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New Approach for Preparing Storm Water Drainage Master Plans for Indian Cities

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Abstract - *In India, many urban areas are facing problem of flooding and water logging during heavy rains resulting in big loss to public and private properties and human lives. To manage the problem of flooding, urban local bodies and other concerned agencies are constructing and improving storm water drains. But, many of such drains are constructed without preparing storm water drainage master plans for the cities. A few large cities suffering badly from floods, have taken initiatives to prepare storm water drainage master plans. Most of such master plans are prepared based on conventional approach. At the same, new concepts on storm water drainage management are being developed and implemented in developed countries. Therefore, in India, the approach to prepare storm water drainage master plans needs to be based on the new concepts. In the research paper, the author high lights the limitations of conventional storm water drainage master plans prepared and new approaches to be adopted. The paper can be an useful guidance to concerned officials of government agencies, urban local bodies involved in management of storm water drainage system.*

Key Words: Storm Water Drainage Master Plan, Urban Local Bodies, Flooding, Watershed, Computer Modeling.

1.1 INTRODUCTION AND CONTEXT

In India, many urban areas are facing the problem of urban flooding during heavy rains. The main reason of urban flooding problem is overdevelopment of the cities, which has resulted in shrinking of area of the permeable land leading to surge of storm-water runoff. There is increase of urban population and increase of development density, which is reflected in the increase of paved area and shrinkage of natural permeable land area. This results in bigger runoff coefficient and more storm-water runoff quantity.

Storm water drainage system in most of Indian cities and towns are based on open drains or channels. Local or neighborhood drainage systems in the cities are mainly suitable for the regular rainfall of low intensity. But, when heavy storm occurs, these local drainage systems fail to discharge rain water. Due to excess urban development, extent of catchment areas of drainage networks have increased, which results in bigger storm water runoff in comparison to drainage capability of drains. This lead to water logging. Also, due to uncontrolled development, there has been shrinkage of the urban water and lake system, which leads to reduction in the capacity to store and drain the storm-water runoff. Some other reasons of urban flooding are lack of drainage from the road network, encroachment of drainage path by buildings and encroachers, lack of interconnectivity between the drains, piece meal construction of drains to suit emergency requirements, deposition of solid wastes, silt and weed growth, irregular sections of drain and culvert, drains of inadequate carrying capacity and lack of utilization of storm waters for ground water recharge. In India, storm water drains are also carriers of partially treated sewage from septic tanks and sullage water from households. Thus, the drains are health hazards and pollute receiving water bodies.

In India, urban local bodies are mainly responsible for development and maintenance of storm water drainage systems. Except for a few major cities, most of the cities and towns do not have storm water drainage master plans. Also, the present approach of storm water management in the available master plans is outdated as new technologies and approaches are being developed to tackle urban flooding problem. In the research paper, the author highlights the conventional approach adopted in preparing storm water drainage master plans by urban local bodies and other concerned agencies, their deficiencies and new approach in managing storm water drainage problems.

1.2 MAJOR ACTIVITIES AND OUTCOMES IN CONVENTIONAL STORM WATER DRAINAGE MASTER PLANS

Storm water drainage master plan is a long term planning generally done for a period of about 20 years. It is a comprehensive planning of storm water drainage works for service area as per likely spread of city in next 20 years. It describes all works required in next 20 years in phased manner. The general strategy followed in India for preparation of storm water drainage master plans and detailed project reports includes the following:

i) Assessment of existing storm water drainage system by conducting topographic survey of the drains, field study for assessment flood affected areas and finding solutions to mitigate the flooding problem in the identified areas.

ii) Preparation of IDF (Intensity Duration Frequency) curve for the town, decide return period or recurrence intervals

and rainfall intensities for design of the existing and new drains.

iii) Find out hydraulic deficiencies of existing storm water drains and hydraulic design of the existing and new drains to find out sizes and bed slopes of the drains.

iv) Hydraulic design of the major drains at disposal points to match with invert level of the receiving water bodies or river. The design of disposal arrangement includes design of pumping arrangement and sluice gates, if needed.

The major activities performed in preparing a storm water drainage master plan include the following:

i) Identification of Drainage Basins, Field Verification and Overall assessment of Existing Storm Water Drainage System: This task involves identification of existing drainage basins, their boundaries and major drains in each of the basins. Existing major drains are studied in the field. Field studies are also made at the outfalls of each of the major drains.

ii) Existing Drain Survey for Condition Assessment: This task involves field study and assessment of the condition of existing drains. The following aspects are studied during the field study for each major drain a) Type of drain b) Originating point and final destination point c) Problems in drain d) Flooding e) Silting f) Bottom and Side Erosion g) Solid waste disposal h) Sewage Disposal i) Encroachment j) Approach for cleaning and maintenance. At the city level, details of drainage system to be collected include a) Total length of drains b)Length of completely obstructed drains c) Length of partially obstructed drains d) Length of drains channelized/developed e) Drains where flooding occurs frequently f) Flooding spots in the city.

iii) Identification of Flooded Areas, Reasons of Flooding and Possible Remedies: A list of low lying and flooded areas are prepared with the help of the concerned Government officials and field study. The reasons of flooding in each area are analysed and remedies identified.

iv) Finalisation of Planning and Design Criteria: The planning and design criteria to be adopted for the hydraulic design of the drains cover the following subjects: a) Method of runoff computation b) Runoff coefficient c) Design rainfall intensity d) Concentration time e) Storm return period f) Formulas for the design of drain sections.

v) Hydraulic Analysis of Existing Storm Water Drainage System: All the existing storm water drains are analysed to find out their carrying capacities and compared with the discharge expected in the design year.

vi) Design of Proposed Storm Water Drainage System: Design of improvements and additions to the existing storm water drainage system include the following: a) Improvement of inadequate drain coverage by proposing new drains b) Augmentation of discharge capacity of existing drains by de-silting, de-weeding, widening and modification of bed slope c) Drainage works for remedies for locally flooded areas d) Improvement of roadside drains e) Remodelling and lining of major drains including modification of discharge capacities of existing culverts f) Provision of pedestrian drain crossings.

vii) Calculation of Capital and O&M Costs: The capital cost of improvements and additions to the existing drainage system are calculated. The general items of works included in the estimate are: a) De-silting and de- weeding of drains b) Concrete or brick walls on both sides of drains c) PCC for foundation of side walls d) Concrete bottom lining of drains e) Coping concrete for side walls of drains f) Pedestrian crossings g) Repair works in existing concrete and masonry drains h) Procurement of excavators, tractors and slab-lifting cranes for maintenance of drains.

viii) Operation and Maintenance Plan: In order to assure that existing and new drains function at their design capacities, regular maintenance works are to be performed. Therefore, the drainage system should be frequently inspected, cleaned and repaired. Blockages in storm water drains are due to deposition of grit, silt and weeds, penetration of roots from nearby trees through the cracks in the drains and growth of plants inside the drain, dumping of solid wastes and construction debris. Blockages are to be prevented by periodic cleaning and removing of plants, roots and solid waste from the drains, accompanied by a public awareness campaign by urban local bodies.

1.3 LIMITATIONS OF CONVENTIONAL STORM WATER DRAINAGE MASTER PLANS

In India, storm water drainage works done by urban local bodies are not properly planned as most of cities and towns do not have storm water drainage plans. Even where storm water drainage master plans are prepared, there are limitations in them. The master plans mostly suggest construction of new drains and re-sectioning or modification of existing drains. Less or no importance is given for development of flood detention ponds or storm water detention facilities and non structural measures such as urban development control, low impact development, operation and maintenance, public outreach and education and flood management plan. Also, the suggestions given in the master plans are not fully implemented by urban local bodies due to lack of fund, difficulty in construction of new drains, widening existing drains and other challenges. Because of these limitations, urban flooding problem persists even after preparation and implementation of the master plans prepared. Therefore, there is an urgent need to change the approach in preparing storm water drainage master plans.

1.4 NEW APPROACH IN PLANNING OF STORM WATER DRAINAGE MASTER SYSTEM

The new approach in planning of storm water drainage system in urban areas needs to consider the following:

i) Incorporation of rainwater harvesting strategies for reduction of storm run off from residential and other plots. This can help in avoiding costly measures to widen drain sections and replace culverts.

ii) Protection and enhancement the natural water-dependent ecosystems and enhance community access to them. Storm water drainage master plans need to include provision of preservation of urban water bodies.

iii) Use of Geographical Information System (GIS): All details of existing and proposed storm water drainage system need to be incorporated into a GIS system for the city. This will help in spatial database development for all watersheds within the planning area. A dynamic GIS database along with computer modelling approach on a watershed scale will be useful for changing land and urban planning strategies to minimise storm runoff from the watersheds.

iv) Developing storm water drainage standards for each town: In India, in most of the cities and towns, IDF (Intensity Duration and Frequency) curves and design rainfall intensity are not derived and available with urban local bodies. It is important that each town develop IDF curves and design rainfall intensities. Furthermore, it is necessary that the cities keep updating their design rainfall intensities for purposes of evaluating and designing storm drainage systems.

v) Management of Drainage Assets: It is necessary that the each city develop a comprehensive drainage infrastructure inventory and drainage asset management system. This asset management system should be continuously updated and include a comprehensive inventory of existing drainage asset, their condition, cost of replacement and prioritization, etc.

vi) Rainfall, Flow Monitoring and Water Quality Data: Except a few big cities, urban local bodies in India do not have adequate data on rain fall, flow monitoring and water quality. Urban local bodies need to generate these data. ULBs need to own and operates rainfall gauges throughout the City.

vii) Computer Hydraulic Model Development: A comprehensive drainage computer model needs to be developed in each city to better understand the drainage system performance under extreme rainfall events and to properly identify flood risk areas. To do this, the drainage infrastructure details of the city are to be fed into a single urban hydraulic model. The model should be able to simulate various conditions including future catchment land use, various design storms and boundary conditions.

viii) Existing Drainage System Assessment: The existing drainage system of the City needs to be evaluated by using the computer hydraulic model for different design rainfall intensities. Simulation results will show performance of the drainage network, culverts, ponding depth in flood affected areas, etc.

ix) Improvement Concept Plans for Existing Drainage System: Drainage improvements are to be conceptualized for all developed areas of the city with a goal to achieve desired flood protection. The general concept will be to reduce, divert and/or convey storm runoff away from flood-prone areas so that the flood risks are reduced to reasonable levels. The details of improvement can include road/ground regrading, larger size drains, large capacity catch basins or storm water retention ponds, increased culvert capacity, etc.

x) Storm Drainage Master Plan for Future Development Areas: Storm drainage master Plan for future development areas also needs to be developed using the computer hydraulic model.

xi) Implementation of Non Structural Maesures: Non structural measures can include adoption of low impact development strategies and proper storm water manual by the ULBs , public education for management of micro water sheds, operation and maintenance of storm water drainage system, etc.

xii) New Concept for Management of Drainage Zones: The concept of catchment area can be redefined as a Storm Water Management Unit. The unit should be managed to minimize storm water runoff. This can be achieved by developing indexes for the storm water management units of the city. The indexes will depend on building density, green area, paved and unpaved area, natural land infiltration rate, pavement infiltration rate, etc. Urban planning and control measures can be undertaken in the storm water management units for controlling the indexes.

xiii) Plan for utilization of the storm-water: An adequate plan for utilisation of storm water for productive use such as irrigation, recycling in water treatment plant, etc. can be useful for management of storm water in a city.

xiv) Enforcement of Stringent Regulation: Urban local bodies need to prepare and implement specific regulations to minimise storm water runoff from residential and other plots, control quality of storm

water within drains, minimise sediments and prohibit solid waste disposal. ULBs should continuously update the standards of regulations.

1.5 CONCLUSIONS

The new approach as mentioned above can be useful as guide lines for preparing storm water drainage master plans for any city. The new approach is supplementary or additional to the conventional approach. All urban local bodies and other concerned authorities need to insist on adoption of the new approach. Storm water management is a big concern for urban local bodies. If adequate measures are not taken, due to climate change and urbanization, flooding problem is going to be severe in near future in many cities in India. Preparation of storm water drainage master plans is the first step in addressing the problem. There are implementation challenges for such plans. The challenges include difficulty in construction of new drains and increasing size of existing drains in developed areas of the city, prevention of solid wastes disposal into drains, retention and development of water bodies, control of quality of water disposed into drains, etc. ULBs must make effort to overcome such challenges.

Disclaimer: The findings and conclusions presented in the paper are personal opinion of the author.