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Development of Pervious Pavement for the Effective Management of Stormwater

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Abstract: ***In India water logging in parking lots is major issue especially during monsoon as pavements are normally impermeable. Pervious pavement is sustainable measure to reduce runoff and water logging. Pervious pavement consists of base and sub-base course which allows movement of water percolated through its pervious concrete surface. In addition to reducing runoff this pavement traps suspended solids and filters storm water. Aim of this work is to make pervious pavement suitable for parking lot which allows water to percolate through surface course and collect percolated water by means of perforated pipes laid in base course. This paper gives details of mix design of pervious concrete, construction and cost analysis of pervious pavement.***

Keywords: Pervious pavement , cost analysis

I. INTRODUCTION

Pervious pavement are those in which all layers are intended to be permeable and pavement structure serves as reservoir to store water during storm period in order to reduce storm water runoff. Pervious concrete pavement is an effective way to minimize runoff and water logging issue. It is best solution for problem of increased storm water runoff.

Pervious pavement has ability not only to reduce runoff volume but also to trap suspended solids.

Topmost layer of this kind of pavement consists of pervious concrete. Pervious concrete consists of cement, water, coarse aggregates and little or no fine aggregates. It has open graded structure and has interconnected voids which allows rainwater or stormwater percolate through it. Below pervious concrete boulders are laid which act as water reservoir. Water from this boulder reservoir is drained out through perforated pipes. These pipes are covered with permeable geo-fabric which allows water to percolate into provide pipes. These geo-fabric also entraps suspended impurities present in water.

Pervious pavement results in more efficient land use by minimizing retention ponds, swales, and other stormwater management devices.

II. METHODOLOGY

A permeable pavement system drain outs the rain water up to 80-90 %. To control runoff water in rain, water should be percolated through pavement so there is need to provide pervious concrete as rigid pavement. But percolated water tens to settlement of pavement so it should not be get contacted with soil surface, hence there is provision of drain out pipes and impermeable fabric. Impermeable fabric separates the pavement system from ground surface. Drainout pipes collect water and directed to reservoir or ground water recharge pit.

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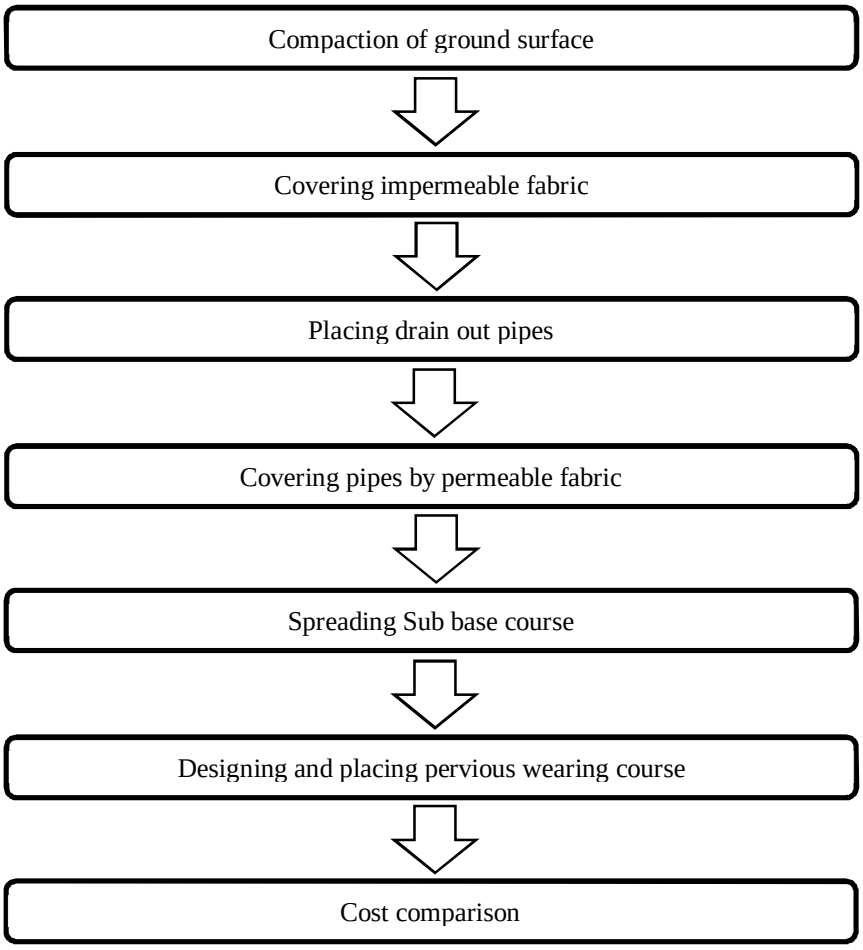

Fig. 1 Flowchart of methodology

III. IMPLEMENTATION

A. Compaction

Ground surfaces compacted with required shape by more than 15 tonnes roller. This shape provides the position to place drain out pipes. Slope provided to flow water towards pipes.

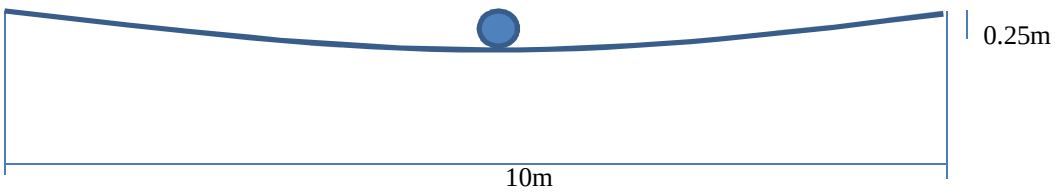

Fig. 2 Shape of ground after compaction

B. Impermeable Fabric

Fabric covered over entire ground where road to be constructed. So that settlement is prevented.

C. Sub-base Course

As regular construction of road boulders are placed on compacted ground and piped of required thickness.

D. Wearing Course

As per the ACI design procedure
Determination of Coarse Aggregate (Wa)
Dry-robbed density is 1450 Kg \m3
Wa = Dry rotted density\ (b/bo) = 1450 Kg/m3 x 1 = 1450 Kg (Dry weight)
Adjust to ssd Weight (wssd)
Wssd = Wa X water absorption on Aggregate. = 1450 Kg X 1.01 = 1465 Kg (ssd)
Determination of Cement Content (C)
C = {Vp/ (0.315 + water cement ratio)} x1000 = {(8.10/35.314)/ (0.31 +0.38)} X1000 =330 Kg
Determination of Water Content (W)
W = Cement x water cement ratio = 330Kg x 0.31 = 102.3 Kg
Determination Solid Volume (Vs)
Aggregate volume (Va) = Wssd/ (Specific gravity of coarse aggregate*1000) = 1477/ (2.75 x 1000) = 101.3 m3
Cement volume (Vc) = (c/Specific gravity of Cement)*1000 = (330/3.15) x 1000 = 0.1035 m3
Water volume (Vw) = (W/1000) = 102.3/1000 = 0.1019 m3
Total solid volume (Vs) = Va +Vc +Vw =0.537 + 0.104 + 0.102 =0.75
Determination of Percentage of Voids (Pv)
Percentage of voids (Pv) = (Vwt - Vs)/Vwt x 100 = (1 -0.743)/1 x 100 =25.8 %
Iterative Trail Batching and Testing
The trail batch weight per cubic meter as follows;
Cement =330 Kg
Water =101 kg
Coarse Aggregate =1465 kg
Test results

TABLE I
COMPRESSIVE STRENGTH

Cube size	3 days	7 days	14 days	28 days
150*150*150	6.4mpa	13.2mpa	18.6mpa	21.3mp=

IV. COST COMPARISON

10m length and 4m width is assumed
Concrete Area – 40 sq.m
Thickness – 0.15m

A. Conventional Pavement

TABLE II
COST OF MATERIAL FOR CONVENTIONAL PAVEMENT

No.	Material	Quantity	Rate	Amount
1	M30 concrete	6 cu.m	6362	38172
2	boulders	40 sq.m	210	8400
			total	46572/-

Cost of labours = 16789.72/-
Total cost = 63361.72/- for 40sq.m
Rate =1584 /- per sq.m

B. Pervious Pavement

TABLE II
COST OF MATERIAL FOR PERVIOUS PAVEMENT

No.	Material	Quantity	Rate	Amount
1	Cement	49bags	320	15680
2	Aggregate	7.45 cu.m	850	6332.5
3	Impermeable fabric	40 sq.m	32	1280
4	Permeable fabric	14m	15	210
5	Pipe	14m	165	2310
6	boulders	40 sq.m	210	8400
			Total	34212.5/-

Cost of labours =21789.72/-
Total =56002.22/-
Rate = 1400/- per sq.m

V. CONCLUSION

This paper discussed about detailed design and construction method of permeable pavement. Also discussed about cost of conventional and pervious pavement. Initial construction cost of pervious pavement is found to be 1400/- per sq.m which is more economical than that of conventional system by 184/- per sq.m. This pervious pavement systems are environmentally sustainable , economical and it is also changing the way development interacts with natural environment.

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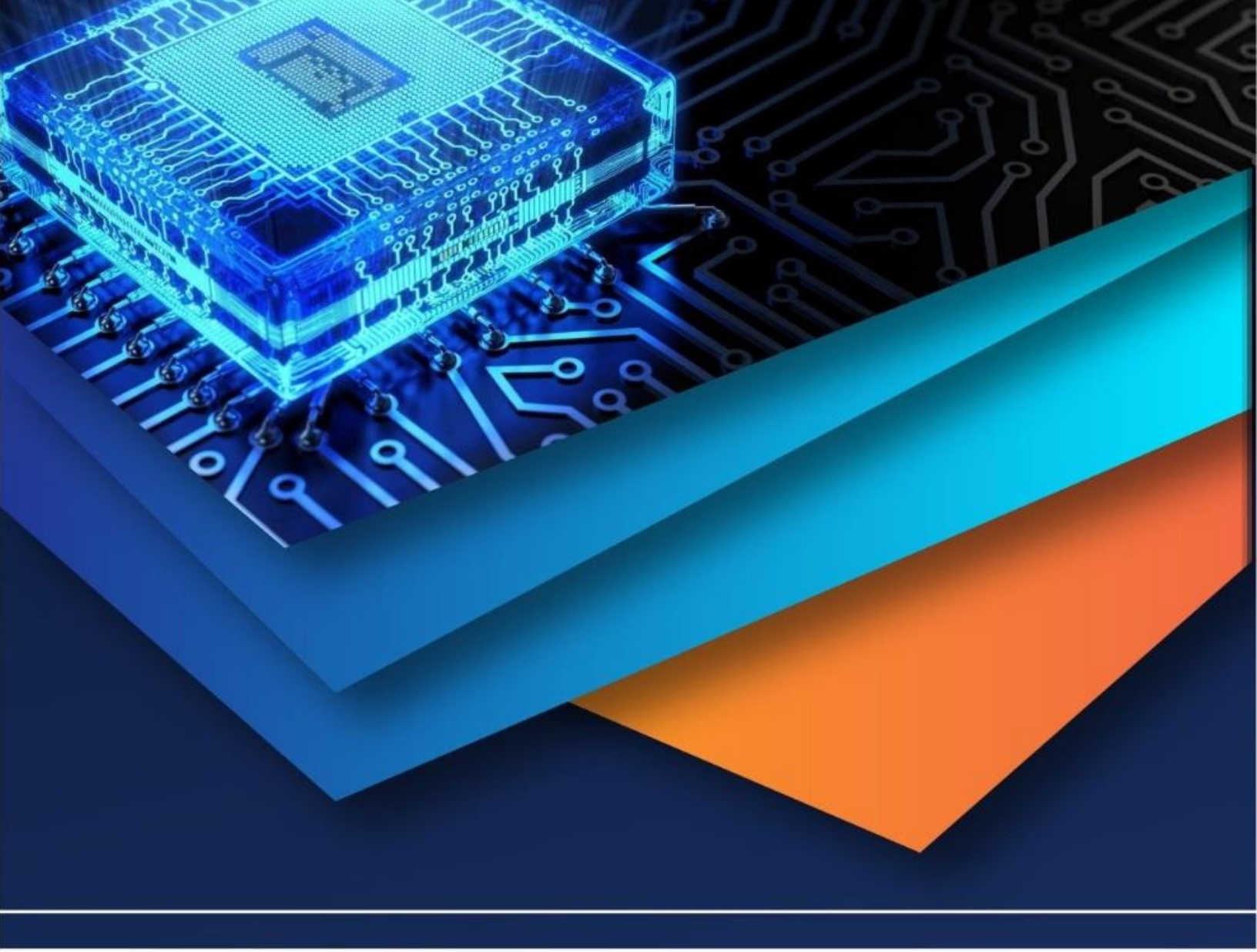

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