Urban Utilities Planning: Water Supply, Sanitation and Drainage
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Module - 08
Water carriage system
Lecture - 38
Storm Water Drainage Planning Part I

Welcome back. In lecture 38, we will talk about Storm Water Drainage Planning which is divided into a three parts. The first part will be covered in this lecture.

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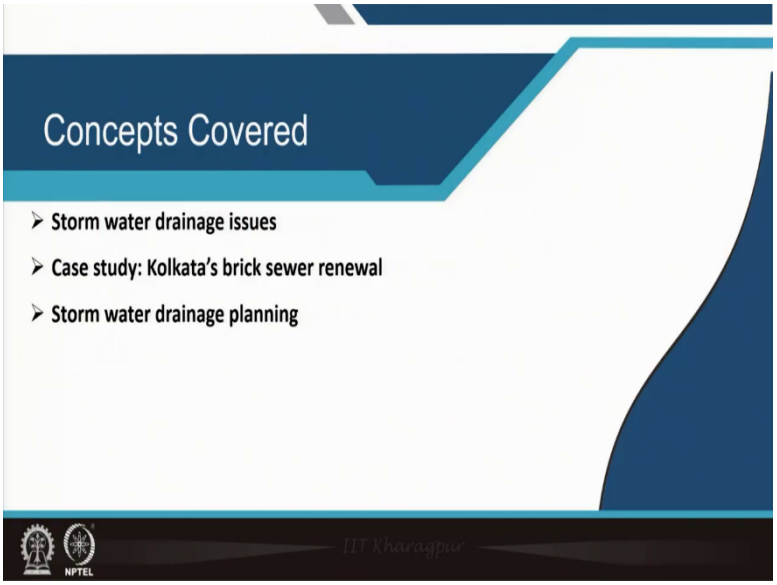

So, the different concepts that we will cover will be on storm water drainage issues, a case study which is Kolkata's brick sewer renewal and general overview of storm water drainage planning.

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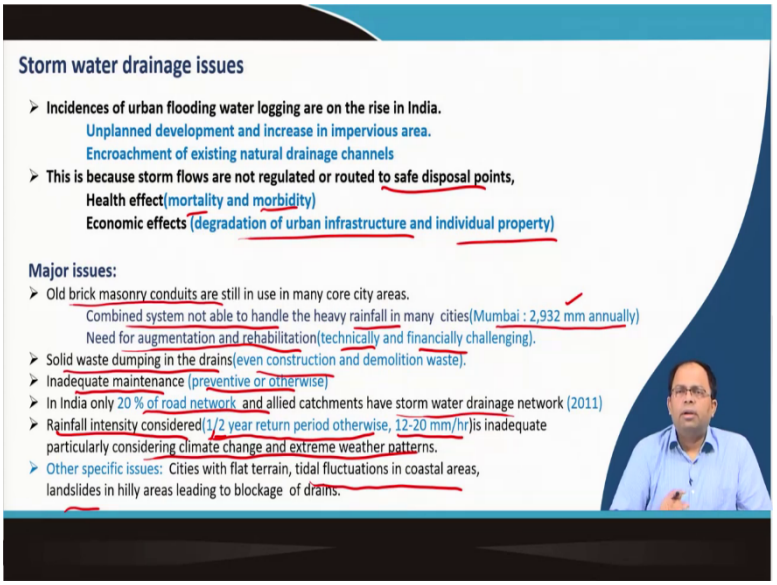

Previously covered concepts

So, in the last lecture, we concluded by saying that when we estimate the total amount of sewage that is generated in an urban area, it is based on the land use, population density, and the building uses. But if storm water is also considered, then we have to do many more detailed estimates and calculations.

If we go for combined sewerage planning, then storm water is a part of the sewer network. So, along with determination of sewage flow, storm water is also determined. So, we have to do both calculations separately and then, add up together to determine the combined sewage flow.

Storm water drainage issues

Even though both storm water and sewage could be in the form of a combined system, in most cases these two are kept separate. We separate that to reduce cost and also to reduce the size of the pipelines. But in the old systems, in most cases, we see these examples of combined systems.

Storm water drainage is related with the incidence of urban flooding and water logging. For the last 5 to 10 years, we have been seeing increased cases of floods in many cities; primarily

in Chennai, Mumbai. This is because of unplanned development and increase in the impervious area that we have discussed earlier. Additionally, the existing natural drainage channels are gradually being encroached upon. All the natural streams that were there earlier are now covered by hard landscapes and buildings. So, water is actually flowing at the surface that is available. And in most cases, it will flow along the direction of the roads or along the roads and we see our roads being flooded most of the time. Other areas have building and plots which are a little bit raised compared to the roads and thus the roads become streams in most cases. Sometimes roads are planned to carry water, but in our case because the entire water goes into the roads, it actually creates floods. In addition, the water also flows along the surface.

We see rising incidence of floods and the main reason is because storm flows are not regulated or routed to safe disposal points. The effects of flood are manifold affecting infrastructure, civil structures and health (mortality or death and morbidity from diseases spreading because of floods). Drinking water becomes unavailable or gets contaminated that leads to diarrhoea and other water borne diseases. Economic effects are degradation of urban infrastructure, individual property, access denial. So, these are the negative effects of flood.

So, for any project towards reducing flood, we have to provide justification in the form of health benefits and economic benefits which have to be estimated.

In many of the older core city areas, we find old brick masonry conduits which are in use. These are combined systems and they are not able to handle the heavy rainfall that is we are now experiencing in many cities. In Mumbai, we are experiencing around 3000 mm of rain annually and these combined old systems are unable to cater to the stormwater load generated because of heavy rainfall and addition of impervious surfaces.

Hence, there is need for augmentation and rehabilitation of these existing sewer systems. However, we cannot start fresh and start laying new sewer networks because it will be too costly as it involves land acquirement and other infrastructure provision.

It is both a technical as well as financial challenge to rehabilitate existing sewer networks. The other major issue is solid waste dumping in drains because of the absence of proper solid waste collection system in the form of garbage bins. People dump their garbage and even

construction and demolition waste in drains. While normal waste can still be cleaned or carried away whereas construction and demolition waste cannot be cleaned by mechanical or pneumatic means that we use for cleaning sewer.

In India, only 20 percent of road network and allied catchments have storm water drainage network. Because the amount of road network is also less, storm water drainage is also not that strong. The storm water drainage network is laid along the roads in most cases.

Suppose, a rainfall event happened for 10 minutes or 20 minutes or 30 minutes. Intensity of rainfall is however measured in millimetre per hour. The standards for estimating storm water currently are 12 to 20 milli meter per hour or we take 1-to-2-year return period. Return periods refer to the frequency at which a particular storm event is repeated; that means, what is the maximum rainfall that happened during that 2-year period? So, instead of 2 years, if I consider 100 years; that means, within the last 100 years whatever was the maximum rainfall for that time period that one is chosen. So, for critical infrastructure like airports we go for 100 years of return period.

These values which are considered in India are inadequate particularly considering climate change and extreme weather patterns. Others specific issues for cities in India is that, most cities have got flat terrain. Then, there are cities in coastal areas, where tidal fluctuations are seen. Then, in hilly areas, we see landslides which blocks the drains. So, these are other issues that also we have to deal with in storm water drainage planning.

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Case Study: Kolkata's brick sewer renewal

Kolkata had a combined sewerage system called Clark's scheme or town scheme. We can see this in an old map of Kolkata. This is a British design from 1886. 5 major brick sewers are shown; Nimtola ghat sewer, Kolutola ghat street sewer, Canning street sewer, Lenin Sarani sewer. This is the central core area of Kolkata during the British period. The APC Roy road sewer is sort of an intercepting sewer and the outfall area is known as Town outfall.

The strange thing is that, the slope of the land is from the river Hooghly towards the east Kolkata wet lands i.e., towards Salt lake. The intercepting sewer drains into the outfall point. The main outfall or the town outfall conveyed the sewage to the Palmer's bridge pumping station where the sewage is lifted to flow towards disposal at Tangra Creek 3.2 kilometre away.

The self-cleansing velocity for this particular sewer was possible by allowing tidal waters into the sewer.

The total catchment area was around 19.1 square kilometres and the total sewage flow is around 1.27-meter cube per second serving a population of around 5,00,000.

This case study is significant because we will find similar cases in many of the Indian cities. This is a brick sewer and in many places, people have broken the sewer and existing utility lines have cut through resulting in structural collapse in some parts of the sewer. People were either not aware or they did not care. Similarly, the silt which has kept on accumulating over time, has solidified. The quantity of silt that was collected in this particular project(26 kilometres of brick sewers) was around 50,000-meter cube. So, that is a very difficult task.

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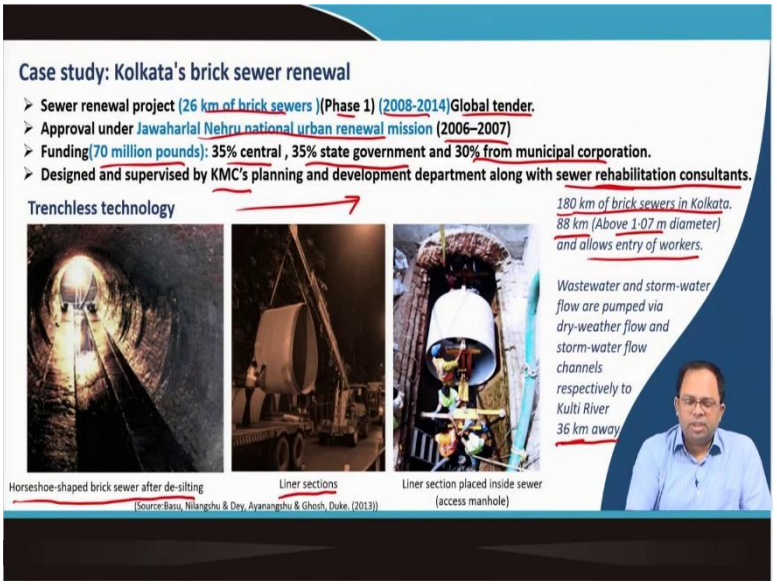

This particular renewal project of 26 kilometres of brick sewers is phase 1. The time period of the project was 2008 to 2014. A global tender was called and this was funded under the JNNURM (Jawaharlal Nehru National Urban Renewal Mission) during 2006 to 2007.

35 percent of the funding was taken care of by the central government, 35 percent by state government and 30 percent by municipal cooperation as per the funding structure of JNNURM. This was designed and supervised by Kolkata Municipal Corporation's planning and development department along with the sewer rehabilitation consultants which was a foreign company.

Out of the total 180 kilometre of brick sewers in Kolkata, 88 kilometres were of size above 1.7-meter diameter which allowed entry of workers inside. Wastewater and storm water flow

are pumped via dry weather flow and storm weather flow channels respectively to Kulti River, 36 kilometres away.

The consultants adopted a trenchless technology; that means they did not dig new trenches to lay sewers. Instead, they rehabilitated the existing horseshoe shaped brick sewers after de-silting. For this purpose, liners were placed inside the sewer. So, rehabilitating was done by placing another set of pipelines inside the sewer, instead of using the existing brick sewer.

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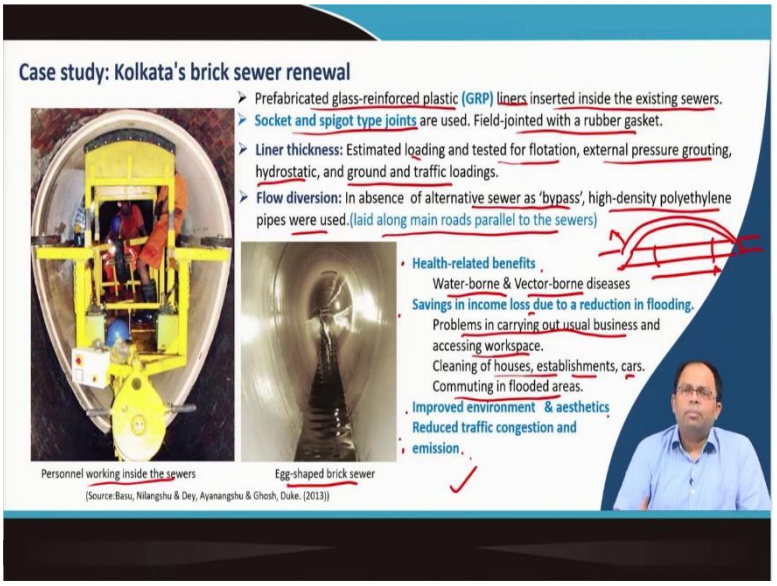

Pre-fabricated glass reinforced plastic liners were inserted inside the existing sewer. Socket and spigot type joints were used and liner thickness was estimated based on which it was tested for different kind of loads, external pressure grouting, hydrostatic tests and water leakage tests, the ground and traffic loadings tests.

Flow was also not stopped since it is a working sewer. In absence of an alternative sewer as bypass, high density polyethylene pipes were used which were laid along the main roads parallel to the sewers. They were used as diversion.

So, this is how the entire rehabilitation was done. These kinds of projects can be justified by their health-related benefits. The benefit estimates are based on water borne and vector borne diseases that were prevented and from savings in income loss due to reduction in flooding.

Floods result in problems; in carrying out usual business and accessing workplace; cleaning of houses, establishments, cars; commuting in flooded areas also involves extra charges. These are all estimated in monetary terms. Then, improved environment and aesthetics can be given monetary value as well. Reduced traffic congestion and emission in water logged section can also be estimated. So, this is how we can justify the cost of these kind of projects.

Thus, it is a costly and a difficult project to implement with a lot of technical challenges. At the same time, it is required because it has got lot of benefits that needs to be estimated to justify these kinds of projects. So, as planners we need to justify these kinds of projects.

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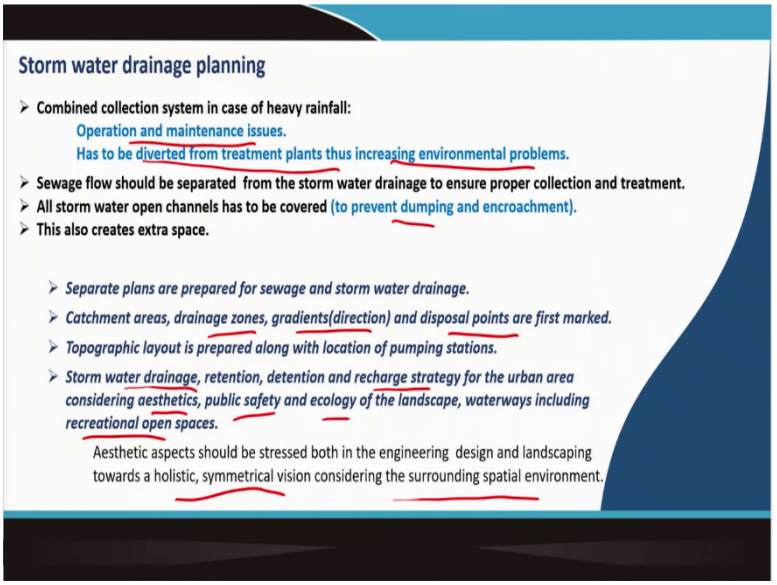

Storm water drainage planning

In case of storm water drainage planning, we can go for a combined collection system. But, in case of heavy rainfall operation maintenance issues arise. Then, lot of this water has to be diverted from treatment plants, increasing environmental problems.

Thus, in most cases, sewage flow should be separated from storm water drainage to ensure proper collection and treatment. All storm water open channels need to be covered which helps in prevention of dumping and encroachment of those particular channels. This also creates extra space for parking, and other recreational activities in urban areas.

Separate plans are created for sewage and storm water drainage. Catchment areas, drainage zones, gradients, direction of flow and disposal points are first marked for a particular area when we are creating a plan. Topographic layer is prepared along with location of pumping station, storm water drainage, retention, detention and recharge strategy for the urban area while also considering aesthetics, public safety and ecology of landscape, waterways and recreational open spaces. Detention and retention basins, helps in recharge of course.

Use of storm water in the urban landscape increases aesthetics and ecology of the landscape and increase public safety. Thus, along with technical aspects, aesthetic aspects are also stressed upon, both in engineering design and landscaping. This will actually lead to a holistic symmetrical vision for the surrounding spatial environment.

Thus, storm water drainage planning can be done in a very innovative way, where we can combine different sorts of strategies. Green infrastructure and recreational parks can be integrated together into an overall vision for a particular urban area.

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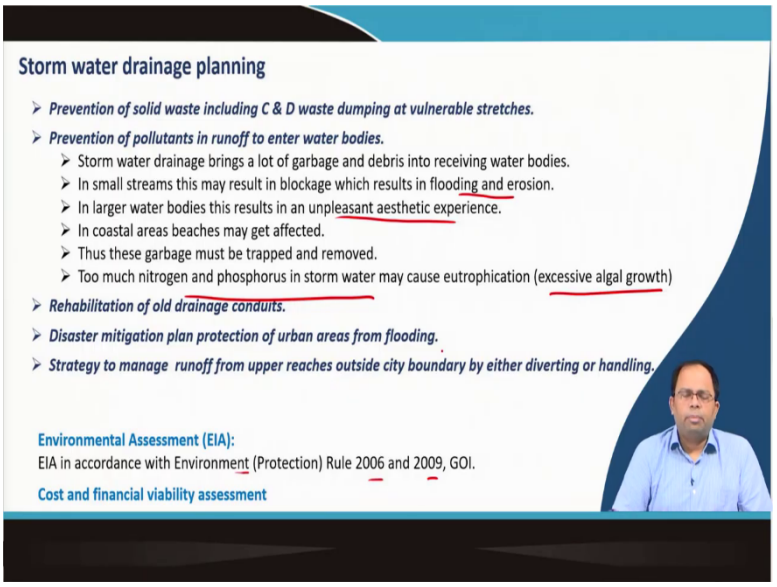

Another related issue of storm water drainage planning is prevention of entry of solid waste like construction and demolition waste in particular stretches of the sewer network. There are certain vulnerable stretches in an urban area, where these kinds of problems are prevalent.

Prevention of runoff to enter water bodies is another important requirement. Runoff carries all the pollutants that is actually being generated into those particular water bodies. So, storm water drainage brings a lot of garbage and debris into the receiving water bodies. So, in small stream, this may result in blockage which results in flooding and erosion of course.

In larger water bodies, this result in an unpleasant aesthetic experience. Whenever a flood happens, we see lot of floating plastic and other garbage which is environmentally and aesthetically detrimental. Coastal areas and beaches also get affected in a similar manner. The garbage needs to be trapped and removed from storm water.

High content of nitrogen and phosphorus in storm water may cause eutrophication. This will result in tremendous growth of algae and the drainage channels will get filled. This also needs to be kept in check.

Storm water drainage planning also involves rehabilitation of old drainage conduits, not only laying new lines.

Disaster mitigation plan involves protecting urban areas from flooding. For this purpose, we need to understand how much flooding is allowed and we can design systems for mitigating these kinds of disasters. We need to formulate strategies to manage runoff from the upper reaches outside the city boundary by either diverting or handling them.

We also need to carry out environmental impact assessment in accordance with the Environmental Protection Rules 2006 and 2009. In addition to this, cost and financial viability assessment also needs to be done in any kind of storm water planning.

Storm water planning is an extension of the sewer network planning or the sewage network planning. In some cases, it is a combined sewer, then both has to be done together; but in most cases, it is done separately.

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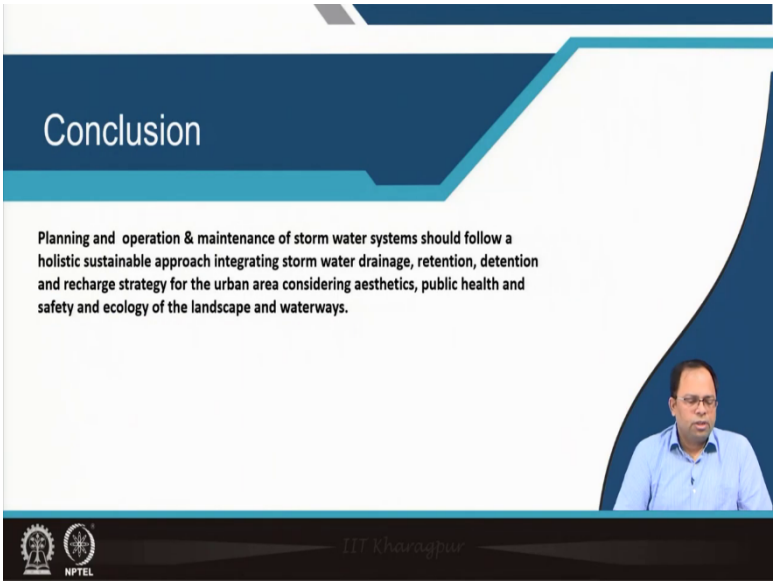

Conclusion

So, to conclude planning, operation and maintenance of storm water system should follow a holistic sustainable approach integrating storm water drainage, retention, detention and recharge strategy for urban area considering aesthetics, public health and safety and ecology of the landscape and waterways.

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So, these are the references we can study.

Thank you!