SUSTAINBALE ROAD DRAINAGE SYSTEM

INTRODUCTION

Road drainage system is mainly design to remove water from the road and its surroundings. The problem with conventional road drainage systems is water clogging, flooding and water pollution of the environment. In 2002, Malaysian government has introduced the Manual Saliran Mesra Alam (MSMA) to be implemented towards achieving sustainable stormwater management.

Sustainable road drainage systems is a natural systems with low environmental impact to drain away dirty and surface water run-off through collection, storage, and cleaning before allowing it to be released slowly back into the environment, such as into water courses.

Conventional road drainage system

Conventional road drainage systems have not been design with green approach which is cannot be considered as a sustainable concept. The major problem with conventional road drainage system is a scouring especially at the downstream due to high flow velocities. Conventional road drainage system is lack on water quality when discharge surface runoff to the discharge point. It is no consideration on element of infiltration, sedimentation and filtration in the conventional drainage. Lack of maintenance can reduce the functional of drain because of blockage and erosion.

Sustainable drainage

Sustainable drainage is a concept towards solving three major problems in Malaysia which are flash flood, water scarcity and water pollution. This is along term environment and social factor about drainage. Sustainbale drainage using a component such as swale, bio-retention dry pond, dry retention basins, ponds and constructed wetlands. The system will minimize the amount of pollution entering the downstream waterways. This paper will discuss on grass swale which is most practical to implement in Malaysia.

Grass swale

Swales are shallow vegetated channels designed to convey road runoff and treat pollutants through filtration and sedimentation through the soil matrix and infiltration into the underlying soil. Swales are design to enhance the water quality before discharge the surface runoff or water collection to the discharge point. The grass will slow down the flows and trap particles and remove pollutant.

The benefits of swale compere to conventional drains are easy to incorporate into landscaping (design, construction and maintenance), good removal of urban pollutants and reduces runoff rate and volume. In term of costing, it is low in capital cost. Swales are not suitable to be constructed in steep areas and limited to small areas. Swales are risk of blockage in connecting pipework or culvert. In certain areas, we may have insufficient land to incorporate for suitable swale design. Standing water in vegetated swale can result in potential safety, odour and mosquito problems

	
An ecological swale with river gravel making up the low flow channel	Shallow vegetated channels designed to convey road runoff and treat pollutants

Design consideration and requirements

The design should have the capacity to convey the flow up to and including the minor system design ARI. Swales are design to enhance water quality. Therefore, the design of swales channel with sufficient mild slope and cross-sectional are important to take into account to maintain non-erosive velocities. The important consideration to take into account is the design of swales should not be sited on unstable ground.

The design of swale should be incorporated into landscaping and public open space and basically difficult to incorporate into dense urban development where space is limited. Steeper side slope must be avoided and the design should be allow for shallow flows and adequate water quality treatment. Reserve must be provided to allow for maintenance purpose.

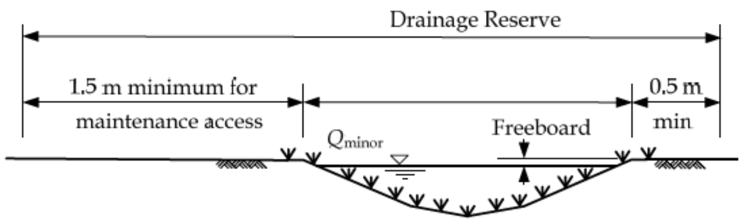

Figure 1: Drainage reserve for swale

There are three (3) shapes of swale that suggested in MSMA 2012. It is 'vee' or triangular shape, trapezoid shape and parabolic shape. Trapezoid shape cross sections are recommended for ease of construction. A parabolic shape is best to control erosion, but is hard to construct.

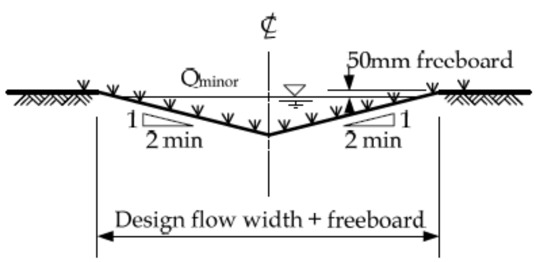

Figure 2: 'Vee shape'

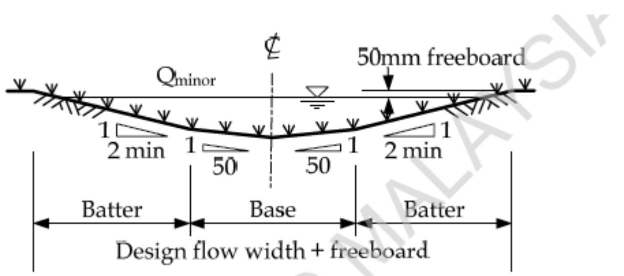

Figure 3: Trapezoid shape

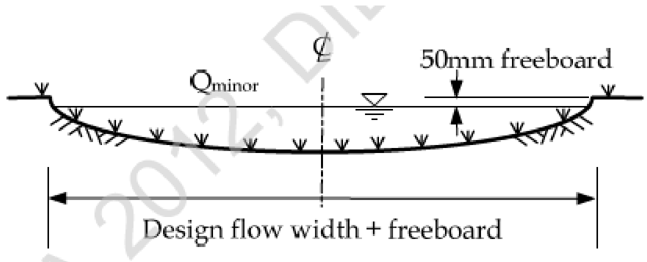

Figure 4: Parabolic shape

Longitudinal slope for swales should be between 0.1% (1 in 1000) and no greater than 0.5% (1 in 200). For slope below 0.2% (1 in 500), underdrain may be required. For slope greater than 0.2%, rock deck dams in channel may be required to reduce the flow velocities. Freeboard 50 mm above the design stormwater shall be included to allow for blockages. Maximum flow rate of velocities suggested in the MSMA 2012 is less than 2m/s unless additional erosion protection is provided.

Grass species for swale must be sturdy, drought resistant, easy to establish and able to spread and develop a strong turf layer after establishment. A thick root structure is necessary to control weed growth and erosion. At least 100mm thick compacted of good quality topsoil is required before grass seeding or planting. A grass height should be maintained at a height of 75-150 mm to prevent flattening during flow events, which prevents sedimentation.

Roughness coefficient, *n*, varies with the type of vegetation cover, longitudinal slope and average depth. Floe velocities for extreme events should be kept below 1.0m/s (or 2.0 m/s if slope stability, soil erosion and safety conditions allow) to prevent erosion.

A swale should have the capacity to convey the peak flows from the design minor ARI without exceeding the maximum permissible velocities. If this is not practical or there is insufficient space for a swale, underground pipedrains or drainage module can be provided.

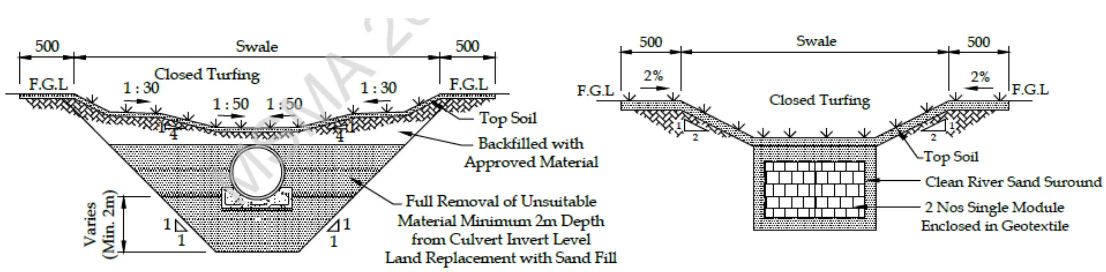

Figure 5: Example of underdrains provided in the subsurface of a swale

Maintenance of swale

Performance of swale is dependent on maintenance. The major maintenance requirement for swale is grass cutting. Grass should be retains at 75-150mm of length to assist in filtering and retaining sediments and to reduce the risk of flattening during runoff events. Grass clippings should be disposed outside the area of the swale to remove nutrients and pollutants.

Occasionally, sediment will need to be removed, although this can be minimized by ensuring that upstream areas are stabilized and by incorporating effective pre-treatment devices. Sediment excavated from a swale that receives runoff from residential or standard road and roof areas are generally not toxic or hazardous material and can therefore be safely disposed of by either land application or landfilling. Sediment testing may be required before sediment excavation to determine its classification and appropriate disposal methods. Any damage due to sediment removal or erosion should be repaired and immediately reseeded or planted.

CONCLUSION

Grass swale has the ability to reduce on site peak flow rates by increasing the roughness of the channels and infiltration rates. These vegetation systems also provide runoff quality treatment by removing low concentration and quantities of TSS, heavy metals, hydrocarbon and nutrients from stormwater. The vegetated systems remove pollutants by means of sedimentation, filtration, soils absorption and plant uptake. To make sure the drainage is functional as the design, the drainage system should include facilities for ease of maintenance.

References:

1. Manual Saliran Mesra Alam (MSMA), 2002, Jabatan Pengairan dan Saliran, Malaysia.

2. CIRIA Suds Manual, 2015, London, UK.

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