Life Cycle Assessment of Pervious Pavements

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Abstract- *The life cycle assessment model is to construct to estimate the environmental implications of pavements using material, distribution, construction, usage, and finish of life modules. A case study of three cover systems, Portland cement concrete overlay, hot mixture asphalt,spread and crack, seat, and overlay, is presented. The case leads to the following conclusions. It is practical to expect less environmental burdens from the PCC and crack, seat, and overspread options as opposed to hot mixture asphalt while although the results have a high degree uncertainties. The material, clogging, and particularly usage modules handout most to energy utilization and air pollutant. Traffic related energy utilization and greenhouse gases are sensitive to traffic expansion and fuel economy betterment. Unpredictability exist in the usage module, especially for the pavement structure effect.*

Keywords- Portland cement, Traffic congestion fuel economy , greenhouse gases.

I. INTRODUCTION

The increase in the frequency of flooding in urban areas related to the increase of impermeable surfaces highlights the inadequacy of traditional urban drainage systems. Permeable pavements are pavements that concurrently support the needs of mechanical stresses and rolling conditions, whose structure allows the percolation and not permanent accumulation of water, reducing surface runoff without causing damage to their structure.

In this type of pavement, the structure is composed of a combination of layers, which are: pervious sub-base, pervious base, pervious bedding layer and pervious surface, dimensioned to resist traffic loading, share stresses on the subgrade and allow the straining of water. The base and sub-base of the pavement consist of open granulometry materials with aggregates that does not contain fines, or with a small amount of fines, resulting in a relatively large void ratio after compaction.

Permeable pavements can be represented with various types of permeable surfaces, such as porous asphalt, pervious concrete, and permeable interlocking concrete. Permeable pavements can be used as a replacement to conventional impervious rigid surfaces, such as roads, car parks, footpaths and pedestrian areas.

Purposes for using permeable pavement systems instead of using other pavement systems are mentioned as:

Promote storm water infiltration, groundwater recharge, and stream base flow preservation.

1. Reduce the discharge of storm water pollutants to surface waters.
2. Reduce storm water discharge volumes and rates.
3. Reduce the temperature of storm water discharges

PERMEABLE PAVEMENT can play a fundamental role in the majority of Sustainable Urban Drainage Systems designs, providing a practical, long-term answer to surface water flooding that can be implemented quickly and cost effectively.

II. METHODOLOGY

Materials Production Phase: Includes each step in the materials manufacturing process, from extraction of raw materials (e.g., limestone) to their

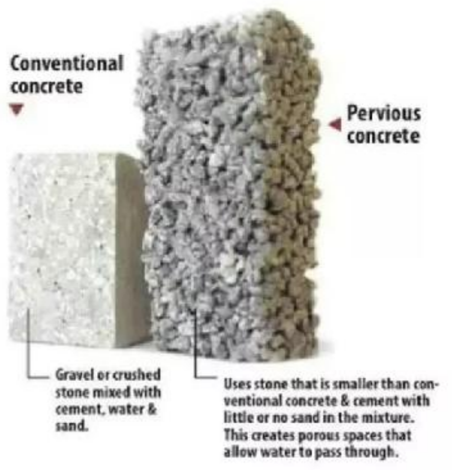

Fig 1. Conventional and pervious concrete .

transformation into a pavement input material (e.g., cement). Also includes any necessary transportation that occurs between facilities.

Construction Phase Processes: In construction phase process, method used in the placement of pavement materials at the project location. It includes onsite construction equipment and traffic delay caused by construction activities. Pavements associate with the environment through many pathways, including albedo, vehicle rolling resistance, carbonation, and lighting.

Maintenance Phase: The preservation, reformation, and reconstruction activities that occur during the life of a pavement. The maintenance phase usually involves its own materials, construction, and use phases.

End-of-Life Phase Depending on boundary conditions, the end-of-life phase can include demolition, disposal in a landfill, recycling processes, and/or other activities that occur when the pavement is taken out of service.

A pervious solution is typically built with 3 layers; “pervious bitumen mix” as the surface layer, followed by a pervious aggregate sub-base over undisturbed soil. The measurements and structure of

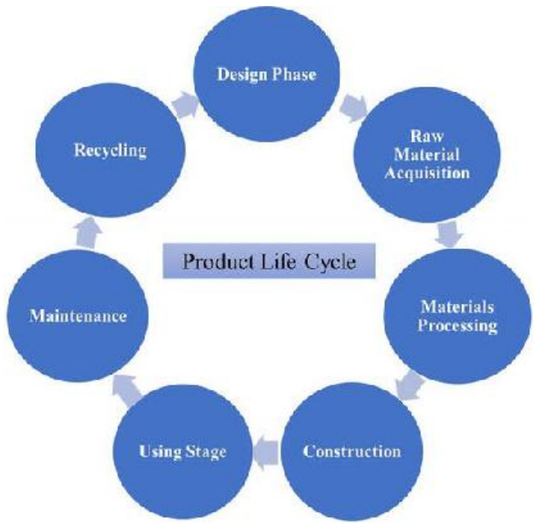

Fig 2. product life cycle flowchart.

each layer is dependent on application, preponderating site conditions and performance requirements.

Permeable bitumen mix allows surface water to freely seep through the wearing surface to the underlying ground (or drainage system) with the ability to act as a reservoir during periods of high downfall. During these times this characteristic can support in delaying the discharge of surface water into water courses or drainage systems reducing the risk of overwhelming systems and causing flash flooding. Collection of water in the system can also have a advantageous effect in reducing the heat island effect. During times of increasing temperatures and heavy rainfall, water collected within the system evaporates creating a cooling effect reducing surface temperatures.

III. LITERATURE REVIEW

1) STUDY OF PERVIOUS CONCRETE:

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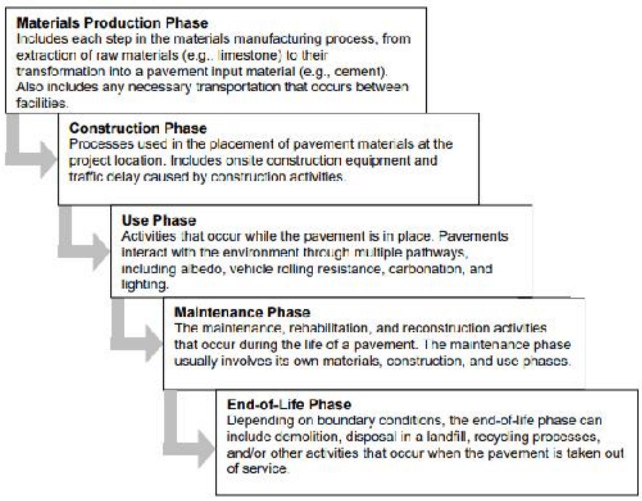
Pervious concrete is a very special type of concrete with high porosity used for flat work application basically that’s allow water from



precipitation and other sources to pass directly through thereby reducing the runoff from the site and allowing ground water recharge. And in this concrete porosity is attain by a highly interconnected void content. Also in permeable or pervious concrete has no fine aggregate and has just enough cementing paste to coarse aggregate particles while preserving the interconnectivity of the voids .permeable or pervious concrete is traditionally used in parking area with lo traffic ,walkways in park and garden residential , green house, basketball court , volleyball house.

2) ENVIRONMENTAL ASSESSMENT AND ECONOMIC ANALYSIS OF POROUS PAVEMENT AT

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This study aims to evaluate economic and environmental benefits of porous pavement surface using life-cycle cost analysis (LCCA) and life-cycle assessment (LCA). The research will focus on application of porous surface for sidewalk. The life-cycle inventory data were collected from literature search, online database, and project records. The comparison study was conducted between pervious paving systems and the conventional impermeable pavement with drainage system and Best Management Practices (BMPs) in storm water management. Three pavement alternatives are considered in this study, including conventional concrete, porous asphalt, and porous concrete. The study results can help quantify the environmental impacts and costs of using porous pavement surface at light traffic condition and select the sustainable pavement alternative.

3) PERMEABLE PAVEMENTS LIFE CYCLE ASSESSMENT: A LITERATURE REVIEW

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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. Although the studies found in the literature present an estimate of the sustainability of permeable pavements, the great heterogeneity in the evaluation methods and results is still notable. Therefore, it is necessary to homogenize the phases of goal and scope, inventory analysis, impact assessment and interpretation. It is also necessary to define the phases and processes of the evaluation, as well as the minimum amount of data to be considered in the modelling of life cycle assessment, in order to avoid heterogeneity in the functional units and other components. Thus, more consistent results will lead to a real evaluation of the environmental impacts caused by permeable pavements. Life cycle assessment studies are essential to guide planning and decision-making, leading to systems that consider increasing water resources and reducing natural disasters and environmental impacts.

4) EXPERIMENTAL INVESTIGATION ON STRENGTH AND DURABILITY CHARACTERISTICS OF CONCRETE BY PARTIAL REPLACEMENT OF COARSE AGGREGATE BY E-WASTE

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At present the demand of coarse mixture is accumulated day by day within the world. eighty five to ninetieth of electronic waste is disposed on landfills might drop in setting and affects human health conditions. For the recovery of terribly serious issue within the world to beat this speedy rising drawback is being questioned. Themanagement and employment of E plastic waste is chop-chop growing because it could be a valuable resource of IT industries and it's terribly unsafe substances and with low employment rate. the employment of e plastic waste materials could be a partial answer to environmental and ecological issues. because the use of E plastic waste can reduces the combination value and provides a decent strength for the structures and roads. it'll reduces the lowland value and it's energy saving. A close experimental study had been administered to investigate the strength properties of typical concrete by casting the cube specimen. The compressive strength test was conducted using casting cube of “150 x 150 x 150 mm” with various percentage of E-waste like 0%,10%,15%,20% and different strength characteristics are conducted in lab.

5) ROAD SIDE DRAINAGE SYSTEM AND DISASTER MANAGEMENT USING PERMEABLE CONCRETE:

Permeable concrete is a relatively a new concept for road pavements, with increase into the problems in rural and urban areas related to the low ground water level and agricultural livestock problems. Permeable concrete has introduced as a road pavement material. Permeable concrete is now being researched and being optimised to be used as a paving material due to its ability to allow water to flow through itself to recharge groundwater level and minimize storm water runoff and store the excessive water for further use. The invention and utilisation of permeable concrete as pavements showcases its applications and engineering properties, including environmental benefits, structural properties, and durability. In any area, cost consideration is the primary factor which must be kept in mind. Permeable concrete pavement is unique and effective means to meet growing environmental demands. By storing storm water and allowing it to percolate into the ground and collect the excessive water. This Smart Management System of storm water technology creates more efficient land use by eliminating the need for retention ponds, swell, and other costly management devices. The prototype showcases the smart management and working of the project and paper. An attempt to experiment the compressive strength of permeable concrete by varying quantity of sand is also made.

IV. CONCLUSION

In the Life cycle Assessment (LCA) comparison of different paving material of the initial construction phase, the results illustrate that mix designs of the pavement surface course greatly influence the LCA comparison results. Porous concrete pavement with slag cement requires less energy consumption than conventional concrete.

Preliminary results from this study indicate that porous pavement is not always environmentally preferable and less expensive when we use the life-cycle approach to quantify cost and environmental impact of energy consumption and GHG emission.

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