this is the very good corbelled people have made this cladded with the the bricks right.

The water reservoir at Vanagiri located around 1.6 kilometres from the sea was made of earthen bund; these are basically earthen bund and with a façade built of bricks. These are the bricks which are being you know joined together. And it was designed with the two corbelled as I was telling these are the corbelles, right, corbelled surface arch to receive water from the

Kaveri river to inlet pond. So, this kind may be is a pond kind of things right. And small feeding channel from the Kaveri River for the irrigation purpose may be for drinking purposes they might be using. So, these are well what you call design whose remnants are still there after so many years of neglect and other things.

So, with this we will stop over, we have seen that there was a very great tradition of making canals and water reservoirs for using for the irrigation purposes and also for drinking and other water other purposes and we in the next lecture will be also looking at how to control this flow of water in the canals and how they are doing that things and thank you very much.