Sheet Steel Facts 22

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Steel Building Systems: Managing Storm Water Cost Effectively

Introduction

One of the frequently asked questions when considering a Steel Building System is, "How can storm water be managed effectively?" Traditional flat roofing systems use the roof area to hold the storm water and gradually allow it to drain into the existing storm sewers. However, this practice is coming under increasing scrutiny for several structural, environmental & maintenance reasons including the increasing risk of roof leaks, particularly as the membrane ages. Described in this Fact Sheet are ways that Steel Building Systems can cost effectively manage storm water runoff.

Natural hydrologic balances are often adversely affected by land development. The most significant change is an increase in storm water runoff caused by adding impervious surfaces such as roofs, streets and parking areas. High runoff volumes and greater peak flow rates following property development can result in millions of dollars in damage causing:

- Overloads on existing storm sewers
- Overloads on existing sewage treatment plants
- Lower groundwater tables
- Soil erosion
- Increased pollution of streams and lakes
- Excessive siltation of streams and lakes.

To minimize these affects, an analysis of the capabilities of existing downstream storm water facilities is an essential part of pre-development planning.

What is Storm Water Management

Stormwater management is the practice of controlling storm runoff from urban areas to reduce the impacts of development on the downstream environment. Generally, runoff quantity is controlled, but water quality improvements may also be a design consideration.

Quantity control, which mitigates flooding and erosion, consists of:

- peak flow control
- restriction or optimization of downstream flow rates
- temperature regulation

Quality control, which mitigates environmental impacts, reduces:

- suspended solids, trash and grit
- floatable oils and chemicals
- heavy metals
- nitrogen and phosphates

Deep sandy soils will naturally filter impurities from storm water as it infiltrates to recharge ground water. In areas of shallow soil or fragmented rock, storm water may enter the groundwater quickly making infiltration controls necessary to prevent contamination.

Pre-development Design

Watershed characteristics of a planned development can be closely predicted using commercially available computer software. The expected maximum runoff can then be compared to historical levels of the pre-developed condition and to the acceptable capabilities of existing drainage systems. Post development runoff quantities exceeding established limits will require control using one or more of the options provided in this bulletin.

Hydrology

The first requirement in the design of a detention system is the development of hydrographs that describe the pre- and post- developed site conditions. A hydrograph is a plot of discharge over time as shown in Figure 1. The hydrograph for the post-developed conditions is referred to as the inflow hydrograph for the design of the storm water detention system. Once the inflow hydrograph is known and compared to the allowable release rate from the detention system, the required storage volume can be estimated. The objective of the design is to reduce the peak discharge for the post-developed runoff so that it is not larger than the pre-developed discharge.

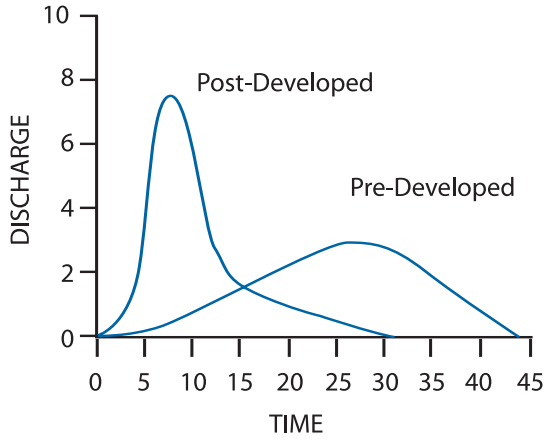

Figure 1: Time-Discharge curve for storm water runoff

Figure 2: Typical sloped roof building site

What is the relationship between Storm Water Management and Steel Building Systems?

All types of building construction impact storm water management. However, there is a misconception that a Steel Building System is at a disadvantage because it does not incorporate a flat roof to retain storm water. While a flat roof may help with storm water management, there are several drawbacks to having a large amount of water retained on the roof. These include increased structural loads, and harsher conditions for the roof membrane (with an increased potential for leaks). Steel Building System construction typically uses a sloped steel roof, and manages the storm water runoff using other types of control.

Storm Water Detention Facilities: Quantity and Quality Control

Whenever planning studies indicate that existing downstream facilities cannot accommodate the projected runoff increases, storm water detention facilities can be used to stabilize runoff rates. Such systems collect and temporarily store excess runoff, while discharging the water at rates not exceeding predetermined levels. There are both aboveground and underground systems that can be used

Stormwater Management Solutions

A) Rooftop

Retaining water on the roof is a common approach to manage storm water. This method utilizes the flat roof area, in conjunction with controlled flow drains, to slow down the discharge of the storm water into the storm sewer.

Costs:
- Minimal

Benefits:
- Long draw-down rate vs. low flow rate
- Single piped outlet
- limited contamination allowing bypass of quality management devices

Drawbacks:
- Water temperature increase may impact downstream fisheries
- Flexing or deterioration of roof membrane
- Higher maintenance
- Higher insurance risk
- Shorter life span
- Structural considerations (i.e. water ponding and ice buildup)
- Potential leaks due to hydraulic pressure
- Standing water infestation

B) Pavement (Car Park Area)

Rainwater, including water from the roof, may be retained on the paved areas. Discharge of water from the catch basins is controlled by outlet devices that restrict flow.

Costs:
- Minimal

Benefits:
- Most expense is in the design/approval stage
- Grading can be used to direct the runoff flow and keep water on the property
- Piped storm systems control and direct discharge to the downstream drainage system

Drawbacks:
- Possibility of short-term pedestrian inconvenience
- Increased maintenance, particularly during winter
- Limited depths allowed in parking lots
- No staged discharge
- Awkward parking grades may be required

Figure 3: Parking lot is often ideal for storm water control

C) Landscaped Pond
If the site permits, a pond may be incorporated to retain water and allow it to gradually enter the drainage system, infiltrate or evaporate.

Costs
- High

Benefits
- Environmentally desirable
- May incorporate quality controls
- Can be made aesthetically pleasing (at a cost)

Drawbacks
- Requires landscaped space
- Requires vertical difference for inlet/outlet
- Requires routine maintenance
- Safety risk and health risk associated with standing water

D) Underground Detention/Retention Systems
When control is needed, subsurface detention systems fabricated from corrugated steel pipe (CSP) have proven to be an effective means of attenuating runoff peaks.

These detention systems work as an integral part of the storm sewer system and provide a temporary storage area for excess storm water. Underground detention units begin storing runoff water when inflow exceeds the permissible discharge rate, The detention system accumulates water and discharges it over an extended time period.

CSP underground detention systems can be sized and shaped to meet most site-specific storage needs. Lightweight sections can be assembled quickly to reduce installation costs and shorten site development time. Versatility in sizing, shapes and fittings allow the designer to detail almost any configuration conceivable. Manholes, sumps, elbows, and tees are factory made, simplifying field installation.

The durability of CSP detention systems need not be a concern. Storm runoff is generally not aggressive to metallic coated steel and granular backfill forms a mild environment. When more corrosive effluents are anticipated, alternate coatings, and heavier walled pipe are options that can be used to meet almost any service life requirement.

Costs:
- Moderate (may be recoverable from little to no roof maintenance)
- Design

Benefits:
- Convenient location - underground
- Less inconvenience to pedestrians
- Staged discharge possible
- Manages volume to improve functionality of water quality management system
- May be designed for ground water recharge
- May be designed for retention and supplemental water uses

Figure 4: Stormwater management pond

Figure 5: Corrugated steel pipe detention systems are unobtrusive and are sized to suit the site requirements

Conclusions

Storm water management is a requirement for all building projects that change the natural runoff characteristics of the site. There are a number of ways that storm water management can be accommodated, each having associated costs and benefits. Steel Building Systems incorporating sloped metal roofing have many advantages for the life cycle cost of the project, including the accommodation of stormwater management systems.

For More Information

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