

Drainage Network System of UTHM Campus

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Abstract: Rapid development has led to many physical changes in Malaysia, such as drainage system, including at Universiti Tun Hussein Onn Malaysia campus. The development also speeds up the deterioration of living conditions, such as wastewater blockage, wastewater sedimentation, and stream pollution during the rainy season. The study aims to produce drainage network system that compiles drainage characteristics of Universiti Tun Hussein Onn Malaysia. The study area covers approximately 500,000 m² of the campus. Characteristics of drainage recorded are cross-section, longitudinal slope and Manning's roughness coefficient. Roughness coefficient is obtained from Manning's roughness flow equation. Equipment used is measuring tape, wheeling meter, float and stopwatch to get dimension and longitudinal slope of the drain, and velocity of flow. All drains are observed to be rectangular and trapezoidal sections. Bottom width and longitudinal slope of the drains range from 0.1 m to 4.0 m and 0.0005 to 0.0805, respectively. Depths of flow in the drains are found to be between 0.02 m and 1.05 m. Meanwhile, the average velocity of flow is between 0.017 m/s and 0.1603 m/s. Compilation of UTHM campus drainage network system provides information for better management of the drainage system.

Keywords: Drainage Network, Drainage Characteristics

1. Introduction

A significant part of Parit Raja is facing continual inundation and flooding due to climate change, including Universiti Tun Hussein Onn Malaysia campus. Drainage system management is very critical in Universiti Tun Hussein Onn Malaysia due to low infiltration of peat soil and high water table [1]. Flood is overflow particularly over what is usually dry land, of much water beyond its usual limits. The method of handling a current flood risk situation is managing flood risk in a narrow sense [2]. The flood is caused by water overflow when passing a maximum discharge for a given cross-section area, resistance coefficient, and bottom pendulum.

1.1 Drainage system

The drainage system is important in controlling the flow of surface water and water quality control. The function of the drainage system is to collect and remove waste periodically to maintain safe

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conditions in a community. Surface drainage systems usually consist of an outlet channel that empties into a natural stream, lateral ditches, and field ditches, such as an existing natural stream or a developed channel. These systems primarily to extract water that collects on the ground in flats with low natural drainage, and then the rainfall rate exceeds the infiltration capacity [3]. Universiti Tun Hussein Onn Malaysia has an issue with the flat backwater from the main drain or river flowing back to the drainage area as topography causes a flash flood.

Subsurface drainage describes the method of extracting water that has entered into the soil beyond the amount capillary forces can carry against gravity [3]. In each quadrants, the subsurface drainage system connects the primary drainage to the outlet that empties into a subsurface county main in the field's northwest corner [4].

1.2 Importance of database for management

The important data in the system excluded from the creation and arrangement of the urban water structure using the conventional method because it analyses only one alternative to urban development. In construction, urban modelling projects are widely for scientific use for the most outstanding planning of planned urban expansion with the agreement of environment requirements [5]. The database makes the flow data available to support the drainage system for all the conveyance devices, including open channels, streams, swales, pipes, and waterways. Next, the database may define the maintenance design features and provide requirements to ensure successful and efficient operation. It also provides the public with the location, scale, schedule, profile, and cross-section of all current and planned watershed hydrological features and facilities, including channels, pipes, ditches, streams, and reservoirs. The soils and preliminary research to control erosion during construction and hydrological modelling can be defined by other information supplied by the database.

1.3 Previous research

There are previous studies of articles relating to the development of the drainage design system. Inadequate drainage of rainwater is a problem encountered in many cities of Nepal. In Lamachaur, Pokhara and other urban areas of Nepal, one can easily observe flooded streets during the rainy season. The present drainage system of Lamachaur was found to be inadequate to safely drain surface water from Keshav and Basnet [6]. Secondly, Abd-elaty et al. reported the impact of climate change on the design the design of subsurface drainage systems in coastal aquifers in the arid/semi-arid region of Nile Delta. Climate change is a global phenomenon, but on a geographical scale, it is very different. The normal climatic conditions such as heat, wind and precipitation patterns characteristics of any area of the world have been defined as disequilibrium [7].

Current drainage systems are built to extract the excess water generated by flooding as rapidly as possible by draining it into the channel, river, and ending up at sea while absorbing water along the way into the field. According to Sunjoto, the amount of water discharged into the sea as wastewater by convectional drainage systems is nearly the same as the amount of clean water needed in an area. The effect of water will be very superfluous [8]. Finally, the loss of excess water by free subsurface drainage networks is a major cause of inefficiency in the irrigation system of Egypt, according to Emad M Mahmoud et al. With nutrients from the soil profile, the drainage water flows continuously and rapidly [9].

2. Methodology

The methods shown in this study are intended for researchers, engineers, and developers to practice with their models or are available as a database layout of the drainage design system. The main objective of this analysis to create a database for the drainage system and features of the southwestern UTHM characteristics. The method of data collection is required to achieve these objectives. Microsoft Office, such as Microsoft Word, Microsoft Excel, and Microsoft Powerpoint, are the resources needed to

incorporate input data into the layout. Observation experiments in the field, data collection, discussion, conclusion, and suggestions were the method used. Primary data for the southwestern region of UTHM can be collected through observation and calculation.

2.1 Location of the study area

This database development study is located at the Southwest of Universiti Tun Hussein Onn Malaysia Parit Raja. It covers approximately 500,000 m² which including Office of Development and Maintenance (PPH), Sultan Ibrahim Hall (DSI), University Health Center (PKU), Academic Management Office (PPA), Students Affairs Office, Tunku Mahkota Ismail Hall (DTMI), Arked Café, University Sports Center Stadium and marching field. In this place, there are many earth drains, block drains, road drains, pipe drains, natural drains, and lakes. Multiple quantities of data from these hydraulic drainage systems, such as the size, gradient, slope, flow rate, velocity, and roughness coefficient, are then required to be manually calculated to establish a database that will encourage future growth. The Southwest of UTHM divided into a smaller zone: zone A, zone B, zone C, and zone D as shown in Figure 1. Each zone is then separate into another smaller part as these parts are the drain itself.



Figure 1 Delineation of The Study Area Into 4 Zones

2.2 Methods

The drainage parameters and characteristics were observed and recorded. Using Google Maps, the drain length is determined by selecting the start point of the drain and dragging it to the end of the drain. The visual drain can be clearly seen in Google Maps, but this approach could not be accurate when measured using a wheel roller. The length calculated using Google Maps is shown in Figure 2. Measured directly on-site will need a very long time and a long route to complete an area.

The velocity of flow is effectively-identified shortly after rainfall events because the water level is rising; thus, water flows rapidly. The velocity of flow is measured by float, thread, long ruler, and stopwatch. A float is used to estimate the uniform velocity for data collection with two reference points for float set using a 1 m long ruler. Once the float begins to travel from the starting point, the stopwatch started.



Figure 2 A drain within UTHM campus shown by Google Map

The slope runoff was calculated using a phone application called bubble level and a 1 m long ruler. This calculation is taken to assess whether the drain is steep or slant and calculate Manning Roughness's coefficient, n . As the base, a ruler is placed inside or beside the drain on the ground. The phone is placed on the ruler with the application and ensures that it stands immediately following its gradient.

2.3 Equations

In terms of Manning Roughness Coefficient, n , roughness in surface irrigation has been expressed. Many current methods for estimating Manning Roughness allow us to collect data in the advanced water process on surface water depth [10]. This research was designed to develop techniques for calculating the coefficient of Manning roughness n where data on surface water depth is needed.

$$Q = AV \tag{Eq 1}$$

$$Q = \left(\frac{1}{n}\right) AR^{\frac{2}{3}} S_o^{\frac{1}{2}} \tag{Eq 2}$$

where, Q = rate of flow, n = Manning roughness coefficient, A = flow cross-sectional area, R = hydraulic radius, and S_o = longitudinal slope of drain. The hydraulic roughness coefficient is used to estimate channel surface runoff and river overland flow ranges. The surface runoff velocity is regulated by hydraulic roughness. Darcy-Weisbach hydraulic roughness coefficient given as

$$V = \sqrt{\frac{8gRS_o}{f}} \tag{Eq 3}$$

G =acceleration due to gravity, S_o =average longitudinal slope, V =velocity of flow, R =hydraulic radius, and f =friction coefficient. While in metric units, Manning hydraulic roughness coefficient n is given as

$$V = \frac{1}{n} R^{\frac{2}{3}} S_o^{\frac{1}{2}} \tag{Eq 4}$$

Manning and Darcy-Weisbach hydraulic roughness coefficient can be related using the following equation

$$n = \frac{R^{\frac{2}{3}} S_o^{\frac{1}{2}}}{V} \tag{Eq 5}$$

3. Results and Discussion

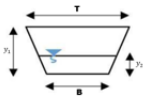
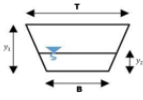
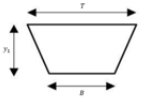
Drainage characteristics were reported and analyzed during the observation and data collection carried out through the fieldwork. The outcomes are attached in the appendix. Observations show that inadequate drainage size can cause runoff of water and thus lead to complete flooding. Reasonable slope measurement is necessary to ensure that water runoff flows smoothly. However, the drainage system is

minor in the Southwest region of the UTHM Parit Raja campus. It is responsible for storing, regulating, and moving water from all buildings, facilities, and services on campus to mitigate disturbance and flooding take place in the future.

3.1 Results

The drains are only rectangular and trapezoidal. There are few natural drains in my study, and most of the drains are concrete drains around the buildings. The water depth for such drains was 0.1m, as not all drains were filled with water. The depth will not be zero since the hydraulic radius, and the Manning roughness coefficient would have an unknown value. The assumption also applies to the velocity because water flow does not occur if there is no water, and velocity will not happen. Drainage A1 can be taken as an example in this calculation since this drain is a trapezoidal shape. Table 1 shows the dimensions of drainage system for drain A1.

Table 1 Dimensions of drainage system

drain name	Location	length of drain (m)	sketch and dimension of drain	B (m)	T (m)	y ₁ (m)	y ₂ (m)	z
A1	Persiaran Tun Mohd Zahir Ismail	58.86		0.70	0.80	0.9	0.1	0.5
A2	Persiaran Tun Mohd Zahir Ismail	181.93		0.90	1.55	0.4	0.18	1.8056
A3	Persiaran Tun Mohd Zahir Ismail	407.17		0.70	0.8	0.9	0.1	0.5

For the trapezoidal section, *A* is the cross-sectional area of flow normal to the direction of flow given as

$$A = By + zy^2 \tag{Eq 6}$$

Wetted perimeter *P* is the length of the lapped line of the channel wetted surface with a cross-sectional plane normal to the direction of flow, was calculated as

$$P = B + 2y\sqrt{1 + z^2} \tag{Eq 7}$$

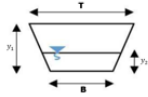
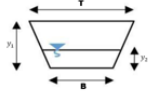
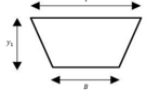
Hydraulic radius *R* is the ratio of the flow area to the wetted perimeter, was calculated by

$$R = \frac{A}{P} \tag{Eq 8}$$

Three readings were taken at each selected drain to obtain average velocity. In a separate section of the drain, the readings are taken as the water passes into it. It took about 25.59 seconds for the first reading, following by 14.27 seconds, and 10.16 seconds for the final reading. The example results of the value of the average velocity for each zone are shown in Table 2. The water is gradually flowing rapidly from an end to the middle of the drain. the average velocity of drain A1 was calculated by

$$V = \frac{V_1 + V_2 + V_3}{3} \tag{Eq 9}$$


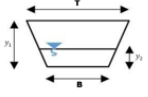
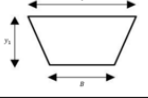
Table 2 Average velocity of drainage system

drain name	Location	length of drain (m)	sketch and dimension of drain	velocity 1 (m/s)	velocity 2 (m/s)	velocity 3 (m/s)	average velocity (m/s)
A1	Persiaran Tun Mohd Zahir Ismail	58.86		0.0333	0.0250	0.0217	0.0267
A2	Persiaran Tun Mohd Zahir Ismail	181.93		0.0333	0.0250	0.0217	0.0267
A3	Persiaran Tun Mohd Zahir Ismail	407.17		0.0333	0.0250	0.0217	0.0267

The reading of the longitudinal slope also has been taken three times. Since drain A1 is concrete cement rubble masonry, the Manning roughness coefficient n is 0.022. Table 3 shows the example results for the value of slope runoff for each zone. The average longitudinal slope was calculated by

$$S_o = \frac{S_{o1} + S_{o2} + S_{o3}}{3} \tag{Eq 10}$$

Table 3 Slope of runoff for drainage system

drain name	Location	length of drain (m)	sketch and dimension of drain	S1 (m)	S2 (m)	S3 (m)	slope of runoff, S_o (m)
A1	Persiaran Tun Mohd Zahir Ismail	58.86		0.1051	-0.0437	-0.0261	0.0118
A2	Persiaran Tun Mohd Zahir Ismail	181.93		0.1228	-0.0175	-0.0612	0.0147
A3	Persiaran Tun Mohd Zahir Ismail	407.17		0.1051	-0.0454	-0.0175	0.0141

3.2 Discussions

This research was done to determine the structure and characteristics of the drainage system, such as the drain dimension, coefficient of roughness, velocity, and slope. Data have been measured and recorded by doing fieldwork before compiled into a database that includes all zones in UTHM. The results show that most of the drain shape, followed by the rectangular and trapezoidal shape. Due to their durability, these two shapes are widely used in drainage systems and best used for maintenance. The bottom width varies between 0.2 m and 0.4 m, and the flow depth varies between 0.4 m and 1.05 m. The depth of water was assumed to be 0.1m because some drains do not carry water. In determining the characteristics, starting with the flow area, the wetted perimeter, the hydraulic radius, and finally the roughness coefficient, this value is important. The Manning roughness coefficient is undefined if there is no value for the height of the water table.

The drainage system plan layout in the Southwest of UTHM was presented as described in the objective. The layout includes related zone plan drawing, drain pictures, and lists of drain length, longitudinal velocity slope, and Manning roughness coefficient.

4. Conclusion

Universiti Tun Hussein Onn Malaysia is constantly being developed to offer students and employees better study and working conditions. The development alters existing characteristics of the drainage system. Therefore, it could help designers, developers, and engineers know the current drainage system before project formation with the features of drainage systems such as the size, velocity, and roughness coefficient prepared from this project. The presence of this database could encourage maintenance work in addition to the construction of buildings. To decide the type and amount of cleaning contractor will need a preview of the condition of the drains before the cleaning phase. The conclusion should summarise the main findings of the analysis and reflect the main points that emerge from the data-related patterns observed and addressed. Some suggestions are to ask friends to calculate longitudinal slope during fieldwork and to use previous levelling results. Preferably use an instrument to calculate water velocity, such as an anemometer, and recommend visiting the site immediately after a rainfall to allow runoff to collect a high water level.

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