The Initial Rain Water Storage Tank Volume Determination and Pollution Interception Efficiency Based on the Swmm Model and Computer Software Analysis

Ling Shi1,*, Honghai Liu1, Chen Xi1, Zhiwen Zhang1

1Tianjin University Research Institute of Architectural Design and Urban Planning Co., Ltd, Tianjin, China, 300073

*Corresponding author e-mail: shiling@tju.edu.cn

Abstract. At present, many cities in China have both severe water shortages and waste of large amounts of rainwater resources during heavy rains caused by urbanization. Turning rainwater resources into cities can reduce urban runoff and reduce peak floods. At the same time, it can increase urban water supply, beautify and clean the urban environment, improve urban microclimate, reduce ground subsidence, control rain and flood processes and reduce urban flood control. Drainage infrastructure investment greatly reduces urban flood disasters, which will bring considerable economic, social and environmental benefits. Therefore, as one of the hot topics in the preparation of special plans for drainage engineering in the new period, urban rainwater should be carried out using the SWMM model and computer software. The plan provides the possibility for further compiling special plans for rainwater utilization and guides the utilization of urban rainwater resources.

Keywords: Rainwater, Volume, Effectiveness, Computer Software

1. Introduction
In recent years, due to climate change, the frequency of urban heavy rain and continuous heavy rainfall has increased. At the same time, due to changes in the underlying conditions of the city, water accumulation on urban roads caused by urban rainfall intensity and surface runoff exceeding the drainage capacity of the rainwater pipe network has been severe. And it happens frequently, causing great harm to road traffic and pedestrian safety. Excessive water accumulation on urban roads can easily lead to vehicle stalls, traffic congestion and difficulty in passing and there are hidden dangers of injury, death and economic loss. Therefore, strengthen the analysis and monitoring of water accumulation points on urban roads, carry out flood impact analysis on newly constructed and reconstructed roads, reasonably and effectively arrange emergency drainage facilities and emergency measures for potential water accumulation points, alleviate traffic pressure caused by road water accumulation and eliminate Security factors are very necessary.

2. SWMM model analysis
SWMM is a dynamic rainfall-runoff simulation model, which is mainly used to simulate a single
precipitation event or long-term water quantity and water quality simulation in a city. Its runoff module part comprehensively handles precipitation, runoff and pollution load in each sub-watershed. Its confluence module part transmits water volume through pipe networks, channels, water storage and treatment facilities, water pumps and regulating gates [1].

3. Rainwater utilization analysis based on SWMM model
In order to fully infiltrate the rainwater in the settlements, firstly ensure that there is sufficient soil bareness and that the vegetation-rich surface water storage capacity is stronger. Studies have shown that vegetation effectively affects surface reflections, surface temperature, the roughness of the underlying surface and the soil-vegetation-atmosphere continuous body-time water exchange. When the vegetation coverage increased from 30% to 80%, the runoff reduction was particularly obvious [2]. Compared with the sloped surface without grass, the surface runoff can be reduced by 47% and the erosion can be reduced by 77%. Herbs, shrubs, and arbor plants have strong ability to control soil erosion, rainfall throttling, soil infiltration, runoff stagnation, transpiration and soil consolidation. It is determined that the stable infiltration rate of soil with turf is 15% -20% greater than that of bare land under the same soil conditions. Therefore, the residential area should be fully landscaped, increase the ground covered by vegetation, reduce the pavement in the garden and use the rainwater-permeable pavement materials as much as possible to form a garden interface that can fully absorb rainwater.

With the development and improvement of urbanization, the changes in the structure and function of the urban surface environment have a significant effect on surface runoff. The increase of impervious ground (road, roof, ground) makes the surface runoff coefficient larger. During rainfall, ground runoff increased [3]. The direct infiltration design is based on the principle of capillary infiltration of soil pores, allowing rainwater to directly infiltrate the ground to achieve the function of soil water conservation. It belongs to the indirect use of rainwater and is a technical application of rainwater ecology and resources. Rainwater in situ infiltration treatment has many ecological and environmental effects and it plays a very important role in controlling urban non-point source pollution and reducing flood peak water. Therefore, it has attracted widespread attention from countries around the world. In some places with good geological conditions, infiltration of rainwater and artificial recharge of groundwater can appropriately raise the groundwater level; on the other hand, it can effectively reduce the drainage of rainwater runoff into municipal pipe networks and rivers, which has a significant effect on urban control. The distribution area is shown in the following Table 1.

| Region  | Volume |
|---------|--------|
| Park    | 235    |
| Road    | 1044   |
| Roof    | 913    |

4. Study on rainwater volume and interception efficiency based on SWMM model
The impervious surface of the road increases and the rainwater falling through the road basin cannot directly infiltrate through the ground surface. The ground runoff can only flow to the rainwater outlets on both sides of the road through the drainage method. There are pits in the longitudinal direction of the road. The design standards for rainwater pipeline networks are low. Due to space, time and economic constraints, the design standards for supporting rainwater pipeline network facilities for construction projects basically adopt the lower limit standards specified in the specification. The project design may not meet the standards due to special reasons, leading to rainwater pipes. The grid cannot support ground surface storms resulting in surface runoff and formation of surface water [4].

During the construction of the urban rainwater pipeline network, to use SWMM model to optimize the design of the pipeline network and promote the pollution control of the initial rainwater, it is necessary to do a good job of the drainage system construction of the rainwater. Including two types of direct current combined system and shunt system. The former is the centralized drainage of mixed
sewage without pollution treatment. This is the first type of pipe network design in urban rainwater construction. This will cause sewage to directly drain into the water body, causing serious water pollution and reducing the self-purification capacity of the water body. If all the sewage is sent to the sewage treatment plant, the uncertainty of precipitation will also cause the construction scale and treatment capacity of the sewage treatment plant to fail to meet the standards effectively and it will also cause waste of resources. The latter adopts the shunt method for rainwater recovery. The sewage and rainwater are separated for recycling to achieve effective pollution control goals. This pipe network shunt design can be separated according to rainwater and sewage drainage. Generally, there are several ways of this shunt [5]. The first is incomplete diversion. This rainwater pipe network is designed with a sewage drainage system and there is no effective rainwater drainage system. Various kinds of sewage are sent to a sewage treatment plant through the sewage drainage system and discharged after treatment. This kind of rainwater pipe The network usually chooses to discharge by means of terrain elements. This incomplete diversion system is subject to large terrain restrictions. Generally, the terrain is flat and it is not suitable for areas where rainwater is easily flooded during the flood season. It is not effective for the initial rainwater pollution treatment. achieve. The complete diversion drainage system includes a sewage drainage system and a rainwater drainage system. Rainwater is collected through the rainwater drainage system and the pollution damage of the initial rainwater cannot be avoided. The last semi-split drainage system is the most effective. This kind of rainwater pipe network design is an optimization design for incomplete diversion system. By adding a set of initial rainwater treatment device, the initial pollution can be effectively controlled, which can effectively reduce the pollution of water by rainwater in the later period and can also effectively reduce investment [6]. Costs and O & M management costs. Therefore, in choosing the design of the shunt drainage system, you can try to use this kind of semi-split drainage system to optimize the rainwater pipe network design. The sewage treatment capacity is shown in the Table 2 below.

**Table 2. The sewage treatment capacity.**

| Region  | Pollution Volume |
|---------|------------------|
| Park    | 178              |
| Road    | 627              |
| Roof    | 498              |

In the control measures of urban rainwater pipeline networks, some cities have adopted pipeline interception methods for pollution treatment. In terms of coastal areas, most interception points are located close to the coast and the elevation of the bottom of the drainage pipe canal is mostly lower than the average seawater tide level. The conventional interception method is easy until the seawater is poured back into the drainage pipe, which causes corrosion of pipelines and equipment and a large amount of seawater enters the sewage treatment plant, which will seriously affect the normal operation of sewage treatment. Therefore, in the corresponding pipeline design, we must focus on the following design work: first of all, we must ensure that the new interception system does not affect the flood capacity of the original drainage ditch; according to the water environment quality of the receiving water body, the sewage treatment system and the pipe Information such as network transportation capacity, regional pollution degree and catchment area is used to determine the interception multiple; a sand removal and slag removal system is set up to reduce sedimentation at the pumping station, etc. Through a sound pipeline design, there is a certain basis for improving the overall initial precipitation treatment effect.

**5. Conclusion**

Use SWMM model to conduct waterlogging analysis on newly-built roads, determine potential water accumulation points on newly-built roads, adjust pipeline network and road design schemes in a timely manner to ensure that the scheme is economical and feasible and implement real-time monitoring of potential water accumulation points based on the analysis results. An early-warning plan is formulated. Once an over-standard flood causes flooding of the road surface water, an emergency rescue response can be made quickly to reduce the occurrence of harm and reduce economic losses. At
the same time, on the basis of the analysis results, the road design plan should comprehensively consider measures such as permeable paving, green belts, rainwater storage tanks and initial rain facilities, so that the rainfall can be absorbed or stored as much as possible and used. The drainage volume outside the small project area will reduce the impact of the project construction on the surrounding environment and reduce the risk of waterlogging. Perform flood analysis on the construction plan before project implementation to avoid the threat of external water to the project, reduce the impact of the project construction on the surrounding environment and avoid economic losses.

References
[1] SangSoo Baek, Mayzonee Ligaray, Yakov Pachepsky, Jong Ahn Chun, Kwang-Sik Yoon, Yongeun Park, Kyung Hwa Cho. Assessment of a green roof practice using the coupled SWMM and HYDRUS models[J]. Journal of Environmental Management, 2020, 261.
[2] S.S. Wanniarachchi, N.T.S. Wijesekera. Challenges in field approximations of regional scale hydrology[J]. Journal of Hydrology: Regional Studies, 2020, 27.
[3] Ying Dai, Lei Chen, Zhenyao Shen. A cellular automata (CA)-based method to improve the SWMM performance with scarce drainage data and its spatial scale effect[J]. Journal of Hydrology, 2020, 581.
[4] Baek SangSoo, Mayzonee Ligaray, Pachepsky Yakov, Chun Jong Ahn, Yoon Kwang-Sik, Park Yongeun, Cho Kyung Hwa. Assessment of a green roof practice using the coupled SWMM and HYDRUS models[J]. Journal of environmental management, 2020, 261.
[5] Seyed Hamed Ghodsi, Zahra Zahmatkesh, Erfan Goharian, Reza Kerachian, Zhenduo Zhu. Optimal design of low impact development practices in response to climate change[J]. Journal of Hydrology, 2020, 580.
[6] Yao Hu, Colleen M. Long, Yu-Chen Wang, Branko Kerkez, Donald Scavia. Urban total phosphorus loads to the St. Clair-Detroit River System[J]. Journal of Great Lakes Research, 2019, 45(6).