EVALUATION OF THE SANITARY SEWERAGE SYSTEM FLOW DESIGN IN KUANTAN CITY

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SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Science.

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Sistem pembetungan adalah infrastruktur yang membawa kumbahan ke loji rawatan kumbahan. Reka bentuk sistem pembetungan perlu dioptimumkan pada untuk meningkatkan perlindungan alam sekitar dan kesihatan manusia. Aliran reka bentuk parameter dan aliran masuk penyusupan adalah penting dalam reka bentuk sistem pembetungan. Sistem pembetungan di Malaysia direka mengikut Malaysian Sewerage Industry Guideline (MSIG). Pertimbangan yang tidak mencukupi aliran reka bentuk parameter dan aliran masuk penyusupan dalam sistem pembetungan boleh membawa kesan negatif dari segi kos pembinaan, kesihatan manusia dan isu-isu alam sekitar. Objektif kajian ini adalah untuk menganalisis dan membandingkan parameter aliran serta kadar penyusupan dalam sistem pembetungan di kawasan tadahan kediaman Kuantan, Pahang. Data flowrate dikumpulkan daripada empat kawasan perumahan, Taman Lepar Hilir Saujana, Taman Pandan Damai, Bandar Putra, dan Kota Sas dengan dipantau jumlah tempoh satu setengah tahun. Population Equivalent (PE) telah dilakukan di lokasi-lokasi terpilih. PE yang dikaji dalam pelbagai nilai adalah 1253, 2244, 1694, dan 3950 masing-masing. ISCO 4250 dan 2150 Area Velocity Flowmeter serta ISCO 674 Rain Gauge telah digunakan untuk mengukur kadar aliran data dan intensiti hujan dalam jangka masa 5 minit. Data tersebut dianalisis secara berasingan untuk tempoh basah dan kering. Sebelum peralatan dipasang di lokasi tapak, penentukuran yang telah dilakukan. Penyusupan air bawah tanah, paras air tanah yang sebenar diukur dari Rugged Baro TROLL dan Rugged TROLL 100 Data Logger selang lima minit. Menurut MSIG Fasal 2.1.14, nilai aliran per kapita dan reka bentuk kriteria adalah 0.225m^3/hari/orang dan 4.7. Sementara itu, kadar penyusupan yang dibenarkan adalah 0.05m^3/km/mm/hari. Berdasarkan keputusan itu menunjukkan aliran per kapita yang diperolehi 0.252m^3/hari/orang yang 12% lebih tinggi daripada 0.225m^3/hari/orang. Untuk reka bentuk kriteria, hasilnya menunjukkan dalam kajian ini adalah 2.01 yang 57% lebih rendah daripada 4.7. Ini menunjukkan bahawa reka bentuk sistem pembetungan di lokasi tapak dipantau adalah berkesan dan mencukupi untuk PE melayan cukup ditinjau. Pada akhir kajian ini, yang baru puncak persamaan faktor aliran diperolehi. Dari segi kadar penyusupan, keputusan yang diperolehi dalam kajian ini adalah 14.99m^3/mm/km/hari yang 29880% lebih tinggi daripada 0.05m^3/mm/km/hari. Mengenai kepada air bawah tanah penyusupan bereksperimen di Bandar Putra, saluran paip pembetung itu tenggelam di dalam paras air bawah tanah. Ini boleh sebab kadar penyusupan yang tinggi di lokasi ini. Parameter aliran dalam sistem pembetungan di kawasan Kuantan, Pahang telah disiasat. Namun, parameter telah dilanjutkan mengikut MSIG. Yang baru diperolehi puncak persamaan faktor aliran dilaksanakan dalam masa membangunkan akan membawa banyak manfaat dalam bidang pembinaan pembetungan. Ini akan mengurangkan kos dari segi bahan paip, penyelenggaraan paip dan pemeriksaan pembetung pada masa akan datang.

ABSTRACT

Sewerage system is the sole infrastructure which conveys sewage to sewerage treatment plants. The usage of a sewerage system should be optimized at the design stage to enhance environmental protection and human health. Flow design parameters and inflow infiltration are significant in the design of sewerage systems. Malaysian sewerage systems are designed according to the Malaysian Sewerage Industry Guidelines (MSIG). Inadequate consideration of flow design parameters and allowable infiltration in sewerage systems can bring negative effects in terms of construction cost, human health and environmental issues. The objectives of this research are to analyze and evaluate the flow parameters as well as infiltration rate in the sewerage system of residential catchments in Kuantan, Pahang. Flowrate data was collected from four residential areas, namely Taman Lepar Hilir Saujana, Taman Pandan Damai, Bandar Putra, and Kota Sas over a period of one and a half years. The Population Equivalent (PE) surveyed amounted to 1253, 2244, 1694, and 3950, respectively. ISCO 4250 and 2150 Area Velocity Flowmeters as well as ISCO 674 Rain Gauge were used to measure flowrate data and rainfall intensity at 5-minute intervals. Those data were analyzed separately for wet and dry period. Before installation on site, equipment calibration was done. For the groundwater infiltration measurement, actual groundwater table was measured using the Rugged Baro TROLL and Rugged TROLL 100 Data Logger at intervals of five minutes. According to MSIG Clause 2.1.14, the current value of per capita flow and design criterion is 0.225 m^3/d/person and 4.7, respectively. Meanwhile, the allowable infiltration rate is 0.05 m^3/mm/km/d. However, based on the results obtained the average per capita flow was found to be 0.252 m^3/d/person, 12% higher than 0.225 m^3/d/person and for the average design criterion, the result from this study gave 2.01 which is 57% lower than 4.7. In terms of infiltration rate, the overall result obtained is 14.99 m^3/mm/km/d which is 29880% higher than 0.05 m^3/mm/km/d. In terms of groundwater infiltration at Bandar Putra, the sewer pipeline is submerged in the groundwater table. This may have caused the infiltration rate to be very high at this location. The results confirmed that the design of the sewerage systems at the monitored site locations are sufficient by using current Peak Flow Factor equation to cater to the PE surveyed.

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LIST OF SYMBOLS

Q_{pcf}	Per capita flow
Q_{ave}	Average daily flow
Q_{peak}	Peak hourly flow
K	Design criterion
Q_u	Upstream flowrate
Q_d	Downstream flowrate
L_{pipe}	Length of sewer pipeline between of the two manholes
ϕ_{pipe}	Diameter of sewer pipeline
Q_{IR}	Infiltration rate
D_G	Depth of ground level to bottom of well
D_{GW}	Actual groundwater level depth in well
M_D	Invert level of manhole
D	Depth from ground surface to groundwater level in well

LIST OF ABBREVIATIONS

ASCE	American Society of Civil Engineers
BP	Bandar Putra
BS	British Standard
HDPE	High-density polyethylene
IWK	Indah Water Konsortium Sdn. Bhd.
KS	Kota Sas
MH	Manhole
MS	Malaysian Standard
MSIG	Malaysian Sewerage Industry Guideline
OSS	On site survey
PE	Population Equivalent
PFF	Peak flow factor
PVC	Polyvinyl chloride pipe
SPAN	Suruhanjaya Perkhidmatan Air Negara
STP	Sewerage Treatment Plant
TLHS	Taman Lepar Hilir Saujana
TPD	Taman Pandan Damai
UMP	Universiti Malaysia Pahang
VCP	Vitrified Clay Pipe

LIST OF APPENDICES

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