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PROPOSAL OF EFFECTIVE STORMWATER MANAGEMENT OVER PAVEMENT

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Abstract: According to the United States Environmental Protection Agency (EPA), Storm water management is the effort to reduce runoff of rainwater or melted snow into streets, lawns and other sites and the improvement of water quality. Storm water runoff from urban and suburban areas generates numerous pollutants. The areas include residential areas, parks, commercial areas, industrial areas and road or highways.

Nowadays there is an increasing amount of everyday flood incidents around the world, the impact of which poses a challenge on the society, economy and environment. The goals of storm water management include protecting our environment; reducing flooding to protect people and property; reducing demand on public storm water drainage systems; supporting healthy streams and rivers; and creating healthier, more sustainable communities. In this project we are aiming to manage storm water effectively by providing appropriate storm water control measures (SCMs).

Index Terms **–Storm water management, runoff, flood, rainwater, pollutants.**

I. INTRODUCTION

Storm water management means to manage surface runoff. It can be applied in rural areas but is essential in urban areas where run-off cannot infiltrate because the surfaces are impermeable. In many cases, urban storm water runoff contains abroad range of pollutants that are transported to natural water systems. Storm water pollutants originate from many sources and activities and can occur as either particulate or dissolved forms. The pollutants that are found in urban storm water runoff originate from a variety of sources. The major sources include contaminants from residential and commercial areas, industrial activities, construction, streets and parking lots and atmospheric deposition. Detaining storm water and removing pollutants is the primary purpose of storm water management. Water stagnation over road pavement has an important role in damaging road pavements. This study focuses on the efficient management of storm water using pervious concrete blocks. The main objective was to eliminate water stagnation over road pavement and to filtrate the storm water through special filtration system.

II. IMPORTANCE OF STORM WATER MANAGEMENT

Storm water management plays a critical role in the maintenance of healthy streams, lakes and aquatic life as well as support human uses by maintaining the natural hydrologic cycle. Apart from that areas that embrace storm water management have a low risk of flooding and thus, less likely to experience flooding. It also plays an important role in ensuring water quality. If storm water is not managed, it can carry contaminants to water sources such as streams, lakes and even groundwater.

By reducing the speed and amount of water running to the streams, storm water management helps to prevent excessive erosion. If storm water is not managed, it can cause excessive erosion that may prevent the stream from fulfilling its normal function of conveying water and sediment.

III. METHODOLOGY

3.1 SITE SELECTION

Table 1: Details of selected road

Shoulder width	0.0025 km
Shoulder length	1.5 km
Total width of road	0.0074 km
Total length of road considered for project	1.5 km
Maximum rainfall occurring	780 mm/hr

Fig.1 Selected site

3.2 CASTING OF PERVIOUS CONCRETE BLOCKS

Pervious concrete is also known as permeable concrete or porous concrete. It is a special type of concrete with high porosity that allows water from precipitation and other sources to pass directly through it thus reduce the runoff from site.

Fig.2 Pervious concrete block

Pervious concrete is made using large aggregate using less or no fine aggregates. The concrete paste then coats the aggregates and allows water to pass through the concrete block. Pervious concrete functions like a storm water infiltration basin and allows storm water to infiltrate the soil over a large area. Pervious concrete is used in parking areas, areas with light traffic, residential streets and pedestrian walkways.

3.3 ASSESSMENT OF WATER QUALITY

Water quality of urban runoff is very low due to the presence of pollutants from industries, vehicles etc. It contains numerous contaminants which may lead to spreading of water born diseases like cholera. Pervious concrete creates a very porous medium which allows the water to filtrate to the drainage. So in order to evaluate the pollutants present in the runoff the following tests pH, Turbidity, Acidity, Sulphate, Total dissolved solids and conductivity are conducted.

3.4 DESIGN OF DRAINAGE

Table2. Details collected for design of drainage

PARAMETER	VALUES
Shoulder area	0.00375km²
Coefficient C1(depends on the nature of shoulder surface)	0.35
Built-up area	0.0111km²
Coefficient C2(depends on the nature of built-up area)	0.8

Design of drainage involve

3.4.1. CATCHMENT AREA CALCULATION

Total catchment area is the sum of shoulder area and built-up area

A= Shoulder area + built-up area

From calculations total catchment area was obtained as 0.01485km²

3.4.2. RUNOFF COEFFICIENT

The coefficient C represents the integrated effect of catchment losses. It depends upon nature of surface, surface slope and rainfall intensity.

$$C= (C1A1+C2A2)/ (A1+A2) \qquad (3.1)$$

Constant C was obtained as 0.606

3.4.3. RUNOFF CALCULATION

Runoff was calculated using rational method

$$Q=0.028CIA \qquad (3.2)$$

Where, Q is the maximum runoff in m^3 per second
C is the constant depending on the nature of surface
I is the critical intensity of storm in mm per hour occurring during the time of concentration
A is the catchment area in km^2
Runoff was obtained as $5.416 m^3$/second

3.4.4. HYDRAULIC DESIGN OF DRAINAGE

From continuity equation,

$$Q=AV \qquad (3.3)$$

Where V is the velocity of flow in m/sec
A is the cross section in m^2
Q is the runoff in m^3/sec

3.4.5 LONGITUDINAL SLOPE OF DRAINAGE

Longitudinal slope is calculated using Manning's formula

$$V= (1/n) \times (R^{2/3}) \times (s^{1/2}) \qquad (3.4)$$

Where V is the average velocity
n is the Manning's roughness coefficient =0.015
R is the hydraulic radius=Cross section area /wetted perimeter
S is the longitudinal slope of channel

Table3. Details of drainage

Cross section	Rectangular
Bottom width	1m
Vertical height	1.805m
Free board	0.1m
Wetted perimeter	4.61m
Longitudinal slope	1 in 564

IV. MATERIALS AND METHODS

4.1 MATERIALS

4.1.1 CEMENT

Pozzolanic Portland Cement (PPC) was used throughout the course of investigation.

4.1.2 COARSE AGGREGATE

Broken stone aggregate with specific gravity 2.62 was used. Coarse aggregates include aggregates which passes through 12.5mm and retained in 10mm IS sieves.

4.1.3 WATER

Casting and curing of specimens were done with the potable water that is available in the college premises.

4.2 MIX DESIGN

Mix design was done by completely eliminating fine aggregates to obtain porosity of the blocks. The cement: fine aggregate: coarse aggregate ratio was taken as 1:0:4.

4.3 CASTING OF SPECIMEN

6 specimens of size 150x150x70mm were prepared. Quantity of materials required were calculated as per given in table.

Table4. Mix proportion of specimen

Cement	Coarse aggregate	water	w/c ratio
0.836 kg	3.34 kg	0.293 L	0.35

4.3.1 MIXING

Preparation of pervious concrete was done by hand mixing.

4.3.2 CURING

The test specimens were stored in moist air for 24 hours. After this period the specimens were removed from the mould and kept submerged in fresh water until taken out prior to test.

V.TESTING

5.1 COMPRESSIVE STRENGTH TEST

Testing was done using compression testing machine. The specimens were kept for curing and were tested at curing ages of 7 and 28 days. The test results are provided in the table below.
Compressive strength of the specimen were done using the formula
Compressive strength=Maximum load in N/Area in mm^2.

Table5. Compressive strength results

5.2

Age of curing(in days)	7days	28days
Compressive strength required (in N/mm^2)	15	22
Compressive strength obtained (in N/mm^2)	13.33	16.66

WATER TESTS

Table6. Water test results

PARAMETERS	RESULTS	RANGE(IS C0DE)
pH	6.2	6.5-8.5
Turbidity	28.2NTU	23NTU
Acidity	24mg/l	
Sulphate	63.609mg/l	200mg/l
Total dissolved Solids	88.19mg/l	500ppm
Conductivity	188.4µs	100-200 µs

CONCLUSION

- The maximum compressive strength attained by the pervious blocks casted in the cement: coarse aggregate ratio 1:4 is $22N/mm^2$ whereas the required strength is $35N/mm^2$.
- The pervious concrete blocks casted does not satisfy the strength requirement of pervious blocks for walkways.
- In order to maintain the strength along the walkways iron grills could be laid below the pervious concrete blocks.
- The turbidity of the water samples collected from the site exceeds the maximum limit .By passing the water through pervious blocks turbidity gets reduced up to a certain limit.
- A rectangular drainage on both sides with a longitudinal slope of 1 in 564 will provide efficient drainage for storm water.
- The drainage could be provided with slow sand filters at definite spacing to maintain reusable quality of storm water.

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