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FLOOD CONTROL OF AN OVERPASS IN DOWNTOWN BEIJING

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EXTENDED SUMMARY

Drainage systems are a critical infrastructure that plays an important role in safeguarding society stability, promoting economy development and improving the quality of public life, especially during urbanisation and modernisation (Sun Huixiu, 1996). With the accelerating urbanization processes and constant promotion of political and economic status, the urban drainage system, which maintains efficient city operation and protects human safety and property has become increasingly important in recent years. Due to the multiple impacts of global climate change, urban heat island effects and microclimate, it makes the intensity and frequency of extreme rainfall events increase significantly in Beijing. For instance, the "6.23" (Rainstorm on June 23rd, 2011) and "7.21"(Rainstorm on July 21st, 2012), which led to several highway overpasses being inundated, and caused serious traffic jams, causing great economic loss in Beijing, while simultaneously exerting negative impact on the normal city operation. Therefore, various departments and organizations have implemented studies and discussions, to explore the root causes of urban local flood in these areas, which aimed at proposing appropriate adaptation countermeasures. This paper focuses on an overall introduction of flood control projects for the flood-prone overpass region in downtown Beijing (Geng Weimin et al, 2001).

There are four main rivers (Qing River, Ba River, Tonghui River, Liangshui River) and 113 tributaries and drainage ditches in the central district of Beijing, which consist of the drain off pathway of rainwater in downtown Beijing with the total length 581km. The separate sewer discharge system has been adopted the new drainage system in downtown Beijing. According to the statistics, the total length of rainwater pipes of downtown Beijing is 2543 km (at the end of 2009), which greatly alleviates urban waterlogging conditions. Certain locations in the city, such as overpasses, underpasses, railway bridges and highway bridges, are prone to be flooded by the water accumulated on the surface without draining immediately. This risk is raised by antiquated underground pipes, low design standards. Simultaneously, it leads to frequent traffic accidents and congestion, even paralysis, which causes unnecessary casualties and property losses, thereby exerting negative impacts on the normal city operation and the residents travel. Therefore, rectification for this overpass region is extremely critical.

The situation of downtown Beijing was highly unusual during the rainstorm which occurred on July 21st, 2012. By the impact of cold air eastward south and southwest airflow, within 19 hours from 9am, July 21st to 4am, July 22nd, Beijing experienced heavy rainstorm, even super rainstorm in some areas. By the data record of 346 sites provided by Hydrological and Meteorological Departments, the average rainfall was approximately 170mm by computation implemented through the arithmetic average method, which was demonstrated as the maximum rainfall since the founding of New China, and the total area with average rainfall over 200mm was about 6000 m^2.

According to the report of Chinese disaster prevention network, "7.21" is a rare natural disaster. There were 91 inundation sites during the "7.21" event, among which 84 sites were at the region near concave-down bridges, and 20 sites had great risk of flooding. The maximum depth of accumulated water was 4m, and the inundation duration could reach as long as 14 hours among the bridges inundated.

Water accumulated in the overpasses is usually excluded by the pumping station, and the flood water depth and drainage time are related to the rainfall intensity, catchment area, customer water imported, rainwater collection capacity, the storage size, pumping capacity, downstream outlet drainage conditions and many other factors. The main reasons are extracted and displayed as follows:(1) Influence of pipe jacking by the water level of downstream river; (2) Insufficient number and unreasonable distribution of gullies; (3) Low design standards of rainwater pipes; (4) Low design capacity of rainwater pumping station.

The 20 overpasses in downtown Beijing included in this study are designed for the flood frequency of 1 in 5 years return period rainfall, and calibrated by not less than 1 in 50 years of drainage standards. The details are as follows: (1) High-lying district drainage system of bridges is designed according to municipal drainage standards of not less than 1 in 5 years. Rainwater which exceeds this design standard enters rainwater storage tank; (2) Low-lying district drainage system of bridges is designed according to municipal drainage standards of not less than 1 in 5 years, and calibrated by drainage standard of not less than 1 in 50 years; (3) Rainwater pumping station in the overpasses are designed according to the municipal drainage standards of not less than 1 in 5 years. Rainwater which exceeds the design standards enters rainwater storage tank; (4) Rainwater Storage tank is designed according to drainage standard of 1 in 50 ~ 100 years; (5) Pumping station and its power supply facilities is designed according to flood control standard of once in 100 years; (6) The value of deferring coefficient "m" involved in rainwater pipes designing is 1.

The watercourse design standards are as follows: (1) The design standard of river channel is to withstand the 1 in 20-year flood, and checked by 1 in 50 to 100 years flood; (2) The designed flow discharge of river channel could be acquired by the simplified method of typical analysis and compared amplification.

Design storm standards are as follows: (1) 24-h rainfall and hyetograph with 1 hour interval provided by Beijing hydrological manual are adopted to determine design storm of river flood control project. Maximum rainfall for 24-hour of downtown Beijing is 335 mm for rainstorm return period 50 years, and maximum rainfall per hour is 115 mm. The maximum 24-hour rainfall for rainstorm 1 in 100 years is 410 mm, and maximum rainfall per is 130 mm; (2) Design storm for Municipal engineering uses 24-h rainfall hyetograph with 5 minutes interval developed by Hydrological Station of Beijing, and rainfall is chosen from the value mentioned in Hydrological Manual of Beijing.

Transformation methodologies of concave-down overpass are as follows: (1) Governing river channel; (2) Reducing the water imported from high district; (3).Improving water collection capacity of low district; (4). Constructing a new storage tank.

Through the survey of drainage designing standards in developed countries as well as drainage system of international mega cities(New York, Paris, London, Tokyo), it is observed that these cities have already established robust drainage system planning, construction and management regulatory norms and standards. Especially for tackling urban waterlogging disasters and urban water pollution, comprehensive prevention and adaptation facilities are proposed to guarantee the normal city operation and socio-economic development, which is worth learning (Wang Wenyuan et al, 1998). In addition, designing drainage standards project of concave-down overpasses in downtown Beijing will be reasonably determined based on existing socio-economic and natural geographical conditions. In this standard, principle is taking into account the combination of long-term and short-term development as well as scientificalness and feasibility. Simultaneously, transformation strategies of these overpasses region in downtown Beijing provides reference for future urban drainage planning and proposed fundamental solution to tackle urban waterlogging and other related issues.

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