Water Absorbing Roads

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Abstract — Roads are the lifeline of our country as it is the most suitable method for all types of vehicles and are most used by common people. The development of any country largely depends on the efficiency of its transportation system, because the transportation of a chain of activities related to economic development. Human wants are satisfied by the production of goods and their distribution. It provides access to the airport, dock & harbor railway stations which are other modes of transport. It modes of transport. Total road length = 5,532,482 km in India including village roads. The road is ordinary types i.e. concrete roads, WBM roads, or bituminous roads. If we replace this road with a water-absorbing road (WAR) we can save a large quantity of water.

Keywords: Water Absorbing Roads (WAR), Bituminous Roads, Impervious Surface, Stormwater

I. INTRODUCTION

Water-absorbing roads: Porous pavement, or permeable pavement, is an engineered hard scaping surface that allows water to flow through it. This differs from traditional types of pavement, which are impermeable and convert most rainfall to runoff. There are three basic types of porous pavement, which are generally suitable as an alternative to the traditional impermeable surface:

1) Pervious concrete: Pervious concrete is similar to conventional concrete but manufactured without most or all of the sand to create voids allowing water to flow through the concrete and drain through the subgrade for filtration, groundwater recharge, and reduction in overall stormwater runoff, says Dan Huffman, vice president of national resources for the National Ready Mixed Concrete Association (NRMCA). Pervious concrete has been limited
2) Permeable Pavers: Pavers are solid concrete blocks that fit together to form a pattern with small aggregate-filled spaces in between the pavers that allow stormwater to infiltrate. These spaces typically account for 5 to 15 percent of the surface area. Various types of pavers are:
   - Permeable interlocking concrete pavers (PICP).
   - Permeable interlocking clay brick pavers (PICBP).
   - Concrete grid pavers (CGP).

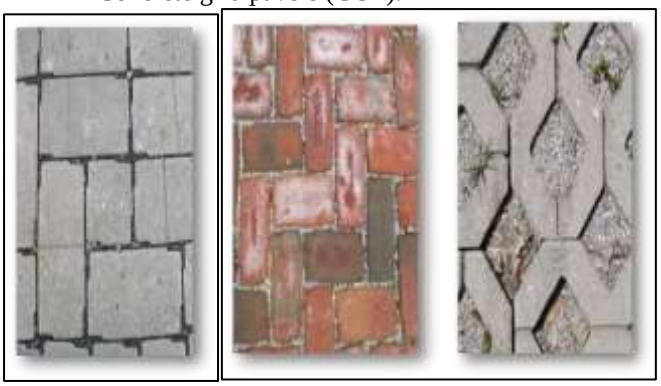

Fig. 1: Types of Permeable Pavers

II. PROBLEM STATEMENT

The road or the pavements are the essentials for the country's growth as they provide door-to-door service of goods and materials. The methods of construction of roads have mutated from one century to another. In traditional road construction, we have faced so many problems like surface water flooding, poor water quality, high maintenance

III. OBJECTIVES

There are numerous objectives associated with the use of WAR:

1) Volume Reduction & Flood Control: Because water flows through the porous pavement, the volume of runoff generated during a storm event is significantly decreased or eliminated and reduces the need for traditional stormwater infrastructure (piping, catch basins, stormwater ponds, curbing, etc.).
2) Water Quality: Pollutants are captured during infiltration, reducing pollutant load to local waterways. Infiltrated runoff recharges groundwater supplies, improves flow in streams, and reduces the need for landscaping irrigation.
3) Road Safety and Durability: Porous pavement increases skid resistance and traction on wet surfaces while also reducing the spray from passing vehicles and decreasing noise. Since water infiltrates rather than pools, black ice does not form and less road salting is needed. Pavement lifespan also increases.
4) Heat Island Effect Mitigation: Heat islands are developed areas that are hotter than surrounding rural areas. Traditional paving materials, which become hotter than vegetated surfaces, contribute to the heat island effect. In applications of porous pavement, the amount of heat released at night is reduced due to the limited transfer of heat to the subsurface layers.

IV. PREVIOUS RESEARCH

Karthik H. Obla (2010) Pervious Concrete: An Overview. Pervious concrete is a special high-porosity concrete used for flatwork applications that allows water from precipitation and other sources to pass through, thereby reducing the runoff from a site and recharging groundwater levels. Its void content ranges from 18 to 35% with compressive strengths of 400 to 4000 psi (28 to 281 kg/cm2). The infiltration rate of pervious concrete will fall into the range of 2 to 18 gallons per minute per square foot (80 to 720 litters per minute per square meter). Typically, pervious concrete has little or no fine aggregate and has just enough cementations paste to coat the coarse aggregate particles while preserving the interconnectivity of the voids.

R., Deekshitha and Kiran Raj Shetty: Challenges in Implementation of Porous Asphalt Concrete in Barmanna Layout, Nelamangala Bangalore Rural District.

The earlier record of 1606mm in 2005. Roads were inundated, all the vehicles were submerged and even found floating. The increased rainfall has led to 50% of accidents and potholes (Times of India, Oct 16 th 2017). Frequent road reconstruction has resulted in heavy traffic, potholes on the rods, and accidents as a result of poor road conditions. This asphalt pavement. A survey was conducted in Barmanna Layout and identified that poor road conditions were the most important problem. The data was collected through a survey and identified that about 57% of the respondents thought that poor road conditions have increased the accidents and number of potholes. For the identified problems porous asphalt pavement can be a solution that helps in overcoming these problems and a cost analysis of asphalt pavement was done. It was concluded that porous asphalt pavement can reduce accidents, potholes, and heavy traffic.

Lucas Niehuns Antunes, Enedir Ghisi and Liseane Padilha Thives (Nov. 2018): Permeable Pavements Life Cycle Assessment: A Literature Review.

The number of studies involving life cycle assessment has increased significantly in recent years. The life cycle assessment has been applied to assess the environmental performance of water infrastructures, including the environmental impacts associated with construction, maintenance, and disposal, mainly evaluating the amount of greenhouse gas emissions, as well as the consumption of energy and natural resources. The objective of this paper is to present an overview of permeable pavements and show studies of life cycle assessment that compare the environmental performance of permeable pavements with traditional drainage systems.

V. DESIGN PROCEDURE CONTENT

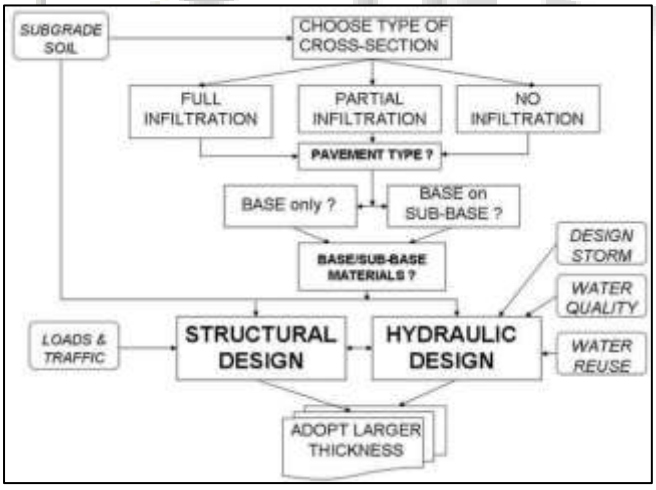

Fig. 2:

VI. MATERIALS

1) Cement 53 Grade OPC provides high strength and durability to the structure because of its optimum particle size distribution and superior crystallized structure. Being a high-strength cement, it provides numerous advantages wherever concrete for special high-strength applications is required, such as in the construction of skyscrapers, bridges, flyovers, chimneys, runways, concrete roads, and other heavy load-bearing structures.
2) Coarse Aggregate: Coarse aggregate was used as a primary ingredient in making the permeable concrete. Larger aggregates provide a rougher surface. Recent uses for previous concrete have focused on parking lots, low-traffic pavements, and pedestrian walkways. For these applications, the smallest sized aggregate feasible is used for aesthetic reasons. Coarse Aggregates are those that are retained on the sieve of mesh size 4.75 mm. Their upper size is generally around 7.5 mm. Gravels from river beds are the best coarse aggregates in the making of Common Concrete
3) Water: Water-to-cementations materials ratios between 0.34 and 0.40 are used routinely with proper inclusion of chemical admixtures, and those as high as 0.45 and 0.52 have been used successfully. The relation between strength and water-to-cementations materials ratio is not clear for pervious concrete because, unlike conventional concrete, the total paste content is less than the void content between the aggregates.
4) Admixture: Chemical admixtures are used in pervious concrete to obtain special properties, as in conventional concrete. Because of the rapid setting time associated with pervious concrete, retarders or hydration-stabilizing admixtures are used commonly. Here we used two different admixtures such as fly ash and conplast sp 500. Fly ash The burning of harder, older anthracite and bituminous coal typically produces Class F fly ash. This fly ash is pozzolonic in nature and contains less than 20% lime (CaO).

A. Permeable Pavers

Permeable interlocking concrete pavement, also referred to as PICP consists of solid concrete paving units with joints that create openings in the pavement surface when assembled into a pattern. (The USEPA has a fact sheet on PICP.) The joints are filled with permeable aggregates that allow water to freely enter the surface. The permeable surface allows units to be placed on a bedding layer of permeable aggregates which rests over a base and sub base of open-graded aggregates. The concrete pavers, bedding, and base layers are typically restrained by a concrete curb in vehicular applications. Permeable interlocking concrete pavers (PICP) and clay brick pavers (PICBP) as well as concrete grid pavers (CGP) are similar in installation and function but are made from different materials.

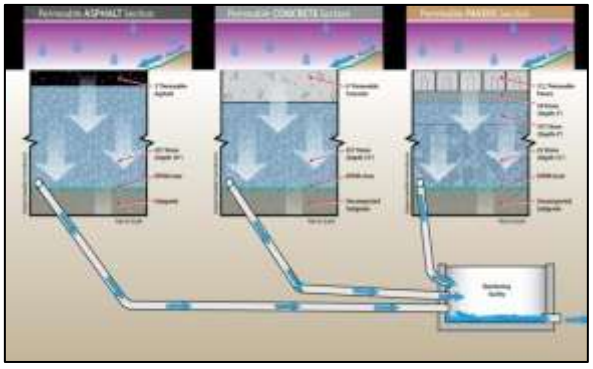

Fig. 3:

VII. ADVANTAGES AND LIMITATIONS

1) Durable

Once filled, permeable pavement is as durable as concrete or asphalt surfaces, and in many cases, even more durable. It can support heavy equipment such as wheel loaders, backhoes, forklifts, dump trucks, and 18-wheelers without a problem.

2) Sustainable

The permeable pavement grids are made from environmentally friendly recycled materials, which reduces the amount of waste in the system and reduces the energy required to acquire new materials. At the end of their lifespan, they can easily be recycled, further reducing their carbon footprint.

3) Eliminates Costly Drainage Systems

With a conventional asphalt or concrete surface, the parking area must be crowned and have a system of storm drains and pipes to control water during rain or flooding events. This can significantly add to the construction costs of the parking area, and if the system is connected to a municipal wastewater system, there may be extra costs and permits required to install the drainage system. Water-absorbing roads allow any water that accumulates to drain through the surface and into the ground. This helps to prevent flooding and allows any aquifers in the area to replenish naturally.

4) Low Cost

Asphalt and concrete can be expensive to install and require a large amount of labour. Permeable pavement is less expensive per square foot and is much less labour-intensive. The fill materials can be obtained from local sources, reducing transportation costs, and because the paving grids are made from lightweight plastic, the shipping costs are kept to a minimum.

5) Limitations

- Limited for use in heavy vehicles traffic areas.
- It requires specialized construction practices.
- Lack of standardize test methods.
- Clogging of voids thus affecting the purpose of pavement.
- Special attention possibly required with high groundwater.

VIII. MAINTENANCE:

The majority of previous concrete pavements function well in the void structure. Maintenance of previous concrete pavement consists primarily of removing this debris and residue from the void structure to rejuvenate some of its original permeability.

A. Routine Maintenance:

All porous surfaces require some maintenance to preserve permeability and service life. A minimum amount of planning and regular maintenance is more effective than surface rehabilitation or replacement. Surfaces should be vacuumed at least 2 times per year. More may be necessary based on site conditions. Well-maintained Regenerative Air Vacuum sweeping equipment is recommended. Operator experience and training on both equipment and porous surfaces is essential.

B. Rehabilitation, Repairs, and Replacement:

Small areas of clogging can be rehabilitated using a focused vacuum and water pressure. If in-situ rehabilitation is not successful the Storm Crete unit can be removed for additional rehab techniques (soaking, air or water pressure applied from the underside of the unit, light vibration/percussion, etc). In the event of widespread clogging, damage, or spill the unit can be removed and replaced in almost any weather, any time of the year.

C. Winter Maintenance:

Do their freely as it does on conventional impermeable pavements as readily as it does on conventional impermeable pavements during thaw-freeze cycles.

Fig. 4: Winter Maintenance

IX. CONCLUSION

This research looked at various studies conducted on water-absorbing roads and their current application. Also discussed about the detailed design of a permeable pavement system, permeable interlocking concrete pavement in brief. Maintenance and water quality control aspects relevant to the practitioner were outlined for permeable pavement systems. These water-absorbing roads are changing the way human development interacts with the natural environment.

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