

Erosion and Sediment Control Requirements for Construction Sites



by Engr. Ngoi Si Cheng and Engr. Choo Ee Li

IN the process of urbanisation, uncontrolled construction activities often create considerable impacts and damage to the surrounding community and environment. Erosion and sedimentation impacts during construction represent a major environmental issue that needs to be addressed and mitigated to prevent unwanted impacts and damage to the surrounding environment. The impacts and damage from erosion and sedimentation are more significant at those developments located at or near to sensitive areas such as highland and waterways (rivers, streams, and swamps).

Below are some of the erosion and sediment hazards caused by uncontrolled construction activities:

- Uncontrolled massive site-clearing without surface protection which exposes the soil surface to wind and water erosion;
- Changes in water runoff, earth movement, sedimentation accumulation, etc.;
- Water pollution and change in river bed levels due to the accumulation of sediments transported from the construction site; and
- Damage to the aquatic life habitat which affects the fishery and agriculture industries.

In order to effectively mitigate the erosion and sedimentation problems, Best Management Practices (BMP) should be planned, designed, implemented and maintained at construction sites. A well prepared and comprehensive plan is the most important factor among the considerations in the BMP. Prerequisites to plan the BMP include understanding the project, collection of all relevant information and allocation of a budget for the BMP.

The Department of Irrigation and Drainage Malaysia (DID) in 2001 introduced a design guideline and manual entitled *Urban Stormwater Management Manual for Malaysia* (MSMA). Recently in 2011, DID further issued a new specific design guideline and manual named *Guideline for Erosion and Sediment Control in Malaysia* to further enhance the erosion sediment control chapter listed in the MSMA. In this latest guideline, all the required local parameters for erosion rate calculation (RUSLE formula) and sediment yield calculation (MUSLE formula) are indicated. This guideline provides sufficient information for planners, developers, engineers and contractors engaged in the planning, design, BMP selection, and construction of the appropriate measures to be adopted on site.

For many years in the past, government agencies of Malaysia such as Department of Environment (DOE) and Department of Irrigation and Drainage Malaysia (DID) have been playing an important role in monitoring and controlling the erosion and sediment impacts caused by development. The awareness of the hazards of erosion and sedimentation that have become more severe and noticeable in recent years has led DOE to introduce a new requirement in 2011 which asserts the following:

1. *All projects subject to Environmental Impact Assessment (EIA) Order, 1987 which involve soil disturbing activities and site preparation are required to prepare an Erosion Sediment Control Plan (ESCP) as part of the EIA approval condition. ESCP will be an integral component of the environment management plan (EMP) prepared by the project proponent/consultant to be submitted and approved by the DOE. Non-compliance with the specifications stipulated in this guidance document will cause delay in the EMP processing.*
2. *The ESCP prepared for EIA projects must be designed based on the project concept, components and minimum mitigating measures approved in the EIA conditions of approval and the preparation of the ESCP must comply with the following guidelines:*
 - *Guideline for Erosion and Sediment Control in Malaysia (2010), DID Malaysia.*
 - *Urban Stormwater Management Manual for Malaysia (2000), DID Malaysia.*

The ESCP shall contain a declaration by the ESCP preparer that the ESCP has been prepared and BMPs have been designed according to the applicable criteria/specifications / standards / codes of practice and best engineering practices in erosion and sediment control.
3. *ESCP shall be prepared and signed by a Professional Engineer who is also a Certified Professional Erosion Sediment Control (CPESC) specialist. (As an interim measure, an equivalent certification may be accepted. The non-CPESC professional must submit certified evidence to the DOE and obtain DOE's consent before undertaking any assignment on ESCP preparation).*
4. *ESCP shall contain a declaration by the owner or authorised person that he will undertake the responsibility to ensure the Erosion and Sediment Control Plan (ESCP) will be implemented and Best Management Practices (BMP) stated in the ESCP will be installed, inspected, and maintained.*

(Continued on page 19)

5. *The ESCP is valid for 2 years if there is no change in the project concept and layout.*
6. *The ESCP prepared by the Professional Engineer shall be submitted to the Department of Irrigation and Drainage (DID) for endorsement. Pre-submission discussion with the Department of Environment (DOE) is recommended. Two copies of the ESCP which has been endorsed by the DID shall be submitted to the DOE within two weeks from the endorsement date.*
7. *Appropriate BMPs shall be selected with emphasis on preventive measures especially erosion control, runoff control and management and preservation of natural vegetation and buffers.*

Erosion and sedimentation is a problem for all construction projects, especially for construction projects located in sensitive areas as mentioned earlier. Water resource projects involving dam construction is one such example, as they are normally located in highland areas. Further more, dam construction in countries under the influence of tropical climate with heavy precipitation, such as Malaysia, will further aggravate the erosion and sedimentation problem.

Under such climatic conditions coupled with the steep terrain of highland topography, the generated surface runoff from a storm event tends to have a high peak and fast velocity. These characteristics of the runoff discharge are highly erosive to the exposed soil surface within the construction area. Careful and comprehensive planning is thus necessary to ensure effective implementation of practical erosion and sediment control measures.

Among the commonly used mitigating measures are construction of silt traps and check dams, installation of silt fences and placing of matting or sheet covers over exposed slope surfaces to minimise the erosion as well as to control and manage the generated sediments from polluting the receiving waters. These measures are part of temporary works during the construction period and are divided into the pre-bulk and post-bulk stages.

The pre-bulk stage is associated with preliminary works at a construction site such as site clearing activity which can leave the land surface exposed to erosion or any temporary condition that might result in a potential risk of erosion. Meanwhile, the post-bulk stage involves major earthwork activity such as during and immediately after cut and fill operations to reach the finished or designed levels. In the latter stage, the erosion and sedimentation impact is much more significant; thus, the implemented erosion and sedimentation control measures at the pre-bulk stage will have to be progressively improved or upgraded and added, if required, to cater for the subsequent post-bulk activities.

In highland areas, exposure of the bare land surface should be minimised as much as possible to only areas required for the current construction needs. In other words, there should be no indiscriminate clearing, and clearing of land and earthworks should be properly planned and carried out in stages. The exposed soil surface in areas of steep slopes should be protected by providing appropriate cover such as fibre matting, geotextile sheets, hydroseeding or turfing, depending on the stage of work, as these are sensitive areas which are more susceptible to erosion in comparison with exposed land surface on flatter terrain.

However, subsequent to these measures, the issue concerning the appropriate timing to apply the cover arises. As the nature of construction work is temporary until completion, the construction area is thus continually changing as work progresses. This changing environment is a familiar occurrence during earthwork activity in highland terrain involving extensive cut and fill slopes. The engineering specification will normally specify hydroseeding or turfing for the final slope cover while temporary protection of slope comes under the contractor's scope of work.

If the construction progress is fast-moving, applying slope cover in the intermediate stages could actually be a hindrance to the project progress as it involves double handling of placing and removing the cover every time the work ends for the day and before the work commences on the next day. Delay in completion would just prolong the potential threats to the environment. Therefore, for the benefit of the environment as well as for timely completion of the project, an allowable exposure period of the soil surface regardless of the construction stage should be set, exceeding which, the exposed slope will need to be protected. These exposed areas of very steep slopes, or steep slopes beside waterways would be recommended to be protected at all times to prevent direct sediment pollution.

Erosion and sediment control measure is not meant to work in isolation, but rather as a system. In addition to controlling the erosion rate at source through construction planning and applying protective cover, there is also a need to manage the eroded sediment from ending up in the receiving waters and polluting them. Among the measures used are constructing a series of check dams, especially along steep drains, silt traps at drain outlets, and silt fences to impede sediment movement overland.

The check dam serves to reduce the fast flowing velocity and thus, reduces the eroding impact while it also helps to arrest some of the coarser sediments, which subsequently reduces the sediment load at the receiving end. On the adoption of silt traps extra caution will need to be considered as construction of silt traps in steep terrain may not be a practical choice in terms of safety and costs, as it would be difficult to find suitable locations for the silt traps. Excavation for silt traps could lead to instability and slope failure of the existing slopes, resulting in additional costs for stabilisation works.

As the sediment control measures are only temporary, the justification for geotechnical expenses for stabilisation work arises when the costs and works are extensive. For both the check dam and silt trap measures, there must be a proper drainage system plan on site to control the runoff. Silt fences could be installed to arrest the sediments in overland or sheet flow across flatter areas, or as a divide between the exposed land and waterway beside it to minimise the flowing of sediments into the waterway. In a construction project, a combination of the above measures is normally adopted. Some pictures of the above sediment control measures implemented on site are shown in Figure 1 to 3.

In addition to design and implementation of the appropriate erosion and sediment control measures, there should also be a proper maintenance scheme set up to regularly inspect, repair any damages if required, and continuously maintain these measures to ensure effective and optimum performance.

Once the accumulation sediment has reached a specific height, normally one third of the height behind the check dam and silt fence, or a certain depth, normally less than 300 mm below full depth of the silt trap, removal of the sediments (see Figure 4) needs to be carried out soonest possible



Figure 1: Construction of Check Dam



Figure 2: Silt trap on site



Figure 3: Provision of a silt fence on site

before the next storm occurs. The effectiveness of the implementation of the ESCP shall be evaluated through regular environmental monitoring and auditing. Therefore, it is essential that sufficient resources in terms of manpower and funds are allocated, mainly by the contractor, and to maintain good housekeeping as per the BMP, apart from keeping records or logs throughout the construction period.



Figure 4: Removal of sediment from silt trap

In summary, government departments such as DOE and DID have placed great interest and focus on addressing the erosion and sedimentation problem, which is a major environmental concern as the nation continues to undergo development, as it threatens the already stressed and polluted river system. New guidelines have been issued as part of the effort to address the issue. The guidelines range from the study on impact assessment aspects to engineering design and the eventual monitoring of implementation of control measures.

At each stage, application for the relevant authority approval is required. Under the requirements, a qualified engineer or supervisor shall prepare the ESCP and inspect its implementation respectively. There are many factors that come into play and various aspects to consider in ensuring appropriate and effective erosion and sediment control measures are implemented on site. Continual efforts to sustain the measures also play an important role in maintaining effective and optimum performance. The complexities of the measures are much higher for water resource projects located in sensitive areas such as storage dams for hydropower or water supply schemes. And with the growing attention and stricter enforcement by the authorities on implementation of erosion and sediment control measures, this has become a new challenge for engineers. ■

REFERENCES

- [1] DID Malaysia, "Urban Stormwater Management Manual", Ministry of Agriculture, 2000.
- [2] DID Malaysia, "Guideline for Erosion and Sediment Control in Malaysia", Ministry of Natural Resources and Environment, 2010.
- [3] DOE Malaysia, "Guidance Document for Addressing Soil Erosion and Sediment Control Aspects in the Environmental Impact Assessment Report", DOE Putrajaya Announcement, 2011.
- [4] DOE Malaysia, "Guidance Document for Preparation and Submission of Environmental Management Plan", DOE Putrajaya Announcement, 2011.
- [5] DOE Malaysia, "Guidance Document for the Preparation of Soil Erosion and Sediment Control Plan", DOE Putrajaya Announcement, 2011.