AQUEDUCTS IN HISTORICAL CITY OF AURANGABAD: - A STUDY

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Abstract

In Aurangabad city the historical water supply system is neglected due to the increase industrial growth and population of Aurangabad City. This water supply system collects underground water from nearby catchments of the city carries water through underground aqueduct called "Naher". The Nahers are live today at present stage. The historical place like "Panchakki" where water is supplied through Naher.

Keywords: Aqueducts, Naher, Pipeline.

Introduction

History of Aurangabad City

Aurangabad is a big historical city. It is famous throughout the world because of Ajanta, Ellora caves and historical monuments like Bibi-ka-Mkhbra (replica of Taj Mahal), Panchakki-Naher (ancient water carriage system). Aurangabad city was developed by Malik Amber. It was designed nicely by considering the safety and beauty. From safety point of

view. A city wall and 52 gates were constructed in the city. For increasing the beauty of city and fulfilling the water requirement Naher-e- Amberi System (hydraulic water carriage system) was developed. There are 12 Nahers in Aurangabad and they supply drinkable water to different parts of city. A few Naher supply water to the lakes of city like Salim Ali Lake, Amkhas or town hall lake, Nehru Lake, Himayat Bag lake, Harsool lake. Imagine the beauty of the city due to the lakes. Hence due to these reasons, tourists are attracted towards Aurangabad. But due to the careless development of city, all the historical Nahers (hydraulic ancient water carriage system) are in danger and some of them have now broken. Also various Lakes & Kham river are in the same critical condition. They are highly polluted. Lake like town hall is totally demolished, In Salim Ali Lake, biodiversity is in danger due to discharge of sewerage water in to it. There is a huge deposition of silt in Himayat Bag Lake. All these Nahers, lakes and the river needs help, so that they can exist for long time to maintain the Ecology.

Physical Feature of Aurangabad Town

The entire area is covered by the Deccan Traps lava flows of Upper Cretaceous to Lower Eocene age. The lava flows are overlain by thin alluvial deposits along the Kham and Sukhana River. The basaltic lava flows belonging to the Deccan Trap is the only major geological formation occurring in Aurangabad. The lava flows are horizontal and each flow has two distinct units. The upper layers consist of vesicular and amygdaloidal zeolitic basalt while the bottom layer consists of massive basalt. The lava flows are individually different in

their ability to receive as well as hold water in storage and to transmit it. The difference in the productivity of groundwater in various flows arises as a result of their inherent physical properties such as porosity and permeability. The groundwater occurs under water table conditions and is mainly controlled by the extent of its secondary porosity i.e. thickness of weathered rocks and spacing of joints and fractures. The highly weathered vesicular trap and underlying weathered jointed and fractured massive trap constitutes the main water yielding zones. The soil is mostly formed from igneous rocks and are black, medium black, shallow and calcareous types having different depths and profiles.

Geography

Aurangabad District is located mainly in the Godavari River Basin and partly in the Tapi River Basin. The district is located between19 and 20 degrees north longitude, and 74 and 76 degrees east latitude.

Geology

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Mountains

There are three mountains:
•Antur – 826 m
•Satonda – 552 m
•Abbasgad – 671 m and Ajintha 578 m; average height of southern portion is 600 -670 Rivers

The major rivers in Aurangabad district are the Godavari and the Tapi, and also the Purna, Shivna,Maniyad, Sukhana and Kham. The famous Shahbaz river is also there in Aurangabad.

The Narangi rises on the southern slopes of the water divide to the south of the Maniyad river a little above Naral village and flows past Vaijapur. A little below the latter, it is joined by the Deo nala, flowing from Nasik district. It has a fairly long south southwesterly course before its point of entry into the Godavari is carried a little down the latter. It is joined by the Chor nala from the west and Kurla nala from the east. Actually the Narangi continues the trend of the Kurla River after the latter's confluence.

Climate

In Aurangabad District the rainy season runs from June to September. Winter is from approximately October to February and summer from March to May. The average rainfall of Aurangabad district is 734 mm, and the temperature range is about 5–46 degrees Celsius.

Malik Amber

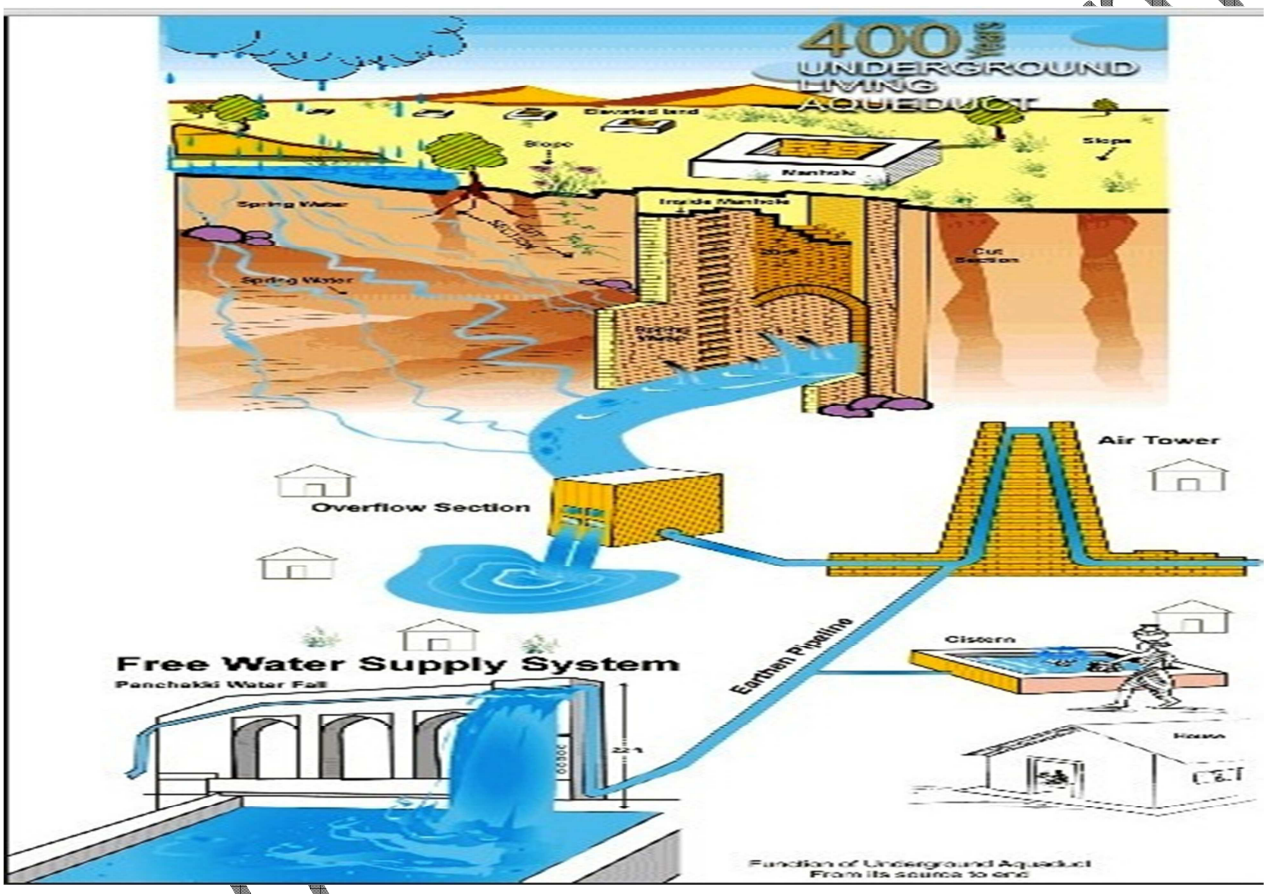
Malik Amber (1549–13 May 1626) was an Ethiopian born in Harar, sold as a child by his parents due to poverty. He was eventually brought to India and remained enslaved by the people that bought him. Nevertheless in time he created an independent army that had up to 1500 men. This army resided in the Deccan region and was hired by many local kings. He also founded the city of Aurangabad, Maharashtra on the site of a previous village. He eventually rose to become a very popular Prime Minister of the Ahmadnagar Sultanate, showing his administrative acumen in various fields. Malik is also regarded as a pioneer in Guerilla warfare in the Deccan region. He is credited with having carried out a systematic revenue settlement of major portions of the Deccan, which formed the basis for many subsequent settlements. He died in 1626. He is a figure of veneration to the Siddis of Gujarat. He humbled the might of the Mughals and Adil Shah of Bijapur and raised the falling status of the Nizam Shah.

Foundation of Aurangabad

He founded/inhabited the city of Khadki in 1610. After his death in 1626, the name was changed to Fatehpur by his son and heir Fateh Khan. When Aurangzeb, the Mughal Emperor invaded Deccan in the year 1653, he made Fatehpur his capital and renamed it as Aurangabad. Since then it is known as Aurangabad. Two capital cities Viz. 'Pratisthan' (Paithan) i.e. the capital of Satavahanas (2nd B. C. to 3rd A. D.) and

Devagiri - Daulatabad the capital of Yadavas and Muhammad bin Tughluq are located within the limits of Aurangabad.

Naher water system



Naher water system provided clean water for the people of Aurangabad and its suburbs. It was created by Malik Amber who founded the town under the name Khadki and was later expanded by Aurangzeb in order to facilitate the military activity that became prevalent under Mughal rule during the 17th century.

The first aqueduct in Aurangabad was designed in 1612 by Malik Amber in order to address the shortage of water caused by the lack of reservoirs and natural water

reserves in the area. Despite the surrounding landscape, which made it difficult to construct the aqueducts supporting pillars, the construction went ahead.

The reason for the construction of the aqueduct was the discovery of a subterranean water supply in the mountainous valleys north of Aurangabad. The consequent construction of the waterway provided a stable water supply for a population of around seven lakhs (around seven hundred thousand people), with the city of Aurangabad receiving enough fresh water to prevent the shortages that had previously occurred. The aqueduct was named Khair-E-Jari. The construction of such aqueducts continued from 1612 until 1803 with two more aqueducts constructed by engineers such as Malik Amber, Shah Mehmood of Panchakki and Shah Ali Nahri.

Malik Amber's design was not well received and it was described by Vazir Mullah Mohammad as imaginary and preposterous. However, Malik Amber managed to construct it within fifteen months, at half the estimated cost.

Aqueduct

Aqueduct, man-made conduit for carrying water (Latin aqua, "water," and ducere, "to lead"). In a restricted sense, aqueducts are structures used to conduct a water stream across a hollow or valley. In modern engineering, however, aqueduct refers to a system of pipes, ditches, canals, tunnels, and supporting structures used to convey water from its source to its main distribution point.

Aqueducts Types

Open channels

The simplest aqueducts are small ditches cut into the earth. Much larger channels may be used in modern aqueducts, for instance the Central Arizona Project uses 7.3 m (24 ft.) wide channels. A major factor in the design of all open channels is its gradient. A higher gradient allows a smaller channel to carry the same amount of water as a larger channel with a lower gradient, but increases the potential of the water to damage the aqueduct's structure. A typical Roman aqueduct had a gradient of about 1:4800.

Underground tunnels

Aqueducts sometimes run for some or their entire path through tunnels constructed underground. A version of this common in North Africa and Central Asia that has vertical wells at regular intervals is called a qanat. One historic example found in Syria, the Qanat Firaun, extends over 100 kilometers.

Pipes

Modern aqueduct may also make extensive use of pipelines. Pipelines are useful for transporting water over long distances when it needs to move over hills, or where open channels are poor choices due to considerations of evaporation, pollution, or environmental impact. They can also be used to carry treated water.

Details of Adequets in Aurangabad

In the hydraulic history of Aurangabad, the system of canals was introduced by Malik Amber in 1617 A.D. Aurangabad township had to face the problem of scarcity of water and there were no big dams or water reservoirs in the vicinity. Personalities like Malik Amber, Shah Mehmood of Panchakki and Shah Ali Nehri were founders, designers and planners of those three famous, novel and useful aqueduct systems for the supply of water to the city. Irrespective of the prolonged span of 350 years the systems were stil1 functioning. The inhabitants of Aurangabad were being benefited by this water supply system for 350 years regularly without any tax. The construction

of these canals started from the oldest era of Malik Amber and after the age of Aurangzeb also. The old water supply system is the reminiscent of medieval period. The city of Aurangabad was having a number of Nahers of pure mineral subterranean drinking water. This practice of construction of such aqueducts continued from the period of Malik Amber (1617) up to the time of Aurangzeb and Asif Jah (1803) for a period of about two centuries. The canals were also constructed one after another by the local kingdoms or by the richest people. The names of these canals are all related to the names of their builders.

Malik Amber was the commander of the Nizam Shahi Kings and Subedar of Daultabad. He was a dynamic commander and a great engineer. His system of water supply is first of its kind and also the last. In the year 1604, he made "Khadki" (present Aurangabad) as his head-quarter and named it as Fateh Nagar. He introduced the system of water supply for the public utility, and this well organized system is known as Naher-¬e-Amberi. Malik Amber in 1617 A.D., discovered subterranean water table of mountainous elevated valleys in north of Aurangabad. He practically manipulated and procured a stable perennial water supply for a population of 2 lakhs of people by constructing unique wonderful aqueduct by name KHAIR – E- JARI. On the high lands around the city from North, East and South wherever the circumstances allowed the engineers of the period brought down Naher in Aurangabad city. During the military activities Malik Amber discovered the Kham river valley and its large natural basin of about 150 sq. miles over head of a well-planned and layout city. Malik

Amber has designed the construction of the aqueduct like that of Nahere Zubeda in a very simple appearance and natural way underneath the river bed of Sawangi and Kham river which has got number of man holes overhead called Abgir Nali up to Gaimukh. An earthen dam was constructed on the river Kham on the north of Aurangabad city.

In 1636, when Aurangzeb was appointed as the subhedar of Deccan, he made Fateh Nagar as his capital and named it as Aurangabad. When he became the emperor of the Mughal Empire, he declared Aurangabad as the capital of the Mughal Empire. Owing to this reason the population grew faster and acute scarcity of water was felt. In order to supply water to the growing population he extended the system of water supply of Amberi and new canals were also dug. It is described that at the peak of Aurangazeb's reign the population of Aurangabad was about two lakhs.

Besides Naher-e-Amberi there were 12 (twelve) canals which were sufficient to supply ample water to the town, some of them are still functioning properly and rest of then can become permanent source of supplying water after the minor repairs.

Live Aqueduct

1. Naher –e-Amberi
2. Naher-e- Panchakki
3. Naher-e- Begumpura
4. Shah Ali Naher

Dead Aqueduct

1. Naher-e- Palsi
2. Opeh-irrigation near Cantonment.
3. Sukar bavli Pipe Line
4. Lall Munkirar's Pipe Line
5. Latchman Pass Bairagi's Pipe Line
6. Dul Badul's Pipe Line near Garkheda
7. Causar Garden Pipeline
8. Deolali Pipeline
9. Satara Hills Pipeline
10. Shah Ali Naher

Bashiruddin Aehalvi gave the same list of aqueducts in his "Waqiyat-e-Mamelat Bijapur" as noted in the Aurangabad District Gazetter, Bashir Ahmed Dilkush find the existence of the following aqueducts in Aurangabad.

1. Naher-e-Nasrallah (Dead aqueduct)
2. Naher-e-Kiradpura (Live aqueduct)
3. Naher-e-Garkheda (Dead aqueduct)
4. Naher-e-Shanoor Hamvi (Live aqueduct)
5. Naher-e-Kotla (Dead aqueduct)

Naher-e-Kiradpura and Naher-e-Shanoor Hamvi are the living aqueducts. Syed Yousufuddin Magarati mentions of the still another aqueduct. Naher-e-Kokadpura,

important aqueduct of the aqueducts of the Aurangabad town have described in the following pages in detail.

Naher-e-Amberi

Malik Amber was a master minded aqua engineer decided to bring underground water to supply the people of Aurangabad by uplifting water on the surface of the earth for drinking purpose. At a distance of 2.5 miles away from the town a well was dugged at the bottom of elevated hills. The Sub-Terrain water current gushed into the well. Underground tunnel was dugged out with providing gradual slope towards town. On both the sides of tunnel walls were raised in brick and lime missionary leaving thousand small cavities for sub-terrain spring water to fall inside the tunnel. The walls were covered in archway and many man holes were left open for repairs cleaning purposes. Tunnel constructed in brick & lime measuring 3ft with 8 ft. height. The bottom of this tunnel has been provided gradual slope towards the city. Thousands of sub-terrain water currents gushed water into the tunnel and move fast towards the city. There was a difference of height of 70 feet between source points to the end point.

The technology of this tunnel was very perfect in its construction. There were various arrangements provided in the tunnel taking into consideration the problems arised in those days. At some places earthen pipelines were also built and siphon system was also used and overflow system was also built.

The output of the water for the use of people:

The huge water supply through this tunnel later on terminated to all corners of the city through earthen pipelines measuring 2 inches to 12 inches. At the end point of these earthen pipelines many small cisterns were constructed with fountains in the center to supply the water. The people were collecting water from these cisterns. Near about 600 cisterns were built in the city connected with these pipelines to supply drinking water.

The air towers were specially constructed at many places over the earthen pipelines to control the flow of water.

The supply section of Naher-e-Amberi the underground aqueduct tapped into hillsides measured 12,840 ft. length having average width of 3 ft. and height 7 ft. Brick walls raised at both sides of the aqueduct are completely covered in archways over sub-terrain water to protect from soil to come inside. Thousands of small cavities specially left in the brick walls to allow sub-terrain water. Solid rock bottom has been provided gradual slopes from its source situated at hillside at 2031 ft. height above the sea-level, to carry water to its destination i.e. Gaimukh (Stone Cow head) erected at the lower height at 1954 ft. S.L. Gravitation forces allows water to flow fast towards the town as there is level difference of 77 ft. in between source and end-points. There are one hundred vertical manholes constructed at every 200ft average length distance over this aqueduct, so as to reach into the bottom of the aqueduct from the surface of ground for cleaning and repairs purposes.

Overflow System:

Considering the aqua pressure developing inside aqueduct, particularly in rainy season, a highly skilled structure for "Overflow" of water is designed in the aqueduct to provide safety.

Gaimukh (Cow Mouth):

Amberi aqueduct was mostly passed by the side of a small stream known as Kham river by which a quantum of water input is raised. Basin shape catchment area at hillside at source point is enough to keep constant supply of water to the town.

Gaimukh is a terminal point of aqueduct, from onward an earthen pipelines of supply section measuring 12" diameter embodied in 1 ½' x 1 ½' in lime mortar nutshell. Network of earthen pipelines ranging from 2", 6", 8" diameters connected to more than seven hundred cistern spread all over the town. People used to take water from cisterns and take it to their houses for drinking and other purposes.

Salient Features of Underground Aqueduct

Useful only for 2 lacks of population:-

The Naher-e-Amberi aqueduct was designed only for 2 lacks of population living in Aurangabad. In modern period existing size of aqueduct is very much useful for the small towns and big villages. This can be useful also for a part of big cities.

Non Polluted Fresh Drinking Water:-

Naher-e-Amberi aqueduct is built under the ground to collect fresh water from perennial currents and it allows the water to flow through watertight tunnel of aqueduct. Hence, there is no chance left for pollution of water.

Built in Local Bricks and Lime/Cement:-

Locally available material i.e. bricks and lime or cement can be used in construction of aqueduct as it was used in Naher-e-Amberi and Naher-e-Panchakki to provide more and more employment to rural people. This indigenous technology is so perfect in itself that even after 400 years there is no maintenance cost moreover not a single person is appointed to look after it.

Water for Irrigation of Gardens:-

Naher-e-Amberi water was also supplied to various gardens. Reasonable taxes were collected. Even in modern times this can easily be made available to villagers for irrigation purposes too.

Useful for Sprinkling Method:-

Advance countries are found using method of sprinkling for irrigation. The network of Amberi pipelines spread over the town opens in all cisterns in the form of fountains due to gravitational force. If the scheme of Naher-e-Amberi is adopted then there will be no need of spending extra energy or expensive motor pumps for sprinkling of water for irrigation.

Useful for "Water Drip" Method:-

Technology to make economic use of water the system of water-drip method has been strongly advocated everywhere for irrigation. But this system also requires motor pumps and electricity. Naher-e-Amberi method could be the best system for water-drip for irrigation, at a very nominal cost. There is no need of motor pumps and use of electricity.

Useful for Minor Irrigation Projects:-

Taking water to each farmer's field is the primary objective. This scheme is known as minor irrigation project. The Naher-e-Amberi method can be most appropriate and also economical to fulfill these objectives on relatively permanent basis which shall bring about "Green Revolution" within shortest possible time.

No Need of Electricity, Motor Pump or Diesel or any energy:-

The system of Naher-e-Amberi is practically based on the simple principle of gravity and siphon. The subterranean water under elevated hills has been brought to the plains of town with the help of gravitational forces through underground conduits, which have the necessary and required slopes. Hence, without any external energy being used the water gets uplifted at desired level in the towns situated in lower heights. Hence, the question of using extra energy for upliftment of water does not arise. Consequently a large quantity of diesel of electricity is saved and expenses on costly motor pumps are avoided.

The New Opening for E.G.S. Schemes :- (40% and 60%) :-

Unfortunately the modern technology based on western science does not go back to the past glory of science to derive benefit from it. Indigenous Naher-e-Amberi looks crude but has proved its reliability and validity and its long service. Construction in bricks and lime of Amberi conduit is the best example to install less expensive

projects. It requires 40% local material and 60% labour and hence useful to undertake under E.G.S. (Rohiyo) scheme. Naher-e-Amberi project is enabled to employ more and more local people mostly of rural areas.

No Need of Filtration Plant:-

Expensive filtration plant is a must in every modern system of supplying drinking water. Indigenous Amberi aqueduct scheme does not require any such plant because it is totally covered with brickwork from all slides. Amberi aqueduct allows only filtered subterranean perennial water currents which come from long distance through underground soil. Amberi aqueduct technique does not require any reservoir and hence question of pollution of water does not arise. Since last 400 years there was never a case of water pollution in Naher-e-Amberi, on the contrary, it is always providing fresh mineral water.

No Maintenance or Repairs Cost:-

Every modern scheme of water supply needs electricity, motor pumps, cost-iron pipes, filtration plant and these require regularly maintenance and repairs. Naher-e-Amberi aqueduct system does not require any amount to be spent on its maintenance for hundreds of years or so. It's like a free gift.

Few Person Required:-

Amberi technology is so perfect and over lasting that it had never require regular staff for maintenance. In the last 100 years there was not a single person appointed to look after it. As this scheme is very simple it requires very few persons for the distribution of water.

No Loss of Water:-

It has been an accepted fact that 70% of water of open canal gets evaporated or drained in to the earth while supplying water from one place to destination. Amberi aqueduct technology is fully closed and hence 100% water reaches the consumer.

Useful at "Rain-Shadow" Areas:-

People living in rain shadow areas of the hills always face problem of scarcity of water. On the other hand people living in rain-fall areas on the other side of the hills get ample water. The technology of Amberi sub terrain aqueduct can bring water to the rain-shadow areas from the rainfall areas.

No Problem of "Dam Affected":-

The problems of Dam-affected people always arise whenever a large dam or reservoir is constructed. Since the Amberi aqueduct is built below the surface of the earth the problem of "Dam-affected" does not arise.

Waste Land Problem:-

It is a waste of fertile land if it is brought under the reservoir area. It is a national waste too. The Amberi aqueduct passes beneath the earth and farmers do not have any problem in making use of the land over the aqueduct. In this way fertile land can be saved by Amberi method of water supply.

Possible to Construct in Modern Days:-

Indigenous system of Naher-e-Amberi was followed in 18th century at Aurangabad supplying water to the people even today. There is no difficulty is adopting Amberi technology even in modern days. 30% of the geographical area of India is feasible for such projects. Local people "particularly of rural areas can be employed under" **Guarantee of Daily wages scheme.**

It is high time that the Government should seriously consider & adopt Amberi aqueduct technology. This will help it to save money, time and energy on one side and on the other it can solve the acute problem of shortage of drinking water in many parts of the country up to some extent. Aqua scientists and aqua engineers must ponder over the possibility and feasibility of making use of this technology and persuade the government to go for it.

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