'Rain Towers' – An Integrated Rainwater Harvesting & Excess Flood Control Structure for Chennai Rivers

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Abstract

During recent (2015) North-East Monsoon, Chennai, capital of TamilNadu, India had received totally 119.73cm of rainfall till November 30; midnight (2015) has broken the 1918 record of 108.8cm which had stood as the highest record. It has also broken the record of last ten years when the capital city received 421 mm of rain in 2005. Due to such heavy rainfall, Chennai had suffered much both economically and socially. Keeping the Climate Change issue aside, it is sensitive alarming time for Chennai as one of the Metropolitan Cities of India, to derive and design the solutions for Urban Flood Management especially for Cooum and Adyar rivers. In this paper, we have presented and discussed a new conceptual idea for a structure that would be useful for rainwater harvesting and for channeling the excess river flood simultaneously. Our Rain Tower design consists of various components and network of conduits as well.

Keywords: *Rain Tower, Chennai Floods, Flood control, Rainwater Harvesting, Urban Flood Management, Adyar and Cooum River*

I. INTRODUCTION

Chennai is located at 13.04°N 80.17°E on the southeast coast of India and in the northeast corner of TamilNadu. It is located on a flat coastal plain known as the Eastern Coastal Plains. The city has an average elevation of 6 meters (20ft). Its highest point being 60m (200ft).

A. Geology of Chennai

The geology of Chennai comprises mostly clay, shale and sandstone. The city is classified into three regions based on geology as:

- Sandy Areas
- Clayey Areas
- Hard-Rock Areas

Sandy areas are found along the banks and coasts. Clayey regions cover most of the city. Hard rock areas are Guindy, Velachery, Adambakkam and a part of Saidapet. In sandy areas such as Thiruvanmiyur, Adyar, Kottivakkam, Santhome, George Town, Tondiarpet and the rest of coastal Chennai, rainwater run-off percolates very quickly. In clayey and hard rock areas, rainwater percolates slowly, but it is held by the soil for a longer time. The city's clayey areas include T.Nagar, West Mambalam, Anna Nagar, Perumbalur and Virugambakkam.

II. RIVER PROFILE OF CHENNAI

The city is intersected by two languid streams, the Cooum and the Adyar River. Cooum runs through the heart of the city and enters the sea in-between the University buildings and the Fort.

These two rivers are almost stagnant and do not carry enough water except during rainy seasons. Though the Adyar River can be traced to a point near Guduvancheri village, it assumes the appearance of a stream only after it receives the surplus water from the Chembarambakkam tank as well as the drainage of the areas in the south-west of Chennai.

The river has no commercial importance, but the fishermen in the neighborhood make their living by fishing in the river.

III. RAIN TOWER – TECHNICAL DESCRIPTION

A. Design Inspiration

Structure of an 'Umbrella' is the basic inspiration behind our Rain Tower Design.

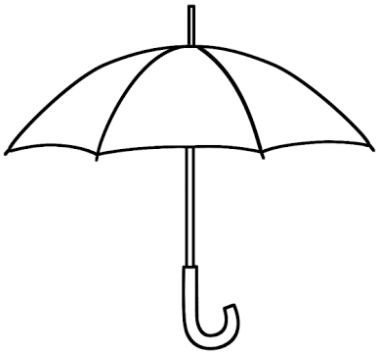
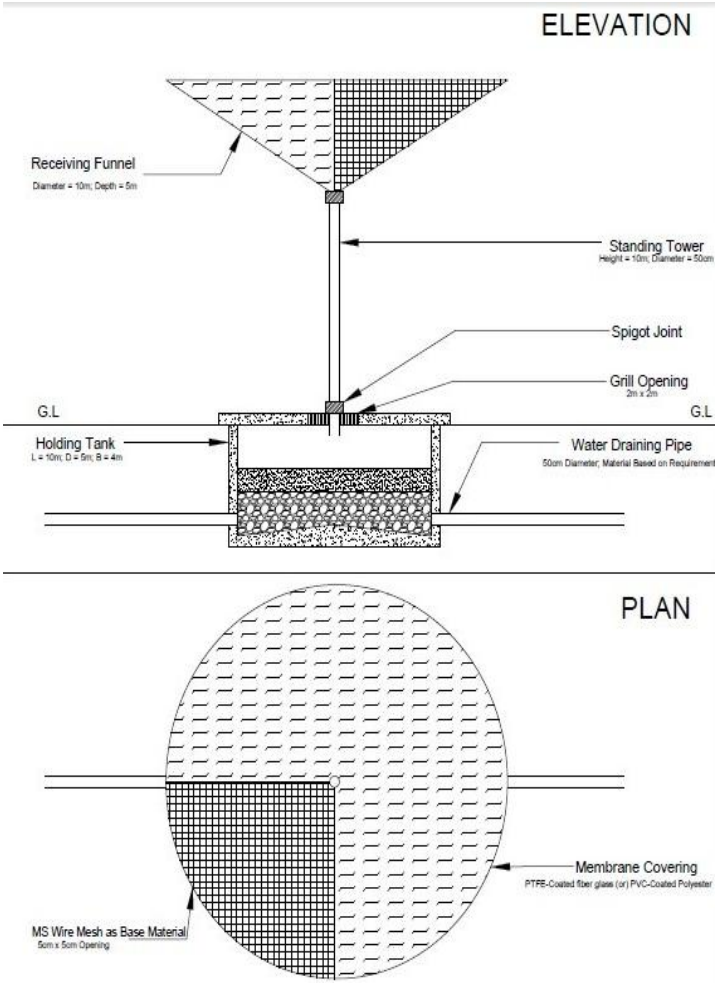


Fig 1: Umbrella Structure

Our Rain Tower resembles an Umbrella put top-down on a tall tower.

Picture Of Rain Tower



B. Principal Components of Rain Tower

Our Rain Tower design consists of several principal parts or components. The design is done in such a way that the entire structure can be constructed easily. The principal components are:

(i) Top Receiving Funnel
(ii) Central Standing Hollow Tower
(iii) Junction of Tower and Base Tank
(iv) Canal Lining along the river bank
(v) Underground Rainwater Holding Tank
(vi) Connecting Conduits
(vii) Pumping Station and a collection tank

C. Functioning of Rain Tower

The working function of Rain Tower can be summarized as following sequence:

(i) Rain Started pouring.
(ii) Top funnel receives rainwater and simultaneously conducts it to the central standing tower.
(iii) The rainwater flows through the central tower and reaches the underground holding tank constructed below the tower.
(iv) The water enters into the underground tank gets filtered (primary level) by the two layers of filter media and well graded aggregates.
(v) Primarily filtered water gets collected underneath and enters into the connecting conduits, which are connected in series ended in a nearby pumping station,
(vi) In case of excess flood, the overflow flood from river faces firstly, the wide canal lining along the river bank.
(vii) The flood water enters the canal automatically channelized towards the Rain Tower by means of selective gradient of the canal flooring.
(viii) The excess flood enters forcibly into the underground holding tank by means of specially designed grill-opening around the Standing tower – Base Tank junction.
(ix) The same action will be done by all the Rain Towers Constructed along the bank at every 150-200m interval connected by the conduits.

If large amount of rainfall happens, the underground holding tank may be gets filled and the overflow water will be carried by the standing tower as well as by the top funnel structure. So, rainwater run-off can be mostly reduced and can be diverted for useful purposes.

D. Materials for Rain Tower Construction

Our Rain Tower can be constructed entirely as R.C.C structure. But, we have the options for its construction with easily available eco-friendly materials as well.

1) Top Funnel:

The top rain receiving funnel can be constructed entirely with R.C.C. But, that will necessitate the strong foundation for the structure, because of the large dead load.

Our 1st suggestion is, fabrication of funnel made with M.S mesh and Tensile Membrane material. The fabric membrane which are commonly used in tensile fabric structures are, PTFE-coated fiberglass and PVC –coated polyester. The warp fibers can carry greater load than the weft of fill fibers, which are woven between the warp fibers.

Our 2nd suggestion would be the PVC made Vinyl Flex Banners in the place of membrane material along with the M.S mesh. Since the wastage from Vinyl flex banners are increasing in the current scenario, they can be brought here for the fabrication of top funnel. The vinyl banners are usually made

with high toughness will be suitably fulfill our requirement. They can be used in multiple layers for load carrying-capacity concern.

2) ***Central Standing Tower***

The standing tower can be constructed in R.C.C entirely. Alternatively, they can be constructed with:

(i) Asbestos Cement
(ii) Hume Steel
(iii) Vitrified Clay (or) Stoneware
(iv) High Quality Bricks
(v) Cast Iron
(vi) Ductile Iron

Whatever the material used, the standing tower is manufactured in such a way that it screws its bottom on the top slab of the holding tank.

3) ***Underground Holding Tank***

Since the underground holding tank plays the major role in storing, filtering and diverting the rainwater for useful purposes, it should be constructed with R.C.C only.

4) ***Canal Lining***

The canal lining for river banks can be done with the interlocking-paver blocks. Such paver blocks holds more scope in the usage of effective alternative materials for its manufacturing. Thus, its impact on environment would get reduced.

E. Application Models of Rain Towers

The Rain Tower concept can be applied in two different models depending upon the requirement of the locality. The two application models are:

(i) Rain Tower with Underground Holding Tank
(ii) Rain Tower with Deep Bore Hole

The 1st model would be useful in case of flood control requirements.

The 2nd model would be useful irrespective of location. Here, the Rain Tower receives the rain water and directly recharges the groundwater table with the deep bore hole.

IV. DISCUSSIONS

As per Indian Metrological Department, the Annual Rainfall in Chennai is around 1333.8mm, being the highest rainfall region in TamilNadu next to Salem 1014mm recorded in between 1951 to 1980.

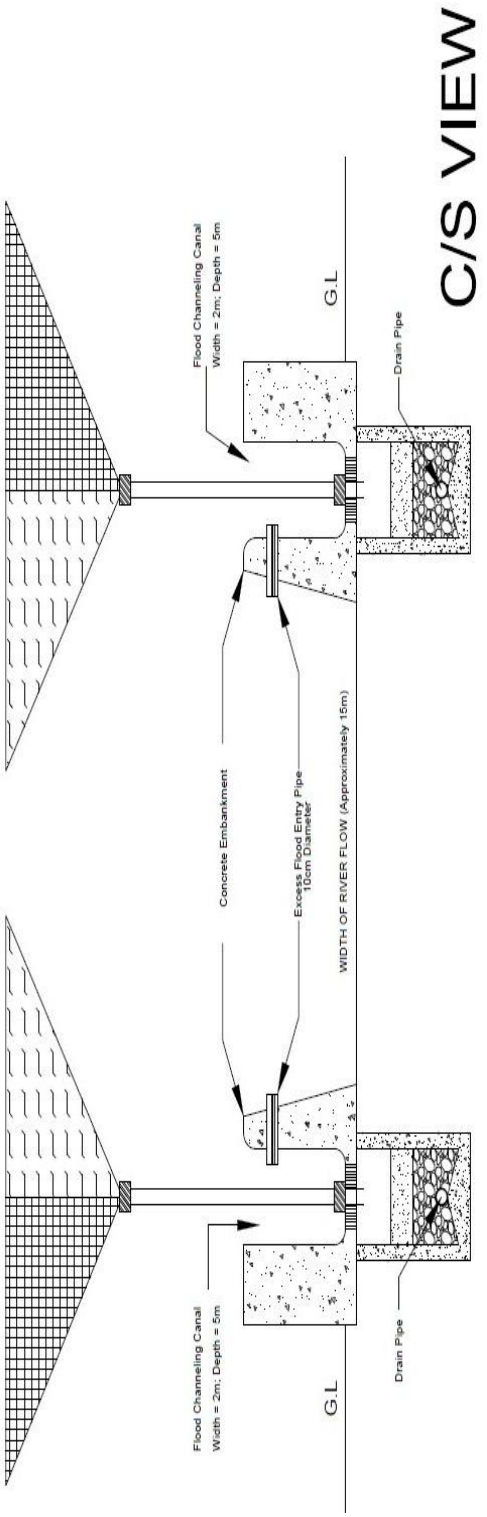
But, In recent North-East Monsoon rainfall brought up 1608mm rainfall against the normal rainfall of 788mm. (*Source:* Regional Metrological Centre, Chennai). All the damages pertaining to the recent floods (2015 December), duly happened due to inadequate excess flood control strategy. With our novel design approach, the excess flood can be stopped and as well as can be diverted for the beneficial purpose.

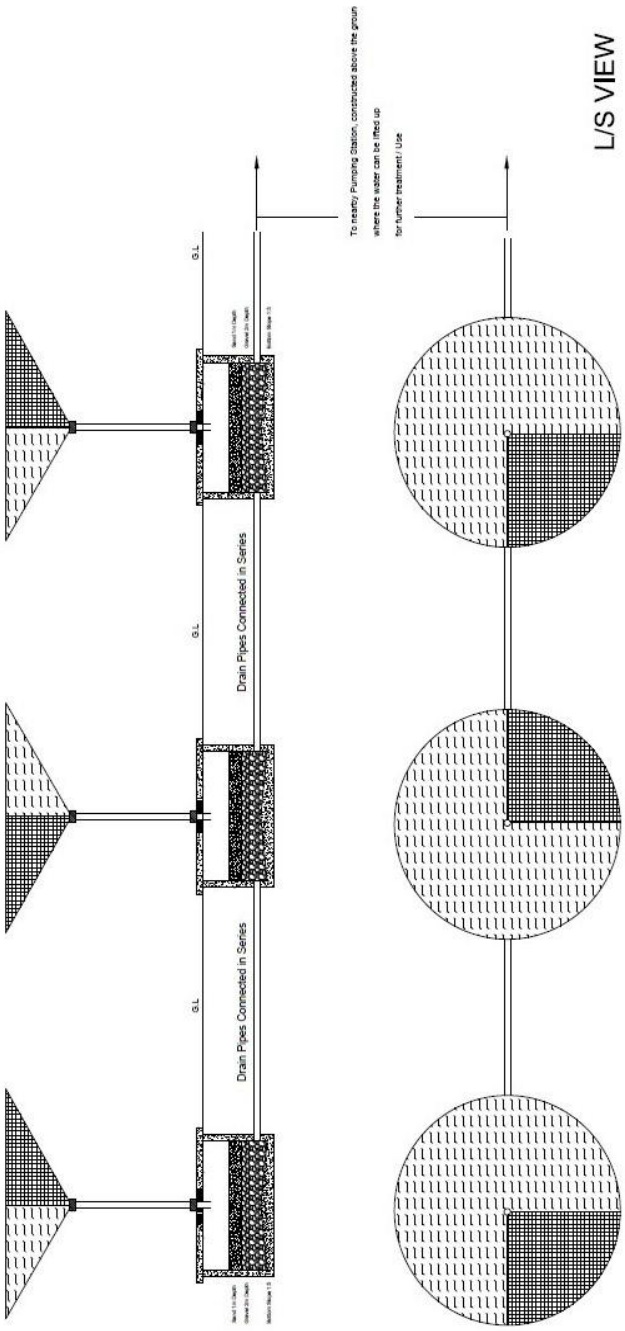
In this paper we have presented only the novel idea of the Rain Tower concept. The in-detail design, specifications, and material estimation are the pending works to carryout.

V. SUMMARY & CONCLUSION

Recent North-East Monsoon have taught a lesson for Chennai city, that it's very important to have the current knowledge in water management. So far, the rivers Cooum and Adyar remains untouched for its remediation. The political parties continues their promises but fails in actions. Moreover, it is Climate Change scenario. If we are not ready to plan means we are planning to be defeated in front of nature.

As a Civil Engineer, we have initiated our part with 'Rain Tower' concept and we hope that our design is an achievable one. And we are keen on working further on our design for its fulfill implement.





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