Performance comparison between infiltration and non-infiltration type of structural stormwater treatment systems

Marla C. Maniquiz, Byung-sik Lee and Lee-Hyung Kim*

Dept. of Civil & Environ. Eng'g., Kongju National University, 275 Budaedong, Cheonan, Chungnamdo, 330-717, Korea (*Corresponding author's e-mail: leehyung@kongju.ac.kr)

Keywords: infiltration BMP; non-infiltration BMP; treatment performance

In Korea, low impact development (LID) site design that incorporate stormwater features into the everyday landscape by using techniques that infiltrate, filter, store, evaporate, and detain runoff close to its source are being adopted in urban development to address issues of physical and biochemical impacts of watershed urbanization on the aquatic ecosystem (Park et al., 2008). In this study, the performance of four structural best management practice (BMP) pilot technologies (categorized to infiltration and non-infiltration type) developed and constructed at Kongju National University campus were compared and evaluated based on their performance in reducing the total volume of runoff and pollutant loadings. In addition, using a monitored storm event data and physical design characteristics (e.g. construction cost, catchment area, surface area and storage volume) in Table 1, regression plots were generated which can be used as a reference for future selection and application of BMP for LID site design based on stormwater needs and regulatory requirements.

Table 1. Physical design characteristics of the structural stormwater treatment systems.

Category	Facility Code	CA:SA[1] (m^2/m^2)	CA:SV[2] (m^2/m^3)	SA:SV[3] (m^2/m^3)	Cost/TV[4] ($/$m^3$)
Infiltration	EBF	104	135	1.30	1,869
	GEF-2	200	256	1.28	2,601
Non-infiltration	SCW-1	92	219	2.38	2,777
	SCW-2	65	155	2.38	3,287

[1]Ratio of catchment area to facility surface area; [2]Ratio of catchment area to facility storage volume; [3]Ratio of facility surface area to facility storage volume; [4]Total capital cost per unit total volume.

Based on the results, infiltration type performed better than non-infiltration type in terms of runoff volume and pollutant reduction. Infiltration type was able to reduce 20 to 30% organics, 10 to 25% nutrients and 5 to 45% heavy metals greater than non-infiltration type; TSS removal was comparable to both types with at least 80% reduction (Fig. 1). The infiltration type was able to reduce the total runoff volume by as much as 72% (mean) that is 25% greater than non-infiltration type (Fig. 2). Particularly, infiltration type could achieve a 60 to 90% reduction of total volume for rainfall below 10 mm while only approximately 50% for non-infiltration type (Fig. 3).

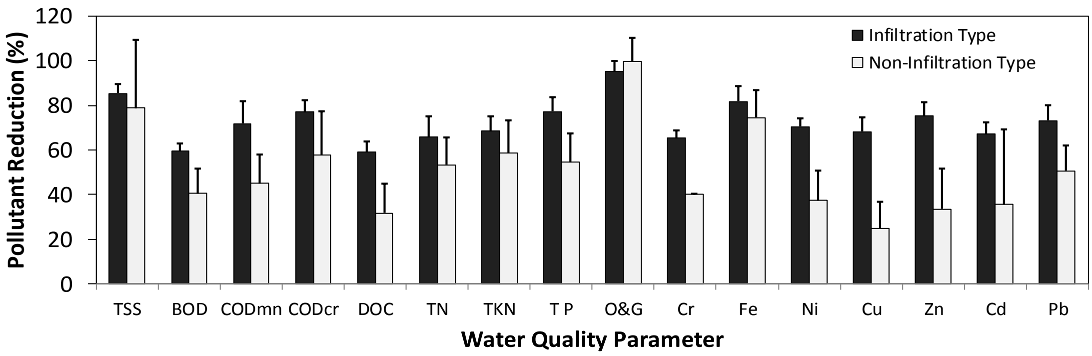


Figure 1 Average pollutant removal efficiency (mean ± S.E.).

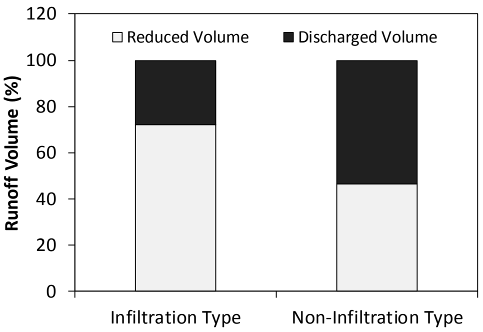


Figure 2 Percentage of reduced and discharged volume.

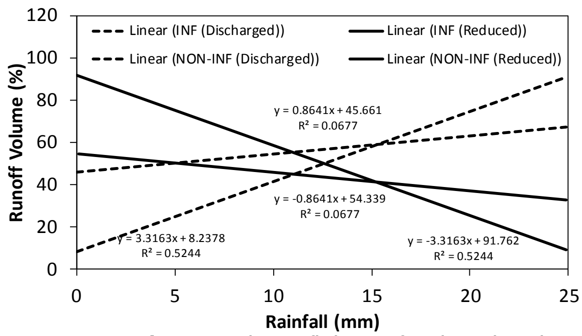


Figure 3 Linear fittings of reduced and discharged volume with respect to rainfall.

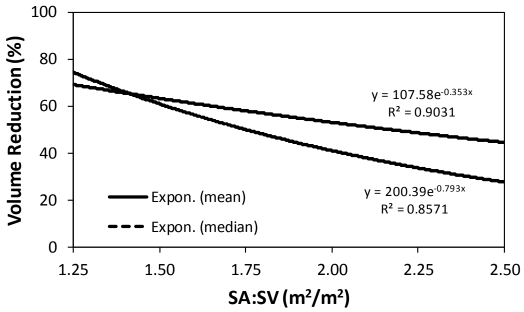


Figure 4 Exponential fittings of volume reduction with respect to SA:SV.

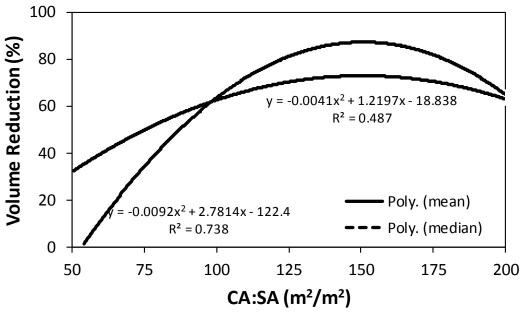
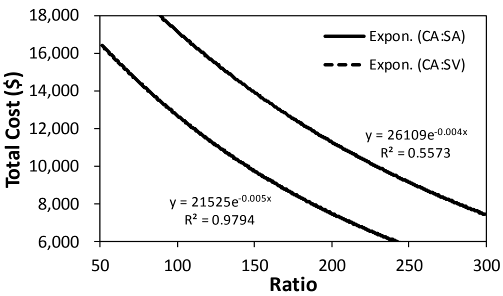


Figure 5 Polynomial fittings of volume reduction with respect to CA:SA.



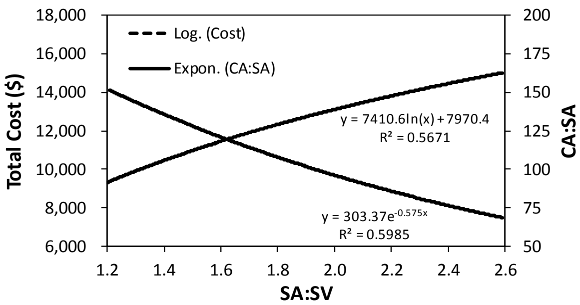


Figure 6 Exponential fittings of total cost with respect to CA:SA and CA:SV.

Figure 7 Satisfactory fittings of total cost and CA:SV with respect to SA:SV.

Satisfactory fittings were obtained when average volume reduction was regressed with SA:SV and CA:SA ratios (Figs. 4 and 5). The rate of decrease of mean volume reduction was 20% per unit increase of SA:SV. For CA:SA below 100, the rate of decrease of mean volume reduction was 0.6% per unit increase of CA:SA. Higher reduction rates (e.g. more than 60%) could be achieved for CA:SA between 100 and 200, which corresponds to a facility surface area of 1 to 2% of catchment area. Cost could be reduced by $5,500 per 100-unit increase in CA:SA ratio (Fig. 6).

Based on the study, it was therefore concluded that infiltration type was the preferred structural stormwater treatment system. For optimal design, a storage volume of 63% of facility surface area (SA:SV=1.58), and facility surface area of 0.8% of the catchment area (CA:SA=122.5) for approximately $11,350 total capital cost is suggested (Fig.7). In terms of application, higher CA:SA or SA:SV ratios could possibly decrease the total capital cost; however, the total runoff volume and pollutant loadings could not be satisfactory reduced.

Reference

Park, J. H., Yoo, Y. G., Park, Y. K., Yoon, H. T., Kim, J. K., Park, Y. S., Jean, J. H., and Lim, K. C. (2008). Analysis of Runoff Reduction with LID Adoption using the SWMM. *J. Korean Society on Water Qual.*, **24**(6), 805–815.