PAVESCAPE Concrete

for Low Volume Traffic Pavements

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Introduction

Due to the tremendous development in the infrastructure, major cities in India are getting covered with buildings and impermeable concrete. Concreting everywhere leads to environmental issues such as reduction in the recharge of rainwater into ground- hence constant fall of water table, formation of hot islands which makes the life at major cities miserable. The solution to minimize this problem is by installing pervious concrete pavements instead of impervious concrete or asphalt pavements for low volume traffic areas.

PAVESCAPE Concrete – Which is a modified pervious concrete developed at R&D Centre of AHLCON Engineering Services, is a special type of concrete obtained by a combination of specially formulated mixture of cement, water and open graded coarse aggregate. Typically, it has little to no fine aggregate content and has just enough cementitious paste to coat the aggregate particles while maintaining the interconnectivity of the voids. The void content in the pervious concrete is in the range of 15 to 22% compared to three to five percent in conventional concrete pavements. It has the ability to percolate the water underneath. It also reduces the runoff from paved areas, which reduce the need for separate drainage for storm water. PAVESCAPE concrete is highly suitable for warm weather climates and areas with native permeable subgrades.

PAVESCAPE concrete is also known as porous concrete, permeable concrete, gap-graded concrete, enhanced-porosity concrete, no-fines concrete and zero-fines concrete. While PAVESCAPE concrete can be used for a surprising number of applications, its primary use is in pavement construction. It is used mainly for low traffic areas such as parking lots, residential roads, driveways and footpaths.

The history of PAVESCAPE concrete dates back to 1852 in England with the construction of residential houses and it became considerably more widespread

during the material shortages after World War II, for cast in place load bearing walls of single & multistoried buildings. The use of PERVIOUS concrete in pavement applications had started in US and Japan since 1980s. Since then a lot of research has been done on pervious concretes in developed countries like US and Japan and it has been extensively used in field.

PAVESCAPE Concrete & Environment

The PAVESCAPE concrete pavement materials have voids (holes) that can cumulate heat. Such pavement can adjust the temperature and humidity of the earth surface thus eliminating the problem of hot islands in cities. It can absorb the noise of vehicles, thus creating a quiet and comfortable environment. In rainy days, the pervious pavement has no splash on the surface and does not glitter at night. This improves the comfort and safety of the drivers.

The key advantage of PAVESCAPE concrete is that it allows the surface water to enter the pavement structure quickly so that the ground water resources can renew on time. The relative high permeability provides for almost complete percolation of surface water into the pavement, with little to no resulting runoff from the paved surface. It improves the environment of road surface. PAVESCAPE concrete can also reduce the impact of development on trees. It allows the transfer of air and water to root system allowing trees to flourish even in highly developed areas.

It also saves construction materials like fine aggregates resulting in saving our natural resources. The quantity of cement can also be reduced, which results in less emission of CO_2 produced during cement production.

Applications of PAVESCAPE Concrete

Following are the areas where PAVESCAPE concrete can be successfully used:

1. Low volume pavements
2. Residential roads, alleys & driveways
3. Sidewalks & pathways
4. Parking areas
5. Low water crossings
6. Tennis courts
7. Slope stabilization
8. Well linings
9. Foundation/Floors for green houses, fish hatcheries, zoos, etc.
10. Pavement edge drain base
11. Noise barriers
12. Walls (including load-bearing)
13. Architectural & Sculpture objects
14. Landscaping

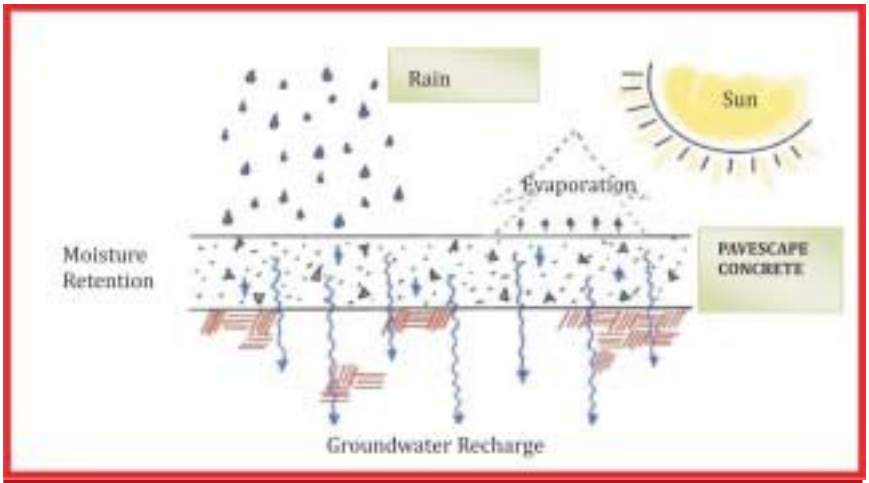

Figure 1: Pavescape Concrete for ground water recharge

Materials and Mixture Proportioning

The aggregate generally used in PAVESCAPE concrete applications usually ranges from 10mm to 20mm. The PAVESCAPE concrete specimens tested had aggregate-cement ratios varying from 6:1 to 10:1. Mix proportions of PAVESCAPE concrete depend on the final application. For pavement applications the concrete strength is more critical and aggregate-cement mixes as low as 4:1 is generally used.

The water content is imperative for the bonding to occur between the aggregate particles. A water-cement ratio higher than the optimum will not create an adequate bond between the cement paste and aggregate causing the cement paste to run off the aggregate particles. If the water-cement is lower than the optimum, the cement paste will not be sufficiently adhesive to bond the aggregate. The absorption rate of the aggregate will also affect the water content and this should be taken into account for design mixes.

The cement paste is only a thin layer and does not contain air bubbles, so the voids are obtained mostly through the interconnected spaces of the aggregate particles. The void content is dependent upon the aggregate-cement ratio and thus varies greatly. The air content of PAVESCAPE concrete ranges from 13 to 28 percent for aggregate-cement ratios between 4:1 and 6:1. Table-1 provides typical ranges of materials proportion in PAVESCAPE concrete.

The density of PAVESCAPE concrete is dependent upon the void content in the concrete. Due to the high air content it is a lightweight concrete with a density of about two-thirds of conventional concrete. The density of pervious concrete normally ranges between 1600 and 1900 kg/m^3. This is dependent upon

Table-1

Item	Proportions (Kg/cum)
Cementitious Materials	270 to 415
Aggregate	1190 to 1480
W/C ratio (by mass)	0.27 to 0.34
Aggregate cement Ratio (by mass)	4 to 4.5:1
Fine : Coarse aggregate ratio (by mass)	0 to 1:1

Table 2: Physical Properties

Agg/cement ratio	Water/cement ratio	Strength N/mm²	Density kg/m³
6	0.35	14	2020
7	0.40	12	1970
8	0.41	10	1940
10	0.45	7	1870

+ Extracted from A M Neville, Properties of Concrete, 4th ed. Longman, Essex, 1995

the shape, size and density of the aggregate, the aggregate-cement-water ratio and the compaction exerted on the concrete.

The strength of the PAVESCAPE concrete mainly depends on the properties of the cement paste and the interface between the paste and the aggregate. To improve the strength of the PAVESCAPE concrete, three components must be improved: strength of the paste, the paste thickness around the aggregate, and the interface between the aggregate and the paste. The compressive strength ranging from 3 to 28 MPa can be obtained on PAVESCAPE concrete, but strengths of 3 to 10 MPa are more common. Use of admixtures for improving bond which results into better strength, performance & durability. Table 2 indicates general properties of PAVESCAPE concrete.

The structure of the PAVESCAPE concrete is like a rice bubble bonded together to form a porous structure. The close look at the PAVESCAPE concrete is shown in the Figure 2.

Typical PAVESCAPE Concrete Pavement

A typical cross section of the PAVESCAPE pavement used in parking lots and lighter load Pathways/walkways consists of a pervious concrete layer with a thickness of 4 to 6 inches, (100 to 150 mm)a permeable base with a thickness upto 18 inches and a permeable subgrade. The details of the layers have been given below in Figure 3.

Figure 2: Closer View of PAVESCAPE concrete

Placing and Curing

PAVESCAPE concrete should be discharged as close as to its final position to avoid raveling and shoveling for a large distance. The concrete can be vibrated using a roller compactor or vibratory screeder. The use of mechanical vibrators and ramming is generally not recommended with PAVESCAPE concrete. A light rodding should be adequate and used to ensure that the concrete reaches all sections of the formwork. A steel roller can be used for compaction. Curing should be done and surface should be covered with polyethylene sheets immediately after placing of PAVESCAPE concrete, preferably within 20 minutes. Curing should be continued at least upto 7 days. Also, for situations where normal conditions are not achieved during placement and curing, the formwork should not be removed after 24 hours as with conventional concrete. PAVESCAPE concrete has very low cohesiveness and formwork should remain until the cement paste has hardened sufficiently to hold the aggregate particles together.

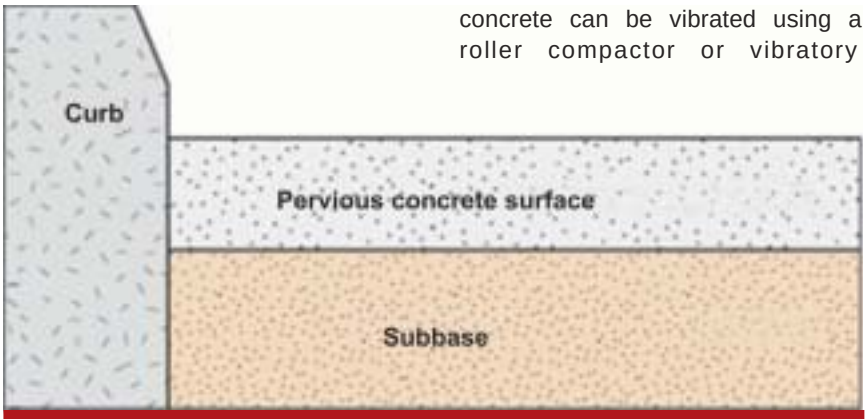

Figure 3: Typical pervious concrete pavement

Scope of Use of PAVESCAPE Concrete

In Indian cities, we are facing three serious problems:

1. Lowering of water table in most of the cities.
2. Flooding of areas during rains, virtually converting our roads/ Pathways/ Parking lots into lakes.
3. Paucity of good quality fine aggregates & increase in environment pollution due to CO_2 emission during cement production.

Use of PAVESCAPE concrete helps in minimizing all the above.

As a part of Infrastructure development activity, huge areas like pedestrian paths, school approaches, backyard pavements, are required to be constructed. By installing pervious concrete, their cost, construction time and environmental impacts can be greatly reduced.

Figure 4: Placing of PAVESCAPE Concrete

Figure 5: Compaction of PAVESCAPE Concrete

R&D work on PAVESCAPE Concrete at AHLCON Engineering Services (AES)

Extensive R&D work has been taken up by AES, which is a subsidiary of AHLCON Ready Mix Concrete (P) Limited. Trial mixes have been developed and their performance has been evaluated at AES laboratory. The aggregate cement ratio of the trail mixes has been kept around 6:1 and the w/c as 0.40. The specimens were demoulded at the end of 24 hours itself and cured in the curing tank, as well by water spray, like normal concrete. At the end of 7 days, compressive strength obtained was of 3 MPa to 5 MPa. Figure 6 shows the samples casted at AES laboratory, which is a NABL acredited Laboratory. The perviousness of the concrete has been tested by pouring water through the top of the sample. Figure 7 shows the PAVESCAPE concrete tested for its perviousness. To add to AES laboratory investigations, a parking lot has been constructed in AHLCON RMC plant to validate the results. The parking lot installed in AHLCON RMC plant is shown in Figure 8. Further research has been in progress to optimize the strength, void content and the durability of the PAVESCAPE concrete.

Availability of PAVESCAPE Concrete

Production of PAVESCAPE concrete at site may be a very difficult job as it needs a high level control during its production, tight water-cement ratio and accurate dosage of admixtures for ensuring strength & durability. The proper coating of cement slurry over each piece of aggregate can only generate proper bond between no fines matrix. This can only be achieved in RMC plants having special facilities for producing pavescape concrete which include selection of proper materials and good R&D back up, highly experienced and qualified manpower. PAVESCAPE concrete for different applications is available from AHLCON RMC, one of the largest producer of R.M. concrete in Delhi and NCR Region.

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Figure 6: PAVESCAPE concrete samples

Figure 7: Testing of perviousness of PAVESCAPE Concrete

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Figure 8: Parking lot at AHLCON RMC Plant

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