Study of Permeable Pavements

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Abstract- *The aim of this paper is to summarize literature on permeable pavements, highlight the present trends in research and industry, and to recommend future areas of research and development. Permeable paving is a range of sustainable materials and techniques for permeable pavements with a base and sub base that allow the movement of storm water through the surface. The goal is to regulate storm water at the source, reduce runoff, reduce cost and increase groundwater water level, thus a method to harvest storm water. Porous pavement is exclusive and effective means to meet growing environmental demands. By capturing rainwater and allowing it to seep into the ground, this pavement technology creates more efficient land use by eliminating the necessity for retention ponds, swell, and other costly storm water management devices.*

Keywords- Permeable pavement, Porous pavement, Sustainable material, Storm water management, Environmental benefits.

I. INTRODUCTION

The large impervious surfaces results in to higher peak stream flows which cause bank erosion, increased sediment transportation, reduction in infiltration which reduces groundwater recharge and lowers stream base flow. Runoff from impervious surfaces also increases pollutant quantity in surface flow. Permeable Pavement is that the best solution for increased storm water runoff and reduce stream water quality. Permeable pavements are an emerging technology constructed for low volume roads and parking lots a alternative storm water management technique or best management practice. Permeable pavement involves use of materials which have voids inside it and will help in infiltration of water thus allowing it store in the storage layer beneath and finding its use for irrigation purpose or for rain water harvesting. Due to the increased void ratio, water is conveyed through the surface and allowed to infiltrate, and evaporate, whereas conventional surfaces won't do so. A permeable pavement surface therefore plays an active part in the hydrological cycle as rainfall is conveyed back to ground in the form of infiltrating water and run-off. This system is not so widely used in India.. The water passes through the voids in the pavement materials and provides the structural support as conventional pavement. That's why permeable pavements can be served as an alternative to conventional road.

II. LITERATURE REVIEW

Permeable pavements are an alternative technology that differs from traditional pavement designs in that the structure allows fluids to pass freely through it, reducing or controlling the amount of runoff from the surrounding area. By allowing precipitation and runoff to flow through the structure, this pavement type functions as an additional storm water management technique accounting for recharging the ground water. The overall benefits of permeable pavements may include both environmental and safety benefits including improved storm water management, improved skid resistance, reduction of spray to drivers and pedestrians, as well as a potential for noise reduction.

III. METHODOLOGY

Permeable pavements are alternative paving surfaces that allow storm water to infiltrate into the ground thus reducing the problem of water accumulation in the areas.

3.1 Need of Permeable Pavements:

- To solve traffic jam due to problem of water logging in highly developed areas.
- Reduce the imbalance in natural ecosystem.
- By using Permeable pavement system, we can collect the rain water/ storm water by this system and store to ground water table or by construction a tank.
- Permeable pavement can reduce the concentration of some pollutants either physical (by trapping in pavement or soil), chemically (bacteria and other micro- organisms can breakdown and utilize some pollutants), or biologically (plants that grow in some type of pavement).

3.2 Types of Permeable Pavements:

Numerous types of permeable pavement are available. Pervious concrete is most common today, but porous asphalt, interlocking concrete pavers, concrete grid pavers, and plastic reinforced grids filled with either gravel or grass are also available. Other types and variations exist, but these are the foremost and versatile designs. The pavement type itself typically refers only to the surface layer of a structure consisting of multiple layers. To stop clogging, only cleaned, washed stone that meets municipal roadway standards should be used. Depending on design needs, perforated pipes are often added near the top of the stone reservoir to discharge excess storm water from large events. Also, rather than of allowing storm water to infiltrate into the underlying soil or where the permeability of the underlying soil is not optimal, perforated under drain pipes can be installed to route water to an outflow facility structure. It is recommended that an observation well to be installed at the down-gradient end of the permeable pavement to observe performance.

A. Porous Asphalt:

Porous asphalt is a standard asphalt mixture of both fine and coarse aggregate bound together by a bituminous binder except it uses less fine aggregate than conventional asphalt. The void space in porous asphalt is similar to the 15 to 35 percent of pervious concrete. The surface appearance of porous asphalt is similar to conventional asphalt, though porous asphalt has a rougher texture. The surface layer of asphalt is usually thinner than a comparable installation of pervious concrete. While the compressive strength of pervious concrete is usually less than that of conventional concrete, the compressive strength of porous asphalt is comparable to that of conventional asphalt. Porous asphalt can be used for pedestrian applications such as greenways and low volume, low speed vehicular traffic applications such as parking lots, curbside parking lanes on roads, and residential or side streets.

B. Pervious Concrete:

Pervious concrete is a mixture of Portland cement, coarse aggregate or gravel, and water. Unlike conventional concrete, pervious concrete contains a void content of 15 to 35 percent (average of 20 percent) that’s achieved by eliminating the finer particles like sand from the concrete mixture. This empty space allows water to infiltrate the underlying soil rather than either pooling on the surface or being discharged as runoff. Sidewalks and parking lots are ideal applications for pervious concrete. The structural strength of pervious concrete, although typically less than standard concrete mix designs, can easily withstand the relatively light loads generated by pedestrian and bicycle traffic. The loads placed on pervious concrete in parking lots can be far more substantial and need consideration when selecting the concrete mix and pavement thickness. While the structural strength of porous concrete can be increased by adding larger amounts of cement, the porosity will decrease, thus decreasing infiltration rates.

C. Pavers:

Permeable interlocking concrete pavers (PICP) and clay brick pavers (PICBP) also concrete grid pavers (CGP) are similar in installation and performance but are made up of different materials. PICPs are solid concrete blocks that fit together to make a pattern with small aggregate-filled spaces in between the pavers that allow storm water to infiltrate. These spaces typically account for 5% to 15% of the surface area. PICBP is as same as PICPs except the material is brick rather than concrete. With CGPs, large openings or apertures are created by the CGPs lattice-style configuration. These openings, which can account for 20% to 50% of the surface area, usually contain soil or grass, though small aggregates can be used. While CGPs have larger openings than PICPs and PICBPs, they’re not designed to be used with a stone reservoir but instead can be placed directly on the soil or an aggregate base. As such, the infiltration rate of PICPs and PICBPs is much higher than that of CGPs. Plastic turf reinforcing grids (PTRG) are made of interlocking plastic units with large open spaces. PTRG are generally used to add structural strength to topsoil and reduce compaction.

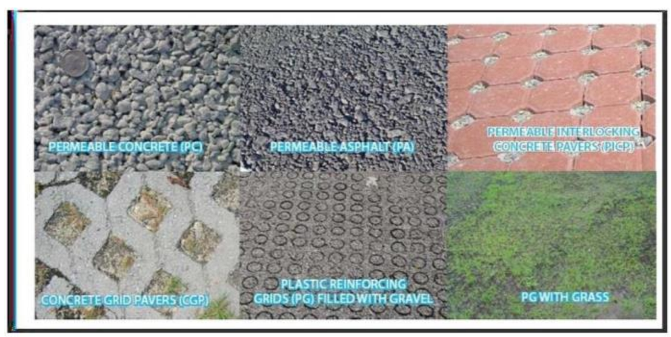

Fig. Types of Permeable Pavement

3.3 Life Span:

The life span of permeable pavement is mainly depends upon the size of air voids in the media. Due to more number of voids, there is more possibility of oxidation, so durability is less. It can be expected that the life span of permeable pavement is shorter than the impermeable pavements due to oxidation, subsequent stripping, and deterioration by runoff and air infiltration.

3.4 Advantages and Disadvantages:

A. Advantages:

- Rapid drainage of surface water.
- Reduction of traffic noise.
- Reduction of spray and therefore the improvement of skid resistance in wet weather.
- Reduction of road surface glare from oncoming headlights of vehicle.
- Improved fuel consumption because of the smooth ride qualities of the negatively textured surface.
- Reduction in tire wear due to reduced rolling resistance.

B. Disadvantages

- Reduced pavement strength. This leads to having to provide more support in the structural layers of the pavement. The reduced strength can also limit the application of the material to areas not susceptible to high stresses which could lead to aggregate fretting.
- Reduced pavement life in comparison with other materials due to the increased likelihood of binder oxidation caused by the voided nature of the material.
- Possible clogging of voids and drainage paths while under construction and also during the service life of the road.
- Increased maintenance costs incurred by many of the above factors and the fact that methods of repairing the pavement would be more complex than with other more traditional materials.

3.5 Applications:

Permeable pavement systems are suitable for wide variety of applications like commercial, residential, industrial, yet for light duty and fewer usage, even though this systems can be used for much wider range of usage. Following are some general applications of permeable pavement systems:

- For residential driveways, roadway shoulders, service and access driveways
- Parking areas
- Bicycle paths, Jogging paths
- Erosion control and slope stabilization
- Land irrigation
- Cart paths and Parking of Golf course
- Tennis Court

IV. CONCLUSION

This paper concludes that the Permeable pavement is a sound choice on economics alone. A permeable pavement surface costs approximately the same as conventional pavement. Because permeable pavement is designed to "fit into" the topography of a site, there is generally less earthwork. The underlying stone bed is usually more costlier than a conventional compacted sub-base, but this cost difference is offset by eliminating the detention basin and other components of storm water management systems. On projects where unit costs have been compared, the permeable pavement has been the less expensive option. Permeable pavements are therefore attractive on both environmental and economic grounds.

V. FUTURE SCOPE

Till date, the application of permeable pavement has been limited to some specific applications like parking lots, low volume roads. Future research may allow for new and innovative applications like village roads, airport runways. Permeable pavements generally have low strength but by increasing its strength and improving the properties it can be used for construction heavy traffic roads like urban roads, Highway Shoulders, etc. Generally in densely populated area less land space exists. So that roads are not properly arranged and also surface drainage facilities are not provided properly. So in rainy seasons the problems of water clogging arises. So For these areas permeable pavement can become a good option. In parks or gardens jogging tracks or walkways are mainly constructed of compacted soils. But in rainy seasons these roads becomes muddy which cannot be used for their intended purpose. This causes various problems to pedestrians. So for this type of situations permeable pavements can be proven advantageous.

REFERENCES

[1] Mansi Darji, Shraddha Bhatt, Aarohi Pattankar, Vaidehi Jain, "*Porous Pavement: Design and Cost Evaluation*", Interwoven: An Interdisciplinary Journal of Navrachana University Vol. 1, Issue 2, December 2017.

[2] Kolluru Hemanth Kumar, "*Review paper on permeable pavement systems*", 2014.

[3] Alok Ranjan, Anzar Alam, Deepak kr. Chaurasia, "*Permeable Pavements: New Technique For Construction of Road Pavements in India*", International Conference on New Horizons in Science, Engineering and Management and Humanities, 2018.

[4] Shital S. Shinde, Pratiksha Dhage, Shravani Doke, Vanmala Karande, Snehal Kale,"*Comparative Study of Permeable Pavement*", International Journal of Research in Engineering, Science and Management, 2019.

[5] Avishresth, Anush K Chandrappa, Prasanna Venkatesh Sampath, Krishna Prapoorna Biligiri, R K Jain," *Case*

Studies on the Construction of Pervious Concrete Pavements in India",2019.

[6] Vinayak Somawarad, Irfan sanni, Rashmi J.V., "*Use of Porous Asphalt for Pavement Construction*", International Research Journal of Engineering and Technology (IRJET), 2018.

[7] Mukul Nama, Akshay Galav, Amit Sharma, Jitendra Singh, Kapil Asoriya, "*Research on Permeable Pavement A Case Study of Sitapura Institutional Area, Jaipur*" , International Journal of Engineering Research & Technology (IJERT), 2016.